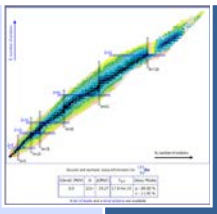

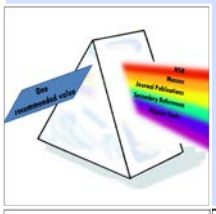

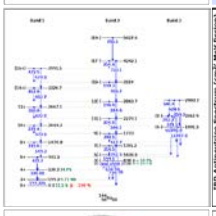

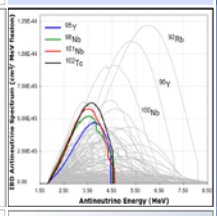

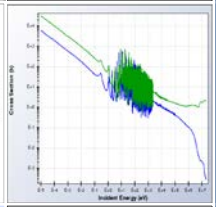

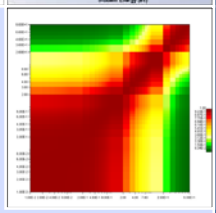

United States Nuclear Data Program

Annual Report for FY2019

This document describes the activities including related metrics performed by the US Nuclear Data program members during fiscal year 2019.

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BNL

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I. Introduction

The USNDP Annual Report for FY2019 summarizes the work of the U.S. Nuclear Data Program (USNDP) for the period of October 1, 2018 through September 30, 2019 with respect to the work plan for FY2018 that was prepared in 2017. The work plan and final report for the U.S. Nuclear Data Program are prepared for the DOE Office of Science, Office of Nuclear Physics. The support for the nuclear data activity from sources outside the nuclear data program is described in the staffing table and in Appendix A. This leverage amounts to about 2.94 FTE scientific, to be compared with 24.6 FTEs at USNDP units funded by the DOE Office of Science, Office of Nuclear Physics. Since it is often difficult to separate accomplishments funded by various sources, some of the work reported in the present report was accomplished with nuclear data program support leveraged by other funding.

Fiscal year 2019 was the 20th year in which the Nuclear Data Program has operated under a work plan developed by the program participants. The program continued to carry out important work in support of the DOE mission. The work balances the ongoing collecting, analyzing, and archiving of nuclear physics information critical to basic nuclear research and to the development and improvement of nuclear technologies with the electronic distribution of this information to users in a timely and easily accessible manner. The present section of the report consists of activity summaries for the major components of the U.S. Nuclear Data Program. This is followed by an updated staff level assignment table that reflects the final distribution of effort among the tasks carried out during FY2019. Then, we continue with the detailed status of work done in FY2019.

In terms of personnel changes, Timothy Johnson left BNL in March 2019, while Kalle Auranen, Shaofei Zhu, Andrea Mattera, Adam Hayes, Ryan Lorek and Matteo Vorabbi joined BNL in March, May, July, August and September 2019, respectively. Kalle Auranen left BNL in September 2019 as he took a staff position in Finland.

Table 1 summarizes the USNDP metrics since 2001. Table 2 shows the breakdown of the metrics by laboratory for the reported fiscal year and comparison with the previous fiscal year. The tables are followed by a definition of each metric.

Table 1: Summary of the USNDP funding and metrics in FY2001- FY2017, the definitions of the various terms follow the table.

Fiscal year	USNDP funding ($K)	Change (%)	Compilations	Evaluations	Disseminations	Articles	Invited talks
2001			7,139	334	667	25	22
2002	4,890		6,159	300	799	40	22
2003	4,932	+0.9	4,975	260	966	40	23
2004	5,015	+1.7	6,241	276	1,212	36	43
2005	5,437	+8.4	6,623	422	1,642	59	42
2006	5,099	-6.6	4,936	318	1,863	60	48
2007	5,841	+14.6	5,355	366	2,239	56	51
2008	5,967	+2.2	5,104	385	2,996	72	68
2009	6,267	+5.0	4,047	400	3,294	61	56
2010	6,549	+4.5	4,662	395	2,843	83	51
2011	6,534	-0.2	4,662	479	3,252	96	67
2012	6,785	+3.8	5,221	209	3,013	90	48
2013	6,249*	-7.9	4,925	282	3,447	84	79
2014	7,032*	+12.5	3,738	166	3,411	107	81
2015	7,381*	+5.0	4,949	271	4,246	98	50
2016	7,597*	+2.9	3,936	375	4,655	82	72
2017	6,953	-8.5	3,684	404	4,730	95	51
2018	8,496[a]	+22.2	4,097	221	4,722	79	58
2019	8,797[b]	+3.5	3,663	202	5,148	67	60

*: It includes $500K of Early Career Award (LANL).
a: It includes the following (a) FIRE collaboration funding $100 (LLNL), (b) LAB17 call funding: $325K (ANL), $220K (LANL), (c) LAB18 call funding $26K (ANL), $282K (BNL), $120K (LANL), $75K (LBNL), $100K (LLNL), $372K (ORNL).
b: It includes the following (a) FIRE collaboration funding $100 (LLNL), (b) LAB17 call funding: $325K (ANL), $220K (LANL), (c) LAB18 call funding $27K (ANL), $289K (BNL), $120K (LANL), $75K (LBNL), $50K (LLNL), $373K (ORNL), (d) WANDA organization: $25K (ORNL).

In particular:

1. **Compilations**: Includes compilations for the NSR, EXFOR and XUNDL databases. The compilation activities are on a healthy situation and these databases are updated regularly with newly published material.

2. **Evaluations**: There were 202 ENDF evaluations and no ENDF/B evaluations were submitted. The number of ENSDF evaluations remains well below the number needed, about 340, to evaluate each of the ENSDF nuclides on average every 10 years.

3. **Dissemination**s: The number of database retrievals has not changed significantly from last year's value.

4. **Articles**: The number of articles has remained relatively constant in the last few years. A selected list of articles published is given in the Appendix B.

5. **Invited Talks**: The number of invited talks has not changed significantly from last year's value.

Table 2: USNDP metrics in FY2018, numbers from the previous fiscal year are shown for comparison.

Laboratory	Compilations		Evaluations		Disseminations (in thousands)		Articles		Invited Talks	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
ANL	15	5	14	13	-	-	31	18	5	12
BNL*	3,976	3568	80	51	4,560	4,608	18	16	15	19
LANL	-	-	0	0	-	-	21	12	18	11
LBNL	17	5	23	5	-	-	16	16	9	3
LLNL	-	-	10	0	-	-	0	2	3	2
MSU	54	54	30	30	-	-	3	3	0	1
ORNL	3	-	25	14	82	460	1	2	4	10
TAMU	-	-	17	17	-	-	2	5	4	1
TUNL	32	26	9	7	80	80	0	1	0	1
Total	4,097	3,663	231	202	4,722	5,148	79	67	58	60

*: BNL compilations for FY2019 consist of a) 3,337 NSR articles, including key-words for 1825 of them; b) 125 articles for EXFOR; c) 106 articles encompassing 234 XUNDL datasets. BNL evaluations for FY2017 consist of a) 51 nuclides for ENSDF and 0 for ENDF/B-VIII.0. For the remaining groups, all compilations are for XUNDL, while all evaluations are either ENSDF (ANL, LBNL, MSU, ORNL and TAMU), or ENDF/B (LANL, LLNL, NIST).

Definitions:

- Compilations: The sum of the new entries added to the USNDP bibliographic (NSR - articles) and experimental databases (EXFOR - reactions, XUNDL - structure data sets).
- Evaluations: The sum of new evaluations submitted or accepted for inclusion in the USNDP evaluated nuclear databases. For ENSDF, it is the number of evaluated nuclides, while for ENDF, it is the number of evaluated reactions/covariances. Dissemination: The number of electronic data retrievals made from USNDP maintained web sites. Data retrieval is defined as a request for data from any of the databases that receives a result. Total pages accessed is not tallied.
- Articles: The number of articles published in refereed journals.
- Invited talks: The number of presentations given at the explicit invitation of the organizers of conferences, symposia, workshops and training courses.

II. Network Coordination and Data Dissemination

The National Nuclear Data Center (NNDC) continues to serve as the core facility of the U.S. Nuclear Data Program (USNDP). It has the main responsibility for national and international coordination, database maintenance, and data dissemination. However, other program participants are also involved in coordination and dissemination activities.

National and International Coordination

The NNDC, while serving as the secretariat for the program, has prepared the work plan for this fiscal year in cooperation with the members of the Coordinating Committee. The NNDC Head serves as a chair of the USNDP Coordinating Committee, which consists of the Principal Investigators from each of the participating group and chairs the annual meeting of the program held at the Brookhaven National Laboratory. A representative from LANL chairs the Nuclear Reaction Data Working Group, and a representative from TUNL chairs the Nuclear Structure Working Group. ORNL chairs the Astrophysics Task Force.

In February 2019, the DOE Office of Nuclear Physics conducted its annual Budget Briefing. Lee Bernstein, David Brown, Allan Carlson, Jun Chen, Lynne Ecker, Toshihiko Kawano, John Kelley, Filip Kondev, Hye Young Lee, Elizabeth McCutchan, Michael Smith, Alejandro Sonzogni and Ian Thompson represented USNDP and made the case for the FY 2021 funding.

The NNDC serves as the focal point for U.S. collaboration in international nuclear data activities. This collaboration continued both in nuclear structure and decay data (Network of Nuclear Structure and Decay Data Evaluators, NSDD) and reaction data (NEA Working Party on International Nuclear Data Evaluation, WPEC, and Network of Nuclear Reaction Data Centers, NRDC).

The NNDC continues to chair the Cross Section Evaluation Working Group, which produces the ENDF/B evaluated nuclear data library for nuclear science and applied nuclear technology use. As in the past, the 2019 CSEWG meeting was held at BNL. The major topic of the CSEWG meeting was feedback on the recently released ENDF/B-VIII.0 library, as well as the fission yield evaluation project recently funded by NA22.

USNDP Databases

The NNDC operates seven Dell servers running the Linux operating system to support its compilation, evaluation, database maintenance, and information dissemination functions. These computers archive and serve the nuclear data produced by the U.S. Nuclear Data Program and the data obtained by other national and international collaborations. In addition, the NNDC maintains the collaboration GForge server that facilitates data and codes development employing Subversion to keep track of changes. Following a careful study, this server will be replaced by a new server running the GitLab software in 2020. The NNDC maintains seven nuclear physics databases for USNDP, which were updated continuously this fiscal year with new and revised information from efforts of the NNDC, USNDP and international

collaborators. Distributions of all or parts of these databases have been made to national and international collaborators as scheduled.

Data Dissemination

There were 5,148 million database retrievals this fiscal year, about 9.0 % higher than the number of retrievals in the previous year. Most of these retrievals, 95%, were from the NNDC web site, with NuDat as the most popular product.

Major Publications

USNDP continues to publish the refereed journal Nuclear Data Sheet, 8 issues were published this fiscal year, 7 dedicated to ENSDF evaluations and one issue devoted to nuclear reactions.

III. Nuclear Structure and Decay Data

The nuclear structure working group emphasizes the evaluation of measured nuclear structure and decay properties for all isotopes. These data are maintained at the NNDC in the Evaluated Nuclear Structure Data File (ENSDF). Production of ENSDF is an international effort operating under the auspices of the IAEA Nuclear Structure & Decay Data (NSDD) network. ENSDF is an important source of information for derivative databases and applications including NuDat, Nuclear Wallet Cards, RIPL, MIRD and ENDF/B. Evaluations are published as peer-reviewed articles in Nuclear Data Sheets. The Nuclear Science Reference (NSR) and Experimental Unevaluated Nuclear Structure Data List (XUNDL) databases have been kept up to date. The combination of ENSDF and XUNDL database represents nearly a complete experimental nuclear structure data of the literature, which is a salient feature of these databases.

In August 2019, a one-day retreat was held adjacent to the Low-Energy Community Meeting at TUNL in order to focus on finalizing the Guidelines for Evaluators and to provide training for using the ConsistencyCheck JAVA evaluation tool that was recently developed by Jun Chen.

Status of ENSDF & Nuclear Data Sheets:

The ENSDF database has increased in size by 0.9% over the past year, and at the end of FY19 there were 3386 nuclides in the database. A total of 189 evaluated nuclides were submitted this fiscal year, including nuclides from 13 mass chains and nuclides for ENSDF update. Evaluation articles from 24 mass chains, encompassing 163 nuclides, were published in the Nuclear Data Sheets this fiscal year. Among them, complete evaluations of super-heavy nuclides, with A=266-298 by Balraj Singh.

The network works to revise all the mass chains within a time frame of 10 years, along with considerations of new data, age, importance, and request from users. One of the many indicators to measure the currency of the database is the average time of the nuclides since they were last evaluated, which was **6.9 years** at the end of FY2004 and **8.9 years** in November 2019. Here it should be noted that the size of the ENSDF database has increased from 148 MB to 237 MB an increase of about 60%, from FY2004 to FY2019,

and every new evaluation, due to limitations of the ENSDF format, not only needs to include the new data but must also repeat some of the work of previous evaluators.

Until 2019, the total effort for ENSDF database while remained nearly the same in the US, combining permanent and temporary (postdoc/contracts) staff; however, the non-US effort has dropped in the last 10 years. The recent hires at the NNDC would bring an additional 1.7 FTE of ENSDF evaluation effort, which we hope will translate into an improvement of the database currency.

General usage statistics for ENSDF and products derived from ENSDF (Nuclear Data Sheets, NuDat, etc.) show a high usage and popularity on the NNDC website and the Elsevier site.

Status of XUNDL:

Based on regular scanning of nuclear physics journals, 441 datasets were compiled from 201 papers. The project to compile data from articles submitted to Phys. Rev. C during the submission process continues well. As a result of positive feedback, starting in December 2018 authors now have the possibility to 'opt out' from the compilation process, while in the past the choice was to 'opt in'. Compilation of articles submitted to the European Physical Journal A during the submission process started in December 2018. More details about this development are given in a later section of this document.

Status of NSR:

In FY2019, 3337 new articles were added to the NSR database. USNDP contributions are from B. Pritychenko (manager), E. Betak, B. Singh, J. Totans, and V. Zerkin from the IAEA participates as a collaborator. The database is up-to-date and in good shape. The number of NSR web retrievals was 316,494.

Horizontal Evaluations and Other Data Related Activities:

A summary list of "Horizontal Evaluations and Other Data Related Activities" involving USNDP structure evaluators includes the following:

- The Atomic Mass Evaluation (AME) effort and NuBase, Kondev: continuing with planned release in FY21.
- Update of r0 radius parameter and revision of ALPHAD-radD analysis code, Singh, Dhindsa: r0 publication in press, ALPHAD-radD article and code in preparation.
- Compilation of current papers on mass measurements on a yearly basis and make data file available on nuclearmasses.org: Singh, Smith: continuing, article published in 2020.
- IAEA-CRP on Nuclear Data for Charged-Particle Monitor Reactions and Medical Isotope Production, Kondev: completed with publications.
- IAEA-CRP on Delayed Neutron Emission Probabilities, Singh, Sonzogni, McCutchan: completed, publications submitted

- New evaluation of LogFt values, Singh and collaborators.

Status of ENSDF codes:

In the last few years, significant developments have been made in modernizing legacy and developing new ENSDF codes by Jun Chen. The MSU-McMaster JAVA-NDS code has been used both to produce print-ready documents for the Nuclear Data Sheets and web retrieval of ENSDF data sets on the NNDC website. The ConsistencyCheck code has been implemented to ensure evaluation consistency and facilitate evaluation process. Other new utility and analysis codes that have been implemented and released are: Java-RULER, KeynumberCheck, and Excel2ENSDF. New developments are underway.

IV Nuclear Reaction data

The nuclear reaction data effort focuses on evaluation of nuclear reaction data and the related measurement and compilation activities. USNDP also makes important contributions to nuclear reaction model code development and improvement of reaction cross-section standards.

In FY19, several new approaches of the statistical nuclear reaction theory were proposed and applied to experimental data, nuclear fission study, as well as the nuclear astrophysics. LANL and BNL studied the impact of particle transmission coefficients in the statistical Hauser-Feshbach theory, and two Phys. Rev. C papers were published on this subject. Our reaction modeling efforts always leverage nuclear physics studies both in the fundamental and applied fields.

The ChiNu array at LANSCE observed anisotropic angular distributions of prompt fission neutron spectra of ^{239}Pu, which were interpreted in the framework of the Feshbach-Kerman-Koonin quantum mechanical pre-equilibrium theory , where the angular momentum transfer is properly included in contrast to other classical pre-equilibrium models. In another development, we also applied the statistical model to the decay of fission fragments, and simultaneously calculated the independent/cumulative fission product yields and prompt fission neutron spectrum by the so-called aggregation method.

The first direct measurement of ^{35}Cl(n,p) cross section above 0.6 MeV was performed with LENZ (Low Energy Neutron-induced charged-particle Chamber) at LANSCE. These data are needed to further the development of advanced nuclear reactor concepts. By combining the newly measured data with theoretical calculations, USNDP is capable of providing an upgraded chlorine evaluation in a timely manner. An article detailing this work has been submitted for publication.

Data analyses on the GENIE array experiments at LANSCE progressed to publish the prompt gamma-ray data taken on fission products of mass range ~100 and the gamma-ray production cross section on ^{126}Xe.

Nuclear Astrophysics highlights

The FIRE (Fission in Rapid-Process Elements) collaboration, which is partially supported by USNDP, studied the possible contributions to kilonova light curves from transuranic elements, concluding that signatures of ^{254}Cf could be observed depending on the role of beta-delayed fission.

Additionally, LANL researchers were involved in a project studying how ^{98}Tc could be synthesized by the supernova neutrino process.

At ORNL, the central values and uncertainties in the STARLIB and NACRE II collections, which are given in pointwise format, were fit into the parameterized functional format of the REACLIB reaction rate library, the most widely utilized library of thermonuclear reaction rates. An extension of the REACLIB format was proposed that includes rate uncertainties.

Additional Highlights

Workshop for Applied Nuclear Data Activities (WANDA)

January 22-24, 2019
George Washington University

The US Nuclear Data Program continues to lead the coordination effort with the applied nuclear science community through the *Workshop for Applied Nuclear Data Activities (WANDA*), held at the George Elliot School of International Affairs at George Washington University in January 2019 and chaired by Lee

Bernstein from Lawrence Berkeley National Laboratory. This workshop is the fourth in a series of joint meetings between the DOE Nuclear Physics, Nuclear Energy, Isotope program and several NNSA offices to plan future nuclear data activities. WANDA was attended by over 139 people from 48 laboratories, institutions and companies. WANDA included:

- Mission needs talks from program managers in Nuclear Physics, Nuclear Energy, Isotope Production, Nonproliferation, Stewardship, AFTAC, DTRA, Criticality Safety.
- A review of international nuclear data efforts (IAEA), a discussion of the "Nuclear Data Pipeline" and reviews of new initiatives from the last two Lab calls.
- Topical Breakout Sessions led by subject matter experts on Energy, Isotope Production, Safeguards, Materials damage, Atomic/XRF data, and (n,x) reactions from 1-3000 keV.

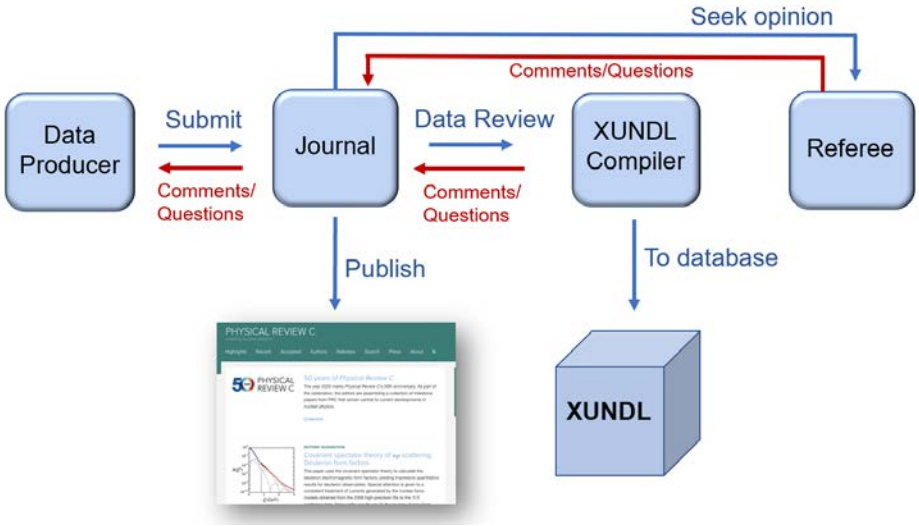
A whitepaper was produced (Report LLNL-PROC-769849) and the input was used to provide guidance for the most recent Nuclear Data Interagency Working Group Lab call and FOA.

New developments in XUNDL compilations.

Nuclear Structure and decay data compilation started about 20 years ago by Balraj Singh from McMaster University, focusing first on high-spin data and then expanding it to all nuclear structure and decay data. The XUNDL library, which shares the same format with ENSDF, was created for this purpose. With XUNDL these days spanning a comprehensive compilation effort, a given user only needs to consult the ENSDF library and the corresponding XUNDL datasets published after the ENSDF evaluation to obtain all the data for a given nucleus.

Traditionally, XUNDL compilation took place once an article was published, and often required communication with the authors to address several issues such as data completeness, typographical errors, inconsistencies, and disagreements with previously published data. This often resulted, in the cases that the authors had interacted with us, in a XUNDL dataset that was different from what had been published, or in a dataset that was considered incomplete or inconsistent when our e-mails went unanswered.

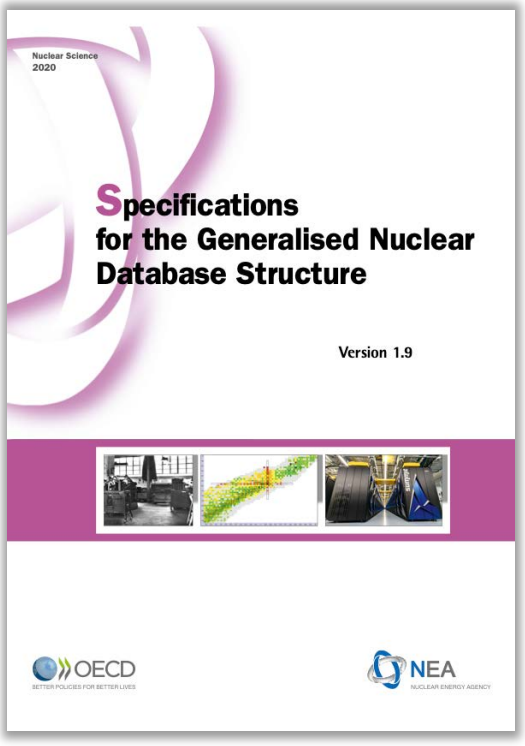
To remediate these issues, we started a pilot program approximately 18 months ago in collaboration with the Physical Review C journal to compile the data as part of the publication process. This allows USNDP to be integrated in the "data distribution" process and ensures that the data in the article is identical to the one in XUNDL. It requires, however, a quick response from us, less of a week, which has been handled by Jun Chen, Elizabeth McCutchan and Balraj Singh. A workflow of the involved tasks is illustrated in the figure below.



New XUNDL Work flow

In the beginning of this program, authors would choose if they wanted their data compiled by us; however, due to its success, authors now choose if they don't want their data compiled. Recently, the European Physical Journal E has started a similar process, and we look forward to integrating all the relevant journals in the near future.

Generalised Nuclear Database Structure.



The de facto international standard format for nuclear reaction data is the Evaluated Nuclear Data File 6 (ENDF-6) format, a format designed originally for 1960s era punch-card readers. Built atop the ENDF-6 format is a series of numerical processing codes that translate ENDF-6 formatted nuclear physics information into application-ready data. The codes that translate between the different systems include some with limited or non-existent documentation or are closed-source or export-controlled. This has held back progress and artificially created a field of expertise that is not reasonably maintainable. Therefore the replacement of the ENDF-6 format and affiliated code base has been a priority of the USNDP and others, allowing us to better capture required physical data, allow robust Quality Assurance practices, interface with modern computing systems and transfer knowledge and expertise to the next generation. In 2013, the NEA Working Party on International Nuclear Data Evaluation Co-operation (WPEC) launched a project to review the requirements for an international replacement for the ENDF-6 format. The

recommendations prompted the creation of a new Expert Group on a Generalised Nuclear Data Structure (GNDS) in 2016 that has used these requirements as the framework for a new format specification. GNDS as a format can be implemented with different technologies (e.g. Hierarchical Data Format (HDF), eXtensible Markup Language (XML) or others) and immediately interpreted with standard libraries in any modern computer programming language. GNDS has been engineered as a replacement to, and extension of, the ENDF-6 format, and maintains a strict one-to-one translation capability with legacy files, while other standard processed outputs may be generated by the open-source FUDGE code system. Following rigorous international review, version 1.9 was unanimously approved by the Expert Group for publication in May 2019.

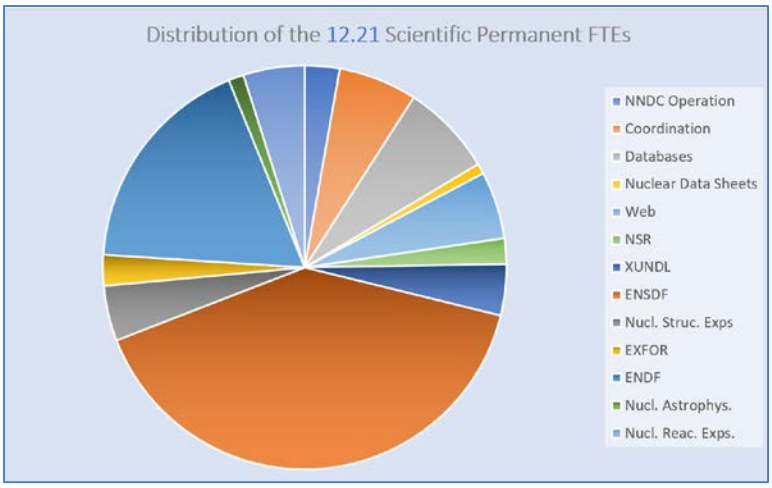
USNDP Staffing Table FY 2019

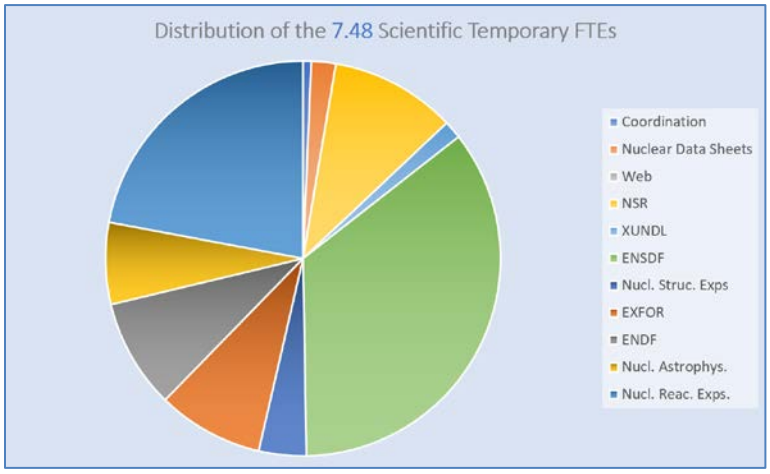
The table below gives the FTE distribution for each USNDP group according to activity. The values in this table and following plots are for the based funding only. In this table PhD P means PhD Permanent; PhD T means PhD Temporary, which includes post-docs and scientists working under contract; T/A means Technical and Administrative; and GS means Graduate Student.

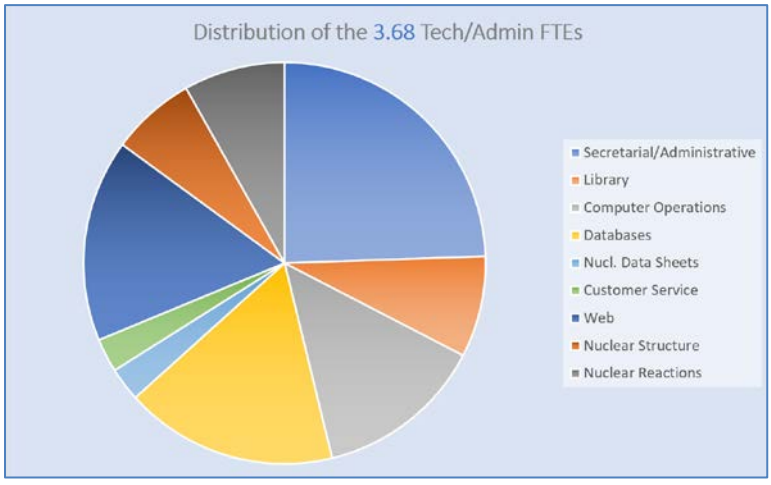
	ANL	BNL			LANL		LBNL		LLNL			MSU	ORNL			TAMU	TUNL			
Activity	PhD P	PhD P	PhD T	T/A	PhD P	PhD T	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD P	PhD T	GS	PhD P	PhD P	PhD T	T/A	Totals
I. NNDC Facility Operation	0.00	0.34	0.00	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04
Management		0.34																		0.34
Secretarial/Admin. Support				0.90																0.90
Library				0.30																0.30
Computer Operations				0.50																0.50
II. Coordination	0.05	0.27	0.00	0.00	0.10	0.00	0.25	0.05	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	0.82
National Coordination		0.19			0.05		0.25						0.05				0.05			0.59
International Coordination	0.05	0.08			0.05			0.05												0.23
III. Nuclear Physics Databases	0.00	0.80	0.00	0.63	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53
Nuclear Science References, NSR		0.25		0.53																0.78
Expr. Nucl. Struct. Data, XUNDL		0.19																		0.19
Eval. Nucl. Structure Data, ENSDF		0.20																		0.20
Numerical Nuclear Data, NuDat		0.06																		0.06
Exp. Reaction Data, EXFOR		0.06																		0.06
Evaluated Nuclear Data File, ENDF		0.04																		0.04
Database Software Maintenance				0.10																0.10
Future Database System Develop.							0.10													0.10
IV. Information Dissemination	0.00	0.71	0.15	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.50	1.71
Nuclear Data Sheets		0.10	0.15	0.10																0.35
Customer Services				0.10																0.10
Web Maintenance & Develop.		0.61		0.10									0.05						0.50	1.26
V. Nuclear Structure Physics	0.80	1.28	1.41	0.00	0.00	0.00	1.05	1.65	0.00	0.00	0.00	1.00	1.00	0.15	0.00	0.63	0.45	0.60	0.25	10.27
NSR Abstract Preparation		0.25	0.47					0.30												1.02
Compilation of Exper. Struct.Data	0.05	0.15	0.11				0.05					0.15					0.10		0.05	0.66
A-chains & Nuc. Evals for ENSDF	0.50	0.69	0.59				0.75	0.90				0.65	1.00	0.15		0.63	0.35	0.60	0.20	7.01
Ground & Metastable State Prop.	0.15																			0.15
Non-ENSDF Decay Data Eval.								0.30												0.30
N-induced γ's Data Evals.								0.10												0.10
Nuclear Structure Data Meas.	0.10	0.19	0.24				0.25	0.05												0.83
ENSDF Phys. & Checking Codes												0.20								0.20
VI. Nuclear Reaction Physics	0.00	1.78	1.07	0.30	0.85	1.05	0.25	0.85	0.25	0.50	1.00	0.00	0.10	0.00	0.20	0.00	0.00	0.00	0.00	8.20
Experimental Data Compilation		0.30	0.55					0.10												0.95
ENDF Manuals & Documentation		0.07																		0.07
ENDF Evaluations		0.78			0.25															1.03
Nuclear Reaction Standards		0.00	0.40					0.05	0.15											0.60
Nuclear Model Development		0.20	0.04		0.20	0.10			0.05											0.59
Nucl. Reac. Data Measurements					0.35	0.95	0.25	0.70												2.25
Astrophysics Nuclear Data Needs					0.05					0.50	1.00		0.10		0.20					1.85
Covariances development		0.10																		0.10
Reactor Antineutrino & Dec. Heat		0.13	0.08																	0.21
Verification and Validation		0.20		0.30																0.50
DOE-SC Nucl. Data Funded Staff	0.85	5.18	2.63	2.93	0.95	1.05	1.65	2.55	0.25	0.50	1.00	1.00	1.20	0.15	0.20	0.63	0.50	0.60	0.75	24.57
Staff Supported by Other Funds	0.15	0.59	0.23	0.07	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.94
TOTAL STAFF	1.00	5.77	2.86	3.00	0.95	1.05	1.65	4.45	0.25	0.50	1.00	1.00	1.20	0.15	0.20	0.63	0.50	0.60	0.75	27.51

USNDP FTE plots FY 2019

The plots below give the FTE distribution for Scientific Permanent, Scientific Temporary and Tech. / Admin. FTEs, in pie charts according to activity.







Detailed Status of the Work Plan

Fiscal Year 2019 Report

I. NNDC Facility Operation

A. Management
This task includes planning, budgeting, personnel, interaction with BNL management, and interaction with funding authorities.

B. Library
NNDC maintains an archival collection of low- and intermediate-energy nuclear physics publications. This library supports the NNDC compilation activities, the U.S. nuclear reaction and nuclear structure data evaluation and international nuclear structure evaluation effort.

C. Computer Operation
The NNDC operates seven servers running Red Hat Enterprise Linux in support of its compilation, evaluation, database maintenance, and information dissemination functions. In addition, each staff member has a PC that supports an interface to these Linux servers and supports administrative functions, such as word processing and email. This task includes software upgrades, hardware and software procurements, machine operations and internal user support.

BNL Planned Activities	Status
In collaboration with ITD, ensure continuous availability of mission-critical Web services through full compliance of NNDC's computers with DOE cyber security requirements.	Completed. All servers up to date with security requirements.
Provide technical computer support to NNDC staff, visitors and external collaborators to enable them to effectively and securely use NNDC computing resources, as well as procure computer hardware, software and support services to meet NNDC's computing requirements.	Completed. A significant number of ageing units were replaced.
Manage NNDC/NE cluster.	Three additional servers, a disk unit and a new data switch were bought and integrated in the cluster.

II. Coordination

A. National Coordination
National coordination is required for activities under the US Nuclear Data Program as well as Cross Section Evaluation Working Group. This is mostly performed by the National Nuclear Data Center, with

contributions from other laboratories (USNDP Working Groups and Task Forces as well as CSWEG Committees).

BNL Planned Activities	Status
Prepare FY2020 work plan for USNDP.	Not completed due to migration to a new collaborative platform.
Organize and chair CSEWG Meeting at BNL in November 2018.	Completed.
Organize and chair USNDP Meeting at BNL in November 2018	Completed.
Edit and publish summary reports and proceedings of the CSEWG and USNDP meetings.	Completed.
Maintain CSEWG and USNDP websites.	Ongoing and completed.
Organize mini-CSEWG meeting in the summer if needed	The mini-CSEWG meeting was organized by LANL and took place in April-May 2019.
Host and help organize NDAC meeting	Not performed as there was no NDAC meeting in FY19

LANL Planned Activities	Status
Organize and chair CSEWG Evaluation Committee meeting at BNL.	CSEWG evaluation committee meeting organized
Organize and chair CSEWG Covariance Committee meeting at BNL.	CSEWG covariance committee meeting organized
Organize and chair Nuclear Reaction Working Group.	Chair of Nuclear reaction working group served and gave a talk at CSEWG.

LBNL Planned Activities	Status
Organize the Nuclear Structure High Priority List together with A. Negret from Bucharest.	Completed.
Unplanned activity: Help Organize WANDA meeting	NDREW meeting took place in January 2019 in Washington DC.

ORNL Planned Activities	Status
Coordinate and outreach USNDP Nuclear Astrophysics activities.	Discussions with MSU regarding the future of the REACLIB database

TUNL Planned Activities	Status
Organize and chair USNDP Nuclear Structure Committee.	Continuing.

A. International Coordination

ANL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Provided lecturer at the IAEA-ICTP workshop; participated and contributed to the NSDD

	meeting; participated and contributed at TM on Antineutrino spectra, TM on ENSDF codes development and benchmarking, TM on Nuclear Data for Monitoring applications

BNL Planned Activities	**Status**
Participate in IAEA-sponsored nuclear data activities.	Completed. NNDC members attended INDEN, NSDD and NRDC meetings.
Participate in NEA WPEC annual meeting.	D. Brown and A. Sonzogni attended the 2019 WPEC meeting and attended several sub-groups.
Participate in IAEA CRP and technical meetings.	A. Sonzogni chaired a meeting on nuclear reactor antineutrinos.
Continue to participate in training/mentoring of new ENSDF evaluators through collaborative work.	L. McCutchan co-organized a Trieste training workshop in October 2018.

LANL Planned Activities	**Status**
Participate in NEA WPEC annual meeting.	LANL scientists participated in WPEC meeting
Participate in relevant IAEA coordinated meetings, such as reference input parameter library, nuclear cross section standards, and photo-nuclear data.	LANL scientists participated in these IAEA coordinated meetings
Host a couple of international visitors to LANL to collaborate on the evaluation of reaction data.	There were no international visitors this fiscal year.
Host a couple of international visitors to collaborate on reaction experiments at LANSCE.	Hosted a long-term visitor from KAERI, and one scientist from Charles University, Prague.

LBNL Planned Activities	**Status**
Coordinate EGAF and RIPL evaluations with the IAEA.	Continuing.
Coordinate the development of a new continuum reaction/gamma-ray database with the IAEA and researchers at the Oslo Cyclotron Laboratory. Also coordinate to create a (n,n') database with the IAEA.	Continuing. An article was published on the properties of ^{140}La using the ^{139}La (n,γ) reaction. Another article on level densities using the ^{239}Pu (d,pγ)^{240}Pu reaction was published in collaboration with the Oslo group.
Coordinate LBNL/Budapest/FRM-II/Julich Trans Actinide Nuclear Data Evaluation and Measurement (TANDEM) collaboration to measure actinide neutron cross sections.	Continuing.

MSU Planned Activities	**Status**
Participate in IAEA-sponsored nuclear data activities.	Completed. Jun Chen participated and presented talks remotely at 2019 NSDD meeting in April and 2018 ENSDF code meeting in December at Vienna.

ORNL Planned Activities	**Status**

Participate in IAEA-sponsored nuclear data activities.	Michael Smith presented details on several USNDP data activities at Plenary talk at ND2019. Murray Martin lectured at IAEA Trieste Workshop in October 2018. Caroline Nesaraja attended NSDD Meeting in Vienna in April 2019.

TAMU Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Attended NSDD meeting. Participated in ND2019

TUNL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Attended NSDD meeting.

III. Nuclear Physics Databases

A. Nuclear Science References (NSR)

The NNDC is responsible for NSR, the bibliographic database for nuclear physics research. This task includes quality control, file update and maintenance, and file distribution to collaborators. Updates are done on a continuing basis. The preparation of NSR entries is given under Nuclear Structure Physics.

BNL Planned Activities	Status
Distribute database to collaborators.	NSR database was distributed to the IAEA on a monthly basis.
Perform Database updates and maintenance.	NSR was updated about 100 times, and cybersecurity updates were implemented.
Continue joint project with the NRDC network to transfer missing nuclear reaction references to NSR.	A new project to improve compilation of fission yield started, jointly supported by NA22.

B. Experimental Nuclear Structure Data (XUNDL)

The NNDC is responsible for maintaining and providing access to the XUNDL database. This database contains compilations (in ENSDF format) of recently published or completed level-structure data for high-spin and low-spin physics. The NNDC coordinates this work and updates the database as new/revised data sets are received from collaborators.

BNL Planned Activities	Status
Perform Weekly update of the database using input received from compilers.	Completed.
Distribute database twice a year to the NSDD network	Completed.

Distribute ENSDF database to collaborators on a monthly basis.	Completed.

C. Evaluated Nuclear Structure Data File (ENSDF)

The NNDC is responsible for ENSDF, a database of evaluated experimental nuclear structure and decay data. The NNDC is responsible for format and content checking, preparation of manuscript, and quality control (review) of evaluations submitted for inclusion. The NNDC maintains the database, which includes database updates and distribution to collaborators. Corrections are implemented on a continuing basis.

BNL Planned Activities	Status
Maintain ENSDF database, includes continuous updating.	Completed.
Process evaluations received from NSDD evaluators.	Completed.
Distribute ENSDF database to collaborators on a monthly basis.	Completed. ENSDF is archived on a monthly basis and made available through the NNDC website.

D. Numerical Nuclear Data (NuDat)

The NNDC is responsible for NuDat, which consists of a database and a suite of codes that access it, allowing web users to search for level and γ-ray properties extracted from ENSDF, ground and meta-stable state properties (Wallet Cards), and atomic and nuclear radiations derived from ENSDF. Additionally, NuDat contains an interactive Chart of Nuclides and interactive level schemes.

BNL Planned Activities	Status
Update NuDat database as necessary.	Completed.

D. Experimental Reaction Data File (EXFOR)

The NNDC is responsible for maintaining the EXFOR database at BNL. This database contains experimental nuclear reaction data for incident energies below 1 GeV, including neutron-induced reactions and reactions with incident charged particles of mass A ≤ 12. Many groups worldwide compile experimental data and send it to the central database in Vienna in the EXFOR format. Then, each group is responsible to update its own database. The effort described here includes quality control, file update and data transfer activities. The NNDC database is updated, as compilations are exchanged and checked from the compiling centers. The compilation activity is given under Nuclear Reaction Physics.

BNL Planned Activities	Status
Update EXFOR database with compilations from cooperating centers (500 entries expected). The NNDC compilation work can be found under Nuclear Reaction Physics, section V of the present document.	Completed. EXFOR database was updated 15 times. A project to produce a JSON output of fission yield data started, jointly funded by NA22.

E. Evaluated Nuclear Data File (ENDF)

The NNDC is responsible for ENDF, a database of evaluated nuclear data required for many nuclear applications. The work is organized under the Cross Section Evaluation Working Group (CSEWG), coordinated by the NNDC. The ENDF file contains complete descriptions of nuclear reactions of neutrons with many nuclides and elements for energies up to 20 MeV and radiations from radioactive decay. A number of evaluations for energies up to 150 MeV and for incident charged particles and photons are also included. The data are stored in the ENDF format developed at NNDC in the 1960s and adopted as an international standard. In addition to the U.S. library, ENDF/B, the database contains evaluated data libraries from the European Union, Japan, Russia, and China. This activity includes the processing and quality control for the U.S. ENDF/B library, the distribution of this database in the United States and the exchange of libraries internationally. New evaluations for the next release of the library, ENDF/B-VIII.0, are assembled, tested and made available to users through NNDC's Web servers and GForge collaboration server.

BNL Planned Activities	Status
Maintain and improve Sigma database and web interface for users without specialized knowledge of ENDF-6 format. (See also information dissemination, chapter IV)	Not performed due to personnel shortage.
Maintain and extend ADVANCE, the ENDF continuous integration system that continually checks for modification to the ENDF database then runs all available tests on the changed data files.	Completed.

F. Database Software Maintenance

This activity includes software bug fixes and enhancements for the five nuclear physics databases maintained by NNDC.

BNL Planned Activities	Status
Fix bugs and develop enhancements for the nuclear physics databases maintained by NNDC.	Completed.

G. Future Database Systems Development

The multi-year effort to migrate the USNDP databases to a LINUX/MySQL environment was completed in FY2009. Afterwards, several follow-up tasks needed to be performed. A new web interface, complementary to the existing one, should be developed to facilitate the retrieval of experimental data in EXFOR by non-ENDF users, such as nuclear astrophysicists. This interface should focus on the relevant experimental data, such as a full reference to the publication, a comprehensive reaction description and the experimental data. The existing interface, giving access to the complete compilation (with more details than the reference, reaction and data) will be retained and will still be accessible to users who need it. Also, a new ENDF interface should be developed for users who do not possess specialized knowledge of ENDF-6 format.

BNL Planned Activities	Status
Upgrade the Linux/MySQL server software to fix bugs, provide new functionalities and improve the system's performance, security and reliability.	Completed. New software versions were installed.
Maintain MySQL database system software for automated replication of updates from the internal database server to the external for continuing compliance with DOE cyber security requirements.	Completed. However, we are now running MariaDB.

IV. Information Dissemination

The goal of the dissemination activities of the USNDP is to provide scientists and engineers with nuclear data from the USNDP-maintained nuclear databases in a variety of user-friendly formats and media.

A. Nuclear Data Sheets

The USNDP provides some paper publications as well as electronic access to the nuclear physics databases that it maintains. This includes the Nuclear Data Sheets journal published by Elsevier and various versions of the Nuclear Wallet Cards.

BNL Planned Activities	Status
Prepare issues of Nuclear Data Sheets for publication.	8 issues of Nuclear Data Sheets, including a Special Issue devoted to nuclear reaction data.
Work on a new version of Nuclear Wallet Cards.	A new code was developed to generate print and mobile versions of Nuclear Wallet Cards.

MSU Planned Activities	Status
Continue development of software for Nuclear Data Sheets publication.	The JAVA-NDS code was updated and distributed to collaborators.

B. Customer Services

This task accounts for the non-electronic services which the USNDP renders to customers. At the scientific staff level, this means direct assistance to users needing advice from nuclear data experts or advice on solving complex queries via electronic access to the database. The NNDC staff allocation at the support level is for maintaining a "help desk" and for administrative/clerical support of its customer services.

BNL Planned Activities	Status
Provide technical support to nuclear data end-users as necessary.	About 250 requests for articles were received by our librarian. Additionally, a large number of emails, about 150, were answered with different type of data requests.
Maintain Comments/Questions for all databases and web products	No longer maintained as users communicate only through e-mail.

C. Web site maintenance

The NNDC provides electronic access to the nuclear physics databases that it maintains on behalf of the USNDP as well as access to other nuclear physics information through its Web site. Other USNDP members also offer nuclear physics information through their websites. These services require resources to maintain currency and improve performance.

BNL Planned Activities	Status
Solicit user suggestions on enhancements to the ENSDF, NSR, NuDat and Sigma web interfaces and be responsive to those needs. Expand search capabilities of ENSDF.	Consultations were held with several physicists as well as preparations were made to have a table at the DNP APS meeting in October 2019.
Maintain web interfaces for ENDF and EXFOR databases.	ENDF and EXFOR database Web interfaces were updated in collaboration with the IAEA.
Maintain currency of the CSEWG, USNDP and the NNDC web sites, proactively respond to the users requests.	Completed.
Maintain the NNDC Web Services availability on the 99% and higher level.	Successfully kept NNDC Web Services downtime at a maximum of eight hours only for the whole year (~99.9% uptime).
Strictly follow all BNL and DOE cybersecurity rules and regulations during the Web application design, development and implementation. Address issues that arise during BNL scans	Completed.
Upgrade GForge server software to provide more powerful and advanced functionalities in the NNDC collaboration services.	Maintenance on the GForge continued; however, it was decided to replace the server with a new one running GitLab.
Make progress with modernization of the web site, enhancing capabilities and follow industry best practices.	Considerable effort spent on the main web page as well as on NuDat, CapGam and ENSDF thanks to the arrival of Ben Shu.

ORNL Planned Activities	Status
Expansion of features of our online software suite that supports the new mass evaluation effort, including new evaluation tools and dissemination capabilities.	No funding was available for the planned expansion of this activity. A new set of compiled masses from McMaster University were uploaded to the system.

TUNL Planned Activities	Status
Continue to improve the TUNL website and provide access to new information on A = 3 - 20 nuclei.	Continuing.
Continue to prepare new PDF and HTML documents of the most recent TUNL reviews.	Continuing.
Continue to provide PDF and HTML documents for FAS reviews for the A = 3 - 20 series with the most current NNDC reference keys and with the direct hyperlink of reference with TUNL keys.	Continuing.

Continue to provide Energy Level Diagrams (in GIF, PDF and EPS/PS formats) to accompany the PDF and HTML documents for the most recent TUNL reviews and preliminary reports, and for the earlier FAS reviews.	Continuing.
Provide compiled and evaluated data on the decay of unstable ground states and on structure data from thermal neutron capture.	Continuing.
Provide compiled data related to the level parameters for A = 3 - 20 nuclei populated in proton- and alpha-particle-induced reactions.	Continuing.
Provide online access of TUNL dissertations collection.	Continuing. The collection is essentially complete and includes all presently available documents.

V. Nuclear Structure Physics

The goal of the dissemination activities of the USNDP is to provide scientists and engineers with nuclear data from the USNDP-maintained nuclear databases in a variety of user-friendly formats and media.

A. NSR Abstract Preparation

The literature search and preparation of KEYWORD abstracts for publications included in NSR require scientific expertise. BNL continues to have the overall responsibility for this database. Similar contributions from other external collaborators are expected. These will be checked and edited by BNL as necessary before being added to the database.

BNL Planned Activities	Status
Prepare entries for about 3,100 new references, and keyword abstracts for 2,000 of them. Provide coverage for 80 major journals, including complete coverage of Physical Review C and Nuclear Physics A.	Completed. 3,337 new references were added, and 1,632 references were keyworded. A large number of materials received from John Hardy and Robert Haight will be added to the library and NSR if applicable.

B. Compilation of Experimental Nuclear Structure Data

This activity involves compilation of recently published or completed experimental nuclear structure data for inclusion in XUNDL. The compilation is managed by the NNDC.

ANL Planned Activities	Status
Compile and review datasets for recently published experimental nuclear structure data for inclusion in the XUNDL database. Interact with the authors for requesting additional experimental data or for further clarification of the published results.	Data from 5 articles, encompassing 10 datasets, were compiled for inclusion into the XUNDL database.

BNL Planned Activities	Status
Compile new B(E2) experimental data. Continue work on a B(E2) evaluation project (in collaboration with McMaster and Central Michigan Universities). Publish an experimental methods analysis and start on Grodzin's formula fits.	Continuing, 24 datasets were compiled.
Compile new double-beta decay experimental data. Start working on a data project with Kiev Institute for Nuclear Research.	Dr. V. Tretyak (KINR) visit to NNDC to continue this work.
Maintain, update and distribute XUNDL.	Completed.
Compile data sets (in ENSDF format) for current experimental nuclear structure publication. Scan the webpages of prominent journals in nuclear physics for new papers. Review compiled data sets submitted by other data centers prior to inclusion in the XUNDL database. Communicate with the authors of the original papers for data-related problems and to request additional details of unpublished data.	Data from 106 articles, encompassing 234 datasets, were compiled for inclusion into the XUNDL database. A total of 448 datasets were reviewed prior to their inclusion into the database.
Compile new mass measurements and submit data file to nuclearmasses.org webpage at ORNL. (McMaster University).	Continuing.
Unplanned activity: Prepublication compilation of Physical Review C articles.	In March 2018, a project started with Physical Review C journal to check and compile papers prior to their publication. This has become an on-going effort.

LBNL Planned Activities	Status
Perform XUNDL compilation.	Data from 5 articles, encompassing 6 datasets, were compiled for inclusion into the XUNDL database.

MSU Planned Activities	Status
Compile datasets for at least 50 journal papers.	Data from 54 articles, encompassing 152 datasets, were compiled for inclusion into the XUNDL database.

ORNL Planned Activities	Status
Compile XUNDL datasets as required.	No XUNDL compilations were requested in FY2019.

TUNL Planned Activities	Status
Compile datasets for current experimental nuclear structure data publications on A=2-20 nuclei for inclusion in the XUNDL database.	Data from 26 articles, encompassing 33 datasets, were compiled for inclusion into the XUNDL database.

C. A-Chains and Nuclides Evaluations for ENSDF

USNDP evaluates nuclear structure and decay data for inclusion in the ENSDF database. This effort includes the critical analysis of all available experimental nuclear structure and radioactive decay data for a nuclide or a group of related nuclei to deduce recommended values from the measured data and prepare a file in ENSDF format that is the basis for publications in Nuclear Data Sheets and is used to update the contents of the USNDP nuclear structure and decay database, ENSDF. The US effort is supplemented by foreign contributions prepared under the auspices of the IAEA-sponsored international Nuclear Structure and Decay Data network.

ANL Planned Activities	Status
Evaluate at least 1 mass chain from the ANL region of responsibility	A=205 was completed and submitted to NNDC, started working on A=203.
Review mass chain evaluations, as requested.	Review of A=100 (completed) and 190 (ongoing)

BNL Planned Activities	Status
At least 4 mass chains, or their equivalent nuclides, will be evaluated.	51 nuclides were evaluated, including 2.5 mass chains.
At least 4 mass chains, or their equivalent nuclides, will be reviewed.	7 mass chains were reviewed.
Update ENSDF for the identification of new nuclides and for the first publication on the findings of the excited states of nuclides. Collaborate with new centers/evaluators as part of mentoring process, as needed (McMaster).	Completed.
All evaluations submitted for publications will be edited including checking for their format and physics content. Extensive changes are often made by NNDC staff.	All mass chains were carefully reviewed and edited prior to their inclusion into the database in order to enhance the quality of ENSDF evaluations.
Continue mentoring new ENSDF evaluators.	Mentoring for new hires, Shaofei Zhu, Andrea Mattera and Adam Hayes started.

LBNL Planned Activities	Status
Evaluate the equivalent of at least 3 mass chains (30 nuclides), including a minimum of one from the A=21-30 region. Emphasis will be placed on evaluating data of current interest to the nuclear structure and nuclear application communities.	30 nuclides were evaluated from 2.5 mass chains.
Review mass-chain evaluations, as requested.	Two reviews were completed.
Train new compilers/evaluators.	Not performed as there were no new evaluators to mentor.

MSU Planned Activities	Status
Evaluate the equivalent of at least 1 mass chain.	Two mass chains (30 nuclides) were evaluated and submitted to ENSDF.
Review mass-chain evaluations, as requested.	One mass chain (18 nuclides) was reviewed

ORNL Planned Activities	Status
1 equivalent mass chains and the data for new nuclides will be evaluated. Mass chains will be reviewed as requested.	A=66 evaluation submitted (Nesaraja) A=98 review in progress (Nesaraja) A=218 evaluation completed (Martin co-author) A=242 corrections in progress based on referee comments (Martin) Radius parameters for alpha decay of even-even nuclides - review in progress (Martin) Guidelines for Evaluators - revision completed (Martin)

TAMU Planned Activities	Status
At least 1 mass chain, or their equivalent nuclides, will be evaluated.	Submitted A=147 with 17 nuclei. A=177 was reviewed.

TUNL Planned Activities	Status
Evaluate about 1-2 A-chains per year for publication in Nuclear Data Sheets and inclusion in the ENSDF database.	We continue to make progress on an evaluation of A=13 nuclides.
Evaluate and update ENSDF for A=2-20 near drip-line nuclides, especially for first observations or when ENSDF has no previous data set.	Completed evaluations of 5H, 8C, 19B, 19N, 20B, 20N, 21B and we made progress on evaluations of 16Ne and 17O.
Update various reaction data sets in ENSDF, such as for beta-decay and beta-delayed particle emission.	We focused on nuclide evaluations and did not update any individual reactions.

D. Ground and Metastable State Properties

ANL Planned Activities	Status
Compile and evaluate atomic masses and complementary nuclear structure data for the Atomic Mass Evaluation and the NUBASE evaluation ofnuclear properties.	Evaluations for 50 nuclides were completed; the work is continuing.

BNL Planned Activities	Status
Update Nuclear Wallet Cards database as new information becomes available	Continuing activity.

E. Non-ENSDF Decay Data Evaluations

ANL Planned Activities	Status
Evaluate and publish nuclear structure and decay data evaluations for selected radionuclides of relevance to medical and energy-related applications	Continuing.

BNL Planned Activities	Status
Contribute to the beta-delayed neutron emitters CRP	Considerable amount of effort went in updating the final table as well as its corresponding article, which should be published in 2020.

LBNL Planned Activities	Status
Produce a horizontal evaluation of beta-delayed proton emitters.	Completed. The article will be published in 2020.

F. Neutron-induced γ-Ray Data Evaluation

LBNL Planned Activities	Status
Continue to maintain and develop the EGAF database. Update EGAF prompt gamma-ray cross sections from new measurements. Add activation data to the EGAF file. Include improved nuclear structure data for the RIPL library in EGAF datasets. Develop a Nuclear Data Sheet publication format for EGAF data.	Continuing.
Collaborate with Charles University (Prague) to perform statistical-model calculations of quasi-continuum γ-ray cascade information and generate ENDF-format capture γ-ray datasets for use with MCNP and other transport-code calculations.	This activity has been discontinued.
Collaborate with the University of Oslo to measure low-energy photon strength functions and level densities.	Continuing.
Work to develop a database of (n, n'gamma), starting with the compilation and release of the Atlas of Inelastic Scattering of Reactor Fast Neutrons. The data is now available on the web at http://nucleardata.berkley.edu and is being integrated with modern structure data from ENSDF.	Continuing.
Continue to update the Inelastic Scattering of Reactor Fast Neutrons Database (e.g., the	Continuing.

"Baghdad Atlas") with modern ENSDF data, http://nucleardata.berkeley.edu	

G. Nuclear Structure Data Measurements

ANL Planned Activities	Status
Participate in nuclear physics research activities at ANL, MSU and other nuclear physics user facilities with main emphasis on decay studies of neutron-rich nuclei, spectroscopy of heavy actinide nuclei and nuclei far from the line of stability.	Participated in research activities at ANL and MSU related to nuclear structure, astrophysics and applied nuclear physics.

BNL Planned Activities	Status
Precisely determine decay schemes of relevant medical isotopes using state-of-the-art gamma-ray spectroscopy.	Assay of 72Se-72As decay performed at UMASS Lowell. Effort is continuing.
Participate in beta-decay measurements at facilities such as Argonne's CARIBU with an emphasis on nuclei relevant to decay heat, antineutrino spectra and delayed nu-bar.	Analysis of the decay of 141Cs, 141Ba and 142La from CARIBU experiments was completed. Effort is continuing.
Driven by deficiencies in nuclear data on the neutron-rich side of ^{208}Pb, complete and analyze deep-inelastic reaction experiments performed at Argonne.	Due to delayed start of postdoctoral researchers, this activity was postponed.

LANL Planned Activities	Status
Analyze and publish the prompt gamma-ray data taken on fission products of mass range ~100, using the GEANIE array.	Completed and published an article, see PRC 99, 024606 (2019).
Publish the gamma-ray production cross section on Xe-126, which was measured using the GEANIE array.	Completed and published an article, see PRC 98, 064606 (2018).

LBNL Planned Activities	Status
Continue to update the Inelastic Scattering of Reactor Fast Neutrons Database (e.g., the "Baghdad Atlas") with modern ENSDF data. (http://nucleardata.berkeley.edu).	Continuing.
Perform DICEBOX statistical model calculations to determine total radiative cross sections and elucidate nuclear level spins and parities.	Continuing.

H. ENSDF Physics and Checking Codes

BNL Planned Activities	Status

Maintain and upgrade ENSDF checking and physics programs for format changes as required.	Updates were performed.
Move codes off the Lahey compiler and make compatible with GFORTRAN.	All codes were moved.

MSU Planned Activities	Status
Maintain and improve the JAVA-NDS code, and the xls2ens and ens2xls Python codes. Maintain and improve the new Java code-Consistency Check-for checking physics and consistency among ENSDF datasets. Develop new utility and analysis codes used by evaluators, as requested. An example is a Java code for calculating angular distribution or correlation coefficients for a given Jpi sequence and for searching for possible Jpi sequences for given coefficients.	Continued to develop new codes, maintain and improve existing codes at MSU: Java-NDS Java-RULER ConsistencyCheck KeynumberCheck Excel2ENSDF ENSDFSearch

V. Nuclear Reaction Physics

A. Experimental Data Compilation

The NNDC, as part of a larger international cooperation, has the responsibility for compiling experimental nuclear reaction data that have been produced in the U.S. and Canada.

BNL Planned Activities	Status
Compile experimental data for neutron, charged particle, and photon induced reactions from 120 publications.	125 new EXFOR entries were compiled, and 220 were corrected.
Explore possibilities of recovering previously unobtainable reaction data and proactively respond to users' needs.	An effort to improve the compilation of fission yield data has started jointly funded by NA22. A new contract for Olena Gritzay was started.

B. ENDF Manuals and Documentation

The NNDC is responsible for maintaining the format and procedures manual for the ENDF system, as well as producing the documentation supporting the contents of the ENDF/B library.

BNL Planned Activities	Status
Maintain GForge version of the ENDF-6 formats manual up-to-date with CSEWG endorsed format changes. Issue official release of the manual.	4 format proposals were submitted and 2 accepted and merged into the manual. 2 more require revisions and are expected to be approved at the next CSEWG meeting.
Automate the generation and posting of the latest unofficial version of the ENDF-6 formats manual.	Continuing.

C. ENDF Evaluations

Evaluated nuclear reaction data, for applications and basic science needs, are stored in the ENDF database, which is maintained by BNL. As chair of the CSEWG evaluation committee, LANL staff works with BNL to ensure quality control, particularly for new evaluations. New evaluations funded primarily from other sources are prepared for archival in the ENDF library. BNL, LANL, LLNL and ORNL provided neutron, proton and photonuclear reaction data evaluations.

BNL Planned Activities	**Status**
Respond to user needs for evaluated nuclear reaction data.	Continuing.
Collect and address users feedback related to the ENDF library.	All ENDF user feedback is collected on the GForge issue tracker for the relevant ENDF sub-library.
Complete evaluation of 56Fe in the frame of the CIELO project. Work with CSEWG on upgraded evaluations for future release of the ENDF/B library.	A final revision of the CIELO 56Fe evaluation was prepared and is ready for submission to ENDF.
Improve methodology for providing covariance data in the resonance region and in the fast neutron region to the next release of ENDF.	In collaboration with SULI students, developed an API for the *Atlas of Neutron Resonances* electronic files and refined the algorithm for the determination of the mean level spacing.
In collaboration with LLNL, coordinate the development of the Generalized Nuclear Data (GND) format as a proposed successor format for ENDF.	Chair the GNDS WPEC Expert Group. Prepared the GNDS-1.9 specifications which were in press at the end of the FY.
Provide production cross sections for medical isotopes.	Mentored SULI Summer student to model isotope-production experiments using the transport code FLUKA. Student developed a preliminary model of a LANL experiment for the production of ^{225}Ac through the irradiation of intermediate-energy protons on ^{232}Th foils.
Improve methodology for generating unresolved resonance region cross section probability distributions.	Continuing. Progress slowed due to insufficient manpower.

LANL Planned Activities	**Status**
Upgrade the LANL ENDF evaluations for U and Pu isotopes that perform well in criticality benchmarks, including new theoretical development of statistical model for deformed systems. Close collaboration with international nuclear data library activities, CIELO coordinated under OECD/NEA.	Preliminary evaluations of U236 produced based on the DANCE neutron capture data. The covariance data of Pu239 elastic scattering angular distributions investigated.
Provide upgraded ENDF evaluated data files for light and medium mass elements and perform criticality benchmarks.	New evaluation of Pb208 produced and provided to benchmark test calculations.

Provide new evaluations of the prompt fission neutron spectra for major actinides, based on the Monte Carlo technique as well as the deterministic method including pre-equilibrium emissions at high energies.	Angular distributions of pre-fission neutron evaporation were added to the prompt neutron spectra, which agree well with the ChiNu data of Pu239. A PRL paper by Kelly was published.
Improve photon production data for neutron capture and inelastic scattering, which will be used in prompt gamma-ray spectroscopy.	The photo-production cross sections of U238 and tungsten isotopes were calculated and compared with the experimental data by Strasbourg group. The results were presented at ND2019.

LLNL Planned Activities	**Status**
Perform new evaluations as per LLNL customer requests and submit these and other LLNL generated evaluations into ENDF.	Continuing.
In collaboration with BNL, coordinate the development of the Generalized Nuclear Data Structure (GNDS) format as a proposed successor format for ENDF.	Prepared the GNDS-1.9 specifications which were in press at the end of the FY.
Finish converting LLNL's 'Charged Particle Library' to ENDF format for targets up to A=7, to make candidates for inclusion in ENDF/B-VIII when/if they are improvements on existing evaluations.	Continuing.
Perform R-matrix fits for proton and alpha particles incident on selected medium-mass nuclei ($4 < A < 50$), to accurately describe low-energy resonances and make candidates for future ENDF/B-VIII evaluations. Translate R-matrix evaluation parameters between those of fitting codes to and from GNDS and ENDF libraries.	Continuing.

D. Nuclear Reaction Standards

Nearly all neutron cross section measurements are made relative to a neutron cross section standard such as the hydrogen elastic cross section. Maintaining accurate current values for the standard cross sections is the primary objective of this task that can be most efficiently accomplished through international cooperation. A new international evaluation of the neutron cross-section standards is now underway. It is important to improve the standards database and procedures for evaluations in preparation for new evaluations of the standards. To assist in this, an IAEA data development project "maintenance of the neutron cross section standards" was initiated to ensure that we are prepared for the next evaluations of the neutron cross section standards. Historically the standards evaluation activity has included data other than the cross section standards, i.e. the thermal constants and the 252Cf spontaneous fission neutron spectrum. Recently the scope has been broadened, largely through the data development project, to include an investigation of possible inelastic scattering cross section reference standards; considering adding additional standards energy ranges for the Au(n,γ) cross section; and proposing updates for the evaluations of the 252Cf spontaneous fission neutron spectrum and the 235U thermal neutron-induced fission neutron spectrum.

LANL Planned Activities	Status
Participate in the international effort to reevaluate the light-element standard cross sections with LANL leadership and investigate the nature of output covariance data from R-matrix analyses of systems containing the light-element standard cross sections.	LANL scientists participated in the international cooperative efforts on the standards organized by IAEA.
Incorporate the cross section standards into the new ENDF evaluations, and perform validation tests with integral measurements.	The new U236 fission cross section evaluated based on the new U235 standards, and a new data file created. ChiNu project has incorporated the 6Li(n,a) cross sections from the new ENDF and performed validation tests as a part of detector response function studies in the Li-glass detector array.
Perform the precision measurements on ^{6}Li(n,α)t and ^{6}Li(n,α)dn using CLYC detectors, in order to improve uncertainties En > 1 MeV due to the triton breakup ambiguity shown in previous measurements.	Measurements were completed and analyses are ongoing. Preliminary results have been presented in various meetings.

BNL Planned Activities (Allan Carlson)	Status
Participate at international meetings devoted to a better understanding of Unrecognized Sources of Uncertainties.	Two meetings at the IAEA in December and June were held. The understanding of these uncertainties led to the more general term "sources" rather than just "systematic" as was initially understood. The objective of our work has been to develop qualitative and quantitative procedures for revealing and including USU estimates in nuclear data evaluations involving experimental input data. A paper, "HPRL – International cooperation to identify and monitor priority nuclear data needs for nuclear applications", was submitted for publication in the ND-2019 proceedings. The OECD-NEA High Priority Request List (HPRL) is a point of reference to guide and stimulate the improvement of nuclear data for nuclear energy and other applications, and a tool to bridge the gap between data users and producers.
Start research project on ^{252}Cf nu-bar.	Work was started on nu bar of ^{252}Cf associated with those IAEA consultants' meetings on uncertainty quantification in standards evaluations. This work resulted from a meeting (unpublished) that I chaired when there was a definite difference in nu bar for bath versus accelerator measurements.

	For the hydrogen scattering experiment, we are very close to finishing the work. The present concerns relate to the determination of the efficiency of the detector used for the experiment. At lower energies the efficiency is relative to the ^{252}Cf standard spectrum. At higher energies sophisticated calculations are used. Those calculations are now being discussed in the collaboration.

E. Nuclear Model Development

This task covers activities such as development and validation of nuclear reaction models used for prediction of nuclear reaction cross sections. The two major codes are CoH3 (LANL) and EMPIRE (BNL). Measurements made by ANL and LANL along with other measurements made with DOE low-energy physics funds will play a crucial role in the validation of the models in these computer codes. BNL and LANL will also participate in the IAEA Coordinated Research Project RIPL to improve accuracy and reliability of input parameters used in nuclear reaction calculations

BNL Planned Activities	Status
Continue to improve reaction modeling in the EMPIRE code, maintain code's numerical integrity and enhance user friendly GUI. Improve EMPIREcovariance capabilities for fast neutrons	Submitted study of the response of reaction observables to level density and other parameters to Phys. Rev. C.

LANL Planned Activities	Status
Continue to develop a microscopic description of fission process in the fast energy range, which includes Class-I and Class-II coupling, as well as penetrability calculations through arbitrary fission barrier shapes. Implement the theory into the Hauser-Feshbach code to facilitate actinide evaluations.	This effort continued. A new method to calculate the fission penetrability implemented in the Hauser-Feshbach code. However, more work is needed to utilize the fission potential energy surface data.
Continue to develop a coupled-channels Hauser-Feshbach method to neutron capture process for deformed targets including M1 scissors mode, in support of DANCE and GEANIE measurements, and fission cycle in r-process nucleo-synthesis studies.	This effort continued. The new coupled-channels Hauser-Feshbach formalisms, as well as the M1 scissors mode, is now fully functional.
Study neutron inelastic scattering from deformed nuclei in the fast energy range, to which theoretical calculations are essential, in collaboration with CEA, France and IAEA.	CEA, CNRS in Strasbourg, IAEA, and LANL presented the results at ND2019, and a full publication is under preparation.
Continue prompt fission neutron and gamma-ray spectrum calculations with the Monte Carlo method to ^{235}U, ^{239}Pu, and ^{252}Cf, and compare	This effort continued, and the current Monte Carlo technique for the prompt fission and gamma

available experimental information. Extend the neutron incident range to cover applications.	spectra has been extended to the higher energy range.
Develop new width fluctuation correction calculation for the deformed systems, based on the Gaussian Orthogonal Ensemble and the Monte Carlo technique, which includes both the coupled and uncoupled channels in a consistent way.	The new fluctuation correction model has been developed and implemented into the Hauser-Feshbach code.
Continue to develop Monte-Carlo Hauser-Feshbach code, CGM, that can be used as an event generator in radiation transport codes.	Development continued. The CGM and CGMF codes are incorporated into the MCNP radiation transport code.
Develop a semi-microscopic level density model based on the Gaussian Orthogonal Ensemble.	Development of the level density model based on the FRDM and GOE models continued.

LBNL Planned Activities	**Status**
Work with the LANL group to update and improve gamma-ray data for neutron-induced reactions using the CoH reaction modeling code.	Continuing.
Work with LLNL to benchmark the newly published RAINIER (Randomizer of Assorted Initial Nuclear Intensities and Emissions of Radiation) statistical model code against gamma-cascade calculations performed using TALYS and CoH.	The focus of this effort has moved over to using Talys and CoH to mode gamma-cascade calculations. Work on RAINIER may restart if warranted.
Use the newly published FIER (Fission Induced Electromagnetic Response) delayed fission gamma-decay code to address deficiencies in fission product yields and decay data	Continuing.

F. Nuclear Reaction Data Measurements

ANL Planned Activities	**Status**
Continue participating at MANTRA research activities at ANL	Completed.

LANL Planned Activities	**Status**
Perform the precision measurement on the prompt fission-neutron spectrum for fission induced by neutrons of 0.5 to 200 MeV on ^{235}U and ^{239}Pu. With the high energy neutron detector array, the measurement will be extended to the outgoing neutrons up to 12 MeV.	Results were presented in various meetings and the work on preequilibrium asymmetries in the 239Pu(n,f) prompt fission neutron spectrum was published in PRL 122, 072503 (2019).
Analyze and publish radiative strength functions in neutron capture on ^{234,236,238}U in collaboration with Theory Division at LANL.	Continuing.
Transmission experiments on oxygen or neon isotopes at neutron energies from 1 MeV to 200 MeV for the interest of Dispersive Optical Model	Measurements were completed and analyses are ongoing.

potential investigation and some level information near particle thresholds.	
Perform the measurements of the Pu-239 fission cross section relative to H(n,n), using the TPC.	Continuing.
Perform the precision measurement on the $^{16}O(n,\alpha)$ reaction cross section at LANSCE	Preliminary cross sections have been presented in meetings and the result with uncertainties is being finalized.

LBNL Planned Activities	**Status**
Measure thermal (n,γ) cross sections using guided neutron beams in collaboration with the Budapest Research Centre and at the Munich Reactor.	Discontinued due to other unplanned project work.
Established and measure (n,n'g) measurement capabilities at the LBNL 88" cyclotron, and the UC Berkeley neutron generator laboratory. Measure gamma ray partial cross sections.	Continuing.
Unplanned activity: Perform measurements of temporally- and spatially-resolved neutron production in a sheared-low stabilized Z-pinch.	Published in Nuclear Inst. and Methods in Phys. A947 162764.

G. Astrophysics Nuclear Data Needs

The objective of this activity is to support the nuclear data needs of the increasingly sophisticated simulations of astrophysical phenomena. The Astrophysics Task Force of the USNDP, presently chaired by ORNL, serves to improve communication and coordination of nuclear data evaluation activities relevant for studies in astrophysics.

BNL Planned Activities	**Status**
Work on neutron capture and fission integral values and their uncertainties in the energy region of interest for nuclear astrophysics.	Maxwellian-averaged cross sections and uncertainties for ENDF/B-VIII.0 library have been calculated and published in Nuclear Data Sheets.
Evaluate nuclear astrophysics potential of EXFOR library.	Work is in progress on evaluation of astrophysical potential of the EXFOR library.

LANL Planned Activities	**Status**
Continue improvement of neutron capture modelling for calculating neutron capture rates off-stability to s and r-process hydro-dynamics simulations. Our focus is on a semi-microscopic level density modeling including spin and parity distributions, which is based on nuclear mean-fields theories.	Development of the semi-microscopic level density model based on the finite-range droplet model is continuing. The obtained level densities for more than 200 nuclei were statistically analyzed and compared with the RIPL compilation.
Continue development of simultaneous beta-delayed neutron and fission calculations,and provide the reaction rates for the fission cycle study in the r-process nucleo-synthesis.	A large-scale beta-delayed neutron and fission calculation performed and and the numerical tables were made available as a supplemental material of Atomic Data and Nuclear Data Tables 125, 1 (2019).

Perform measurements on (n,p) and (n,α) cross sections on the isotopes of interest for better understanding of p-process nucleosynthesis, in conjunction with the improvement on Hauser-Feshbach calculations	Measurement on 75As(n,p) (n,a) is planned for the impact on p-process nucleosynthesis and improved Hauser-Feshbach calculations have been applied for NZ data analyses.

ORNL Planned Activities	**Status**
Continue assessments of capture reactions on p-rich unstable nuclides that are important for novae and X-ray bursts. The nuclei to be studied are those planned for measurements at radioactive beam facilities.	Assessing levels in 16O+p and 17F+p capture for future measurement at FRIB. Assessments of the rate uncertainties of proton capture on light nuclei for nova explosions in progress.
Extract spectroscopic information (excitation energies, spectroscopic factors, spins, parities, ANCs) on nuclei near the N=82 closed shell – 81Ge, 127,129Sn, 135Te - from transfer reaction measurements on radioactive Ge, Sn, and Te nuclei. Use this information to calculate direct capture cross sections needed to model the r-process in supernovae. Develop techniques to quickly provide the nuclear structure information needed for these cross section calculations.	Work completed on level information and direct/semi-direct capture cross sections on 125,127,129,131,133Sn and published in Phys. Rev. C. Work continues on implications of these levels for nuclear structure models. Calculations of direct neutron capture on these nuclei using complementary approach is in progress.

H. Covariances Development

BNL Planned Activities	**Status**
COMMARA-3, a library of covariance matrices including cross-reaction correlations will be produced for the iron evaluations (54,56,57,58Fe) developed within the international CIELO project.	The COMMARA project ended with the passing of Sam Hoblit, nevertheless covariance development continues. As part of GNDS-1.9, we have developed a flexible and simple scheme for storing all covariances currently supported by ENDF-6, in the GNDS format.

I. Reactor Antineutrino Spectra and Decay Heat Calculations

BNL Planned Activities	**Status**
Improve our methods and databases to calculate anti-neutrino spectra for major actinides.	Worked to understand the tension among the latest Daya Bay, PROSPECT results with the ILL electron spectra. Additionally, we have worked on improving the evaluation of the energy released in fission.
Perform decay heat calculations in collaboration with experimental groups.	Decay heat calculations were performed in collaboration with the Valencia and Nantes groups.
Possibly participate in relevant experiments.	No opportunities for experimental activities appeared.

J. Verification and Validation

Quality Assurance (QA) of a nuclear data library requires that all files are checked for integral consistency and conformance with the adopted format. This part of the QA is called verification and is one of the fundamental functions of the National Nuclear Data Center. Furthermore, checking performance of the library against the integral experiments, known as validation, is an important step ensuring usefulness of the library for the end-users. The most extensive validation is performed by LANL and other CSEWG contributors funded with non-DOE-SC sources. The USNDP supports the ultimate validation effort carried out at BNL.

BNL Planned Activities	Status
Establish automatic, real time verification and validation of new/modified ENDF evaluations submitted to the NNDC GForge server.	Progress on this task continues. A new server was bought to replace the previous one, which will be incorporated in the new NNDC cluster.

Appendix A

Fiscal Year 2019 Additional Funding Sources

ANL
Additional support from one LAB 18-1903 funded proposal.

BNL
Additional support for the nuclear data work at the National Nuclear Data Center comes from the following sources: 1. The US Nuclear Criticality Safety Program (NCSP) supports the NNDC services in maintaining NCSP data submitted to the ENDF/B library as well as data development work on evaluations of neutron cross section covariances for criticality safety applications. 2. The Fission in Rapid Process Elements (FIRE) collaboration. 3. Evaluation of energy dependent fission product yields, funded by NA22. 4. Three LAB 18-1903 funded proposals.

LANL
Additional supports for the nuclear data project at LANL are as follows: 1. Advanced Simulation and Computing under NNSA 2. The US Nuclear Criticality Safety Program (NCSP) 3. Evaluation of energy dependent fission product yields, funded by NA22 4. Fission in R-Process Elements (FIRE) collaboration 5. Two LDRDs at LANL 6. Science Campaign support under Office of Experimental Sciences by NNSA.

ORNL
The nuclear data work is partly funded by the DOE-SC Low Energy Nuclear Physics program.

TAMU
Data and experimental activities supported by U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Grant No. DE-FG03-93ER40773.

TUNL
The nuclear data work is partly funded by the DOE-SC Low Energy Nuclear Physics program through a TUNL/NCSU grant.

Appendix B

Fiscal Year 2019 Selected Articles published by USNDP staff

2018BA41 Nucl.Data Sheets 153, 1 (2018)
C.M.Baglin, E.A.McCutchan, S.Basunia, E.Browne
Nuclear Data Sheets for A=170

2018CH54 Nucl.Data Sheets 152, 1 (2018)
J.Chen
Nuclear Data Sheets for A = 38

2018DA21 Phys.Rev. C 98, 064606 (2018)
S.J.Daugherty, J.B.Albert, L.J.Kaufman, M.Devlin, N.Fotiades, R.O.Nelson, M.Krticka
Neutron inelastic scattering measurements on 136Xe at En = 0.7 to 100 MeV

2018DE08 Nucl.Data Sheets 148, 322 (2018)
M.Devlin, J.A.Gomez, K.J.Kelly, R.C.Haight, J.M.O'Donnell, T.N.Taddeucci, H.Y.Lee, S.M.Mosby, B.A.Perdue, N.Fotiades, J.L.Ullmann, C.Y.Wu, B.Bucher, M.Q.Buckner, R.A.Henderson, D.Neudecker, M.C.White, P.Talou, M.E.Rising, C.J.Solomon
The Prompt Fission Neutron Spectrum of 235U(n, f) below 2.5 MeV for Incident Neutrons from 0.7 to 20 MeV

2018GA34 Phys.Rev.Lett. 121, 222501 (2018)
J.M.Gates, G.K.Pang, J.L.Pore, K.E.Gregorich, J.T.Kwarsick, G.Savard, N.E.Esker, M.Kireeff Covo, M.J.Mogannam, J.C.Batchelder, D.L.Bleuel, R.M.Clark, H.L.Crawford, P.Fallon, K.K.Hubbard, A.M.Hurst, I.T.Kolaja, A.O.Macchiavelli, C.Morse, R.Orford, L.Phair, M.A.Stoyer
First Direct Measurements of Superheavy-Element Mass Numbers

2018MC07 Nucl.Data Sheets 152, 331 (2018)
E.A.Mccutchan
Nuclear Data Sheets for A = 136

2018NI14 Phys.Rev. C 98, 054321 (2018)
N.Nica, J.C.Hardy, V.E.Iacob, V.Horvat, H.I.Park, T.A.Werke, K.J.Glennon, C.M.Folden, V.I.Sabla, J.B.Bryant, X.K.James, M.B.Trzhaskovskaya
Precise measurement of αK andαT for the 39.8-keV E3 transition in 103Rh: Test of internal-conversion theory

2018NI16 Nucl.Data Sheets 154, 1 (2018)
N.Nica
Nuclear Data Sheets for A=140

2018SI28 Phys.Rev. C 98, 054307 (2018)
K.Siegl, K.Kolos, N.D.Scielzo, A.Aprahamian, G.Savard, M.T.Burkey, M.P.Carpenter, P.Chowdhury, J.A.Clark, P.Copp, G.J.Lane, C.J.Lister, S.T.Marley, E.A.McCutchan, A.J.Mitchell, J.Rohrer, M.L.Smith, S.Zhu

B-decay half-lives of 134, 134mSb and their isomeric yield ratio produced by the spontaneous fission of 252Cf

2019Ah02 Appl.Radiat.Isot. 145, 106 (2019)
I.Ahmad, F.G.Kondev
Decay properties of 2.05-h 245-95Am

2019Ah04 Nucl.Instrum.Methods Phys.Res. A940, 56 (2019)
I.Ahmad, F.G.Kondev
High-precision α-particle energies in the decay of Es, Fm, and Md Isotopes

2019AL09 Phys. Rev. C 99, 024621 (2019)
Y. Alhassid, G.F. Bertsch, P. Fanto, T. Kawano
Transmission coefficients in compound-nucleus reaction theory

2019Ay04 Phys.Rev.Lett. 123, 102501 (2019)
A.D.Ayangeakaa, R.V.F.Janssens, S.Zhu, D.Little, J.Henderson, C.Y.Wu, D.J.Hartley, M.Albers, K.Auranen, B.Bucher, M.P.Carpenter, P.Chowdhury, D.Cline, H.L.Crawford, P.Fallon, A.M.Forney, A.Gade, A.B.Hayes, F.G.Kondev, Krishichayan, T.Lauritsen, J.Li, A.O.Macchiavelli, D.Rhodes, D.Seweryniak, S.M.Stolze, W.B.Walters, J.Wu
Evidence for Rigid Triaxial Deformation in 76Ge from a Model-Independent Analysis

2019Ba16 Phys.Rev. C 99, 044612 (2019)
J.C.Batchelder, S.-A.Chong, J.Morrell, M.A.Unzueta, P.Adams, J.D.Bauer, T.Bailey, T.A.Becker, L.A.Bernstein, M.Fratoni, A.M.Hurst, J.James, A.M.Lewis, E.F.Matthews, M.Negus, D.Rutte, K.Song, K.Van Bibber, M.Wallace, C.S.Waltz
Possible evidence of nonstatistical properties in the 35Cl (n, p) 35S cross section

2019BE12 Phys.Rev. C 99, 034603 (2019)
G.F.Bertsch, T.Kawano, L.M.Robledo
Angular momentum of fission fragments

2019BE23 Phys.Rev. C 100, 015503 (2019)
M.Bencomo, J.C.Hardy, V.E.Iacob, H.I.Park, L.Chen, V.Horvat, N.Nica, B.T.Roeder, A.Saastamoinen, I.S.Towner
Precise branching ratio measurement for the superallowed β+ decay of 26Si: Completion of a second mirror pair

2019CH23 Nucl.Data Sheets 157, 1 (2019)
J.Chen, B.Singh
Nuclear Data Sheets for A=50

2019Ch24 Phys.Rev.Lett. 122, 212502 (2019)
Z.Q.Chen, Z.H.Li, H.Hua, H.Watanabe, C.X.Yuan, S.Q.Zhang, G.Lorusso, S.Nishimura, H.Baba, F.Browne, G.Benzoni, K.Y.Chae, F.C.L.Crespi, P.Doornenbal, N.Fukuda, G.Gey, R.Gernhauser, N.Inabe, T.Isobe, D.X.Jiang, A.Jungclaus, H.S.Jung, Y.Jin, D.Kameda, G.D.Kim, Y.K.Kim, I.Kojouharov, F.G.Kondev, T.Kubo, N.Kurz, Y.K.Kwon, X.Q.Li, J.L.Lou, G.J.Lane, C.G.Li, D.W.Luo, A.Montaner-Piza, K.Moschner, C.Y.Niu, F.Naqvi, M.Niikura, H.Nishibata, A.Odahara, R.Orlandi, Z.Patel, Z.Podolyak, T.Sumikama, P.-

A.Soderstrom, H.Sakurai, H.Schaffner, G.S.Simpson, K.Steiger, H.Suzuki, J.Taprogge, H.Takeda, Zs.Vajta, H.K.Wang, J.Wu, A.Wendt, C.G.Wang, H.Y.Wu, X.Wang, C.G.Wu, C.Xu, Z.Y.Xu, A.Yagi, Y.L.Ye, K.Yoshinaga
Proton Shell Evolution below 132Sn : First Measurement of Low-Lying beta-Emitting Isomers in 123,125Ag

2019De15 Phys.Rev. C 99, 044604 (2019)
V.V.Desai, W.Loveland, K.McCaleb, R.Yanez, G.Lane, S.S.Hota, M.W.Reed, H.Watanabe, S.Zhu, K.Auranen, A.D.Ayangeakaa, M.P.Carpenter, J.P.Greene, F.G.Kondev, D.Seweryniak, R.V.F.Janssens, P.A.Copp
The 136Xe + 198Pt reaction: A test of models of multi-nucleon transfer reactions

2019En01 Nucl.Data Sheets 155, 56 (2019)
J.W.Engle, A.V.Ignatyuk, R.Capote, B.V.Carlson, A.Hermanne, M.A.Kellett, T.Kibedi, G.Kim, F.G.Kondev, M.Hussain, O.Lebeda, A.Luca, Y.Nagai, H.Naik, A.L.Nichols, F.M.Nortier, S.V.Suryanarayana, S.Takacs, F.T.Tarkanyi, M.Verpelli
Recommended Nuclear Data for the Production of Selected Therapeutic Radionuclides

2019FO04 Phys.Rev. C 99, 024606 (2019)
N.Fotiades, P.Casoli, P.Jaffke, M.Devlin, R.O.Nelson, T.Granier, P.Talou, T.Ethvignot
Prompt fission product yields in the 238U(n, f) reaction

2019GO30 Eur.Phys.J. A 55, 172 (2019)
S.Goriely, P.Dimitriou, M.Wiedeking, T.Belgya, R.Firestone, J.Kopecky, M.Krticka, V.Plujko, R.Schwengner, S.Siem, H.Utsunomiya, S.Hilaire, S.Peru, Y.S.Cho, D.M.Filipescu, N.Iwamoto, T.Kawano, V.Varlamov, R.Xu
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