Hardware Development for the LISA Mission of ESA

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28.11.2025

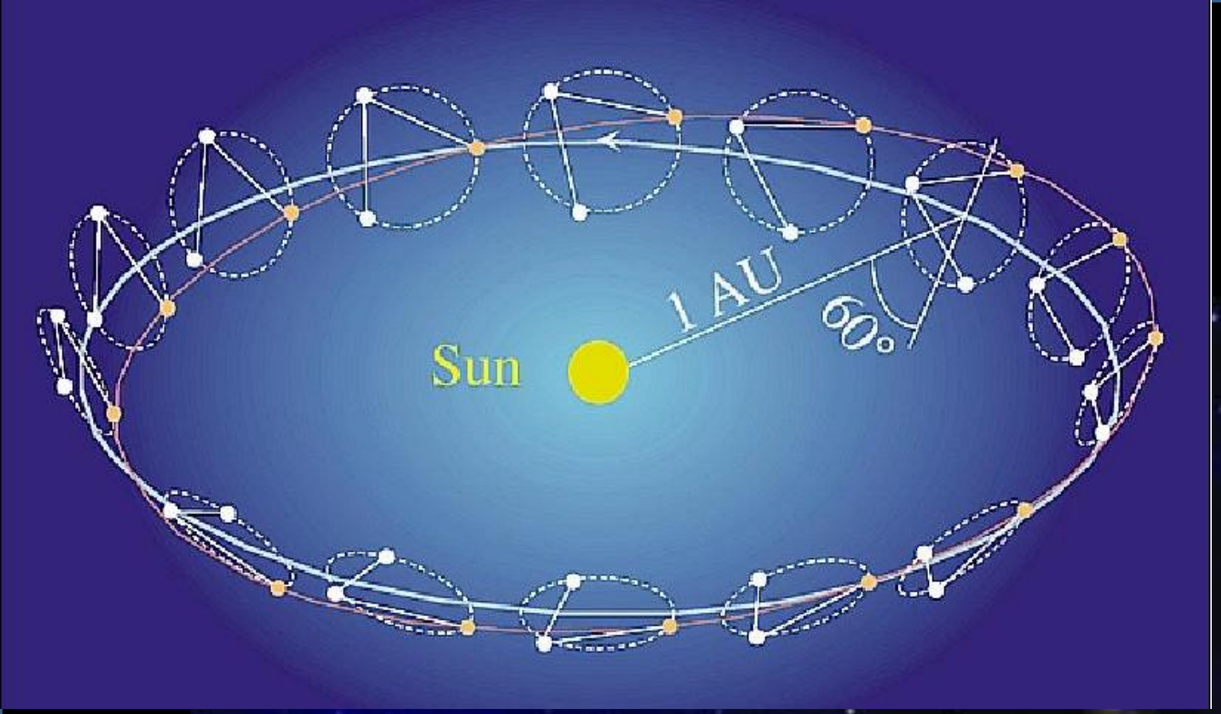
On behalf of:

FZU Institute of Physics of the Czech Academy of Sciences

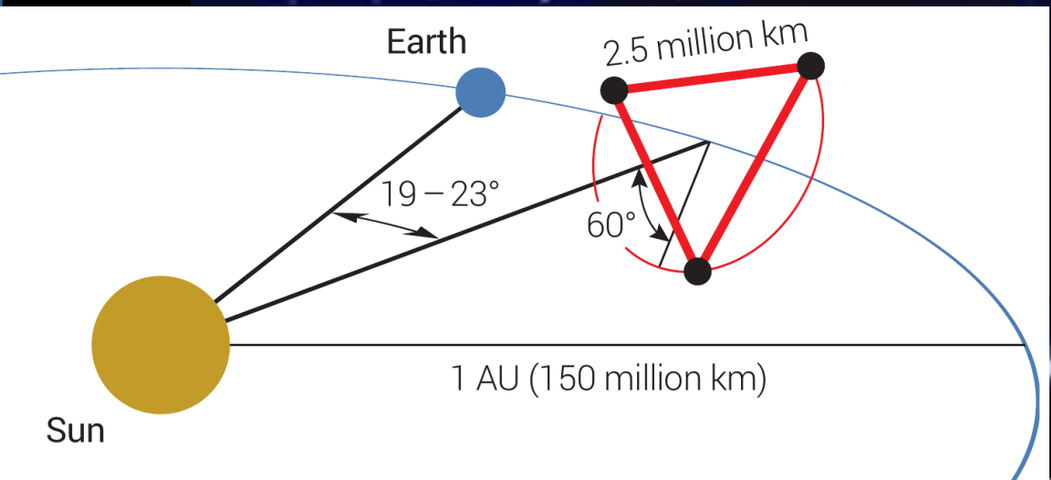
INSTITUTE OF THERMOMECHANICS CZECH ACADEMY OF SCIENCES

asu Astronomical Institute of the Czech Academy of Sciences

ÚSTAV FYZIKY ATMOSFÉRY AV ČR



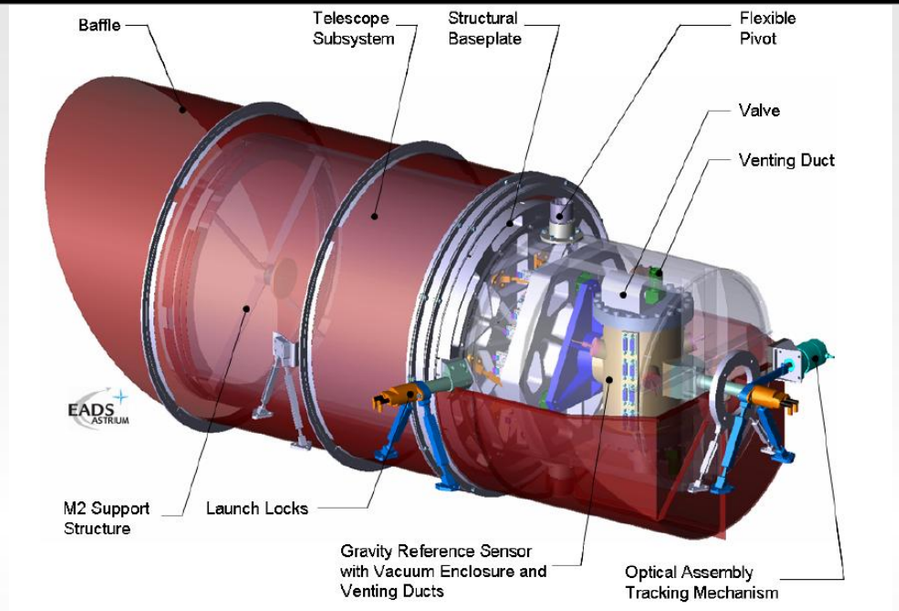
- Constellation of three satellites
- 2.5M km separation
- 14 month travel to the final orbit

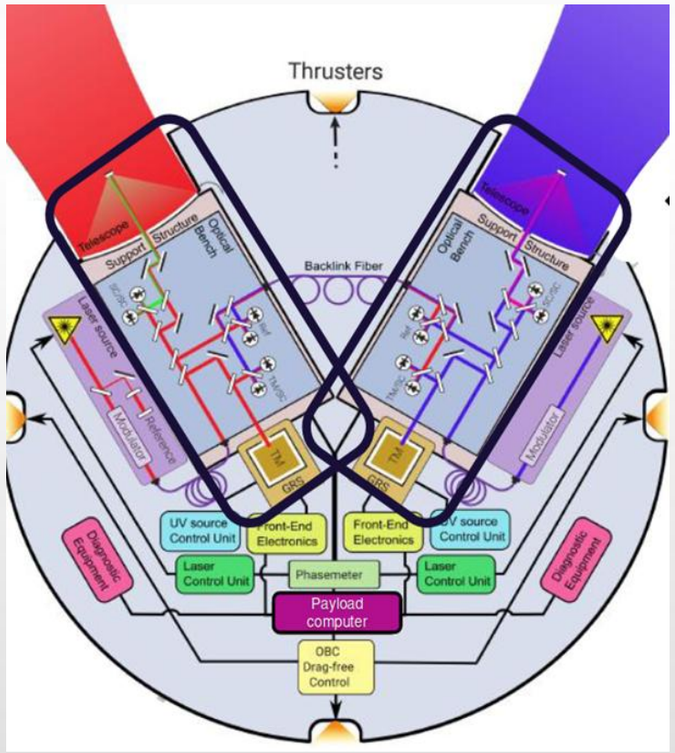


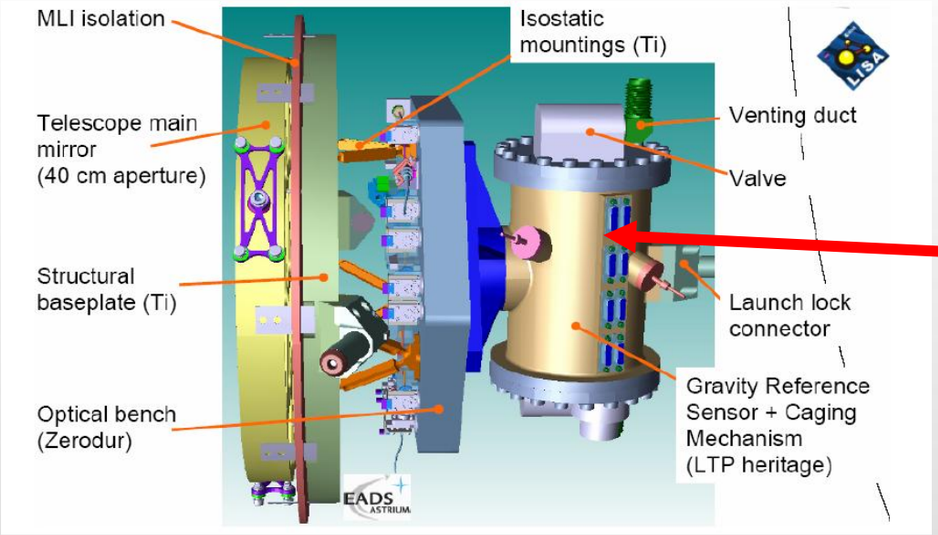
LISA Satellite Layout

Each satellite: 2x Moving Optical Sub-Assembly, and each:

- A telescope pointing to the other space craft
- Optical bench
- Free-floating mass (46 mm cube of Au-Pt alloy)



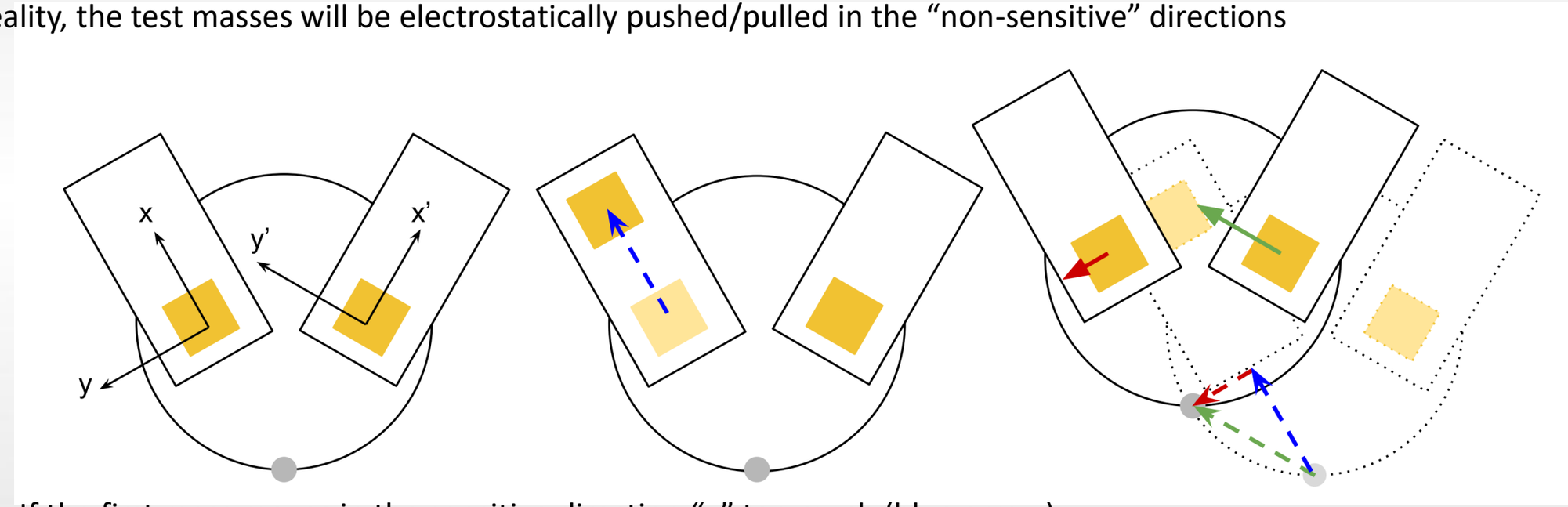




cubic conducting housing that also serves as a capacitive position sensor and electrostatic force actuator

About the free-falling …

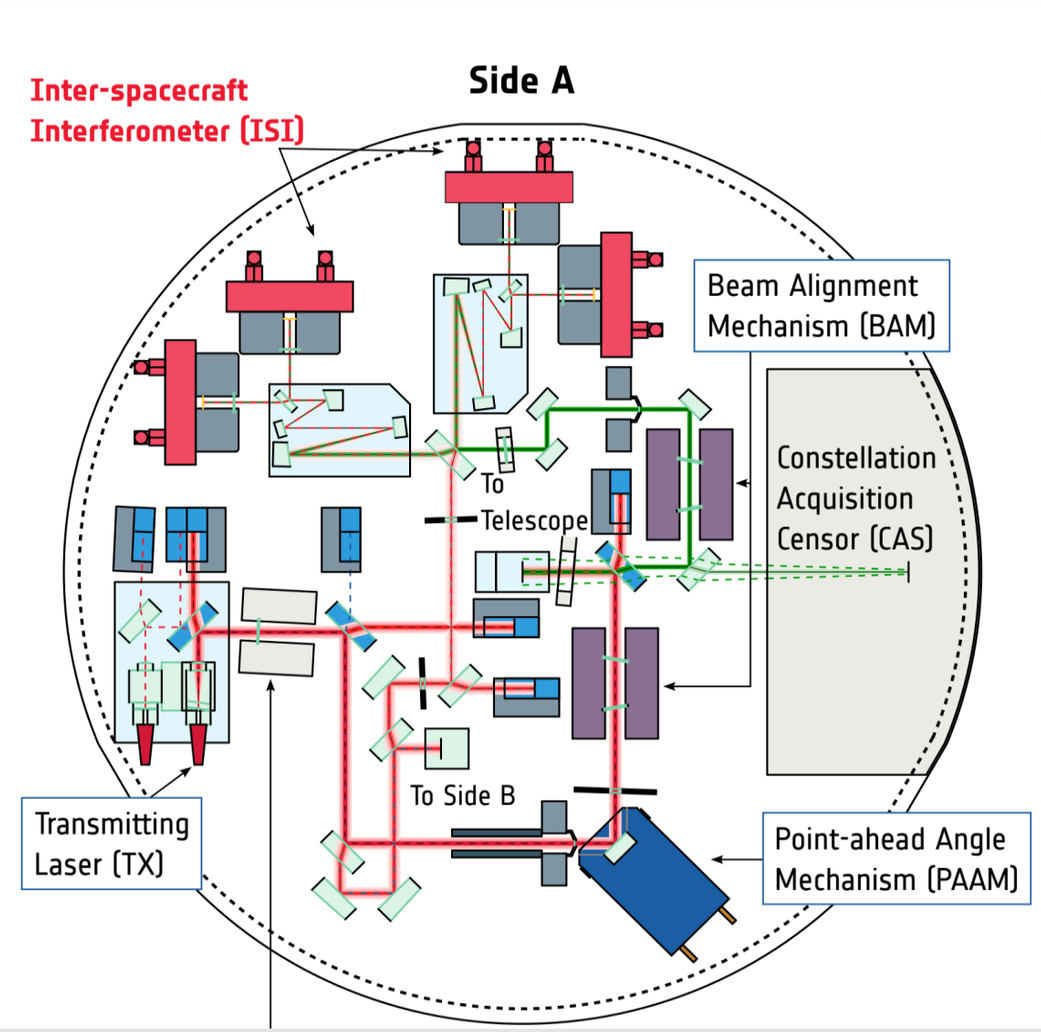
- Test masses should be free-falling and the spacecraft should maneuver around them
- Doesn't really work →
  - There are two masses in each spacecraft, following different orbits
  - One may need to correct the pointing
- In reality, the test masses will be electrostatically pushed/pulled in the "non-sensitive" directions



If the first mass moves in the sensitive direction "x" too much (blue arrow)
→ The spacecraft must compensate
→ Moving in the non-sensitive direction of the second mass (green)
→ Additional correction to the first mass (red) in its non-sensitive direction

LISA optical bench

Side A (transmission)



LISA optical bench

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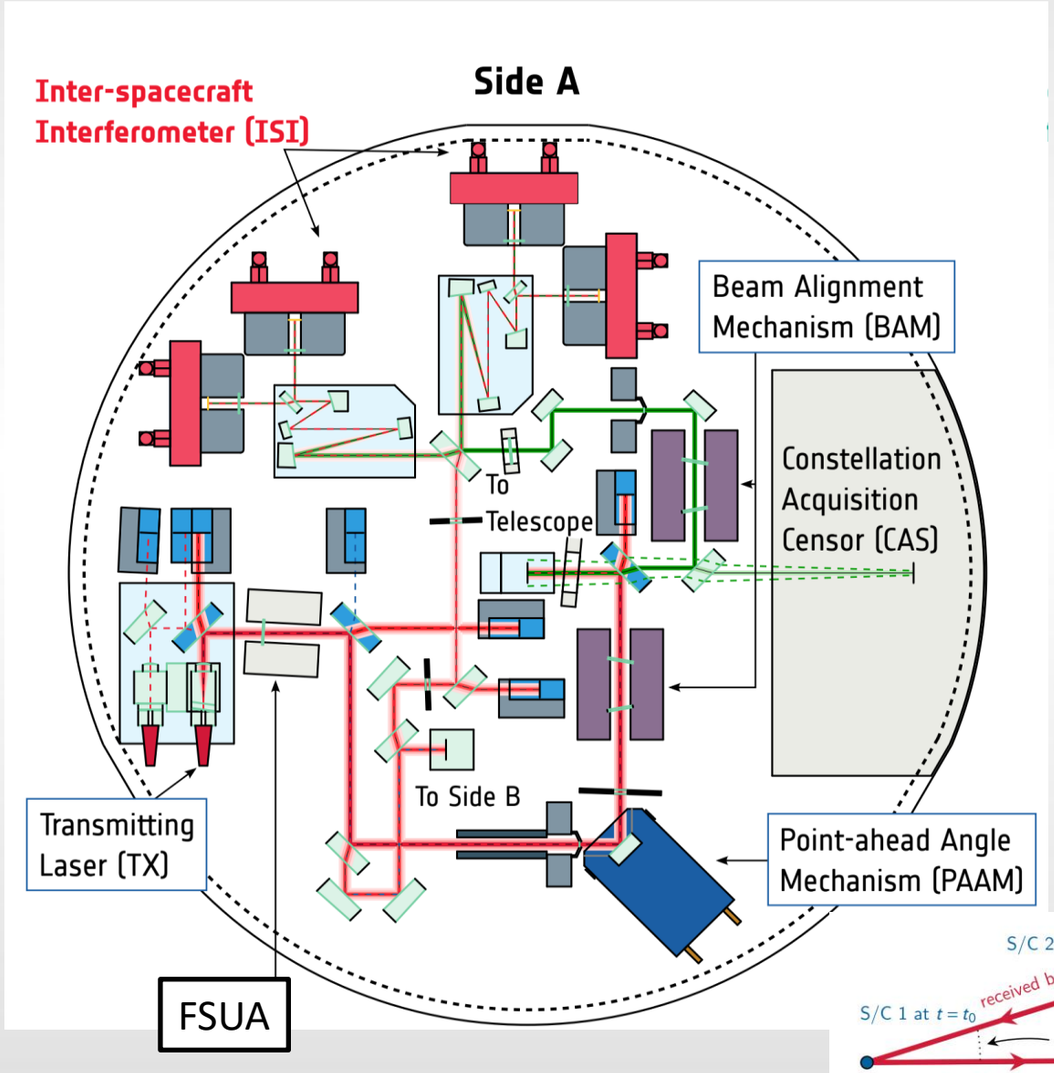
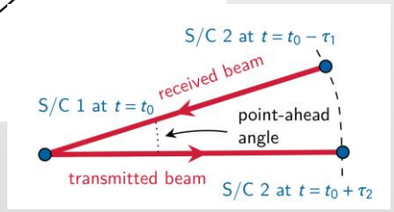
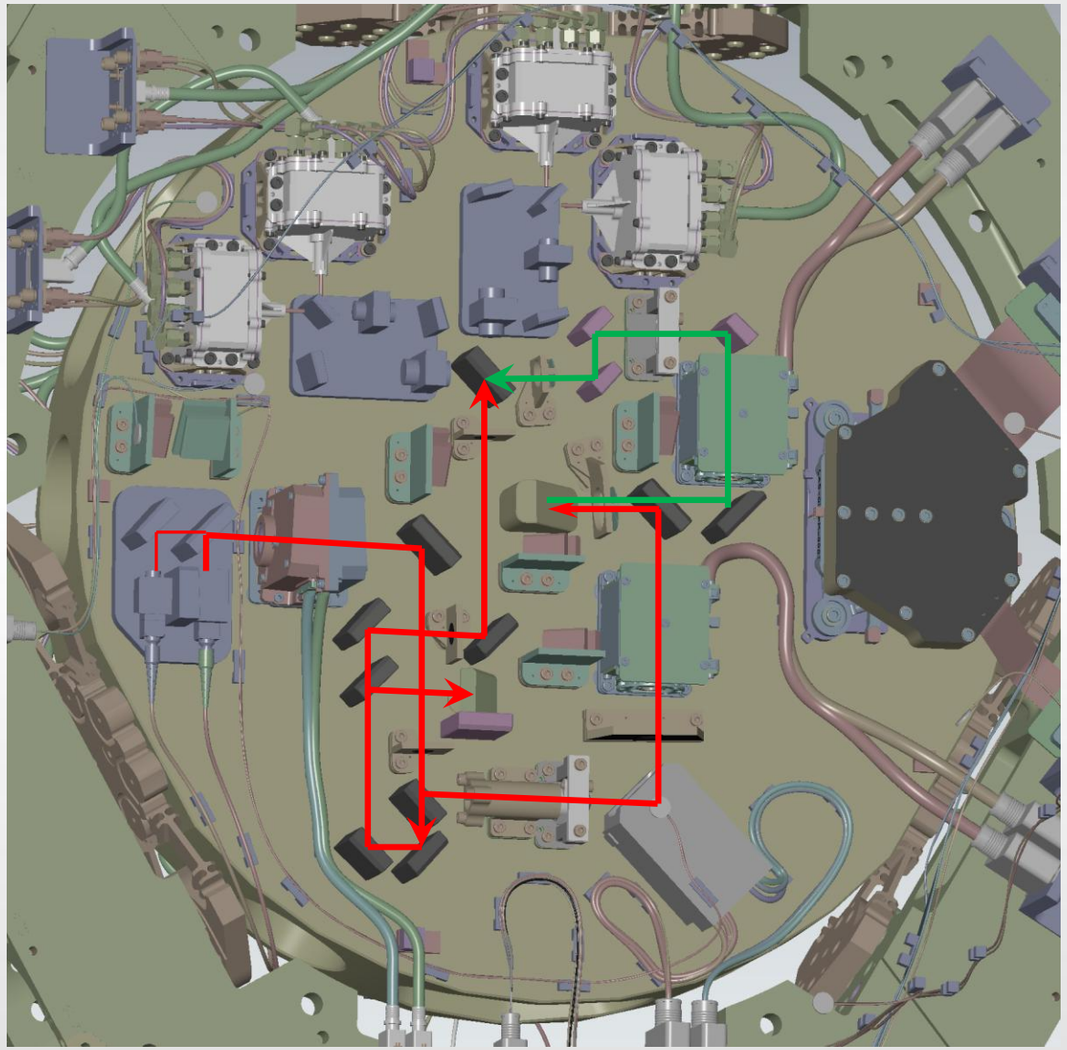
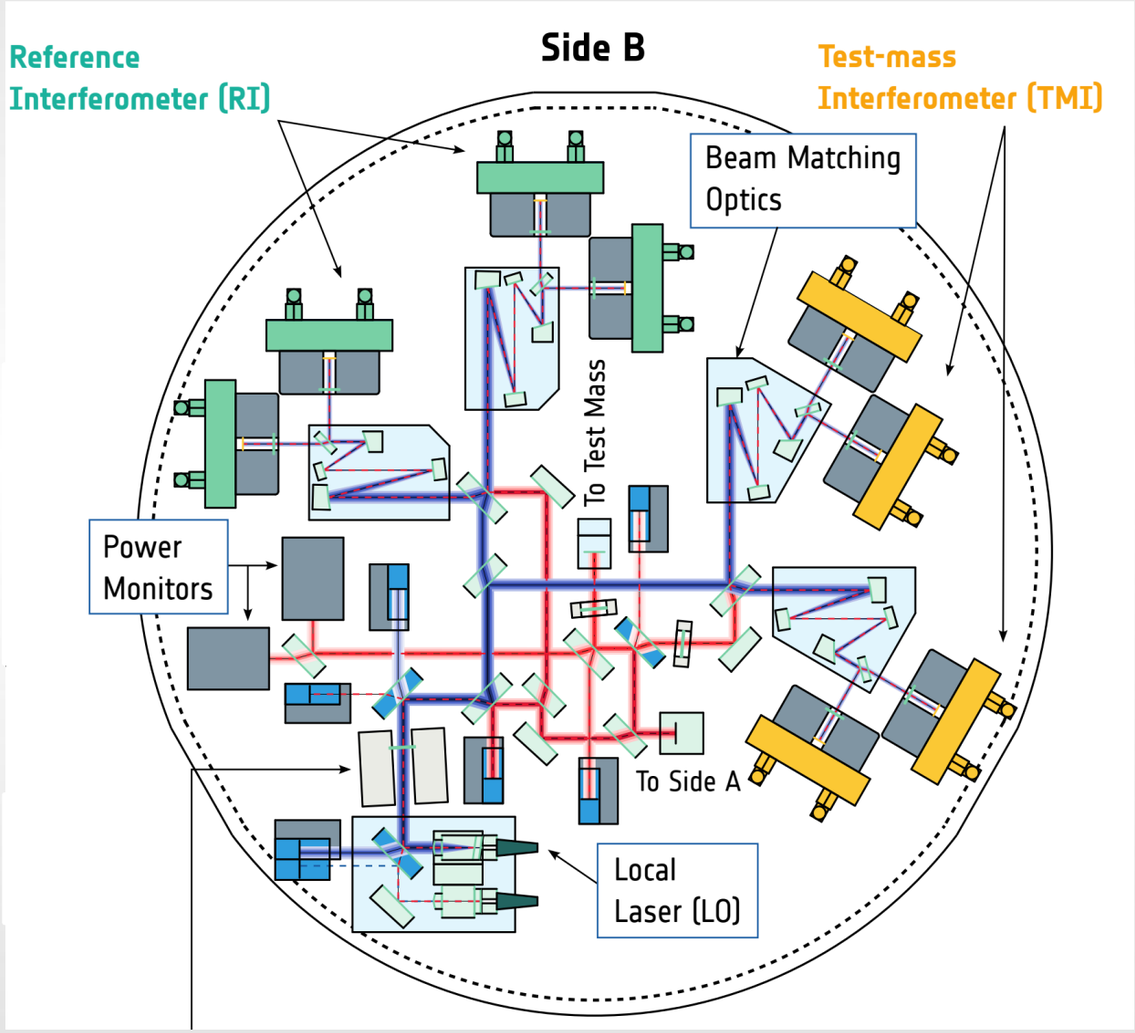


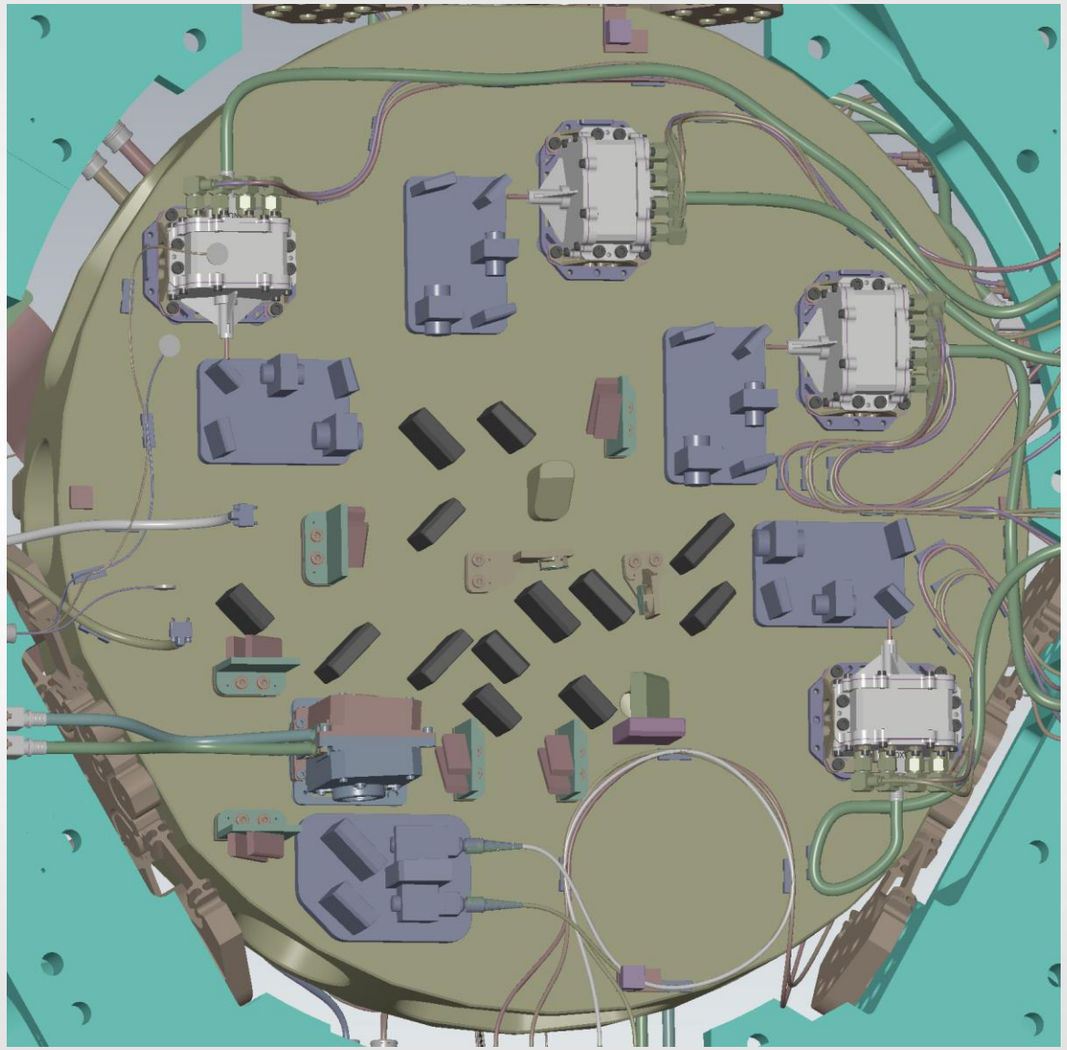




LISA optical bench

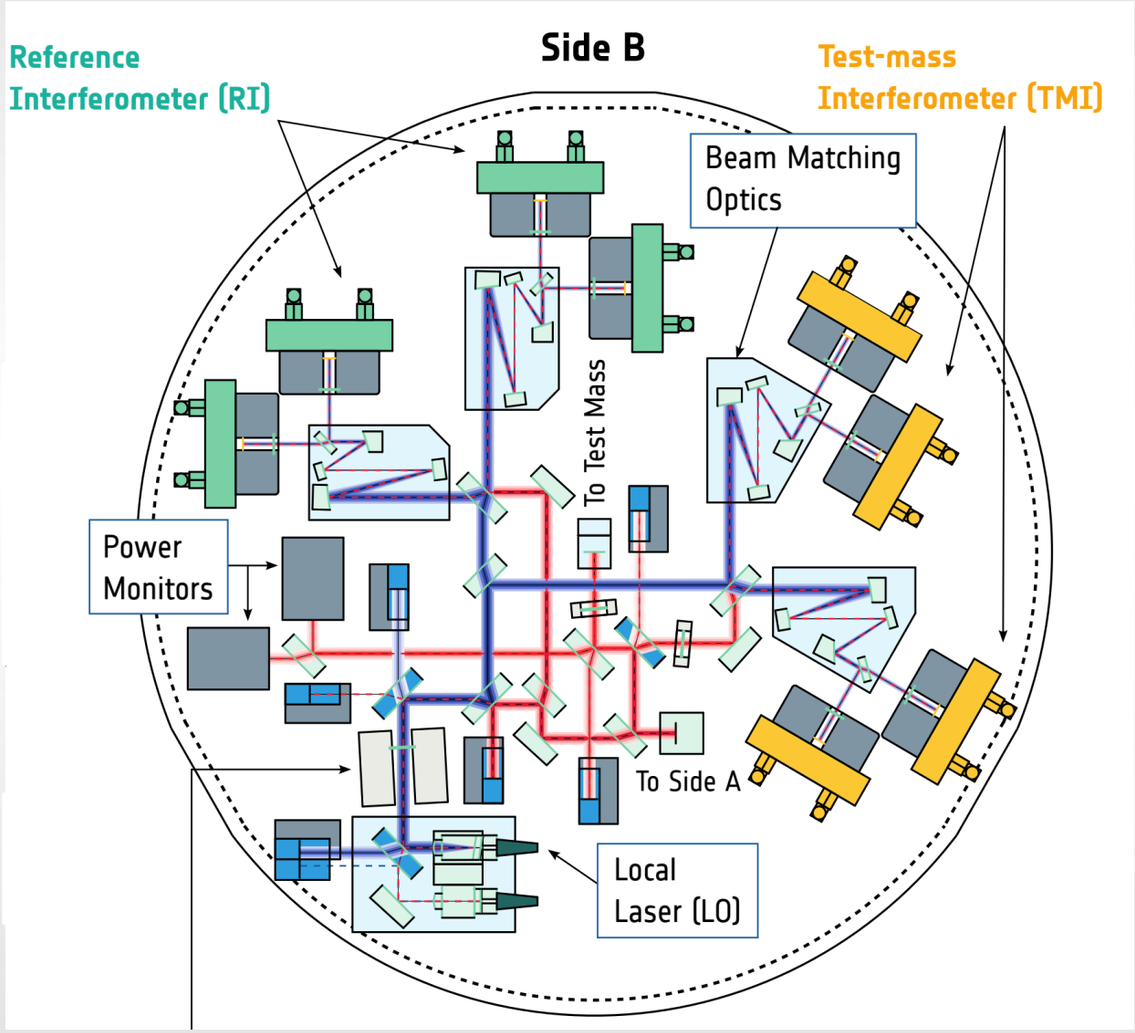
Side B (test mass)

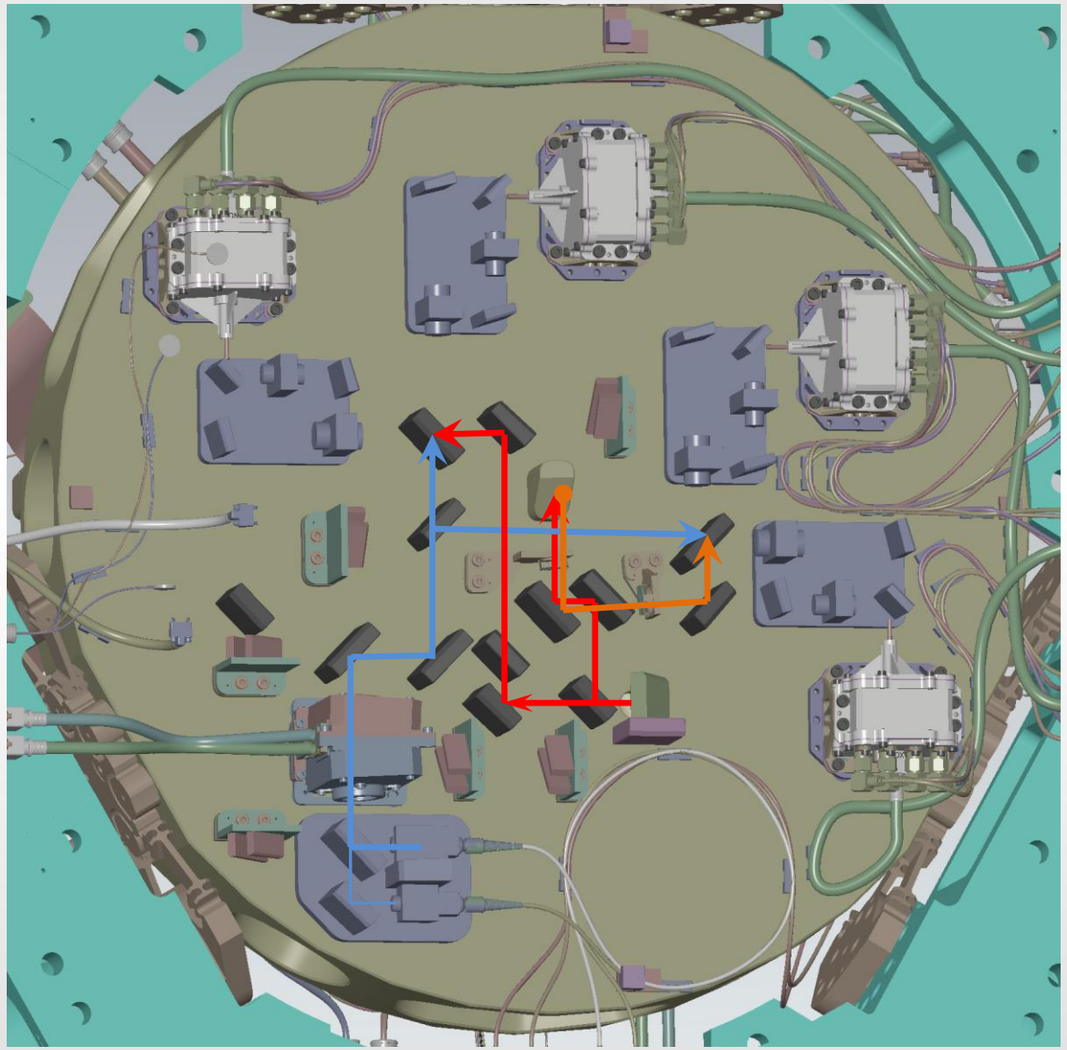




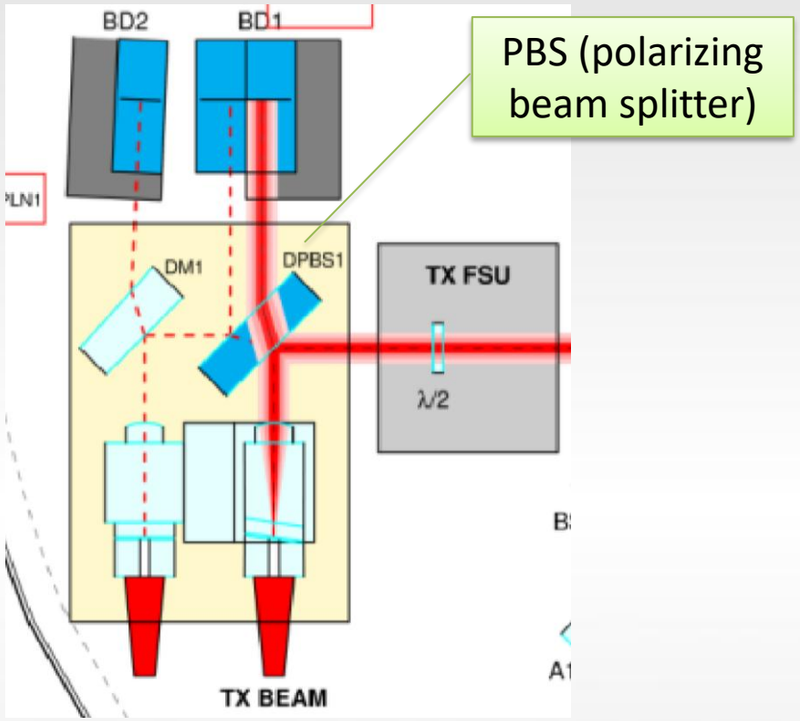
LISA optical bench

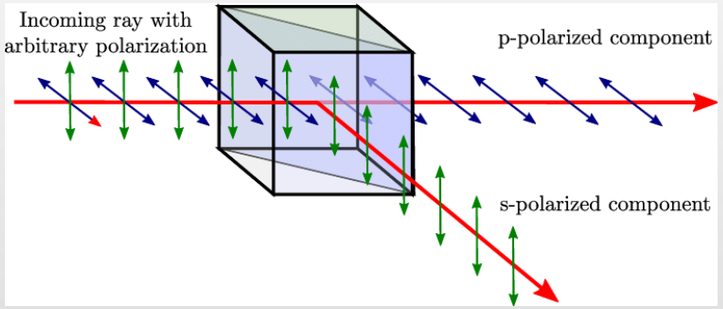
Side B (test mass)



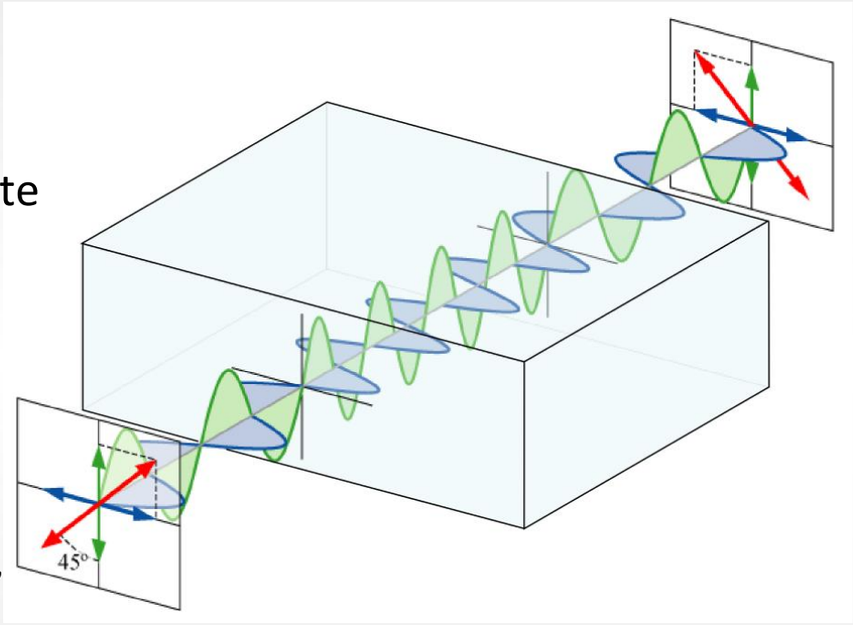


FSUA - fibre switching unit assembly

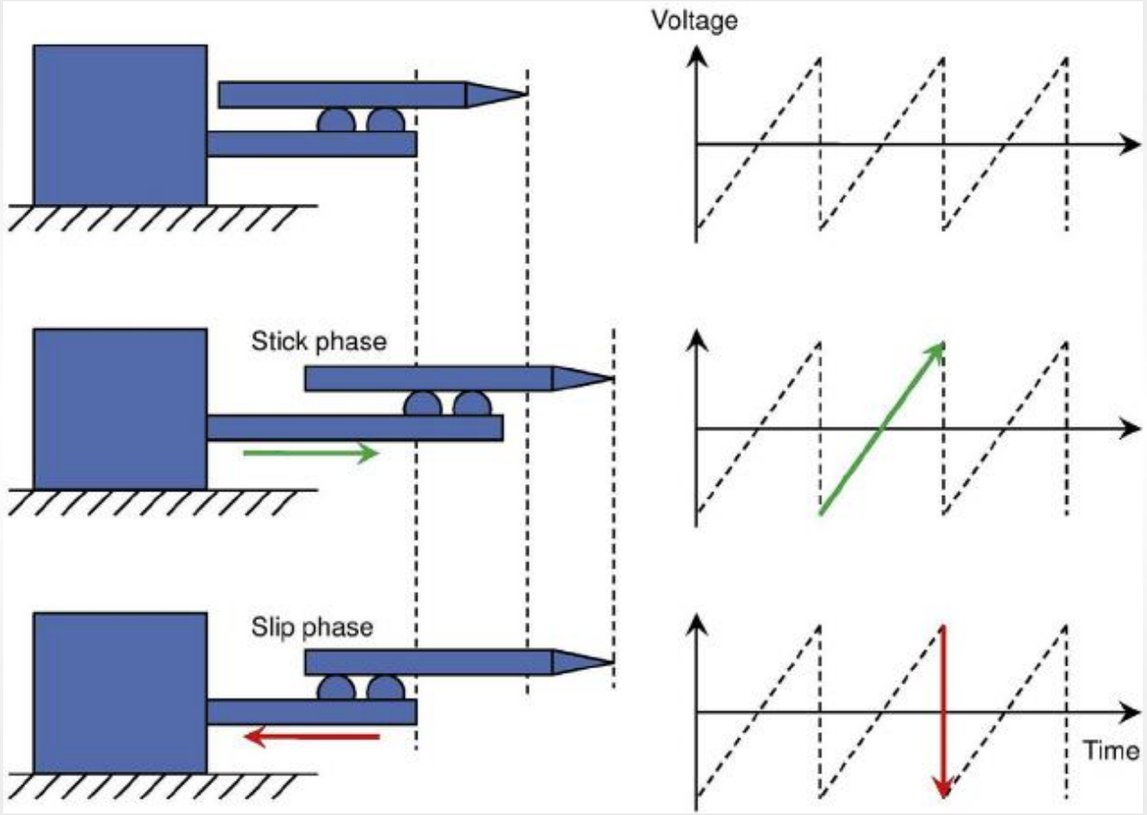




- Fixing the beam polarization when switching between primary and redundant laser
- Principle of operation:
  - Rotation of $\lambda/2$ polarization plate
- Needs to be:
  - non-magnetic,
  - stable when off,
  - provide position measurement,
  - survive launch,
  - function after many years of not moving, or being moved regularly?



Piezo slip stick



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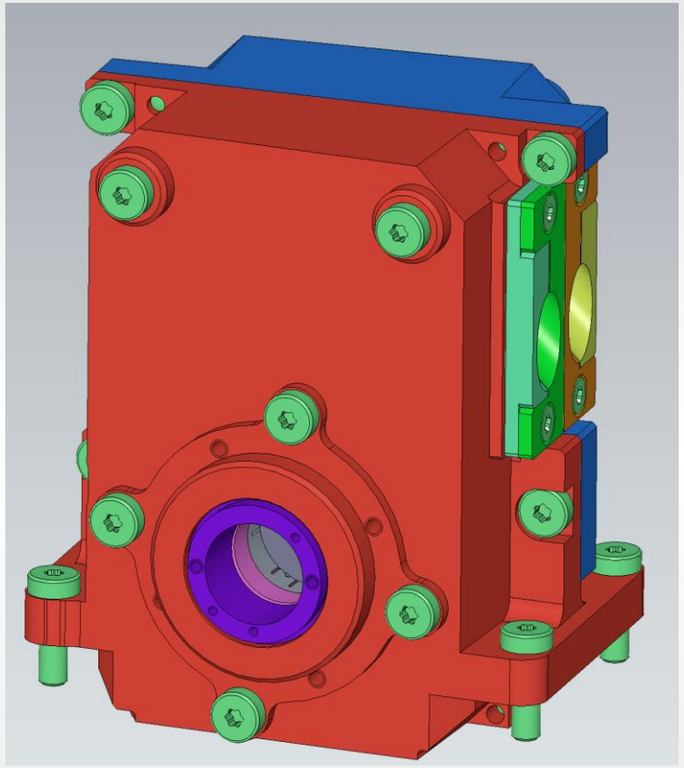

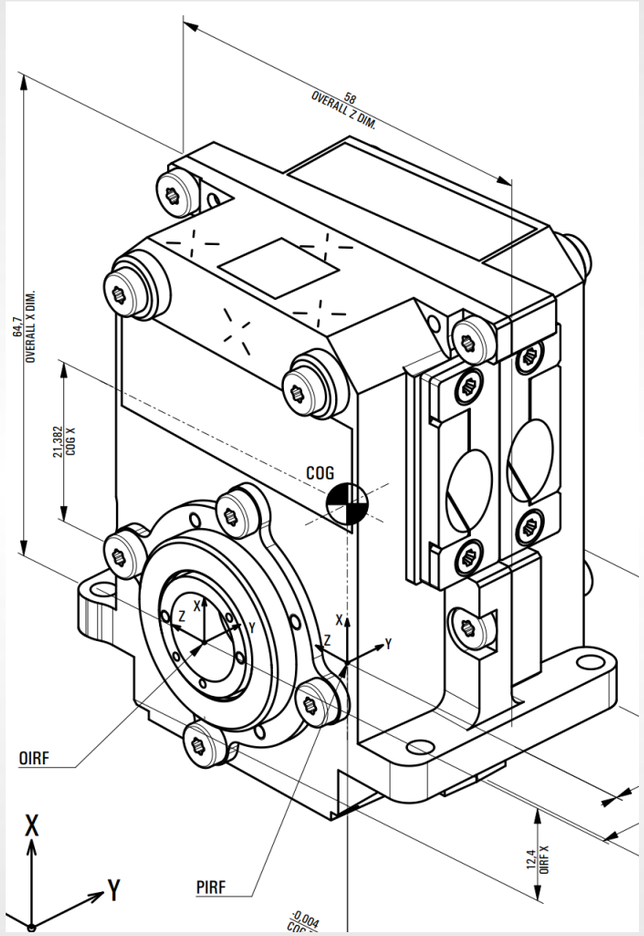

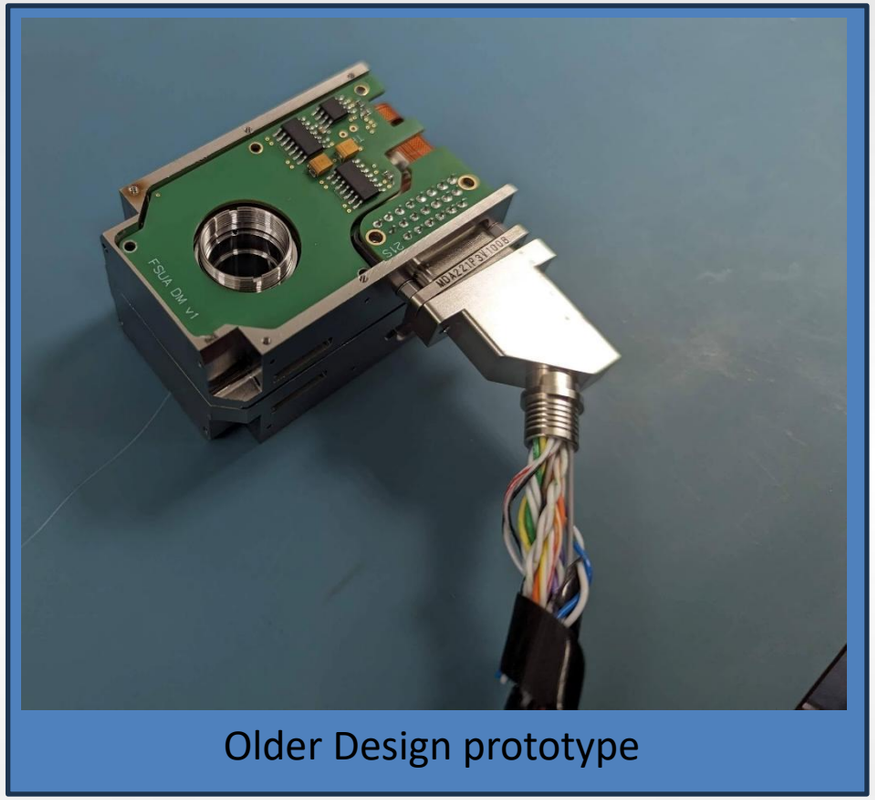

Older Design prototype

Structural Model status

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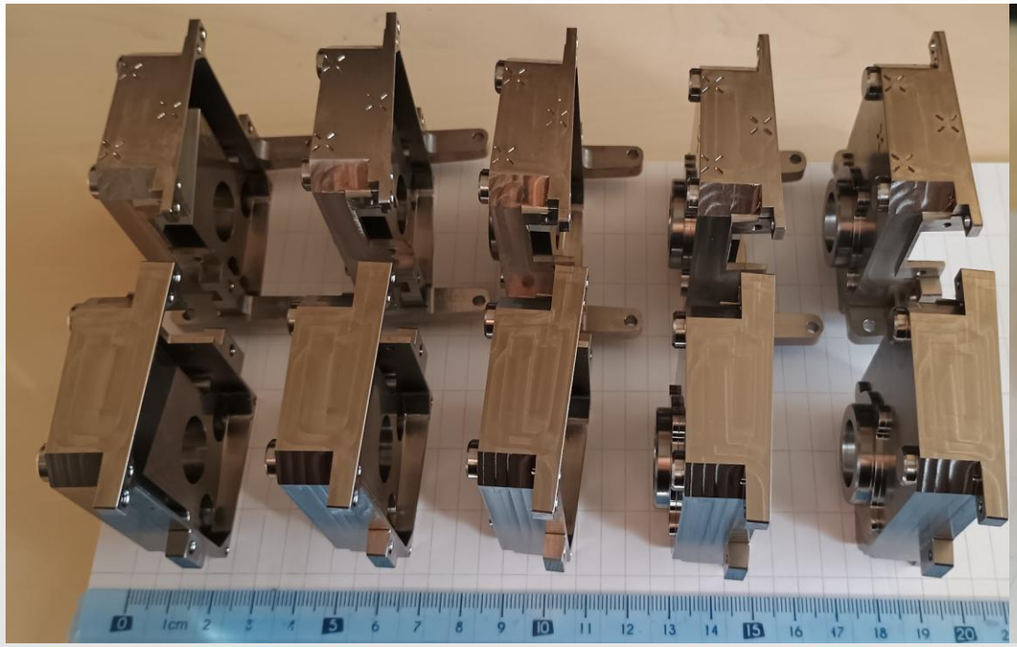
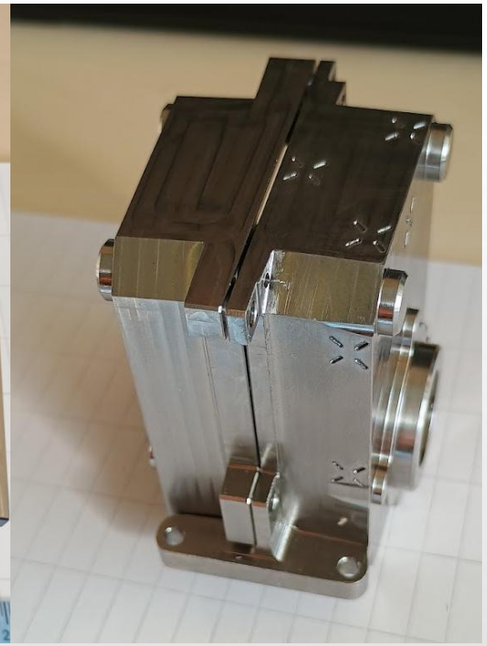
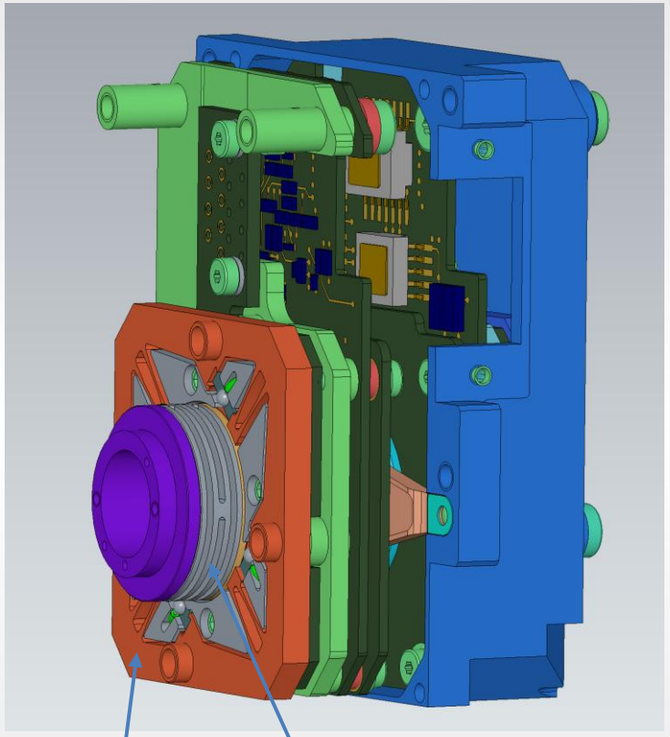
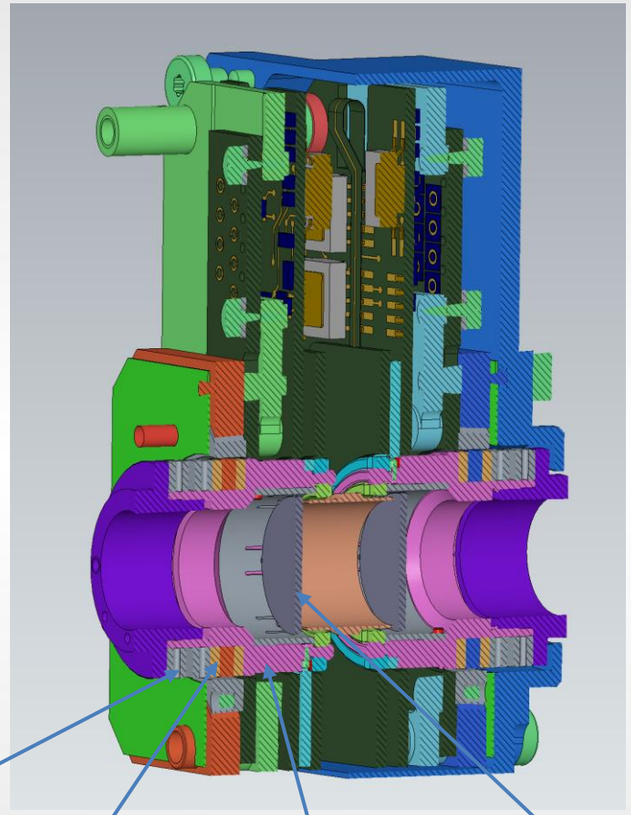




FSUA - fibre switching unit assembly





Vibrating frame

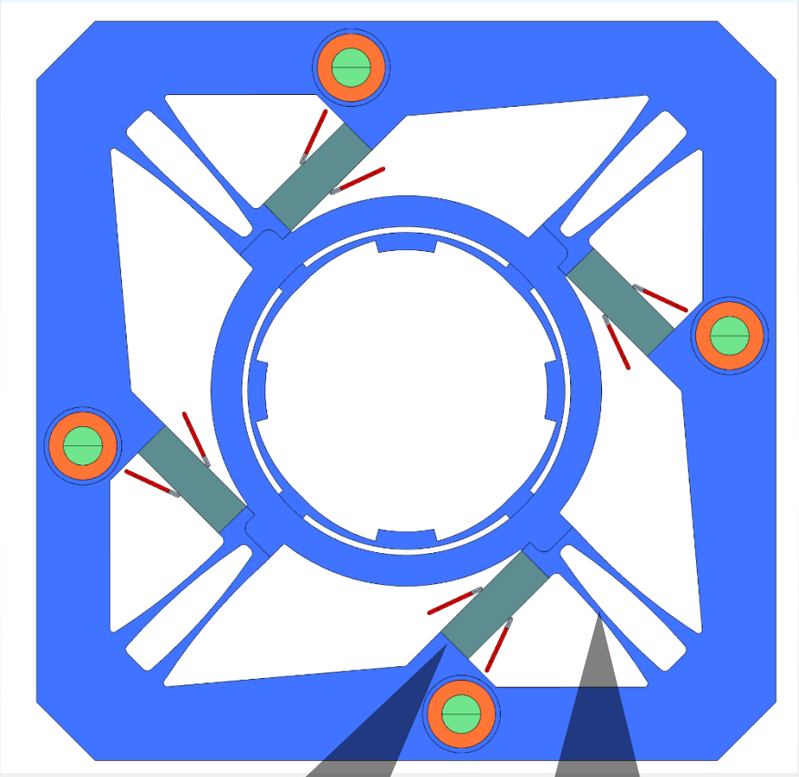
Spring defining the friction

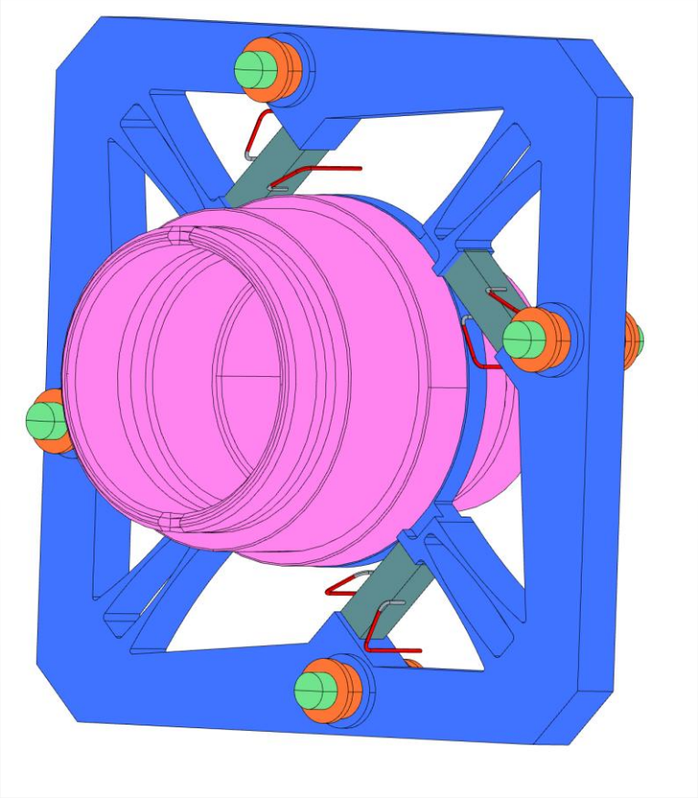
Slip-stick interface

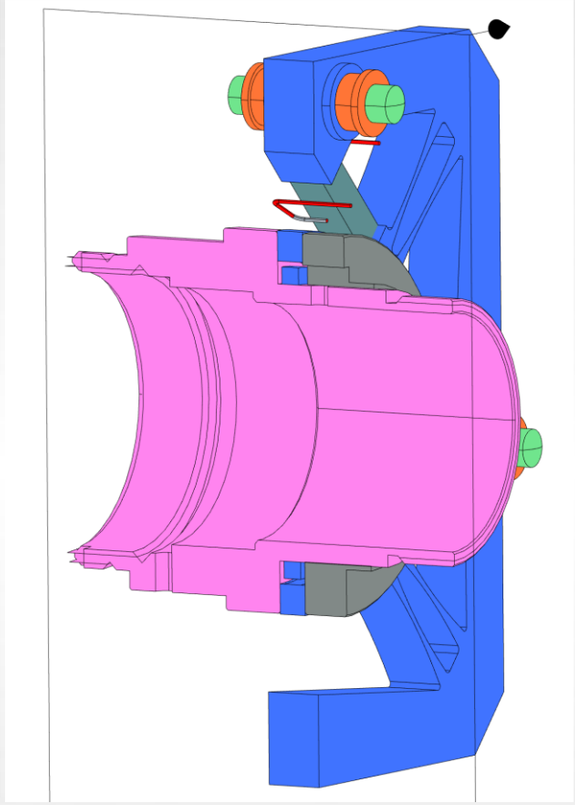
Rotating optics tube

Optical element

The vibrating frame



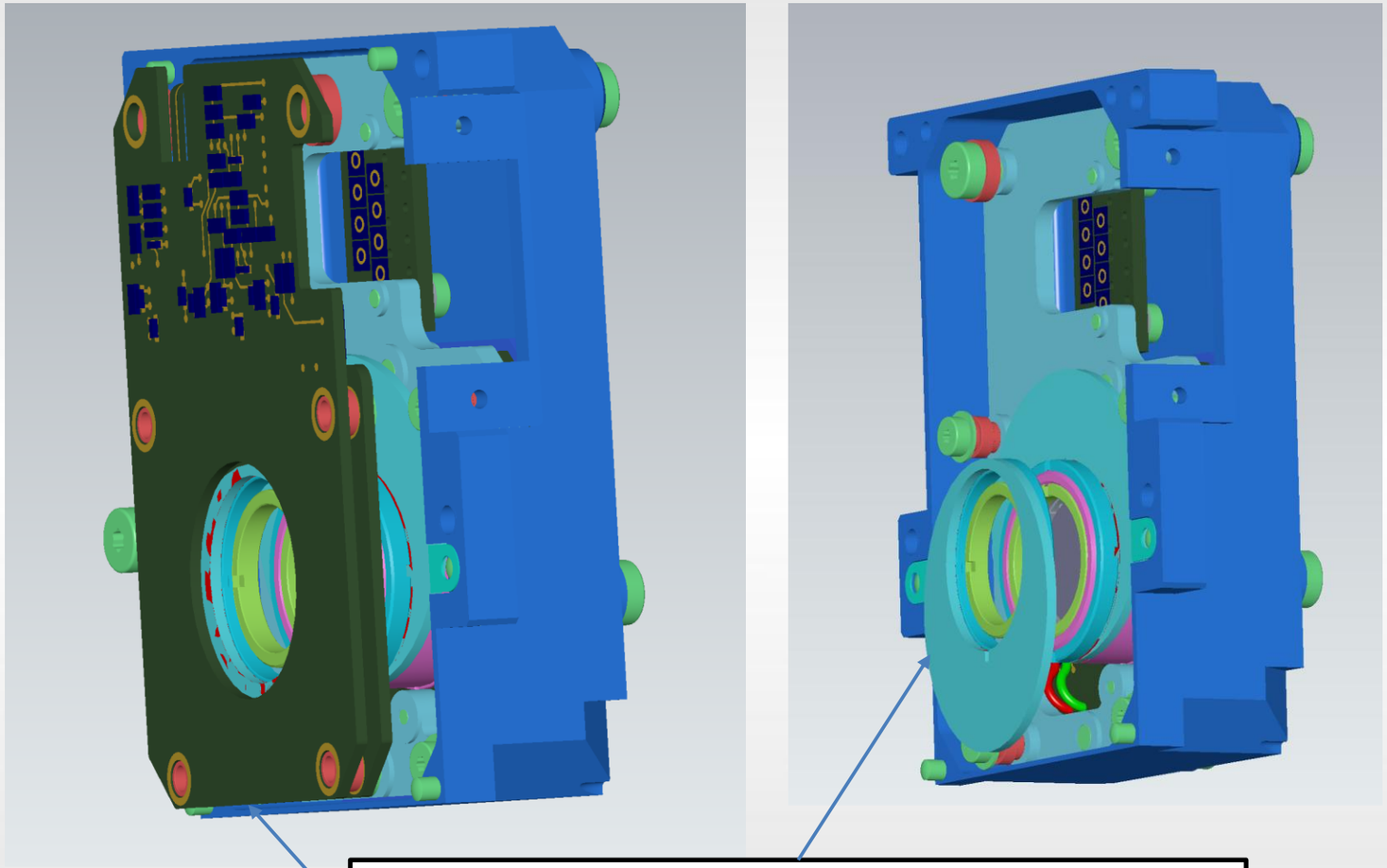




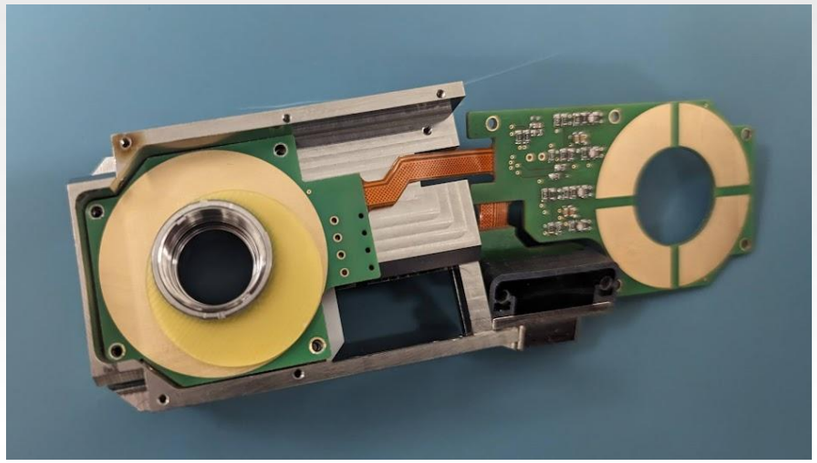
Piezos move the inner ring counter-clockwise

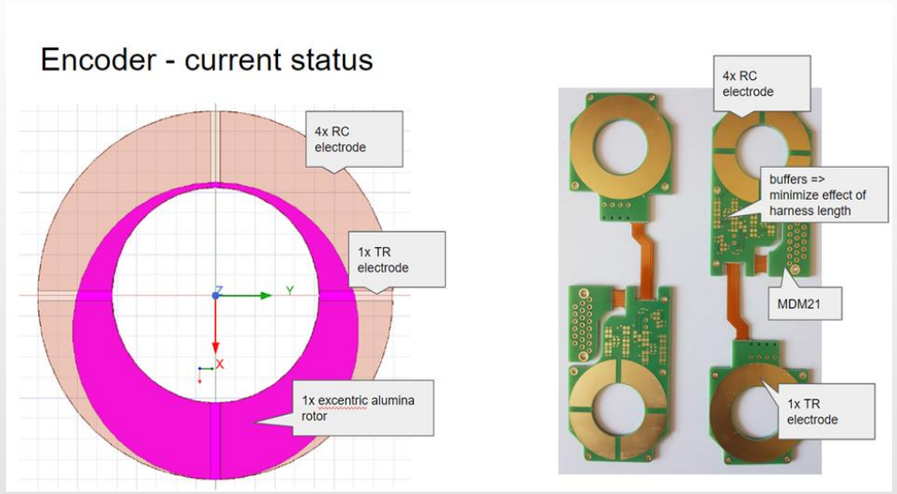
Flexible hinges return it into position

Internal encoder

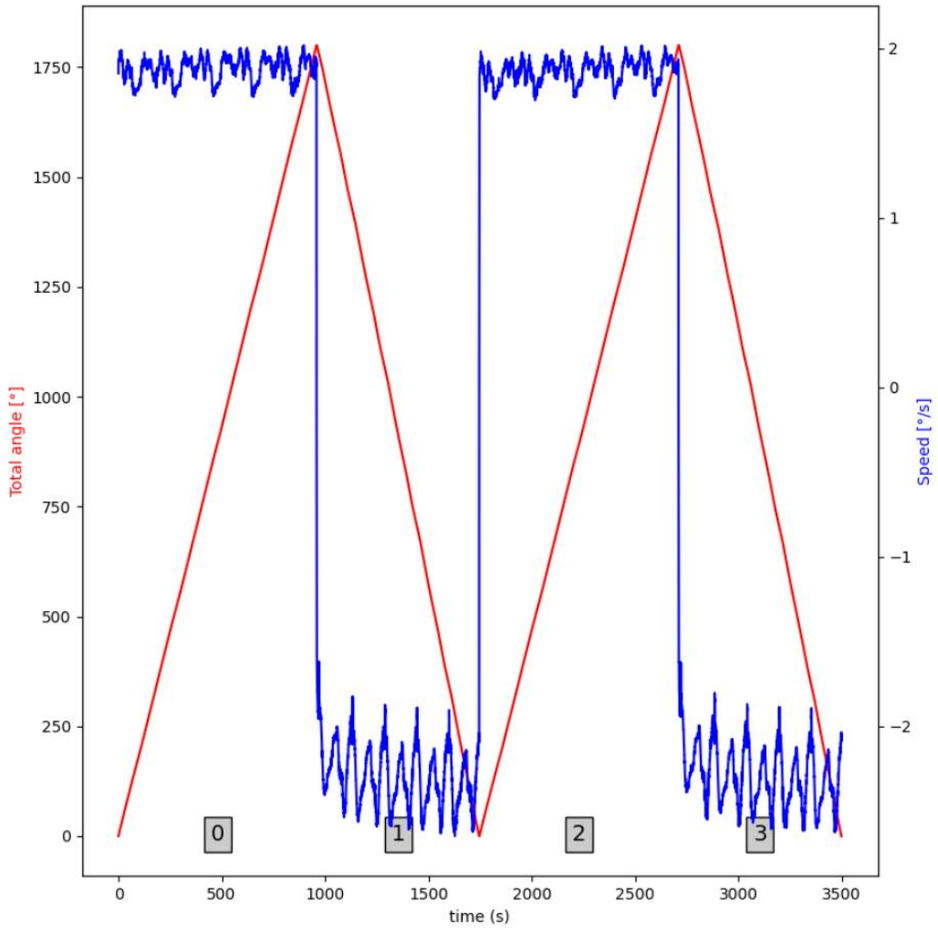


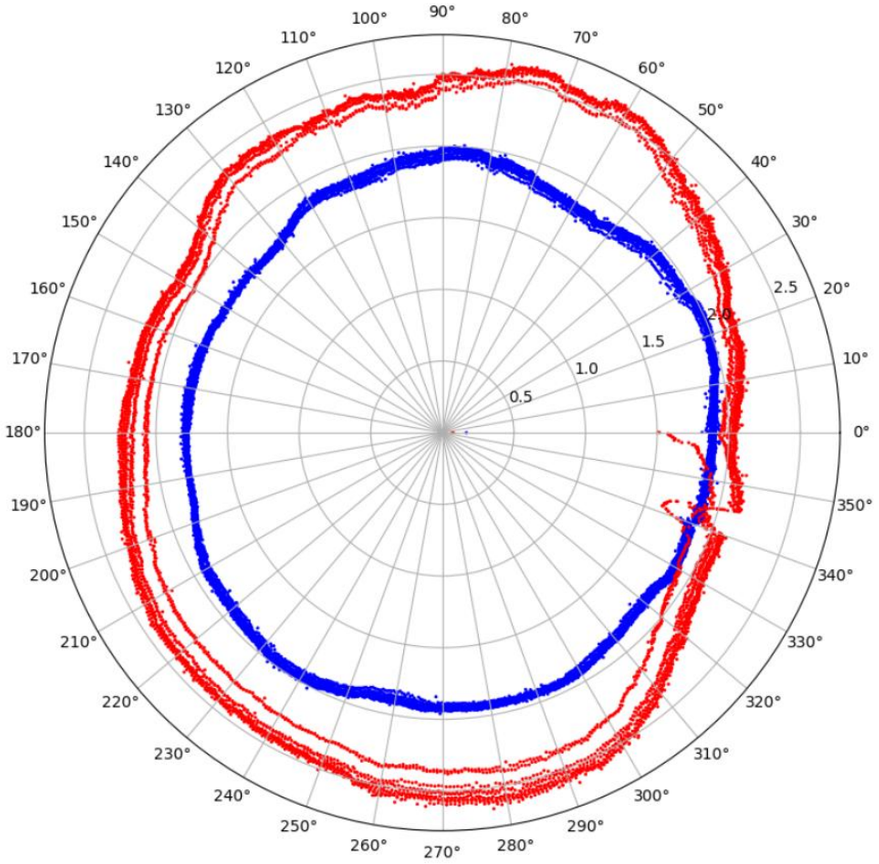
Asymmetric ring in-between two PCBs (electrodes)
Capacitive sensing





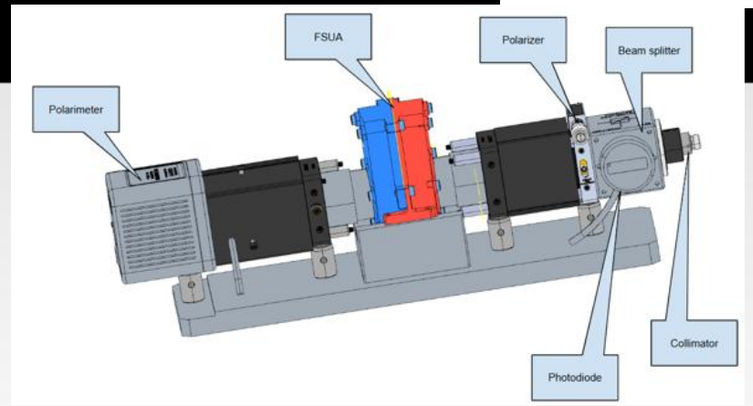
Speed measurement with ext. encoder

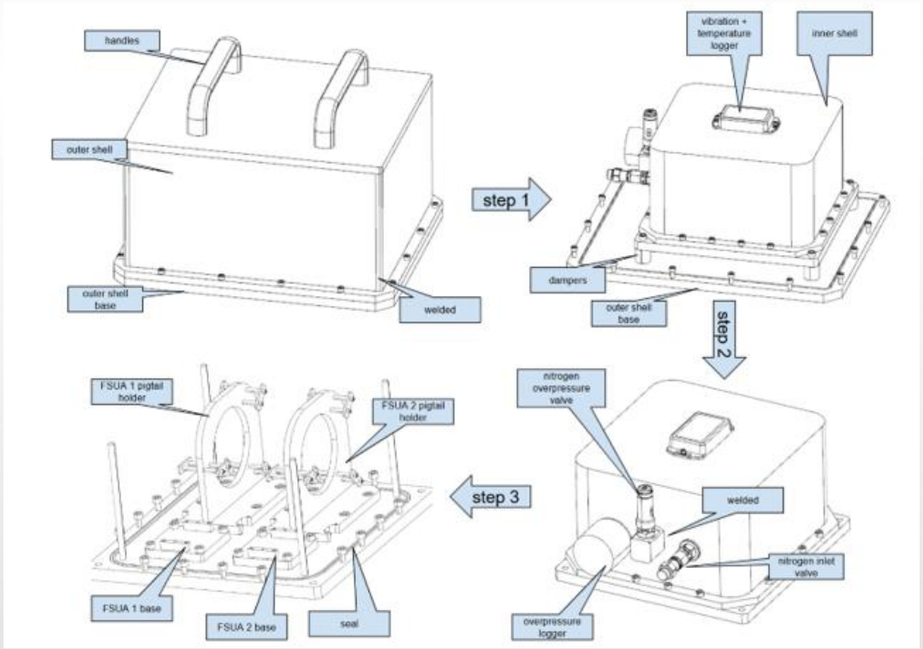


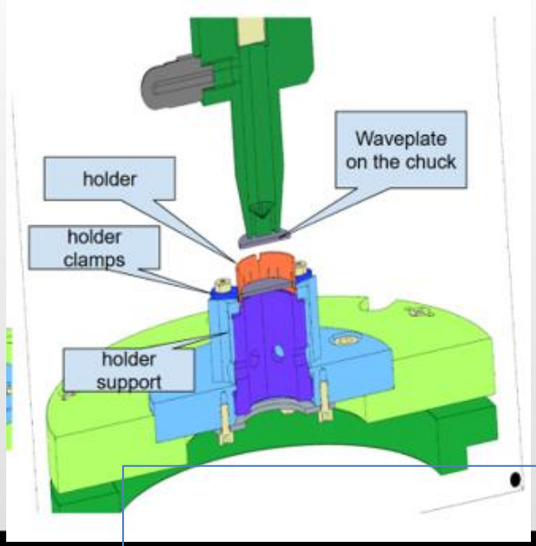


GSE status

- **GSE-CAL** – polarization calibration, being assembled
- **GSE-GLUE** – optics element gluing jig, being produced, tests planned with mockups
- **GSE-FTC** – FSUA transport container – assembled, new CIP interface being produced
- **EGSE** – controls the mechanism, read the internal and optical encoders, is being used for tests with DM







Challenges and Outlook

- We are still receiving changes of the requirements
  - Last one: clearance under the mechanism
  - We finished the Engineering model design already few times ;-)
  - Delivery of the Structural model - within month(s)
  - Core components being manufactured in the final quality for additional testing.
  - Preparing for Preliminary Design Review (need to implement the changes first)