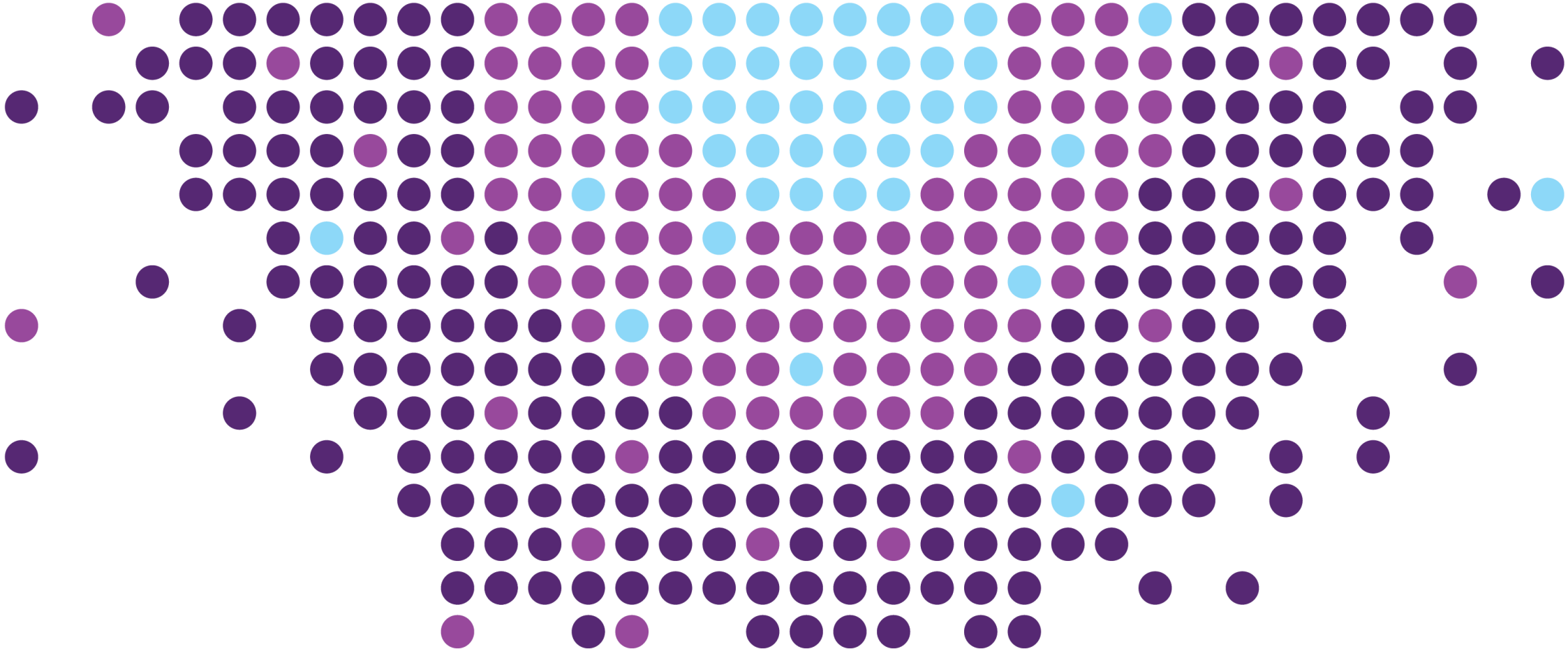


sck cen
Belgian Nuclear Research Centre

Tim Vidmar

GammaRay X Webinar, Helsinki, 20/10/2021

Validation of EFFTRAN for TCS corrections

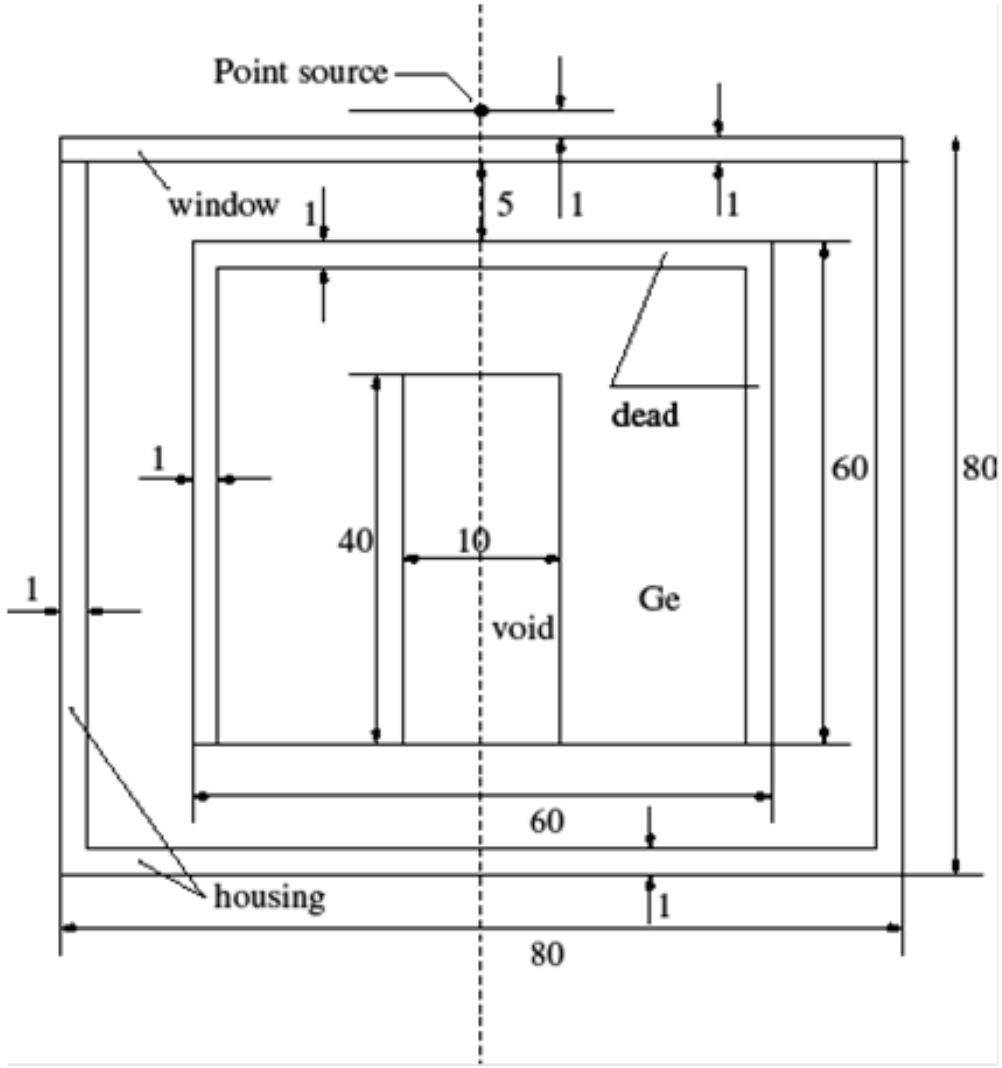
Introduction

- In the past, EFFTRAN has been successfully validated for efficiency transfer
- For true coincidence summing corrections, a comparison was made with GESPECOR for high-energy detectors
- Here, we present a similar comparison for low-energy detectors, …
- … and a comparison with experimental results

GESPECOR

Parameter	Detector A	Detector B
Crystal material	Ge	Ge
Crystal diameter (including the side dead slayer)	60	60
Crystal length (including the top dead layer)	60	60
Dead layer thickness (top and side)	1	0
Hole diameter	10	10
Hole depth	40	40
Window thickness	1	1
Window material	Al	Al
Crystal-to-window distance	5	5
Housing length	80	80
Housing thickness	1	1
Housing material	Al	Al

GESPECOR


Point source
window
1
5
1
1
dead
1
60
80
40
10
1
Ge
void
60
housing
1
80

GESPECOR

Parameter	Water	Point	Soil	Filter
Sample diameter	90	-	60	80
Sample thickness	40	-	20	3
Sample material	Water	-	Dirt	Cellulose
Sample-to-window distance	1.0	1.0	1.0	1.0

GESPECOR

Material	Density	Chemical formula
Ge	5.323	Ge
Al	2.70	Al
Water	1.0	H_2O
Dirt	1.4	SiO_2
Cellulose	0.3	$C_6H_{10}O_5$

ISC: Restricted

GESPECOR

Nuclide	E [keV]	Detector B Water	Detector B Soil	Detector B Point	Detector B Filter	Detector A Water	Detector A Soil	Detector A Point	Detector A Filter
Eu-152	**121.8**	0.2	-0.2	-1.3	-0.6	-0.9	-0.3	-1.3	-1.6
	244.7	0.0	-0.5	-2.8	-1.6	-0.3	0.4	-2.2	-1.8
	344.3	0.1	-0.1	-0.6	-0.4	0.4	0.2	-0.2	-0.1
	411.1	0.5	-0.4	-2.4	-1.4	1.2	0.4	-1.7	-0.8
	444.0	0.4	-0.4	-2.3	-1.3	-0.3	0.1	-1.9	-1.6
	564.0	1.1	-0.4	-2.2	-1.3	0.4	0.0	-1.9	-1.6
	778.9	-0.1	-0.5	-1.6	-1.0	0.3	0.0	-0.8	-0.6
	867.4	-0.3	-0.8	-4.0	-2.3	0.0	0.6	-2.7	-1.7
	964.1	-0.3	-0.6	-2.2	-1.3	-1.3	-0.3	-1.5	-1.9
	1085.8	-0.1	-0.1	-0.3	-0.4	-2.1	-1.1	-0.9	-2.1
	1089.7	0.4	-0.2	-1.7	-0.9	0.9	0.2	-0.8	-0.6
	1112.1	-0.5	-0.8	-2.4	-1.5	-1.9	-0.9	-2.3	-2.6
	1299.1	0.3	0.1	-1.5	-0.7	0.8	0.6	-0.4	-0.3
	1408.0	-0.5	-0.8	-2.4	-1.5	-1.7	-0.7	-2.1	-2.4
Cs-134	**475.3**	0.4	-0.1	-1.8	-1.0	1.1	0.6	-0.7	-0.2
	563.2	0.2	-0.3	-2.3	-1.2	0.9	0.5	-1.1	-0.4
	569.3	0.2	-0.2	-2.0	-1.0	1.0	0.6	-0.9	-0.3
	604.7	0.1	-0.2	-1.2	-0.8	0.5	0.1	-0.5	-0.3
	795.8	0.0	-0.3	-1.3	-0.8	0.5	0.1	-0.6	-0.4
	801.9	0.2	-0.3	-1.9	-1.1	0.9	0.4	-0.8	-0.2
	1038.6	0.2	-0.7	-1.5	-1.2	0.5	-0.3	-0.8	-0.8
	1167.9	-0.7	-1.5	-1.9	-2.3	-1.1	-1.2	-0.9	-2.1
	1365.2	-3.0	-4.1	-4.8	-5.1	-1.8	-1.9	-0.8	-2.8

GESPECOR

		Detector B				Detector A			
Nuclide	E [keV]	Water	Soil	Point	Filter	Water	Soil	Point	Filter
Ba-133	53.2	0.5	-0.5	-2.8	-0.7	0.3	0.8	-1.8	-1.3
	79.6	-0.5	-1.3	-4.3	-2.2	-0.5	-0.3	-4.9	-2.9
	80.9	-0.1	-0.7	-2.5	-1.2	-0.4	-0.1	-1.9	-1.7
	276.4	-0.6	-0.9	-2.8	-1.7	-0.9	0.4	-2.4	-2.3
	302.9	-0.5	-0.7	-2.1	-1.2	-1.5	0.0	-1.8	-2.3
	356.0	-0.4	-0.5	-1.7	-1.0	-1.4	-0.3	-1.6	-2.2
	383.8	-0.2	-0.2	-0.8	-0.5	-2.1	-0.9	-0.7	-2.2
Co-60	1173.2	0.0	-0.2	-0.7	-0.5	0.2	0.0	-0.3	-0.2
	1332.5	0.0	-0.2	-0.7	-0.5	0.2	0.1	-0.3	-0.2
Y-88	898.0	0.0	-0.2	-0.6	-0.4	0.4	0.2	0.0	0.0
	1836.1	0.0	-0.2	-0.9	-0.7	0.5	0.2	-0.1	-0.1
Na-22	1274.5	0.1	-0.3	-2.9	-1.7	1.0	0.6	-1.4	-0.7

Experimental

- Intercomparison exercise organized by LNHB in 2010 (M-C. Lépy et al., Applied Radiation and Isotopes 68 (2010) 1407–1412)
- Same decay data for all the participants (NUCLEIDE)
- Experimental values of TCS corrections provided for Eu-152 and Cs-134
- Results presented for an extended sample with a diameter equal to that of the detector
- Low-energy coaxial detector, three different absorbers
- No optimization of detector model attempted

Experimental, Eu-152

Absorber	Mylar	Plexiglas	Copper
Energy [keV]	Difference (%)		
121.8	-0.6	-0.7	-0.2
244.7	-2.5	1.1	-2.5
344.3	-3.5	-1.9	-2.3
411.1	-2.4	-1.6	-3.3
444	0.1	-0.1	-1.6
564	-3.2	-0.5	-4.2
688.6	-5.2	-6.5	4.5
778.9	1.0	-0.6	-0.7
867.4	0.9	0.0	-1.2
964.1	0.1	1.5	0.8
1085.8	-1.2	-0.4	2.4
1089.7	-4.0	1.6	3.7
1112.1	0.8	1.1	3.1
1212.9	0.9	8.9	3.2
1299.1	-3.5	5.2	5.1
1408	-0.2	2.2	2.9
Average	**-1.4**	**0.6**	**0.6**

Experimental, Eu-152

Absorber	Mylar	Plexiglas	Copper
Energy [keV]	z - score		
121.8	0.29	0.34	0.09
244.7	1.07	0.46	1.08
344.3	1.59	0.86	1.00
411.1	0.98	0.63	1.29
444	0.02	0.05	0.60
564	0.86	0.14	1.13
688.6	0.93	1.13	0.89
778.9	0.37	0.24	0.29
867.4	0.29	0.01	0.37
964.1	0.02	0.56	0.28
1085.8	0.38	0.14	0.75
1089.7	1.24	0.51	1.11
1112.1	0.25	0.40	0.97
1212.9	0.19	1.94	0.67
1299.1	0.90	1.45	1.28
1408	0.06	0.80	0.87
Average	**0.59**	**0.60**	**0.79**

Experimental, Cs-134

Absorber	Mylar	Plexiglas	Copper
Energy [keV]	Difference (%)		
475.3		0.64	-8.30
563.2		-2.64	-2.70
569.3		-3.18	-2.37
604.7		-2.61	-2.64
795.8		-1.27	-1.05
801.9		-0.93	-1.30
1038.6		-6.05	-6.55
1167.9		0.68	-0.08
1365.2		-3.75	1.01
Average		**-2.12**	**-2.67**

Experimental, Cs-134

Absorber	Mylar	Plexiglas	Copper
Energy [keV]	z - score		
475.3		0.16	1.91
563.2		1.12	1.09
569.3		1.40	1.00
604.7		1.17	1.14
795.8		0.52	0.43
801.9		0.36	0.51
1038.6		1.44	1.48
1167.9		0.21	0.02
1365.2		1.31	0.29
Average		**0.86**	**0.87**

Conclusion

- EFFTRAN's performance adequate for use in environmental gamma-ray spectrometry

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