2011
Cross Section Evaluation Working Group
and
US Nuclear Data Program
Annual Meetings

Preface

The 2011 Nuclear Data Week has been held November 14-18 at Brookhaven National Laboratory. As usual, the USNDP/CSEWG meetings were accompanied by the Nuclear Physics Working Group (NPWG) and Nuclear Data Advisory Group (NDAG) of the Criticality Safety Program. In 2011 the schedule of the Nuclear Data Week was the following

- NDAG, Nov 14,
- CSEWG Annual Meeting, November 15-17,
- USNDP Annual Meeting, November 16-18,
- NPWG, Nov 17-18.

The present document contains the Summary of the CSEWG and USNDP Meetings that is produced in the electronic form only. It is available, along with all presentations given at these two meetings, at www.nndc.bnl.gov/meetings/csewg 2011/.

Jan 24, 2012 Michal Herman
CSEWG chair
USNDP chair

Summary of the 61th Cross Section Evaluation Working Group Meeting

Held at
Brookhaven National Laboratory, Upton, NY
November 15-17, 2011

Cross Section Evaluation Working Group

Chairman's Summary

Michal Herman
National Nuclear Data Center, BNL

The 61th CSEWG meeting was held on November 15-17, 2011 at the Brookhaven National Laboratory attended by 66 registered participants. Among the participants were representatives of national laboratories, academia and nuclear industry of the United States and Canada, as well as a few participants from abroad. The main scope of the meeting was to discuss state and performance of the ENDF/B-VII.1 version of the US nuclear reaction data library in view of its release scheduled for the December 2011. As usual, the CSEWG meeting was held next to the USNDP annual meeting, with a common session on modeling of nuclear reactions.

ENDF/B-VII.1 release

CSEWG reviewed progress towards the release of VII.1 version of the ENDF/B library with emphasis on review of a few new and updated evaluations introduced after the mini-CSEWG meeting in June 2011. During the past year extensive effort has been dedicated to the improvement of the library by BNL, LANL, LLNL, ORNL and external collaborators (IAEA, JSI, KAERI). A micro-CSEWG meeting held March 30-31, 2011 at the NNDC brought together key representatives of the validation community and evaluators from the leading Labs to review performance of the beta1 release. This meeting was followed by a more extended mini-CSEWG meeting held in June 2011 at Montauk, NY. Altogether, five beta versions of the library were released and tested in integral benchmark calculations. The latest beta5 release contains full set of evaluations and covariances intended for the final release. The ultimate changes will be of purely cosmetic nature and should not affect validation results.

The essential role in the development of the ENDF/B-VII.1 was played by the GForge server operated by the NNDC, which facilitated collaboration between evaluators and allows for a detailed tracking of the development.

Covariance data

The main focus of most of the presentations was in the area of testing the candidate covariance data for ENDF/B-VII.1 to determine whether they would satisfy both mathematical and physical requirements demanded of contemporary ENDF/B covariance data, as defined in the Covariance Quality Assurance (QA) Standards. It has been

concluded that content of ENDF/B-VII.1 has greatly improved compared to the VII.0 version. This has been achieved partially due to the evaluators' effort and partially due to the valuable feedback from the users community. Collaboration with foreign colleagues turned out to be extremely beneficial in developing new evaluation methodology. For the first time a covariance review process has been implemented.

Next generation of covariances should ingrate closer with the actual evaluation procedure to meet more stringent quality requirements of the dosimetry community and a a broader group of covariance data users. Refinements should be made to the covariance QA review process based on experience gained from work on ENDF/B-VII.1.

Next Meeting

The next Nuclear Data Week will be held at BNL Nov. 5 through 9, 2012. This period avoids conflict with the ANS meeting and is firm. Dates of the individual meetings may change but the tentative schedule is:
NDAG: Nov. 5 (Mo),
CSEWG: Nov. 6-8 (Tue - Thu),
USNDP: Nov. 7-9 (Wed - Fri),
NPWG: Nov. 8-9 (Thu – Fri).

CSEWG Executive Committee Meeting

The Executive Committee met during the lunchtime on November 15, 2011, with all 11 members present. This included chair (M. Herman), five committee chairs (M. Chadwick, Y. Danon, M. Dunn, A. Kahler, D. Smith) as well as five regular members (N. Summers, A. Carlson, T. Kawano, L. Leal, R. McKnight).

Agenda

- **Release date of the ENDF/B-VII.1 library** has been confirmed to occur in December 2011. There will be no mini-CSEWG meeting in 2012. Ways of improving evaluation quality in future releases were discussed. It has been proposed to reintroduce Web-based 'review kits' and pear reviews. NNDC will consider introducing automatic pre-commit filters in the GForge subversion to impose basic correctness of the evaluation before Subversion commit is allowed.
- **Plans for the Next Special Issue of Nuclear Data Sheets** were discussed. The 2012 issue is proposed to contain nine papers organized in three groups:
    - Papers related to ENDF/B-VII.1, total 100 pages
        - vd Marck: Benchmarking ENDF/B-VII.1, 60 pages
        - G. Hale: Covariances of light nuclei, 20 pages (not submitted in 2011)
        - L. Leal: Covariances in the resonance region, 20 pages (submitted, review not yet completed)
    - Experimental covariances, total 100 pages
        - D. Smith: Experimental covariances - formalism, 50 pages
        - P. Schilleebeckx: Experimental covariances - resonance region, 25 pages
        - A. Plompen: Experimental covariances - activation and n-TOF, 25 pages
    - Modeling, evaluation methods and libraries, total 100 pages
        - A. Koning: TALYS, TMC and TENDL, 100 pages

- **ND2013 conference**: M. Herman reported on the preparations to the Conference on Nuclear Data for Science and Technology in 2013 organized by the NNDC. M. Herman proposed that for the ND2013 proceedings submission of a few relatively large papers on important projects or particularly interested topics be encouraged. These papers could have a relatively large number of authors and could replace a number of smaller contributing papers. The intention is to produce a few important and informative papers that would have higher impact than many short papers.
- **The worldwide evaluated nuclear reaction data file** idea a has been proposed and discussed. No conclusion was formulated but there has been consensus that the idea should be pursued further by bringing it under discussion in a broader forum. The next WPEC meeting in Paris (May 2012) and panel discussion at ND2013 were

indicated as options for such forums. The IAEA-NDS was suggested as a candidate for serving as a coordinating centre.

- **XML format,** intended as a replacement of the ENDF-6, has been discussed. The reaction of the Committee members to the, new development was positive and it was put forward that the proposal should be brought to the attention of the WPEC for creation of the Subgroup.
- **WPEC matters**: The next WPEC meeting will be hosted by the NEA Data Bank in Paris (May 24-25, 2012). The US delegation should include 4 official members (CSEWG chair and 3 Committee chairs), three chairs of the acting working groups (M. Dunn, L. Leal, T. Kawano) and D. McNabb (LLNL) who will propose a new WPEC Subgroup on the XML format.

Cross Section Evaluation Working Group

Evaluation Committee Report

M. Chadwick, LANL
Committee chair
M. Herman, BNL
CSEWG chair

Herman described the changes from beta3 to beta4, including work on covariances, Zr, Gd, ^{243}Am, ^{242}Pu, and oxygen (capture from JENDL-4). Mike then described changes for beta5 that essentially don't change beta4 validation results (except for ^{19}F). He also described new work on Tl and Tm isotopes from BNL and LANL. There are still some additions needed, e.g., recent modification of capture cross sections in ^{169}Tm by Mughabghab, documentation and clerical fixes.

Kawano described work supporting the sublibraries for decay data and FPY. He described the new Hauser-Feshbach calculations combined with ENSDF information on beta-decay probabilities and branching ratios. Kawano also talked about work to extend Chadwick's ^{239}Pu chain yields to include individual and cumulative libraries, also with energy dependence at 0.5 and 2 MeV. Constraints were applied using the Kalman adjustment approach (sum of yields is 2; as well as sum of Y.A is 240 - nu-bar, and sum of Y.Z is 94. CINDER code was also used for this work).

Nobre talked about extending LANL's dosimetry file for Tm isotopes, and creating new Tl evaluated data. The EMPIRE code system was used. Zolaratev's IRDF work was used for ^{169}Tm(n,2n) - which agreed well with LANL's evaluation but had the merit of having a covariance file associated with it. Also, this file had been tested by Capote and Trkov, with good agreement with activation measurements in PFNS spectra from Cf and from thermal ^{235}U.

D. Brown described the new Brookhaven VII.1 Zr isotope evaluations. The angular distributions of elastic scattering influence k_{eff} significantly; adopted JENDL-4.0 values showed dramatic improvement in TRIGA benchmark validation. Mughabghab updated resonance parameters for ^{90,91}Zr (later 91 updates weren't included because of lack of time). Next steps (VII.2) include Said's ^{91}Zr extended RR region, and update of $^{92-95}$Zr.

Mughabghab talked about capture cross section adjustments. This work was based on new differential data; Dean's thermal and fast dimple reactor (worth) data; Palmiotti's PROFIL analyses (fast reactor); 30 keV Macs data; and Mughabghab's work on average p-wave to s-wave capture ratio, as published in his ND2010 paper.
Mughabghab noted discrepancies with Atlas values, and worked to fix such problems.
For ^{169}Tm, the Atlas values for S_o and gamma-gamma are lower than Macklin's data above 3 keV. Macklin had fitted his results to a Dilg measurement and his values appear to be inconsistent with the Atlas systematics. By analyzing the data, including Chinese ones, Said finds p to s wave ratios consistent with his systematics. His conclusion - in fast region, Mughabghab's UR region above 3 keV agrees with the updated Macklin values, but at energies below 2 MeV he finds a lower gamma-gamma width. He invokes a doorway state near 3-8 keV.

D. Brown discussed fixes made for ENDF/B-VII.1, and changes for beta5. Many minor errors were corrected. Automated fixes were made with FUDGE code for Q values and branching ratio summations.

Herman discussed an ongoing effort on assimilation - where information from differential and integral data is used to adjust EMPIRE input parameters. Cross sections on ^{235}U were used as a test case. In the future, this work will be extended to account for nu-bar and PFNS.

Sonzogni described the new decay data file. The tags data suggest the ^{239}Pu decay heat is well modeled; improvements are needed for ^{235}U at small times. He also noted his community 'prefers' JEFF to ENDF FPY - e.g., for ^{241}Pu fission yields, and some isomer issues.The new decay library is more current since JEFF-3.1 dates from 2005. Robin Forrest noted updates for JEFF-3.1.1. Alejandro noted his Web page that shows differences with JEFF decay data.

Leal talked about ^{239}Pu in the resonance region, with a focus on issues in trying to better model the Pu solution criticals. In the current evaluation there are different regions, with artificial boundaries at 1 and 2 keV. New work aims to analyze the whole range more seamlessly with SAMMY.
New analysis didn't improve the k_{eff} overprediction for solutions. Leal then described the WPEC efforts to study this, including data testing of 15 representative benchmarks by Kahler. Also, sensitivity studies were done with TSUNAMI, and data adjustments with TSURFER. TSUNAMI tells us that PFNS would need to be changed quite a lot - but in the opposite direction to Maslov's. Conclusion is that a combination of tweaks to many things might be needed.
Question - can this subgroup tell us how much we are allowed to change nu-bar near thermal? Is it any bigger than the standards would allow? (Standards have about 0.15

percent nu-bar thermal uncertainty,). Said Mughabghab notes the (n,g) f-process - was it included? How is eta defined? Let's check it's handled rightly.

Future plans

LLNL (Summers):

- **Optical potentials** - use more converged CC calculations (12-14 coupled levels), which might have an impact on inelastic and elastic distributions.
- **PFNS** work continues, as well as work on correlated gamma and n decay of fission fragmants. An in line FREYA fragment decay model is implemented in MCNP, as well as fission energy, FPY, etc.
- **Surrogate work -** fission, Y, Zr(n2n) and (n,g).
- **Light ion** work for NIF, including isotopic. Also Fadeev calculations for (n,d) and (n,t) reactions. Many new charged particle evaluations to be supplied to ENDF. Charged particle evaluations could also be added from the radchem libraries.

ORNL (Leal):

- **^{182,3,4,6}W and ^{63,65}Cu**: new resonance region (RR) evaluations
- **^{56}Fe**: plan to extend RR region from 845 keV up to 2 MeV, with help from Trkov, Capote, and BNL. Will include new data from Plompen.
- **^{239,240}Pu:** new RR evaluations.
- **^{235}U:** update capture, including new data from LANL and RPI.
- **^{19}F:** fix new evaluation.

BNL (Herman):

- **Zr isotopes**: continue working by using updated Capote's soft-rotor omp and using EMPIRE angular distributions, extending RR for ^{90}Zr by Mughabghab and revisiting treatment of fluctuations.
- **^{23}Na:** finalize evaluation, including usage of new inelastic data from Kentucky and Geel, extending RR and completing new omp (with ORNL?).
- **^{56}Fe:** long term plan with Capote, Trkov and Leal.
- **Assimilation**: Continue work on the major actinides, develop usable framework.

LANL (Chadwick):

- **^{235,8}U** and **^{239}Pu:** major focus aiming to remove likely compensating errors, studying PFNS, nu-bar, inelastic, and capture. Update ^{235}U(n,g) near 1 keV using new DANCE (Jandel) and RPI data.
- **^{12}C, ^{16}O:** work on new evaluations.
- **^{56}Fe:** would also like to study elastic and inelastic scattering.
- **Correlated emission from fission fragments**: We will continue to advance modeling for n and g emissions.
- **Dosimetry radchem evaluations**: if funding permits.

Actions

The following actions were suggested by:

Herman - authors should clean File1 descriptions of historical information no longer relevant to the evaluations in ENDF/B-VII.1.

Brown - all evaluators should make an effort to clear the tracker item list in GForge.

Cross Section Evaluation Working Group

Data Validation Committee Report

A. C. (Skip) Kahler, LANL
Committee chair

The CSEWG Validation committee met Tuesday, November 15, 2011. Twelve presentations were given, mostly focused on data testing that supported the planned ENDF/B-VII.1 neutron cross section library release which subsequently occurred in December.

Presenters included Robin Forrest (IAEA), Ramon Arcilla and Boris Pritychenko (BNL), Russ Mosteller and Skip Kahler (LANL), Ken Kozier and Dan Roubtsov (AECL), Dick McKnight (ANL), Gino Palmiotti (INL), Mike Zerkle (Bettis), Tim Trumbull (KAPL) and Mark Cornock (Atomic Weapons Establishment, AWE). A summary of the individual presentations follows.

Forrest's (IAEA) presentation was titled "The IAEA Dosimetry File". Robin noted that the current International Reactor Dosimetry File, IRDF was developed in the early 2000s and released in 2005. The file contains 66 reactions and new data and evaluations are now available. The new file will be extended to 60 MeV, using results from the TENDL-2010 library and a new file is expected to be available for testing in December, 2011.

Arcilla's (BNL) talk was titled "VII.1 Phase I Testing". Ramon described the process followed by the NNDC to verify the correctness (primarily per the ENDF6 format, not necessarily the underlying physics) of each of the 423 ENDF/B-VII.1-candidate neutron evaluated files. This included processing of each file through the STANEF, CHECKR, FIZCON and PSYCHE codes, processing by NJOY to create an ACE formatted continuous energy file and a simple "GODIVA-like" MCNP job to test that ACE file. All 423 neutron files were verified, but Ramon noted that the utility codes, particularly FIZCON, should be upgraded so that fewer "false positive" error messages result.

Pritychenko's (BNL) talk was titled "Calculation of Integral Quantities in VII.1". Boris described his work to compare some basic aspects of the candidate-ENDF/B-VII.1 files such as Thermal and 30 keV Maxwellian-averaged capture cross sections, resonance integrals and Westcott g-factors with experimental data, past ENDF evaluations and other evaluated files (e.g. JEFF, JENDL, etc.). During the earlier beta phases of ENDF/B-VII.1 the ratios for one or more of these quantities with either data or other evaluations differed significantly from unity. In many cases it was a deficiency in the candidate file that

needed to be resolved, particularly with regard to the Maxwellian data. Past ENDF evaluations had not benefitted from this type of checking and significant improvements have been made in the relatively small keV range capture cross sections for a number of nuclides important to the astrophysics community. Criticality testing is not sensitive to this deficiency and so the additional testing performed here is a valuable contribution to increased accuracy in the evaluated file.

Mosteller's (LANL) talk was titled "MCNP Results for ENDF/B-VIIbeta4". LANL staff member Brian Kiedrowski was a co-author for this work. Russ described an "expanded criticality validation suite for MCNP". This test suite consists of 119 benchmarks from the ICSBEP Handbook and covers the major fuel types (^{233}U, HEU, IEU, LEU and Plutonium) and spectra (Fast, Intermediate and Thermal). Eigenvalue calculations have been performed using ENDF/B-VII.0 and the various ENDF/B-VII.1β cross section files. Russ noted that benchmarks containing beryllium, cadmium and tungsten from this suite yielded significantly more accurate eigenvalues with the latest, ENDF/B-VII.1β4, cross section files, although there is still room for improvement in the beryllium benchmarks. Some improvement was also seen for zirconium bearing benchmarks. In contrast, benchmarks sensitive to the unresolved resonance energy range of ^{235}U, the thermal energy range for ^{239}Pu and the fast energy range for copper, ^{237}Np and ^{232}Th continue to exhibit deficiencies. Data from several benchmarks are also available for "Rossi-α"; which is the rate of change of the population of prompt neutrons. Parameters to predict Rossi-α can be calculated with MCNP5, version 1.60. Calculations for HEU and IEU benchmarks were found to be in reasonable agreement with experiment, except for the unmoderated ZEUS benchmark. Results for ENDF/B-VII.1β4 ^{233}U were slightly improved compared to ENDF/B-VII.0 while results for plutonium benchmarks were statistically identical.

Kozier's (AECL) talk was titled "Nuclear Data Testing at AECL". Ken reviewed deuterium and oxygen data. In particular he noted that the energy grid for deuterium scattering data, expressed as a ratio of backward to forward scattering in the 0.5 MeV to 1.0 MeV range is too coarse. A denser energy grid, as used by other libraries such as JENDL, CENDL, ROSFOND and even earlier ENDF/B versions is recommended. Ken also expressed continued reservations about the magnitude of the ^{16}O elastic scattering and total cross section in the thermal range. These observations have been passed to the evaluator (Gerry Hale, LANL) in the past and remain an unresolved difference of opinion, as the measurements given the greatest weight by AECL are not as well regarded by Hale. In addition, the changes that AECL support to improve the calculated eigenvalues of D_2O moderated systems will reduce the accuracy for H_2O moderated systems. Ken concluded with a few words about efforts to preserve the data for AECL's Whiteshell Reactor; a reactor system that used UC driver fuel and a mixture of terphenyls as moderator. This reactor operated from the mid-1960s to mid-1980s. It is hoped that this system can be included in a future edition of the IRPhEP.

Roubtsov's (AECL) talk was titled "Analysis of Critical Assemblies from First Principals". Dan analyzed several D_2O moderated HST experiments with various perturbations to the underlying deuterium and oxygen low energy cross sections. While there seems to be a linear change in calculated eigenvalue versus thermal scattering cross section, and a fairly high sensitivity (hundreds of pcm per % change in σthermal scattering), it is not clear that a unique cross section value can be found for all sampled benchmarks. A similar conclusion is reached for perturbations to the oxygen cross section. This remains a work in progress. It should be noted that Ken Kozier was a co-author with Dan on this work, and that Dan was a co-author with Ken on the previous paper.

McKnight's (ANL) talk was titled "Testing at ANL". Dick summarized the results of data testing for a suite of ZPR experiments that were published in the ENDF/B-VII.1 Validation paper. For criticality, these experiments included Pu-metal systems, HEU and IEU fuelled systems and mixed (Pu/U) fuelled systems. In all instances the keff C/E values were improved for ENDF/B-VII.1 versus ENDF/B-VII.0 cross sections. Beta-effective calculations were made for three systems yielding results that were essentially unchanged to slightly better with the latest cross sections. C/E values for sodium-void measurements are little changed with most ENDF/B-VII.1 based results being as accurate or slightly more accurate than ENDF/B-VII.0 results. However occasional C/E comparisons became worse with the newer cross section data. Finally, results for control rod worths were generally statistically equivalent whether using ENDF/B-VII.0 or ENDF/B-VII.1 cross sections.

Palmiotti's (INL) talk was titled "Data Testing at INL". Pino, with co-author Hikaru Hiruta, summarized actinide reaction rate comparisons that will also appear in the ENDF/B-VII.1 Validation Paper. The data come from the PROFIL and TRAPU irradiation experiments performed at the CEA's PHENIX reactor. The proprietary nature of these measurements limit the information that can be disclosed, but C/E values for a number of uranium and transuranic nuclides are reported. Improved C/E capture results are observed for ^{238,242}Pu, ^{241,243}Am, ^{244}Cm, ^{97}Mo, ^{151}Sm and ^{153}Eu as well as for ^{240}Pu(n,2n). Capture in ^{235}U and ^{239}Pu was underestimated previously and remains so … not a surprising result since the major actinide cross sections were not changed in the ENDF/B-VII.1 upgrade. The calculation of ^{243}Cm build-up is significantly improved. Fission products, ^{105,106}Pd, ^{143,144}Nd and ^{147,149}Sm are underestimated while ^{101}Ru and ^{151}Sm are overestimated. ^{238,240}Pu fission cross sections seem to have improved with ^{242}Pu has worsened and the overestimated ^{241}Am fission results are unchanged. Other C/E results are provided in the December Nuclear Data Sheets Validation Paper.

Zerkle's talk was titled "Data Testing at Bettis". Mike's presentation focused upon the performance of zirconium and hafnium cross sections. He, and co-author Reza Gouw, looked at various combinations of these cross sections, starting with ENDF/B-VII.0 through the various beta iterations. They also looked at JENDL-4.0 zirconium and the

JENDL-4.0 and JEFF-3.1 hafnium evaluations. They concluded that a combination of the beta3 zirconium and either JENDL-4.0 or JEFFZ.3.1 hafnium cross sections provided the best overall eigenvalue performance. JENDL-4.0 zirconium elastic scattering distributions were observed to be too forward-peaked, particularly below 1 MeV while beta2 hafnium appeared to be too absorptive. A greater energy point density was recommended to represent the zirconium scattering data.

Trumbull's talk was titled "Data Testing at KAPL". Tim calculated a suite of 135 ICSBEP benchmarks. These included both uranium (HEU, IEU, LEU) and plutonium fuelled systems and thermal to fast spectral conditions. Average eigenvalue C/E's and standard deviations were similar between ENDF/B-VII.0 and ENDF/B-VII.1, with notable improvements in selected systems containing ^{233}U, Zr, C and Ti. No statistically significant reactivity trends were observed in the important HST/LST benchmarks although linear regression fits versus above-thermal leakage fraction, ATLF, and above-thermal fission fraction, ATFF, yields slightly larger slope parameters. Zirconium data were tested via the "TRIGA" (ICT3) benchmark. The calculated eigenvalue, near unity with ENDF/B-VI.8, increased nearly 0.4% with ENDF/B-VII.0 but with the latest cross sections this eigenvalue is observed to decrease back towards the earlier value.

Cornock's (AWE) talk was titled "Automated GENDF Validation at AWE". Mark, a first-time visitor to CSEWG, discussed some of the multigroup data checking that is being implemented as AWE begins to process there nuclear data; a task previously contracted to Serco Assurance. They have mostly worked with the existing ENDF/B-VII. 0, JEFF-3.1 and JENDL-3.3 + Actinoid files; hence this work is not related to data testing for ENDF/B-VII.1. An important "test" is simply to compare the processed results from two libraries. This usually reveals important differences in threshold reactions or in derived quantities such as KERMA. It can also reveal processing code deficiencies if, for example, two evaluated files use different analytical representations that should produce similar results. Data discontinuities, unexpected spikes or other anomalous features may appear. An unexpected low energy tail in the ^{237}U fission spectrum is such an example and is occurs in NJOY processing because of an inadequate approximation to the error function; a deficiency that will be rectified in a future NJOY release.

Kahler's talk was titled "LANL Data Testing & Validation Paper Highlights". The final presentation summarized additional LANL data testing performed by Bob MacFarlane and Skip. Eigenvalues were calculated for over 1000 ICSBEP critical configurations. In some cases, such as the traditional LANL fast assemblies (Godiva, Jezebel, Jezebel-23 and their reflected Flattop counterparts) we confirm that the previous good results remain. The same is true for the HST benchmark class. In other instances, such as fast titanium and fast tungsten reflected assemblies we observe significant improvement in the calculated eigenvalues. The previous, accurate LCT eigenvalues are also retained. A previously unreported calculation for the LCT79 benchmark which contains ^{103}Rh indicates that the cross sections for this important fission product nuclide are accurate.

However, previously existing deficiencies in systems with lead reflectors remain, as do significant trends in thermal and epithermal ^{233}U systems. The long-standing ~0.5% bias in Pu solution systems remains also. A suite of zirconium bearing benchmarks generally calculate more accurately, but further improvements are expected in future zirconium evaluation. Beryllium reflected systems remain puzzling, as results are generally accurate to within about 0.5%, but this variation exceeds the estimated experimental error. Finally, reaction rate results such as those reported above by INL and the so far little used FUND-IPPE-RR-MULT-RRR-001 results will be an important data source to guide further revisions in selected fission, capture and (n,2n) cross section data.

This was a full session that extended into the early evening. The breadth of topics provided a comprehensive picture of the data testing underlying the new, ENDF/B-VII.1, neutron data file. These presentations, coupled with the peer-reviewed articles that appeared in the December, 2011 issue of Nuclear Data Sheets provide a firm foundation to support the underlying accuracy of these data files for a wide range of applications.

Cross Section Evaluation Working Group

Covariance Committee Report

D. Smith, ANL
Committee chair

Introduction

A 3½-hour meeting of the CSEWG Covariance Committee was held on Thursday, 17 November. There were 10 individual presentations, each of approximately 15 minutes duration, followed by a 45-minute session devoted to an open discussion of various covariance-related matters, including several specific issues mentioned during the formal presentations. This session (embedded in the 2011 annual CSEWG meeting) reflected the intense activity in the area of covariance data generation and testing for ENDF/B that took place during the preceding year in anticipation of the release of ENDF/B-VII.1 (either in late December 2011 or early January 2012). This new release of ENDF/B will contain a much greater quantity of covariance data than the preceding version, ENDF/B-VII.0. Furthermore, while these data are not perfect (nor will they ever be by definition), it was generally conceded that for the most part their quality is significantly improved relative to the body of earlier ENDF/B covariance data. A large portion of these new covariance data have also been subjected to testing by data users from the defense program, criticality safety, and advanced fast-reactor design application communities and found, in most instances, to be "reasonable."

The main focus of most of the presentations was in the area of testing the candidate covariance data for ENDF/B-VII.1 to determine whether they would satisfy both mathematical and physical requirements demanded of contemporary ENDF/B covariance data, as defined in the Covariance Quality Assurance (QA) Standards adopted by CSEWG during the 2010 annual meeting in Santa Fe, New Mexico. Effort devoted to identifying discrepancies, and attempts to rectify as many of these problems as possible prior to the release of the library, was discussed. Certain unresolved technical issues were mentioned and possible paths forward to eventually resolving them in later releases of ENDF were discussed. In addition some aspects of recent work on generating covariances and on the development of new methods were presented during this meeting.

A summary of each presentation made at the present meeting is given below, in the order of their appearance in the session agenda as posted on the Web. The complete presentations are available for downloading from the Web, as PDF documents, through hypertext links provided on the CSEWG-2011 meeting agenda Web page:

http://www.nndc.bnl.gov/meetings/csewg2011.

Individual presentations

S. Hoblit (BNL) – ENDF/B-VII.1 Covariances

Covariance data are provided in ENDF/B-VII.1 (henceforth, VII.1) for 190 different materials compared to only 26 materials for ENDF/B-VII.0 (henceforth, VII.0). These covariances originated from several sources including: 1) new ORNL, LANL, and BNL evaluations; 2) IAEA/JSI evaluations; 3) the COMMARA-2.0 database for fast-reactor development; 4) the neutron standards; 5) JENDL-4; and 6) carryovers from VII.0. A variety of methodologies have been used to generate these data, as listed in a slide from this presentation. Several largely new quality insurance (QA) procedures have been applied to stress-test these covariance data, including: 1) preparation of Web-accessible plots to facilitate human uncertainty and correlation data visualization; 2) integral uncertainty checks; 3) checks for covariance data "reasonableness" based on screening with the NNDC UnCor code (and human inspection as well); 4) tests for negative eigenvalues (non-positive definite matrices); and 5) routine NNDC checks for proper formatting, processibility, and various other numerical issues. Not every covariance matrix to be included in VII.1 passed all of these screening tests, but the major requirements were satisfied by all of them. In those instances where certain tests were failed by particular files, most could be attributed to largely unavoidable numerical precision issues that were deemed to be of minimal practical significance. This presentation offered a number of examples that illustrated some problems that were encountered in the review process and how fixes were applied where feasible. It also pointed out some remaining deficiencies that would need to be addressed in future releases of ENDF/B.

A. Palumbo, G. Nobre, S. Hoblit, and M. Herman (BNL) – VII.1 Covariance Review

This presentation further discussed the covariance review effort at BNL that was mentioned in the preceding presentation. The mechanism for the review process, and the tracking of the review comments and fixes via the GForge system at BNL, was described. The methodology used to reach decisions regarding whether or not certain considered covariance data were "reasonable" or not was outlined. A number of fixes – some modest and some more significant – were applied to the original evaluations during this process. Although this approach could be viewed as somewhat ad hoc, it was felt that the end product from this pragmatic approach is a body of covariance data which will be more likely to meet the needs of many users than would have been the case if effort had not been expended on this process.

D. Brown (BNL) – Eigenviolence and Other Fixes to ENDF/B-VII.1 Covariances

For certain applications, e.g., spectrum adjustment using generalized least-squares techniques, or Monte-Carlo (henceforth, M-C) uncertainty propagation in the presence of correlations, a basic requirement is that covariance data (in the absence of constraints) should be represented by positive-definite covariance matrices with positive eigenvalues so that orthogonal transformations required to expedite M-C sampling can be applied. This presentation described the application of a screening process for the occurrence of zero or negative eigenvalues for VII.1 covariance data. It was discovered that an extensive number of these matrices failed this test. Those cases are identified in this presentation. Steps to apply fixes to alleviate this problem were taken with considerable (but not universal) success. In those cases where the matrices failed to be positive definite, it was found that these effects were generally rather small, and most could be attributed to numerical precision issues. However, this was not always the case. Some matrices proved (for undetermined reasons) to be incorrigibly singular and "unfixable". This presentation also suggested a practical approach for dealing with such situations when utilizing afflicted covariance data in applications.

C.M. Mattoon (LLNL) – Covariance Applications at LLNL

This presentation described some of the new tools being developed at LLNL for large-scale uncertainty quantification (UQ) studies. The approach is to develop the means to include all sources of uncertainty data, including those inherent in the physics and mathematics of models used in covariance data generation. Covariance data are now available in ENDL (the in-house LLNL nuclear data library) where none existed previously. The "Kiwi" interface for applying these covariance data has been developed at LLNL. Presently, this system has some remaining obstacles that are being addressed, including inflexibility and inefficiency in data handling. A user for LLNL nuclear data requires the ability to vary the input nuclear data for Monte Carlo and other applications, so a procedure for doing this within the Kiwi framework was described. The importance of properly handling correlation information as well as variances was stressed, and an examples involving ^{235}U(n,f) and ^{234}U(n,2n) were described. LLNL is making a big effort to generate a new nuclear data framework entitled GND, involving use of XML. This approach was described briefly since presentations on this topic were made at other sessions during the 2011 Nuclear Data Week. LLNL has invested several man-years of effort in this data project and, as a consequence, has come a long way toward overcoming earlier objections from the data community. The potential for achieving "backward compatibility", that would enable a smooth transitioning from the ENDF-6 formatted nuclear data currently used by most global data projects, is appealing. Thus, the LLNL approach appears to be gathering favorably reviews. This may eventually lead to adoption of this approach by CSEWG and other global data projects.

G. Arbanas (ORNL) – Unifying Nuclear Data Evaluations

A long-standing concern in the nuclear reaction data community is that owing to the fact that both experimental and model calculated data are generated by generally quite distinct nuclear measurement and modeling techniques in the thermal, resolved resonance (henceforth, RR), unresolved resonance (henceforth, URR), and fast neutron regions, the evaluated values and covariance matrices cross section data sets that span the entire ENDF region (from thermal to fast) usually exhibit isolated blocks of covariances with zeroes elsewhere and discontinuities in the central values at the boundaries. This presentation describes a project – currently in its early stages – that aims to develop a methodology based on generalized least-squares to overcome this problem. If feasible to implement, this approach might eliminate the problems associated with discontinuities in both central values and covariances at the region boundaries. The essential idea is to identify sources of correlation between these traditional regions, both in the experimental data and in the nuclear modeling, so that correlations in the evaluated results that serve to link these currently disparate regions can be generated by the described generalized least-squares methodology.

G. Arbanas (ORNL) – Covariance Matrix of a Double-Differential Elastic Scattering Cross Section

This presentation described a new deterministic approach for analyzing double-differential neutron elastic scattering (energy-angle) at relatively low energies where temperature-dependent molecular interaction (lattice) effects need to be considered. This deterministic approach is then compared to M-C techniques used to address the same problem, and numerical results are given to demonstrate that both approaches can lead to essentially the same outcomes. This new approach can also be used to generate covariance data for neutron elastic scattering in this low-energy region.

M. Rising, P. Talou, T. Kawano, and A. Prinja (LANL) – Prompt Fission Neutron Spectrum: Evaluation and Uncertainty Quantification for a Suite of Uranium Isotopes

Knowledge of the uncertainties in the prompt fission-neutron spectra for actinides – particularly the major actinides – is extremely important for many applications of uncertainty propagation in applied nuclear science. Consideration of cross section uncertainties while neglecting spectrum uncertainties can lead to too-small uncertainties in calculated integral quantities. The major problem in evaluating fission-neutron spectra and assessing their uncertainties is centered on the low- and high-energy regions of these spectra where few neutrons are present and the data are very uncertain. Also, the absence of experimental data for minor actinides is a problem. There is heavy reliance on nuclear modeling of these spectra. The LANL team is focusing on further developing and using the Los Alamos model of Madland-Nix, and on achieving parameterizations of this

model-calculated spectrum that fit existing good quality experimental data. Then, hopefully, reliable representations can be achieved for the major actinide spectra and for minor actinides where only the theory can predict the spectrum. Covariances are generated by the evaluation procedures used to fit the model to the existing experimental data. This presentation describes the on-going work at LANL that generated some of the actinide fission spectrum evaluations and covariances included in VII.

D. Smith (ANL) – ENDV/B-VII.1 Covariances: Some Thoughts

This presentation had as its objective stimulating discussion in the concluding session. The following points were made (taken directly from the slides):

Covariance successes

1) The content (of VII.1) is greatly improved from ENDF/B-VII.0.
2) Evaluators have put a great deal of effort into producing a reasonable product, with considerable success.
3) Feedback from certain user communities (e.g., criticality safety, advanced fast-reactor development, and defense programs) has been extremely valuable in this process.
4) A lot of developmental work has gone into learning how to produce improved covariance data over the entire energy range applicable to the ENDF/B library.
5) Collaboration with foreign colleagues in developing new covariance evaluation methods, and in producing content for the new ENDF/B library, has been extremely valuable.
6) A covariance review process has been implemented for the first time. It involves procedures targeted at both the mathematical and physical aspects of these data.

Room for improvement

1) Better integration of the processes of evaluating cross sections and producing their covariance should be sought.
2) Refinements should be made to the covariance QA review process (and updating the stated requirements) based on experience gained from work on ENDF/B-VII. 1.
3) More time should be allowed for the covariance review process. It was overly rushed for ENDF/B-VII.1.
4) It would be worthwhile to try an approach suggested by Pavel Oblozinsky (former director of the NNDC): Convene a group of a few people for the expressed task of reviewing all the covariance data for a given library several months prior to its

release date.

5) More attention should be given to discussing and attempting to meet the needs of a broader group of covariance data users, e.g., those in reactor dosimetry.

Resolve a long-standing issue

An attempt should be made to try and bridge the gap between the standards and requirements for traditional data testing (C/E ≈1 to within a few pcm) and realistic data uncertainties, as reflected in the covariance data. Put more specifically: If the underlying data and the evaluation procedures used suggest uncertainties of a few percent for a particular important reaction cross section, e.g., ^{235}U fission, does it make sense to always require C/E consistencies so close to unity for major benchmarks with high sensitivity to ^{235}U nuclear data?

Discussion

A number of issues were discussed during this open session. Some of the main topics that were brought up during this session were the following:

The difficulty (perhaps impossibility from a pragmatic point of view) of insuring that all covariance data emerge solely from the evaluation process with no “tweaking”.

The need to try in the future to satisfy the requirements of a wider range of user communities through improved evaluations and covariances, e.g., the dosimetry community.

The difficulties associated with using integral data to improve differential evaluations without leading to files that are biased toward particular applications.

The need to investigate just how important cross-reaction and cross-material covariances are from the perspective of both data evaluations and applications.

The need for further exploration of techniques for treating the boundary regions between thermal, RR, URR, and fast neutron regions from the perspective of both evaluated central values and covariances.

Cross Section Evaluation Working Group

Formats and Processing Committee Report

Michael E. Dunn, ORNL
Committee Chair

The Formats and Processing Committee meeting was convened on November 16, 2011 at Brookhaven National Laboratory (BNL). The initial part of the meeting was devoted to a summary report of the XML format session held on November 14 prior to the official CSEWG meeting. David Brown provided a summary of the XML meeting. Subsequently, Mike Dunn presented an ENDF-102 manual issue (File 6) that was submitted by Chris Dean (Serco). After a discussion of the format-related agenda items, status reports on the major processing codes were presented. The Formats and Processing meeting concluded with a status report from BNL concerning NNDC activities related to the ENDF-102 Manual and checking codes. The following are the minutes from the Formats and Processing Committee meeting.

Formats and Related Issues

XML Data Structure Summary Discussion from Meeting on November 14, 2011

David Brown (BNL) provided the summary report of the XML data structure meeting. Specifically, the report covered the following topics:

1. Why is a new data structure/format needed?
2. What is GND?
3. What is FUDGE?
4. What are the next steps?

Regarding Item 1, a new format is needed because the existing ENDF/B format is rigid and does not lend itself to easy extension. Moreover, information that is not part of the existing format cannot be stored in the evaluated files without the processing codes being instructed to ignore the information. In addition, the existing format is constrained by a fixed number of digits. With regard to covariance data, new formats are needed to improve the storage and handling of cross-section uncertainty and correlation information. In short, a modern extendable data structure is needed, and LLNL has already performed a significant amount of work towards the development of the

Generalized Nuclear Data (GND) format that is an XML data structure. The GND structure could serve as the basis for a new ENDF/B data format.

The GND data structure has been actively developed by LLNL for the past few years with the goal to make a single unified data structure for all forms of nuclear data (i.e., evaluated, Monte Carlo libraries, deterministic libraries, and experimental data). The GND hierarchy is easily readable and mirrors the physics of particle interactions. Moreover, multiple data forms can be provided in a single file, and the structure permits hyper-linking between different data elements. During the discussion, Brown provided an overview of the XML schema for GND and reviewed xData (i.e., data structures for storing the data). Moreover information about GND can be obtained from the BNL website (https://ndclx4.bnl.gov/gf/project/gnd).

In terms of GND processing tools, LLNL has developed the FUDGE processing package to read the GND structure and translate back-and-forth between the current ENDF/B format and GND. The translation capabilities provide backwards compatibility that is a major concern for the ENDF community. Also, FUDGE provides plotting capabilities that can be used to visualize the data in the GND structure.
With regard to the path forward, Brown presented some discussion items about the XML-based data structure. Specifically, LLNL will be working to address GND and FUDGE usability issues such as documentation, design philosophies, Python 2 versus 3 compatibility problems, numpy dependence, C/C++/FORTRAN extensions. Also, there is a need to develop an evaluator toolkit, transport code API, improved tools for checking/fixing problems/visualization as well as addressing some ENDF format issues as it pertains to GND. Before a new data structure is adopted, the international community needs to be included in the development and deployment process. To this end, NNDC now has a GForge project page devoted to GND, and there is an opportunity to review GND to provide feedback to the developers.

After the summary presentation by Brown, the CSEWG discussed GND and the issues surrounding the move to a modern XML-based data structure for future ENDF/B evaluations. The plan is for LLNL to develop a subgroup proposal to present at the next WPEC meeting in 2012, and the international subgroup will work to review GND and develop recommendations for the international community on the implementation of a new ENDF/B format.

File 6 Manual Issue from Chris Dean (Serco--presented by Mike Dunn, ORNL)

In the months prior to the November 2011 CSEWG meeting, Chris Dean raised a question asking for clarification for Equation 6.3 in Section 6.2.2.1 “Legendre Coefficients Representation (LANG=1).” Specifically, Dean wanted to know how to interpret the Equation 6.3 if the NA parameter equals zero. Per Dean, the equation

appears to default to f0(μ,E,E′) = 0.5f0(E,E′) P0(μ). Since P0(μ) is unity, Dean noted that the equation appears to state that f0(E,E′) = 0.5f0(E,E′). Further, the term f0(E,E′) is the total probability of scattering from E to E′ (i.e., not twice the probability). Dean asked for further clarification and asked whether additional clarification should be provided in the manual. Dean could not be at the CSEWG meeting, and Dunn presented the issue to the CSEWG to discuss whether further clarification is needed in the manual. Dunn noted that the missing point is the user must be aware that there is an integral over all μ. If one performs the integration, the ½ cancels out, and the correct relationship is obtained [i.e., f0(E,E′) = f0(E,E′)]. After a brief discussion, the CSEWG determined that further clarification is not needed in the manual.

Status of Processing Codes

NJOY (Skip Kahler, LANL)

NJOY99.366 was released to the user community in 2011. Additional patches to allow more robust plotting of ACER-produced secondary distributions and to increase array space in GASPR have been provided to BNL. These additional patches will be part of the next public release in December 2011. Regarding NJOY2010, LANL has a new version that is currently undergoing final testing and debugging. Moreover, NJOY2010 has been used at LANL for all ENDF/B-VII.1 beta processing. Efforts are currently in progress to work with the LANL Technology Transfer organization to finalize the software package for release. At this stage, nondisclosure agreements (NDA) are currently in force between LANL and other beta testing organizations.

As noted at the 2010 CSEWG meeting, NJOY99.336 was release in 2010, and the latest version of NJOY99 is NJOY99.366. The following updates have been made since the release of NJOY99.336:

- Implemented new MT values approved at November 2010 CSEWG meeting.
- More robust axis limit determination for secondary energy distribution plots from ACER,
- Larger array space in ACER for check plots,
- More robust RECONR processing for evaluations with no RR data but URR data with LSSF=1—new JENDL-4.0 flies have this feature,
- Revised coding in GROUPR for two-digit LFS values,
- Included more MF1/MT451 data (elis, sta, lis, lis0, nfor, emax, lrel, never) in PENDF output files,
- Included missing index and increased array space in MIXR to allow merging of pointwise data,
- Increased array space in ERRORR, COVR, and VIEWR,
- Allow either ASCII or binary GENDF input to ERRORR,
- Restored inadvertently deleted AWR data in ERRORR output,

- Upgraded MODER to handle previously approved scattering radius format,
- Allow larger group structures in GROUPR,
- Reverted from log interpolation to linear interpolation in HEATR when negative coefficients are encountered,
- ACER revisions to support more robust JENDL-4.0 evaluations,
- Larger array space for BROADR to allow larger delta-T broadening in a single step,
- GASPR corrections recognizing new MT values (previously approved format change),
- Revisions to COVR to allow the user to specify correlation matrix color intervals.

In addition to the noted updates, there is a recent issue related to charged particle elastic scattering that will be resolved in the December 2011 NJOY update. The File 6 LAW 5 processing is governed by the LTP flag. The current coding assumes LTP=2 if the flag is not unity, but recent TALYS/TENDL files use LTP=12. In addition, Jerry Hale's new deuterium evaluation uses a higher LTP value as well. The new update will properly handle the higher LTP values.

During the discussion, the CSEWG asked which version of NJOY does LANL recommend for processing ENDF/B-VII.1. Kahler noted that LANL plans to release NJOY2010 in 2012, and the preferred approach would be for users to use NJOY2010 for ENDF/B-VII.1 processing.

ANL (Dick McKnight, ANL)

Dick McKnight provided the status report on the ANL codes and noted that ANL's primary processing code is MC2-3. Although MC2-3 has not been updated to provide new features during the past year, ANL has identified some software bugs that have been fixed during the past year.

AMPX (Dorothea Wiarda, ORNL)

Dorothea (Doro) Wiarda provided a detailed status report on the AMPX development and maintenance activities since the November 2010 CSEWG meeting. During the past year, AMPX has been updated to provide improved atomic mass ratios for the SCALE Standard Composition Library that is based on the Nuclear Physics Journal article by Wapstra and Audi. Specifically, a new AMPX module was developed to provide the AWR values to SCALE, and AMPX was used to update the SCALE cross-section libraries with the new AWR values for the release of SCALE 6.1 in 2011. In addition, the AMPX module PLATINUM that is used to provide continuous-energy (CE) libraries for SCALE has been updated to use library functions that are available in AMPX for 1-D data and collision kinematics data. Likewise, PLATINUM has been updated to handle gamma-production data that are used for a new CE shielding radiation transport software capability in SCALE.

During the past year, AMPX has been used to provide updated ORIGEN gamma library data for SCALE. Specifically, the ORIGEN library has been updated using NUDAT data that are based on ENSDF. To this end, a new AMPX module has been developed to process a NUDAT text file and convert to the ORIGEN format. Further, the new library provides decay data to the ground state and lists all yield and gamma-ray intensities. The library includes all emissions, including the metastable daughter products. In addition, ORNL has changed the ORIGEN library generation procedure to be more flexible and process JEFF and ENDF/B-VII data evaluations. Moreover, the new ORIGEN library generation procedure is more analogous to other AMPX-library generation procedures. Regarding the latest ORIGEN library generation, ORNL assessed the impact of using ENDF/B-VII.0 for the depletion library relative to JEFF-3.1. Based on the study, JEFF-3.1 is more complete; however, the latest ORIGEN library uses ENDF/B-VII.0 data for 239Np capture. Likewise, for 241Am, the ENDF/B-VII.0 branching ratio data are used with the JEFF-3.1 cross-section data. JEFF-3.1 data are used for all other nuclides on the latest ORIGEN library.

During the past year, AMPX has been used to prepare a new broad-group SCALE cross-section library to support High Temperature Gas-cooled Reactor (HTGR) analyses. ORNL has developed an 81-group library that is collapsed from a 999 fine-group library. To support this library generation effort, a new AMPX module has been developed to generate intermediate resonance (IR) parameter factors for all isotopes. The new HTGR library will be released with a future version of the SCALE package, and new self-shielding module (BONAMI-IR) will be needed to use the HTGR library with SCALE.

In addition, ORNL has worked to develop new ENDF/B-VII.0 versions of the VITAMIN and BUGLE libraries that were previously based on ENDF/B-VI.3. The new libraries (VITAMIN-B7 and BUGLE-7) have been developed and tested for use in pressure vessel fluence calculations, and the new libraries are now available from RSICC.

With regard to AMPX code testing, AMPX has been used to process the ENDF/B-VII.1 beta evaluations and produce prototypic CE and multi-group libraries. Likewise, AMPX has been used to process JENDL-4.0 evaluations. Also, AMPX has been used to process the ENDF/B-VII.1 Beta 3 covariance evaluations. Based on the code testing, a processing error in PUFF-IV has been corrected for LRF=7 evaluations with a different number of open channels per spin group. Note that the processing error does not affect the RSICC-released version of PUFF-IV. However, the error does affect versions of PUFF-IV that have been patched previously. Please contact ORNL if there are any questions about the LRF=7 processing error.

ORNL is working to release the latest version of AMPX (i.e., AMPX-6) from RSICC, and a beta version of AMPX-6 is available from RSICC to beta testers. ORNL is

working to finalize the manual documentation in order to release the software package in FY2012.

During the subsequent discussion, Mike Herman noted that ORNL has not provided a detailed overview of SCALE to the CSEWG, and Mike Dunn noted that ORNL will arrange to provide an overview of SCALE at a subsequent CSEWG meeting.

LLNL (Bret Beck, LLNL)

Bret Beck provided the status report on the LLNL data structure and processing work effort. LLNL has developed the Generalized Nuclear Data (GND) structure, and the report addressed the GND data structure development and associated processing capability development with the FUDGE (For Updating Data and Generating ENDL) processing software. With regard to the motivation for developing GND, there are three "flavors" of nuclear data: experimental (EXFOR), evaluated, and processed (i.e., deterministic and Monte Carlo libraries), and LLNL wanted to develop the GND structure to interface with these different types of data. Moreover, the existing legacy formats have limitations on the types of data that can be stored and often result in bloated data files with redundant information (e.g., ENDL). Moreover, the legacy data files are often slow to access for large data files. As a result, LLNL needed new evaluated, deterministic, and Monte Carlo nuclear data formats to support new applications at LLNL.

Regarding the GND design effort, LLNL has a primary goal to develop a data structure that represents physics. Moreover, LLNL is developing a new data structure and not a format. At this point, LLNL has invested ~3-4 FTE years of effort to date (i.e., related to design, development, translation, infrastructure, processing, and C accessing). Currently, GND supports ENDL and ENDF data. Moreover, the developers realized that most of the needed structure is the same whereas only the end data are different.

LLNL has developed the FUDGE suite of processing tools that can work with the GND structure. Moreover, FUDGE can be used to read, modify, plot, process, and write data to and from the GND structure. The top level of the package is written in Phython (C, C++, FORTRAN wrappers are used when speed is an issue). LLNL has also developed converters for the following:

- ENDL to GND
- ENDF to GND
- GND to ENDF
- GND/XML to GND/HDF5

Currently, FUDGE is widely available if users are interested in working with FUDGE processing package. Subsequently, Beck provided an overview of the various FUDGE

processing options, and additional details are available in the presentation on the CSEWG website. LLNL will continue efforts to complete the FUDGE code package in FY2012 (e.g., LLNL is adding C accessing routines for transport codes).

During the CSEWG discussion following the LLNL presentation, Yaron Danon (RPI) expressed concern about the ability to modify or add to the GND File. Specifically, Danon noted that one should not be allowed to modify the base ENDF file. Subsequently, Skip Kahler (LANL) asked whether Windows users work with the GND structure. Beck noted that we should be able to translate to a new format but may need to do an additional build on Windows machines (i.e., need C/C++ compiler). Morgan White (LANL) noted that there is a shell environment that can be used to support the new XML structure. Ramon Arcilla (BNL) asked how extensible is GND (i.e., if in the future, a new language comes along, can GND accommodate the new language?)? Beck noted XML is a meta-language. As long as the new language supports nesting, then it will be easy to convert from one meta-language to another.

BNL Activities Related to Formats and Processing

ENDF-6 manual and checking codes (Mike Herman, BNL)

ENDF-102 Manual

The ENDF-102 Manual has been updated during the past year, and Mike Herman provided the following changes for the manual (i.e., see 2nd slide of presentation on CSEWG website):

- Incremented the ENDF-102 revision to Revision 2,
- Extended the set of MT numbers that were approved at the November 2010 CSEWG Meeting,
- Two sentences describing the ordering of products were themselves out of order,
- Fmts-32, Fmts-D: correction of Eq 15-18 (C. Lubitz 8/12/2010),
- Fmts-32, Fmts-D: correction of NLS (rep. C. Lubitz, 8/27/2010),
- MF33 correct length definitions for NT LB=6 and NT for LS=0,
- Fmts-06 and -07 correct typos (reported by C. Mattoon and C. Lubitz, respectively),
- Added units to kerma
- Correction of error related to MF32 LRF=7 format

The updated ENDF-102 manual should be released together with the ENDF/B-VII.1 release in December 2011.

After the ENDF-102 Manual updates were reviewed, Herman presented the updates for the following checking codes: CHECKR, FIZCON, and PYSCHE. In order to distribute

the updated checking codes, NNDC will link web downloads of the checking codes and manual to the current Subversion version. Further, the latest revision numbers for the checking codes are as follows in Subversion:

CHECKR-2128
FIZCON-2129
PSYCHE-1984

Following the checking codes update, Herman presented the "MyENDF" website for uploading an ENDF file for checking. MyENDF provides an integrated web tool for evaluators. Specifically, evaluators can upload the ENDF data file, run the ENDF utilities remotely, plot and compare data with EXFOR and ENDF databases. In the future, MyENDF will be linked to Subversion. Currently, MyENDF is password controlled (i.e., password is csewg123$). NNDC is planning to use the MyENDF toolkit for ENDF/B-VII.2.

Additional Discussion Items

After the NNDC presentation, Skip Kahler noted that LANL may propose a prompt neutron fission spectrum (PNFS) format. Currently, more detailed PNFS work is in progress at LANL, and there is the possibility that LANL may want to provide PNFS distribution data in future evaluations. Morgan White noted that a new format may not be needed if LANL can utilize the existing File 6 format structure to transmit the PNFS data.

The Formats and Processing Session was closed after the PNFS discussion.

Cross Section Evaluation Working Group

Measurements Committee Report

Yaron Danon, RPI
Committee chair

The measurement committee session was held on the morning of November 16, 2011. Nine presentations representing experimental programs at LANL, LLNL, ORNL, RPI, ANL, LBL, and NIST were given. The presentations provided an overview of current research and measurement performed at the different US laboratories. The full presentations can be found on the CSEWG web site.

The Agenda

1. Nuclear data experiments at LANSCE - Highlights 2011, Height, 30'
2. Experimental nuclear data program in LLNL, Wu, 25'
3. ORNL cross section measurement activities, Guber, 25'
4. Nuclear Data Measurements at RPI, Danon, 25'
5. Experimental activities at ANL, Kondev, 20'
6. Overview of LBL Na and K thermal cross section measurements, Firestone, 25'
7. NIST Measurements and Standards Related Work at Other Facilities, Carlson, 20'
8. Thermal neutron-capture cross sections of the W isotopes, Hurst, 15'
9. Thermal neutron-capture cross section of the Y-90 isotope, Abusaleem, 15'

U.S. Laboratories Measurement Programs

Nuclear data experiments at LANSCE - Highlights 2011 (Height, LANL)

Chi-Nu - Development of a system to measure fission neutrons spectrum below 1 MeV using Li-Glass and liquid scintillator neutron detectors, targeted accuracy on the prompt fission neutron spectrum is 5%. LANL also reported on the use of tagged neutrons to measure the efficiency of liquid scintillator detectors above 1 MeV.

GEANIE – (array of High resolution Germanium gamma detectors)
Sn - structure of 118,120 Sn, combine GEANIE and GAMMASPHERE experiments (some results were presented). Reported on work in progress (no results shown): Cu(n,xnγ), x = 1,2,... and Ar(n,xnγ), x=1,2,... for double-beta decay experiments (Mitzi Boswell and Sean Macmullin (NCSU)),
^{86}Kr(n,xnγ), x= 1,2,... (Matt Devlin), NaI(n,xn) for data libraries (Nikolaos Fotiades),
Various elements for neutron-induced gamma-production standards (Ron Nelson) and x-ray yield from n-induced fission (R. Nelson and Thierry Granier - CEA)

Capture measurement with DANCE – Results were shown for the gamma spectrum from $^{236}U(n,\gamma)$ reaction in 44 eV and 77 eV resonances comparing to simulations. Reported on work in progress:
$^{152,154,155,156,158}Gd$ Bayarbadrakh Baramsai, NCSU/LANL,
^{97}Mo Carrie Walker, NCSU PhD dissertation, in progress,
$^{184,186}W$ Capture, Marian Jandel LANL (in progress),
$^{191,193}Ir$ Capture; Todd Bredeweg LANL,
$^{233,235}U$, $^{239,241}Pu$ Capture to fission: LANL, LLNL,
$^{239,241}Pu$ Fission gamma ray multiplicity and spectra: LANL/LLNL,
^{238}Pu Capture, capture/fission: LLNL,
^{252}Cf Fission gamma multiplicity and spectra: LLNL,
$^{242m,\ 243}Am$ Capture, Marian Jandel LANL,
^{238}U Capture cross section, gamma rays John Ullmann LANL.

Fission neutron measurements - presented progress for experimental fission physics studies: A TPC for high accuracy fission cross section measurements is developed by a collaboration of LANL, LLNL, INL and several universities. A prototype detector was constructed and is now being tested at LANL.
A new Spectrometer for Ion Detection in Fission Experiments (SPIDER) is considered in order to provide high fission fragment mass resolution for fast neutron fission.

LSDS – Fission cross section for ^{237}U ($t_{1/2}$=6.75d) was measured (2 eV- 2 keV) and preliminary results were presented.

Experimental nuclear data program in LLNL, (Wu, LLNL)

Reported on the prompt gamma emission measurement using Chi-nu setup at LANSCE and the development of several unfolding technics. Measurements of ^{252}Cf gamma multiplicity were presented. A thin wall fission counter was used at DANCE (LANL) to measure the capture cross section of ^{239}Pu (0.937 mg), ^{241}Pu (0.147 mg), ^{235}U (0.923 mg), ^{238}Pu (0.374 mg). Steps to measure ^{153}Gd capture cross section using surrogate reactions were discussed. Results were given for $^{238}Pu(n,f)$ cross section measurements in the energy of ~1 MeV – 20 MeV. Progress on $^{241,242}Am$ fission cross section measurements was presented. Development of methods to measured delayed neutron emission using recoil nuclei technic (no need for neutron detection) was discussed.

ORNL cross section measurement activities (Guber, ORNL)

Neutron capture and transmission measurements for $^{63,65}Cu$ were performed at GELINA, new evaluation will include old ORELA data. The ^{63}Cu data show resonance structure up to 1 MeV. Measurements with Ca samples are planned for next year.

Nuclear Data Measurements at RPI (Danon, RPI)

Transmission: several transmission measurements were completed this year and total cross sections were presented for:
^{95}Mo, Fe-filtered transmission, 100m flight path
^{95,96,98,100}Mo, 10 eV - 600 keV, 100m and 30m flight path
^{95,96,98,100}Mo, 0.5-20 MeV, 250m flight path
^{56}Fe, 0.5-20 MeV, 250m flight path

Neutron scattering Data for ^{238}U neutron scattering in the energy range from 0.5-20 MeV, was presented differences between evaluations and experimental data are more evident in back angles.

Capture and Fission: RPI is developing a method for simultaneous capture and fission measurements using the RPI multiplicity detector the goal is to measure the capture of in ^{235}U in the unresolved region up to 10 keV. Preliminary results were presented showing capture data in the energy range from 500 eV to 5 keV.
^{236}U capture measurement support a reduction of about 30% in the capture cross section of the 5.45 eV resonance.

Analysis – Thermal capture cross sections for ^{151,153}Eu were extracted from capture and transmission measurements and show slightly higher values compared ENDF/B-7.0. Resonance parameter analysis of Rh capture and transmission measurements from few eV to 500 eV shows slight differences from ENDF/B-7.0
Resonance parameter fits for^{155,156,157,158,160}Gd and ^{161,162,163,164}Dy were shown and provide and extension of the resolved resonance region up to 1 keV for some of the Gd isotopes.

Thermal scattering Data: Thermal scattering data measured at SNS were shown for water at room temperature for several scattering angles. The data is a proof or principle for the feasibility of such measurements and are of very high quality with smaller statistical and systematic errors relative to older RPI data that is still used today in most thermal scattering evaluations.

Experimental activities at ANL, (Kondev, ANL)

MANTRA - Measurement of Actinide Neutronic Transmutation Rates with Accelerator mass spectroscopy is a project in development at ANL. In this project small samples are irradiated at ATR and analyzed using AMS at ANL, desired mass accuracy 2%, full test expected soon.
CARIBU – Californium Rare Ion Breeder Upgrade of ATLAS, use fission fragments from ^{252}Cf and measure decay schemes, first results for ^{142}Ba were shown.
Isomers: Studies of ^{177m}Lu and ^{178m}Hf decay schemes were presented.

Overview of LBL Na and K thermal cross section measurements, (Firestone, LBL)

Thermal capture cross section measurements are done at the Budapest reactor. The measurements are done by summing all the observable levels and adding levels from a statistical model. Results were given for several samples: ^{24g}Na σ_γ=0.541±0.004mb (ATLAS=0.517±0.004mb), ^{39}K σ_γ=2.28±0.04b (ATLAS=2.1±2b), ^{40}K σ_γ=90±7b (ATLAS=30±8mb), ^{41}K σ_γ=1.62±0.03b (ATLAS=1.46±0.03mb), ^{54}Fe σ_γ=2.13±0.04b (ATLAS=2.25±0.18b), ^{56}Fe σ_γ=2.47±0.02b (ATLAS=2.59±0.14b), ^{57}Fe σ_γ=1.65±0.03b (ATLAS=2.48±0.30b), ^{151}Eu σ_γ=9165±400b (ATLAS=9200±100b), ^{153}Eu σ_γ=292±12b (ATLAS=316±8b), ^{155}Gd σ_γ=292±12b (ATLAS=316±8b)
Firestone commented that these might not be the final values.

NIST Measurements and Standards Related Work at Other Facilities, (Carlson, NIST)

H(n,n) – Several regions that need more work (some is in progress) were highlighted: small angles in the CMS near 15 MeV, at intermediate and high energies where data are sparse and typically not available for a large angular range, there is the lingering concern for back angles in the hundred + MeV region.
^{6}Li(n,t) and the ^{10}B standards need additional work with emphasis on extending the energy range to higher energies.
^{235}U(n,f), ^{238}U(n,f) and ^{239}Pu(n,f): additional work should be done in the high energy region of the cross sections to support of the needs for better standards in that energy region.

Thermal neutron-capture cross sections of the W isotopes, (Hurst, LBL)

Measurements of tungsten capture cross section measurements at the Budapest reactor were discussed. The results: ^{182}W, σ_γ=20.5(11), (atlas, σ_γ=19.9(3)), ^{183}W σ_γ=10.44(41), (atlas, σ_γ= 10.4(2)), $^{184}\sigma_\gamma$= 1.15(10), atlas, σ_γ= 1.7(1)), $^{186}\sigma_\gamma$= 43.2(12), atlas, σ_γ= 38.1(5))

Thermal neutron-capture cross section of the Y-90 isotope, (Abusaleem, LBL),

Discussed the calculations to support the measurements at the Budapest reactor, cross section results were not given.

Summary of the 13th U.S. Nuclear Data Program Meeting

Held at
Brookhaven National Laboratory, Upton, NY
November 16-18, 2011

US Nuclear Data Program

Chairman's Summary

M. Herman
National Nuclear Data Center, BNL

The 14th Annual Meeting of the United States Nuclear Data Program was held on November 16-18, 2011 and attended by 51 registered participants. The meeting was held adjacent to the CSEWG Annual Meeting, with a common USNDP-CSEWG session on nuclear reaction modeling.

Nuclear Structure Working Group

The status of basic nuclear structure databases NSR, XUNDL and ENSDF was reviewed. NDS publication format and scope of the ENSDF evaluations have been discussed. No essential changes to the current practices are recommended at present. The idea of moving to the new XML format has been put forward and some preliminary developments were presented. This initiative goes in line with the similar push within the reaction community. The NSR and ENSDF evaluation efforts remained on a stable level. The ENSDF and NSR continue to be a truly international effort with contributions from US, Canada, Japan, China, France, Russia, Hungary, Poland, Slovakia, Ukraine, India, Kuwait, and Jordan. In 2011 dissemination of the structure data grew by more than 20% with a notable spike immediately after the Japanese earthquake.

Nuclear Reaction Working Group

A common CSEWG-USNDP session was devoted to recent advances in nuclear reaction modeling and development of related codes in four US laboratories.
Computer simulation at ORNL confirmed that the energy average of the fluctuating part of the S-matrix becomes zero for energy-dependent eigenvalues and eigenvectors. The major changes in et EMPIRE code were inclusion of the CC code OPTMAN, adding RRR covariance module KERCEN, upgrade of the checking codes, and direct access to C4 files with experimental data instead of the original EXFOR file. The improved clustering model (LANL) proved to give better reproduction of the production cross sections and the secondary particle energy spectra.

User Discussion Forum

This activity, established in 2005 and aimed to strengthen interaction between the user community and USNDP, has been suspended in 2010 due to logistical difficulties to organize it off-site. The user's forum resumed during the 2011 Autumn Week with two astrophysics related talks by **I. Dillmann (GSI)** and by **I.N. Borsov (ORNL).** The

Stellar Neutron Capture database (KADONIS) was discussed by Dillmann, while Borisov described calculations of the beta strength function using finite Fermi system theory.

Task Forces

The two task forces (Nuclear Data for Astrophysics and Nuclear Data for Homeland Security) continue their activity and presented their reports.

Planning and Reporting

- Summary of the present Annual Meeting should be issued in January 2012,
- Annual Report for FY 2011 in January 2012, and
- Workplan FY 2013 in February 2012.

The next budget briefing will be held at the DOE Headquarters on February 15, 2012. The USNDP team will include USNDP Chairman(M. Herman) , WG chairmen (R. Firestone and T. Kawano) and the members of the USNDP executive committee who have specific issues to bring to the briefing.

Next Meeting

The next Nuclear Data Week will be held at BNL Nov. 5 through 9, 2012. The tentative date of the USNDP meeting is Nov. 7-9 (Wed - Fri).

USNDP Coordinating Committee Meeting

The Coordinating Committee met at working lunchtime on Thursday, November 17, 2011. Nine members attended the meeting, including M. Herman, R. Firestone, A. Carlson, T. Kawano, J. Kelley, F. Kondev, N. Summers, A. Cheng, and M. Smith. The meeting was also attended by Ted Barnes, DOE-SC.

The participants shortly described the situation in their home institutes. Funding shortages were reported by A. Cheng (McMaster) and M. Smith (ORNL). It was noted that USNDP personnel has been considerably strengthen by hiring six scientists (2 LANL, 4 BNL) during the last year.

A. Sonzogni presented status of preparations to the ND2013 while M. Herman proposed unusual approach to the ND2013 proceedings that would encourage submission of a few relatively large papers on important projects or hot topics. These papers would involve a relatively large number of authors, who would contribute to the “big” paper rather than presenting a regular contribution. The intention is to produce several important and comprehensive papers that would have higher impact than many short papers. This approach will also allow certain projects, which are missing a clear reference, to increase their visibility and

improve citation possibilities. Most of the participants did not object, although T. Kawano expressed skepticism whether this new policy will bring expected benefits. Proceeding of ND2013 will be published in two special issues of Nuclear Data Sheets in December, 2013 / January, 2014. Taking into account short time available for processing, reviewing, and assembling of the proceedings contributions will have to be submitted in LaTeX.

US Nuclear Data Program

Structure and Decay Data Working Group

R. Firestone (LBNL),
Working Group Chair

Committee: A joint CSWEG/USNDP session was held providing research reports from both communities. This session marked significant progress in the communication between the reaction and structure communities. F. Kondev (ANL) presented the nuclear data measurement activities at Argonne National Laboratory. R. Firestone (LBNL) presented the latest results on the neutron cross section measurements for ^{23}Na, ^{39,40,41}K, ^{54,56,57}Fe, ^{151,153}Eu, and ^{155,157}Gd. A. Hurst (LBNL) presented the latest results on the neutron cross section measurements for ^{182,183,184,186}W. K. Abusaleem (Jordan, LBNL) presented initial results on the cross section measurement for ^{89}Y.

ENSDF Proposals: A publication proposal was submitted by J. Tuli (NNDC) to publish only adopted and decay data in Nuclear Data Sheets in order to stem the rapid increase in size of these publications. The proposal was withdrawn because the publisher indicated that page constraints are no longer an issue. Although, hard copy publication is expected to continue for the near future electronic publication can help enhance the appearance and usefulness of the journal. There exists the possibility of an electronic-only publication of part or whole evaluations with proper citation.

An evaluation proposal was submitted by R. Firestone (LBNL) to stop evaluating the supporting ENSDF datasets and replace them by merging the XUNDL and ENSDF files. Adopted Levels, Gammas would be evaluated directly from the XUNDL data, Adopted Decay data would be evaluated in collaboration with the Decay Data Evaluation Project (DDEP), and Adopted (n,γ) data would be evaluated by the IAEA/LBNL/LLNL collaboration. Additional adopted data files can be developed through collaborative efforts between the nuclear data and research communities. The proposal stressed that greater efficiency would be achieved by no longer independently evaluating secondary information. Providing complete XUNDL data in ENSDF would also be a greater service to researchers. There was considerable discussion following the proposal. Some thought the proposal of eliminating experimental datasets was unrealistic since XUNDL is limited to literature appearing only in last decade.

There was a broad consensus to work more closely with the DDEP, through its leadership M. Be' (France) and F. Kondev (ANL), to evaluated decay data although some thought that DDEP work duplicates effort of ENSDF evaluators.

Progress on the modernization of ENSDF formats to XML was presented by Johnson (NNDC) and Patel (LLNL). This is part of a larger project supported by an ARRA grant at LLNL to modernize both the ENDF and ENSDF formats into a more flexible language accessible by multiple user applications. Concern was expressed for the continued support of legacy ENSDF applications. Increased collaboration between the NNDC and LLNL has been established and is expected to expedite this transition with a minimum of difficulties.

ENSDF Status: Tuli (NNDC) reported that the ENSDF file grew by 4% during the past year with 17361 datasets representing 3172 nuclides. An average of 26 mass chains was in prepublication status last year and 21 were published in 2011. ENSDF electronic downloads were dominated by Europe (37%), Asia (32%), and North America (28%).

Mass chains Published in 2011: 27 (LBNL), 32 (McMaster), 33 (McMaster), 35 (McMaster), 44 (McMaster), 50 (Hungary, McMaster), 56 (China), 71 (Jordan, McMaster), 93 (LBNL), 99 (NNDC, LBNL), 125 (Japan), 127 (Japan), 133 (Russia, Argonne), 142 (NNDC, Ukraine, France), 161 (NNDC), 207 (ANL), 220 (NNDC,LBNL), 222 (India, NNDC), 245 (NNDC, LBNL), 246 (NNDC, LBNL), 249 (Jordan)

XUNDL Status: Singh (McMaster) reported that XUNDL continues to remain up to date in its coverage of the primary nuclear physics journals. The effort is lead by the McMaster group with substantial contributions from the IAEA, ANL, Russia, LBNL, and others.

NSR Status: Pritychenko (NNDC) reported that NSR has grown to cover nearly 205,000 articles. The primary effort remains at the NNDC with significant contributions from Slovakia and McMaster. An initiative to automate some of the keywording through a contract with XSB, Inc. had only limited success. Efforts to enlist American Physical Society authors in the generation of NSR keywords have been renewed.

Nudat Status: Sonzogni (NNDC) reported that Nudat has been updated to include the 2011 Atomic Mass evaluation and the 2011 Wallet Cards. Retrievals were up 24% in 2011 with a notable spike immediately after the Japanese earthquake.

DDEP Status: Kondev (ANL) reported that 190 nuclide decay evaluations have been published on the WWW including 63 x-ray/γ-ray standards and 85 actinides supported by IAEA CRP's. DDEP decay evaluations are now recommended by the International Committee for Radionuclide Metrology (ICRM).

EGAF Status: Firestone (LBNL) reported that the first version of the Evaluated Gamma-ray Activation File (EGAF) is completed and available from the IAEA. New, more extensive evaluations for seven isotopes are expected to be published in 2012. Evaluations of an additional 22 isotopes are expected to be completed in 2012. For the first time primary γ-ray transition probabilities have been determined based on EGAF γ-ray cross sections and total radiative cross sections and γ-ray widths from Mughabghab's (NNDC) Atlas of Neutron Resonances. They provide guidance for γ-ray strength functions in statistical model calculations.

IAEA Nuclear Data Section: Abriola (IAEA) reported that in 2011 there were 6 completed Coordinated Research Projects (CRP), 6 ongoing CRPs, and 10 Data Development Projects. There is a pending call for a CRP on Beta-delayed neutron emission evaluation. The IAEA compiles data for ENSDF and XUNDL and references for NSR. They supported 5 ENSDF evaluators, 2 horizontal evaluations, the 2011 International Nuclear Structure and Decay Data evaluators meeting in Vienna, and an evaluator's workshop in Trieste in 2010. Another evaluator's workshop is scheduled for 2012 in Trieste. The IAEA provides a mirror site to the NNDC and supports a "Livechart" display of nuclear data.

Analysis Codes: Johnson (NNDC) reported on the status of analysis codes available from the NNDC. A new version of BRICC, developed by Kibedi (ANU), is available. New versions of FMTCHK (NNDC) and GABS (LBNL) are in progress.

User Forum

Presentations from the astrophysics community:

***Nuclear Astrophysics with Neutron,* I. Dillmann (GSI).** Information about the Stellar Neutron Capture database was reported. Compilation of data for 357 isotopes experimental and theoretical Maxwellian cross sections (kT=5-100 keV). Karlsruhe Astrophysical Database of Nucleosynthesis in Stars (KADONIS) data sheets was compared with ENDF.

***Beta Decay Data from Microscopic Models,* I.N. Borsov (ORNL).** Borsov described calculations of the beta strength function using finite Fermi system theory. Promising results were obtained for near N=50, 82, and 126 isotopes.

Other presentations

***Editorial Process and Data Handling at the Physical Review*, C. Wesselborg (PRC).** The editorial process at Physical Review was discussed. Considerable interest was excited by PRC's capability of generating PDF output directly from XML publication

formats. The NNDC will work with Phys. Rev. Editors to improve communication with XUNDL and NSR.

Status of B(E2;$0^+_1 \rightarrow 2^+_1$) Evaluation for Z=2-22, **B. Pritichenko (NNDC)**, M. Birch (McMaster), J. J. Choquette (McMaster, M. Horoi (Central Michigan), B. Singh (McMaster). An earlier publication of S. Raman is being updated with improved statistical methods.

Procedures for Optimum Representation of the Measured B(E2) Values for the First 2+ States, **M. Birch (McMaster)**. This undergraduate project describes a solution for averaging quantities with asymmetric uncertainties. We were impressed with Michael Birch's depth of physics knowledge and his ease of presentation as a sophomore undergraduate student.

Summary of the DNP Workshop and Minisymposium, **B. Pritichenko (NNDC)** discussed the very successful workshop and minisymposium held at the Fall DNP Meeting at MSU. Representatives of nuclear astrophysics, nuclear theory, and nucleon-resonance spectroscopy discussed their data needs with members of the USNDP. It was agreed that members of the research and data communities should work more closely together. A follow up meeting is tentatively planned to coincide with ND2013.

Summary of IAEA Technical Meeting ``Intermediate-term Nuclear Data Needs for Medical Applications: Cross Sections and Decay Data, **F. Kondev** discussed the nuclear data needs of the medical community. Emphasis was placed on cross sections, decay data, atomic radiations, and modeling. Improved production cross sections for numerous isotopes were recommended.

Further test of internal-conversion theory with a measurement in ^{119m}Sn, **N. Nica (TAMU)** reported on progress of the precise ^{199}Sn^{m} M4 internal coefficient measurement needed to study the hole/no-hole question in ICC calculations.

Unexpected uncertainty for the NIST 4πβ-γ Ionization Chamber, **F. Kondev (ANL)** discussed problems uncovered in the NIST 4πβ–γ long-lived half-life measurements. The problems were ascribed to an unstable source holder and corrections to the data are planned.

Unexpected uncertainty for the Japanese 4πβ-γ Experiments, **Firestone (LBNL)** reported on substantial errors in 4πβ–γ transition probability measurements for ^{42}K and ^{187}W β^- decays at a Japanese laboratory. Although the P_γ values were reported to a precision of 1%, values obtained in the EGAF (n,γ) measurements were 10-15% lower. The cause of the discrepancy is believed to be due to a failure to correct for the

absorption of betas in the source. These errors have lead to incorrect decay schemes and resulted in faulty thermal neutron cross sections that are inferred from P_γ.

US Nuclear Data Program

Nuclear Reaction Working Group

T. Kawano, LANL
Working Group Chair

Model code development

Arbanas of ORNL gave a talk on extension of the KKM (Kawai-Kerman-McVoy) theory of statistical nuclear reaction; inclusion of the exact energy-dependence of eigenvalues and eigenvectors, and the generalization of KKM for the door-way states. In KKM the T-matrix is expressed as the sum of the average part and the fluctuating part, which is the foundation for many statistical nuclear theories. With a computer simulation technique, it was shown that the energy average of the fluctuating part becomes zero for energy-dependent eigenvalues and eigenvectors. In the second part in his talk, the door-way states, whose intermediate structure has finer than the gross but coarser than the fine structure in the T-matrix, are considered explicitly in the formulation. Some preliminary numerical simulation was performed.

Herman of BNL presented the status of the EMPIRE code development, and new features in the recent version, EMPIRE-3 .1. The major changes since the last USNDP meeting were inclusion of OPTMAN, KERCEN, and upgraded checking codes, direct access to C4 files with experimental data. For better reproduction of the measured cross sections, parameters in the EGSM level density were updated, and the level density has become possible to be shifted manually. EMPIRE has implemented on a Linux cluster at NNDC so that the code can be intensively used for sensitivity calculations. He announced that the new version will be available soon (in December or January).

Kunieda of LANL/JAEA gave a talk on the (n,x alpha) cross section calculations with the clustering pre-equilibrium model, which includes an improved Iwamoto-Harada model for better reproduction of the experimental alpha-particle production data in the higher energy regions. The improved clustering model gives good agreements with both the production cross sections and the secondary particle energy spectra. His new calculations for structural materials were included in ENDF/B-VII.1.

Vogt of LLNL gave a talk on the application of the event-by-event fission simulation code, FREYA, to the prompt fission neutron spectrum. In FREYA, the prompt neutrons are evaporated from excited fission fragments, and the neutron emission takes place until the excitation energy of residual nucleus becomes less than the neutron separation energy.

Three parameters, which are related to TKE, level densities, and relative excitation of both fragments, are selected as the model parameters, and they were estimated to reproduce the average number of neutrons per fission in the energy range thermal to 20 MeV with the Bayesian method. It was shown that the probability distribution of maximum temperature of the fragments is not in a triangular shape that was assumed in the past, and shown that the emitted neutrons are strongly correlated depending on the fissioning nucleus.

US Nuclear Data Program

USNDP Reports

B. Pritychenko, BNL
Session Chair

The reporting session started with the USNDP Web Services report: **B. Pritychenko** discussed several improvements of the NNDC front page, NSR Web interface, Sigma QA system that played crucial role in the ENDF/B-VII.1 release, ENSDF & ENDF online code system developed in collaboration with the IAEA, IUPAC Table of Isotopes and retrieval statistics. This presentation generated considerable interest of the audience: T. Kawano indicated needs for mobile applications, I. Dillmann cited problems with accessing NNDC website from abroad and F. Kondev indicated limited number of ENSDF codes in the current online system.

The two Task Force reports were delivered by C. Nesaraja (ORNL) and D. Brown (BNL):
C. Nesaraja reported on the Astrophysics Task Force that included contributions from the Argonne, Oak Ridge, Brookhaven National Laboratories and McMaster University. This presentation contained experimental proposal from Argonne, measurements & reaction assessment for nova nucleosynthesis from Oak Ridge, ENDF/B-VII.1 Maxwellian-averaged cross section and uncertainty calculations for s-process from Brookhaven and ^{29}P,^{30}P(p,γ) reaction measurements and evaluation work from McMaster University. R. Firestone asked about prospects for JINA-ORNL cooperation.
D. Brown presented an update on Nuclear Data for Homeland Security and reported on the status of the homeland security nuclear data needs document that is in preparation. It is expected to be completed in December, 2011. Dave raised a possibility of adding to ENDF database μ-sublibrary and homeland security application development.

Nine laboratory reports were given:
BNL Report, M. Herman: NNDC provided an update on the personnel, GForge Server, Web and database services, ENSDF and ENDF evaluations, and status of NSR and EXFOR compilations. The highlights included work on the ENDF/B-VII.1 library, EMPIRE nuclear model code, publication of Nuclear Data Sheets Journal and Nuclear Wallet Cards booklet. R. Firestone pointed out lack of connection between ENSDF and elemental data, and the old data sets in RIPL. More interactions between ENDF and ENSDF groups are necessary.

ANL Report, F. Kondev: The Argonne report consisted of program overview, nuclear data evaluation and research activities. Future plans and funding issues were discussed in details.

LANL Report, T. Kawano: Los Alamos presentation included an extensive program overview, evaluation and theory development for sequential neutron emission, correlations between gamma energy and neutrons and β-decay calculated spectra. Personnel and manpower data were also included to the report. M. Herman: These activities are partially funded by the DOE.

LBNL Report, R. Firestone: Isotopes project report discussed nuclear structure and cross section evaluations, nuclear data measurements and calculations. This team actively collaborates with scientists worldwide. Developed in collaboration with Budapest and Prague, EGAF library contains thermal (n,γ) cross sections from ^{6}Li to ^{186}W and supported by the Dicebox code calculations. Isotope project scientists would re-evaluate the old LBNL data from the Total Absorption Spectroscopy (TAS) measurements and will employ a neutron generator at Nuclear Engineering Department, UC Berkeley. Finally, nuclear data are used for tracking supernova explosions in the past. T.D. Barnes asked to send supernova preprints to DOE.

LLNL Report, N. Summers: The Livermore report included USNDP personnel changes, update on the new data format, ENDL2011 data library compilations, EGAF contributions, Total Monte Carlo toolset, and experimental as well as theory efforts. M. Herman asked to clarify capabilities of the Monte Carlo toolset.

NIST Report, A. Carlson: NIST presented an updated list of neutron cross section standards, recent work on angular distributions, nuclear reaction experimental and evaluation activities, recent data development and consultancy results. R. Firestone inquired about thermal cross sections for ^{197}Au, while M. Herman was interested in release of the new standards from IAEA data development project.

McMaster Report, A. Chen: McMaster group presented highlights for nuclear structure and astrophysics activities. MCMaster is a major ENSDF and XUNDL and substantial NSR contributor. These projects include active participation of undergraduate students. The group actively collaborates with other USNDP and research groups. Astrophysics activities include Nova outburst ^{29}P,^{30}P(p,γ) reaction measurements that are conducted in parallel with the evaluation effort.

ORNL Report, C. Nesaraja: Oak Ridge group activities include nuclear structure and nuclear astrophysics data evaluations and measurements. ^{80}Ge(d,p)^{81}Ge reaction was investigated at HRIBF. This group is leading the development of Computational Infrastructure for Nuclear Astrophysics (CINA). Presentation also includes publications, staff and future plan updates.

TUNL Report, J. Kelley: TUNL group presented staff, nuclear structure and website data. It is worth to notice recent work on A=11-13 evaluations. M. Herman asked about thermal neutron cross section compilation. This compilation is updated once a year using NSR database.