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# CALLIO LAB

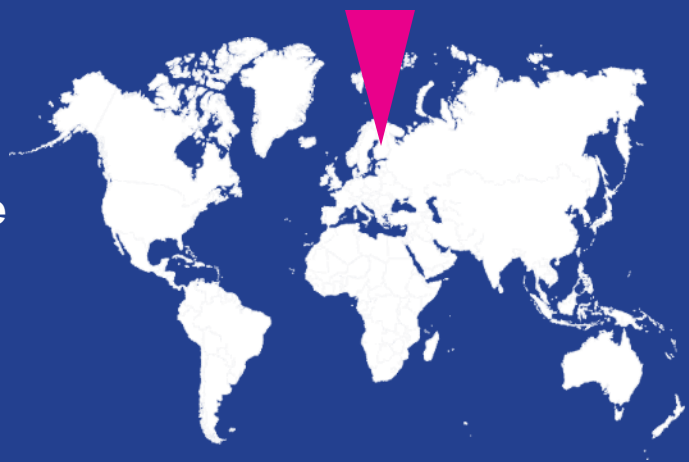
Underground Center for Science and R & D

Finland





#unioulu #arcticattitude



## Who am I?

- 8+ years working as an electrician and automation technician for the Pyhäsalmi Mine (owned by First Quantum Minerals)
- Began working for the University of Oulu and Callio Lab in 2018
- BSc. in General Physics and MSc. in Space Physics & Astronomy
- Product of outreach (high school particle physics course)
- “Boots on the ground” on-site





**CALLIO LAB**  
Underground Center for Science and R & D



### Traveling to Callio Lab in Pyhäjärvi:

- 1 hour flight from Helsinki-Vantaa International Airport to Oulu, then 2 hour drive to Pyhäjärvi

### Traveling to University of Oulu main campus:

- 1 hour flight from Helsinki-Vantaa International Airport to Oulu airport
- or
- 6 hour train ride from Helsinki to Oulu

# before CALLIO LAB there was CUPP

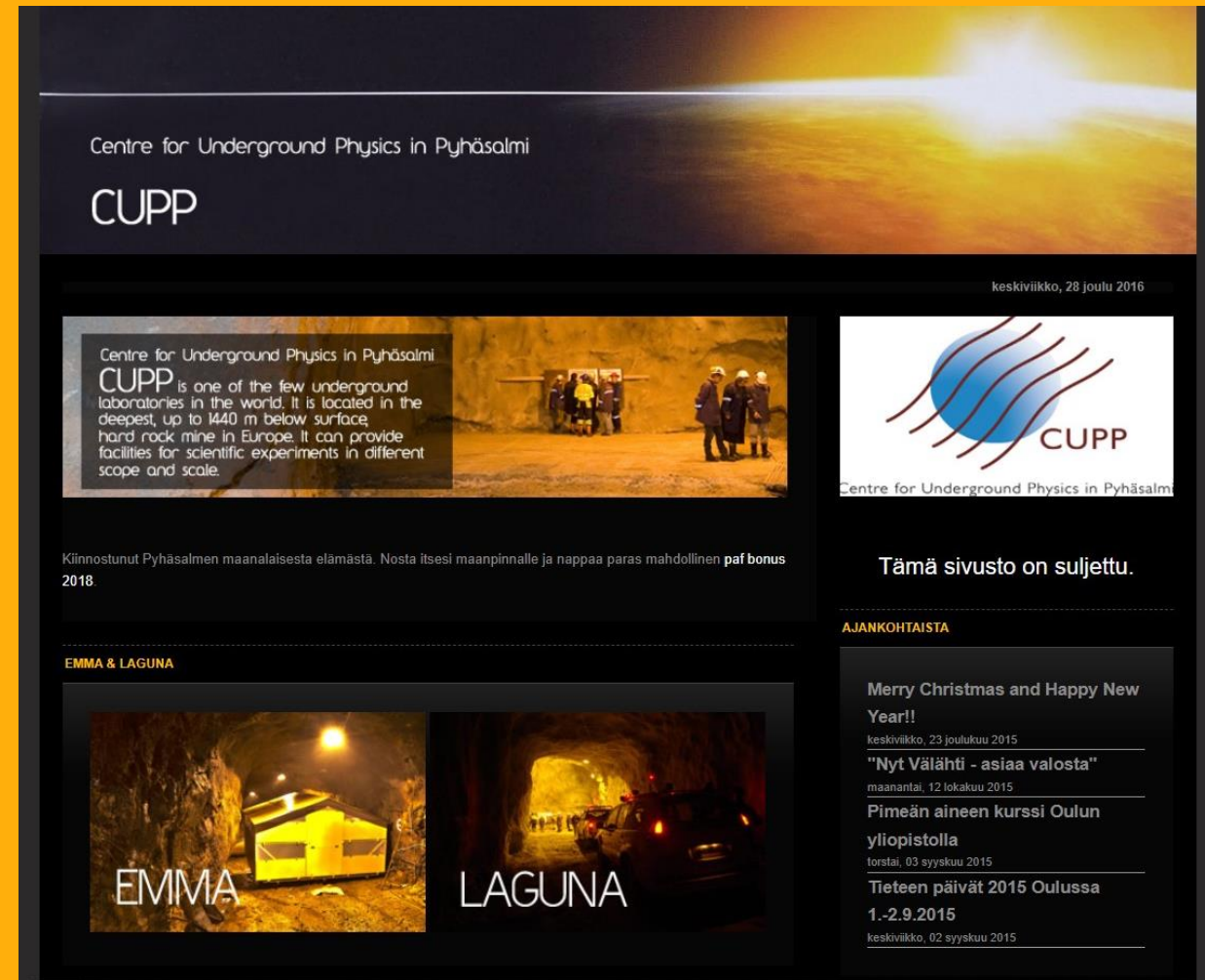
In 2000, the Centre for Underground Physics in Pyhäsalmi (CUPP) began operation.

Projects included:

- Muons UnderGround experiment (MUG)
- Mobile Underground Detector (MUD)
- Experiment with MultiMuon Array (EMMA)
- Two FP7 design studies of a pan-European Infrastructure for Large Apparatus studying Grand Unification and Neutrino Astrophysics (LAGUNA DS and LAGUNA LBNO DS)



The LAGUNA & and LAGUNA LBNO design studies found the Pyhäsalmi mine site to be the most ideal location.





- An EPOS Research Infrastructure (ESFRI, 2020)
- A FIN-EPOS Infrastructure (FIRI, 2020)
- A strategic research infrastructure of University of Oulu
- Member of DULIA network and collaborating with CELLAR network
- Founding member of European Underground Laboratories Association (EUL, BSUIN projects) [Undergroundlabs.network](https://undergroundlabs.network)

**We offer coordination, cooperation, networking and facilitation**



**Education and training**



**Mining & tunnelling**



**Mine reuse**



**Geothermal research**



**Working environment**



**Underground H&S**



**Future food & Underground farming**



**SpaceLab**



**Earth Observation and remote sensing**



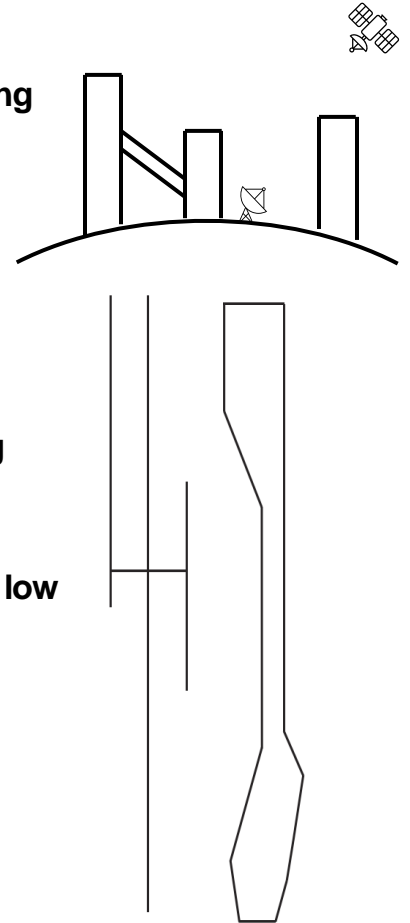
**Deep underground low background facility**



**Particle physics & muography**



**Something new?**



# CALLIO LAB at the Pyhäsalmi Mine, in Pyhäjärvi Finland

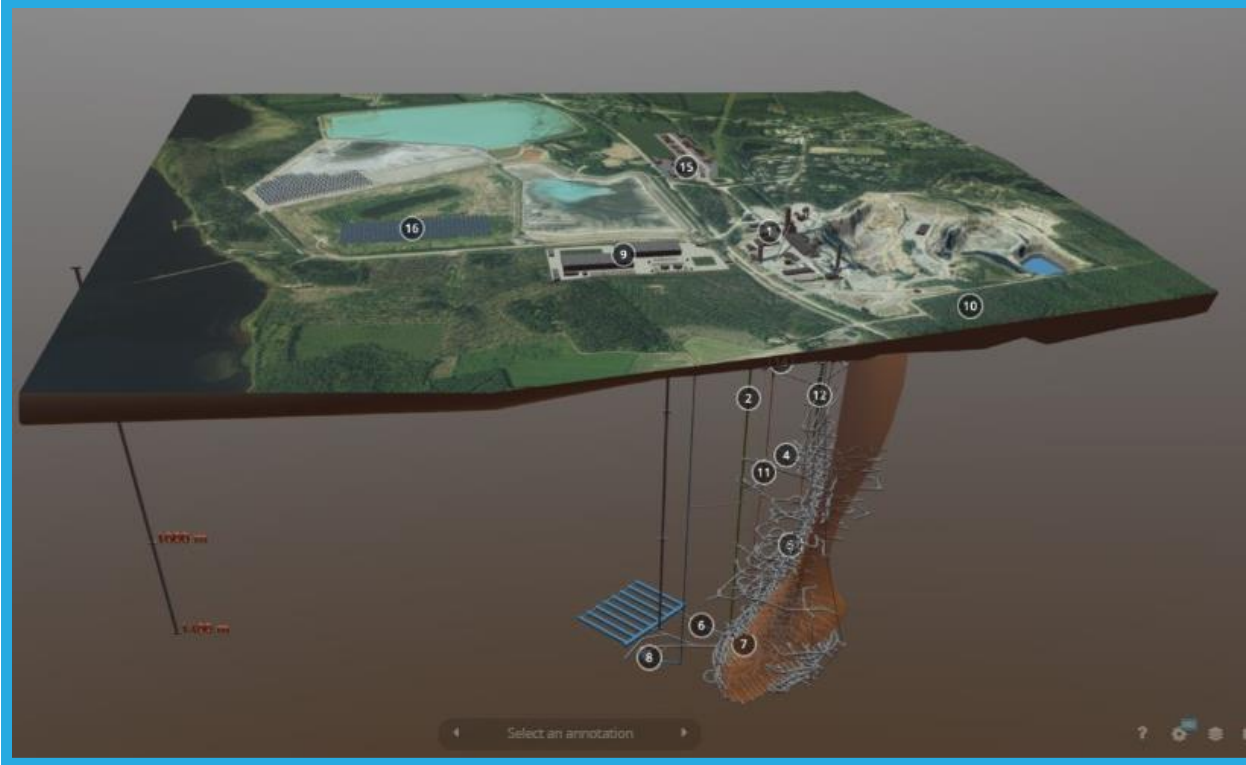


## About the Pyhäsalmi mine:

- 1430 meters deep (~4000 m.w.e.)
- Underground mining 1962-2022
- **Owned by** Pyhäsalmi Mine Oy
- **Post-mining activities** coordinated by the Pyhäjärvi town-owned Callio-Mine for Business
- **Scientific activities** are coordinated by the University of Oulu Callio Lab







3D-model on Sketchfab 

## New life for Pyhäsalmi underground mine as a pumped hydro energy storage

**Owner of mining site:** Pyhäsalmi Mine Oy (PMO)  
**Reuse coordinator:** Callio Mine for Business (Callio)  
**Scientific coordination:** Callio Lab (CLab)



## Pumped hydro energy storage:

- Planned mode of operation is continuous
- 7/9 h cycle (generation/pumping)
- 50 year lifetime
- Building would take 3-4 years
- Power 75 MW, capacity of 530 MWh
- Cost 125 MEUR + inflation
- EU commission approved 26MEUR Finnish measure to support construction



The existence of such a facility would ensure the future of scientific activity underground. Final decision due in 2023.

# Supergraafi

## Kaivoksen uusi elämä

umpuvoimalan ja tutkimus-  
laboratorioiden lisäksi Pyhäsalmen  
aivoksen alueelle suunnitellaan muun  
uassa datakeskusta ja kasvintuotantoa.

### Loppuu 2019

- Maanalainen kaivostointi  
Pyhäsalmissä päättyy  
vuonna 2019.
- Vuodesta 1962 toimineen  
kupari- ja sinkkikaivoksen  
omistaa First Quantum Minerals.
- 1 445 m syvä kaivos  
on Euroopan syvin  
metallikaivos.
- Kaivos sijaitsee  
Pyhäjärven kaupungissa  
Pohjois-Pohjanmaalla.

NA RAUTIAINEN ja SIMO SAHLA  
TUTK: PYHÄJÄRVEN KEHITYS OY, PÖYRY

### Säätövoimaa

Pumppuvoimalaitoksessa on vesivoimala  
ja pumppaamo sekä vesialtaat maan  
pinnalla ja maan alla. Sähköä tuotetaan  
maan pinnalla pumpattuun vetoon  
varastoituneen energian avulla.

Uusiutuvan energian vaihtelevuus vaatii  
entistä joustavamman järjestelmän,  
joka sisältää energian varastoinnin.  
Pumppuvoima pystyy reagoimaan  
nopeasti ja suurella voimalla tuotannon  
ja kulutuksen välisen eron vaihteluihin.

# 99 %

aailman energian  
rastoinnista toteutetaan  
pumpussäätövoimalla.

### Pyhäsalmen pumppuvoimala

- Perustuu suljettuun kiertoon
- Käyttöikä jopa 50 vuotta
- Hyödyntää olemassa olevaa infraa

voite-  
katalogi

2017 toteutettavuusselvitys, kohteen markkinointi toteuttajille,  
rahoittajille ja sijoittajille, yksityiskohtainen suunnittelu, luvat ja tarjoukset

2019 Rakentaminen

2022 Käyttöönotto

eho  
75 MW  
+ 75 MW)

Kapasiteetti  
530 MWh  
(1 054 MWh)

Vesivaraston tilavuus  
162 000 m<sup>3</sup>

Yksiköt rakennetaan vaiheittain, lisäkapasiteettia  
mahdollista rakentaa myöhemmin

Alempi vesivarasto

Putouskorkeus  
1 400 m

Voimalaitos

Kaivoksessa sijaitsee tiettävästi  
maailman syvimmällä sijaitseva sauna.

Kaivoksessa te  
tutkimuksista on  
49 tieteellistä ju

Ilmanvaihtokuilu

100 m

500 m

1 000 m

1 400 m

LAB1 75 m  
Kosmisiä säteitä  
tutkiva EMMA-ko

LAB4 660 m  
Kasvintuotanto

LAB3 990 m  
Uusi koetila, sien-  
viljelyko, radon-ko

LAB2 1 430 m  
Uusi laboratoriotila,  
ensimmäisessä  
kokeessa selvitetään  
C-14-pitoisuutta

Voimalaitos



# CALLIO LAB

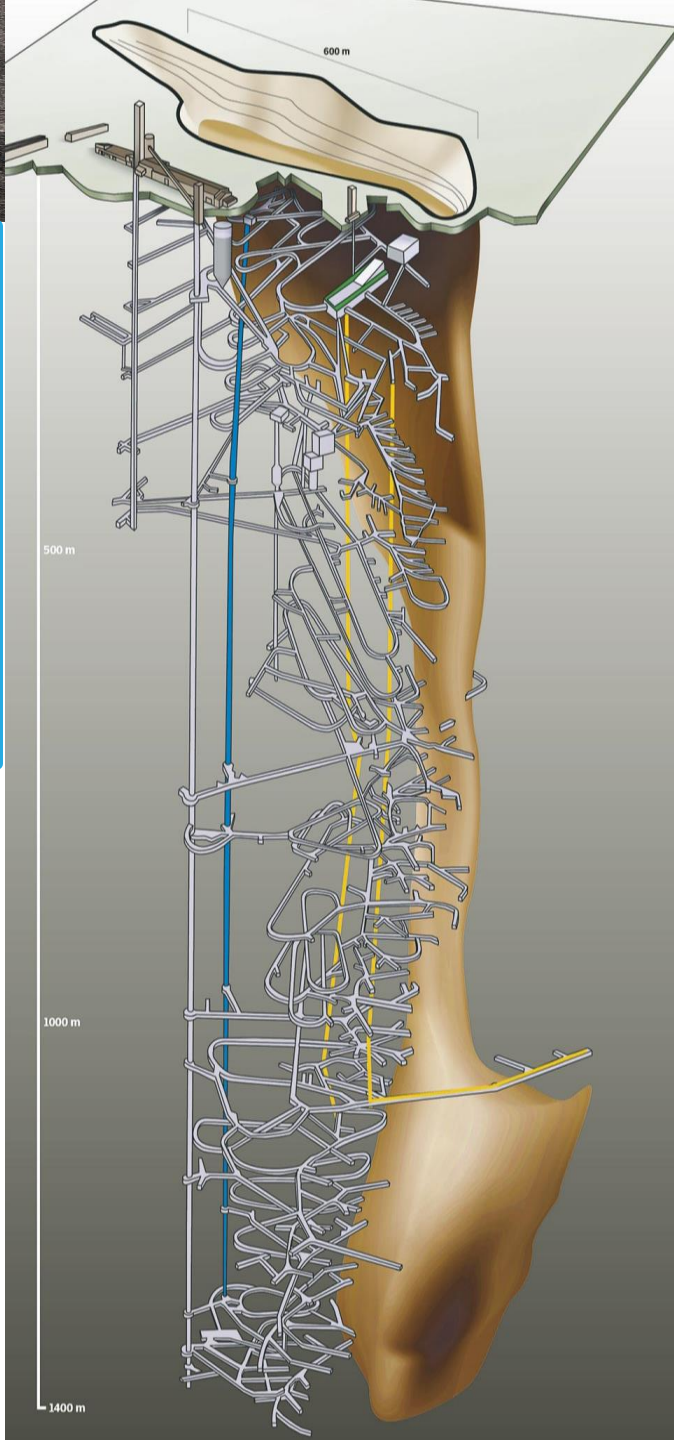
## Access and transport

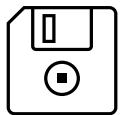
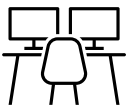
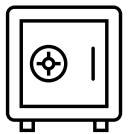
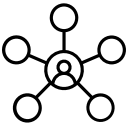
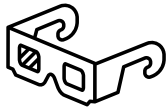
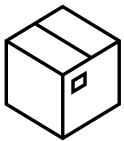
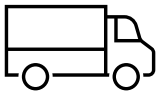
Elevator from surface to main level takes 3 minutes

Incline tunnel leads from the surface to the bottom, is 11 km long and takes about 30-40 minutes to drive



Independent working requires safety induction





- Trucks and shipments up to 20' containers (max. width 3.5 m), can be taken through the incline
- Elevator can take 1.5 x 2.0 x 1.5 m packages
- Train tracks lead to mine site from Kokkola port
- All re-use sites have been scanned: 3D point clouds available
- Electricity easily available
- Internet access: optical base line (1+ Gb) & Wi-Fi
- HPC cloud computing services at CSC (through Finnish collaborators)
- Leaky feeder (radio phone network)
- Refuge bases (shelters) for emergencies
- Microseismic monitoring network
- Office space and meeting rooms
- Support from local team
- Extensive datasets

**Future: Globally  
recognised underground  
research network and  
infrastructure**



# Tunneling cost estimates

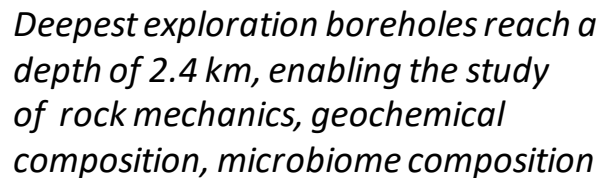
## Example for 100 meters of tunneling in 2021

- Excavation + preliminary support for 5x5.5m tunnel 2200e/m
- Ventilation 35k
- Electric installations >20k
- Water and air lines 15k
- Not included in estimate, is the hauling and storage of the excavated material



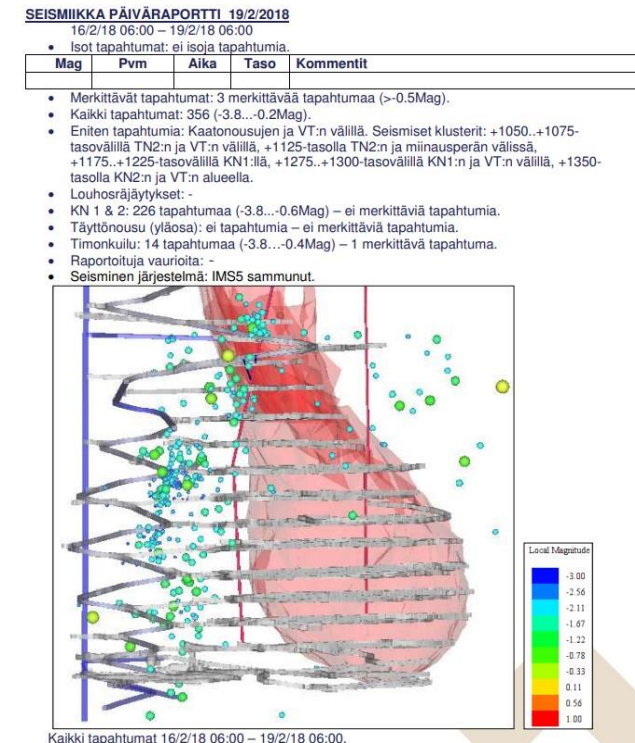
*Factoring in inflation, total would currently run up to 350kEUR.*





- Mafic volcanic 47.2%
- Felsic volcanic 36.6%
- Pegmatite 7.1%

January 2023, there were 46 events between  $-1.5...-0.6$  Mag.





## ➤ Site description and data



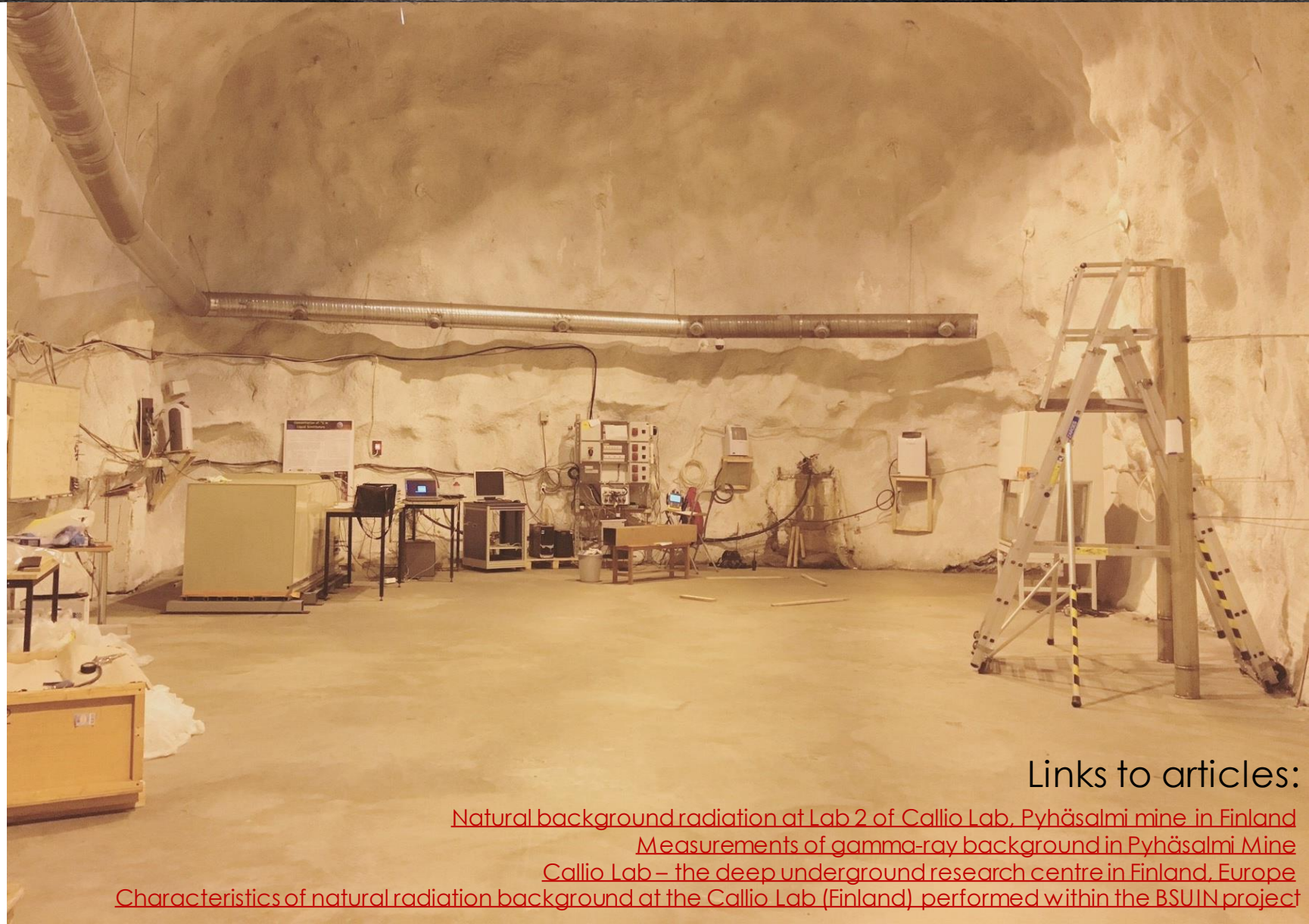
- Use and access
- Competencies and quality control
- R&D possibilities
- Geological bedrock data and properties
- Stress field conditions
- Strength and deformation properties of the rock
- Hydrological data and properties
- Lists of data sources

## ➤ Natural background radiation scheme



- Neutron flux
- Muon flux
- Gamma ray background
- Radioisotope content in rock and water
- Radon concentration in air

## ➤ LAGUNA LBNO site investigations *available on request*



Links to articles:

[Natural background radiation at Lab 2 of Callio Lab, Pyhäsalmi mine in Finland](#)

[Measurements of gamma-ray background in Pyhäsalmi Mine](#)

[Callio Lab – the deep underground research centre in Finland, Europe](#)

[Characteristics of natural radiation background at the Callio Lab \(Finland\) performed within the BSUIN project](#)



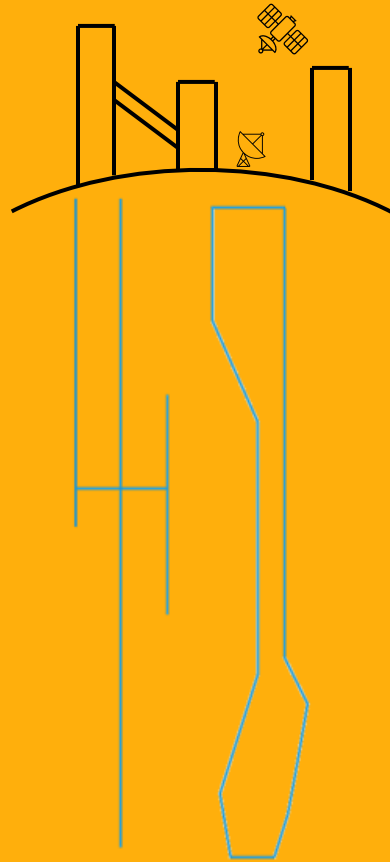
## Multi- and crossdisciplinary network of experts

- Marko Aittola, PhD in Planetary Science, Vice Chairman at Arctic Planetary Science Institute (APSI) & Director of Kokkola University Consortium Chydenius
- Marko Huttula, Professor, Head of the Nano and Molecular Systems Research Unit (NANOMO), University of Oulu
- Rauno Heikkilä, Professor of Digitalized construction and mining operations, Faculty of Technology, University of Oulu
- Jari Joutsenvaara, Project Manager, Callio Lab, Kerttu Saalasti Institute, University of Oulu
- Veiko Karu, Associative professor, Department of Geology, School of Science, Tallinn Technical University
- Jan Kisiel, Professor, Institute of Physics, University of Katowice, Silesia, Poland
- Ossi Kotavaara, Research Director, Regional Excellence, Kerttu Saalasti Institute, University of Oulu
- Saija Luukkanen, Professor, Director, Oulu Mining School, University of Oulu
- Henrika Pihlajaniemi, Postdoctoral researcher, Oulu School of Architecture, University of Oulu
- Matti Muhos, Professor, Director, Kerttu Saalasti Institute, University of Oulu
- Vesa Nykänen, Research Professor, Geological Survey of Finland
- Juha Röning, Professor of Embedded System, Computer Science and Engineering, University of Oulu
- Ilya Usoskin, Professor, Head of Oulu Cosmic Ray station, Sodankylä Geophysical Observatory, University of Oulu
- Seppo Vainio, Professor in Developmental Biology, Research Unit leader Developmental Biology, Biocenter Oulu
- Marko Paavola, Senior Scientist, VTT Technical Research Centre of Finland

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For more information, please visit:  
[www.calliolab.com](http://www.calliolab.com)  
[www.oulu.fi/en/callio-lab](http://www.oulu.fi/en/callio-lab)



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**Meet us at:**

- Cambridge 27.-28.3.2023
- EGU2023 Vienna 23.-28.4.2023

[Gl3.1](#) & [Gl6.7](#) sessions