

Gamma Cascade Summing

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WANDA 2020



PNNL is operated by Battelle for the U.S. Department of Energy





- Critical Limit— L_C
 - Answers whether the net count is significant
 - Is the feature background or a feature
- Decision Limit— L_D , DLR
 - Are the number of counts significant
 - Did we detect anything quantifiable
- MDA/MDC
 - L_D but converted to activity

•
$$MDA = \frac{\lambda \cdot L_D \cdot e^{\lambda t}}{\varepsilon \cdot \Gamma \cdot (1 - e^{-\lambda \Delta})}$$





Improving Detection Probability for Trace Analytes

- Scales proportionally with with efficiency
 - Requires larger crystals
 - Requires close-proximity counting of samples
 - Requires multi-detector arrays



Monte-Carlo Modeling of Detectors & Detector Arrays to Measure Efficiency





Angular Correction Factors ⁶⁰Co

- Photon Correlations
 Produce:
 - Differences in detector response
 - Require unique corrections based on solid angle coverage



[1] M. J. Jackson, R. Britton, A. V. Davies, J. L. McLarty, and M. Goodwin, "An automated Monte-Carlo based method for the calculation of cascade summing factors," *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, vol. 834, pp. 158–163, Oct. 2016, doi: <u>10.1016/j.nima.2016.07.016</u>.



Eu-152: Consistently Inconsistent

- Applied TCS corrections from multiple codes
- All codes underestimate the correction magnitude

				RPL Sample #:	16-
_	Energy	RIMMER (Bq) [1]	GEANT4 (Bq)	Genie2k (Bq)	Distar
	121.7820	3.00E+02	2.97E+02	2.99E+02	3.22
	344.2790	3.34E+02	3.32E+02	3.33E+02	3.34
	778.9040	3.27E+02	3.25E+02	3.27E+02	3.32
	867.3800	2.78E+02	2.85E+02	2.74E+02	3.15
	964.0570	2.37E+02	2.35E+02	2.34E+02	3.12
	1085.8400	3.14E+02	3.21E+02	3.23E+02	3.28
	1112.0800	3.10E+02	3.04E+02	3.02E+02	3.30
	1408.0100	3.03E+02	3.00E+02	3.04E+02	3.28
_	Average	3.00E+02	3.00E+02	3.00E+02	3.25
	stdev	10.15%	10.27%	10.85%	2.
	% diff from Dist.	-7.6%	-7.7%	-7.9%	0

"Known" isotopes appear to have errors

-0694 nce (Bq) 2E+02 4E+02 2E+02 5E+02 2E+02 8E+02 0E+02 8E+02 5E+02 5E+02 47% 0.0%



Needs & Benefits

Needs

- Angular correlation factor library
 - Include in ENSDF?
 - Separate Library?
- Inclusion of angular correlations in modeling tools
 - What are the limitations in accomplishing this action?
- Improved branching ratio uncertainties and decay cascades from nuclear decay

Benefits

- Accuracy:
 - Spectroscopy response modeling
 - Cascade summing correction factors
- Expedite:
 - Faster count-times
- Sensitivity:
 - Reduce minimum-detection limits
 - Improved counting statistics



Thank you



