National Institute of Standards and Technology

Neutron Cross Section and Fluence Standards Program

PROGRESS REPORT

USNDP Meeting
Brookhaven National Laboratory
November 8, 2018

Activities

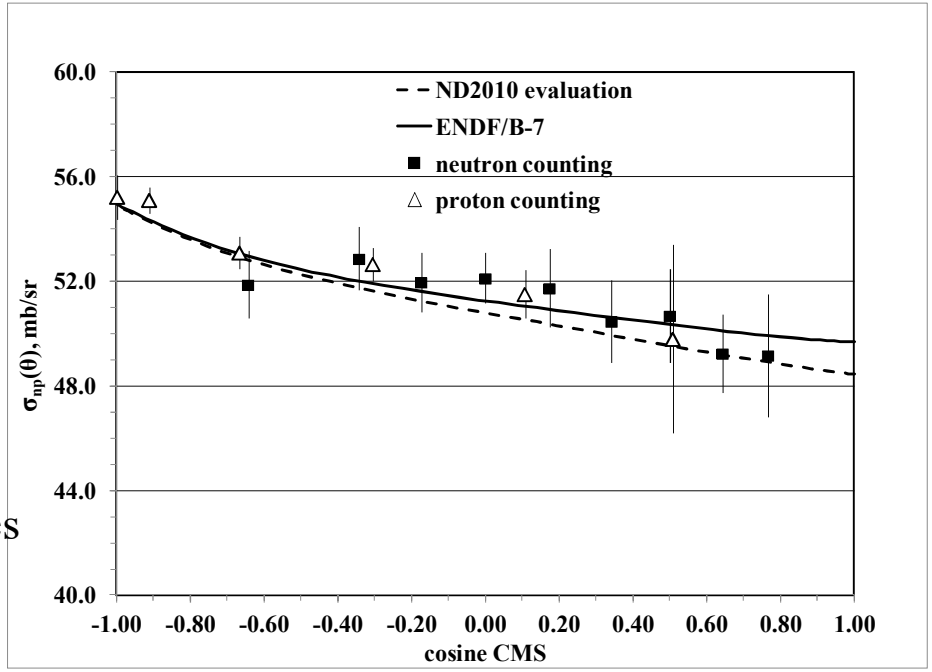
- **Measurements of Standards**
- **Evaluation of Standards**
- **Other work**

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, LANL and the University of Guelma)

This work is nearing completion. The results in the accompanying plot are expected to only have very minor changes. Work is underway on a publication of 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-VII standards evaluation within the uncertainties but there is a trend toward lower values at small CMS angles for both experiments.



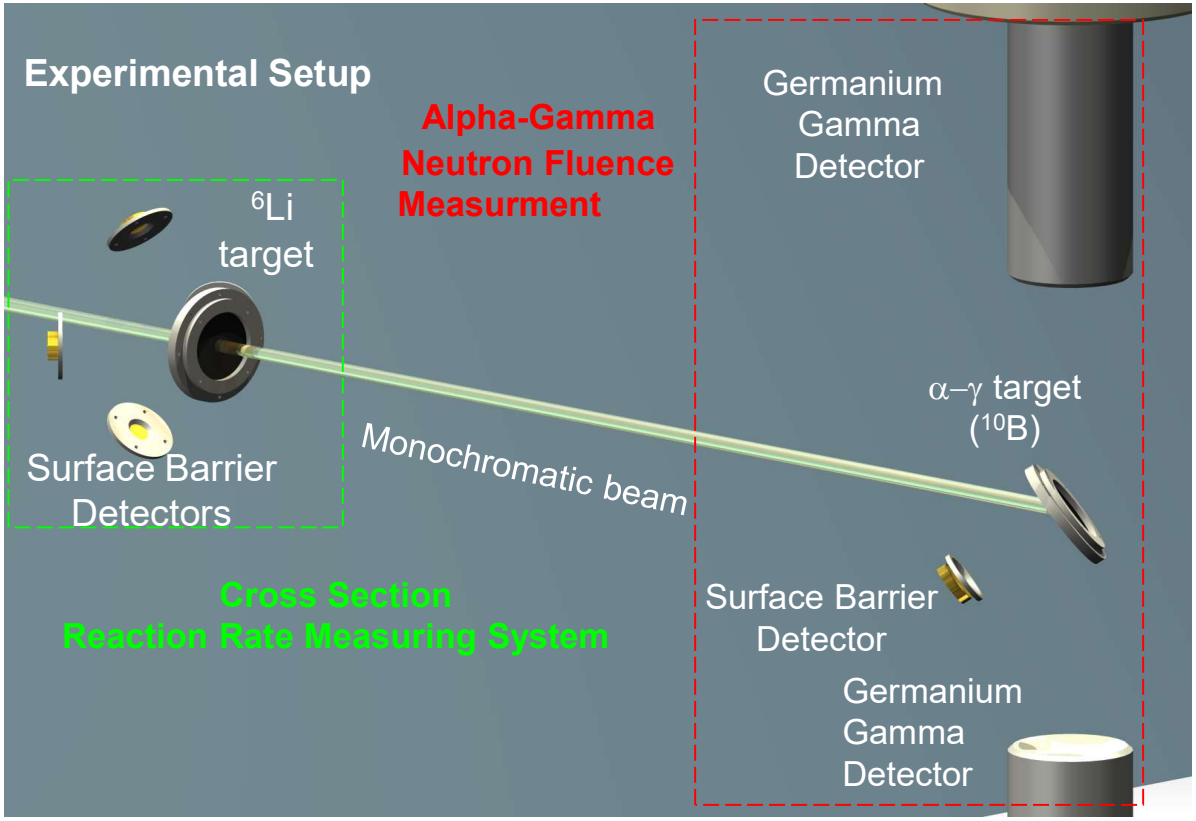
Nuclear Reaction Activities: Standards Measurements

^{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. **The mass is going to be determined using Isotope Dilution Mass Spectrometry.**

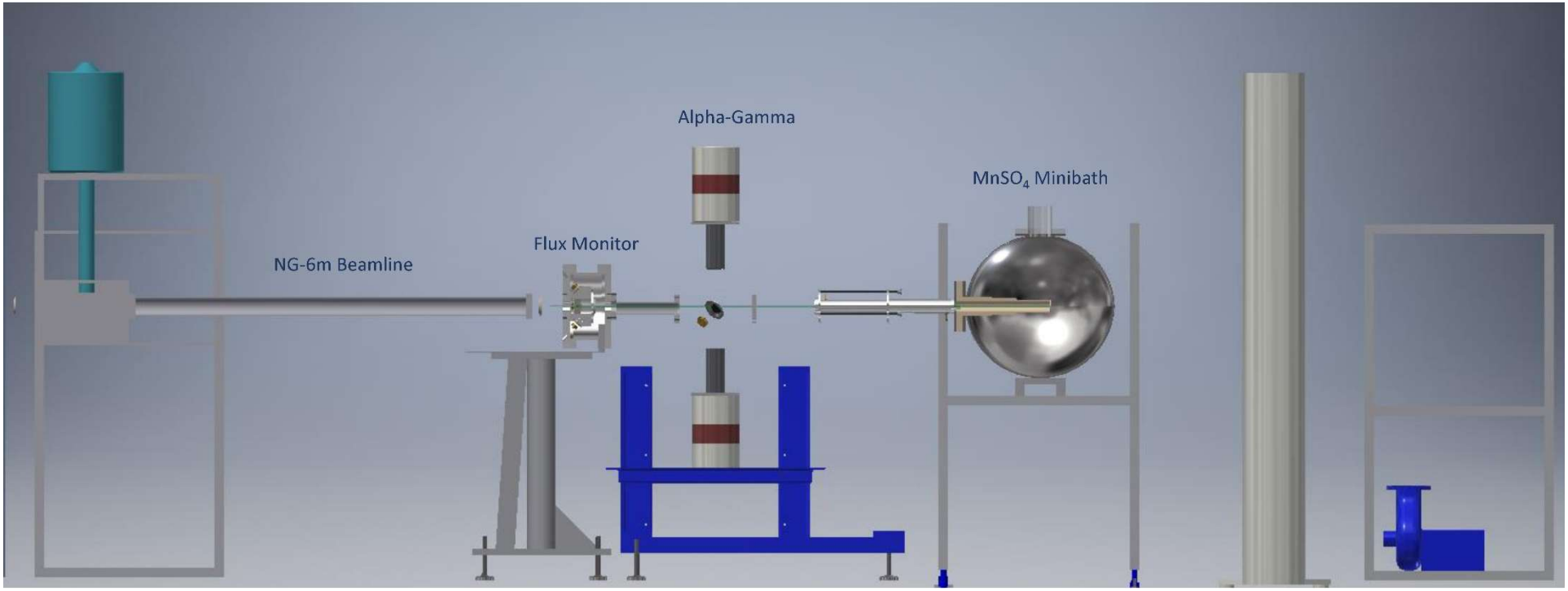
(collaboration of NIST with the University of Tennessee and Tulane University)

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



NBS-I Source Strength Determination Work

- Work continues on improvements in the determination of the neutron source strength for NBS-I, the U.S. national fast-neutron source standard. This work will have an impact on many cross section measurements that have used this source as a standard and any future measurements made using this source.
  - The work requires first that a $MnSO_4$ bath be calibrated using the very accurate measurement of neutron fluence method referred to previously. Then calibration of the NBS-I source can be done by putting it into the calibrated bath.



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.
- NIST has been actively involved in the entire process of evaluating the standards which were used for the ENDF/B-VIII evalution.

Other Standards Related Work

- Work has been done on the gold cross section at low energies-now a standard
- Reference cross sections for prompt gamma-ray production in fast neutron-induced reactions have been studied and proposed.
- Very high energy fission reference cross sections for Bi and Pb have been evaluated.
- An effort was directed at improvement in the ^{235}U thermal neutron fission spectrum evaluation and some improvement in the ^{252}Cf spontaneous fission neutron spectrum.
- A new evaluation of the thermal constants was done.

National Repository for Fissionable Isotope Mass Standards

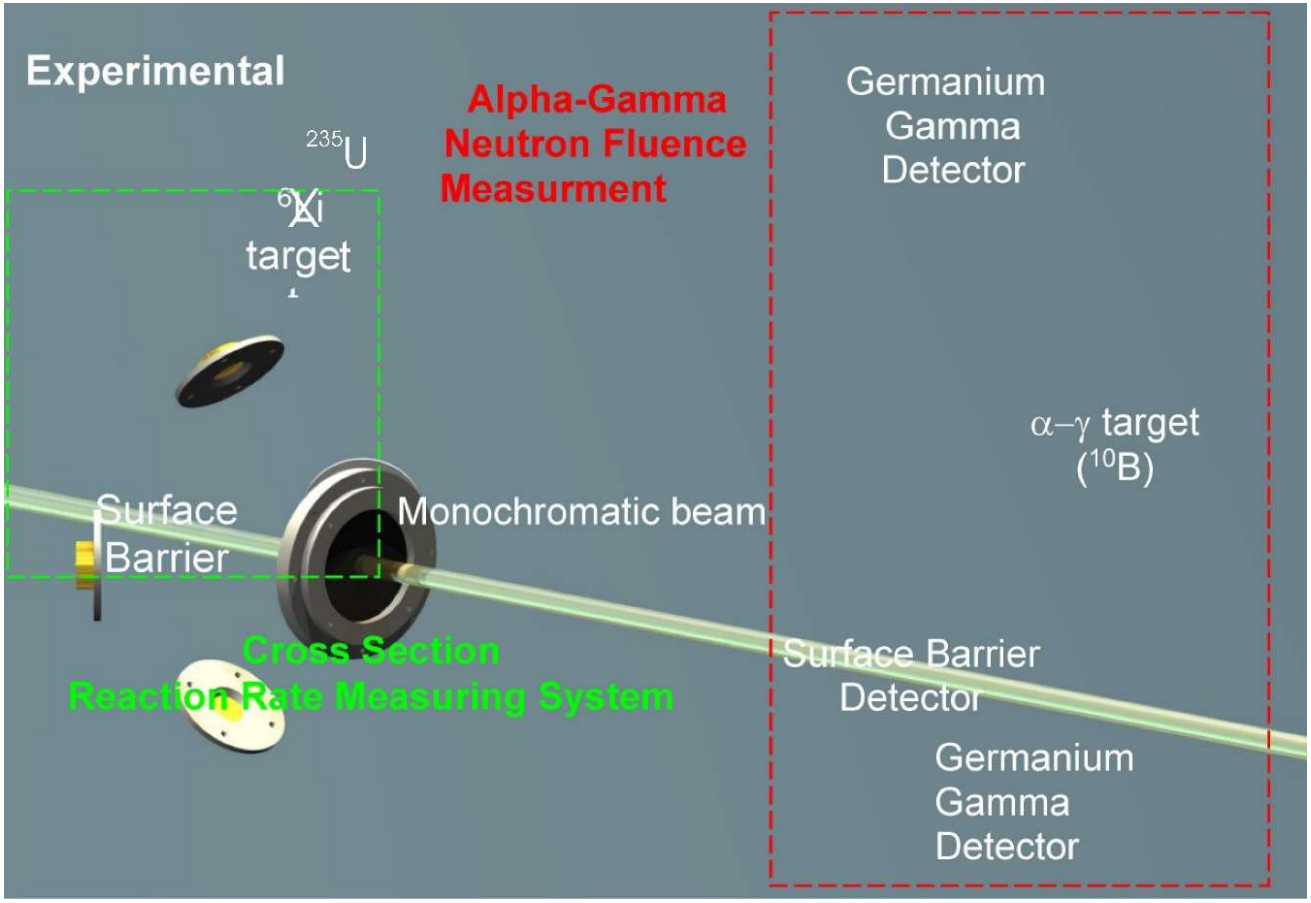
- These are well characterized samples that have been obtained from various labs that no longer are in the nuclear measurement field. They are routinely monitored.

^{235}U(n,f) Cross Section Measurements (At Thermal – 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	589.73	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 using the same basic setup used for the ^{6}Li(n,t) measurement.

^{235}U(n,f) Cross Section Measurement



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. Study USU (IAEA CM in December)
- Do diagnostic work involving symmetry of angular distributions to relate the fluence of lower energy neutrons to the fluence of higher energy neutrons. This should lead to measurements of the H(n,n)H angular distribution with the new deuterium gas target at smaller center-of-mass angles.
- 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.