Fiducial Protocol

# Preparation

* Download and use **Slicer 4.10.2**

# Naming Scheme for Fiducials

**[VolumeID]\_[Contrast]\_[Rater]\_[N] (e.g. MNI2009b\_T1\_JL\_1\_20170511)**

* **[VolumeID]** = the identifier for the volume on which you are performing the fiducial placements; for the tutorial it will be one of the well known MRI templates:
  + MNI2009b: average of 152 healthy controls
  + UHF: average of 12 healthy controls at 7T
  + Colin27: average of 27 Colin brains
* **[Contrast]** = T1, T2, PD, other (typically will be **T1**)
* **[Rater]** = the unique identifier for the rater performing the fiducial placement; convention will be first initial and last name to prevent overlap
* **[N]** = reference for fiducial placement session (helpful if performing placements more than once; starting with 1)
* **[YYYYMMDD]** = year month and date

# AC-PC Placement

Download assigned volume/template from github repository.

Go to **Markups Module** and create Module named **ACPC\_[VolumeID]\_[Rater]\_[N]**. Place AC and PC landmarks:

1. AC = anterior commissure (center)

2. PC = posterior commissure (center)

# Create new AC-PC Transform

Create a new Markup list entitled **Fid32\_[VolumeID]\_[Rater]\_[N]**.

Create a new Markup list entitled **midline**.

To create a new AC-PC Transform you must place AC and PC fiducial markers in previous step.

1. Copy AC and PC markers from **ACPC** to the **midline** list.
2. Go back to the **midline** list and place a fiducial marker in the **infracollicular sulcus** (point 3)
3. Place another fiducial marker at the **Genu of CC** (point 19)
4. You should now have AC and PC in the ACPC markups list and AC, PC, **infracollicular sulcus** and **Genu of CC** in the **midline list**
5. Under modules select **Registration** 🡪 **Specialized** 🡪 **ACPC Transform**.
6. In the **Transform Panel**, under **ACPC Line** select the **ACPC markups list**, under **Midline** select the **midline** list, and under **Output transform** select **Create new linear transform as…** and name it **Output transform**
7. Click apply at the bottom of the window
8. Next under modules go to **Data**. Beside the image volume select the ‘eye’ icon to turn the volume back on.
9. Next under Modules go to **Transforms** and under **Active Transform** dropdown tab select the create **Output transform** (if not already selected).
10. Under **Apply Transform** select all 4 items (i.e MNI2009b\_T1w\_GGl\_20190801, ACPC, Midline and FID32) and transfer them to the transformed side.

# General Fiducial Placement Strategies

Use the "**Jump to Slice**" feature to center your view on the fiducial of interest and ensure that the placed landmark appears accurate on all three standard views (axial, sagittal, coronal). Once a fiducial is placed, **dragging** the fiducial can allow for more refined placement. Holding down **shift** centers the view in all views on the cursor (use along with crosshair function). If a given fiducial is classified as **[midline]**, jump to an existing midline fiducial (e.g. AC or PC) and start by placing the fiducial on the **sagittal** view and refine placement using the other views. Try to place fiducials at the **boundary/edge** of the feature of interest. For some of the fiducials, the instructions for placement will explicitly say to place the landmark using information mostly from one view (e.g. axial view for olfactory sulcus). Be aware that changing the windowing of your images (and lighting in the room) may affect your perception of where landmarks should be placed. When you're satisfied with the location of a fiducial, **lock it in place** to prevent yourself from displacing it later. **NOTE: there is no UNDO feature for fiducial placements.**

# Placement of Fiducial Series

When placing the fiducials make sure you are on the **Fid32\_[VolumeID]\_[Rater]\_[N]** markup list. Click on **midline** and copy over AC, PC along with the other points to your FID32 list by selecting all fiducials, right click and choosing "Copy”. Select **Fid32\_[VolumeID]\_[Rater]\_[N]**. Place each of the **fiducials** in the markups list entering the associated fiducial number in **Name** and enter the underlined name in the **Description** textbox.

NOTE: zoom into word doc to better visualize fiducial placement

|  |  |  |
| --- | --- | --- |
| 1 | AC **[midline]** | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.28.42%20 |
| 2 | PC **[midline]** | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.28.53%20 |
| 3 | infracollicular sulcus **[midline]**   * inferior part of sulcus of inferior colliculi at the midline junction of inferior colliculi * Inferiormost boundary of longitudinal intercollicular sulcus | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.48.30%20 |
| 4 | PMJ = pontomesencephalic junction **[midline]**   * At the junction but because it doesn't end on a sharp point choose the ventral/inferior/pontine side of the junction using the sagittal and coronal views | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.29.16%20 |
| 5 | superior interpeduncular fossa **[midline]**   * most superior axial slice * Use coronal slice to help optimize location at boundary of 3rd ventricle and surrounding brain * Commentary: nice landmark for DBS since subthalamic nucleus close by | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.29.35%20 |
| 6 | R superior LMS = right superior lateral mesencephalic sulcus   * Localize using axial slices; at boundary of CSF and brain | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.49.53%20 |
| 7 | L superior LMS = left superior lateral mesencephalic sulcus (as in 6) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.30.00%20 |
| 8 | R inferior LMS = right inferior lateral mesencephalic sulcus   * Localize at junction between midbrain and pons first using axial slices * Then refine positioning using sagittal view (at the change in angle of brainstem at the PMJ) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.56.27%20 |
| 9 | L inferior LMS = left inferior lateral mesencephalic sulcus (as in 8) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.31.03%20 |
| 10 | Culmen **[midline]**   * most superior point of cerebellar vermis; one of the vermian lobules | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.31.12%20 |
| 11 | Intermammillary sulcus **[midline]**   * Midpoint between the mamillary bodies | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.31.23%20 |
| 12 | R MB = right mammillary body (center) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.31.31%20 |
| 13 | L MB = left mamillary body (center) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.31.41%20 |
| 14 | pineal gland **[midline]** | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.32.14%20 |
| 15 | R LV at AC = right lateral aspect of frontal horn on coronal section of AC   * Defined at same coronal slice as AC (jump to it) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.32.39%20 |
| 16 | L LV at AC = left lateral aspect of frontal horn on coronal section of AC (as in 15) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.32.49%20 |
| 17 | R LV at PC = right lateral aspect of frontal horn on coronal section of PC | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.03%20 |
| 18 | L LV at PC = left lateral aspect of frontal horn on coronal section of PC (as in 17) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.12%20 |
| 19 | Genu of CC = genu of corpus callosum **[midline]**   * Place using sagittal view and optimizing as most anterior point on coronal slice | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.23%20 |
| 20 | Splenium of CC = splenium of the corpus callosum **[midline]**   * Place using sagittal view and optimize as inferiormost point on axial section | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.31%20 |
| 21 | R AL temporal horn = right anterolateral temporal horn   * Place using coronal view as anteriormost (and lateral) point of temporal horn * Choose a more ventral/inferior point on the coronal view * Place at the boundary of CSF and brain | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.39%20 |
| 22 | L AL temporal horn = left anterolateral temporal horn (as in 21) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.33.48%20 |
| 23 | R superior AM temporal horn = Rhoton's R uncal recess   * At the superior hippocampal-amygdalar transition area (HATA); NOTE: there is also an inferior anteromedial temporal horn * Rhoton's **uncal recess**: "narrow medially projecting space between hippocampal head & ventricular surface of amygdala located lateral to uncal apex") * Place at the boundary of CSF and brain | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.52.25%20 |
| 24 | L superior AM temporal horn = Rhoton's L uncal recess (as in 23) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.34.01%20 |
| 25 | R inferior AM temporal horn   * Initially place using coronal view | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.34.08%20 |
| 26 | L inferior AM temporal horn (as in 25) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.34.14%20 |
| 27 | R indusium griseum origin   * Defined on sagittal slice at takeoff from posterior hippocampus below splenium | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.34.22%20 |
| 28 | L indusium griseum origin (as in 27) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.34.31%20 |
| 29 | R ventral occipital horn   * Defined on ventral/inferior portion of last visible coronal slice with occipital horn * Optimize using other views | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.36.09%20 |
| 30 | L ventral occipital horn (as in 29) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.36.20%20 |
| 31 | R olfactory sulcal fundus   * Sulcal fundus = at depth of sulcus and boundary of gray matter-white matter * Posterior and most superior portion visible on axial slice | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.36.39%20 |
| 32 | L olfactory sulcal fundus (as in 31) | ../../../../../Desktop/Screen%20Shot%202017-05-27%20at%2010.36.48%20 |