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Title: NaI Measurements of Plutonium & Other Sources with the INL Coin

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# Nal Measurements of Plutonium & Other Sources with the INL Coin

Pete Karpus

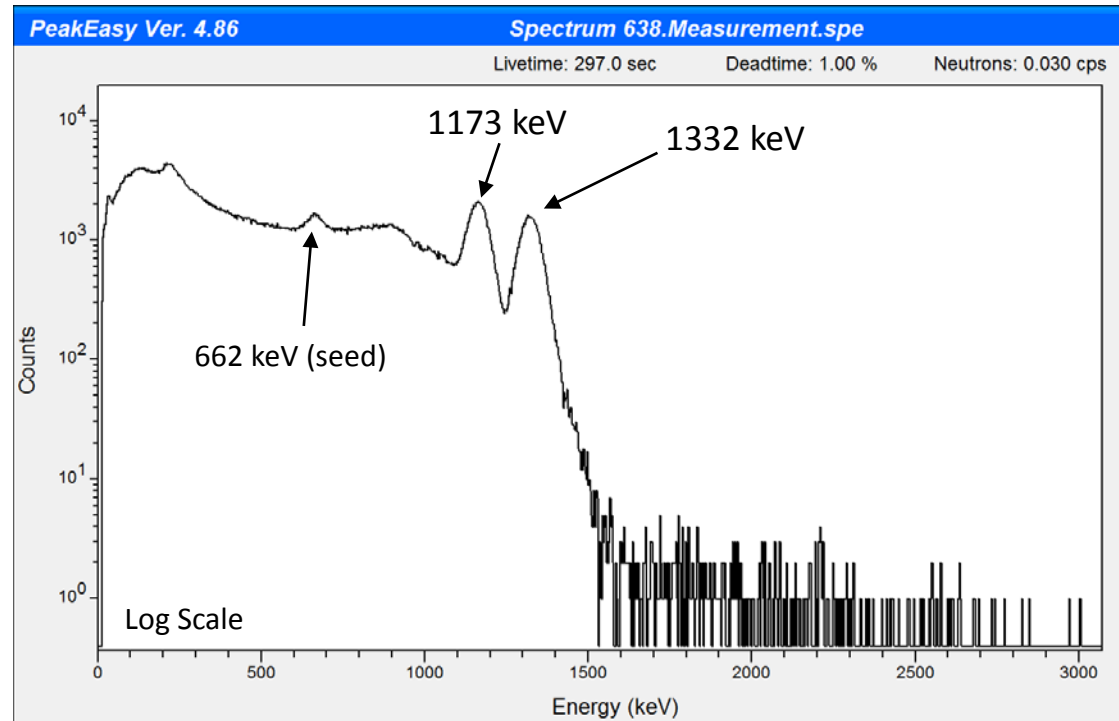
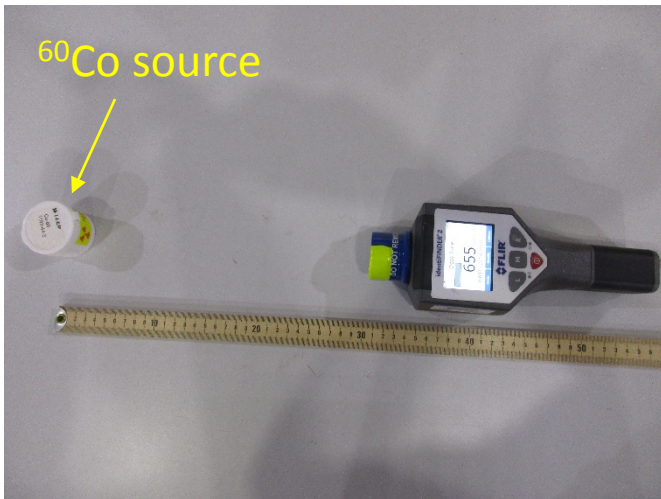
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# Introduction

- Several low-resolution (NaI) gamma-ray measurements were conducted with an IdentFINDER2 and the INL (dose ratio) Coin
- These slides summarize the effect of the INL Coin on gamma-ray spectra for  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$ , and plutonium.
- An investigation into gamma-ray scattering was also performed to explain a spectrum anomaly.

# $^{60}\text{Co}$ (bare) Baseline Spectrum

A bare 48  $\mu\text{Ci}$   $^{60}\text{Co}$  source was measured at  $\sim 30$  cm from a NaI IdentiFINDER 2. ID was  $^{60}\text{Co}$ .

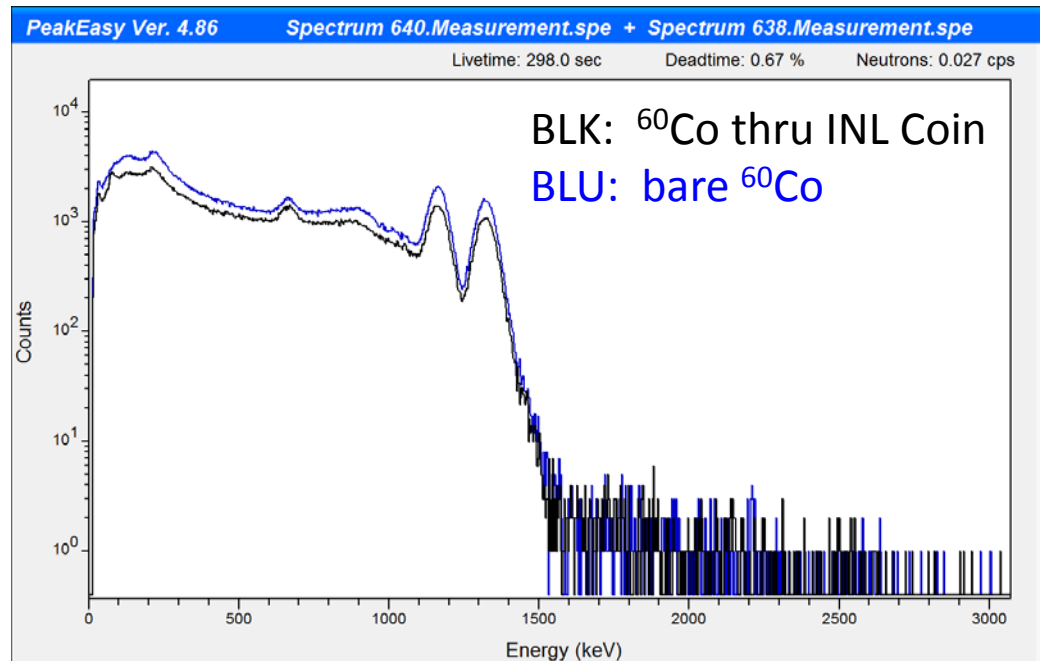


The two prominent gamma-ray peaks from  $^{60}\text{Co}$  are at 1173 and 1332 keV. This is what we normally consider fairly high energy and the INL Coin will have only a slight effect on them.

# $^{60}\text{Co}$ + 1 INL Coin

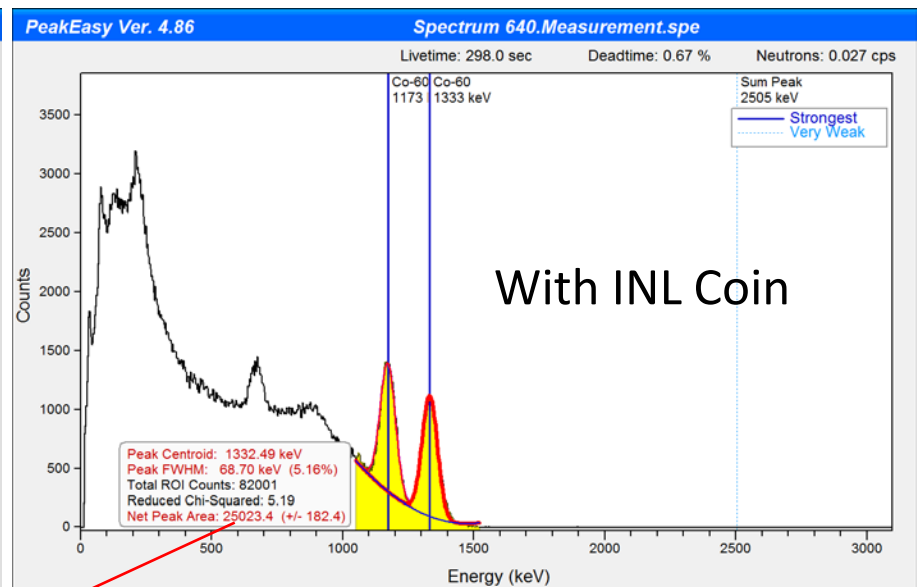
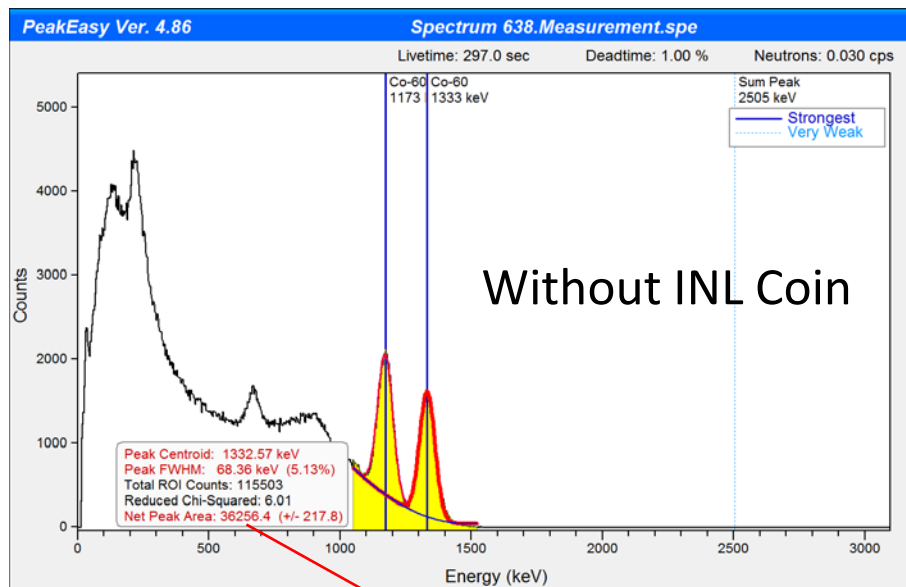
A single INL Coin was placed between the  $^{60}\text{Co}$  source and the IdentiFINDER 2.

ID was  $^{60}\text{Co}$ .



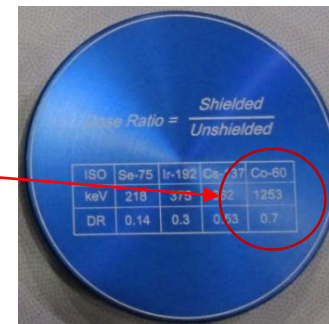
# Effect of INL Coin on $^{60}\text{Co}$ Peak Area

Here we compare the **peak area** of the 1332-keV peak of  $^{60}\text{Co}$  as measured with the INL Coin to that without.



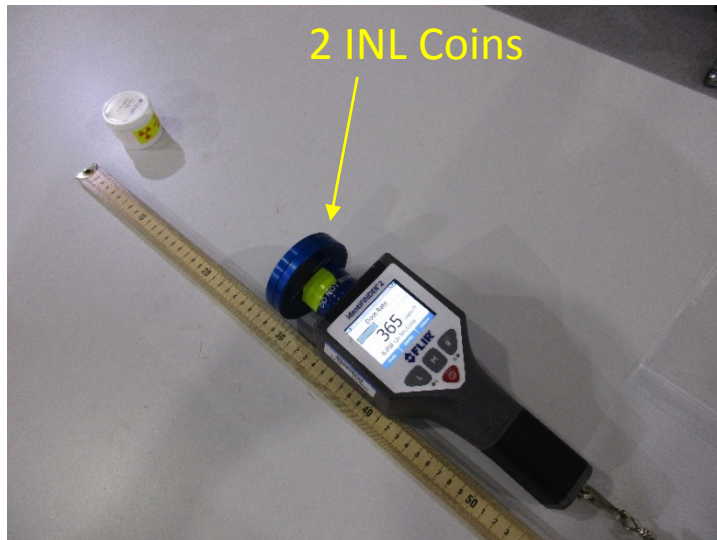
$$T = \frac{I}{I_0} = \frac{25023}{36256} \approx 0.69$$

This is called the 'transmission'. It describes the fraction of gammas *at a specific energy that* get through an attenuator.



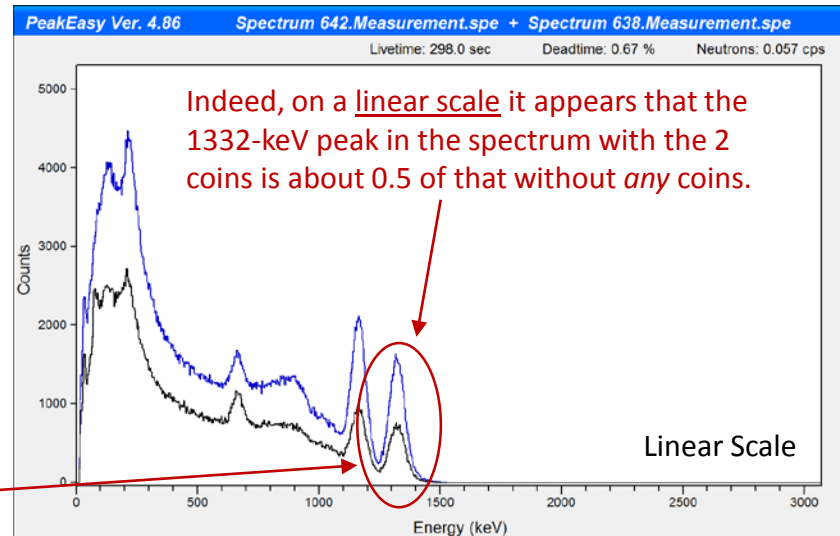
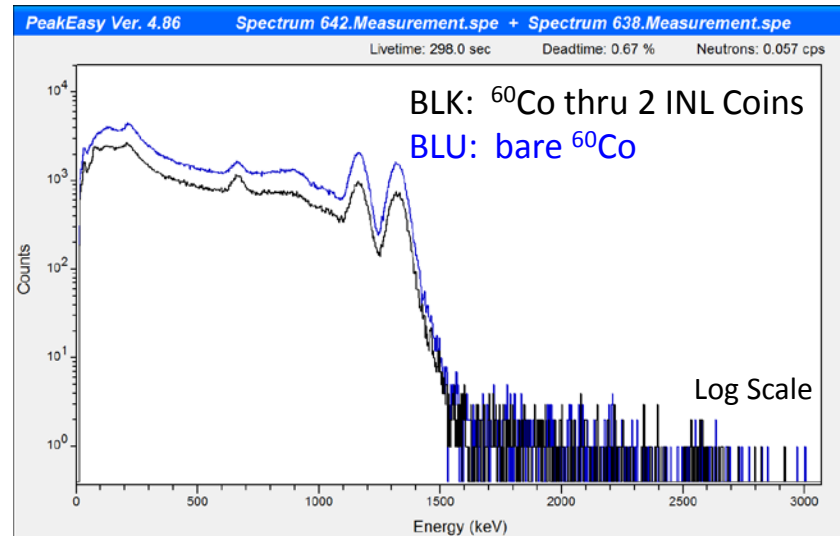
# $^{60}\text{Co}$ + 2 INL Coins

Two INL Coins were placed between the  $^{60}\text{Co}$  source and the IdentiFINDER 2.  
ID was  $^{60}\text{Co}$ .



Transmission factors multiply, so since the transmission through 1 coin was 0.7, for two coins the transmission will be:

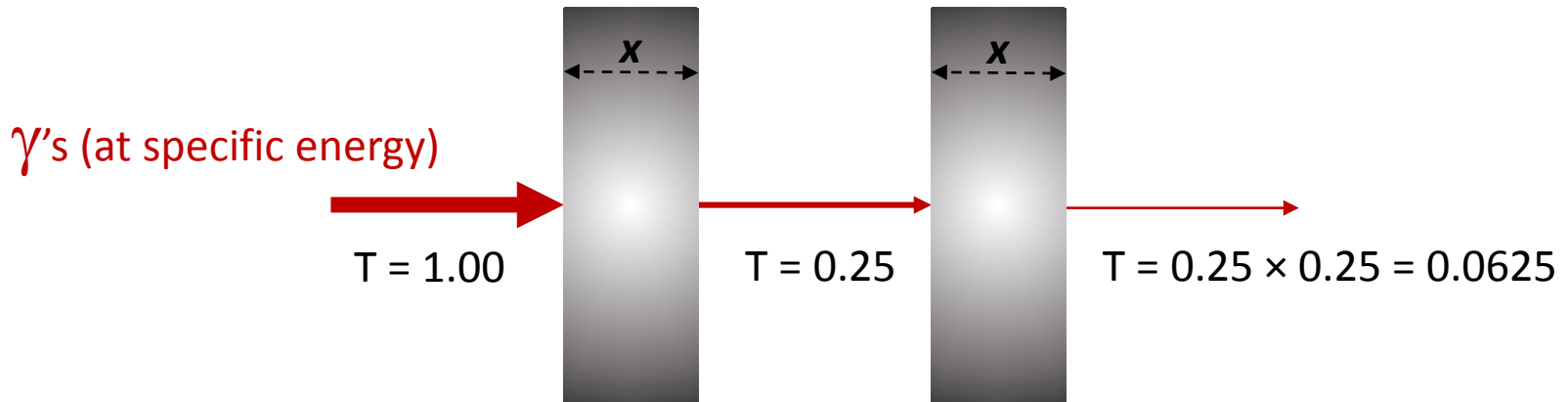
$$T = 0.7 \times 0.7 \approx 0.5$$



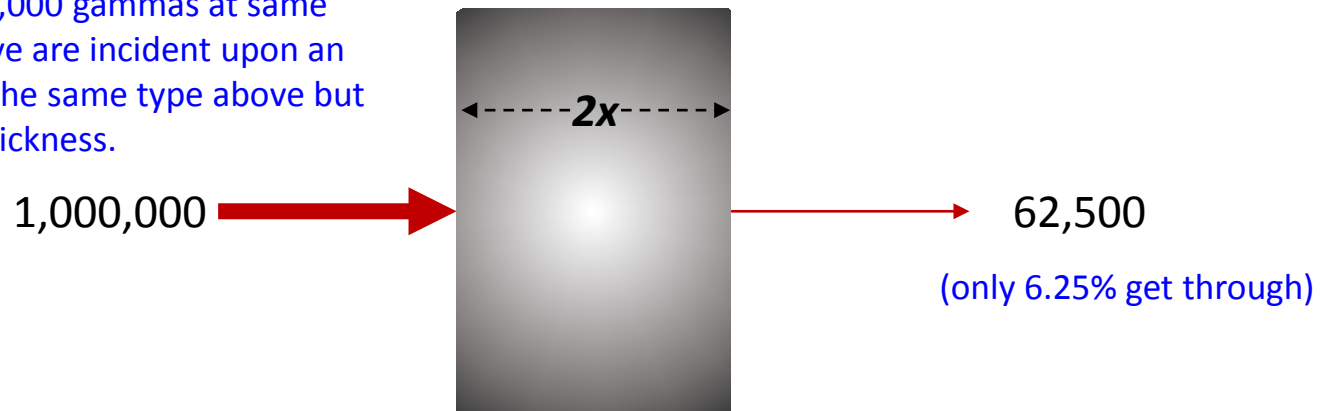


# More on Transmission

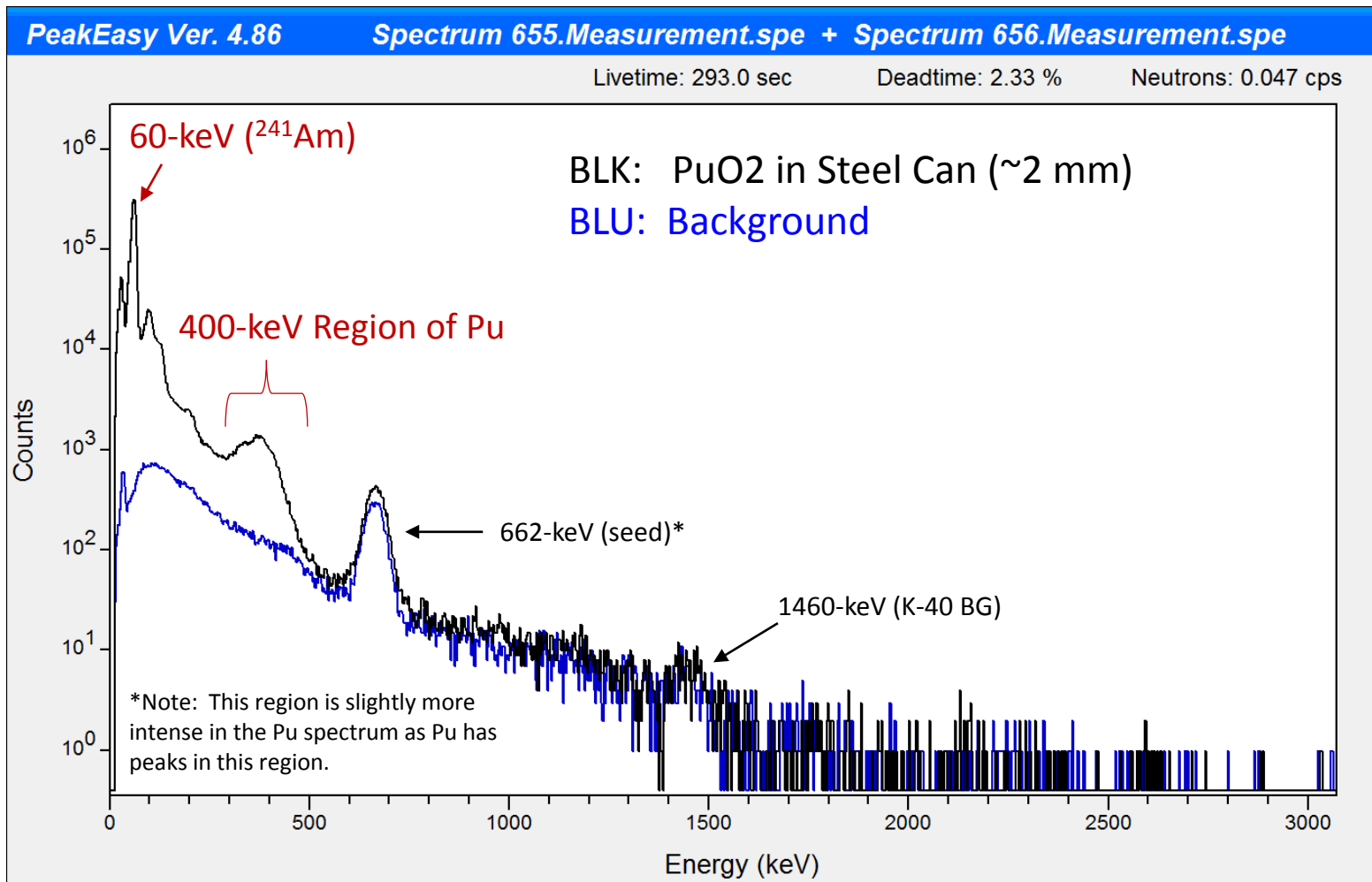
Shielding of the same type and thickness,  $x$



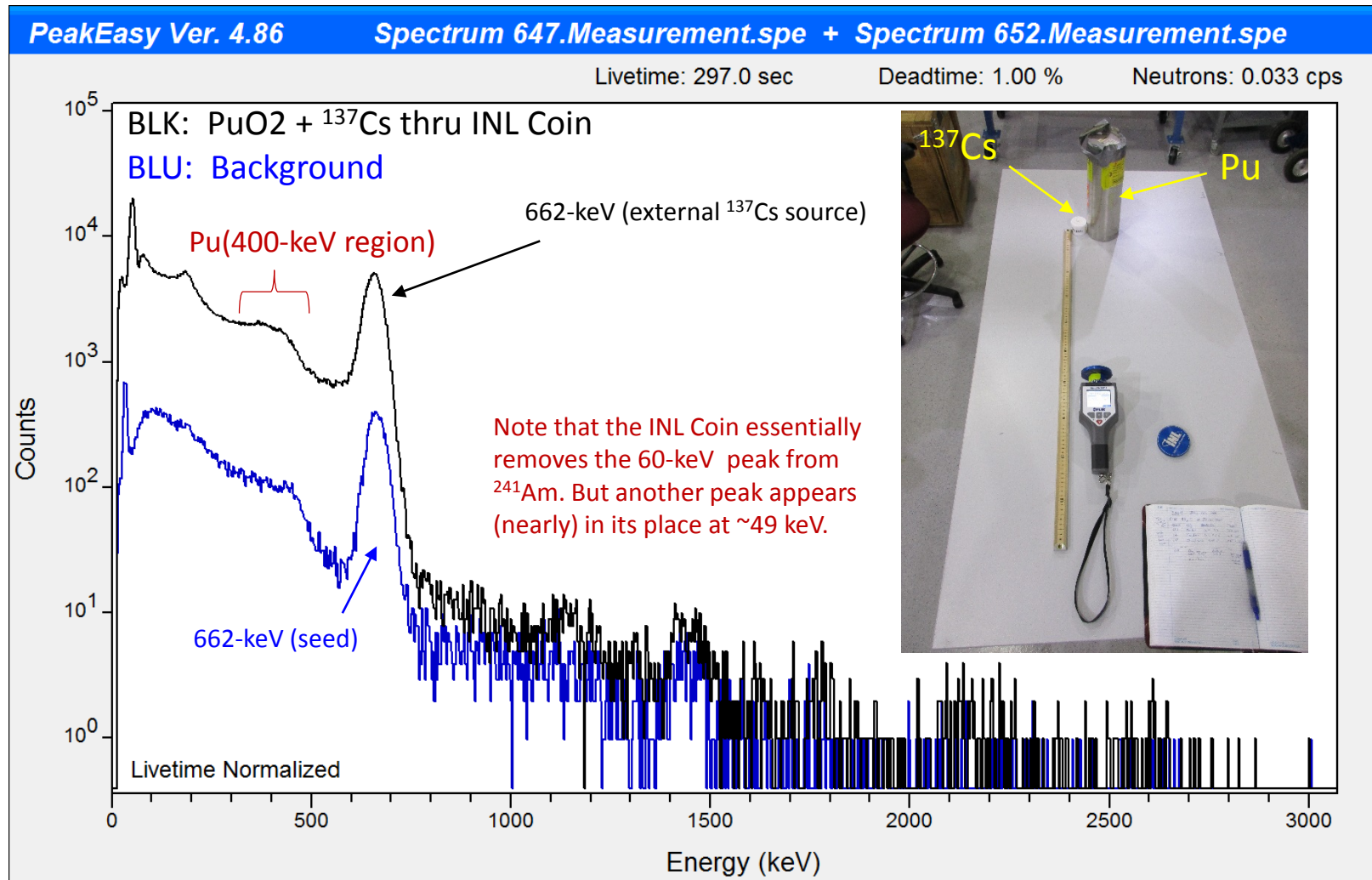
Let's say 1,000,000 gammas at same energy as above are incident upon an attenuator of the same type above but of twice the thickness.



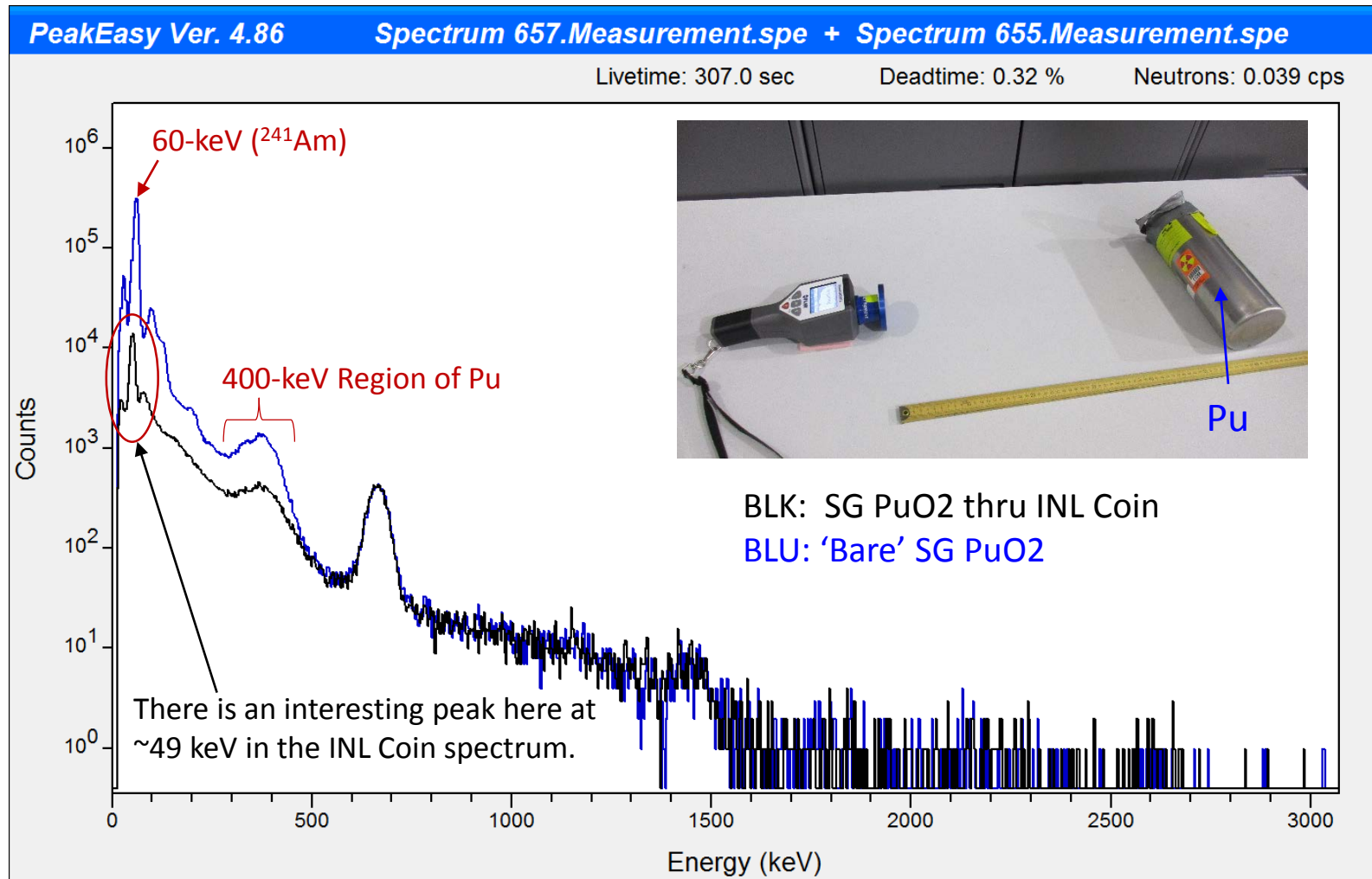
# 'Bare' Super-Grade (SG) Plutonium



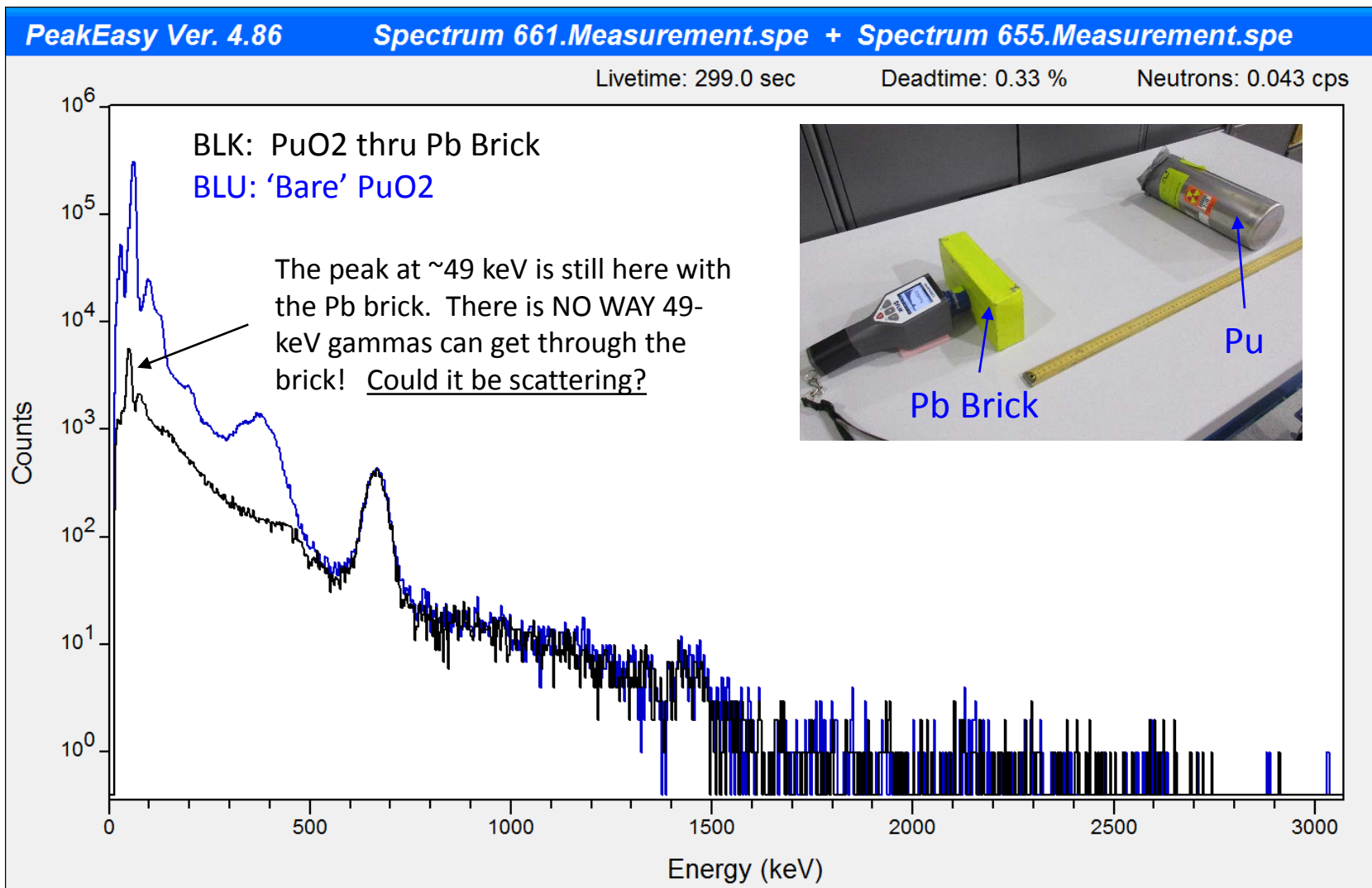
# SG Pu + $^{137}\text{Cs}$ thru INL Coin



# Bare Pu vs. Pu thru INL Coin

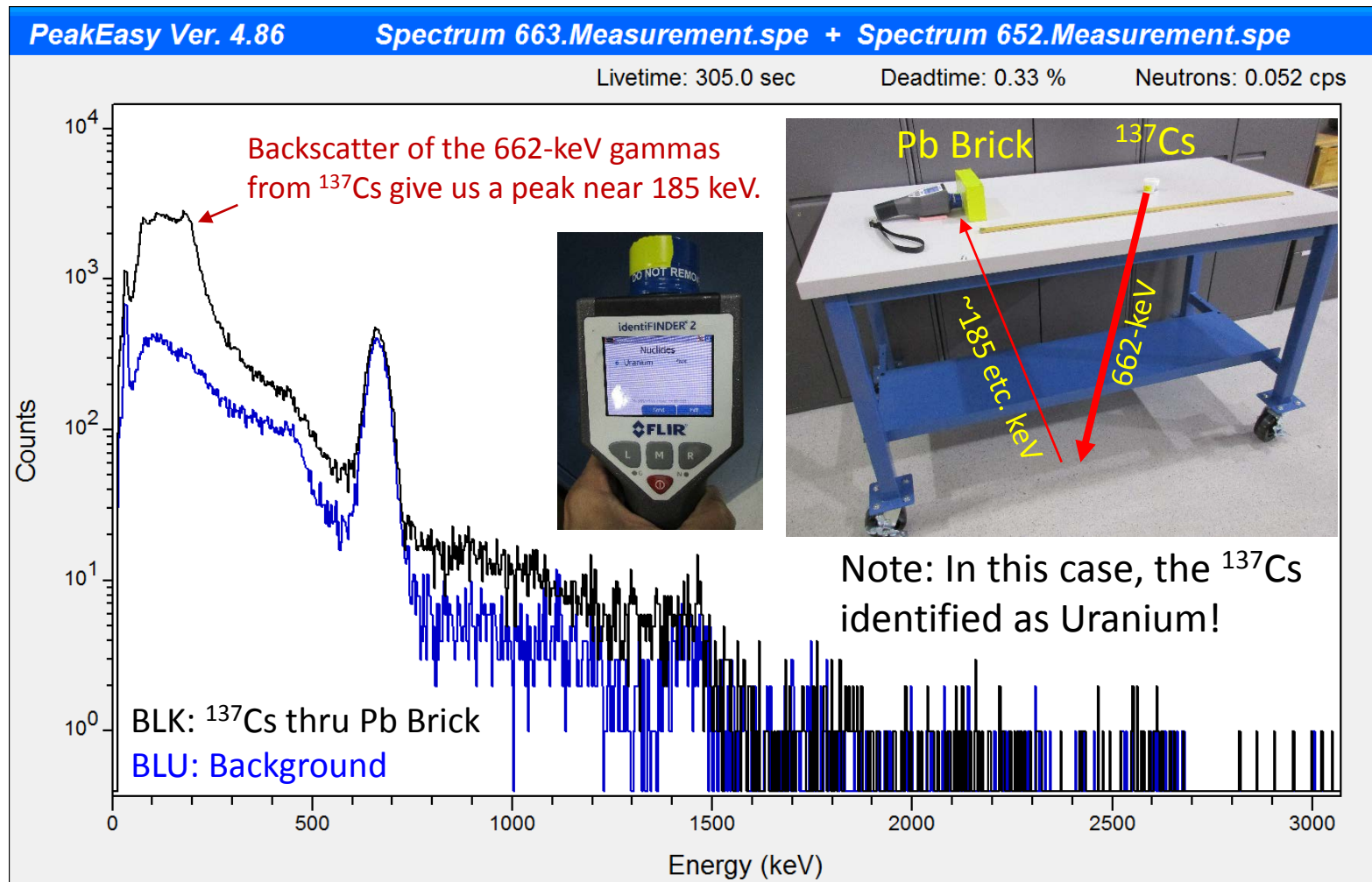


# SG Pu thru 2" Pb brick

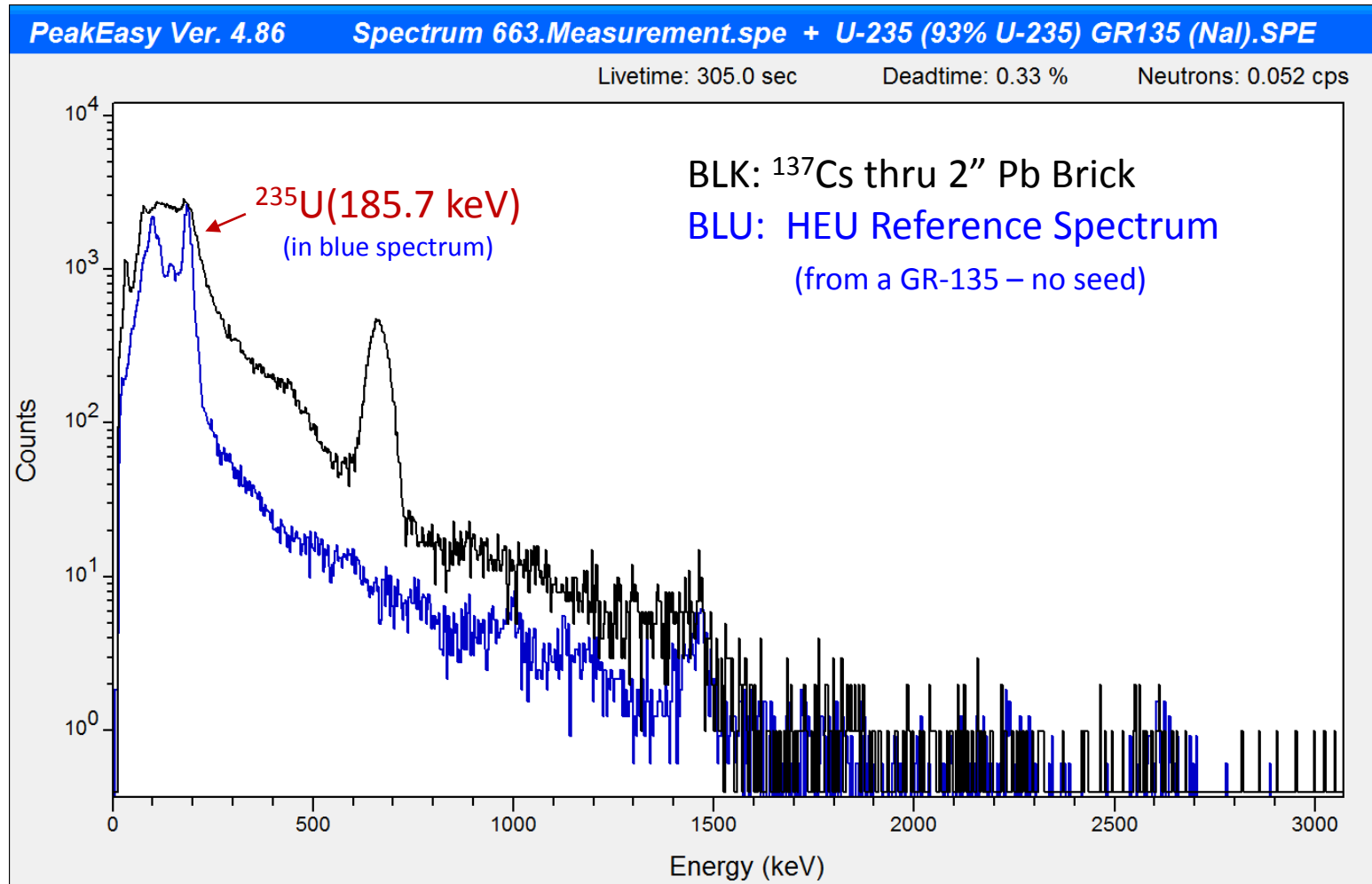


# $^{137}\text{Cs}$ Scattering Study

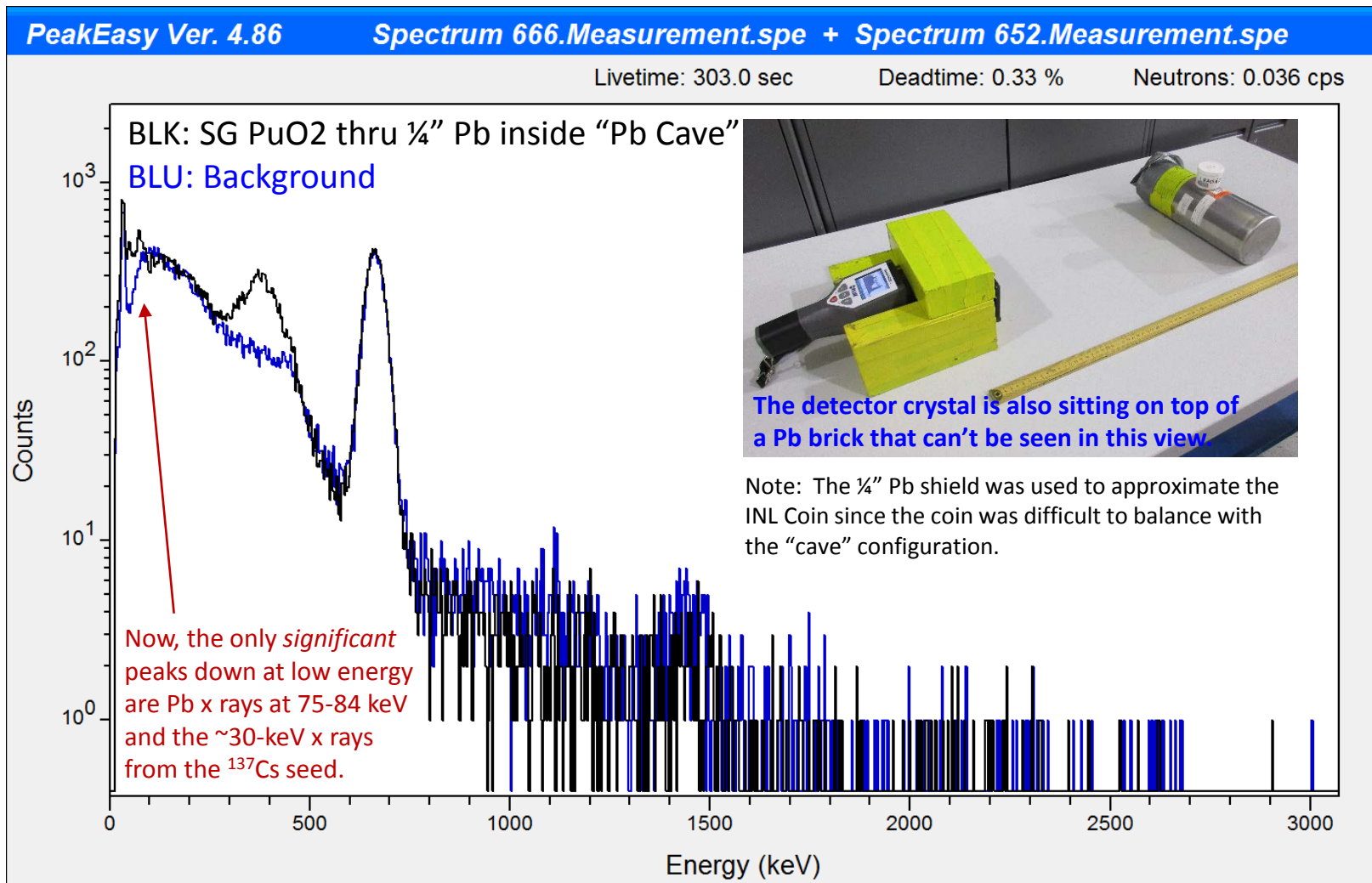
To study the possibility that the 49-keV peak is just scattering of the 60-keV peak of  $^{241}\text{Am}$  we use  $^{137}\text{Cs}$  (it has a simpler spectrum than Pu) with the Pb brick on the table.



# Why does scattered $^{137}\text{Cs}$ ID as U?



# Eliminating the Scattered Peak





# Summary

- Spectra recorded with and without the INL Coin illustrate how transmission plays a role in the dose-ratio factors written on the coin
  - Note: the coin references dose ratios, which are not exactly the same thing as peak area ratios.
- Plutonium was measured through the coin with and without the presence of other nuclides
- Nuclide ID results vary greatly.
- The issue of unwanted scattering reinforces documenting (through photos etc.) the measurement geometry and environment.