AmBe Detector Calibration Calculations

John Boyington
Kansas State University

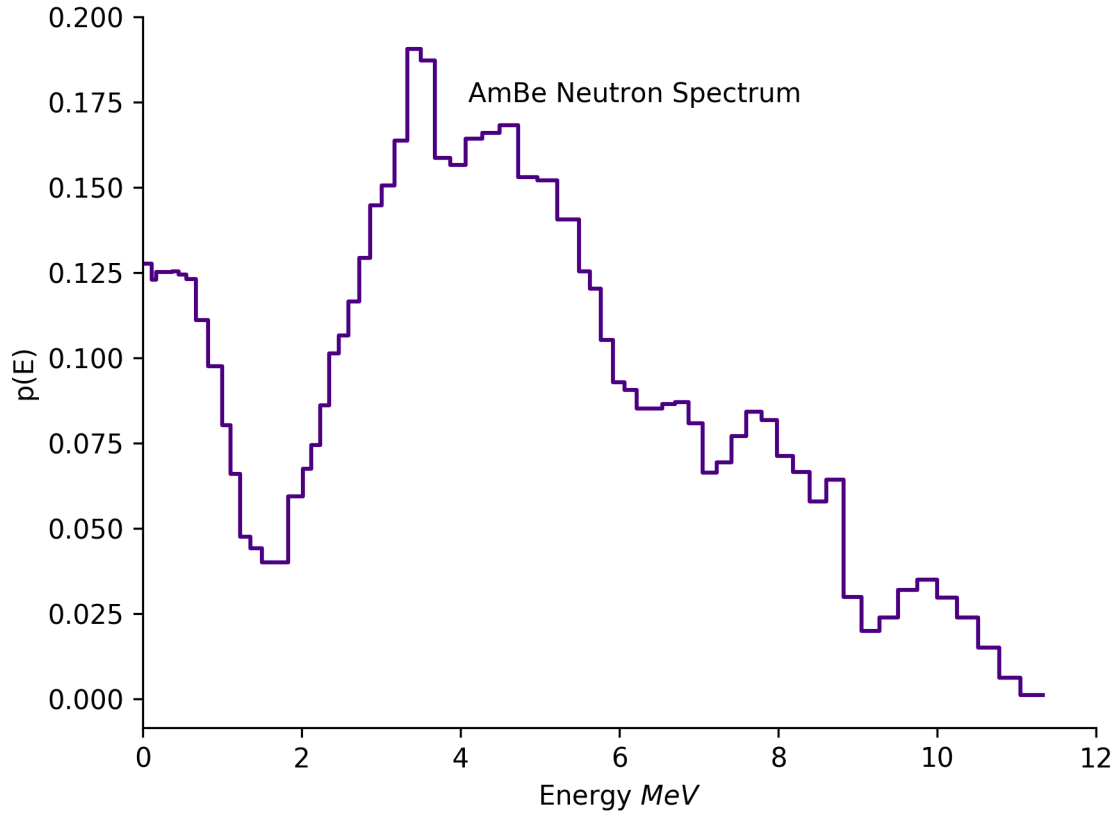
The document describes the calculations used to obtain the absolute efficiency of the LiI neutron detector used in Bonner Sphere measurements.

1 Source Term

The following equation was used to determine W, a value for the `WGT` parameter on the source SDEF card, which represents the total number of source neutrons emitted during the measurement period.

$$W = At3.7 \times 10^{10}(\text{Bq/Ci})$$

Here, A is the source activity, 4.85 Ci, t is the total measurement time, 60s, and 3.7×10^{10} is the conversion from Ci to Bq. This equation yields a value of 1.0767×10^{13} for W. Below is given a PDF of the energy-dependent source spectrum.



2 Tally Normalization

The result of the MCNP F4 tally will be given in units of [1/cm^2]. By using a tally multiplier card with an ENDF reaction number of 105, that value will be multiplied by the microscopic cross section σ[barns]. A constant of proportionality, C, equal to the atomic number density N in [1/b $\cdot$ cm] times the volume V in [cm^3] is needed to convert this fluence value into a total reaction rate.

$$R = C \int \Phi(E)\sigma(E)dE$$

where

$$C = VN\frac{1}{10^{24}}(\text{barns/cm}^2)$$

and

$$N = \frac{\rho N_A}{M}$$

In this case, N is reported as 1.74×10^{22} [atoms/cm^3] in a paper by Decker. The detector volume V is a 4mm $\times$ 4mm cylinder, and therefore equal to $\pi(\frac{D}{2})^2 h$, or 0.0502645 cm^3. The value for C calculated using these parameters is thus 8.7965 $\times 10^{-4}$ cm^2/barn.

3 Efficiency Calculation

Experimentally, for a 60s count, a total experimental response, R_e, of 53,016 counts were measured (53,161 gross cpm - 145 background cpm). The MCNP result for the response was found to be 580,541. The following equation is used to determine the detection efficiency of the detector.

$$\text{efficiency} = \frac{R_e}{R_{mc}}$$

Therefore, the overall efficiency of the detector is:

$$\text{efficiency} = 0.0913$$