E-TEST Einstein Telescope EMR Site & Technology

Progress on E-TEST: a compact low-frequency isolator for a large cryogenic mirror.

SIDER, Ameer (phd student)

asider@uliege.be

On behalf of the E-TEST collaboration

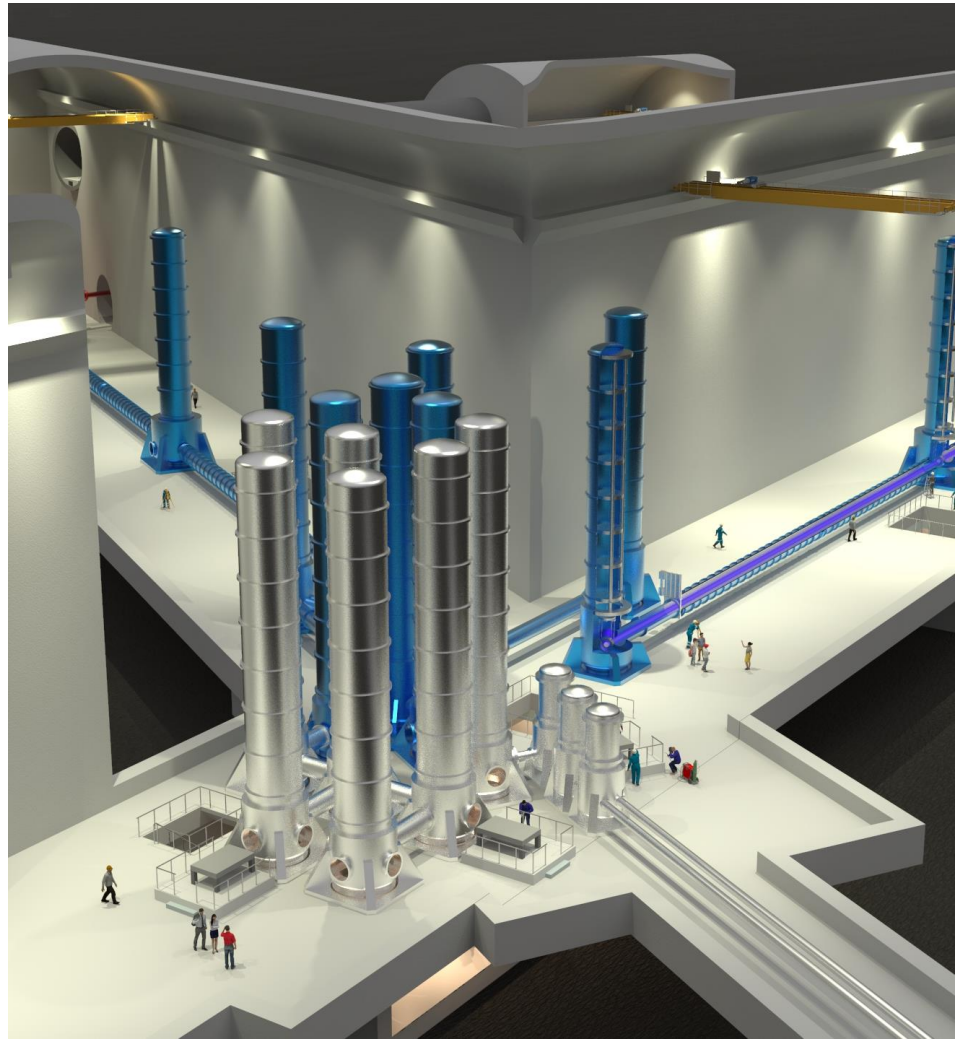
DCC No.

LVK 2023, Septemper- Toyama

E-TEST project for proof of concepts

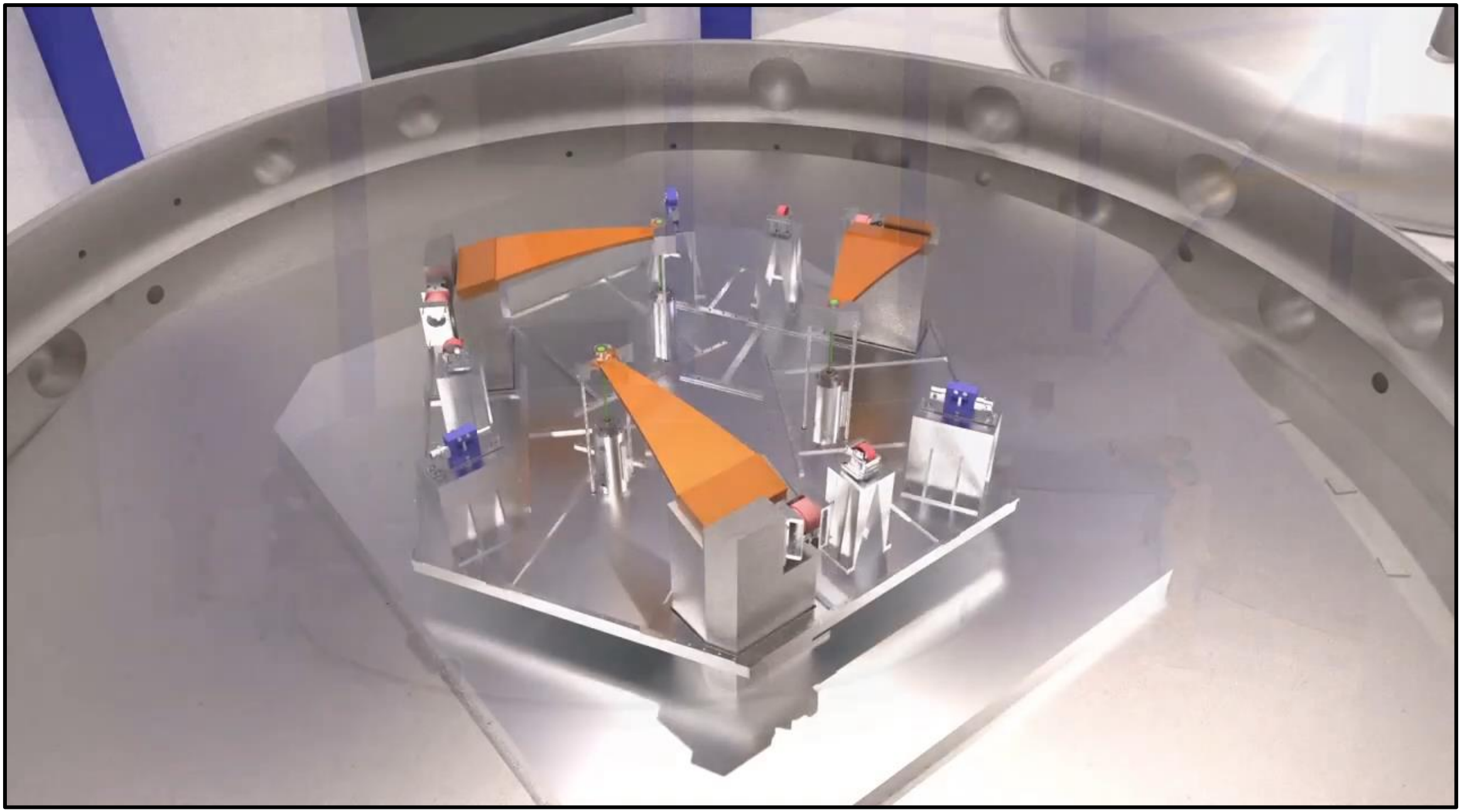
Features of E-TEST Project:

- Compact suspension (4.5 meters) with isolating at low frequency (0.1-10 Hz).
- Suspend large silicon mirror (100 kg)
- Operate at cryogenic temperature (25 K)
- Develop cryogenic sensors and electronics.
- Laser and optics at 2 microns.



E-TEST is a project funded by the Interreg Euregio Meuse-Rhine and ET2SME consortium.

E-TEST: Einstein Telescope mirror-scale prototype (5.5m height, 2.5m width)

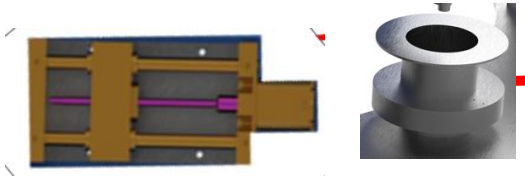


credit: Marco Kraan (Nikhef)

Sensors & Actuators (vacuum compatible)

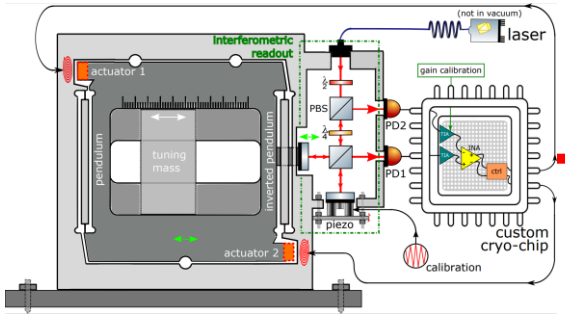
4 Interferometric sensors
4 Voice coil actuators
4 stepper motors

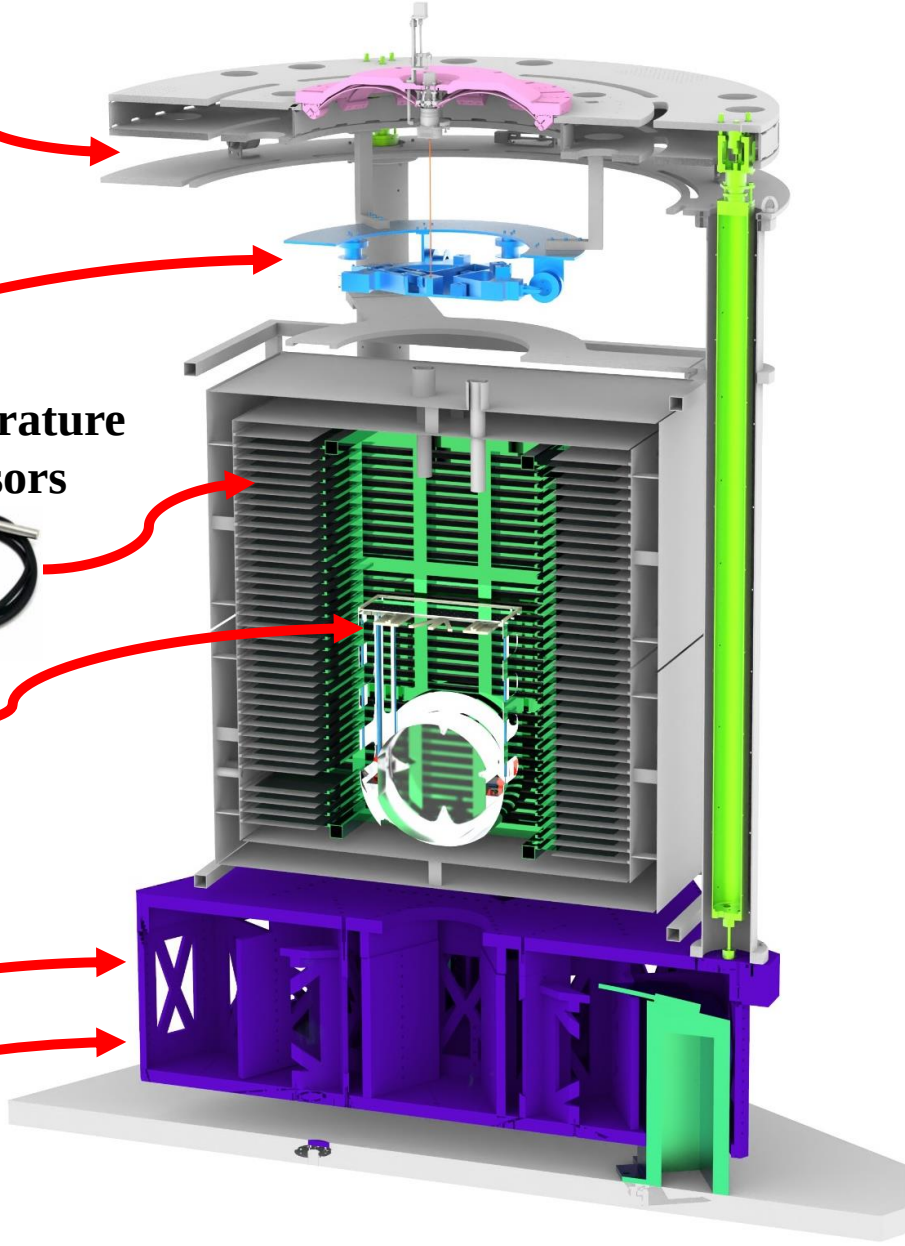
2 stepper motor
8 coil-magnet actuators
2 optical levers



Temperature sensors

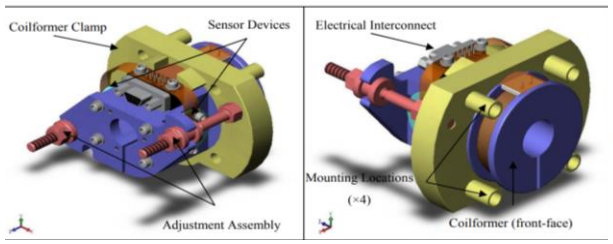
6 Cryogenic inertial sensors
(3 horizontal & 3 vertical)

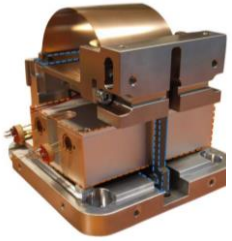




6 voice coil Actuators

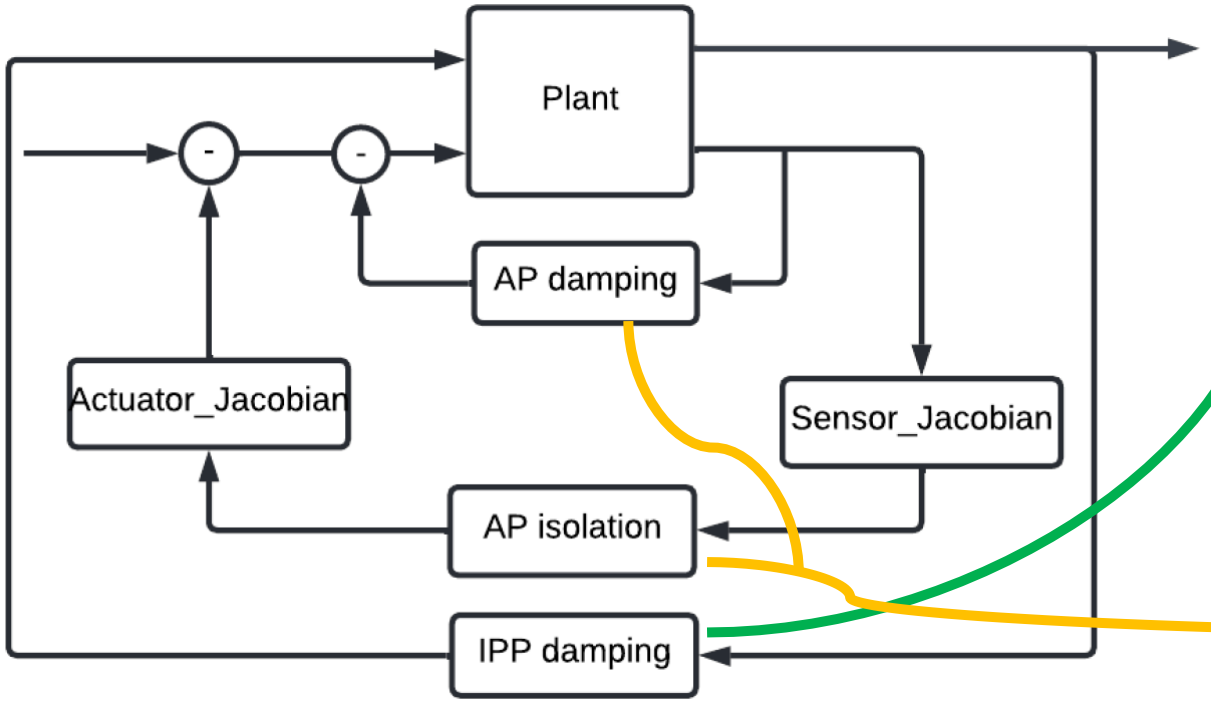
6 Inertial sensors (3 horizontal & 3 vertical)
6 BOSEMs (3 horizontal & 3 vertical)

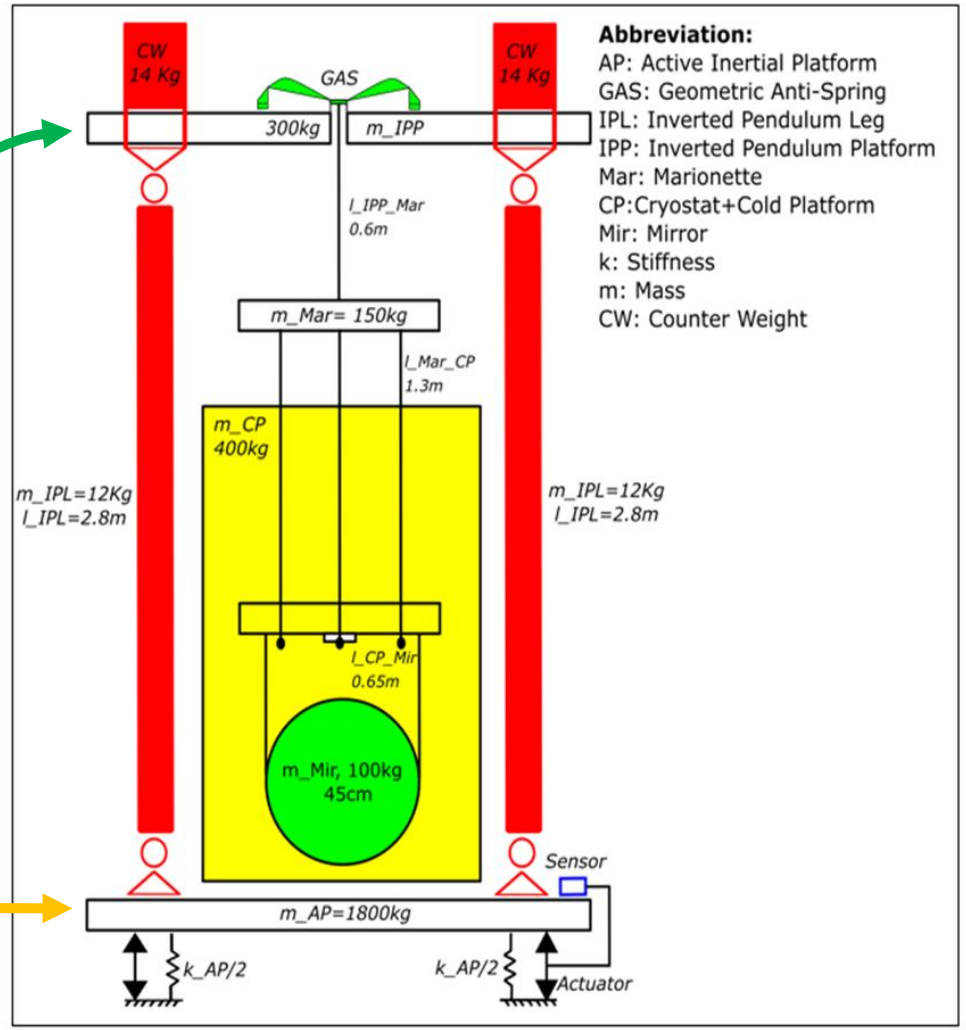




Simulation result can be found in this link: https://agenda.infn.it/event/32907/contributions/200484/

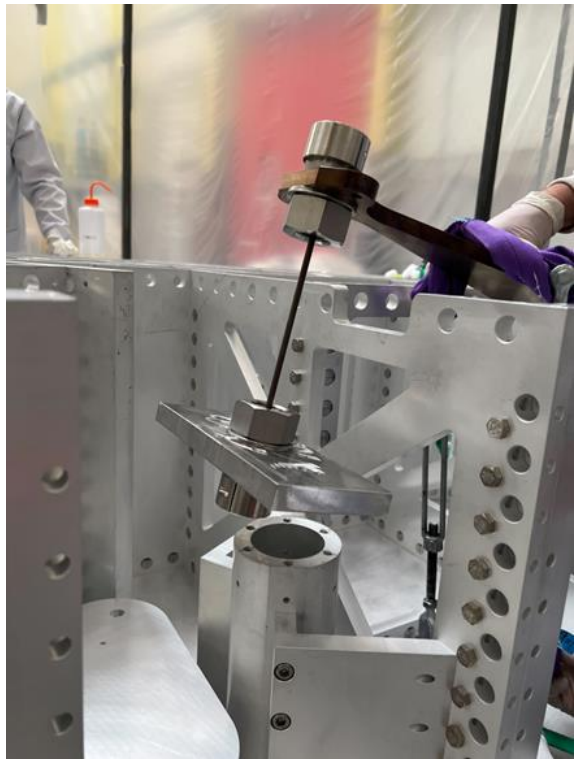
Control strategy

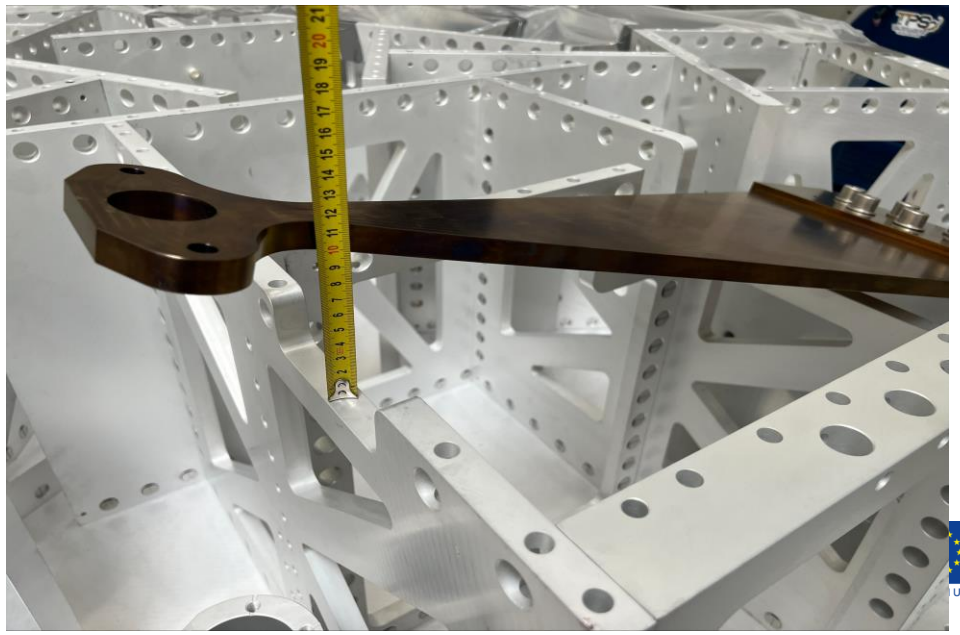


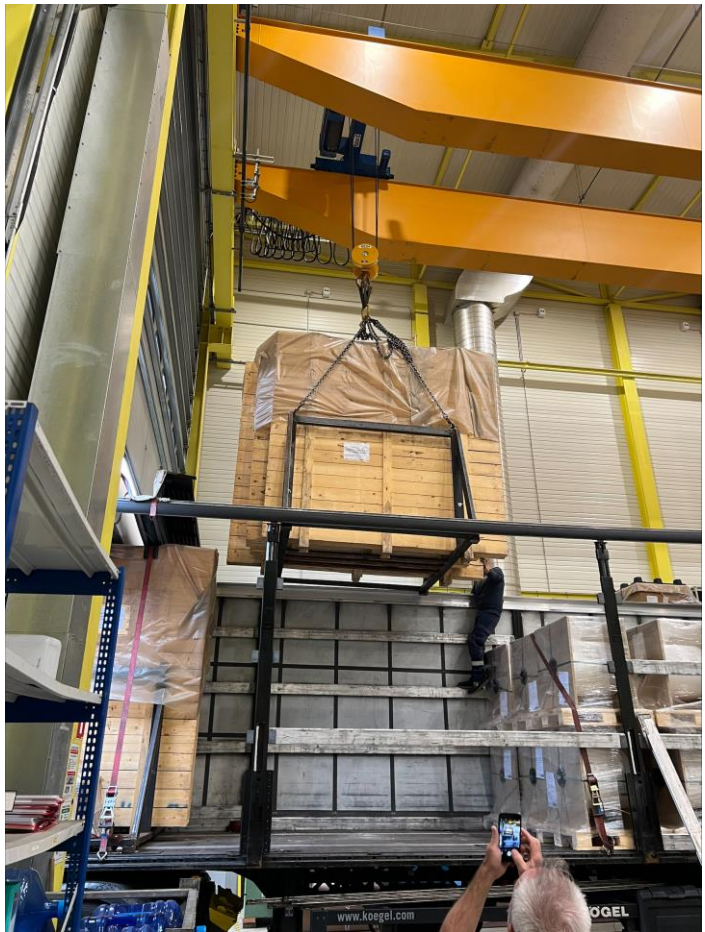


Status of the mechanical parts: Started the assembly

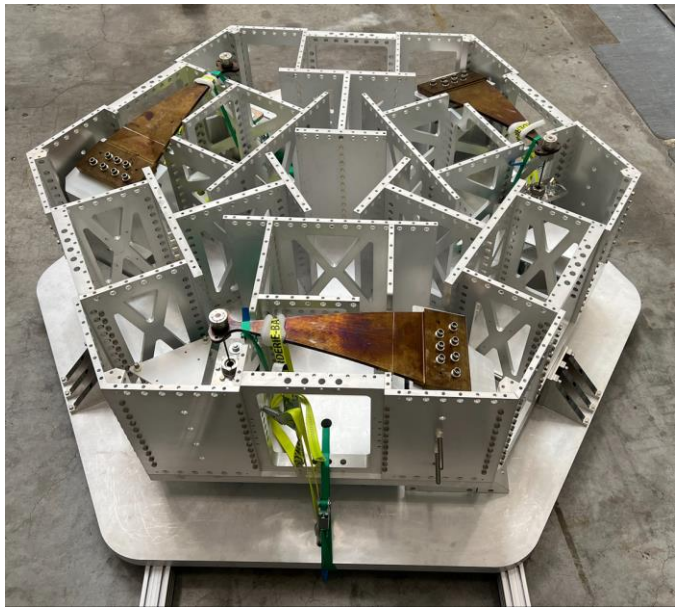
Received parts in first week of August







Active platform is ready
Next: assemble inverted pendulum & suspended masses



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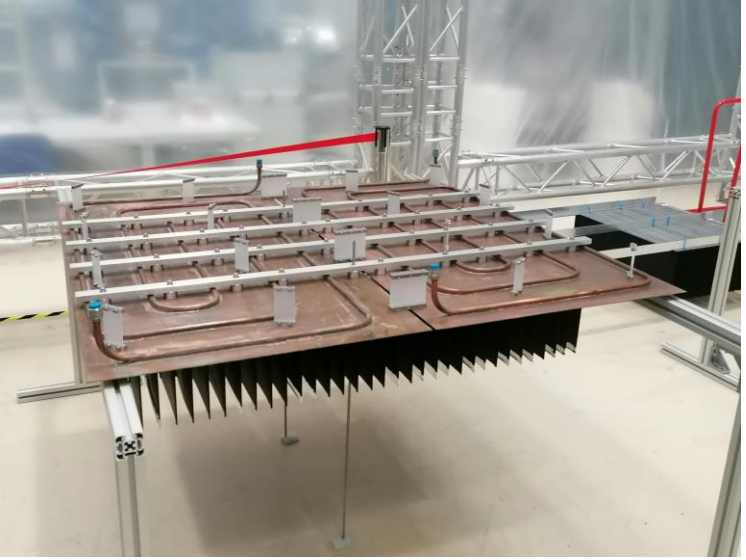
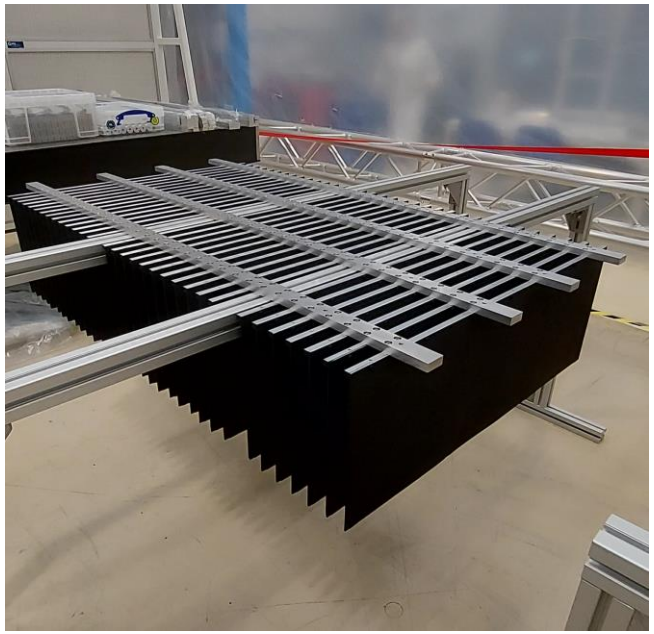
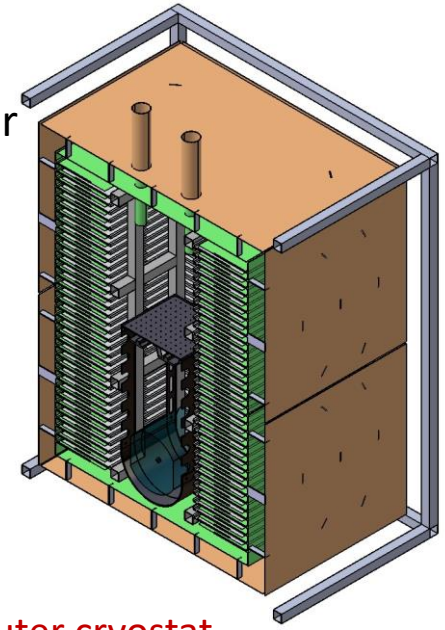
Cryostat: Radiation heat transfer for mirror cooling (started the assembly)

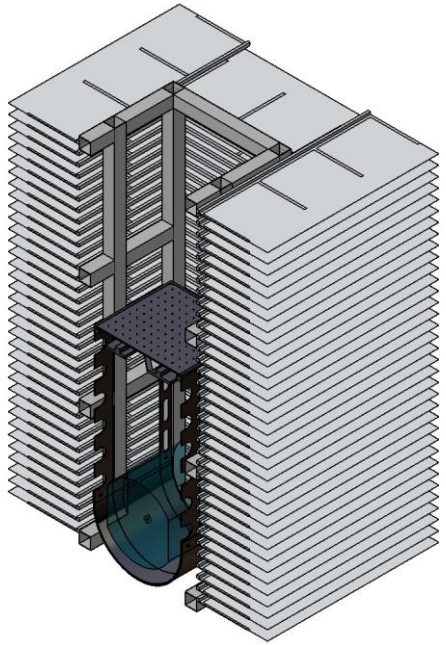


- ✓ Overall dimensions: 1.8 x 1.6 x 2 m^3
- ✓ Conventional radiator design with horizontal fins (25K)
- ✓ Three 30-mm diameter optical feedthroughs towards the mirror





Outer cryostat
(connected to the vacuum chamber):
- 80K LN2 shield (brown)
- 25K GHe panels (green)



Inner cryostat
suspended and conductively linked to the silicon mirror

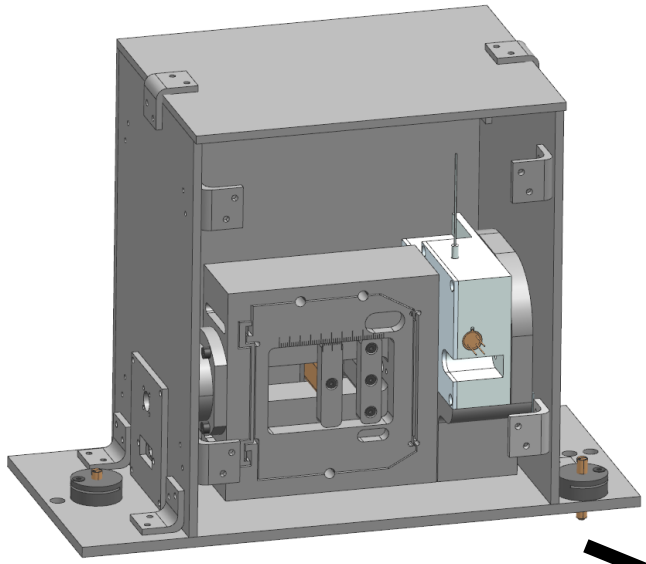
Contact: Cedric Lenaerts (CSL)
Cedric.Lenaerts@uliege.be

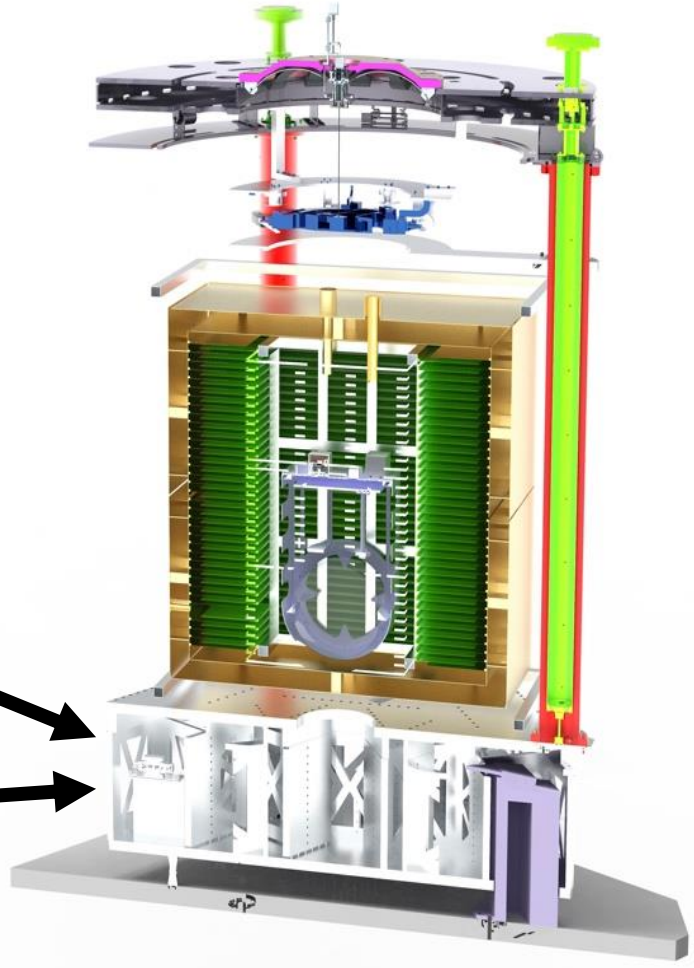
Inertial sensors: for active seismic attenuation at low frequency

Precision Mechatronics Laboratory

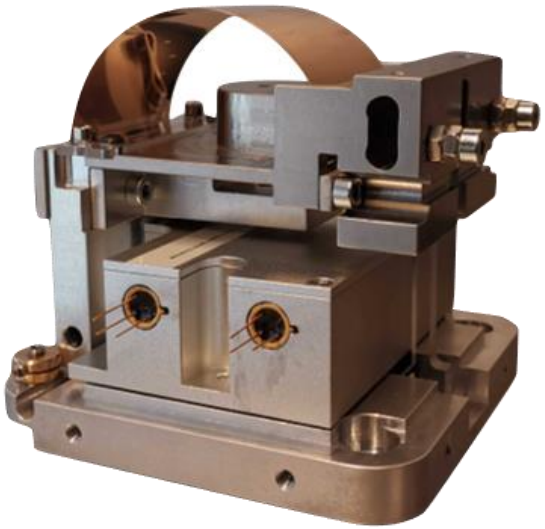
Waiting for some mechanical parts

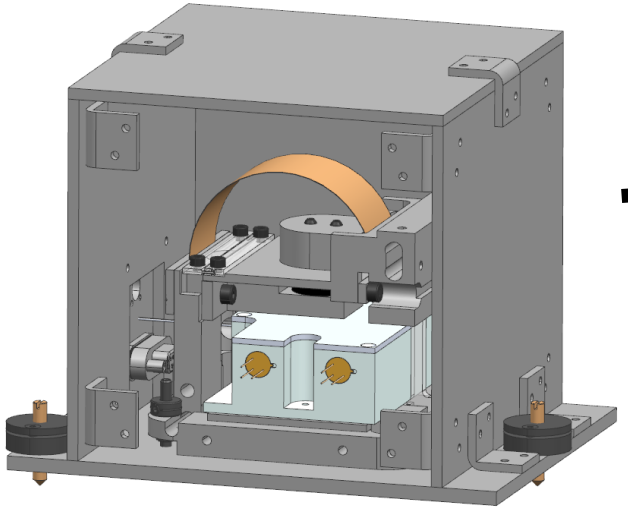
Horizontal sensor





Vertical sensor





Loïc Amez-Droz (PML) lamezdroz@uliege.be
Anthony Amorosi (PML) Anthony.Amorosi@uliege.be

Interreg Euregio Meuse-Rhine European Regional Development Fund
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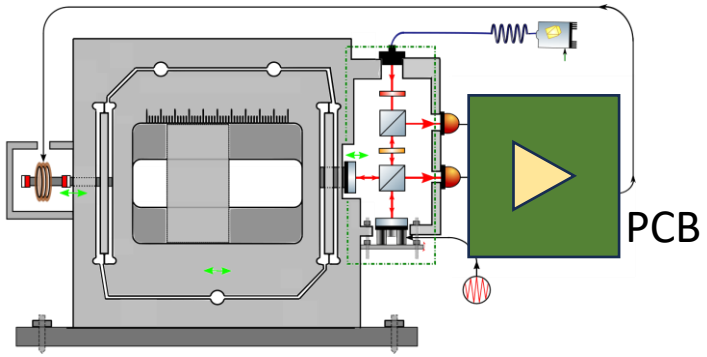
Cryogenic inertial sensors (vertical & horizontal): measure residual motion at the cold platform

UCLouvain

Precision Mechatronics Laboratory

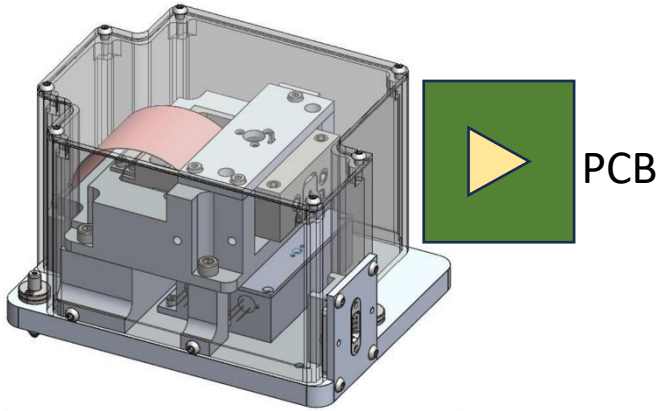
Waiting for some mechanical parts

Horizontal sensor

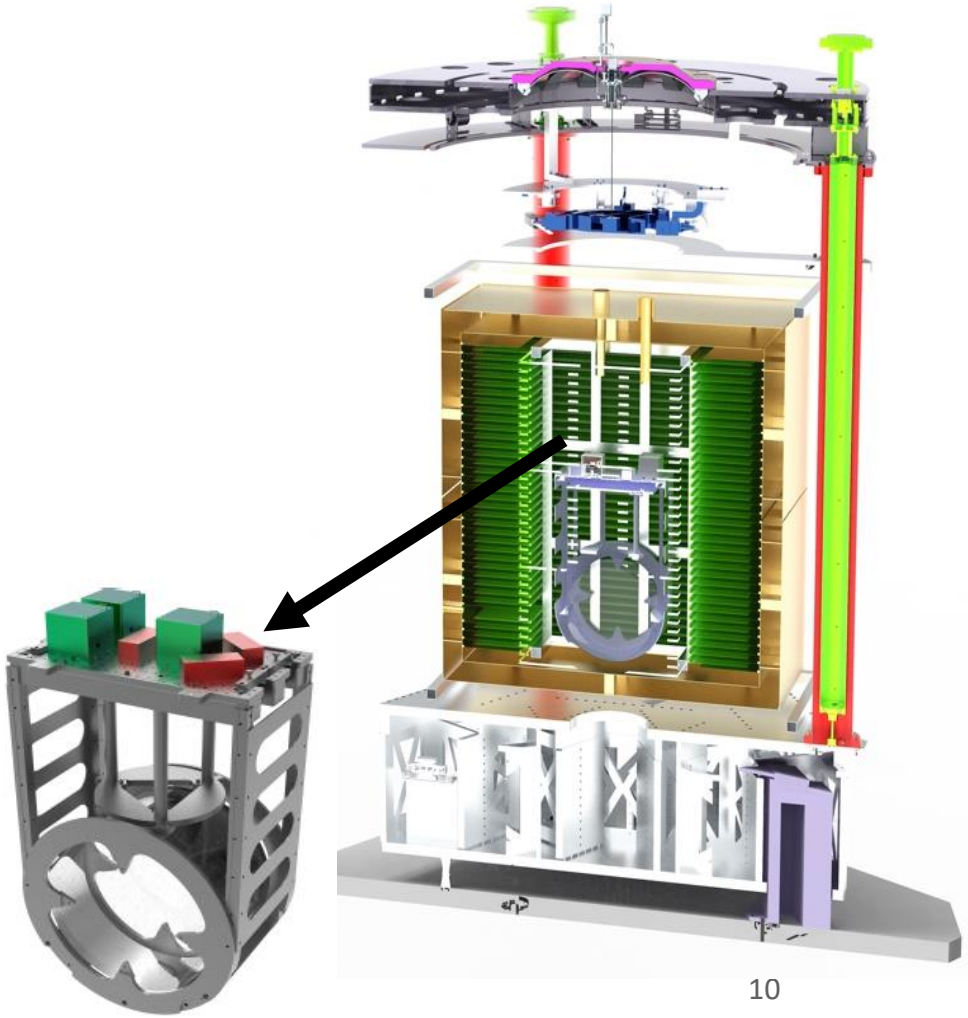


- titanium Watt's linkage
- coil-magnet(s) actuator
- room-temperature electronics
- interferometric readout

Vertical sensor

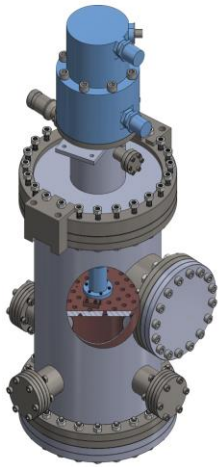


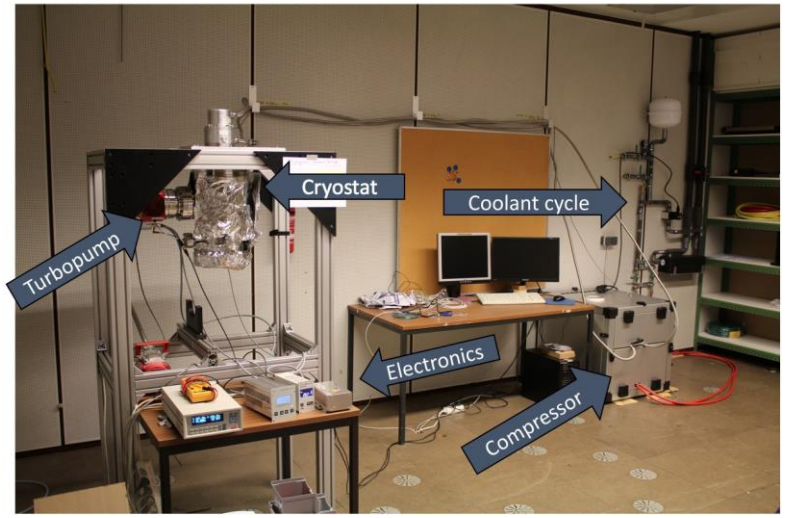
- leaf spring mechanics
- open-loop operation
- room-temperature electronics
- interferometric readout

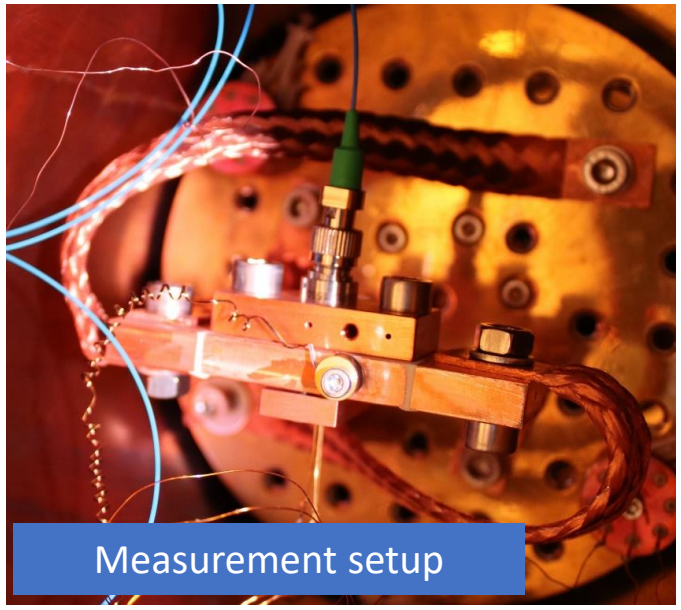


Morgane Zeoli (PML, UCL) morgane.zeoli@uliege.be
Joris van Heijningen (UCL) joris.vanheijningen@uclouvain.be

Cryogenic test bench for photodiode/electronics testing







1550 nm photodiode testing

CQG paper: https://iopscience.iop.org/article/10.1088/1361-6382/ac8fdb/meta

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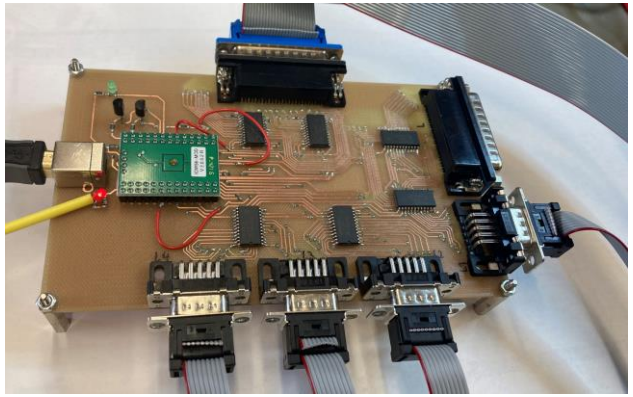
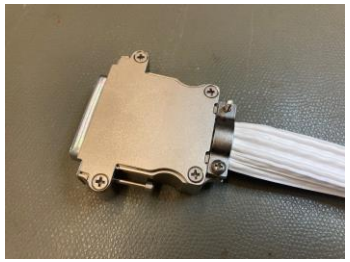
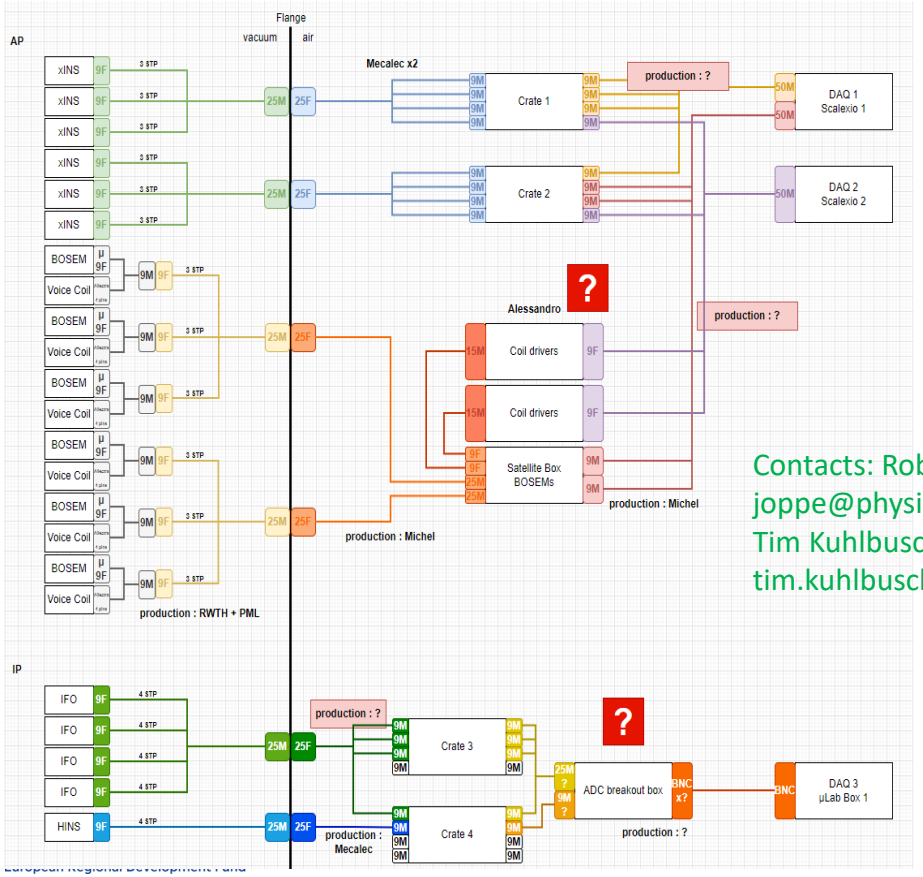
Vacuum cabling





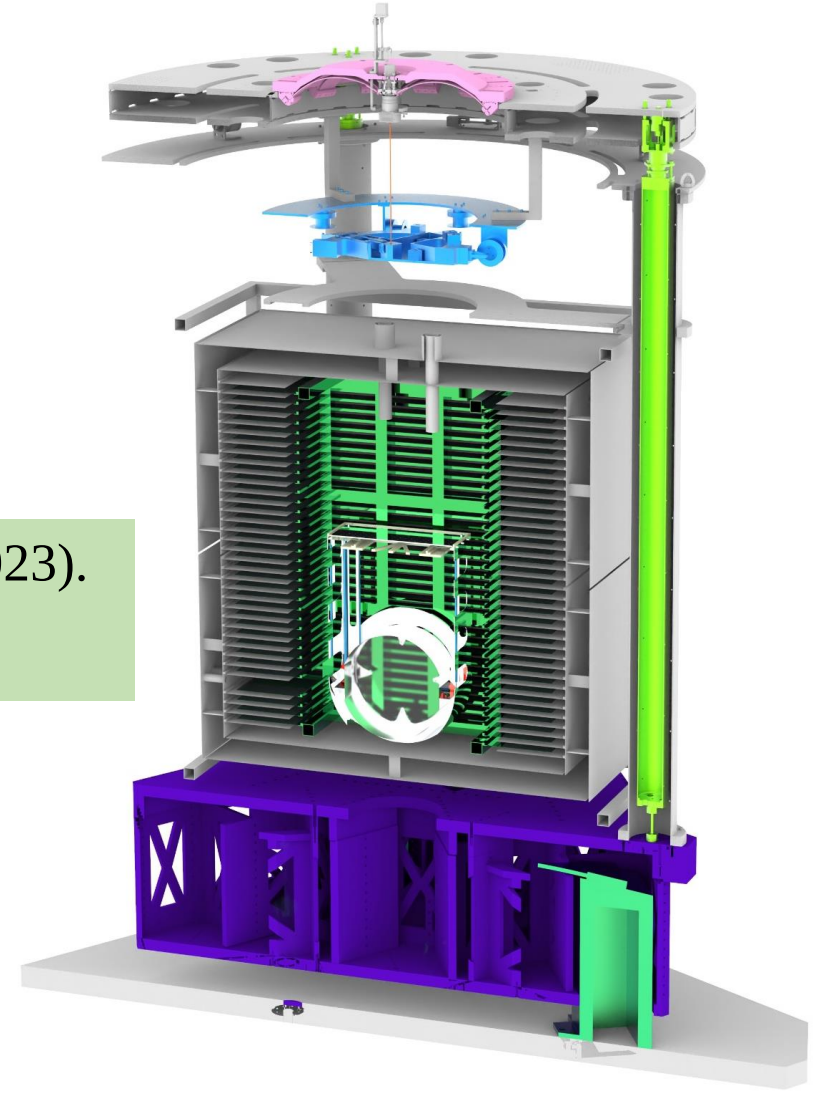


Contacts: Robert Joppe
joppe@physik.rwth-aachen.de
Tim Kuhlbusch
tim.kuhlbusch@rwth-aachen.de

Mirror

Features:

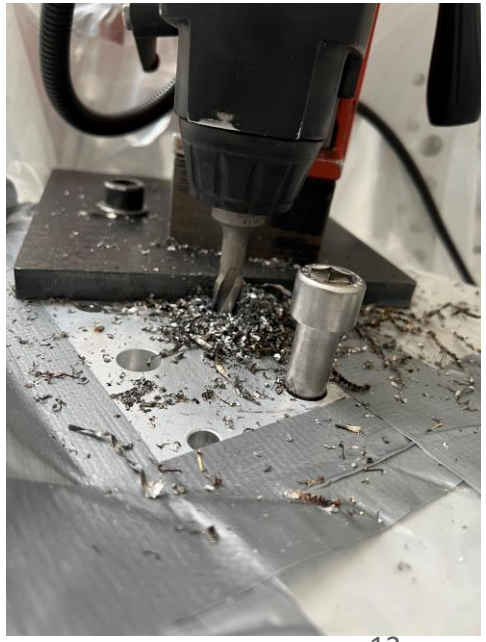
- 100kg, 45cm.
- Polished/coated?



- Experimental work → Cryogenic test with Aluminum dummy mass (Q4 2023).
- Experimental work → Cryogenic test with silicon mirror (Q4 2024).

Initial Assembly at:
Advanced Mechanical and Optical Systems (AMOS) - Belgium & Nikhef - Netherlands

Facilities at AMOS



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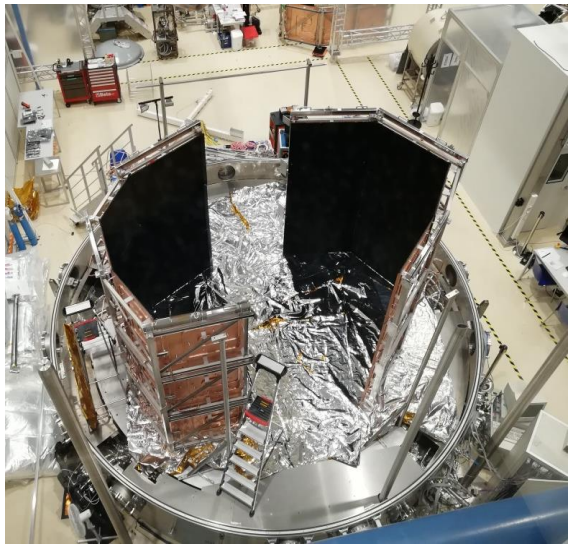
Operation: Liège Space Center - Belgium



Focal 6.5 optical bench

Conclusion

We are very excited to validate the concept of E-TEST

Next:

- Continue the assembly.
- Experimental work → Cryogenic test with Aluminum dummy mass (Q4 2023).
- Experimental work → Cryogenic test with silicon mirror (Q4 2024).

Useful links:

CDR: E-TEST prototype design report
https://arxiv.org/abs/2212.10083

E-TEST Project website
https://www.etest-emr.eu/

LIGO Document P2200399-v1
E-TEST: a compact low-frequency isolator for a large cryogenic mirror

CQG paper:
https://iopscience.iop.org/article/10.1088/1361-6382/ace230/meta

PML website
http://www.pmlab.be/

The End

Thank you!

The Financiers

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