Building a Conventional Gait Model

Introduction

The conventional gait model has many variations and can go by many n
Clinical Manager, Newington, and Cleveland Clinic to name a few. For
will refer to this model as The Conventional Gait Model. We will not discuss each variati
point out some of the variations that can exist and how you might hand

What is the Conventional Gait Model?

The conventional gait model refers to the marker set (both unilateral a
used to estimate the pose (position and orientation) of the segments,
representing model based items (joint angles and joint moments). This
years ago and was largely a result of inadequate technology rather tha
markers. At HAS-Motion we prefer to think of this as The Legacy Gait Model because
presented with a better alternative, most knowledgeable users natural
representation.

Legacy Data

The persistence of the conventional gait model is often attributed to t
the argument being that adopting a new marker set would render this l
would argue that the assessment of sensory motor functioning is const
be unfair to patients to ignore this evolution and to persist in perpetu
model.

Simplicity of Marker Placement

A sensible reason for the persistence of the conventional gait model m
simplicity of the marker placement. A consequence of this simplicity is
be used conveniently for all subjects (young and old).

Rationale for the Conventional Gait Model

The principal advantage may actually be that using the term Conventi
implicitly the deß nitions and conventions of the kinematic and kinetic
this isn't necessarily true, but it is treated this way in the literature.
Conventional Gait Model was used, the reader, and more importantly t
comfortable that they understand the conventions used, whether or no

Visual3D users that have the ß exibility to deß ne custom conventions a

subject populations are expected to describe explicitly these conventi
of course, should probably be true of all articles, so it is actually goo
this need only be done in one article, while all subsequent articles ca

Limitations of the Conventional Gait Model

The principal limitations of the marker placement are that the tracking
track the segments) are often placed such that the markers on each se
(e.g. lie in a straight line). If the markers were actually collinear, the
the position and orientation of a segment. If the markers are almost c
but it is very sensitive to any noise or artifacts in the data.

In particular, one consequence of the marker placement is that the axi
unreliable.

In many cases only two tracking markers are actually provided for eac
is not possible to compute the pose of a segment independently of oth
freedom analyses are not possible).

A variant of the conventional gait model, which distributes the trackin
segments has been published by Alberto Leardini and colleagues, and
Motion as IORGait. The IORGait model has sufficient markers to permit
the segments.

Another important limitation is that the model cannot be used directly
deformities or even prostheses.

Equivalence with other Implementations

Segment Coordinate Systems

The definition of the segment coordinate systems is based on anatomic
consistent with many other gait models. The main differences lie in the
algorithms used to estimate the position and orientation of the segmen

Pose Estimation

The following description of the Visual3D segments will generate cons
commercial and non-commercial representations, but note that the res
precisely equivalent because Visual3D uses either Segment Optimization or Global Optim
estimation algorithms, while the conventional models typically use Direct (Nor
Estimations.

It is our opinion that the Direct Pose Estimation is the least effective
position and orientation of a segment/model, and that given the superi
any differences in the pose estimation between the conventional gait m

reveal limitations in Direct Pose Estimation and therefore in the other

We attempt to elucidate the pit-falls of using this marker set during th

Conventional Gait Model Decisions

Since there are variations of the conventional gait model, decisions m
placement and data collection. The diagram below lays out some of the
segment. This is not comprehensive since many variations exist. The f
conventional gait model marker placement locations and challenges ba

Hip Joint Center

The conventional gait model has three variations for hip joint center c
the Helen Hayes (Davis) Pelvis and the other is the Coda_Pelvis with the Bell and Brand (1989
calculation. All three are based on regression equations. The Hip Join
the Helen Hayes (Davis) Pelvis is based on Leg Length, inter-ASIS Distance, and
to Greater Trochanter distance. The Coda_Pelvis is based on the Bell and Brand (1989)
equation which uses the inter-ASIS Distance. The following sections d

Marker Placement

Appropriate marker placement for any model is critical. The motion sys
of the marker so when placing markers on the subject, use the center
not the attached bases or wands. It is also good practice to use an ey
the subject the locations of the markers. If a marker is knocked oß or
the same location. But, one has to be very careful about replacing ma
Optimization or Global Optimization pose estimation algorithms are us
be replaced, then the standing trial should be collected again; simply
usually sußcient.

Pelvis Markers

The conventional gait model pelvis has two marker set variations: a th
marker set. The three market set Pelvis is known as the Helen Hayes (Davis) Pelvis and the four marker
set Pelvis is known as the Coda Pelvis. The Pelvis Overview section discussed the dißerence
the two models.

Four Marker Set Pelvis - CODA Pelvis

RIAS , LIAS= Right Ilium Anterior Superior (Anterior Superior Iliac Sp
RIPS , LIPS= Left Ilium Posterior Superior (Posterior Superior Iliac Sp

As with the Helen Hayes (Davis) Pelvis, the plane of the Coda Pelvis is visualized as a triangle
plane. In this case the plane is formed by the Right and Left Anterior
LIAS) and the mid point of the Right and Left Posterior Superior Iliac
centers of the markers over both Anterior Superior Iliac Spines (ASIS'

Iliac Spines (PSIS’s).

The origin of the pelvis is deßned as being halfway between the ASIS
the line joining them regardless of the position of the PSIS markers. S
medial/lateral position of the PSIS markers is not critical but care sho
vertical position.

Three Marker Set Pelvis - Helen Hayes (Davis) Pelvis

RIAS , LIAS= Right Ilium Anterior Superior (Anterior Superior Iliac Sp
RIPS , LIPS= Left Ilium Posterior Superior (Posterior Superior Iliac Sp
between RIPS and LIPS)
The plane of the Pelvis is visualized as a triangle or plane that is for
and Left Anterior Superior Iliac Spines (RIAS and LIAS) and the mid-p
Spines (SACR). Place the centers of the markers over both Anterior Su
sacral marker (SACR) is placed over the mid-point of the Posterior Su
LIPS).

For the Visual3D implementation of the Helen Hayes pelvis the mediol
marker is very important, so care should be taken in the placement of
well as the vertical position. The origin of the Helen Hayes pelvis is a
markers.

Placement challenges for obese subjects

Placement on obese subjects can be challenging due to excessive tiss
palpate the ASIS’s since the skin and tissue may be in dißerent locati
position. There are three options for marker placement: move the ASIS
the ASIS markers anterior or use the pointer to identify a virtual point

Move ASIS markers Laterally

Move both ASIS markers lateral to the anatomical ASIS in the pelvic p
displacement is symmetrical between sides. Measure this distance and Subject Metric
Inter-ASIS_distance.

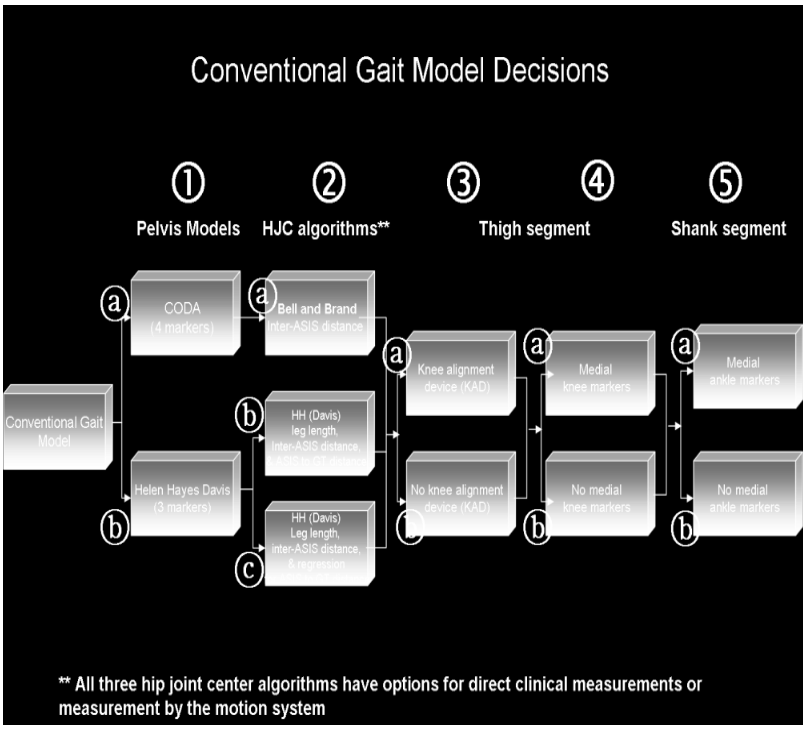
Move ASIS markers Anteriorly

Move both ASIS markers anterior (coming forward directly anterior to
directly over them in the coronal plane of the pelvis) by an equal dista
would have been. Measure this distance and add a landmark that spec
ASIS. These ASIS landmarks should be used for deßning the segment
but the original markers should be used as the tracking markers for th

Use a Pointer to make ASIS Landmarks

A [Digitizing Pointer] can be used to identify the ASIS markers.

Upper Leg Markers



RFCH, LFCH=Femur Center of Head
RTH, LTH=Thigh marker
RFLE, LFLE=Femur Lateral Epicondyle
RFME, LFME=Femur Medial Epicondyle

There are few variations for the thigh segment. One in which a [Knee Alignment Device] (KAD) is used, one without a KAD, one that uses both, and one that uses medial knee

Without Knee Alignment Device (KAD)

The upper leg segment can be visualized as a triangle or plane formed
LFCH) and the Knee Flexion/Extension axis. Palpate the medial and la
knee flexion/extension axis. Place a marker on the right and left Later
approximate this axis. This should be done in the standing position wi
and extending the joint to confirm placement. You are looking for a po
about which the lower leg appears to rotate. Mark that location with e

When not using a Knee Alignment Device (KAD) the placement of the thigh markers (
wands (stick on a base with an attached marker) is critical. This mark
plane of the femur (knee flexion/extension axis location and orientatio
the best location to decrease movement due to muscle bulk and swing
height is not critical but try not place the thigh marker too low on the
position of this marker is critical and it is extremely difficult to visuali
aligned in the plane that contains the hip and knee joint centers and t
Position this marker standing and observe knee flexion/extension to co

Using a Knee Alignment Device (KAD)

As above, the upper leg segment can be visualized as a triangle or pla
Center (RFCH, LFCH) and the Knee Flexion/Extension axis. The differe
Knee Alignment Device (KAD) is used in the static trial to define the coronal p
Palpate the medial and lateral epicondyles to estimate the knee flexio
over the epicondyles such that the device is in line with the visualized
This should be done in standing position.

After the subject static calibration trial, remove the KAD and mark the
epicondyle with a eyeliner pencil or pen. Place a marker on that locat
the thigh (RTH, LTH) markers or wands (stick on a base with an attach
case so it can be placed anywhere on the thigh.

Improper Placement of KAD

The KAD can be aligned improperly or can slip after placement. If this
coronal plane will be improperly defined. Care should be taken when u
measure, it may be best practice when using the KAD to align the thig
medial knee markers (which is detailed in the next section) and collec
without the KAD. A choice can be made post data collection on whethe
the thigh or medial knee alignment.

Medial Knee Markers

Another variation of the model is to use medial knee markers. Palpate epicondyles to estimate the knee ß exion/extension axis. After lateral marker on the right and left Medial Epicondyles (RFME, LFME) to appr ß exion/extension axis. Remember to mark that location with eyeliner p marker only in the static trial (without KAD) and remove it for the dyn knocked oß .

Knee Diameter

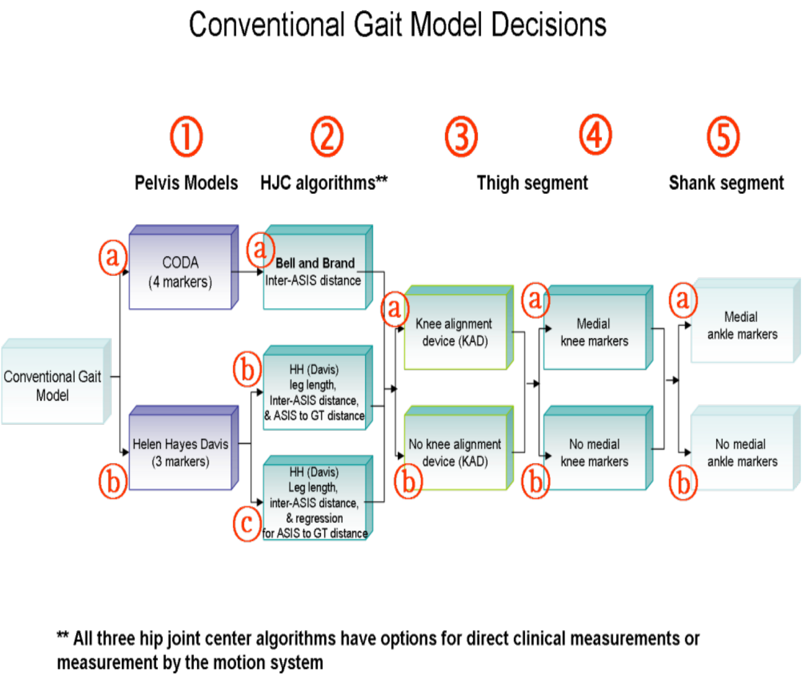
If a medial knee marker is not placed, it is critically important to mea (e.g. the distance between the medial and lateral epicondyles) becaus identify the distal end of the thigh segment.

Axial Rotation of the Thigh

If the thigh segment uses only lateral markers (e.g. lateral knee and g and lateral thigh) and the hip joint center, the axial rotation of the th reliably, and the user should not try to interpret the axial rotation.

The inclusion of the medial knee marker as a tracking marker improves rotation dramatically.

Lower Leg Markers



RFLE, LFLE=Femur Lateral Epicondyle
RFME, LFME=Femur Medial Epicondyle
RFAL, LFAL=Fibula Apex of Lateral Malleolus
RTAM, LTAM=Tibia Apex of Medial Malleolus

The lower leg segment can be visualized as a triangle or plane formed
the Ankle Flexion/Extension axis (Transmalleolar axis). Palpate the m
visualize an imaginary line that runs through the transmalleolar axis.
left Lateral Malleolus (RFAL, LFAL) along that line. Remember to mark
pencil or a pen.

As in the thigh, the placement of the shank markers (RSK, LSK) or wa
attached marker) is critical. This marker is used to define the coronal
flexion/extension axis location and orientation). The distal 1/3 of the
decrease movement due to muscle bulk. The vertical height is not criti
marker too low on the shank. The anterior/posterior position of this m
extremely difficult to visualize. An alignment reference device such as
can be used to visualize the placement. Adjust the marker so that it is
contains the knee and ankle joint centers and the ankle flexion/extens
placed in a seated position but should be checked when standing to co

Medial Ankle Markers

Another variation of the model is to use medial ankle markers. Palpate
and visualize an imaginary line that runs through the transmalleolar a
placement, place a marker on the right and left Medial Malleolus (RTA
Remember to mark that location with eyeliner pencil or a pen. Some us
trial and remove it for the dynamic trials since it can be knocked off.

Ankle Diameter

If a medial ankle marker is not placed, it is critically important to measure the diameter of t
ankle (e.g. the distance between the medial and lateral malleolus) bec
identify the distal end of the shank segment.

Axial Rotation of the Shank

If only lateral tracking markers are used (e.g. lateral knee, lateral sh
rotation of the shank is not tracked reliably.

If the medial ankle, or an anterior tibial tuberosity marker are added a
reliability of the axial rotation of the shank improves substantially.

Foot Markers

The foot is visualized as a line along the long axis of the foot from a
metatarsal heads and the ankle joint center projected onto the planta

The forefoot (toe) marker (RSMH, LSMH) is placed on the dorsal aspe
metatarsal heads proximal to the MP joint (on the mid-foot side of the
and midfoot). Care should be taken in feet with midfoot breakdown or

marker should be proximal to the deformity to avoid exaggerating dors

The heel marker (RCA, LCA) is placed on the calcaneous where the me with the ankle joint center. In a plantargrade foot, the heel marker is plantar surface of the foot as the toe marker. For a non-plantargrade conditions, the height of the heel marker must be placed so that the li viewed from the sagittal plane) is parallel to the plantar surface of th

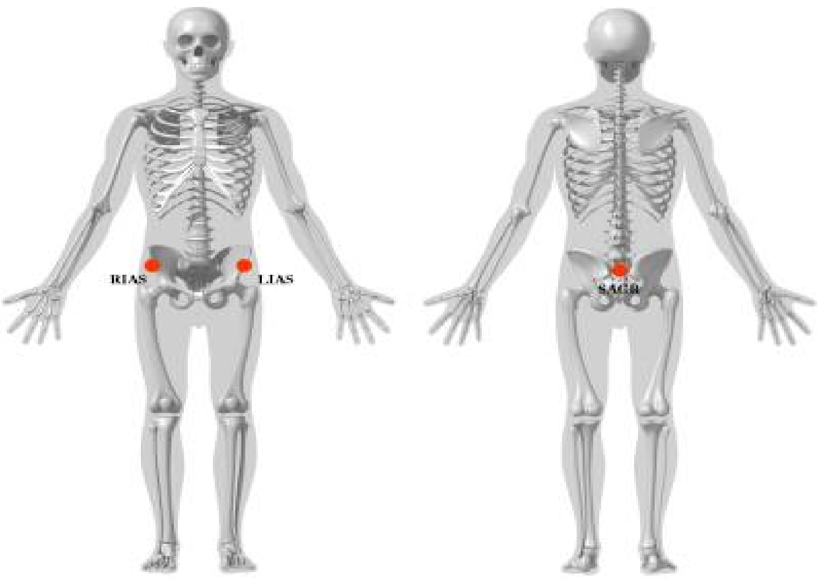
Note that the foot in the Conventional Gait model is not really segmen insuﬃcient information to track the orientation of the segment. For exa inversion/eversion of the foot cannot be measured reliably with the Co Model

Enhancing the Foot Segment

The addition of even one tracking marker that is not colinear (e.g. in the calcaneous and toe marker is suﬃcient to track the foot as a segm an additional marker could be placed on the 5th metatarsal.

If there are 3 tracking markers on the foot segment, it is possible to t inversion-eversion, and inward-outward rotation.

The placement of the calcaneous marker is then very important. The h relative to the height of the toe marker deﬁnes dorsi-plantar ﬂexion in lateral placement of the calcaneous marker is important because the s deﬁned by the calcaneous marker, the toe marker, and the virtual ankl



CA[1](FCC)[2] p. 160 = Posterior Surface of Calcaneus
SMH[1](FM2)[2] p. 160 = Head of 2nd Metatarsus
VMH[1](FM5)[2] p. 160 = Head of 5th Metatarsus

Anthropometric measures necessary for the Co Gait Model

The following table describes the anthropometric measurements that a the Clinical Gait Model. The X represents the needed measurement. clinically measured while others are calculated from the 3D markers o no clinical measurements are entered, then calculated value is used.

Variable	Helen Hayes Pelvis 1	Helen Hayes Pelvis 2	CODA Pelvis	Visual 3D Default Calculations
Height: Remember to account for crouched standing posture.	X	X	X	None
Weight: Weight is measured without shoes or braces	X	X	X	None
Inter-ASIS distance: The three dimensional reconstruction of ASIS markers may be used, but it is often diß cult to place markers on the ASIS on subjects that are overweight. * Clinically Measured ASIS Distance * Calculated ASIS Distance: from 3D distance between ASIS markers * Adjustments for Obese Subjects	X	X	X	3D distance between ASIS markers, but th user can enter a measurement.
Bilateral anteroposterior distance (ASIS to GT): The anteroposterior distance from the ASIS to the greater trochanter. * Clinically ASIS to GT: If there is asymmetry, use the side that appears to be most normal rather than an average. Measure with patient supine. * Calculated from a regression equation: 0.1288*Leg Length-0.04856	X	X		0.1288*Leg Length-0.04856
Bilateral leg lengths: Measured as the distance between the ASIS and the malleolus. * Clinically Measured: should be measured as the distance between the ASIS and the medial malleolus. If the legs are of diß erent lengths, the user should enter the leg length of the more normal leg. * Calculated from: distance from ASIS to Proximal Foot Marker	X	X		*Right Leg length =distance from Right ASIS to Right Proxim Foot Marker *Left Leg length =distance from Left ASIS to Left Proxima Foot Marker *Leg Length =0.5*(Right Leg Length + Left Leg Length)
Width of the bilateral knees: Should be measured at the same level as the markers used to identify the knee ß exion/extension axes.	X	X	X	Knee Width=0.086
Width of the bilateral ankles: Should be measured at the same level as the markers used to identify the ankle plantarß exion/dorsiß exion axes.	X	X	X	Ankle Width=0.056

Width of the foot: Should be measured from the first to the fifth metatarsal. If the foot marker is placed above the third metatarsal, measure the vertical distance from the marker to the center of the foot.	X	X	X	Foot Width	0.056

Conventional Gait Model Construction - 3 exam

This tutorial will not construct every variation of the conventional gai variations of the model.

- Example 1: CODA pelvis, Bell and Brand HJC, no KAD, no medial k 1a,2a,3b,4b,5b
- Example 2: HH pelvis, Davis HJC with ASIS to GT regression, no K markers - Steps: 1b,2c,3b,4b,5b
- Example 3: HH pelvis, Davis HJC with ASIS to GT regression, with markers - Steps: 1b,2c,3a,4b,5a

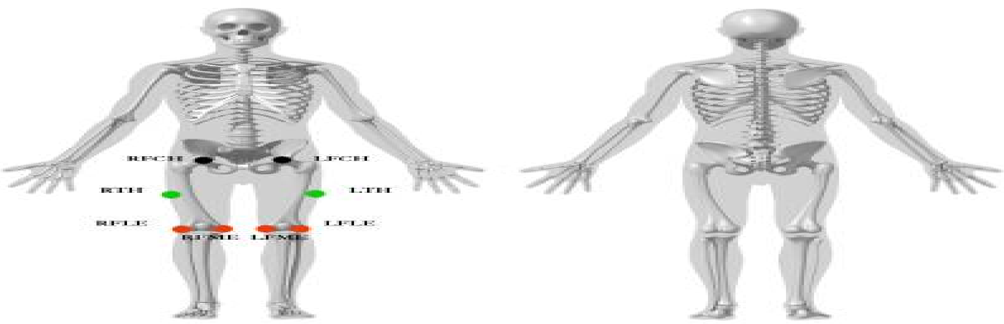
Example 1: with CODA Pelvis - Steps:1a,2a,3b,4b,5b

This section will detail the construction of the following version of the Conventional Gait Example 1 to download the example files.

- CODA pelvis, Bell and Brand HJC, no KAD, no medial knee or ankl 1a,2a,3b,4b,5b

We begin by using the static standing trial.

1. From the Model menu, select Create (Add Static Calibration File)

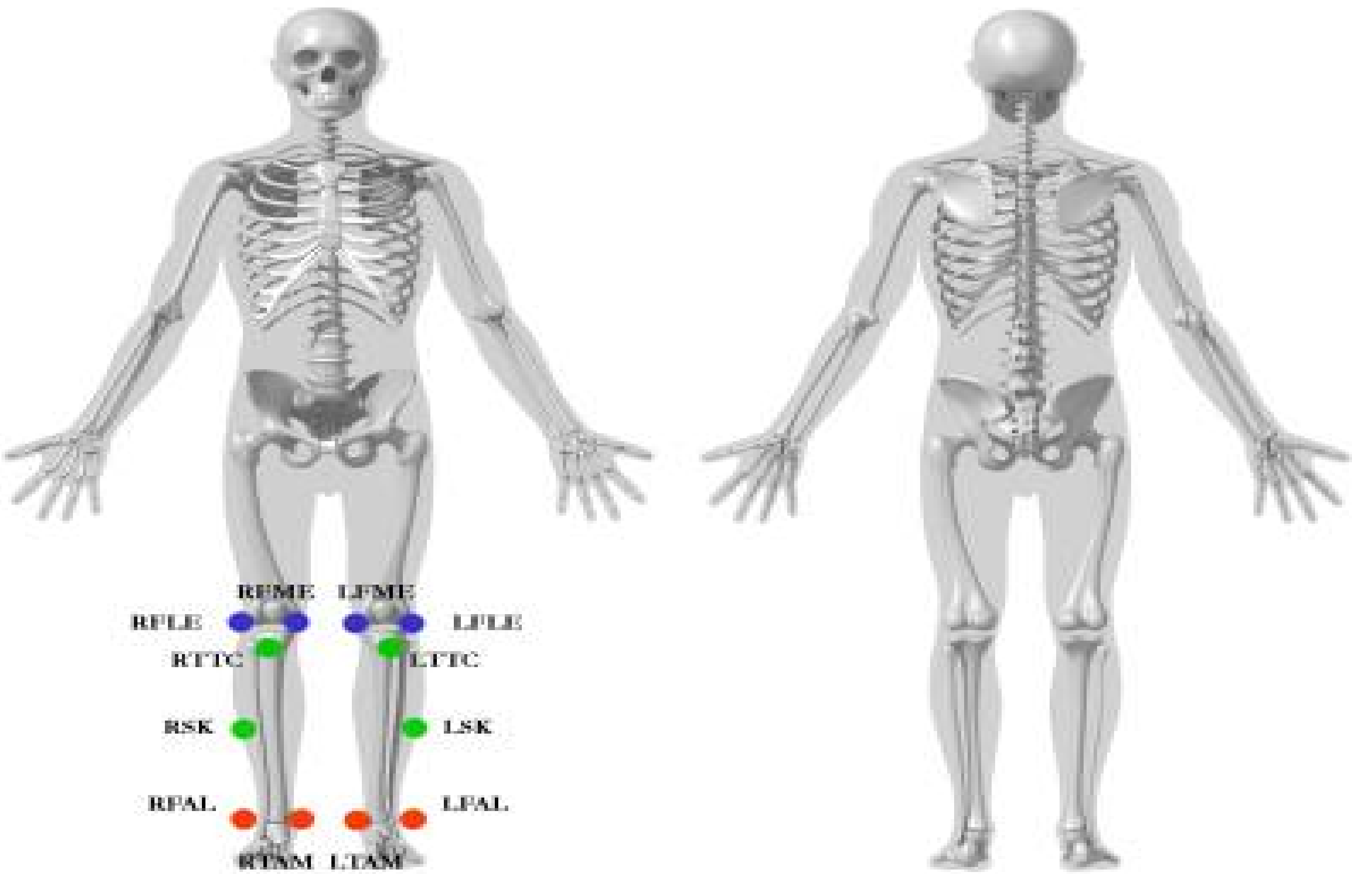


1. Select Hybrid Model from C3DFile
2. A dialog will appear. Select the calibration file for the new model. Select c3d and click Open.
3. Visual3D will switch to Model Building mode automatically. The 3D average value of the marker locations from the standing file. The c screen will contain a list of segments, which by default will contai the Laboratory.

Creating the CODA Pelvis Segment - Step 1a

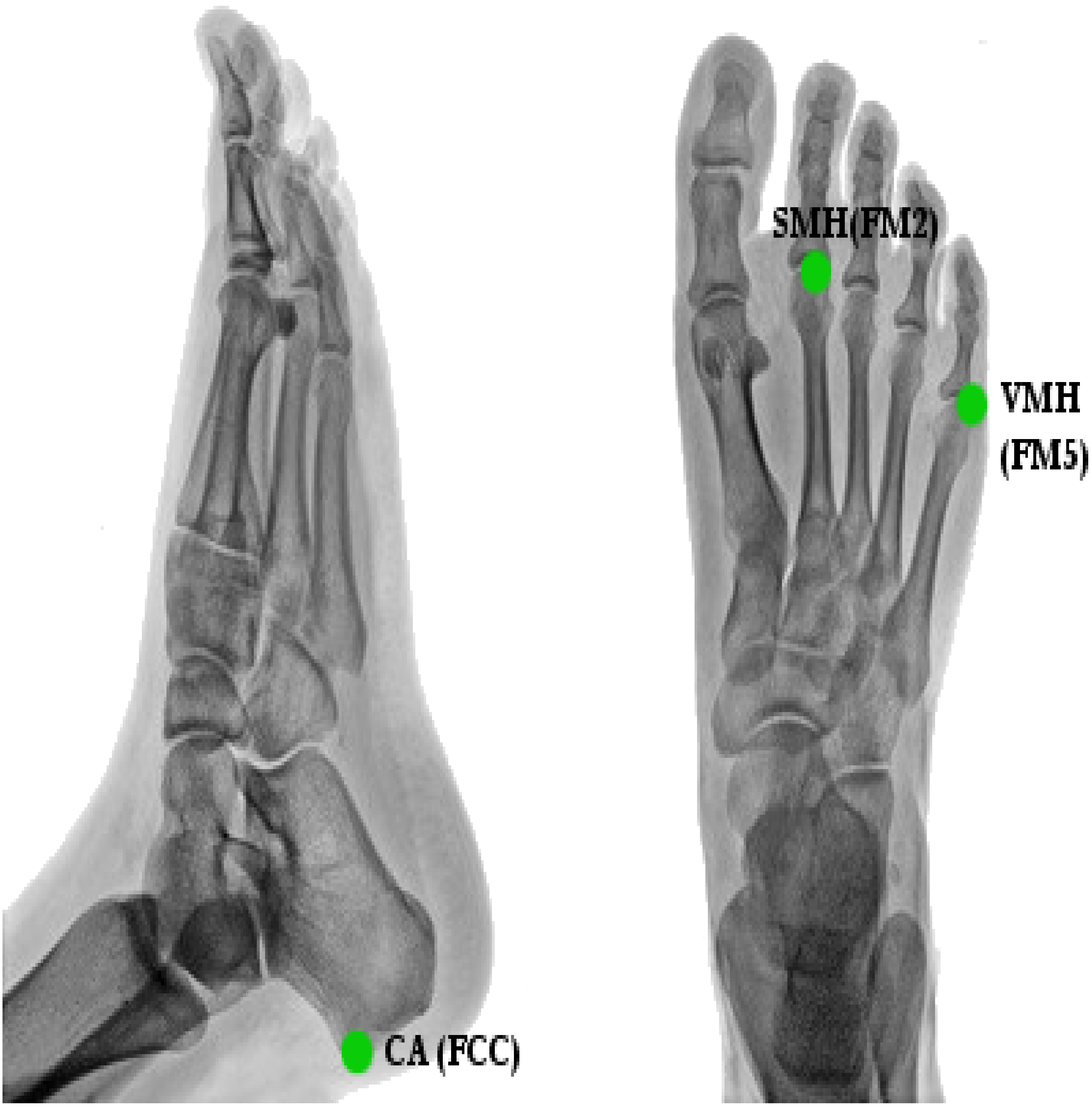
To construct the CODA Pelvis segment:

1. From the **Segment Name** box, select **Pelvis**.
2. From the **Segment Type** box, select **Coda**.
3. Click **Create**.



1. A dialogue box labelled **Enter Body Mass and Height** will open because Visual3D ne
subject to be assigned a mass and a height. For this example, Enter 56 kg and 1.57 m, and click
OK.

1. A dialogue box labelled **CODA Segment Markers** will open. Select the markers so t
correspond to the figure below. Click **Close**.



1. Click Build Model to build the segment. You should now see a pelvis seg model. If you do not see the pelvis segment after clicking Build Model, double check the values you entered in the last step.

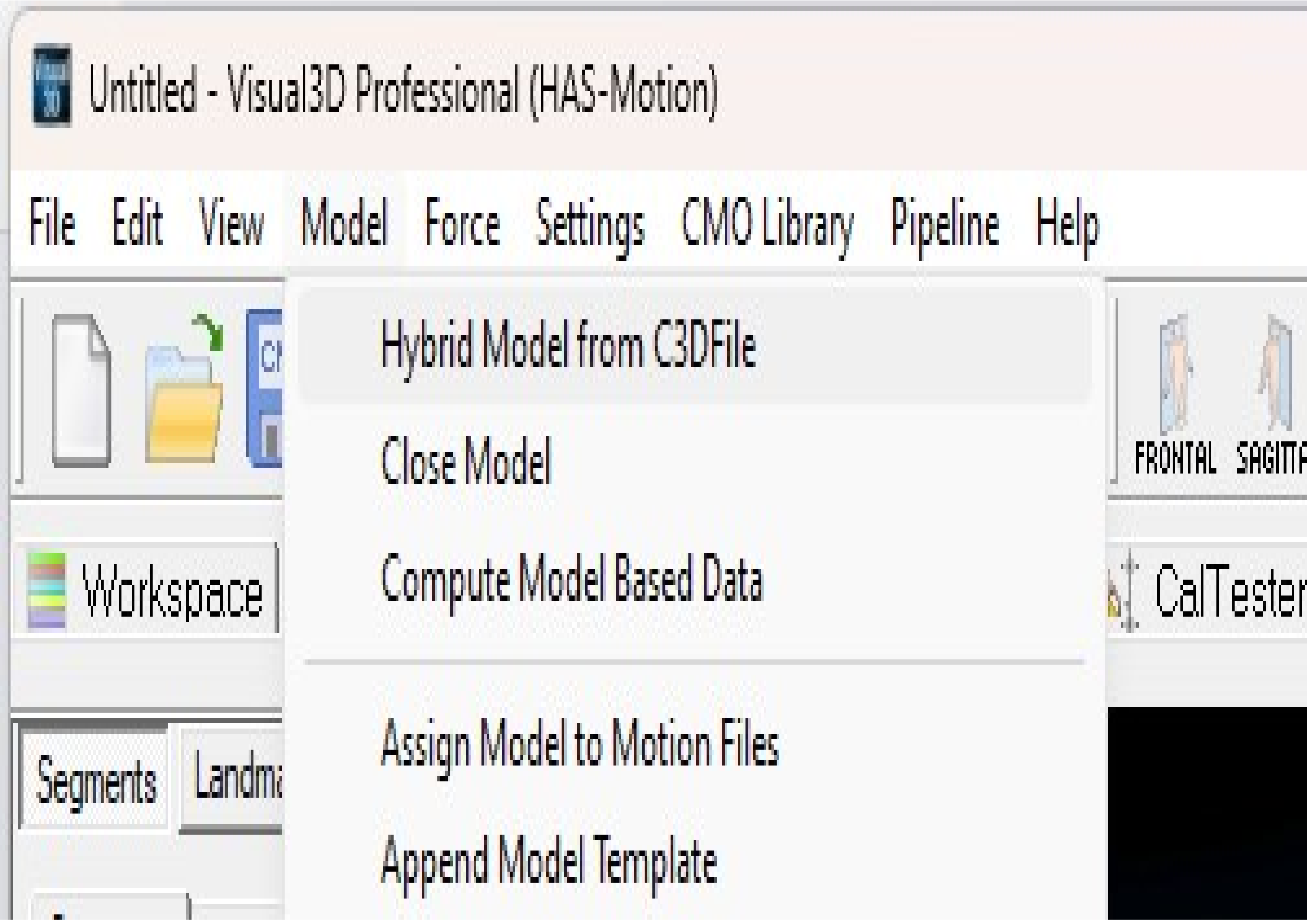
Bell and Brand Hip Joint Center - Step 2a

The hip joint center calculation is based on a regression equation (Be provide estimates of the distance from the pelvic origin to the hip join coordinate system. Inter-ASIS distance is the only measurement that i section describes inter-ASIS distance measurement. It can be clinicall be calculated from the 3D positions of the ASIS markers. No measurem is needed.

The hip joint center regression equation is deßned as:

```
RIGHT_HIP=(0.36*ASIS_Distance,-0.19*ASIS_Distance,-0.3*ASIS_Dist
LEFT_HIP=(-0.36*ASIS_Distance,-0.19*ASIS_Distance,-0.3*ASIS_Dista
```

Estimates for the Right and Left Hip Joint Center are represented as L automatically when the Coda_Pelvis segment is created. To view right and left hip on the Landmarks TAB. In the image below, the Landmarks are shown in blu



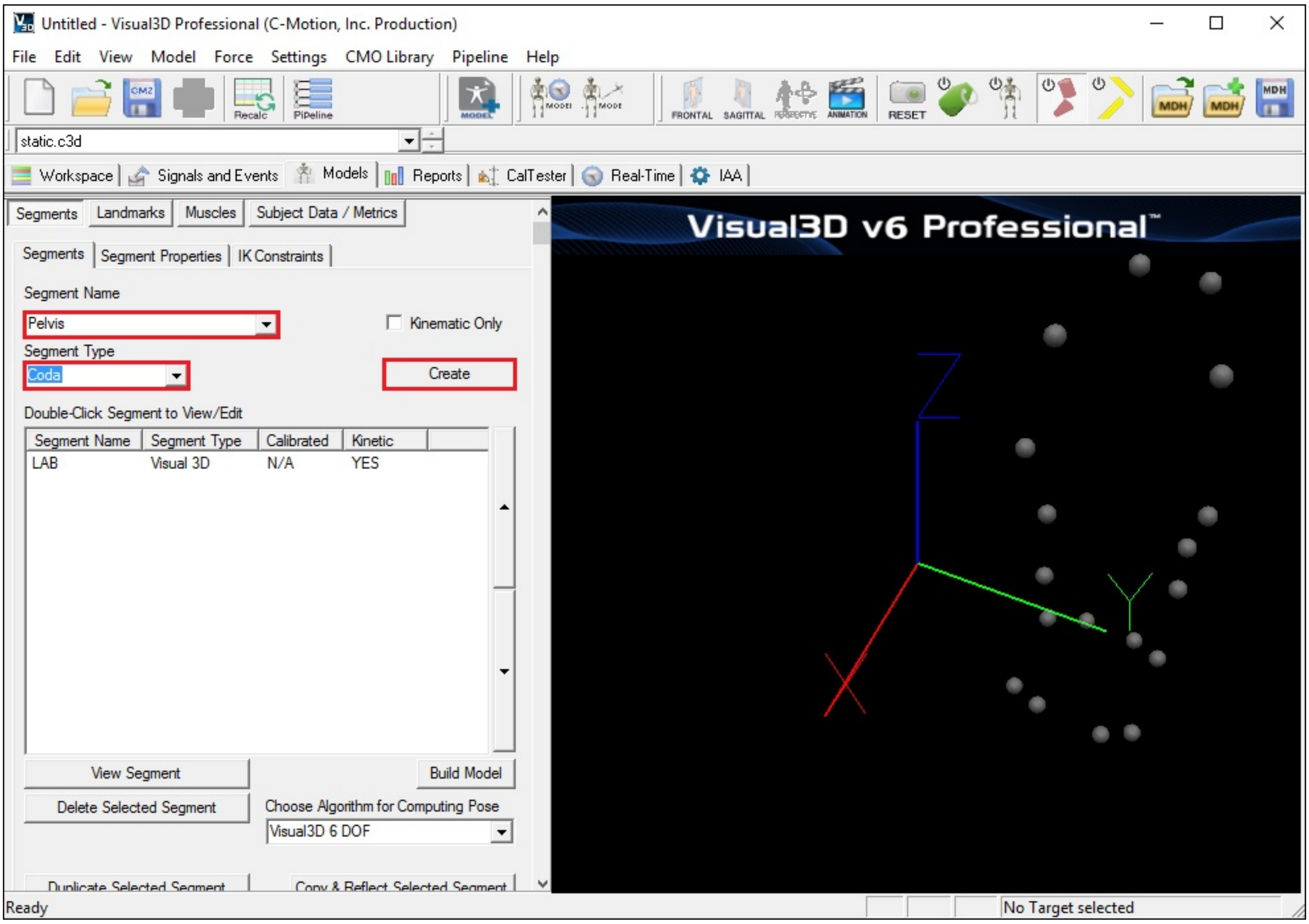
Note: that if the ASIS markers have been placed medial or lateral to t landmark because the subject is obese or because the markers cannot locations, it is important to measure the inter-ASIS distance and ente Subject Data/Metrics TAB. If this is not done, then the hip joint center calcula incorrect.

Enter Subject Measurements

The CODA pelvis does not require direct measurement. However, the c require measurement of knee and ankle width. To enter those measure must create a Subject Data Metric for that measurement.

1. Click on Subject Data/Metrics tab

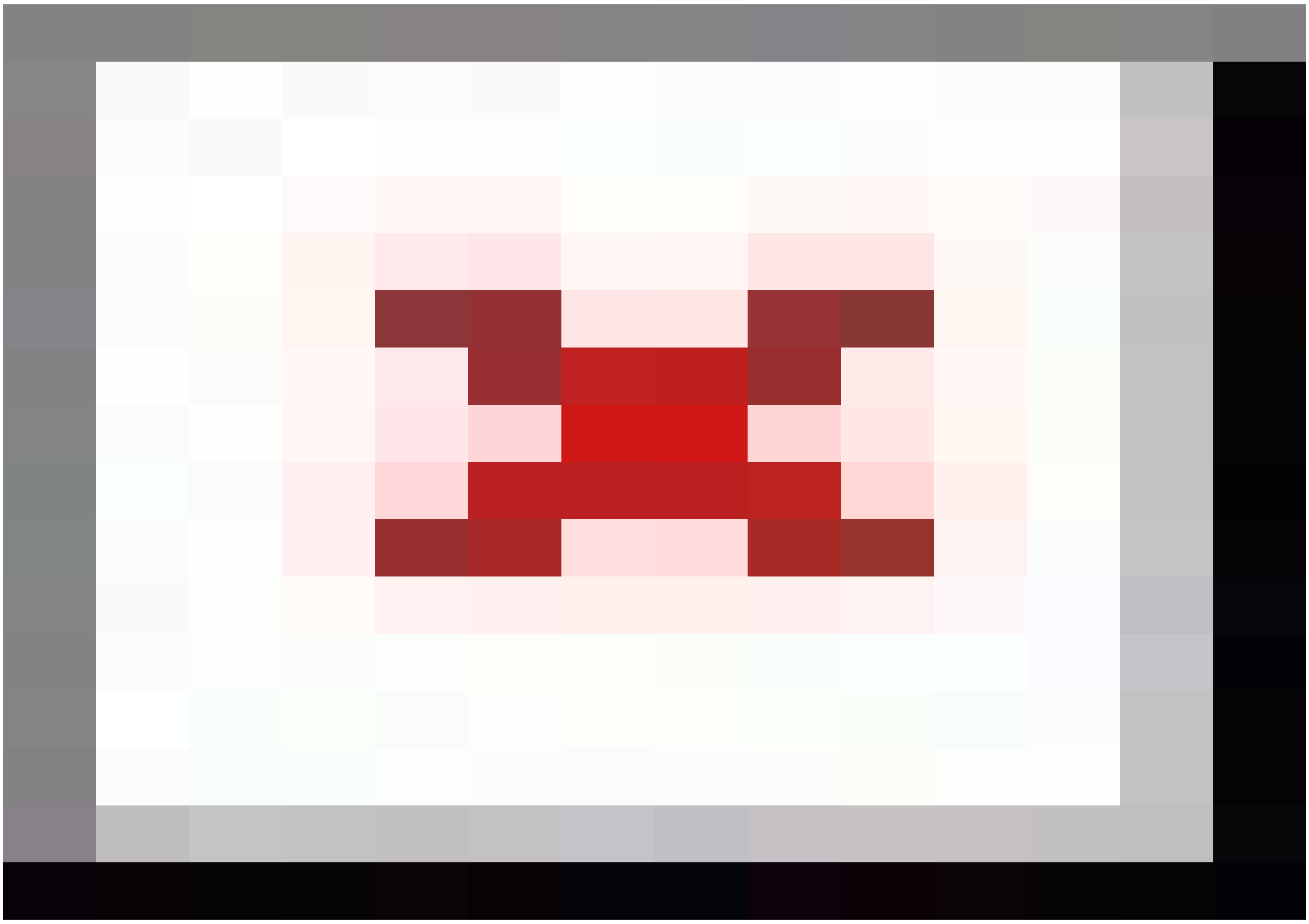
2. Click Add New Item
3. Type RKNEEWIDTH in Name
4. Type 0.099 in Value of Expression
5. Click OK



RKNEEWIDTH should now appear in the list. Using the above steps, contin
subject data metrics:

- LKNEEWIDTH in Name and 0.1 in Value of Expression
- RANKLEWIDTH in Name and 0.066 in Value of Expression
- LANKLEWIDTH in Name and 0.069 in Value of Expression
- MARKER_Radius in Name and 0.012 in Value of Expression

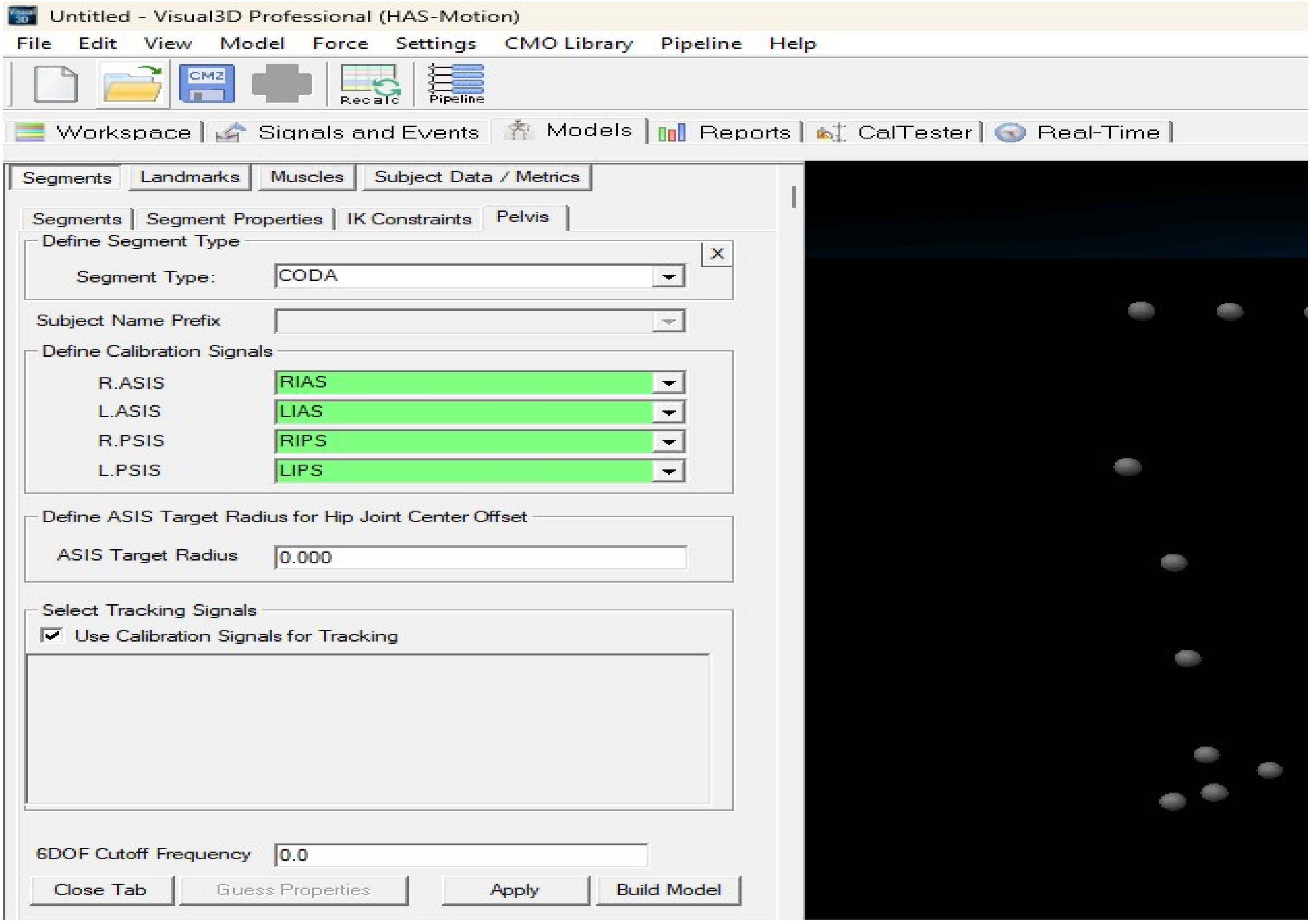
The Subject Data/Metrics should look like the image below.



Create Thigh Segments - Steps 3b and 4b

To create the right thigh segment:

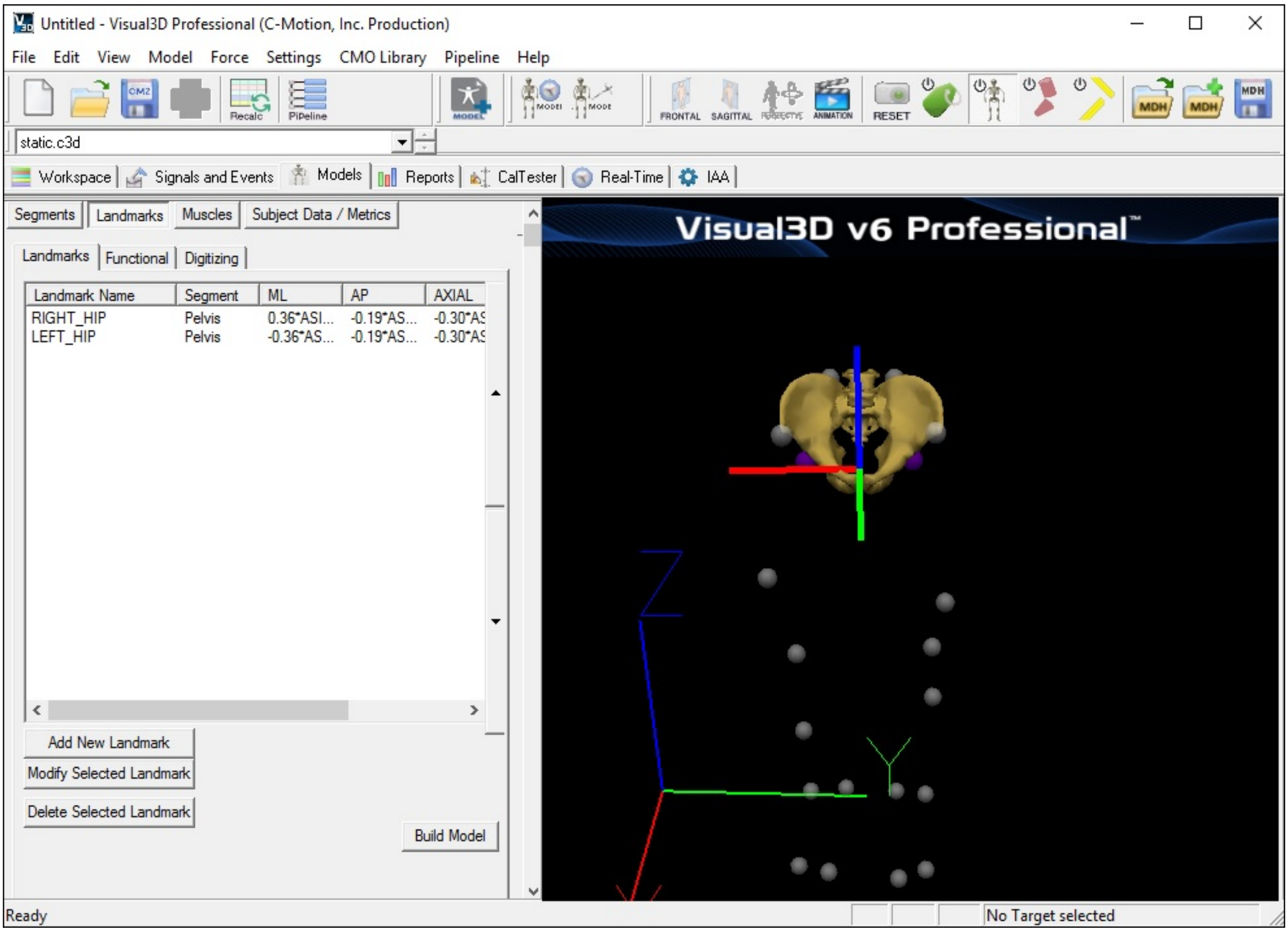
1. Click the **Segments** tab
2. From the **Segment Name** box, select **Right Thigh**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.



A dialog will open that will allow us to define the segment. To create a
the thigh as a geometrical primitive (conical frustrum). The proximal a
must be defined.

1. In the Define Proximal Joint and Radius section, select RIGHT_HIP for the Joint.
2. In the Proximal Radius box, enter 0.089. The proximal radius is the geometrical
   proximal end of the thigh. You can use calipers to measure this or
   measure as one quarter of the distance between the greater trocha
3. In the Define Distal Joint and Radius section, select RFLE for the Lateral.
4. In the Distal Radius box, enter 0.5*RKNEEWIDTH+MARKER_RADIUS
5. In the Extra Target to Define Orientation section, select Lateral for the location and RTH
   for the marker.
6. In the Select Tracking Targets, click RIGHT_HIP, RFLE and RTH
7. Click Build Model

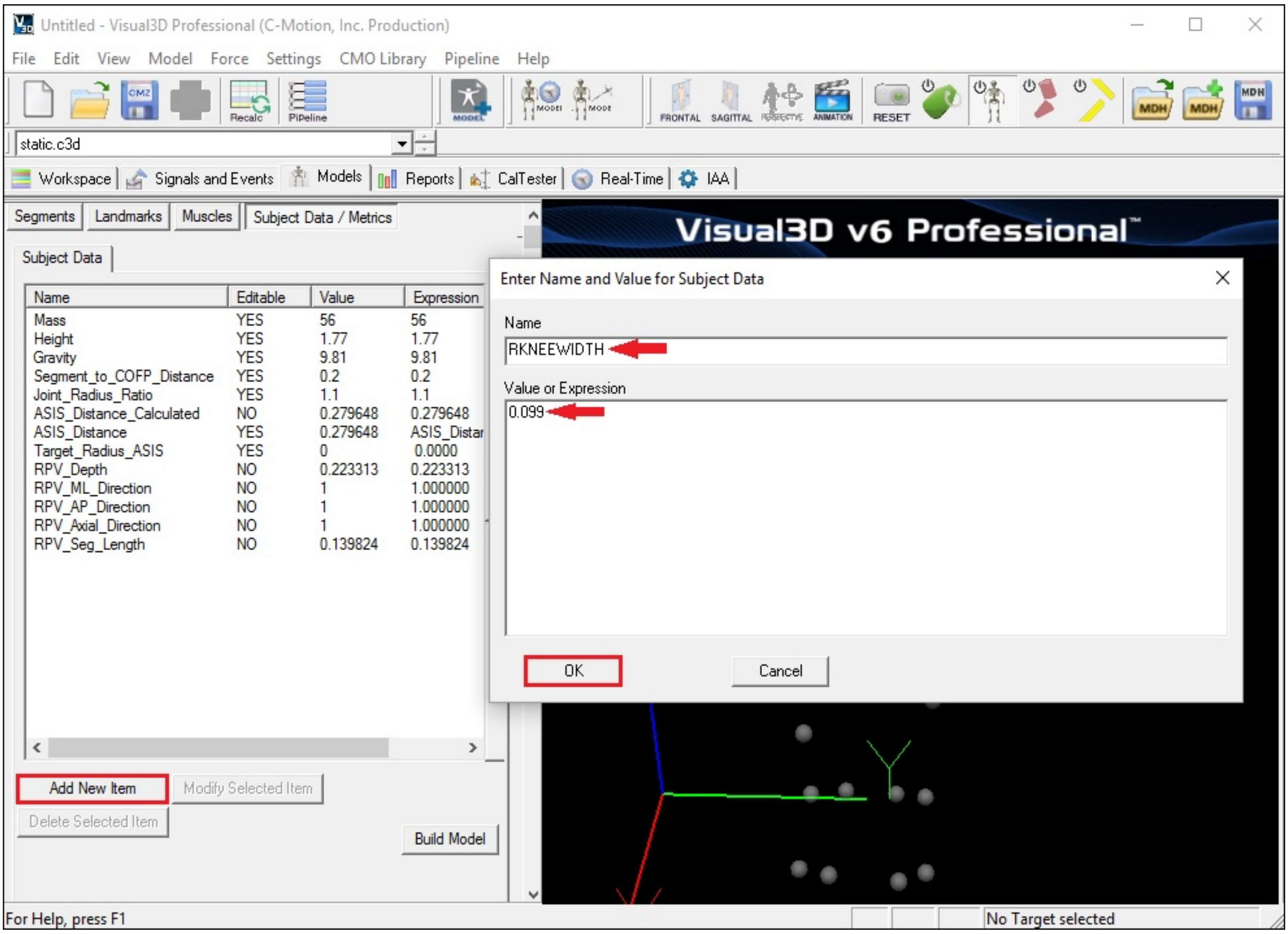
You should now see a thigh segment on your standing model. If you do
after clicking Build Model, double check the values you entered in the



To create the left thigh segment:

1. Click on Close tab
2. From the **Segment Name** box, select **Left Thigh**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.
5. In the **Define Proximal Joint and Radius** section, select **LEFT_HIP** for the Joint.
6. In the **Proximal Radius** box, enter 0.089
7. In the **Define Distal Joint and Radius** section, select **LFLE** for the Lateral.
8. In the **Distal Radius** box, enter 0.5*LKNEEWIDTH+MARKER_RADIUS
9. In the **Extra Target to Define Orientation** section, select **LFLE** for the Location and **LTH** for the marker.
10. In the **Select Tracking Targets**, click on LEFT_HIP, LFLE, and LTH
11. Click **Build Model**

You should now see both thigh segments on your standing model.



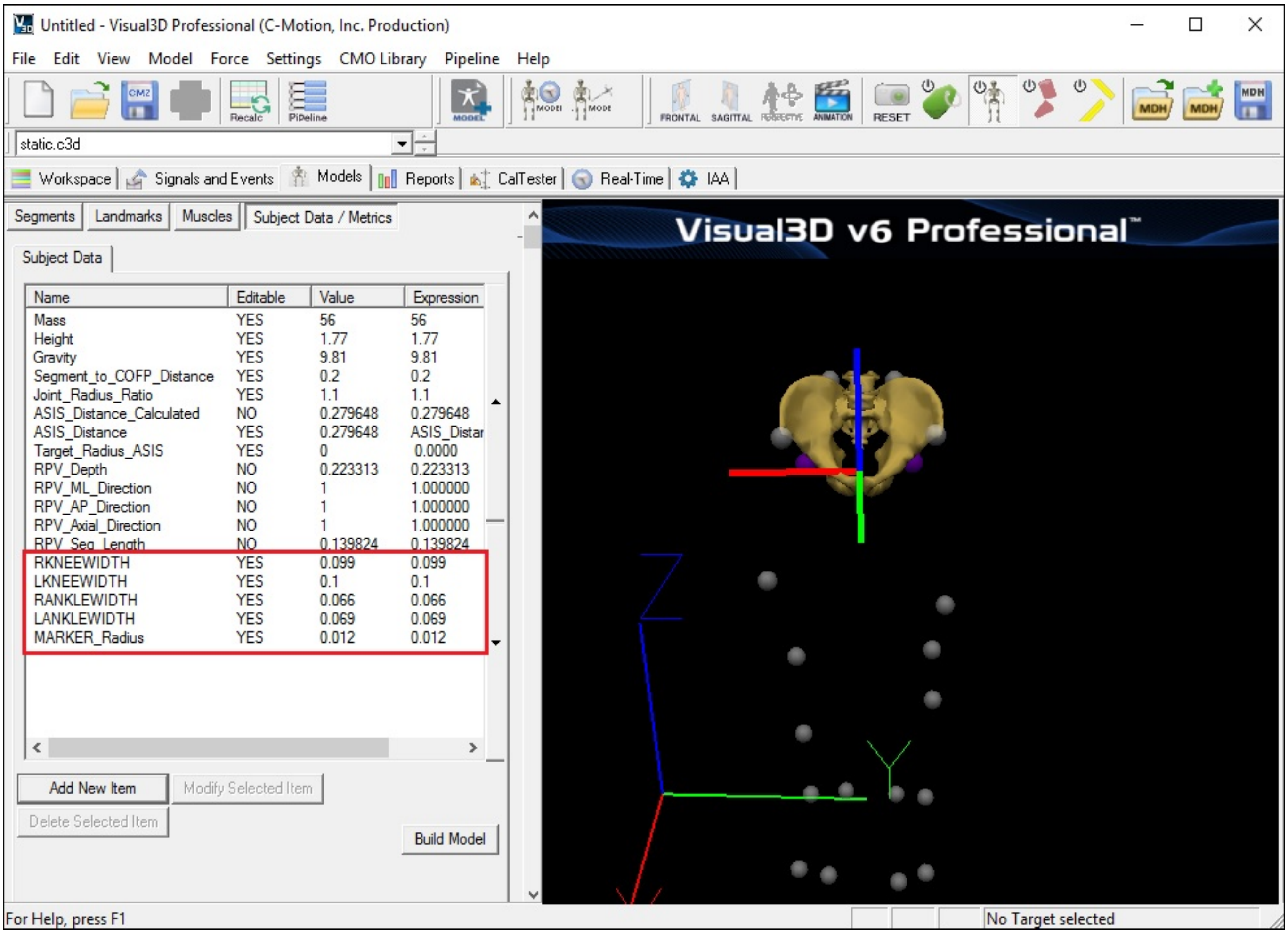
Create Knee Joint Centers

The knee joint center of the Conventional Gait Model is assumed to be tibia. It's location is half the knee width and half a marker diameter m epicondyle marker in the plane of the femoral segment.

When we constructed the thigh segments, we used these calculations t radius. Now we can explicitly define the knee joint center by creating the thigh segment.

To create the right knee joint center landmark:

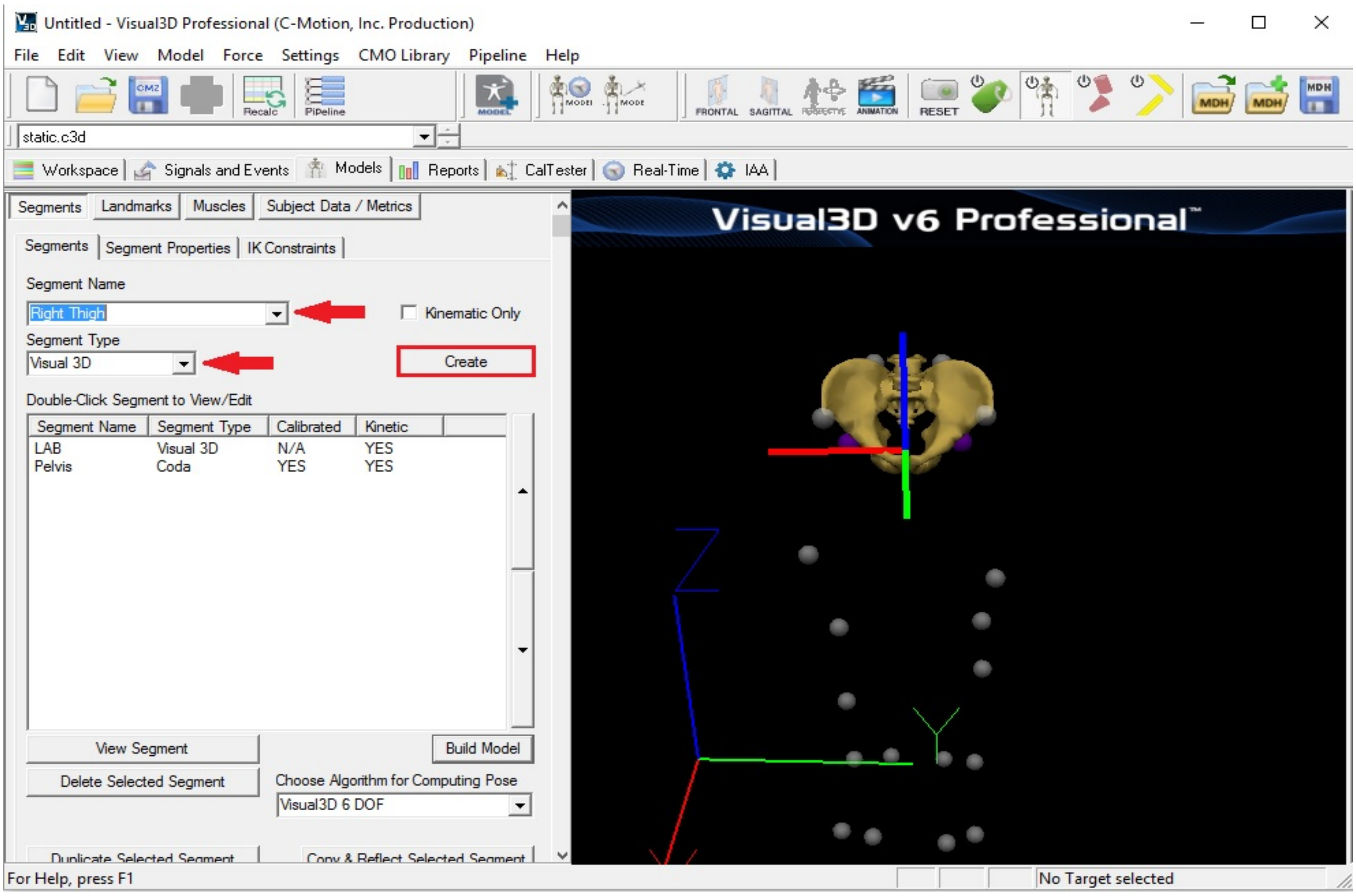
1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter RIGHT_KNEE
4. From the Existing Segment box, select Right Thigh.
5. From the Offset Using the Following AP/ML/Axial Axes, in the Axial text box enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.



To create the left knee joint center landmark:

1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter LEFT_KNEE
4. From the Existing Segment box, select Left Thigh.
5. From the Offset Using the Following AP/ML/Axial Axis, in the ML Axis enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.

In the image below, the Landmarks are shown in blue.



Create Shank Segments - Steps 5b

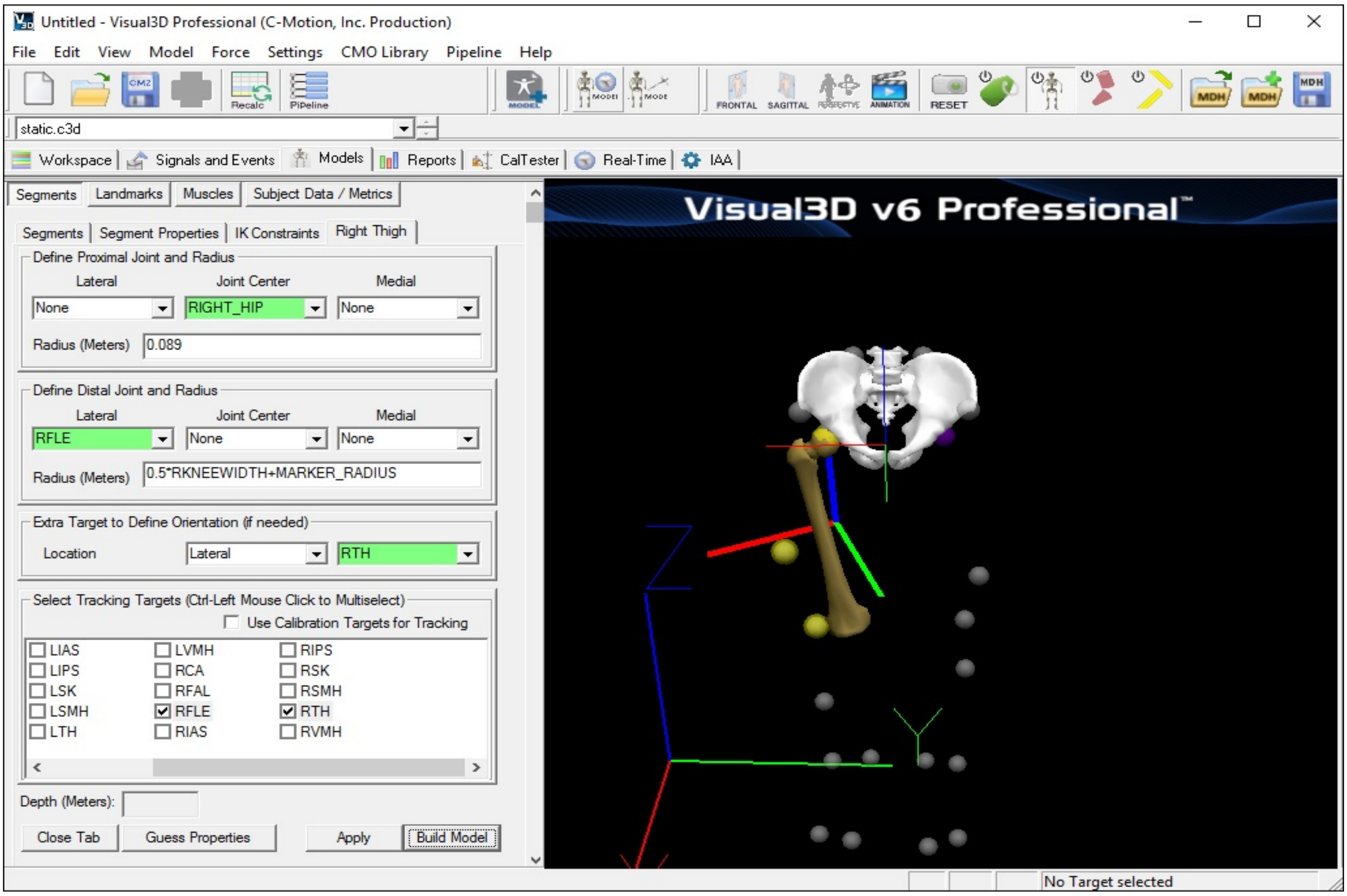
To create the right shank segment:

1. Click Segments tab
2. From the Segment Name box, select Right Shank.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to deﬁne the segment. To create a

1. In the Deﬁne Proximal Joint and Radius select RFLE for the lateral.
2. In the Deﬁne Proximal Joint and Radius select RIGHT_KNEE for the Joint.
3. In the Deﬁne Distal Joint and Radius select RFAL for the lateral.
4. In the Distal Radius box, enter 0.5*RANKLEWIDTH+MARKER_RADIUS
5. In the Select Tracking Targets, click RIGHT_KNEE, RFAL, RFLE, and RSK
6. Click Build Model

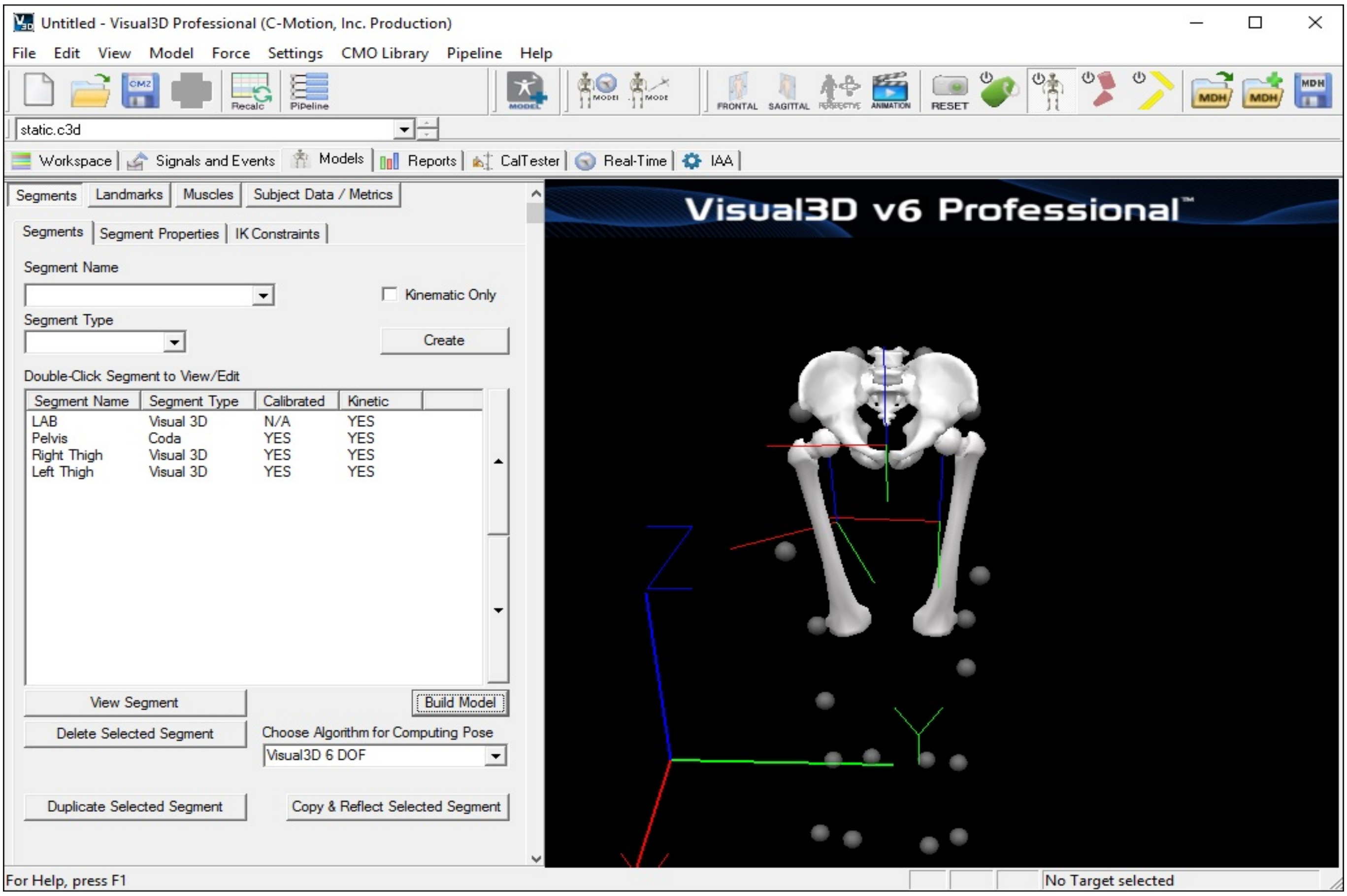
You should now see a shank segment on your standing model. If you d
after clicking Build Model, double check the values you entered in the



To create the left shank segment:

1. Click on Close tab
2. From the Segment Name box, select Left Shank.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius select LFLE for the lateral.
6. In the Define Proximal Joint and Radius select LEFT_KNEE for the Joint.
7. In the Define Distal Joint and Radius select LFAL for the lateral.
8. In the Distal Radius box, enter 0.5*LANKLEWIDTH+MARKER_RADIUS
9. In the Select Tracking Targets, click LEFT_KNEE, LFLE and LSK
10. Click on Build Model

You should now see both shank segments on your standing model.



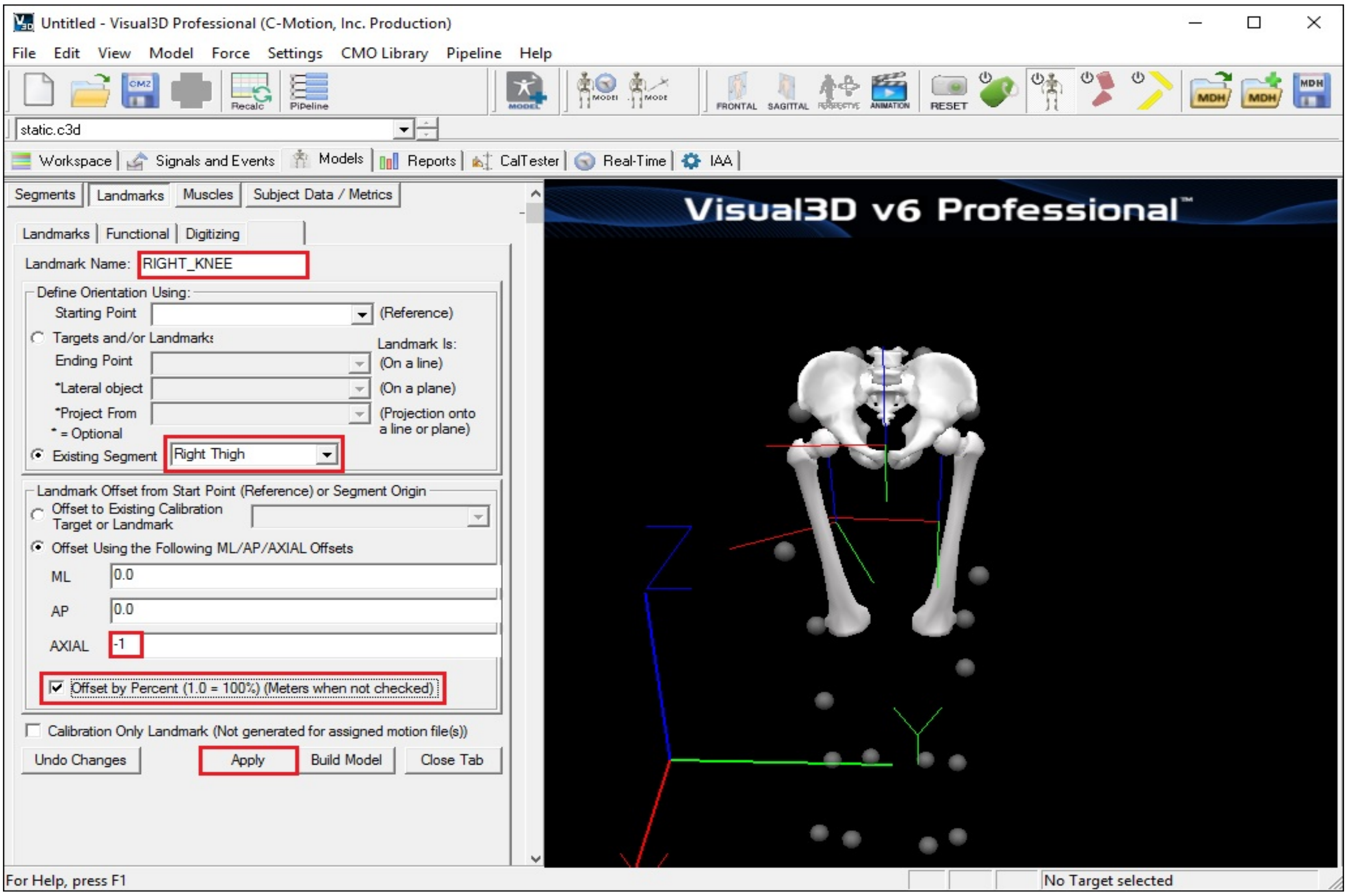
Create Ankle Joint Centers

As with the knee, the ankle joint center is assumed to be fixed in both is half the ankle width and half a marker diameter medial to the cente in the plane of the tibial segment.

When we constructed the shank segments, we used these calculations radius. Now we can explicitly define the knee joint center by creating the thigh segment.

To create the right ankle joint center landmark:

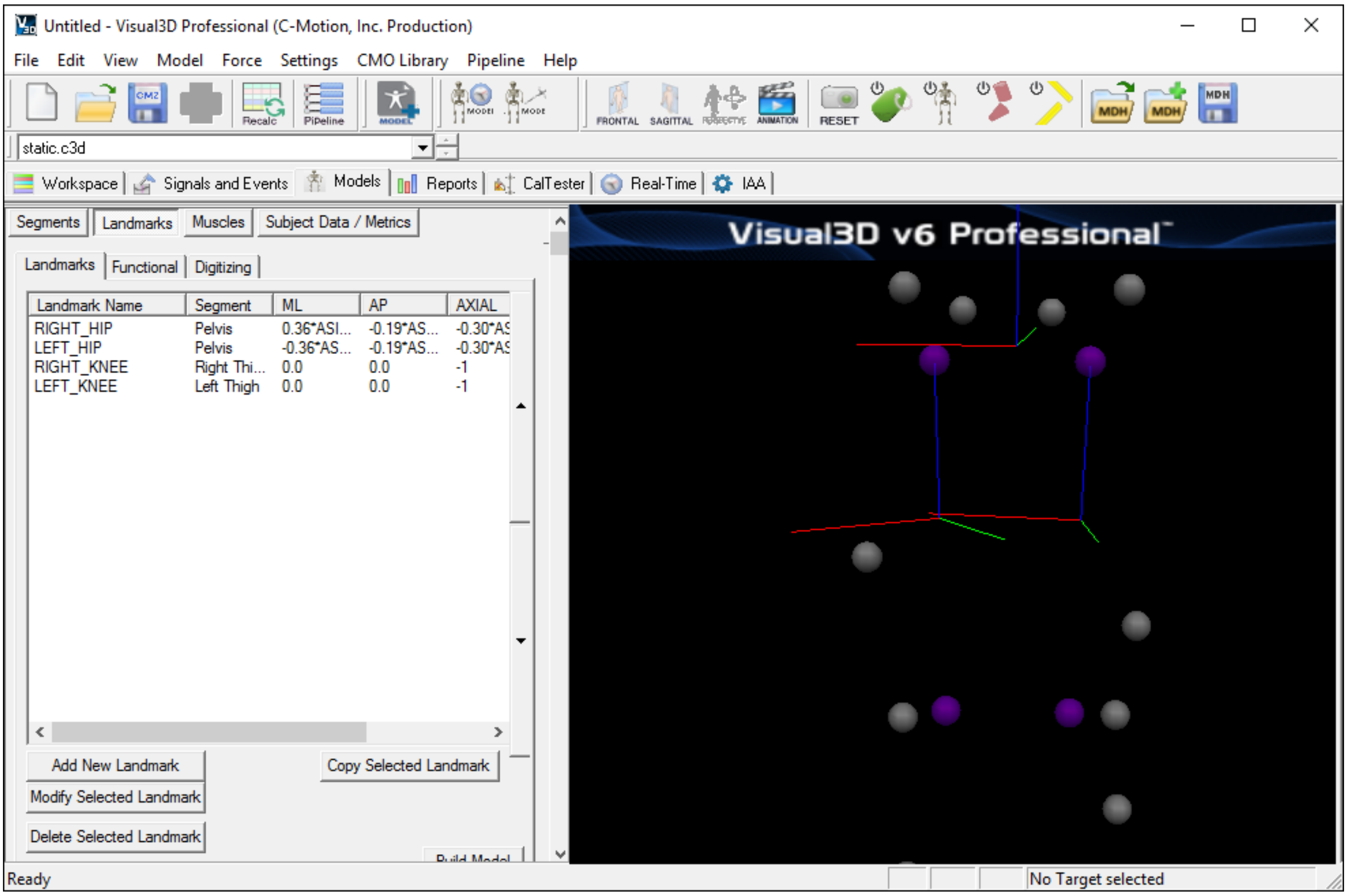
1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter RIGHT_ANKLE
4. From the Existing Segment box, select Right Shank.
5. From the Offset Using the Following AP/ML/Axial box, enter [illegible] 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.



To create the left ankle joint center landmark:

1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter LEFT_ANKLE
4. From the Existing Segment box, select Left Shank.
5. From the Offset Using the Following AP/ML/Axial, in the AXIAL enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.

In the image below, the Landmarks are shown in blue.



Create Foot Segments

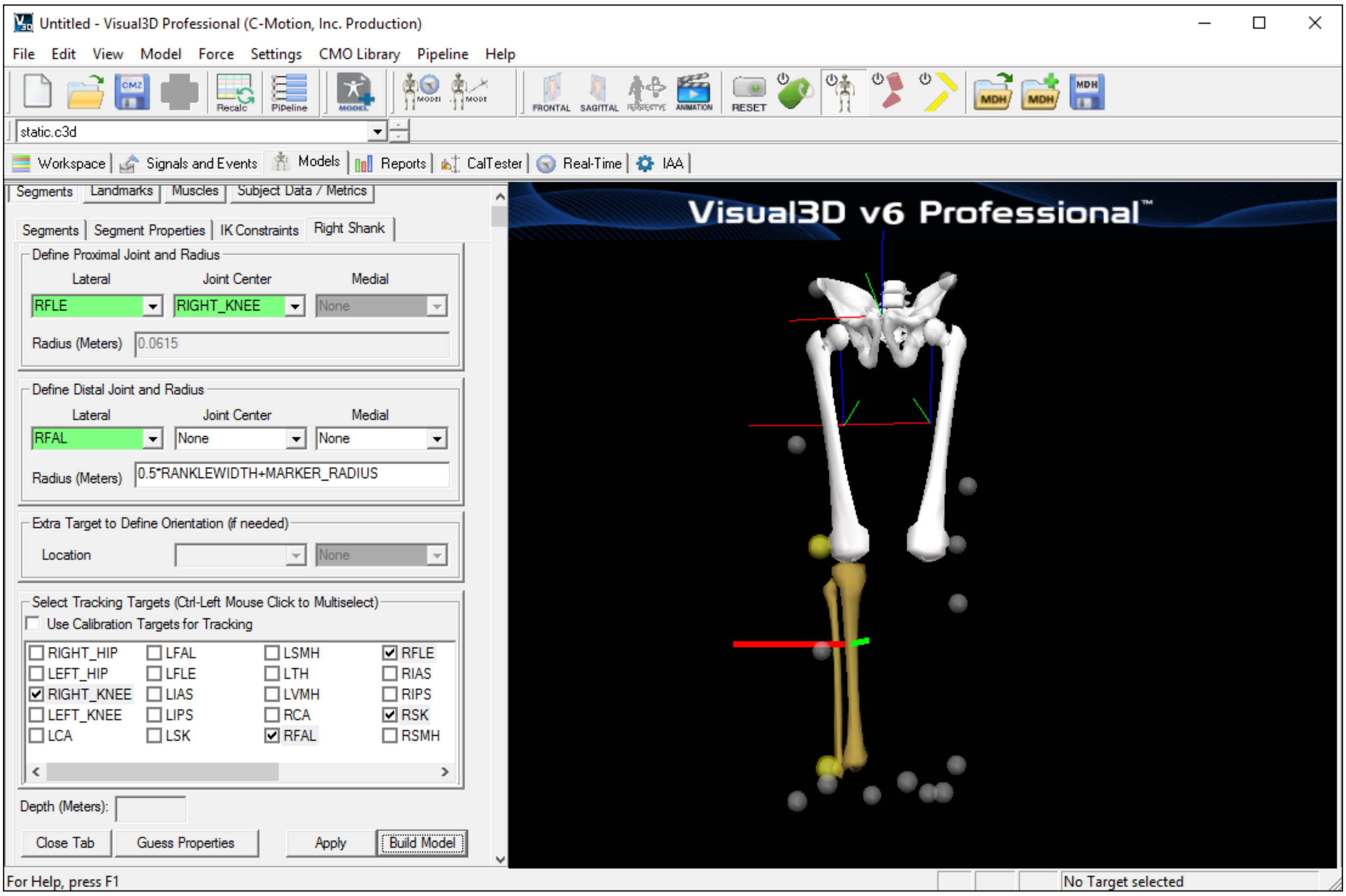
To create the right shank segment:

1. Click Segments tab
2. From the Segment Name box, select Right Foot.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to define the segment. To create a

1. In the Define Proximal Joint and Radius select RFAL for the Lateral.
2. In the Define Proximal Joint and Radius select RIGHT_ANKLE Joint.
3. In the Define Distal Joint and Radius select RSMH for Joint.
4. In the Distal Radius box, enter 0.06
5. In the Select Tracking Targets, pick RIGHT_ANKLE, RFAL and RSMH
6. Click Build Model

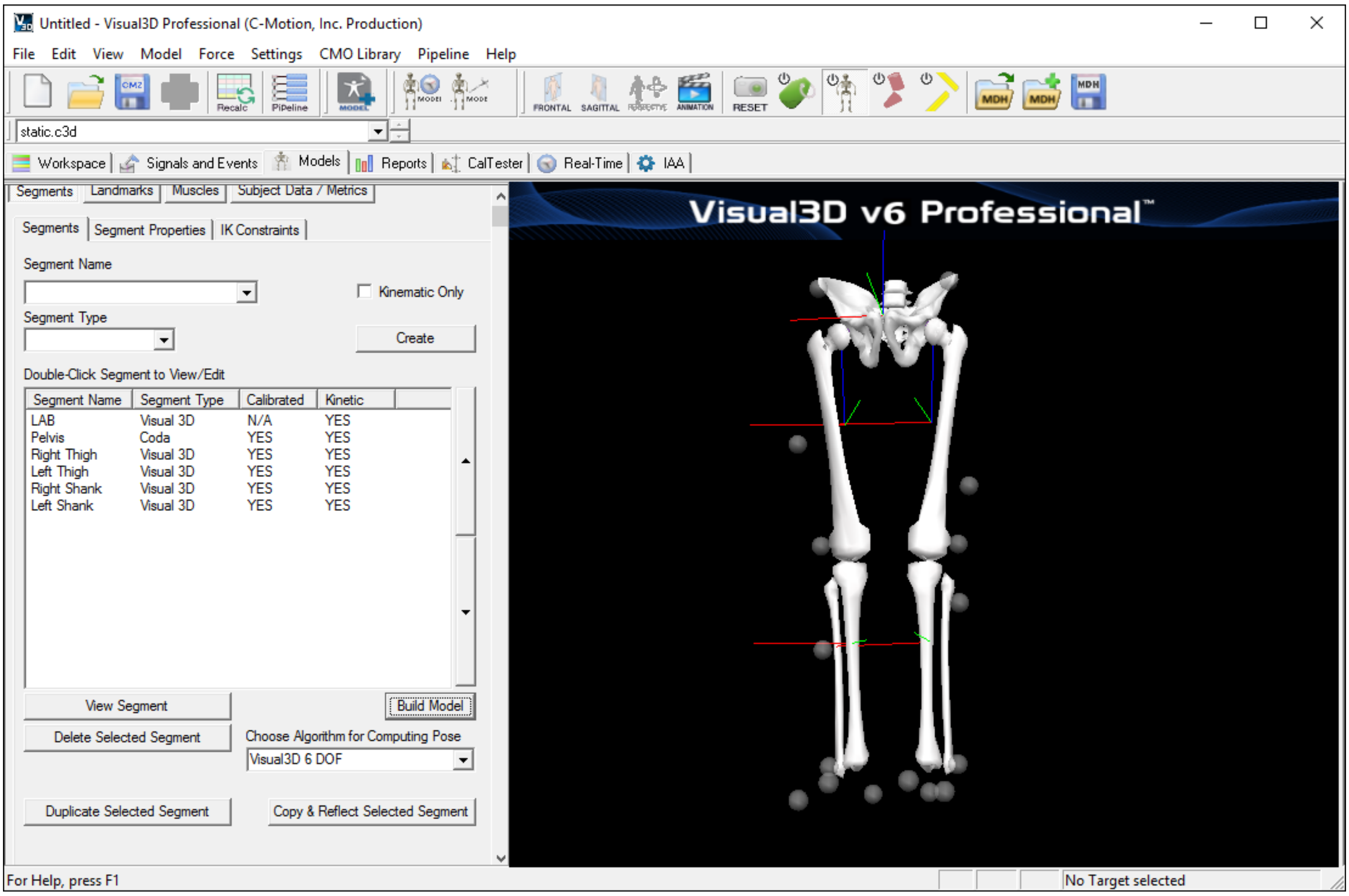
You should now see a foot segment on your standing model. If you do
clicking Build Model, double check the values you entered in the last



To create the left foot segment:

1. Click **Close** tab
2. From the **Segment Name** box, select **Left Foot**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.
5. In the **Define Proximal Joint and Radius** select **LFAL** for the **lateral**.
6. In the **Define Proximal Joint and Radius** select **LEFT_ANKLE** for the **joint**.
7. In the **Define Distal Joint and Radius** select **LSMH** for the **joint**.
8. In the **Distal Radius** box, enter **0.06**
9. In the **Select Tracking Targets**, check **LEFT_ANKLE**, **LFAL**, and **LSMH**
10. Click **Build Model**

You should now see both foot segments on your standing model.



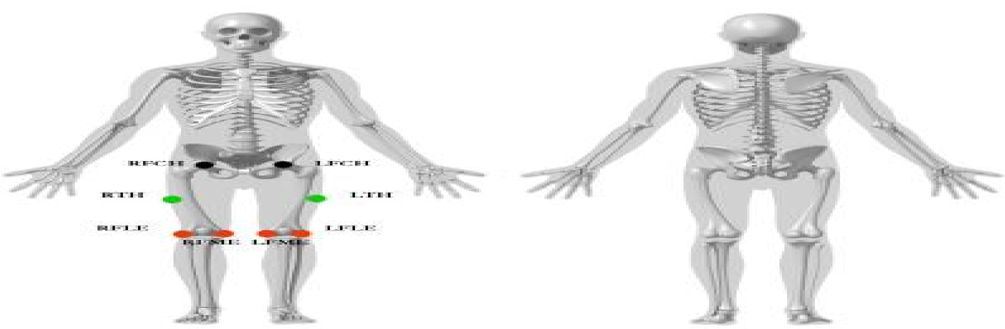
Example 2: with HH pelvis & no KAD - Steps:1b,2c,3b,4b,5b

This section will detail the construction of the following version of the Conventional Gait Example 2] (download example files.

- HH pelvis, Davis HJC with ASIS to GT regression, no KAD, no med
  Steps: 1b,2c,3b,4b,5b

We begin constructing the Conventional Gait Model by using the static

1. From the Model menu, select Create (Add Static Calibration File)



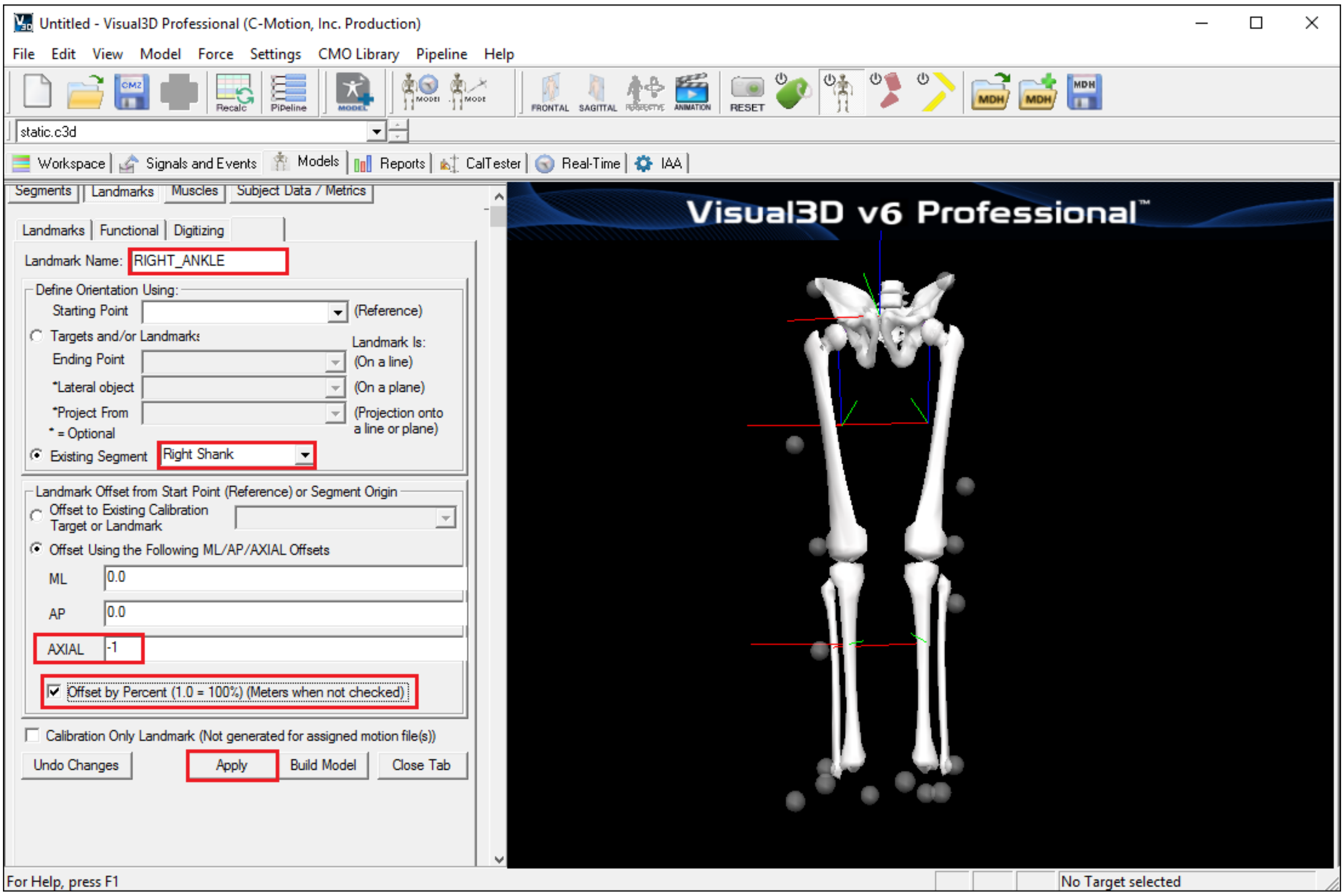
1. Select Hybrid Model from C3DFile
2. A dialog will appear. Select the calibration file for the model. Select Static no KAD Trial.c3d and click Open.

1. Visual3D will switch to Model Building mode automatically. The 3D
average value of the marker locations from the standing file. The
screen will contain a list of segments, which by default will contai
the Laboratory.

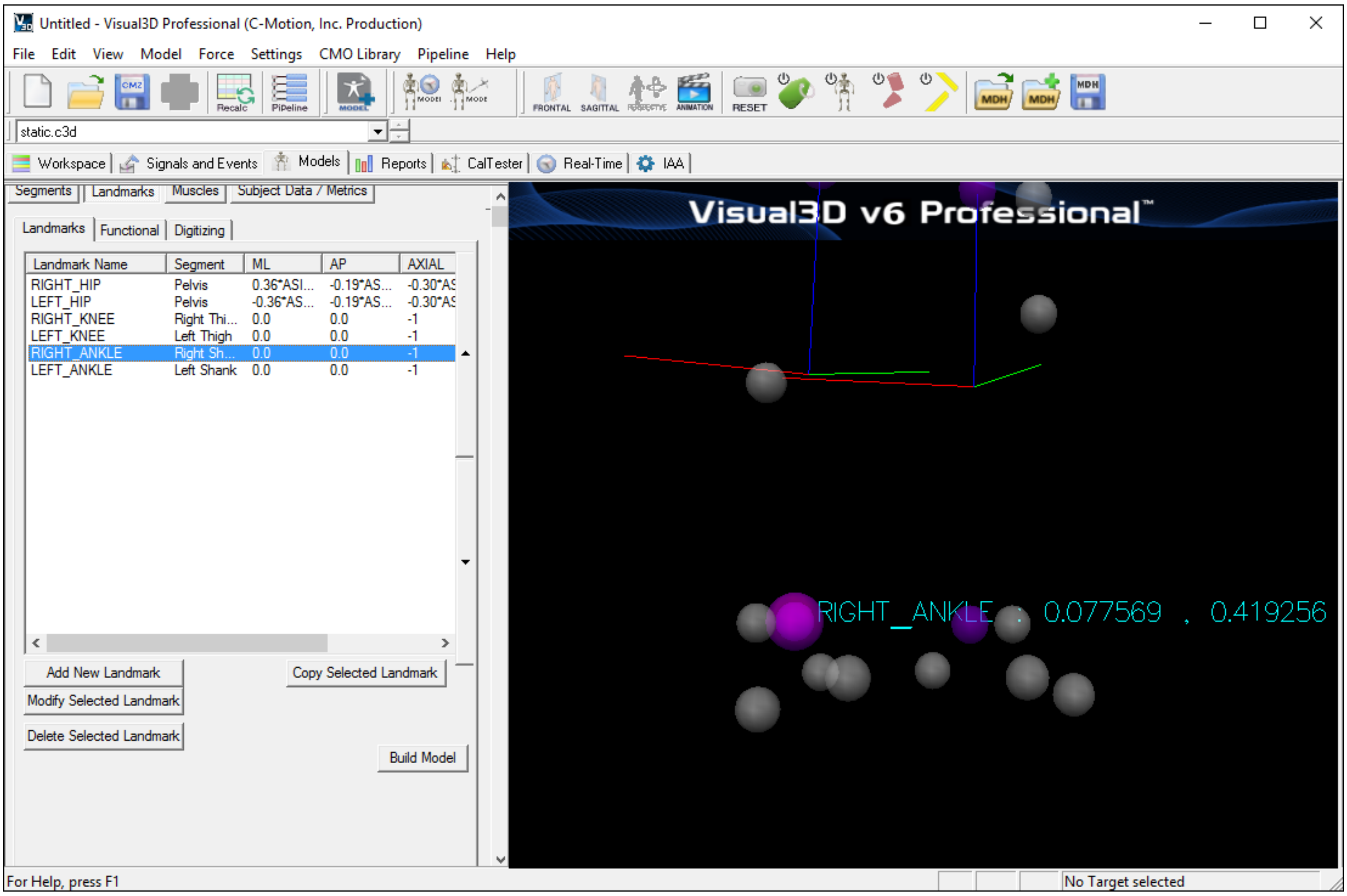
Creating the HH Pelvis Segment - Step 1b

To construct the HH Pelvis (Davis) segment:

1. From the **Segment Name** box, select **Pelvis**.
2. From the **Segment Type** box, select **Helen Hayes**.
3. Click **Create**.



1. A dialogue box labeled **Body Mass and Height** will open because Visual3D ne
subject to be assigned a mass and a height. For this example, enter 56 kg and 1.77 m, and click
OK.
2. A dialogue box labeled **Helen Hayes/Derived Segment Markers** will open. Select the
markers so that they correspond to the Figure below. Click



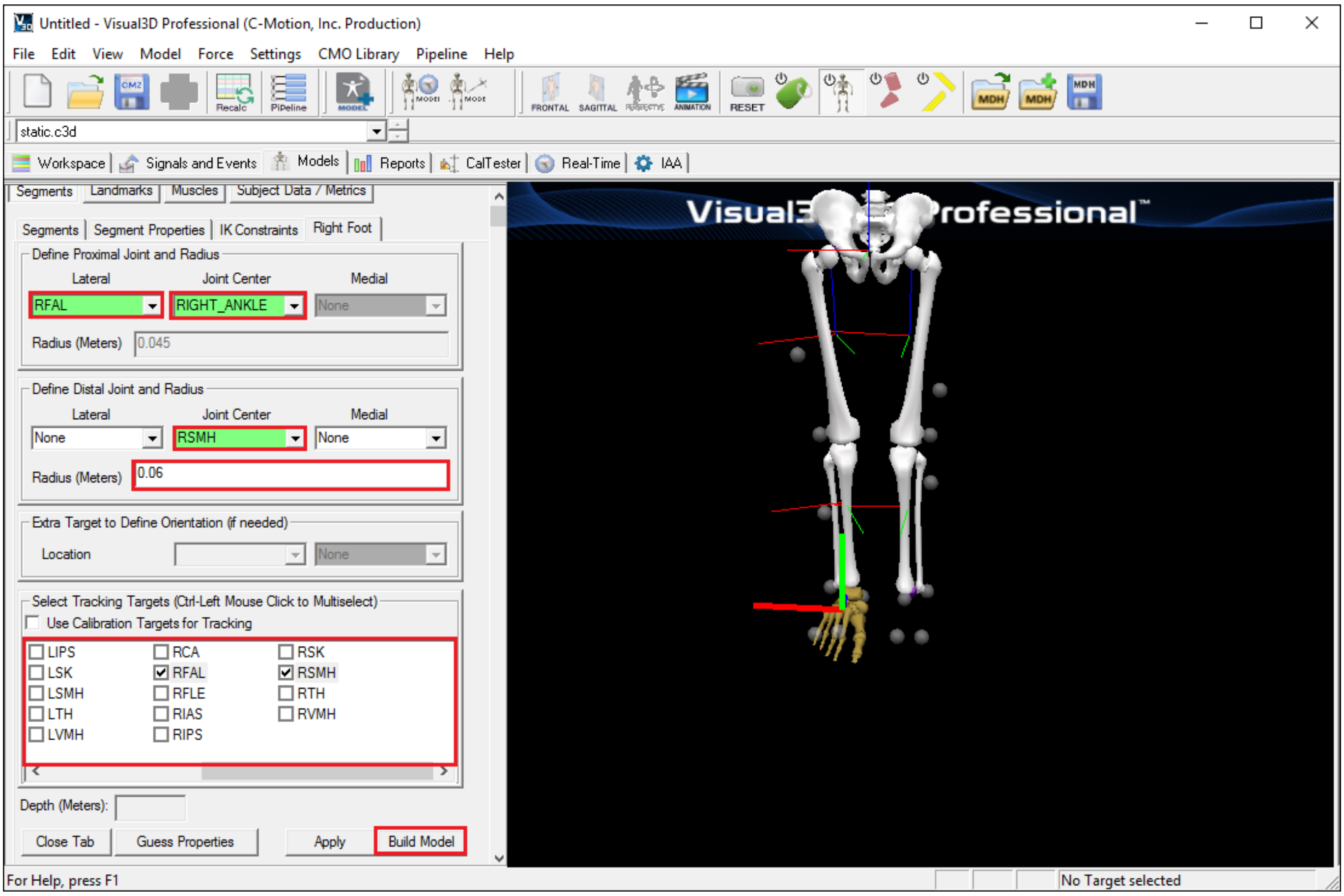
1. Click Build Model to build the segment. You should now see a pelvis seg
model. If you do not see the pelvis segment after clicking Build Model, double check the values you entered in the last step.

Enter Subject Measurements

When Visual 3D creates the HH Pelvis, Subject Data/Metrics are created for the model. Sin
hip joint center calculation for HH Pelvis model is based on inter-ASIS
GT distance, these values need to be entered in the Subject Data/Metrics tab. In addition, kn
and ankle width Subject Data/Metrics need to be created and entered.

Enter the values by selecting Modify Selected for each of the items below:

1. Enter 0.950m for HH_Right_Leg_Length
2. Enter 0.950m for HH_Left_Leg_Length



1. In this example, the values for inter-ASIS distance will be calcula
positions of the ASIS's and the ASIS to GT distance will be calcul
equation. There is no need to enter or change values for these var
distance is not entered, Visual 3D defaults to the calculated varia
2. Click **Build Model** to build the segment. The hip joint centers should now
properly. For further disussion on the hip joint center calculations
Calculations section.

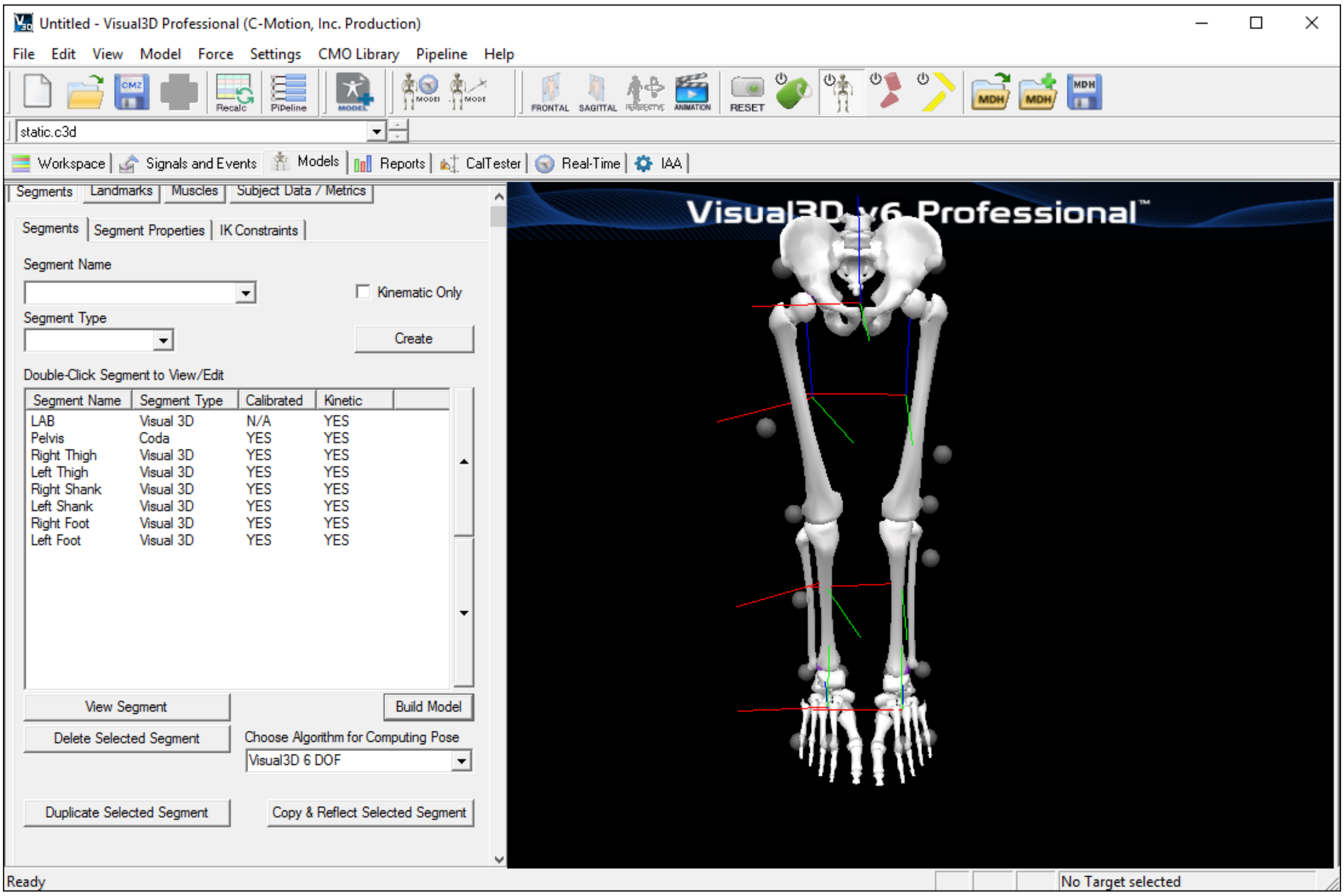
To add Knee and Ankle width:

1. Click **Add New Item**
2. Type **Right_Knee_Width** in **Name**
3. Type **0.110** in **Value of Expression**
4. Click **OK**

Using the above steps, continue to enter the following subject data me

- **Left_Knee_Width** and **0.110** in **Value of Expression**
- **Right_Ankle_Width** and **0.080** in **Value of Expression**
- **Left_Ankle_Width** and **0.080** in **Value of Expression**

The Subject Data/Metrics should look like the image below.



HJC Regression Without Clinical Measurement of ASIS to GT (Davis 1991)

The hip joint center calculation is based on a regression equation (Da
estimates of the distance from the pelvic origin to the hip joint center
system. Measurements of leg length, anteroposterior ASIS to Greater
ASIS distance are needed. The anthropometric section describes the m
inter-ASIS distance.

If no clinical measurement of anteroposterior distance between the AS
taken, then the equation below will be used:

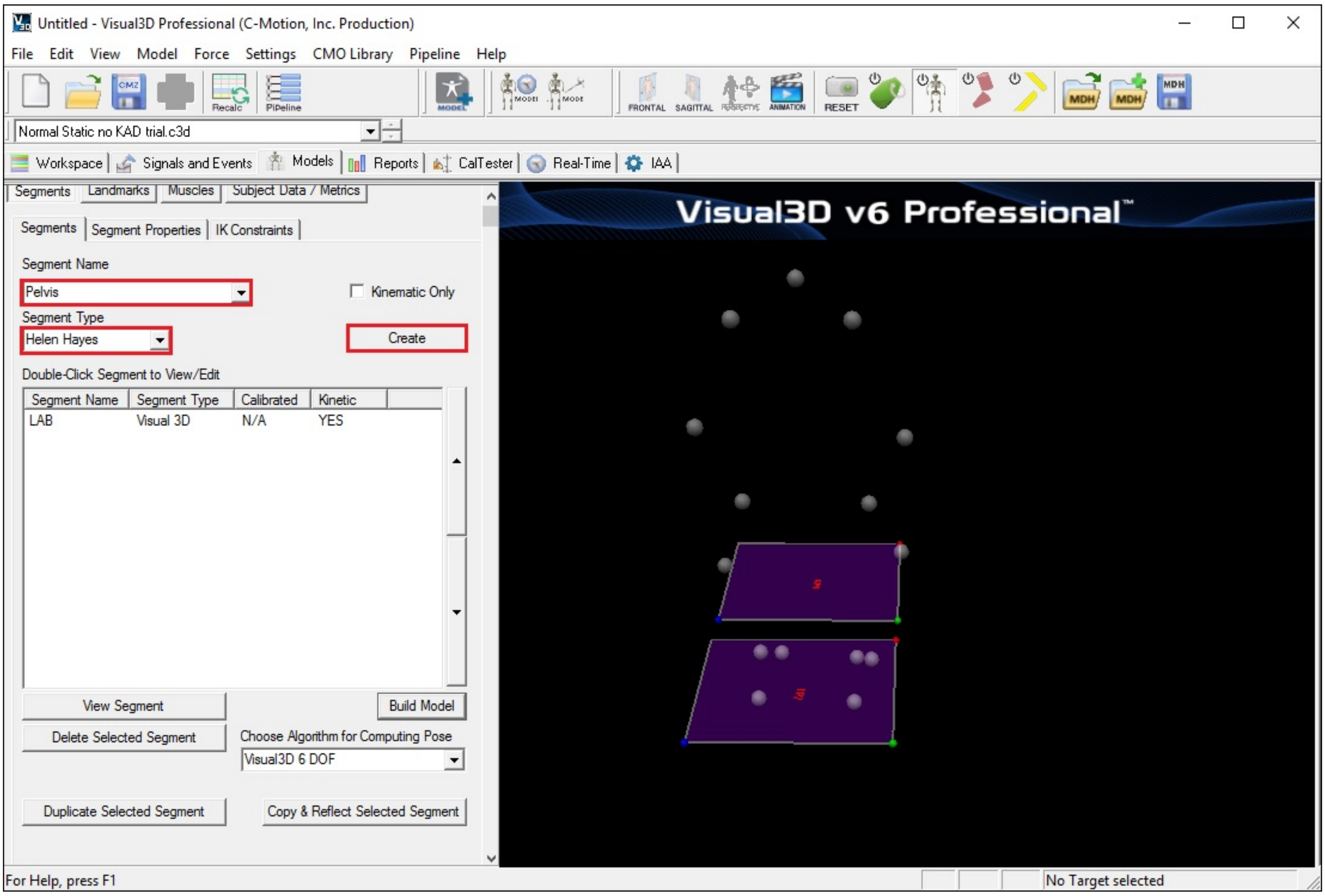
```
Bilateral anteroposterior distance= 0.1288*Leg Length-0.04856
```

The regression equation is follows:

```
Hip X = -S (C sin(theta)-0.5*distASIS)
Hip Y = (-Xdis-Rmarker) cos(beta)+ C cos(theta) sin(beta)
Hip Z = (-Xdis-Rmarker) sin(beta)- C cos(theta) cos(beta)

Where:
C = 0.115*LegLength - 0.0153 (in meters)

theta = 28.4*PI/180.0
```

```
beta = 18.0*PI/180.0

distASIS = ASIS to ASIS distance, measured during clinical exam

Xdis = anterior/posterior component of the ASIS/hip center distance i
sagittal plane of the
       pelvis and measured during the clinical exam

If Xdis not measured:
 Xdis = 0.1288*LegLength - 0.04856

Rmarker = marker Radius (in meters)

S = +1 for the right side and -1 for the left side
```

Estimates for the Right and Left Hip Joint Center are represented as L automatically when the Helen Hayes (Davis) Pelvis segment is created. To view right and centers, click Landmarks TAB. In the image below, the Landmarks are sho



Note: that if the ASIS markers have been placed medial or lateral to t landmark because the subject is obese or because the markers cannot locations, it is important to measure the inter-ASIS distance and ente Subject Data/Metrics TAB. If this is not done, then the hip joint center calcula incorrect.

Create Thigh Segments - Steps 3b and 4b

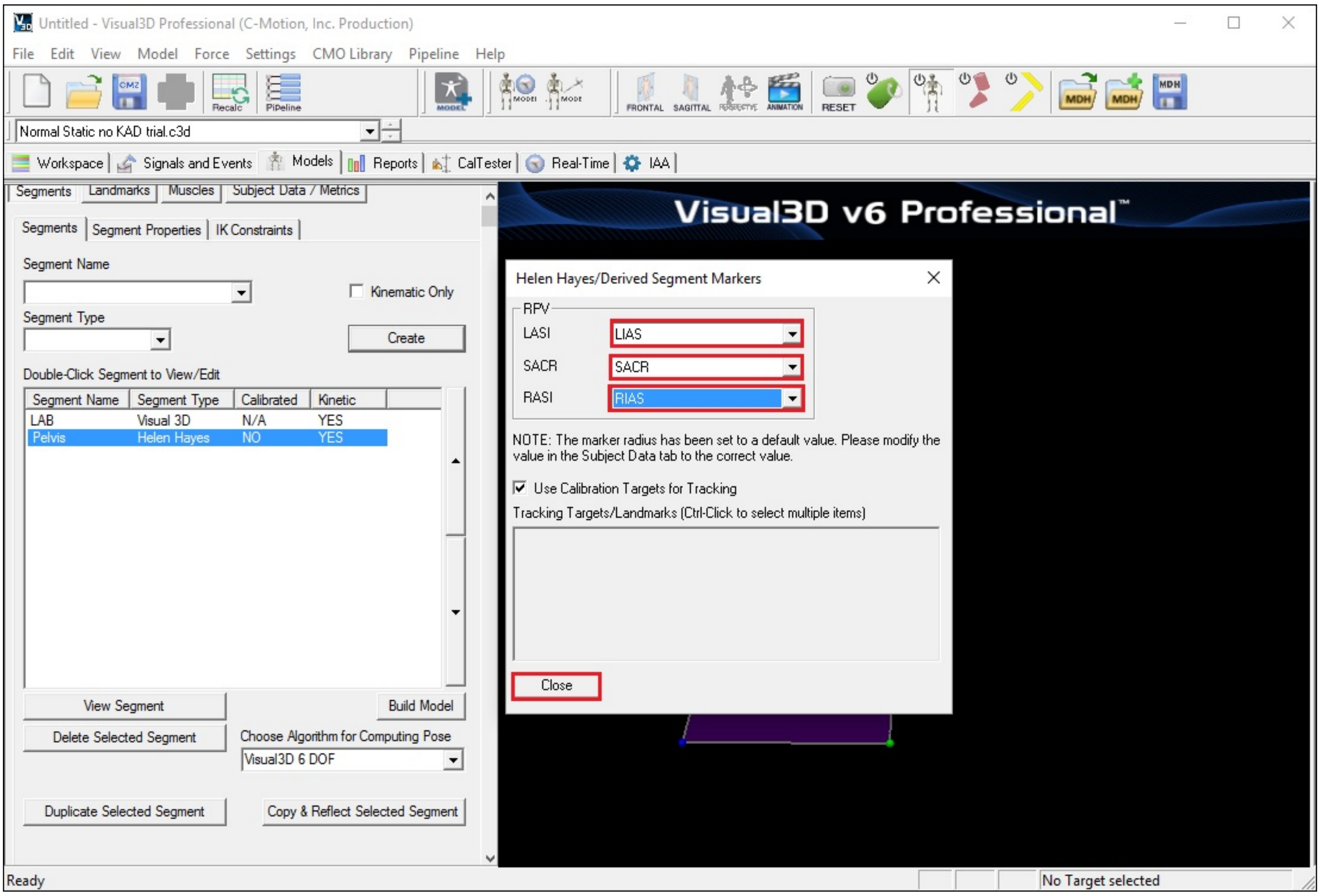
To create the right thigh segment:

1. Click Segments tab
2. From the Segment Name box, select Right Thigh.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to define the segment. To create a
the thigh as a geometrical primitive (conical frustrum). The proximal a
must be defined.

1. In the Define Proximal Joint and Radius section, select HHe_RIGHT_HIP for the joint.
2. In the Proximal Radius box, enter 0.089. The proximal radius is the geometrical
   proximal end of the thigh. You can use calipers to measure this or
   measure as one quarter of the distance between the greater trocha
3. In the Define Distal Joint and Radius section, select RFLE for the Lateral.
4. In the Distal Radius box, enter 0.5*Right_Knee_Width+Marker_Radius
5. In the Extra Target to Define Orientation section, select Lateral for the Location and RTH
   for the marker.
6. In the Select Tracking Targets, click HHe_RIGHT_HIP, RFLE, and RTH
7. Click Build Model

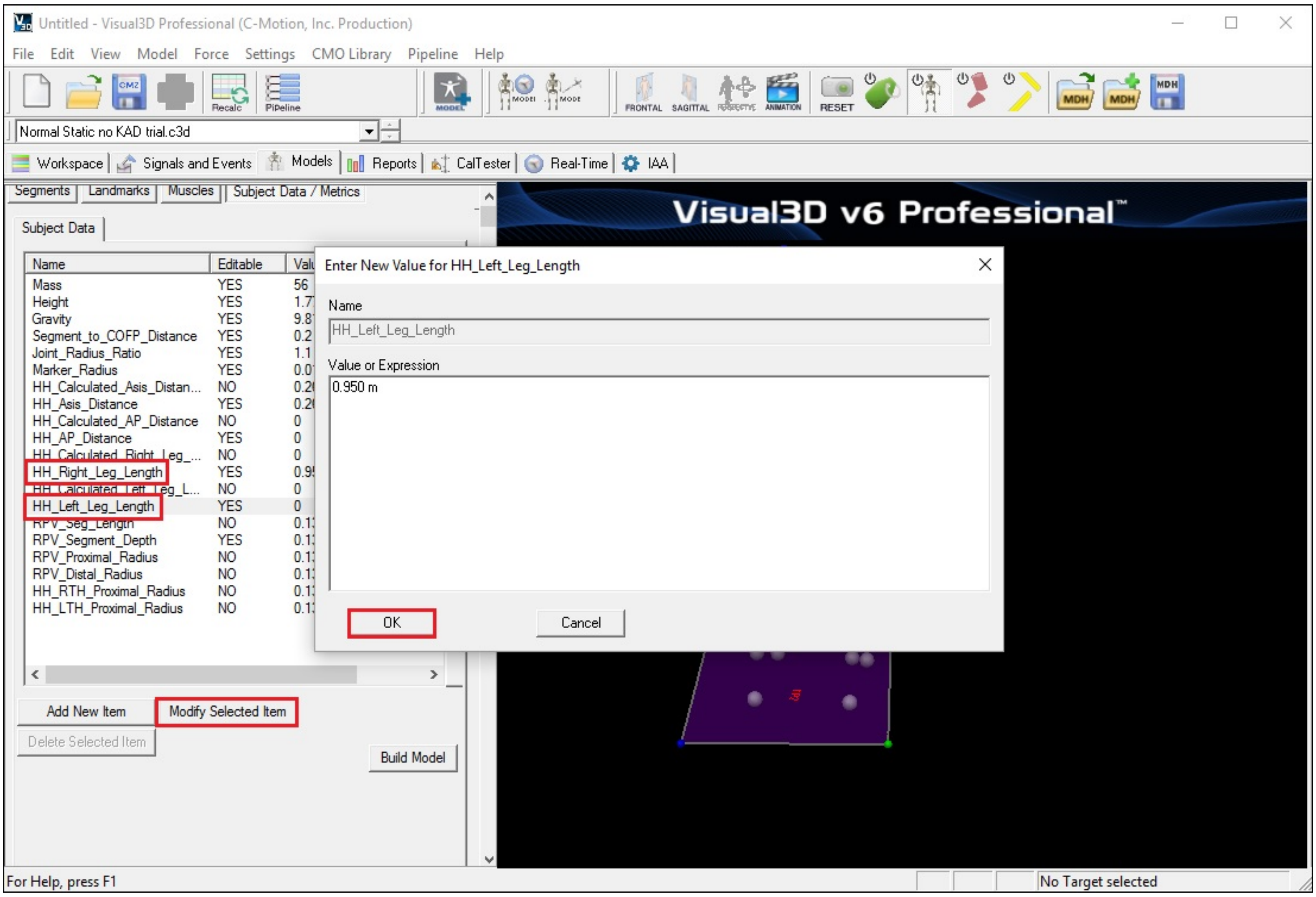
You should now see a thigh segment on your standing model. If you do
after clicking Build Model, double check the values you entered in the



To create the left thigh segment:

1. Click Models tab
2. From the Segment Name box, select Left Thigh.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius, select the HH_LEFT_HIP for the Joint.
6. In the Proximal Radius box, enter 0.089
7. In the Define Distal Joint and Radius, select LFE for the Lateral.
8. In the Distal Radius box, enter 0.5*Left_Knee_Width+Marker_Radius
9. In the Extra Target to Define Orientation section, select LFE for the Location and LTH for the marker.
10. In the Select Tracking Targets, check HH_LEFT_HIP, LFE and LTH
11. Click Build Model

You should now see both thigh segments on your standing model.



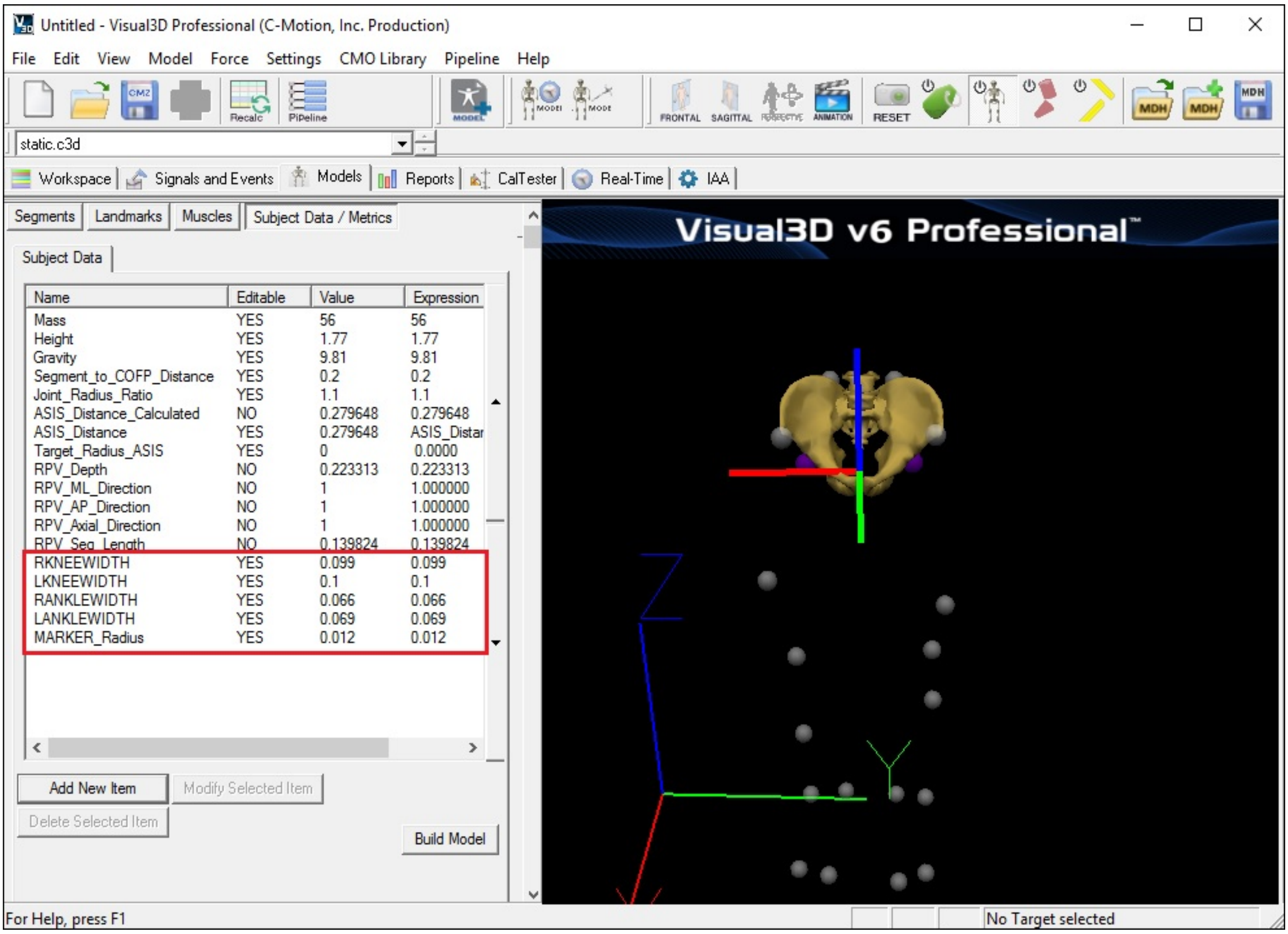
Create Knee Joint Centers

The knee joint center of the Conventional Gait Model is assumed to be tibia. It's location is half the knee width and half a marker diameter m epicondyle marker in the plane of the femoral segment.

When we constructed the thigh segments, we used these calculations t radius. Now we can explicitly deﬁne the knee joint center by creating the thigh segment.

To create the right knee joint center landmark:

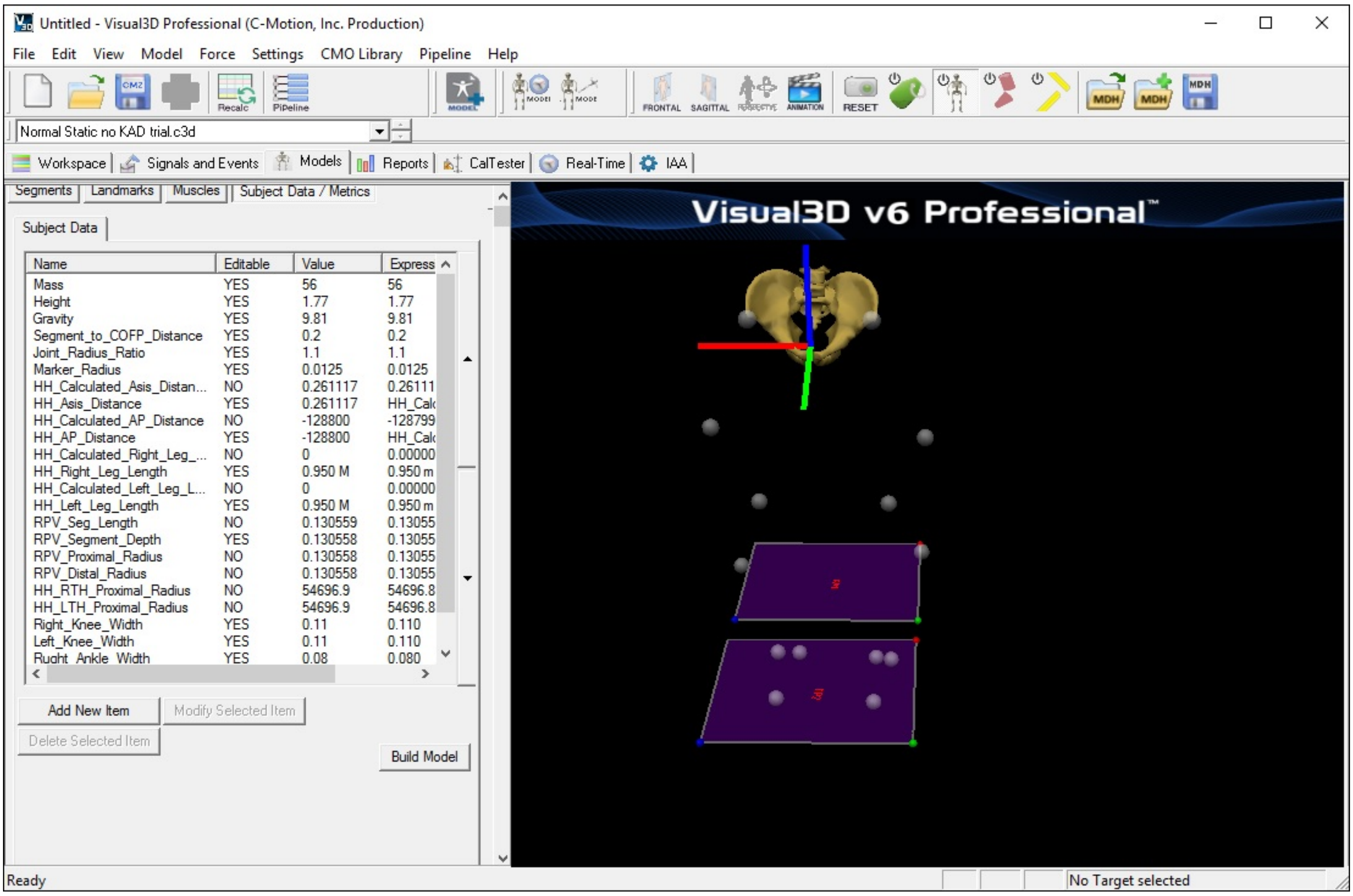
1. Click on the Landmarks TAB
2. Click Add New Landmark
3. In the Landmark Name box, enter RIGHT_KNEE
4. From the Existing Segment box, select Right Thigh.
5. From the Offset Using the Following AP/ML/Axial Offset, Axial Offset enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.



To create the left knee joint center landmark:

1. Click on the Landmarks TAB
2. Click Add New Landmark
3. In the Landmark Name box, enter LEFT_KNEE
4. From the Existing Segment box, select Left Thigh.
5. From the Offset Using the Following AP/ML/Axial Offset, Axial Offset enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.

In the image below, the Landmarks are shown in blue.



Create Shank Segments - Steps 5b

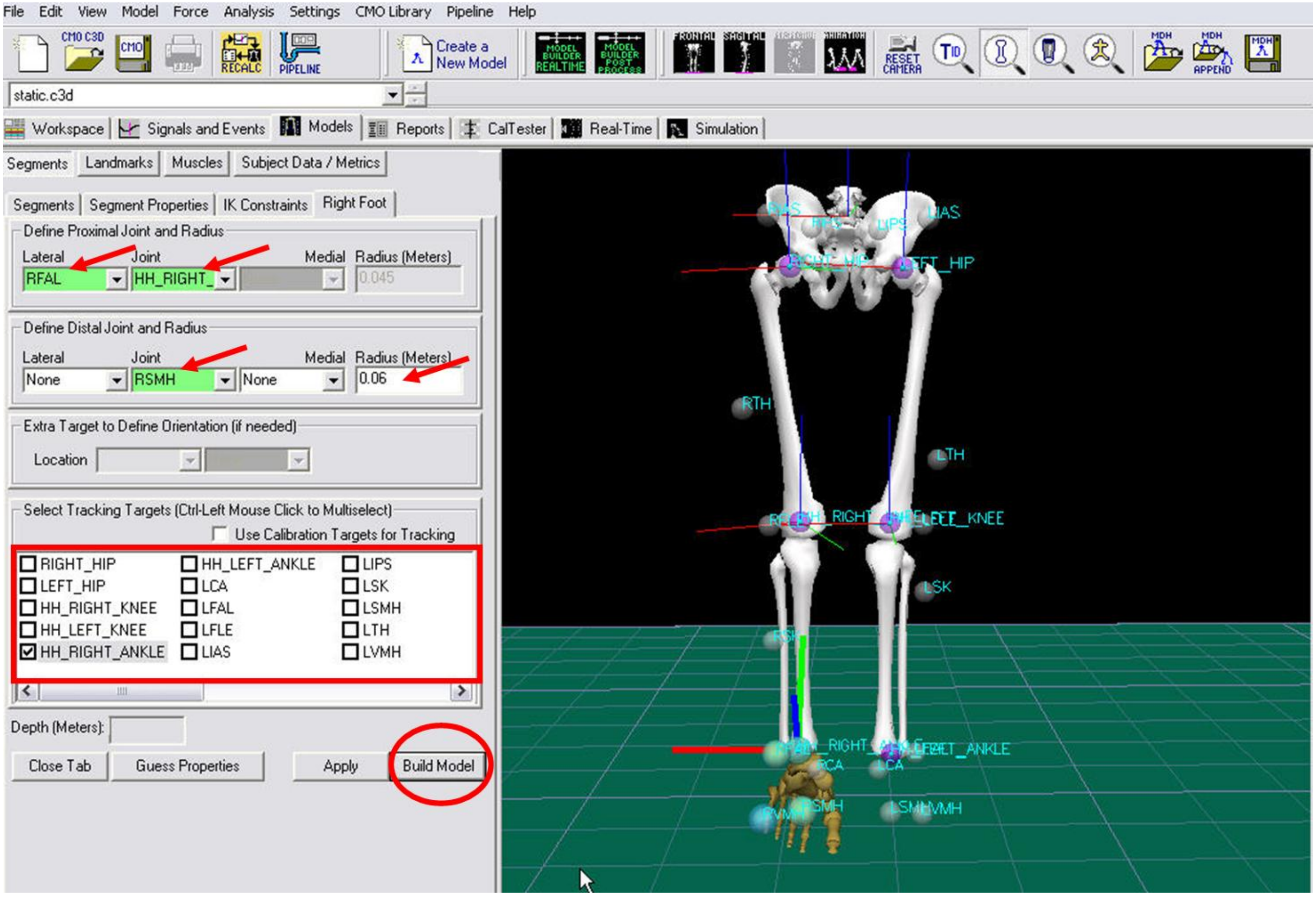
To create the right shank segment:

1. Click **Segments** tab
2. From the **Segment Name** box, select **Right Shank**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.

A dialog will open that will allow us to define the segment. To create a

1. In the **Define Proximal Joint and Radius** section, select **HH_RIGHT_KNEE** for **Joint**.
2. In the **Proximal Radius** box, enter 0.5*Right_Knee_Width+Marker_Radius
3. In the **Define Distal Joint and Radius** section, select **RFAL** for the **Lateral**.
4. In the **Distal Radius** box, enter 0.5*Right_Ankle_Width+Marker_Radius
5. In the **Extra Target to Define Orientation** section, select **Lateral** for the **location** and **RSK** for the marker.
6. In the **Select Tracking Targets** box, click **HH_RIGHT_KNEE**, **RFAL**, and **RSK**
7. Click **Build Model**

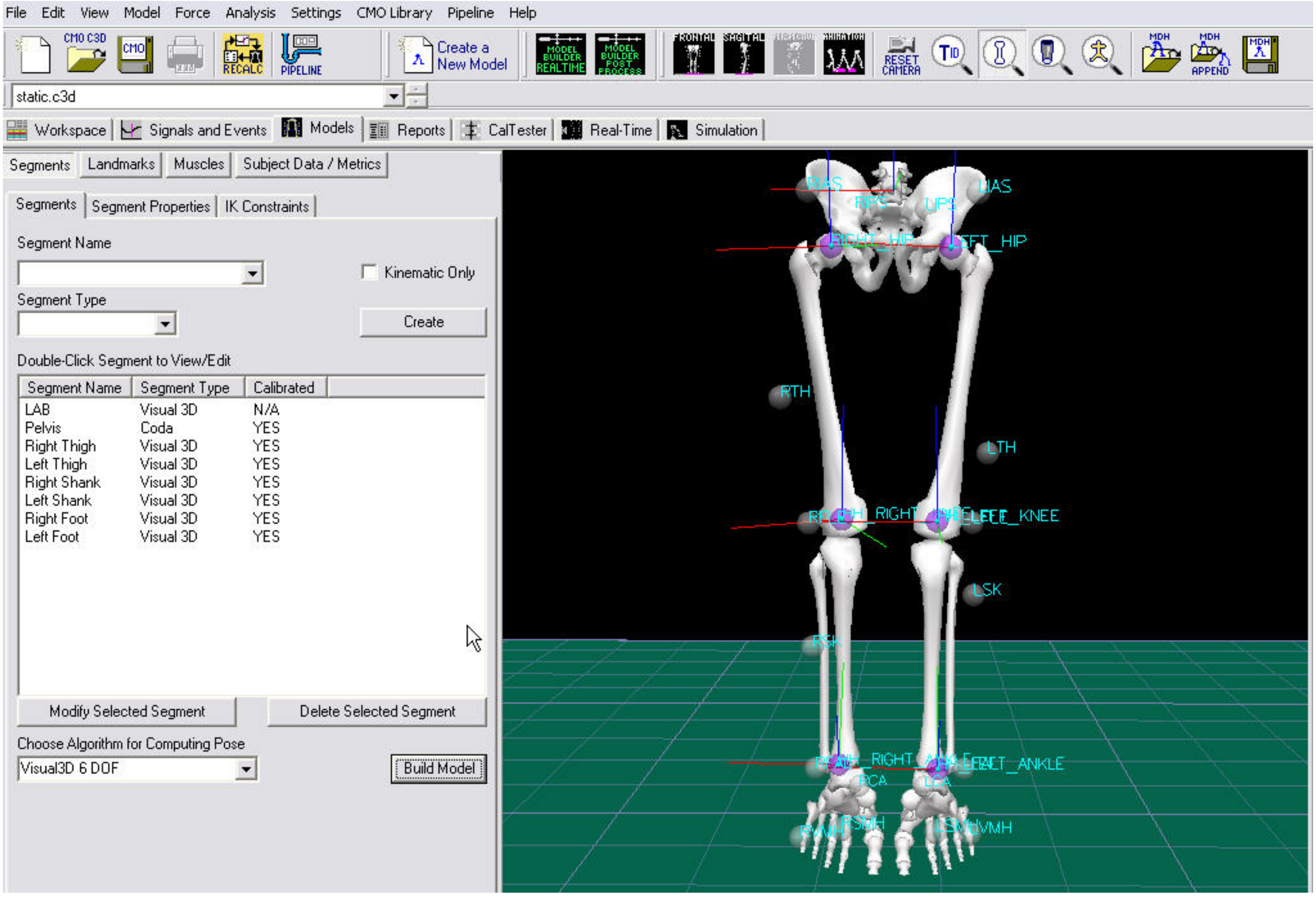
You should now see a shank segment on your standing model. If you d
after clicking Build Model, double check the values you entered in the



To create the left shank segment:

1. Click Close tab
2. From the Segment Name box, select Left Shank.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius, select HH_LEFT_KNEE for the Joint.
6. In the Proximal Radius box, enter 0.5*Left_Knee_Width+Marker_Radius
7. In the Define Distal Joint and Radius, select LFAL for the Lateral.
8. In the Distal Radius box, enter 0.5*Left_Ankle_Width+Marker_Radius
9. In the Extra Target to Define Orientation section, select Lateral for the location and LSK for the marker.
10. In the Select Tracking Targets, check HH_LEFT_KNEE, LFLE, and LSK
11. Click Build Model

You should now see both shank segments on your standing model.



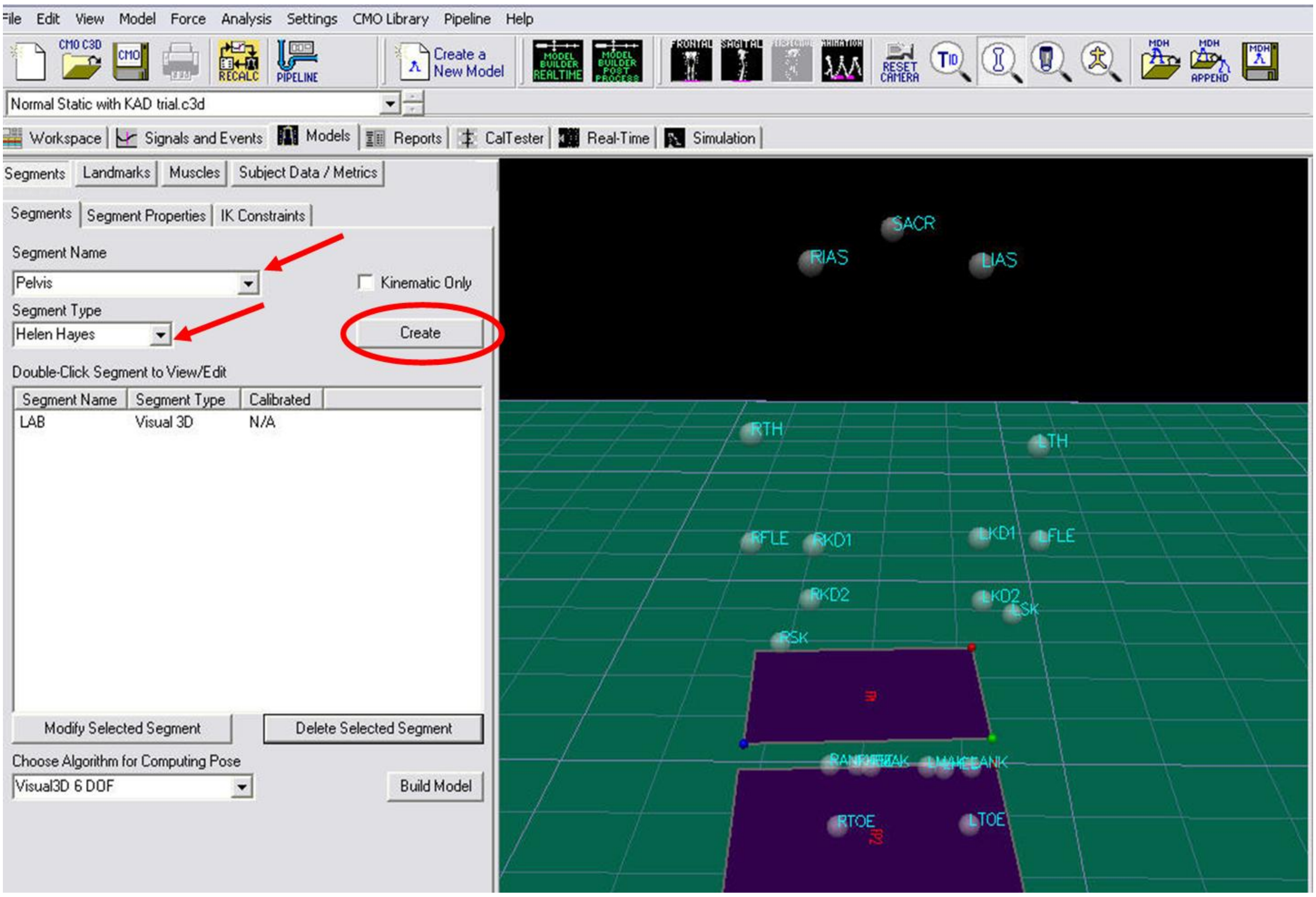
Create Ankle Joint Centers

As with the knee, the ankle joint center is assumed to be ßxed in both is half the ankle width and half a marker diameter medial to the cente in the plane of the tibial segment.

When we constructed the shank segments, we used these calculations radius. Now we can explicitly deßne the knee joint center by creating the thigh segment.

To create the right ankle joint center landmark:

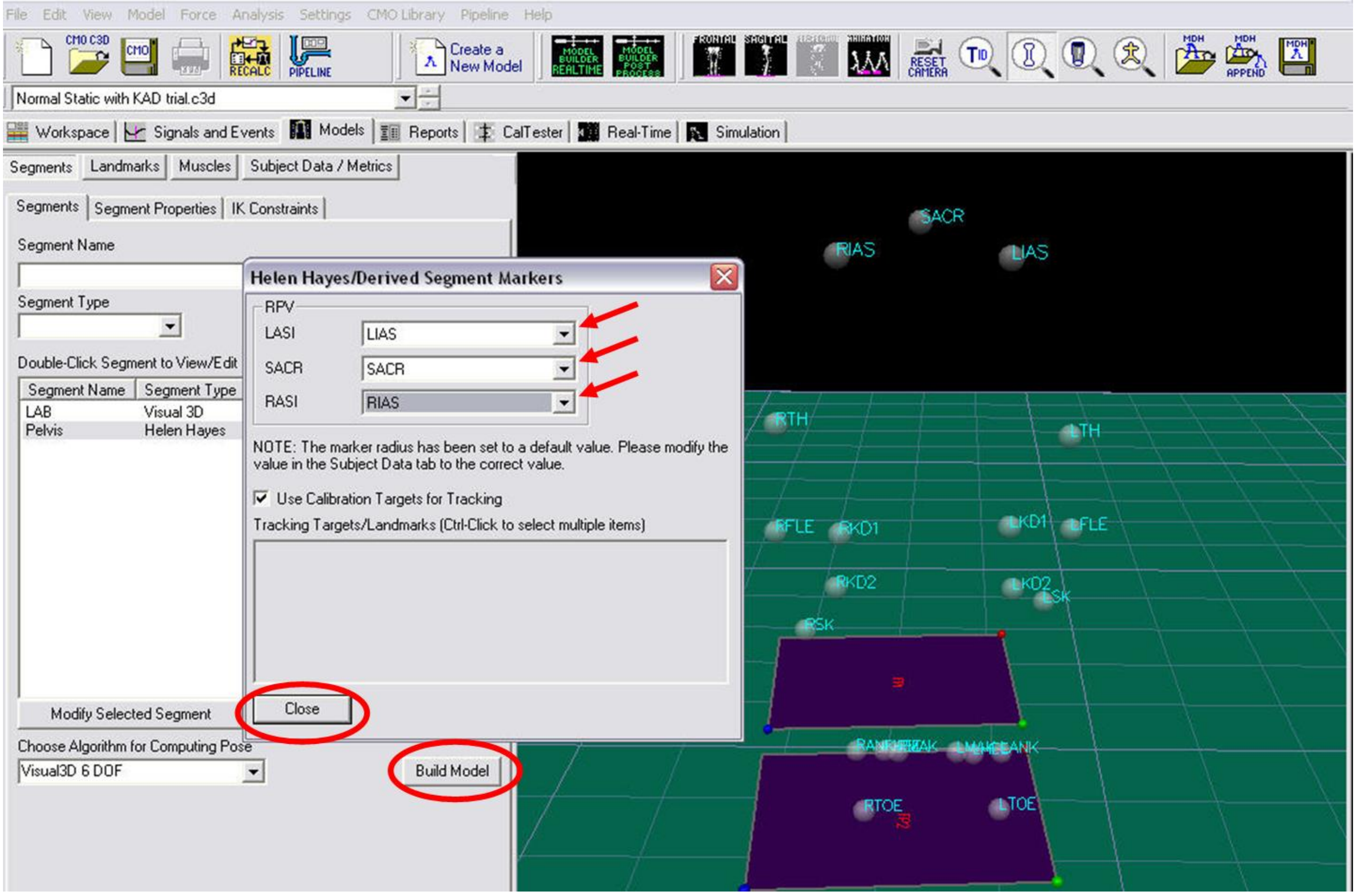
1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter RIGHT_ANKLE
4. From the Existing Segment box, select Right Shank.
5. From the Offset Using the Following AP/ML/Axial Offsets box, enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.



To create the left knee joint center landmark:

1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter the Hr_LEFT_ANKLE
4. From the Existing Segment box, select Left Shank.
5. From the Offset Using the Following AP/ML/Axial, in Axial Offset enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.

In the image below, the Landmarks are shown in blue.



Create Foot Segments

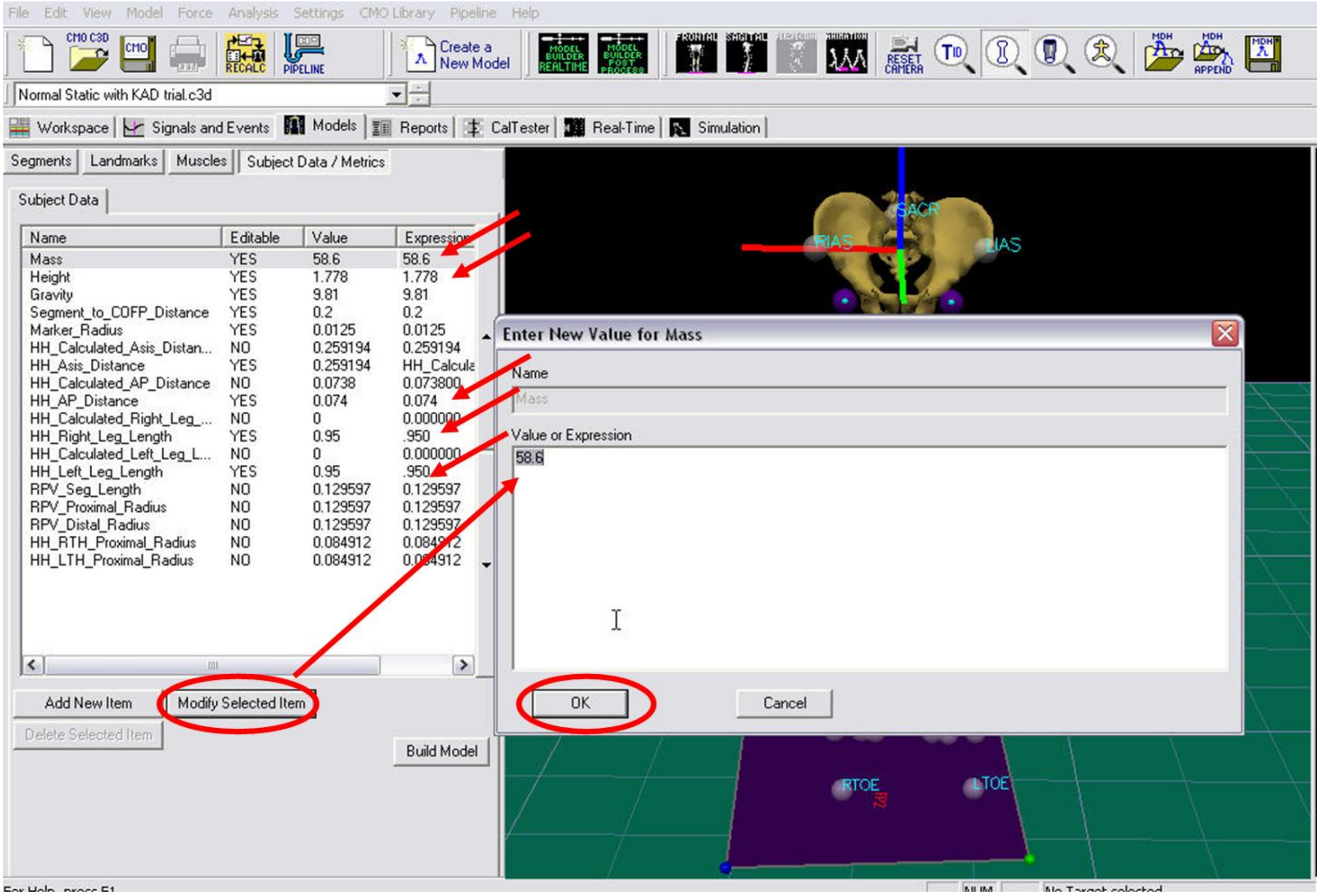
To create the right shank segment:

1. Click Segments tab
2. From the Segment Name box, select Right Foot.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to define the segment. To create a

1. In the Define Proximal Joint and Radius, select RFAL for the Lateral.
2. In the Define Proximal Joint and Radius, select HH_RIGHT_ANKLE for the Joint.
3. In the Define Distal Joint and Radius, select RSMH for the Joint.
4. In the Distal Radius box, enter 0.06
5. In the Select Tracking Targets, ctrl click HH_RIGHT_ANKLE, RFAL, RSMH, and RVMH
6. Click Build Model

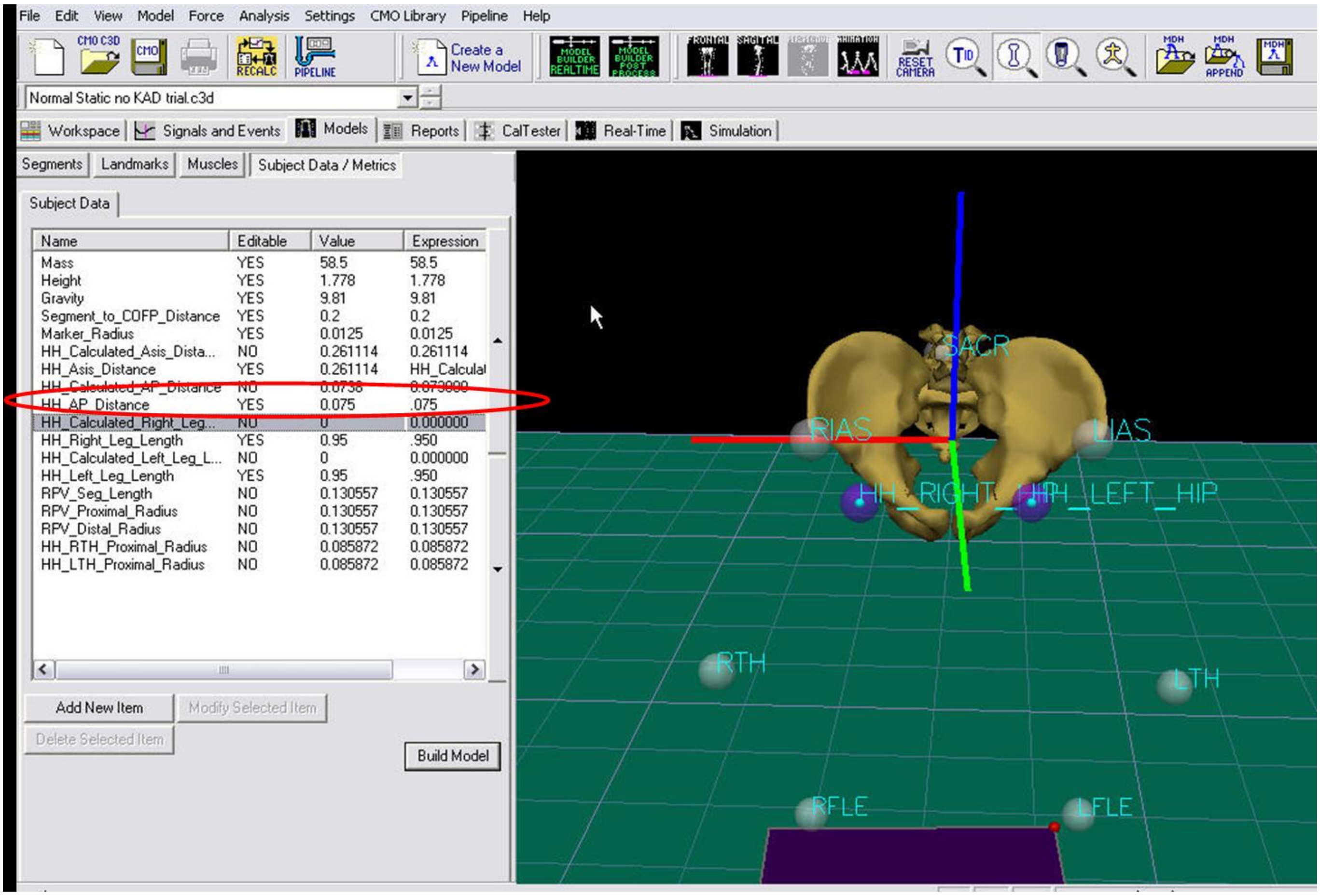
You should now see a foot segment on your standing model. If you do
clicking Build Model, double check the values you entered in the last



To create the left foot segment:

1. Click on Close tab
2. From the Segment Name box, select Left Foot.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius section, select LFA1 for the Lateral.
6. In the Define Proximal Joint and Radius section, select HH_LEFT_ANKLE for the Joint.
7. In the Define Distal Joint and Radius section, select LSMH for the Joint.
8. In the Distal Radius box, enter 0.06
9. In the Select Tracking Targets, click on HH_LEFT_ANKLE, LFA1, LSMH, and LVMH
10. Click Build Model

You should now see both foot segments on your standing model.



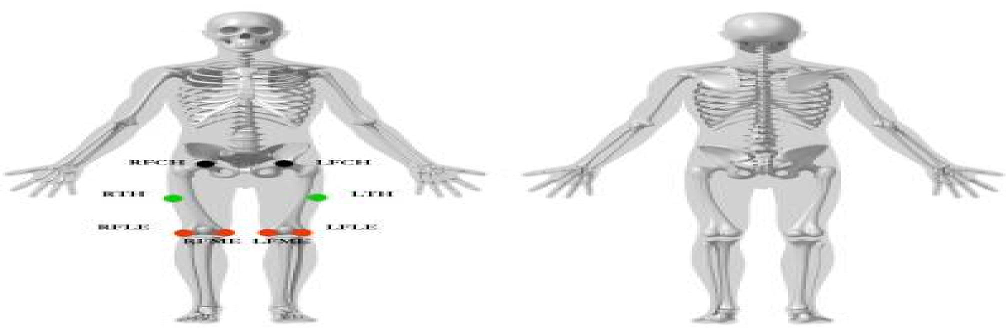
Example 3: with HH Pelvis with KAD - Steps:1b,2b,3a,4b,5a

This section will detail the construction of the following version of the Conventional Gait Example 3] to download example files.

- HH pelvis, Davis HJC with clinically measured ASIS to GT distance ankle markers - Steps:1b,2b,3a,4b,5a

We begin by using the static standing trial.

1. From the Model menu, select Create (Add Static Calibration File)



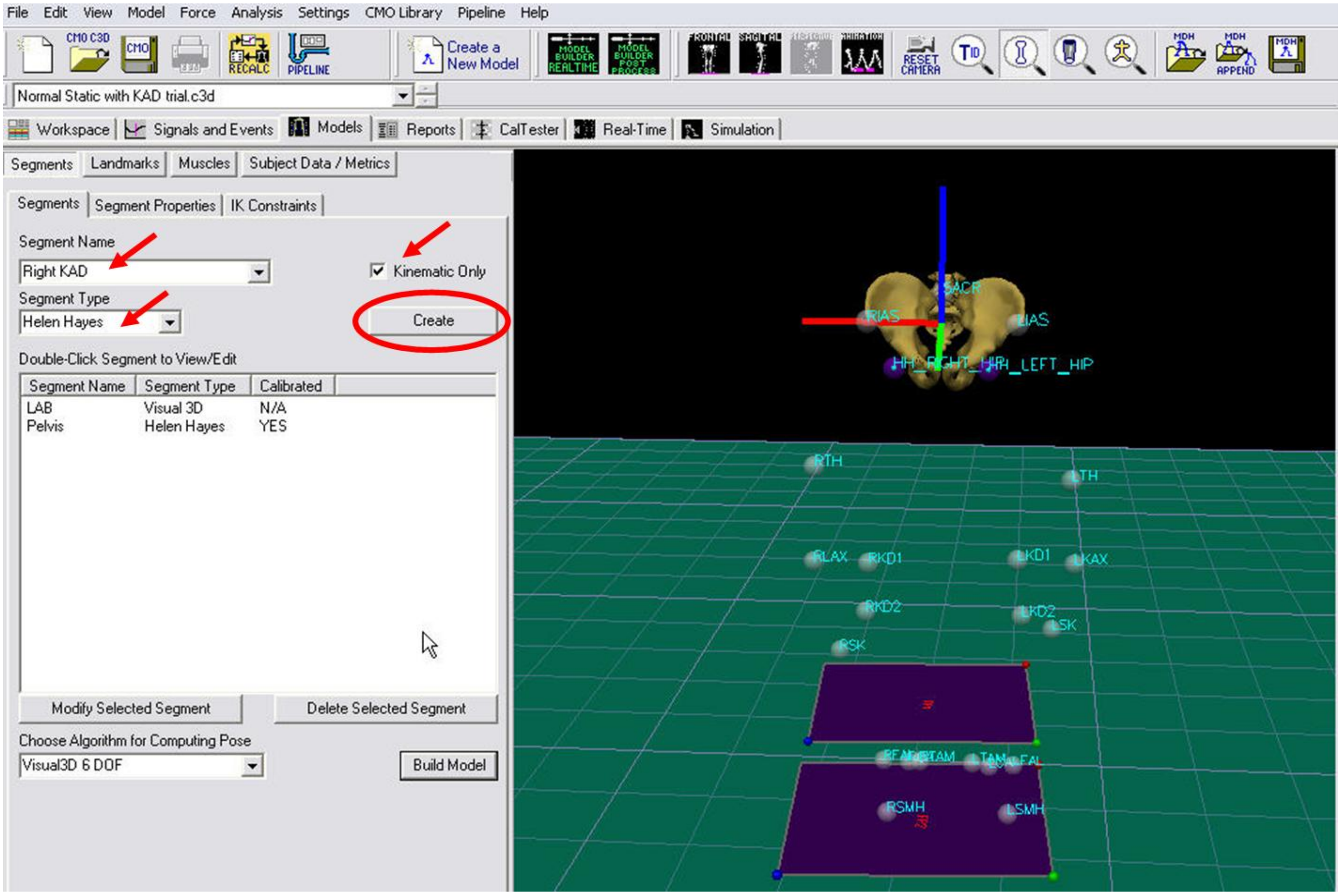
1. Select Hybrid Model from C3DFile
2. A dialog will appear. Select the calibration file for the new model. Select Static with KAD trial.c3d and click Open.

1. Visual3D will switch to Model Building mode automatically. The 3D average value of the marker locations from the standing file. The screen will contain a list of segments, which by default will contai the Laboratory.

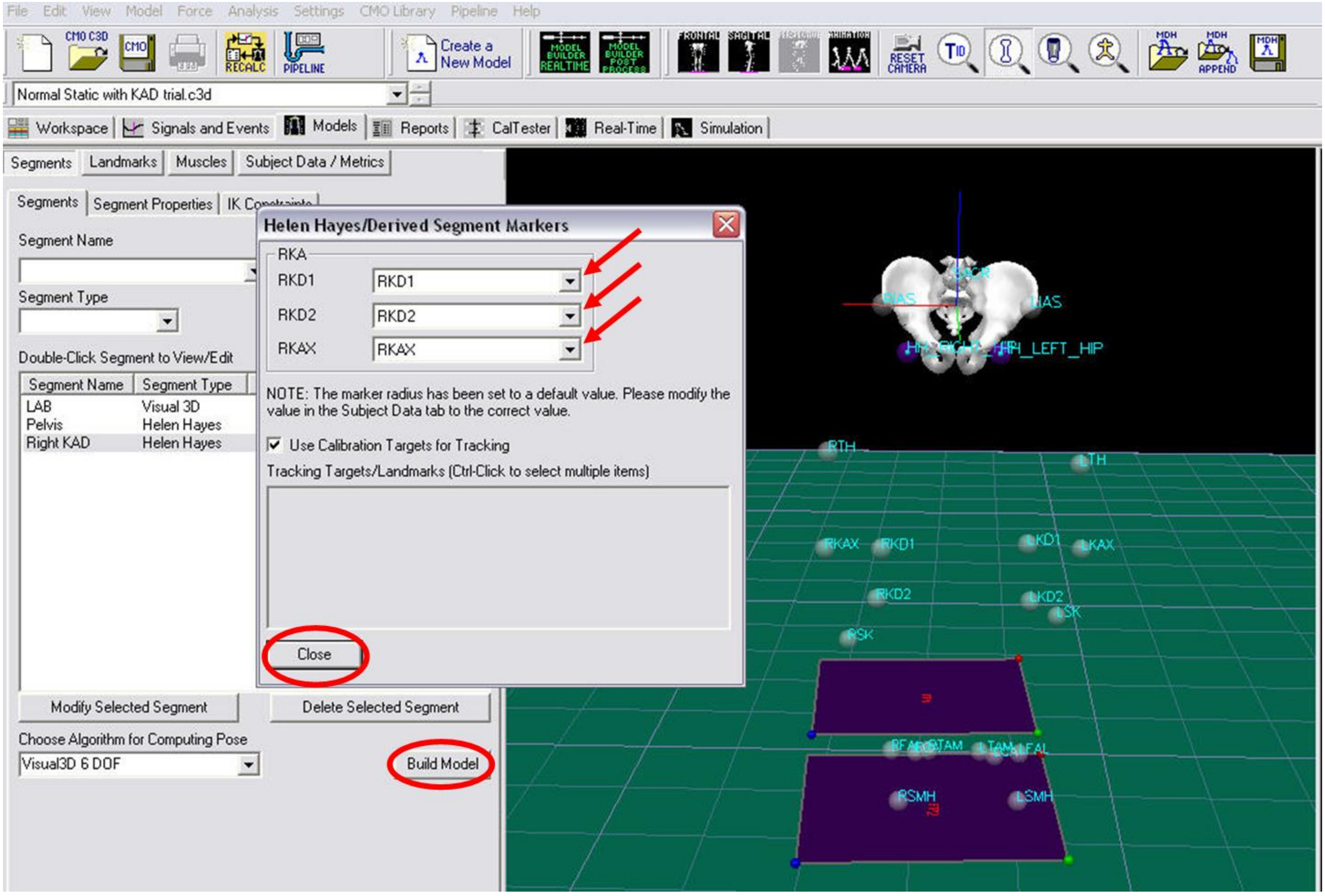
Creating the HH Pelvis Segment

To construct the HH Pelvis (Davis) segment:

1. From the **Segment Name** box, select **Pelvis**.
2. From the **Segment Type** box, select **Helen Hayes**.
3. Click **Create**.



1. A dialogue box labeled **Enter Body Mass and Height** opens because Visual3D ne subject to be assigned a mass and a height. Enter 56 kg and 1.57 m, and click OK.
2. A dialogue box labeled **Helen Hayes/Derived Segment Markers** will open. Select the markers so that they correspond to the figure below. Click **Close**.



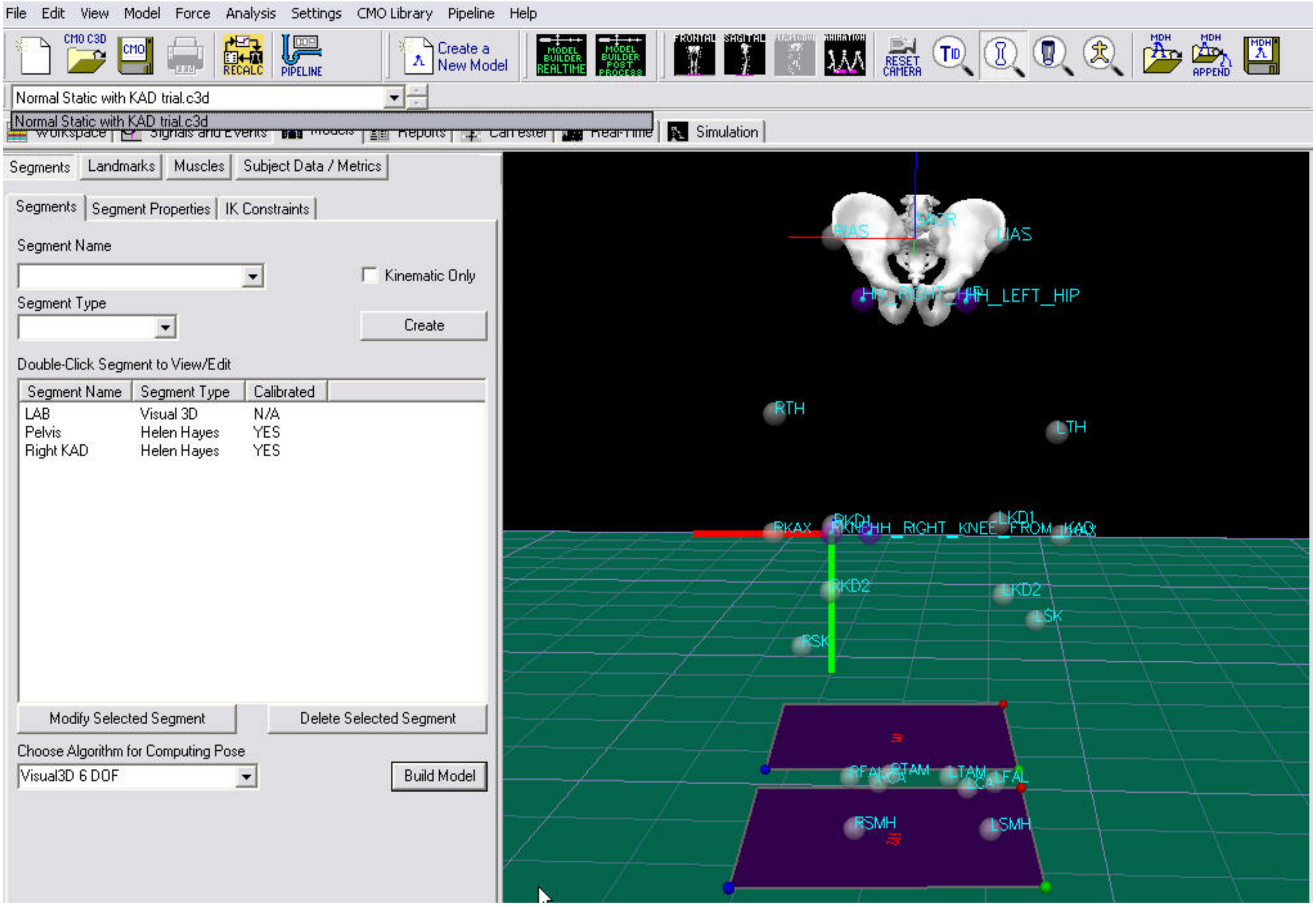
1. Click **Build Model** to build the segment. You should now see a pelvis seg
   model. If you do not see the pelvis segment after clicking **Build Model**, double check the values you entered in the last step.

Enter Subject Measurements

When Visual 3D creates the **HH Pelvis**, **Subject Data/Metrics** are created for the model. Sin
hip joint center calculation for HH Pelvis model is based on inter-ASIS
GT distance, these values need to be entered in the **Subject Data/Metrics** tab.

Enter the values by selecting **Modify Selected** for each of the items below:

1. Enter **0.950m** for **HH_Right_Leg_Length**
2. Enter **0.950m** for **HH_Left_Leg_Length**
3. In this example, the values for inter-ASIS distance will be calcula
   positions of the ASIS's
4. The ASIS to GT distance is measured clinically. Enter **0.074m** for **HH_ALP_Distance**

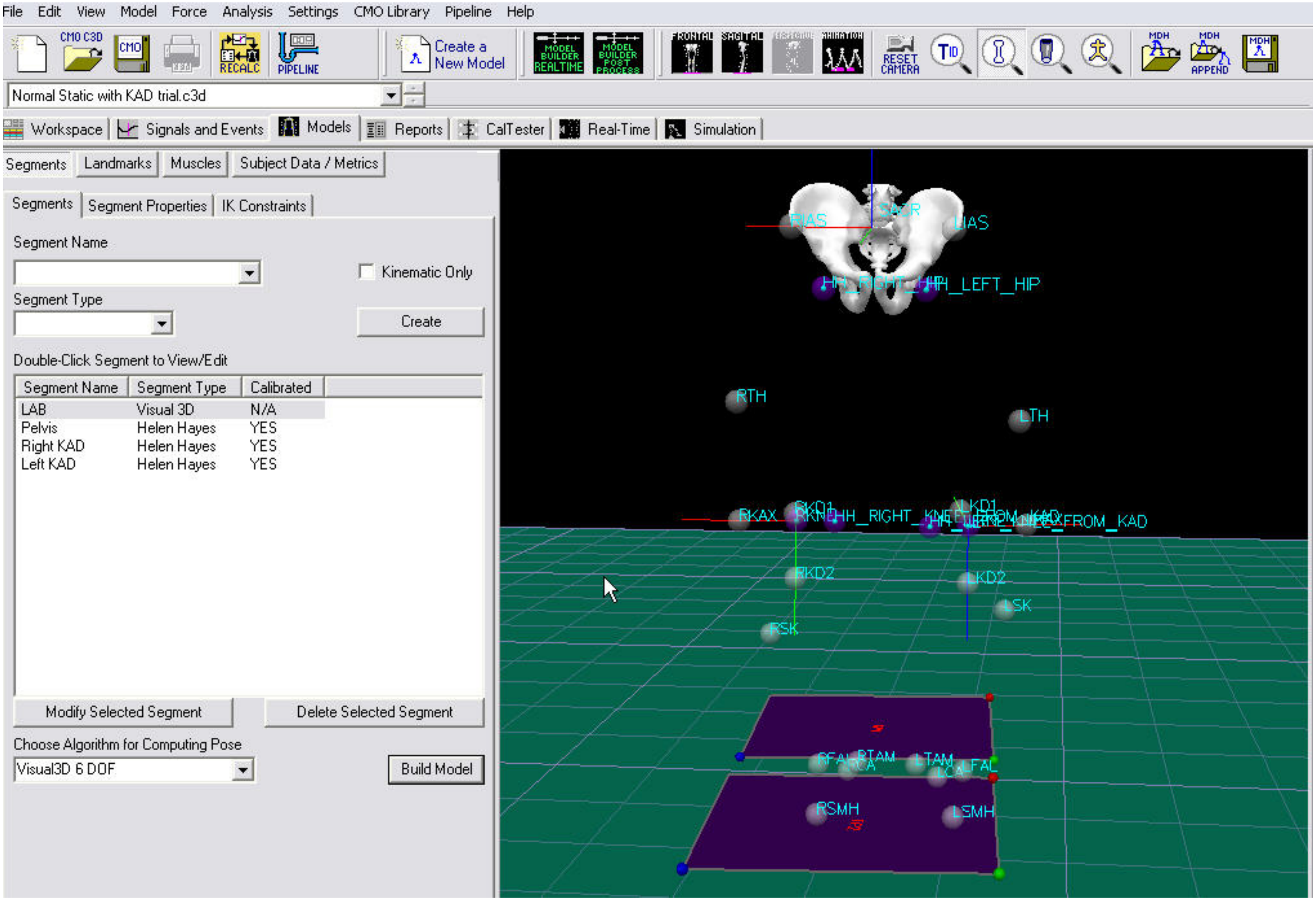


1. Click **Build Model** to build the segment. The hip joint centers should now
   properly. For further disussion on the hip joint center calculations
   Calculations section.

HJC Regression with Clinical Measurement of ASIS to GT (Davis 1991)

The hip joint center calculation is based on a regression equation (Da
estimates of the distance from the pelvic origin to the hip joint center
system. Measurements of leg length, anteroposterior ASIS to Greater T
ASIS distance are needed. The anthropometric section describes the m
anteroposterior ASIS to Greater Trochanter distance, and inter-ASIS d
was shown in the Hip joint center calculations in Example 2.

Estimates for the Right and Left Hip Joint Center are represented as L
automatically when the Helen Hayes (Davis) Pelvis segment is created. To view right and
centers, click the Landmarks TAB. In the image below, the Landmarks are sho

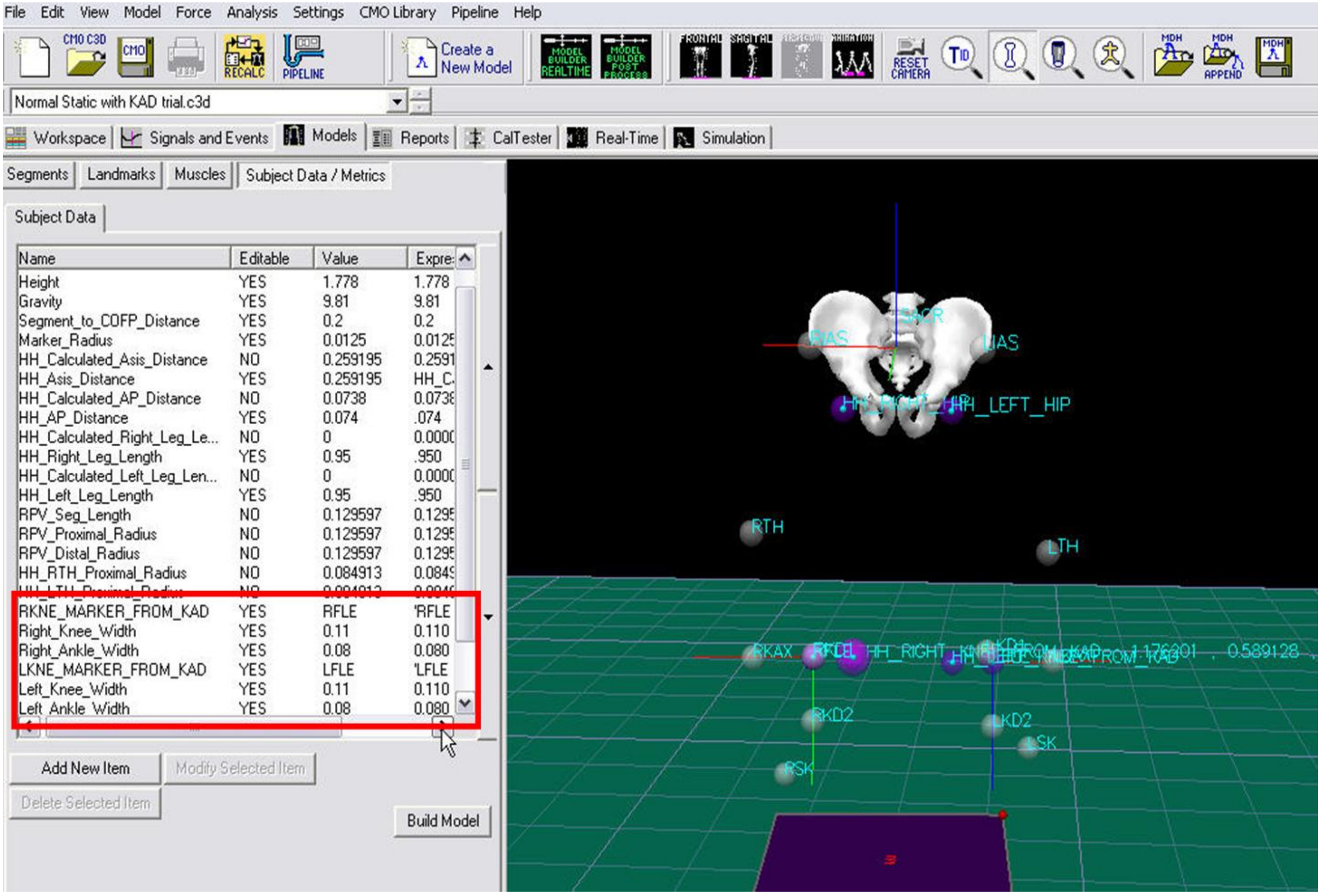


Note: that if the ASIS markers have been placed medial or lateral to t landmark because the subject is obese or because the markers cannot locations, it is important to measure the inter-ASIS distance and ente Subject Data/Metrics tab. If this is not done, then the hip joint center calcula incorrect.

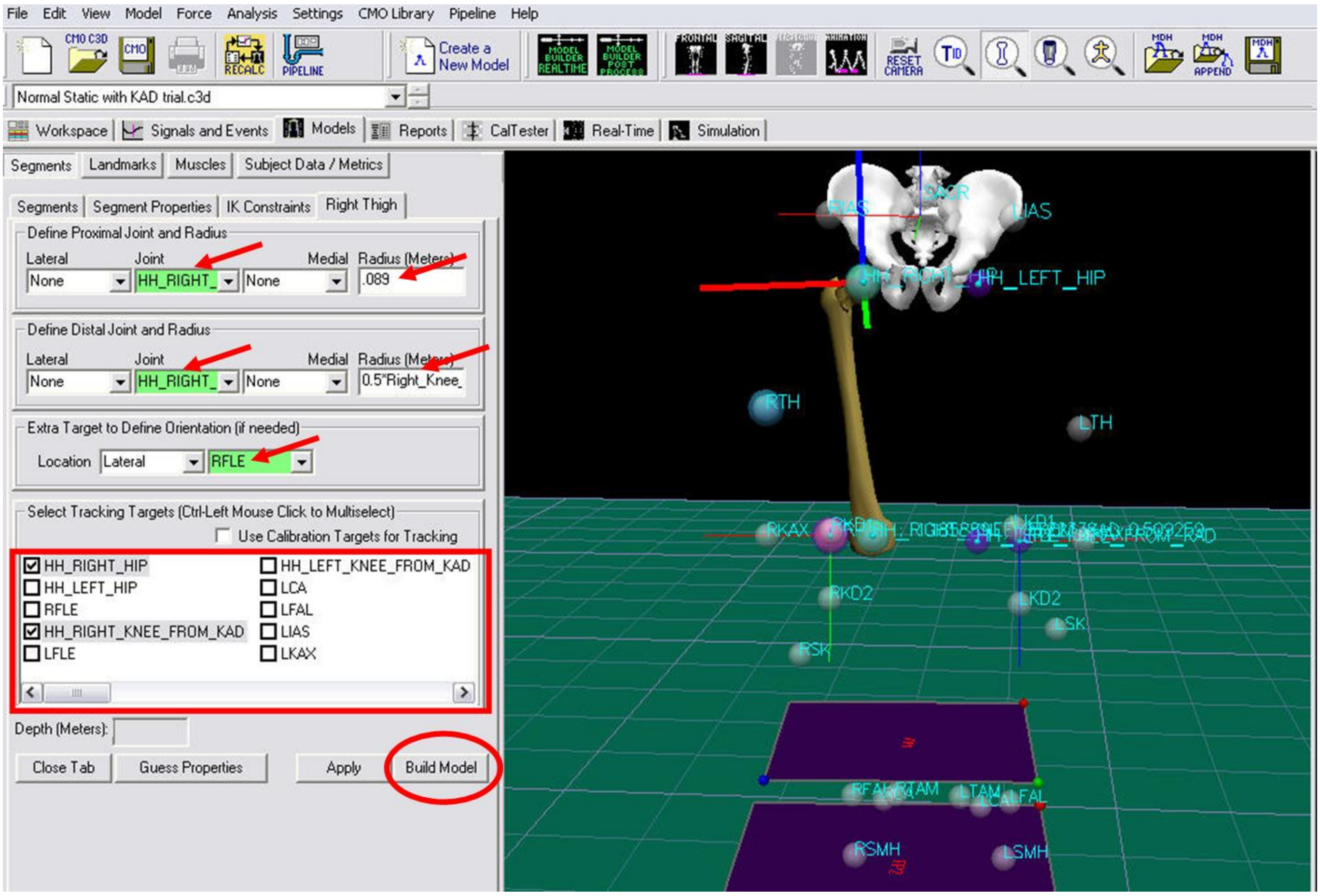
Create KAD Segments - Steps 3a

We must make a virtual segment (kinematic only) for the KAD. To crea segment:

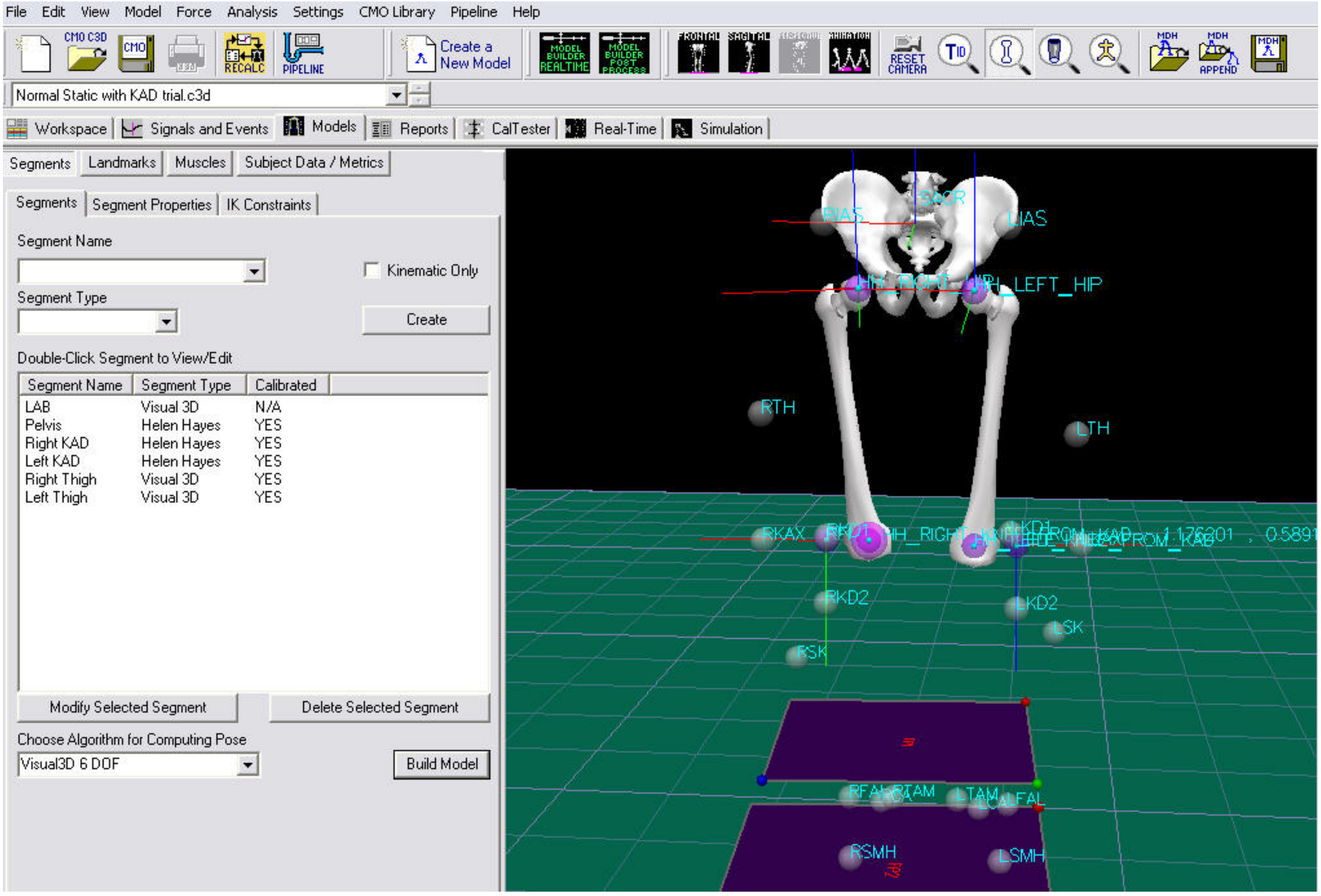
1. Click **Segments** tab
2. From the **Segment Name** box, select **Right KAD**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Check the **Kinematic Only** box
5. Click **Create**.



1. A dialogue box labelled Hall Hayes/Derived Segment Markers will open. Select the markers so that they correspond to the figure below. Click Close.

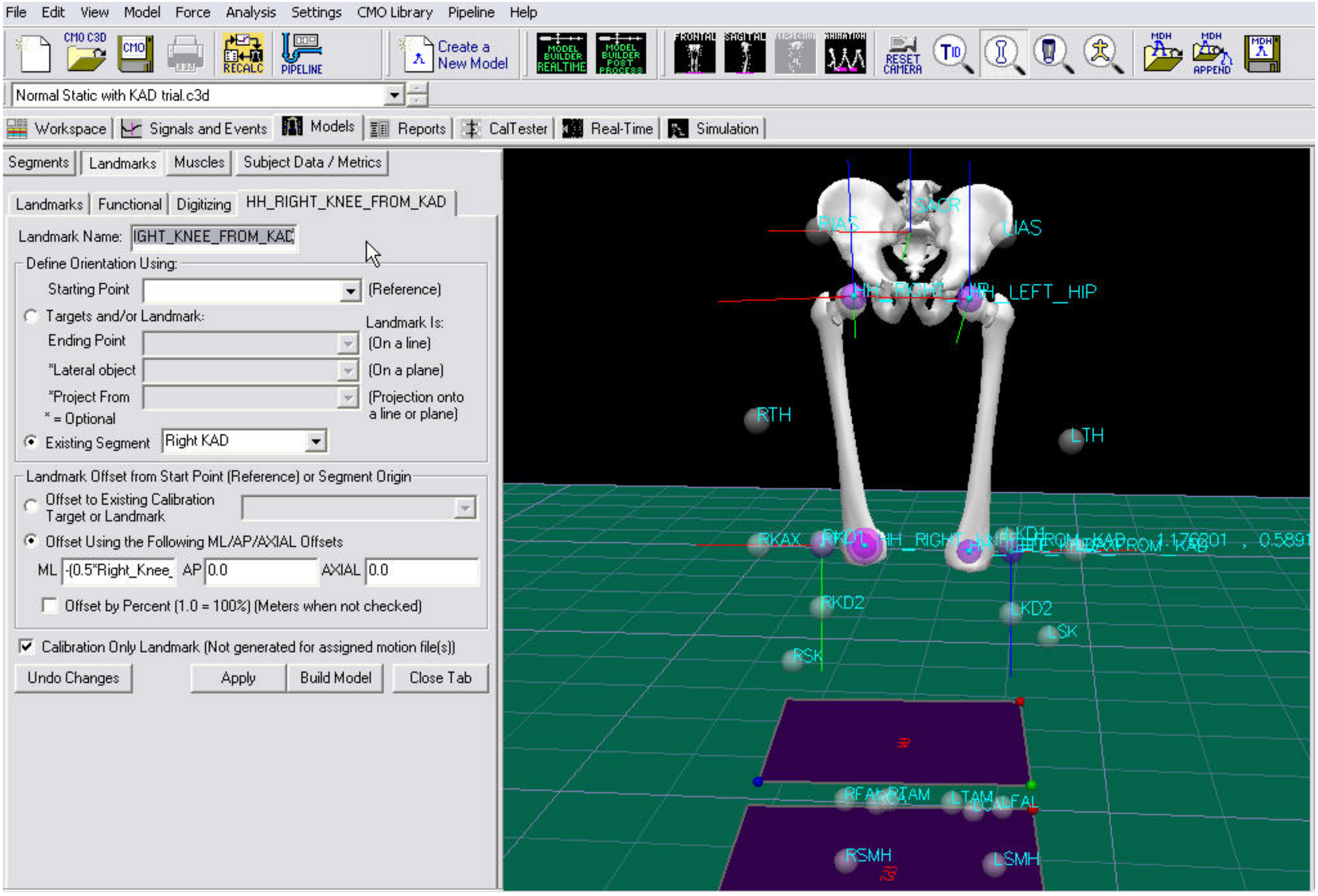


1. Click Build Model to build the segment. You should now see the KAD seg system on your standing model. If you do not see the KAD coordina Build Model, double check the values you entered in the last step.



To create the left KAD segment:

1. Click the **Segments** tab
2. From the **Segment Name** box, select **Left KAD**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.
5. A dialogue box labeled **Helen Hayes/Derived Segment with Markers**. Select the markers similar to step 6 above. Click **Close**. Click
6. Click **Build Model** to build the segment. You should now see the KAD seg system on your standing model. If you do not see the KAD coordina **Build Model**, double check the values you entered in the last step.



Note: Many laboratories have taken to replacing the 25 mm markers wi
in an erroneous assumption that it would be a good idea to have all m
body and the KAD to be the same size. This actually introduces an err
assumptions of how the KAD is used. If this is done, the user must be
accommodate this change to the original assumptions.

Edit Subject Metrics and Landmarks

When the KAD segments are created, Visual 3D creates the Knee and A
from default values. These need to be edited to reflect the current sub Subject
Data/Metrics tab and enter the values by Modify Selected for each of the items
below:

1. Enter 0.110 m for Right_Knee_Width
2. Enter 0.110 m for Left_Knee_Width
3. Enter 0.080 m for Right_Ankle_Width
4. Enter 0.080 m for Left_Ankle_Width

In addition, when the KAD segments are created, Visual 3D also create
for the knee. These need to be edited to reflect our tutorial marker se

1. Enter RFLE for HH_RIGHT_KNEE_FROM_KAD
2. Enter LFLE for HH_LEFT_KNEE_FROM_KAD

The Subject Data/Metrics should look like the image below.

Create Thigh Segments - Steps 4b

To create the right thigh segment:

1. Click the Segments tab
2. From the Segment Name box, select Right Thigh.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to define the segment. To create a
the thigh as a geometrical primitive (conical frustrum). The proximal a
must be defined.

1. In the Define Proximal Joint and Radius section, select RTH_RIGHT_HIP for the Joint.
2. In the Proximal Radius box, enter 0.089 The proximal radius is the geometrical proximal end of the thigh. You can use calipers to measure this or measure as one quarter of the distance between the greater trocha
3. In the Define Distal Joint and Radius section, select RTH_RIGHT_KNEE_FROM_KAD for the Joint.
4. In the Distal Radius box, enter 0.5*Right_Knee_Width+Marker_Radius
5. In the Extra Target to Define Orientation section, select Lateral for the Location and RFLE for the marker.
6. In the Select Tracking Targets, click RTH_RIGHT_HIP, RTH_RIGHT_KNEE_FROM_KAD, RFLE, and RTH
7. Click Build Model

You should now see a thigh segment on your standing model. If you do
after clicking Build Model, double check the values you entered in the

To create the left thigh segment:

1. Click on Segments tab
2. From the Segment Name box, select Left Thigh.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

In the dialog enter:

1. In the Define Proximal Joint and Radius section, select LEFT_HIP for the joint.
2. In the Proximal Radius box, enter 0.089. The proximal radius is the geometrical
   proximal end of the thigh. You can use calipers to measure this or
   measure as one quarter of the distance between the greater trocha
3. In the Define Distal Joint and Radius section, select LEFT_KNEE_FROM_KAD for the joint.
4. In the Distal Radius box, enter 0.5*Left_Knee_Width+Marker_Radius
5. In the Extra Target to Define Orientation section, select Lateral for the Location and LFLE for the marker.
6. In the Select Tracking Targets, click LEFT_HIP, LEFT_KNEE_FROM_KAD, LFLE, and LTH
7. Click Build Model

Knee Joint Centers

The knee joint center of the Conventional Gait Model is assumed to be
tibia. It's location is half the knee width and half a marker diameter m
epicondyle marker in the plane of the femoral segment. When we const
segments, we used these calculations to deﬁne the distal joint and rad
explicitly deﬁned the by creating a landmark at the distal end of the t
are HH_LEFT_KNEE_FROM_KAD and HH_RIGHT_KNEE_FROM_KAD. To view the knee joint cente
landmarks, click the Landmarks TAB.

Create Shank Segments - Steps 5b

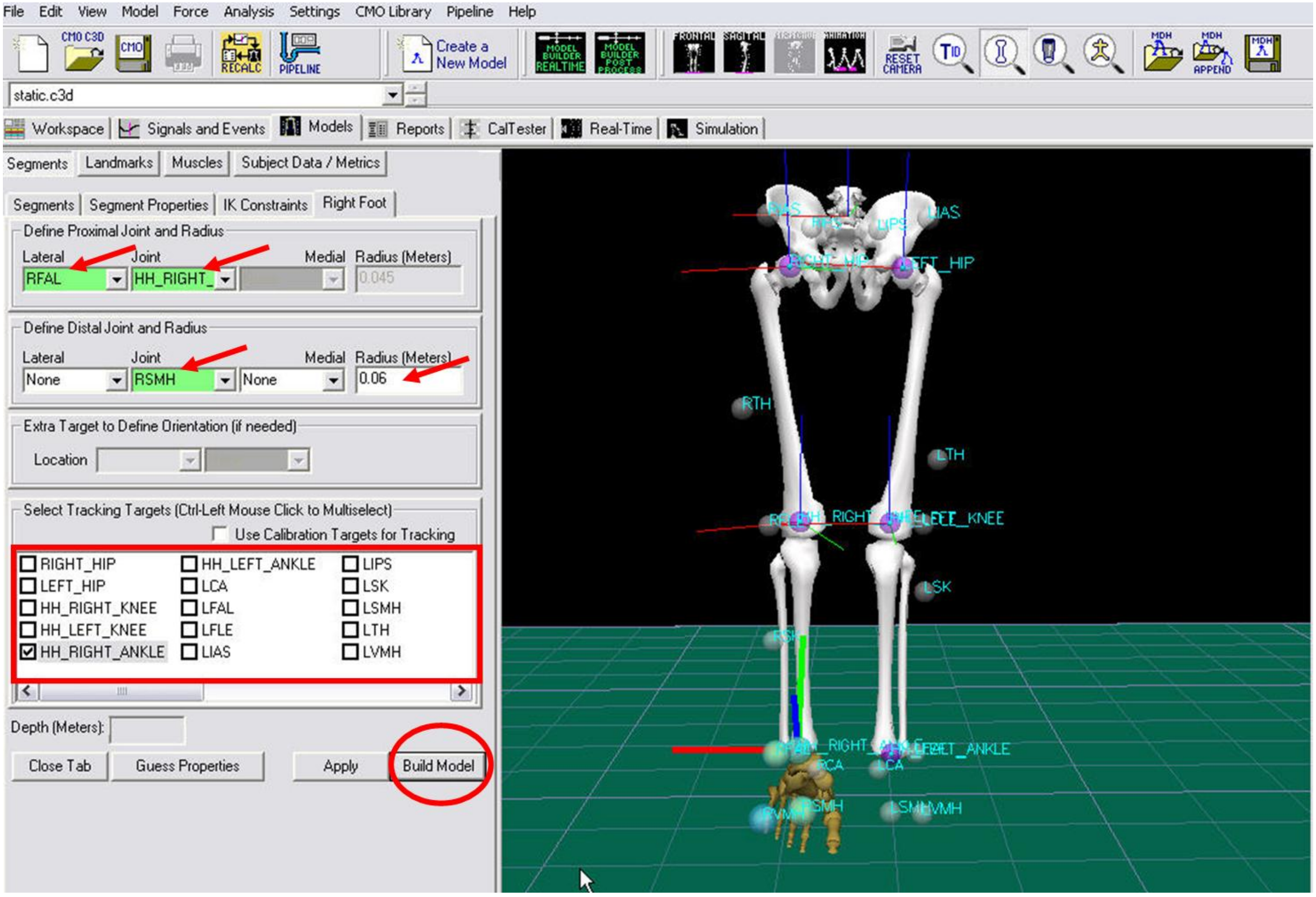
To create the right shank segment:

1. Click on **Segments** tab
2. From the **Segment Name** box, select **Right Shank**.
3. From the **Segment Type** box, select **Visual 3D**.
4. Click **Create**.

A dialog will open that will allow us to define the segment. To create a

1. In the **Define Proximal Joint and Radius** section, select **RIGHT_KNEE_FROM_KAD** for the Joint.
2. In the **Proximal Radius** box, enter **0.5*Right_Knee_Width+Marker_Radius**
3. In the **Define Distal Joint and Radius** section, select **RFAL** for the **Lateral**.
4. In the **Distal Radius** box, enter **0.5*Right_Ankle_Width+Marker_Radius**
5. In the **Extra Target to Define Orientation** section, select **Lateral** for the **Location** and **RSK** for the marker.
6. In the **Select Tracking Targets**, click on **RIGHT_KNEE_FROM_KAD**, **RFAL**, **RFAM**, and **RSK**
7. Click **Build Model**

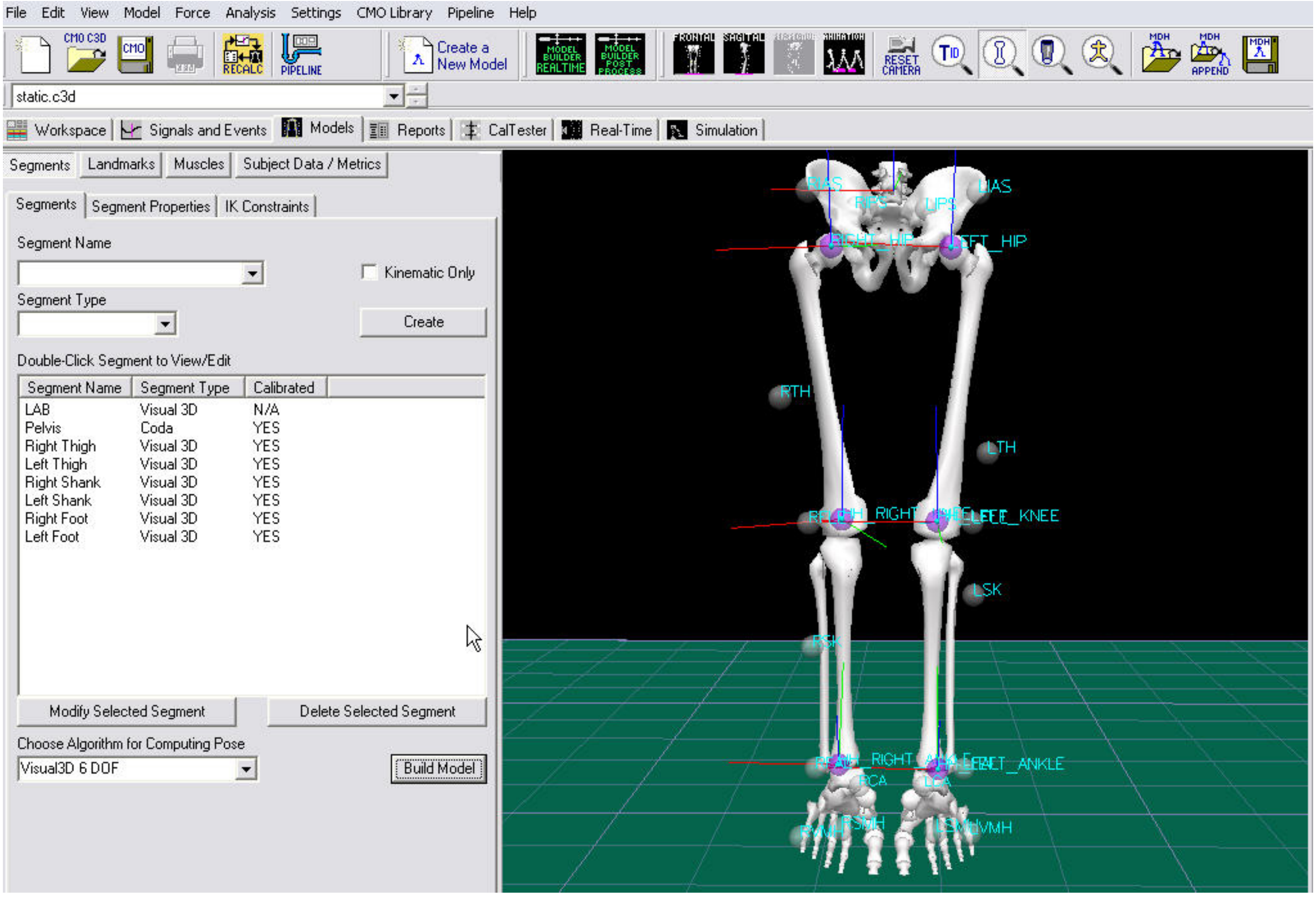
You should now see a shank segment on your standing model. If you d
after clicking Build Model, double check the values you entered in the



To create the left shank segment:

1. Click Close tab
2. From the Segment Name box, select Left Shank.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius section, select HH_LEFT_KNEE_FROM_KAD for the Joint.
6. In the Proximal Radius box, enter 0.5*Left_Knee_Width+Marker_Radius
7. In the Define Distal Joint and Radius section, select LFAL for the Lateral.
8. In the Distal Radius box, enter 0.5*Left_Ankle_Width+Marker_Radius
9. In the Extra Target to Define Orientation section, select LSK for the Location for the marker.
10. In the Select Tracking Targets, click HH_LEFT_KNEE_FROM_KAD, LFAL, LFLE and LSK
11. Click Build Model

You should now see both shank segments on your standing model.



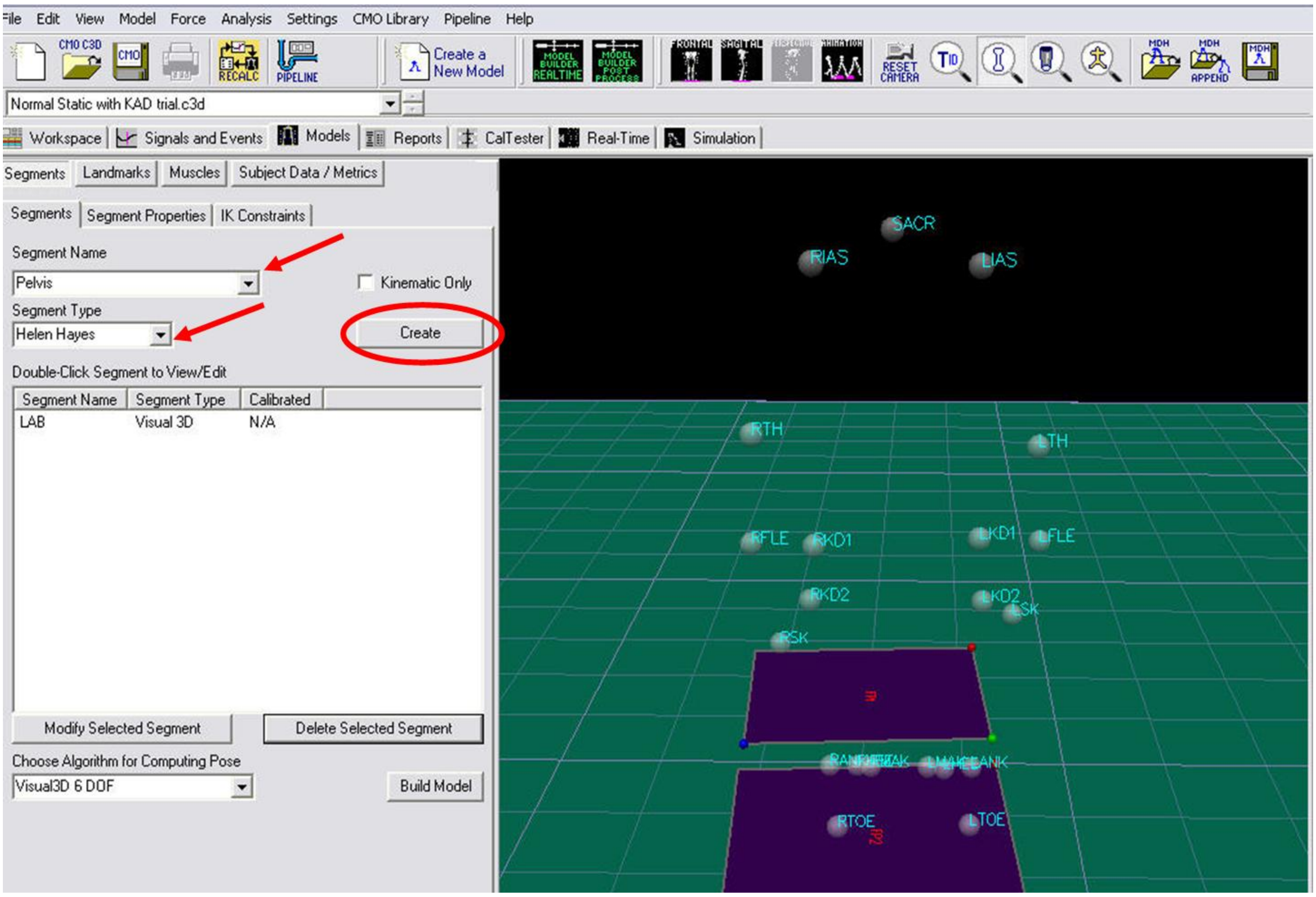
Create Ankle Joint Centers

As with the knee, the ankle joint center is assumed to be ßxed in both
is half the ankle width and half a marker diameter medial to the cente
in the plane of the tibial segment.

When we constructed the shank segments, we used these calculations
radius. Now we can explicitly deßne the knee joint center by creating
the thigh segment.

To create the right ankle joint center landmark:

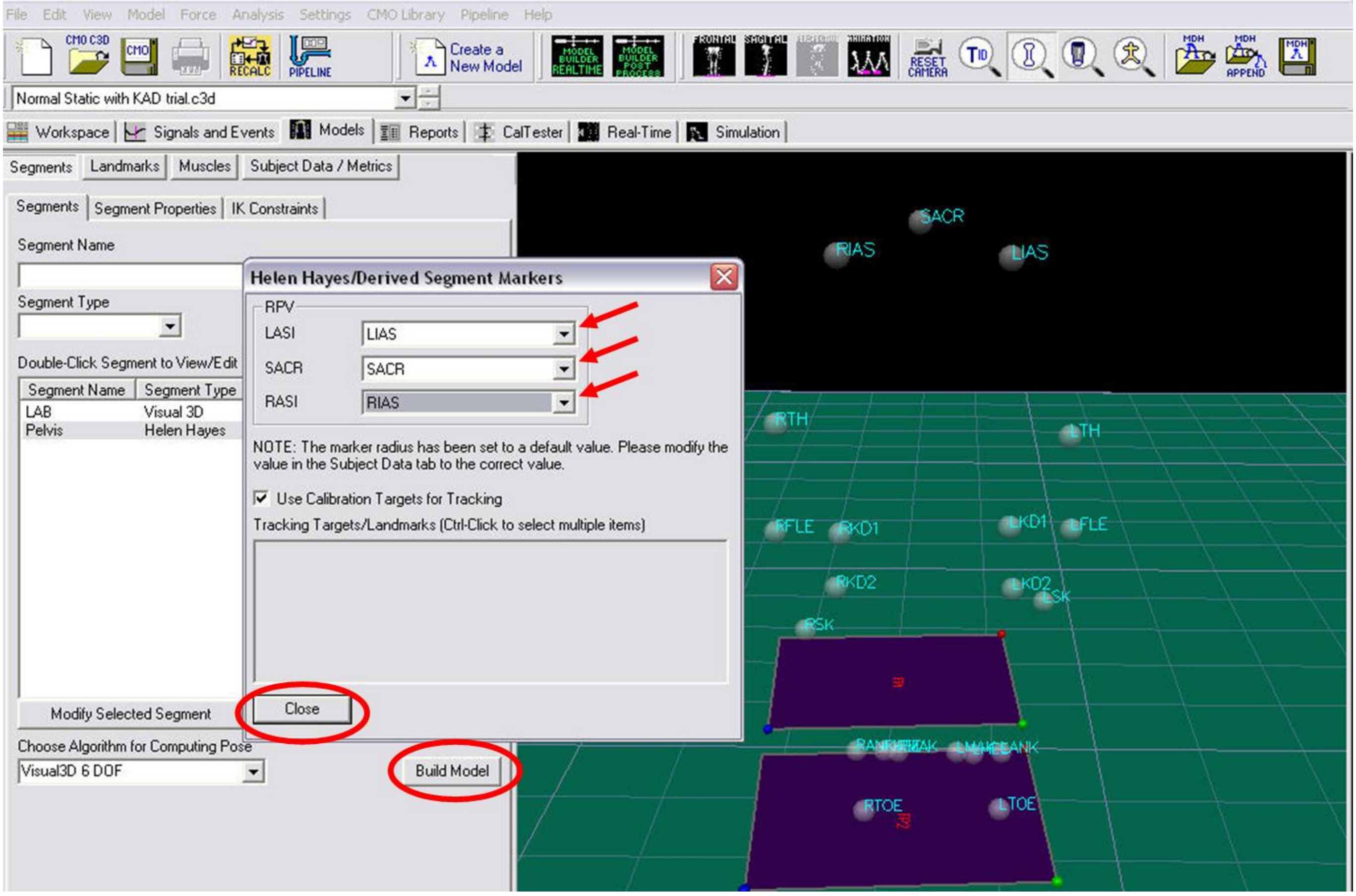
1. Click on the Landmarks TAB
2. Click Add New Landmark tab
3. In the Landmark Name box, enter RIGHT_ANKLE
4. From the Existing Segment box, select Right Shank.
5. From the Offset Using the Following AP/ML/Axial box, in the Axial Offset enter 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.



To create the left knee joint center landmark:

1. Click on the Landmarks TAB
2. Click Add New Landmark
3. In the Landmark Name box, enter H r_LEFT_ANKLE
4. From the Existing Segment box, select Left Shank.
5. From the Offset Using the Following AP/ML/Axial Offsets, enter 0 0 1
6. Check the Offset by Percent (1.0=100%) (Meters when not checked)
7. Click Apply.

In the image below, the Landmarks are shown in blue.



Create Foot Segments

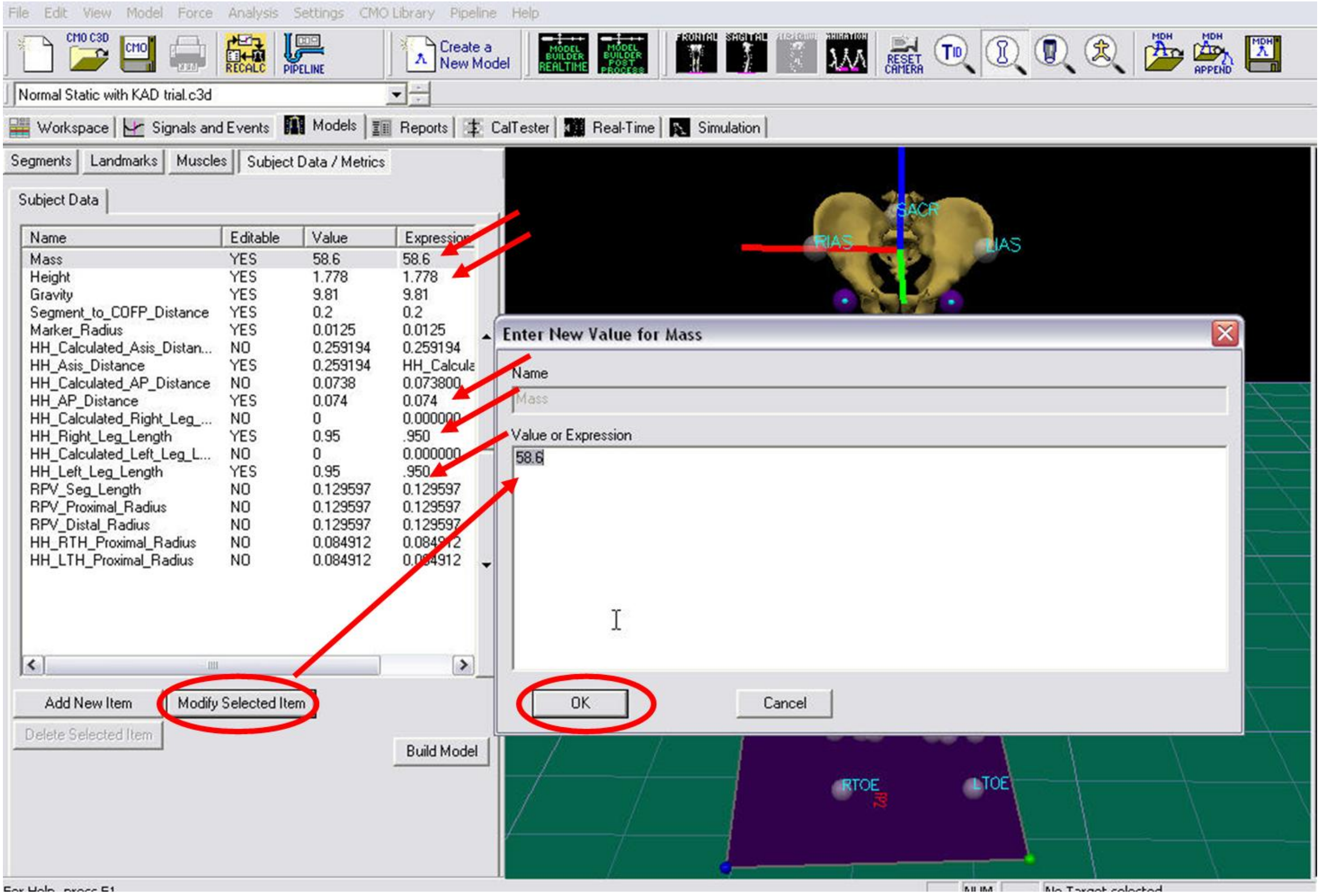
To create the right shank segment:

1. Click Segments tab
2. From the Segment Name box, select Right Foot.
3. From the Segment Type box, select Visual 3D.
4. Click Create.

A dialog will open that will allow us to define the segment. To create a

1. In the Define Proximal Joint and Radius, select RFAL for the Lateral.
2. In the Define Proximal Joint and Radius, select HH_RIGHT_ANKLE for the Joint.
3. In the Define Distal Joint and Radius select RSMH for the Joint.
4. In the Distal Radius box, enter 0.06
5. In the Select Tracking Targets, click HH_RIGHT_ANKLE, RFAL, and RSMH
6. Click Build Model

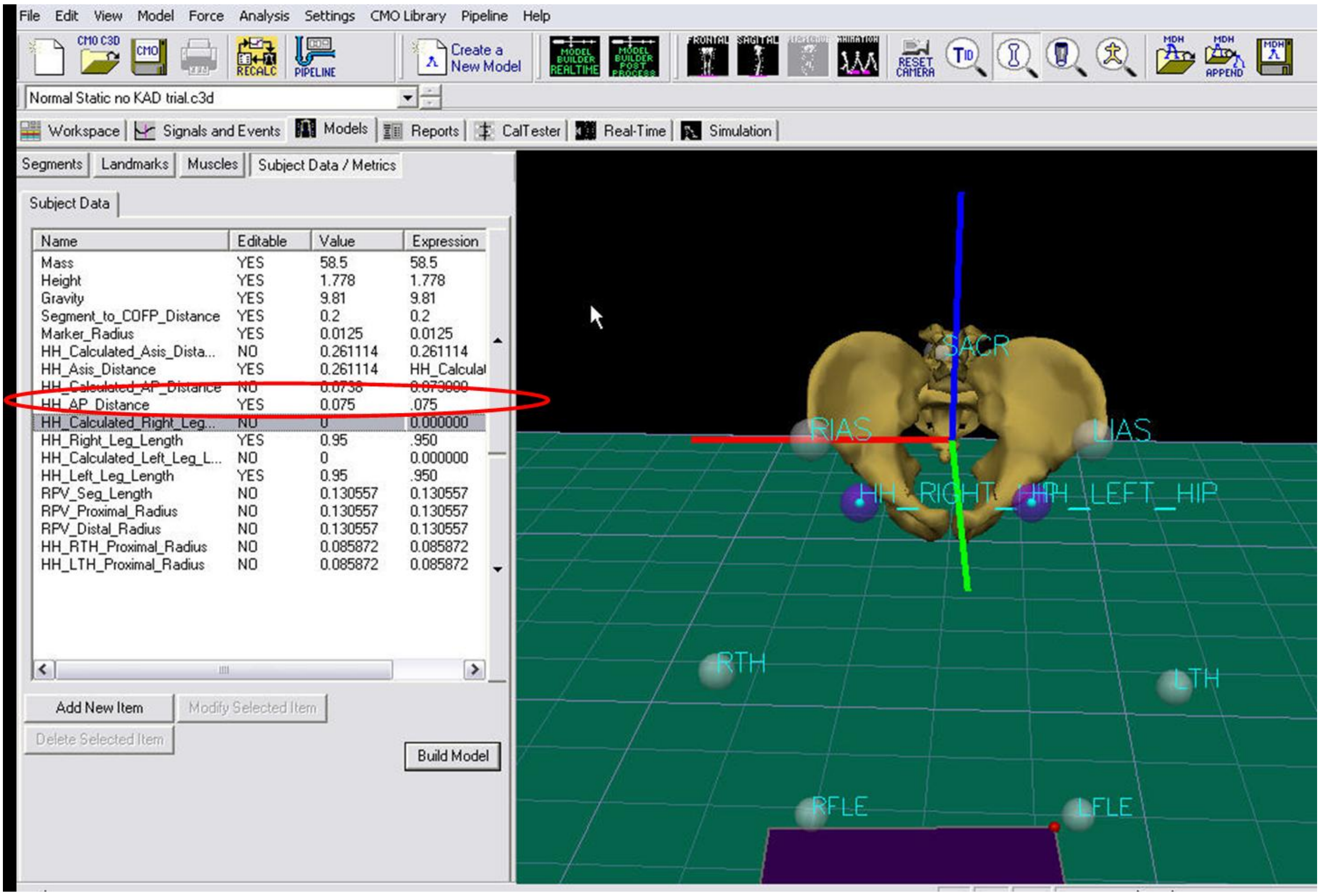
You should now see a foot segment on your standing model. If you do
clicking Build Model, double check the values you entered in the last



To create the left foot segment:

1. Click on Models tab
2. From the Segment Name box, select Left Foot.
3. From the Segment Type box, select Visual 3D.
4. Click Create.
5. In the Define Proximal Joint and Radius section, select LFA for the Lateral.
6. In the Define Proximal Joint and Radius section, select HH_LEFT_ANKLE for the Joint.
7. In the Define Distal Joint and Radius section, select LSMH for the Joint.
8. In the Distal Radius box, enter 0.06
9. In the Select Tracking Targets, click HH_LEFT_ANKLE, LFA, and LSMH
10. Click Build Model

You should now see both foot segments on your standing model.



Summary

This tutorial walked you through some of the variations of the convent
marker placement issues, and gave you 3 examples that you construct
was not meant to be comprehensive and some variations of the model
these listed below:

- Constructing virtual foot segment in Visual 3D for which the alignm
yields the desired joint angle.
- Rotation of thigh segments by entering in a rotation value
- Rotating tibial segments by entering in a tibial torsion rotation off
measures the transmalleor axis on the table and enters in the valu
- Using medial knee markers to define the knee flexion/ext axis
- Using medial ankle markers to define the transmalleolar axis

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