



# Environmental radioactivity measurements and the background at HADES

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# Joint Research Center at a glance

Work conducted in directorates  
distributed over 6 sites  
in 5 Member States

Since 2016:

- JRC-Geel
- JRC-Karlsruhe
- JRC-Ispra
- JRC-Petten
- JRC-Seville
- JRC-Brussels



# European Atomic Energy Community

## (Euratom Treaty)

### Article 8

- After consulting the Scientific and Technical Committee, the Commission shall **establish a Joint Nuclear Research Centre**.
- This Centre shall ensure that the research programmes and other tasks assigned to it by the Commission are carried out.
- It shall also ensure that a **uniform nuclear terminology** and a **standard system of measurements** are established.
- **It shall set up a central bureau for nuclear measurements (CBNM).**

### ► IRMM ► JRC-Geel

- Primary standardisation of radioactivity
- Decay data
- Realisation of the unit becquerel (Bq)

Consolidated version of the Euratom Treaty 2016/C 203/01:

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02016A/TXT-20160901>

# Monitoring radioactivity in the environment (Euratom Treaty)

## Articles 30 – 39: Health and Safety Proficiency Tests in support of Article 35

- Articles 35 and 36: The Member States shall monitor radioactivity in the environment\* and report to the EC, which shall verify the operation
- Article 39: The J(N)RC shall support the EC in its work on Chapter 3
- Extensive work carried out by **many** laboratories (big and small)

\*originally "air, water and soil" but today covering more (food, feed, building materials,...) following the basic safety standards (Article 30)

Matrix	Year	Radionuclides
Soil	2010	$^{40}\text{K}$ , $^{90}\text{Sr}$ , $^{137}\text{Cs}$ , $^{212,214}\text{Bi}$ , $^{212,214}\text{Pb}$ , $^{226}\text{Ra}$ , $^{230,232}\text{Th}$ , $^{234,235,238}\text{U}$ , $^{238,239,240}\text{Pu}$
Bilberry	2011	$^{40}\text{K}$ , $^{90}\text{Sr}$ , $^{137}\text{Cs}$
Drinking water	2012	Total $\alpha/\beta$ activity
	2018	Radon
	2019	Total $\alpha/\beta$ activity
Air filter	2014	$^{137}\text{Cs}$
	2016	$^{131}\text{I}$ , $^{134}\text{Cs}$ , $^{137}\text{Cs}$
Maize	2017	$^{131}\text{I}$ , $^{134}\text{Cs}$ , $^{137}\text{Cs}$
Building materials	2020	$^{40}\text{K}$ , $^{226}\text{Ra}$ , $^{228}\text{Ra}$ , $^{210}\text{Pb}$ , $^{228}\text{Th}$ , $^{238}\text{U}$
Air filter	2024	$^{90}\text{Sr}$ , $^{137}\text{Cs}$ , $^{152}\text{Eu}$ , $^{40}\text{K}$

# World-leading lab for reference materials production

## 2011 – 2021:

- 30000 units CRM
- 7000 units radioactive “RM”
- 30 different matrices



Cutting and sieving



Preparing spiking solution in a rotary evaporator



Cryo-milling



Ultra-sonic sieving



Packaging /shipping

# JRC input to recent Supplementary comparisons organised by Asian signatories to the CIPM MRA

- CCRI(II)-S13, Cs-134 and Cs-137 in wheat flour (NMIJ, Japan).
- CCRI(II)-S15, Cs-137 and K-40 in mushrooms (KRISS, Rep. of Korea) – Final report in preparation by KRISS.
- JRC was also asked to contribute to the **Asia-Pacific Metrology Programme (APMP)**. This work is also listed under the BIPM website and done under the auspice of CCRI(II).
- APMP.RI(II)-S3, Cs-134 and Cs-137 in brown rice (NMIJ, Japan).

# Nuclear Science Applications in High Activity Disposal Experimental Site HADES

## Article 4 and 6 (Euratom)

- The Commission shall be responsible for **promoting and facilitating nuclear research** in the Member States and for complementing it by carrying out a Community research and training programme.
- Support for a multitude of JRC projects
- Access to novel technologies for member state scientists, e.g. Open Access projects

## Examples:

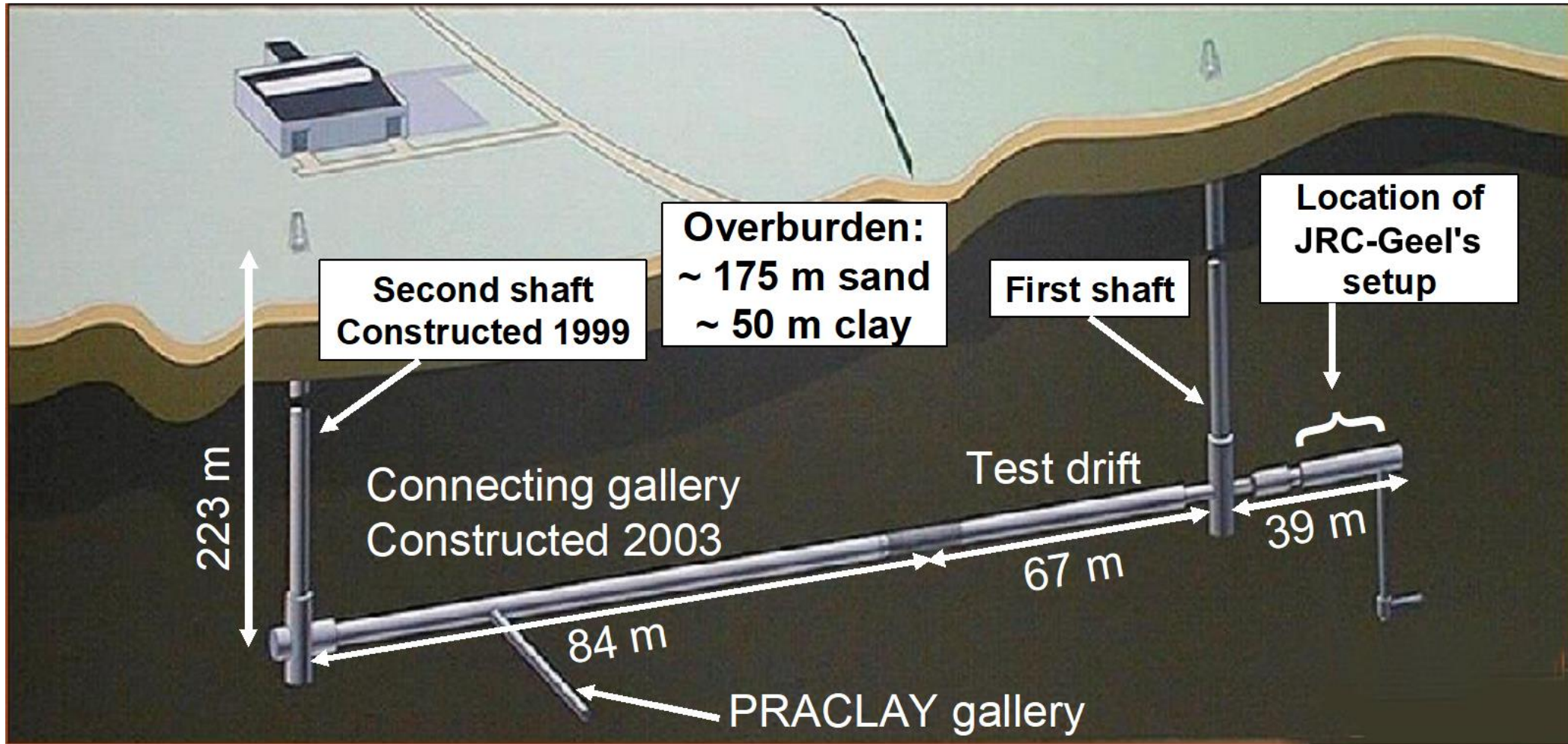
- Mapping ocean currents
- The world's oldest living organism
- Least radioactive space on Earth
- Most long-lived isomeric state in Universe
- Lowest gamma decay energy
- How to cultivate on contaminated soil
- CO<sub>2</sub>-free concrete
- Solving the Hiroshima enigma

Call for projects:

[https://joint-research-centre.ec.europa.eu/calls-proposals\\_en](https://joint-research-centre.ec.europa.eu/calls-proposals_en)

# HADES underground research facility

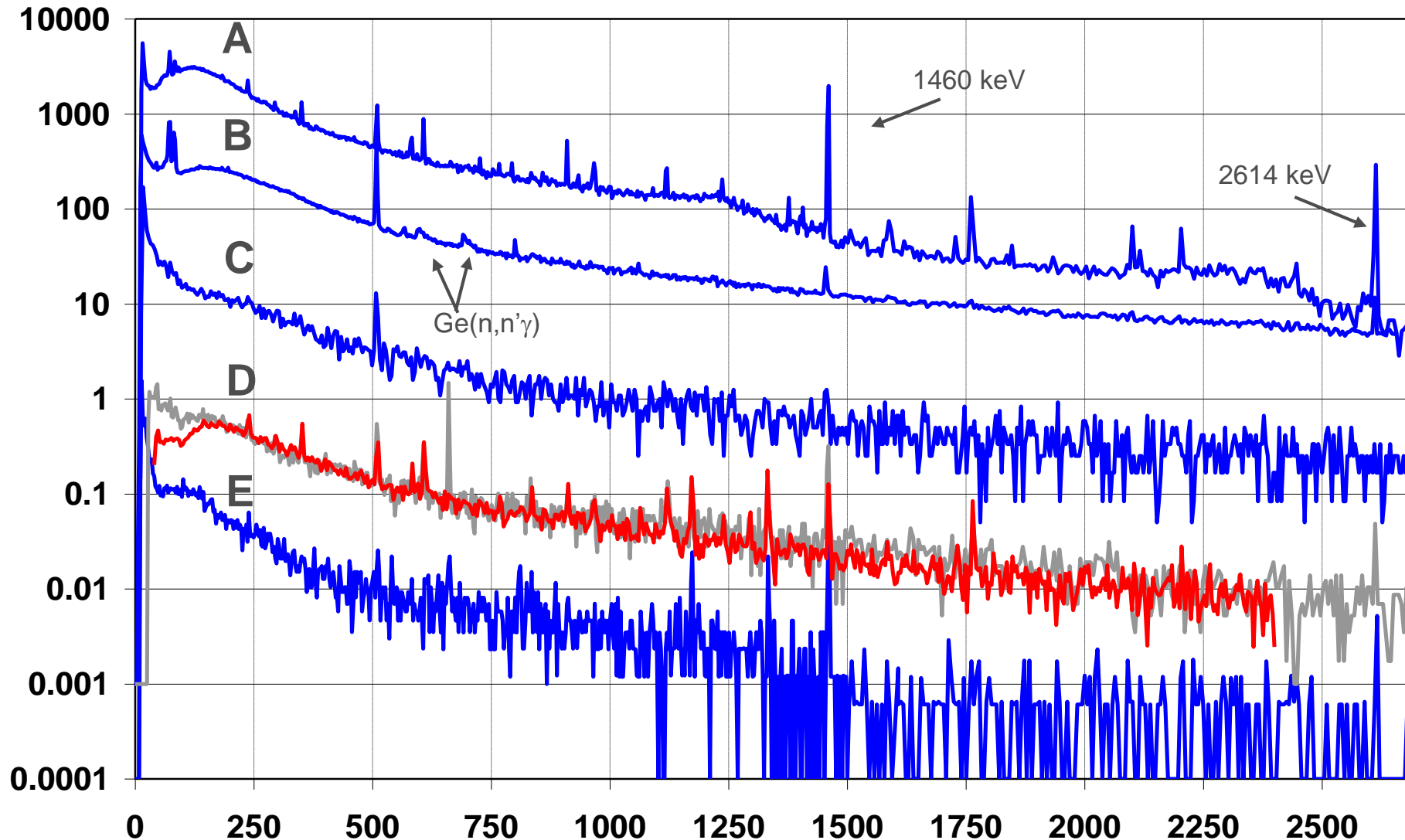
[https://joint-research-centre.ec.europa.eu/laboratories-z/underground-laboratory-ultra-low-level-gamma-ray-spectrometry\\_en?prefLang=ga](https://joint-research-centre.ec.europa.eu/laboratories-z/underground-laboratory-ultra-low-level-gamma-ray-spectrometry_en?prefLang=ga)



Operated by EURIDICE and located at SCK CEN in Mol



# Steps towards the ultralow background

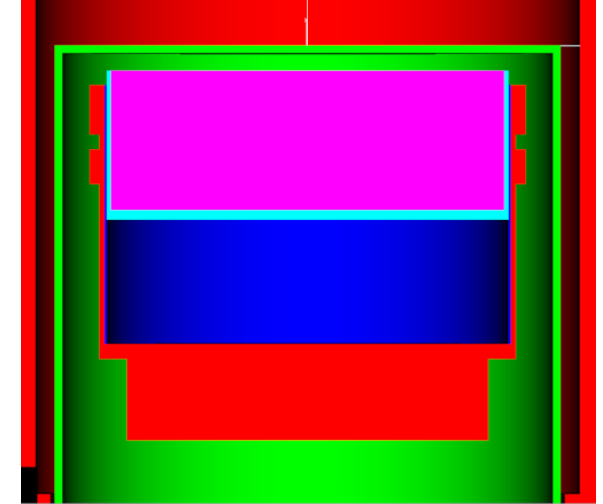
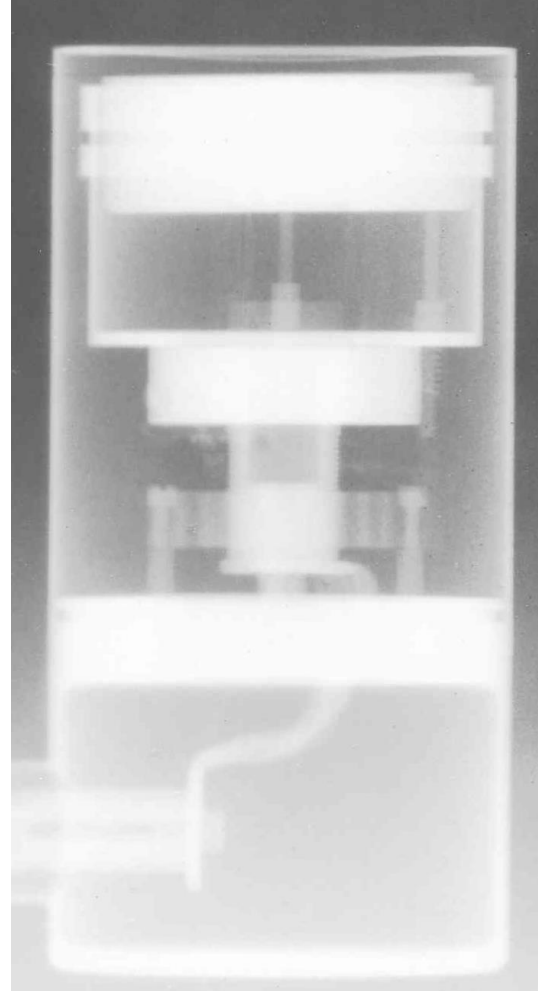


- A: „Normal”
- B: „Low-level”
- C: Falsenkeller
- D: HADES
- E: Gran Sasso (LNGS)



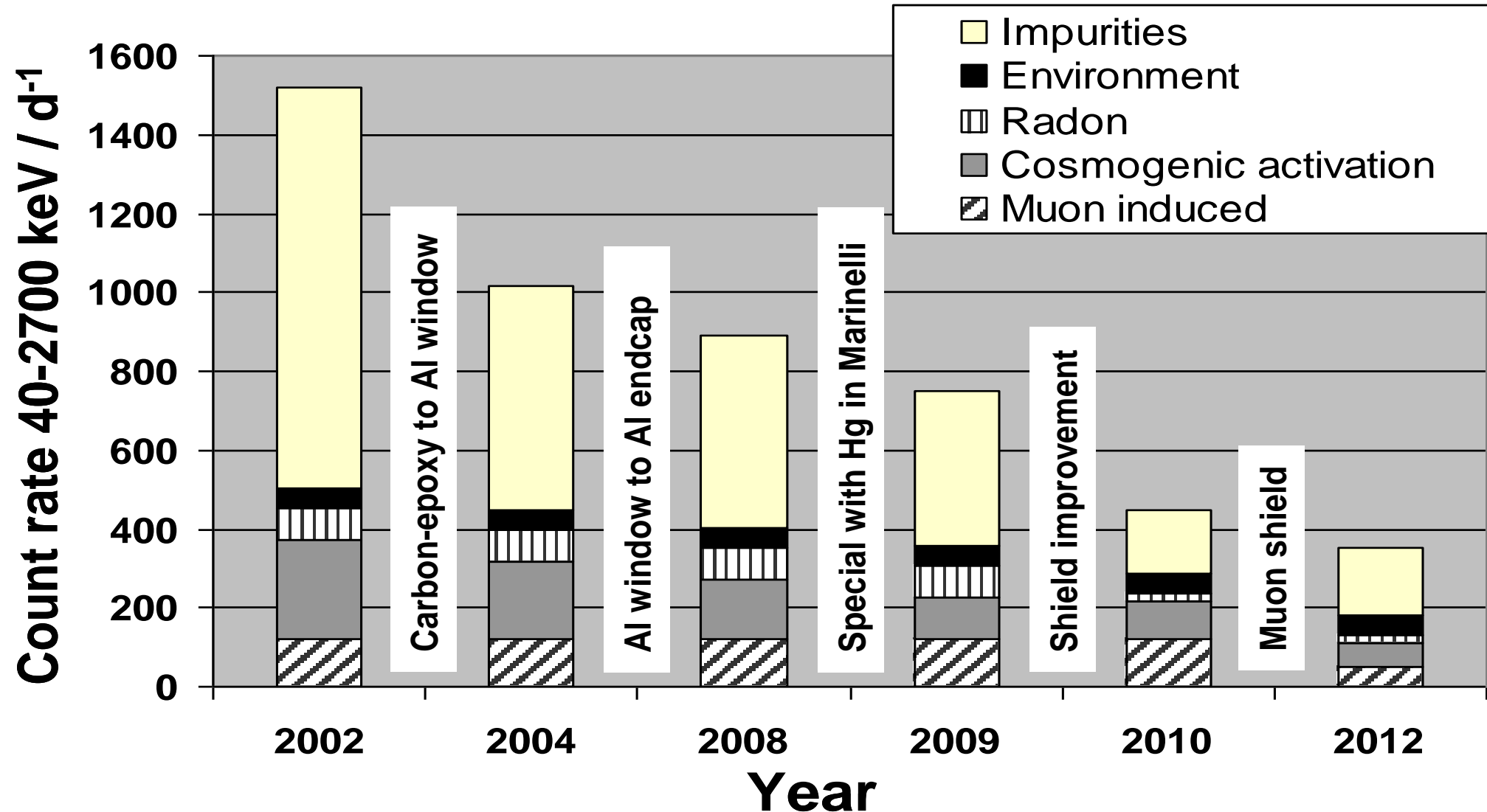
# First commercial BEGe detector operated underground *Ge-5*

- BEGe p-type planar detector
  - 50% relative efficiency, 0.8 kg
  - 2.0 keV resolution (FWHM)
  - Commissioned in 2001
- 
- Background count rate (2023):  $586 \pm 6 \text{ cts d}^{-1} \text{ kg}^{-1}$



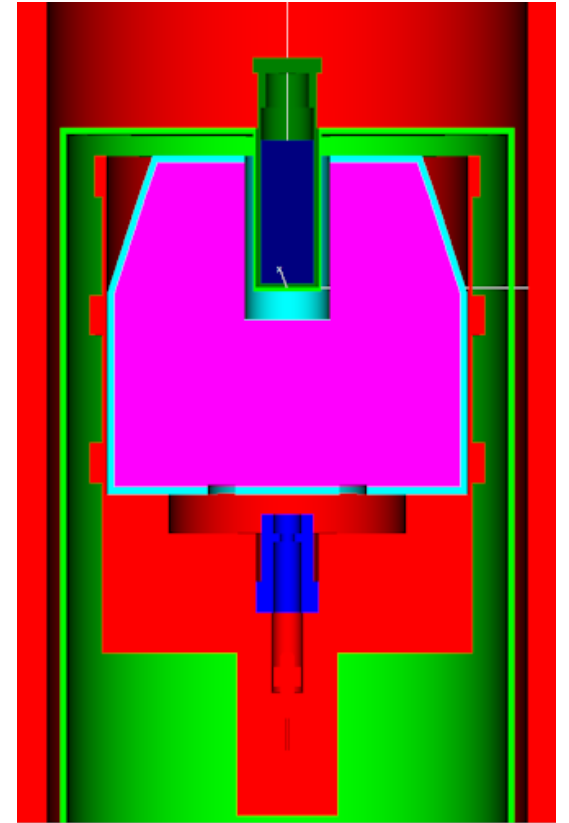
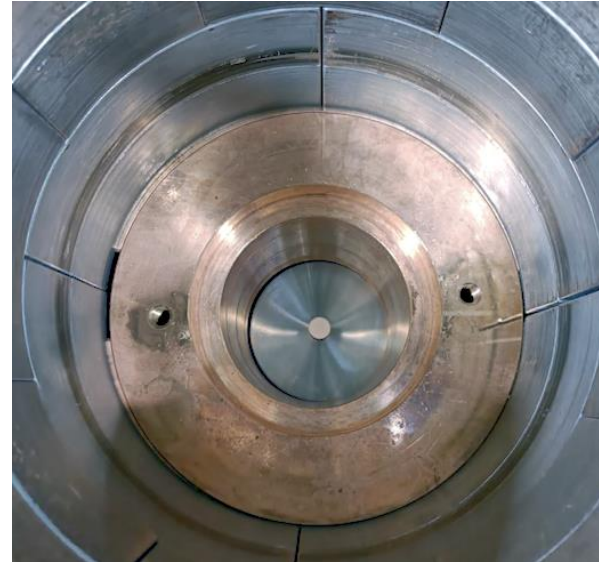
# First commercial BEGe detector *Ge-5*

operated underground – identified background sources



# First commercial SA-Ge-well detector operated underground *Ge-14*

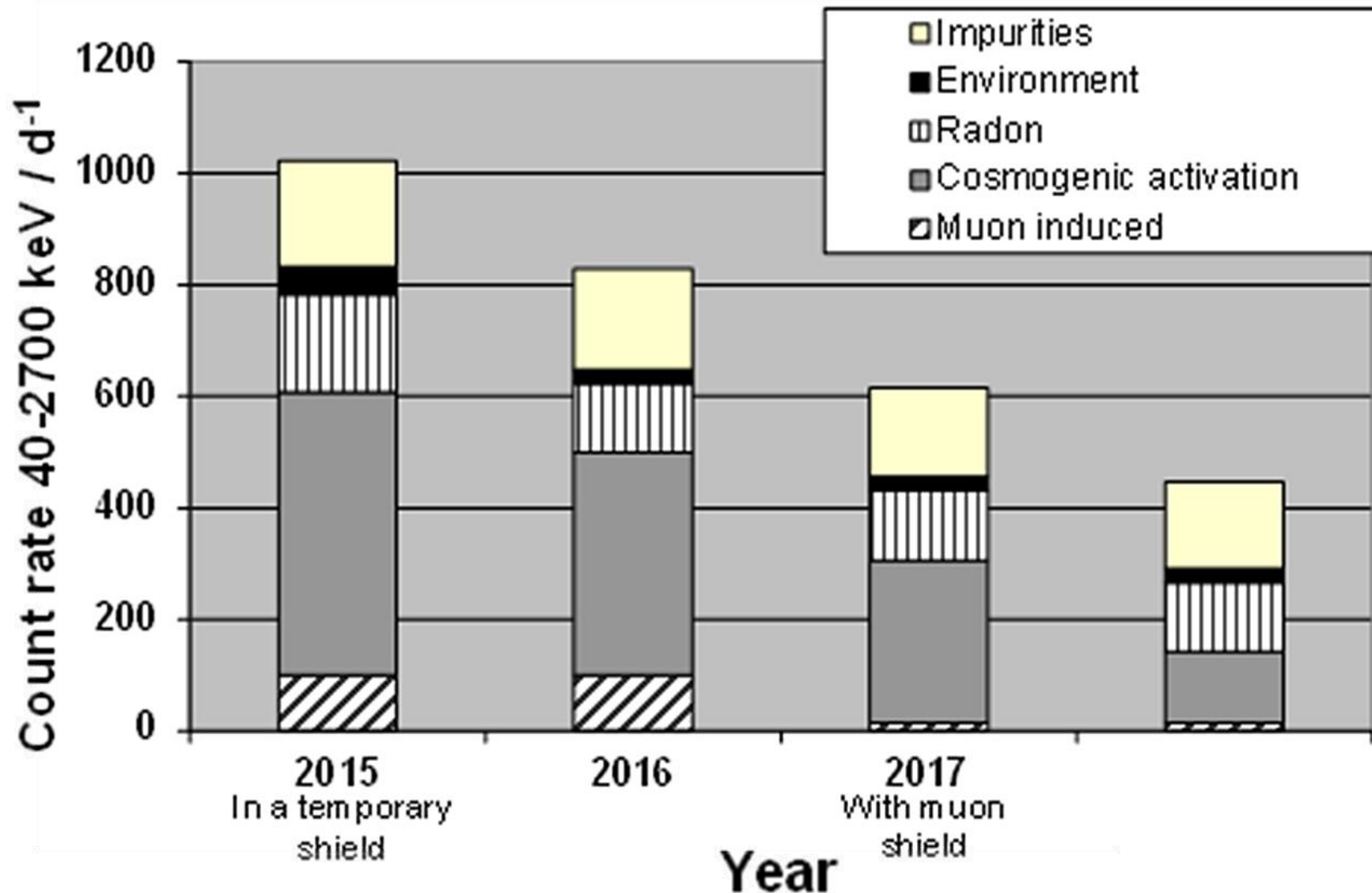
- Small Anode HPGe Well detector
- 118% relative efficiency, 2.26 kg
- 2.1 keV resolution (FWHM)
- Commissioned in 2016



- Background count rate (2023):  $178 \pm 8 \text{ cts d}^{-1} \text{ kg}^{-1}$

# First commercial SAGe-well detector *Ge-14*

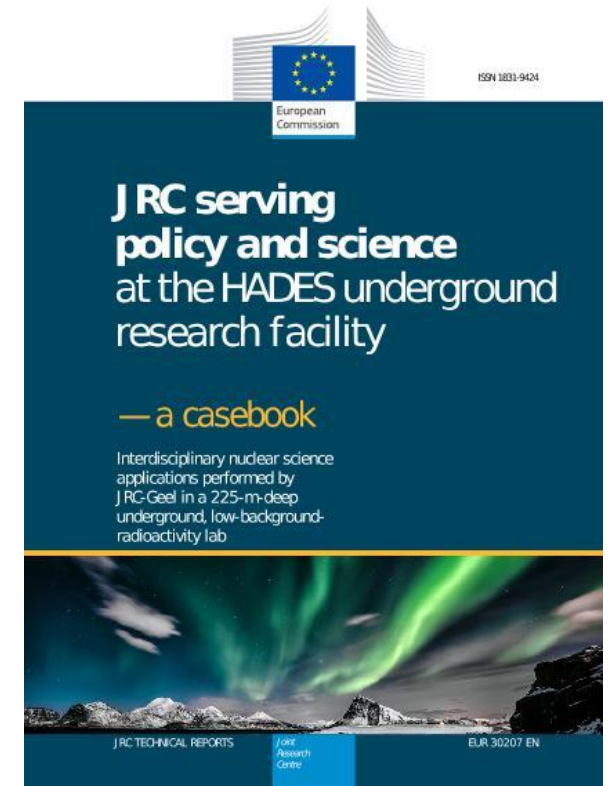
operated underground – identified background sources



2024 - Numbers **without muon shield** thanks to decay of Th-228

# Summary

- Radioactivity laboratory operated by JRC inside HADES uses 12 HPGe detectors; this includes three well detectors and two dual-detector systems.
- JRC serves the society following guidelines of the Euratom Treaty
- Numerous samples for Borexino, Gerda and Legend assayed
- Two types of novel HPGe detectors were successfully operated for the first time in the underground environment in HADES: SAGe-well and BEGe.
- A novel alpha Time of Flight (A-TOF) spectrometer under construction (2 keV resolution)



# Thank you



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