

The Sar-Grav Laboratory Status and Perspectives



The SarGrav Laboratory

Founded by the Regione Autonoma della Sardegna (RAS) to host low seismic noise underground experiments (low seismic noise experiments, cryogenic payloads, low frequency and cryogenic sensor development)

- 200 m² surface Laboratory with annexed control room
- 120 m² underground Laboratory under construction
- First experiment: Archimedes (founded by INFN)



Financial Support from Regione Sardegna (RAS)

- Sar-Grav project approval (2017) 1Meuro
- Infrastructure enhancement (2020) 1MEuro
- Network link (2020) 1MEuro
- Site studies (2020) 0.5MEuro

Sar-Grav Management Structure

Executive Board (EB)

- ✓ M. Carpinelli (Chair), UniSS delegate
- ✓ S. Falciano, INFN delegate
- ✓ G. Saccorotti, INGV delegate
- ✓ M. Caria, IGEA delegate
- ✓ 2 RAS delegates

Technical-Scientific Board (TSB)

- ✓ F. Ricci (Chair, La Sapienza University)
- ✓ G. Saccorotti (INGV)
- ✓ D. D'Urso (UniSS)
- ✓ 1 RAS delegate

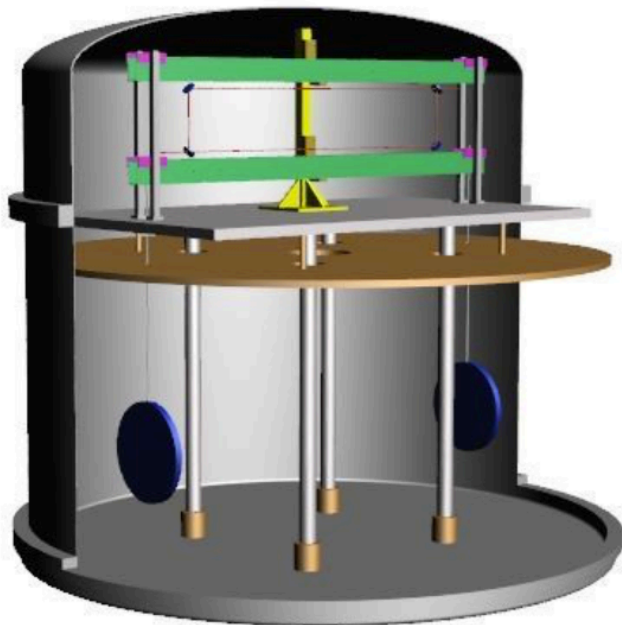
Current Activities

- Site Characterization (see L. Naticchioni talk)
- Activities on Surface
- Underground excavation
- Infrastructure enhancement

Activities on the Surface

First Experiment: Archimedes

- Experimental Goal: measurement of the interaction between vacuum fluctuations with gravity weighting a Casimir multi-cavity while changing the reflectivity of its layers. A change in the reflectivity corresponds into a variation of the internal vacuum state energy.
- Apparatus: high sensitivity balance working in cryogenic conditions (~ 90 °K)

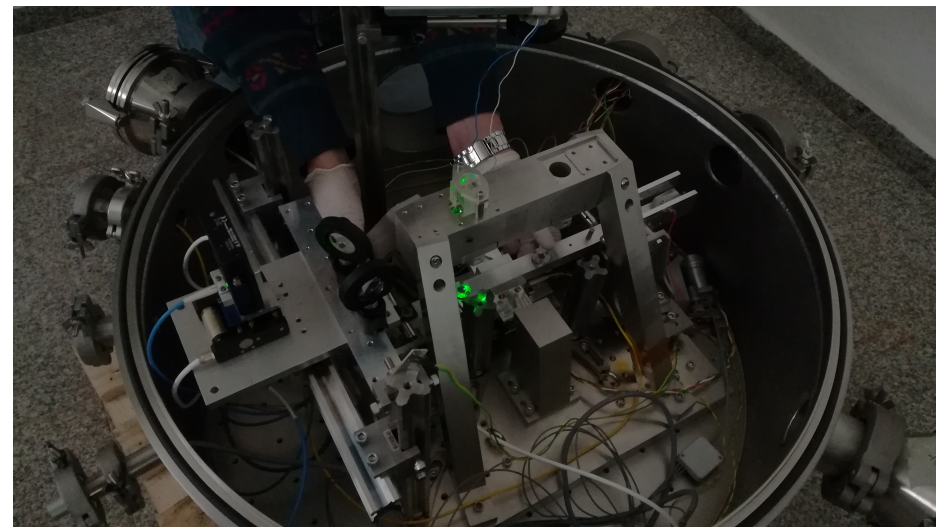


- High- T_c superconductors (i.e. YBCO) as natural Casimir multi-cavities;
- Measurements taken in HV (10^{-8} mbar) at cryogenic temperature ($T = T_c \approx 90$ K);
- Reflectivity changed via thermal actuation;
- Flexible thin joints with low thermal noise;
- Two suspended arms to apply coherent noise subtraction;
- Interferometric read-out system;
- Feedback control;
- Low seismic noise site.

Optics Lab

➤ Optics Laboratory

- ✓ Activity started on February 2020
- ✓ Test of optical components of a Tiltmeter (the Tiltmeter is the one used @ EGO), prototype of the Archimedes balance



Control Room and DAQ

- Multi-purpose control and acquisition system for Archimedes under commissioning @ Sassari
 - ✓ based on cRIO controller of the National Instruments (cRIO -9049)



Control Room and DAQ (2)

- Data acquisition/storage system for not seismic probes under commission @ Cagliari
 - ✓ DAQ card PCIe-24DSI64C200K
(http://www.generalstandards.com/view-products2.php?BD_family=24DSI64C200K)
 - ✓ Mini PC INTEL NUC
(<https://www.intel.it/content/www/it/it/products/boards-kits/nuc.html>)
 - ✓ Akitio Node eGPU box
(<https://www.akitio.com/expansion/node>) to host the DAQ card and connected to the mini PC via Thunderbolt 3 cable
 - ✓ DAQ system designed to operate underground

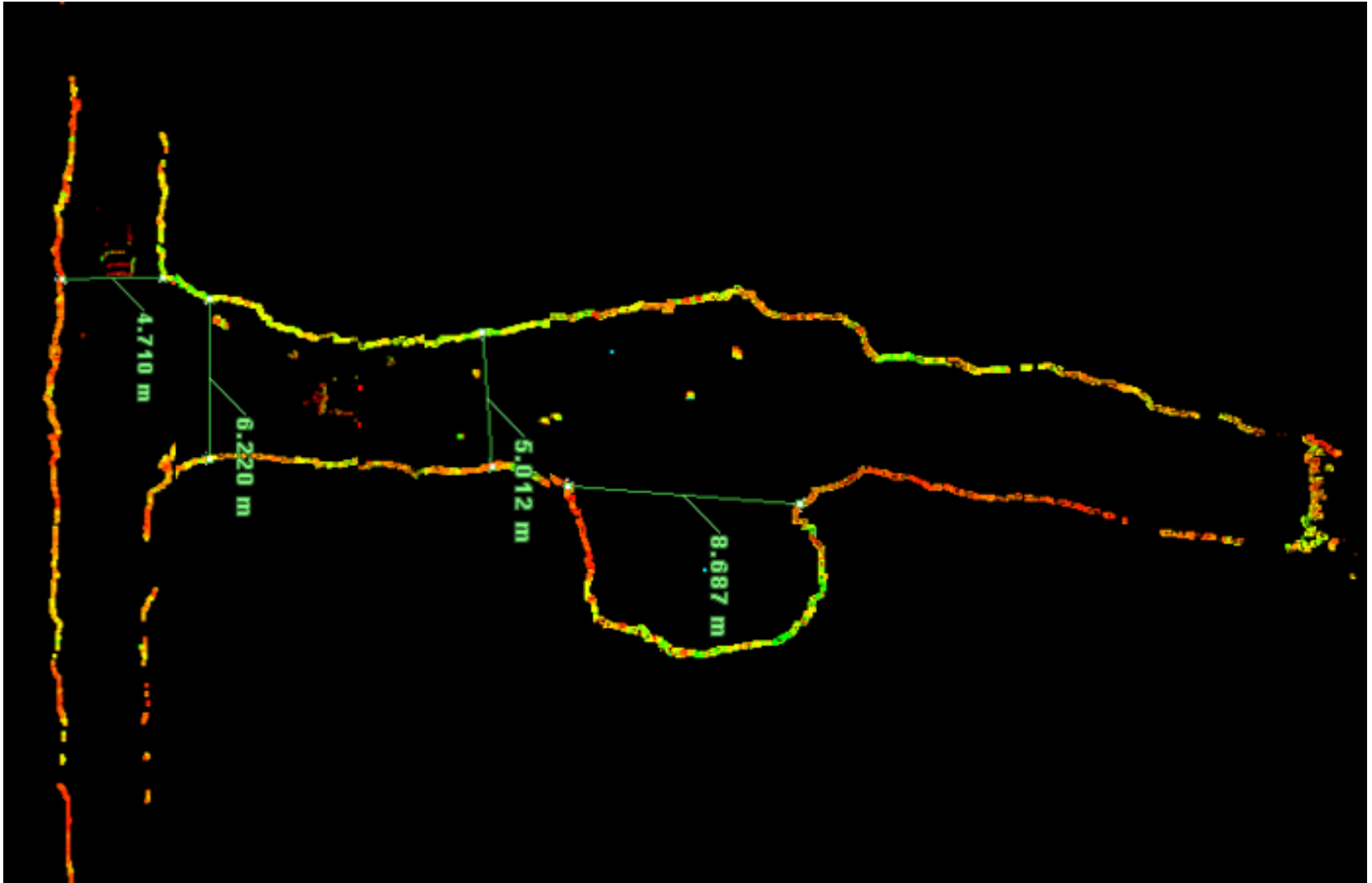


Next on surface

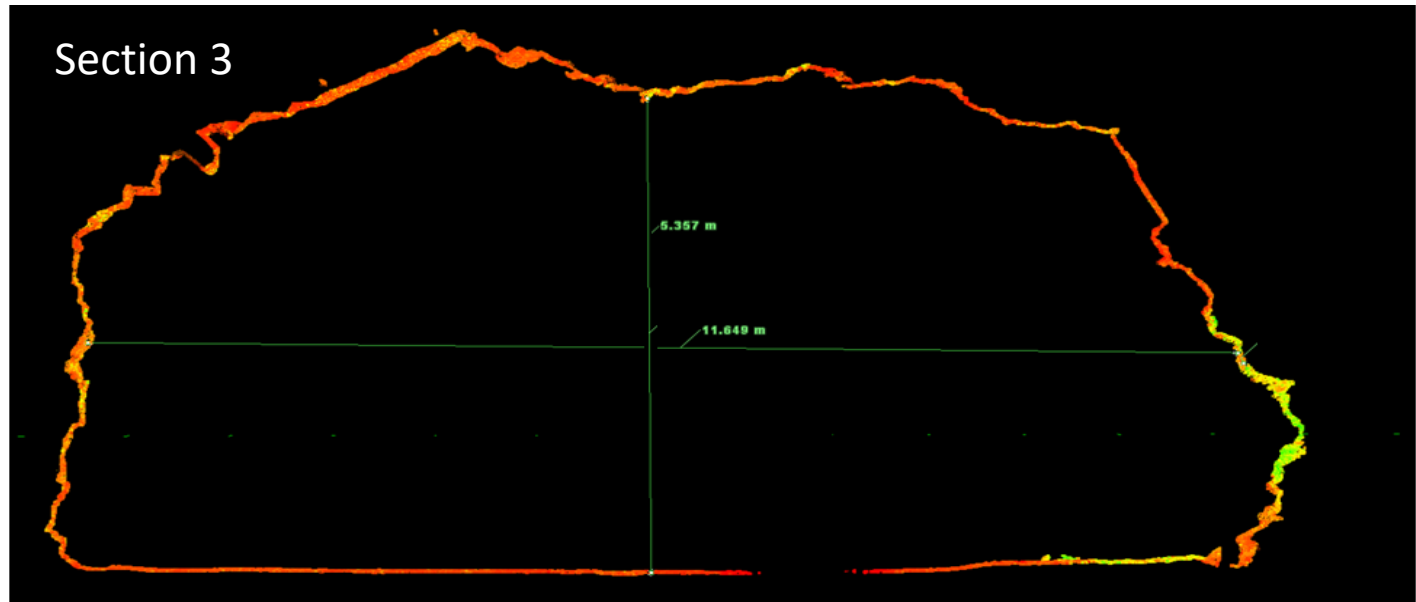
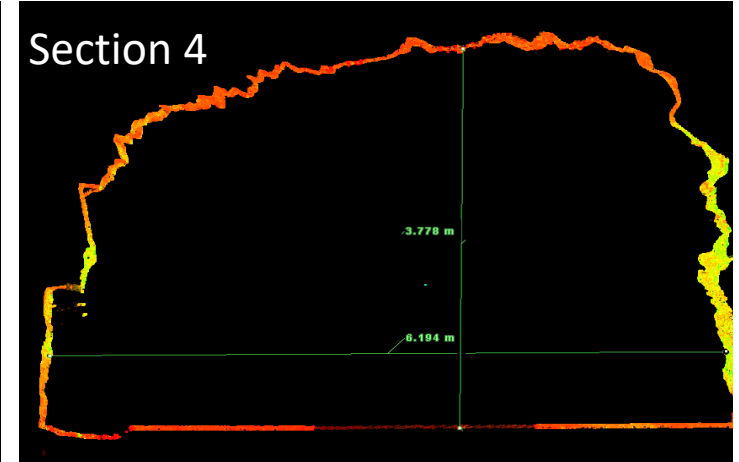
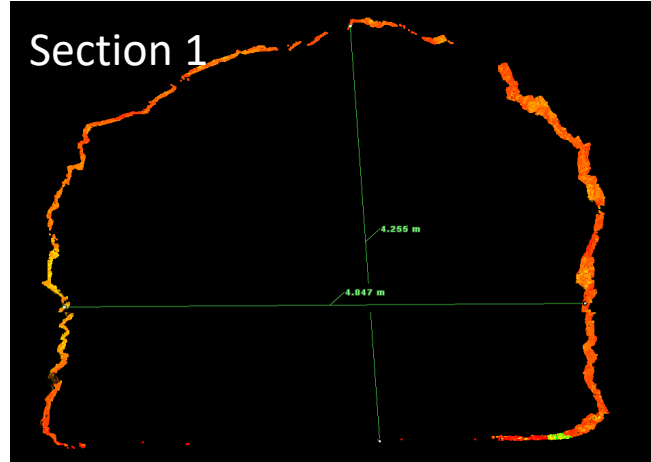
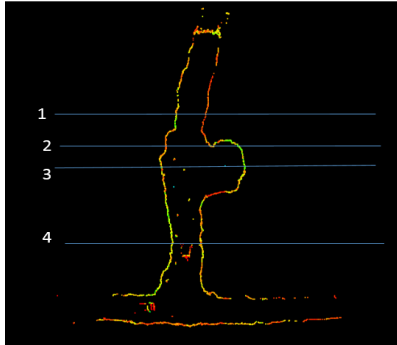
- Installation of the vacuum system for the tiltmeter (location and design to be optimized to minimize the noise impact)
- Shipment of the first Archimedes components, the vacuum chamber (currently under test @ Rome) and the mechanical components of the balance

Underground Excavation

Underground Lab: present stage

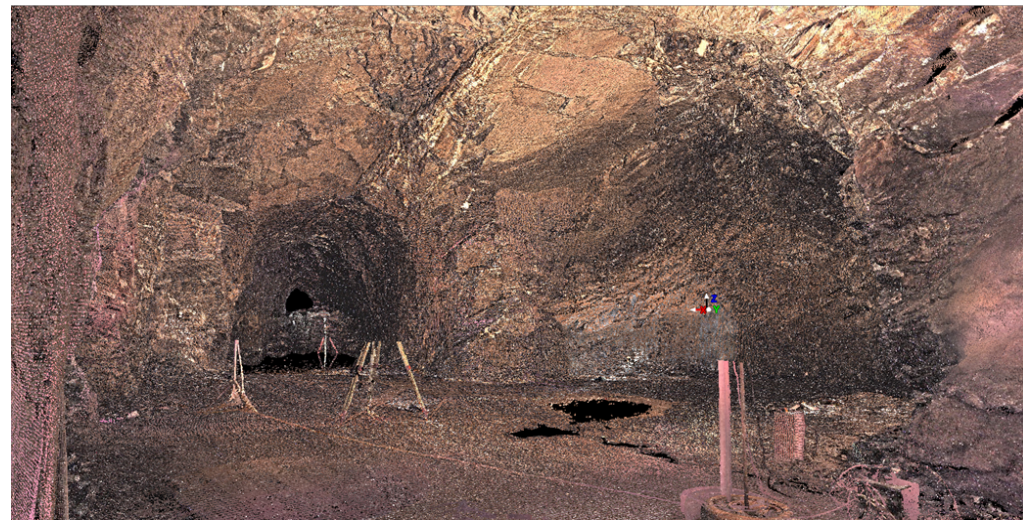


Underground Lab: present stage

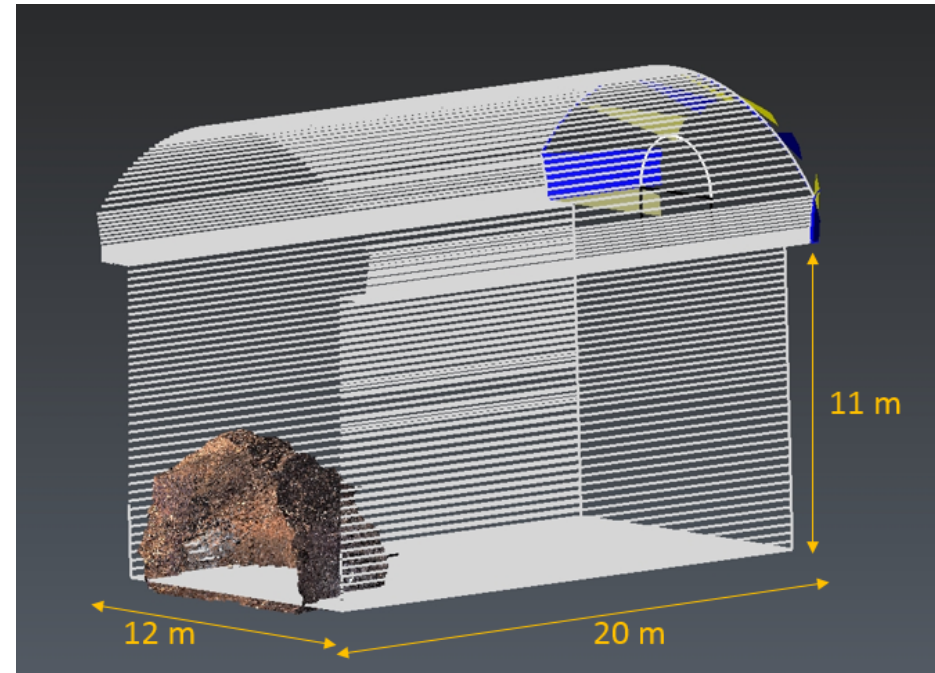
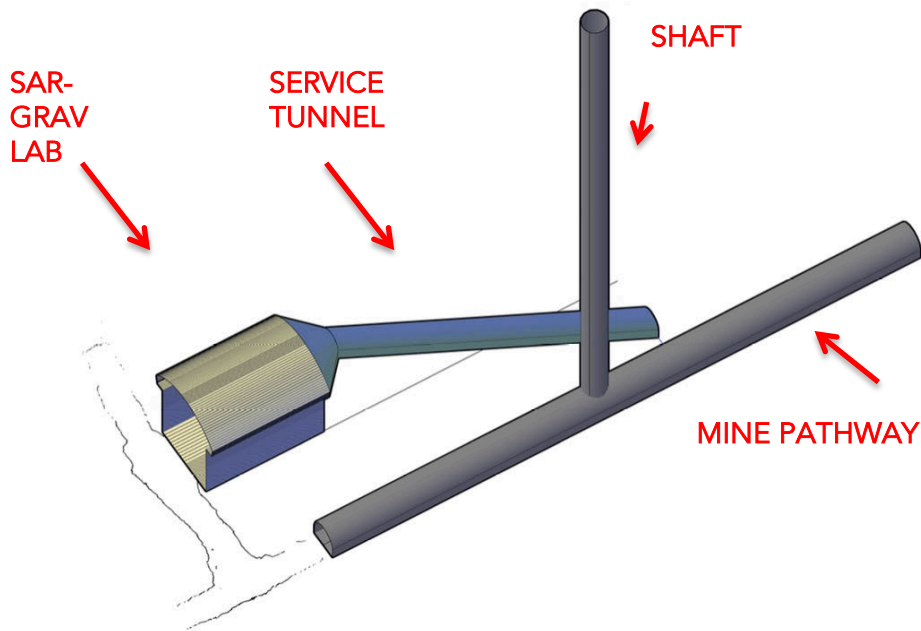


The feasibility study preceding the final design has been completed

- 3D modelling activity
- Rock characterization analysis
- Modelling of the excavation and consolidation phases
- Geometry of lab and service areas have been defined
- Technological and safety infrastructures have been defined



The procedure for the contracting the construction will start in the next months



Infrastructure Enhancement

Infrastructure Enhancement

- A plan to equip Sar-Grav lab with additional facilities has been already founded by the RAS (formal agreement under discussion)
 - ✓ Mechanic Lab equipped with a 20 tons crane
 - ✓ Clean Room on the surface
 - ✓ Data storing and management system
 - ✓ Nitrogen liquefier
- Network link already founded (formal agreement under discussion)

Conclusions and perspectives

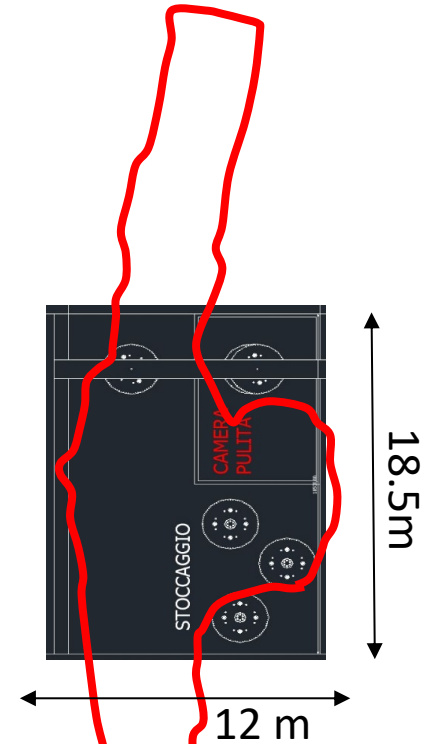
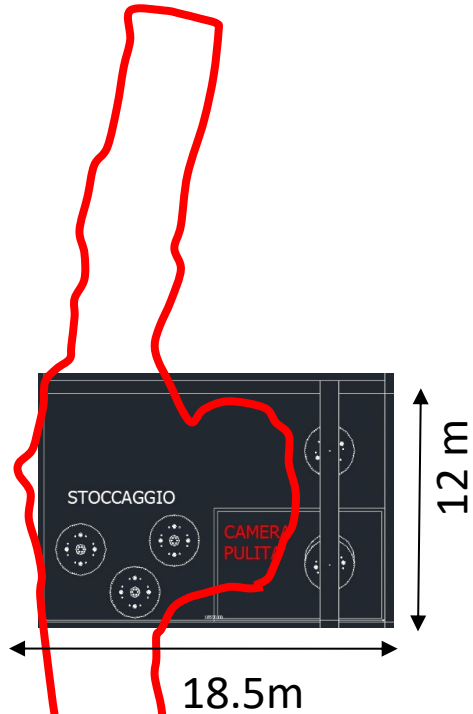
- Site characterization campaign on going (see L. Naticchioni talk)
- Surface activities:
 - ✓ preliminary experimental tests to assembly Archimedes components
 - ✓ DAQ and control systems in commissioning phase
- Underground excavation
 - ✓ feasibility study preceding the final design completed
 - ✓ The procedure for the contracting the construction is going to start

Conclusions and perspectives

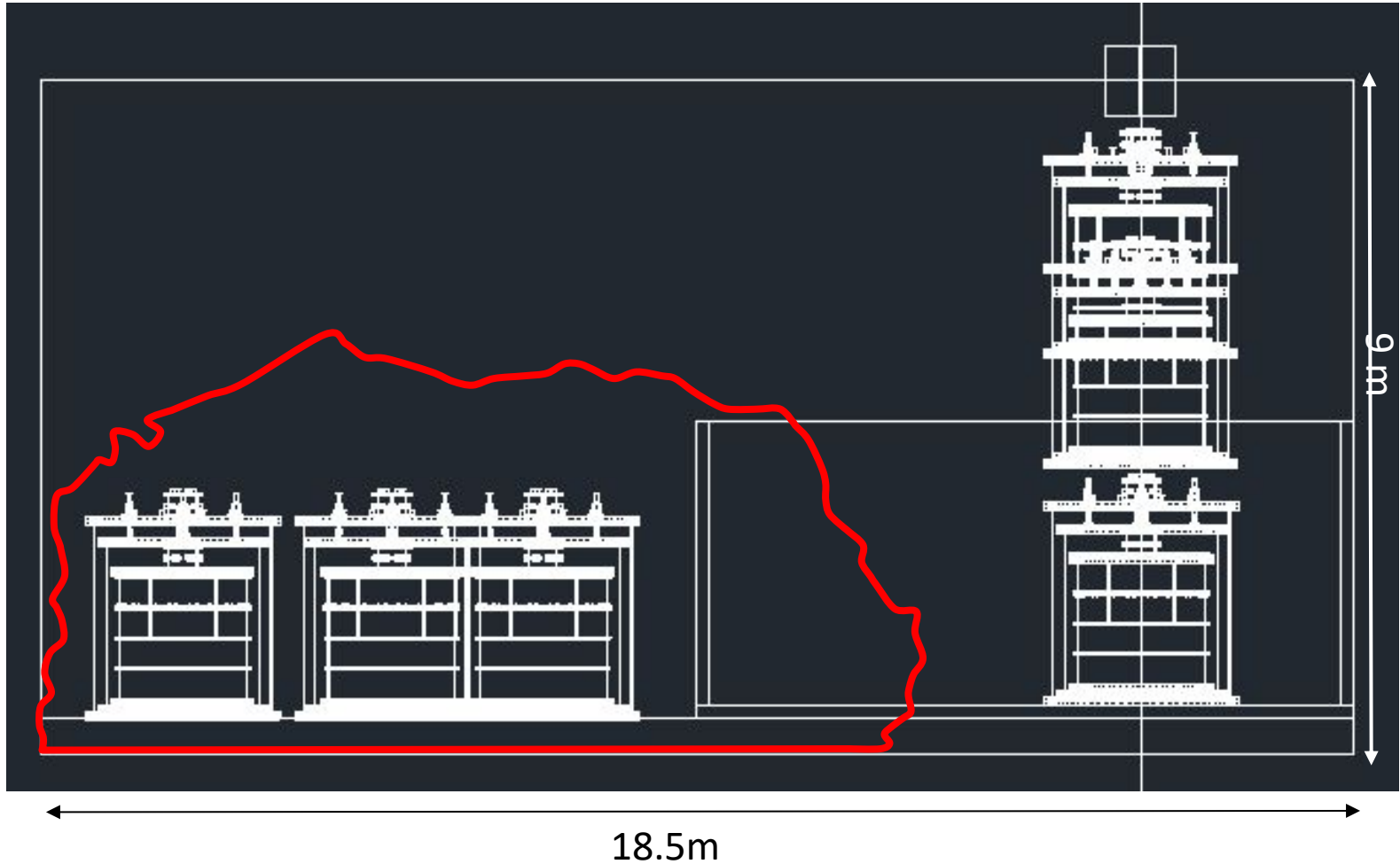
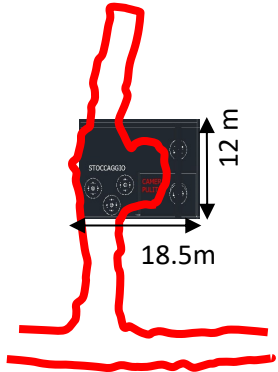
- Underground lab will be ready for Archimedes by the end of 2022
- Infrastructure enhancement plan and Network link already founded by RAS, formal agreement under discussion
- New collaborators are welcome, there is room for sensors and payload installation

Backup Slides

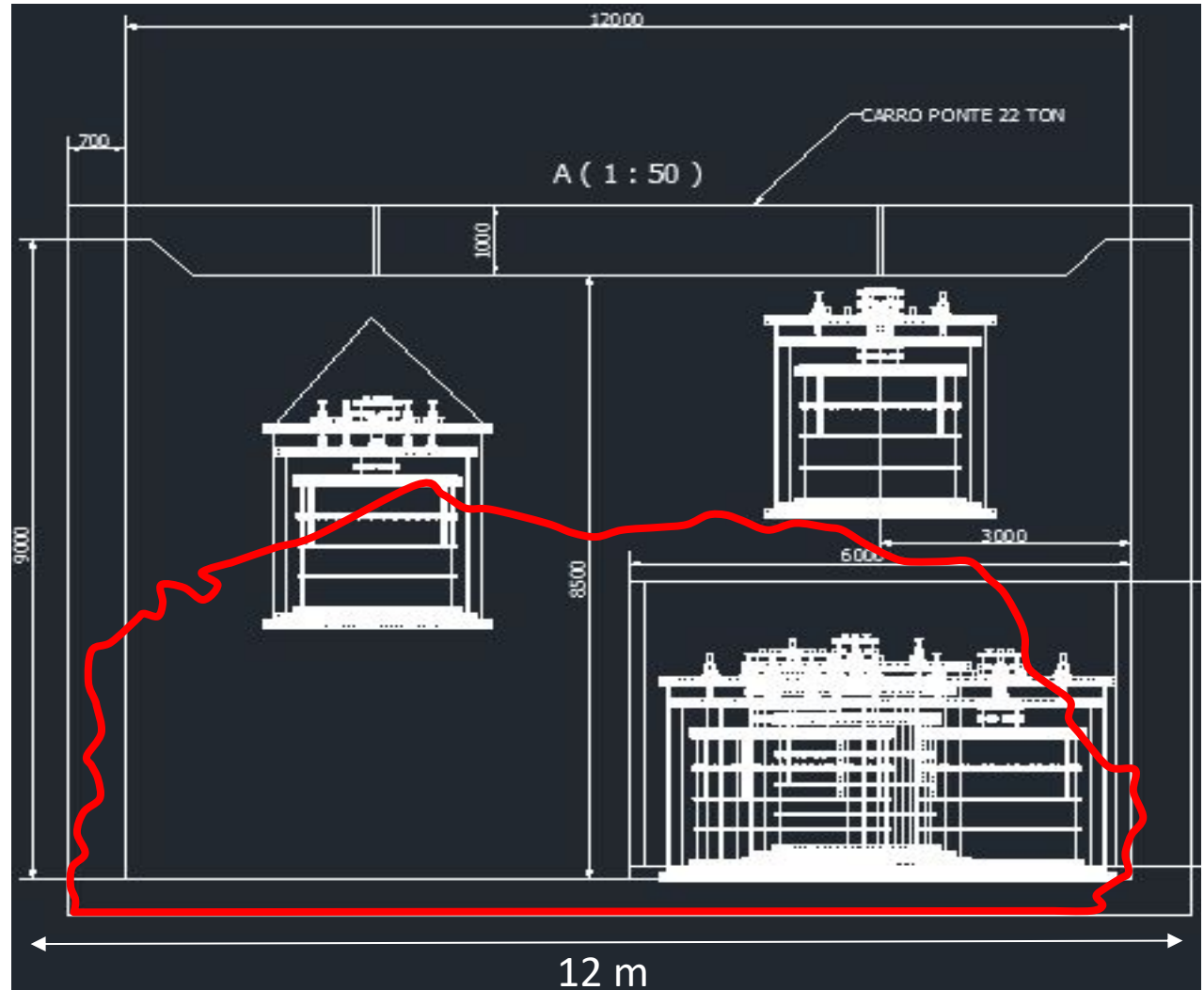
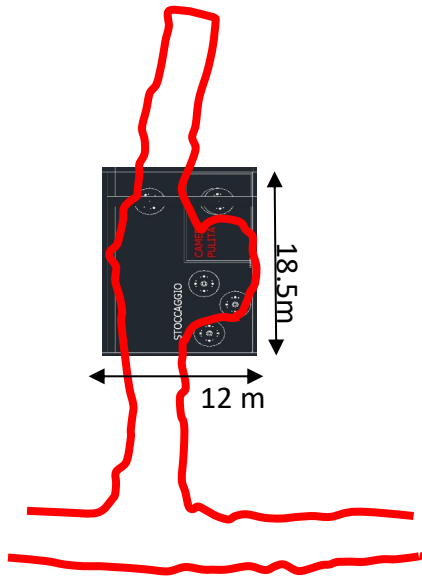
Archimedes underground lab: future configuration



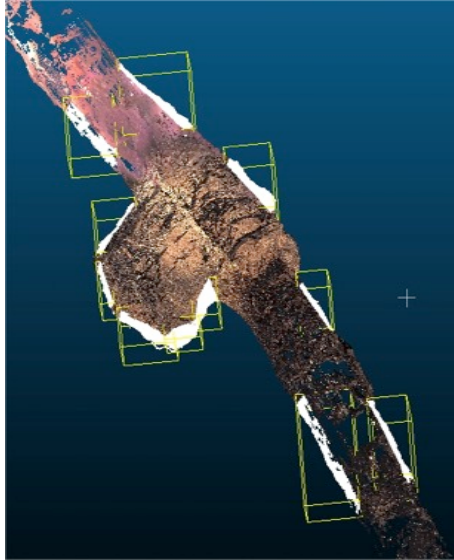
Archimedes underground lab: future configuration



Archimedes underground lab: future configuration

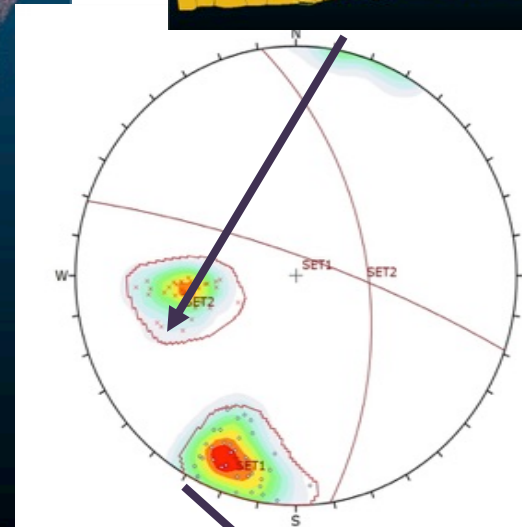
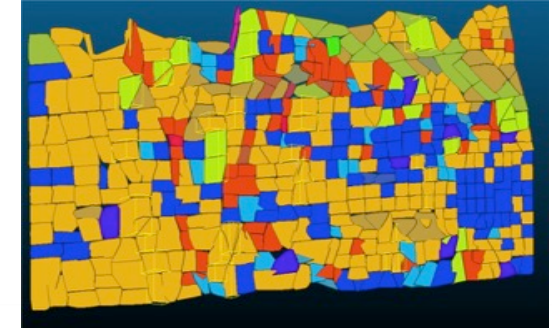
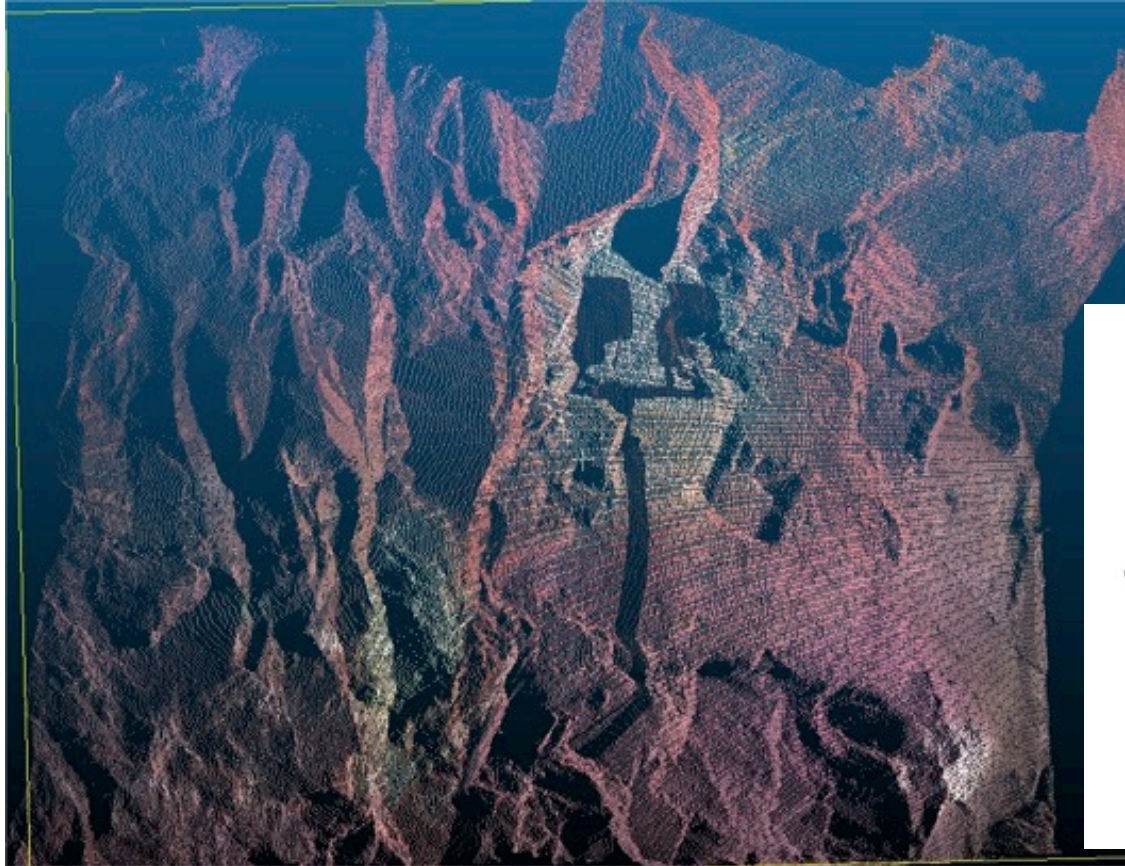


Laser scanning for geo-structural surveying



- ❑ Rock discontinuities identified by the dense laser point cloud
- ❑ Laser scans at different orientations and position along the galleries

Laser scanning for geo-structural surveying



Symbol	SET	Quantity
+	1	36
+	2	31

Color	Density Concentrations
0.00	0.20
2.20	4.40
4.40	6.60
6.60	8.80
8.80	11.00
11.00	13.20
13.20	15.40
15.40	17.60
17.60	19.80
19.80	22.00

Maximum Density	21.77%
Contour Data	Five Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Five Vectors
Vector Count	67 (67 Entries)
Hemisphere	Lower
Projection	Equal Angle



- segmentation
- Semi automatic (supervised) plane extraction
- Set parameters for rock kinematic stability analysis

Toward the cavern design

Theoretical (12 m radius) vs measured

