IAEA
International Atomic Energy Agency

Joint ICTP-IAEA School on LoRa Enabled Radiation and Environmental Monitoring Sensors

ICTP

Characterization of Radiation Sensors Supplementary

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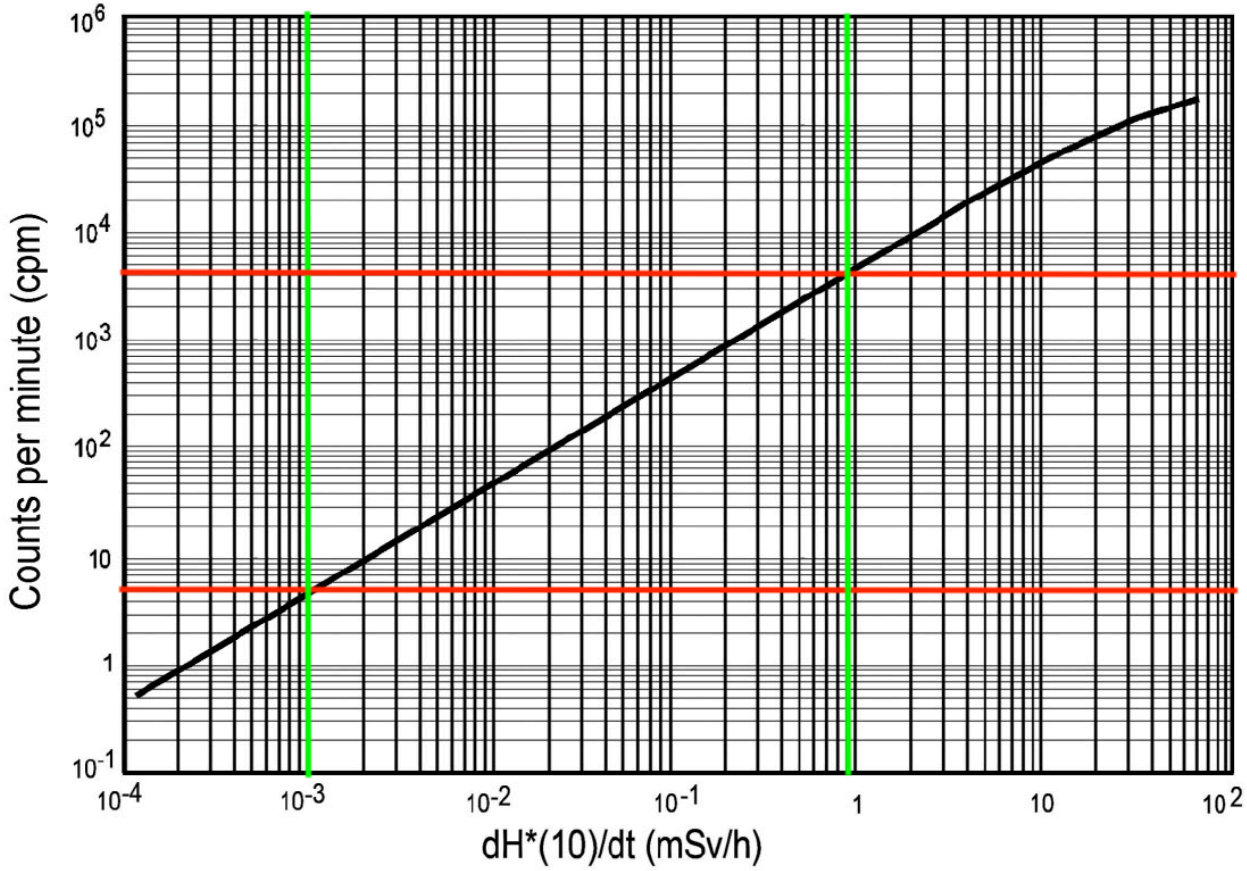
Counts and calibration

Response functions

BG51 Sensor Linearity



dH*(10) / dt = Radiation dose equivalent rate for Cs-137 and Co-60 (mSv/h)

Response functions

counts	dose (uSv/h)	nSv/h	mSv/h
1	0.2	200	0.0002
5	1	1000	0.001
10	2	2000	0.002
20	4	4000	0.004
50	10	10000	0.01
100	20	20000	0.02
500	100	100000	0.1
1000	200	200000	0.2
2000	400	400000	0.4
3000	600	600000	0.6
4000	800	800000	0.8
5000	1000	1000000	1

counts	dose (uSv/h)	nSv/h	mSv/h
1	0.1612	161.2	0.0001612
5	1.0612	1061.2	0.0010612
50	11.1862	11186.2	0.0111862
100	22.4362	22436.2	0.0224362
500	112.4362	112436.2	0.1124362
1000	224.9362	224936.2	0.2249362
2000	449.9362	449936.2	0.4499362
3000	674.9362	674936.2	0.6749362
4000	899.9362	899936.2	0.8999362

counts	dose (uSv/h)	nSv/h	mSv/h
1	0.2195	219.5	0.0002195
5	0.9999	999.9	0.0009999
24	4.7068	4706.8	0.0047068
50	9.7794001	9779.4	0.0097794
100	19.5344	19534.4	0.0195344
500	97.574412	97574.41	0.0975744
1000	195.12445	195124.4	0.1951244
2000	390.2246	390224.6	0.3902246
3000	585.32484	585324.8	0.5853248
4000	780.42518	780425.2	0.7804252
5000	975.52563	975525.6	0.9755256

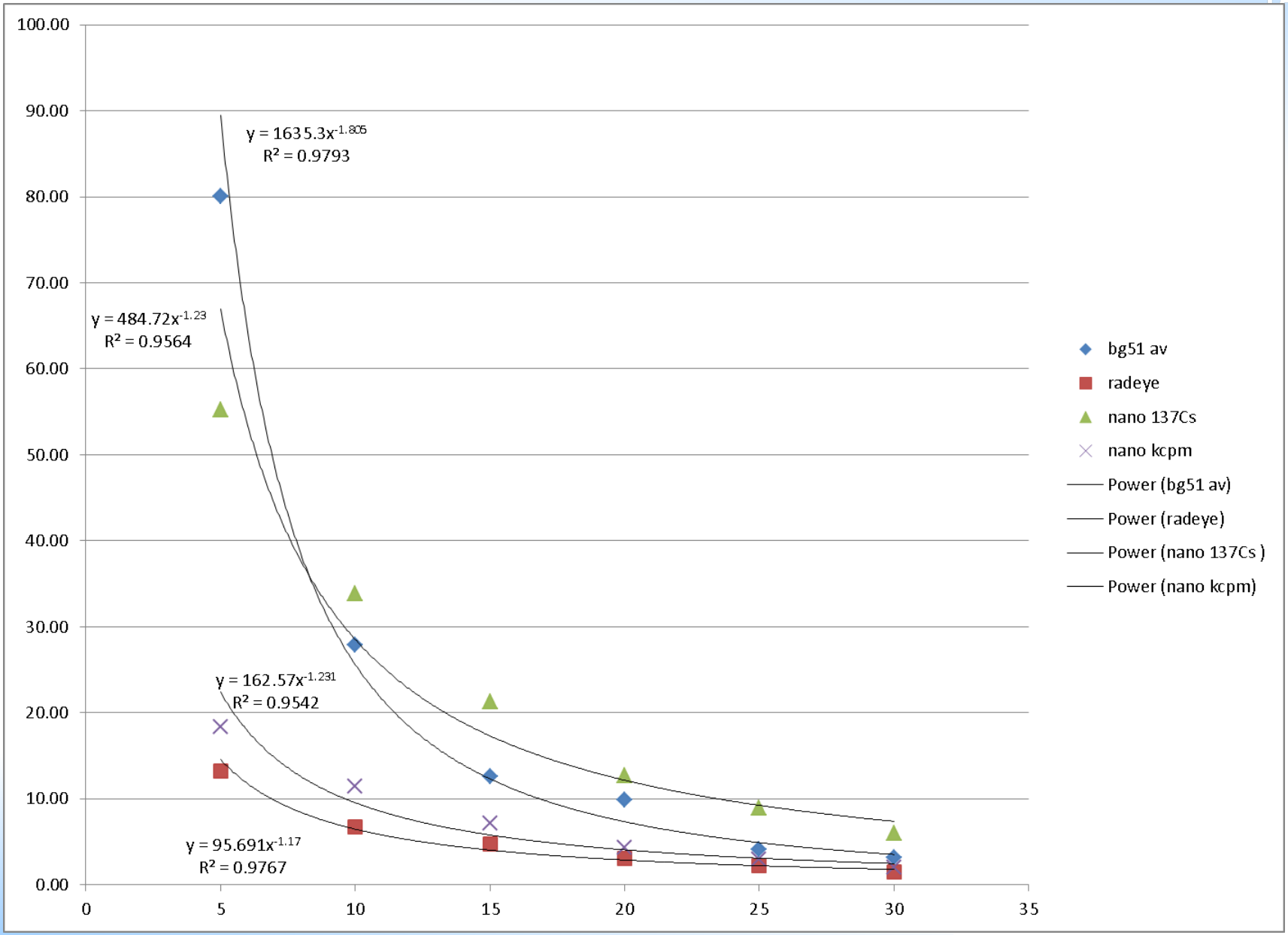
Experiment

cm / uSv/h	bg51	hi	av	radeye	nano 137Cs	nano kcpm	Calibration check
30	1.50	4.75	3.13	1.50	6.04	2.00	2017.36
25	3.50	4.75	4.13	2.25	8.98	3.00	2999.32
20	8.36	11.30	9.83	3.10	12.73	4.30	4251.82
15	11.90	13.40	12.65	4.70	21.25	7.10	7097.5
10	21.99	33.90	27.95	6.70	33.90	11.40	11322.6
5	77.10	83.00	80.05	13.20	55.24	18.40	18450.16

bg51

```
 15m 6.4s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
 15m 8.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 10.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 12.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 14.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 16.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 18.3s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
15m 20.2s: Tot.pulses:      30 puls/min: 0 mSv/h: 0.000000
```

Experiment


100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
5
10
15
20
25
30
35
y = 1635.3x-1.805
R² = 0.9793
y = 484.72x-1.23
R² = 0.9564
y = 162.57x-1.231
R² = 0.9542
y = 95.691x-1.17
R² = 0.9767
bg51 av
radeye
nano 137Cs
nano kcpm
Power (bg51 av)
Power (radeye)
Power (nano 137Cs)
Power (nano kcpm)

Response functions

Radeye B20 (pancake probe)

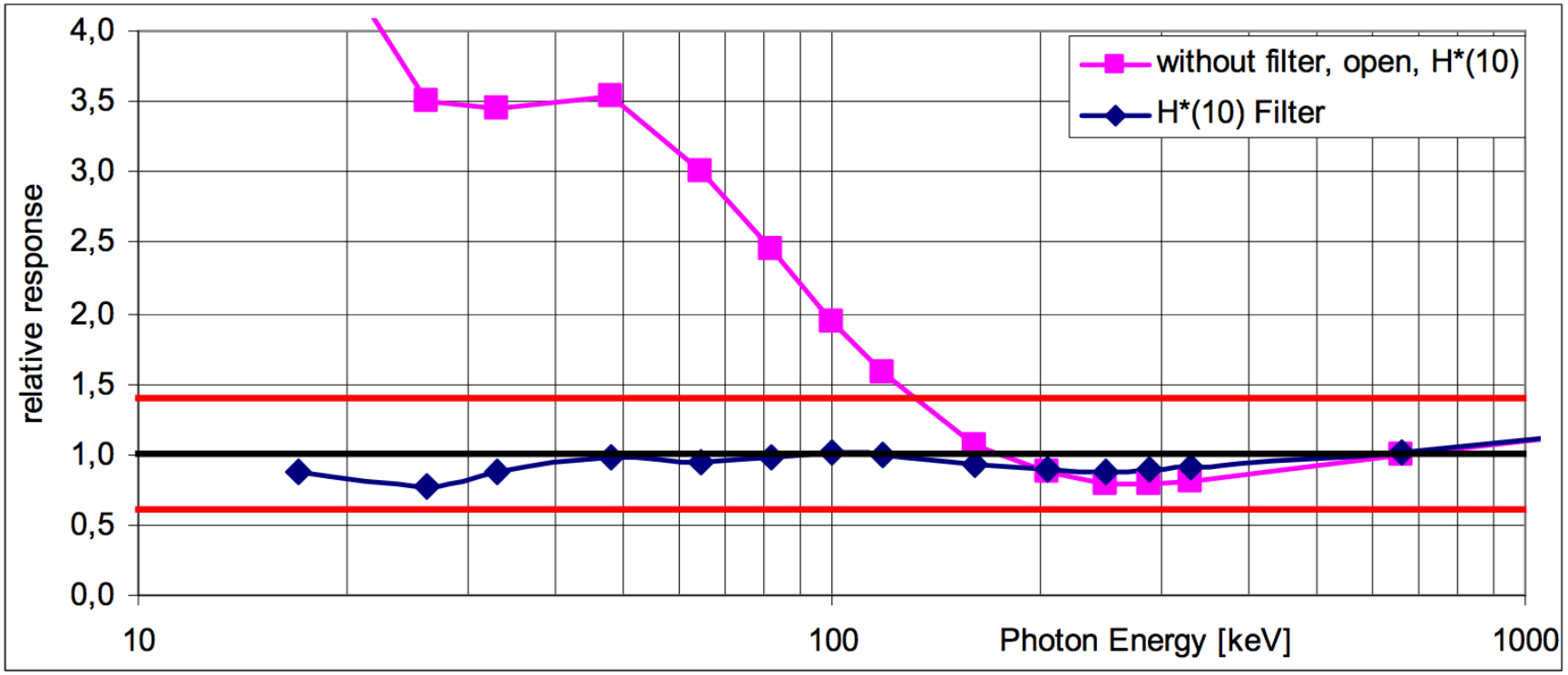
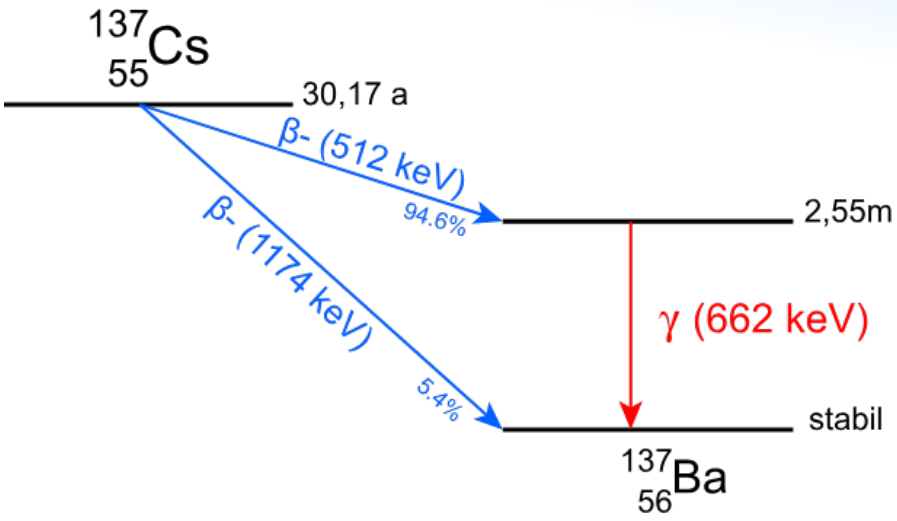


Diagram 12-1: Energy dependence for ambient dose equivalent H*(10)

Response functions



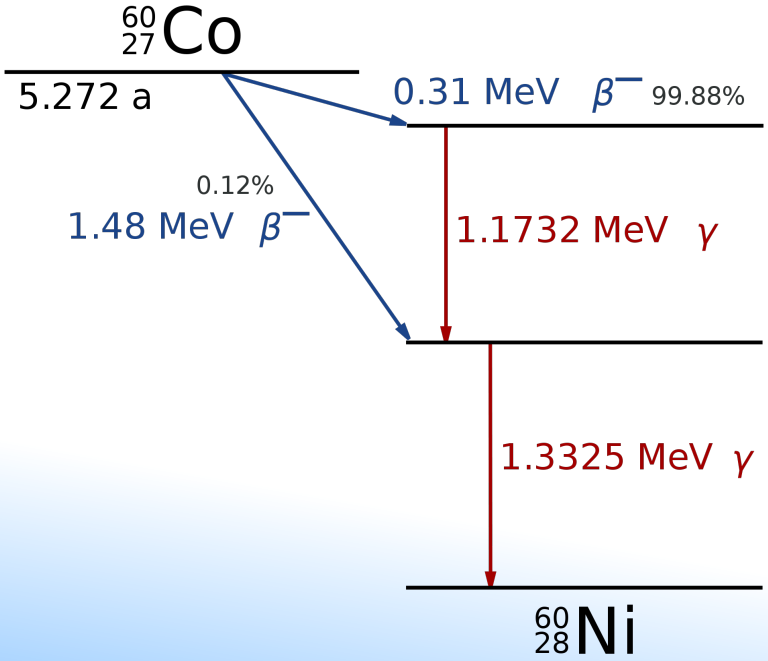


Table 2.3 Decay details of the Uranium (^{238}U) decay chain [WAH07]

Parent nuclide	Half-life $t_{1/2}$	Decay Mode (% branch)	Decay Energy (MeV)	% Intensity	Daughter nuclide	γ-emission Energy (keV)	% γ-emission Intensity
^{238}U	4.5x10^{9} y	α (100)	4.198	79.0	^{234}Th	49.55	0.063
			4.151	20.9		113.50	0.0102
^{234}Th	24.10 d	β (100)	0.199	70.3	^{234m}Pa	63.28	4.1
			0.104	19.2		92.37	2.4
			0.103	7.6		92.79	2.39
^{234m}Pa	1.17 m	β (99.84)	2.269	98.2	^{234}U	1001.03	0.837
			1.224	1.007		766.38	0.294
		IT (0.16)	*		^{234}Pa	73.92	*
^{234}Pa	6.70 h	β (100)	0.642	19.4	^{234}U	131.30	0.029
			0.472	33.0		946.00	0.021
^{234}U	2.5x10^{5} y	α (100)	4.7746	71.38	^{230}Th	53.20	0.123
			4.7224	28.42		120.90	0.0342
^{230}Th	7.5x10^{4} y	α (100)	4.6870	76.3	^{226}Ra	67.672	0.373
			4.6205	23.4		143.872	0.0483
^{226}Ra	1600 y	α (100)	4.7843	94.45	^{222}Rn	186.21	3.59
			4.601	5.55		262.27	0.0050
^{222}Rn	3.8235 d	α (100)	5.4894	99.92	^{218}Po	511.00	0.076
^{218}Po	3.10 m	α (99.98)	6.0024	100.0	^{214}Pb	**	
		β (0.02)	*		^{218}At		
^{218}At	1.60 s	α (100)	6.0024	100.0	^{214}Bi	*	
^{214}Pb	26.8 m	β (100)	0.671	48.9	^{214}Bi	351.93	35.1
			0.728	42.2		295.22	18.2
			1.023	6.3		241.99	7.12
^{214}Bi	19.9 m	β (99.98)	3.272	18.2	^{214}Po	609.31	44.6
			1.542	17.8		1764.50	15.1
			1.507	17.02		1120.29	14.7
		α (0.02)	5.452	53.9	^{210}Tl	1238.11	5.78
			5.516	39.2		2204.21	4.98
^{214}Po	164.30 µs	α (100)	7.6868	99.99	^{210}Pb	799.7	0.0104
^{210}Tl	1.30 m	β^{-} (100)	4.209	30.0	^{210}Pb	*	
			1.863	24.0			

* No data ** No γ-rays observed

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ReNuAL Renovation of the Nuclear Applications Laboratories

Department Nuclear Sciences & Applications

Division Physical & Chemical Sciences

Physics Section

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Thank you!