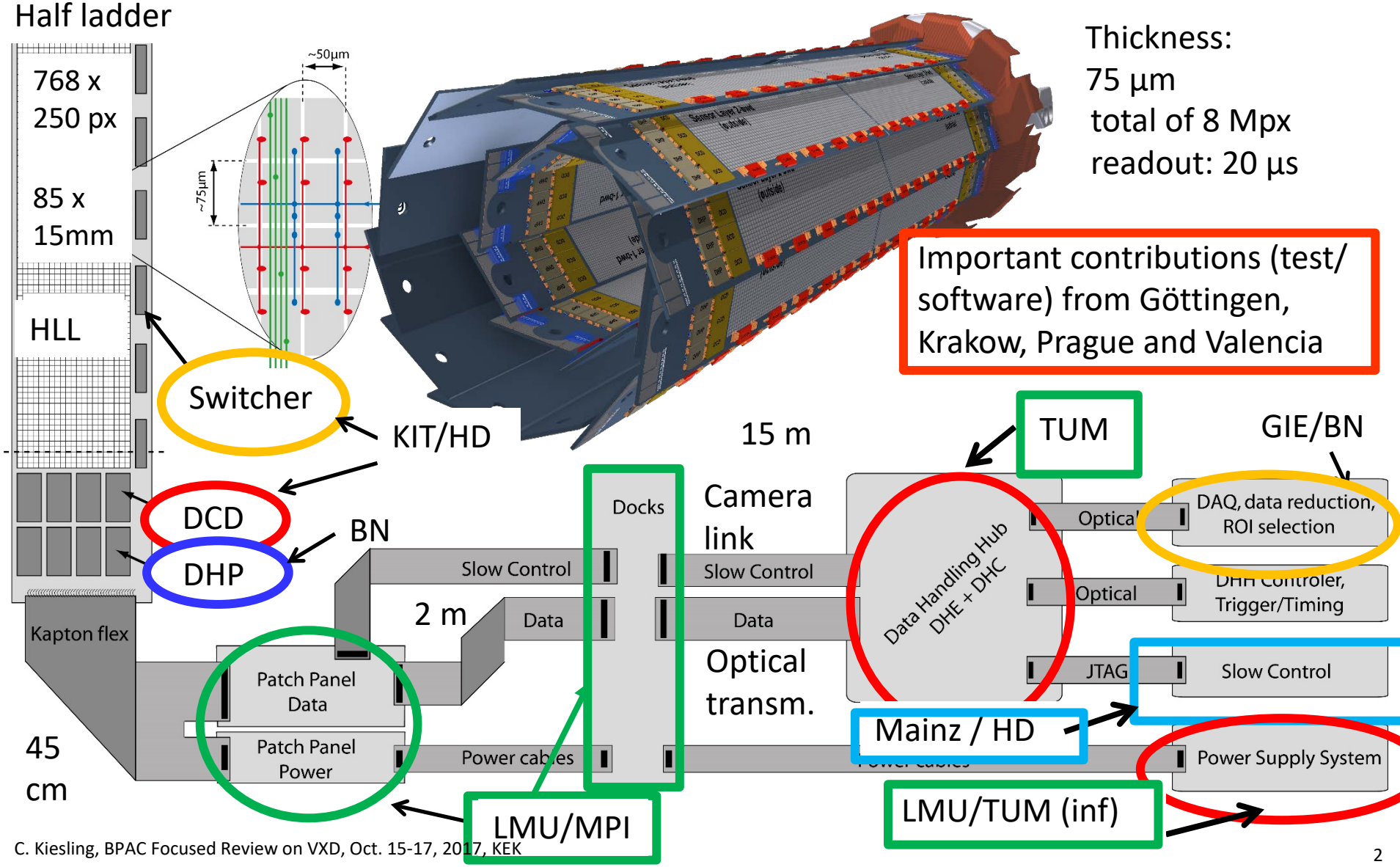
PXD Ladder Assembly, Half Shell Assembly and Mounting on the Beampipe

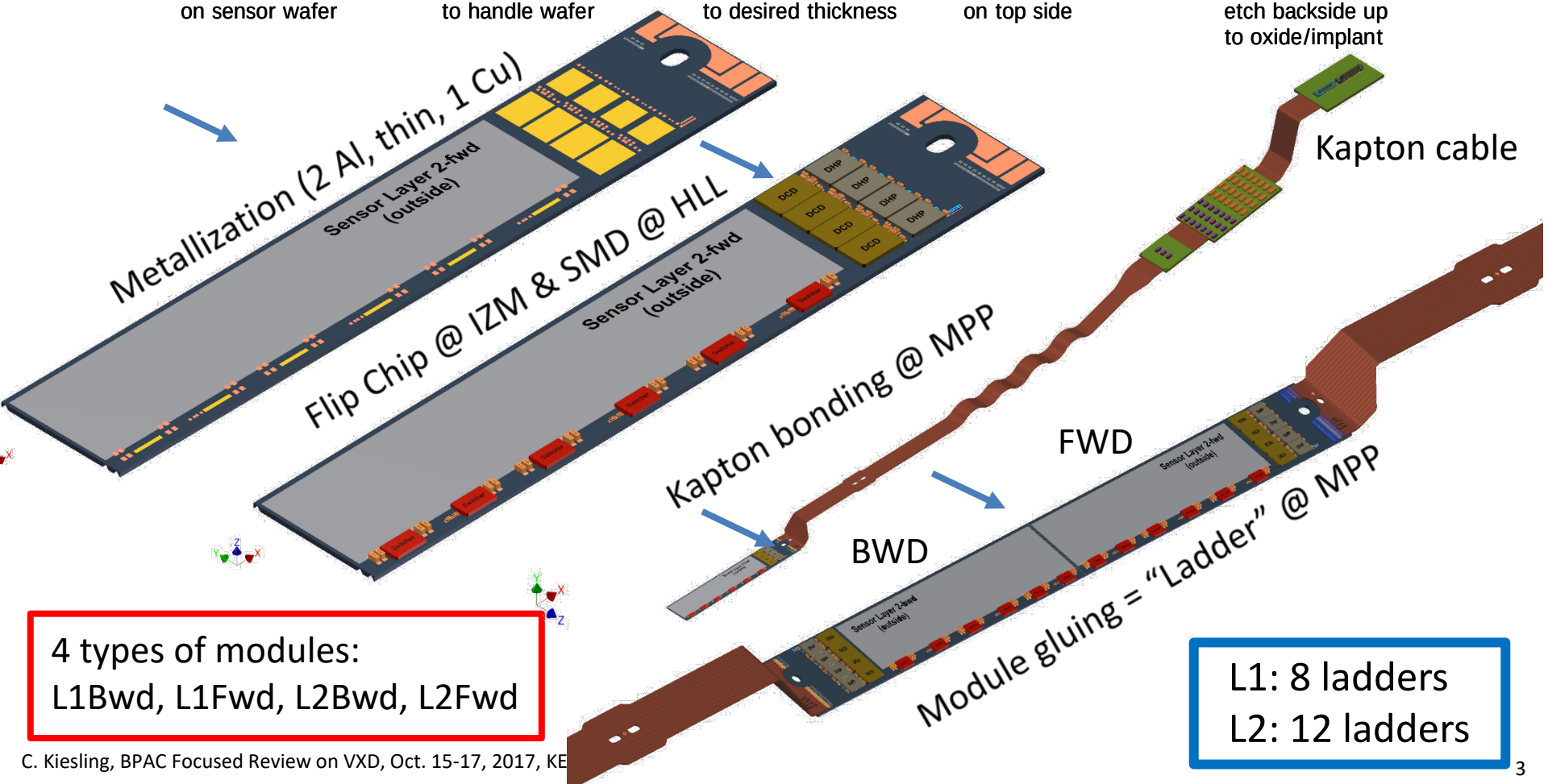
PXD System Overview

Total of 0.2% of X_0 | 2 layers: @1.4(2.2) cm | Pixels: 50 x 60(85) µm



Production Steps of PXD Ladders

1. implant backside on sensor wafer
2. bond sensor wafer to handle wafer
3. thin sensor side to desired thickness
4. process DEPFETs on top side
5. structure resist, etch backside up to oxide/implant



4 types of modules:
L1Bwd, L1Fwd, L2Bwd, L2Fwd

L1: 8 ladders
L2: 12 ladders

Last Step after Module Testing: Gluing

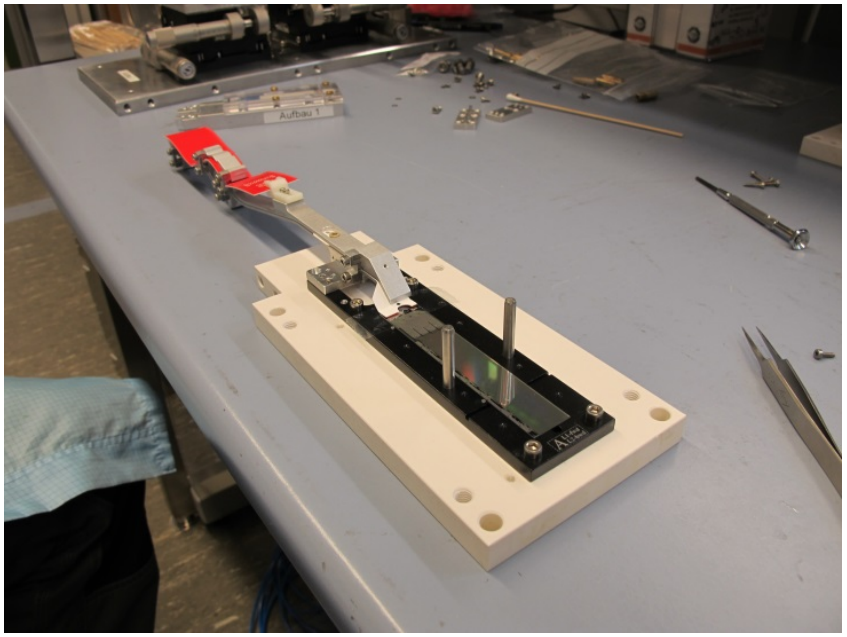
Modules arrive with Kapton attached (tested)

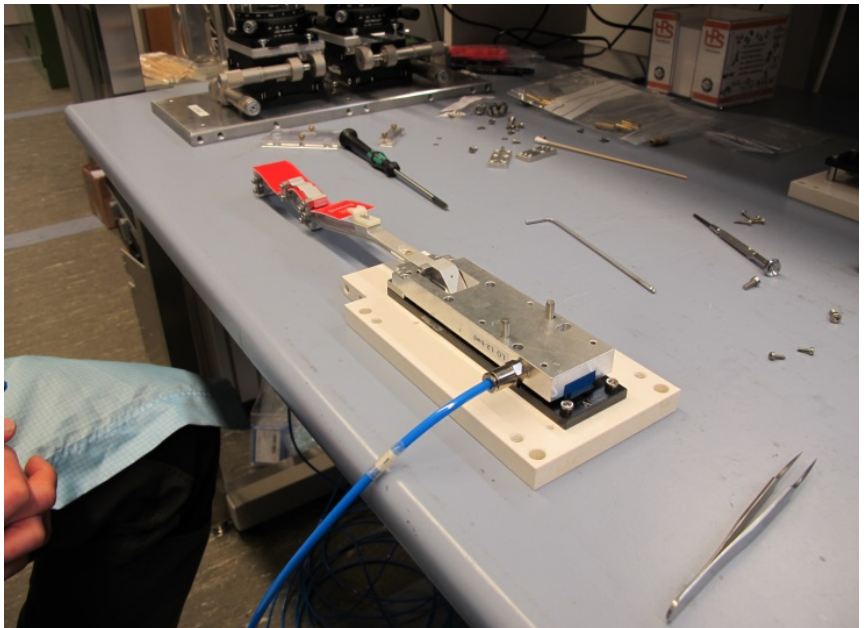
Module will be turned "on its back" for gluing

Vacuum jig for turning and ladder gluing

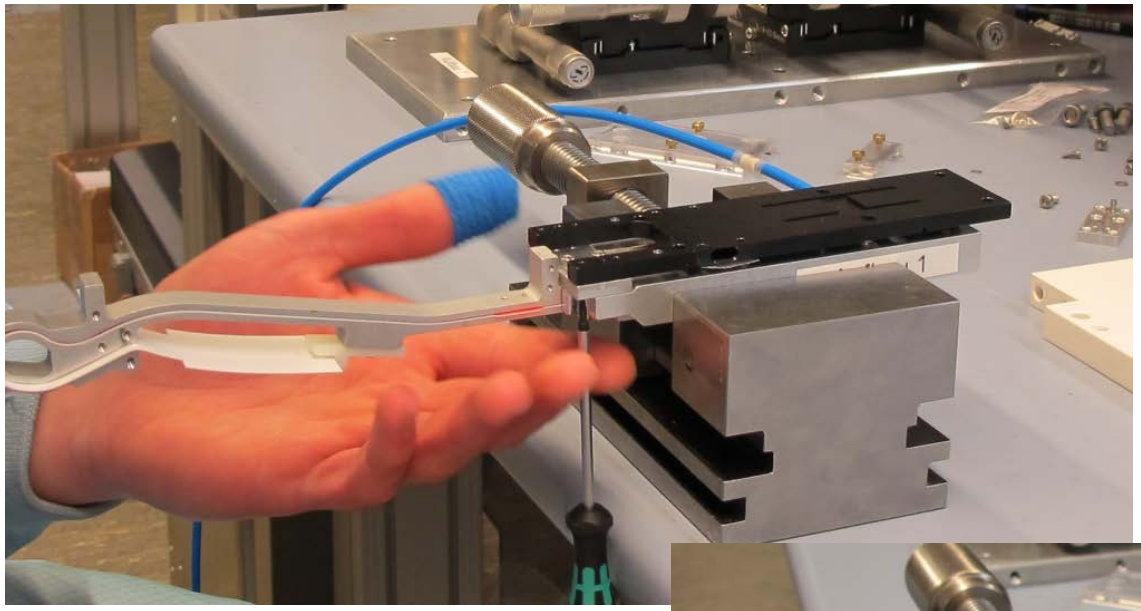
made from microporous plate (gentle vacuum on sensor top side)

fits on top side (cutouts for switcher)



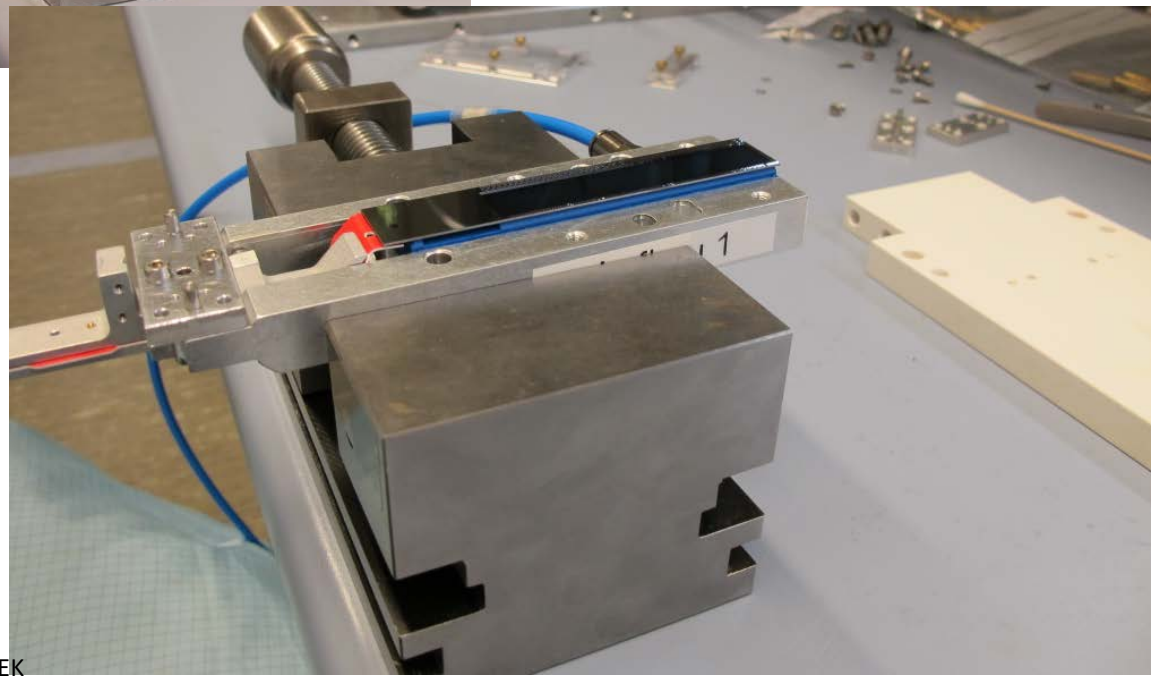


Preparations for Gluing Step

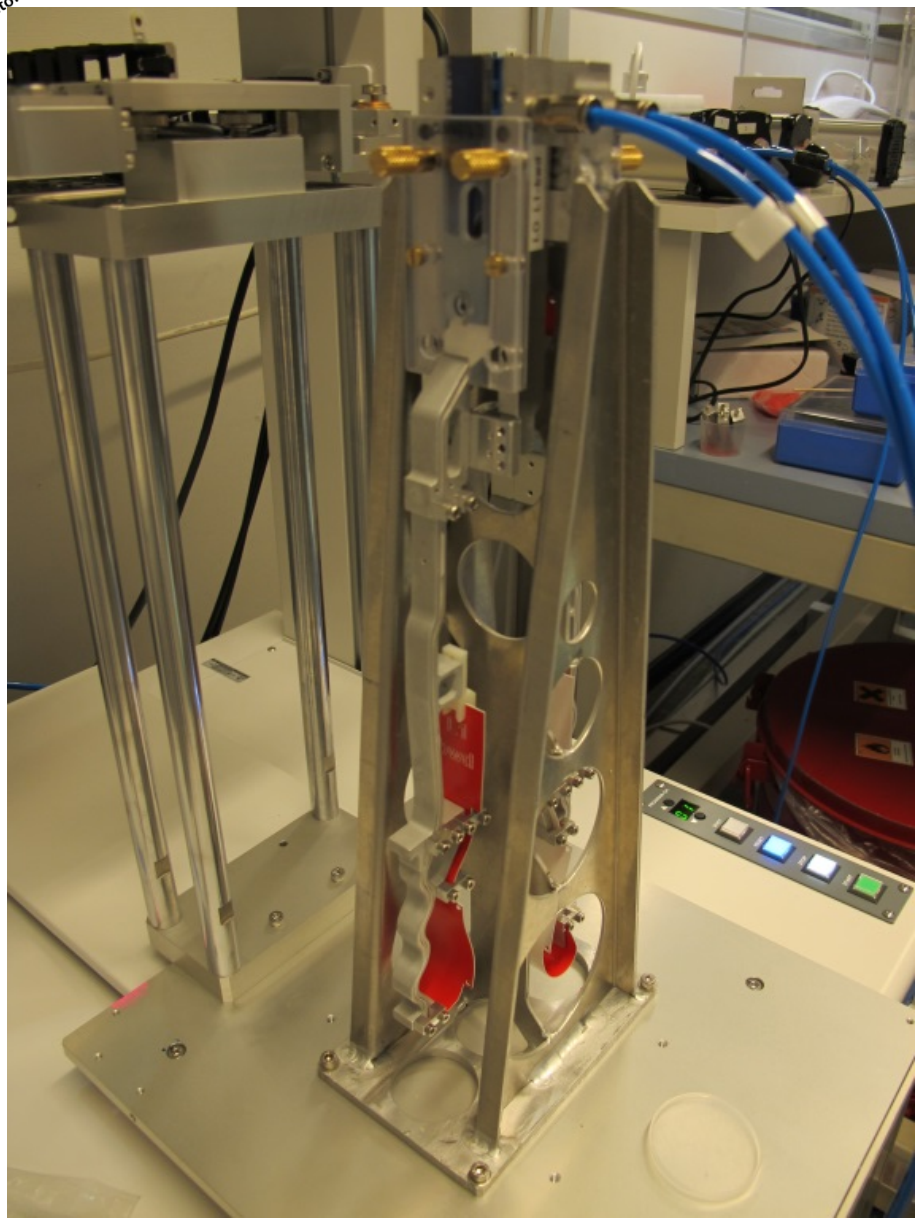


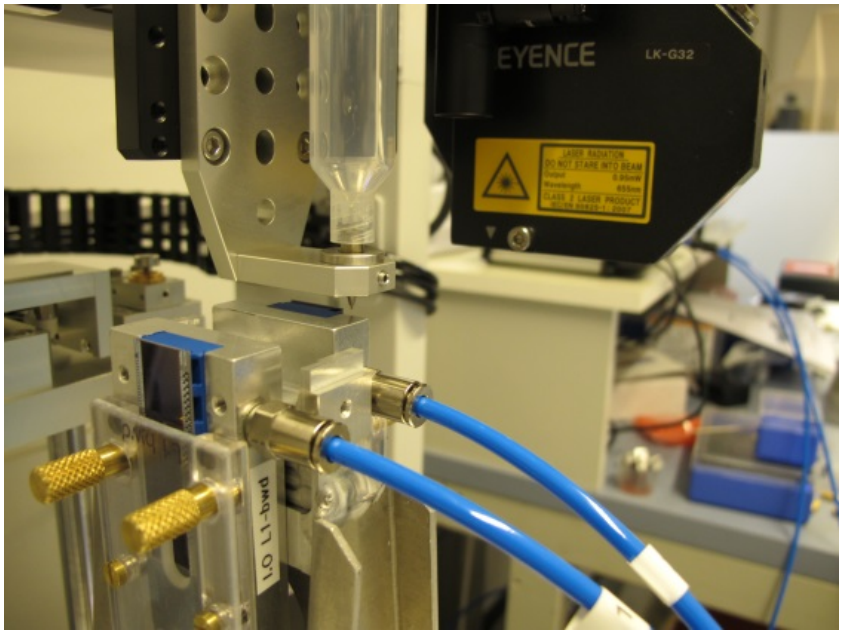
Turn around …

… and take off base jig



Glue Dispenser Machine (Musashi)

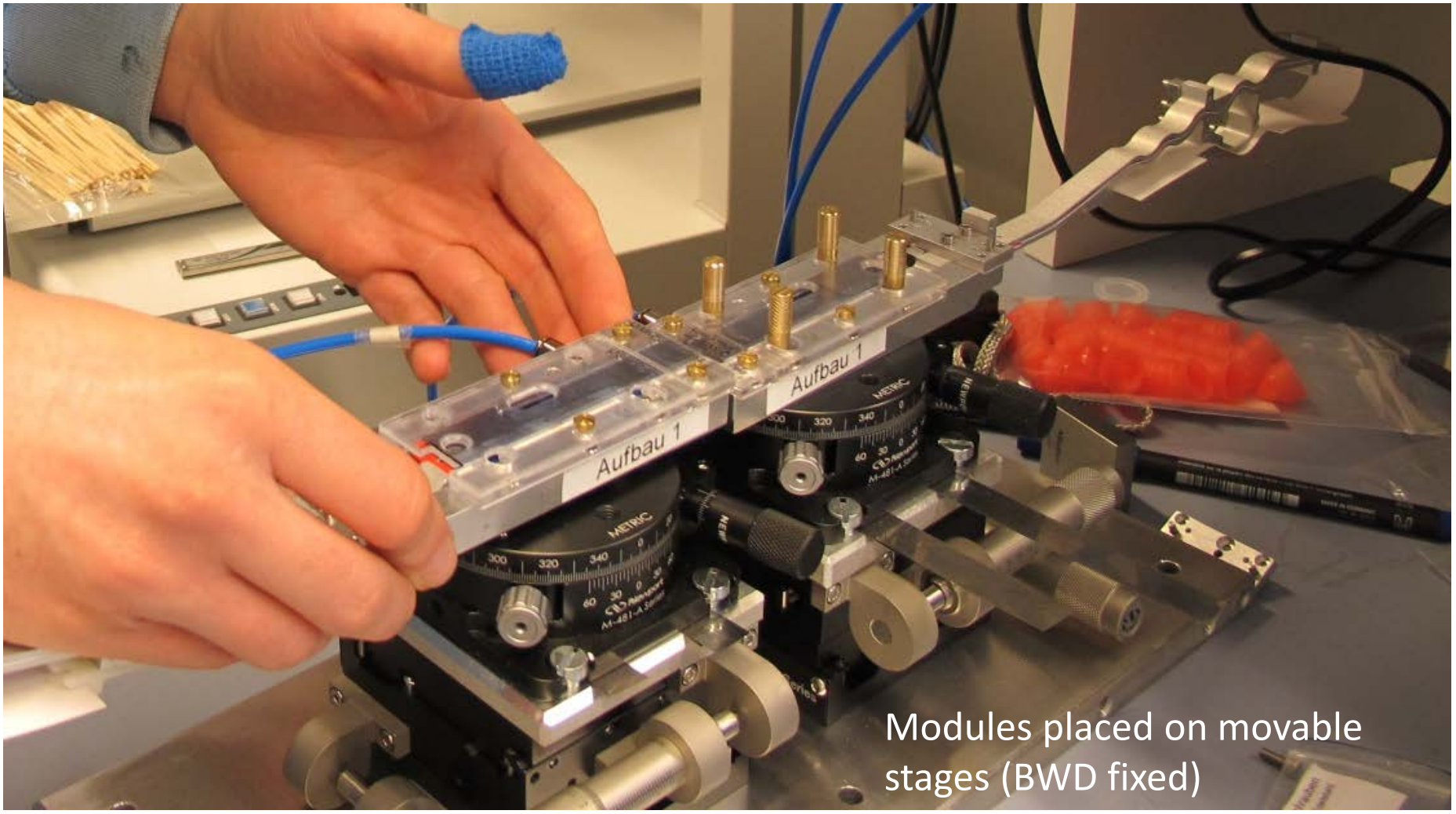




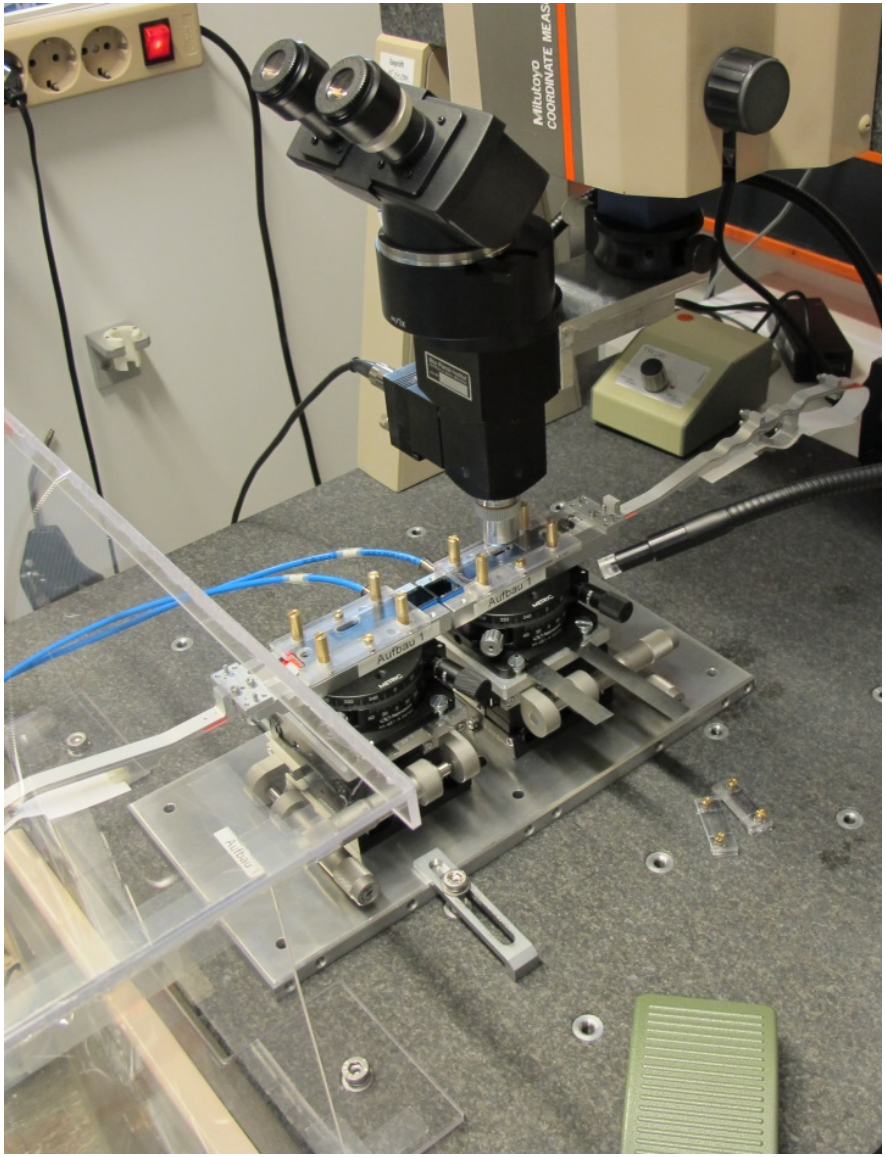
FWD and BWD modules prepared in the same way

Glue automatically dispensed on sensor front edge for both modules in one step

Position Adjustment Devices



Position Adjustment Under Microscope

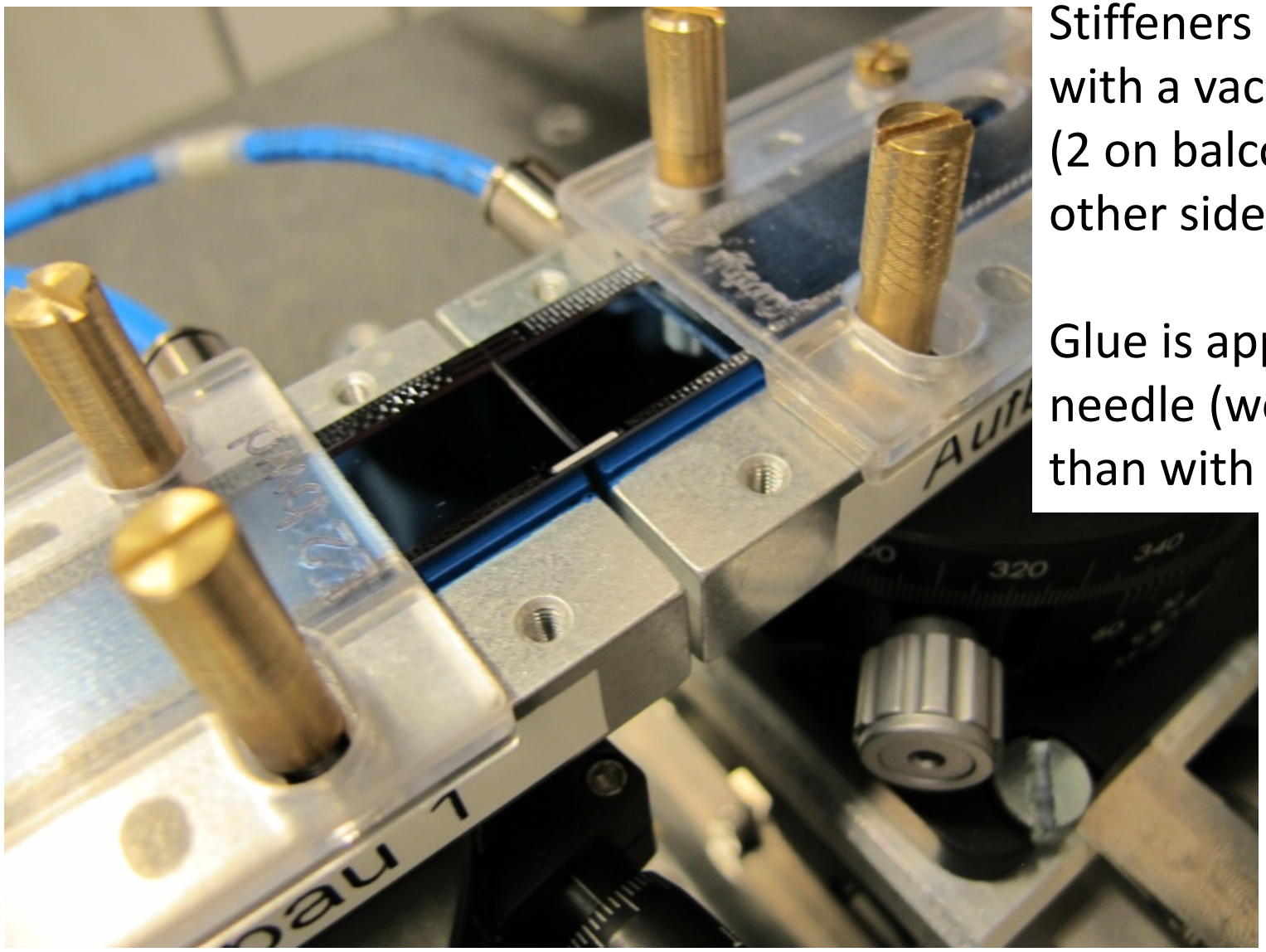


Modules are pushed together to roughly 30µm distance to ensure good distribution of the glue.

Modules are then driven apart to the nominal gap of 50µm

Precision achieved:
10 µm over full
length of ladder

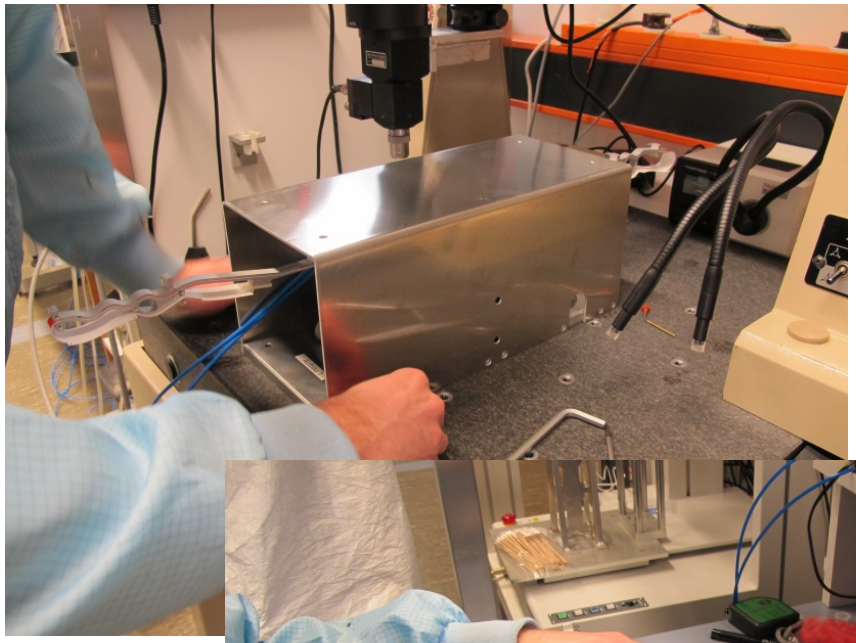
Ceramic Stiffeners for High Stability

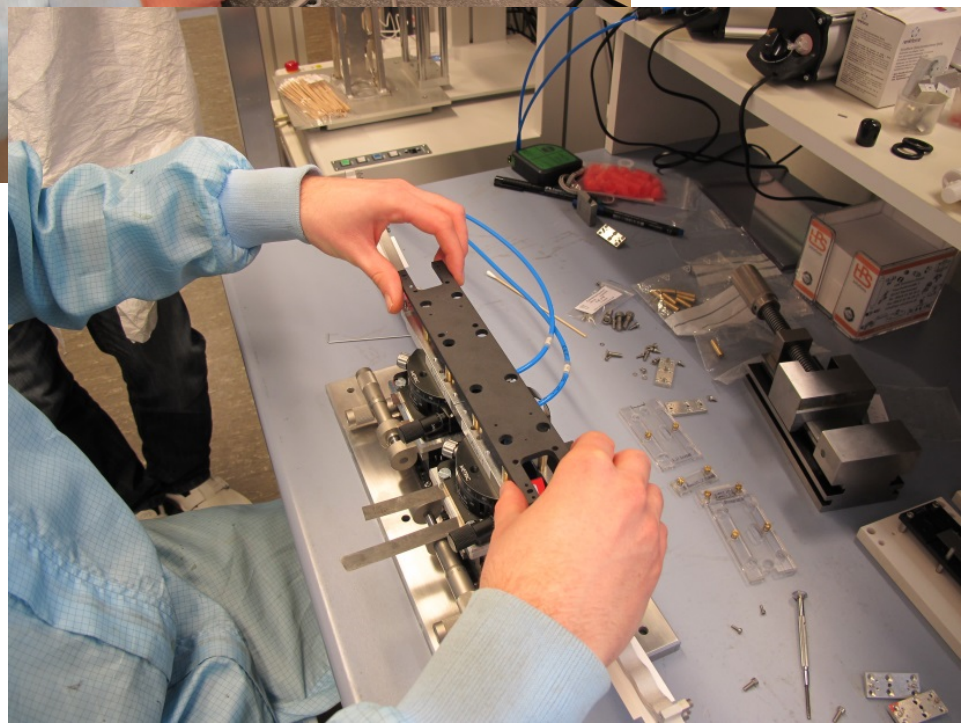


Stiffeners are handled with a vacuum tool (2 on balcony, 1 on other side)

Glue is applied with a needle (works better than with a dispenser)

Curing Process for 48 Hours



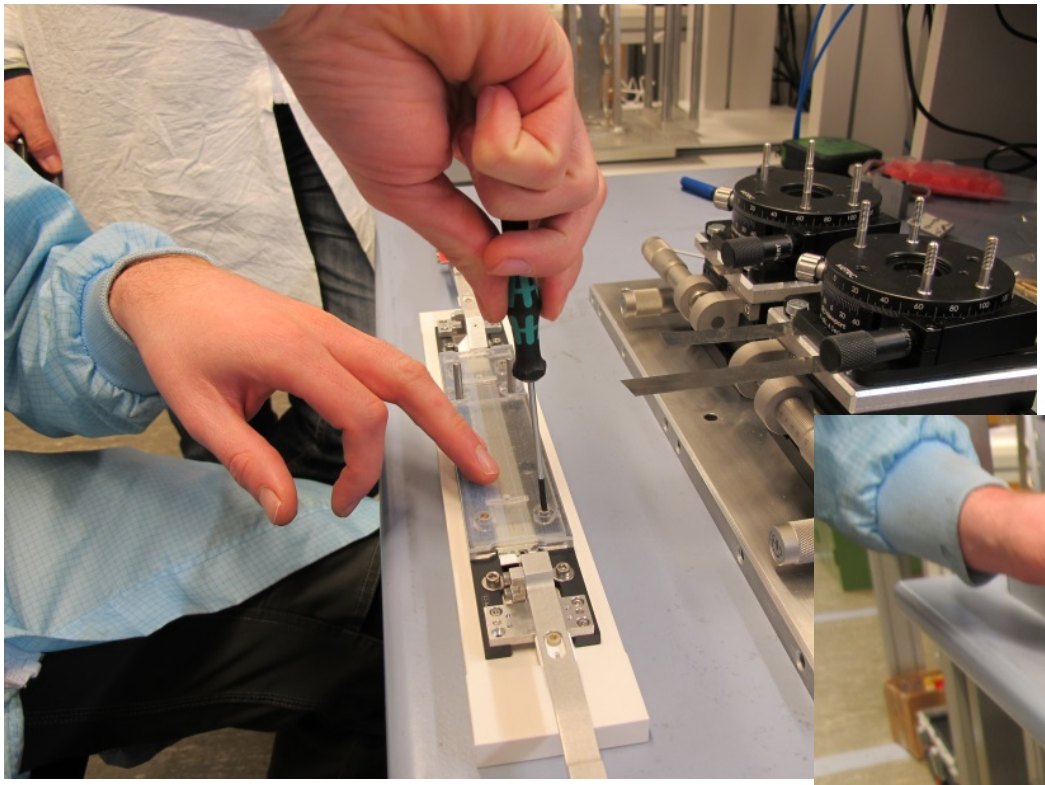


For curing the ladder is covered and stored in a safe place

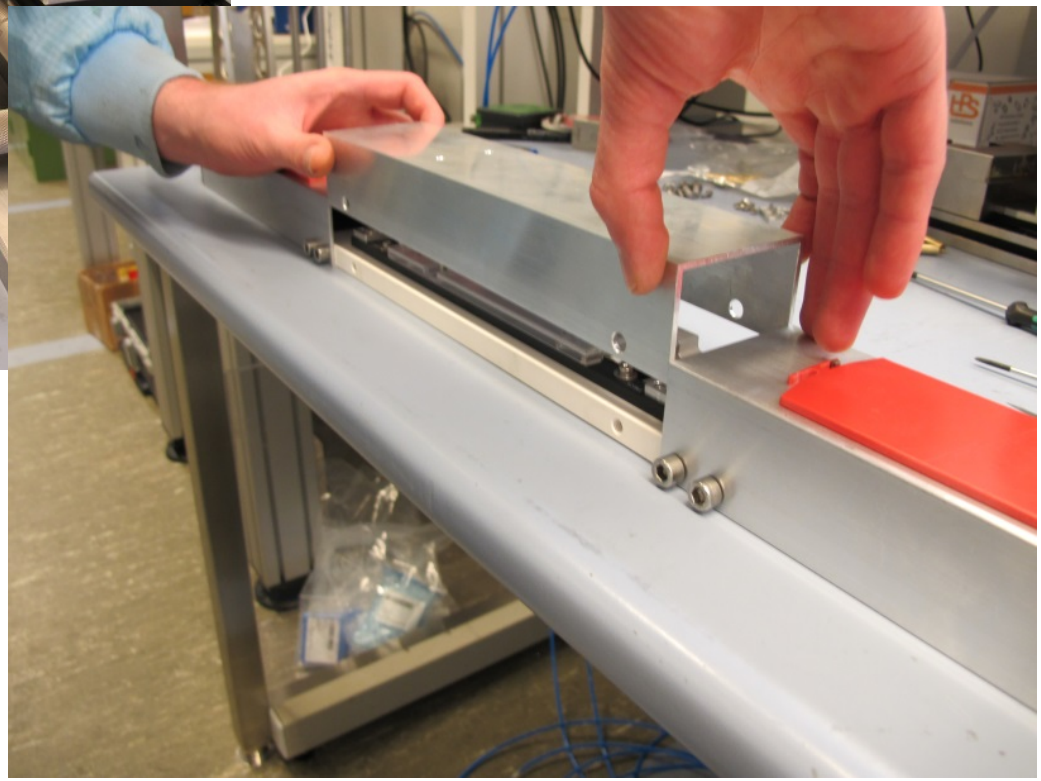
After curing the base jig is added

… and the vacuum jig is removed

Finally Protect and Store



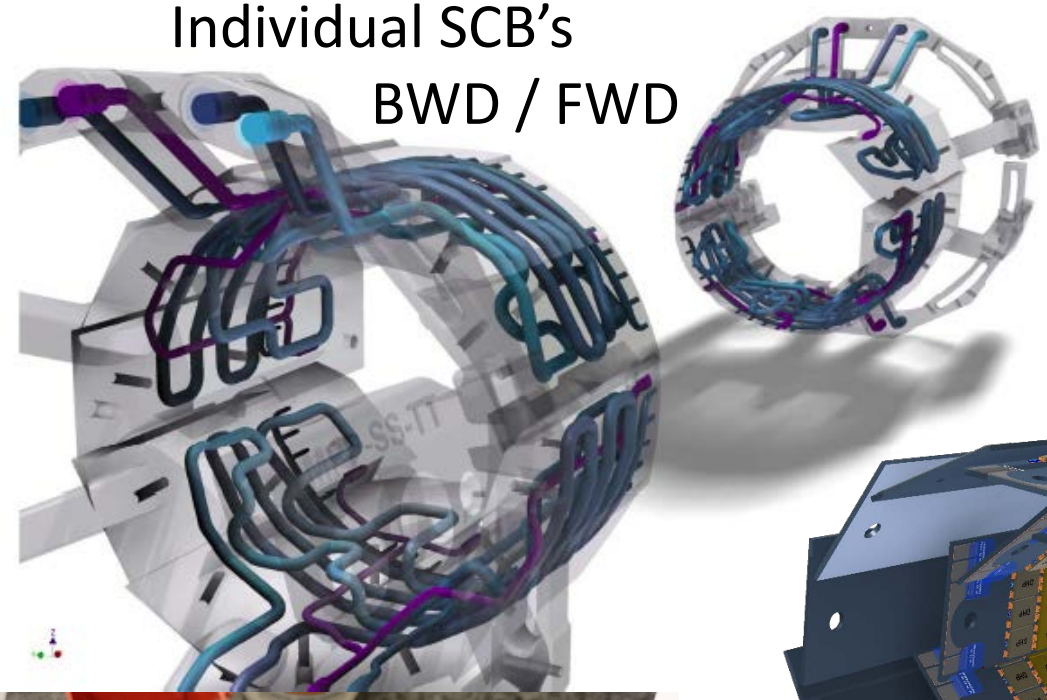
A protective cover is added …



… and the ladder is stored in the transport jig

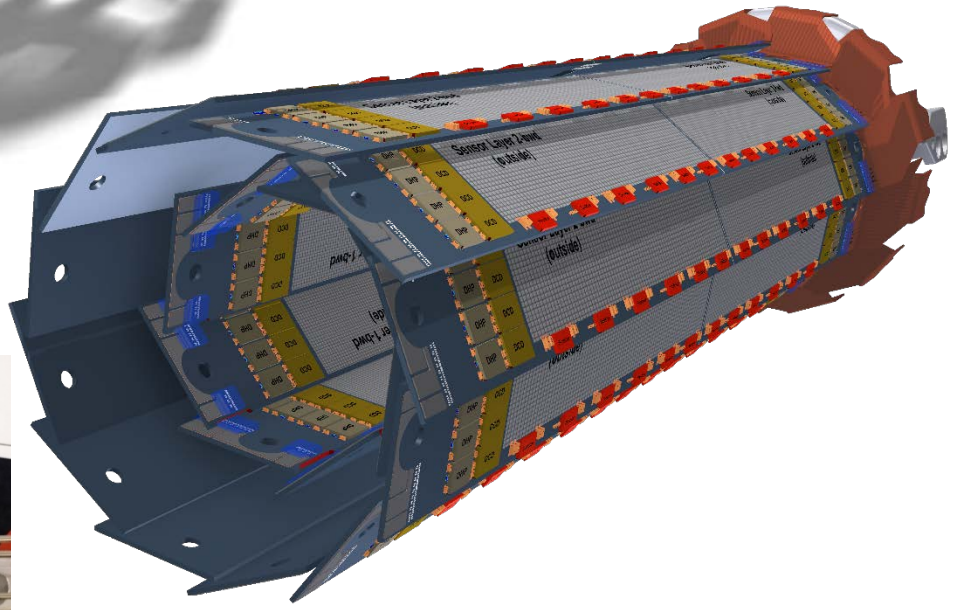
Ladder Mounting Phase 3

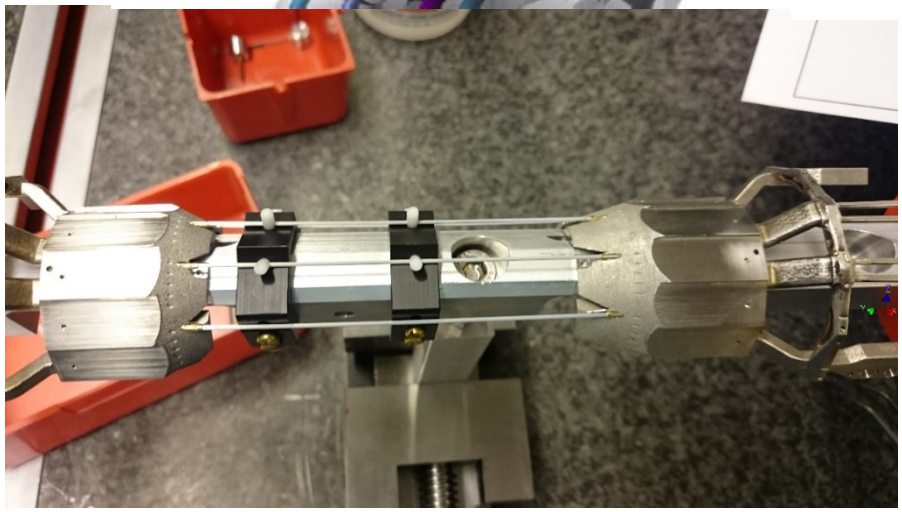
Individual SCB's
BWD / FWD



40 modules glued to
20 ladders
(8 inner, 12 outer)

L1 L2



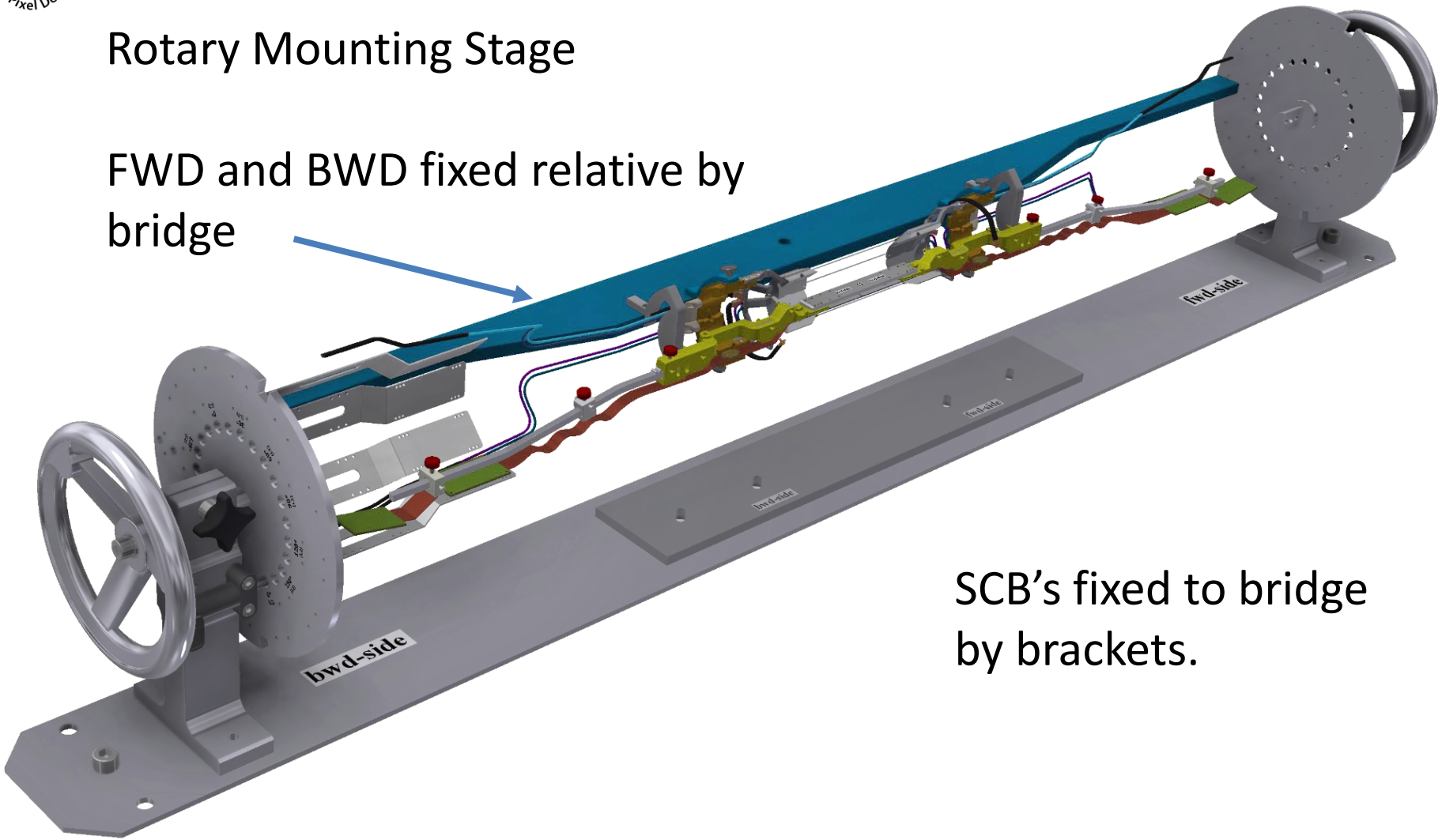


SCB Half Shell prepared for the ladder mount
[SCB: Support and Cooling Block]

Ladder Mounting Phase 3

Rotary Mounting Stage

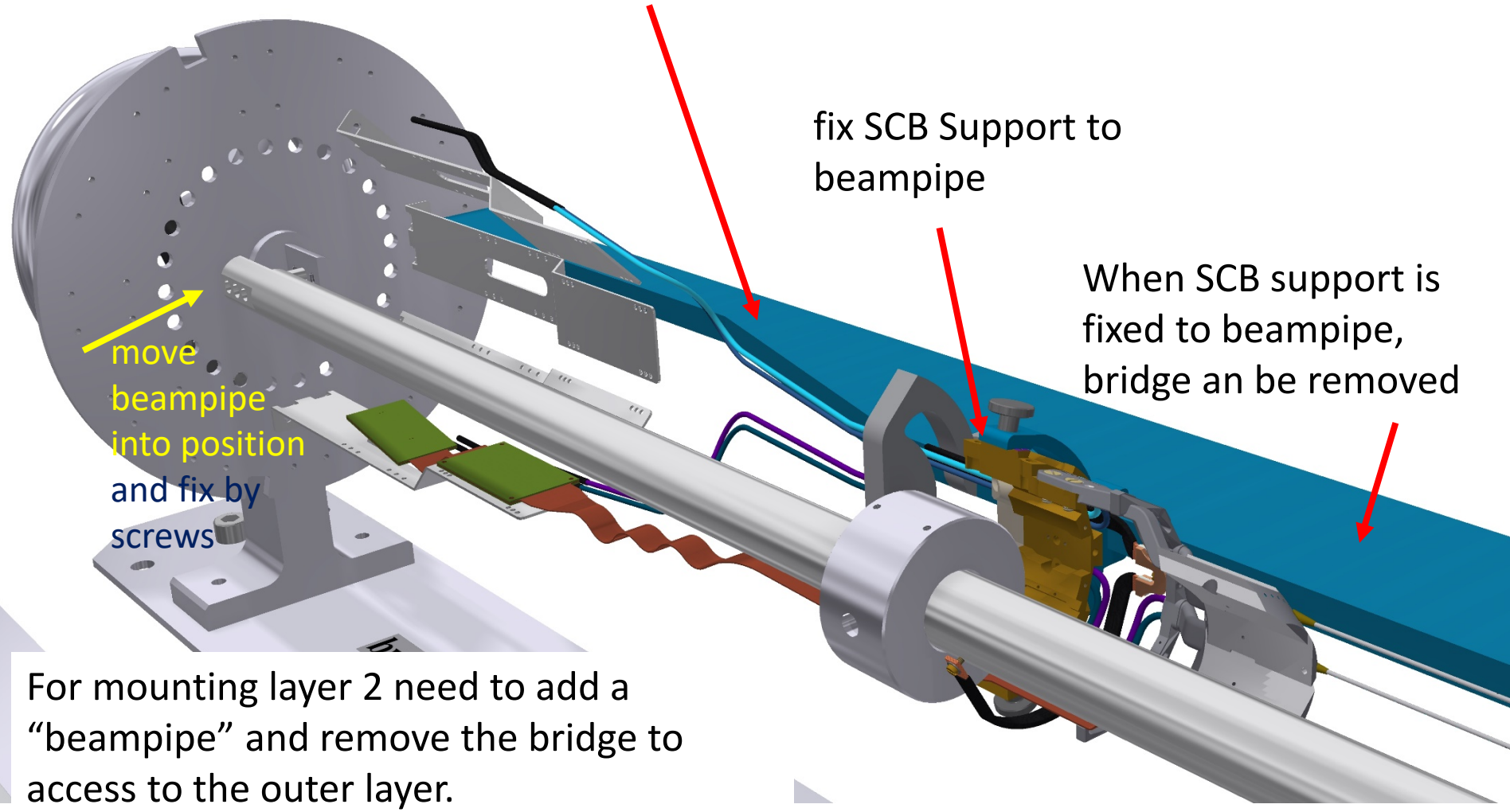
FWD and BWD fixed relative by bridge



SCB's fixed to bridge by brackets.

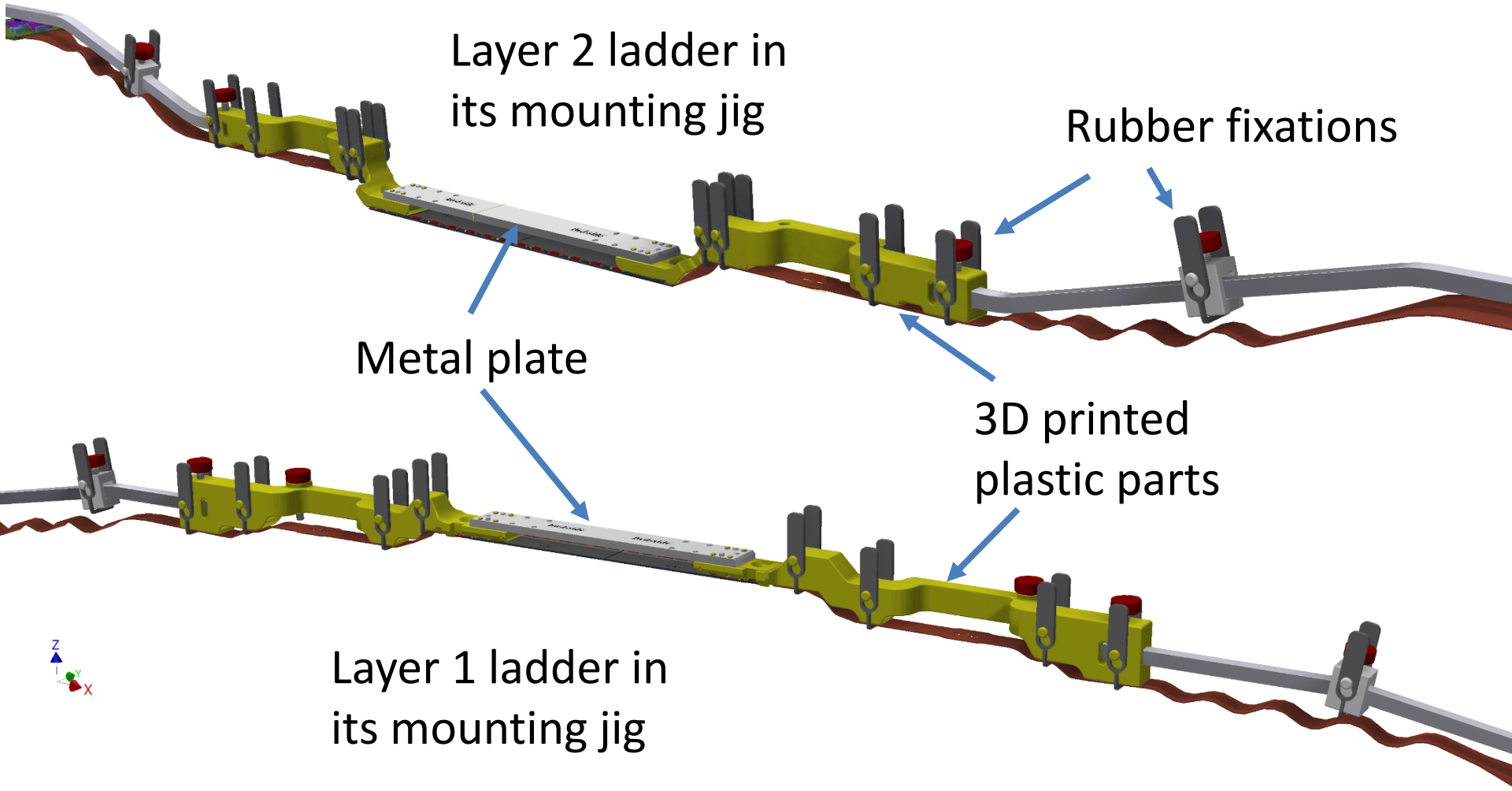
Support Tools for Ladder Mounting

For mounting of layer 1 need to install a support ("bridge") connecting the wheels of the rotation stage



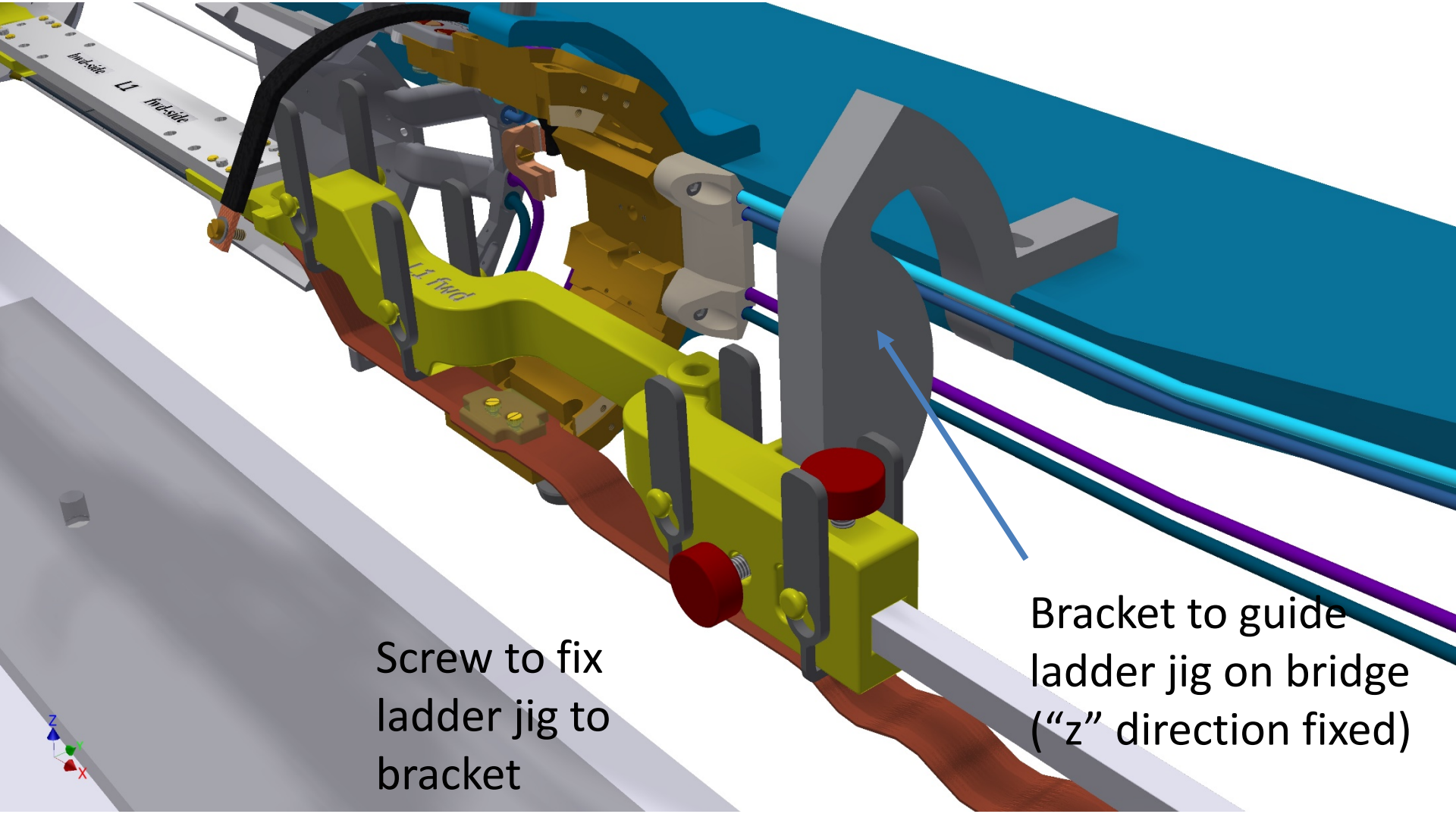
For mounting layer 2 need to add a "beampipe" and remove the bridge to access to the outer layer.

Ladder Mount Jigs



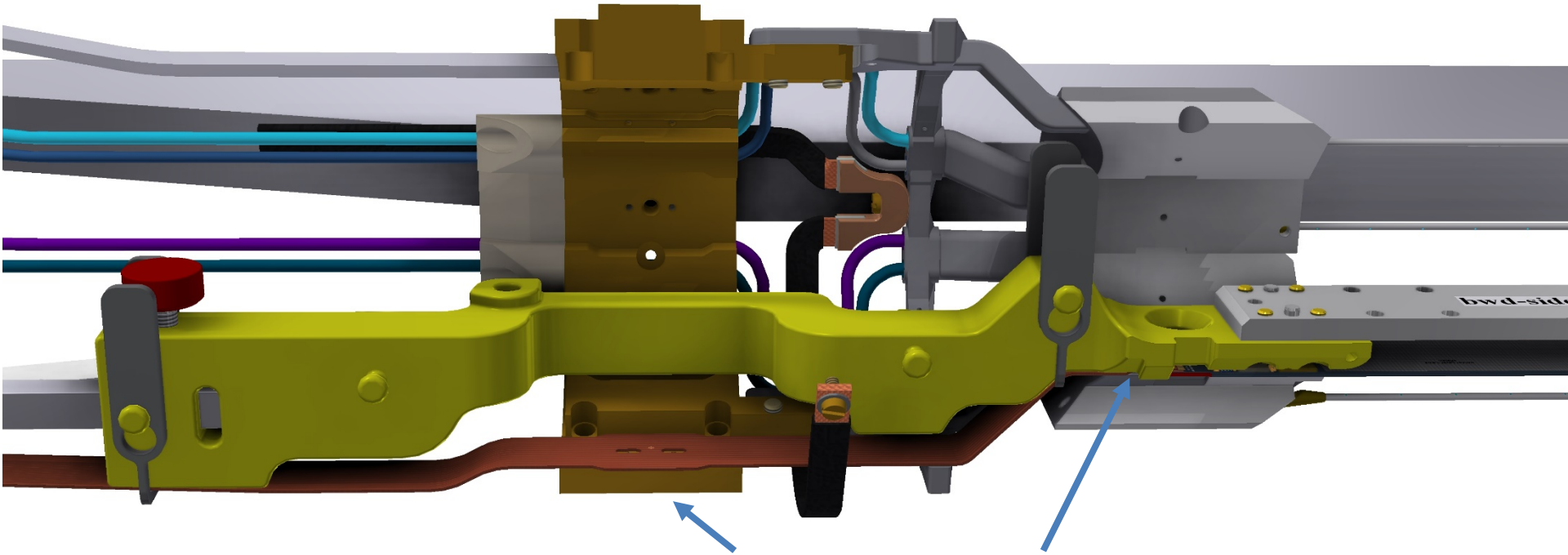
(tested procedure how to get from base jig to ladder mount jig -> backup)

Insert Ladder on Half Shell



Fix Ladder on Half Shell

Example inner layer: use bridge



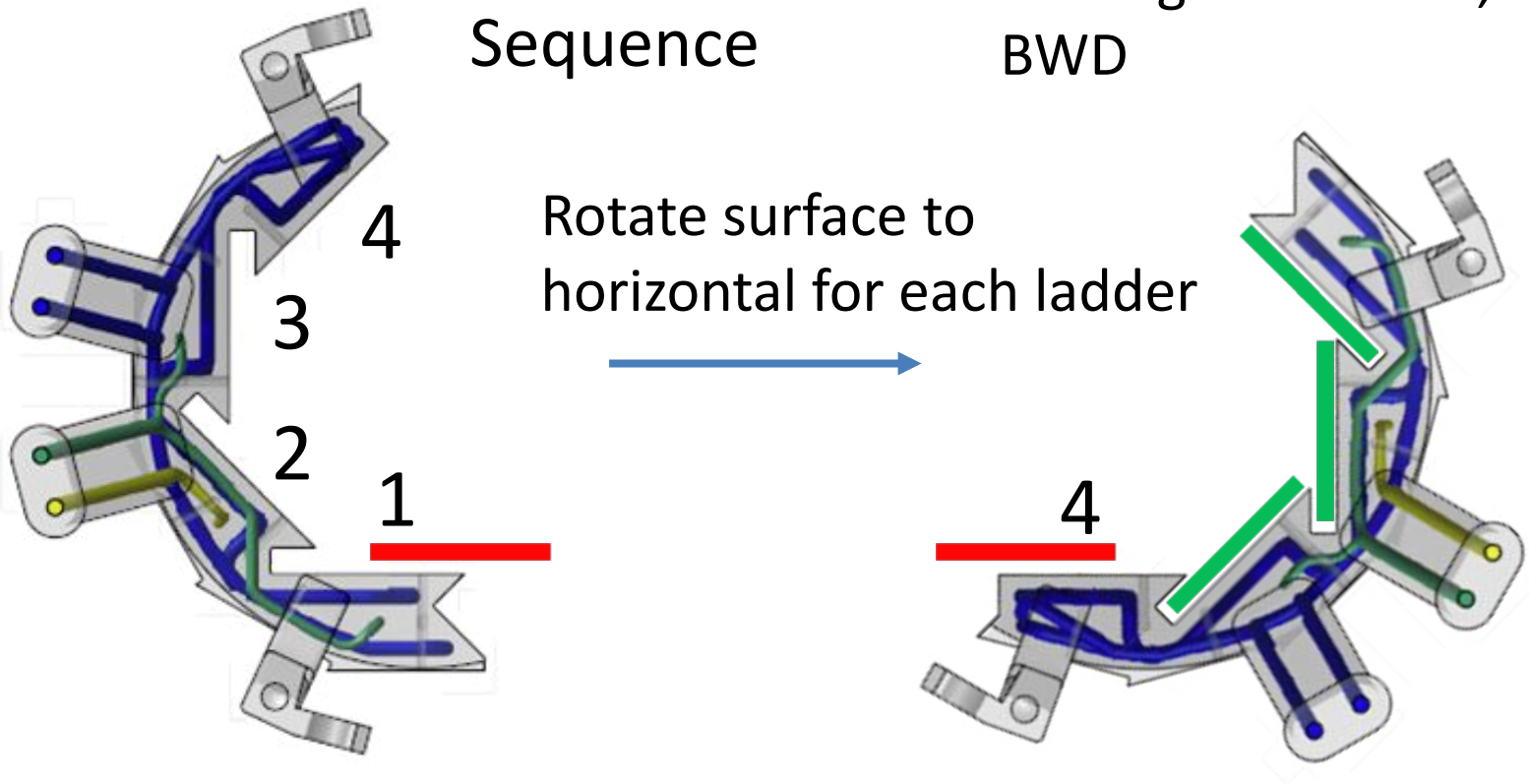
Actions after mounting:

- fix Kapton and sensor by screws,
- cut the rubber bands
- remove screws from bracket
- lift ladder jig upwards

Ladder Mounting: Overview

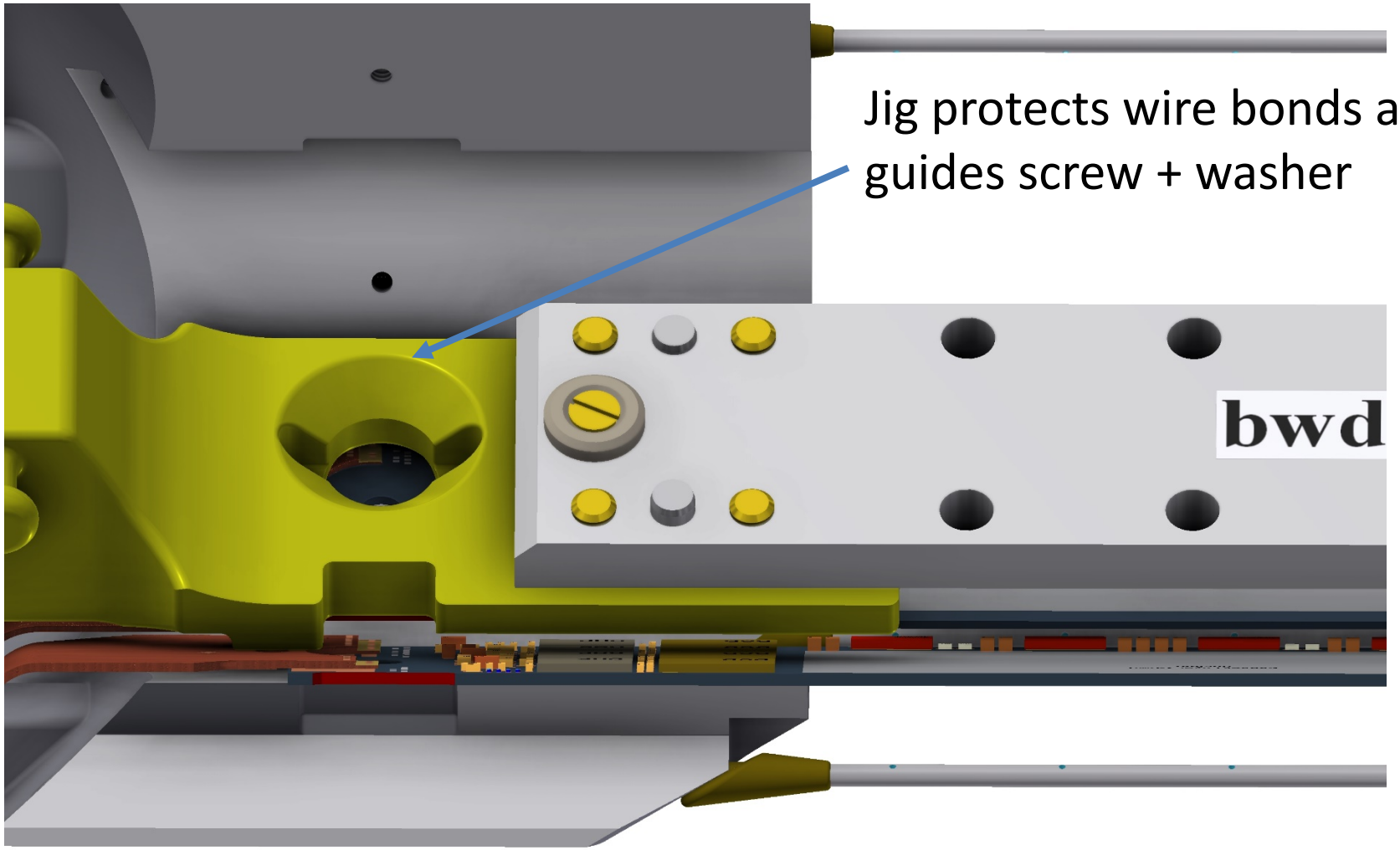
Mounting Sequence

looking towards +z, i.e. from BWD



1st and last ladder are “easy”

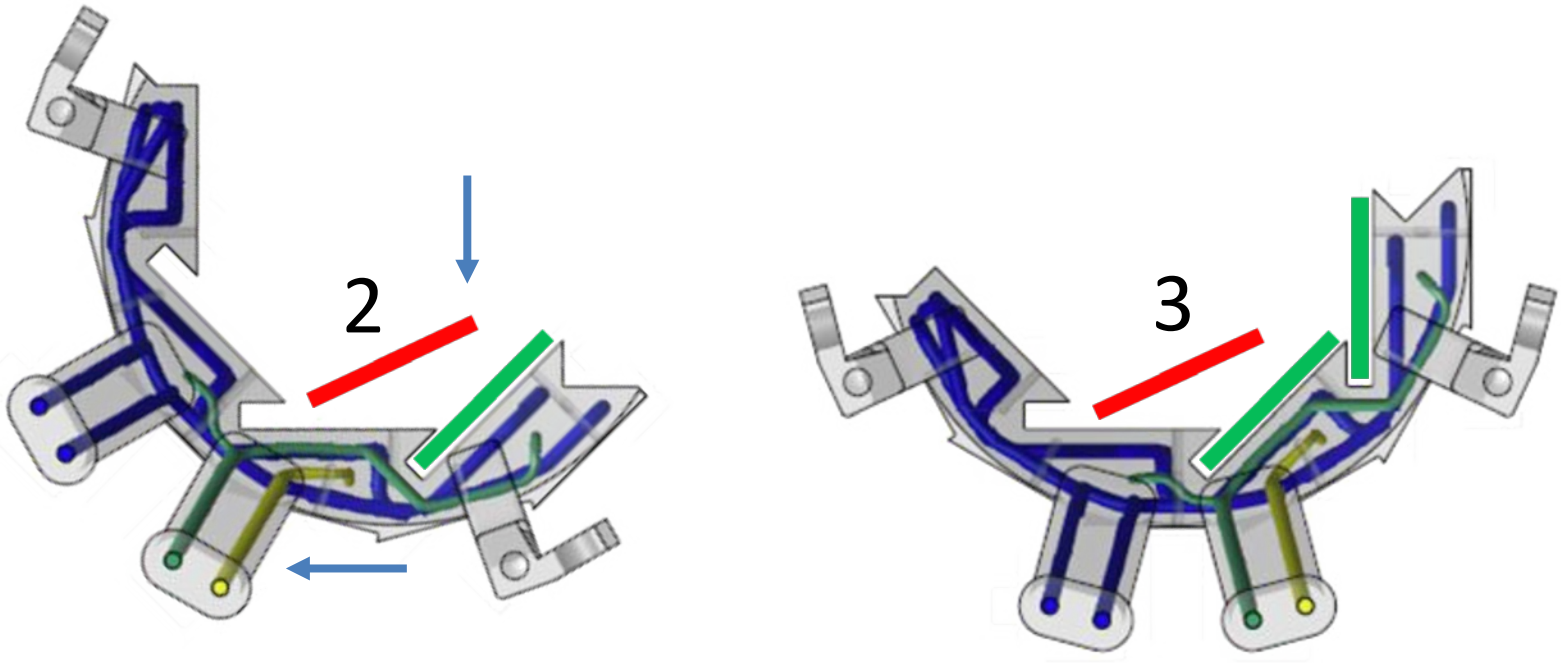
Ladder Fixing on SCB



M1.2 screw, 15 mNm torque

Ladder Mounting: Layer 1

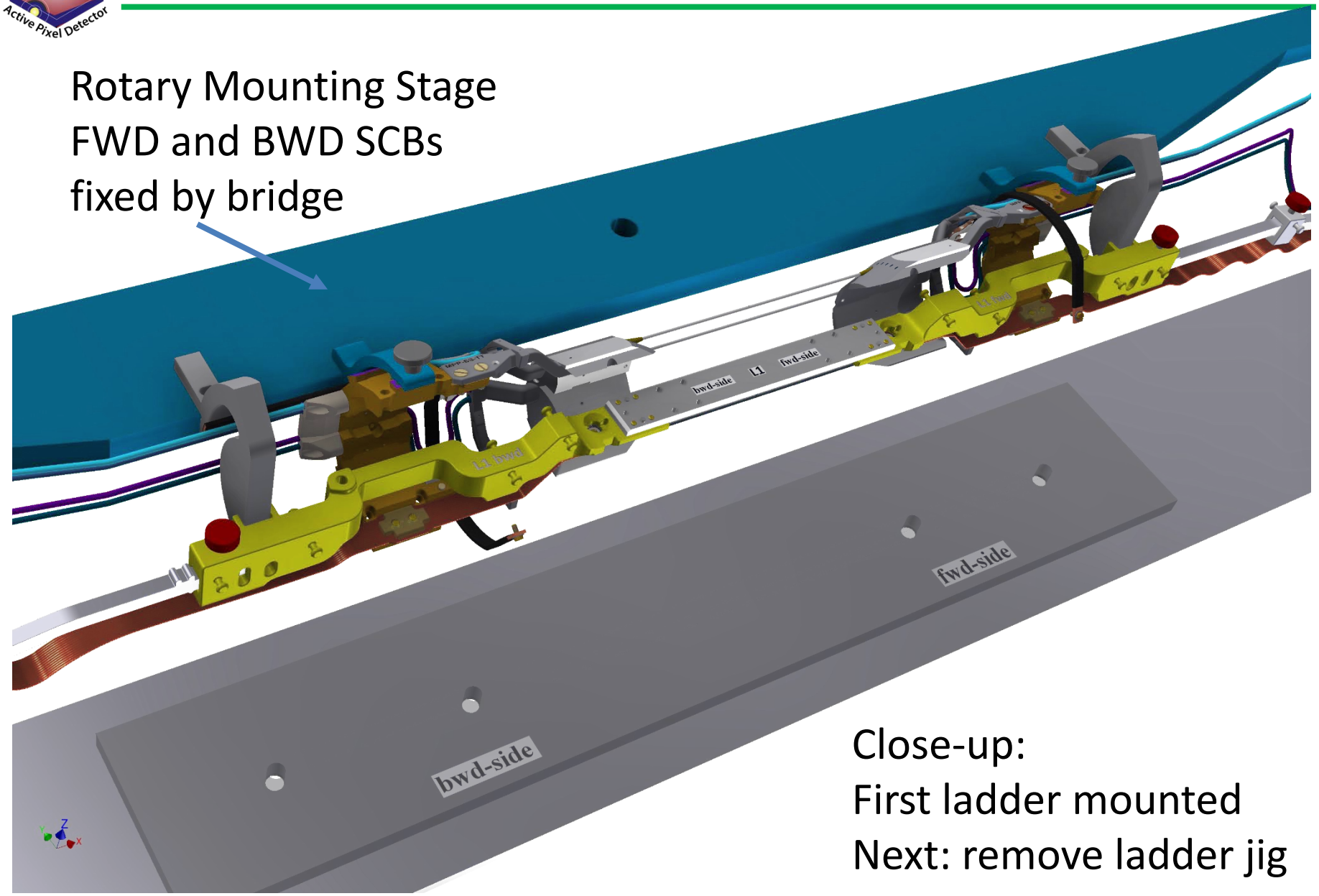
Ladders 2 and 3 are tricky



Ladder 2(3) must be guided “down” and “left” in a well coordinated way (tactile feedback mandatory)

Ladder Mounting: Layer 1

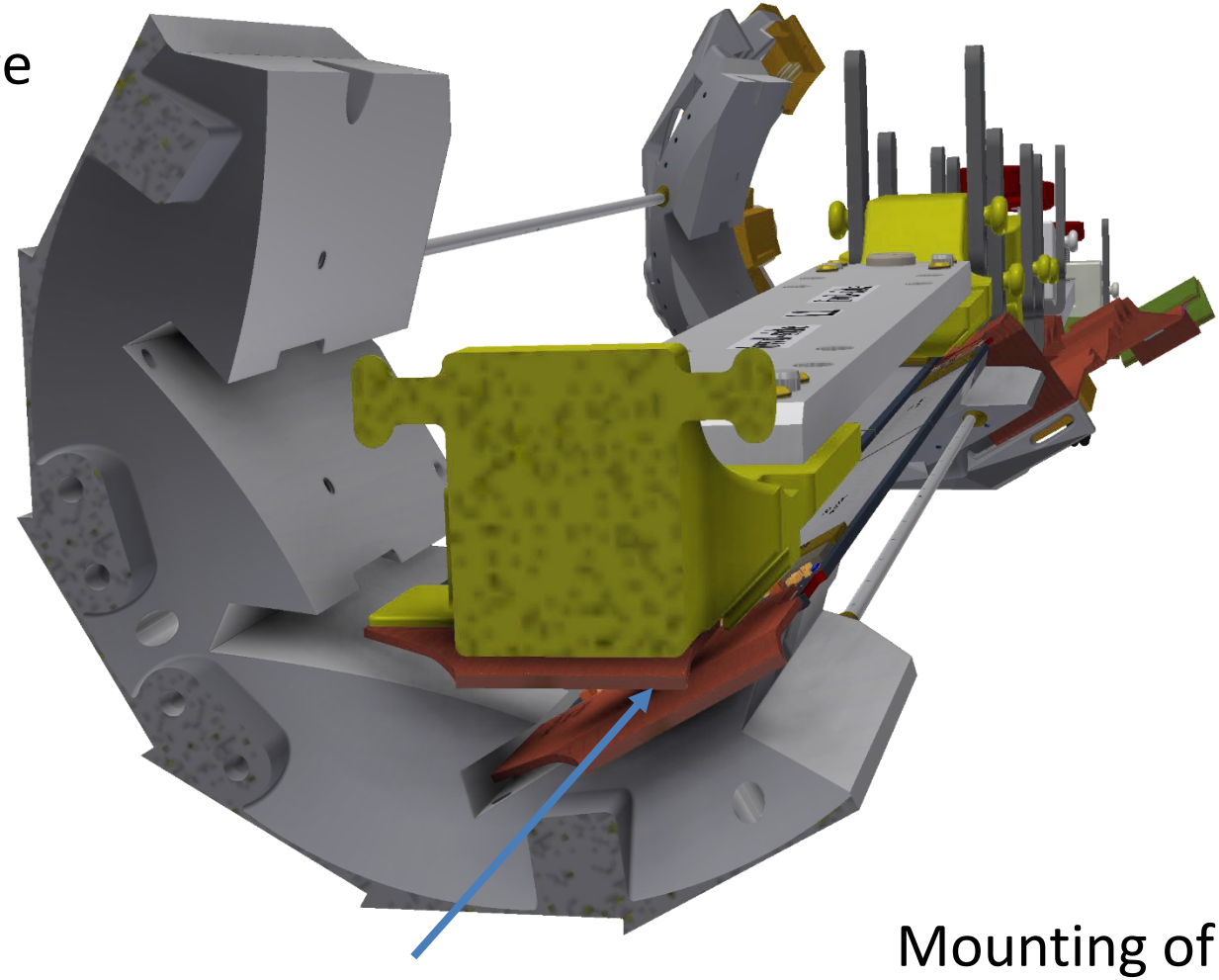
Rotary Mounting Stage
FWD and BWD SCBs
fixed by bridge



Close-up:
First ladder mounted
Next: remove ladder jig

Ladder Mounting: Layer 1, Ladder 2(3)

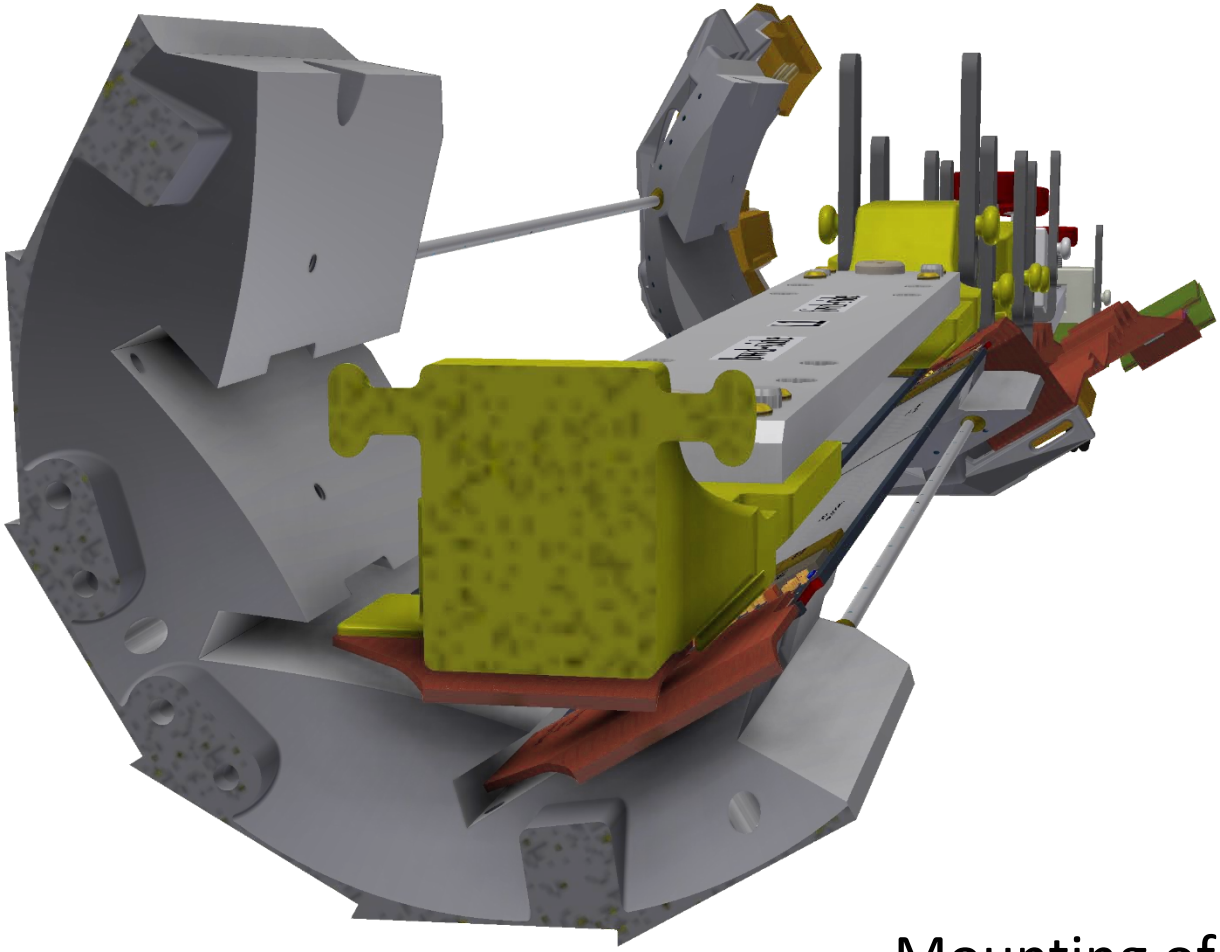
Rotate stage by 45°



Mounting of Ladder 2

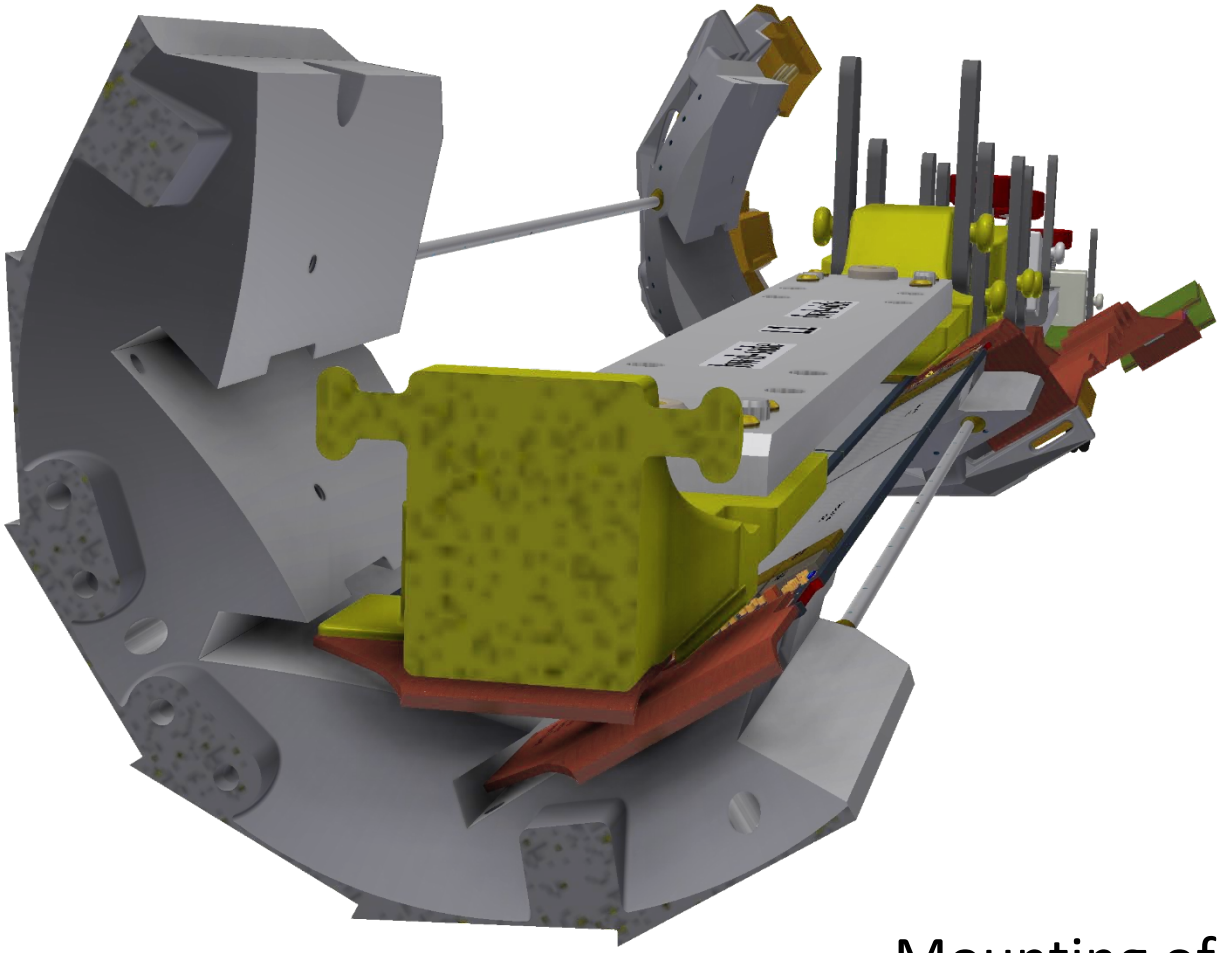
Kapton(2) touches Kapton(1)

Ladder Mounting: Layer 1



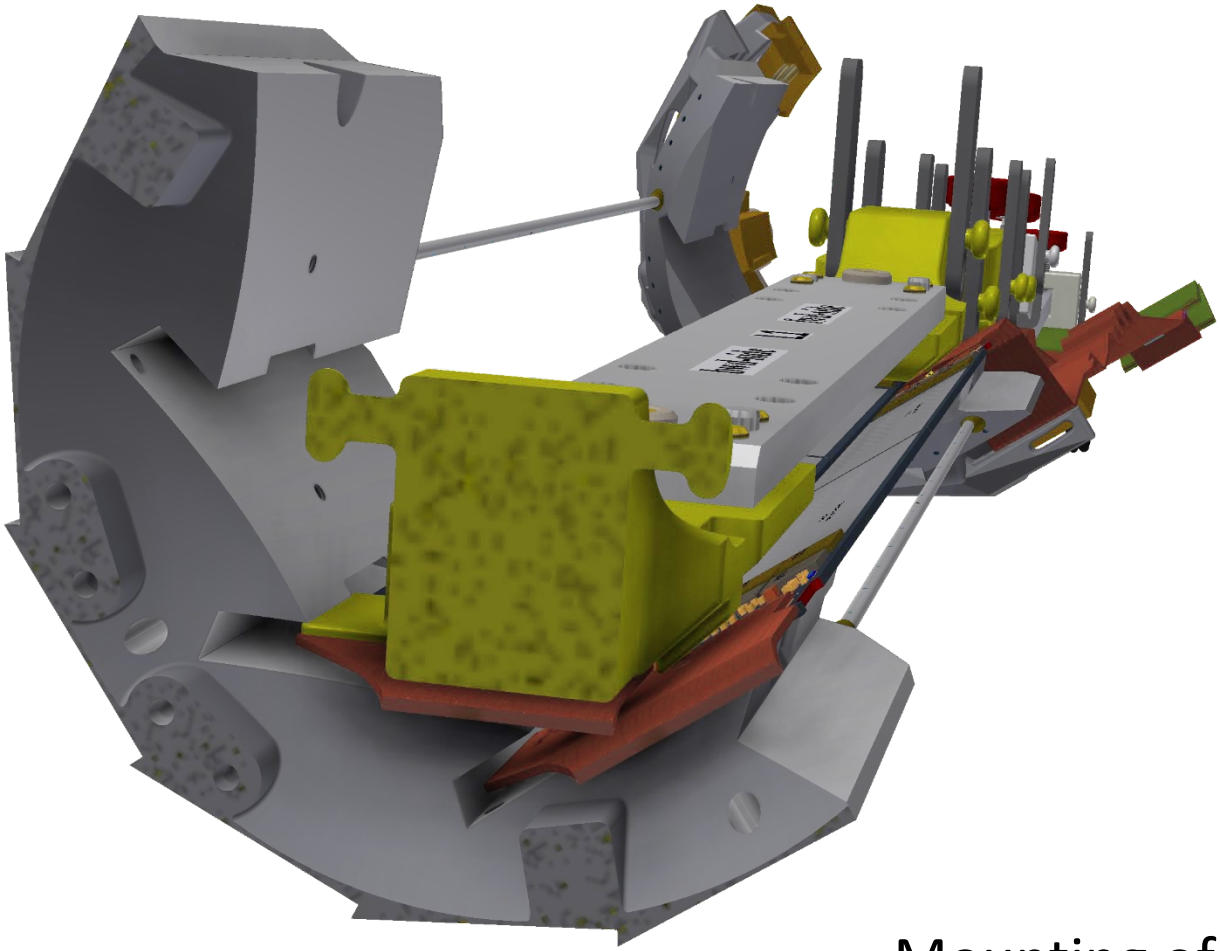
Mounting of Ladder 2

Ladder Mounting: Layer 1



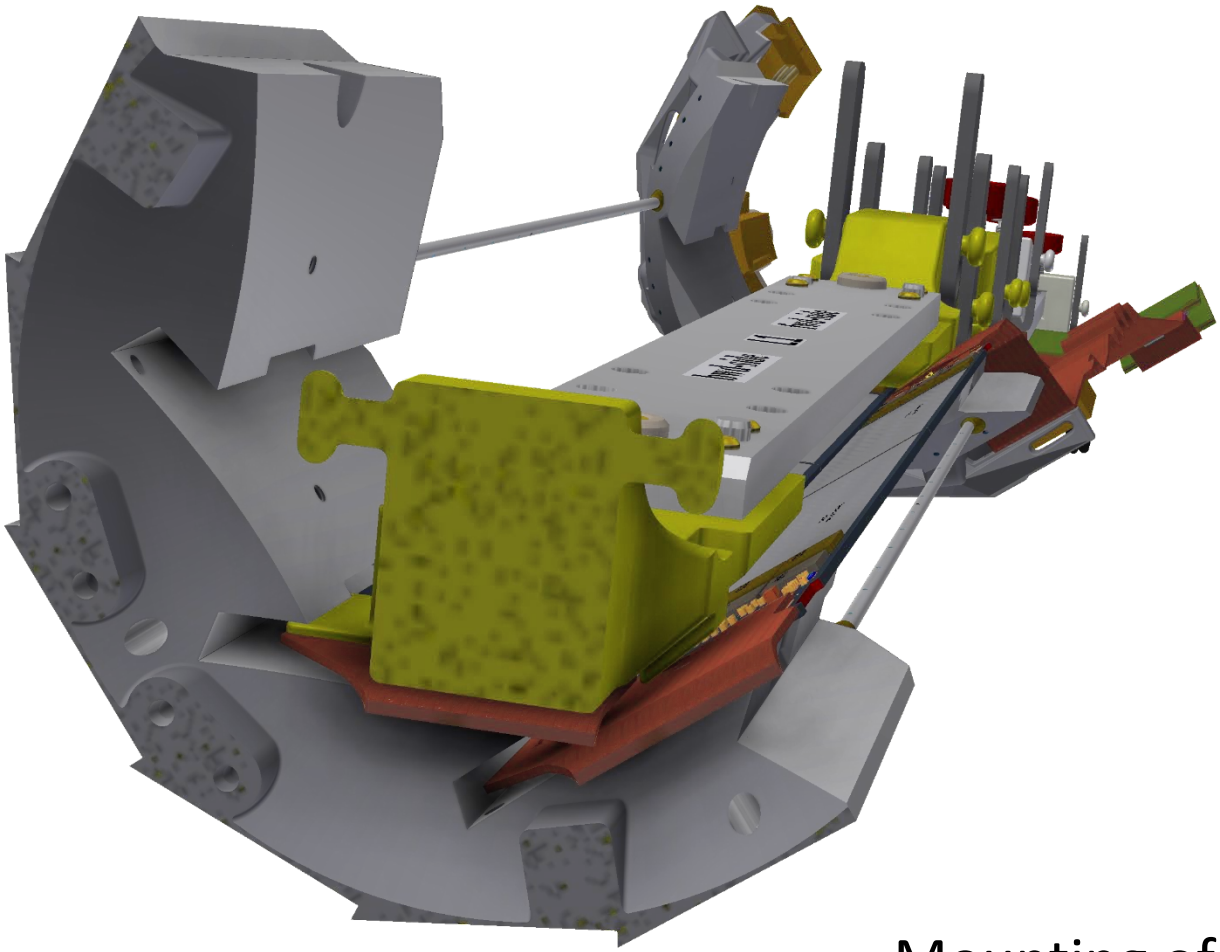
Mounting of Ladder 2

Ladder Mounting: Layer 1



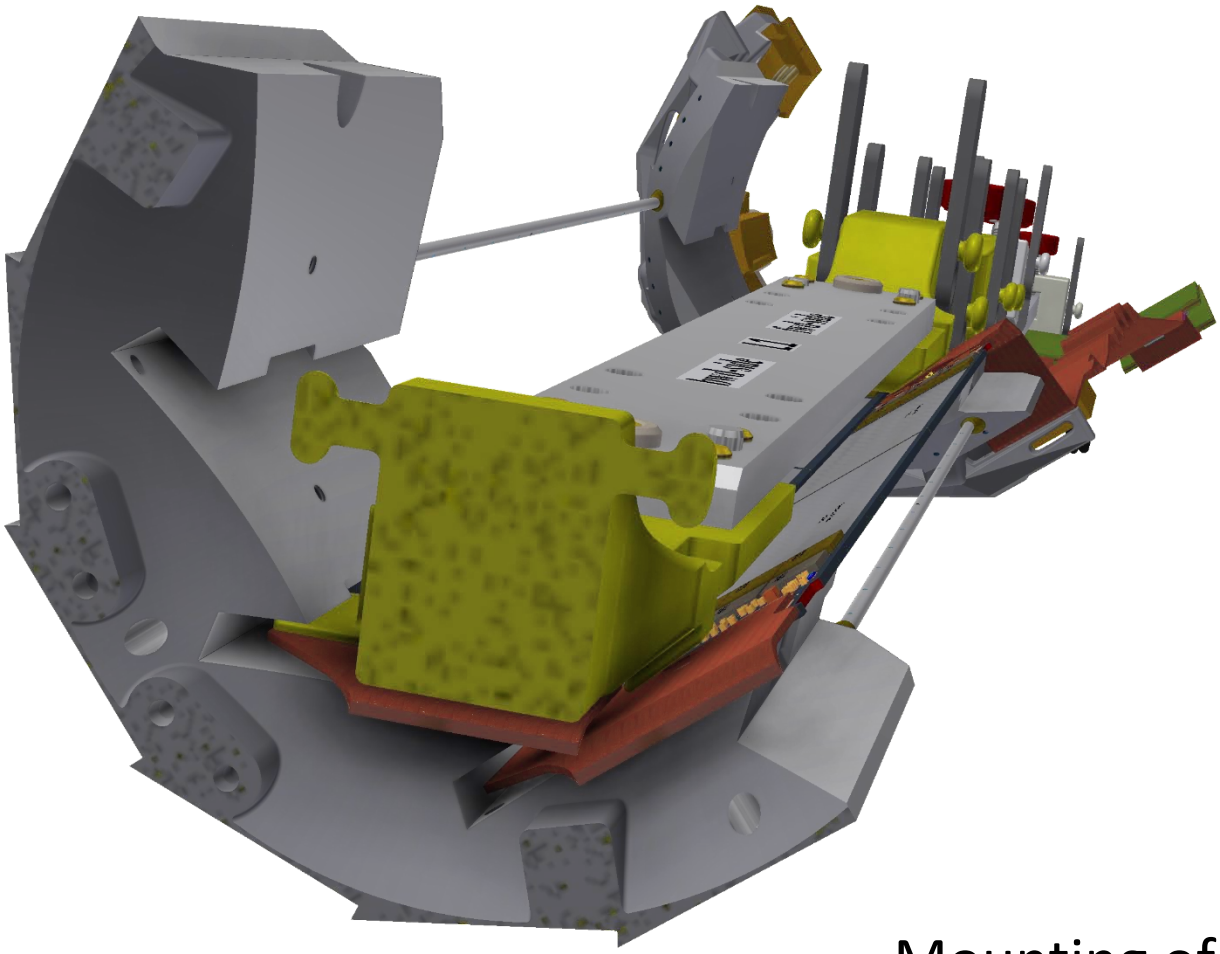
Mounting of Ladder 2

Ladder Mounting: Layer 1



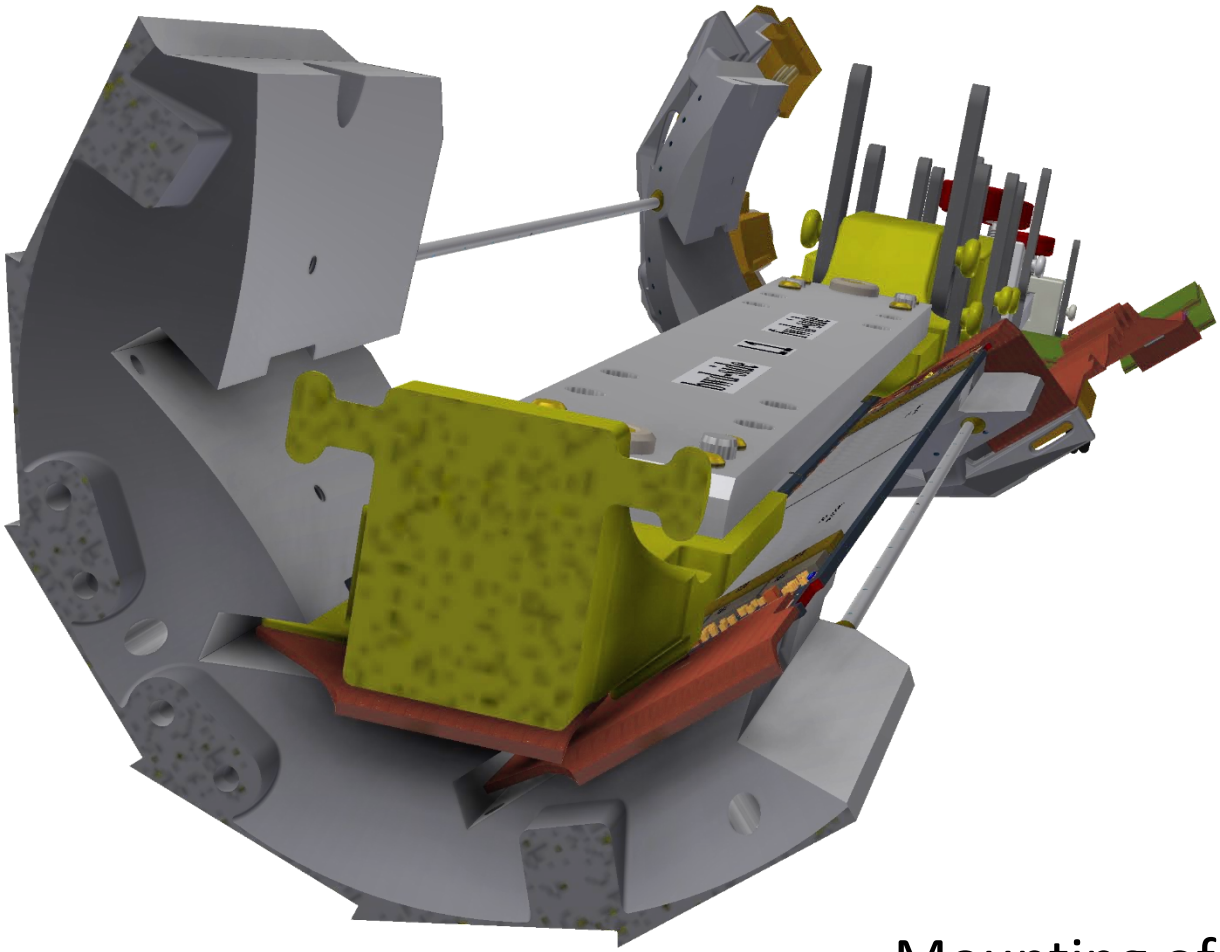
Mounting of Ladder 2

Ladder Mounting: Layer 1



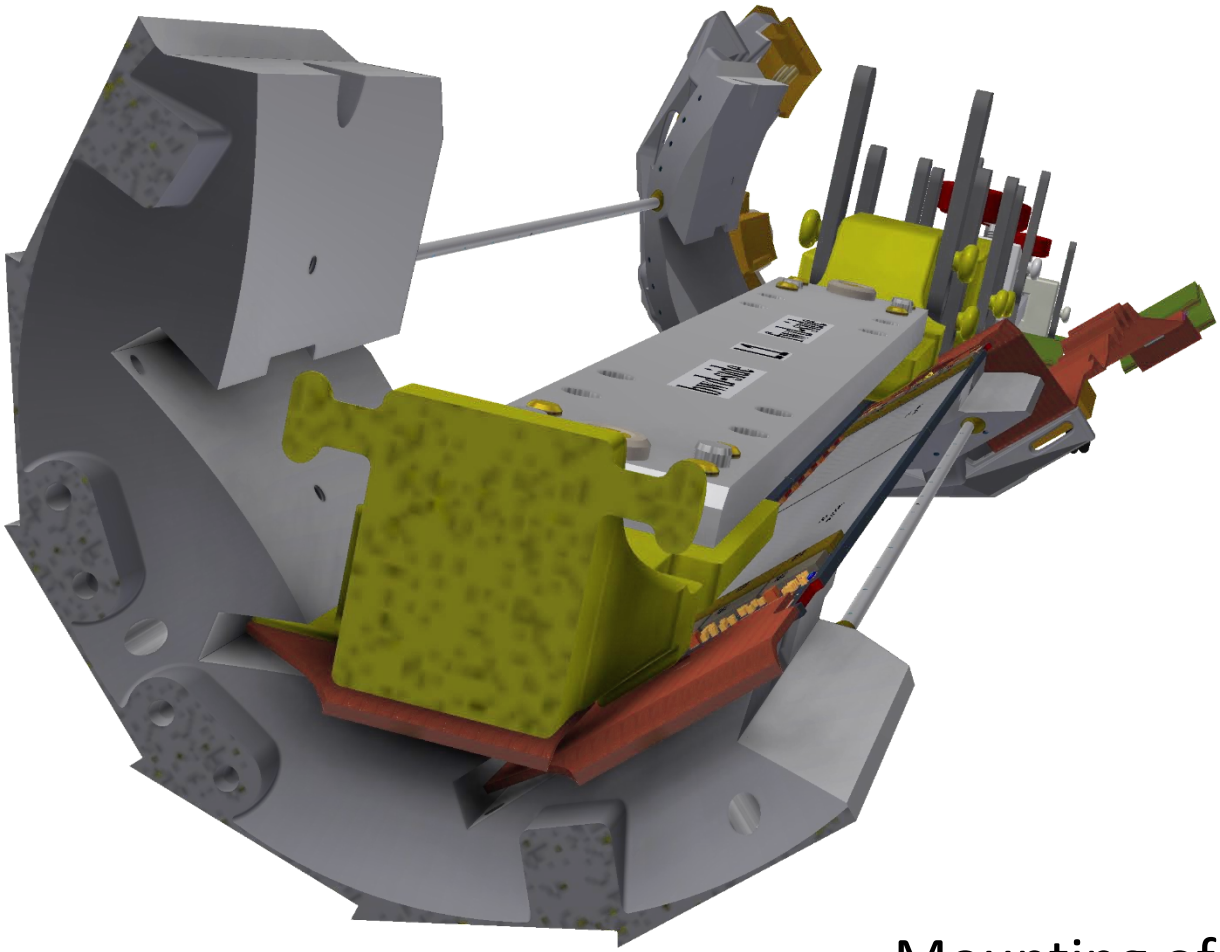
Mounting of Ladder 2

Ladder Mounting: Layer 1



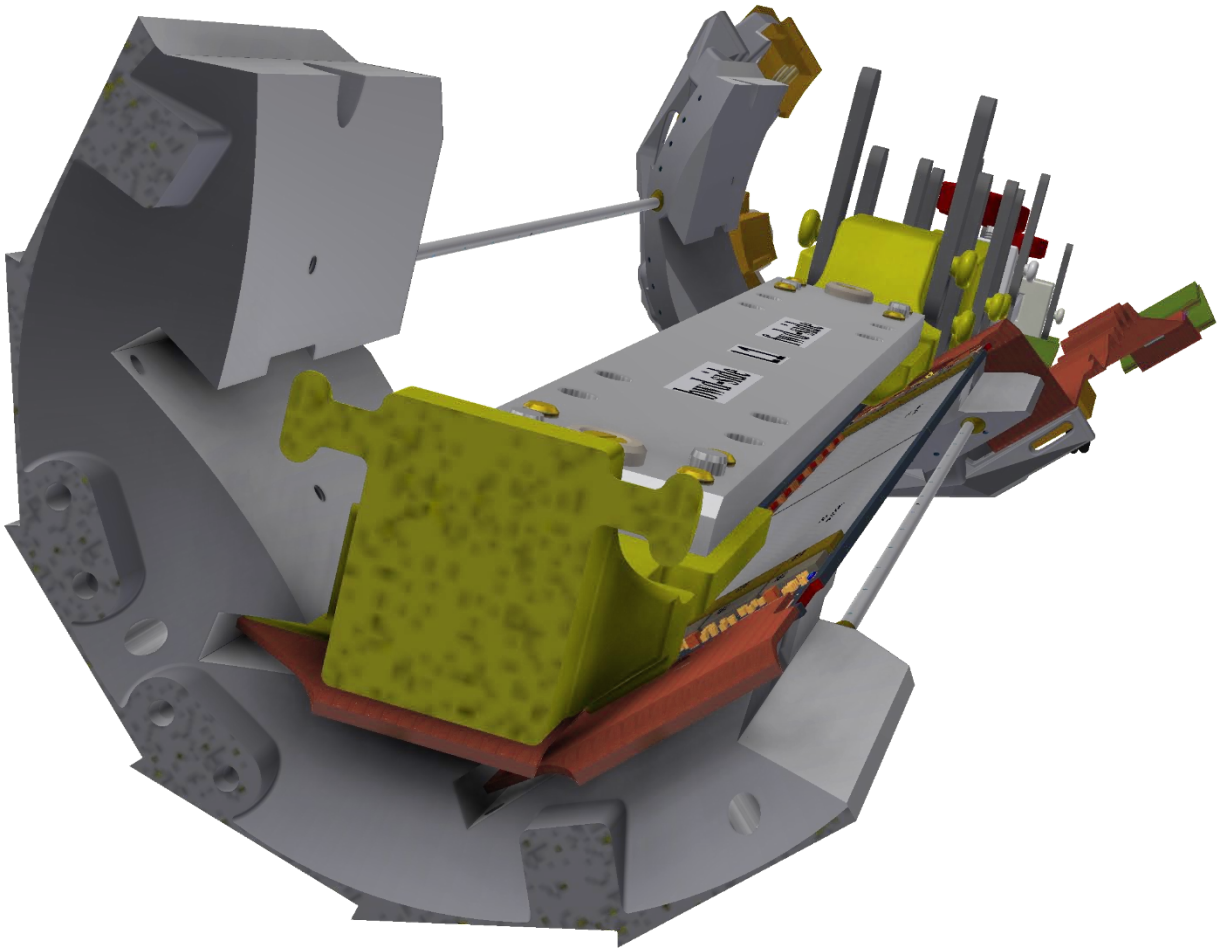
Mounting of Ladder 2

Ladder Mounting: Layer 1



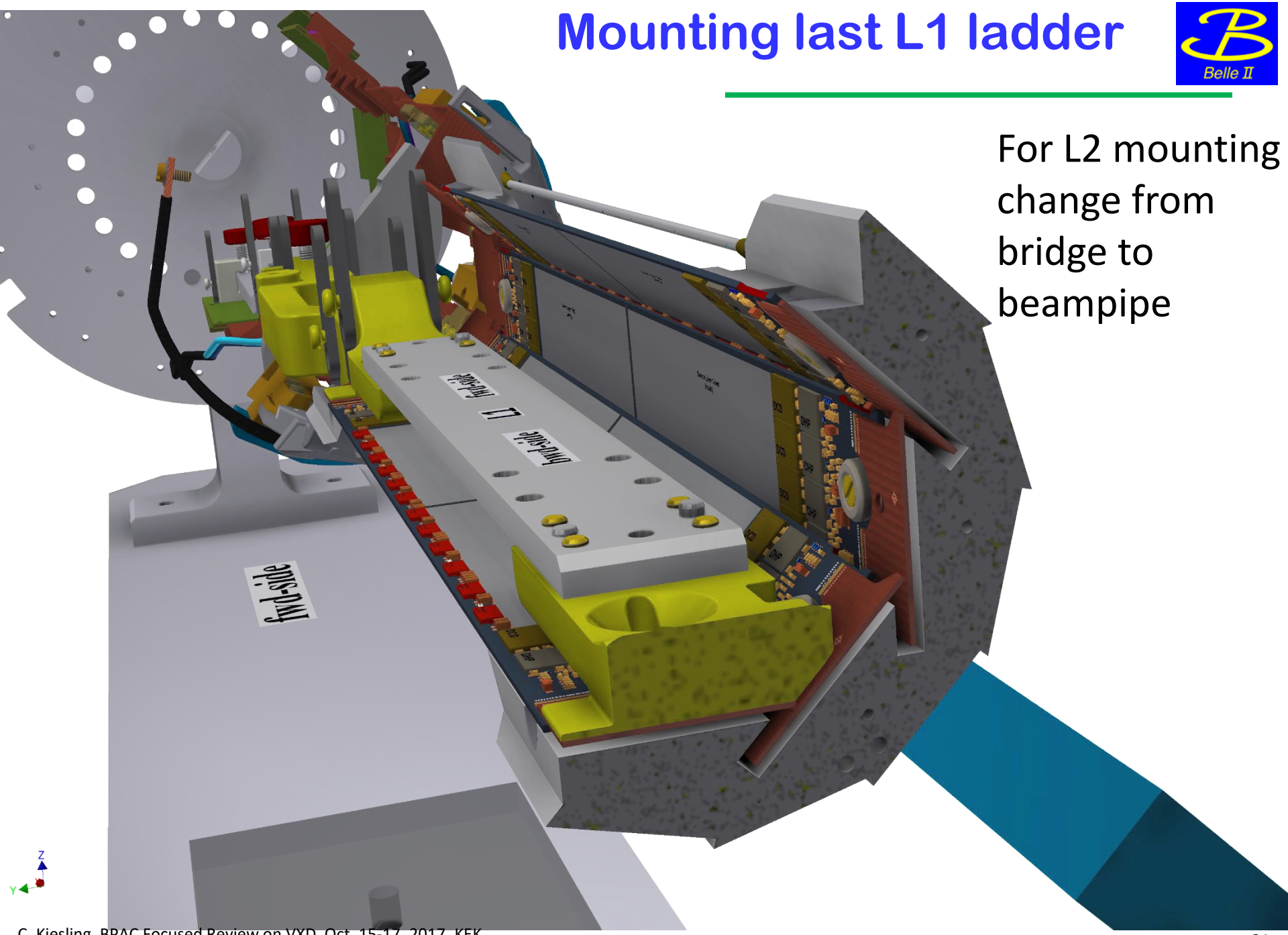
Mounting of Ladder 2

Ladder Mounting: Layer 1



Mounting of Ladder 2, final position.
Next: fix screws, remove jig

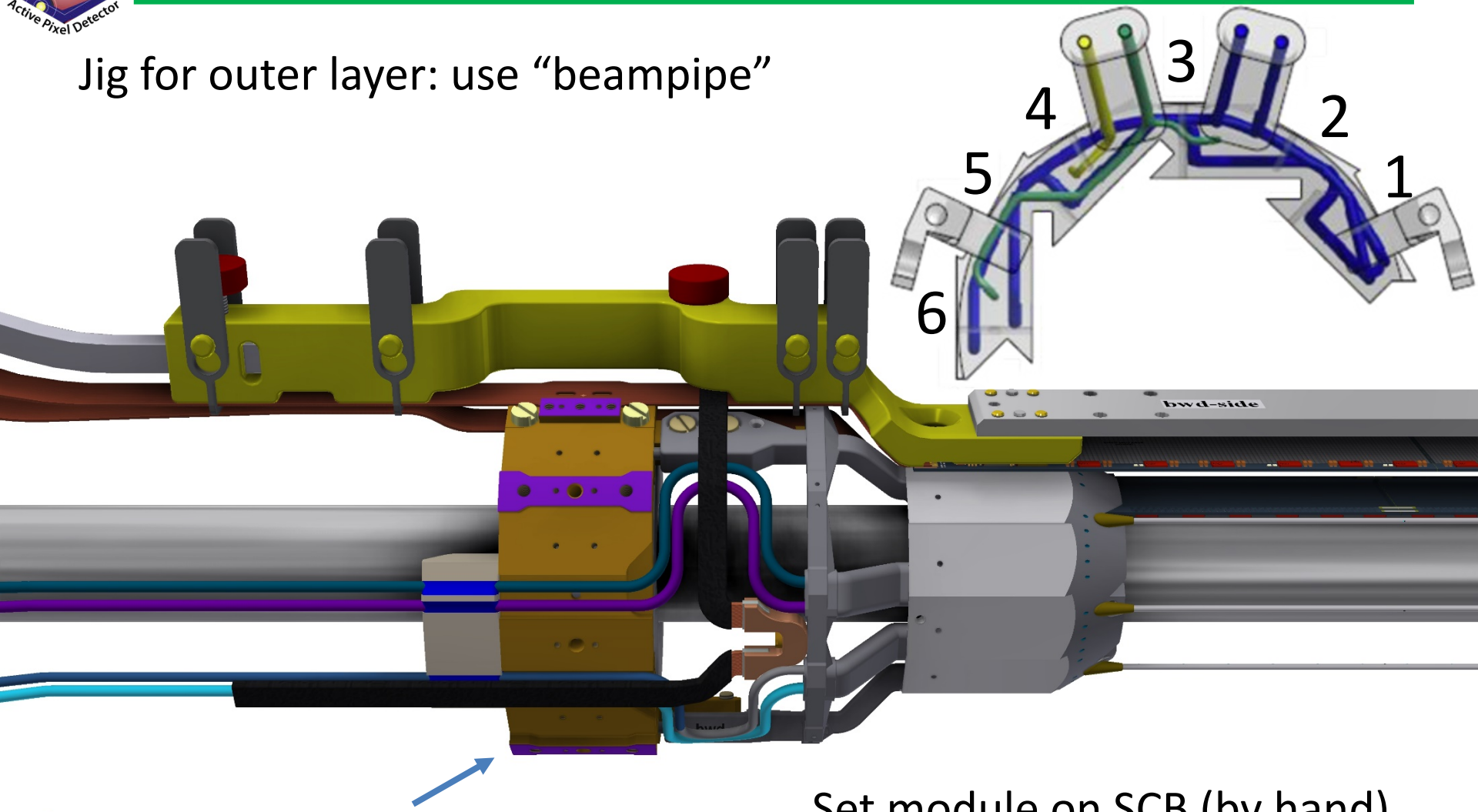
Mounting last L1 ladder



For L2 mounting change from bridge to beampipe

Mount Outer Ladders on Half Shell

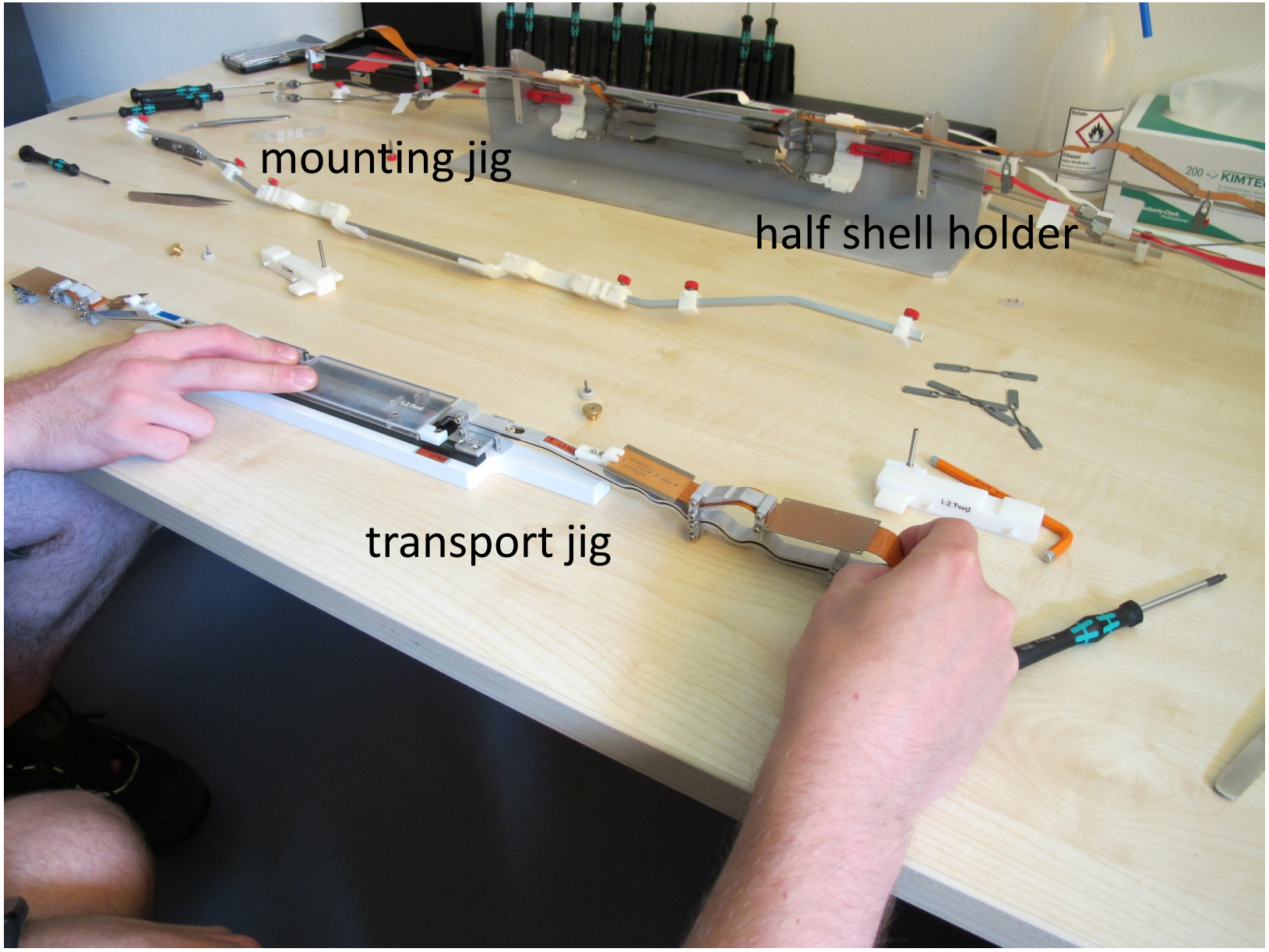
Jig for outer layer: use “beampipe”



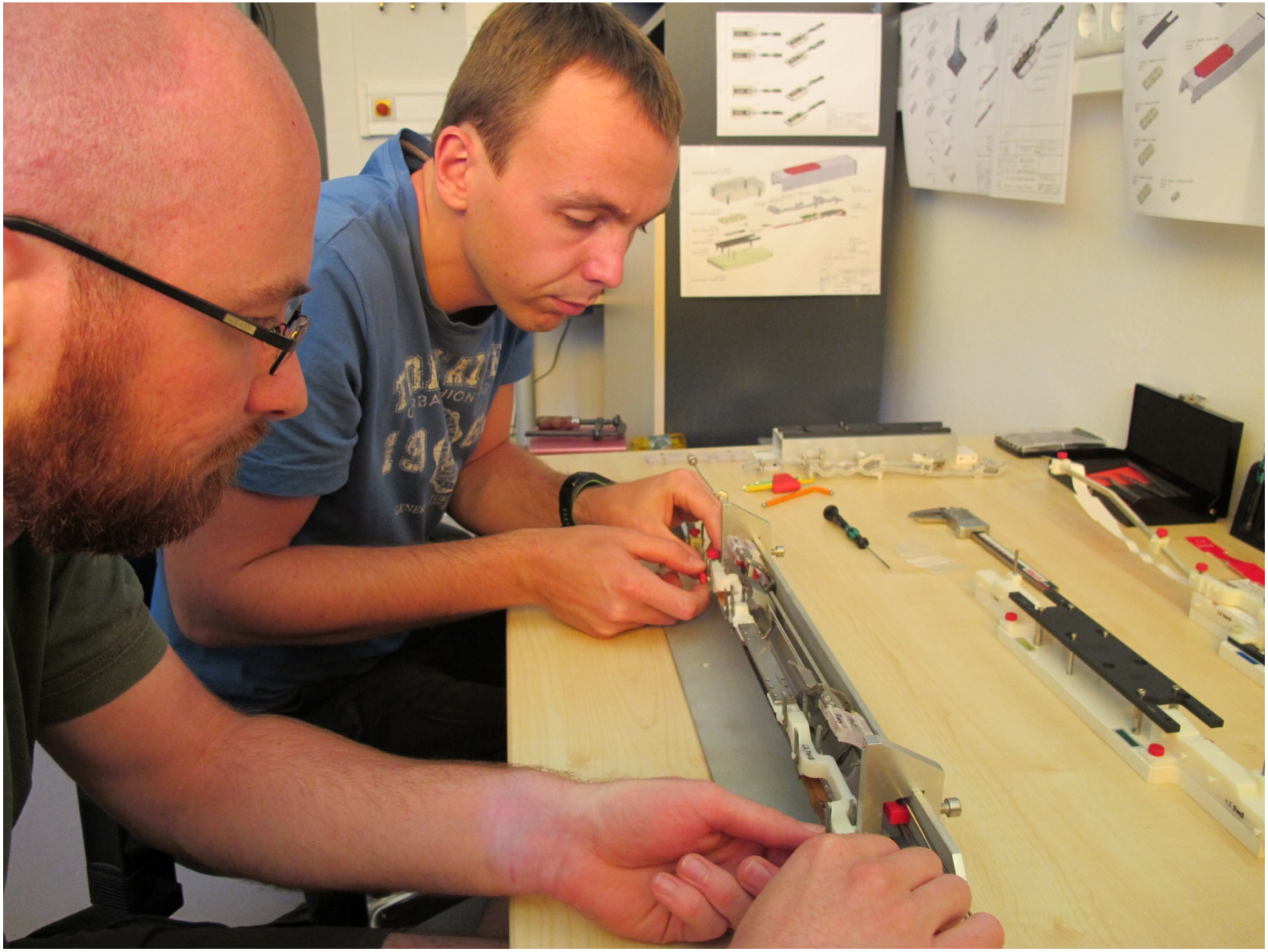
Half Shell support
(fixed on “mount block”)

Set module on SCB (by hand)
- Screw module to SCB
- Screw Kapton to SCB support

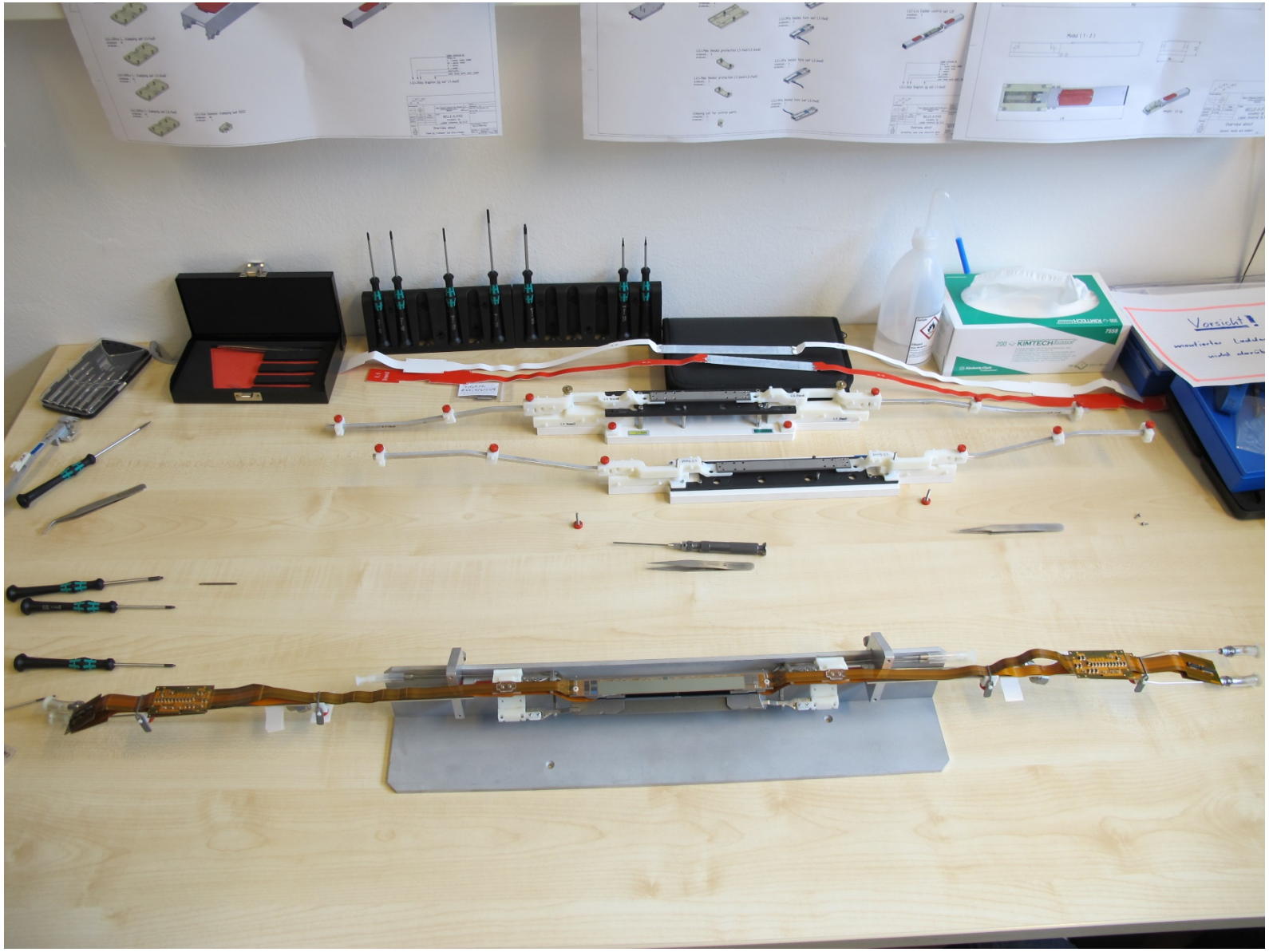
Ladder Mounting in Reality



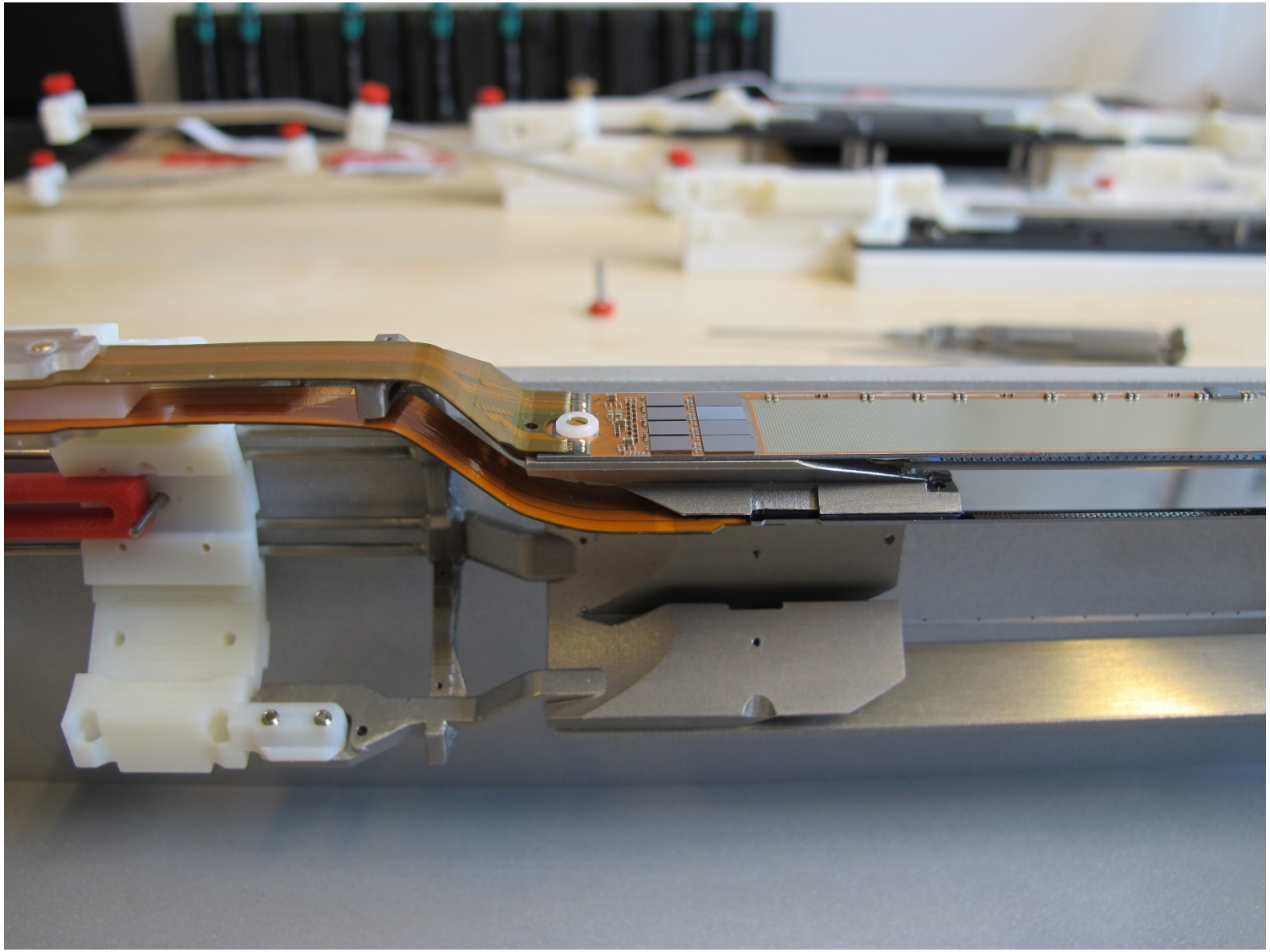
Installation of Ladder on SCB Half Shell



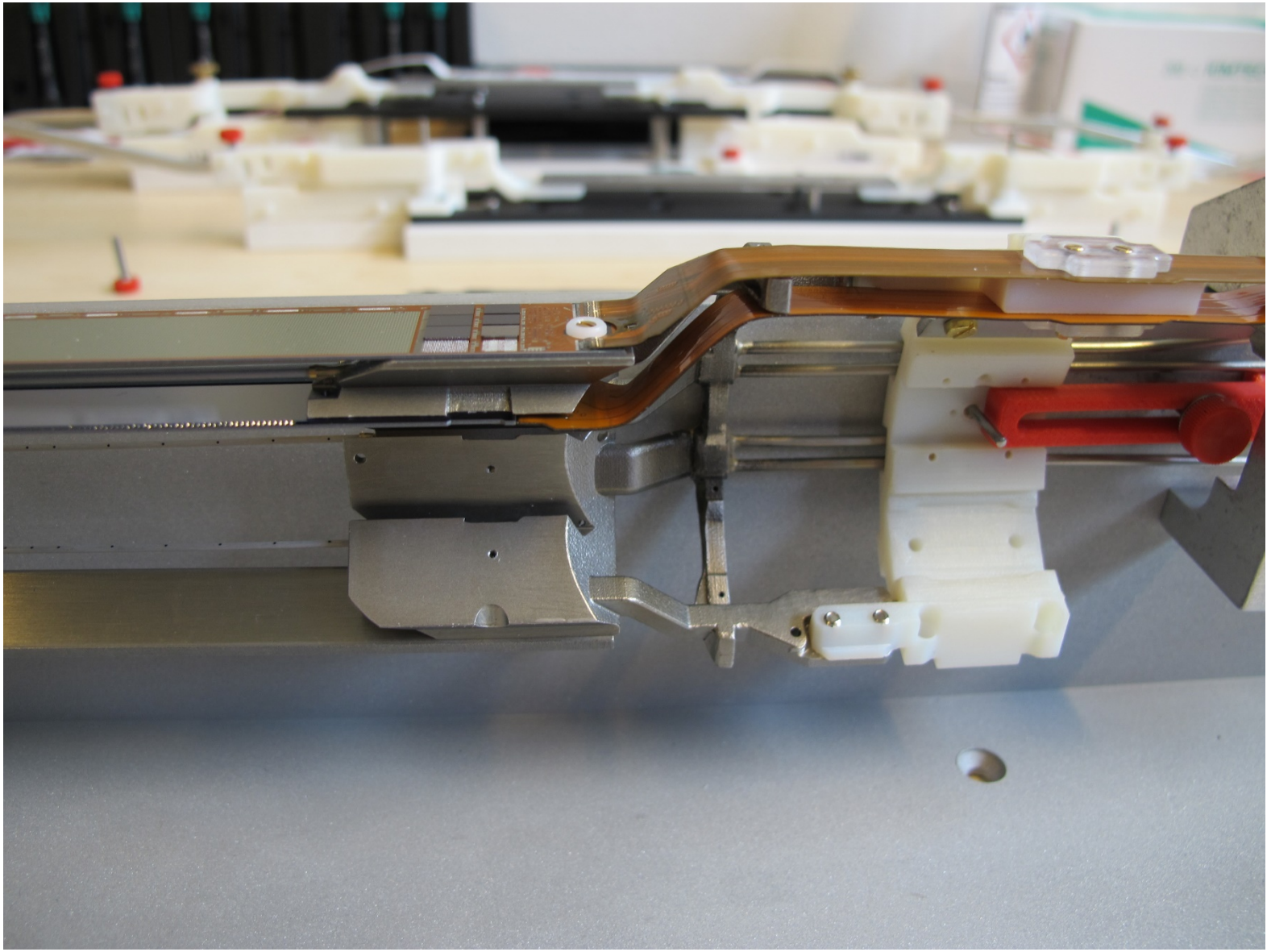
Fully Installed Ladders (Layers 1 and 2)



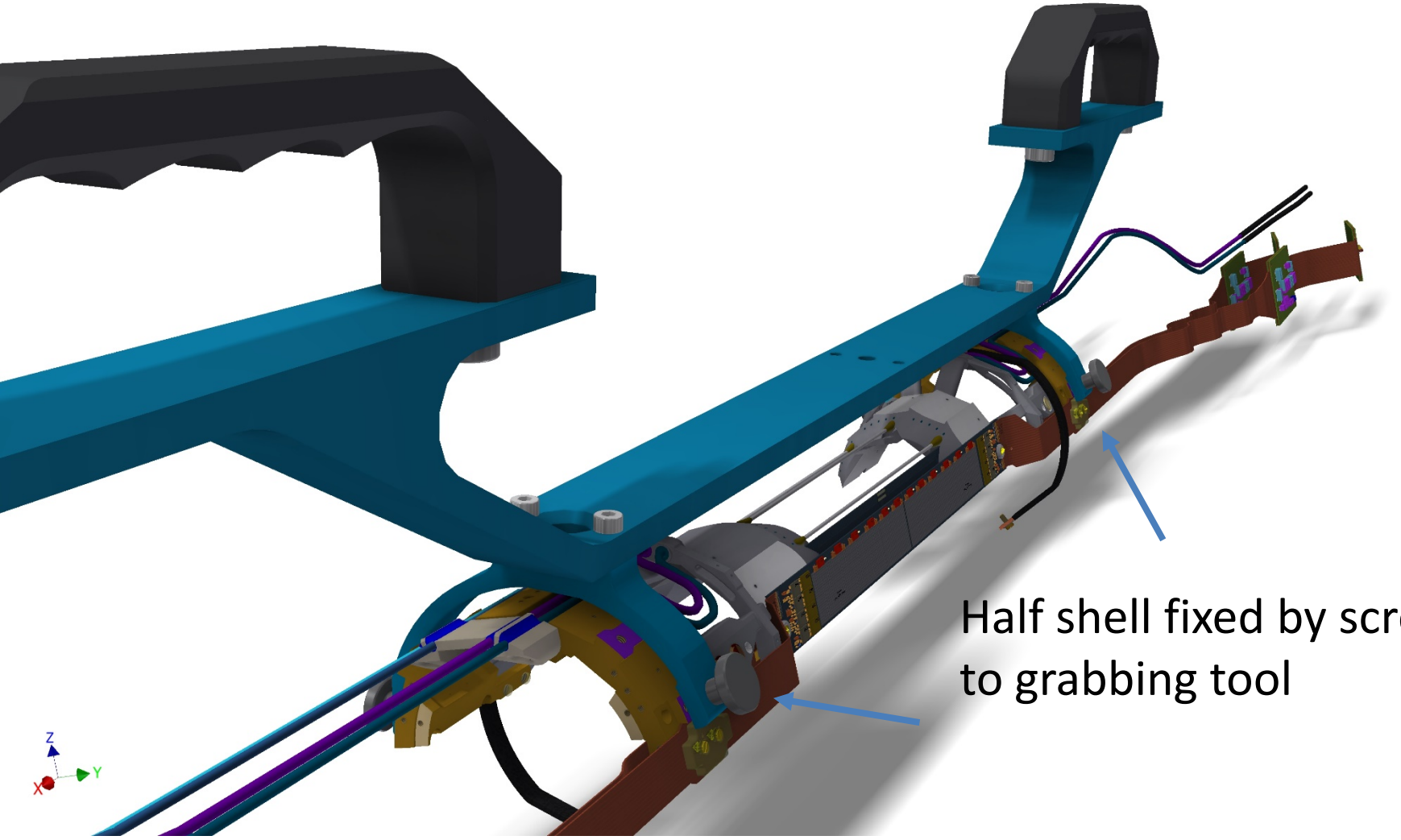
Fully Installed Ladders (FWD Side)



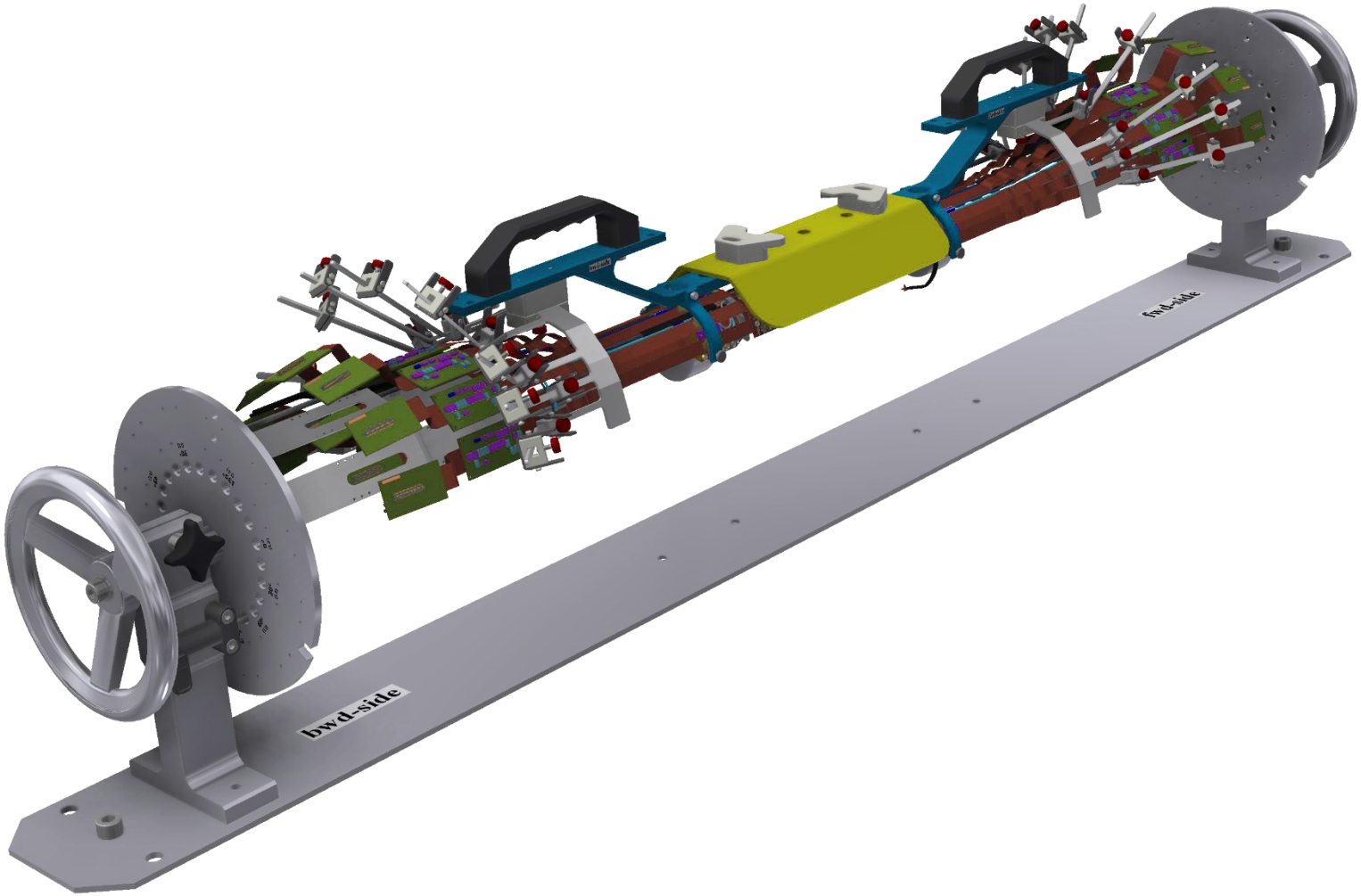
Fully Installed Ladders (BWD Side)



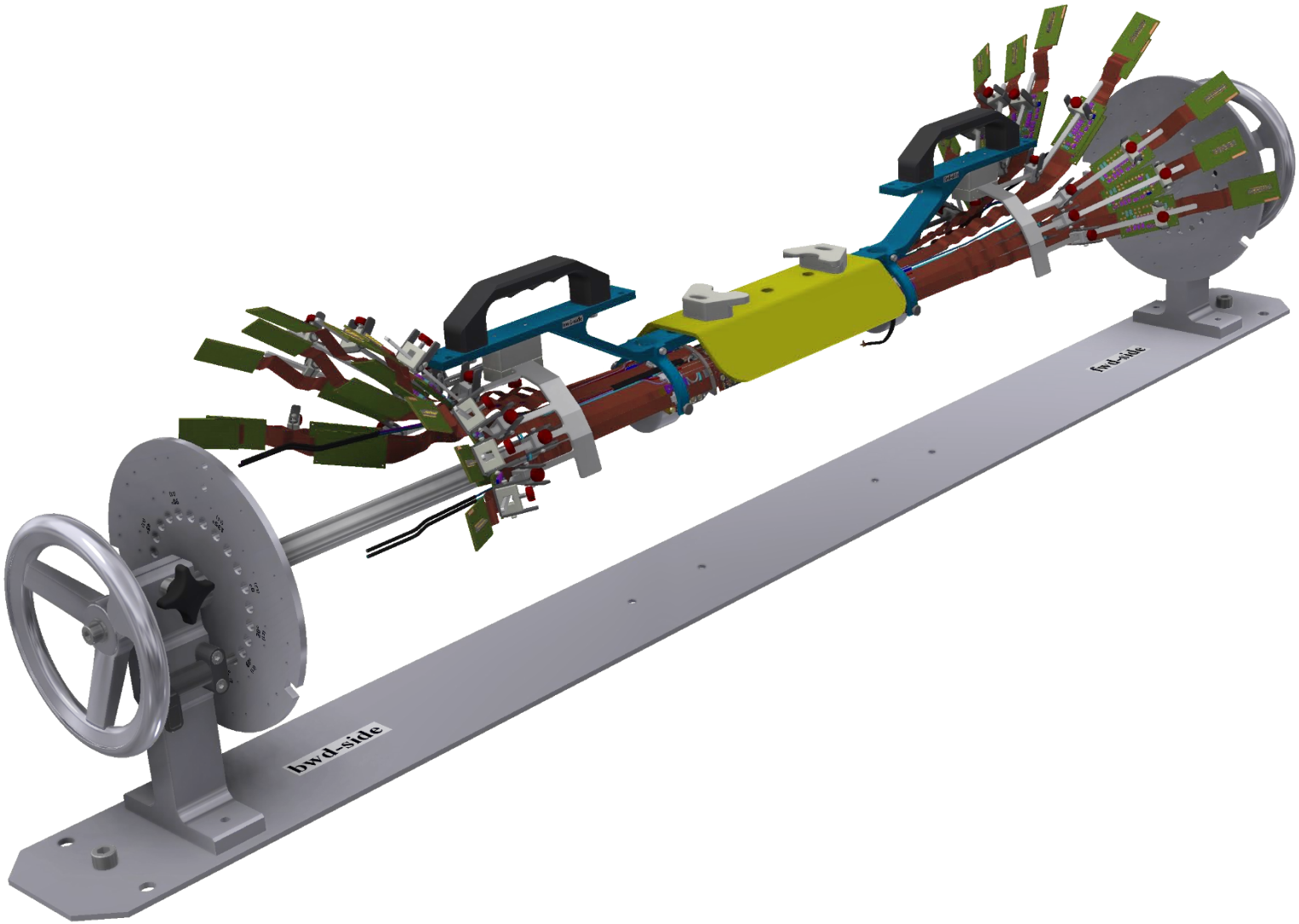
Half Shell Grabbing Tool



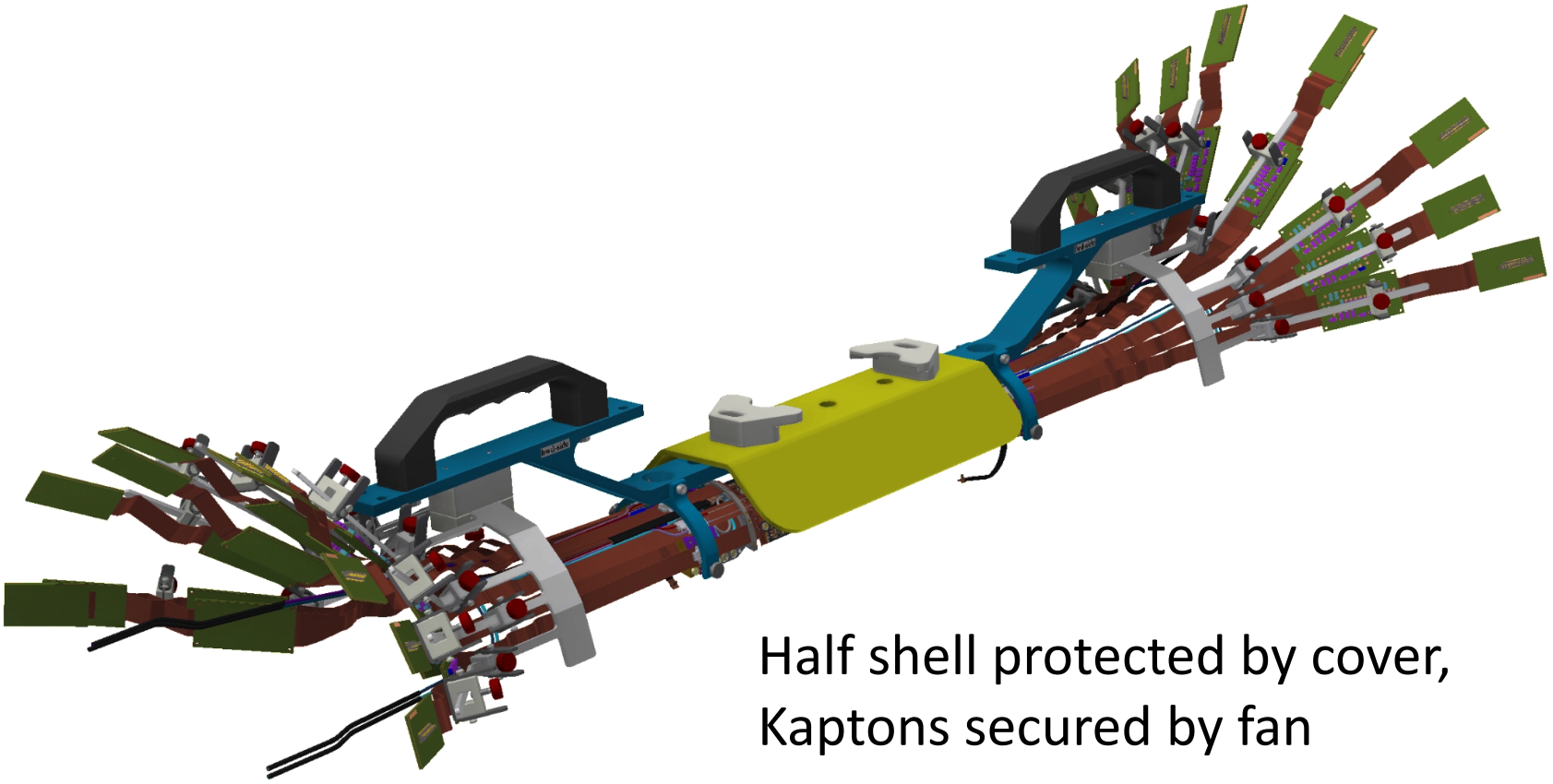
Half Shell Grabbing Tool



Half Shell Grabbing Tool



Half Shell Grabbing Tool



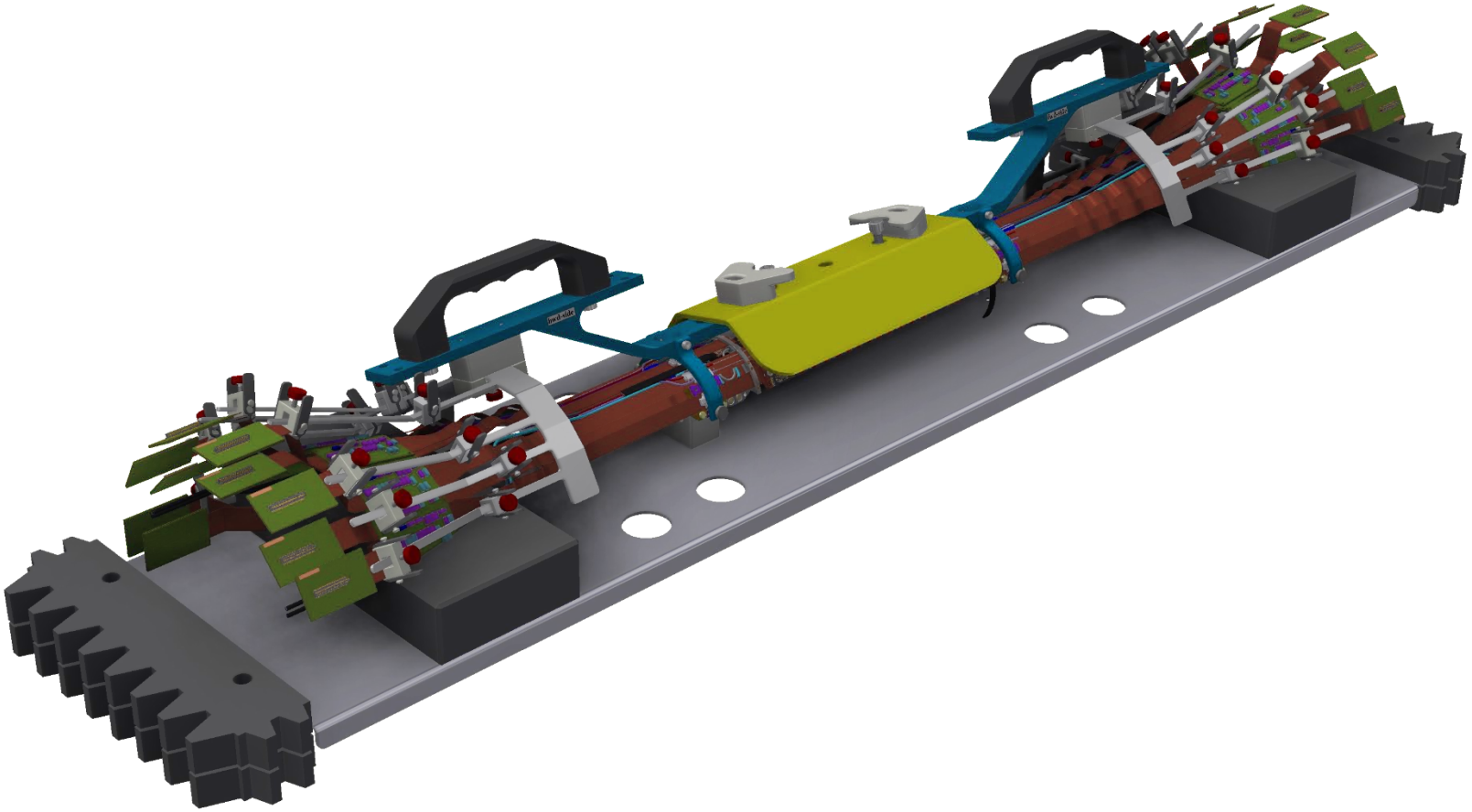
Half shell protected by cover,
Kaptons secured by fan

DEPFET

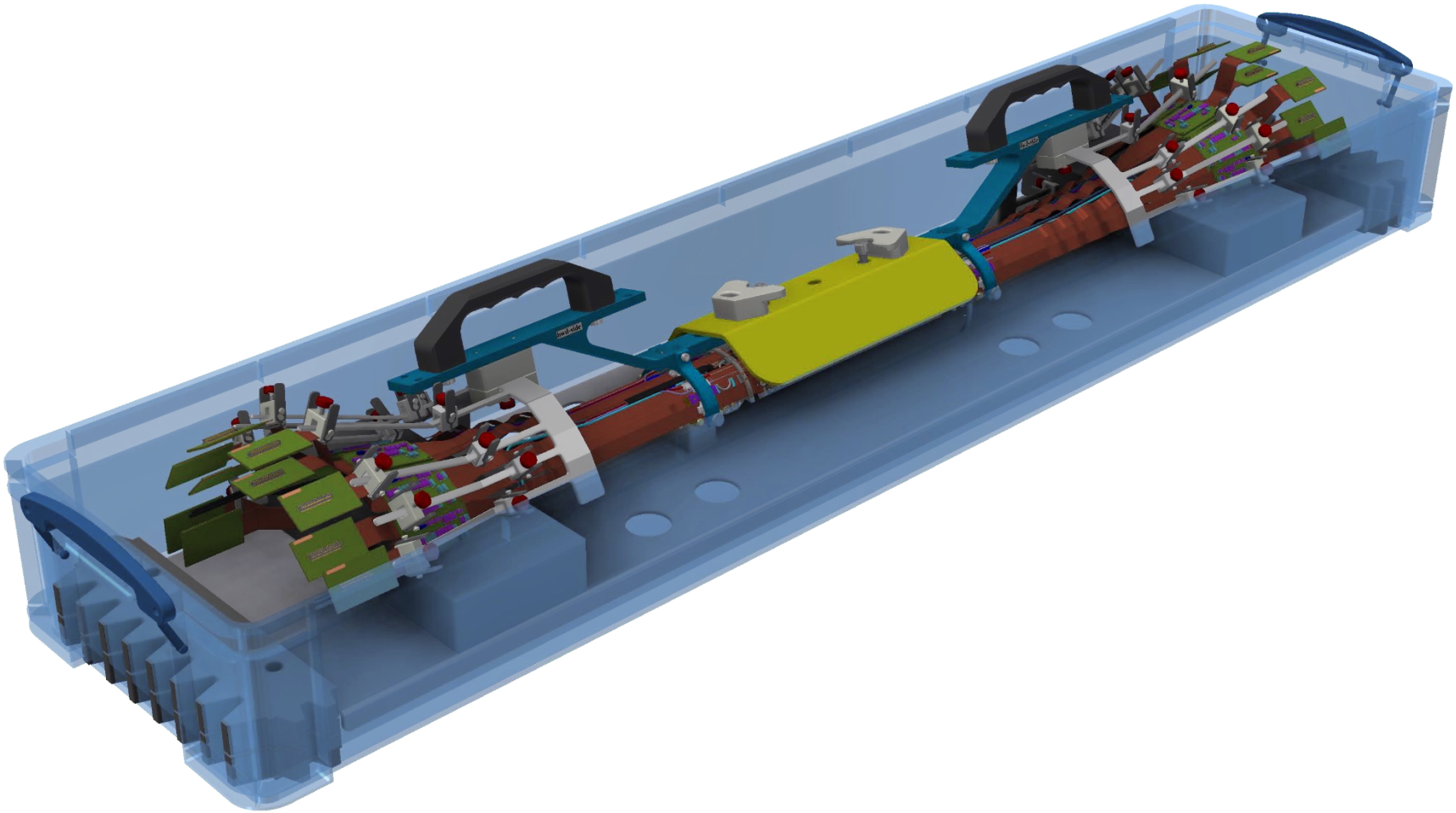
Active Pixel Detector

Half Shell Securing and Transport

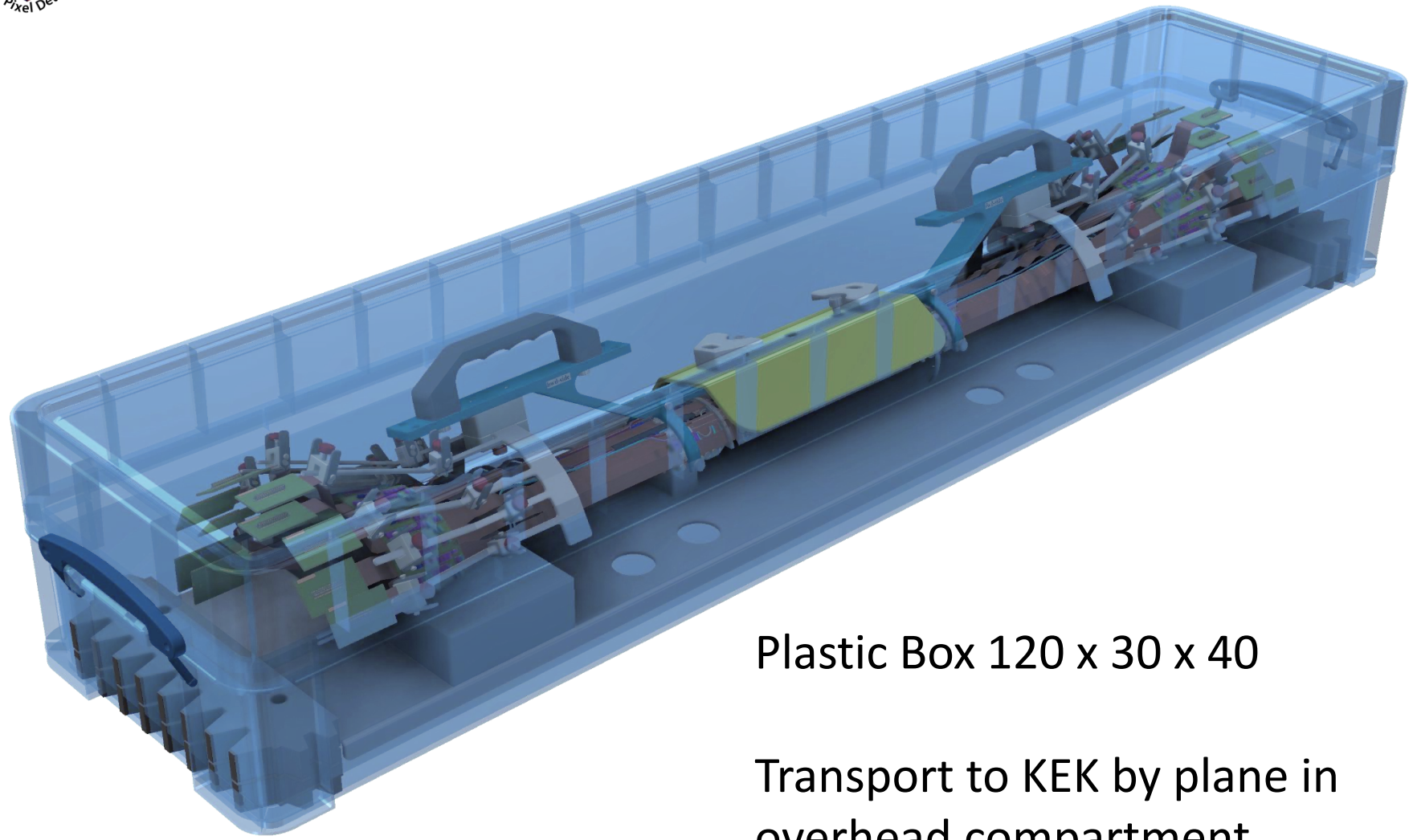
Belle II



Half Shell Securing and Transport



Half Shell Securing and Transport

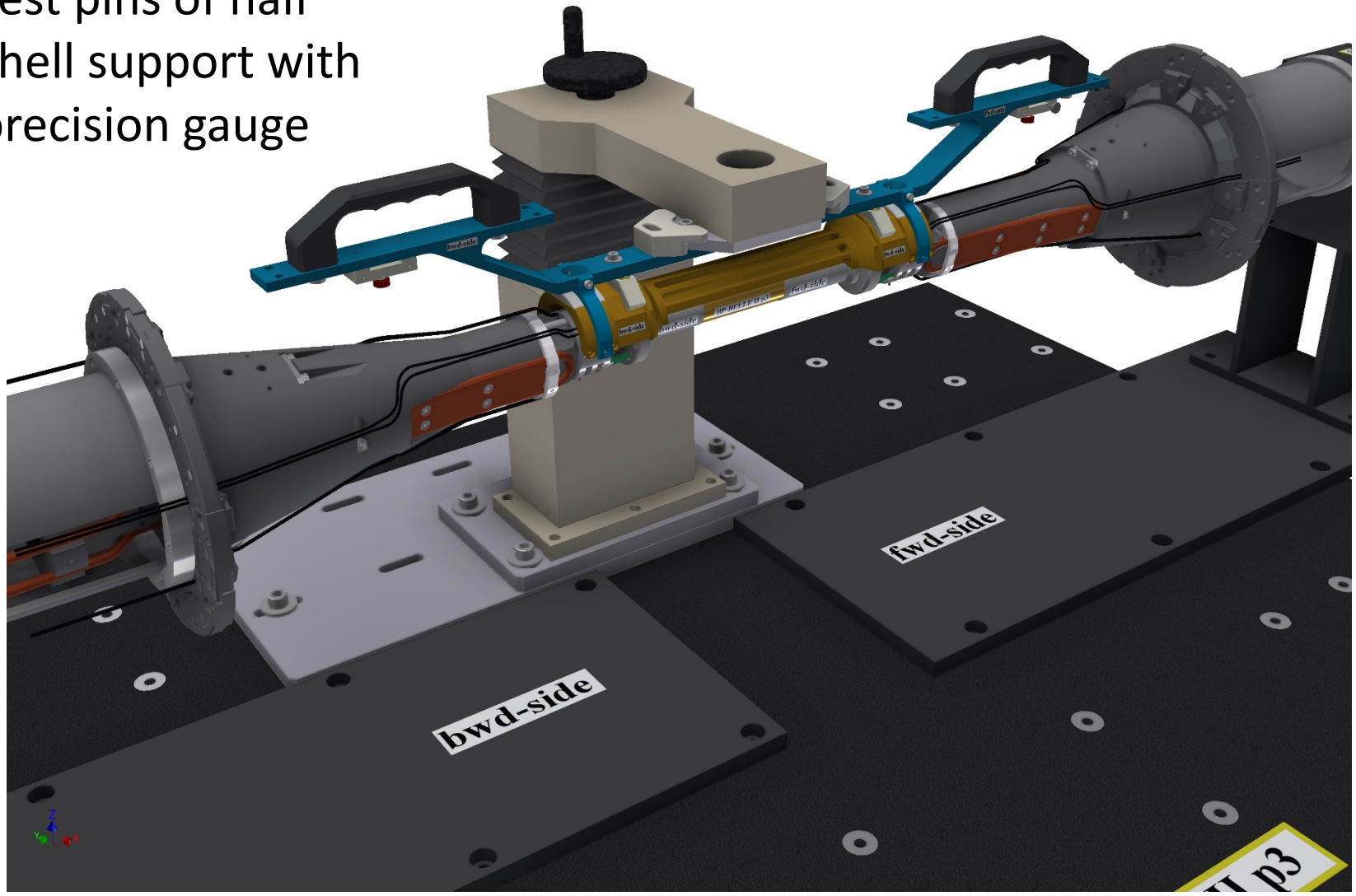


Plastic Box 120 x 30 x 40

Transport to KEK by plane in overhead compartment

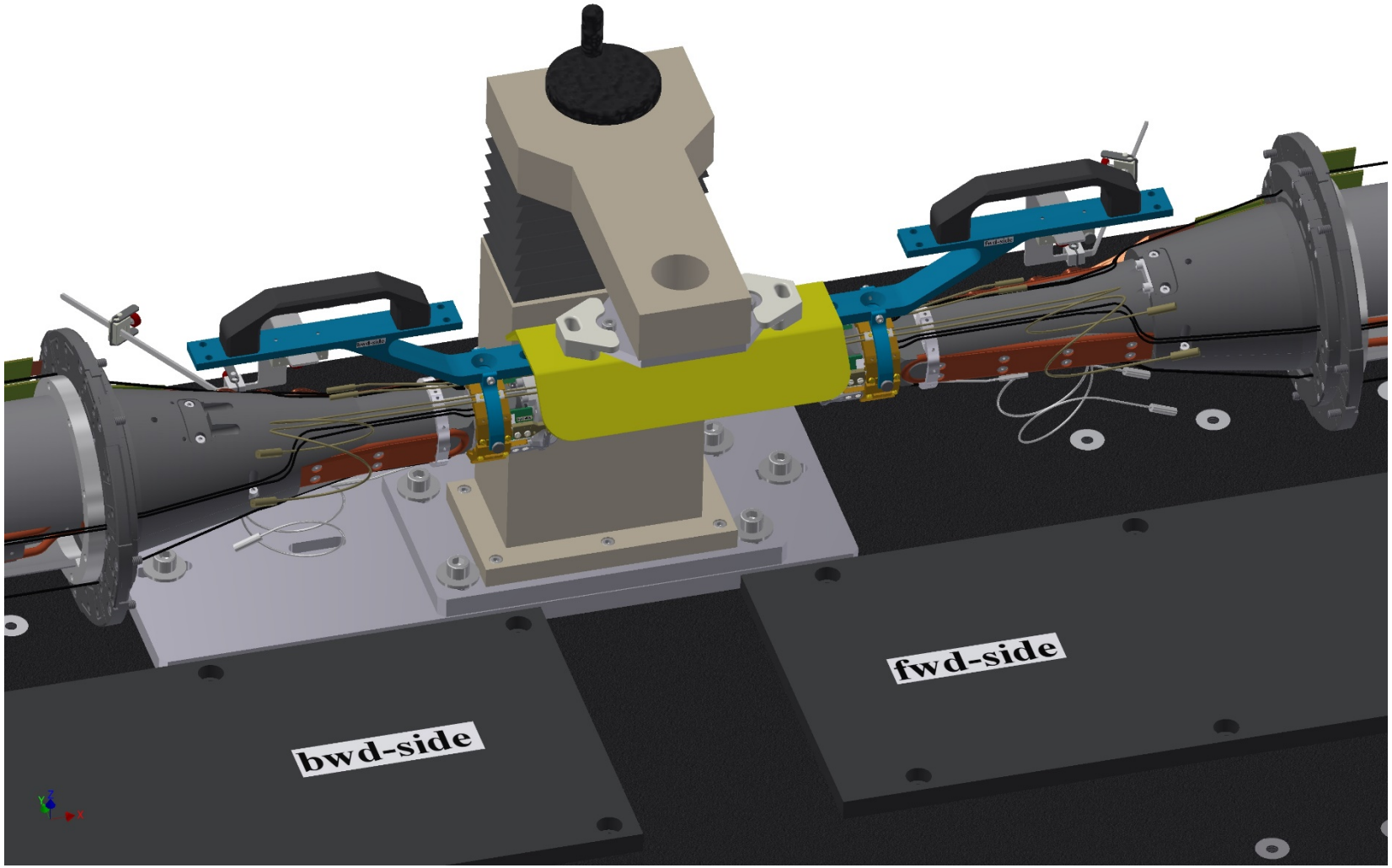
Half Shell Mounting Tool

Test pins of half shell support with precision gauge

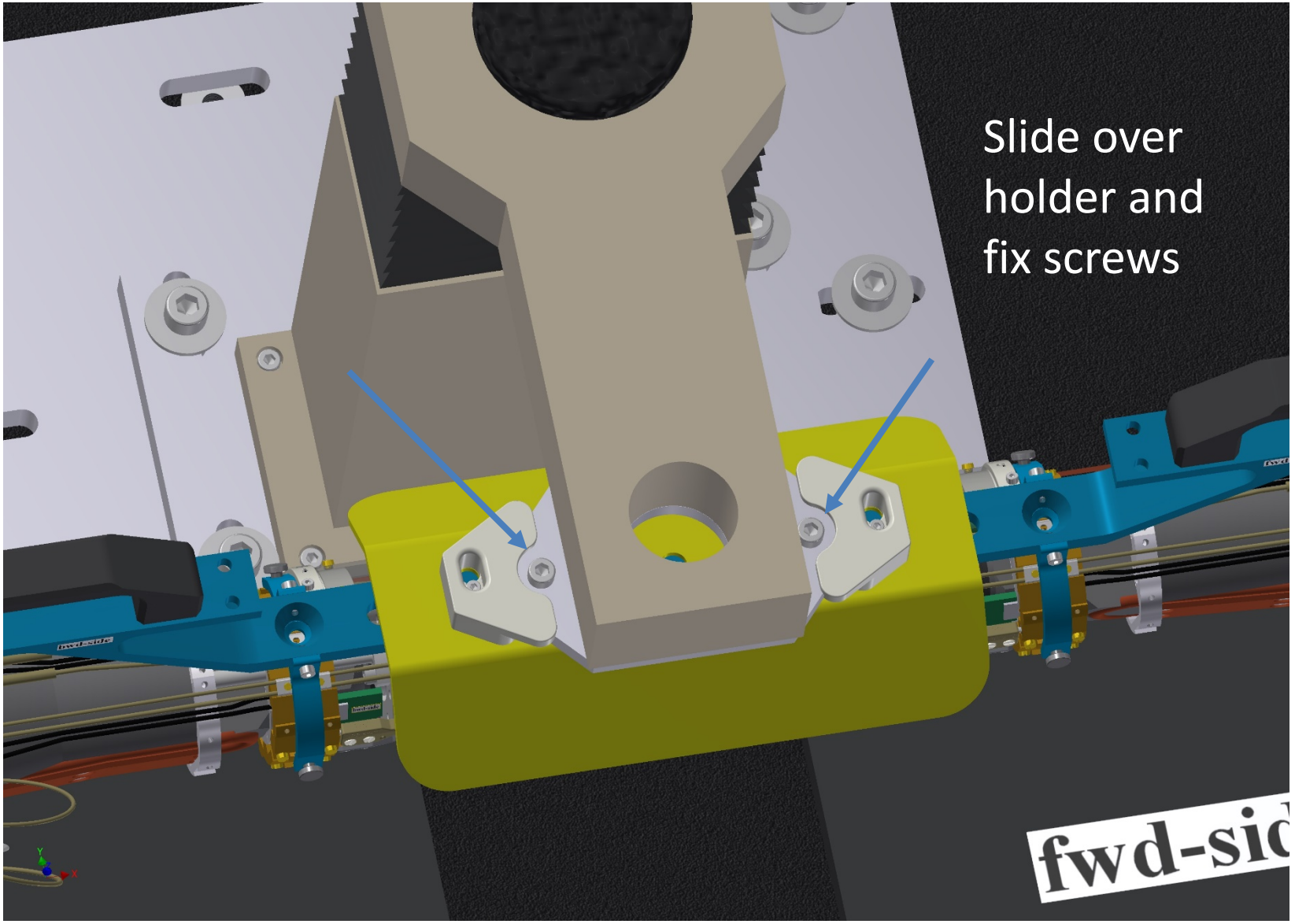


Half Shell Mounting

Bring half shell by grabbing tool to lowering stage

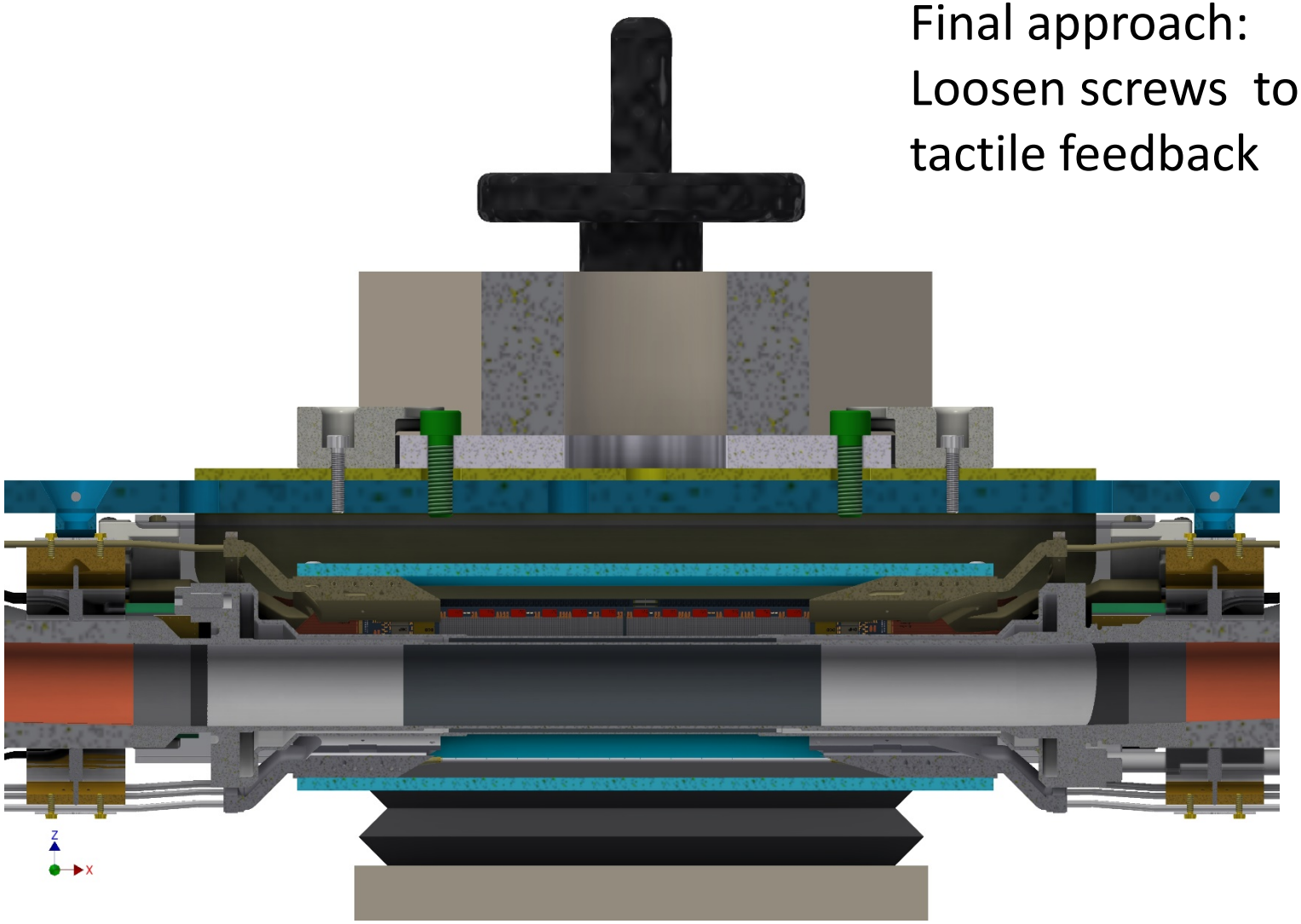


Half Shell Mounting



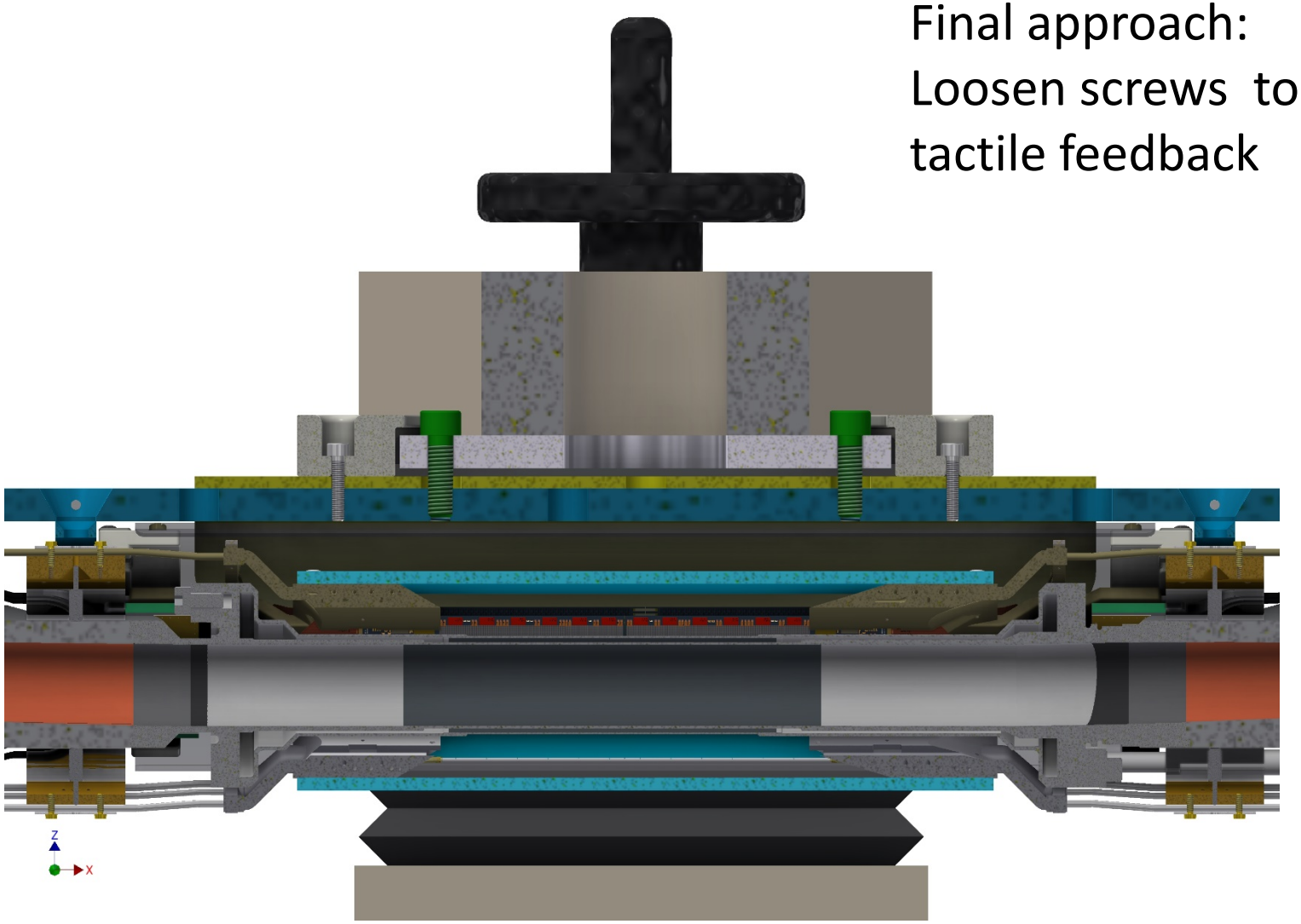
Half Shell Mounting

Final approach:
Loosen screws to get tactile feedback

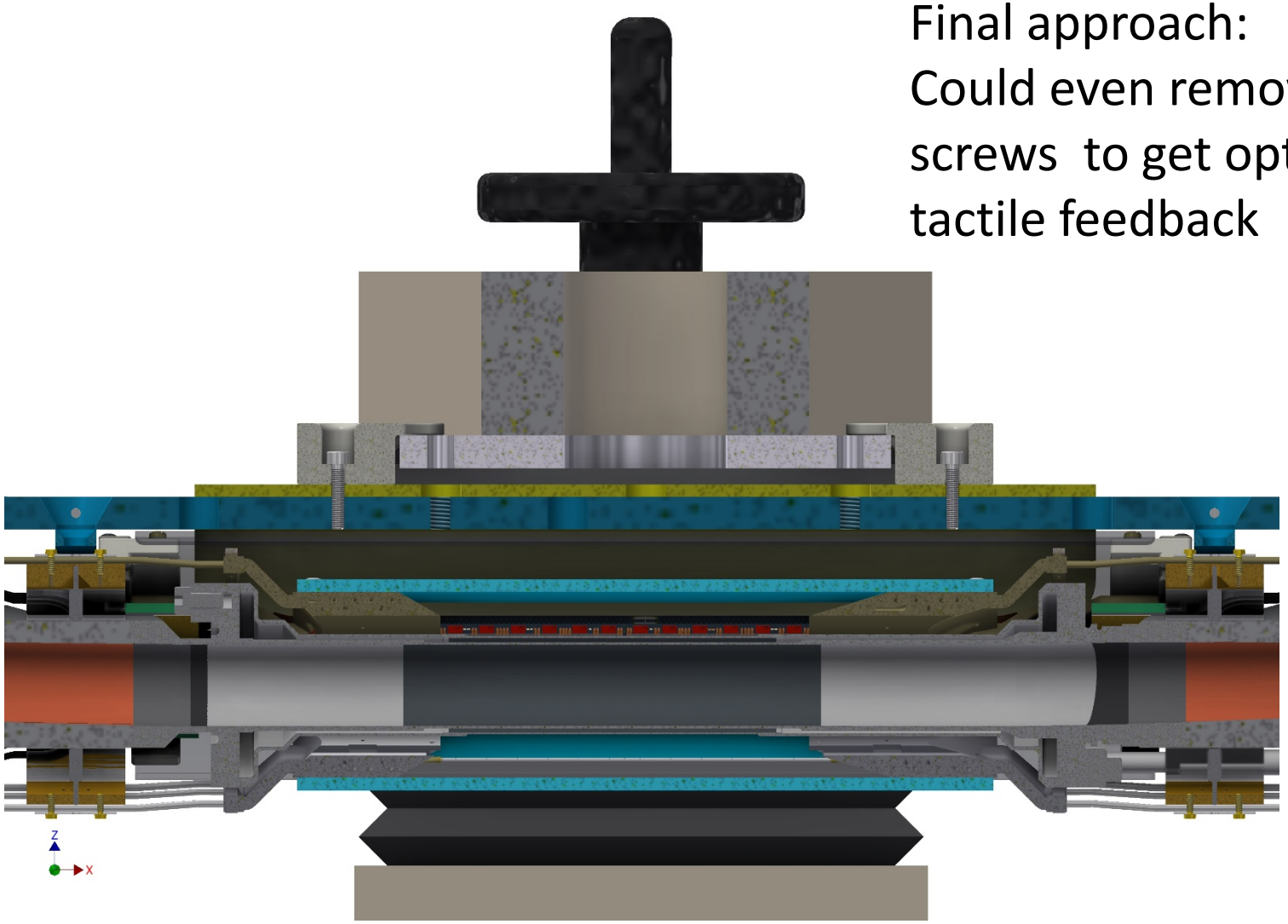


Half Shell Mounting

Final approach:
Loosen screws to get tactile feedback

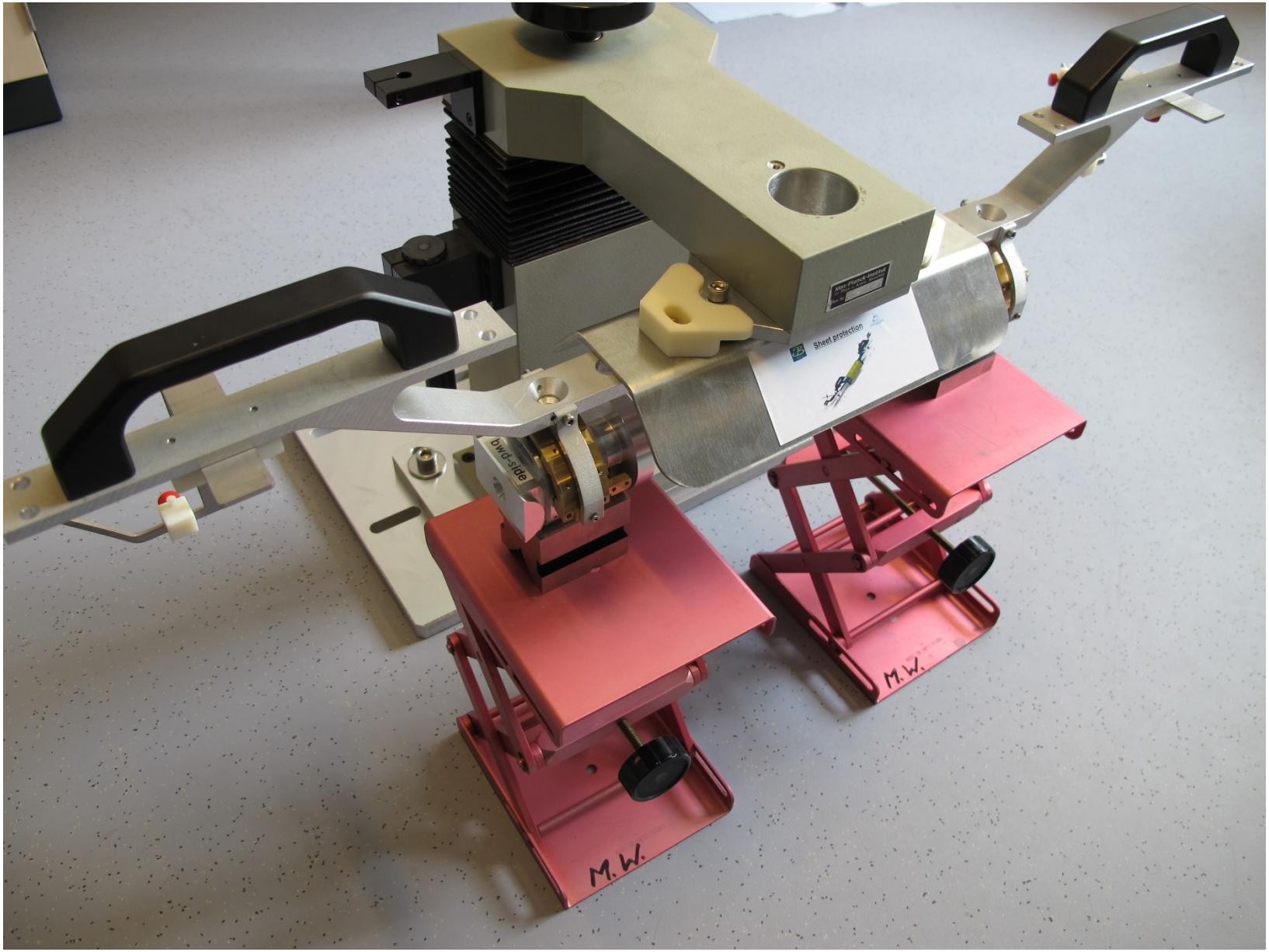


Half Shell Mounting

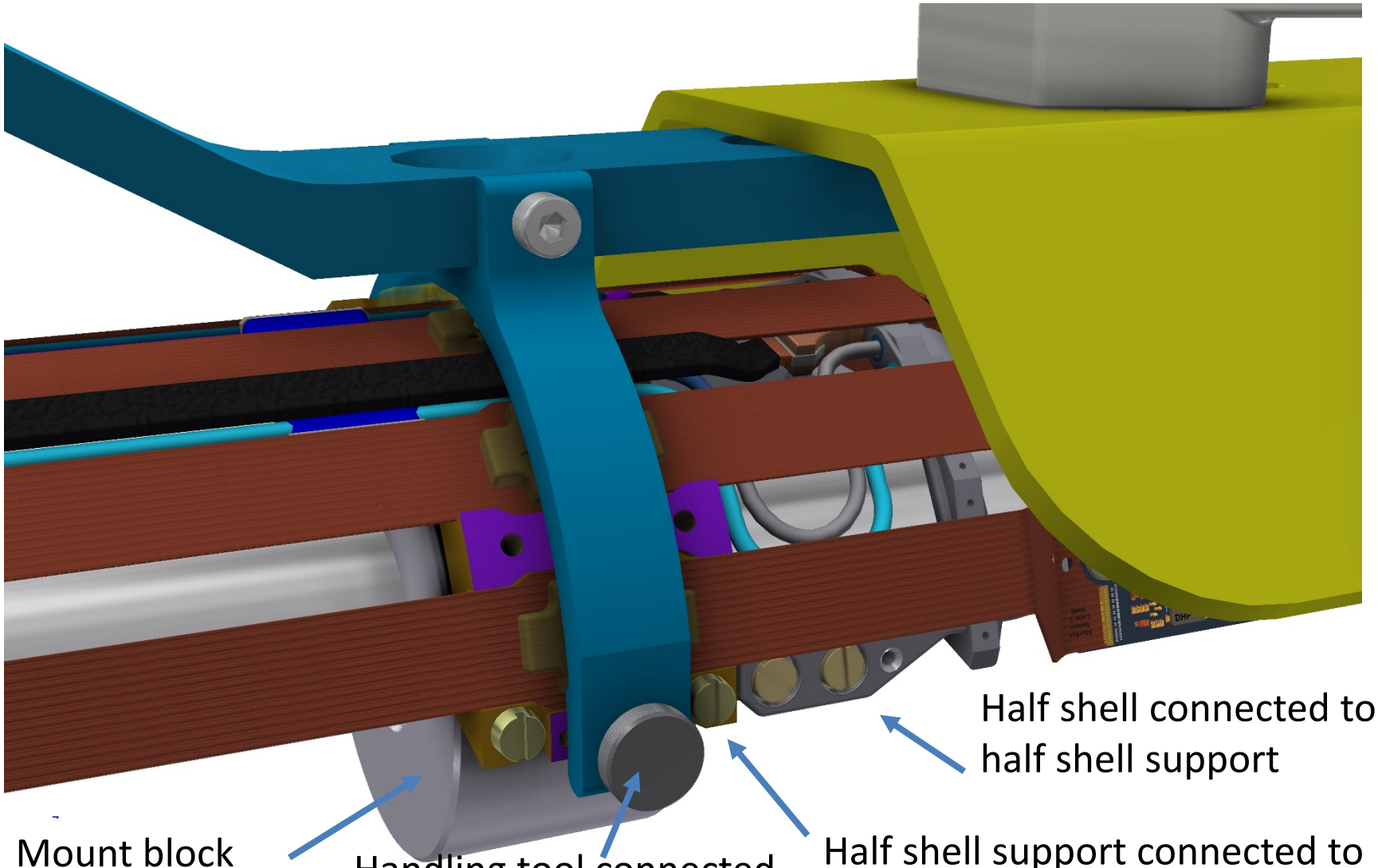


Final approach:
Could even remove screws to get optimal tactile feedback

First Half Shell Mounting Exercises

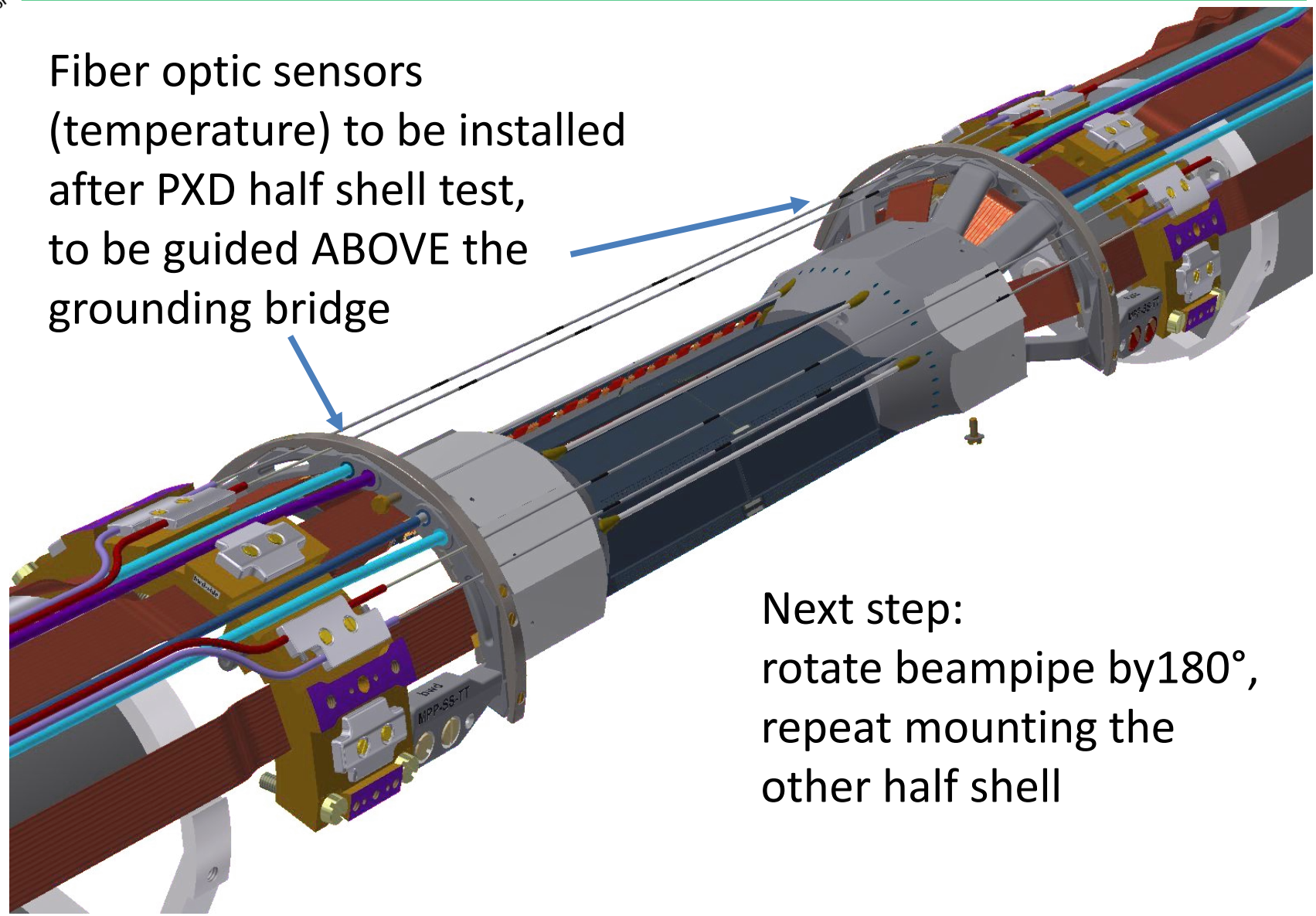


First Half Shell Mounting Exercises



Remark on Installation / Test

Fiber optic sensors (temperature) to be installed after PXD half shell test, to be guided ABOVE the grounding bridge



Next step:
rotate beampipe by180°, repeat mounting the other half shell

Summary and Next Steps

- Glueing of 2 modules to one ladder fully developed, successfully exercised, including tests of the ladder
- Final ladder mounting procedure for Phase 2 has been exercised successfully, first with dummies, now with real ladders
- Ladder mounting tools have been optimized on CAD, tested with real ladders
- Two trained technicians at MPI co-operating in the full procedure of the ladder mounting (need to train one additional team)
- Mounting procedure of „45°“ ladders of Layer 1 developed, still to be exercised with „semi-hot“ ladders

Next Steps and Schedule

To do:	starting next week:
Finalize design of rotation stand and build it	about 1 month
In parallel: prepare SCBs for half shell assembly (need to decide on CO2 isolator and tube routing)	about 3 weeks
Parylen coating pf SCBs with all tubes on (done in industry, order slot soon)	about 3 weeks
Assemble SCBs to (unpopulated) final half shells for Phase 3 (add aluminum coated carbon fiber tubes, alignment, gluing)	about 2 weeks
Ready for ladder mount	January 2018

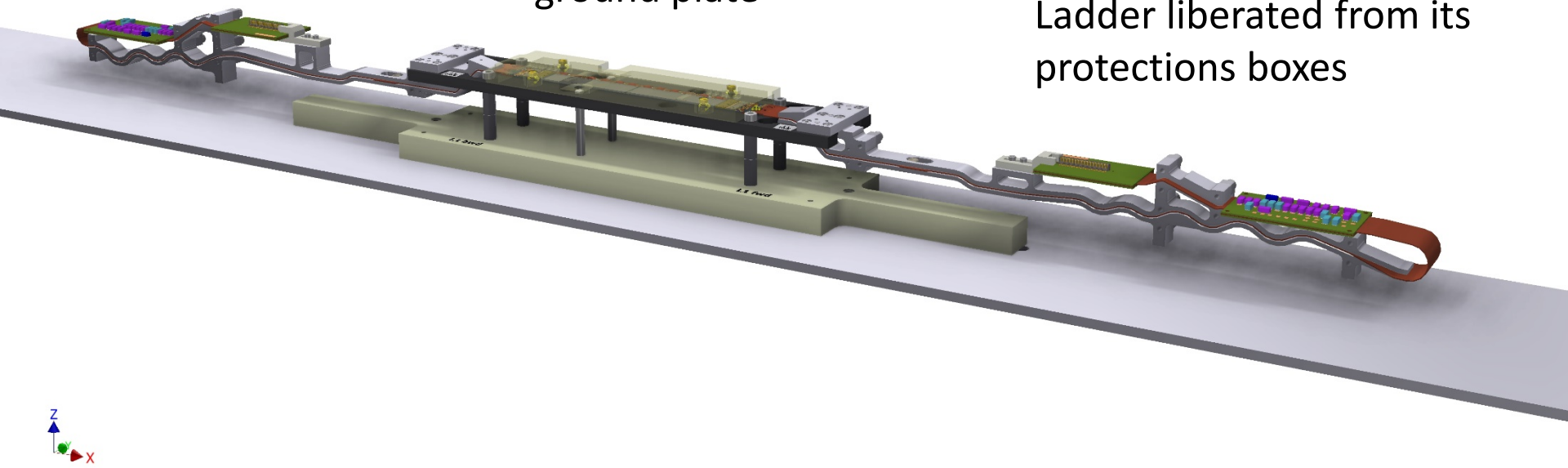
Backup

Ladder Mounting Sequence L1

Procedure presented at Ringberg
(unless otherwise explicitely stated, procedure applies to both Phase 2 and Phase 3)

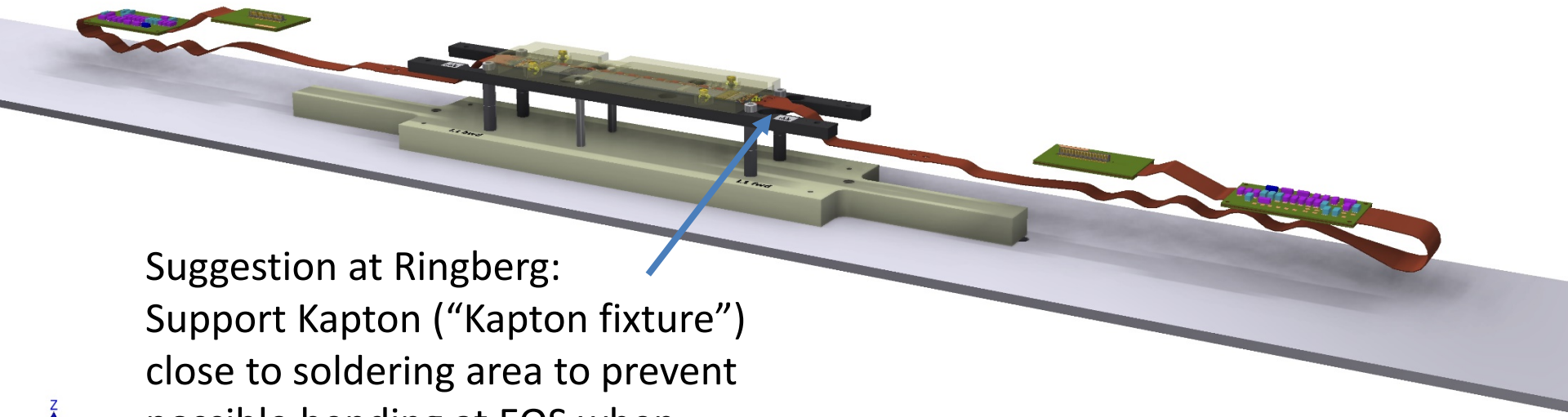
Transport jig fixed to ground plate

Ladder liberated from its protections boxes



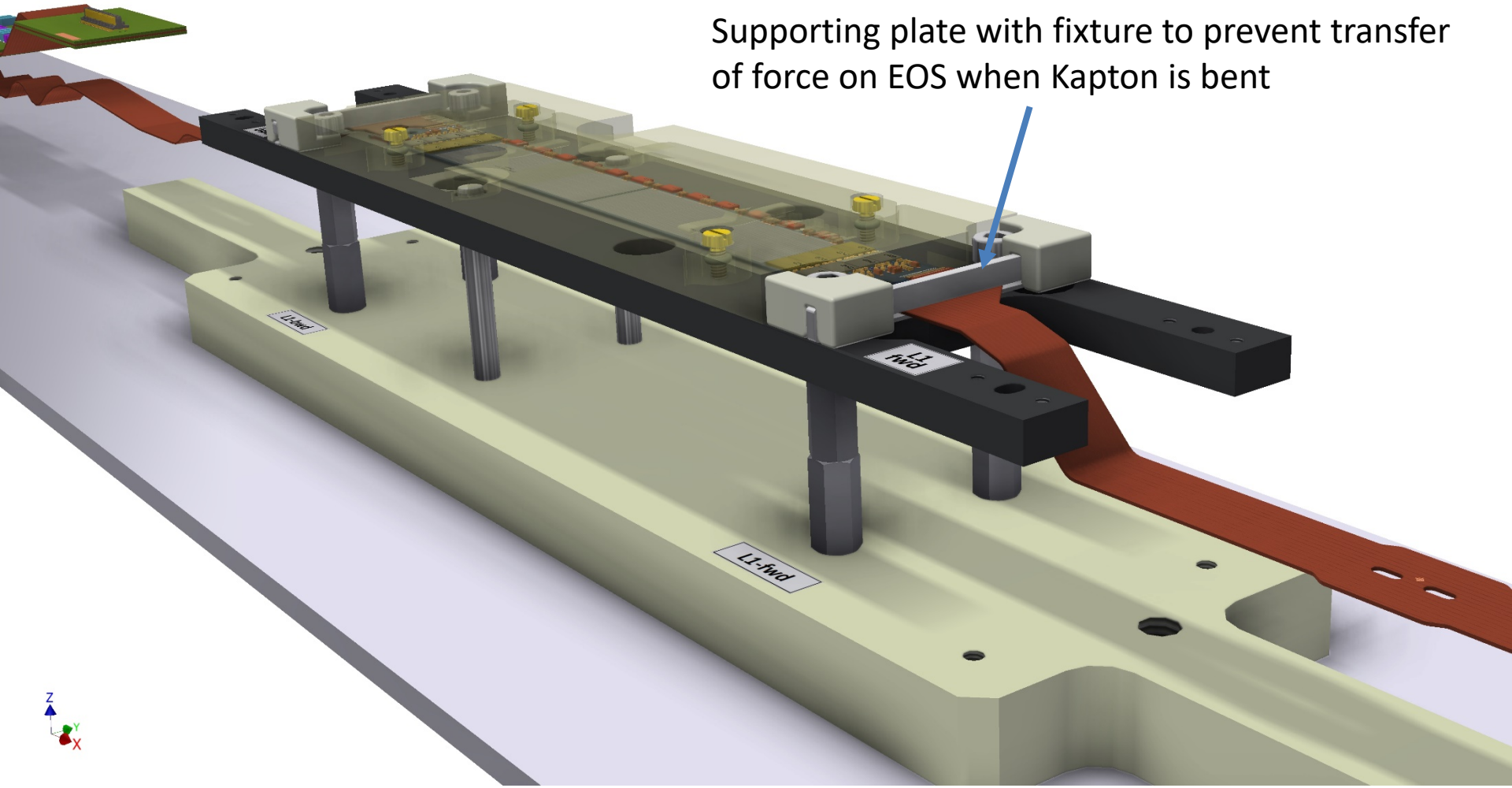
Ladder Mounting Sequence L1

Kapton jigs removed



Suggestion at Ringberg:
Support Kapton (“Kapton fixture”) close to soldering area to prevent possible bending at EOS when removing Kapton jig

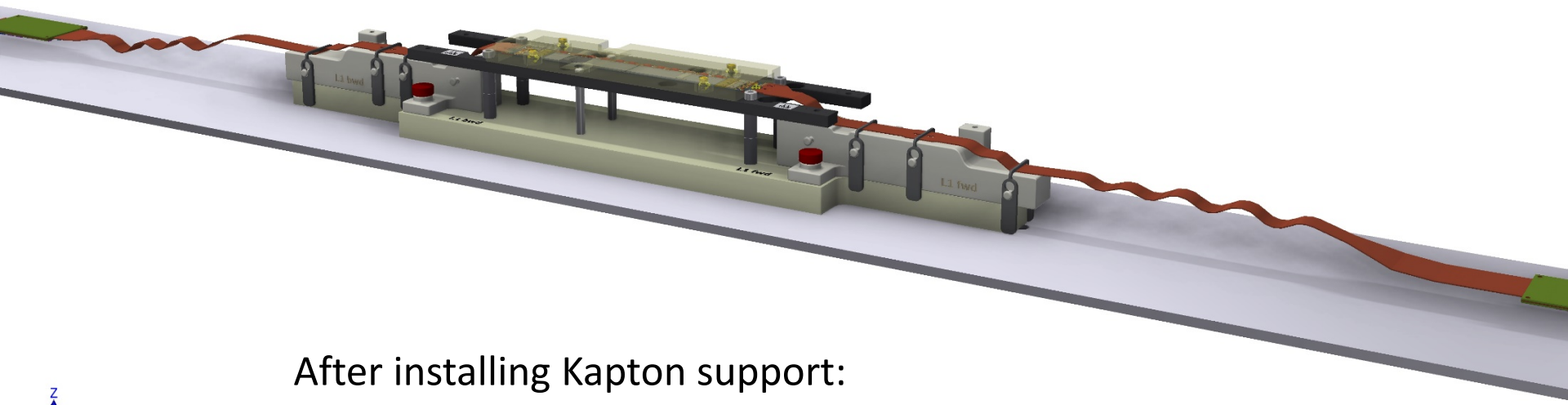
Ladder Mounting Sequence L1



Ladder Mounting Sequence L1

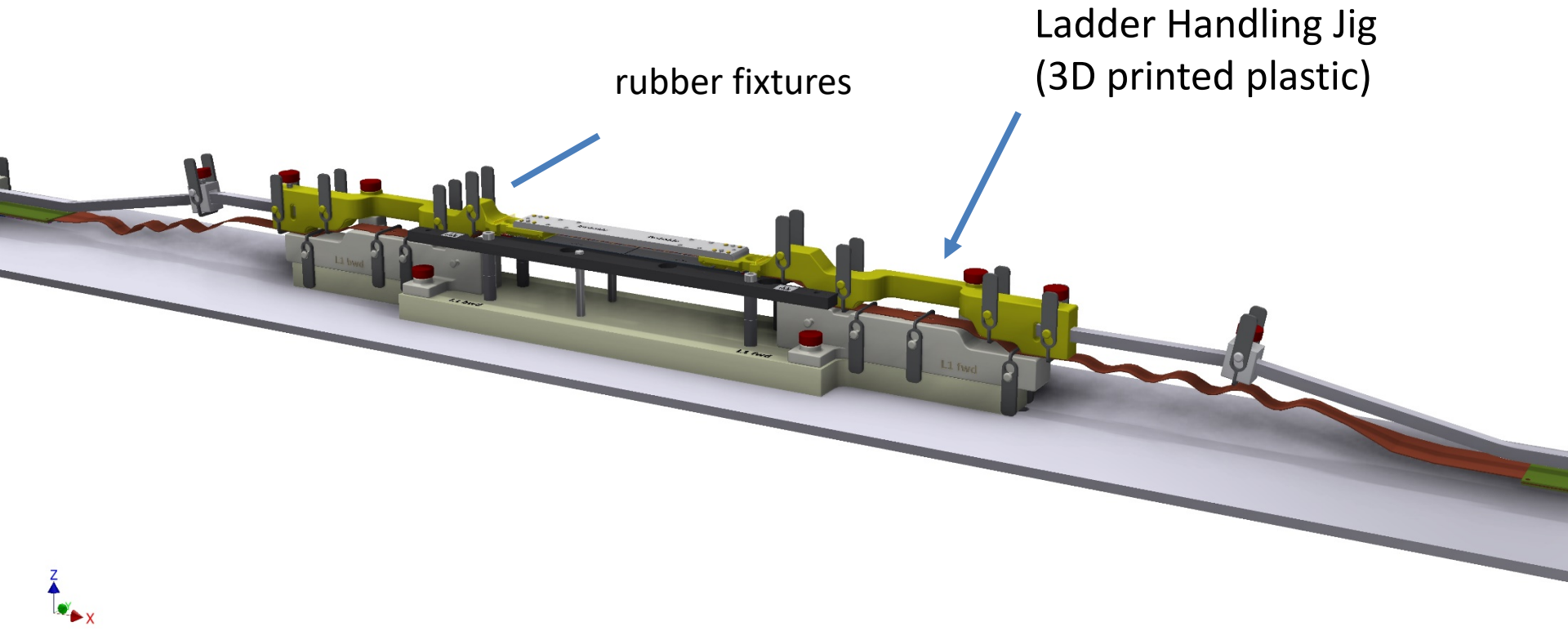
Push in Kapton support structure (3D printed)

New: rubber fixtures (instead of vacuum)

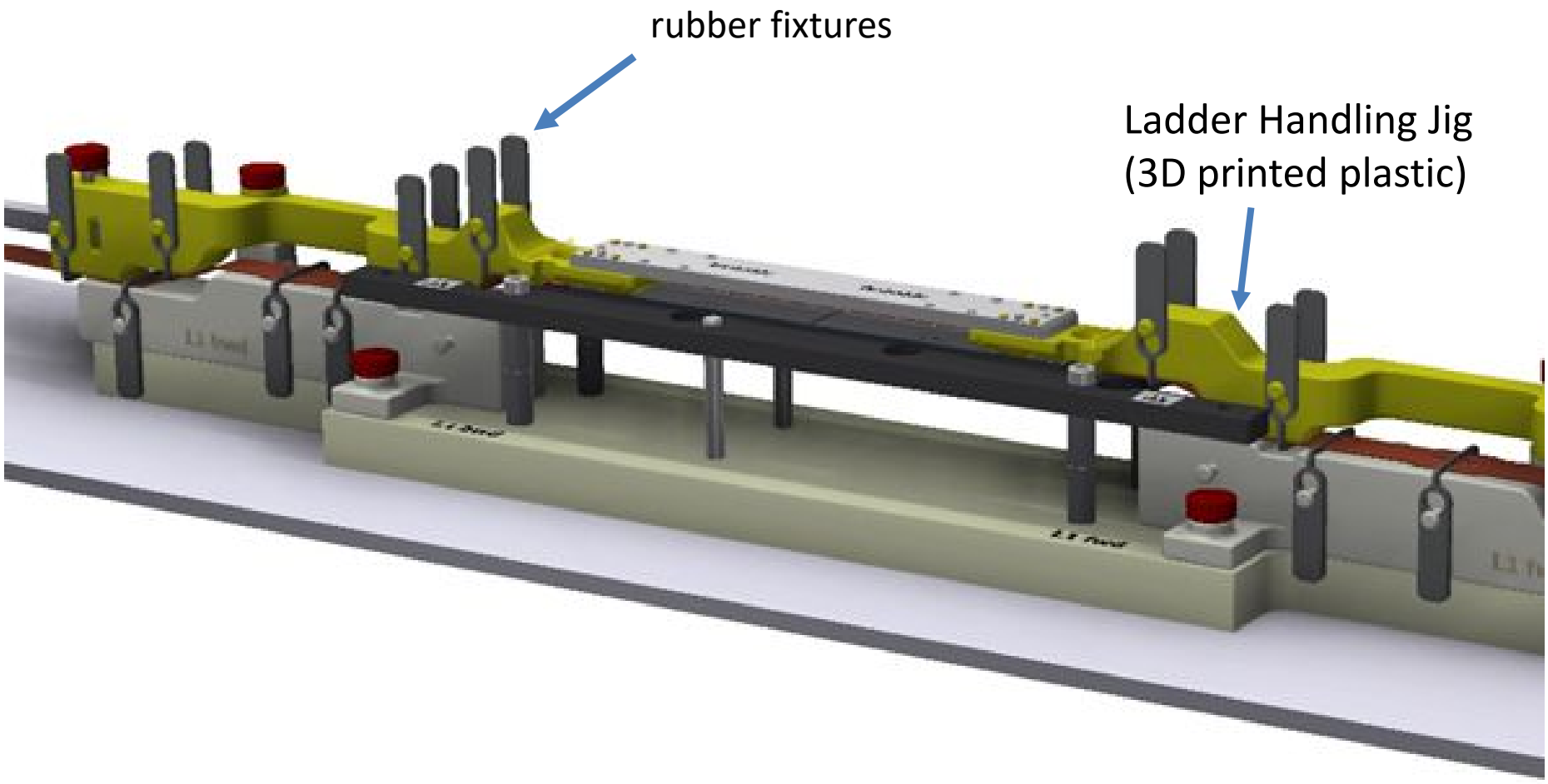


After installing Kapton support: remove Kapton fixture

Ladder Mounting Sequence L1

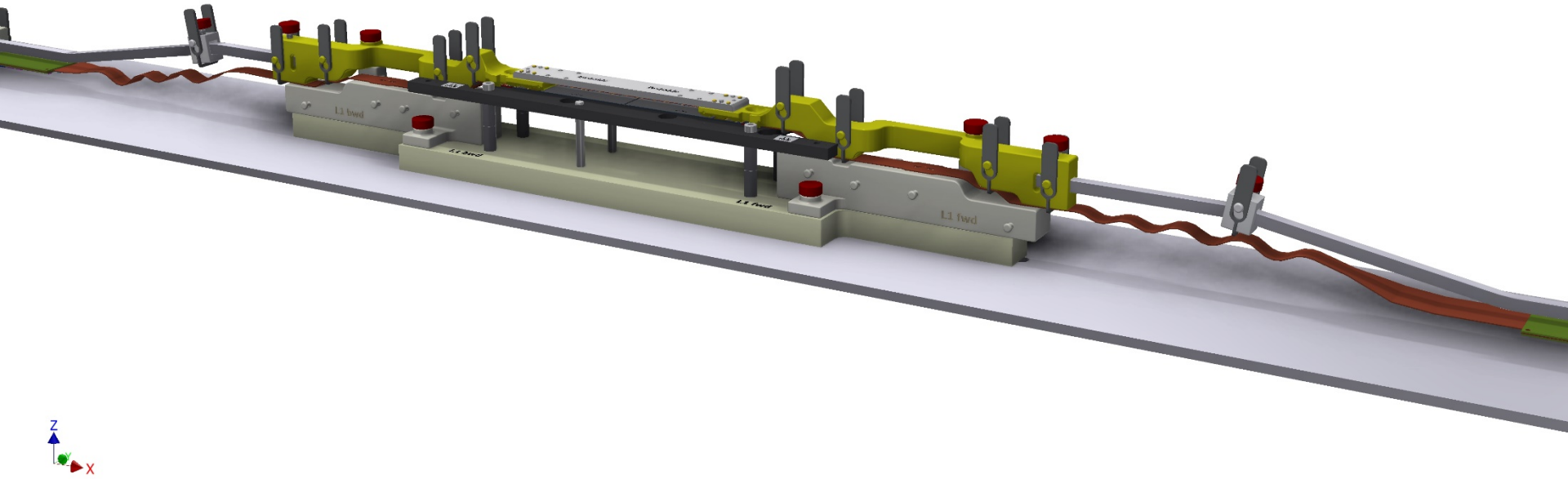


Ladder Mounting Sequence L1



Ladder Mounting Sequence L1

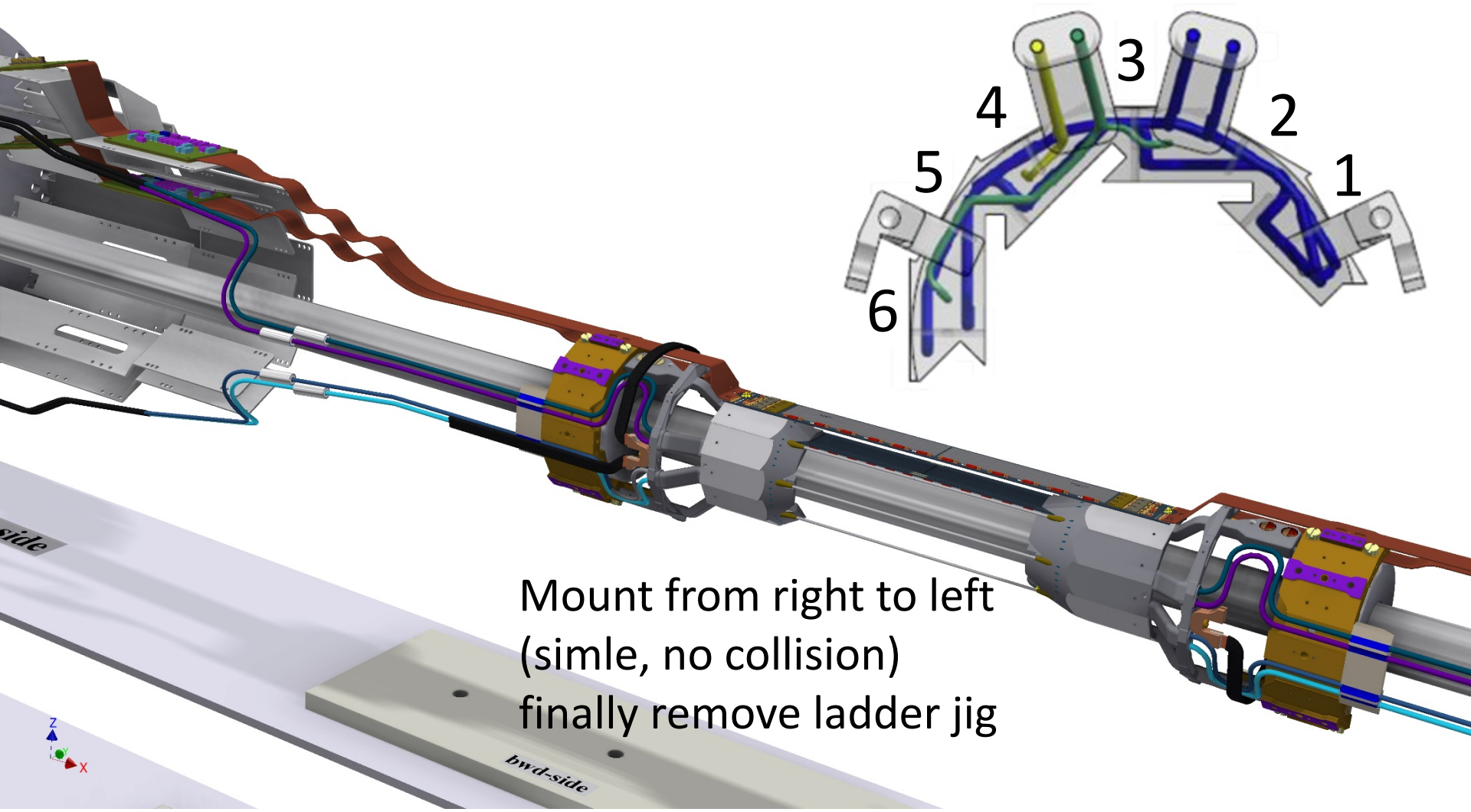
Remove rubber fixtures from Kapton jig



Ladder Mounting Sequence L1

"lift off" by hand

Ladder Mounting Sequence L2



Mount from right to left
(simle, no collision)
finally remove ladder jig