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

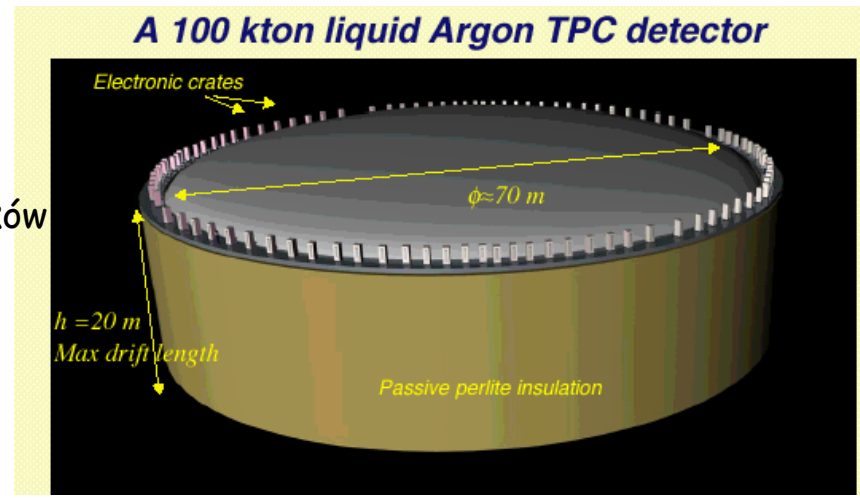
J. Kisiel, J. Dorda, A. Konefał

University of Silesia, Katowice

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

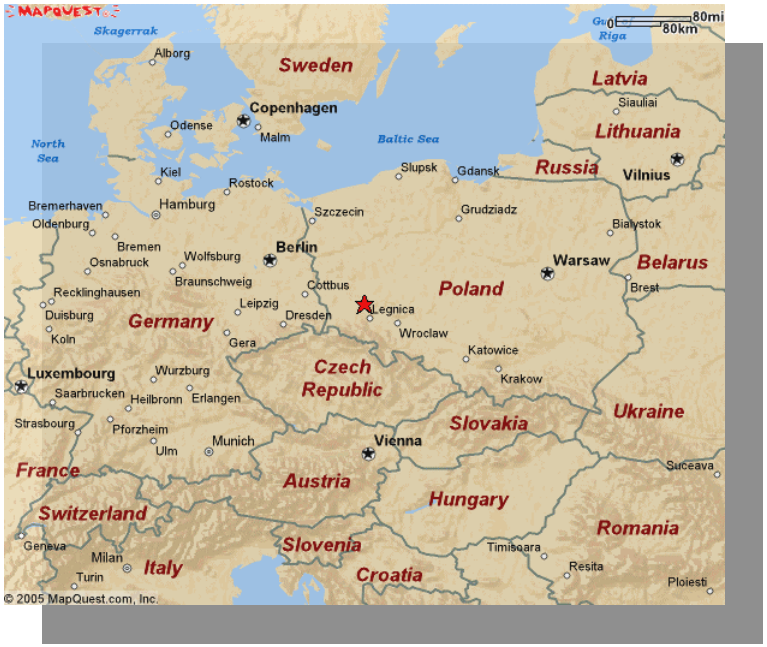
IFJ PAN Kraków

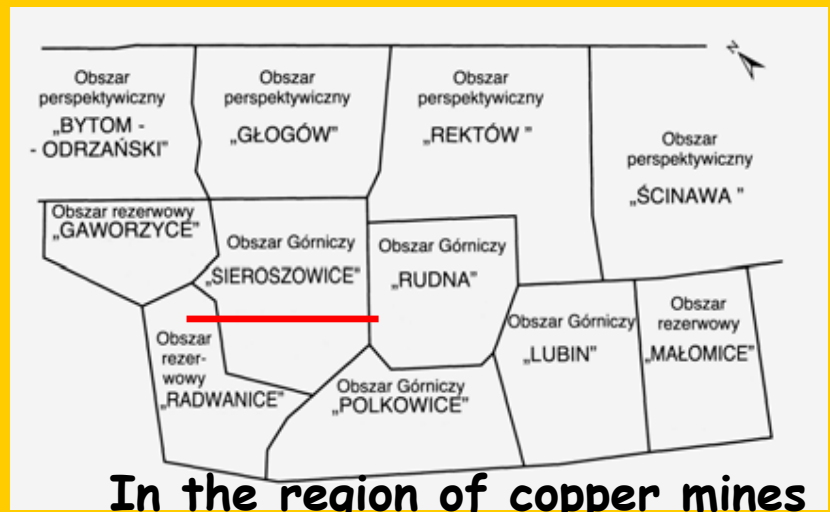
The origin of this study was a search of the location for



A.Rubbia, hep-ph/0402110

SUNLAB - where?





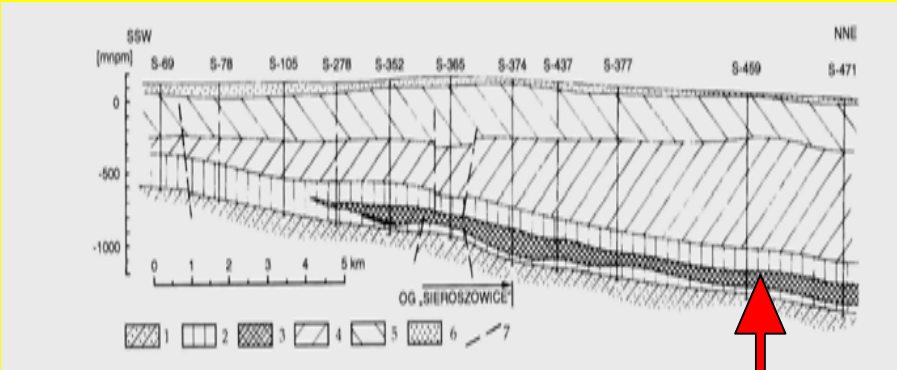
In the region of copper mines (6th position in the world's copper production and 2nd position for silver

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

The Sieroszowice mine (part of the KGHM holding)

Zaragoza, 22.11.2007

A thick salt layer above copper ores



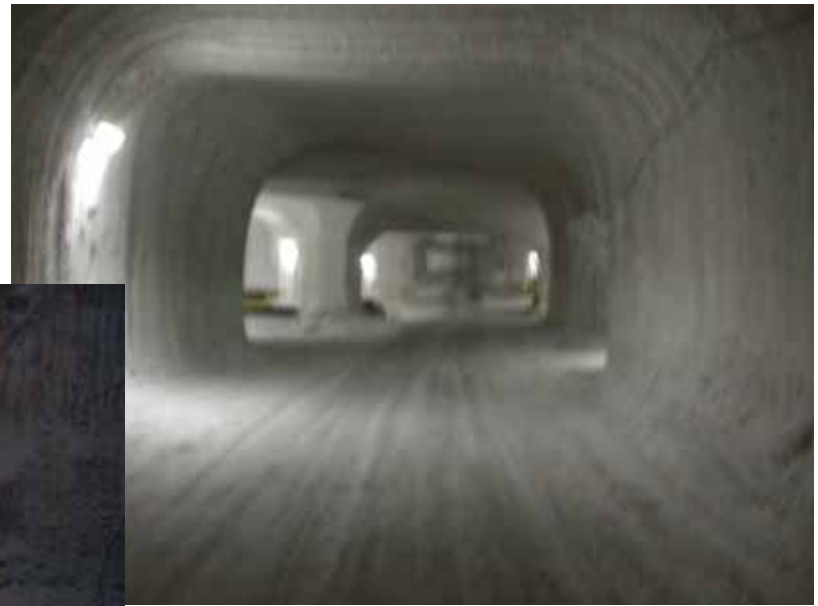
Geological cutoff – salt

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

Measurements of the wall movements

More photos from the measurements in 2004-2006



Can one make use of the existing chamber?

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

Radiochemical α and γ measurements of salt and anhidrite

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 BG/kg)

Anhidrite:

U-238: 0.82+-0.10 Bq/kg

U-234: 0.76+-0.09 Bq/kg

Th-232: 0.52+-0.15 Bq/kg

Th-230: 1.26+-0.24 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 under the surface it is 65 nGy/h)

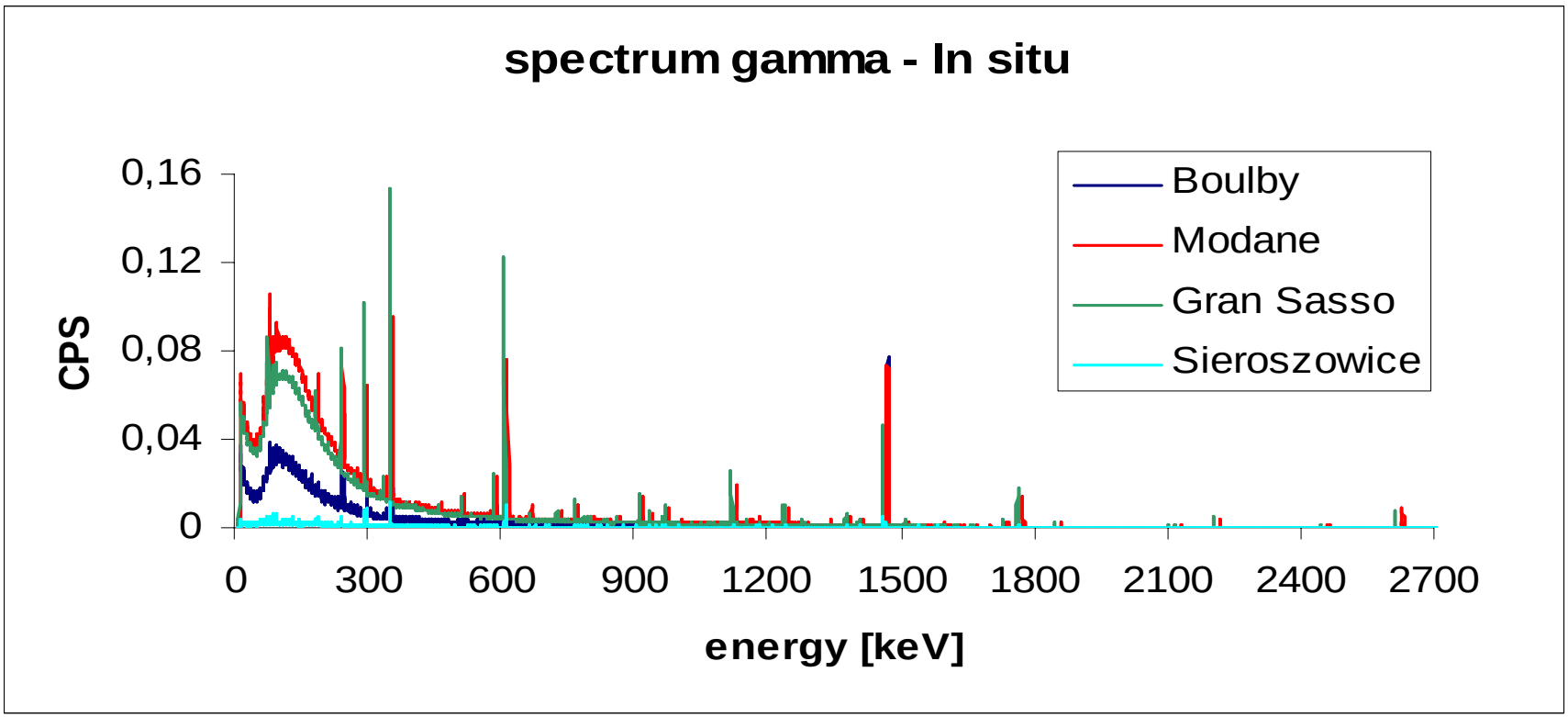
Radon mostly due to ventillation

Background due to natural radioactivity (*in-situ*): Boulby, Gran Sasso, Modane and Sieroszowice

J. Kisiel et al., University of Silesia, Katowice

Integral background counting rates 50 – 2700 keV [CPS/keV*kg]	
Sieroszowice	**2.30 (0.02)**
Gran Sasso	**57.68 (0.02)**
Modane	**66.06 (0.03)**
Boulby	**23.83 (0.05)**

Background due to natural radioactivity: Boulby, Gran Sasso, Modane and Sieroszowice



J. Kisiel et al., University of Silesia, Katowice

(measurements performed in the framework of ILIAS)

SUNLAB in the LAGUNA Design Study

List of participants:

Participant no.	Participant organisation name	Country
1. ETH Zurich	Swiss Federal Institute of Technology Zurich	Switzerland
2. U-Bern	University of Bern	Switzerland
3. U-Jyväskylä	University of Jyväskylä	Finland
4. U-Oulu	University of Oulu	Finland
5. Rockplan	Kalliosuunnittelu Oy Rockplan Ltd	Finland
6. CEA/ DSM/ DAPNIA	Commissariat à l'Energie Atomique /Direction des Sciences de la Matière	France
7. IN2P3	Institut National de Physique Nucléaire et de Physique des Particules (CNRS/IN2P3)	France
8. MPG	Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.	Germany
9. TUM	Technische Universität München	Germany
10. U-Hamburg	Universität Hamburg	Germany
11. IFJ PAN	H.Niewodniczanski Institute of Nuclear Physics of the Polish Academy of Sciences, Krakow	Poland
12. IPJ	A.Sołtan Institute for Nuclear Studies	Poland
13. US	University of Silesia	Poland
14. UWr	Wroclaw University	Poland
15. KGHM CUPRUM	KGHM CUPRUM Ltd Research and Development Centre	Poland
16. IGSMiE PAN	Mineral and Energy Economy Research Institute of the Polish Academy of Sciences	Poland
17. LSC	Laboratorio Subterraneo de Canfranc	Spain
18. UGR	University of Granada	Spain
19. UDUR	University of Durham	United Kingdom
20. U-Sheffield	The University of Sheffield	United Kingdom
21. Technodyne	Technodyne International Ltd	United Kingdom
22. ETL	Electron Tubes	United Kingdom
23. U-Aarhus	University of Aarhus	Denmark
24. AGT	AGT Ingegneria Srl, Perugia	Italy

SUNLAB in the LAGUNA Design Study

Work package no.	Work package title	Type of activity	Lead participant no.	Person-months	Start month	End month
WP1	Management, coordination and assessment	MGT	ETHZ	52	1	36
WP2	Underground Infrastructures and Engineering	RTD	U-Oulu	221	1	35
WP3	Tank Infrastructure and Liquid Handling	RTD	TUM	249	1	35
WP4	Tank Instrumentation and Data Handling	RTD	IN2P3	439	1	35
WP5	Safety and environmental issues	RTD	U-Sheffield	65	1	35
WP6	Science Impact and Outreach	RTD	IFJ PAN	454	1	35
	TOTAL			**1480**		

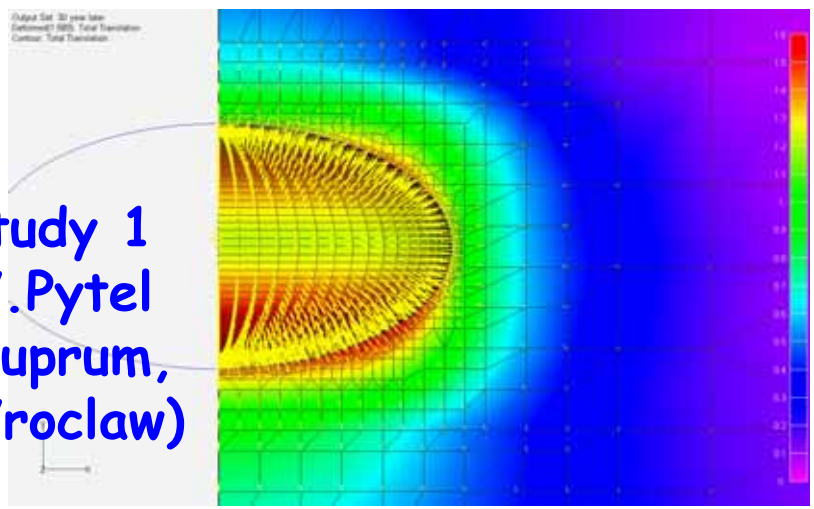
Can one dig a huge stable cavern for 100 ktons of Liquid Argon at 950 m?

Requirements:

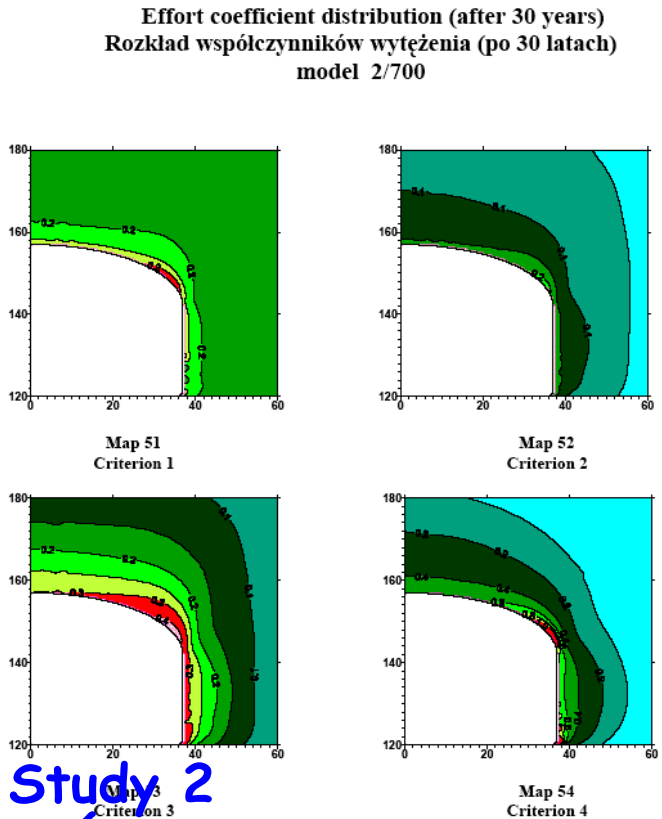
- cavern's diameter 70-100m
- stable for 30 years

Assumptions:

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



Study 1
W.Pytel
(Cuprum, Wroclaw)



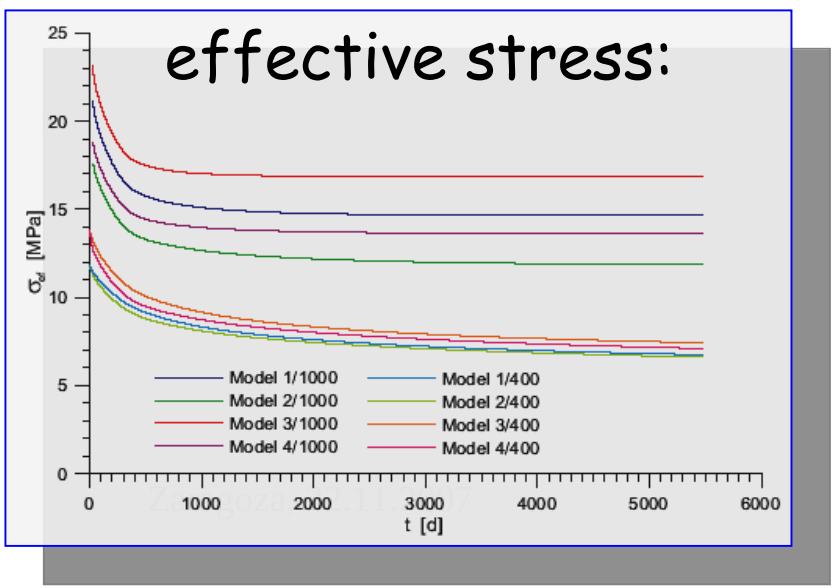
Study 2
J.Ślizowski, K.Urbańczyk
(IGSMiE, Cracow)

Two independent preliminary geomechanical analyses performed in 2004-2005

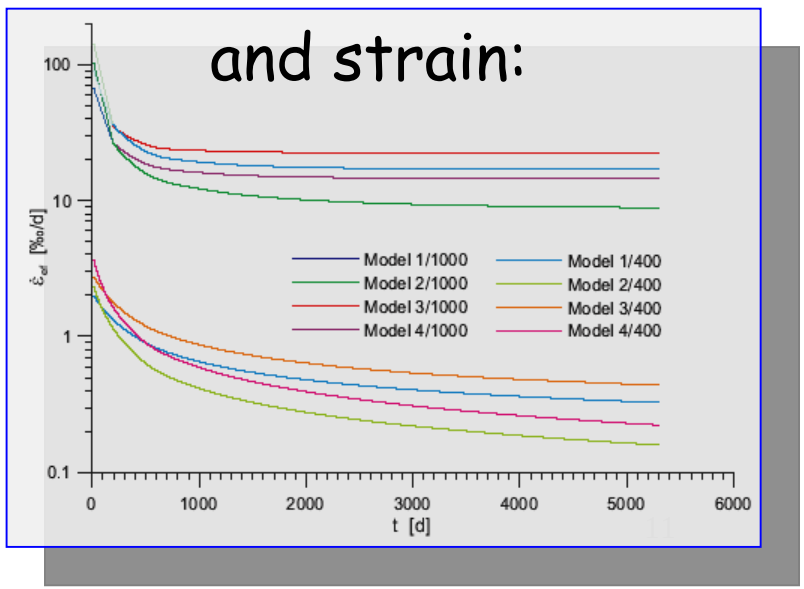
Results of the simulations

- Anhydrite stability after excavation is guaranteed,
- After 30 years the caver'n walls will move by 1.5 m, instant movement after excavation is 0.145 m,
- Stability of the salt cavern: an ellipsoidal cavern is stable at a depth of 950 m (study 1), a cylindrical cavern with a dome is stable at a depth of 700 m (study 2),
- More studies (both the simulations and the measurements of wall movements) are needed → the work has restarted – both groups in contact, using very good but independent software

effective stress:



and strain:



Who works for SUNLAB?
KGHM Cuprum and IGSMiE

- KGHM CUPRUM – full range of experts for designing the KGHM mines and their infrastructure, equiped with specialized laboratories and the best software, backped by the Wroclaw technical university.
- IGSMiE – specialists in underground storage, in particular designing large underground chambers (up to 10^6 m^3) for natural gas storage.
- Support from KGHM management

Who works for SUNLAB? Polish physics groups

- Close collaboration of the groups from Cracow, Katowice, Warsaw and Wroclaw since 2000 (joining the ICARUS collaboration) within the Polish Neutrino Group, now common participation in other projects (T2K, LAGUNA)
- Creation of the Polish astrophysics network in 2007 with SUNLAB as one of the workpackages (with a limited but existing funding)
- Creation of the dedicated SUNLAB network or consortium in 2008, after the LAGUNA DS. negotiations are successfully finished
- Wide range of expertise in the participating institutions (astrophysics, particle physics, nuclear physics, geophysics, engineering staff etc.)
- Support of the Ministry of Science and Higher Education

Example: H.Niewodniczański Institute of Nuclear Physics in Cracow

- Five divisions, specialized laboratories, strong engineering support, 60 PhD students, close contacts with the Jagellonian University and with two technical universities in Cracow.

- Physicists from the Divion of Particle and Astropaticle Physics (1) and from the Division of Applications of Physics and Interdisciplinary Research (5) are engaged in the SUNLAB project

- Division 1 – about 100 physicists, participation in ATLAS, ALICE and LHCb at LHC, ILC, H1 and ZEUS at DESY, Belle at KEK, PHOBOS at RHIC, Pierre Auger Observarory, ICARUS at Gran Sasso, T2K at JPARC and LAGUNA

- Division 5 – specialists in environmental measurements, geophysics, low background measurements and radiochemistry

Great tradition

PHYSICAL REVIEW VOLUME 77, NUMBER 3 FEBRUARY 1, 1950

On Some Low Ionizing Radiation Observed by Measurements of Cosmic Radiation at Great Depths

M. Miesowicz, L. Jurkiewicz, and J. M. Massalski
Physical Laboratory of the Mining Academy, Cracow, Poland
(Received September 22, 1949)

By measurements of twofold, threefold, and fourfold coincidences with a Geiger counter telescope, the underground rays at 660 and 540 m w.e. (water equivalent) have been divided into two components. One of the components is ionizing, discharging the counters with almost 100 percent efficiency, and has a strong maximum in the vertical direction. The other component discharges the counters with a very low efficiency, producing numerous twofold coincidences but practically no threefold or fourfold coincidences. It is isotropic in direction and rapidly absorbed in lead. This second component is thought to be composed of γ-rays of local radioactive origin. The telescope used in these experiments differed from that of Barnóthy and Forró in that it was protected from side showers by anticoincidence counters. The ratio of twofold to threefold coincidences was found to be about 1.4 instead of 20 as reported by Barnóthy and Forró at 1000 m w.e.

Professor Marian Mięsowicz
-father of particle physics
And of nuclear geophysics
in Cracow, supervisor of my PhD

Near future

- Building up the community around the initial, smaller laboratory in one of the existing chambers – startup of the clean underground laboratory for low background material measurements, some ideas for further measurements - the dedicated meeting in Cracow in October 2007

- Visiting SNOLAB with mine representatives in January 2008 – they want to understand better the coexistance of the scientific laboratory and the active mine

- Full studies of the excavation of large chambers within the LAGUNA project