Theia

Theia's markerless motion capture technology integrates with Visual3D and Sift by exporting C3D files, allowing users to process, analyze, and visualize their data. Visual3D recognizes these C3D files as Theia3D output and automatically creates a model and assigns the associated motion file during import.

A standing (static) trial is generated virtually based on the parameters found within the movement trial, rather than requiring a separate static capture. Model segments and landmarks are created automatically based on the Theia data. It's important to note that Theia3D stores ROTATION signals, not traditional TARGET signals. These ROTATION signals include the full six degrees of freedom (6 DOF) for each segment, as a 4×4 transformation matrix. When a ROTATION signal is selected for a segment location, only the position component is used unless further configuration is specified. Unless there is a specific need to modify the coordinate system, the ROTATION signal is directly assigned to the pose of the model segment without further processing. The ROTATION folder in **Signals and Events** displays all the ROTATION signals exported by Theia3D.

Each ROTATION signal consists of 17 float values per frame: sixteen values represent the 4×4 transformation matrix, and the seventeenth is a reliability metric. These signals are stored sequentially in the C3D file. This data type is used in practice because if a segment's origin is defined at the proximal end, the ROTATION matrix provides a description of both the position and orientation of that segment. This eliminates the need for additional calculations to estimate pose and makes data management easier, since the pose is a single signal.

This integration supports all Theia3D software versions including Theia Apex v2026, Theia Axiom v2025, Theia Apollo v2024, Theia 2023, Theia 2022, and Theia 2021.

Automatic Model-building

Visual3D will automatically build a model for C3D files output by Theia3D. The model has 17 body segments, two lab coordinate systems (global and virtual lab, and 4 shadow segments. Visual3D also builds model segments for Theia's baseball bat and ball tracking.

1. Lab	6. Right Toes	11. Thorax	16. Left Upper Arm	21. Left Foot (Shadow)
2. Pelvis	7. Left Thigh	12. Head	17. Left Forearm	22. Thorax/Ab (Shadow)
3. Right Shank	8. Left Shank	13. Right Upper Arm	18. Left Hand	23. Head (shadow)
4. Right Thigh	9. Left Foot	14. Right Forearm	19. Virtual Lab	24. Baseball Bat
5. Right Foot	10. Left Toes	15. Right Hand	20. Right Foot (Shadow)	25. Baseball Ball

Kinetic But No Force Assignment

For the automatic model built for Theia3D output data, and other similar markerless systems, force assignments at the feet are intentionally assigned to the toe segment rather than the foot segment. This is accomplished by defining the foot segment as "Kinetic with no force assignment" while the toe segment is defined as "Kinetic". This ensures that forces are assigned always assigned to the Right/Left Toes segments which are the most distal segments in the kinetic chain.

The reason for this is that the Net Joint Moment and Joint Reaction Force at the ankle are identical regardless of which segment is assigned the force, as they are part of the kinetic chain, but if the force is assigned to the foot segment then the metatarsal moment cannot be computed.

Shadow Segments

The shadow segments defined to model Theia3D and their underlying purpose are:

- Right/Left Foot: Make joint angles easier to interpret
- Thorax/Ab: Invert proximal/distal; place origin at pelvis
- Head: Place origin at proximal head; account for CoM

Version Requirements

Theia releases newer, more advanced, models over time and users must make certain that their version of Visual3D supports automatic model-building for their version of Theia3D. Different versions of Theia will produce different model / segment definitions.

Theia3D Version	Notes/Description	Visual3D Version
Apex (v2026.1.0)	Added Ball Modelling to automatic model	v2026.04.1
	Implemented Bat and Ball modelling using multiple subjects, allowing multiple balls and bats to be modelling within a single session	
v2025.2.0	Introduced Bat Tracking feature	v2026.01.1
Axiom (v2025.1.0)	Separate inertial parameters for male and female participants.	v2025.03.2
Apollo (v2024.1.0)	Introduction of new model.	v2024.08.4
	Model 10	v2024.02.1
	Initial Model	v2020.03.16

Merging Theia3D Files

Typically, users want to merge Theia3D's motion capture output and analog signals such as force platform recordings.

The Manage_File_Merge command is designed to merge multiple files that recorded data from the same motion capture trial. This command merges data types from each .c3d file into one trial in the Visual3D workspace. This command was originally called **Manage_Theia3D_Merge**, but since has been updated to be used for file types other than from Theia3D.

This pipeline command makes it simple to merge markerless motion capture files from Theia with marker-based motion capture files from Qualisys QTM.

The following sample data can be used to follow along with the outlined steps in Merge Theia with QTM Analog Data

Loading Theia C3D Files into Sift

Users wanting to import Theia C3D files into Sift can use the Theia Builder to build CMZ files from the Theia3D outputs and merge these with analog data if desired. Sift's tutorials include a walkthrough of how to use the Theia Builder feature.

Batch Reprocessing Theia Files

If your reprocessing workflow involves going back to your raw video data and rerunning Theia's pose estimation, e.g., when a new model is released, then you can incorporate this into your Sift console script. The -RunTheiaBatch console command tells Sift to call to Theia3D with an instruction file for batch processing.