IOR Gait Full Body Model

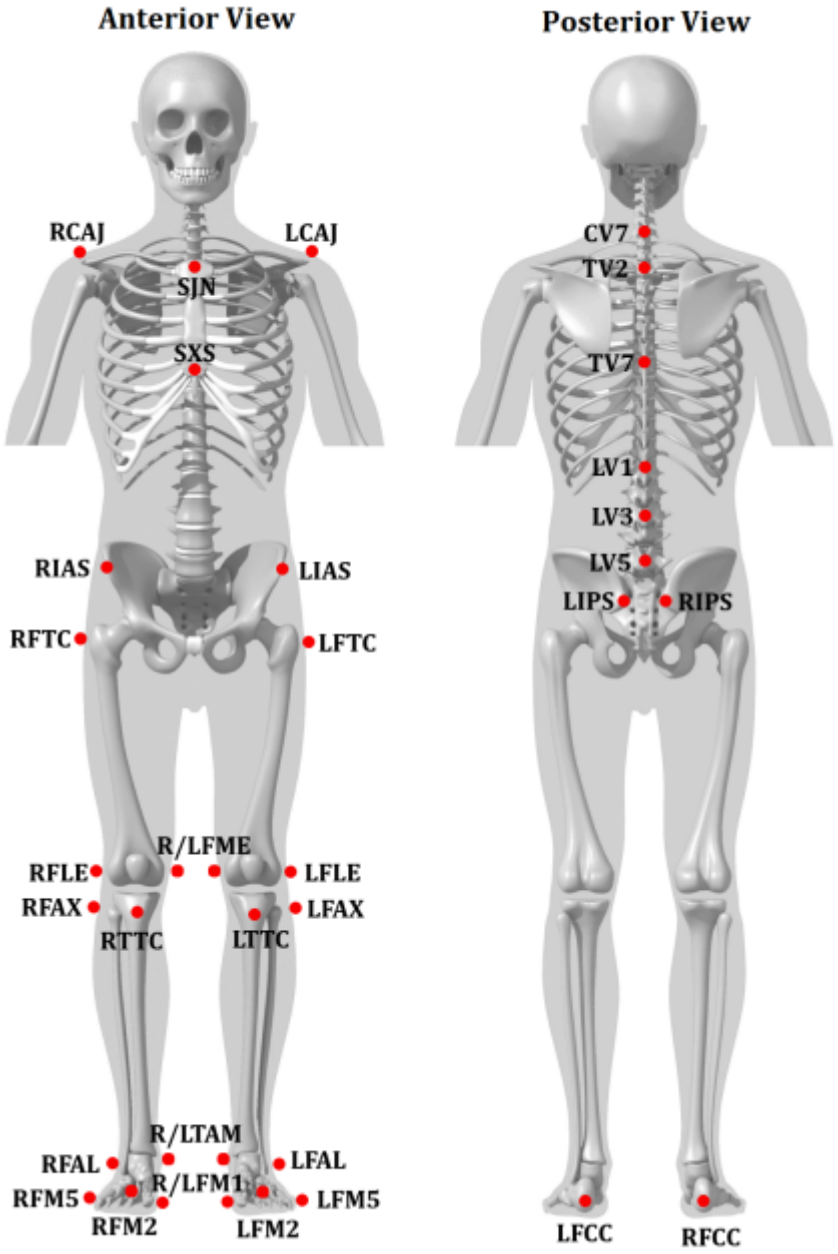
This tutorial explains how to implement the IOR Full Body Model in Visual3D. The IOR Full Body Model is a combination of the IOR Multi-Segment Trunk, and the IOR Lower Extremity Model. The naming convention in this tutorial follows Serge Van Sint Jan's convention.

Downloads

Sample files may be downloaded here. The zip file contains:

1. C3D files which you can use to follow along with the tutorial
2. A model template which contains the landmark & segment definitions
3. A script which contains the planar & joint angle definitions
4. A report template which plots the relevant kinematics (joint angles & planar angles)
5. A completed CMO file

Target Placement



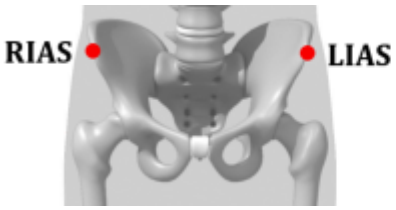
LCAJ/RCAJ (LA/RA): Left/Right acromion
SJN (IJ): Deepest point of the incisura jugularis
SXS (PX): Xiphoid process, i.e. most caudal point of the sternum
CV7 (C7): Spinous process of the seventh cervical vertebrae
TV2 (T2): Second thoracic vertebrae
TV7 (MAI): Midpoint between the inferior angles of the most caudal points of the two scapulae
LV1, LV3, LV5 (L1, L3, L5): First, third and fifth lumbar vertebrae
LIAS/RIAS (LASIS/RASIS): Left/Right anterior superior iliac spine
LIPS/RIPS (LPSIS/RPSIS): Left/Right posterior superior iliac spine
LFTC/RFTC (LGT/RGT): Most lateral prominence of the greater trochanter
LFLE/RFLE (LLE/RLE): Most medial prominence of the medial femoral epicondyle
LFME/RFME (LME/RME): Most medial prominence of the medial femoral epicondyle
LFAX/RFAX (LHF/RHF): Proximal tip of the head of the fibula
LTTC/RTTC (TT/RTT): Most anterior border of the tibial tuberosity
LFAL/RFAL (LLM/RLM): Lateral prominence of the lateral malleolus

LTAM/RTAM (LMM/RMM): Most medial prominence of the medial malleolus
LFCC/RFCC (LCA/RCA): Aspect of the Achilles tendon insertion on the calcaneus
LFM1/RFM1 (LFM/RFM): Dorsal margin of the first metatarsal head
LFM2/RFM2 (LSM/RSM): Dorsal aspect of the second metatarsal head
LFM5/RFM5 (LVM/RVM): Dorsal margin of the fifth metatarsal head

Segment Definitions

Pelvis

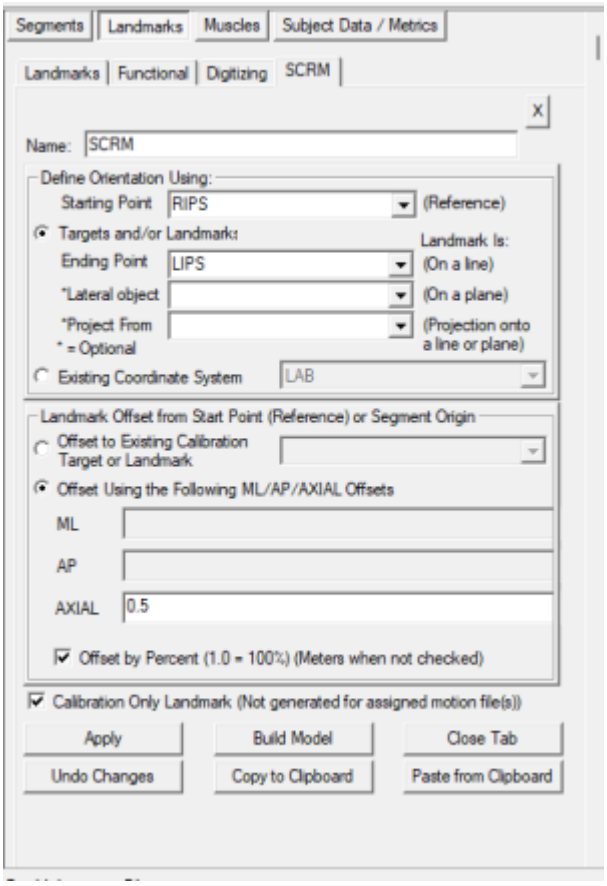
The pelvis segment coordinate system is consistent with the CODA pelvis, from which the Left and Right Hip Joint centers are automatically created.



LIAS/RIAS (LASIS/RASIS): Left/Right anterior superior iliac spine
LIPS/RIPS (LPSIS/RPSIS): Left/Right posterior superior iliac spine

Pelvis Landmarks

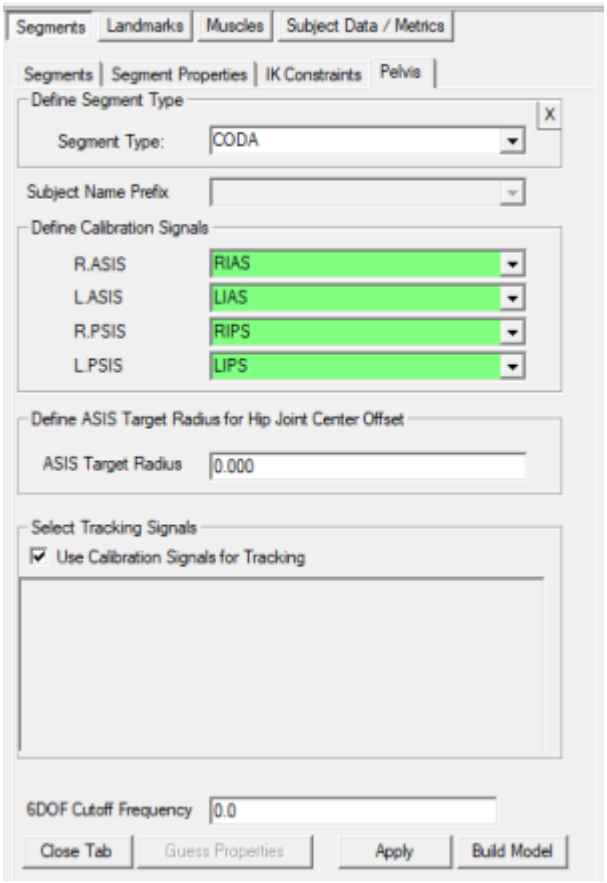
1. Create SCRM:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: SCRM
    - **Landmark Name:** SCRM
    - **Define Orientation Using:**
    - **Starting Point:** RIPS
    - **Ending Point:** LIPS
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **X:** 0.0 **Y:**0.0 **Z:**0.5
5. **Check:** Offset by Percent (1.0 = 100%)
6. **Check:** Calibration Only Landmark

Pelvis Definition

2. Create Pelvis Segment:



1. In the **Segments** tab, select *Pelvis* in the Segment Name box
2. In **Segment Type**, select CODA
3. Click on the **Create Segment** button
4. In the **Pelvis** dialog:
    - **Define Calibration Targets**

    - **R.ASIS:** RIAS
    - **L.ASIS:** LIAS
    - **R.PSIS:** RIPS
    - **L.PSIS:** LIPS
    - **Select Tracking Targets:**
    - **Check:** Use Calibration Signals for Tracking
5. Clost **CODA Segment Markers** dialog box
6. Click on **Build Model**
7. Click on **Close Tab** before proceeding

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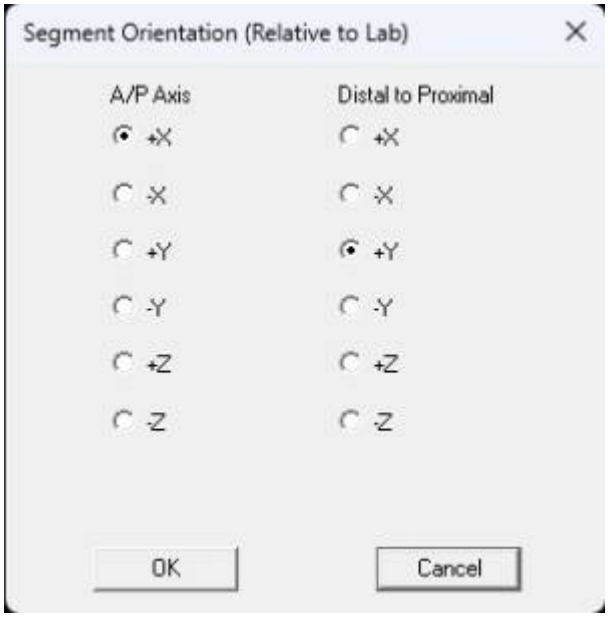
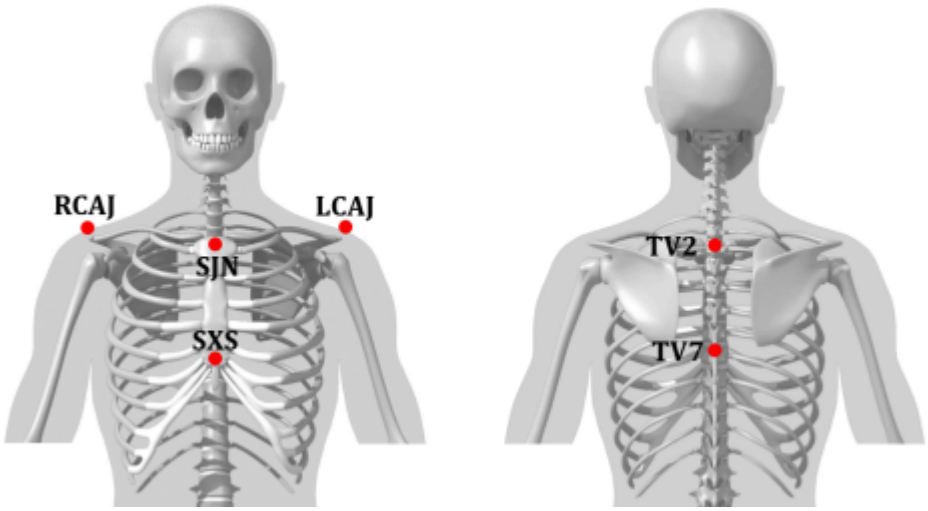
3. Modify the Segment Coordinate System



- Define the Segment Orientation as:
    - **A/P Axis:** +X
    - **Distal to Proximal:** +Y

Thorax Segment

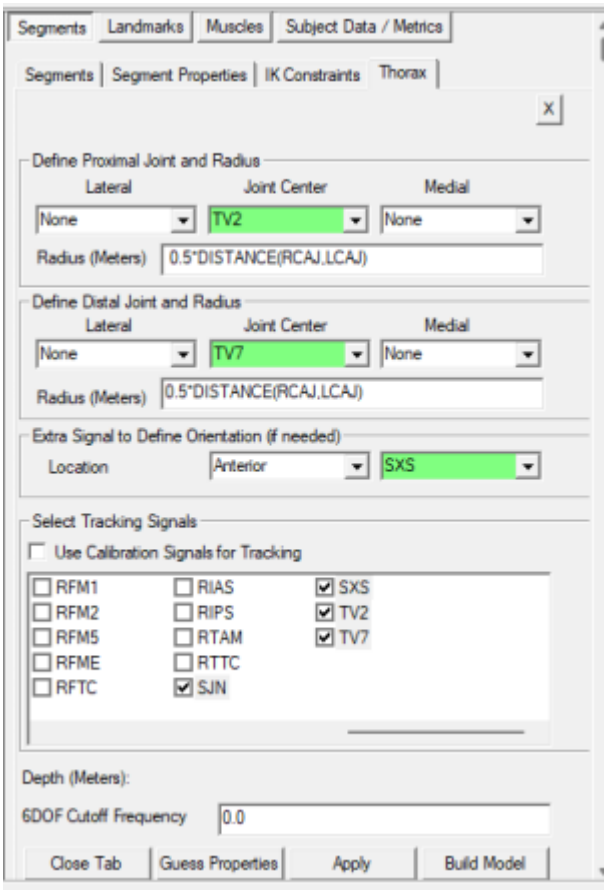
This marker set is consistent with the Rizzoli Gait model and the ISB recommendations.



LCAJ/RCAJ (LAR/RA): Left/Right acromion
SJN (IJ): Deepest point of the incisura jugularis
SXS (PX): Xiphoid process, i.e. most caudal point of the sternum
C7V (C7): Spinous process of the seventh cervical vertebrae
TV2 (T2): Second thoracic vertebrae
TV7 (MAI): Midpoint between the inferior angles of the most caudal points of the two scapulae

Thorax Definition

4. Create Thorax/Ab:



1. In the **Segments** tab, select *Thorax/Ab* in the Segment Name box.

2. Click **Kinematic Only**
3. Click on the **Create Segment** button
4. In the **Thorax/Ab** tab, enter these values:
    - **Define Proximal Joint and Radius**
    - **Lateral:** None **Joint:** TV2 **Medial:** None
    - **Radius** 0.5*DISTANCE(RCAJ,LCAJ)
    - **Define Distal Joint and Radius**
    - **Lateral:** None **Joint:** TV7 **Medial:** None
    - **Radius:** 0.5*DISTANCE(RCAJ,LCAJ)
    - **Extra Target to Define Orientation**
    - **Location:** Anterior SXS
    - **Select Tracking Targets:**
    - SJN, SXS, TV2, TV7
5. Click on **Build Model**
6. Click on **Close Tab** before proceeding.

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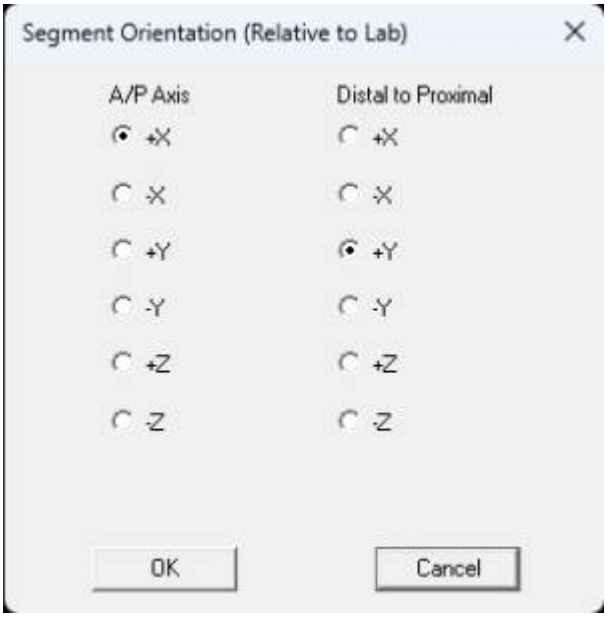
5. Modify the Segment Coordinate System ** * **Define the Segment Orientation as:** * **A/P Axis:** +X



- **Distal to Proximal:** +Y

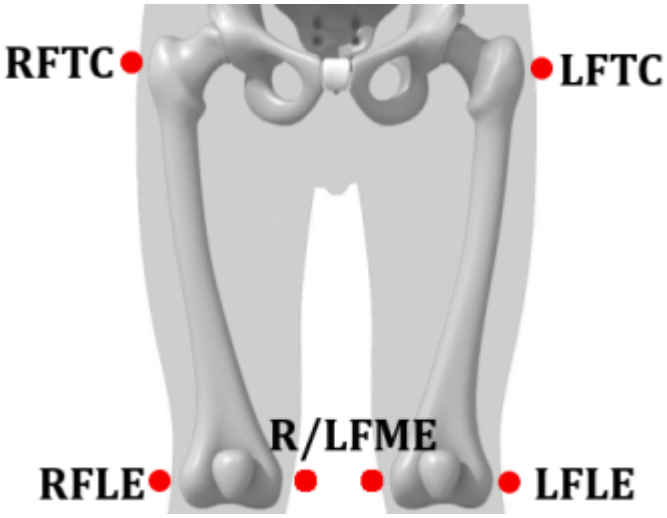
Change the graphic:

Model File: *thoraciccervicleacromiumtot12.v3g*

Thigh Segment

The RIGHT_HIP/LEFT_HIP landmarks are used to define the thigh segments. These landmarks are

created automatically when the Pelvis segment is defined (so the Pelvis must be defined prior to creating the thigh segments).



LFTC/RFTC (LGT/RGT): Most Lateral prominence of the greater trochanter
LFKE/RFLE (LLE/RLE): Most lateral prominence of the lateral femoral epicondyle
LFME/RFME (LME/RME): Most medial prominence of the medial femoral epicondyle

Thigh Definition

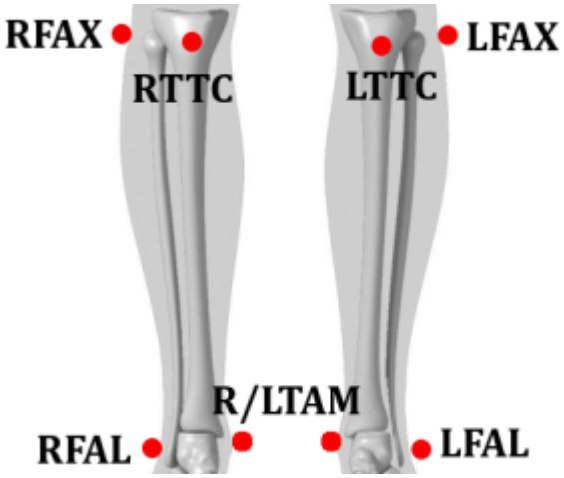
6. Create Right Thigh:

1. In the **Segments** tab, select Right Thigh in the Segment Name box
2. Click on the **Create Segment** button
3. In the **Right Thigh** tab, enter these values:
    - **Define Proximal Joint and Radius**
    - **Lateral:** None **Joint** RIGHT_HIP **Medial:** None
    - **Radius:** 0.5*DISTANCE(RIGHT_HIP,LEFT_HIP)
    - **Define Distal Joint and Radius**
    - **Lateral:** RFLE **Joint:** None **Medial:** RFME
    - **Select Tracking Targets:**
    - RIGHT_HIP,RFLE,RFME,RFTC
4. Click on **Build Model**
5. Click on **Close Tab** before proceeding

Shank Segment

The segment coordinate system is different from the conventional gait model because the shank

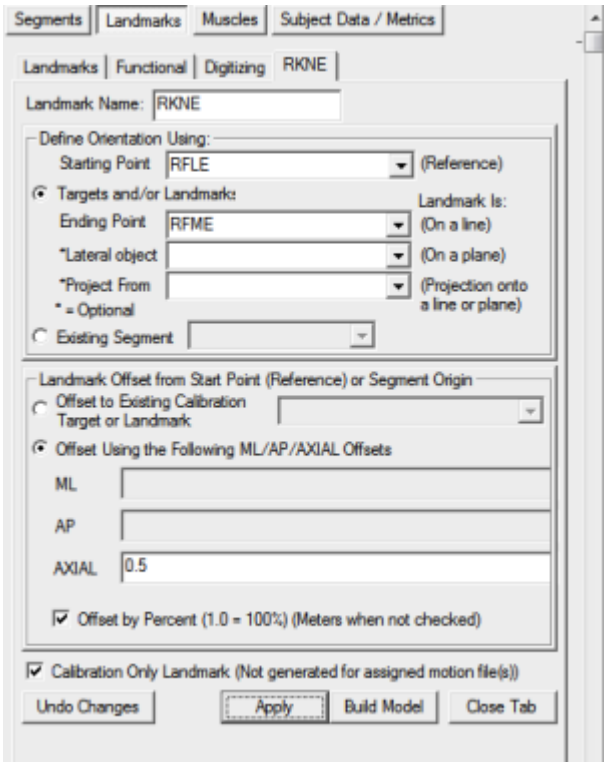
segment is designed according to markers located on the tibia and fibula, not the femur as with the Conventional Gait Model



LFAX/RFAX (LHF/RHF): Proximal tip of the head of the fibula
LTTC/RTTC (TT/RTT): Most anterior border of the tibial tuberosity
LFAL/RFAL (LLM/RLM): Lateral prominence of the lateral malleolus
LTAM/RTAM (LMM/RMM): Most medial prominence of the medial malleolus

Shank Landmarks

7. Create RKNE Joint Center:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: RKNE
    - **Landmark Name:** RKNE
    - **Define Orientation Using:**
    - **Starting Point:** RFLE

- **Ending Point:** RFME

4. Offset Using the Following **AXIAL** Offset: 0.5
5. **Check:** Offset by Percent (1.0 = 100%)
6. **Check:** Calibration Only Landmark

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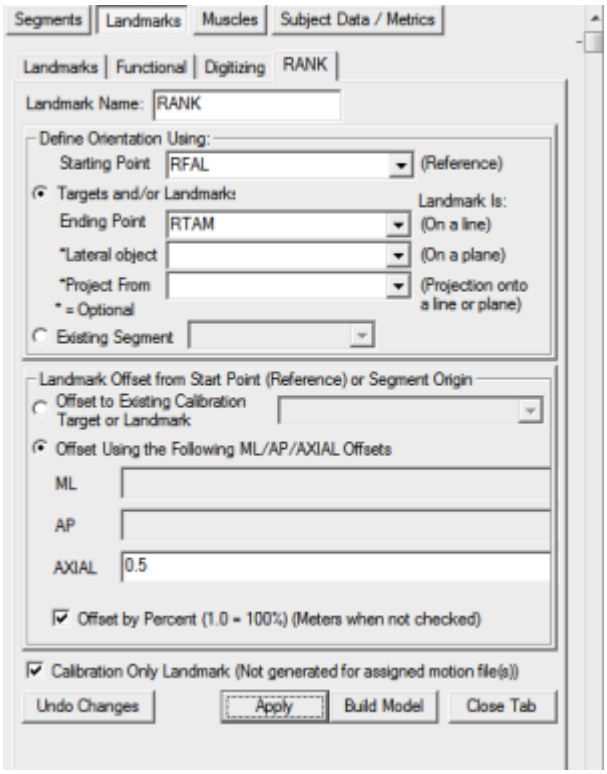
8. Create RANK Joint Center:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: RANK
   - **LANDMARK Name:** RANK
   - **Define Orientation Using:**
   - **Starting Point:** RFAL
   - **Ending Point:** RTAM
4. Offset Using the Following **AXIAL** Offset: 0.5
5. **Check:** Offset by Percent (1.0 = 100%)
6. **Check:** Calibration Only Landmark

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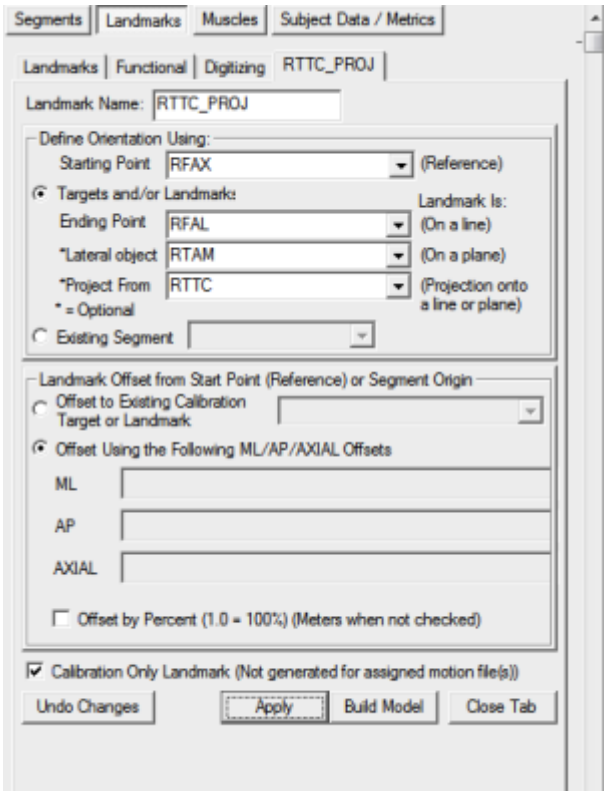
9. Create RTTC_PROJ:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: RTTC_PROJ
    - **Landmark Name:** RTTC_PROJ
    - **Define Orientation Using:**
    - **Starting Point:** RFAX
    - **Ending Point:** RFAL
    - **Lateral Object:** RTAM
    - **Project From:** RTTC
4. **Do Not Check:** Offset by Percent (1.0 = 100%)
5. **Check:** Calibration Only Landmark

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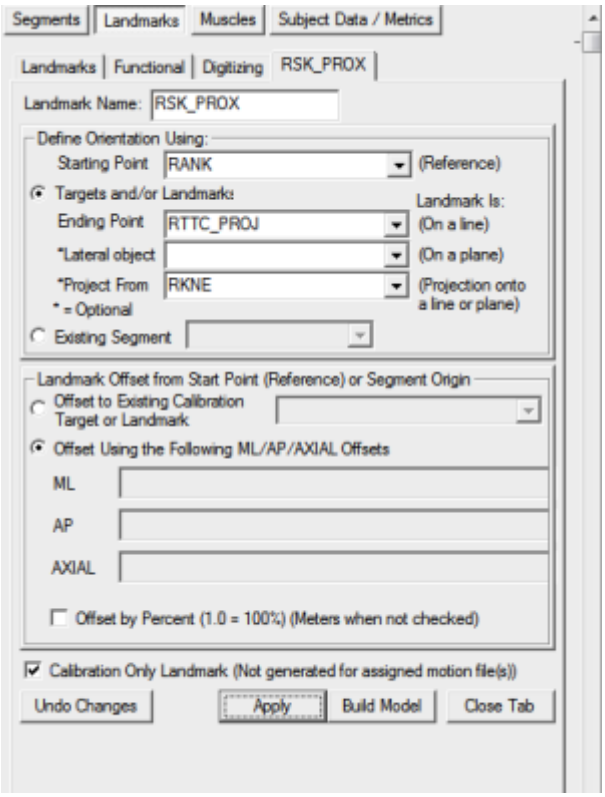
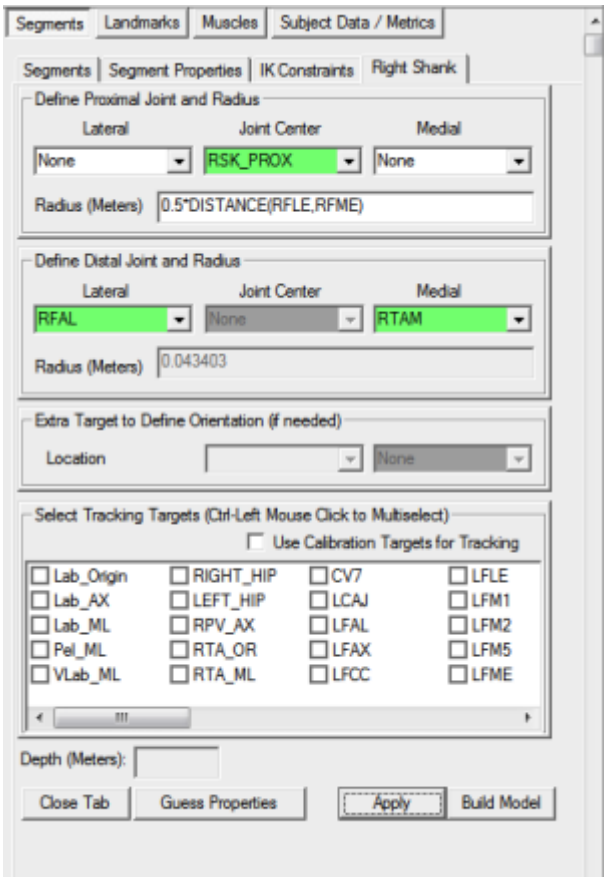
10. Create RSK_PROX:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: RSK_PROX
    - **Landmark Name:** RSK_PROX
    - **Define Orientation Using:**
    - **Starting Point:** RANK
    - **Ending Point:** RTTC_PROJ
    - **Lateral Object:** Leave Blank
    - **Project From:** RKNE
4. **Do NOT Check:** Offset by Percent (1.0 = 100%)
5. **Check:** Calibration Only Landmark

Shank Definition



11. Create Right Shank:

1. In the **Segments** tab, select Right Shank in the Segment Name box
2. Click on the **Create Segment** button
3. In the **Right Shank** tab, enter these values:
    - **Define Proximal Joint and Radius**
    - **Lateral:** None **Joint:** RSK_PROX **Medial:** None
    - **Radius:** 0.5*DISTANCE(RFLE,RFME)
    - **Define Distal Joint and Radius**
    - **Lateral:** RFAL **Joint:** None **Medial:** RTAM
    - **Select Tracking Targets:**
    - RFAL, RFAX, RTAM, RTTC

12. Modify the Segment Coordinate System:

- Define the Segment Orientation as:
- **A/P Axis:** +X
- **Distal to Proximal:** +Y

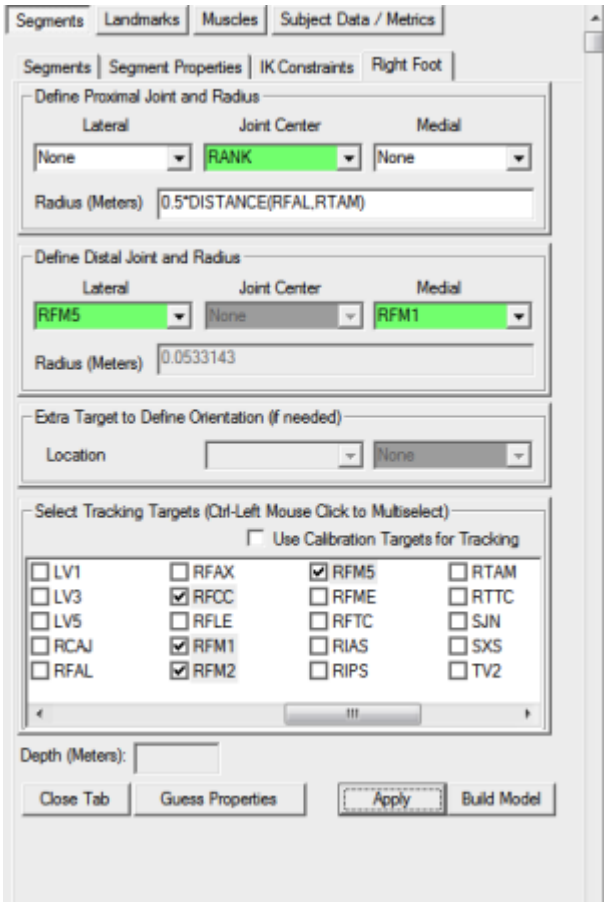
Foot Segment

The foot segment coordinate system is consistent with some version of the Conventional Gait Model. The foot segment is created using the RANK/LANK landmarks which are described in the Shank Landmarks section

LFAL/RFAL (LLM/RLM): Lateral prominence of the lateral malleolus
LTAM/RTAM (LMM/RMM): Most medial prominence of the medial malleolus
LFCC/RFCC (LCA/RCA): Aspect of the achilles tendon insertion on the calcaneous
LFM1/RFM1 (LFM/RFM): Dorsal margin of the first metatarsal head
LFM2/RFM2 (LSM/RSM): Dorsal aspect of the second metatarsal head
LEFM5/RFM5 (LVM/RVM): Dorsal margin of the fifth metatarsal head

Kinetic Foot

13. Create Right Foot:



1. In the **Segments** tab, select the Right Foot in the Segment Name box
2. Click on the **Create Segment** button
3. In the **Right Foot** tab, enter these values:
    - **Define Proximal Joint and Radius**
    - **Lateral:** None **Joint:** RANK **Medial:** None
    - **Radius:** 0.5*DISTANCE(RFAL,RTAM)
    - **Define Distal Joint and Radius**

- **Lateral:** RFM5 **Joint:** None **Medial:** RFM1
- **Select Tracking Targets:**
- RFCC, RFM1, RFM2, RFM5

4. Click on the **Build Model**
5. Click on **Close Tab** before proceeding

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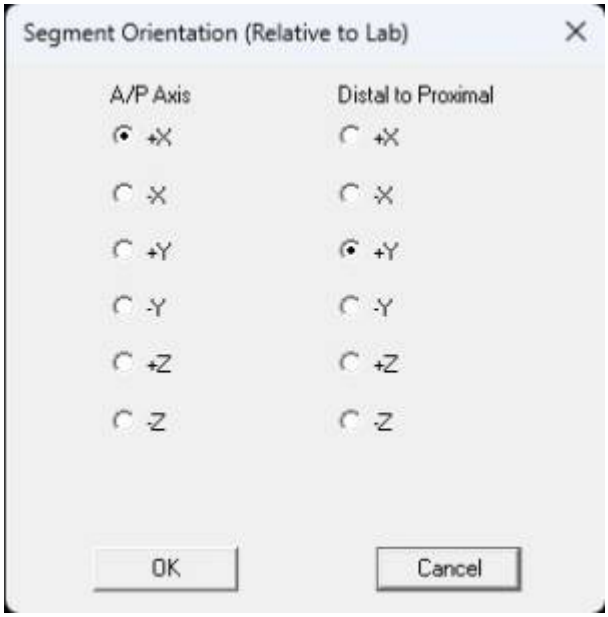
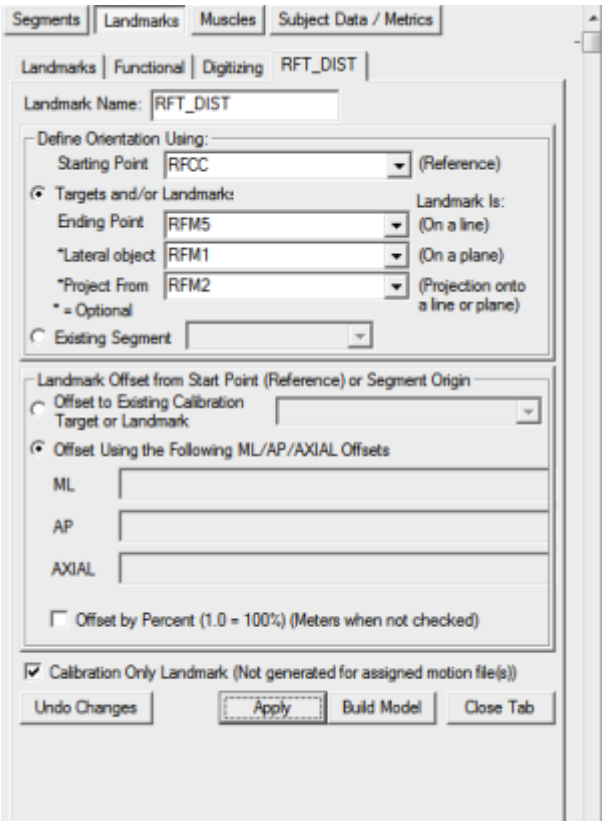
14. Modify the Segment Coordinate System:



- Define the Segment Orientation as:
  - **A/P Axis:** +X
  - **Distal to Proximal:** +Y

Kinematic Foot Landmarks

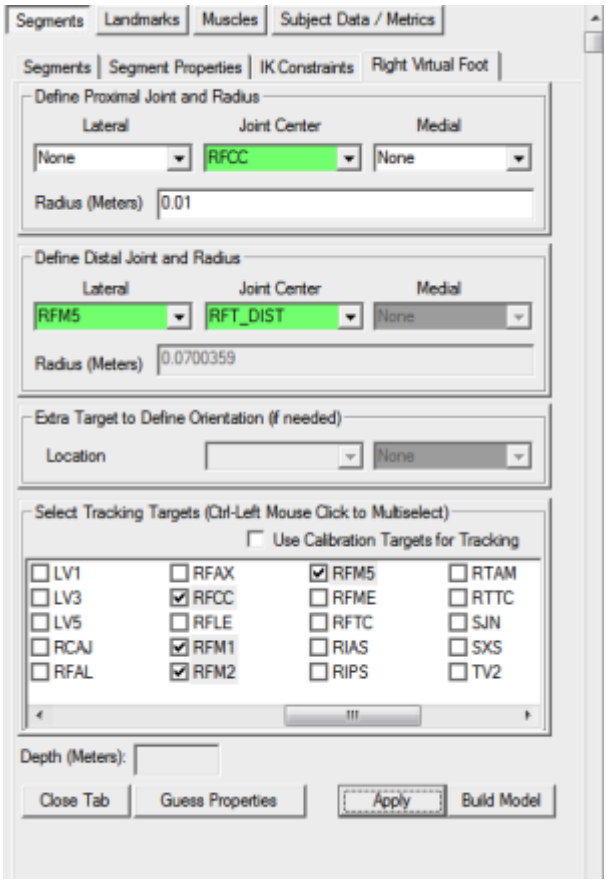
15. Create RFT_DIST:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: RFT_DIST
    - **Landmark Name:** RFT_DIST
    - **Define Orientation Using:**
    - **Starting Point:** RFCC
    - **Ending Point:** RFM5
    - **Lateral Object:** RFM1
    - **Project From:** RFM2
4. **Do NOT Check:** Offset by Percent (1.0 = 100%)
5. **Check:** Calibration Only Landmark

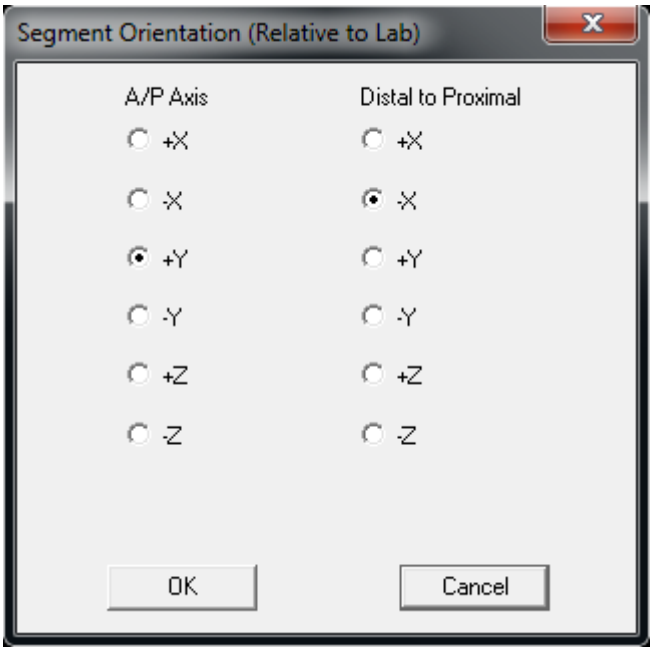
Kinematic Foot Definition

16. Create Right Virtual Foot:



1. In the **Segments** tab, type *Right Virtual Foot* int the Segment Name box
2. Check the **Kinematic Only** Check Box
3. Click on the **Create Segment** button
4. in the **Right Virtual Foot** tab, enter these values:
    - **Define Proximal Joint and Radius**
    - **Lateral** None **Joint:** RFCC **Medial:** None
    - **Radius:** 0.01
    - **Define Distal Joint Radius**
    - **Lateral:** RFM5 **Joint:**RFT_DIST **Medial:** None
    - **Select Tracking Targets:**
    - RFCC, RFM1, RFM2, RFM5

17. Modify the Segment Coordinate System:

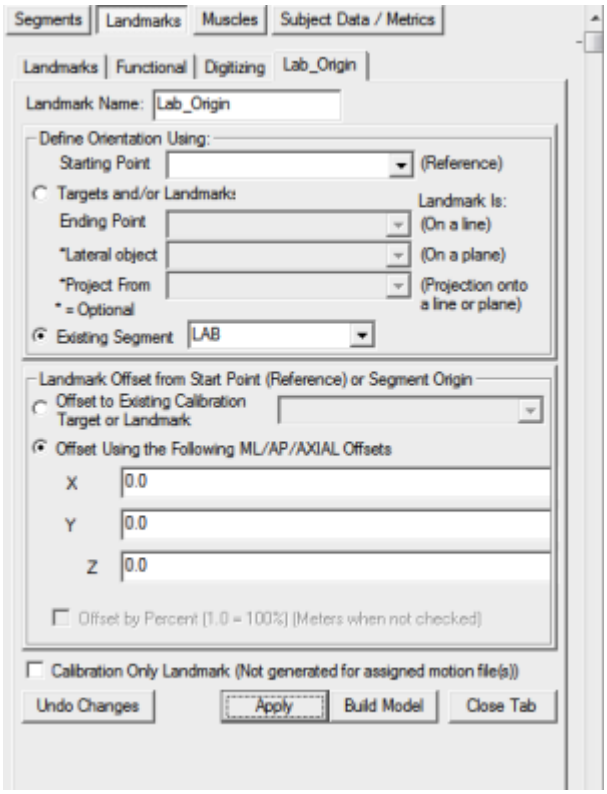


- Define the Segment Orientation as:
  - **A/P Axis:** +Y
  - **Distal to Proximal:** -X

Virtual Lab

Virtual Lab Landmarks

18. Create Lab_Origin:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: Lab_Origin
    - **Landmark Name:** Lab_Origin
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **X:** 0.0 **Y:** 0.0 **Z:** 0.0
5. **Do NOT Check:** Offset by Percent (1.0 = 100%)
6. **Do NOT Check:** Calibration Only Landmark

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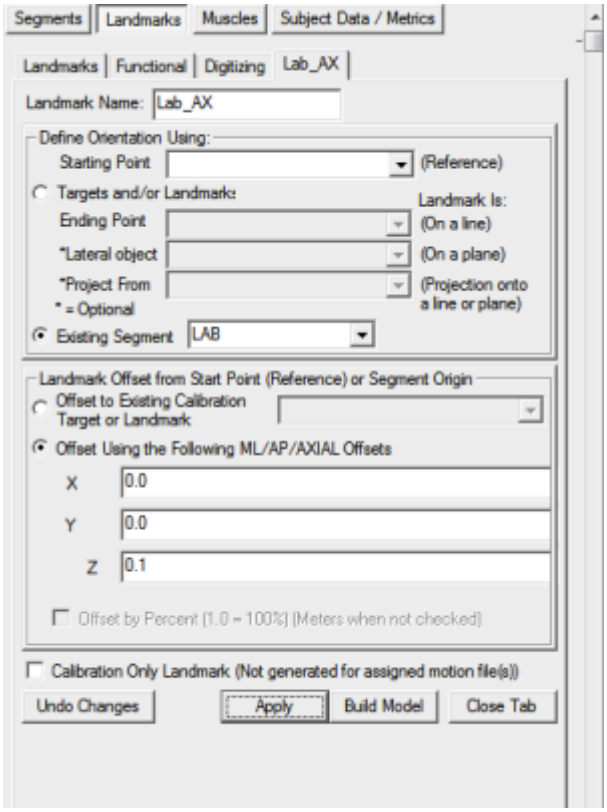
19. Create Lab_AX:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: Lab_Origin
    - **Landmark Name:** Lab_AX
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **X:** 0.0 **Y:** 0.0 **Z:** 0.1
5. **Do NOT Check:** Offset by Percent (1.0 = 100%)
6. **Do NOT Check:** Calibration Only Landmark

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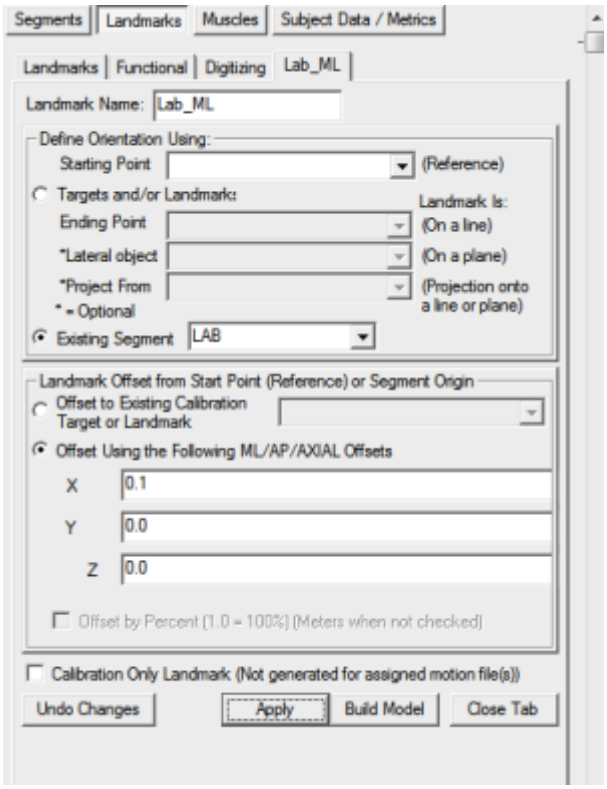
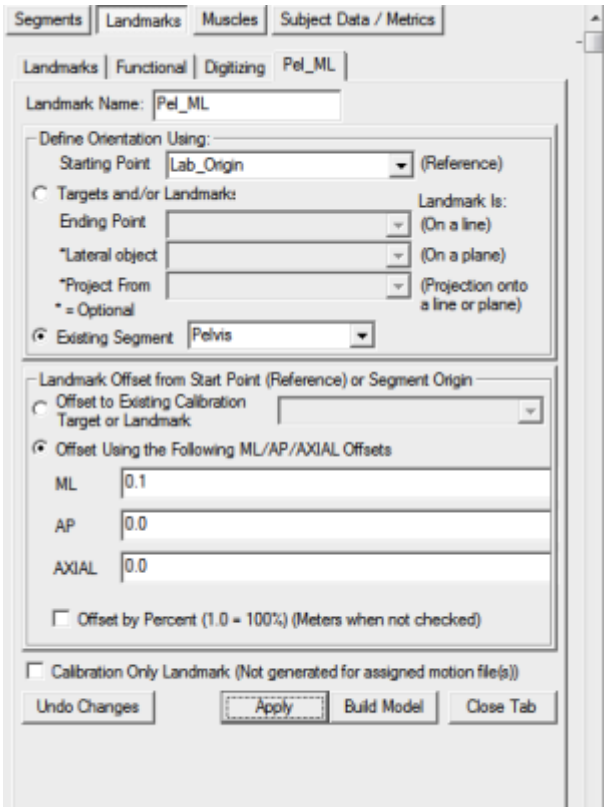
20. Create Lab_ML:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: Lab_ML
    - **Landmark Name:** Lab_ML
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **X:** 0.1 **Y:** 0.0 **Z:** 0.0
5. **Do NOT Check:** Offset by Percent (1.0 = 100%)
6. **Do NOT Check:** Calibration Only Landmark

21. Create Pel_ML:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: Pel_ML
    - **Landmark NameL** Pel_ML
    - **Define Orientation Using:**
    - **Starting Point:** Lab_Origin
    - **Existing Segment:** Pelvis
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **X:** 0.1 **Y:** 0.0 **Z:** 0.0
5. **Do NOT Check:** Offset by Percent (1.0 = 100%)
6. **Do NOT Check:** Calibration Only Landmark

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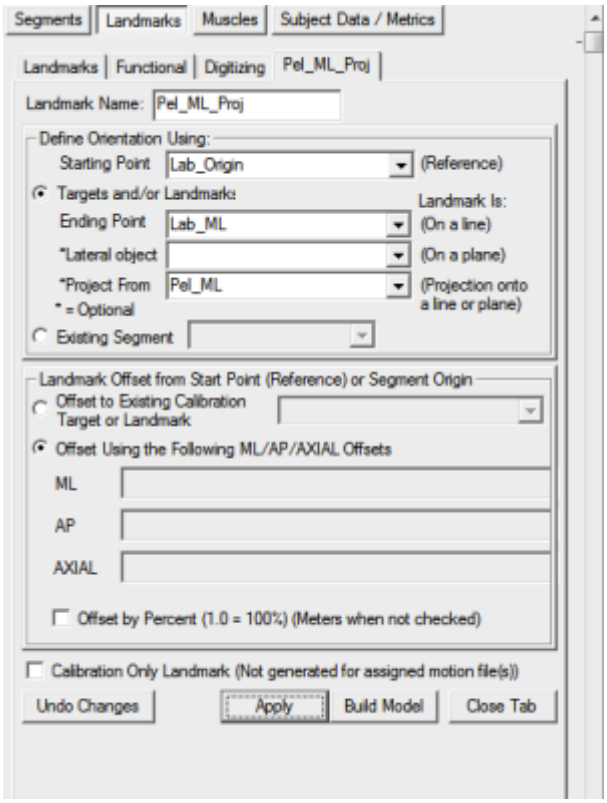
22. Create Pel_ML_Proj:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: Pel_ML_Proj
    - **Landmark Name:** Pel_ML_Proj
    - **Define Orientation Using:**
    - **Starting Point:** Lab_Origin
    - **Ending Point:** Lab_ML
    - **Project Point:** Pel_ML
4. **Do NOT Check:** Offset by Percent (1.0 = 100%)
5. **Do NOT Check:** Calibration Only Landmark

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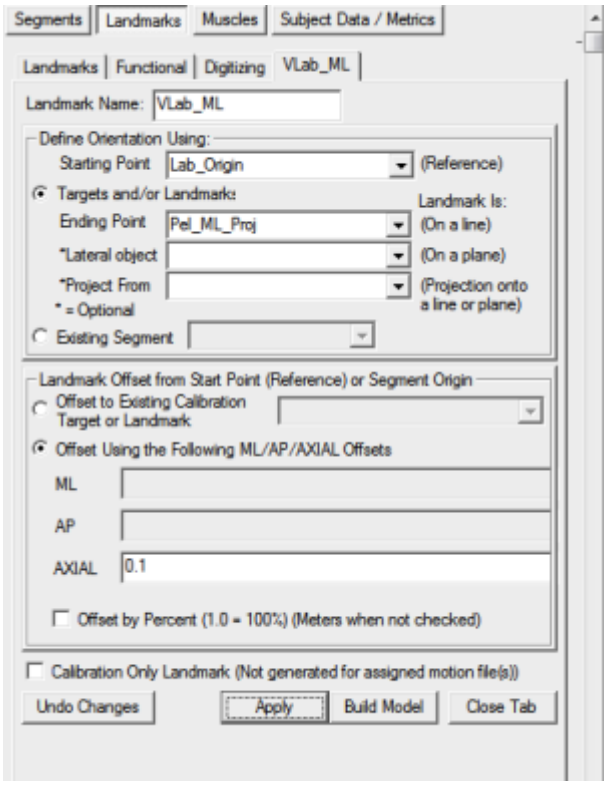
23. Create VLab_ML:



1. Click **Landmarks** button
2. Click **Add New Landmark** button
3. Create Landmark: VLab_ML
    - **Landmark Name:** VLab_ML
    - **Define Orientation Using:**
    - **Starting Point:** Lab_Origin
    - **Ending Point:** Pel_ML_Proj
4. Offset Using the Following **ML/AP/AXIAL** Offsets:
    - **AXIAL:** 0.1
5. **Do NOT Check:** Offset by Percent (1.0 = 100%)
6. **Do NOT Check:** Calibration Only Landmark

Additional Details

Once the IOR Gait Full Body model has been created, additional items can be calculated specific to the IOR Gait model.

- **Planar Angles**: Compute the orientation of different parts of the thorax relative to one another.
- **Shoulder Orientation and Translation**: This tutorial goes through computing the orientation and the translation of the shoulder targets relative to the trunk segment.
- **Joint Angles**: Compute IOR Gait specific joint angles.
- **IOR Multi-Segment Foot Model**: Define a multi segment foot model.