ISOTTA project

(ISOTope Trace Analysis)

Advanced Techniques for the Production, Purification and Radio-Purity Analysis of Isotopically Enriched Sources for Double Beta Decay

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ISOTTA: Polish institutions and tasks (WP3)

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National Centre for Nuclear Research, Świerk -NCBJ
Institute of Physics, University of Silesia, Katowice - IFUŚ

1. **Analysis of the enriched samples with ICP-MS (Inductively Coupled Plasma Mass Spectrometry), Ge spectrometry and alpha/beta spectrometers.**

2. **Design study on the low-energy Ge detector – construction of a prototype.**

Design study of a large surface alpha spectrometer based on a gas detector or on a matrix of low background semiconductor diodes – construction of a prototype (? – needed extra support).

3. **Studies of the neutron shield efficiency – simulations and measurements with neutrons of different energy.**

4. **Study of SUNLAB locations in ZG Polkowice-Sleroszowice for a new low-level laboratory, measurement of natural background, background simulations.**

ISOTTA: WP3 – Isotope radio-purity assessment with nuclear and mass spectroscopy

The deliverables of WP3:

- the reports on the screening campaign of the enriched samples and sources,
- the reports on the Monte Carlo studies for the new detectors and the related backgrounds,
- construction of the prototype of gamma spectrometer for underground lab and design study of a large surface alpha spectrometer

ISOTTA: WP3 – The equipment of Polish laboratories involved…

Alpha spectrometry (IFJ PAN)

Alpha spectrometers (12)

1. Silena AphaQuattro (4 tracks)
2. Three Ortec 576A (6 tracks)
3. Ortec Sloist (1 track)
4. Ortec AlphaDuo (2 trcks)
5. 2 Csnberra 7401 (2 tracks)
6. A home made unit (1 track)

Skills and experience in radiochemical procedures for:

1. Pu (about 5000 analyses since 1993)
2. Am, Cm
3. U
4. Th
5. Sm-147
6. Po-210
7. Ra

Beta spectrometry LSC (IFJ PAN)

Wallac Guardian LS
alpha/beta spectrometer

Skills and abilities in analyses:

1. Sr-90

2. Pu-241

now in progress

1. Ni-63 (PhD)

2. Tc-99 (Polish grant, PhD)

3. H-3

Gamma spectrometry (3 Institutions)

At IFJ PAN 12 HPGe spectrometers, inc. 4 within Accredited laboratory, one with veto detector and old lead:

At IFUJ – 1 with veto detector and old lead

At IFUŚ – Potable HPGe

Skills and abilities

- ***Radiocesium (including radiochemical conc.)***
- ***Hot particles***
- ***Natural (U,K,Th)***
- ***Cosmogenic (Be-7, Na-22: PhD)***
- ***...***

Other equipment

- Workshop for HPGe detectors production and regeneration (IFJ PAN)
- Access to ICP-MS instruments at ING PAN in Kraków
- Skills and abilities in simulations (NCBJ, IFJ PAN, IF UŚ) - GEANT
- Skills and abilities in gas detectors (IF UJ, NCBJ)

Spectrometer ICP MS Thermo Neptune (ING PAN) in Krakow

Sample preparation „Clean room” (ING PAN)

ISOTTA: WP3 – The low background detector for underground laboratory

ISOTTA: WP3 – The low background detector for underground laboratory (TASK 2)

1. Germanium bought Umicore, Belgium (about 0.6 kg)
2. Low background cryostat
3. Implantations and formation in germanium detector workshop at IFJ PAN
4. Standard NIM electronics from Canberra or Ortec
5. MCA from NCBJ, Poland
6. Optimisation of shields using Geant
7. Moving into SUNLAB

ISOTTA: WP3 – The large area detector for alpha particles (TASK 2)

Concept and model studies – current financial support seems to be not sufficient to build full scale prototype. Needed external financial support (extra project)

ISOTTA: WP3 – The calculations of neutron screening (TASK 3)

The GEANT software will be applied to model neutron intractions with different detectors, shields and materials.

Example : The modelling of HPGe spectra obtained in different neutron fields started.

Sieroszowice Underground LAB - SUNLAB (TASK4)

The Polkowice-Sieroszowice mine is located in the south-western Poland, 90 km NW of Wroclaw. The mine belongs to KGHM Polska Miedz S.A. – the holding of copper ores mines and metallurgic plants. The mine is operating within tectonically stable and good quality hard rock consisting of dolomites and anhydrites, and locally of saltrock. Anhydrite layers provide excellent conditions for locating the LAGUNA laboratory.

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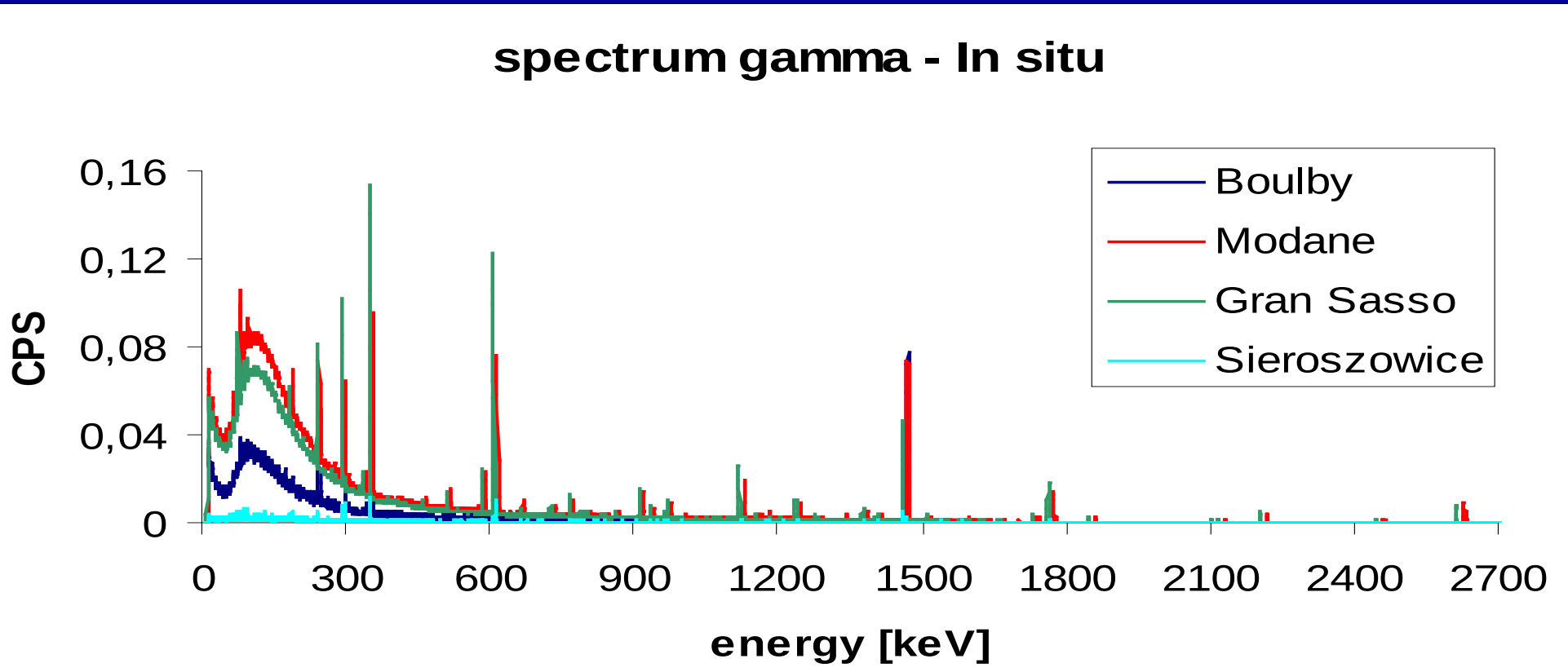
Sieroszowice: salt chambers

KGHM S.A.

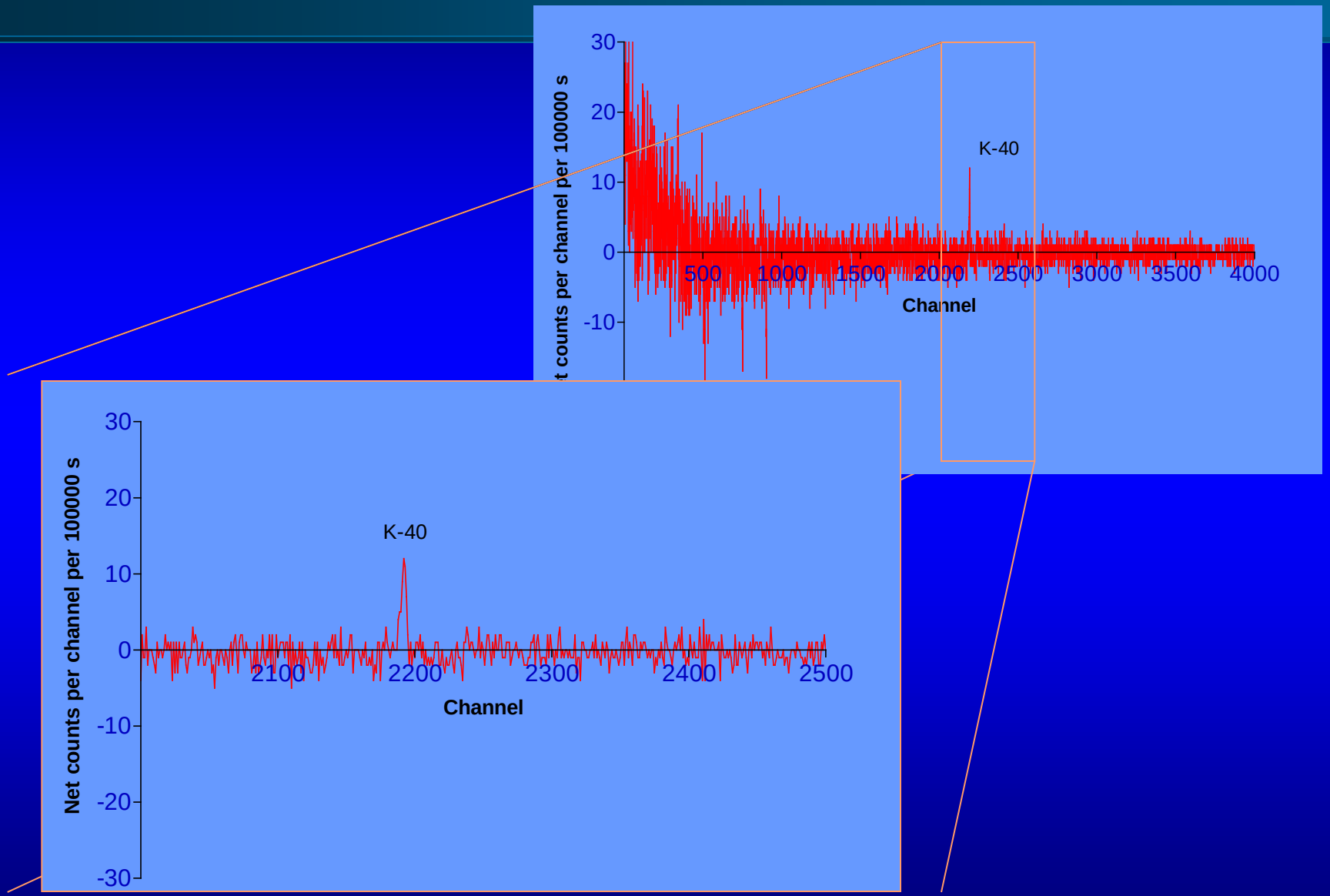
6. (2.) large word producer of copper (silver)

4 chambers (100x15x20)m^3,
depth ~900m
(~2500 m.w.e., temp. ~35^oC),
Salt deposit ~70m, in anhydrate rock

In situ gamma spectra (J.Kisiel et al.., IFUŚ) : Boulby, Gran Sasso, Modane i Sieroszowice



Net gamma spectrum Sieroszowice salt (10.8 days):



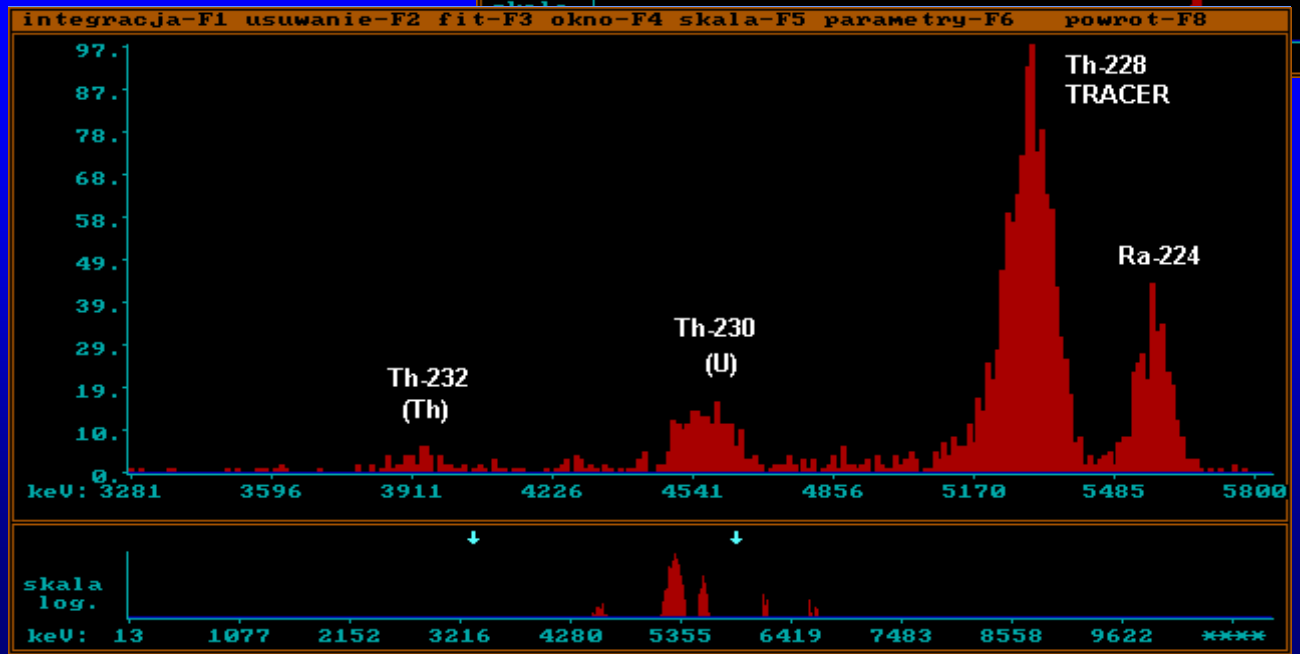
Radiochemical procedure (U+Th)

1. Dissolution and complete mineralization, U-232+Th-228 added
2. Th-228 expected in samples – check for Th equilibrium needed. Additional sample (100 g) taken without tracers added. Blank sample processed as well.
3. Preconcentration of U & Th by $Fe(OH)_3$ co-precipitation at pH 9
4. Separation of U using anion-exchange resin Dowex-1x8 from 9 M HCl
5. Separation of Th using anion-exchange resin Dowex – 1x8 from 8 M HNO_3
6. Preparation of alpha sources by NdF_3 micro co-precipitation

Alpha spectra (Sieroszowice salt, examples:)

U fraction (s.4)

Th fraction (s.2)



Results for alpha emitters [Bq/kg] – Sieroszowice salt:
corrected for blank (~0.02 Bq/kg subtracted)

	SAMPLE No: 1	2	3	4
U series:				
^{238}U	0.40±0.06	0.34±0.05	0.10±0.02	0.14±0.02
^{234}U	0.38±0.06	0.33±0.05	0.14±0.02	0.14±0.02
^{230}Th	0.29±0.05	0.34±0.06	0.10±0.03	0.19±0.03
Mean:	*0.357*	*0.337*	*0.113*	*0.157*

(~0.03 – 0.01 ppm)

Th series				
^{232}Th	0.09±0.03	0.08±0.02	0.03±0.02	0.11±0.02

(~0.03 ppm)

Perspective of SUNLAB

Excellent place, but extra founds needed for infrastructure
Attemps at country scale are continued (A.Zalewska, IFJPAN)