Characterization of the payload of the Type B suspension system for KAGRA according to the prototype experiments at TAMA300

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Outline

- Description of the payload.
- Description of the OSEM.
- Damping the resonances of the suspension.
- Alignment range.
- Pictures of the assembly.
- Mechanical changes to the payload design.
- Conclusion

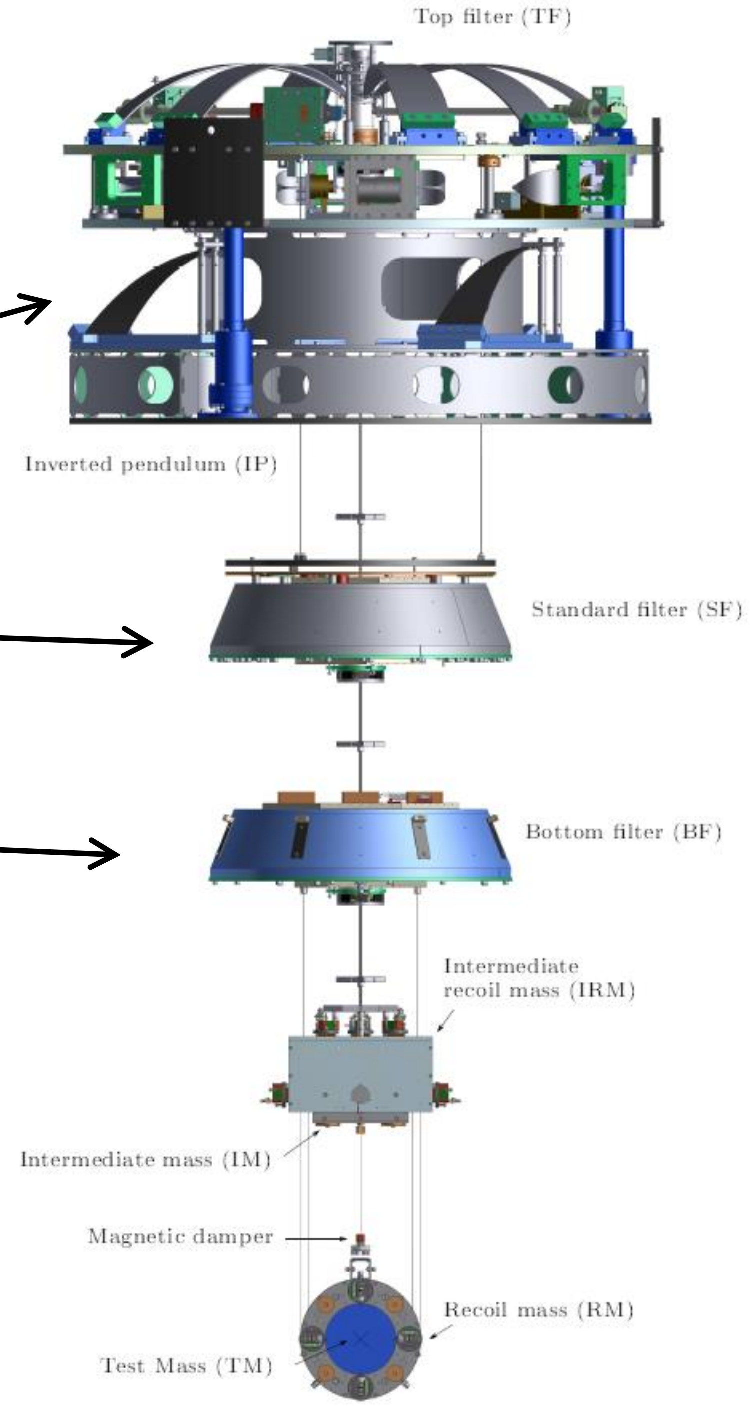
Type B seismic attenuation System

Pre-isolator

Standard GAS filter

Bottom GAS filter

Payload

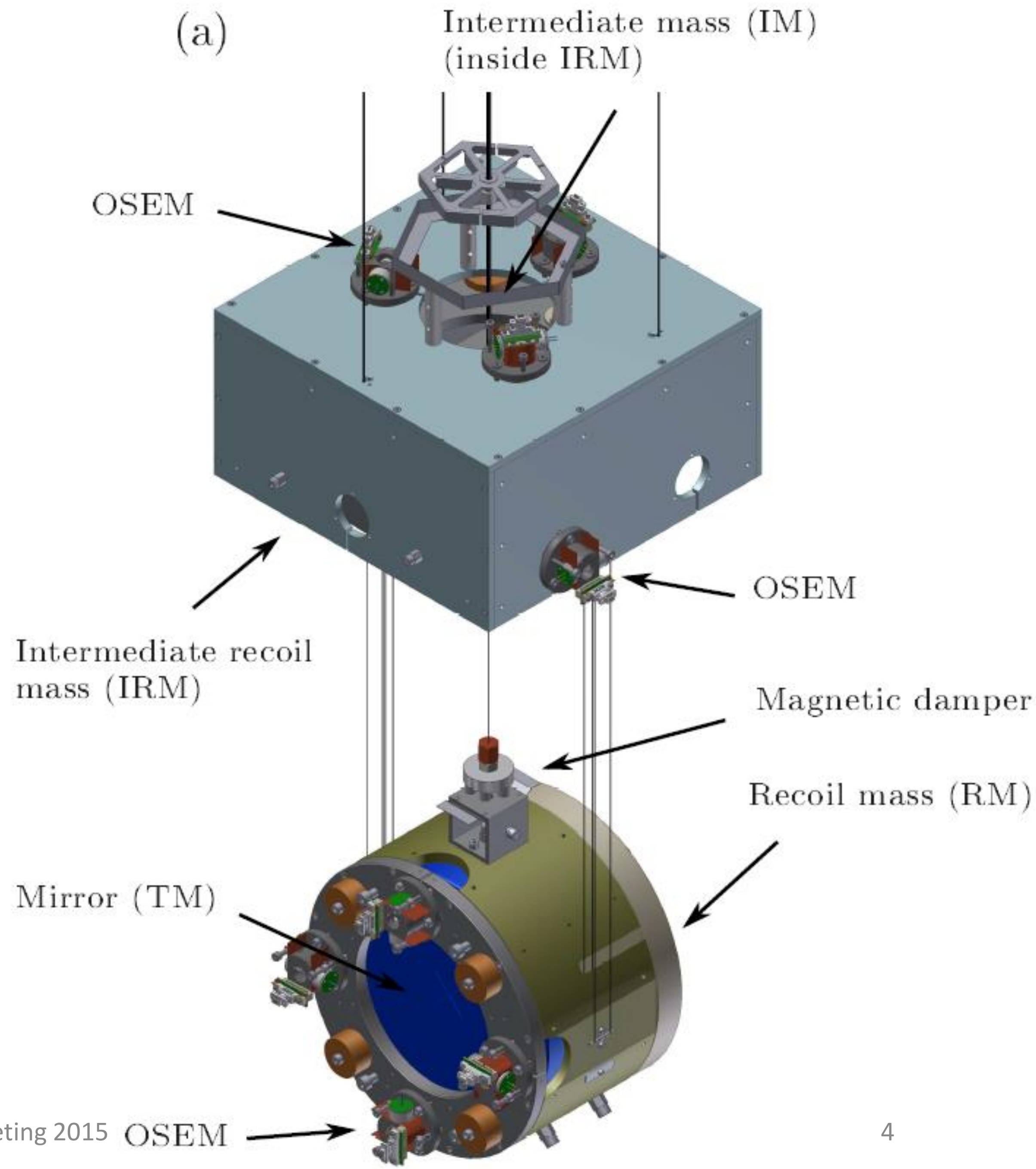


The payload prototype (1)

- Test mass
- Recoil mass
- Intermediate mass (marionette)
- Intermediate recoil mass
- 10 OSEMs

Test mass: 200 µm steel wire.

Recoil mass: 600 µm tungsten wire.

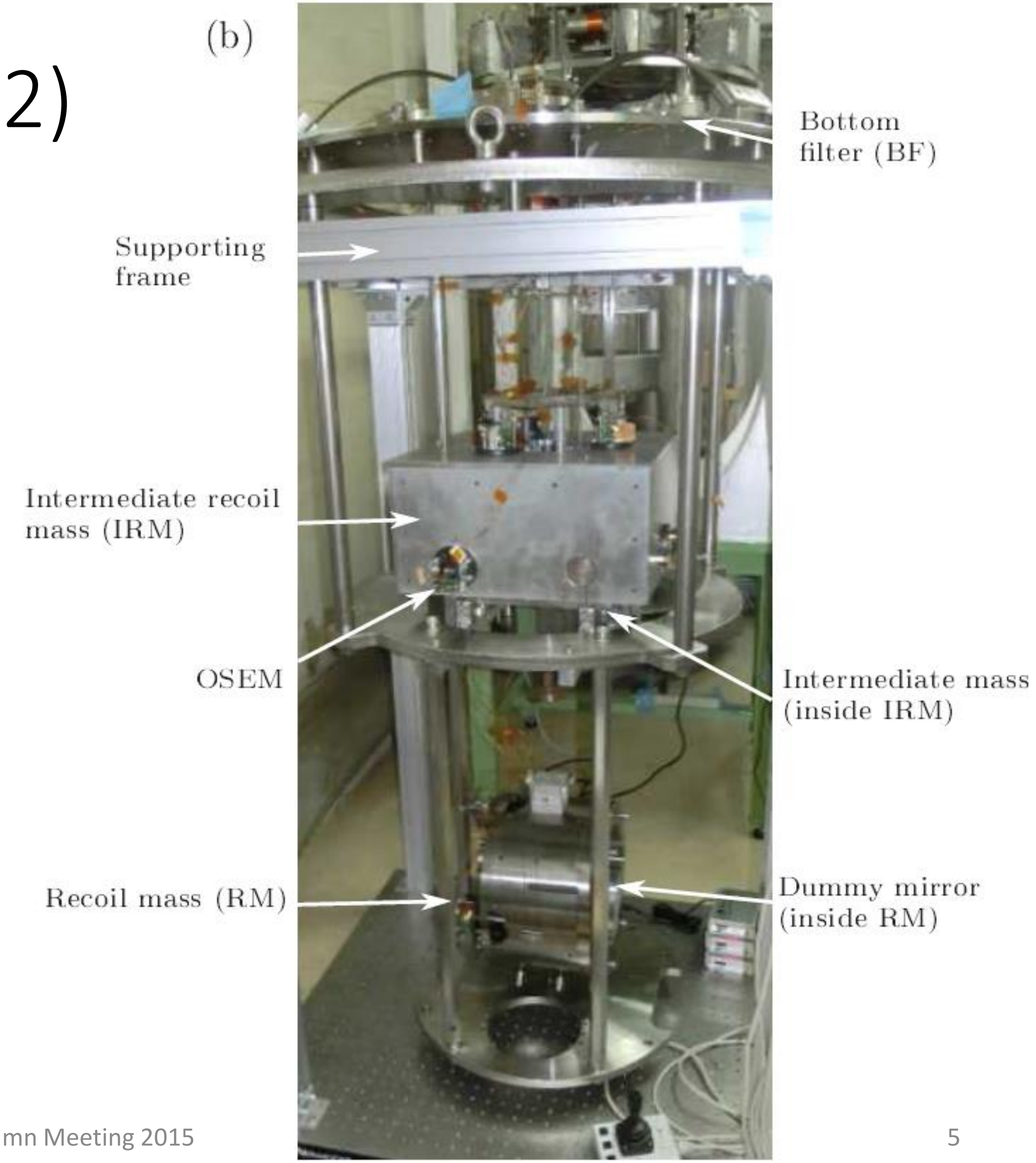


The payload prototype (2)

- Test mass
- Recoil mass
- Intermediate mass (marionette)
- Intermediate recoil mass
- 10 OSEMs

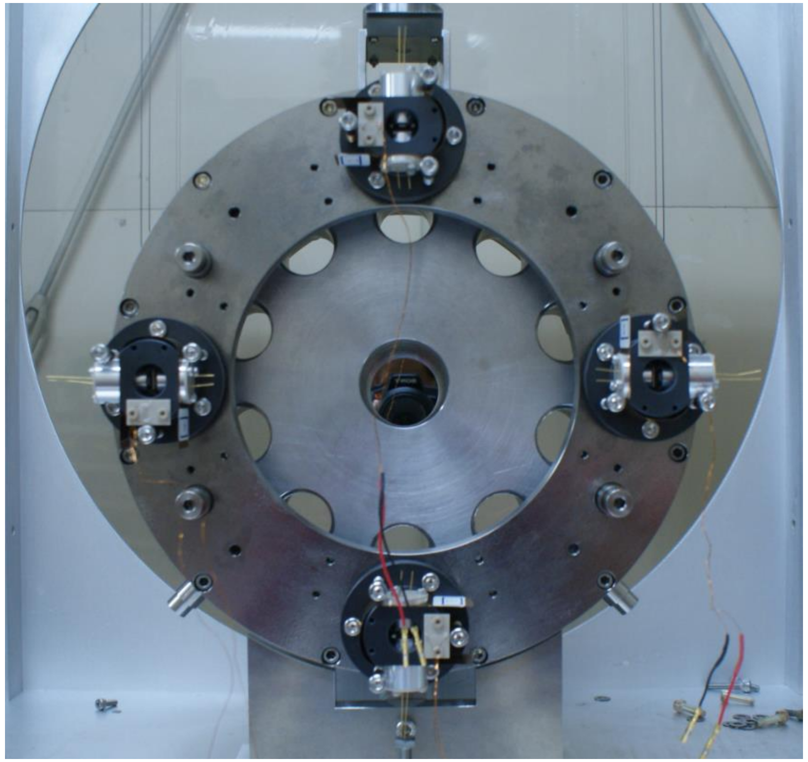
Test mass: 200 µm steel wire.

Recoil mass: 600 µm tungsten wire.



The payload prototype (3)

- Test mass
- Recoil mass
- Intermediate mass (marionette)
- Intermediate recoil mass
- 10 OSEMs

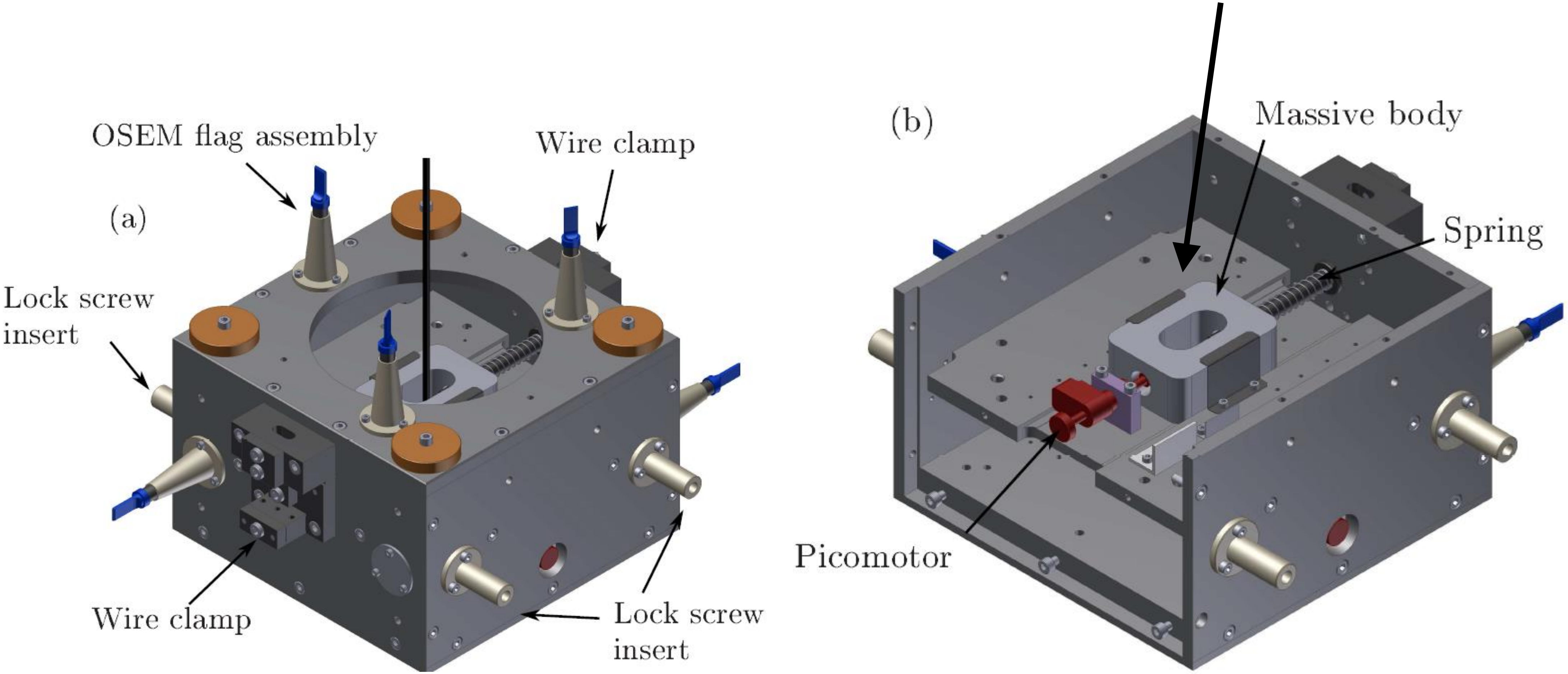


Test mass: 200 μm steel wire.

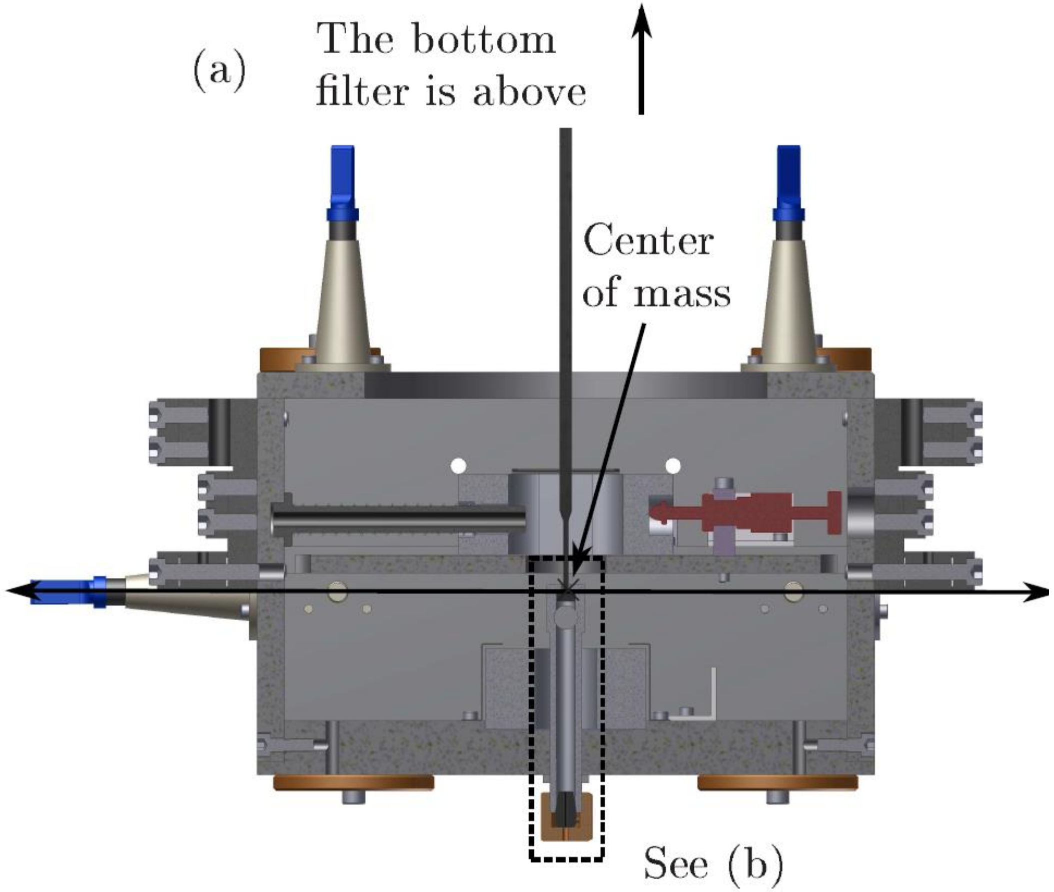
Recoil mass: 600 μm tungsten wire.

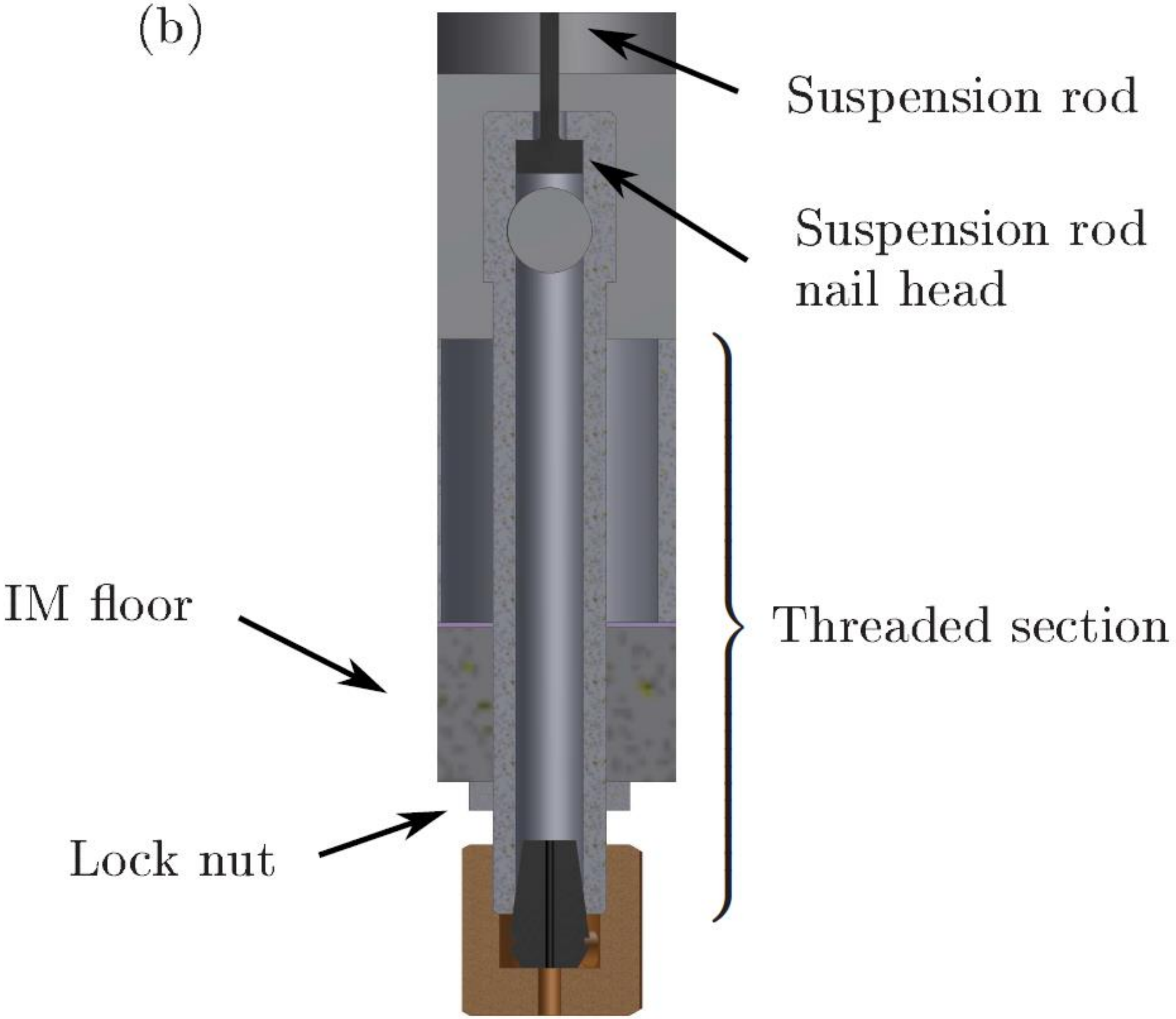
Intermediate mass (1)

It was calculated that this system provides roll and pitch adjustment of approximately ±2.5 degrees.



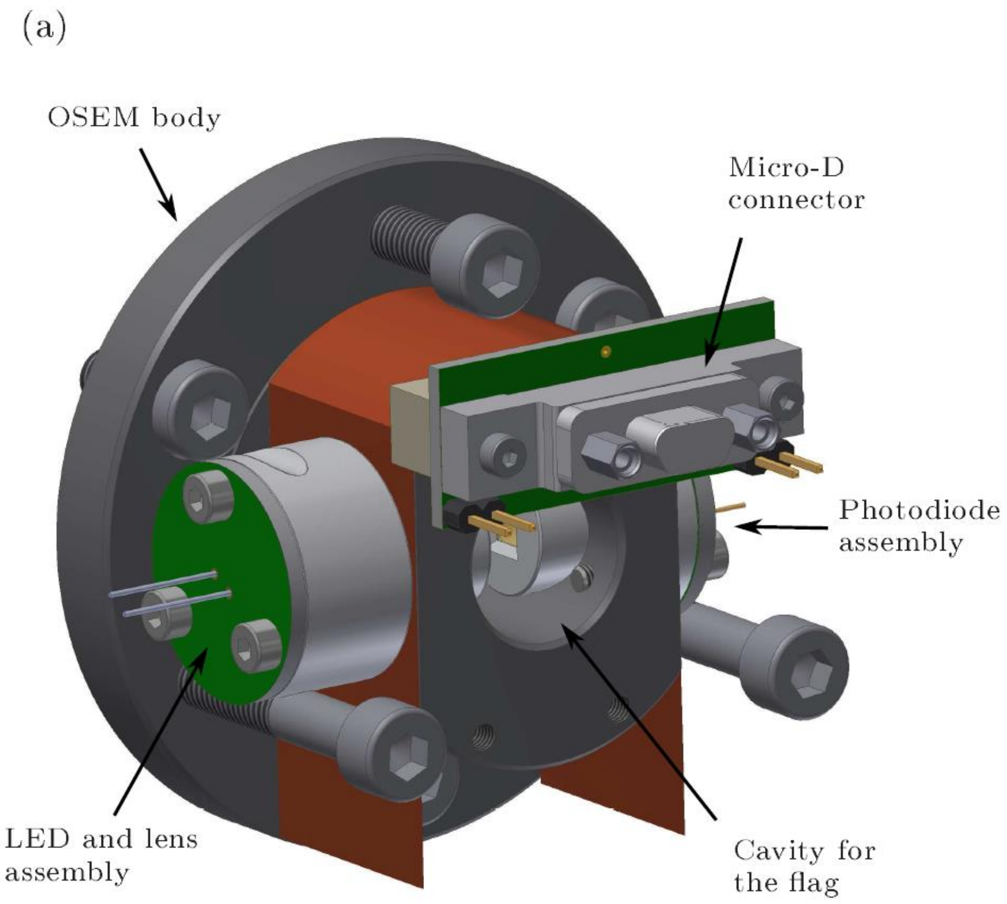
Intermediate mass (2)





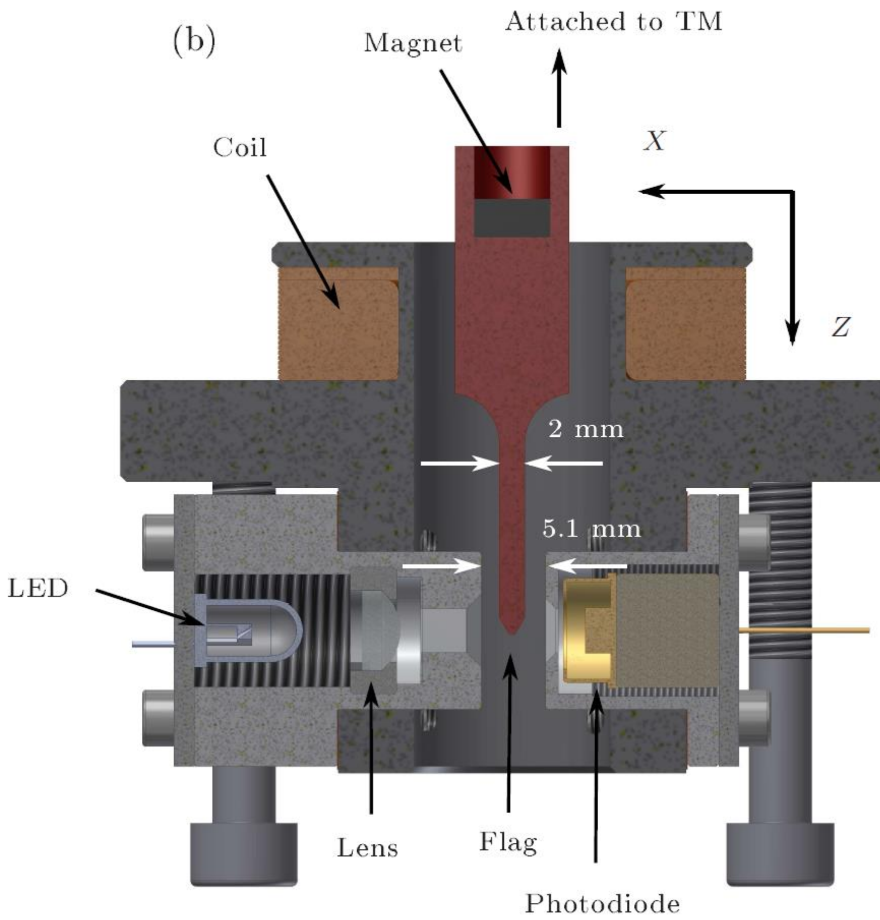
OSEM (1)

- OSEM: Optical sensor and electromagnetic actuator.
- shadow sensor.
- Coil-magnet actuator.

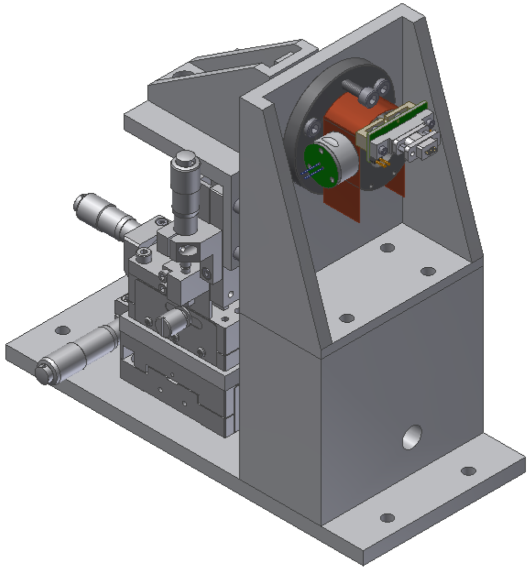


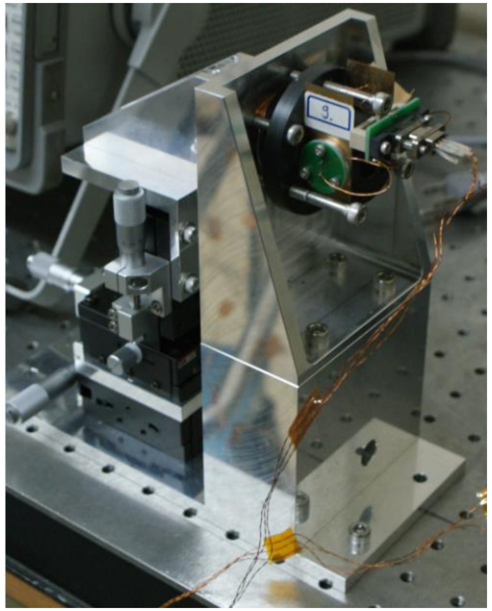
OSEM (2)

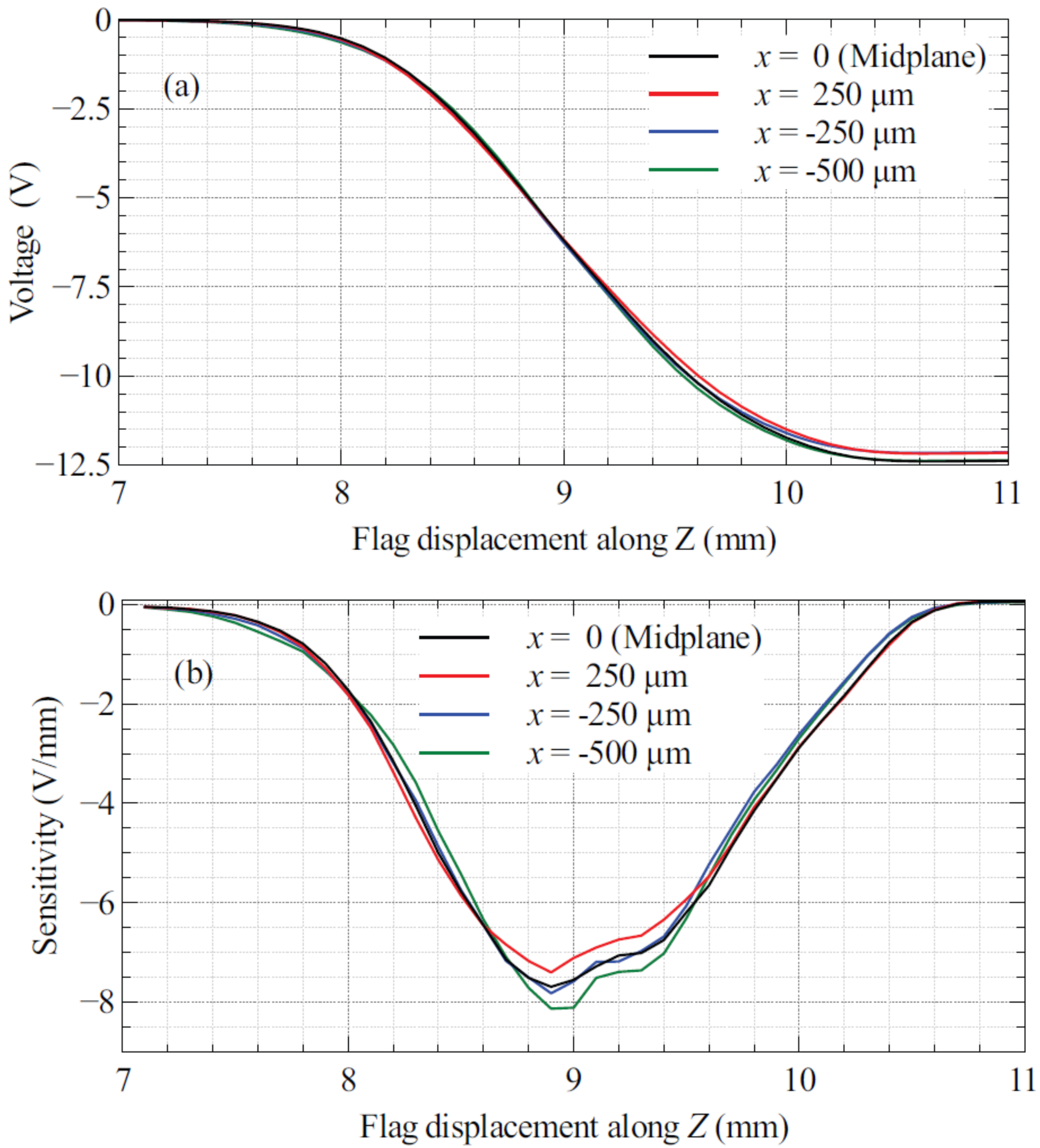
- OSEM: Optical sensor and electromagnetic actuator.
- shadow sensor.
- Coil-magnet actuator.



OSEM calibration



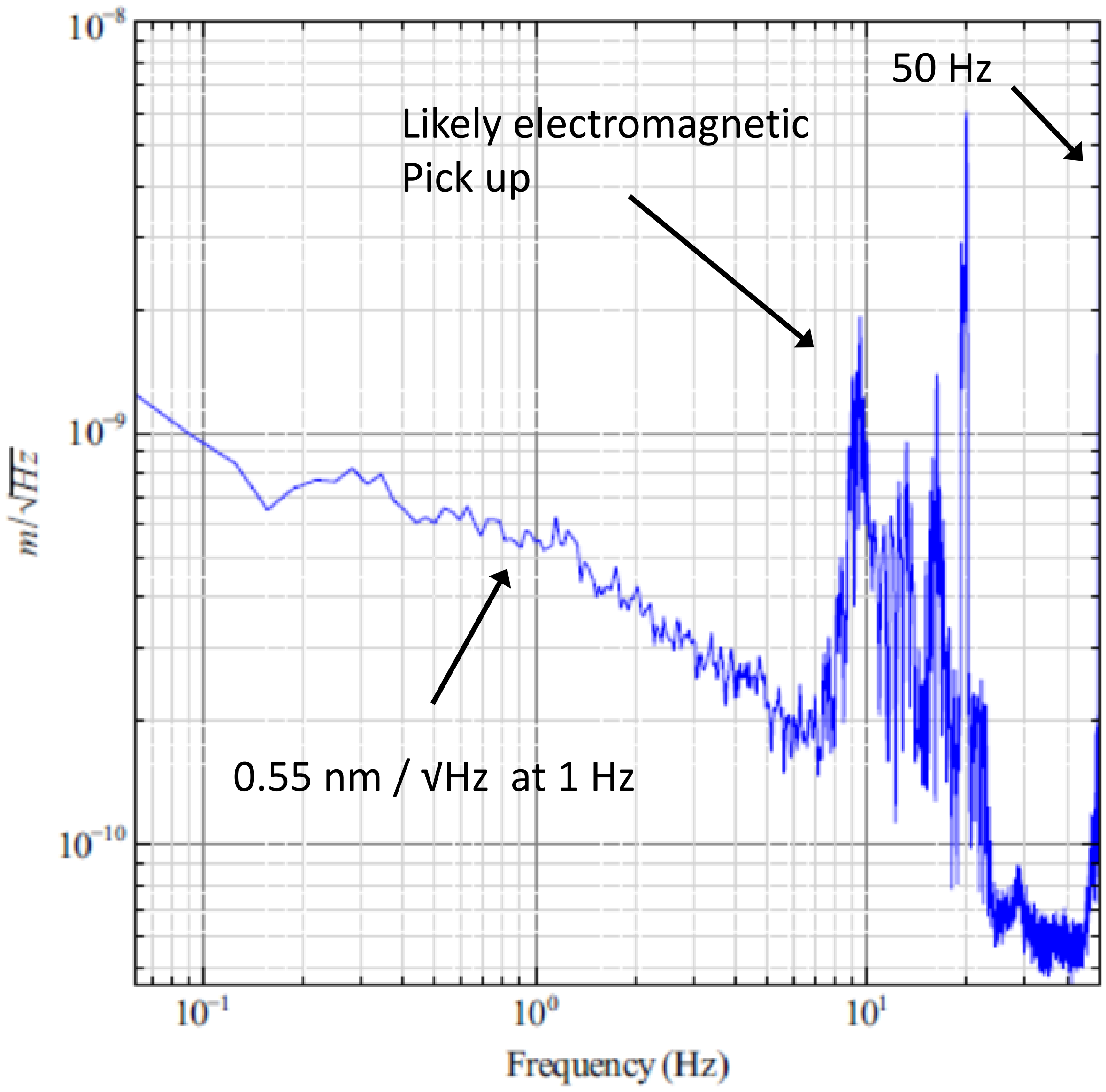




Measurement range (linear regime along *Y*): **1 mm**.

Alignment tolerance (along *X*): **± 400 μm** for a **±5%** error.

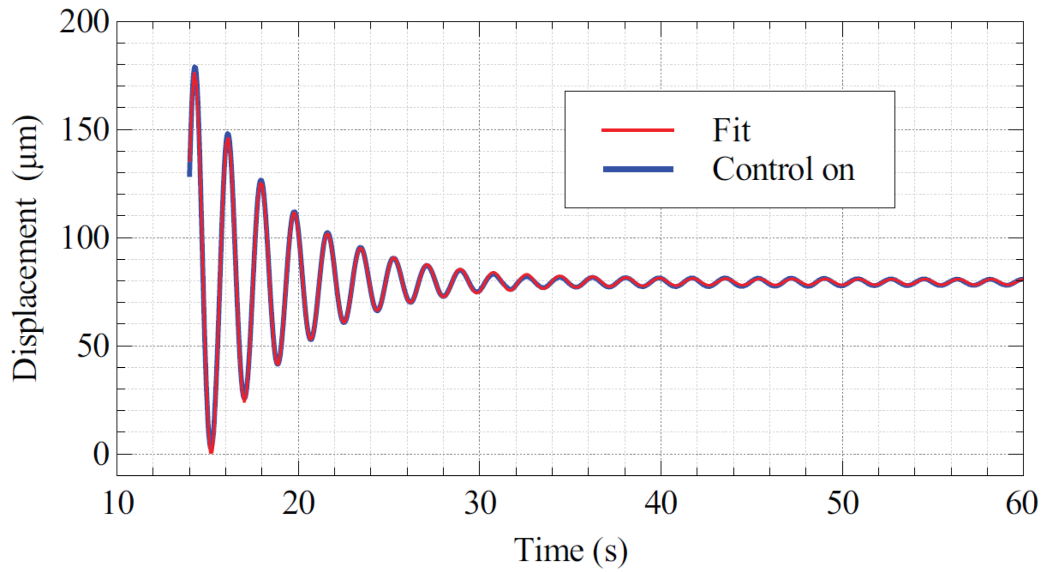
OSEM sensitivity

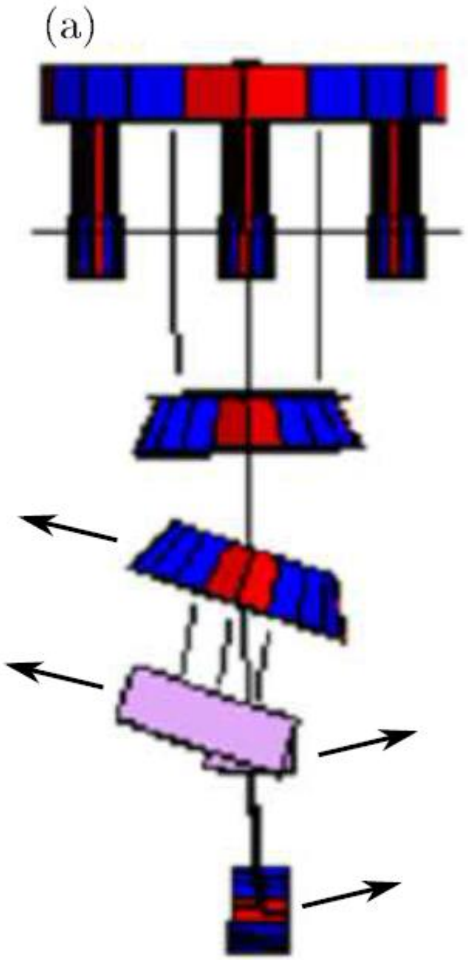


Damping the suspension resonances (1)

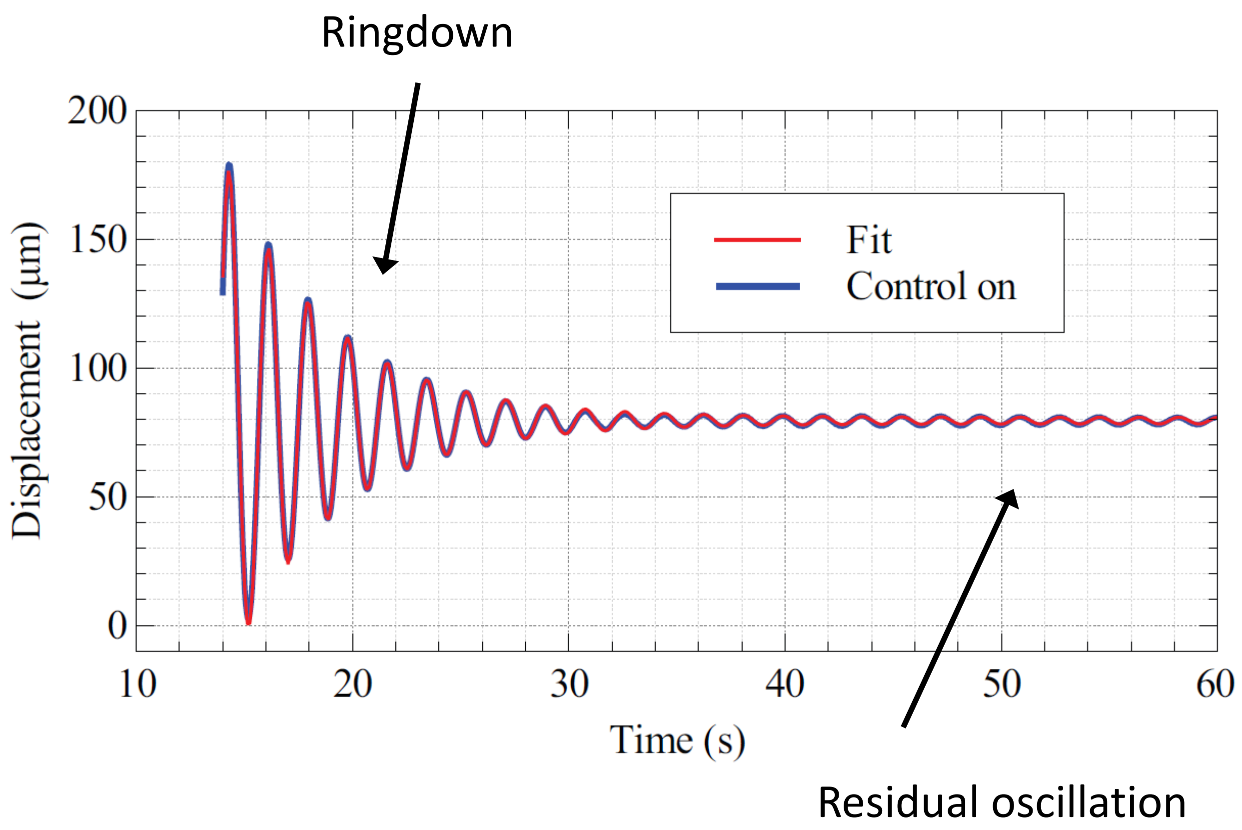
We used the traditional method:

1. The modes were excited separately using the OSEMs.
2. An exponentially damped sinusoidal function was fitted to the ringdown.
3. The quality factor was calculated as $Q = \pi f_0 \tau$.



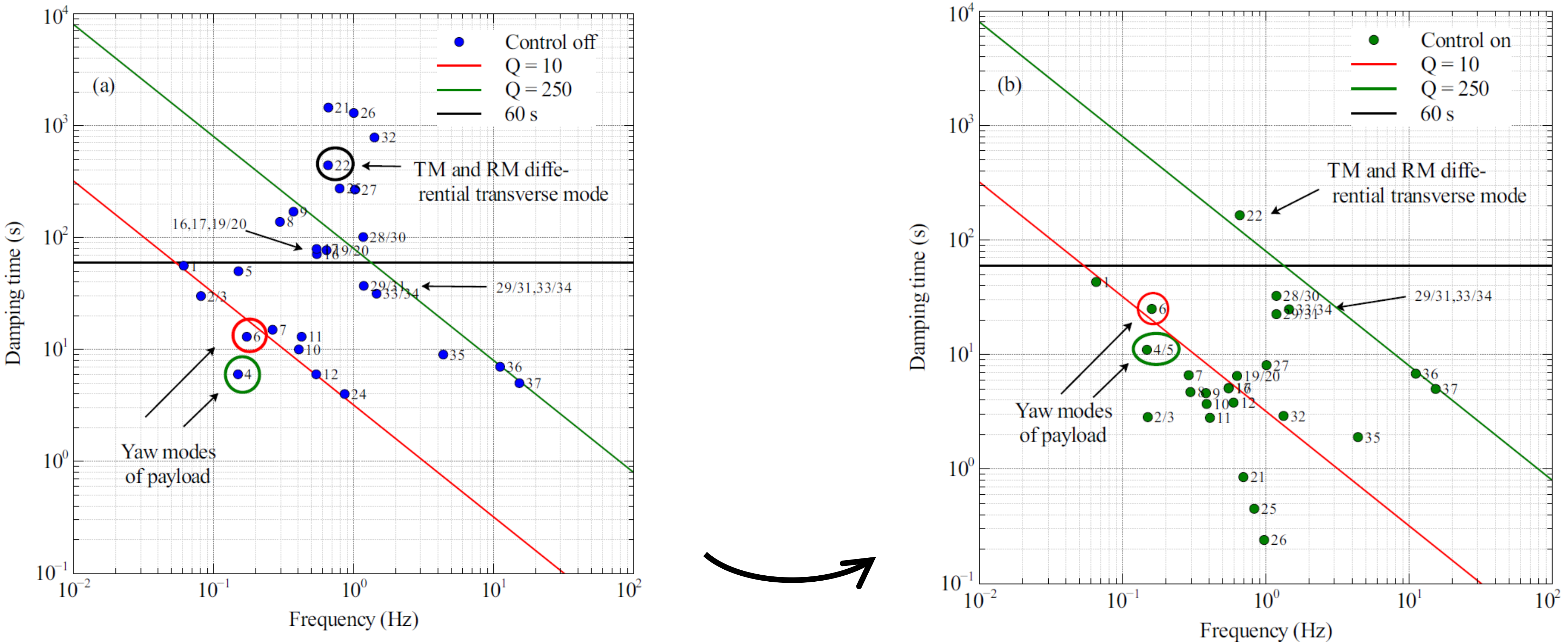


Damping the suspension resonances (2)



- The residual oscillation may be seismic motion not filtered by the chain.
- However, that requires other frequencies to be present in the residual movement because the resonant peak becomes wider.
- More investigation is needed.

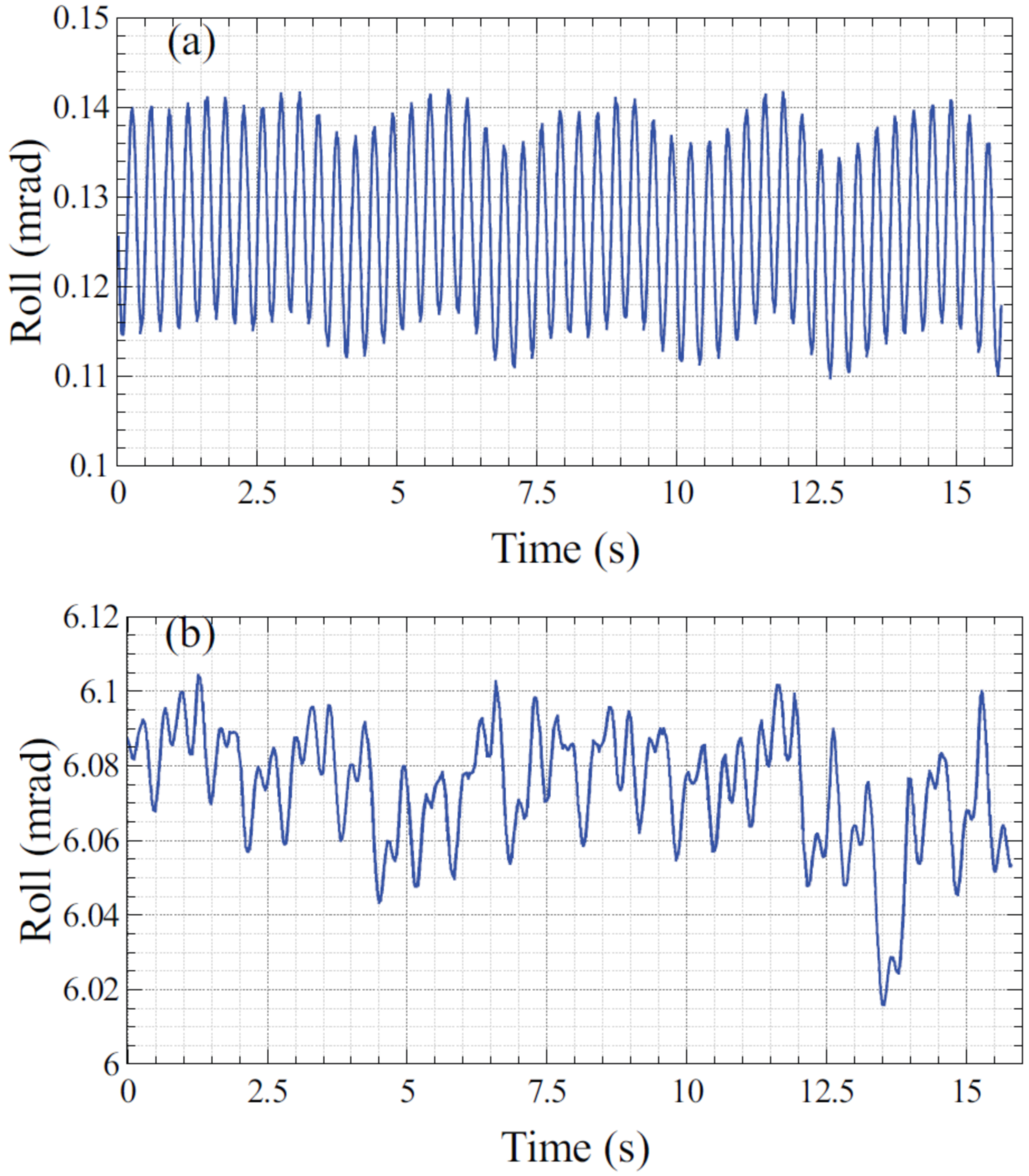
Damping the suspension resonances (3)



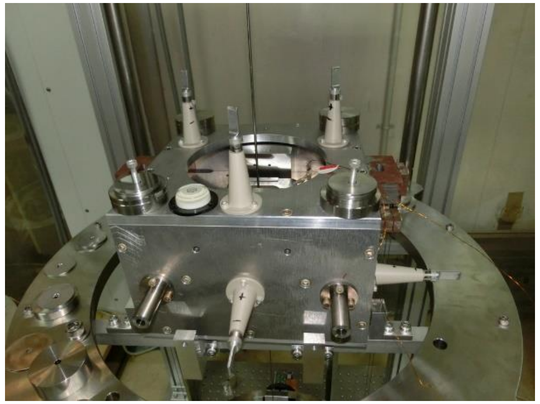
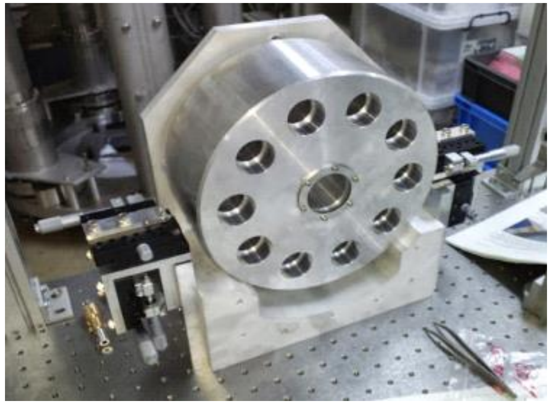
Vacuum broken

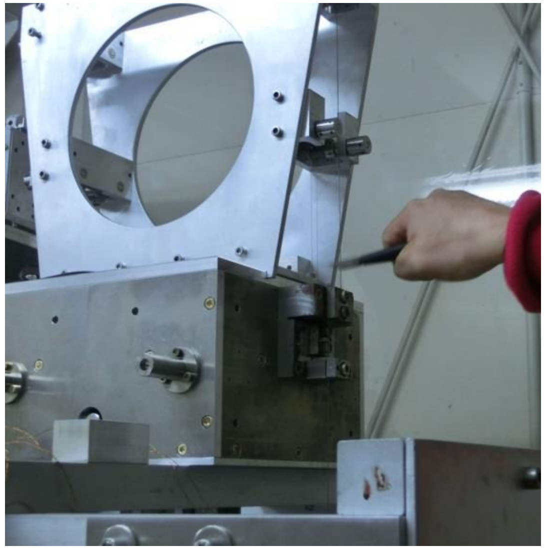
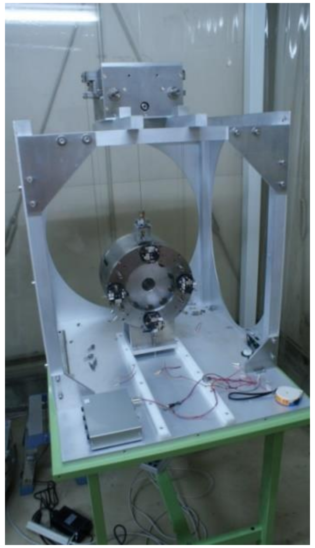
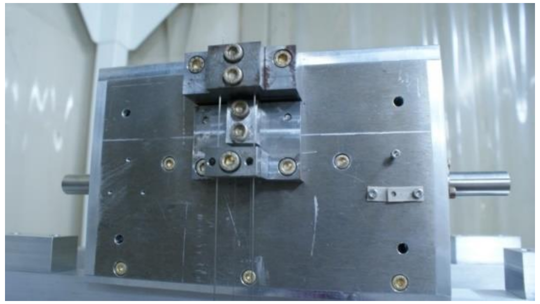
Alignment range

DOF	Minimum (mrad)	Maximum (mrad)
Roll	-4.7	5.9
Pitch	-5.0	5.0
Yaw	-1.8	3.5

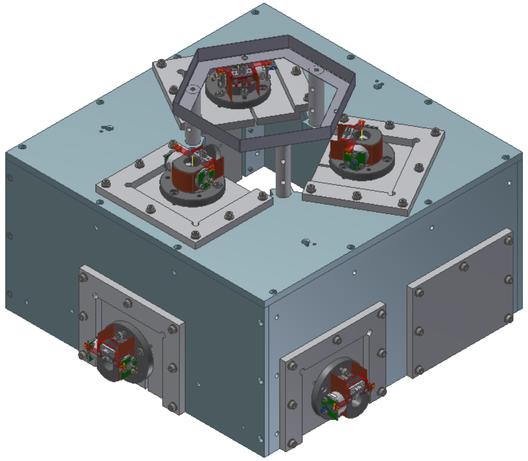


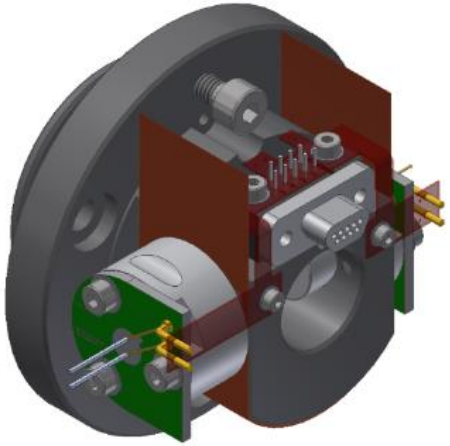
Assembly of the payload

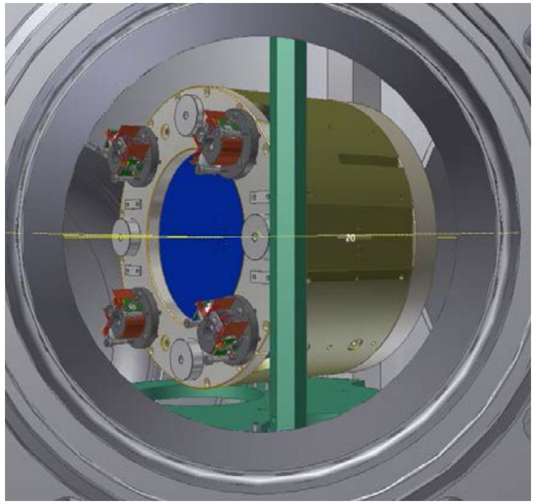



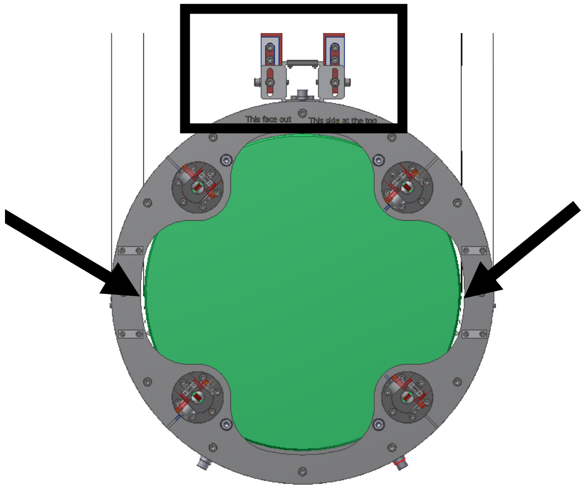





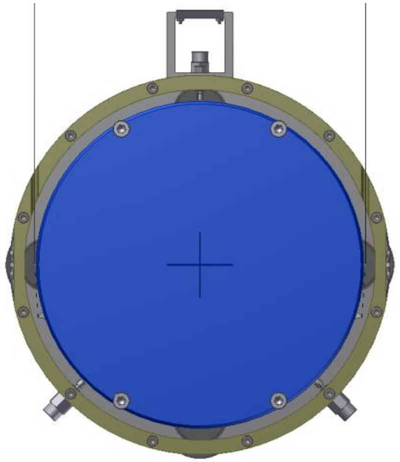
Changes in the payload

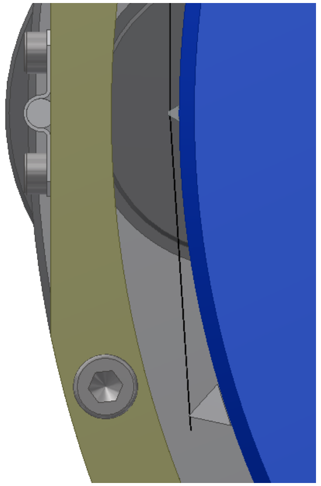


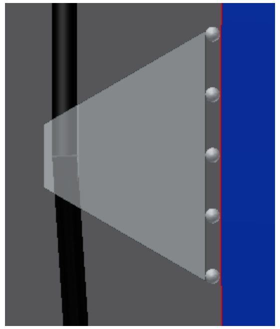












Conclusions and future work

- The payload prototype was assembled and tested at NAOJ.
- Values of quality factors were given with the active control on:
  - We require to increase the stiffness of the damper suspension (mode #22).
  - The filter has to be checked (modes #4 and #6).
- Alignment range of the payload was given.
- The mechanical design was changed in order to ease the assembly.
- Installation work at Kamioka will begin soon.