Validation of S(α,β) thermal neutron scattering libraries using pulsed-neutron die-away experiments

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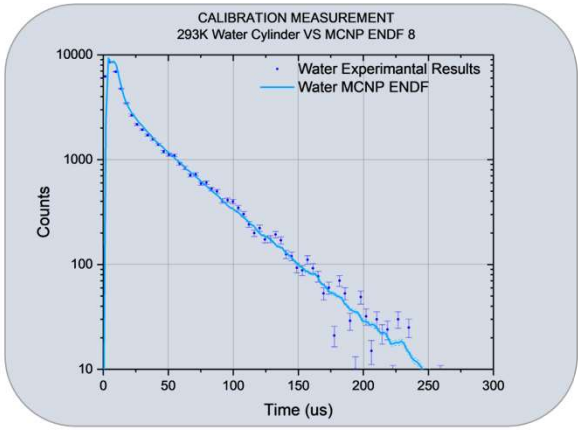
Motivation:

Thermal Scattering Law (TSL) Libraries are used to generate cross section in the thermal energy region. Some TSL libraries show discrepancies for the same material when used in MCNP simulations. Experimental data is thus needed to identify the inconsistencies between evaluations.

Pulsed Neutron Die Away (PNDA) is a method for experimentally validating a cross section by measuring the leakage rate of thermal neutrons from a target and comparing to an analytical or numerical solution.

At the Gaerttner Linear Accelerator Center at RPI a PNDA assembly has been constructed and utilized to experimentally determine the accuracy of TSL libraries. The most recent measurements involve utilizing a cold Polyethylene moderator at 24K and comparing the accuracy of cold poly using ENDF and CAB TSL libraries.



Equations and Theory:

PNDA measures the rate of leakage from a moderator. This leakage time dependent rate can be estimated by diffusion theory as an exponential function with decay constant as:

$$\alpha = \left(\frac{\lambda}{v}\right) = \Sigma_a + DB_g^2 - (C-d)B_g^4$$

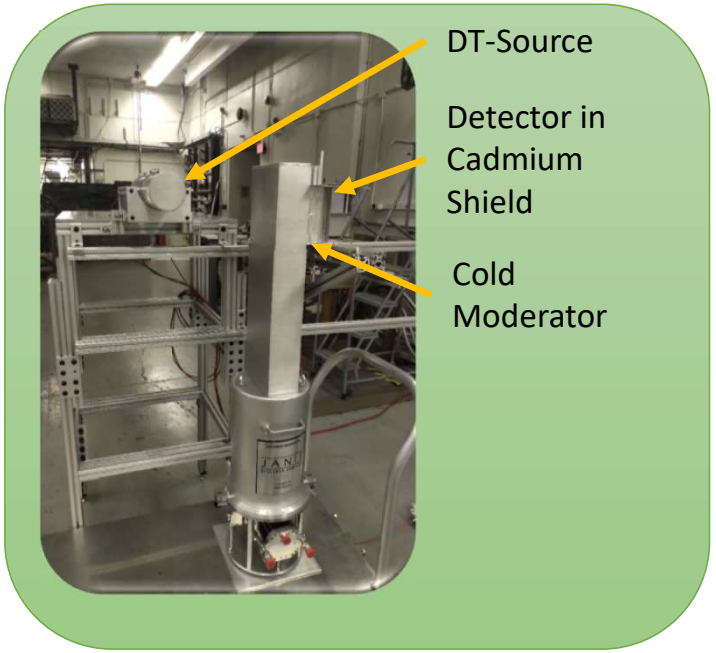
Where; v is velocity, Σ_a is total absorption cross section, D is Diffusion Coefficient which is defined as $(D = \frac{\Sigma_a}{3*\Sigma_s^2})$, Bg is geometric buckling, C is Neutron Cooling Coefficient, and d is a correction factor.

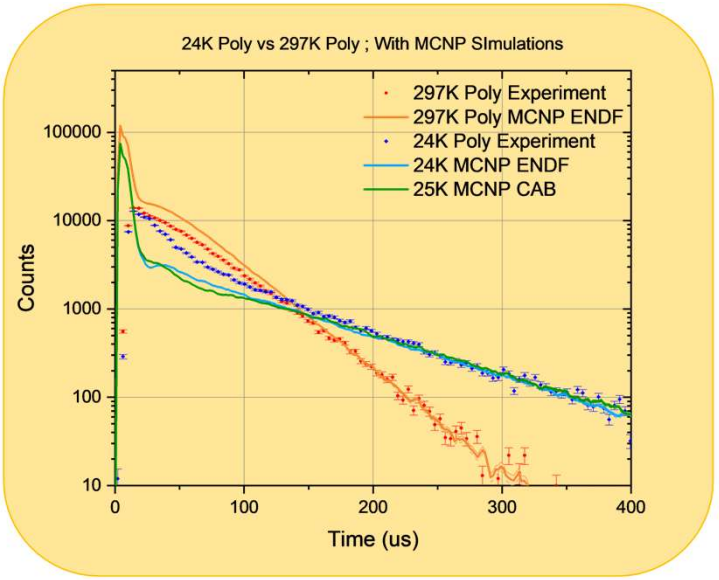
Thus, having smaller geometries (larger Buckling) increases the sensitivity to the effects of the TSL in the measurement, but shortens neutron die-away.

To test and calibrate the experimental assembly measurements were taken using distilled water in a borosilicate glass beaker. Once system calibration was complete measurements with Low Temperature Polyethylene were conducted.

Results

Experimental results and MCNP simulations show excellent agreement for distilled water measurements. The results also show good agreement with low temperature poly in the fully thermalized region of the die away. There is some discrepancy in the thermalization and pulse regions of the results for poly.





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