

# Results of the peak identification exercise

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# Exercise

- **Identification of radionuclides in**
  - *sewage sludge sample spectrum*
  - *contaminated film badge dosimeter spectrum*
- task was to report all identified nuclides
- a complete solution: identification of all significant peaks
  - no background subtraction

# Dried sewage sludge

- *sewage sludge sample spectrum (12711G6.chn)*
- *sample measured in 0.5 l Marinelli beaker*
- *detector: coaxial, p-type HPGe detector, relative efficiency 39%*
- *counting time 1082 min*
- *energy calibration options*
  - *spectrum: calibG6.chn. certificate of calibration source: certif.txt (files provided)*
  - *energy calibration equation:  $E = 0.3337 * ch - 0.183$  ( $E =$  energy in keV,  $ch =$  channel)*
  - *channel-energy –pairs:*
    - *140.2– 46.54 keV*
    - *1531.4 – 511.0*
    - *4378.6 – 1460.8*
    - *7835.4 – 2614.5*

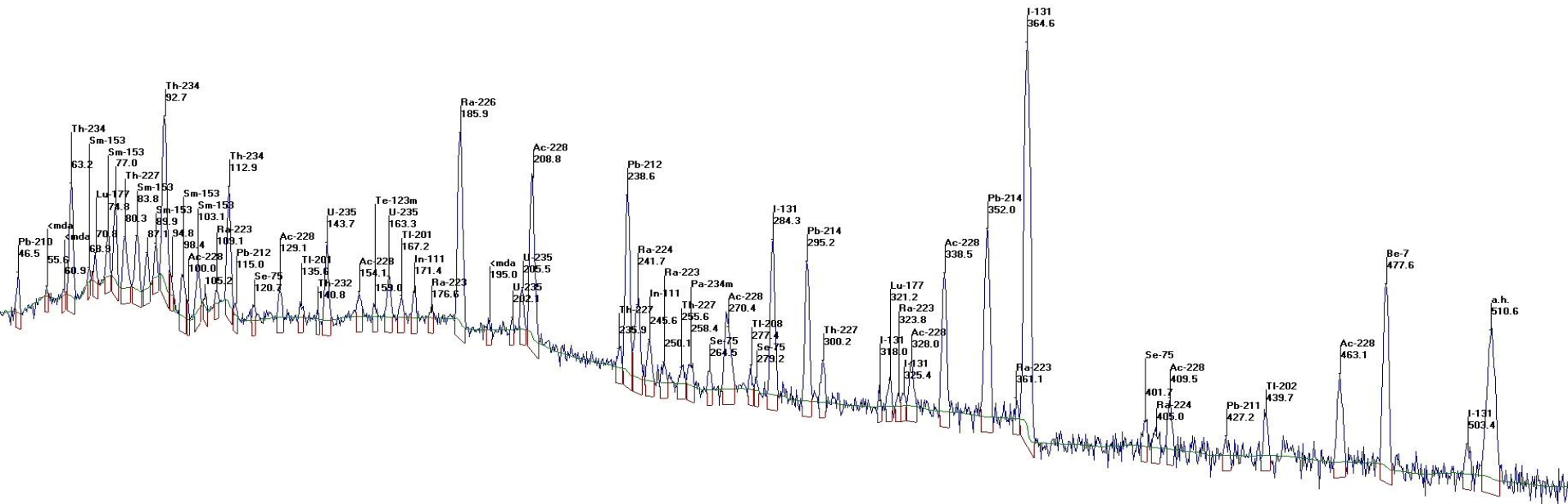
# Results - sludge

- 12 reports received
  - 5 (+ 2) reported individual peak identifications
    - 126 (significant) peaks found (at least two participants reported)
  - 5 reported only identified nuclides
- 23 artificial nuclides reported (9 < reports, 4 <):
  - Mn-54, Co-57, **Co-58**, **Co-60**, Se-75, Nb-97, Tc-99m, Cd-109, **Ag-110m**, In-111, **Sb-124**, Sb-125, Te-123m, I-123, I-124, **I-131**, Cs-134, **Cs-137**, Ce-139, Eu-152, Sm-153, Lu-177, Tl-201
- 19 natural nuclides reported (7 < reports)
  - **Be-7**, **K-40**, **Tl-208**, **Pb-210**, **Pb-212**, **Bi-212**, **Pb-214**, **Bi-214**, Rn-219, Ra-224, **Ra-226**, **Ac-228**, Th-228, Th-231, Th-232, **Th-234**, **Pa-234m**, **U-235**, U-238

# Sludge - Natural nuclides

## Comments:

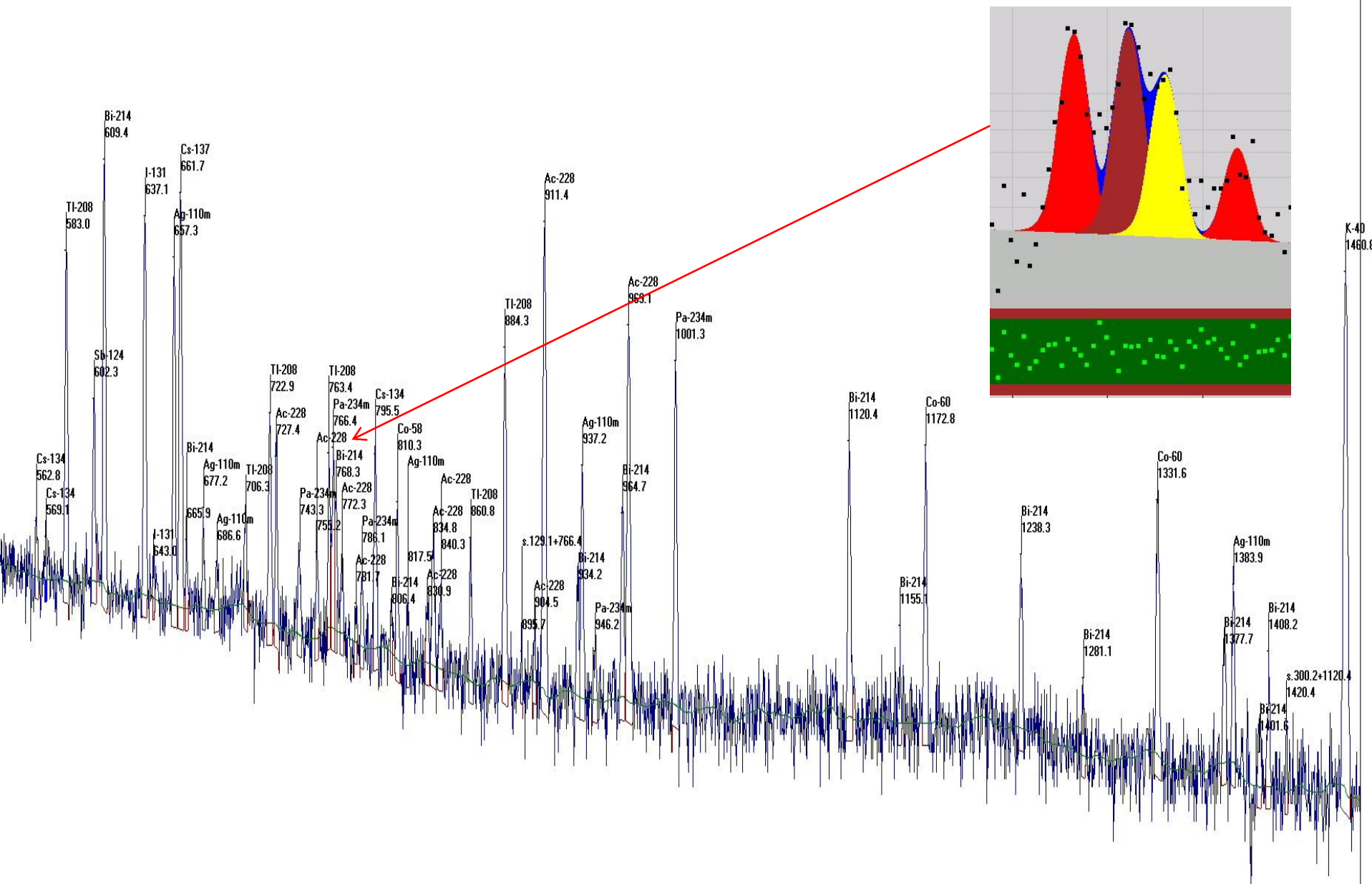
- OK, except **U-238** and perhaps Th-228, Th-231 and Th-232, which possibly present but detection is questionable ...
- Additionally Pb-211, Ra-223 and Th-227 can be indentified, at least based on quantitative results



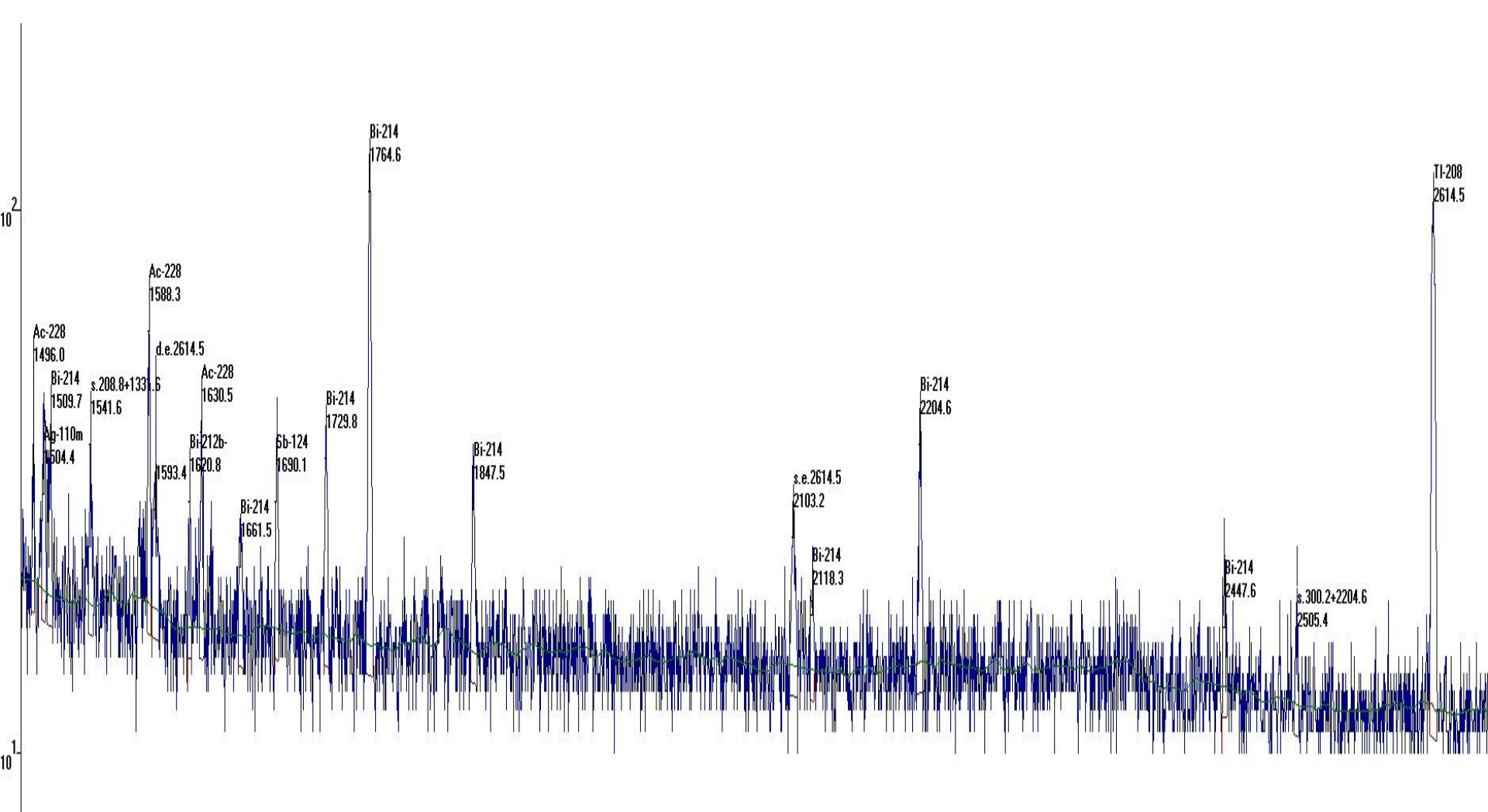
# Sludge - Artificial nuclides

Comments:

- Co-57 is questionable (121 keV and 135 keV can be explained by Se-75 and Tl-201)
- Nb-97 is questionable (657 keV explained by Ag-110m)
- Tc-99m uncertain: weak peak possibly explained by natural decay series
- Cd-109 difficult to convince amongst natural series X-ray peaks
- I-123 and Te-123m: 159 keV explained by Ra-223 ?
- I-124: peaks explained also by Sb-124
- Sb-125: 428 keV can be explained by Pb-211
- Cs-134: main peak very weak
- Ce-139: 165 keV peak missing
- Eu-152: 344 keV peak missing
- 438 peak 10 x larger than K-40 D.E. : Tl-202: longer lived Tl-201 impurity ?







# Contaminated film badge dosimeter

- *dosimeter spectrum file: 11100B1.chn*
- *sample measured on top of the detector end-cap*
- *detector: Canberra BEGe detector BE5030, relative efficiency 50%, composite carbon entrance window, very thin Ge dead layer*
- *counting time 64 min, date Dec 8 2000*
- *energy calibration options*
  - *energy calibration equation:  $E = 0.3305 * ch + 0.7301$  ( $E = \text{energy in keV}$ ,  $ch = \text{channel}$ )*
  - *channel – energy -pairs:*
    - *67.7 – 23.1 keV*
    - *516.3 – 171.3*
    - *740.2 – 245.4*
    - *1258.3 – 416.6*



# Results - dosimeter

- 9 reports received
  - 7 reported individual peak identifications (6 - 35 explained)
  - 2 reported only the (correctly) identified single nuclide : In-111

5 Photon Emissions  $^{111}_{49}\text{In}_{62}$

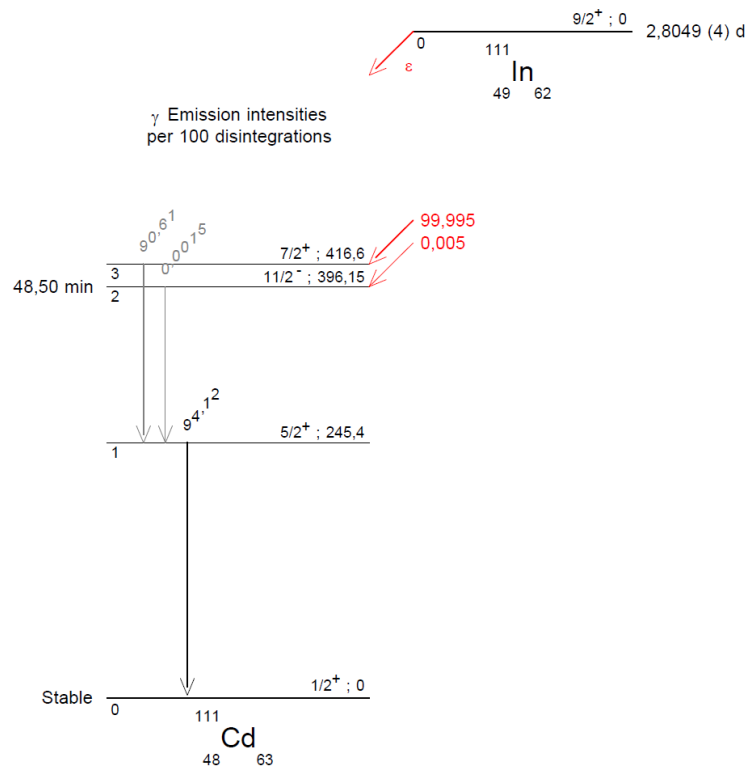
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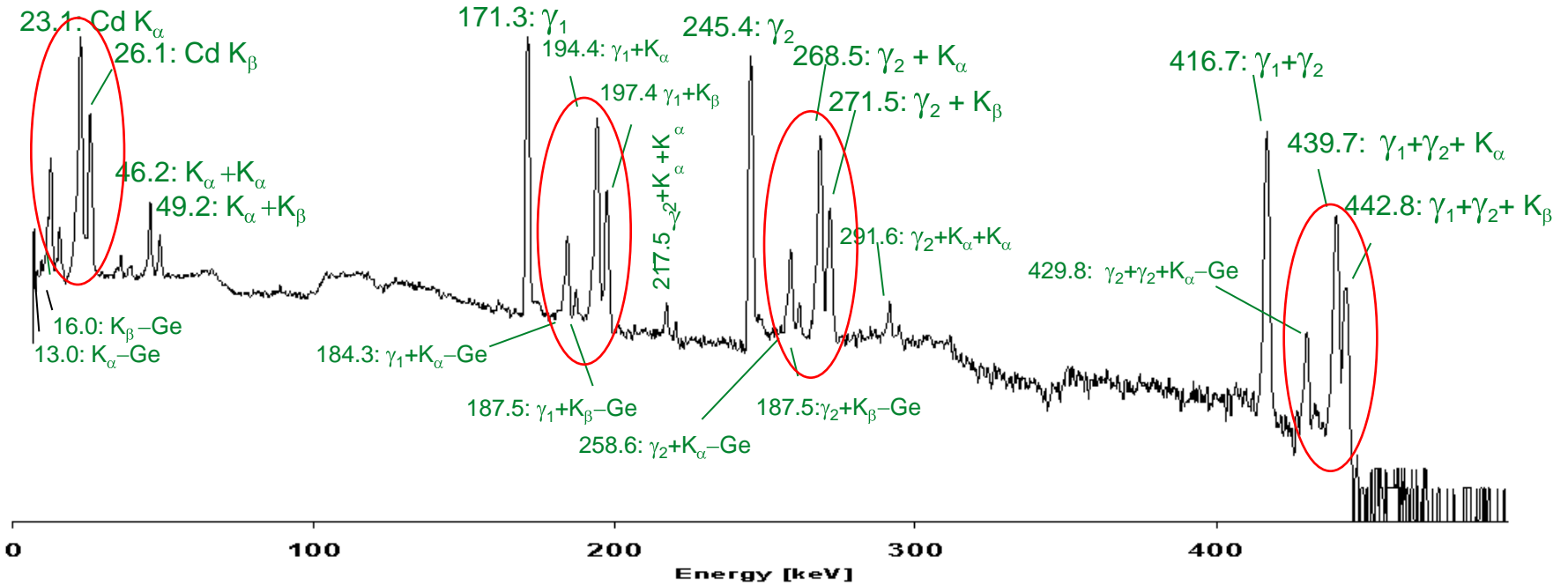
5.1 X-Ray Emissions 29/09/1998 – 26/4/2006 BNM – LNHB/CEA – Table de Radionucléides

		Energy keV	Photons per 100 disint.	
XL	(Cd)	2,77 — 3,95	6,78 (14)	
XK $\alpha_2$	(Cd)	22,9843	23,65 (18)	} K $\alpha$
XK $\alpha_1$	(Cd)	23,1739	44,47 (26)	
XK $\beta_3$	(Cd)	26,0615	}	} K' $\beta_1$
XK $\beta_1$	(Cd)	26,0958	} 12,40 (14)	
XK $\beta'_5$	(Cd)	26,304	}	
XK $\beta_2$	(Cd)	26,644	}	
XK $\beta_4$	(Cd)	26,7106	} 2,26 (7)	
				} K' $\beta_2$

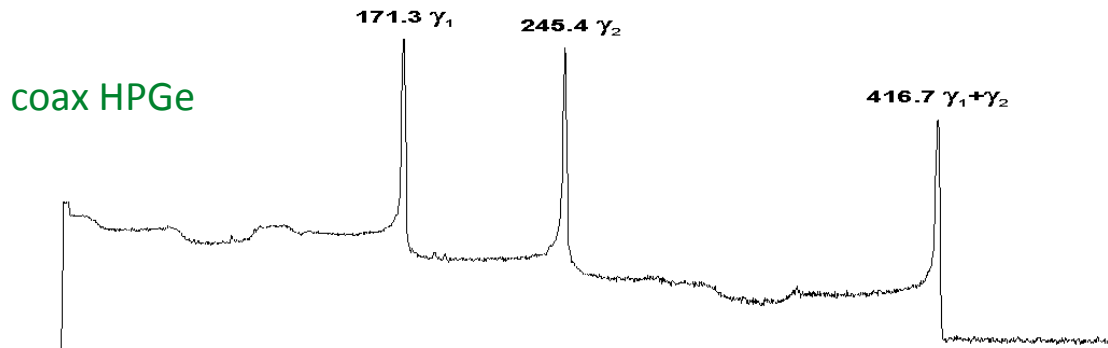
## 5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{2,1}(\text{Cd})$	150,81 (3)	0,0015 (15)
$\gamma_{3,1}(\text{Cd})$	171,28 (3)	90,61 (20)
$\gamma_{1,0}(\text{Cd})$	245,35 (4)	94,12 (6)





Multiple summing of In-111 gamma and X-ray peaks and additionally Ge escape peaks



Energy (keV)	expl.
13.2	23.1 – Ge esc (9.9 keV)
16.5	26.4 – Ge esc
23.2	In-111 K $\alpha$ X
26.4	In-111 K $\beta$ X
36.3	Sum(23.2; 23.2) – Ge
39.7	Sum(26.10; 23.17) – Ge
46.2	Sum(23.2; 23.2)
49.6	Sum(26.10; 23.17)
52.7	Sum(26.4; 26.4)
161.4	171.3 – Ge
171.7	In-111 ( $\gamma_{3,1}$ )
184.9	Sum(171.3; 23.2) – Ge
187.8	Sum(171.3; 26.4) – Ge
194.4	Sum(171.3; 23.2)
197.7	Sum(171.3; 26.4)
207.6	Sum(171.3; 23.2; 23.2) – Ge
217.7	Sum(171.3; 23.2; 23.2)

Energy (keV)	expl.
220.7	Sum(171.3; 26.4; 23.2)
224.0	Sum(171.3; 26.4; 26.4)
235.6	245.4 – Ge
245.4	In-111 ( $\gamma_{1,0}$ )
258.5	Sum(245.4; 23.2) – Ge
261.8	Sum(245.4; 26.4) – Ge
268.4	Sum(245.4; 23.2)
271.7	Sum(245.4; 26.4)
281.6	Sum(245.4; 23.2; 23.2) – Ge
284.9	Sum(245.4; 26.4; 23.2) – Ge
291.8	Sum(245.4; 23.2; 23.2)
294.8	Sum(245.4; 26.4; 23.2)
406.8	Sum(245.4; 171.3) – Ge
416.9	Sum(245.4; 171.3)
429.8	Sum(245.4; 171.3; 23.2) – Ge
433.1	Sum(245.4; 171.3; 26.4) – Ge
439.7	Sum(245.4; 171.3; 23.2)
443.0	Sum(245.4; 171.3; 26.4)

# This particular spectrum has been published !



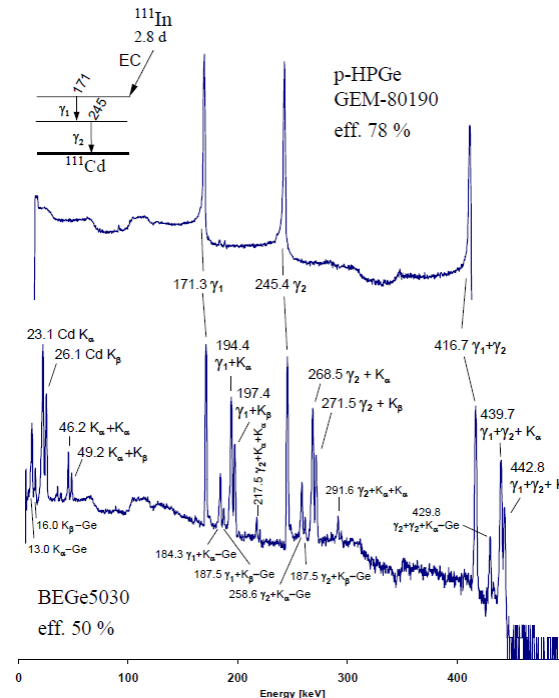
DET ÅTTONDE NORDISKA RADIOEKOLOGISEMINARIET  
THE EIGHT NORDIC SEMINAR ON RADIOECOLOGY  
Rovaniemi 25. - 28.2.2001



## THE EFFECT OF X-RAY SUMMING IN CALIBRATION OF EXTENDED ENERGY RANGE GE DETECTORS

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# Participants

- DTU Nutech, Denmark
- Forsmarks Kraftgrupp AB, Sweden
- Icelandic Radiation Safety Authority, Iceland
- Institute of Marine Research (IMR), Norway
- Lund University, Sweden
- Norwegian Defence Research Establishment (FFI), Norway
- Norwegian Radiation Protection Authority (NRPA), Norway
- Radiation and Nuclear Safety Authority (STUK), Finland
- Studsvik Nuclear AB, Sweden
- Swedish Defence Research Agency (FOI), Sweden
- Swedish Radiation Safety Authority (SSM), Sweden
- University of Helsinki, Finland