

Virtual Laboratory

A segment coordinate system in Visual3D does not have to be associated with the subject, or even with motion capture data for that matter. We refer to these as virtual segments. **The only distinction between virtual segments and real segments is that typically we set them to be *Kinematic only* segments, which means that they are not included in the Inverse Dynamics calculations.** In all other ways they are just segments and are constructed with the same rules as all segments.

Example: Simple Virtual Laboratory

A Virtual Laboratory is not a physical segment in Visual3D but is equivalent to a physical segment to the effect that it has a Segment Coordinate System that can be used to represent the laboratory (or other objects) and has an associated surface model that can be animated as part of the scene. A typical use of the Virtual Laboratory is to represent the floor so that motion capture markers can be projected onto the floor.

Note: A typical use of the Virtual laboratory is for creating [Normalized Joint Angles and Normalized Segment Angles](#).

Below is a straightforward virtual lab that has a specified constant orientation.

An example of the Simple Virtual Lab can be downloaded [here](#).

Create 4 Landmarks

First, create 4 landmarks **Lab_Origin**, **Lab_X**, **Lab_Y**, and **Lab_Z**. To create these landmarks, go to the **Model** tab and select the **Landmarks** tab.

1. Create Lab_Origin:

The screenshot shows the 'Lab_Origin' dialog box within a software interface. The 'Landmarks' tab is selected, and the 'Lab_Origin' sub-tab is active. The 'Landmark Name' field is set to 'Lab_Origin'. Under 'Define Orientation Using:', the 'Starting Point' is set to '(Reference)'. The 'Existing Segment' is set to 'LAB'. Under 'Landmark Offset from Start Point (Reference) or Segment Origin', the 'Offset Using the Following ML/AP/AXIAL Offsets' is selected, with X, Y, and Z values all set to 0.0. The 'Offset by Percent' checkbox is unchecked, and the 'Calibration Only Landmark' checkbox is also unchecked. At the bottom, there are buttons for 'Undo Changes', 'Apply', 'Build Model', and 'Close Tab'.

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Origin*

Landmark Name: *Lab_Origin*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.0* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

2. Create Lab_X:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_X*

Landmark Name: *Lab_X*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.1* **Y:** *0.0* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Landmarks | Functional | Digitizing | Lab_Origin

Landmark Name: Lab_X

Define Orientation Using:

Starting Point (Reference)

Targets and/or Landmark:

Ending Point (On a line)

*Lateral object (On a plane)

*Project From (Projection onto a line or plane)

* = Optional

Existing Segment LAB

Landmark Offset from Start Point (Reference) or Segment Origin

Offset to Existing Calibration Target or Landmark

Offset Using the Following ML/AP/AXIAL Offsets

X 0.0

Y 0.0

Z 0.0

Offset by Percent (1.0 = 100%) (Meters when not checked)

Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes Apply Build Model Close Tab

3. Create Lab_Y:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Y*

Landmark Name: *Lab_Y*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.1* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

4. Create Lab_Z:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Z*

Landmark Name: *Lab_Z*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.0* **Z:** *0.1*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

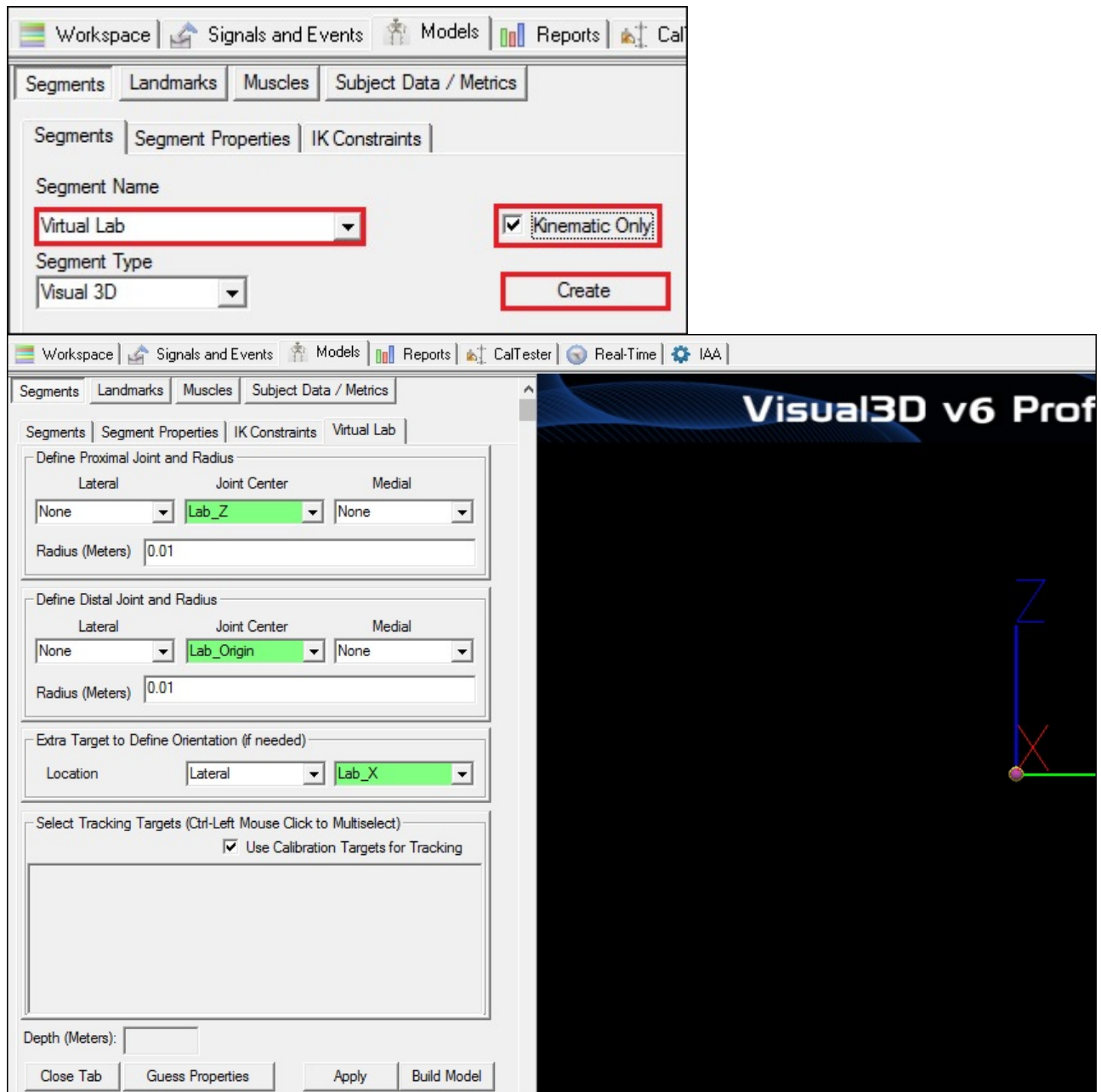
A subset of 3 of these Landmarks can be used to represent the Segment Coordinate System

Create the Virtual Laboratory Segment

To create the Virtual Laboratory segment, switch to the **Segment** Tab in model builder mode.

1. Create the Virtual Lab Segment:

1. In the Segment Name combo box type **Virtual Lab**
2. Check the **Kinematic Only** Check Box
3. Select the **Create** button



4. In the **Virtual Lab** tab, enter these values:

Define Proximal Joint and Radius

Lateral: None **Joint:** Lab_Z **Medial:** None
Radius: 0.01

Define Distal Joint and Radius

Lateral: None **Joint:** Lab_Origin **Medial:** None
Radius: 0.01

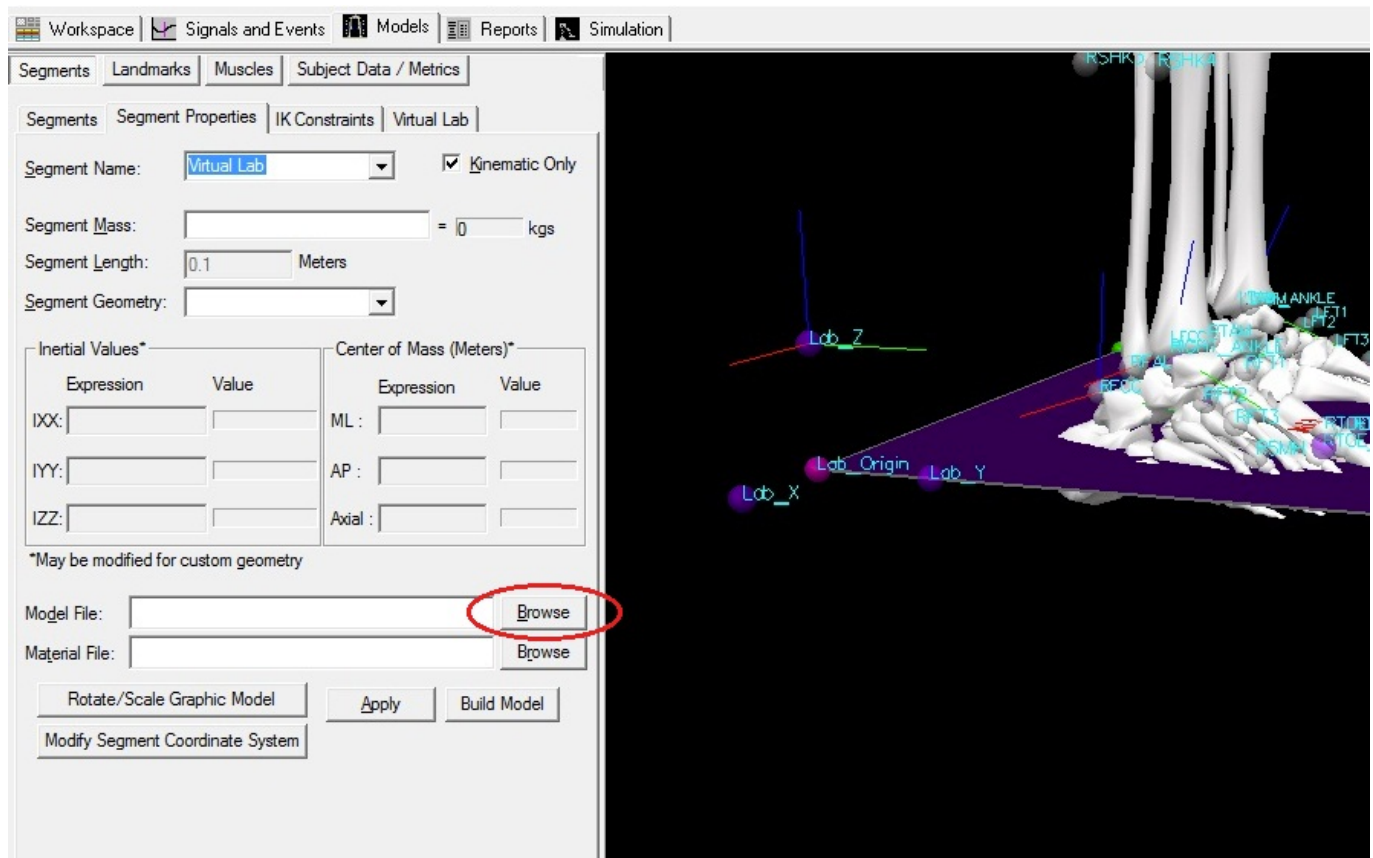
Extra Target to define Orientation **Select:** *Lateral* *Lab_X*

Select Tracking Targets:

Check: *Use Calibration Targets for Tracking*

5. Click on **Build Model**.
6. Click on **Close Tab** before proceeding.

Adding a Surface Model



To add a surface model or graphic switch to the **Segment Properties** Tab.

1. Select **Virtual Lab** as Segment Name.
2. Near the bottom of the dialog **Browse** for a Model File (.obj or .v3g) of your choosing.
3. Select **Apply**.

Note: A surface model need not be applied to the virtual lab.

Example: Virtual segment aligned with a different principal axis of the laboratory

The following example will construct a segment coordinate system that is rotated from the laboratory coordinate system.

An example of a Rotated Virtual Lab can be downloaded [here](#).

Create 3 Landmarks

First, create 3 landmarks **Lab_Origin**, **Lab_Other**, and **Lab_Z**. To create these landmarks, go to the **Model** tab and select the **Landmarks** tab.

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Landmarks | Functional | Digitizing | Lab_Origin

Landmark Name: Lab_Origin

Define Orientation Using:

Starting Point (Reference)

Targets and/or Landmarks:

Ending Point (On a line)

*Lateral object (On a plane)

*Project From (Projection onto a line or plane)

* = Optional

Existing Segment LAB

Landmark Offset from Start Point (Reference) or Segment Origin

Offset to Existing Calibration Target or Landmark

Offset Using the Following ML/AP/AXIAL Offsets

X 0.0

Y 0.0

Z 0.0

Offset by Percent (1.0 = 100%) (Meters when not checked)

Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes Apply Build Model Close Tab

1. Create Lab_Origin:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Origin*

Landmark Name: *Lab_Origin*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.0* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Landmarks | Functional | Digitizing | Lab_Origin | Lab_Other

Landmark Name: Lab_Other

Define Orientation Using:

Starting Point (Reference)

Targets and/or Landmarks:

Ending Point (On a line)

*Lateral object (On a plane)

*Project From (Projection onto a line or plane)

* = Optional

Existing Segment LAB

Landmark Offset from Start Point (Reference) or Segment Origin

Offset to Existing Calibration Target or Landmark

Offset Using the Following ML/AP/AXIAL Offsets

X 0.0

Y 0.1

Z 0.0

Offset by Percent (1.0 = 100%) (Meters when not checked)

Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes Apply Build Model Close Tab

2. Create Lab_Other:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Other*

Landmark Name: *Lab_Other***Define Orientation Using:****Starting Point:** *Leave Blank***Existing Segment:** *LAB*Offset Using the Following **ML/AP/AXIAL** Offsets:**X:** *0.0* **Y:** *0.1* **Z:** *0.0***DO NOT** Check: *Offset by Percent (1.0 = 100%)***DO NOT** Check: *Calibration Only Landmark*

3. Create Lab_Z:

1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: *Lab_Z*

Landmark Name: *Lab_Z*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.0* **Z:** *0.1*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

Create the Virtual Laboratory Segment

To create the Virtual Laboratory segment, switch to the **Segment** Tab in model builder mode and

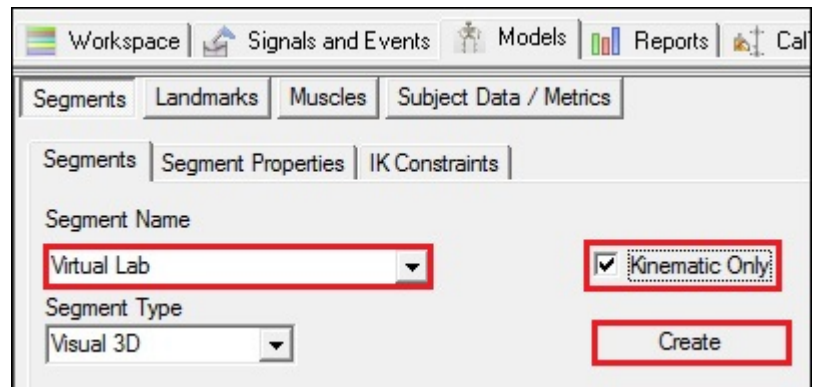
enter the following:

1. Create the Virtual Lab Segment:

1. In the Segment Name combo box type **Virtual Lab**

2. Check the **Kinematic Only** Check Box

3. Select the **Create** button



4. In the **Virtual Lab** tab, enter these values:

Define Proximal Joint and Radius

Lateral: *None* **Joint:** *Lab_Z* **Medial:** *None*

Radius: *0.01*

Define Distal Joint and Radius

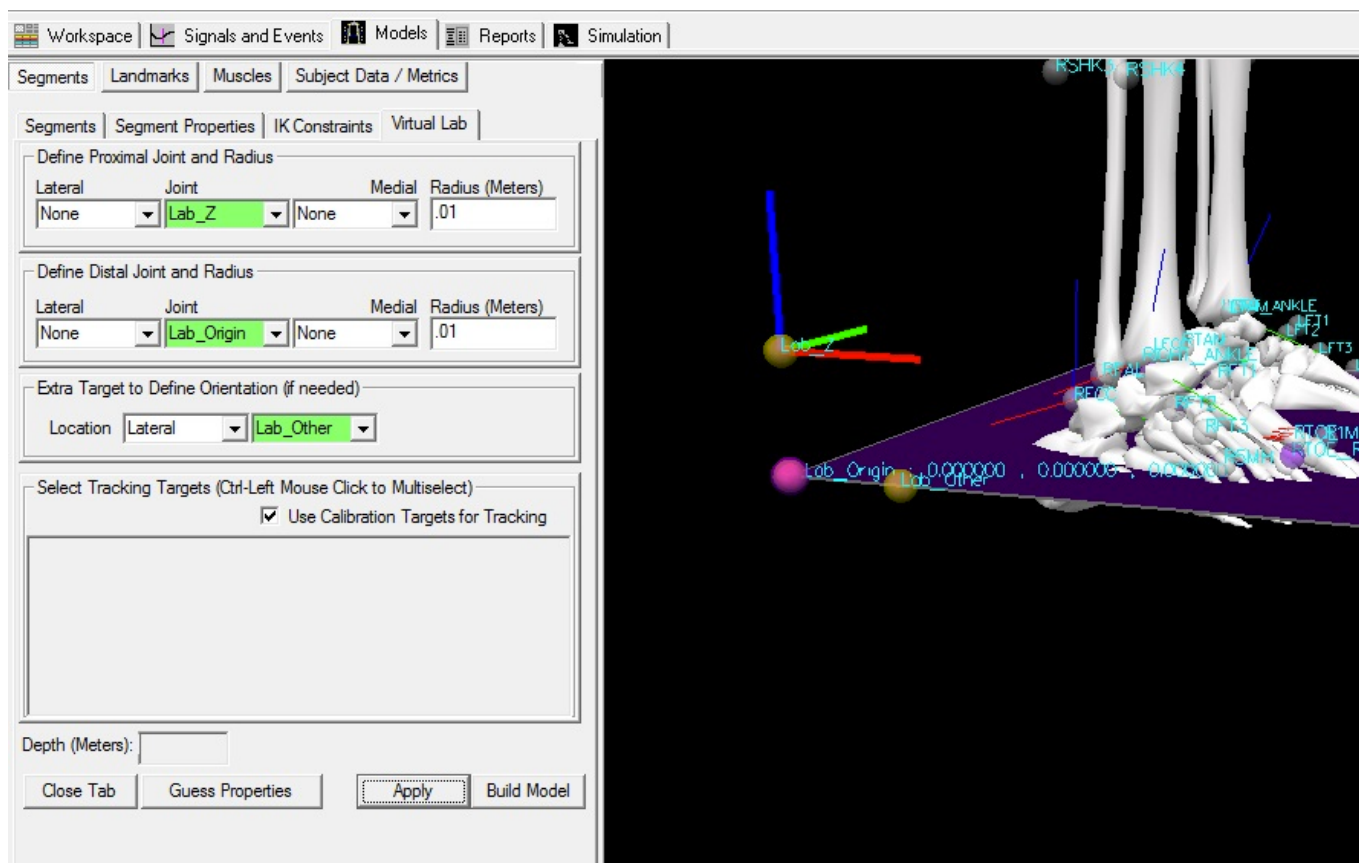
Lateral: *None* **Joint:** *Lab_Origin* **Medial:** *None*

Radius: *0.01*

Extra Target to define Orientation

Select: *Lateral* *Lab_Other*

Select Tracking Targets:



i
on Targets for Tracking

5. Click on **Build Model**.

6. Click on **Close Tab** before proceeding.

We have just created a virtual lab that is aligned with a different axis of the lab coordinate system (rotated).

Example: Creating a virtual laboratory that changes with the direction of walking

In this example file (Example3.cmo) the subject is walking in the anterior direction in one walking trial and walking in the posterior direction of the laboratory coordinate system (LAB) in the other trial. If the pelvis angle is defined as the pelvis with respect to the laboratory, the data are rotated 180 degrees from the desired angle for one of the trials (see *Pelvis Angle wrt Lab*). To create a pelvis angle that makes intuitive sense (e.g. in the direction of walking), a virtual lab segment was created. The pelvis angle can then be defined with respect to the virtual lab (see *Pelvis Angle wrt Virtual Lab*). In Example2.cmo the virtual laboratory was defined statically. But, in this example (Example3.cmo), the Virtual lab is defined relative to the lateral direction of the pelvis segment; the lateral direction is forced to lie along one of the principal axes rather than to float with the pelvis.

An example of a Virtual Lab which changes with the direction of walking can be downloaded [here](#).

See Also [A virtual lab with 4 possible orientations](#)

Create 3 Landmarks

Create 2 landmarks **Lab_Origin**, **Lab_X**, and **Lab_Z**. To create these landmarks, go to the **Model** tab and select the **Landmarks** tab.

1. Create Lab_Origin:

Click **Landmarks** button

Click **Add New Landmark** button

Create Landmark: *Lab_Origin*

Landmark Name: *Lab_Origin*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.0* **Y:** *0.0* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

The screenshot shows the 'Lab_Origin' landmark creation dialog box. The 'Landmarks' tab is selected. The 'Landmark Name' is 'Lab_Origin'. Under 'Define Orientation Using:', 'Existing Segment' is selected and set to 'LAB'. Under 'Landmark Offset from Start Point (Reference) or Segment Origin', 'Offset Using the Following ML/AP/AXIAL Offsets' is selected, with X, Y, and Z all set to 0.0. The 'Offset by Percent' checkbox is unchecked. The 'Calibration Only Landmark' checkbox is also unchecked. At the bottom are buttons for 'Undo Changes', 'Apply', 'Build Model', and 'Close Tab'.

2. Create Lab_X:

Click **Landmarks** button
Click **Add New Landmark** button
Create Landmark: *Lab_X*

Landmark Name: *Lab_Other*

Define Orientation Using:
Starting Point: *Leave Blank*
Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: *0.1* **Y:** *0.0* **Z:** *0.0*

DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Landmarks | Functional | Digitizing | Lab-Origin

Landmark Name: Lab_X

Define Orientation Using:

Starting Point (Reference)

Targets and/or Landmark:

Ending Point (On a line)

*Lateral object (On a plane)

*Project From (Projection onto a line or plane)

* = Optional

Existing Segment LAB

Landmark Offset from Start Point (Reference) or Segment Origin

Offset to Existing Calibration Target or Landmark

Offset Using the Following ML/AP/AXIAL Offsets

X 0.0

Y 0.0

Z 0.0

Offset by Percent (1.0 = 100%) (Meters when not checked)

Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes Apply Build Model Close Tab

3. Create Lab_Z:

Click **Landmarks** button
 Click **Add New Landmark** button
 Create Landmark: *Lab_Z*

Landmark Name: *Lab_Z*

Define Orientation Using:

Starting Point: *Leave Blank*

Existing Segment: *LAB*

Offset Using the Following **ML/AP/AXIAL**
 Offsets:

X: 0.0 Y: 0.0 Z: 0.1 DO NOT Check:
Offset by Percent (1.0 = 100%)\\DO NOT
 Check: *Calibration Only Landmark*

Create a Landmark from the Pelvis lateral axis projected onto a Laboratory Axis

Create a landmark **Pelvis_Lateral** 10 cm from the Laboratory Origin in the lateral direction of the Pelvis. Create another landmark **Pelvis_Lateral_Projected** that projects **Pelvis_Lateral** onto a line formed by the **Lab_Origin** and **Lab_X** landmarks. Then create a landmark

1. Create Pelvis_Lateral:

Click **Landmarks** button
Click **Add New Landmark** button
Create Landmark: *Pelvis_Lateral*

Landmark Name: *Pelvis_Lateral*

Define Orientation Using:
Starting Point: *Lab_Origin*
Existing Segment: *Pelvis*

Offset Using the Following **ML/AP/AXIAL** Offsets:

X: 0.1 Y: 0.0 Z: 0.0 **DO NOT** Check:
Offset by Percent (1.0 = 100%)
DO NOT Check: *Calibration Only*
Landmark

The screenshot shows the Visual3D software interface with the 'Landmarks' tab selected. The 'Pelvis Lateral' landmark is being defined. The 'Landmark Name' is 'Pelvis Lateral'. The 'Define Orientation Using' section is active, with 'Starting Point' set to 'Lab Origin' (Reference). The 'Existing Segment' is 'Pelvis'. The 'Landmark Offset from Start Point (Reference) or Segment Origin' section is also active, with 'Offset Using the Following ML/AP/AXIAL Offsets' selected. The offsets are: ML: 0.1, AP: 0.0, AXIAL: 0.0. The 'Offset by Percent (1.0 = 100%) (Meters when not checked)' checkbox is unchecked. The 'Calibration Only Landmark (Not generated for assigned motion file(s))' checkbox is also unchecked. At the bottom, there are buttons for 'Undo Changes', 'Apply', 'Build Model', and 'Close Tab'.

2. Create Pelvis_Lateral_Projected:

Click **Landmarks** button Click **Add New Landmark** button
 Create Landmark:
Pelvis_Lateral_Projected

Landmark Name:
Pelvis_Lateral_Projected

Define Orientation Using:
Starting Point: *Lab_Origin*
Ending Point: *Lab_X*
Project From: *Pelvis_Lateral*

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Landmarks | Functional | Digitizing | Pelvis Lateral | Pelvis Lateral Projected

Landmark Name:

Define Orientation Using:

Starting Point (Reference)

☒ Targets and/or Landmarks: Ending Point Landmark Is: (On a line)

*Lateral object (On a plane)

*Project From (Projection onto a line or plane)

* = Optional

☐ Existing Segment

Landmark Offset from Start Point (Reference) or Segment Origin

☐ Offset to Existing Calibration Target or Landmark

☒ Offset Using the Following ML/AP/AXIAL Offsets

ML

AP

AXIAL

☐ Offset by Percent (1.0 = 100%) (Meters when not checked)

☐ Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes | Apply | Build Model | Close Tab

DO NOT Check: *Offset by Percent (1.0 = 100%)* **DO NOT** Check: *Calibration Only Landmark*

3. Create Lab_Lateral:

Workspace | Signals and Events | Models | Reports | Cal

Segments | Landmarks | Muscles | Subject Data / Metrics

Digitizing | Pelvis Lateral | Pelvis Lateral Projected | Lab Lateral

Landmark Name:

Define Orientation Using:

Starting Point: (Reference)

☒ Targets and/or Landmarks:

Ending Point: (On a line)

*Lateral object: (On a plane)

*Project From: (Projection onto a line or plane)

* = Optional

☐ Existing Segment:

Landmark Offset from Start Point (Reference) or Segment Origin

☐ Offset to Existing Calibration Target or Landmark:

☒ Offset Using the Following ML/AP/AXIAL Offsets

ML:

AP:

AXIAL:

☐ Offset by Percent (1.0 = 100%) (Meters when not checked)

☐ Calibration Only Landmark (Not generated for assigned motion file(s))

Undo Changes | Apply | Build Model | Close Tab

Click **Landmarks** button

Click **Add New Landmark** button

Create Landmark: *Lab_Lateral*

Landmark Name: *Lab_Lateral*

Define Orientation Using:

Starting Point: *Lab-Origin*

Ending Point: *Pelvis_Lateral_Projected*

Offset Using the Following **AXIAL** Offset: *0.1*

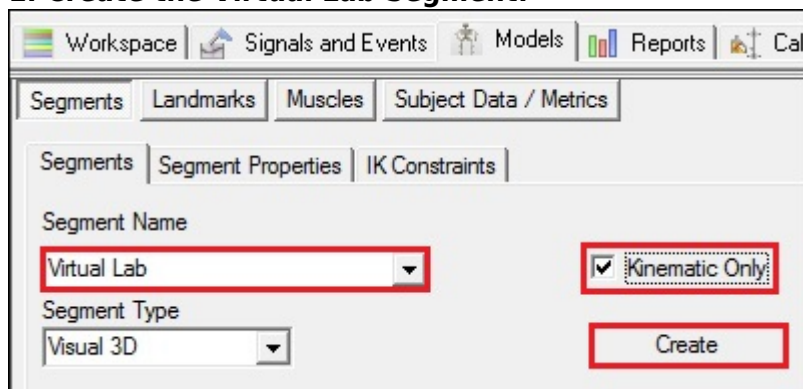
DO NOT Check: *Offset by Percent (1.0 = 100%)*

DO NOT Check: *Calibration Only Landmark*

Create Virtual Laboratory Segment

To create the Virtual Laboratory segment, switch to the **Segment** Tab in model builder mode and enter the following:

1. Create the Virtual Lab Segment:



1. In the Segment Name combo box type **Virtual Lab**

2. Check the **Kinematic Only** Check Box

3. Select the **Create** button

4. In the **Virtual Lab** tab, enter these values:

Define Proximal Joint and Radius

Lateral: *None* **Joint:** *Lab_Z* **Medial:** *None*

Radius: *0.01*

Define Distal Joint and Radius

Lateral: *None* **Joint:** *Lab_Origin* **Medial:** *None*

Radius: *0.01*

Extra Target to define Orientation

Select: *Lateral* *Lab_Lateral*

Select Tracking Targets:

Check: *Use Calibration Targets for Tracking*

5. Click on **Build Model**.

6. Click on **Close Tab** before proceeding.

The screenshot shows the 'Virtual Lab' configuration window in the Visual3D software. The window has a top menu bar with 'Workspace', 'Signals and Events', 'Models', 'Reports', and 'CalT'. Below this is a sub-menu bar with 'Segments', 'Landmarks', 'Muscles', and 'Subject Data / Metrics'. The 'Virtual Lab' sub-menu is active, showing options for 'Segments', 'Segment Properties', 'IK Constraints', and 'Virtual Lab'. The 'Virtual Lab' panel contains several sections: 'Define Proximal Joint and Radius' with dropdowns for 'Lateral' (None), 'Joint Center' (Lab Z), and 'Medial' (None), and a 'Radius (Meters)' field set to 0.001; 'Define Distal Joint and Radius' with dropdowns for 'Lateral' (None), 'Joint Center' (Lab Origin), and 'Medial' (None), and a 'Radius (Meters)' field set to 0.001; 'Extra Target to Define Orientation (if needed)' with a 'Location' dropdown set to 'Lateral' and a 'Lab Lateral' dropdown; 'Select Tracking Targets (Ctrl-Left Mouse Click to Multiselect)' with a checked box for 'Use Calibration Targets for Tracking'; and a 'Depth (Meters)' field. At the bottom are buttons for 'Close Tab', 'Guess Properties', 'Apply', and 'Build Model'.

We have just created a virtual lab that is aligned with the direction of progression of the subject.

Example: Virtual Lab Not Aligned with the Lab Axes

What if the subject is not walking along the lab axes? What if the subject is walking at a diagonal?

To calculate certain measures, such as the trunk angle relative to the lab, the virtual lab should be aligned with the subject's direction of progression. Although there are many methods to do this, some examples can be found [here](#).

From:

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Last update: **2026/02/06 19:30**

