



4DCT Processing in SlicerAutoscopers^M

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Outline

- **4DCT overview**
- **Data upload**
- **Segmentation**
 - **Automatic Segmentation**
- **Creating models**
- **Registration – Hierarchical 3D Registration**
- **Saving registration**

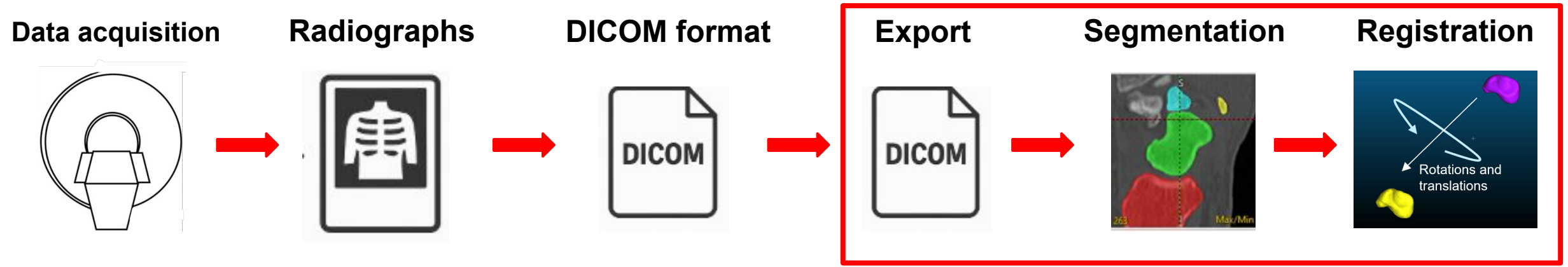
4DCT Overview

- Traditional radiographs: **overlapping anatomy; difficult to assess subtle joint abnormalities**
- Three-dimensional imaging modalities (CT, MRI): **single time point**; viewed as **serial 2D images**
- Dynamic instability challenges: may appear “**normal**” on traditional imaging

Why 4DCT?

- Certain instabilities and impingements only appear during motion demonstrating a need for dynamic imaging
- 4DCT (3DCT over time) offers the opportunity to visualize bones during motion
 - *Osteokinematics* (bone motion) can be used to quantify bone biomechanics (or arthrokinematics) during motions and functional tasks

4DCT Overview

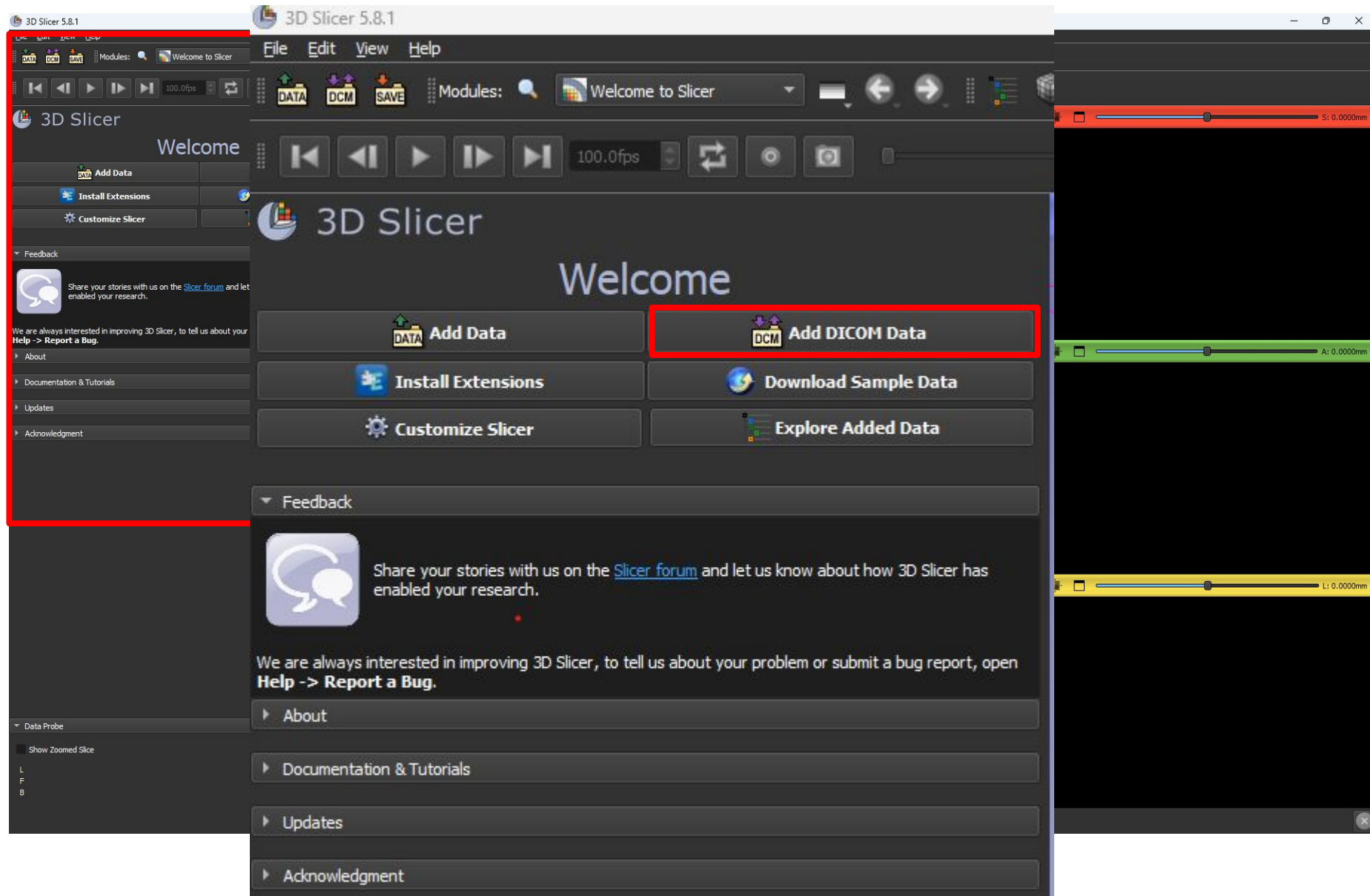


Processing 4DCT

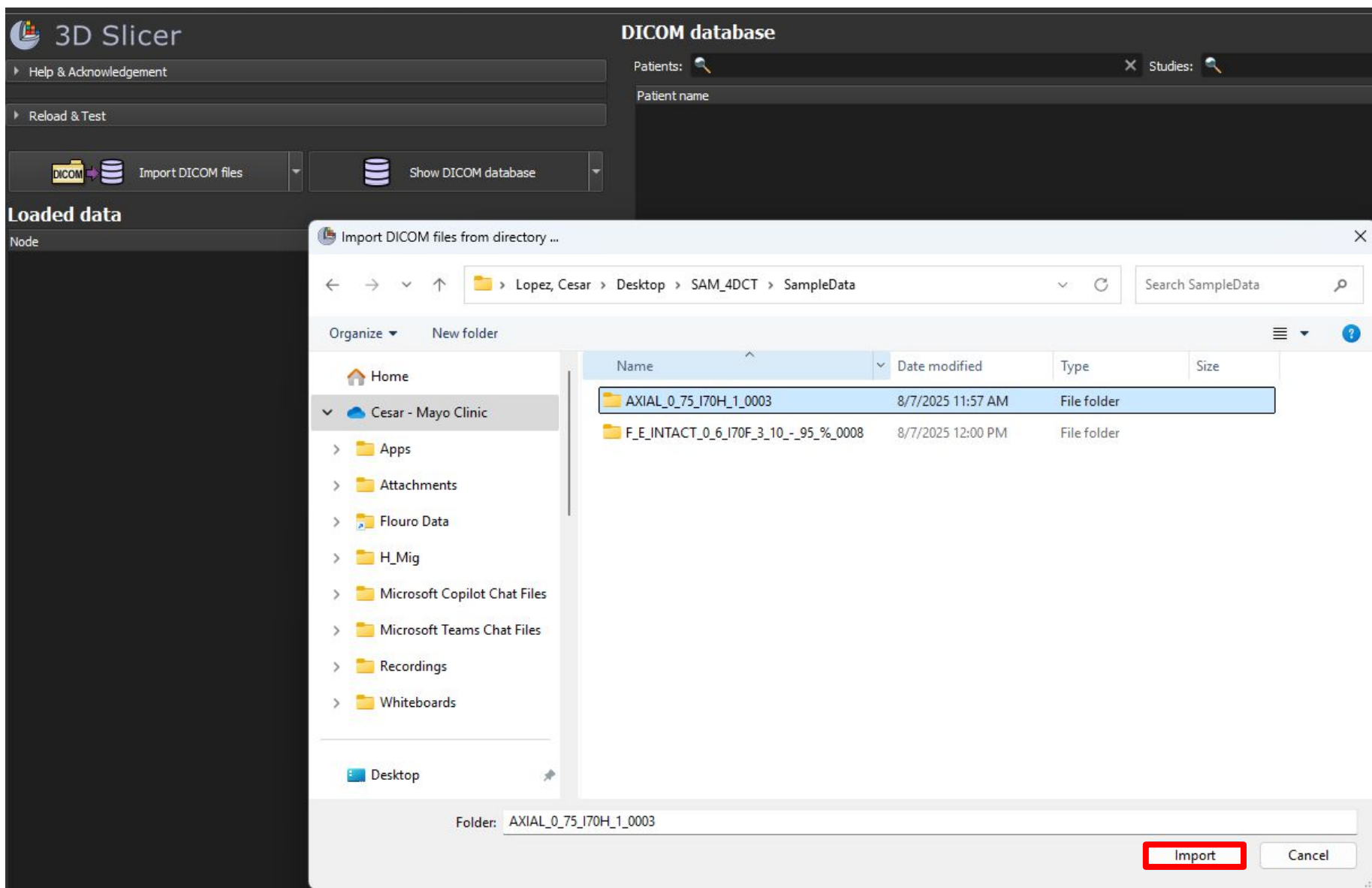


SlicerAutoscooper^M

4DCT Data upload



4DCT Data upload



4DCT Data upload

The screenshot displays the 3D Slicer DICOM database interface. The top menu bar includes File, Edit, View, and Help. Below it is a toolbar with various icons. The main window is divided into several panels. On the left, there is a sidebar with 'Help & Acknowledgement', 'Reload & Test', and 'Import DICOM files' and 'Show DICOM database' buttons. The central area is titled 'DICOM database' and contains three tables: 'Patients', 'Studies', and 'Series'. The 'Patients' table has one entry: R5130LEFT, ZHAO. The 'Studies' table has one entry: 20190327, 1, Private:Zhao_Wrist_4Dseq (Adult). The 'Series' table has two entries: 3, Axial 0.75 170h 1, CT, 512x512 471, 2025-06-14 8:06:09, and 10, FE intact 0.6 170f 3 10 - 95 %, CT, 512x512 1530, 2025-06-14 35:50:08. At the bottom right, there is a 'Load' button highlighted with a red rectangle. The bottom status bar shows 'Advanced'.

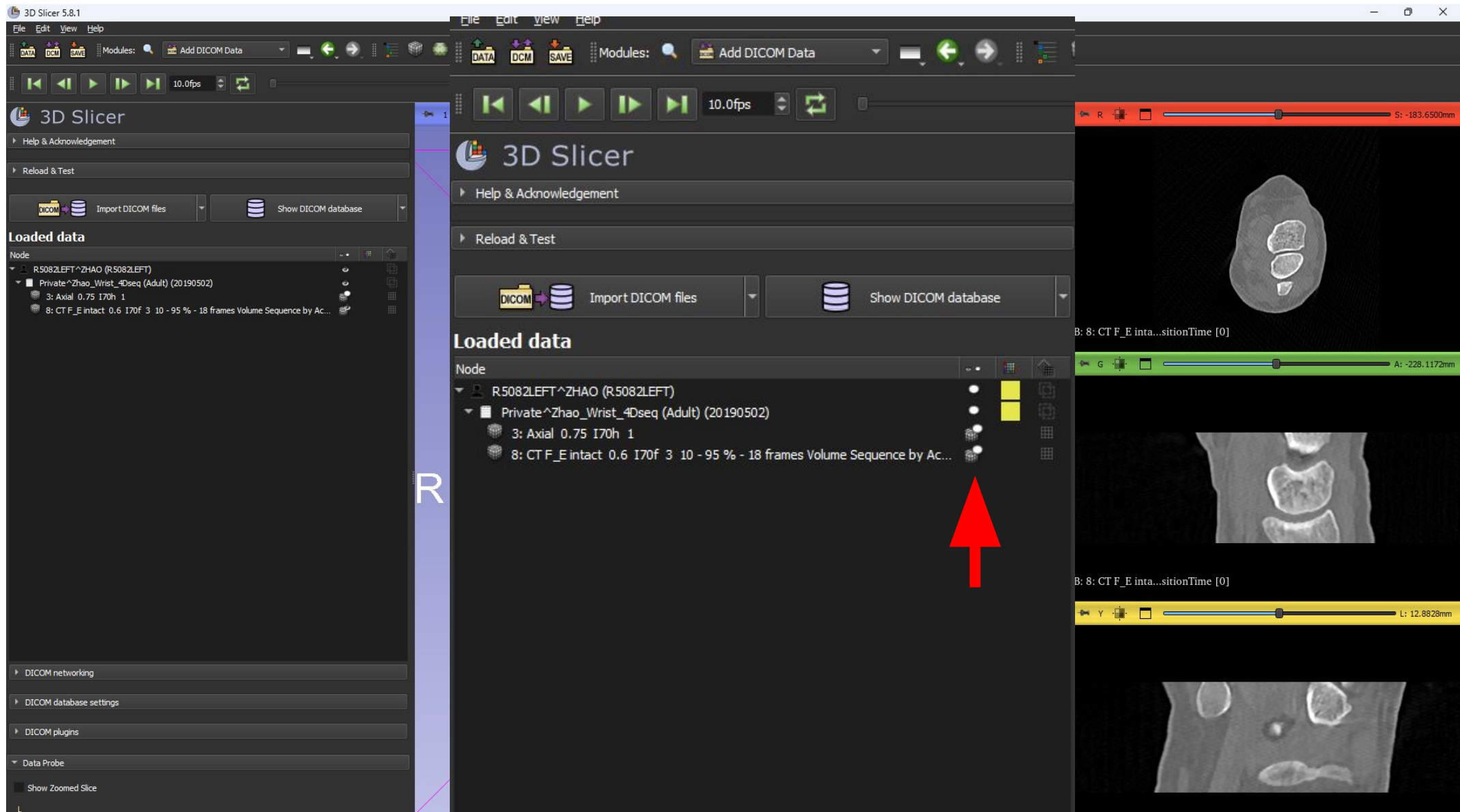
Patient name	Patient ID	Birth date	Sex	Studies	Last study date	Date added
R5130LEFT, ZHAO	R5130LEFT	1920-03-27	O	1	2019-03-27	2025-06-14 8:06:07

Study date	Study ID	Study description	Series	Date added
20190327	1	Private:Zhao_Wrist_4Dseq (Adult)	2	2025-06-14 8:06:09

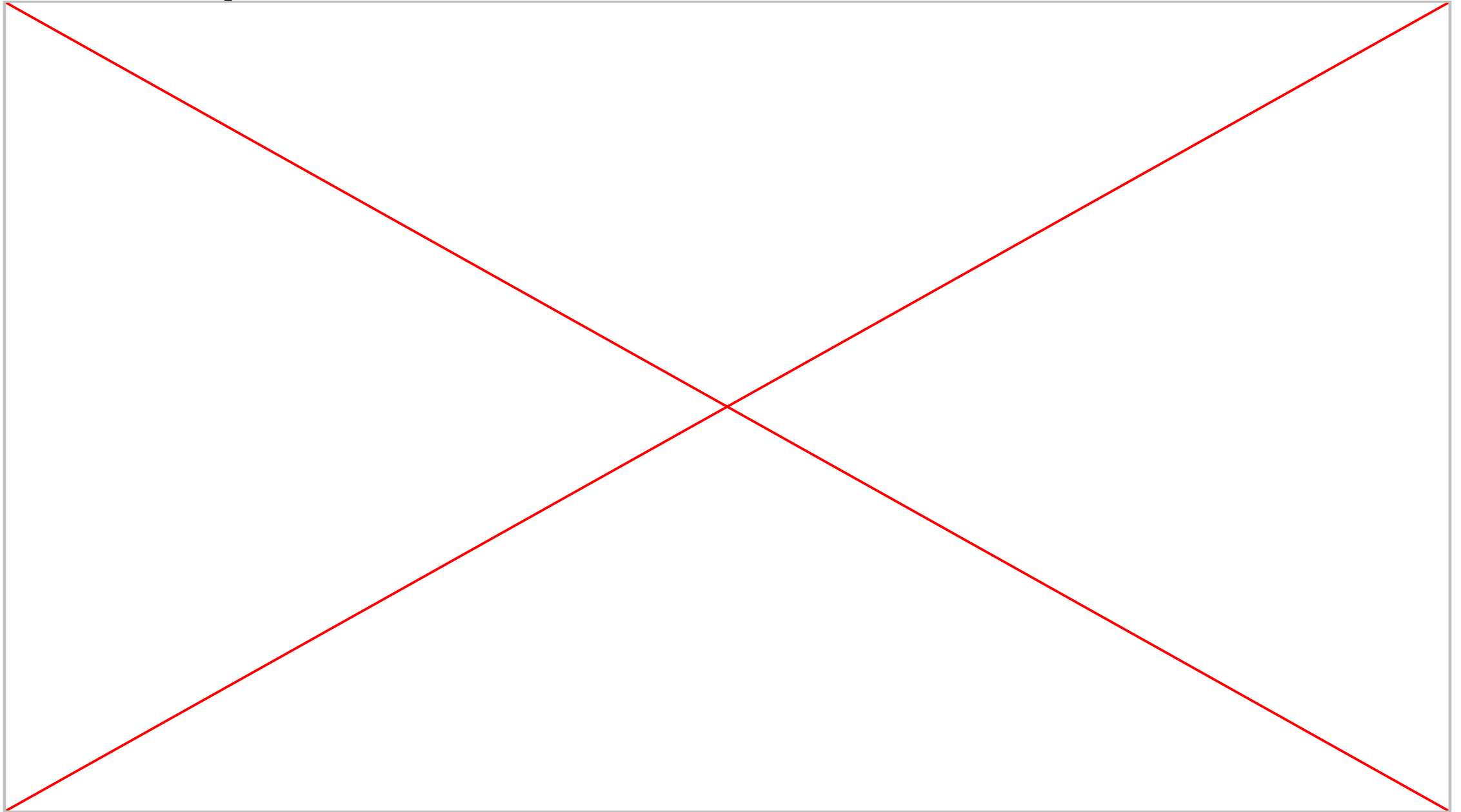
Series #	Series description	Modality	Size	Count	Date added
3	Axial 0.75 170h 1	CT	512x512	471	2025-06-14 8:06:09
10	FE intact 0.6 170f 3 10 - 95 %	CT	512x512	1530	2025-06-14 35:50:08

Load

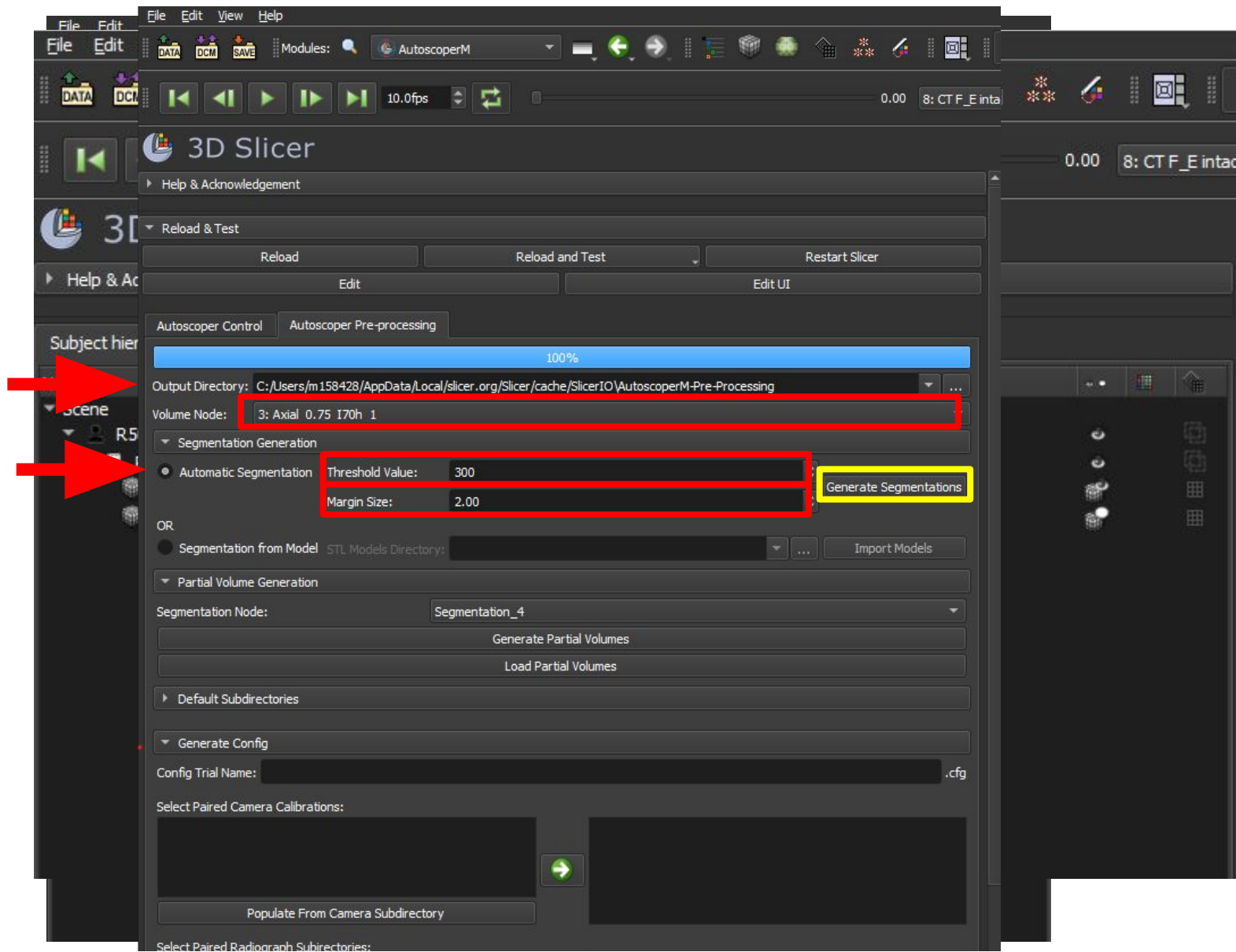
4DCT Data upload



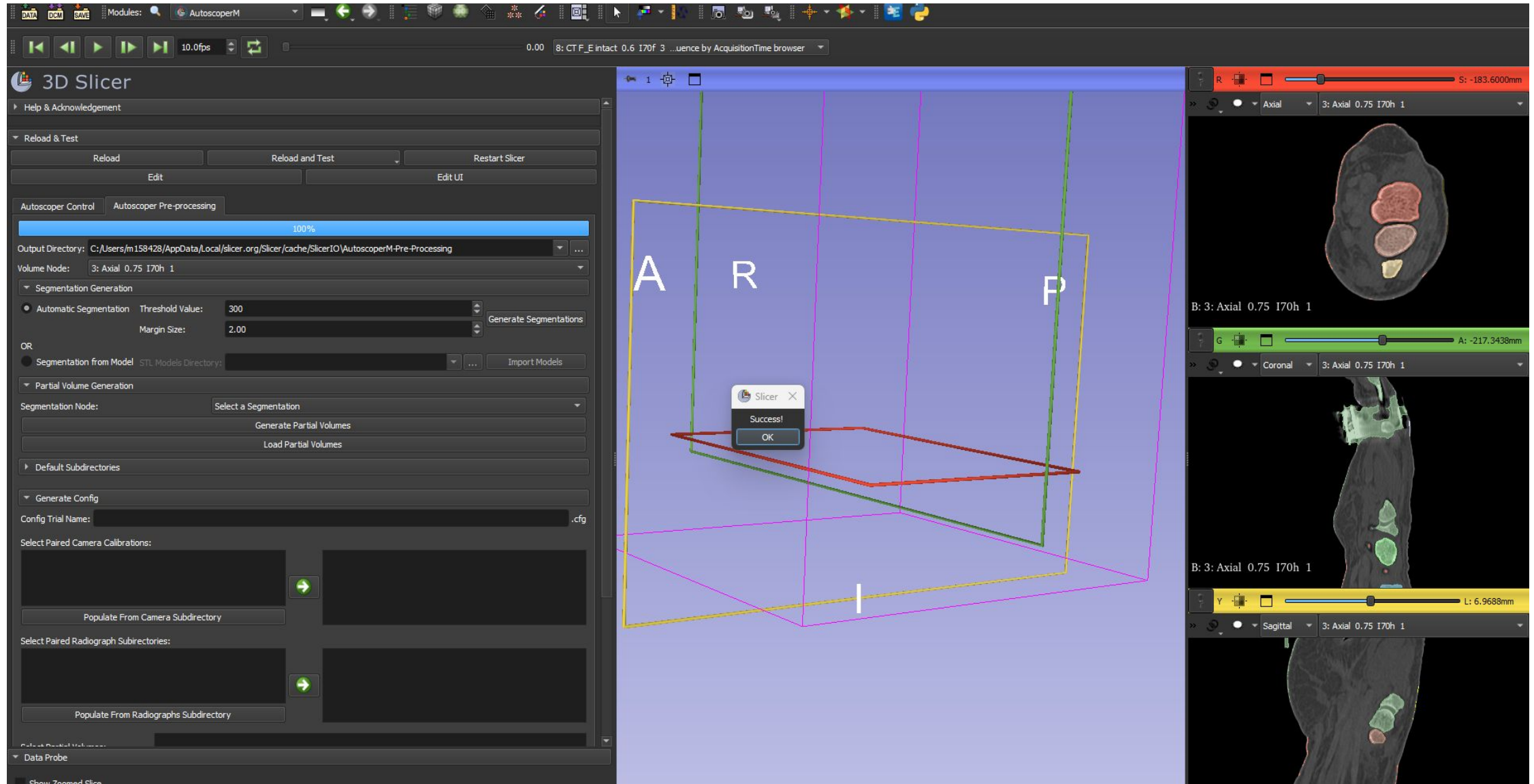
4DCT Data upload



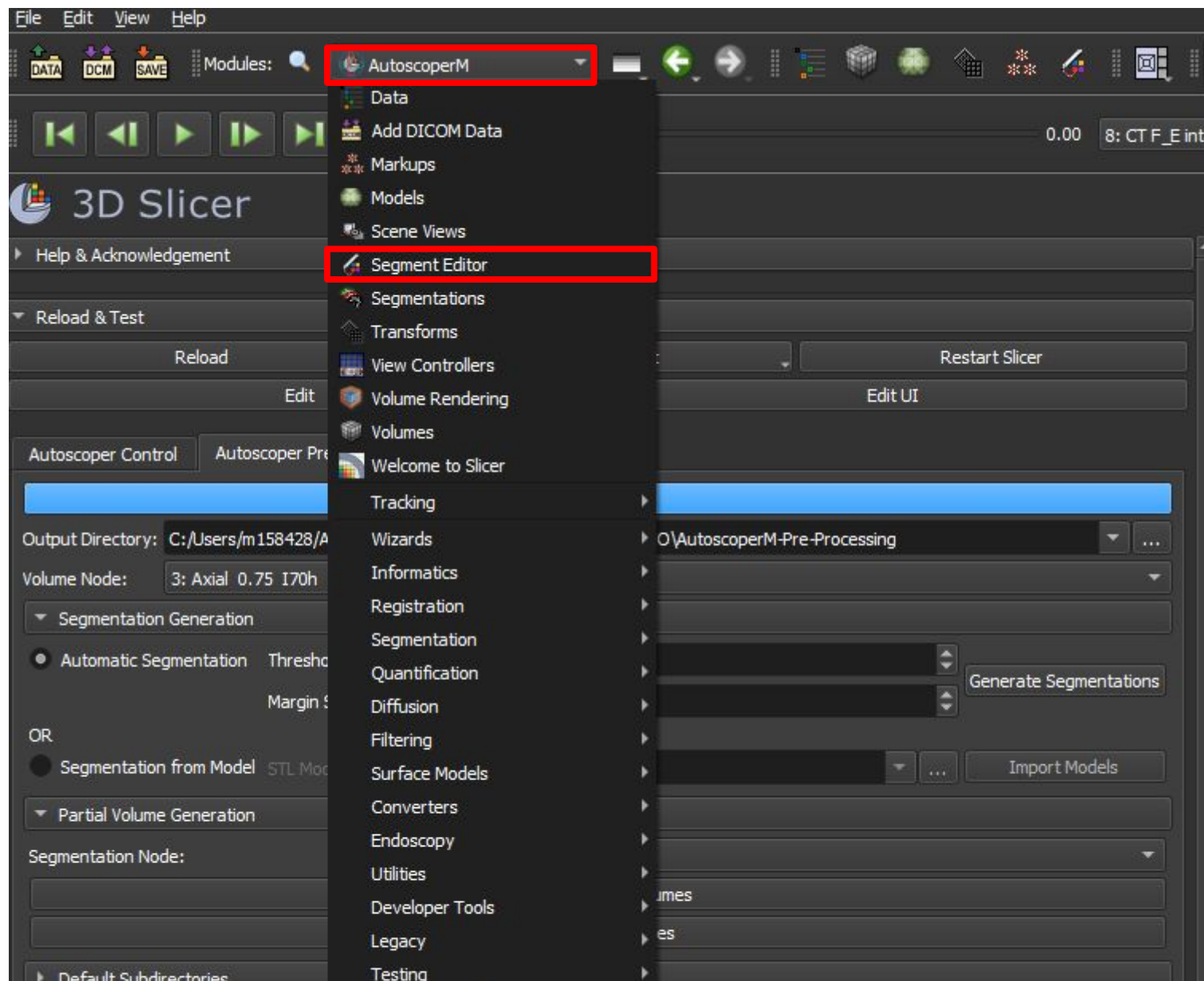
Segmentation - Autoscoper^M



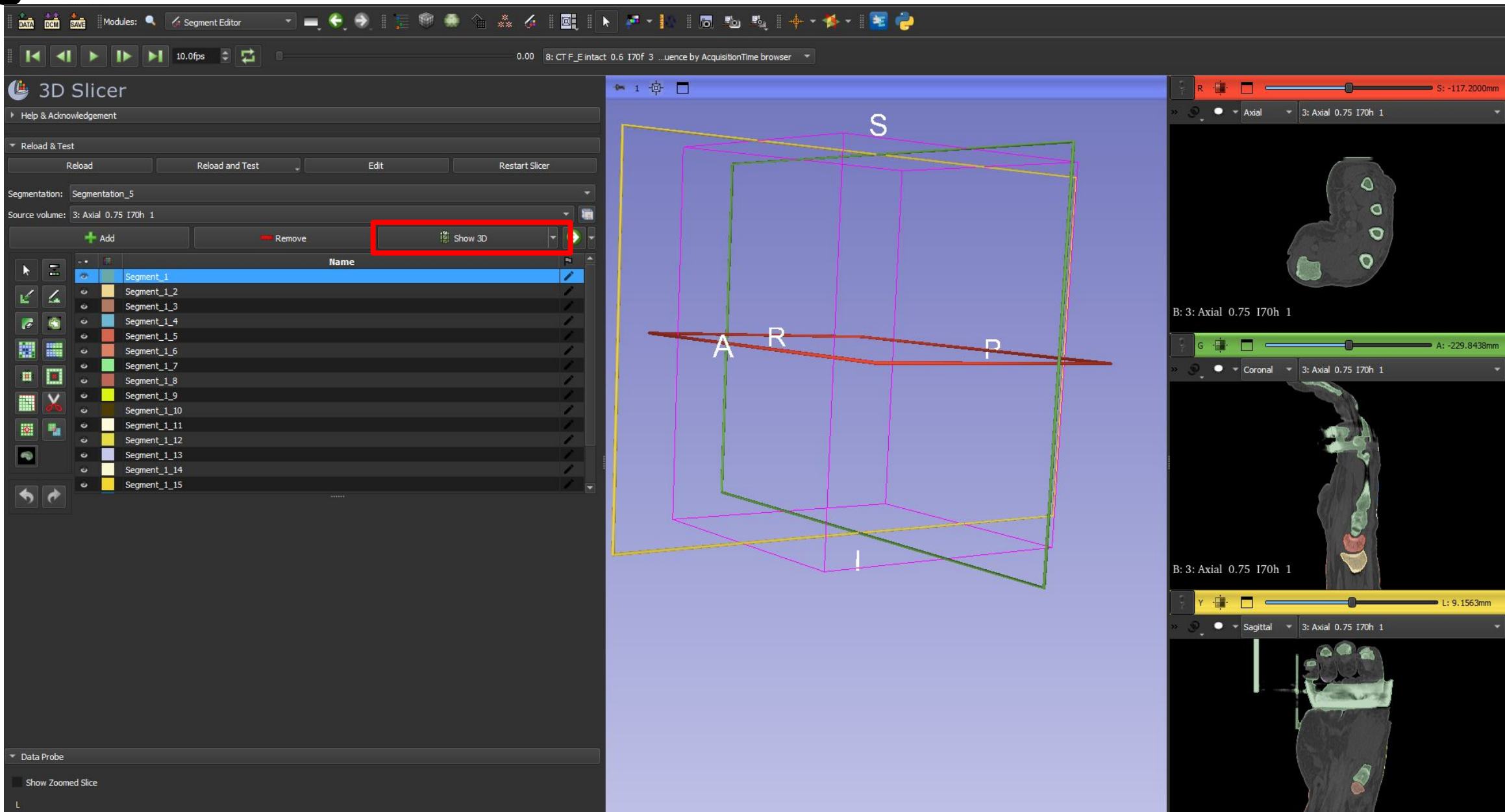
Segmentation - Autoscooper^M



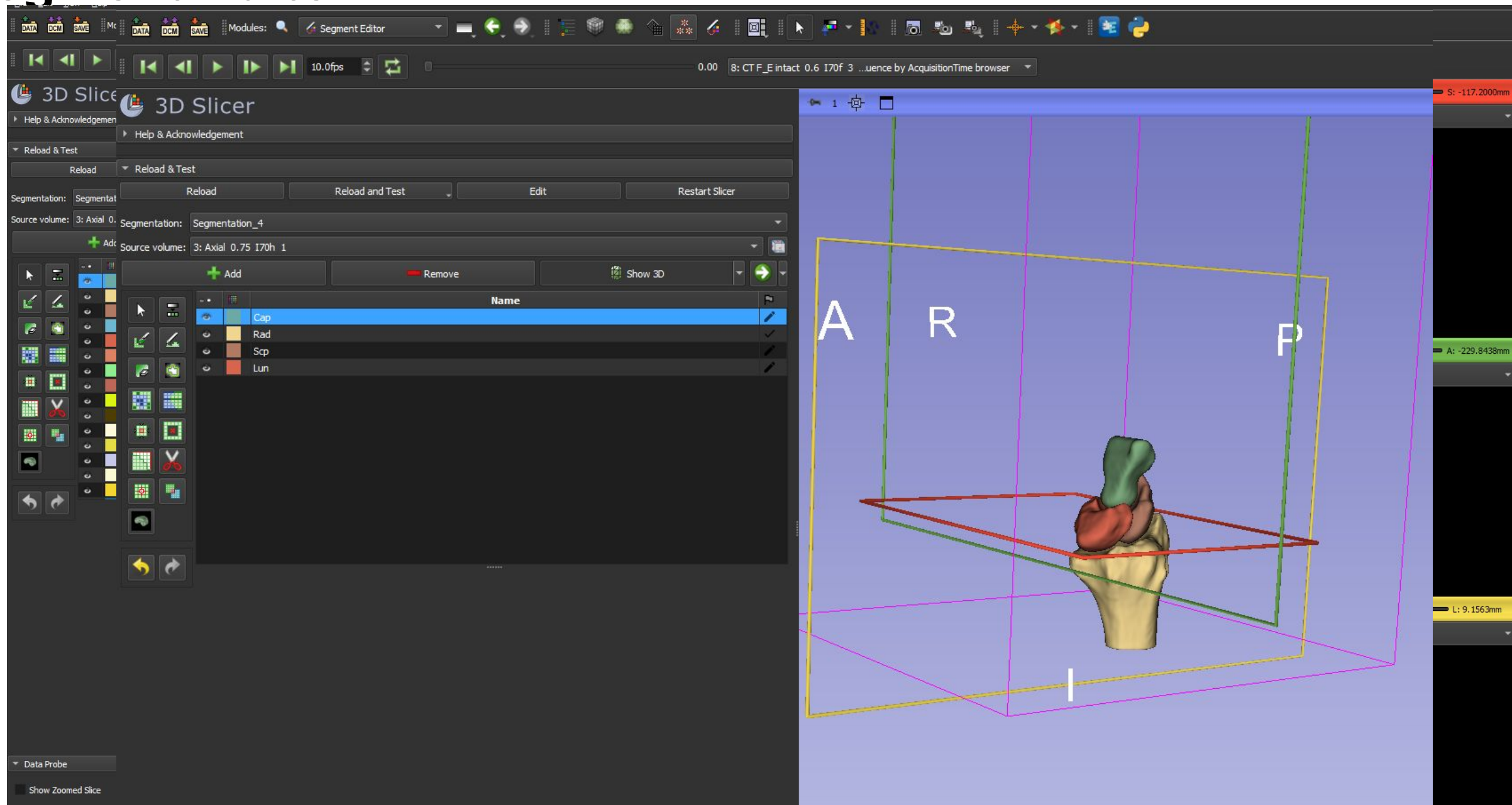
Segment Editor



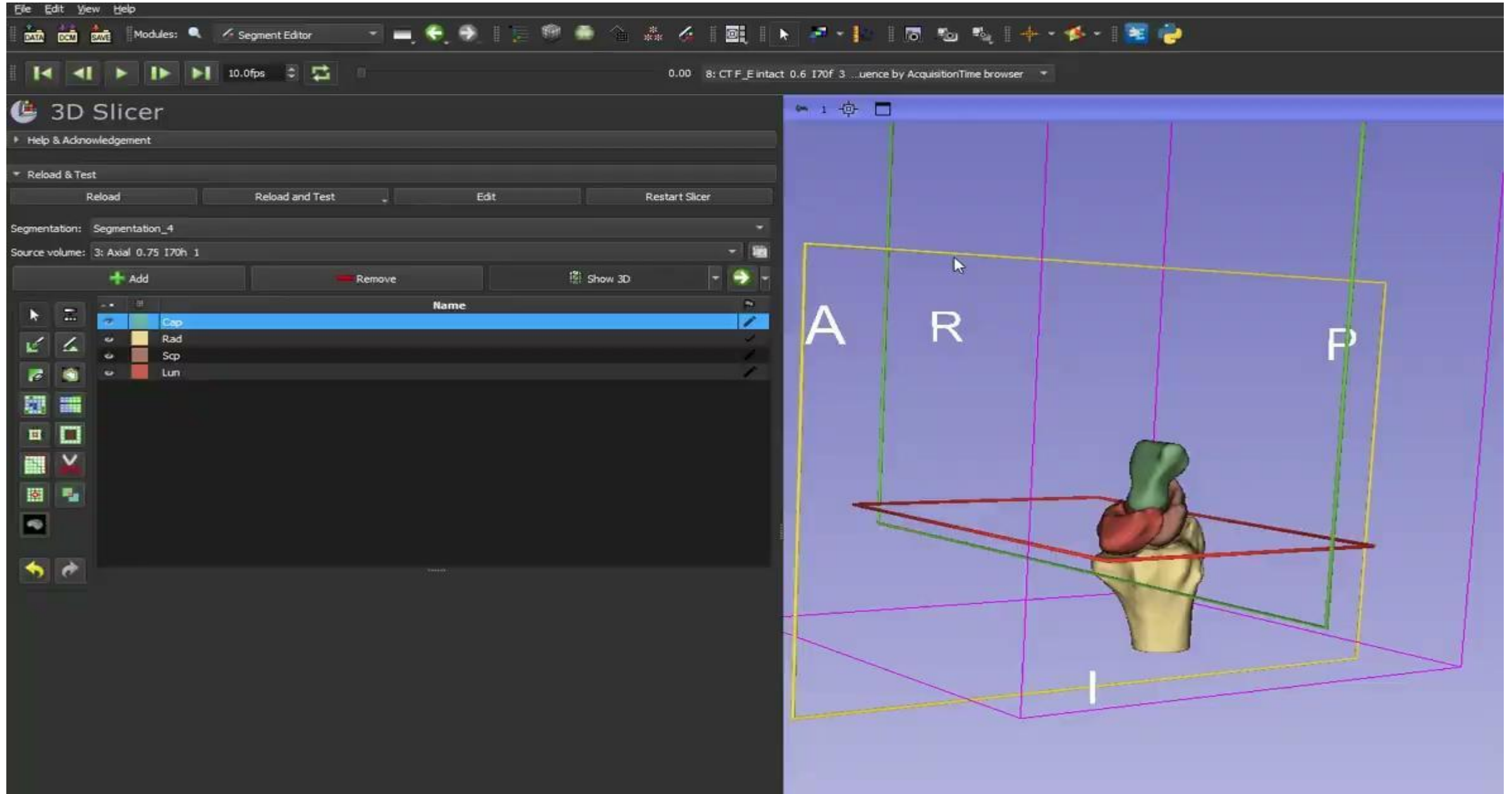
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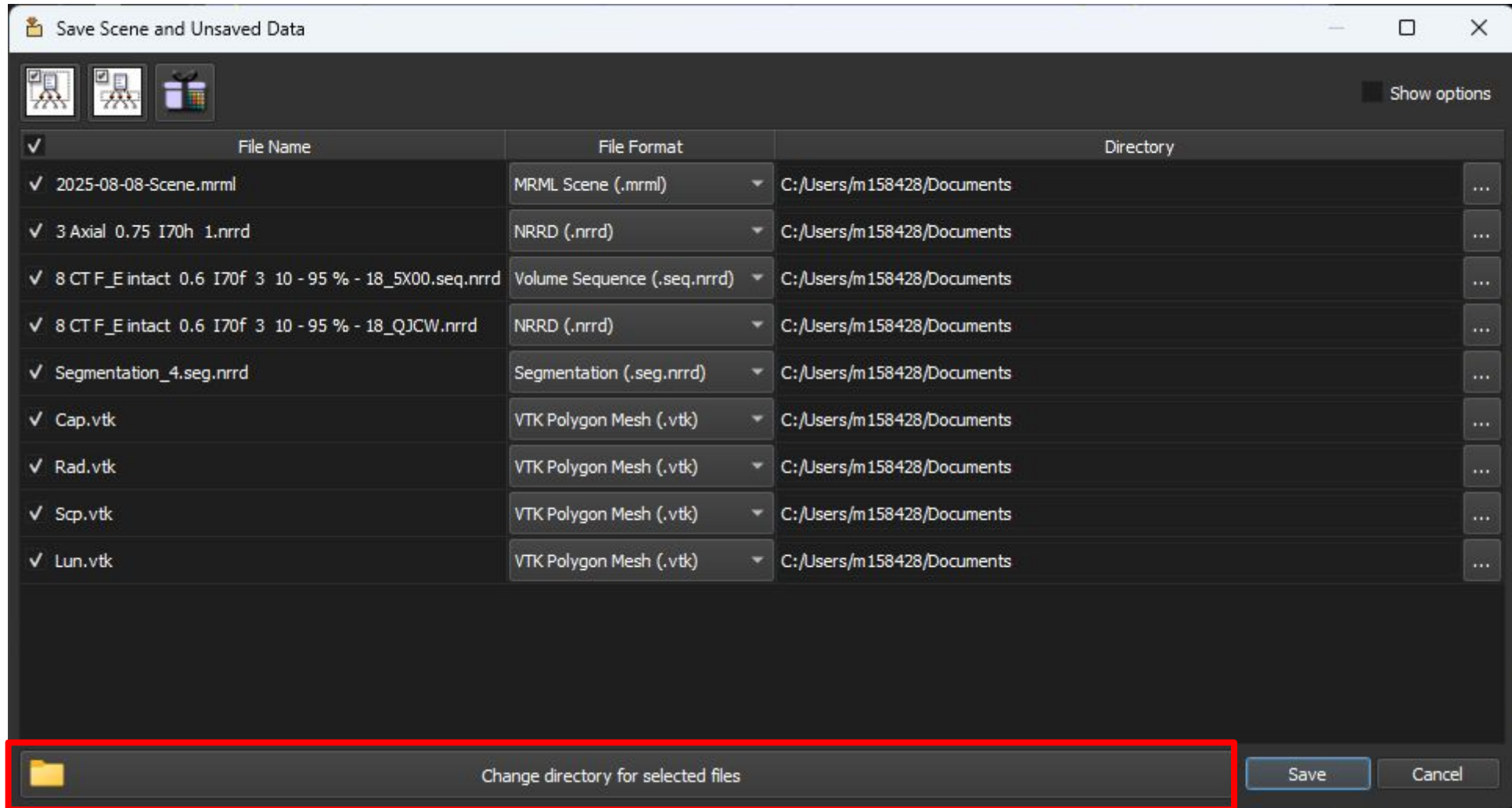
Segment Editor



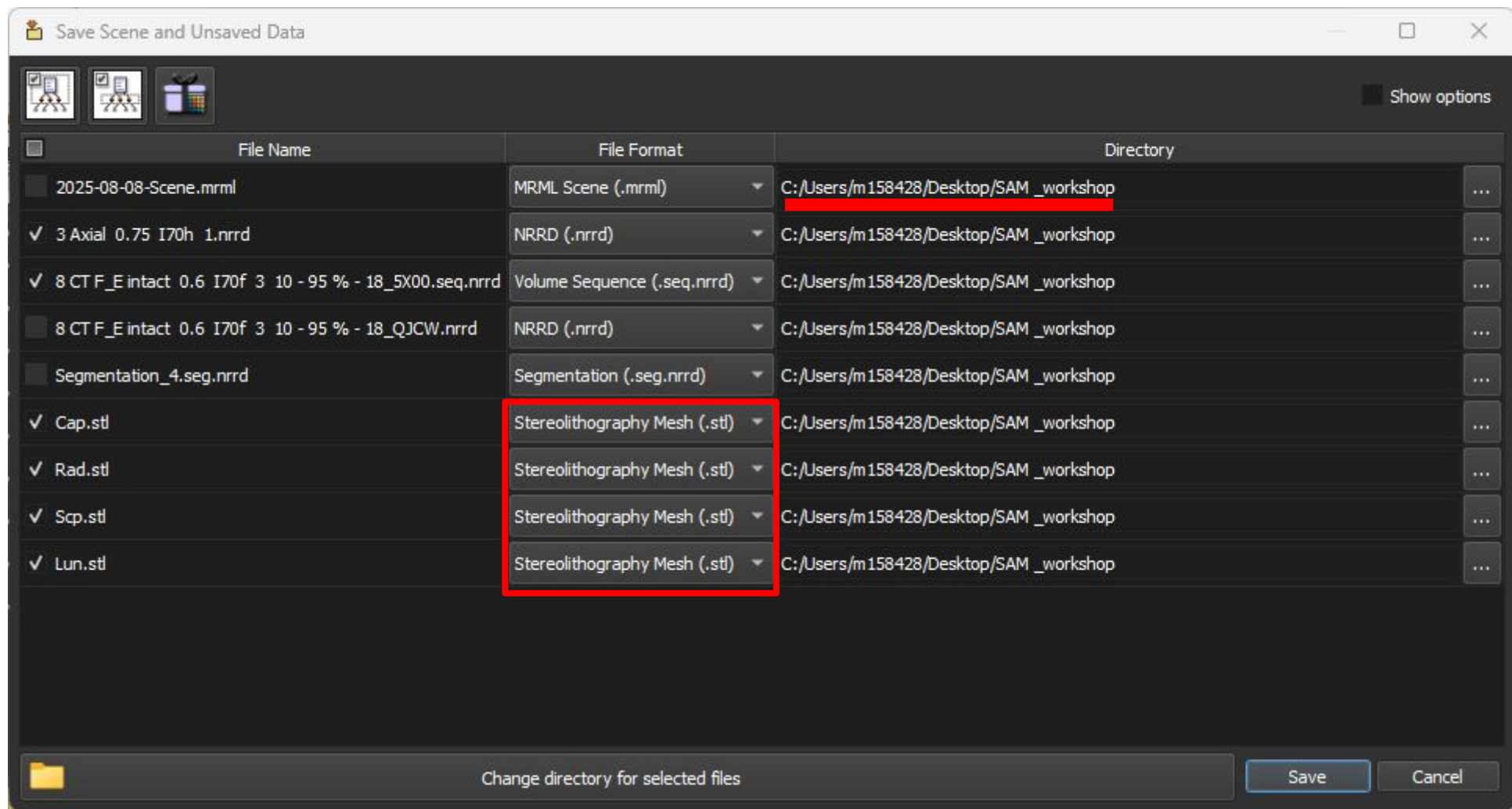
Model Creation



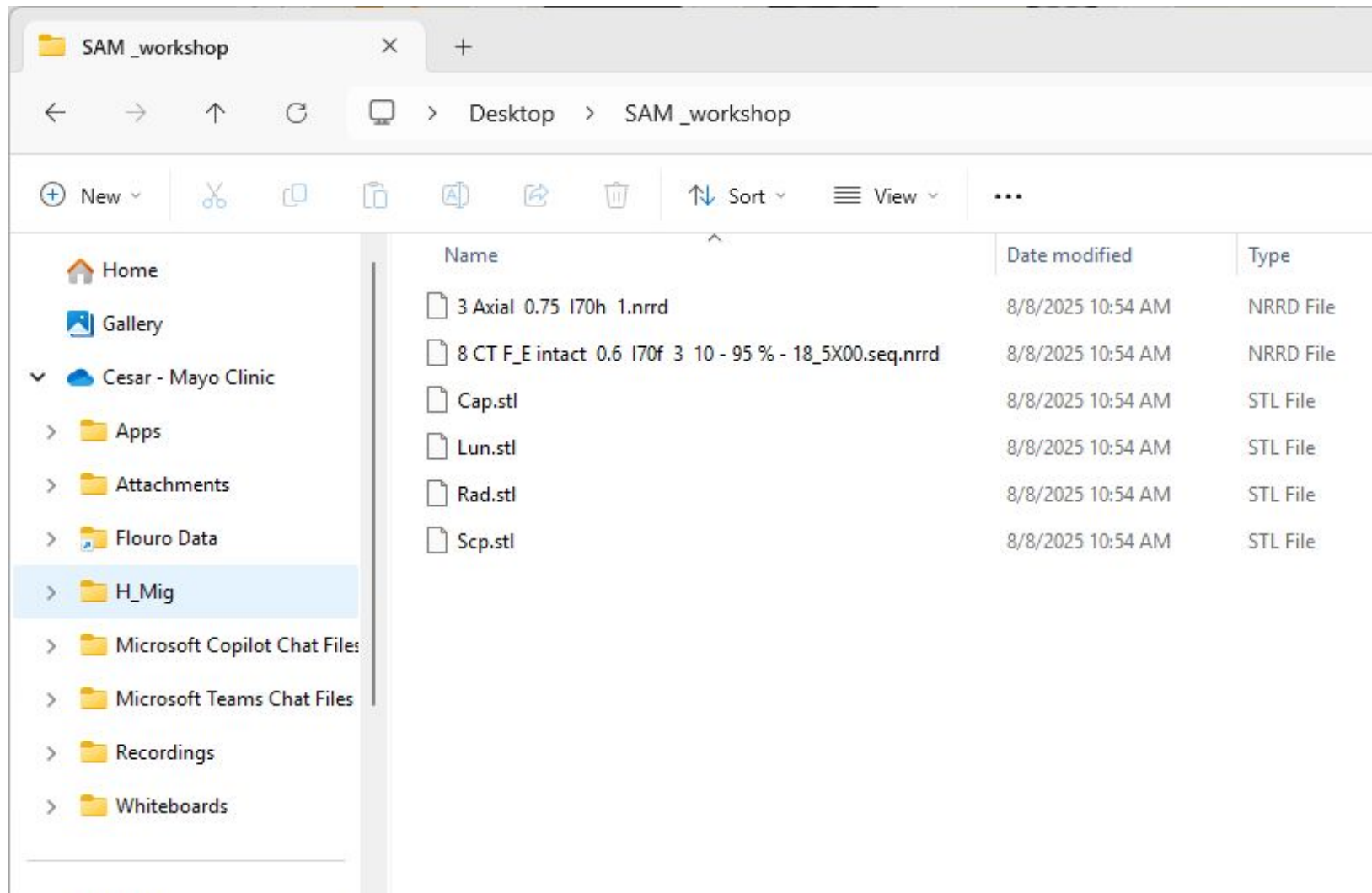
Saving NRRD, Volume Sequence, Model



Saving NRRD, Volume Sequence, Model



Saving NRRD, Volume Sequence, Model

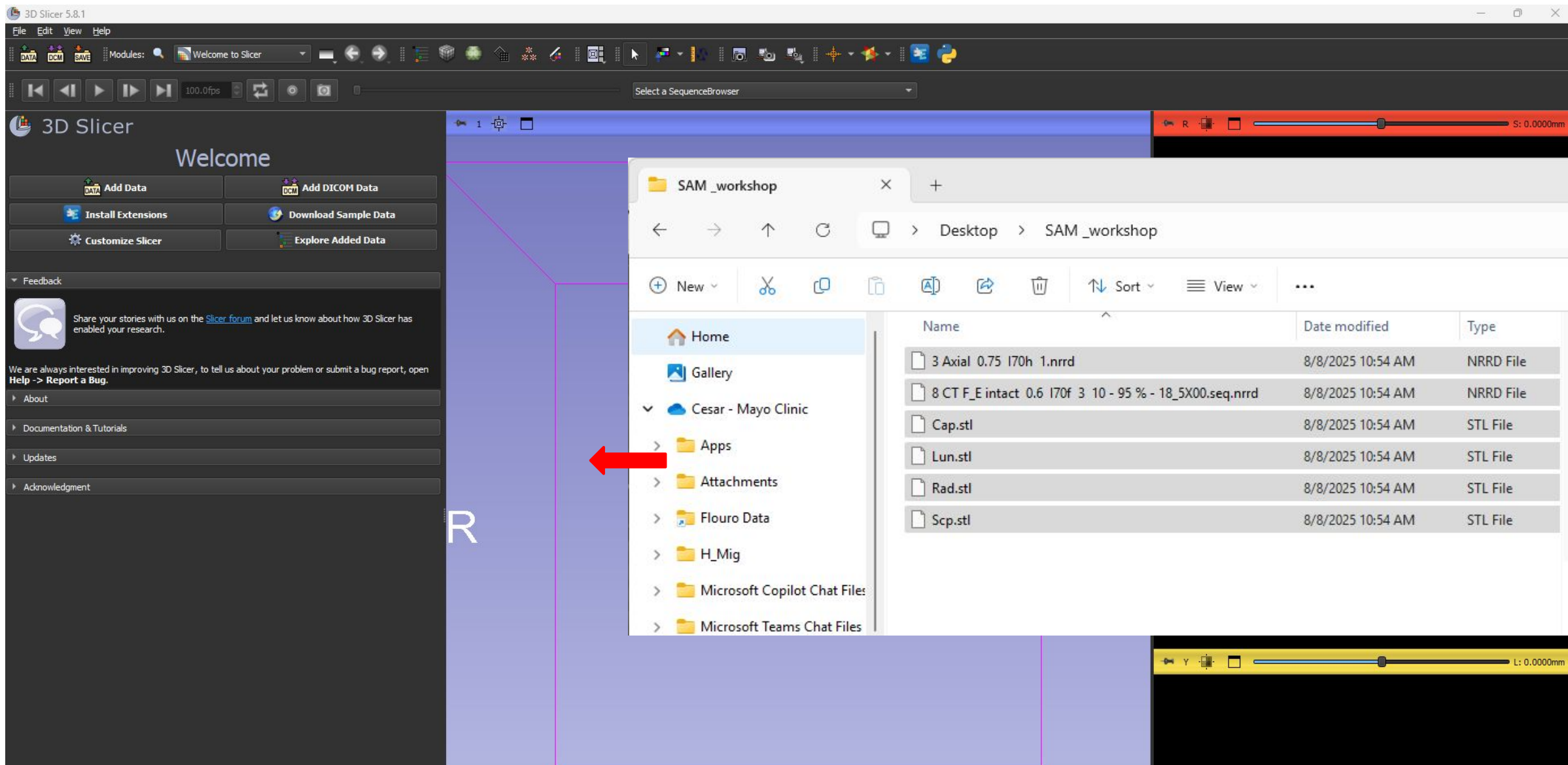


Hierarchical3DRegistration

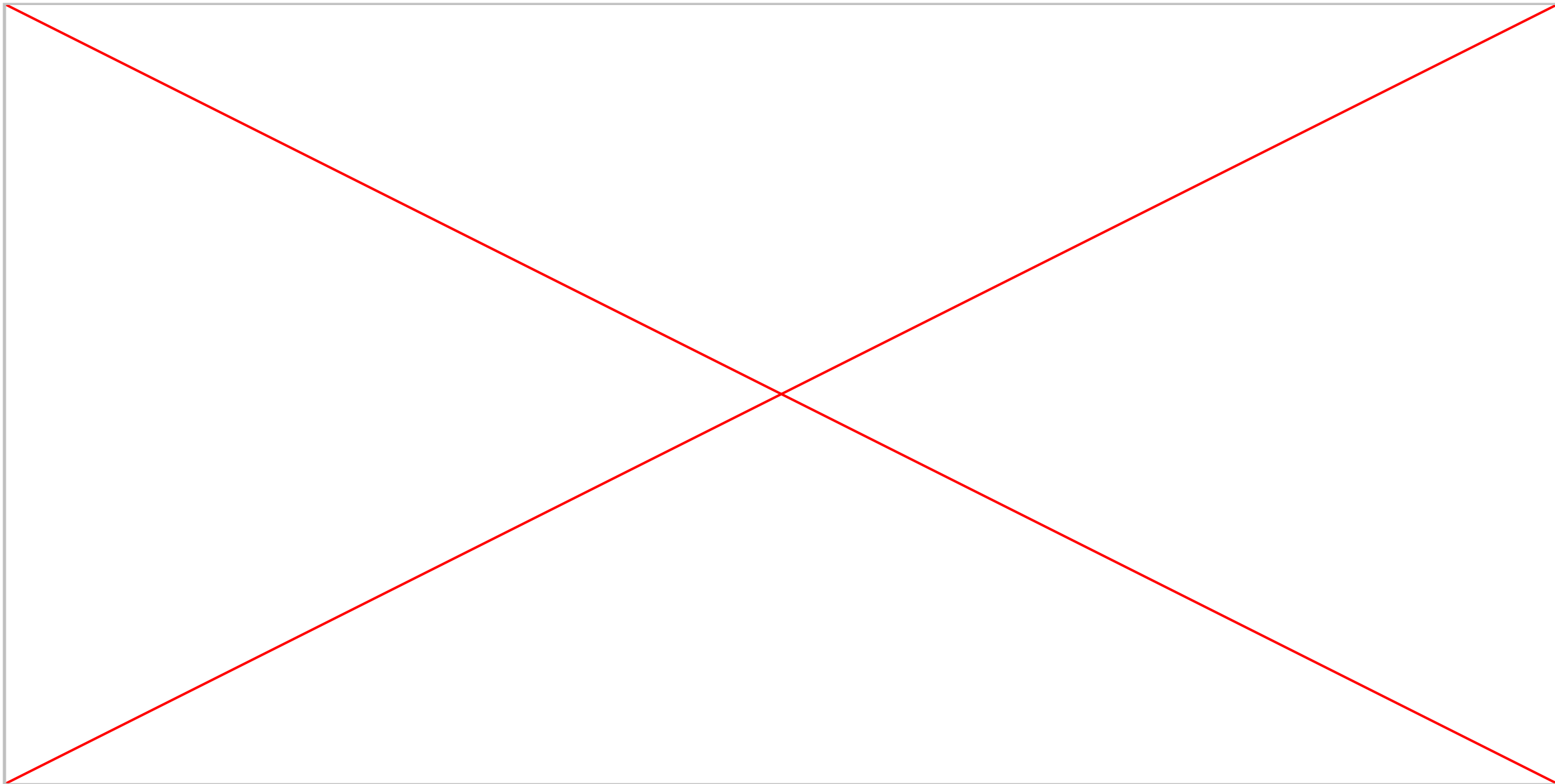


SlicerAutoscooper^M

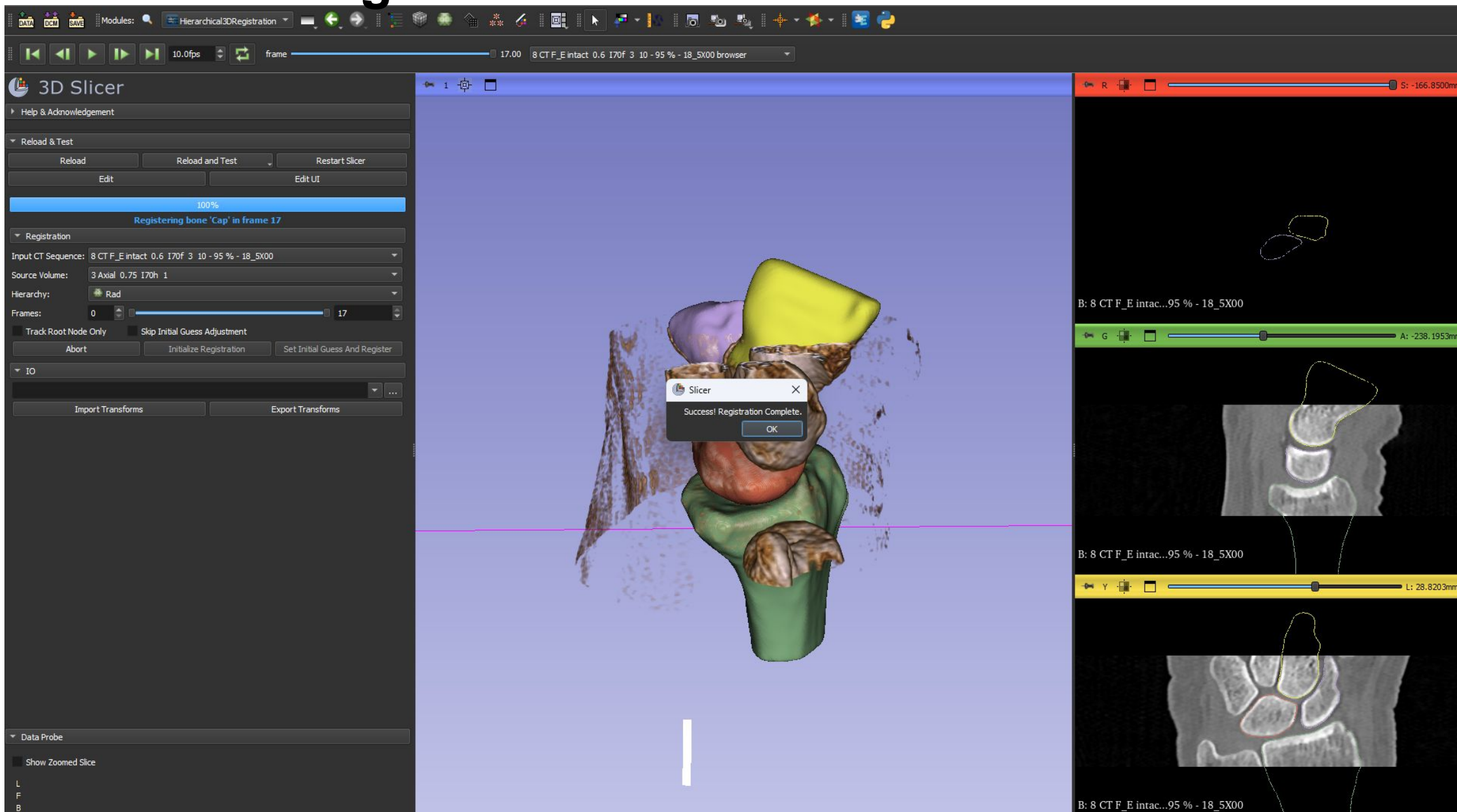
Hierarchical3DRegistration



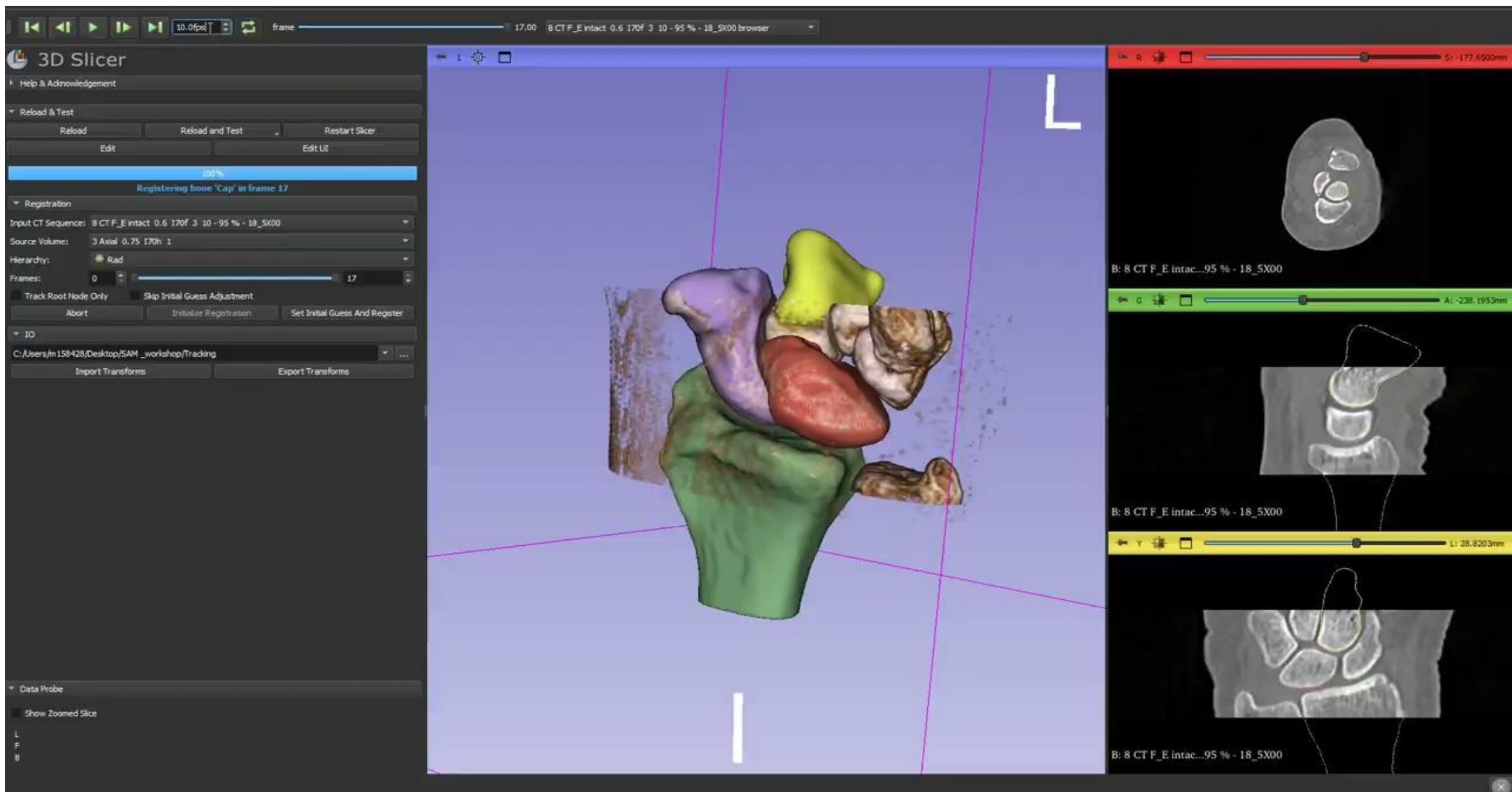
Hierarchical3DRegistration



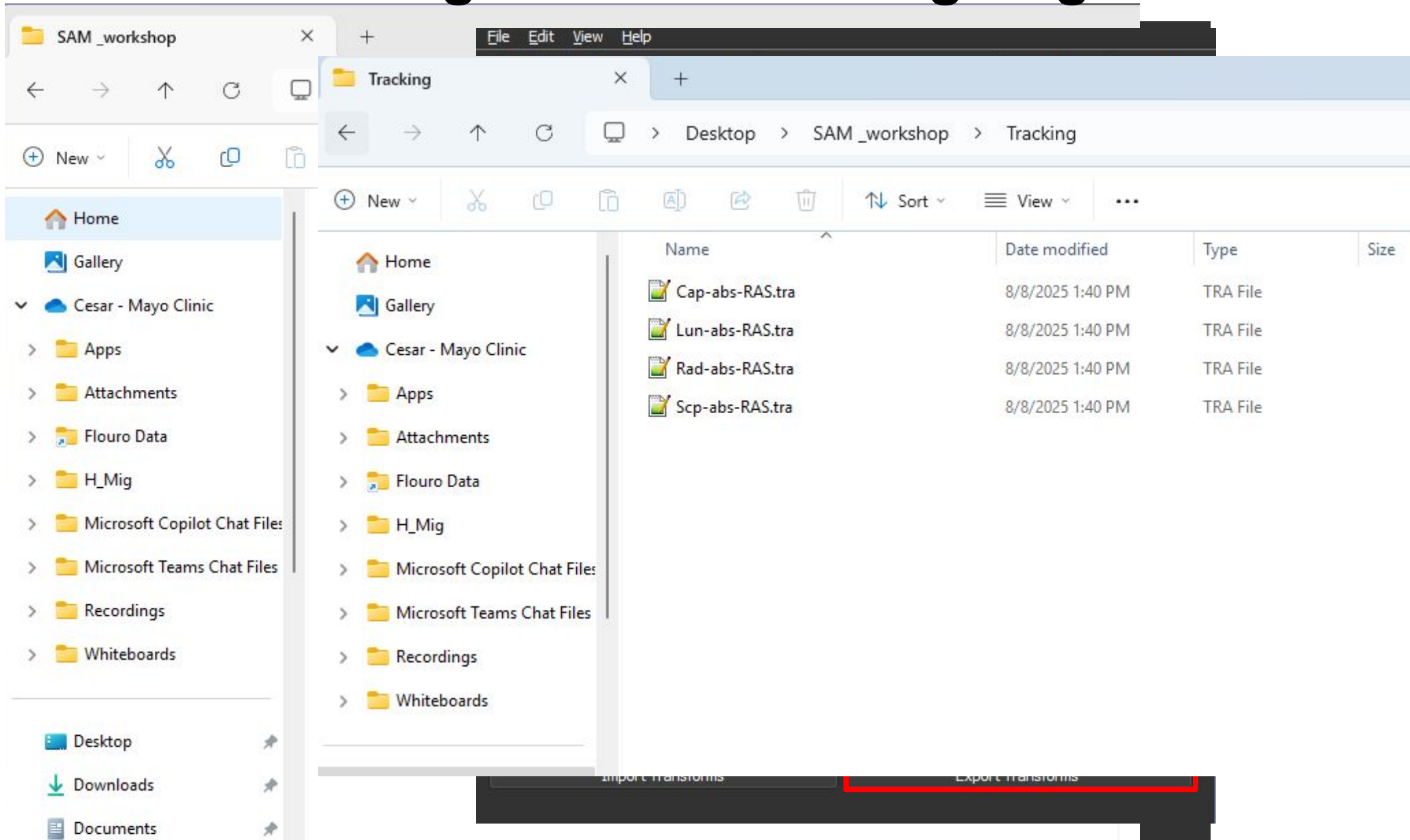
Hierarchical3DRegistration



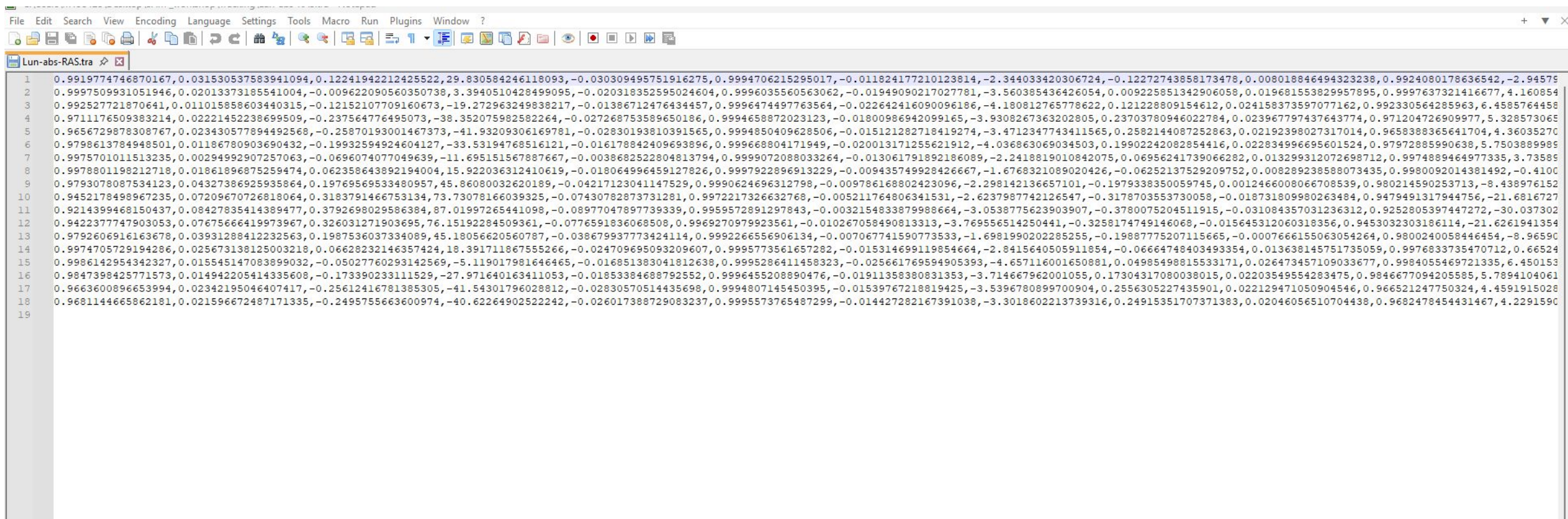
Hierarchical3DRegistration



Hierarchical3DRegistration – Saving Registration



Hierarchical3DRegistration – Tracking file



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File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
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19
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SlicerAutoscooper^M

- Community-driven
- Integration of BVR, 3DCT and 4DCT workflows into a single platform
- Standardization across institutions
- Promotes transparency and collaboration
- Faster learning curve: Improved accessibility for trainees and non-engineers
- Partial volumes? **NOT A PROBLEM!!!!**

*Greater alignment in software capabilities may facilitate post-processing approaches
*Software alignment may **expedite translation to the clinic**

Acknowledgments



R01 AR071338

R01 AR078924

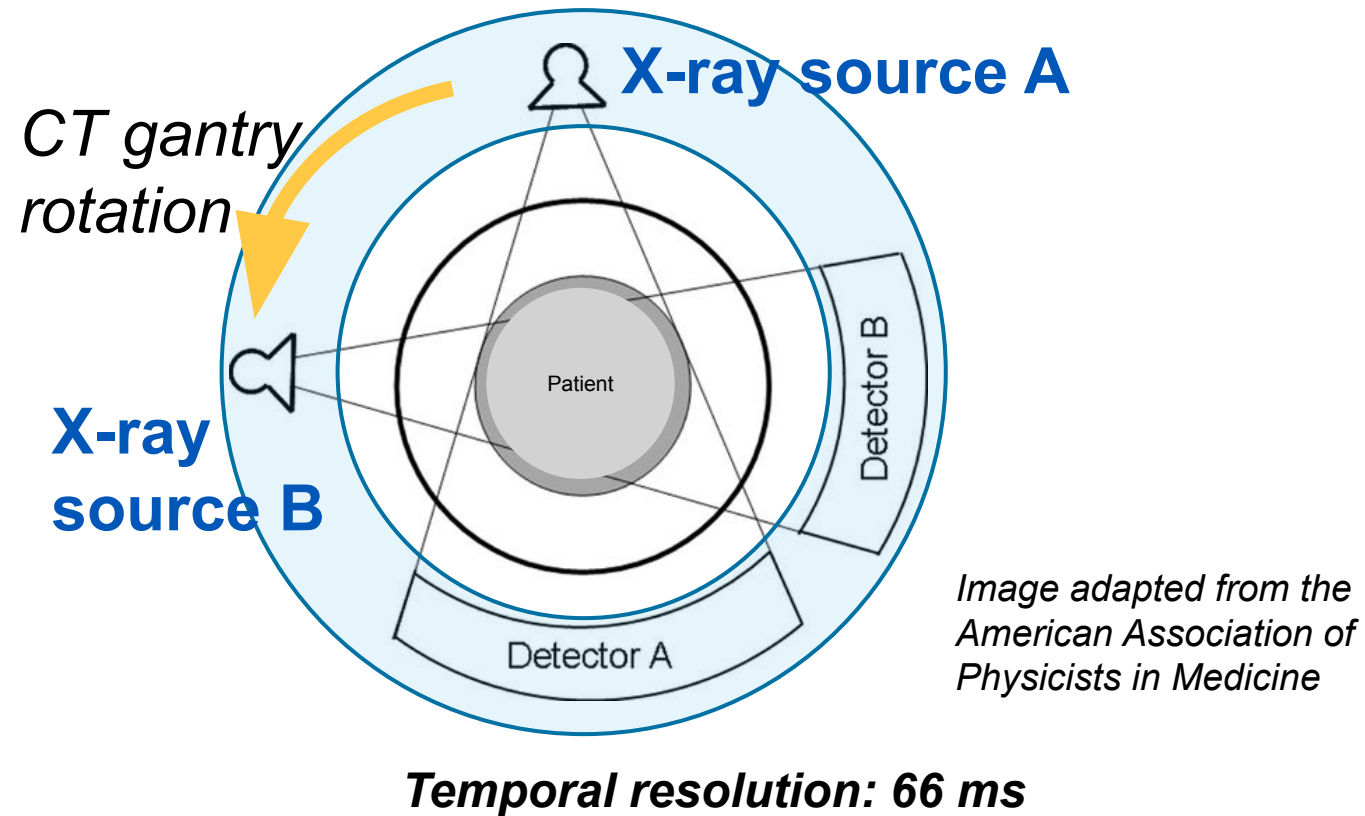
THANK YOU



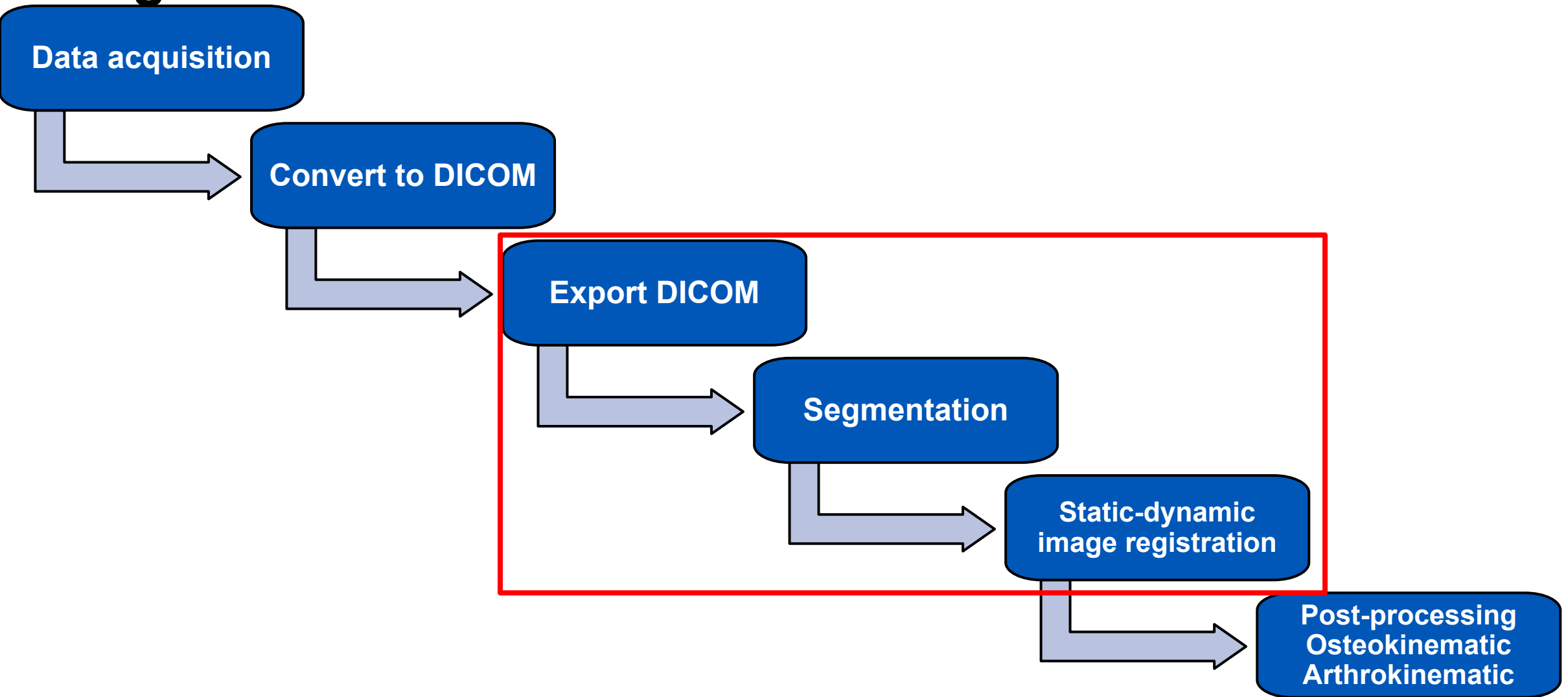
Extra

Image acquisition

- A third-generation, dual-source CT scanner (SOMATOM Definition Force, Siemens Healthcare) is used to acquire neutral-static and dynamic CT scans



Background – 4DCT Process



Background

Image acquisition

- **Static:**
 - Bilateral static (3D) CT volumes are acquired typically in neutral position using a routine CT scan protocol (120 kV, 200 mAs/rotation, 1 second gantry rotation).
- **Dynamic:**
 - Bilateral dynamic (4D) CT volumes are acquired using sequential, dual-source cardiac protocol over a 1.5-second period
 - Data collection was triggered via EKG simulator (30 bpm)
 - Auditory and visual cues were delivered to participants with a digital metronome (70 bpm) to set the cadence such that a full motion cycle would be acquired during the scanning interval
 - This yielded 17 sequential CT volumes evenly temporally-distributed across the motion cycle