Detector contamination from a broken sealed test source

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September 19, 2017

Radioactivity measurements laboratory in Bremen

Bremen state laboratory since 1986 (after Chernobyl accident)

1. Official role within the Civil defense and Defense against nuclear hazards
   - Radionuclide monitoring in the environment within the German environmental radioactivity surveillance system IMIS
   - Emergency preparedness
   - Consultancy: state and public
2. Teaching
3. Research

Room S4020 (nuclear legacy, “ASSE 3”)

- Making an inventory of old and unused radioactive sources (sealed and unsealed)
- Organizing disposal of obsolete sources

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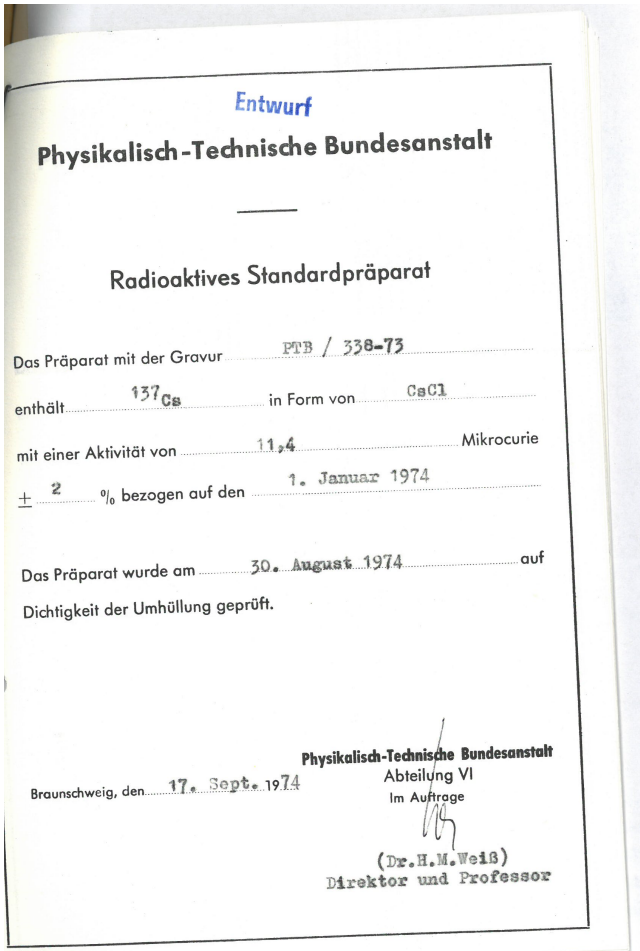
A super-GAU[1] in the lab

- HPGe detector (Det 5) contaminated with ^{137}Cs!
- Where does the contamination come from? What else could be contaminated (other detectors, labs, workers)?

[1] GAU: the worst possible or foreseeable accident considered when designing something such as a nuclear or industrial plant. *[Wictionary]*

So what happened?

- In parallel, the efficiency calibration project with standard solutions in different geometries ongoing...
- But only ^{137}Cs contamination was found



Entwurf

Physikalisch-Technische Bundesanstalt

Radioaktives Standardpräparat

Das Präparat mit der Gravur PTB / 338-73

enthält ^{137}Cs in Form von CsCl

mit einer Aktivität von 11,4 Mikrocurie

± 2 % bezogen auf den 1. Januar 1974

Das Präparat wurde am 30. August 1974 auf Dichtigkeit der Umhüllung geprüft.

Braunschweig, den 17. Sept. 1974

Physikalisch-Technische Bundesanstalt
Abteilung VI
Im Auftrage

(Dr.H.M.Weiß)
Direktor und Professor

Test source (radiation?) damage

Estimated 4% (7.5 kBq) of the total activity of (originally) sealed ^{137}Cs test source contaminated the detector endcap.

Step 1: Debris removal (adhesive tape)

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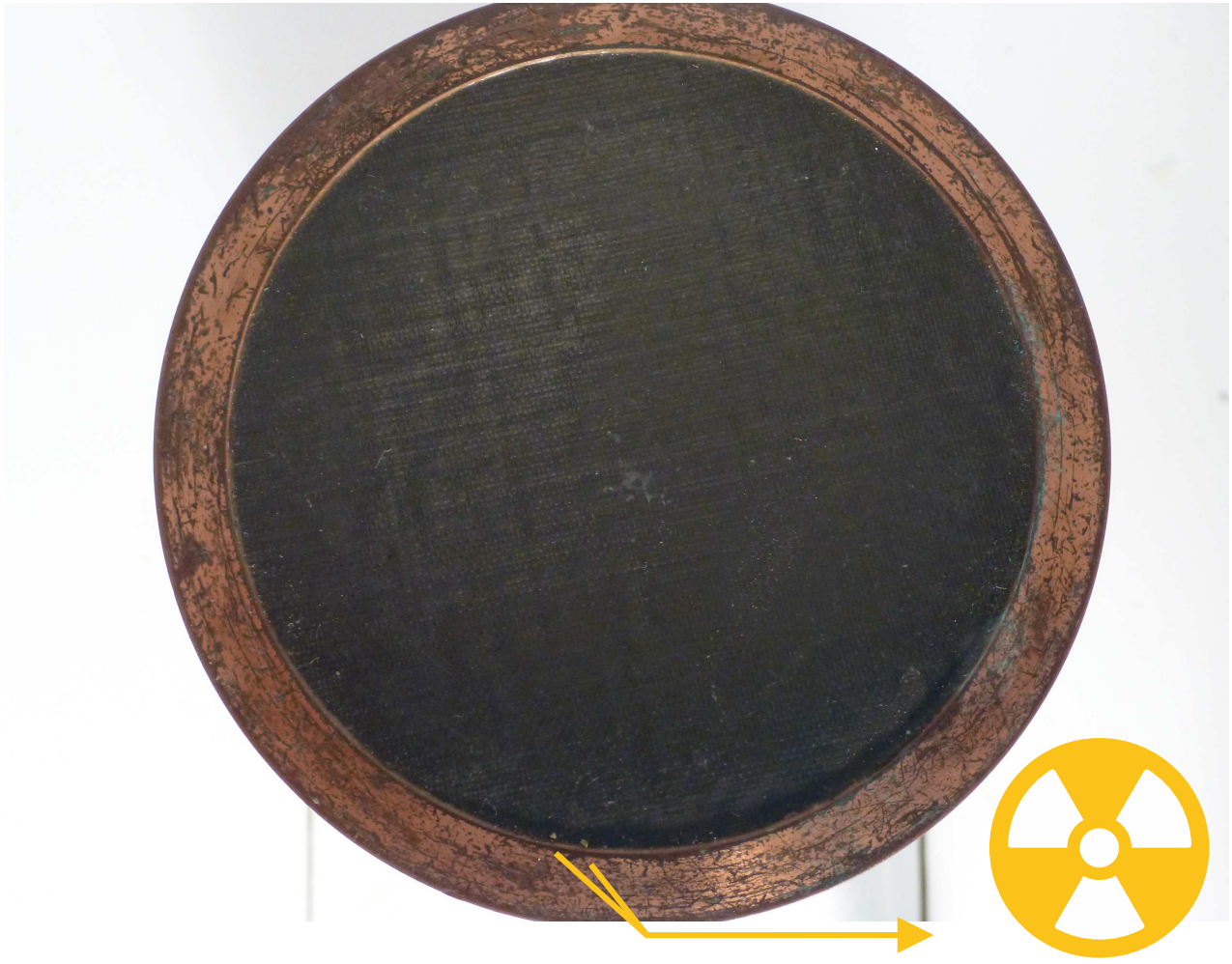
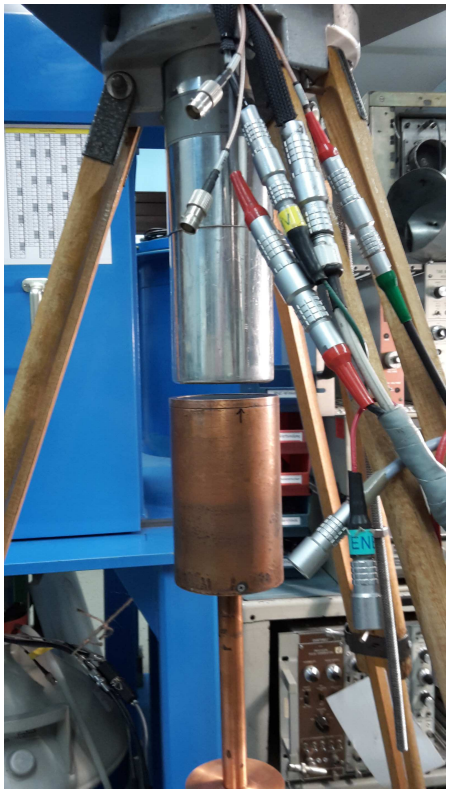
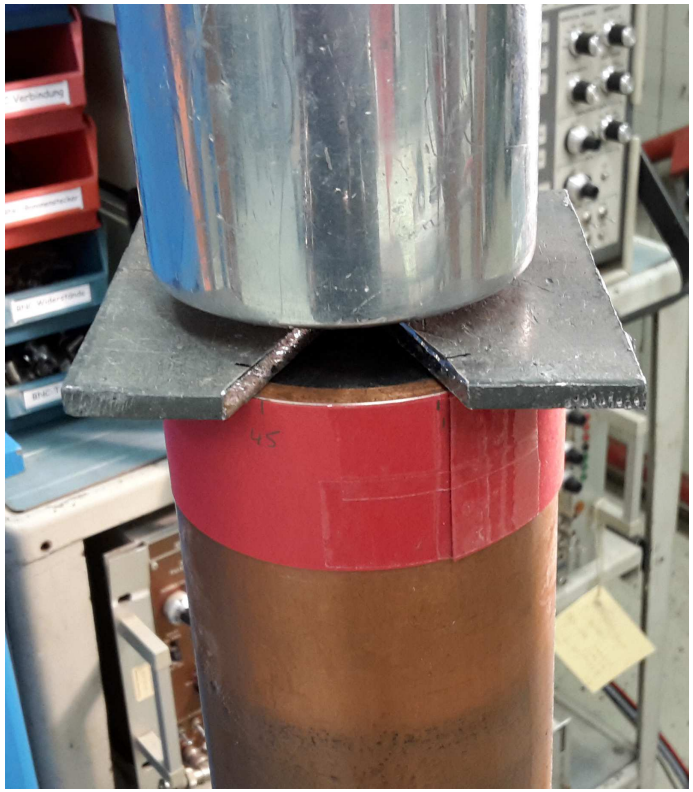


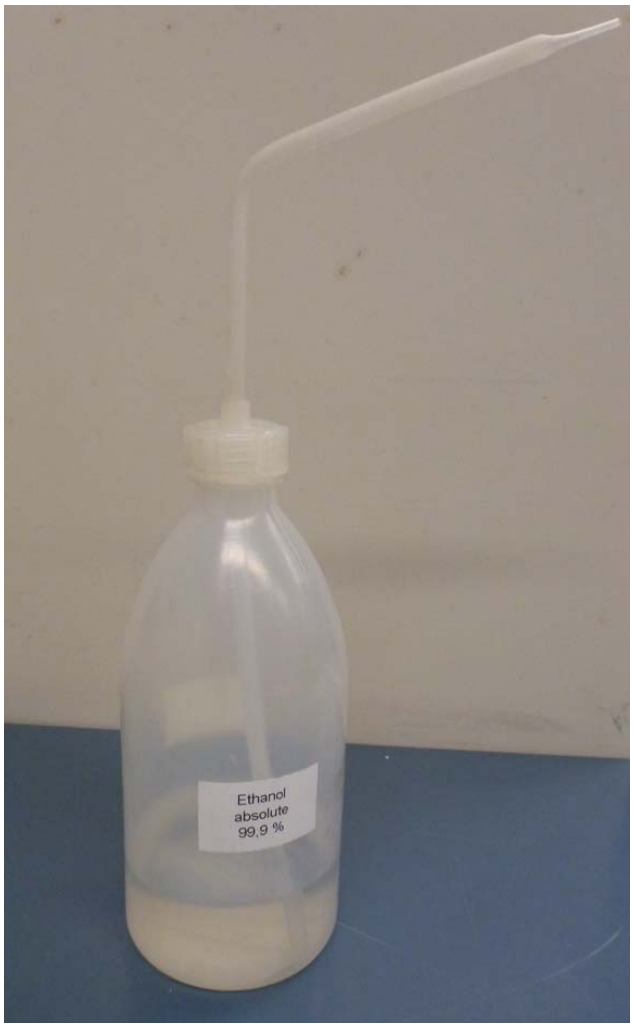
Where exactly is the contamination located?





- Localization of contamination on the detector and inside the shielding
- Only detector endcap was contaminated

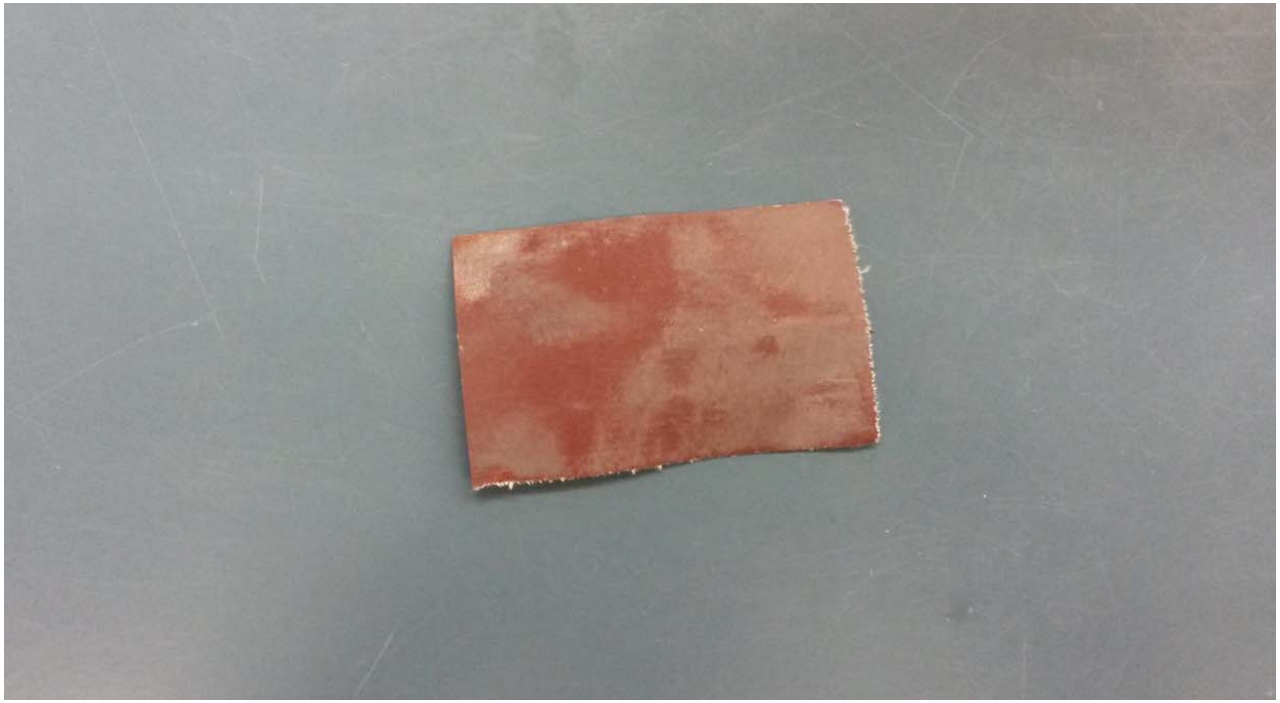
Step 2 & 3: Ethanol



Recommended by the manufacturer.

Step 4: Acidic cleaning (2M HNO_3), water

Step 5: Sandpaper (600), water, ethanol



Step 6: Cleansing milk

Step 7: Abrasive scouring milk + sponge (rough side)

Long-term background study

Table: Detectors used for background comparison.

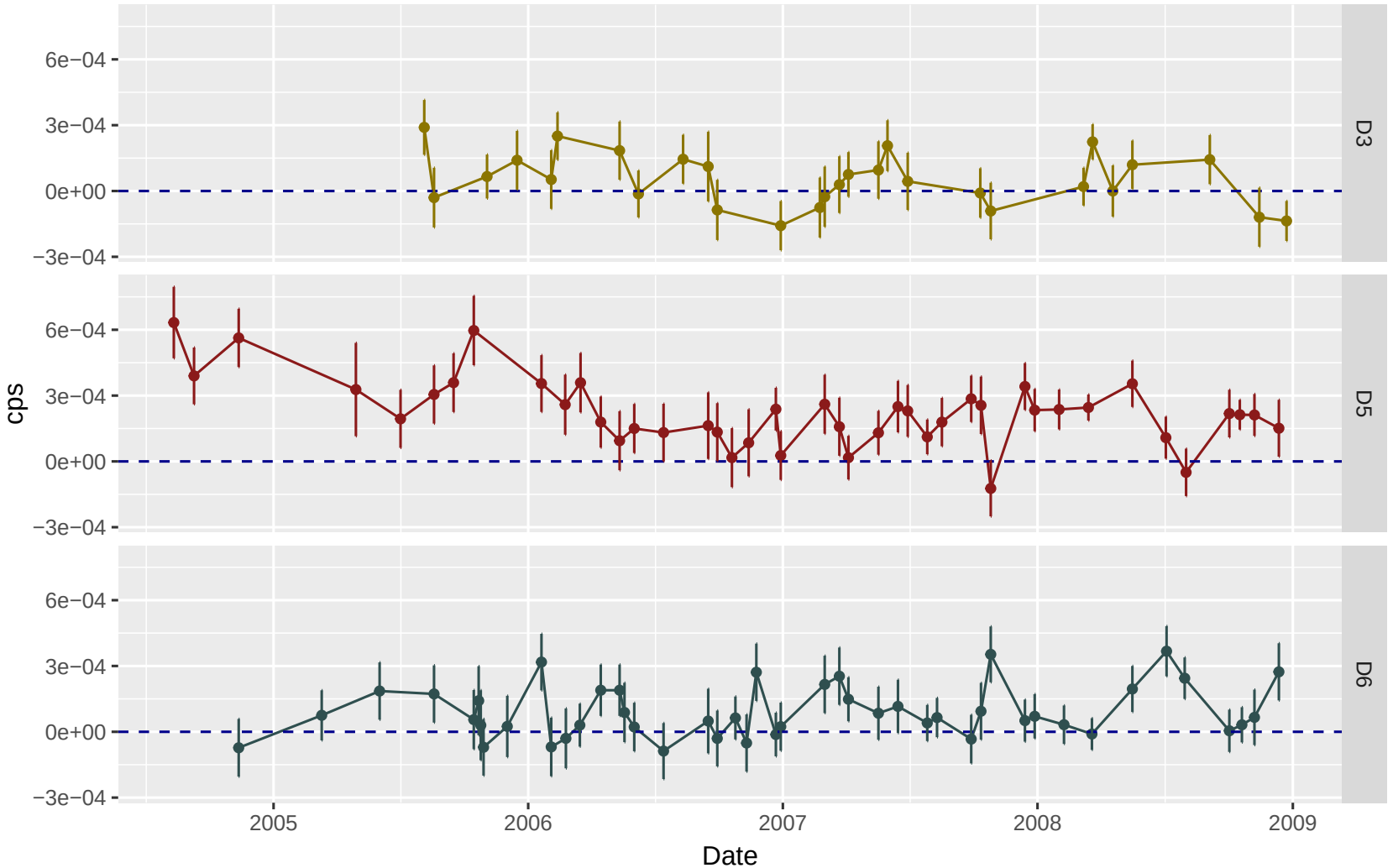
	Det. 3	Det. 5	Det. 6
Description	reverse p-type coaxial Ge detector, Canberra	n-type coaxial Ge detector, Canberra	n-type coaxial Ge detector, Canberra
Size (diameter / length mm)	67 / 60.5	64 / 60	63.5 / 63.5
End- cap	Cu endcap with C epoxy window	Cu endcap with C epoxy window	Cu endcap with C epoxy window
Relative efficiency (%)	51.2	50.8	50.9
FWHM (122 keV / 1332 keV)	0.857 / 1.76	0.931 / 1.87	0.865 / 2.05
Shielding	Pb: 92 mm, Cu: 10 mm, Cd: 1.3 mm, PMMA: 5 mm	Pb: 92 mm, Cu: 10 mm, Cd: 1.3 mm, PMMA: 5 mm	Pb: 100 mm, Cu: 10 mm

Long-term background study

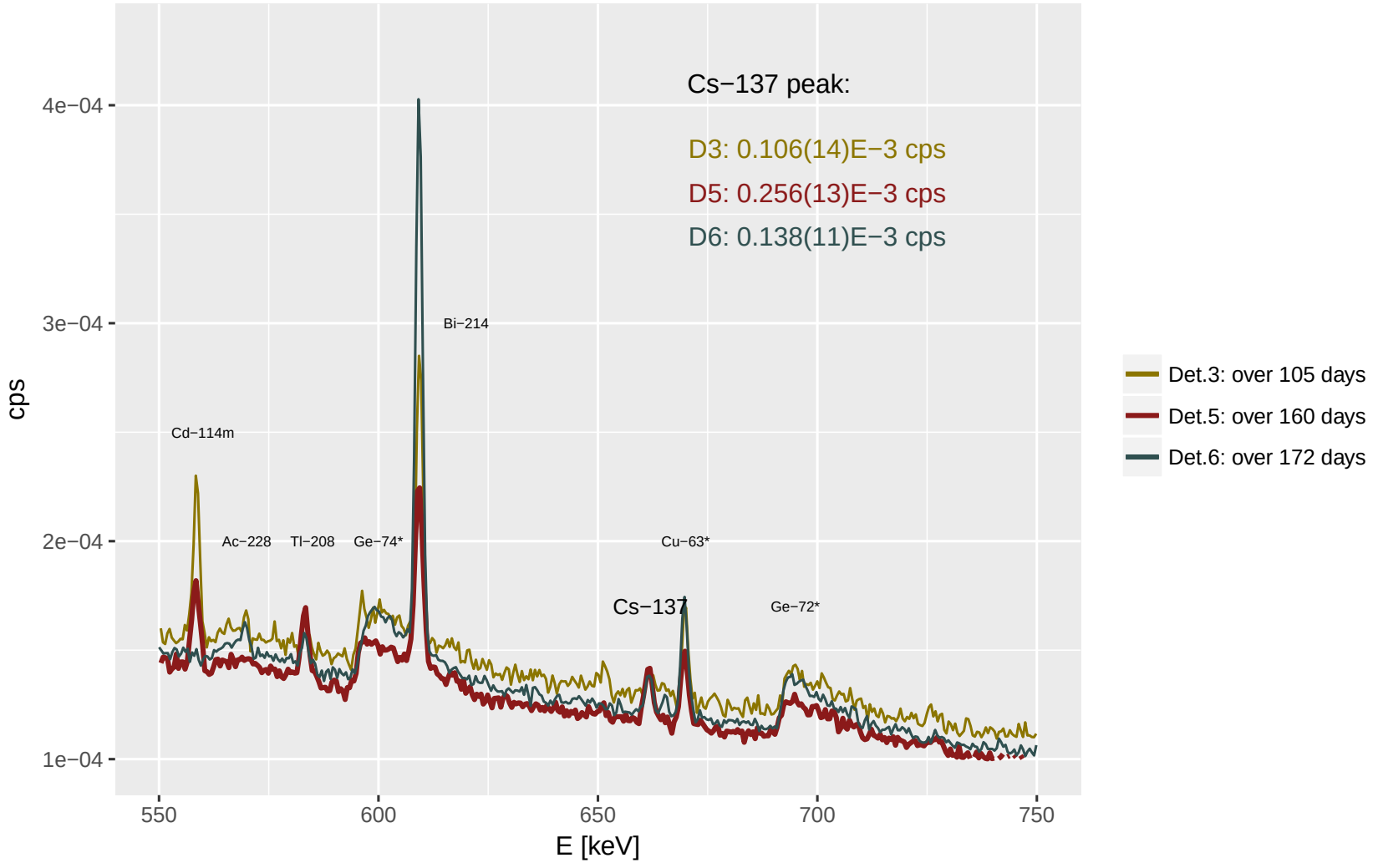
Table: Spectra summing

	Det. 3	Det. 5	Det. 6
Number of summed-up spectra	29	43	46
Time period	8/2005-12/2008	8/2004-12/2008	11/2004-12/2008
Total summed-up time (days)	104.5	159.8	171.9
Count rate 20-2040 keV (s^{-1})	1.35	1.28	1.30

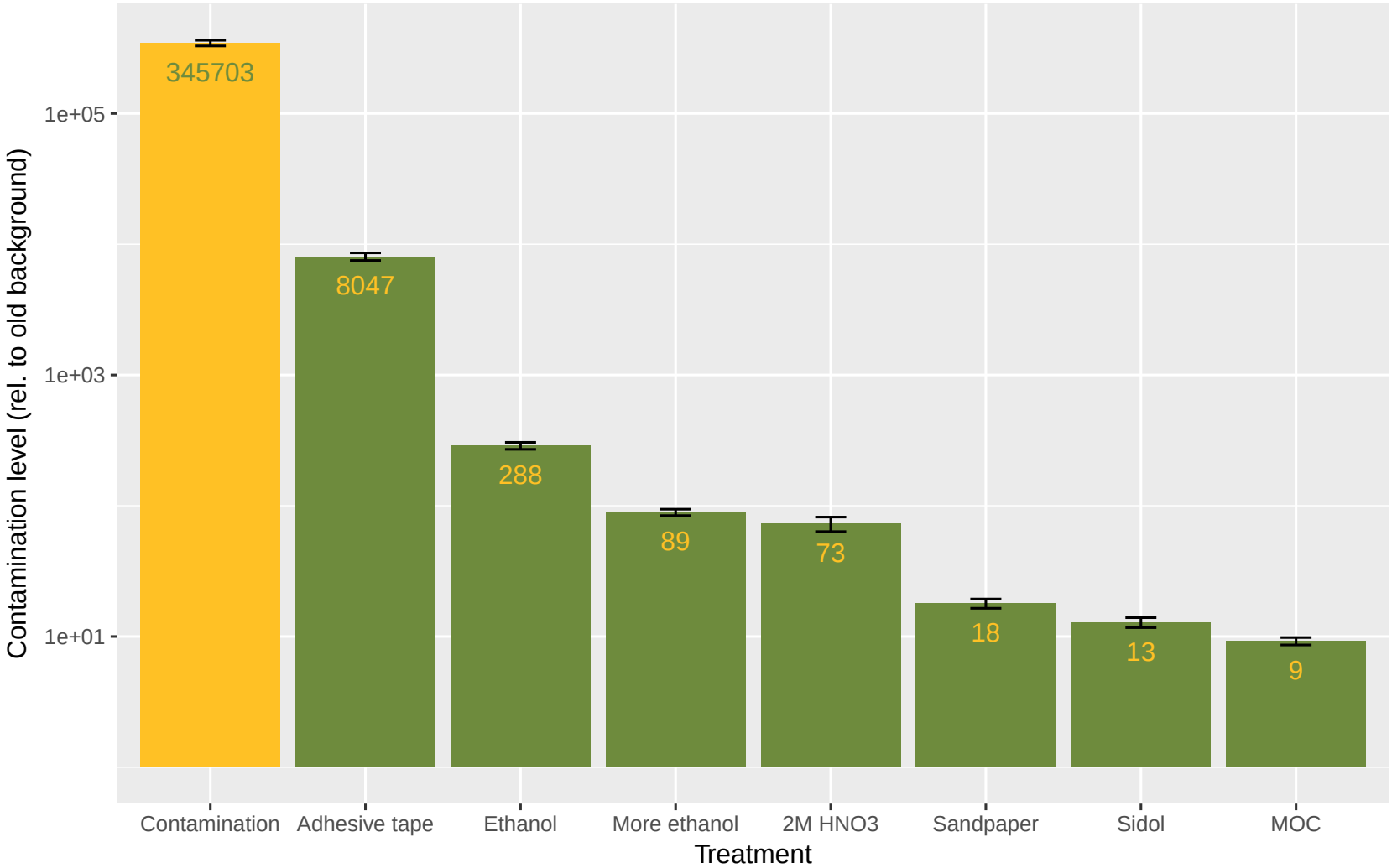
Old background series: net count rates in ^{137}Cs region



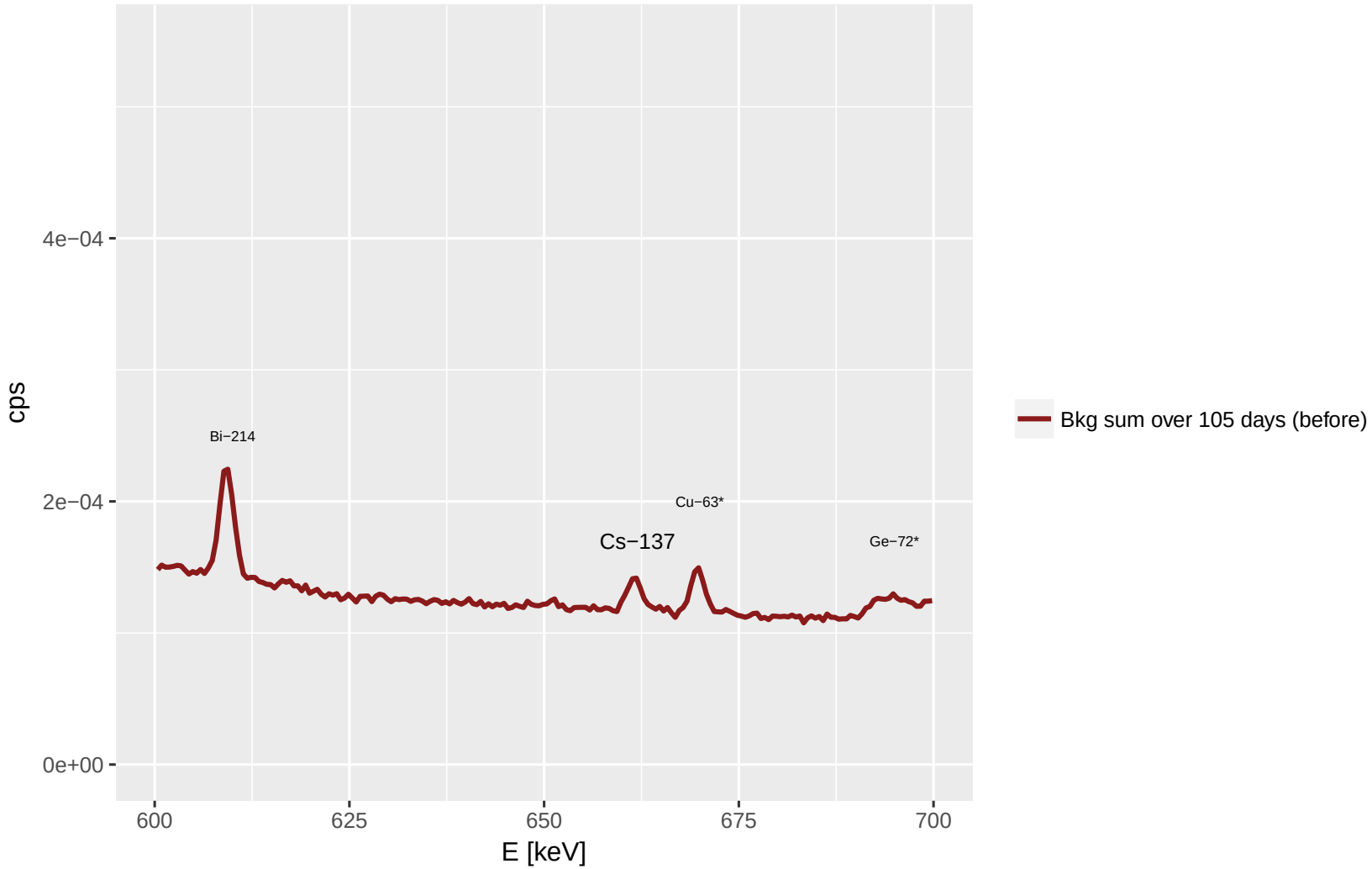
Long-term background spectrum



Decontamination progress



Remaining contamination of detector 5



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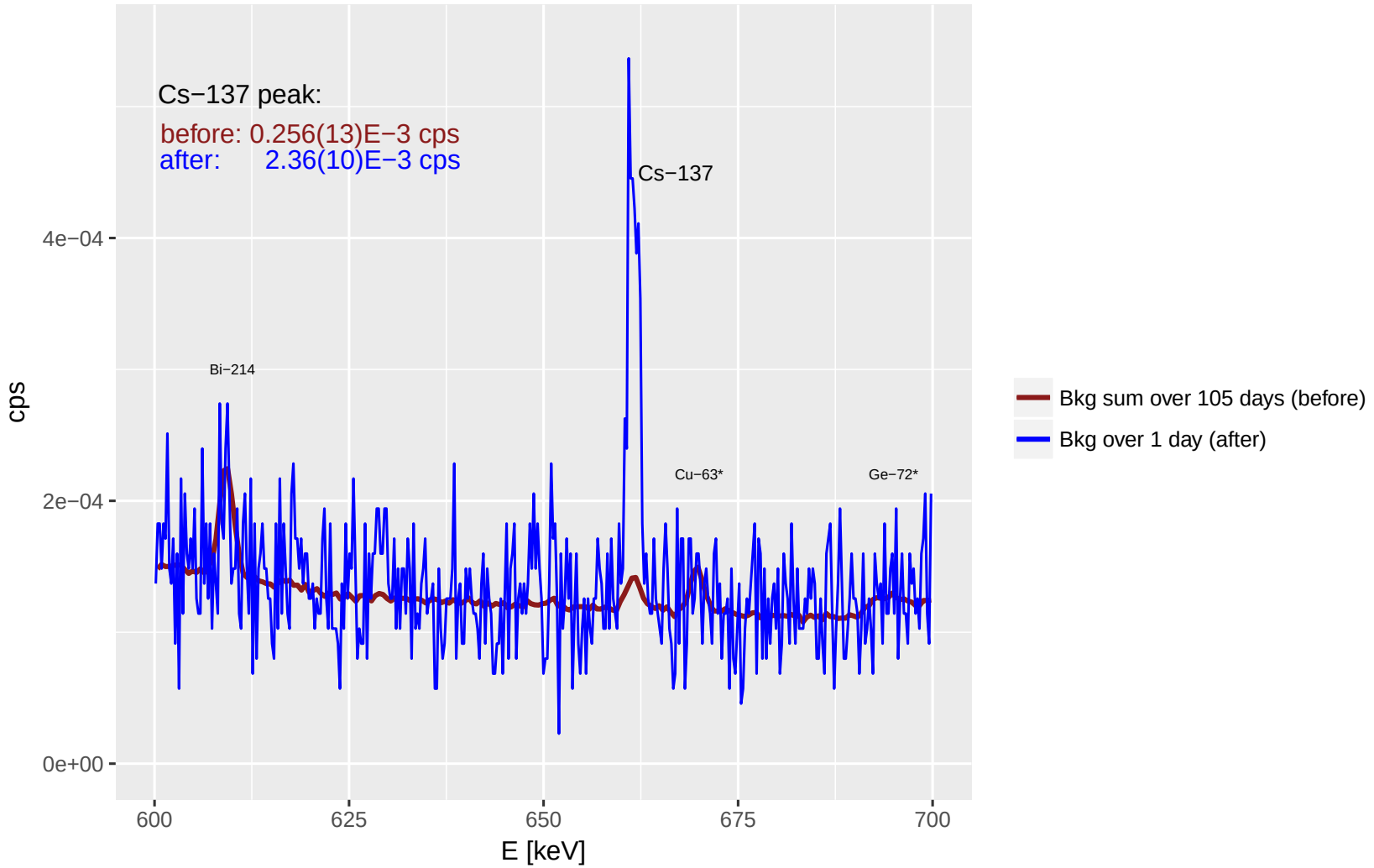

Summary, outlook

- The contaminated HPGe detector endcap was cleaned in several steps by conventional means.
- Still, $2.36 \cdot 10^{-3}$ cps remained in the ^{137}Cs area, 9.2 times the value before the contamination.
- Consequences: MDAs increase. Acceptable for routine environmental samples.
- Good news: the detector was undamaged by the decontamination efforts.
- More sophisticated decontamination approach?
- Autoradiography for localizing the contamination? Chemical agents for binding the remaining ^{137}Cs and removing it?
- Future prevention: regular leak tests?

Take home

Sealed test sources DO age and can get leaky!