

Efficiency

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Xe-135 metastable state

Group looked into the isomeric yield ratio of the Xe-135m to Xe-135g state using gamma ray spectroscopy

Looking for a higher level of precision

Efficiency

Xenon-134 irradiated was a gas

Previous Efficiency measurements examined solids

Simulated Gas Standard

Fill cylindrical canister with polystyrene beads

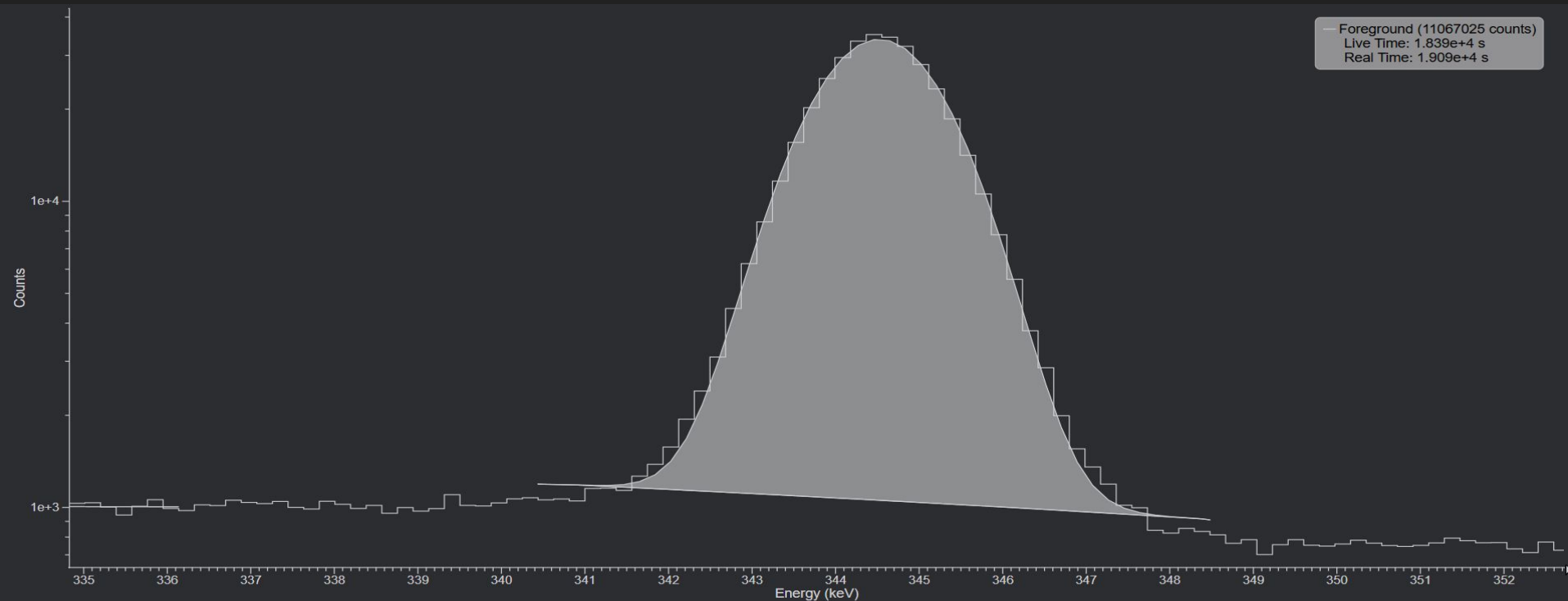
Fill in liquid natural europium for irradiation

Vacuum sealed the container to remove contaminants

Examine the gamma rays produced from the liquid europium

Interspec

Examined the data in interspec for the Europium 152 efficiency peaks



Efficiency

High activity caused an aliquot of undetermined size to be taken from the sample

The absolute activity was unable to be determined

Relative efficiency was calculated

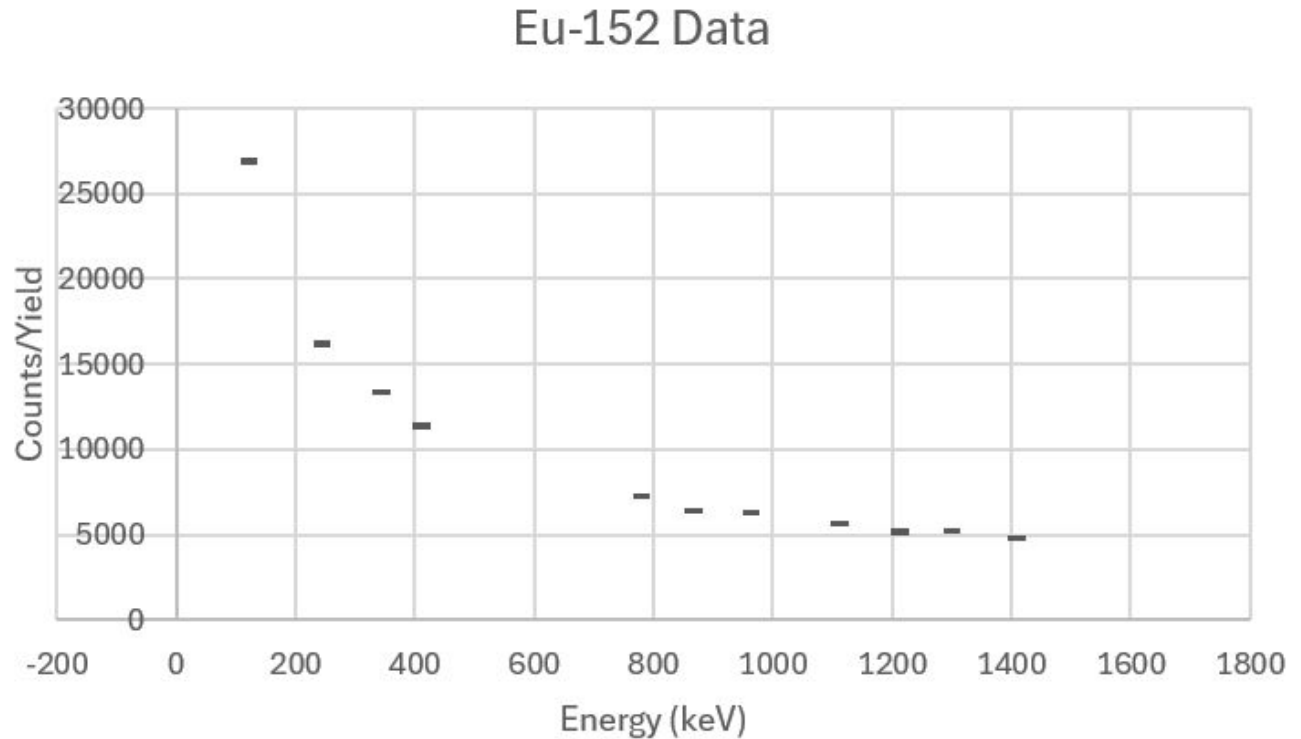
Examine the efficiencies for the peaks of Xe-135m and take their ratio

Data collected from interspec and source

Atom	Energy (keV)	uncertainty	Net Area Counts	uncertainty	yield	uncertainty
Eu-152	122.03	1	766826.3	1000.2	28.53107	1.30E-01
Eu-152	244.9	1	122236	417.9	7.548901	4.00E-02
Eu-152	344.52	1	354433.5	636.2	26.59981171	1.20E-01
Eu-152	411.37	1	25494.5	215.6	2.2370167	1.00E-02
Eu-152	779.32	1	93984.7	340.6	12.928058	6.00E-02
Eu-152	867.85	1	27180.3	208.3	4.22781	2.30E-02
Eu-152	964.54	1	90957.3	327.6	14.510163	6.00E-02
Eu-152	1112.63	1	77638.5	301.1	13.66726	6.00E-02
Eu-152	1213.55	1	7277.5	112	1.414588	9.00E-03
Eu-152	1299.77	1	8538	105	1.632626	9.00E-03
Eu-152	1408.68	1	100765.1	321	20.867832	8.00E-02

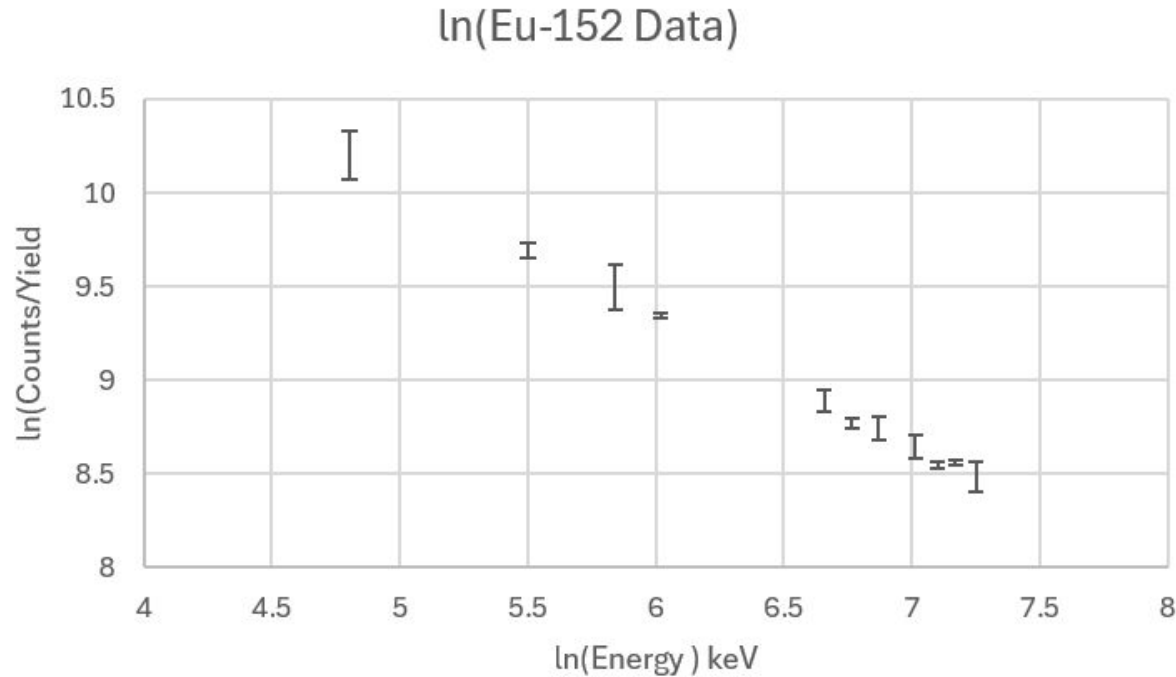
Graph of data

Get this graph for
energy vs
counts/yield



Graph of data points

Linearize with Natural Log



Weighted Least Squares

Chose Weighted least squares to examine the data to account for the varying errors on the gamma ray peaks

Weighted Least Squares

Calculate weights multiplied by the variables as shown in the table below

Using the natural log data X is energy and Y is counts/yield

wx	wy	wx^2	wxy	
284.2475342	603.4316748	1365.601024	2899.046831	
3413.098185	6013.76065	18774.94103	33080.79506	
405.6142554	659.3921777	2369.660192	3852.269424	
35095.76683	54461.75996	211258.7246	327832.1857	
1842.838647	2460.879927	12270.39692	16385.57642	
11512.09441	14919.33937	77891.04822	100944.532	
1901.93862	2419.973288	13069.459	16629.2126	
1940.360427	2391.346685	13610.62302	16774.05794	
22341.75497	26886.04793	158655.6214	190926.0327	
30873.00464	36867.4521	221357.6713	264337.5155	
1131.082797	1323.267142	8200.812183	9594.227166	

Weights

Next Sum the weights to get needed values

sum				
w	wx	wy	wx^2	wxy
16719.08592	110741.8013	149006.6509	738824.5589	983255.4513

Use equations 27-32 to calculate Delta, A and B along with their uncertainties and the covariance using the sum values for w, wx, wy, wx^2, and wxy

$$\Delta = w * wx^2 - (wx)^2 \quad (27)$$

$$A = \frac{wy * wx^2 - wx * wxy}{\Delta} \quad (28)$$

$$B = \frac{w * wxy - wx * wy}{\Delta} \quad (29)$$

$$\sigma A = \sqrt{\frac{wx^2}{\Delta}} \quad (30)$$

$$\sigma B = \sqrt{\frac{w}{\Delta}} \quad (31)$$

$$covariance = \frac{-wx}{\Delta} \quad (32)$$

Efficiency Calculation

Use Equations 33- to calculate the efficiency of specific energy lines and then the desired relative efficiency with their uncertainty.

Ln(energy is used) since the previously calculated A/B values deal with linearized data. The energy should be whatever line you want to know the relative efficiency for.

$$Efficiency = e^{\ln(energy)*B+A} \quad (33)$$

$$Relative\ efficiency = \frac{Efficiency_1}{Efficiency_2} \quad (34)$$

$$\sigma Efficiency = Efficiency \sqrt{\ln(Energy)^2 * \sigma B^2 + \sigma A^2 + 2 * covariance * \ln(Energy)} \quad (35)$$

$$\sigma Relative\ Efficiency = Relative\ Efficiency \sqrt{\frac{\sigma Eff_1^2}{Eff_1^2} + \frac{\sigma Eff_2^2}{Eff_2^2}} \quad (36)$$

Xenon-135 efficiency

Relative efficiency value for the Xe-135m vs the Xe-135 gamma ray

Energy Line	Relative efficiency	uncertainty
527.94	0.592489588	0.011425808
249.99		

Acknowledgements

Collaborators: Dr Moldenhauer, Dr Flanagan, Grace Martin, Julian Herrera,
Tanner Gordon

Funding: University of Dallas, Department of Energy University of Texas at Austin
Impact of REsearch REactors to Education