

The MotionMonitor xGen Hardware Guide: The MotionMonitor xGen Interface to OptiTrack – Motive Tracker and Motive Body

Overview

The MotionMonitor xGen can collect data from Motive Tracker and Motive Body in realtime using **The MotionMonitor xGen** Rigid Body 6DOF Tracking. This process assumes that each segment is being tracked by at least 3 markers rigidly attached directly to the skin or to a rigid plate. **The MotionMonitor xGen** records the position and orientation of markers assigned to each rigid body, computes the centroid and coordinate system of these rigid bodies and then uses that data to perform **The MotionMonitor xGen's** standard analytical and visualization routines. The user has the option to use a fixed marker set to locate joint centers or, alternatively, can digitize landmarks using a stylus whose position and orientation are tracked using one of the 6DOF sensors. This document reviews the process of using the 6DOF method, as is commonly done with marker clusters.

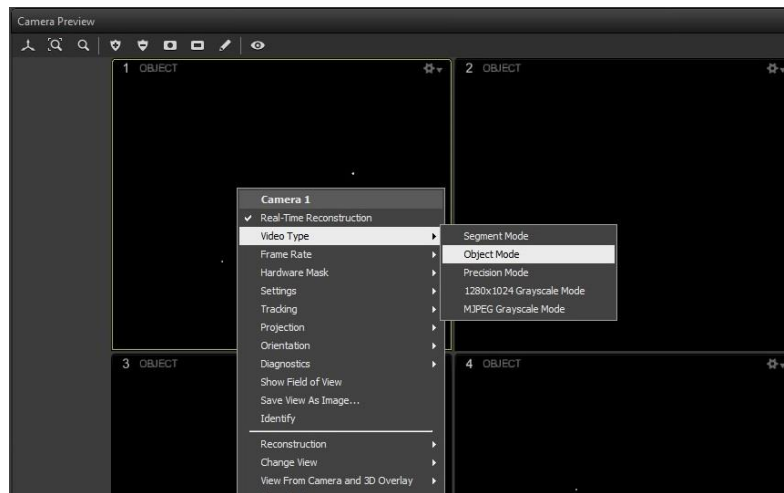
Rigid Body 6 DOF Tracking

Rigid Body 6 DOF tracking works on the following set of principles. The subject is instrumented with a minimum of 3 markers on each tracked body segment. The markers are relatively rigid (the more so the better) with respect to each other. Within Motive, the markers are selected and combined into Rigid Bodies.


Within **The MotionMonitor xGen** rigid bodies are computed from the marker's streamed (x,y,z) coordinates from Motive or the 6DoF Rigid Body data streaming from Motive can be used directly. The computed position and orientation of these rigid bodies are used within **The MotionMonitor xGen** to track objects, define subject segment lengths, locate joint centers, digitize and track landmarks of interest, etc.

A step by step guide to setup this method follows. This guide assumes that the camera hardware is connected and has been setup in the environment and that each camera is optimally zoomed and focused. It is also assumed that a Database has been created within Motive.

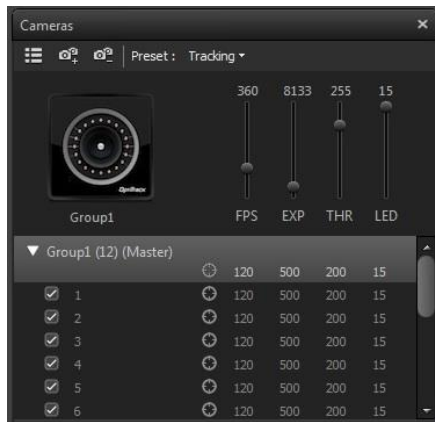
1. From the Camera Preview window, right click and select the video type as seen below. To aim each camera, switch the Video Type to Grayscale Mode. This will provide a digital video image for the camera to assist in aiming. When calibrating the cameras or collecting data, the Video Type should be switched back to Object Mode. This mode uses the least amount of CPU, so it's ideal for streaming marker data in real time. To optimize this process, place objects or markers in your environment that will represent the limits of your data capture volume. Switch between these two modes to assist in optimizing the camera settings.



2. From the Camera Preview window, right click and select Settings. This will allow you to adjust the Exposure, Threshold, and Intensities for each camera. These settings may need to be adjusted based on several factors, such as the ambient light in your environment, the reflective characteristics of materials in your capture volume and the distance of the cameras from the center of the capture volume. Set the environment lighting and measurement rate first, as these will affect the other settings. Set LED to 15 and then adjust the Exposure and Threshold as part of eliminating reflections in the space (greyscale mode will help identify sources of reflection). Some camera models may also have rings on the camera lens that can adjust the focus and f-number. The goal should be to adjust each camera in order to minimize stray light or reflections and maximize the circularity and pixels of markers in the 2D view. In order to effectively perform this process, be sure to place markers at different locations throughout your data capture volume.


Camera settings can also be modified through the cameras icon () in the toolbar. Note: Clicking on an icon will toggle open a pane in the main workspace that can be closed after parameters are modified.

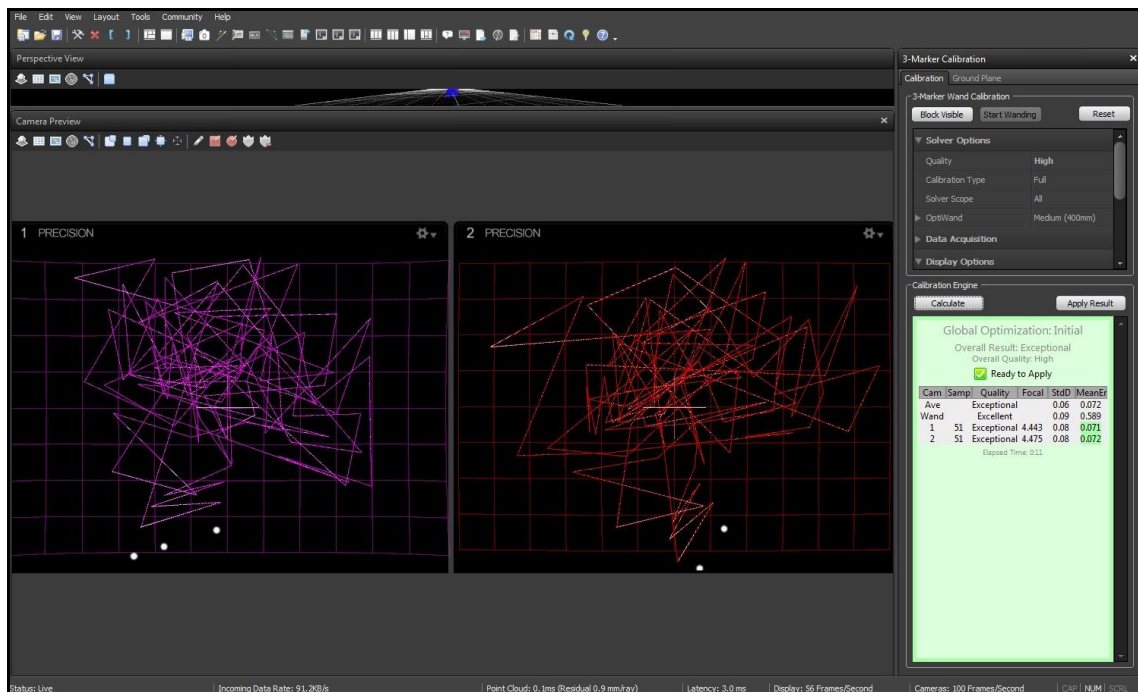
Additional camera properties can also be set here. The Gain can be set between Low and High based on the camera distance from the center of the data capture volume. Click on “Group 1”, then under the Advanced section Synchronization Control should be set to “Timely Delivery”.



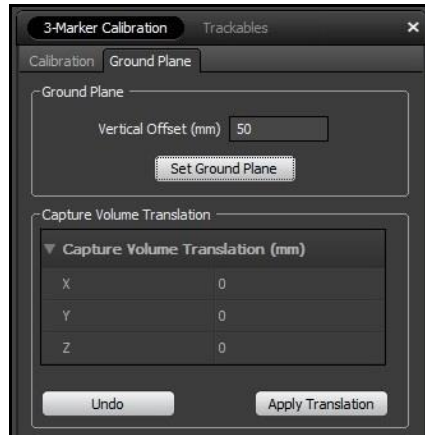
Depending on the camera model, there might also be a setting for Illumination Type under the camera settings. Strobed illumination is optimal for most standard data collection environments, while continuous is ideal for volumes where there may be interference from other IR devices.

- From the Camera Preview window, right click and select Hardware Mask. This will let you either Block Visible Markers or Clear Blocking that already exists. Blocking visible markers will allow the camera to ignore any pixels showing stray light or reflections during calibration and recording. The amount of masked pixels should be minimized as much as possible, since any pixels that are masked will not be able to contribute to the tracking of markers for that camera.



- Next, click on the Camera Calibration icon () in the toolbar. This will open the 3-Marker Calibration window. Blocking visible markers can also be performed at this point by clicking on the “Block Visible” button. Select the appropriate size OptiWand from the dropdown menu. When ready to begin the wandng process, click the “Start Wandng” button. While wandng, each Camera Preview will provide a visual representation for where data have been collected. Be certain to wand throughout the entire capture volume. The calibration engine will notify you when an acceptable amount of data is ready for calculation. When adequate data are collected, click the “Calculate” button. The calibration process will continue to optimize and refine the calibration. The “Apply Result” button should be clicked to complete the calibration process.

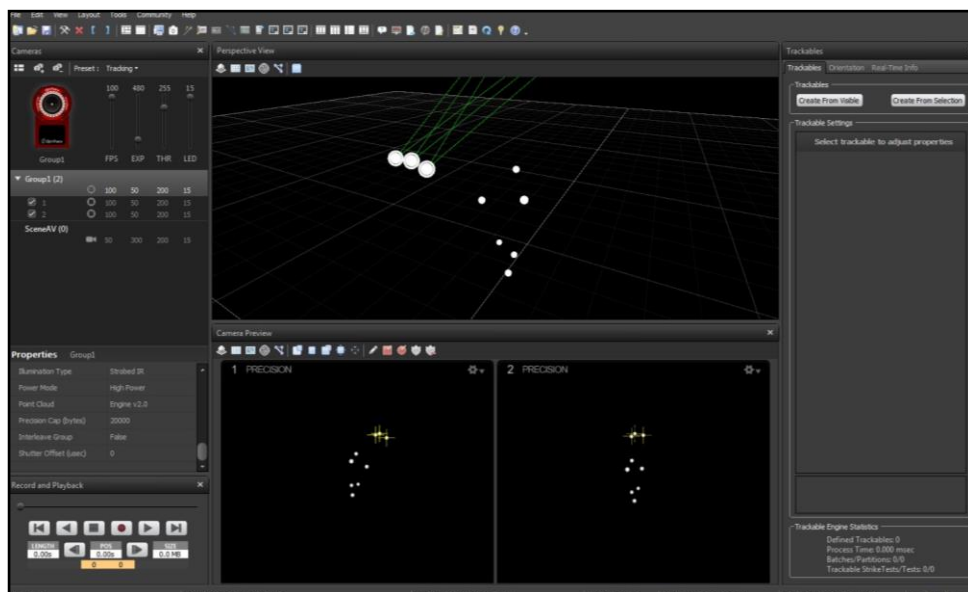


- After performing an acceptable calibration, place the L-frame at the origin to determine the ground plane as well as to define the position and orientation of the default global coordinate system. To minimize setup time within **The MotionMonitor xGen**, the L-frame (which will be the world axis system of the hardware in **The MotionMonitor xGen**) should be placed in the exact same position and orientation within the lab for each calibration. After selecting placement, click “Set Ground Plane” before removing the L-frame from the space.

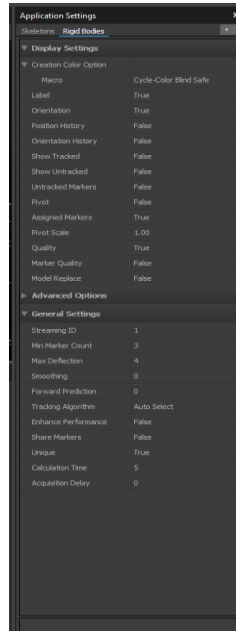


Rigid Bodies can now be defined and tracked within Motive. These Rigid Bodies are necessary for identifying and streaming marker labels and coordinates into **The MotionMonitor xGen**.

- Click on the Rigid Bodies icon () in the toolbar. With the markers in full view of the cameras, highlight the markers to be assigned to a Rigid Body by left clicking and dragging a box around them in the Perspective view. Click the “Create From Selection” button in the Rigid Bodies window. Remember, each Rigid Body must contain at least 3 non-linearly placed markers. From the Rigid Bodies Settings in Assets (), give the Rigid Body a name.

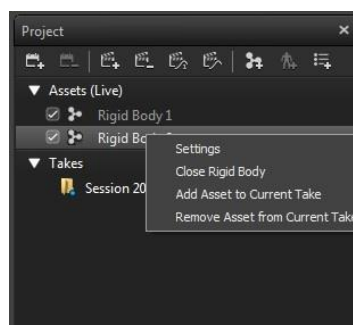



Other parameters such as the tracking properties and visualization effects can also be adjusted here. Repeat these steps for each Rigid Body. It's recommended to minimize the number of visualization effects enabled, as they can impact CPU usage and interfere with real time marker identification and streaming. The Display options for Untracked, Pivot, and Untracked Markers should all be set to "False". If sharing markers between rigid bodies, the Advanced Share Markers option should be set to "True" for each rigid body sharing a marker with another rigid body.

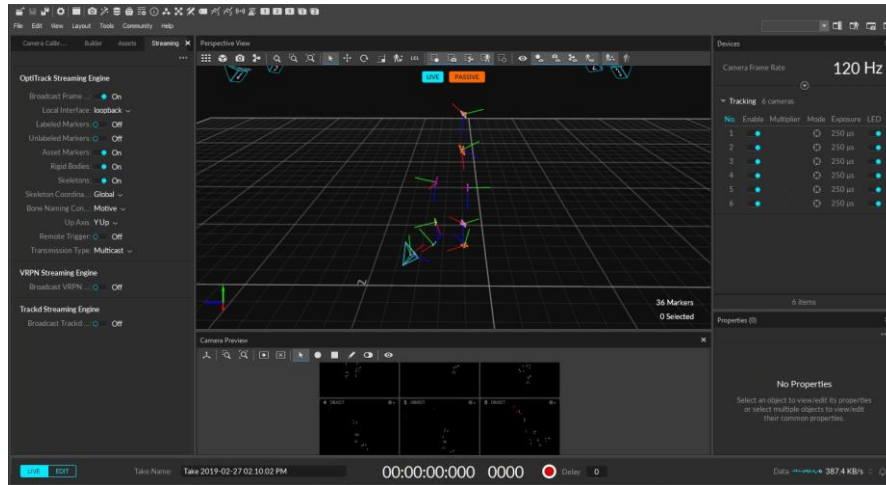


Since Rigid Bodies cannot be modified or updated, it is highly recommended that markers are placed on rigid plates. This will eliminate the need to define new Rigid Bodies for every data collection session when markers are placed on a new subject. If using markers on rigid plates or integrating force plate data, you'll also need to setup a Rigid Body to be used as a stylus. The tip of the stylus will be used to identify joint centers, define additional landmarks and align force plates.

The order in which Rigid Bodies are added will determine the order which they stream into **The MotionMonitor xGen**. The markers for the first rigid body created will be the first markers in the list streaming to **The MotionMonitor xGen**. The order of Rigid Bodies can also be confirmed by clicking on the Assets icon in the toolbar. The properties for Rigid Bodies can also be modified from this dialog by right clicking on the rigid body of interest and selecting "Settings". To remove a Rigid Body, select the "Close Rigid Body" option. Any rigid body not in use should be removed as a live asset before connecting to **The MotionMonitor xGen**.

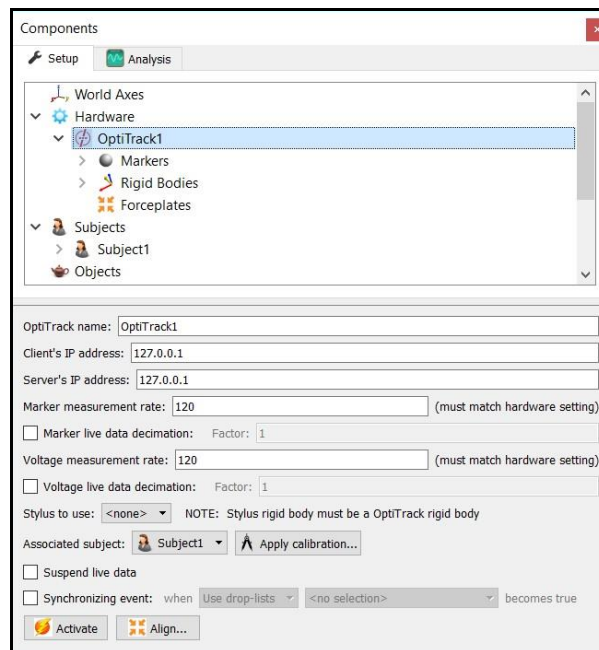


- Next, click on the Streaming icon () in the toolbar. This will open the Streaming Properties window. Enable the Broadcast Frame Data check box, set the Local Interface to Local Loopback, and “Rigid Bodies” must be turned on as seen below.



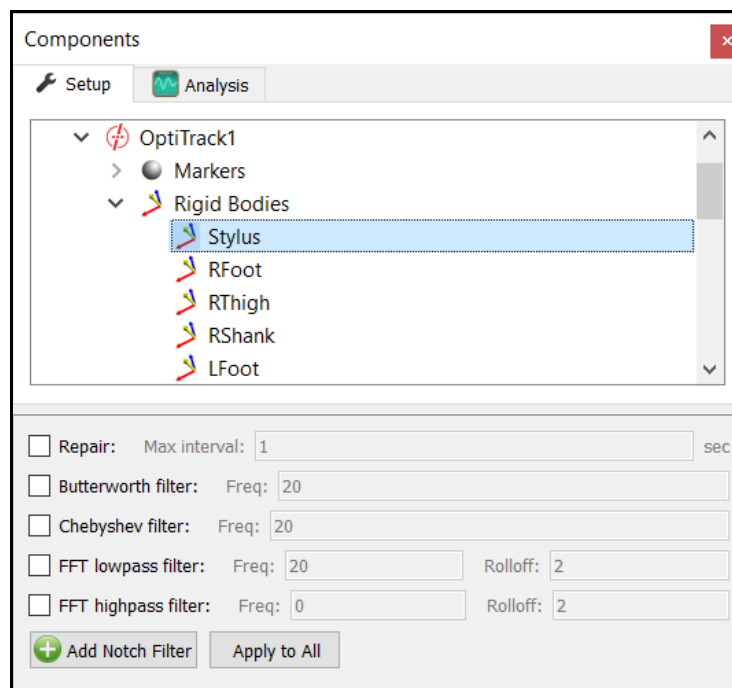
Data are now ready to be streamed into **The MotionMonitor xGen**. Again, markers will be streamed based on the order that their Trackables are listed in the Project window under the Assets (Live) pane.

- In **The MotionMonitor xGen**, go to the Setup tab in the Components Window and add or click on the OptiTrack hardware component in order to configure the hardware. Confirm that the settings entered here match the settings of Motive for the marker and voltage data measurement rates and the IP address of the computer running Motive. Click the Activate button to initialize communication with the Motive.



The data measurement used in live calculations and for updating graphics can be scaled down by enabling the live data decimation checkbox. This will result in an effective measurement rate for real time purposes being equal to the hardware's measurement rate divided by the specified decimation factor. Similarly, the display of data in the Live window can be suspended by placing a mark in the checkbox for Suspend live data. The processing and display of data in a live mode uses computer resources, so these options allow the user to optimize computer resources and free up more processing power for data collection. These settings are independent for each hardware device and once an activity has been recorded data from the full measurement rate will be accessible for analysis. The stylus that is being used for aligning this hardware device (i.e. digitizing a new world axes, unique from what was defined in Motive) must be selected here for the Stylus to use. Motive Body also supports the use of certain marker sets or Skeletons. These would be selected through the use of Associated subjects droplist, but would require some unique setup steps within Motive Body and The MotionMonitor xGen, which are not described here. Please contact your client support engineer if you are interest in using the Motive Body skeletons.

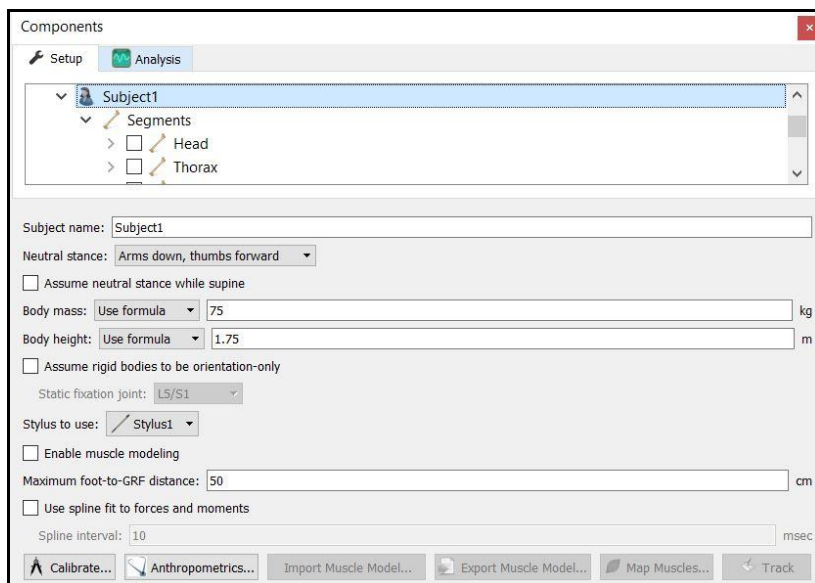
9. After successfully activating the OptiTrack device, the markers and 6DoF data from Motive will be populated under the appropriate headers for the OptiTrack component. Data repair and smoothing settings can be enabled or disabled here, pre or post data collection.



- 6 DOF rigid bodies can be defined through **The MotionMonitor xGen** as seen in the dialog below. Rigid Body Collections can be added to the Setup Components dialog window as a Hardware device. Multiple Rigid Bodies can be added to a Rigid Body Collection, each of which can be defined using different combinations of marker assignments. Remember that 3 or more markers are required to create a Rigid Body. Markers can be selected for a rigid body either by selecting them through a drop down menu or defining them using a formula. Do not include markers in the rigid body definitions which will be removed for dynamic recordings. Markers can also be lassoed in the Animation window using the Shift key + Left Mouse button to create and add to an existing Rigid Body. Clicking on the Highlight button will highlight the selected Rigid Body markers in the Animation Window.

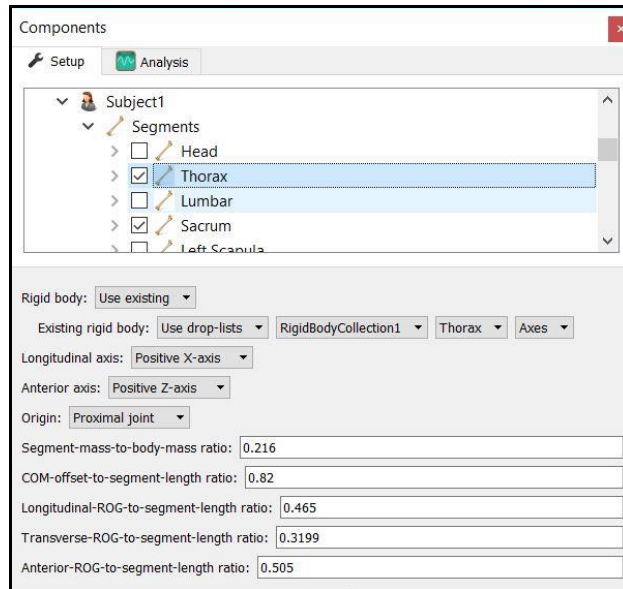
The Calibrate Rigid Bodies button takes a reading of the markers, computes centroids, creates sensor axes, establishes the relationship between markers and generally prepares the system to track the cluster of markers as 6 DOF data. Rigid Bodies can be calibrated one by one or all at the same time by going to the top level of the Rigid Bodies Collection and clicking the Calibrate All button. After this step, markers and their “sensor” axes can be viewed in Animation window or graphed and recorded as position and orientation data.

- The next step is to define your biomechanical model within **The MotionMonitor xGen**, which entails selecting which body segments you’ll be tracking, assigning rigid bodies to track each body segment, defining segment endpoints or joint centers and generating customized segment axes, if desirable. To begin this process, right click on the Subjects header within the Components Setup tab and add a new subject.

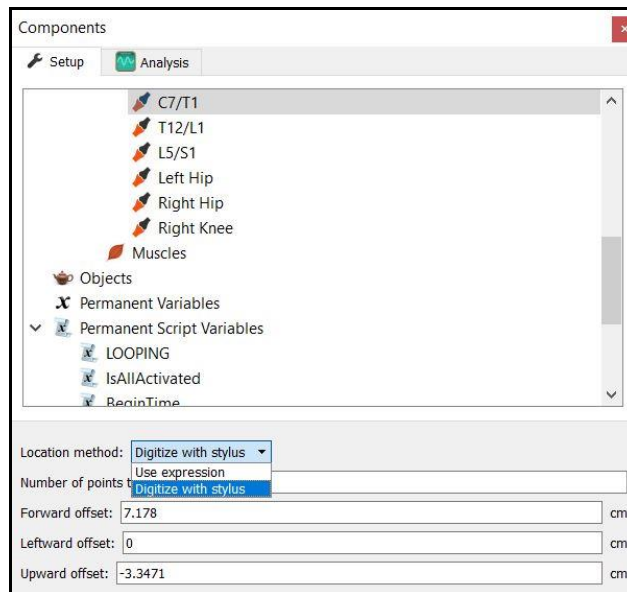


As seen above, a name can be assigned to the subject and basic anthropometric data can be entered. Confirmation for the orientation of the subject during the static reading and selection of a stylus to be used for digitizing, if required, are also selected here. The Calibrate button can be clicked after all of the required setup information has been entered.

12. The Segments header located under the Subject is where the desired segments to be tracked can be enabled as well as where the assignment for which rigid body will be used to track the segment is defined. Additional basic anthropometric information can be defined here for each segment as well.

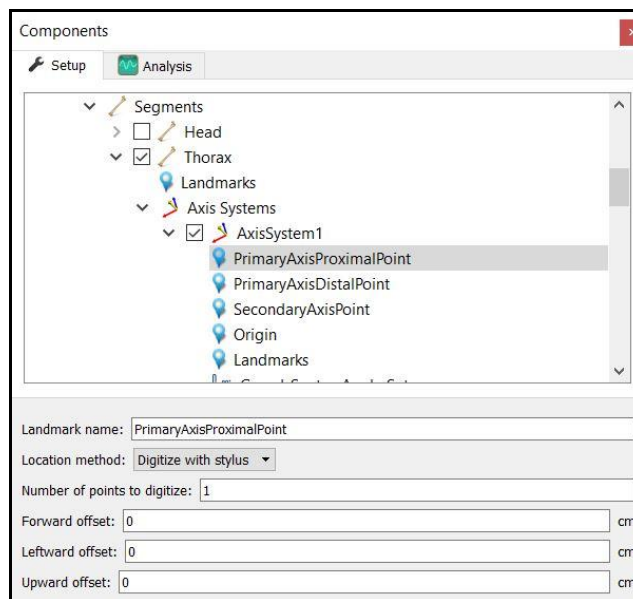


13. Each body segment which is enabled will require the definition of a proximal and distal endpoint or joint centers. The required joint centers will be automatically populated based on the selection of segments.



14. As seen above, each joint center can be defined using a digitizing method or expression based on marker positions. Alternatively, the hip and shoulder joints can be defined using linear regression algorithms or functional (rotational) methods.

15. Once these definitions are completed, the Subject Calibrate button can be clicked. A warning message will be displayed for any definitions that have not been appropriately defined.
16. Additionally, if alternative or anatomically based local coordinate systems are desired, they can be defined by right clicking on a segment and selecting Add Axis System. First, the Rigid Body axes tracking the segment and general axes layout are selected. Then, points can be defined for the proximal and distal endpoints of the primary axis, a point along the secondary axis and a point for the Origin. The default local coordinate axes generated by The MotionMonitor xGen are defined as having a long axes through the joint centers and A/P and M/L axes being orthogonal to the long axes and parallel to the world when the subject was standing in the neutral position.



17. At this point, the **The MotionMonitor xGen** subject is fully defined and can be used for biomechanical models, recording activities, performing computations and reducing data.
18. By saving a Workspace file, *File/Save Workspace As*, in **The MotionMonitor xGen**, all of the setup selections will be retained as a template and can easily be re-loaded using *File/Load Workspace*.