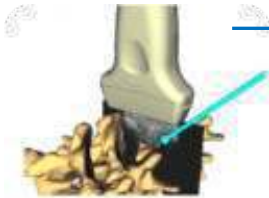


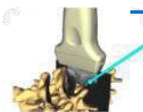
Pivot calibration



SlicerIGT Tutorial Series

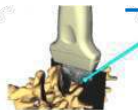
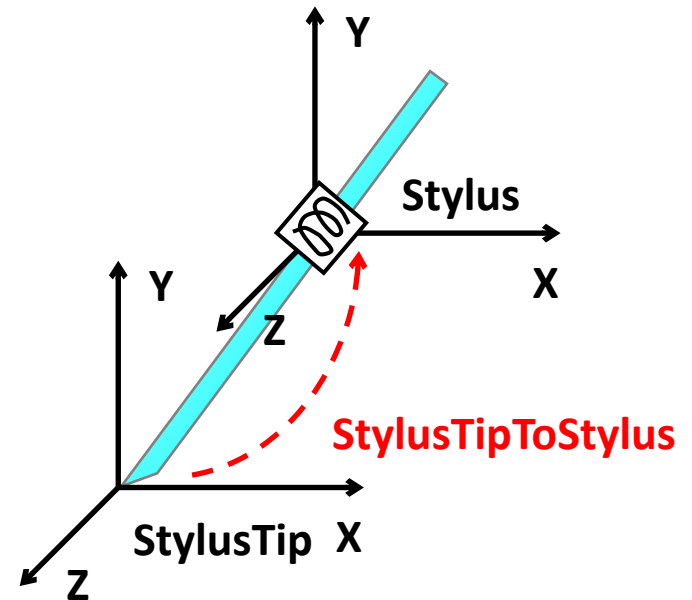
Introduction

- A ***pointer tool*** is used in almost every medical navigation systems. It can be a tracked stylus, needle, or any tracked object that has a pointy part.
- A position marker (e.g. electromagnetic sensor, or optical marker) is used to track the position of the pointer tool.
- But the marker cannot be at the very tip of the pointer. Therefore, we need to determine where is the ***pointer tip*** relative to the pointer marker.
- The names ***Pointer***, ***Stylus***, and ***Needle***. Are used interchangeably in this tutorial.



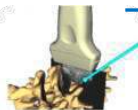
Stylus coordinate systems

- There are two coordinate systems associated with a stylus tool:
 - Stylus
 - Origin: center of the position marker
 - StylusTip
 - Origin: tip of the stylus.
- The StylusTipToStylus transformation is computed using the ***Pivot Calibration*** algorithm.



Pivot Calibration in a Real Hardware Setup

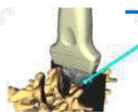
- When performing a pivot calibration with a tracked needle
 - Find a secure position to pivot in the Reference coordinate system
 - You must not shift the tip of the needle, only the shaft of the needle may move relative to the tip while you pivot



Example 1.

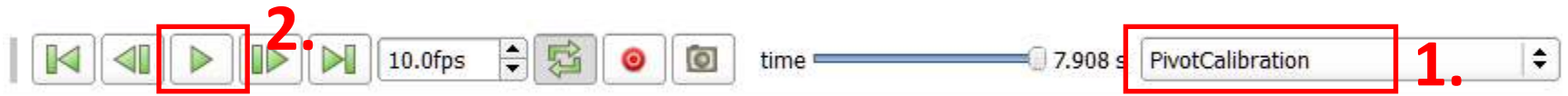
Load example data

- Load **SlicerIGT-Data/Skull_StylusCalibration.mrb**
- In **Data** module, right click on **StylusToReference**, *Insert transform*
- Rename new transform to **StylusTipToStylus**
- Create a needle model
- In **Data** module Drag-and-drop needle model on **StylusTipToStylus**
- Make sure the **Sequences** toolbar is visible

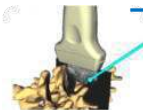


Pivot calibration

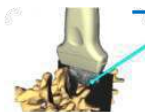
- In **IGT / Pivot Calibration** module select *Input: StylusToReference*, *Output: StylusTipToStylus*
- In the Sequences toolbar, select PivotCalibration and start playback with the play button



- Press **Start Pivot Calibration** and wait until message at the bottom of module widget displays ***Root-mean-square error*** value.
- This value should be under 1 mm

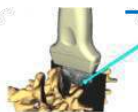
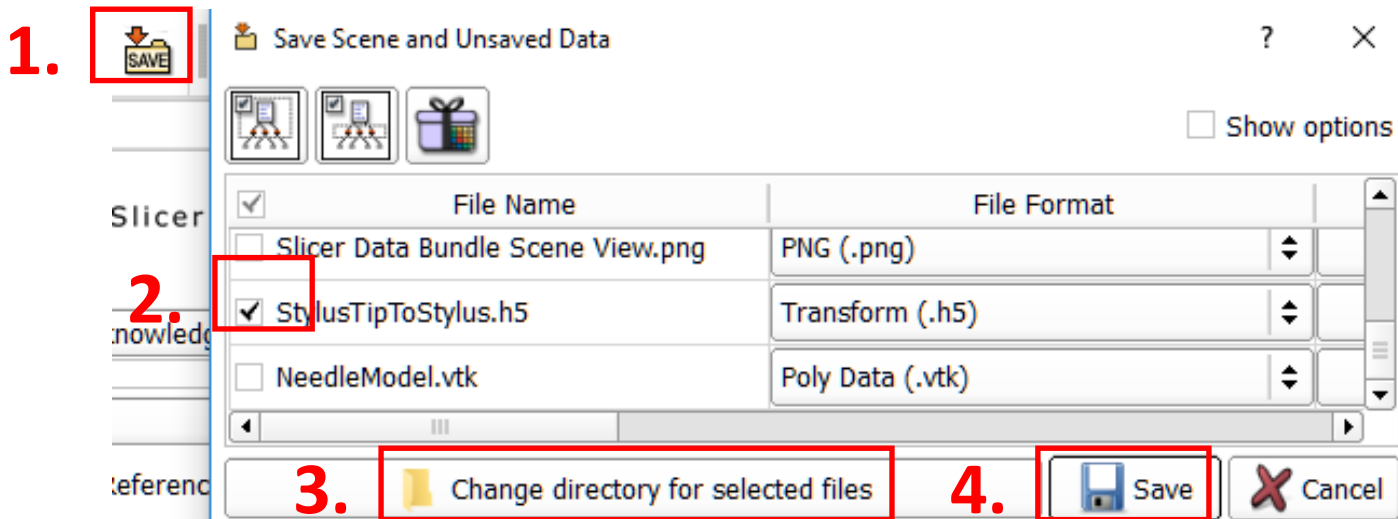


Pivot calibration



Spin calibration

- Press **Start Spin Calibration**
- Wait until **Root-mean-square error** value updated
- With this particular stylus design, **StylusTipToStylus** transform does not change significantly
- Save StylusTipToStylus transform into a **.h5** file

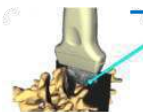


Example 2.

(PLUS required. This is method is getting obsolete.)

Pivot calibration in Slicer

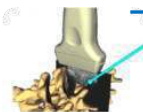
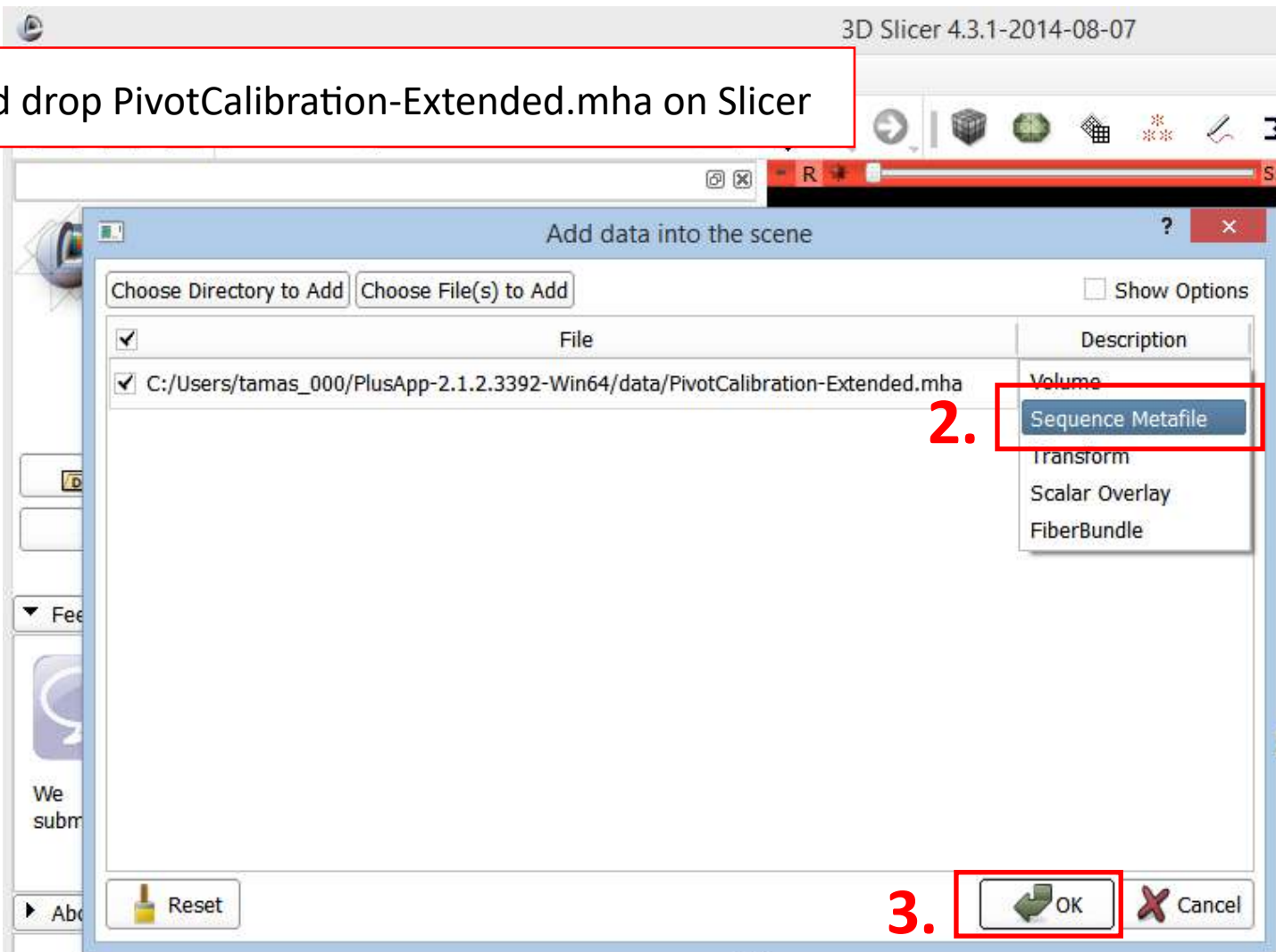
- There is a data sequence in SlicerIGT-Data which was recorded using a pivoting stylus:
PivotCalibration.mha
- The stylus tip was pivoting relative to a tracked **Reference** object. Therefore we need **StylusToReference** transformation to find the **StylusTip** (as the pivot point).
- Run **PivotCalibrationExtend.bat** to get **PivotCalibration-Extended.mha** the /data folder of your PLUS installation. E.g. in c:
\users\you\PlusApp-2.1.2.3392-Win64\data\



Load pivot calibration sequence

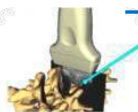
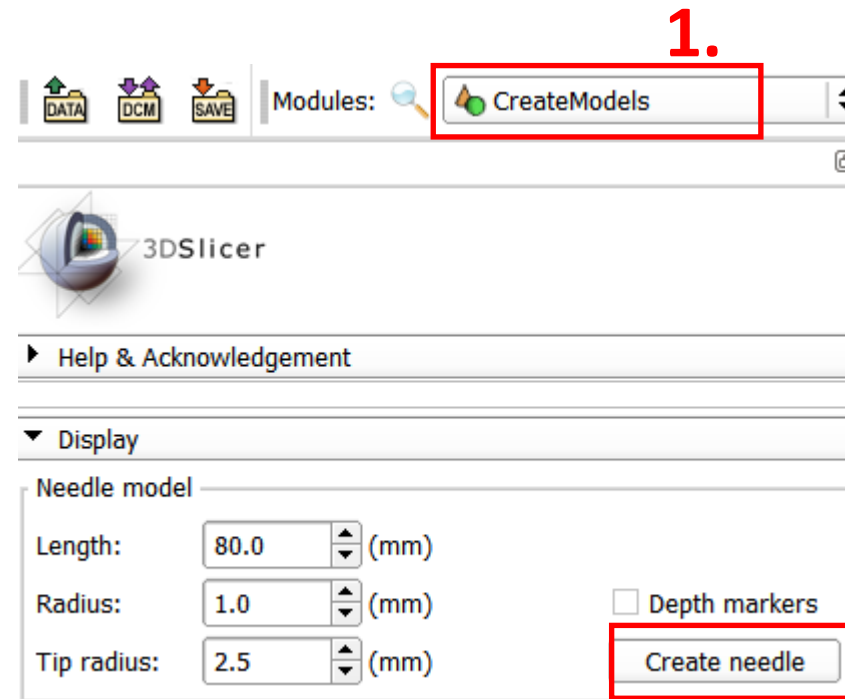
1.

Drag and drop PivotCalibration-Extended.mha on Slicer



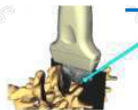
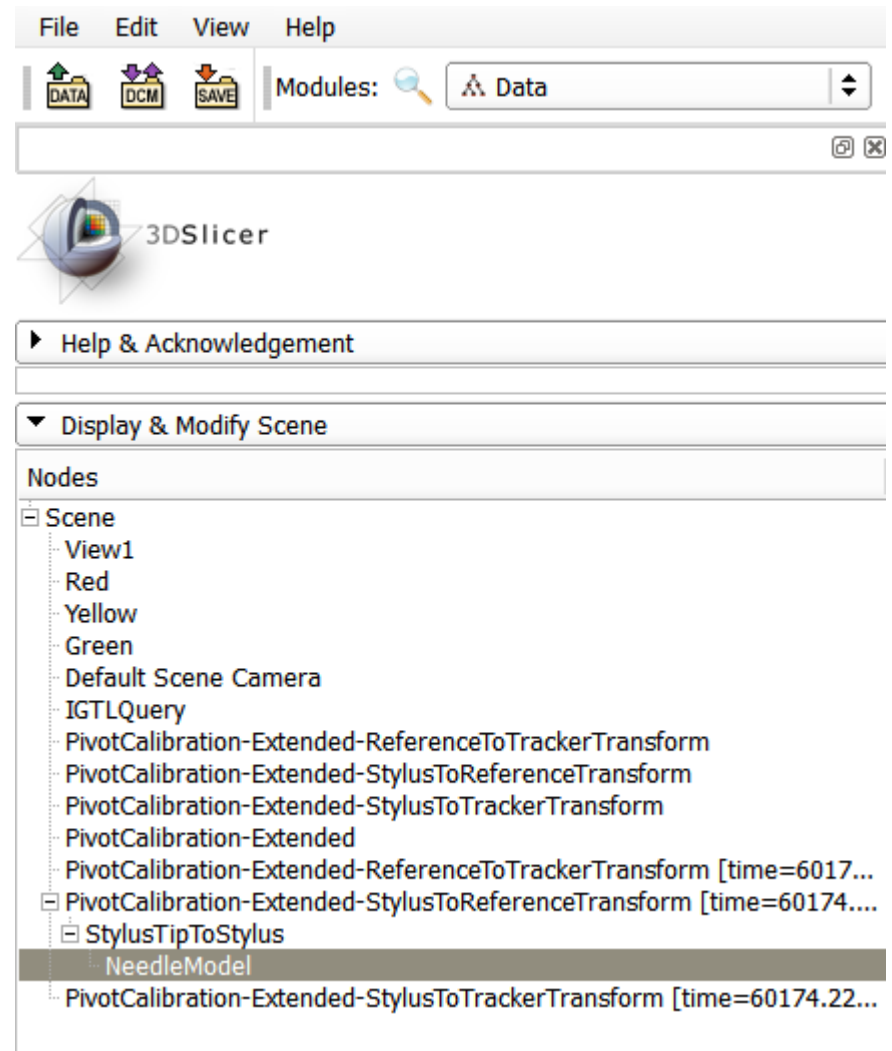
Example: Pivot calibration in Slicer

- Create a needle model using **IGT/Create Models** to represent the stylus tool.
- A needle model should appear in the scene that looks like this:



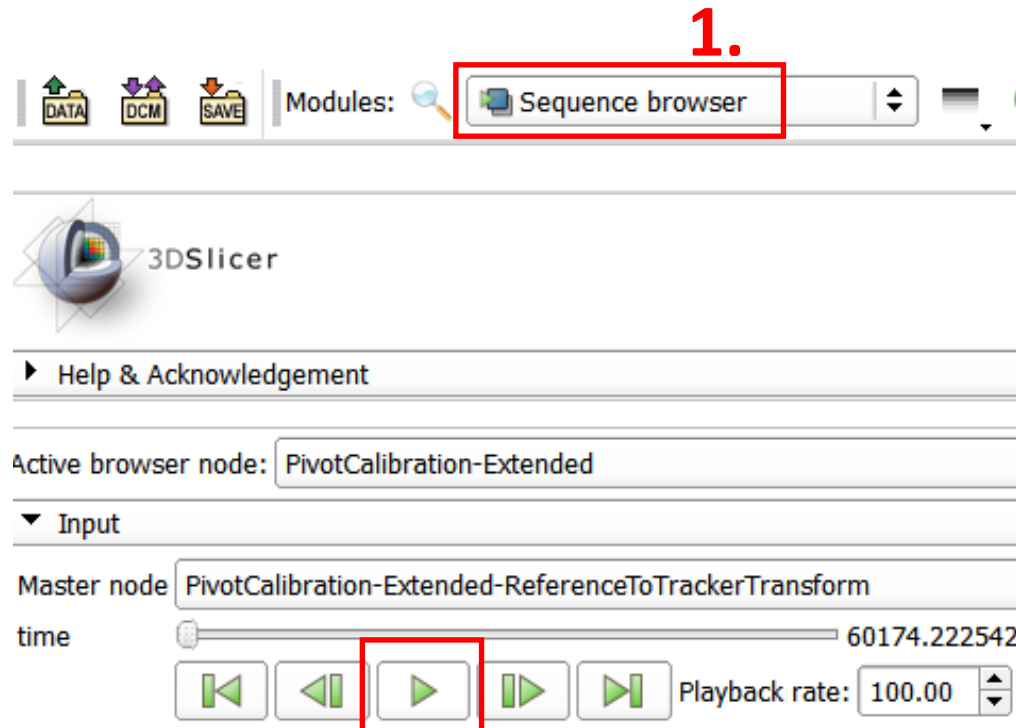
Example: Pivot calibration in Slicer

- Create the transform hierarchy for the scene:
- Select the ***Transforms*** module and create a new transform, named **StylusTipToStylus**.
- Set up the transform hierarchy in the Data module as seen in the figure.



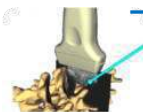
Play the recorded sequence

1.



The screenshot shows the 3DSlicer software interface. At the top, the 'Modules:' dropdown menu is open, and 'Sequence browser' is selected, highlighted with a red box. Below this, the '3DSlicer' logo is visible. The 'Active browser node:' field contains 'PivotCalibration-Extended'. Under the 'Input' section, the 'Master node' is 'PivotCalibration-Extended-ReferenceToTrackerTransform'. A 'time' slider is set to 60174.222542. At the bottom, the playback controls are shown, with the play button (a green triangle pointing right) highlighted with a red box.

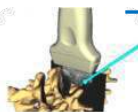
2.



Example: Pivot calibration in Slicer

- Initially, you should see the tip of the stylus swinging.
- Follow the steps shown in red.
- After pivot calibration, the tip of the stylus should be relatively stable (within about 0.5 mm)

The screenshot shows the 3D Slicer software interface with the Pivot Calibration module selected. The interface includes a top toolbar with icons for DATA, DCM, and SAVE, and a Modules dropdown menu where 'Pivot Calibration' is highlighted (1.). Below the toolbar is the 3D Slicer logo. The main panel is divided into sections: Help & Acknowledgement, IO, Controls, and Display. In the IO section, the Input (StylusToReference) and Output (StylusTipToStylus) dropdown menus are both set to their respective default values and are highlighted with a red box (2.). In the Controls section, the 'Delay and duration (seconds):' input field is set to '8' and is highlighted with a red box (3.). Below this, the 'Start Pivot Calibration' button is highlighted with a red box (4.). At the bottom of the Controls section, the text 'Sampling complete' is followed by the instruction '5. Wait until sampling complete' in red. The Display section at the bottom shows the 'Root-mean-square error: 0.22005'.



Saving the result

- Save the Slicer scene to save your **StylusTipToStylus** calibration transformation.
- The **.mrml** file in the scene folder contains a human-readable format of the transformation matrix.
- The **StylusTipToStylus.h5** file in the scene folder contains encrypted numbers, but if you drag and drop it on Slicer, it will recover your calibration transformation.

