What's New in Vicon Nexus 2.4

Contents

What's New in Vicon Nexus 2.4, June 2016
For use with Vicon Nexus 2.4

Vicon Motion Systems is an OMG plc company.
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About upgrading to Vicon Nexus 2.4

Vicon Nexus 2.4 is a point release that provides features and enhancements in addition to those that were included since Nexus 2.0. For a description of the features and enhancements that are specific to Nexus 2.4, see New features and updates in Vicon Nexus 2.4 on page 11.

For information about requirements and systems supported for this version of Nexus, and what is included in this guide, see:

- Requirements for Nexus 2.4
- Systems supported in Vicon Nexus 2
- About upgrading Vicon Nexus
- About this guide

Note

The Vicon motion capture system and the Nexus software, manufactured by Vicon Motion Systems Limited, have been tested prior to shipment and meet the metrological requirements as detailed in the Medical devices directive on page 255.

Requirements for Nexus 2.4

Vicon Nexus 2.4 is compatible with and fully supported under the Microsoft Windows 7 operating system. Installation, software operation and required third-party drivers have been tested under this operating system. Vicon recommends the Windows 7, 64-bit operating system for use with Nexus 2.4. Nexus 2.4 has also undergone limited testing under the Windows 10 operating system. Although Vicon Nexus may install and function under other Microsoft Windows operating systems, this is not officially supported or recommended by Vicon.

Basler video cameras and Nexus 2.4

If Basler digital cameras will be connected to Nexus 2.4, ensure you have updated the Basler Pylon drivers to version 2.3.5 (available from the Vicon website).

If you are using an Intel i340, i350 or i210 network card, when you install the drivers, select the option for **Filter drivers**, not **Performance drivers**.

MATLAB and Nexus 2.4

If you are planning to use MATLAB with Nexus 2.4, ensure that, in addition to installing MATLAB, you install the .NET Framework version 4.5.

Systems supported in Vicon Nexus 2

Before you install Nexus 2.4, note the following limitations on supported systems:

- Nexus captures data only from Vicon systems (including Vicon Vero, Vicon Vue, Vicon Vantage, T-Series, F-Series, MX+, MX, Bonita cameras, and units).
- Nexus 2.4 does not support connection to the Reference Video System (Nexus Slave application).

About upgrading Vicon Nexus

This section describes functionality that is dependent upon the version of Nexus that is being upgraded:

- Upgrading from Nexus 1.x
- Upgrading from earlier versions of Nexus 2

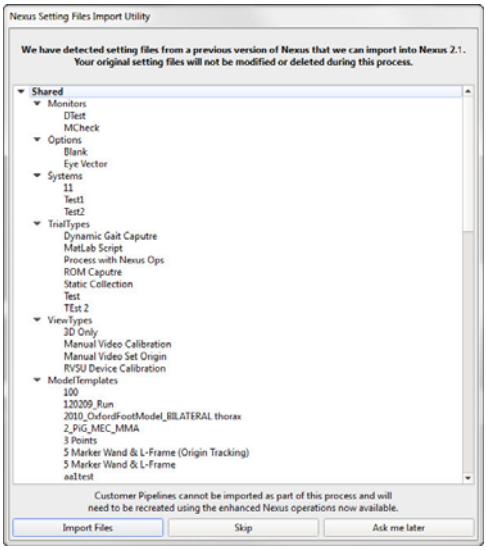
Upgrading from Nexus 1.x

Note

This section applies only to versions of Nexus that are earlier than 2.0.

Nexus 2.4 installs into its own folder, called **Nexus**2.4. If you already have Nexus 1.x installed, it will remain installed alongside the new Nexus installation.

On installation, Nexus 2.4 automatically scans for Nexus 1.x files, displays a list of any older files that it finds, and provides an automated system for importing these into Nexus 2.4.



This process copies all the old files and converts the copies, ensuring that original files are not moved, altered, or destroyed.

Important

Custom pipelines are not copied from earlier versions of Nexus, so if you want to use your old pipelines, copy them from the following Vicon product installation folder (by default

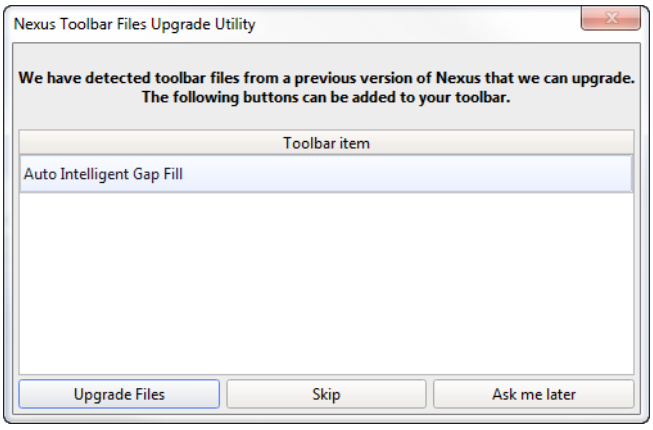
in C:\Program Files (x86)\Vicon or C:\Program Files\Vicon):
\Nexus\WorkstationPlugins
and paste them to the following location in the Vicon production installation folder (by default in C:\Program Files (x86)\Vicon or C:\Program Files\Vicon):
\Nexus2.x\LegacyPlugins.
They will then be available in the **Legacy** pipeline operations in Nexus 2.4.

For more information on the installation and licensing process, see Installing and licensing Vicon Nexus on page 86.

Upgrading from earlier versions of Nexus 2

If you are upgrading from a previous version of Nexus 2, during installation you are given the option of adding the **Auto Intelligent Gap Fill** button to your Nexus toolbar. For more information on this feature, see Automated gap-filling on page 37.

When you install Nexus 2.4, a dialog box similar to the following is displayed.



To add the **Auto Intelligent Gap Fill** button to your toolbar, click **Upgrade Files**.

About this guide

In the following sections, this guide describes the main new features of Nexus 2.

- Overview of new features (includes summary of the latest new features added in Nexus 2.4, Nexus 2.3, Nexus 2.2, Nexus 2.1, and Nexus 2.0).
- Installing and licensing Vicon Nexus
- Vicon Nexus 2 user interface
- Automated data quality
- New workflow for improved labeling
- Biomechanics workflow
- Modeling with Nexus 2: Plug-in Gait, MATLAB, Python

For a list of current known issues, together with available workarounds, and issues addressed in this release, see Known and addressed issues on page 233.

Note

In the documentation, the expression 'Vicon systems' refers generically to MX, MX+, T-Series, Bonita, and Vicon Vantage systems. The expression 'Vicon cameras' refers generically to MX, MX+, T-Series, Bonita, Vicon Vantage and Vicon Vero cameras. When referring to functionality specific to MX, MX+, T-Series, Bonita, Vicon Vantage or Vicon Vero systems and/or cameras, unique system and camera terminology is used.

Overview of new features

This chapter introduces Vicon Nexus 2 and provides a summary of its new features. Changes made for the latest point release are summarized at the beginning of this chapter.

New features and updates in Vicon Nexus 2.4

Nexus 2.4 introduced the following new features and updates.

- Compatibility with Motek Forcelink force plates
- Compatibility with Vicon Vero cameras
- Compatibility with Vicon Vue cameras

See also the following additional guidance that is provided with Nexus 2.4:

- Lists of current hot keys and shortcuts: see Hot keys and shortcuts on page 122.
- Updated guidance on setting up mixed Vicon camera systems on page 27.

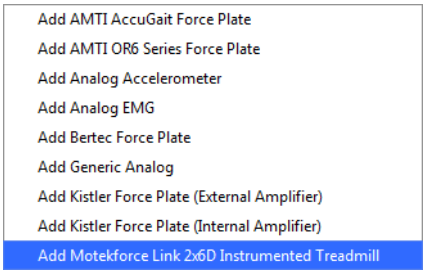
Compatibility with Motek Forcelink force plates

- Location: **System Resources** tree > **Devices** node > **Add Analog Device** and **Properties** pane

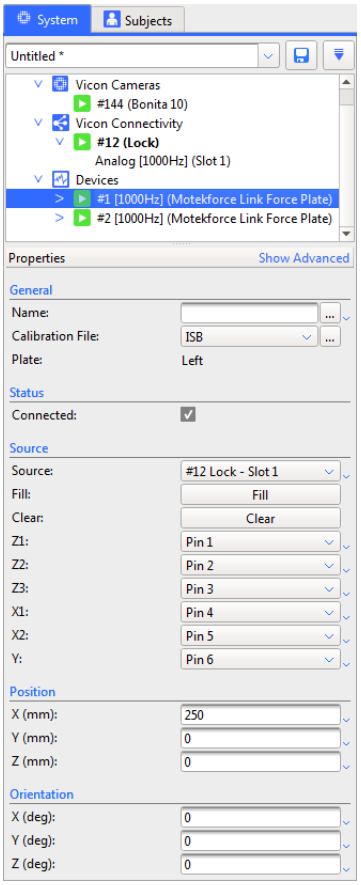
You can now add a Motekforce Link treadmill to your Vicon system in the same way as you add other analog devices.

To add a Motekforce Link treadmill:

1. Ensure Nexus is in **Live** mode.
2. In the **System Resources** tree, right-click **Devices**.
3. Point to **Add Analog Device** and from the list, select the **Motekforce Link** option.



In the System tree, below the **Devices** node, two new device nodes are displayed, one for each plate.

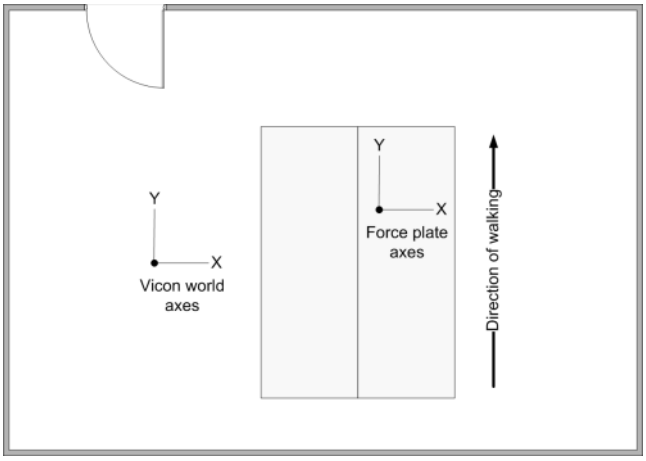


4. To change the settings of your device, select both new nodes (Shift+click) and in the **Properties** pane, make the required adjustments.
5. Note that a single calibration file is used for both plates. To select the calibration file, in the System tree, select the nodes for both plates and in the **General** section of the **Properties** pane, click the ellipsis (...) next to the **Calibration File** field to browse to the relevant location. You can then select the required file from the **Calibration File** list.

Usage recommendations for Motekforce Link treadmill

Note the following recommendations for setting up and using your Motekforce Link treadmill with Nexus:

- For ease of use, align the Vicon world Y-axis with the direction of walking on the treadmill. To achieve this, you can either move the treadmill in the laboratory to align with the Vicon world axes in Nexus, or change the Vicon world axes to align with the position of the treadmill. You can then set the incline of both plates of the treadmill by adjusting the **X Orientation** property of the force plate.



- Assuming you follow this advice so that the direction of walking on the force plates aligns with the Vicon Y-axis, and the left-right (medial-lateral) direction aligns with the Vicon X-axis, inclination of the force plate will correspond to a rotation of the plate about its X-axis. For example, to set a 10 degree inclination of the treadmill, you would set a 10 degree **X (deg)** rotation in the plate's **Orientation** properties.
- Each capture must use only one inclination of the treadmill. If you need to capture multiple inclinations, to enable you to switch easily between different inclinations, create a number of separate system files: one for each required inclination.

Compatibility with Vicon Vero cameras

The latest version of Nexus is compatible with Vicon's new Vicon Vero and Vicon Vue cameras, enabling you to benefit from their speed, flexibility and affordability.

Vicon Vero includes two optical camera models: Vero 2.2, which can provide up to 330 fps with 2.2 megapixel resolution; and Vero 1.3, which offers up to 250 fps with 1.3 megapixel resolution.

Vicon Vero cameras are fitted with:

- Side-mounted status LEDs on both the camera and the strobe, which give clearly visible camera status information. For more information, see Vero camera status LEDs on page 15.
- An accelerometer, which enables you to select a camera in the volume by tapping it, and which monitors the camera position to alert you if any cameras are accidentally knocked or moved from their intended positions. For more information, see Vero Tap to Select camera feature on page 17 and Vero bump detection and display on page 18.
- Thermal sensors, which monitor camera temperature levels so that you are warned of any changes in temperature that could affect the system status. For more information, see Vero temperature sensor display on page 20.

To connect Vero cameras to the host PC, Vicon offers a range of options, depending on the number of cameras you want to use and whether you are adding them to an existing Vicon system. To determine the most appropriate switch for your system, contact your local Vicon Sales representative.

For synchronization to third-party devices and timecode, together with connections for analog devices, you can add a Vicon Lock+ to your Vero system.

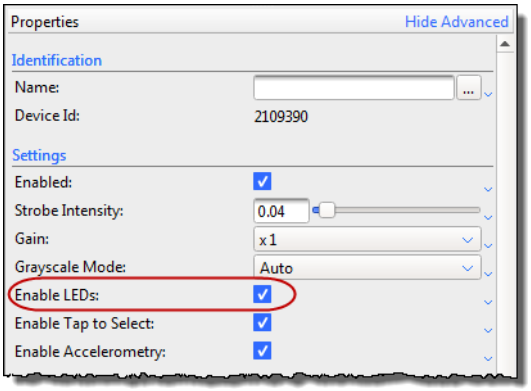
Vicon Vero cameras can be used in the same system as Vicon T-Series, Bonita and Vantage cameras, but note that they cannot be connected to a Giganet.

In addition to working with current Vicon Nexus, Vicon Vero cameras can also be used with the Vicon Control app (see Compatibility with Vicon Control on page 62).

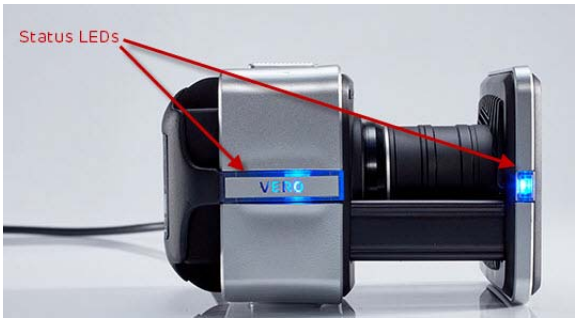
For instructions on setting up Vicon Vero systems, see the **Vicon Vero Quick Start Guide**, which you can download from the Vicon website.

Vero camera status LEDs

- Location: Camera's **Properties** pane > **Settings** section



To help you monitor the status of the cameras, they are fitted with status LEDs. Two pairs of tri-color LEDS provide feedback on camera operation, one pair on either side of the camera, and the second pair on either side of the strobe.



To change the display of camera status information:

1. In the **System Resources** list, select a camera (or all cameras).
2. In the **Settings** section of the **Properties** pane, select or clear **Enable LEDs**.

   With **Enable LEDs** selected (its default setting), while the camera is booting, the status LED color changes from yellow during booting, to red when booting is complete.

   When the cameras are communicating with Nexus, the status LEDs turn blue.

After the camera has booted, you can check the cameras' status by observing the status LEDs on each camera, in addition to monitoring the camera status in Nexus.

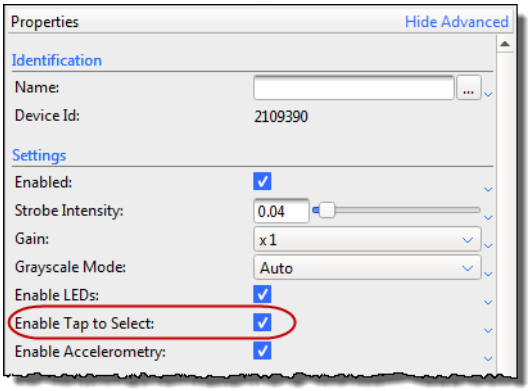
Color	Status
Blue	Enabled
Red	Not contributing
Red (flashing)	Bumped
Off	Disabled
Magenta	Selected
Off	Calibration (Wand count == 0)
Magenta (flashing, period decreases with wand count)	Calibration (0 < Wand count < Required wands)
Green	Calibration (Wand count >= Required wands)
Cyan	Automasking
Off	Status LEDs disabled

Tip

In certain camera modes and in certain system configurations, the status LEDs on the camera are automatically turned off to ensure maximum power is available to the strobe.

Vero Tap to Select camera feature

- Location: Camera's **Properties** pane > **Settings** section



Vicon Vero cameras provide a Tap to Select feature, which 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. The Tap to Select feature is on by default.

To turn Tap to Select on or off:

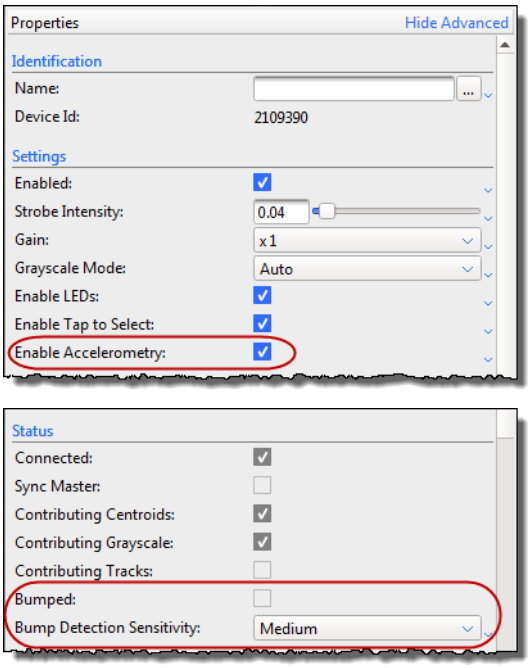
1. In the **System Resources** list, select the required camera.
2. In the **Properties** pane, go to the **Settings** section and select or clear **Enable Tap to Select**.

Note that when **Enable Accelerometry** is selected, if you tap a camera too hard, or if the camera is accidentally knocked, a calibrated camera is reported as 'bumped', that is, the camera's status LEDs flash red and in Nexus, the **Status** section in the **Properties** pane for the relevant camera displays a check mark in its **Bumped** check box.

You can remove a camera's **Bumped** status in Nexus. If this is a frequent occurrence, you can change its sensitivity to being tapped by reducing the **Bump Detection Sensitivity**. For more information see the following section.

Vero bump detection and display

- Location: Camera's **Properties** pane > **Settings** section and Camera's **Properties** pane > **Status** section



In addition to the Tap to Select feature (see above), Vicon Vero cameras also provide bump detection.

When **Enable Accelerometry** is selected (its default setting), bump detection works on calibrated cameras to alert you when they have moved from their calibrated positions.

To turn bump detection on or off:

1. In the **System Resources** pane, select a camera (or all cameras).
2. In the **Properties** pane, expand the **Settings** section and select or clear **Enable Accelerometry**.
   When **Enable Accelerometry** is selected, if a calibrated camera is accidentally knocked, the camera's status LEDs indicate that it is a bumped camera by flashing red and in Nexus, the camera's **Bumped** check box (in its **Status** properties) displays a check mark.

To change the sensitivity of the accelerometer:

1. In the **System Resources** list, select the required camera (or all cameras).
2. In the **Properties** pane, go to the **Status** section and in the **Bump Detection Sensitivity** pull-down, select a different option.

To clear a camera's Bumped status:

For a single camera:

1. In the **System Resources** list, select the bumped camera.
2. In the **Properties** pane, go to the **Status** section and clear the **Bumped** check box.

For all cameras:

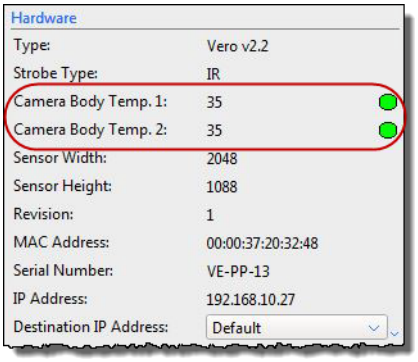
- Press Ctrl+Shift+B

Note the following limitations:

- Bump detection is active only on calibrated cameras.
- Bump detection cannot detect movement that does not change the local gravity vector, for example. slow translation with no rotation; rotation about the G-vector.
- Bump detection cannot detect movements that occur when the camera is not connected to a live system.
- The camera is detected as bumped when the reading from the accelerometer is sufficiently different from the last reading that was sent. Therefore gradual changes (for example, a slipping camera mount) may not be detected until they are large enough to trigger a new notification.

Vero temperature sensor display

- Location: Camera's **Properties** pane > **Hardware** section > **Camera Body Temp 1** and **Camera Body Temp 2**



Significant changes in camera temperature can have small effects on the camera's lens. Camera calibrations take into account lens intrinsics. Changes in these intrinsic properties can have small impacts on overall data quality.

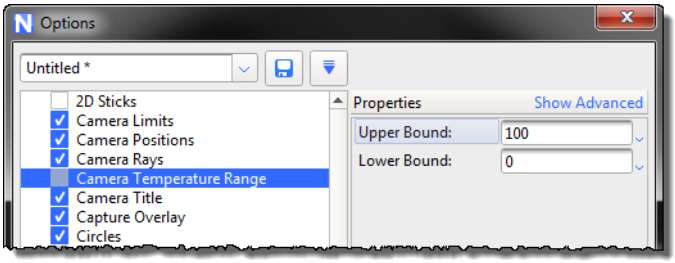
However, note that large temperature changes generally result in only very small data effects. Temperature monitoring is made available to optimize calibration-to-collection consistency.

Vicon Vero cameras have on-board temperature sensors. These sensors enable you to determine when cameras have reached a stable temperature from a cold start and to observe any change in camera temperature (possibly associated with environmental changes).

The data for the onboard sensors is displayed in the **Hardware** section. A numeric indicator (in degrees Celsius) and a colored temperature indicator is displayed for each sensor. The color of the indicator 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).

Because Vicon motion capture cameras are used in a wide variety of environments, a stable camera temperature will be different for different users. The **Camera Temperature Range** option enables you to set values that are representative of your laboratory environment.

You can change the upper and lower bounds of the **Camera Temperature Range** in the **Options** dialog box (F7).



Compatibility with Vicon Vue cameras

Nexus 2.4 is compatible with Vicon's latest video camera: Vicon Vue.

The Vue video camera offers 1080p. It is fitted with:?

- Side-mounted status LEDs, which give clearly visible camera status information. For more information, see Vue camera status LEDs on page 22.
- An accelerometer, which enables you to select a camera in the volume by tapping it, and which monitors the camera position to alert you if any cameras are accidentally knocked or moved from their intended positions. For more information, see Vue Tap to Select camera feature on page 23 and Vue bump detection and display on page 24.
- Thermal sensors, which monitor camera temperature levels so that you are warned of any changes in temperature that could affect the system status. For more information, see Vue temperature sensor display on page 26.

For instructions on setting up Vicon systems containing Vue cameras, see the **Vicon Vue Quick Start Guide**.

Vue camera status LEDs

- Location: Camera's **Properties** pane > **Settings** section

To help you monitor the status of the cameras, they are fitted with status LEDs. A pair of tri-color LEDS on either side of the camera provide feedback on camera operation.

To change the display of camera status information:

1. In the **System Resources** list, select a camera (or all cameras).
2. In the **Settings** section of the Properties pane, select or clear **Enable LEDs**.

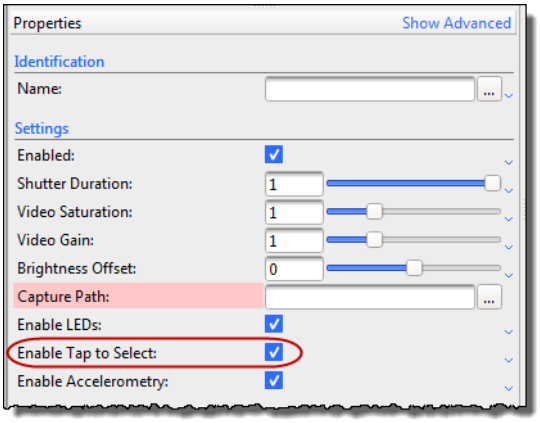
   With **Enable LEDs** selected (its default setting), while the camera is booting, the status LED color changes from yellow during booting, to red when booting is complete.

   When the cameras are communicating with Nexus, the status LEDs turn blue.

After the camera has booted, you can check the cameras' status by observing the status LEDs on each camera. You can also monitor the camera status in Nexus.

Vue Tap to Select camera feature

- Location: Camera's **Properties** pane > **Settings** section



Vicon Vue cameras provide a Tap to Select feature, which 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. The Tap to Select feature is on by default.

To turn Tap to Select on or off:

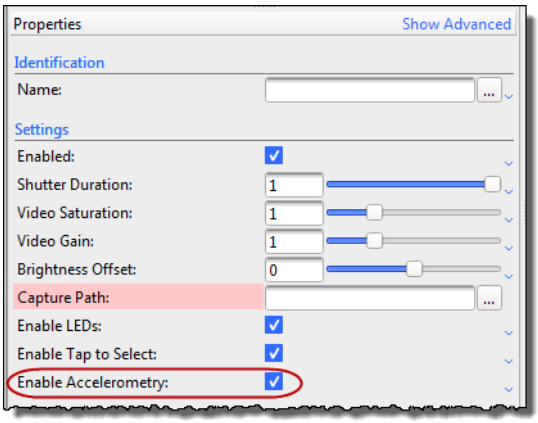
1. In the **System Resources** list, select the required camera.
2. In the **Properties** pane, go to the **Settings** section and select or clear **Enable Tap to Select**.

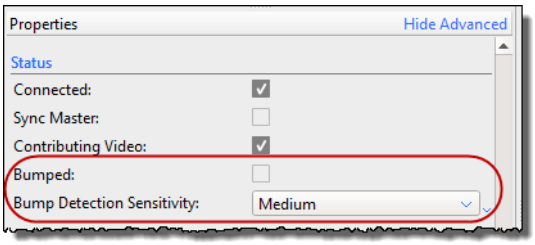
Note that when **Enable Accelerometry** is selected, if you tap a camera too hard, or if the camera is accidentally knocked, a calibrated camera is reported as 'bumped', that is, the camera's status LEDs flash red and in Nexus, the **Status** section in the **Properties** pane for the relevant camera displays a check mark in its **Bumped** check box.

You can remove a camera's **Bumped** status in Nexus. If this is a frequent occurrence, you can change its sensitivity to being tapped by reducing the **Bump Detection Sensitivity**. For more information see Vue bump detection and display on page 24.

Vue bump detection and display

- Location: Camera's **Properties** pane > **Settings** section and Camera's **Properties** pane > **Status** section





In addition to the Tap to Select feature (see above), Vicon Vue cameras also provide bump detection.

When **Enable Accelerometry** is selected (its default setting), bump detection works on calibrated cameras to alert you when they have moved from their calibrated positions.

To turn bump detection on or off:

1. In the **System Resources** pane, select a camera (or all cameras).
2. In the **Properties** pane, expand the **Settings** section and select or clear **Enable Accelerometry**.

   When **Enable Accelerometry** is selected, if a calibrated camera is accidentally knocked, the camera's status LEDs indicate that it is a bumped

camera by flashing red and in Nexus, the camera's **Bumped** check box (in its **Status** properties) displays a check mark.

To change the sensitivity of the accelerometer:

1. In the **System Resources** list, select the required camera (or all cameras).
2. In the **Properties** pane, go to the Status section and in the **Bump Detection Sensitivity** pull-down, select a different option.

To clear a camera's Bumped status:

For a single camera:

1. In the **System Resources** list, select the bumped camera.
2. In the **Properties** pane, go to the **Status** section and clear the **Bumped** check box.

For all cameras:

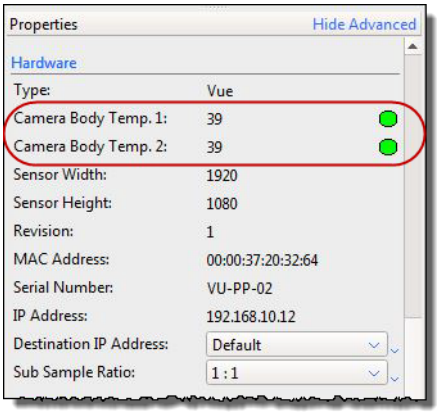
- Press Ctrl+Shift+B

Note the following limitations:

- Bump detection is active only on calibrated cameras.
- Bump detection cannot detect movement that does not change the local gravity vector, for example. slow translation with no rotation; rotation about the G-vector.
- Bump detection cannot detect movements that occur when the camera is not connected to a live system.
- The camera is detected as bumped when the reading from the accelerometer is sufficiently different from the last reading that was sent. Therefore gradual changes (for example, a slipping camera mount) may not be detected until they are large enough to trigger a new notification.

Vue temperature sensor display

- Location: Camera's **Properties** pane > **Hardware** section > **Camera Body Temp 1** and **Camera Body Temp 2**

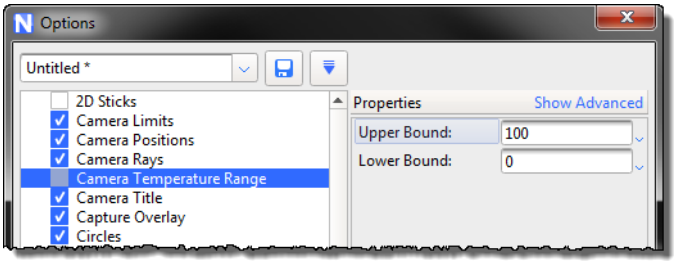


Thermal sensors enable you to monitor the internal temperature of your camera(s).

The data for the onboard sensors is displayed in the **Hardware** section. A numeric indicator (in degrees Celsius) and a colored temperature indicator is displayed for each sensor. The color of the indicator 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).

Because Vicon motion capture cameras are used in a wide variety of environments, a stable camera temperature will be different for different users. The **Camera Temperature Range** option enables you to set values that are representative of your laboratory environment.

You can change the upper and lower bounds of the **Camera Temperature Range** in the **Options** dialog box (F7).



Updated guidance on setting up mixed Vicon camera systems

Nexus 2.4 enables you to run mixed Vicon camera systems consisting of Vicon Vero cameras (v1.3 and v2.2), Vicon Vantage cameras (V5, V8, V16) and/or MX T-Series cameras (T10, T20, T40, T160, or S Edition) and Bonita Optical cameras (B3, B10). You can also use Vicon Vue and Bonita Video cameras in the same mixed system.

Caution

The use of mixed systems that include Vicon cameras older than T-Series and Bonitas is not supported and full functionality cannot be guaranteed.

Setting up a mixed camera system

For systems involving only Vero, Vantage and Bonita cameras, the shutter period characteristics for all cameras match exactly. Irrespective of individual cameras' strobe (shutter) settings, the center alignment of these periods in any Vantage/Vero/Bonita camera in the same system align exactly. You do not need to make any adjustments to ensure that this alignment occurs.

However, for systems involving Vicon MX T-Series cameras, depending on your requirements (see When are differences in strobe timings important? on page 73), you may need to make some manual adjustment (see below).

Important

Support for mixed systems' center strobe alignment requires Vicon firmware 700 or later. Vicon recommends that you always update to the latest firmware.

Due to the differences in strobe timings between the current Vicon cameras (Vero, Vantage and Bonita cameras) and the MX T-Series cameras (see Support for mixed Vicon Bonita and T-series systems on page 72), in situations where very small timing differences are considered to be relevant and greater than other accepted limitations (such as skin movement artifacts), ensure that the camera strobe periods match by setting the **Strobe Intensity** for the MX T-Series camera(s) to maximum as described below.

To obtain consistent strobe timing and sensor exposure in mixed camera systems that include T-series:

1. In the System tree, select the MX T-Series camera(s).
2. In the selected camera's **Properties** pane, in the **Settings** section, ensure the **Strobe Intensity** is set to its maximum.

This ensures that the center of the strobe pulse and shutter period for the Vero/Vue/Bonita cameras matches that of the MX T-Series cameras.

New features and updates in Vicon Nexus 2.3

Nexus 2.3 introduced the following new features and updates.

- Auto start/stop capture
- Auto-crop trials
- Automated assessment of foot strikes
- Automated gap-filling
- Export 3D workspace as AVI
- Auditory feedback
- Processing history
- Cyclic pattern fill (gap-filling for cyclic motion)
- Sensor windowing display
- Other enhancements in Nexus 2.3

See also the following additional guidance that is provided with Nexus 2.3:

- A new, detailed description of subject calibration operations: see Skeleton calibration operations in detail on page 171.
- New explanation of the various workflows for subject calibration: see Subject calibration workflows on page 180.

Auto start/stop capture

▸ Location: **Tools** pane > **Capture** tab > **Auto Capture Setup** section

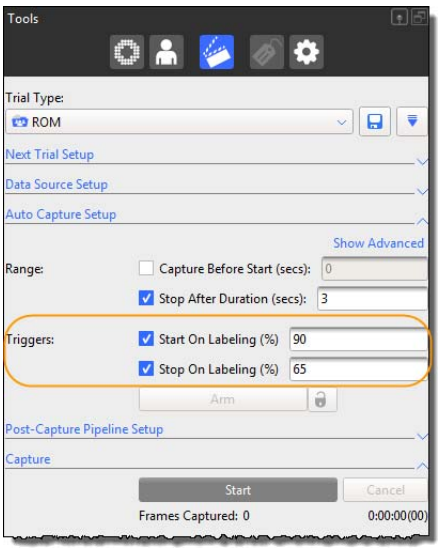
Nexus now provides you with an option to start and stop captures automatically when the subject enters and leaves the capture volume.

With the **Start on Labeling %** option selected, captures automatically start when a subject first fully enters the volume. If the **Stop on Labeling %** option is also selected, captures automatically stop when the subject leaves the volume.

You can 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 or to have left the volume and therefore to trigger capture start/stop.

To automatically start and stop captures:

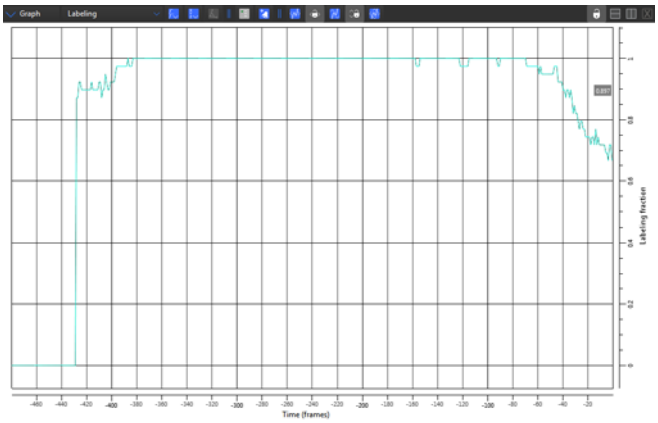
1. In the **Capture Tools** pane, expand **Auto Capture Setup** and select **Start on Labeling %** and/or **Stop on Labeling %**.
2. The default values for this operation start capture when at least 90% of a subject's markers are recognized and stop when less than 65% remain (volume exit). You can adjust these percentages to suit your capture type.



3. Have a subject wearing the required marker set enter the volume.

Tip

To check data quality, you can display the labeling percentage by selecting the subject and in a **Graph** view choosing **Labeling** to show how many labels are present on each frame.



Auto-crop trials

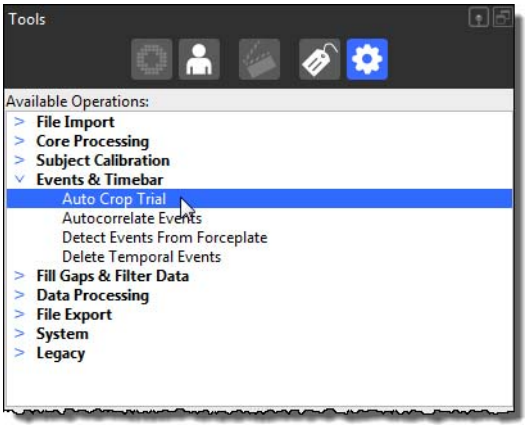
- Location: **Tools** pane > **Pipeline** tab > **Available Operations** section > **Events & Timebar** > **Auto Crop Trial**

For workflows where the subject starts outside the volume, moves into the volume and then exits, Nexus can save you time by automatically determining the first and last frame where the subject is fully in the volume.

When you run the autocrop operation, Nexus automatically zooms the time region of interest to the points where the subject first fully enters and then leaves the volume.

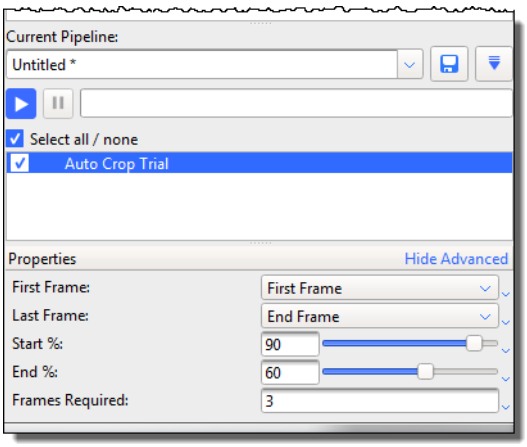
To set up auto-cropping:

1. Ensure the required trial is reconstructed and labeled.
2. In the **Tools** pane, click the **Pipelines** tab and in the **Available Operations** list, expand **Events & Timebar**.
3. Double-click the **Auto Crop Trial** pipeline operation to add it to the current pipeline.



4. In the **Current Pipeline** list, click **Auto Crop Trial** and in the **Properties** pane, ensure that the **First** and **Last Frame** options are set to the beginning and end frames during which the subject enters and leaves the volume.
5. Set the **Start** and **End %** options to the required minimum percentage of markers (ie, the percentage of markers expected from the total number of

markers in your subject's labeling skeleton) that must be labeled in each case.



If the trial involves multiple subjects, ensure the required subject is selected in the **Subjects** list at the bottom of the **Properties** pane.

6. If necessary, adjust the **Frames Required** 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 %, but the point at which the trial is intended to start (ie, the point at which the % is maintained over a number of frames) is later in the trial.
7. Run the **Auto Crop Trial** operation.

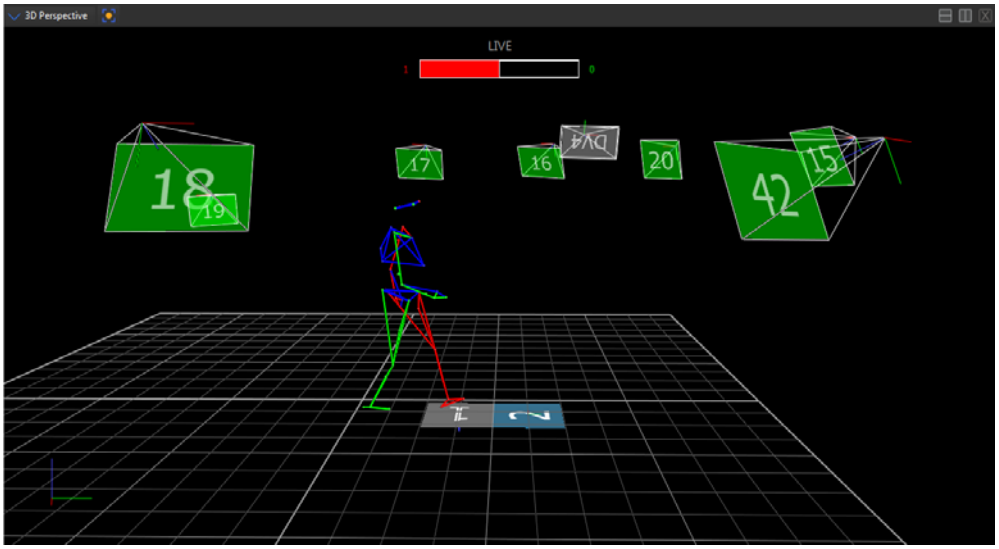
   The trial is automatically cropped to the frames you have selected.

Automated assessment of foot strikes

- Location: **Options** dialog box (F7) > **Footstrikes** option and display in **3D Perspective** view

In clinical gait trials for kinetic analysis involving one or more force plates, Vicon Nexus saves you time by automatically assessing foot contacts with a force plate.

Nexus provides an indication of whether or not the foot is correctly positioned and is producing valid data for your live trials, and displays this information on screen. This can save you time when you are assessing each foot strike to decide whether it is valid.



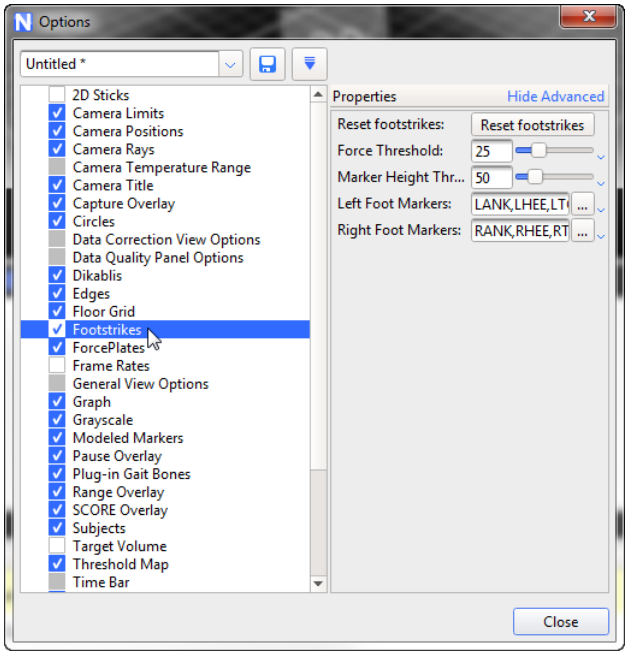
As each strike is detected, or is determined to be invalid, the box representing the force plate in the **3D Perspective** view pane turns the appropriate color:

- Red: left foot strike
- Green: right foot strike
- Dark gray: invalid strike

Counters on either side of the force plate box show how many valid strikes have been detected for the left foot and the right foot during the current session.

To use auto-detection of foot strikes:

1. Before you begin, ensure that you have:
   - Calibrated the Vicon system.
   - Applied the appropriate marker set to the subject.
   - Ensured that you have a valid subject in Nexus.
   - Connected and configured one or more force plates.
2. In the **Options** dialog box (F7), ensure that **Footstrikes** is selected.
3. Ensure the options for foot strikes are set as required:
   - **Reset footstrikes** button enables you to reset the foot strike counters.
   - **Force Threshold**: Minimum force required on force plate to produce foot strike
   - **Marker Height Threshold**: Minimum height of foot marker above force place for foot to be recognized for foot strike
   - **Left** and **Right Foot Markers**: Comma-separated list of names of one or more markers that define the segment (i.e. foot) that will strike the plate.



To reset foot strike counters:

- Right-click anywhere in the workspace and then click **Reset**.

Using multiple foot plates

If your trial requires multiple force plates, they are laid out in the order of the force plate IDs (that is, FP1 is furthest left/uppermost depending on the position of the force plate box).

Strikes straddling two force plates are marked invalid. However, if required they can be processed by the **Process Dynamic Plug-in Gait Model** pipeline operation, by selecting the **Allow cross-plate strikes** option.

Automated gap-filling

- Location: **Tools** pane > **Pipeline** tab > **Auto Intelligent Gap Fill** pipeline

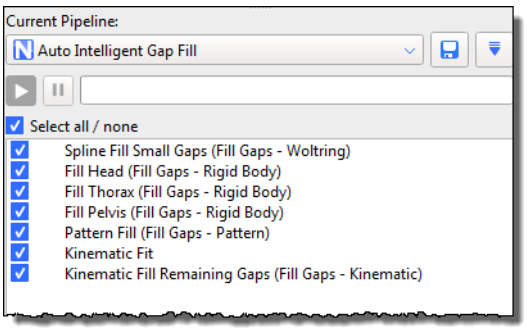
or

- Location: Nexus tool bar > **Auto Gap Fill** button

To enable you to quickly fill all gaps in your trial, without having to choose which fill method is best for each gap, you can now let Nexus do the work for you. You can do this in an easy, one-click operation or, if you want to modify the supplied operations, by changing and running the **Auto Intelligent Gap Fill** pipeline.

To use the Auto Intelligent Gap Fill pipeline:

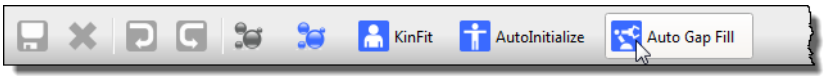
1. On the **Tools** pane, click the **Pipelines** button.
2. From the **Current Pipeline** list, select the **Auto Intelligent Gap Fill** pipeline.



3. From the list of operations below, select the gap-filling operations that you want to use. If required, in the **Properties** pane, modify the relevant settings.
4. Either click the **Run** button or use the **Auto Gap Fill** button on the tool bar, as described below, to run the pipeline with any changes you have made.

To use automatic gap-filling:

1. Ensure your trial has been fully reconstructed and labeled.
2. In the Nexus tool bar, click Auto Gap Fill.



Nexus assesses each gap one-by-one in series and fills all the gaps.

Export 3D workspace as AVI

The new Export 3D Workspace as AVI feature lets you easily create visually rich content for presentations or for use in other third-party applications.

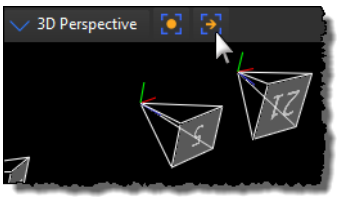
Nexus 2.3 enables you to create video files of a selected 3D workspace.

Before you export a workspace, ensure you have:

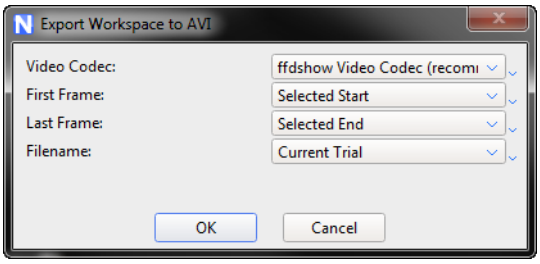
- Loaded a trial.
- Installed the any desired video compression codec.

To export a workspace as an AVI:

1. Ensure Nexus is not in Live mode.
2. In the workspace, click the **Export Workspace to AVI** button.



3. In the **Export Workspace to AVI** dialog box, enter the required information and then click **OK**.



A progress bar indicates the status of the export process and by default, a video file with the same name as the current trial is created in the trial session folder. (You can change the name and location if required.)

Note

In addition to exporting to AVI from the 3D views (**3D Perspective** and **3D Orthogonal**), you can also export to AVI from a **Camera** view.

Auditory feedback

Nexus 2.3 plays 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.

By default, Nexus uses speech sounds to alert you to the following events:

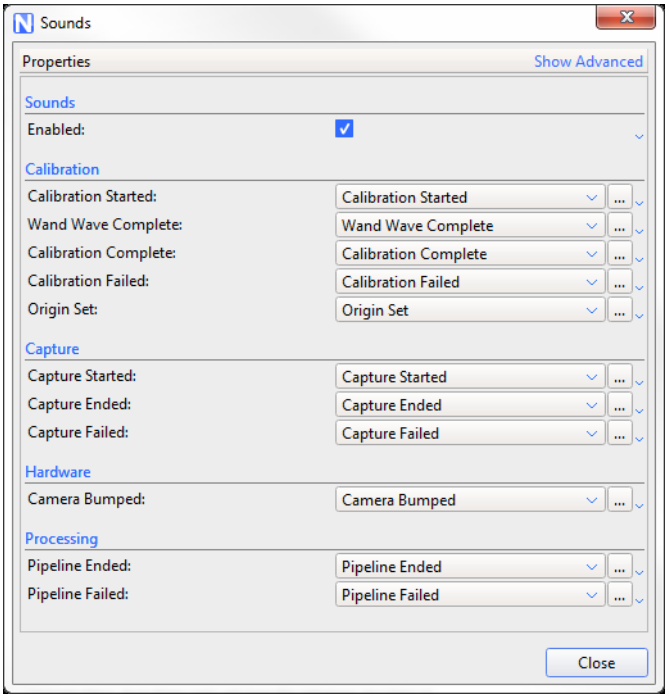
- Calibration start
- Wand Wave complete
- Calibration complete
- Calibration failed
- Origin set
- Capture started
- Capture ended
- Capture failed
- Camera bumped
- Pipeline ended
- Pipeline failed

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 disable sounds individually or disable all sounds.

To change these settings:

- Press F6; or

- On the **Windows** menu, click **Sounds**.



To disable all sounds, in the **Sounds** section, clear the **Enabled** check box.

To disable 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.

Processing history

Location: **Communications** pane > **History** tab

A new **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. For example, if you work as part of group, when you open a trial that someone else has been working on, you can immediately review what processing (e.g. filtering, gap filling) has occurred and what settings were used.

Being able to view processing history helps you understand your data, prevents errors introduced by performing certain operations (for example, filtering) more than once and reduces the need to reprocess data because its current state is not well known.

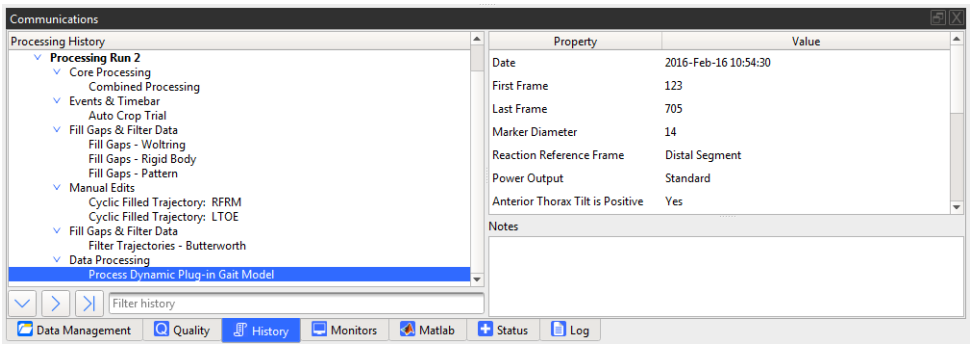
To view processing history:

1. Open a trial.
2. In the **Communications** pane, click the History tab and view the **Processing History** list.

   A summary of the data processes and major events is displayed.

3. To display information about a particular event, click on the event that is of interest.

   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 will only be available for files processed in Nexus 2.3 and above.

Cyclic pattern fill (gap-filling for cyclic motion)

- Location: **Tools** pane > **Pipeline** tab > **Fill Gaps - Cyclic** pipeline operation

or

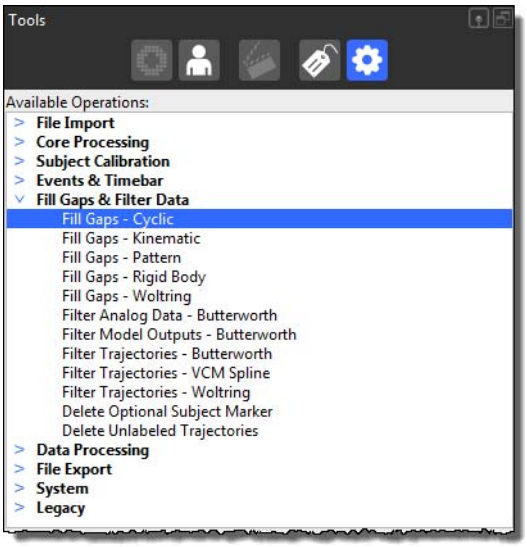
- Location: **Tools** pane > **Gap Filling** section > **Cyclic Fill** section

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), Nexus can now use patterns from a missing marker from earlier or later gait cycles to fill gaps.

You can do this in an easy, one-click operation or, if you want to modify the supplied operations, by changing and running the **Fill Gaps - Cyclic** pipeline operation.

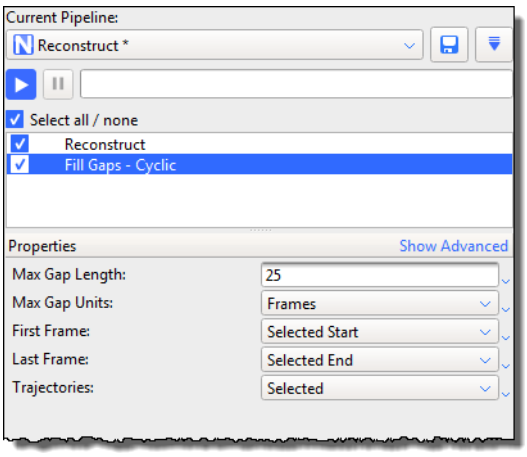
To use the pipeline operation to perform cyclic pattern filling:

1. On the **Pipelines** tab, expand **Fill Gaps & Filter Data** and add the **Fill Gaps - Cyclic** operation to the current pipeline.



2. Select the **Fill Gaps - Cyclic** operation.
3. In the **Properties** pane, adjust the **Gap Length**, **Units** and **First** and **Last Frame** parameters as necessary.

4. In the **Trajectories** field, select the trajectories to fill.



5. Run the pipeline

   Nexus fills gaps in the specified trajectories based on the marker positions in other cycles of the movement.

After you have adjusted the settings for the **Fill Gaps - Cyclic** operation, you can either run it as described above or use it as specified in the following steps.

To use cyclic pattern fill:

1. Ensure you have captured a trial containing repetitive motion.
2. Select the gap/range that is to be filled.
3. In the **3D Perspective** view and the graph of the marker component, preview the gap fill solution provided by Nexus.
4. If the suggested solution is acceptable, in the **Tools** pane, click the **Label/ Edit** tab and ensure **Gap Filling** is expanded.
5. In the **Cyclic Fill** area, select the required option:
   - Fill Fills the currently selected range
   - All Attempts to fill all gaps in the selected trajectory.

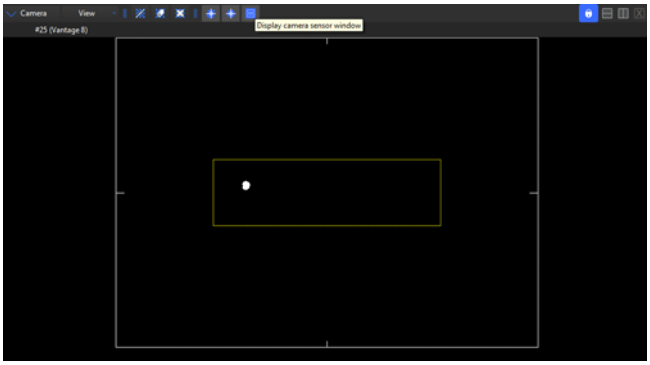
   The gap is filled with data based on other cycles of the same movement.

Sensor windowing display

Windowing is a process where an area of the camera sensor is sacrificed (ie, not captured), to enable higher capture rates - FPS.

Using Vicon Nexus 2.3 with Vicon Vantage or MX T-Series cameras, you can now see an accurate 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.



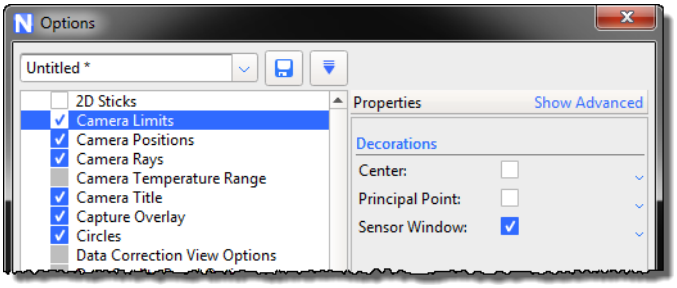
The windowing display is visible in the **Camera** view, in the **3D Overlay** view and in **Rotated** view.

To toggle the display of windowing:

- On the **Camera** view toolbar, click the **Display camera sensor window** button.

or

- In the **Options** dialog box (F7), click the **Camera Limits** option and in the **Properties** pane, select the **Sensor Window** property.



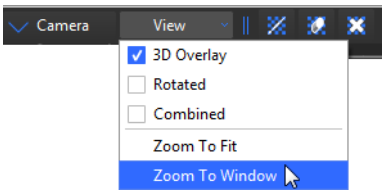
You can gain instant feedback on the area that is captured and save room on the screen by zooming in to the sensor window.

Note

For captures made in versions of Nexus before 2.3, zooming in to the sensor window applies to **Live** mode only.

To zoom in to the displayed sensor window:

1. Ensure sensor windowing is displayed (see above).
2. In a **Camera** view, from the **View** menu, select **Zoom to window**.



To turn on Zoom to window for all windows:

- Press the hot keys: Ctrl+Shift+Z.

Other enhancements in Nexus 2.3

The following additional enhancements were added to Nexus 2.3:

- File transfer In the **Communications** pane, **File Transfer** interface, **select the Transferred/Select Untransferred** options.
- Capture hot keys Press Ctrl+Enter to toggle start/stop capture.
- Multi-select pipeline operations In the **Tools** pane, **Pipeline** tab, select or clear the **Select all/none** option at the top of the **Current Pipeline** list of operations.
- Sweep select for manual masking In a Camera view, Alt+drag to select.
- Set all Subject properties to default On the **Subjects** tab, select the subject, and in the **Properties** pane, click **Set All to Default.**
- Progress bar for Matlab operations In the **Communications** pane, click on the **Matlab** tab.

New features and updates in Vicon Nexus 2.2

Nexus 2.2 introduces the following new features and updates.

- Native Oxford Foot Model
- Greater choice of joint types
- Advanced MATLAB modeling
- Compatibility with Vicon Vantage systems
- Support for Vicon Lock+ control units
- Compatibility with Vicon Control

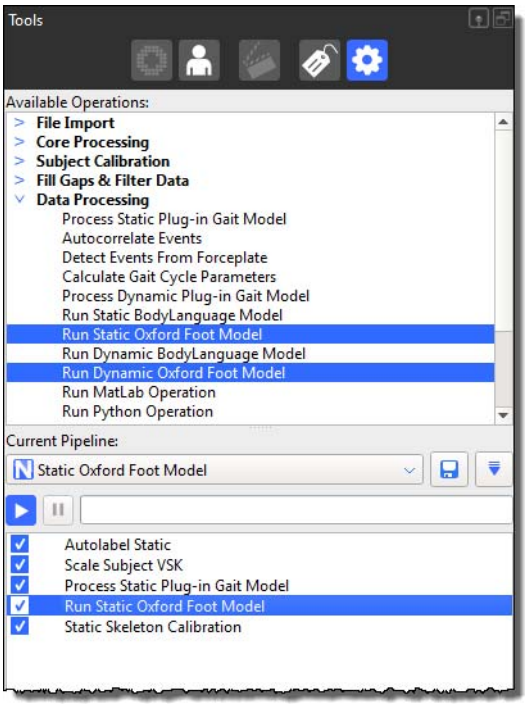
For information on issues addressed in this release, see Nexus 2.2 solved issues on page 237.

Native Oxford Foot Model

- Location: **Tools** pane > **Pipeline** tab

In Nexus 2.2, the static and dynamic Oxford Foot Model pipeline operations that were previously available as separate legacy VPIs are now available as native Nexus operations on the **Pipeline** tab, complete with new VSTs and pipelines.

As the Oxford Foot Model operations are now installed as part of the Nexus installation, you no longer have to perform a separate download in order to use them.



Greater choice of joint types

▸ Location: **Tools** pane > **Subject Preparation** tab > **Labeling Template Builder**

The selection of a joint type enables you to specify how freely a joint is able to move with respect to its parent segment.

In Nexus 2.2, on the **Subject Preparation** tab, the **Labeling Template Builder** offers two additional advanced joint types:

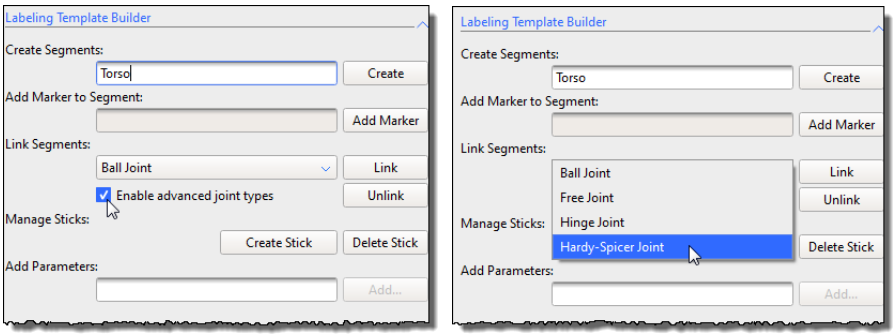
- **Hinge Joint**: A 1-Degree of Freedom joint with rotational freedom around a single axis. This joint has a single vector defining the axis of the hinge.
- **Hardy-Spicer Joint**: A 2-DoF joint with two rotational degrees around two axes. This joint type has two perpendicular vectors defining the directions of the two axes around which the joint can rotate.

Important

Joint types as defined by the **Labeling Template Builder** are for the Labeling Skeleton, meaning that the true biomechanical joint type may not necessarily be the best choice for the skeleton. For the majority of skeletons, the Nexus 2 labeler works best when the joint types of **Ball Joint** and **Free Joint** are used. The advanced joint types are only required for very specific labeling needs.

To access the new joint types:

▸ In the **Link Segments** section, select **Enable advanced joint types**.
In the **Link Segments** list, the additional joint types become available to its parent segment for the purpose of labeling.



Advanced MATLAB modeling

With Nexus 2.2, 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 (as fixed, Euler or helical angles)

```
% 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 );
```

Compatibility with Vicon Vantage systems

The latest version of Nexus is compatible with the Vicon Vantage range of cameras and hardware, enabling you to benefit from the power and usability of the new system.

Vicon Vantage includes three camera models, beginning with the V5, which offers up to 420 fps with 5 megapixel resolution, the V8 at up to 270 fps with 8 megapixel resolution, and the V16, which can provide up to 120 fps with 16 megapixel resolution.

In addition, all three models offer:

- A front-facing OLED display as well as side-mounted status lights, which give clearly visible camera ID information and system feedback. For more information, see New camera status LEDs and OLED display on page 53.
- An accelerometer, which enables you to select a camera in the volume simply by tapping it, and which monitors the camera position to alert you if any cameras are accidentally knocked or moved from their intended positions. For more information, see New Tap to Select feature on page page 56 and New bump detection and display on page 57.
- Thermal sensors, which monitor camera temperature levels so that you are warned of any changes in temperature that could affect the system status. For more information, see New temperature sensor display on page 58.

With a new Vicon-provided PoE+ switch, you can connect up to 12 Vicon Vantage cameras to the Vicon Vantage host PC. The system can be expanded

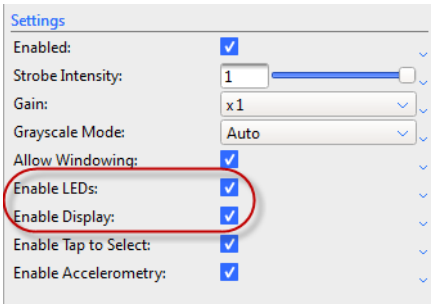
to add more cameras or additional hardware by connecting further PoE+ switches.

For synchronization to third-party devices and timecode, together with connections for analog devices, you can add a Vicon Lock+ (see Support for Vicon Lock+ control units on page 61).

For more information on Vicon Vantage systems, see the **Vicon Vantage Quick Start Guide** and the **Vicon Vantage Reference**.

New camera status LEDs and OLED display

- Location: Camera's **Properties** pane > **Settings** section



To help you monitor the status of Vicon Vantage cameras, the cameras include status LEDs and an OLED display:

- Two pairs of tri-color LEDS provide feedback on camera operation, one pair on either side of the camera, and the second pair on either side of the strobe.
- The OLED display on the front of the Vicon Vantage strobe, combined with the status LEDs' color, gives information about the current camera status.

Under normal conditions (unless a connected application changes the display, and unless the display has been disabled in Nexus), the display changes to reflect the camera status.

To change the display of Vicon Vantage camera status information:

1. In the **System Resources** list, select a camera (or all cameras).
2. In the **Settings** section of the **Properties** pane, select or clear **Enable LEDs** and/or **Enable Display**.

   With **Enable LEDs** and **Enable Display** selected, while the camera is booting, the OLED display shows the Vicon logo and the status LED color changes from yellow during booting, to red when booting is complete.

   When the cameras are communicating with Nexus, the status LEDs turn blue.

   The display changes to reflect the camera's status, giving information about camera status, for example when the camera has finished booting, its calibration status, and whether it has been moved since calibration.

When **Enable Display** is cleared, the display is blank.

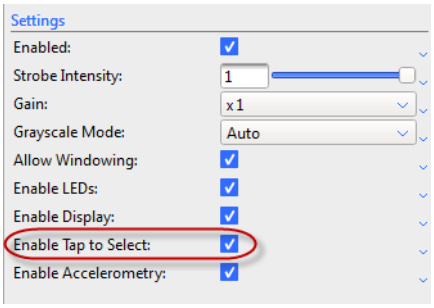
If **Enable Accelerometry** is selected (see New bump detection and display on page 57), the image on the display rotates based on the orientation of the camera.

After the camera has booted, you can check the cameras' status by observing the status LEDs and the OLED display on each camera. You can also monitor the camera status in Nexus.

For more information about the status LEDs, see the **Vicon Vantage Reference**.

New Tap to Select feature

- Location: Camera's **Properties** pane > **Settings** section



Vicon Vantage cameras provide a Tap to Select feature, which enables you to lightly tap the camera in the volume to select it (and deselect the other cameras). **Enable Tap to Select** is selected by default.

To turn Tap to Select on or off:

1. In the **System Resources** list, select the required camera.
2. In the **Properties** pane, go to the **Settings** section and select or clear **Enable Tap to Select**.

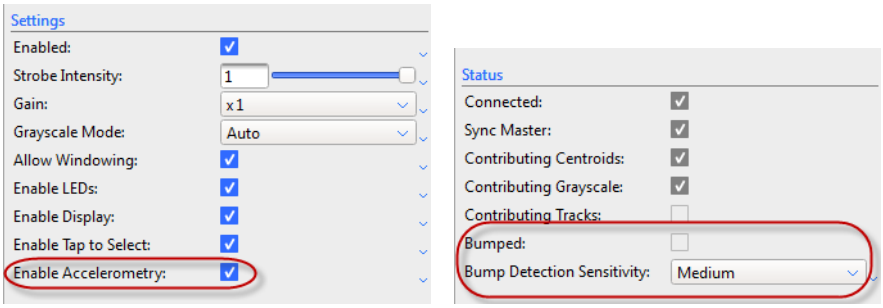
Note that when **Enable Accelerometry** is selected, if you tap a calibrated camera too hard, the camera is reported as 'bumped' (that is, its status LEDs and OLED display (if enabled) indicate that it is a bumped camera).

You can remove a camera's bumped status in Nexus. If this is a frequent occurrence, you can change its sensitivity to being tapped by reducing the **Bump Detection Sensitivity**.

For information on removing a camera's bumped status and reducing **Bump Detection Sensitivity**, see New bump detection and display on page 57.

New bump detection and display

- Location: Camera's **Properties** pane > **Settings** section and Camera's **Properties** pane > **Status** section



In addition to the Tap to Select feature (see above), Vicon Vantage cameras also provide bump detection.

When **Enable Accelerometry** is selected (its default setting), bump detection works on calibrated cameras to alert you when they have moved from their calibrated positions. (This setting also turns on or off the auto-rotation of the display on Vantage cameras.)

To turn bump detection on or off:

1. In the **System Resources** pane, select a camera (or all cameras).
2. In the **Properties** pane, expand the **Settings** section and select or clear **Enable Accelerometry**.

   When **Enable Accelerometry** is selected, if a calibrated camera is accidentally knocked, its display changes.

   In Nexus, the camera's **Bumped** check box (in its **Status** properties) displays a check mark.

To change the sensitivity of the accelerometer:

1. In the **System Resources** list, select the required camera.
2. In the **Properties** pane, go to the **Status** section and select a different option in the **Bump Detection Sensitivity** pull-down.

To clear a camera's Bumped status:

For a single camera:

1. In the **System Resources** list, select the bumped camera.
2. In the **Status** section of the **Properties** pane, clear the **Bumped** check box.

For all cameras:

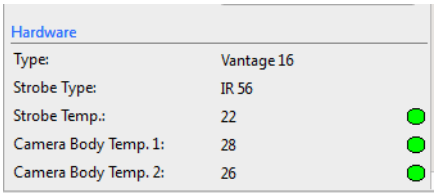
- Press Ctrl+Shift+B

Note the following limitations:

- Bump detection is active only on calibrated cameras.
- Bump detection cannot detect movement that does not change the local gravity vector, for example. slow translation with no rotation; rotation about the G-vector.
- Bump detection cannot detect movements that occur when the camera is not connected to a live system.
- The camera is detected as bumped when the reading from the accelerometer is sufficiently different from the last reading that was sent. Therefore gradual changes (for example, a slipping camera mount) may not be detected until they are large enough to trigger a new notification.

New temperature sensor display

- Location: Camera's **Properties** pane > **Hardware** section > **Strobe Temp**, **Camera Body Temp 1** and **Camera Body Temp 2**



Significant changes in camera temperature can have small effects on the camera's lens. Camera calibrations take into account lens intrinsics. Changes in these intrinsic properties can have small impacts on overall data quality.

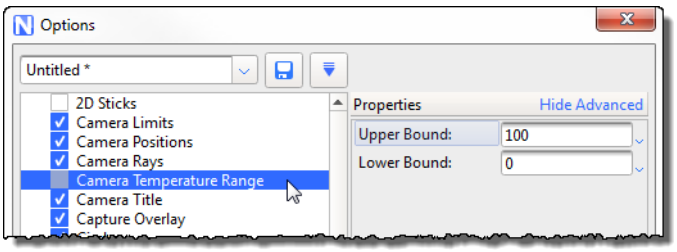
However, note that large temperature changes generally result in only very small data effects. Temperature monitoring is made available to optimize calibration-to-collection consistency.

Vicon Vantage cameras have on-board temperature sensors. These onboard temperature sensors enable you to determine when cameras have reached a stable temperature from a cold start and to observe any change in camera temperature (possibly associated with environmental changes).

The data for the onboard sensors is displayed in the **Hardware** section. A numeric indicator (in degrees Celsius) and a colored temperature indicator is displayed for each of the sensors. The color of the indicator 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).

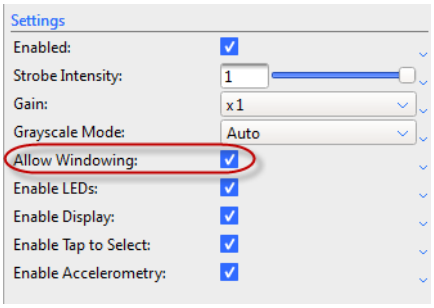
Because Vicon motion capture cameras are used in a wide variety of environments, a stable camera temperature will be different for different users. The **Camera Temperature Range** option enables you to set values that are representative of your laboratory environment.

You can change the upper and lower bounds of the temperature range in the Options dialog box (F7).



Allow Windowing control

- Location: Camera's **Properties** pane > **Settings** section



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.

Windowing is enabled by default.

To change whether to use windowing:

- In the **Settings** section of a camera's **Properties** pane, select or clear the **Allow Windowing** check box.

Support for Vicon Lock+ control units

Nexus 2.2 is compatible with Vicon Lock+, a new Vicon connectivity device that facilitates the integration of synchronous third-party equipment with Vicon Vantage and Vicon Bonita cameras by providing or receiving synchronization and/or timecode. It also provides connectivity for third-party analog capture sources, such as force plates, EMG equipment, and generic devices.

Important

The use of Vicon Lock+ is supported for Vicon Vantage and Vicon Bonita camera systems only.

When a Lock+ is connected into a compatible Vicon system, it appears in the **System Resources** list in the same way as other Vicon connectivity devices.

To access its properties and settings, in the **System Resources** list, click the name of the Lock+ device.

You can then access its controls in the **Properties** pane.

For information on connecting a Vicon Lock+ into a Vicon camera system, see the **Vicon Lock+ Quick Start Guide** and the relevant specification sheet.

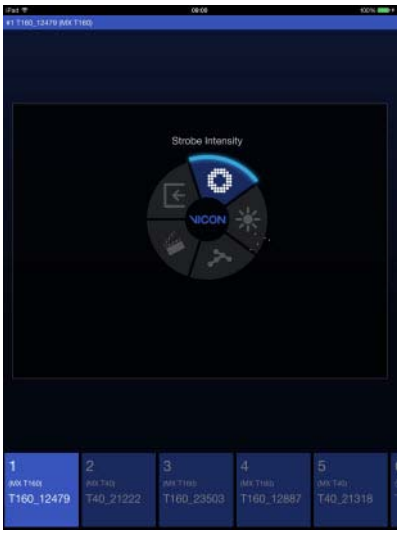
Compatibility with Vicon Control

With the latest version of Nexus, you can use the Vicon Control app, currently available on iOS 8 devices, to set up, calibrate, and capture with a Vicon Vantage, T-Series or Bonita system.

Control connects wirelessly to Vicon Nexus and streams camera data to your mobile or tablet, enabling a single user to change camera settings, calibrate the system, and start or stop capture from anywhere in the volume.

Vicon Control features include:

- The ability to change camera settings, calibrate, and start and stop capture with its intuitive single-handed dial



- View adjustments to the aperture and focus settings by selecting the camera from Control
- Select a Vantage camera and display it automatically using Tap to Select

Note that Vicon Control is compatible with the following devices:

- Phone 5, 5C, 5S, 6, 6+
- iPad Air, iPad Air 2, iPad Mini 2, and iPad 3

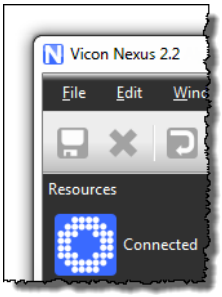
Connect Vicon Control

Before you can use your iOS device with Nexus, you must pair it with the PC that is running Nexus (the Vicon host PC).

To connect an iOS device running the Vicon Control app to Nexus on a Vicon host PC:

1. Ensure that your iOS device is connected to a Wifi access point that is on the same subnet as the Vicon host PC.

2. On the Vicon host PC, ensure that the required connection is used, that Nexus is running, and the system is connected.



3. On the device, open the Vicon Control app.

The connection to Nexus is displayed on the initial Control screen:

4. Tap the Nexus icon.

   You are alerted that you must authorize the connection on the Vicon host PC before you can continue.

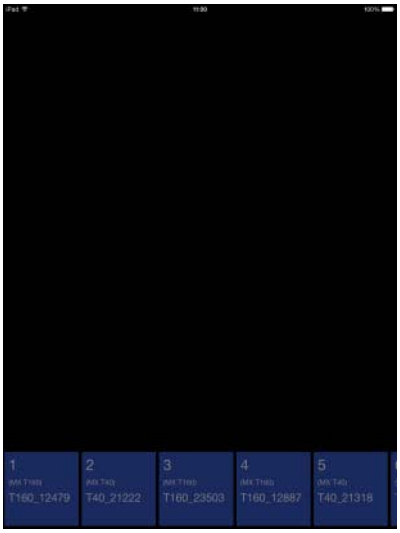
   In Nexus on the Vicon host PC, an authorization request is displayed:

5. To use the same connection in future, select **Remember this choice for future connection attempts**. To permit Control to access Nexus, click **Allow**.

   Tip

   If later you need to revoke authorizations for Vicon Control, on the **Window** menu in Nexus, click **Reset Control Authorization**. This revokes all stored authorizations.

   On the iOS device, a screen similar to the following is displayed:



6. To select a camera and display a camera view, tap at the bottom of the screen.

   You can swipe the camera view right or left to change to the next or previous camera and use stretch and pinch as normal to zoom in and out.

To access the dial control, tap and hold in a selected camera view.

Use the dial to view and change settings, calibrate and capture.

New features and updates in Vicon Nexus 2.1

Nexus 2.1 introduces the following new features and updates.

- Compatibility with Vicon Lock
- Additional video standards and timecode options
- Support for mixed Vicon Bonita and T-series systems
- Cross-plate foot strike feature
- Improved system calibration refinement

To ensure you are using the currently recommended calibration workflow, also see the latest advice on the New workflow for improved labeling on page 149.

For a list of the latest fixes, see Addressed issues on page 234.

Compatibility with Vicon Lock

▸ Location: **Resources** pane > **System** tab

Nexus 2.1 supports the use of Vicon's latest connectivity device, Vicon Lock, which enables you to run Bonita cameras using a sync signal and timecode, but without a Giganet.

Important

The use of Vicon Lock is supported for Vicon Bonita camera systems only.

When a Lock is connected into a Vicon system, it appears in the **System Resources pane** in the same way as other Vicon connectivity devices. To access its properties, on the **System** tab, click the name of Lock device. You can then change its settings in the **Properties** pane.

For information about connecting a Lock device into a Vicon camera system, see the **Vicon Lock QuickStart Guide** (PDF).

Change to the synchronization master

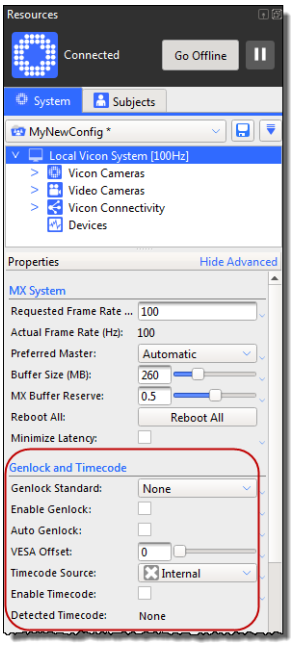
- Location: **Resources** pane > **System** tab > **Local Vicon System** > **Properties** pane > **MX System** section > **Preferred Master** list

When you use a Lock, it automatically becomes the synchronization master for your Vicon system. You can still select your choice of master, by selecting from the **Preferred Master** list (formerly the **Master Select** list) in the **MX System** section of **Local Vicon System** properties, but if you are using a Lock, the Lock will always be the synchronization master.

Additional video standards and timecode options

- Location: **Resources** pane > **System** tab > **Local Vicon System** > **Properties** pane > **Genlock and Timecode** section

The **Properties** pane (**Advanced Properties**) for **Local Vicon System** includes additional controls and changed options.



Note

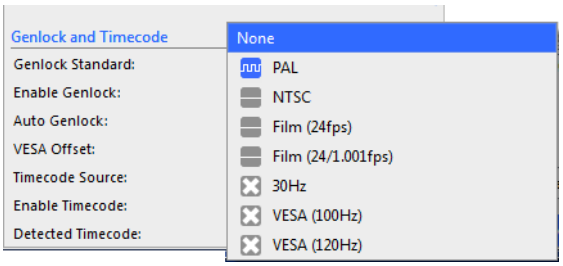
Genlock and Timecode settings that were formerly properties of **Vicon Connectivity** devices are now available as properties of **Local Vicon System**.

Greater choice of video standards

To choose the type of video standard supported by the connected video source, in the **Local Vicon System** properties, select an option from the **Genlock Standard** list, now available in the **Genlock and Timecode** section. Supported standards now include 30Hz and VESA options.

Important

Before using the 30Hz option, ensure that the MX firmware is upgraded to Bundle 500 or above.



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 master 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 master device in the system.

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

New Auto Genlock option

When **Auto Genlock** is selected in the **Genlock and Timecode** section of **Local Vicon System** properties, Nexus automatically selects a genlock standard and enables genlock based on the signals that are currently detected.

Timecode Source list changes

The **Use Dropframe** check box, which determined whether the internal timecode source generated a drop-frame timecode when the genlock standard

is NTSC, is replaced by an **Internal Drop** option in the **Timecode Source** list of the **Genlock and Timecode** section.

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 master device that is genlocked.

New VESA Offset option

VESA Offset only applies when you have selected one of the VESA standards from the **Genlock Standard** list in the **Genlock and Timecode** section. 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 virtual reality systems.

Detected Timecode change

Detected Timecode is now given as the number of timecode frames per second for example, 24 fps, 25 fps, 30 fps, 30 fps DropFrame, instead of PAL, NTSC etc.

Support for mixed Vicon Bonita and T-series systems

With Nexus 2.1, you can run mixed systems consisting of both Vicon MX T-Series cameras (T10, T20, T40, T160) and Bonita Optical cameras (B3, B10). Nexus gives you access to all the controls and user interface features for both types of camera.

Caution

The use of mixed systems that include Vicon cameras older than T-Series and Bonitas is not supported and is at your own risk.

Setting up a mixed camera system

To obtain optimum performance from a mixed camera system, it is important to understand the difference in strobe power between the larger T-Series cameras and the more compact Bonita models.

Understanding strobe timings

- Strobe Intensity. All Vicon cameras have a **Strobe Intensity** control, which is found in the selected camera's **Properties** pane, in the **Settings** section

  This control adjusts the intensity of the camera's strobe independently of the other cameras in the system. Along with other key camera properties such as lens aperture, circle fitting, and sensitivity, **Strobe Intensity** can be adjusted to create the best set up for data collection in a volume. The **Strobe Intensity** setting affects the total energy of strobe light produced by a camera. As the voltage supplied to a camera's LEDs is constant, strobe energy is changed by adjusting the period of time within a strobe 'on' cycle to be longer (higher intensity/power) or shorter (lower intensity/power).

- Strobe timings. For all current Vicon optical motion capture cameras, the **strobe on** period (the length of time that the strobe is on) and **sensor exposure** period (the length of time that the sensor gathers data) are coincident. This means that higher strobe intensities, which have a longer strobe periods, result in longer sensor exposure periods. Lower strobe intensities, which have shorter strobe periods, result in shorter exposure periods. This produces small changes in timing between cameras that have different strobe periods because, despite strobe pulses starting at the same time, they may stop at different times. This results in slight discrepancies in the times of the middle of the pulses.

Effect of differences in strobe timings in mixed camera systems

When you are setting up a mixed camera system, you may need to consider the effect of strobe timings. A single reconstruction is the result of two or more camera sensors recognizing the same marker. If two cameras with significantly different strobe timings are used to capture and reconstruct a marker, small differences in the absolute timing of this data can occur. These differences are generally very small as they will be half of the exposure time difference between two cameras.

Depending on the speed and type of motion being captured, these differences may or may not be a setup consideration. Given other accepted limitations, such as maximum level of calibration accuracy and skin movement artifacts, in a typical setup most of these small differences are insignificant.

Obtaining equal strobe timings in mixed systems

When setting up a camera capture system containing both Vicon T-Series and Bonita cameras, it is important to take into account the relative maximum strobe intensity of these cameras. T-Series cameras have a larger, more powerful strobe ring, compared with the smaller Bonita cameras. The **Strobe Intensity** settings in Nexus are scaled in percent units of the total strobe output. This means that when you slide the value from 0 to 1, a camera's strobe moves from 0 percent of the strobe's total power to 100 percent of the strobe's total power.

The maximum output length of strobe pulse from a Bonita camera strobe is exactly half of the total output of a T-Series camera. To obtain a precise and equal strobe timing and sensor exposure, you must set **Strobe Intensity** for the T-Series strobe to 50% and for the Bonita strobe to 100%.

When are differences in strobe timings important?

In situations where very small timing differences are considered to be relevant and greater than other accepted limitations (such as skin movement artifacts), ensure that all the camera strobe periods match by setting an appropriate value in the **Strobe Intensity** for the cameras you are using. If all cameras are of the same type, this value is the same for all cameras, but for systems that include both T-series and Bonita cameras, set the Bonita value to half that of the T-Series, as described above. Situations that may warrant this consideration include studies where very fast ballistic movements are expected and/or where very small markers are likely to be in close proximity.

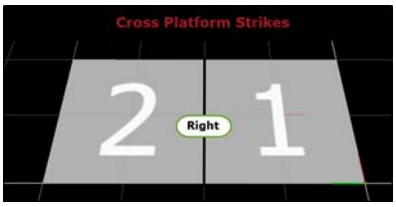
Cross-plate foot strike feature

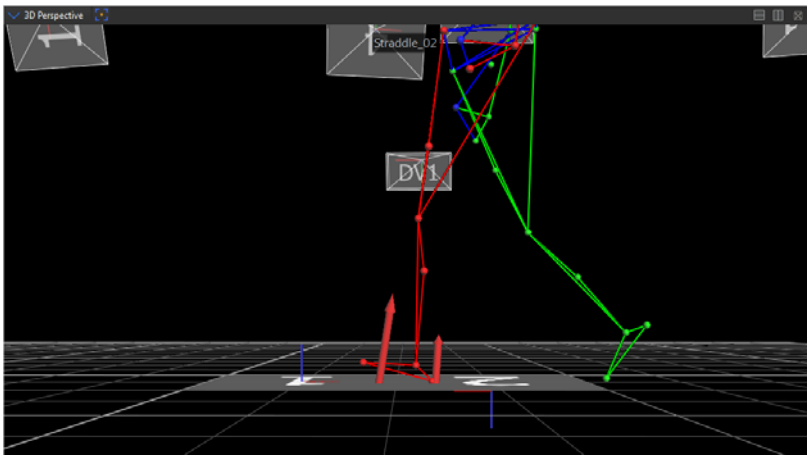
- Location: **Tools** pane > **Pipeline** tab > **Current Pipeline** > **Plug-in Gait Dynamic** pipeline > **Process Dynamic Plug-in Gait Model** operation > **Properties** pane (**Advanced**) > **Allow cross-plate strikes** option

To perform an inverse reaction calculation from a foot strike, forces and moments recorded by a force plate must:

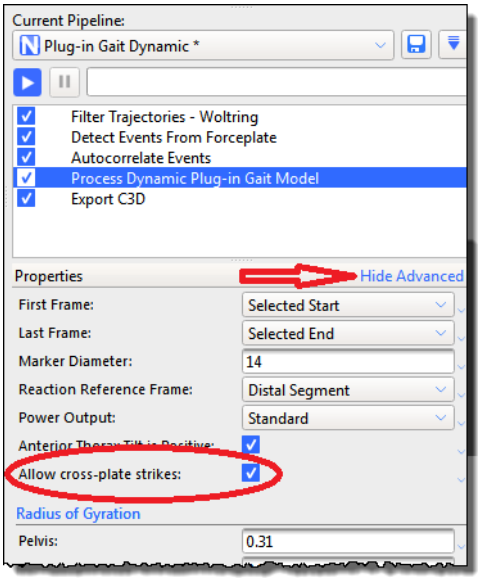
- Be assigned to a single context (left or right)
- Represent the full forces and moments produced by the subject

In some instances, a foot may be in contact with more than one forceplate simultaneously; for example, the heel may land on the far side of one plate and then the toes roll onto the near edge of the subsequent plate.



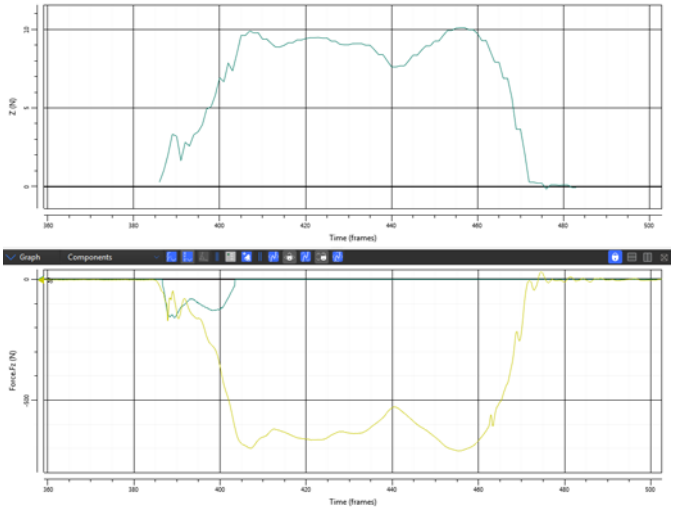


Dynamic Plug-in Gait now includes an Advanced option to permit calculations based on these cross-plate strikes.



Reactions from the two plates are combined during processing, with the plate that is struck first being considered the primary. The forces reported by each plate are added together; the moments are also combined by referring the moment from the secondary plate back to the origin of the primary plate. In effect, the two plates are treated as a single forceplate with the same origin as the primary plate.

Dynamic Plug-in Gait can automatically detect which foot is activating a forceplate by checking whether the origin of the segment is above the plate. To account for cross-plate strikes, the activating area is expanded beyond the bounds of the plate by the length of the segment (that is, a foot is considered to be above the plate if the ankle joint center is within a foot-length of the plate boundary). You may also set the foot strike manually, as in previous versions of Vicon Nexus.



Note that the existing restriction that there must be only a single foot in contact with any given forceplate still applies.

Important

Although every effort has been made to ensure the mathematical combination of forces and moments between two plates is correct, it is the responsibility of the operator / analyst to review the outcomes produced by this process and ensure they are correct. Use of this option in clinical assessments is strictly at the discretion of the operator/ analyst.

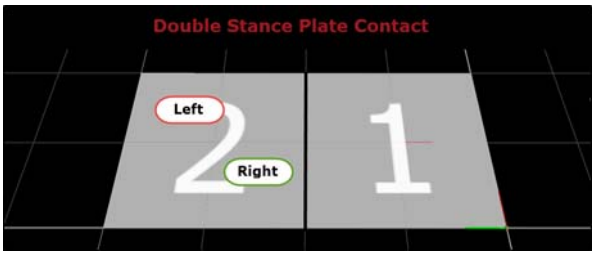
Invalid strike types that do not benefit from the Allow cross-plate strikes option

Only Cross Plate strikes can benefit from the **Allow cross-plate strikes** option; do not use other invalid strike types for kinetic calculation. The other invalid strike types to which Allow cross-plate strikes does *not* apply include:

- **Double stance plate contacts**

  Multiple feet simultaneously in contact with a single plate.

  In the following example, the left and right foot of a subject contact Force Plate 1 at the same time.

  Problem: An inability to assign forces to context

- **Force plate to floor contacts**

  A single foot strike that transitions from an initial contact with the force plate to the lab floor or begins on the floor and transitions to a force plate.

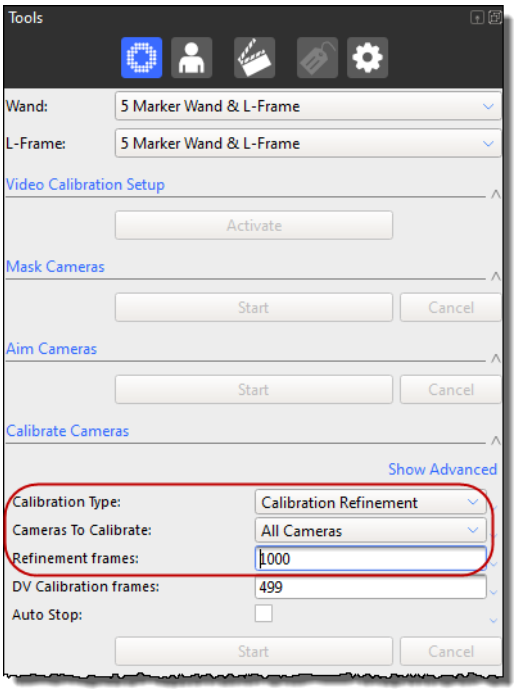
  In the following example, the heel strikes the force plate but the foot rolls forward off the force plate and the later stages of foot contact prior to toe off are in contact with the floor.

  Problem: Full forces / moment are not recorded as the some of these are applied to the floor and not the plate.

Improved system calibration refinement

Calibration refinement now 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.

From Nexus 2.1, **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.

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.	**Calibration Refinement** 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.

New features and functions in Vicon Nexus 2.0

The following new features were introduced in Nexus 2.0.

- Updated user interface
- Updated licensing: VAULT - SafeNet
- Active Communications window
- Enhanced database navigation and search
- Updates to Pipeline operations
- Automated data quality feedback tab
- New processing engine and improved labeling
- Biomechanics workflow
- MATLAB interface
- Python interface

Updated user interface

Vicon Nexus 2 has a new, clean, modern look, complete with new icons and colors. It also enables you to increase the available workspace by using the new hide and slide feature, and provides a new active Communications window.

For more information, see Vicon Nexus 2 user interface on page 106.

Updated licensing: VAULT - SafeNet

Instead of the HASP licensing control, Nexus 2 uses Safenet licensing and the VAULT licensing system.

Nexus 2.x automatically installs into its own folder, so your old Nexus installation is unaffected. Any old files that you choose to import into Nexus 2.x are copied from their original locations, leaving the originals untouched.

Tip

If you need to find out information about licensing while you are using Nexus 2, on the **Help** menu, click **Vicon Product Licensing** or **About Vicon Nexus**.

For more information, see Installing and licensing Vicon Nexus on page 86.

Active Communications window

A new expandable **Communications** window houses new tabs and alerts you to possible issues.

To avoid the window taking up too much onscreen space, you can now to minimize the **Communications** window tabs to the bottom of the screen without completely closing the tabs, so that they remain available when you need them.

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).

For more information, see Active Communications window on page 111.

Enhanced database navigation and search

Nexus 2 includes an updated data management system that offers improved navigation, a data query builder, and greater scope for customization.

Data Management now provides an up-to-date navigation system that takes its cues from Microsoft Windows Explorer and familiar web browsers.

The search query wizard enables you to search Vicon data using both database metadata and outputs within the C3D trial file to retrieve sets of trials. The system can perform search operations within a single database or across multiple databases at once.

For more information, see New Data Management tab on page 112.

Updates to Pipeline operations

Pipelines have been reorganized to make operations easier to find, with new categories introduced and new pipeline operations listed. For more information, see Reorganized Pipeline tools pane on page 119.

Although legacy pipeline files (VPIs) are not installed with Nexus 2 by default, you can manually copy them into a Legacy operations folder and use them with Nexus 2.

To use your old pipelines in Nexus 2:

1. Copy the VPIs from the following location in the previous installation folder (by default **C:\Program Files (x86)\Vicon** or **C:\Program Files\Vicon**):

   \Nexus\WorkstationPlugins

2. Paste them to the following location in the current installation folder (by default **C:\Program Files (x86)\Vicon** or **C:\Program Files\Vicon**):

   \Nexus2.x\LegacyPlugins

   They will then be available in the **Legacy** pipeline operations in Nexus 2.

To bring your software up-to-date, you can also use the replacement APIs (MATLAB and Python) to rewrite custom operations or PECS scripts.

For more information, see Modeling with Nexus 2: Plug-in Gait, MATLAB, Python on page 215.

Automated data quality feedback tab

A new tab in the **Communications** window intelligently assesses data quality and presents this information immediately after processing.

You can choose the way that information about data quality is displayed:

- Heat map A heat map overlay is now displayed in the timebar, providing all marker, single marker, or multiple marker heat maps across the trial. This feature can help you to identify a time area where data quality is low or provide a time/all frame view of a single marker's quality.
- Data correct view The data correct view automatically rearranges the data windows and is triggered when you select a quality blob on the **Quality** tab. The default view presents you with a split screen showing the gap in both a **3D Perspective** view and a **Graph** view at the same time.

Improved data-fixing toolkit

A new set of tools provides greater automation in correcting data quality problems. The tools include filling options, such as **Rigid Body Fill** and **Kinematic Fill**. You can select from options to automatically select donor trajectories and **Fill All**.

For more information, see Automated data quality on page 131.

New processing engine and improved labeling

Updated architecture offers significant improvements to the fundamental labeling and real-time functions of Vicon Nexus 2. Benefits include:

- More accurate calibration
- Improved labeling (can eliminate the need for manual labeling in many cases, fewer mismatches, etc)
- Reduced time spent manual labeling and, due to significant improvements in labeling quality, in processing dynamic trials.

For more information, see New workflow for improved labeling on page 149.

Biomechanics workflow

The new methodology included in Vicon Nexus 2 uses the dynamic movement around a subject's joints to minimize errors and significantly improve the estimation of joint centers and joint axes. This approach is known as functional calibration.

Nexus 2 introduces a full functional calibration workflow, in which the SCoRE and SARA methods and algorithms, patented by the Julius Wolff Institute for Biomechanics and Musculoskeletal Regeneration, at the University of Berlin, can be included.

The biomechanics workflow offers two key components:

- You can now create and save subject calibration pipeline steps (a workflow).
- Real-time visual calibration feedback provides you with an instant and reliable indication that enough subject joint calibration frames have been collected for a successful calibration.

The biomechanics workflow system largely replaces the functions of the Nexus 1.x Protocols by enabling you to save a series of live and/or offline steps (a workflow) for both collecting and processing data.

For more information, see Biomechanics workflow on page 183.

Real-time subject monitors (joint range overlay monitors)

To allow real-time monitoring of subject calibration (particularly functional calibrations), Nexus 2 includes a new monitor type. These new joint range monitors enable you to monitor any kinematic subject joint in real-time during a range of motion trial (ROM) or single joint calibration.

The new monitors are also valuable in non-calibration trials, for example, sports performance trials.

For more information, see View real-time subject calibration feedback with monitors on page 186.

Auto Initialize Labeling pipeline for fast calibration

The new **Auto Initialize Labeling** pipeline can, in many circumstances, eliminate the need for the manual labeling step that was previously required for static trials, and enables you to run functional subject calibration.

For more information, see New workflow for Vicon Nexus 2 on page 158.

MATLAB interface

Vicon Nexus 2 provides a native MATLAB interface and new associated offline API within Nexus to replace PECS.

The Nexus **Communications** pane now contains an integrated **Matlab** tab to enable you to launch MATLAB, pass arguments to it, and run MATLAB scripts that you created using the new API. You can create and share code with other users of Nexus.

For more information, see Modeling with MATLAB on page 218.

Python interface

If you don't have access to MATLAB, you can still benefit from the new modeling and code-sharing functionality in Nexus 2 by using the new Python interface.

For more information, see Modeling with Python on page 229.

Installing and licensing Vicon Nexus

This chapter provides information about installing Vicon Nexus. It also includes details about how to license Nexus using the updated licensing software, SafeNet Sentinel and Vicon Automated Unified Licensing Tool (VAULT). For details, see the following topics:

Install Vicon Nexus

To install Vicon Nexus:

1. Visit the Vicon Downloads page at http://www.vicon.com/downloads/.
2. From the **Core software** area, download the Vicon Nexus 2.x software installer.
3. In Windows Explorer, go to the folder to which you downloaded the installer and double-click **setup.exe**.

   Note

   If you are upgrading from an earlier version of Nexus, note that before proceeding with installation, Nexus 2 automatically scans for Nexus 1.x files, displays a list of any older files that it finds, and provides an automated system for importing these into Nexus 2. This process copies all the old files and converts the copies, ensuring that original files are not moved, altered, or destroyed.
4. On each wizard page, provide the requested details, and click **Next**.
5. On the **End-User License Agreement** wizard page, read and accept the terms.

   Tip

   If you choose to install the license server, if an older version of the license server is already installed, it is replaced. If the same version is already installed, the license server is not installed. If you are already using any other version of the SafeNet licensing tools, before replacing them with the version included with Vicon Nexus, contact Vicon Support for advice.

   If you are setting up a network license server and you do not want Vicon Nexus on that machine, you can choose to install only the license sever.
6. In the confirmation boxes, check that the selected components have been successfully installed and click **OK**.
7. On the final wizard page, click **Finish**.
8. Enter the required information into the subsequent dialog boxes until the installation is complete.

Note

Installing the Sentinel License Manager also installs the License Tools.

File and folder locations

The main installation folder, to which Vicon Nexus 2 is installed is:

InstallLocation\Nexus2.x

Where:

InstallLocation is the location you select during installation. If you don't select a location, Nexus is installed in the default location:

C:\Program Files (x86)\Vicon)\Nexus2.x or
C:\Program Files\Vicon\Nexus2.x

Important

Files in this folder are Read-Only system files and must not be modified.

Shared and Private files

When you use Nexus, files that you create as Shared files are stored in subfolders in the following folder:

C:\Users\Public\Documents\Vicon\Nexus2.x

Files that you create as Private files are stored in subfolders of the following folder:

C:\Users\username\AppData\Roaming\Vicon\Nexus2.x

Calibration files

Calibrations are shared between Vicon products and are stored in a common Program Data folder:

C:\ProgramData\Vicon\Calibrations

About licensing Vicon Nexus 2

From release 2.0, Nexus is licensed using SafeNet Sentinel and Vicon Automated Unified Licensing Tool (VAULT). Licenses are delivered via email from Vicon Support or Sales. The licenses are attached to email as files with extension .lic or with no extension. All license files are readable in a text editor.

A dongle is not necessary to license Nexus through SafeNet, although you can use dongles with Nexus. These must be SafeNet USB dongles and ordered in addition to Nexus. You cannot use existing HASP dongles that were previously used to license Nexus.

See also:

- Types of license
- License locking
- Network licensing
- USB dongles
- Running multiple instances of Vicon Nexus

Types of license

Two different types of license are available.

- Standalone A license that is installed on the machine that is running Vicon Nexus.
- Network A license that is installed on a SafeNet license server, which can serve multiple seats of Nexus running on different machines.

License locking

Licenses can be locked in two different ways.

- PC locked A combination of the MAC address of one of the network interfaces and an ID from one of the hard disks in the machine are used to create a unique lock code.
- Dongle locked A SafeNet USB dongle has a unique lock code.

You can have any combination of the type and locking stated above, giving four different license configurations.

- Standalone – PC locked
- Standalone – Dongle locked
- Network – PC locked
- Network – Dongle locked

Network licensing

The SafeNet License Server software is installed in addition to Vicon Nexus. You can install the SafeNet Licenser Server software in the following ways.

- Using the Vicon Nexus installer (as part of the normal Nexus installation procedure)
- Using the Vicon Product Licensing installer
- Using SafeNet's installer. This may have been sourced from either SafeNet or through Vicon.

The SafeNet License Server software can be installed on the same machine that needs to run Nexus or (more usually) on a machine central to all machines that need to run Nexus.

USB dongles

When using a SafeNet USB dongle, the correct dongle driver needs to be installed. This driver can be installed in the following ways:

- Windows may automatically install the driver when the dongle is plugged in for the first time.
- Using the Vicon Nexus installer (as part of the normal Nexus installation procedure)
- Using the Vicon Product Licensing installer
- Using SafeNet's installer. This may have been sourced from either SafeNet or through Vicon.

Standalone dongle licensing

When you start Nexus, the presence of the dongle will be checked to ensure that the standalone license will allow Nexus to run. You do not need to have the dongle plugged in to activate the license.

Network dongle licensing

At the time that the License Server starts (usually at machine start), the presence of the dongle will be checked. If the dongle is not plugged in when the License Server starts, it will not be possible to activate a license or use a license previously activated on the server locked to the dongle.

Running multiple instances of Vicon Nexus

Usually, multiple instances of Nexus can be run on the machine from the same license. Multiple network seats are not used up when running multiple instances on the same machine.

License Vicon Nexus

To start using Vicon Nexus, you must first request a license and activate it. You may also need to set the license server for your license. If you want to use Vicon Nexus remotely, you will need to set up commuter licensing. For details of these procedures, see the following topics:

- Request a license
- Activate a license
- Set the license server
- Move and revoke Vicon Nexus licenses (including commuter licensing)

The Vicon Licensing software also enables you to:

- View information about license servers

Request a license

To request a license, you start Vicon Nexus and supply the relevant details.

To request a license from Vicon Support:

1. If you are using a SafeNet dongle to license your machine:
   a. Ensure you have installed the latest dongle drivers onto the PC on which you will run Vicon Nexus. You can either choose the option for dongle drivers when you install Vicon Nexus, or run the Vicon Nexus installer at any time, or you can download the drivers from the Downloads page on the Vicon website.
   b. Insert the dongle.
2. On the machine for which you want the license (either a networked license server or a standalone machine), start Vicon Nexus and at the left of the dialog box, click **Request License**.

Tip

You can also manage licensing in the following ways:
– After you have licensed Vicon Nexus, start Nexus and on the Help menu, click **Vicon Product Licensing**; or
– To run the Vicon Automated Unified Licensing Tool (VAULT) independently of Vicon Nexus, click the **Start** button, then **All Programs > Vicon > Licensing > Vicon Product Licensing**.

3. At the top of the **Request a License** dialog box, from the **Product** and **Product Version** menus, ensure Vicon Nexus and **2.x** are selected.

4. In the appropriate fields, type your name, email address and company name.

5. In the **Options** area, select whether to request:

   - **Standalone license locked to local PC name**: for use by the PC from which you are sending this request only
   - **Network license locked to license server name**: for use on the license server machine from which you are sending this request by one or more PCs on the same network
   - **Standalone license locked to a dongle**: for use with the specified dongle on a single PC. In the **Dongle ID** field, type the ID, which is found on the dongle.
   - **Network license locked to a dongle**: for use on a license server machine by one or more PCs via the specified dongle. In the **Dongle ID** field, type the ID, which is found on the dongle.

6. For network/server based licenses only: if necessary, change the value for the **Number of Seats**.

7. Leave the settings in the **Machine** area at their default values unless you are asked to change them by Vicon Support (for example, if you are using a dual-booting system or have had to reinstall Windows).

8. Do one of the following:

   - If you can currently email your license request, click the **Email Request** button; or
   - If email is currently unavailable, click **Save Request to a file**, so that you can send the request later. Type or browse to a suitable location and click **OK**. The file is saved as **ViconLicenseRequest*.xml**. When possible, email the file to Vicon Support.

Activate a license

After you have received a license file from Vicon Support, you must activate it before you can start using Vicon Nexus.

To activate a license:

1. Check your email for a message from Vicon Support. The license file (named Vicon Nexus Release Number License Type.lic, for example, Vicon Nexus 2.1 Network.lic) is attached to the email. If you are using a Safenet dongle, the email has the ID of your dongle (of the form UBnnnnnn) in the **Subject** line.

   If you have not received a license file, request one as described in Request a license on page 92.

2. Save the license file (*.lic) to the Windows desktop of the machine for which you have a license (or any other suitable location).

3. Start Vicon Nexus and in the **Vicon Automated Unified Licensing Tool** dialog box, click **Activate License**.

4. Depending on whether you are using the file as it was received from Vicon Support or as a text string copied from the file:

   - In the **License File Activation** field, type or browse to the location of the license file (*.lic) and click **Activate from File**; or

   - Copy the text to the **License Activation string** field and click **Activate from String**.

5. Click **OK**.

Tip

You can deactivate a network license from the relevant license server machine only, not from any of the client machines.

When you have activated your license, you are ready to start using Vicon Nexus.

Set the license server

If a server provides licenses to client PCs on your network, to enable a client PC to find its license quickly, on the client PC specify the license server for Vicon Nexus to use.

If you use standalone licensing, Vicon Nexus should find its license. If not, or if you need to change the license server, complete the following steps.

To enable Vicon Nexus to find its license:

1. Ensure you have installed Vicon Nexus as described in Install Vicon Nexus on page 87. Depending on the type of license you have, ensure that your system is ready:
   - If your PC obtains its license from a license server, ensure that Vicon Nexus is licensed on the relevant server.
   - If you are using a standalone license, ensure that you have requested, saved and activated your license on this machine.
2. Start Vicon Nexus and depending on whether or not a license is found:
   - If the **Vicon Automated Unified Licensing Tool** dialog box opens, click **Set License Server**; or
   - If Vicon Nexus opens and you want to view or change the current license server:
     a. On the **Help** menu, click **Licensing**.
     b. In the **Vicon Automated Unified Licensing Tool** dialog box, go to the **Product License Location** list (in the lower half of the dialog box), and right-click on the line that shows the relevant Vicon Nexus license and then click **Set License Type**.

3. In the **Change License Server** dialog box, do one of the following:
   - To use standalone licensing, select **Use Standalone/Commuter Licenses Only** and then click **OK**.
   - To obtain a license from any available license server (local or on a network), select **Use Standalone/Commuter Licenses Or Scan for a License Server** and then click **OK**.
   - To select a specific license server from a list of available servers:
     a. Click **Discover**. Local and network licenses are displayed.
     b. In the **Available Servers** list, double-click the required license server and then click **OK**.
   - To specify a license server on your network, select **Use a Specific Network License Server**, type the name in the **License Server** field, and click **OK**.

Tip

You can instead select the required license server by going to the **License Server** list (in the upper half of the **Vicon Automated Unified Licensing Tool** dialog box), right-clicking on the line that shows the relevant Vicon Nexus license and then clicking **Use This License for Vicon Nexus**.

View information about license servers

In the **Vicon Automated Unified Licensing Tool** dialog box, you can view information about all available license servers without affecting the license server that is currently in use. To do this:

1. Open the advanced **Vicon Automated Unified Licensing Tool** dialog box by doing one of the following:
   - Before licensing Vicon Nexus, start Nexus and in the **Vicon Automated Unified Licensing Tool** dialog box click **Advanced Licensing**; or
   - After Vicon Nexus is licensed, start Vicon Nexus and on the **Help** menu, click **Licensing** to open the **Vicon Automated Unified Licensing Tool** dialog box; or
   - Click the Windows **Start** button, then **All Programs** > **Vicon** > **Licensing** > Vicon **Product Licensing**.
2. In the **Vicon Automated Unified Licensing Tool** dialog box, if the required license server is not displayed in the **License Server** field at the top, click **Change** at the top right of the dialog box.
3. In the **Options** area of the **Select License Server** dialog box, do one of the following:
   - To view local standalone licenses and commuter licenses (for information on commuter licenses, see Use commuter licenses on page 98), select **View Licenses from the Locally Installed License Server**; or
   - To view licenses on a specified license server, type the name of the required server in the **License Server** field. If you don't know the name of the license server, click **Discover** and in the **Available Servers** list, double-click a license server.
4. Click **OK**.

   In **License Server** list at the top of the **Vicon Automated Unified Licensing Tool** dialog box, licenses from the specified license server are displayed.

Tip

Changing the license server that is displayed in the **License Server** list does not affect the license server that is used for licensing, shown in the **Product License Location** list in the lower part of the dialog box. To change the license server that is used for licensing, see Set the license server on page 97.

Move and revoke Vicon Nexus licenses

While using Vicon Nexus, you may find that you want to temporarily use a seat from a license on a machine that is not on the license server network (commuter licensing), or that you need to permanently move the license from one machine to another, involving license revocation.

This section contains information on how to:

- Use commuter licenses
- Revoke a license

Use commuter licenses

After you have licensed Vicon Nexus, if required, you can check out (borrow) a seat from a network license so that it can be used for the number of days that you specify, on a machine that is not connected to the license server network (known as commuter licensing). You can check out a seat to either:

- A machine on your network (see Check out to a network machine on page 99), so that Vicon Nexus can subsequently be used when the machine is no longer connected to your network; or
- A machine that is not connected to your network (see Check out to a remote machine on page 99).

When a commuter license is no longer needed, it is checked back in again, so that it can be used from the license server network as usual. Licenses are automatically checked in at the end of a specified check-out period, or can be manually checked in early (not applicable to remotely checked-out licenses), For more information, see Check in a commuter license on page 103.

Check out to a network machine

You can check out a seat from an existing license for use on a machine on your license server network, so that Vicon Nexus can subsequently be used on the machine when it is no longer connected to your network.

To check out a seat to a machine on the license server network:

1. On a network machine that you later want to use remotely, open the advanced **Vicon Automated Unified Licensing Tool** dialog box by doing one of the following:

   - Start Vicon Nexus and on the **Help** menu, click **Licensing**; or
   - Click the **Start** button, then **All Programs** > **Vicon** > **Licensing** > **Product Licensing**.

2. In the **License Server** list in the top part of the dialog box, right-click on the license that contains the seat that you want to check out and click **Check Out**.

3. In the **Check Out License** dialog box, specify the number of days for the license to be used remotely and then click **Check Out**.

   Checked out licenses are flagged with **Commuter** in the **Type** column in the **License Server** list in the top part of the **Vicon Automated Unified Licensing Tool** dialog box.

Check out to a remote machine

In addition to checking out a license to a network machine (see Check out to a network machine above), you can also check out a license to a machine that is running the Vicon Automated Unified Licensing Tool (VAULT), but is not connected to the network containing the license server. This involves the following procedures:

- Generate a locking code on the remote machine and send it to a user of a machine on the license server network.
- Check out a commuter license on a network machine and send it to the remote user.
- Save and activate the commuter license on the remote machine

Generate a locking code on the remote machine

On the remote machine on which you want to use Vicon Nexus, use VAULT to generate a locking code, which can then be sent to someone on the network that includes the Vicon Nexus license server.

To generate a locking code:

1. To open the advanced **Vicon Automated Unified Licensing Tool** dialog box, do one of the following:

   - Start Vicon Nexus and in the **Vicon Automated Unified Licensing Tool** dialog box click **Advanced Licensing**; or

   - Click the **Start** button, then **All Programs** > **Vicon** > **Licensing** > **Product Licensing**.

2. In the **Vicon Automated Unified Licensing Tool** dialog box, click **View Remote Locking Code**.

3. In the **Current Machine Locking Code** dialog box, type the email address of a person to whom the network license server is available, and click **Send**, or to save it to a string to send later, type or browse to the required location and filename, click **Save to File** and close the dialog box.

   The person with access to the license server can then check out a commuter license for use on the remote machine, as described in Check out a commuter license on a network machine on page 101.

Check out a commuter license on a network machine

When you receive a locking code for a remote machine, you can use the locking code to check out a license for the number of days that you specify. You can then send the license to the user of the remote machine.

To check out a commuter license

1. To open the advanced **Vicon Automated Unified Licensing Tool** dialog box:
   - Start Vicon Nexus and on the **Help** menu, click **Licensing**; or
   - Click the **Start** button, then **All Programs** > **Vicon** > **Licensing** > **Product Licensing**.
2. In the **License Server** list in the top part of the dialog box, right-click on a license that permits commuter licensing for Vicon Nexus.

   If the selected license permits commuter licensing, the context menu displays a **Check Out** option and at the bottom of the dialog box, a **Check Out** button is displayed.
3. Click **Check Out** and in the **Check Out License** dialog box:
   a. Specify the number of days to use the license remotely.
   b. Expand the **Advanced Options** by clicking the downward pointing arrow on the right, and click **Remote Check Out**.

   Caution

   Do not overestimate the number of days for which the license will remain checked out. After a remote check out, you cannot check the license back in again until the number of days that you specified has expired.
4. In the **Remote Commuter License Check Out** dialog box, enter the locking code string for the remote machine that was emailed or sent by the user of the remote machine, as described in Generate a locking code on the remote machine above, and click **Check Out**.
5. In the **Save Commuter License** dialog box, type or browse to a path and filename for the saved commuter license, click **Save to File** and then close the dialog box. The commuter license is saved as a license file (*.lic).
6. Email the saved commuter license file to the remote user. The remote user can then save and activate the checked-out commuter license on the remote machine, as described in Save and activate the commuter license on the remote machine on page 102.

Save and activate the commuter license on the remote machine

When you receive a license file for a remote machine, you can use VAULT to activate the license for use on the remote machine.

1. Save the file that was sent to you as described in Check out a commuter license on a network machine above to the Windows desktop (or any other suitable location).

2. To open the advanced **Vicon Automated Unified Licensing Tool** dialog box, do one of the following:

   - Start Vicon Nexus and in the **Vicon Automated Unified Licensing Tool** dialog box click **Activate License**; or
   - Click the **Start** button, then **All Programs** > **Vicon** > **Licensing** > **Product Licensing**, and then click **Activate License**.

3. Depending on whether you are using the file as it was received from the license network user or a text string copied from the file, do one of the following:

   - In the **License File Activation** field, type or browse to the location of the license file (*.lic) and click **Activate from File**; or
   - Copy the text to the **License Activation string** field and click **Activate from String**.

4. Close the **Activate a License** dialog box.

   In the **License Server** list in the top part of the **Vicon Automated Unified Licensing Tool** dialog box, checked out licenses are flagged with **Commuter** in the **Type** column.

Check in a commuter license

Licenses that have been checked out are checked back in and made available for use from the network in either of the following ways:

- If the specified check-out period has expired, the license is automatically checked back in.
- If the license is no longer needed for remote use, you can check it back in early.

Caution

This does not apply to licenses that were checked out using **Remote Check Out**, which remain checked out until their check-out period expires.

To check in a license manually:

1. To open the advanced **Vicon Automated Unified Licensing Tool** dialog box, do one of the following:
   - Start Vicon Nexus and on the **Help** menu, click **Licensing.**; or
   - Click the **Start** button, then **All Programs** > **Vicon** > **Licensing** > **Product Licensing**.
2. In the top part of the **Vicon Automated Unified Licensing Tool** dialog box, click on the license you want to check in and then click **Check In License**.

Important

You cannot check in a license that was checked out using **Remote Check Out** before its check-out period has expired. You set the check-out period when you check out a license. To see how many days are left on a commuter license, in the **License Server** list in the top part of the **Vicon Automated Unified Licensing Tool** dialog box, find the relevant license and look at the date in the **Expiry** column.

Revoke a license

You may find that you need to move your Vicon Nexus license to a license server machine that is different from the one for which you originally obtained the license. To do this, you must revoke the original license. (If you want to temporarily use a single license seat on a remote machine, see Use commuter licenses on page 98.)

Important

To avoid delays when changing license servers, before clicking **Revoke License**, email Vicon Support and wait to receive a reply before proceeding.

Ensure that your email to Vicon Support includes the following details:

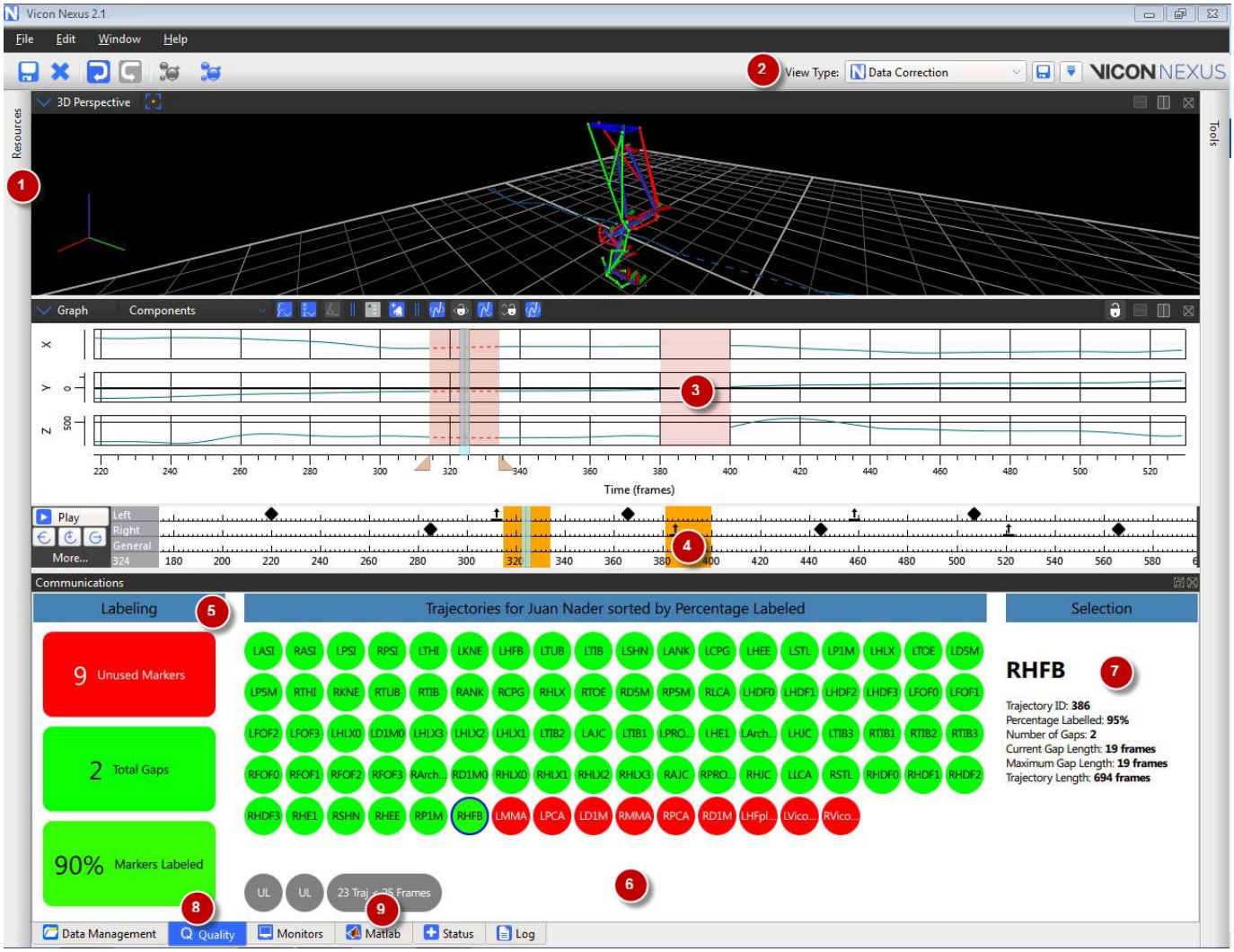
- The Vicon product name (ie Vicon Nexus) and `license revocation` in the **Subject** line of the email.
- Information about the license that you want to revoke, including number of seats and locking code of the license server machine.
- The locking code of the machine to which you want to move the license.

Vicon Nexus 2 user interface

This chapter covers the following topics:

New look Nexus

The Vicon Nexus user interface has been updated. As soon as you load a trial, you can see some of the new features of this release.

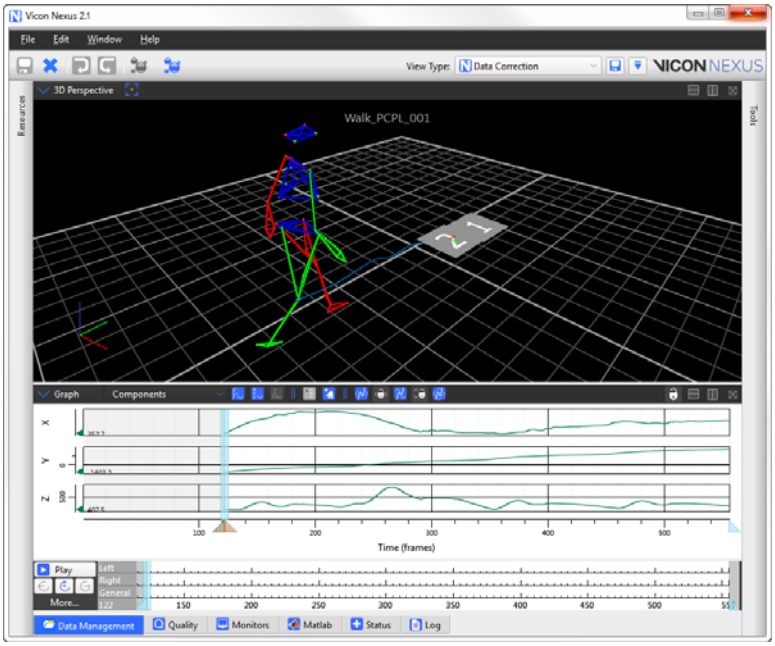


Features of the Nexus 2 user interface

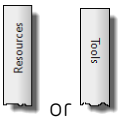
1. Slide and hide panes (**Resources** and **Tools**) (click the Unpin button to use them)
2. **Data Correction** view type selected
3. Gap indicators
4. Heat map display on timebar
5. Overall trial health indicators (on new **Quality** tab)
6. Trajectory health blobs
7. Selection information with blob selected (if no blob is selected, shows general information about the trial.)
8. **Quality** tab
9. **MATLAB** tab

Make space with the slide and hide panes

The option of sliding the **Resources** and **Tools** panes to either side of the Vicon Nexus window gives you a larger workspace area.



To use the hide and slide panes:

Requirement	Action
To hide a pane	At the top of the **Resources** or **Tools** pane, click the **UnPin** button. 
To reveal a pane	Click the tab at the side of the Nexus window  or

To return a pane to being locked into place	At the top of the pane, click the **Pin** button.	
To undock (float) and dock a pane	At the top of the (pinned) pane, click the **Undock** or **Dock** button.	 or 

Active Communications window

The Communications window now can now be optionally hidden to increase the available workspace, and can easily be restored with a double-click of the mouse. It now houses new tabs, including an updated **Log** tab.

The icon on the **Log** pane in the **Communications** window alerts you to important new information by appearing to scroll when new errors are displayed, and is a valuable diagnostic tool throughout the workflow.

To hide or reveal the Communications window:

- Double-click any of the tabs at the bottom of the Communications window.

To dock and undock the Communications window:

Requirement	Action	Button
To undock (float) and dock the Communications window	At the top of the window, click the **Undock** or **Dock** button.	
To make an undocked Communications window full screen	At the top of the window, click the **Full Screen** button.	

New Data Management tab

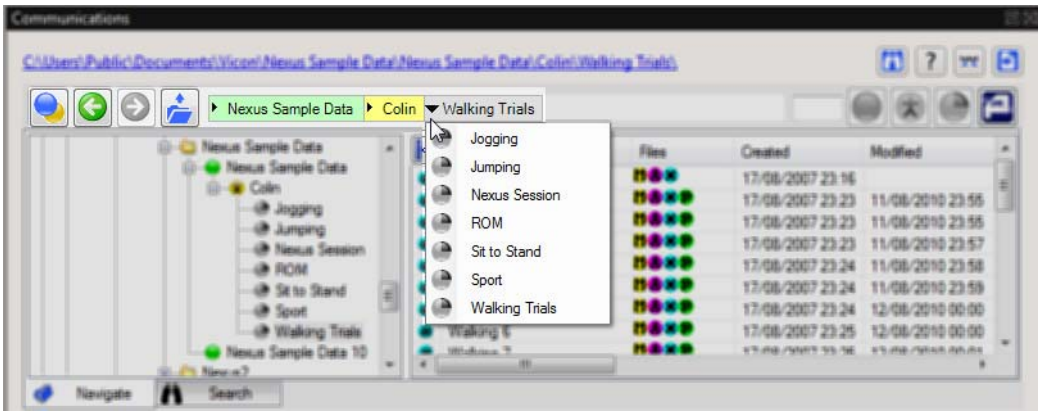
The default location of **Data Management** is now on an easily accessed tab at the bottom of the **Communications** window. If you prefer, you can click the buttons at the top right of the tab to undock it and display it full-screen.

See also:

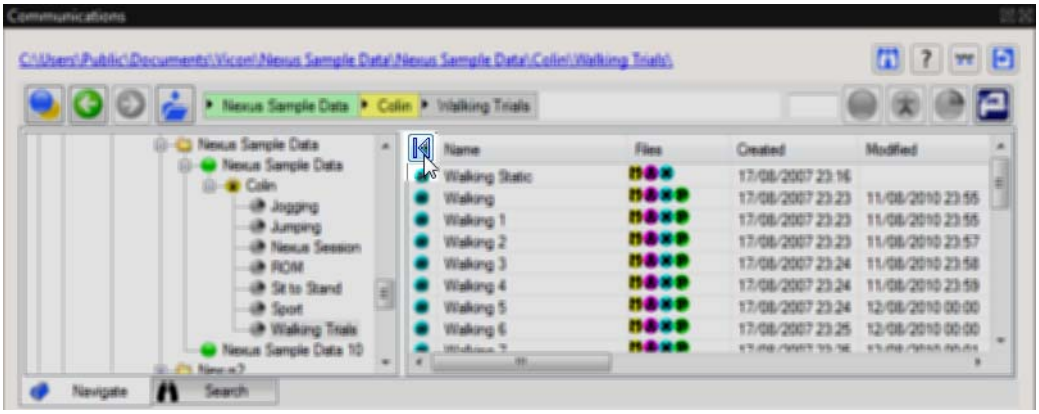
- Improved Data Management navigation
- Easier customization of Data Management
- Advanced data searching

Improved Data Management navigation

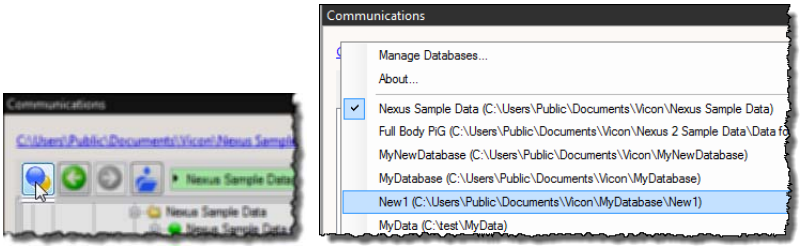
Navigation in Data Management is now similar to the familiar environments of the web or in Microsoft Windows. Forward, back and up controls are displayed and path navigation, similar to that in Windows Explorer is available.



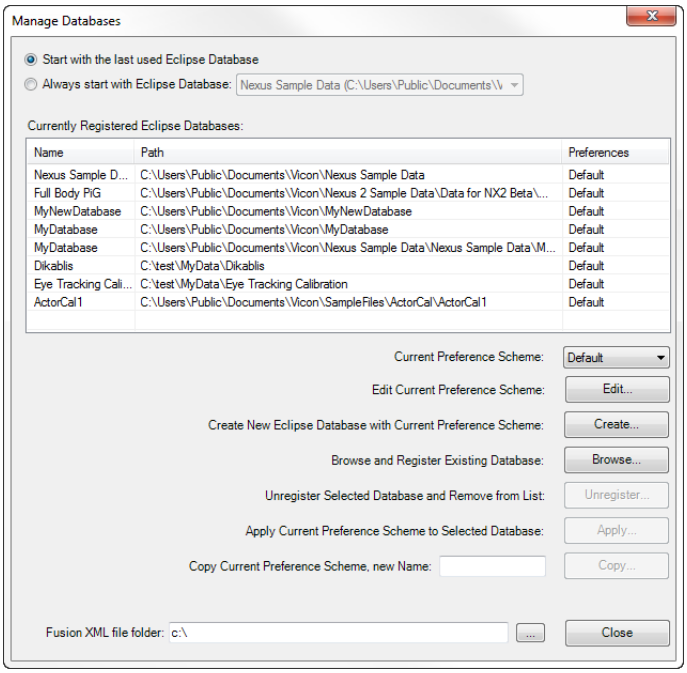
For faster navigation within a database or across a hard drive, you can also hide the tree view to expand panes.



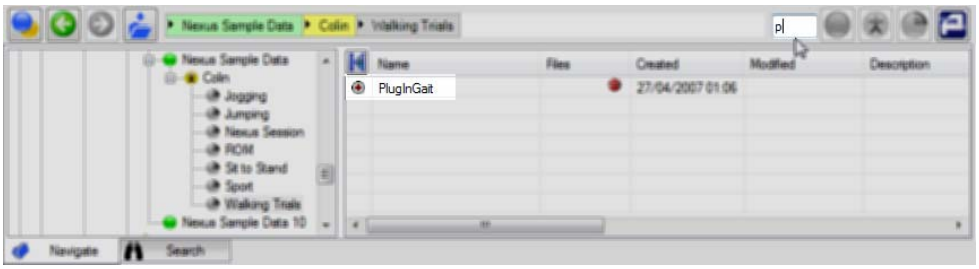
The main menu gives you instant access to the most recently used database.



It also gives you access to the **Manage Databases** dialog box, enabling you to create, browse and register databases, as well as access other options for managing them.



The Quick Search facility enables you to filter all the files that are visible in the current view by typing any letter into the Quick Find box.



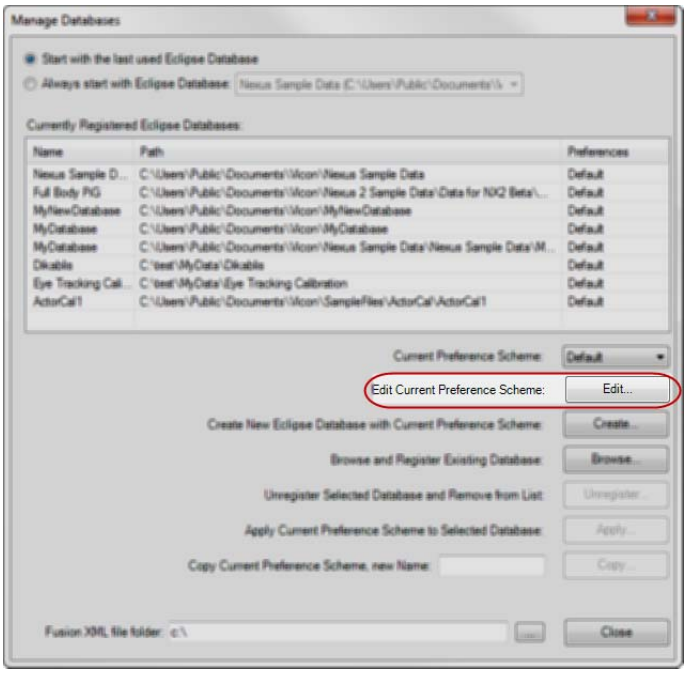
Easier customization of Data Management

You can now customize databases from within Vicon Nexus to display the required columns, to show specific, searchable metadata.

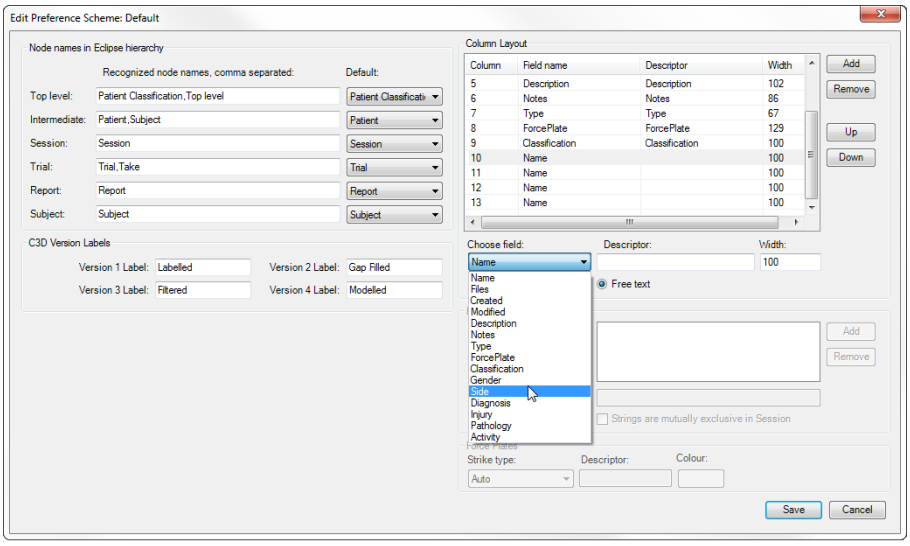
To customize the display of data on the Data Management tab:

1. On the **Data Management** tab, click the **Main Eclipse menu** button and then click **Manage Databases**.

2. In the **Manage Databases** dialog box, click the **Edit** button.



3. In the **Edit Preference Scheme Default** dialog box, specify how you want to display your data, for example, which columns to display, and how to display force plate data.



Advanced data searching

The new 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 now:

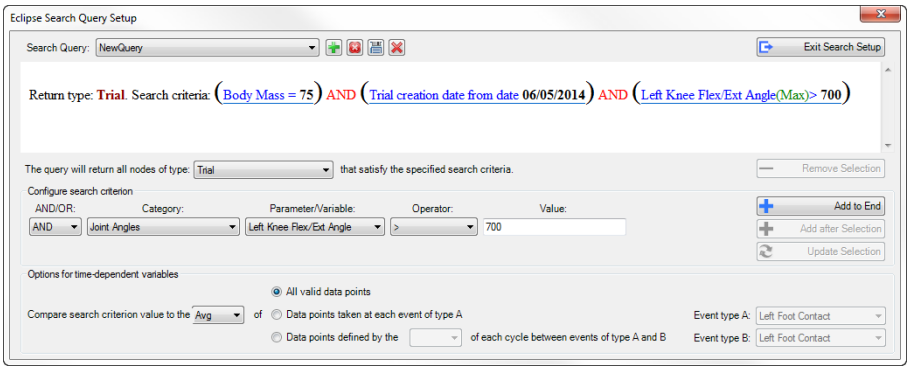
- Search a single database or across multiple databases
- Search databases that exist on the local PC or across a network drive
- Use the wizard-based search building system
- Build complex search criteria for metadata or C3D information

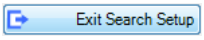
For example, searches you might set up could be:

- 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.

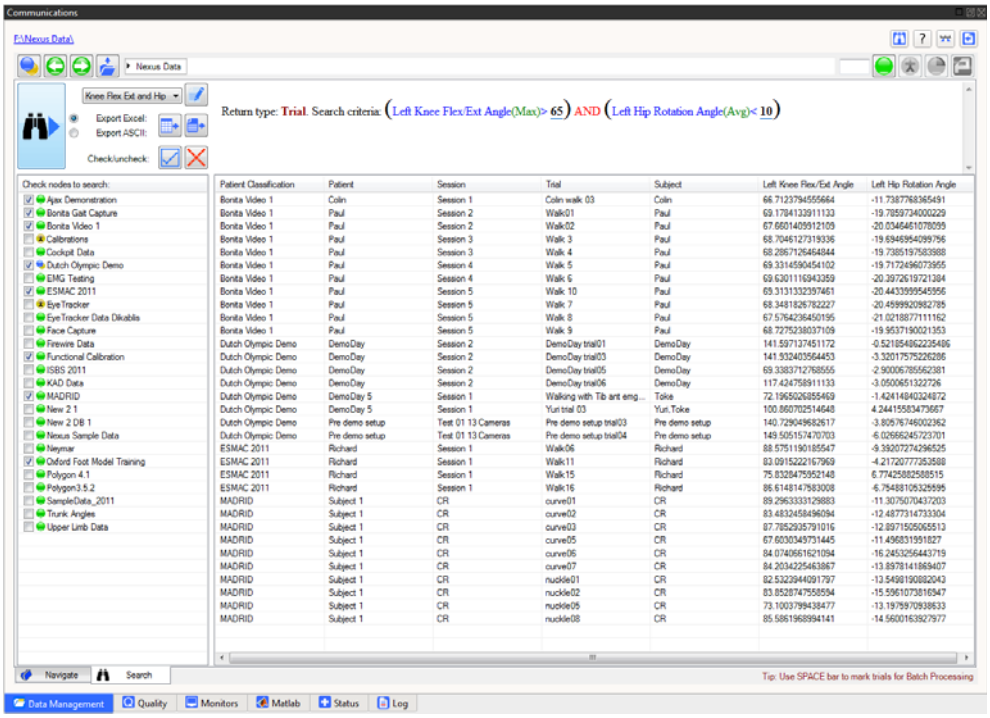
To use the search query wizard:

1. On the **Data Management** tab, click the **Search** tab at the bottom of the pane, and then click the **Open search queries for editing** button  .
2. In the **Eclipse Search Query Setup** dialog box, click the **Add New** button (green plus sign) and specify your search.



3. When you have finished, click the **Exit Search Setup** button (top right) 
.
4. Make sure you have selected the required location to search and then click the **Run currently selected search** button.

The results of your search are displayed.

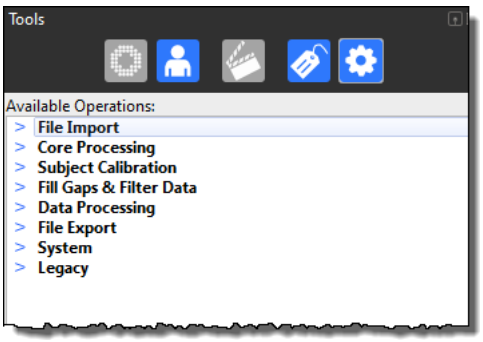


You can now:

- 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)

Reorganized Pipeline tools pane

The pipelines have been reorganized to make individual operations easier to find, with new categories introduced and new pipeline operations listed.



The categories are listed in the order in which you are likely to need to use them, so File Import operations are listed first, with File Export operations towards the end.

New pipeline operations

The following new pipeline operations have been added to the reorganized and renamed sections. Instructions for using the new pipeline operations are found throughout this guide.

Core Processing

- Combined Processing
- Reconstruct
- Label
- Kinematic Fit

Subject Calibration

- Autolabel Static
- Scale Subject VSK
- Calibrate OCST
- Calibrate SCoRE/SARA

Fill Gaps and Filter Data

- Fill Gaps - Kinematic
- Fill Gaps - Rigid Body
- Fill Gaps - Woltring

Data Processing

- Run MatLab Operation
- Run Python Operation
- Process OCST
- Process SCoRE/SARA.

Recognize Shared, Private, and System files

When pipelines, view types, monitors, labeling skeleton templates, and configurations are displayed in Nexus, you can immediately recognize whether they are Private, Shared, or System files:

Icon	File type	Description
	Shared	Can be viewed by multiple users; can be changed only by the user who was logged on when the file was first created and saved. Shared files are stored in subfolders in: C:\Users\Public\Documents\Vicon\Nexus2.x
	Private	Can be viewed and changed only by the user who was logged on when the file was first created and saved. Private files are stored in subfolders in: C:\Users\username\AppData\Roaming\Vicon\Nexus2.x
	System	Cannot be changed (Read-Only) and are upgraded when the next version of Nexus is installed. Stored in subfolders in the Nexus installation folder, whose default location is: C:\Program Files (x86)\Vicon)\Nexus2.x or C:\Program Files\Vicon\Nexus2.x

Hot keys and shortcuts

This section covers the following topics:

Common hot keys and shortcuts

You can use the mouse to manipulate items and manage the way data is displayed in the Vicon Nexus window. Standard mouse actions can also be combined with keyboard keys. The following mouse actions and hot keys are available throughout Nexus, where applicable/available:

Task	Mouse and key
Start/stop capture	CTRL+Enter
Select individual items	Click
Select items within a bounding outline	ALT+click and drag
Select multiple non-consecutive items	CTRL+click
Rotate/orbit	Click and drag
Zoom	Right-click and drag
Translate/Move	Click wheel button (or left-and-right-click) and drag
Scroll forward or backward through a list	Rotate mouse wheel
Undo	CTRL+Z
Redo	CTRL+Y
Save currently enabled subject data to the current trial's *.c3d* file (equivalent of clicking **Save** on the **File** menu)	CTRL+S
Reset Core Processor	CTRL+R
Esc	Exit current model (labeling, etc)

Important

The behavior of the ALT GR key depends upon the regional settings specified for your keyboard in the Windows operating system. In some regions, the behavior of this key is identical to that of the ALT key, while in other regions the ALT GR key functions as if the ALT+CTRL keys were pressed together. Nexus assumes the latter behavior. If you wish to use the ALT GR key as if it was the ALT key, you must change the regional settings for your keyboard to use the US layout, which assumes identical behavior for these two keys. You change your keyboard language settings in the Text Services and Input Languages dialog box, accessed from the Languages tab in the Regional and Language Options dialog box in Windows Control Panel. For more information, see the Microsoft Windows help.

Shortcuts for navigating in Vicon Nexus

Use the following hot keys to navigate to the different areas of the Vicon Nexus user interface.

Task	Keys
Display the Vicon Nexus online help	F1
Display/Close Data Management tab	F2
Enter/Exit full screen mode	F5
Display/Close Options dialog box	F7
Go to System Preparation tools pane	F8
Go to Subject Preparation tools pane	F9
Go to Capture tools pane	F10
Go to Label/Edit tools pane	F11
Go to Pipeline tools pane	F12

Tip

The behavior of function keys is dependent upon the area of the Nexus window that has focus when the key is pressed. Click anywhere in the window to set the focus before using the function keys to navigate to a different part of the user interface.

Shortcuts for managing real-time data

Use the following hot keys to manage real-time data streaming and offline data processing in Vicon Nexus.

Task	Keys
Switch between Live and Offline mode	CTRL+TAB
Pause/Restart real-time data streaming (Live mode)	SPACE
Play/Stop offline data (Offline mode)	SPACE

Shortcuts for selecting items

Use these hot keys and mouse actions to select items in the Vicon Nexus window. To cancel a selection, left-click again in the view pane.

Task	Keys and mouse
Select single item	Click
Select multiple non-consecutive items	CTRL+click
Select multiple non-consecutive items maintaining the order of selection	SHIFT+CTRL+click
Select multiple consecutive items	SHIFT+click, SHIFT and drag, or drag
Select next optical camera	]
Select previous optical camera	[
Select next video camera	CTRL+]
Select previous video camera	CTRL+[

Shortcuts for moving the camera view

Use the following mouse actions to move the camera view in the 3D Perspective, 3D Orthogonal, and Camera view panes.

Task	Mouse
Zoom: Move the camera viewpoint closer to or further away from the focal point	Right-click + drag forward or backward
Orbit: Move the 3D viewpoint around the focal point	Left-click + drag left, right, forward, or backward
Translate: Move the 3D viewpoint along a horizontal or vertical axis	Click wheel button + drag left, right, forward, or backward
Zoom to window (for all windows). Applies in Camera, 3D Overlay and Rotated views.	CTRL+SHIFT+Z

Shortcuts for viewing data in the 3D views

Use the following hot keys to view data in the 3D Perspective and 3D Orthogonal views:

Task	Keys
Toggle display of labels	CTRL+space bar

Shortcuts for viewing data in the Graph view pane

Use the following hot keys and mouse actions to view data in the Graph view pane. For more information, see Shortcuts for visualizing graph data below.

Task	Keys and mouse
Select range of frames to zoom	ALT and right-click + drag across frames
Slide x-axis left	Click wheel button + drag left
Slide x-axis right	Click wheel button + drag right
Slide y-axis up	Click wheel button + drag forward
Slide y-axis down	Click wheel button + drag backward
Zoom x-axis in	Right-click + drag left
Zoom x-axis out	Right-click + drag right
Zoom y-axis in	Right-click + drag backward
Zoom y-axis out	Right-click + drag forward

Shortcuts for visualizing graph data

The way the graph that is displayed in a **Graph** view pane depends on whether the system connection is live or offline and whether an individual point or a range has been selected for plotting.

- Zoom an axis (x or y)
- Zoom selected range of frames
- Pan across an axis (x or y)

Tip

When zooming into or out of graph data, the display of grid lines in the view pane 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, open the **Options** dialog box (F7) and under **General View Options**, select **Graph**. In the **Properties** pane on the right, ensure **Show Minor Grid Lines** is selected.

Zoom an axis (x or y)

All component graphs in a single workspace maintain the same scale for both the x- and y-axes. The x-axis is shared across all components, but each component has its own y-axis. The y-axes may show different ranges, but represent the same number of values.

- Offline: The portion of the specific component trace displayed in the view pane is centered around the point where the mouse was clicked. All other component views are scaled by the same amount, with the vertical range centered on the median value of the visible portion of all the selected traces.
- Live: The x-axis, the workspace is centered around zero, keeping zero on the right edge of the workspace and changing the values displayed on the left.

Zoom selected range of frames

- Offline: The y-axis displays only the selected area of the specific trace and the x-axis displays only the selected frames.
- Live: This type of zooming in the x-axis is disabled to ensure that the live frame is always on the right of the graph.

Pan across an axis (x or y)

- Offline: Each component in the y-axis can be panned independently.
- Live: Panning in the x-axis is disabled to ensure that the live frame is always on the right of the graph.

Shortcuts for working with the time bar

Use the following hot keys and mouse actions to work with the time bar at the bottom of a view pane:

- Timescale displayed in timeline
- Time bar data displayed in view pane
- Event identification mode in timeline

Timescale displayed in timeline

Task	Keys and mouse
Slide timeline left	Middle-click + drag left
Slide timeline right	Middle-click + drag right
Select range of frames to zoom	ALT and right-click + drag across frames
Zoom scale in	Right-click and drag right or up
Zoom scale out	Right-click and drag left or down

Time bar data displayed in view pane

Task	Keys and mouse
Start/Stop data playback	Middle-click
Jog forward/backward through data playback	Rotate mouse wheel forward/backward
Move Current Time Cursor to specific frame	Click frame in the timeline
Move Start Range Frame Cursor back to zero frame of trial	Click cursor
Move End Range Frame Cursor back to last frame of trial	Click cursor
Go to the previous frame	LEFT ARROW
Go to the next frame	RIGHT ARROW
Go to the first frame	HOME
Go to the last frame	END
Go forward 10 frames	PAGE UP
Go backward 10 frames	PAGE DOWN

Event identification mode in timeline

Task	Keys
Enter/exit event identification mode (where the time cursor follows the mouse)	CTRL+E
Go to the previous event	CTRL+LEFT ARROW
Go to the next event	CTRL+RIGHT ARROW
Lock/unlock event context (In event identification mode, select desired Left, Right, or General event context on timeline; subsequently moving the mouse forward or backward does not change context.)	UP ARROW or DOWN ARROW
Display context menu (after event context locked)	ENTER
Highlight command from context menu	UP ARROW or DOWN ARROW
Select highlighted command from context menu	ENTER

Shortcuts for gap-filling

Use the following hot keys to speed up gap-filling:

Task	Keys
Select next gap	CTRL+8
Select previous gap	CTRL+7
Spline fill	CTRL+U
Spline fill all	CTRL+I
Pick source for pattern filling	CTRL+9
Pattern fill	CTRL+O
Pattern fill all	CTRL+P
Pick source for rigid body fill	CTRL+J
Rigid body fill	CTRL+M
Rigid body fill all	CTRL+,
Pick segment for kinematic fill	CTRL+K
Kinematic fill hot key event	CTRL+L
Kinematic fill all hot key	CTRL+.

Shortcuts for using the Quality tab

Use the following hot keys to speed up working on the **Quality** tab, using the **Data Correction** view type:

Task	Keys
Show/hide unlabeled trajectories	CTRL+F3
Show/hide trajectory names	CTRL+F4
Move to next gap for selected trajectory	CTRL+8
Move to previous gap for selected trajectory	CTRL+7
Move to next trajectory	CTRL+PgUp
Move to previous trajectory	CTRL+PgDown

Automated data quality

The new data quality features in Vicon Nexus 2 enable you to achieve the best possible data more quickly and efficiently.

- Detect and display data quality
- Navigate to gaps using the new data quality features
- Use enhanced gap-filling

Detect and display data quality

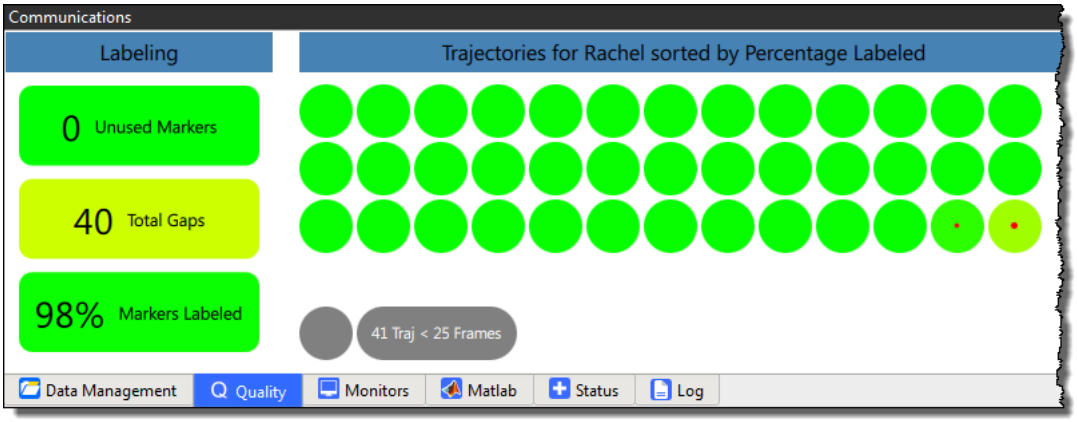
The new automated data quality features of Vicon Nexus enable you to instantly assess the quality of your trials, saving time and effort.

See also:

- Instantly assess trial health with the data Quality pane
- Detect and fill gaps in the Graph view
- View and fill gaps with the Data Correction view
- View data quality across a trial

Instantly assess trial health with the data Quality pane

The data **Quality** pane, a tab in the **Communications** window, provides both a broad overview of data quality for a subject across the entire trial and a way to examine the health of individual trajectories. It also enables you to navigate to the highlighted issues.

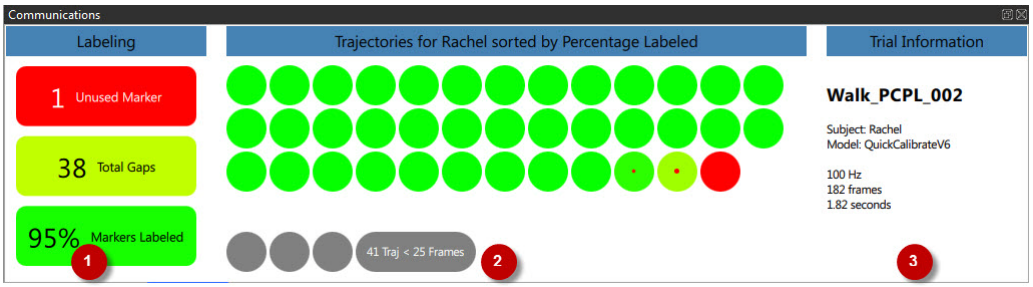


The three most common data issues that you need to find and resolve are:

- Missing markers (usually knocked off before capture)
- Unlabeled or incompletely labeled trajectories

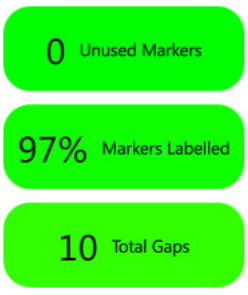
- Gaps in trajectories

The **Quality** tab helps you to find this information:

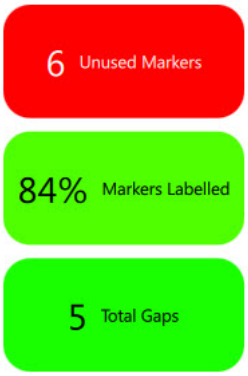


1. Overview of the health of the whole trial. The text in each rectangle indicates the number of unused markers, any gaps, and the percentage of markers labeled. As a quick indicator, to enable you to assess whether to continue working with the trial, the color green indicates good health, red indicates probable major issues, and colors between the two (yellow, amber, orange) indicates that the overall health of the trial lies somewhere between these extremes.

   For example, a good trial, worth further work, would be indicated by no missing markers, a high percentage of labeled markers, and only a small number of gaps.



A low quality trial, which would probably have to be re-run, would be indicated by missing markers, and/or a high number of gaps, and/or a lower percentage of labeled markers.



In the above example, six required markers are completely absent from the trial, so, without further work, you would instantly know that you would have to either re-reconstruct or (more likely) re-collect the trial.

2. Individual trajectories. If you hover the mouse over a blob, the blob displays information about the trajectory. If you click on it to select it, information about the trajectory is displayed in the **Selection** column on the right. For more information, see Navigate to gaps using the new data quality features on page 140.

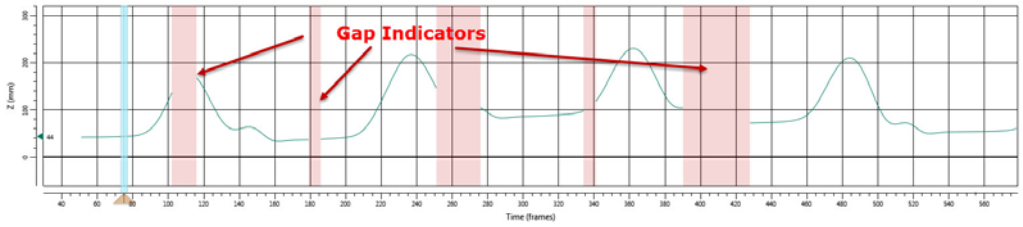
3. General trial information/selected trajectory Information. If no blob is selected, general information about the currently loaded trial is displayed. If a blob is selected, information about the trajectory is displayed.

Tip

You can configure the display options for the data **Quality** tab in the **Options** dialog box (F7), by clicking **Data Quality Panel Options** on the left and changing the required properties.

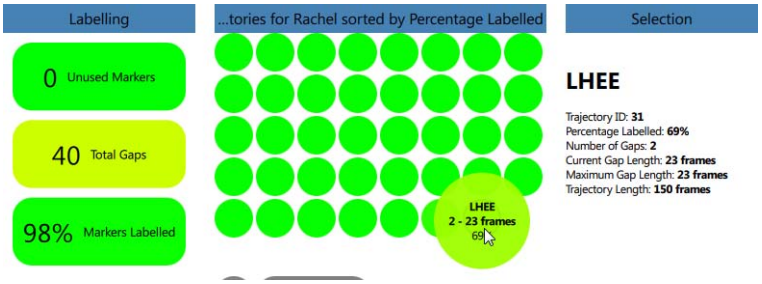
Detect and fill gaps in the Graph view

The Graph view enables you to view and fix gaps for a selected trajectory.

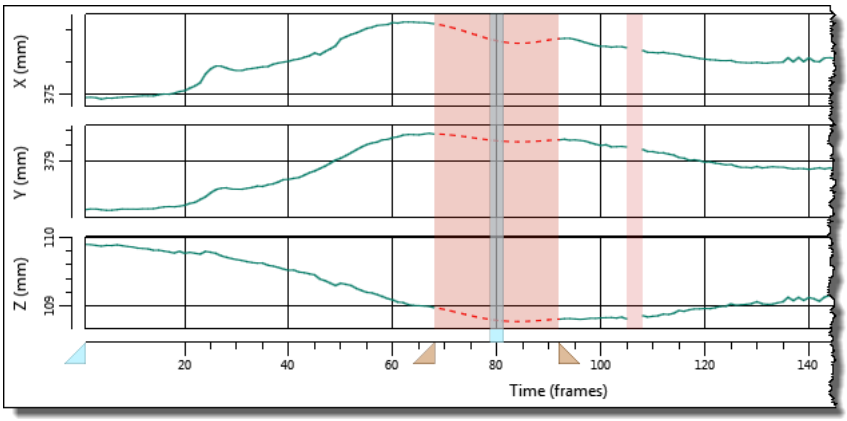


To display gaps:

1. On the **Quality** pane, click a trajectory blob that is reporting a gap.



Gap indicators are displayed in pink in the **Graph** view.

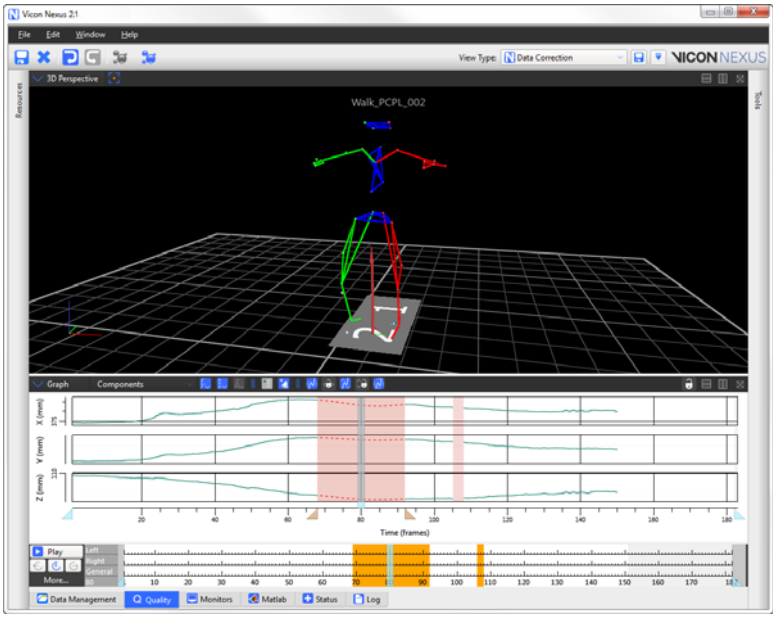


2. To zoom in and out, CTRL+double-click on a gap indicator (the pink area) on the graph.

View and fill gaps with the Data Correction view

A new view type called **Data Correction** that is supplied with Vicon Nexus 2 enables you to simultaneously view data in a **3D Perspective** view and a **Graph** view.

The default **Data Correction** view type that is supplied with Nexus 2 displays a **3D Perspective** view above a **Graph** view.



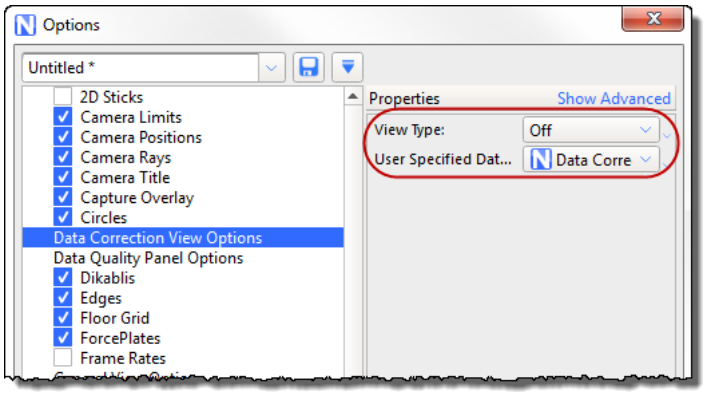
You can turn **Data Correction** view on or off in the **Options** dialog box, as described below.

When the **Data Correction** view is turned on, it is automatically displayed when you navigate using the data **Quality** pane.

If you would prefer the **Data Correction** view to appear differently (for example, displaying the **Graph** above the **3D Perspective** view), you can save your own preferred view and select this instead.

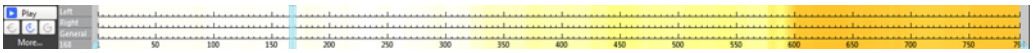
To configure the Data Correction view:

1. Open the **Options** dialog box (F7).
2. Click on **Data Correction View Options** on the left and change the properties as required on the right:
   a. If you want to display this view type automatically when you are navigating via the **Quality** tab, ensure **View Type** is set to **On**.
   b. If you have saved a different view type to be displayed when you are using the **Quality** tab, ensure it is selected in the **User Specified Data Correction View** field.



View data quality across a trial

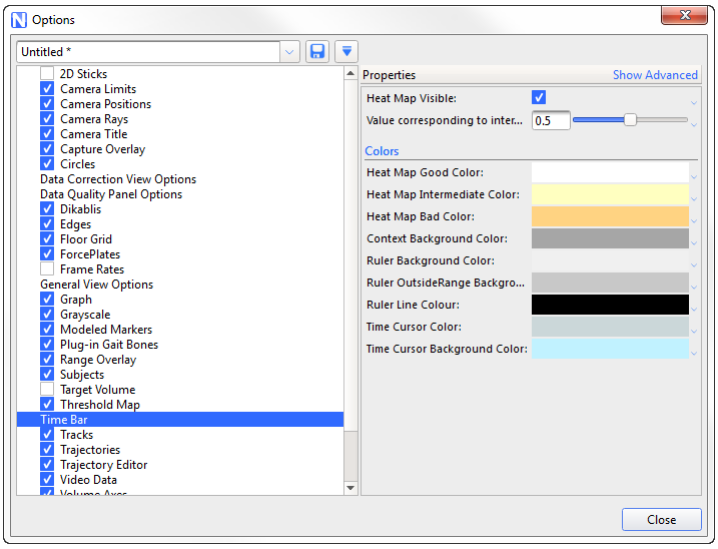
In addition to viewing data quality on the **Quality** tab and **Graph** and **Data Correction** views, you can now also view data quality as a heat map on the time bar, to get an overall picture of the current trial.



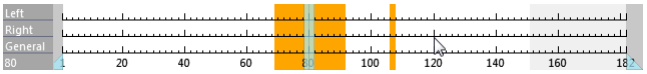
To turn on the heat map overlay:

1. In the **Options** dialog box (F7), click on **Time Bar** on the left, and select the **Heat Map Visible** check box on the right.

2. If required, change the colors of the heat map.



When you click on a trajectory on the **Quality** tab, the time bar now shows gaps for the selected trajectory.



Viewing data quality for multiple trajectories

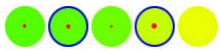
To select multiple trajectories, on the **Quality** tab, CTRL+click the required blobs.

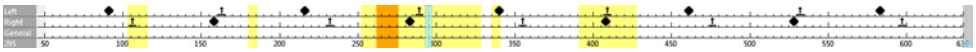
When multiple trajectories are selected, the heat map's color gradient system is activated.

Lighter colors show where one of the trajectories has a gap but other selected trajectories do not. Darker areas show where a number of selected trajectories has a gap.

Two trajectories selected

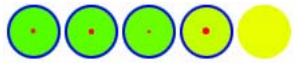
The following images show two trajectories selected. The darker area indicates gaps in both trajectories.

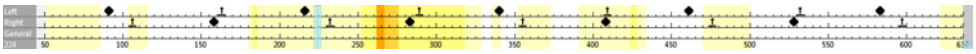




More trajectories selected

As more trajectories are added the view starts to morph from individuals gaps for one or two trajectories, to areas in the volume/time where there are issues.





Navigate to gaps using the new data quality features

Using the **Quality** tab and the **Data Correction** view type, you can quickly navigate to gaps in data, and use the new **Zoom**, **Translate**, and **Rotate** options for a better view.

For more information, see:

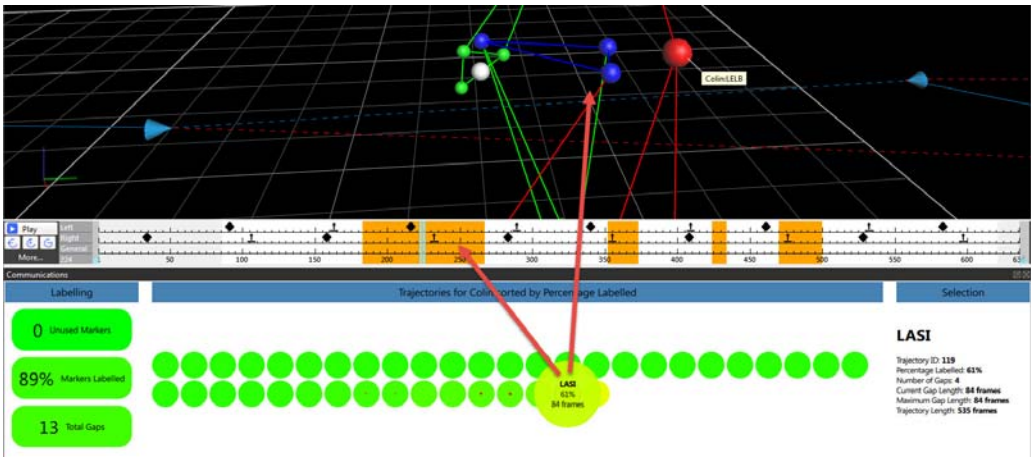
- Quick navigation to gaps
- Get a better view of gaps

Quick navigation to gaps

To quickly navigate to gaps:

1. On the **Quality** tab, click on a trajectory blob.

   Immediately, the time bar and view pane displays the first gap (if any) for the selected trajectory.



2. To move to the next gap or previous gap for the selected trajectory, press the new hot keys: CTRL+8 and CTRL+7 respectively.

Tip

On the data **Quality** tab, you can move to the next trajectory and previous trajectory by pressing CTRL+PgUp and CTRL+PgDown.

Get a better view of gaps

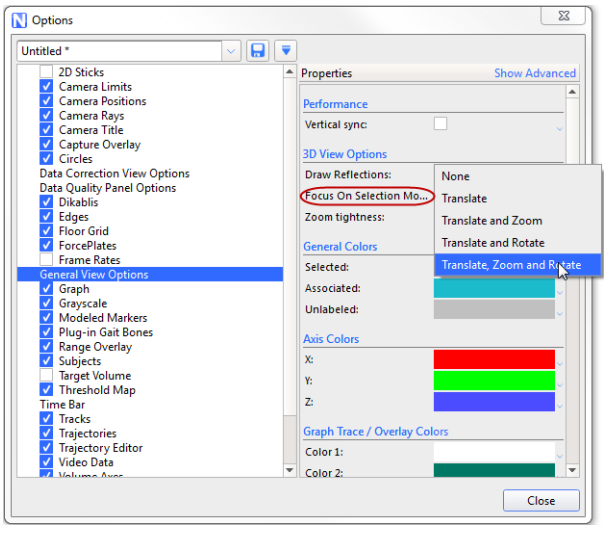
The new **Zoom, Translate and Rotate** options for viewing a gap make it easier to zoom in on and fix selected gaps.

To view gaps more clearly:

1. In the **Options** dialog box (F7), click **General View Options** on the left.

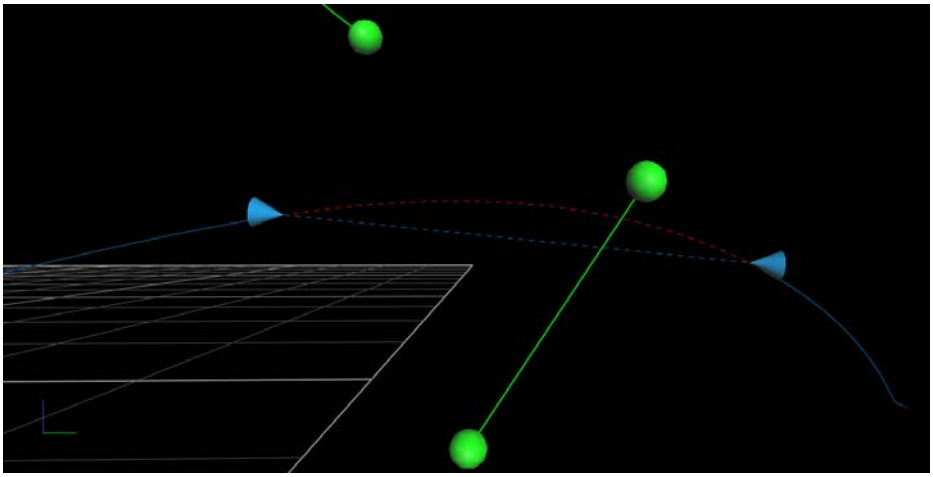
2. In the Properties pane on the right, in the **3D View Options** section, click the **Focus on Selection Mode** list.

3. To display a zoomed view that rotates the workspace to a flat perspective of the gap, click **Zoom, Translate and Rotate**.



4. On the **Quality** tab, click the blob for the trajectory whose gaps you want to examine.

The **3D Perspective** view zooms in and rotates as necessary to clearly show the selected trajectory's first gap.



Use enhanced gap-filling

Vicon Nexus 2 provides enhanced gap-filling functionality, including:

- New gap-filling options
- Intelligent automatic donor selection
- Automatically fill all gaps
- Use pipelines to automate gap-filling

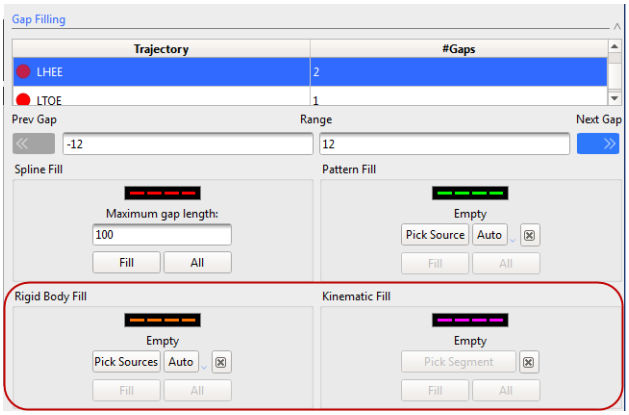
For detailed information about all the Nexus gap-filling algorithms, go to the Vicon FAQs web page and find the FAQ **What Gap Filling Algorithms are used in Nexus 2?**

New gap-filling options

The following gap-filling options are new in Nexus 2:

- Rigid Body Fill
- Kinematic Fill

The new gap-filling options are accessed in the usual way (in the **Label/Edit** tools pane in the **Gap Filling** section):



Rigid Body Fill

This option is the Nexus equivalent of the **Replace 4** option, which is available in BodyBuilder.

Use it when a rigid or semi-rigid relationship exists between markers.

For example:

- Pelvis (LASI, RASI, LPSI, RPSI)
- Head (LFHD, RFHD, LBHD, RBHD)

Kinematic Fill

This option uses information about the connection of markers to segments in the labeling skeleton template (VST).

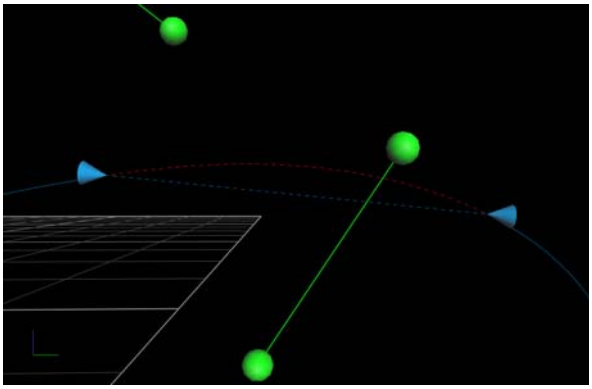
Intelligent automatic donor selection

New in Vicon Nexus 2, this feature uses intelligent pattern matching algorithms to suggest the best donor trajectory to fill a gap.

To use automatic donor selection:

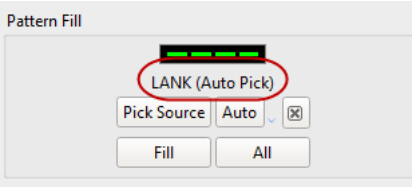
1. On the data **Quality** tab or in the **Gap Filling** section of the **Label/Edit** tools pane, ensure the required trajectory is selected.

   The selected trajectory gap is displayed in the **3D Perspective** window.

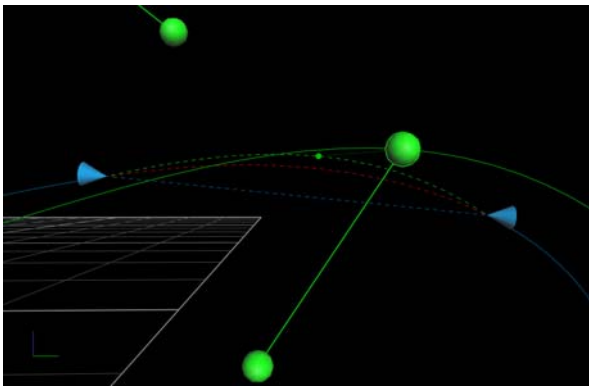


2. In either the **Pattern Fill** or **Rigid Body Fill** area, click **Auto**.

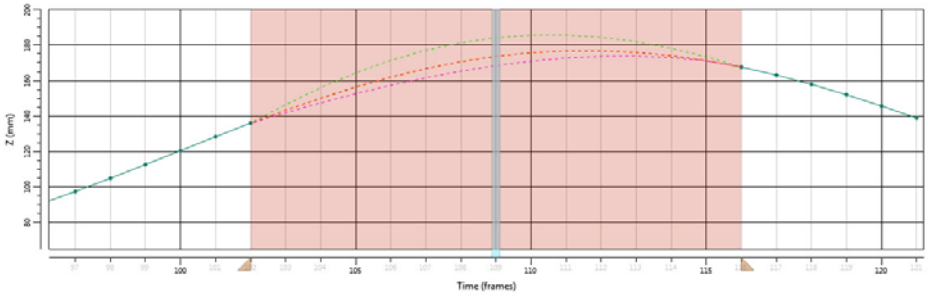
   A suggested donor trajectory (for **Pattern Fill**) or three trajectories (for **Rigid Body Fill**) are listed in the space above the **Auto** button.



   The suggested fill is displayed in green in the **3D Perspective** window.



   You can also view the suggested fill options as colored dotted lines in the **Graph** view:



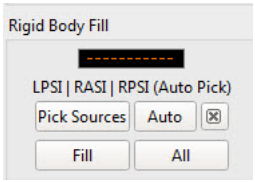
3. Decide whether or not you want to accept the suggested donor:

   - To accept the suggested donor, click **Fill**; or
   - To reject the suggestion and manually pick a source, click the **Clear selected donor** button, click **Pick Source**, then click (or CTRL+click to multi select), the required trajectory, and then click **Fill**.

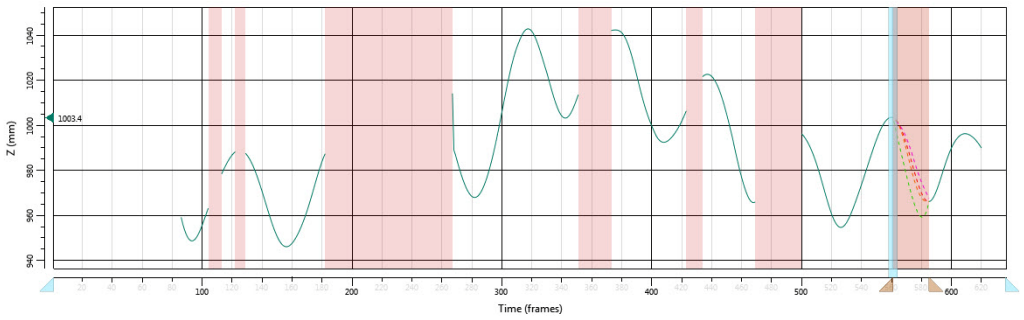
Automatically fill all gaps

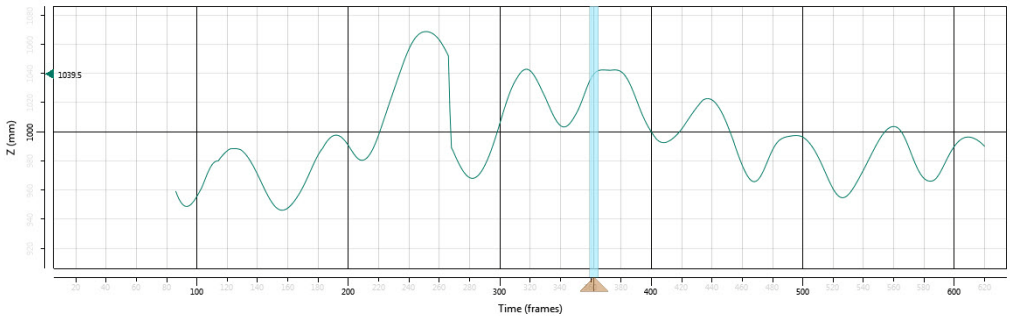
In addition to manually filling individual gaps, Vicon Nexus 2 offers a **Fill All** option for all four types of gap-filling in the **Gap Filling** section of the **Label/Edit** tools pane. This enables you to apply your currently chosen fill to all gaps in a selected trajectory.

This feature is particularly useful when, for example, you have 7 gaps in LASI and you want to fill them all with a **Rigid Fill** from the other pelvic markers (RASI, RPSI, LPSI).



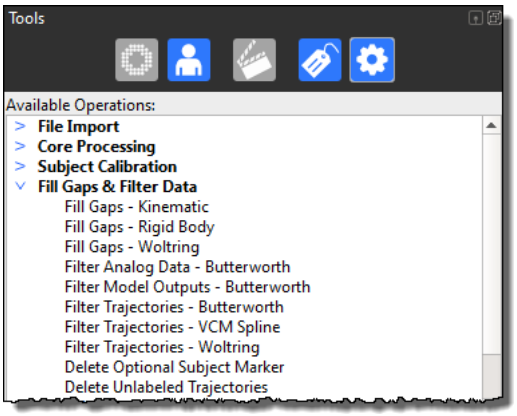
All gaps in the selected trajectory can now be filled with a single click:





Use pipelines to automate gap-filling

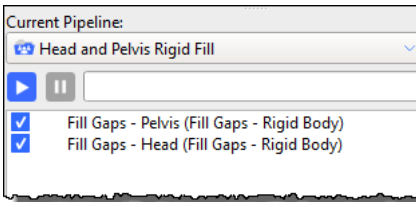
In Vicon Nexus 2, all the gap-filling options are available as pipeline operations on the **Pipeline** tools tab, under the new **Fill Gaps & Filter Data** category.



To save time, you can create custom pipelines that include the type of gap-filling operations that you commonly perform, such as Rigid fills for Pelvis and Head markers.

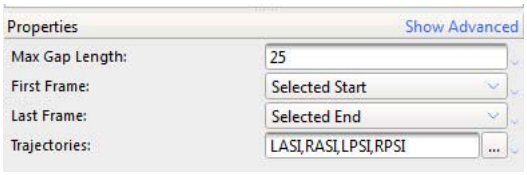
To create a custom gap-filling pipeline:

1. Create a new pipeline (for example, called **Head and Pelvis Fill**), which contains two **Rigid Body** fill operations.

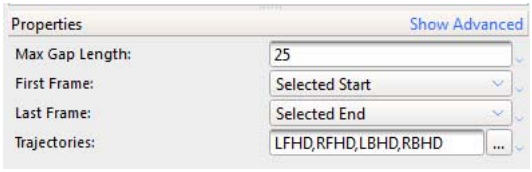


2. Click on each operation in turn and in the **Properties** pane, customize the fills so that Pelvis and Head markers will be filled appropriately. For example:

Pelvis Rigid Fill properties



Head Rigid Fill properties



3. Save the pipeline.

4. Add a new button to the Nexus toolbar (**Window > Toolbar**) to give quick access to your custom pipeline.

Now, with one mouse click, you can automatically fill any Pelvis and Head gaps.

New workflow for improved labeling

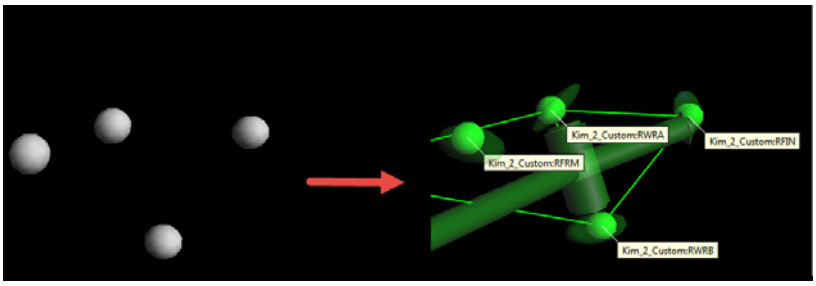
In Vicon Nexus 2, labeling has been improved to give better results and fewer mislabels.

For information about the ways in which labeling and reconstruction has been updated, and how to follow the new workflow to gain the full benefits of this, see the following topics:

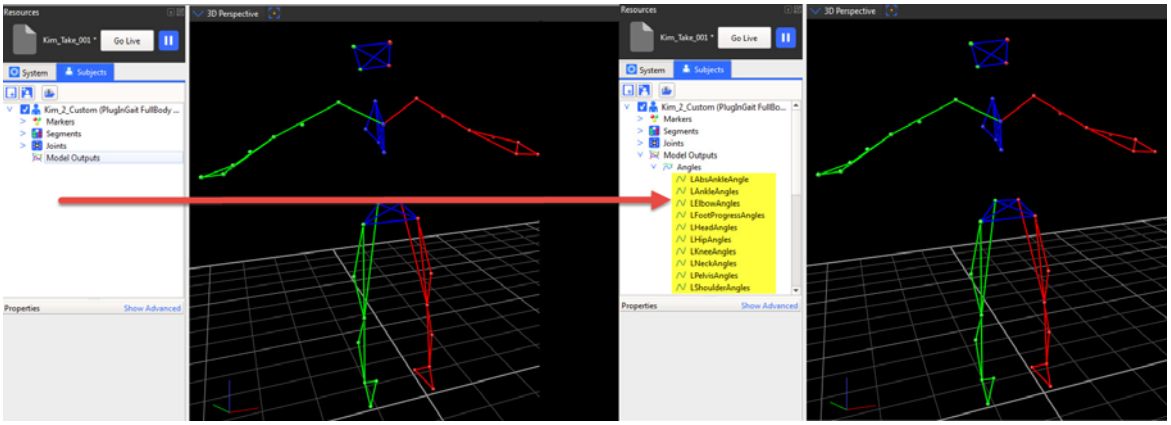
New labeling terminology

To understand labeling in Nexus 2, note the following terms:

- 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.

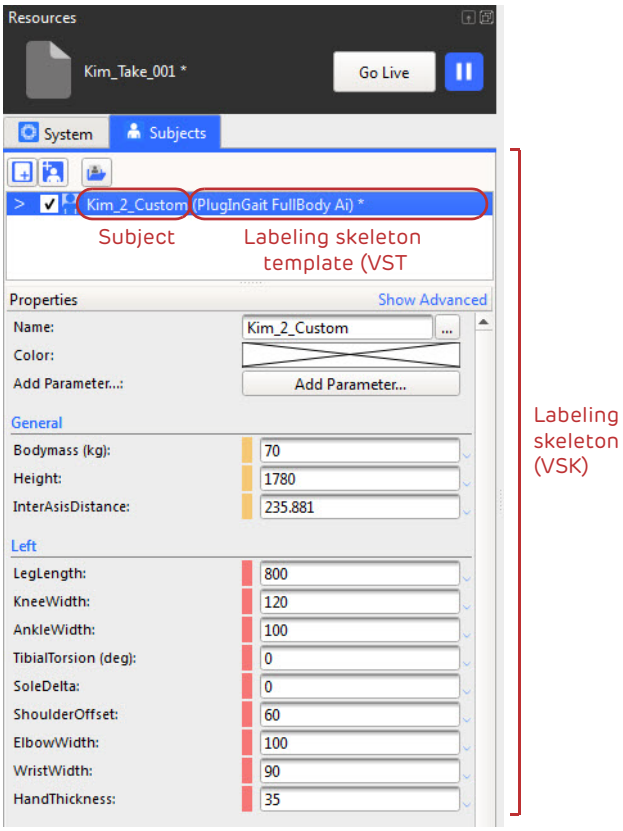


- Models: Files or operations that produce new calculations after labeling. Plug-in Gait and the Oxford Foot Model are models, as are MOD files built in BodyBuilder.

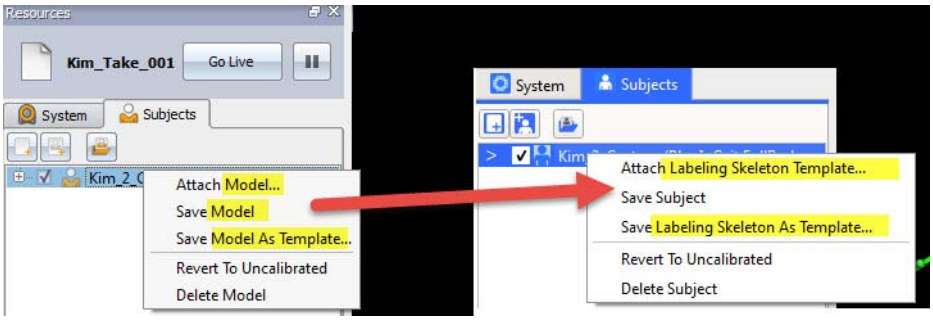
- Subject: The representation in Nexus of a physical entity (eg a patient)

- 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)



To make the distinction clear in Nexus 2, a number of menu items now have names that are different from those used in earlier versions of Nexus:


Resources
Kim_Take_001
Go Live
System
Subjects
Attach Model...
Save Model
Save Model As Template...
Revert To Uncalibrated
Delete Model
System
Subjects
Attach Labeling Skeleton Template...
Save Subject
Save Labeling Skeleton As Template...
Revert To Uncalibrated
Delete Subject

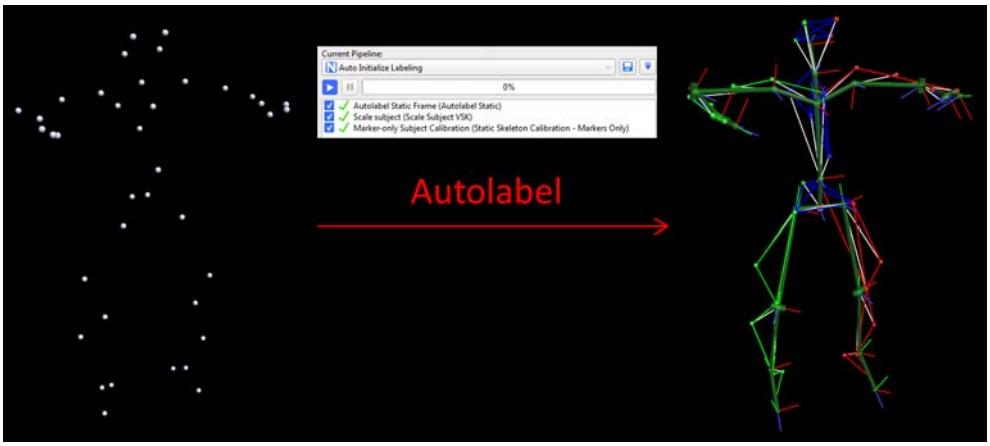
Overview of improvements to labeling

For information about the improvements to labeling, including details of how this affects the way you work with Vicon Nexus, see:

- New subject setup workflow
- More effective labeling

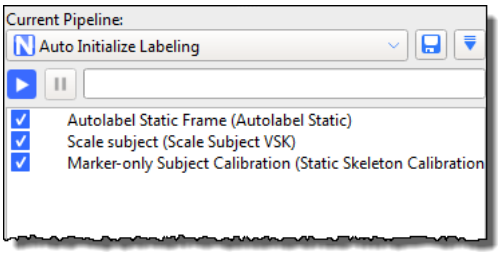
New subject setup workflow

With the new labeling feature of Vicon Nexus 2, you can greatly reduce the time spent manually labeling complex trials.



In Vicon Nexus 2, subjects can be calibrated using a dynamic (ROM) trial, instead of a static trial. This new type of calibration gives more reliable labeling and more accurate results, and forms part of the new recommended workflow for Nexus.

An autolabeling feature, which works with dynamic calibration and is also part of the new recommended workflow, enables you to avoid time-consuming and error-prone manual labeling of the static pose. It is available via a new **Auto Initialize Labeling** pipeline.



For instructions on the new workflow and how to use the new pipeline, see New workflow for Vicon Nexus 2 on page 158.

Important

You can still calibrate from a static trial, in the same way as you did in Nexus 1.x, by capturing and reconstructing a static trial, manually labeling it, etc. However, if you do this, you will not benefit from the new, more accurate labeler, and you will be unable to use automated labeling.

For information on how to use the old calibration workflow in Vicon Nexus 2, see Use the old Vicon Nexus calibration workflow on page 168.

More effective labeling

Nexus 2 uses the labeling skeleton (VSK) to label trajectories more effectively and with far fewer mis-labelings. This is done by combining two approaches:

- When **booting**, 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.
- When **tracking**, 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.

Both booting and tracking are carried out in parallel and the results are merged to get the best solution. The two methods are complementary. Booting is

required to start the tracking. Tracking is efficient and can be robust to marker occlusion. By continually checking the tracking with the booting Nexus is able to correct any tracking mistakes.

To further improve the labeler's ability to prevent mislabeling, it can also make use of joint ranges on the labeling skeleton. If you enable joint range parameters, segments whose joints are out of range are not labeled and no distal segments from an out-of-range segment are labeled.

To get the full benefit of the new labeling feature, you must use the new subject setup workflow and a labeling skeleton template that is designed for the new labeler (not Plug-in Gait templates designed for use with Nexus 1.x).

Improved subject calibration

The new Nexus 2 labeler makes use of additional information available in Nexus 2 labeling skeleton templates (VSTs). This information is provided via the subject calibration workflow. The subject calibration workflow consists of incremental steps that enable you to balance the time taken for calibration against the overall extent of the information in the labeling skeleton (VSK), depending upon your specific labeling requirements.

The new **Auto Initialize Labeling** pipeline enables you to quickly calibrate a subject for simple labeling. It provides the following operations:

Operation	Description
Autolabel Static Frame	Attempts to label the subject when they are standing in a known pose. 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.
Scale subject	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 Frame**. This scaling respects any constraints that you have specified in the labeling skeleton 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.
Marker-only Subject Calibration	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.

All of the operations make their calculations on a single frame, however, any labels that are assigned are applied to the whole trajectory.

To use automated labeling, you must follow a slightly different workflow from that previously used in Nexus.

The new **Auto Initialize Labeling** pipeline uses the supplied updated labeling skeleton templates files (VSTs) to reduce, or in many cases, eliminate the need for manual labeling. The new pipeline also works with custom VSTs that are built using the **Labeling Template Builder** in Nexus 2.x.

Requirements for custom labeling skeleton templates (VSTs)

To obtain the best results from the **Auto Initialize Labeling** pipeline, ensure your custom VSTs meet the following guidelines:

- Are built using the **Labeling Template Builder** in Nexus 2.x.
- Have at least three markers per segment.
- Use a repeatable base pose (used for initial labeling).

In addition, ensure that:

- A good ROM trial is used for the initial calibration.

New workflow for Vicon Nexus 2

Although, if required, you can continue to use your existing workflow for subject calibration, to gain the full benefits of the new autolabeling feature and higher quality labeling, you will need to attach the supplied new labeling model template (VST) and adopt the new workflow.

The following workflow is just one approach that can be adapted to suit your particular circumstances. Step-by-step instructions are provided. For a detailed explanation of the various methods of subject calibration, see Skeleton calibration operations in detail on page 171.

You begin by capturing and processing a ROM trial. Vicon Nexus then uses the information from the ROM trial in the subsequent dynamic trials, as explained in the following topics:

1. Capture and process a ROM trial

2. Capture and process dynamic trials

If you want to use your existing workflow, see Use the old Vicon Nexus calibration workflow on page 168.

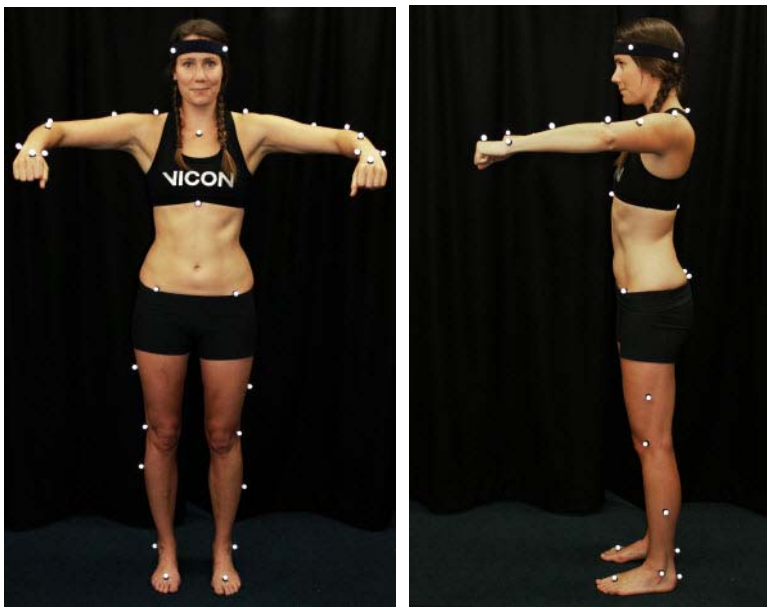
Capture and process a ROM trial

In the Vicon Nexus 2 workflow, you begin by capturing a ROM (Range of Motion) that starts with a few frames where the subject is static, as described in the following steps.

To use the new workflow to calibrate a subject:

1. Capture a ROM trial where the first 1–3 seconds are of the subject in the 'motorbike' pose, as shown in the following image, in which:

    - Arms are outstretched, held level or slightly lowered, with elbows bent and further forward than the shoulders (so that they don't hide any of the body markers).
    - Rest of body is straight.
    - Feet point forward

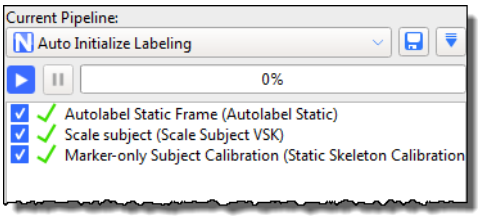


2. For the rest of the ROM trial, have the subject go through the required range of motion.

3. In Nexus, attach the new **PlugInGait FullBody Ai** (Auto Initialize) labeling skeleton template (VST) file to the subject. (If your trial is for lower body only, you can use the supplied new **PlugInGait LowerBody Ai** template.)

4. Reconstruct the trial.

5. Run the supplied **Auto Initialize Labeling** pipeline:



6. Save the trial and the labeling skeleton (VSK) (press CTRL+S or click the **Save** button).

7. Assess the results by looking at the labeling of the first frame in the **3D Perspective** view. For a more detailed check, look at the information on the data **Quality** tab.

8. Depending on the results of the labeling, take the appropriate action:

   - If the static frame is correctly labeled and the labeling skeleton fits well, processing your first dynamic trial will give you an indication of the level of labeling that this subject calibration will provide for your specific trial type. Based on these results, you can decide whether they meet your requirements. For example, for walking trials, the quick calibration produced by the **Auto Initialize Labeling** pipeline is likely to produce good labeling of dynamic trials,

     If you judge that the results are satisfactory, go straight to step 10 (**Process Static Plug-in Gait Model**).

   - If the results are not satisfactory, this may be because your dynamic trials include more challenging or complex movement and therefore require a further level of labeling reliability. To provide this enhanced reliability you will need to run a functional calibration, which calibrates the subject's bone lengths and joint and marker locations from the whole ROM trial, as described in step 9. To ensure the best results, first consider the following two factors:

- If any markers are labeled incorrectly, fix them and from the **Auto Initialize Labeling** pipeline, re-run the **Scale subject** and **Marker-only Subject Calibration** operations; or
- If all the labels are correct but there is a large distance between a marker and the corresponding reconstruction, the labeling skeleton cannot accurately represent the configuration of labeled reconstructions. This is an indication that you may get poor labeling results and may need to improve your labeling skeleton template (see Requirements for custom labeling skeleton templates (VSTs) on page 157).

  Note that **Functional Skeleton Calibration** takes more processing time to complete than the **Auto Initialize Labeling** pipeline.

9. (Optional step) Run a **Functional Skeleton Calibration** by completing the following steps:

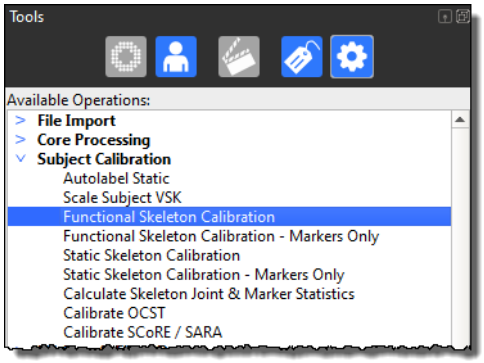
   a. Verify that the trial is correctly labeled for every frame.

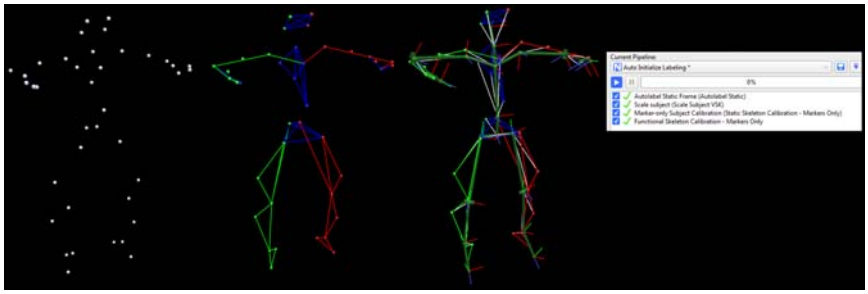
   Tip

   Note that **Autolabel Static Frame** only labels the trajectories that are present on the static frame(s).

   b. Check for any markers that get occluded and re-label them when they re-appear.

c. From the **Subject Calibration** operations section, add the **Functional Skeleton Calibration** operation and run it.





d. When the **Functional Skeleton Calibration** has completed, in the display properties (F7), click **Subjects** and in the **Markers** section, select **Draw Covariance**.

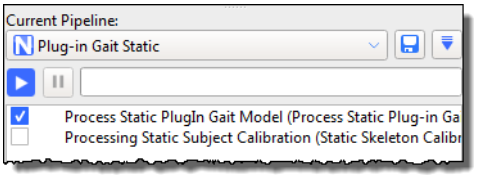
If you can see any large covariance ellipsoids around a marker, check for mis-labeling of a small number of frames for that marker and fix any mislabels. Note that some markers, such as the ASIS markers, will naturally have a larger covariance, due to skin motion.

Tip

The size of covariance ellipsoids vary, depending upon the way a marker is defined in a skeleton, the amount of marker movement possible, and the quality of the subject calibration. Particularly large covariance ellipsoids may indicate a poor calibration.

10. On the Time Bar, set a range of frames to select only the first few seconds of the static pose at the beginning of the trial.

11. In the **Current Pipeline** list, select the **Plug-in Gait Static** pipeline, and ensure that you leave the check box for **Processing Static Subject Calibration** cleared (its default setting).



12. Click on the **Process Static Plugin Gait Model** operation and ensure that in the **Properties** pane, the **First Frame** is set to **Selected Start** and **Last Frame** is set to **Selected End** (the default settings).

13. Run the **Plug-in Gait Static** pipeline.

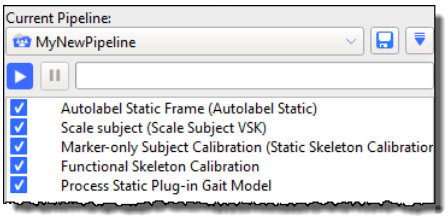
14. Save the ROM trial and the subject (VSK).

The new workflow may take longer than the previous process, particularly calibrating the ROM (**Functional Skeleton Calibration**). However, the extra time results in a significant improvement in labeling quality, which means that you will save significant amounts of time in processing the subsequent dynamic trials.

You can now Capture and process dynamic trials.

Tip

To save time in future, you may want to save all the relevant pipeline operations to one customized pipeline. To do this, add the relevant operations to the end of the **Auto Initialize Labeling** pipeline and save the pipeline under a new name.



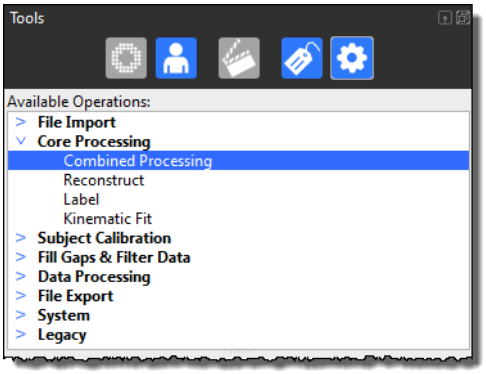
Capture and process dynamic trials

After you have processed a ROM trial, you can capture the related dynamic trials in a similar way to the workflow in previous versions of Nexus.

To use the new workflow to capture and process dynamic trials:

1. Capture the required dynamic trials.

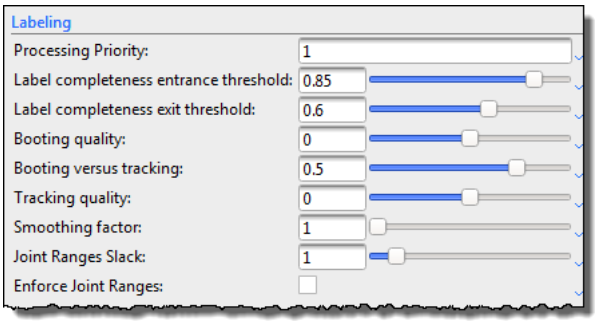
2. Run the **Combined Processing** operation, found in the **Core Processing** operations section, setting the **Processing Output level** to the required level, for example, **Labels**, and specify any required properties. For information on the **Labeling** properties, see Specify new Labeling properties on page 165.



3. As you did previously, run the **Dynamic Plug-in Gait** pipeline, specifying the relevant properties.

Specify new Labeling properties

The labeling properties are available when you select the new **Core Processing** pipeline operations that include labeling (**Label** and **Combined Processing**). They are also available in the **Properties** pane when you click on **Local Vicon System** in the **System** resources pane.



In addition to the tooltips for each property, which are available when you hover the mouse pointer over each field, see the following additional descriptions on adjusting the values to suit your particular trials.

Property	Description
Processing Priority	Has no effect on labeling. Default is 1.
Label completeness entrance threshold	Minimum proportion of markers that must be recognized by the system to start labeling the subject. 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 is 0.85.

Property	Description
Label completeness exit threshold	Minimum proportion of markers that must be recognized by the system to continue labeling the subject. 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 is 0.6.
Booting quality	Affects when the system starts labeling based on how well the labeling skeleton matches the reconstructed data. 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), an increase in this number may result in fewer mis-labels. Default is 0 (zero).
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 smaller than 0 favor rebooting while values greater than 0 favor tracking. Default is 0.5

Property	Description
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. Default is 0 (zero).
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 does not go through their entire Range of Motion during calibration. Higher values can be set to reduce the chances of mis-labels. Default is 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.

Use the old Vicon Nexus calibration workflow

The recommended workflow for Nexus 2 is to use a ROM trial and dynamic calibration as this offers the benefits of the new, more efficient labeler and automated labeling (for more information on the new workflow, see New workflow for Vicon Nexus 2 on page 158).

However, if you need to reproduce exactly the same results that you obtained from versions of Nexus prior to 2.0, you can do this, using the same workflow and the same labeling skeleton template as before.

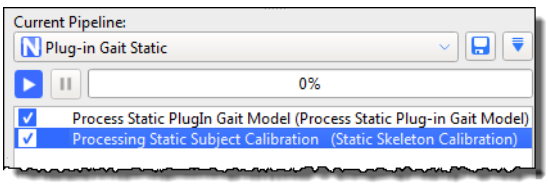
To use the earlier subject calibration workflow:

1. Capture a static trial.
2. Reconstruct the trial using your usual preferred method (**Reconstruct** button or **Pipeline** tools).
3. Attach the appropriate old labeling skeleton template (VST file) to the subject, for example, **PlugInGait FullBody.vst**.

   Important

   To use the old workflow, ensure you use the required old labeling skeleton template, (**PlugInGait.vst**, **PlugInGait Fullbody.vst**, etc). If you chose to import old settings files when you first installed Nexus 2.x, you can select it from the list of available templates. If you didn't import the old settings files when you installed Nexus 2, copy the old VST files from ...\Vicon\Nexus\ModelTemplates to ...\Vicon\Nexus2.x\ModelTemplates.

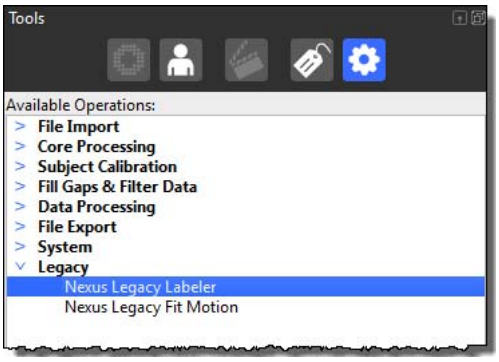
4. Manually label the subject in the usual way, using the **Label/Edit** tools pane.
5. In the **Pipeline** tools pane:
   a. Select the **PlugInGait Static** pipeline.
   b. Enable the **Processing Static Subject Calibration** operation.
   c. Run the pipeline.



6. Collect the required dynamic trials.

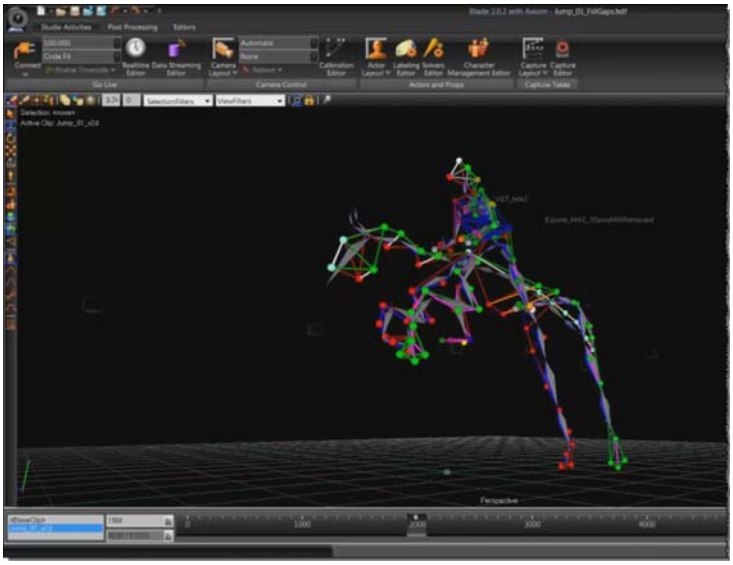
7. Run the **Reconstruct And Label** pipeline.

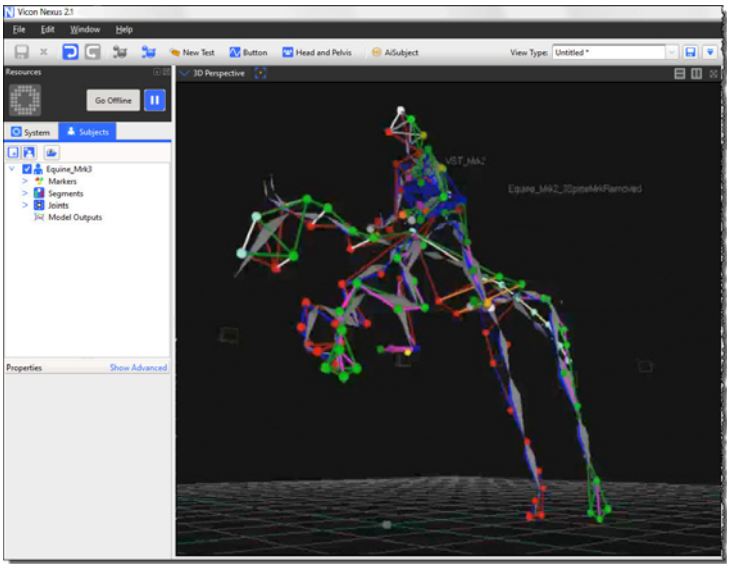
Note also that if you used labeling in Nexus 1.x and want to reprocess old data to get the same results as you did in Nexus 1.x, you can do this by using a pipeline operation called **Nexus Legacy Labeler**, which is available in the **Legacy** pipeline operations section.



Improved compatibility with other Vicon applications

The improvements to labeling in Vicon Nexus 2 include greater compatibility with Vicon Blade. Labeling skeleton templates (VSTs) can be shared between the applications.





Skeleton calibration operations in detail

Calibrating a Vicon labeling skeleton (VST/VSK) is the process that enables Nexus to recognize the subject and automatically determine which labels belong to the reconstructions. There is more than one process and multiple calibration options. A number of factors can affect which process and which options are best for your data/situation.

For a step-by-step introduction to the calibration workflow in which the operations described in this topic are used, see New workflow for Vicon Nexus 2 beginning on page 158.

The following types of trial can be used to calibrate a labeling skeleton:

- ROM trial This is a Range Of Motion trial. You can use a ROM trial to create a labeling skeleton for the subject. In a ROM trial, the subject completes a series of movements that exercises all of their joints. To produce the best calibration (and auto-labeling), the subject moves all of their joints through as full a joint range as possible. For the best results, ensure that each joint is moved through a range that represents what the subject is likely to do during collection. Full ROM calibrations provide the most information of any of the methods and therefore often provide the best labeling performance outcomes. For this reason Vicon recommends using a full ROM calibration whenever possible.

- Static trial This is a short trial where the subject stands in a base pose. A base pose is a static pose that is used when you first create the VST file. This is often a T-pose or 'motorbike' pose (see Capture and process a ROM trial on page 159). As with the ROM trial, the purpose of this trial is subject setup. With a well-designed VST, a static trial can be used to calibrate a labeling skeleton. You do this by using the **Auto Initialize Labeling** pipeline for Plug-in Gait. This operation requires the least processing time as it operates on only a single frame of data. However, static calibration provides less information than functional calibration, for the same reason. This type of calibration trial can be very helpful if:
  - A subject's ability to perform a ROM trial is limited.
  - Time is factor.

- Dynamic trial This is a trial in which the subject performs the activity that is being studied. As such this trial is similar to a ROM trial, but focuses on only joint movements that are expected and specific to the task/activity being performed. In a gait laboratory, an example would be using a walking trial for this calibration. These trials are not normally used for an initial or full

subject setup, but can be used in combination with some operations to improve labeling. Dynamic activity-matched trials may be of benefit if the movement of the subject during collection is not similar enough to what is captured when using a Static or ROM trial.

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.

Comparison of skeleton calibration operations

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 level of labeling accuracy.

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

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

- A fully labeled trial (ROM, static, or dynamic) must exist.
- The trial must contain only raw reconstructions; leave any gaps unfilled.

Note

Unlabeled reconstructions (obviously) have no influence on the operations.

- Functional Skeleton Calibration operation
- Functional Skeleton Calibration - Markers Only operation
- Static Skeleton Calibration operation
- Static Skeleton Calibration - Markers Only operation
- Calculate Skeleton Joint & Marker Statistics operation

The operations change the following pieces of information in the skeleton

Operation	Parameters	Segments	Joints statistics	Marker positions	Marker statistics
Functional skeleton calibration	Yes	Yes	Yes	Yes	Yes
Functional skeleton calibration - markers only	Yes	No	Yes	Yes	Yes
Static skeleton calibration	Yes	Yes	No	Yes	No
Static skeleton calibration - markers only	Yes	No	No	Yes	No
Calculate skeleton joint & marker statistics	No	No	Yes	No	Yes

For information on how to use the operations in common Nexus workflows, see Subject calibration workflows on page 180.

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 dynamic 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 dynamic 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 will not be absorbed into the joint, but rather by either the segment or marker positions, where the effect will have less impact. In sparse marker sets this is sometimes a trade-off that has to be made.

- The second algorithm calculates the joint and marker statistics (see Calculate Skeleton Joint & Marker Statistics operation on page 178).

Examples of using Functional Skeleton Calibration

- This calibration method requires more processing time but generates 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 Subject calibration workflows on page 180.

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 on page 178).

Algorithm description

The **Functional Skeleton Calibration - Markers Only** operation is very similar to the full **Functional Skeleton Calibration** algorithm (see Functional Skeleton Calibration operation on page 174). 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.

For information on how to use this operation in common Nexus workflows, see Subject calibration workflows on page 180.

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.

For information on how to use this operation in common Nexus workflows, see Subject calibration workflows on page 180.

Calculate Skeleton Joint & Marker Statistics operation

This operation calculates joint and marker statistics from either a dynamic trial or a ROM trial. Both the **Functional Skeleton Calibration** and the **Functional Skeleton Calibration - Markers Only** operation runs 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 dynamic 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 Subject calibration workflows on page 180.

Subject calibration workflows

The following standard workflow descriptions outline recommended ways of working with various scenarios. Your choice of workflow depends upon the raw data you are able to collect and your desired outcome.

- Subject set up workflows
- Re-calibrate workflows

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.

1. Put markers on the subject and get them to perform a static trial.

2. Reconstruct the trial and run the **Auto Initialize Labeling** pipeline.

The **Auto Initialize Labeling** pipeline consists of three operations:

1. A T-pose label operation (**Autolabel Static**). This operation labels the trial for the following two operations to use.

2. 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.

3. **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 collection/calibration is paramount. In these types of collection 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 dynamic 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 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.

   Important

   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.

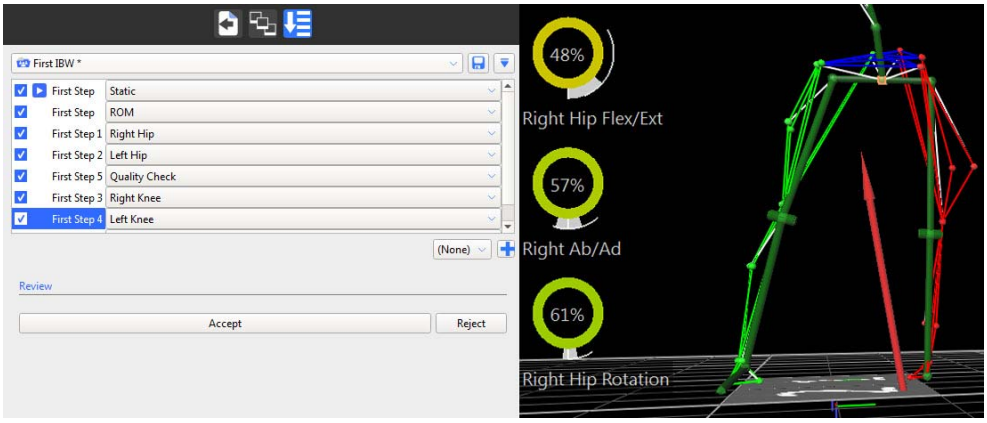
Biomechanics workflow

Vicon Nexus 2 includes a new 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.

The following topics explain how to use the biomechanics workflow to simplify and speed up your work, and includes information on using functional calibration and SCoRE and SARA.

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 new processing algorithms that can be used for hip and knee joint estimation.



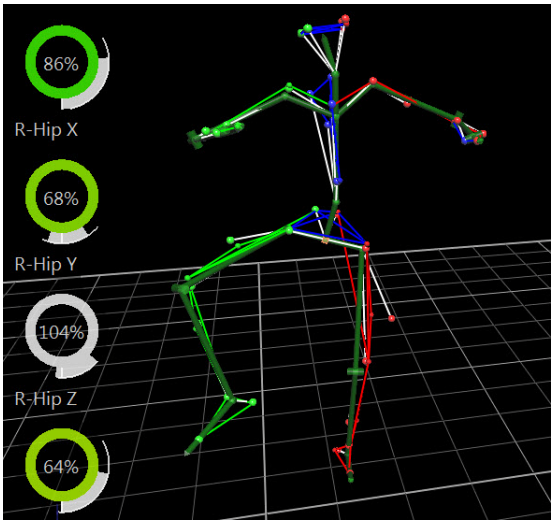
The new biomechanics workflow enables you to:

- 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.

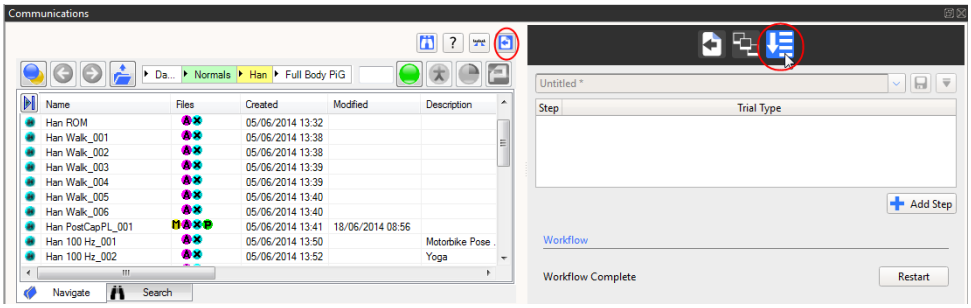
When you have set up all the steps in your biomechanics workflow, you can save it for future re-use. You can then apply the whole workflow or selected steps to your future work with Vicon Nexus, from capture right through to data export.

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 new 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 amount of 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

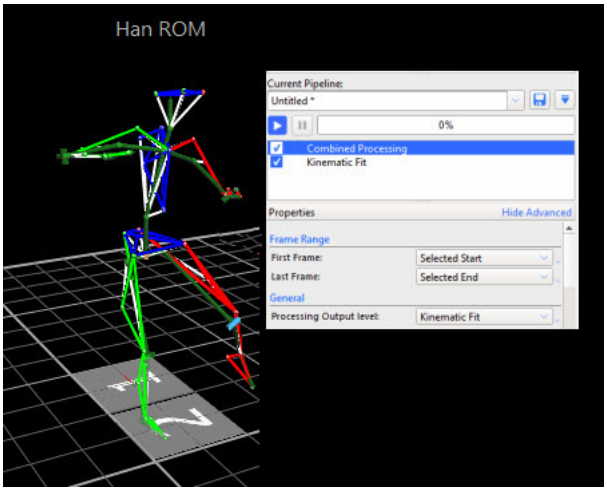
To create a joint range overlay monitor, you use a new type of monitor, called a **Range Overlay** monitor, which is available from the **Actions** menu in the **Monitors** area.

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:
   - Either – **Kinematic Fit** (if the subject is already labeled); or
   - **Combined Processing** with the **Output** level set to **Kinematic Fit**.

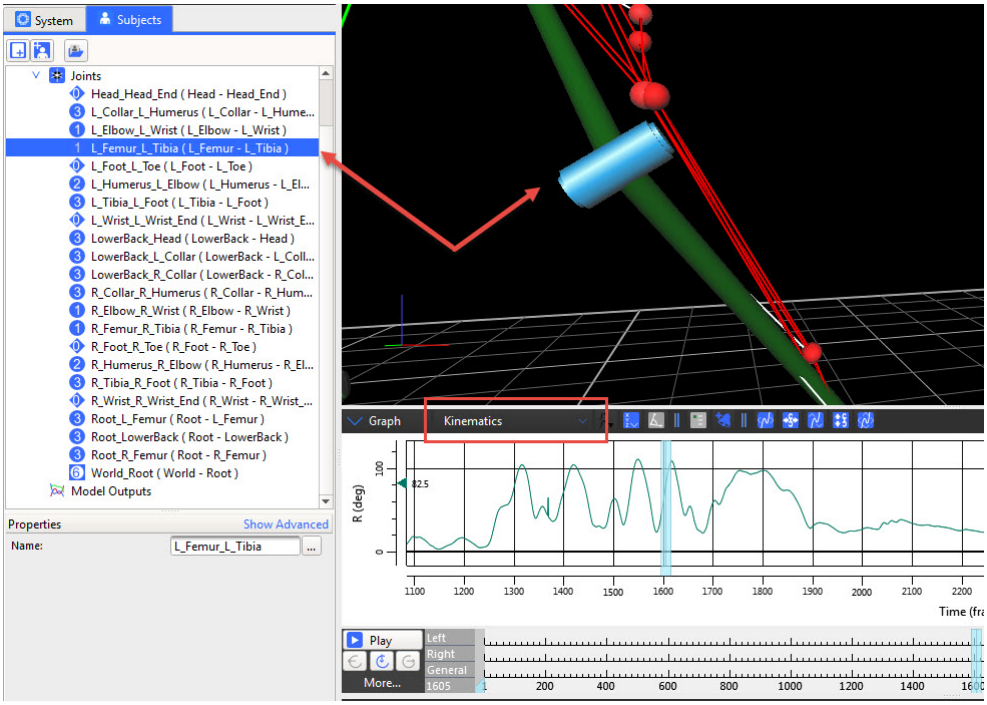
The following image shows a subject after kinematic fitting.



The subject now shows the internal labeling skeleton, displaying joints, as well as the labeled markers and segments.

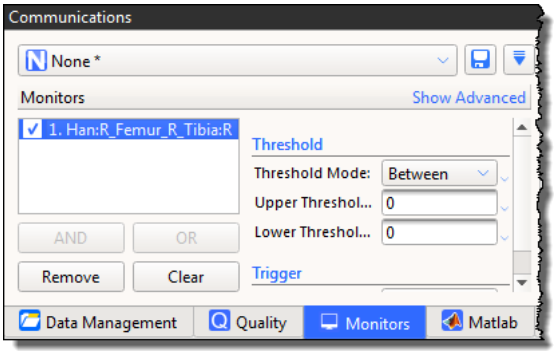
5. In the **Communications** pane, click on the **Monitors** tab to give it focus and ensure a **Graph** pane is displayed.

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:

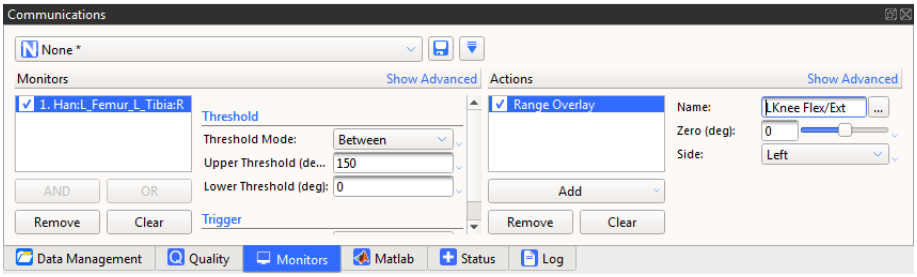
   a. Click on the new monitor to select it, and in the **Threshold** area, set the desired Range of Motion for the selected joint by specifying the **Threshold Mode**, and the upper and/or lower limits of the range to be monitored.

   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.

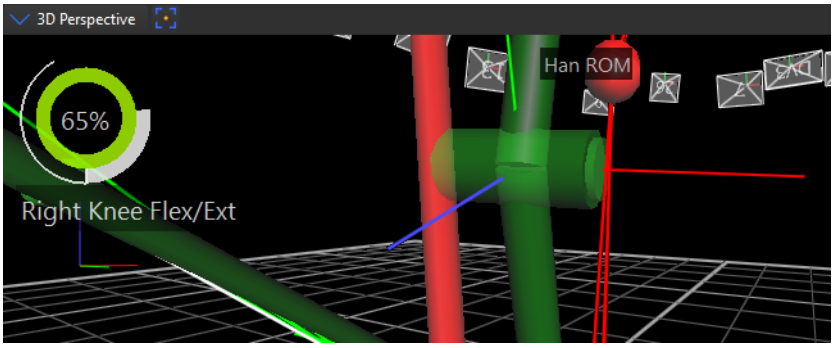
   c. Ensure the new action is selected (blue) and in the **Name** field, provide a descriptive name for your new monitor.



   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

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.

Whereas earlier versions of Vicon Nexus offered only static joint calibration, 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 on page 186).

To save time and effort, the new 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 on page 193.

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

- What is static joint calibration?
- What is functional joint calibration?
- What is local optimization?

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.

See also:

- Create a biomechanics workflow
- About SCoRE and SARA in Vicon Nexus

Create a biomechanics workflow

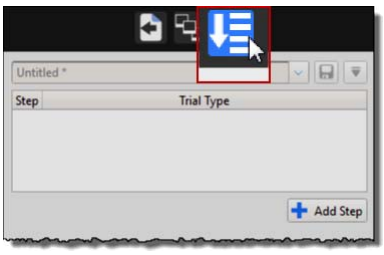
To create a biomechanics workflow, you use the new Biomechanics Workflow area of the **Data Management** tab in the **Communications** window to associate specified data capture and processing steps with particular trial types, and monitors.

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 on page 186).

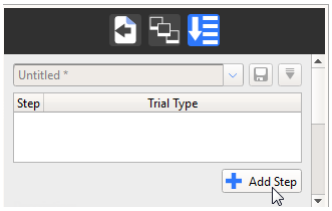
The following example shows you how to set up a biomechanics workflow that includes steps for a static capture, followed by a ROM capture coupled with a joint range monitor.

To create a new workflow:

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



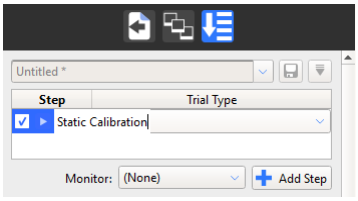
2. Click the **Add Step** button to add your first step,



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

Important

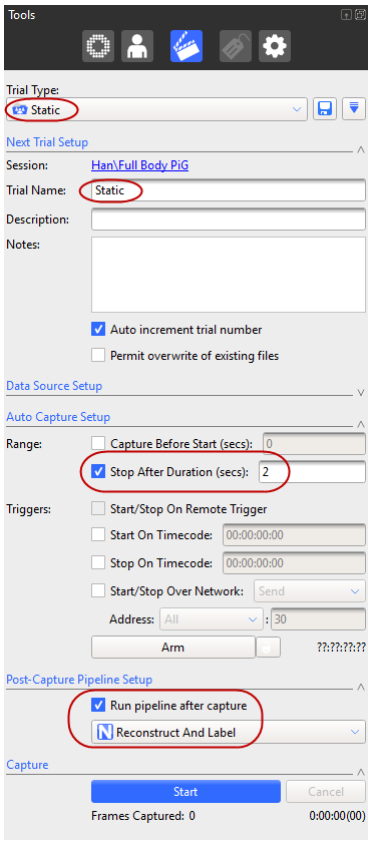
For each step, this name will be the name of the trial that is saved as a result of running the step.



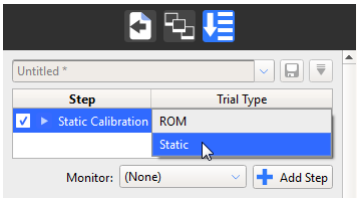
4. From the list of trial types to the right of the step name, select the required trial type for the step.

   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



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).

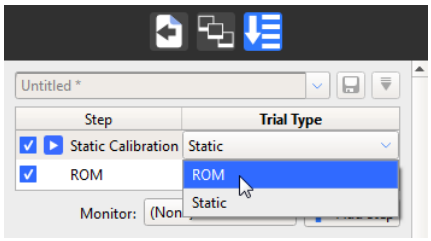
5. To set up step 2, in the **Biomechanics Workflow** area:

   a. Click **Add Step** again.

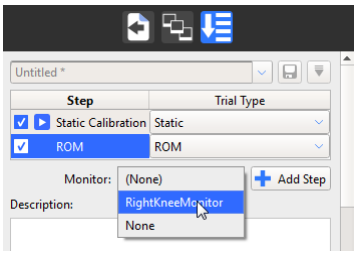
   b. In the **Step** column, type a name for the second step, in this case **ROM**.

   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.



6. 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 on page 186).



7. 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.

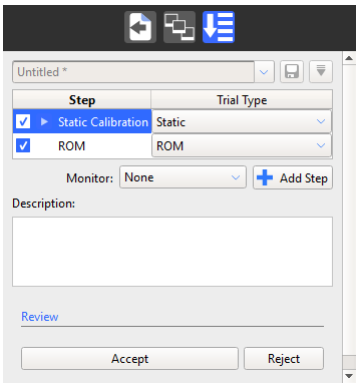
Tip

To reorder the steps, click on a step and drag it to the required position in the list.

8. 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.

9. To run your new workflow, change to **Live** mode and in the **Biomechanics Workflow** area, click **Start**.

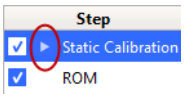
   When the step has run, Nexus automatically goes to **Offline** mode and the **Biomechanics Workflow** area displays buttons to enable you to accept or reject the result of the step.



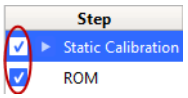
   If you click **Accept**, the next step, is run. If you click **Reject**, Nexus returns to Live mode, so that you can perform another capture.

Tips for creating biomechanics workflow steps

- When you run through the new 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 (support@vicon.com).

See also:

- About SCoRE
- About SARA
- Prepare data for use with SCoRE and SARA
- Capture and process a trial with SCoRE and SARA

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.

Related research can be found in the published papers:

Repeatability and reproducibility of OSSCA, a functional approach for assessing the kinematics of the lower limb. 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

To create a segment using OSCT:

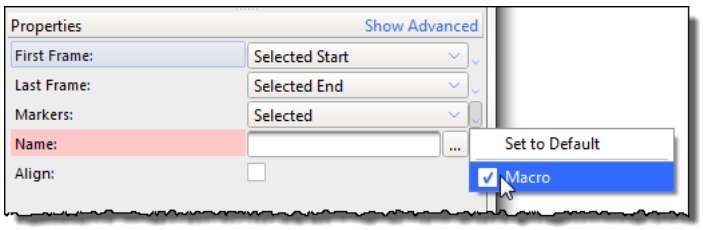
1. Load the trial containing the markers whose positions are to be calculated using OCST. These markers will form the segments that will be used in SCoRE and SARA pipeline operations.

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.

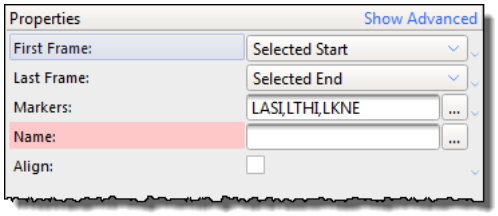
3. Click on **Calibrate OCST** and in the **Properties** pane ensure the required start and end frames, together with the required markers (at least three) are specified. To select the required markers, in the **3D Perspective** view, CTRL+click or ALT+drag the markers (at least three per segment). If 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.

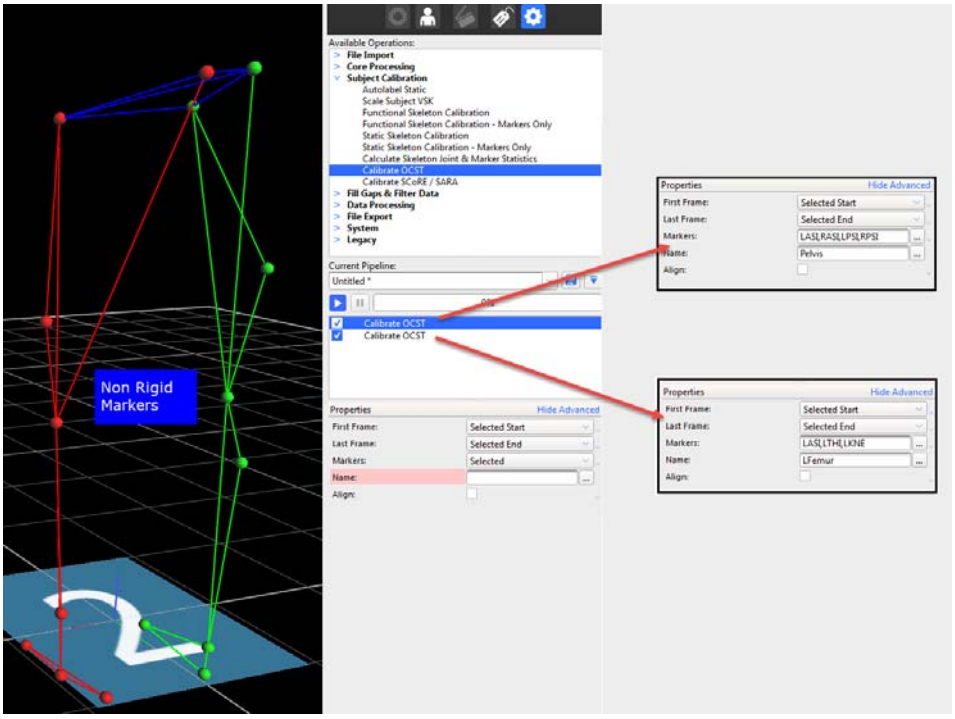


b. When you have made sure you have selected the required markers, re-select **Macro** again.

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.

See also:

- About SCoRE and SARA in Vicon Nexus
- Capture and process a trial with SCoRE and SARA

Capture and process a trial with SCoRE and SARA

You can use the new 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.

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 (support@vicon.com).

For more information, see:

- Collecting data for use with SCoRE and SARA
- Capturing hip and knee ROMs
- Using SCoRE and SARA

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.

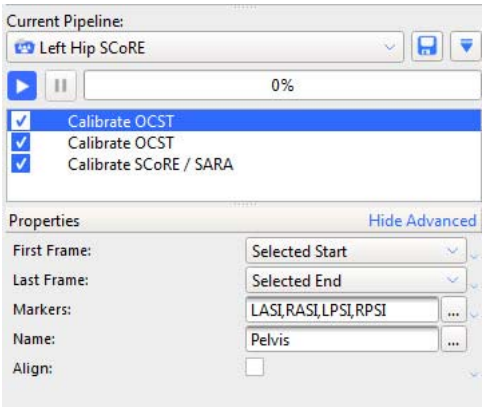
Using SCoRE and SARA

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.

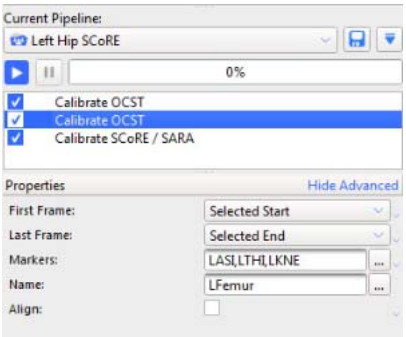
To use SCoRE and SARA:

1. Create a pipeline that includes all the necessary operations:

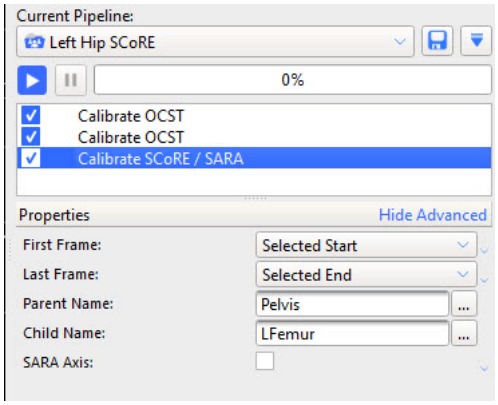
   - A Calibrate OCST operation that specifies the parent segment (for example, Pelvis), by selecting at least three markers (for example, LASI, RASI, LPSI, RPSI). For information on how to do this, see (see Prepare data for use with SCoRE and SARA on page 201)



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

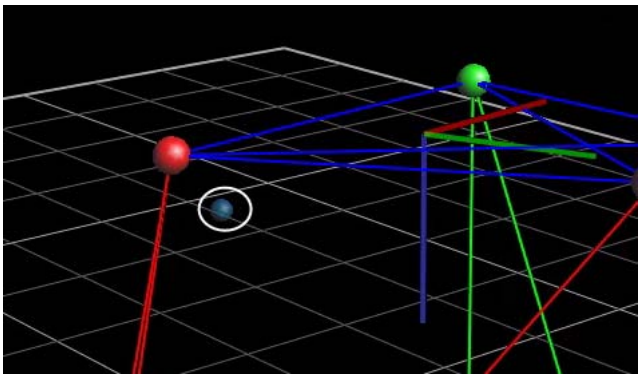


- A Calibrate SCoRE /SARA operation that creates a joint center between the specified parent (Pelvis) and child (LFemur).



2. Run the pipeline.

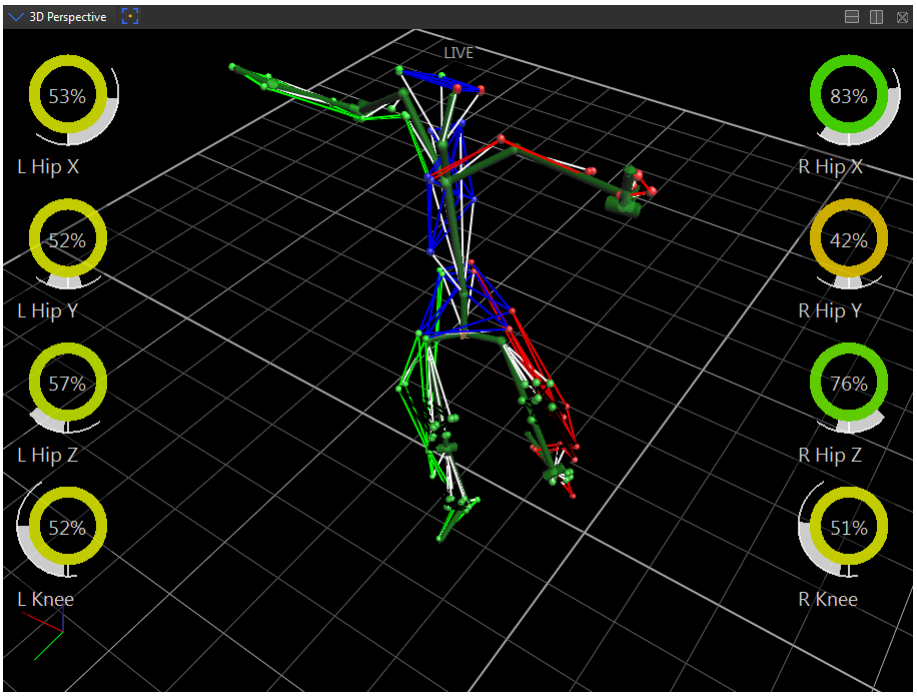
   In the 3D Perspective view pane, you can see an additional SCoRE (or SARA) marker.



Process multiple joints with SCoRE and SARA

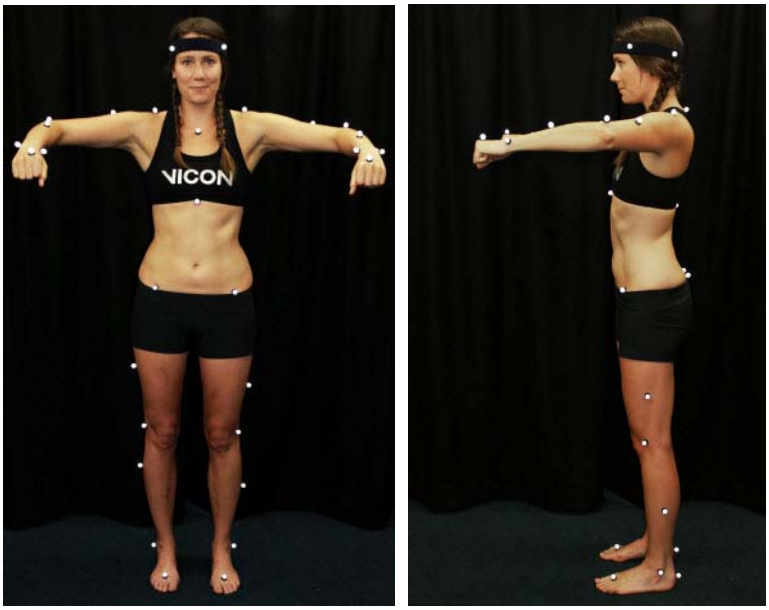
The following steps show how to calculate SCoRe joint centers and SARA knee axes in the same workflow. Including both hips and knees in the same workflow saves time, but relies on having a subject who can perform the required ROMs reasonably easily and without much assistance.

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 on page 186.)

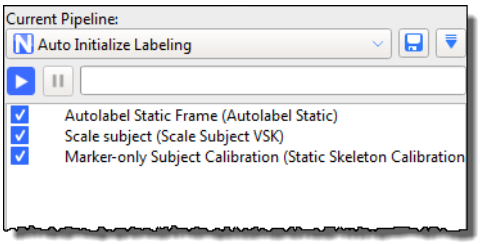


To calculate SCoRE joint centers and SARA knee axes:

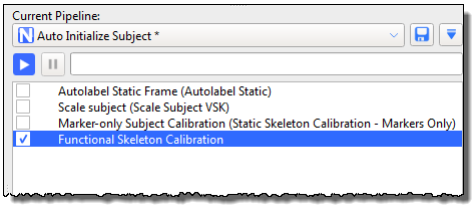
1. Capture a subject ROM. Ensure that, for the first few frames and last few frames, the subject is in the motorbike pose, as shown in the following images.



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

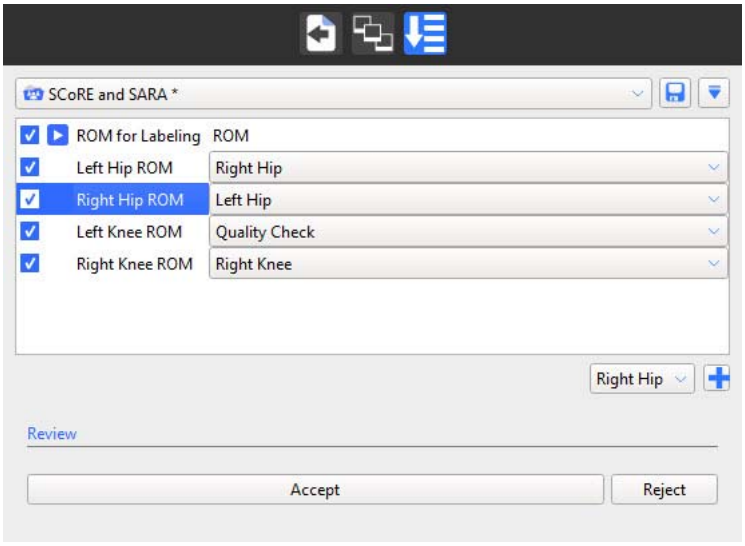


3. Run the **Functional Skeleton Calibration** pipeline operation (found in the **Subject Calibration** pipeline operations) to calibrate the labeling skeleton.



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 on page 204.

   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 on page 193.

5. Run the **Reconstruct and Label** pipeline.

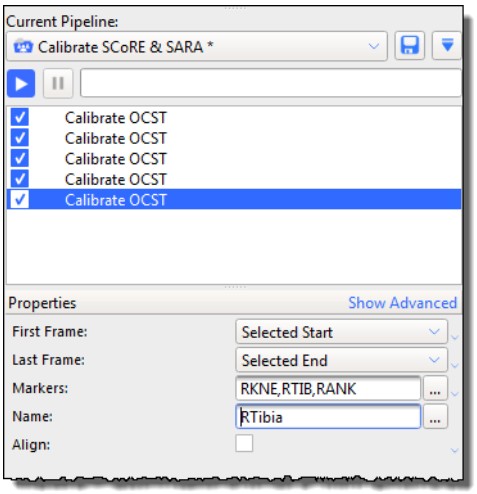
6. Create a new pipeline to contain the SCoRE/SARA calibrations you will need, plus any required OCST calibrations. For example, you could call the pipeline **Calibrate SCoRE & SARA**.

7. Add the required Calibrate OCST pipeline operations to the new pipeline (see Prepare data for use with SCoRE and SARA on page 201).

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:

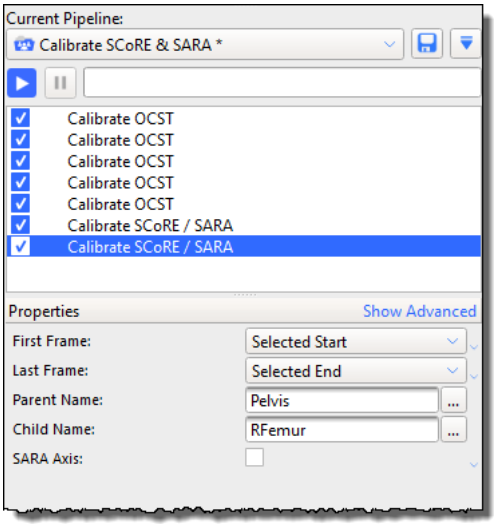


9. For each joint, add a **Calibrate SCoRE/SARA** operation (found in the **Subject Calibration** pipeline operations), and specify each parent and child segment, for example:

- 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.

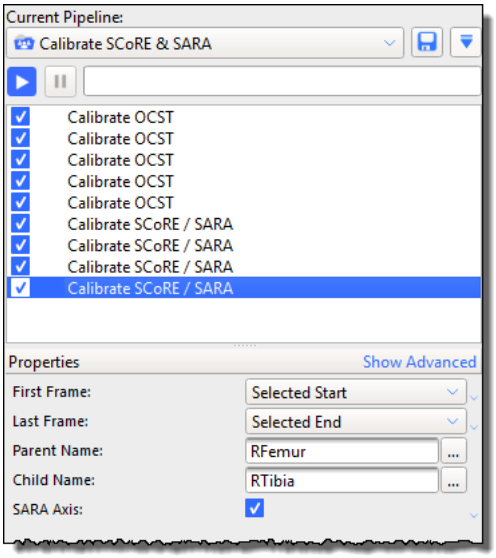


Then add two more Calibrate SCoRE/SARA operations for the knee joints:

- 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.



10. Save the pipeline and calibrate the joints by running the **Calibrate OCST** and **Calibrate SCoRE/SARA** pipeline operations.

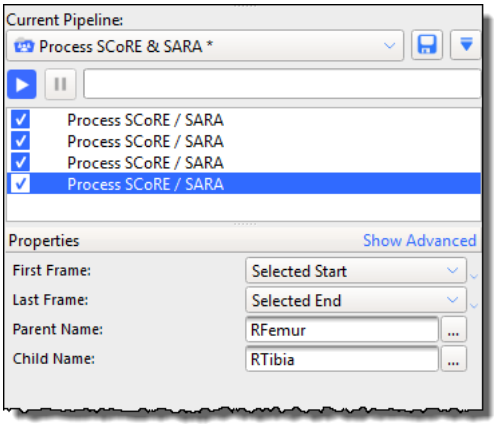
    New hip and knee joint markers are displayed in the **3D Perspective** view pane.

11. Collect dynamic trials with the subject performing the required movement (walking, etc).

12. Create a new **Process SCoRE & SARA** pipeline to contain the processing operations.

13. For each SCoRE/SARA joint that you created previously, add a **Process SCoRE/SARA** operation (found in the **Data Processing** pipeline operations).

Specify the same **Parent** and **Child** segments as those you created in the **Calibrate SCoRE & SARA** pipeline.



14. Run the processing pipeline.

Modeling with Nexus 2: Plug-in Gait, MATLAB, Python

For a description of the enhanced modeling features offered by Vicon Nexus 2, see the following topics.

Overview of Vicon Nexus 2 modeling

Modeling in Nexus 2 has undergone substantial changes to provide improvements to the approaches adopted in earlier versions of Nexus.

With Nexus 2, you can continue to use both Plug-in Gait and the Oxford Foot Model in the same way as before. For more information, see Modeling with Plug-in Gait on page 217.

In addition, to provide a widely accessible environment in which to develop custom models, Nexus 2 makes it easier to model with both MATLAB and Python. For more information, see Modeling with MATLAB on page 218 and Modeling with Python on page 229.

Note

For research and experimental purposes, a version of Plug-in Gait in open MATLAB script is also available. For further details, contact Vicon Support.

About modeling terminology

Just as modeling within Nexus has undergone improvements, so the language used to describe it, both within Nexus itself and within the accompanying Help and other documentation, has been refined. To gain a clear understanding of the way modeling is represented in Nexus, bear in mind the following definitions:

Modeling This term is applied to:

- Calculations that occur after labeling
- Maths/models that produce:
  - Biomechanical definitions of segments and joints, etc.
  - The creation of variables for analysis

Important

During the *labeling* process, you calculate joints, segments, bones, parameters and variables. These are labeling skeleton definitions.

After labeling, the *modeling* process produces segments, bones, parameters and variables; and other information used for analysis.

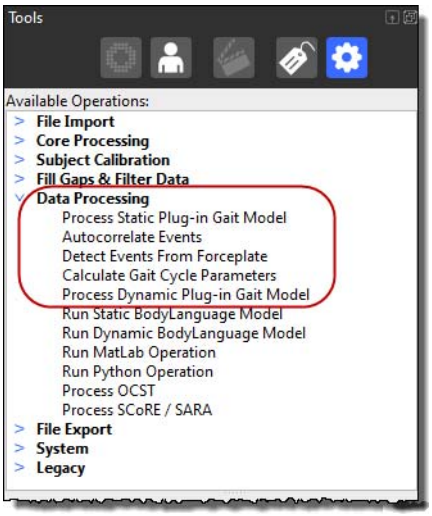
The following examples show the distinction between labeling and modeling:

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

Modeling with Plug-in Gait

As in previous versions of Nexus, you can continue to work with the Plug-in Gait model, Vicon's implementation of the Conventional Gait Model, which provides widely used and reliable full body kinematic and kinetic modeling, without the need for any customizations. With Nexus 2, you can continue to use both Plug-in Gait and the Oxford Foot Model in the same way as before.

Operations relating to modeling with Plug-in Gait are available in the **Data Processing** operations in the **Pipeline** tools pane.



Modeling with MATLAB

Important

Vicon Nexus 2 is compatible with, and has been tested with MATLAB R2013b. 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.

The improved MATLAB interface provides immediate feedback of scripting changes in the **3D Perspective** view. This enhancement means that you do not have to save a.**c3d** file before you can see the results of your scripting changes: with Nexus 2, the effect on the currently loaded trial is displayed as soon as you change your MATLAB script.

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

C:\Program Files (x86)\Vicon\Nexus2.x\SDK\Win64\Matlab\Examples

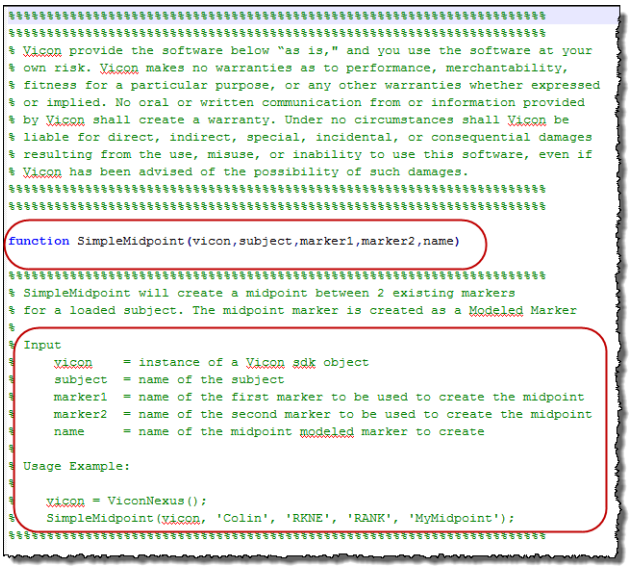
This example script creates a marker mid way between two existing markers in a loaded trial, so you must specify the subject, the two markers between which to create the midpoint, and the name of the midpoint marker that is to be created.

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 **Input arguments** field, if your script requires arguments, provide a comma-separated list of arguments to be used by the script, surrounding each argument with single quotes. In this example:

   ```
   'Colin','LWRA','LWRB','LWRM'
   ```

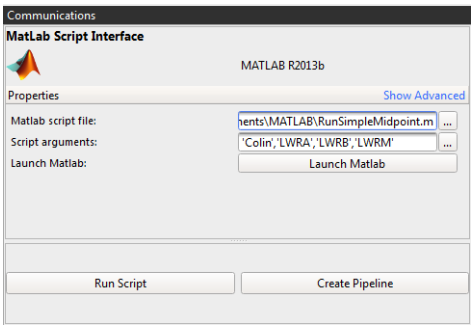
   The supplied examples show the required input and its format.



```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 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');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```



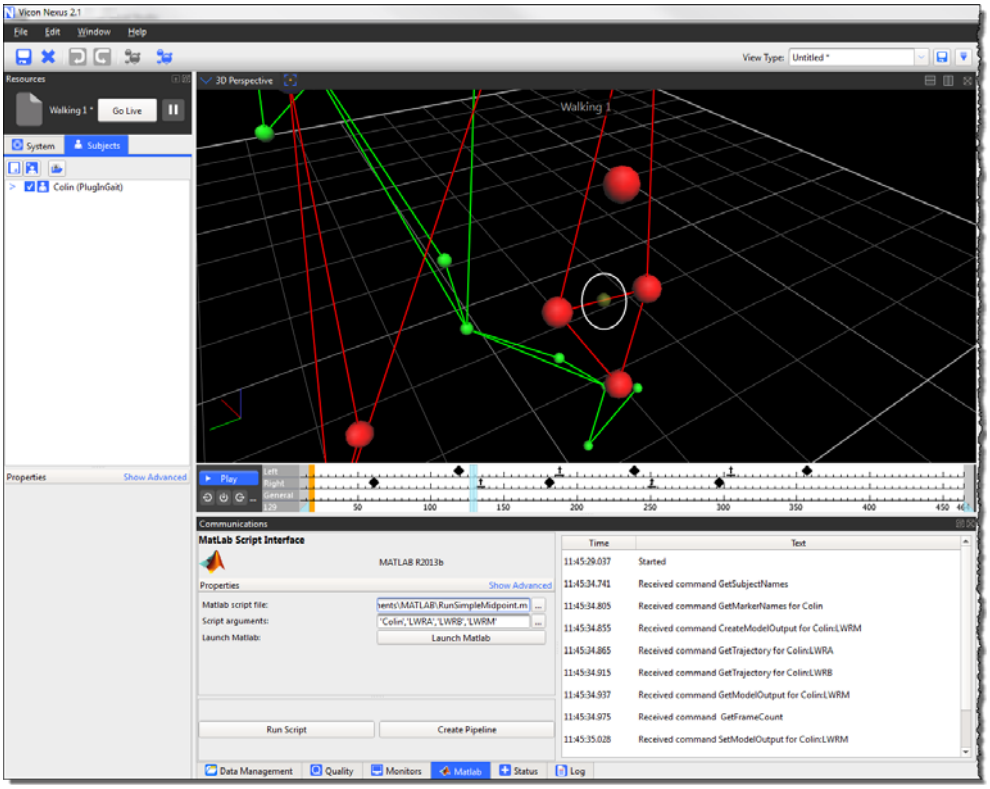
If your script does not require any arguments, leave the **Script arguments** field blank.

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

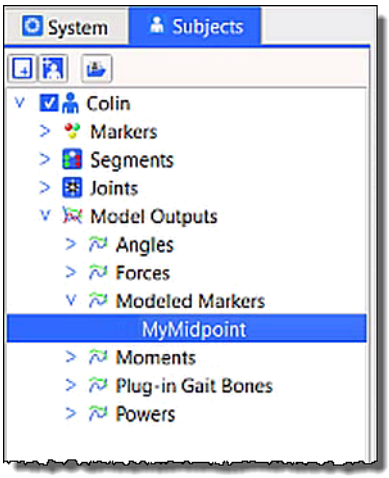
6. Click **Run Script**.

   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.

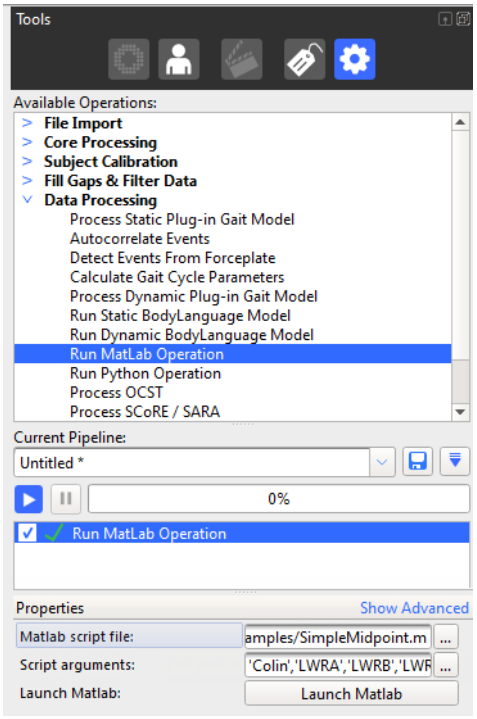


Display a **Graph** view of the new marker to see that a trajectory for the new marker has been created for the whole trial.

7. 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.

8. 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.



For information on how to access the help provided on the relevant MATLAB commands, see MATLAB commands for use with Nexus on page 223.

For troubleshooting tips, see MATLAB troubleshooting on page 225.

MATLAB commands for use with Nexus

Information on the following commands is provided to help you to get started using MATLAB for modeling with Vicon Nexus 2:

- DisplayCommandList
- DisplayCommandHelp

DisplayCommandList

This method has been defined in the MATLAB class provided to display a list of commands. The MATLAB standard MethodsView command can be used to query method signatures on not only the top-level ViconNexus class but the underlying .NET assembly as well.

To obtain a list of commands for use with Nexus:

1. At the command prompt, create an instance of the ViconNexus object (if you haven't already created one) to get access to its methods.

   ```
   » vicon = ViconNexus()
   ```

2. You can then call any of its defined methods or use the 'client' property to access the .NET assembly directly.

   ```
   » vicon.DisplayCommandList()
   ```

   A list of command names is displayed.

DisplayCommandHelp

You can display the help available for each command that can be used with Vicon Nexus.

To obtain help on each command that you can use with Nexus:

1. At the command prompt, create an instance of the ViconNexus object (if you haven't already created one) to get access to its methods.

   ```
   » vicon = ViconNexus()
   ```

2. At the command prompt, enter:

   ```
   » vicon.DisplayCommandHelp('commandName')
   ```

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

For example, the following command displays help on GetTrajectory:

```
» vicon.DisplayCommandHelp('GetTrajectory')
```

The following information is displayed:

```
ans =

GetTrajectory Retrieve X, Y, Z values for the specified
trajectory for all frames in the currently loaded trial.

Input Parameters

MarkerName = Name of a defined marker for the loaded subject

SubjectName = Name of the Subject that is loaded in to the
Nexus workspace.

Output Parameters

E = Indication of whether or not the coordinate for a specific
frame exists. A true value indicates that the data exists,
a false value indicates that the data does not exist and the
coordinate values do not contain valid data.

X = Array of X coordinates.

Y = Array of Y coordinates.

Z = Array of Z coordinates.

»
```

MATLAB troubleshooting

The following table lists possible issues, 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
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 disable 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 **Adding the MS Loopback Adapter on Windows 7**, on blogs.msdn.com

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. For a 32-bit installation of MATLAB, install the 32-bit version of the SDK; for a 64-bit installation of MATLAB, install the 64-bit version of the SDK.
		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 on the **Start** menu to set the MATLAB path.

Issue	Reason	Action

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++ 64bit 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.

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 you 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.

Issue	Reason	Action
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.

Plug-in Gait in open MATLAB script

Vicon has produced an open source version of the Plug-in Gait model, which is written in MATLAB script. This script is provided as both a research tool and as an example of how to code with the new Vicon Offline Data API. If you are familiar with MATLAB, this script is also a form of documentation that can help you to further understand the calculations used in standard Plug-in Gait operation. The open source code means that you can make additions or changes to the definitions and calculations for research purposes.

This script is a prerequisite if you want to use SCoRE and SARA with Vicon Nexus 2,

Caution

Due to the fact that this code can be altered and resaved, it is not intended or recommended as a replacement for the current Plug-in Gait pipeline operations in clinical assessment workflows. In these cases, you should continue to use the standard Plug-in Gait operations (**Process Static Plug-in Gait Model**, and **Process Dynamic Plug-in Gait Model**, found in the **Data Processing** operations in the **Pipeline** tools pane).

To obtain a copy of the script, contact Vicon Support.

Modeling with Python

Python is a powerful, widely used programming language that can be a useful tool for mathematical modeling with Vicon Nexus 2.

To ensure that custom modeling is available whether or not you have access to MATLAB, Python is automatically installed with Nexus 2.

To launch Python:

1. Click **Start** and point to **All Programs (or press the Windows key)** and then start to type **Python**.

2. Click the Python symbol.

3. To automatically configure Python for scripting with Nexus, at the command prompt, enter the following:

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

For information on how to access the help provided on the relevant Python commands, see Python commands for use with Nexus on page 230. For more information about how to use Python, see https://www.python.org/about/gettingstarted/

Tip

If you disconnect your Ethernet cable and disable 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 on how to do this, see **Adding the MS Loopback Adapter on Windows 7**, on blogs.msdn.com

Python commands for use with Nexus

The following commands are provided to help you to get started using Python for modeling with Vicon Nexus 2:

- DisplayCommandList
- DisplayCommandHelp

DisplayCommandList

To obtain a list of commands for use with Nexus:

- Ensure you have launched and configured Python as described in Modeling with Python on page 229, then at the Python command prompt, enter:

  `vicon.DisplayCommandList()`

  A list of relevant Python commands is displayed:

```
>>>
>>> vicon.DisplayCommandList()
ClearAllEvents
CreateAnEvent
CreateModelOutput
CreateSubjectParam
GetDeviceChannel
GetDeviceChannelAtFrame
GetDeviceChannelGlobal
GetDeviceChannelGlobalAtFrame
GetDeviceChannelIDFromName
GetDeviceDetails
GetDeviceIDFromName
GetDeviceIDs
GetDeviceNames
GetDeviceOutputDetails
GetDeviceOutputIDFromName
GetEvents
GetFrameCount
GetFrameRate
GetJointDetails
GetJointNames
GetMarkerNames
GetModelOutput
GetModelOutputAtFrame
GetModelOutputDetails
GetModelOutputNames
GetRootSegment
GetSegmentDetails
GetSegmentNames
GetSubjectNames
GetSubjectParam
GetSubjectParamDetails
GetSubjectParamNames
GetTrajectory
GetTrajectoryAtFrame
GetTrialName
GetTrialRange
OpenTrial
RunPipeline
SaveTrial
SetDeviceChannel
SetDeviceChannelAtFrame
SetModelOutput
SetModelOutputAtFrame
SetSubjectParam
SetTrajectory
SetTrajectoryAtFrame
>>>
>>>
>>> vicon.DisplayCommandHelp( "ClearAllEvents" )
ClearAllEvents
Clear ALL events from the currently loaded trial.
----------------
Input Parameters
----------------
None
-----------------
Output Parameters
-----------------
None
```

DisplayCommandHelp

To obtain help on each command that you can use with Nexus:

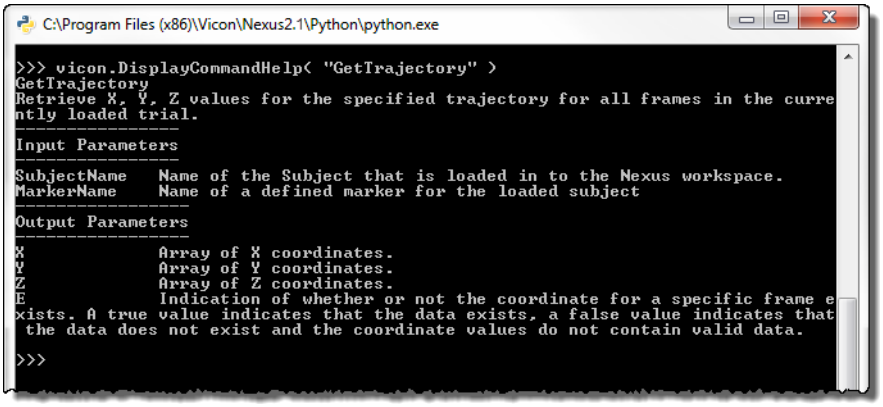
- At the Python command prompt, enter:
  `vicon.DisplayCommandHelp('commandName')`

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

  For example, the following command displays help on GetTrajectory:

  `vicon.DisplayCommandHelp('GetTrajectory')`

  Help on GetTrajectory is displayed:



Known and addressed issues

This chapter covers the following topics:

Addressed issues

For information on the fixes included in each point release since the launch of Vicon Nexus 2.0, see:

- Nexus 2.4 solved issues
- Nexus 2.3 solved issues
- Nexus 2.2 solved issues
- Nexus 2.1.1 solved issues
- Nexus 2.1 solved issues
- Nexus 2.0 solved issues

Nexus 2.4 solved issues

- Playing back trials recorded with timecode now always displays the timecode.
- Analog force plates' settings are no longer unexpectedly changed when you reapply a non-default **Gain**.
- The reliability of events when collecting treadmill data has been improved.
- Calibrations no longer fail if a previously connected video cameras is physically disconnected but not removed from Nexus **System** tree.
- The calculation of the Plug-in Gait center of mass markers has been updated to more accurately align with the recommendations from the conventional gait model.
- The **Kinematic Gap Filling** operation no longer crashes if an invalid subject is part of the trial.
- If you select an L-Frame, it now persists when Nexus is restarted.
- The C3D has been updated to contain the units associated with modeled marker entries.
- Nexus 2.4 corrects a behavior with Boolean AND monitor triggers when analog data is a component.
- Adjusted the default value of InterASIS Distance for the Oxford Foot Model.
- The trial name no longer persists in the **Resources** pane when Nexus is restarted.

- A behavior that caused the subject to be deselected when a parameter is added has been changed.
- Nexus has been updated to prevent the application start up time from being increased if Bonjour has not been installed.
- An issue where Basler camera settings were not loading when switching between system files has been corrected.

Nexus 2.3 solved issues

Vicon Nexus 2.3 contains fixes for the following issues:

- Deleting or renaming trials via Eclipse that have untransferred video now behaves correctly.
- Analog device outputs and output components can now have names exceeding a total length of 16 characters.
- Calibration of selected cameras has been updated. This allows the calibration of a single camera as long as other calibrated cameras exist in the system.
  Calibration now correctly permits calibration using one optical camera and one video camera.
  Calibration now correctly uses information from unselected but calibrated cameras.
- Imported AVI files with non-ASCII names now correctly associate to the trial.
- Manual camera masking now correctly updates and applies masks when the camera is present in multiple views.
- Nexus now displays an information message when a graph cannot be drawn.
- The subject builder can now create segments with the same name as an existing marker.
- Graph trace colors now correctly follow the order specified in the View options.
- Fixed a memory leak when operations were too large to store on the undo stack.
- Calibration now succeeds for users who run Plug-in Gait marker sets without UPA and FRM markers.
- Matlab and Python APIs now support Unicode.

- Monitors now trigger correctly when an **Above Upper** threshold is negative.
- Changing the system rate no longer prevents monitors from triggering.
- **ArchHeightIndex** values are no longer missing from the output when running the native Oxford Foot Model operation.
- Newly connected video cameras are now aware of the video calibration mode state and set their defaults accordingly.
- Renaming trials with transferred video now renames the AVI files correctly to remain associated with the trial and camera number.
- ProEclipse subject viewer now supports visualization of VST3 subjects.
- Invalid subject names no longer causes crashes when starting capture.
- When the last opened database is not available, ProEclipse opens in the next available folder above this location instead of generating an error.

AGW resolved issues:

- The Matlab Plug-in Gait model now supports KAD and medial ankle markers for the calculation of tibial torsion.
- Fixes to the calculation of joint centers under certain circumstances.

Nexus 2.2 solved issues

Vicon Nexus 2.2 contains fixes for the following issues:

- Kinematic fill operation can now be performed on multiple segments. The **All** option works as expected.
- **Export ASCII** operation now exports the frame numbers for frames with no visible markers.
- Digital device plug-ins are now stored in a common location for all 2.x releases (**C:\Users\Public\Documents\Vicon\Nexus2.x\DigitalDevices**). Nexus prompts to upgrade the install location.
- New Nexus SDK command **GetTrialRegionOfInterest()**, which returns the cropped trial range.
- Removed components of an analog device no longer reappear after a save and reload.
- Device channel names no longer prepended by the output component names.
- SCoRE and SARA operations can now be run on subjects where marker names include an underscore character.
- Marker order now respected when saving the subject as a VST file.
- Default offline streaming rate increased to 120Hz. Option available from the timebar context menu to stream every frame.
- Events no longer generated from forceplates that are marked as invalid.
- X1D files with non-English characters are now supported.
- Labeling template builder assigns more appropriate joint location parameters to newly created joints.
- Nexus no longer becomes unresponsive when running the **Calculate Gait Cycle Parameters** operation.
- Head offset angle now calculated from the selected frame range
- Cross-plate strikes work correctly when segments are manually assigned to a footplate
- Crashes no longer occur where the Noraxon vdd attempts to write to a privileged location. VDDs are now stored in a common location that does not require elevated privileges.

Nexus 2.1.1 solved issues

Vicon Nexus 2.1.1 contains fixes for issues that were reported following the release of Nexus 2.1, including the following:

- SCoRE and SARA dynamic calculation operations now produce outputs.
- The issue of the cross-plate strikes option in the dynamic Plug-in Gait operation always combining data from plates if the foot strikes are manually assigned to a segment has been corrected. The **Static Head Offset** values are now calculated by the Plug-in Gait Static operation.
- The **Run Python** operation completes successfully, even if non default pathways contain scripts or required files.
- Focus now returns from ProEclipse data manager to Nexus.
- An issue related to OpenGL, which caused transparent subject items to be rendered in the wrong order, has been corrected.
- When running the **Generate Gait Cycle Parameters** operation, events for a previous trial are no longer used in calculations, even if the current trial has no event present.
- An update in the Plug-in Gait native operation prevents a small discrepancy that can occur in ankle moment when compared to the legacy Plug-in Gait operation.
- Updates to the **Fill Gaps - Rigid Body** pipeline operation prevent bad fill suggestions.
- An issue that affected processing when more than one instance of Nexus is open at the same time has been corrected.
- The **Process Static Plug-in Gait Model** operation now uses the First-Last frame range for calculating the static head offsets.

Nexus 2.1 solved issues

Vicon Nexus 2.1 contained 65 solved issues, including the following:

- There is no longer a difference in frame selection / filtering for analog sub-frames between PiG and Vicon Gait Model.
- The Labeling Template Builder does not now cause crashes on linking segments.
- Auto-correlate no longer creates double events with multiple forceplates.
- Markers that are Calibration only or Optional that had been removed and were not present in trial are no longer displayed.
- Bounding boxes are now available for Polygon use.
- A MKR file is exported to the session folder.
- The Aim camera feature no longer crashes Nexus.
- The issue that SCORE could crash with multiple subjects has been fixed.
- Attaching a different VST to a labeled subject no longer un-labels the subject.
- F7 now works after a loading a trial.
- Ctrl+S now saves as expected.
- The issue of potential latency when using Dikablis eye tracker has been corrected.
- A marker added to a segment now contains scalable parameters.
- Nexus no longer becomes unresponsive when running Filter Model Outputs - Butterworth pipeline.
- Running a BodyLanguage model without data loaded no longer crashes Nexus.
- In the Plug-in Gait model, the Reaction Reference Frame now defaults to Distal instead of to Proximal.
- Modeled markers are stored in the C3D in a more user-friendly format.
- Center of Pressure (CoP) coordinate frame output is now global instead of local.

Nexus 2.0 solved issues

The following issues were fixed in Nexus 2.0:

- Pausing a pipeline operation no longer causes a hang.
- Nexus AMTI force plate – When RAW data channels are captured, voltage is now correctly scaled.
- The presence of a Noraxon EMG digital device no longer causes a crash.
- The issue that the **Start Capture** button could be disabled for unconfigured videos, even when video cameras were disabled, has been corrected.
- When digital and analog devices are present, a device no longer goes missing if the devices arrive in a different order.
- Bonita Video camera masks are now retained correctly on restarting.
- Analog channel monitor threshold settings now load properly when a monitor is reloaded.
- If the classification, patient, or session name was in Japanese, then recording a trial no longer fails to create an x2d in the session folder.
- Static subject calibration does not now require you to look at the frame you were calibrating in order to run.
- Plug-in-Gait joint force and moment units indicate that they are normalized to body weight.
- Subject measurements are no longer incorrectly populated automatically, even when the previous dependent parameters are not cleared.
- The Graph pane no longer incorrectly switches to trajectory count during analog filtering operations.
- You can now delete a model when model outputs or generated trajectories are present.
- Docking/un-docking windows multiple times no longer results in a crash.
- View Lock: Lock function in camera view is now correctly saved as part of a view type definition.
- The presence of a dummy subject no longer causes monitor loading issues.
- The preferred segment angle format is now correctly stored in a view type definition.
- The issue that the Y axis for force plate graphs did not scale until the threshold value was broken has been corrected.

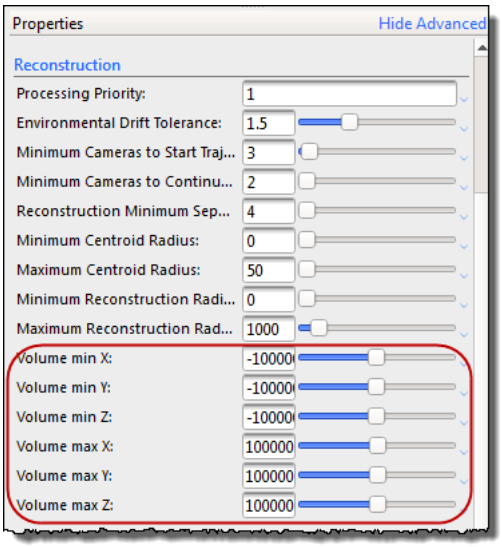
- Long captures no longer cause Nexus to crash.
- Selecting Remove Subject now removes model outputs.

Specify the volume to avoid creating unnecessary reconstructions

Vicon Nexus 2 enables you to specify the dimensions of the volume in which reconstructions are created, so that you can avoid unnecessarily creating unwanted reconstructions (for example, reconstructions that are too high up in the volume).

The reconstruction properties are available when you select the new **Core Processing** pipeline operations that include reconstruction (**Reconstruct** and **Combined Processing**).

To specify the required size of the volume in which reconstructions will be created, enter values in the **Volume min** (X, Y, and Z) and **Volume max** (X, Y, and Z) fields.



Known issues

The following table lists issues known to exist in this release of Vicon Nexus, and offers possible solutions.

Description	Workaround
Some of the latest versions of the FFDShow video encoder fail to work properly.	Vicon recommends the use of **ffdshow_rev3562_20100907**.
Running a legacy VPI operation removes non-standard model outputs.	Use the equivalent native operations.
AMTI digital device plugins missing required dependencies.	For AMTI Digital Device V1_00.vdd, download Microsoft Visual C++ 2008 SP1 Redistributable Package (x86) from https://www.microsoft.com/en-gb/download/details.aspx?id=5582 For AMTI Digital Device V1_10.vdd, download Microsoft Visual C++ 2010 Redistributable Package (x86) from https://www.microsoft.com/en-gb/download/details.aspx?id=5555
Basler cameras do not work under Windows 10.	Basler cameras require Pylon 5 drivers for Windows 10. These are not compatible with Nexus. Use Windows 7 and Pylon 2.3.5 instead.
Cometa/Aurion ZeroWire/Wave do not work under Windows 10.	Device drivers are not available for Windows 10. Use Windows 7 instead.
When the system frame rate is set above 80Hz, if you enable Preview mode, no preview is displayed for Vicon Vantage cameras (the Camera view is blank).	To use Preview mode with Vantage cameras, select a system frame rate below 80Hz.
When you right-click the **Devices** node on the **System Resources** pane, **Noraxon** is not available in the **Add Digital Device** menu.	When you install the Noraxon plug-in (**ViconInterfaceForNoraxon - v1.0.2.1.msi**), change the installation path to **C:\Users\Public\Documents\Vicon\Nexus2.x\DigitalDevices**

Description	Workaround
.NET is turned off by default on Microsoft Windows 8, which stops ProEclipse running.	Enable .NET framework 3.5 on Windows 8 machines. To do this, open the **Control Panel**, click **Programs** and then click **Programs and Features**. Click **Turn Windows features on or off** and select the **Microsoft .NET Framework 3.5.1** check the box. You can do this before or after installing Nexus.

MATLAB/Nexus integration will not operate on Windows 7 unless the .NET framework 4.5 is installed. Attempting to run MATLAB pipeline operations reports:
`Error Run MatLab Operation`
`Error using NET.addAssembly`
	Install .NET framework 4.5 from microsoft.com.

Noraxon Telymyo DTS device halts camera and analog data delivery when Noraxon devices are housed/not charged.	Digital devices now have an **Enabled** parameter in their **Properties** pane. To prevent a given manufacturer's plugin from holding up the rest of Nexus, clear **Enabled** for ALL devices from that manufacturer.
Unable to run legacy Static Gait Model under Japanese Windows. Log entry reads: `No parameter file found`	The legacy Plug in Gait model does not support international character sets. Instead of using the legacy Plug-in Gait model, use the native Nexus 2 replacement gait model (found under **Data Processing** pipeline operations: **Process Static Plug-in Gait Model** and **Process Dynamic Plug-in Gait Model**).
Export c3d at the end of a pipeline does not clear the trial and leaves the trial with a dirty flag (*).	The **Export C3D** operation does not write out the subjects associated with the trial. To remove the dirty flag on a trial, save the entire trial, which saves all associated files (x2d, xcp, etc), using the **Save Trial - C3D + VSK** operation.
Video capture duration can be limited directly after deletion from SSD storage.	After deleting your video files, wait a few seconds before starting your next capture. This is because some Solid State Drives require a few seconds to recover full Write speed after file deletion.

Description	Workaround
Spaces in variable names can cause BodyLanguage to fail.	When creating subject parameters for use in BodyLanguage modeling, use underscores instead of spaces.
Nexus can suffer many problems if Eclipse databases are created in locations that are Read-only. These problems range from data silently failing to save to crashes.	NEVER create Eclipse databases in locations that require administrator privileges to read or write.
Starting a capture very soon after a change to the system frame rate, or a resynchronization, can result in erratic capture behavior (failure or dropped frames).	Avoid starting captures soon after changing the hardware setup.
PAL or NTSC camcorders are included in Active Wand camera calibration if the MX system is set to run at the same standard (i.e. PAL or NTSC).	Before performing active wand camera calibration, disable the camcorders.
Running the **Butterworth Filter (Analog Devices)** operation on a force plate may result in erratic noise in the Center of Pressure (CoP) output during periods where there is little or no force being measured. This is because the CoP is derived by dividing Moment by Force, which produces chaotic results when these numbers are approximately zero.	Only filter the force plate data over regions of time where a force is registered.

Troubleshooting

For possible solutions to commonly encountered issues, see the following:

- I have run the subject calibration operation, but cannot see the subject being fitted to the markers.
- My subject calibrated, but it fails to automatically label in Live mode.
- I am having problems using MATLAB with Nexus 2.

I have run the subject calibration operation, but cannot see the subject being fitted to the markers.

- Have all the markers in your labeling skeleton template been identified?

  For the subject calibration to succeed, all the markers specified in the template must be identified in the **3D Perspective** view. To see if you have successfully done this:

  a. On the **Subjects** tab in the **Resources** pane, expand the relevant subject's node.

  b. Expand the **Markers** sub node.

     Each marker in the labeling skeleton is displayed. Markers that have not been identified yet will be shown in gray text, whereas identified markers will be shown in black.

  c. Label any unidentified markers.

- Is the subject's name under the subject node on the **Subjects** tab shown in red?

  - The red color indicates that something is missing and that the labeling skeleton is incomplete. This could be due to either the labeling skeleton not being fully developed, for example, if links are missing between segments, or to the required subject measurements not being defined.
  - Is the Subjects display enabled in the view **Options**?

    a. From the **Window** menu choose **Options**.

    b. In the **General View Options** list, ensure that the **Subjects** item is selected.

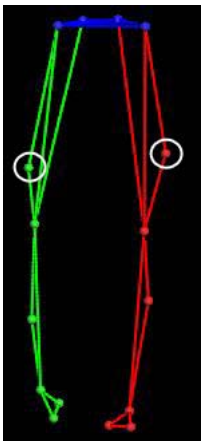
My subject calibrated, but it fails to automatically label in Live mode.

- Is the **Processing Output level** set to at least the **Labels** level?
  a. In the **System** resources pane, select **Local Vicon System**.
  b. In the **Properties** section, make sure the **Processing Output level** parameter in the **General** section is set to **Label** or **Kinematic Fit**.
- Is the correct subject selected?
  - On the **Subjects** resources tab, make sure that the subject you created and calibrated is the only subject selected.
- Is the correct labeling skeleton template still attached to the subject?

  On the **Subjects** resources tab, check that the required labeling skeleton template name (on the right of the subject name, in parentheses) is still displayed.
- Is the **entrance threshold** for **Labeling completeness** set too high?

  The **Labeling completeness: entrance threshold** parameter specifies the minimum proportion of markers that Vicon Nexus must recognize to start labeling. If it is set too high, labeling may fail altogether. Aim to achieve a balance between setting it too low (which may result in mis-labeling when the subject first enters the volume) or too high (which may result in failure to label due to Nexus not recognizing sufficient markers for labeling to start). The default value is 0.85.
  a. In the **System** resources pane, select **Local Vicon System**.
  b. In the **Properties** pane, go to the **Labeling** section and lower the **Labeling completeness: entrance threshold** value by a small amount (for example, 0.05).
- Did the subject calibration pipeline operation succeed?
  - Sometimes the subject calibration pipeline operation will fail, as indicated by a red X instead of a green check mark by the pipeline operation name in the **Pipeline** tools pane.
    - If it has failed, check the **Communications** pane **Log** tab for information as to why the failure occurred. Troubleshoot any error, and run the subject calibration pipeline again.

- You can help the auto labeling routine distinguish right from left by introducing asymmetry into your marker placement, for example, by placing one thigh marker higher than the other.

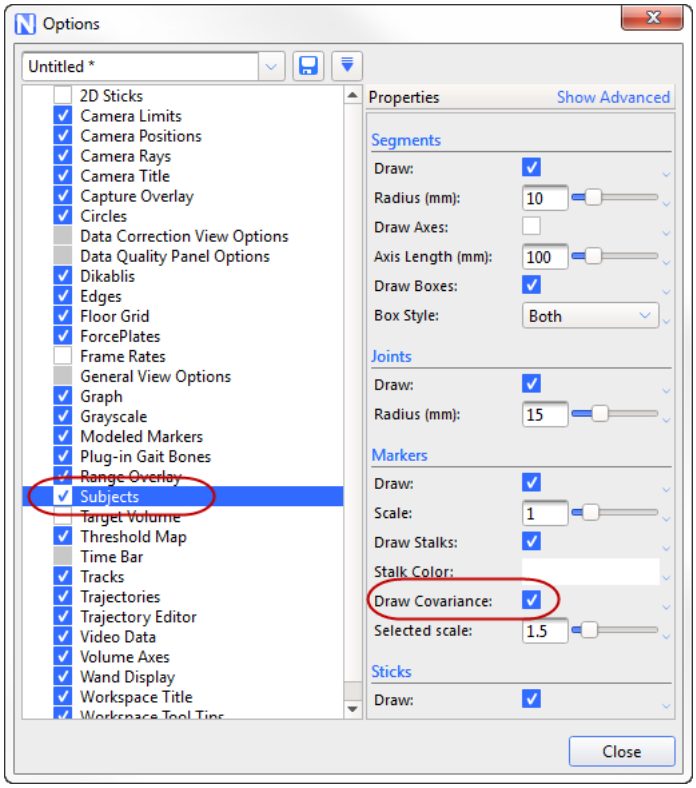


- Labeling problems are often caused by tracking skeleton problems so it is often worth looking at the data used for calibration.If you have followed the recommended workflow (see New workflow for Vicon Nexus 2 on page 158), and labeling is not working well, try the following steps:

  a. Try recalculating the subject statistics for the type of activity performed by the subject. For example, try manually labeling a trial of the subject performing the relevant activity, then run a **Calculate Skeleton Joint & Marker Statistics** pipeline operation to recalculate statistics for this particular subject, instead of using the defaults.

  b. Try a full functional calibration, by capturing a ROM trial, manually labeling it, and running a **Functional Skeleton Calibration** pipeline operation. Note that this may take some time. Open the **Options** dialog

box (F7) and select **Subjects**. In the **Properties** pane on the right, select **Draw Covariances**.



If there are small covariance ellipsoids, this indicates that the calibration will produce good labeling. Large covariance ellipsoids may indicate that labeling quality may be unsatisfactory. Reasons for larger than expected covariance ellipsoids may be due to a poor subject calibration. This can be caused by the existence of an incorrect label in the calibration trial, or need for further optimization of the labeling skeleton template (see Requirements for custom labeling skeleton templates (VSTs) on page 157).

I am having problems using MATLAB with Nexus 2.

See MATLAB troubleshooting on page 225.

Further resources

If you need more information than that supplied in the documentation or on the Vicon Support web pages, please use the following additional resources

Denver, CO

Vicon Denver
7388 S. Revere Parkway, Suite 901
Centennial
CO 80112
USA
T:303.799.8686
F:303.799.8690
E: support@vicon.com

Los Angeles, CA

Vicon LA
3750 S. Robertson Boulevard, Suite 100
Culver City
Los Angeles
CA 90066
USA
T:303.799.8686
F:310.388.3200
E: support@vicon.com

Oxford, UK

Vicon Oxford
14 Minns Business Park
West Way
Oxford
OX2 0JB
UK
T:+44.1865.261800
F:+44.1865.240527
E: support@vicon.com

Singapore

Vicon Singapore
T:+65 6400 3500
E: support@vicon.com

Regulatory information

This chapter contains:

ISO certification

This topic contains ISO certification relating to Vicon Nexus:

- ISO 13485: 2003 and 2012 Certificate of Approval
- ISO 9001: 2008 Certificate of Approval

ISO 13485: 2003 and 2012 Certificate of Approval

Lloyd's Register LRQA

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Vicon Motion Systems Ltd t/a Vicon
14 Minns Business Park, West Way,
Oxford
United Kingdom

has been approved by Lloyd's Register Quality Assurance
to the following Quality Management System Standards:

ISO 13485:2003
EN ISO 13485:2012

The Quality Management System is applicable to:

Design, manufacture and support of motion capture systems for life science applications, including development of related software.

This certificate forms part of the approval identified by certificate number LRQ 4003146

Approval
Certificate No: LRQ 4003146/C

Original Approval: 17 August 2007
Current Certificate: 17 August 2015
Certificate Expiry: 16 August 2018

Issued by: Lloyd's Register Quality Assurance Limited

UKAS MANAGEMENT SYSTEMS 001

1 Trinity Park, Bickenhill Lane, Birmingham, B37 7ES, United Kingdom

ISO 9001: 2008 Certificate of Approval

Lloyd's Register LRQA

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Vicon Motion Systems Ltd t/a Vicon
14 Minns Business Park, West Way,
Oxford
United Kingdom

has been approved by Lloyd's Register Quality Assurance
to the following Quality Management System Standards:

ISO 9001:2008

The Quality Management System is applicable to:

Design, manufacture and support of motion capture systems. Development of software for motion capture systems, measurement and analysis of three-dimensional structures.

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

This certificate forms part of the approval identified by certificate number LRQ 4003146

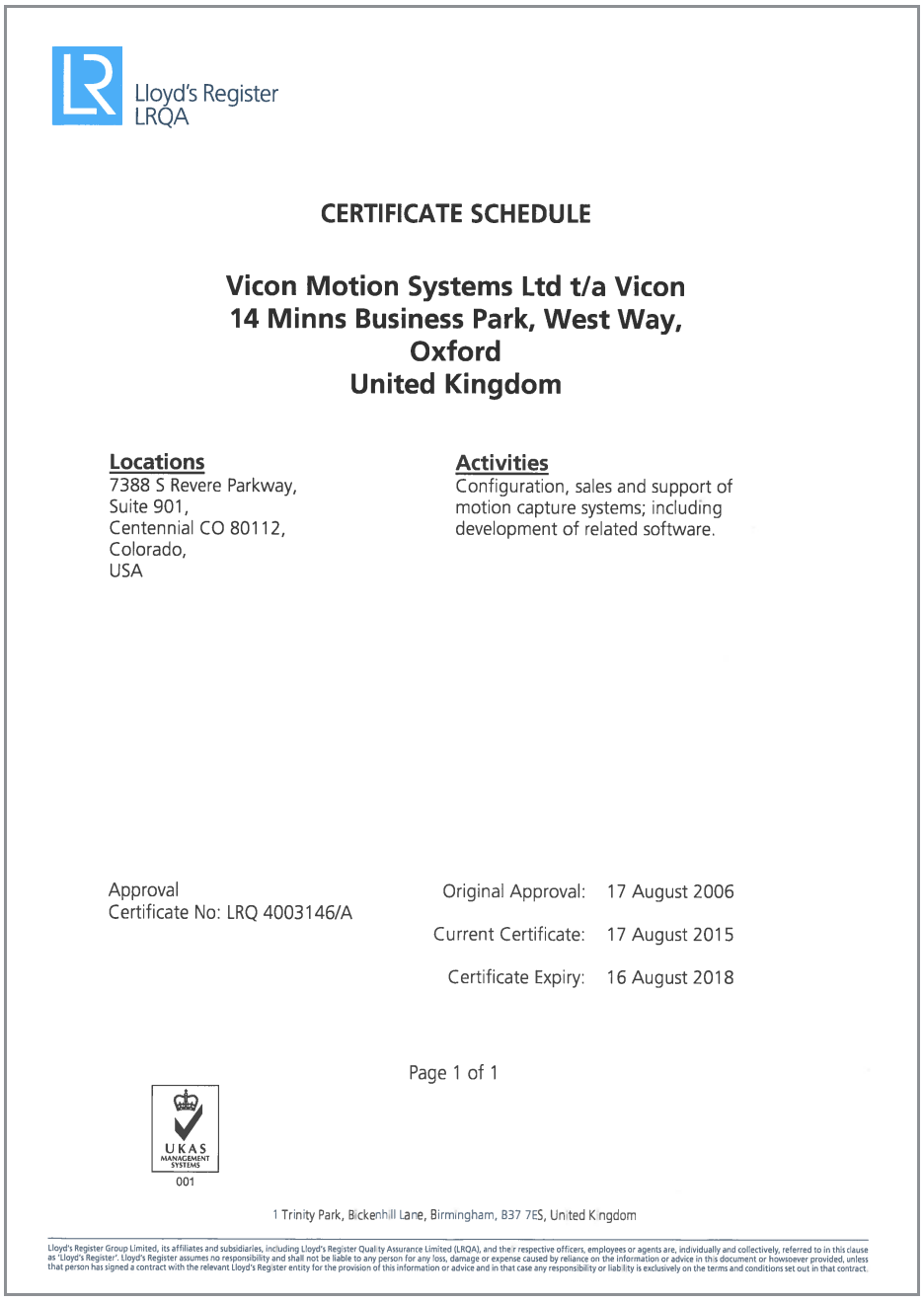
Approval
Certificate No: LRQ 4003146/A

Original Approval: 17 August 2006
Current Certificate: 17 August 2015
Certificate Expiry: 16 August 2018

Issued by: Lloyd's Register Quality Assurance Limited

UKAS MANAGEMENT SYSTEMS 001

1 Trinity Park, Bickenhill Lane, Birmingham, B37 7ES, United Kingdom



Lloyd's Register LRQA

CERTIFICATE SCHEDULE

Vicon Motion Systems Ltd t/a Vicon
14 Minns Business Park, West Way,
Oxford
United Kingdom

Locations
7388 S Revere Parkway,
Suite 901,
Centennial CO 80112,
Colorado,
USA

Activities
Configuration, sales and support of motion capture systems; including development of related software.

Approval
Certificate No: LRQ 4003146/A

Original Approval: 17 August 2006
Current Certificate: 17 August 2015
Certificate Expiry: 16 August 2018

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UKAS MANAGEMENT SYSTEMS 001

1 Trinity Park, Bickenhill Lane, Birmingham, B37 7ES, United Kingdom

Medical devices directive

CE Declaration of Conformity

CE 0088

Medical Devices Directive 93/42/EEC as amended by Directive 2007/47/EC.
Electromagnetic Compatability to EMC Directive 2004/108/EC.
Electrical Safety to Low Voltage Directive 2006/95/EC.

We, Vicon Motion Systems Limited
Unit 14 Minns Estate
Oxford OX2 0JB
United Kingdom

declare that the VICON MX T-Series motion capture system manufactured by VICON MOTION SYSTEMS LIMITED meets ANNEX V and VII Section 5 of the Medical Devices Directive 93/42/EEC as amended by Directive 2007/47/EC in that the Quality Management System has been approved by Lloyd's Register Quality Assurance, a notified body of the European Union (Reg No. 0088) for the manufacture and support of the aforementioned CLASS 1 Medical device. The topic Product configurations and software options details the product configurations and software options that conform to the metrological requirements of the Directive.

VICON MOTION SYSTEMS LIMITED has tested and demonstrated that all products of its own manufacture meet 2004/108/EC: MX T-Series Systems (MX Giganet based)

Electromagnetic Compatibility to:
EN60601-1-2:2007

Immunity to paragraph 6.2.3.1 to:
Immunity test level of 3V/m over 50 - 60 Hz

Electrical Safety of MxGiganet Power Supply Unit (Low Voltage Directive 2006/95/EC)
IEC 60601-1:1:1988 + A1:1991 + A2:1995 EN 60601-1:1990 A1,A2 and A13, excluding clause 36 and Korean national differences.

T.M.L. Shannon, TD, FIE (Aust), CPEng (Biomedical)
Director of Regulatory Compliance
1 June 2016

Not for use in an operating theater, anesthetic gas environment, or oxygen-rich environments. Not for use where there is a risk of compromising the essential performance of medical electrical equipment. Not suitable for use in high magnetic flux, ionizing radiation, sterile, or life- or safety-critical environments.

Product configurations and software options

This section provides information relating to the CE Declaration of Conformity.

Conformity of the Metrological Performance of CLASS 1 Products in accordance with Annex V and VII Section 5 of the Medical Devices Directive 93/42/EEC as amended by Directive 2007/47/EC

We, Vicon Motion Systems Limited
Unit 14 Minns Estate
Oxford OX2 0JB
United Kingdom

declare that the VICON MX T-Series motion capture system manufactured by VICON MOTION SYSTEMS LIMITED has been tested prior to shipment and meets the following metrological performance:

- Resolution of the distance between the centers of two static 14 mm spherical markers located within a volume no less than 4 m x 4 m x 1.5 m to within 1 mm Mean; 1 mm Standard Deviation; sample size no less than 1,000
- Resolution of a given analog voltage to within +/-20 mV RMS within the following configurations and constraints:
  - No fewer than two cameras of any variant fully viewing static markers
  - Independent of lens and strobe variants fitted to each camera
  - Controlled lighting (no greater than 100 lux) and temperature (17-25° C)
  - Single termination to each analog input
  - Testing using the following Vicon application software: Nexus Version 1.4 or later

Production quality assurance certificate

Lloyd's Register LRQA

EC CERTIFICATE – PRODUCTION QUALITY ASSURANCE

In accordance with the requirements of the Medical Devices Directive 93/42/EEC and the Medical Devices Regulations 2002, UK Statutory Instrument 2002 No. 618

This is to certify that the Quality Management System of:

Vicon Motion Systems Ltd t/a Vicon
14 Minns Business Park, West Way
Oxford
United Kingdom

has been assessed against the requirements of Annex V of the Medical Devices Directive 93/42/EEC, and the Medical Devices Regulations 2002 and conforms to the requirements for the products shown on the attached schedule.

Approval is subject to the maintenance of the quality system in accordance with the requirements of the above Directive and Regulations.

Authorisation is hereby given to use the LRQA Notified Body Registration Number in accordance with the requirements of the specified Directives/Regulations in relation to the products as identified above.

Certificate No:	LRQ 4003146/B
Original Approval:	17 August 2006
Current Certificate:	17 August 2015
Certificate Expiry:	16 August 2018

LRQA Notified Body Number 0088

Issued by: Lloyd's Register Quality Assurance Limited

1 Trinity Park, Bickenhill Lane, Birmingham B37 7ES, United Kingdom

Lloyd's Register LRQA

EC CERTIFICATE – PRODUCTION QUALITY ASSURANCE CERTIFICATE LRQ 4003146/B SCHEDULE

In accordance with the requirements of the Medical Devices Directive 93/42/EEC and the Medical Devices Regulations 2002, UK Statutory Instrument 2002 No. 618

Vicon Motion Systems Ltd t/a Vicon
14 Minns Business Park, West Way
Oxford
United Kingdom

Class I Measuring Products
Vicon MX+ System
ViconT-Series System
Vicon Vantage System

Schedule Issue: 01

Date of Schedule Issue: 17 August 2015

LRQA Notified Body Number 0088

Issued by: Lloyd's Register Quality Assurance Limited

Page 1 of 1

1 Trinity Park, Bickenhill Lane, Birmingham B37 7ES, United Kingdom

Regulatory notices

This topic provides required regulatory notices and incident report forms relating to the supply and use of Vicon systems in the United Kingdom and in the United States of America.

Medical device adverse event reporting

Use the appropriate information and form to report any adverse events involving Vicon systems:

- MHRA Adverse Incident Reporting (UK)
- FDA MedWatch Adverse Event Reporting Program (US)

Should an adverse event occur, complete the appropriate form and forward it within one working day to Vicon Motion Systems Limited at one of the following addresses:

Denver, CO

Vicon Denver
7388 S. Revere Parkway Suite 901
Centennial
CO 80112
USA
T:303.799.8686
F:303.799.8690
E: support@vicon.com

Los Angeles, CA

Vicon LA
5419 McConnell Avenue
Los Angeles
CA 90066
USA
T:303.799.8686
F:310.388.3200
E: support@vicon.com

Oxford, UK

Vicon Oxford
14 Minns Business Park
West Way
Oxford
OX2 0JB
UK
T:+44.1865.261800
F:+44.1865.240527
E: support@vicon.com

Singapore

Vicon Singapore
8 Cross Street # 11-00
PWC Building
Singapore 048424
T:+65 6400 3500
E: support@vicon.com

MHRA Adverse Incident Reporting (UK)

The information in this section covers the reporting of incidents involving medical devices to the UK Medicines and Healthcare products Regulatory Agency (MHRA).

Note

Notice to Agents:
For inclusion in all Vicon systems supplied from the United Kingdom for use outside of the United States of America (for supply and use in the US, see FDA MedWatch Adverse Event Reporting Program).

The master Medicines and Healthcare products Regulatory Agency (MHRA) file is located at Vicon Motion Systems Limited. Should an adverse event occur, the MHRA Adverse Incident Report is to be completed and forwarded within one working day to Vicon Motion Systems Limited.

Full information and guidance on reporting Adverse Incidents is available on the MHRA Yellow Card website. For details on reporting requirements, contact the MHRA:

Medicines and Healthcare products Regulatory Agency
151 Buckingham Palace Road
Victoria, London SW1W 9SZ
UK

Tel: +44 (0)20 3080 6000
Fax: +44 (0)20 3118 9803
Web: www.mhra.gov.uk

Tip

For additional information and guidance, refer to the latest revision of MEDDEV 2.12-1 on The European Commission Web site (http://ec.europa.eu/health/medical-devices/files/meddev/2_12_1_ol_en.pdf).

MHRA Adverse Incident Report Form

You report adverse incidents on the MHRA web site (https://yellowcard.mhra.gov.uk/). You can either report the problem online or use a printed version of the MHRA Adverse Incident Report, which is also available from that web site.

Important

If you have any difficulty obtaining the MHRA Adverse Incident Report, contact Vicon Support immediately to receive the form.

To complete the MHRA Adverse Incident Report Form:

1. On the MHRA web site (https://yellowcard.mhra.gov.uk/), click the **Devices** button.

2. Complete the subsequent parts of the form, including an email address to which your own printer-friendly version of the report can be sent. Remember to complete the **Email copy of report to** field with Vicon's email address.

3. Finish completing all sections of the report (you must complete all entries flagged with a red asterisk) and submit the form online.

4. If you want to work with a printed copy, retrieve the printer-friendly copy from your email. If required, you can print and fax the form to the nearest Vicon office (see Medical device adverse event reporting on page 259).

Tip

In section **Type of device**, select **General Report Form / All other devices** and on the next page, in the **Type of device** field, specify your Vicon system and device.

FDA MedWatch Adverse Event Reporting Program (US)

This section covers the reporting of incidents to the US Department of Health & Human Services.

Note

Notice to agents:
For inclusion in all Vicon systems supplied to the United States of America (for supply and use outside the US, see MHRA Adverse Incident Reporting).

The master Medical Device Reporting (MDR) file is located at Vicon Motion Systems Limited. Should an adverse event occur, MEDWATCH Form FDA 3500A is to be completed and forwarded within one working day to Vicon Motion Systems Limited.

Department of Health & Human Services,
US Food and Drug Administration
Medical Device Reporting System—Reportable Events

Code of Federal Regulations
Title 21, Volume 8
Revised as of April 1, 2014
Cite: 21CFG803.50

Under 803.50(a) device user facilities and manufacturers must report deaths and serious injuries that a device has or may have caused or contributed to. Should such an event occur, please complete the form specified in this section and forward it in accordance with the applicable regulations and time limits to your nearest Vicon office (for addresses, see Regulatory notices on page 259).

FDA Adverse Event Report Form

You can obtain the FDA Adverse Event Report Form (MEDWATCH form FDA 3500A) from the FDA's MedWatch Adverse Event Reporting program on their web site (https://www.accessdata.fda.gov/scripts/medwatch/). The form can be completed online or printed out.

Important

To download a PDF of the form, click the **Download Forms** link at the bottom of the page. If you have any difficulty obtaining the FDA Adverse Event Report Form, contact Vicon Support.

To complete the Adverse Event Report form (MEDWATCH form FDA 3500A):

1. Go to https://www.accessdata.fda.gov/scripts/medwatch/.
2. Either complete the online MedWatch Voluntary Report or print and complete the PDF form. Then:
   - Send it to support@vicon.com, including Adverse Event Report in your email subject line;

   or

   - Fax it to the nearest Vicon office (for contact details, see Regulatory notices on page 259).

Tip

Section C. Suspect Product(s) is not applicable to Vicon systems. For further guidance on completing the form, see the instructions contained in the PDF form.