

Calibrate a labeling skeleton

Calibrating a Vicon labeling skeleton (VSK) enables Nexus to recognize the subject and automatically determine which labels belong to its reconstructions.

Having chosen a labeling skeleton template (VST) for your subject (see [Create a new subject from a template](#)), you then capture a short subject calibration trial (see below), run the required calibration operations on it and save the trial and the labeling skeleton (VSK). The calibration process applies the general information contained in the VST to your particular subject, who is wearing the marker set described in the VST. When you save the calibration, a labeling skeleton (VSK), containing information that is specific to your particular subject is saved.

You can then use that VSK to automatically label all the trials in an entire capture session. You only need to recalibrate if the subject changes, for example, if a different subject wears the same marker set, or if the markers are moved. For more detailed information about VSKs and labeling skeleton templates (VSTs) see [Creating labeling skeleton templates \(VSTs\)](#).

Nexus provides a number of processes and multiple calibration options for calibrating a labeling skeleton. The factors that affect which process and which options are best for your situation, include:

- Whether your subject is able to perform a full ROM (Range of Motion) trial
- The type of movement you are studying
- Whether obtaining results quickly or labeling accuracy is more important

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

- **ROM trial** 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 moves through a range that represents what the subject is likely to do during capture of trial data (ie, movement trials). Full ROM calibrations provide the most information of any of the calibration methods and therefore often provide the best labeling. For this reason Vicon recommends using a full ROM calibration whenever possible.
For step-by-step instructions on using this type of trial to calibrate a labeling skeleton, see [Calibrate a labeling skeleton using a ROM trial](#).
- **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 the VST (labeling skeleton template) file is first created. For Plug-in Gait, this is a T-pose or 'motorbike' pose. (To view images of the motorbike pose, see [Calibrate a labeling skeleton using a ROM trial](#).) This operation requires the least processing time, but provides less information than functional calibration (which is often used as part of ROM calibration, described above), as it operates on only a single frame of data. Consider using this type of calibration if:
 - A subject's ability to perform a ROM trial is limited; and/or
 - You want to obtain results as quickly as possible.For step-by-step instructions on using this type of trial to calibrate a labeling skeleton, see [Calibrate a labeling skeleton using a static trial](#).
- **Movement trial** This trial type is similar to a ROM trial, but focuses on only joint movements that are expected and specific to the activity being studied. For example, a gait laboratory might use a walking trial for this type of calibration. Movement trials are not normally used for an initial or full subject setup, but can be used in combination with some pipeline operations to improve labeling. They may be of benefit if the motion of the subject during movement trials is not similar enough to what is captured when using a static or ROM trial. For more information on this type of labeling skeleton calibration, see [Labeling skeleton calibration in detail](#) in the *Vicon Nexus Reference Guide*.

Whichever type of calibration you choose, note the following requirements for your calibration trial:

- Aim to produce a trial (ROM, static, or movement) that is as fully labeled as possible.
- The trial must contain only raw reconstructions; leave any gaps unfilled. (Unlabeled reconstructions have no influence on subsequent operations.) However, if necessary, you can manually label any missing markers (see [Manually label a trial](#)) or correct any swapped markers (see [Correcting swapped labels](#)).
- Do not perform multiple calibrations on the same subject as this may result in an increasingly poor quality calibration.

For information on creating custom labeling skeleton templates (VSTs), see [Creating labeling skeleton templates \(VSTs\)](#).



Note

This topic assumes that you are using a Vicon-supplied PlugInGait Ai VST, although you could instead use a custom VST, providing it conforms to the requirements listed in [Requirements for custom labeling skeleton templates](#) in *Creating labeling skeleton templates (VSTs)*.

Calibrate a labeling skeleton using a ROM trial

The recommended workflow for Nexus 2, which is described below, is to use a ROM trial and dynamic calibration to calibrate a labeling skeleton, as this is likely to produce more accurate automated labeling. However, if you need to use a static frame to calibrate your labeling skeleton (for example, if your subject cannot perform a full ROM, or you are capturing simple movement and/or want to obtain some results quickly), see [Calibrate a labeling skeleton using a static trial](#).

After you have prepared a subject for capture (see [Prepare a subject](#)), to enable Nexus to provide correct automatic labeling for your subject, you capture a ROM (Range of Motion) trial that starts with a few frames where the subject is static, as described in the following steps.

Vicon Nexus then uses the information from the ROM trial to automatically label the subject in subsequent movement trials.

On this page:

- [Calibrate a labeling skeleton using a ROM trial](#)
- [Calibrate a labeling skeleton using a static trial](#)

The following workflow is just one approach that you can adapt to suit your particular circumstances. For a detailed explanation of all the methods of subject calibration, see [Labeling skeleton calibration in detail](#) in the *Vicon Nexus Reference Guide*.

The workflow for calibrating a labeling skeleton based on a ROM trial can be divided into the following stages:

- [Perform an initial calibration of a labeling skeleton using a ROM trial](#)
- [Review & finalize calibration of a labeling skeleton using a ROM trial](#)

Perform an initial calibration of a labeling skeleton using a ROM trial

1. Ensure you have obtained any subject measurements required to run the model (required measurements are highlighted in pink in the Subjects Resources pane): for Plug-in Gait Lower Body, these are the body weight and height as well as measurements of both left and right leg lengths, knee widths, and ankle widths. These are used to calculate joint center positions, and must be measured and entered into Nexus before any modeling can take place can begin. Optionally, you can also measure tibial torsion, the inter-ASIS distance, the ASIS-to-greater trochanter distance, and the sole delta if the subject is wearing shoes. For more information on the measurements needed to run the Plug-in Gait model, see [Take subject measurements for Plug-in Gait](#).
2. In the **Communications** pane, on the **Data Management** tab, ensure that you have created or opened the required database in which to store the data you will be capturing and that the required session is active. (For a reminder of how to do this, see [Prepare a data storage location](#).)
3. In the **Resources** pane, ensure Nexus is in Live mode.
4. In the **System Resources** tree, select the **Local Vicon System** node and then in the **Properties** section under **General**, check that the **Processing Level**, which sets the amount of real-time processing that is performed on the source data, is set appropriately. If you are not sure, set it to at least the **Labels** level.
5. Display a **3D Perspective** view.
6. In the **Subjects Resources** tree, ensure the required PlugInGait Ai (Auto Initialize) labeling skeleton template (VST) file is specified for the subject (see [Create a new subject from a template](#)) and that the subject node you created from the template is the only entry enabled for capture. (When enabled, the check box contains a check mark.)
7. If required by your model, in the **Properties** section at the bottom of the **Subjects Resources** pane, enter any subject measurements you obtained in step 1.
8. In the **Subject Preparation Tools** pane, ensure that the subject you created is selected in the **Subject** list.



Tip

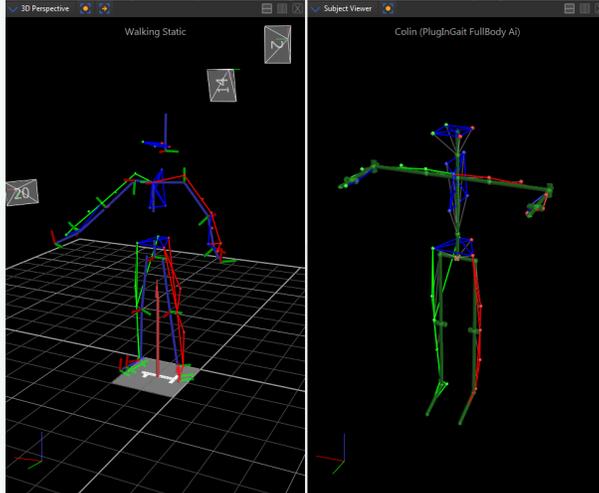
If you want to capture video or if you want to avoid automatically switching to **Offline** mode as soon as you have captured a trial, instead of clicking the **Subject Preparation** button, click the **Capture** button and on the **Capture** tab, ensure the settings are as required (for example, to capture video, ensure that in the **Data Source Setup** section, **Video Camera Data** is selected).

9. To enable Nexus to automatically label the key trajectories, in the capture volume, have the subject stand in the stationary neutral pose that was selected when the labeling skeleton template was created. If you are using a Vicon-supplied PiG template, ensure the pose is as described in step 12.



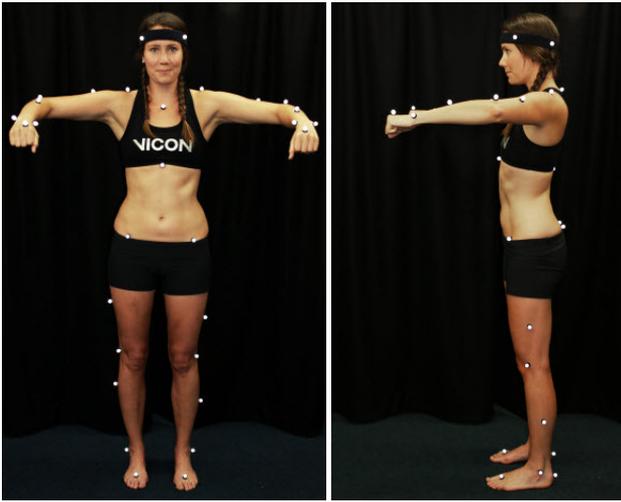
Tip

To help you to ensure that the subject adopts the correct base pose, on the view pane toolbar, click the **Split vertically** button and in the second pane, open a **Subject Viewer**. This displays the base pose for the current labeling skeleton template (VST).



10. To make sure all the markers are visible, count the number of markers under the **Markers** node in the **Subjects Resources** tree, and make sure the same number of markers is visible in the **3D Perspective** view.

11. On the **Capture Tools** pane, in the **Capture** section, click **Start**.
The **Start** button switches to its **Stop** setting.
12. 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



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

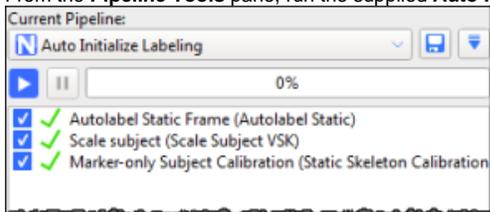


Tip

If the subject is not able to attain the base pose, they can use any pose where all of the markers are visible to the cameras. This ensures that the markers can be reconstructed, but is unlikely to produce good autolabeling when **Autolabel Static Frame** (part of the **Auto Initialize Labeling** pipeline) is run. If this is the case, you will need to manually label the trial (see [Manually label a trial](#)) and then run the two remaining operations from the **Auto Initialize Labeling** pipeline. (For information on running pipelines, see [Run a pipeline](#).)

If the chosen base pose proves unattainable by many subjects, consider substituting a different, attainable pose by specifying a different frame. To do this, on the **Pipeline Tools** pane, expand the **Subject Calibration** section and double-click the **Set Autolabel Pose** pipeline operation to add it to the current pipeline. In the **Properties** pane, ensure the frame with the required pose is selected and then run the **Set Autolabel Pose** pipeline.

13. When enough data has been captured, click **Stop** to end the trial. For a ROM trial, this is typically 1–3 seconds of static data capture, followed by the required ROM.
14. If you are using the **Subject Preparation** tab, Nexus automatically switches to **Offline** mode.
15. Reconstruct the trial either by clicking **Reconstruct**  on the Nexus toolbar or, if you need to change the reconstruction settings, by clicking the **Pipeline** button  in the **Tools** pane and configuring and running the **Reconstruct** pipeline to create a 3D image of the captured markers. (For information on how to run a pipeline, see [Run a pipeline](#).)
16. View the subject data in a **3D Perspective** view and ensure that all the markers are clearly visible to the Vicon cameras. (If they are not, check your camera settings, system setup steps, system calibration, etc. Also check that clothing isn't causing markers to move, and the condition (age, etc) of the markers themselves.)
17. From the **Pipeline Tools** pane, run the supplied **Auto Initialize Labeling** pipeline (or if preferred, you can manually label the trial):

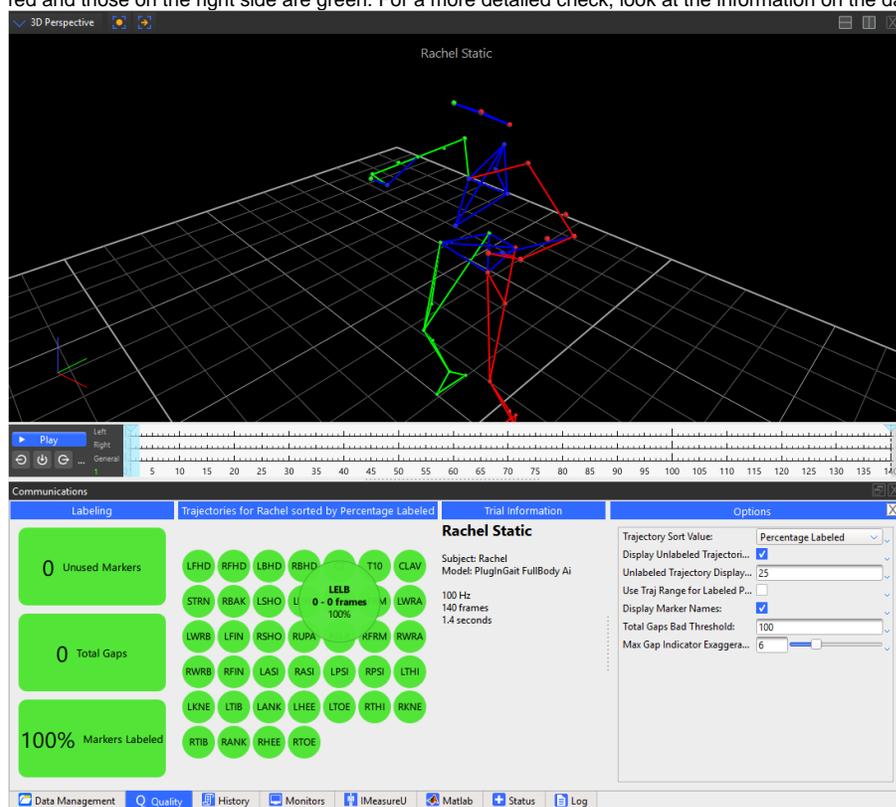


18. Nexus labels the trajectories based on the marker set defined in the **.vst** file.
19. Save the trial and the labeling skeleton (VSK) by pressing CTRL+S or by clicking the Save button  on the Nexus toolbar. If an asterisk is displayed to the right of the the subject name in the **Subjects Resources** pane, this means that you have also made changes that affect the labeling skeleton template (VST). To save the VST, right-click on the subject name and click **Save Subject**.

Review & finalize calibration of a labeling skeleton using a ROM trial

1. After you have saved your initial calibration (see above), assess the results by looking at the labeling of the frame that contains the static base pose in the 3D Perspective view. Ensure that all markers are connected by sticks and that the sticks on the left side of the subject are

red and those on the right side are green. For a more detailed check, look at the information on the data **Quality** tab.



Tip

To see all the assigned marker labels in the **3D Perspective** view, press CTRL+space bar. This enables you to check that all the required markers are present and correctly labeled.

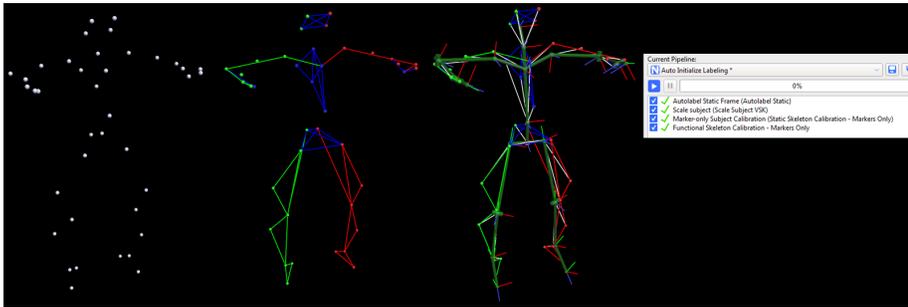
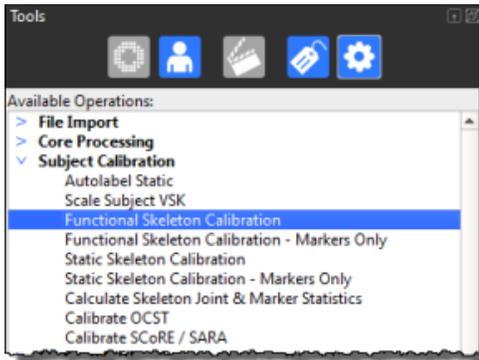
2. Depending on the results of the labeling, take the appropriate action:

- If the static frame is correctly labeled and the labeling skeleton fits well, any further processing of your first movement trial (see [Capturing movement trials](#)) 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 movement trials. When the subject has been calibrated, segments of the labeling skeleton are fitted to the labeled markers in the **3D Perspective** view, and your subject is automatically labeled. To verify that the subject has been calibrated successfully, switch Nexus to **Live** and ask your subject to move around in the capture volume. You should see that the markers are labeled and the subject is tracked. If the results are satisfactory, go straight to step 4 (set a range).
- If the results are not satisfactory, this may be because your movement 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 3. To ensure the best results, first consider the following factors:
 - If any markers are labeled incorrectly, fix them (see [Correcting swapped labels](#) and [Manually label a trial](#)) 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](#) in *Creating labeling skeleton templates (VSTs)*).

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

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

- Verify that the trial is correctly labeled for every frame. Note that **Autolabel Static Frame** only labels the trajectories that are present on the static frame(s).
- Visually check for any markers that get occluded and manually re-label them (see [Manually label a trial](#)) when they re-appear.
- On the **Pipeline Tools** pane, expand the **Subject Calibration** operations section, add the **Functional Skeleton Calibration** operation to the current pipeline and run it.



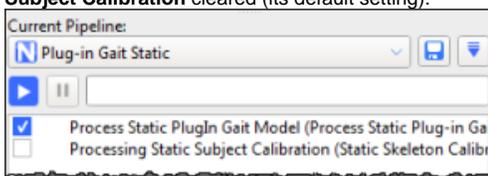
- d. When the **Functional Skeleton Calibration** has completed, in the **Options** dialog box (F7), click **Subjects** (on the left) and in the **Properties** pane, go to the **Markers** section, and select **Draw Covariance**. If you can see any large covariance ellipsoids around a marker, check for 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

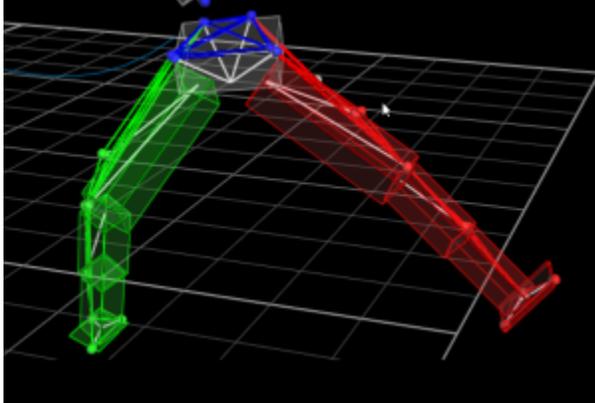
The size of covariance ellipsoids vary, depending on how a marker is defined in a skeleton, the amount of marker movement possible, and the quality of the subject calibration. Very large covariance ellipsoids may indicate a poor calibration.

4. On the Time Bar, move the **Start Range indicator** and **End Range indicator** (the blue triangles) along the timeline to set a range of frames to select only the first few seconds of the static pose at the beginning of the trial.
5. Run any further processing needed to achieve the required modeling. For example, if you are using Plug-in Gait, to make the necessary calculations and calibrate the static subject, run the **Plug-in Gait Static** pipeline:
 - a. 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).



- b. 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).
 - c. Run the **Plug-in Gait Static** pipeline.
6. To check that your model has been processed correctly:
 - Ensure that in the **Pipeline Tools** pane, a green check mark is displayed to the left of the operation in the **Current Pipeline** list.
 - Ensure that Plug-in Gait bones are visible in the **3D Perspective** view. If they are not, press F7 to open the **Options** dialog box and select **Plug-in Gait Bones**.
 - In the **Subjects Resources** pane, ensure that you can expand **Model Outputs** to see all the calculated components of variables for a kinematic model (such as Angles, Forces, Moments, etc).
To verify that Nexus has successfully created a labeling skeleton and that it is automatically labeling, ensure that, as shown in the

following image, the bounding boxes for Plug-in Gait model segments are displayed in the **3D Perspective** view. (The bounding boxes that Nexus draws around each segment that is defined in the template are for visualization purposes only.)



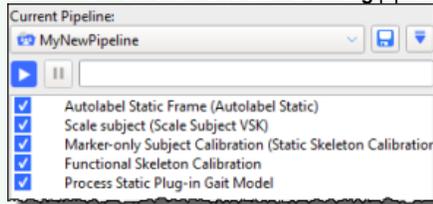
7. Save the ROM trial and the labeling skeleton (VSK) by pressing CTRL+S or clicking the Save button  on the Nexus toolbar.

When you have a fully labeled and processed trial (containing only raw reconstructions and no gap-filling), you can proceed to capture and process your movement trials (see [Capture movement 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.



Calibrate a labeling skeleton using a static trial

The recommended workflow for Nexus 2 is to use a ROM trial and dynamic calibration as this offers the benefits of the more efficient, automated labeler (for more information on this workflow, see [Calibrate a labeling skeleton using a ROM trial](#)). However, if you need to use a static frame to calibrate your labeling skeleton (eg, if you are capturing simple movement, or your subject cannot perform a full ROM, and/or you want to obtain results quickly), you can instead use the following workflow.

To perform a static calibration:

1. Ensure you have obtained and entered any subject measurements required to run the model (required measurements are highlighted in red in the **Subjects Resources** pane): for Plug-in Gait, these are the body weight and height as well as measurements of both left and right leg lengths, knee widths, and ankle widths. These are used to calculate joint center positions, and must be measured and entered into Nexus before any processing can begin. Optionally, you can also measure tibial torsion, the inter-ASIS distance, the ASIS-to-greater trochanter distance, and the sole delta if the subject is wearing shoes.
2. In the **Communications** pane, on the **Data Management** tab, ensure that you have created or opened the database in which to store the data you will be capturing, and that the required session is active. (For a reminder of how to do this, see [Prepare a data storage location](#).)
3. In the **Resources** pane, ensure Nexus is in Live mode.
4. Display a **3D Perspective** view.
5. Capture a static trial. For more details, see [Perform an initial calibration of a labeling skeleton using a ROM trial](#).
6. Reconstruct the trial either by clicking **Reconstruct** on the Nexus toolbar or, if you need to configure the reconstruction settings, by clicking the **Pipeline** button  in the **Tools** pane and changing and running the **Reconstruct** pipeline to create a 3D image of the captured markers. (For information on how to run a pipeline, see [Run a pipeline](#).)
7. In the **Subjects Resources** tree, right-click on the subject node and attach the required PlugInGait Ai (Auto Initialize) labeling skeleton template (VST) file (see [Create a new subject from a template](#)) to the subject.



Tip

To use a workflow prior to Nexus 2.x, 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.#\ModelTemplates.

8. Ensure that the subject node is the only entry enabled for capture. (When enabled, there is a check mark in the check box.)

9. In the **Pipeline** tools pane, select and run the **Auto Initialize Labeling** pipeline or if necessary, manually label the trial (see [Manually label a trial](#)).
Nexus labels the trajectories based on the marker set defined in the .vst file.
10. Assess the results by looking at the labeling in the **3D Perspective** view. Ensure that all markers are connected by sticks and that the sticks on the left side of the subject are red and those on the right side are green.
11. Save the trial and the labeling skeleton (VSK) by pressing CTRL+S or clicking the Save button  on the Nexus toolbar.
12. You can now run any further processing needed to achieve the required modeling and finalize the calibration (see steps 5–7 of [Review and finalize a calibration of a labeling skeleton using a ROM trial](#)).

When you have saved a fully labeled trial (containing only raw reconstructions and no gap-filling), you can proceed to capture and process your movement trials (see [Capture movement trials](#)).