New underground initiatives in Europe

A.Zalewska, J.Kisiel

ILIAS 5th annual meeting, Jaca, 19.02.2008

Summary of the presentations at the DUL- CoMag meeting
in Zaragoza, 18.11.07

A. Zalewska: SUNLAB – (future) Sieroszowice UNderground LABoratory
R. Margineanu: Slanic Project, Romanian underground laboratory
J. Peltoniemi: Underground Laboratory in Pyhäsalmi Mine
S. Gaffet: Rustrel Laboratory

1.

SUNLAB – (future) Sieroszowice Underground LABoratory

Agnieszka Zalewska

Zaragoza, ILIAS CoMag meeting, 22.11.2007

Contributions from:

W. Pytel

Technical University of Wrocław, CUPRUM Wrocław

K. Urbańczyk, J. Ślizowski

Mineral and Energy Economy Research Institute PAN, Kraków

J. Kisiel, J. Dorda, A. Konefał

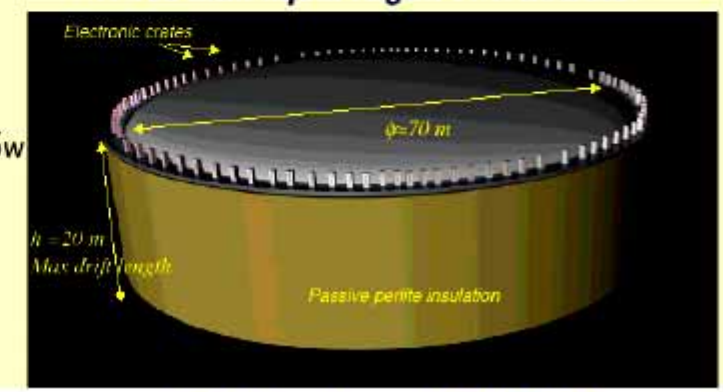
University of Silesia, Katowice

M.Budzanowski, S.Grabowska, K.Kozak, J.Mazur, J.W. Mietelski, M.Puchalska, E.Tomankiewicz

IFJ PAN Kraków

The origin of this study was a search of the location for

A 100 kton liquid Argon TPC detector



A.Rubbia, hep-ph/0402110

SUNLAB - where?

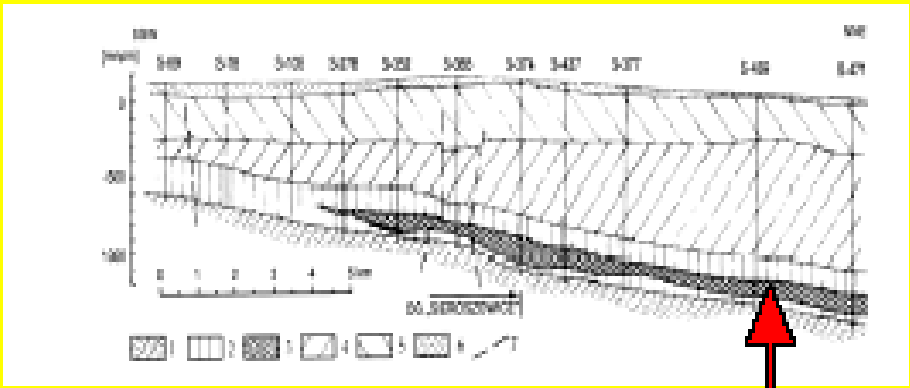
Near Wrocław, south-west of Poland - easily accessible from the Wroclaw airport and from the A4 motor-way, 950 km from CERN

In the Polkowice-Sieroszowice copper mine (belonging to the KGHM holding)

Who works for SUNLAB?

Polish nuclear, particle and astroparticle physicists, engineers specialized in designing the KGHM mines and their infrastructure, specialists in underground storage, in particular designing large underground chambers (up to 10^6 m^3) for natural gas storage, support from the KGHM management

A thick salt layer above copper ores



Geological cutoff – salt

Existing big chambers in salt:

- volume: 85 x 15 x 20 m^3
- at a depth ~950 m from the surface (2200 m.w.e.)
- very low humidity, temperature ~35^0

Long term measurements of the wall movements

to understand better salt viscous creep

Can one make use of the existing chamber?

Yes, one can place there an initial underground laboratory characterized by an exceptionally low natural radioactivity

Radiochemical α and γ measurements of salt

U-238: **0.0165+-0.0030 Bq/kg**

U-234: **0.0225+-0.0030 Bq/kg**

Th-232: **0.008+-0.001 Bq/kg**

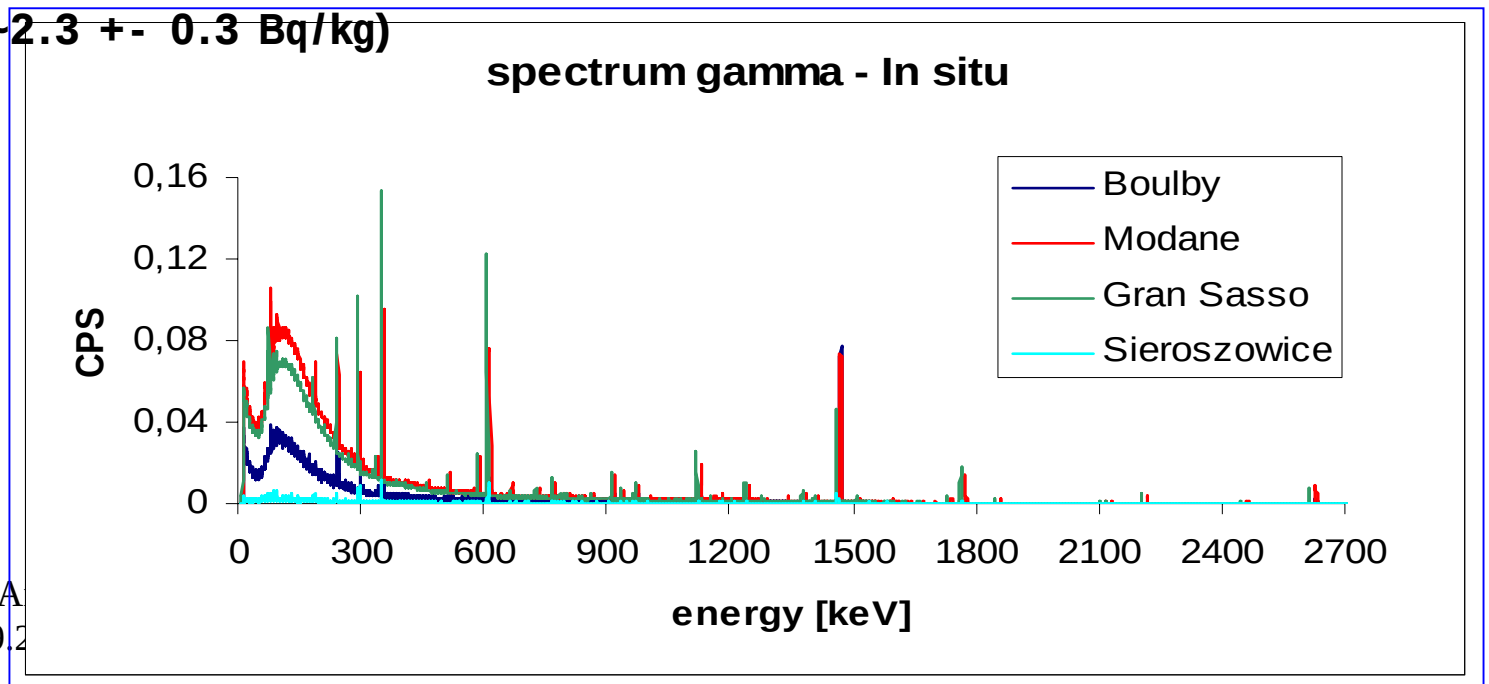
K-40: **4.0 +-0.9 Bq/kg**

(avarage ~2.3 +- 0.3 Bq/kg)

Dose measurements with TL detectors (8 months of the dose integration time)

1.8 nGy/h, similar for 11 sets of detectors (in Cracow at 1m depth under the surface it is 65 nGy/h)

Radon is mostly due to ventillation



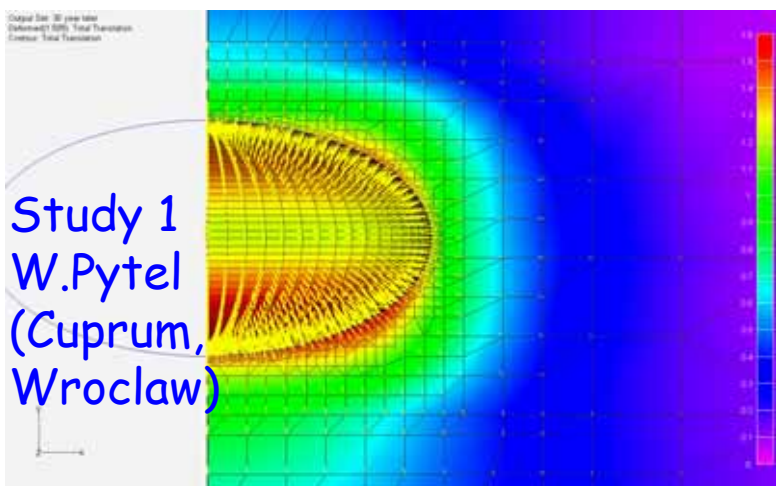
Can one dig a huge stable cavern for 100 kton detector in salt at 950 m depth?

Requirements:

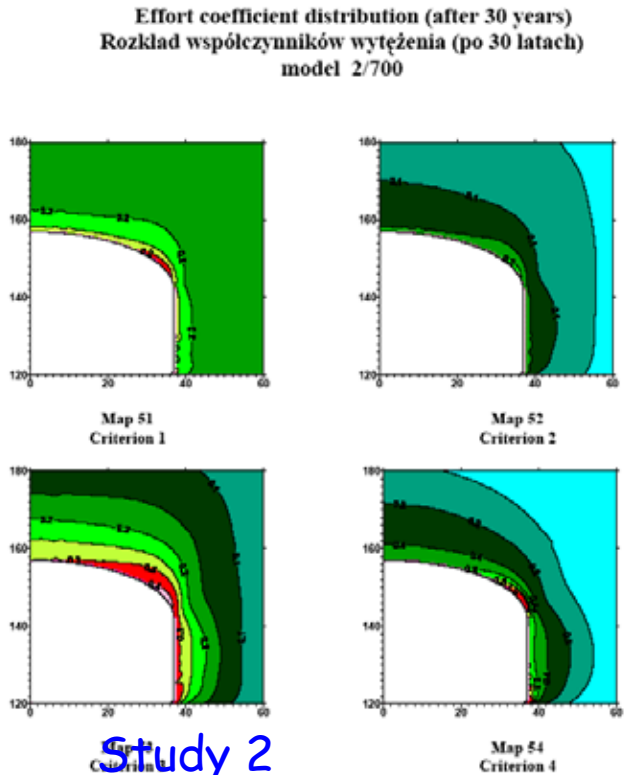
- cavern's diameter 70-100m
- stable for 30 years

Assumptions:

- differences in the cavern geometry
- different models of the salt viscous creep
- different depths



Study 1
W.Pytel
(Cuprum, Wroclaw)



Study 2
J.Ślizowski, K.Urbańczyk
(IGSMiE, Cracow)

Two independent preliminary geomechanical analyses performed in 2004-2005, results are promissing, a full common analysis will be done in the framework of LAGUNA DS

2.

Slanic Project
Romanian underground laboratory

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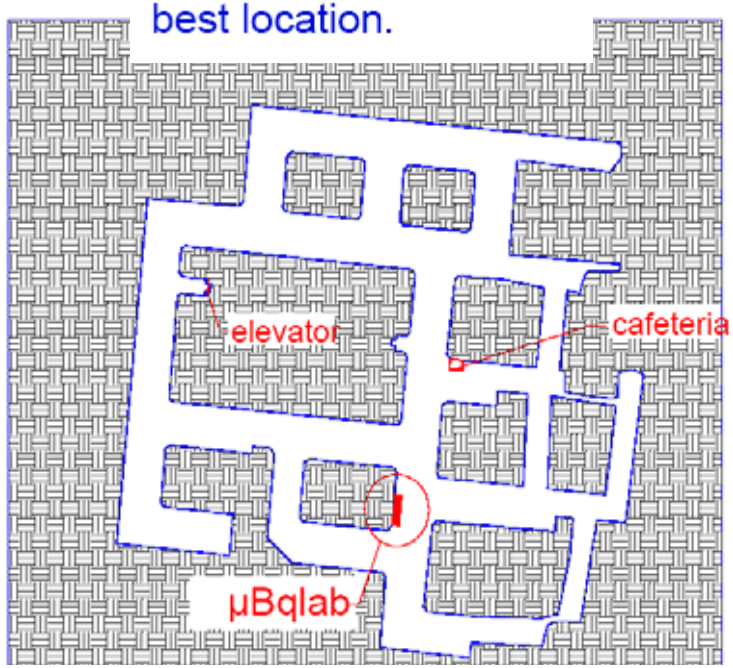
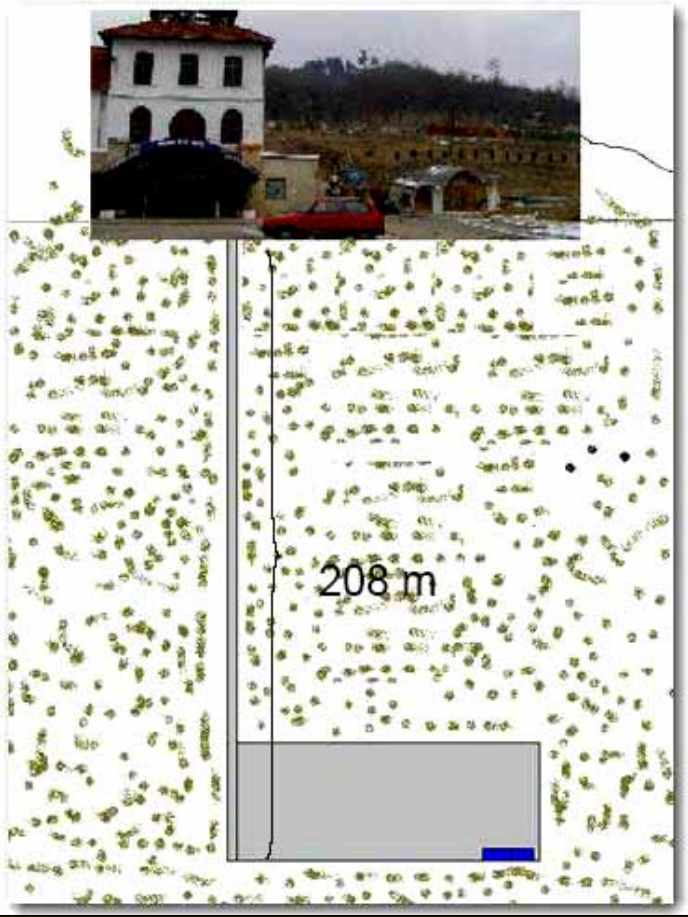
ILIAS CoMaG, 22-23 Nov. 2007,
Zaragoza, Spain

The radiological mapping of three salt mines was initialy performed using a high resolution gamma spectrometer and an Eberline FH40G dosimeter indicated that **Unirea** salt mine from **Slanic Prahova** town as the best location.



UNIREA salt mine gallery



The Unirea salt mine environment:

temperature: 12.0 -13.0 °C

humidity: 65-70 %

excavated volume: 2.9 million m^3

floor area: 70000 m^2

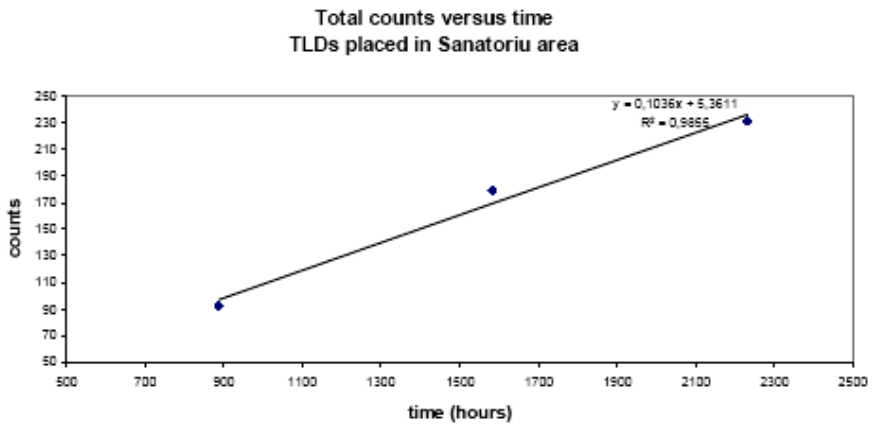
average high: 52-57 m

Salt lens dimensions:

Length: 5km

Width: 3km

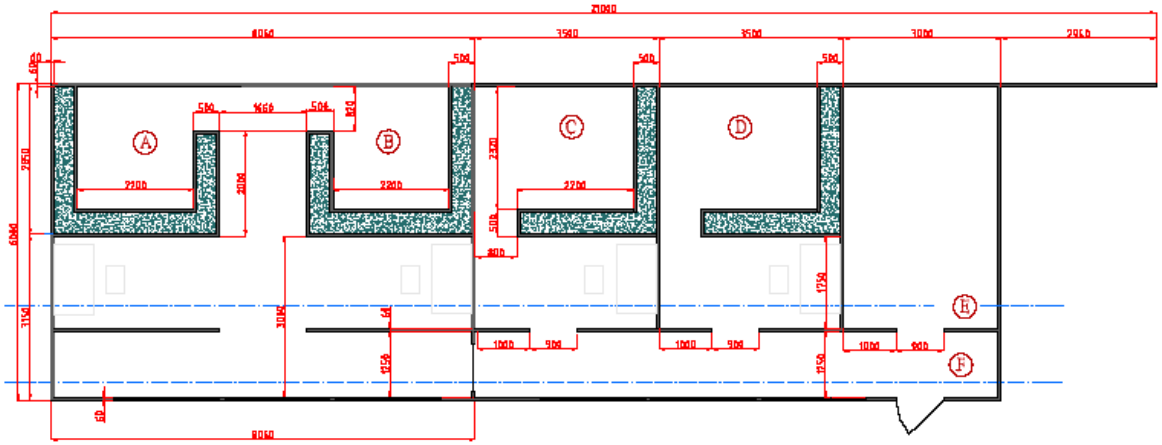
Thickness: 0.5km



dose rate: 0.2 – 2.0 nSv/h

Extremely low level of natural radioactivity

The construction of low-background radiation laboratory started in January 2006 and ended in April 2006.

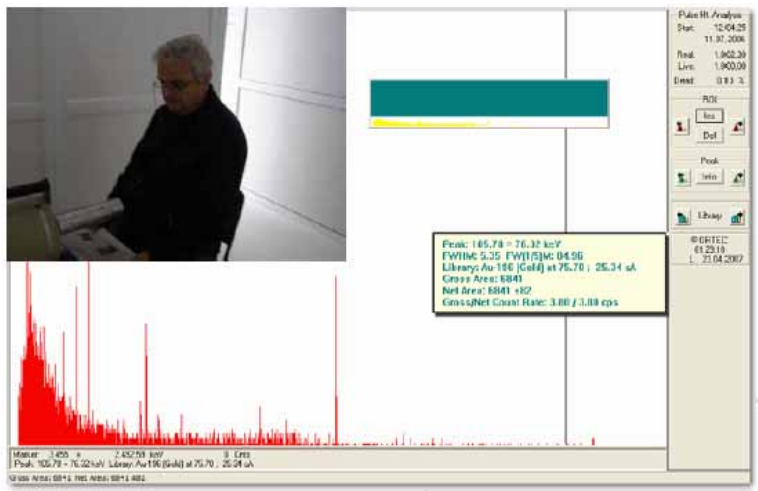


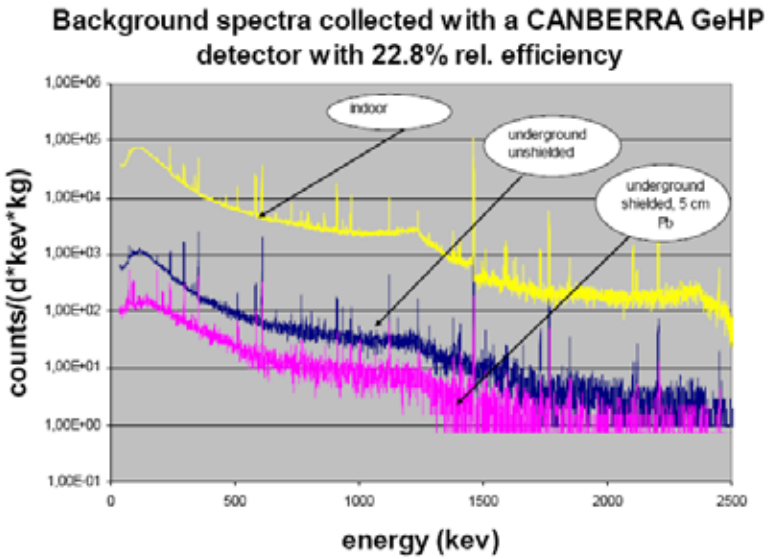
The goal is the setting up of an underground laboratory for:

- high resolution gamma ray spectrometry
- whole body counter
- radiation metrology

A high resolution gamma-ray spectrometer equipped with a GeHP detector 22.8 rel. eff. was put into the laboratory in October 2006.

A TLD reader and a portable high resolution gamma-ray spectrometer equipped with a GeHP detector 35.4 rel. eff. for whole body counter were introduced in the underground lab. in November this year.





Projects to be submitted in February 2008:

Ongoing project

Determination of beta emitters from agro-ecosystems in underground laboratory

From Sept 2007 to August 2010

- Radiation metrology in ultralow radiation background
- Muon detection in underground
- Gamma emitting radionuclides in human body

3.

Underground Laboratory
in Pyhäsalmi Mine

Juha Peltoniemi

Location of the Pyhäsalmi site

- Pyhäsalmi mine in Pyhäjärvi town
- Connections
  - Roads open all year round
    - Pyhäjärvi-Oulu: 2 h car drive
    - Pyhäjärvi-Jyväskylä: 2 h car drive
  - Pyhäjärvi-Helsinki: bus & train connections
  - 4 airports within 2 hours drive, connections
    - Oulu-Helsinki: ca 20 flights a day
  - Railway to the mine
- Distance to accelerators
  - CERN 2300 km
    - Density profile well known
  - JPARC 7100 km

Pyhäsalmi Mine

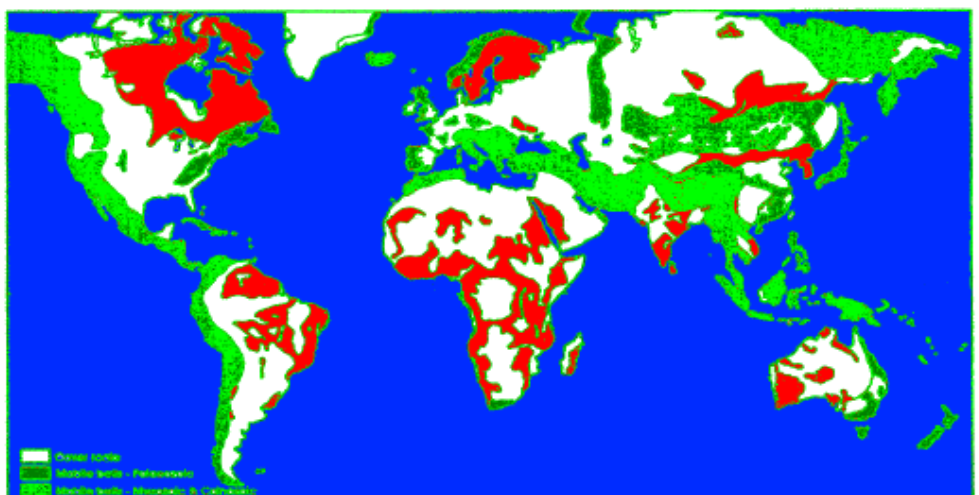
- Pyhäsalmi Mine Ltd
  - Inmet Mining Corporation, Canada
  - Produces zinc, copper and pyrite (FeS_2)

1)Exceptionally good rock

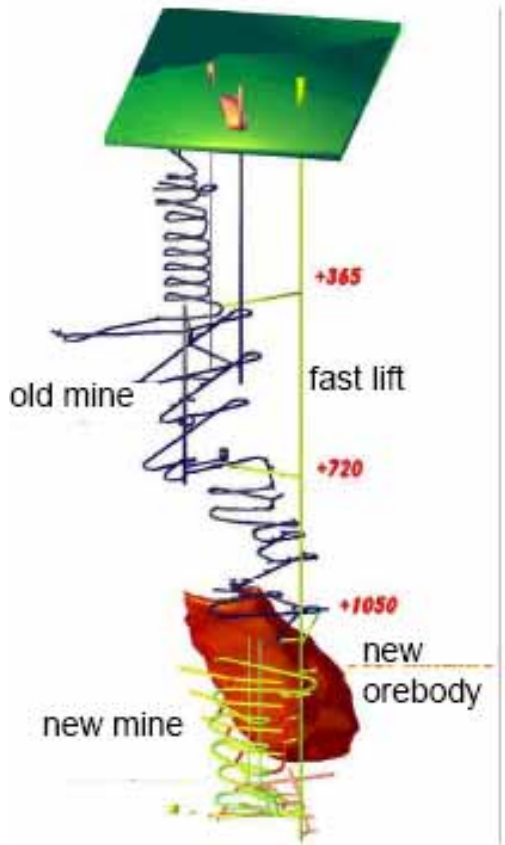
- Ca 2 gigayears old, very stable
- Cheaper, faster and safer to build large cavities for long-time use
- There is abundant experience and expertise in rock planning and construction in Finland

2)Northern location

- Low nuclear reactor flux
- Distance for neutrino beams (very beam-dependent)
- Beneficial for supernova neutrino observations



- Red: very old bedrock, hard crystalline rock: very good



3)Deepest metal mine in Europe

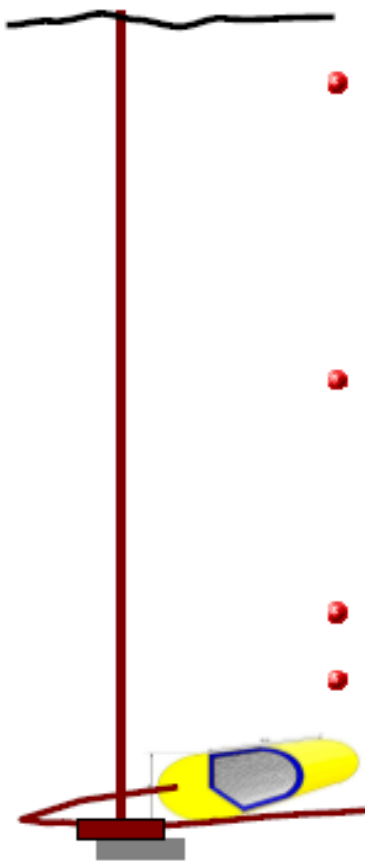
- Existing cavities at different depths 80-1440 m

Current focus: EMMA experiment

- EMMA = Experiment with MultiMuon Array
  - Underground cosmic ray experiment
  - Study secondary muons in air showers
- Objective:
  - Clarify the composition of the cosmic rays in the knee region
    - Not known what hits the Earth (p, He, C, Fe,...?)
  - Search for high-multiplicity events as observed at CERN
- EMMA is the first dedicated underground cosmic-ray experiment at this depth

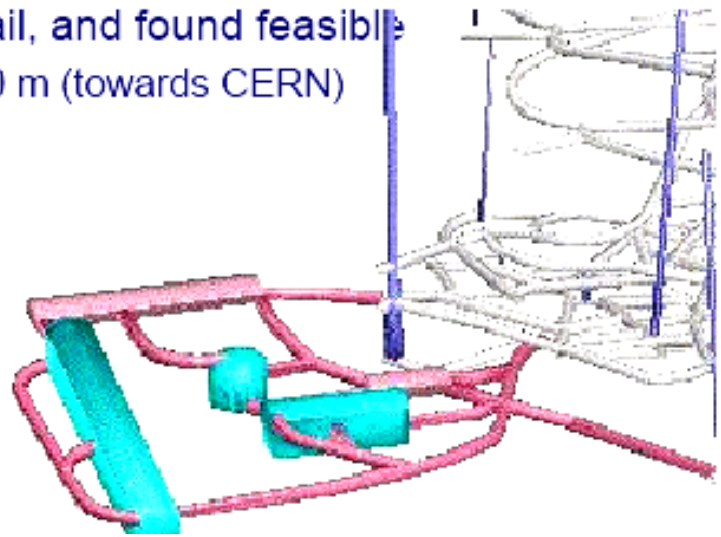
Future plans

- LAGUNA
  - Main initiative for the next few years
- Neutrino beam experiments
  - Depends on the beam and its location
  - Maybe after LAGUNA



Studies for a new laboratory

- Properties of rock, rock mechanics and constructibility of the laboratory in Pyhäsalmi mine studied in a pre-feasibility study 2002
  - No show-stoppers
  - Very good rock
  - Rock types vary, sometimes even at O(1m) scale.
  - Natural radioactivity rather low (but varies)
- Studied several caverns in detail, and found feasible
  - Inclined hall 20 m x 20 m x 120 m (towards CERN)
  - Cylinder d=25 m, h=25 m



- Laboratory must be separated from the mine
- Independent access
- Own power and air pipes
- Rock quality probably better than near the mine

4.

Laboratoire Souterrain à Bas Bruit RUSTREL Pays d'APT

LABORATOIRE SOUTERRAIN À BAS BRUIT RUSTREL - PAYS D'APT (LSBB)

Université de Nice - Sophia-Antipolis
CNRS
Observatoire de la Côte d'Azur

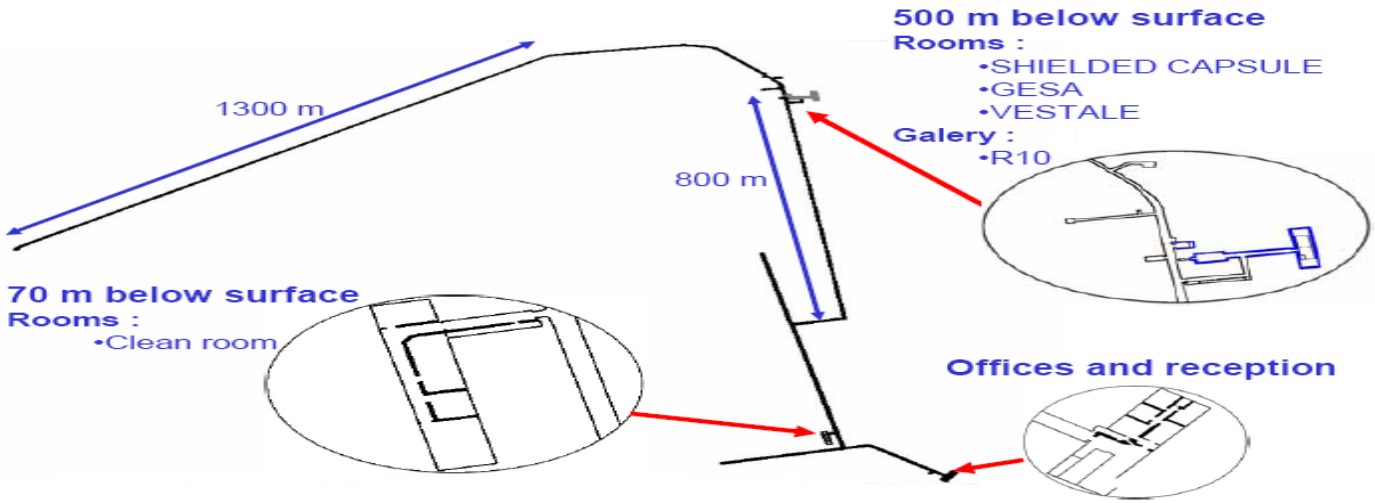
Universités région PACA
CEA/DASE

La Grande Combe, 84400 Rustrel (France)
http://lsbb.unice.fr

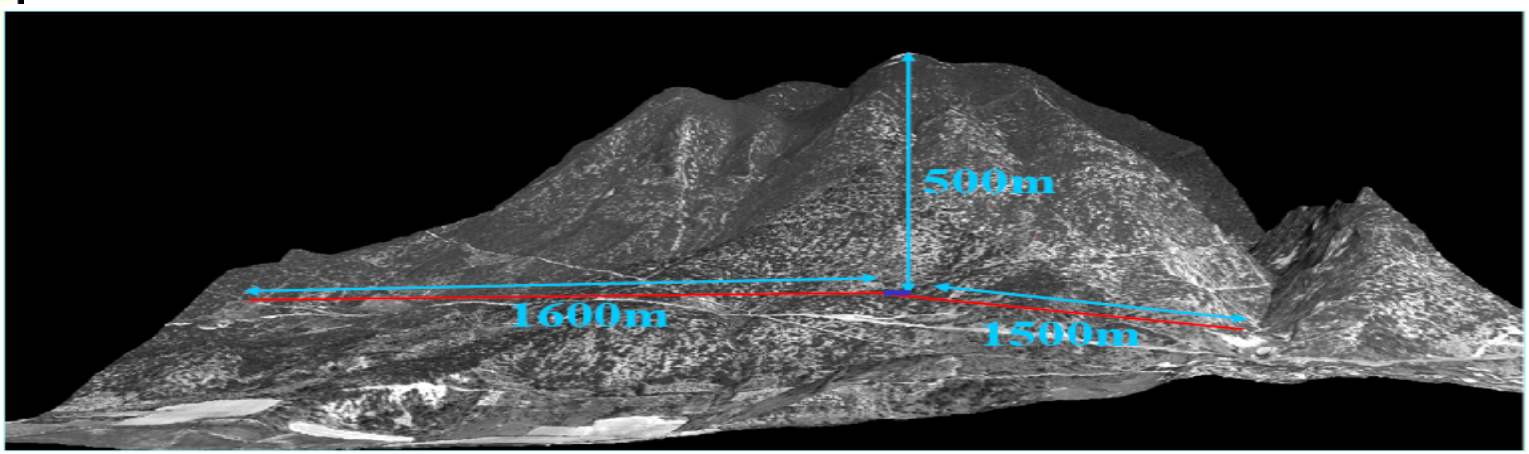
Laboratoire Souterrain à Bas Bruit RUSTREL Pays d'APT

I – LSBB CONTAINS SEVERAL ROOMS AT DIFFERENT DEPTHS

ALLOWING : - Underground laboratory experiments
- Installation of sensors for low noise survey



I



An underground device initially designed to insure protection against mechanical, blast, heat, irradiation and radioactive fallout, and against the electromagnetic pulse

Laboratoire Souterrain à Bas Bruit RUSTREL Pays d'APT

RADIATIVE CHARACTERIZATION OF LSBB (APC, LSM, DAPNIA)

Measurements to be done

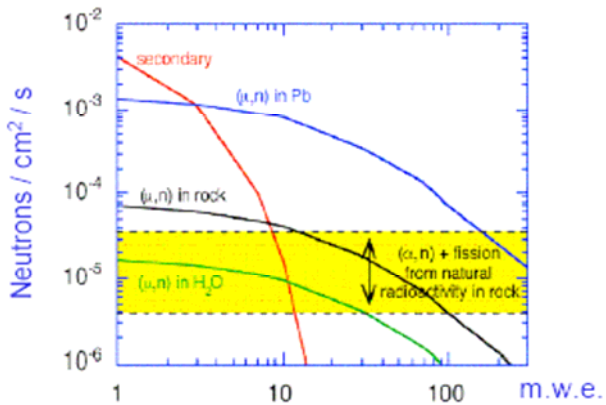
- Rock & concrete isotopic composition (concrete & karstic rock) done by LSM
- Muon flux: set-up 4 **muon telescopes** (**0.3 m^2 counter**), set-up at LSBB
- Neutron flux: 4 ^{3}**He neutron counters**, at LSBB, Neutron-Sphere, in progress
- The radon: **Nitton radon-meter**, in use at LSBB, measurement in progress

Radon

Radon-meter « NITTON »

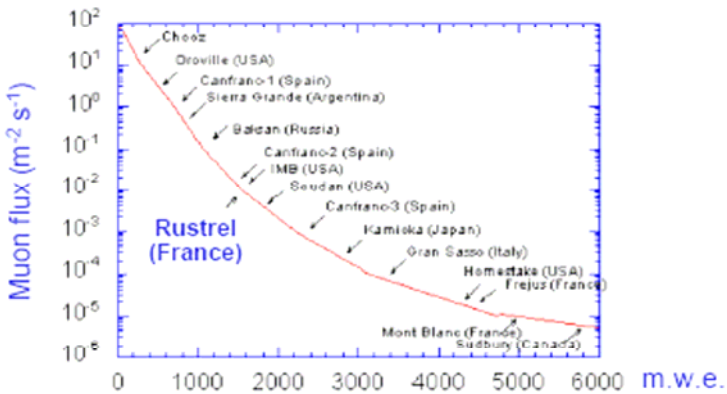
Neutrons simulation

Natural radioactivity induced neutrons
Flux from (a,n) reactions
Cosmogenic neutrons flux (induced by muons)

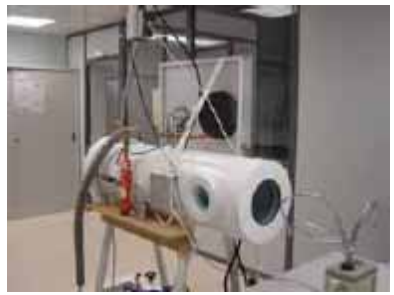


Muons simulation

Flux attenuation versus depth, medium density (geology profile well known)
Flux attenuation versus hydrology variability



The ongoing research program:



- **Simple: Superheated Instrument for Massive Particle Experiments**

- **Rustrel Ultra Low Noise Magnetometer System:**
  first observation of: (1) magnetic wave associated to seismic wave propagation, (2) magnetic response of the surrounding LSBB karstic system to P wave for strong earthquakes, (3) ionosphere magnetic response to P waves reaching the ionosphere floor for each eartquake and (4) very long periods ionosphere resonance modes.
- **Metrological developments:**
  HPPP (High Pulse Poroelasticity Protocole): an innovative protocol for synchronous measurements of fluid pressure and mechanical displacement
- **Hydrogeological measurements**
- **In-Situ experiments on wave propagation in partially saturated medium with a mesoscale porosity**

Laboratoire Souterrain à Bas Bruit RUSTREL Pays d'APT

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PERSPECTIVES I

Contribute to ILIAS-Next proposal :
The association of astroparticle sciences to the other scientific fields (e.g. geosciences, life sciences, biotechnology, nanotechnology, semi conductor and electronic) will allow

- A better knowledge of the measurement environment for astroparticle detection,
- An access to low noise and ultra low noise facilities dedicated to metrological developments and qualifications,
- The analysis of weak processes requiring highly sensitive measurements,
- The in-situ access to geosciences topics below the subsurface weather zone.

Develop emerging collaborations :

- Metrology for planetary and space science (weak coupled ground process measurements, space device for gravitational waves …)
- 4D Radar and seismic surveys and large scale tomography
- Multiparametric data processing (multicomponent array analysis)
- High sensitivity seismic and magnetic experiments
- Life Science metrology (e.e.g., …)
- Microdevice testings and developments