National Institute of Standards and Technology

Neutron Cross Section and Fluence Standards Program

PROGRESS REPORT

USNDP Meeting
Brookhaven National Laboratory
November 8, 2019

Activities

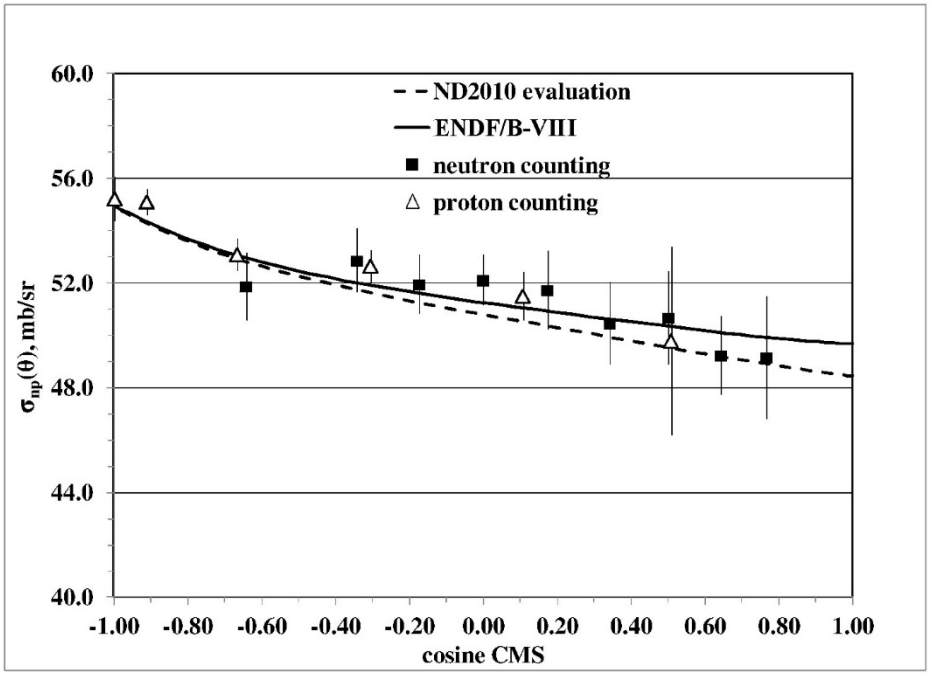
- **Measurements of Standards**
- **Evaluation of Standards**
- **Other work**

Nuclear Reaction Activities: H(n,n)H Standard Angular Distribution Work

This work was initiated to resolve problems with the hydrogen database.

- We previously made measurements at 10 and 14.9 MeV at the Ohio University accelerator facility. The data were obtained by detecting the recoil proton.
- New measurements at 14.9 MeV have been made detecting the neutron in coincidence with the associated proton so that data can be obtained at smaller CMS angles. The data were obtained at the Ohio University accelerator facility.
- (collaboration of NIST with Ohio University and the University of Guelma)

This work has been completed. A paper has been submitted for publication on this work. Present results shown here are compared with data obtained using detection of the recoil proton. There is excellent agreement with the ENDF/B-VIII standards evaluation within the uncertainties but there is a trend toward lower values at small CMS angles for both experiments.



Nuclear Reaction Activities: Standards Measurements

^{6}Li(n,t) Cross Section

- At the NIST Neutron Center for Neutron Research a measurement was made of the ^{6}Li(n,t) cross section standard. This is the first direct and absolute measurements of this cross section in this neutron energy range using monoenergetic neutrons.
  - A primary effort was focused on measuring the neutron fluence accurately. It was determined with an uncertainty of 0.06%.
  - A better determination of the mass must be made to improve the uncertainty of this measurement. **Last month samples were submitted for mass determination using Isotope Dilution Mass Spectrometry.**

(collaboration of NIST with the University of Tennessee and Tulane University)

Nuclear Reaction Activities: - Evaluations

- Experimental data in the standards database have been improved as a result of NIST involvement or encouragement. These data were used in the evaluation of the neutron cross section standards. Work is continuously done to investigate new experiments for improvements that may be needed.
- NIST has been actively involved in the entire process of evaluating the standards which were used for the ENDF/B-VIII evaluation.
- Co-authored a paper on unrecognized sources of uncertainty (USU). In many (if not all) experiments of a given type there exist unrecognized (unknown) experimentally related sources of uncertainty that cannot be eliminated by repeated measurements. These uncertainties might enhance the observed scatter in the data points (if they are random in nature) or introduce biases (if they are correlated). These types of uncertainties ultimately limit the precision and accuracy to which physical quantities can be measured. These unknown uncertainty sources are denoted Unrecognized Sources of Uncertainties (USU), (**Unrecognized Sources of Uncertainties (USU) in Experimental Nuclear Data, R. Capote, et al.**)

Nuclear Reaction Activities: - Evaluations

- Co-authored a paper on the OECD-NEA High Priority Request List (HPRL). It is a point of reference to guide and stimulate the improvement of nuclear data for nuclear energy and other applications, and a tool to bridge the gap between data users and producers. (**HPRL – International cooperation to identify and monitor priority nuclear data needs for nuclear applications by E. Dupont, et al.**)

- Co-authored a paper on templates used in updating uncertainties of cross-section data in the neutron standards database. These templates can help evaluators in identifying missing or suspiciously low uncertainties for a specific uncertainty source and missing correlations between uncertainties of the same and different experiments, when estimating covariances for measurements entering their evaluation. (**Applying a Template of Expected Uncertainties to Updating Uncertainties of 239Pu(n,f) Cross-section Data in the Neutron Data Standards Database, by D. Neudecker, et al.**)

Nuclear Reaction Activities- Measurements

Previous ^{235}U(n,f) 2200 m/s Cross Section Measurements (No Maxwellian Data)

Author	Date	CS (b)	DCS (%)	Reference
Saplakoglu	1959	593.17	2.2	*2nd Geneva Conf.* ***4,*** *157*
Raffle	1959	581.97	3.1	*AERE/R-2998*
Deruytter	1961	589.37	1.3	*J. Nucl. Energy* ***15****, 165*
Maslin	1965	583.71	1.4	*Phys. Rev.* ***139****, 852*

- A new measurement is planned at NIST of the ^{235}U(n,f) cross section at low neutron energy using the same basic setup used for the ^{6}Li(n,t) measurement. A well characterized sample has been obtained.

National Repository for Fissionable Isotope Mass Standards

- These are well characterized samples that have been obtained from various labs that no longer are in the nuclear measurement field. They are routinely monitored.

Proposed Work

- Pursue improvements in the experimental database so they are available for the next evaluation of the standards.
- In an effort to continually improve the standards, continue to recommend and encourage new measurements and perform examinations of the data from them for use in future evaluations of the standards. Continue USU and Template work.
- Calibrate NBS-I using an absolutely calibrated source based on the α-γ coincidence system.
- Continue to acquire and monitor samples in the National Repository for Fissionable Isotope Mass Standards. Make these samples available for loan in experiments
- Determine the mass of the ^{6}Li sample used for the ^{6}Li(n,t) cross section by Isotope Dilution Mass Spectrometry and consistency measurements. Then finalize the ^{6}Li(n,t) cross section data.
- Measure the ^{235}U(n,f) cross section at a sub-thermal energy with high accuracy.