VICON NEXUS

BEYOND MOTION

VICON NEXUS REFERENCE GUIDE

WHAT'S INSIDE?

Revision 3. For use with Nexus 2.16

Email: support@vicon.com Web: http://www.vicon.com

About this guide

This guide contains information about Nexus functionality that is likely to be of interest if you are already familiar with the basic procedures described in the *Vicon Nexus User Guide*.

These chapters are included:

For instructions on configuring your Vicon system within Nexus and on the basic tasks that are part of the everyday Nexus workflow, see the *Vicon Nexus User Guide*.

About Vicon Nexus documentation

The following documentation is available for Nexus, both online and as PDFs that you can download from help.vicon.com[1]:

Document	Description
What's New in Vicon Nexus	Information about the main features that are new in the current version of Nexus.
Vicon Nexus Quick Start Guide for Blue Trident	Introductory information on connecting and using Vicon Blue Trident (IMU) sensors with Nexus (print/PDF only).
Installing and licensing Vicon Nexus	Step-by-step instructions installing and licensing Nexus.
Vicon Nexus User Guide	Information about how to use Nexus.
Vicon Nexus Reference Guide (this guide)	Descriptions of less frequently used or more complex procedures, background information, and further details about the Nexus user interface.
FLIR Video Cameras Setup Guide	Guidance on how to set up the cameras and other hardware needed to include FLIR video cameras in your Nexus system.
Creating labeling skeleton templates (VSTs)	Instructions on how to create your own custom labeling skeleton templates for use with Nexus.
Plug-in Gait Reference Guide	Detailed information on the Plug-in Gait model.

Regulatory information

For regulatory documentation relating to Vicon Nexus and your Vicon hardware, see the Vicon Regulatory Information[2].

1 http://help.vicon.com
2 https://help.vicon.com/space/regs

Data management with Nexus

The **Data Management** tab of the **Communications** window provides functionality for storing and managing all data associated with your motion capture files. Data is organized in a hierarchical structure, with data and information stored in relevant nodes.

For a video guide to database management, see the Vicon video, proEclipse: Preparing and managing your database[3].

The default location of **Data Management** is on a tab at the bottom of the **Communications** window. If you prefer, you can click the buttons at the top right of the **Communications** window to un-dock it and display it full-screen. To toggle the display of the Data Management tab, press F2.

> **Tip**
> You can also choose to hide the entire **Communications** pane, in which the **Data Management** tab appears, when you load a trial. To do this, on the **Window** menu, select the **Close Communications Pane on Trial Load** option. Alternatively, to temporarily hide/reveal the **Communications** pane, double-click any of its tabs.

By default, the last opened database is loaded when you restart Nexus.

3 https://www.youtube.com/watch?v=rZh-R7eHwcg&feature=youtu.be

Data management with Nexus

The following topics provide an introduction to data management with Nexus:

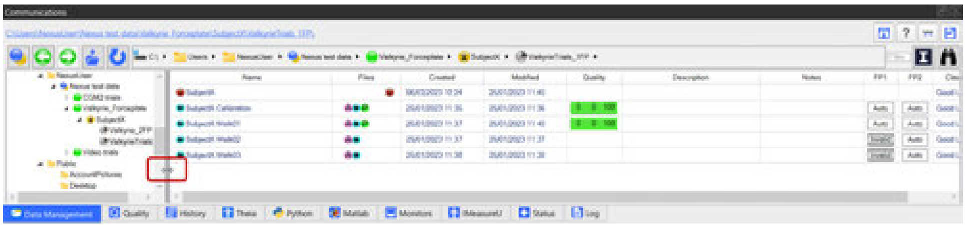
The **Data Management** tab also enables you to perform file transfers and transcoding of reference video files, as well as providing access to batch processing functionality. For information on these topics, see Work with digital video files in the *Vicon Nexus User Guide* and Batch process trials, page 19.

Navigate in Data Management

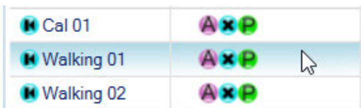
Navigation in Data Management (located in the **Communications** pane) is similar to that of the web or in Microsoft Windows. Forward, back and up controls are displayed and path navigation, similar to that in Windows Explorer is available.

The live path link at the top of the pane contains icons and arrows which, when clicked, give access to other folders at the selected level, and enable you to open Windows Explorer.

For faster navigation within a database or across a hard drive, you can also hide the tree view to expand panes.



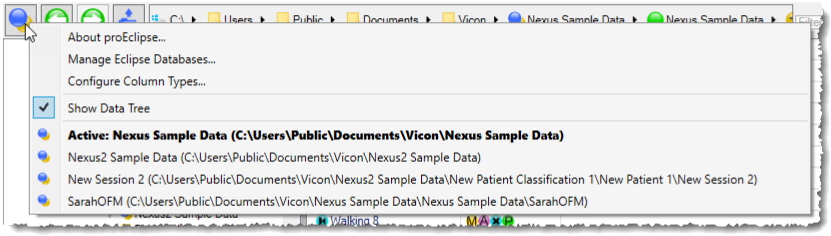
When you hover the mouse pointer over a trial row, it is highlighted in blue.



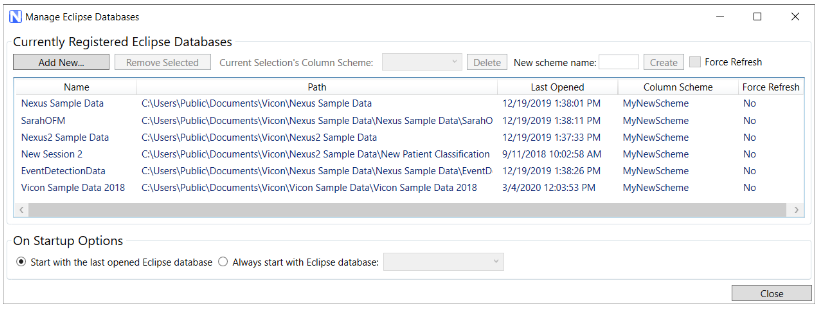
The currently selected node is highlighted in gray:

When you mark a node, it is highlighted in red:

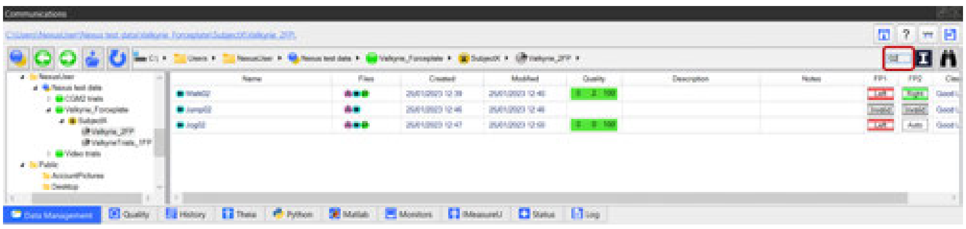
The **Show main proEclipse menu** button gives you instant access to the most recently used databases.



It also gives you access to the **Manage Eclipse Databases** dialog box, where you create, browse and register databases, and access other management options.



The quick search facility enables you to filter all the files that are visible in the current view by typing any letter into the **Filter** box.



Work with database hierarchy nodes

You view and manage the nodes created for the database hierarchy on the **Data Management** tab of the **Communications** window.

The data management function keeps all files associated with a Vicon motion capture trial together in a strict hierarchical order. The database hierarchy can contain up to four levels (**Database**, **Patient Classification**, **Patient**, and **Session**) to define the appropriate hierarchical structure for your motion capture trial as defined in the database template (.eni) file on which the database is based.

Each level (node) in the hierarchy has its own properties and can contain only certain types of data. The top-level node for the hierarchy has the same name as the database, with sub folders for each node. Sub-sessions and trials do not have their own folders but are sets of files within the session folder.

> Caution
> The hierarchy shown on the **Data Management** tab is mirrored in the folder system on your hard drive. Under no circumstances should you manually change these folders on your hard drive as this will prevent your database system from functioning correctly. Make any changes from within the **Data Management** tab in Nexus.

You can expand and contract the nodes in an database hierarchy as you would with standard file explorers. Additionally, you can identify a node for which you want to perform an action in the following ways:

- **Marked node** A marked node will be acted on by buttons selected from the **Data Management** toolbar.
  A marked node is highlighted with a red check mark across the node icon. Its row has a red background, unless it is also selected, when it is gray.
- **Selected node** A selected node will be acted on by commands selected from the context menu displayed when you right-click on the node.
  A selected node is highlighted with a gray background for its row.

After you have selected or marked a node, you can carry out the operations described below.

Manage database nodes

After you have created one or more nodes in a trial database, on the **Data Management** tab you can create, delete, rename, and move folders and files to meet your requirements.

You can manage database nodes using the mouse and/or the following commands from the context (right-click) menu:

- Open Patient/Session/Trial/Subject
- Rename
- Delete
- Create copy of Primary with tag
  This can be one of Labeled, Modeled, Filtered, or Backup.
- Mark
  When you mark one or more nodes, the **Show/hide marked nodes** button is displayed in the Data Management toolbar, enabling you to display only marked nodes on the Data Management tab.
- Clear All Marks
- Create Backup (Session node and below)
- Archive (Session node and above)
- Restore

For information about archiving, backup and restoring, see Archive and back up data, page 12.

About Data type icons

View and open the different data types saved for a motion capture trial using the Data Type icons on the **Data Management** tab.

The icons for the standard data types that can be associated with Vicon motion capture trials are shown here in the default order in which they appear from left to right in the **Files** column:

Icon	Data type	Description
	Movie File	Multimedia sound and moving picture data in *.mp4* or *.avi* format files
	Raw Analog Data	Unprocessed analog data (e.g., from force plates) in .x1d format files
	Model Parameter File	The model's parameters for Plug-in Gait or BodyLanguage models
	Centroid/ Grayscale File	Unprocessed Vicon video data from Vicon cameras in .x2d format files
	Processed Capture Data	Processed Vicon 3D motion data in .c3d format files

Archived nodes are displayed with a red cross over them, to indicate that they cannot be used until restored.

You may also see additional icons for file types of motion data created in earlier Vicon motion capture application software or exported for use in third-party applications (such as animation software or Excel spreadsheets).

Manage data files

View and manage the motion capture data saved to a trial database on the **Data Management** tab. The data files associated with a motion capture trial are indicated by data type icons in the **Files** column to the right of a node name in the database hierarchy.

To open a trial:

In the database hierarchy, double-click the node name.

Nexus opens the trial, and the reconstructed data (and the associated movie file if present) is displayed in the view pane.

To open a data file:
In the database hierarchy, click a node icon and in the context menu, click the required file name.

Nexus opens the specified data file, displays system and subject data in the appropriate **Resources** pane and displays the visual data in the current view pane.

To delete a data file:

In the database hierarchy, right-click the desired node name and on the context menu click **Delete** " *Filename* ".

The specified data file is deleted from the current database hierarchy, and the associated folders and files are deleted from your hard disk.

Archive and back up data

Archiving and creating backups enables you to save your data (optionally in compressed format), so that it can be restored when required.

Archiving (moving files to a specified location (optionally a .zip file) so that they can be restored when required) can be applied to the Session node and all nodes above it in the hierarchy. When you archive a node, data from the node and all nodes below it in the hierarchy are moved to the archive and can be restored to the same location when required. The archived node is indicated by a red cross over its icon . This is useful if you need to save space.

Creating a backup (creating a zipped copy of a node, but leaving the original node(s) in place) can be applied to all nodes in the hierarchy. When you back up a node, data from the node and all nodes below it in the hierarchy are copied to the backup (a .zip file) and can be restored to the same location when required.

This is useful if you want to share files with Vicon Support or with your colleagues.

Archive a node:

1. On the **Data Management** tab, in the pane on the right, right-click the required node.

2. On the context menu, click **Archive** and in the **Create Archive** dialog box:
   a. Enter or browse to the required location.

   b. Ensure that the**Options** line is as required.

   c. Click **Start/Stop**.

   The bar displays the progress of the archiving.

3. When all the files have been processed, click **Close**.
   The node is saved to the specified location, as a zip file if this option was selected in step 2.
   On the **Data Management** tab, the archived node is shown with a red cross over it and cannot be used until it is restored.

Restore an archived or backed up node:

1. In the **Data Management** hierarchy, locate the node that you want to restore and in the pane on the right, right-click the required node.
2. On the context menu, point to **Restore Backup** and then click the required file name.
3. In the **Restore Backup** dialog box:
   a. Ensure the path is as required, or enter or browse to the required location.
   b. Ensure that the **Archive Name** field displays the name of the required archive.
   c. Click **Start/Stop**.

   The bar displays the progress of the restoration.
4. When all the files have been processed, click **Close**.

Back up a node:

1. In the **Data Management** hierarchy, right-click the required node.
2. On the context menu, click **Create Backup**.
3. In the **Create Backup** dialog box:
   a. Ensure the path is as required, or enter or browse to the required location.
   b. Ensure that the**Options** line is as required.
   c. Click **Start/Stop**.

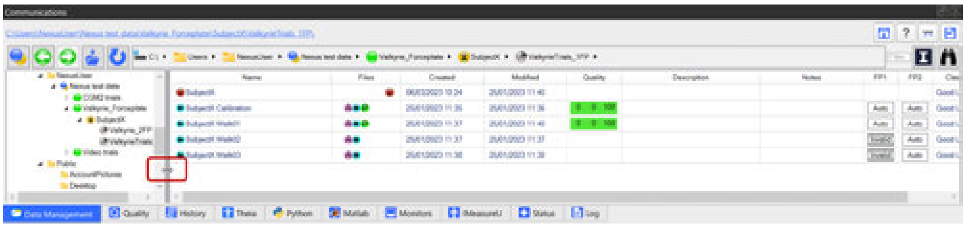
   The bar displays the progress of the backup.
4. When all the files have been processed, click **Close**.
   A .zip file containing the backup is saved to the specified location. This can be sent to Vicon Support or shared within your organization as required. The original node is unaffected.
   To restore a backup, follow the procedure in Restore an archived or backed up node, page 14.

Customize the Data Management display

You can customize databases from within Vicon Nexus to hide the tree view, and to display the required columns, to show specific, searchable metadata.

Drag to customize the display

To hide the tree view and expand the data pane, drag the splitter:



Add custom data fields

To add custom data fields to Data Management:

1. In Data Management, click Show main proEclipse menu .
2. Click Configure Column Types and under the Defined Column Types list, click Add Column Type.
3. Click ENTER LABEL and in the Edit Selected Column Type section, change the text in the Column Identifier, Header Text and Metadata Key fields as required (to display a tooltip, hover the mouse pointer over the relevant field).
4. Ensure that the correct option is chosen in the Column's base type field.

   Tip: In addition to adding custom data fields, you can change the available options for the existing field types. To do this, in the Defined Column Types list, click a field type to select it and in the Edit Fixed Values for Selected Column Type section, change the values as required.

5. Click OK at the bottom right of the dialog box to save the new column type(s).

Advanced data searching

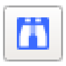
The advanced search in Data Management enables you to create custom search fields that will return trials (or other data levels) based on your chosen set of search criteria that exist in either the metadata (columns) or within the C3D files (variables). This is particularly useful if you are trying to find an individual trial or sets of trials for comparison purposes. You can:

- Search a single database or across multiple databases
- Search databases that exist on the local PC or across a network drive
- Use the wizard-based search building system
- Build complex search criteria for metadata or C3D information

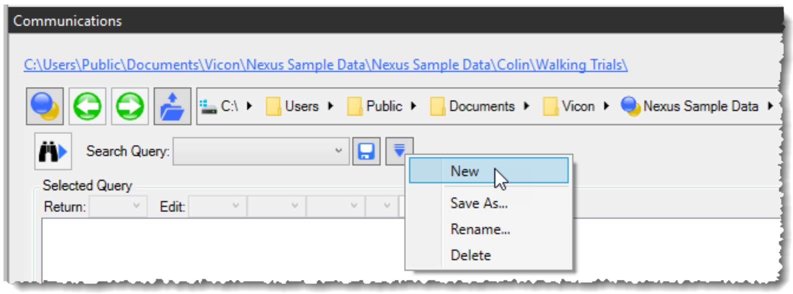
For example, searches you might set up could be:

- Find all trials where the subject BodyMass is greater than 75Kg, the Pathology is Osteoarthritis, the Affected Side is Left and the Maximum Knee Moment is greater than 715Nm; or
- Find all Subject Names where the Activity is Baseball Pitching, the Maximum Shoulder Angle Velocity is higher than 80 degrees per second and Trial Date is between Jan 1, 2013 and Today.

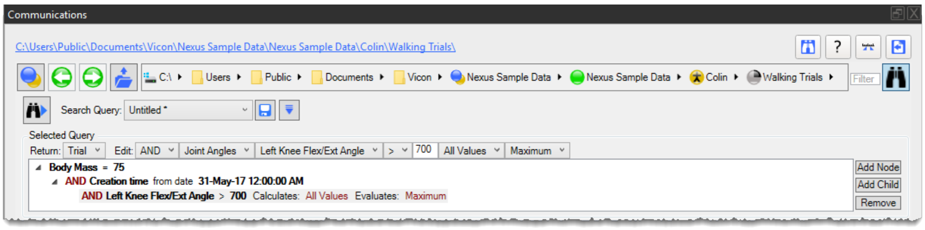
To use the search query wizard:

1. On the **Data Management** tab, make sure the required location is selected.
2. Click the **Search** button  (or click the **Toggle search interface** button .)

3. In the **Search Query** line, either select an existing search from the drop-down list, or to start a new search, click the **Configuration menu** button and then click **New**.



4. To specify a new search, in the **Selected Query** area, select the required options, working from left to right. To add further criteria to your search, click the **Add Node** button or **Add Child** button to the right of the pane.



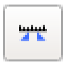
Note that the criteria available for selection change depending on the currently selected line.

5. To run the current search, click the **Execute Search** button at the left of the pane.
   The results of your search are displayed.
6. To save the search, click either the **Save** button or from the **Configuration menu** list, click **Save As**.
7. To close the search controls, in the toolbar at the top of the pane, click the **Search** button again (see Step 2).
   You can now:
   - Sort based on any of the returned data columns
   - Open any level of data by double-clicking on it
   - Export the data as ASCII to either Notepad or Excel
   - Export the data as a list of paths to either Notepad or Excel (for external processing)

Load large trials

To facilitate working with very large unprocessed data files, you can choose which files will be loaded (.x2d camera data and/or .x1d analog data), and how many frames of the trial are loaded.

To work with large trial data:

1. In the **Communications** window, at the top right of the **Data Management** tab, click **Show Trial Loading Options** .
2. To select only required frames, in the **Raw Data Loading Options** area, select **Load Frames From** and type the frame to start from in the first box and the end frame in the second box.
3. If required, choose whether to load both centroid/grayscale data (X2D) and raw analog data (X1D) files, or only one of these options.
4. Process the file(s) as normal.

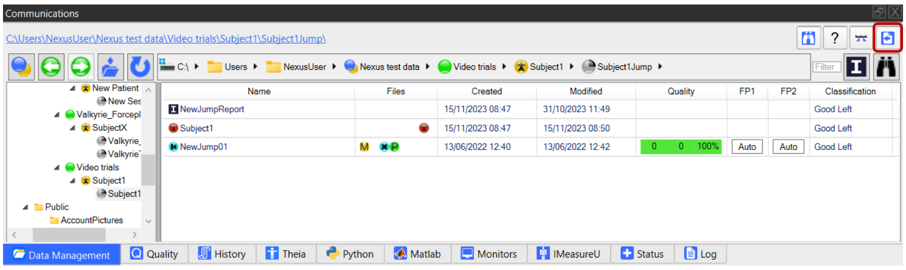
Only the selected range and files are processed.

Batch process trials

If necessary, for example, if you are working with large numbers of files, you can set up and run automated operations as batch processes, using the controls in the **Batch Processing interface** on the **Data Management** tab.

Batch process multiple trials

You can automatically process any number of trials from the current motion capture database using the **Show File Transfer/Batch Processing interface** button on the **Data Management** toolbar at the top of the **Data Management** tab.



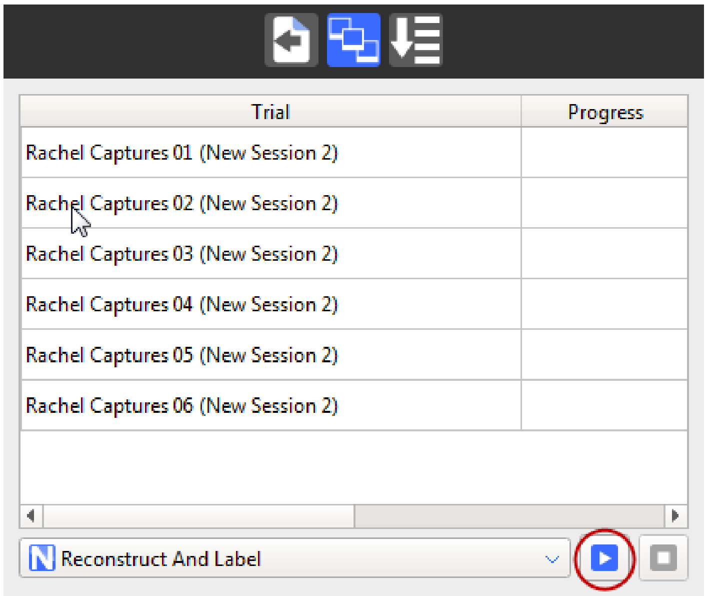
Batch processing is optional. It is useful for processing large numbers of files simultaneously or for automating frequently used processing operations.

> **Important**
> Before batch processing trial data, ensure that you have already:
> - Captured trial data
> - Created any pipelines you intend to run

To batch process trial data:

1. On the **Data Management** tab, mark the nodes (select nodes, right-click and click **Mark**) containing the files you wish to batch process.
2. If the **File Transfer/Batch Processing** interface is not already displayed, on the **Data Management** toolbar, click the **Show File Transfer/Batch Processing interface** button, and then click the **Batch Processing** button. The marked nodes are displayed in the list on the **Batch Processing** tab.

   Tip: To remove nodes from batch processing, on the **Data Management** tab, unmark the nodes (right-click marked nodes and click **Clear Marks**).
3. From the drop-down menu at the bottom right of the **Batch Processing** interface, select the pipeline to be run on the listed trial files and click the **Start Processing** button to start the batch process.



   When batch processing begins, an information window is displayed when a file is being imported for processing. It indicates the import status and contains buttons to Pause, Stop, or Cancel the import operation.

During the batch processing, the **Progress** column in the trials list indicates the overall status of the processing:

- Blank: Batch processing idle.
- Yellow moving bar: Batch processing in progress.
- Green static bar: Batch processing successfully completed.
- Red static bar: Batch processing failed or canceled.

Tip
Hover the mouse pointer over a progress bar to view details of the batch processing operations.

Labeling skeleton calibration in detail

The following topics will help you to choose the most appropriate type of labeling skeleton calibration for your particular trials.

Comparison of skeleton calibration operations

Subject-specific information is what enables a skeleton labeling template (VST) to be converted to a subject-specific labeling skeleton (VSK). All of the skeleton calibration operations make changes to the labeling skeleton, as can be seen inside the VSK file. For VST version 3 files, the attributes that are modified by at least one of the existing skeleton calibration operations are:

- **Parameters**. These control the pose of joints and the position of markers in the parent segment coordinate frame. A single parameter can be applied to both a segment and a marker or any combination of markers and segments. The calibration operations can change the value stored in the parameter.
- **Segments**. Bone lengths can be changed due to the parameters changing. The VST format doesn't have a concept of bone length. Bone lengths are inferred from the pose transformation between a pair of joints. This is made up of a pre- and a post-transformation. It is quite common for this transformation to have only one parameter that can be changed: this parameter is often named SomeBoneLength. The calibrated values are written to the VSK but are not reloaded on VSK import.
- **Joints**. Various attributes on the joint can be changed by the calibration operations. The mean, covariance, range-center and range can all be calculated from data.
- **Targets**. Target (marker) mean and covariance can be calculated from data.

Deciding which of the different skeleton calibration operations is best in your situation depends on a number of considerations including trial type, processing time, and desired labeling quality.

The following descriptions cover the various operations that use the same underlying skeleton calibration algorithm.

- Functional Skeleton Calibration operation, page 25
- Functional Skeleton Calibration - Markers Only operation, page 26
- Static Skeleton Calibration operation, page 27
- Static Skeleton Calibration - Markers Only operation, page 28
- Calculate Skeleton Joint & Marker Statistics operation, page 29

The operations change the following information in the skeleton:

Operation	Parameters	Segments	Joints statistics	Marker positions	Marker statistics
Functional Skeleton Calibration operation, page 25	Yes	Yes	Yes	Yes	Yes
Functional Skeleton Calibration - Markers Only operation, page 26	Yes	No	Yes	Yes	Yes
Static Skeleton Calibration operation, page 27	Yes	Yes	No	Yes	No
Static Skeleton Calibration - Markers Only operation, page 28	Yes	No	No	Yes	No
Calculate Skeleton Joint & Marker Statistics operation, page 29	No	No	Yes	No	Yes

For information on how to use the operations in common Nexus workflows, see Choose the appropriate subject calibration workflow, page 31.

Functional Skeleton Calibration operation

This operation is the most general of the skeleton calibration operations. It is used to fully calibrate a labeling skeleton from a trial in which the subject is moving. This is normally a ROM trial but can sometimes be a movement trial.

Functional Skeleton Calibration optimizes both joint and marker positions. It also calculates joint and marker statistics.

Ensure the trial covers the full range of motion that is expected in the movement trials.

Algorithm description

The Functional Skeleton Calibration operation runs two algorithms:

- The first optimizes the skeleton segment and marker parameters. This is done using a subset of the frames in the trial. These are chosen to get the subject in a variety of poses. The more frames that are considered, the better the skeleton will be, however, using more frames makes the calibration take longer.
  The calibration algorithm simultaneously tries to get the skeleton marker positions to be as close as possible to the corresponding labeled reconstructions. It does this by changing the joint angles, segment poses and marker positions. It considers only the selected frames, so selecting more frames gives the algorithm more poses to try to match. The algorithm minimizes a statistical distance measuring how close the skeleton markers are to the reconstructions. This distance accounts for the fact that some skeleton markers (with a larger covariance) are expected to be found a larger physical distance away from their reconstructions. The default parameters reset this covariance to the template covariance (in the VST). The motion that is allowed between segments is constrained by the joint type. Any joint type mis-modeling is not absorbed into the joint, but by either the segment or marker positions, where the effect has less impact. In sparse marker sets this is sometimes a necessary trade-off.

- The second algorithm calculates the joint and marker statistics (see Calculate Skeleton Joint & Marker Statistics operation, page 29).

Examples of using Functional Skeleton Calibration

- Generating a skeleton with the best quality labeling results. This is because the method provides a large amount of data for markers and joint movement.
- Creating a custom labeling skeleton template defined using the Labeling Template Builder.

For information on how to use this operation in common Nexus workflows, see Calibrate a labeling skeleton using a ROM trial in the *Vicon Nexus User Guide*.

Functional Skeleton Calibration - Markers Only operation

This operation calculates the skeleton's marker positions from a ROM trial. This operation is useful if the skeleton has already been scaled appropriately for the subject and more accurate marker position information is required. Any parameters that are shared between bones and markers are not altered. The operation finishes by calculating joint and marker statistics (see Calculate Skeleton Joint & Marker Statistics operation, page 29).

Algorithm description

The Functional Skeleton Calibration - Markers Only operation is very similar to the full Functional Skeleton Calibration algorithm (see Functional Skeleton Calibration operation, page 25). The only difference is that the parameters that refer to segments positions are kept constant. For this algorithm to provide good labeling results, the skeleton must already be the correct size. You can achieve this in the following ways:

- Scale the template skeleton to a reconstruction point cloud.
- Recalibrate a subject after adjusting its markers.

Compared with the full Functional Skeleton Calibration operation, the Markers Only version has an extra step at the beginning. In this step, the parameters that influence segment properties (bone lengths) are identified. These parameters are held constant during the operation. If a parameter refers to both a segment and a marker, it is also held constant. This reduction in parameters to estimate means that a Markers Only calibration tends to be faster than a full calibration.

The algorithm uses the same criteria as the full skeleton calibration to decide how to move the marker parameters and joint angles for each selected frame. It also runs the algorithm to calculate the joint and marker statistics.

Examples of using Functional Skeleton Calibration - Markers Only

Recalibration of an existing skeleton when the markers have moved, for example, when an orthosis has been applied. If the orthosis is expected to move significantly with respect to the underlying segment, this operation is more suitable than **Static Skeleton Calibration - Markers Only** because this operation updates the marker covariances as well as the marker positions.

Static Skeleton Calibration operation

Static Skeleton Calibration attempts to calibrate a skeleton from a single frame. It tries to optimize both joint and marker positions. The subject is usually in a T-pose for the entire trial.

Algorithm description

This operation calibrates the joint and marker positions from a single frame. It also tries to fit the skeleton joint angles. To do this, it runs the same algorithm as **Functional Skeleton Calibration** with only one frame selected. It is not normally advisable to run this operation on a general skeleton template because it is not possible to determine the joint centers without any motion. For this operation to succeed, every joint center must be defined by a linear combination of marker positions. As it is not possible to estimate the joint and marker statistics from a single frame, the subject statistics are left unchanged.

Static Skeleton Calibration - Markers Only operation

This operation calculates the skeleton's marker positions from a single frame. This operation is only useful if the skeleton has already been scaled appropriately for the subject.

Algorithm description

The **Static Skeleton Calibration - Markers Only** operation provides a quick way to update a skeleton's marker positions. It usually operates on a static trial in which the subject is in the T-pose. Sometimes it is run on a single frame from a full ROM as part of the **Auto Initialize Labeling** pipeline. **Static Skeleton Calibration - Markers Only** estimates both the joint angles and the marker positions for the selected frame. Before running this operation, the subject skeleton must be correctly scaled. This is usually done by scaling the subject, as is done by the **Auto Initialize Labeling** pipeline. You could also use a previously calibrated skeleton for the same subject.

As happens in **Functional Skeleton Calibration - Markers Only**, the parameters that refer to segments are identified and held constant by the operation. The calibration then optimizes the joint angles and marker positions for the frame selected. Optimizing the joint angles allows the subject to be in a pose that is different from the T-pose. This protects against the calibration from introducing marker position errors due to the subject being in a slightly incorrect base pose.

As with **Static Skeleton Calibration**, the joint and marker statistics are left unchanged.

Examples of using Static Skeleton Calibration - Markers Only

This operation is used for recalibration of an existing correctly scaled skeleton. It is part of the **Auto Initialize Labeling** pipeline and runs after the **Scale subject** operation. It can also be used to recalibrate markers if they have fallen off and been replaced.

Calculate Skeleton Joint & Marker Statistics operation

This operation calculates joint and marker statistics from either a movement trial or a ROM trial. Both the **Functional Skeleton Calibration** and the **Functional Skeleton Calibration - Markers Only** operations run this operation after calculating the skeleton parameters.

Algorithm description

This operation calculates joint and marker statistics for the subject. Joint and particularly marker statistics are used in the labeling algorithms. Joint statistics tell the labelers how much a particular joint is expected to move. Marker statistics give information about how much soft tissue motion is expected for the markers. Good marker statistics can improve labeling significantly.

This operation assumes that the skeleton has already been calibrated. It does not change any joint or marker positions. If it is run on an uncalibrated skeleton, the covariances and ranges calculated will be large.

For joints, this operation calculates values for: mean, covariance, range center, and range matrix. For markers, it calculates mean and covariance. The statistics are calculated from all of the frames in the trial.

The values stored in the mean and covariance are not calculated directly from the data. During a ROM trial the subject has only a few joints moving at a time, the rest are not moving much. If you plot the joint position samples over a trial you tend to see a large peak of samples and a few spread across the joint range.

In some cases, such as the knee, a mean and covariance calculated from the samples does a very bad job of representing the distribution. In the case of the knee, the majority of the samples are collected with the knee straight. This leads to a mean that is nearly straight and a covariance that suggests the knee can bend forward and backward equally well.

Instead of calculating the mean and covariance directly, a range and range center is calculated. This applies to both joints and markers. It is then assumed that the samples that really represent the distribution are uniformly distributed across the range. If you look in the VSK, you can see that joint means and joint range centers are the same.

Examples of using Calculate Skeleton Joint & Marker Statistics

Calculate Skeleton Joint & Marker Statistics can be used when a skeleton has been calibrated using a single frame but doesn't label well. This operation can be used on a movement trial to calculate better joint and marker statistics which will improve the labeling performance.

For information on how to use this operation in common Nexus workflows, see Choose the appropriate subject calibration workflow, page 31.

Choose the appropriate subject calibration workflow

Your choice of workflow depends upon the raw data you are able to collect and your desired outcome.

To use any of the operations, observe the following preconditions:

- A fully labeled trial (ROM, static, or movement) must exist.
- The trial must contain only raw reconstructions; leave any gaps unfilled. (Unlabeled reconstructions have no influence on the operations.)

The following table summarizes the workflow to follow for common labeling skeleton calibration scenarios:

In this scenario	Use this trial type	And this pipeline/operation
Simple movement (eg basic gait). Subject is unable to complete full ROM. Speed of subject setup takes precedence over labeling accuracy.	Single static frame (base pose used when VST was created)	**Reconstruct** pipeline **Auto Initialize Labeling** pipeline For step-by-step instructions, see Calibrate a labeling skeleton using a static trial in the *Vicon Nexus User Guide*.
Automatic labeling (eg **Auto Initialize Labeling**) or the **Labeling** operation alone does not produce satisfactory labeling. The movement during capture is not sufficiently similar to the static/ROM trial.	Movement (ie, same motion as that being studied) that includes static motorbike/base pose as the first frame.	**Reconstruct** pipeline **Auto Initialize Labeling** pipeline and manual labeling Calculate Skeleton Joint & Marker Statistics operation, page 29
Complex movement (sports movements, or multi-segment, high velocity movement, where segments or markers interact). Labeling accuracy is more important than speed of subject setup.	ROM, beginning in static auto-label pose **Note:** Because of its labeling quality, Vicon recommends that this method is used whenever possible.	**Reconstruct** pipeline **Auto Initialize Labeling** pipeline on static frame, then use it to label whole trial. Use **manual labeling** to correct any labeling errors for the whole trial. Functional Skeleton Calibration operation, page 25 on whole trial. For step-by-step instructions, see Calibrate a labeling skeleton using a ROM trial in the *Vicon Nexus User Guide*.
A marker has fallen off and been re-applied.	Single static frame (base pose used when VST was created)	**Reconstruct** pipeline **Label** pipeline (or use previously calibrated skeleton) with Static Skeleton Calibration - Markers Only operation, page 28 to recalibrate the marker that fell off.

For further details, see the recommended ways of working in the following workflow descriptions.

- Subject set up workflows, page 33
- Re-calibrate workflows, page 36

Subject set up workflows

The following workflows are the recommended ways of working when you are setting up a subject for labeling.

Auto Initialize Labeling pipeline

This is a recommended workflow for setting up a subject for labeling when you want to produce a labeling skeleton that can be used for trials that capture *simple* data, such as basic gait, non-ballistic/sports movements, or other movements that are not multi-segment, high velocity, or complex, where segments or markers tend to interact. This method uses less data (single static frame) than Functional Skeleton Calibration, and can be processed very quickly.

- Put markers on the subject and get them to perform a static trial.
- Reconstruct the trial and run the Auto Initialize Labeling pipeline.

The Auto Initialize Labeling pipeline consists of three operations:

- A T-pose label operation (Autolabel Static). This operation labels the trial for the following two operations to use.
- Subject scale (Scale Subject VSK). This operation takes the labeled reconstruction cloud and scales the template skeleton to be the same size. This enables you to use the same template skeleton for both children and adults.
- Static Skeleton Calibration - Markers Only. This operation finishes off the set up by moving the skeleton markers to the correct locations in the segment coordinate frames. This is to allow for the variable placement of the markers.

This workflow calibrates both the bone lengths and marker positions from a single frame. However, the calibration is split over two operations. Scaling the subject changes all of the bone lengths by the same factor. The marker-only calibration can then use the scaled skeleton to optimize the marker positions.

Auto Initialize Labeling pipeline with Calculate Statistics

The standard Auto Initialize Labeling workflow is useful in cases where the subject's ability to perform a full ROM trial might be limited or where total time of capture/calibration is paramount. In these types of capture scenarios, the Auto Initialize Labeling pipeline will often produce completely acceptable labeling. If less than ideal labeling performance is found, the addition of the **Calculate Skeleton Joint & Marker Statistics** operation can improve labeling.

To do this, you (semi-)manually label one of the movement trials and run a **Calculate Skeleton Joint & Marker Statistics** operation on it. This calculates the joint and marker statistics that represent the subject in that particular activity.

> **Important**
> Ensure that the trial contains no labeling errors, as any errors have the potential to significantly increase the estimated covariance of affected markers.

ROM trial subject set up

This workflow for setting up a subject provides more information (multi-frame, multi-joint range movements) to the Nexus subject calibrator and gives the best labeling performance in most scenarios. However, the increased amount of calibration data results in higher processing times than the simpler Static method (see Auto Initialize Labeling pipeline, page 33 above).

This workflow consists of the following steps:

1. The subject performs a range of motion trial in which they fully exercise all of their joints. It is recommended that the subject starts the ROM trial in the static autolabel pose, so that the Auto Initialize Labeling pipeline can be run on the first frame to generate a skeleton that can be used to help label the rest of the ROM trial.
2. After the trial has been captured you must reconstruct and label it. The recommended way of doing this is to run the Auto Initialize Labeling pipeline on a T-pose frame and use the skeleton generated by that operation to label the rest of the trial.
   Tip: If the trial is being labeled semi-automatically, scrub through the trial to make sure that all of the labels are correct. Incorrect labels degrade the quality of the calibration.
3. After you have labeled the trial, you run the Functional Skeleton Calibration operation. This calculates bone lengths, marker positions, and skeleton statistics.

Re-calibrate workflows

You may find yourself in a situation where a quick recalibration is preferable to performing a new full calibration. The following are two examples where a recalibration operation may be preferable to a full calibration.

Recalibrate for orthosis

Some capture sessions involve trials in which the subject is wearing an orthosis and others without. If the othosis is large or moving significantly with respect to the segment(s), the trials with the orthosis might not label well. In this case you might want a quicker calibration procedure than a full Functional Skeleton Calibration.

One way of achieving this is to capture a second ROM trial with the orthosis. Instead of running a full Functional Skeleton Calibration, you could run a Functional Skeleton Calibration - Markers Only operation to update the marker positions and the subject statistics for the trials using the orthosis.

Recalibrate after replacing a marker

Markers sometimes get knocked off the subject and need to be re-applied. In this case you can use a frame in which the marker has been re-applied to run a Static Skeleton Calibration - Markers Only operation to recalibrate the marker that had fallen off.

In this situation it is highly likely that the marker covariance will not need to be updated so you do not need to run a Functional Skeleton Calibration - Markers Only operation.

Using monitors

Monitors enable you to evaluate subject and device outputs, so that when a specified condition or event happens (eg, a leg is raised to a specified height or a knee exceeds a specified angle), one or more actions is triggered (eg, a sound is played). If required, you can configure multiple actions and multiple monitors.

You can use monitors in both Live and Offline modes. In Live mode, you can compare the current value against the thresholds. In Offline mode, you can tune a series of monitors against captured data before applying them to live data.

For more information, see:

- Create a monitor, page 38
- Configure a monitor, page 40
- Configure an AND or OR Monitor, page 47
- Activate and deactivate a monitor, page 49
- Reload a monitor, page 50
- Monitor configuration examples, page 51

For an example of creating monitor, see Create a joint range overlay monitor, page 125 (part of a biomechanics workflow).

> **Note**
> For information on running a monitor as part of a pipeline, see the Run Monitor option in System operations, page 342.

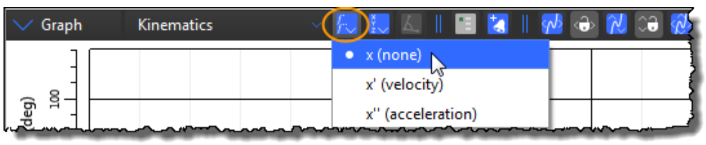
Create a monitor

Monitors enable you to specify conditions or events during motion capture sessions, and to interact with them. For example, you can create a monitor for a graphed model output (such as the subject raising an arm to a certain height, or the subject's left knee angle exceeding 180 degrees), and then configure it on the **Monitors** tab of the **Communications** window to trigger one or more actions (such as an event on the time bar or a tone sounding) when the model output matches a condition you specify.

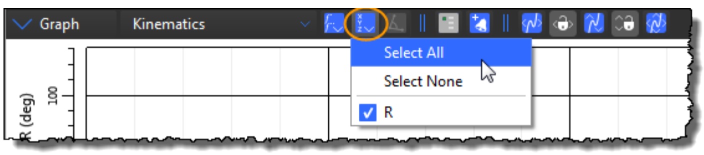
You create monitors in the **Graph** view. You can then configure the monitors in the **Monitors** tab of the **Communications** pane.

To create a monitor:

1. Decide on the elements you wish to monitor (trajectories, model outputs, devices, or joints).
2. In a Graph view, click the **Differentiate the graph button** and from the dropdown list, select either:
   - The current variable (x); or
   - Its first derivative, that is, its velocity or angular velocity (x'), or
   - Its second derivative, that is, its acceleration or angular acceleration (x") For example, a graph of a trajectory will have X, Y, and Z axes, but when differentiated to x' (velocity), the axes will change to X', Y', and Z' axes.

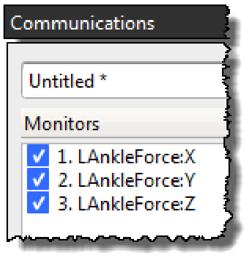
   

3. Click the **Choose the components** button and select the graph components that you want to plot in the **Graph** view (the options depend on your choice in the previous step).

4. On the Graph view toolbar, click the **Create a Monitor** button.

The monitor is added to the **Monitors** list in the **Monitors** communications pane. The monitor takes the name of the component you selected. For example, if the Graph view you've selected shows X, Y, and Z for the LeftAnkleForce, three monitors are created: LAnkleForce:X, LAnkleForce:Y, and LAnkleForce:Z.



Tip: If you select multiple components for your Graph view, a monitor is created for each component (e.g., x, y, z). You can select and remove one or more monitors that you don't need from the **Monitors** list, or click **Clear** to remove all of them.

You can now configure the monitor, for example to specify a monitor threshold and trigger conditions that will trigger an action.

Configure a monitor

After you have created a monitor for a motion capture event in the **Graph** view pane, you can configure the monitor in the **Monitors** tab of the **Communications** pane. You can change the monitor's default name, and configure it to be triggered upon a specified event or action.

To rename a monitor:

- In the **Monitors** list on the **Monitors** tab, double-click the name of the required monitor and type a new name.

To configure a monitor:

1. In the **Monitors** list on the **Monitors** tab, click the name of the required monitor to select it.
2. In the **Threshold** section on the right, specify the value and condition that will trigger the action (see Threshold and trigger descriptions, page 42).
3. To specify the action that will execute when the monitor threshold and trigger conditions are met, ensure the required monitor is selected and in the **Actions** area on the right of the **Monitors** tab, click **Add** and select the required action (see Action descriptions, page 43).
4. To configure multiple actions for the monitor, repeat steps 2 and 3.
5. In the Configuration Management area of the **Communications** pane, click **Save** to save the configured monitor, enter a name for the monitor configuration and select **Shared** or **Private**.
6. In the Configuration Management area of the View pane, click **Save** to save the **Graph** view that corresponds to the monitor you have configured, type a name for the **Graph** view configuration, and select **Shared** or **Private**.
   Tip: Whenever you want to view the graph related to the monitor, select it from the View pane list.

7. Test the monitor to ensure that the action occurs when the specified condition is met.

> **Important**
> Monitor actions function only in a forward time sequence. In other words, monitors will not activate when you manipulate the time bar ruler back and forth.

To configure multiple monitors, repeat steps 1–7 for each monitor.

Threshold and trigger descriptions

Property	Description	
Threshold Mode	Select the type of threshold:	
	Above Upper	Tracks a graph value above a specified range. You must also set the **Upper Threshold** value.
	Below Lower	Tracks a graph value below a specified range. You must also set the **Lower Threshold** value.
	Between	Tracks a graph value within a specified range (default). You must also enter the **Upper Threshold** and **Lower Threshold** values.
	Outside	Tracks a graph value outside a specified range. You must also enter the **Upper Threshold** and **Lower Threshold** values.
	Tip: The threshold range you specify is displayed as a shaded area with a dashed line in the Graph view.	
Condition	In the Trigger section, select the condition under which the threshold should activate:	
	On Enter	Monitor triggers upon entering the threshold range.
	On Exit	Monitor triggers upon exiting the threshold range.
	Within	Monitor triggers on every frame within the threshold range.
	Max Value on Exit	Monitor triggers upon exiting the threshold range, but the event is registered at the point of maximum value within the range. For example, if you set a **Timebar Event** with **Max Value on Exit**, the time bar event registers at the point of maximum value within the specified threshold range.
	Min Value on Exit	Monitor triggers upon exiting the threshold range, but the event is registered at the point of minimum value within the specified range.
	Always	

Action descriptions

Action	Description/Properties	
Capture	Captures the required data.	
	Start	Starts a capture.
	Stop	Stops a capture.
	Toggle	Switches to the opposite capture state, e.g., stops a capture that is in progress, or starts a capture if the previous state was stopped. Capture actions can only be performed in Live mode. If you want to create and test a capture action based on a representative trial, you can add a complementary **Timebar Event** to indicate that the condition was met. Then for the live test or real trial capture, turn off the monitor time bar action. **Tip:** In the Auto Capture settings of the Capture Tools pane, ensure the Arm button is enabled (pressed down) before triggering capture. You can also use other Auto Capture settings in conjunction with monitor events. For example, in addition to setting up a monitor event to trigger a capture, you can also set a pre-trigger capture time. To do this, set up the monitor to trigger the capture and also set a pre-trigger capture time so that the first frame captured is prior to the condition which triggers the capture.
External Trigger	Sends a trigger pulse to external equipment or software from the Sync Output ports on the back of the connectivity device.	
	Sync Port	Select which port you want to use to send the pulse (sends a trigger pulse from the **Sync Output** port of a Vicon Lock to an external piece of equipment or software). Affects all connected devices.
	Action	Choose from: • Toggle (between Low and High) • Go High (+4.3V) • Go Low (0V)
Timebar Event	Places an event on the time bar, which can be configured to include:	
	Subject Name	Enter the subject name.

Action	Description/Properties	
	Context	Select where to place a time bar event: • General: Places a marker on the **General** rule of the time bar ruler. • Left: Places a marker on the Left (e.g., left side of the body) rule of the time bar ruler. • Right: Places a marker on the Right (e.g., right side of the body) rule of the time bar ruler.
	Event Type	Select the type of user-defined event that will be specified on the time bar: • General: Indicates the point on the time bar at which the trial subject performs a user-defined event. • Foot Strike: Indicates the point on the time bar at which the trial subject's foot contacts the ground. • Foot Off: Indicates the point on the time bar at which the trial subject's foot leaves the ground.
	Clip	Select the clip: • Active: Sets the action to whichever state Nexus is in. Tip: Active has the same functionality as Offline if you are analyzing or processing an offline trial, and Live if you are currently in Live mode. This eliminates having to change this property when you switch between Live and Offline. • Live: Sets the action to occur on a live clip. • Offline: Sets the action to occur on a captured trial that has been loaded or a trial that is currently being captured.

<table>
<tr><th>Action</th><th colspan="2">Description/Properties</th></tr>
<tr><td></td><td>Frame</td><td>Select the frame:
Current: Sets the action for the currently selected frame in the clip.
First: Sets the action to the first frame in the time interval. For an offline clip, this would be frame 1. For a live clip, this would be the first frame of a 100-frame moving time window.
Last: Sets the action to the last frame in the current interval. For an offline clip, this would be the very last frame.
The Frame settings detect real time events that are written to the offline clip. During capture, the current Live frame is equivalent to the last Offline frame. If you set Clip to Offline and Frame to Last, you will have real time event detection during capture. If you configure this option, you will need to run a post-capture pipeline.</td></tr>
<tr><td></td><td>Frame Offset</td><td>Type a number in the field to indicate the number of frames of offset before adding the event.</td></tr>
<tr><td>Progress Bar</td><td colspan="2">Displays a progress bar. The progress bar reflects a normalized value within the boundaries of the threshold; that is, Vicon Nexus computes the upper and lower threshold values so that a given value within the range is represented as a progress bar percentage.
This action works best when the Monitor Threshold is set to Between, and is intended for a Trigger condition of Within. The Progress Bar will function when used On Enter, On Exit, etc., but will not provide meaningful results. For example, if you set the trigger condition to On Enter and the parameter enters the threshold region from below, then the progress bar value will remain near 0%.
If the parameter enters the threshold region from above, the progress bar value will remain around 100%.
Tip: The Progress Bar is divided into thirds, each designated by a color: Red for the lower third, yellow for the middle third, and green for the upper third.</td></tr>
<tr><td>Range Overlay</td><td colspan="2">Displays an overlay in the 3D Perspective view that provides an easy, visual way to verify whether a ROM trial has captured enough of the required movement to be likely to provide a good calibration of the subject. For more information, see Create a joint range overlay monitor.</td></tr>
<tr><td></td><td>Name</td><td>The title of the overlay</td></tr>
<tr><td></td><td>Zero (deg)</td><td>Type a value or move the slider to specify where zero appears on the dial</td></tr>
</table>

<table>
<tr><th>Action</th><th colspan="2">Description/Properties</th></tr>
<tr><td>Sound Tone</td><td colspan="2">Sounds a system tone based on the threshold range and trigger condition.
Sound Tone is recommended with the trigger conditions of Between and Within. The Sound Tone provides an audio alert in a similar fashion to the Progress Bar: If set to Between or Within, the sound pitch varies in proportion to the parameter's value within the threshold range.
Play Sound File (see below) is recommended with the trigger actions of On Enter or On Exit.</td></tr>
<tr><td rowspan="3">Toggle Monitor</td><td colspan="2">Changes the enabled state of the selected monitor to On, Off, or Toggle.
Important: Vicon Nexus adjusts the Monitor Index field if changing the number of Monitors in a configuration affects the Monitor Index. That is, if you configure multiple monitors and set Toggle Monitor events, deleting a monitor can change the Monitor Index field number.

Example (1):
You configure Monitor 1, Monitor 2, and Monitor 3.
You add a Toggle Monitor event to Monitor 2, with the Monitor Index set to 3 (meaning that Monitor 3 will toggle).
If you remove Monitor 1, Monitor 2's Monitor Index will change from 3 to 2 (Monitor 3 is now Monitor 2).

Example (2):
You configure Monitor 1, Monitor 2, and Monitor 3.
You add a Toggle Monitor to Monitor 2, with the Monitor Index set to 3.
If you delete Monitor 3, Monitor 2's Monitor Index will be blank (there is no longer any Monitor 3 to toggle).</td></tr>
<tr><td>Monitor Index</td><td>Type the number corresponding to the monitor in the Monitors List</td></tr>
<tr><td>Action</td><td>Sets the toggle state to On, Off, or Toggle.</td></tr>
<tr><td rowspan="2">Play Sound File</td><td colspan="2">Plays the sound file you specify.</td></tr>
<tr><td>Sound File</td><td>Click the Browse button to navigate to the relevant directory on your computer, then select a .wav file from the drop-down list.</td></tr>
</table>

Configure an AND or OR Monitor

In the **Communications** pane, on the **Monitors** tab, you can configure two special monitor types that run actions based on the conditions of a group of monitors. They are called AND or OR monitors, or Boolean monitors.

The monitors that make up a Boolean monitor are called children. The Boolean monitor bases its action on the status of the child monitors; that is, based on whether the child's thresholds and triggers are present. You can trigger an action based on a Boolean monitor's condition like you can for an individual monitor, but Boolean monitors operate in specific ways:

- Boolean AND monitor, page 48
- Boolean OR monitor, page 48

To configure an AND or OR monitor:

> **Important**
> This procedure assumes that you have already configured multiple monitors. For information on creating and configuring monitors, see Create a monitor, page 38 and Configure a monitor, page 40.

1. On the **Monitors** tab, in the **Monitors** list, select two or more monitors that will make up the AND or OR monitor.
2. Click the AND or OR button below the **Monitors** list.
   A new Boolean monitor appears in the list (Boolean AND or Boolean OR).
3. Highlight the monitor name and a list of the child monitors within the monitor appears.
   Tip: To change the child monitors included in the Boolean monitor, click in the Children field and type the monitor numbers, separated by commas.
4. Configure the monitor (see Configure a monitor, page 40).

Boolean AND monitor

If all the child monitors within a Boolean AND monitor meet the monitor configuration condition at the same time, then the Boolean AND monitor executes its configured action. In other words, if the condition of all the children is TRUE then the Boolean AND monitor condition is TRUE, and the Boolean AND monitor executes.

- Example: If in Child monitor1 the Left Knee Angle > 180 AND in Child monitor 2 the Right Knee Angle > 180, the Boolean AND monitor is true and the monitor action executes.

All the Boolean AND monitor children must meet the specified condition at the same time or the Boolean AND monitor condition is FALSE, and the Boolean AND monitor will not execute the action.

Boolean OR monitor

If at least one of the child monitors within a Boolean OR monitor meets the specified monitor configuration (threshold, trigger, and condition), then the Boolean OR monitor executes the specified action. In other words, the condition of at least one of children is TRUE, therefore the Boolean OR monitor condition is TRUE.

- Example: If in Child monitor 1 the Left Knee Angle > 180 OR in Child monitor 2 the Right Knee Angle > 180, the Boolean OR monitor is true and the monitor action executes.

When none of the Children meets the specified condition, the Boolean OR monitor's condition is FALSE and the Boolean OR monitor does not execute.

Activate and deactivate a monitor

After you configure a monitor (see Configure a monitor, page 40), you can activate or deactivate it.

To activate or deactivate a monitor:

- On the **Monitors** tab in the **Communications** pane, select or clear the check box for the required monitor.

Reload a monitor

You will need to reload your monitor if you do any of the following:

- Make changes to the monitor configuration; or
- Configure or use other monitors; or
- Switch between Live and Offline mode.

To reload a monitor:
For a monitor to take effect in Live mode:

- Reload the trial file on the **Data Management** tab.

For a monitor to take effect in Offline mode:

- Select **Refresh List** from the Configuration menu on the **Monitors** tab.

> Tip
> Because monitors can be set to toggle on and off, you may need to reload the monitor before processing a new trial.

Monitor configuration examples

You can configure monitors in a variety of ways.

For details, see the following examples of configuring monitors.

- Configure multiple actions on one monitor, page 51
- Configure multiple monitors, page 51
- Configure multiple actions on multiple monitors, page 52
- Configure Boolean monitors, page 53

Configure multiple actions on one monitor

A single monitor can perform multiple actions, such as to write a time bar event, display a progress bar, and sound a tone.

To configure a monitor with multiple actions that detects only the first occurrence of an event:

1. Configure a monitor to detect an event.
2. Add a **Timebar Event** action.
3. Add a **Toggle Monitor** action to toggle the monitor Off so that the **Timebar Event** is identified only the first time.

Configure multiple monitors

You can use multiple monitors to identify multiple events. Each event type, such as Foot Strike and Foot Off, would have its own monitor.

For example, you may want one monitor to look for the start of a particular body motion, which starts another monitor that evaluates whether the pelvic alignment is within the threshold range. If the pelvic alignment exceeds the threshold range, the second monitor could sound a tone to notify the operator, and activate a third monitor to evaluate the range of yet another element.

To configure multiple monitors:

1. Configure monitor 1 to detect the counter-motion of a jump (e.g., when the angular velocity of the knee exceeds a threshold).
2. Add a Capture action to the monitor to start a capture when this condition is met.
3. Add a Toggle Monitor action to toggle the monitor off so that the capture is initiated only once.
4. Configure monitor 2 to detect the maximum height of the sacrum for both the initial jump and the jump after landing on the force plate (Maximum Value on Exit).
   Add a **Timebar Event** action to the monitor.
5. Configure monitor 3 to detect landing on the force plate.
   Set the **Threshold Mode** to monitor the vertical force value (Fz) at the appropriate threshold (On Enter).
   Tip: Force plate monitor properties will depend on which force plate device is being used. Some force plates used with Vicon Nexus register a positive vertical force on contact (such as the AMTI), while others register a negative force on contact (such as Kistler).
6. Add a **Timebar Event** action.
7. Configure monitor 4 to detect takeoff from the force plate.
   Set the **Threshold Mode** to detect when the vertical force value (Fz) drops below a threshold (you can use the same trigger value as for Monitor 3, but you would set the condition to On Exit).

Configure multiple actions on multiple monitors

To configure multiple monitors, each with multiple actions:

1. Configure a primary monitor to trigger the detection of trial events (e.g., subject jumps onto a force plate and then jumps off).
2. Configure a series of monitors with **Timebar Event** actions (e.g., **Foot Strike** and **Foot Off**).
3. Clear each monitor's check box so that its initial state is Off.
4. Add a Toggle Monitor action to the primary monitor for each event monitor.
5. Set each Toggle Monitor to On. Once the primary monitor is triggered, the event monitors will turn On. The events are detected and written to the time bar.

> Tip
> The trial conditions could be such that a primary monitor isn't necessary to control the event detection monitors in Step 2. The value of the primary monitor is to make sure that the monitored parameters are in the proper state for appropriate event detections. This is a safeguard against identifying false events.

Configure Boolean monitors

You should carefully consider how you configure Boolean monitor thresholds and triggers to execute event actions.

If you use an AND monitor, it will mark an event only if the conditions of the child monitors occur at the same frame (an AND monitor event requires all child monitor parameters to be true). This seems obvious, but let's say you want to mark an event when parameter 1 is above one threshold and parameter 2 falls below another threshold. You'd be inclined to set:

- AND Child monitor 1:
  - Threshold Mode: Above Upper
  - Condition: On Enter
- AND Child monitor 2:
  - Threshold Mode: Below Lower
  - Condition: On Enter

However, configured this way, the AND monitor will mark the event only if the two parameters enter the respective threshold regions on the same frame, which is unlikely.

Unless you want this specific occurrence tracked, instead you would set:

- AND Child monitor 1:
  - Threshold Mode: Between
  - Condition: Within
- AND Child monitor 2:
  - Threshold Mode: Below Lower
  - Condition: On Enter

Configured in this way, when the parameter for Child monitor 1 is within its threshold, the action will execute the instant the parameter for Child monitor 2 falls below its threshold.

If you use an OR monitor, because the child monitor trigger conditions do not need to coincide (an OR monitor requires only one of the monitor parameters to be true), you can set:

- OR Child Monitor 1
  - Threshold: Above Upper
  - Trigger: On Enter
- OR Child Monitor 2
  - Threshold: Below Lower
  - Trigger: On Enter

Modeling with Vicon Nexus

Nexus 2 offers the following options for modeling:

- Plug-in Gait (and the Oxford Foot Model). If you are new to modeling with Nexus, this provides a good introduction: the Plug-in Gait model is supplied with Nexus and all the operations necessary to run the model are easily accessible and ready to use. For more information, see Modeling with Plug-in Gait in the *Vicon Nexus User Guide*.
- MATLAB. If you are familiar with MATLAB, you can use the supplied examples to create your own custom model. See Modeling with MATLAB, page 61.
- Python. If you are familiar with Python, you can use the supplied examples to create your own custom models. See Modeling with Python, page 72.
- CGM2. You can use the Conventional Gait Model 2 (CGM2) from within Nexus so that you can execute CGM2 models on your data. See Modeling with CGM2, page 83.

> **Note**
> For research and experimental purposes, a version of Plug-in Gait in open MATLAB script is available. For further details, contact Vicon Support[4].

4 mailto:support@vicon.com

About modeling terminology

For a clear understanding of the way modeling is represented in Nexus, bear in mind the following definitions:

- **Labeling** Any process, operation or algorithm that is used in Vicon Nexus to assign a label to a reconstruction
- **Modeling** Takes labeled reconstructions and uses these to perform calculations whose results are new variables.
- **Models** Files or operations that produce new calculations after labeling. Plug-in Gait and the Oxford Foot Model are models, as are MOD files built in BodyBuilder.
- **Subject** The representation in Nexus of a physical entity (eg a patient)
- **Labeling skeleton template (VST)**: Contains information and definitions related to labeling.
- **Labeling skeleton (VSK)** A subject that has a labeling skeleton template attached to it and subject-specific properties that are required for modeling (after labeling)

The following examples show the distinction between labeling and modeling:

- **Labeling** VSTs/VSKs, labeling skeleton calibration (labeling calibration)
- **Modeling** PlugInGait.MOD, scripts in Bodybuilder, PECS, MATLAB calculations

API functions for digital device data

Two functions, `GetDeviceChannelForFrame` and `GetDeviceChannelForFrameGlobal`, enable you to access digital device data that corresponds to optical measurements.

These functions are available in the the SDK for Python and MATLAB.

They address the issue that while the existing function `GetDeviceChannelAtFrame` provides the analog frame that contains the requested optical measurement (ie, the frame number in Nexus), for digital devices the analog frame may not align with the optical measurements. These functions return the analog samples that correspond to the optical frame requested.

Note that these functions are not available in the Datastream.

Example of using GetDeviceChannelForFrame

```
import ViconNexus
vicon = ViconNexus.ViconNexus()
# ... stuff to work out what IDs are available...

# demonstrate that the frame counters are different for the system and the
force plate (output results are different)
# demonstrate that frame length is different (different number of samples, 16
vs 10)
vicon.GetDeviceChannelAtFrame(10, 1, 1, 100)
# output ([-0.475459, 1.28333, 0.554047, -0.855607, -3.24367, -2.81851,
-1.16626, -0.394893, -2.00863, -3.02354, -2.41265, -0.732007, -0.266873,
-0.487017, -0.627091, 0.381795], True, 1000.0)
vicon.GetDeviceChannelForFrame(10, 1, 1, 100)
# output ([-2.00863, -3.02354, -2.41265, -0.732007, -0.266873, -0.487017,
-0.627091, 0.381795, 1.51932, 1.49286], True, 1000.0)

# demonstrate that the force plate has an initial sample offset
# (ForFrame initial sample is AtFrame's 11th sample at frame 1)
vicon.GetDeviceChannelAtFrame(10, 1, 1, 1)
# output ([0.18679, 0.174022, 0.191151, 0.301362, 0.0804058, -0.479919,
-1.002, -1.38398, -1.51135, -1.14212, -0.547826, -0.127377, -0.0933952,
-0.106104, -0.190911, -0.428488], True, 1000.0)
# compare this to the graphed value, initial sample here is the value at frame
1
vicon.GetDeviceChannelForFrame(10, 1, 1, 1)
# output ([-0.547826, -0.127377, -0.0933952, -0.106104, -0.190911, -0.428488,
-0.649677, -0.551753, -0.666456, -0.713149], True, 1000.0
```

Help on `GetDeviceChannelAtFrame`:

```
In[2]: import ViconNexus
In[3]: ViconNexus = ViconNexus.ViconNexus()
In[4]: help(ViconNexus.GetDeviceChannelAtFrame)
Help on method GetDeviceChannelAtFrame in module ViconNexus:

GetDeviceChannelAtFrame(self, deviceID, deviceOutputID, channelID, frame) method of ViconNexus.ViconNexus instance
    Retrieve a single frame of data
    from the channel identified by deviceID:deviceOutputID:channelID
    A device can have multiple device outputs and each device output
    can have multiple channels associated with it

    Devices can run at different rates than the trial data.
    Channel data could have multiple samples for each trial frame. All samples for a channel are output.
    Channel data list will be in the format:
      [sample1], [sample2], ... [sampleN]

    Input
      deviceID     = unsigned int, DeviceID of and existing device
      deviceOutputID  = unsigned int, DeviceOutputID of the device output you are interested in
      channelID    = unsigned int, ID of the channel
      frame      = integer value, trial frame number as displayed in the application time bar
    Returns
      channelData   = numerical(double) list, component data list for the frame of size samplesPerFrame
      ready      = logical, T/F indication as to whether or not the device output is in the ready state
                   if the device output is not in the ready state, there will not be any valid data
                   associated with this device output component
      rate       = double value, sample rate of the channel data

    Usage Example:
```

Help on `GetDeviceChannelForFrame`:

```
In[5]: help(ViconNexus.GetDeviceChannelForFrame)
Help on method GetDeviceChannelForFrame in module ViconNexus:

GetDeviceChannelForFrame(self, deviceID, deviceOutputID, channelID, frame) method of ViconNexus.ViconNexus instance
    Retrieve a single frame of data
    from the channel identified by deviceID:deviceOutputID:channelID
    This function will return data corresponding to the requested optical frame.
    A device can have multiple device outputs and each device output
    can have multiple channels associated with it

    Devices can run at different rates than the trial data.
    Channel data could have multiple samples for each trial frame. All samples for a channel are output.
    Channel data list will be in the format:
      [sample1], [sample2], ... [sampleN]

    Input
      deviceID     = unsigned int, DeviceID of and existing device
      deviceOutputID  = unsigned int, DeviceOutputID of the device output you are interested in
      channelID    = unsigned int, ID of the channel
      frame      = integer value, trial frame number as displayed in the application time bar
    Returns
      channelData   = numerical(double) list, component data list for the frame of size samplesPerFrame
      ready      = logical, T/F indication as to whether or not the device output is in the ready state
                   if the device output is not in the ready state, there will not be any valid data
                   associated with this device output component
      rate       = double value, sample rate of the channel data

    Usage Example:
```

Close trials using the SDK

You can use the SDK to close the current trial without saving. This functionality is available for both MATLAB and Python.

The function requires the following call:

```
vicon.CloseTrial(timeout)
```

`timeout` is in milliseconds and specifies the length of time during which the function tries to run.

Note that the command can only be used from an external application such as MATLAB or Python, and cannot be used in a script that is executed from within Nexus.

The following example uses Python:

```
import ViconNexus

vicon = ViconNexus.ViconNexus()
 subject = vicon.GetSubjectNames()
 vicon.CloseTrial(200)
```

Note that this call function is not listed by using `DisplayCommandList`. To display details about the call, use `vicon.DisplayCommandHelp('CloseDontSave')`.

Modeling with MATLAB

> **Important**
> Vicon Nexus 2 is supported with MATLAB 2013b and later. Nexus may function with other versions of MATLAB, but other versions have not been extensively tested by Vicon. To use MATLAB with Vicon Nexus 2, ensure that, in addition to installing MATLAB, you install .NET Framework version 4.5[5].

The MATLAB interface provides immediate feedback of scripting changes in the **3D Perspective** view.

For more information, see:

- Example of modeling with MATLAB, page 62
- Advanced MATLAB modeling, page 66
- MATLAB commands for use with Nexus, page 67
- MATLAB troubleshooting, page 69

5 https://www.microsoft.com/en-gb/download/details.aspx?id=30653

Example of modeling with MATLAB

> **Important**
> The example MATLAB scripts work on normal gait (that is, overground walking) such as the gait trials in the sample data that is provided, and not on other walking types. If your data includes walking types that are atypical (for example, is not overground walking or requires cropping), ensure you copy the scripts and modify them as needed before running them on your trial data.

The following example uses a supplied MATLAB script (*SimpleMidpoint.m*), which is installed with Nexus 2 in the following default folder:

C:\Program Files\Vicon\Nexus2.#\SDK\MATLAB\Examples

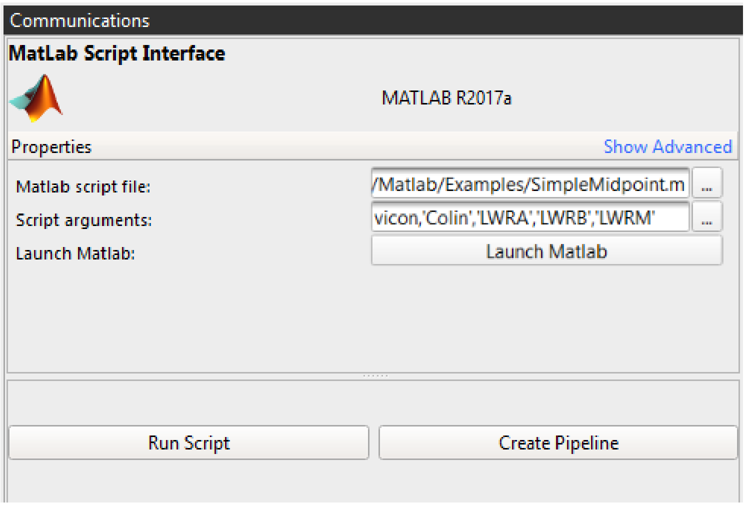
This example script creates a marker mid way between two existing markers in a loaded trial, so you must specify the subject, the two markers between which to create the midpoint, and the name of the midpoint marker that is to be created.

To execute a MATLAB script from within Vicon Nexus:

1. In Nexus, open the trial on which the script is to run.
2. In the **Communications** window, click on the **Matlab** tab.
3. In the **Matlab script** field, enter or browse to the folder that contains the required MATLAB script (**.m*).
4. In the **Script arguments** field, if your script requires arguments, provide a comma-separated list of arguments to be used by the script, surrounding each argument for the subject and marker names with single quotes. The syntax is:
   ```
   vicon, 'Subject Name', 'Marker1', 'Marker2', 'New Marker'
   ```
   For the following example, you would enter:
   ```
   vicon,'Colin','LWRA','LWRB','LWRM'
   ```

The supplied examples also show the required input and its format.

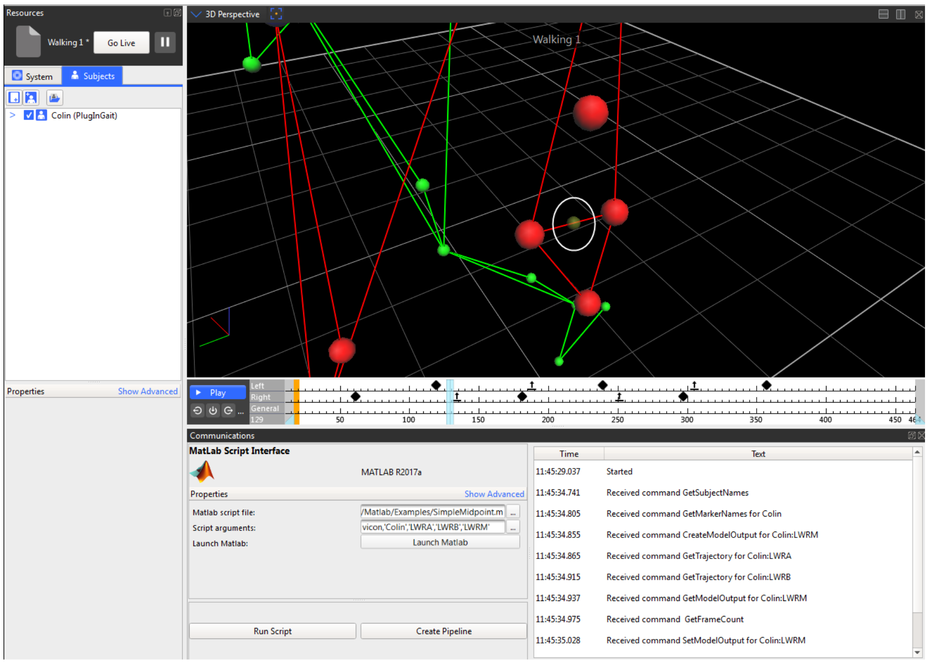
```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Vicon provide the software below "as is," and you use the software at your
% own risk. Vicon makes no warranties as to performance, merchantability,
% fitness for a particular purpose, or any other warranties whether expressed
% or implied. No oral or written communication from or information provided
% by Vicon shall create a warranty. Under no circumstances shall Vicon be
% liable for direct, indirect, special, incidental, or consequential damages
% resulting from the use, misuse, or inability to use this software, even if
% Vicon has been advised of the possibility of such damages.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

function SimpleMidpoint(vicon,subject,marker1,marker2,name)

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SimpleMidpoint will create a midpoint between 2 existing markers
% for a loaded subject. The midpoint marker is created as a Modeled Marker
%
% Input
%     vicon    = instance of a Vicon sdk object
%     subject  = name of the subject
%     marker1  = name of the first marker to be used to create the midpoint
%     marker2  = name of the second marker to be used to create the midpoint
%     name     = name of the midpoint modeled marker to create
%
% Usage Example:
%
%    vicon = ViconNexus();
%    SimpleMidpoint(vicon, 'Colin', 'RKNE', 'RANK', 'MyMidpoint');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```



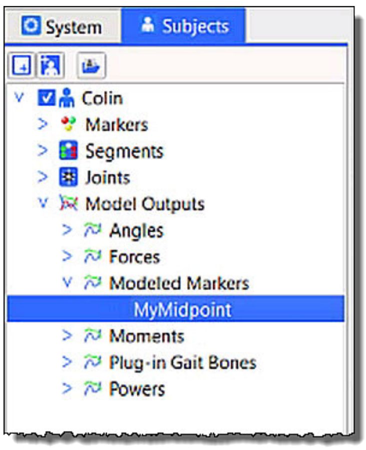
If your script does not require any arguments, leave the **Script arguments** field blank.

5. If you want to launch MATLAB and display your script, click the **Launch Matlab** button.

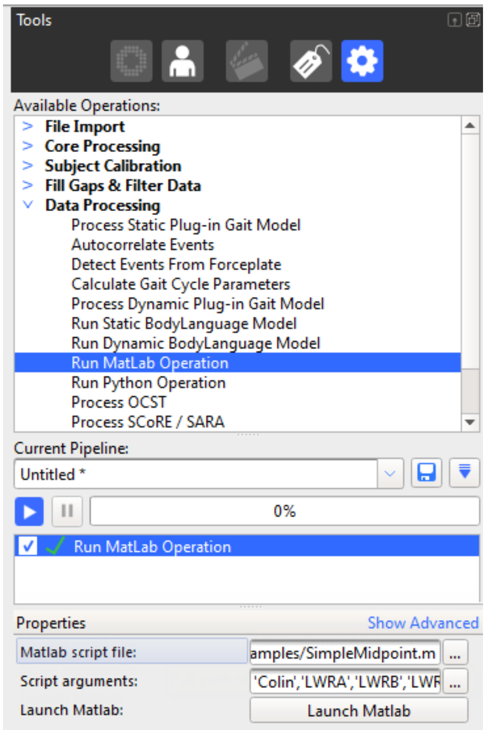
6. Click **Run Script**.
   Information, such as a time stamp and text describing the processing, together with any error messages, is displayed on the **Matlab** tab. Relevant information is also displayed in the **Log** pane.
   The modeled marker (in this case, the midpoint marker, LWRM) is created, and can be seen in the **3D Perspective** view.



On the **Subjects Resources** pane, additional outputs are displayed under a newly created **Modeled Markers** node of the resources tree. In the following example, the new marker is called **MyMidpoint**.



7. Display a **Graph** view of the new marker to see that a trajectory for the new marker has been created for the whole trial.
8. If necessary, you can change your script in MATLAB and, to check that it has the desired result, run it again from either MATLAB or by clicking **Run Script** again.
9. When you have finished refining your script, to include it in a pipeline, click **Create Pipeline**, which copies the information you have supplied to a **Data Processing** pipeline operation, **Run Matlab Operation** in the **Pipeline** tools pane. The required inputs are displayed in the **Properties** pane.



Advanced MATLAB modeling

From Nexus 2.2 and later releases, to simplify biomechanical modeling, additional MATLAB scripts are available in the Nexus SDK.

Classes that represent trajectories (read from Nexus or created as modeled markers), body segments, and angle outputs have been included to ease modeling of biomechanics based on Nexus data.

Sample functions include:

Calculating the angles between two segments

```
% Calculate the angle between two segments.
% Can choose euler, fixed or helical angle.
% Specify order of output angles for fixed and euler.

  LKneeAnglesEulerML = AngleBetween( LThigh, LShank, 'euler', 'yxz' );
  LKneeAnglesEulerML.Create( vicon );
  LKneeAnglesEulerML.Write( vicon );
  LKneeAnglesFixedML = AngleBetween( LThigh, LShank, 'fixed' );
  LKneeAnglesFixedML.Create( vicon );
  LKneeAnglesFixedML.Write( vicon );
  LKneeAnglesHelicalML = AngleBetween( LThigh, LShank, 'helical' );
  LKneeAnglesHelicalML.Create( vicon );
  LKneeAnglesHelicalML.Write( vicon )
```

Creating modeled markers based on existing trajectory data

```
% Create a trajectory from the segment origin
%
  LThighPosML = NexusTrajectory( 'Colin' );
  LThighPosML.SetPosition( LThigh.Position() );
  LThighPosML.Create( vicon );
  LThighPosML.Write( vicon );
```

Translating points in the coordinate system of existing segments

```
% Create a global trajectory that is offset by (100,0,0) in the
% segment coordinate system
  Offset = NexusTrajectory('Colin');
  Offset.SetPosition( [100;0;0] );
  TestTranslateML = LKNE + Offset*LThigh - LThigh.Position();
  TestTranslateML = LThigh.TranslatePointInSegment( LKNE, [100; 0; 0 ] );
  TestTranslateML.Create( vicon );
  TestTranslateML.Write( vicon );
```

MATLAB commands for use with Nexus

The following information is provided to help you to get started using MATLAB for modeling with Vicon Nexus 2.

Display all Nexus MATLAB SDK commands

At the MATLAB command prompt, enter:

```
methods ViconNexus
```

A list of all Nexus MATLAB SDK commands is displayed:

```
Command Window
>> methods ViconNexus

Methods for class ViconNexus:

ClearAllEvents           GetDeviceChannelAtFrame          GetFrameRate             GetSubjectNames           SaveTrial
CloseTrial               GetDeviceChannelForFrame         GetJointDetails          GetSubjectParam           SetAnalysisParam
Connect                  GetDeviceChannelGlobal           GetJointNames            GetSubjectParamDetails    SetDeviceChannel
CreateAnEvent            GetDeviceChannelGlobalAtFrame    GetMarkerNames           GetSubjectParamNames      SetDeviceChannelAtFrame
CreateAnalysisParam      GetDeviceChannelGlobalForFrame   GetModelOutput           GetTrajectory             SetModelOutput
CreateModelOutput        GetDeviceChannelIDFromName       GetModelOutputAtFrame    GetTrajectoryAtFrame      SetModelOutputAtFrame
CreateModeledMarker      GetDeviceDetails                 GetModelOutputDetails    GetTrialName              SetSubjectActive
CreateSubjectParam       GetDeviceIDFromName              GetModelOutputNames      GetTrialRange             SetSubjectParam
DisplayCommandHelp       GetDeviceIDs                     GetRootSegment           GetTrialRegionOfInterest  SetTrajectory
DisplayCommandList       GetDeviceNames                   GetSegmentDetails        GetUnlabeled              SetTrajectoryAtFrame
GetAnalysisParam         GetDeviceOutputDetails           GetSegmentNames          GetUnlabeledCount         SetTrialRegionOfInterest
GetAnalysisParamDetails  GetDeviceOutputIDFromName        GetServerInfo            HasTrajectory             SubmitSplineTrajectory
GetAnalysisParamNames    GetEvents                        GetSplineResults         OpenTrial                 ViconNexus
GetDeviceChannel         GetFrameCount                    GetSubjectInfo           RunPipeline

>>
```

Display help on a command

To display help on one of the commands listed above:

At the command prompt, enter:

`help ViconNexus/`*`commandName`*

Where *commandName* is the command for which you want to display help.

For example, to display help about **GetTrajectory**, enter:

`help ViconNexus/GetTrajectory`

```
>> help ViconNexus/GetTrajectory
  GetTrajectory get all frames of data for the trial for the specified marker.

  Input
     subject  = string, name of an existing subject
     marker   = string, name of an existing marker
  Returns
     x        = numerical(double) array, x-coordinates of the trajectory
     y        = numerical(double) array, y-coordinates of the trajectory
     z        = numerical(double) array, z-coordinates of the trajectory
     e        = logical array, T/F indication as to whether the data exists for each frame

  Usage Example: Display trajectory coordinate at frame 50

     [trajX, trajY, trajZ, trajExists] = vicon.GetTrajectory( 'Colin', 'C7' );
     doesexist = ' - Missing Data';
     if( trajExists(50) )
         doesexist = ' - exists';
     end
     framedata = ['frame 50 = ', num2str(trajX(50)), ', ', num2str(trajY(50)), ', ', num2str(trajZ(50)), doesexist ];
     display( framedata );
```

MATLAB troubleshooting

The following table lists possible issues you may encounter when modeling with MATLAB, helps you to understand why the issue may have occurred, and suggests the remedial actions to take, in the order to try them.

Issue	Reason	Action

When you import a long trial into MATLAB, after some time, importing stops and the following error message is displayed:
`Error using ViconNexus/ GetDeviceChannelGlobal (line ####)`
`Host application failed to respond to the information request.`
	MATLAB cannot load device data if the number of device frames is too large.	Import the data using `GetDeviceChannelGlobalAtFrame` or `GetDeviceChannelGlobalForFrame` to get a subsection of the trial, repeat the process as necessary and append each data subsection at the end to join the data again.

If your data is atypical (for example, if it includes gait that is not normal overground walking, or if it requires cropping) and you don't modify the script to your particular trial, this may result in blank outputs.	The scripts are designed for normal gait (that is, overground walking) such as the gait trials in the sample data that is provided.	To ensure the scripts work well with your particular data, copy them and modify them as required.
Nexus error: When you click the **Run Script** button, Nexus becomes unresponsive for some time, and finally, the **Matlab** tab displays the following error: `Default Run Matlab Operation Host Application is not connected, unable to retrieve command list` MATLAB error: `Default Run Matlab Operation Host Application is not connected, unable to retrieve command list`	MATLAB connects to Nexus over TCP/IP. If you disconnect your Ethernet cable and turn off wifi (ie, if you are working entirely offline), MATLAB and Nexus cannot connect.	Install the Microsoft Loopback Adapter. For instructions on how to do this, see Install the Microsoft loopback adapter, page 78.

Issue	Reason	Action

MATLAB error when constructing an instance of the ViconNexus object
`vicon = ViconNexus();`
` Undefined function or variable 'ViconNexus'`
	When you try to create an instance of the class object ViconNexus, MATLAB is unable to locate the definition for the class.
	This is generally an indication that the Search path in MATLAB has not been set to include a path to the NexusSDK or that the NexusSDK has not been installed
		Ensure that the NexusSDK has been installed. The 32-bit version of the SDK should be installed for a 32bit installation of MATLAB; the 64-bit version of the SDK should be installed for a 64-bit installation of MATLAB.
		In MATLAB, ensure that the path to the NexusSDK has been added:
		64-bit MATLAB NexusSDK path is:
		NexusInstallFolder*SDK\Win64\Matlab*
		32-bit Matlab NexusSDK path is
		NexusInstallFolder*SDK\Win32\Matlab*
		Use the shortcut provided on the **Start** menu to set the MATLAB path.

MATLAB error when constructing an instance of the ViconNexus object
`vicon = ViconNexus();`
 	
` Could not load file or assembly 'NexusSDKClientDotNET.dll' or one of its dependencies. The specified module could not be found.`
	This can happen if the VC++ 64-bit runtimes did not get installed from the Nexus bootstrap installer *setup.exe*	Install the runtimes manually.
		Navigate to the folder where the installation files were unzipped
		run *vcredist_x64.exe*

Generic type error message received in MATLAB after calling a function
`result = vicon.function();`
` Error using ViconNexus/function (line 123)`
` Error: Invalid Parameter Value`
		Look at the log in the Nexus **Matlab** tab as it may contain more detailed information on the error that has been generated.

Issue	Reason	Action
MATLAB error `Host application failed to respond to the information request.`	After MATLAB sends a command to Nexus, it waits for a specific amount of time for the reply to be received. If the reply is not received in that timeframe, this error is generated. Delays in processing can occur when Nexus is waiting for input from the user to proceed or it has become unresponsive.	Look at the log in the Nexus **Matlab** tab to see if an error has been generated. Often, commands will return a reply, but some commands, such as **OpenTrial** and **RunPipeline**, require that Nexus generates a notification of task completion. An error in these commands can cause the reply to be delayed or not be generated. Look at the log in the Nexus **Matlab** tab to see if the command was received by Nexus. If the log does not have an entry showing that the command was received then it is possible that something has happened to the connection between the applications. Restart Nexus. Make sure that Nexus is not displaying a user prompt, if it is, answer the prompt and retry the command. Restart Nexus.
MATLAB error `Unable to Communicate with the host application.`	The function called failed to execute because the connection to Nexus has either been dropped or never established.	Make sure that Nexus is running and is responsive. If running from within MATLAB, remove the **ViconNexus** object from the workspace using the MATLAB **clear** command and re-create the object. Restart Nexus. Restart MATLAB.
Nexus error MATLAB version is shown in the **Matlab** tab but a message states that MATLAB is not accessible.	This can happen if Nexus is able to determine that MATLAB is installed but it is unable to access the MATLAB automation server.	Run **matlab.exe** with the /register option to have MATLAB re-register its automation server components.
When there are multiple versions of MATLAB installed, Nexus is running the wrong version of MATLAB	MATLAB registers COM components to provide access to its automation server, Nexus will use the currently registered components so the order of installation/uninstall/ upgrade of different MATLAB versions can make a difference.	Run **matlab.exe** from the MATLAB version you wish to use with the /register option to have MATLAB re-register its automation server components.

Modeling with Python

Python is a powerful, widely used programming language that can be a useful tool for mathematical modeling with Vicon Nexus.

To ensure that custom modeling is available whether or not you have access to MATLAB, Python is automatically installed with Nexus.

For more information, see:

- Set up Python for use with Nexus, page 73
- Python commands for use with Nexus, page 80
- Python scripts supplied with Nexus, page 82

In addition, the following Vicon Nexus 2 videos are available on YouTube:

Python Plug-in Gait to Excel[6]

Python demonstration with custom Gait Kinematics script[7]

> **Note**
> As the videos were recorded using an earlier version of Nexus 2, you may notice small differences in the user interface.

6 https://www.youtube.com/watch?v=rrYlNsGdNgs&index=6&list=PLxtdgDam3USUSIeuO6UloG3ogPsFNtEJS
7 https://www.youtube.com/watch?v=s5pU_ZDHWsg

Set up Python for use with Nexus

The Nexus API is supplied as a Python package called *viconnexusapi* and is automatically installed with Nexus. The build of Python installed within Nexus is Python 3. You can run the Python SDK for Nexus in a Python 3 environment as well as in a Python 2 environment.

For more information, see:

- Configure Python for scripting with Nexus, page 74
- Run a Python script from within Nexus, page 75
- Install the Nexus API into other Python distributions, page 76
- Launch the required Python, page 77
- Install the Microsoft loopback adapter, page 78

Configure Python for scripting with Nexus

To set up Python to work with Nexus:

1. Go to Windows Search and start to type `Python`.
2. Click the required Python.
3. To automatically configure Python for scripting with Nexus, at the command prompt, enter one of the following:

UsingViconNexusAPI.py

```
from viconnexusapi import ViconNexus
vicon = ViconNexus.ViconNexus()
```

UsingViconNexusAPI2.py

```
import viconnexusapi
vicon = viconnexusapi.ViconNexus.ViconNexus()
```

The Python installed with Nexus contains the API version shipped with that version. However, if you install the package into another Python distribution, you are responsible for installing the appropriate version.

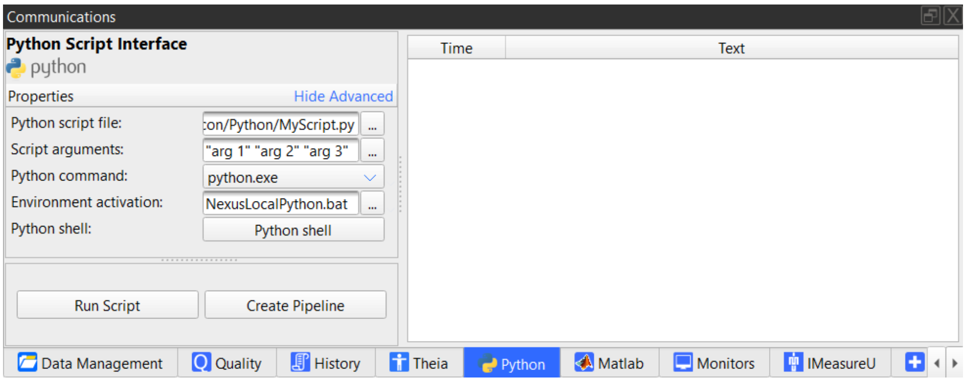
For information on how to access the help provided on the relevant Python commands, see Python commands for use with Nexus, page 80. For more information about how to use Python, see the Python Getting Started[8] page.

> **Important**
> If you disconnect your Ethernet cable and turn off wifi, when you enter a Python command, the following error may be displayed:
> `Host Application is not connected, unable to retrieve command list`
> This is because Python connects to Nexus over TCP/IP and if you are working entirely offline, Python and Nexus cannot connect.
> To solve this issue, install the Microsoft Loopback Adapter. For instructions, see Install the Microsoft loopback adapter, page 78.

8 https://www.python.org/about/gettingstarted/

Run a Python script from within Nexus

In the **Communications** pane, the **Python** tab enables you to set the path to your Python installation and run a script without having to include it in a pipeline operation.



To run a Python script:

1. On the Python tab, ensure the **Advanced** properties are displayed.
2. In the **Python script file** field, enter or browse to the full path and filename of the Python script you want to run.
3. In the **Script arguments** field, enter any arguments needed by the Python script you specified.
4. In the **Python command** field, select the required Python (for an explanation of the options, see Launch the required Python, page 77). The default is *python.exe*.
5. If the Python installation you want to use is not in the PATH, in field, in thethe **Environment activation** field, enter or browse to the full path name of executable file (usually a *.bat* file) that will run in the command shell to configure your Python environment before running the Python script that you specified in the **Python script file** field. The executable should run the commands needed to activate the virtual environment, which could include changing directories, configuring PATH, etc.
   By default, the **Environment activation** file is the supplied *NexusLocalPython.bat* file.
   This sets the PATH environment to point to the Python installation provided by Nexus.

6. If you want to launch a Python shell, using the selected Python, click **Python shell**.
7. To run the specified script, click **Run Script**.

To create a new pipeline that contains all the above properties with the values you specified, click **Create Pipeline**.

Note that the settings in the **Python Script Interface** persist between runs, and the settings for **Python command** and **Environment activation** are used as the initial values when you create a **Run Python Operation** pipeline operation. If you change the parameters for a specific operation in a pipeline, they do not affect the persisted values of the parameters and they do not alter the values of the settings on the panel.

Install the Nexus API into other Python distributions

The build of Python (Python 3) installed within Nexus automatically installs the *viconnexusapi* package as part of Nexus. A script is also available with the installer, which installs the package into the system Python distribution. You can also directly install the package into any other Python distributions that you have installed.

Installing_viconnexusapi

```
cd "C:\Program Files\Vicon\Nexus2.14\SDK\Win64\Python"
# install the api into the system python
./install_vicon_nexus_api.bat
# install the api into a specific python distribution
<path to user python> -m pip install ./viconnexusapi
```

The advanced modeling scripts are provided as a package called *viconnexusutils* and are available in the same way as *viconnexusapi*, except that these scripts are not automatically installed. This is because they have additional dependencies that cannot be guaranteed to be present and must be downloaded by *pip*.

Launch the required Python

The shell launched by the python operation is either the Python distribution shipped with Nexus or your default Python (as determined by the PATH variable).

If the Python distribution shipped with Nexus is launched, the API package is automatically available for import, and additional scripts are not required.

If you choose to use a Python that is different from the installed Nexus distribution, you can use an advanced option to select the command used to launch Python. The options for this are **python.exe** or **py.exe**:

- If you have only a Python 2 **or** a Python 3 installation in the path, **python.exe** launches that version of Python.
- If you have both versions and the *pylauncher* utility, **py.exe** launches either Python 2 or Python 3, depending on a shebang comment at the start of the launched script.

CGM2 Python version

CGM2 launches using the version of Python 3 installed with Nexus.

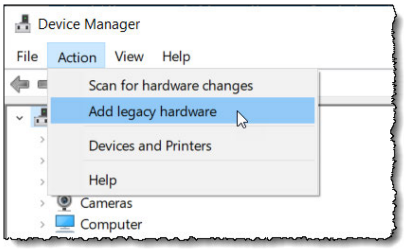
Note that:

- To ensure pyCGM2 continues to operate correctly, do not modify the Python installation that is installed with Nexus.
- Do not use versions of pyCGM2 other than that supplied by Vicon. Using other versions of pyCGM2 may cause Nexus operations to fail.
(If you want to use a different version of pyCGM2 for comparison purposes, create pipelines with the **Environment activation** file set appropriately in the pipeline operation(s).)
- If you customize your Python environment, note that it is assumed that the *Scripts* folder that contains the pyCGM2 scripts is the current folder after the **Environment activation** file has finished running.

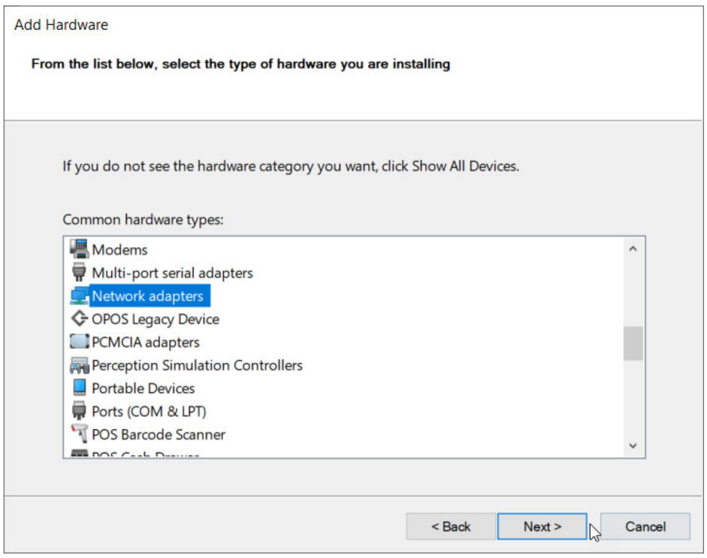
Install the Microsoft loopback adapter

To install the Microsoft loopback adapter on Windows 10:

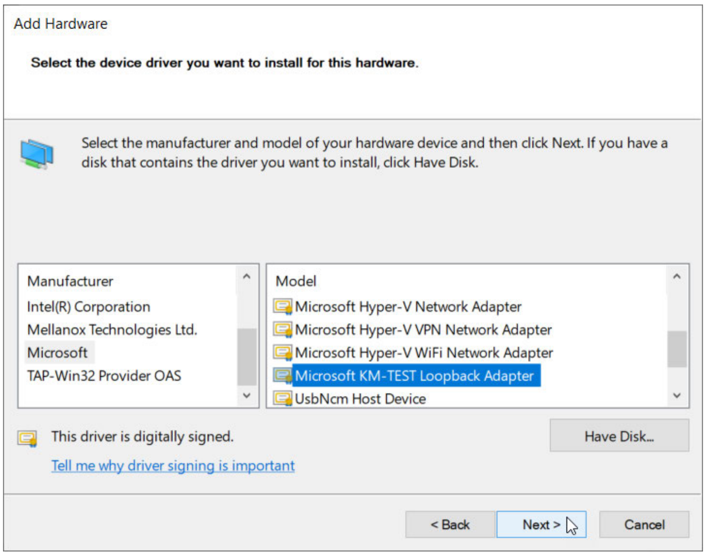
1. Right-click the Windows **Start** menu icon and select**Device Manager** (or use your preferred method of opening the Device Manager).
2. In the **Device Manager**, click the **Action** menu and then select **Add legacy hardware**.



3. On the welcome screen, click**Next**.
4. In the Add Hardware screen, select **Install the hardware that I manually select from a list** and then click **Next**.
5. In the next screen, scroll down the **Common hardware types** list, select **Network adapters** and then click **Next**.



6. From the **Manufacturer** list, select **Microsoft**, and then select **Microsoft KM-TEST Loopback Adapter**card model and click **Next**.



7. In the next screen, click **Next**.
8. Click **Finish**.

Python commands for use with Nexus

The following information is provided to help you to get started using Python for modeling with Nexus.

Before you begin, ensure you have launched and configured Python as described in Set up Python for use with Nexus, page 73.

> **Tip**
> Remember to import the module first:
> `import ViconNexus`

Display all Nexus Python SDK commands

At the Python command prompt, assuming you have completed the above preparatory step, enter:

```
dir(ViconNexus.ViconNexus)
```

A list of all Nexus Python SDK commands is displayed:

Display help on a command

To display help on one of the commands listed above:

At the Python command prompt, enter:

`help(`*`commandName`*`)`

Where *commandName* is the command for which you want to display help.

For example, to display help about **GetTrajectory**, enter:

`help(ViconNexus.ViconNexus.GetTrajectory)`

```
In[4]: help(ViconNexus.ViconNexus.GetTrajectory)
Help on method GetTrajectory in module ViconNexus:

GetTrajectory(self, subject, marker) unbound ViconNexus.ViconNexus method
    Get all frames of data for the trial for the specified marker.

    Input
      subject = string, name of an existing subject
      marker  = string, name of an existing marker
    Returns
      x    = numerical(double) list, x-coordinates of the trajectory
      y    = numerical(double) list, y-coordinates of the trajectory
      z    = numerical(double) list, z-coordinates of the trajectory
      e    = logical list, T/F indication as to whether the data exists for each frame

    Usage Example: Display trajectory coordinate at frame 50

      trajX, trajY, trajZ, trajExists = vicon.GetTrajectory( 'Colin', 'C7' )
      doesexist = ' - Missing Data'
      if( trajExists[49] ):
        doesexist = ' - exists'

      framedata = 'frame 50 = ({0}, {1}, {2}){3}'.format( trajX[49], trajY[49], trajZ[49], doesexist )
      print framedata
```

Python scripts supplied with Nexus

To make it simpler to develop Python models with Nexus, additional Python scripts are supplied.

These advanced modeling scripts are provided as a package called *viconnexusutils*, found in:

C:\Program Files\Vicon\Nexus2.15\SDK\Win64\Python\viconnexusutils\viconnexusutils

To install the package, use the appropriate *pip* for the Python installation that you want to use (or, to add it to the system Python, use the scripts provided, as described in Set up Python for use with Nexus, page 73).

The following scripts are included in the package:

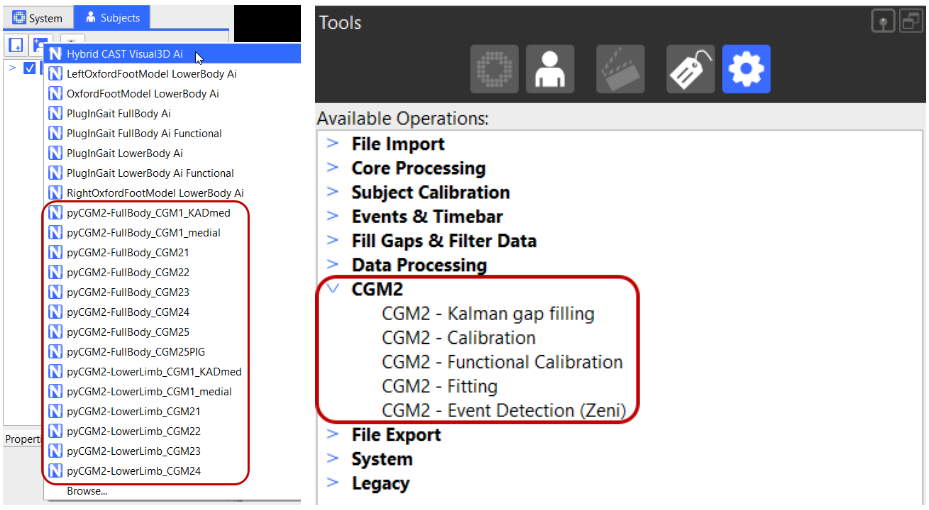
- NexusAngles.py
- NexusObject.py
- NexusSegment.py
- NexusTrajectory.py

> **Using Python 2 with Nexus 2.14 and later**
> The sample scripts that are installed with Nexus are compatible with Python 3. If you want to run Python 2 scripts, either the machine you are using must have Python2 in its PATH, or if you are using both Python 2 and Python 3, create *.bat* files to configure the Python environment that is needed to run the required script.

Modeling with CGM2

The Conventional Gait Model 2 (CGM2) was developed by Dr Fabien Leboeuf (University of Salford), and partly funded by Vicon. It is an open-sourced biomechanical model originally developed in Python 2, and now developed in Python 3. The design of the CGM2 model enhances the Conventional Gait Model whilst maintaining its strengths.

You can use Conventional Gait Model 2 (CGM2) VSTs and biomechanical models from within Nexus so that you can execute CGM2 models on your data.



pyCGM2 is compatible with versions of Nexus from 2.12 and later. It fits straight into Nexus pipelines with the usual gait plug-ins such as the Woltring Filter, Gait Cycle event detection, and Plug-in Gait.

CGM2 is automatically installed and you can use it without any further setup or installation.

The following topics contain information about setting up and using CGM2 with Nexus:

- What's new in CGM2?, page 85
- Use pyCGM2 in Vicon Nexus, page 86
- Known issues for CGM2, page 94
- Addressed issues for CGM2, page 96

For more information, also see the following links:

- For more details about the model: https://pycgm2.netlify.app/
- For information on setting up Python with Nexus 1.12 or later, see https://pycgm2.netlify.app/installation/setup-python/

What's new in CGM2?

The following updates were made to using CGM2 with Nexus 2.14 (no additional updates are included with Nexus 2.16, but see the Addressed issues, page 96):

- CGM2 version updated to v4.2.
- CGM2 now uses Python 3.
- New operations for event detection and Kalman gap-filling (see Additional information about CGM2, page 88).
- In Nexus, all CGM2 pipeline operations are now displayed in their own section in the **Available Operations** list in the **Pipeline Tools** pane.

For information on the updates made by Dr Fabien Leboeuf (University of Salford) to the Conventional Gait Model 2 (CGM2) that is included with Nexus, see the pyCGM2 changelog[9].

9 https://pycgm2.netlify.app/changelog/

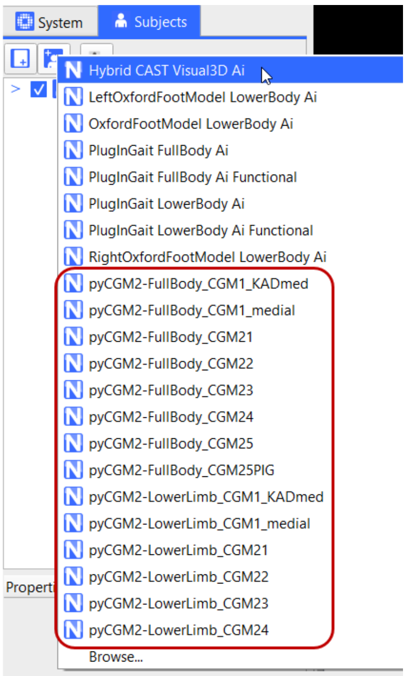
Use pyCGM2 in Vicon Nexus

In this section:

CGM2 labeling templates (VSTs)

CGM2 VSTs are automatically installed in:
C:\Users\Public\Documents\Vicon\Nexus2.x\ModelTemplates

Note that VSTs are available for both lower and full body.



> **Note**
> If you are using a version of CGM2 earlier than 2.5 and want to perform upper body modeling, run either a custom upper limb model or the full body Plug-in Gait model. If you use the full body PiG model, add a script prefix to the outputs, so that the PiG model does not overwrite your CGM2 lower body model. (If you're not sure which version of CGM2 you're using, see Find the version number of CGM2, page 93.)

For all versions of CGM2, you must use the appropriate marker set for the model, for example, you must run a 2.5 model using a 2.5 marker set.

Find information about CGM2

For more information about CGM2, see the following:
https://pycgm2.netlify.app/

Information about the CGM2 models:

- CGM 1.0 (Vicon Plug-in Gait Clone):
  https://pycgm2.netlify.app/cgm/cgm1.0/
- CGM 1.1:
  https://pycgm2.netlify.app/cgm/cgm1.1/
- CGM 2.1 (Hip Joint Center):
  https://pycgm2.netlify.app/cgm/cgm2.1/
- CGM 2.2 (Inverse Kinematic):
  https://pycgm2.netlify.app/cgm/cgm2.2/
- CGM 2.3 (Skin Clusters):
  https://pycgm2.netlify.app/cgm/cgm2.3/
- CGM 2.4 (Forefoot):
  https://pycgm2.netlify.app/cgm/cgm2.4/
- CGM 2.5 (Upper body model):
  https://pycgm2.netlify.app/cgm/cgm2.5/
- CGM 2.6 (Knee calibration)
  https://pycgm2.netlify.app/cgm/cgm2.6/

Note that each subsequent model includes the improvements made in all prior models, eg, skin cluster calculations, inverse kinematics, and hip joint center calculations will also be applied within the forefoot model.

Additional information about CGM2:

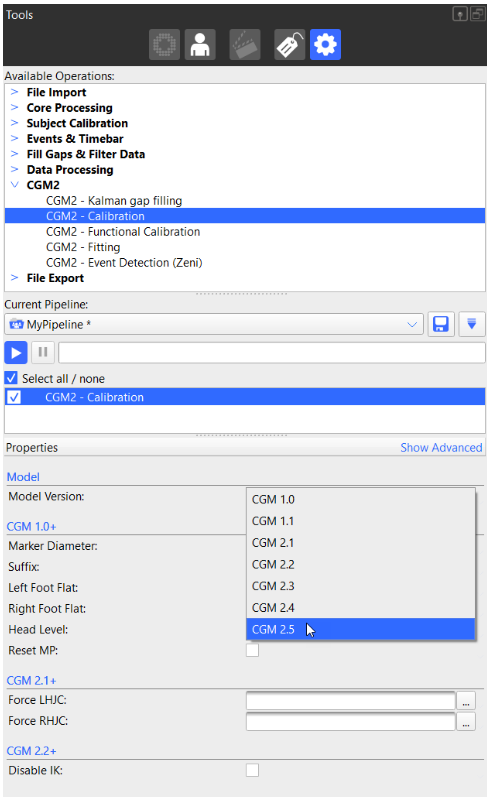
- CGM 4.2 (Event detection)
  https://pycgm2.netlify.app/nexusqualisys/vicon-apps/events/
- CGM 4.2 (Kalman gap-filling)
  https://pycgm2.netlify.app/nexusqualisys/vicon-apps/gaps/

Information about marker placement:
https://pycgm2.netlify.app/ressources/palpation/

Run the static CGM2 model

To apply the model, run the **CGM2 - Calibration** pipeline operation on static trials.

Add the **CGM2 - Calibration** pipeline operation to the current pipeline, select it and in the **Properties** pane, select the required parameters:

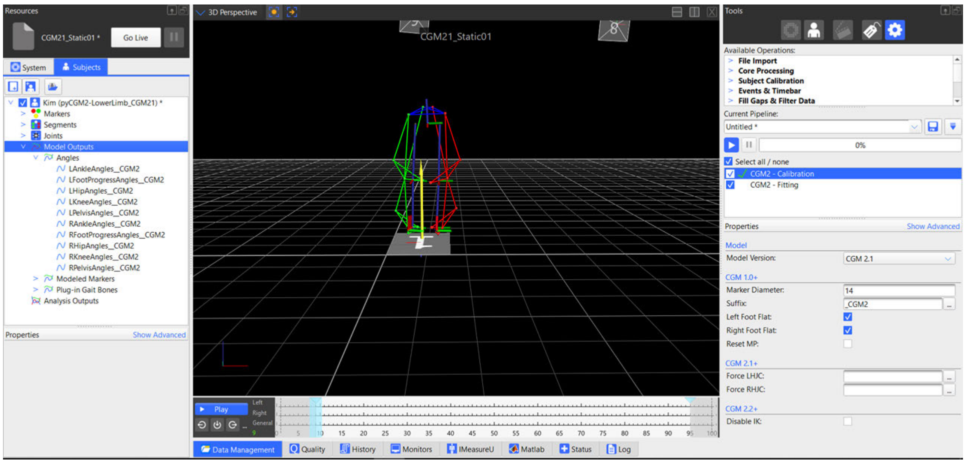


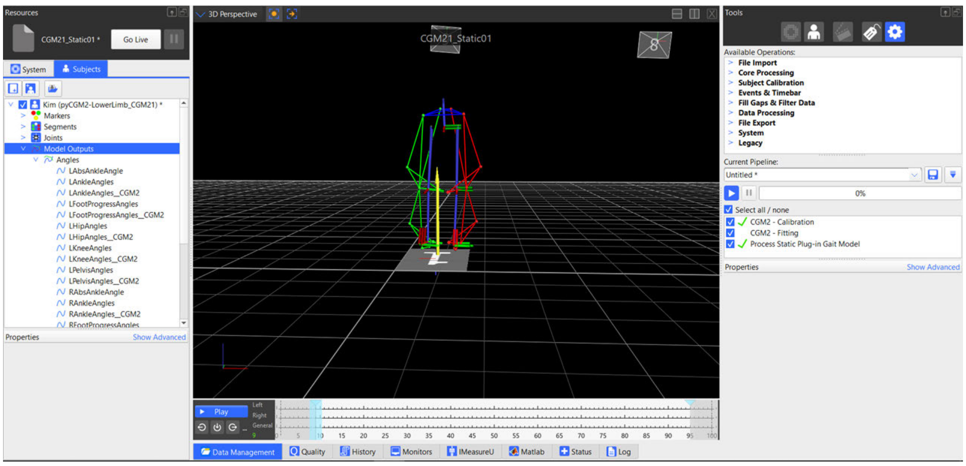
- **Environment activation** If you need to run an executable file to configure the Python environment before running the script, specify the full path to the file.
- **Model Version** Select the CGM version that you want to use.
- **Marker Diameter** Default is 14 mm.
- **Suffix** Add your preferred naming convention, eg, `CGM2`. Note that CGM2 automatically adds an underscore, so if you specify the suffix `CGM2`, all the outputs will have the suffix `_CGM2`.
- **Left Foot Flat** and **Right Foot Flat** Default is selected.
- **Head Level** Select or clear the head horizontal option.

- **Reset MP** Reset computation of optional parameters, eg, **interAsisDistance** and shank offsets. If selected, the information entered in the **Properties** pane of the **Subjects Resources** tab is accounted for when applying the model.
- **Force LHJC** and **Force RHJC** Forces the local position of the left/right hip joint center in the pelvic coordinate system. Note that this applies only for the CGM2 model from CGM 2.1 and later.
- **Disable IK** To turn off inverse kinematics, select this check box.

When you run the operation, the model outputs appear in the **Subjects** tree.

Note that in the following example, the suffix `CGM2` has been specified so that the outputs for CGM2 and Plug-in Gait can be compared. If no suffix had been specified, the outputs would be overwritten.

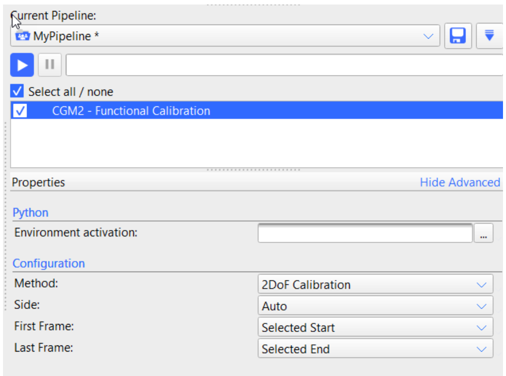




Run the knee calibration (CGM 2.6)

The knee calibration routine (CGM 2.6) provides two options: **2DoF Calibration** or **SARA**. To apply the knee calibration, run the **CGM2 - Functional Calibration** pipeline operation between the static/calibration (see above) and the dynamic/fitting trials (see below).

Add the **CGM2 - Functional Calibration** pipeline operation to the current pipeline, select it and in the **Properties** pane, select the required parameters:

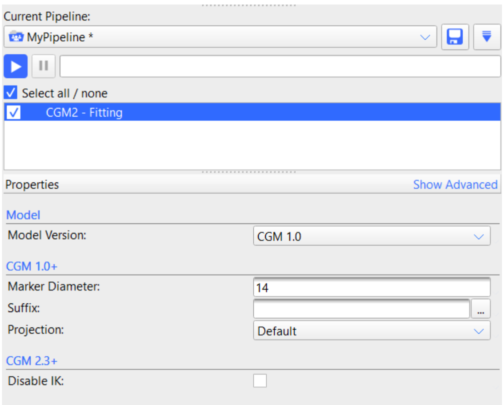


- **Environment activation** If you need to run an executable file to configure the Python environment before running the script, specify the full path to the file.
- **Method** Select the required knee calibration method.
  - **2DoF Calibration**
  - **SARA** Note that SARA can only be used with a subject that has been statistically calibrated in CGM 2.3 or later.
- **Side** Select the option to which to apply the functional calibration.
  - **Auto** Expects each leg to be calibrated from a separate trial. If not, you must specify the frame range for the movement of each leg within the trial.
  - **Left** Runs on the left knee.
  - **Right** Runs on the right knee.
- **First Frame** Default is Selected Start.
- **Last Frame** Default is Selected End.

Run the dynamic CGM2 model

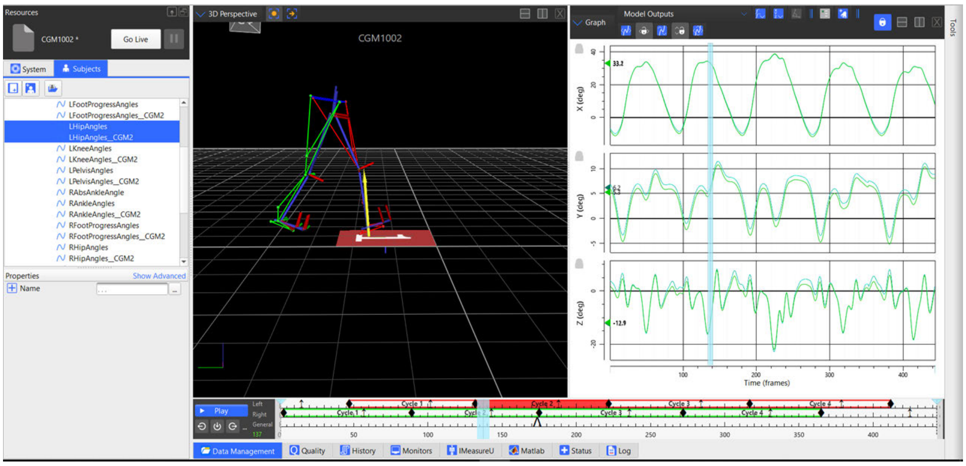
To apply the model, run the **CGM2 - Fitting** pipeline operation on dynamic trials.

Add the **CGM2 - Fitting** pipeline operation to the current pipeline, select it and in the **Properties** pane, select the required parameters:



- **Model Version**: Select the CGM version that you want to use.
- **Marker Diameter** Default is 14 mm.
- **Suffix** Add your preferred naming convention, eg, `CGM2`.
- **Projection**: Select the coordinate system for joint moment from the options:
  - **Default** - CGM 1.0 = distal and all other CGM2 models default to JCS (Joint Coordinate System)
  - **Proximal**
  - **Distal**
  - **Global**
  - **JCS** - Joint Coordinate System
- **Disable IK** If selected, inverse kinematics is deactivated. Applicable only to the CGM2 model from CGM 2.3and later.

The model outputs appear in the Subjects tree. In the same way as in the static/calibration example above, to enable a comparison of CGM2 with Plug-in Gait, a suffix (`CGM2`) was specified.



Find the version number of CGM2

You can find out which version of CGM2 is currently installed in either of these ways:

- Display a list of the installed modules for Nexus Python by entering this command:
  ```
  "C:\Program Files\Vicon\Nexus2.14\Python\python.exe" -m pip
  freeze | findstr pyCGM2
  ```
- Look at the installed package directly, for example:
  ```
  C:\Program Files\Vicon\Nexus2.14\Python\Lib\site-
  packages\pyCGM2-4.2.dist-info

  C:\Program Files\Vicon\Nexus2.14\pyCGM2-wheels\pyCGM2-4.2-py3-
  none-any.whl
  ```

Known issues for CGM2

Issue	Workaround
If you run a **CGM2 - Functional Calibration** pipeline operation on lower body only data, the operation fails.	Run the **CGM2 - Functional Calibration** operation on full body data only.
If you use a SACR marker instead of the LPSI and RPSI markers, and you try to run the **CGM2 - Functional Calibration** pipeline operation, CGM2 doesn't work with Nexus and CGM2 calibration errors are logged.	See Modify the Translators information, page 95.
When you run a CGM2 pipeline operation in Nexus and generate a MKR file, the forearms may be poorly scaled. Also, for CGM2.4 and later, the feet may be offset.	In Polygon, manually adjust the mesh visualization segment scales.
You installed Nexus 2.9 or later, having previously installed CGM2 standalone (ie, pre-Nexus 2.9) and encounter issues running CGM2.	Delete this folder: *C:\ProgramData\pyCGM2*
You can't find the version number for CGM2.	See Find the version number of CGM2, page 93.

Note also that CGM2 is currently only a bilateral model.

For questions regarding CGM2, including the biomechanical model details and known issues, please contact Dr Fabien Leboeuf at:

https://pycgm2.netlify.app/contact/

If you have any questions regarding Vicon pyGM2, please contact support@vicon.com.[10]

10 mailto:support@vicon.com

Modify the Translators information

If you use a SACR marker instead of the LPSI and RPSI markers and need to run the **CGM2 - Functional Calibration** pipeline operation, to enable CGM2 to work with Nexus, you need to modify the information about the relevant markers. This information is stored in the `Translators` section of the *CGM1-pyCGM2.settings* file and the *CGM1.translators* file. To modify the information:

1. Copy the *pyCGM2* folder from:
   C:\Program Files\Vicon\Nexus2.#\Python\Lib\site-packages
   to
   C:\ProgramData

2. Depending on how often you use a SACR marker, edit the Translators information:

   - If you use the SACR marker by default:
     i. Edit this file:
     C:\ProgramData\pyCGM2\CGM1-pyCGM2.settings
     ii. Under `Translators` , change:
     `LPSI: None` and `RPSI: None` to
     `LPSI: SACR` and `RPSI: SACR`

   - If you use the SACR marker in only some sessions:
     i. Copy this file into the relevant session folder:
     C:\ProgramData\pyCGM2\translators\CGM1.translators
     ii. Edit the file as described above.

Addressed issues for CGM2

This issue was addressed in CGM2 4.2:

- When you create normalized moments and powers using MATLAB or Python, the generated units for the model outputs are Nmm/Kg and Watts/kg. After you save the C3D in Nexus and reopen the trial, the units no longer change to Nmm and Watts, as long as your labels fulfill any of the following criteria:
  - They match the usual Plug-in Gait normalized model output names
  - They match the usual Plug-in Gait normalized model output names followed by an underscore and by 0..N characters (*`_suffix`*)
  - They contain the text `Normalized` or `Normalised`.

Biomechanics workflow

> **Important**
> The Optimum Common Shape Technique (OCST) 1[11] , Symmetrical Center of Rotation Estimation (SCoRE) 2[12] and Symmetrical Axis of Rotation Analysis (SARA) 3[13] methods are based on research publications that can be obtained from Vicon on request. As the research and validation of the values produced by these methods is a continuing effort, it is recommended that OCST, SCoRE and SARA are used for investigative and research purposes. It is the responsibility of the user to review the scientific references and understand the methods. Any use of the methods as part of a clinical assessment is strictly at the discretion of the user.

Vicon Nexus 2 includes a Biomechanics Workflow area that enables you to associate specified data capture and processing steps with particular trial types, add joint range monitors for instant feedback, and quickly accept or reject the results of each step.

11 http://www.gaitposture.com/article/S0966-6362%2810%2900129-3/abstract
12 http://www.jbiomech.com/article/S0021-9290%2806%2900415-5/abstract
13 http://www.jbiomech.com/article/S0021-9290%2805%2900446-X/abstract

In the Biomechanics Workflow area, you can run (or modify and then run) the supplied Advanced Gait Workflow, or set up your own workflows:

- To help you to calculate a repeatable Hip Joint Center location using the SCoRE method, and an optimized Knee Joint Flexion Axis using the SARA method, Nexus includes an Advanced Gait Workflow. TheAdvanced Gait Workflow also incorporates a mathematical approach (known as OCST) that finds the average or common shape for selected sets of markers. The OSCT method allows non-rigid arrangements of skin-based markers to be used in SCoRE and SARA calculations where rigidity is assumed. TheAdvanced Gait Workflow steps each have an associated step description in the Biomechanics Workflow area that guides you through the process from marker placement to capture and processing. For more information, see Using the Advanced Gait Workflow, page 99.
- To set up your own workflow, see Using a custom biomechanics workflow, page 121, which explains how to set up and use custom workflows, and includes further information on using functional calibration and SCoRE and SARA.

In addition, a Vicon Nexus 2 video: SCoRE and SARA[14], is available on YouTube.

Note
As the videos were recorded using an earlier version of Nexus 2, you may notice small differences in the user interface.

14 https://www.youtube.com/watch?v=zGzd3cJkmiI&index=5&list=PLxtdgDam3USUSIeuO6UloG3ogPsFNtEJS

Using the Advanced Gait Workflow

Important
The Optimum Common Shape Technique (OCST) [1][15], Symmetrical Center of Rotation Estimation (SCoRE) [2][16] and Symmetrical Axis of Rotation Analysis (SARA) [3][17] methods are based on research publications that can be obtained from Vicon on request. As the research and validation of the values produced by these methods is a continuing effort, it is recommended that OCST, SCoRE and SARA are used for investigative and research purposes. It is the responsibility of the user to review the scientific references and understand the methods. Any use of the methods as part of a clinical assessment is strictly at the discretion of the user.

Nexus 2 includes a feature called the **Biomechanics Workflow**. This area on the **Data Management** tab enables you to create a custom series of sequential steps that constitutes a collection protocol. These steps can automatically select aspects of Nexus for data collection and processing, including trial types, trial names, and processing pipelines.

The Advanced Gait Workflow (AGW) helps you to calculate a repeatable Hip Joint Center location using the SCoRE method, and an optimized Knee Joint Flexion Axis using the SARA method. The Advanced Gait Workflow also incorporates a mathematical approach (known as OCST) that finds the average or common shape for selected sets of markers. The OSCT method allows non-rigid arrangements of skin-based markers to be used in SCoRE and SARA calculations where rigidity is assumed. The Advanced Gait Workflow steps each have an associated step description in the **Biomechanics Workflow** area that guides you through the process from marker placement to capture and processing.

15 http://www.gaitposture.com/article/S0966-6362%2810%2900129-3/abstract
16 http://www.jbiomech.com/article/S0021-9290%2806%2900415-5/abstract
17 http://www.jbiomech.com/article/S0021-9290%2805%2900446-X/abstract

The Advanced Gait Workflow steps you through a series of trial captures and automated processes to:

- Calibrate the subject's labeling skeleton
- Calibrate the OCST pelvis, femur, and tibia segments
- Monitor the range of motion (ROM) of the hip and knee joints for SCoRE and SARA calibration
- Calibrate the SCoRE hip joint centers
- Calibrate the SARA knee flexion axes
- Capture a dynamic trial and use the calibrated OCST, SCoRE and SARA data to compute the hip joint centers and knee flexion axes for further analysis

The workflow enables you to accept the outcome of the current step and proceed to the next automatically or to reject it to repeat the step until the outcome is satisfactory. It illustrates how to use the Biomechanics Workflow and its corresponding features with the supplied Advanced Gait Workflow VSTs, but if required, you can modify it and the associated trial types, monitors and pipelines to suit your needs.

The following topics describe each step in the Advanced Gait Workflow along with its outcome. The final topic describes how to use the MATLAB Plug-in Gait scripts with the SCoRE and SARA data for further analysis.

- Advanced Gait Workflow files, page 101
- Prepare a subject for SCoRE and SARA and the Advanced Gait Workflow, page 105
- Run the Advanced Gait Workflow, page 106
- Troubleshoot AGW reconstruction and labeling, page 113
- Process a kinematic model with SCoRE and SARA, page 114

Advanced Gait Workflow files

By default, the Advanced Gait Workflow files are located in the following installation folder:

C:\Program Files\Vicon\Nexus2.#

You are given the option to change this location during the Nexus installation.

The Advanced Gait Workflow (AGW) files are:

- AGW labeling skeleton template and marker files, page 102
- AGW pipelines, page 102
- AGW trial types, page 102
- AGW monitors, page 103
- AGW capture workflow, page 103
- AGW MATLAB folder and files, page 103
- PlugInGait FullBody Ai Functional VST, page 103

AGW labeling skeleton template and marker files

The following labeling skeleton template and marker files are installed in:

<*installation folder*>\ModelTemplates

- PlugInGait FullBody Ai Functional.vst
- PlugInGait FullBody Ai Functional.mkr
- PlugInGait LowerBody Ai Functional.vst
- PlugInGait LowerBody Ai Functional.mkr

AGW pipelines

The following pipelines are installed in:

<*installation folder*>\Configurations\Pipelines

- AGW Static.Pipeline
- AGW LHip.Pipeline
- AGW LKnee.Pipeline
- AGW RHip.Pipeline
- AGW RKnee.Pipeline
- AGW Process.Pipeline

AGW trial types

The following trial types are installed in:

<*installation folder*>\Configurations\TrialTypes

- AGW Static.TrialTypes
- AGW LHip.TrialTypes
- AGW LKnee.TrialTypes
- AGW RHip.TrialTypes
- AGW RKnee.TrialTypes
- AGW Process.TrialTypes

AGW monitors

The following monitors are installed in:

<installation folder>\Configurations\Monitors

- AGW LHip.Monitors
- AGW LKnee.Monitors
- AGW RHip.Monitors
- AGW RKnee.Monitors

AGW capture workflow

The following capture workflow is installed in:

<installation folder>\Configurations\CaptureWorkflows

- AGW Lower Body.CaptureWorkflow

AGW MATLAB folder and files

The following MATLAB folder and files are installed in:

<installation folder>\SDK\Matlab

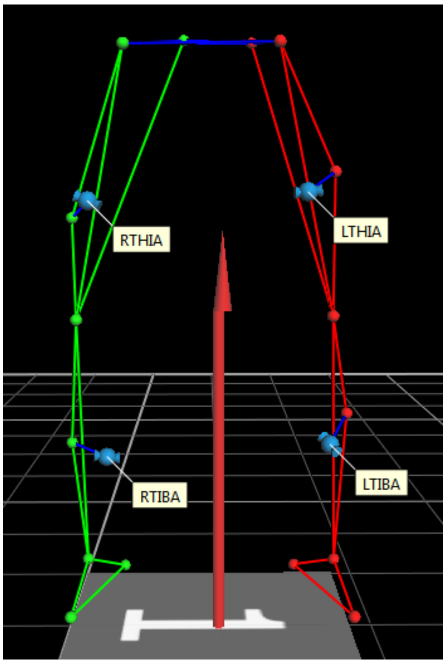
- +Vicon (folder containing the Plug-in Gait MATLAB model)
- DynamicPiG.m
- StaticPiG.m

PlugInGait FullBody Ai Functional VST

The *PlugInGait FullBody Ai.vst* uses the same marker set and marker locations as the legacy *PlugInGait FullBody* (UPA and FRM).vst but it has been rewritten into the VST/VSK format to take advantage of the skeleton calibration and labeling algorithms of Nexus 2.

The *PlugInGait FullBody Ai Functional.vst* has four additional markers that are used to define independent thigh and tibia segments for SCoRE and SARA processing. (Note that this VST is just one example of the possible marker sets that can be used with SCoRE and SARA.) The additional markers include the L and R THIA, typically placed on the anterior aspect of the thigh, which combine with the THI and KNE markers to define the left and right femur OCST segments.

Also the L and R TIBA markers, typically placed on the anterior aspect of the tibia, combine with the TIB and ANK markers to define the left and right tibia OCST segments. Although the exact placement of these additional markers does not necessarily correspond with anatomical landmarks, it's important that the markers form a solid geometrical relationship with the other markers on the segment to provide well-defined and stable OCST segments, as shown in the following illustration.



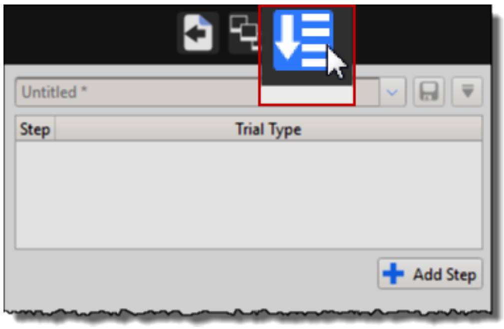
Prepare a subject for SCoRE and SARA and the Advanced Gait Workflow

1. Take the standard Plug-in Gait Full Body anthropometric measurements.
2. Attach the markers to the subject.
3. On the **Subjects** tab, click **Create a new subject from a Labeling Skeleton** and select **PlugInGait FullBody Ai Functional**.
4. Enter the subject's anthropometric measurements into the subject **Properties** fields.

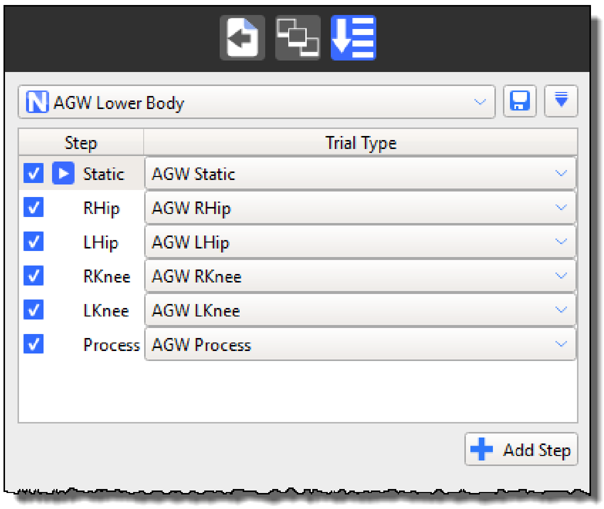
> **Note**
> These anthropometric measurements aren't used to calculate OCST/SCoRE/SARA values, however they are required for Plug-in Gait processing (standard and/or MATLAB).

Run the Advanced Gait Workflow

1. After attaching markers, have the subject enter the volume.
2. On the **Data Management** tab, click the **File Transfer/Batch Processing Interface** icon .
3. Click the **Biomechanics Workflow** icon.



4. From the dropdown list, select **AGW Lower Body**.
   The steps are displayed in the **Biomechanics Workflow** area:

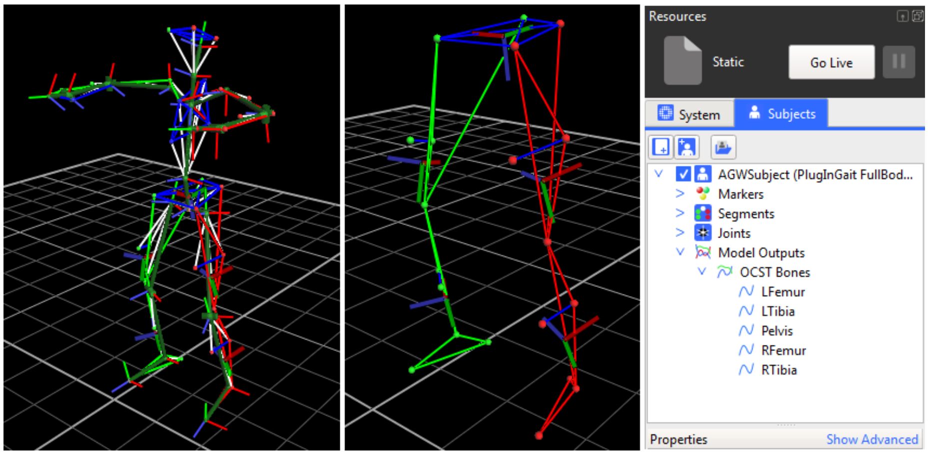


Complete the steps as described in the following sections.

Step 1: AGW Static

This step calibrates the subject's labeling skeleton and OCST segments from a static trial.

1. Have the subject stand in the motorbike pose and click on the first step, which is labeled **Static**. When selected, the play icon is positioned at that step, as shown in the previous illustration.
2. To initiate the capture, click **Start**.
   The **AGW Static** trial type is loaded automatically. It is set to capture a 1-second trial and run the **AGW Static** pipeline after the capture is complete. The outcome is a calibrated labeling skeleton and calibrated OCST Pelvis, RFemur, LFemur, RTibia, and LTibia segments.
3. Review the subject in the **3D Perspective** view to make sure the results are acceptable.
   The OCST local segment axes are displayed on the subject as well as written to the subject's **OCST Bones** node, in the **Model Outputs** node.

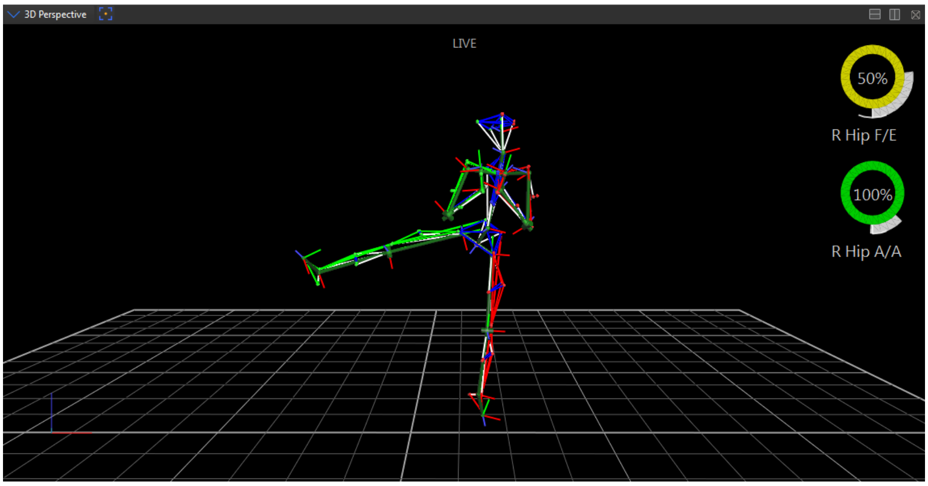
   If the results look incorrect, check the **Log** tab for any error messages.
4. If the results are acceptable, click **Accept** to move on to the next step or to repeat the current step, click **Reject**.
   When you click **Accept**, the current offline trial is automatically saved, which updates the subject's *.mp* file with the calibrated data.

Step 2: AGW RHip

This step calibrates the right SCoRE hip joint center.

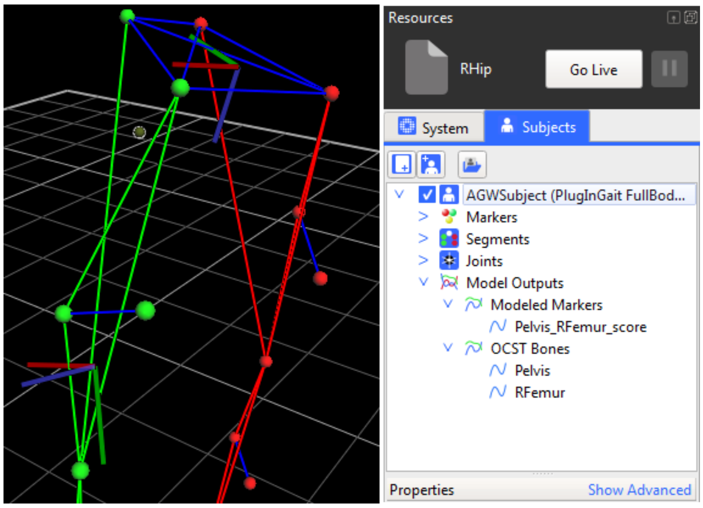
> **Important**
> To make the subject's skeleton joint data available to the range monitors, set the **Processing Output Level** property of **Local Vicon System** to **Kinematic Fit**.

1. Prepare the subject to perform a star-arc movement pattern for the right hip.
2. To initiate the capture, click **Start**.
   The **AGW RHip** trial type and the **AGW RHip** range monitor are loaded automatically. The trial type starts the capture automatically, but you must stop the capture after the hip joint has moved about all three axes through the acceptable ranges.



Tip: The axes correspond to the labeling skeleton's segment definitions, where RHip X is flexion/extension, RHip Y is internal/external rotation, and RHip Z is abduction/adduction. The range values defined within the monitors serve as examples, but can be modified to suit your application needs.

3. When the joint ranges have been satisfied, stop the capture manually.
   The **AGW RHip** pipeline runs automatically and the outcome is a calibrated right SCoRE hip joint center. The hip joint center appears in the **3D Perspective** view as a virtual point and is added to the subject's **Modeled Markers** node in the **Model Outputs** node.



4. Review the virtual point location and the **Log** tab for errors.
5. If the results are acceptable, click **Accept** to move on to the next step or to repeat the current step, click **Reject**.
   When you click **Accept** the current offline trial is automatically saved, which updates the subject's *.mp* file with the calibrated data.

Step 3: AGW LHip

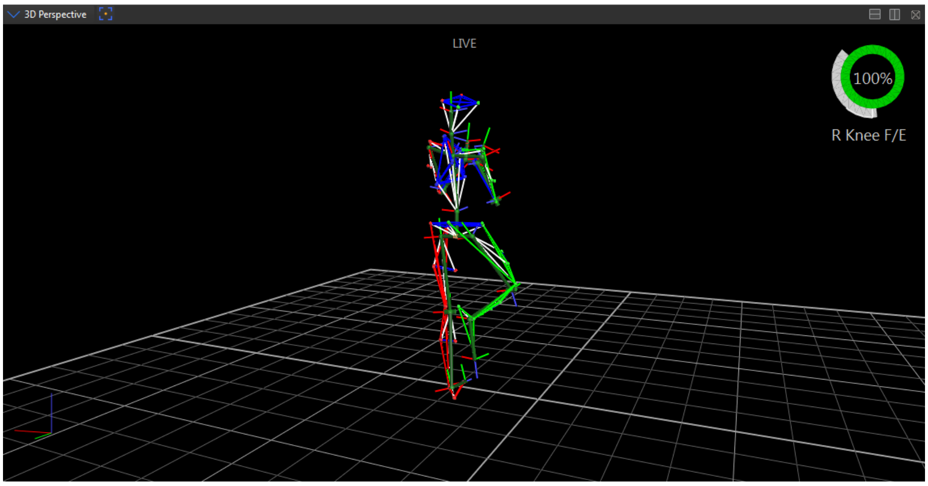
This step calibrates the left SCoRE hip joint center.

1. Prepare the subject to perform a star-arc movement pattern for the left hip.
2. Follow the same procedure as that of the right hip, but note that the **AGW LHip** trial type and the **AGW LHip** range monitor are automatically loaded.

Step 4: AGW RKnee

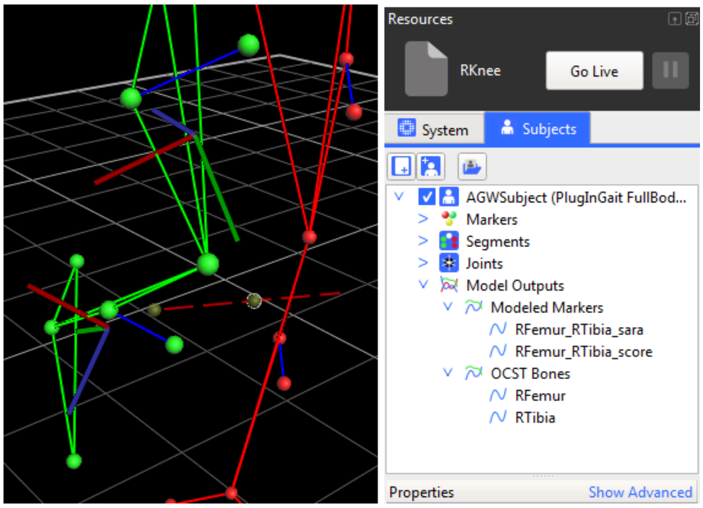
This step calibrates the right knee SARA flexion axis.

1. Prepare the subject to perform a knee flexion movement pattern for the right knee.
2. To begin capturing, click **Start**.The AGW RKnee trial type and the AGW RKnee range monitor are loaded automatically. The trial type starts the capture automatically, but you must stop the capture after the knee joint has moved about its flexion axis through the acceptable range.



3. When the joint range has been satisfied, stop the capture manually.
   The AGW RKnee pipeline runs automatically and the outcome is a calibrated right SARA knee flexion axis. The SCoRE knee joint center appears in the 3D Perspective view as a virtual point and is added to the subject's **Modeled Markers** node in the **Model Output** node. Because the knee joint range of motion is primarily about its flexion axis, the SCoRE joint center location is not as accurate as that of the hip. In this case, the knee joint center serves more appropriately as an endpoint of the knee flexion axis vector.

The SARA knee flexion axis appears in the **3D Perspective** view as the opposite endpoint of a vector formed along with the SCoRE knee joint center. The joint axis line appears in the **3D Perspective** view. The anatomical knee joint center estimation is expected to be defined by more conventional means, such as Plug-in Gait.



4. Review the virtual point location and check the **Log** tab for any errors.
5. If the results are acceptable, click **Accept** to move on to the next step, or to repeat the current step, click **Reject**. When you click **Accept**, the current offline trial is automatically saved, which updates the subject's *.mp* file with the calibrated data.

Step 5: AGW LKnee

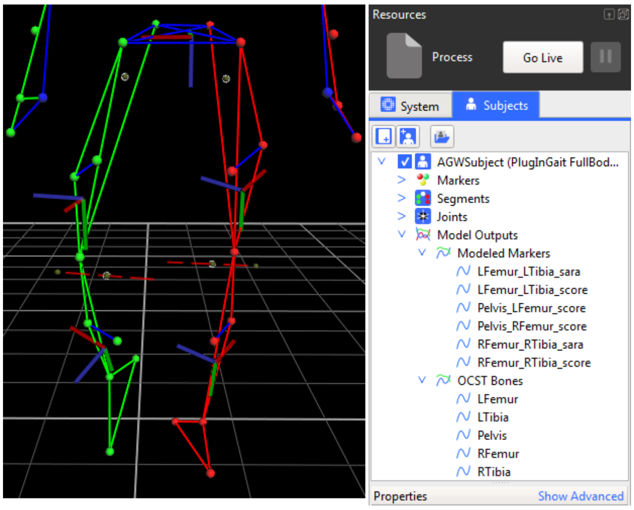
This step calibrates the left knee SARA flexion axis.

1. Prepare the subject to perform a knee flexion movement pattern for the left knee.
2. Follow the same procedure as that for the right hip, but note that the **AGW LKnee** trial type and the **AGW LKnee** range monitor are automatically loaded.

Step 6: AGW Process

This step captures and processes a dynamic trial.

1. Prepare the subject to perform the dynamic activity.
2. Because the SCoRE and SARA calibrations are complete and there is not a range monitor associated with the dynamic capture step, at this stage, if desired, you can switch the **Processing Output Level** of **Local Vicon System** back to **Labels**.
3. To begin the capture, click **Start**.
   The AGW Process trial type is loaded and the capture starts automatically.
4. When the trial activity is complete, stop the capture.
   The **AGW Process** pipeline is run automatically and the outcome is a reconstructed and labeled trial that includes the processed SCoRE hip joint centers and the SARA knee flexion axes.
   As in the calibration steps, these calculations are represented in the **3D Perspective** view as well as in the subject's **Modeled Markers** node.



Troubleshoot AGW reconstruction and labeling

If the captured data contains gaps or incorrect labels, you can adjust the settings of the **Combined Processing** operation, which is found in each of the relevant pipelines (see Advanced Gait Workflow files, page 101) to improve the reconstruction and labeling of the data.

Process a kinematic model with SCoRE and SARA

The SCoRE and SARA operations are solely joint calibrations and are not a full kinematic model. If you want to produce kinematic outputs (for example, Joint Angles), the Hip Joint locations and Knee flexion axes must be input into a secondary full kinematic model such as Plug-in Gait.

When Nexus is installed, a version of Plug-in Gait written in MATLAB is also installed. The following steps describes how to use this model to calculate Plug-in Gait variables that use SCoRE hip joint centers and SARA optimized knee axes as their foundation. You are assumed to have run through the Advanced Gait Workflow (see Run the Advanced Gait Workflow, page 106).

Using Plug-in Gait Matlab with SCoRE and SARA

Plug-in Gait Matlab has been created for research purposes and to allow the incorporation of SCoRE and SARA within the modeling process.

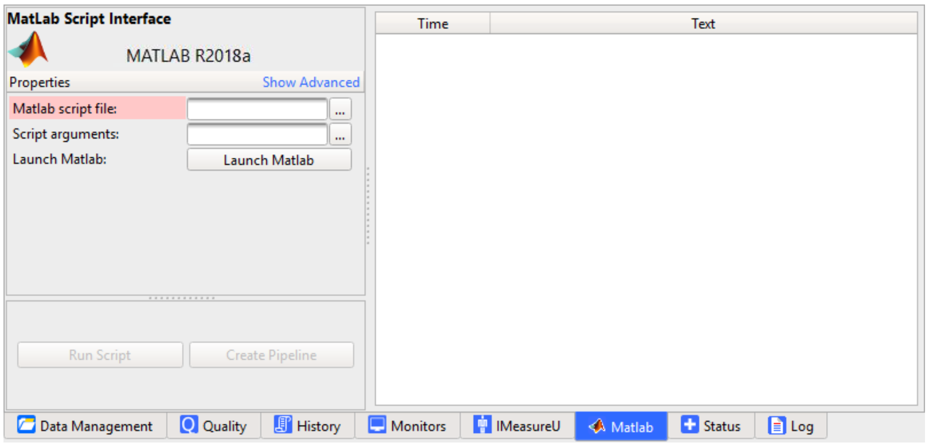
> **Important**
> To run PlugInGait Matlab, you need a valid MATLAB license.

To use Plug-in Gait Matlab with SCoRE and SARA, you run a static script followed by the dynamic script:

- Process static Plug-in Gait, page 115
- Process dynamic Plug-in Gait, page 118

Process static Plug-in Gait

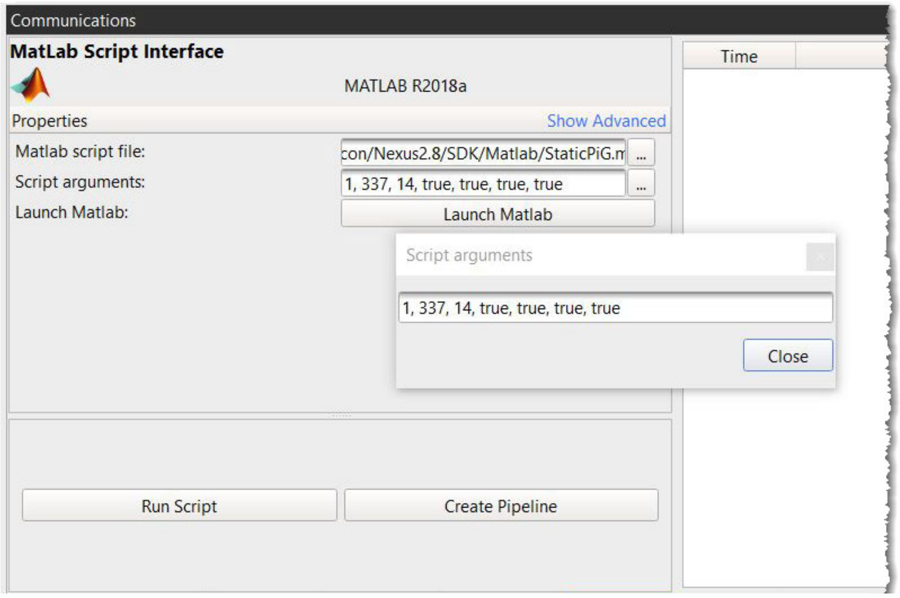
1. Load your static trial (created during Step 1: Static, page 107).
2. Run the **AGW Process** pipeline to calculate the SCoRE hip joint centers and SARA knee flexion axes outputs for the static trial.
3. Click on the **Matlab** tab.



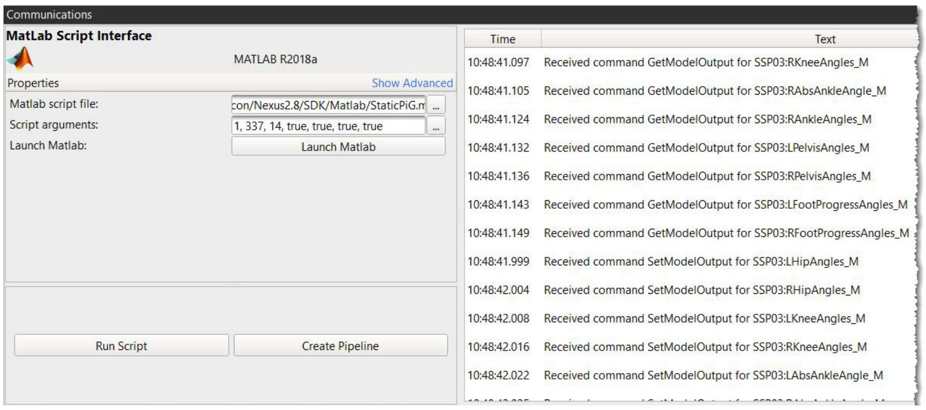
4. In the **Matlab script file** field, browse to *C:\Program Files\Vicon\Nexus2.#\SDK\MATLAB* and select *StaticPiG.m*.
5. In the **Script arguments** field enter the following values as a comma-separated string:
   - FirstFrame (a number)
   - LastFrame (a number)
   - MarkerSize (marker size in mm)
   - bAntTiltPos (true or false)
   - bLFootFlat (true or false)
   - bRFootFlat (true or false)
   - bHeadLevel (true or false)

Static example:

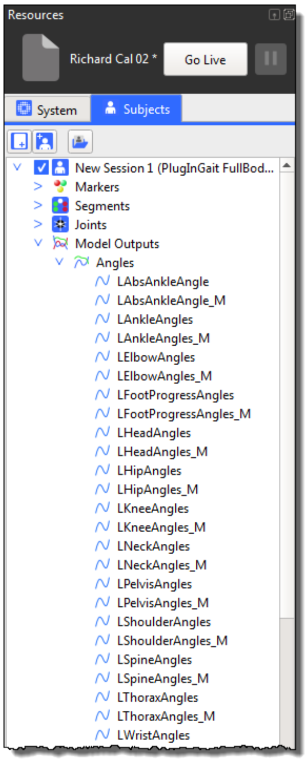
```
1, 337, 14, true, true, true, true
```



6. After you have entered all the required information, click **Run Script**. The log file displays the relevant feedback.



An extra set of Model Outputs are created - <AngleName>_M:



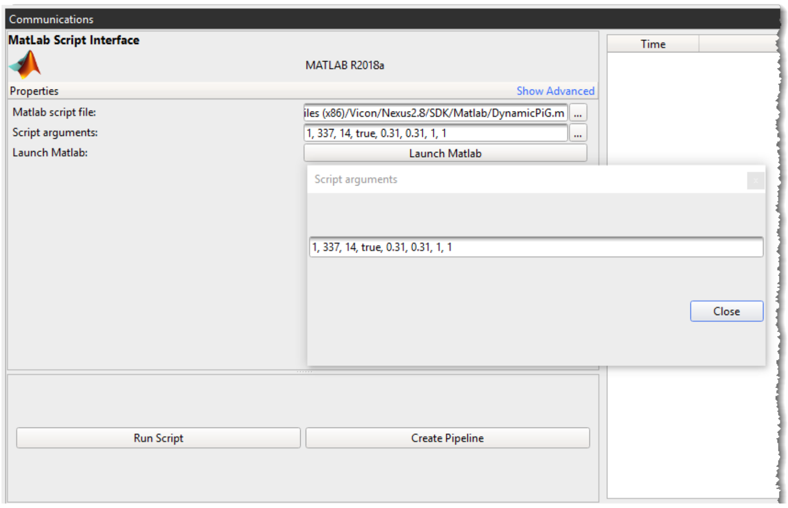
7. Save the trial.

Process dynamic Plug-in Gait

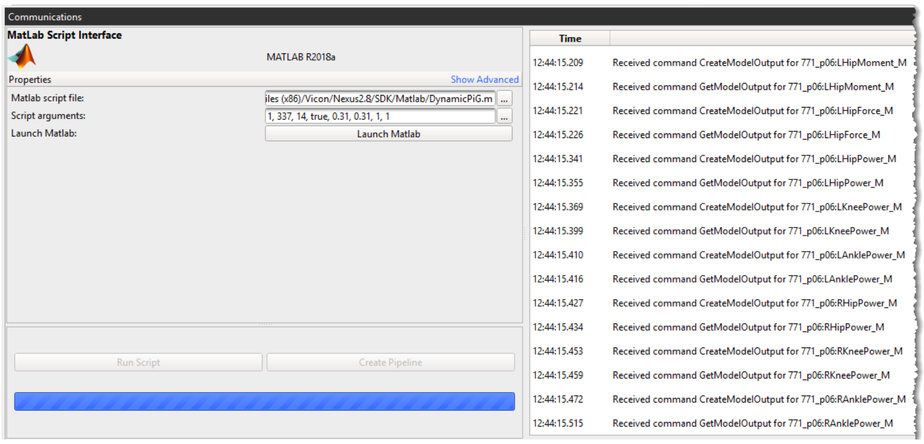
1. Load your dynamic trial (created in Step 6: Process, page 112).
2. Click on the **Matlab** tab.
3. In the **Matlab script** file field, browse to *C:\Program Files\Vicon\Nexus2.#\SDK\MATLAB* and select *DynamicPiG.m*.
4. In the **Script arguments** field, enter the following values as a comma-separated string:
   - FirstFrame (a number)
   - LastFrame (a number)
   - MarkerSize (marker size in mm)
   - bAntTiltPos (true or false)
   - PelvisROG (0.31)
   - ThoraxROG (0.31)
   - ReactionFrame (a number: 0=proximal segment, 1=distal segment, 2=global frame)
   - PowerOutput (a number: 1=single value power, 3=3-component power)
   - bAllowCrossPlateStrikes (true or false, optional, default false). When this variable is set to true, Plug-in Gait combines the dynamics of foot strikes that straddle two adjacent plates.

Dynamic example:

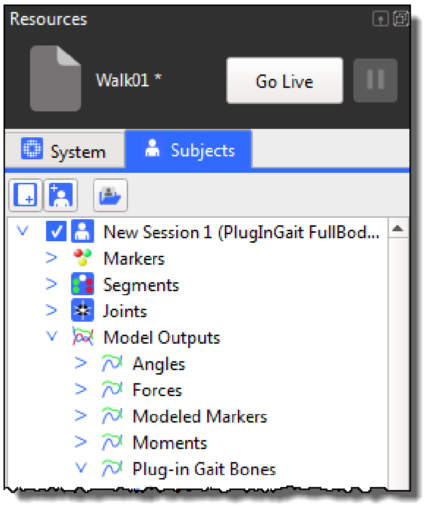
`1, 337, 14, true, 0.31, 0.31, 1, 1`



5. After you have entered all the required information, click **Run Script**.
   The **Log** file displays all the relevant feedback.



An extra set of **Model Outputs** is created: <AnglesName>_M, <ForcesName>_M, <ModeledMarkers>_M, <MomentsName>_M, <Plug-InGaitBonesName>_M, <PowerName>_M



6. Save the trial.

Using a custom biomechanics workflow

> Important
>
> The Optimum Common Shape Technique (OCST)[18], Symmetrical Center of Rotation Estimation (SCoRE)[19] and Symmetrical Axis of Rotation Analysis (SARA)[20] methods are based on research publications that can be obtained from Vicon on request. As the research and validation of the values produced by these methods is a continuing effort, it is recommended that OCST, SCoRE and SARA are used for investigative and research purposes. It is your responsibility to review the scientific references and understand the methods. Any use of the methods as part of a clinical assessment is strictly at your discretion.

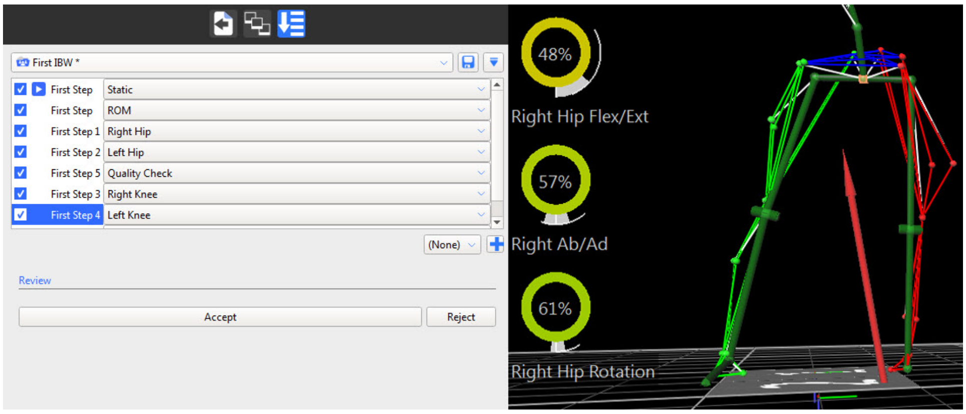
To help you use a biomechanics workflow, Nexus includes the Advanced Gait Workflow, which steps you through a series of trial captures and automated processes to enable you to use the calibrated OCST, SCoRE and SARA data to compute the hip joint centers and knee flexion axes for further analysis. You can use the workflow as supplied, or if required, you can modify it and the associated trial types, monitors and pipelines to suit your needs. For information, see Using the Advanced Gait Workflow, page 99.

If you need to set up a biomechanics workflow from scratch, see these topics.

18 http://www.gaitposture.com/article/S0966-6362%2810%2900129-3/abstract
19 http://www.jbiomech.com/article/S0021-9290%2806%2900415-5/abstract
20 http://www.jbiomech.com/article/S0021-9290%2805%2900446-X/abstract

Overview of the biomechanics workflow

The Biomechanics Workflow area is a powerful tool for simplifying and speeding up multi-step procedures, such as those involving SCoRE and SARA, the processing algorithms that can be used for hip and knee joint estimation.

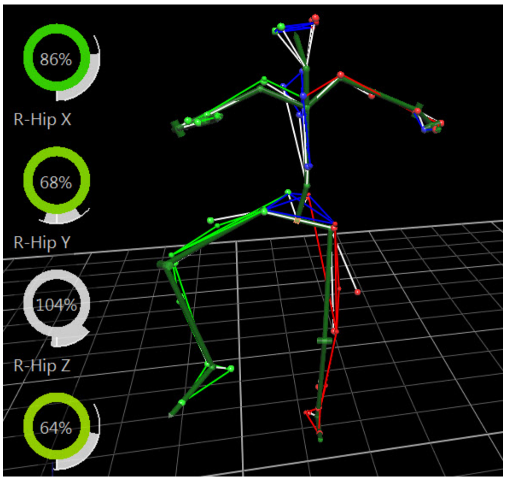


The biomechanics workflow enables you to:

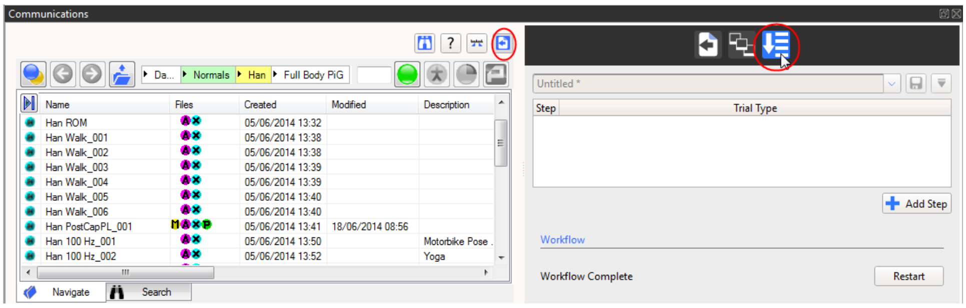
- Create a series of collection and processing steps for any set workflow.
- Specify capture settings for any step (a trial type, for example static, ROM, etc).
- Specify post-capture processing steps (post capture pipelines, for example, Reconstruct and Label).
- Associate real-time monitors (for example, joint range monitors) with a step.
- Accept or reject the results of each step with a single mouse click.

When you have set up all the steps in your biomechanics workflow, you can save it for future re-use. You can then apply the whole workflow or selected steps to your future work with Vicon Nexus, from capture right through to data export.

To use a biomechanics workflow that includes functional calibration, which is the recommended way of working, it is a good idea to begin by setting up joint range monitors to provide real-time subject calibration feedback. This is necessary, because, for functional calibration to work, you need to be sure that the ROM trial has included enough of the required movement to result in a successful subject calibration.



You can then include joint range monitors and define the steps required in your workflow, using the Biomechanics Workflow area on the **Data Management** tab in the **Communications** pane.



View real-time subject calibration feedback with monitors

Before you set up a biomechanics workflow that includes functional calibration, you can set up a joint range overlay monitor to provide instant visual feedback on how much joint movement the subject has performed during a ROM trial.

This is important because a minimum amount of angular movement (per joint) is needed to obtain the best possible calibration. Setting up a monitor enables you to decide immediately whether the ROM trial has captured enough range of joint movement to provide an accurate calibration.

> **Important**
> Although collecting the recommended/desired range does not *guarantee* a good calibration, obtaining positive feedback from a joint range monitor indicates that the ROM trial has the potential to provide a good calibration.

Create a joint range overlay monitor

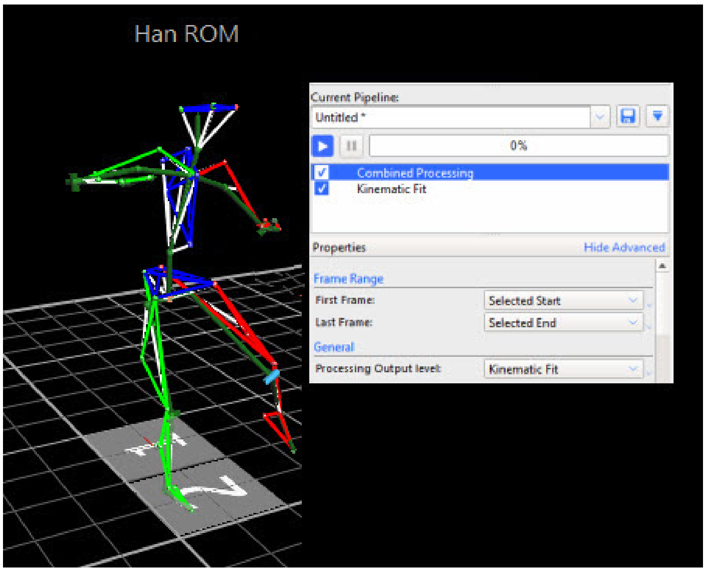
To create a joint range overlay monitor, you use a **Range Overlay** monitor, which is available from the **Actions** menu in the **Monitors** area.

Because you will be monitoring joint movement, you need to first ensure a **Kinematic Fit** operation has been run on the subject. You can then create the monitor for a joint movement range.

To create a joint range overlay monitor:

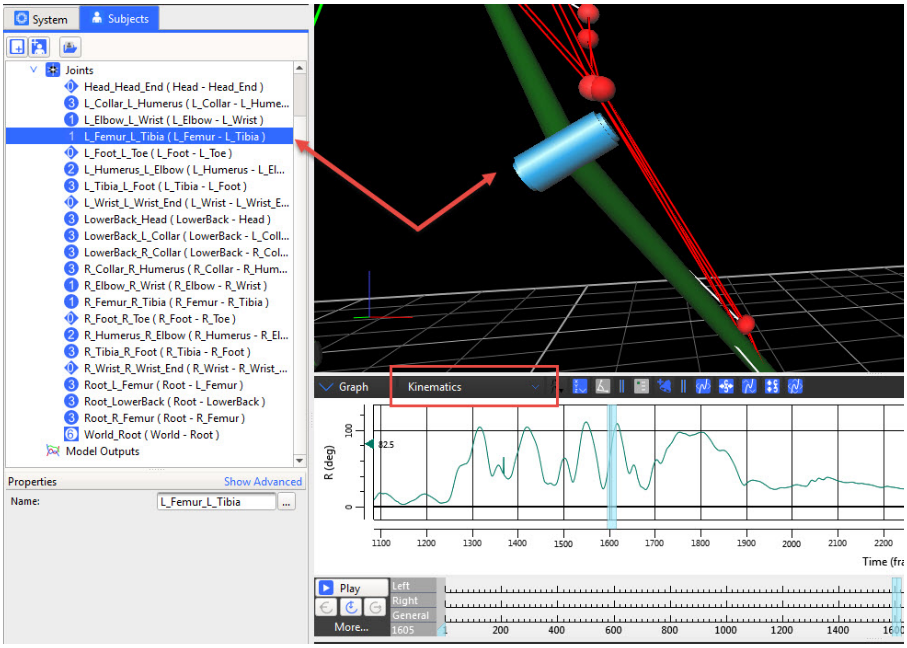
1. Load a ROM trial.
2. **Reconstruct and Label** the ROM trial.
3. Run a **Functional Skeleton Calibration** pipeline operation.
4. Kinematic fit the subject using a **Pipeline** operation under the **Core Processing** category. Choose one of:
   - **Kinematic Fit** (if the subject is already labeled); or
   - **Combined Processing** with the **Output** level set to **Kinematic Fit**.

   The following image shows a subject after kinematic fitting.

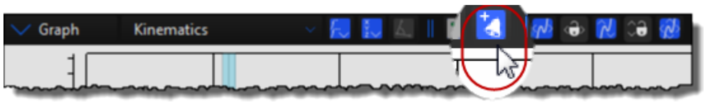
   

   The subject now shows the internal labeling skeleton, displaying joints, as well as the labeled markers and segments.
5. In the **Communications** pane, click on the **Monitors** tab to give it focus and ensure a **Graph** pane is displayed.

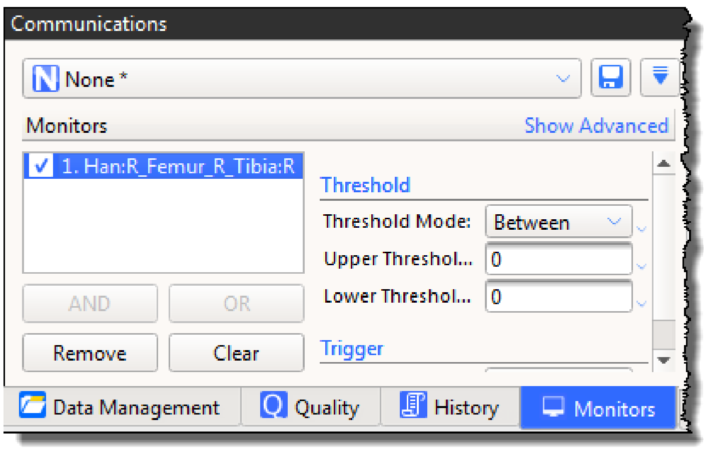
6. In either the **3D Perspective** view or in the **Subjects** Resources tree, click on a joint whose range you want to monitor.



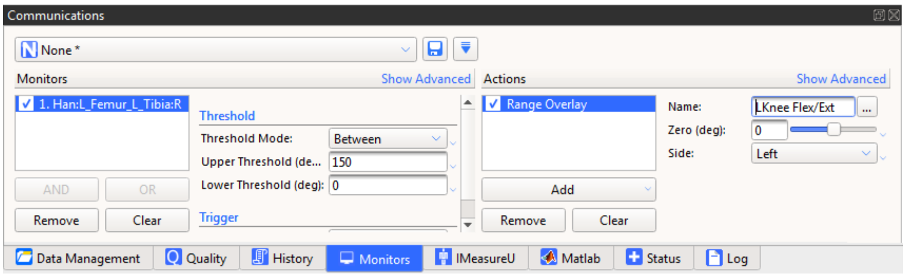
7. In the **Graph** pane, click the **Create a Monitor** button.



The new monitor is added to the Monitors list on the **Monitors** tab in the **Communications** pane.

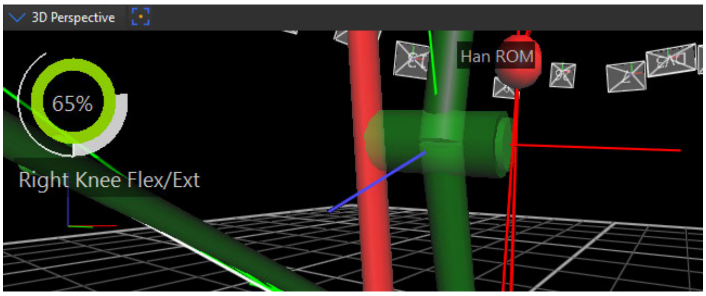


8. On the **Monitors** tab:
   a. Click on the new monitor to select it, and in the **Threshold** area, set the desired Range of Motion for the selected joint by specifying the **Threshold Mode**, and the upper and/or lower limits of the range to be monitored.
   Tip: To select the required range, look at the values in the **Graph** view and choose the highest and lowest values shown over the whole trial.
   b. In the **Actions** area, click **Add** and select Range Overlay from the list of monitor types
   c. Ensure the new action is selected (blue) and in the **Name** field, provide a descriptive name for your new monitor.



   The named monitor appears as an overlay in the Graph view.

9. Play through the trial to see the monitor working.As the trial progresses, the monitor reflects the collected range of motion for the selected joint.



   The nearer to 100% that is displayed by the monitor, the more of the required movement has been captured.

10. Save the configuration under a suitable name.
    You can use your new monitor for both Live and Offline trials and include it in a biomechanics workflow.

Note that you can use a monitor that was based on a particular subject, such as monitors for labeled trajectories, model outputs, joints, or segments, for other subjects that contain the same marker/segment/joint name. However, note the following restrictions:

- If multiple subjects are present, the monitor will only work with the original subject.
- The new subject must have the same marker/segment/joint name as was used to configure the monitor.
- The new subject must be the only active subject (that is, selected in the **System** tree) that contains that marker/segment/joint name.

About functional calibration in the biomechanics workflow

For calibration, the subject variables of interest: Kinematics (Joint Angles) and Kinetic (Forces, Moments and Powers), must be calculated from a joint center point and have a joint axis line to be accurate.

Nexus 2 provides functional joint calibration, which estimates the center and axis of a joint using joint movement collected in a Range of Motion (ROM) trial.

Because functional calibration requires you to be able to decide whether, for a particular ROM trial, you have collected the minimum amount of angular movement (per joint) needed to obtain a good calibration, it is a good idea to set up a joint range monitor to give you the instant visual feedback that enables you to make this decision quickly (for information on setting up a joint range monitor, see View real-time subject calibration feedback with monitors, page 124).

The biomechanics workflow enables you to include functional calibration and joint range monitors in your workflow steps, so that you can set up the required procedures once and then reuse them as required. For information on setting up a biomechanics workflow, see Create a biomechanics workflow, page 131.

For more information about the distinction between static and functional joint calibration, see the following definitions.

- What is static joint calibration?, page 130
- What is functional joint calibration?, page 130
- What is local optimization?, page 130

What is static joint calibration?

Static calibration uses a single frame of data. The subject is captured in a single pose (body position). Regression equations are used to estimate / calibrate:

- The location of a Virtual Joint Center point (relative to a segment)
- A line defining the axis of rotation for the Joint

Vicon's Plug-In Gait model uses static joint calibration.

What is functional joint calibration?

Functional joint calibration uses multiple frames of data where the joint of interest is moving (dynamic).
Using Range Of Motion (ROM) data from a joint enables functional joint calibration to better estimate the true center and axis of a joint.

What is local optimization?

The process of eliminating errors and finding the best solution for joint centers and axes is sometimes referred to as optimization.
Local optimization takes information from one joint at a time and tries to find the best solution only for that joint.
SCoRE and SARA are local optimization techniques. They are a set of algorithms produced by researchers at the University of Berlin – Julius Wollf Institute for Biomechanics and Musculoskeletal Regeneration.

Create a biomechanics workflow

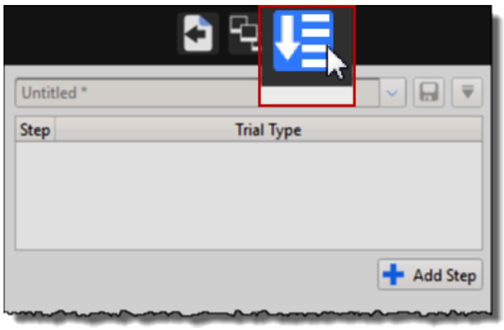
To create a biomechanics workflow, you use the Biomechanics Workflow area of the **Data Management** tab in the **Communications** window to associate specified data capture and processing steps with particular trial types, and monitors.

Before you begin adding the steps that will comprise your new workflow, make sure you have set up any required range monitors (see View real-time subject calibration feedback with monitors, page 124).

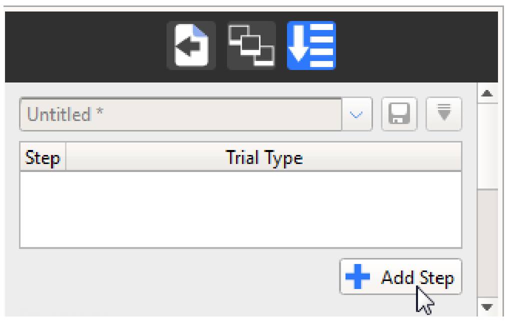
The following example shows you how to set up a biomechanics workflow that includes steps for a static capture, followed by a ROM capture coupled with a joint range monitor.

To create a new workflow:

1. On the **Data Management** tab in the **Communications** pane, open the File Transfer/Batch Processing interface .
2. Click the **Biomechanics Workflow** button.

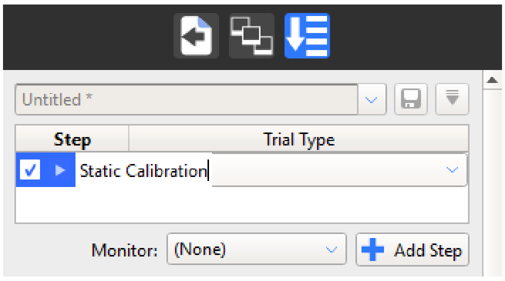


3. Click the **Add Step** button to add your first step.



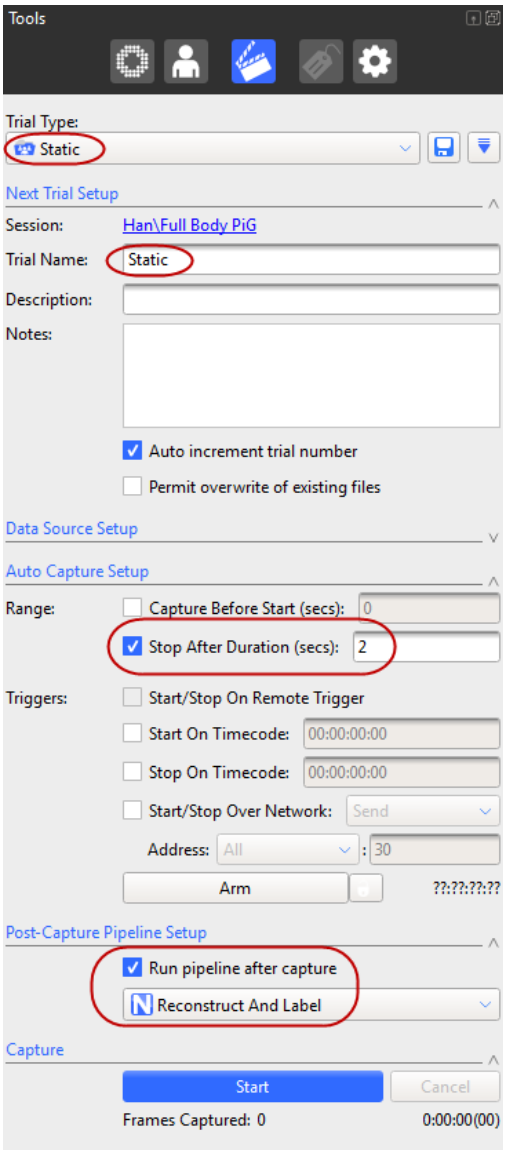
4. Double-click on the new step and add a name for it, in this case, Static Calibration.

   Tip: For each step, this name will be the name of the trial that is saved as a result of running the step.

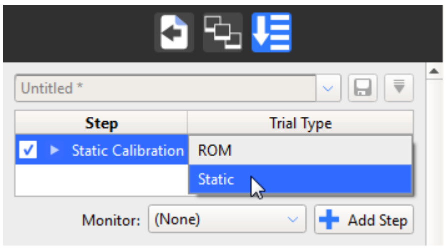


5. From the list of trial types to the right of the step name, select the required trial type for the step.
   If the trial type doesn't exist yet, switch to **Live** mode and on the **Capture** tools pane, specify the required settings for the trial type, for example, for a static trial:

   - **Name**: Static
   - **Duration of the capture**: 2 secs
   - **Run pipeline after capture:** Reconstruct and Label

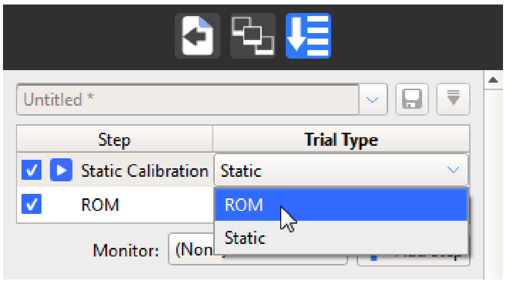


6. Save the new trial type and in the **Trial Type** list, select the new trial type (in this case **Static**).

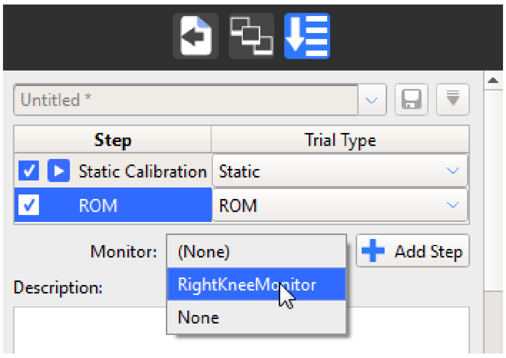


Now, every time you go to **Live** mode and run the new workflow, the first step will automatically capture a 2-second, static trial, and run the **Reconstruct and Label** pipeline afterwards. It will then automatically go to Offline mode and display buttons to enable you to accept or reject the result of the first step (the reconstructed and labeled trial).

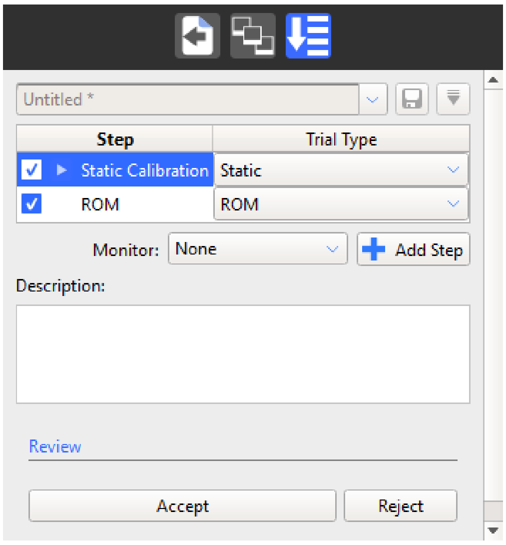
7. To set up step 2, in the **Biomechanics Workflow** area:
   a. Click **Add Step** again.
   b. In the **Step** column, type a name for the second step, in this case **ROM**.
   c. In the **Trial Type** list, select the required trial type, for example, ROM.
   If the ROM trial type doesn't exist yet, you will need to create it, using the same procedure as you used for creating a static trial type in the previous step. For a ROM trial, you may want to specify a different duration, or clear the **Auto Capture Setup** options so that you can start and stop the capture manually, when sufficient data has been collected.



8. To add a range monitor to your ROM step so that you can quickly assess whether to accept it, click the **Monitor** button, and from the list of available monitors, select the required monitor, for example, the one you created previously (see View real-time subject calibration feedback with monitors, page 124).



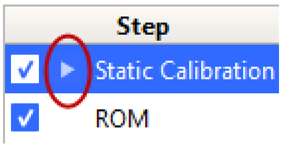
9. Continue adding steps, creating appropriate trial types as necessary, and adding monitors to help you make the Accept or Reject decision for each step, until you have completed your workflow.
   Tip: To reorder the steps, click on a step and drag it to the required position in the list.
10. To save the completed workflow, click the **Save current configuration** button  at the top of the Biomechanics Workflow area, and enter a suitable name for your new workflow.
11. To run your new workflow, change to **Live** mode and in the **Biomechanics Workflow** area, in the **Step** column, right-click on the step that you want to start from (normally the first step), and select **Set Step**.
12. Click **Start**.
    When the step has run, Nexus automatically goes to **Offline** mode and the **Biomechanics Workflow** area displays buttons to enable you to accept or reject the result of the step.



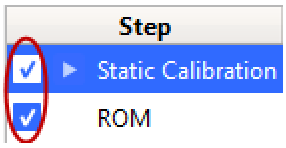
If you click **Accept**, the next step, is run. If you click **Reject**, Nexus returns to Live mode, so that you can perform another capture.

Tips for creating biomechanics workflow steps

- When you run through the biomechanics workflow, the Play icon is displayed next to the current step, so that you can instantly see where you are in the workflow.



- In a similar way to running pipeline operations in the Pipeline tools pane, you can select or clear the check boxes next to each step to run only the required steps.



- If necessary, you can reorder the steps by dragging steps up or down in the Biomechanics Workflow area.

About SCoRE and SARA in Vicon Nexus

The SCoRe and SARA operations are provided with Vicon Nexus 2 for research purposes and to enable clinical researchers to assess their use, compared with other methods. You can download the literature for these methods from the Vicon website or obtain it from the group at the University of Berlin. Before using these methods, you are strongly advised to review the published material to understand the methods and best practices for gaining meaningful results.

A review of this literature suggests that for the joints of the lower limbs, SCoRE can produce a meaningful estimation of hip joint center locations. The axes produced by the SARA optimization may not be useful. This is due to ball and socket nature of the joint.

The opposite is suggested for the hinge-link knee joint. The SARA-optimized axis (primary flex/ext axis) may be useful; however the joint center location may not be strictly defined along this axis.

To allow further development and validation of these methods, Nexus does not restrict where they can be run. The operations allow the calculation of SCoRE and SARA for any combination of parent and child segments.

> **Important**
> You are responsible for reviewing the published articles before using these operations. Research is continuing the area of functional joint calibration and it is solely your responsibility as the user to determine whether the results from these methods are appropriate for your research outcomes or clinical use.

By combining SCoRE and SARA with an existing Plug-in Gait model, you can obtain full kinematic and kinetic outputs with reduced errors.

> **Note**
> To apply SCoRE and SARA to Plug-in Gait, you need to obtain the Plug-in Gait MATLAB script. For more information, contact Vicon Support[21].

21 mailto:support@vicon.com

About SCoRE

SCoRE is an acronym for Symmetrical Center of Rotation Estimation.

It is an optimization algorithm that uses functional calibration frames between a parent and child segment to estimate the center point of rotation. It is particularly valuable in providing repeatable and -accurate hip joint center locations.

SCoRE locates the joint center only. Kinematics and kinetics must still be calculated by a full biomechanical model (such as Plug-in Gait).

About SARA

SARA is an acronym for Symmetrical Axis of Rotation Analysis.

It is an optimization algorithm that uses functional calibration frames between a parent and child segment to estimate the axis of rotation. It is particularly valuable in providing repeatable and accurate knee joint axes.

SARA locates the joint axis only. Kinematics and kinetics must still be calculated by a full biomechanical model (such as Plug-in Gait).

Prepare data for use with SCoRE and SARA

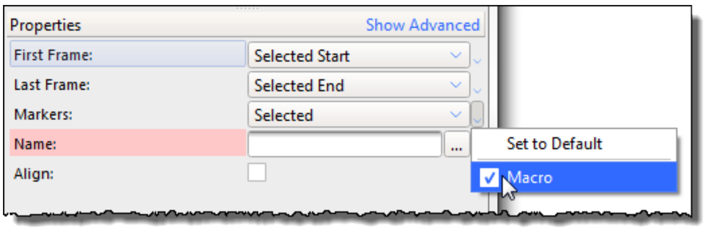
OCST is a mathematical approach that finds the average or common shape for selected sets of marker (3 or more). It enables a non rigid cluster (skin-based) to be described as if it were truly rigid.

> **Important**
> Although marker clusters that are attached to a truly rigid base do not necessarily require OSCT processing to provide rigidity, if you want to include the supplied SCoRE and SARA pipeline operations as part of your workflow, use of the **Calibrate OCST** and **Process OCST** operations is recommended to provide the best possible results.

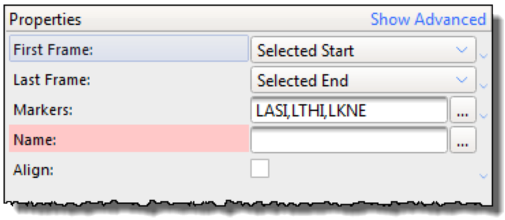
For related research, see OCST, SCoRE and SARA research references, page 152.

To create a segment using OSCT:

1. Load the trial containing the markers whose positions are to be calculated using OCST. These markers will form the segments that will be used in SCoRE and SARA pipeline operations.
2. In the **Pipeline** tools pane, from the **Subject Calibration** pipeline operations, double-click the **Calibrate OCST** operation to add it to the current pipeline.
3. Click on **Calibrate OCST** and in the **Properties** pane ensure the required start and end frames, together with the required markers (at least three) are specified. To select the required markers, in the **3D Perspective** view, CTRL+click or ALT+drag the markers (at least three per segment).
   If you have **Markers** set to **Selected** in the **Properties** pane, to check that you have selected the required markers:
   a. In the **Properties** pane for **Calibrate OCST**, click the small arrow to the right of the **Markers** field and clear the **Macro** check box.



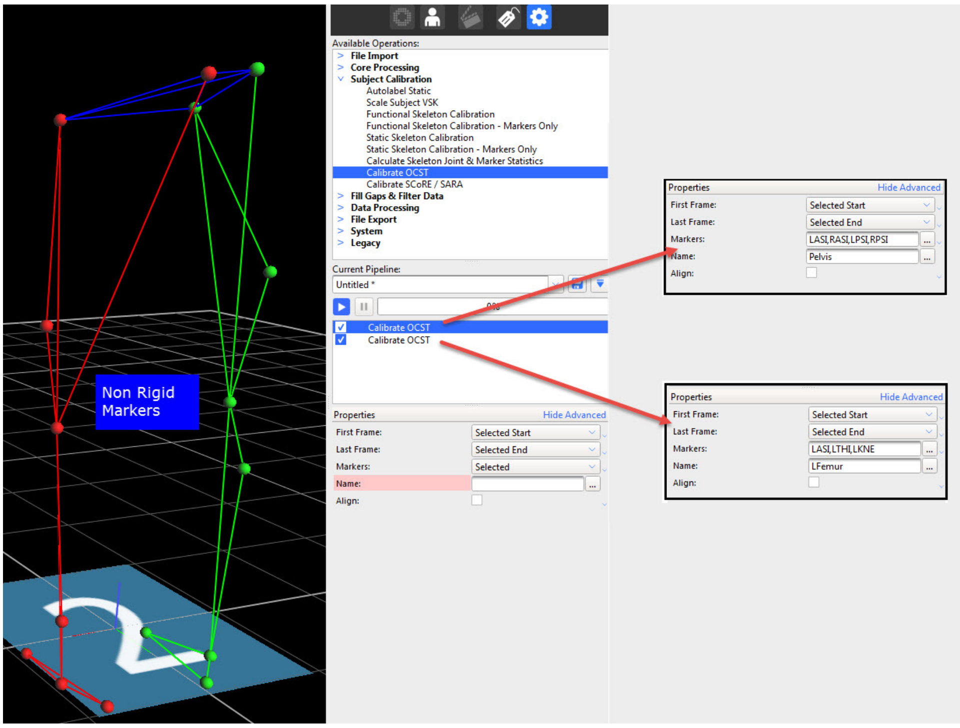
You can now see the selected marker names in the **Markers** field.



b. When you have made sure you have selected the required markers, re-select **Macro** again.

4. In the **Name** field, enter a name for the segment to be created by OCST.
5. To create the new segment, run the pipeline.

In the following example, OCST segments called Pelvis and LFemur are created.



The new OCST segment names (Pelvis and LFemur in the above example) can now be passed into SCoRE and SARA pipeline operations.

Capture and process a trial with SCoRE and SARA

You can use the biomechanics workflow to simplify and speed up the capturing and processing of data that requires a number of repeated steps, and can include trial types, range monitors and post-processing pipelines. This makes it a particularly useful tool if you want to use the new SCoRE and SARA pipeline operations that are included in Vicon Nexus 2, as you can save any required ROM trial types, including joint range monitors, OCST pipeline operations, and any other processing needed, in a single workflow.

Advice was sought from research labs in the biomechanics community who use the SCoRE and SARA methodologies in their clinical assessments. The recommended Vicon Nexus 2 workflow for using these functional joint calibrations is derived from this advice.

To apply SCoRE and SARA to Plug-in Gait, you need to obtain the Plug-in Gait MATLAB script. For more information, contact Vicon Support[22].

For more information, see:

- Collecting data for use with SCoRE and SARA, page 142
- Capturing hip and knee ROMs, page 142
- Using SCoRE and SARA, page 143

22 mailto:support@vicon.com

Collecting data for use with SCoRE and SARA

You can capture trials in the following ways:

- One joint per trial, that is separate trials for each hip and knee (Left Hip, Right Hip, Left Knee, Right Knee); or
- A single ROM trial that includes joint movement for all four joints

Collecting a single ROM trial can save time in both capture and processing. However, some pathological subjects may require assistance in completing a joint ROM, so this is not always an option and multiple ROMs may be needed. The biomechanics workflow provides a way of performing the ROMs in one or multiple trials and saving the workflow so that it can be easily repeated and results obtained with the minimum of effort.

Capturing hip and knee ROMs

The goal with either hip or knee joints is to move the joint through as much of its entire range as possible.

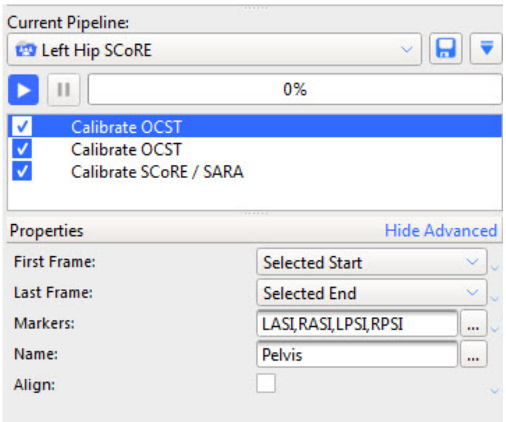
- Knees are basically hinge joints with flexion and extension. Flexing and extending the knee through its full range is all that is required to capture the required motion.
- Hips are ball joints. When capturing a ROM for hip joints, the recommended approach is to have the subject (on their own or with assistance) perform a 'star arc'. This involves swinging the leg directly forward, then back to the static position, then to the side at a forty-five degree angle to the first swing, and back, and so on, round in a circle.

Using SCoRE and SARA

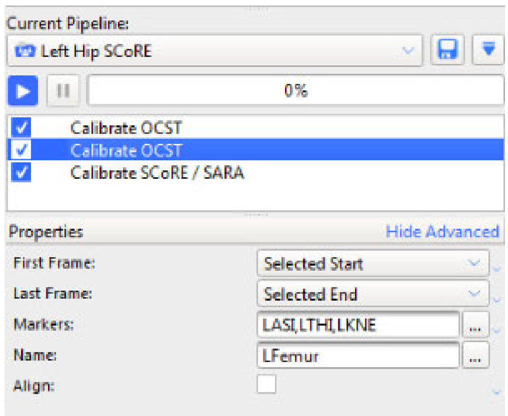
Before you run a **Calibrate SCoRE/SARA** pipeline operation, specify and run a **Calibrate OCST** pipeline operation on the relevant data, as described in the following steps.

To use SCoRE and SARA:

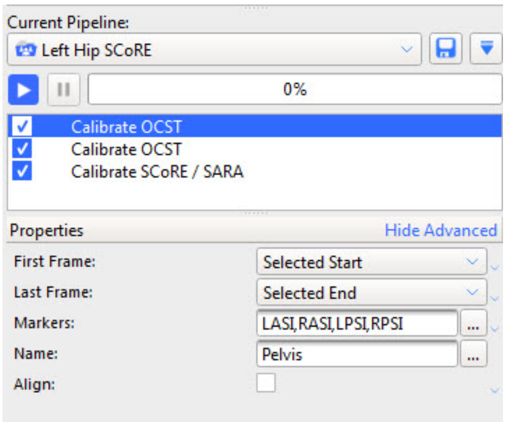
1. Create a pipeline that includes all the necessary operations:
   - A Calibrate OCST operation that specifies the parent segment (for example, Pelvis), by selecting at least three markers (for example, LASI, RASI, LPSI, RPSI). For information on how to do this, see (see Prepare data for use with SCoRE and SARA, page 139).



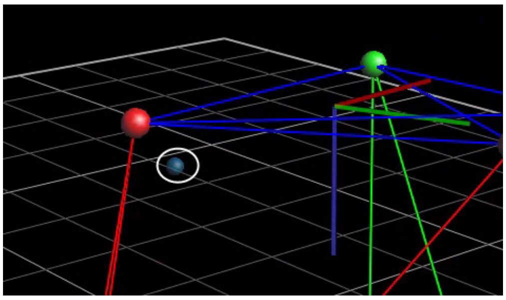
   - A Calibrate OCST operation that specifies the child segment (for example, LFemur), by selecting at least three markers (for example, LASI, LTHI, LKNE).



- A Calibrate SCoRE/SARA operation that creates a joint center between the specified parent (Pelvis) and child (LFemur).



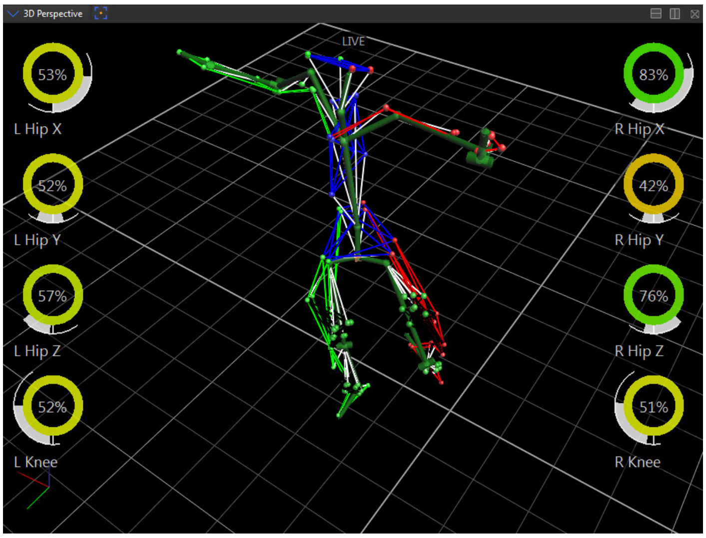
2. Run the pipeline.
   In the **3D Perspective** view, you can see an additional SCoRE (or SARA) marker.



Process multiple joints with SCoRE and SARA

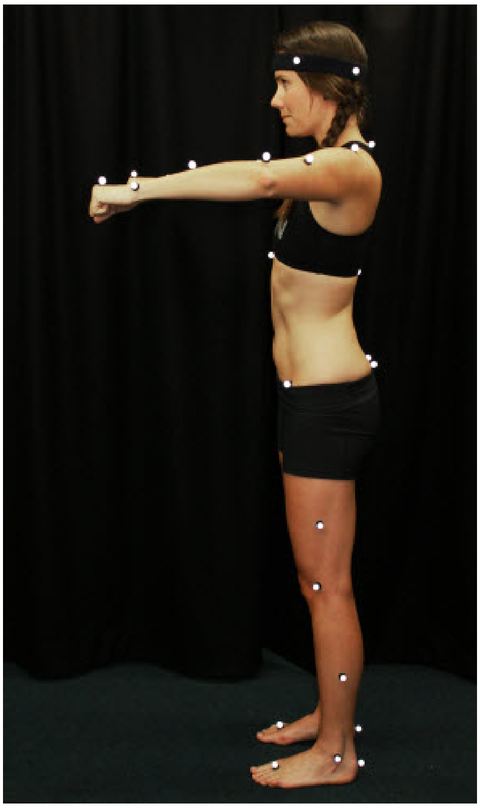
The following steps show how to calculate SCoRe joint centers and SARA knee axes in the same workflow. Including both hips and knees in the same workflow saves time, but relies on having a subject who can perform the required ROMs reasonably easily and without much assistance.

Before you begin, make sure you have set up monitors to display all the required range of motion for both hips and knees. (For information on setting up joint range monitors, see View real-time subject calibration feedback with monitors, page 124.)

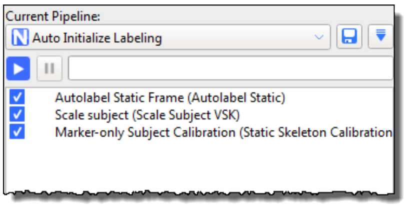


To calculate SCoRE joint centers and SARA knee axes:

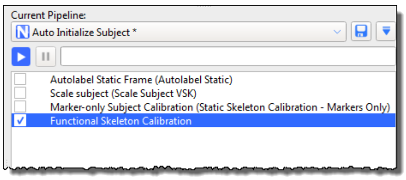
1. Capture a subject ROM. Ensure that, for the first few frames and last few frames, the subject is in the motorbike pose, as shown in the following images.



2. Reconstruct the trial and then run the **Auto Initialize Labeling** pipeline on the first frame of data (motorbike pose) to initialize the labeling.

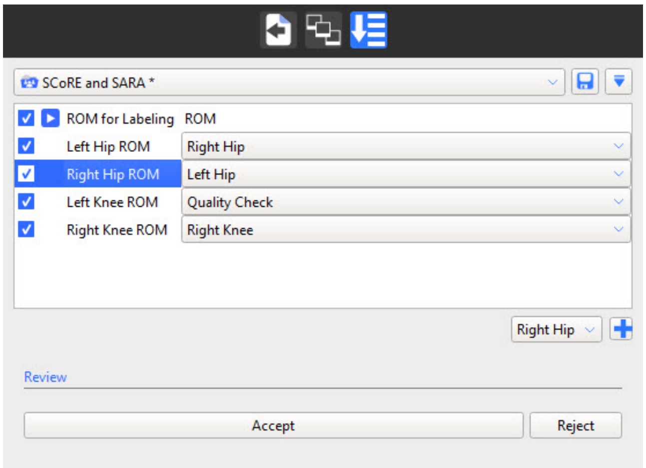


3. Run the **Functional Skeleton Calibration** pipeline operation (found in the **Subject Calibration** pipeline operations) to calibrate the labeling skeleton.



4. Capture ROM trials that move the hip joint and knee joints through a ROM, as described in Capture and process a trial with SCoRE and SARA, page 141.To enable you to quickly assess the ROMs for multiple SCoRE and SARA trials,

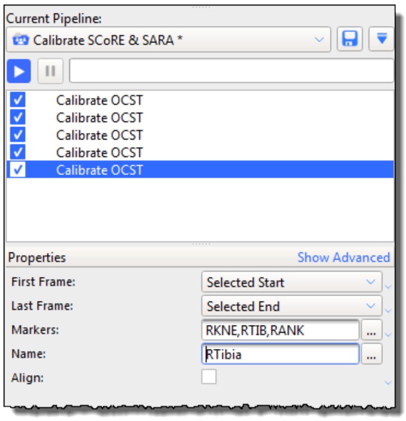
you can set up a biomechanics workflow, including joint range monitors, similar to the following:



For information on setting up a biomechanics workflow, see Create a biomechanics workflow, page 131.

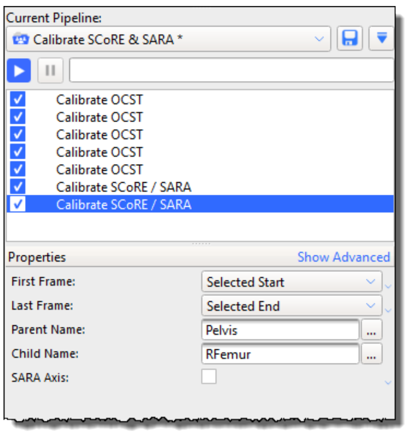
5. Run the **Reconstruct and Label** pipeline.
6. Create a new pipeline to contain the SCoRE/SARA calibrations you will need, plus any required OCST calibrations. For example, you could call the pipeline **Calibrate SCoRE & SARA**.
7. Add the required **Calibrate OCST** pipeline operations to the new pipeline (see Prepare data for use with SCoRE and SARA, page 139).
8. Specify OCST segments for all the required joints, for example:
   - Pelvis (LASI, RASI, LPSI, RPSI)
   - LFemur (LASI, LTHI, LKNE)
   - LTibia (LKNE, LTIB, LANK)
   - RFemur (RASI, RTHI, RKNE)
   - RTibia (RKNE, RTIB, RANK)

Your new pipeline will now look similar to this:



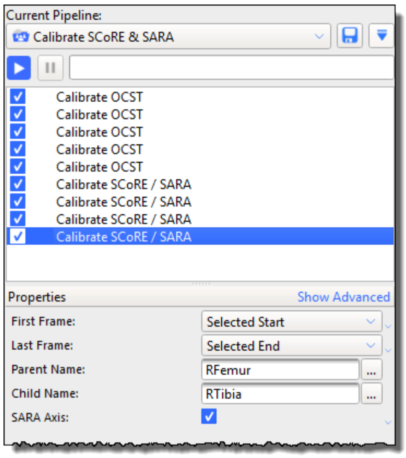
9. For each joint, add a **Calibrate SCoRE/SARA** operation (found in the **Subject Calibration** pipeline operations), and specify each parent and child segment, for example:
   - For left hip:
     Parent Name: Pelvis;
     Child Name: LFemur
   - For right hip:
     Parent Name: Pelvis
     Child Name: RFemur

   For these two joints, leave the **SARA Axis** check box cleared, as it is normally more applicable to the knee joints.



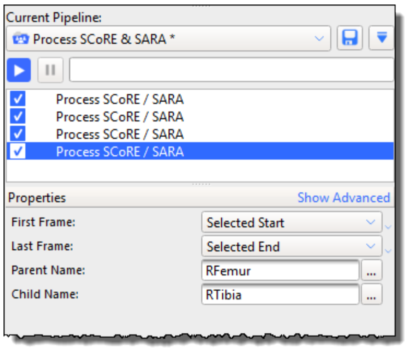
10. Add two more Calibrate SCoRE/SARA operations for the knee joints:
    - For the left knee:
      Parent Name: LFemur
      Child Name: LTibia
    - For the right knee:
      Parent Name: RFemur
      Child Name: RTibia

    For these two joints, select the **SARA Axis** check box, as it is applicable to the knee joints.



11. Save the pipeline and calibrate the joints by running the **Calibrate OCST** and **Calibrate SCoRE/SARA** pipeline operations.
    New hip and knee joint markers are displayed in the **3D Perspective** view.
12. Collect dynamic trials with the subject performing the required movement (walking, etc).
13. Create a new **Process SCoRE & SARA** pipeline to contain the processing operations.

14. For each SCoRE/SARA joint that you created previously, add a **Process SCoRE/SARA** operation (found in **Data Processing** pipeline operations). Specify the same **Parent** and **Child** segments as those you created in the **Calibrate SCoRE & SARA** pipeline.



15. Run the processing pipeline.

OCST, SCoRE and SARA research references

1. On intrinsic equivalences of the finite helical axis, the instantaneous helical axis, and the SARA approach. A mathematical perspective[23]. R .M. Ehrig and M. O. Heller, *Journal of Biomechanics* 84 (2019) 4–10
2. Repeatability and reproducibility of OSSCA, a functional approach for assessing the kinematics of the lower limb[24]. W. R. Taylor, E. I. Kornaropoulos, G. N. Duda, S. Kratzenstein, R. M. Ehrig, A. Arampatzis, M. O. Heller. publ. *Gait & Posture* 32 (2010) 231–236
3. A survey of formal methods for determining functional joint axes[25]. Rainald M. Ehrig, William R. Taylor, Georg N. Duda, Markus O. Heller. *Journal of Biomechanics* 40 (2007) 2150–2157
4. A survey of formal methods for determining the centre of rotation of ball joints[26]. Rainald M. Ehrig, William R. Taylor, Georg N. Duda, Markus O. Heller. *Journal of Biomechanics* 39 (2006) 2798–2809

23 https://www.sciencedirect.com/science/article/pii/S0021929018309333?via%3Dihub
24 http://www.gaitposture.com/article/S0966-6362(10)00129-3/abstract
25 http://www.jbiomech.com/article/S0021-9290(06)00415-5/abstract
26 http://www.jbiomech.com/article/S0021-9290(05)00446-X/abstract

Improve manual labeling

In addition to the procedures described in Review trials and fill gaps in the *Vicon Nexus User Guide*, if your data contains overlapping trajectories and/or ghost markers, you may need to do some further work.

For more information, see:

- Eliminate overlapping trajectories, page 154
- Prevent ghost markers, page 155

Eliminate overlapping trajectories

Nexus recognizes a marker's trajectory continuously throughout a captured trial. There can be gaps in the data, but Nexus can still recognize the same marker trajectory on either side of a gap, as long as the gap is small enough or the marker's movement doesn't vary significantly within the gap.

Occasionally, instead of a gap or a continuous marker trajectory, Nexus creates two separate sub-trajectory sections that belong to the same marker. This is called an overlapping trajectory, because the two sections overlap; that is, they are both present in the same frame(s).

During the labeling process, because both trajectories are present in the same frame(s), Nexus assumes that they must belong to separate markers. Therefore, when Nexus auto-labels these trajectory sections, it labels one and leaves the other unlabeled.

Overlapping trajectories can cause difficulties during manual labeling. One common difficulty occurs when two markers are correctly labeled at the start of the trial but then become confused or "swapped" later in the trial.

If you attempt to correct this label swap with **Whole** selected in the **Manual Labeling** section of the **Label/Edit Tools** (the default setting), you may lose correct labels early in the trial. The easiest way around this issue is by clicking the **Backward** or **Forward** button before labeling, so that labeling is only continued in the frames before or after the current frame.

When this labeling method is used, Nexus "snips" the trajectory at the current frame and only labels in the direction chosen (forward in time or backward in time from the current frame). The process of snipping a trajectory causes a single continuous trajectory to be split into two separate unique trajectories at the current time frame.

Prevent ghost markers

The typical cause of overlapping trajectories is spurious, or ghost, markers that are present during marker reconstruction. A ghost marker is a false marker reconstruction that appears as an additional trajectory very close to a legitimate marker trajectory. Ghost markers can be reconstructed if:

- The Nexus Core Processor settings are not optimized for the type of capture you are performing. For example, if a **Reconstruction Minimum Separation** is set too low, Nexus may reconstruct all detected marker positions rather than selecting only the best candidates.
  Depending on whether you want to adjust the Core Processor settings for offlline data or live capture:
  - If you don't want to recapture the trial you are processing, adjust the Offline processing parameters and reprocess the existing trial to see if Nexus resolves the overlapping trajectory. You set offline processing parameters in the **Core Processing** operations in the **Pipeline Tools** pane.
  - You may also need to evaluate whether future captures will be similar enough to the current trial conditions (such as subject movements, marker placement and movement, number of cameras, etc.), that adjusting the Live Core Processor settings will eliminate the issue in future. To set live processing parameters, in the **System Resources** pane, click on **Local Vicon System** and in the **Properties** pane go to the **General** section and select the required **Processing Output Level**.
- One or more cameras need to be recalibrated, eg, if one or more cameras has been accidentally knocked since it was calibrated. For details, see Understand camera calibration refinement, page 312.
- Camera masking is inadequate or has not been performed. For details, see Mask unwanted reflections in the *Vicon Nexus User Guide*.

After you have addressed the above issues, reprocess the trial before proceeding.

If adjusting the reconstruction parameters and reprocessing do not produce a properly labeled trajectory, you may need to manipulate the trajectory sections manually.

Eye tracking with Vicon Nexus

The following eye tracking solutions are available with Vicon Nexus:

- Use Tobii Eye Tracker with Nexus, page 157
- Use Dikablis Eye Tracker with Nexus, page 168

Use Tobii Eye Tracker with Nexus

You can include a Tobii Eye Tracker in your Vicon Nexus system, enabling you to output eye tracker position and gaze direction.

> Restrictions:
> - Tobii integration is for only Tobii Pro Glasses 2 and Tobii Pro Glasses 3.
> - For Tobii Pro Glasses 2, the use of only one pair of glasses at a time is supported.
> - For Tobii Pro Glasses 3, the use of multiple devices is supported, but has received limited testing. For details on how to integrate multiple devices, please contact Vicon Support[27].
> - For a combination of Tobii Pro Glasses 2 and 3, you can use one pair of Tobii Pro Glasses 2 with multiple pairs of Tobii Pro Glasses 3.

To include Tobii Pro Glasses in your Vicon Nexus system, complete these procedures:

- Set up Tobii Pro Glasses, page 158
- Integrate Tobii Pro Glasses into Nexus, page 159

For details of Tobii Pro Glasses properties, see Tobii Pro Glasses node, page 259.

Before you begin, ensure your Nexus system is calibrated and that you have created a subject.

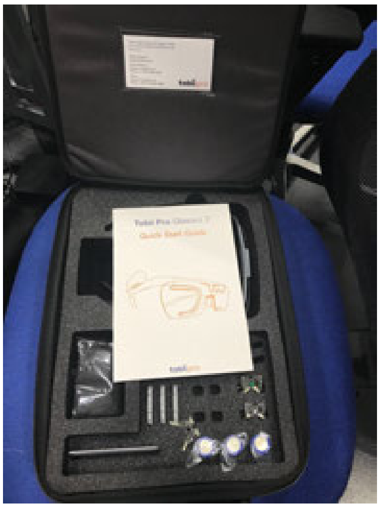
> Terminology
> For Tobii Pro Glasses 2, the controller software is called 'Tobii Pro Glasses Controller software'. For Tobii Pro Glasses 3, the equivalent software is called 'Glasses 3'. In the following instructions, the term 'Tobii Glasses software' is used to refer to both versions.

27 mailto:support@vicon.com

Set up Tobii Pro Glasses

To set up your Tobii Pro Glasses for use with Nexus:

1. Follow the instructions provided by Tobii. The quick start guide provided in the Tobii Pro Glasses box provides instructions on preparing and connecting the glasses to the recording unit.



2. To use Tobii Glasses software, connect the Tobii Pro Glasses, either through Ethernet or WiFi, by following the instructions provided by Tobii.
   When setting up networking connection properties for an Ethernet port, ensure that you select the required option:
   - For Tobii Pro Glasses 2, select Internet Protocol Version 6 (TCP/IPv6).
   - For Tobii Pro Glasses 3, you can select Internet Protocol Version 4 or Internet Protocol Version 6
3. Calibrate the glasses in the Tobii Glasses software.
   This enables you to check the fit of the glasses before connecting to Nexus.
4. After calibration is complete, close the Tobii Glasses software.

> **Note**
> Note that the recording unit requires batteries. A battery charger is provided, however, please ensure sufficient charging time. The recording unit requires only one battery, but takes 5+ hours charging time for a full charge.

Integrate Tobii Pro Glasses into Nexus

> **Important**
> Before attempting to connect Tobii Pro Glasses 3, ensure that you installed Bonjour, which is an option (selected by default) when you installed Nexus, and that the Bonjour service is running (Task Manager > Services > Bonjour Service).
> Connection may take up to 20 seconds, as Bonjour broadcasts the available services at intervals.
> If you need to start the Bonjour service after you've added the Tobii Pro Glasses in Nexus, either remove and re-add the device or restart Nexus after the service has been restarted.

Connect a Tobii Pro Glasses 3 recording unit to the Nexus computer

To connect the Tobii recording unit to the Nexus computer, it must be able to obtain a valid IP address (IPv4 or IPv6).

To enable this, we recommend the following workflow, starting with connecting via Ethernet. Note that this method requires a valid DHCP router. (If you don't have access to a router, see Other connection methods, page 161.)

Connect via Ethernet:

From the router (such as a D-Link), connect via Ethernet to:

- An Ethernet network port on the Nexus computer
- The RJ45 port on the Tobii recording unit

If you don't need to connect the Tobii Pro Glasses 3 via Wi-Fi, you can now add the Tobii glasses into Nexus, page 162.

Connect via Wi-Fi:

1. Ensure you have successfully connected the Tobii recording unit via Ethernet, as described above.
2. Browse to *http://*<recording unit serial number>*.local/network.html*.
3. Either create a new Wi-Fi configuration or select an existing one. To create a new one:
   a. Under **WiFi**, click **Create**
   b. Set the SSID, network security type, and password, if required.
   c. Click **Apply**.
4. Disconnect the Ethernet cable.

> **Important**
> With this method, whenever the Tobii is powered down, it resets to the default Wi-Fi configuration. You must reconnect to the device (via direct Wi-Fi or an Ethernet connection) and choose the correct Wi-Fi configuration each time the recording unit is powered on.

Other connection methods

If you want to use an alternative way to connect the Tobii Pro (for example, if you don't have access to a router), you may find the following additional information helpful.

- Connect to the Tobii 3 directly via Wi-Fi, page 161
- Connect to the Tobii 3 using a direct Ethernet link, page 161

Connect to the Tobii 3 directly via Wi-Fi

If you use this connection method, the Tobii Pro Glasses 3 recording unit acts as an Access Point so any device with a spare Wi-Fi card can connect.

- SSID = <recording unit serial number> (eg, TG03B-080200013621)
- Default password = *TobiiGlasses*

> **Important**
> This option, while allowing connection to the recording unit for configuration purposes, does not provide the neccessary Zeroconf services, which are used by Tobii Pro 3 Glasses to advertise their availability on the network. Do not use this method to add the device into Nexus as it will not be found.

Connect to the Tobii 3 using a direct Ethernet link

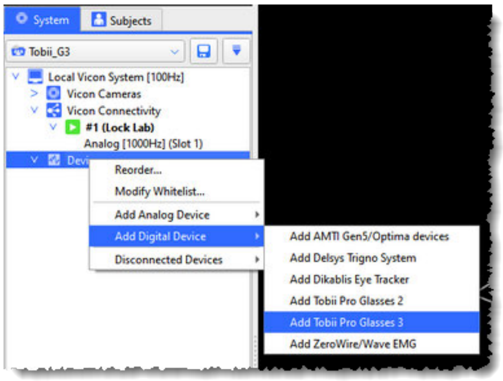
This connection method requires some config on the device first:

1. Connect to the Tobii via one of the methods above.
   - If connection is via the direct Wifi connection, go to http://192.168.75.51/network.html (assuming no other config has been done to change the default IP address)
   - If connection is via Ethernet, go to *http://*<recording unit serial number>*.local*
2. Do one of the following:
   - Under the wired network settings at the bottom of the page, change the profile to `default-link-local` and click **Apply**; or
   - Configure the Tobii to be a DHCP server.
3. Connect the Tobii 3 directly to the PC via Ethernet.

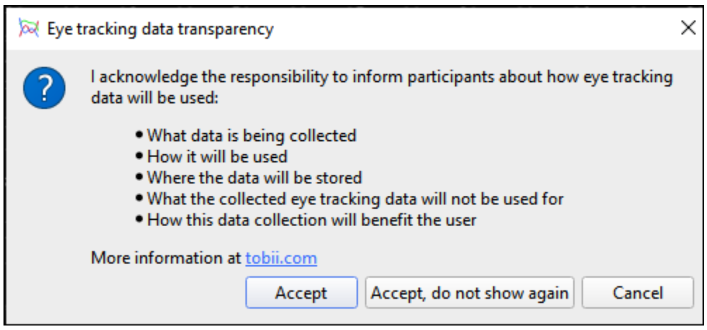
Add the Tobii glasses into Nexus

To add the Tobii Pro Glasses device into Nexus:

1. Ensure the Tobii recording unit is connected to the Nexus computer via Ethernet or WiFi (see Connect a Tobii recording unit to the Nexus computer, page 160).
2. Ensure that the Tobii glasses are being worn by a subject in the volume. (Tobii glasses connect to Nexus only when the glasses are worn: if no eye is detected, the device is gray in the System Resources tree.)
3. In the **System Resources** tree, right-click **Devices**, point to **Add Digital Device** and then select **Add Tobii Pro Glasses 2** or **Add Tobii Pro Glasses 3**.



With Nexus 2.12 and later, when you first create a Tobii Pro 3 or Tobii Pro 2 device, a pop-up is displayed.

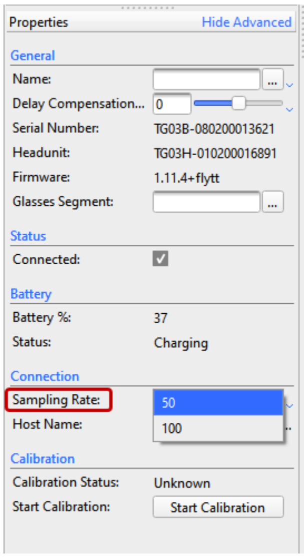


To continue, select from the displayed options:

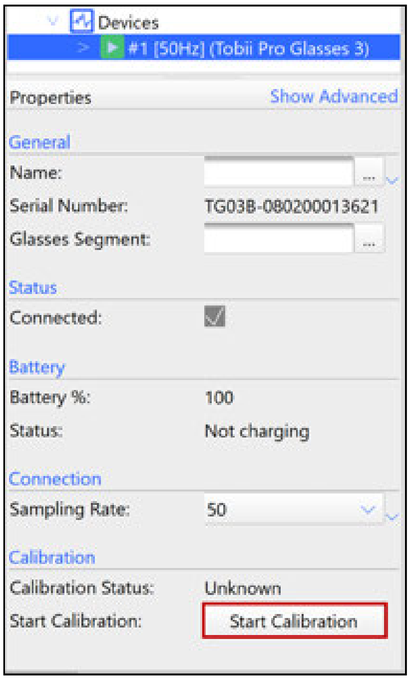
- Accept - No further pop-ups are displayed until Nexus is restarted.
- Accept, do not show again - No further pop-ups are displayed until a later version of Nexus is used.
- Cancel - No device is created and the pop-up is displayed again if the you try to create a new Tobii device.

If you selected either of the Accept options, Nexus searches for the glasses on the network. When the glasses are discovered, data begins streaming in Nexus.
Note that this process can take some time.

4. With the Tobii Pro Glasses device selected in the System tree, in the Properties pane, ensure that in the Sampling Rate field, the required sample rate is selected.

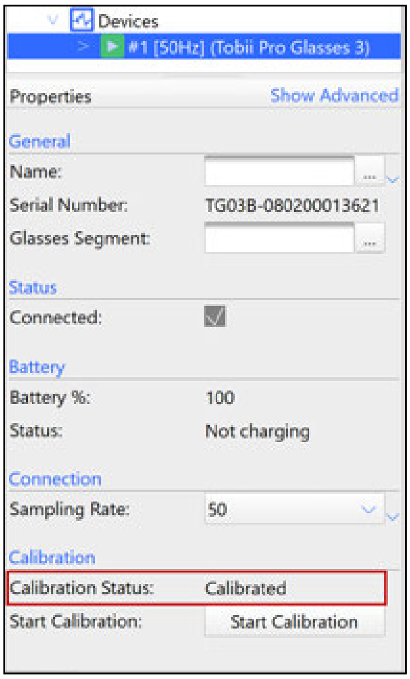


5. Before capturing data, for each subject, perform a calibration on each subject in the same way as it is done in the Tobii Glasses software.
   a. Instruct the subject to look at the calibration card, with the card held between 0.5 m and 1.5 m from the subject (for correct placement of the card, see the Tobii documentation).
   b. In the System Resources tree, ensure the required Tobii Pro Glasses device is selected and in the Properties pane, go to the Calibration section and click Start Calibration.



Ensure the subject continues to look at the calibration card. After approximately three seconds, status information is displayed, with a success or fail status at the end of the process.

- If calibration is successful, the **Calibration Status** changes to **calibrated**.
- If calibration fails, see Possible calibration issues, page 167 for a list of suggested issues, and correct any issues that you identify.

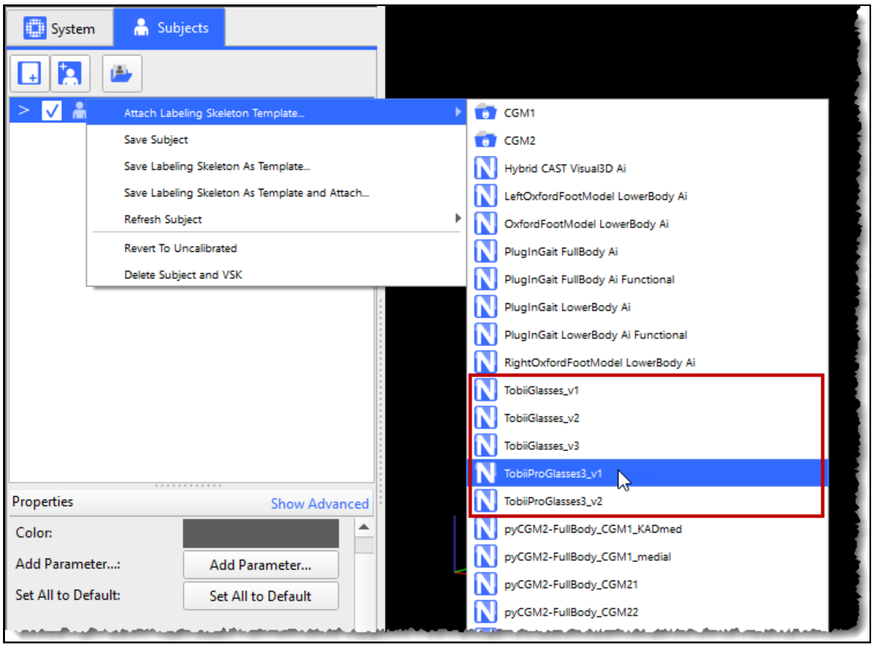


Note that, for Tobii Pro Glasses 2, data that is needed for calibration is created on the SD card and is deleted when the device is deleted. If the connection is lost, projects and participants may be left on the SD card.If no data is received for approximately one second, it is assumed that the connection has been lost and the device reverts to 'discovery' mode to try to re-connect to the device when it becomes available again.

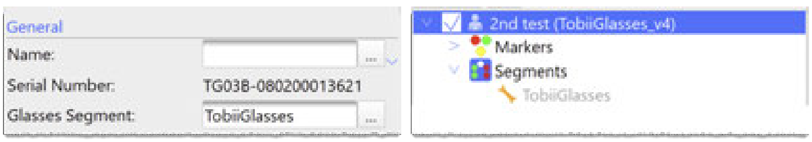
6. The Tobii Pro Glasses 3 mocap integration kit is provided as two marker tree attachments. Attach the mocap integration kit by screwing it into the fittings on the frame of the glasses.
   The Nexus installer provides two VSTs for the two variants of these marker trees. If you require more subjects, you can interchange the left/right trees from each of these two sets . For additional VSTs, contact Vicon Support[28] .

28 mailto:support@vicon.com

7. Load the appropriate VST. The relevant VSTs for the version of the integration kit provided in your Tobii Pro Glasses box are found in:
C:\Program Files\Vicon\Nexus2.#\ModelTemplates



8. To visualize the gaze data in the Nexus workspace, with the Tobii Pro Glasses device selected in the System tree, go to the **General** section of the **Properties** pane and set the **Glasses Segment** to the name of the segment that the glasses are attached to.



Note that specification of the Glasses Segment is not a requirement for receiving the data from the glasses: it is used for visualization in the Nexus workspace only. Also note that if multiple Tobii Pro Glasses are in use, you must ensure that the subjects have unique segment names. To do this, for each eye tracker, in the Glasses Segment field, specify the subject name followed by a colon and the segment name, for example, `SubjectAGlasses:TobiiGlasses` and `SubjectBGlasses:TobiiGlasses`.

9. Ensure that Nexus is running in **Kinematic Fit** processing mode. The eyes are displayed relative to the glasses segment at positions specified by the Left/Right Eye X,Y,Z components, and gaze direction is shown as a line from each eye to the Gaze position.
   The eye itself also rotates to match the Left/Right Gaze value, though this may be difficult to observe.

For details of the resulting data that is reported by Nexus, see Understand output data, page 167 .

Possible calibration issues

If calibration was not successful, check for these possible issues:

- Calibration card is too close (<0.5m).
- Calibration card is too far away (>1.5m).
- The subject is not looking at the calibration card.
- There are multiple possible calibration targets (multiple cards or objects that look like cards, or the card is visible in the displayed video that is also in view).
- There is too much movement of the eye tracker or card during calibration.

Understand data output

Tobii Pro Glasses outputs are available for:

- **Left(Right) Eye** X, Y, Z position of the eye with respect to the origin of the glasses segment/scene camera and the diameter of the pupil
- **Left(Right) Gaze** A three-component vector specifying the direction of the gaze for the eye
- **Gaze position** The calculated point of focus for the combined gaze with respect to the origin of the glasses segment/scene camera

Use Dikablis Eye Tracker with Nexus

The Dikablis Eye Tracking system, when combined with a Vicon motion capture system, enables you to calculate the head position and 3D gaze vector of a test subject. It is compatible with current Vicon cameras. A minimum of two cameras are required for use with the system.

The Dikablis Eye Tracking unit is available in either wired or wireless options. The wireless unit provides unlimited mobility and allows the test subject to move within a perimeter of up to 800 meters.

For more information, see:

- Set up Dikablis eye tracking hardware, page 169
- Add a Dikablis Eye Tracker device in Vicon Nexus, page 171
- Calibrate Dikablis eye tracking in Vicon Nexus, page 172
- Export Dikablis eye vector data, page 179

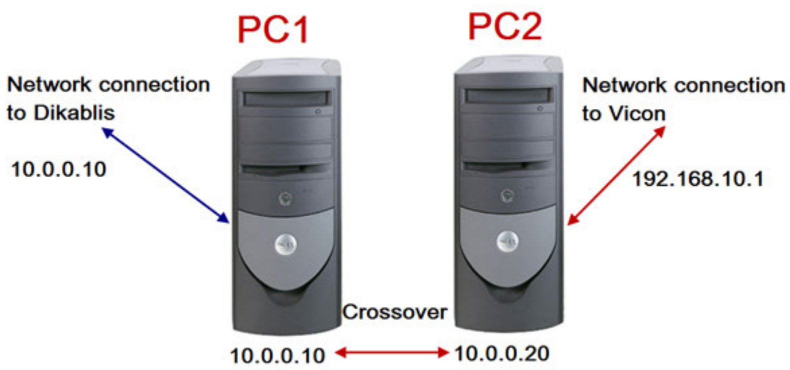
Set up Dikablis eye tracking hardware

Before setting up your Dikablis Eye Tracking system with Vicon Nexus, ensure the following system components are ready for use:

- Head unit
- Dikablis laptop
- Ethernet cable or crossover cable
- Battery pack and wireless transmitter (for wireless option), with battery fully charged
- Dikablis wireless receiver (for wireless option)

Although you can capture both Vicon data and Dikablis gaze data on a single PC, a dual-computer setup is recommended, where:

- The Dikablis laptop connects to the head unit and runs the Dikablis software.
- The desktop computer is connected to the Vicon system and runs Nexus.
- The Dikablis laptop is directly connected to the Nexus PC via a cable that runs between two Ethernet ports.



> **Note**
> Before proceeding, ensure the battery is fully charged. When fitting the battery into its holder, make sure the battery is correctly oriented by first inserting the end with the contact points and then clicking the other end into place in the holder. For further instructions on setting up the hardware, see the *Dikablis Eye Tracker User Manual*.

Ensure the Dikablis Eye Tracking system is calibrated

Before you add a Dikablis Eye Tracker device to Vicon Nexus, set up the Dikablis laptop and ensure that eye tracking is calibrated, so that the pupil is tracked accurately by Dikablis Recorder.

To ensure the Dikablis Eye Tracking system is calibrated:

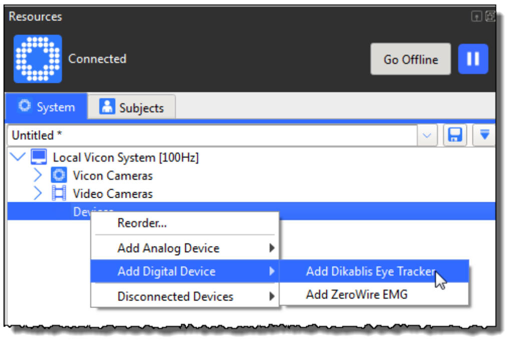
1. Turn on the Dikablis laptop.
2. Double-click the **Dikablis Recorder** icon on the desktop to start the software.
3. Attach the head unit to the subject's head (for instructions, see the *Dikablis Eye Tracker User Manual*).
4. In **Dikablis Recorder**, ensure that a cross hair appears on subject's pupil and that the pupil is accurately tracked (for instructions, see the *Dikablis Eye Tracker User Manual*).

Add a Dikablis Eye Tracker device in Vicon Nexus

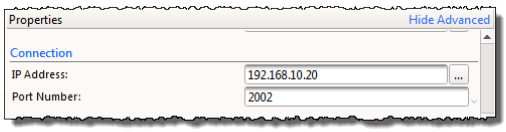
After you have verified that the Dikablis Eye Tracking system is calibrated, add the Dikablis Eye Tracker in Nexus as a device.

To add eye tracking in Nexus:

1. In the **System** resources pane, click the **Go Live** button.
2. Right-click **Devices**, point to **Add Digital Device**, and select **Add Dikablis Eye Tracker**. A **Dikablis Eye Tracker** node appears under **Devices.**



3. Click **the Dikablis Eye Tracker** node that you just added to select it and in the **Properties** pane, set the following communication parameters in the **Connection** section:
   - **IP Address**: Use the same IP address that has been set in the Dikablis eye tracking software.
   - **Port Number**: Leave as default (2002).



4. If the connection and IP address are correct, the Dikablis Eye Tracker icon in the **System** resources tree turns green. This indicates that Nexus is able to communicate with and receive the data stream from the Dikablis laptop.
5. With the head unit attached to the subject, display a **Graph** view in Nexus and ensure that a line is displayed charting the pupil coordinates.

Data begins streaming from the Dikablis software when it is in Record mode.

Calibrate Dikablis eye tracking in Vicon Nexus

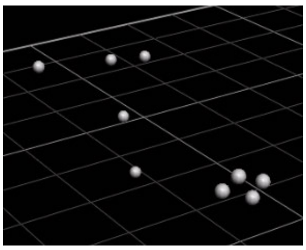
Before capturing an eye tracking trial, you must calibrate eye tracking within Nexus. To do this, complete the following procedures in the order shown:

- Set up a calibration trial for eye-tracking, page 172
- Create objects for eye tracking in Vicon Nexus, page 173
- Specify Dikablis Eye Tracker device properties, page 176
- Calibrate eye tracking in Vicon Nexus, page 177

Set up a calibration trial for eye-tracking

To set up a Vicon Nexus calibration trial for eye-tracking:

1. Before you begin a calibration trial for eye-tracking, ensure you have calibrated your Vicon cameras, set the volume origin, and added the Dikablis device to Nexus.
2. Get your subject to enter the volume wearing the head unit with markers, and holding the calibration wand in front of them.
3. In the **Capture** tools pane, in the **Next Trial Setup** section, enter a **Trial Name** (for example, Calibration), and in the **Capture** section, click **Start** to capture a short trial (a couple of seconds).
4. Load the trial you just created (on the **Data Management** tab (F2), double-click on the trial) and on the Nexus toolbar, click the **Reconstruct** button .
5. In **3D Perspective** view, zoom in so you can see the two objects (subject and wand).



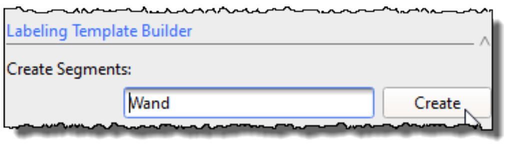
Create objects for eye tracking in Vicon Nexus

To set up a calibration trial for eye tracking, you need to create wand and head objects.

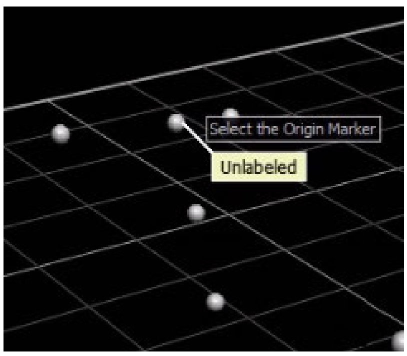
To create the objects in Nexus:

1. On the **Subjects** resources pane, click the **Create a blank subject** button.

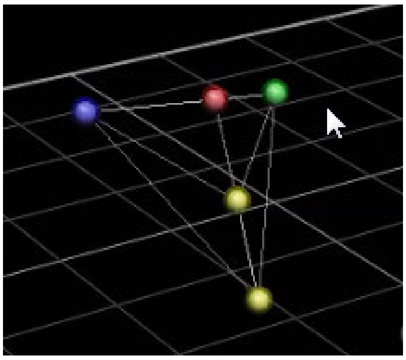
2. In the **Enter Subject Name** dialog box, enter the subject name: `Wand`.
3. On the **Subjects** tab, click the **Wand** object you just created to select it and at the top of the **Subject Preparation** tools pane on the right of the screen, in the **Subject** dropdown menu, ensure **Wand** is selected.
4. In the **Subject Preparation** tools pane, in the **Labeling Template Builder** section, enter a segment name (Wand) in the **Create Segments** box and click **Create**.



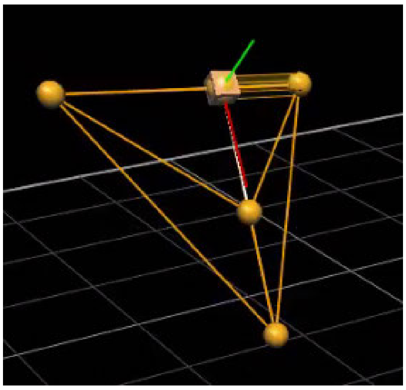
5. In a **3D Perspective** view, select the wand markers, beginning with the origin (middle) marker.



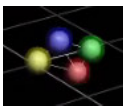
6. Ensure all the wand markers are selected.



7. In the **Labeling Template Builder** section, click **Create** again.
8. In the **3D Perspective** view, check the axes and origin are shown for the wand.

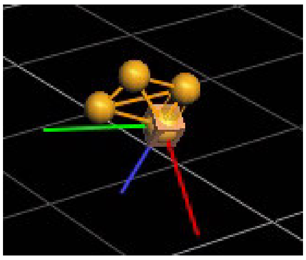


9. To create a head object, in the **Subjects Resources** pane, click the **Create a blank subject** button and in the **Enter Subject Name** dialog box, enter Head.
10. On the **Subjects** resources pane, click the **Head** object you just created and at the top of the **Subject Preparation** tools pane, ensure **Head** is selected.
11. In the **Labeling Template Builder** section, in the **Create Segments** box, type Head and click **Create**.
12. In the **3D Perspective** view, select the head markers, beginning with the origin marker. For the head's origin marker, select the marker closest to the eyeball, then select the others.



13. In the **Labeling Template Builder** section, click **Create** again.

14. In the **3D Perspective** view, check the axes and origin are shown for the new object.

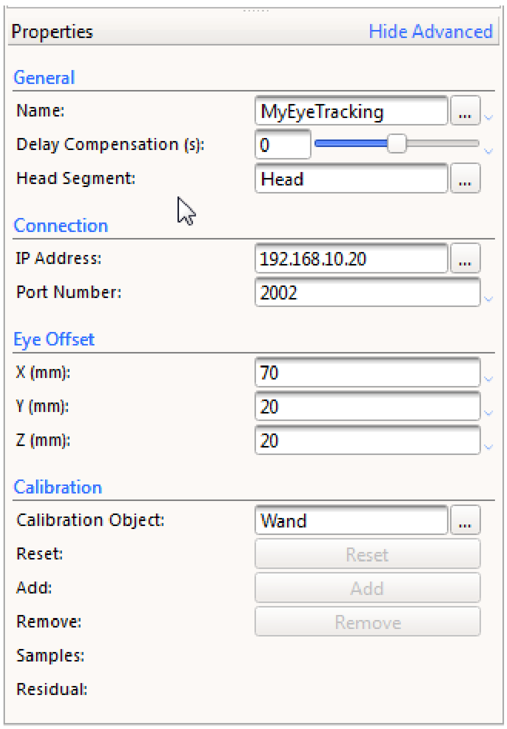


15. Before proceeding, it is a good idea to save both subjects (Wand and Head). To do this, on the **Subjects Resources** pane, right-click on the node for each subject in turn and then click **Save Subject**.

Specify Dikablis Eye Tracker device properties

After you have created both the Wand and the Head in Nexus, specify their properties on the **System Resources** tab.

1. On the **System** resources tab, click on the **Dikablis Eye Tracker** node, and in the **General** section of the **Properties** pane, in the **Head Segment** field, enter Head.
2. In the **Eye Offset** section, enter the relevant values (that is, the distance between the origin marker and the eye).
   Tip: To find the relevant eye offset values, if your Vicon system includes video cameras, you can use overlay video. If not, you can measure the distance from the origin marker.
3. In the **Calibration Object** field in the **Calibration** section, enter the name of the calibration object (Wand).



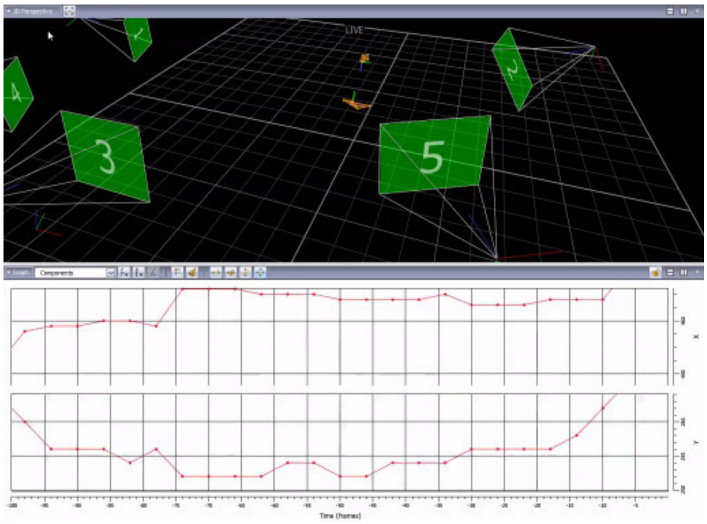
You have now set up the eye tracker properties.

Calibrate eye tracking in Vicon Nexus

After you have added eye tracking to Nexus, created Head and Wand objects, and set the eye tracking properties, you can complete the final steps.

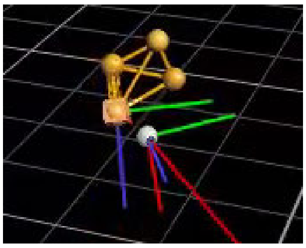
To calibrate the eye tracker in Nexus:

1. On the **System Resources** pane, under the expanded **Dikablis Eye Tracker** node, click the **Eye** node to select it.
2. Display a **Data Correction** view, to show both a **3D Perspective** and **Graph** view.

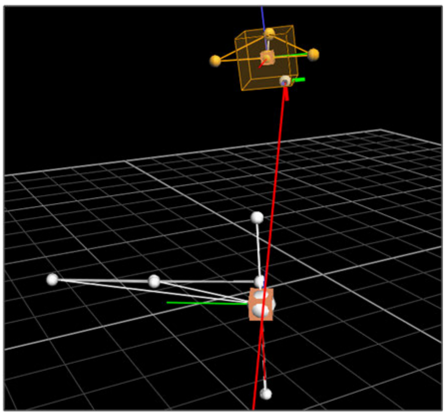
   You should see the x and y values for the selected eye.
3. In the capture volume, place the wand 2–2.5 meters from the subject and get the subject to look at the origin marker (the middle marker at the top of the T).
4. On the **System Resources** tab, click the **Dikablis Eye Tracker** node and in the **Properties** pane, go to the **Calibration** section and click **Add**.
5. Move the wand to another part of the volume and click **Add** again.
   In the **Samples** box, 2 is displayed.

6. Repeat the previous step.
   After you have collected three samples, an eye vector and an eyeball are displayed in the **3D Perspective** view.

7. Collect more samples (aim for at least five samples in total) to refine your results.
   Tip: When collecting samples, place the wand in the bottom left of volume and have the subject look at the origin marker. Pause for about a second and then in the **Calibration** section, and click **Add**. Then place the wand in the top left of the volume, and have the subject look at the origin marker. Again, pause, and click **Add**. Repeat with the wand at the top right of the volume, and then at the bottom right of the volume. Continue to move the wand and click **Add** until the eye gaze vector accurately tracks the origin marker.

8. When the eye tracker system has been calibrated (and if the subject is looking at the origin marker), in **3D Perspective** view, the eye gaze vector will pass through (or point to) the origin marker of the calibration wand, depending on how far the subject's head is from the wand.

9. View the results in a **3D Perspective** view.

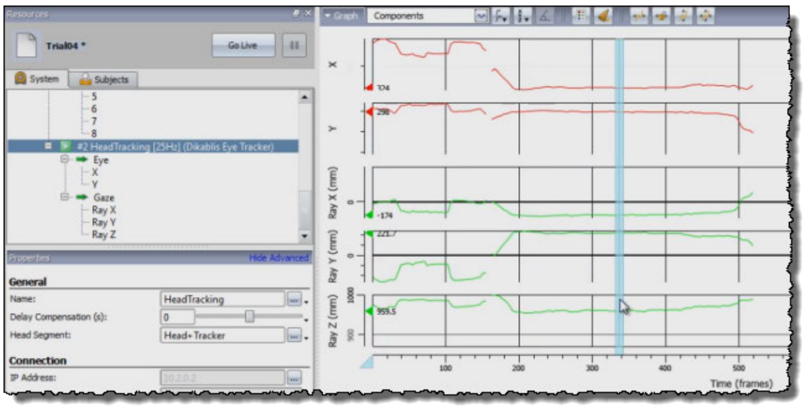
10. To check that the eye tracks the wand correctly, record a short trial.

Export Dikablis eye vector data

To use eye vector data, you will normally want to export both the eye vector data itself and the Head and Tracker data (the segment data) that relates the eye vector to its position within the global coordinate system. To export all the information relating to the eye vector, you must reconstruct and label the trial and kinematically fit the data before exporting it.

To export eye vector data and segment data:

1. Load into Vicon Nexus the trial from which you want to export eye tracking data.
2. On the System tab of the Resources pane, click the Dikablis Eye Tracker node to select it.
3. To check that the eye vector data is included, open a **Graph** view pane and observe the eye vector x and y values.

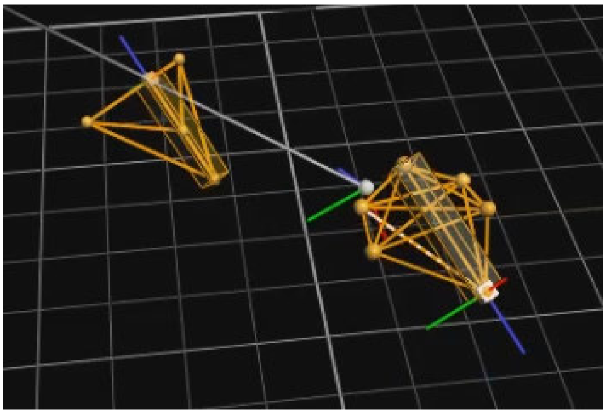


Tip: You can export the eye vector data at this point, but the exported file will not include the segment data, which is necessary to position the eye vector within the global coordinate system.

4. Run **Reconstruct and Label**, either by clicking the **Reconstruct and Label** button on the Nexus toolbar or by running the **Reconstruct and Label** pipeline in the **Pipeline Tools** pane.
   In the **3D Perspective** view, as processing proceeds, you can see first the addition of the object markers and then the labeling.
5. After labeling is complete, to see and use the eye vector, you need to kinematically fit the data. To do this, run **Kinematic Fit**, either by clicking the **KinFit** button on the Nexus toolbar or by running the **Kinematic Fit** pipeline in the **Pipeline Tools** pane, making any changes necessary in the **Properties** pane.

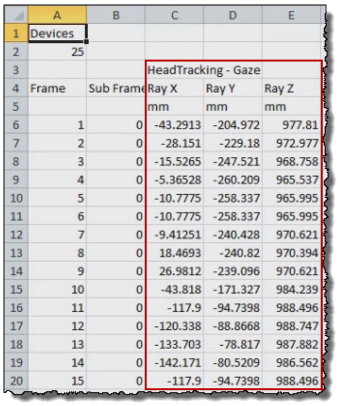
Tip: To produce the required result, you may need to reduce the Prior Importance to zero.

6. Run the Kinematic Fit operation.
   The eye vector is displayed in the 3D Perspective view.



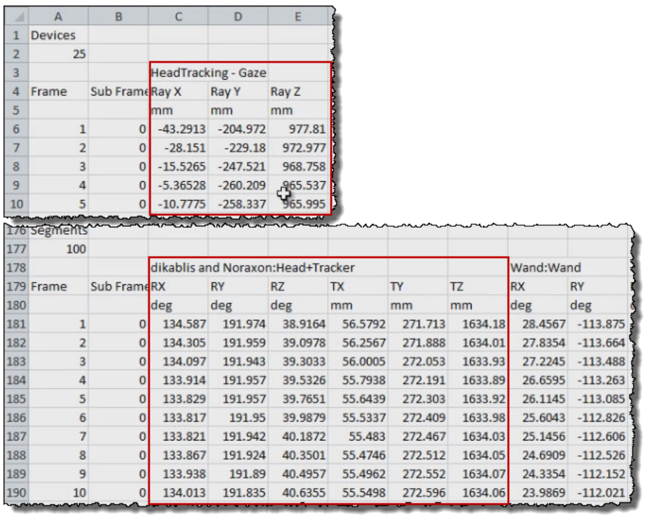
7. In the Pipeline Tools pane, expand File Export, then double-click Export ASCII.
8. In the Properties pane, in the Segments section, change the Global Angle setting to All.
9. Run the Export ASCII pipeline operation.

10. To see the exported data, on the **Data Management** tab, with the relevant trial selected, click on the hyperlink at the bottom and double-click the relevant *.csv* file to open it.
    The eye vector data is displayed as a unit vector in the columns headed **RayX**, **RayY**, and **RayZ**.



	A	B	C	D	E
1	Devices				
2	25				
3			HeadTracking - Gaze		
4	Frame	Sub Frame	Ray X	Ray Y	Ray Z
5			mm	mm	mm
6	1	0	-43.2913	-204.972	977.81
7	2	0	-28.151	-229.18	972.977
8	3	0	-15.5265	-247.521	968.758
9	4	0	-5.36528	-260.209	965.537
10	5	0	-10.7775	-258.337	965.995
11	6	0	-10.7775	-258.337	965.995
12	7	0	-9.41251	-240.428	970.621
13	8	0	18.4693	-240.82	970.394
14	9	0	26.9812	-239.096	970.621
15	10	0	-43.818	-171.327	984.239
16	11	0	-117.9	-94.7398	988.496
17	12	0	-120.338	-88.8668	988.747
18	13	0	-133.703	-78.817	987.882
19	14	0	-142.171	-80.5209	986.562
20	15	0	-117.9	-94.7398	988.496

The units are between 1000 and -1000 mm. The eye vector data is local to the segment to which the eye tracker is connected (ie, the Head). Both the eye vector data and the Head and Tracker (and Wand) data are exported.



	A	B	C	D	E
1	Devices				
2	25				
3			HeadTracking - Gaze		
4	Frame	Sub Frame	Ray X	Ray Y	Ray Z
5			mm	mm	mm
6	1	0	-43.2913	-204.972	977.81
7	2	0	-28.151	-229.18	972.977
8	3	0	-15.5265	-247.521	968.758
9	4	0	-5.36528	-260.209	965.537
10	5	0	-10.7775	-258.337	965.995

176	Segments									
177	100									
178			dikablis and Noraxon:Head+Tracker						Wand:Wand	
179	Frame	Sub Frame	RX	RY	RZ	TX	TY	TZ	RX	RY
180			deg	deg	deg	mm	mm	mm	deg	deg
181	1	0	134.587	191.974	38.9164	56.5792	271.713	1634.18	28.4567	-113.875
182	2	0	134.305	191.959	39.0978	56.2567	271.888	1634.01	27.8354	-113.664
183	3	0	134.097	191.943	39.3033	56.0005	272.053	1633.93	27.2245	-113.488
184	4	0	133.914	191.957	39.5326	55.7938	272.191	1633.89	26.6595	-113.263
185	5	0	133.829	191.957	39.7651	55.6439	272.303	1633.92	26.1145	-113.085
186	6	0	133.817	191.95	39.9879	55.5337	272.409	1633.98	25.6043	-112.826
187	7	0	133.821	191.942	40.1872	55.483	272.467	1634.03	25.1456	-112.606
188	8	0	133.867	191.924	40.3501	55.4746	272.512	1634.05	24.6909	-112.526
189	9	0	133.938	191.89	40.4957	55.4962	272.552	1634.07	24.3354	-112.152
190	10	0	134.013	191.835	40.6355	55.5498	272.596	1634.06	23.9869	-112.021

11. To position the eye vector in global coordinate space, use the **Head** and **Tracker** data. To ensure accuracy, also apply the offset from the **Head** segment. To find the offset, in the **System Resources** pane, click the **Dikablis Eye Tracker** node and in the **Properties** pane, go to the **Eye Offset** coordinates.

12. When you save, kinematic data is not saved, so to preserve kinematics, rerun **Kinematic Fit**.

Vicon Nexus user interface

The following topics describe the main components of the Vicon Nexus user interface:

For basic instructions on how to use these components, see the *Vicon Nexus User Guide*.

About the Vicon Nexus user interface

The Vicon Nexus user interface includes the following components:

- Resources pane, page 184: Enables you to manage the components of your Vicon system and the subjects whose motion is to be captured.
- View pane, page 282: Enables you to set up the way you want to view the capture data from one or more cameras (or supported third-party devices), either live in real time or from file for post-processing.
- Tools pane, page 303: Enables you to manage each step of the motion capture workflow through preparation, acquisition, and review.
- Communications pane, page 348: Enables you to run customized workflows, monitor trials, work with data from Vicon IMUs, work with MATLAB, check system status and view log information.
- Menu bar, page 360: Enables you to access common commands from the current workflow stage.
- Toolbar, page 379: Enables you to access frequently used commands from the current workflow stage.

For introductory information about the Nexus user interface, see Introducing Vicon Nexus in the *Vicon Nexus User Guide*.

Resources pane

The **Resources** pane contains the following elements:

- System connection buttons, page 185
- Resources tabs, page 186
- System and Subjects trees, page 186
- Properties pane, page 187

You can hide, pin, and unpin the **Resources** pane to ensure you use the available screen space as efficiently as possible (see Customize the Vicon Nexus user interface in the *Vicon Nexus User Guide*).

System connection buttons

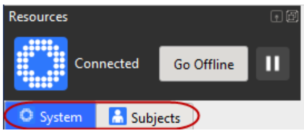
Nexus has two operating modes: Live Mode and Offline Mode. The system status indicators at the top of the **Resources** pane make it easy for you to immediately identify the current operating mode and the hardware connection status.

- Live mode connects the system and starts real-time streaming.
- Offline mode disconnects the system and stops real-time data streaming. Previously captured and saved data can be played back offline (see the following table).

Appearance	System status
	System in Live Mode - No connection established with Vicon hardware
	System in Live Mode - Connection established with Vicon hardware
	System in Offline Mode - No trial loaded in memory
	System in Offline Mode - Trial is loaded in memory The trial name is displayed to the left. The tool tip shows the file location.
 Pause button	Pauses real-time data streaming. This button is available and is a brighter color when the system is in its Live mode.

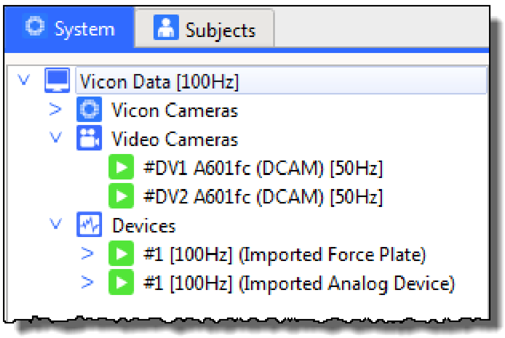
Resources tabs

You select the type of resources to be displayed by clicking the appropriate **Resources** tab:



- **System** tab Lets you configure the components of your Vicon system. For more information, see System tab, page 188.
- **Subjects** tab Lets you load and manage files for the subjects whose motion data you want to capture and analyze in Vicon Nexus. For more information, see Subjects tab, page 272.

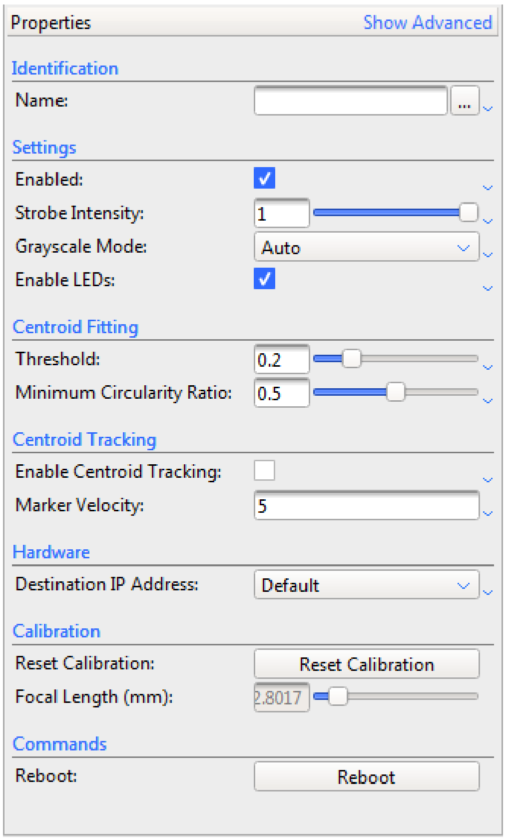
System and Subjects trees



You select the items and any sub items to be configured with the **System** tree or Subjects tree in the middle of the **Resources** pane. The nodes displayed in the tree depend on whether you are viewing the **System tab** or the **Subjects** tab in **the Resources pane**.

For more information, see System Resources nodes, page 195 and Subjects tab, page 272.

Properties pane



You view and change settings for the item selected in the resources tree in the **Properties** pane at the bottom of the **Resources** pane. The contents of this section depend on the node selected in the **Resources** tree.

For information about the available properties, see the *Properties* section for the required node in System Resources nodes, page 195.

To see additional settings for the selected node, click **Show Advanced** at the top right of the **Properties** pane. To show basic settings only, click **Hide Advanced**.

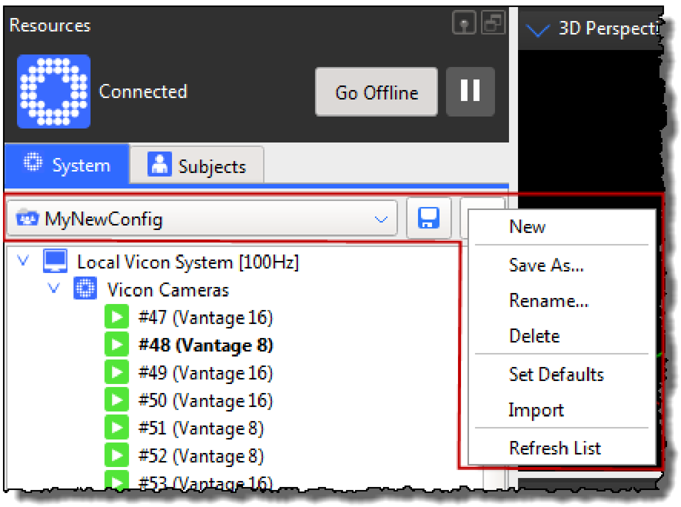
System tab

The **System** tab in the **Resources** pane enables you to manage the components of your Vicon system.

The System tab contains the following sections:

- System configuration management, page 188
- System Resources tree, page 189
- System Properties pane, page 194

System configuration management

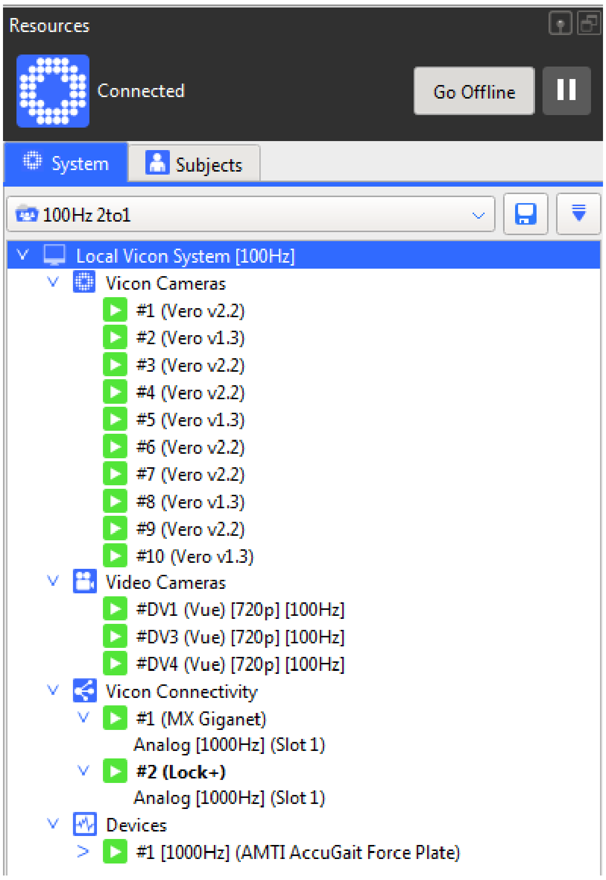


You create or manage configurations for the settings on the **System** tab using the configuration management section at the top of the pane. This section is displayed when Nexus is in Live or Pause mode (click the **Go Live** button or the **Pause** button).

This enables you to save any changes you make to the settings on the System tab to a configuration file, with the extension **.System**. You can then re-use your saved configuration file as required, for example, you could save different system settings for each type of motion capture application that you use.

In addition to creating customized **Systems** configurations, the Configuration menu button enables you to rename, import, reload and delete configurations and refresh the list.

System Resources tree



You select the node for the system component you want to configure in the **Resources** tree on the **System** tab (the nodes displayed depend on the current system connection mode and connected system components):

Node	Description
Local Vicon System	Displayed in Live mode only. Enables you to view and/or control the Vicon system capture rate and the Nexus memory buffer size; real-time processing settings; and the identification and connection settings for the Nexus host PC. The **Local Vicon System** node contains sub nodes for each device connected to your Vicon system under the following nodes: • Vicon Cameras • Vicon Connectivity • Video Cameras • Devices (including force plates, accelerometers, EMG, Dikablis eye tracker, etc) The node for the device designated as the Vicon system synchronization source is highlighted in bold in the **System Resources** tree. For more information, see *Change the synchronization source* in the *Vicon Nexus User Guide*. For more information on this node, see Local Vicon System node, page 196.
Vicon Data	Displayed in Offline mode only. The details for cameras and capture devices in your Vicon system that were used for a previously saved motion capture trial. For more information, see Vicon Data node, page 213.
Vicon Cameras	The identification and configuration settings for each Vicon camera connected to your Vicon system. For more information, see Vicon Cameras node, page 214.
Vicon Connectivity	The identification and configuration settings for each Vicon connectivity device included in your Vicon system architecture. For more information, see Vicon Connectivity nodes, page 235.
Devices	The connection and configuration settings for Vicon and supported third-party devices included in your Vicon system architecture. For more information, see Devices node, page 243.

You can perform commands specific to a type of system component node or sub node by right-clicking on a node in the **System Resources** tree and selecting the desired command from the displayed context menu.

Device status

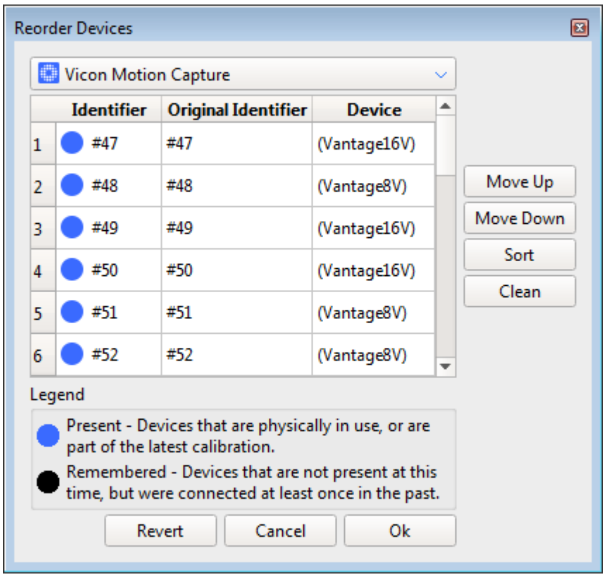
Some nodes have sub-nodes for individual components of that type:

- Green play button: Component OK (active or connected); if an analog device is connected to the Vicon component, the analog source is selected and all channels are configured.
- Yellow pause button: Component not fully set up
- Gray play button: Component connected but not contributing any data.
- Red stop button: Component down (unavailable or disconnected)
- Green arrow: Analog channel connected to source device.
- Yellow arrow: Analog channel not connected to source device, or device is disabled (Enabled check box is not selected in the **Status** section of the **Properties** pane.)

For more information on the status of system components, see Status tab, page 358.

Reorder Devices dialog box

You change the order in which devices are displayed in the **System Resources** tree in the **Reorder Devices** dialog box.



> **Tip**
> You can automatically number cameras according to their position in the volume by using the **Auto number cameras** feature. For more information, see System Preparation tools, page 307.

You access the **Reorder Devices** dialog box by right-clicking **Vicon Cameras**, **Video Cameras**, **Vicon Connectivity** nodes, or **Devices** in the **System Resources** tree and selecting **Reorder** from the context menu. This menu is available only when the system is in Live mode (click the **Go Live** button); devices listed in an offline processing file cannot be reordered.

Each Vicon camera and connectivity device is assigned a unique ID at manufacture, which remains the same, regardless of its position in the list of other devices of the same type. Once integrated in a Vicon system, each device is assigned a sequential ID, which is used to identify it (for example, in user interface lists and camera calibration parameters (.xcp) files). This sequential ID is not dependent on which socket the device is plugged into (for example, a Vicon camera plugged into socket 2 in a Vicon Lock is not necessarily assigned a device ID of 2). Reordering the device changes its sequential ID. You may find this useful if you want to order your device numbers to match their physical sequence in your capture volume.

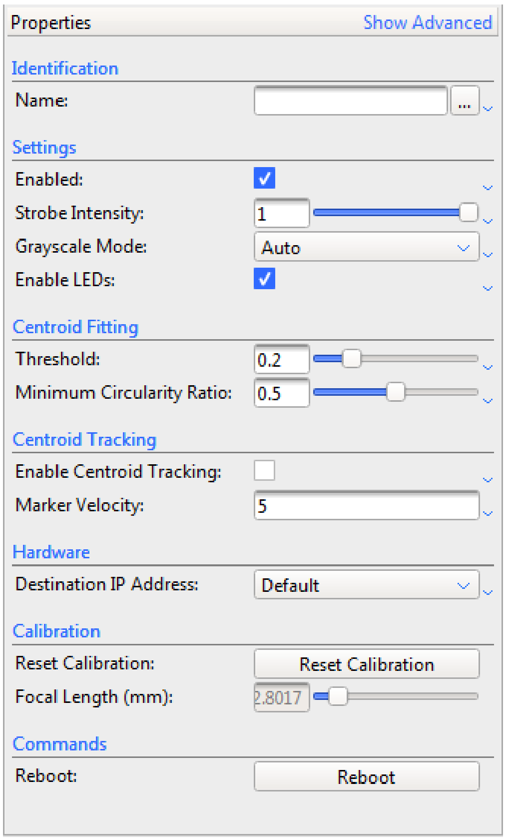
To change the order of devices in the Reorder Devices dialog box:

1. In the **System Resources** tree, right-click **Vicon Cameras**, **Video Cameras**, **Vicon Connectivity** or **Devices** and from the displayed context menu select **Reorder**.
2. In the **Reorder Devices** dialog box, click on the device whose position you want to change.
   In the **Identifier** column, the color of the circle to the left of the ID number indicates the current status of that device:
   - Blue (Present) - Devices that are physically in use, or are part of the latest calibration
   - Black (Remembered) - Devices that are not present at this time, but were connected at least once in the past

   The **Original Identifier** column shows the sequence ID previously assigned to the device.
3. Change the order of the device using the buttons:
   - **Move Up** Move the selected entry up one position in the list.
   - **Move Down** Move the selected entry down one position in the list.
   - **Sort** Sorts the list of devices according to name and type. Remembered devices are at the bottom of the list.
   - **Clean** Removes the entries for devices that are not present in the current session.
4. Repeat steps 1–3 for each device whose position you wish to change.
5. Click OK to save the changes and close the **Reorder Devices** dialog box.

System Properties pane

You can view or modify system components in the **Properties** pane, which is at the bottom of the of the **System** tab.



The properties displayed depend upon the component node selected in the **System Resources** tree. **Properties** can be presented in categories such as **General**, **Settings**, etc.

To see all the properties for a selected component node, ensure you have clicked **Show Advanced** at the top of the **Properties** pane.

System Resources nodes

The following topics describe nodes that are displayed in the tree on the **System** tab of the **Resources** pane:

Local Vicon System node

The **Local Vicon System** node is the top-level node that is displayed for the Nexus host PC when Nexus is in Live mode. It contains sub-nodes for each device connected to your Vicon system:

- Vicon Cameras
- Vicon Connectivity (Vicon Lock)
- Video Cameras
- Devices (including force plates, accelerometers, EMG, Dikablis eye tracker, etc)

The node for the device designated as the synchronization source is highlighted in bold in the **System Resources** tree. (For more information, see *Change the synchronization source* in the *Vicon Nexus User Guide*.)

For more information on the **Local Vicon System** node, see the following topics.

- Local Vicon System node context menu, page 197
- Local Vicon System properties, page 198

Local Vicon System node context menu

You can select from the following commands on the context menu displayed when you right-click on the **Local Vicon System** node:

Command	Description
Reboot Vicon Hardware	Resets all of the Vicon hardware devices in the Vicon system. Use this command if a camera has failed to boot, or if you need to reset the whole system for other reasons. Alternatively, use the **Reboot All** button in the **System** section of the **Properties** pane.
Reboot Core Processor	Restarts the Core Processor and resets the labeler. Alternatively, press CTRL + R.
Resynchronize	Forces the synchronization source to resynchronize the frame rate for all connected cameras and third-party devices.

Local Vicon System properties

You can configure the following settings in the **Properties** pane for the **Local Vicon System** node.

> Tip
> If you can't see some of the listed properties, click **Show Advanced** at the top of the **Properties** pane.

These settings affect the local Vicon system in Live mode. The equivalent settings for offline processing can be found under Core Processing operations, page 327 on the **Pipeline** tab.

Local Vicon System properties are divided into the following sections:

System section

Contains system-wide parameters that affect all the connected cameras and devices.

Property	Description
Requested Frame Rate (Hz)	The rate (in Hertz) at which to synchronize the Vicon cameras. If using external video signal, select from displayed values (multiples of the base frame rate of the PAL, NTSC, or Film video standard specified in Standard) up to a maximum of 2,000. You can choose any number you want if you do not have any Genlock Standard set. The configured Vicon system capture rate is displayed in square brackets beside the node. For example, if the Vicon system frame rate is set to 100 Hz, the node title is displayed as Local Vicon System [100Hz]. If the Requested Frame Rate cannot be met due to the camera frame rate, Vicon Nexus displays the nearest adjusted frame rate in square brackets. To meet the Requested Frame Rate, you can change the Sub Sample Ratio of the relevant camera(s). Default: 100
Actual Frame Rate (Hz)	The frame rate used by the Vicon system, which is constrained by the camera frame rate limits.
Preferred Sync Source	A list from which you can choose the synchronization source. If you are using multiple devices such as Vicon Locks, to connect and control your cameras, a synchronization source is automatically chosen by Vicon Nexus. If the automatically selected synchronization source is not the required choice, you can select the appropriate device from the Preferred Sync Source list. (For more information, see *Change the synchronization source* in the *Vicon Nexus User Guide*). Default: Automatic

Property	Description
Buffer Size (MB)	The size (in MB) of the memory buffer on the host PC when Nexus is receiving data from Vicon hardware. Specify a value between 0-1024 MB. This buffer is used if data comes in faster than Nexus can process it; therefore, the larger the buffer, the longer it takes before capture fails. Increasing this value enables a greater Capture Before Start duration to be set. The optimum size of the Buffer Size parameter depends on the amount of memory on your PC. The proportion of the total memory buffer that is reserved for Vicon devices is determined by the Buffer Reserve (see below). Tip: If you experience failure of a combined video and optical camera calibration , particularly if you are capturing a long wand wave, close and restart Nexus. Reduce the Buffer Size to 0 MB before calibrating. Do not increase the buffer size to its usual level until you have completed a successful calibration. Default: 250
Buffer Reserve	The proportion of the total buffer size (see Buffer Size above) that is reserved for Vicon video devices. The default of 0.5 results in half of the total buffer size being reserved for Vicon video devices (Vicon Vue Video cameras). The remaining buffer space is used by third-party video cameras. If you want to maximize the buffer space reserved for Vue Video cameras, set this value to 1.0. If you are using only third-party DV cameras, set this value to 0. Default: 0.5
Reboot All	Resets all of the Vicon hardware devices in the Vicon system. Use this button if a camera has failed to boot, or if you need to reset the whole system for other reasons. Alternatively, use the Reboot Vicon Hardware command from the context menu.
Minimize Latency	Minimizes the level of latency, or lag time, the RealTime Engine introduces during data streaming when data rates approach or exceed system processing capacity. If selected, the RealTime Engine introduces no lag time when processing data frames. This decreases data throughput, but increases the possibility of frames being dropped. If cleared, the RealTime Engine introduces 20 frames of lag time when processing data frames. As this increases data throughput, it can produce better labeling results. Default: Cleared

Genlock and Timecode section

Settings for genlock and timecode.

Property	Description
Genlock Standard	The type of video standard supported by the connected video source: None, PAL, NTSC, Film (24 fps), Film (24/1.001 fps, 30Hz, VESA (100Hz) or VESA (120Hz). For information about the symbols in this list, see Icons in Genlock and Timecode lists, page 202. Default: None **Important**: To use the 30Hz option, the Vicon firmware must be Bundle 500 or above.
Enable Genlock	Enables genlock based on the signals that are currently detected.
Auto Genlock	Automatically selects a genlock standard and enables genlock based on the signals that are currently detected.
Genlock Offset	Enables you to specify a system offset relative to the genlock signal, as a fraction of the genlock frame period. Values are in the range 0–1. For VESA modes, specify a value using the **VESA Offset** control.
VESA Offset	Applies only if you have selected one of the VESA standards from the **Genlock Standard** list (see above). It enables a system offset relative to VESA signal (as a fraction of the VESA frame period). It changes when the Vicon cameras take a frame (and hence when the camera strobes are on) relative to the incoming VESA frames. The camera timing can be offset by up to one VESA frame. The main purpose of this feature is to prevent camera strobes from interfering with the IR-synchronized 3D glasses used in some VR systems.
Timecode Source	The genlock timecode source. Can be VITC, LTC, Internal or Internal Drop (uses drop frame when applicable). Default is Internal. For information about the symbols in this list, see Icons in Genlock and Timecode lists, page 202. **Note**: VITC and LTC always display a flat line if the system is not genlocked. This is because these signal types can only be detected by a source device that is genlocked.
Enable Timecode	When selected, timecode is enabled.
Detected Timecode	Given as the number of timecode frames per second for example, 24 fps, 25 fps, 30 fps, 30 fps DropFrame

Icons in Genlock and Timecode lists

The icon to the left of each option provides additional information about the availability of that standard:

Icon	Meaning
Cross	The standard is not supported by the hardware (that is, no connected device supports locking to a signal of that type). If you select an unsupported standard, it restricts the available frame rates as it does in the previous version of Nexus.
Flat line	No device in the system is detecting that standard.
Blue square wave	The source device is detecting that signal and can genlock to it.
Green square wave	If you select a mode with the blue wave icon and then select the **Enable Genlock** check box, the icon turns green.
Red square wave	A device in the system is detecting the mode but a problem prevents it from being used, for example, if the signal is being detected by a device that is not the source device in the system.

In all cases, you can display a tooltip by holding the mouse over the **Genlock Standard** list.

General section

Settings for the Core Processor component, which receives data from the Vicon cameras and transforms the data to the trajectories or segments that your Vicon system is tracking.

Property	Description
Processing Output Level	The amount of real-time processing the Core Processor is to perform on source data: • **Circles**: Have the Nexus Core Processor attempt to circle fit grayscale blobs that the Vicon cameras could not resolve. Data will not be reconstructed to 3D trajectories, so you will only see data in the 2D Camera view pane. • **Reconstructions**: Create 3D reconstructions of marker images. 3D trajectories are created, but they are not labeled. • **Labels**: Assign labels to markers, based on the Vicon Skeleton (.vsk file). Labels are applied to the reconstructed trajectories if a *.vsk* file is present. • **Kinematic Fit**: Fit joint angles defining the relationship between segments. The segments defined in the *.vsk* file are fitted and displayed. Default: **Labels** **Important:** These settings are applied cumulatively. For example, selecting **Labels** applies that setting as well as the **Reconstructions** and **Circles** settings.

Grayscale Circle Fitting section

Property	Description
Enable	Select this check box to enable circle fitting of grayscale blobs. If selected, processing speed may be slightly slowed, but more data may be collected. Default: Selected.

Reconstruction section

Controlling the number of cameras that are required to start or continue a trajectory can be beneficial in producing higher quality data. The ability to define how trajectories are created can help you to produce higher quality data that requires less manual editing.

Property	Description
Environmental Drift Tolerance	Increase this parameter to reduce the sensitivity (in mm) of the camera calibration to environmental factors, particularly temperature change. Use this setting to compensate for environmental changes when you do not have time or other resources to recalibrate the whole system. For the most accurate results, recalibration remains the preferred solution. Default: 1.5
Minimum Cameras to Start Trajectory	This parameter controls how many cameras (rays) must see the same marker (centroid) in order to create a new reconstruction and potentially form a new trajectory. The minimum value that can possibly create a reconstruction is two cameras. The maximum value of this parameter is 30 cameras or the total number of cameras in your system. This value can be increased if there are a large number of unlikely reconstructions being created. Default: 3 cameras
Minimum Cameras to Continue Trajectory	This parameter controls how many cameras (rays) must see the same marker (centroid) in order to create a reconstruction to continue a recognized trajectory. The minimum value that can possibly create reconstructions is two cameras. The maximum value of this parameter is 30 cameras or the total number of cameras in your system. The value can be decreased if there are gaps in trajectories where reconstruction should be possible when viewed by fewer cameras. Default: 2 cameras

Property	Description
Reconstruction Minimum Separation	The minimum distance, specified as a value in the range 0–1000000 millimeters, allowed between 3D marker positions in order for them to be considered for reconstruction. If two candidate reconstructions are closer than this minimum separation, only the most likely reconstruction (in terms of the number of cameras contributing) will be reported. The other will be discarded. A higher value decreases the likelihood of creating spurious reconstructions, but increases the possibility that some genuine markers will not be reconstructed. Generally, this parameter should be slightly above the size of the markers you are using. For examples, if you are using 14mm markers, try setting it to 16mm. Then, for example, if during reconstruction two markers (one a ghost marker) are found within 17mm, one would be discarded. Default: 14
Minimum Centroid Radius	The minimum radius (in pixels) of a 2D centroid that is allowed for a reconstruction. Any reconstruction with a radius less than this value is ignored. Default: 0
Maximum Centroid Radius	The maximum radius (in pixels) of a 2D centroid that is allowed for a reconstruction. Any reconstruction with a radius greater than this value is ignored. Default: 50
Minimum Reconstruction Radius	The minimum 3D radius (in mm) that is allowed for a reconstruction. Any reconstruction with a radius less than this value is discarded. Default: 0
Maximum Reconstruction Radius	The maximum 3D radius (in mm) that is allowed for a reconstruction. Any reconstruction with a radius greater than this value is discarded. Default: 1000
Volume min X	X value of lower corner of reconstruction volume. Default -100000.
Volume min Y	Y value of lower corner of reconstruction volume. Default -100000
Volume min Z	Z value of lower corner of reconstruction volume. Default -100000

Property	Description
Volume max X	X value of upper corner of reconstruction volume. Default 100000.
Volume max Y	Y value of upper corner of reconstruction volume. Default 100000.
Volume max Z	Z value of upper corner of reconstruction volume. Default 100000.
Use Target Volume	Sets the reconstruction volume to the dimensions of the target volume (Set the target volume dimensions in the **Options** dialog box (press F7)

Trajectory Tracking section

Property	Description
Trajectory Startup Error	The deviation allowed (in mm/sec) in a marker's position at the start of a trajectory. This value is related to the radius within which the current trajectory is matched to a reconstruction in the following frame. To help start trajectories on faster moving markers, increase the value. To help with dense marker sets, decrease the value. Default: 150
Trajectory Prediction Error	The deviation allowed (in mm/sec) in a marker's position on a trajectory. This value is related to the radius within which the current trajectory is matched to a reconstruction in the following frame. To help continue trajectories on faster moving markers, increase the value. To help with dense marker sets, decrease the value. Default: 150

Labeling section

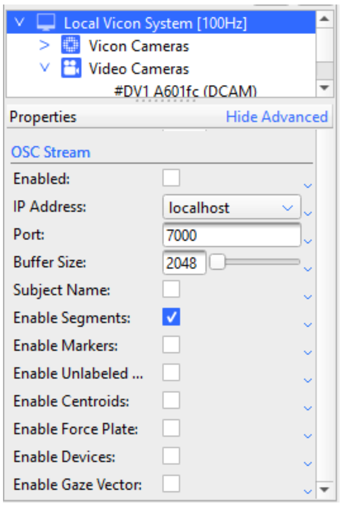
Property	Description
Label Completeness Entrance Threshold	Specifies the proportion of markers that have to be present when a subject enters the capture volume or when the trial starts. If it is less than this value, the subject is not labeled. Higher values help to prevent mis-labeling when the subject first enters the volume. For example, if labeling starts only a significant number of frames after the subject has entered the volume, then a reduction of this value may encourage labeling to start earlier, when a smaller percentage of total subject markers are first seen. Conversely, if when the subject enters the volume, the initial labeling result is poor, increasing the value encourages the labeler to wait until a larger proportion of subject markers are seen and should produce a more reliable labeling result. Default: 0.85
Label Completeness Exit Threshold	Specifies the proportion of a subject's markers below which the subject is considered by Nexus to have left the capture volume. Labeling will not recommence unless the proportion reaches the Entrance Threshold. Higher values help to prevent mis-labeling when the subject leaves the volume. For example, a value of 1 requires all markers to be recognized for labels to continue to be produced. Tip: Do not set this value higher than Label completeness entrance threshold. Default: 0.6
Booting quality	Affects when the system will start labeling based on how well the labeling skeleton matches the reconstructed data. For greater tolerance, reduce this value; to reduce the risk of mis-labeling, increase this value. Lower values are more tolerant, but may result in more mis-labels, whereas higher values require a closer match between the labeling skeleton and the reconstructed data, and therefore reduce the risk of mis-labeling. If fewer than expected labels are achieved, reducing this value may decrease the number of labeled reconstructions. Conversely, if the labeling results produce an unacceptably high number of mis-labels (due to poor skeleton-to-reconstruction matching), increasing this value may result in fewer mis-labels. Default: 0

Property	Description
Booting versus tracking	Booting is a process in which Nexus attempts to work out the labeling for the active subjects with marker statistics calculated from the VSK. This is done without requiring any information from earlier frames, such as previous labels. Tracking is a process in which Nexus uses the pose of the labeling skeleton from the previous frame's labels. This is used to predict the labeling in the current frame. Values <0 favor rebooting; values >0 favor tracking. Default: 0
Tracking quality	Compares the match between reconstructions and skeleton data with the previous frame to determine whether labeling continues. Adjusting this parameter affects how close this match must be. Higher values require a closer match between frames. This reduces the risk of incorrect labeling, but may leave more constructions unlabeled. Lower values do not require as close a match between frames. This can increase the total number of labeled reconstructions but may produce more mis-labels. For greater tolerance, reduce this value; to reduce the risk of incorrect labeling, increase this value. Default: 0
Smoothing factor	Specifies how much the subject markers can move between frames before labeling stops. This value can be increased for slow-moving subjects and decreased for faster motion (at the cost of a greater likelihood of mis-labels). Default is 200.
Joint Ranges Slack	A calibrated skeleton contains joint range information. This informs the labeler about the expected Range of Motion for any joint and the markers associated with that joint, helping the labeler make decisions. If a subject's joints move beyond the estimated range, the result may be unlabeled reconstructions. Increasing this value may increase the number of labels and is useful when the subject doesn't perform an entire Range of Motion during calibration. Values greater than 1 extend the joint ranges allowed in the subject calibration. Higher values can be set to reduce the chances of mis-labels. Values less than 1 tighten the ranges. Default: 1
Enforce Joint Ranges	If selected, Nexus considers only a marker labeling solution that adheres strictly to the joint range values defined in the labeling skeleton (VSK). Default is cleared.

OSC Stream section

To access the OSC data streaming options:

- On the **System Resources** tab, select **Local Vicon System** and in the **Properties** pane, ensure the **Advanced** properties are displayed. The data available for output is a subset of the data available using the DSSDK.



> **Important:**
> To stream device data, you must give the device a name.

OSC Stream properties

This table lists the OSC Stream properties.

Property	Description
Enabled	Turns streaming on/off
IP Address	Address used to create the outbound socket
Port	Port number used to create the outbound socket
Buffer Size	Size of the buffer to allocate to store a frame's worth of data
Subject Name	If a single subject is loaded, this option enables you turn on/off the subject name in the message address (see Packet contents, page 211). If multiple subjects are loaded, the subject name is always included as part of the message address.
Enable Segments, Markers, …	Turn on/off specific data types

Packet contents

Each packet consists of a bundle containing one or more messages. Each message has an address associated with it to identify its contents. The **/vicon/frame** message is always generated; other messages may or may not be present, depending on the output data types selected.

Full address (Base in bold)	Nexus property	DSSDK type	Data values	Description
/vicon/frame	NA	Output_GetFrameNumber Output_GetFrameRate Output_GetTimecode	long - Frame Number float - Frame Rate int32 - TimecodeHours int32 - Timecode Minutes int32 - Timecode Seconds int32 - Timecode Frames int32 - Timecode Subframes int32 - Timecode Field Flag int32 - Timecode Standard int32 - Timecode SubframesPerFrame int32 - Timecode UserBits	Always present in the bundle. Timecode values are only present if the application has timecode enabled.
/vicon/seg/SUBJECT/SEG_NAME **/vicon/seg/**SEG_NAME	Enable Segments	Output_GetSegmentGlobalTranslation Output_GetSegmentGlobalRotationMatrix	float(3) - Translation float(9) - Rotation matrix	SUBJECT: Subject Name SEG_NAME: Name of the segment If the Subject Name property is cleared and a single subject is loaded, the SUBJECT portion of the address is omitted. In all other cases it is present.

Full address (Base in bold)	Nexus property	DSSDK type	Data values	Description
/vicon/marker/ SUBJECT/ MARKER_NAME **/vicon/marker/** MARKER_NAME	Enable Markers	Output_GetMarkerGlobalTranslation	float(3) - Translation	SUBJECT: Subject Name MARKER_NAME: Name of the marker If the Subject Name property is cleared and a single subject is loaded, the SUBJECT portion of the address is omitted. In all other cases it is present.
/vicon/ unlabeled/N	Enable Unlabeled Markers	Output_GetUnlabeledMarkerGlobalTranslation	float(3) - Translation	N: A number starting at 0 Unlabeled marker numbers are arbitrary so you can't assume that the same unlabeled marker will be given the same number frame-to-frame.
/vicon/2D/ CameraID	Enable Centroids	Output_GetCentroidPosition	int32 - Number of centroids For each centroid: float(2) - Position float - Radius	
/vicon/fp/N	Enable Force Plate	Output_GetGlobalForceVector Output_GetGlobalMomentVector Output_GetGlobalCentreOfPressure	int32 - Number of samples For each sample: float(3) - Force float(3) - Moment float(3) - CoP	N: Force plate index number
/vicon/device/ NAME/ OUTPUT/ COMPONENT	Enable Devices	Output_GetDeviceOutputValue	int32 - Number of samples For each sample: float - Device output value	NAME: Device name OUTPUT: Device output name COMPONENT: Device output component name
/vicon/gaze/N	Enable Gaze Vector	Output_GetEyeTrackerGlobalGazeVector Output_GetEyeTrackerGlobalPosition	float(3) - Gaze vector float(3) - segment position	N: Eye tracker index

Vicon Data node

The **Vicon Data** node is the top-level node that is displayed on the **System** tab in the **Resources** pane when Nexus is in Offline mode. It represents the Nexus host PC.
in this mode, you can view but not manage the device details displayed on the **System** tab.

It enables you to view details of the cameras and capture devices in your Vicon system that were used for a previously saved motion capture trial.

The **Vicon Data** node contains sub-nodes for each capture device that was connected to your Vicon system during the trial capture under the following nodes:

- Vicon Cameras node
- Video Cameras node
- Devices node (including force plates, accelerometers, etc)

The top-level **Vicon Data** node does not have any displayed properties. Not all properties that are configurable for a device in Live mode are visible in Offline mode. For further details, see Local Vicon System node, page 196.

Vicon Cameras node

The Vicon Cameras node on the **System** tab of the **Resources** pane enables you to manage the identification and configuration settings for each Vicon camera connected to your Vicon system.

For more information, see:

- Vicon Cameras node context menu, page 214
- Vicon Camera properties, page 216

Vicon Cameras node context menu

You can select the following commands from the context menu displayed when you right-click on the **Vicon Cameras** node:

Command	Description
Reorder	Display the Reorder Devices dialog box, page 192 in which you can change the order in which Vicon cameras are displayed in the **System Resources** tree.
Reboot Vicon Cameras	Stop and restart all of the Vicon optical cameras in the Vicon system.
Remove Vicon Cameras	Displays a choice of **Disconnected** or **Missing**: • **Disconnected** - removes from the **Resources** tree cameras that are currently unplugged. • **Missing** - removes from the **Resources** tree cameras that are unplugged, but were previously used in a calibration.
Enable Preview Mode	Displays a video image from the optical sensor of Vicon cameras that offer this option. This enables you to aim cameras more quickly and easily and to check volume coverage by the cameras during setup. **Note**: This preview feature is for system setup purposes only. You cannot use Preview modewhen you are calibrating, auto masking, capturing, or reviewing data. **Tip**: If the image produced by Preview mode is too dark, adjust the aperture to maximize the light. After you've finished setting up the cameras, return the aperture to its required setting.

You can select the following commands from the context menu displayed when you right-click on a node for a specific Vicon camera:

Command	Description
Reset Calibration	Remove the selected camera from the current calibration.
Reboot	Start and restart the selected Vicon camera.

Vicon Camera properties

You can configure settings in the following sections of the **Properties** pane for Vicon cameras:

Identification section

Property	Description
Name	A user-defined display name for the entire set of Vicon cameras or for each individual camera. For example, if a camera is placed over a door, you could name it "Over Door." Default: Blank
Device ID	The unique identification number Vicon assigns to each camera during manufacture. The top-level entry for all Vicon cameras takes no value. Default: Identified on connection

Settings section

Property	Description
Enabled	Whether or not the Vicon camera is currently enabled for use. Default: Selected
Strobe Intensity	The amount of light emitted by Vicon camera strobe units. This value can be set between 0-1 to minimize reflections and obtain clear marker images. The higher the setting, the larger the markers appear, but this may cause blobs to be produced from unwanted reflection sources. Lower settings reduce unwanted reflection sources but make the markers themselves less visible to the Vicon cameras. In almost all circumstances, you will want to keep the intensity at its maximum level because the system works by recording light from the strobes that is reflected from the markers, thus the more light the strobes send out the more light the markers reflect. However, there are two significant cases where you may want to lower the intensities: • If you see a lot of reflections in the volume, either from other cameras or from other objects in the room, such as shiny equipment, floors, or from the subject. • If you are capturing a very fast moving subject. The strobe intensity affects the time the strobe is on for each camera frame. The full strobe intensity corresponds to 1ms for normal frame rates. Lower strobe intensities mean that the markers are captured with the strobes on for less time and, therefore, have less time to move during the frame. **Tip:** In normal circumstances, it is advisable to use full strobe intensity and deal with reflection problems by closing the camera lens aperture. However, especially when the capture volume is very small, this may be uncomfortable to the patient, so less than the full intensity may be the best setting. Adjust this setting in conjunction with the Threshold setting until reflections are minimized or gone.
	Note: If you are using a Vicon system that consists of a mix of MX T-Series cameras and current Vicon cameras, and if it is crucial to your work that the shutter periods for all cameras are precisely aligned, ensure that your firmware is upgraded to version 700 or later, and set the **Strobe Intensity** for the T-Series camera(s) to its maximum. (Note that lthough you can use T-Series cameras with Nexus 2.15, this is not supported or tested. For information on using these cameras, see the documentation for versions of Nexus earlier than 2.15. Also note that if you add Valkyrie cameras to a system that includes T-Series cameras, the T-Series cameras will not work.) Default: 1

Property	Description
Sensor Mode	Nexus 2.11 and later supports the use of the Vantage+ firmware upgrade, enabling you to use High Speed mode on your Vantage cameras without having to change the field of view (FOV) or lens. When you capture optical data, subsampling (selectively reducing the pixel count) enables you to run at high camera frame rates without reducing the FOV (frame size). In High Speed mode, you can run your Vantage cameras at higher frames rates while maintaining the FOV. You can change frame rates during capture and you do not need to set up your cameras again when you increase the frame rate, as the FOV is unchanged.Because the higher speeds are achieved through subsampling (removing some pixels from the frames), some reduction in resolution is incurred. For details, see Run in High Speed mode, page 221 and **High-speed mode** in the *Vicon Vantage Reference Guide*.
Gain	The digital amplification of the pixel value. Select a displayed value to determine the intensity of the grayscale from the Vicon cameras: x1, x2, x4, or x8. This setting is applied to the camera to change the dynamic range of the recorded image. Increasing the gain means that the marker has less variation in grayscale intensity between its center and its edge, but in certain circumstances, using a higher gain yields markers that are easier for the camera to distinguish. Vicon does not recommend using a gain setting higher than x2. Adjust this setting if the markers appear too faint or if the cameras have trouble distinguishing them; otherwise, leave the this property at the default x1 setting. Default: x1

Property	Description
Grayscale Mode	The type of data for processed grayscale blobs that the Vicon cameras send to Vicon Nexus. The Vicon cameras perform data processing to create 2D data for Vicon markers. They generate grayscale blobs for reflections from objects in the capture volume and then use centroid-fitting algorithms to determine which of these are likely to be markers by comparing the shape of the grayscale blobs to the Minimum Circularity Ratio and Max Blob Height settings. During this processing, Vicon cameras can produce these types of data for grayscale blobs: centroids data (x, y coordinates and the radius of the centroid calculated), grayscale data (pixel and line information), or coordinates data (line information, i.e. grayscale data without pixel values). You can specify which type of processed data Vicon cameras send to Nexus: • Auto: Send grayscale data only of the grayscale blobs for which centroids were not generated, that is, those below the threshold specified for Minimum Circularity Ratio.Send coordinates data of grayscale blobs for which one or more line segments, or the total number of lines in the blob, exceeds the value set for Max Blob Height. If a marker can be centroid fitted by the Vicon camera, the centroid is passed to the capture PC. If it cannot, the full grayscale of the image is sent, allowing the data to be post-processed on the PC. This is the default and recommended mode. • None: Send no grayscale or coordinates data; send only centroid data. Any grayscale image that cannot be centroid fitted by the camera will be discarded. Select this mode if you are capturing a large number of markers and have redundancy in your capture setup. • All: Send grayscale data both of grayscale blobs for which centroids were generated and of those for which centroids were not generated, that is those below the threshold specified for Minimum Circularity Ratio. Send coordinates data of grayscale blobs for which one or more line segments, or the total number of lines in the blob, exceeds the value set for Max blob height. Select this setting if you need to see exactly where the camera calculates the centroid with respect to the grayscale marker image, for example when adjusting parameters. This setting results in much larger data rates and files; it may be useful for diagnostic purposes, but do not use it in normal capture situations. • Only: Send all grayscale and coordinates data; send no centroid data.This setting is useful when focusing or making other adjustments to the cameras themselves as you see exactly the image recorded on the sensor. • Edges: Send only edge coordinates data; send no centroid or grayscale data.If data rates are very high, for example when there are too many reflections, the camera automatically enters this mode. Use this setting to manually force the camera into this mode. • No Edges: Send grayscale data both of grayscale blobs for which centroids were generated and of those for which centroids were not generated; send no coordinates data.Use this setting to prevent the Vicon camera from sending edge coordinates.

Property	Description
	Default: Auto **Caution** Even if you have not specified a Grayscale mode setting that would have coordinates data sent to Nexus, a Vicon camera automatically sends coordinates data– either temporarily or permanently– if it is overloaded with data (e.g., too many markers, too many reflections, hand or reflective objects immediately in front of the camera, too low a threshold or too high a gain). If a camera automatically starts to present coordinates data, identify the source of the overload and try to remedy it.
Allow Windowing	Windowing enables Vicon cameras that support windowing to run at a faster frame rate by using letterboxing to reduce the dimensions of the camera sensor area. The configured frame rate affects the field of view. When you select Allow Windowing, if you specify a frame rate greater than the maximum frame rate for the camera at full resolution, image size is automatically reduced in comparison with that for a lower camera frame rate by windowing. This keeps the pixel rate the same by transmitting a greater number of smaller images per second. Cannot be used in calibration mode. Default: Selected
Enable LEDs	Enables you to select whether or not to use the status lights on the Vicon camera strobe unit that provide feedback on the status of the camera (such as its enabled, connection, or selection state and any processing feedback). This is useful for motion capture applications in very dark environments (such as Virtual Reality) where the brightness of these LED status lights can cause problems. Default: Selected
Enable Display	Toggles on or off the display on the front of the camera (of supported Vicon cameras), which gives feedback about the current camera status, eg, when the camera has finished booting, its calibration status, and whether it has been moved since calibration. If **Enable Accelerometry** is selected (see below), the image on the display rotates based on the orientation of the camera. For more information, see the *Vicon Vantage Reference Guide* or the *Vicon Valkyrie Reference Guide*.
Enable Tap to Select	For supported Vicon cameras, enables you to lightly tap the camera in the volume to select it (and deselect the other cameras). This is useful, for example, when you are setting up cameras, before they are calibrated. Default: Selected
Enable Accelerometry	Applies to supported Vicon cameras only. Accelerometers in the Vicon cameras enable bump detection to operate in calibrated cameras to alert you when they have moved from their calibrated positions. If a calibrated camera is knocked, the camera's status LEDs flash blue and in Nexus, the camera's Bumped check box (in its Status properties) displays a check mark. See also Bumped and Bump Detection Sensitivity, page 226 in the **Status** section. Default: Selected

Run in High Speed mode

Nexus 2.11 and later supports the use of the Vantage+ firmware upgrade (Firmware 725), enabling you to use **High Speed** mode on your Vantage cameras without having to change the field of view (FOV) or lens. When you capture optical data, subsampling (selectively reducing the pixel count) enables you to run at high camera frame rates without reducing the FOV (frame size).

> **Important**
> To use **High Speed** mode, you must upgrade to Firmware 725 or later.

In **Default** mode, to run Vantage cameras at higher frame rates while maintaining their maximum resolution, windowing is used, which reduces the size of the FOV.

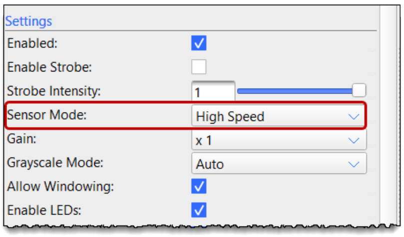
In **High Speed** mode, you can run your Vantage cameras at higher frames rates while maintaining the FOV. You can change frame rates during capture and you do not need to set up your cameras again when you increase the frame rate, as the FOV is unchanged.

Note that because the higher speeds are achieved through subsampling (removing some pixels from the frames), some reduction in resolution is incurred. For details, see **High-speed mode** in the *Vicon Vantage Reference Guide*.

To select high-speed mode:

1. With your Nexus system in Live mode, set the system frame rate to the speed you want to use in High Speed mode.
   A warning may temporarily be displayed, alerting you to the discrepancy between the requested frame rate and the actual system frame rate, until you select high speed mode for all the relevant cameras, as explained next.
2. On the **System** tab, select one or more cameras.

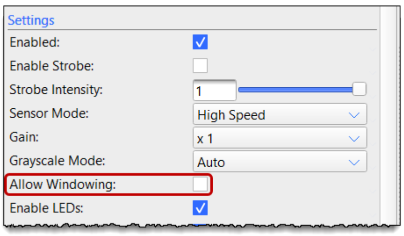
3. In the **Properties** pane, ensure the Advanced properties are displayed and in the **Settings** section, click the **Sensor Mode** menu and select **High Speed**.



In the **Camera** view pane, notice that the High Speed mode icon is displayed in the bottom left corner of the view .

4. With **Allow Windowing** selected (the default), windowing (reducing the size of the field of view) is used above the following frame rates:
   - V16: 500 fps
   - V8: 900 fps
   - V5: 1060 fps

   If you don't want to use windowing in addition to High Speed mode, clear the **Allow Windowing** check box.



After a few moments, the system runs at the new speed.

Centroid Fitting section

Property	Description
Threshold	The threshold for the minimum brightness (intensity) for marker pixels (the setting does nothing to an overall marker, just the individual pixels); pixels of an intensity lower than this threshold are ignored. This value can be set between 0-1 to determine the pixels to be considered for centroid fitting onboard the Vicon cameras. Lower settings enable the camera to detect lower light levels, thus making the markers appear larger, but introduce more noise from unwanted reflections and other light sources. Higher settings reduce the noise, but make the markers themselves less visible. This setting differentiates between markers and ambient light. Vicon cameras record 10-bit grayscale data, which for each sensor pixel is a measure of how much light fell on that pixel during a given amount of time. However, the cameras will almost always pick up some ambient light in the volume. To enable the cameras to distinguish between light that comes from markers and light that does not, a threshold is applied. Anything above this threshold is deemed to be a marker, anything below is deemed to be ambient light. A value in the region of 0.2 to 0.5 is usually appropriate, but Vicon strongly recommends that you use static markers in the volume in order to establish an appropriate setting. If cameras are evenly spaced around the volume, the same Threshold value is usually sufficient for all cameras. Adjust this setting, the Strobe Intensity, and the camera's aperture until reflections are minimized or gone. Default: 0.2
Minimum Circularity Ratio	The circularity threshold used by the centroid-fitting algorithms in a Vicon camera. This value can be set between 0-1 to determine how similar a grayscale blob must be to the internal model of a marker–that is a radially symmetric object that has smooth, sharp edges and whose pixel intensity is brightest at the center and gradually fades towards the edges. The Vicon cameras consider grayscale blobs with circularity equal to or greater than this threshold to be well-formed, circular marker images. The higher the value, the more stringent the centroid fitter is; the lower the value, the less stringent the centroid fitter is. You may wish to apply higher settings for camera calibration to ensure that the Vicon system selects the best markers and thus provides the best possible calibration. A lower value may be appropriate for data capture. Default: 0.5

Property	Description
Maximum Blob Height	The maximum height in pixels of a grayscale blob for a camera to attempt to circle fit it. If the number of pixels exceeds this value, the Vicon camera determines that the grayscale blob is not a marker, stops processing it, and discards the pixel values (it preserves just the coordinates data, which can be sent to Vicon Nexus, depending on the Grayscale mode setting). Set this value between 0-500 to determine how large a grayscale blob can be for a Vicon camera to consider it a candidate marker. The Vicon cameras consider grayscale blobs with horizontal lines containing this number or fewer pixels to be good-sized, circular marker images. The higher the value, the larger a grayscale blob can be; the lower the value, the smaller a grayscale blob must be. Default: 50

Centroid Tracking section

Property	Description
Enable Centroid Tracking	When Nexus recognizes the presence of Vicon cameras, the Enable Centroid Tracking parameter becomes available. Tracking and identifying 2D centroids on an individual camera allows the production of 2D tracks. Tracking and identifying 2D camera centroids provides extra information that maintains marker labels in real time when only one camera can see a marker. When selected, the 2D track calculations are performed by the cameras' onboard sensors. When cleared, the 2D track calculation is performed by the PC (in Nexus). Click on a Vicon camera to turn on 2D switchable tracks. Clear this option to turn off. **Note:** Applies only to Vicon cameras that have the ability to process this information on board the camera. Default: Off
Marker Velocity	Maximum velocity at which a marker will be tracked, expressed as the percentage of image width per second. Default: 5

Status section

Property	Description
Connected	Whether or not the Vicon camera is currently connected to the Vicon system. Default: Identified on connection
Sync Source	Whether or not the Vicon camera is designated as the synchronization source for the Vicon system. For more information, see *Change the synchronization source* in the *Vicon Nexus User Guide*. Default: Identified on connection
Contributing Centroids	Whether or not the Vicon camera is contributing centroid data during the current motion capture. Default: Identified during capture
Contributing Grayscale	Whether or not there is a socket open to the Vicon camera that is capable of receiving grayscale. This socket may be dropped when the system is under heavy load, therefore this property is useful as a system status monitor. It is not related to Grayscale property under Settings. Default: Selected
Contributing Tracks	Whether or not the camera is contributing tracks. Default: Cleared
Bumped	If selected, indicates that a calibrated camera has moved (usually because it has been accidentally knocked) since it was calibrated. To remove selected camera's bumped status, clear this check box. To clear all cameras' Bumped status, press CTRL+SHIFT+B. Applies only to Vicon cameras that support indicating Bumped status. Default: Cleared
Bump Detection Sensitivity	Enables you to change the sensitivity of the camera to knocks and bumps. Applies only to Vicon cameras that support bump detection. Default: Medium

Hardware section

Property	Description
Type	The type of Vicon camera. The top-level entry for all Vicon optical cameras takes no value. Default: Identified on connection
Strobe Type	The type of strobe unit (if any) attached to the front of the Vicon camera: Visible Red (VR), Near Infrared (NIR), or Infrared (IR). Default: Identified on connection
Camera Body Temp 1 Camera Body Temp 2 or Strobe Temperature	Current operating temperature given in degrees Celsius. A colored temperature indicator on the right changes to reflect a change in temperature: yellow (warming up to the temperature specified by the lower bounds), green (between the specified upper and lower bounds) or red (overheated above the upper bounds). To change the upper and lower bounds, click **Camera Temperature Range** in list on the left of the **Options** dialog box (F7). Applies only to Vicon cameras that support temperature sensor display. Default: Identified during connection
Sensor Width	The width (in pixels) of the Vicon camera sensor. Default: Identified on connection
Sensor Height	The height (in pixels) of the Vicon camera sensor. Default: Identified on connection
Revision	Camera revision number.
MAC Address	The Media Access Control (MAC) address assigned to the Vicon camera during manufacture. This is a hexadecimal value in the format ##.##.##.##.##.##. The top-level entry for all Vicon cameras takes no value. Default: Identified on connection
IP Address	The Internet Protocol (IP) address assigned to the Vicon camera on the Vicon Ethernet network. The top-level entry for all Vicon cameras takes no value. Default: Identified on connection
Destination IP Address	The IP address of the network adapter to which data from this camera will be sent. Default: Default

Firmware section

Property	Description
Firmware Version	The version number of the firmware currently installed on the Vicon camera. Default: Identified on connection
Firmware Complete	Whether or not the currently installed firmware is complete. If not, you can reprogram the firmware. See Update firmware in the Vicon Nexus User Guide. Default: Identified on connection

Calibration section

Property	Description
Reset Calibration	Removes the selected camera from the current calibration.
Focal Length (mm)	The focal length (in millimeters) of the Vicon camera lens. The focal length of the lens is automatically calculated by the calibration algorithm. You only need to enter this value manually if you use the **Aim Cameras** function. Can be set to a value between 2-100. Default: 8

Commands section

Property	Description
Reboot	Stop and restart the selected Vicon camera.

Video Cameras node

The **Video Cameras** node on the **System** tab of the **Resources** pane enables you to manage the identification and configuration settings for each digital video camera connected to your Vicon system. You can also remove or reorder video cameras.

For more information, see the following topics.

- Video Cameras node context menu, page 229
- Video Camera properties, page 230

See also:

- *Vicon Systems Setup Guide* (PDF available from the Vicon documentation website[29]).
- For information on the settings for FLIR cameras, see Configure and calibrate FLIR cameras in the *Nexus User Guide*.

Video Cameras node context menu

You can select the following options from the context menu displayed when you right-click on the Video Cameras node:

Command	Description
Reorder	Display the Reorder Devices dialog box, page 192 in which you can change the order in which digital video cameras are displayed in the System resources tree.
Reboot Video Cameras	Stop and restart all of the Vicon Video cameras in the Vicon system.
Remove Video Cameras (Disconnected or Missing)	Removes disconnected video cameras

29 https://help.vicon.com/

Video Camera properties

You can configure settings in the following sections of the **Properties** pane for video cameras. The available properties depend on the type of video camera included in your Vicon system, so you may not see all of the properties described.

The settings for some properties may differ depending on whether you are using video calibration setup mode or live capture mode. For these properties, changes you make in video calibration setup mode do not affect the settings in live capture mode and vice versa. In the following lists, these properties are indicated by an asterisk (*).

Identification section

Property	Description
Name	A name that you supply, which enables you to identify the camera in Vicon Nexus. Default: Blank
Device ID	The unique identification number Vicon assigns to the digital video camera. The top-level entry for all cameras takes no value. Default: Identified on connection

Settings section

Property	Description
Enabled	Whether or not the digital video camera is currently enabled for use. Default: Selected
Color*	Whether the video camera captures in color. Default: Selected
Shutter Duration*	The length of time that the camera shutter is open during an image capture. The maximum shutter speed cannot exceed the value specified in Requested Frame Rate. For example, if the frame rate is set to 50 fps, an image is taken every 20 milliseconds, the shutter speed cannot exceed 19 ms. Default: 9
Video Saturation	This value controls the amount of color in the image. Decreasing the value towards 0 results in a grayscale image with no color; increasing the value over 1 results in supersaturated colors. Default: 1
Video Gain*(all)	The digital amplification of the pixel value. Select a displayed value to determine the intensity of the grayscale from the video cameras: x1, x2, x4 or x8. This setting is applied to the camera to change the dynamic range of the recorded image. Increasing the gain means that the marker has less variation in grayscale intensity between its center and its edge, but in certain circumstances, using a higher gain yields markers that are easier for the camera to distinguish. Vicon does not recommend using a gain setting higher than x2. Adjust this setting if the markers appear too faint or if the cameras have trouble distinguishing them; otherwise, leave the this property at the default setting. Default: x1
Camera Gain*	The digital amplification of the pixel value. The value can be set between 0-100. Gain on a video camera is similar to the contrast control on a television. Higher values mean a greater camera response to a change in light level and, therefore, a greater visible difference between pixels of different intensity. Adjust this setting until you are satisfied with the image quality– the optimum settings depends on factors such as the ambient light conditions and the Camera Brightness setting. Default: 10

Property	Description
Camera Brightness*	The brightness of pixels. The value can be set between 0-100. Brightness on a video camera is similar to the brightness control on a television; it represents an offset of the entire image signal. Higher values mean a greater apparent brightness of the image. Adjust this setting until you are satisfied with the image quality– the optimum settings depends on factors such as the ambient light conditions and the Camera Gain setting. Default: 50
Camera Gamma*	The gamma setting of the camera. The value can be set between 0.1-10. A setting of 1 is linear. Default: 1
Brightness Offset*(all)	A linear intensity offset that is applied to each component of the video image. Where Video Gain is a multiplication, Brightness Offset adds a value to the component. Default: 0
Capture Path	The drive letter (e.g., C:\ or H:) of the computer from which video data from the digital video camera is to be captured. Because the data rates can be very high, you are advised to capture digital video data to a different drive than the Vicon optical data. For optimum performance, specify a different capture drive for each camera. Do not use a mapped drive. Default: Blank
Pixel Aspect Ratio	The height vs. width ratio of pixels. The default varies according to camera type: Vicon Nexus detects whether the camera is likely to produce non-square pixels and adjusts the ratio accordingly. Default: Depends on camera type

Frame Rate section

Property	Description
Trigger Source	The source of the synchronization signal. Select the Vicon connectivity unit to which the video camera is connected from this drop-down list. If **None** is selected, no synchronization occurs. Default: Blank
Trigger Offset (ms)*	The sync pulse delay, in millisecond (ms). Default: 0
Requested Frame Rate*	The rate, in frames per second (fps), for the video camera to control the camera shutter speed, data rate, and area of interest to achieve the desired frequency. Default: Depends on the connected camera
Incoming Frame Rate	The actual system frame rate at which the camera is sending video frames to Nexus. The Incoming Frame Rate may differ from the Requested Frame Rate and the rate reported next to the camera node in the System tree due to system limits and fluctuations.

Centroid Fitting section

Property	Description
Threshold	This setting differentiates between markers and ambient light. To enable the cameras to distinguish between light that comes from markers and light that does not, a threshold is applied. Anything above this threshold is deemed to be a marker, anything below is deemed to be ambient light. A value in the region of 0.2 to 0.5 is usually appropriate. Default: 0.5

Hardware section

Property	Description
Destination IP Address	The IP address of the network adapter to which data is to be sent. For video cameras, the Destination IP address must not be shared with another camera. Always choose the shortest possible path between the camera and the computer and ensure that the network adapter with the destination IP address is plugged into the same Vicon connectivity device or switch as the camera. Default: Default For more information, see the *PC Setup for Vicon Systems* PDF.
Sub Sample Ratio*	Ratio of sub-sampled frames to requested frame rate, for example, for a Requested Frame Rate of 240Hz, a sub sample ratio of 2:1 gives a sub-sampled frame rate of 120Hz. Default: 1:1

Calibration section

Property	Description
Reset Calibration	Removes the selected camera from the current calibration.
Focal Length (mm)	The focal length (in millimeters) of the camera lens. Set this to a value between 2-100. Set this value if you use the Aim Cameras function or Static Video Calibration. On some cameras with variable zoom, the focal length may be difficult to determine; to obtain the lens properties, see the documentation supplied with the camera.

Commands section

Property	Description
Reboot button	When clicked, reboots the selected video camera

You can also remove or reorder video cameras (see Video Cameras node context menu, page 229).

Vicon Connectivity nodes

You use the **Vicon Connectivity** node on the **System** tab of the **Resources** pane to configure Vicon connectivity units (eg, Vicon Locks), which are smart boxes that can be combined to create a distributed architecture.

See also:

- Vicon Connectivity node context menu, page 235
- Vicon Lock node, page 236

> **Note**
> Except where noted, references to Vicon Lock, Lock units, and Lock apply to all current models of the Vicon Lock unit (at the time of publication, this includes Vicon Lock Studio and Vicon Lock Lab).

Vicon Connectivity node context menu

You can select the following commands from the context menu displayed when you right-click on the **Vicon Connectivity** node:

Command	Description
Reorder	Display the Reorder Devices dialog box, page 192 in which you can change the order in which Vicon connectivity units are displayed in the **System Resources** tree.
Reboot All Vicon Connectivity Units	Stop and restart all of the Vicon connectivity units in the Vicon system.

Vicon Lock node

Vicon Lock nodes are displayed under the **Vicon Connectivity** node on the **System** tab of the **Resources** pane when Vicon Nexus is connected to a Vicon system with at least one Lock unit and is in Live mode.

These connectivity unit nodes enable you to manage the identification and configuration settings for each Vicon Lock unit included in your Vicon system architecture.

For each connectivity unit the node name includes:

- The device position number
- Any display name specified in the Identification property
- The device type listed in parentheses
  For example, `#1 Name (Lock Lab)`.
  If either or both analog option cards are installed in the Lock Lab, the sample rates are displayed in brackets, for example, `#1 Name [1000Hz/1000Hz] (Lock Lab)`, and an Analog Card (Slot 1) sub node is displayed as appropriate. If no analog source is selected, `[No Source]` is displayed after the device name.

See also:

- Vicon Lock node context menu, page 236
- Vicon Lock node properties, page 237
- Analog card properties, page 242

Vicon Lock node context menu

You can select the following commands from the context menu displayed when you right-click on a node for a specific Lock unit.

Command	Description
Reboot	Stop and restart the selected device.
Reset Timecode	Reset the Timecode to 00:00:00:00.

Vicon Lock node properties

You can configure settings in the following sections of the **Properties** pane for the **Vicon Connectivity** node and nodes for any current Vicon connectivity units:

- Identification section, page 237
- Status section, page 238
- Genlock section, page 238
- Timecode section, page 239
- Sync Out section, page 240
- Hardware section, page 241
- Firmware section, page 241
- Commands section, page 242

If you are using an analog card (this applies to all Lock Lab units), see also:

- Analog card properties, page 242

Identification section

Property	Description
Name	A user-defined display name for the entire set of Vicon connectivity units or for each individual connectivity unit. Default: Blank
Type	The device type Default: Identified on connection.
Device ID	The unique identification number Vicon assigns to each connectivity unit during manufacture. The Vicon Connectivity node takes no value. Default: Identified on connection

Status section

Property	Description
Connected	Whether or not the connectivity unit is currently connected to the Vicon system. Default: Identified on connection
Enabled	Whether or not the connectivity unit is currently enabled for use. Default: Selected
Sync Locked	Whether or not the connectivity unit is receiving and locked to the main (source) synchronization signal for the Vicon system. Default: Identified on connection
Sync Source	Whether or not the connectivity unit is designated as the synchronization source for the Vicon system. For more information, see *Change the synchronization source* in the *Vicon Nexus User Guide*. Default: Identified on connection

Genlock section

Property	Description
Enabled	Whether or not Genlock functionality supported by the connectivity unit is currently enabled. If so, the scan rate of the incoming video signal from a PAL or NTSC video source is synchronized with Vicon cameras. Default: Identified on connection
Source	The genlock device source. Default: Internal
Standard	The video standard of the external video source with whose incoming video signal scan rate the connectivity device is to synchronize the Vicon cameras. If one is not identified, None is displayed. Default: Identified on connection
Status	The status of the Genlock functionality: None, In Use, Ready To Use, Requires Other Frame Rate, Requires Device To Be Sync Source, or Requires Genlock. Default: Identified on connection

Timecode section

Property	Description
Enabled	Whether or not Timecode functionality supported by an connectivity unit nis currently enabled. If so, the connectivity unit can be configured to trigger from or be time-stamped from a connected VITC (video) or LTC (audio) Timecode source. Default: Identified on connection
Source	The source designated as the main Timecode signal generator: VITC (external video device), LTC (external audio device), or Internal (Vicon connectivity unit). Default: Internal
Dropped Frames	Whether or not the connectivity unit is to adjust its internal counter to drop frames for the NTSC video standard. This option is available only if Internal is specified in Source. If selected, the separator character in the Timecode display in the Capture tools pane changes between a colon (:) for non-drop frames and semicolon (;) for drop frames. Default: Cleared
Standard	The video standard of the Timecode source from which the connectivity unit will trigger data capture or be time-stamped. If one is not identified, None is displayed. Default: Identified on connection
Status	The status of the Timecode functionality: None, In Use, Ready To Use, Requires Other Frame Rate, Requires Device To Be Sync Source, or Requires Genlock. Default: Identified on connection

Sync Out section

The characteristics of a synchronization pulse that the connectivity unit is to generate to synchronize third-party hardware with the Vicon system (for technical details, see the *Vicon Systems Setup Guide*). The general purpose output driver (*.*gpo* file) you specify here determines the output frequency of the synchronization pulse. You can select a driver for each of the sync outputs.

For each sync output, use the Browse for a folder button to navigate to the folder containing the *.gpo* files (by default, *C:\Program Files\Vicon\Nexus2.# \GPO*) and then used the drop-down list button to select the desired file (None, Duration, DV_Double, DV_Half, DV_Normal, or DV_Quarter):

Property	Description
Socket 1	The .gpo configuration file to use to specify the synchronization signal for Powered Sync Output 1 in the rear panel of the connectivity unit. Default: Blank
Socket 2	The .gpo configuration file to use to specify the synchronization signal for Powered Sync Output 2 in the rear panel of the connectivity unit. Default: Blank
Socket 3	The .gpo configuration file to use to specify the synchronization signal for Powered Sync Output 3 in the rear panel of the connectivity unit. Default: Blank
Socket 4	The .gpo configuration file to use to specify the synchronization signal for Powered Sync Output 4 in the rear panel of the connectivity unit. Default: Blank
Socket 5	The .gpo configuration file to use to specify the synchronization signal for Sync Output 5 in the rear panel of the connectivity unit. Default: Blank
Socket 6	The .gpo configuration file to use to specify the synchronization signal for Sync Output 6 in the rear panel of the connectivity unit. Default: Blank
Socket 7	The .gpo configuration file to use to specify the synchronization signal for Sync Output 7 in the rear panel of the connectivity unit. Default: Blank

Property	Description
Socket 8	The .gpo configuration file to use to specify the synchronization signal for Sync Output 8 in the rear panel of the connectivity unit. Default: Blank

Hardware section

Property	Description
MAC Address	The Media Access Control (MAC) address assigned to the connectivity unit during manufacture. This is a hexadecimal value in the format ##.##.##.##.##.##. The top-level entry for all connectivity units takes no value. Default: Identified on connection
IP Address	The Internet Protocol (IP) address assigned to the connectivity unit on the Vicon system Ethernet network. The top-level entry for all connectivity units takes no value. Default: Identified on connection

Firmware section

Property	Description
Firmware Version	The version number of the firmware currently installed on the connectivity unit. Default: Identified on connection
Firmware Complete	Whether or not the currently installed firmware is complete. If not, you can reprogram the firmware. See Update firmware in the *Vicon Nexus User Guide*. Default: Identified on connection

Commands section

Property	Description
Reboot	Stop and restart the connectivity unit.

Analog card properties

Configuration section

You can configure the following settings in the **Properties** pane for an analog card connected to a connectivity unit:

Property	Description
Sampling Frequency (HZ)	The sample rate for the analog card. The default analog sampling frequency is 1000 Hz and the corresponding default Vicon system frame rate is 100 Hz. The analog frequency must be an integer multiple of the frame rate and both must divide evenly into 135 MHz (the overall clock frequency). If you change the frame rate, the analog frequency may change automatically to meet these criteria. Similarly, if you enter an invalid analog sampling rate, its value is automatically adjusted to meet the criteria. Default: Identified on connection
Channel Count	The number of channels provided by the analog card Default: 64

Devices node

Use the **Devices** node to manage the connection and configuration settings for supported analog and digital devices of all types, including force plates, accelerometers, EMG devices, Vicon IMUs (sensors), and the Dikablis eye tracker.

See also:

- Devices node context menu, page 244
- Force plate nodes, page 245
- Analog accelerometer, EMG, & other analog device nodes, page 256
- Dikablis Eye Tracker node, page 262
- Tobii Pro Glasses 2 node, page 259
- Vicon IMU node, page 265

Devices node context menu

You can select the following commands from the context menu displayed when you right-click on the **Devices** node:

Command	Description
Reorder	Selecting this command displays the Reorder Devices dialog box, page 192. Reordering the force plates changes their position in the Devices tree.
Add Analog Device	Enables you to select from the following options to add supported analog devices: • Add AMTI AccuGait Force Plate • Add AMTI OR6 Series Force Plate • Add analog accelerometer • Add analog EMG • Add Bertec Force Plate • Add generic analog • Add Kistler Force Plate (External Amplifier) • Add Kistler Force Plate (Internal Amplifier) • Add Motekforce Link treadmill
Add Digital Device	Enables you to select from the following options to add supported digital devices: • Add Dikablis Eye Tracker • Add Tobii Pro Glasses 2 • Add Tobii Pro Glasses 3 • Add ZeroWire/Wave EMG
Disconnected Devices	Enables you to select whether to show or hide devices that are not currently connected to the system.

Force plate nodes

You manage the connection and configuration settings for supported force plates included in your Vicon system architecture with the appropriate force plate node. You select the required force plate node under the **Devices** node in the **System Resources** tree. If no analog source is selected, `[No Source]` is displayed after the device type. Force plate data can be acquired through the analog capture functionality of a Vicon Lock Lab with an analog card.

See also:

- Force plate node context menu, page 246
- Force plate properties, page 247

For information about configuring force place display options, which affect the way force plates are displayed in the **3D Perspective** view, see *Configure force plates* in the *Vicon Nexus User Guide*.

For information on how to handle cross-plate foot strikes when modeling with Plug-in Gait, see Cross-plate foot strikes in the *Vicon Nexus User Guide*.

Force plate node context menu

You can select the following commands from the context menu displayed when you right-click on a force plate node:

Command	Description
Foot Contact	Attributes the force plate to: • Auto-detect, in which Nexus attributes the force plate contact based upon foot segment kinematics • Left foot contact • Right foot contact • Invalid if no valid left or right foot contact can be associated with the force plate. You can also adjust these settings by right-clicking a displayed force plate in the **3D Perspective** view pane.
Show Raw	Adds each raw voltage signal for the device. For example, Kistler force plates contain 8 input channels that are processed to yield a resultant force and moment (3 components each, 6 total). Using the **Show Raw** command, you can select one or more inputs and graph their raw data in a Graph view pane, allowing you to view, troubleshoot, or configure a monitor for the raw signals. If you use **Show Raw** and collect a trial, the raw voltages will be stored in the .x1d file, so you can view them in the offline trial as well as the force channels. If you save the trial, or export a .c3d file, when you load the trial the raw channels will be grouped together and designated within an Imported Analog Device. To remove the raw inputs from the **System Resources** tree, right-click on the force plate node and click **Hide Raw**.
Zero Level	Calibrates the force plate. This process eliminates any significant offset between the force plate's nominal output levels at rest and its theoretical zero level. Select this option if, after setting the force plates to the electrical zero level, small differences remain between the theoretical zero level and the observed output level. This option is also available in the **General** section of the **Properties** pane.
Remove Device	Removes the force plate entry from the **System Resources** tree.

Force plate properties

You can configure settings for force plates in the following sections in the **Properties** pane for force plates.

General section

For all force plates:

Property	Description
Name	A user-defined display name for the force plate. Default: Blank
Delay Compensation	The delay compensation value (in seconds). All devices have a delay compensation value which adjusts the synchronization offset between the device and the Vicon data. Analog data collected with a Vicon connectivity device should already be synchronized, so this value should be set at 0. Values can be set between -10 and 10. Default: 0

For all but Kistler force plates:

Property	Description
Calibration File	The force plate calibration file Nexus is to use. This file describes the forces plate's properties, such as its physical dimensions, output voltages, and crosstalk coefficients between each analog output. Nexus automatically displays some of these values as the default settings in the relevant properties for the force plates (for example, X Length, Y Length and Calibration Matrix). Use the Browse for a folder button to navigate to the folder containing the calibration file supplied by the force plates manufacturer. Then use the drop-down list button to select the desired file. Default: Blank
Calibration Matrix	Displays the size of the calibration matrix (e.g., 6x6 Matrix). Click the Edit Text button to display the Calibration Matrix dialog box, which shows the values supplied by the force plate manufacturer. If you do not have a calibration file for your force plate, contact the manufacturer for a replacement file or refer to the calibration information supplied in your force plate documentation. You can manually edit the values for each channel scale. If you manually enter the values, ensure that you use the correct input values to transform the voltages captured by the Vicon connectivity device's analog card to forces and moments. The sensitivity values you must specify depend upon the type of force plate as shown in Calibration matrix values, page 250. Default: Identified from calibration file specified in the Calibration File property
Zero Level	Resets the force plate voltage zero level. This process eliminates any significant offset between the force plate's nominal output levels at rest and its theoretical zero level. Use this function if after setting the force plates to the electrical zero level, small differences remain between the theoretical zero level and the observed output level. Click the Edit Text button to display the Zero Level matrix in which you can enter the required value to calibrate the force plate. Then click Apply, then click Close.

Property	Description
Correction Factor	The factor by which Nexus is to convert the values supplied from a force plate into the values it requires. Correction factor corresponds to a force plate's amplifier setting and is used along with the calibration matrix to convert raw Volts to Newtons. For an AMTI OR6 Series force plate: • Forces: from Newtons per microvolt (N/μV) to Newtons (N). • Moments: from Newton meters per microvolt (Nm/μV) to Newton millimeters (Nmm). The formula for calculating the coefficient (K) is: K = 1000000/(Gain x Excitation Voltage) where both Gain and Excitation Voltage are established in the AMTI amplifier. Check the settings for your AMTI amplifier. Default: 25 (for an AMTI amplifier with a default setting of 4,000 Gain and 10V Excitation Voltage).
Force Threshold (N)	The threshold (in Newtons) identifying the noise floor value for calculated forces. Forces that do not exceed this magnitude are assumed to be too noisy and are clamped to zero. Values can be set between 0-50. This value is not affected by the value for Force Threshold that is set in the Options dialog box (see Visualize and record Force Threshold) in the *Vicon Nexus User Guide*. Default: 25

For Kistler (Internal amplifier) force plates only:

Property	Description
Sensitivities (mV/N)	Force plate sensitivity vector. Click the Edit Text button to display the Sensitivities (mV/N) matrix in which you can enter the required values in millivolts per Newton. Default: Identified on connection

Calibration matrix values

Supported Force Plate	Manufacturer Supplied Units	Nexus Required Units	
		Force Channels	Moment Channels
AMTI Hall Effect Plate (AccuGait Series)	United States Customary (USC) units Supplied in manufacturer's .acl file.	lb/V	lb/V
AMTI Strain Gage Plate (BP Series and OR6 Series) (See following **Note**)	United States Customary (USC) unit matrix Supplied in manufacturer's .plt file and Sensitivity Matrix.	uV/Vex/lb	uV/Vex/in lb
Bertec	International System (SI) units Supplied in manufacturer's documentation.	N/V	Nm/V
Kistler (External Amplifier)	International System (SI) units Supplied in manufacturer's documentation.	pC/N	pC/N
Kistler (Internal Amplifier)	International System (SI) units Supplied in manufacturer's documentation.	mV/N	mV/N

Note

If you are connecting to AMTI OR6 Series force plates, Nexus expects the force plate calibration values from the USC matrix in pounds (lb) and Inch-Pounds (in-lb) as supplied by AMTI with recent plates. Some older AMTI OR6 Series plates, however, have their USC calibration matrix presented in units of Pounds and Foot-Pounds (ft-lb).

If the calibration matrix for your force plate is presented in units of ft-lb, you must convert the values to the required in-lb units.

To do this, create a copy of the calibration *.plt* file and in this copy, divide the values of the last three columns of the matrix by 12.

Save this modified calibration file and apply it to your force plate by specifying it in the **Calibration File** field.

If you enter the matrix values manually, first divide the terms in the **Sensitivity Matrix** by 12.

The force plate moments will then scale correctly.

Source section

Property	Description
Source	The Vicon connectivity device to which the physical force plates device is connected. From the drop-down list, select the correct one from the available analog option cards detected in your Vicon system architecture. Default: None
Gain (V)	The programmable gain (+/- volts) for the channel: 1.25 Volts, 2.5 Volts, 5 Volts, or 10 Volts. The gain voltages correspond to 8, 4, 2 and 1 gain values, respectively (e.g., a gain of 2.5 Volts means that the input signal will be multiplied by 4. Default: 10.00
Fill	Fills all input connections in the expected sequence, starting with the lowest unassigned pin, for the device selected in Source.
Clear	Clears the input connection setting from all pins.
Channel	The input connections from the device. After selecting the Source, select the source input from the drop-down list, or use the Fill button to automatically fill all the positions. • AMTI AccuGait: FzA, FzB, FzC, FzD, FyAC, FxDC, FxAB, FyBD • AMTI OR6 and Bertec: Fx, Fy, Fz, Mx, My, Mz • Kistler: Fx (1+2), Fx (3+4), Fy (1+4), Fy (2+3), Fz1, Fz2, Fz3, Fz4 Default: None

Dimensions section

Property	Description
X Length (mm)	The length (in millimeters) of the x axis of the force plate. Default: Identified from calibration file specified in the Calibration property, if one.
Y Length (mm)	The length (in millimeters) of the y axis of the force plate. Default: Identified from calibration file specified in the Calibration property, if one.

Position section

Property	Description
X Position (mm)	The origin coordinate (in millimeters) for the X axis of the force plate in relation to the origin of the capture volume, as specified by the L-Frame when you perform the System calibration. Default: 0
Y Position (mm)	The origin coordinate (in millimeters) for the Y axis of the force plate in relation to the origin of the capture volume, as specified by the L-Frame when you perform the System calibration. Default: 0
Z Position (mm)	The origin coordinate (in millimeters) for the Z axis of the force plate in relation to the origin of the capture volume, as specified by the L-Frame when you perform the System calibration. Default: 0

Normally, the force plate origin is chosen by placing the calibration device on the desired corner of the force plate. In this case, the position offset is half the width and half the length of the plate. However, for other plates that did not have the calibration device placed on them during calibration, you must fully specify the coordinates of the center of the plate in relation to the capture volume origin.

Orientation section

Property	Description
X Angle Axis (deg)	Maps the x axis (in degrees) of the local force plate coordinate system to the global coordinate system specified for Nexus in the System Preparation tools pane. Default: 0
Y Angle Axis (deg)	Maps the y axis (in degrees) of the local force plate coordinate system to the global coordinate system specified for Nexus in the System Preparation tools pane. Default: 0
Z Angle Axis (deg)	Maps the z axis (in degrees) of the local force plate coordinate system to the global coordinate system specified for Nexus in the System Preparation tools pane. Default: 0

Origin section

For all but Kistler force plates:

Property	Description
X Origin (mm)	The displacement (in millimeters) from the sensor X origin to the force plate X origin. Default: 0
Y Origin (mm)	The displacement (in millimeters) from the sensor Y origin to the force plate Y origin. Default: 0
Z Origin (mm)	The displacement (in millimeters) from the sensor Z origin to the force plate Z origin. Default: 0

For Kistler force plates:

Property	Description
a (mm)	The displacement (in millimeters) from the sensor X origin to the force plate X origin. Default: 120
b (mm)	The displacement (in millimeters) from the sensor Y origin to the force plate Y origin. Default: 200
az0 (mm)	The negative displacement (in millimeters) from the sensor Z origin to the force plate surface. Default: 48

Analog accelerometer, EMG, & other analog device nodes

You manage the connection and configuration settings for supported analog devices included in your Vicon system architecture with the appropriate **Devices** sub-node on the **System** tab of the **Resources** pane.

See also:

- Analog device node context menu, page 256
- Analog EMG device node properties, page 257

For information on force plates, see Force plate nodes, page 245.

Analog device node context menu

You can select the following options from the context menu displayed when you right-click on a sub-node for an analog accelerometer or EMG:

Option	Description
Zero Level	Calibrates the force plate. This process eliminates any significant offset between the force plate's nominal output levels at rest and its theoretical zero level. Select this option if, after setting the force plates to the electrical zero level, small differences remain between the theoretical zero level and the observed output level. This option is also available in the General Properties pane.
Remove Device	Remove the device entry from the System resource tree.

You can select from a list of available outputs from the context menu that is displayed when you right-click on a **Generic Analog** sub-node. Nodes representing the outputs you select are added below the **Generic Analog** sub-node in the **System Resources** tree.

Analog EMG device node properties

You can configure settings in the following sections in the **Properties** pane for analog EMG devices:

- General section, page 257
- Source section, page 257

General section

Property	Description
Name	A user-defined display name for the device. Default: Blank
Delay Compensation (s)	The delay compensation value (in seconds). Many EMG systems, particularly new wireless systems, may introduce a small delay in transmission of data. This delay may cause a misalignment between Vicon frames of data and EMG frames of data. The Delayed Compensation slider bar enables you to correct this difference and properly align Vicon data with EMG data. To find the amount of delay for an EMG system. refer to the operating manual of the EMG system. If you can't find the value in the EMG manual, contact the EMG manufacturer. All devices have a delay compensation value which adjusts the synchronization offset between the device and the Vicon data. Analog data collected with a Vicon Lock is already synchronized, so this value should be set at 0. Values can be set between -10 and 10. Default: 0
Amplifier Gain (V)	The voltage gain scale factor. Can be set between 1 - 1000. Default: Depends on device

Source section

Property	Description
Source	The Vicon connectivity device to which the physical force plates device is connected. From the drop-down list, select the correct one from the available analog option cards detected in your Vicon system architecture. Default: None

Digital device nodes

You manage the connection and configuration settings for supported digital devices included in your Vicon system architecture with the appropriate **Devices** sub-node in the **System Resources** tree.

A sub-node is displayed under the **Devices** node of the **Local Vicon System** node when Vicon Nexus is connected to a Vicon system with at least one analog or digital device and is in Live mode. The sub-node is displayed under the **Devices** node of the **Vicon Data** node when Nexus is in Offline mode.

Currently supported digital devices include:

- Dikablis Eye Tracker node, page 262
- Tobii Pro Glasses node, page 259
- Vicon IMU node, page 265
- ZeroWire EMG node, page 268

Nexus also supports other digital devices via *.vdd files created by the following third-party suppliers:

- AMTI
- Cometa (ProPhysics and GPEM)
- Delsys
- Kistler (ProPhysics)
- NIDAQ (ProPhysics)
- Noraxon

Tobii Pro Glasses node

The Tobii Pro Eye Tracker enables you to output eye tracker position and gaze direction, with binocular gaze tracking. Its nodes (Tobii Pro Glasses 2 and Tobii Pro Glasses 3) are displayed under the **Devices** node.

The Tobii Pro Eye Tracker is compatible with current Vicon cameras. A minimum of two cameras are required for use with the system. Note that Nexus supports the use of only one pair of glasses at a time.

For information on setting up a Vicon system that includes Tobii Eye Tracker, see Use Tobii Eye Tracker with Nexus, page 157.

Tobii Pro Glasses node context menu

The following command is available from the context menu that is displayed when you right-click on a Tobii Pro Glasses node in the Resources tree on the System tab:

Command	Description
Remove Device	Removes the Tobii Pro Glasses node from the System Resources tree.

Tobii Pro Glasses node properties

You can configure the following settings in the **Properties** pane for a Tobii Pro Eye Tracker. For instructions on preparing and connecting the glasses, see the quick start guide provided in the Tobii Pro Glasses box.

- General section, page 260
- Status section, page 260
- Connection section, page 261
- Calibration section, page 261

General section

Property	Description
Name	Enter a display name for the device. Default: Blank
Delay Compensation (s)	The delay compensation value (in seconds). Many eye tracking systems, particularly new wireless systems, may introduce a small delay in transmission of data. This delay may cause a misalignment between Vicon frames of data and eye tracking frames of data. The **Delay Compensation** slider bar enables you to correct this difference and properly align Vicon data with eye tracking data. To find the amount of delay for an eye tracking system, refer to the operating manual of the eye tracking system. All devices have a delay compensation value which adjusts the synchronization offset between the device and the Vicon data. Analog data collected with the Vicon connectivity devices should already be synchronized, so this value should be set at 0. Values can be set between -10 and 10. Default: 0
Firmware	The version of the firmware that is obtained from the recording unit.
Headunit	The version of the headunit that is obtained from the recording unit.
Battery %	Percentage charge remaining on the current battery.
Glasses Segment	Enter or navigate to the name for the segment that is attached to the glasses. Default: Blank

Status section

Property	Description
Connected	Indicates whether or not the device is connected.

Connection section

Property	Description
Sampling Rate	Frequency of the data samples from the Tobii Recorder.
Serial Number	Serial number of the Tobii Recorder.
IPv4	Connection address

Calibration section

Property	Description
Calibration Status	Status of the last calibration
Start Calibration	Click to start the Tobii calibration

Dikablis Eye Tracker node

The Dikablis Eye Tracker enables you to track movement of the eye's pupil to calculate the gaze vector. Its node is displayed under the **Devices** node when Vicon Nexus is connected to a Vicon system that includes at least one Dikablis Eye Tracker.

The Dikablis Eye Tracking system is compatible with current Vicon cameras. A minimum of two cameras are required for use with the system.

For information on setting up a Vicon system that includes Dikablis Eye Tracker, see Eye tracking with Vicon Nexus, page 156.

Dikablis Eye Tracker node context menu

The following command is available from the context menu that is displayed when you right-click on a Dikablis Eye Tracker node in the Resources tree on the System tab:

Command	Description
Remove Device	Removes the Dikablis Eye Tracker node from the System Resources tree.

Dikablis Eye Tracker node properties

You can configure the following settings in the **Properties** pane for a Dikablis Eye Tracker. For instructions on setting up the hardware, see the *Dikablis Eye Tracker User Manual*.

- General section, page 263
- Connection section, page 263
- Eye Offset section, page 264
- Calibration section, page 264

General section

Property	Description
Name	A user-defined display name for the device. Default: Blank
Delay Compensation (s)	The delay compensation value (in seconds). Many eye tracking systems, particularly new wireless systems, may introduce a small delay in transmission of data. This delay may cause a misalignment between Vicon frames of data and eye tracking frames of data. The **Delayed Compensation** slider bar enables you to correct this difference and properly align Vicon data with eye tracking data. To find the amount of delay for an eye tracking system, refer to the operating manual of the eye tracking system. All devices have a delay compensation value which adjusts the synchronization offset between the device and the Vicon data. Analog data collected with the Vicon connectivity devices should already be synchronized, so this value should be set at 0. Values can be set between -10 and 10. Default: 0
Head Segment	Enter or navigate to the name of the segment that contains the eye.

Connection section

Property	Description
IP Address	Enter the same IP address that has been set in the Dikablis Recorder software.
Port Number	The port number for connecting the Dikablis Recorder on the Dikablis laptop. Normally, leave this number at its default value (2002).

Eye Offset section

To find the relevant eye offset values, if your Vicon system includes video cameras, you can use overlay video. If not, you can measure the distance from the origin marker.

Property	Description
x	Enter the X-coordinate of the eye in the head segment coordinate frame (the distance between the origin marker and the eye (in mm)
y	Enter the Y-coordinate of the eye in the head segment coordinate frame (the distance between the origin marker and the eye (in mm)
z	Enter the Z-coordinate of the eye in the head segment coordinate frame (the distance between the origin marker and the eye (in mm)

Calibration section

Property	Description
Calibration Object	Enter the name of the calibration device (normally Wand)
Reset	Clears the current calibration
Add	Add a point to the current calibration.
Remove	Undoes the last Add operation
Samples	The number of points used in the current calibration
Residual	Estimated residual accuracy value. Calculated as the average reprojection error in eye tracker pixels.

Vicon IMU node

> **Important**
>
> - Vicon IMUs are supported for use with Nexus for research purposes only. For full sensor safety and regulatory details, see the Vicon Blue Trident Model V2 Safety and Regulatory Information.
>
> Blue Trident sensors
>
> - Windows 10 and later only is supported. Ensure the latest Windows 10 updates are installed.
> - The firmware for Blue Trident sensors that are to be used with Nexus 2.10 or later must be updated to version 9.0.2 or later, using Capture.U Desktop 1.1 or later, which is available from the Capture.U page[30] on the Vicon website.
> - Second-generation Blue Trident sensors are supplied with Firmware 10 – do **not** downgrade their firmware. If you have first-generation Blue Trident sensors, you can safely downgrade their firmware, if necessary. However, as Capture.U 1.3.1 Desktop is not compatible with firmware earlier than 10.#, if you downgrade the firmware from version 10, you must uninstall Capture.U 1.3.1 and use an earlier version of Capture.U.
>
> Blue Thunder sensors
>
> - Blue Thunder IMU sensors are not supported in Nexus 2.10 or later. If you want to capture Blue Thunder data, use Nexus 2.9.x.
> - You can load existing processed trials with Blue Thunder data into Nexus 2.10 or later and view the captured IMU data.
> - The IMeasureU plug-in is not available in Nexus 2.10 or later.

You can configure the following settings in the **Properties** pane for a Vicon IMU device.

For information on setting up and using IMUs with Nexus, see Configure Vicon IMUs and Work with Vicon IMUs in the *Vicon Nexus User Guide*.

30 https://www.vicon.com/software/capture-u/

General section

Property	Description
Name	When the IMU is first connected, the name defaults to the Bluetooth® Name of the IMU. If required, you can change this name.
Delay Compensation	Delay compensation value in seconds. Default: 0
Enabled	When selected, data capture is enabled for this sensor. Default: Selected
Bluetooth® Name	Bluetooth® name of the device, derived from the Assembly Serial Number.
Bluetooth® Address	The unique 48-bit Bluetooth® Device Address
Output Preset	Choose from a list of preset output channels, which are displayed as axes on the graph. For information on customizing the outputs by selecting or clearing individual axes, see Deactivate an axis in the *Vicon Nexus User Guide*.
Record Output	If selected, the IMU records data to its internal storage. Default: Selected
Assembly Serial Number	Unique identifier for the sensor (eg, TS-00180), which is found on the back of the sensor.
Board Serial Number	The sensor's board serial number
Hardware Revision	Sensor hardware revision number
Firmware Revision	Firmware version of the connected sensor
Battery Level	The percentage of battery life (charge) remaining of the connected sensor
Storage Used	The percentage of storage used on the sensor

Property	Description
Record Rate	The sample rate of recorded sensor data (Hz). The sample rate depends on the selected outputs. For rates above 225 Hz, deactivate Global Angle output. Default: 225 Hz
Stream Rate	The sample rate of preview (streaming) data for the sensor (Hz). Default: 50 Hz

Status section

Property	Description
Connected	Indicates whether the sensor is connected.

Orientation section

World X, Y and Z angle axis components (degrees) and local X, Y and Z angle axis components (degrees).

X, Y and Z are the world transformation. If the volume origin orientation is changed, they must be recalculated (using Align to World and Copy).

X2, Y2 and Z2 are the local transformation. They must be recalculated using Align to Segment every time the sensors are attached.

See also Align IMU data to the Vicon world in the *Vicon Nexus User Guide*.

Radio Sync section

Property	Description
Prefer Radio Sync	When selected, radio sync (via a Vicon Beacon) is used to synchronize your IMU sensor data to your Vicon system. Default: Selected
Radio Sync Device	Indicates whether a radio sync source (Vicon Beacon) is available.

> **Note**
> Nexus supports the use of only 1 Vicon Beacon in a Vicon Nexus system.

Zerowire EMG node

You can configure these settings in the **Properties** pane for a digital ZeroWire EMG device:

Property	Description
Auto Populate	Enables or disables automatic detection of ZeroWire EMG modules that are in use. When enabled, Nexus automatically adds and removes EMG components when they are connected, and the Add and Remove EMG menu items are unavailable. Default: Selected
Sync Rate	Sets the device frame rate, and affects the number of samples per frame. In free-running mode this parameter may be left at its default. In hardware sync mode, this parameter should be set to the appropriate sync frame rate, which would usually be the same as the Vicon system frame rate. Values which do not divide into 2000 can not be used. See the Sync Pulse parameter. Default: 50
Sync Pulse	Enables or disables the use of a TTL compatible hardware sync pulse to control drift between the ZeroWire device and a Vicon system. If you wish to use this feature, connect the ZeroWire unit to a GPO pin via the included ZeroWire sync cable. Advanced users wishing to synchronize ZeroWire to a Vicon system running at a frame rate which does not divide into 2000Hz (for example, 120Hz) should construct a GPO program which provides a sync pulse at a rate which does divide. The GPO program entitled *ZeroWire 100Hz Sync.gpo* is provided as an example (see Example ZeroWire100Hz Sync.gpo program, page 271). Default: Unchecked
Trigger Pulse	Enables or disables the use of a TTL compatible hardware trigger pulse to synchronize the start and stop of ZeroWire data acquisition with a Vicon system. Users wishing to synchronize ZeroWire to a Vicon system should connect the ZeroWire unit to a GPO pin via the included ZeroWire sync cable, and run the included GPO program entitled *ZeroWire Trigger.gpo* (see below). For best results, use this feature with the Sync Pulse feature. Consult the ZeroWire technical manual for a description of the ZeroWire sync cable. Default: Unchecked

General section

Property	Description
Name	A user-defined display name for the device. Default: Blank
Delay Compensation (s)	The delay compensation value (in seconds). All devices have a delay compensation value which adjusts the synchronization offset between the device and the Vicon data. Analog data collected with the Vicon connectivity devices should already be synchronized, so this value should be set at 0. Values can be set between -10 and 10. Default: 0
Errors	An advanced parameter which stores any diagnostic errors received from the ZeroWire device. Use this parameter for troubleshooting. For further information, see the documentation supplied by the manufacturer. Default: Determined by device state

Sync section

Property	Description
Sync Rate	Sets the device frame rate, and affects the number of samples per frame. In free-running mode this parameter may be left at its default. In hardware sync mode this parameter should be set to the appropriate sync frame rate, which would usually be the same as the Vicon system frame rate. Values which do not divide into 2000 can not be used. See the Sync Pulse parameter. Default: 50
Sync Pulse	Enables or disables the use of a TTL compatible hardware sync pulse to control drift between the ZeroWire device and a Vicon system. If you wish to use this feature, connect the ZeroWire unit to a GPO pin via the included ZeroWire sync cable. Advanced users wishing to synchronize ZeroWire to a Vicon system running at a frame rate which does not divide into 2000Hz (for example, 120Hz) should construct a GPO program which provides a sync pulse at a rate which does divide. The GPO program entitled *ZeroWire 100Hz Sync.gpo* is provided as an example (see Example ZeroWire100Hz Sync.gpo program, page 271). Default: Unchecked
Trigger Pulse	Enables or disables the use of a TTL compatible hardware trigger pulse to synchronize the start and stop of ZeroWire data acquisition with a Vicon system. Users wishing to synchronize ZeroWire to a Vicon system should connect the ZeroWire unit to a GPO pin via the included ZeroWire sync cable, and run the included GPO program entitled *ZeroWire Trigger.gpo* (see Example ZeroWire Trigger.gpo program). For best results, use this feature with the Sync Pulse feature. Consult the ZeroWire technical manual for a description of the ZeroWire sync cable. Default: Unchecked

The *ZeroWire 100Hz Sync.gpo* file is defined as follows:

Example ZeroWire100Hz Sync.gpo program

```
<?xml version="1.0" standalone="yes"?>
<AllPrograms>
  <Program Name="ZeroWire 100Hz Sync">
    <Type>Repeating</Type>
    <Polarity>High</Polarity>
    <StartEvent>MXDVStart</StartEvent>
    <StopEvent>MXDVStop</StopEvent>
    <StartOffset MicroSeconds="0"/>
    <StopOffset MicroSeconds="0"/>
    <PulseWidth MicroSeconds="5000"/>
    <PulsePeriod MicroSeconds="10000"/>
  </Program>
</AllPrograms>
```

The *ZeroWire Trigger.gpo* file is defined as follows:

Example ZeroWire Trigger.gpo program

```
<?xml version="1.0" standalone="yes"?>
<AllPrograms>
  <Program Name="Duration">
    <Type>Duration</Type>
    <Polarity>High</Polarity>
    <StartEvent>MXDVStart</StartEvent>
    <StopEvent>MXDVStop</StopEvent>
    <StartOffset Frames="0"/>
    <StopOffset Frames="0"/>
    <PulseWidth Frames="0"/>
    <PulsePeriod Frames="0"/>
   </Program>
</AllPrograms>
```

Subjects tab

The **Subjects** tab of the **Resources** pane enables you to prepare and manage the subjects whose motion data you want to capture and analyze in Vicon Nexus.

The **Subjects** tab contains the following sections:

Subjects toolbar

Create or manage subject nodes for Vicon labeling skeleton templates (.vst files) or Vicon labeling skeletons (.vsk files) using the following buttons in the toolbar at the top of the **Subjects Resources** pane:

-  **Create a blank subject** Create a new subject node in the Resources tree. You can subsequently create, attach, or import .vst or .vsk files for the blank node. The node automatically includes the minimum sub nodes for the elements required for a .vst file.
-  **Create a new subject from a labeling skeleton** Create a new subject node in the Resources tree based on an existing .vst file. The node automatically includes any sub nodes and data for the elements defined in the selected .vst file.
-  **Load an existing subject** Load an existing labeling skeleton (.vsk file) into a subject node in the Resources tree. The node automatically contains sub nodes and data for all elements defined in the selected .vsk file.

Subjects Resources tree

Enable a subject for motion capture and data recording in the tree in the Subjects Resources pane.

Expand (>) or collapse (V) the following sub-nodes to display or hide a list of subject elements that you can use for selecting, editing, or showing in graph traces:

- Markers Model markers defined in the .vst or .vsk file as well as trajectories for markers visible in the capture volume or from a loaded .c3d file. The marker text is gray if the marker is not physically present in the capture volume.
- Segments Segments defined in the .vst or .vsk file.
- Joints Joints defined in the .vst or .vsk file. The names of the segments that the joint connects are shown in parentheses after the joint name.
- Model Outputs Components of variables calculated for a kinematic model (such as Angles, Forces, Moments, Powers, or Bones) created by Vicon Plug-in Gait and available in Nexus from a loaded .c3d file.

You can perform commands to manage specific nodes by right-clicking on the node in the Subjects Resources tree and selecting the desired command from the displayed menu.

The color-coded symbols displayed for entries in the Markers and Segments lists correspond to the colors defined for each model marker and joint in the .vst or .vsk file. This provides a helpful visual aid when you are manually labeling a subject. The symbols for entries in the Joints list and the Traces list are not color coded: the same joint symbol is displayed for all joints, and the same model outputs symbol is displayed for all model outputs.

If no markers, segments, or joints have yet been defined for a new subject, the lists may not contain any entries.

Subjects properties

The **Properties** section at the bottom of the **Subjects Resources** pane enables you to view or edit properties of the node selected in the **Subjects** tree. The properties displayed depend upon the subject node, sub node, or element selected in the **System Resources** tree (marker, segment, joint, or trace). For details on how to specify settings for properties, see Set properties in Vicon Nexus in the *Vicon Nexus User Guide*.

For more information, see:

- Subject node context menu, page 275
- Subject node Properties pane, page 276
- Markers context menus, page 277
- Markers properties, page 278
- Segments context menu, page 279
- Segments properties, page 279
- Joints context menu, page 279
- Joints properties, page 280
- Model Output properties, page 280
- Model Outputs context menu, page 280
- Element color properties, page 281

Subject node context menu

You can select the following commands from the context menu displayed when you right-click on a subject node:

- Attach Labeling Skeleton Template In the Choose a Subject file dialog box, navigate to and select the .vst or .vsk file to be attached to this subject node and then click Open. Nexus attaches the specified .vst or .vsk file, closes the dialog box, and updates the subject node with sub nodes and data contained in the specified file.
- Save Subject Nexus saves the contents of the subject node in a .vsk file in the currently active session of the motion capture database.
- Save Labeling Skeleton as Template In the Choose a Subject file dialog box, navigate to the folder in which you want to save the Vicon labeling skeleton template, enter the name for the .vst file, and then click Save.

Nexus saves the contents of the subject node in the specified .vst file. It also generates a corresponding marker file with the same base name and a .mkr extension in the same folder. If you subsequently run a BodyBuilder model that requires a marker file, this .mkr file is automatically copied to the relevant session folder.

Save your .vst file in the default Nexus model templates folder (C:\Program Files\Vicon\Nexus2.#\ModelTemplates) to make it available from the list of available .vst files displayed when you create a new subject node from a template.

- Revert to Uncalibrated Nexus discards any calibration data in the .vsk file and reverts to the template values within the .vsk.
- Delete Subject and VSK In the Warning confirmation message, click Yes to proceed.
- Nexus deletes the subject node from the Subjects Resources pane, unloads the .vsk file from the current session, and unlabels the trajectories associated with that subject

Subject node Properties pane

The Properties section of the Subjects Resources pane enables you to edit the properties of a Vicon labeling skeleton template (.vst file).

You can configure the following settings for a Subject node:

- Name The name of the selected subject node. This name is used when the Vicon labeling skeleton template is saved in a .vst file or the Vicon labeling skeleton is saved in a .vsk file. You can change this either by overtyping the current name or by clicking the ellipsis (...) to display the Name dialog box in which you can overtype the existing node name with a text string.
- Color Not currently applicable.
- Add Parameter Enables you to add a custom parameter (measurement) to the model. In the Add Subject Parameter dialog box, supply a name, specify whether the measurement is required to run the model, specify the units, value and default for your new measurement.
- Set All to Default Sets all the selected subject's parameters to their default values.

In the remaining sections, properties vary depending on the labeling skeleton used for the subject selected in the Subjects tree (the following example properties are from a subject based on Plug-in Gait):

General section

- Bodymass The subject's body mass (in kg).
  Default: As defined in the .vsk or .vst file, or user-specified.
- Height The subject's height (in mm).
  Default: As defined in the .vsk or .vst file or user-specified
- InterAsisDistance The distance (in mm) between the subject's left and right anterior superior iliac spine (ASIS).
  Default: As defined in the .vsk or .vst file or user-specified
- HeadOffset Patient's head offset (in degrees).

Left section and Right section

- **LegLength** The length (in mm) of the subject's leg.
  Default: As defined in the .vsk or .vst file or user-specified
- **AsisTrocanterDistance** The distance (in mm) between the subject's ASIS and greater trochanter.
  Default: As defined in the .vsk or .vst file or user-specified
- **KneeWidth** The width (in mm) of the subject's knee.
  Default: As defined in the .vsk or .vst file or user-specified
- **AnkleWidth** The width (in mm) of the subject's ankle.
  Default: As defined in the .vsk or .vst file or user-specified
- **TibialTorsion** The torsion (in deg) of the subject's tibia.
  Default: As defined in the .vsk or .vst file or user-specified
- **SoleDelta** The distance in millimeters between the thickness of the sole at the toe and at the heel.
- **ShoulderOffset** The vertical distance (in millimeters) from the base of the acromion marker to the shoulder joint center.
- **ElbowWidth** The width (in millimeters) of the elbow along flexion axis.
- **WristWidth** The anterior/posterior width (in millimeters) of the wrist.
- **HandThickness** The anterior/posterior width (in millimeters) of the hand.

For more details on these measurements, see *Take subject measurements for Plug-in Gait* in the *Vicon Nexus User Guide*.

Markers context menus

You can select the following command from the context menu displayed when you right-click on the **Markers** node:

- **Reorder** Displays the **Reorder Markers** dialog box, where you can change the order in which the markers are displayed.

You can select the following command from the context menu displayed when you right-click on a sub node for a specific marker:

- **Detach Marker** The marker is detached from the subject and is no longer displayed in the list of markers on the **Subjects** tab (and is removed from the VSK) or the **Manual Labeling** list in the **Label/Edit Tools** pane.

Markers properties

You can configure the following settings in the **Properties** section for the markers:

- **Name** The name of the Vicon marker. You can rename a marker by overtyping it.
  Default: As defined in .vsk or .vst file or as specified in the **Labeling Template Builder**.
- **Color** The color in which to display the Vicon marker in a 3D Perspective view pane. You can assign either a specific color or the associated context color.
  Default: As defined in .vsk or .vst file or as specified in the **Labeling Template Builder**.
- **Radius** The size of the Vicon marker attached to subject during trial capture. This setting also dictates the size of the marker displayed in the 3D Perspective view pane. You can change the radius by either overtyping the current value or dragging the slider bar left to decrease the value or right to increase it.
  Default: As defined in .vsk or .vst file or as specified in the Labeling Template Builder
- **Status** The requirement for the marker's inclusion in a .vst file for static trials (used for calibration) and/or the .vsk file calibrated from the .vst file for dynamic trials (used for analysis):
- **Required**: Marker must be present for both static and dynamic trials.
- **Optional:** Marker can optionally be left off. If the marker is not present for the calibration, the autolabeler will not look for it in the dynamic trials. If the marker is present in the static trial, it will also form part of the dynamic marker set and will be used to aid tracking and to provide redundancy.
- **Calibration Only**: Marker must be present for static trials to align coordinate systems, but it must be removed for dynamic trials.
  Default: Required

Segments context menu

You can select the following commands from the context menu displayed when you right-click on a sub node for a specific segment:

- **Pick as Kinematic Fill Source** Enables you to copy the kinematics from the selected segment to fill a gap.
  The suggested fill is displayed in purple in the **3D Perspective** window. You can also view the suggested fill options as colored dotted lines in the **Graph** view.
- **Delete Segment** Deletes the selected segment.

Segments properties

You can configure the following settings in the **Properties** section for the segments:

- **Name** The name of the skeleton segment.
  Default: As defined in .vsk or .vst file or as specified in the **Labeling Template Builder**
- **Color** The color in which to display the skeleton segment in a **3D Perspective** view pane. You can assign either a specific color or the associated context color.
  Default: As defined in .vsk or .vst file or as specified in the **Labeling Template Builder**

Joints context menu

You can select the following command from the context menu displayed when you right-click on a sub node for a specific Joint:

- **Unlink Joint** Unlinks the selected segments.

Joints properties

- **Name** The names of the segments connected by the joint.Default: As defined in .vsk or .vst file or as specified in the **Labeling Template Builder.**
- **Output Format** The joint angle output format (if appropriate):
  - XYZ Euler Angles
  - ZYX Euler Angles
  - XZY Euler Angles
  - ZX Euler Angles
  - YXZ Euler Angles
  - ZXY Euler Angles
  - Helical Axis

  Default: Helical Axis

Model Output properties

- **Name** The names of the model outputs in a loaded .c3d file.
  Default: As defined in the .c3d file

Model Outputs context menu

Model outputs depend upon the modeling that is performed, but can include some or all of the following:

- Angles
- Forces
- Moments
- Powers
- Scalars
- Bones

You can delete a single model output, groups of model outputs or all the outputs under a single output sub-node by right-clicking on the relevant node(s) in the **Subjects Resources** tree and then clicking **Delete**. (You can also delete model outputs using the **Delete Model Outputs** pipeline operation, available in the **Data Processing** operations on the **Pipeline Tools** pane.)

Element color properties

In the **Color** property for Markers and Segments, you can specify the default color for these subject elements using one of the following methods:

- Assign a specific color using the color map.
- Click the current color in the entry field to display the **Select Color** dialog box.
- In the **Basic colors** area, click the square for the desired color, or in the **Custom colors** areas define a new color.
- Specify the default color of its associated context (if any) using the **Context Color** macro.
- Click the **Color** property context menu button and select **Macro**. Context Color is displayed in the entry field. A marker inherits its context from the segment to which it is attached. A segment's context is derived from its name, for example "LeftFemur" has a left context. To turn off the context color macro, clear **Macro** in the **Color** property context menu.

Context	Default Color
General	Orange
Left	Red
Right	Green

View pane

The View pane enables you to visualize data from one or more cameras in real time or from a saved file.

You can visualize the system components or subjects selected in the **Resources** pane, or the results of processing performed in the **Tools** pane during any stage of the Nexus motion capture workflow.

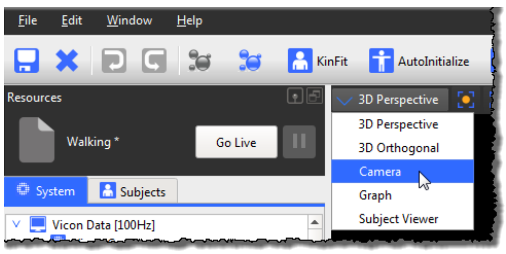
> **Tip**
> By default, the View pane is in the center of the Nexus window. You cannot detach or change the position of this pane, but you can open a separate floating view workspace.

You view and manipulate the type of data you specified for display in the view pane below the toolbar. By default, a single view pane is displayed. You can display multiple view panes, and specify the same or different view in each. You can manually resize each view pane.

You can control the way data is visualized in the view panes, for example, by changing the display options for force plate, in the **Options** dialog box (press F7).

View panes contain the following controls:

- **View pane toolbar** Select the view to use, manage any display options for the selected view, and specify the number and arrangement of views displayed in the toolbar at the top of the view pane. The lists and buttons on the View pane toolbar that are available from all types of view panes are described below.
- **View list**



- Select the views to be displayed from the View list:
  - 3D Perspective view, page 284 Reconstructed motion capture data from all active Vicon cameras in 3D (three-dimensional) perspective, that is length, width, and depth.
  - 3D Orthogonal view, page 286 Motion capture data in 3D perspective viewed from a specified point of sight, or direction, of the capture volume.
  - Camera view, page 287 Raw 2D motion capture data from an individual Vicon camera or a supported digital video camera.
  - Graph view, page 290 Various values of one or more selected items (such as the x, y, and z components of a marker trajectory) plotted against each other or against time.
  - Subject viewer, page 298 The base pose for the labeling skeleton template (VST) of the currently selected subject. Also facilitates manual labeling.
- Standard buttons

  Specify the number and arrangement of view panes displayed in the workspace using the following buttons:
  - Horizontal Split the current view horizontally into two view panes.
  - Vertical Split the current view vertically into two view panes.
  - Close Close the current view pane. (You cannot close the default View pane in the center of the Nexus window.)

  Depending upon the view selected, there may be additional lists and buttons available.
- Time bar, page 299 You manipulate offline trial data using the time bar.

3D Perspective view

The **3D Perspective** view enables you to visualize reconstructed motion capture data from all active Vicon cameras, or Vicon Skeleton Templates (.vst), or Vicon Skeleton (.vsk) files, in 3D (three dimensional) perspective, that is length, width, and depth.

You can view 3D data live in real time or from a previously saved trial.

In addition to the standard buttons (see View pane, page 282), the **3D Perspective** view contains the following sections:

- **3D Perspective view pane toolbar** You manage the display of 3D data in the active workspace by selecting these buttons at the top of the view pane:
  - **Center camera on selection** Position the currently selected data in the center of the view pane. This option does not automatically zoom in on the selected data.
  - **Export Workspace to Video** Enables you to create video files (*.mp4* or *.avi*) of a selected 3D workspace (including any labeled subject). For details, see *Export 3D Workspace to Video* in the *Vicon Nexus User Guide*.
- **3D Perspective view** You view and manipulate 3D data in the view pane below the toolbar. For example, you can dolly, orbit, pan, tilt, truck, and zoom to control the portion of the capture volume that is displayed.

3D Perspective view usage tips

When you display a 3D Perspective view pane:

- If you have additional **3D Perspective** or other view panes (**3D Orthogonal**, **Camera**, **Graph view** or **Subject Viewer** panes) open, you can change the number and arrangement of view panes displayed in the workspace to suit your preferences using the view pane toolbar buttons at the top right of the view pane.
- You can highlight the representations of specific cameras in the **3D Perspective** view pane workspace by selecting one or more cameras under the Vicon Cameras node in the **System Resources** pane.
- You can configure display options in the **Options** dialog box (F7), such as force plate display options.

To visualize data in the view pane:

1. Either stream live camera data (click Go Live), or double-click the name of a processed data file on the Data Management tab.
2. From the View pane toolbar, select **3D Perspective**. The reconstructed 3D data from all cameras is displayed in a single **3D Perspective** view pane. Information about the current trial appears at the top of the view pane:
   - NO TRIAL if no trial is loaded
   - LIVE if Nexus is in Live mode
   - The trial file name if you are viewing a trial in Offline mode.
3. If you want to change the way this text is displayed, open the Options dialog box (F7), and configure the **Workspace Title** option.

3D Orthogonal views

The **3D Orthogonal** view pane enables you to visualize motion capture data in 3D perspective viewed from a specified point of sight, or direction, of the capture volume.

You can view 3D data from an orthogonal perspective live in real time or from a previously saved trial.

In addition to the standard buttons (see View pane, page 282), the **3D Orthogonal** view pane contains the following sections:

- **3D Orthogonal view pane toolbar** Manage the display of data in the active workspace with the following list and button at the top of the view pane:
- **Orthogonal view list** Set the point of sight by selecting one of the following orthogonal projections (also called orthographic projections): -Z (default), +Z, +X, -X, +Y, -Y
- **Center camera on selection** Position the currently selected data in the center of the view pane. This option does not automatically zoom in on the selected data.
- **3D Orthogonal view** View and manipulate 3D data in the view pane below the view pane toolbar. For example, you can dolly, tilt, truck, and zoom (but not pan or orbit) to control the portion of the capture volume that is displayed.

3D Orthogonal view usage tips

When you display a **3D Orthogonal** view pane:

- To visualize data in the view pane, either stream live camera data (click **Go Live**), or double-click a processed data file on the **Data Management** tab.
- Reconstructed 3D data from all cameras is displayed in a single **3D Orthogonal** view pane, initially from the -Z (top) view.
- The current trial name appears at the top of the view pane:
  - – NO TRIAL if no trial is loaded
  - – LIVE if Nexus is in Live mode
  - – The trial file name if you are viewing a trial in Offline mode.
- If you want to change the way this text is displayed, open the **Options** dialog box (F7), and configure the **Workspace Title** option.

Camera view

The **Camera** view pane enables you to view raw 2D motion capture data from an individual Vicon camera or a supported digital video camera either live in real time or from a previously saved raw capture file (.x2d).

In addition to the standard buttons (see View pane, page 282), the **Camera** view pane contains the following sections:

- **Camera view pane toolbar** Manage the display of camera data in the workspace with the following controls and buttons in the **Camera** view pane toolbar at the top of the view pane:
  - **View list** Manage the way camera data is visualized in the active **Camera** view pane by selecting the following options from the **View** drop-down list:
  - **3D Overlay** Overlay multiple **Camera** view panes on top of each other, so all camera views are displayed in a single view pane. Each camera is rendered in a unique color.
    Default: Off
  - **Rotated** Rotate the **Camera** view, so it is corrected to the vertical axis defined in the system calibration (which corresponds to the earth's vertical axis). It also enables you to manually rotate the view by dragging the view left or right. Information from the camera calibration is required to present the rotated view.
    Default: Off
  - **Mirrored** Mirrors the view displayed for both optical and video cameras. To enable you to quickly identify when you are looking at a mirrored view, the view title now displays **Mirrored** when this option is selected.
  - **Combined** Correctly model lens distortions and display a corrected camera view with the 3D view rendered underneath the 2D camera view. This is particularly useful for viewing Vicon optical data overlaid onto images from video cameras. You can burn this overlay information onto the *.mp4* or *.avi* file to view in other applications using the **Export 3D Overlay Video** pipeline operation.
    Default: Off
  - **Zoom to Fit** Zoom the selected **Camera** view pane to fit the full workspace.
    Default: On
  - **Zoom to Window** See **Display camera sensor window**, below.

- **Export Workspace to Video button** Enables you to create video files, including labeled subject, of a selected 3D workspace. For more information, see *Export workspace to video* in the *Vicon Nexus User Guide*.
- **Paint a mask onto the camera button** Paint over any cells in the camera grid (displayed when the button is clicked) that contain unwanted reflections. When a cell is painted, its background color changes from black to blue. The camera mask consists of blue cells obscuring unwanted reflections. For more information, see *Mask unwanted reflections* in the *Vicon Nexus User Guide*.
- **Erase a mask from the camera button** Erase a previously painted cell from a mask. When an individual cell is erased, its background color changes from blue to black, and any reflection that had previously been obscured is visible again.
- **Clear the mask from the camera button** Automatically remove a previously painted mask. When the mask is cleared, the background color of any previously painted cells changes from blue to black, and any reflections that had previously been obscured are visible again.
- **Display grayscale blobs button** When selected, grayscale blobs are displayed in the **Camera** view.
- **Display centroid circles button** When selected, centroids are displayed in the **Camera** view.
- **Display camera sensor window button** Displays a visual representation of the windowing that occurs at higher frame rates. The windowed area is indicated by a rectangle within the Camera view, showing the size and position of the active window on the camera sensor. (Windowing is also displayed in the **3D Overlay** view and in **Rotated** view). For instant feedback on the area that is captured and to save room on the screen, you can zoom in to the sensor window. To do this, in a **Camera** view, from the **View** menu, select **Zoom to window**, or to turn on **Zoom to window** for all windows, press the hot keys: Ctrl+Shift+Z.
  To toggle the display of windowing, in the **Options** dialog box (F7), click the **Camera Limits** option and in the **Properties** pane, select the **Sensor Window** property.
- **Lock / Unlock button** (displayed with standard buttons on the right) Lock the current **Camera** view pane, so that it is effectively detached from the selection set and is not affected by any subsequent selections in other open view panes. This is useful for displaying views from different cameras in multiple **Camera** views.
  When the active clip changes, or when you switch from Live to Offline mode, the selection is automatically unlocked.

- **Camera view pane** View and manipulate 2D data in the view below the view pane toolbar. For example, you can orbit, truck, dolly, and zoom the displayed data.

Camera view usage tips

To visualize optical data in a Camera view:

1. Either stream live camera data (click **Go Live**), or double-click a raw data file (.x2d file) on the **Data Management** tab.
2. In the **System Resources** tree, select one or more cameras whose data you want to visualize. To do this, expand the **Vicon Cameras** node and then click on the sub node for one or more cameras.
   The 2D data from each selected camera is displayed in a separate **Camera** view pane.

To visualize video data in a Camera view:
Note that a video camera is listed under the **Video Cameras** node for each *.mp4* or *.avi* file you have loaded.

1. Do one of the following:
   - Double-click on the desired movie file on the **Data Management** tab; or
   - From Windows Explorer, drag the required *.mp4* or *.avi* file onto a **Camera** view pane. (If you drag an*.mp4* or *.avi* file onto a **Camera** view pane, the current trial closes, and no file name is displayed in the View pane, because the *.mp4* or *.avi* file is not associated with any particular trial.); or
   - Import an *.mp4* or *.avi* file into the current trial by running the **Import Video** pipeline operation. This operation is located in the **File Import** operations list in the **Pipeline Tools** pane.
2. If you make a change to the video file camera settings, an asterisk (*) appears next to the configuration name at the top of the **System Resources** tree, reminding you that there are unsaved changes to your system configuration.
3. In the **System Resources** pane, expand the **Video Cameras** node and select one or more digital video cameras.
4. To play offline video, click Play in the tool bar. The video from each camera selected is displayed in a separate **Camera** view pane.

Graph view

The **Graph** view enables you to view various values of one or more selected items (such as the x, y, and z components of a marker trajectory) against each other or against time, or analog data from any supported force plates or EMG devices.

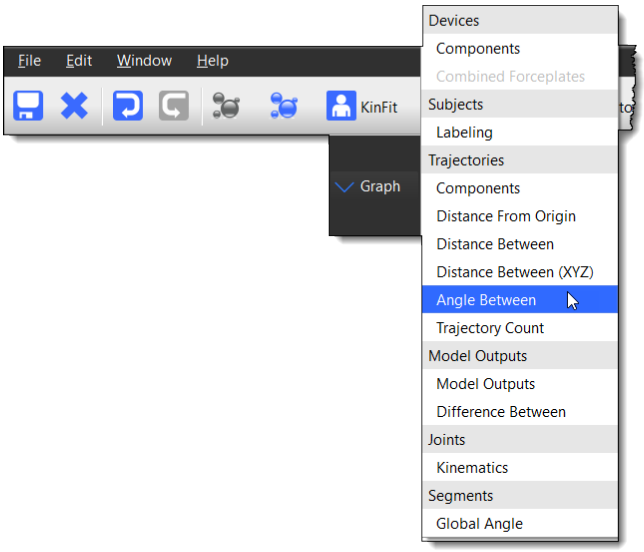
You can view graphs of motion data live in real time or from a previously saved reconstructed and labeled trial.

In addition to the standard buttons (see View pane, page 282), the Graph view contains the following controls.

Graph view pane toolbar

Manage the display of graph data in the view pane with the following controls at the top of the view pane. The **Graph** view pane toolbar leads you left to right through the normal flow of operations required to plot a graph for the selected elements

- Graph type drop-down list
  Select the type of graph to be displayed from the categories in this drop-down list. (Graph types that are not available for the data currently selected in the **System Resources** pane are dimmed.) See Graph type options, page 293.)



- Differentiate the graph button Specify, for the currently displayed graph, the current variable, its first derivative (velocity or angular velocity), or its second derivative (acceleration or angular acceleration) by selecting the desired options from this drop-down list:

- x (none)
- x' (velocity)
- x" (acceleration)

A graph of a trajectory will have X, Y, and Z axes, but when differentiated to x' (velocity), the axes will change to X', Y', and Z' axes.
Tip: You can then use the Add Monitor button to provide real-time bio-feedback on differentiated as well as positional data. For more information, see Using monitors, page 37.

- Choose the components of the graph button Specify the components of the selected graph type to be plotted in the active **Graph** view by selecting the desired options from this drop-down list (only components that you have selected for **Graph** view are available).
This option enables you to focus on a component of particular interest, which occupies more of the workspace. When multiple components are plotted, each is always shown on a separate axis, and the components shown are applied to all channels visible in the workspace. The number of vertically stacked graphs displayed in the workspace depends on the number of options selected for graph view, and from those, the number selected from this list.
- Legend button Display a legend for the current graph listing the color for each trace plotted, the subject (if multiple subjects are loaded), and the name of each element being plotted in that trace. To display a temporary tooltip with this information, hovering the mouse pointer over the button. To open a separate splitter pane to permanently display the legend to the right of the graph view, click the button.
- Choose the rotation order button If you select a segment in the **Subjects Resources** pane, you can select **Global Angle** from the **Graph type drop-down** list. This enables the **Choose the rotation order** button. Clicking on the **Rotation Order** button lists the angle convention choices of **Helical** (default), **XYZ**, **XZY**, etc. This enables you to choose either a Helical or an Euler angle convention. The Euler angle convention has multiple rotation order conventions represented by **XYZ**, **XZY**, etc.
- Create a monitor button Add the selected graph component as a monitor entry in the Monitors communications pane.

- Scale the graph to fit (horizontal) button Zoom out the x-axis to show the complete range of the trace for the selected time period. This is useful if you have zoomed in a long way and now want to quickly see the entire graph again.
- Lock the horizontal graph axis button Lock the horizontal axis to prevent further rescaling of the axis once it is at a desired length of frames. This is useful if you want the horizontal axis range to stay the same.
- Scale the graph to fit (vertical) button Scale the y-axis so that all the data in selected traces for the currently visible x-axis is visible. If there are multiple components in the selected traces, they are all set to the same range, that is, the range required to show all the data in the component with the largest range.
  If Nexus is in Live mode, this button acts as a toggle, enabling you to leave this mode switched on or off. If on, when plotting live data, the y-axis is automatically scaled as the data changes so all traces are visible. Manually zooming switches the automatic mode off.
- Lock the vertical graph axis button Lock the vertical axis to prevent further rescaling of the axis once it is at a desired range. This is useful if you want the vertical axis range to stay the same.
- Scale the graph to fit (horizontal and vertical) button Scale the x and y axes simultaneously to fit the horizontal and vertical ranges of data.
- Lock / Unlock button (displayed with standard buttons on the right) Lock the current **Graph** view pane, so that it is effectively detached from the selection set and is not affected by any subsequent selections in other open view panes. This is useful for displaying elements in multiple **Graph** views. When the active clip changes, or when you switch from Live to Offline mode, the selection is automatically unlocked.

Graph view pane

View and manipulate graph data in the view pane below the view pane toolbar. For example, you can slide the displayed data along the axes or zoom in and out.

Graph type options

Devices

Displays graphs for the components of the analog signals from force plates or EMG devices. This is useful for examining analog device activity such as force plate strikes or EMG voltage output. You can also display graphs displaying units of mm/s2 of analog signals from an accelerometer device, which allows you to examine voltage output from an accelerometer device.

- Components: View force plate data such as Forces, Moments, and Center of Pressure, or to view Other Devices, such as EMG and Accelerometer data.
- Combined Forceplates: Enables you to view combined selected outputs from multiple force plates. For more information, see View combined output from multiple force plates in the *Vicon Nexus User Guide*.

Subjects

- Labeling: View labeling data for the current subject

Trajectories

Displays graphs for one or more marker trajectories selected, such as the global XYZ components of a marker, a marker's distance from the global origin, distance between two markers, angle between three markers, or a count of how many reconstructed markers are in any current frame of data.

- Components: View the X, Y, and Z coordinates of a marker selected in either the Subjects Resources pane or the 3D Perspective view.
- Distance From Origin: View the straight-line distance between the chosen point and the global origin. Plots the distance from the capture volume origin to each selected marker. This is useful for plotting velocity or acceleration of markers.
- Distance Between: View the straight-line distance between two markers selected in either the Subjects Resources pane or the 3D Perspective view.
- Distance Between (XYZ): View the global X, Y, and Z components of the distance between two markers selected in either the Subjects Resources pane or the 3D Perspective view. Plots the absolute distance (as a vector) between two selected markers. This is useful, for example, to see how the distance between two markers that are assumed to have a rigid relationship changes over time. This graph type calculates a separate component (X,Y,Z) distance between the two markers. It is only available when two markers are selected in the 3D Perspective view.

- **Angle Between**: Plots the angle between the two vectors formed by any three markers selected in either the **Subjects Resources** pane or from the **3D Perspective** view pane. This is useful for seeing how the group of markers moves over time.
- **Trajectory Count**: View the number of markers (both labeled and unlabeled) currently reconstructed in the **3D Perspective** view. Plots the total number of trajectories over time visible to the Vicon cameras (if streaming Live data in real time) or processed in trial (if viewing previously captured data in a file).

Model Outputs
Displays three graphs of the components of any output variables (such as Angles, Forces, Moments, Powers, or Bones) that have been calculated by Vicon Plug-in Gait for your model. This is useful for visually validating data produced by post-capture processing models without having to load the data into Polygon for full biomechanical analysis or reporting.

- **Model Outputs**: Select to view outputs from calculations run in post-capture pipeline.
- **Difference Between**: The difference between first and second selected model output in X, Y and Z (example: New Patient 1:LAnkleAngles - New Patient 1:RAnkleAngles)

Joints
Displays graphs of the components of selected joint kinematics, either three graphs for Euler angles or six graphs for a helical vector (as appropriate for the joint type). This is useful for displaying approximate joint angles between linked segments of the labeling template worn by your subject in real time. This type of graph can only be plotted for a subject that has been kinematically fitted (for example, one that has had the **Kinematic Fit** operation, found under **Core Processing** on the **Pipeline Tools** pane, run on it).

- **Kinematics**: Select to view kinematic angles between linked segments of the subject. (To see these angles, you must have performed kinematic fitting on labeled trajectories.)

Segments

- **Global Angle** The angle between the selected segment and the global origin in rotation (RX, RY, RZ) and translation (TX, TY, TZ).

Graph view usage tips

- When zooming into or out of graph data, the display of grid lines can be set to guide the eye toward the selected area of focus. Major grid lines remain at their normal weight, while any minor grid lines gradually fade. To obtain this behavior, in the Options dialog box (F7), select Graph and then ensure the **Show Minor Grid Lines** property is selected.
- The **Graph** view contains rulers and axes along the left and bottom edges and graph traces for the item being plotted. The contents of the axes of the **Graph** view depend on whether the system is in Live or Offline mode:
- **Live** The y-axis vertical ruler is on the right side of the graph and the x-axis horizontal ruler is below the graph. The y-axis represents the live frame, so is constantly updated in real time. The x-axis represents the time (in frames). It starts on the right side, which is labeled 0 (zero) and is labeled from right to left with decreasing negative values to reflect the number of frames away from the live frame. Because the current time is always zero, the Time Bar is not displayed at the bottom of the workspace.
- **Offline** The y-axis vertical ruler is on the left side of the graph and the x-axis horizontal ruler is below the graph. The rulers indicate the scale and the variable names that are being plotted and the horizontal and vertical axes are labeled to indicate the units of measurement used. The graph traces represent the actual data and are scaled to the current rulers. You can select elements to graph in the **Resources** pane or the **3D Perspective** view.
  If the elements selected have more than one component, these components are shown on separate, vertically stacked axes sharing a common x-axis. You can select the components to be displayed from the **Component Options** list in the **Graph** view pane toolbar.
- You navigate in Graph view in the usual way, using the mouse. For example, to pan and zoom, click and hold the right mouse button and then drag the mouse up/down to zoom along the Y axis or drag left/right to zoom along the X axis. To pan the graph in any direction, hold the left and right mouse buttons down at the same time as you drag the mouse.
- When you select a data type in the **System Resources** pane (Trajectories, Model Outputs, Devices, or Joints), Nexus will attempt to intelligently update the **Graph** view type to match the data type you've selected.

To visualize data in a graph:

1. Either click the **Go Live** button or on the **Data Management** tab, double-click a processed data file (*.c3d*) file.
2. Select the elements to be graphed (eg markers, model outputs, force plates, etc) in any of the following ways:
   - In the **Subjects Resources** pane, expand the desired **Subject** node, expand the relevevant sub-node (eg Markers, Model Outputs, etc), and then select (CTRL+click to select multiple elements) one or more elements; or
   - In a **3D Perspective** view pane, select one or more elements displayed in the view pane.

   The number of elements you select depends on the type of graph you wish to view.
3. From the view pane toolbar select **Graph**.
   If required, you can select additional elements to add to the **Graph** view pane. If you are viewing trajectories, each one is displayed in a different color trace. You can use the **Legend** button in the **Graph** view pane toolbar to identify the color trace used for each trajectory. If the trace for any additional elements is not visible, use the **Fit Horizontally**, **Fit Vertically**, or **Fit Both Horizontally and Vertically** buttons.
4. If you want to save a particular graph view (for example, specific trajectories that you have selected), save your configuration using the**Configuration menu** button next to the **View Type** list on the Nexus toolbar.

You can visualize raw analog signals in a **Graph** view by selecting **Show Raw** from the device node context menu in the **System Resources** pane.

Graphing joint kinematics

1. Select the joints that are of interest.
2. From the Graph Type list in the **Graph** view pane toolbar, select the **Kinematics** option under the **Joints** section to plot the joint angles for the selected joints.
   Kinematic components for root segments include Tx, Ty, and Tz, accompanied by Rx, Ry, and Rz. These components can be further differentiated to also include Rx', Ry', Rz', Rx'', Ry'', Rz'', Tx', Ty', Tz', Tx'', Ty'', and Tz''. Designate the T's as translations and the R's as rotations between the two segments that the joint connects.
   Note: The ' and " designations are used to indicate velocity and acceleration, respectively.

Tip

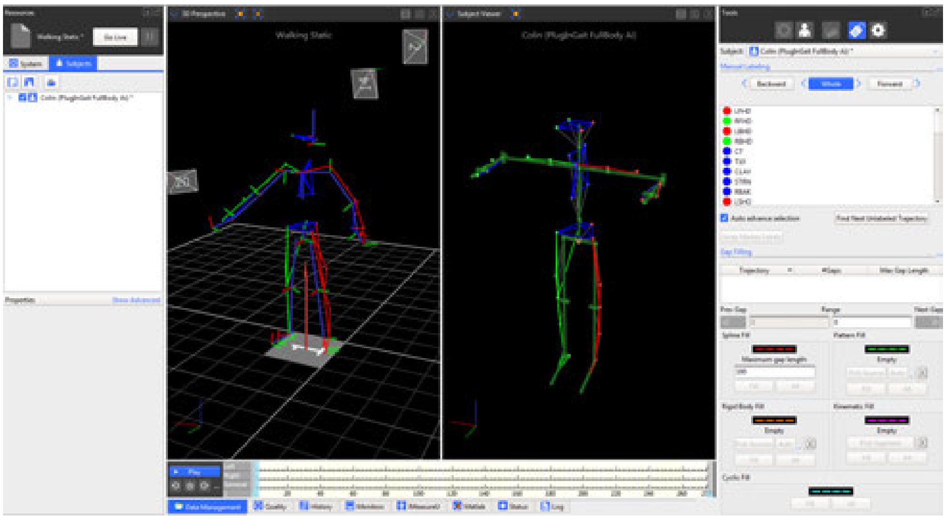
You can plot the Mean and Standard Deviation values for a component in a Graph view pane.

To do this, in the **Options** dialog box, select **Graph** from the list on the left.

Click **Show Advanced** and then select the **Show Mean and SD** check box.

Subject viewer

The Subject Viewer pane enables you to display the base pose for the labeling skeleton template (VST) of the currently selected subject. This helps you ensure that your subjects adopt the correct base (neutral) pose.

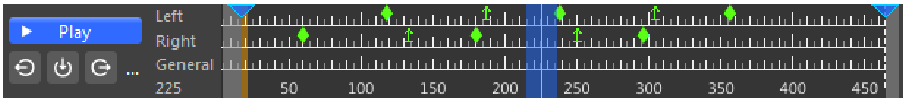


You can also use the **Subject Viewer** to assist with manual labeling by making it easy to correlate reconstructions with the appropriate marker. To do this:

1. Ensure the **Label/Edit Tools** pane is displayed and that the view pane displays both a 3D view of the subject whose markers you are labeling and the **Subject Viewer**.
2. Select a marker in the **Subject Viewer**.
   Nexus switches to labeling mode. The mouse pointer changes to display the name of the currently selected marker and the marker is highlighted in the **Manual Labeling** list.
   This works both ways: selecting a marker in the **Manual Labeling** list highlights the marker in the **Subject Viewer**.
3. In the 3D view, click on the marker that is the equivalent of that highlighted in the **Subject Viewer** and the **Manual Labeling** list.
   The next marker is automatically highlighted, ready for you to continue labeling.

Time bar

You manipulate offline trial data with time and synchronization characteristics in the time bar.



The time bar is available at the bottom of all types of view pane when you play back data from a saved trial. It is displayed only when the system is in Offline mode (click the Go Offline button), and contains the following controls:

- Play/Stop button

  Play forward continuously through trial. When clicked, the button switches to its Stop setting.

- Jump to Previous Event button

   Play backward one event (when in Event Identification Mode).

- Enter Event identification mode button

   Switch between modes in which you can manipulate data based on time (button off) or events (button on). For details on manipulating data, see *Add events to trials* in the *Vicon Nexus User Guide*.

- Jump to the next event button

   Play forward one event (when in Event Identification Mode).

- Ellipsis

   Display a context menu from which you can select the following options to manipulate trial data (you also can display the context menu by right-clicking anywhere on the time bar):

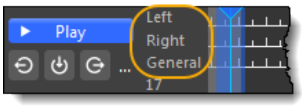
  - Zoom to Trial Reset the ruler to the full trial timescale after zooming in or out.
  - Zoom to Region-of-Interest Reset the ruler to the range of frames identified by the Start Range Frame indicator and the End Range Frame indicator (for details on these indicators, see below).
  - Set Current Frame Opens the Go to Frame dialog box, in which you can specify the required frame. When you click OK, the current time indicator moves to the specified frame.

- Set Region-of-Interest Opens the Set Region of Interest dialog box, in which you can specify the start and end frames for the region of interest.
- Play Every Frame When selected, the datastream ships all frames. (Rendering is unaffected.) Select this option only if you want to perform calculations on the datastream data.
- Replay Speed Specify the playback speed relative to real time by selecting one of the following sub options: 1/10, 1/4, 1/2, 1, 2, or Other. The Other option displays a dialog box in which you can set a specific value.
  Default: 1
- Trajectory Tails Specify the length of tails for selected trajectories, as a value in frames before and after every gap by selecting one of the following from the displayed context menu: 0 frames, 25 frames, 50 frames, 100 frames, 200 frames, or Other. The Other option displays the Trajectory Tails dialog box in which you can set a specific value.
  Default: 100 frames
- Clear All Events Clear all marked events from the ruler. Note that you can also use the Delete Timebar Events pipeline operation to delete events from a specified range of frames.

- You can also manage data playback using the keyboard. For example, you can use keys and mouse actions to manage the timescale displayed in the timeline, the time bar data displayed in the workspace, and event identification mode. For more information see *Hot keys and shortcuts* in the *Vicon Nexus User Guide*.

You identify or manipulate trial data based either on time or event, depending on the whether the **Enter Event Identification Mode** button is on or off with the following areas of the time bar.

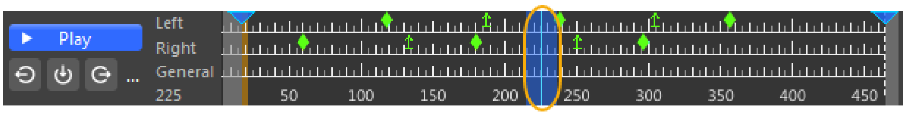
- **Timeline** The overall time span and the range of frames currently viewable in the workspace. The timeline is split into default contexts:



  - **Left** The top rule on the timeline contains markers for any events specified for the left context.
  - **Right** The middle rule on the timeline contains markers for any events specified for the right context.
  - **General** The bottom rule on the timeline contains markers for any events specified for the general context.
  - **Selected frame** The number of the currently selected frame is displayed at the bottom of the timeline.

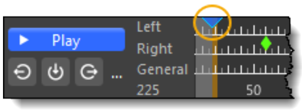
- **Timescale**
  Displays the overall span of time for the range of frames that can currently be selected. The current frame of trial data is displayed in the label on the left side of the scale at the bottom of the timeline. You can move the visible portion of the timescale or zoom in or out of it (for details, see *Shortcuts for working with the time bar* in the *Vicon Nexus User Guide*).

- **Indicators**
  Indicate a selected characteristic of the trial data for playback. You can move the indicators along the timeline to manually move the data playback forward or backward and display the desired frame in the view pane. Indicators are displayed when appropriate for the playback operation:
  - **Current time indicator**



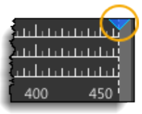
  Indicates the current time of the data playback along the timeline. This vertical bar spans the entire height of the timeline. In Event Identification Mode, the current time indicator follows the mouse cursor. You can click and drag the mouse for slow-motion playback. When you release the mouse button, the event context menu is displayed.

- Start of range indicator

  Indicates the frame specified as the start of the range of trial data to play back or process. This blue triangle is initially positioned on the first frame at the top of the timeline.

- End of range indicator

  Indicates the frame specified as the end of the range of trial data to play back. This blue triangle is initially positioned on the last frame at the top of the timeline.

- Event markers
  Indicate a specific event to be applied or displayed in the currently selected frame of the trial data:
  - Foot Strike The point at which the trial subject's foot contacts the ground.
  - Foot Off The point at which the trial subject's foot leaves the ground.
  - General A point at which the trial subject performs a user-defined event.
  - Custom A point at which the trial subject performs a user-defined event that can be named.
  - Delete Event <Type> Deletes the selected event.
  - Delete All Events at Frame x Deletes all events previously set for the current frame.
  - Clear All Events Deletes all events previously set for the entire trial.

  To work with an event, you must be in Event Identification Mode (see Enter Event identification mode button, page 299).

Tools pane

Configure settings, run tools, and view data processing results in the sections below the toolbar in the Tools pane. The contents of this section depend on the button you select in the Tools pane toolbar.

The **Tools** pane contains the following tabs:

- System Preparation tools, page 304
- Subject Preparation tools, page 314
- Capture tools, page 315
- Label/Edit tools, page 321
- Pipeline tools, page 322

System Preparation tools

System calibration is a process by which Vicon Nexus calibrates the system based on specialized calibration objects (whose dimensions and relative marker positions are known). It consists of several procedures:

- Camera calibration The camera calibration process calculates the physical position and orientation of each Vicon camera in the capture volume based on the movement of the calibration object. Nexus uses this information to determine each camera's physical position and orientation in the capture volume, to correct for any lens distortion, and to set internal camera parameters.
- Set volume origin During this process, Nexus measures the position of the calibration object and uses this information to identify the origin of the world (center of the capture volume) and its horizontal and vertical axes. These volume origin and axes are referred to as the global coordinate system. The global origin coordinates are always (0,0,0). The global axes coordinates are given in the form (x, y, z), where x is a horizontal axis, y is the horizontal axis perpendicular to x, and z is the vertical axis. If the floor of your volume is uneven, you can also use the Set Floor Plane option as part of this process.

For basic step-by-step instructions on how to complete these procedures, see *Calibrate a Vicon system* in the *Vicon Nexus User Guide*.

To enable you to perform these procedures, the System Preparation Tools pane contains the following sections (to show additional options, click Show Advanced in the relevant section).

- Video Calibration Setup section, page 305
- Mask Cameras section, page 305
- Aim Cameras section, page 305
- Calibrate Cameras section, page 305
- Set Volume Origin section, page 307
- Static Video Calibration section, page 307
- Manage Camera Calibration section, page 307
- Camera Calibration Feedback section, page 308

Video Calibration Setup section

Enables you to activate video calibration mode by clicking the **Activate** button. Note that if you haven't saved the current configuration, you will be prompted to do so before you can proceed.

You automatically activate calibration mode when you click **Start** in the **Mask Cameras** section, the **Aim Cameras** section or the **Calibrate Cameras** section.

To exit calibration mode, click the **Deactivate** button in the **Video Calibration Setup** section.

Mask Cameras section

Enables you to automatically create cameras masks to obscure all reflections visible to the Vicon cameras. By enabling the Advanced properties, you can choose to mask all cameras or just selected cameras.

For more information on how to mask cameras, see *Mask unwanted reflections* in the *Vicon Nexus User Guide*.

Aim Cameras section

Enables you to check the positioning of Vicon cameras around the capture volume with real-time feedback. You normally perform this step before you begin calibration check.

For more information on how to aim cameras, see *Aim Vicon cameras* in the the *Vicon Nexus User Guide*.

Calibrate Cameras section

Enables you to calibrate the Vicon cameras to determine their positions, orientations, and lens properties, which enables Nexus to produce accurate 3D and 2D (video) data from motion data captured throughout the capture volume. The **Advanced** properties contain the following options:

- **Wand** The calibration object to be used during the dynamic stage of the camera calibration process.
  Default: Active Wand v2 (both optical cameras and digital video cameras are calibrated with an Active Wand)
- **Calibration Type** Specify whether to use a **Full Calibration** or a quicker **Calibration Refinement**. (If you have not already calibrated or aimed all cameras, you cannot perform a calibration with the **Calibration Refinement**

option.) For more information on calibration options, see Understand camera calibration refinement, page 312.

- **Cameras to Calibrate** Can be **All Cameras** or **Selected Cameras** (that is, the cameras selected in the **System Resources** tree). The selection is applied when the **Stop** button in the **Calibrate Cameras** section is clicked.
  Default: All Cameras
- **Refinement frames** The minimum coverage (in number of frames) required per camera in the final phase of the refine camera calibration process.
  Default: 1000. For more information, see Understand camera calibration refinement, page 312.
- **Wand Ratio Tolerance** (Advanced setting) Tolerance of the distance between the markers on the wand (expressed as a ratio), to enable it to be labeled in 2D.
  Default 0.2.
- **Wand Straightness Tolerance** Tolerance in alignment of wand markers (relating to the maximum angle allowable between the markers), to enable it to be labeled in 2D.
- **DV Calibration frames** The minimum coverage (in number of frames) required per DV camera for the calibration to autostop (if Auto Stop is selected).
  Default: 500
- **Auto Stop** Whether or not Nexus is to automatically stop the camera calibration process when sufficient data has been collected.

For more information on how to calibrate cameras (both optical and video), see *Calibrate Vicon cameras* in the *Vicon Nexus User Guide*.

Set Volume Origin section

Enables you to define the global origin and the axes of the world (in the context of the capture volume).

The Advanced options are:

- **L-Frame** The calibration object to be used for setting the volume origin. Default: **5 Marker Wand & L-Frame**
- **Start/Set Origin** and **Cancel** buttons Enable you to start, set the origin and cancel setting the origin.
- **One Marker** Enables you to set the origin to the selected marker.
- **Three Markers** Enables you to set the origin to the selected three markers.
- **Set Floor Plane** Enables you to set the position of the floor plane in Nexus by using markers in the volume to automatically define it. For more information, see Calibrate the floor plane in the *Vicon Nexus User Guide*.

Static Video Calibration section

If you are not using an Active Wand, you use this section to calibrate digital video cameras included in your Nexus system. This enables 3D overlay from Vicon cameras to be displayed with the 2D video from the digital video cameras.

Manage Camera Calibration section

Contains the following controls:

- **Auto number cameras** Ensure you have aimed the cameras (seeAim Vicon cameras) before clicking this button. Automatically numbers the currently connected Vicon cameras in ascending order, according to their position in the capture volume. Automatic numbering starts with the camera furthest from the volume origin. The cameras are then numbered in a clockwise direction around the volume. If your cameras are positioned at different levels, the cameras in the level that contains the most cameras are numbered first.
- **Reset** Removes all non-existing cameras, clears the calibrated position for existing cameras, and reverts all calibration parameters to their defaults. This enables you to recalibrate the system from a clean starting point.
- **Load** Navigate to and select a previously saved camera calibration (.xcp file) defining settings for the Vicon cameras and any supported digital video cameras in your Nexus system.

Camera Calibration Feedback section

Enables you to view system calibration processing progress and status information. This section contains the following controls:

- **Progress bar** This bar displays a percentage indicating the progress of the overall camera calibration process.
- **Camera** This column contains the device ID for each Vicon camera being calibrated.
- **Wand Count** For each Vicon camera, this value identifies the number of frames it has captured containing the calibration object. Initially, the entry for the number of wand frames is displayed in red; the entry turns green when Nexus has acquired enough wand data to calibrate that camera, typically 1000 frames.
  By default, the calibration process stops when the camera with the lowest frame count reaches the number of frames specified in the **Refinement frames** parameter in the **Calibrate Cameras** section.
- **World Error** Displays the calibration error in millimeters. World error is calculated per camera from the **Image Error** in pixels and the distance of the camera to the center of the volume. Cameras further away, with the same image error, display a larger world error.
- **Image Error**This value (RMS distance in camera pixels) indicates the accuracy of the 3D reconstruction of the markers. This value represents the difference between the 2D image of each marker on the camera sensor and the 3D reconstructions of those markers projected back to the camera's sensor. Acceptable values depend on factors such as the size of the capture volume and the camera lens type.

Additional features in this section enable you to export your calibration, to identify calibration issues or to ensure that the current calibration conforms to an established standard.

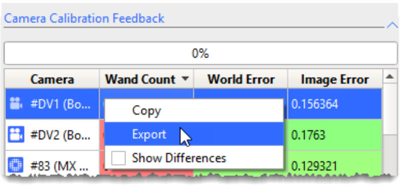
- Export a calibration as a CSV file, page 309
- Compare calibrations, page 309
- Set calibration error threshold, page 310
- Sort columns, page 311

Export a calibration as a CSV file

You can export the current calibration as a *.csv* file. This helps you to monitor your calibration standards over time.

To export a calibration as a CSV file:

1. In the **Camera Calibration Feedback** section, right-click and then click **Export**.



2. Enter a file name, ensure the file extension is .csv and click **Save**.

Compare calibrations

You can compare the current calibration results with the results from the previous calibration.

To compare the current and last calibrations:

- In the **Camera Calibration Feedback** section, right-click and then select **Show Differences**.
  The **World Error** and **Image Error** columns display the differences between the two calibrations.
  If the results from the latest calibration are better (ie produce smaller errors) than the previous one, the columns are displayed in green to yelllow.
  If the results from the latest calibration are worse (ie produce larger errors) than the previous one, the columns are displayed in red to orange.

Set calibration error threshold

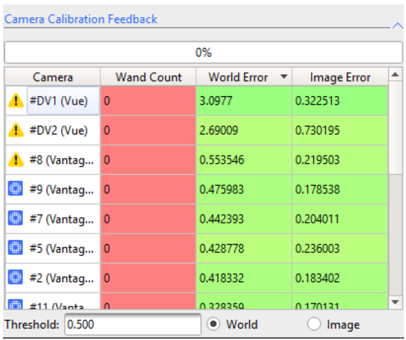
You can specify a maximum calibration error, above which cameras are flagged as having an error that is higher than the threshold that you have set.

To set a calibration error threshold:

- At the bottom of the the **Camera Calibration Feedback** section, set the error threshold (**World** or **Image**).

After calibration, in the **Camera Calibration Feedback** section, cameras with an error greater than this value are displayed with a yellow warning icon instead of the normal blue camera icon. The default setting (0.000) turns off any warnings.

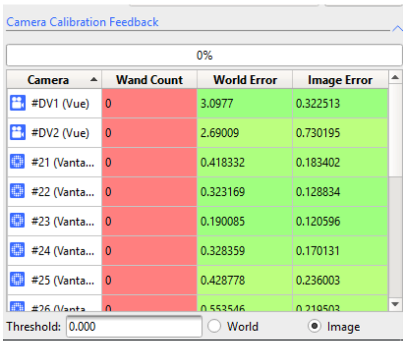
In the following example, the error threshold is set to 0.5mm, so that the three cameras with a calibration error greater than this are displayed with a warning icon:



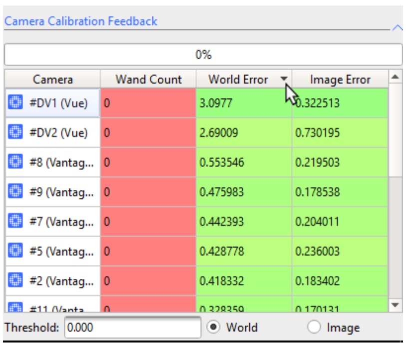
Sort columns

If you are working with a large number of cameras, it is useful to be able to sort the results to enable you to quickly identify problematic cameras. You can now sort the columns in the **Camera Calibration Feedback** section by clicking on the required column heading.

The default sorting is on the camera number (low to high):

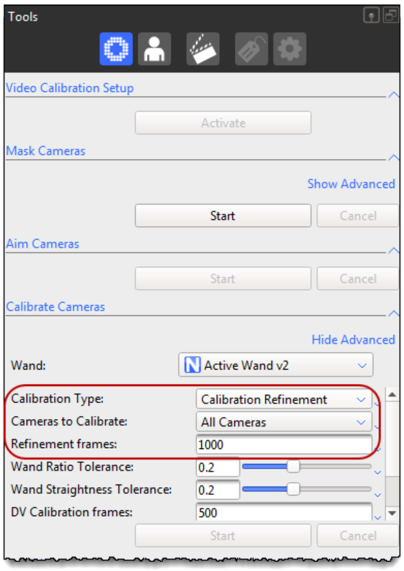


To make it easy to find cameras with the highest errors, you can sort on World Error or Image Error, displaying the cameras with the highest errors at the top of the column:



Understand camera calibration refinement

Calibration refinement provides a fast, reliable way to fine-tune an existing camera calibration, for example, as part of your daily calibration workflow before beginning the day's captures.



Full Calibration consists of an initialization phase, followed by a multi-pass process to optimize the camera positions.

Calibration Refinement uses exactly the same process as full calibration, but without the initialization phase. It provides a reliable way to refine existing calibration data to produce a calibration that is as good as a full calibration of the same system, but is much faster.

> **Important**
> As **Calibration Refinement** operates on existing data, you must have loaded a full calibration into Nexus before running the refinement calibration.

To save time while maintaining accuracy, you can perform both full and refinement calibration on any selected camera(s), as well as on all cameras.

Under most circumstances, the default value for **Refinement frames** produces good results. If you need to improve the results, particularly if you are using larger numbers of cameras, try increasing this value.

Note that the value specified for **Refinement frames** applies to the number of frames used:

- By Auto Stop
- In the refinement phase of a **Full Calibration**
- When running a **Calibration Refinement**

When to use a refinement calibration

The following table gives guidance on when to use each type of calibration:

Scenario	Type of calibration
A full calibration of all cameras has recently been performed, but since then, several cameras have been repositioned to another part of the volume.	**Full Calibration** on just the moved cameras, with a short wand wave that concentrates on the moved cameras.
A full calibration of all cameras has recently been performed, but during the trial, one camera was accidentally slightly bumped.	**Full Calibration** on the bumped camera, with a short wand wave that concentrates on the bumped camera.
Since yesterday's full calibration, environmental factors may have caused small changes in the camera positions and it is necessary to re-calibrate them accurately and quickly.	**Calibration Refinement** of all cameras, with a normal length wand wave that includes all cameras.

Subject Preparation tools

You must create a Vicon labeling skeleton template (.vst file), or import an existing one, for each type of subject whose motion is to be captured and analyzed in Nexus. You only need to do this once for each type of subject. Sample .vst file are provided under the Nexus model templates folder (by default, C:\Program Files\Vicon\Nexus2.#\ModelTemplates).

You must then calibrate the .vst file to create a Vicon labeling skeleton (.vsk file) that is scaled for each specific subject of that type. You must do this the first time you intend to capture a new subject and each time you want to use a different marker arrangement on the same subject.

For detailed information about creating and using custom Vicon labeling skeleton templates, see *Creating Labeling Skeleton Templates (VSTs)*.

To enable you to produce .vst and .vsk files, the **Subject Preparation Tools** pane contains the following sections:

- **Subject** Select a specific Vicon labeling skeleton template (.vst file) or Vicon labeleling skeleton (.vsk file). The contents of this list depends on the subject nodes enabled for capture (ie displayed with a check mark next to them) in the **Subjects Resources** pane.
- **Subject Capture** Enables you to capture a brief trial to obtain subject data. You can use the subject data to build or calibrate a Vicon labeling skeleton template and to manually label a subject.
- **Subject Calibration** Enables you to manage the subject calibration process to create a Vicon labeling skeleton (.vsk file) for a specific subject.
- **Labeling Template Builder** Enables you to build a generic Vicon labeling skeleton template (.vst file) for a type of subject (for example, humans, wearing a particular marker set). You subsequently use this .vst file to calibrate a Vicon labeling skeleton (.vsk file) for a specific subject of that type (for example, Jane, wearing the same particular marker set).

Capture tools

The **Capture Tools** pane enables you to collect motion data.

Collecting motion data involves identifying where in a motion capture trial database to store the data, specifying the type of source data that is to be captured, optionally configuring any remote triggering, optionally determining any automated processing to be performed, and managing the capture process. You can capture trials manually or configure Nexus to capture trials automatically.

For basic instructions on collecting data, see *Capture movement trials* in the *Vicon Nexus User Guide*.

The **Capture Tools** pane contains the following sections:

- **Trial Type list** Create or manage configurations for the motion capture trial types specified in the **Capture Tools** using the configuration management section at the top of the pane. (For information on managing configurations, see Manage configurations in Vicon Nexus in the *Vicon Nexus User Guide*.)
- **Next Trial Setup** Specify identification and information details for the way Nexus is to store data for this trial in a motion capture database:
  - **Session** A link to the active subject\session node in the currently loaded trial database. Click the link to open the Communications window, displaying the Data Management tab, or bring it to the front if it is already open, with the active node highlighted. If you make a different session the active node, the **Session** link is updated.
    Default: Identified by system
  - **Trial Name** The name under which to save the trial data in the motion capture database.
    Default: Blank if you are creating a new trial in a new session, or if the trial is the latest of several in a session and **Auto increment** is selected (see below), the system automatically names it after the preceding trial and increments numbering by 1.
    Do not use the following special characters in a trial name:
    \ backslash
    . period
    / slash
    , comma
    < left angle bracket
    ? question mark
    > right angle bracket
    *asterisk
    : colon
    " double quotation mark
    | vertical bar
    % percent
    $ dollar sign
  - **Description** Enter any description you want to specify for the trial. This description is displayed on the **Data Management** tab in the row associated with the captured trial.
    Default: Blank

  - **Notes** Enter any notes you want to specify for the trial. These notes are displayed on the **Data Management** tab in the row associated with the captured trial.
    Default: Blank
  - **Auto increment trial number** Choose whether or not to have Nexus automatically add a numerical suffix to the trial name for each subsequent trial, for example, Trial001, Tria002, Trial003, etc.
    Default: Selected
  - **Permit overwrite of existing files** Choose whether or not to have Nexus overwrite an existing data file without prompting you with a warning that it has the same name as that specified in the **Trial Name** field with this trial data.
    Note that if **Auto increment trial number** is selected and the file name that would be created using the next sequential numerical suffix is the same as that for an existing file, that previous file is overwritten.
    Default: Cleared

- **Data Source Setup** Specify the type of motion data to be captured by your Nexus system in the **Data Source Setup** section of the **Capture Tools** pane:
  - **Device Data** Analog signals captured by any third-party devices such as force plates or EMG devices.
    Default: Selected
  - **Optical Camera Data** Marker images visible to the Vicon optical cameras
    Default: Selected
  - **Video Camera Data** Digital video captured by any connected digital video cameras.
    Default: Selected

- Auto Capture Setup You can configure Vicon Nexus to automatically capture trials using the following controls:
  - Range Use an external remote control device to trigger data capture in your Vicon system. The remote control device must be connected to a Vicon Lock unit in your Vicon system (for details, see the *Vicon Systems Setup Guide*), and the sync outputs (GPO pins) for the remote functionality must be configured under the relevant Vicon Connectivity node in the System Resources pane.
    - Capture before Start Specify the number of seconds of data to record prior to capture being triggered either manually (with the Start button) or automatically (based on timecode or a remote control device).
    - Stop after duration Specify the number of seconds of data to record after which capturing will automatically stop.
  - Triggers Use a labeling percentage value that you specify or an external timecode source to trigger data capture in your Vicon system. The timecode source must be connected to an a Vicon Lock unit (for details, see *Vicon Systems Setup Guide*), and the corresponding timecode options must be configured under the relevant Vicon Connectivity node in the System Resources pane.
    - Start on Labeling (%) Captures automatically start when a subject first fully enters the volume. Set the labeling percentage (ie, the percentage of markers expected from the total number of markers in your subject's labeling skeleton) that needs to be recognized by Nexus within the capture volume for the subject to be considered as fully in the volume and therefore to trigger capture start.
    - Stop on Labeling (%) Captures automatically stop when the subject leaves the volume. Set the labeling percentage (ie, the percentage of markers expected from the total number of markers in your subject's labeling skeleton) that needs to be recognized by Nexus within the capture volume for the subject to be considered to have left the volume and therefore to trigger capture stop.
    - Start/Stop on remote trigger Start and/or stop capture on the activation of a remote trigger. This option is disabled if no remote trigger devices are recognized.
      Trigger the start of the capture from your remote control device. After you have acquired the data you need, trigger the stop of the capture from your remote control device.
    - Start on Timecode Select this check box and specify the timecode at which capture should automatically start.

    - Stop on Timecode Select this check box and specify the timecode at which capture should automatically stop.
      For further details on the use of timecode functionality in Vicon systems, see the *Vicon Systems Setup Guide*.
  - Start/Stop over network Broadcast a UDP message over an intranet or direct network cable connection to or from another application (or instance of Nexus) to trigger capture start and stop.
  - Address Enables you to select the network interface (first field) and UDP port (second field) on which to broadcast.
  - Arm button To set the system to a state where it is ready to accept a trigger signal for automatic capture based on a remote control device, click the Arm button.
  - Lock button If you want to enable the system to remain ready to receive subsequent remote capture signals after the capture is stopped, click the Lock button to the right of the Arm button.
- Post-Capture Pipeline Setup Enables you to specify any automatic post-processing that you want Nexus to perform on the captured data:
  - Run pipeline after capture Whether or not to run a previously defined pipeline immediately after the trial is captured. Select the pipeline that you want from the drop-down list. Default: Cleared

- **Capture section** Enables you to manage the motion capture process and view the number of frames captured and the current duration in seconds during processing:
  - **Start/Stop** Click this button to start a capture. When clicked, the button switches to the Stop setting.If you have set the **Stop after Duration** or **Stop on Timecode** settings in the **Auto Capture Setup** section, or if there is data in the buffer that has still to be written to disk, the button switches to **Stopping** until the capture has completed. If you click the button while it displays **Stopping**, the capture stops, and you will lose any data that was due to be captured, or that is currently in the buffer but not yet written to disk.
  - **Cancel** Click this button to cancel an active capture.
  - **Frames Captured** Displays the number of frames captured in the current trial. This number increments until the motion capture process is stopped.
  - **Trial time** The amount of time elapsed during the current capture is displayed in hh:mm: ss(ff) format, where hh is hours, mm is minutes, ss is seconds and ff is frames. For example, a 2.5 second capture at 50 Hz (125 frames) is displayed as 00:00:02(125).

Label/Edit tools

The **Label/Edit Tools** pane enables you to manually label trial data and fill any gaps in trial data. It contains the following sections:

- **Subject** You select the subject to manually label or edit in the **Subject** list at the top of the **Label/Edit Tools** pane. To appear in this list, the subject's node must be selected (ie, its check box must be selected in the **Subjects** tree in the **Resources** pane).
- **Manual Labeling** You manually label reconstructed trial data for the selected subject using the controls in this section. For instructions, see *Manually label a trial* in the *Vicon Nexus User Guide*.
- **Backward**, **Whole**, and **Forward** buttons. Label the currently selected trajectory either for the whole trial, or backward or forward from the current frame. Use **Whole** if you are confident that the trial data contains very few mislabels or swaps. Use **Backward** or **Forward** to label the trial data backwards or forwards from the current frame, without affecting other frames.
  Tip: When you are manually labeling a subject, to help you place the selected label onto the correct 3D reconstruction, in the **3D Perspective** view pane the pointer changes to include a tooltip that identifies the label. You can also use the **Subject Viewer** to help you identify the markers (see Subject Viewer, page 298).
- **Auto advance selection** When selected, Nexus automatically advances to the next marker in the **Manual Labeling** list. Default: Selected
- **Find Next Unlabeled Trajectory** When you click this button, Nexus advances to the next frame that contains an unlabeled marker trajectory.
- **Swap Marker Labels** To correct swapped marker labels, select the relevant two marker trajectories and then click this button.
- **Gap Filling** Enables you to identify and fill gaps in reconstructed marker trajectories. See also the FAQ *What gap-filling algorithms are used in Nexus 2?* on the Vicon website[31].

31 http://www.vicon.com/faqs

Pipeline tools

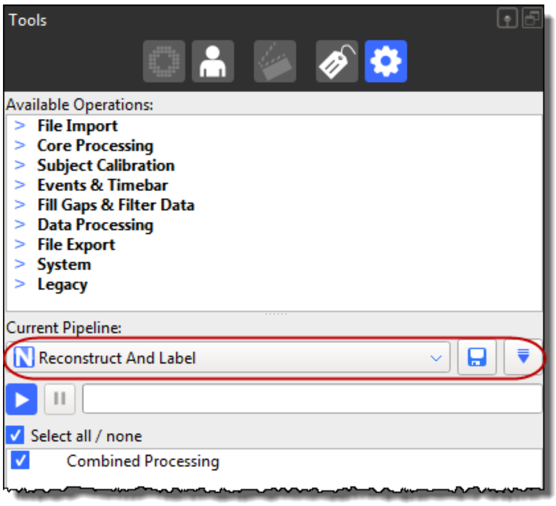
The **Pipeline Tools** pane enables you to create and manage a customized sequence of operations to automate the processing of a trial.

Pipeline processing is optional, but is useful for automating the data processing operations that you use frequently or on a large number of trials.

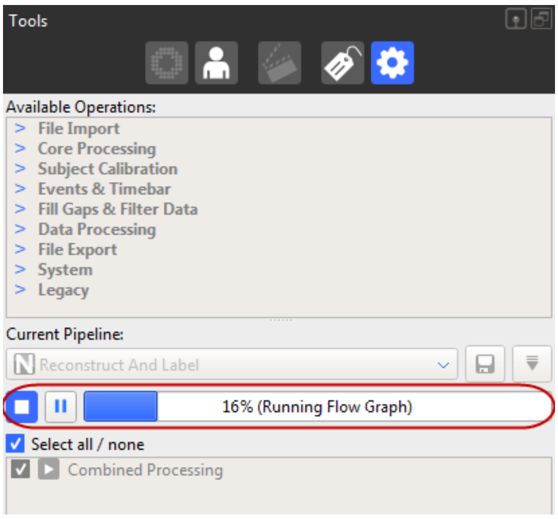
The **Pipeline Tools** pane contains the following sections:

- **Available Operations** section
  The **Available Operations** section enables you to select the type of pipeline you want to create and the operations to run. Operations are grouped under the following types:
  - File Import operations, page 326 For automating the import of trial files into Vicon Nexus from third-party software packages.
  - Core Processing operations, page 327 For automating reconstruction, labeling, and kinematic fitting to produce 3D trajectories from raw marker data.
  - Subject Calibration operations, page 328 For automating the processing of system and subject calibration.
  - Events & Timebar operations, page 330 For automating operations involving events and/or normally performed using the time bar.
  - Fill Gap & Filter Data operations, page 332 For automating the post-processing of data, such as gap-filling.
  - Data Processing operations, page 337 For automating the production of model outputs (forces and moments, joint angles, etc).
  - File Export operations, page 340 For automating the export of trial files from Nexus to third-party software packages.
  - System operations, page 342 For automating offline camera calibration and applying a codec to video.
  - Legacy operations, page 343 For automating the processing of legacy trial data.

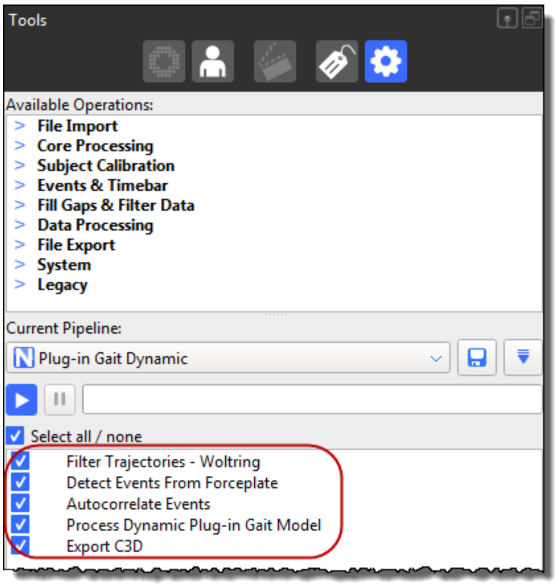
- **Current Pipeline** section
  At the top of the **Current Pipeline** section, the configuration management controls enable you to create or manage configurations for the settings specified in the **Pipeline Tools** pane.



The middle of the **Current Pipeline** section enables you to manage the pipeline operations and view their status with the playback controls and progress bar.



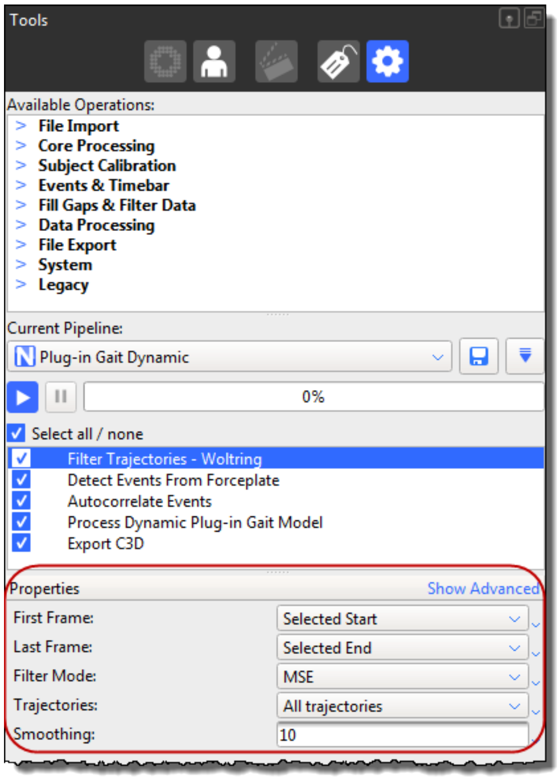
In the list at the bottom of the **Current Pipeline** section, you can view the operations included in the currently loaded pipeline.



For information on using pipelines, see *Work with pipelines* in the *Vicon Nexus User Guide*.

Tip: Pipeline operations are run in the order they appear in this list. You can drag operations into the desired position in the list. Alternatively, you can run an individual operation by right-clicking on it and clicking **Run selected Op**.

- **Properties** pane
  You can view or change settings for the selected pipeline operation in the **Properties** pane at the bottom of the **Pipeline Tools** pane.



Pipeline operations

Pipeline operations are found in the **Pipeline Tools** pane, in the **Available Operations** section.

File Import operations

Use **File Import** operations to automate the import of trial files to Vicon Nexus from third-party software packages.

Operation	Description
Import Video	Import a video *.mp4* or *.avi* file to be saved and associated with the current trial.
Import MP	Import subject parameters specified in a .mp file into the active subject.
Import VSK	Import a labeling skeleton (*.vsk)* file.
Import XCP	Import a calibration file (*.xcp*) into the current trial to replace the current calibration.
Add Theia Data	Normally run after running Theia processing on Nexus video trials, either by using the Theia pipeline operation, page 339 or the **Theia Batch Interface**. Combines rotation data from Theia with a Nexus trial. See also Run Theia processing on video files in the *Vicon Nexus User Guide*.

Core Processing operations

Use **Core Processing** operations to automate the processing of offline reconstruction, labeling, and kinematic fitting to produce 3D trajectories from raw marker data.

Operation	Description
Combined Processing	Performs one or more of: reconstruction, labeling, and subject motions. Running this operation is faster than running each process individually.
Reconstruct	3D trajectories are reconstructed from the raw 2D marker data.
Label	Controls how 3D trajectories are labeled with subject data
Kinematic Fit	Controls how the labeling skeleton contained in the .vsk is kinematic-fitted to the marker data. In addition to specifying the frames on which to operate, you can adjust settings for: • **Prior importance**: Weighting given to the uncalibrated values from the VST. Range is 0-100, default is 25. • **Mean pose ratio**: Ratio of tracking pose as prior (where 0 = mean pose only; 1 (default) = external (or tracking) prior only.)

Tip

The equivalent settings for Live processing can be found in the Local Vicon System properties, page 198, found in the **System Resources** pane.

Subject Calibration operations

Use **Subject Calibration** operations to automate the processing of labeling skeleton calibration.

Operation	Description
Set Autolabel Pose	Sets the pose for Autolabel Static to be the pose at the selected frame.
Autolabel Static	Run on a reconstructed static trial to automatically label the labeling skeleton in a single frame, using information from the *.vst* file. It matches the shape of the reconstruction to the shape of the subject template for that pose. The labels are applied to the whole trajectory, not just the chosen frame. It works best when all the markers have been reconstructed and there are no additional markers or clutter in the scene. This operation does not require a *.vsk* file.
Scale Subject VSK	Scales the labeling skeleton to be the same size as a labeled set of reconstructions on a particular frame. The scale factor is calculated assuming that the subject is in the same pose as was used for **Autolabel Static (see above)**. (Note that this scaling respects any constraints that you may have specified in the template. For example if your template specifies (ie a StaticParameter) that a segment is 100mm long, the segment will not be scaled. Only parameters are considered for scaling.)
Functional Skeleton Calibration	Calibrate the subject's bone lengths, joint locations, and marker locations from a whole trial. Use to calibrate a whole ROM trial.
Functional Skeleton Calibration - Markers-only	Calibrate the subject's marker locations from a whole trial. This is useful, for example if a marker becomes detached from the subject and you need to re-run the calibration with the replaced marker.
Static Skeleton Calibration	Calibrate the subject's bone lengths, joint locations, and marker locations from a single frame. Use to calibration a static calibration, as in versions of Vicon Nexus earlier than 2.0.

Operation	Description
Static Skeleton Calibration - Markers-only	Uses a single frame to update the marker locations for the labeling skeleton. This operation both fits the subject pose (that is, the pose that was defined when the labeling skeleton was created) to the labeled reconstructions and calibrates the marker locations. Fitting the subject pose allows for the likely situation of your subject standing close to the template pose. Again, this operation respects any constraints specified in the labeling skeleton template and changes only parameters. This operation is useful, for example if a marker becomes detached from the subject and you need to re-run the calibration with the replaced marker.
Update Skeleton Parameters	Initial label booting can be improved by providing more representative data from a movement or ROM trial. This operation enables you to do this by updating the default values of a selected skeleton with movement or ROM trial data contained in the current calibrated labeling skeleton (VSK). The options for this operation are: • Update Marker Covariances Marker covariance is used by the labeler to account for skin motion, so the default for this option is Selected. • Update Parameters If you have calibrated a skeleton from the Labeling Template Builder, select this check box. • Update Joint Mean & Covariance Joint covariance is used in booting the labeling. If you have a very flexible subject, a larger covariance will help, so select this check box. • Update Joint Ranges Joint ranges can be enforced to detect infeasible joint angles. If you have a very flexible subject, larger joint ranges are needed, so select this check box.
Calculate Skeleton Joint & Marker Statistics	Measure the subject's labeling statistics from a whole trial.
Calibrate OCST	Finds the Optimum Common Shape
Calibrate SCoRE/ SARA	Calibrate joint positions using the Symmetrical Center of Rotation Estimation and Symmetrical Axis of Rotation Analysis.

See also Labeling skeleton calibration in detail, page 22.

Events & Timebar operations

Use **Events & Timebar** operations to automate processes relating to events and the timebar.

Operation	Description
Auto Crop Trial	For trials where the subject starts outside the volume, moves into the volume and then exits, Nexus can automatically determine the first and last frame where the subject is fully in the volume. • **First Frame** and **Last Frame** Set these options to the frames during which the subject enters and leaves the volume. • **Start %** and **End %** Set these options to the required minimum percentage of markers (ie, the percentage expected from the total number of markers in your subject's labeling skeleton) that must be labeled in each case. • **Frames Required** If necessary, adjust this option to set a minimum number of frames where the **Start %** criterion must be met. This is helpful if early single frames of data meet the percentage, but the point at which the trial is intended to start (ie, the point at which the percentage is maintained over a number of frames) is later in the trial.
Autocorrelate Events	Based on user-defined parameters, this operation detects the pattern of the tracked marker at the set events and defines these events for the rest of the trial. The available parameters are: marker being tracked; the X, Y, or Z component of the marker; and the position, velocity, or acceleration of the marker. An Advanced property (**Correlation Method**) enables you to choose the correlation method to automatically place events at the correct location in the time bar, from the choice of **Legacy**, **Least Squares** or **Pearson Coefficient** (see Correlation Method parameters, page 331). **Autocorrelate Events** is normally used after the **Detect Events from Forceplate** operation.
Detect Events from ForcePlate	Automatically detects gait cycle events and adds them to the time bar throughout the trial using vertical GRFs measured by a force plate connected to the Vicon system. Includes the option to set the force threshold and the label of the markers attached to the front and back of the foot for both sides.

Operation	Description
Delete Timebar Events	Delete events from the specified range for the subject(s). Advanced options lets you choose: • **Range to Delete** Whether to delete events that are inside or outside the specified range of frames. • **Context** Whether to delete events from All, Left, Right or General contexts. **To delete custom events:** 1. Click the downward arrow next to the **Context** field and clear the **Macro** check box. 2. In the **Context** field, enter the name of the custom event. 3. Run the pipeline.

Correlation Method parameters

- **Legacy** (reproduces the behavior from Nexus 2.5 and earlier)
  Maximizes the value of:

$$\frac{2\sum xy}{\sum x^2 + \sum y^2}$$

- **Least Squares** (default) Minimizes the value of:

$$\frac{\sum (x-y)^2}{n}$$

- **Pearson Coefficient** Maximizes the value of:

$$\frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2}\sqrt{\sum (y-\bar{y})^2}}$$

  Where $\bar{x}$ indicates the mean of x over the sample range

Fill Gap & Filter Data operations

Use **Fill Gap & Filter Data** operations to automate gap-filling and other post-processing.

Operation	Description
Fill Gaps - Cyclic	For trials that contain captured data that is cyclic in nature (for example, when a motion on a treadmill or other repetitive motion is captured), fills gaps using patterns from earlier or later gait cycles. You can specify the Gap Length, Units, First and Last Frame, and select the trajectories to fill.
Fill Gaps - Kinematic	Fills all gaps in trajectories that pass through a selected segment, based on calculated kinematics. To run this operation, you must have already obtained the kinematic data on which to base gap-filling, for example, by running the **Nexus Legacy Fit Motion** pipeline.
Fill Gaps - Pattern	Fills the selected gap using the shape of another trajectory without a gap. Use this tool only if there is a suitable marker with a trajectory similar to the one whose gap you wish to fill.
Fill Gaps - Rigid Body	Fills gaps in a trajectory based on other trajectories in a rigid body. This option is the Nexus equivalent of the Replace 4 option, which is available in BodyBuilder. Use this option when a rigid or semi-rigid relationship exists between markers.

Operation	Description
Fill Gaps - Woltring	Run on labeled dynamic trials to fill in gaps using Woltring quintic spline interpolation. Includes the option to choose maximum gap frame length to fill. For more information on Woltring filtration, see the FAQ What are the details of the Woltring filter?[32] You can configure the following settings in the Properties section: • Max Gap Length The maximum length of any gap in a marker trajectory that will be filled with this operation. Default: 5 • First Frame The first of the range of frames in the region of interest of the trial that you wish to analyze. For example, if the capture includes the subject entering the capture volume, you are strongly advised to set the range of frames to exclude this portion of the capture. That will simplify the job of cleaning up your data. You can specify the following settings: • First Frame: The first frame of the trial. • Selected Start: The frame indicated by the Start Range Frame indicator on the time bar ruler. • Current Frame: The frame indicated by the Current Time indicator on the time bar ruler. • First Full Frame: First full frame of range to process Default: Selected Start • Last Frame The last of the range of frames in the region of interest of the trial that you wish to analyze. For example, if the capture includes the subject leaving the capture volume, you are strongly advised to set the range of frames to exclude this portion of the capture. That will simplify the job of cleaning up your data. You can specify the following settings: • End Frame: The last frame of the trial. • Selected End: The frame indicated by the End Range Frame indicator on the time bar ruler. • Current Frame: The frame indicated by the Current Time indicator on the time bar ruler. • Last Full Frame: Last full frame of range Default: Selected End

32 https://www.vicon.com/support/faqs/?q=what-are-the-details-of-the-woltring-filter

Operation	Description
Filter Analog Data - Butterworth	Filter analog device data using a low-pass digital Butterworth filter. The filter is by default setup as recommended in Winter, D.A. Biomechanics of Motor Control and Human Movement to filter out signal noise above 300 Hz using a fourth order filter with zero lag (see descriptions below for an explanation of these parameters). Note: For force plates, only the calculated Force and Moment signals can be filtered. Raw and Center of Pressure signals cannot be filtered. You can configure the following settings in the Properties section: • **Cut-Off Frequency** The filter cut-off frequency, separating the low-frequency signal from high frequency noise. Data at frequencies above the cut-off frequency are attenuated increasingly as the frequency increases. The attenuation exactly at the cut-off frequency is designed to be "half power," or -3 dB. Note Cut-off frequencies greater than half of the analog device sampling frequency (often called the Nyquist frequency) cannot be used and will result in an error message and no filtering of the data. • **Filter Order** The Second Order filter performs a single pass of the filter in the forwards (increasing time) direction, resulting in a "lag," or "phase shift" in the analog data. The Fourth Order filter performs two passes of the filter, in first the forward, then the reverse direction, resulting in any lag being cancelled out (hence "zero lag"). The parameters of the Fourth Order filter are adjusted, such that the attenuation exactly at the cut-off frequency is maintained at "half power," or -3 dB. • **Filter Type** Can be Low Pass (default) or High Pass. Select **High Pass** to filter low-frequency noise from your data. • **Devices** You can enter a comma-separated list of Devices, Outputs and Components, or use the macros **All**, **Selected**, **Force Plates** or **Other Devices**. • **All** filters the data from every device currently connected. • **Selected** filters the data from the devices, device outputs, and output components with names matching those currently selected in the **System Resources** pane and in the **3D Perspective** view. • **Force Plates** applies the filter to force plates that are connected to your system. • **Other Devices** applies the filter to all other devices (except force plates) that are connected to your system.

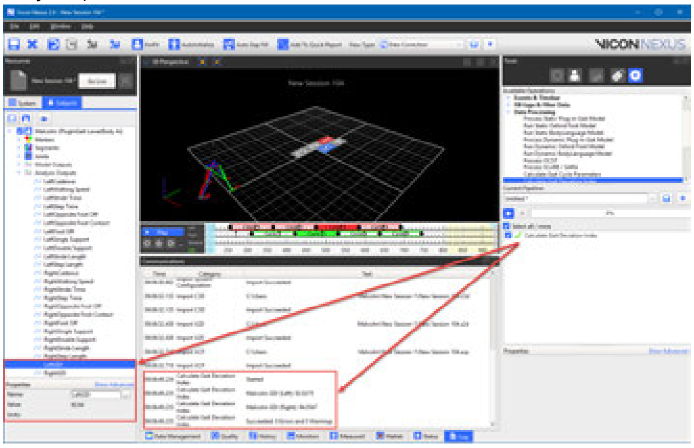
Operation	Description
Filter Model Outputs - Butterworth	Filter subject model outputs using a low-pass digital Butterworth filter. The filter is by default setup as recommended in Winter, D.A. Biomechanics of Motor Control and Human Movement to filter out signal noise above 6 Hz using a Fourth Order filter with zero lag. You can configure the following settings in the Properties section: • **Cut-Off Frequency** Same as Analog Data above. • **Filter Order** Same as Analog Data above. • **Model Outputs** A comma separated list of Model Outputs can be typed, or the Macros All or Selected can be used. All will always filter all Model Outputs calculated for a subject and Selected will filter Model Outputs with names matching those currently selected on the Subjects tab of the Resources pane and in the 3D Perspective view. You can use the * wildcard for all model outputs.
Filter Trajectories - Butterworth	Filter trajectories using a low-pass digital Butterworth filter. The filter is by default set up as recommended in Winter, D.A. Biomechanics of Motor Control and Human Movement to filter out signal noise above 6 Hz using a Fourth Order filter with zero lag. You can configure the following settings in the Properties section: • **Cut-Off Frequency** Same as Analog Data above. • **Filter Order** Same as Analog Data above. • **Trajectories** A comma separated list of trajectories can be typed, or the Macros All, All Labeled, or Selected can be used. All will always filter every trajectory, including unlabeled ones, All Selected will filter every currently labeled trajectory, and Selected will filter trajectories with names matching those labeled trajectories currently selected on the Subjects tab of the Resources pane and in the 3D Perspective view.
Filter Trajectories - VCM Spline	Vicon Gait Model event VCM Spline Filter
Filter Trajectories - Woltring	Filters the data using the Woltring filter to ensure smooth trajectories for calculating kinetics.

Operation	Description
Residual Analysis - Butterworth	Enables you to run a residual analysis to determine the optimum cut-off frequencies to apply for a low-pass filter for your devices. Results are displayed in the **Log** and saved in the trial **History**. **Important:** This feature is for low pass filtering analysis only, eg, for force plates and plantar pressure plates, and not for high-pass filter devices like EMG. In the (Advanced) Properties section, in addition to the usual First Frame, Last Frame options (see above), you can configure these settings: • **Filter Order** See Filter Analog Data - Butterworth, above. • **Devices** Select whether to apply the value to **All** or **Selected** devices. • **Steps** Specify the number of frequencies to evaluate. Default =50, minimum = 5 and maximum = 200. • **Rho Squared** Specify the minimum rho-squared value to accept. This is used to determine the linear region of the residual-frequency curve via a simple linear regression. Default = 0.95, minimum = 0 and maximum = 1. After running the pipeline, the results of the analysis for each channel are displayed in the Log, enabling you to decide which channel output to use to apply as the cut-off frequency for the Filter Analog Data - Butterworth pipeline operation. The filter cut-off is dependent on the type of device to which it is applied, eg, how noisy a force plate is: this may differ for analog vs. digital devices. You can use the Residual Analysis as part of a batch process. Results of the Residual Analysis are saved in the trial History.
Delete Optional Subject Marker	Run on a any trial to delete a specified group of subject markers from the marker list that will not be used during the dynamic captures.
Delete Unlabeled Trajectories	Run on a fully labeled trial to delete any remaining unlabeled trajectories. Includes the option to choose maximum length of unlabeled trajectory to delete.

Data Processing operations

Use **Processing** operations to automate real-time and offline motion capture data processing.

Operation	Description
Process Static Plug-in Gait Model	Runs the static Plug-In Gait model on the active subject of the current trial. For more information, see *Modeling with Plug-in Gait* in the *Vicon Nexus User Guide* and the *Plug-in Gait Reference Guide*.
Run Static Oxford Foot Model	Runs the static Oxford Foot Model pipeline operation (installed as part of Nexus) that was previously available as a separate legacy VPI.
Run Static BodyLanguage Model	Runs the static BodyLanguage model
Process Dynamic Plug-in Gait Model	Runs the dynamic Plug-In Gait model on the active subject of the current trial. For more information, see *Modeling with Plug-in Gait* in the *Vicon Nexus User Guide* and the *Plug-in Gait Reference Guide*.
Run Dynamic Oxford Foot Model	Runs the dynamic Oxford Foot Model pipeline operation (installed as part of Nexus) that was previously available as a separate legacy VPI.
Run Dynamic BodyLanguage Model	Runs the dynamic BodyLanguage model
Process OCST	Finds the coordinate system trace using the Optimum Common Shape Technique. For more information, see Biomechanics workflow, page 97.
Process SCoRE / SARA	Generates joint position model outputs using Symmetrical Center of Rotation Estimation and Symmetrical Axis of Rotation Analysis. For more information, see Biomechanics workflow, page 97.
Calculate Gait Cycle Parameters	Calculate Vicon Gait Model temporal parameters and enables calculation of step width and limp index. Includes the option to set the output units. For more information, see Calculate step width and limp index in the *Vicon Nexus User Guide*.

Operation	Description
Calculate Gait Deviation Index	Generates a GDI (Gait Deviation Index) score for the subject of the current trial. [1] When you run this operation on a trial, two GDI values (left and right), are output to the log and saved as subject parameters.  To output these values when you run the **Export ASCII** pipeline operation, select the **Export Gait Cycle Parameters** option.
Run MatLab Operation	Execute MATLAB script. For information on using MATLAB with Nexus, see Modeling with MATLAB, page 61.
Run ProCalc Operation	Run ProCalc scripts/models directly from Nexus. For information on Procalc, see the Vicon Procalc documentation.
Run Python Operation	Execute Python script. This operation uses the path to the Python script from the Python tab (Communications pane) as its default location, but you can change it on a per-operation basis if required. For information on using Python with Nexus, see Modeling with Python, page 72.
Run External Application	Run an external executable program. For more information, see Run an executable from a Nexus pipeline operation, page 344.
Run Theia ProCalc Scheme	Generate ProCalc joint angles from Nexus trial data that contains Theia rotations. Run this operation on the data after you have run the Add Theia Data, page 326 pipeline operation. See also Run Theia processing on video files in the *Vicon Nexus User Guide*.

Operation	Description
Delete Model Outputs	Enables you to delete from the current trial the selected model output(s), all model outputs, or to specify a comma-separated list of model output names. Tip: You can also access the same options by right-clicking the relevant node in the **Subjects Resources** tree.
Add Trial to Quick Report	Adds the current C3D to the Quick Reports window. For more information, see Quick Reports, page 363.
Theia	Runs Theia processing on one or more Nexus video trials. Normally run before the Add Theia Data , page 326 operation. See also Run Theia processing on video files in the *Vicon Nexus User Guide*.
CGM2 - Calibration	Run on static trials. For more information, see Run the static CGM2 model, page 89.
CGM2 - Functional Calibration	Provides knee calibration with two options: **2DoF Calibration** or **SARA**. Run between the static/calibration trials (see CGM2 - Calibration, above) and the dynamic/fitting trials (see CGM2 - Fitting, below). For more information, see Run the knee calibration (CGM 2.6), page 91.
CGM2 - Fitting	Run on dynamic trials. For more information, see Run the dynamic CGM2 model, page 92.

1. For supporting information on the scientific basis and validation of Vicon's implementation of the calculation of the GDI score, see:
   Schwartz, M. H., and Rozumalski, A., The gait deviation index: A new comprehensive index of gait pathology, *Gait & Posture* 28 (2008), p351–357.

File Export operations

Use **File Export** operations to export of data from Vicon Nexus for use with third-party software packages.

Operation	Description
Export 3D Overlay Video	Export a copy of the reference video *.mp4* or *.avi* file(s) with the 3D Perspective data overlaid onto the video image. You can choose which 3D view option to display and select the codec used to compress the new video file. You can configure the following settings in the **Properties** section: • **View Options Set** The *.options* configuration files that have been saved in the Options dialog box (F7). You can select settings for the 3D data to be exported with the *.mp4* or *.avi* file. Select a configuration file from the drop-down list. If you do not specify a file, the current view options are used. Default: blank • **Cameras** Choose which video cameras from which to export overlay video: either **Selected Video Cameras** or **All Video Cameras**. • **File Output** The file type (*.mp4* or *.avi*) and video compression method (h.264 or Uncompressed) to use when exporting the video file. Default: h.264 MP4 • **h.264 Compression** If you selected any File Output option except Uncompressed, this sets the compression option. Choose between options ranging from **Best Quality / Largest file** (if the quality of the output is the priority) to **Lowest Quality / Smallest File** (if it is important to keep the file size as small as possible). Default: Best Quality / Largest file • **First Frame and Last Frame** Enables you to specify the range of frames to export. **Tip:** If you want to export labeled subjects in the Nexus 3D workspace, use instead the **Export Workspace to Video** button (available on the View pane toolbar) . For more information, see *Export Workspace to video* in the *Vicon Nexus User Guide*.
Export ASCII	Export delimited ASCII format to a *.csv* or *.txt* file, or another format that you specify by clearing the Macro check box (click the downward arrow at the right of the extension list) and entering the required extension. You can select commas, tabs, or line feeds as the delimiter.

Operation	Description
Export C3D	Export the current state of the processed data to a *.c3d* file. You can then import the data into other software for further processing or report generation. For example, in Vicon Polygon you can visualize the trajectories, kinematic model elements, and kinetics data. If you manually import the corresponding .vst file into Polygon, it also visualizes the bones.
Export MKR	Export an *.mkr* file. You can choose whether the exported file name is based on the active subject name(s) or active labeling skeleton template name(s). If you choose **Active Labeling Skeleton Names**, the name of any labeling skeleton template attached to the subject (for example, PlugInGait FullBody Ai) is used as the name of the MKR file. If more than one subject is present with the same model attached, a log message indicates that only one MKR file will be exported.
Export MOT	Export files in .mot format for use in OpenSim.
Export MOX	Export Nexus data files in .mox format for MoXie (http://moxie.smalll.eu/).
Export MP	Export the current subject parameters to an *.mp* file (subject parameter file compatible with legacy software).
Export TRC	Export a *.trc* file.
Export VSK	Export a labeling skeleton (*.vsk*) file
Export XCP	Export the current calibration file to an *.xcp* file in a specified location.
Save Trial - C3D + VSK	Save the files associated with the currently open trial.

For more information on how to use the export operations, see *Export trial data* in the *Vicon Nexus User Guide*.

System operations

Use **System** operations to automate offline camera calibration and applying codecs to video files.

Operation	Description
Process Offline Camera Calibration	Run on a captured trial of a calibration wand wave to calibrate a system (instead of calibrating the system live).
Transcode Video for Trial	Automates transcoding the raw video files associated with the current trial. Enables you to choose the required codec.
Apply Codec to Video	Applies a codec to all video files (*.mp4* or *.avi*) associated with the current trial. You can select which codec to use, whether to keep the original movie file, and whether to force recompression (not recommended).
Reset force plate offsets	Resets the force plate offsets. Enables you to specify the range of frames on which to operate, the affected device(s), and the range of frames to use for zeroing the force plate.
Set Delay Compensation	Sets the delay compensation for selected devices. After the pipeline has been run, the Delay Compensation value is saved and is displayed on the History tab.
Set Camera Calibration Origin	Sets the camera calibration origin using a calibration object.
Run Monitor	Enables you to run a monitor as part of a pipeline. To do this: 1. Create the monitor you want to use (see Create a monitor, page 38 in the *Vicon Nexus Reference Guide*). 2. Ensure Nexus is in Offline mode. 3. Add **Run Monitor** to your pipeline and in its Properties, select the required monitor from the **Monitor Configuration** list.

Legacy operations

Use Legacy operations to automate the processing of legacy trial data:

Operation	Description
Nexus Legacy Labeler	Run on fully reconstructed trials to label the subject as a whole instead of frame-by-frame as in the Core Processor. This operation requires a *.vsk* file.
Nexus Legacy Fit Motion	Run on fully labeled trials to Kinematic Fit the trial as a whole instead of frame-by-frame as in the Core Processor.

Run an executable from a Nexus pipeline operation

Nexus 2.14 and later enables you to run an executable file (written in compiled languages such as C++ or C#) from a Nexus pipeline operation. You can use this feature to speed up or update processing and produce a more automated workflow, for example:

- To quickly run an application you've written that takes filter-related parameters as command line options by connecting to Nexus using the offline SDK, loading the data, filtering using the provided filter parameters, and updating the model output data in Nexus.

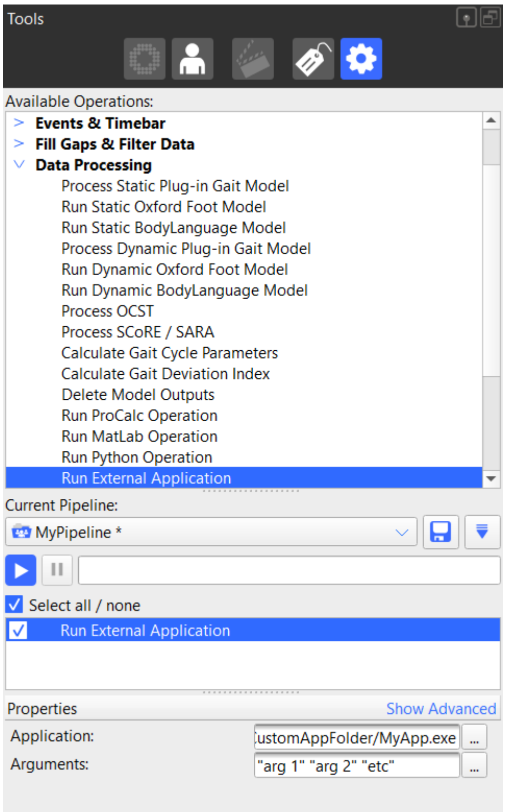
or

- For legacy VPIs that you want to continue to use in the latest 64-bit version of Nexus, you could port them to use the offline SDK rather than the VPI interface.

To run an executable from within Nexus:

1. In the **Pipeline Tools** panel, expand **Data Processing** and double-click **Run External Application** to add the operation to the current pipeline.
2. With **Run External Application** selected, in the **Properties** pane, click in the **Application** field and enter or browse to the location of the executable file that you want to run, ensuring that the full path, including the filename, is specified.
   If the executable doesn't require any arguments, you can now run the operation.

3. If your app requires arguments, in the **Arguments** field, enter these as a space-delimited list that is passed to the application upon execution. Surround each string argument with double quotes.



4. Run the operation in the usual way. (For a reminder of how to use pipelines in Nexus, see Work with pipelines in the *Vicon Nexus User Guide*.)

Make pipelines read-only

From Nexus 2.14 and later, you can make pipelines and the operations within them read-only by storing pipeline files in a location you choose. This enables you to to create pipelines that all users of Nexus can access, but that are protected from editing. It is particularly useful if you need to meet MDR requirements for running standardized pipelines that must not be altered by the user.

The location for the read-only pipelines is separate from the Shared/Private/Installed scheme that Nexus provides (for information on Shared/Private files see Manage configurations in Vicon Nexus in the *Vicon Nexus User Guide*).

The read-only pipeline folder location is stored in the system level *Prefs.conf* file in the following location:

C:\Users\Public\Documents\Vicon\Nexus2.x\Configurations\Config

To specify the location of the read-only pipelines:

In a text editor, open *Prefs.conf* and add `value="MyPath/MyFolder"` to the ReadOnlyFolder parameter, for example:

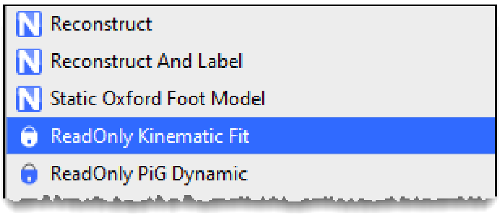
Specify read-only pipeline location

```
<ParamDefinitionList name="com.vicon.Nexus.Pipeline">
    <ParamListGroup name="">
       <ParamList name="default">
         <Param name="ReadOnlyFolder" value="C:/MyReadOnlyPipelines"/>
       </ParamList>
     </ParamListGroup>
</ParamDefinitionList>
```

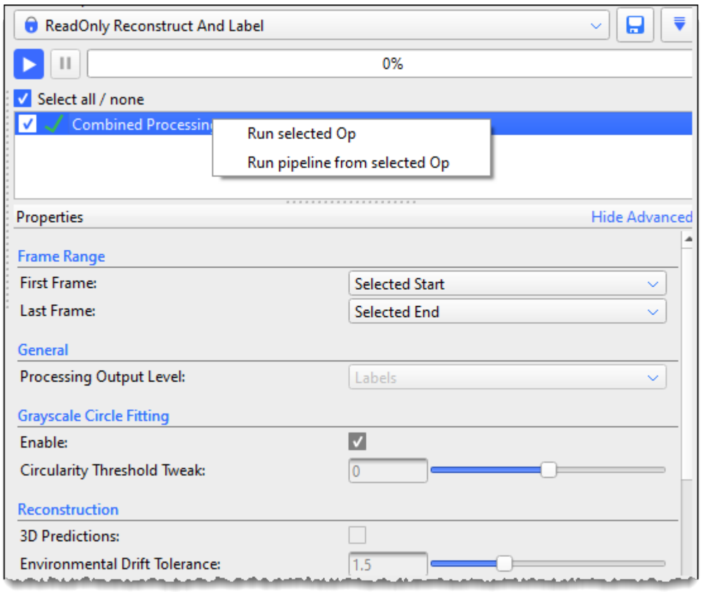
When you have specified the required location, save the file.

> **Note**
> As neither *Prefs.conf* nor the folder specified within it are protected by default, you may want to change their permissions to prevent unauthorized changes.

When you select a pipeline selector in Nexus, the read-only pipeline files are displayed with a padlock icon, along with files from the Shared/Private/Installed locations:



You can select these pipelines and run them but you cannot modify them, rename them, or delete them from within Nexus. With read-only pipelines, all the parameters are set to read-only (except the first and last frame selection) and you cannot add or remove operations from the pipeline.



Operations run from read-only pipelines are noted in the history file, showing the pipeline that was active at the time the operation was run.

If you need to change a read-only pipeline, you can use Save As to save it to a different location with a new name. This copy of the pipeline is editable and behaves the same way as a standard Shared/Private pipeline.

Communications pane

The **Communications** pane enables you to view and manage the state of your Vicon system, and streamline your motion capture workflow.

The tabs at the bottom of the **Communications** pane enable you to switch between the available monitoring tools.

> Tip
> To avoid the pane taking up too much onscreen space, you can choose to hide the **Communications** pane when you load a trial. To do this, on the **Window** menu, select the **Close Communications Pane on Trial Load** option. Alternatively, to temporarily hide/reveal the **Communications** pane, so that the tabs are minimized to the bottom of the screen without completely closing, double-click any of its tabs.
> You can also hide individual tabs by clearing options in the **Plug-ins** panel (**Window** menu > **Plug-ins**) and then restarting Nexus.

For information, see:

- Data Management tab, page 349
- Quality tab, page 350
- History tab, page 351
- Theia tab, page 351
- Python tab, page 353
- Matlab tab, page 353
- Monitors tab, page 353
- IMeasureU tab, page 355
- Status tab, page 358
- Log tab, page 359

Data Management tab

The **Data Management tab** contains the following controls:

- **Database location** You can view the full path of the active node in the trial database at the top of the **Data Management** tab. To access the files in Windows Explorer, click the hyperlink.
- **Navigation buttons** You open the **Manage Databases** dialog box, go forward a node, go back a node and move up a level using the navigation buttons at the top left of the **Data Management** tab.
- **Search button** Displays or hides the **Search** window. For more information, see Advanced data searching, page 16.
- **Show Trial Loading Options button** Displays or hides the **Raw Data Loading Options** area, in which you can specify your requirements for loading large trials.
  For more information, see Load large trials, page 18.
- **Show File Transfer/Batch Processing Interface** button Displays or hides the **Video Transfer/Batch Processing/Biomechanics Workflow** pane on the right side of the **Data Management** tab.
  For more information, see Work with digital video files in the *Vicon Nexus User Guide*, and Batch process trials, page 19 and Biomechanics workflow, page 97 in the *Vicon Nexus Reference Guide*.
- **Data Management toolbar** You create and manage nodes in the database hierarchy using the buttons in the toolbar at the top right of the **Data Management** tab. The buttons are:
  - New Patient Classification button
  - New Patient button
  - New Session
  - Filter displayed items Filter (Enter text to begin filtering)
  - Launch Nexus Insight (Nexus 2.16 and later—see the Nexus Insight documentation[33])

33 https://help.vicon.com/space/NexusInsight

- New Polygon Report
- Turn search interface on or off (see Advanced data searching, page 16 in the *Vicon Nexus Reference Guide*).

- **Database hierarchy nodes** You view a visual representation of the structure and contents of a trial database, and select individual data types for loading in Nexus, in the nodes on the **Data Management** tab.
- **Data type icons** You can view and select individual motion capture files using the icons that represent the data saved for the trial.
- **Data fields** You can view or enter descriptive text or numerical data associated with a specific node in the trial database in the fields in the columns to the right of a node name.

For information on using Data Management in Vicon Nexus, see Data management with Nexus, page 5.

Quality tab

The data **Quality** pane, a tab in the **Communications** window, provides an overview of data quality for a subject across a whole trial and enables you to examine the health of individual trajectories. It also provides a way to navigate to the highlighted issues.

The display options in the **Options** column enable you to configure the display options for this tab. Alternatively, you can open the **Options** dialog box (F7), click **Data Quality Panel Options** on the left, and change the properties as required.

The **Trajectory Sort Value** list contains the following options:

- **Percentage Labeled** Orders blobs with the highest labeling percentage first (from top left).
- **Max Gap** Orders blobs with the trajectories containing the longest gaps first (see the **Max Gap Length** column of the **Gap Filling** section in the **Label/Edit Tools**).
- **Model Order** Displays blobs in the same order as the markers are listed under the **Markers** node in the **Subjects Resources** tree.
- **Number Of Gaps** Orders blobs with the trajectories with the highest number of gaps first (see the **#Gaps** column of the **Gap Filling** section in the **Label/Edit Tools**).
- **Trajectory Length** Orders blobs with the longest trajectories first.

You can also select other options in the **Options** column to tailor the display to your requirements.

To save any changes to these settings, click the **Save current configuration** button in the **Options** dialog box.

For information on using the **Quality** tab, see Assess trial health with the data Quality pane in the *Vicon Nexus User Guide*.

History tab

The **History** tab in the **Communications** pane enables you to review all processing that has been performed on a loaded trial file.

This ensures that, even if you have not worked with the data before, you can continue to work on the trial without missing or duplicating processing steps performed by another Nexus user.

To display information about a particular event, click on the event on the **History** tab. Details about the settings used to run the event are displayed in the **Property** and **Value** columns on the right.

In the **Notes** field, you can add notes that will be useful to you or anyone else working with the same trial. Your notes are saved with the trial.

> Note
> A processing history is available only for files processed in Nexus 2.3 and above.

Theia tab

The **Theia** tab enables you to process Nexus video data from within Theia3D, without having to launch Theia3D and manually process the data.

The **Theia Batch Interface** on the left enables you to select the required video files to process and to run Theia processing on all the files in the specified session folder. The files are processed through Theia3D, resulting in the output of C3D file(s) that contain rotation data for each subject. You can then run Nexus pipeline operations to merge the rotations into your Nexus subject and to calculate the joint angles, all without leaving Nexus.

Tip
Unlike the **Theia** pipeline operation, which loads each trial into Nexus, when you use the Theia Batch Interface, you can process your optical data at the same time in Nexus while Theia runs and processes the video data in the background.

The Theia tab contains the following areas:

- Theia Batch Interface, page 352
- Theia processing results area, page 353

For more information, see Run Theia processing on video files in the *Vicon Nexus User Guide*.

Theia Batch Interface

Component	Description
Folder field	Enter or browse to the full path of the video trials that you want to process in Theia. Note that when you exit and relaunch Nexus, the path is remembered.
Theia executable field	Enter or browse to the full path for the *Theia3D.exe* file, for example, *C:\Program Files\Theia\Theia3D*. Note that when you exit and relaunch Nexus, the path is remembered. If Theia closes, Nexus tries to relaunch Theia for a single retry for a trial. If the trial won't open, it moves on to the next trial. If you want to stop Theia launching, click **Cancel processing**.
Theia preferences field	If you want to use the preferences that you use in Theia, enter the full path to the required Theia prefererences file. This must be exported from Theia and saved as a PXT file on the local machine.
Create folder hierarchy check box	If you want a folder hierarchy to be created, using the trial video files, ensure that this check box is selected. Unless you have a specific reason to save your files elsewhere, leave this option selected.
Process trials in folder button	Click to process the files specified in the **Folder** field.

Theia processing results area

In this area on the right of the Theia tab, the results of processing the specified files are displayed. Details include the time and the current status of the processed files. When processing is finished, the right side of the Theia tab displays the text '**Batch Processing: Finished.**'

Python tab

The **Python** tab in the **Communications** pane enables you to set the path to your Python installation, and run Python scripts. For more information, see Modeling with Python, page 72.

Matlab tab

The **Matlab** tab in the **Communications** pane enables you to run MATLAB scripts from within Nexus and to launch MATLAB. For more information, see Modeling with MATLAB, page 61.

Monitors tab

The **Monitors** tab enables you to configure monitors that you create in the Graph view pane to detect motion capture events.

For information on creating and using monitors and detailed descriptions of the options, see Using monitors, page 37.

The **Monitors** tab contains the following areas:

Monitors configuration management area

You manage monitor configurations in the **Monitors** tab using the configuration management section at the top of the pane.

Monitors area

The **Monitors** area enables you to define the monitor behavior. It contains the following components:

Component	Description
Monitors list	Lists the currently defined monitors. Select the check box next to a monitor name to enable the monitor, or clear the check box to deactivate the monitor. Select a monitor in the list to view or configure its properties.
AND button	When multiple monitors are selected from the list, this button adds a Boolean AND monitor that triggers an action when all of the monitor trigger conditions are present.
OR button	When multiple monitors are selected from the list, this button adds a Boolean OR monitor that triggers an action when at least one of the monitor conditions is present.
Remove button	Removes the selected monitor from the list.
Clear button	Removes all monitors from the list.

Actions area

The **Actions** section of the **Monitors** tab enables you to view or modify monitor action settings. It contains the following components:

Component	Description
Actions list	Actions that you add will execute when the monitor threshold and trigger conditions are met.
Add button	Click to add the selected action to the Actions list. Select from: Capture, External trigger, Timebar Event, Progress Bar, Range Overlay, Sound Tone, Toggle Monitor and Play Sound File.
Remove button	Click to remove the selected action from the Actions list.
Clear button	Clears all actions from the Actions list.

IMeasureU tab

The **IMeasureU** tab enables you to work with data recorded from Vicon IMUs (Inertial Measurement Units).

After you have finished capturing data and have plugged the IMUs into the PC, you use the IMeasureU tab to work with and transfer the data from the IMUs to the Nexus Session folder.

For information on working with IMUs and Nexus, see Work with Vicon IMUs in the *Vicon Nexus User Guide* .

The IMeasure U tab contains the following areas:

- Transfer pane, page 355
- Alignment pane, page 357

Transfer pane

The **Transfer** pane of the **IMeasureU** tab lets you transfer data captured with Vicon IMUs to the current Session folder in Nexus. Its buttons and lists enable you to filter the displayed items so that you transfer only the items that are required. It contains these components:

Option	Description
Select All	Selects all of the items in the filtered sensor item list.
Select None	De-selects all of the items in the filtered sensor item list.
Transfer Status	Choose from one of: • **All** Selects all trials for each sensor that are listed with both **Transferred** and **Not Transferred** progress status • **Not Transferred** Selects all trials for each sensor that is listed with **Not Transferred** progress status • **Tranferred** Selects all trials for each sensor that is listed with **Transferred** progress status

Option	Description
Connection Status	Choose from one of: • **All** Selects items from all IMU sensors regardless of connection status • **Connected** Selects items from only IMU sensors that are connected to Nexus • **Not Connected** Selects items from only IMU sensors that are not connected to Nexus
Session	Choose from one of: • **All** Selects items from all sessions • **Selected** Selects items from selected sessions only To clear currently selected sessions, choose **Clear Selected**.
Erase Selected Devices	Erases all data from the selected devices. Successfully cleared trials are removed from the list.
Sync trials with sensor	Removes from the transfer list data that cannot be found on the selected IMU sensor(s). (Advanced option)
Rebuild Transfer List	Adds trials to the transfer list from selected IMU sensor(s), if possible. (Advanced option)
Transfer Files button	Transfers selected trials from connected IMUs to the current Session folder in Nexus.
Cancel Transfer button	Cancels the current transfer operation.

Note that:

- If you have filtered an item from the list, it is automatically de-selected. This is to prevent accidental transfer of items that are not displayed in the list.
- **Select All** and **Select None** operate on all items that are visible in the list: an item must be visible in the list for its selection status to be updated.
- The top level sensor item is never filtered out of the list.

- The filering is dynamic and the list refreshes when:
  - Sensors are connected or disconnected
  - Trials are captured
  - Sensors are erased

Alignment pane

For information on using the controls in the Alignment pane, see Align IMU data with the Vicon world in the *Vicon Nexus User Guide*.

Status tab

Enables you to monitor the state of your Vicon system during any stage of the Nexus motion capture workflow. This is useful for identifying problems and determining the Nexus system component that needs to be examined.

The **Status** tab contains the following sections:

- Status Summary
  View a visual summary of the status of system components in the **Status Summary** section of the Status communications pane:
  - Vicon Cameras
    View the status of Vicon cameras.
  - Video Cameras
    View the status of digital video cameras.
  - Connectivity
    View the status of Vicon connectivity units.
  - Capture
    View the status of capture sessions in Nexus.

  Tip: The background in each summary corresponds to the icon displayed for the devices in the **System Resources** pane. The color of a summary border reflects the status for the set of components:
- Green: All components OK
- Yellow: One or more components are on standby
- Red: One or more components are down
- Status Details
  View details of the status of a system component in the Status Details section of the Status tab. The contents of this section depend on the component you click on in the Status Summary section.

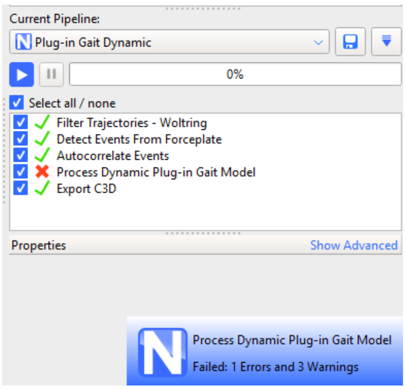
Log tab

Enables you to monitor Nexus system activity and troubleshoot any errors. For example, if a pipeline operation fails (indicated by a red X next to the operation in the **Pipeline Tools** pane), you can find information as to why the failure occurred on the **Log** tab.

The icon on the **Log** tab 

automatically appears to scroll to indicate that a warning is displayed (for example, a new log entry indicating that an operation has failed).

You are alerted to important errors by popup notifications that are briefly displayed at the bottom right of the Nexus window.



If you are using the default sounds supplied with Nexus and have audio enabled, a relevant sound clip is also played.

To view further details about the error in the Log, click the notification.

The notification disappears after four seconds.

Menu bar

The Nexus menu bar contains the following controls:

- File menu, page 360
- Edit menu, page 361
- Window menu, page 362
- Help menu, page 378

File menu

The **File** menu contains the following options:

- **Save** (shortcut CTRL+S) Saves the current data for subjects enabled in the **Subjects Resources** pane to the .c3d file for the current trial.
- **Copy As** Displays the **Choose a c3d file** dialog box in which you can enter or select the name of the file to copy to. Makes a copy of the current trial .c3d, .vsk, and .mp files. Using this feature, you can archive copies of a .c3d file to document its processing progression.

  Tip: You are prompted to save the copy in the same location in the **Data Management** hierarchy as the original file, and after saving it will be available in the **Data Management** pane.
- **Import XCP** Displays the **Choose an XCP file** dialog box in which you can select the desired Vicon camera calibration parameters (.xcp) file to load in Nexus. Use this command to import .xcp files created in Vicon Nexus.
- **Export XCP** Displays the **Choose an XCP file** dialog box in which you can specify a calibration parameters (.xcp) file into which to export the current Vicon camera settings. Use this command to export .xcp files created in Vicon Nexus.
- **Exit** Closes the Vicon Nexus application window. If you have not saved any changes made to trial data, Nexus displays a prompt to enable you to save changes to trial data, subjects, or both, before it closes.

Edit menu

The **Edit** menu contains the following options, which take effect only when the system is in Pause or Offline mode:

- **Undo** (shortcut CTRL+Z) Undoes the last action. This command is available only after a relevant action has been performed. The name of the Undo command changes to reflect the latest action, for example, **Undo Import XCP**. You also can hover the mouse pointer over the Undo button to display a tooltip that identifies the action to be undone. Some actions, such as reconstructing data, cannot be undone.
- **Redo** (shortcut CTRL+Y) Reinstates the previously undone action. This command is available only after an **Undo** command has been performed. The name of the **Redo** command changes to reflect the latest action, for example, Redo Import XCP. Hover the mouse pointer over the **Redo** button to display a tooltip that identifies the action to be redone. Any action that was undone can be redone.

Window menu

The **Window** menu contains the following options:

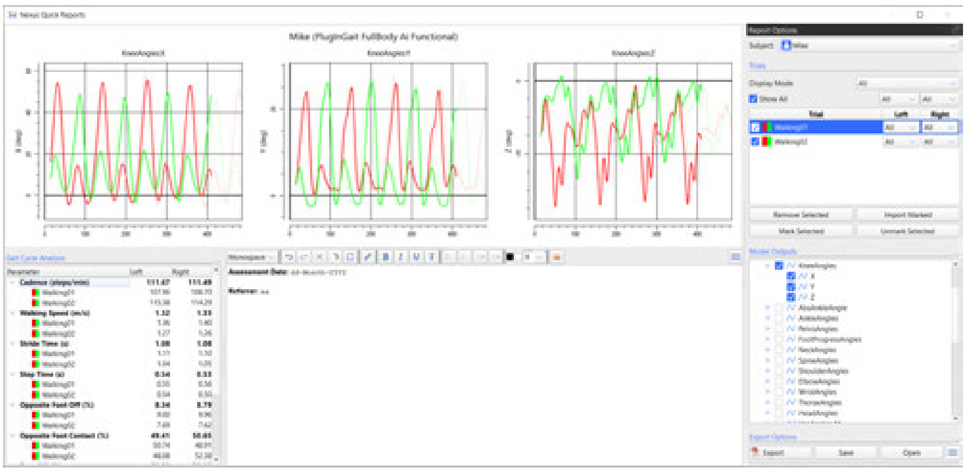
- **Simple Capture Mode** (shortcut CTRL+H). Displays a window containing only the minimum of controls necessary for capture, facilitating the capture of multiple trials. See Use Simple Capture Mode in the *Vicon Nexus User Guide*.
- **New floating workspace**. Opens a separate floating view pane. See View pane, page 282.
- **Reset to default layout** Resets the Nexus panes to their layout when Nexus was installed.
- **Toolbar** Opens the **Customize Toolbar** dialog box, in which you can add, remove, and customize buttons on the Nexus toolbar. See Customize Toolbar dialog box, page 381.
- **Quick Reports** (shortcut F4) Opens a Quick Reports window, in which you can display multiple graphs of model outputs. See Quick Reports, page 363.
- **Sounds** (shortcut F6) Opens the **Sounds** dialog box, in which you can view or change the sounds that are used to alert you to Nexus events. You can also turn off the sounds individually or turn off all sounds. See Sounds dialog box, page 371.
- **Options** (shortcut F7) Opens the Options dialog box, in which you control how data is displayed. See Options dialog box, page 373.
- **Plug-ins** Displays the **Plugins** dialog box in which you can view and manage plug-in modules that are loaded in Vicon Nexus. If you clear the checkboxes for Theia, MATLAB, Python, etc, their plug-ins are not loaded and their tabs are not displayed in the **Communications** pane.
- **Manage Control Authorizations** Opens the **Vicon Control** dialog box, where you can authorize or revoke authorizations for instances of Vicon Control that are connected to the Vicon system. See Vicon Control dialog box, page 375.
- **Footstrike Monitor Settings** Lets you set options for foot strike monitoring. See Automatically assess foot strikes in the *Vicon Nexus User Guide*.
- **Close Communications Pane on Trial Load** Enables you to show or hide the **Communications** pane when you load a trial. If selected, the **Communications** pane is minimized at the bottom of the Nexus window the next time you load a trial. The **Communications** pane stays hidden until you double-click one of the tabs at the bottom of the **Communications** pane. Your choice for this

option is retained when you exit and restart Nexus. It can be set as required by each Nexus user.

- **Error Message Settings** Opens the **Error Settings** dialog box, where you can adjust the length of time that popup notifications are displayed and the maximum number of notifications that are displayed. See Error Settings dialog box, page 376.

Quick reports

The **Nexus Quick Reports** window enables you to display multiple graphs of model outputs normalized over the gait cycle (like a simplified Vicon Polygon graph view).



To display model outputs in Nexus Quick Reports:

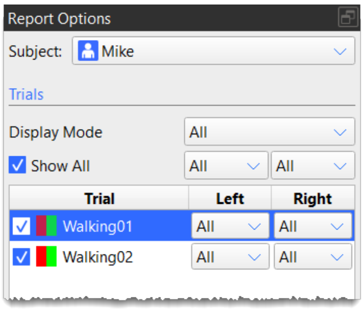
1. On the **Window** menu, click **Quick Reports**, or press F4 to open the **Nexus Quick Reports** window.
2. In the main Nexus window, ensure that the trial (*.C3D file) that you want add to Quick Reports is the current trial.
3. From the **Pipeline Tools** pane, expand **Data Processing** and double-click **Add Trial to Quick Report** to add it to the current pipeline.
4. In the **Current Pipeline** list, right-click the **Add Trial to Quick Report** operation and click **Run select Op**.

5. For each trial that you want to add, repeat step 2–4.

   Tip: To add trials to Quick Reports, you can also:

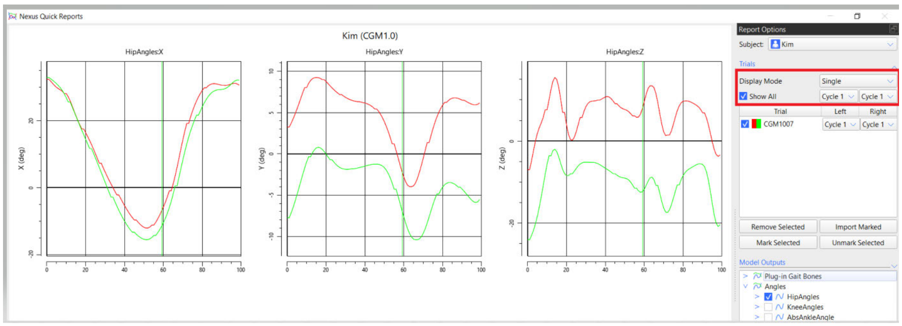
   - Drag and drop one or more trials (*.C3D files) from Windows Explorer into the **Quick Reports** window; or
   - Click the **Add To Quick Report** button on the Nexus toolbar (adds the current trial); or
   - On the **Data Management** tab, mark the required files and in the Quick Reports window, click **Import Marked**.

6. In the Nexus **Quick Reports** window, the added trials are displayed in the **Trials** list, by default on the right of the window.

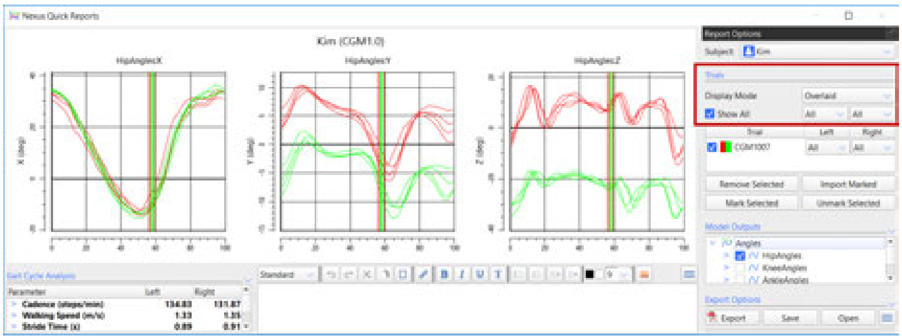


7. From the **Display Mode** list, select the required option.

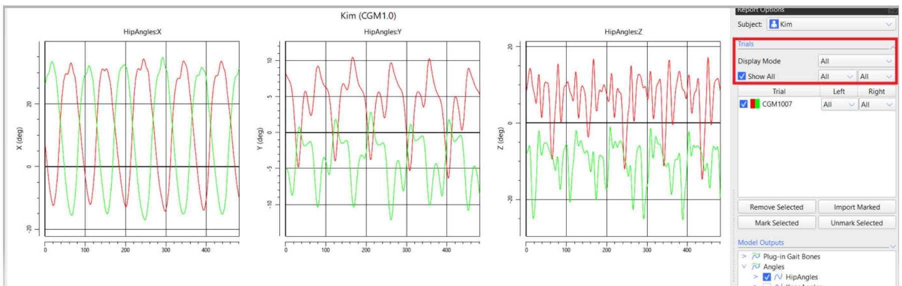
- Single Displays either one context (Left or Right) or both (Left and Right) for a specific cycle, for example: Left = Cycle 1, right = Cycle 1. This option displays data as a normalized gait cycle 0-100.



- Overlaid Displays either one context (Left or Right) or both (Left and Right) for all cycles. This option displays data as a normalized gait cycle 0-100.

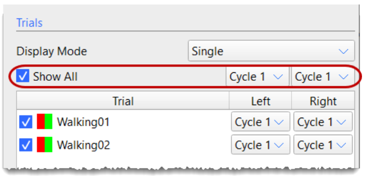


- All Displays either one context (Left or Right) or both (Left and Right) for all cycles. This option displays data as frames and is not normalized, in a similar way to the previous All cycles feature in Quick Reports.

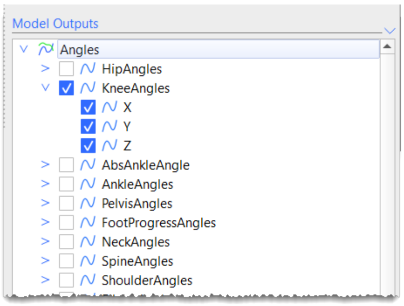


8. Ensure the required cycle is selected in the **Left** and **Right** columns.

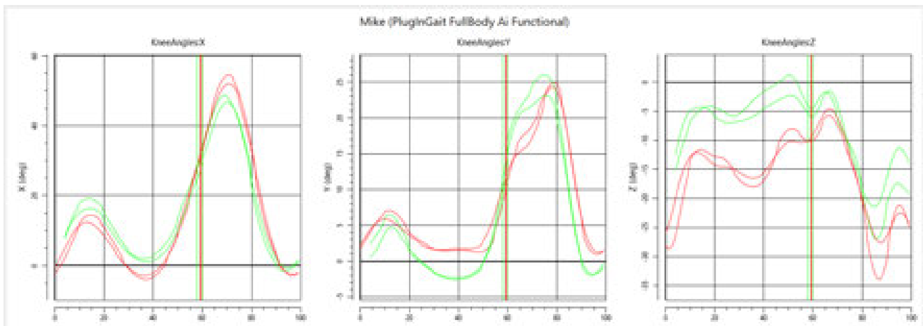
   Tip: To change the options for all the trials, in the **Trials** section, click the appropriate option at the top of the columns.



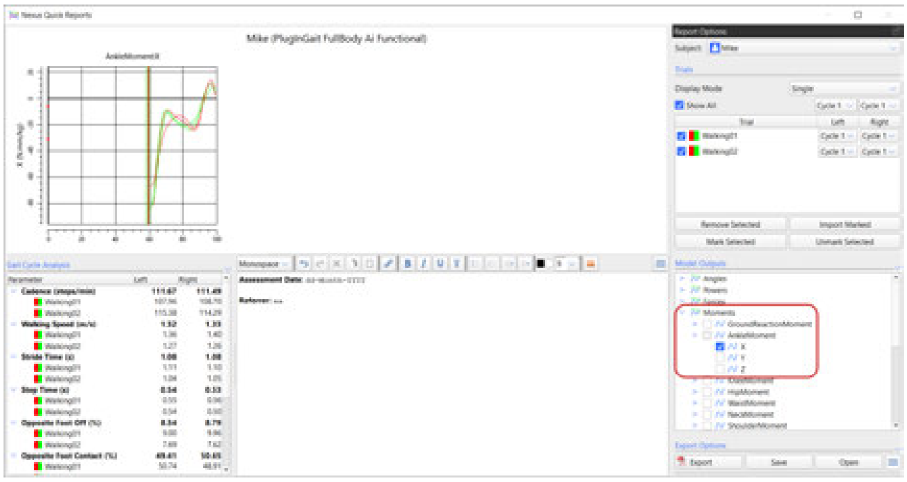
9. To display model outputs in the graphs, in the **Model Outputs** list, expand the relevant node and then select the required check box(es).



   The selected outputs are displayed as graphs in the **Nexus Quick Reports** window.

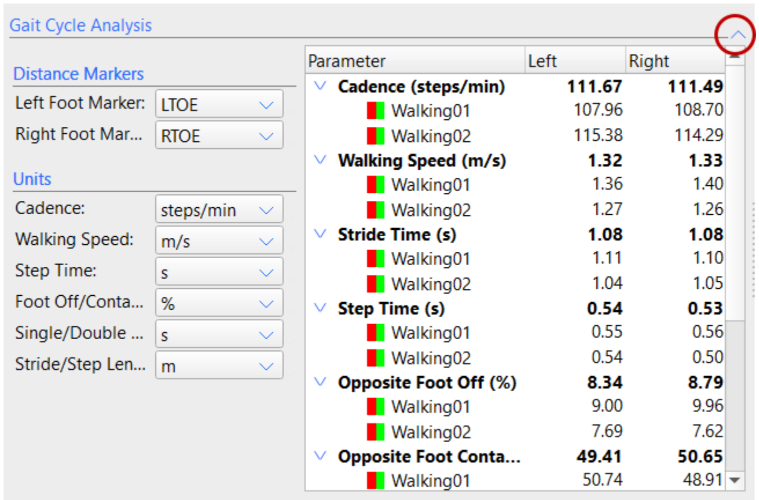


To display only the required components, in the **Model Outputs** tree, clear the check boxes for the unwanted components.
For example, if you are interested in AnkleMoment X only, you can select this only.



Tip: By default a red line represents data from the left side and a green line represents data from the right. The trial currently selected in the **Report Options** list is represented by a heavier line on the graphs. To change green and red to solid and dashed lines, in the **Options** dialog box (press F7), on the left, click **Quick Reports** and then clear **Use Context Colors**. To change the colors displayed for each trace on the graph, click the color(s) that you want to change.

10. Expand the **Gait Cycle Analysis** section at the bottom left of the window and ensure the **Distance Markers** and **Units** are as required.



Tip: If the nodes are not expanded, the **Parameter** column displays average values (in bold) across all selected trials. To view the average value for each trial, ensure the relevant parameter nodes are expanded.

11. To export a PDF of the data in the **Nexus Quick Reports** window:
    a. Expand the **Export Options** section and clear or select as required.
    b. From the **Title Alignment** list, select the required option.
    c. Click **Export** and in the **Export to PDF** dialog box, enter or browse to the required location.
    d. Click **Save**.

12. To save your work, click the **Save** button at the bottom of the **Report Options** pane and select the appropriate option:
    - *. *qrd* (Quick Reports Document): Saves the current Quick Report. Select this option if you have to suspend work on the report and want to carry on where you left off later.
    - *. *qrt* (Quick Reports Template): Saves the layout of the **Nexus Quick Reports** window (ie the options currently selected in the Quick Reports window). Select this option if you want to produce reports of the same type of information for later trials. Quick Reports templates that are saved to the default location:
      C:\Users\Public\Documents\Vicon\Nexus2.x\Configurations\QuickReports
      are listed when you click the **Apply Report Template** button.

About the Nexus Quick Reports window

The **Nexus Quick Reports** window comprises two sections:

- Controls are contained in a dockable **Report Options** pane, which by default is displayed to the right of the window. Expand the **Trials**, **Model Outputs** and **Export Options** sections by clicking the downward arrow to the right of each section divider. To move the controls pane, drag the **Report Options** title. The pane can be floated or docked to the left or right.
- Graphs of the data selected in the **Report Options** pane are shown in the main workspace. The current subject's name and model template are shown as a title at the top.

To the bottom left of the main workspace, **Gait Cycle Analysis** parameters for the loaded trials are displayed.

In the large text box on the right, you can enter a description or notes, etc, which can be formatted using the buttons on the toolbar above the text box.

To close the **Nexus Quick Reports** window, press F4.

Report Options controls

In the **Report Options** pane, the following controls are available:

Control	Description
Subject field	Enables you to select the subject whose data you want to view.
Trials list	Lists the trials that you have added to the report. In this list, you can select or clear the relevant check boxes to display the required trial(s). To show/hide all trials, expand the **Trials** section and select or clear the check box at the top. The outputs for selected trials are displayed in each graph. The **Cycle** dropdown lists at the top and in the **Left** and **Right** columns of the **Trials** list enable you to select which gait cycles to show for the left and right contexts for each trial. To select trials, click (or Shift+click/Ctrl+click) in the **Trial** column of the required row(s) in the list. The selected row(s) in the list are highlighted with a blue background and by thicker lines in the graph. To remove selected trials from the report or to mark selected trials in **Data Management** (eg, for use in Vicon Polygon), click **Remove Selected** or **Mark Selected** at the bottom of the list.
Model Outputs list	Displays available model outputs from the trials that have been added to the report.
Export button	Opens the **Export to PDF** dialog box, which enables you to save the contents of the current **Nexus Quick Reports** window to a *.PDF file, with a name and location that you specify.
Save button	Enables you to save the current Quick Report either as a document (**.qrd*) or a template (**.qrt*).
Open button	Enables you to enter or browse to aQuick Report document (**.qrd*) or a template (**.qrt*).
Apply Report Template button	Enables you to apply a report template that was saved to the default location (*C:\Users\Public\Documents\Vicon\Nexus2.x\Configurations\QuickReports*).

Sounds dialog box

Nexus can play sounds through your PC's speakers to alert you when a Nexus event has taken place (for example, operation completion, system status, and issues). This keeps you informed of system status while you're still in the volume, so that you don't have to spend time returning to the PC to look at the screen.

You can access this dialog box from the **Window** menu or by pressing F6.

By default, Nexus uses speech sounds to alert you to the following events:

- Calibration start
- Wand Wave complete
- Calibration complete
- Calibration failed
- Origin set
- Capture started
- Capture ended
- Capture failed
- Camera bumped
- Pipeline ended
- Pipeline failed

Nexus is supplied with a set of default sound files (.wavs). You can modify the sounds that are used for each event and you can turn off sounds individually or turn off all sounds.

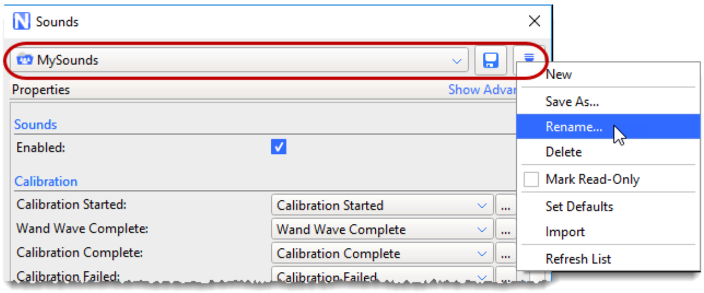
To turn off all sounds, in the **Sounds** section, clear the **Enabled** check box.

To turn off one or more sounds, click the relevant drop-down arrow and select (None) from the list.

To choose one of the other sounds supplied with Nexus, click the drop-down arrow and select the required sound from the list.

To substitute your own sounds for those supplied with Nexus, click the relevant ellipsis (...) and enter or browse to the location of the required .wav files.

Use the configuration management area at the top of the **Sounds** dialog box to name, to save, delete and if necessary protect the sounds that you have allocated to Nexus events. After you have saved sounds configuration files, you can select them from the menu at the top of the dialog box and can use the **Configuration menu** to manage them.

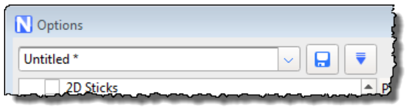


The sounds configuration file (*.*AudioScheme*) is saved into an *AudioSchemes* folder, in the same location as other Nexus configuration files (see Manage configurations in Vicon Nexus in the *Vicon Nexus User Guide*).

Options dialog box

The **Options** dialog box enables you to control the way data is visualized in the view panes . You can access this dialog box from the **Window** menu or by pressing F7.

The **Options** dialog box includes a configuration area:



This enables you to save any changes you make in the **Options** dialog box to a configuration file, with the extension **.Options**. You can then re-use your saved configuration file as required, for example, you could save a different set of options for each type of motion capture application that you use.

In addition to creating customized **Options** configurations, the **Configuration** menu button enables you to rename, import, reload and delete configurations, and refresh the list.

To configure settings in the Options dialog box:

1. Open the Options dialog box in either of these ways:
   - Click the Window menu and then click Options; or
   - Press F7.
2. In the list of options on the left side of the dialog box, click an option whose properties you wish to view or change. You can now:
   - Select the check box to switch on the functionality or clear the check box to switch off the functionality for the option.
   - In the Properties section on the right side of the dialog box, view or change settings as desired for any available properties. (To see additional settings that may be available for an option, click Show Advanced.)
3. Repeat step 2 for each property whose settings you wish to configure.
4. To save your settings, do one of the following:
   - To save your settings as the current configuration and close the Options dialog box, click Close; or
   - To give your configuration a name, so that you can easily find it for re-use later, click the Configuration menu button, then click Save As, enter a name in the dialog box, click OK, and then choose whether to save your configuration as Shared or Private.

Vicon Control dialog box

To open the Vicon Control dialog box, on the Window menu, select Manage Control Authorizations.

The Vicon Control dialog box enables you to carry out the following operations:

- To grant unprompted access in future, ensure the relevant device's check box is selected in the Known Devices list.
  In future, the device will be able to connect without having to be re-authorized.

- To permanently revoke access, clear the device's check box in the Known Devices list.
  The device is disconnected and in future, it will not be able to connect. This is useful if you accidentally authorized a device, or if you need to remove an authorized device from the system, for example, if it is lost or sold.

- To remove a connected device from the Known Devices list and force re-authorization on the next attempt to connect, select the device and then click Forget Device.
  To reconnect, the device will have to send an authorization request and be re-authorized.

- To remove all connected devices from the Known Devices list and force re-authorization on the next attempt to connect by any of the listed devices, click Forget All.

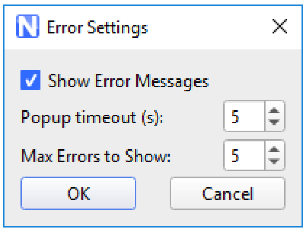
Error Settings dialog box

The **Error Settings** dialog box enables you to adjust the length of time that popup notifications are displayed and their maximum number.

To control popup notifications:

1. On the **Window** menu, select **Error Message Settings**.
2. In the **Error Settings** dialog box:
   a. Change **Popup timeout** to the length of time (in seconds) that you want the messages to be displayed, up to a maximum time of 10 seconds. Note that if you set **Popup timeout** to 0, the error message remains unless you either click on the message or the **Max Errors to Show** is reached, when this error message is automatically removed.

   b. Change **Max Errors to Show** to the number of error messages that you want to be displayed at any one time, up to a maximum of 10 messages.



The default popup timeout is 5 seconds and the default number of messages is 5.

If more errors occur within the **Popup timeout** period, the oldest error is removed from the top of the stack and newest is displayed at the bottom of the stack.

To open the Log, click on any of the error messages.

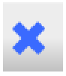
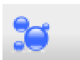
Help menu

The **Help** menu contains the following commands:

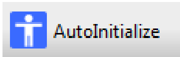
- **View latest help from vicon.com** Displays the most recent version of the live online help.
- **View installed help** Displays the help file (PDF) that was installed with Vicon Nexus.
- **Check for updates** Detects whether any Nexus updates are available.
- **Check for firmware updates** The **Checking Firmware Version** dialog box displays information about the latest released firmware version. See also Update firmware in the *Vicon Nexus User Guide*.
- **About Vicon Nexus** Displays the Vicon Nexus startup screen, in which you can view version and license server information about the installed release of Nexus.
- **Hotkeys** Displays a list of Nexus shortcuts and hot keys.
- **Vicon Product Licensing** Displays the Vicon Product Licensing tool, which enables you to manage your Vicon product licensing.

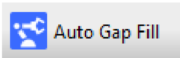
Toolbar

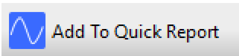
The Nexus toolbar contains the following controls . For information on how to change the standard toolbar, see Customize Toolbar dialog box, page 381:

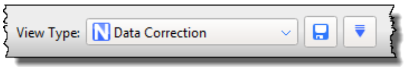
- Save  Saves the current data for subjects enabled in the **Subjects Resources** pane to the .c3d file for the current trial.
- Close  Closes the current trial and clears data. You are prompted to save any unsaved changed before closing the current trial.
- Undo  Undoes the last action. This command is available only after a relevant action has been performed. Hover the mouse pointer over the Undo button to display a tooltip identifying the action to be undone. Some actions, such as reconstructing data, cannot be undone.
- Redo  Reinstates the previously undone action. This command is available only after an Undo command has been performed. Hover the mouse pointer over the Redo button to display a tooltip identifying the action to be redone. Any action that was undone can be redone.
- Reconstruct  Runs the **Reconstruct** pipeline defined in the **Pipeline Tools** pane. For information on Reconstruct settings, see the equivalent **Local Vicon System** settings (Reconstruction section, page 204), which control the same functionality for realtime.
- Reconstruct and Label  Runs the **Reconstruct and Label** pipeline defined in the **Pipeline Tools** pane. For information on Reconstruct settings, see the equivalent **Local Vicon System** settings (Reconstruction section, page 204). For information on Label settings, see the equivalent **Local Vicon System** settings (Labeling section, page 207), which control the same functionality for realtime.
- KinFit 

Runs the **Kinematic Fit** pipeline defined in the **Pipeline Tools** pane.

- AutoInitialize 

Runs the **Auto Initialize Labeling** pipeline, which consists of the **Autolabel Static**, **Scale Subject VSK**, and **Static Skeleton Calibration - Markers-only** pipeline operations.. For more information, see Subject calibration operations, page 328.
- Auto Gap Fill 

Runs the **Auto Intelligent Gap Fill** pipeline, which consists of Nexus gap-filling operations (see Fill Gap & Filter Data operations, page 332). This enables you to quickly fill all gaps in your trial, without having to choose which fill method is best for each gap.
- Add To Quick Report 

Adds the current trial to a Quick Report. For more information, see Quick Reports, page 363.
- View Type list 

Create or manage the layouts specified in the View pane using the View Type list at the top of the pane.
The view type includes the layout of view panes as well as any cameras, hardware devices, and subject elements that were selected in the **System Resources** pane or the **Subjects Resources** pane when the view type was saved.
For example, if you save a view type with all cameras selected and a **Camera** view specified for each, the next time you select that view type, all of the cameras are automatically selected and displayed in separate **Camera** views.
If you save a view type with a **Graph** view showing the EMG channels, when you next select this view type, the correct EMG device is selected.
If you save a view type with a **Graph** view showing the distance between two specific markers, when you next select this view type, these two markers are selected.

Customize Toolbar dialog box

You can add, remove, and customize buttons on the Nexus toolbar using the **Customize Toolbar** dialog box.

To access this dialog box:

- On the **Window** menu, click **Toolbar**.

The toolbar settings are saved in the appropriate configuration file: the default Nexus toolbar is stored in the **Shared** configuration folder; if customized, the toolbar is saved in a **Private** configuration folder and loaded the next time you start Vicon Nexus.

The Save, Undo, and Redo buttons always appear on the Nexus toolbar in their default positions on the left of the toolbar; you cannot customize these buttons.

You can add new buttons to run a specified pipeline, load a previously created **View Option** configuration, or display a **View Type** configuration. For each button, you can define a tooltip, associate an icon, and associate a text string. You can group related buttons together on the toolbar with separators or reposition buttons along the toolbar.

You can customize your toolbar in these ways:

- Add or change toolbar buttons, page 382
- Change a button's position on the toolbar, page 383
- Group related buttons with separators, page 384
- Remove a button or separator from the toolbar, page 384

Add or change toolbar buttons

To add or change a toolbar button in the Customize Toolbar dialog box:

1. Click **Add Button**. A new button entry is added to the bottom of the Toolbar Buttons list and is highlighted and selected. Alternatively, select an existing toolbar button.
2. In the **Button Properties** area, configure the following information for the selected button:
   - **Caption**: The label to be displayed on the button.
   - **Icon**: The icon to be displayed for the button. Select an available icon from the drop-down list.
   - **Tooltip**: The text to be displayed to indicate the operation to be executed when the button is pressed.
3. Select the check box for one of the following actions to be taken when the button is pressed:
   - **Load View Options**: Apply the specified view options settings. Select a previously created View Option configuration from the drop-down list. If you have not created any configurations, this check box is not selectable and this list is empty.
   - **Load View Type**: Apply the specified view type. Select a previously created **View Type** configuration from the drop-down list. If you have not created any configurations, this check box is not selectable and this list is empty.
   - **Run Pipeline**: Run the specified pipeline. Select a pipeline file supplied with Nexus or a previously created custom pipeline from the drop-down list.
4. Click **Apply** to preview the button on the Nexus toolbar. If you are not happy with the result, change the button details in the **Customize Toolbar** dialog box and preview the changes again.
5. Repeat steps 1-4 for each button you want to add to the Nexus toolbar.
6. Click OK to save the customized toolbar and close the dialog box.

Change a button's position on the toolbar

To change the position of a toolbar button in the Customize Toolbar dialog box:

1. In the Toolbar Buttons list, select the entry for the button whose position you want to change.
   Button entries in this list from top to bottom correspond to the button positions on the toolbar from left to right.
2. Change the button's position on the toolbar using the buttons:
   - **Move Up**: Move the selected button up one position in the list, that is, left one position on the toolbar.
   - **Move Down**: Move the selected button down one position in the list, that is, right one position on the toolbar.
3. Click **Apply** to preview the changed button location on the Nexus toolbar. If you are not happy with the result, change the position again in the **Customize Toolbar** dialog box and preview the position again.
4. Click OK to save the customized toolbar and close the dialog box.

> **Important**
> Nexus executes any customized buttons in the following order:
> 1) View Option
> 2) View Type
> 3) Pipeline
> Vicon recommends that you lay out your custom toolbar buttons in this order to avoid the potential for losing unsaved changes if you press multiple buttons before saving a configuration.

Group related buttons with separators

To group related buttons together on the toolbar in the Customize Toolbar dialog box:

1. Click **Add Separator**. A new separator entry is added to the bottom of the **Toolbar Buttons** list and is highlighted and selected.
2. Change the separator's position on the toolbar using the buttons:
   - **Move Up**: Move the selected separator up one position in the list, that is, left one position on the toolbar.
   - **Move Down**: Move the selected separator down one position in the list, that is, right one position on the toolbar.
3. Repeat steps 1–2 for each separator you want to add between buttons on the Nexus toolbar.
4. Click OK to save the customized toolbar and close the dialog box.

Remove a button or separator from the toolbar

To remove a toolbar button or separator in the Customize Toolbar dialog box:

1. In the **Toolbar Buttons** list, select the entry for the button or separator you want to remove from the toolbar.
2. Click **Remove**.
3. In the displayed confirmation dialog box, click **Remove Item**. The entry is removed from the list and button or separator is removed from the toolbar.
4. Click OK to save the customized toolbar and close the dialog box.

If you want to discard any changes you have made in the **Customize Toolbar** dialog box, click **Cancel**.
Nexus displays a warning message for you to confirm that you want to lose any changes you have made.

If you want to reload the default Nexus toolbar, click **Reset**.
Nexus displays a warning message asking you to confirm that you want to discard any customizations you have previously saved.