The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1833-8

Workshop on Understanding and Evaluating Radioanalytical Measurement Uncertainty

5 - 16 November 2007

The Romanian underground laboratory

Romul M. MARGINEANU

National Institute of R & D for Physics & Nuclear Engineering
Department of Life & Environmental Physics "Horia Hulubei"
407 Atomistilor Street
P.O. Box MG-6, RO-77125
ROMANIA

Romanian underground laboratory

R. Margineanu, Corina Simion, Ana Maria Apostu, Claudia Gomoiu,
Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Magurele, ROMANIA

O.G. Duliu
University from Bucharest, Department of Atomic and Nuclear Physics

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

AKNOWLEDGEMENTS: The authors express their gratitude to the Academy of Medical Sciences from Romania for its support through the CEEX Program for the project "The study of necessary conditions and the setting up of an underground laboratory in ultra-low radiation background"

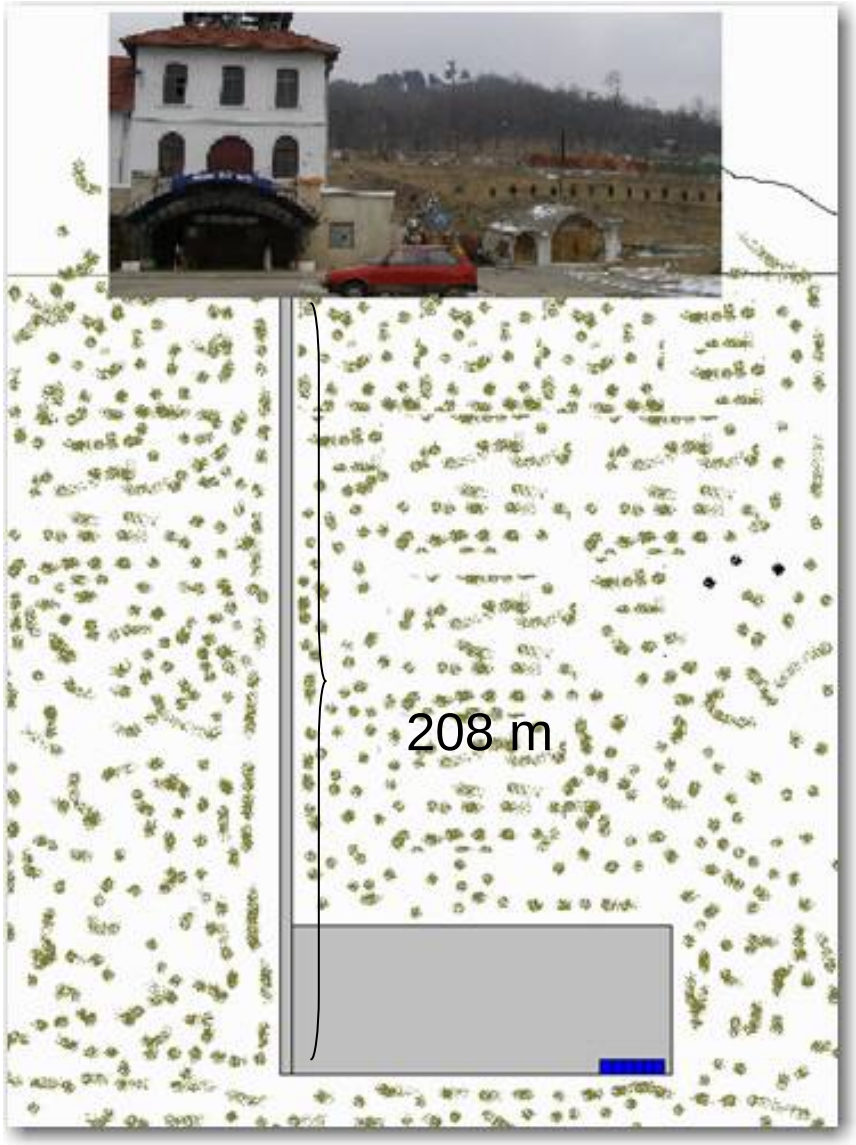
The construction and exploitation of low-background radiation laboratories represents a great challenge for nuclear as well as for elementary particle physics, first of all for reducing cosmic radiation.

For this purpose, a best ways to reduce the background radiation consists in using underground mines or tunnels for housing this kind of laboratories.

To reduce the level of natural rocks background radiation, for underground laboratories locations in rocks with a low content of natural radionuclides are preferred. The formation of salt ore in the natural process of fractional crystallization in a supersaturated marine brine partially remove potassium chloride as well as other salts, significantly reducing the presence of natural radionuclides.

Romania is rich in natural deposits of salts, mainly encountered in the sub-Carpathian region which have been exploited since ancient times housing many active and in conservation salt mines, the last ones representing ideal locations for low background radiation laboratories.

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.



The Unirea salt mine environment:

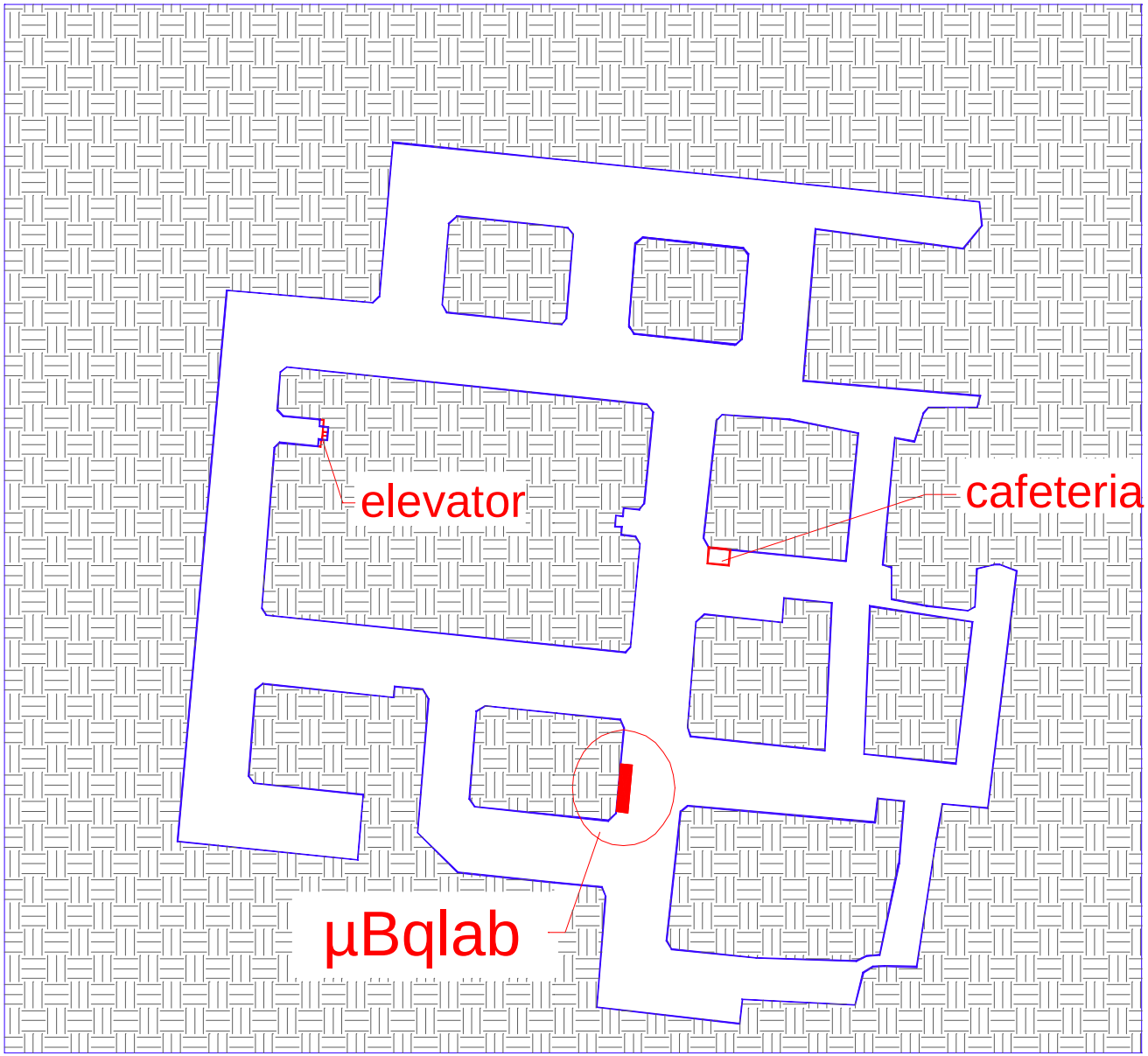
temperature: 12.0 -13.0 ^{o}C

humidity: 65-70 %

excavated volume: 2.9 million m^3

floor area: 70000 m^2

average high: 52-57 m



UNIREA salt mine gallery

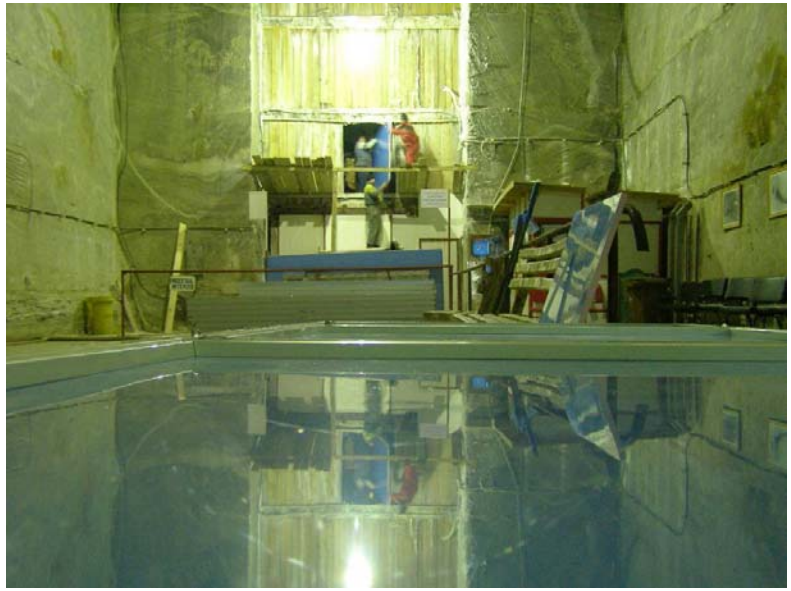
microBq laboratory realization stages:

I. – conception, design, constructor selection, material selection;

II. – material conditioning, transportation and construction;

III. – leveling the mine floor under laboratory using granulated salt,

IV. – measurement systems purchasing

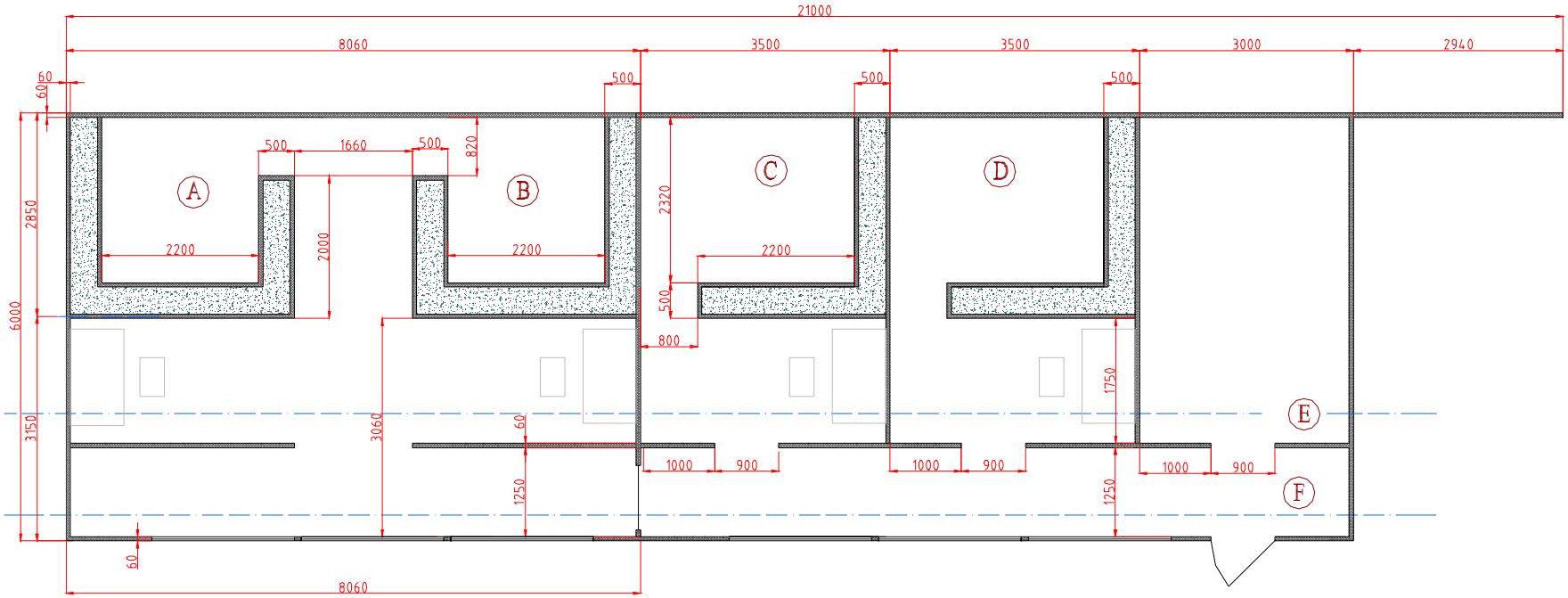


ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy



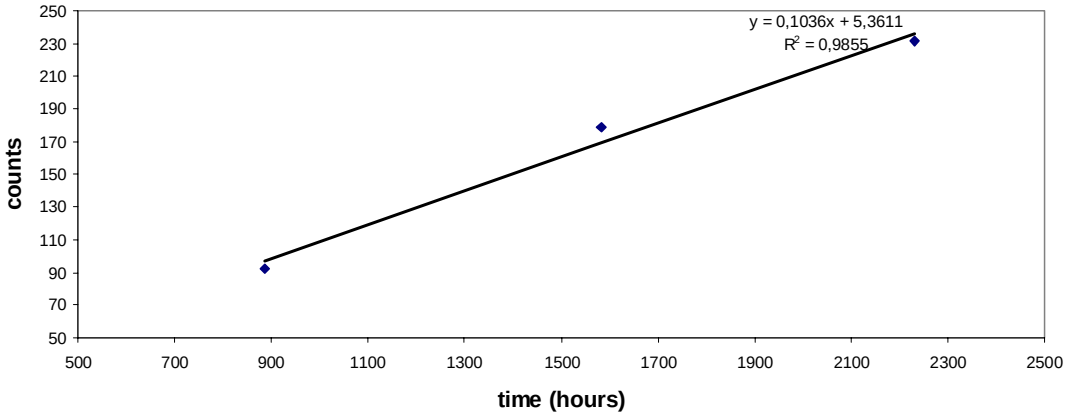
UNDERGROUND LABORATORY

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

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

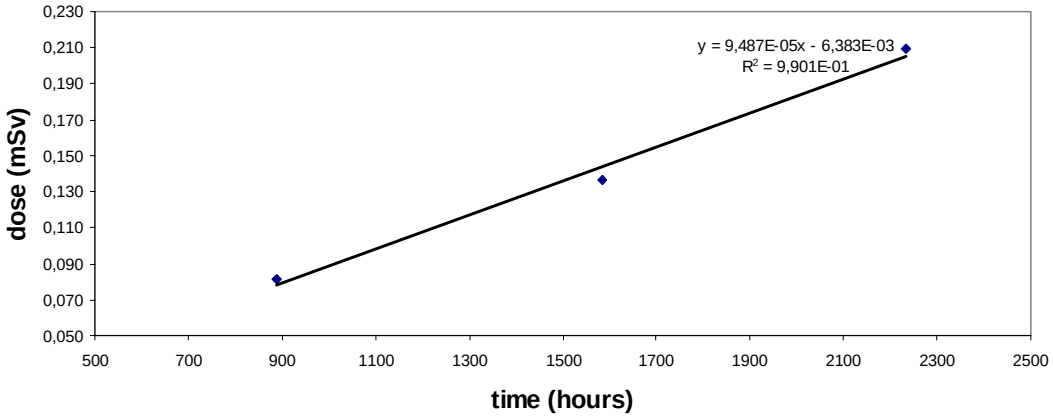
- high resolution gamma ray spectrometry
- whole body counter
- radiation metrology

Total counts versus time
TLDs placed in Sanatoriu area



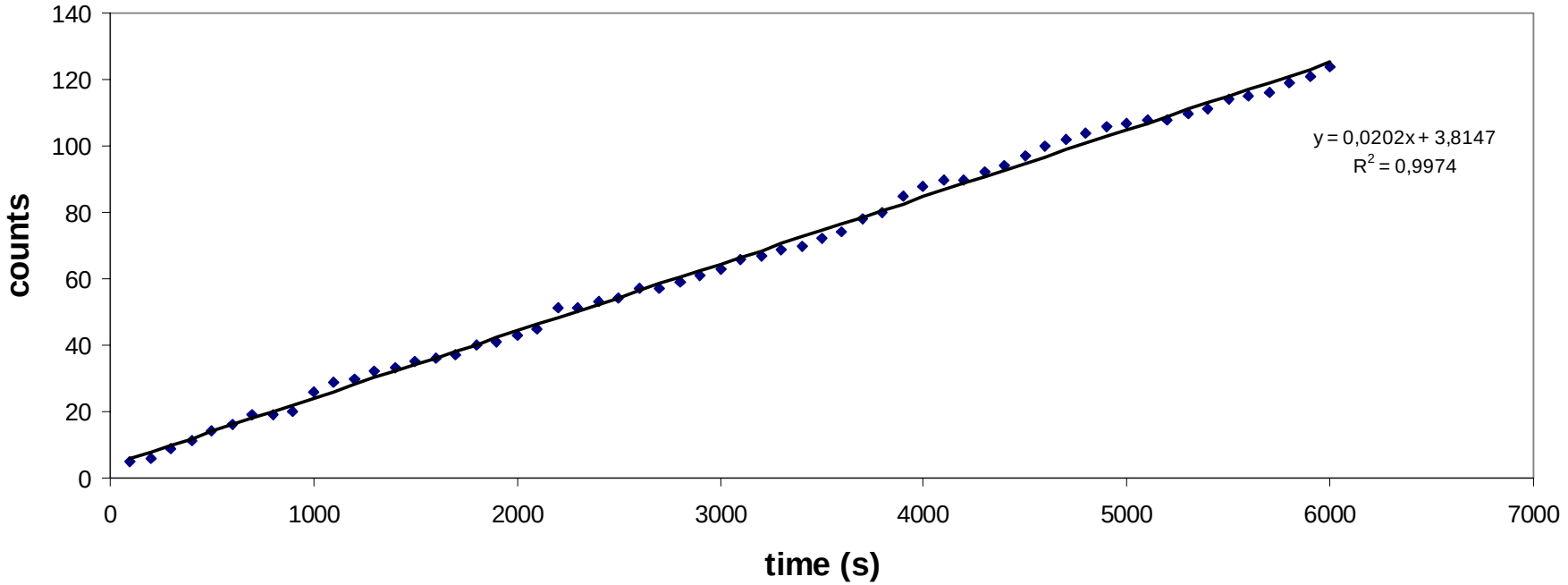
dose rate: 0.2 – 2.0 nSv/h

Dose versus time in Slanic area
TLDs placed in an open wood construction

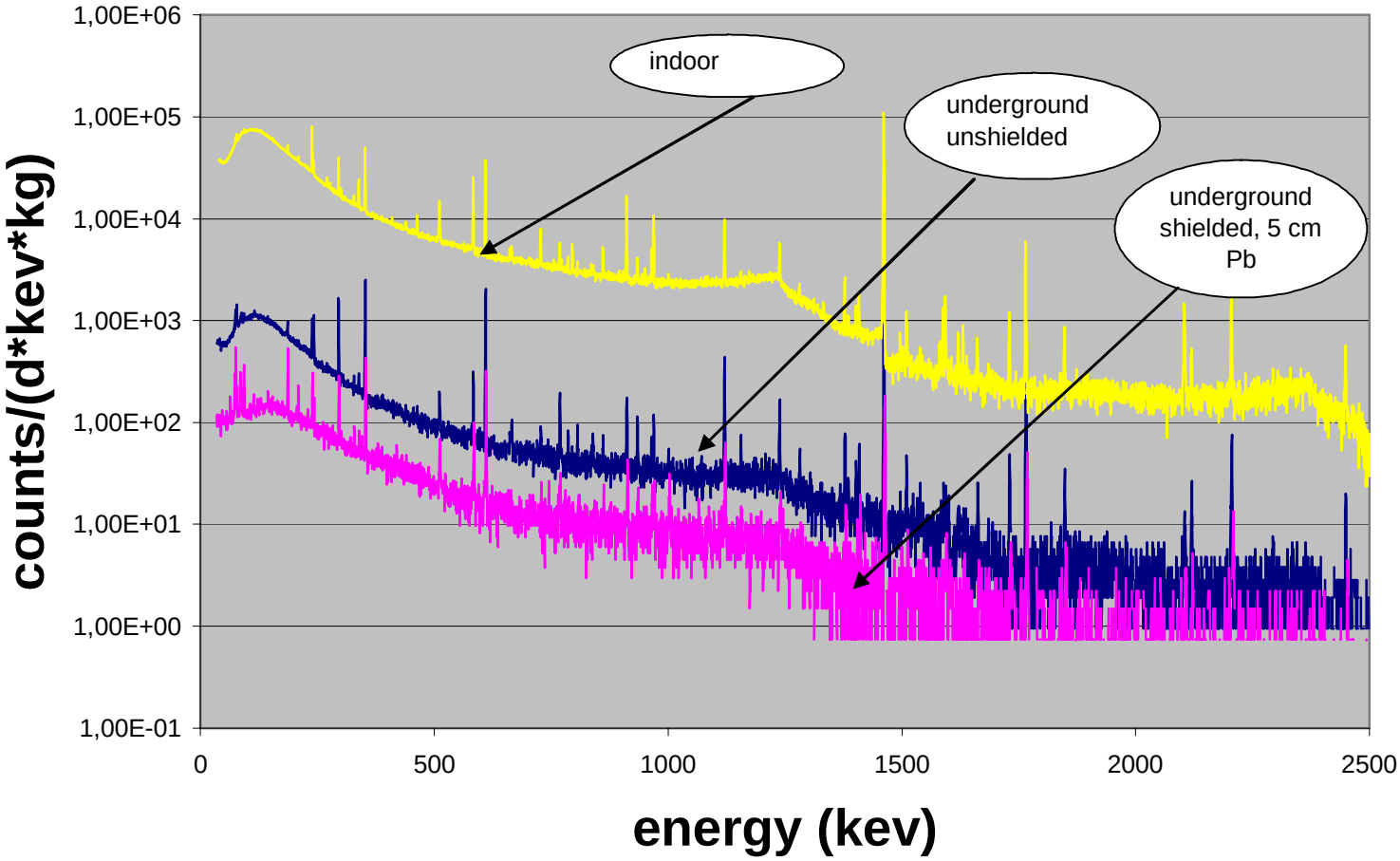


dose rate: 82 – 94 nSv/h

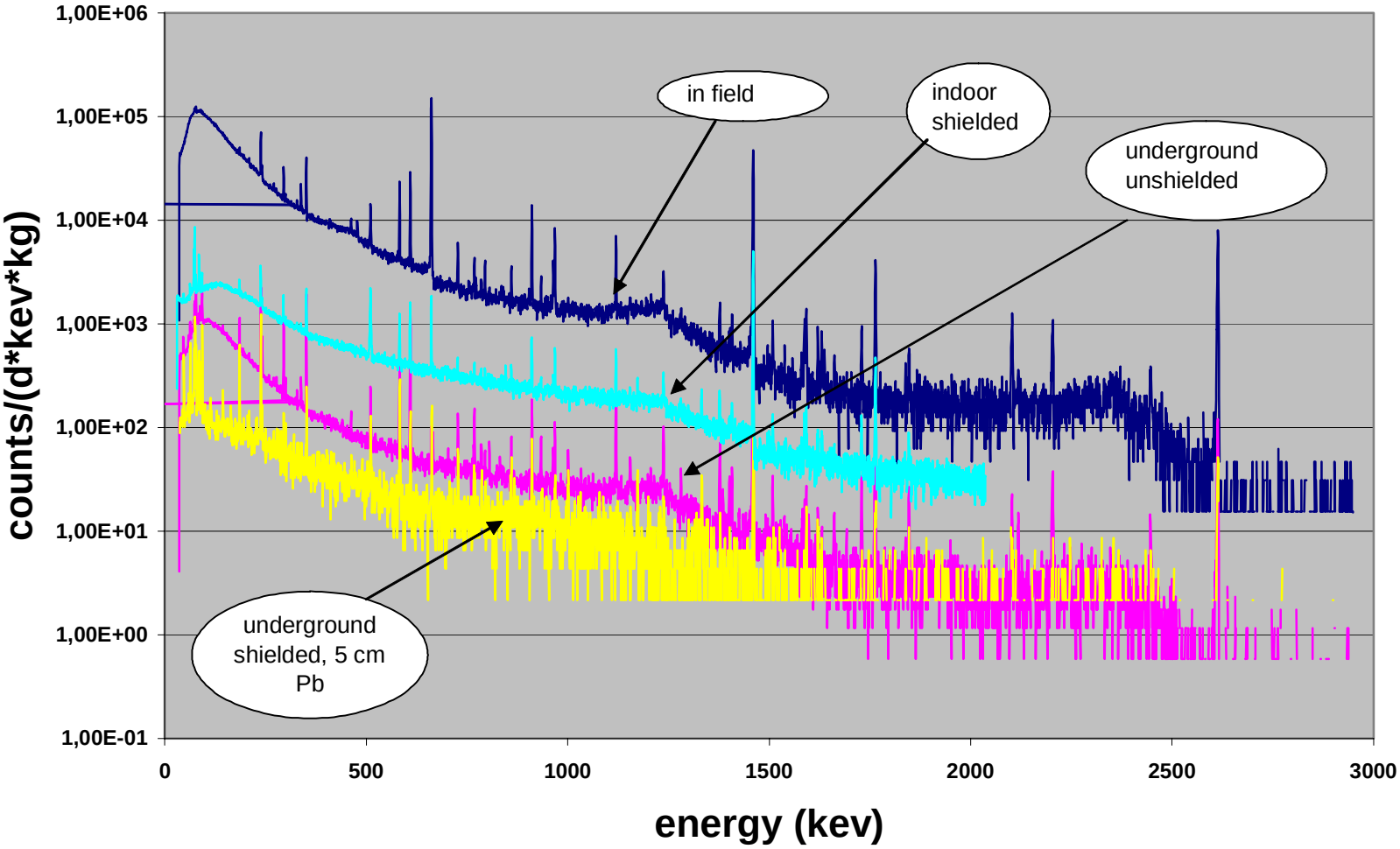
Fig. 5, Counts vs. time,
sanatoriu area - Slanic Unirea salt mine
measurement performed with a doseratemeter Eberline FH40-10



Background spectra collected with a CANBERRA GeHP detector with 22.2% rel. efficiency



Background spectra collected with an ORTEC GeHP detector with 33% rel. efficiency

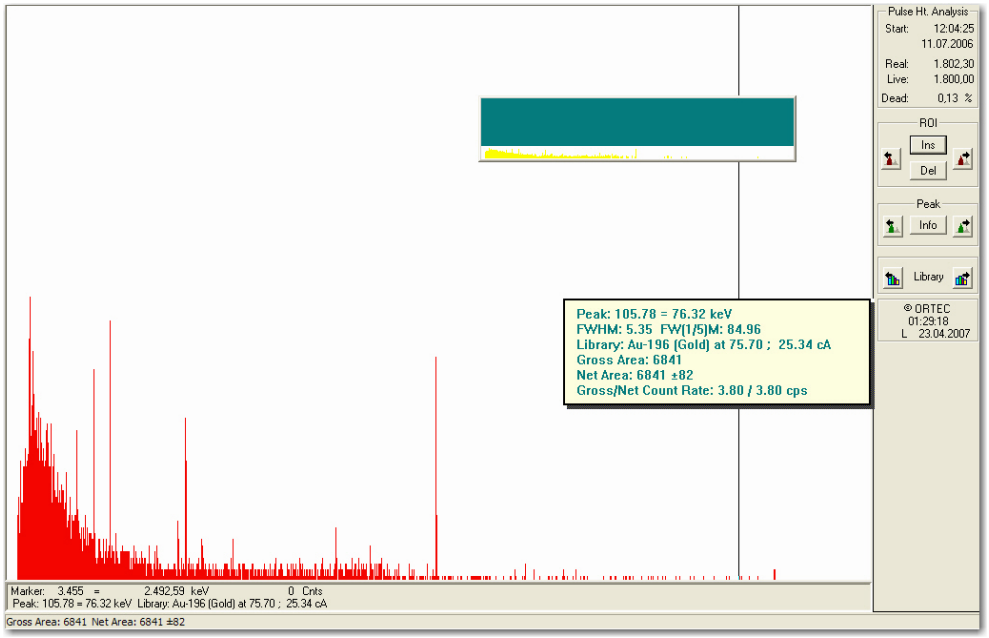


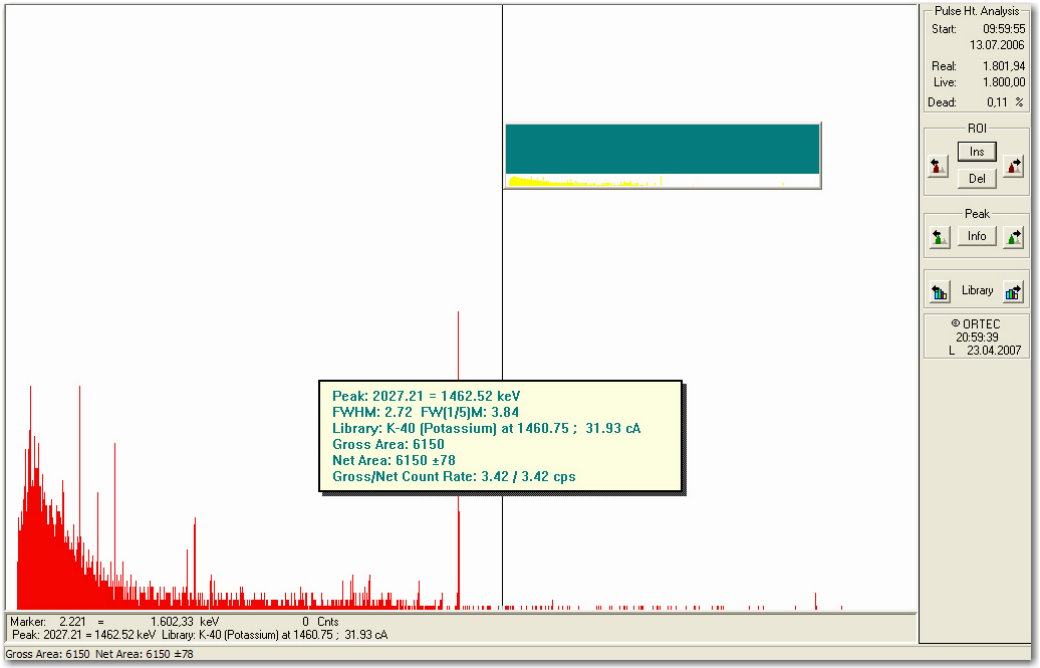
Gamma ray peaks in the background spectrum, collecting time=267500 s, ORTEC detector, 33% rel. eff., underground unshielded

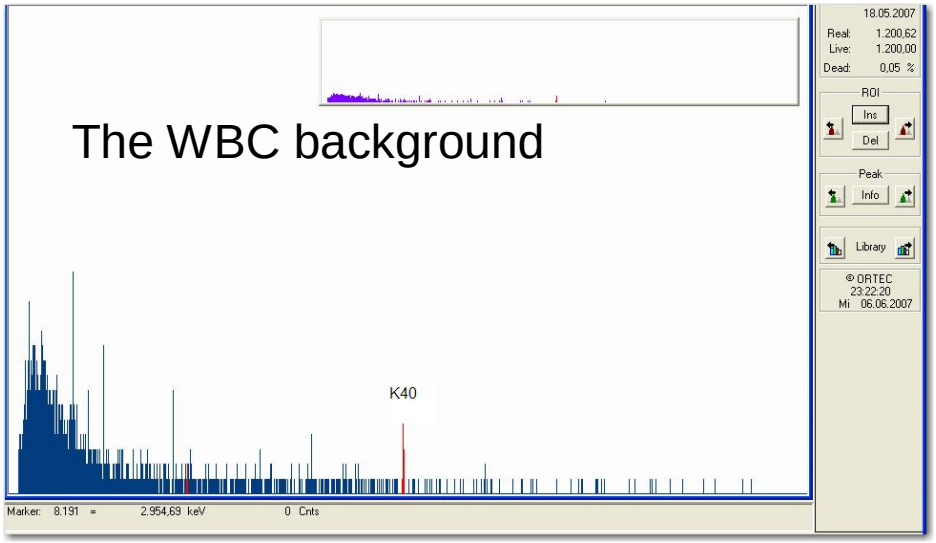
Isotope	Energy (k	cps		Isotope	Energy (k	cps
Pb-210	46,52	0,0025		Pa-228	911,23	0,0024
Pb-212	77,11	0,0201		Bi-214	934,05	0,0009
U-228	92,29	0,0132		Ac-228	968,90	0,0020
Ra-226	185,99	0,0072		Bi-214	1120,28	0,0041
Ac-228	209,40	0,0004		Bi-214	1155,19	0,0004
Pb-212	238,63	0,0273		Bi-214	1238,11	0,0016
Tl-208	277,36	0,0024		Bi-214	1280,96	0,0004
Pb-214	295,22	0,0134		Bi-214	1377,65	0,0011
Ac-228	328,00	0,0004		Bi-214	1407,98	0,0011
Pa-228	338,32	0,0011		K-40	1460,75	0,0158
Pb-214	351,99	0,0207		Bi-214	1509,19	0,0005
Pa-228	463,00	0,0008		Bi-212	1620,56	0,0003
Tl-208	510,72	0,0028		Bi-214	1661,28	0,0003
Tl-208	583,14	0,0064		Bi-214	1729,60	0,0007
Bi-214	609,32	0,0194		Bi-214	1764,51	0,0037
Bi-214	665,45	0,0014		Bi-214	1847,44	0,0005
Bi-212	727,17	0,0011		Tl-208	2103,47	0,0004
Bi-214	768,36	0,0017		Bi-214	2118,54	0,0003
Pb-214	785,95	0,0008		Bi-214	2204,12	0,0009
Bi-214	806,17	0,0004		Bi-214	2447,71	0,0004

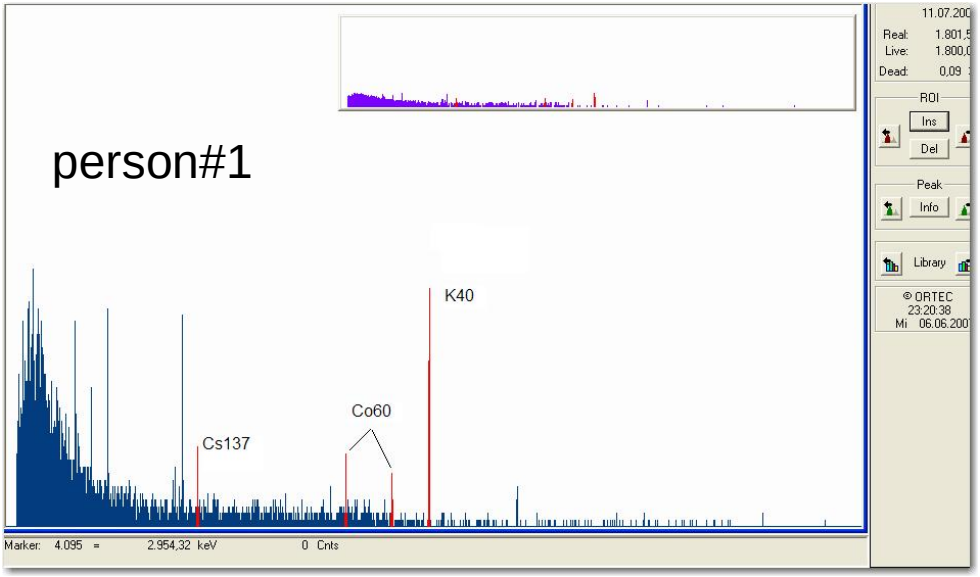
ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

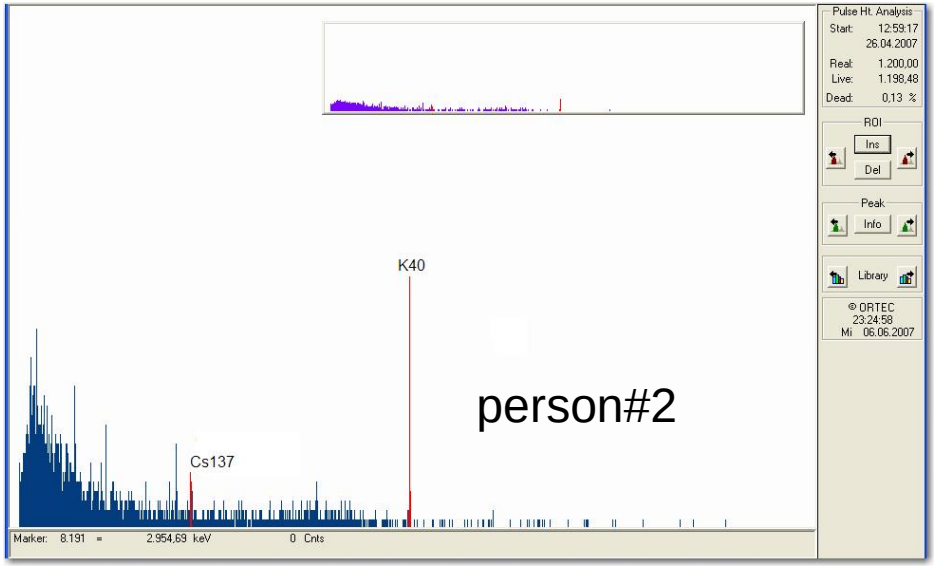
Whole body counter











ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

CONCLUSIONS

The dose rate inside the salt mine measured with TL detectors ranges from 0.2 nSv/h to 2 nSv/h.
The dose rates into the galleries, measured with commercial dose rate meters, due to natural background, corrected for the electronic noise are between 1.6–9.8 nSv/h.
The gamma ray spectra collected with two different detectors show a reduction of about 80 times between unshielded outside the mine and unshielded inside the gallery. A 5 cm thick lead shield has further reduced the background by a factor 4-5.
The total reduction is about 400 times compared with in-situ conditions
The measurements of human subjects by high resolution gamma ray spectrometry show in many cases the presence of Cs137 inside the body. In one case the presence of Co60 was put into evidence.

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy

ALMERA Meeting, 5-7 Nov. 2007,
Trieste, Italy