

SAR-GRAV Lab

SAR-GRAV is an in-fieri laboratory located at Sos Enattos mine, the Italian site candidate to host ET

- SAR-GRAV hosts ET activities as well as Geophysics and Fundamental Physics activities
- currently consists of a surface laboratory, built inside a building formerly used for marble processing, and a series of small caverns located inside the mine, which are protected and house seismic and magnetic sensors.
- In the surface laboratory, in addition to various experimental rooms, there is a control room that is used both to monitor the experiments being carried out and to collect data from the mine.



The cavern that should host the Archimedes Experiment

The Surface Laboratory

During these years a LAB has been created, inside a former marble processing building: A **main experimental** hall (named Planck) – A **small experimental** hall (named Bekestein) – an **auxiliary hall** (named D'Urso) - a **Control room**, a small **meeting room** and a small warehouse.



*The front view of Planck hall
(in this hall the Archimedes
balance is located)*



The auxiliary D'Urso hall



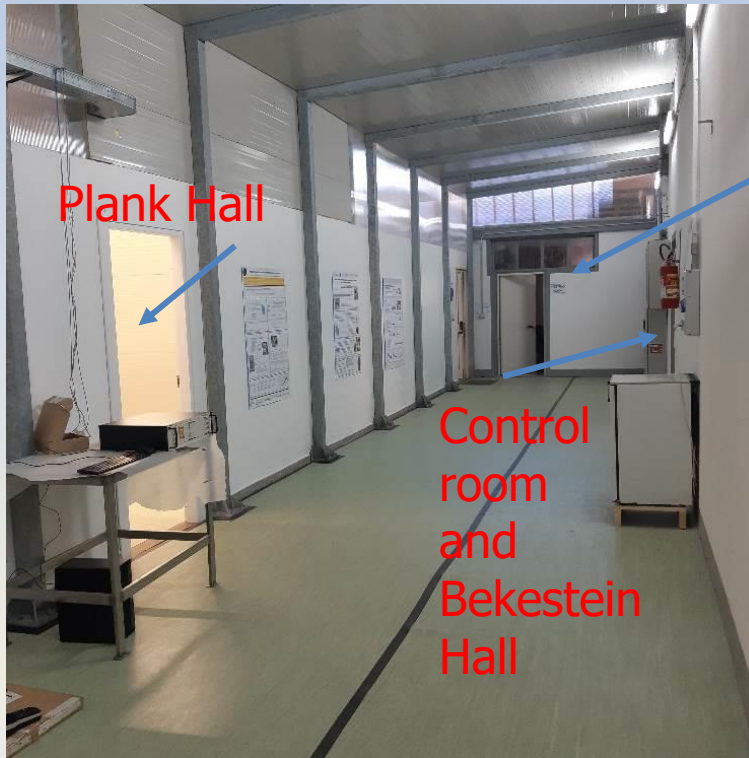
*Beckestein hall (in this hall
the prototype is located)*



The control room

Recent extension of the Lab

- Further expansion of the laboratory by closing the partition of the laboratory housing the prototype and the Archimedes laboratory
- Access to all rooms possible from inside the Archimedes area - reduction of dust problem from the “granite building”



Meeting room

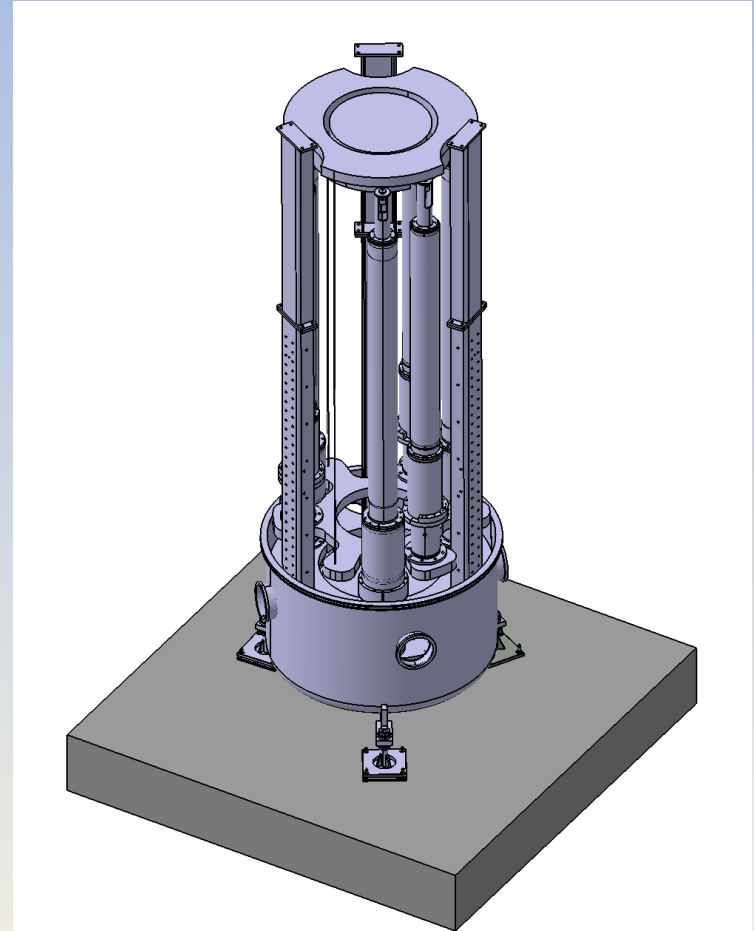


An aerial view of the site

The new 80 m² room connects the various rooms and 'isolates' the Archimedes workshop from the granite building

SAR-GRAV and ET

- SAR-GRAV provides the caverns in the mine and the infrastructures to host the instruments for environmental measures
- It offers the support for instruments installed in the surrounding regions
- It collects the data from the various sensors, both in the mine and in the surrounding region
- It host a tiltmeter on the surface lab
- It is planned to test at least partially a preliminary version of the double-suspended inverted pendulum to study it in a quiet environmental condition



Double inverted pendulum: see L. Di Fiore talk on Tuesday

SAR-GRAV and ET: Underground Measurement stations

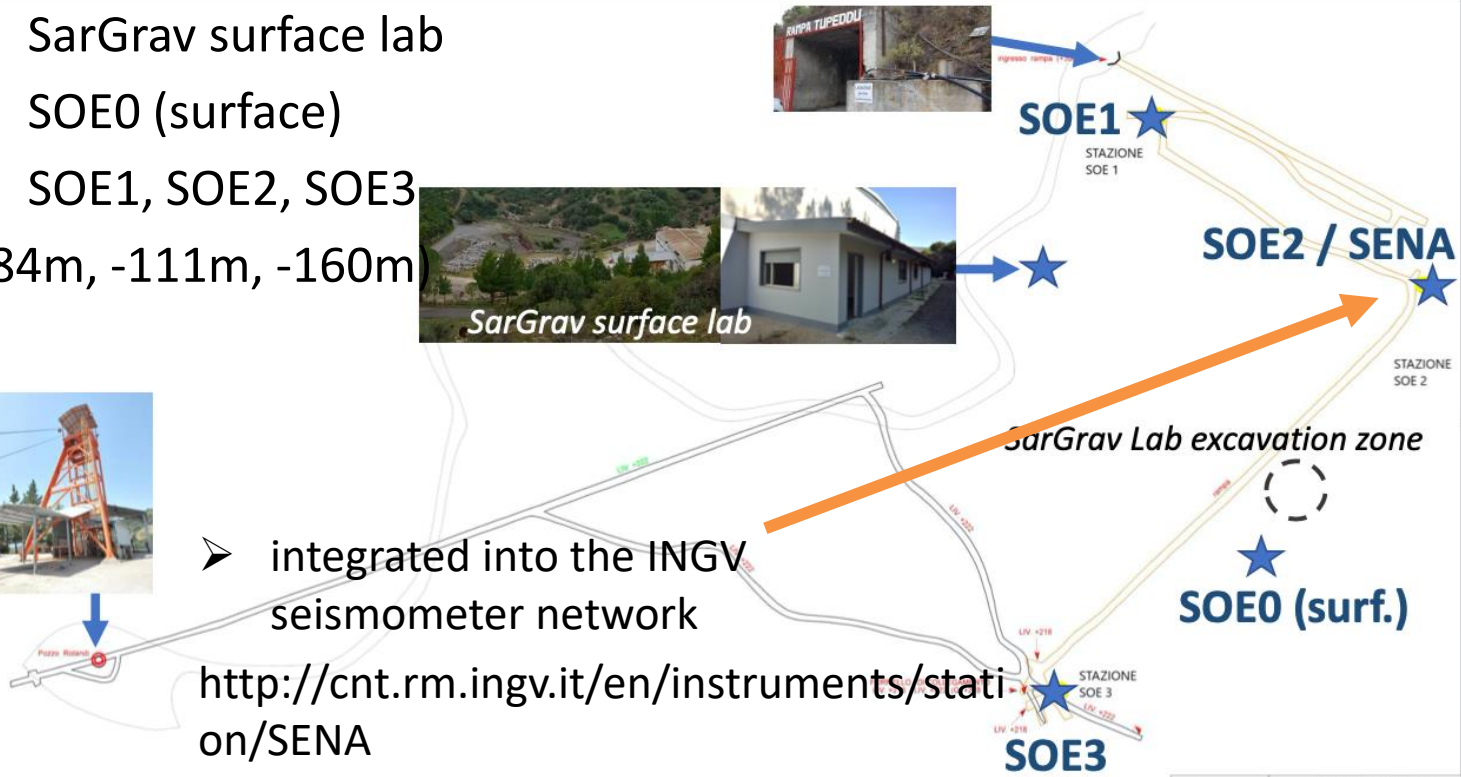
Sos Enattos measurement stations (since Aug. 2020)

- SarGrav surface lab
- SOE0 (surface)
- SOE1, SOE2, SOE3
(-84m, -111m, -160m)



- integrated into the INGV
seismometer network

<http://cnt.rm.ingv.it/en/instruments/station/SENA>



SAR-GRAV and INGV

(National Institute for Geophysics and Vulcanology)



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PIANO NAZIONALE
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PNRR project “Monitoring Earth Evolution and Tectonics” (MEET)



Principal Investigator: Giulio Selvaggi, INGV

framework:

Progetto infrastrutturale finanziato Missione 4 del PNRR “Istruzione e Ricerca”

Componente 2 “Dalla ricerca all’impresa”

Linea di investimento 3.1 “Fondo per la realizzazione di un sistema integrato di infrastrutture di ricerca e innovazione”

11 WPs national al local seismic and geodetic networks, laboratories, observatories

43 M € di budget totale, 2.5 M € for WP7 Sardinia Faber

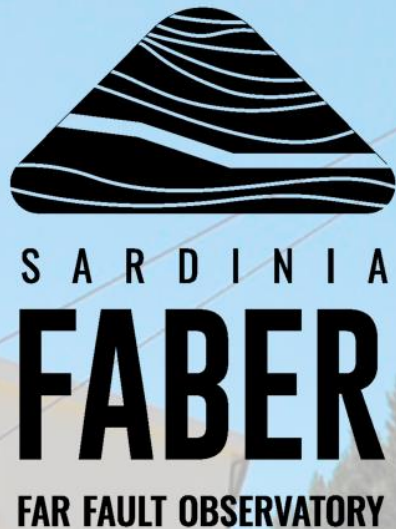
Objectives:

SPECIFIC OBJECTIVE 1
Strengthening the Data
Production

SPECIFIC OBJECTIVE 2
Implementing Services
for Science and Society

SPECIFIC OBJECTIVE 3
Integration in the National and
European Frameworks & FAIR
Data Management

INGV and the FABER project



**Sardinia FABER is a
geophysical observatory
located at Sos Enattos Mine**

Infrastructure consolidation

- power line and data line upgrade
- solar power plant and electric vehicles to access the tunnel

New instrumentations

- broadband and very broadband seismometers
- magnetometer
- gravimeter
- strainmeter
- tiltmeter
- micro barometer and other ambient controls

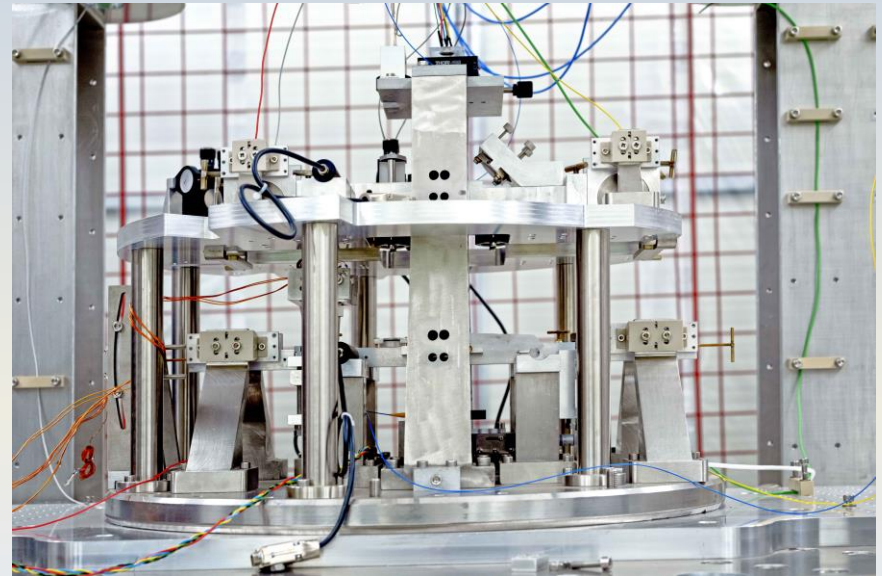
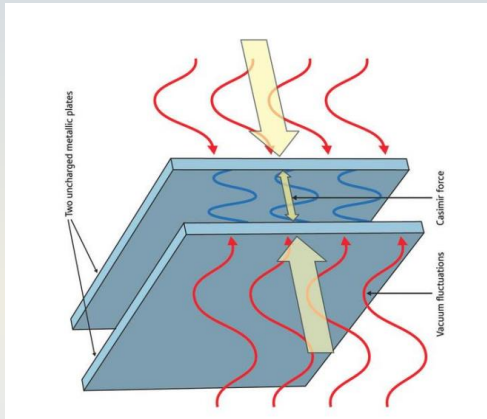
Surface laboratory

- equipment maintenance and test
- data acquisition, archive and transission
- hospitality (and lodging)

SAR-GRAV and fundamental physics: Archimedes

- Goal: Archimedes is devoted to measure the problematic interaction of electromagnetic quantum vacuum fluctuations and gravity
- Methodology: variation of weight of type II stratified multi-layer superconductive sample at the transition
- Experimental Apparatus: extremely sensitive cryogenic balance – presently under installation

Conceptual scheme of the Archimedes experiment → measure the Archimedes buoyancy of vacuum



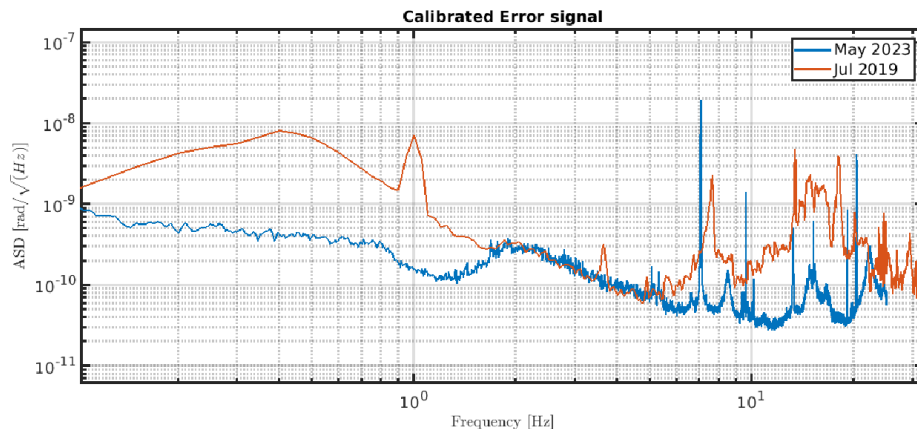
The balance

Fall out towards Virgo and ET: TILTMETER

A beam-balance, in particular not having suspended samples, is a tiltmeter. A first version was installed in Virgo in 2019.

Hence in Sos Enattos, after various upgrades, it was proved a sensitivity of about 10^{-12} rad/sqrt(Hz) in the few Hz frequency region and now an updated version of the tiltmeter is installed in Virgo for NN studies and suspension control studies.

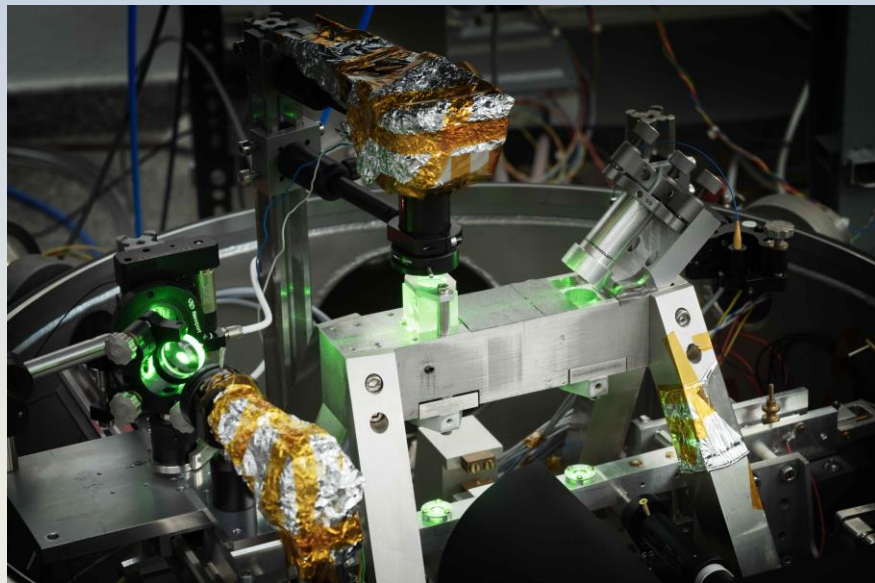
Comparison between tiltmeters sensitivity in 2019 vs 2023



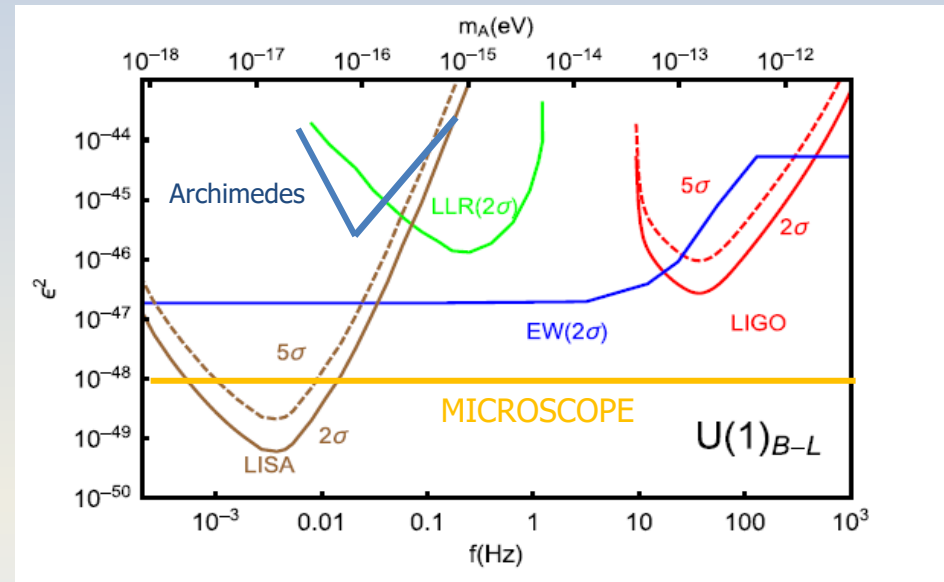
Present tiltmeter at Virgo

Fall out: Dark Photon search

The balance signal is referred at ground, as many small force sensors: benefiting of the low ground tilt it is possible to reach also a good sensitivity in force and torque also with the balance prototype. Having the suspended sample and the counterweight made of difference material it is possible to search for B-L dark photon



The balance prototype



Very preliminary: can be improved by long data taking

CONCLUSION

- SAR-GRAV is a laboratory that is providing, for ET, underground sites where to provide the needed low-noise conditions and the support for the seismic measurements in the all around region
- It can provide, especially for the future, a site where to test ET apparatus in realistic (low noise) conditions
- The same feature is being used and furthermore could be used for other Geophysical and Fundamental Physics experiments that can benefit of the low noise environment