Status of the Experimental Data for the International Standards Evaluation

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Introduction The database for the ENDF/B-VI standards evaluation was defined in September of 1987. Since that time, many experiments relevant to a new evaluation of the standards have been completed. There are also a large number of experiments that are not finished since data taking is still underway or experimental data are under analysis. Also some of the measurements that were used in the ENDF/B-VI evaluation have been found to need additional corrections, or errors have been found. All of these data can be used to define the changes in the database for the new international evaluation of the neutron cross section standards. The original cutoff date for data that would be used in the evaluation has passed. Unfortunately there are still many experiments that could have an impact on the evaluation that are not completed. Once the process for doing the complete evaluation is established, it should be relatively easy to add additional data sets and re-do the evaluation. Thus since the evaluation is expected to be completed next year, we should be able to accept additional data sets early into 2004. Thus the cutoff date will be extended to early spring of 2004.

Table 1. Neutron Cross Section Standards

Reaction	Proposed energy range
H(n,n)	1 keV to 200 MeV
^{3}He(n,p) †	0.0253 eV to 50 keV
^{6}Li(n,t)	0.0253 eV to 1 MeV
^{10}B(n,α)	0.0253 eV to 1 MeV
^{10}B(n,$\alpha_1\gamma$)	0.0253 eV to 1 MeV
C(n,n)*	0.0253 eV to 1.8 MeV
Au(n,γ)	0.0253 eV, 0.2 to 2.5 MeV
^{235}U(n,f)	0.0253 eV, 0.15 to 200 MeV
^{238}U(n,f) ††	Threshold to 200 MeV

In Table 1, the cross section standards to be evaluated are listed. The database also includes data involving the ^{238}U(n,γ) and ^{239}Pu(n,f) cross sections. There are many very accurate measurements of these cross sections. The use of these additional data improves the database as a result of ratio measurements of those cross sections to the traditional standards. Also scattering and total cross section data have been included for ^{6}Li and ^{10}B since they provide information on the standard cross sections. There is a significant increase in the energy range of the database for the standards compared with previous evaluations. No evaluation of the C(n,n) cross section is planned since very little new data have been obtained since the last evaluation and what was obtained is in good agreement with that evaluation.

Database Studies

Work continues on the encouraging, motivating and coordinating of measurements that can be used in the evaluation. Studies of possible experiments for the standards database continues. For each experiment a process is followed that includes checking the documentation for corrections that may need to be made and looking for possible errors or missing information. Poor documentation is a very frequent problem! The investigative procedure can lead to improved estimates of the uncertainties within an experiment and correlations with other experiments. This information is used to assist in forming covariance matrices for the measurements so that a proper analysis can be performed for the evaluation. Additional experiments will to be added as they are found in the literature searches that are underway. Also corrections to new or old experiments will be incorporated in the experimental results. Recently documentation was received from W.P. Poenitz containing corrections and comments concerning experiments used for the GMA database in the ENDF/B-VI standards evaluation. Some effort has been and will be spent looking at that documentation. There is concern about certain experiments used in the ENDF/B-VI evaluation process that had large weight in the evaluation. Investigations are being made of those experiments.

Table 2 lists standards related experiments that have been investigated, at least to some degree. Additional experimental work will be added to this list as they become available. Recent measurements that should have important impact on the evaluations have been done on the H(n,n), ^{3}He total, ^{6}Li(n,t), ^{10}B(n,α), ^{235}U(n,f), ^{238}U(n,f) and ^{239}Pu(n,f) cross sections.

Hydrogen Scattering

The most recent measurements of the hydrogen scattering angular distribution are those of Vigdor et al. Since these data have been obtained with high accuracy and are absolute, they can make an important contribution with respect to both the shape and normalization of the hydrogen scattering cross section thereby providing needed information for understanding a discrepancy at back angles. This discrepancy is present at 90 and 162 MeV in measurements by the Uppsala group of the differential H(n,n) cross section that disagree with the evaluated shape given by the Arndt VL40 phase-shift solution. The Arndt evaluation was accepted by the NEANDC/INDC as a primary standard for cross section measurements in the 20 MeV to 350 MeV range. The Uppsala data have a steeper angular shape at back angles by as much as 10% compared with the VL40 results This discrepancy has led to large increases in the uncertainty associated with this cross section. The Vigdor et al. data are high accuracy absolute H(n,n) measurements at 200 MeV that ultimately should have about 1% accuracy. They were obtained at Indiana University using tagged neutrons. Some of the experimental data have been analyzed by Sarsour, so that results at about the 5% level are available. The preliminary results suggest better agreement with the Bonner data (and the VL40 solution) than the Uppsala data at back angles. Complicating the issue are the PSI data of Franz et al. at somewhat higher energies that tend to support the Uppsala work. The analysis of the remainder of the Indiana data continues. Final results are expected by the end of this year.

The NIST-Ohio University-LANL collaboration on measurements of the hydrogen scattering angular distribution has begun diagnostic work leading to measurements at 15 MeV neutron energy. It is hoped that these data will be available in time for the present international evaluation. These data are needed as a result of the reduction in the quality of the database at ~14 MeV since our studies have shown that the measurements of Nakamura, and Shirato near 14 MeV, which had small reported uncertainties, required expanded uncertainties. This NIST-Ohio University-LANL collaboration led to H(n,n) measurements with an average uncertainty of less than 1% at 10 MeV neutron energy (Boukharouba et al.) that resolved a problem with the shape of the angular distribution given by evaluations of this cross section.

Coherent scattering length measurements for hydrogen with an accuracy of 0.05% were completed at the NIST reactor facility. The coherent scattering length is related to the phase shift and can be used directly in certain analysis codes, such as R-matrix analyses, for the evaluation of the hydrogen scattering cross sections.

^{3}He

Measurements were made by Keith et al. of the ^{3}He total neutron cross with uncertainties of less than 1% for the energy region from 0.1 to 500 eV. They are the most precise measurements of this cross section. The results are in excellent agreement with those of Als-Nielsen & Dietrich (1964) that had very high weight in previous evaluations of the ^{3}He(n,p) standard cross section. The results suggest that the data of Borzakov (1982) that have a reported uncertainty of about 1%, but are lower than the Keith results by about 8%, are in error.

Coherent scattering measurements were made with an accuracy of 0.1% for ^{3}He at NIST.

^{6}Li(n,t)

Zhang et al. have made the latest measurements of this cross section. The most recent being published in 2003. In separate experiments, data were obtained at 3.67 MeV and 4.42 MeV; and at 1.85 and 2.67 MeV. The data were all obtained with a gridded ionization chamber. Angular distribution measurements were obtained with this detector. The distributions have gaps near 90 degrees in the CMS which require fitting to get the integrated cross section. Corrections must be made to these data to account for the “particle leaking” effect. Particle leaking results when both reaction products are emitted in the forward direction. The particle identification feature which is possible with the gridded chamber treats this as a quasi ^{7}Li+α particle. It appears in the pile-up portion of the spectrum and is rejected. Data taken without taking this into account are correct over only a limited angular range. Since particles are lost, the integrated cross section will be lower than the correct value. The magnitude of this correction is not known for the Zhang et al. data. A measurement of the ^{6}Li(n,t) cross section at ~4 meV has been made at NIST using a cryogenic radiometer. The result is in excellent agreement with the ENDF/B-V evaluation. It is about 0.5% lower than the ENDF/B-VI evaluation. The uncertainty in this measurement is still being evaluated. It is presently estimated to be about 0.4%. Additional work is being done to study possible heat loss processes that may allow the uncertainty to be reduced even further.

^{10}B Standards

The relatively poor ^{10}B database caused problems with the ENDF/B-VI standards evaluation process. These problems led to appreciable experimental activity on the ^{10}B(n,α) and ^{10}B(n,$\alpha_1\gamma$) standards since the completion of the ENDF/B-VI standards evaluation. Work was done on the differential cross section for the ^{10}B(n,α)^{7}Li reaction, the branching ratio, the ^{10}B(n,$\alpha_1\gamma$) cross section, the total neutron cross section, and the ^{10}Be(p,n) reaction. The use of the R-matrix allows all these types of data to be used in helping to define the ^{10}B(n,α) cross sections.

Differential cross section measurements in the MeV energy region have recently been made by Zhang et al., and Giorginis and Khriachkov using Frisch-gridded ionization chambers. The Zhang et al. data are significantly lower than those of Giorginis and Khriachkov. This is a result of the previously noted "particle leaking" effect. Since particles are lost, the integrated cross section is lower than the correct value. This agrees with the comparison between the Giorginis and Khriachkov, and Zhang et al. data sets. Zhang et al. have decided they can not correct for this effect. They are planning to re-measure the cross section using a more sophisicated data taking method.

Measurements by Weston and Todd of the branching ratio, (the ^{10}B(n,$\alpha_0\gamma$) cross section/the ^{10}B(n,$\alpha_1\gamma$) cross section), are 10 % to 30 % low in the 100 keV to 600 keV energy region compared with the ratios calculated from the ENDF/B-VI cross sections. The data agree with ENDF/B-VI at the lowest and highest energies of the experiment. To check these data, measurements of this ratio have been measured in this energy region by Hambsch and Bax. The measurements of Hambsch and Bax are in better agreement with ENDF/B-VI than the Weston and Todd measurements. Higher values were obtained by Hambsch and Bax in the hundred keV energy region that are expected to be a result of backgrounds which have not been subtracted yet. These data were obtained with a Frisch-gridded ionization chamber and require the particle leaking correction referred to previously. However the ratio should depend only weakly on particle leaking. Also the leaking correction is less at lower neutron energies.

In an NIST/ORNL collaboration, Schrack et al. have made measurements of the shape of the ^{10}B(n,$\alpha_1\gamma$) cross section from 0.3 MeV to 4.0 MeV neutron energy. The cross sections obtained from this investigation, normalized to the ENDF/B-VI evaluation over the region from 0.2 MeV to 1 MeV, agree with the ENDF/B-VI evaluation below 1.5 MeV. The measured cross sections differ as much as 40 % with the ENDF/B-VI evaluation for neutron energies greater than 1.5 MeV. An additional measurement by this collaboration extended the cross section to lower energies so that better normalization of shape measurements could be made. The measurement covered the neutron energy range from 10 keV to 1 MeV. These data are lower than the ENDF/B-VI shape by about 5 % in the region above 100 keV.

Measurements of the ^{10}B total cross section have been made at the IRMM linac and Van de Graaff facilities. The linac work extends to 730 keV neutron energy. The present results of this work are approximate agreement with ENDF/B-VI below 10 keV, a maximum deviation above ENDF/B-VI of 5% at 100 keV and a maximum deviation below ENDF/B-VI of 7% at 700 keV. These data are under final analysis. The Van de Graaff facility data are lower than ENDF/B-VI by 3-4% at 0.3 and 0.4 MeV, and by 6 to 9% from 0.6 to 1.3 MeV. They agree with that evaluation at 1.7 and 1.9 MeV. These data are expected to be finalized later this year. Wasson et al., in an NIST-ORNL collaboration have also made measurements of the ^{10}B total cross section. These data extend from about 20 keV to 20 MeV using two different flight paths at the ORELA facility. The results of these experiments agree with the ENDF/B-VI evaluation for neutron energies greater than about 2 MeV, but are lower by as much as 4 % between 600 keV and 2 MeV, and are greater by as much as about 5 % below 600 keV. There is generally good agreement among the IRMM linac, IRMM Van de Graaff and NIST-ORNL measurements within the uncertainties. The data sets are still undergoing checks and corrections which are expected to improve the agreement.

Though many of the experiments are preliminary, the lower $^{10}B(n,\alpha_1\gamma)$ cross sections of Schrack et al., and the higher total cross section work suggest that the Weston and Todd branching ratio data are in error in the hundred keV energy region. The preliminary branching ratio work of Hambsch and Bax appear to be more consistent with those measurements.

^{235}U(n,f)

The most recent measurements of the $^{235}U(n,f)$ cross section below 20 MeV are those of Carlson et al., Lisowski et al., and Alkhazov et al. These measurements suggest a cross section as much as 5% larger than the ENDF/B-VI evaluation above 14 MeV neutron energy. For the energy region above 20 MeV, very few measurements have been made. The recent work by Nolte et al. is an important contribution since these are the only data other than those of Lisowski et al. in this energy region that have relatively small uncertainties. Except for a data point at 96 MeV, which Nolte et al. suggest may be in error, there is agreement within the uncertainties of these data with the Lisowski et al. data. Since so many cross sections are being measured relative to the $^{235}U(n,f)$ cross section, additional corroborative measurements of this important standard should be made.

^{238}U(n,f)

The most recent measurements of the $^{238}U(n,f)$ cross section in the 10 to 20 MeV energy region, those of Lisowski et al., Merla et al. and Winkler et al., indicate the ENDF/B-VI evaluation is low an average of a few percent from 15 to 20 MeV. Above 20 MeV, the most recent data are ratio measurements to the $^{235}U(n,f)$ cross section by Nolte et al., Shcherbakov et al. and Lisowski et al. The measurements reported by Newhauser et al. required revision. The corrected results from that work have been incorporated into the Nolte work. The final results by Nolte et al. are generally in good agreement with the Lisowski et al. measurements, though the uncertainties on the Nolte et al. work are considerably larger. There is a difference between the Shcherbakov et al and the Lisowski et al. measurements that is a couple of percent at the lowest energies but becomes more than 5% at the highest energies. Preliminary measurements have been made by Eismont et al. at 22 and 75 MeV neutron energy. These data are low compared with the Lisowski et al. However, they are generally in good agreement with the Lisowski et al. data, within the rather large uncertainties of the Eismont et al. measurements. It may not be possible to reduce the uncertainties on the Eismont et al. data due to the uncertainties in the neutron fluence.

^{239}Pu(n,f)

The most recent measurements of the ^{239}Pu(n,f)/^{235}U(n,f) cross section ratio are those of Lisowski et al, Staples and Morley, and Shcherbakov et al. The three data sets agree very well up to about 20 MeV neutron energy. Between 20 MeV and 60 MeV neutron energy, the Staples and Morley data are about 4% higher than the Lisowski et al. data. In that same interval the Shcherbakov et al. data increase from 0% to about 2% higher than the Lisowski et al. data. Above 60 MeV neutron energy, the disagreement increases between the Shcherbakov et al. and Lisowski et al. data sets with the Shcherbakov et al. data being almost 10% higher than the Lisowski et al. data set at 200 MeV.

Conclusion

Better measurements and improved methods to handle discrepant data are needed. But working with what is available, the database continues to be prepared for use in the new international evaluation of the neutron cross section standards.

Table 2. New Experiments for the Standards Database

$^{++}$ means the data have been reviewed and are in the library
$^{+}$means the data are available and the review process is underway
no superscript means that final data are not available

H(n,n)

$^{++}$Nakamura, J. Phys. Soc. Japan 15 (1960) 1359, 14.1 MeV; error in transformation from laboratory to CMS angles; needs correction for proton scattering, an estimate of error associated with neglecting these corrections was made; tail problems; note Table II uncertainty is statistical only (mb/sr).

$^{++}$Shirato, J. Phys. Soc. Japan 36 (1974) 331, 14.1 MeV, needs correction for proton scattering; tail problems.

$^{+}$Ryves, 14.5 MeV, $\sigma(180°)/\sigma(90°)$, Ann. Nucl. Energy 17, 657 (1990).

$^{++}$Buerkle, 14.1 MeV, angular distribution from 89.7° to 155.7°, Few-Body Systems 22, 11 (1997). The angular range is too limited.

$^{++}$Boukharouba, Phys Rev C 65, 014004, 10 MeV, angular distribution from 60° to 180°, additional work planned for 15 MeV.

Uppsala data:
$^{+}$Rönnqvist, Phys Rev C45, R496 (1992), 96 MeV angular distribution from 116° to 180°
$^{+}$Rahm, Phys. Rev. C57, 1077 (1998) 162 MeV, angular distribution from 72° to 180°,

$^{+}$Benck, (Louvain la Neuve), Nucl. Phys. A615, 222 (1997) and Proc. Conf. on NDST, Trieste (1997) p.1265, 28-75 MeV, angular distribution from 40° to 140°. Angular range is too limited.

Vigdor (IUCF) 185-200 MeV, angular distribution from 90° to 180°. Data have been obtained. Sarsour is analyzing the data and has preliminary data at 200 MeV, Private Comm.

^{3}He(n,p)
$^{++}$Borzakov, 0.26 keV to 142 keV, relative to ^{6}Li(n,t), Sov. J. Nucl. Phys. 35, 307 (1982). OK

^{3}He total cross section
$^{++}$Keith, 0.1 to 500 eV, BAPS DNP Oct 1997 paper IG.03 and thesis of D. Rich, U of Indiana. OK.

^{6}Li(n,t)
$^{+}$NIST collaboration, thermal measurement with high accuracy using cryogenic calorimeter, Private Comm. OK

$^{++}$Knitter, (1983) NS&E 83, 229; ^{6}Li(n,t)^{4}He angular distribution, 0.035-325 keV, new corrections required for particle leaking effect. Giorginis is investigating

$^{++}$Drosg, 0.50 MeV to 4.1 MeV, NIM B94, p.319 (1994), using concept based on the two groups from the source reaction. Set 1011. OK

Bartle, 2 to 14 MeV, angular distribution, Proc. Conf on Nuclear Data for Basic and Applied Science, Sante Fe (1985), p. 1337 (questionable value, due to energy range and information not available).

Schwarz, 1 to 600 keV, NP 63, p.593, some based on hydrogen scattering cross section. Assumptions need study!

Koehler, 1 keV to 2.5 MeV, angular distribution data (ratio of forward and backward hemispheres responses), private comm.

Yu Gledenov, .025 eV, 87KIEV 2 237 (1988) no data given

$^{+}$Guohui Zhang, 3.67 and 4.42 MeV, angular distribution, Comm. Of Nuclear Data Progress No.21 (1999) China Nuclear Data Center, also NSE 134, 312 (2000). Also 1.85 MeV and 2.67 MeV, NSE 143, 86 (2003). Has "particle leaking" effect.

^{10}B(n,$\alpha_1\gamma$)
Maerten, 320 keV to 2.8 MeV, GELINA linac, relative to ^{235}U(n,f) and carbon standards, private comm. from H. Weigmann. Not enough information on uncertainties is available.

$^{++}$Schrack, 0.2 MeV to 4 MeV, shape data relative to Black Detector (at ORNL), NSE 114, 352 (1993). Set 113. OK

$^{+}$Schrack, 10 keV to 1 MeV, shape data relative to H(n,n) prop ctr (at ORNL), Proc. Conf. on NDST, Gatlinburg (1994)p. 43. Set 1034 OK

+Schrack, .3 MeV to 10 MeV, relative to ^{235}U(n,f) ion chamber (at LANL), Private comm. Set 1033 OK

^{10}B(n,α) Branching Ratio
++Weston, 0.02 MeV to 1 MeV, Solid State detectors, NSE 109, 113 (1991). Set 1024. May have systematic errors.

++Hambsch and Bax, ND2001, 0.04 MeV to 1.0 MeV, Frisch gridded ion chamber, in progress. Set 1015. Background problems

^{10}B(n,α)
Haight, 1 MeV to 6 MeV, angular distribution at 30°, 60°, 90° and 135°, private comm.

Hambsch and Bax, ND2001, keV to MeV, angular distribution, Frisch gridded ion chamber, in progress.

Giorginis and Khriachkov, MeV energies, angular distribution, VdG data. The integrated cross sections are available. Private communication (2003). OK

+Guohui Zhang, 4.17, 5.02, 5.74, 6.52 MeV angular distribution, submitted for publication to NSE. Problems with particle leaking.

^{10}B total cross section
+Wasson, 0.02 MeV to 20 MeV, NE-110 detector, Proc. Conf. on NDST, Gatlinburg (1994), p. 50. OK

Wattecamps, Van de Graaff, 1 to 18 MeV, large statistical uncertainty, NE-213 detector, Proc. Conf. on NDST, Gatlinburg (1994), p. 47. OK

Plompen, Van de Graaff, 0.3 MeV to 1.9 MeV, NE-213 detector, 3 independent monitors, Proc. Conf. on NDST, Trieste (1997), p. 1283. OK

Brusegan, Linac data, 80 eV to 730 keV, Li-glass detector, Proc. Conf. on NDST, Gatlinburg (1994)p. 47, Proc. Conf. on NDST, Trieste (1997)p. 1283 and private comm. OK

^{10}Be(p,n) ^{10}B
Massey, E_p from 1.5 MeV to 4 MeV, data at 0°, private comm. New measurements to be made at lower energies (~.5 MeV). Also possibly ^{10}Be (p,α). No final data.

C total cross section
+Schmiedmayer and M. C. Moxon, Proc. Conf. Nuclear Data for Science and Technology Mito, Japan, May 30 June 3, 1988, p. 165, 50 eV to 100 keV, linac, excellent agreement with ENDF/B-VI.

+Kirilyuk, *et al.*, Proc. of the Int. Conf. on Neutron Physics, Kiev, 1987, vol. 2, p. 298, filtered beam measurement at 2 keV,very good agreement with ENDF/B-VI.

Au(n,γ)

+Yamamoto, thermal, linac, NEANDC(J)-155,59,9008, 1990. Little impact due to high accuracy of evaluated cross section.

++Tolstikov, 0.49 to 0.69 MeV, Van de Graaff, relative to ^{235}U(n,f), Yad Konstanty,4, 46 (1994). Set 1020. OK.

++Sakamoto, 23 keV and 967 keV, photoneutron source, activation experiment, NSE 109,215 (1991). Set 452. May have systematic error.

++Davletshin, .16 MeV to 1.1 MeV, relative to H(n,n), Sov. J. At. Energy 65, 91 (1988), (Corrected data from Sov. J. At. Energ. 58, 183 (1985)). Two sets 347 & 348. OK

++Davletshin, .62 MeV to .78 MeV, relative to ^{235}U(n,f), Sov. J. At. Energy 65, 91 (1988). Set 349. OK

++Davletshin, .813 MeV to 2.435 MeV, relative to ^{235}U(n,f) YK,(1), 41 (1992). Set 1018. OK

++Davletshin, .37 MeV to 1.0 MeV, relative to ^{235}U(n,f), YK,(1), 13 (1993). Set 1019 OK

++Kazakov, Yad Konstanty, 44, 85 (1985); AE,64,(2),152,1988, Van de Graaff, relative to ^{6}Li(n,t) .0035 to .105 MeV. Set 1021. OK

++Kazakov, Yad Konstanty, 44, 85 (1985); AE,64,(2),152,1988, Van de Graaff, relative to ^{10}B(n,α_1) .115 to .41 MeV set 1022. May have systematic errors

+Demekhin, 2.7 MeV, Proc. 36th All Union Conf. on Nuclear Data, p. 94 (1986). No data

++Voignier, ~.5 MeV to ~3 MeV, NSE, 93, 43 (1986), long counter, capture gamma spectrometer, private comm. Set 1016. OK

^{235}U(n,f)

++Carlson, 2 MeV to 30 MeV, relative to H(n,n), Proc. Spec. Meeting on Neutron Cross Section Standards for the Energy Region above 20 MeV, Uppsala, Sweden, 1991, Report NEANDC-305, "U", p. 165. Set 524 OK

++Merla, +2.6, +4.45, +8.46, +14.7, +18.8 MeV ?, associated particle, Proc. Conf. on NDST Juelich (1991) p.510. Sets 591, 590, 592, 593, 587. OK

++Lisowski, 3 MeV to 200 MeV, relative to H(n,n), Proc. Spec. Meeting on Neutron Cross Section Standards for the Energy Region above 20 MeV, Uppsala, Sweden, 1991, Report NEANDC-305, "U", p. 177, and private communication. Set 1028 OK

+Nolte, 14 to 150 MeV, ND2001, and Private Comm. to increase energy range, Preliminary data. Concerns about 96 MeV point. Additional work underway

++Buleeva, 0.624 MeV to 0.785 MeV, relative to H(n,n), Sov. J. Atomic Energy 65, 930 (1988). Set 522. OK

Grundl comment, ^{252}Cf spontaneous fission spectrum averaged cross section. NOTE; only the last NIST measurement (Schroder) should be used in the evaluation. The earlier data are improved upon with each new measurement.

[++]Kalinin, 1.88 MeV, 2.37 MeV CCW, associated particle, Sov. J. Atomic Energy 71,(2),181,1988 Set 1026 OK

[++]Carlson, 0.3 MeV to 3 MeV, absolute fluence from black detector, Proc. IAEA Advisory Group Meeting on Nuclear Standard Reference Data, Geel Belgium, p.163, IAEA-TECDOC-335 (1985). Set 523. OK

[++]Johnson, 1 MeV to 6 MeV, absolute fluence from a dual thin scintillator, Proc. Conf. on NDST Mito (1988) p.1037. Set 1025 OK

[++]Iwasaki, 14 MeV (13.5 to 14.9 MeV), relative to H(n,n) and associated particle, Proc. Conf. on NDST Mito (1988) p. 87. Set 1027 OK

[++]Weston and Todd, NSE 111, 415 (1992), relative to ^{10}B(n,α), 0.15 keV to 1.5 keV. Set 1023 OK

^{238}U(n,f)

[++]Merla, 5 MeV +, associated particle, Proc. Conf. on NDST Juelich (1991) p.510. Set 810. OK

[++]Winkler, 14.5 MeV, relative to Al(n,α) & ^{56}Fe(n,p), Proc. Conf. on NDST Juelich (1991), p.514. Set 809. OK

[++]Lisowski, 0.8 MeV to 357 MeV, relative to H(n,n), Proc. Spec. Meeting on Neutron Cross Section Standards for the Energy Region above 20 MeV, Uppsala, Sweden, 1991, Report NEANDC-305, "U", p. 177, and private communication. Set 1030. OK, possible problems at highest energies compared with Shcherbakov

[+]Nolte, 14 to 150 MeV, ND2001, and Private Comm. to increase energy range, Preliminary data. Concerns about data from 30 MeV to 100 MeV

[+]Newhauser, 34, 46, and 61 MeV MeV, absolute, Proc. Conf. on NDST Juelich (1991), *removed from database.*

[+]Meadows, 14.74 MeV, CCW, ANE,15,421 (1988), relative to ^{235}U(n,f).

[++]Baba, 4.6 MeV to 6 MeV, Van de Graaff relative to ^{235}U(n,f), J. Nucl. Sci. & Techn.,26,11 (1989). Set 1035

[++]Shcherbakov, 1-196 MeV, relative to ^{235}U(n.f), ISTC 609-97, see also Fomichev, 0.7 MeV to 200 MeV, relative to ^{235}U(n.f), Proc. Conf. on NDST, Trieste (1997), p.1283, also ND2001 set 1013. OK except possibly at the highest energies (incositent with Lisowski there)

[+]Li Jingwen, 14.7 MeV, CCW, ratio to ^{235}U(n,f) CNP,11,(3),17,89.

Eismont, Trieste conf, p.494, 33.7, 46 and 60.6 MeV, relative to hydrogen scattering cross section. See also Gatlinburg conference results at 135 and 160 MeV. Data not finalized. They have concerns about neutron fluence determination for getting smaller uncertainty.

$^{+}$Garlea, 14.7 MeV, relative to ^{235}U(n,f) cross section, RRP,37,(1),19,92.

^{238}U(n,γ)

$^{+}$Corvi. Thermal range, linac, Mito conf (1988).

$^{+}$Macklin, linac, 1 to 100 keV, ANE,18,567,91, relative to ^{6}Li(n,t) cross section.

$^{+}$Kazakov, Yad Konstanty, 37, (1986); Van de Graaff, 4-440 keV, liquid scintillator, VDG.

$^{++}$Kobayashi, 0.024 MeV, 0.055 MeV, 0.146 MeV, relative to ^{10}B(n,$\alpha_1\gamma$), Proc. Conf. on NDST Juelich (1991), p. 65. Set 448 OK

$^{++}$Quang, 23 keV and 964 keV, photoneutron source, activation experiment, NSE 110, 282 (1992). Set 453 Ok except point at 964 may have systematic error.

$^{++}$Adamchuck, 150 eV to 45 keV, relative to ^{10}B(n,$\alpha_1\gamma$), J. Atomic Energy, 65, 920 (1989). Set 446 OK

$^{++}$Buleeva (Davletshin), 0.34 MeV to 1.39 MeV, relative to H(n,n), Sov. J. Atomic Energy, 65, 930 (1989). Set 436 OK except possible systematic errors at highest energies. Also 0.62 MeV and 0.78 MeV relative to Au(n,γ) Set 437 OK

$^{++}$Voignier, ~0.5 to 1.1 MeV, NSE,93,43 (1986), capture gamma spectrometer, long counter, Van de Graaff. Set 1017 Method gives large uncertainties.

^{239}Pu(n,f)

$^{++}$Weston, linac, 0.15 keV to 15 keV, fission chamber, ^{10}B(n,α) standard, NSE 111,415 (1992). Set 1024 OK

$^{++}$Merla, 4.9, 8.65, 14.7 and 18.8 MeV, associated particle, Proc. Conf. on NDST Juelich (1991) p.510; see also Alkhazov, YK,1986,(4),19,198612. Sets 611, 617, 615, and 616. OK

$^{+}$Meadows, 14.74 MeV, CCW, ANE,15,421,8808, relative to ^{235}U(n,f).

$^{+}$Shcherbakov, 0.6-196 MeV, relative to ^{235}U(n.f), ISTC 609-97 (2000). Set 1012. OK but problems at high energy compared with Lisowski.

$^{+}$Staples, 0.8 MeV to 62 MeV, relative to ^{235}U(n,f), NSE 129, 149 (1998). Set 1014. OK except differences compared with Lisowski and Shcherbakov at highest energies.

$^{+}$Lisowski, 0.5 MeV to 256 MeV, relative to H(n,n) and ^{235}U(n,f) , Proc. Spec. Meeting on Neutron Cross Section Standards for the Energy Region above 20 MeV, Uppsala, Sweden, 1991, Report NEANDC-305, “U”. Set 1029 OK problems at highest energies compared with Shcherbakov

++Garlea, 14.7 MeV, relative to $^{235}U(n,f)$ cross section, RRP,37,(1),19,92. Set 633
Value is high