Probe alignment tool

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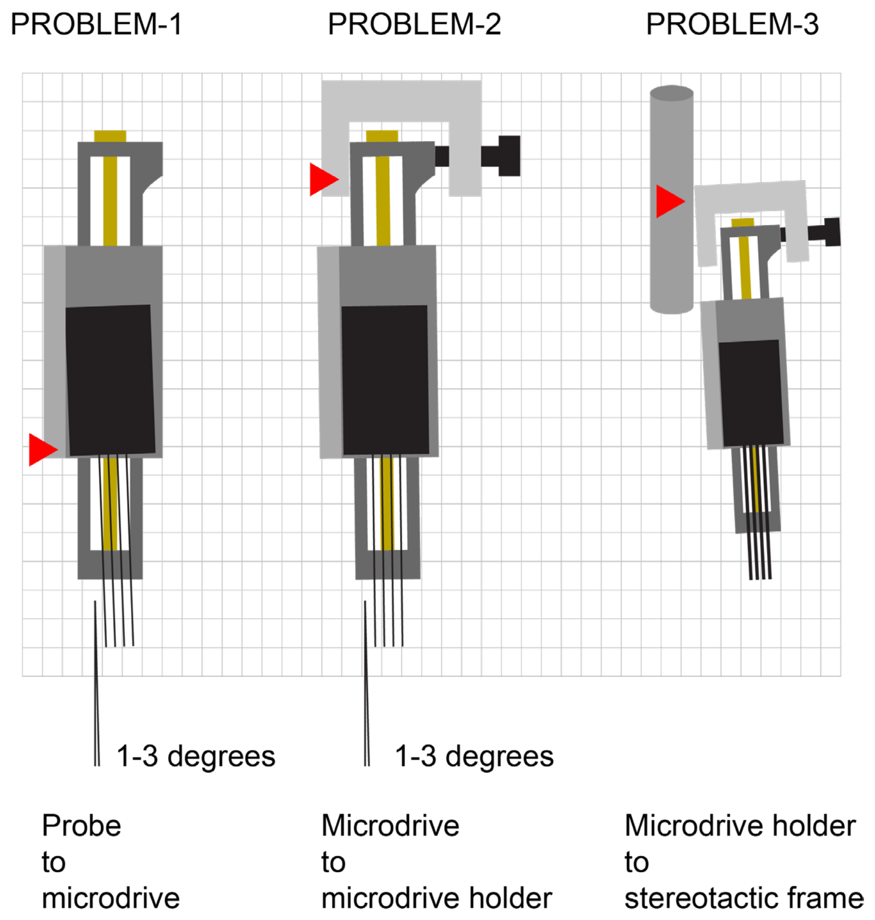
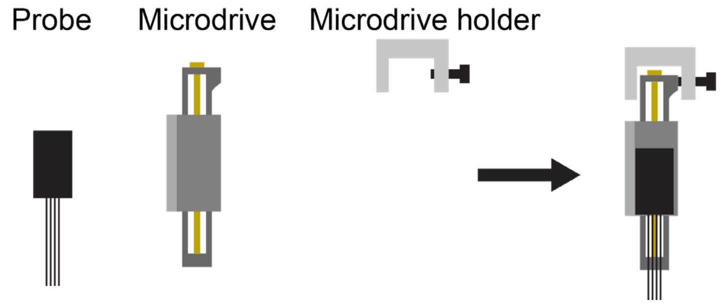
The problem

- Probe is misaligned relative to motion of axis
  - Increased tissue damage
  - Less single-unit yield
- Probe can be misaligned to
  - Microdrive (initial glueing process)
  - Microdrive holder
  - Stereotactic frame
    - Can occur with any shuttle
  - Red triangles show possible locations of misalignment





Why does this increase insertion damage?

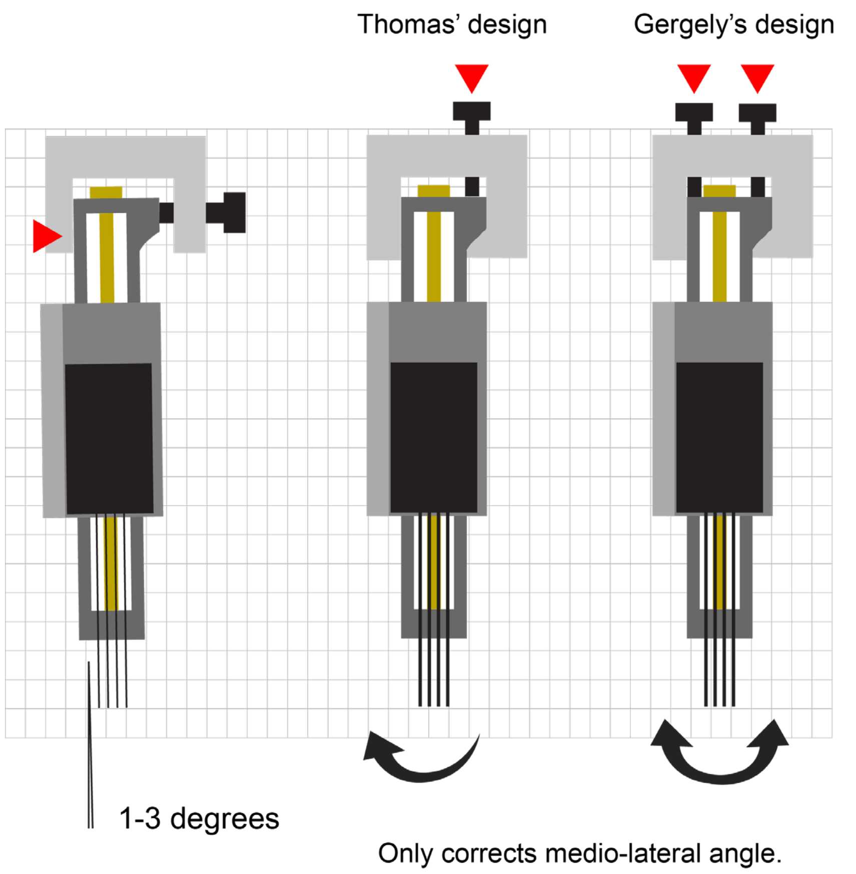
If the shank is even slightly angled relative to the travel axis, then as you advance it:

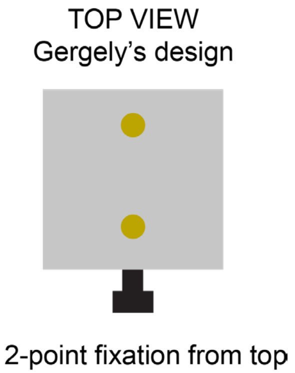
- the shank **sweeps laterally** through tissue (a “side-cut” path),
- you get **extra shear/tearing**, larger track, and more dimpling,
- and you can introduce **side-load/buckling** on thin shanks.

Coaxial alignment minimizes lateral sweep → a straighter track with less trauma.

Initial solutions

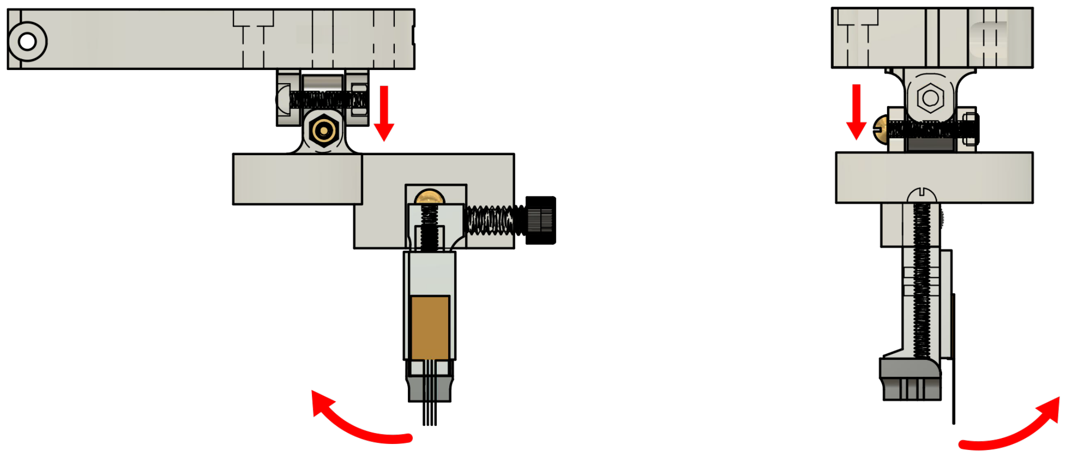
- Probe can be realigned in microdrive holder
  - Top screw(s) can push the microdrive
- Issues
  - Only corrects medio-lateral angle
  - Only corrects Problem-1 (slide-2).

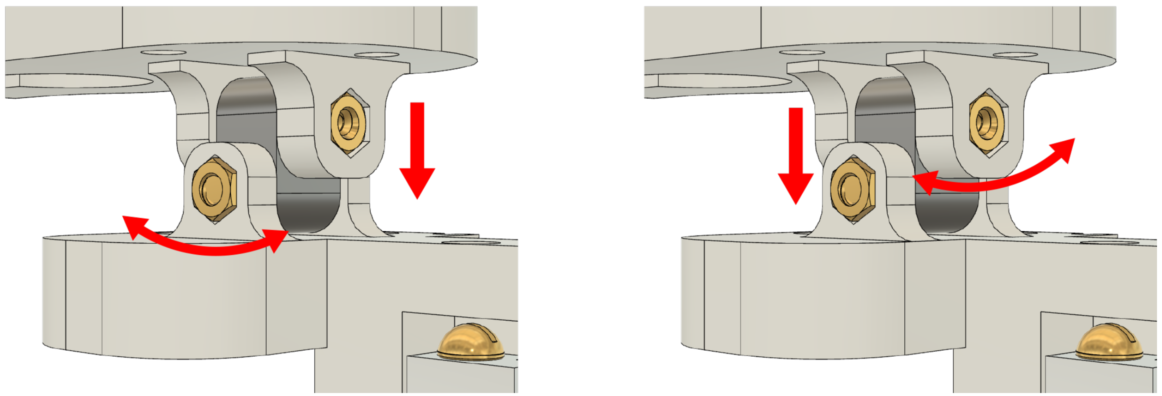




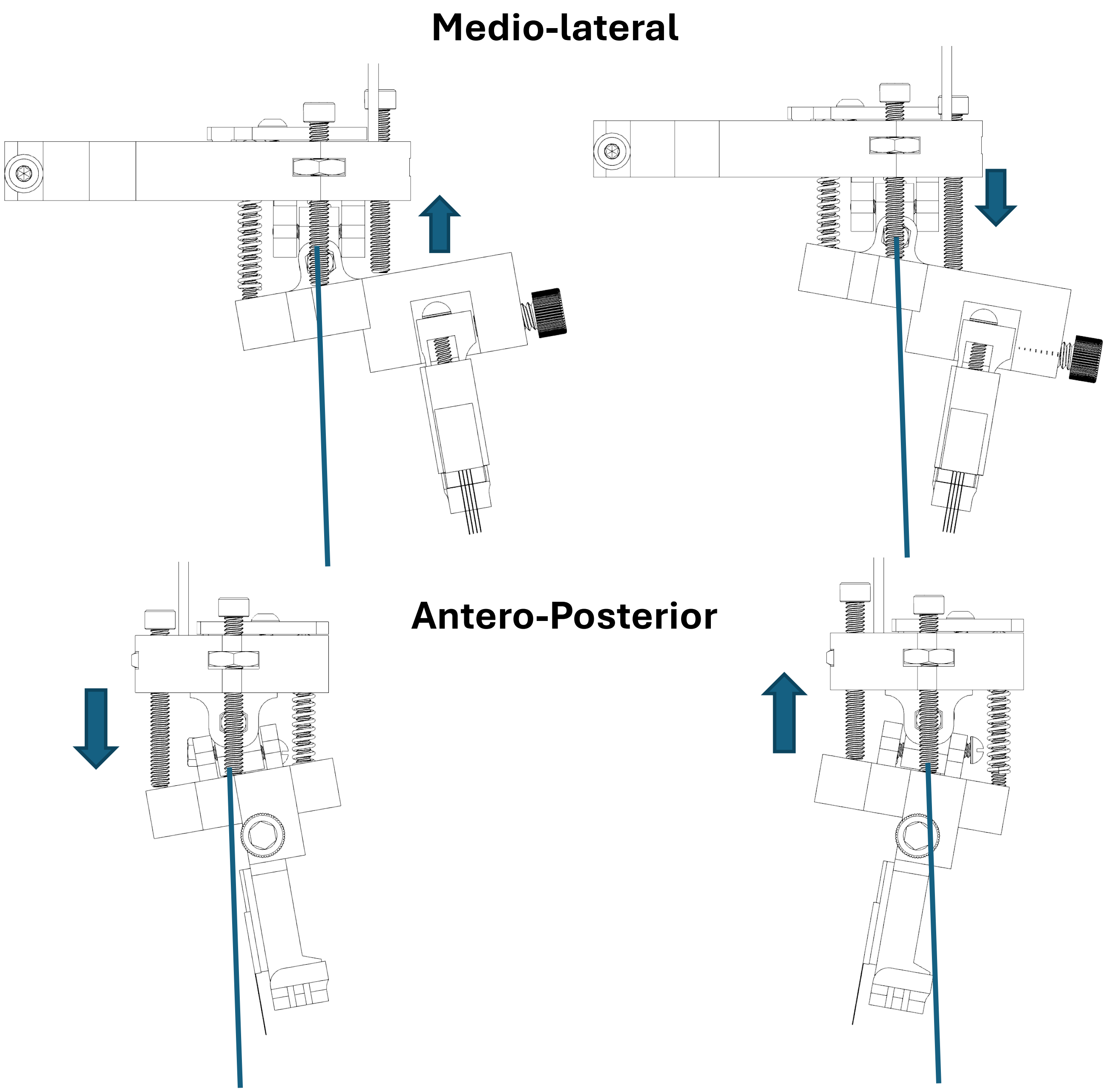
'Final' solution

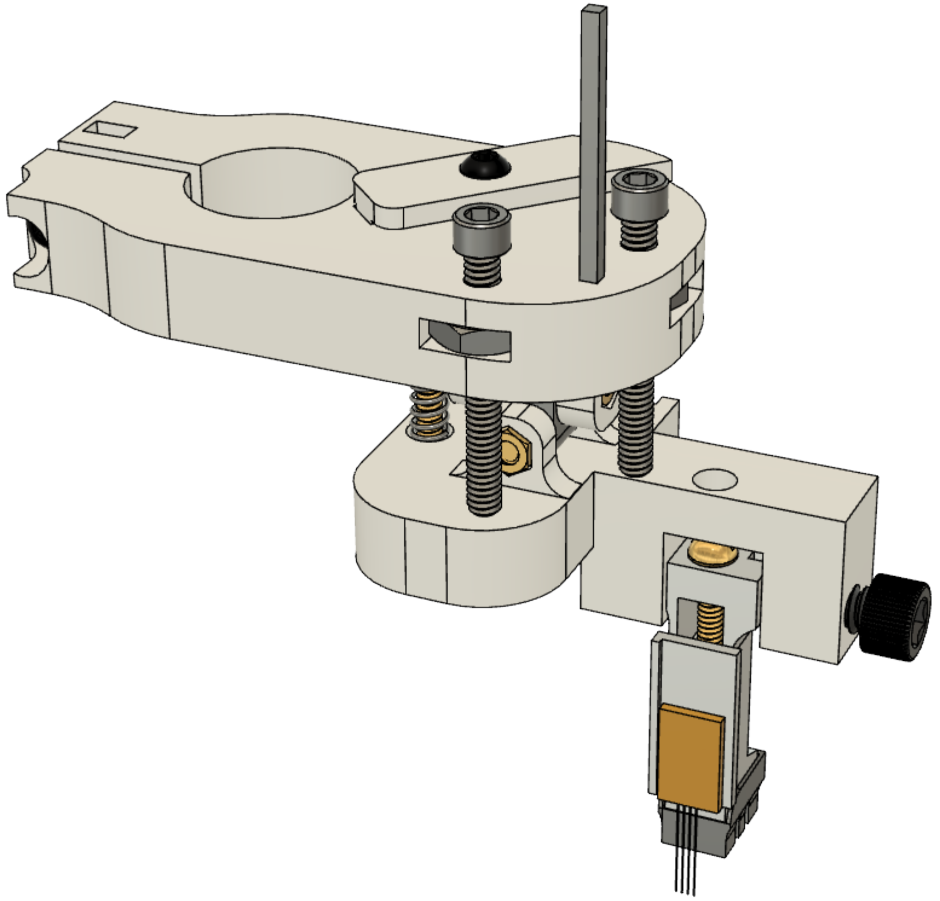
- Multi-angle probe holder
- Two-axis gimbal (dual-pivot)
  - enables AP and ML alignment
- Two revolute hinges in series with orthogonal axes
  - 2-DOF angular adjustment joint



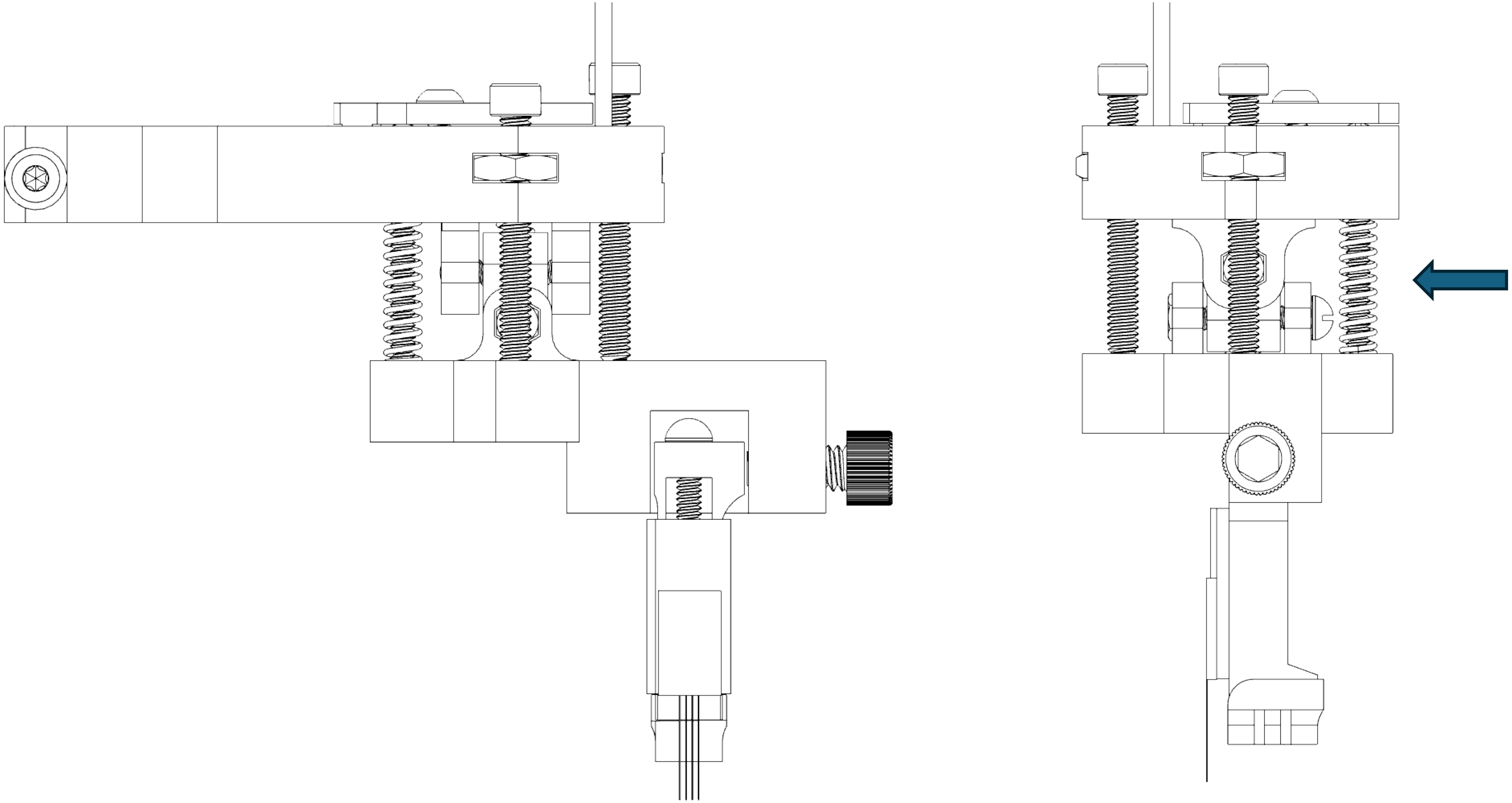


Multi-angle implantation tool



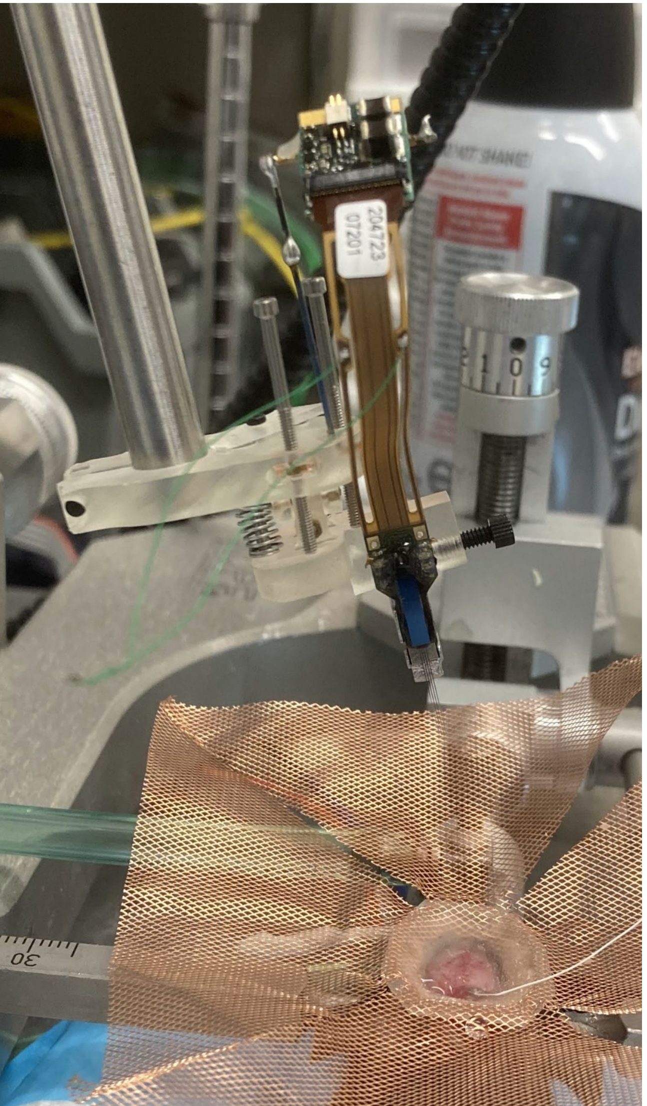


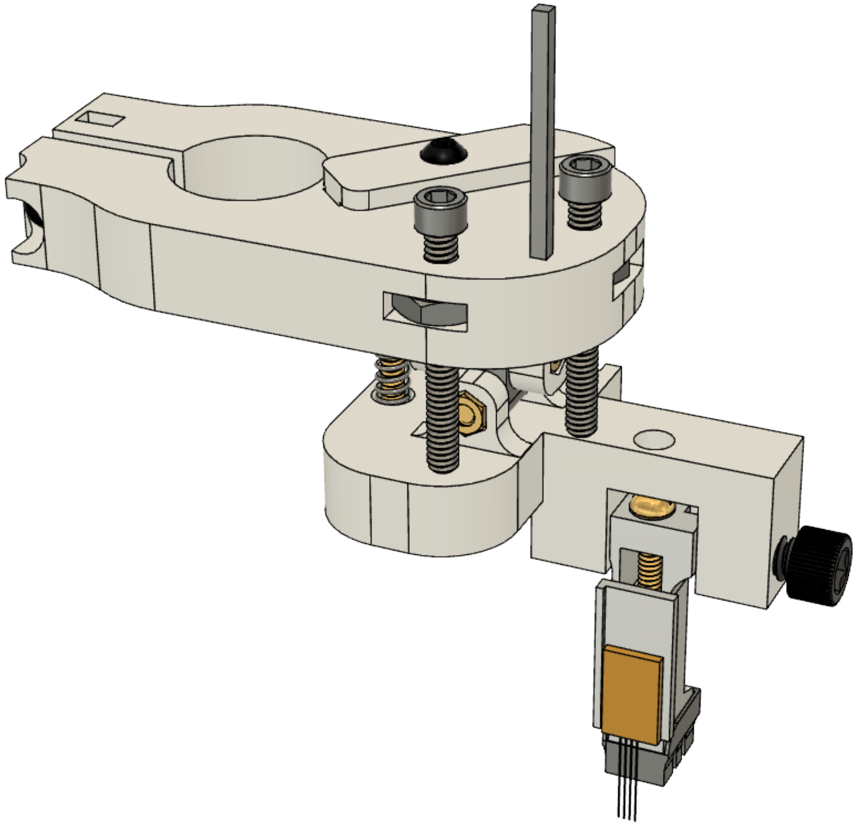
Multi-angle implantation tool

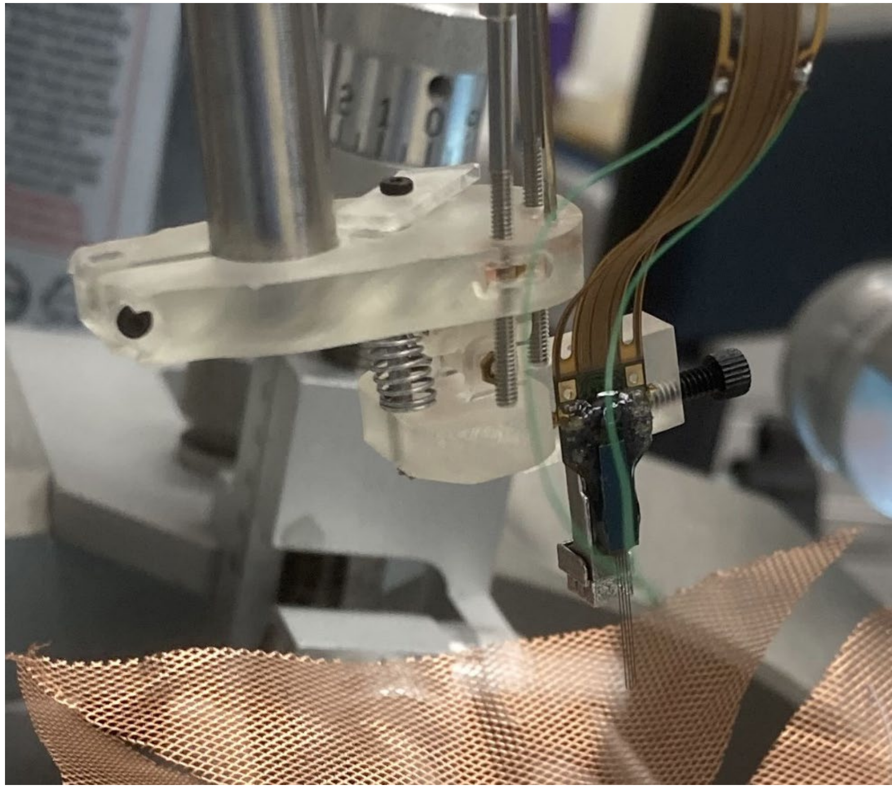


Spring load applies constant force

Multi-angle implantation tool with NP2.0 probe







Alignment process

Tools needed

- Reticle for microscope
- Multi-angle probe holder
- Stereotactic frame

What the 2-axis gimbal is doing?

- Multi-angle probe holder provides two small angular adjustments (think pitch and roll) between:
  - the manipulator carriage (defines the Z axis), and
  - the probe assembly (defines the shank axis).

You tweak those two angles until the shank axis becomes **parallel/coincident** with the manipulator Z axis.

Alignment process

- You’re using the reticle as a fixed ruler to test whether the probe shank is coaxial with the manipulator’s vertical axis of travel.
- The reticle is just a stationary reference in the microscope image. You pick a crosshair point and ask a single question:
  - When I move the manipulator purely along Z by the intended insertion depth, does the shank tip stay on the same reticle point?
  - If it drifts laterally, that drift is *direct evidence* the probe is tilted relative to the manipulator’s Z axis.
  - The orientation of the reticle grid (rotated 17° or whatever) doesn’t matter, because you’re measuring a *displacement*, not an absolute direction in space.

Alignment process (why rotate 90° and repeat)

- A tilt can have two components (one in the AP plane, one in the ML plane). In the microscope view, you're measuring drift in the camera's x–y plane.
- Rotating the probe (or the whole holder) 90° about the Z axis (yaw) is just a practical way to "swap" which physical plane maps to the camera axes, so you can confidently null both components.

Alignment loop

1. Place the tip on a chosen reticle intersection (your “fixed point”).
2. Move **pure Z** down by a known distance (ideally the expected brain insertion, e.g. ~3 mm; for bench testing you can use 5–10 mm to amplify error).
3. Measure lateral drift on the reticle (in µm).
4. Adjust the gimbal:
    1. If the tip drifts “right” during descent, adjust the gimbal axis that counter-tilts it left (small changes!).
    2. Return to the starting height and repeat steps 4–7 until drift is below criterion.

Orthogonal check

5. Rotate the probe assembly 90° about Z (yaw) and repeat steps 4–8.
6. Rotate back and re-check (small couplings often appear; do a final pass).