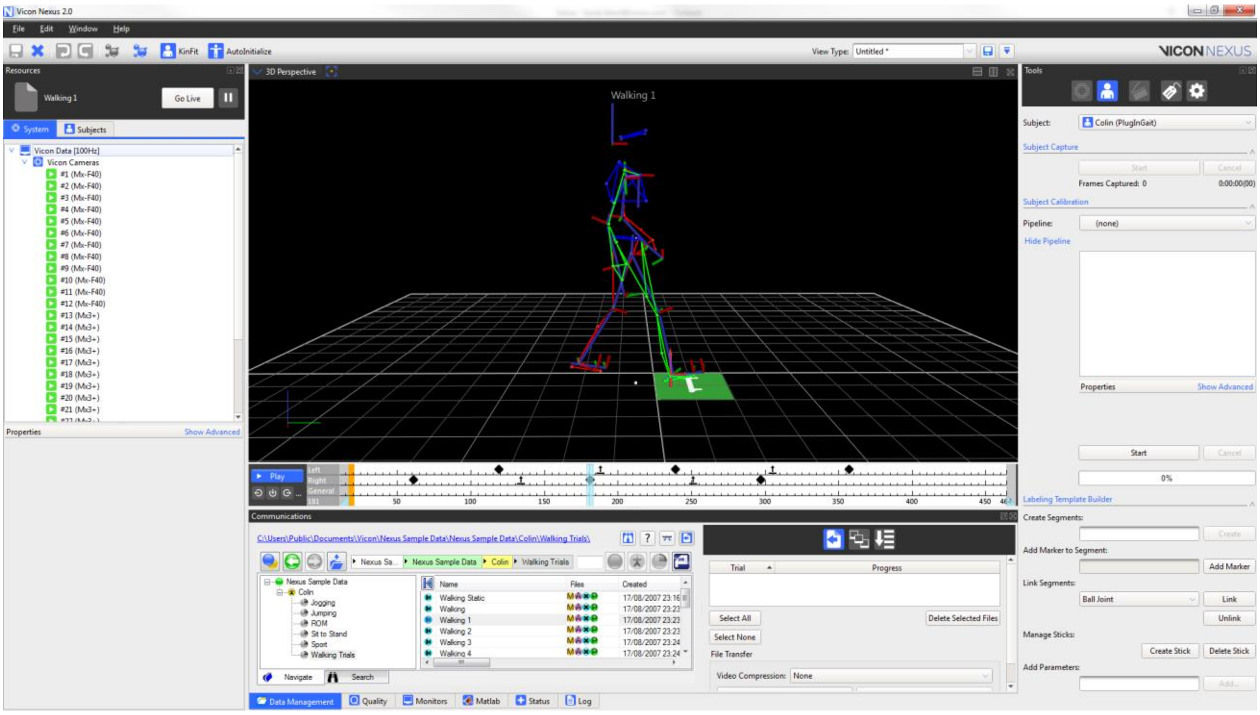
Introduction to NEXUS 2

Getting to know the Nexus Interface

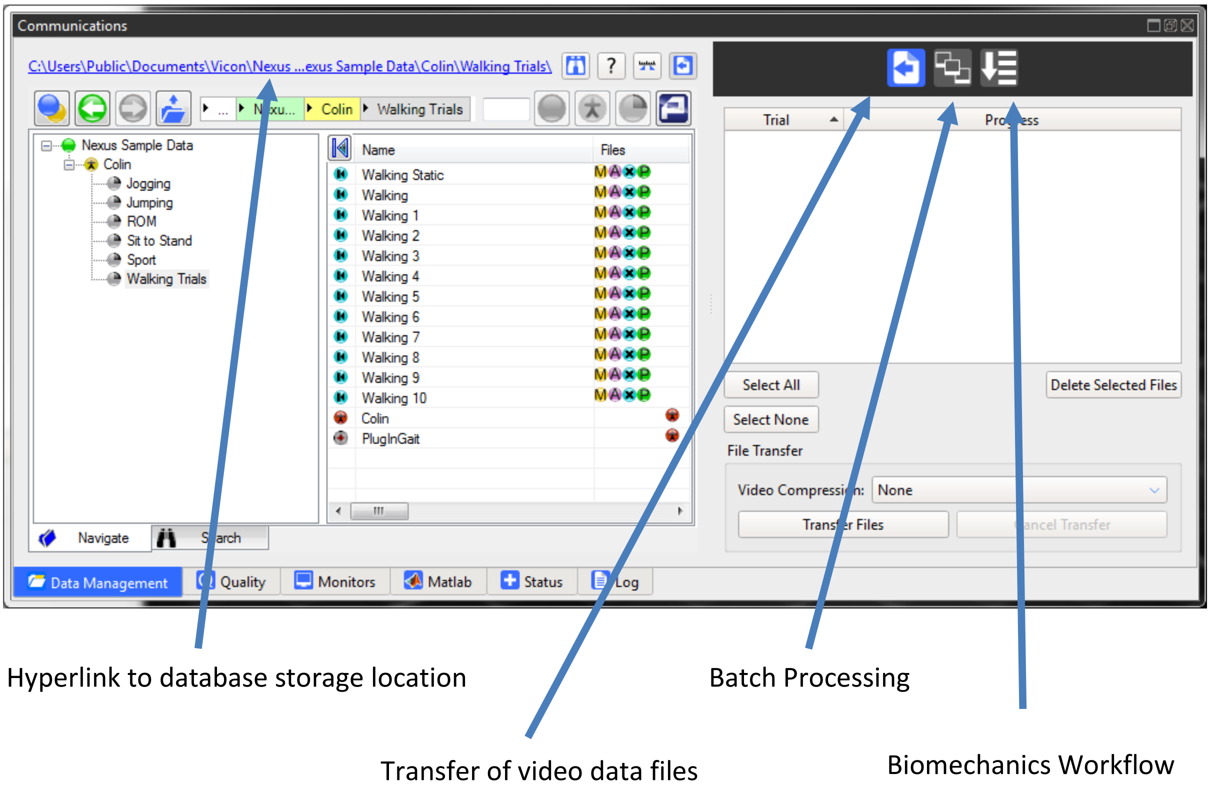
Nexus Interface Window

- Consists of four main panes;
    1. Communications – data management, data quality, monitors, Matlab and log
    2. Resources – adjust hardware settings
    3. Viewing – visualise camera, 3D workspace and graphs
    4. Tools – tools to setup, capture and edit data



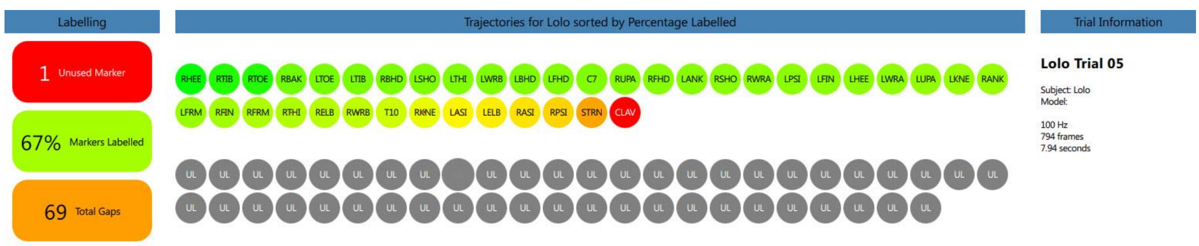
Data Management Tab

- Present in all Vicon software
- Organises your capture sessions – by project, by subject, by user
- Lists the type(s) of data collected in each trial



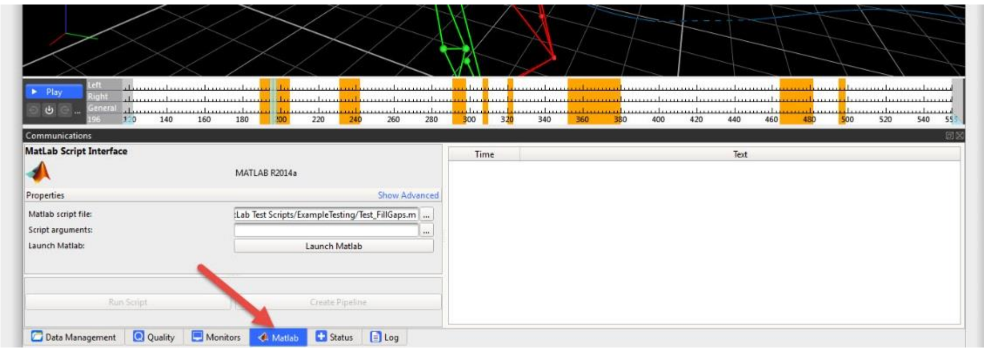
Data Quality Tab

Overview of labelled and unlabelled trajectories



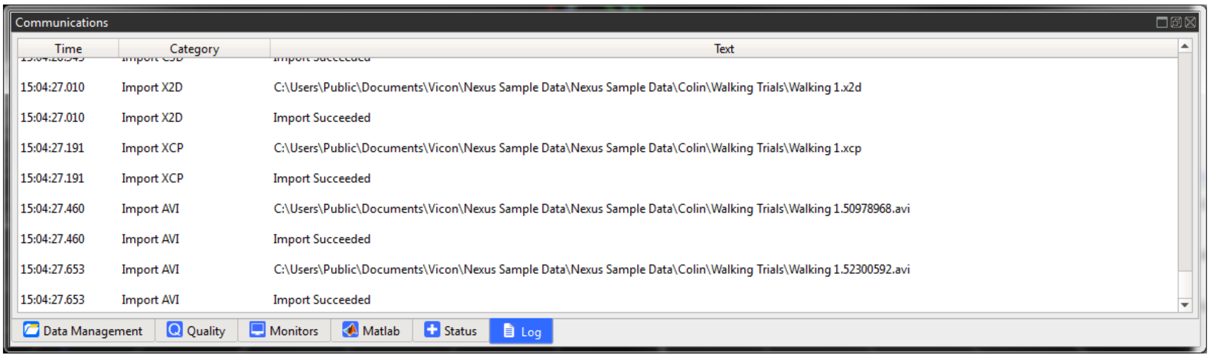
Matlab Tab

Run Matlab scripts offline from within Nexus

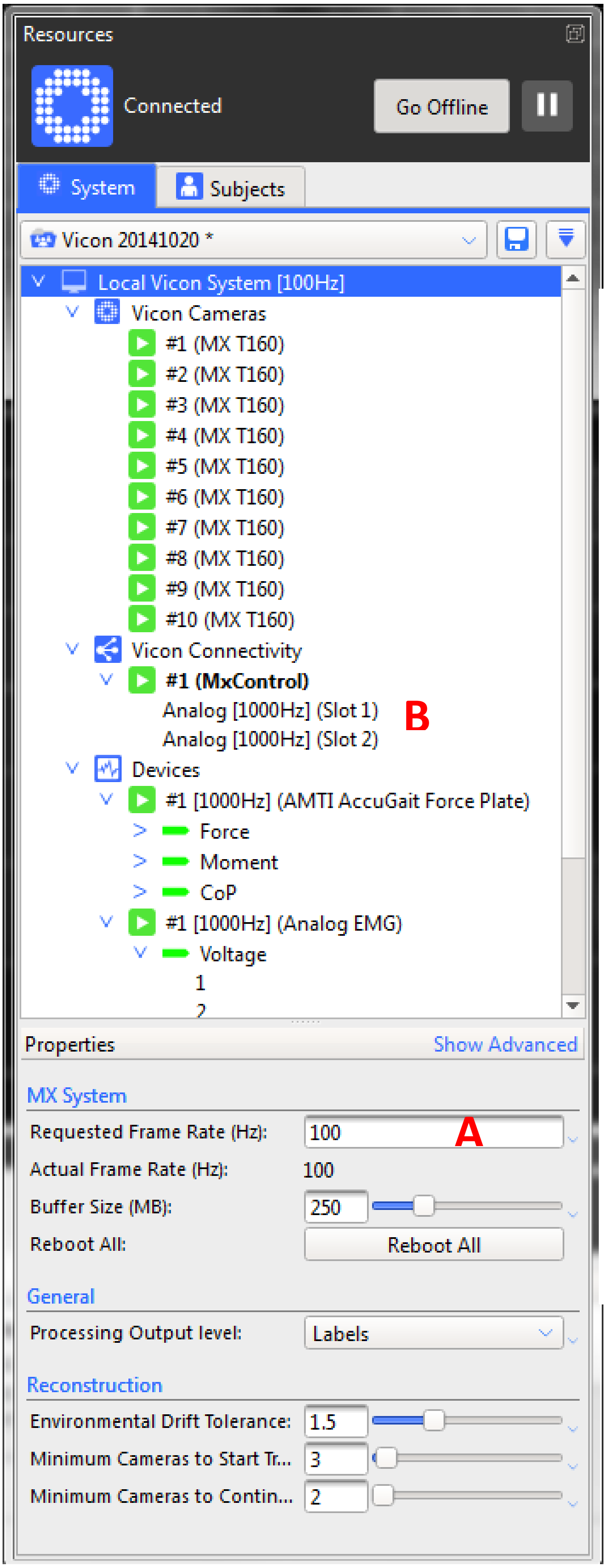


Log Tab

Contains a log of the processes that have been performed since the program was launched. This log can contain useful information about any errors you may come across during the capture process.



Time	Category	Text
15:04:27.010	Import X2D	C:\Users\Public\Documents\Vicon\Nexus Sample Data\Nexus Sample Data\Colin\Walking Trials\Walking 1.x2d
15:04:27.010	Import X2D	Import Succeeded
15:04:27.191	Import XCP	C:\Users\Public\Documents\Vicon\Nexus Sample Data\Nexus Sample Data\Colin\Walking Trials\Walking 1.xcp
15:04:27.191	Import XCP	Import Succeeded
15:04:27.460	Import AVI	C:\Users\Public\Documents\Vicon\Nexus Sample Data\Nexus Sample Data\Colin\Walking Trials\Walking 1.50978968.avi
15:04:27.460	Import AVI	Import Succeeded
15:04:27.653	Import AVI	C:\Users\Public\Documents\Vicon\Nexus Sample Data\Nexus Sample Data\Colin\Walking Trials\Walking 1.52300592.avi
15:04:27.653	Import AVI	Import Succeeded



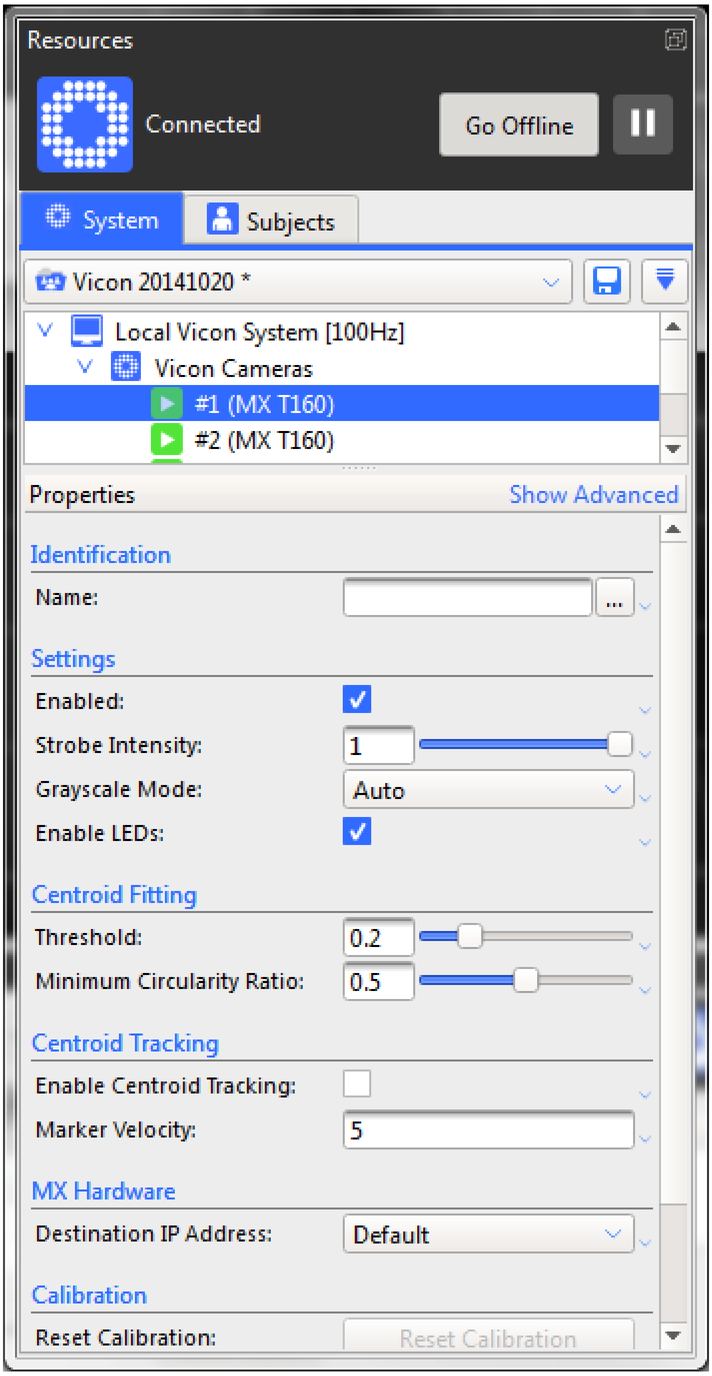
System Tab

The System tab contains all the hardware and peripheral devices associated with your capture setup. Within the System tab, you are able to select and adjust the properties of the hardware.

Local Vicon System – lists all the devices associated with the Vicon hardware

- Allows you to reboot and resynchronize hardware, and reprogram firmware (right click)
- Set Vicon MX camera capture frequency **(A)**
- MX Giganet/Connectivity
  - Properties of the Analog card
  - Use this to set your Analog capture rate **(B)**
- Bonita Video, Basler or DV Cameras
- Force Plates
  - lists the Force Plates in the system and allows you to adjust the properties
- Other Devices – e.g. EMG, accelerometer
- Control the processing level of the software
  - Circles (2D only)
  - Reconstructions
  - Labels
  - Kinematic Fit

Vicon Cameras – this lists all of the MX cameras in your system and allows you to individually adjust each cameras settings;

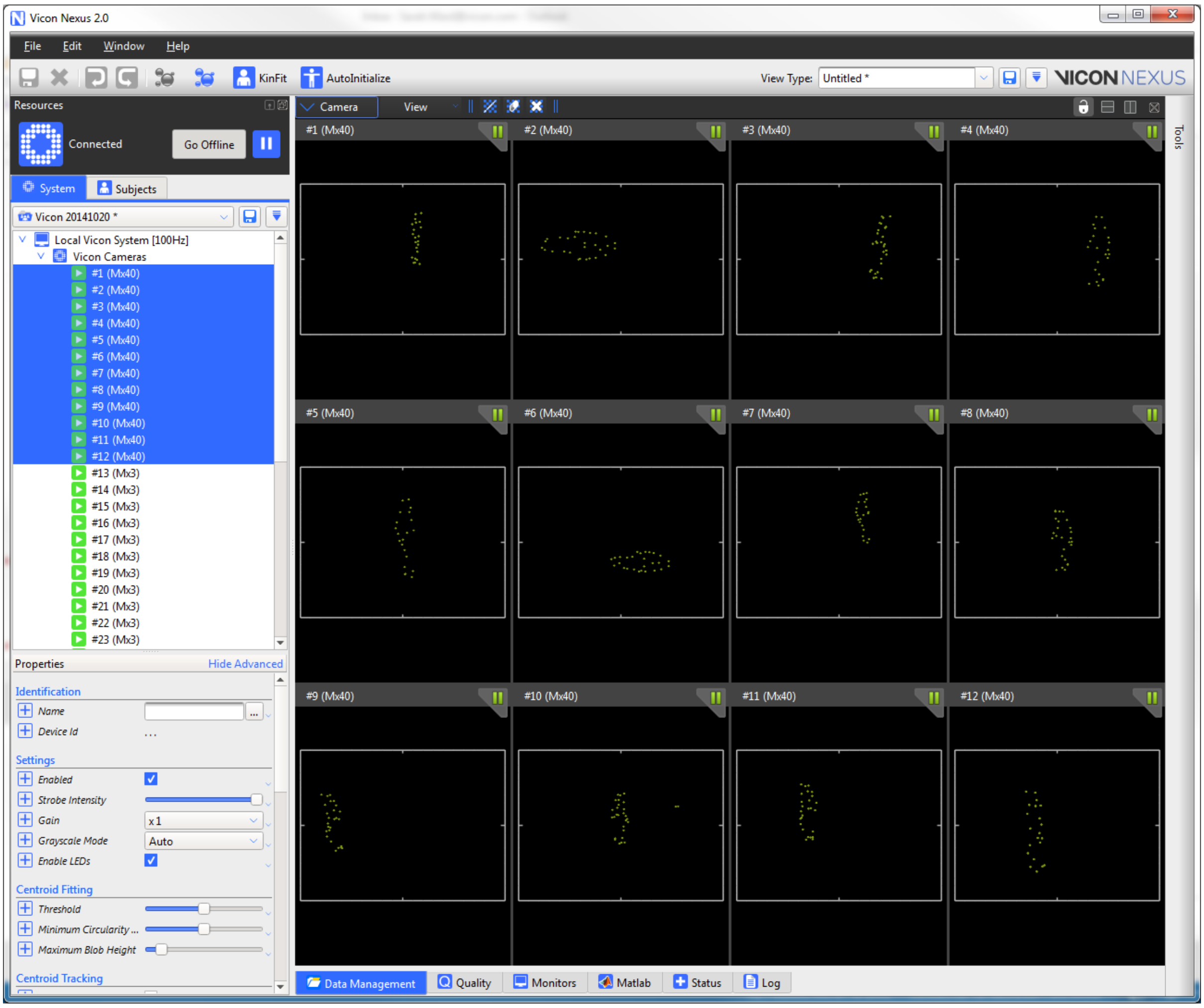


- Strobe intensity
  - around 0.9 -1.0, usually 1
- Threshold
  - approximately 0.15 – 0.25
- Grayscale - two settings need to be used;
  - **ALL** to setup and adjust cameras,
  - **AUTO** to capture data

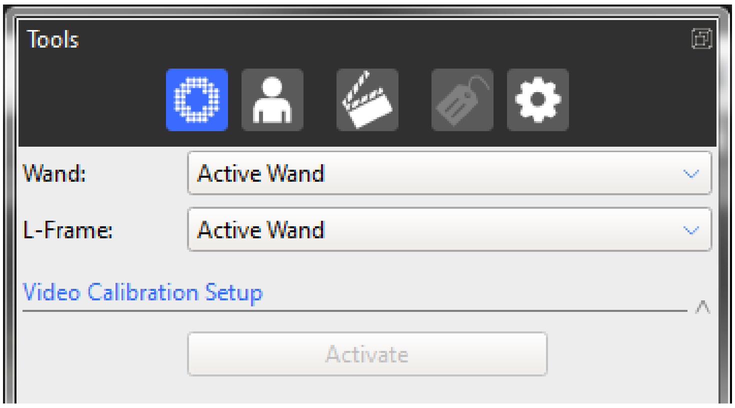
Nexus Capture Workflow

Prepare your system for capture

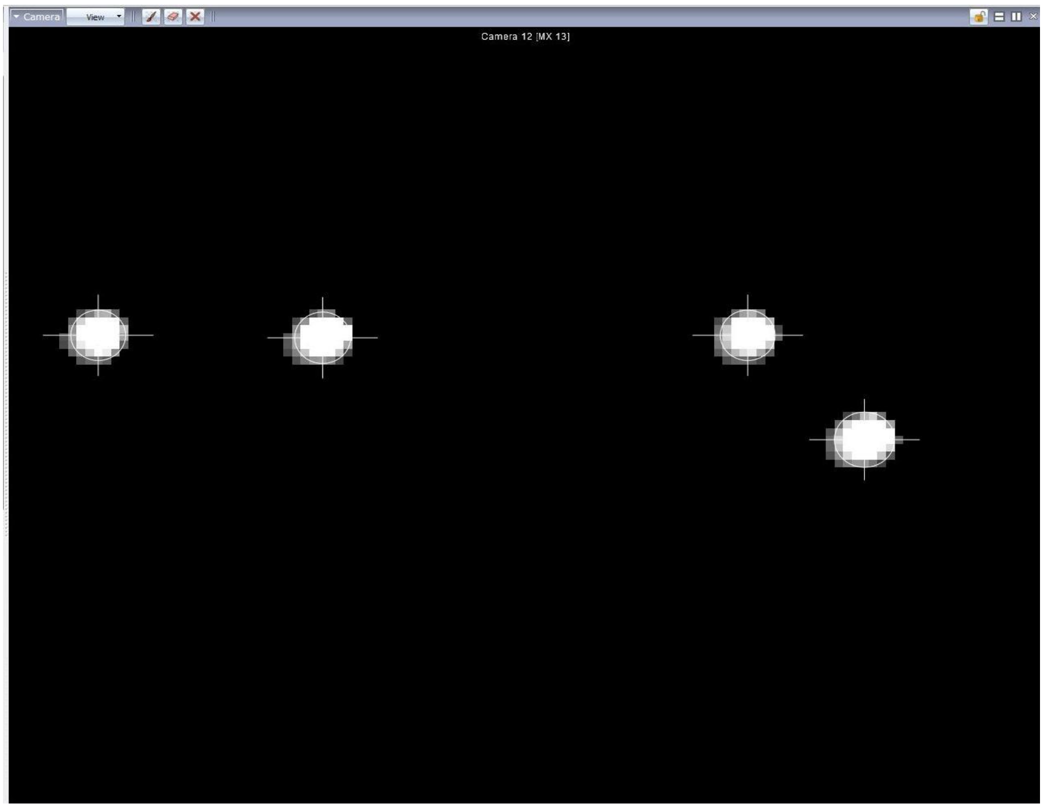
1. Position the Vicon cameras in the desired locations to capture the movement performance
    a. Place calibration frame in the middle of the desired volume
    b. Place markers to cover the area of interest
    c. Turn the Active Wand on
    d. Adjust individual camera positions so that they cover the volume that the movement will be performed in
        i. The markers on the floor covering the area of interest will help determine the aiming of the Vicon cameras
    e. Place the Bonita Video camera(s) in the desired position (e.g. frontal or sagittal view)
        i. check the image of the Bonita Video camera in Nexus and make adjustments to the camera to ensure the image has enough light and the camera is in focus.



2. Under the System Preparation node, check that the ‘Active Wand’ calibration object is selected and click on the ‘Activate’ button if you have video cameras

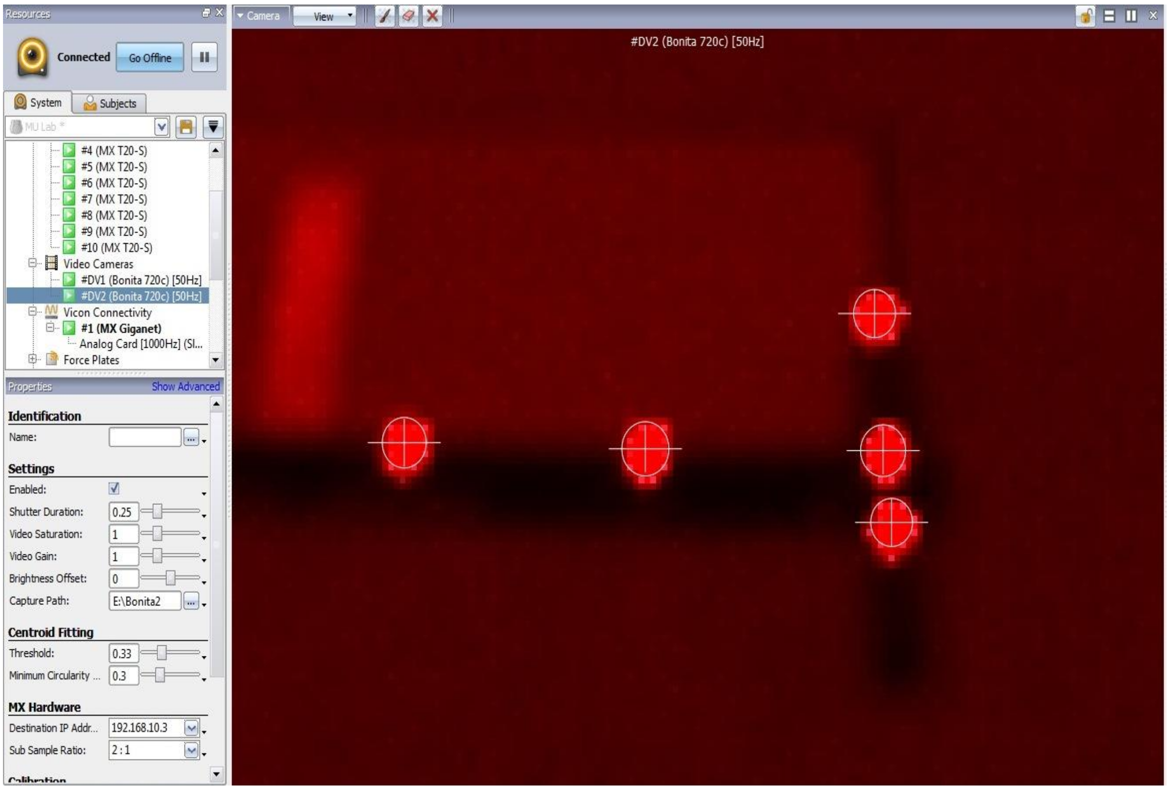


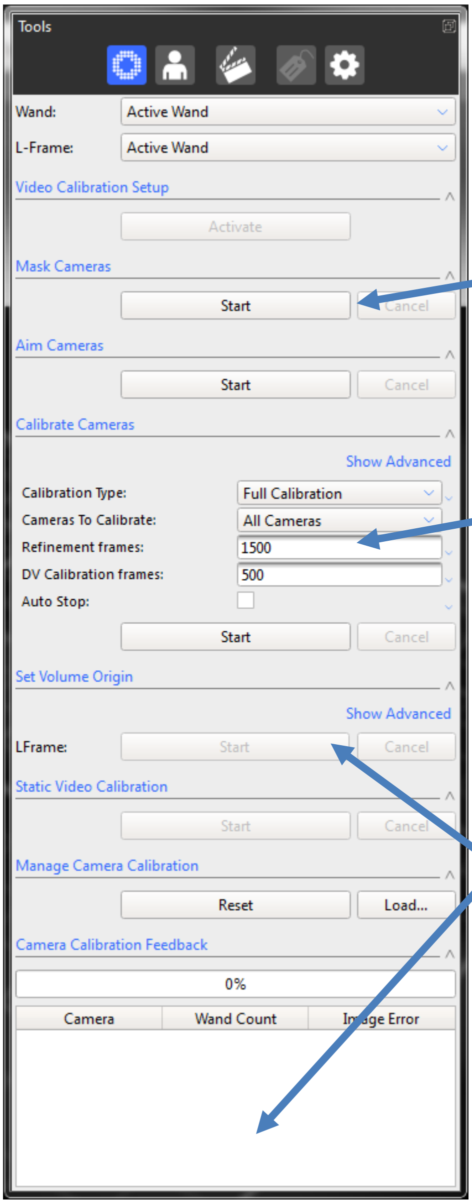
3. Adjust individual camera settings to ensure good grayscale images – bright white pixels (squares) in the middle of the circle, and grey pixels around the edges of the circle. Try to limit the number of pixels that are ‘flashing’
    a. Ensure Grayscale setting is set to ‘All’ when adjusting settings
    b. Change this setting back to ‘Auto’ once cameras are adjusted



Adjust the Threshold of the Bonita Video cameras (if connected) to check that it is appropriately circle-fitting the markers on the Active Wand.

N.B. The circle-fit should be around the edges of the LED markers. You may need to slightly reposition the wand to check the circle fit if the wand is in-line with the Bonita Video camera.





In the *System Preparation* Node*:*

5. Apply mask to MX cameras
   a. Wait until the noise reflections are covered in blue, then press stop

6. Calibrate MX (and Bonita) cameras
   a. Adjust number of 'refinement frames' if necessary
   b. See note below on Calibration – Wand Waving Technique

7. Check the ***Image Error*** of the cameras - Recommend an image error less than 0.3

8. Place the Calibration Wand in the desired location and ***Set Volume Origin***

You are now ready to capture trials with your subject!

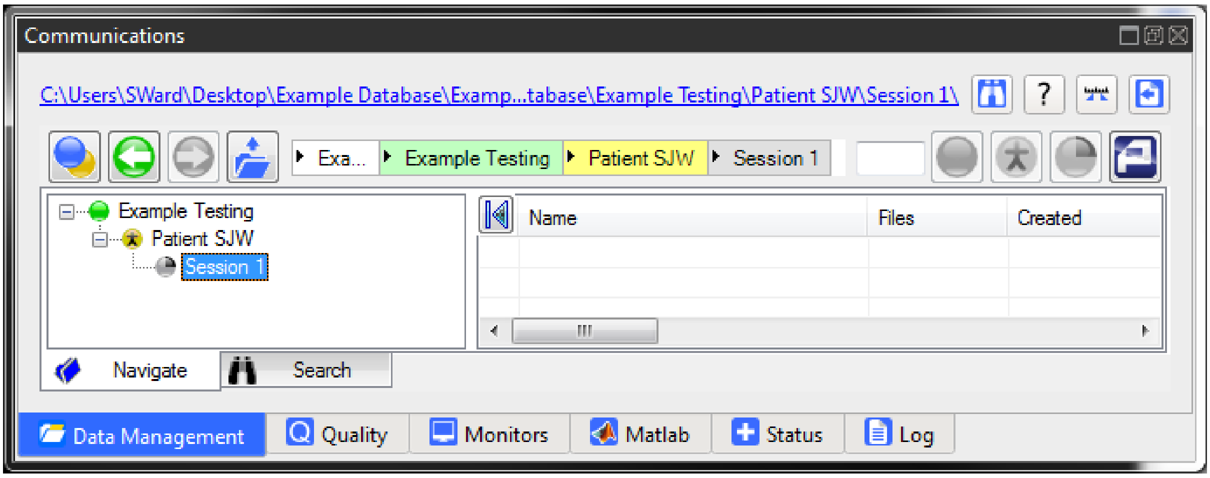
Calibration – Wand Waving Technique

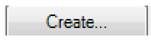
The number of frames needed to perform the calibration will depend on the size of the volume and capture rate of the Vicon cameras. If your volume has increased, or you are capturing at a rate faster than 100Hz, you may need to increase the number of 'Refinement Frames' so that the wand can be moved through each cameras complete field of view. Ensure that the wand passes through as much of the camera field of view for a better calibration.

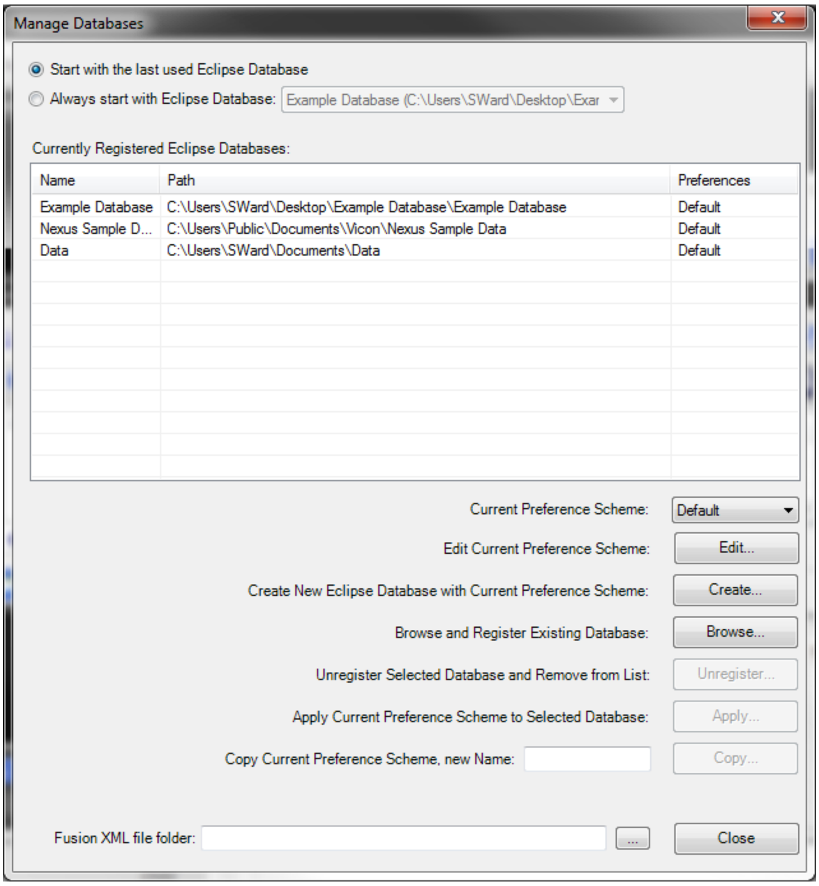
A calibration frame is recorded when all 5 markers on the Active Wand are recognised by the camera. Therefore, try to keep the LEDs of the Active Wand facing upwards during the calibration wand wave. Rotating the wand so that the LEDs face downwards or away from the camera(s) will increase the time taken to calibrate the Vicon system.

Capturing Subject Data

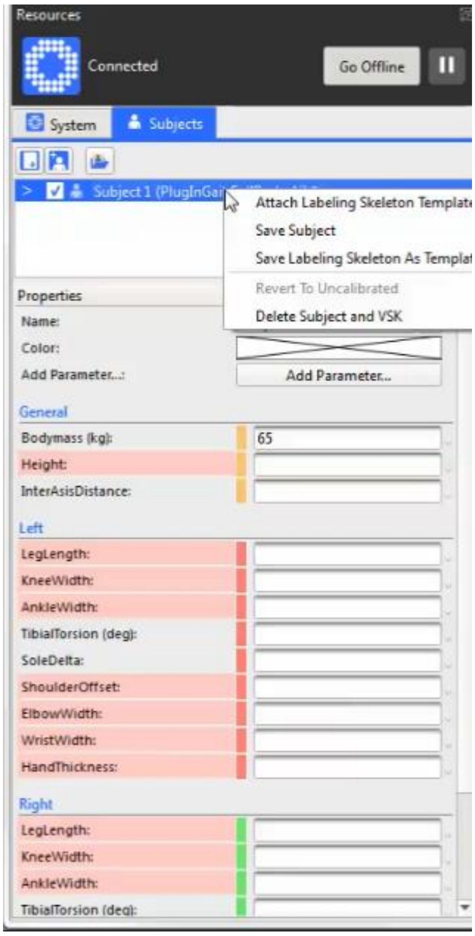
1. In the data management window, create a session where the data will be stored under



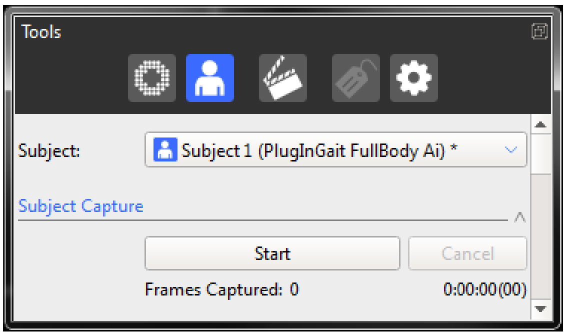
   a. When creating a new database click on  and select ***Manage Databases*** and select 



2. Create a subject from an existing template
    a. Select template being used for capture – e.g. PlugInGait Fullbody Ai
    b. Enter the subject name
    c. Enter in the required subject measurements which are highlighted in pink

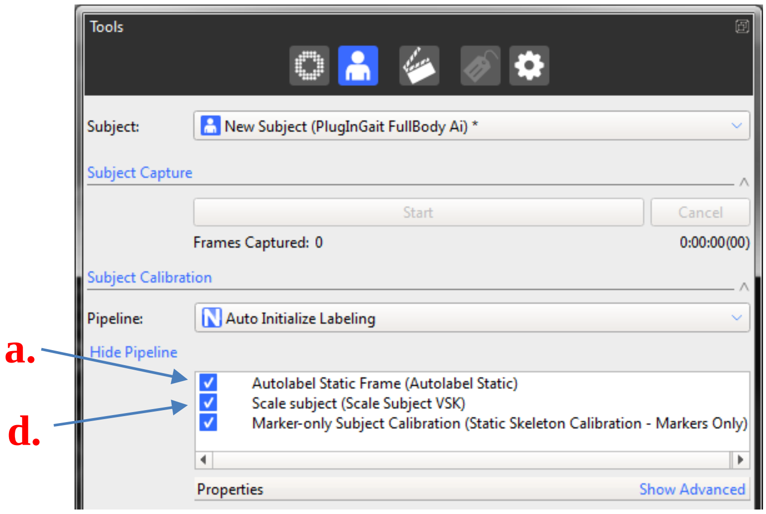


3. Place markers on the subject according to selected .VST template
4. Capture a static trial under the **Subject Preparation** node



5. Reconstruct the trial 

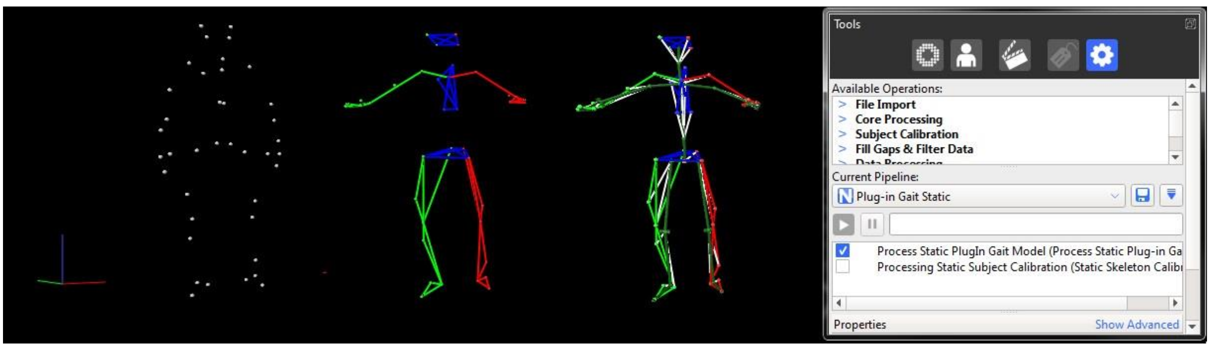
6. Label the subject and set-up auto label using the Auto Initialize Labelling pipeline
    a. Right click on ***Autolabel Static Frame*** and select ***Run selected Op***
    b. Check that the static frame has labelled the markers correctly.
    c. Make any changes to labels in the **Label/Edit** node 
    d. Right click ***Scale subject*** and select ***Run pipeline from selected op***



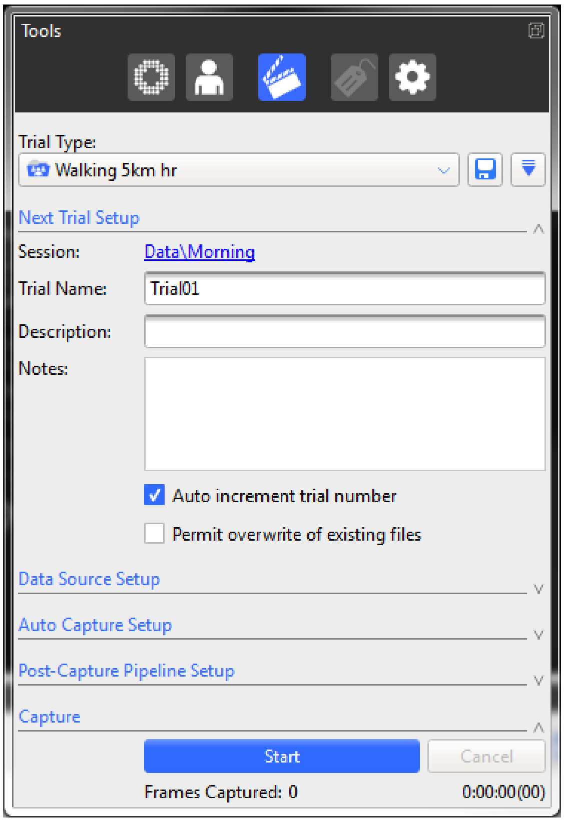
7. Run the Static Calibration pipeline located in the **Subject Preparation** node
    a. Blue tick if successful
    b. Segment sticks appear

NB: Only the first operation (Process Static PlugIn Gait Model) should run. **DO NOT** run the Processing Static Subject Calibration* operation as this will overwrite your auto label setup.

*Processing Static Subject Calibration is a legacy operation used by old Nexus and Workstation users

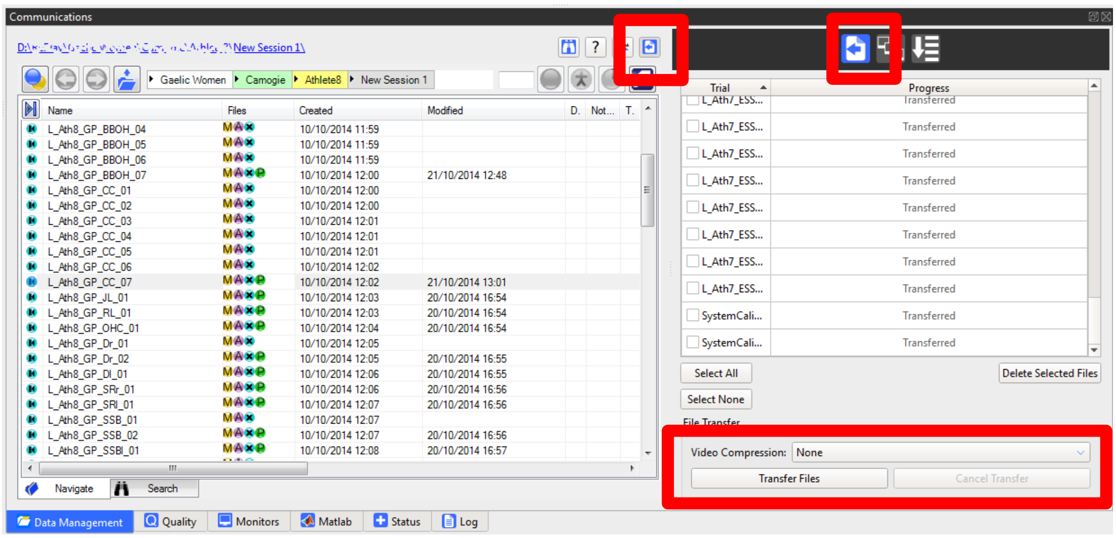


8. Go back to 'Live Mode' and capture the movement performances under the **Capture** node.

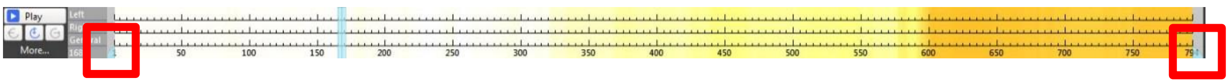


Post-Capture Data Editing

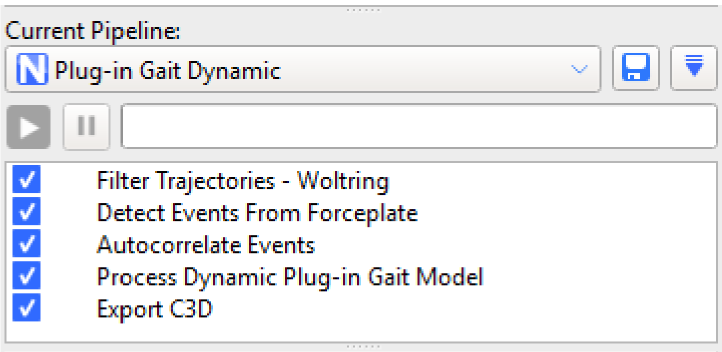
1. Transfer the video (Bonita Video) files to the session from the File Transfer window of the Data Manager
    a. Select if you would like to compress the video (FFDShow Codec recommended)
    b. Delete the transferred video files if required



2. Open the trial (from Data Manager) and run the Reconstruct and Label pipeline 
3. 'Crop' the trial to remove any unwanted parts at the start and end of capture



4. Check that the labelling is correct for the complete trial
5. Edit trajectories and fill any gaps that are present using the tools in the **Label/Edit** node 
6. Run the Dynamic pipeline located in the **Pipeline** node to filter trajectories and model marker data

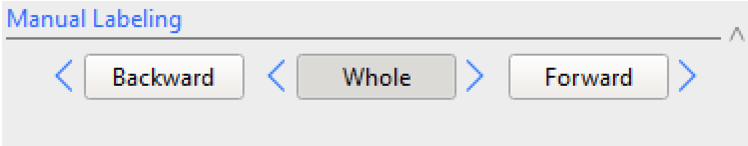


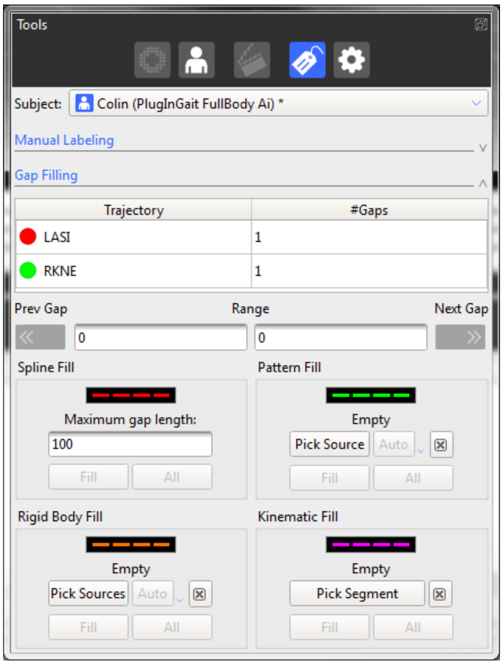
7. Analyse modelled trial data
    a. Within Nexus interface
    b. Export ASCII (exports the file to .csv/.txt etc)
    c. Polygon

Advanced Labelling

In some cases, marker trajectories may merge and swap trajectory names. In these cases, there are several advanced labelling features that can be used;

Snip and delete a section of the trajectory
Label Forwards
Label Backwards





Spline Fill

Uses a cubic spline interpolation operation to fill the currently selected gaps.

Pattern Fill

Uses the shape of another trajectory without a gap to fill the selected gap. You should use this tool only if there is a suitable marker with a trajectory similar to the one whose gap you wish to fill. This is typically the case when the trajectories originated from markers attached to the same segment, such as those attached to the ankle or heel.

Rigid Body Fill

This operation is a Nexus version of the old Replace 4 operation in BodyBuilder. It is best used when a rigid or semi-rigid relationship exist between markers.

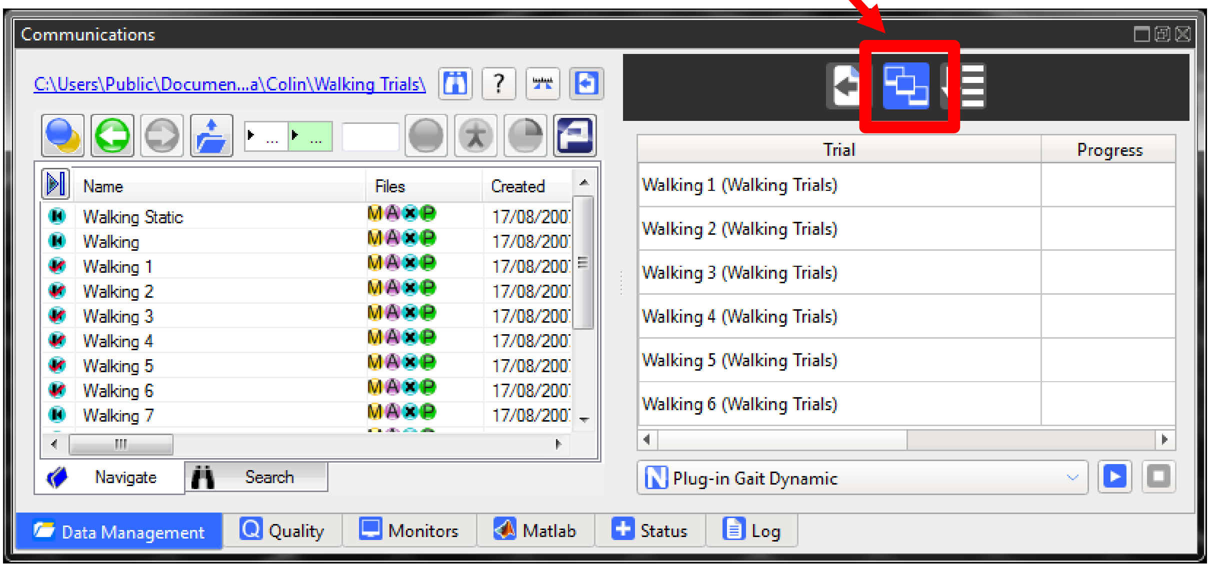
Kinematic Fill

Uses information about the connection of marker to segments in the VST.

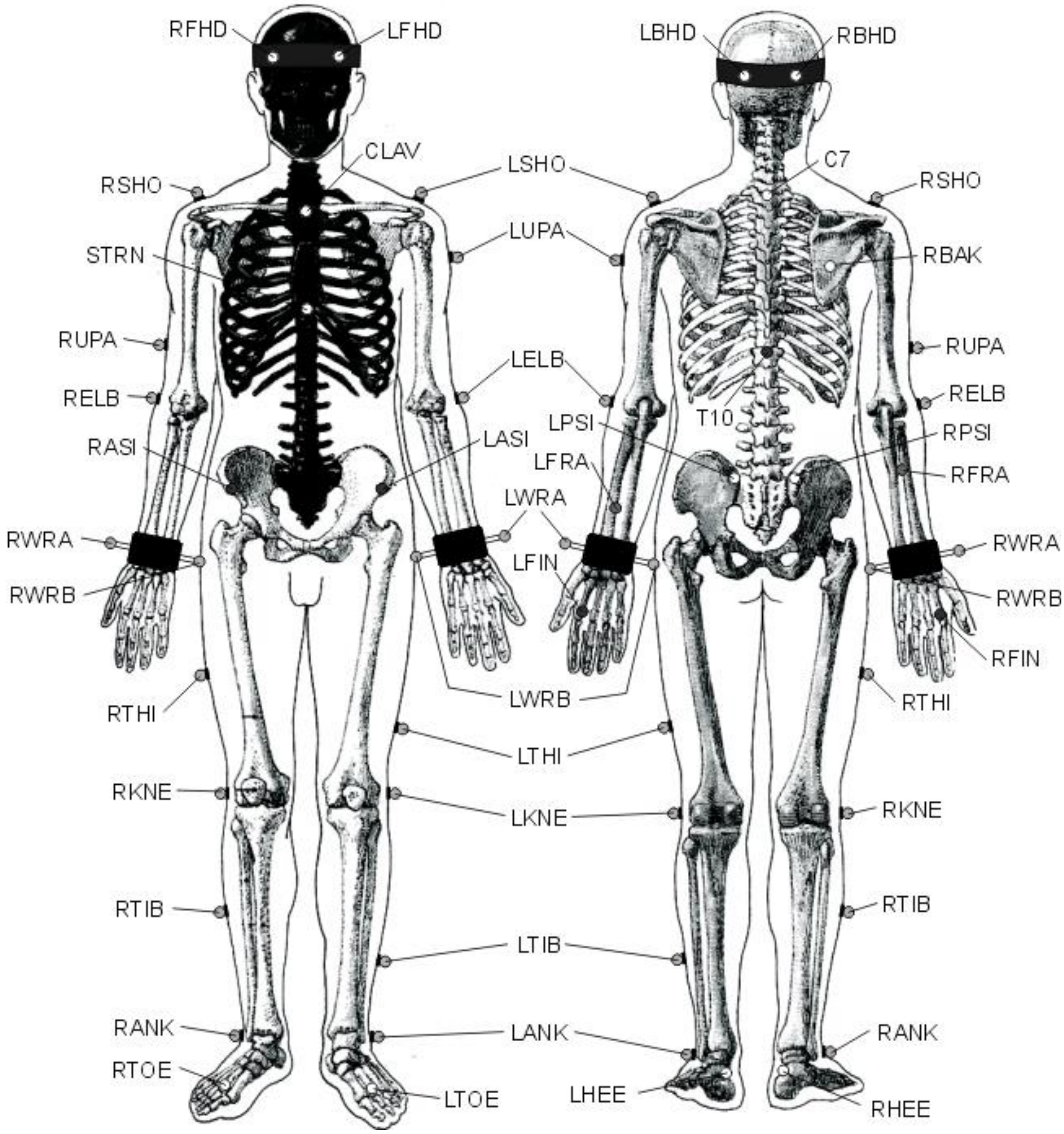
Batch Processing

To save time, a batch of trials can be processed without opening the trial. This can be done in the *Data Management* tab.

1. Select the trials you wish to process, right click and choose mark trial
2. The trials will appear in the **Batch Process** node
3. Choose the pipeline you wish to run and press play
    a. The progress bar will turn green when the pipeline has completed successfully



Plug-In Gait Full Body Marker Placement



VICON

Plug-In Gait Full Body Marker Placement

Maker Label	Definition	Position
LFHD	Left front head	Left temple
RFHD	Right front head	Right temple
LBHD	Left back head	Left back of head (defines the transverse plane of the head, together with the frontal markers)
RBHD	Right back head	Right back of head (defines the transverse plane of the head, together with the frontal markers)
C7	7th cervical vertebra	On the spinous process of the 7th cervical vertebra
T10	10th thoracic vertebra	On the spinous process of the 10th thoracic vertebra
CLAV	Clavicle	On the jugular notch where the clavicles meet the sternum
STRN	Sternum	On the xiphoid process of the sternum
RBAK	Right back	Anywhere over the right scapula
LSHO	Left shoulder	On the acromio-clavicular joint
LUPA	Left upper arm	On the lower lateral 1/3 surface of the left arm (Place asymmetrically with RUPA)
LELB	Left elbow	On the lateral epicondyle approximating the elbow joint axis
LFRM	Left forearm	On the lower lateral 1/3 surface of the left forearm (Place asymmetrically with RFRM)
LWRA	Left wrist marker A	At the thumb side of a bar attached symmetrically with a wristband on the posterior of the right wrist, as close to the wrist joint center as possible
LWRB	Left wrist marker B	At the little finger side of a bar attached symmetrically with a wristband on the posterior of the left wrist, as close to the wrist joint center as possible
LFIN	Left Finger	Just proximal to the middle knuckle on the left hand
RSHO	Right shoulder	On the acromio-clavicular joint
RUPA	Right upper arm	On the lower lateral 1/3 surface of the right arm (Place asymmetrically with LUPA)
RELB	Right elbow	On the lateral epicondyle approximating the elbow joint axis
RFRM	Right forearm	On the lower lateral 1/3 surface of the right forearm (Place asymmetrically with LFRM)
RWRA	Right wrist marker A	At the thumb side of a bar attached symmetrically with a wristband on the posterior of the right wrist, as close to the wrist joint center as possible
RWRB	Right wrist marker B	At the little finger side of a bar attached symmetrically with a wristband on the posterior of the right wrist, as close to the wrist joint center as possible
RFIN	Right Finger	Just proximal to the middle knuckle on the right hand

Plug-In Gait Full Body Marker Placement

Maker Label	Definition	Position
SACR	Sacral	On the skin mid-way between the posterior superior iliac spines (PSI) and positioned to lie in the plane formed by the ASIS and PSI points.
LASI	Left ASIS	Left anterior superior iliac spine
RASI	Right ASIS	Right anterior superior iliac spine
LPSI	Left PSIS	Left posterior superior iliac spine (immediately below the sacro-iliac joints, at the point where the spine joins the pelvis) This marker is used with the RPSI marker as an alternative to the single SACR marker
RPSI	Right PSIS	Right posterior superior iliac spine (immediately below the sacro-iliac joints, at the point where the spine joins the pelvis) This marker is used with the LPSI marker as an alternative to the single SACR marker
LTHI	Left thigh	Over the lower lateral 1/3 surface of the left thigh in line with the hip and knee joint centers
LKNE	Left knee	On the flexion-extension axis of the left knee
LTIB	Left tibia	Over the lower 1/3 surface of the left shank
LANK	Left ankle	On the lateral malleolus along an imaginary line that passes through the transmalleolar axis
LHEE	Left heel	On the calcaneus at the same height above the plantar surface of the foot as the toe marker
LTOE	Left toe	Over the second metatarsal head, on the midfoot side of the equinus break between forefoot and mid-foot
RTHI	Right thigh	Over the lower lateral 1/3 surface of the right thigh in line with the hip and knee joint centers
RKNE	Right knee	On the flexion-extension axis of the right knee
RTIB	Right tibia	Over the lower 1/3 surface of the right shank
RANK	Right ankle	On the lateral malleolus along an imaginary line that passes through the transmalleolar axis
RHEE	Right heel	On the calcaneus at the same height above the plantar surface of the foot as the toe marker
RTOE	Right toe	Over the second metatarsal head, on the midfoot side of the equinus break between forefoot and mid-foot

Joint Kinematic Specifications (Euler Angle)

Table 1 below specifies how the rotations within each of the joints of the model are ordered as trajectories in the .C3D file. For all of the joints, the joint co-ordinate system method of reporting kinematics has been used to specify flexion, abduction and rotation. It is difficult to give a consistent definition of these angles for all of the joints due to the differing meaning of flexion etc. Instead, the axis in the proximal segment embedded co-ordinate system about which each of the rotations takes place (together with the order these rotations should be applied) is given in Table 1 below:

Table 1: Euler Angle Specification

Joint	1st Component	2nd Component	3rd Component	Order
Global → Pelvis	Tilt (Y)	Obliquity (X)	Rotation (-Z)	1,2,3
Left Hip	Flexion (-Y)	Adduction (-X)	Rotation (-Z)	1,2,3
Left Knee	Flexion (Y)	Adduction (-X)	Rotation (-Z)	1,2,3
Left Ankle	Flexion (-Y)#	Inversion (Z)	Rotation (X)	1,3,2
Right Hip	Flexion (-Y)	Adduction (X)	Rotation (Z)	1,2,3
Right Knee	Flexion (Y)	Adduction (X)	Rotation (Z)	1,2,3
Right Ankle	Flexion (-Y)#	Inversion (-Z)	Rotation (-X)	1,3,2

The feet segments are peculiar to the rest of the model, not only because of the different rotation order, but also because the orientation of the foot at zero degrees flexion is straight upwards, i.e. the toe will point towards the knee. An offset of +90 degrees should be applied in order to point the foot forwards.

Joint Kinetics

For both forces and moments, the reaction frame can be specified within Plug-In Gait to be proximal, distal or in the global frame.

For each of the forces, the components in the .C3D file match the co-ordinate directions described in this document. For the moments, however, the order they are stored in the .C3D file matches the rotation order in Table 1 and therefore do not correspond to any of the segment embedded co-ordinate systems. Table 2 lists the components of the moments in terms of the axes about which they act.

Table 2: Joint Moment Specification

Joint	1st Component	2nd Component	3rd Component
Left Hip	-Y	X	Z
Left Knee	Y	X	Z
Left Ankle (prox.)#	Y	X	Z
Left Ankle (dist.)#	Y	Z	-X
Right Hip	-Y	-X	-Z
Right Knee	Y	-X	-Z
Right Ankle (prox.)#	Y	-X	-Z
Right Ankle (dist.)#	Y	-Z	X

Due to the differing alignment of the foot and tibia segment co-ordinate systems, the components of the ankle moment differ depending on whether they are represented in the proximal, distal or global co-ordinate systems.