EURADOS Webinar:

Production of sources, quality assurance and measurement campaign

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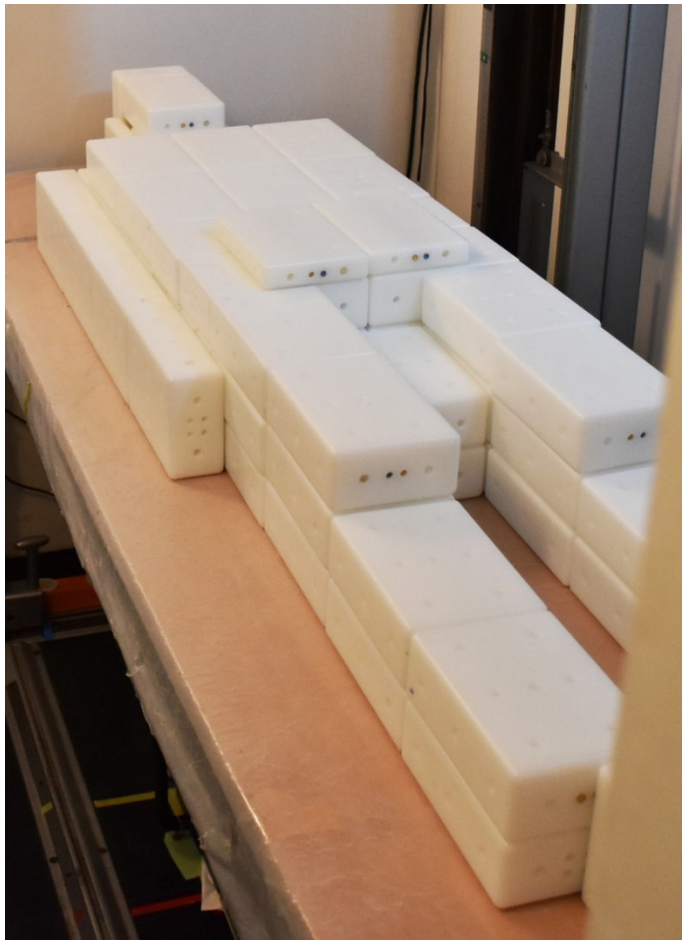
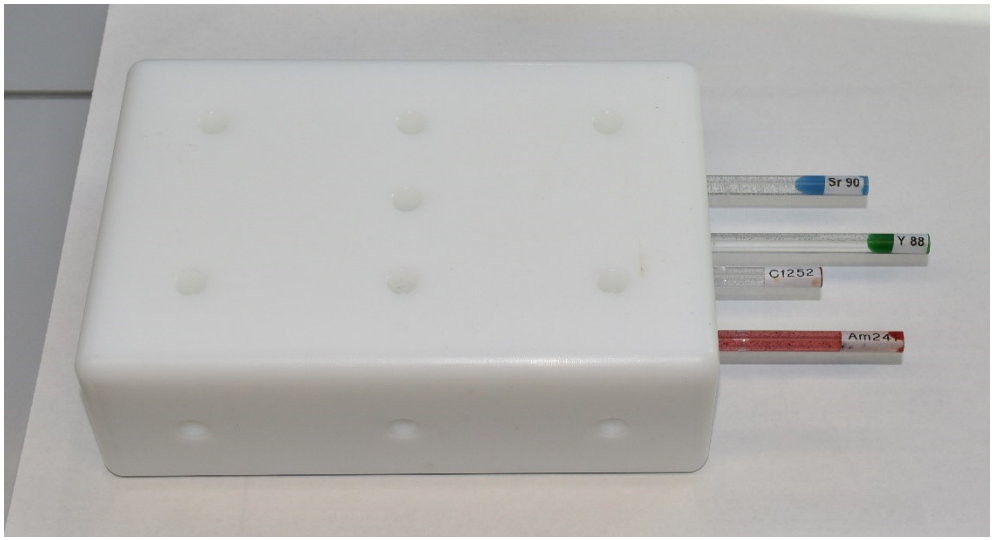
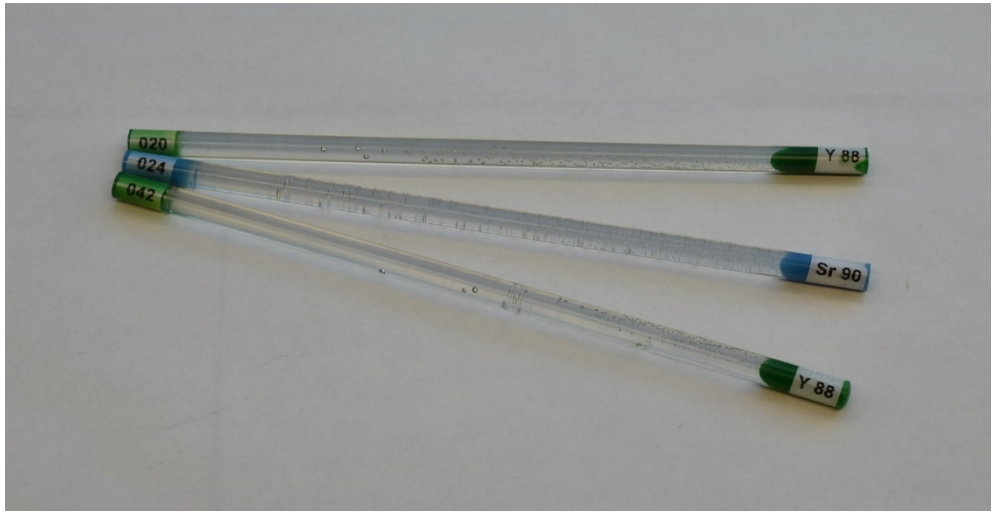
Federal Office for Radiation Protection (BfS)

Brick phantom and rod sources

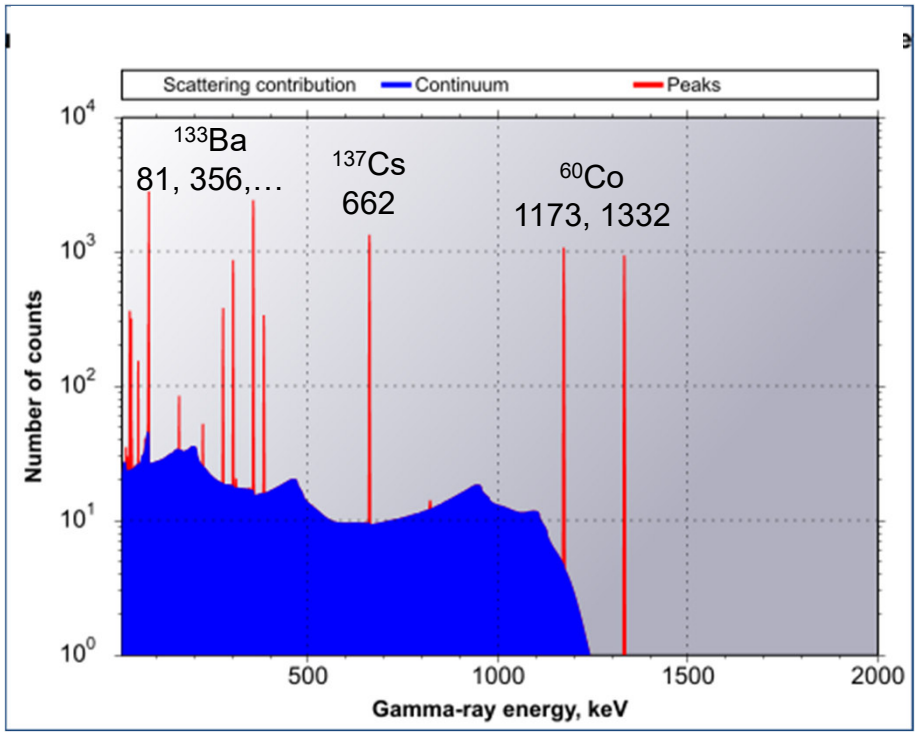




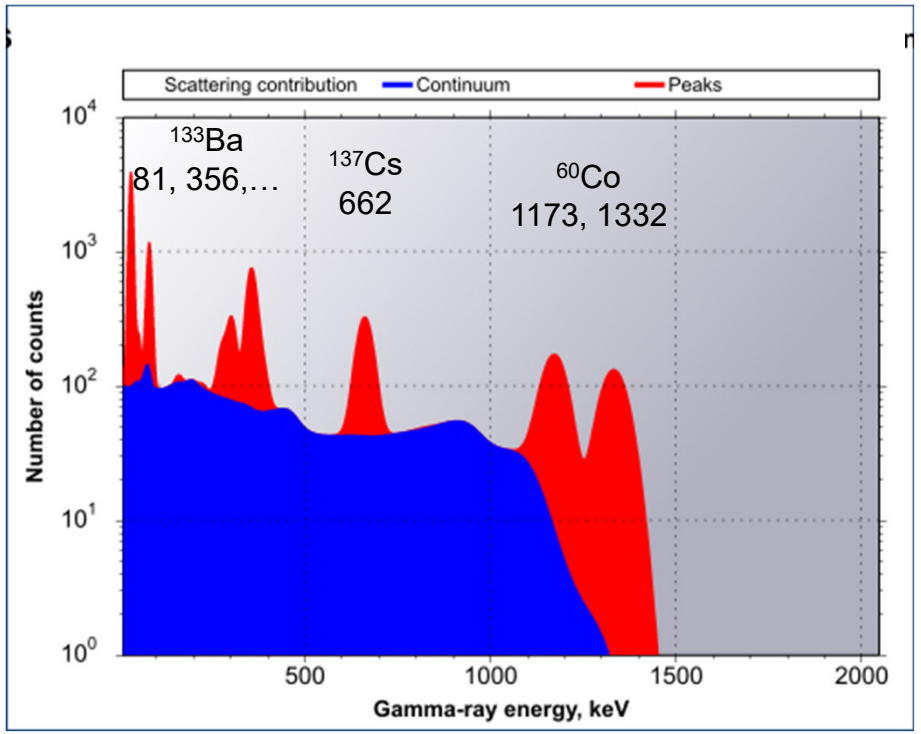


Kovtun et al., Metrological parameters of the unified calibration whole-body phantom with gamma-emitting radionuclides. Radiat. Prot. Dosim., 89 (3–4) (2000), pp. 239-242.

Task 1 “Victor”



HPGe detector

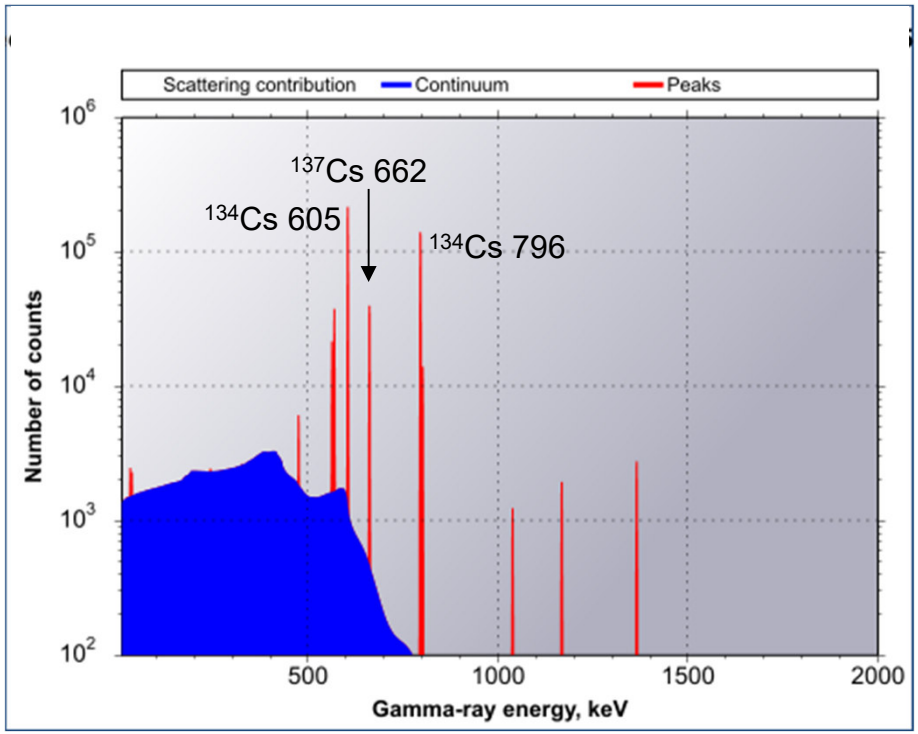


NaI detector

Standard task for proficiency tests of whole-body counters
Easy to solve for HPGe and NaI detectors

Spectra simulated on nucleonica.com, © Nucleonica GmbH

Task 2 “Emergency”

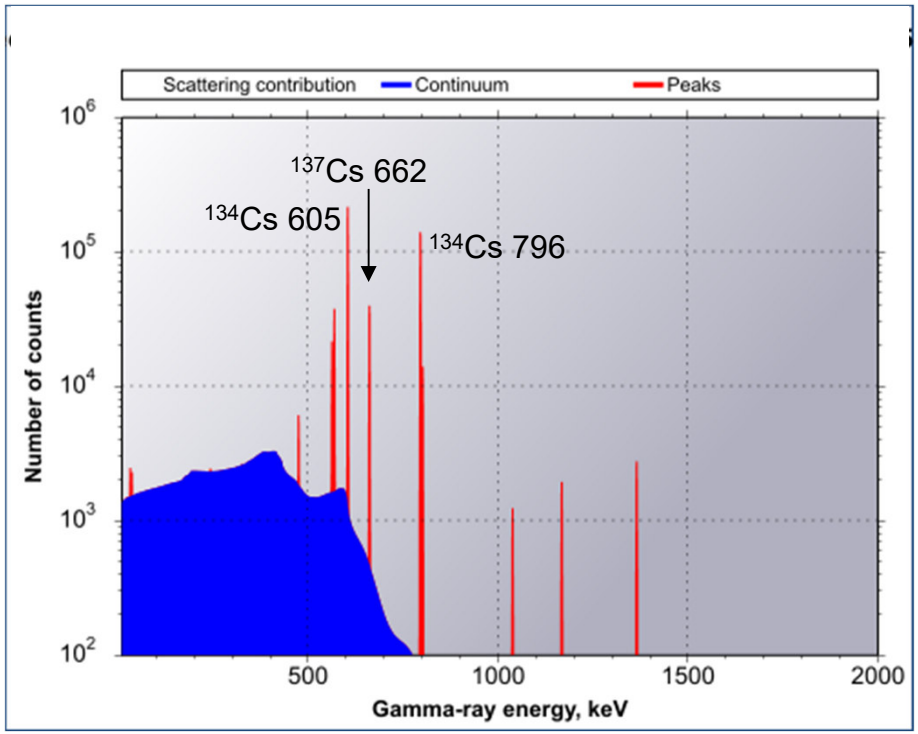


HPGe detector

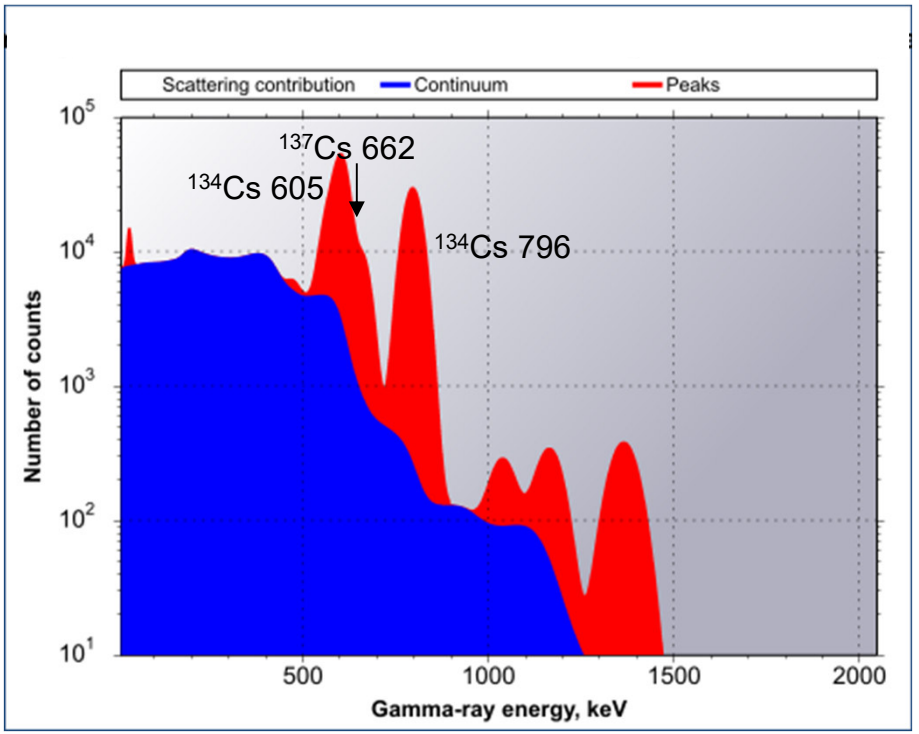
Important nuclides for measurements after nuclear accidents
Ratio of activities approximately 1:1 as in the Fukushima accident

Spectra simulated on nucleonica.com, © Nucleonica GmbH

Task 2 “Emergency”



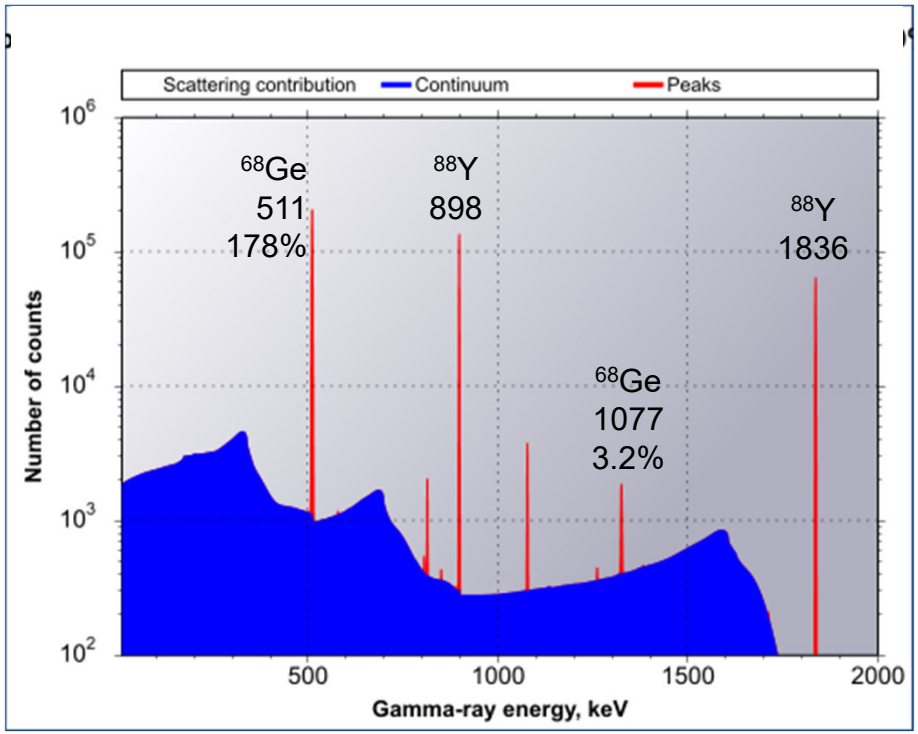
HPGe detector



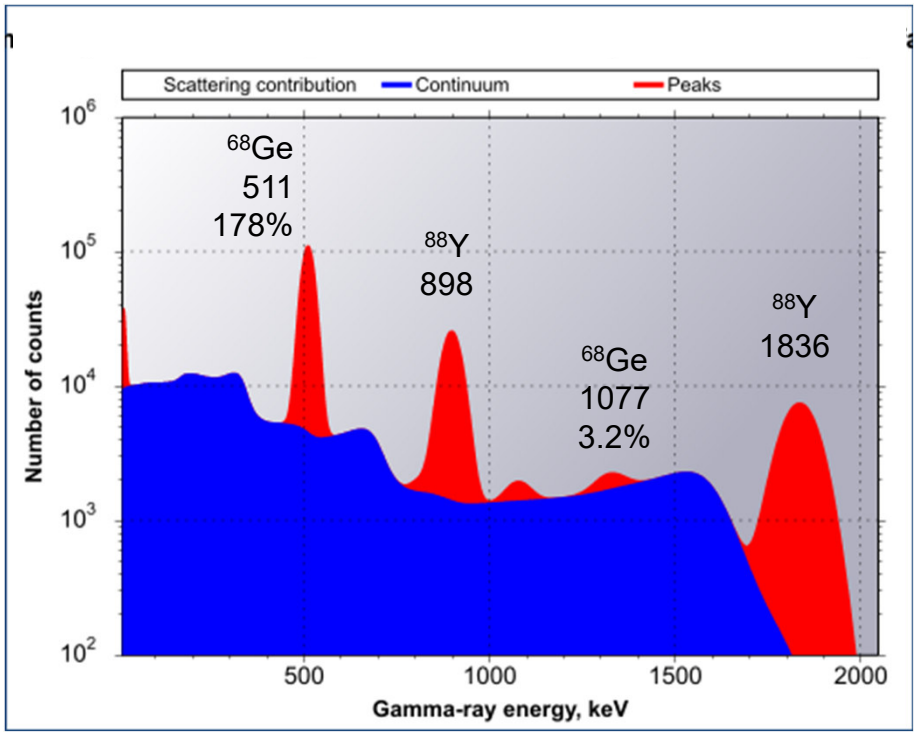
NaI detector

Spectra simulated on nucleonica.com, © Nucleonica GmbH

Task 3 “Medicine”



HPGe detector



NaI detector

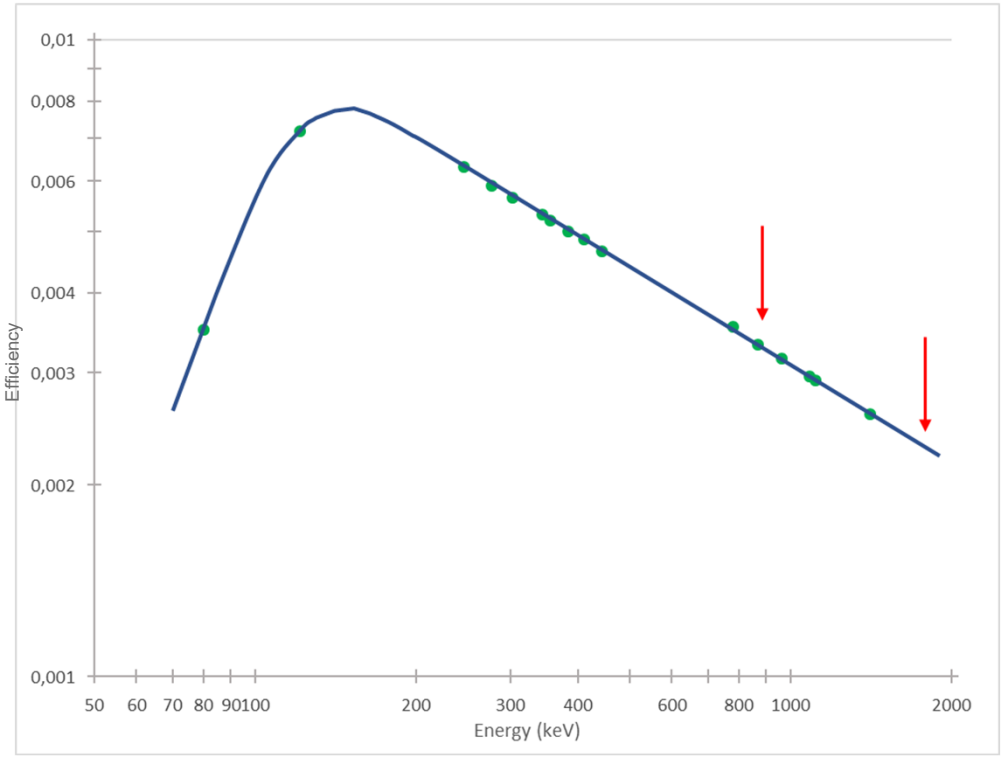
^{68}Ge: strong emission at 511 keV not suitable for identification (secondary annihilation radiation)
peak wider than other gamma peaks

^{88}Y: emission at 1836 keV is beyond the usual energy range of the efficiency calibration

Spectra simulated on nucleonica.com, © Nucleonica GmbH

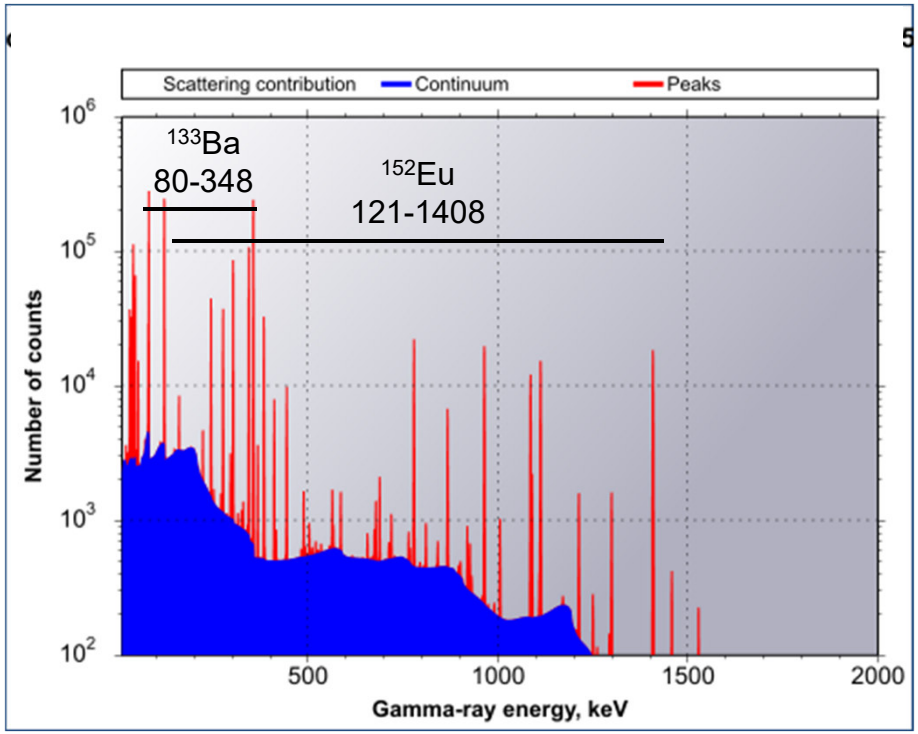
Task 3 “Medicine”

^{88}Y: emission at 1836 keV is beyond the usual energy range of the efficiency calibration

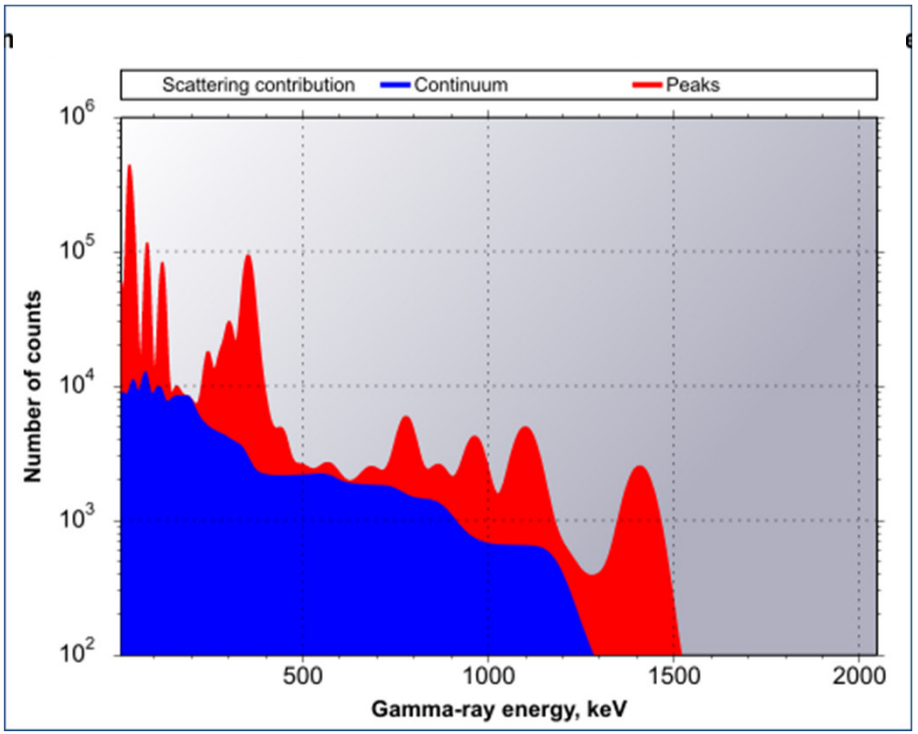


green: calibration points of ^{133}Ba and ^{152}Eu up to 1408 keV
blue: shape of a calibration curve with linear extrapolation on a log-log scale
red: emissions of ^{88}Y at 898 and 1836 keV

Task 4 “Calibration”



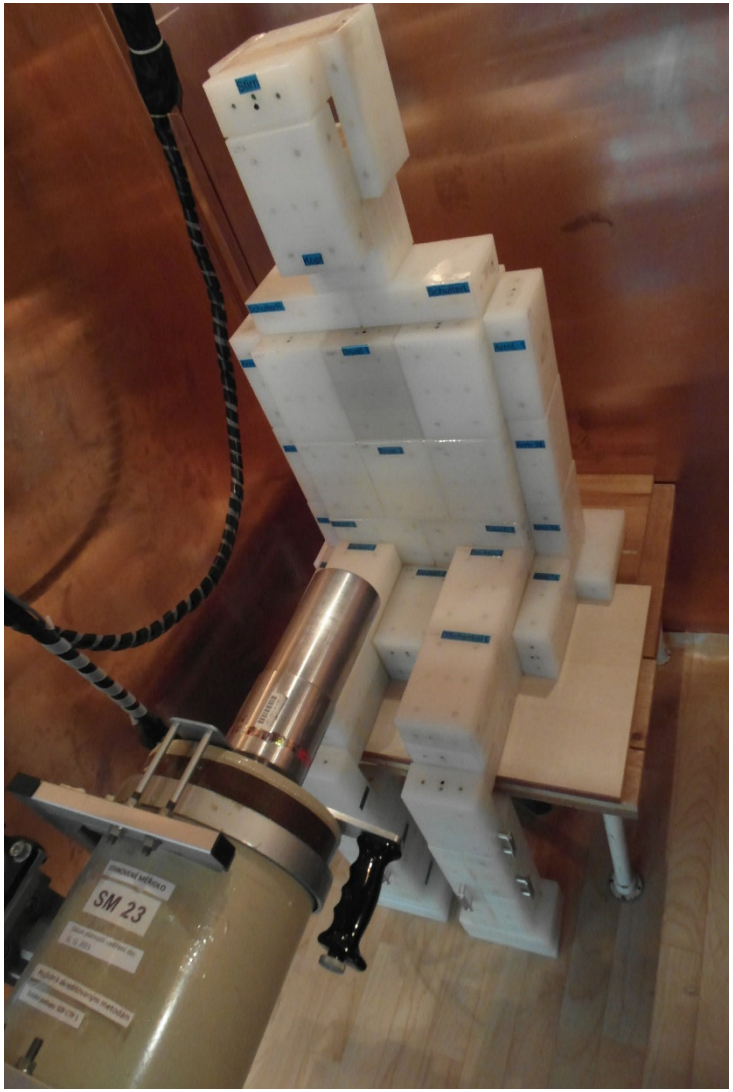
HPGe detector



NaI detector

Spectra simulated on nucleonica.com, © Nucleonica GmbH

Advantage 1 of the phantom: versatility



Advantage 2 of the phantom: sealed sources

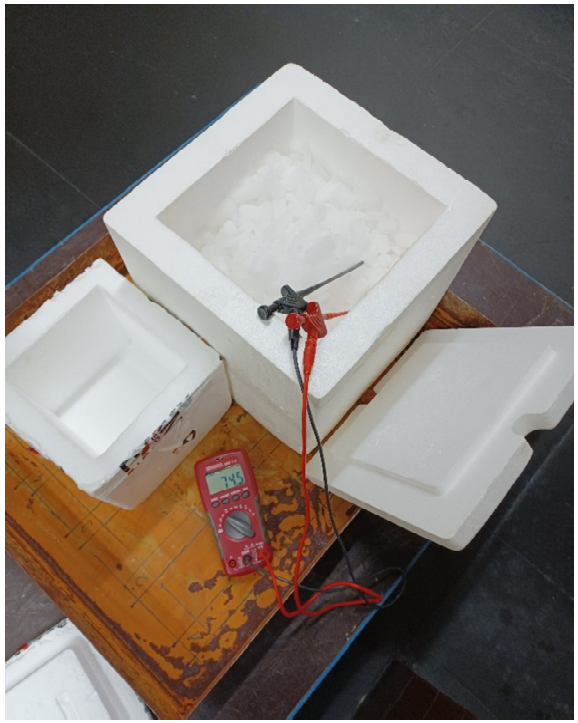
- Sealed sources are more robust.
- Some laboratories might have permission to handle only sealed sources.
- No contamination check of surfaces required.

→ Tests according to ISO 2919
"Sealed radioactive sources – General requirements and classification"
Class 2 for low-activity calibration sources

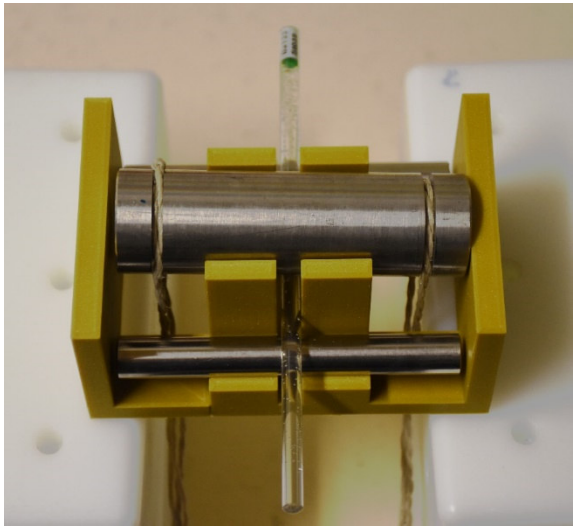
- Impact: 50 g from a height of 1 m, weight with flat bottom
- Puncture: 1 g from a height of 1 m, weight with pointed bottom (diameter 3 mm)
- Temperature: -40 °C for 20 min, +80 °C for 60 min
- Low pressure: 25 kPa
- Bending: weight of 10.2 kg acting on the middle of the rod

Advantage 2 of the phantom: sealed sources

Impact and puncture test



Low temperature test
with dry ice



Bending test

Production of sources

Sources for Task 1 from IRSN stock,

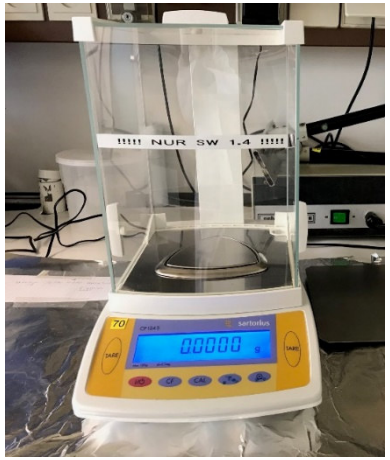
all other sources needed to be produced.

Production of sources at BfS:

- Radioactive filling made of epoxy resin in a tube of PVC
- Based on a method developed at the Institute of Radiation Physics, Lausanne, Switzerland

  Bailat C., Bochud F., Juget F., Buchillier T. (2014) Development, design and validation of solid reference samples. Applied Radiation and Isotopes 87:480-484

Calculation of the activity



The activity was determined

- from the net weight of the radionuclide solution
- from gamma-spectroscopy measurements at BfS
- from measurements of entire phantoms at all organisers

Problems:

- Net weight: weighing masses of a few 10 µg, five weighings required per rod
- Gamma-spectroscopy: true-coincidence summing
- Phantom measurements: differences between the current phantom and the phantom that was used for the calibration of the whole-body counter

→ Differences of up to 10% between the results.

→ Application of the robust mean as the reference activity.

Calculation of the activity

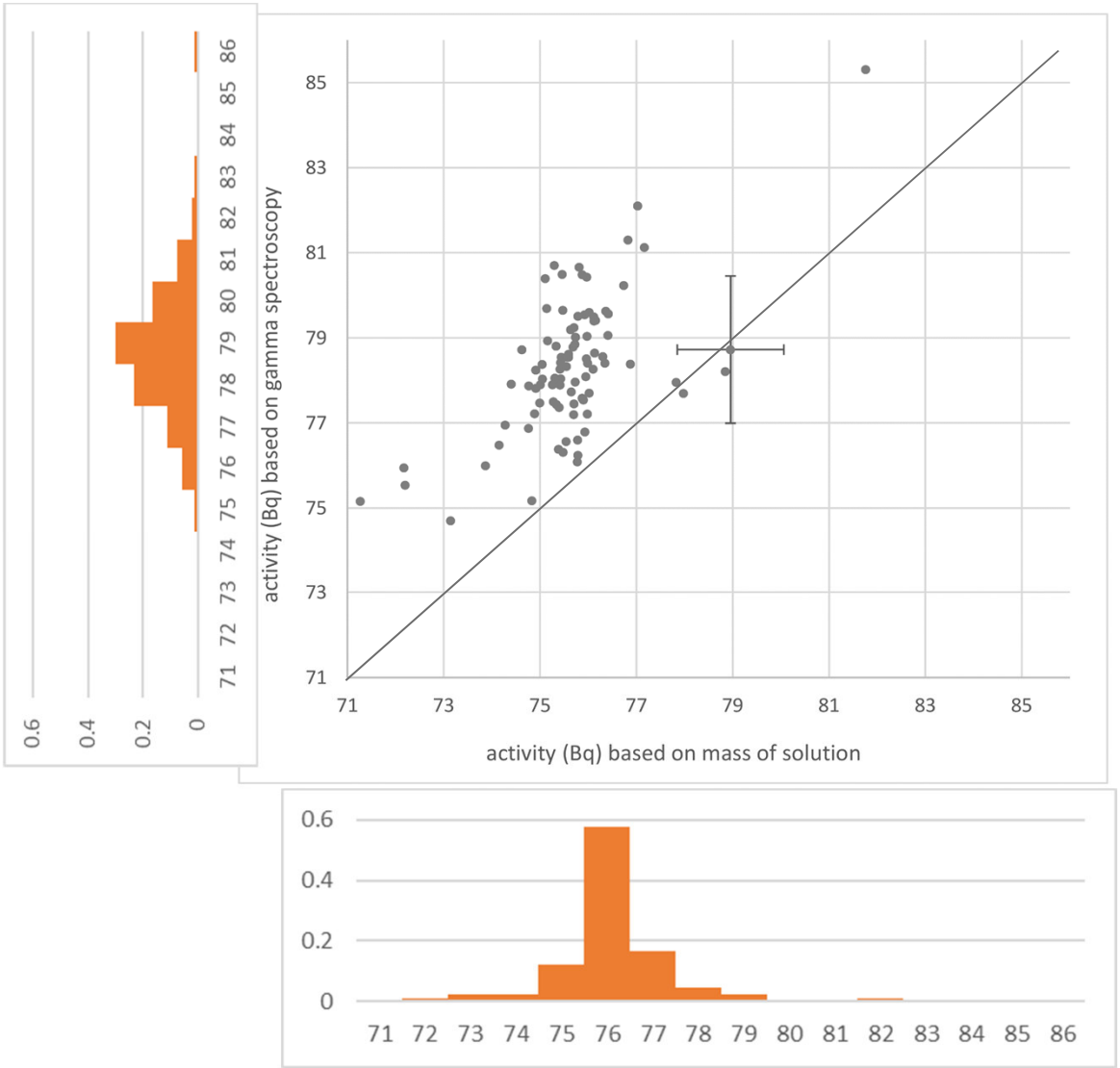
Cs-137
in “Emergency“ sources

- based on mass:

  75.6 ± 1.3 Bq

- based on measurement:

  78.2 ± 2.2 Bq
  bias of 3.5%



Map

Attended tour

Shipment

Organisation of shipment and transport

- All shipments organised and ordered in the web portal of DHL
  (content not a radioactive substance)
- Scheduling of the pickup and delivery exact to the day (mostly reliable),
  also at short notice

- For countries outside the EU: Attended transport much easier than shipment
  ATA Carnet allows temporary import without customs clearance

- Attended transport: 1 lab in 1-2 days → 24 labs in 12 weeks
  Shipment: 1 lab in 5-7 days → 11 labs in 18 weeks

- Shipment: Detailed instructions for the setup required.
  Yet mistakes can occur
  (such as which set of sources to use for Task 3 Medicine)