



# Metrology for Radiological Early Warning Networks in Europe

**MetroERM**

**Work Package 1 - status March 2017**

**Dr. Harald Dombrowski**



**EMRP**

European Metrology Research Programme  
► Programme of EURAMET



The EMRP is jointly funded by the EMRP participating countries  
within EURAMET and the European Union

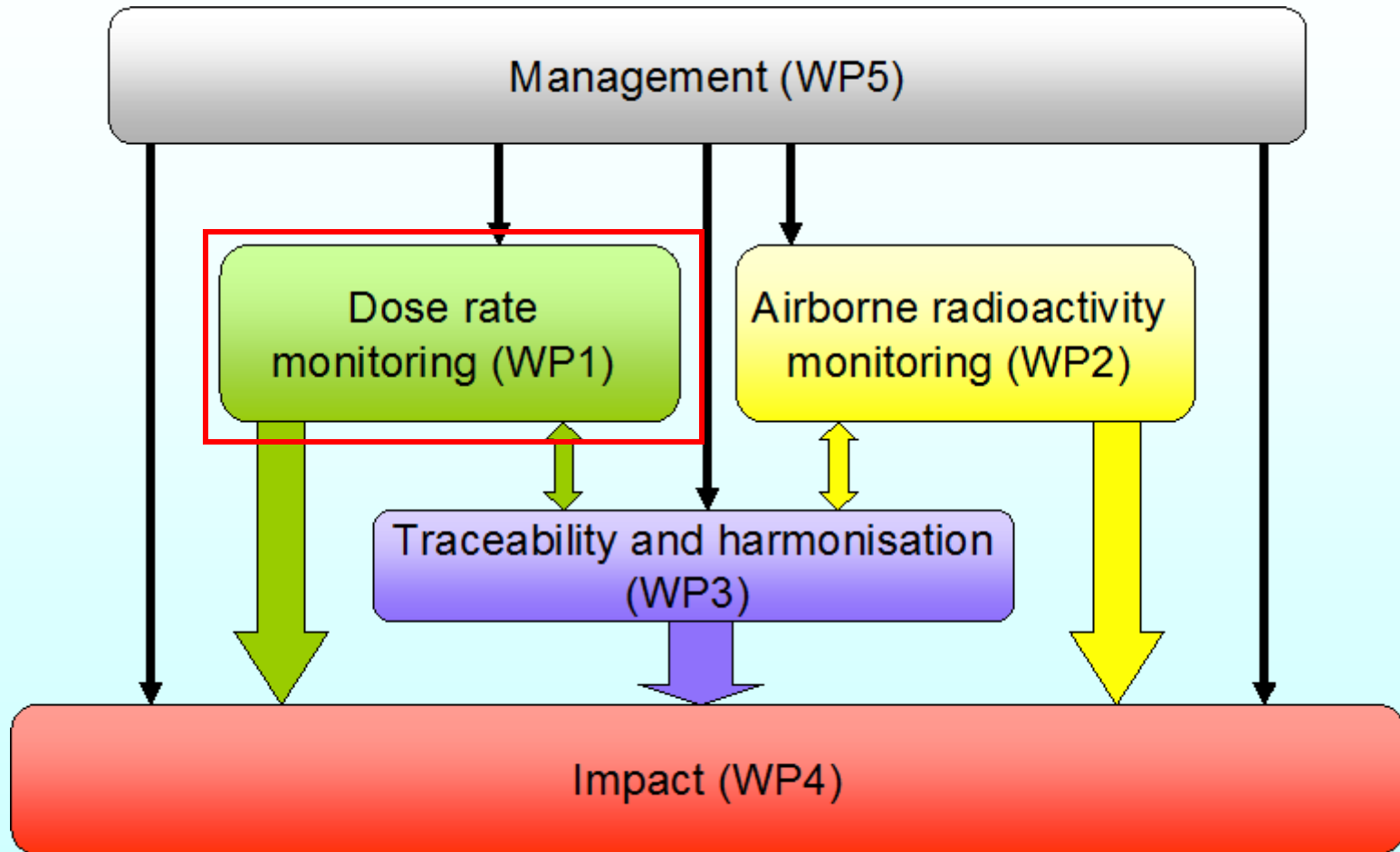


Diagram of the relationships between the work packages of the Joint Research Project (JRP)



## WP1: Dose rate monitoring networks

- 1.1: Review of dose rate monitoring instruments and methods
- 1.2: Development of novel and improved dose rate instrumentation for field-station use
- 1.3: Dose rate and contamination level calculation and validation of spectrometry data
- 1.4: Data analyses of spectrometry data
- 1.5: Background level estimation and correction methods
- 1.6: Influence of radon progeny concentrations on dose rate detectors



## Collaborators:

[PTB \(Physikalisch-Technische Bundesanstalt\)](#),

[CIEMAT \(Centro de investigaciones energeticas, medioambientales y tecnologicas\)](#),

[CMI \(Cesky Metrologicky Institut Brno\)](#),

[ENEA \(Agenzia Nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile\)](#),

[JRC \(Joint Research Centre - European Commission\)](#),

[SCK•CEN \(Studiecentrum Voor Kernenergie\)](#),

[BfS \(Bundesamt für Strahlenschutz\)](#),

[IRSN \(Institut de Radioprotection et de Surete Nucleaire\)](#),

[AUTH \(Aristotle University of Thessalonica\)](#),

[UPC \(Technical University of Barcelona\)](#)



## 1.1: Review of dose rate monitoring instruments and methods

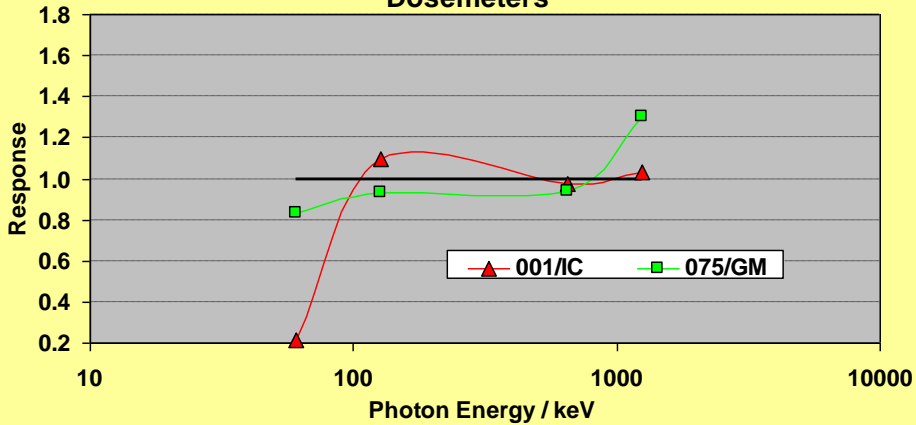
- Questionnaire to obtain information on dose rate measuring systems, measuring techniques and on the data evaluation algorithms circulated
- Evaluation of questionnaire
- Compilation of information on relevant standards, guidelines and recommendations
- Compilation of basic metrological properties of dosimeters, which are needed to calculate corrected net dose rate data (compilation of AIRDOS data)

Dated Mar 2017

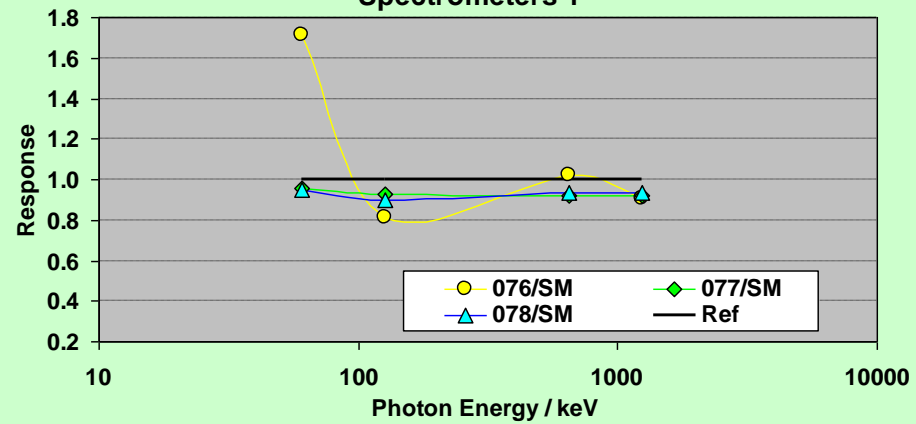




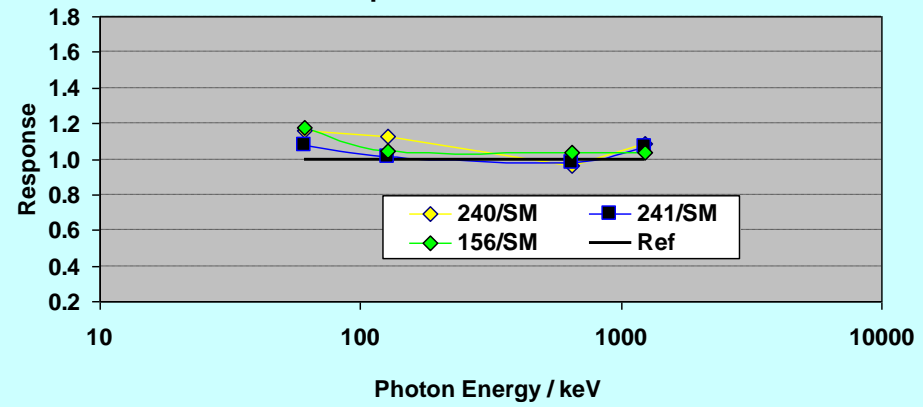
Dosemeters



Spectrometers 1



Spectrometers 2

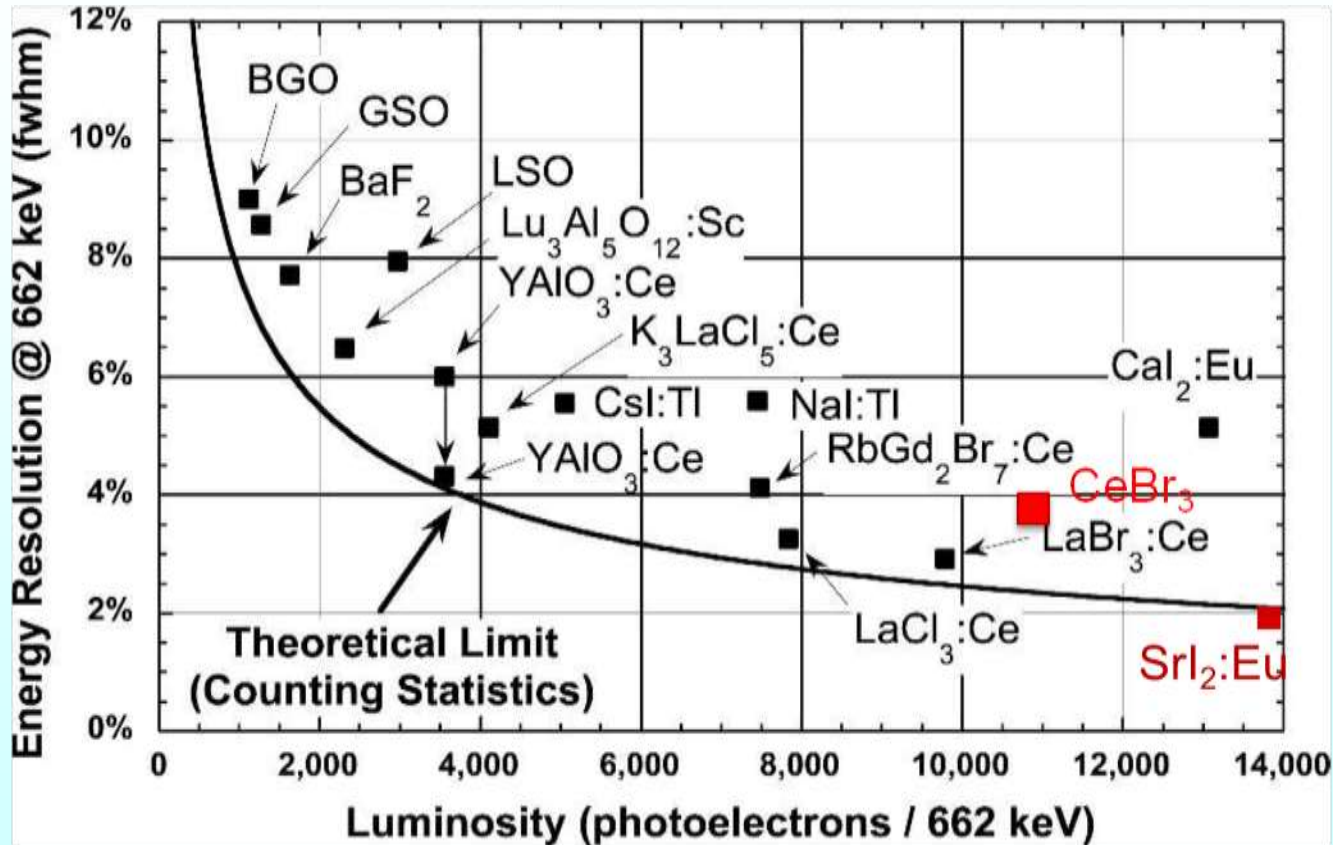




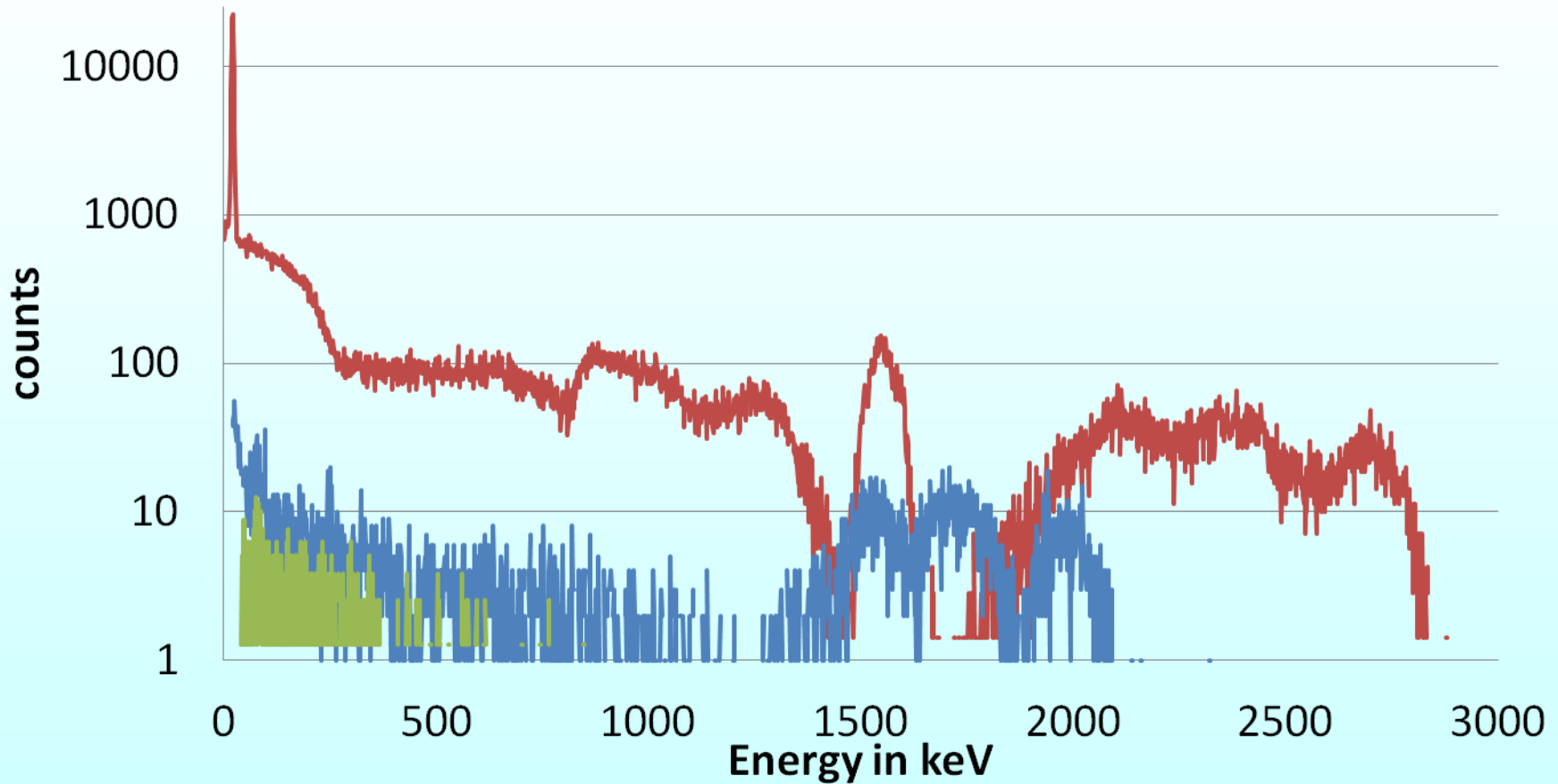
### 1.2: Development of novel and improved dose rate instrumentation for field-station use

- Two new detector systems based on CdZnTe and LaBr<sub>3</sub> designed, assembled and tested (BfS)
- CdZnTe and LaBr<sub>3</sub> detector stabilisation procedures and dedicated internal spectrum analysis procedures developed and tested (BfS, ...)
- Two novel LaBr<sub>3</sub> and Srl<sub>2</sub> scintillation spectrometer systems commissioned (PTB)
- Two novel LaBr<sub>3</sub> and Srl<sub>2</sub> scintillation spectrometer systems compared (PTB) [[paper](#)]





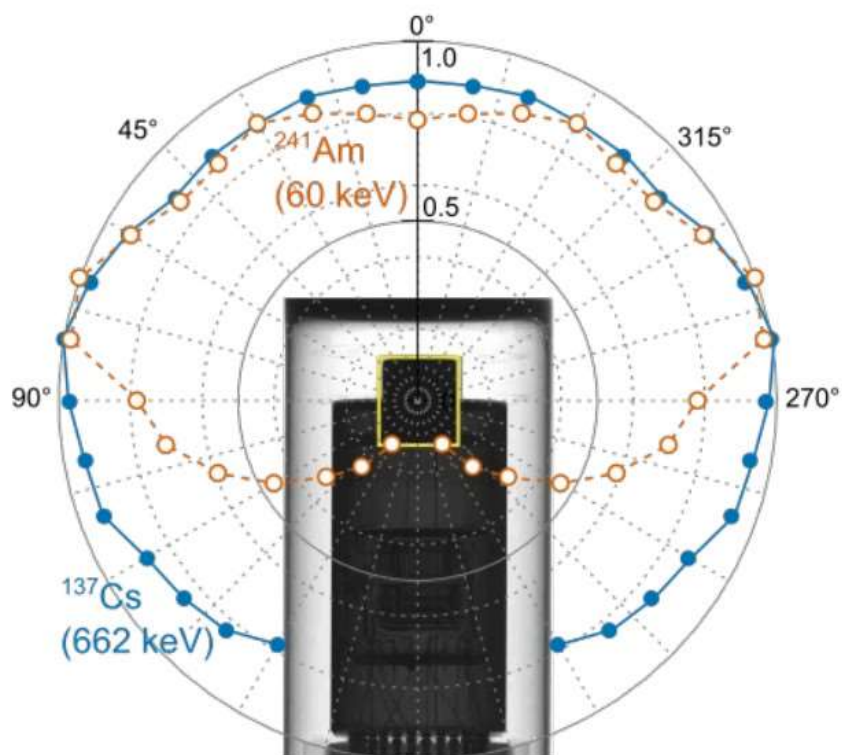
*Nucl. Instrum. Methods Phys. Res. A* 487, W.W. Moses, p. 124



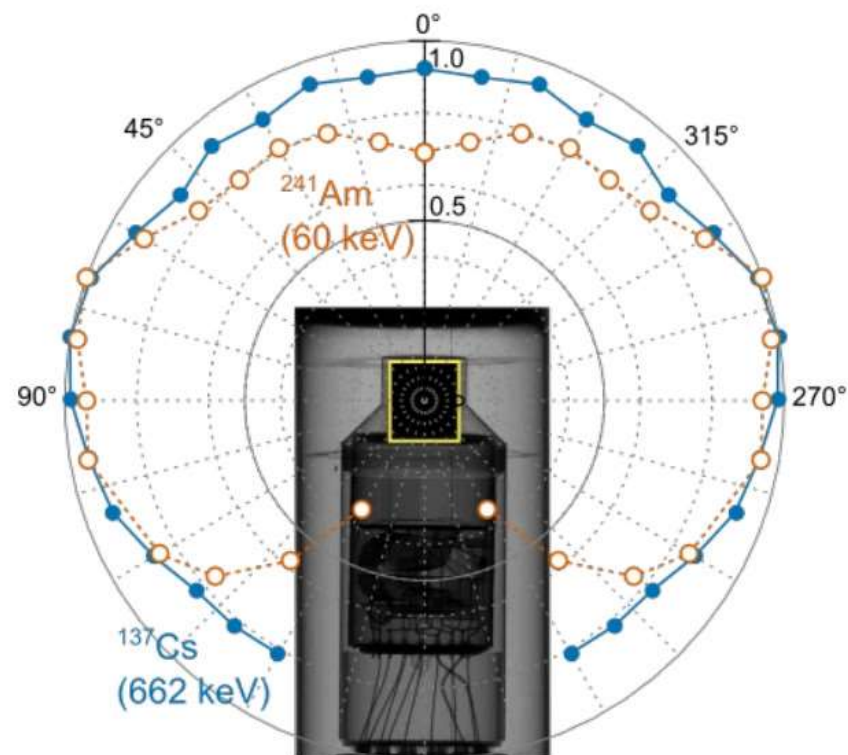
measured at 0.1 nSv/h at PTB UDO II in lead castle for 2 h



## CeBr<sub>3</sub>



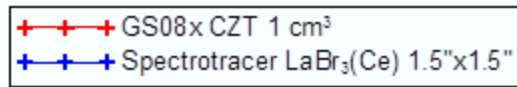
## LaBr<sub>3</sub>



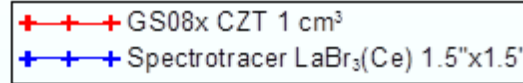
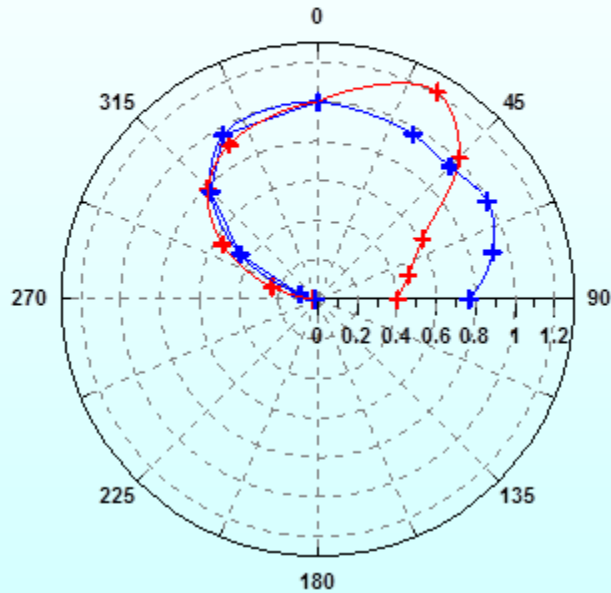


### 1.3: Dose rate and contamination level calculation and validation of spectrometry data

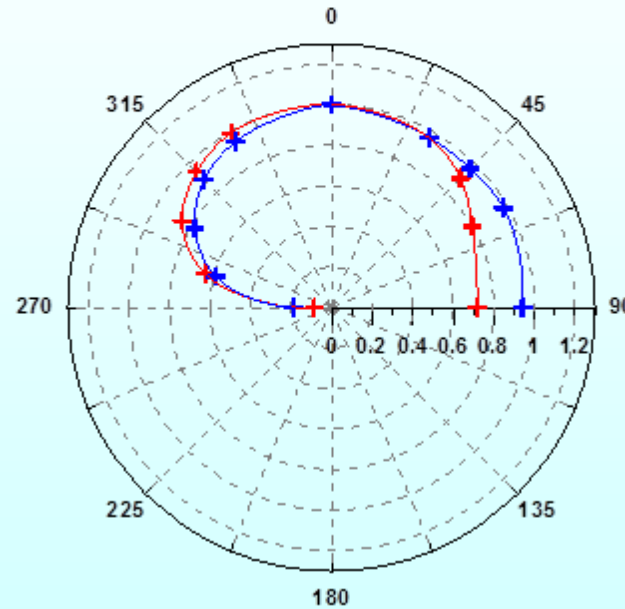
- MC code PENELOPE prepared for investigations on LaBr<sub>3</sub> and CdZnTe detectors and instruction manual on variance reduction written
- Detection forcing incorporated in PENELOPE
- LaBr<sub>3</sub> and CdZnTe novel spectrometer instruments characterised
- New version of MC code DETEFF created including LaBr<sub>3</sub> material data, new sources and new field geometries
- Computer codes for estimating  $H^*(10)$  from LaBr<sub>3</sub> spectra compared (Reg(UPC) + CIEMAT)
- Detector efficiencies for the measurement of activities at the ESMERALDA station and the INTERCAL station determined
- **Paper** on the benchmarking of techniques for  $H^*(10)$  estimation at in-situ stations (UPC)
- Validated software for the calibration of spectrometers for ground-level in-situ measurements developed (SCK•CEN)



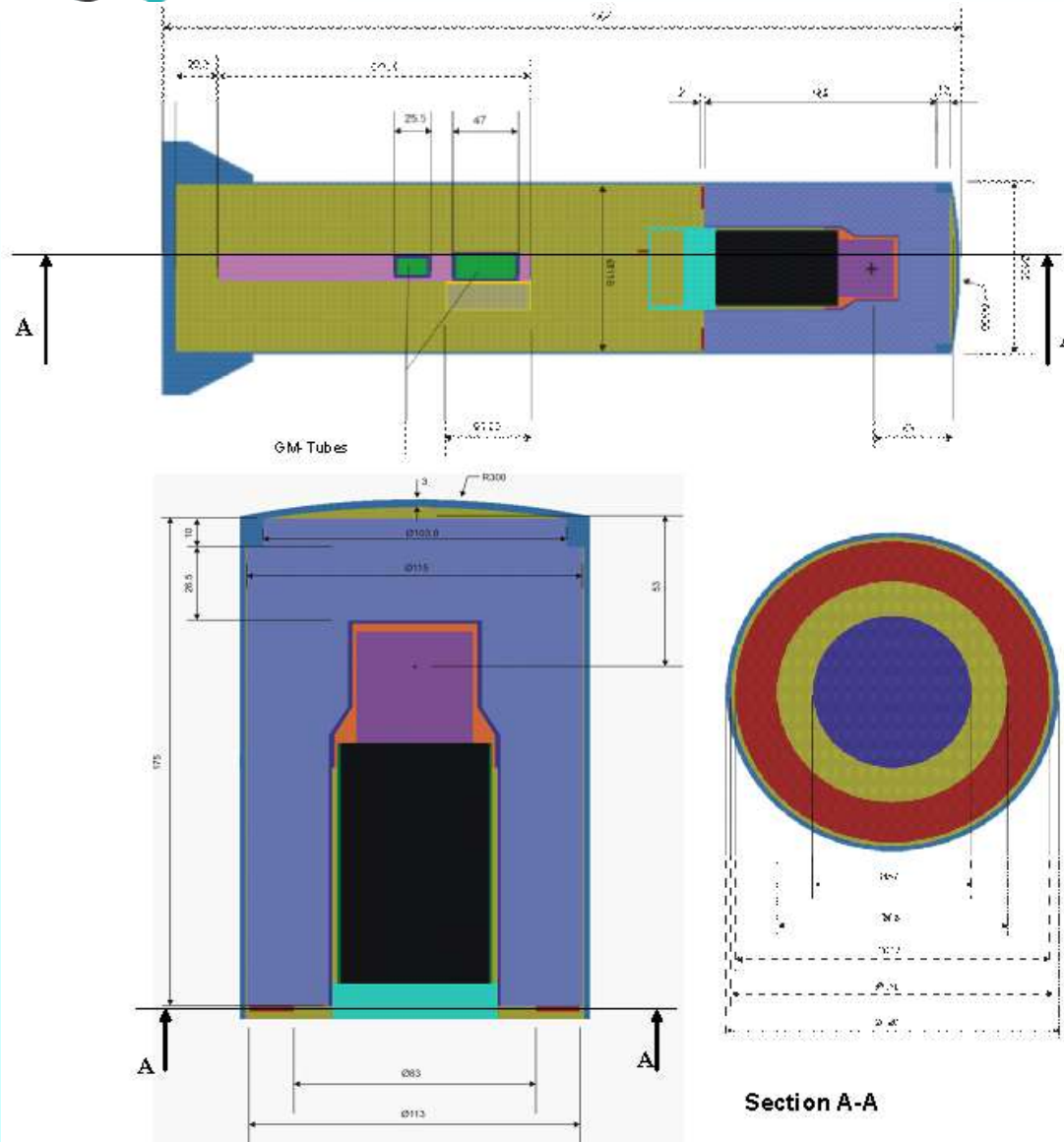
$^{241}\text{Am}$  (59.5 keV)



$^{137}\text{Cs}$  (662 keV)



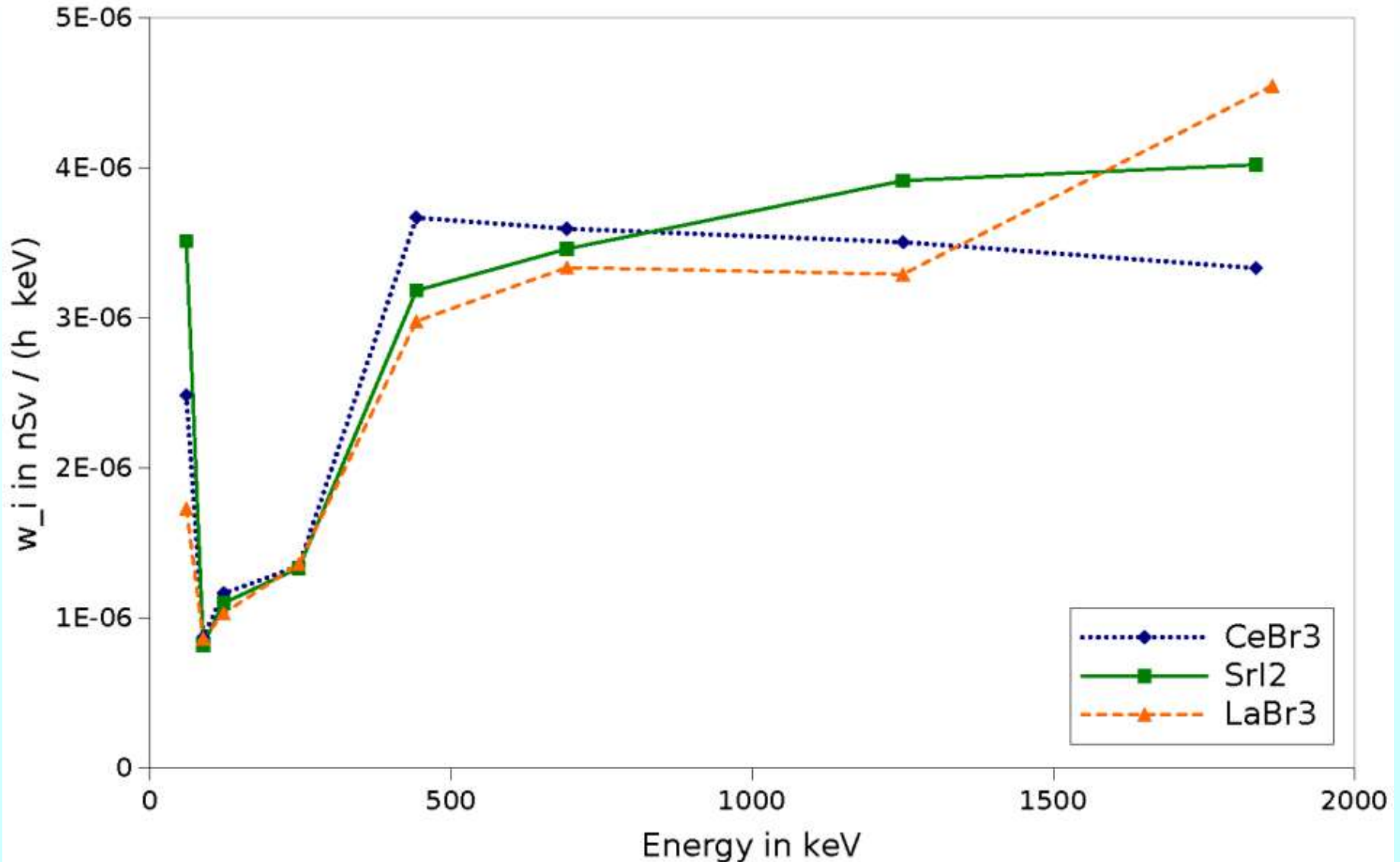
←  
Beam direction



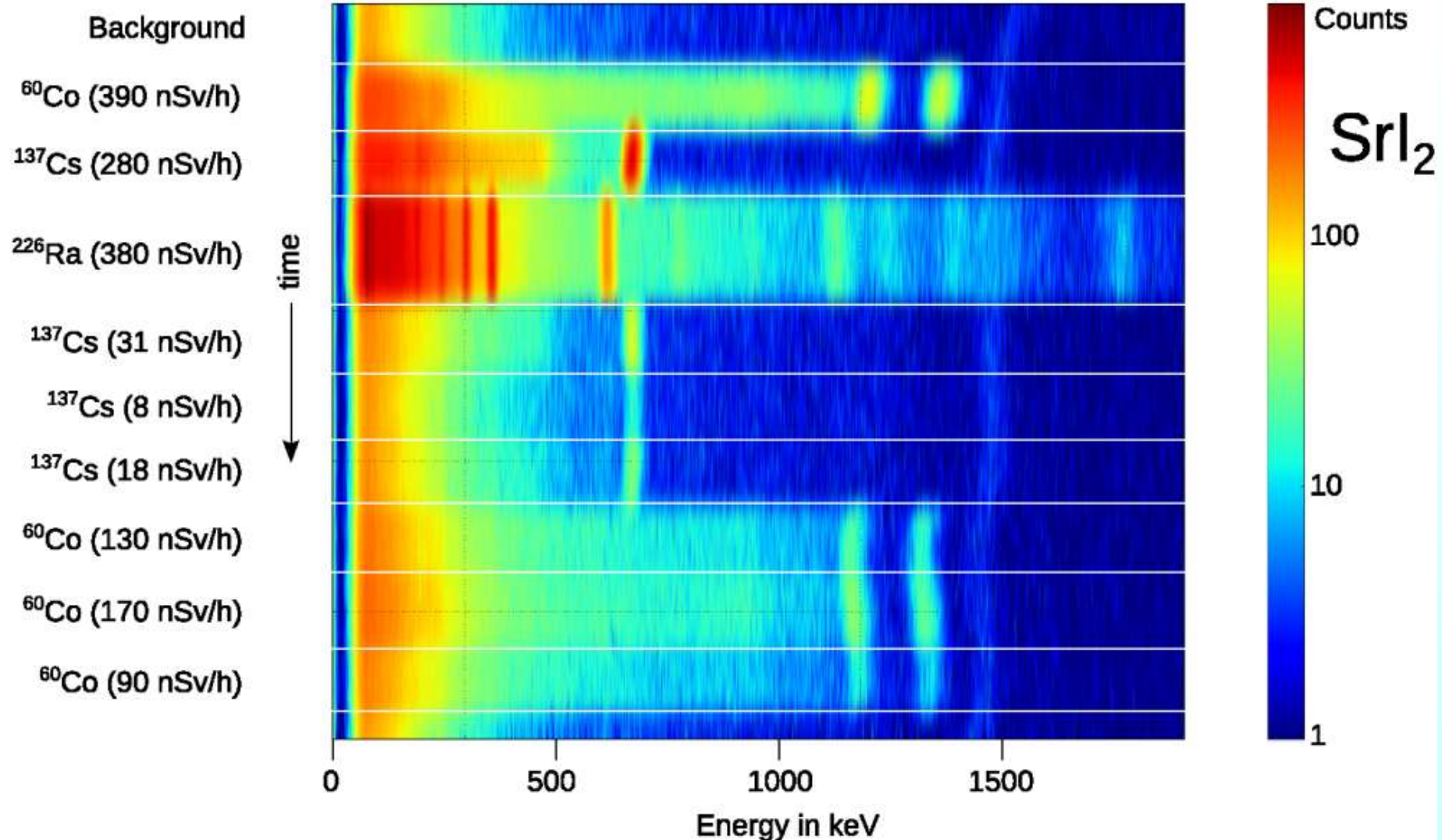


### 1.3: (continued)

- Two  $\text{LaBr}_3$  and  $\text{SrI}_2$  scintillation spectrometers characterised to derive conversion factors between spectra and area dose rate values (PTB)
- Characteristics of two scintillation spectrometers  $\text{LaBr}_3$  and  $\text{SrI}_2$  experimentally verified
- Response of two different scintillation spectrometers to secondary cosmic radiation determined
- Realistic spectra produced by  $^{131}\text{I}$  and  $^{137}\text{Cs}$  in  $\text{LaBr}_3$  and  $\text{CdZnTe}$  instruments simulated (REG(UPC))
- Two methods for calculating  $H^*(10)$  from  $\text{LaBr}_3$  spectra incorporated in a new version of the DETEFF MC code
- User-friendly Monte Carlo code for calculating  $H^*(10)$  rate from  $\text{LaBr}_3$  spectra developed (CIEMAT)









## 1.4: Data analyses of spectrometry data

- Questionnaire on practices and needs related to gamma spectra analyses techniques used by network monitoring stations developed and circulated
- Responses to questionnaire evaluated
- Database installed for integration of and access to heterogeneous spectroscopy data

The screenshot displays the Winssi web interface. At the top, there are logos for IRSN (Institut de Radioprotection et de Sûreté Nucléaire), EURAMET, EURADOS, and STUK. Below the logos, the text reads "Welcome to Winssi - based on Linssi" and "EURADOS WORKING GROUP 3 - GAMMA SPECTROMETRY SUB GROUP". The main content area shows the "LINSSI\_EURADOS\_METRO\_ERM database" and a table titled "6 MISSIONS". The table has two columns: "Mission Id" and "Period". Below the table, there is a section for "7 SITES" and a footer indicating the database is "linssi\_eurados\_metro\_erm" with a "Change" button.

6 MISSIONS	
Mission Id	Period
IRSN_FRANCHE_COMTE_2015_1	07/09/2015 00:00 ... 11/09/2015 00:00
METRO_ERM_ENV57_INTERCOMP_PTB_2015	15/06/2015 01:00 ... 18/06/2015 23:00
UPC_CAMPUS_SUD_MONITORING_20150401	01/04/2015 00:00 ... 01/06/2015 00:00
UPC_LCD_2015_SEM1	05/02/2015 00:00 ... 22/05/2015 00:00
IRSN_ARGOS_IRRADIATIONS_20140919	19/09/2014 07:00 ... 16/10/2014 23:00
IRSN_CREA_ELBEUF_20141505	15/05/2014 12:00 ... 30/07/2014 12:00

7 SITES

Database: linssi\_eurados\_metro\_erm



## Long-term measurements in reference stations (2016)

ESMERALDA-CIEMAT (Madrid)

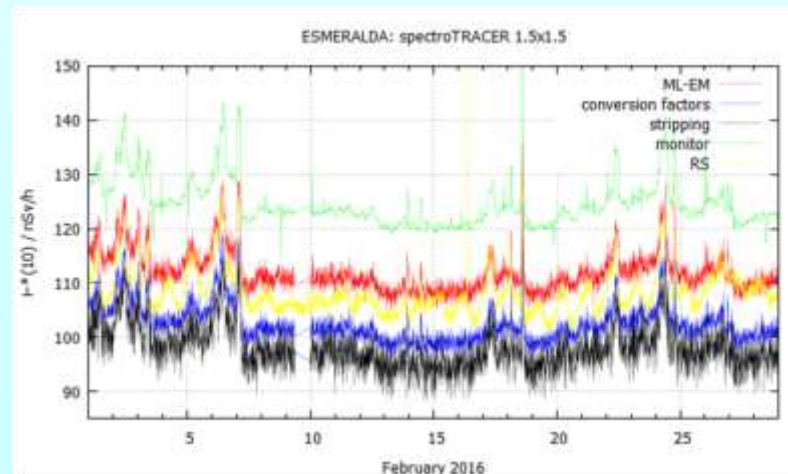


INTERCAL-Bfs (Schauinsland)



## 1.5: Background level estimation and correction methods

- Contribution of the different background sources for the detectors at CIEMAT stations determined and correction methods developed
- Different components of the natural radiation assessed and methods described to minimise background effects





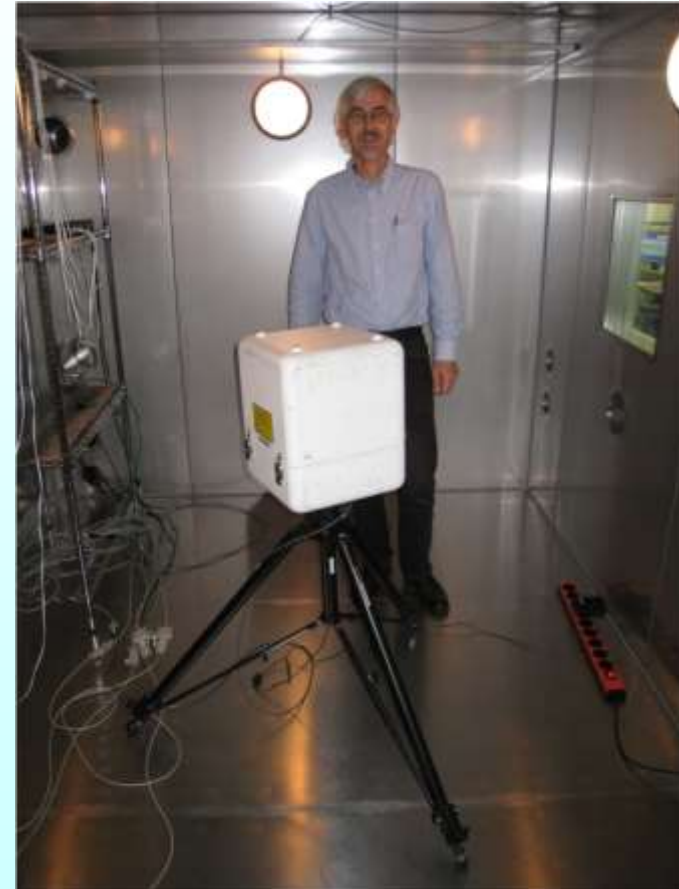
### 1.5: (continued)

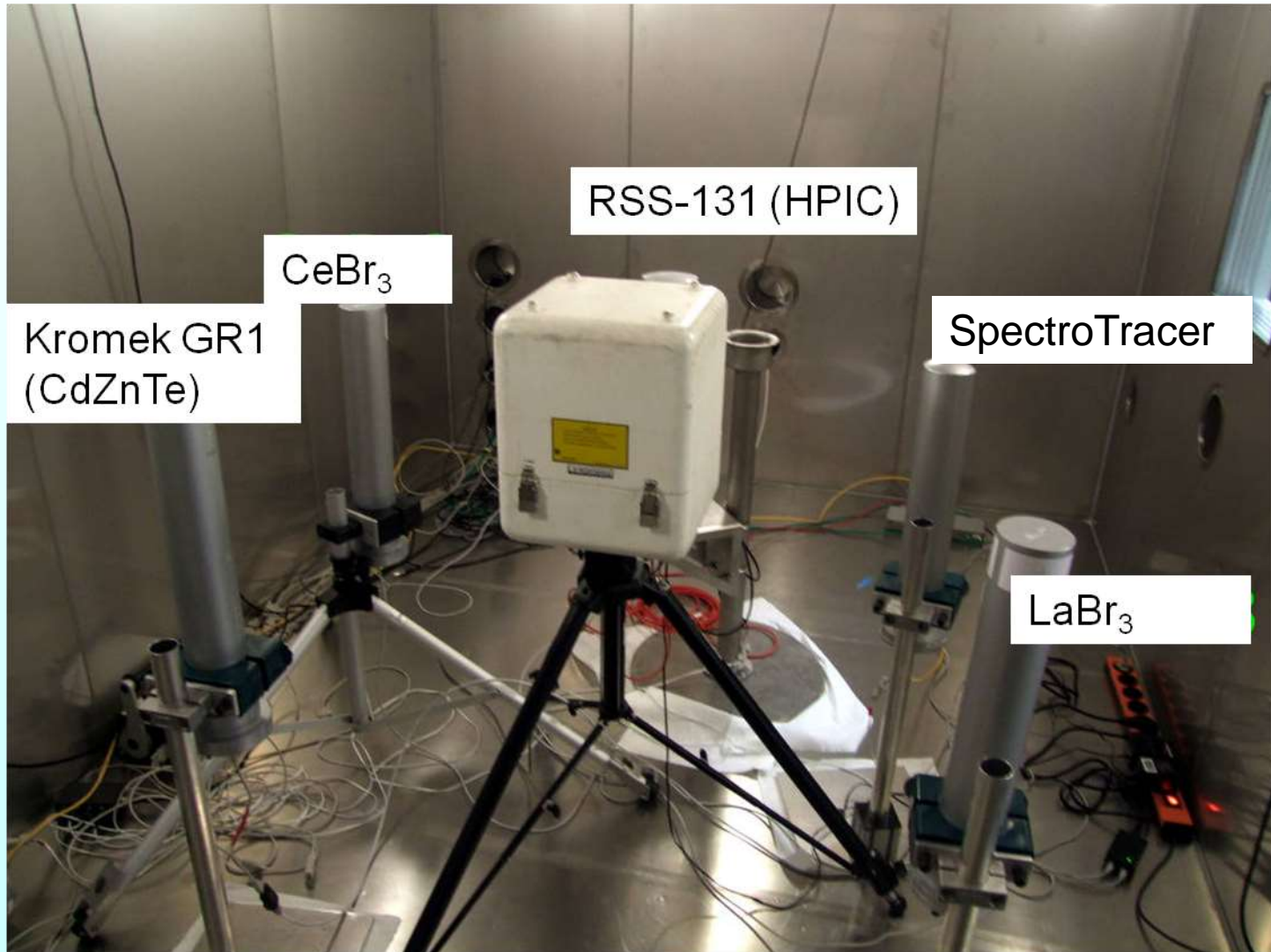
- Site characterisation methods and corrective procedures developed (BfS)
- Signal processing methods for the time series analysis of the long-term dose rate measurements described (REG(AUTH))
- **Paper** on the analysis of a time series of 26 years of daily gamma dose rate measurements using a NaI(Tl) detector
- Dose rate data of Reuter-Stokes high pressure chambers in combination with gamma-ray spectra determined
- Response of Reuter-Stokes high pressure chambers to terrestrial and cosmic radiation evaluated in comparison with spectroscopic data and a **paper** submitted
- Report on estimation of area dose rate due to sky shine effect at the Cosmic radiation site of PTB by Monte Carlo simulations



### 1.6: Influence of radon progeny concentrations on dose rate detectors

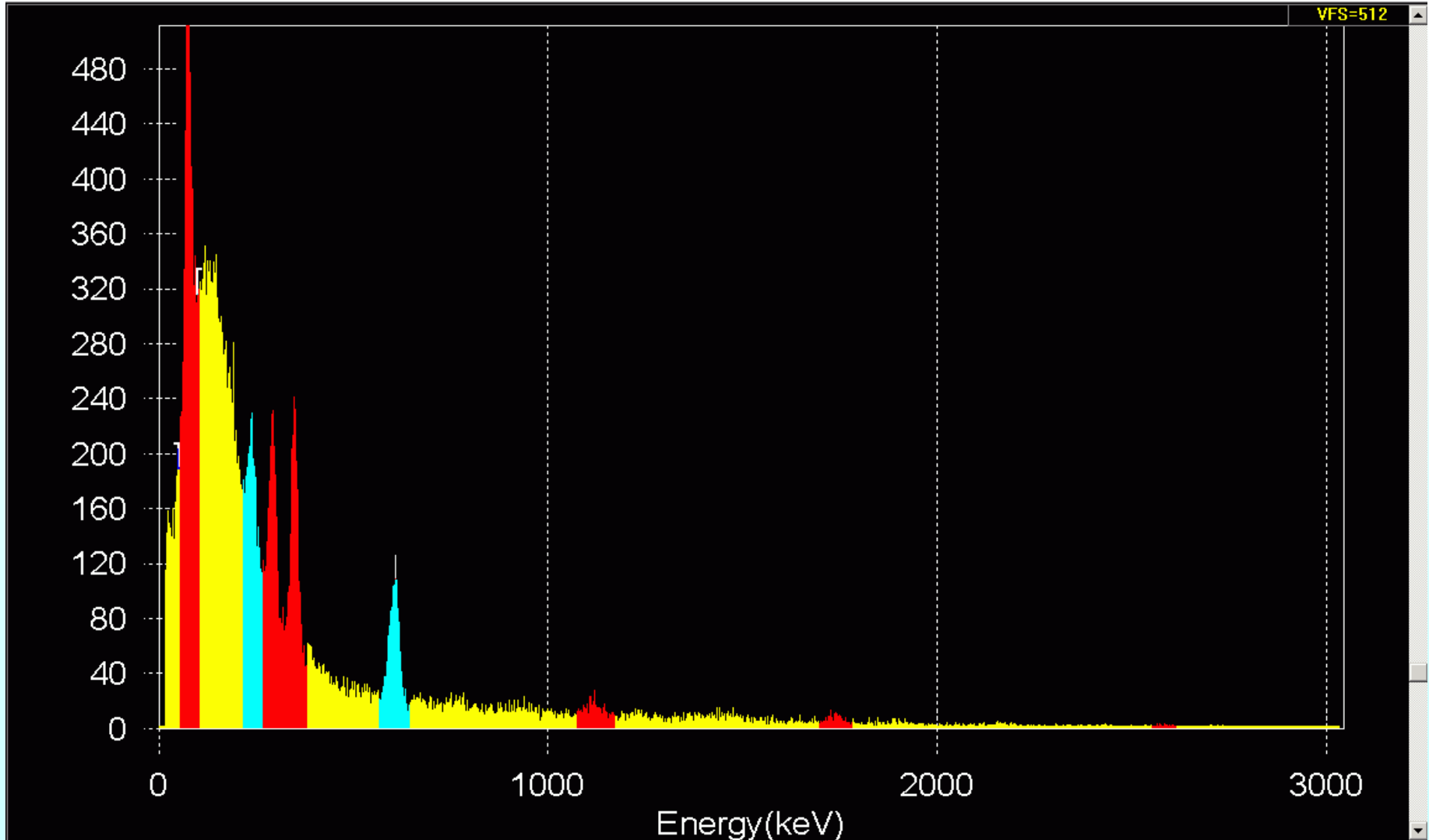
- Response of dose rate detectors to activity concentrations and temperature in the radon reference chamber experimentally determined - Report (PTB, REG(UPC))
- **Paper** on the influence of radon (gas and progeny) on the ambient dose equivalent rate measured at the reference station ESMERALDA
- **Paper** on the response of  $\text{LaBr}_3$  and  $\text{CdZnTe}$  gamma spectrometry instruments to radon progeny concentrations in known reference atmospheres evaluated experimentally and using MC simulations







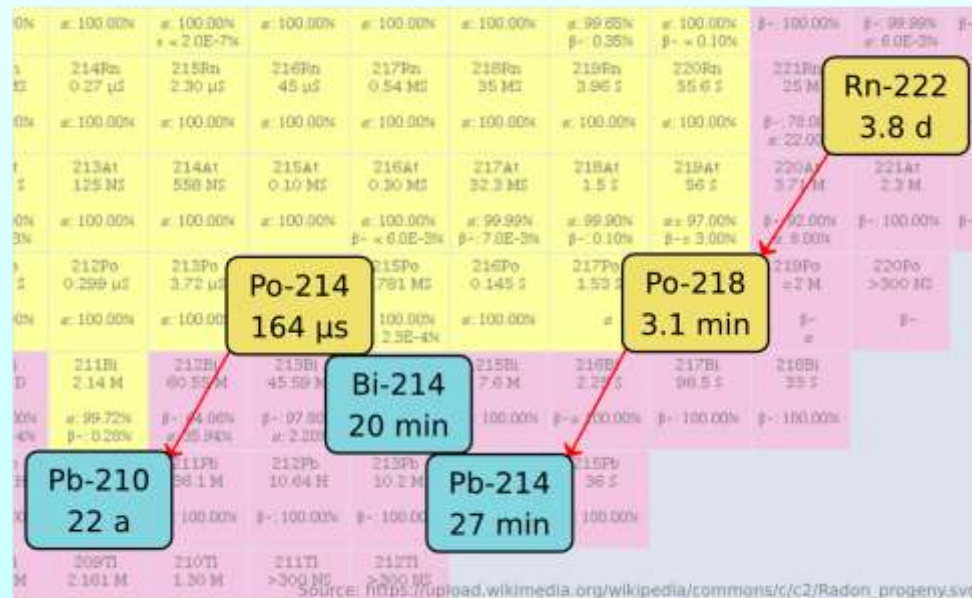
# CrBr<sub>3</sub> spectrum at PTB's radon chamber





## 1.6: (continued)

- Time dependency of soil radon concentrations, radon progeny in air, gamma dose rates and radon exhalation rates measured and MC simulations performed (REG(AUTH))
- **Paper** on the influence of soil radon and air radon progeny concentrations on dose rate detectors submitted







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**MetroERM slogan (?):  
Success stories don't happen by chance!**



# The end of this talk

