The MotionMonitor xGen Hardware Guide: Interface to VICON Cameras- Tracker Using Clusters

Overview

The MotionMonitor xGen can collect data from VICON Nexus 2.0, Nexus, Tracker and Workstation in realtime using **The MotionMonitor xGen** Rigid Body 6DOF Tracking. This process assumes that each segment is being tracked by at least 4 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 or "virtual sensor", 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. Joint centers and other landmarks can be digitized 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, in Tracker.

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 4 markers on each tracked body segment. The markers are relatively rigid (the more so the better) with respect to each other. Within Tracker, the markers are identified and combined into rigid bodies. The purpose is to provide robust marker identification within Tracker so that accurate, identified marker x, y, z positions and rigid body centroids and orientations can be streamed directly to **The MotionMonitor xGen**.

Within **The MotionMonitor xGen** "virtual sensors" or rigid bodies can be computed from the marker's streamed (x,y,z) coordinates from Tracker. The computed position and orientation of these "virtual sensors" is used within **The MotionMonitor xGen** to track objects, define subject segment lengths, locate joint centers, digitize and track landmarks of interest, etc. Alternatively, the rigid body centroids and orientations from Tracker can be used directly.

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.

1. After launching the Tracker application, highlight all the cameras within the System tab. From the View pane, select the "Camera" view from the dropdown, as shown below.
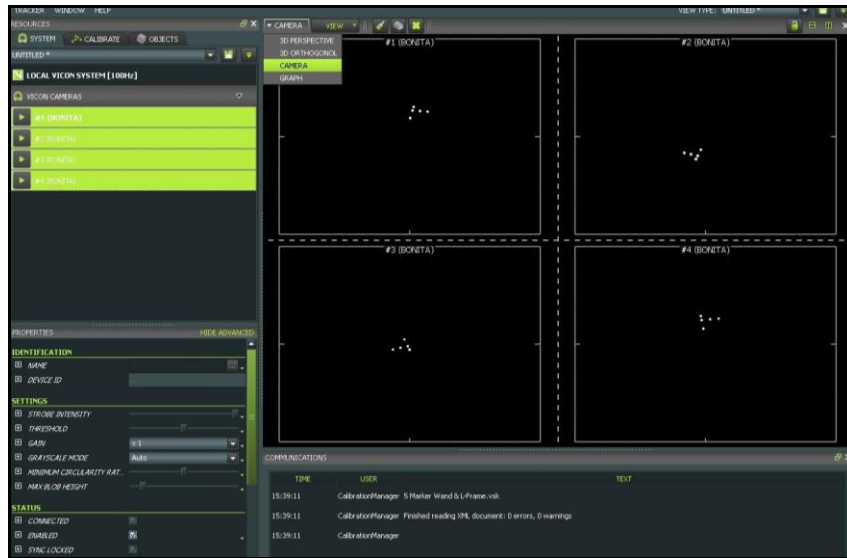

2. Now, begin the process of calibration by selecting the "Calibrate" tab from the Resources toolbar. Ensure the appropriate calibration device is selected (i.e. "5 Marker Wand & Frame") and then expand the "Calibrate Cameras" section. In the Refinement Frames field, enter the number of frames required to complete a calibration with good coverage in your environment. Click Start when you are ready to begin.

3.   Move the wand throughout the measurement volume, being sure to move the wand in all three axes. The camera view will display the area that has been covered with a rainbow pattern, and the Wand Count will update as frames are collected. Once all of the cameras have collected the minimum number of Refinement Frames, the calibration will be calculated.
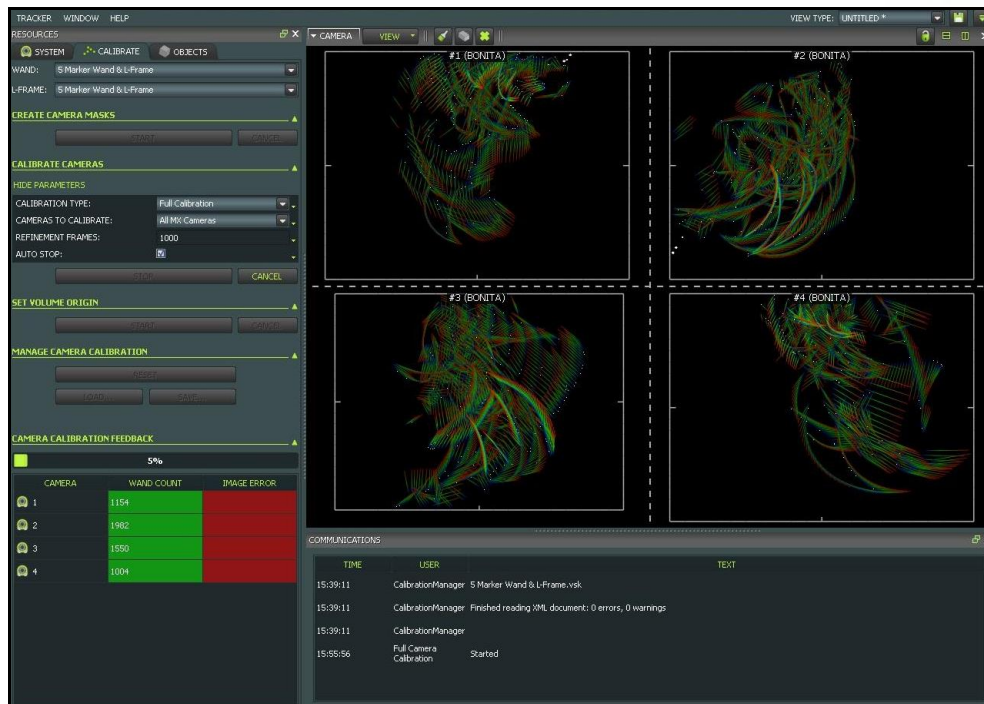

4.   Now place the wand at origin of the global coordinate system. Ensure that all 5 markers can be seen by most cameras. Expand the "Set Volume Origin" dropdown. Click Start and then "Set Origin" when you are ready to take a reading.
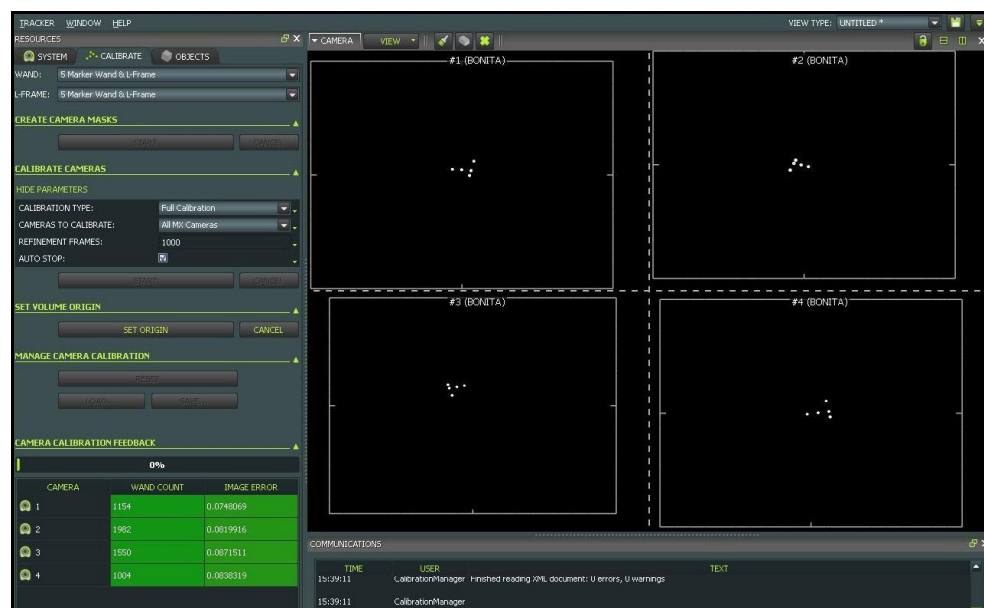
5.   From the View pane, select the "3D Perspective" view from the dropdown menu. The animation will display the layout of the calibrated cameras; this should replicate the real life position and layout of the camera system. Attach markers and/or rigid body clusters to the subject or object to be tracked. Have the subject/object enter the capture space and the markers should be displayed in real-time. Note that a minimum of 3 markers per rigid body are required, a minimum of 4 is recommended for tracking robustness, and markers *cannot* be shared between 2 rigid bodies. All markers must be assigned to a rigid body; individual markers cannot be streamed stand-alone.

6.   The next step will be to generate Objects. Click on the "Objects" tab in the Resources toolbar. When all markers are in view, click the Pause button (▐▐) and select 3 or more markers that you will assign to the first rigid body (Lasso in the 3D Perspective window). Under the "Create Object" section, enter the name of the rigid body and click "Create" as shown below. This process can be performed while Live, but cameras may lose line the line of sight for a marker while not paused.
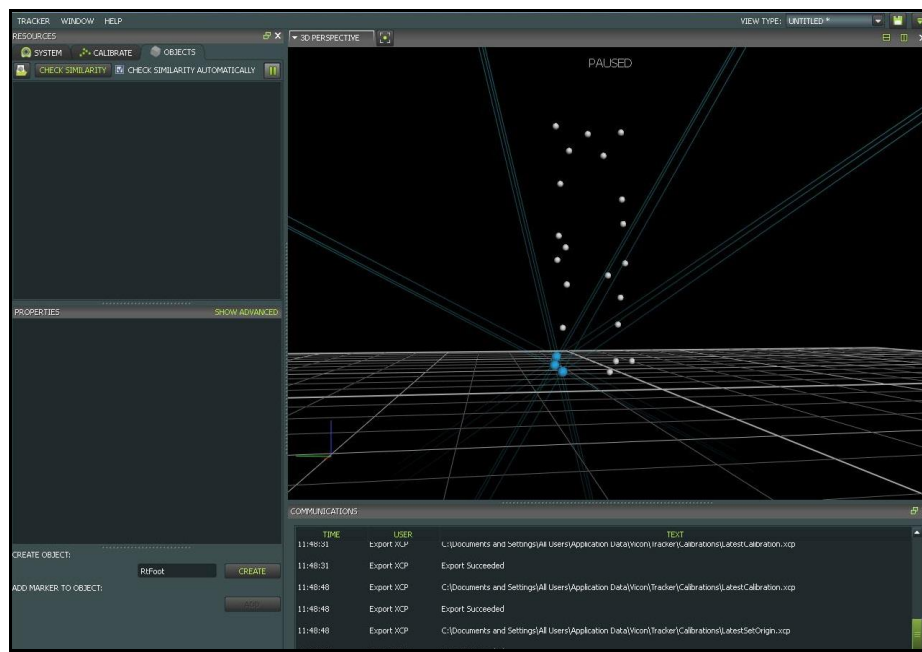
7.   After the Object is created, the markers can be named and custom colors can be assigned to each marker. To name a marker, select the marker in the animation window or click on the default marker name from the list on the left. Under "Properties" enter a name and assign a color. Select either a "Required" or "Optional" assignment from the Status dropdown. At least 3 markers on the rigid body must be "Required." If additional markers are attached to the object, their status can be assigned at the discretion of the user. For example, if medial markers are used to locate joint centers, and these markers will be removed during dynamic trials, their status would be assigned as "Optional."
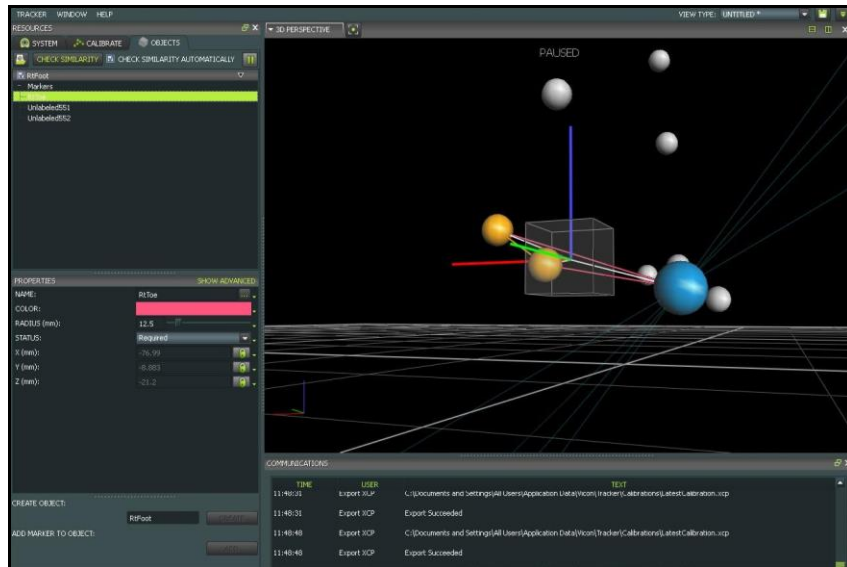
8.   Create Objects for each rigid body that will be tracked in The MotionMonitor. Once all the rigid bodies are created, right-click on their names and save the Object; this will save a *.vsk file. Tracker will automatically reload the list of Objects from the previous session when the application is restarted. To modify the list, load previously saved Objects by clicking the Load button ( ) and selecting the appropriate rigid bodies.
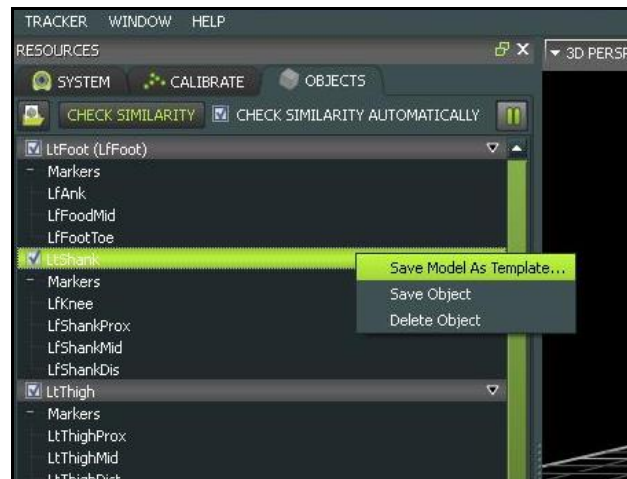
9. At this point, all objects have been created and saved. Click the Pause button (⏸) again to return to a Live capture environment. Close Tracker and re-launch it. This is an important step as it will set the order markers are streamed to TMM. Restart Tracker and stream in Live mode. Launch The MotionMonitor.
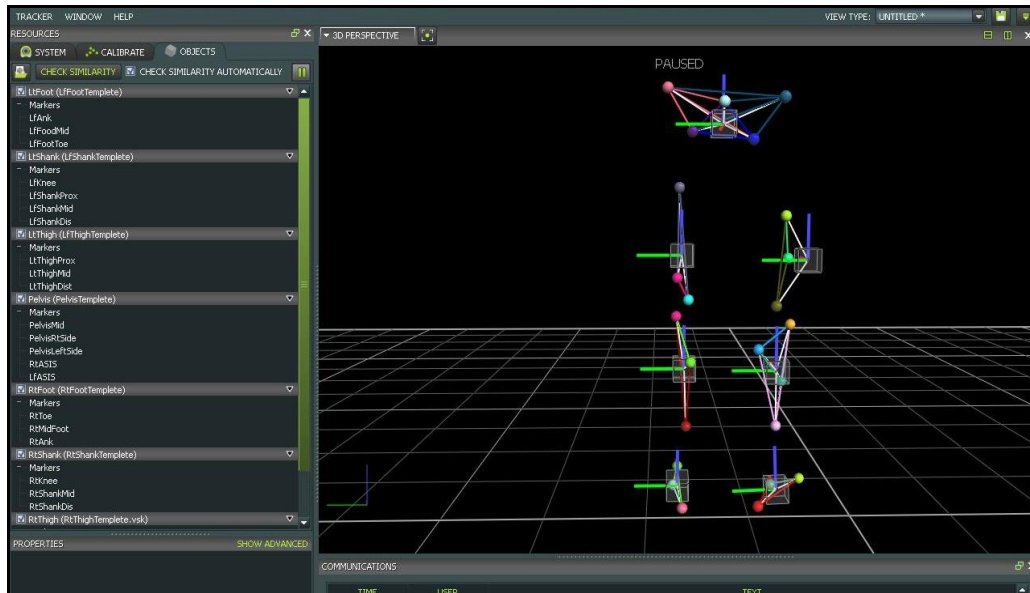

NOTE: If marker swapping occurs within Tracker pressing "Ctrl + R" on the keyboard will reboot the camera's processors and re-label markers.
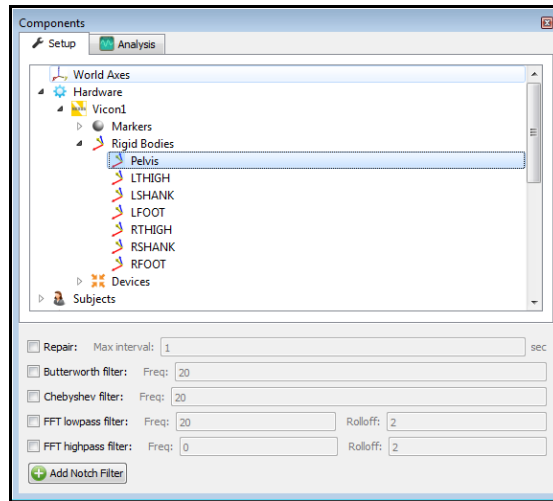
10. In **The MotionMonitor xGen**, go to the Setup tab in the Components Window and add or click on the Vicon hardware component in order to configure the hardware. Confirm that the settings entered here match the settings of Tracker for the measurement rate, number of markers and the IP address of the computer running Tracker. If analog data will be streaming from Tracker, enable the Digital Devices Present checkbox and set the measurement rate to match the settings of Vicon for analog data. Click the Activate button to initialize communication with the Vicon Tracker software.   Please refer to the Vicon A/D Knowledge Base Article for more information on streaming analog data from Vicon into **The MotionMonitor xGen**
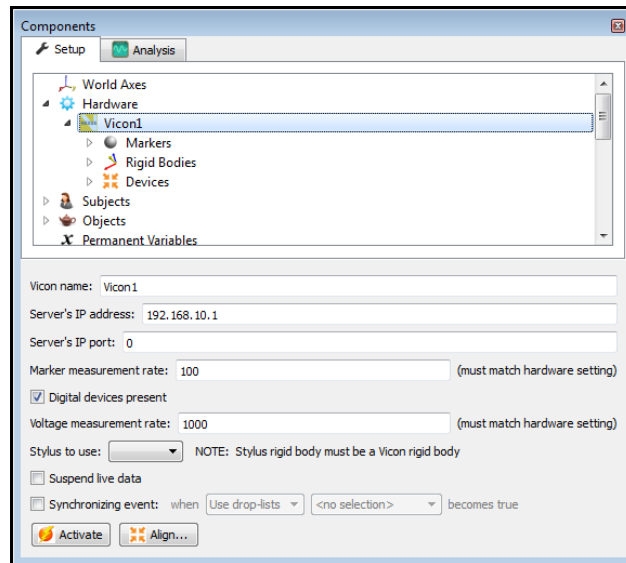

11. After successfully activating the Vicon device, the marker list, rigid bodies list and any analog data configured within Vicon will be populated under the appropriate headers for the Vicon component. Data repair and smoothing settings can be enabled or disabled here, pre or post data collection.
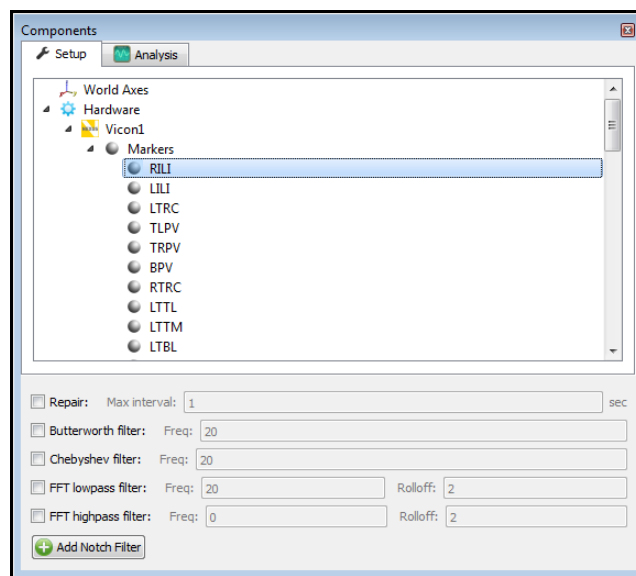
12.   The Rigid Bodies header will be populated with any rigid bodies that were configured within Vicon Nexus.


13.   Alternatively, 6 DOF rigid bodies could also 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. Clicking on the Highlight button will highlight the selected Rigid Body markers in the Animation Window.
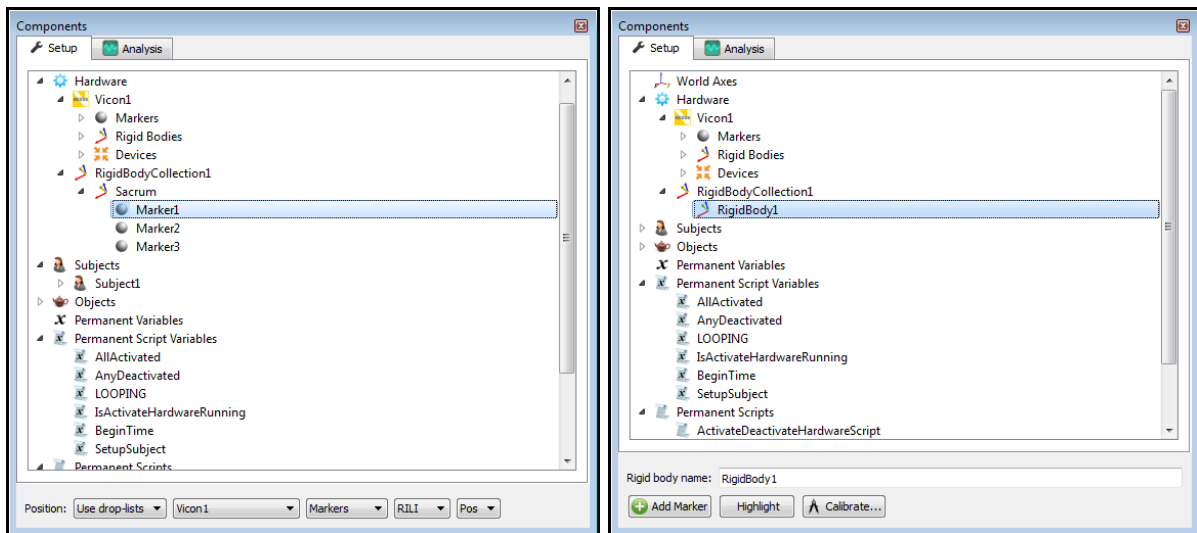
NOTE: The virtual markers "Calculated Left Hip Joint" and "Calculated Right Hip Joint" can be used as thigh markers. The Davis and Bell methods for locating the hip joint centers only require that you have 2 additional markers assigned to the thigh, whereas the Rotation method requires 3 markers during the static pose. During the dynamic trial, the hip joint and a minimum of 2 original thigh markers can be used to track the thigh when using the Rotation method. Any additional markers that are used for calibration only should not be included in the Rigid Body parameters.

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.

14.   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.
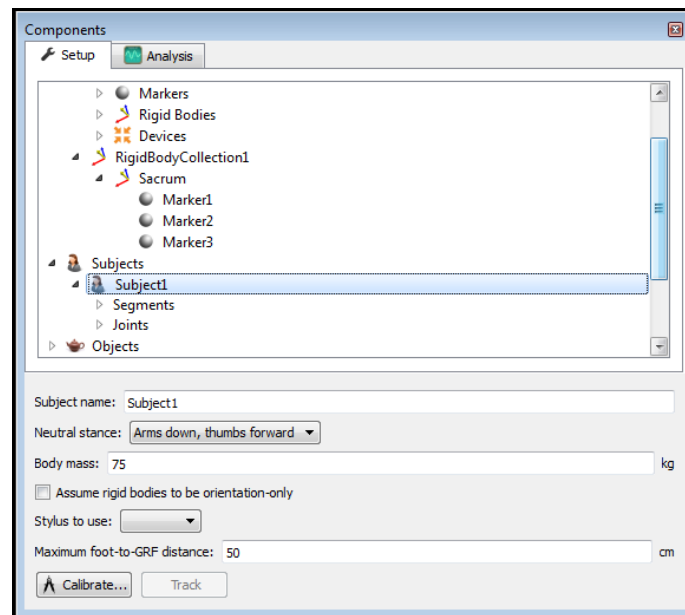

As seen above, a name can be assigned to the subject and basic anthropometric data can be entered. Confirmation for the orientation of the subject during the static reading and selection of a stylus to be used for digitizing, if required, are also selected here. The Calibrate button can be clicked after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

15.   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.
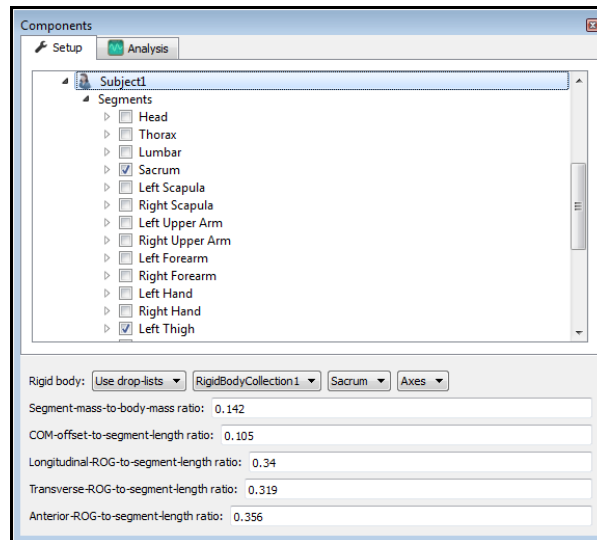

16.   Each body segment which is enabled will require the definition of a proximal and distal endpoint or joint centers. The required joint centers will be automatically populated based on the selection of segments.
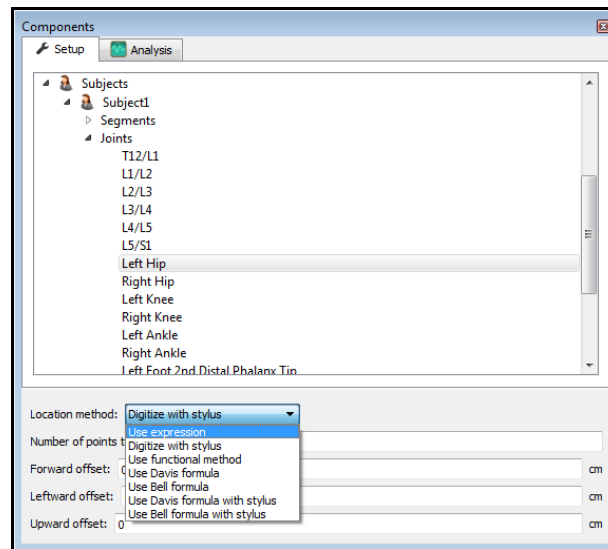
17.   As seen above, each joint center can be defined using a digitizing method or expression based on marker positions. Alternatively, the hip and shoulder joints can be defined using linear regression algorithms or functional (rotational) methods.

18.   Once these definitions are completed, the Subject Calibrate button can be clicked. A warning message will be displayed for any definitions have not been appropriately defined.

19.   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.
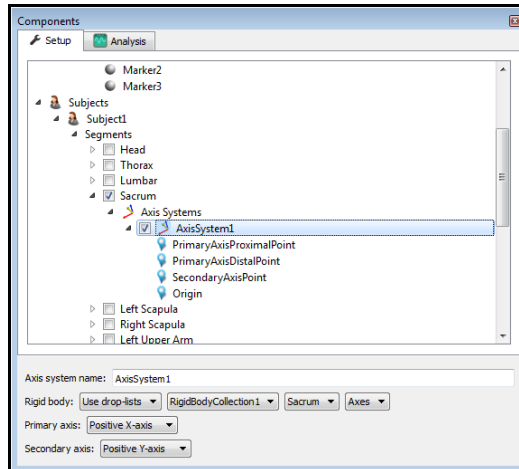
20.   At this point, the **The MotionMonitor xGen** subject is fully defined and can be used for **biomechanical models, recording activities, performing computations and reducing data**.

21.   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.