Driven by innovation

JPE PRESENTATION

Active vibration isolation for Cold Finger Einstein Telescope

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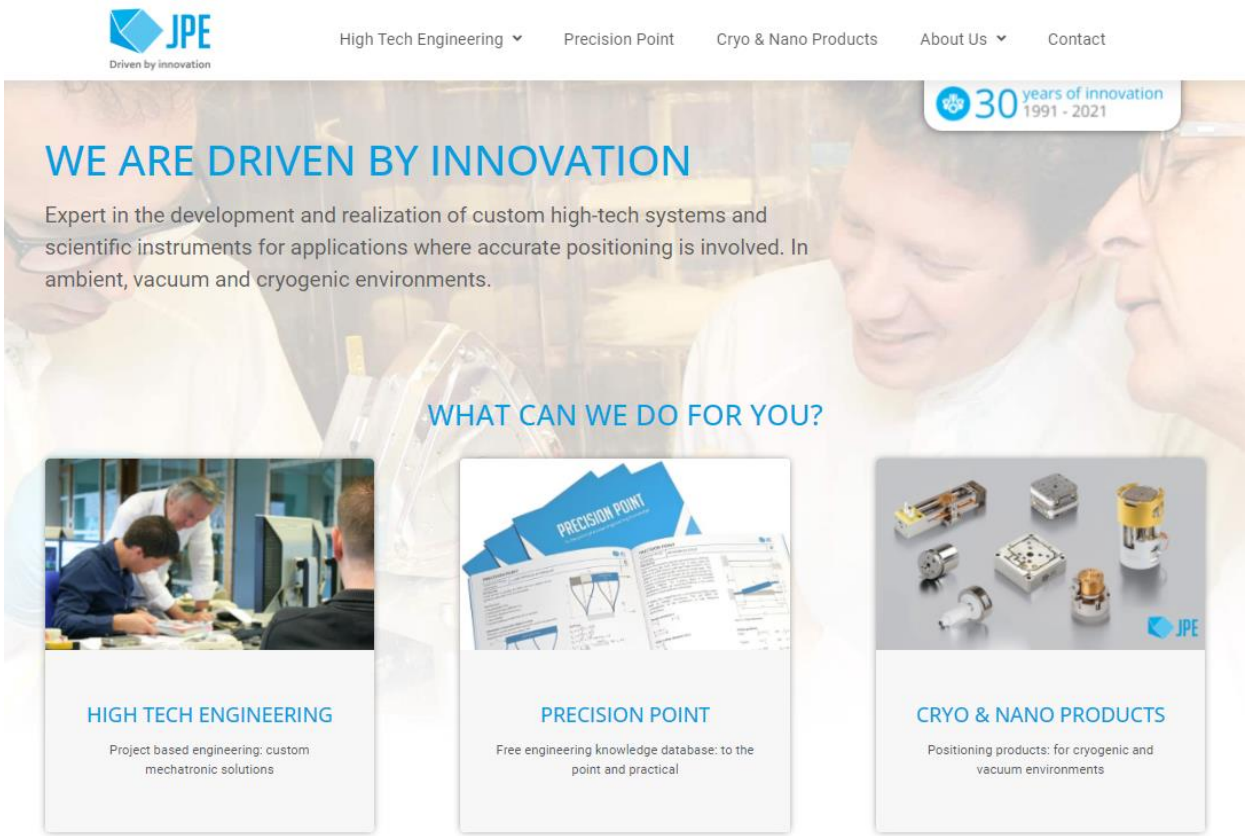
JPE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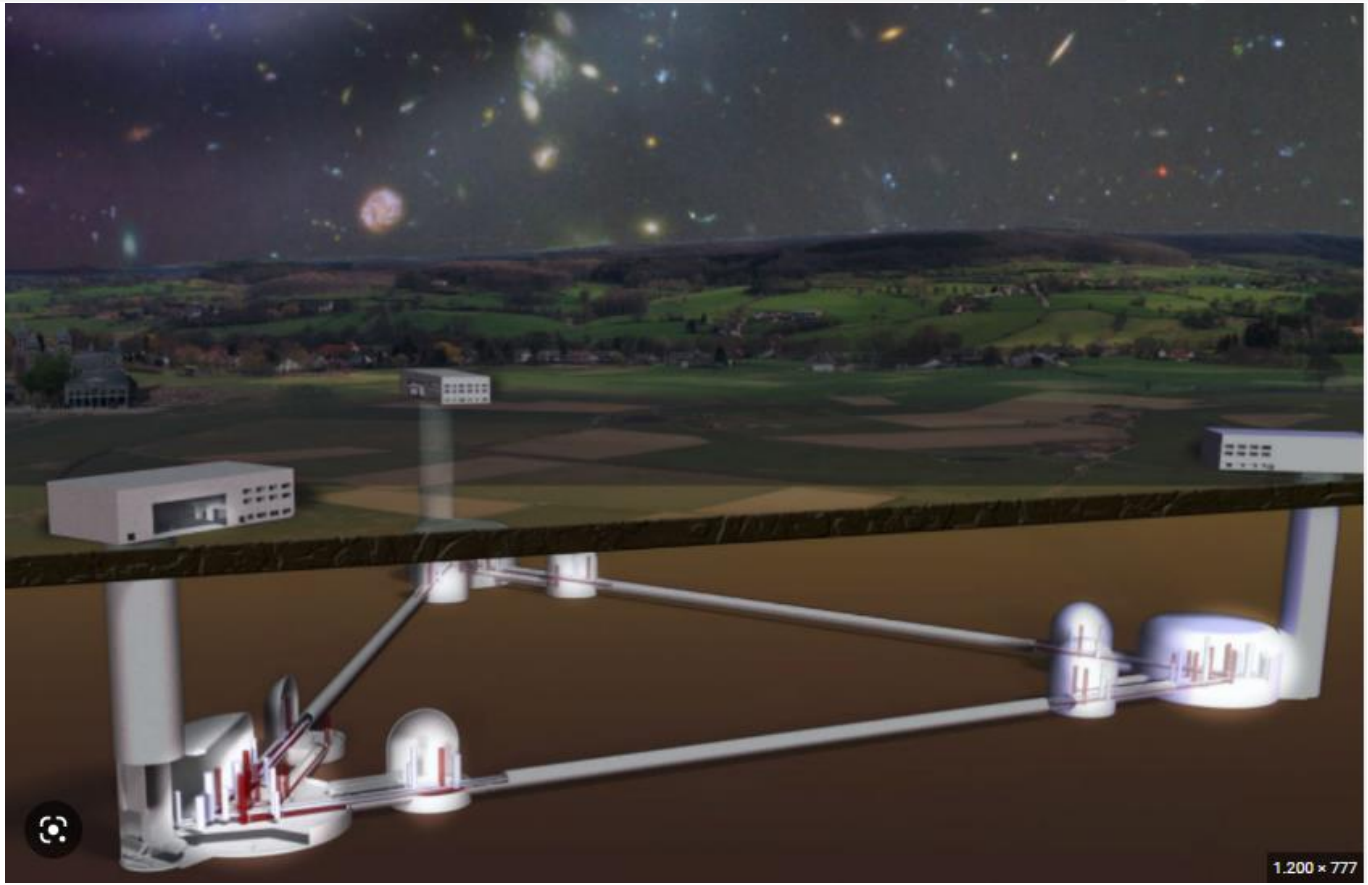
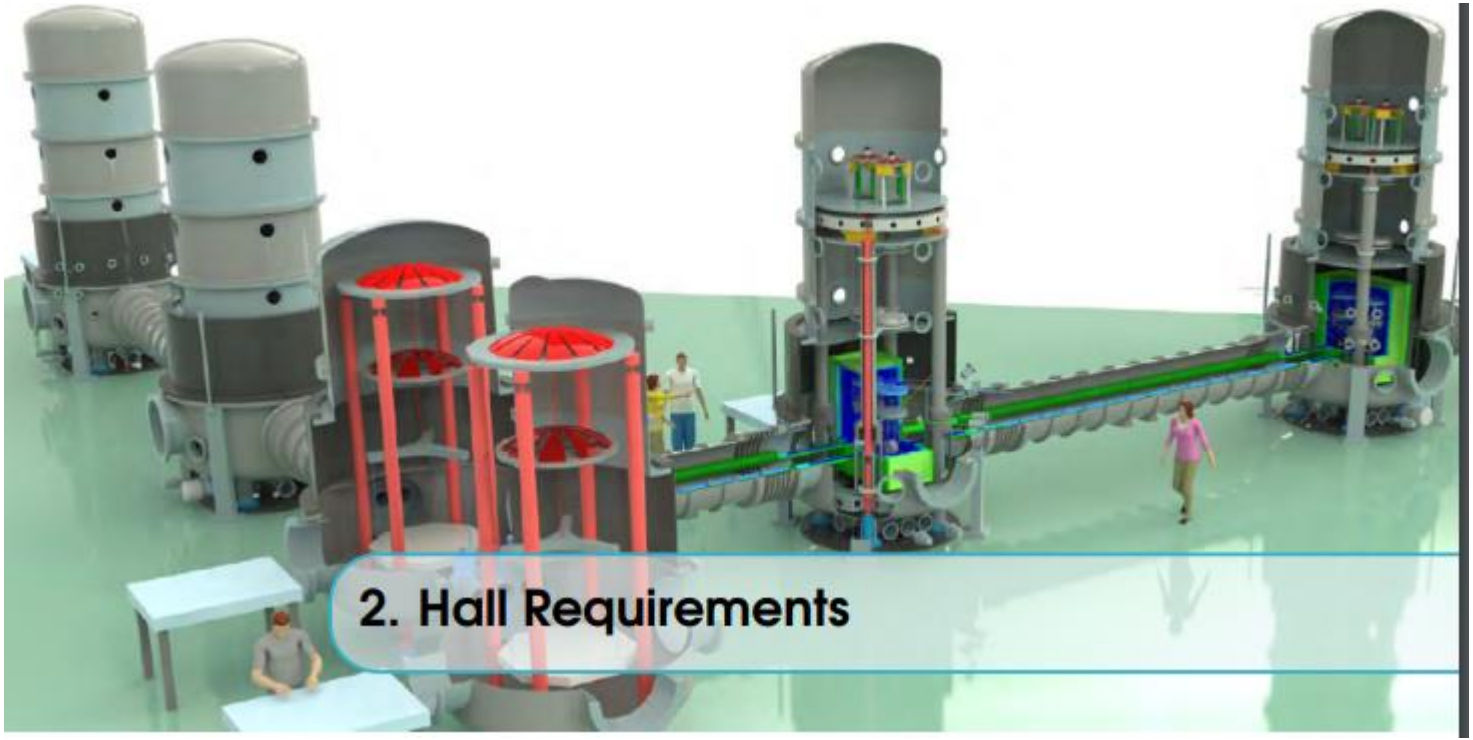
Einstein Telescope

- Einstein Telescope – ET Pathfinder
- How is JPE involved?
- Design of cryogenic vibration isolator.
- Test evaluation.

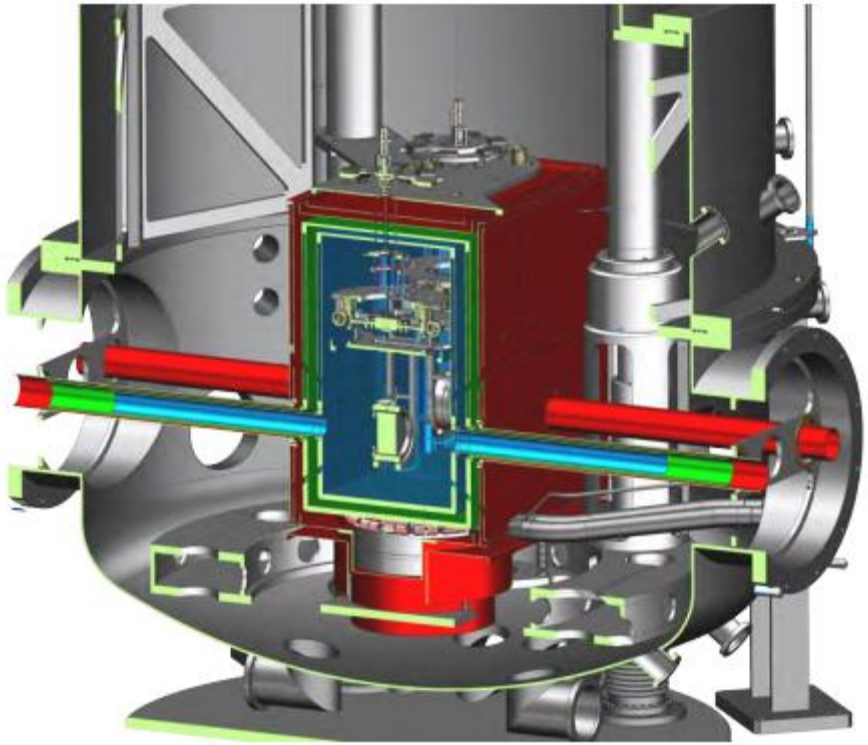
Einstein Telescope



ET Pathfinder Universiteit Maastricht

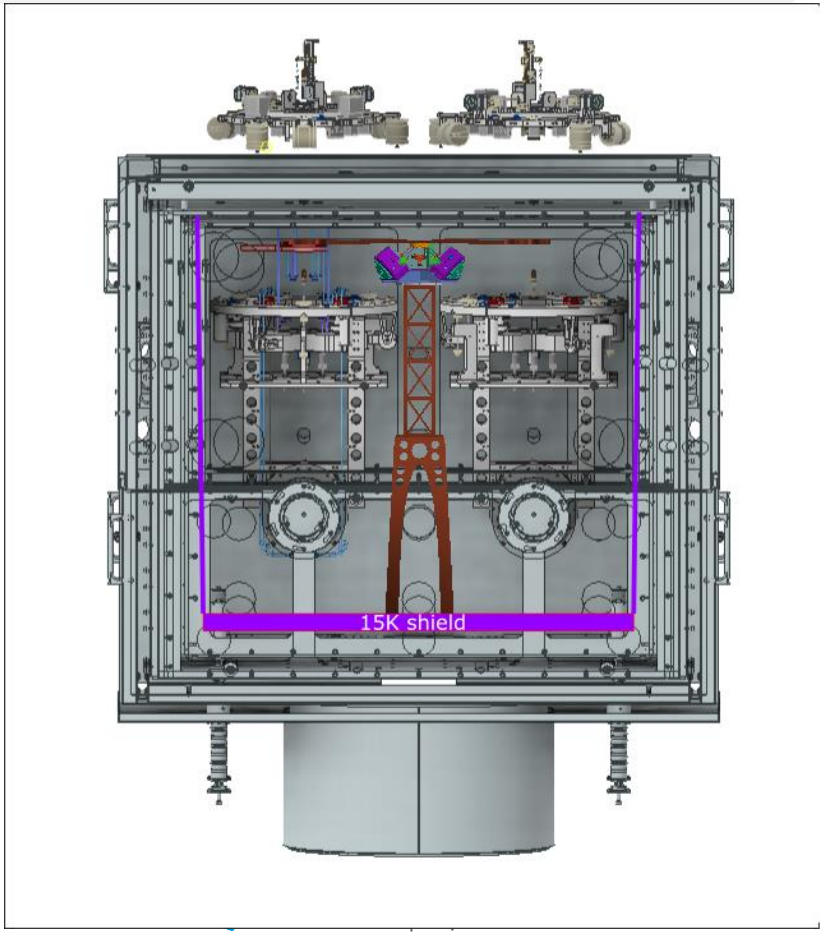


Mirror suspension



Cold finger

- Cold Finger



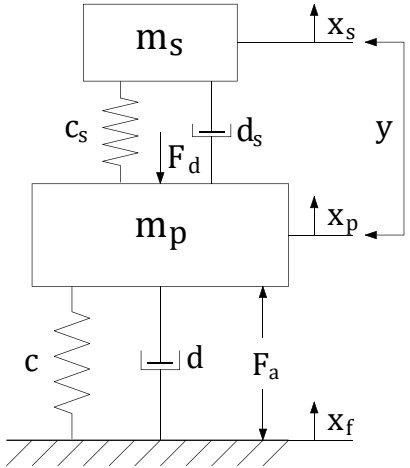
How is JPE involved?

- Proven track record on accurate positioning in vacuum and cryogenic environment.
- In house development of cryogenic positioners with nanometric resolution.
- Vibration challenges from customers in scientific research.

Design of cryogenic vibration isolator

- **Requirements**
  - XYZ isolation of Cold Finger
  - Compact volume (250 mm diameter and 200 in height)
  - Low payload mass
  - Resonance frequency about 1 Hz (low pass filter)

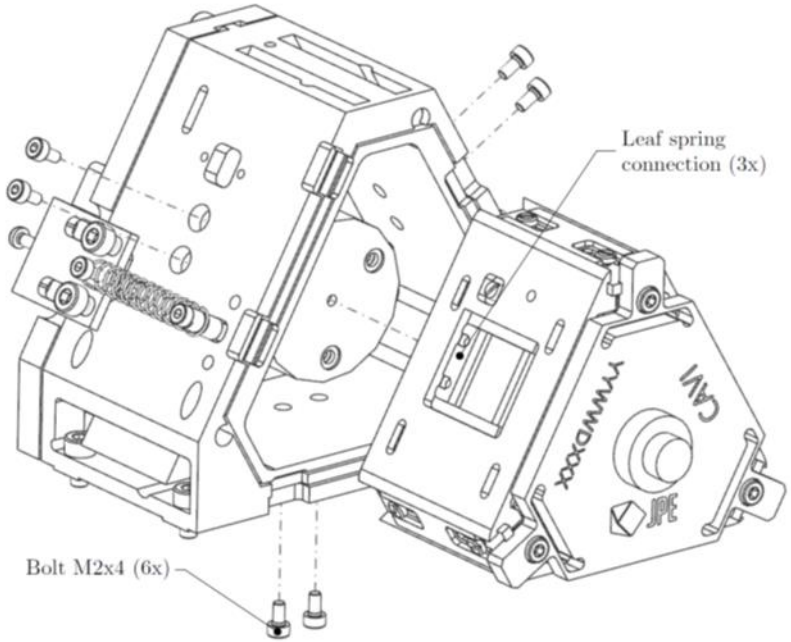
Mechatronic concept



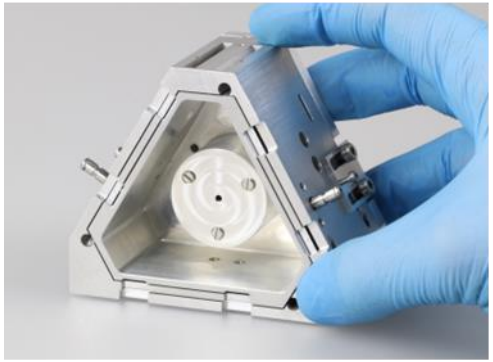
The mechanical design is based on the following key items:

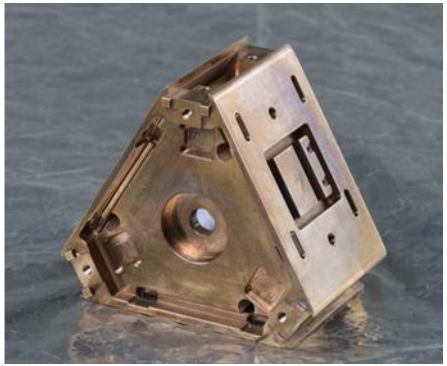
- Completely frictionless guides of payload mass and sensor mass by introduction of flexure elements.
- Magnetic gravity compensation of sensor mass.
- Force actuation by means of cryogenic compatible voice coil actuator.
- Displacement measurement by means of optical interferometer.
- Gravity compensation of payload mass by mechanical spring.

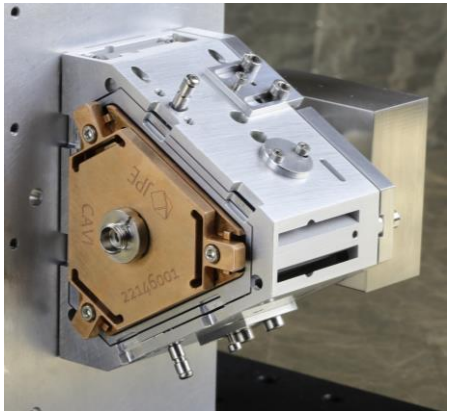
Mechanical layout

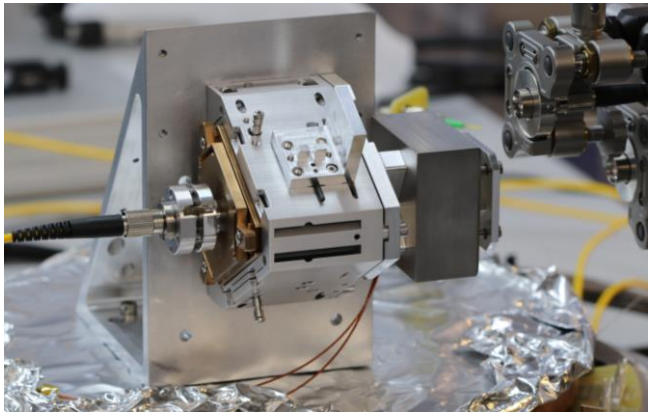


Mechanical layout



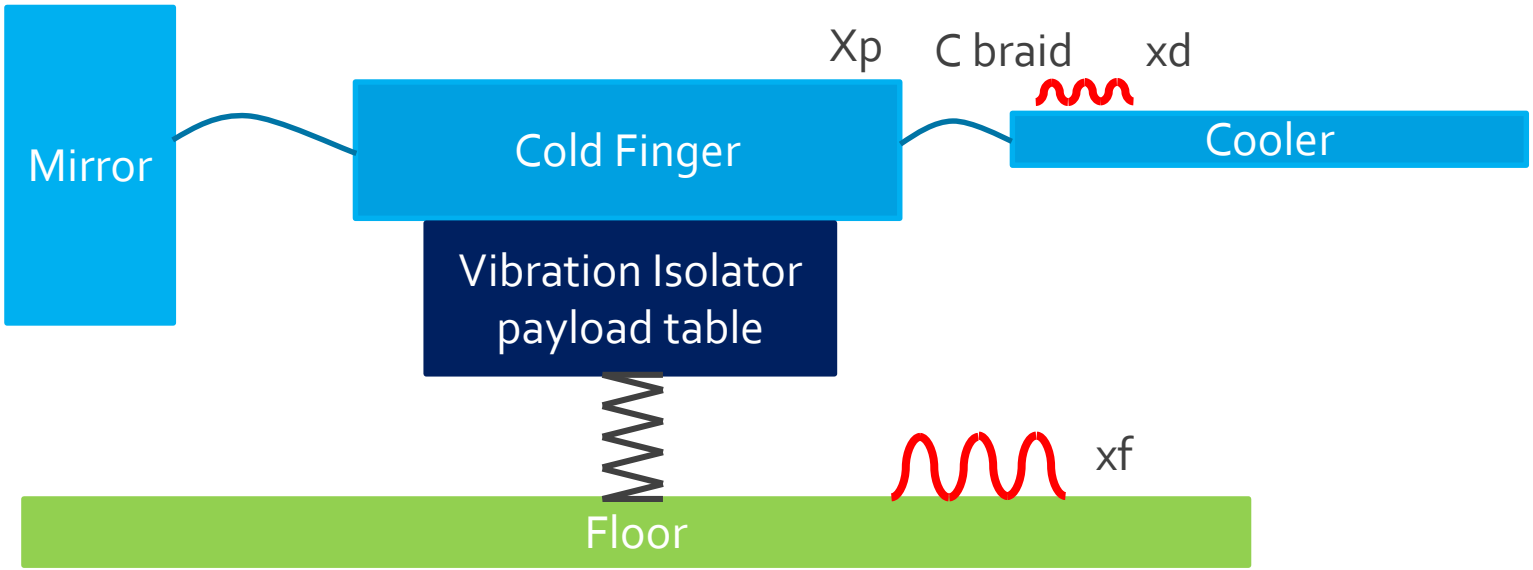






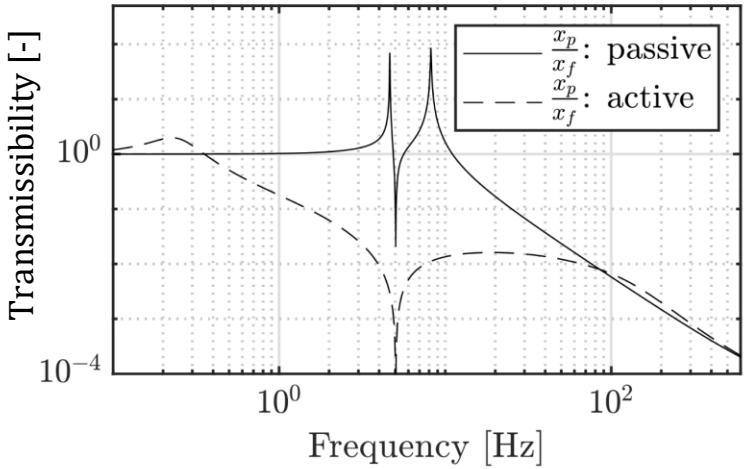
Test evaluation

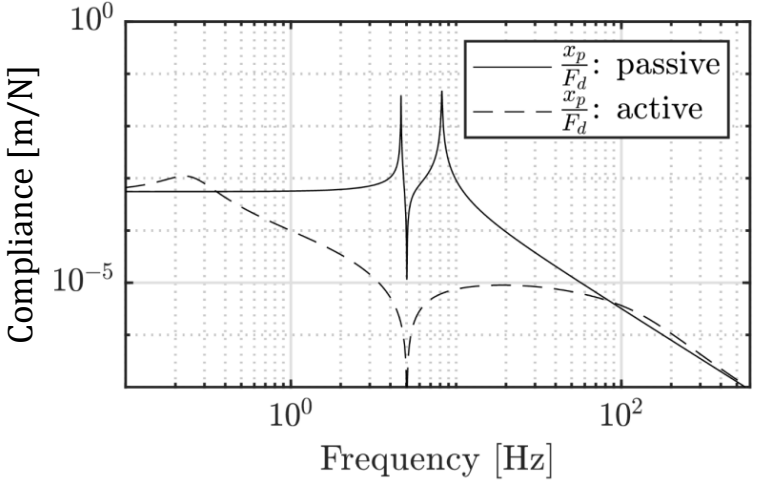
- Transmissibility = xp/xf [-] (goal: << 1)
- Compliance = xp/Fd [m/N] (goal: << 1); Fd=xd * Cbraid [N]



Theoretical expectations

Transmissibility and Compliance



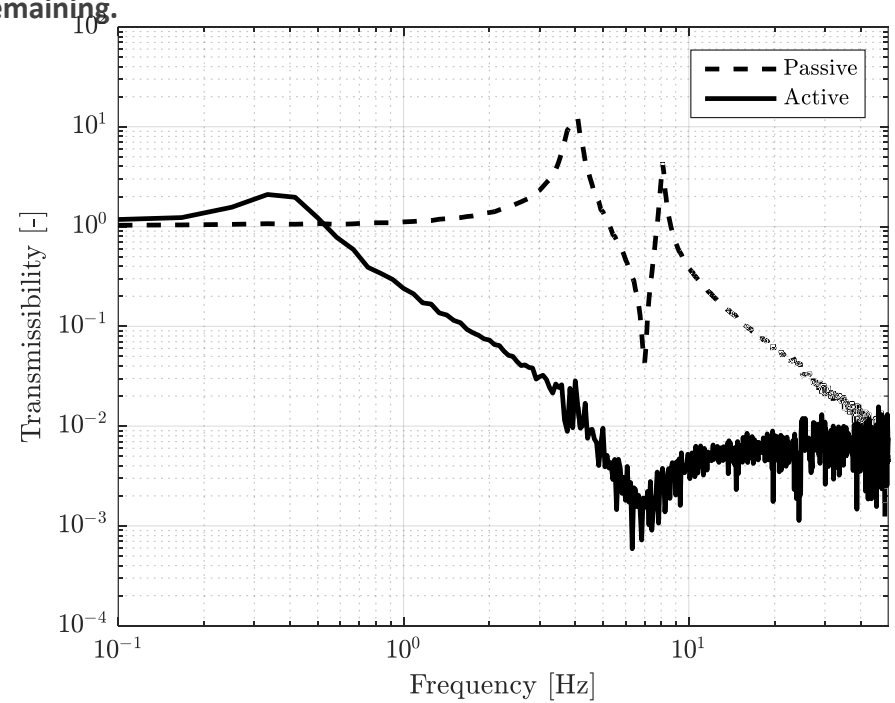


Active isolation starts at 0.33 Hz while passive isolation starts at 10 Hz
Active compliance starts at 0.33 Hz while passive compliance starts at 10 Hz

Measured results

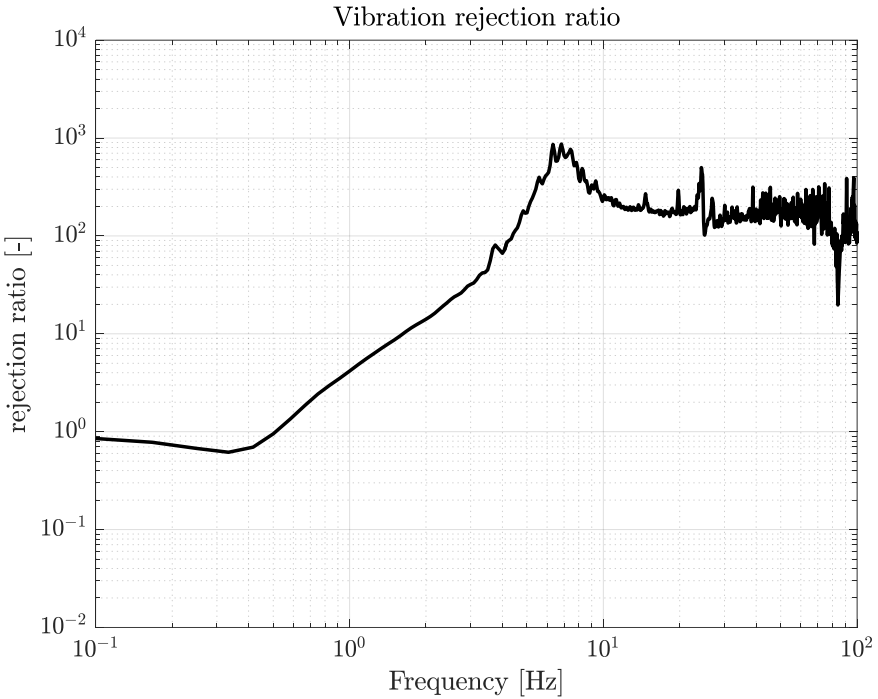
Transmissibility

- In passive mode: resonances of both the suspended inertial- and payload mass are present at 4 Hz and 8 Hz respectively.
- In active mode: damped resonance at 0.3 Hz remaining.



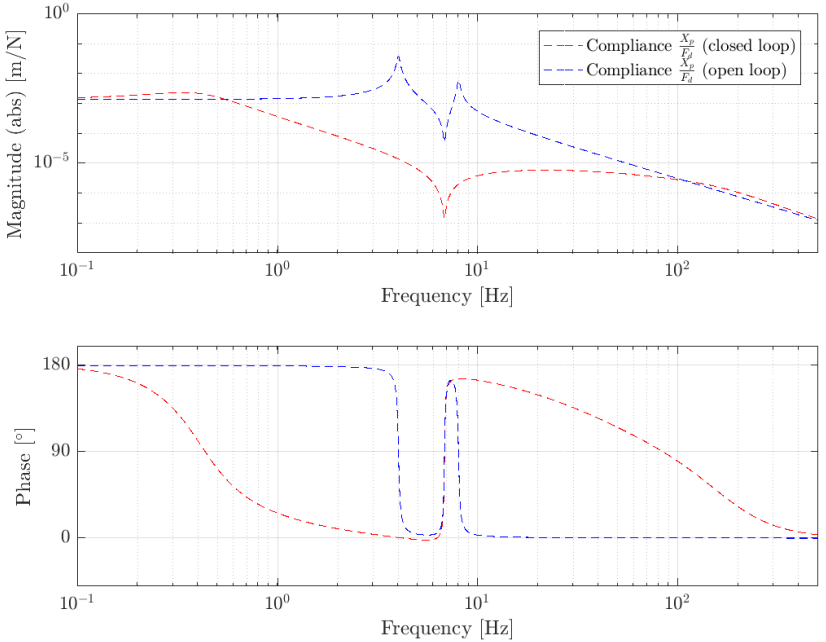
Vibration rejection ratio – active isolation

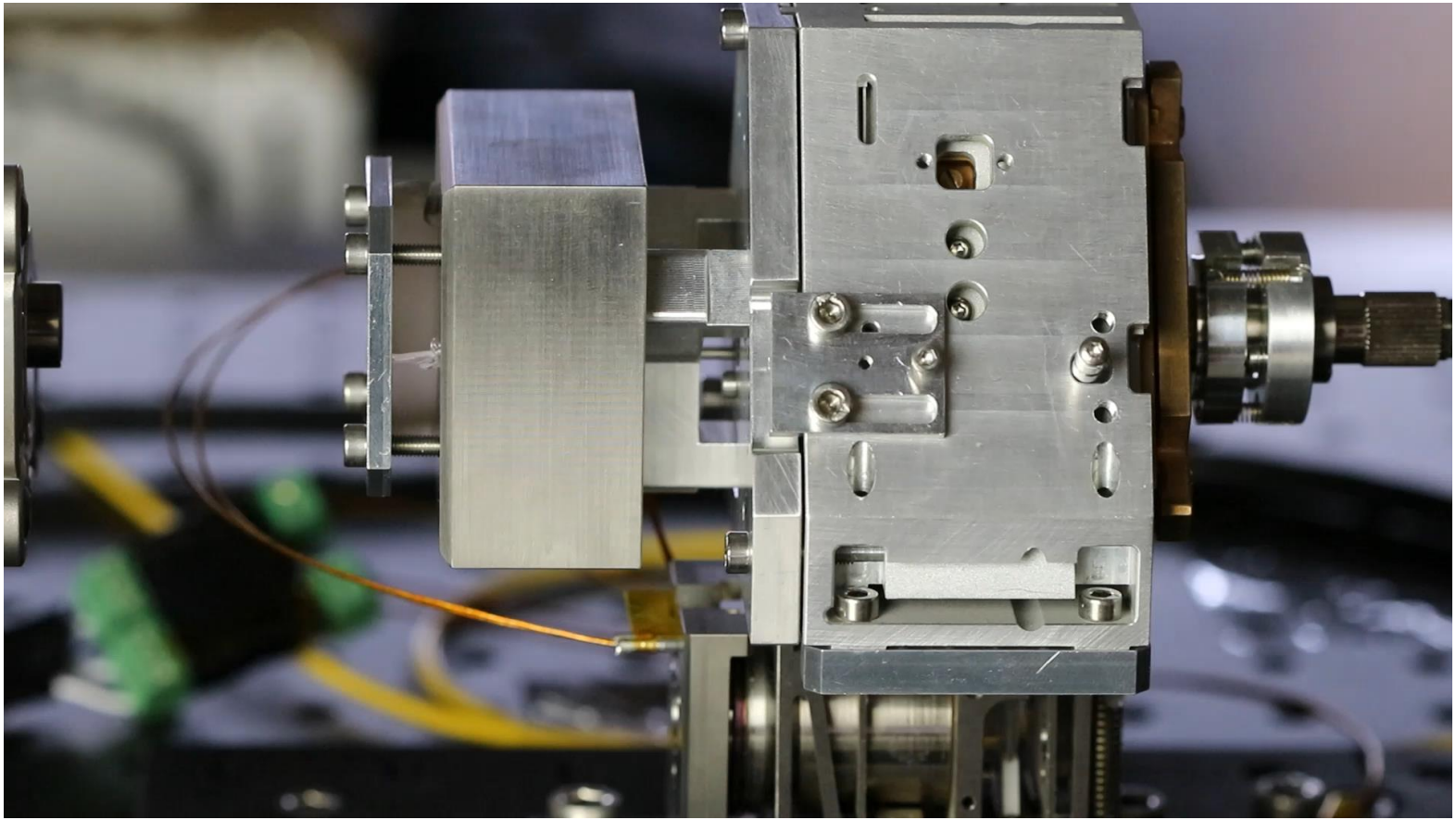
- Inverse of transmission ratio



Measured results

- Compliance. (predicted)





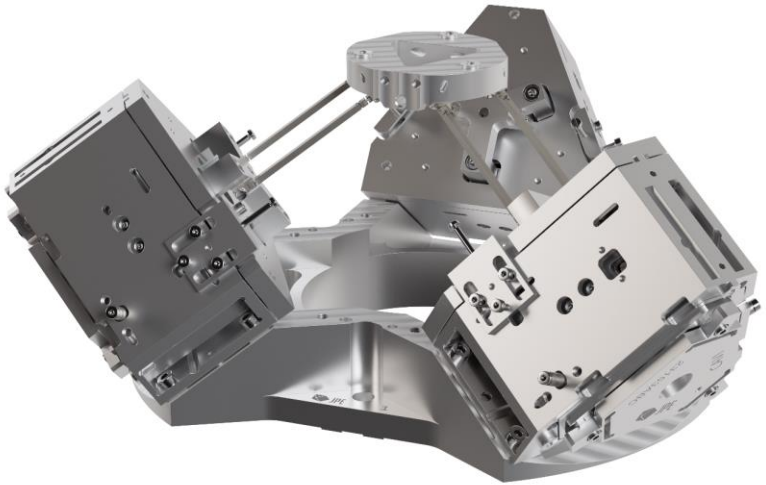
Conclusions

- Realized a cryogenic compatible compact active isolator with a relatively small mass that is able to significantly attenuate floor vibrations and reduce disturbance forces on the payload above 0.3 [Hz]

- Great improvement found of the passive to active isolation frequency:
  - Passive resonance frequencies are 4 and 8 Hz with very little amount of damping
  - Active effective resonance frequency around 0.3 Hz with a large amount of damping.

Next steps

- Realization of XYZ vibration isolator



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