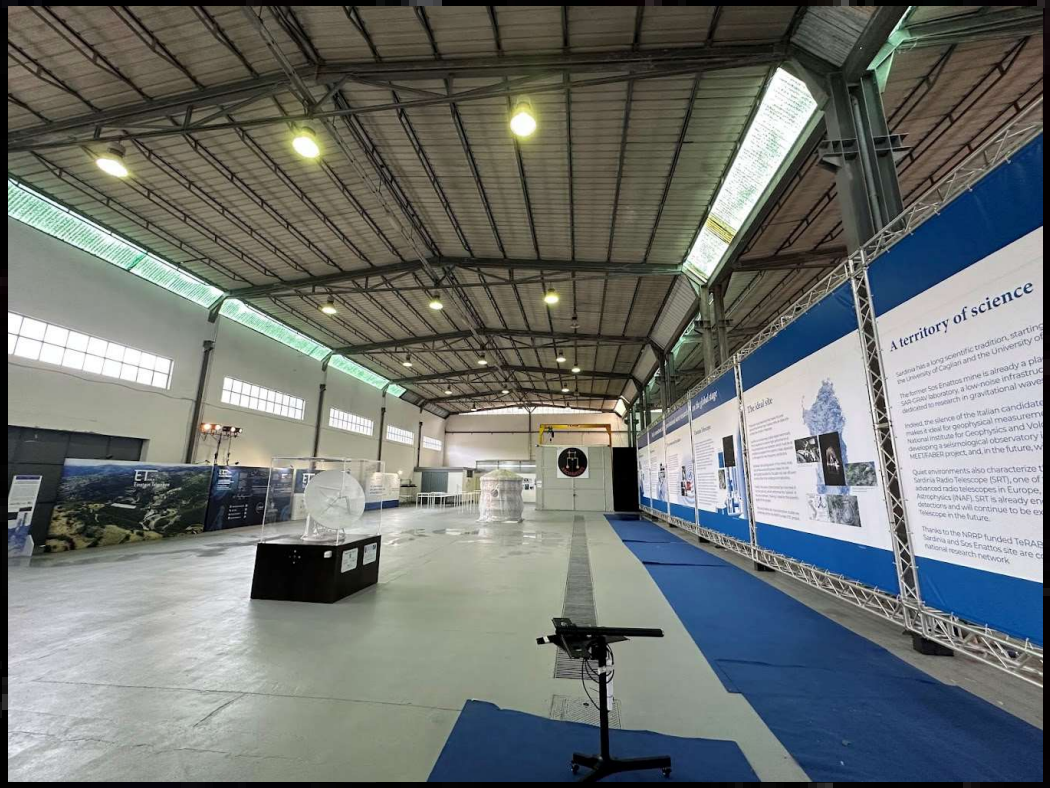
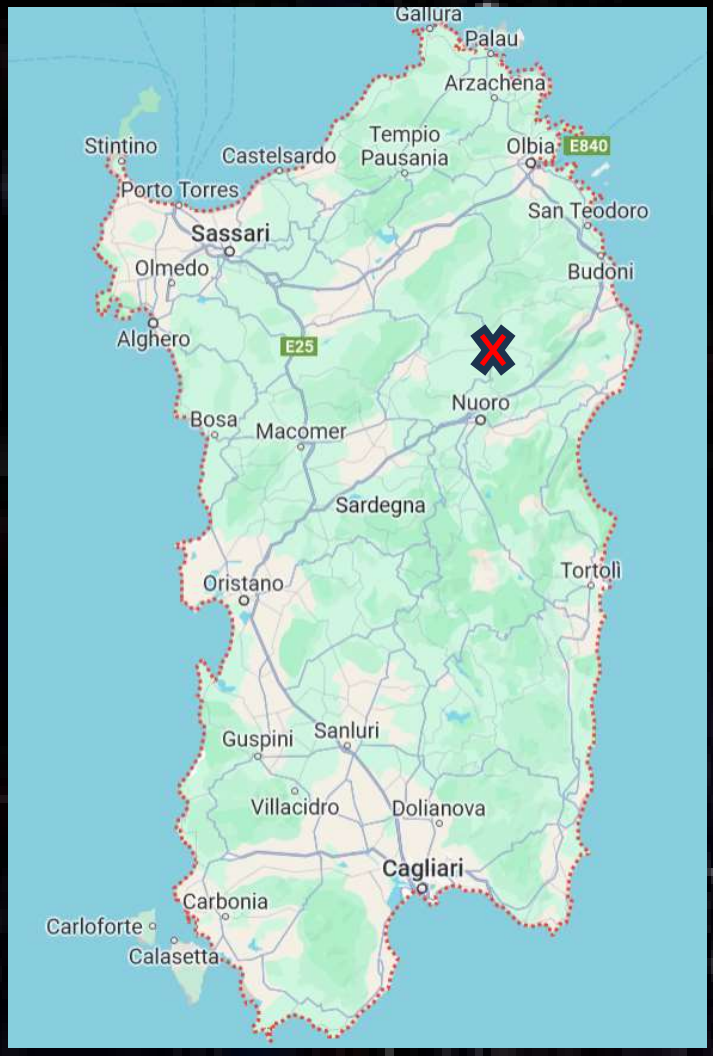
Double suspended arm differential balance





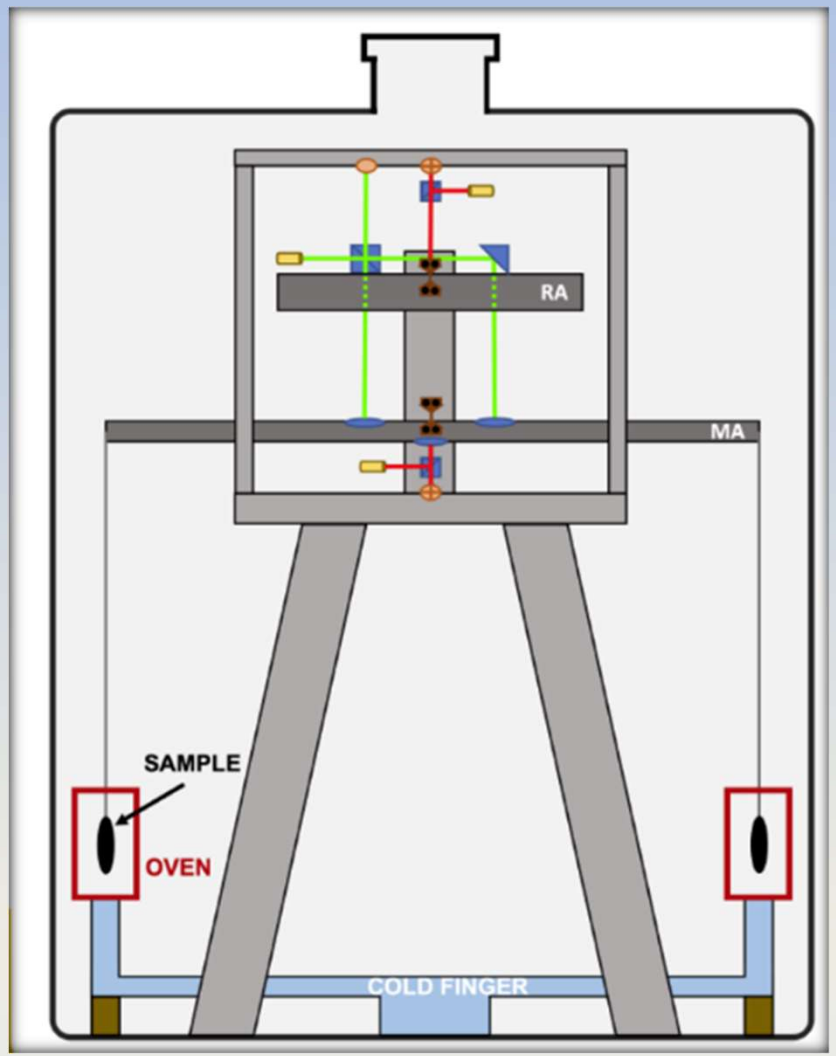
Principal activity

- Archimedes experiment devoted to measure the discussed interaction of vacuum fluctuations and gravitational field

Relationship with ET

- Low frequency seismic and environmental studies
- Control loops in very low frequency
- Tiltmeters study for Newtonian Noise Reduction

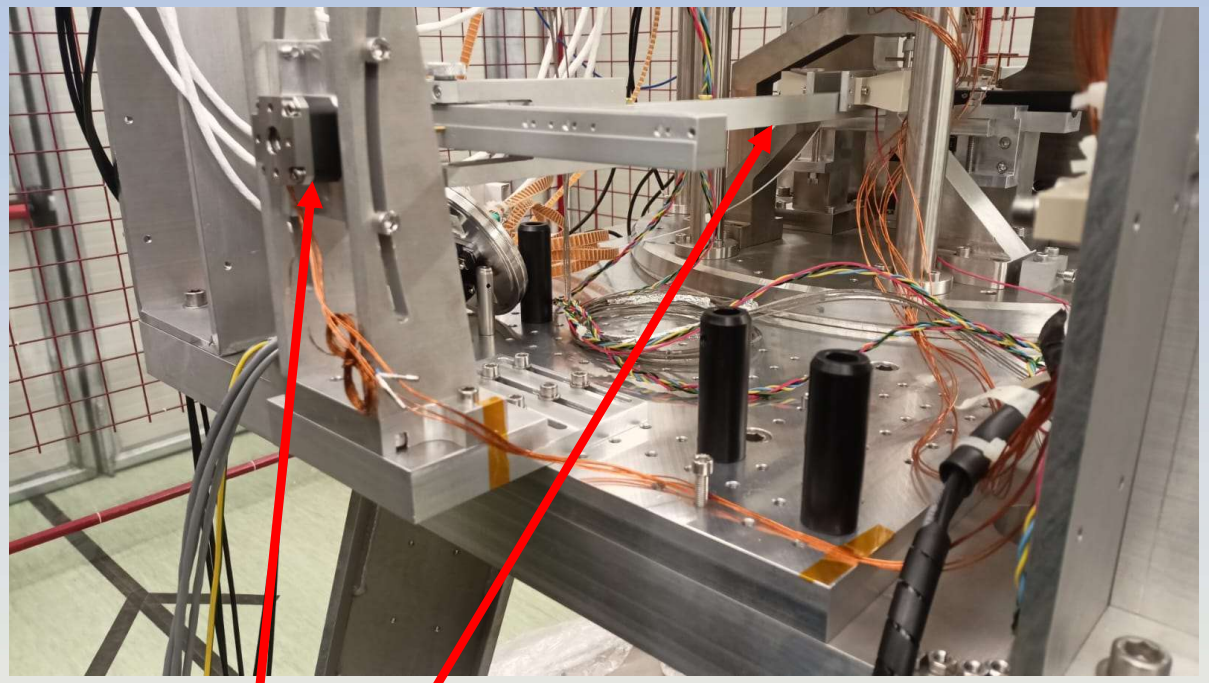
Scheme of the balance



- Each arm (reference and measurement) is suspended to a soft joint
- The measurement arm suspends a sample at each end, with a 1 m long tungsten wire
- The present samples are 0.2 kg metallic plates - one in Aluminum and the other in Lead
- The aluminum plate is insterted in a thermal chamber to allow for temperature modulation
- The differential tilt of the arms is read with a Michelson interferometer operated in closed loop

Some pictures

Final Balance with suspended samples

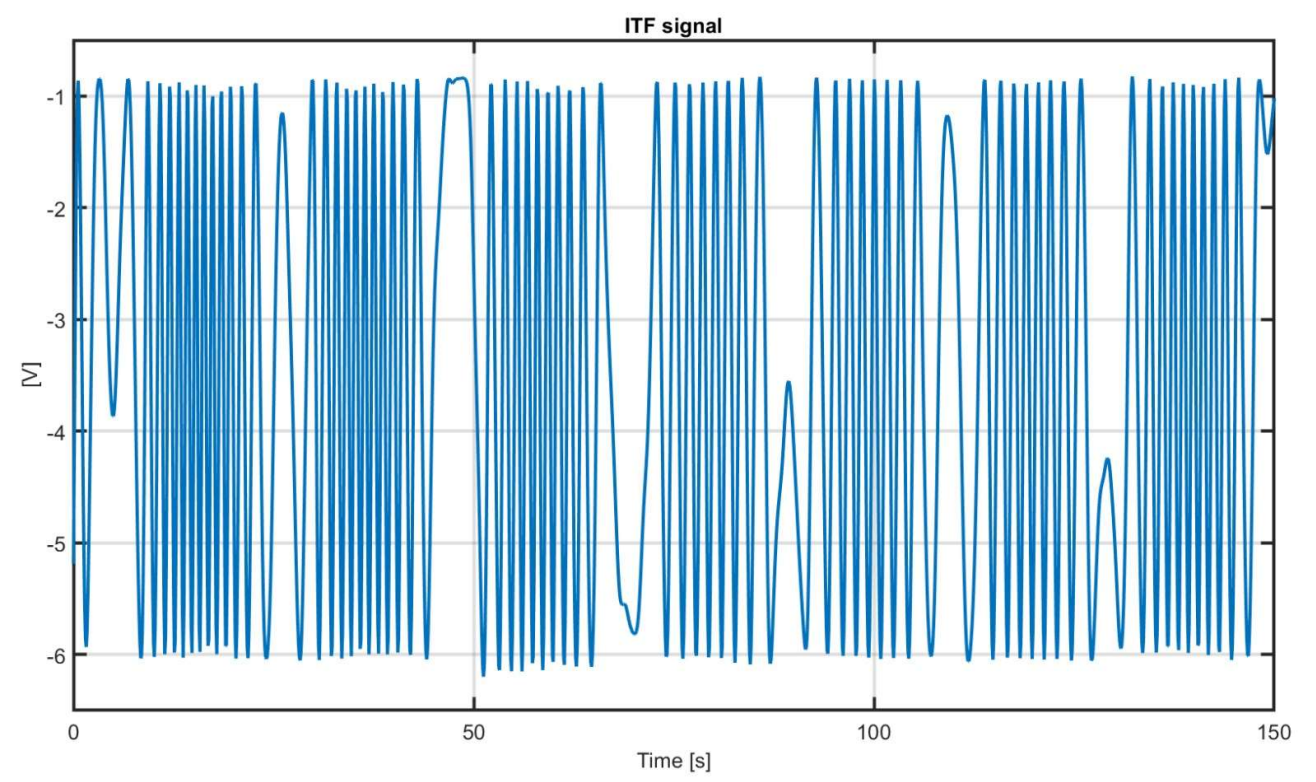


Measurement arm

Rotation Motor to remotely bring the arm in equilibrium

Interferometer

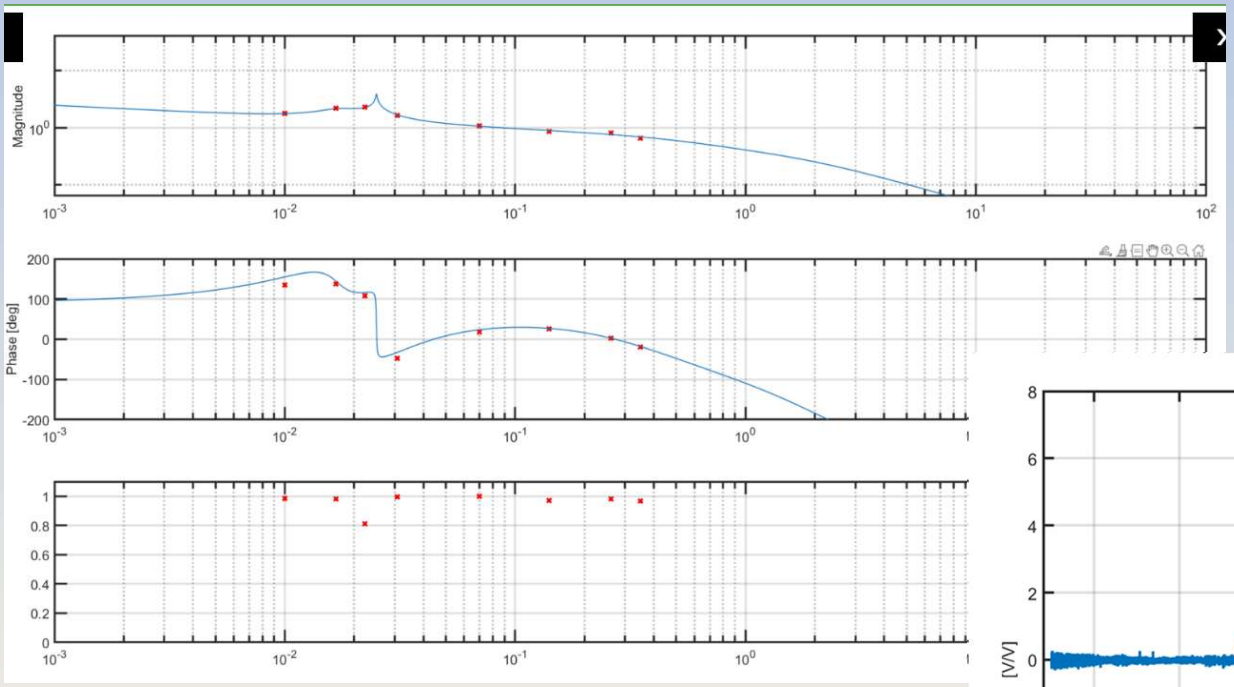
- Good constrast also for quite large tilts
- The operating point is presently on the middle fringe – plans to go towards dark fringe still in DC



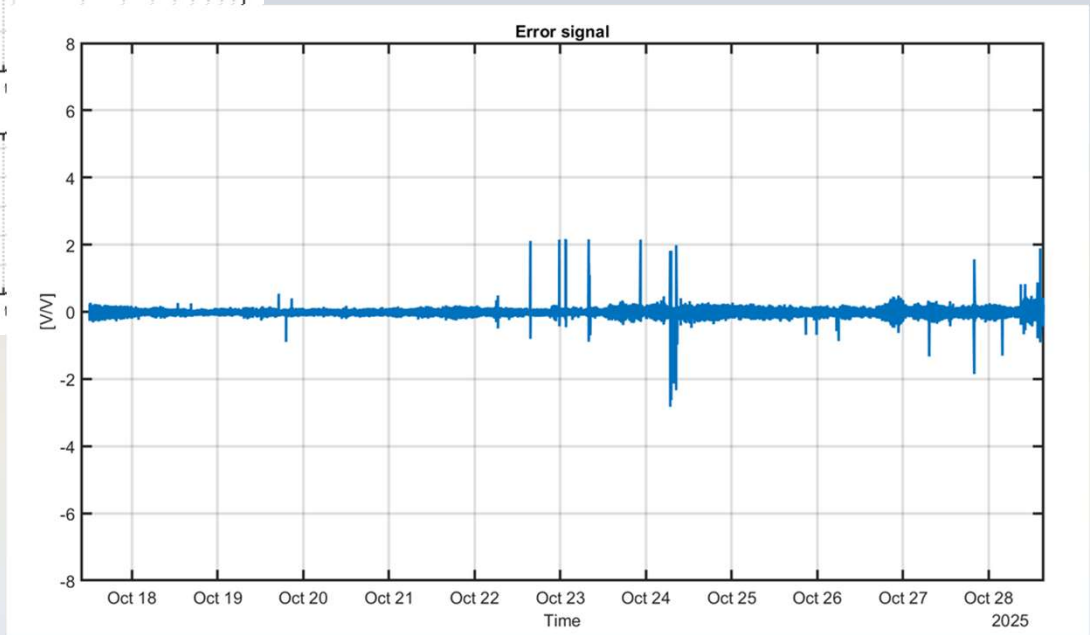
Free spanning fringes in a non-quiet environmental condition

First commissioning run

- The whole system (mechanics&Control) simulated with Octopus
- Lock very stable – the system has been continuos locked for about 10 days – manually interrupted for commissiong

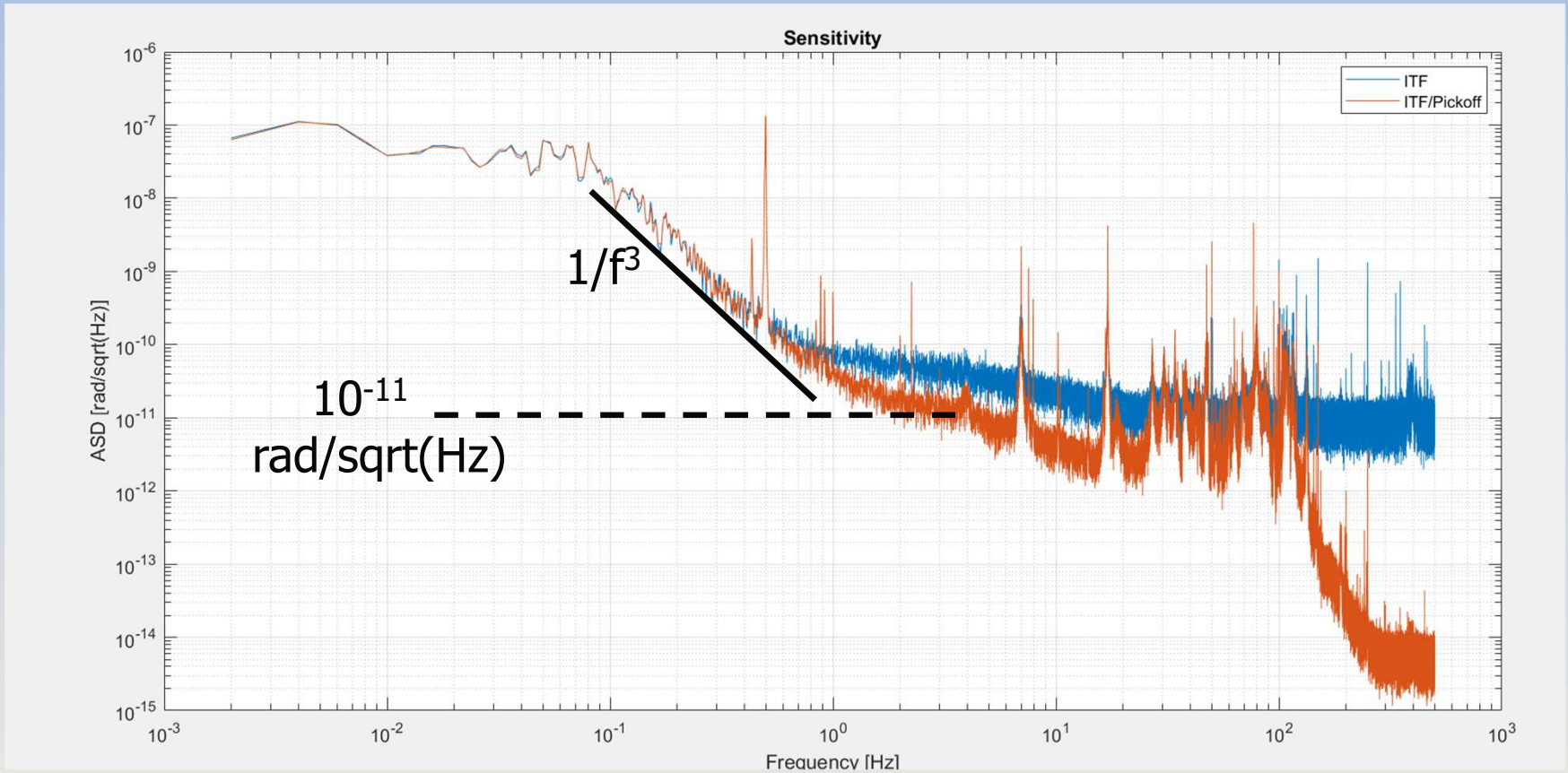


Open loop Tranfer Function – red points measured – blue curve expected - Unity Gain 100 mHz



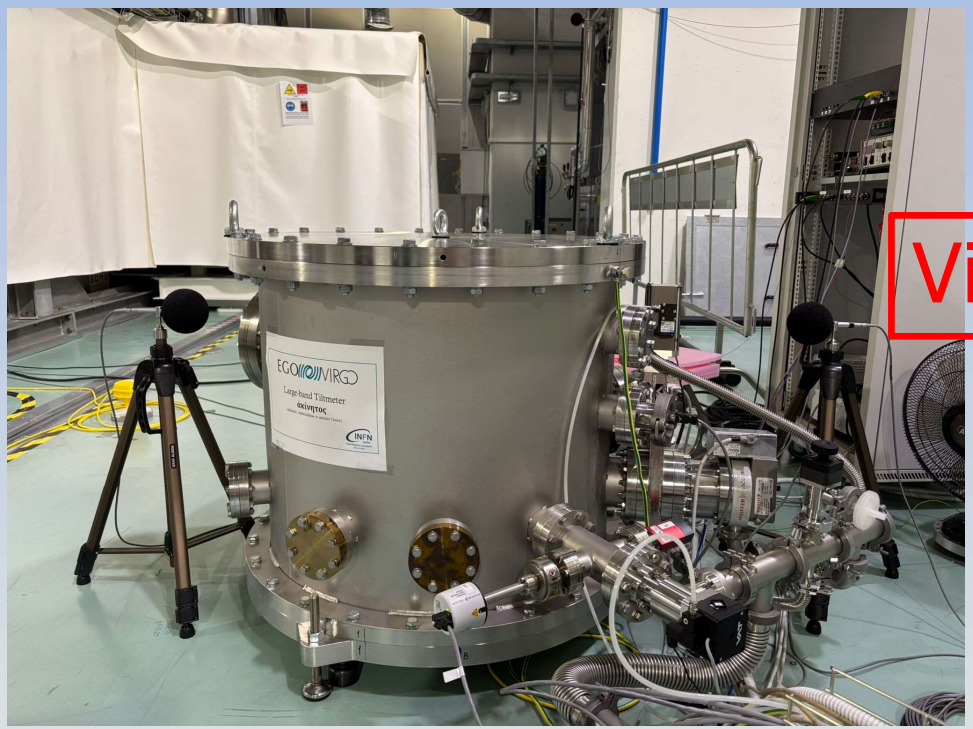
10 days continuos lock

Preliminary Sensitivity



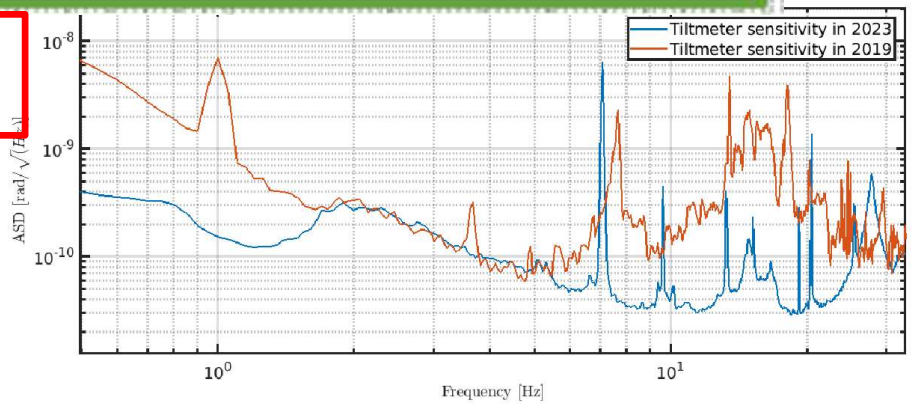
- Low/middle frequency – 10 < f < 1 Hz – **Actuation noise** – need to replace a broken rotation motor that imposes to balance the arm with a high, and noisy - DC voltage on actuator
- High frequency f > 1 Hz – **to be studied**

Fall-out activities – Tiltometry for NNC



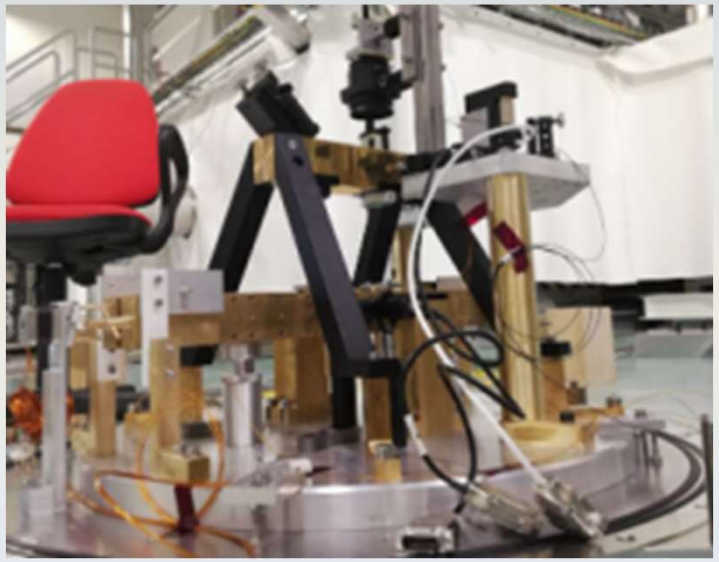
Virgo

About 8 e-11 @1Hz,
3 e-11 @10 Hz



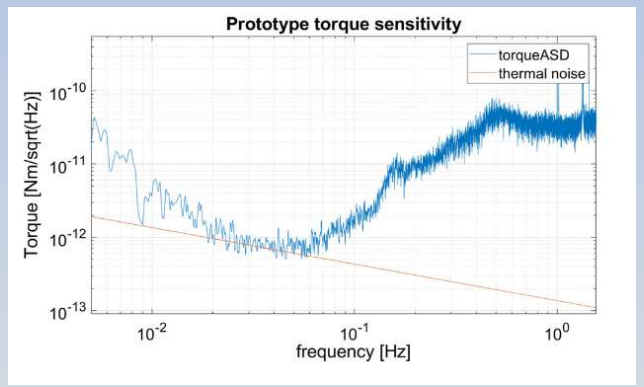
ET

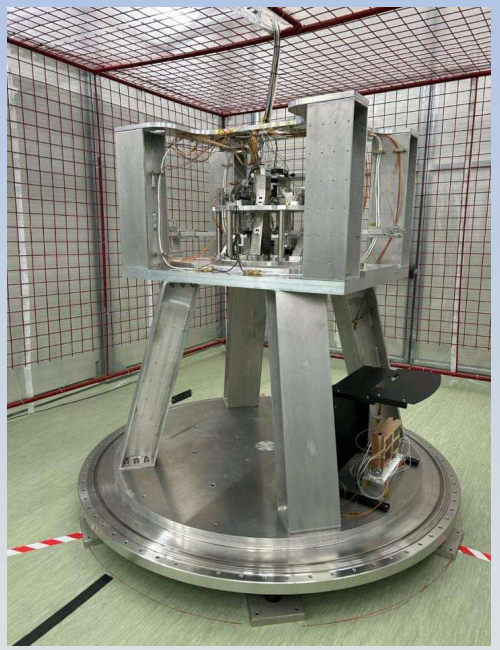
A new tiltmeter will be installed underground in a Sos Enattos ad-hoc Lab

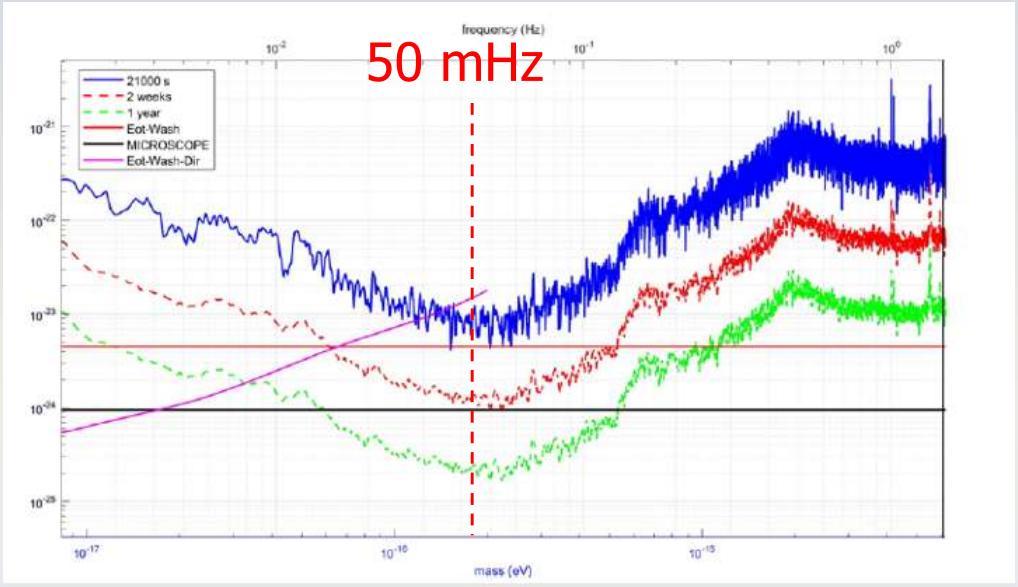


Fall-out activites: direct search for ultralight B-L dark photon

The expected signal on the balance is a monocromatic noise at the frequency $f = mc^2/h$







Increase of a factor 10 with respect to the prototype would allow direct search for B-L dark-photon

1 night of measurement ! With prototype in Sos Enattos

Conclusion on the balance

- First double suspended with interferometric read-out
- Ready to allow for room temperature tests of temperature modulation on suspended samples
- Commissioning started, especially focused on low-frequency behaviour

Relationship with ET

- Investigation on environmental noises at low frequencies ($f < 0.1$ Hz) and contribution to NNC in 2-20 Hz frequency regime
- Eventual contribution to tilt reduction in ET seismic attenuator
- Support that Sos Enattos – starting with the SAR-GRAV Laboratory - is a site suitable for high sensitivity experiments

Thanks