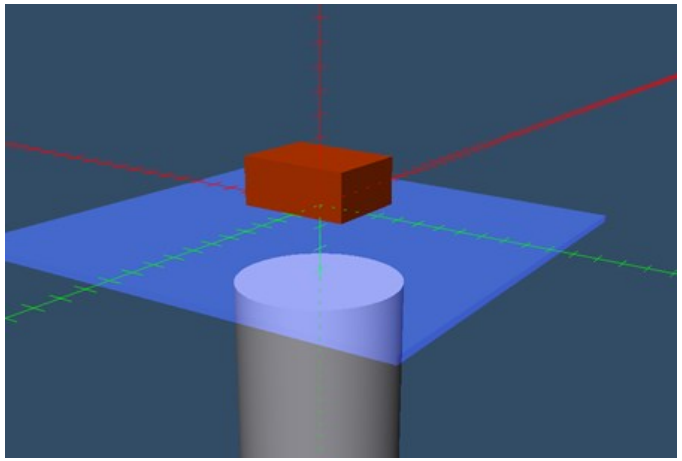
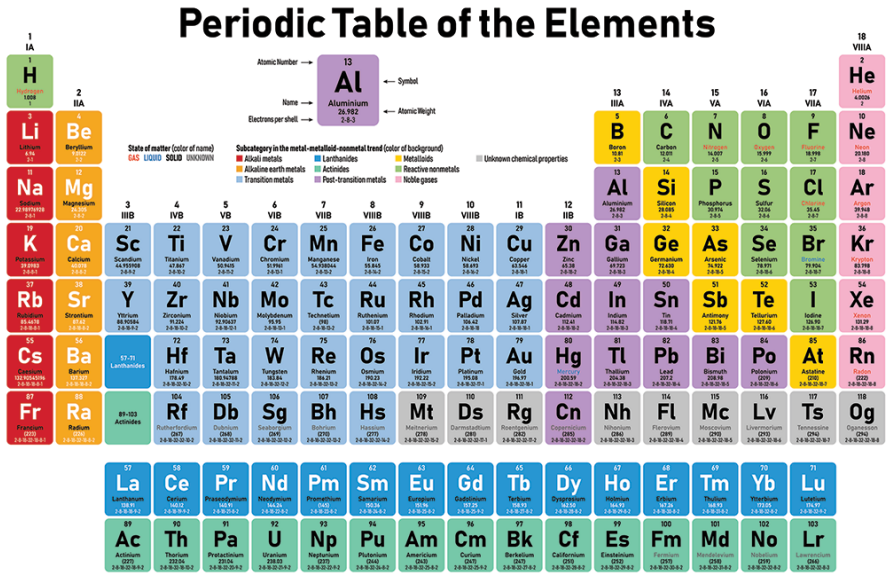
SUNDHEDSSTYRELSEN

Experiences with accreditation of variable-geometry gamma-spectrometry

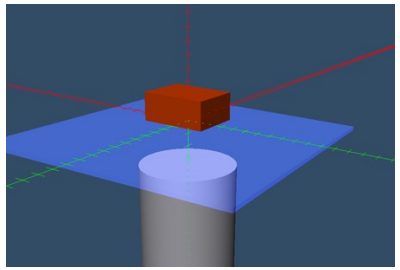
19. september 2023
Asser Nyander Poulsen
Specialkonsulent

Dealing wit irregular geometries and unknown sample compositions





Terms



The client must agree on the proposed geometry model and assumed elemental composition.

The client must accept errors caused by deviations between the real sample and the used geometry model (LabSOCS), regarding:

- Dimensions and form (detailed structure)
- Distribution of radioactivity
- Self-absorption (elemental composition)

This was accepted by the accreditation authorities, **but**:

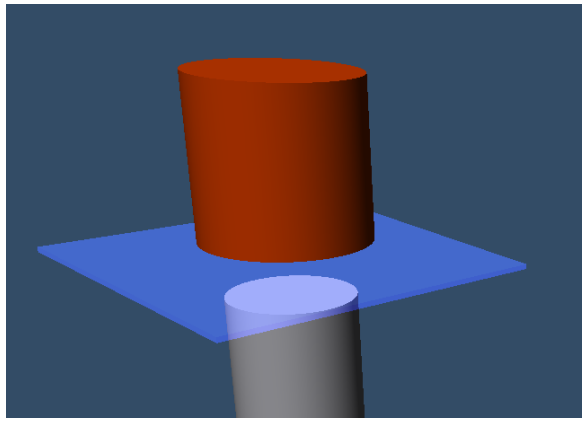
The lab must assist in trying to identify/justify the material composition and must provide guidance on magnitude of potential errors.

Therefore, sensitivity analysis was performed.

Energy–dependent sensitivity analysis (LabSOCS)

Assumed e.g.:

SiO_2 (quartz)
10x10 cm cylinder



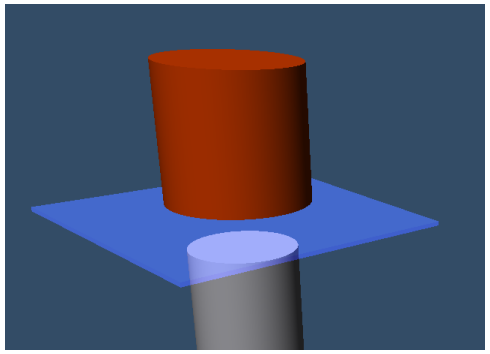
↓ .GIS file

Eff(E)

A_0 (E)= 1/Eff

What if:

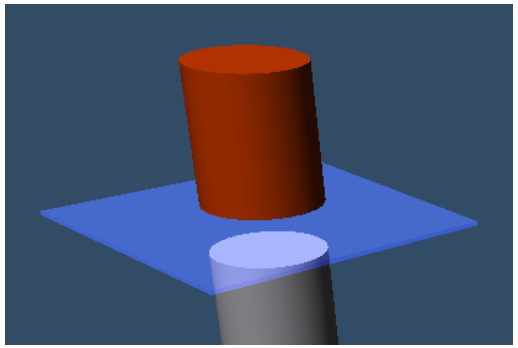
$BaSO_4$ (barite)



↓ .GIS file

A_i (E)= ?

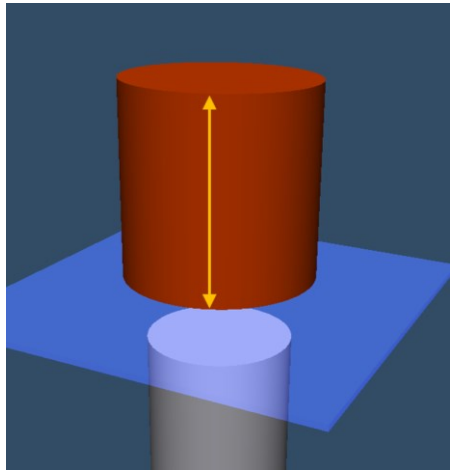
10x8 cm cylinder

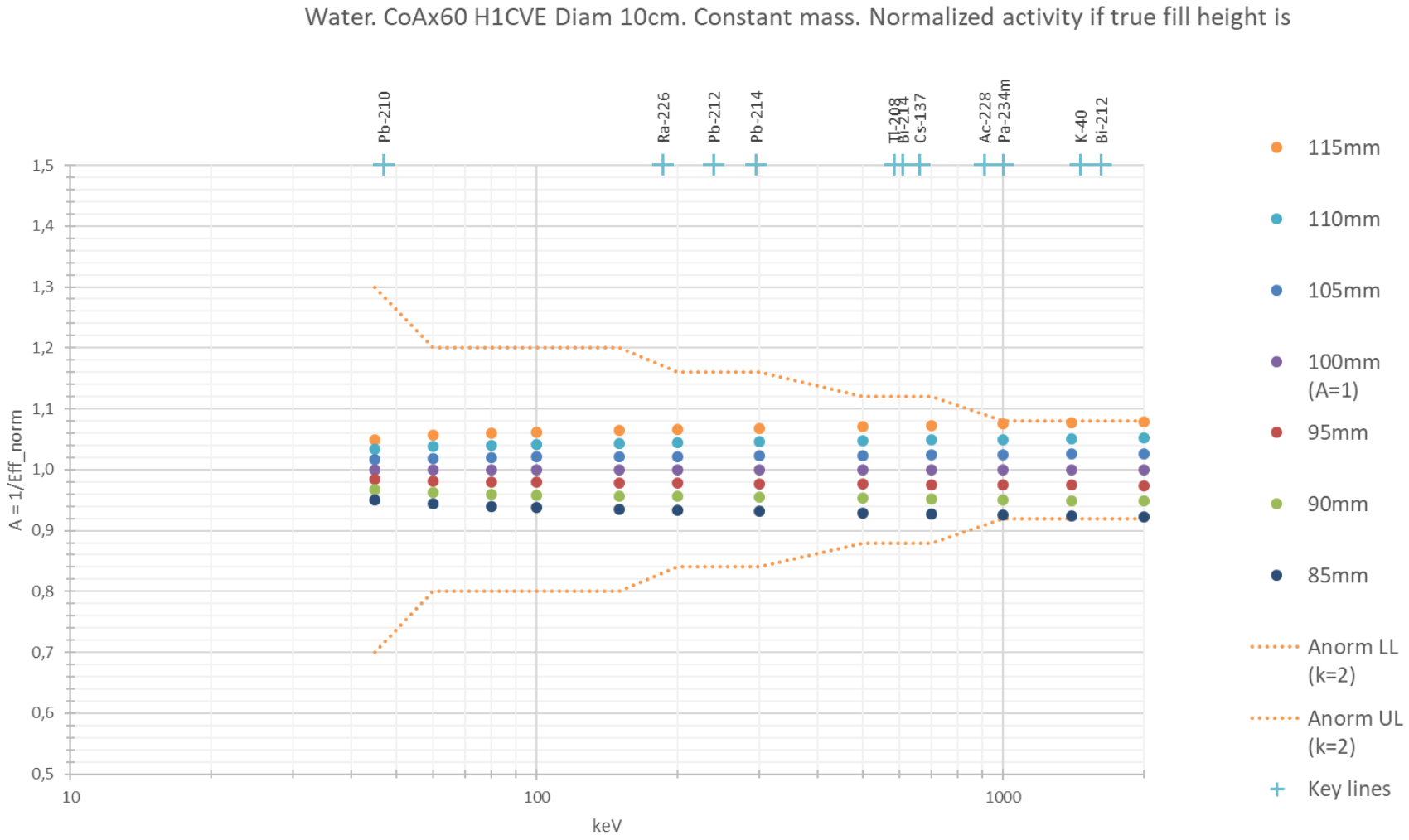


↓ .GIS file

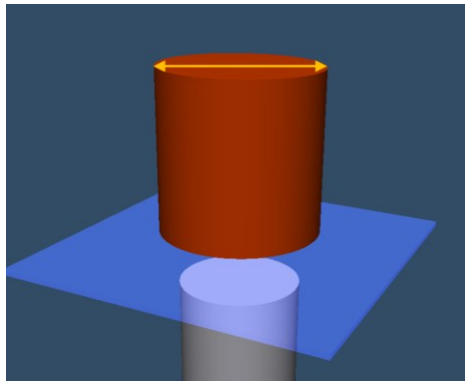
A_i (E)= ?

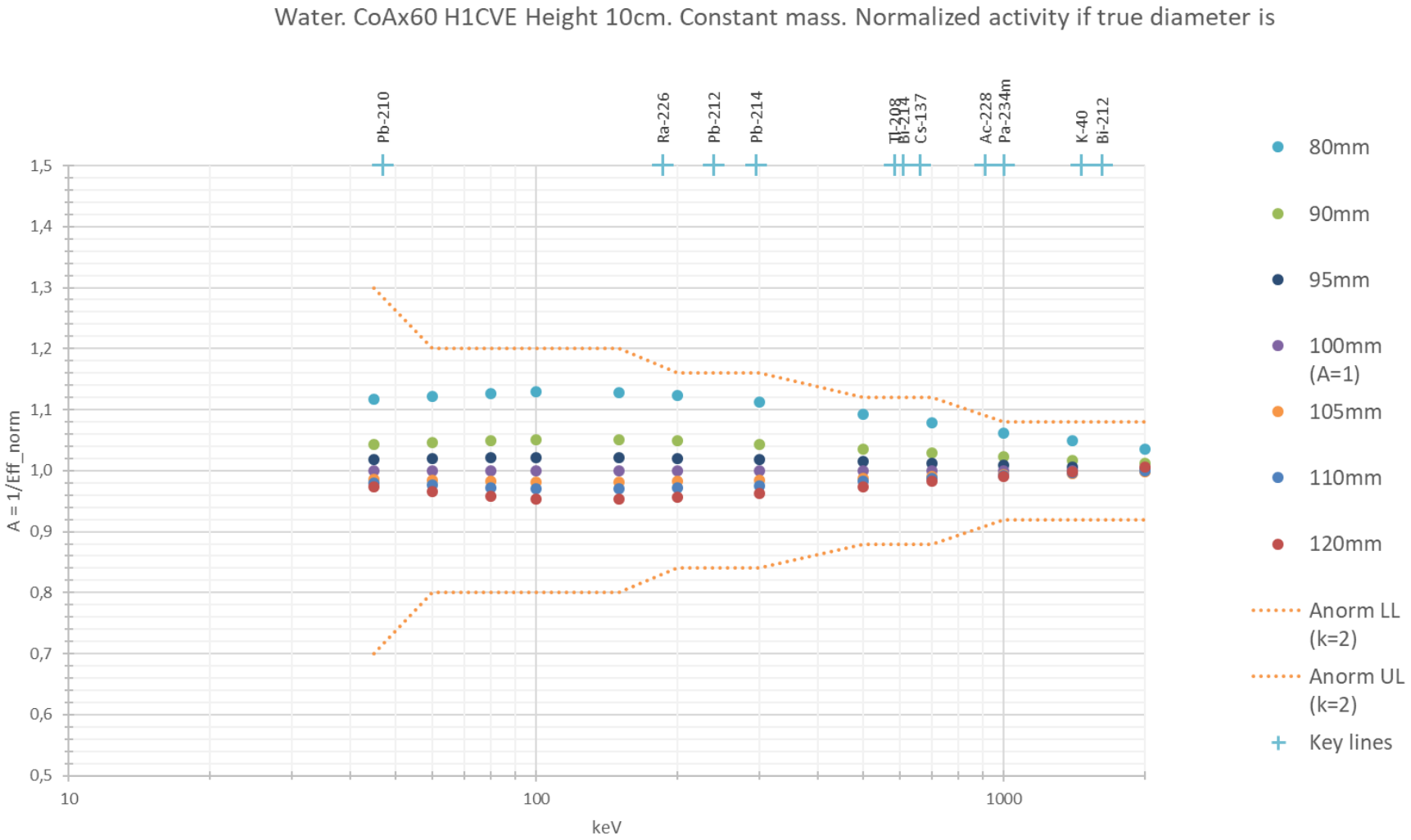
Sample height



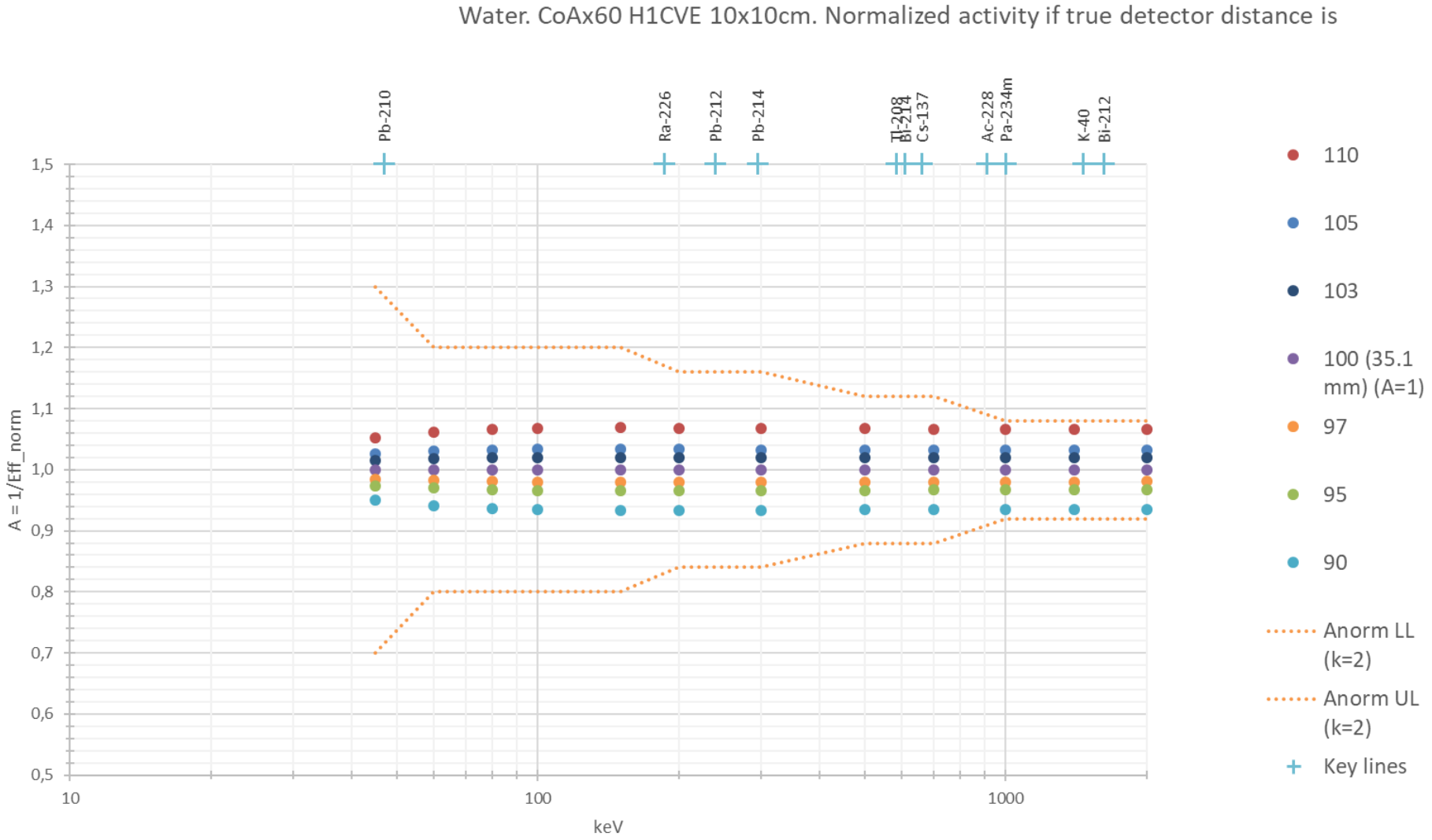


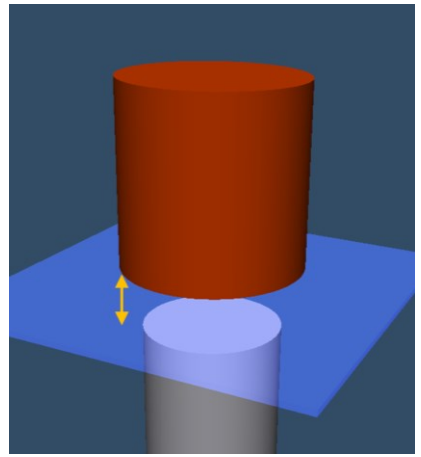
Sample diameter



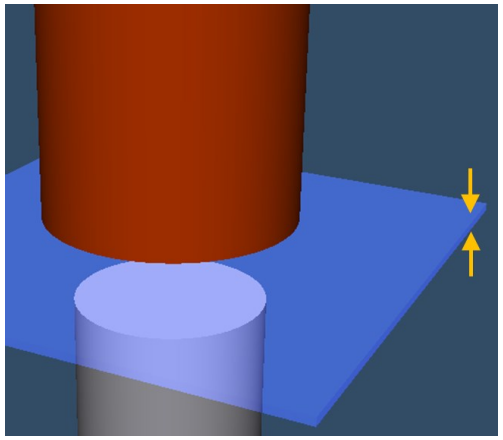


Source-detector distance

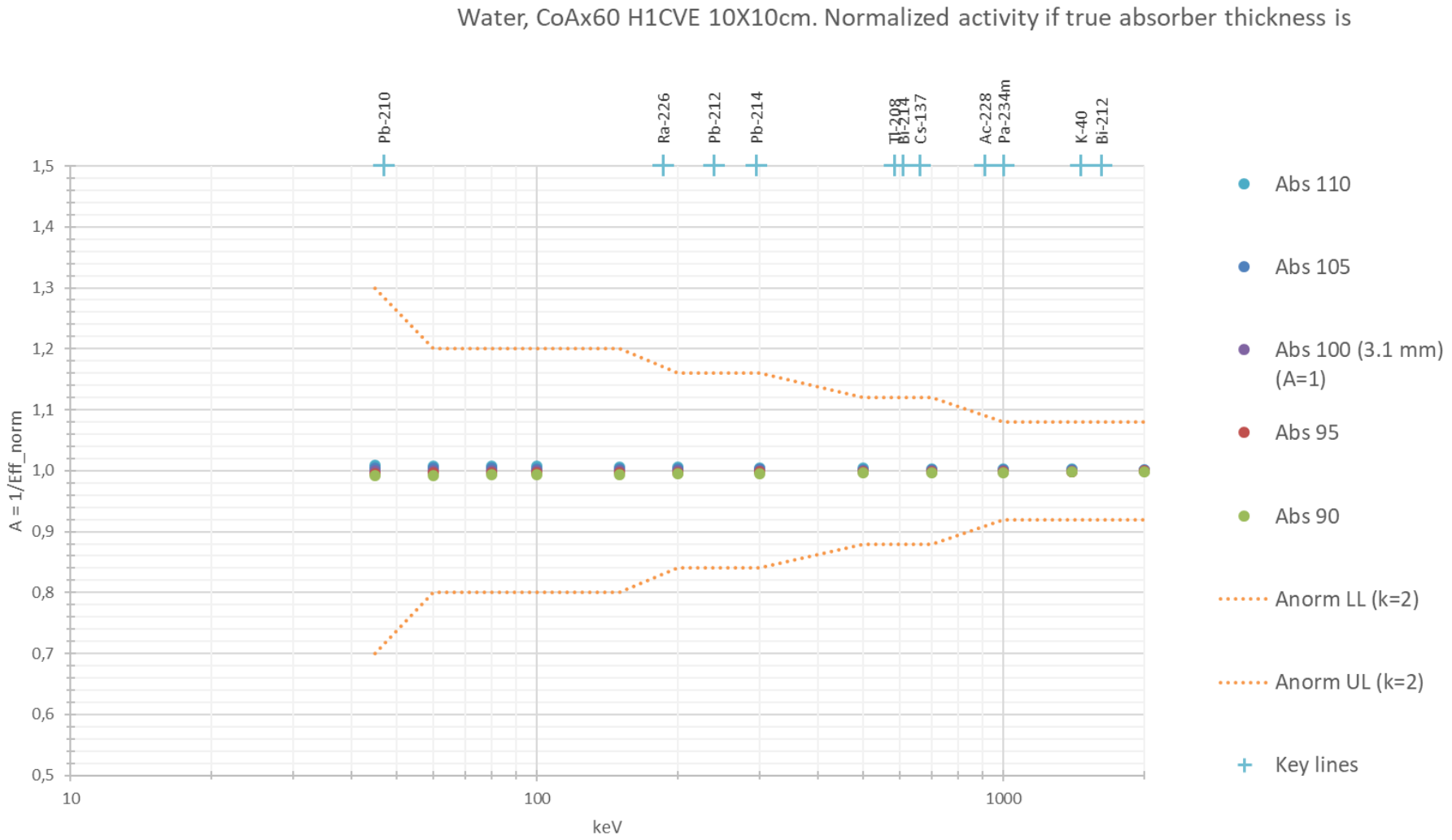




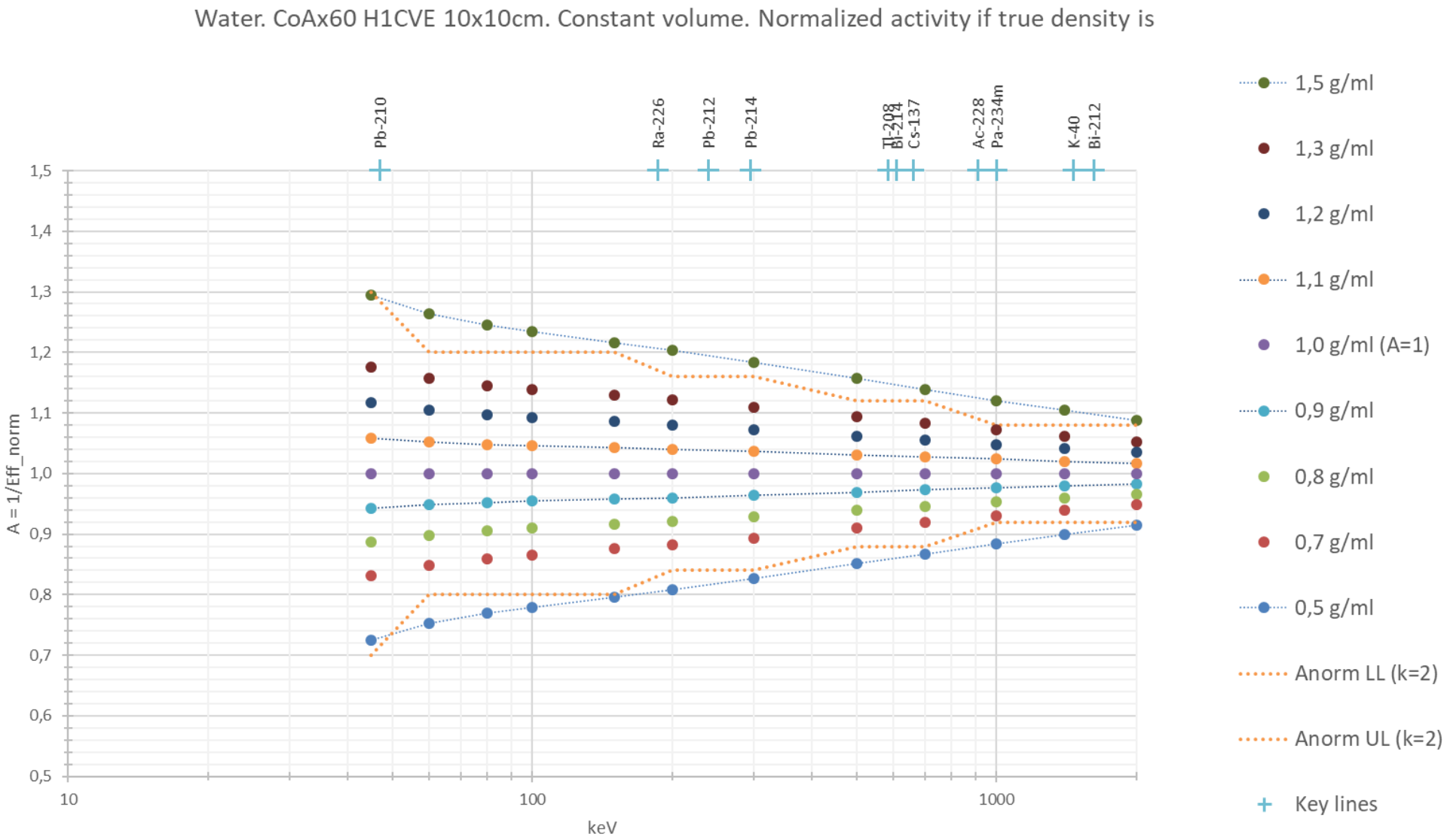
Absorber thickness



plexiglas



Sample density



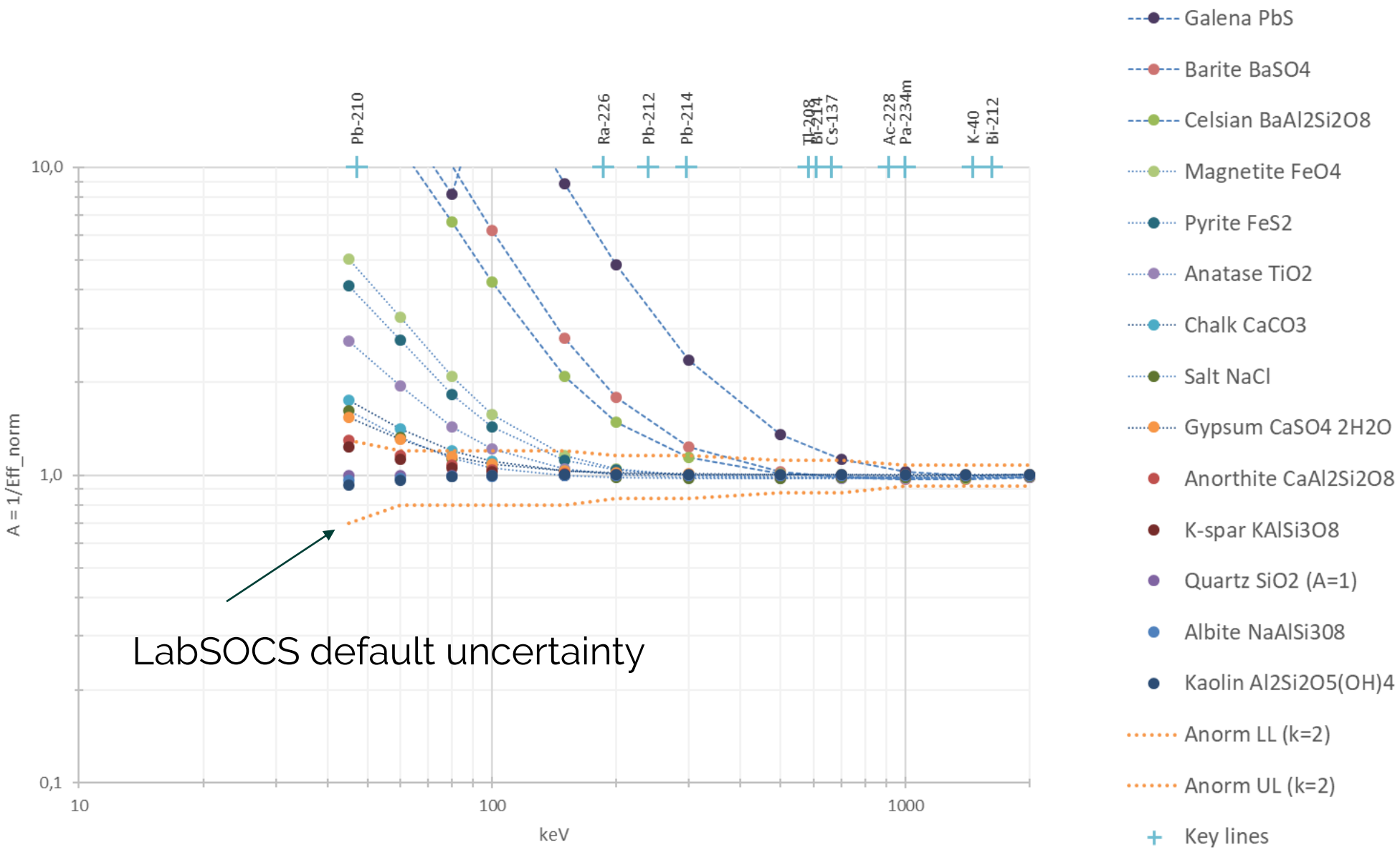
Minerals

Density: 2-5 g/ml

"Tugtupit"
2,35 g/ml

"Apatit"
2,8 g/ml

Minerals. CoAx60 H1CVE 10x10cm. Constant density (2.6g/ml). Normalized activity if true material is



Polymers

PE
(polyethylene)
0,93 g/ml

PVC
1,38 g/ml
(+ chlorine)

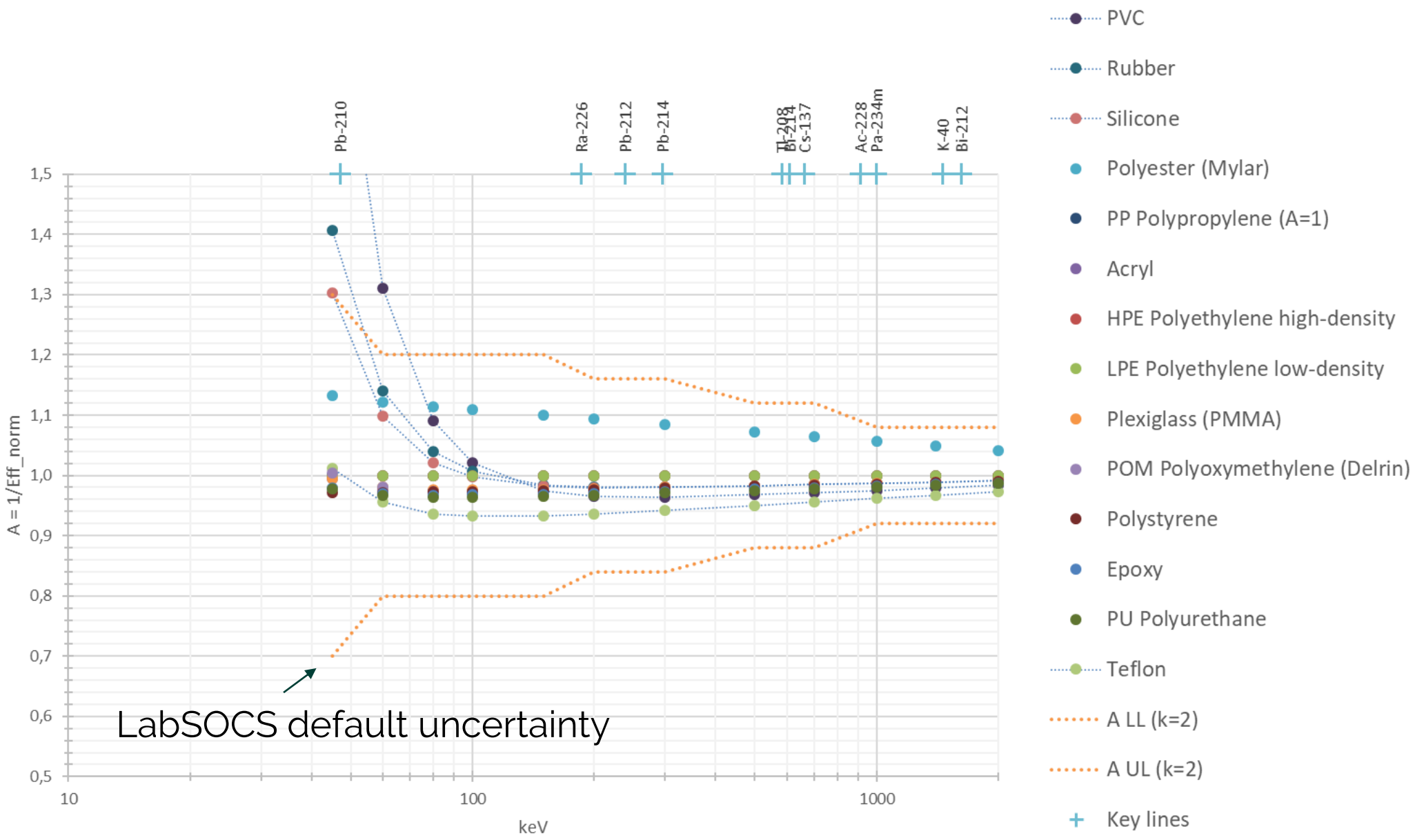
PP
(polypropylene)
0,91 g/ml

Silicone
0,95-1,20 g/ml
(+ silicium)

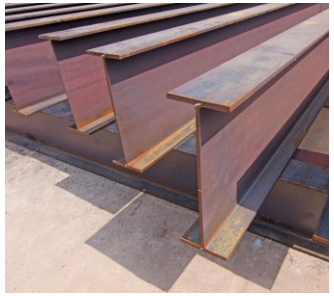
PU
1,0 -1,3 g/ml

Rubber
1,34 g/ml
(+ sulphur)

Plastics, CoAx60 H1CVE 10x10cm. Constant density (1 g/ml). Normalized activity if true material is



Metals and alloys



Steel / iron
ca. 8 g/ml

Stainless
ca. 8 g/ml

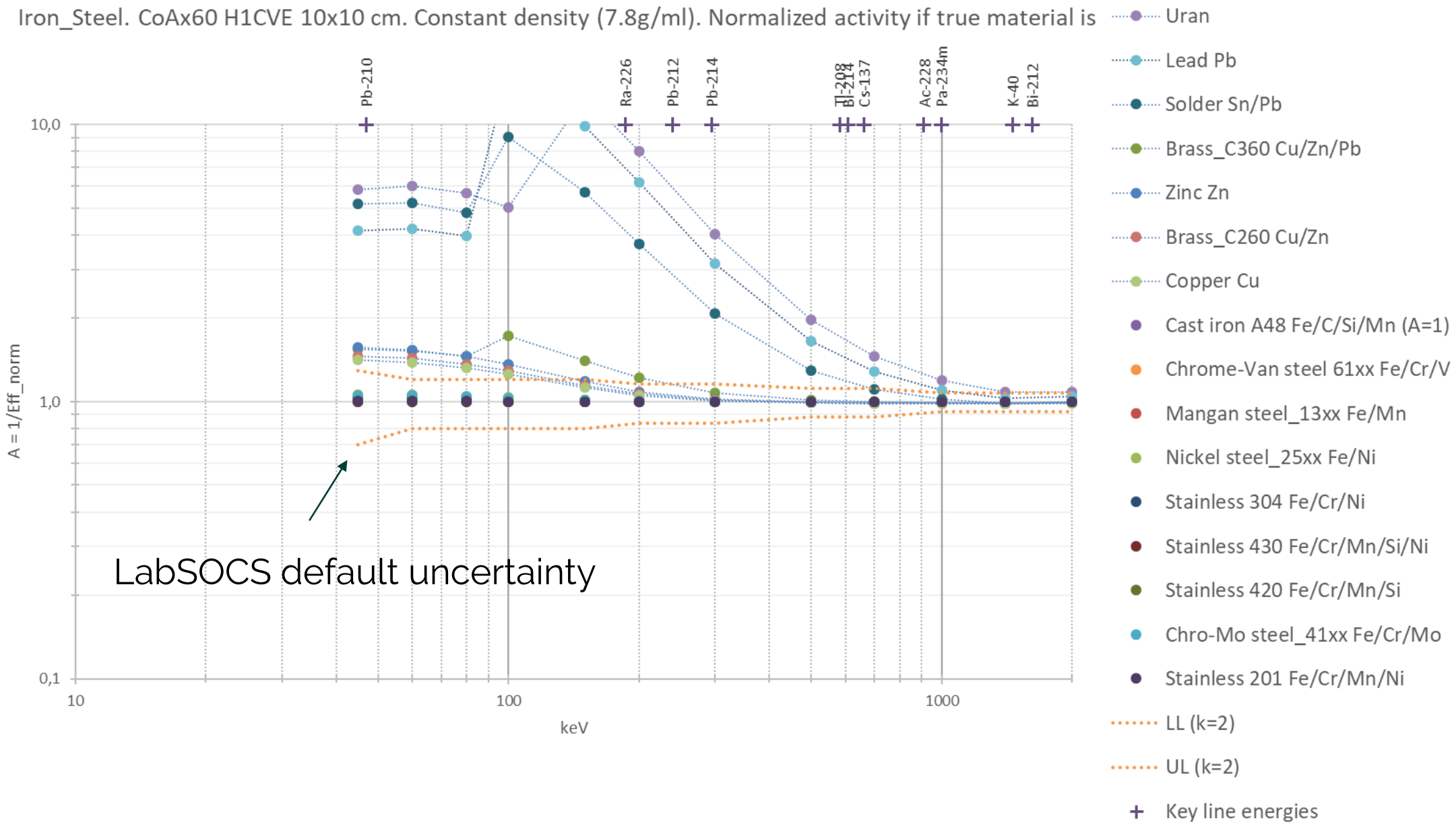
Brass
ca. 8,5 g/ml

Zinc
7,1 g/ml

(Surface only?)

Lead
11,3 g/ml

Cupper
9 g/ml


Iron_Steel. CoAx60 H1CVE 10x10 cm. Constant density (7.8g/ml). Normalized activity if true material is
Pb-210
Ra-226
Pb-212
Pb-214
Tl-208
Bi-214
Cs-137
Ac-228
Pa-234m
K-40
Bi-212
10,0
1,0
0,1
A = 1/Eff_norm
10
100
1000
keV
LabSOCS default uncertainty
Uran
Lead Pb
Solder Sn/Pb
Brass_C360 Cu/Zn/Pb
Zinc Zn
Brass_C260 Cu/Zn
Copper Cu
Cast iron A48 Fe/C/Si/Mn (A=1)
Chrome-Van steel 61xx Fe/Cr/V
Mangan steel_13xx Fe/Mn
Nickel steel_25xx Fe/Ni
Stainless 304 Fe/Cr/Ni
Stainless 430 Fe/Cr/Mn/Si/Ni
Stainless 420 Fe/Cr/Mn/Si
Chro-Mo steel_41xx Fe/Cr/Mo
Stainless 201 Fe/Cr/Mn/Ni
LL (k=2)
UL (k=2)
Key line energies

Light-metal alloys

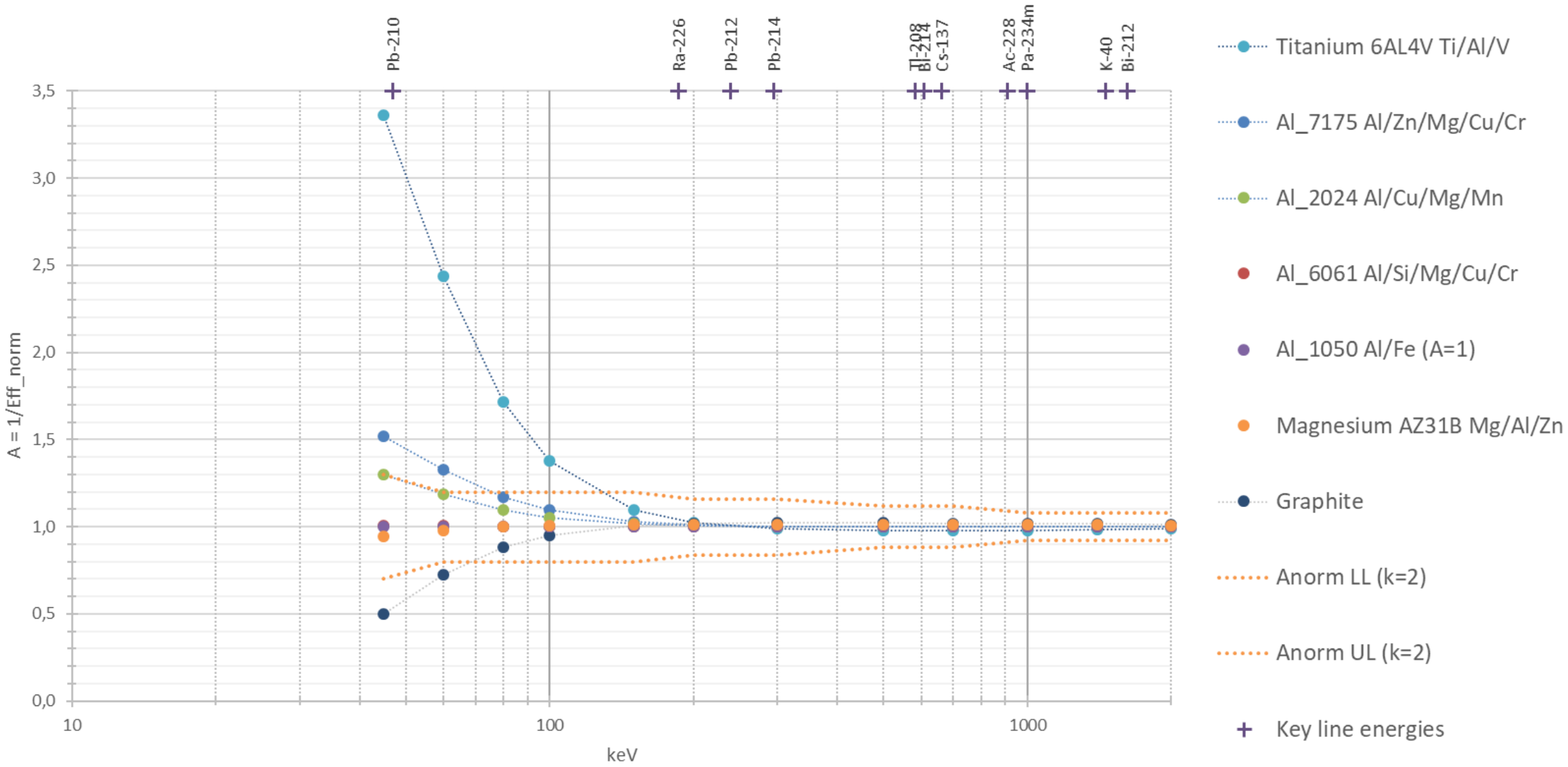
Aluminium
2,7 g/ml
(evt. + Zn, Cu, Mg, Fe, Cr)

Carbon
2,26 g/ml

Magnesium
1,7 g/ml

Titanium
4,5 g/ml

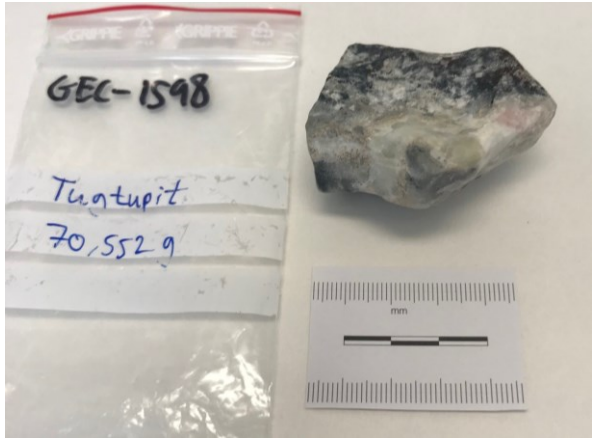
Light metals. CoAx60 H1CVE 10x10 cm. Constant density (2.8g/ml). Normalized activity if true material is

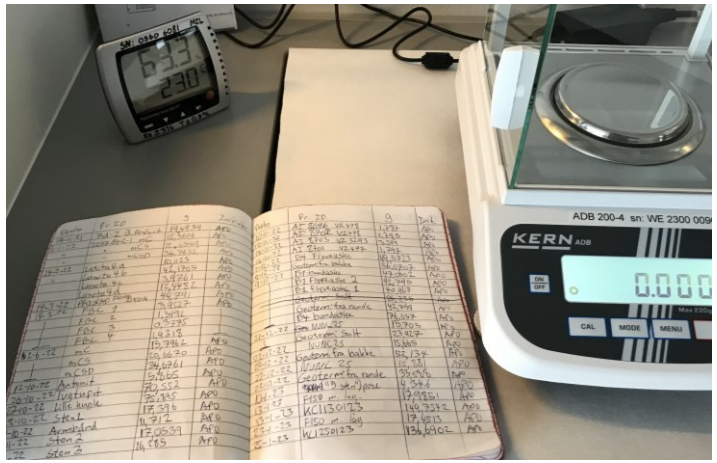


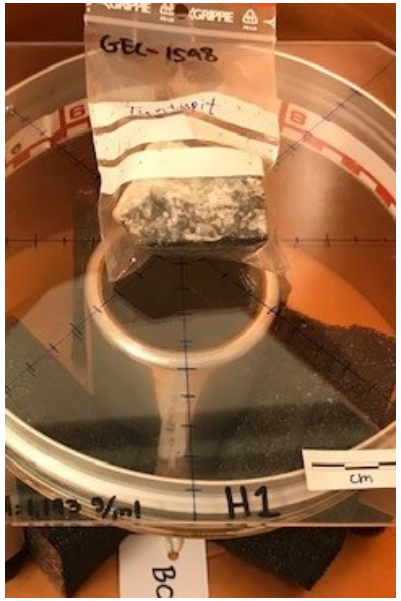
Conclusions

- Material-knowledge is important.
- Light elements can be excluded based on observed density (porosity is possible - compression is not) .
- Variation in sample dimensions and density typically leads to errors that are within LabSOCS default uncertainty.
- Unknown presence of heavy elements in e.g. minerals, light-metal alloys and plastics can lead to singnificant under-reporting of activity – primarily for E < 200 keV (e.g. Pb-210).
- Variations in steel-alloys have little or insignificant effect.

Documentation







Notatskema for gammaspektrometri (dd-mm-yyyy) Ref: DokID 5386

Udfyldt af: APO Dato: 26-10-22 ☒ Indskannet

Projekt-titel: Krystaller 12-10-22 SIS nr.: GEC-1593

Prøve ID: Tugtupit Ref. dato: 12-10-22 12:00

Anvendt vægt: ☒ GR-202 sn 14226971 ☐ EK-3000i sn P1871910

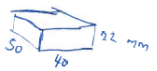
Total vægt: — g Beholder vægt: — g

Sample Quantity: 70,552 Unit: g u: 0,001 u ref: DokID 4941

Holder:
- ☒ "H1" 3.1 mm plexigls (+ 32 mm)
- ☐ "PLEX" 5 mm plexigls (+ 16 mm)
- ☐ "CAP" 3 mm delrin (+ 16 mm +...)

Detektor:
- X B08006 (GEC-)
- B20128 (GEC-)
- 13000044 (FAL-)
- 13000328 (FAL2-)
- Repræsentativ
- X Tilnærmet

Template:
- Cust. General Purp. Beaker CGB
- Cust. Simplified Beaker CSB
- Cylinder CVE
- Cylinder From Side CHO
- Disk DSK
- Gen. Purpose Beaker DGB
- Gen. Purp. Marinelli Beaker GMA
- Point PNT
- Simplified Beaker DSB
- X Simplified Box SBX
- Simplified Marinelli Beaker SMA
- Simplified Sphere SPH



Fyldhøjde: — mm "Contour file": — .BKR

Vol (b*h*d, r^2*pi*h, r^3*pi*4/3): 5·4·2,2 44 cm^3

Beregnet densitet: 70552/44 = 1,603 g/ml

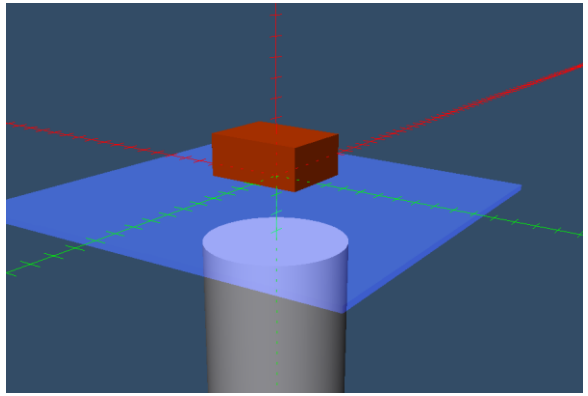
d X.X	mm	Materiale	Densitet (g/ml)	Evt. vægt (g), Rel. Conc.
1.1	0	none		
1.2	50	none		
1.3	40	none		
2.1	0	none		
3.1	22	Feldspar	1,603	
4.1	3,1	plexigls	1,2	
5.1	35,1			

Geometri-model (.GIS udtræk).

Template:	'SIMPLIFIED_BOX'			Kontur:	na		
.Geo file:	'c:\genie2k\isocs\data\geometry\laboratory\simplified_box\gec-1598_h1sbx.geo'						
Detektor:	B08006	Description:		GEC-1598_H1SBX			
Ambient pres.:	760	Amb. temp.:	22	Rel. hum. (%):		30	
MC Conv. (%):	1	L. units:	mm	Density units:		g/cu.c	(cu.c = ml)
D	**.1**	**.2**	**.3**	**.4**	**Material**	**Density**	**Rel. C.**
1.	na	50	40	na	na	na	
2.	na	na	na	na	na	na	na
3.	22	na	na	na	FELDSPAR	1,603	1
4.	na				na	na	na
Abs1	3,1				PLEXIGLS	1,2	
Abs2	na				na	na	
Source-Det.	35,1						
X-Offset	na						

Sammensætning (mu01_8lb.txt udtræk)

Material 1:	na	na
Material 2:	na	na
Material 3:	FELDSPAR	KALSI3O8:33.00%_NAALSI3O8:33.00%_CAAL2SI2O8:34.00%
Material 4:	na	na
Absorb. 1:	PLEXIGLS	C5H8O2:100.00%
Absorb. 2:	na	na
Rapport ID:	GEC-1598-K1-Tugtupit [18-09-2023 15:43:12]	



Dimensions