

2007 IOR Foot Model

This tutorial has been updated to match the naming convention used in the IOR foot paper. The original tutorial can be found [here](#).

In 2014, updates to the IOR foot model were published. The updated tutorial can be found [here](#).

Sample Data

Sample data can be downloaded [here](#).

Once the zip file has been downloaded, you can find a static C3D and three dynamic trials in the SampleFiles folder. These files will be used to complete the tutorial.

The model, planar angles and joint angles for the right side were defined and plotted in the Leardini_2007_Angles.cmo. Once the left side angles have been defined, the report template will graph both the left and right angles.

Introduction

Visual3D is a general tool capable of implementing many different foot models.

This tutorial focuses on the multi-segment foot model as described in the following article:



Available online at www.sciencedirect.com



Gait & Posture 25 (2007) 453–462



www.elsevier.com/locate/gaitpost

Rear-foot, mid-foot and fore-foot motion during the stance phase of gait

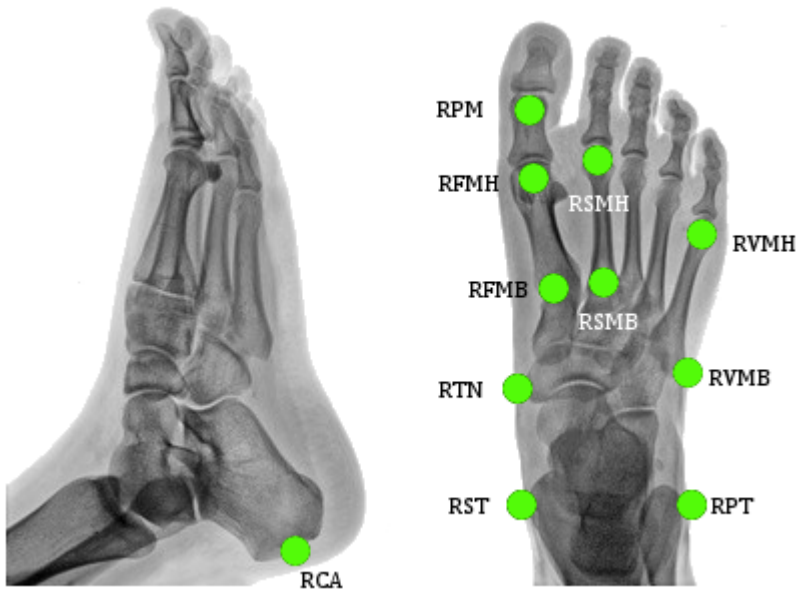
A. Leardini^{*}, M.G. Benedetti, L. Berti, D. Bettinelli, R. Nativio, S. Giannini

Movement Analysis Laboratory, Istituti Ortopedici Rizzoli, Via di Barbiano 1/10, Bologna 40136, Italy

Received 15 May 2006; accepted 15 May 2006

Multi-Segment Foot Marker Set

Foot Targets

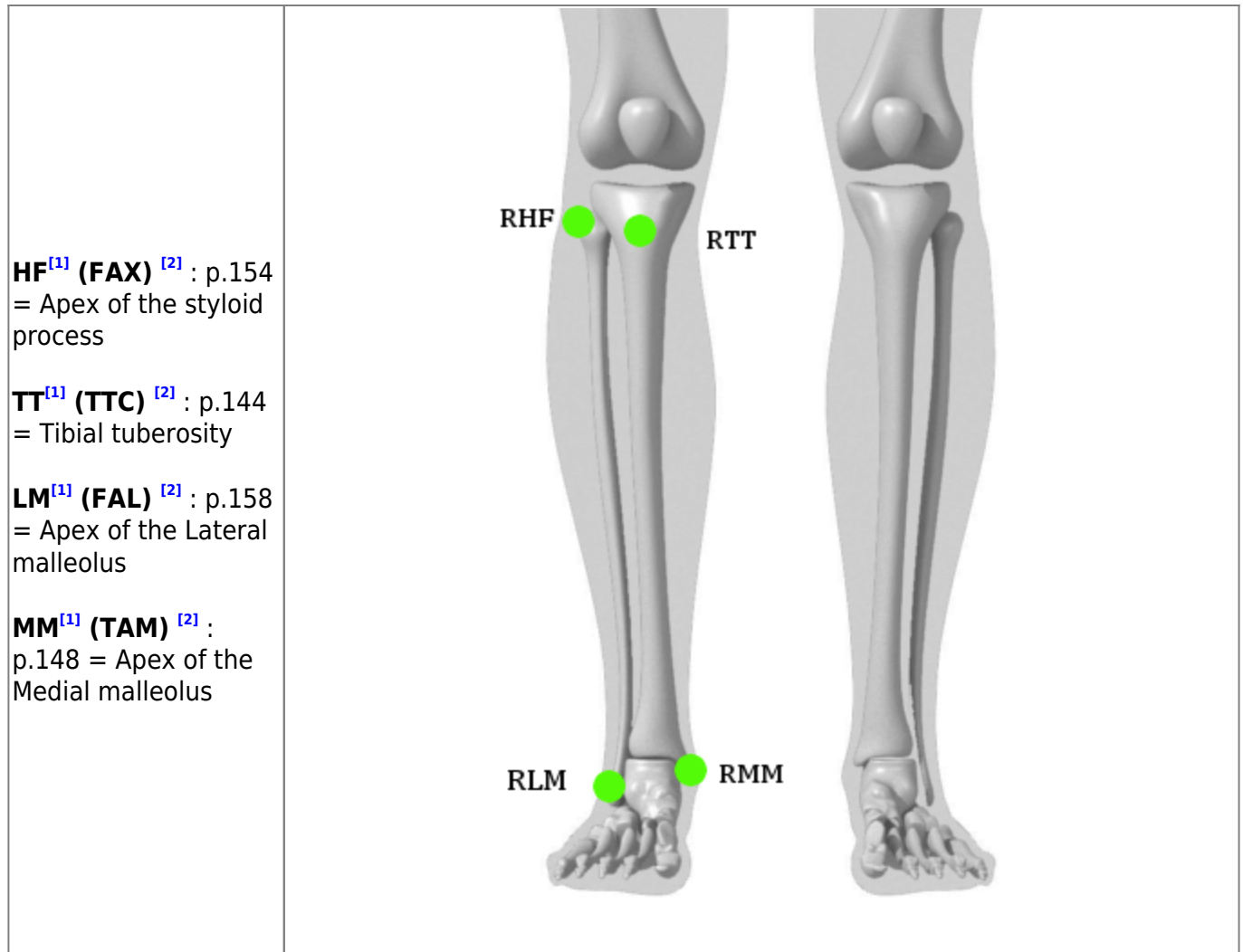


CA^[1] (**FCC**)^[2] :p. 162 = Posterior Surface of Calcaneus **ST**^[1] (**FST**)^[2] : p.164 = Sustentaculum Tali of Calcaneus **PT**^[1] (**FPT**)^[2] : p.171 = Lateral apex of the peroneal tubercle **TN**^[1] (**FNT**)^[2] : p.165 = Medial apex of the tuberosity navicular. **FMH**^[1] (**FM1**)^[2] : p.173 = Head of 1st Metatarsus **SMH**^[1] (**FM2**)^[2] : p.173 = Head of 2nd Metatarsus **VMH**^[1] (**FM5**)^[2] : p.173 = Head of 5th Metatarsus **VMB**^[1] (**FMT**)^[2] : p.172 = Tuberosity of 5th Metatarsal **PM**^[1] (**PD6**)^[2] : p.175 = Proximal Distal Phalanx. * **FMB**^[1] = Base of First Metatarsal. ** **SMB**^[1] = Base of Second Metatarsal. **

* Serge Van Sint Jan describes palpation for the mediolateral borders of this landmark (PM6/PL6), the target should be placed at the midpoint.

** There is no reference for this landmark in Serge Van Sint Jan text, please see the IOR Foot paper for further clarification

Shank Targets



NOTE: This tutorial follows the naming convention presented in the IOR Foot paper.

Metatarsus (Met)

Landmarks

1. Create RMET_DIST: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RMET_DIST	Landmark Name: RMET_DIST Define Orientation Using: Starting Point: RFMH Ending Point: RVMH Lateral Object: RSMB Project From: RSMH	• Do NOT Check: Offset by Percent (1.0 = 100%) • Check: Calibration Only Landmark	Workspace Signals and Events Models Reports Call Segments Landmarks Muscles Subject Data / Metrics Landmarks Functional Digitizing RMET_DIST Landmark Name: RMET_DIST Define Orientation Using: Starting Point: RFMH (Reference) Targets and/or Landmarks: Ending Point: RVMH (On a line) *Lateral object: RSMB (On a plane) *Project From: RSMH (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
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Segment Definition

1. Create RMet Segment:

- In the **Segments** tab, select **RMet** in the Segment Name box.
- Select **Kinematic Only**
- Click on the **Create Segment** button.
- In the **RMet** tab, enter these values:

Define Proximal Joint and Radius

Lateral: None **Joint:** RSMB **Medial:** None

Radius: 0.1

Define Distal Joint and Radius

Lateral: None **Joint:** RMET_DIST **Medial:** None

Radius: 0.1

Extra Target to Define Orientation (if needed)

Location: Medial RFMH

Select Tracking Targets: RFMB, RFMH, RSMB, RSMH, RVMB, RVMH

[illegible]

The image to the right (and all other images in this tutorial) show a mediolateral view of the segment coordinate system after it has been modified.

Mid-foot (Mid)

Landmarks

1. Create RID Joint Center: - Click Landmarks button - Click Add New Landmark button - Create Landmark: <i>RID</i>	Landmark Name: <i>RID</i> Define Orientation Using: Starting Point: <i>RTN</i> Ending Point: <i>RVMB</i>	- Offset Using the Following AXIAL Offset: <i>0.5</i> Check: <i>Offset by Percent (1.0 = 100%)</i> Check: <i>Calibration Only Landmark</i>	WorkspaceSignals and EventsModelsReportsCal SegmentsLandmarksMusclesSubject Data / Metrics LandmarksFunctionalDigitizingRID Landmark Name: RID Define Orientation Using: Starting PointRTN(Reference) Targets and/or Landmarks Ending PointRVMB(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 AXIAL0.5 ☒ Offset by Percent (1.0 = 100%) (Meters when not checked) ☒ Calibration Only Landmark (Not generated for assigned motion file(s)) Undo ChangesApplyBuild ModelClose Tab
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Segment Definition

1. Create RMid Segment:

- In the **Segments** tab, select *RMid* in the Segment Name box.
- Select **Kinematic Only**.
- Click on the **Create Segment** button.
- In the **RMid** tab, enter these values:

Define Proximal Joint and Radius

Lateral: None **Joint:** *RID* **Medial:** None

Radius: 0.1

Define Distal Joint and Radius

Lateral: None **Joint:** *RSMB* **Medial:** None

Radius: 0.1

Extra Target to Define Orientation

Location: *Medial* **RTN**

Select Tracking Targets

RSMB, RTN, RVMB

- Click on **Build Model**.
- Click on **Close Tab** before proceeding.

[illegible]

Calcaneus (Cal)

Landmarks

1. Create RIC Joint Center:

- Click **Landmarks** button
- Click **Add New Landmark** button
- Create Landmark: *RIC*

Landmark Name: *RIC*

Define Orientation Using:

Starting Point: *RST*

Ending Point: *RPT*

Check: *Offset by Percent (1.0 = 100%)*

Check: *Calibration Only Landmark*

- Offset Using the Following **AXIAL** Offset: *0.5*

Segment Definition

1. Create RCal Segment: • In the Segments tab, select RCal in the Segment Name box. • Click on the Create Segment button. • In the RCal tab, enter these values: <td> Define Proximal Joint and Radius Lateral: <i>None</i> Joint: <i>RCA</i> Medial: <i>None</i> Radius: <i>0.1</i> Define Distal Joint and Radius Lateral: <i>None</i> Joint: <i>RIC</i> Medial: <i>None</i> Radius: <i>0.1</i> Extra Target to Define Orientation Location: <i>Medial</i> <i>RST</i> Select Tracking Targets: <i>RCA, RPT, RST</i> </td> <td> • Click on Build Model. • Click on Close Tab before proceeding. </td> <td> Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Segments Segment Properties IK Constraints RCal Define Proximal Joint and Radius Lateral: <i>None</i> Joint Center: <i>RCA</i> Medial: <i>None</i> Radius (Meters): <i>0.1</i> Define Distal Joint and Radius Lateral: <i>None</i> Joint Center: <i>RIC</i> Medial: <i>None</i> Radius (Meters): <i>0.1</i> Extra Target to Define Orientation (if needed) Location: <i>Medial</i> <i>RST</i> Select Tracking Targets (Ctrl-Left Mouse Click to Multiselect) ☐ RF2P_Offset ☐ RFMB_proj ☐ LCA ☐ LMM ☐ LAB_O ☐ RSMH_proj ☐ LFMB ☐ LPM ☐ LAB_X ☐ RSMB_proj ☐ LFMH ☐ LPT ☐ LAB_Y ☐ RVMH_proj ☐ LHF ☐ LSMB ☐ RFMH_proj ☐ RVMB_proj ☐ LLM ☐ LSMH Depth (Meters): Close Tab Guess Properties Apply Build Model </td>	Define Proximal Joint and Radius Lateral: <i>None</i> Joint: <i>RCA</i> Medial: <i>None</i> Radius: <i>0.1</i> Define Distal Joint and Radius Lateral: <i>None</i> Joint: <i>RIC</i> Medial: <i>None</i> Radius: <i>0.1</i> Extra Target to Define Orientation Location: <i>Medial</i> <i>RST</i> Select Tracking Targets: <i>RCA, RPT, RST</i>	• Click on Build Model. • Click on Close Tab before proceeding.	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Segments Segment Properties IK Constraints RCal Define Proximal Joint and Radius Lateral: <i>None</i> Joint Center: <i>RCA</i> Medial: <i>None</i> Radius (Meters): <i>0.1</i> Define Distal Joint and Radius Lateral: <i>None</i> Joint Center: <i>RIC</i> Medial: <i>None</i> Radius (Meters): <i>0.1</i> Extra Target to Define Orientation (if needed) Location: <i>Medial</i> <i>RST</i> Select Tracking Targets (Ctrl-Left Mouse Click to Multiselect) ☐ RF2P_Offset ☐ RFMB_proj ☐ LCA ☐ LMM ☐ LAB_O ☐ RSMH_proj ☐ LFMB ☐ LPM ☐ LAB_X ☐ RSMB_proj ☐ LFMH ☐ LPT ☐ LAB_Y ☐ RVMH_proj ☐ LHF ☐ LSMB ☐ RFMH_proj ☐ RVMB_proj ☐ LLM ☐ LSMH Depth (Meters): Close Tab Guess Properties Apply Build Model
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2. Modify the Segment Coordinate System: • Define the Segment Orientation as:	A/P Axis: +Y Distal to Proximal: -X	
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Foot (Foo)

Landmarks

1. Create RFT_DIST: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RFT_DIST	Landmark Name: RFT_DIST Define Orientation Using: Starting Point: RCA Ending Point: RFMH Lateral Object: RVMH Project From: RSMH	• Do NOT Check: Offset by Percent (1.0 = 100%) • Check: Calibration Only Landmark	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Landmarks Functional Digitizing RFT_DIST Landmark Name: RFT_DIST Define Orientation Using: Starting Point RCA (Reference) Targets and/or Landmarks: Ending Point RFMH (On a line) *Lateral object RVMH (On a plane) *Project From RSMH (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
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Segment Definition

1. Create Right Foot Segment: In the Segments tab, select Right Foot in the Segment Name box. Click on the Create Segment button. In the Right Foot tab, enter these values:	Define Proximal Joint and Radius Lateral: None Joint: RCA Medial: None Radius: $0.5 * \text{DISTANCE}(\text{RST}, \text{RPT})$ Define Distal Joint and Radius Lateral: None Joint: RFT_DIST Medial: None Radius: $0.5 * \text{DISTANCE}(\text{RFMH}, \text{RVMH})$ Extra Target to Define Orientation Location: Medial RFMH Select Tracking Targets: RCA, RFMH, RVMH	Click on Build Model. Click on Close Tab before proceeding.	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Segments Segment Properties IK Constraints RCal Right Foot Define Proximal Joint and Radius Lateral: None Joint Center: RCA Medial: None Radius (Meters): $0.5 * \text{DISTANCE}(\text{RST}, \text{RPT})$ Define Distal Joint and Radius Lateral: None Joint Center: RFT_DIST Medial: None Radius (Meters): $0.5 * \text{DISTANCE}(\text{RFMH}, \text{RVMH})$ Extra Target to Define Orientation (if needed) Location: Medial RFMH Select Tracking Targets (Ctrl-Left Mouse Click to Multiselect) ☐ Use Calibration Targets for Tracking ☐ RF2P_Offset ☐ LAB_O ☐ LAB_X ☐ LAB_Y ☐ RFMH_proj ☐ RFMB_proj ☐ RSMH_proj ☐ RSMB_proj ☐ RVMH_proj ☐ RVMB_proj ☐ LCA ☐ LFMB ☐ LFMH ☐ LHF ☐ LLM ☐ LMM ☐ LPM ☐ LPT ☐ LSMB ☐ LSMH Depth (Meters): Close Tab Guess Properties Apply Build Model
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2. Modify the Segment Coordinate System: Define the Segment Orientation as:	A/P Axis: +Y Distal to Proximal: -X	
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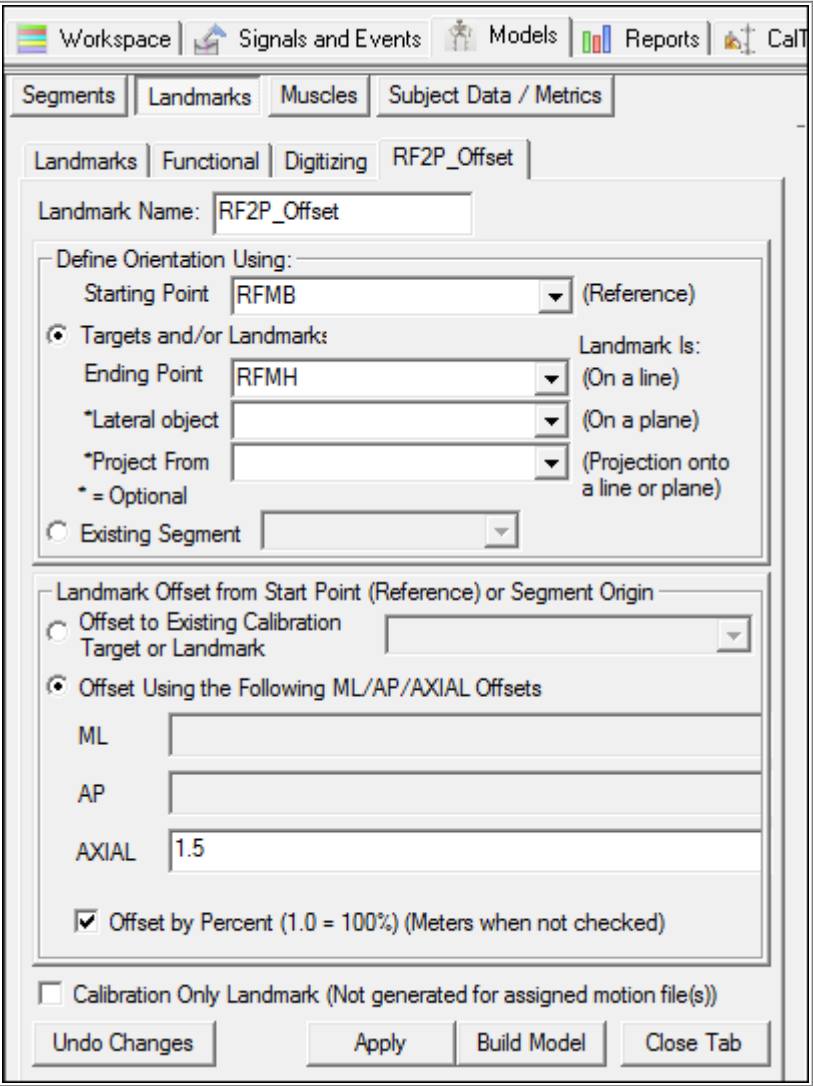
Shank (Sha)

Landmarks

1. Create RIM: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RIM	Landmark Name: RIM Define Orientation Using: Starting Point: RLM Ending Point: RMM	• Offset Using the Following AXIAL Offset: 0.5 • Check: Offset by Percent (1.0 = 100%) • Check: Calibration Only Landmark	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Landmarks Functional Digitizing RIM Landmark Name: RIM Define Orientation Using: Starting Point RLM (Reference) Targets and/or Landmarks: Ending Point RMM (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 0.5 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 RSK_PROX: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RSK_PROX	Landmark Name: RSK_PROX Define Orientation Using: Starting Point: RIM Ending Point: RLM Lateral Object: RHF Project From: RTT	• Do NOT Check: Offset by Percent (1.0 = 100%) • Check: Calibration Only Landmark	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Landmarks Functional Digitizing RSK_PROX Landmark Name: RSK_PROX Define Orientation Using: Starting Point RIM (Reference) Targets and/or Landmarks: Ending Point RLM (On a line) *Lateral object RHF (On a plane) *Project From RTT (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

Landmarks

The F2Pt and F2Ps planar angles are calculated as the angle between the lines created by the targets FMB-FMH and FMH-PM. To calculate this angle using the Compute Planar Angle command, an offset along the line between FMB and FMH is created to define the 3 point angle.

1. Create RF2P_Offset: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RF2P_Offset	Landmark Name: RF2P_Offset Define Orientation Using: Starting Point RFMB (Reference) Targets and/or Landmarks: Ending Point RFMH (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 1.5 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	• Offset Using the Following AXIAL Offset: 1.5 • Check: Offset by Percent (1.0 = 100%) • Do NOT Check: Calibration Only Landmark	
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2. Create LF2P_Offset:

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When defining the left signal, use same definitions as for the RF2P_Offset landmark

The F2G, S2G and V2G angles are calculated in the plane orthogonal to the ground. These landmarks will need to be projected onto the ground. To project landmarks onto the ground, the Lab_O, Lab_X and Lab_Y landmarks will need to be created to identify the plane of the ground.

3. Create Lab_O: - Click Landmarks button - Click Add New Landmark button - Create Landmark: <i>Lab_O</i>	Landmark Name: <i>Lab_O</i>	- Offset Using the Following ML/AP/AXIAL Offsets: X: 0.0 Y: 0.0 Z: 0.0 Do NOT Check: <i>Offset by Percent (1.0 = 100%) (Meters when not checked)</i> Do NOT Check: <i>Calibration Only Landmark (Not generated for assigned motion file(s))</i>	
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4. Create Lab_X: - Click Landmarks button - Click Add New Landmark button - Create Landmark: <i>Lab_X</i>	Landmark Name: <i>Lab_X</i>	- Offset Using the Following ML/AP/AXIAL Offsets: X: 0.05 Y: 0.0 Z: 0.0 Do NOT Check: <i>Offset by Percent (1.0 = 100%) (Meters when not checked)</i> Do NOT Check: <i>Calibration Only Landmark (Not generated for assigned motion file(s))</i>	
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5. Create Lab_Y: • Click Landmarks button • Click Add New Landmark button • Create Landmark: Lab_Y	Landmark Name: Lab_Y	• Offset Using the Following ML/AP/AXIAL Offsets: X: 0.0 Y: 0.05 Z: 0.0 • Do NOT Check: Offset by Percent (1.0 = 100%) (Meters when not checked) • Do NOT Check: Calibration Only Landmark (Not generated for assigned motion file(s))	Workspace Signals and Events Models Reports Cal Segments Landmarks Muscles Subject Data / Metrics Landmarks Functional Digitizing LAB_Y Landmark Name: LAB_Y Define Orientation Using: Starting Point (Reference) ☐ Targets and/or Landmarks: Ending Point *Lateral object *Project From * = 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 0.05 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
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6. Create RFMH_proj: • Click Landmarks button • Click Add New Landmark button • Create Landmark: RFMH_proj	Landmark Name: RFMH_proj Define Orientation Using: Starting Point: LAB_O Ending Point: LAB_X Lateral Object: LAB_Y Project From: RFMH	• 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 RFMH_proj Landmark Name: RFMH_proj Define Orientation Using: Starting Point LAB_O (Reference) ☒ Targets and/or Landmarks: Ending Point LAB_X *Lateral object LAB_Y *Project From RFMH * = 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
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Create landmarks 7-17 by following the same format as the RFMH_proj landmark for: ****

7. RFMB	12. LFMH
8. RSMH	13. LFMB
9. RSMB	14. LSMH
10. RVMH	15. LSMB
11. RVMB	16. LVMH
	17. LVMB

**** ****

Planar Angles

F2Pt

F2Pt - the angle between the lines FMH-PM and FMB-FMH projected onto the transverse plane of the metatarsus

Represents - valgus of the first metatarsophalangeal joint

1. Create RF2Pt planar angle:

- Define **Resulting Signal**
Name: RF2Pt
- Calculate a **3 point angle** between the following targets:

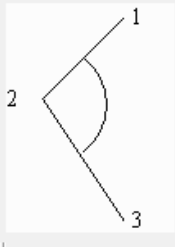
1 - LANDMARK::ORIGINAL::RF2P_offset

2 - TARGET::ORIGINAL::RFMH

3 - TARGET::ORIGINAL::RPM

Angle Direction: Left Hand Rule
Use Range: -180 to 180 degrees
Projected onto Plane: XZ

Note: The reference segment will need to be changed to RMet within the text option.



Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal
Name: RF2Pt
Folder: PROCESSED

1 LANDMARK::ORIGINAL::RF2P_offs

2 TARGET::ORIGINAL::RFMH

3 TARGET::ORIGINAL::RPM

Specify 3 or 4 points
☒ 3 Point
☐ 4 Point

Angle Direction
☐ Right Hand Rule
☒ Left Hand Rule

Use Range
☐ 0 to 360 degrees
☒ -180 to 180 degrees

Projected onto Plane
☐ XY
☒ XZ
☐ YZ

3D Space
☐ 3D Always 0 to 180 degrees (Unspecified Direction)
☐ 3D Specify a Vector Normal to the Two Vectors

Example
 With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.
 3D: Angle = 95 degrees
 Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees
 Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

2. Create LF2Pt planar angle: When defining the left signal, use same definitions except set:	Angle Direction: <i>Right Hand Rule</i> Note: The reference segment will need to be changed to LMet within the text option.
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S2F

S2F - the angle between the lines FMB-FMH and SMB-SMH projected onto the transverse plane of the metatarsus

1. Create RS2F planar angle:

- Define **Resulting Signal** Name: RS2F
- Calculate a **4 point angle** between the following targets:

1 - TARGET::ORIGINAL::RSMH

2 - TARGET::ORIGINAL::RSMB

3 - TARGET::ORIGINAL::RFMB

4 - TARGET::ORIGINAL::RFMH

Angle Direction: *Right Hand Rule*

Use Range: -180 to 180 degrees

Projected onto Plane: XZ

Note: The reference segment will need to be **changed to RMet** within the text option.

Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal

NameRS2F

FolderPROCESSED

1

2

3

4

1TARGET::ORIGINAL::RSMH

2TARGET::ORIGINAL::RSMB

3TARGET::ORIGINAL::RFMB

4TARGET::ORIGINAL::RFMH

Specify 3 or 4 points

3 Point

4 Point

Angle Direction

Right Hand Rule

Left Hand Rule

Use Range

0 to 360 degrees

-180 to 180 degrees

Projected onto Plane

XY

XZ

YZ

If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal.

3D Space

3D

3D

Always 0 to 180 degrees (Unspecified Direction)

Specify a Vector Normal to the Two Vectors

Example

With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.

3D: Angle = 95 degrees

Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees

Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

Cancel

OK

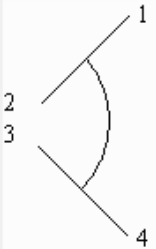
2. Create LS2F planar angle: When defining the left signal, use same definitions except set:	Angle Direction: <i>Left Hand Rule</i> Note: The reference segment will need to be changed to LMet within the text option.
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<https://has-motion.com/wiki/>

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S2V

S2V - the angle between the lines VMB-VMH and SMB-SMH projected onto the transverse plane of the metatarsus

1. Create RS2V planar angle: - Define Resulting Signal Name: RS2V - Calculate a 4 point angle between the following targets:	1 - TARGET::ORIGINAL::RSMH 2 - TARGET::ORIGINAL::RSMB 3 - TARGET::ORIGINAL::RVMB 4 - TARGET::ORIGINAL::RVMH Angle Direction: Left Hand Rule Use Range: -180 to 180 degrees Projected onto Plane: XZ Note: The reference segment will need to be changed to RMet within the text option.	Compute the angle between two vectors, represented by 3 or 4 points Resulting Signal Name: RS2V Folder: PROCESSED  1 TARGET::PROCESSED::RSMH 2 TARGET::PROCESSED::RSMB 3 TARGET::PROCESSED::RVMB 4 TARGET::PROCESSED::RVMH Specify 3 or 4 points ☐ 3 Point ☒ 4 Point Angle Direction ☐ Right Hand Rule ☒ Left Hand Rule Use Range ☐ 0 to 360 degrees ☒ -180 to 180 degrees Projected onto Plane ☐ XY If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal. ☒ XZ ☐ YZ 3D Space ☐ 3D Always 0 to 180 degrees (Unspecified Direction) ☐ 3D Specify a Vector Normal to the Two Vectors Example With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis. 3D: Angle = 95 degrees Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees Cancel OK
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2. Create LS2V planar angle:

When defining the left signal, use same definitions **except** set:

Angle Direction: Right Hand Rule

Note: The reference segment will need to be changed to LMet within the text option.

F2G

F2G - the angle between the lines FMB-FMH and the ground, plane orthogonal to the ground (3D angle relative to the ground)

The **FMH_proj** and **FMB_proj** landmarks will be used to calculate the **F2G** planar angle which are described in the [landmarks](#) section.

1. Create RF2G planar angle:

• Define Resulting Signal Name: RF2G

• Calculate a 4 point angle between the following targets:

1 - TARGET::ORIGINAL::RFMB

2 - TARGET::ORIGINAL::RFMH

3 - TARGET::ORIGINAL::RFMH_proj

4 - TARGET::ORIGINAL::RFMB_proj

Angle Direction: Right Hand Rule

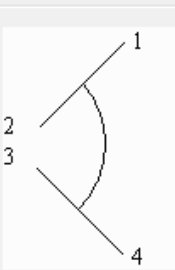
3D Space: Always 0 to 180 degrees

Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal

Name: RF2G

Folder: PROCESSED



1: TARGET::PROCESSED::RFMB

2: TARGET::PROCESSED::RFMH

3: LANDMARK::ORIGINAL::RFMH_proj

4: LANDMARK::ORIGINAL::RFMB_proj

Specify 3 or 4 points

☐ 3 Point

☒ 4 Point

Angle Direction

☒ Right Hand Rule

☐ Left Hand Rule

Use Range

☒ 0 to 360 degrees

☐ -180 to 180 degrees

Projected onto Plane

☐ XY

☐ XZ

☐ YZ

If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal.

3D Space

☒ 3D

Always 0 to 180 degrees (Unspecified Direction)

☐ 3D

Specify a Vector Normal to the Two Vectors

Example

With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.

3D: Angle = 95 degrees

Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees

Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

Cancel

OK

2. Create LF2G planar angle:

- When defining the left signal, use same definitions as for the right angle

S2G

S2G - the angle between the lines SMB-SMH and the ground, plane orthogonal to the ground (3D angle relative to the ground)

The **SMH_proj** and **SMB_proj** landmarks will be used to calculate the **S2G** planar angle which are described in the [landmarks](#) section.

1. Create RS2G planar angle:

• Define Resulting Signal Name: RS2G

• Calculate a 4 point angle between the following targets:

1 - TARGET::ORIGINAL::RSMB

2 - TARGET::ORIGINAL::RSMH

3 - TARGET::ORIGINAL::RSMH_proj

4 - TARGET::ORIGINAL::RSMB_proj

Angle Direction: Right Hand Rule

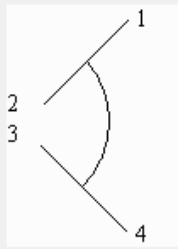
3D Space: Always 0 to 180 degrees

Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal

NameRS2G

FolderPROCESSED



1TARGET::ORIGINAL::RSMB

2TARGET::ORIGINAL::RSMH

3LANDMARK::ORIGINAL::RSMH_proj

4LANDMARK::ORIGINAL::RSMB_proj

Specify 3 or 4 points

☐ 3 Point

☒ 4 Point

Angle Direction

☒ Right Hand Rule

☐ Left Hand Rule

Use Range

☒ 0 to 360 degrees

☐ -180 to 180 degrees

Projected onto Plane

☐ XY

☐ XZ

☐ YZ

If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal.

3D Space

☒ 3D

Always 0 to 180 degrees (Unspecified Direction)

☐ 3D

Specify a Vector Normal to the Two Vectors

Example

With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.

3D: Angle = 95 degrees

Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees

Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

Cancel

OK

2. Create LS2G planar angle:

- When defining the left signal, use same definitions as for the right angle

V2G

V2G - the angle between the lines VMB-VMH and the ground, plane orthogonal to the ground (3D angle relative to the ground)

The **VMH_proj** and **VMB_proj** landmarks will be used to calculate the **V2G** planar angle which are described in the [landmarks](#) section.

1. Create RV2G planar angle:

- Define **Resulting Signal** Name: RV2G
- Calculate a **4 point angle** between the following targets:

1 - TARGET::ORIGINAL::RVMB

2 - TARGET::ORIGINAL::RVMH

3 - TARGET::ORIGINAL::RVMH_proj

4 - TARGET::ORIGINAL::RVMB_proj

Angle Direction: Right Hand Rule

3D Space: Always 0 to 180 degrees

Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal

Name: RV2G

Folder: PROCESSED

1	TARGET::ORIGINAL::RVMB
2	TARGET::ORIGINAL::RVMH
3	LANDMARK::ORIGINAL::RVMH_proj
4	LANDMARK::ORIGINAL::RVMB_proj

Specify 3 or 4 points

☐ 3 Point

☒ 4 Point

Angle Direction

☒ Right Hand Rule

☐ Left Hand Rule

Use Range

☒ 0 to 360 degrees

☐ -180 to 180 degrees

Projected onto Plane

☐ XY If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal.

☐ XZ

☐ YZ

3D Space

☒ 3D Always 0 to 180 degrees (Unspecified Direction)

☐ 3D Specify a Vector Normal to the Two Vectors

Example

With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.

3D: Angle = 95 degrees

Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees

Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

Cancel

OK

2. Create LV2G planar angle:

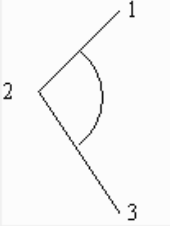
.

When defining the left signal, use same definitions as for the right angle

F2Ps

F2Ps - the angle between the lines FMH-PM and FMB-FMH projected onto the sagittal plane of the metatarsus

Represents - dorsiflexion of the first metatarso-phalangeal joint

1. Create RF2Ps planar angle: - Define Resulting Signal Name: RF2Ps - Calculate a 3 point angle between the following targets:	1 - LANDMARK::ORIGINAL::RF2P_offset 2 - TARGET::ORIGINAL::RFMH 3 - TARGET::ORIGINAL::RPM Angle Direction: Right Hand Rule Use Range: -180 to 180 degrees Projected onto Plane: XY Note: The reference segment will need to be changed to RMet within the text option.	Compute the angle between two vectors, represented by 3 or 4 points Resulting Signal Name: RF2Ps Folder: PROCESSED  1 LANDMARK::ORIGINAL::RF2P_Off 2 TARGET::ORIGINAL::RFMH 3 TARGET::ORIGINAL::RPM Specify 3 or 4 points ☒ 3 Point ☐ 4 Point Angle Direction ☒ Right Hand Rule ☐ Left Hand Rule Use Range ☐ 0 to 360 degrees ☒ -180 to 180 degrees Projected onto Plane ☒ XY ☐ XZ ☐ YZ If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal. 3D Space ☐ 3D Always 0 to 180 degrees (Unspecified Direction) ☐ 3D Specify a Vector Normal to the Two Vectors Example With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis. 3D: Angle = 95 degrees Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees Cancel OK
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2. Create LF2Ps planar angle: When defining the left signal, use same definitions except set:	Angle Direction: Right Hand Rule Note: The reference segment will need to be changed to LMet within the text option.
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MLA

MLA - the angle between the lines CA-ST and ST-FMH projected onto the sagittal plane of the foot
Represents - navicular drop

1. Create RMLA planar angle:

- Define Resulting Signal Name: RMLA
- Calculate a 3 point angle between the following targets:

1 - TARGET::ORIGINAL::RCA

2 - TARGET::ORIGINAL::RST

3 - TARGET::ORIGINAL::RFMH

Angle Direction: Right Hand Rule

Use Range: -180 to 180 degrees

Projected onto Plane: XY

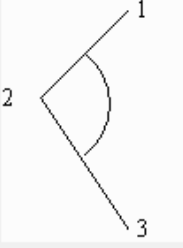
Note: The reference segment will need to be changed to RMet within the text option.

Compute the angle between two vectors, represented by 3 or 4 points

Resulting Signal

Name: RMLA

Folder: PROCESSED



1 TARGET::ORIGINAL::RCA

2 TARGET::ORIGINAL::RST

3 TARGET::ORIGINAL::RFMH

Specify 3 or 4 points

☒ 3 Point

☐ 4 Point

Angle Direction

☒ Right Hand Rule

☐ Left Hand Rule

Use Range

☐ 0 to 360 degrees

☒ -180 to 180 degrees

Projected onto Plane

☒ XY

☐ XZ

☐ YZ

If the angle is projected onto one of the principle planes, the direction of the normal to the two vectors is the third principle axes. The Right Hand Rule and the Range are with respect to this normal.

3D Space

☐ 3D

Always 0 to 180 degrees (Unspecified Direction)

☐ 3D

Specify a Vector Normal to the Two Vectors

Example

With respect to the figure. Assume the two vectors lie in the XY plane; Rotation is about the Z-axis.

3D: Angle = 95 degrees

Projected onto XY: Use RHR: Use 0- to 360: Angle=265 degrees

Projected onto XY: Use RHR: Use -180 to 180: Angle=-95 degrees

Cancel

OK

2. Create LMLA planar angle:

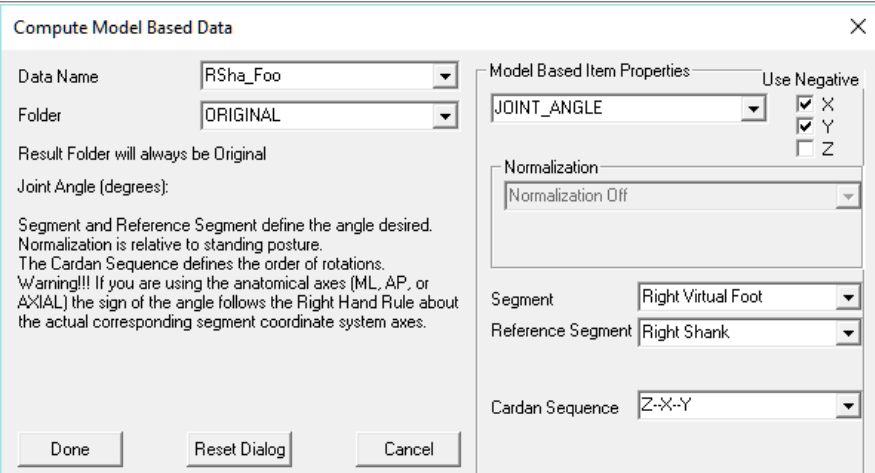
- When defining the left signal, use same definitions **except** set:

Angle Direction: Right Hand Rule

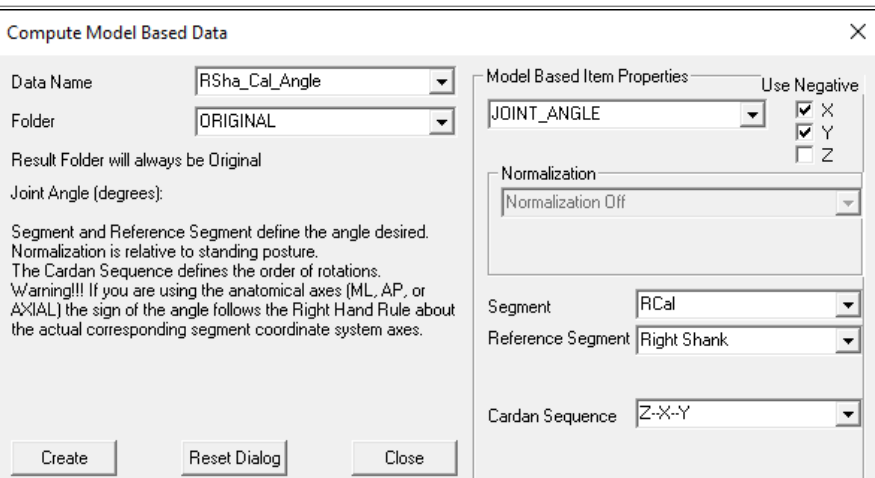
Note: The reference segment will need to be changed to LMet within the text option.

Joint Angles

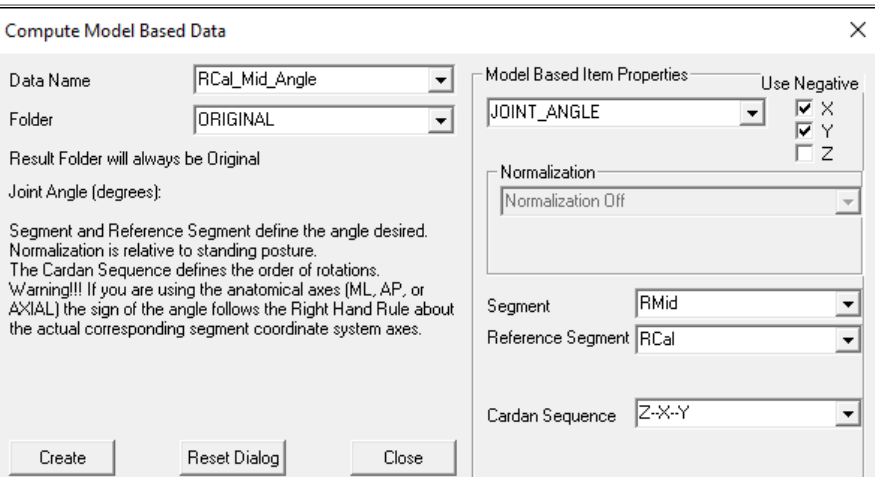
Sha_Foo_Angle

1. Define the RSha_Foo_Angle: - Open the Compute Model Based dialog - Select JOINT_ANGLE from drop down list	Data Name: <i>RSha_Foo_Angle</i> Segment: <i>Right Foot</i> Reference Segment: <i>Right Shank</i> Cardan Sequence: Z-X-Y	Use Negative: X: TRUE Y: TRUE Z: FALSE	
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Sha_Cal_Angle

1. Define the RSha_Cal_Angle: - Open the Compute Model Based dialog - Select JOINT_ANGLE from drop down list	Data Name: <i>RSha_Cal_Angle</i> Segment: <i>RCal</i> Reference Segment: <i>Right Shank</i> Cardan Sequence: Z-X-Y	Use Negative: X: TRUE Y: TRUE Z: FALSE	
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Cal_Mid_Angle

1. Define the RCal_Mid_Angle: - Open the Compute Model Based dialog - Select JOINT_ANGLE from drop down list	Data Name: <i>RCal_Mid_Angle</i> Segment: <i>RMid</i> Reference Segment: <i>RCal</i> Cardan Sequence: Z-X-Y	Use Negative: X: TRUE Y: TRUE Z: FALSE	
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Mid_Met_Angle

1. Define the RMid_Met_Angle: • Open the Compute Model Based dialog • Select JOINT_ANGLE from drop down list	Data Name: RMid_Met_Angle Segment: RMet Reference Segment: RMid Cardan Sequence: Z-X-Y	• Use Negative: X: TRUE Y: TRUE Z: FALSE	Compute Model Based Data Data Name RMid_Met_Angle Folder ORIGINAL Result Folder will always be Original Joint Angle (degrees): Segment and Reference Segment define the angle desired. Normalization is relative to standing posture. The Cardan Sequence defines the order of rotations. Warning!!! If you are using the anatomical axes (ML, AP, or AXIAL) the sign of the angle follows the Right Hand Rule about the actual corresponding segment coordinate system axes. Create Reset Dialog Close Model Based Item Properties JOINT_ANGLE Use Negative ☒ X ☒ Y ☐ Z Normalization Normalization Off Segment RMet Reference Segment RMid Cardan Sequence Z-X-Y
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Cal_Met_Angle

1. Define the RCal_Met_Angle: • Open the Compute Model Based dialog • Select JOINT_ANGLE from drop down list	Data Name: RCal_Met_Angle Segment: RMet Reference Segment: RCal Cardan Sequence: Z-X-Y	• Use Negative: X: TRUE Y: TRUE Z: FALSE	Compute Model Based Data Data Name RCal_Met_Angle Folder ORIGINAL Result Folder will always be Original Joint Angle (degrees): Segment and Reference Segment define the angle desired. Normalization is relative to standing posture. The Cardan Sequence defines the order of rotations. Warning!!! If you are using the anatomical axes (ML, AP, or AXIAL) the sign of the angle follows the Right Hand Rule about the actual corresponding segment coordinate system axes. Create Reset Dialog Close Model Based Item Properties JOINT_ANGLE Use Negative ☒ X ☒ Y ☐ Z Normalization Normalization Off Segment RMet Reference Segment RCal Cardan Sequence Z-X-Y
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References

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Leardini, A., M.G. Benedetti, L. Berti, D. Bettinelli, R. Natio, and S. Giannini. "Rear-foot, Mid-foot and Fore-foot Motion during the Stance Phase of Gait." Gait & Posture 25 (2007): 453-55

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