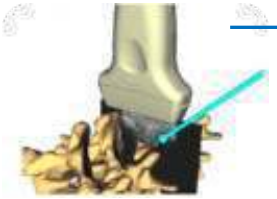
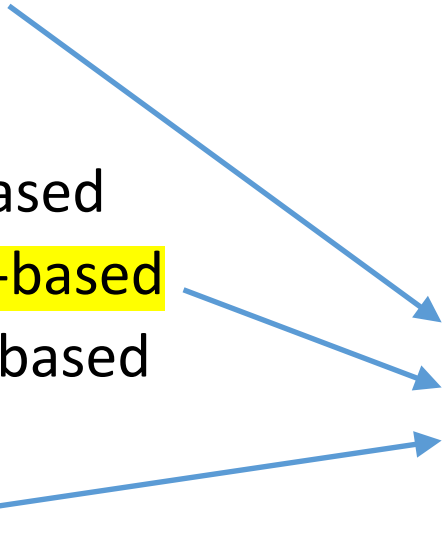
Surface registration



SlicerIGT Tutorial Series

Registration methods overview

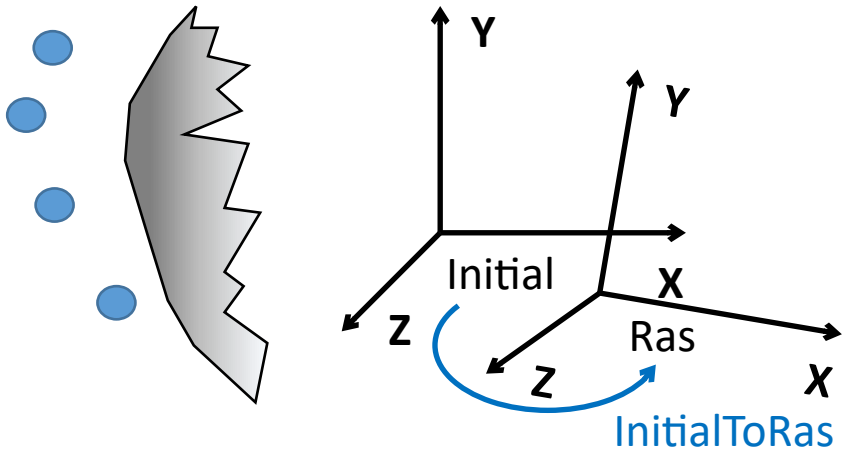
- Dimension
  - 3D/2D to 3D/2D
- Metric
  - Point distance-based
  - Surface distance-based
  - Image similarity-based
- Transformation
  - Rigid
  - Similarity
  - Deformable



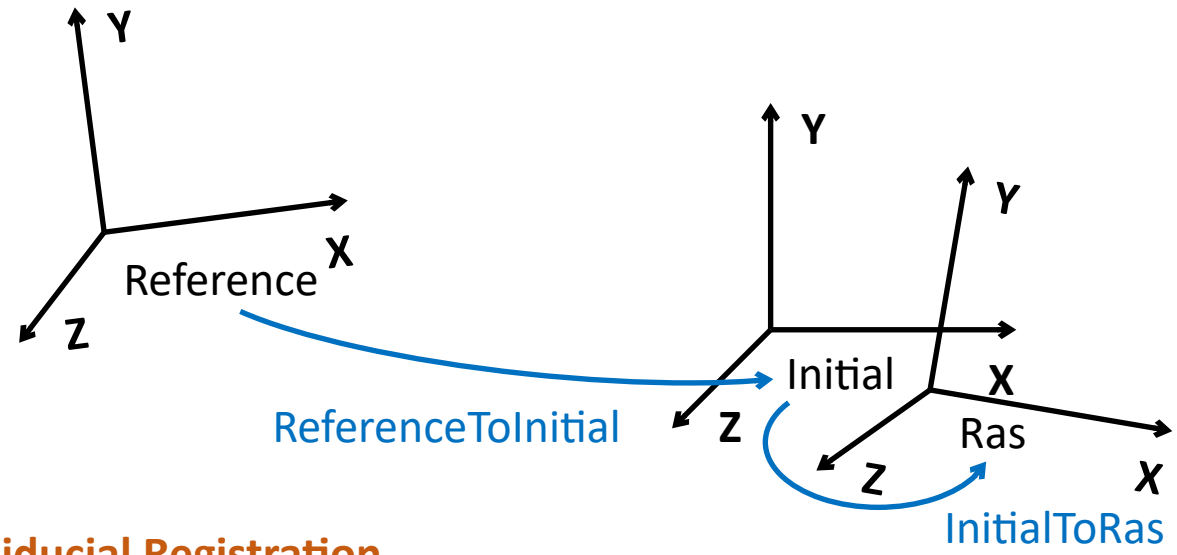
this example

Surface registration

- Finds transformation that minimizes points cumulative distance from a surface
- Computation iterative, needs stopping condition
- Requires initial registration
- Implementation: vtkIterativeClosestPointTransform



Registration strategy

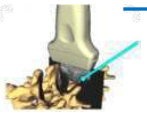


- **Fiducial Registration**
- 3 points in **Reference**
- 3 points in **Initial**
- approximate locations

- **Fiducial-Model Registration**
- ~30-40 points in **Initial**
- CT-based surface model in **RAS**

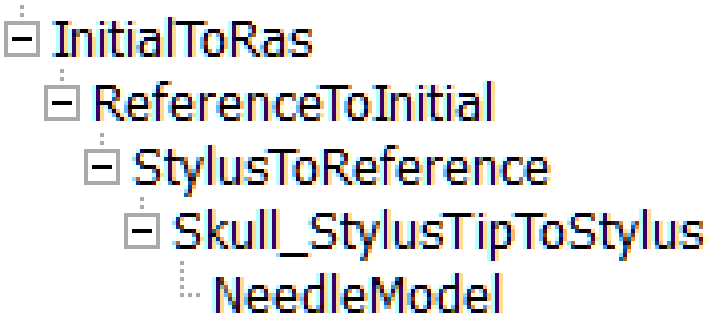
Load example scene

- Load three pieces of data in a clean Slicer scene:
  - SlicerIGT-Data\Skull_Registrations.mrb contains stylus position and video sequences
  - SlicerIGT-Data\Skull_Phantom.vtk contains a detailed surface model of the skull
  - SlicerIGT-Data\Skull_StylusTipToStylus.h5 contains pivot calibration for the stylus
- You can drag-and-drop all these files on Slicer and load them with default options
- Create a needle model using **IGT / CreateModels**



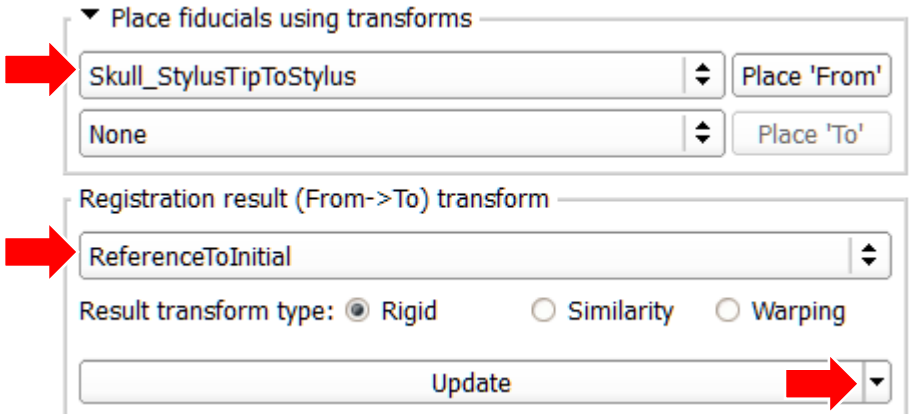
Set up transform hierarchy

- Select **Data** module
- Right-click on Scene and insert new transform, and double-click on it to rename to **InitialToRas**
- Right-click on InitialToRas and insert transform, and double-click to rename it to **ReferenceToInitial**
- Drag and Drop nodes to get the following transform hierarchy



Set up initial registration

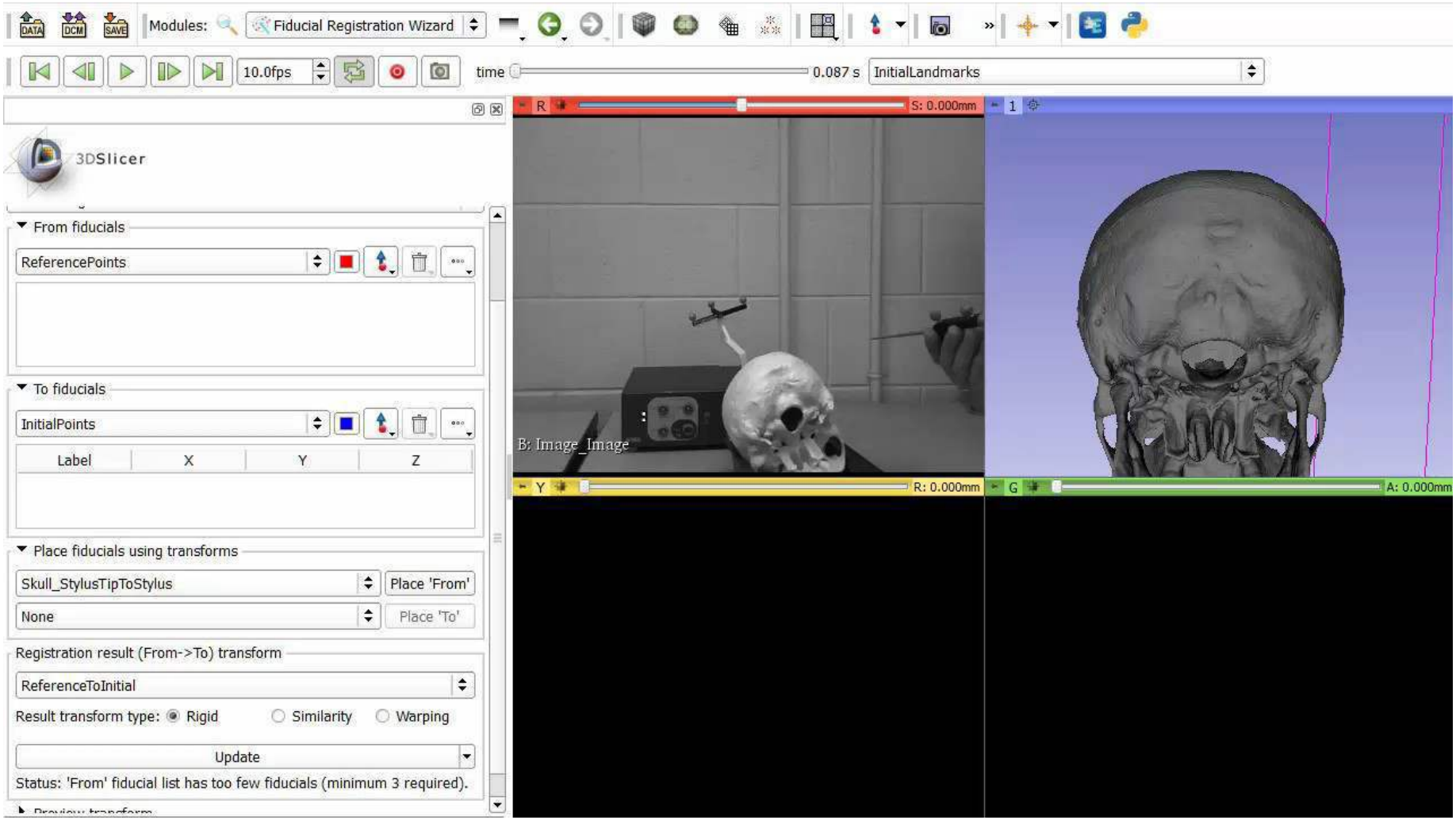
- Select **IGT / Fiducial Registration Wizard** module
- Create *From* fiducials as **ReferencePoints**, and *To* fiducials as **InitialPoints**
- Under **Place fiducials...** group select **Skull_StylusTipToStylus** for the **From** (upper) list
- Under Registration result select **ReferenceToInitial**, and set **Manual update** instead of **Auto-update**



Initial registration

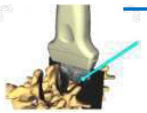
- In the Sequence toolbar, select **InitialLandmarks**
- Using the Sequence toolbar time slider, review video for landmarks
- Use the place fiducials button  to add these points (in the same order!) in the *InitialPoints* list
- Use **Place 'From'** button to add points to the *ReferencePoints* list
- Do this three times, so you have three points in both lists
- Watch next slide for illustration

Initial registration



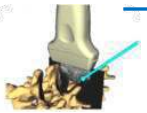
Compute initial registration

- Under **Registration result** press **Update**
- If you don't see "Status: Success!" under the **Update** button, check if you have three different points in both lists.
- RMS Error should be under 10 mm ideally, but not necessarily
- Note: that if you want to restart initial registration, you need to go to **Transforms** module and press Identity on **ReferenceToInitial** transform to reset it. Otherwise, **StylusTip** will not be in **Reference**.

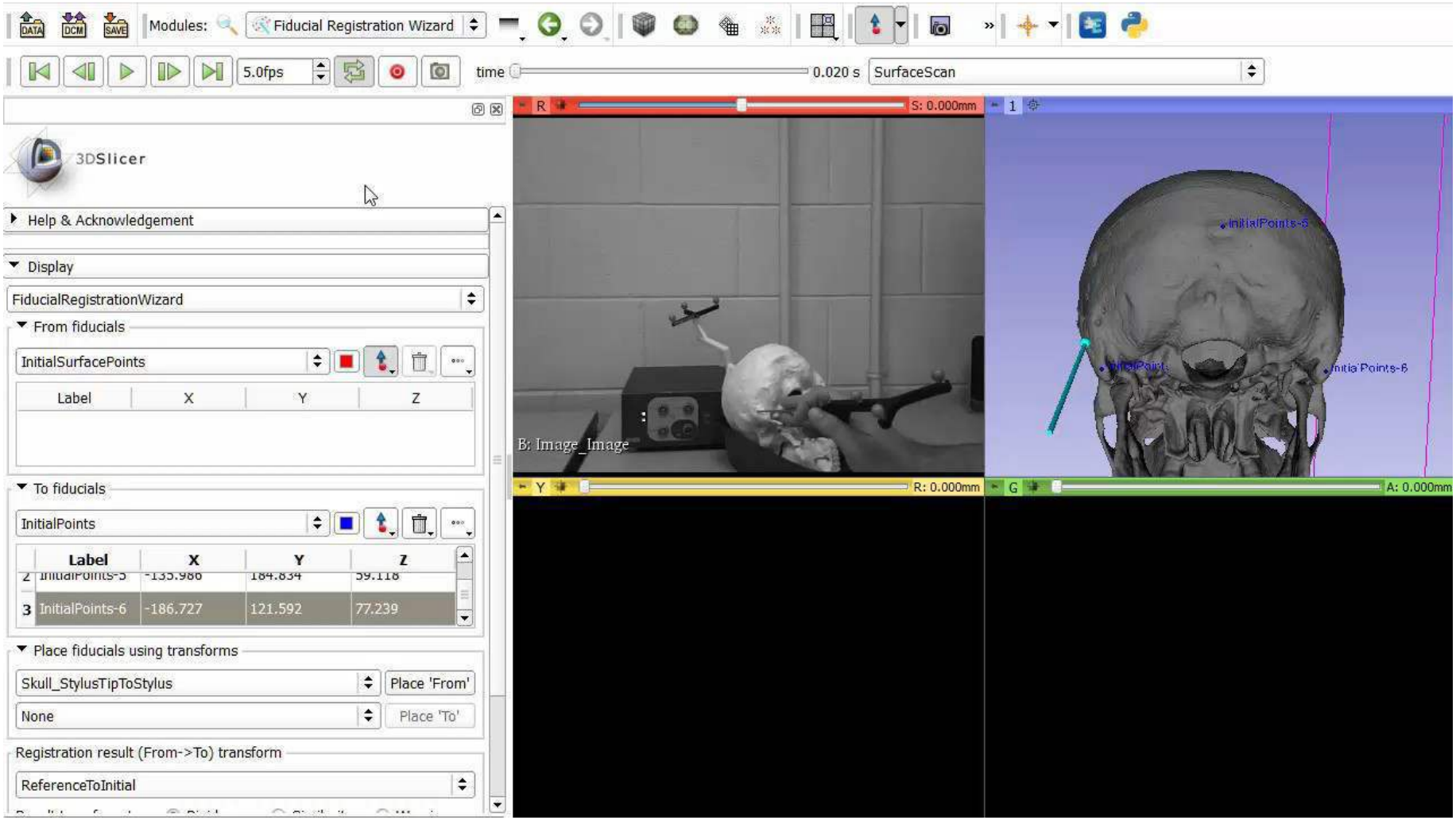


Collect surface points

- Still in the **Fiducial Registration Wizard** module, create a new list under **From fiducials** and name it **InitialSurfacePoints**
- On Sequence toolbar, select the **SurfaceScan** node
- Let the sequence run using the play button, maybe lower frame rate to 5 fps
- Keep clicking Place 'From' until you collect about 40 points evenly near the skull surface
- Screen video on next slide



Collect surface points



Compute surface registration

- Select **IGT / Fiducial-Model Registration** module
- Input fiducials: **InitialSurfacePoints**
- Input model: **Skull_Phantom**
- Output transform: **InitialToRas**
- Press **Apply**
- **Mean distance after registration** should be under 1 mm
- When you play the **SurfaceScan** sequence, the stylus tip should be sliding on the skull surface in the 3D viewer