E-TEST Einstein Telescope EMR Site & Technology

A compact low-frequency isolator for large cryogenic mirror

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European Regional Development Fund
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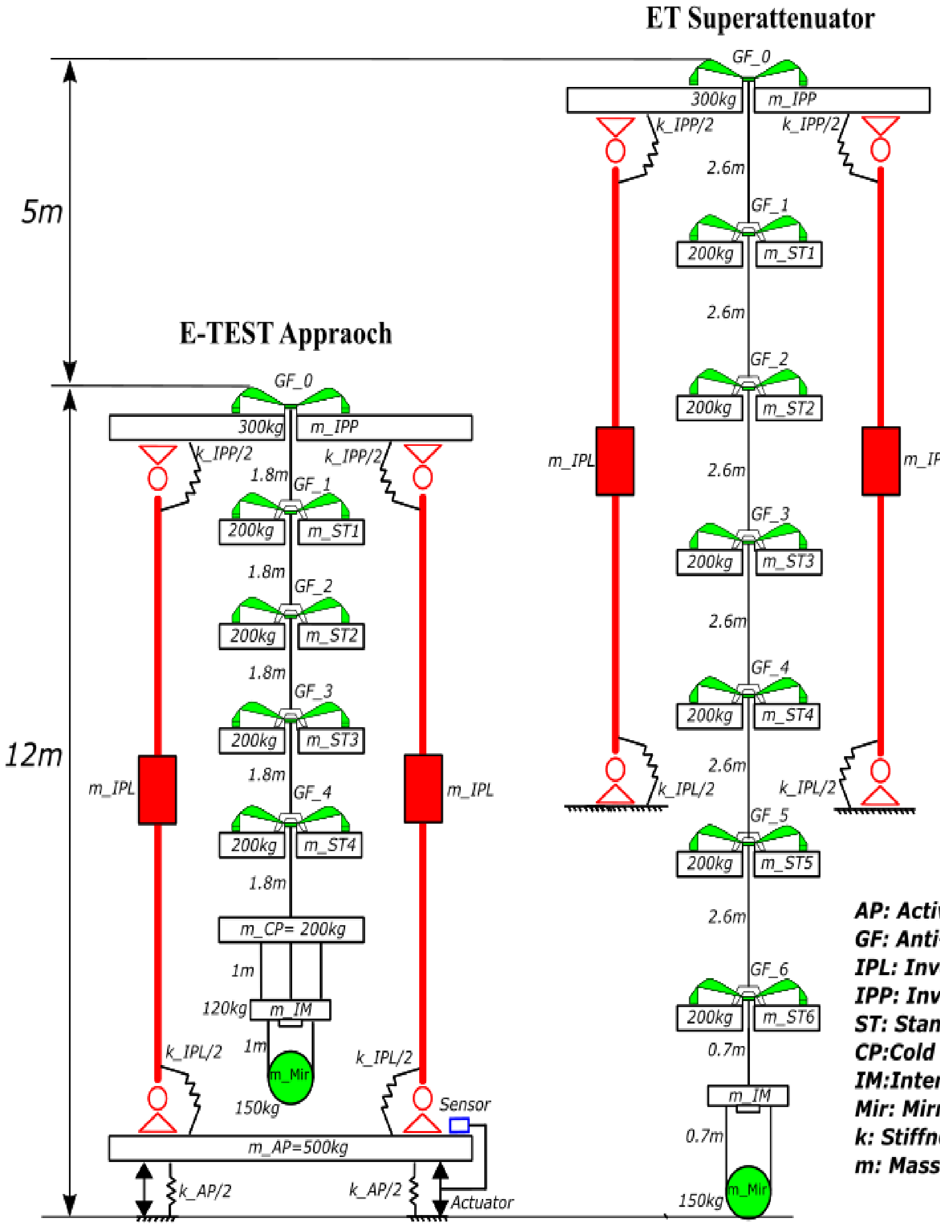
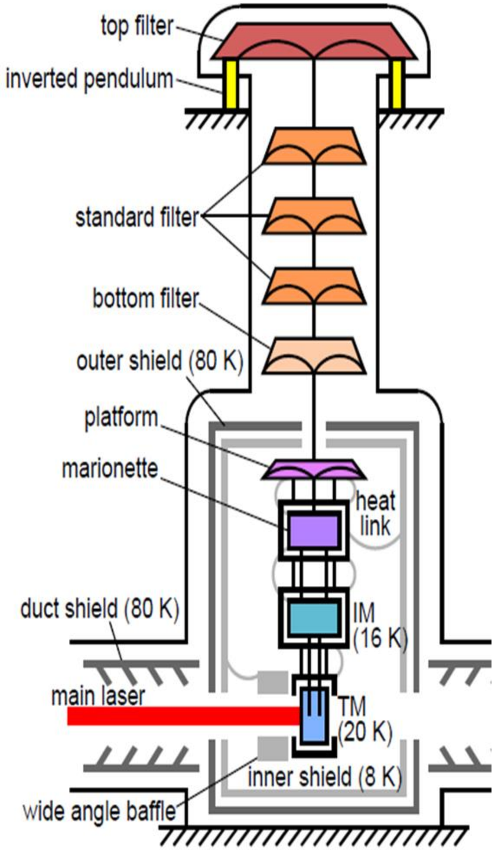
E-TEST: New GW Isolator



AP: Active Control Platform
GF: Anti-Geometric Spring Filter
IPL: Inverted Pendulum Leg
IPP: Inverted Pendulum Platform
ST: Standard Stage
CP: Cold Platform
IM: Intermediate Mass
Mir: Mirror
k: Stiffness
m: Mass



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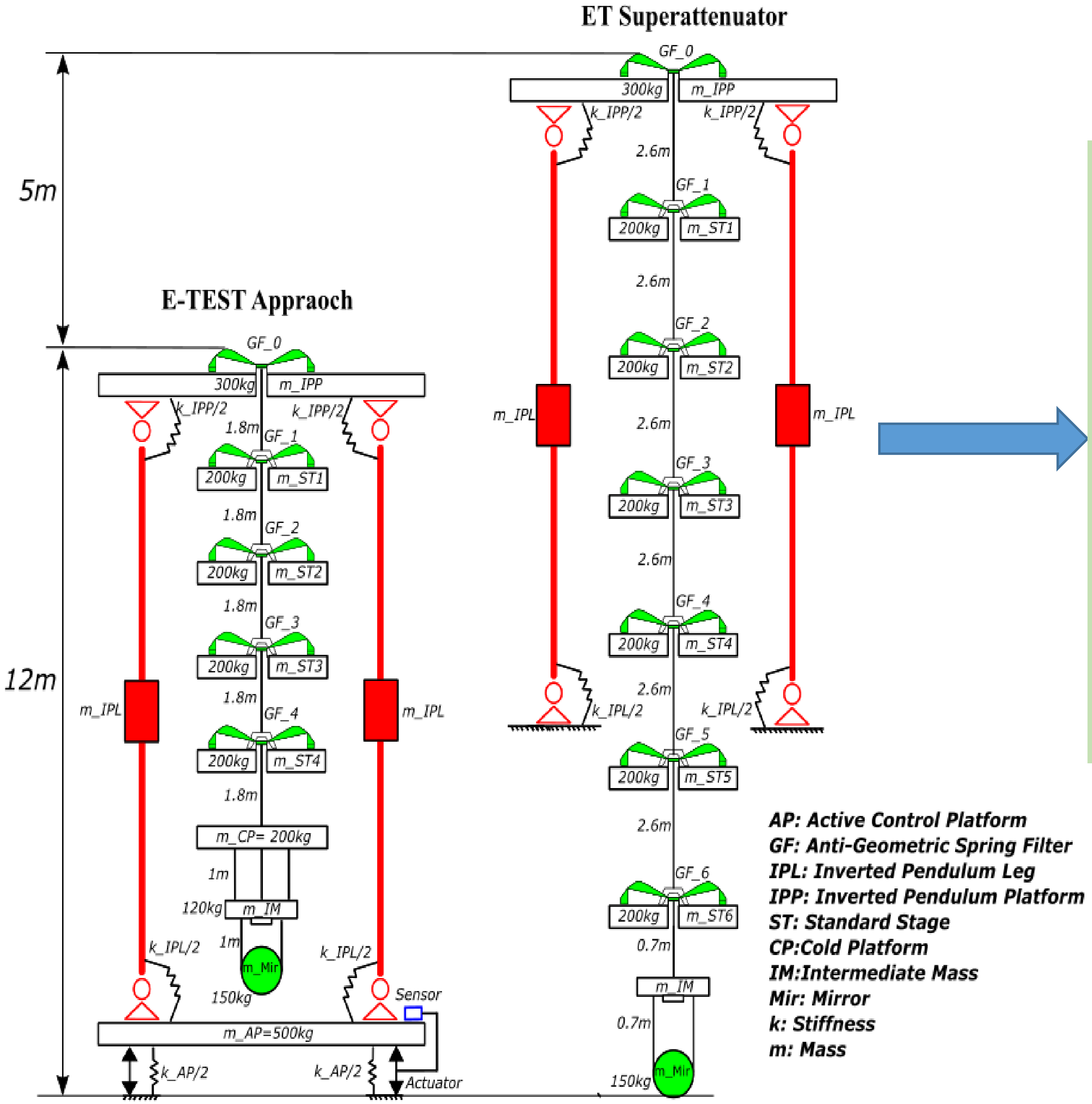
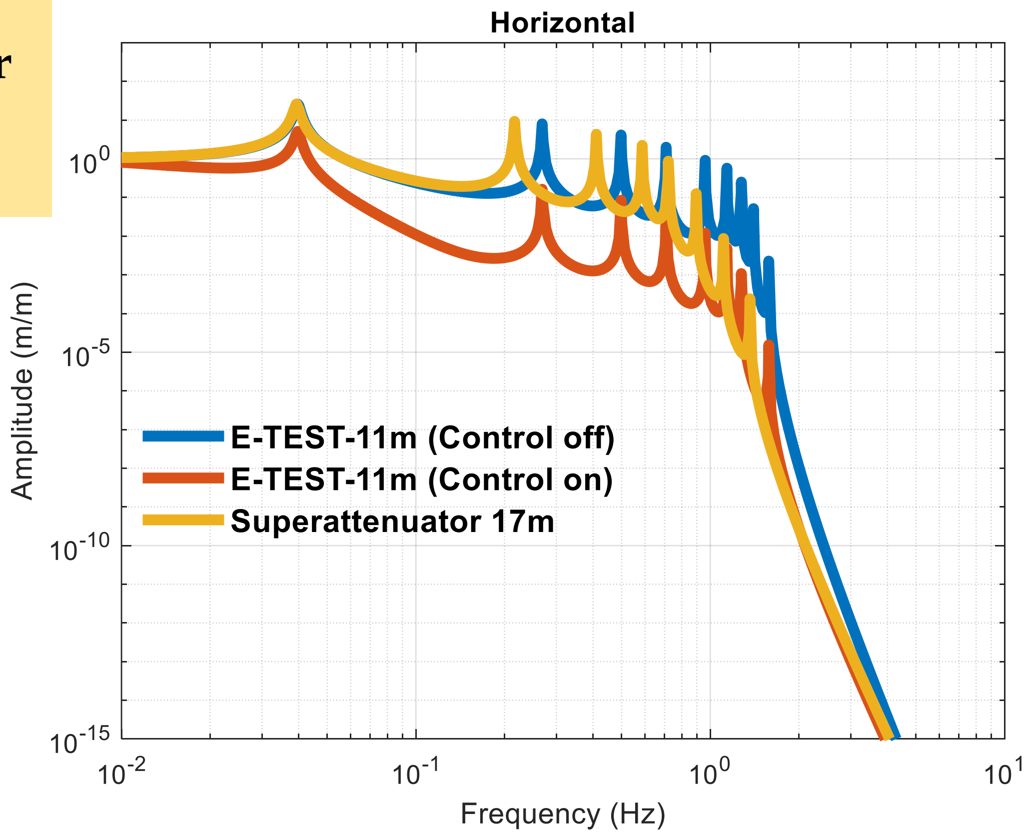


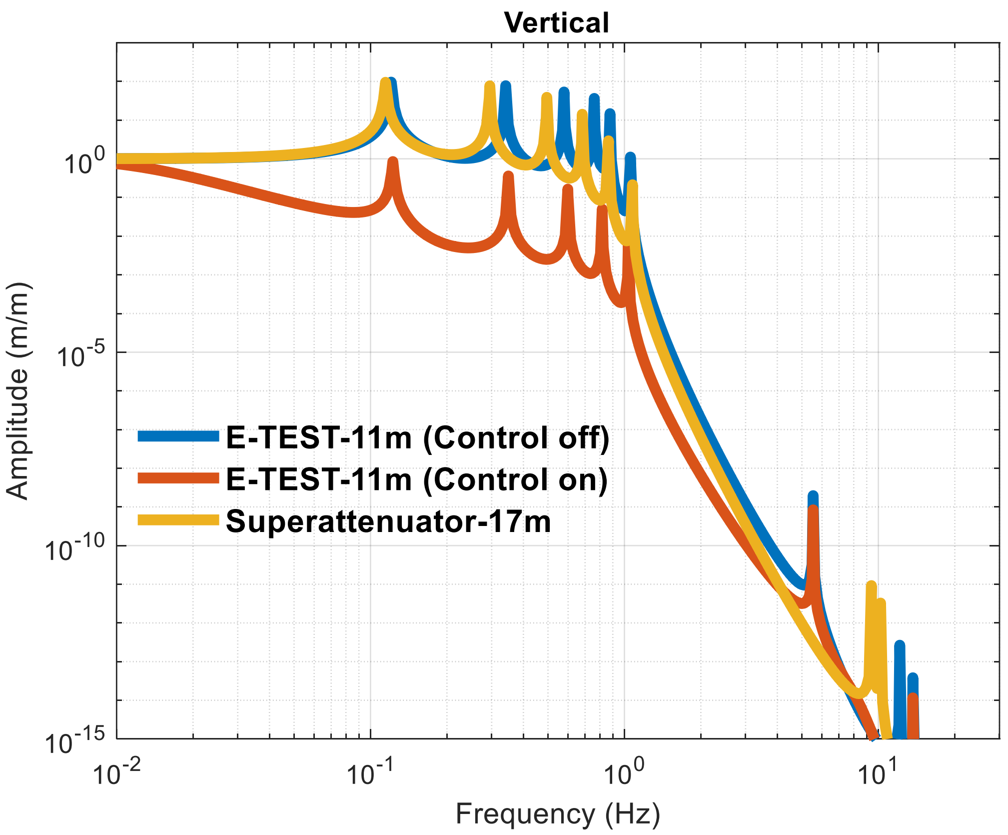
E-TEST isolator aims to:

- improve low seismic noise isolation.
- obtain more compact isolator than ET Superattenuator.

Transmissibility of ET Superattenuator & E-TEST Isolator

E-TEST Isolator achieves Superattenuator with less 5m of height



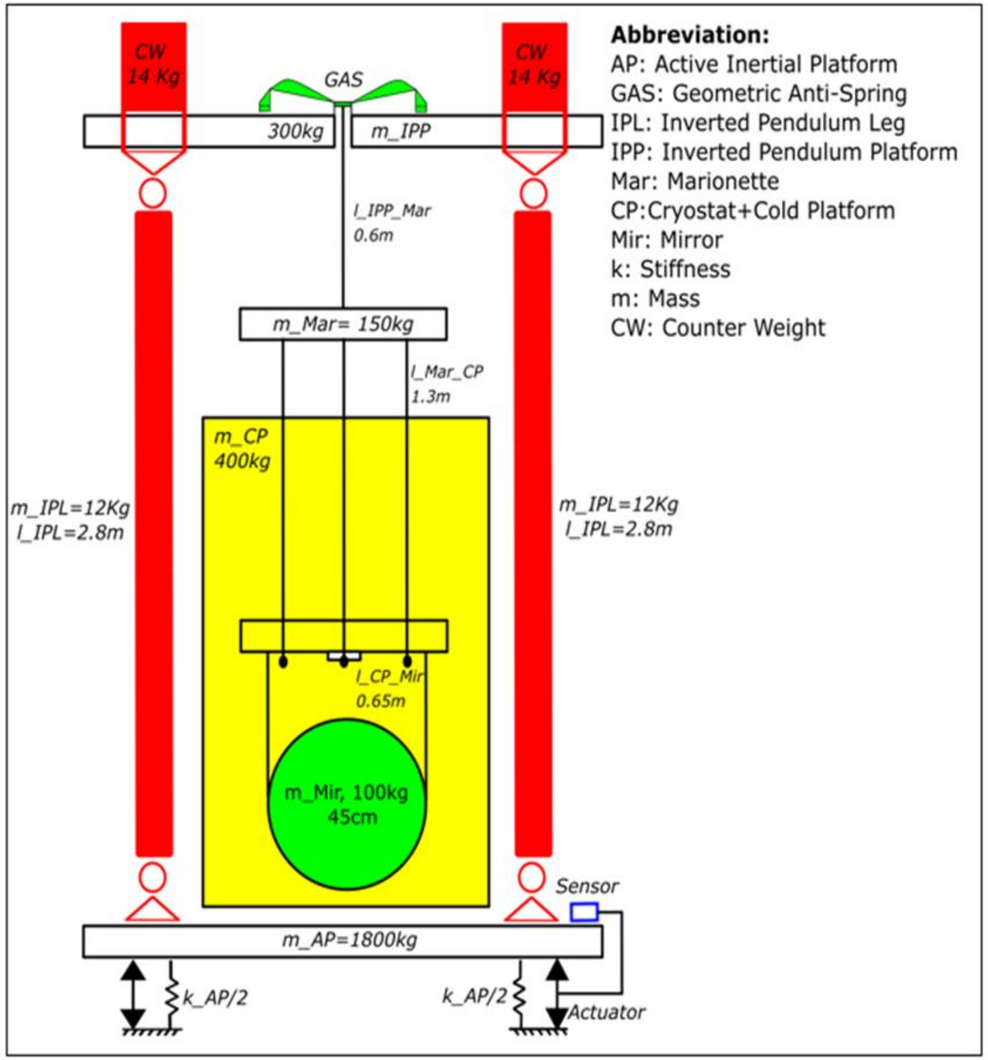


E-TEST Prototype for proof of principle

https://www.etest-emr.eu/

Features of E-TEST Project:

- Suspended heavy mass (100 kg, 300mm X 300m).
- At cryogenic temperature (20k).
- Radiative cooling strategy (no contact).
- Developing cryogenic sensors and electronics.
- Operation of the laser and optics at 2 microns.
- **Developing isolation system → concern of this presentation.**



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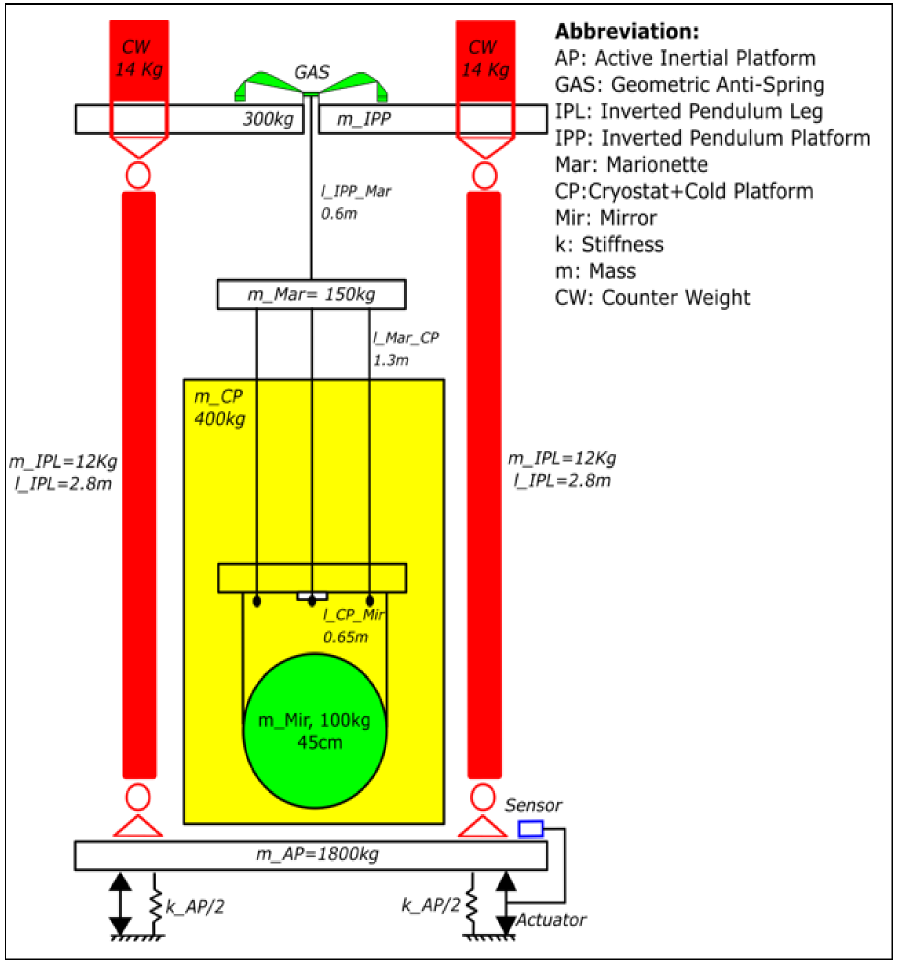
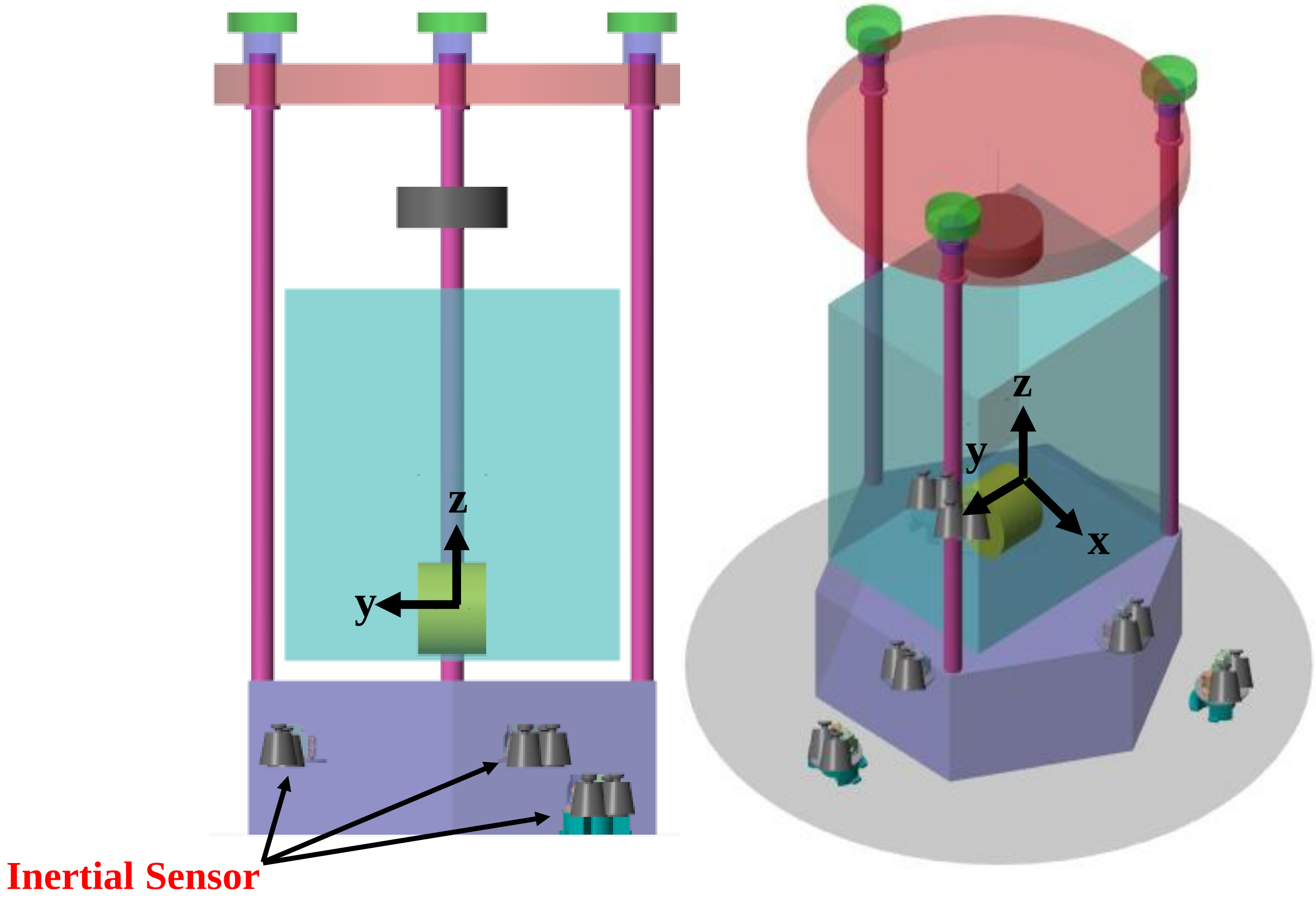
E-TEST Prototype

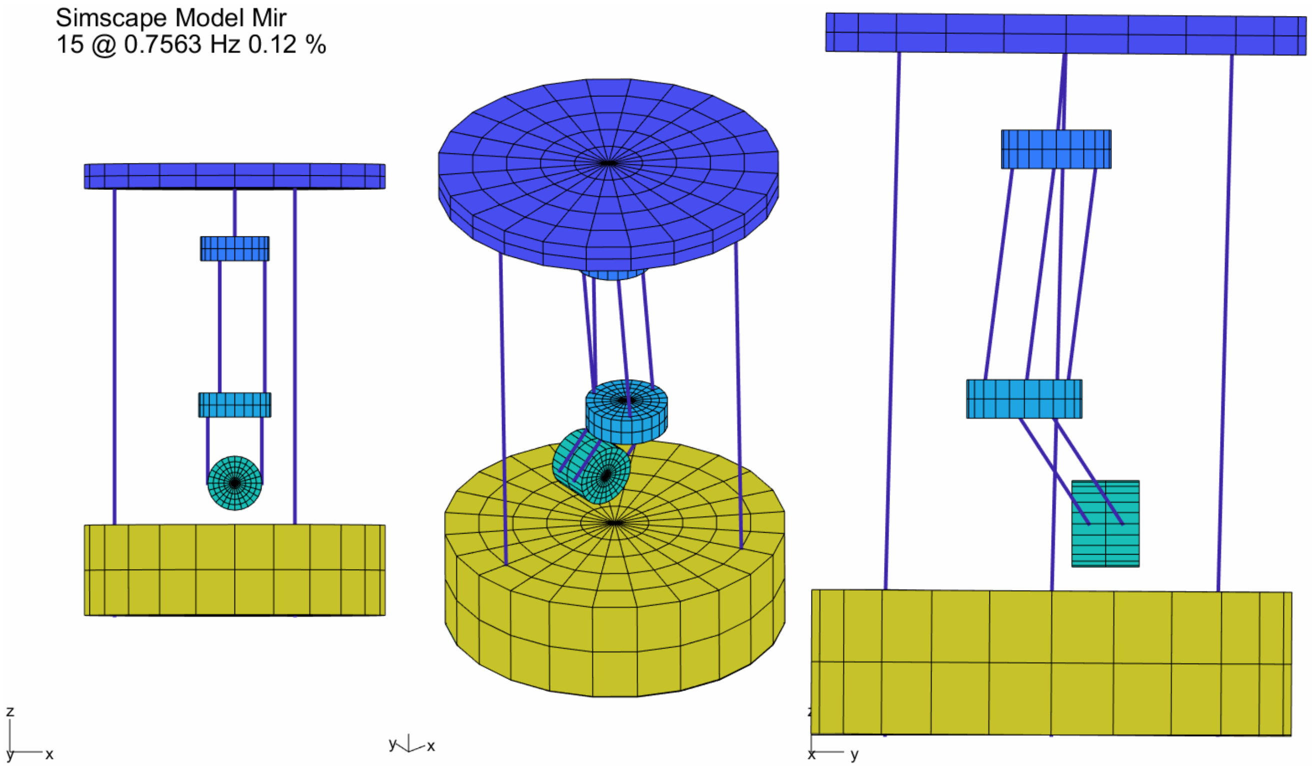
Schematic Diagram

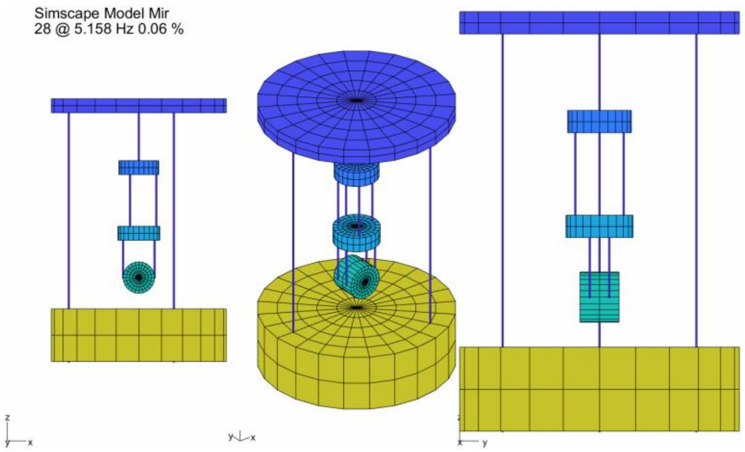


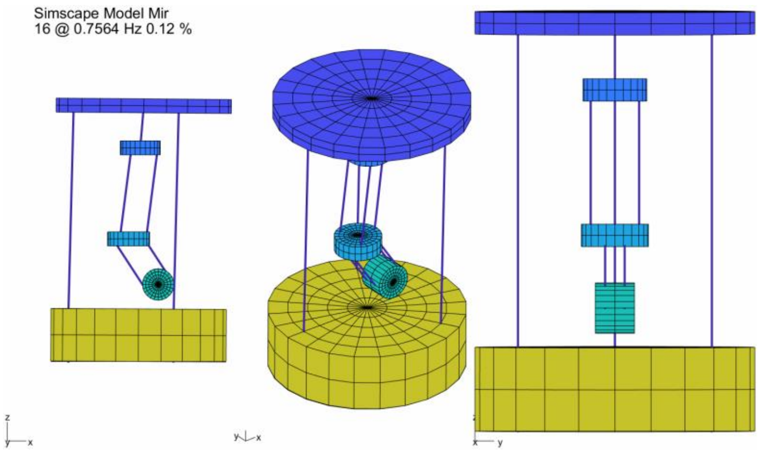
Simscape Model to obtain system dynamics

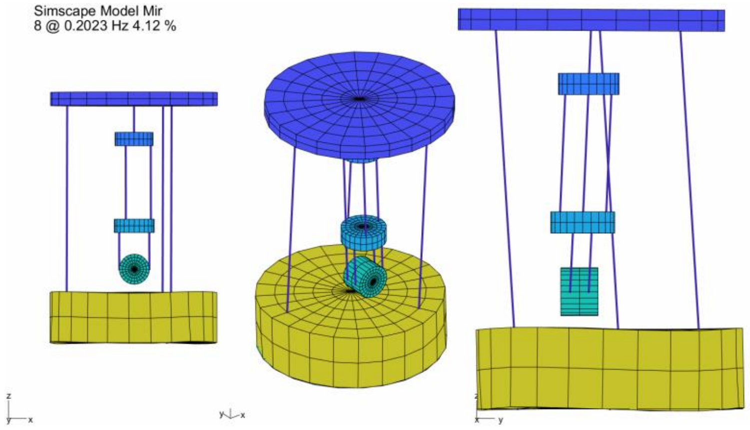


Extracting mode shape

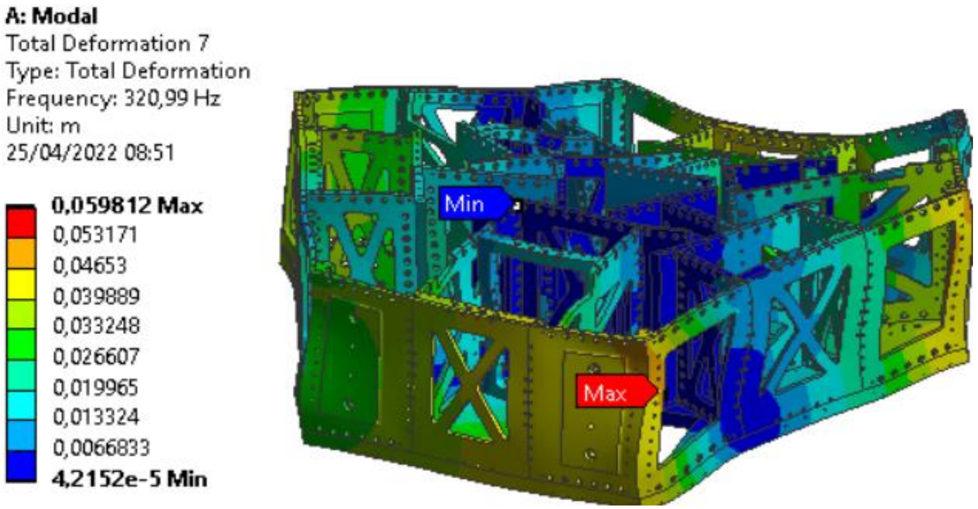


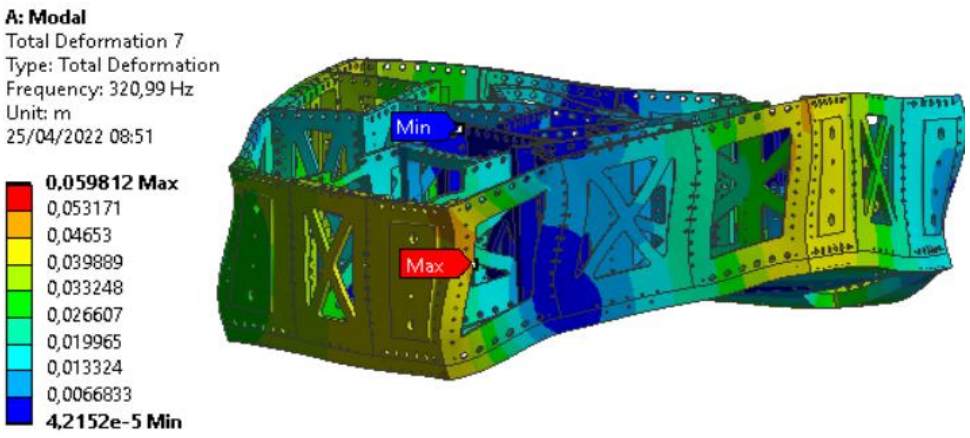


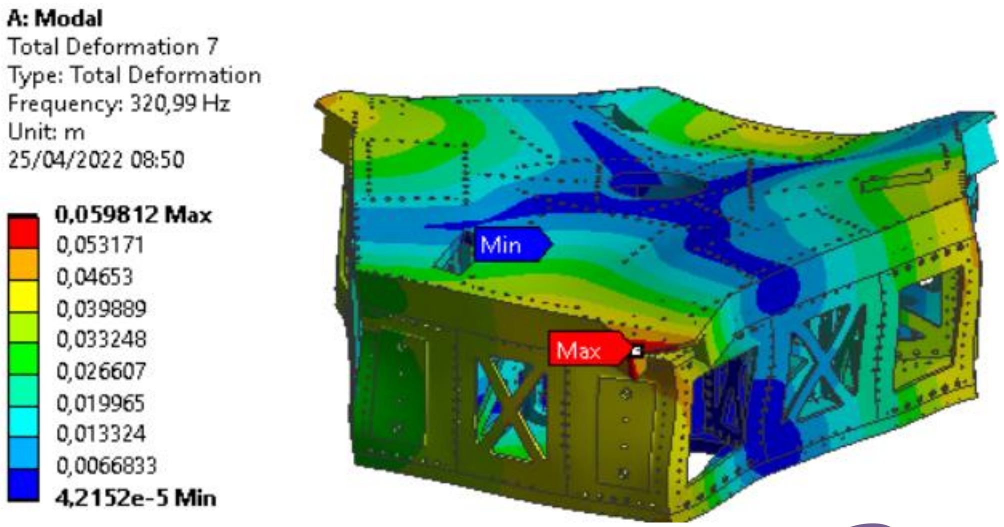


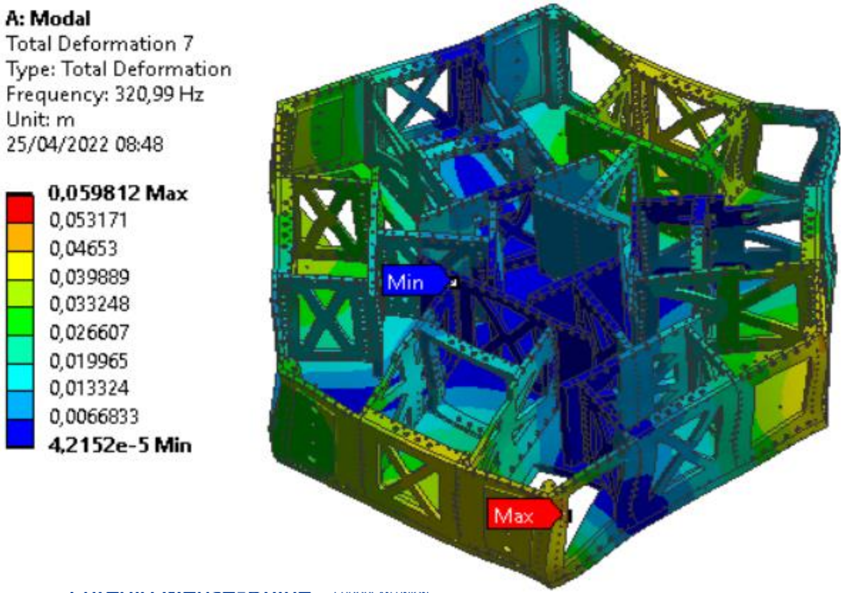


Active Inertial Platform
Sandwich structure to maintain first flexible mode above 300hz









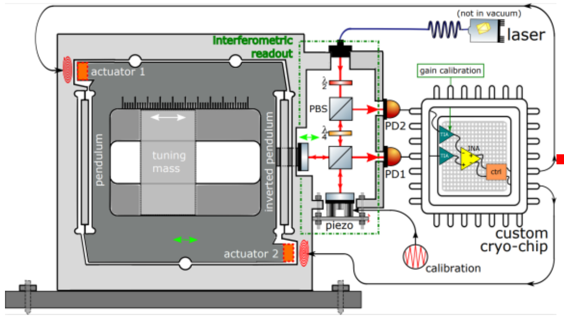
Sensors & Actuators (vacuum compatible)

4 Optical Sensors

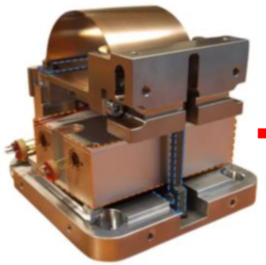
4 Voice coil actuators

Temperature sensors

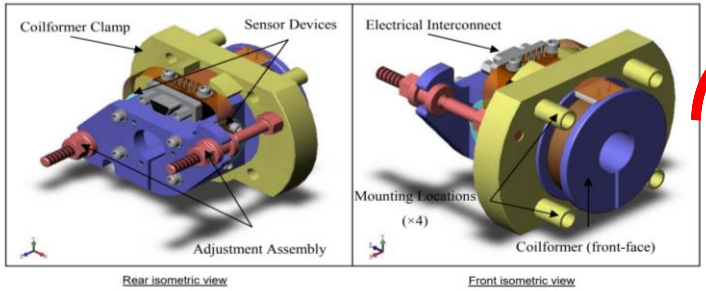
6 Cryogenic inertial sensors



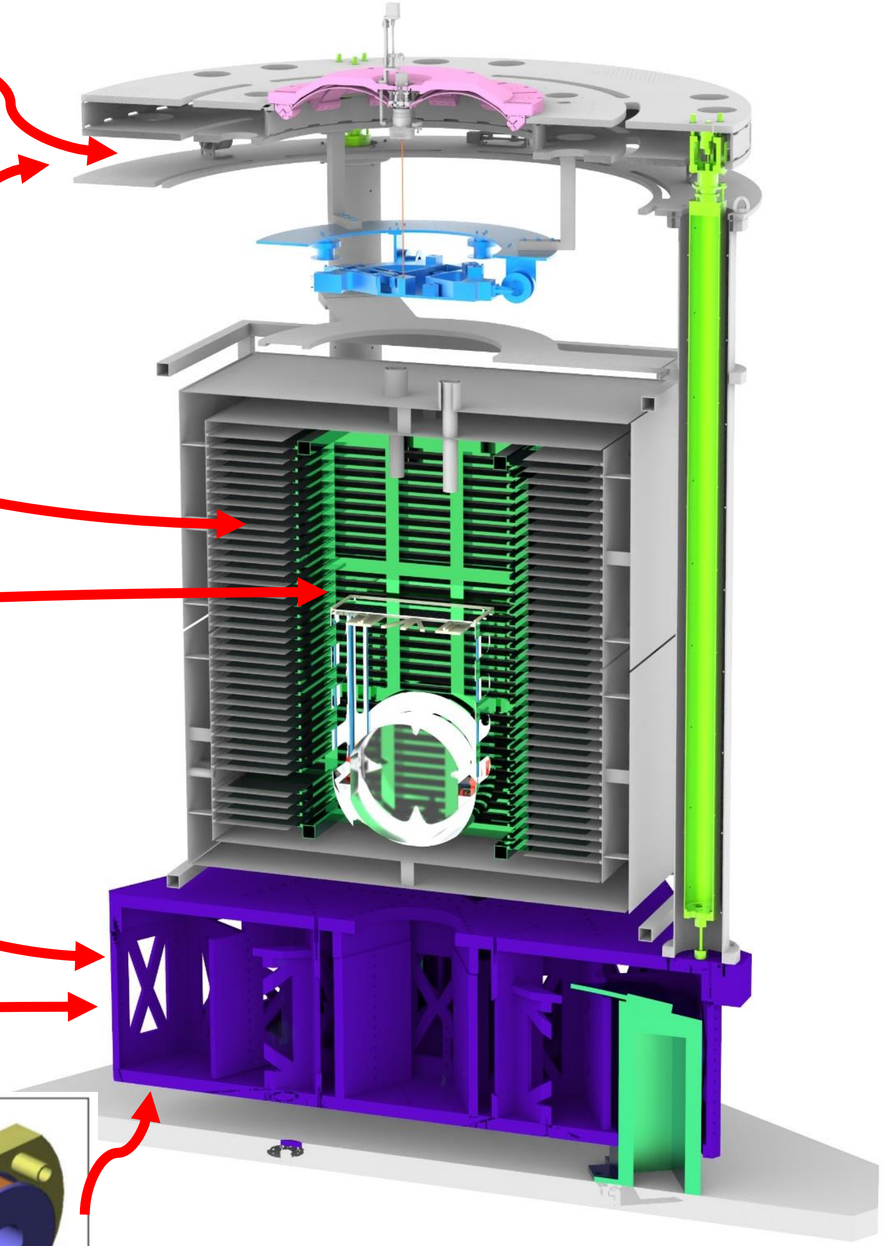
6 Inertial sensors



6 voice coil Actuators

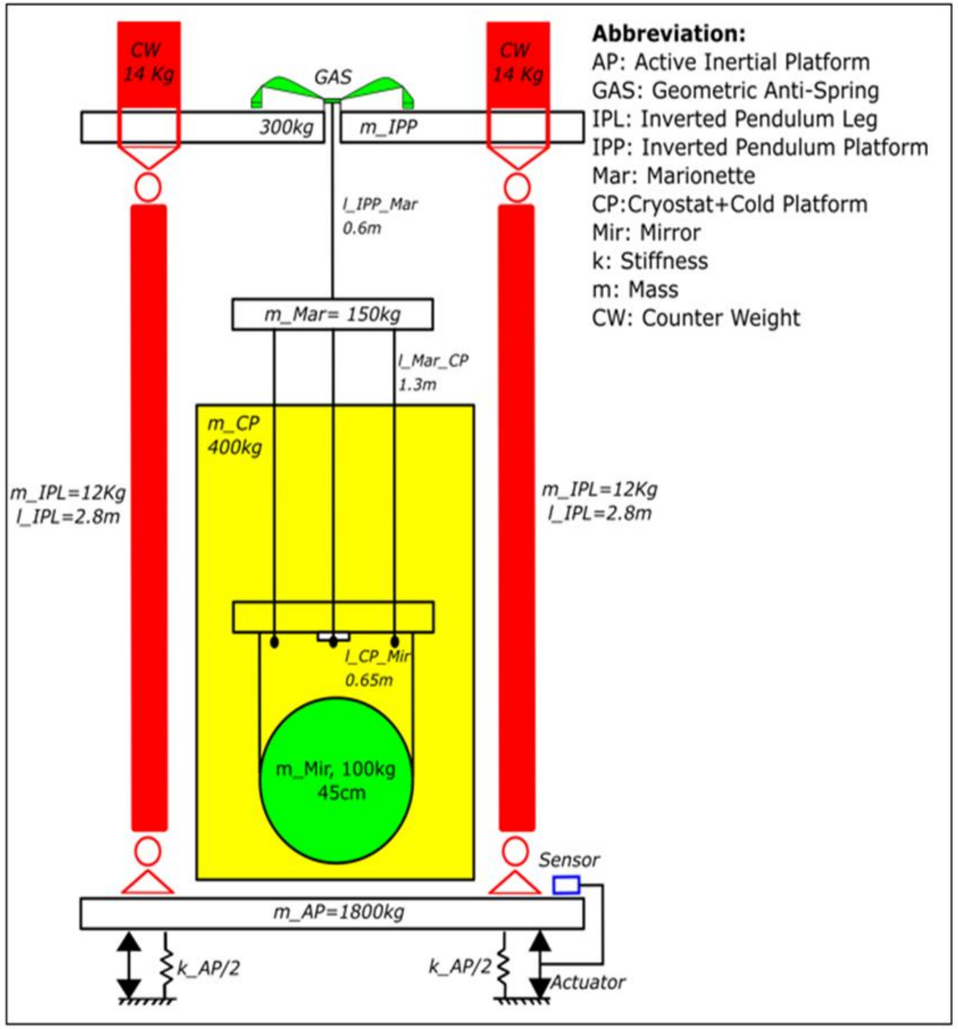


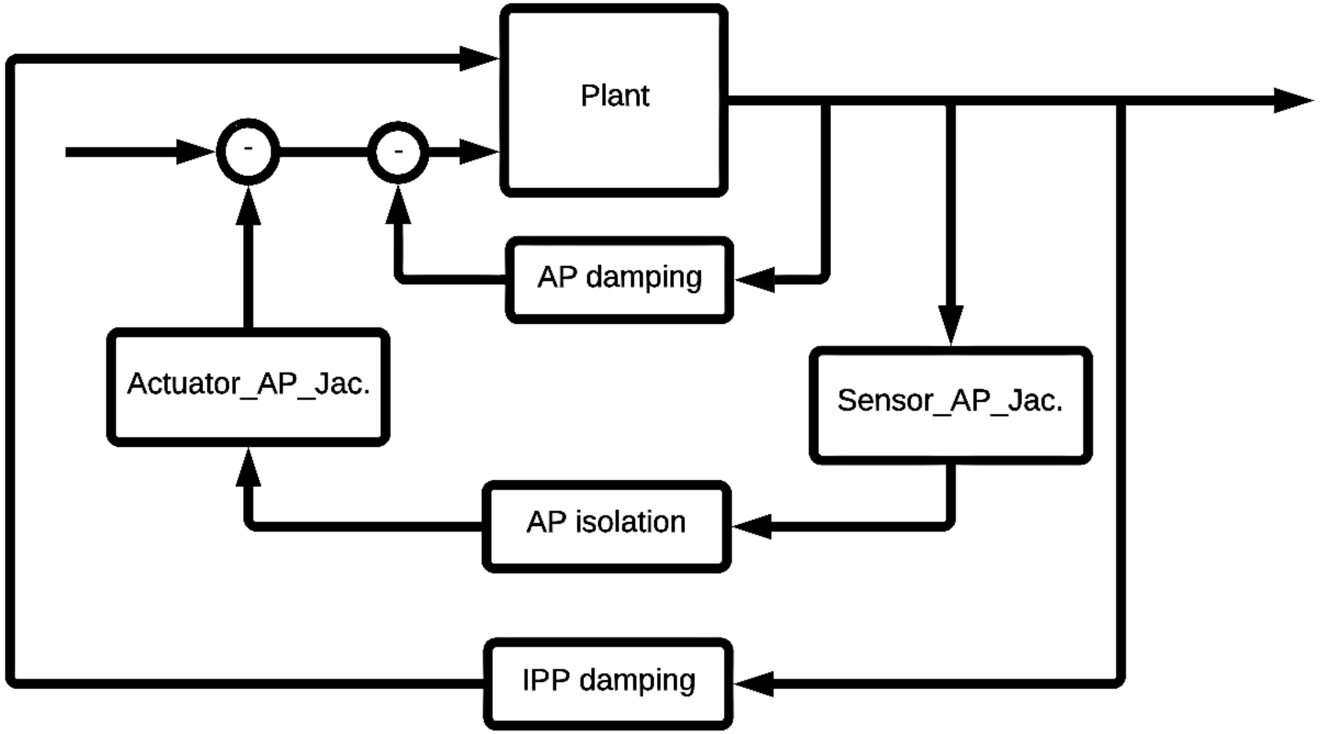
6 BOSEMs



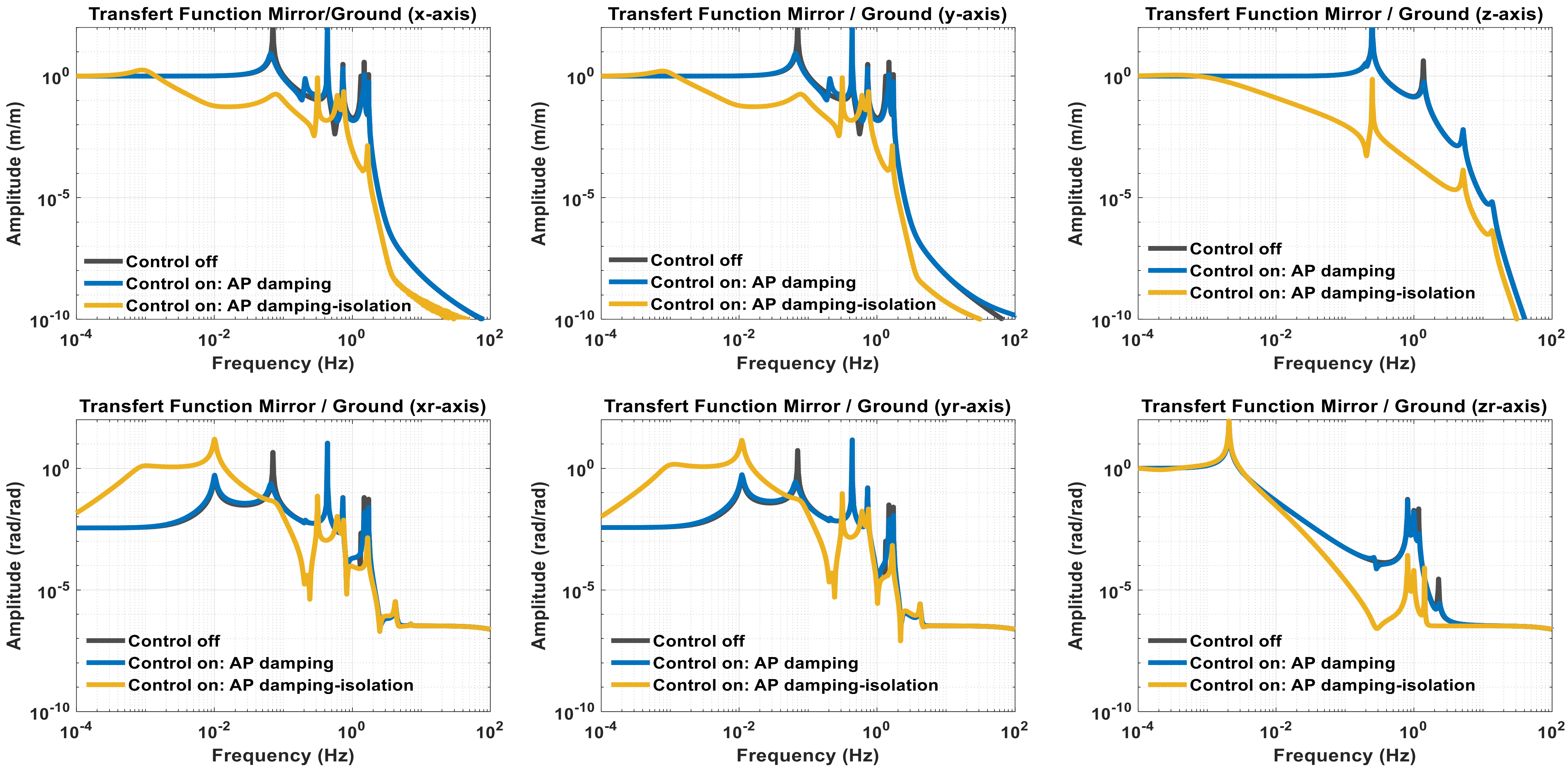
Classical Control

Controllers are designed based on loop shaping; lead-lag compensator





Transmissibility mirror/ground



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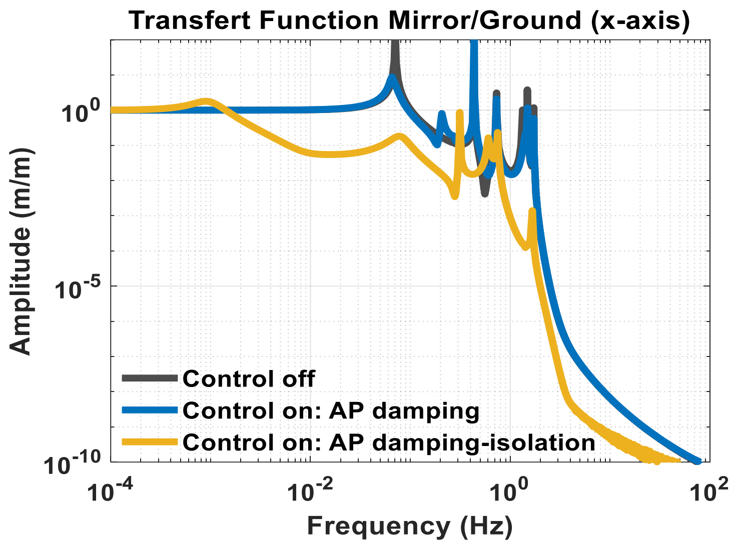
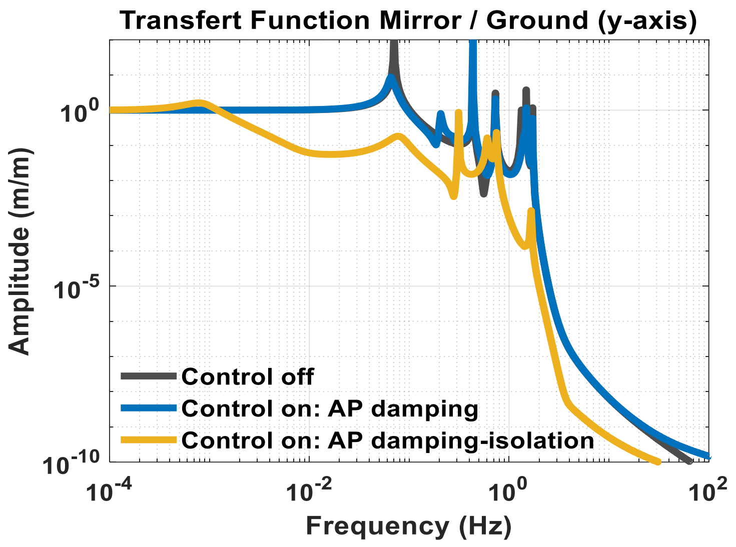
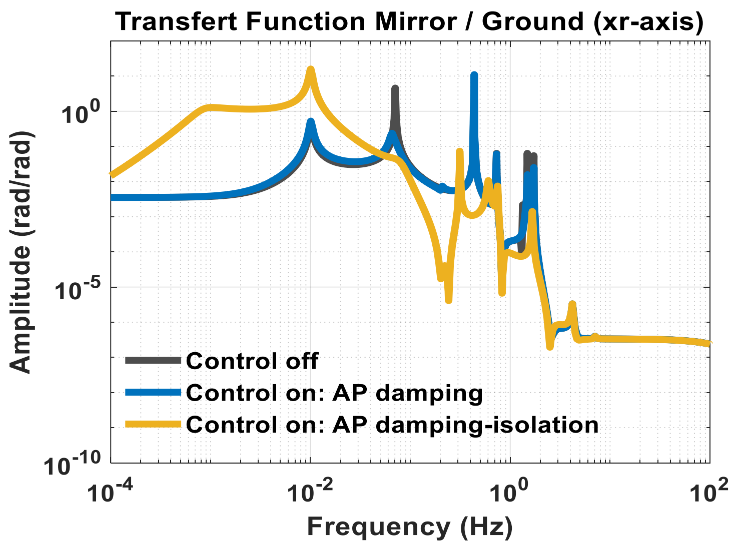
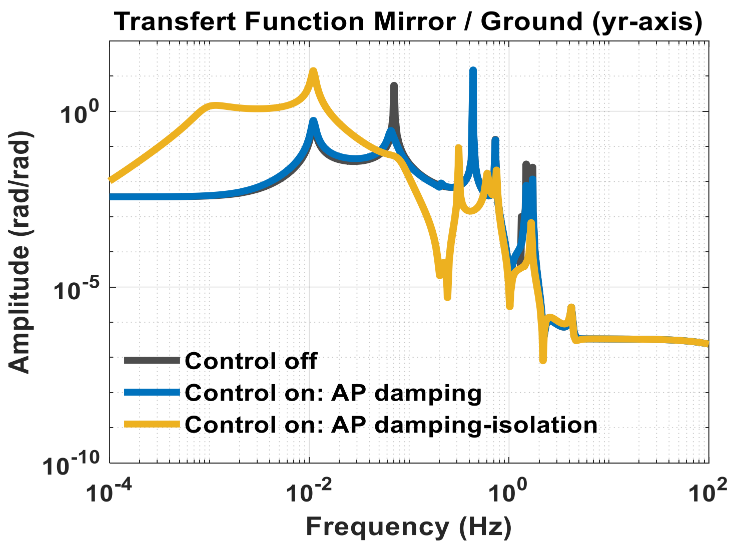
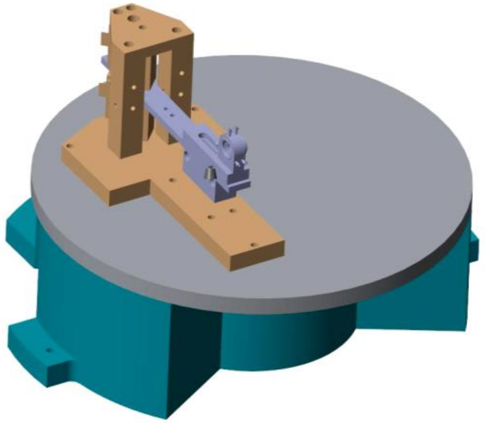




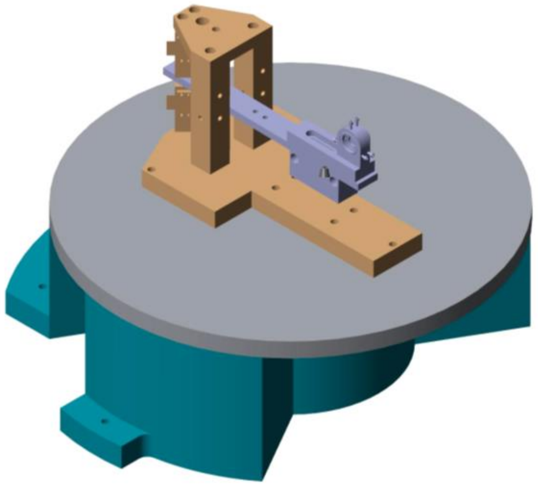




Inertial sensor response for horizontal motion



Inertial sensor response for rotational motion



Challenging issues !!!

Most welcome for collaboration

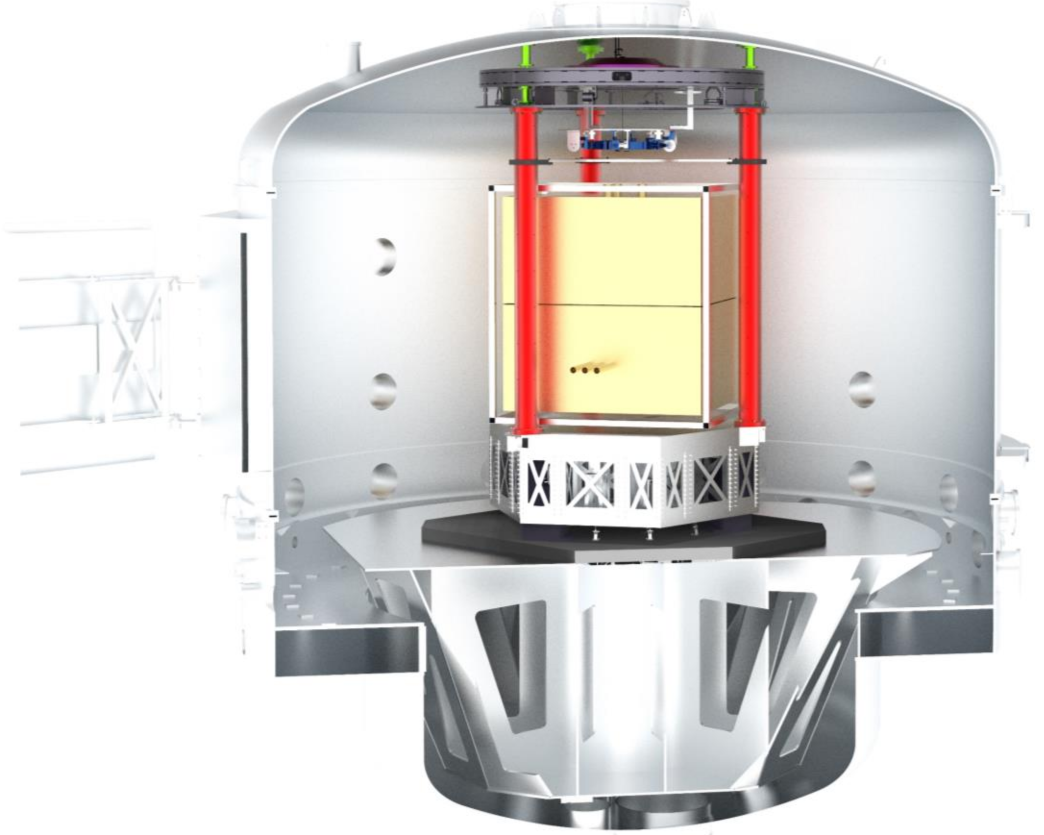
- How our model is close to the experimental result & what are the tools to tune the parameters?
- How to reduce tilt inertial sensor coupling?
- How much the inverted pendulum can reduce the control performance?
- How to apply the decoupling strategy experimentally?
- What other control strategies can be applied?

Conclusion

Done:

- Dynamic model is obtained.
- Mode shape is obtained.
- First control strategy is applied (simulation).
- CAD design is finished (procurement process start

E-TEST prototype inside the vacuum chamber



Next:

- Apply another control strategy.
- Assemble the system.
- Experimental work.

Thank you

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The Financiers

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