



CSEWG & USNDP
Meetings '2006

Summary of the
56th Cross Section Evaluation Working Group Meeting
November 6 - 8, 2006

and

9th U.S. Nuclear Data Program Meeting
November 7 - 9, 2006

Held at
Brookhaven National Laboratory
Upton, NY 11973

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www.nndc.bnl.gov/proceedings/2006csewgusndp

Preface

In 2006, following the tradition established in the previous three years, the Cross Section Evaluation Working Group (CSEWG) and the U.S. Nuclear Data Program (USNDP) Annual Meetings were organized jointly. In the week of November 6 - 9, 2006, three nuclear data meetings were held at BNL:

- CSEWG Annual Meeting (Nov 6-8),
- USNDP Annual Meeting (Nov 7-9), and
- Nuclear Data Advisory Group, Criticality Safety Program Meeting (Nov 9).

Those, who attended the CSEWG meeting, witnessed historical event for the US nuclear data community – approval of the next generation of the US Evaluated Nuclear Data File, ENDF/B-VII.0. The new library should be released on December 15, 2006.

The present document contains the Summary of the CSEWG and USNDP Meetings. This Summary is produced both as a hardcopy and in electronic form but the presentations and the reports are available electronically only. One should go to www.nndc.bnl.gov/proceedings/2006csewgusndp for a full set of the CSEWG-USNDP 2006 meeting documents.

November 27, 2006

Pavel Oblozinsky
CSEWG chair
USNDP chair

Group Photo
56th Cross Section Evaluation Working Group Meeting, Nov 6 - 8, 2006



Table of Contents

| | <u>Page No.</u> |
|-----------------------------------|-----------------|
| Agenda | 1 |
| List of Participants | 7 |

1. Summary of the 56th Cross Section Evaluation Working Group Meeting

| | |
|--|----|
| Chairman's Summary (<i>P. Oblozinsky</i>)..... | 11 |
| CSEWG Annual Meeting..... | 11 |
| CSEWG Executive Committee Meeting..... | 12 |
| ENDF/B-VII Validation (<i>M.B. Chadwick & R. McKnight</i>)..... | 13 |
| Validation of ENDF/B-VII beta3..... | 13 |
| Action Items..... | 17 |
| Updates on Ongoing Evaluation Work..... | 18 |
| Formats and Processing (<i>M. Greene</i>)..... | 19 |
| Post ENDF/B-VII.0 Format Revisions..... | 19 |
| Processing Codes..... | 20 |
| BNL Activities Related to Formats and Processing..... | 21 |
| Measurements (<i>D.L. Smith</i>)..... | 22 |
| US Laboratory Measurement Programs..... | 22 |
| Reports on Conferences..... | 25 |
| Special Topics..... | 25 |
| Common CSEWG-USNDP Session (<i>M.B. Chadwick</i>)..... | 29 |
| Nuclear Data Sheets: Journal for Structure and Reaction Data?..... | 29 |

2. Summary of the 9th U.S. Nuclear Data Program Meeting

| | |
|---|----|
| Chairman's Summary (<i>P. Oblozinsky</i>)..... | 33 |
| USNDP Annual Meeting..... | 33 |
| USNDP Coordinating Committee Meeting..... | 34 |
| Minutes of the Nuclear Structure and Decay Data WG (<i>C. Baglin</i>)..... | 35 |
| Database Status Reports..... | 35 |
| Software and Web Pages..... | 36 |
| Formats and Procedures..... | 37 |
| Nuclear Data Sheets Issues..... | 39 |

| | <u>Page No.</u> |
|--|-----------------|
| Minutes of the Nuclear Reaction WG (<i>T. Kawano</i>)..... | 41 |
| Model Code Development..... | 41 |
| Nuclear Astrophysics..... | 41 |
| Cross Section Standards..... | 42 |
| Covariances..... | 42 |
| User Community – USNDP Discussion Forum (<i>A. Sonzogni</i>)..... | 44 |
| USNDP Reports | |
| Task Force Reports..... | 46 |
| Laboratory Reports..... | 46 |
| Distribution List | 47 |

Note

The present document, along with many presentations and reports given at both the CSEWG and USNDP meetings, can be found at www.nndc.bnl.gov/proceedings/2006csewgusndp

Agenda

CSEWG & USNDP Annual Meetings, November 6-9, 2006

Underlined items are available at
www.nndc.bnl.gov/proceedings/2006csewgusndp

Nov 6, 2006, Monday, Berkner B

- 08:30-08:45 CSEWG Opening, Oblozinsky
- 08:45-12:30 **Validation of ENDF/B-VII** (Chadwick, chair)
 - Status of ENDF/B-VII beta3, Herman, 10'
 - Phase 1 testing, Arcilla, 5'
 - ENDF/B-VII.0 paper and follow-up papers, Oblozinsky, 15'
 - Validation of beta3 at LANL, 1h
 - Overall b3 testing results, Kahler, 45'
 - 233U/Zr testing and Be results, MacFarlane, 15' (conference call)
 - New Evaluation of Zr-90, Herman, 10'
 - Overview of Zr data in ENDF/B-VII.0, Lubitz
 - Testing of Zr, Zerkle, 10'
 - Revision of 235U delayed nubar, Lubitz, 15'
 - Final report on standards, Carlson, 15'
 - Observation on data testing, Chadwick/MacFarlane, 15'
 - 237Np evaluation, Kawano, 5'
- 12:30-14:00 **Lunch Break**
 - *CSEWG Executive Committee Working Lunch, Berkner A*
 - *ENDF/B-VII.0 release*
 - *CSEWG after ENDF/B-VII.0*
 - *WPEC matters*
 - *ND2007 conference*
 - *Next meeting*
- 14:00-16:45 **Validation of ENDF/B-VII continues** (McKnight, chair)
 - Summary of validation at Petten including keff and transmission, McKnight, 20'
 - Update on 2H, Kozier, 10'
 - Validation at LLNL, Brown, 10'
 - ENDF/B-VII.0 covariances, D. Smith, 15'
 - Covariance generation in resonance region, Leal, 10'

- [Covariances for major actinides in fast region](#), Kawano, 10'
- [Update on NJOY-ERRORJ](#), Kawano, 5'
- [Comments on work for b3 \(photonuclear, adjustments\)](#), Young, 15'
- [Decay data library in ENDF/B-VII](#), Sonzogni, 15'
- [Fission energy release in b3](#), Kahler/MacFarlane, 15'
- [Benchmarking system](#), White, 10'
- [Comments on calibration](#), Chadwick, 15'
- 16:45-17:00 **ENDF/B-VII.0 release**, Oblozinsky

- 18:30 **CSEWG Dinner** (courtesy of Brookhaven Science Associates)
Danfords on the Sound, Port Jefferson

Nov 7, 2006, Tuesday, Berkner B, Berkner C

- 08:30-10:30 General discussion: [CSEWG after ENDF/B-VII.0](#) (Oblozinsky, chair)
 - CSEWG committees
 - Future priorities
 - Future releases
 - ENDF-6 Formats Manual
 - [Questions for the Post ENDF/B-VII.0 Era](#), McKnight (More from ANL processing!)
- 11:00-12:30 Formats and Processing Committee (Greene, chair)
 - Considerations for Post ENDF/BVII.0 Format Revisions (30')
 - [Proposed format modification in the resonance region](#), Larson
 - [Fission energy release format modification](#), Kahler
 - OECD Format Needs, OECD Representative
 - [Q-values in ENDF](#), Brown
 - Processing Codes (50')
 - [NJOY Status Report](#), Kahler & MacFarlane
 - [AMPX Status Report](#), Dunn
 - [LLNL Codes Status Report](#),

- 08:30-12:30 **Informal round-table discussion on ENSDF evaluation policies**
Open to all ENSDF evaluators (Tuli, chair)

- ANL Codes Status Report, McKnight
 - [Covariance processing code PUFF](#), Dunn
 - Status of Other ENDF related codes, All
- BNL Activities Related to Formats and Processing (10')
 - Checking Codes, Herman
 - ENDF-102, Herman

- 12:30-14:00 **Lunch Break**

- 14:00-14:10 [USNDP Opening](#), Oblozinsky, Berkner B

- 14:10-15:10 Common Session CSEWG + USNDP (Chadwick, chair), Berkner B
 - Nuclear Data Sheets: Journal for structure & reaction data?
 - [Introductory comments](#), Oblozinsky, 15'
 - Discussion, all

- 15:15-16:45 Measurements and Basic Physics Committee (D. Smith, chair), Berkner B
 - Neutron cross section measurements, 65'
 - [Measurements at n_TOF](#), Mengoni, 20'
 - [Measurements at LANL](#), Haight, 20'
 - [Measurements at NIST](#), Carlson, 5'
 - [Measurements at ORNL](#), Dunn, 10'
 - [Measurements at RPI](#), Block, 10'
 - Other topics, 25'
 - [Measurements at ANL](#), Kondev, 5'
 - [Status of ITER and neutronics](#),

- 15:15-18:00 **User Community-USNDP Discussion Forum** (Sonzogni, chair), Berkner C
 - Research/user talks
 - [Talk by Cyrus Baktash \(ORNL\)](#), 35'
 - [Talk by Gilles de France \(GANIL\)](#), 35'
 - [Talk by Betty Tsang \(MSU\)](#), 35'
 - [n_TOF project at CERN](#), Alberto Mengoni (IAEA), 35'
 - Discussion, 30'
 - How are current USNDP services utilized
 - How can current services be improved
 - How research community can

- Sawan, 10'
 - [EAF 2007 Activation Workshop](#), Cheng, 5'
 - [Status of CSISRS compilation](#), Rochman, 5'
- 16:45-18:00 Evaluation Committee (Chadwick, chair)
 - Updates on recent/ongoing evaluation work
 - [Evaluation work at LANL \(includes Ir, Am\)](#), Kawano, 15'
 - [Evaluation work at ORNL](#), Leal, 15'
 - [Evaluation work at BNL \(includes resonances\)](#), Herman, 15'
 - [Evaluation work at LLNL \(includes delayed \$\gamma\$ -s\)](#), Brown, 10'
 - [Work on quantification of uncertainties for fast reactors at KAERI](#), Gil, 10'
 - Future priorities for evaluations beyond VII.0, 30'
 - GNEP needs
 - Discussion, all

contribute

Nov 8, 2006, Wednesday, Berkner B, Berkner C

- 8:30-9:30 Validation Committee (McKnight, chair)
 - [Summary discussion of outstanding discrepancies from VII.0 validation](#)
 - Discussion of broader issues beyond VII.0
- 09:30-11:00 **CSEWG concluding session** (Oblozinsky, chair)
 - [Sigma: New ENDF interface](#), Pritychenko, 10'
 - [Concluding discussion](#)
 - Next meeting, Minutes
 - Other business

- 08:30-12:30 **USNDP Structure WG** (Baglin, chair)
 - 8:30-9:00 Database Status reports:
 - [ENSDF](#) (J. Tuli; 5'-10')
 - [NSR](#) (D. Winchell; 5'-10')
 - [XUNDL](#) (B. Singh; 5'-10')
 - 9:00-10:00 Software, web pages:
 - [Status of ENSDF Analysis and Utility Codes](#) (T. Burrows; 10'-15')
 - [Absolute and relative \$\gamma\$ -ray intensities in ENSDF](#) (E. Browne; 10')

- 11:00 CSEWG adjourns

- [Obtaining mixing ratio data from conversion coefficients](#) (5')
 - [Status of \$\beta\beta\$ -decay and B\(E2\) data](#) (B. Pritychenko; 20')
- 10:00-10:15 Coffee Break
- 10:15-12:30 Reports:
 - [BRICC: How good are the conversion coefficients now?](#) (T. Burrows; 20')
 - [New evaluators](#) (J. Tuli; 10')
 - [ENSDF contribution to ENDF/B-VII decay data library](#) (A. Sonzogni; 20')

- 12:30-14:00 Lunch break

- *USNDP Coordinating Committee, Berkner A*
 - *Report FY06*
 - *Workplan FY08*
 - *Budget briefing FY09*
 - *Next meeting*

- 14:00-17:30 USNDP Reaction WG (Kawano, chair), parallel session, Berkner B

- Nuclear reaction modeling
 - [Code PRECO](#), Kalbach, 10'
 - [Code EMPIRE](#), Herman, 10'
 - [Code McGNASH](#), Bonneau, 10'
- Covariances
 - [Covariance work at BNL](#), Rochman, 10'
 - [Resonance covariances for actinides](#), Leal, 10'
 - [Fast covariances for actinides](#), Kawano, 10'
 - Processing of covariances by ERORJ, Kawano, 5'
 - [Processing of covariances by PUFF](#), Dunn, 5'

- 14:00-17:30 USNDP Structure WG continues (Baglin, chair)

- 14:00-15:30 Formats/Procedures /J rules/Policies, etc.
 - [New rotational band J rules](#) (B. Singh)
 - [Expediting ENSDF](#) (T. Burrows)
 - Should priority be given to rapid inclusion in ENSDF of papers on new nuclides and/or first observations of excited states in nuclides?
 - [Evaluator reminders](#)
 - [Membership and responsibilities](#)
- 15:30-15:45 Coffee break
- 15:45-16:30 Nuclear Data Sheets:
 - Space limitations
 - Access to and content of introductory material
- 16:30-17:00 Other issues

- [ICC](#) (N. Nica)
- Interactions with structure and decay data user community
- Other business?
- 17:30 End of WG Meeting

Nov 9, 2006, Thursday, Berkner B, Berkner C

- 08:30-11:00 **USNDP Reports** (TF reports, Lab reports) (Tuli, chair)
 - Task Force Reports, 10' each
 - [Nuclear Data for Astrophysics](#), C. Nesaraja
 - Nuclear Data for/from RIA, Kawano
 - [Nuclear Data for Homeland Security](#), Brown
 - Laboratory reports, 10' each
 - [NNDC Report](#), Oblozinsky
 - [ANL Report](#), Kondev
 - [LANL Report](#), Kawano
 - [LBNL Report](#), Baglin
 - [LLNL Report](#), Brown
 - [NIST Report](#), Carlson
 - [McMaster Report \(structure and astrophysics combined\)](#), Chen
 - [ORNL Report](#), Nesaraja
 - [TUNL Report](#), Kelly, Kalbach
- 11:30-12:30 **[Concluding discussion](#)**, Oblozinsky
 - [NNDC Web services](#), Pritychenko, 10'
 - [Advanced Fuel Cycle Workshop \(Aug 06\)](#), Baglin, 10'
 - Budget briefing
 - Next meeting, Minutes
- 13:00 **USNDP adjourns**

- 08:30-17:30 **NDAG Criticality Safety Meeting** (Nuclear Data Advisory Group) (McKnight, ANL, chair)

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 USNDP Annual Meeting, November 7-9, 2006
 NDAG^{*)} Meeting, November 9, 2006

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*) Nuclear Data Advisory Group of the Nuclear Criticality Safety Program

**Summary of the 56th Cross Section Evaluation
Working Group Meeting**

Held at
Brookhaven National Laboratory
November 6 - 8, 2006

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Chairman's Summary

Pavel Oblozinsky
National Nuclear Data Center, BNL

CSEWG Annual Meeting

The 56th CSEWG meeting was held on November 6-8, 2006 at BNL and attended by 52 participants. Among them were representatives of national laboratories, academia, nuclear industry of the United States and Canada, and a few participants from abroad. The CSEWG meeting was held adjacent to the USNDP annual meeting, with a common CSEWG-USNDP session to discuss the future of the journal Nuclear Data Sheets.

ENDF/B-VII.0 release

The central topic of the meeting was approval of the release of the ENDF/B-VII.0 library. It should be emphasized that this 2006 release of ENDF/B-VII.0 is an event of historical importance for CSEWG as it is the first major release since 1990. The new library has been carefully validated against integral critical assembly data and shielding neutron transmission data. Its overall performance is very good, noticeably better than the earlier ENDF/B-VI library initially released in 1990, and its most recent upgrade, the ENDF/B-VI.8 library released in 2001.

ENDF/B-VII beta3 validation was discussed, with the overwhelming conclusion that the library performs very well. Several minor deficiencies were identified that should be fixed before the library release. The ENDF/B-VII.0 library should be officially released on December 15, 2006.

An extensive paper on the ENDF/B-VII.0 library was completed and submitted for print. This 'big paper' should appear in the Special Issue of Nuclear Data Sheets in December 2006, NDS **107**(2006) pp. 2931-3060. A follow-up issue with several papers related to ENDF/B-VII.0 should be published in 2007.

CSEWG after ENDF/B-VII.0 release

Initial discussion was held on the CSEWG in future. There are several specific areas that require future work. In particular, 239-Pu at low and intermediate energies; 235-U capture in the 30 keV – 1 MeV region; some remaining problems with 233-U and Zr; certain controversy with 157-Gd thermal capture; n + D scattering; some problems with Cu and W, and others.

Probably the most important future challenge is the need to meet pressing user requests for covariance data for neutron reactions. CSEWG intends to make this one of its priorities in the next few years.

CSEWG committees may need some revision. In particular, it seems that it would be useful to establish a task force/committee overseeing the work on covariance data.

Common CSEWG-USNDP session

A common session explored a possibility that the journal Nuclear Data Sheets may serve both the nuclear structure and nuclear reaction communities, with the understanding that it should preserve its dominant nuclear structure character.

Next CSEWG annual meeting

The next meeting will be held at BNL on Nov 6-8, 2007 (Tuesday – Thursday), while the USNDP meeting will be held on Nov 7-9, 2007 (Wednesday – Friday). The NDAG Criticality Safety meeting will be held on Nov 5, 2007 (Monday).

CSEWG Executive Committee Meeting

The Executive Committee met during lunchtime on November 6, 2006, with all 10 members or their representatives present. This included chair (P. Oblozinsky), four committee chairs (M. Chadwick, M. Greene, R. McKnight, D. Smith) as well as R. Block, A. Carlson, E. Cheng, L. Leal and D. Brown for D. McNabb.

Agenda

- ENDF/B-VII.0 release: The library was approved for release; the date of the release should be December 15, 2006.
- CSEWG after ENDF/B-VII.0: CSEWG chairman noted that Maurice Greene retired, and thanked him for all his good work; Mike Dunn was approved as the new chair of the Formats and Processing Committee. Future CSEWG committees were discussed, and several suggestions were made (create covariance task force/committee, establish chair-elects for smooth transition of responsibilities to younger colleagues, drop ‘basic physics’ from the name of the Measurements Committee).
- WPEC matters: The US delegation should include P. Oblozinsky - head, Mark Chadwick, R. McKnight, D. Smith - members, and also M. Dunn, who should attend as the chair of the new Subgroup 28 on covariance processing. Several other U.S. participants are expected to attend, reflecting their active contributions to subgroup activities. The next WPEC meeting should be held in Paris in a week preceding the ND2007 conference that should be held in Nice, France, April 22-27, 2007.
- ND2007 Conference: CSEWG contributions were discussed. It was noted that M. Chadwick should give plenary invited talk on simulations, D. Smith should chair covariance session and P. Oblozinsky should give invited talk on ENDF/B-VII.0.

Cross Section Evaluation Working Group

ENDF/B-VII Validation

Chair M.B. Chadwick, LANL & R. McKnight, ANL

Validation of the ENDF/B-VII beta3 Library

Mike Herman: Status of ENDF/B-VII beta3

Beta3 had 83 updates to the neutron sublibrary in beta2. Mike gave an overview of these changes, as listed in his viewgraphs.

Some issues have been identified by Sublet in running beta3 through NJOY on Suns:

- 133Ba doesn't run through UNRESR
- H1, Ho166m do not run through HEATR, PURR, etc. (though H1 doesn't have unresolved resonances)
- Although these problems don't seem to occur on Linux, or can be worked around – eg, running without optimization, or not on Unix machines.

Fixes for ENDF/B-VII.0:

- 241Am, 156Gd covariances, photonuclear fixes.

ENDF/B-VII.0 will be accompanied by NJOY99.161, there could be some tiny FORTRAN fixes still made for the final B-VII version.

Ramon Arcilla: Verification

Ramon described the use of NJOY and MCNP, in running a simple test case – Godiva with various test impurity materials added. Brookhaven also uses ERRORR (developed by Go Chiba with Kawano) with NJOY99.161 to process covariances.

Ramon looked into the Sun/Solaris minor problems noted by Sublet for Ba-133, H-1, and Ho-166m.

Oblozinsky: Big Paper on ENDF/B-VII.0 and Follow-up

Pavel discussed the big paper we have written documenting ENDF/B-VII.0. This was a major piece of work and will be published in December 2006 as a Special Issue of Nuclear Data Sheets.

A follow-up issue should be published that contains U isotopes (Young), Resonances (Leal), EMPIRE (Herman), Gd evaluations (Rochman), NJOY (MacFarlane). Tentative deadline for draft papers is March 2007.

Kahler: Beta 3 validation

Skip summarized the extensive data testing done on Beta-3 at Los Alamos by he and McFarlane. He showed how the beta-2 good results are maintained, and how in some case beta3 produced significant improvements.

Kahler showed puzzling and inconsistent results for beryllium, based on the slightly lower elastic scattering cross section we adopted. Many benchmarks improved (and a reflector bias was eliminated), but quite a few got worse, with a drop in reactivity below the measurements. Future work is needed on Beryllium. MacFarlane has noted that, because of extrapolations from subcritical measurements to criticality, it is possible that there are differences in the definition of k-eff employed that could lead to some of these discrepancies. He noted that he and Red Cullen could study this.

Bob MacFarlane: U233, Zr and Be (via conference call)

Fast 233 had got a lot better because of Godiva and Jezebel. Henirichs had shown some scatter in previous studies.

For very thermalized values, the thermal extrapolation looks good (1 for b-VII, 0.996 for B-VII), but the bias got worse as the ATFF increase for faster systems. But the results for Be looked contradictory. Here, k decreased with ATFF – just the opposite behavior! When beta3 came out, we had new 90Zr data. In beta3 the UCT1 series got bigger due to 90Zr, and these came in high. But we don't know if this is due to u233 or 90Zr. Indeed, the high values seem consistent with the 233U water criticals which were also high – so this could suggest it is a 233U issue, not a 90Zr issue. Another puzzle is that the poly and Be criticals seem to be very similar – why do they both have this trend? We think we know ploy and H very well! Be numerical results that Bob created showed: sometime good agreement between the new cross sections and data, but not always. We have tried to solve the bias issue for Be reflectors, and this indeed did seem to help and remove this bias. But some other problems remain, for example, for HMF66, where the Be is in the middle. Uncertainties due to reported Be composition also add some uncertainties and possible biases in the measurements, for these experiments.

Bob also tried substituting into B-VII older Be evaluations – B-VI and JEFF. B-VI.8 gives bad results – too high k-eff; Using JEFF gives halfway decent values in the fast range, but doesn't help the HMF58 bias slope that we had fixed. In the thermal range, both ENDF/B-VI and JEFF give values higher than V-II, but still don't match the data.

Bottom line: lots of puzzles for Be, 233U, etc, and maybe 90Zr, that needs further work to resolve.

Cecil Lubitz said that we should focus on the U233 HST without the complication of other uncertain materials (eg Be, etc) to try to solve 233U first.

Cecil Lubitz: Status of 90Zr data

The beta2 90Zr evaluation (from SG23 = BROND-2 library) led to an unwanted drop in reactivity. They did sensitivity calculations and determined that it was largely the elastic and inelastic cross sections that were most important – mainly the elastic region (it was fortunate that we didn't have to change the resonance region, as Mughabghab thought it was fairly reliable).

Mike Herman used EMPIRE in default mode and made an official file, beta2.5, which solved their problems. This largely fixed the problem with low reactivity. He made a beta3 and a beta4 version. Beta3 was tested, and we will adopt this. (Beta4 included other refinements, which, although good were not made official, as they were not widely tested by VDM).

Cecil noted that there are very few assemblies that test 90Zr in the ICSBEP. We have to take his word that his KAPL assemblies work well with the beta3 B-VII data!

M. Herman: 90Zr evaluation

Mike noted that he studied the total and elastic cross sections. Capote provided a sophisticated dispersive optical potential (for Rh, but used for Zr) that reproduced the total cross section and gave a higher elastic cross section. The total cross section agrees with the Finlay, Haight etc LANL total cross section data. Beta3 reproduces the inelastic cross sections for the first 4 levels pretty well.

Calculations from BNL, and data from LANL:

- Elastic: Optical model potential was taken from Capote, and resonances from Russia (though Mughabghab blessed this!). We could get replace the Russian resonance data, using beta4.
- 90Zr capture. Significant differences between various evaluations – could be tested perhaps with LANL 90Zr reaction rate data for critical assemblies. Mike Zerkle notes that HEU and Zr LANL experiments could also test this (assemblies that had various amounts of Zr in plates in the intermediate & fast energy range).

Mike Zerkle: Zr testing

Use the various versions of Zr in Bettis propriety benchmarks. They're happy with either beta3 or beta4. Both perform in essentially the same way.

Recommended reevaluating the remaining Zr isotopes using the same methods as for beta-4 Zr90, for use in a future B-VII.1 release. Also, other future work could include studies on angular distributions for a possibly refined optical model.

Kawano noted that recent JOYO Japanese reflector experiments are testing Zr reflector properties, and Zr nuclear data is a current topic of interest in Japan.

Lubitz: 235 Thermal nubar beta-eff

Lubitz described the rationale for the lower thermal ²³⁵U delayed nubar in B-VII – based on experiment and theory. We now have a delayed nubar thermal that is different for thermal and fast. Different thermal ν fast values are now also adopted for JENDL3.3 and JEFF3.1, and WPEC subgroup 6, and probably ANS19.9 coming up, as well as commercial reactor companies. We changed the thermal prompt nubar slightly so as to maintain the total thermal nubar as constant.

Beta eff is proportional to $\beta = \nu - d / \nu - \text{tot}$. The changes we made result in better beta-eff testing, as summarized by VDM in our paper and in his paper.

Lubitz recommends making future delayed nubar changes (eg to higher-energy region) only after ANS19.9 comes out. He also notes that Fort at WONDER-2006 has recommended a prompt energy-dependent nubar. This includes the n,gf effects, where gamma-ray decay occurs before fission.

A. Carlson: Standards

Alan summarized the standards going into ENDF/B-VII. An important aspect to the evaluation is that it includes covariances – both as a function of energy and of different materials. Alan also showed the ²³⁸U(n,g) B-VII data adopted versus the ²³⁸U(n,g) data that came from the standards analysis, but is not a standard. The B-VII data smoothed out the standards result – at the lower energies (~100 keV) the evaluation was intentionally a bit (few percent) higher, on average, than the standard – to maintain good agreement with the BigTen integral data testing (to the best of MBC’s recollection!).

Dick McKnight: Summary of testing in Petten

Dick summarized Steven van der Marck’s testing of the ENDF/B-VII beta3 library. As we have discussed before, beta3 testing shows very good performance. Dick noted the value of the “shot-gun” type broad sweep, where over 700 assemblies were tested.

Dick showed that Pu data at intermediate energies are problematic – as we have known – and that even B-V data perform much better than B-VI. The Pu assembly (with Cr too) has a ~ 5% bias!

Ken Koziar: Update on Deuteron

Townsend noted that (old) data sets tend to show lower (?) back angle cross sections than ENDF/B-VI.8, and agree better with the older VI.4 data. (However, Hale made his changes in part based on p+D data with charge symmetry/independence arguments). He is hoping to motivate a new measurement of n+D scattering below 3.2 MeV. JENDL-3.3

is based on a Fadeev 3-body calculation. He notes that ENDF/B-VI seems to be on a coarse grid. He also showed some progressing using the AGS equation - Fadeev like - to solve this exactly (by L. Canton). His results support the JENDL results. 1 MeV is the key range for his sensitivities to this cross section. We should connect this fundamental work with Hale + MIT work and with Hoffman calculations.

Don Smith: Covariances

Don gave an overview of the covariance work for ENDF/B-VII.0. He noted that actinide covariances should be completed soon. Where methods are merged, he noted that he sees discontinuities at the boundaries, which would be good to resolve. Fundamental model uncertainties are needed in some cases. Don also emphasized the need to think practically when considering resonance covariance formats - how to keep the databases to a reasonable size, whilst preserving the key physics.

Phil Young: Summary of corrections and updates

Phil summarized the work he did to correct an old problem, dating from B-VI, that involved renormalizing to the prompt nubar instead of the delayed nubar for Cf. The new ENDF/B-VI fixes all these problems.

Action Items

1. The ENDF/B-VII.0 library will be available for release at the beginning of December, while official date for release is December 15, 2006.
2. BNL will do basic verification (Phase 1 testing).
3. LANL will see if it can do some repetition of very basic testing.
4. Bettis noted problem with ^{46}Ca . BNL will consider fixing the format problem noted by Bettis.
5. LANL could distribute MCNP5-1.50 that is able to use the old larger Rh-103 evaluation. It is likely that ENDF/B-VII, though, will use smaller Rh-103 files so that existing versions of MCNP can still use ENDF/B-VII.
6. LANL. We need to check ^9Be . Bob Block showed his new high-precision total cross section data below ~ 1 MeV. He showed B-VI.8 and B-VII values, and to our surprise the B-VII values seemed quite a bit lower at ~ 0.1 MeV (almost 10%). We had remembered Hale making changes to B-VI at the \sim few % level. This difference is bigger than we expected. Can Gerry /Phil /Bob look into this? (When plotting the EXFOR data up against these evaluations, we see quite a spread in the data, but the new B-VII values do appear to be too low), one hopes that Gerry had other data that were motivating the B-VII values!

Updates on Ongoing Evaluation Work

Kawano, LANL work

Toshihiko summarized recent evaluation work on $^{234}\text{U}(n,g)$, $^{237}\text{Np}(n,f)$ and Am isotopes, especially $^{241}\text{Am}(n,2n)$. All these improvements have been incorporated into ENDF/B-VII. He also described preequilibrium spin-dependence physics, as informed by GEANIE measurements for $^{193}\text{Ir}(n,n')$, for ^{48}Ti , and recently for reactions on ^{197}Au . He also described fundamental HF calculations for ^{238}U capture, and some studies in CC and potential theory, that are part of a study he made on ^{238}U capture. Using Leal's average gamma-ray decay width from the resonance region results in a calculated capture cross section in the keV region that is above the ENDF/B-VII standards result (which is almost identical to the B-VII evaluation).

Leal, ORNL work

Luiz discussed new work on ^{239}Pu resonances. He combined 3 previous ranges into one single range, from 0-2.5 keV for the Sammy analysis. The results appear to be close to those from the standards analysis at thermal. He further talked about the size of the covariance file he would create – it is about 190 MB. Then, he discussed the ^{55}Mn analysis they are doing at Oak Ridge, in collaboration with Geel. He also described work on ^{103}Rh . This uses transmission data from Geel.

Herman, BNL work

Mike talked about how BNL did 73 new evaluations in the fission product range for B-VII, and also used Mughabghab's Atlas resonance data for over 100 cases. Several recent evaluations cover full isotopic chains (Nd isotopes, Gd isotopes, ...). The most recent evaluations include also covariance data (MF33) in the entire energy range (^{89}Y , ^{99}Tc and $^{191,193}\text{Ir}$).

Formats and Processing Committee Report

N. Maurice Greene, ORNL
Committee Chairman

The Formats and Processing Code Meeting started at approximately 11:15 am. After opening comments by the chair, the scheduled topics were discussed.

Considerations for Post ENDF/B-VII.0 Format Revisions

The first speaker was **N. Larson**, whose title was: “Proposed extension and clarification of MF32 format”. She suggested two modifications:

- A. A need to specify a format to describe covariance data for the extension to the Reich-Moore format described by LRF=7 in MF2. Here, only the LCOMP=1 (full covariance matrix) situation was considered. This situation was inadvertently left out of the previous format proposal for presenting resonance covariance data.
- B. A need to introduce a modification to the LCOMP=2 (compact covariance matrix format) to allow the use of from 2 to 6 digits for the values specified for the matrix elements. This latter proposal was made because it has been discovered that the use of only two digits will sometimes result in non-positive definite matrices that lead to problems.

The chair noted that, because these formats were not posted on the BNL CSEWG website by the end of September preceding the meeting, they were not eligible to be voted on, but, after Ms. Larson noted that the complete documentation had been submitted in advance of the due date, the attendees voted to approve the formats as submitted.

Ms. Larson noted inconveniences arising from the lack of up-to-date and correct information about procedures to use with resonance data that is in the present Formats Manual. This led her to produce an ORNL report that contains documentation of the sections of the manual pertaining just to resonance parameters. This matter created discussion where it was noted that the ENDF Formats Manual was supposed to be the “official” report about CSEWG, and an agreement that ORNL would provide the new documentation to NNDC for inclusion in the official manual resulted, as will be noted later in this report.

The next presenter was **A. Kahler**, whose topic was “A Proposal for energy dependence in fission energy release”. Mr. Kahler described the new format, whose need had already been noted by a presentation in an earlier session. The chair noted that this format also

fell in the category of not having been posted on the BNL website, and also was not accompanied by the requisite description of how the format should be documented in the Formats Manual. After some discussion, it was decided by the group to approve the format, contingent on the delivery of the Formats Manual changes documentation.

The third presenter was **Y. Rugama**, the current JEFF Formats Liaison to CSEWG. Ms. Rugama noted that the JEFF community was in the process of developing new evaluations for moderator materials that had not been previously included anywhere in ENDF/B, and, therefore, needed new material (MAT) designations. After discussion, it was suggested that she submit the MAT-material designations to M. Herman at BNL, who would attempt to ensure that the JEFF identifiers were duly reserved, and that other parties would not use them for other evaluations.

Processing Codes

The first presenter was **A. Kahler**, who discussed the current status of the LANL NJOY processing system. He noted some changes in the processing of thermal data, along with modifications to the LEAPR module, which prepares scattering law data. It was noted that programming had been introduced to properly treat H1 capture using relativistic kinematics in a trial version of NJOY. This coding will be included in the distributed version of NJOY when it becomes necessary. He mentioned a correction of a bug affecting the calculation of fission capture energy release. Finally, it was noted that many JENDL evaluations use interpolation code 22 (unit base transform), which was not treated by earlier versions of NJOY. The latest version has been fixed to properly handle this situation. He mentioned that procedures developed in the Japanese ERRORJ program will probably be implemented in the NJOY covariance matrix calculation schemes.

M. Dunn gave a presentation regarding the ORNL AMPX system that covered the multi-group, point, and covariance processing capabilities provided by the current system. He noted that all of Version 6 had been processed and tested on a suite of 502 benchmark calculations that included around 400 cases from the ICSBEP Handbook. (The chair notes that ENDF/B-VII.b2 was also processed through AMPX, but not in time to be used to contribute benchmark calculation results for presentation at the meeting. All nuclides were successfully processed, except three cases that failed because of numbers in the evaluations smaller than that allowed in a single precision real number, and these were made to work by simply setting these unreasonably lower values to zero!) Mr. Dunn thoroughly described an upgrade to the covariance data processing capabilities in AMPX included in the new PUFF-IV module. This generated discussion regarding a concern that resonance covariance data files now being supplied in ORNL evaluations were literally dwarfing other sections in the evaluations. N. Larson noted an awareness of this “problem” and mentioned some alternate approaches that were being considered to reduce the storage requirements.

Next, **D. Brown** discussed the status of a multi-year effort to implement processing of ENDF-6 formats (identical to ENDF-7 formats) in the LLNL processing codes that presently use the ENDL format used for their in-house libraries. Mr. Brown described a procedure that converted data from ENDF formats to ENDL formats that allows their present processing codes to be used with minimal or no modifications to these codes.

Next, **R. McKnight** discussed the status of the ANL codes and noted that they had not been able to prepare results using the ENDF/B-VII.0 data, because of time and funding limitations, though their previous efforts had been able to process all of ENDF/B-VI, indicating that they would expect few problems with the new data, since the formats are the same.

BNL Activities Related to Formats and Processing

In this section of the meeting, **M. Herman** from BNL discussed the status of the BNL ENDF/B Data Checking Codes, and of the ENDF Formats Manual.

It was noted that there are some areas, such as covariance data, that are either not checked in the present codes, or that do not have enough checking. Work on these areas is planned for the coming year.

Mr. Herman also noted that the present copy of the Formats Manual is stored using Microsoft Word files, that are not convenient for use as on Online Manual, or have serious timing disadvantages, when the files have to be converted to the familiar "Portable Document File--pdf" format. Consideration is being given for converting back to the LaTeX schemes used in previous times. An extensive effort is also expected in the next year to make many extensions and corrections to the manual. In this regard, he asked for, and was promised input from ORNL about their in-house documentation of the formats and procedures used in the resonance regions.

The session was adjourned around 1 pm.

Cross Section Evaluation Working Group

Measurements Committee Report

Donald L. Smith, ANL
Committee Chairman

The Measurements and Basic Physics Committee session was held from 15:15 to 16:45 h on 7 November 2006 during a well attended, technically intense and time-challenged plenary session of CSEWG-2006. Nine presentations were given. They are organized according to the three categories appearing below. The presenter of each report is also indicated.

U.S. Laboratory Measurement Programs

- *Argonne National Laboratory* (Filip Kondev)

This presentation focused on the following areas: Measurements at the Argonne ATLAS facility aimed at investigating properties of K-Isomers using the Gammasphere and FMA (Fragment Mass Analyzer) detectors, measurements on the decay spectroscopy of actinide nuclei, studies of ^{186m}Re with relevance to nuclear astrophysics, and reactivity studies at the accelerator driven sub-critical facility YALINA in Belarus.

The K-Isomer studies during the past year have emphasized ^{174}Lu , $^{185,187}\text{Re}$, $^{246,248}\text{Pu}$, $^{170,172}\text{Er}$, and $^{250,254}\text{No}$. The work on Lu has been completed while data analysis for the Re isotopes continues. New results were obtained for the Pu isotopes. Partial results have been published for the Lu, Er, and No isotopes.

Measurements on α -, β -, and γ -ray decay (both singles and coincidences) have been performed for ^{233}Pa , ^{237}Np , ^{240}Pu , ^{242m}Am , $^{243,244,245,246}\text{Cm}$, and $^{249,250}\text{Cf}$ using unique mass-separated sources. Results for ^{240}Pu , $^{244,246}\text{Cm}$, and ^{250}Cf have been published. The experimental part of an investigation of ^{186m}Re decay is almost complete. This work has revealed the detail structure of levels above the $\approx 10^5$ y 8^+ isomer. The impact of these new data on isomer production (and destruction) cross sections is being investigated using codes TALYS and EMPIRE. New cross-section measurements are envisioned in FY07.

The two experimental campaigns carried out in FY06 at YALINA in Belarus addressed sub-critical reactivity studies for various configurations of the core using the Pulsed-Neutron-Source, Source-Jerk, and Feynman- α measurement techniques. Transmutation reaction-rate measurements on minor-actinide and fission-product samples will follow in the near future.

- *Los Alamos National Laboratory* (Robert Haight)

Extensive nuclear data measurements at the Los Alamos LANSCE facility have been reported in which use was made of the following detector systems: GEANIE (for n,xy processes), FIGARO (for n,xn+y processes), DANCE (for radiative neutron capture processes), N,Z-Spectrometer (for neutron-induced charged-particle emission processes), LSDS (for fission measurements), and Double-Frisch-Grid Fission Chamber (also for fission measurements). GEANIE, FIGARO, N,Z-Spectrometer, LSDS, and the Double-Frisch-Grid Fission Chamber are situated at the Weapons Neutron Research Facility (WNR) while DANCE is located at the Manuel Lujan Center.

Measurements have been carried out at GEANIE for ^{48}Ti , $^{70,72,74}\text{Ge}$, ^{100}Mo , ^{103}Rh , ^{130}Te , ^{124}Sn , ^{138}Ba , ^{150}Sm , ^{169}Tm , ^{186}W , $^{203,205}\text{Tl}$, ^{233}U , $^{\text{nat}}\text{Pb}$, and $^{\text{nat}}\text{Te}$. Analysis of these results is either complete or is in progress. Future measurements are planned for ^{138}Xe as well as other Xe and Kr isotopes. New data obtained for $^{193}\text{Ir}(n,n')^{193\text{m}}\text{Ir}$ significantly improve the data base, and they have been used to validate nuclear modeling. Data for the odd Tl isotopes help to understand the properties of the $9/2^-$ isomer attributable to the one proton in the $h_{9/2}$ orbital in these isotopes, and they enable a study to be made of the half-life corrected excitation function of the 408.9-keV γ -ray decay transition from this state in ^{203}Tl . The structure of the even Tl isotopes has also been investigated. In particular, the most accurate determination to date has been made of the half life of the 7^+ isomer in ^{202}Tl .

Measurements are currently in progress at FIGARO on neutron-emission spectra and v -bar for ^{235}U , ^{237}Np , and ^{239}Pu . Gamma-ray triggered measurements for $^{\text{nat}}\text{Ba}$, $^{\text{nat}}\text{Sr}$, and ^{56}Fe are also being carried out.

Charged-particle emission – (n,Z) – measurements are being carried out using two techniques. Measurements on the $^6\text{Li}(n,t)\alpha$ reaction are being made using a Si detector “sandwich” in order to reduce the uncertainties in this standard cross section in the few-MeV region. The standard N,Z-Spectrometer telescope system is also being used to study this reaction, including the determination of angular distributions, in order to provide information to aid in R-matrix analyses of the ^7Li compound system. The N,Z-Spectrometer, used earlier for measurements with Cr and Ta isotopes, has been employed recently to study neutron-induced hydrogen and helium production from ^{56}Fe in support of the Advanced Fuel Cycle Initiative (AFCI). Measurements of this latter type are also being planned for Zr and Mo.

An active program of low-energy radiative neutron-capture measurements on small samples is being carried out at DANCE. Recent experiments have included the following sample materials: $^{94,95}\text{Mo}$, ^{143}Nd , ^{147}Sm , ^{151}Sm , $^{151,153}\text{Eu}$, $^{203,205}\text{Tl}$, $^{234,235,236}\text{U}$, ^{237}Np , $^{240,242}\text{Pu}$, and $^{241,242\text{m},243}\text{Am}$. This work has also involved the development of new detector concepts as well as the use of γ -ray tagging and procedures to correct for background from fission γ -rays in those measurements involving fissile nuclides.

Conventional fission cross-section measurements using a parallel-plate fission ionization chamber and gridded ion chamber have been carried out over a wide energy range for

^{237}Np . Further measurements are either being planned or are in progress for ^{233}U , $^{238,239,240,242}\text{Pu}$, $^{242,242,242\text{m}}\text{Am}$, $^{242,243}\text{Cm}$, and ^{238}Np . These measurements are being supplemented by a program of fission cross-section experiments using the Lead Slowing-Down Spectrometer (LSDS). The effective high neutron fluences obtainable in this facility permit measurements to be made with sub-microgram sample quantities. The method has been validated using ^{239}Pu . Furthermore, the α -particle decay of ^{239}Pu is being exploited in order to collect sufficient amounts of $^{235\text{m}}\text{U}$ to use in performing fission cross-section measurements on this isomer.

- *National Institute for Standards and Technology* (Carlson)

Nuclear data measurements at NIST emphasize standard neutron reaction processes, in accordance with the core mission of this laboratory. An experiment to measure the H(n,n)H scattering angular distribution to high accuracy at 15 MeV is currently in progress. This work should be approaching completion in FY07.

Measurements of the ^3He total cross section and coherent scattering length have been published in Physical Review. An experiment utilizing polarized neutrons and a polarized ^3He beam is being designed. This measurement will allow separation of the real part of the two spin channels of this interaction. These data will also be valuable in R-matrix evaluations to improve the $^3\text{He}(n,p)$ standard cross section.

An extremely accurate measurement of the $^6\text{Li}(n,t)$ cross section at ≈ 4 meV is in progress. Three distinct methods are being used to measure the neutron fluence. The first involves using the accurately known $\bar{\nu}$ for ^{252}Cf . The second is an absolute measurement based on α - γ coincidences using the $^{10}\text{B}(n, \alpha_1\gamma)$ reaction. The third utilizes a cryogenic radiometer to measure the heat produced by neutrons being absorbed by the $^6\text{Li}(n,t)$ neutrons in a thick lithium target. A paper on this work will be presented at the ND-2007 conference.

- *Oak Ridge National Laboratory* (Michael Dunn)

An important component of the ORNL experimental activities during the past year has been the refurbishment of ORELA. This has involved improvements to the vacuum system, the electron gun, and the neutron radiative capture measurement apparatus. Collaborative work with scientists at the IRMM facility GELINA in Belgium was also ongoing during this period.

Recent measurements have been carried out at ORELA for $^{41}\text{K}(n,\gamma)$ and $^{95}\text{Mo}(n,\gamma)$ and the analysis of these data is in progress. The work at GELINA has focused on the $^{55}\text{Mn}(n,\gamma)$ and $^{103}\text{Rh}(n,\gamma)$ reactions. Analysis of these data continues. Future work will include continued refurbishment activities for ORELA to restore power to its previous level, to replace old worn out components, and to build a stockpile of spare parts for this venerable facility. The continuation of an on-going measurements program for astrophysics will include studies of $^{64}\text{Zn}(n,\alpha)$ and $^{149}\text{Sm}(n,\alpha)$, as well as neutron total and radiative capture measurements for $^{87,89}\text{Sr}$.

- *Rensselaer Polytechnic Institute* (Robert Block)

Experiments are performed at the Gaertner Linac Laboratory at RPI. The main experimental focus is on neutron transmission, radiative neutron capture, and neutron fission. Incremental improvements have been made to both the accelerator facility itself and to the detector and data acquisition apparatus employed in measurements at this laboratory. An apparatus to perform neutron scattering measurements is under development and is being tested using carbon scattering. A filtered beam technique offering discrete neutron groups in the energy range 0.024 to 0.9 MeV has also been implemented and validated using the well-known C total cross section. Furthermore, an experimental setup for studying fission fragment kinematics using the RPI Lead Slowing-Down Spectrometer has been developed and is undergoing testing.

Neutron transmission measurements on Be and ^{236}U were completed this year. Conventional Linac white spectrum neutrons were used for the ^{236}U measurements while the high precision filtered beam mentioned above was used for the work on Be. Preliminary data for Be obtained by this method suggest that the new ENDF/B-VII.0 evaluation for Be is too low. The new data tend to favor the earlier ENDF/B-VI.8 results.

Data acquired earlier for Nd, Nb, Gd, Rh, Cd, Re, and Mo are either being analyzed (Rh, Cd, Re, and Mo), have been submitted for publication (Nb and Gd), or have already been published (Nd).

Reports on Conferences

- *EAF 2007 Activation Workshop* (Edward Cheng, TSI Research)

The European Activation File (EAF) is maintained as an important resource for the worldwide nuclear fusion energy development program, including ITER. The library is part of the EASY software package used to analyze radioactivity issues associated with the operation of conceptual fusion reactors and the storage and disposition of radioactive waste from fusion. An updated version of this library is issued every two years (the most recent version now in use is EAF-2005). The next version (EAF-2007) will be issued in 2007. This workshop was held to review the status of activation data in EAF-2005 (at midterm) and to discuss those updates that will be included in EAF-2007. The workshop was held on 2-4 October 2006 in Prague, Czech Republic.

Special Topics

- *Status of the CSISRS Compilation Activity* (Dimitri Rochman, NNDC, BNL)

The status of the experimental nuclear reaction data compilation effort at the National Nuclear Data Center, Brookhaven National Laboratory, was reviewed briefly in this

presentation. These data are extracted from journal articles, conference proceedings, laboratory reports, and other documented sources, and are compiled in an internationally accepted format known as EXFOR. In the U.S. this database is frequently referred to as the CSISRS database. The compiled data are made available worldwide via a network of sister nuclear data centers as well as on the Internet. More than 16,500 publications have been compiled since 1965. During 2005 there were 411 references compiled at the NNDC while 171 have been compiled there so far during 2006. A “pie chart” showing the distribution of user retrievals from the Internet was presented. The largest portion (39%) were from *.gov domains U.S. national labs and other civilian government agencies). The second largest source of “hits” (38%) corresponded to *.edu domains (universities). Additional statistics were presented that indicated how these retrievals were formulated by users. More than 80% of the retrievals corresponded to cross sections and differential cross sections.

There is a broad consensus that some improvements are needed in the area of quality control within the EXFOR system, but it has not been established how this should be accomplished. Suggestions for improvement have included an approach based on categorizing data sets according to their perceived quality by use of a flagging system. The possibility of adjusting certain compiled EXFOR data to account for obvious errors, for changes in measurement standards, and for more subtle numerical errors, was discussed. However, it was pointed out that this is an area that engenders considerable controversy. Nevertheless, in this era when sophisticated computer codes are being used to combine nuclear modeling results with experimental data in order to produce evaluated data libraries, it is clear that something eventually needs to be done to improve the *de facto* quality of experimental data retrieved from the EXFOR system.

- *Status of the ITER Project and Fusion Neutronics Work in the U.S.* (Mohamed Sawan, University of Wisconsin - Madison)

This presentation provided an overview of the current status of the ITER fusion reactor project. The ITER International Agreement, initialed on 24 May 2006 in Brussels, Belgium, was described briefly. An outline of the ITER organizational structure was also shown. It was pointed out that the ITER collaboration, which includes the U.S., European Community, Russia, China, Japan, India, and South Korea, represents over half of today’s world population. It is also one of the largest contemporary international collaborative scientific projects. The time line for the development of ITER was also shown. The current schedule calls for construction to begin in 2008 (at Cadarache, France). The target date for the first plasma is 2016.

A simplified diagram of ITER, along with a few key statistics, was shown to provide a sense of the large size of this machine. Those aspects of its construction which are within the scope of the allocated U.S. responsibilities in this project were indicated in another slide. Of particular interest to CSEWG was the discussion of current U.S. neutronics computational activities in support of ITER. The nuclear data library now being used in these calculations is FENDL 2.1 (and its derivatives) as well as EAF-2005 (see the contribution from E. Cheng above). This library was assembled by experts who chose

what were perceived to be the best components from each of the national and regional nuclear data libraries. ENDF/B-VI.8 provides the largest component. System simulation computer codes that are being used in these neutronics analyses were indicated, and the quality assurance procedures that have been established for ITER were described briefly. Several slides that were presented discussed the manner in which the adopted computational libraries are being benchmarked, including a brief discussion of some of the validation experiments that are being performed using the intense 14-MeV neutron generator at the FNS/JAEA laboratory in Tokai, Japan.

- *Measurements at the CERN n_TOF Facility* (Alberto Mengoni, IAEA-Vienna)

n_TOF was commissioned in 2001-2002 at CERN. It is a “white” neutron spectrum facility devoted to both applied nuclear data and basic nuclear physics measurements, including those relevant to nuclear astrophysics. The main emphasis of the n_TOF experimental program is on neutron radiative capture and neutron fission processes, but other reaction processes such as charged-particle emission are also being investigated. n_TOF is an international user facility that currently encompasses 40 research institutions and 120 researchers (The n_TOF Collaboration).

n_TOF utilizes a 20 GeV/c proton beam incident impinging on a Pb spallation target to produce an intense source of neutrons over a broad energy range. This offers the possibility of performing measurements using relatively small quantities of stable sample materials as well as radioactive samples. Another feature of this facility is the relatively high number of neutrons available in the spectrum at higher energies compared to more conventional electron Linac facility neutron sources. Initially, only a single 200 m beam line was available for experiments. However, a second shorter (20 m) beam line is being developed at 90 degrees relative to the incident protons. This newer facility will offer even higher neutron intensity (a factor of ≈ 100 enhancement) and drastic reduction of the t_0 flash, but at some expense of measurement resolution.

During the 2002-2004 time period measurements were devoted to neutron cross sections relevant to nuclear waste transmutation and related nuclear technologies (Th/U fuel cycle, transmutation of minor actinides, and transmutation of fission products), to cross sections pertinent to the S-process for nuclear astrophysics, and to studies of nuclear level densities and neutron-nucleus interactions in general for fundamental physics. Neutron radiative capture measurements have been performed for $^{24,25,25}\text{Mg}$, $^{90,91,92,93,94,96}\text{Zr}$, ^{139}La , ^{151}Sm , $^{186,187,188}\text{Os}$, $^{204,206,207,208}\text{Pb}$, ^{209}Bi , ^{232}Th , $^{233,234}\text{U}$, ^{237}Np , ^{240}Pu , and ^{243}Am . Fission measurements have been reported for ^{209}Bi , ^{232}Th , $^{233,234,235,236,238}\text{U}$, ^{237}Np , $^{241,243}\text{Am}$, and ^{245}Cm . Additional neutron radiative capture measurements are either currently in progress or are being planned for Fe, Ni, Zn, Se, Mo, Ru, and Pd stable isotopes, ^{79}Se , various $A \approx 150$ isotopes, $^{231,233}\text{Pa}$, $^{234,235,236,238}\text{U}$, $^{239,240,242}\text{Pu}$, $^{242,243}\text{Am}$, and ^{245}Cm . Additional fission measurements related to minor actinides, ^{234}U , and ^{235}U (as a high-energy standard) are also in progress. Various neutron-induced charged-particle emission studies for ^{147}Sm , ^{67}Zn , ^{99}Ru , Al, V, Cr, Zr, Th, and ^{238}U are progressing as well. This presentation discussed the status of these various experiments and offered some highlights of the results obtained from the extensive and international n_TOF measurement program.

Many slides of data were shown, but the details are too numerous to present in this summary report.

This presentation on n_TOF also described the general layout of the facility, including the proton target assembly, and it mentions some of the detector systems which have been developed at this facility for both neutron radiative capture and neutron fission measurements.

Nuclear Data Sheets: Journal for Structure & Reaction Data?

Mark Chadwick, LANL
Chair of the Common CSEWG-USNDP Session

Oblozinsky: Introductory Comments

The 'Big Paper' on ENDF/B-VII.0 will be published in NDS Special Issue in December 2006 (along with another paper on Benchmarking, altogether 187 pages = 6.0% of NDS volume in 2006). Pavel explained why and how this happened, scope of the journal is sufficiently broad, traditional NDS issue containing Recent References (NSR) was dropped, and that issue was made available to ENDF/B-VII.0.

Pavel suggested that Nuclear Data Sheets could become structure & reaction data journal, preserving its structure dominant component (~80%). This could be achieved if structure papers could be shortened somewhat (current length is typically 150-200 pages per paper). The journal would gain prestige by publishing high quality reaction papers, and this would strengthen the two communities within USNDP.

There is a need for detailed nuclear data papers on:

- Evaluation methodology and codes
- Results of international projects such as IAEA/CRPs (RIPL library, etc.), and WPEC activities, in the pipeline are Standards Cross Sections, Actinide Decay Library, ...

Chadwick noted that this refers also to Peter Moller type papers that are highly cited.

Discussion:

John Kelley raised some concerns. Noted that Elsevier says that it is currently for structure data, papers from people from the international network (IAEA NSDD). One can view ENSDF as the best available data. Don't want turn the tables on the current users of the journal. He agrees that the community signed off on this one ENDF issue.

Jag Tuli (NDS editor-in-chief) said that it should be 1 issue per calendar year max, and there is a backlog. He would argue that other international groups should be offered an opportunity to publish ENDF-type papers. He noted a possibility to create a new journal, or create sections A, B.

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**Summary of the
9th U.S. Nuclear Data Program Meeting**

Held at
Brookhaven National Laboratory
November 7 - 9, 2006

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US Nuclear Data Program

Chairman's Summary

P. Oblozinsky
National Nuclear Data Center, BNL

USNDP Annual Meeting

The 9th Annual Meeting of the United States Nuclear Data Program was held on November 7-9, 2006 and attended by 39 participants. The meeting was held adjacent to the CSEWG Annual Meeting, with a common USNDP-CSEWG session to discuss the future of the journal Nuclear Data Sheets.

Nuclear Structure Working Group

The status of basic databases NSR, XUNDL and ENSDF was reviewed. The ENSDF evaluation productivity continued to be fairly high, while increasing amount of contributions from young evaluators were noted with satisfaction. To strengthen this positive trend, two post-docs are being hired (TUNL and ANL), each with approximately equal share between the structure evaluation and structure research work.

Procedures were agreed to shorten the size of papers in Nuclear Data Sheets and modernization of the NDS publication technology including drawings was recommended.

Nuclear Reaction Working Group

Nuclear reaction activity was driven by evaluations for the ENDF/B-VII beta 3 testing version of the library. Evaluation activities funded by the USNDP were reported by LANL, BNL and LLNL.

A session was devoted to covariance methodology, stimulated by the growing needs for cross-section covariance data in many applications. A post-doc is being hired by BNL in the anticipation of increased activity in this field.

User Discussion Forum

This useful activity, started in 2005 and aimed to strengthen interaction between the user community and USNDP, continued in 2006. A half-day session was devoted to presentations and discussions with two prominent scientists from the United States and another two from Europe. A mini-symposium on Nuclear Data should be organized at APS DNP meeting (J. Kelley, October 2007).

Task Forces

The Task Force on Nuclear Data for/from RIA should be terminated. This activity should be restarted once the funding for RIA facilities will become better defined. The other two

task forces will continue (Nuclear Data for Astrophysics, Nuclear Data for Homeland Security).

Planning and Reporting

- Summary of Annual Meeting 2006 should be issued in December 2006, and
- Annual Report for FY06, together with Workplan FY08, in January 2007.

The next budget briefing is likely to be held in February 2007, as a preparation for FY 2009. Unless otherwise required by DOE, the budget briefing team will include Pavel Oblozinsky and WG chairs Coral Baglin and Toshihiko Kawano. If possible, John Kelley should be included to provide the University perspective. One should emphasize positive trend in solving the ENSDF manpower issue and explain ENSDF value for nuclear structure science, cross section evaluations, and applications.

Next Meeting

The next USNDP annual meeting will be held at BNL on Nov 7-9, 2007 (Wed – Fri), while the CSEWG meeting will be held on Nov 6-8, 2007 (Tue – Wed). The NDAG Criticality Safety meeting will be held on Nov 5, 2007 (Mon).

USNDP Coordinating Committee Meeting

The Coordinating Committee met at working lunchtime on Wednesday, November 8, 2006. All 9 members or their representatives attended the meeting, including P. Oblozinsky (chair), C. Baglin, A. Carlson, T. Kawano, J. Kelley, F. Kondev, D. Brown for D. McNabb, A. Chen (replaced B. Singh), and C. Nesaraja for M. Smith.

Agenda

- USNDP Status: An overall manpower and funding situation at the USNDP laboratories was discussed. FY2006 was difficult due to the budget cuts. For example, BNL did not hire replacement for C. Dunford; TUNL lost reaction funding; McMaster's astrophysics grant expired and could not be extended. FY07 should be considerably better assuming that the President's budget is approved. Three laboratories reported that post-docs are being hired, ANL – nuclear structure, BNL – reaction covariances, TUNL – nuclear structure. McMaster indicated a possible problem with the future funding by Canada (this was successfully resolved after the meeting).
- Annual Report FY06 and Workplan FY08: See above
- Budget Briefing FY09: See above
- Next Meeting: See above

US Nuclear Data Program

Minutes of the Structure and Decay Data Working Group Meeting

8:30 am-5:35 pm Wednesday 8 November 2006

C. Baglin, LBNL (Chair)

Present: C. Baglin, S. Basunia, E. Browne, T. Burrows, J. Cameron, J. Kelley, F.G. Kondev, C. Nesaraja, N. Nica, B. Pritychenko, C. Reich, B. Singh, A. Sonzogni, J. Tuli, D. Winchell, S. Zhu. Also, C. Baktash, A. Chen, A. Mengoni, P. Oblozinsky and M. Tsang were present for segments of the meeting.

Database Status Reports

- **ENSDF (J.Tuli):** The ENSDF database now contains ~2990 nuclides. Of the total of ~15800 datasets, 3760 are decay datasets and 8360 are reaction datasets. A summary of literature cut-off dates for $A > 20$ chains was presented. The most recent list of 150 priority nuclides was distributed in August 2006.
- **NSR (D. Winchell):** 3993 entries (including 3039 keyword abstracts) were added to this database during FY2006 and monthly distribution of the database continued. As of October 30, 2006, NSR contained 186,889 entries. Approximately 10% of the keyword preparation is done by IAEA. A draft of the coding manual has been completed and a new *Recent References* web page, similar in format to the discontinued *Recent References* publication in Nuclear Data Sheets, has been made available from NNDC. The latter provides both quarterly and full-year summaries. Bibtech versions of references have been available from NSR for several months. A new author dictionary, which indexes two initials rather than just one, along with several other database improvements are ongoing. The importance of the NSR database to structure and decay evaluators and our user community alike was noted, and those present expressed their thanks to Dave Winchell for a job particularly well done. He plans to leave NNDC in several months' time, and the search for his successor is now well underway.
- **XUNDL (B. Singh):** This database now contains 2010 datasets; 380 new datasets were added in FY06 and 28 existing ones were revised. These datasets contain information from 1550 primary references and cover ~1250 nuclides spread over ~225 A-chains from ${}^7\text{Li}$ to ${}^{288}\text{115}$. In recent years, the scope of XUNDL has been expanded to include publications on radioactive decay and nuclides far from stability. Datasets are currently prepared at McMaster by Maxim Mitchell, an undergraduate student, under the close supervision of Balraj Singh. A copy of all communications between XUNDL compilers and authors is routinely sent to NNDC to be archived. Some refereed publications continue to present problems because details of basic data

are missing or drawings are illegible, and Balraj is preparing a letter to the editors of Phys. Rev. C on this subject.

Software and web pages

- **Status of ENSDF Analysis and Utility Codes (T. Burrows):** A number of improvements or corrections were made in BrIcc, ComTrans, ENSDAT, FMTCHK, GTOL, PANDORA and RULER during the past year. Some of the corrected problems stemmed from conversion of Fortran77 code to Fortran95, other changes were dictated by the adoption of the higher precision and more extensive conversion coefficient information provided by BrIcc. Additionally, the ENSDF translation dictionary file has been updated, ENSDAT was revised to correspond to the current version of the Nuclear Data Sheets publication program, and GTOL has a new control option (G in level energy field) which causes uncertainty to be added in quadrature with that derived from the least-squares adjustment. Further improvements in BrIcc, HSICC, LOGFT and RadList are in progress or planned for the near future. LBNL is still working on the debugging and documentation of a Windows version of GAMUT.
- **Revision of GABS (E. Browne):** For decay data sets, one frequently needs to deduce absolute intensities from measured relative intensities using the decay scheme; due to cancellation effects, it is not a trivial procedure to correctly deduce the corresponding uncertainties. GABS performs this operation. E. Browne has now modified GABS so that it will automatically write the absolute intensity with its correct uncertainty on a GAMMA continuation record, accompanied by a suitable comment record. The original proposal was that this be done for all transitions in the decay scheme, regardless of whether cancellation effects had any impact on the final result; however, the consensus of the meeting was that the additional records should be added only for those transitions for which the cancellation effects cause a significant change and the program should decide for itself which ones these are. The quantity $%IG$ will be reinstated in the ENSDF manual so it can be used on the GAMMA continuation records.
- **Web Interface for Evaluated Double β -Decay and First 2^+ State B(E2) Data (B. Pritychenko):** Both web offerings are now available. Presently, the B(E2) data are for first 2^+ states of even-even nuclei only; data from Raman's 2000 compilation have been augmented with post-November 2000 measurements of either B(E2) or half-life, including some data from conference proceedings and abstracts, and the user can choose between units of W.u., e^2b^2 and ps. The meeting urged that a clear differentiation between the B(E2) and half-life measurements be made in data tables presented from this site. The double- β decay site presents data for 13 nuclides from over 300 publications; future plans include a summary publication and collaborative work with V. Tretyak (Kiev).

- **Progress on Software to Deduce Mixing Ratio from Conversion Electron Data** (A. Sonzogni): As an initial response to a request during last year's USNDP meeting, a program which calculates the mixing ratio from an individual conversion coefficient datum or subshell ratio is nearing completion and could be posted on the web when ready. However, it is reported that V. Vanin (Brazil) recently developed a C⁺⁺ program which will read an ENSDF file and can handle multiple subshell ratios; he is also looking into whether it can be expanded to provide penetration parameter calculations. Alejandro learned of this work only during discussions at this meeting and he will look into whether it can be provided through NNDC as an additional tool for evaluators; this might require additional programming manpower, however.
- **How Good Are the Conversion Coefficients Now?** (T. Burrows): the collaboration which developed the network's BrIcc package has been working on a thorough, systematic comparison of the most precise experimental conversion coefficient and sub-shell ratio data now available with the values predicted using three different Dirac-Fock methods ('no hole', 'frozen orbital' or 'self-consistent'). Three statistical approaches were applied to sets of data that were discrepant. While the analysis overall suggests a preference for either the 'frozen orbital' or 'self-consistent' method, there are some cases (*e.g.*, for K/L (E2)) where the 'no hole' method seems to be preferred. Analysis is ongoing, and already a number of new high precision measurements can be suggested.

Later in the working group meeting, N. Nica reported on two recent precision conversion coefficient measurements at Texas A&M.

- **New Evaluator Recruitment, Training (J. Tuli):** The most recent two-week *Workshop on Nuclear Structure and Decay Data: Theory and Evaluation* was held in Trieste, Italy from 20 Feb. – 3 Mar. 2006. One of the attendees is a coauthor of the recently-submitted evaluation of A=221. Funding of newly trained evaluators has been a challenge. However, encouraging news has just been received from Europe: NUPECC and EU funding to establish a European data network is anticipated. This would probably involve Bulgaria, France, Germany, Romania, UK and possibly Spain and Switzerland.
- **ENSDF Contribution to ENDF/B-VII Decay Data Library** (A. Sonzogni): The radioactive decay data used by the ENDF database are taken directly from ENSDF. However, database structure and format differences between the two databases mean that the transfer cannot be fully automated. A. Sonzogni processed the relevant decay data in ENSDF for this year's ENDF/B-VII release.

Formats/Procedures/J π Rules/Policies

- **Revision of J π Rules 37, 38, 39 for Rotational Bands** (B. Singh): After extensive discussion (primarily between B. Singh, F.G. Kondev, C. Reich, C. Baglin and J. Tuli) prior to this meeting, it was proposed that a newly-worded rule replace the old

rules 38 and 39 and that a modified version of the old rule 39 be moved to the section on ‘weak arguments’, as follows:

1. Replace old rules 37 and 38 with the following:

For a deformed nucleus, a regular sequence of gamma-ray transitions can be assigned to a $\Delta J=2$ (decoupled) or a $\Delta J=1$ (strongly-coupled or magnetic-dipole) rotational-band structure with definite spin-parity assignments if:

- a) *the spin and parity of at least one level in this band is unambiguously determined; and*
- b) *for $\Delta J=2$ band structures, at least one of the in-band transitions has a well established E2 multipolarity, or, for $\Delta J=1$ band structures,*
 - i) *at least one of the crossover ($\Delta J=2$) transitions has a well established E2 multipolarity, or,*
 - ii) *at least one of the stopover ($\Delta J=1$) transitions has a well established M1 (or M1+E2) multipolarity or (for parity-doublet bands) E1 multipolarity; and*
- c) *some other in-band transitions are stretched quadrupole for the $\Delta J=2$ band structures or stretched dipole (or dipole plus quadrupole) for $\Delta J=1$ band structures.*

2. Revise rule 39 as follows and move it into the ‘weak arguments’ section:

In the absence of angular distribution/correlation data or other supporting arguments, a regular sequence of gamma-ray transitions in high-spin data may be assigned to a common structure or a band with tentative spin-parity assignments if either the bandhead or some other low-lying member of this structure has reasonably well established spin and parity.

It was proposed (m. T. Burrows, s. J. Kelley) that the rules be adopted as stated and the motion was passed without objection. Last month these rules were circulated for comment to all NSDD evaluators and no changes were required in response to comments, so evaluators should immediately start to apply these rules. J. Tuli will inform all NSDD evaluators that the above rules are now in effect. He will also revise the Nuclear Data Sheets introductory material appropriately.

- **Usefulness of .pdf Versions of Mass Chains (T. Burrows):** In the course of two international collaborations, the use of .pdf files for mass chain and other documents, combined with the current ‘Commenting’ and ‘Compare Documents’ capabilities of Adobe Acrobat (Professional), has proved to be a very effective and fast means of correcting or modifying documents. For those who have the appropriate software, there is the potential for this approach (possibly combined with use of Microsoft Word’s ‘Track Changes’ and ‘Compare Documents’ options) to expedite the passage of mass chains through the production pipeline, especially in the case of international collaborations for which the mailing of hard-copy may be quite slow. It is straightforward for NNDC to provide .pdf files of mass chains so this will now be done; hard copy will still be available for evaluators who lack the software or do not choose to work with the .pdf files.
- **Priority Inclusion in ENSDF of Newly-Observed Nuclides (B. Singh):** Since the McMaster group now includes in XUNDL the data from primary publications that

report the first experimental identification of nuclides far from stability (ground and/or excited states), it would require little additional effort for them to submit evaluations of these new nuclides to ENSDF, thereby ensuring their prompt inclusion in both ENSDF and NuDat. McMaster offers to do this for all mass chains, regardless of Center responsibilities. Since any material submitted to ENSDF under this arrangement would be completely orthogonal to what already existed in ENSDF, it was agreed that McMaster should proceed with this. Note that, in addition to adding nuclides previously absent from ENSDF, any nuclide in ENSDF for which no previous experimental evidence existed will be revised when some becomes available.

- **Reminders of ENSDF Policies:**

Nuclear Resonance Fluorescence data sets: NRF is fundamentally a gamma-ray measurement, yet some evaluators include no G records in the data set, thereby losing any photon branching and multipolarity information coming from the measurement. Such information should be included.

Inclusion in Adopted Levels of states at the neutron or proton separation energy: this should never be done! The neutron capture state(s) are shown only in neutron capture source datasets and they should appear there with an 'S' in column 80.

Inclusion of BM1/BE2 ratios: this is unnecessary because this information can easily be calculated from other information that is presented.

Other reminders: J. Tuli has prepared a list of additional reminders. Although this list was not presented during the meeting, it is available along with other USNDP06 material from the NNDC website.

- **Policy Development Needed:** The need to develop guidelines for nomenclature of rotational bands and configurations and the handling of transition quadrupole moments in ENSDF was reiterated. F.G. Kondev and B. Singh are preparing recommendations to be discussed at a later date.

Nuclear Data Sheets (NDS) issues

- **Journal description:** For several years now, the Elsevier home page for NDS has erroneously described the journal contents as 'evaluated nuclear structure data for A<44'. J. Tuli reports that this problem is about to be fixed.
- **Content of and access to material on pages i to xi and on inside covers of the print version of the journal:** increasingly many readers have access only to the electronic version of NDS, but there is no electronic access to these vital pages. J. Tuli will endeavor to persuade Elsevier to provide electronic access to this material. In the case of the printed version, the material will appear only in the January issue, but a note in the abstract for all mass chains will refer readers to that issue. The NNDC's NDS webpage has a link to pages iv to xi , but the version given there needs to be brought up to date and the other material needs to be added. It was also suggested

that the page which gives the cumulative index to A-chain and nuclide publications should also list recent topical publications such as those on proton emitters, superdeformed bands, and $\log ft$ and alpha-decay systematics. J. Tuli will look into the practicality of this.

- Space limitations: Elsevier limits NDS to ~2800 pages per year and it seems unlikely that this could be increased. In 2006, one issue was devoted to reactions papers and one issue in 2007 has already been promised for reactions papers, leaving about 2600 pages for structure publications. We currently have a number of completed mass chains whose publication has been delayed for lack of journal space in 2006, so the problem will probably be even more acute in 2007 unless we can shorten the hard-copy versions of mass chain publications. While acknowledging the need to avoid compromising the quality of the material published, it was decided that the following general actions would be taken, starting with the January 2007 issue:

i) drawings will be dropped from reaction data sets,

ii) if the adopted data set has more than 2 or 3 pages of band drawings, the interband transitions will no longer be shown.

Some space could be saved by reducing the white space on the printed pages; the present production program is versatile, but will require human intervention (*i.e.*, additional manpower) to achieve this.

Also, commencing immediately, we will look for new technologies to improve/modernize the NDS publications, starting with the perennial question of the quality of the drawings. As a starting point, the person responsible for the drawings in the latest superdeformed band paper is also conversant with ENSDF and it may be productive to consult with him if he has time available. It will be important to build on our existing capabilities and cumulative experience and care should be taken to avoid losing the tight linkage between printed publications and archived database files, dictionaries, *etc.* Currently, the production code could incorporate .eps files for drawings prepared by an evaluator, but this has the potential for creating inconsistencies between drawings and the ENSDF file.

Interactions with Data User Communities: It is essential that our structure and decay data evaluation efforts maintain visibility within our user community and that we remain attuned to their needs. To that end, a number of our evaluators have presented data evaluation talks at US nuclear structure conferences and APS meetings in recent years, N. Nica did likewise at a European conference this year, a ‘user forum’ was organized during the 2005 and 2006 USDNP meetings (this year including prominent researchers from European as well as US labs) and, two years ago, Dave Winchell organized a minisymposium on nuclear data at an APS DNP meeting. It was agreed that it was time to hold another minisymposium and J. Kelley agreed to try to set this up during next October’s APS DNP meeting in Virginia. In the meantime, several USDNP structure evaluators expect to attend the next International Nuclear Data Conference (Nice, April 2007).

The meeting closed at 5:35 pm.

Minutes of the Nuclear Reaction Working Group Meeting

T. Kawano, LANL (Chair)

Model Code Development

Kalbach, TUNL, presented several improvements in the exciton model code PRECO, and the code manual was completed. The effort was reduced due to budget issue. An effect of coupling between the single-particle state density and the averaged matrix element was investigated. One interesting physical problem is underestimation of the particle emission cross sections in the high-energy region, and this could be explained by a collective model.

Bonneau, LANL, summarized a current status of the McGNASH code development. Several new modules were recently developed, which includes the direct/semi-direct (DSD) capture model using the Skyrme-Hartree-Fock-BCS model, and optical model module. The calculated results of $^{208}\text{Pb}(n,\gamma)$, $^{238}\text{U}(n,\gamma)$, and $^{63}\text{Cu}(p,\gamma)$ show a good agreement with the experimental data. The new fission model and width fluctuation models are underway. The McGNASH code CVS was set up, and made it available to internal test users.

Herman, BNL, described recent developments of the EMPIRE code for nuclear data evaluation work. The prompt fission neutron spectra are calculated using the Los Alamos model. The direct cross section on odd nuclei is calculated with the DWBA method. A dispersive optical potential can be used with the ECIS code in the EMPIRE code system. The MSD model was extended to deformed nuclei, ^{232}Th for example, and it was shown that a missing strength in the continuum inelastic scattering cross section is filled with this modeling.

Nuclear Astrophysics

Nesaraja, ORNL, gave a talk on the computational infrastructure for nuclear astrophysics, which aims at getting the latest nuclear evaluations into astrophysical simulations. New experimental activities are also summarized, which include (p,p), (p,d), and (p, α) reactions on light elements. The (p,d) data are used to estimate the (p, γ) reaction rate by including theoretical calculations.

Moeller, LANL, gave a talk on the recent improvement to the fission barrier calculation, including an axial asymmetry. The potential energy of deformed nuclei is calculated with the microscopic/macrosopic model, and the single-particle

energies are calculated. The results were published in Phys. Rev. Lett. 2006. The fission barrier data will be used for fission cross-section calculations for many actinides.

Bonneau and Kawano, LANL, presented new calculations of the direct/semi-direct capture on ^{122}Sn and ^{132}Sn , and showed the importance of the DSD process for the double-magic nuclei. It is also pointed out that nuclear structure information is crucial for cross section calculations on nuclei off stability.

Cross Section Standards

Carlson, NIST, gave a review of final status of standards evaluation. Standards cross sections are evaluated under the international collaboration coordinated by IAEA, and the data were accepted as a standard library, and they were also merged into ENDF/B-VII.0. Though the evaluation was finished and the report was prepared (IAEA TECDOC), there exists experimental efforts to measure cross sections such as $^6\text{Li}(n,t)$, $^{10}\text{B}(n,\alpha)$, and $^{238}\text{U}(n,f)$. Those information could be useful to maintain the standards cross sections in future.

Covariances

Rochman, BNL, summarized covariance evaluation works at BNL, from the thermal to 20MeV. The group cross-section covariance is given in the resonance range, which is based on the evaluated uncertainties in Atlas. An example was shown for ^{236}U covariance data in the resonance region. At high energies, the EMPIRE-KALMAN method is applied to generate the covariance data. Full evaluations were given for ^{89}Y , ^{191}Ir , ^{193}Ir , ^{99}Tc , and Gd isotopes, and the results were processed with NJOY, ERRORJ, and PUFF-IV.

Leal, ORNL presented a method to generate covariance data for resonance parameters using SAMMY. The method was applied to evaluate the covariance data of ^{233}U , ^{235}U , ^{238}U , ^{232}Th , and ^{239}Pu . ^{240}Pu and ^{241}Pu data are underway. The processing codes, ERRORJ and PUFF-IV, were used to generate a group cross section covariance. The resonance parameter covariance requires a huge computer memory, 1.7GB for ^{239}Pu for example, but it is feasible nowadays. The processed resonance parameter covariance of ^{239}Pu gives about 3% for the capture cross sections.

Dunn, ORNL, gave a talk on the status of AMPX covariance processing. The PUFF-IV code processes the ENDF uncertainty data, which is written in F90, object oriented manner, and tested using the previous version of PUFF. The SAMRML code is used to process the MF32 data. It was shown that the processed covariance data for the Gd158 total cross section using SAMMY, PUFF-IV, and ERRORJ are identical.

Kawano, LANL, showed the covariance evaluation for ^{235}U , ^{238}U , and ^{239}Pu in the fast region. The method, GNASH-KALMAN, is similar to the BNL/LANL method. The covariance data of the fission cross sections were taken from the standards evaluation with necessary modification to the boundary energies. Kawano also presented a recent development of ERRORJ by Chiba of JAEA. The new version of ERRORJ can be used as an ERRORR module in NJOY. The new code runs faster and more accurately than the previous version.

US Nuclear Data Program

User Community-USNDP Discussion Forum

A. Sonzogni, BNL (Chair)

This year's user forum speakers were Cyrus Baktash from ORNL, Gilles de France from GANIL (France), Betty Tsang from MSU and Alberto Mengoni, currently at the IAEA and formerly head of the CERN n-TOF project.

Cyrus Baktash, ORNL, gave an overview of the Holifield Radioactive Ion Beam Facility at ORNL and the experimental techniques used, such as angular distributions following transfer reactions, Coulomb excitation, measurement of g-factors and B(E2) values, and incomplete fusion. A possible upgrade using photon fission of actinide targets was also presented. Baktash presented the different experimental signatures of magic numbers and how different nuclear configurations can be near the drip lines. Baktash emphasized the wealth of physics opportunities in the ENSDF database and suggested we should offer searches on B(E2) and G-factors in NuDat, which we plan to implement soon. Advanced select-and-plot capabilities in NuDat were suggested.

Gilles de France, GANIL, talk highlighted the many impressive accomplishments of GANIL in the last years as well as future plans. Current nuclear structure research at GANIL focuses on nuclei at the farthest distance from the valley of stability, such as ^{34}Ca and ^{54}Ca . These nuclei have many surprising properties, for instance the first 2+ energy in ^{36}Ca is above the proton separation energy, and the theoretical description quite a challenge. The last part of the presentation was devoted to the Spiral 2 facility, an exotic beam facility that should be in full operation by 2012 at a cost of 135 million Euros. Spiral 2 will have a Linac as main accelerator and will be able to produce far more intense beams than current facilities.

Betty Tsang, MSU, started by pointing out the prominence of the National Superconducting Cyclotron Laboratory at Michigan State University in Nuclear Physics research and education. The NSCL currently has 282 employees, 50 graduate students and 24 faculty members, successfully operating an exotic beam fragmentation facility and counting with many state of the art instruments. Moreover, the NSCL has very ambitious plans to build the Isotope Science Facility (ISF), which will use a Linac as main accelerator. This project may cost about half a billion dollars.

Tsang pointed out the lack of compiled cross sections for fragmentation reactions, which are of relevance for accelerator design space radiation shielding. Tsang suggested the NNDC should incorporate this data in CSIRSR and her team would be interested in submitting an article with their measurements to Nuclear Data Sheets.

The last part of Tsang's talk focused on spectroscopic factors. In cross section studies, spectroscopic factors are defined as the ratio of experimental angular distributions to

calculated angular distributions using an independent particle model. In 1977, Endt published a compilation in Atomic Data and Nuclear Data Tables. Thirty years later, much more data is available and modern computers allow performing large-scale analysis. Tsang suggested that the results of her research could be published in a Nuclear Data Sheets article. A frequent user of NSR and a google fan, Tsang also pointed out the potential benefits of incorporating google techniques in NSR searches.

Alberto Mengoni, IAEA, gave the last talk. He first gave an overview of the n-TOF project at CERN and then described in detail some measurements and their applications. Neutrons in n-TOF are produced in the impact of 20 GeV protons on Pb. Neutrons travel 200 meters before hitting the target. An array of 40 BaF2 crystals are used for (n, γ) measurements while ionization chambers are used to detect fission fragments. These measurements are of importance in nuclear astrophysics as well for nuclear reactor design. The second part of the talk was devoted the slow capture process, in particular the measurement of $^{186,187}\text{Os}(n,\gamma)$ cross sections which can be used to study the age of the universe and the chemical evolution of the Milky Way.

USNDP Reports 2006

Altogether 12 reports were given, three on Task Force activities and nine on laboratory activities. Actual reports are at www.nndc.bnl.gov/proceedings/2006csewgusndp.

Task Force Reports

1. Nuclear Data for Astrophysics (C. Nesaraja for M. Smith)
2. Nuclear Data for Homeland Security (D. Brown for D. McNabb)
3. Nuclear Data for/from RIA (T. Kawano) – no formal presentation

For the time being, the Task Force on Nuclear Data for/from RIA should be terminated. This activity should be restarted once the funding for RIA facilities will become better defined. The other two task forces will continue (Nuclear Data for Astrophysics, Nuclear Data for Homeland Security).

Laboratory Reports

1. NNDC report (P. Oblozinsky)
2. ANL report (F. Kondev)
3. LANL report (T. Kawano)
4. LBNL report (C. Baglin)
5. LLNL report (D. Brown)
6. NIST report (A. Carlson)
7. McMaster report (B. Singh)
8. ORNL report (C. Nesaraja)
9. TUNL report (J. Kelley and C. Kalbach)

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