EMRP
European Metrology Research Programme
Programme of EURAMET

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

MetroERM
radiological
early warning

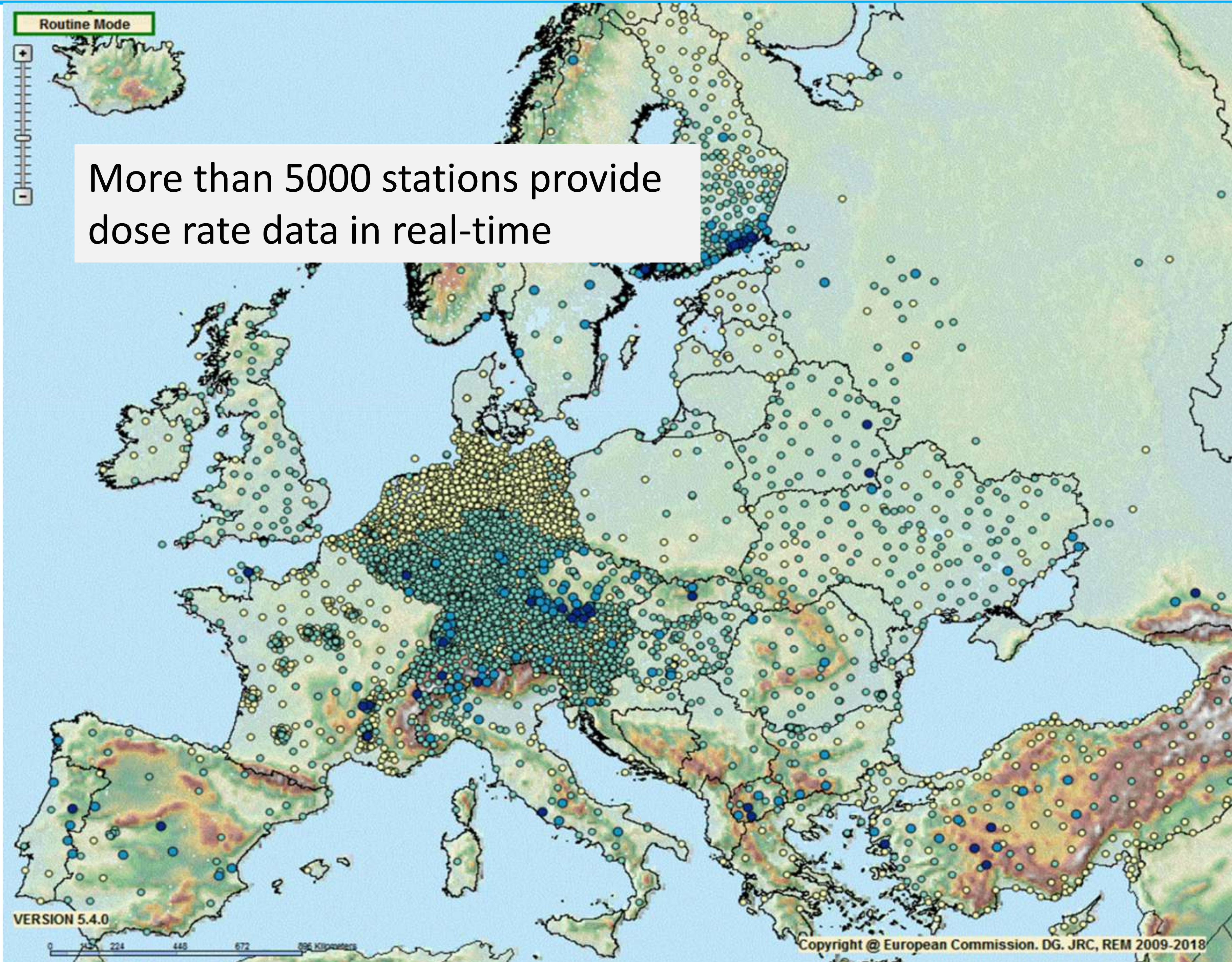
Metrology for radiological early warning networks in Europe

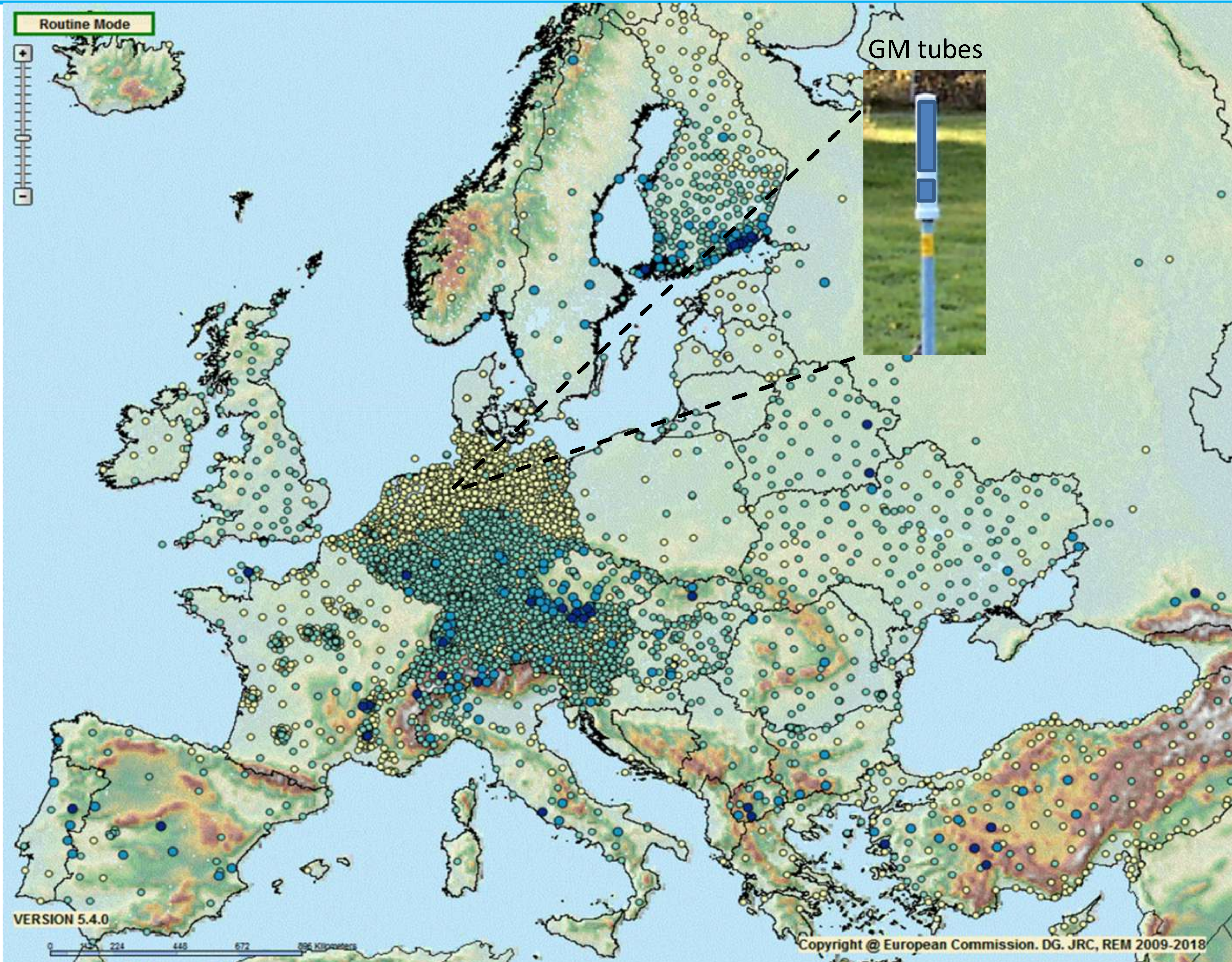
(ENV57 „MetroERM“)

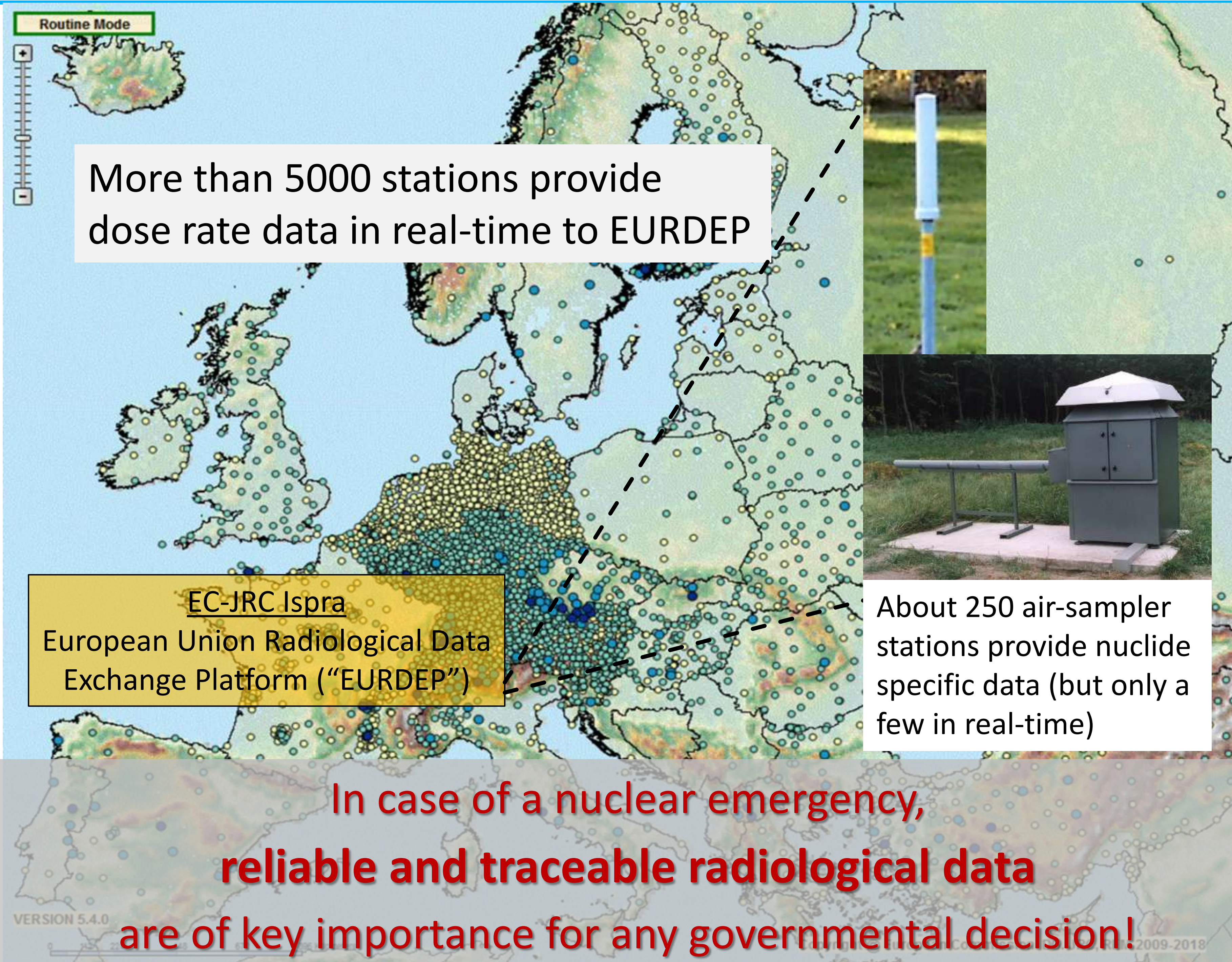
June 2015 - May 2017

Stefan Neumaier, PTB (MetroERM coordinator)

More than 5000 stations provide dose rate data in real-time




Routine Mode
GM tubes
VERSION 5.4.0
0 224 448 672 896 Kilometers
Copyright @ European Commission. DG. JRC, REM 2009-2018



More than 5000 stations provide dose rate data in real-time to EURDEP

About 250 air-sampler stations provide nuclide specific data (but only a few in real-time)

<u>EC-JRC Ispra</u>
European Union Radiological Data Exchange Platform ("EURDEP")

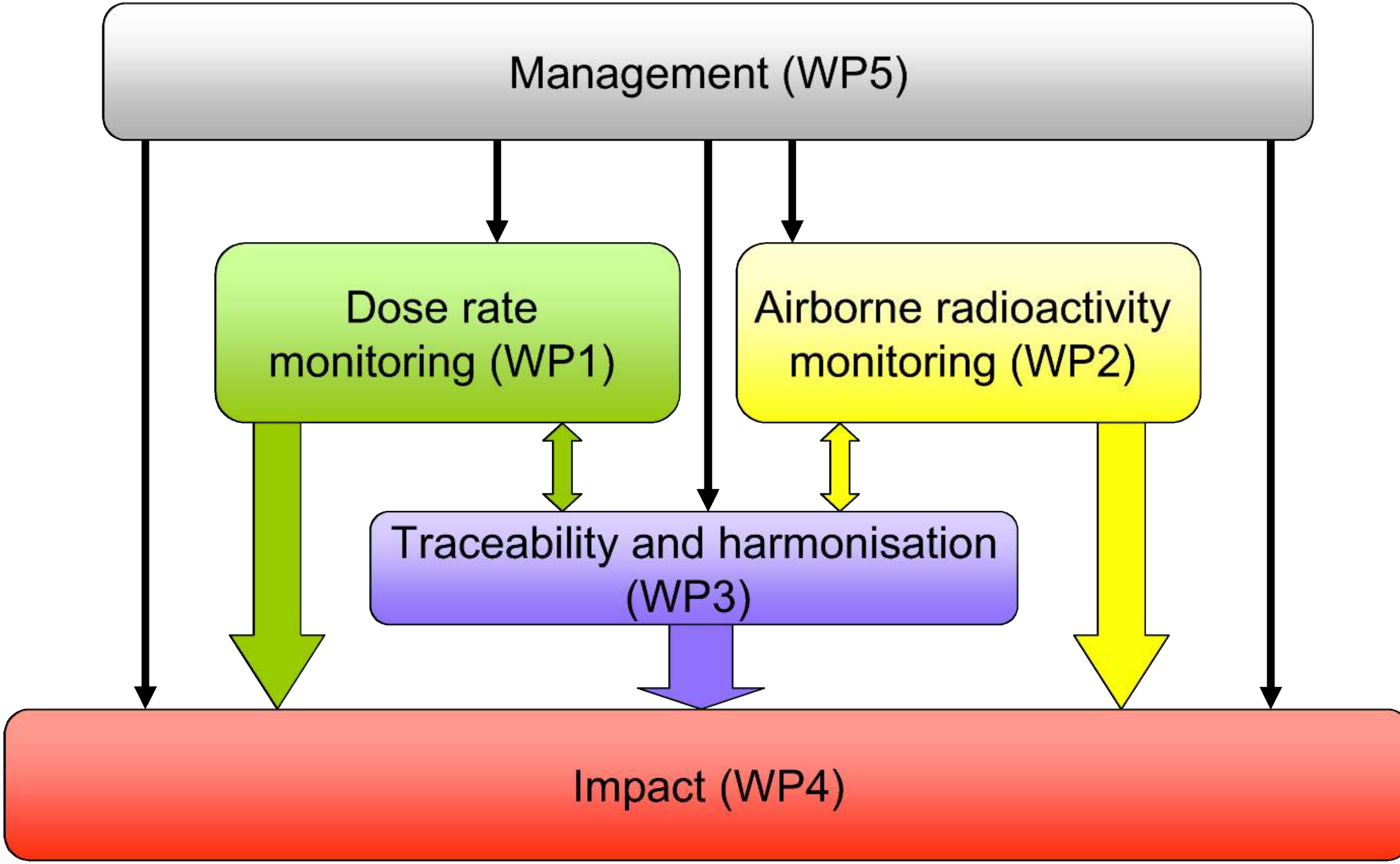
In case of a nuclear emergency,
reliable and traceable radiological data
are of key importance for any governmental decision!

Objectives of MetroERM

to

- harmonise dose rate and airborne radioactivity monitoring
- develop novel / improved instrumentation for field station use
- develop traceable calibration procedures and reference materials
- validate detection principles
- improve the metrological infrastructure in Europe

MetroERM: Work package structure



MetroERM consortium

17 partner institutions from 11 European countries

10 NMI/DI: PTB, CMI, NPL, TAEK;
CEA, CIEMAT, ENEA, IFIN-HH, JSI, SCK·CEN

EC-JRC: Ispra, Geel

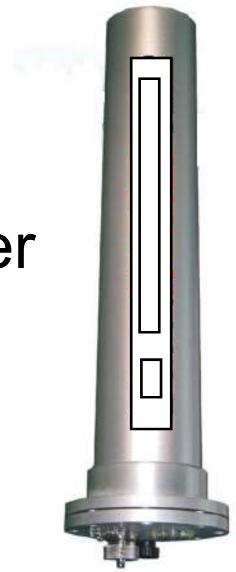
2 unfunded: BfS, IRSN

3 Researcher Excellence Grants: AUTH, UPC, NUVIA

Dosimetry systems for ERM*

Present state of the art

Geiger-Muller counters



VS.

A new generation of „spectro-dosimeters“

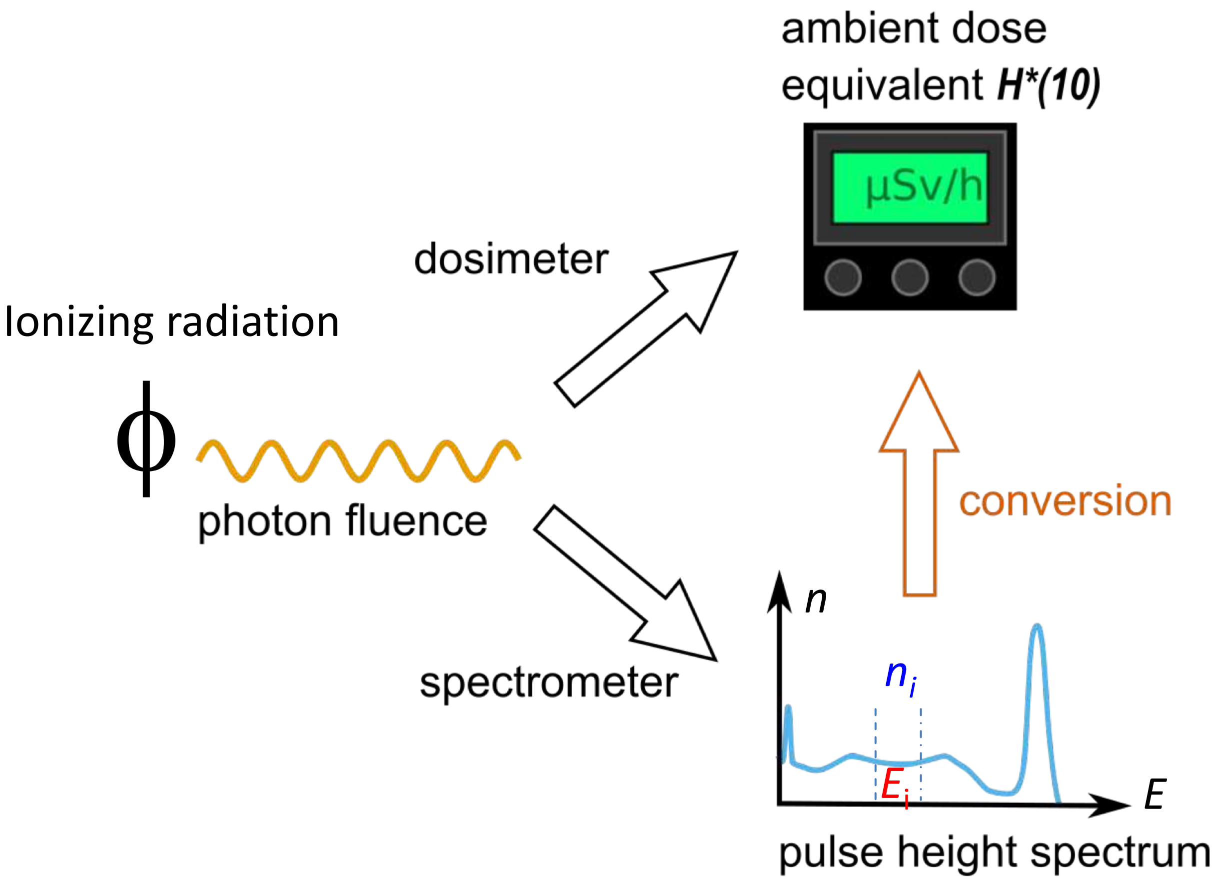
Robust scintillation-detectors with good energy resolution: $LaBr_3$, $CeBr_3$, SrI_2

- No energy and no nuclide specific information
- Medium sensitivity

- Spectra with detailed energy and nuclide specific information
- High sensitivity

*ERM = Environmental Radiation Monitoring

Dose determination from pulse height spectra of quasi spherical spectrometers



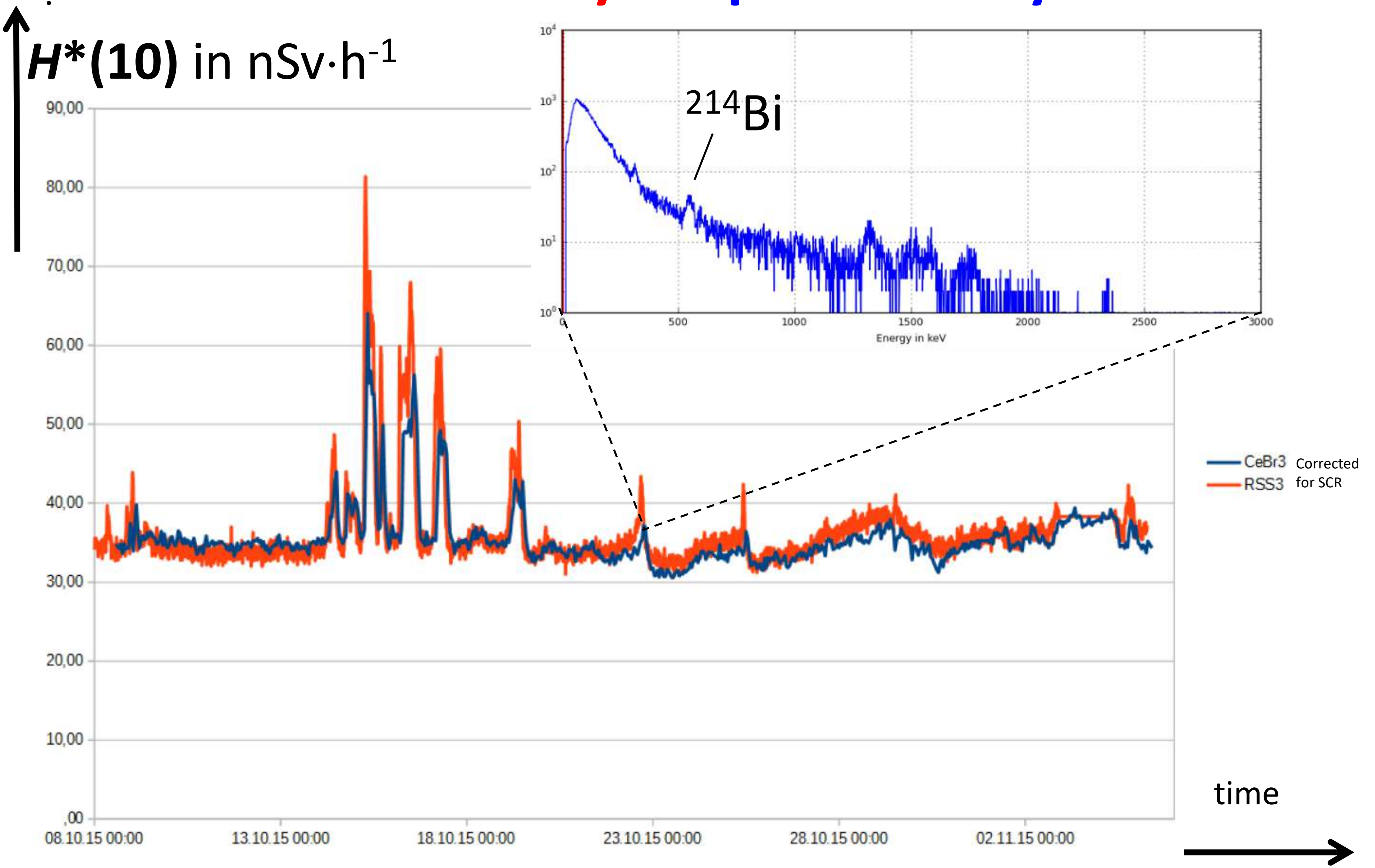
Various puls height to dose conversion methods:

- Spectrum deconvolution by stripping
- Spectrum deconvolution using a maximum entropy approach
- Photopeak to dose conversion (not used by MetroERM)
- ....
- Application of conversion factors w_i

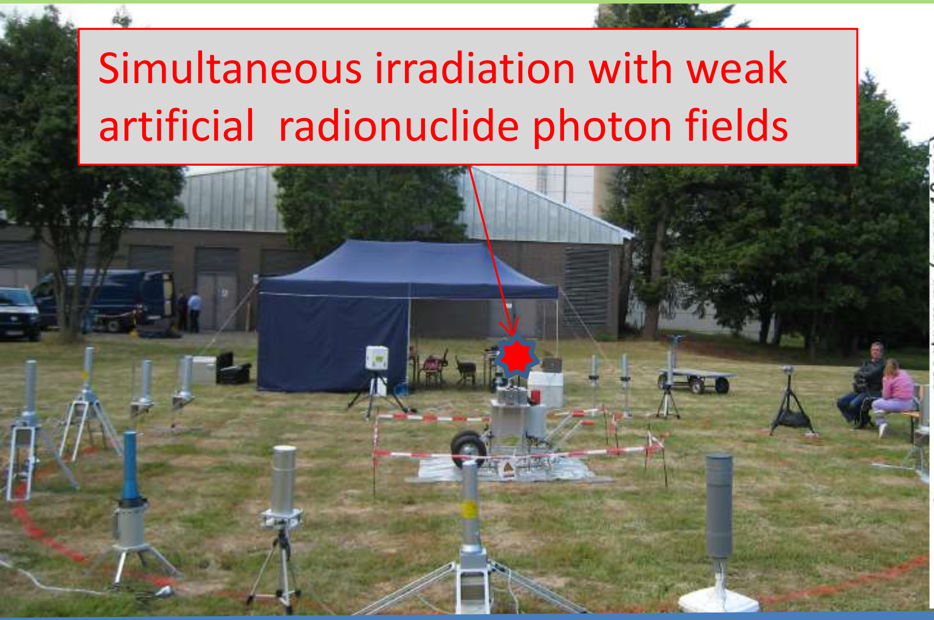
$$H^*(10) = w_1 \cdot E_1 \cdot \boldsymbol{n_1} + w_2 \cdot E_2 \cdot \boldsymbol{n_2} + \ldots + w_Z \cdot E_Z \cdot \boldsymbol{n_Z}$$

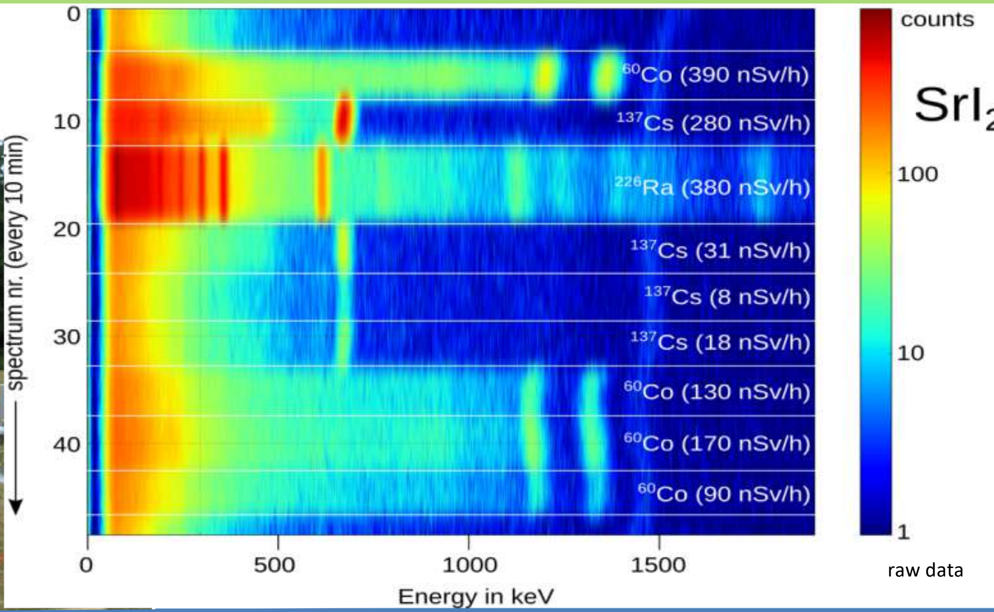
w_i = pulse height to dose conversion factors, derived experimentally or by MC methods

External dose rate measurements: dosimetry vs spectrometry



Intercomparison of spectro-dosimetry systems





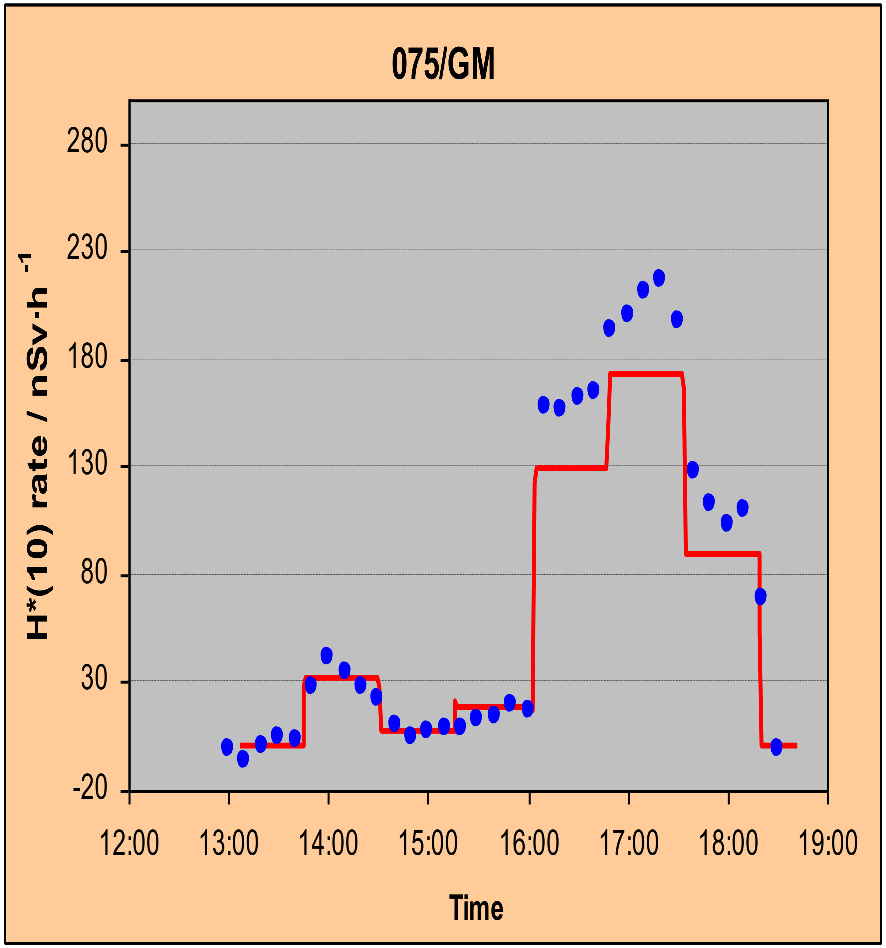
Secondary cosmic radiation

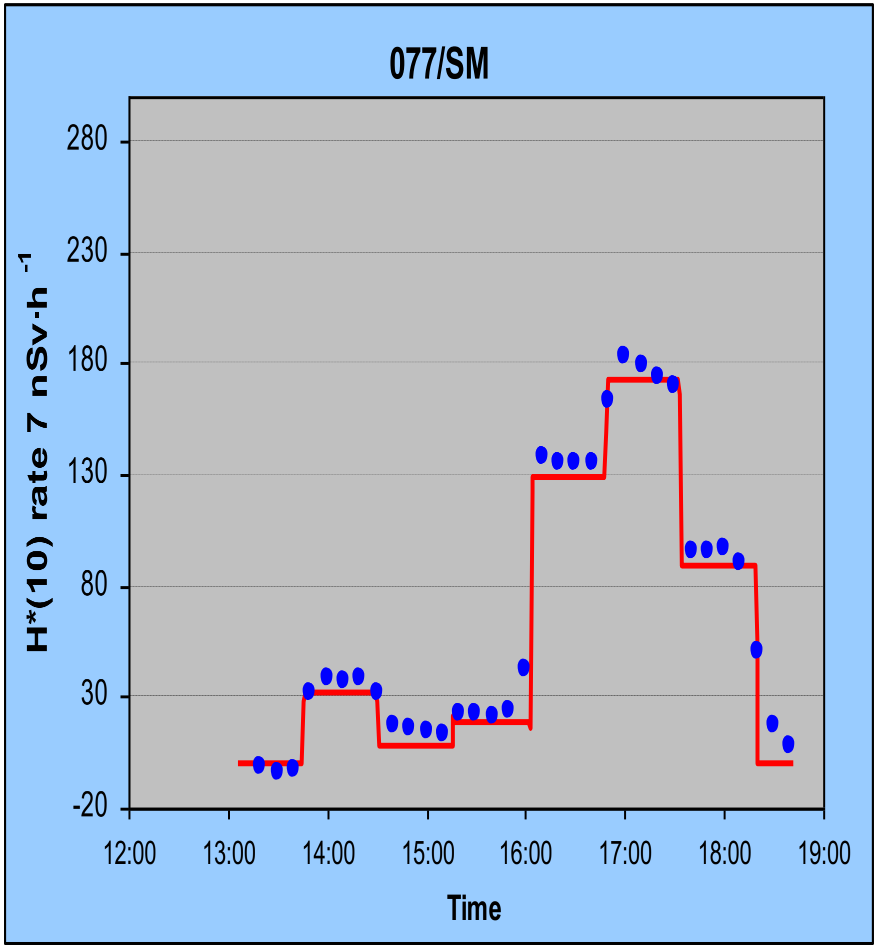
Calibration facility
deep underground (UDO II)

Measurement of plume profiles*

GM counter **vs** $\mathbf{LaBr_3}$-spectrometer

(reference curve in red)

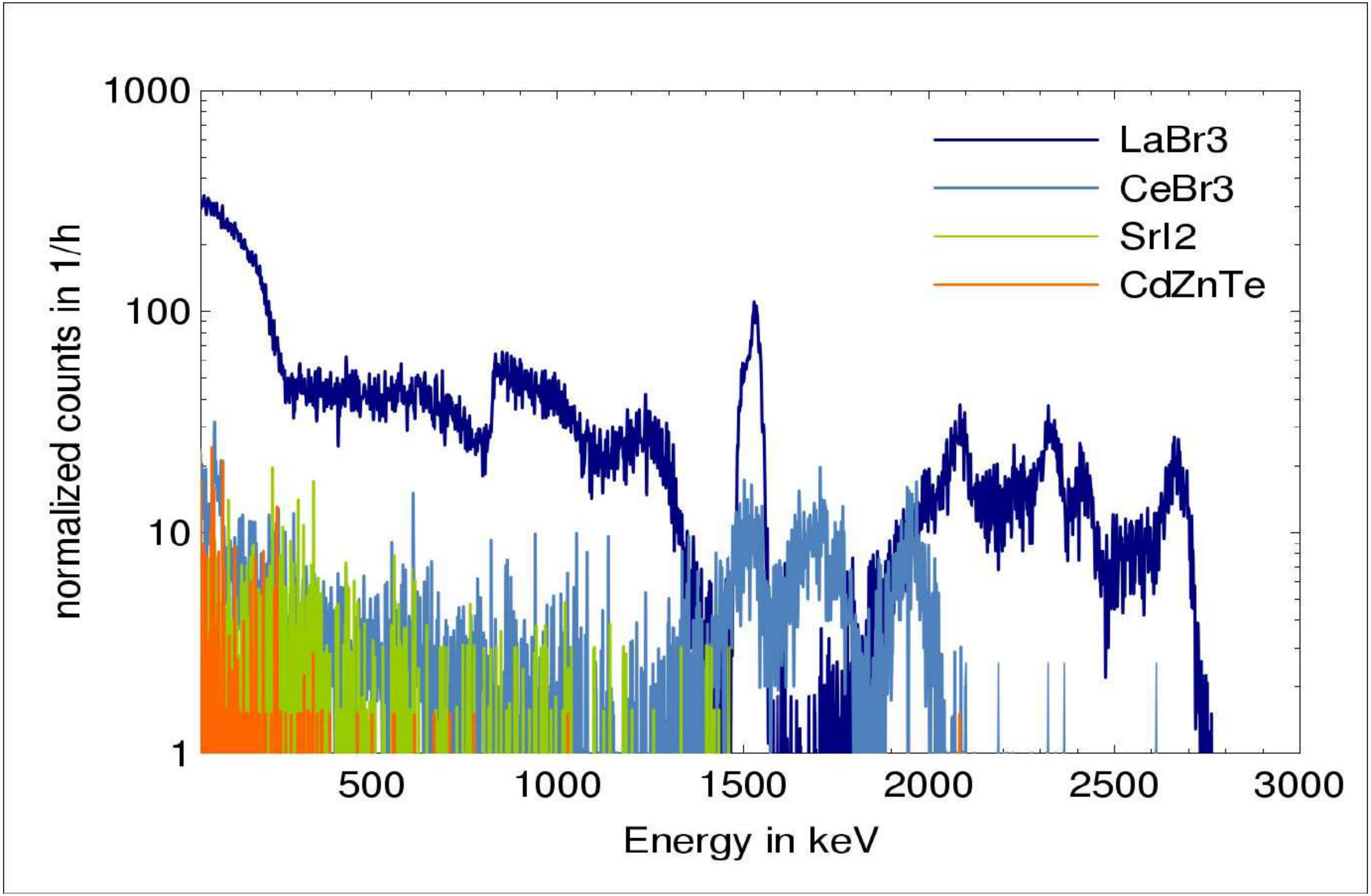




* „natural background” subtracted

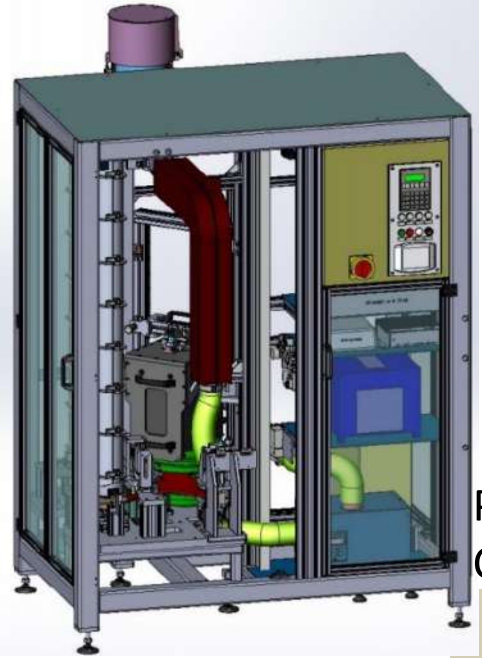
Inherent background of different detector types

measured in a lead castle in PTB's underground laboratory UDO II



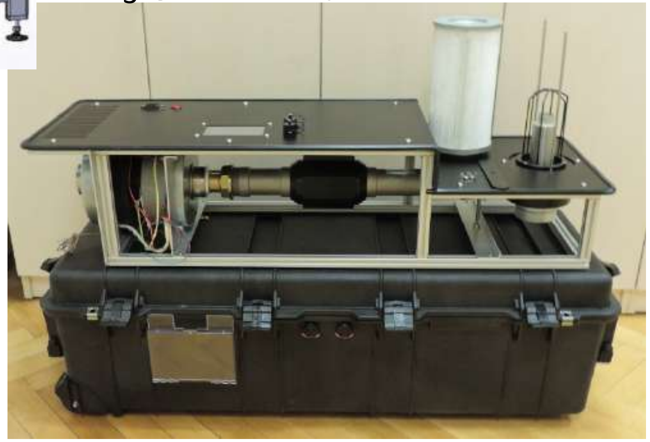
Achievements WP2:

- Novel air-samplers for airborne radioactivity monitoring
- Best practice guides for calibration and operation
- New and more rapid radiochemical techniques for analysis of aerosol samples

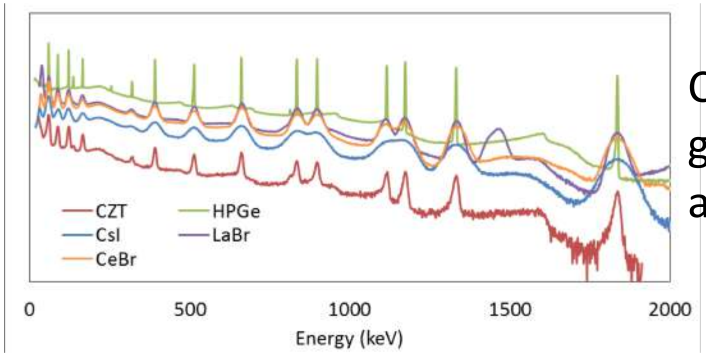


Automated air-sampler with HPGe- gamma spectrometer (CMI & REG(NUVIA))

Portable air-sampler with in-situ $CeBr_3$ gamma spectrometer (IJS)



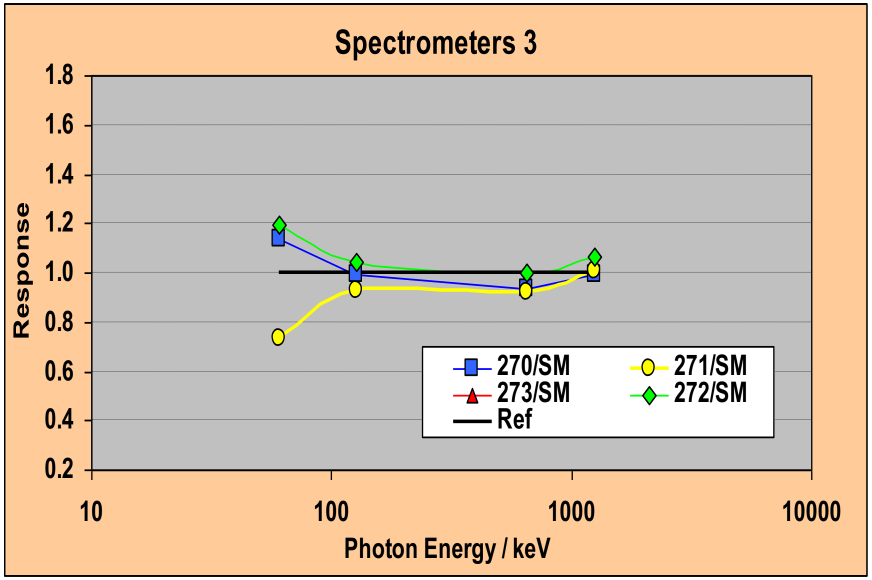
Continuous air monitor with in-situ HPGe-gamma spectrometer (CIEMAT)

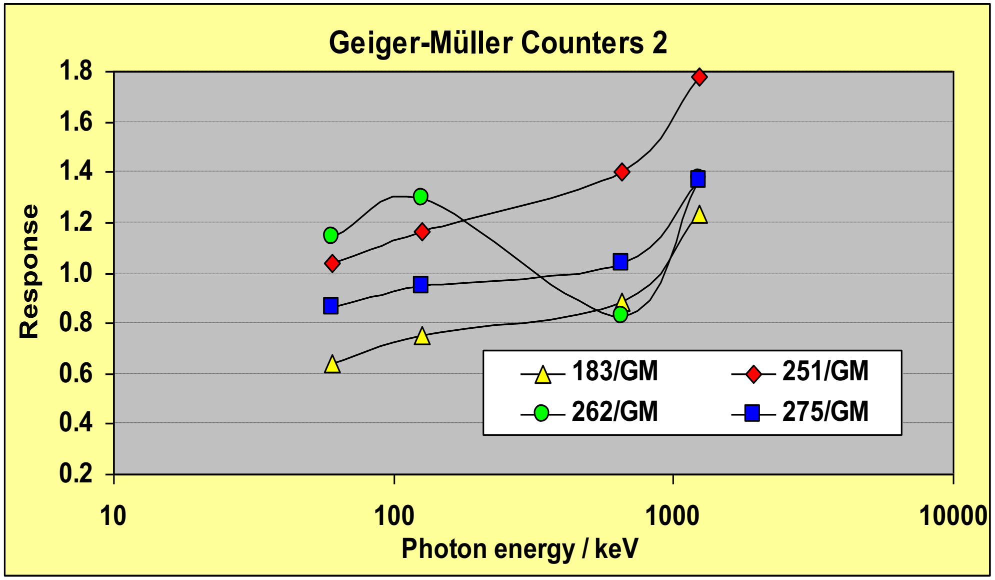


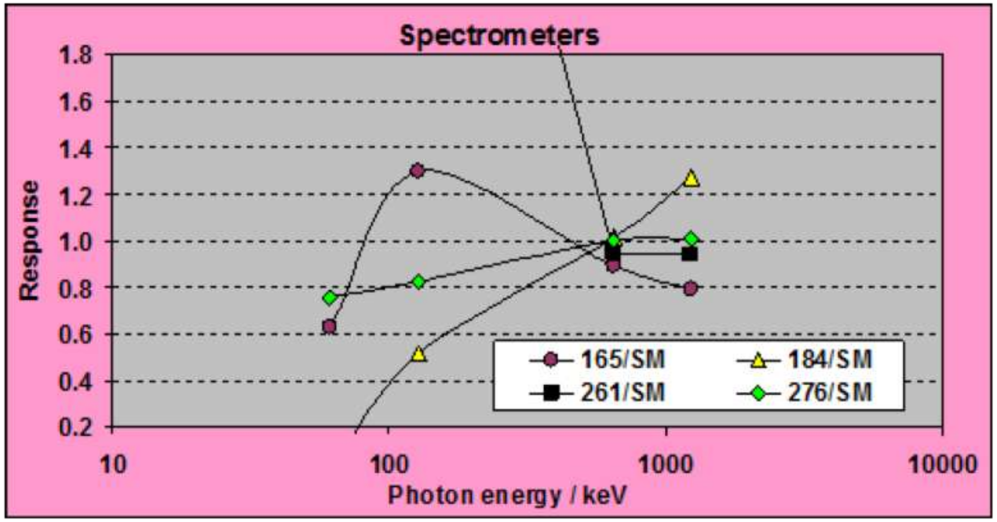
Comparison of different gamma spectrometers for aerosol monitoring (NPL)

Energy response of

MetroERM' s spectrometers, GM counters



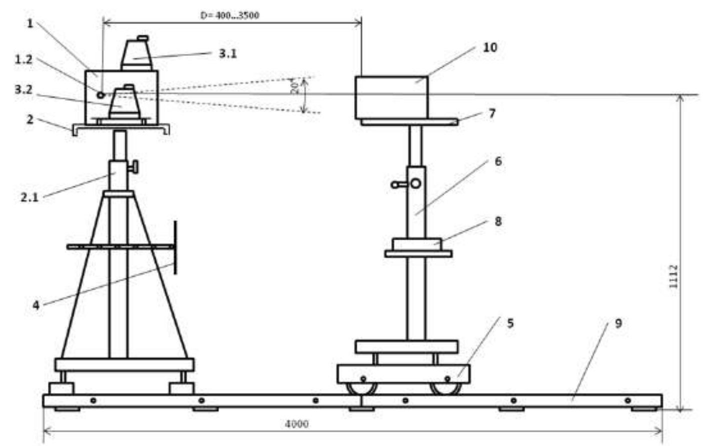




and commercial spectrometers.

Achievements WP3:

Calibration facility established at the IFIN-HH underground lab. in the Unirea salt mine (- 200 m), Rumania, (IFIN-HH)



IFIN-HH, CEA, PTB, ENEA

Achievements – Summarised in MetroERM's final publishable report (42 pages)

- **A potentially new detector-generation of spectro-dosemeters for Europe's early warning network systems**

- **New prototypes of air samplers** to measure air borne radioactivity in real-time developed and successfully tested

- **A world-wide second underground facility for calibrations at low dose rates established at the IFIN-HH underground lab, Romania**

Google: "MetroERM final publishable report" (for download)

Thank you for your attention!

PTB

NPL
National Physical Laboratory

CMI
CZECH
METROLOGY
INSTITUTE

ENEA

DE LA RECHERCHE À L'INDUSTRIE
cea
Laboratoire National
Henri Becquerel
LNE-LNHB

European
Commission

GOBIERNO
DE ESPAÑA

MINISTERIO
DE ECONOMÍA
Y COMPETITIVIDAD

Ciemat
Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas

Bundesamt für Strahlenschutz

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE
Enhancing nuclear safety

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENT[illegible] [illegible]EAIRE

IFIN-HH

TAEK
TÜRKIYE ATOM ENERJİSİ KURUMU

Jožef Stefan
Institute
Ljubljana
Slovenia

ARISTOTLE
UNIVERSITY OF
THESSALONIKI

UPC
UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

envinet
NUVIA GROUP

Impact

EURAMET "good news stories":

Results from radioactivity project invaluable in event of a nuclear accident

Spectroscopic dosimeters developed within EMRP project (ENV57 MetroERM) ***undergo first intercomparison worldwide and get mention at UK parliamentary meeting.***

The early warning of nuclear accidents will help improve Europe's ability to detect and respond to radiological incidents.

Figure 12: Automatic radioactive aerosol monitor developed by CIEMAT.

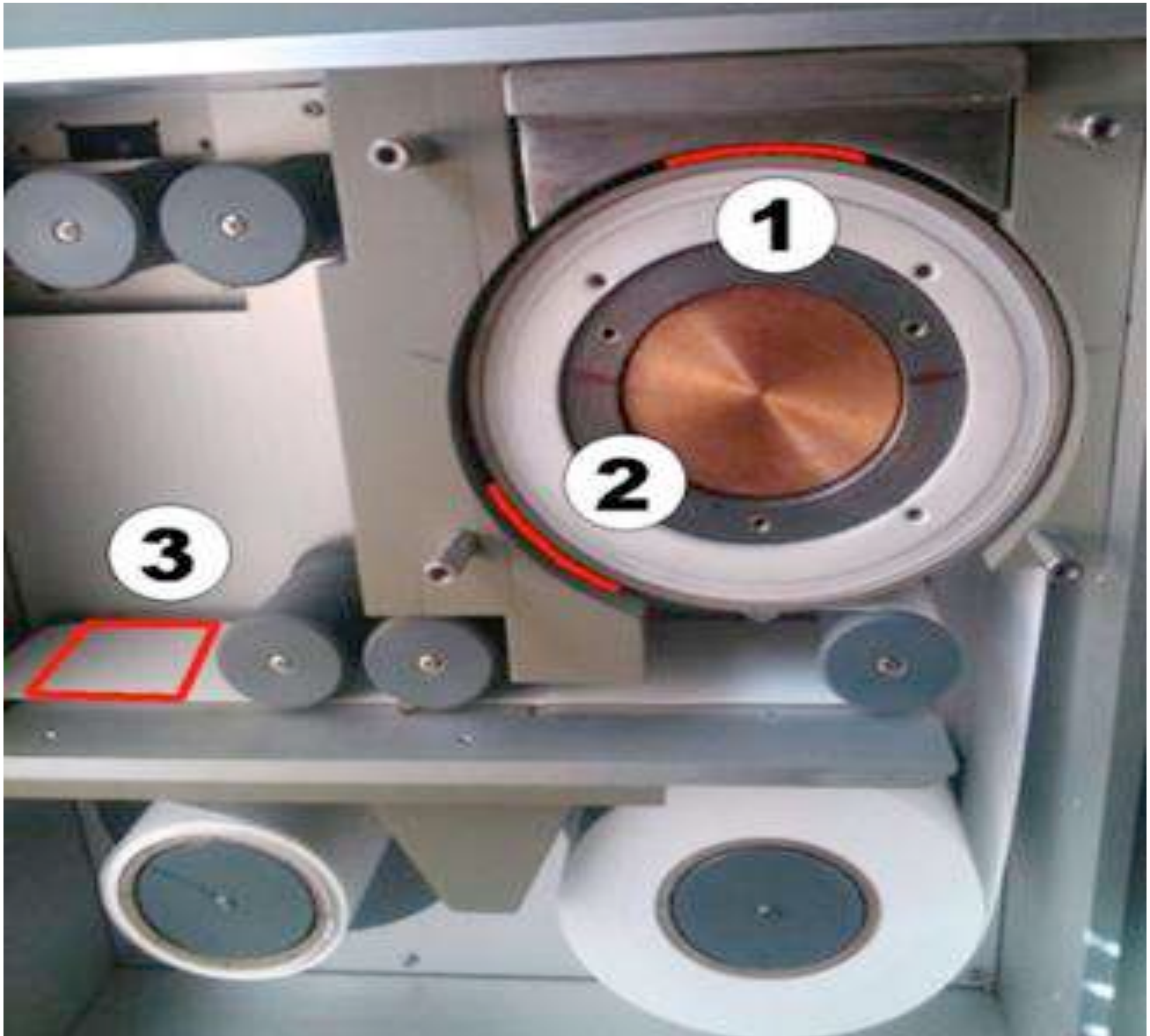


Figure 15: Modular, transportable radioactive aerosol monitor developed by CMI and NUVIA.

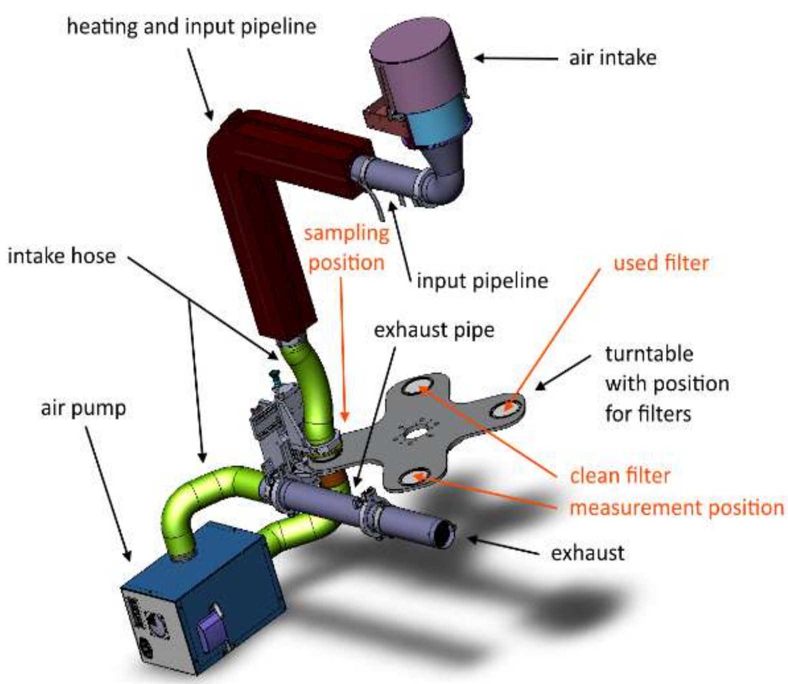
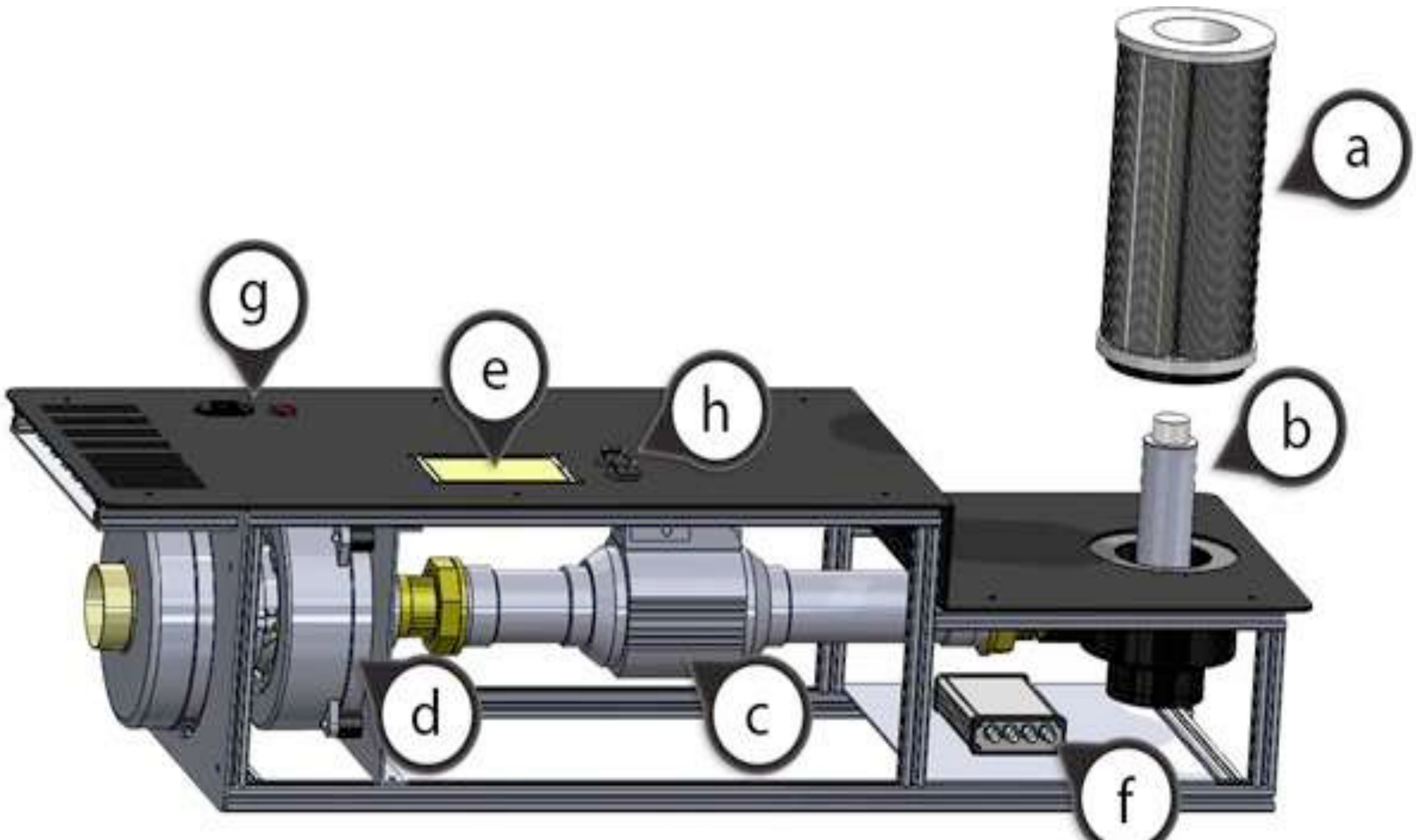


Figure 17: Novel portable Monitoring Air pump for Radioactive aErosols (MARE). The system consists of the following components: a) concertina shaped aerosol filter, b) $CeBr_3$ scintillation detector with PM read-out, c) air-flow meter, d) air-pump turbine, e) microcontroller unit with touch screen, f) preamplifier and digital pulse processing unit, g) power socket, h) USB sockets for communication.



On the origin of radiological early warning networks in Europe

Chernobyl – accident of nuclear power plant block IV

April 26, 1986

European Commission CD 87/600 EURATOM on
„Community arrangements for the early exchange of information in the event of a radiological emergency”.

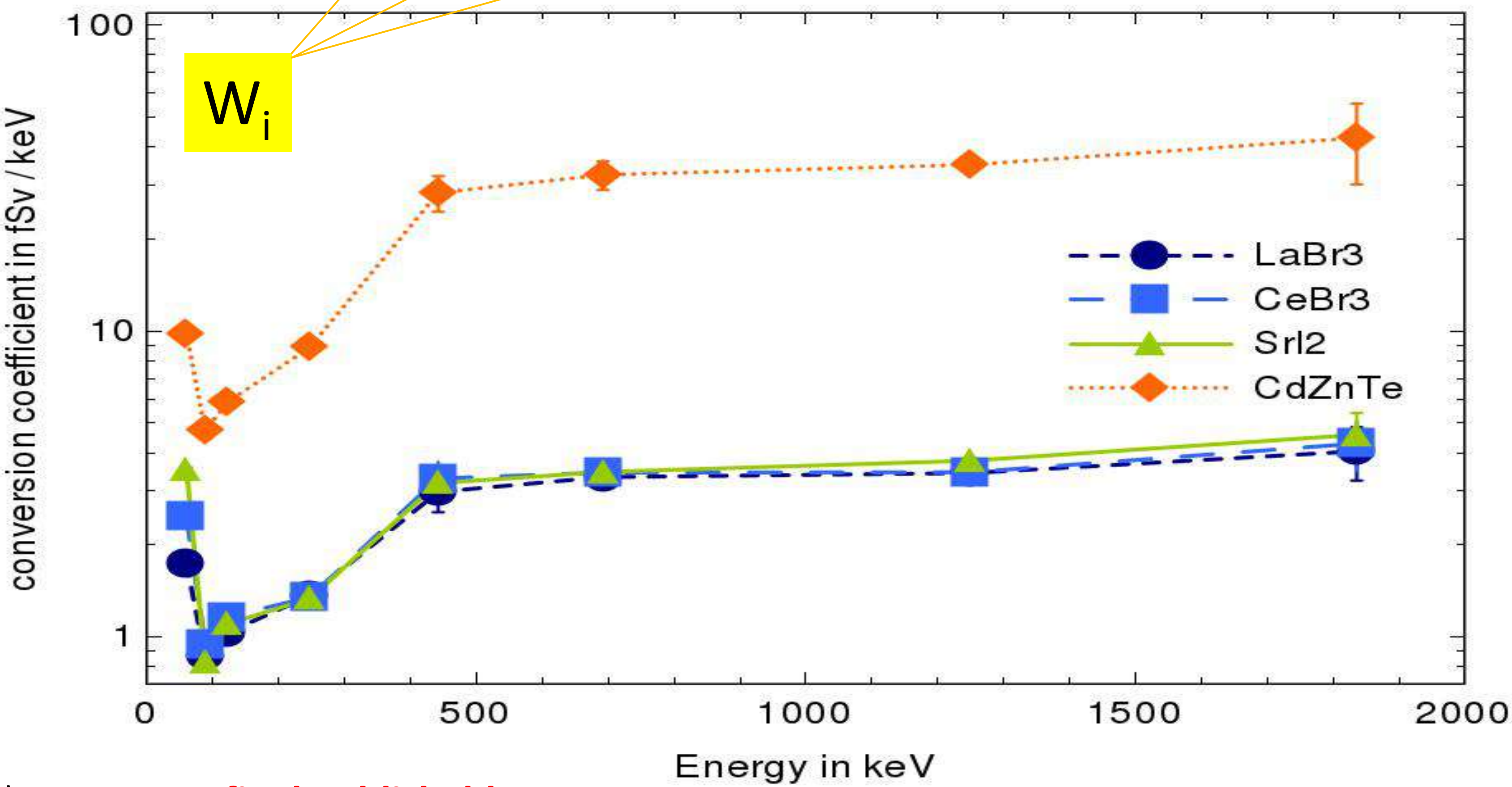
Fukushima Daiichi, March 11, 2011

In Europe:

- **No measurable effects on dose rate values, but**
- **significant increase of ^{137}Cs-activity concentrations in air**

Figure 3*: Conversion coefficients w_i from counts n_i to ambient dose equivalent $H^*(10)$

$$H^*(10) = w_1 \cdot E_1 \cdot \boldsymbol{n_1} + w_2 \cdot E_2 \cdot \boldsymbol{n_2} + \ldots + w_Z \cdot E_Z \cdot \boldsymbol{n_Z}$$



*MetroERM final publishable report

Figure 4: Relative angular response of the different detectors for 60 , 122 and 662 respectively.

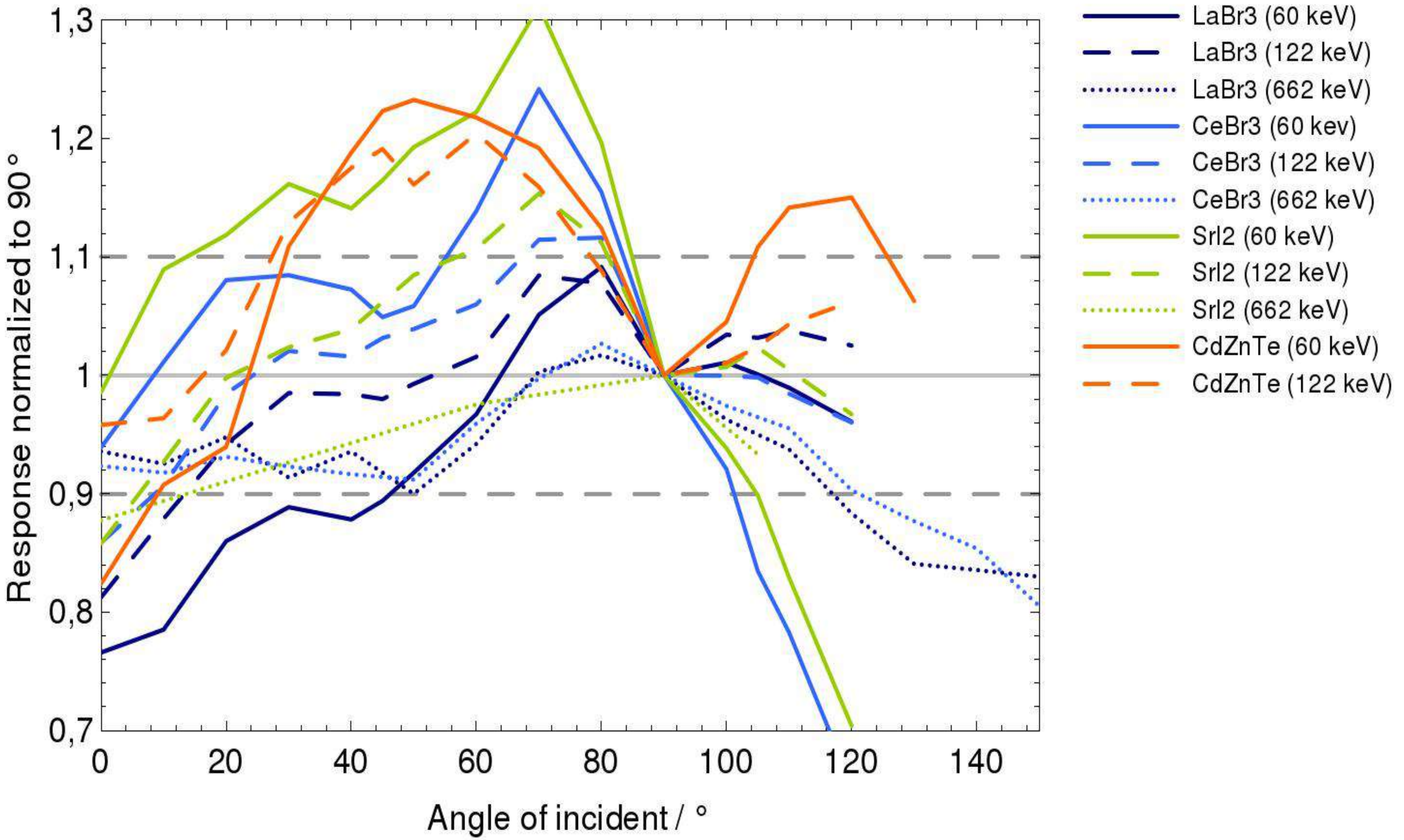


Figure 11. Results after applying the three methods for rain detection to data of a $CeBr_3$ spectrometer, by simulating a radioactive fallout by using ^{137}Cs and ^{60}Co sources during a rain event.
The dotted lines show dose rate values and results of the methods without the addition of the artificial spectra [21].

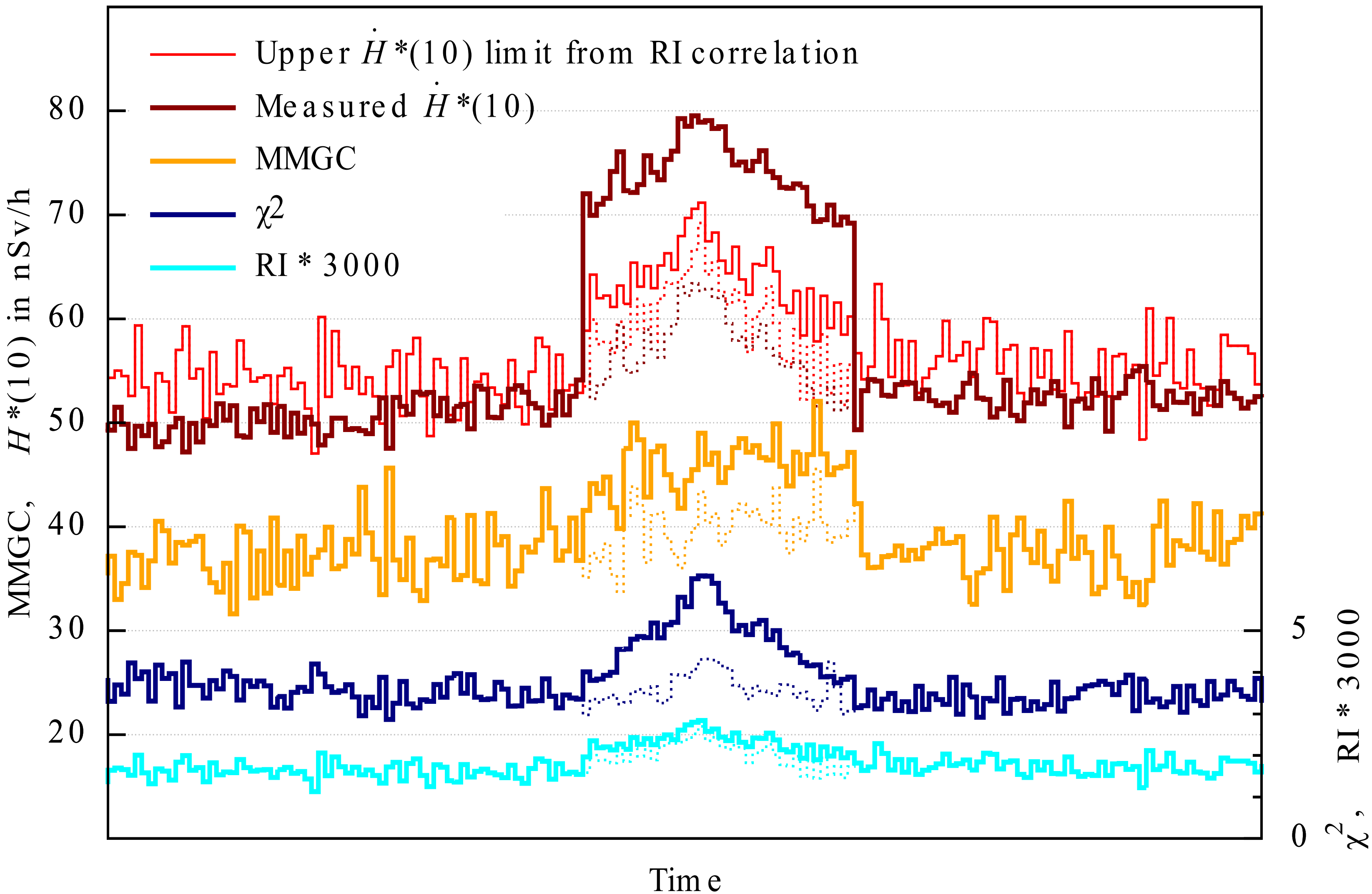


Figure 24: BfS reference site INTERCAL at the mount Schauinsland, near Freiburg, Germany.