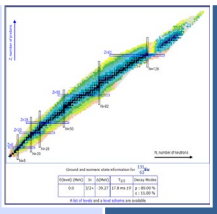

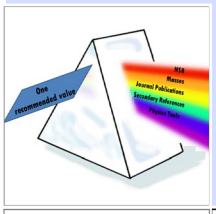

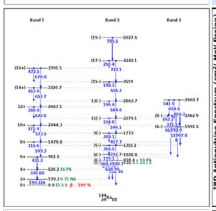

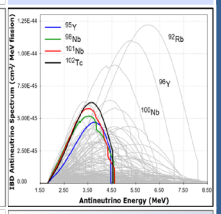

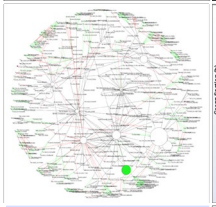

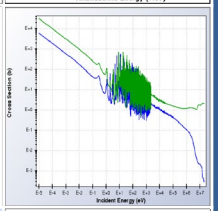

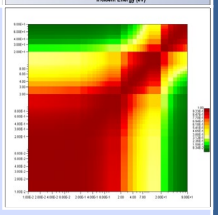

United States Nuclear Data Program

Annual Report for FY2020

This document describes the activities including related metrics performed by the US Nuclear Data program members during fiscal year 2020.

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BNL

Acknowledgements

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I. Introduction

The US Nuclear Data Program (USNDP) Annual Report for FY2020 summarizes the work of USNDP for the period of October 1, 2019, through September 30, 2020, with respect to the work plan for FY2020 that was prepared in 2018. The work plan and final report for USNDP 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 2020 was the 21st 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 USNDP. This is followed by an updated staff level assignment table that reflects the final distribution of effort among the tasks carried out during FY2020. Then, we continue with the detailed status of work done in FY2020.

In terms of personnel changes, Benjamin Shu joined the NNDC in December 2019 following two SURP internship terms; Benjamin has a bachelor's degree in computer science from Stony Brook University and is working mainly on web and mobile dissemination. Bethany Goldblum joined LBNL in September 2020, having worked before in UC Berkeley; Bethany will work on nuclear reaction experiments as well as AI/ML projects.

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. 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	203	5,148	67	60
2020	9,344[c]	+6.2	3,603	159	5,678	78	49

*: 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).
c: It includes the following (a) FIRE collaboration funding $100 (LLNL); (b) LAB calls funding: $354K (ANL), $619K (BNL), $120K (LANL), $75K (LBNL), $50K (LLNL) and $375K (ORNL); (c) WANDA organization: $150K (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 the last two fiscal years, numbers from the previous fiscal year are shown for comparison.

Laboratory	Compilations		Evaluations		Disseminations (in thousands)		Articles		Invited Talks	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
ANL	5	0	13	13	-	-	18	16	12	5
BNL*	3,568	3,493	51	88	4,608	5,138	16	32	19	21
LANL	-	-	0	3.4	-	-	12	8	11	9
LBNL	5	0	32+	0	-	-	16	14	3	4
LLNL	-	-	0	0.1	-	-	2	1	2	2
MSU	54	61	30	26.5	-	-	3	2	1	2
ORNL	-	-	14	9	460	460&	2	4	10	6
TAMU	-	2	17	17	-	-	5	3	1	0
TUNL	26	47	7	2	80	80	1	1	1	0
Total	3,663	3,603	202	159	5,148	5,678	67	63	60	49

*: BNL compilations consist of a) 3,103 NSR articles, including keywords for 1801 of them; b) 214 articles for EXFOR; c) 286 articles encompassing 483 XUNDL datasets. BNL evaluations consist of a) 76.5 nuclides for ENSDF and 11.5 for ENDF/B. 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).

+: An earlier version of the FY2019 report mistakenly indicated a lower number (5) of LBNL evaluations.

&: A considerable increase in web traffic was observed at the ORNL web site, which is not reflected in this number.

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 2020, the DOE Office of Nuclear Physics conducted its annual Budget Briefing. Lee Bernstein, David Brown, Jun Chen, Lynne Ecker, 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 2022 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 topics of the CSEWG meeting was feedback on the recently released ENDF/B-VIII.0 library and next release of the VIII.1 version, originally scheduled for February 2023. Additionally, there were presentations about the fission yield evaluation project funded by NA-22.

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 USNDP and the data obtained by other national and international collaborations. In addition, the NNDC maintains the collaboration GitLab server that facilitates data and codes development and keeps track of changes. 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 5,678 million database retrievals this fiscal year, about 10 % 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 databases represents nearly a complete experimental nuclear structure data of the literature, which is a salient feature of these databases.

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 3,396 nuclides in the database. A total of 144 evaluated nuclides were submitted this fiscal year, including nuclides from 11 mass chains and nuclides for ENSDF update. Evaluation articles from 5 mass chains were published in the Nuclear Data Sheets this fiscal year.

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 **9.07 years** in November 2020. Here it should be noted that the size of the ENSDF database has increased from 148 MB to 240 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 2020, the total effort for the 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.

A project to modernize ENSDF lead by Elizabeth McCutchan from the NNDC in collaboration with scientists from BNL's Computing Science Initiative, ANL and LLNL, has been funded for three years starting in FY21. We expect that as a consequence, ENSDF currency will improve considerably.

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, 483 datasets were compiled from 286 papers. The project to compile data from articles submitted to Physical Review C and European Physical Journal A during the submission process continues well.

Status of NSR:

In FY2020, 3,103 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 208,498.

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 FY2021.
- Update of r0 radius parameter and revision of ALPHAD-radD analysis code, Singh, Dhindsa: r0 publication was published, 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, article will be published in 2021 Nuclear Data Sheets special issue.
- 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 FY2020, the first official release of the Generalised Nuclear Database Structure (GNDS) version 1.9 specifications were published by the OECD/NEA (2020BR01). The GNDS format is part of a larger, community-wide, nuclear reaction data modernization effort. The ENDF/B-VIII.0 library was released simultaneously in both the legacy ENDF-6 format and the new GNDS-1.9 format. Newer GNDS format versions will likely be incompatible with the legacy ENDF-6 format. The GNDS Expert Group is chaired by D. Brown (BNL) with collaborators at LLNL, LANL, ORNL and elsewhere.

BNL investigated the details of the relationship between the nuclear level densities (LD) and cross sections and spectra calculated by reaction models implemented in computational codes. Limits of current experimental constraints into LD were pointed out, and a complementary method of using well-measured cross-section and neutron-spectra experimental data to constrain LD and level parity and spin distributions was proposed. With this approach we are able to perform fits of the LD based on actual experimental data, constraining the model and ensuring its consistency. This approach can be particularly useful in extrapolating the LD to nuclei for which high-excited discrete levels and/or values of resonance spacing are unknown or poorly known. It also predicts neutron-induced inelastic gamma cross sections that in some cases can differ significantly from more standard phenomenological LD models [2020NO03].

The compound nuclear reaction theory, despite its long history in the nuclear physics, still has some open problems. LANL has been applying the Monte Carlo technique to the Gaussian Orthogonal Ensemble (GOE) to better understand the statistical properties in the neutron-induced nuclear reactions. During this fiscal year, we studied the relation between the average decay width and compound nucleus reaction cross sections in terms of S and K-matrices, which defines the partial decay amplitude in the GOE model. By performing the Monte Carlo calculation for the stochastic S and K-matrices, we demonstrated that an energy (or ensemble) average cross section of the compound reaction may have a large uncertainty when it is calculated in terms of the decay width, and the correct expression of the reaction cross section is always by the transmission coefficient. Toshihiko Kawano participated in the IAEA-led photonuclear data library project to update the currently available photon-induced nuclear data library produced in 1999. The older library was adopted by the US nuclear data library ENDF as the photon-induced data files as a

whole. We foresee the new IAEA library will be a part of the new ENDF library. This IAEA-led project concluded in 2019 and Toshihiko Kawano led this collaboration to publish a final document.

With H.Y. Lee as PI, a project on "Incorporating new evaluation on angular distributions and energy spectra of neutron induced charged particle reactions into the next ENDF library release" received DOE-Nuclear Energy, International-Nuclear Energy Research Initiative (I-NERI) award in collaboration with Dr. Hyeong Il Kim from the Korea Atomic Energy Research Institute. This project will run from Jan. 2020 to Dec. 2022.

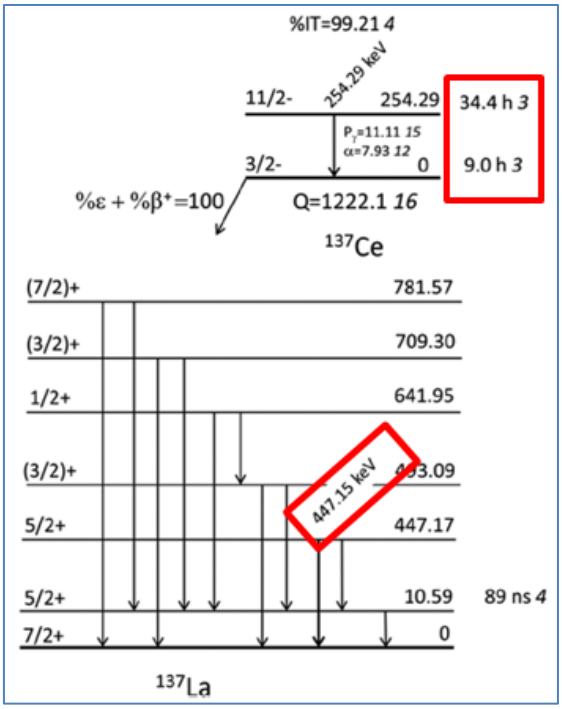
Nuclear Astrophysics highlights

The ENDF/B-VIII library of evaluated cross sections was used by BNL to generate thermonuclear reaction rates which can be used in simulations of the synthesis of heavy elements in supernova and neutron star mergers. Numerous studies addressing element creation in nova explosions were published this year, involving updating level properties for sd-shell nuclei that are critical for the formation of nuclei in the mass range of 24 - 40. These include studies of ^{39}Ca (led by Notre Dame, including ANL and ORNL researchers); ^{34}Ar and ^{30}P (both led by ANL); and ^{23}Mg (led by SKKU with ORNL researchers). Additionally, two studies of the critical ^{13}C(alpha,n) reaction were published this year. One study, led by Notre Dame and involving ORNL researchers, addressed the role of this reaction as a neutron source for the slow neutron capture process in AGB stars; the second study, led by ORNL, addressed the role in generating background neutrons that must be characterized for reactor anti-neutrino and geoneutrino studies.

Additional Highlights

LBNL/ORNL $^{137}Ce^{g}$ decay measurement.

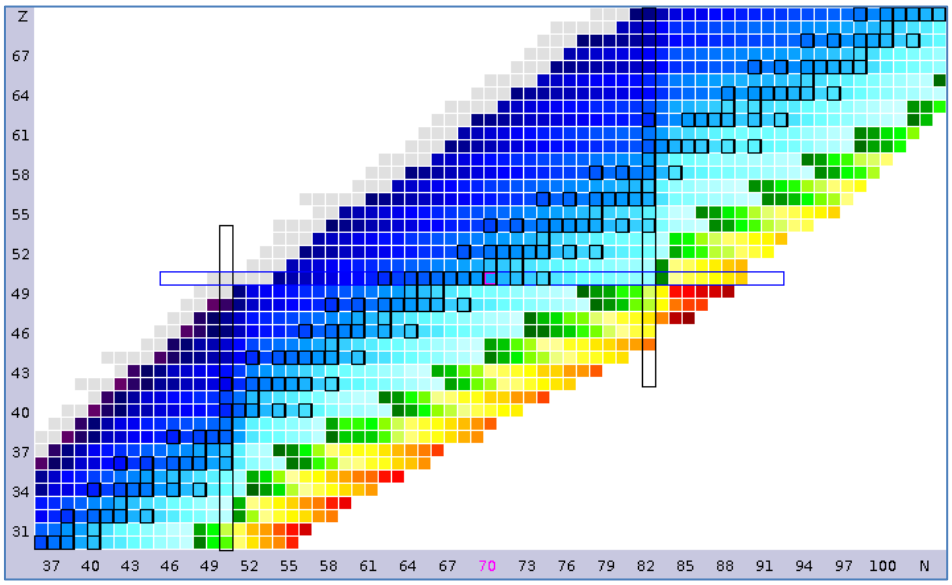
Following the reported anomaly of the gamma-ray emission probability, %Pγ (447), in ^{137}Ceg decay, we deduced the emission probability of the 447-keV γ ray from the ε + β+ decay of ^{137}Ceg (9.0 h) relative to that of the 254-keV γ ray from the ^{137}Cem (34.4 h) decay in transient equilibrium. The time-dependent factor in transient equilibrium was applied following the Bateman's equation for a radioactive decay chain. The isotope was produced via the ^{139}La(p, 3n) 137Cem,g reaction by bombarding natural Lanthanum foil with a proton beam from the 88-in. cyclotron at Lawrence Berkeley National Laboratory. γ -ray intensities were measured using an HPGe detector. The emission probability for the 447-keV γ ray deduced in this work is 1.21 ± 0.03 per hundred parent decays, which differed significantly from an earlier published value of 2.24 ±0.10. We identify the source of this discrepancy to be an incorrect use of the time-dependent factor.



Our work [1] highlighted the importance of explicit description by authors of any time-dependent correction they have made when reporting γ -ray intensities for nuclides in transient equilibrium.

[1] M.S. Basunia, J.T. Morrell, M.S. Uddin, A.S. Voyles, C.D. Nesaraja, L.A. Bernstein, E. Browne, M.J. Martin, S.M. Qaim, "Resolution of a discrepancy in the γ-ray emission probability from the β decay of 137Ceg", Phys. Rev. C. 101, 6 (2020).

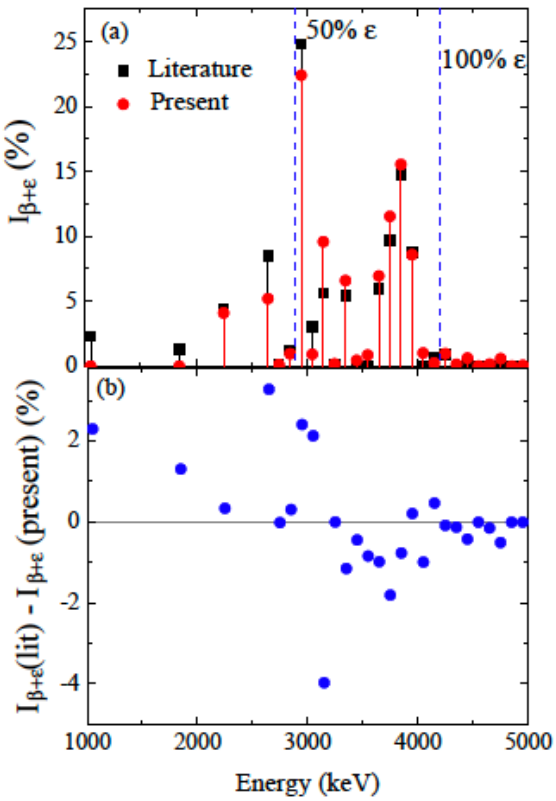
Beta-delayed neutron emitters CRP



The emission of neutrons following beta-minus decay is a phenomenon that happens for neutron-rich nuclides, when the beta-minus Q-value is larger than the daughter's neutron separation energy. The difference between these two parameters is known as $Q_{\beta-n}$, which colors the chart on the right. As can be seen, odd-Z nuclides are energetically more favored to show this decay mode, and in particular, Br, Rb, I and Cs fission products are the main contributors to the delayed-neutron multiplicity, which is a fundamental parameter in nuclear reactor operations. Additionally, this decay mode is of interest in nuclear astrophysics to compare natural abundances to those generated in the r-process.

Due to the relevance of this topic, the IAEA's Nuclear Data Section organized a Coordinated Research Project on it, which among its goals included the compilation and evaluation of half-lives as well as 1- and 2-neutron emission probabilities following beta minus decay. Four articles were published in Nuclear Data Sheets, with the last one scheduled for early 2021. Balraj Singh, Elizabeth McCutchan and Alejandro Sonzogni were the USNDP people involved in this project.

Precise decay measurement of ^{86}Y



An emerging direction of nuclear medicine is the pairing of a therapeutic isotope with an imaging isotope to quantitatively track and image the delivery. One promising pair is ^{90}Y/^{86}Y, with ^{86}Y serving as the PET imaging isotope. Given the potential medical application interest in ^{86}Y, we performed a new gamma-ray spectroscopy experiment using the Gammasphere array at Argonne National Laboratory. Gamma-ray emissions down to an intensity level of <0.0001% of that of the strongest transition were identified. Over 200 new gamma-ray transitions were identified, more than double that which was previously known in the databases. The position emission intensity inferred from our measurement leads to a 14% reduction with respect to the previously recommended value. An article detailing these results has been published, A.C. Gula, E.A. McCutchan, C.J. Lister, J.P. Greene, S. Zhu, P.A. Ellison, R.J. Nickles, M.P. Carpenter, S.V. Smith, A.A. Sonzogni, *State-of-the-art γ-ray assay of 86Y for medical imaging.* Phys. Rev. C **102**, 034316 (2020).

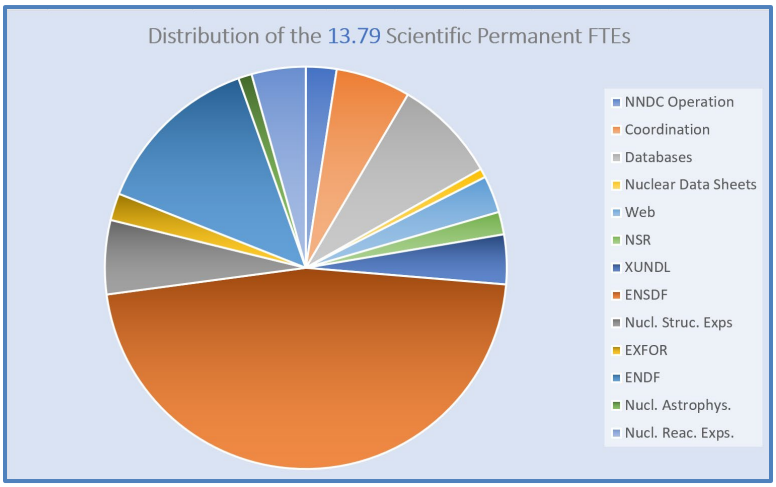
USNDP Staffing Table FY 2020

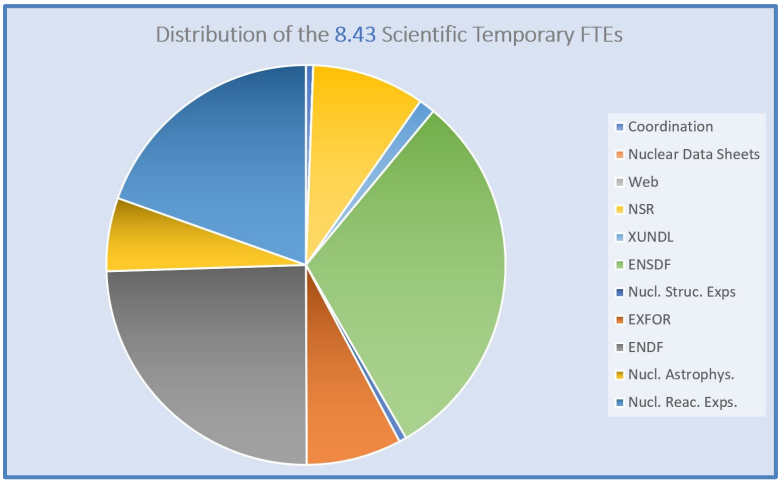
The table below gives the FTE distribution for each USNDP group according to activity. The values in this table and following plots are for the based funding only. In this table, PhD P means PhD Permanent; PhD T means PhD Temporary, which includes post-docs and scientists working under contract; T/A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

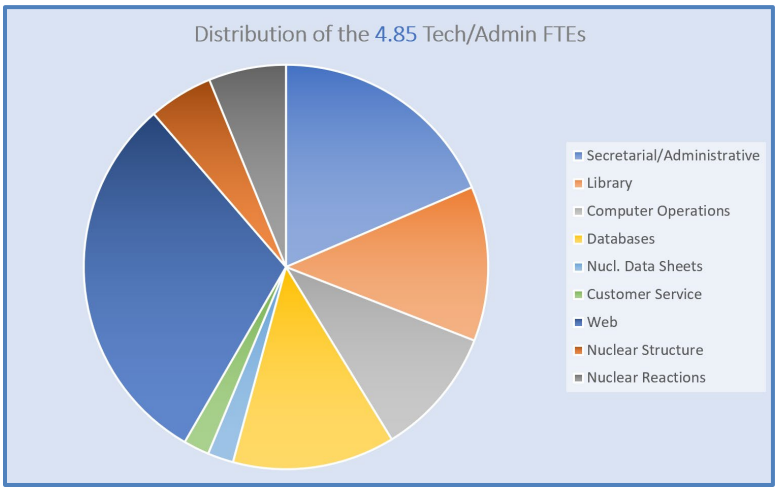
	ANL	BNL			LANL		LBNL		LLNL			MSU	ORNL			TAMU	TUNL			
Activity	PhD P	PhD P	PhD T	T/A	PhD P	PhD T	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD P	PhD T	GS	PhD P	PhD P	PhD T	T/A	Totals
I. NNDC Facility Operation	0.00	0.34	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.34
Management		0.34																		0.34
Secretarial/Admin. Support				0.90																0.90
Library				0.60																0.60
Computer Operations				0.50																0.50
II. Coordination	0.05	0.33	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	0.88
National Coordination		0.29			0.05		0.25						0.05				0.05			0.69
International Coordination	0.05	0.04			0.05			0.05												0.19
III. Nuclear Physics Databases	0.00	1.05	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	1.78
Nuclear Science References, NSR		0.25		0.53																0.78
Expr. Nucl. Struct. Data, XUNDL		0.10																		0.10
Eval. Nucl. Structure Data, ENSDF		0.50																		0.50
Numerical Nuclear Data, NuDat		0.10																		0.10
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	0.46	0.00	1.17	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	2.18
Nuclear Data Sheets		0.10		0.10																0.20
Customer Services				0.10																0.10
Web Maintenance & Develop.		0.36		0.97									0.05						0.50	1.88
V. Nuclear Structure Physics	0.75	2.79	1.11	0.00	0.00	0.00	1.05	1.65	0.00	0.00	0.00	1.00	1.00	0.15	0.00	1.00	0.45	0.60	0.25	11.80
NSR Abstract Preparation		0.25	0.47					0.30												1.02
Compilation of Exper. Struct.Data	0.05	0.20	0.11				0.05					0.15					0.10		0.05	0.71
A-chains & Nuc. Evals for ENSDF	0.50	1.30	0.53				0.75	0.90				0.65	1.00	0.15		1.00	0.35	0.60	0.20	7.93
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.	0.05	0.52	0.00				0.25	0.05												0.87
ENSDF Phys. & Checking Codes												0.20								0.20
VI. Nuclear Reaction Physics	0.00	1.47	2.47	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	9.29
Experimental Data Compilation		0.30	0.55					0.10												0.95
ENDF Manuals & Documentation		0.06																		0.06
ENDF Evaluations		0.72			0.25															0.97
Nuclear Reaction Standards		0.00	0.40					0.05	0.15											0.60
Nuclear Model Development		0.12	0.52		0.20	0.10			0.05											0.99
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		0.10	0.50																	0.60
Verification and Validation		0.07		0.30																0.37
DOE-SC Nucl. Data Funded Staff	0.80	6.44	3.58	4.10	0.95	1.05	1.65	2.55	0.25	0.50	1.00	1.00	1.20	0.15	0.20	1.00	0.50	0.60	0.75	28.27
Staff Supported by Other Funds	0.20	0.90	1.34	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	4.41
TOTAL STAFF	1.00	7.34	4.92	4.17	0.95	1.05	1.65	4.45	0.25	0.50	1.00	1.00	1.20	0.15	0.20	1.00	0.50	0.60	0.75	32.68

USNDP FTE Plots FY 2020

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 2020 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.	The new cluster has now 240 cores and further improvements are planned.

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.	Completed.
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	Didn't take place due to Covid-19.
Host and help organize NDAC meeting	The NDAC meeting took place in November 2020, just after the end of FY20; however, most of the preparation work took place in FY20.

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
Help Organize WANDA meeting	WANDA meeting took place on 3-5 March, 2020 in Washington DC.

ORNL Planned Activities	Status
Coordinate and outreach USNDP Nuclear Astrophysics activities.	Outreach of USNDP activities in nuclear astrophysics to researchers in South Korea at Sungkyunkwon Univ. was made, followed by efforts to recruit faculty and students to contribute assessments of critical reactions for element synthesis studies.

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.	Participated in IAEA-CRP and other IAEA-led activities related to NSDD and nuclear data

BNL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Active participation in the INDEN collaboration leading the Cr evaluation effort.
Participate in NEA WPEC annual meeting.	Chaired WPEC GNDS Expert Group and organized several expert group meetings. Participated in WPEC SGs 43, 49, 50 virtual meetings in May 2020.
Participate in IAEA CRP and technical meetings.	Participated in the INDEN meeting on structural materials in Dec. 2019.
Continue to participate in training/mentoring of new ENSDF evaluators through collaborative work.	A=90 mass chain evaluation published in collaboration with S. Basu from India Center.

LANL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Participated in the Reference Input Parameter Library CRP in Oct. 2019 and coordinated the final report of IAEA photonuclear data library 2019.
Participate in NEA WPEC annual meeting.	Attended the WPEC meeting.

LBNL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	No meetings were attended.

MSU Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Ongoing.

ORNL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Ongoing.

TAMU Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Ongoing

TUNL Planned Activities	Status
Participate in IAEA-sponsored nuclear data activities.	Continuing.

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.	Ongoing task. Goals for the year were completed.

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.

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.

E. 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 10 times. A project to produce a JSON output of fission yield data started, jointly funded by NA22.

F. 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 GitLab collaboration server.

BNL Planned Activities	Status
Maintain and improve Sigma database and web interface for users without specialized knowledge	Not completed due to lack of personnel.

of ENDF-6 format. (See also information dissemination, chapter IV)	
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.	Ongoing activity.

G. 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.

H. Future Database Systems Development

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

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

I. Future Database Systems Development

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.

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.	Completed.
Work on a new version of Nuclear Wallet Cards.	Ongoing.
Work on a new version of Handbook of Radioactive Nuclei.	Ongoing.

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 220 requests for articles were received by our librarian. Additionally, a large number of emails, about 150, were answered with different type of data requests.

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.	CapGam and MIRD web applications were updated and modernized.
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 GitLab server software to provide more powerful and advanced functionalities in the NNDC collaboration services.	Completed.

Make progress with modernization of the web site, enhancing capabilities and follow industry best practices.	Ongoing.
Continue development of mobile applications targeting highly used databases.	Ongoing.

ORNL Planned Activities	Status
Incorporation of new mass compilations and new rate libraries into online collections.	McMaster mass compilation number 13 was posted in the online collection at nuclearmasses.org, along with links to new papers including "Compilation of recent atomic mass measurements and deduced quantities", L. Kroll, B. Singh, A. Chen, Atomic Data and Nuclear Data Tables 133-134 (2020) 101336.

TUNL Planned Activities	Status
Provide access to present and past evaluations of Energy Levels of Light Nuclei for A=3-20 nuclides, including associated figures and energy-level diagrams and tables.	Continuing.
Provide access to compiled and evaluated data on light nuclei related to p-, alpha- and n-capture reactions, and ground-state decays.	Continuing.
Provide access for TUNL dissertations collection.	Continuing.

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. 3,103 new references were added, and 1,801 references were keyworded.

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.	Continuing, based on request from the XUNDL database manager

BNL Planned Activities	Status
Compile new B(E2) experimental data. Continue work on a B(E2) evaluation project in collaboration with McMaster University.	Ongoing activity.
Compile new double-beta decay experimental data. Start working on a data project with Kiev Institute for Nuclear Research.	Ongoing activity.
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.	318 datasets from 176 articles were compiled in FY20.
Review compiled datasets submitted by other data centers prior to inclusion in the XUNDL database. Work with PRC and EPJA to check and compile data prior to publication.	A total of 483 datasets from 286 articles were reviewed and incorporated in the database.
Compile new mass measurements and submit data file to nuclearmasses.org webpage at ORNL. (McMaster University).	Continuing.

LBNL 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.	No requests were received.

MSU 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.	111 datasets from 61 articles were compiled.

Review compiled datasets submitted by other data centers prior to inclusion in the XUNDL database. Work with PRC and EPJA to check and compile data prior to publication.	Ongoing.

TUNL 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.	52 articles from 47 articles were compiled.

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.

ANL Planned Activities	Status
Evaluate at least one mass chain from the ANL region of responsibility.	One mass chain was evaluated.
Review mass chain evaluations, as requested.	No reviews were requested by the ENSDF database manager.

BNL Planned Activities	Status
Evaluate at least four mass chains or their equivalent nuclides.	6 mass chains were evaluated.
Review at least four mass chains or their equivalent nuclides.	6 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.	Completed.
Edit all evaluations submitted for publication, including checking their format and physics content.	Completed.
Continue mentoring new ENSDF evaluators.	Mentoring for new hires, Shaofei Zhu, Andrea Mattera and Adam Hayes continues.

LBNL Planned Activities	Status
Evaluate the equivalent of at least three 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	No new submission were made – mainly worked to finalize earlier published mass chains A=23, A=186, A=233.

nuclear structure and nuclear application communities.	
Review mass-chain evaluations as requested.	Reviewed one mass chain.

MSU Planned Activities	Status
Evaluate the equivalent of at least 1 mass chain.	Three mass chains were evaluated, 2 of them 50/50 shared with Balraj Singh.
Review mass-chain evaluations, as requested.	Two reviews were completed.

ORNL Planned Activities	Status
One equivalent mass chain and the data for new nuclides will be evaluated.	No new evaluations were submitted.
Review mass-chain evaluations, as requested.	Two reviews were performed

TAMU Planned Activities	Status
At least 1 mass chain, or their equivalent nuclides, will be evaluated.	One mass chain was submitted.
Review mass-chain evaluations, as requested.	One review was completed.

TUNL Planned Activities	Status
Evaluate about 1-2 A-chains per year for publication in Nuclear Data Sheets and inclusion in the ENSDF database.	Evaluation of A=13 is progressing.
Evaluate and update ENSDF for A=2-20 near drip-line nuclides, especially for first observations or when ENSDF has no previous data set.	Updated 9C and 16Ne in ENSDF.
Update various reaction data sets in ENSDF, such as for beta-decay and beta-delayed particle emission.	Continuing.

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 of nuclear properties.	Continuing.

BNL Planned Activities	Status
Develop new database for ground and metastable state properties (WalletCraft).	Ongoing.
Begin evaluation process to provide recommended ground and metastable state properties.	Ongoing.

E. Non-ENSDF Decay Data Evaluations

ANL Planned Activities	Status
Contribute to the IAEA-led project on "Evaluated Decay Data Library for Monitoring Applications."	Continuing.

BNL Planned Activities	Status
Contribute to the beta-delayed neutron emitters IAEA CRP.	Evaluation of nuclides in fission fragment region was published in August 2020 in Nuclear Data Sheets. CRP has been completed and article was published in NDS during 2021.

LBNL Planned Activities	Status
Work with researchers at Pacific Northwest National Laboratory on the development of a numerical database with complete Gamma-ray-X ray coincidence data in a joint effort with the Defense Threat Reduction Agency. The database will be benchmarked against existing decay data from ENSDF as well as recently published datasets not yet included in ENSDF. These efforts will be coordinated with the ENSDF modernization initiative led by BNL.	Continuing.

MSU Planned Activities	Status
Contribute to the IAEA-led project on "Evaluated Decay Data Library for Monitoring Applications."	Completed.

F. Neutron-induced γ-Ray Data Evaluation

LBNL Planned Activities	Status
Continue updating the Inelastic Scattering of Reactor Fast Neutrons Database (e.g., the "Baghdad Atlas") with modern ENSDF data, as a validation database for (n,n'gamma) as well as with additional sources of energy differential (n,n'gamma) data from GELINA at Geel, neutronELBE at HZDR, and the GENESIS array at LBNL. Extract information from ENDF needed to produce flux-weighted partial gamma-ray cross sections and comparing the result to values in the Atlas.	Continuing.
Start benchmarking reaction modeling codes, including Talys and EMPIRE. This work will be	Continuing.

performed in collaboration with researchers from the IAEA and Naval Nuclear Laboratory.	
Explore the role of quasi-continuum contributions through collaboration with researchers from LLNL and the University of Oslo.	Continuing.

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 the main emphasis on decay studies of neutron-rich nuclei, spectroscopy of heavy actinide nuclei, and nuclei far from the line of stability.	Continuing.

BNL Planned Activities	Status
Precisely determine decay schemes of relevant medical isotopes using state-of-the-art gamma-ray spectroscopy.	High precision decay data measurement on ^{86}Y was published in Physical Review C.
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.	Experiment took place in March 2020. No participation in additional experiments due to Covid-19.
Perform gamma-ray spectroscopy experiments with GRETINA to remedy data deficiencies uncovered during ENSDF evaluations.	Experiment on the decay of ^{226}Ra was performed in December 2019 using GRETINA at MSU.

LBNL Planned Activities	Status
Perform targeted decay-data measurements to address inconsistencies in decay data using light-ion and neutron activation and the Fast Loading and Unloading Facility for Fission Fragment Yields (FLUFFY) combined with a local array of single-crystal and Clover HPGe detectors. Results from these experiments will be published and updates presented to the ENSDF database manager.	The 283 keV to 656 keV γ-ray emission ratios of 61Cu decay from seven experiments and a variety of detectors and detection geometries were analyzed to resolve the issue of the recommended values with observed data. A manuscript has been prepared to submit to the Applied Radiation and Isotopes journal. Experiments using the FLUFFY facility at the 8-inch cyclotron were carried out – data are being analyzed.
Unplanned activities 1) Resolution of a discrepancy in the gamma-ray emission probability from the β decay of 137Ceg. 2) Accurate determination of production data of the non-standard positron emitter 86Y via the 86Sr(p,n) reaction.	1) Discrepancy was resolved and published in Phys. Rev. C 101, 064619 (2020) DOI: 10.1103/PhysRevC.101.064619 2) Published in Radiochimica Acta 108, issue 9. DOI: https://doi.org/10.1515/ract-2020-0021

3) Measurements of temporally- and spatially resolved neutron production in a sheared-low stabilized Z-pinch.	3) Published in Nuclear Inst. and Methods in Phys. A947 162764. https://doi.org/10.1016/j.nima.2019.162764

H. ENSDF Physics and Checking Codes

BNL Planned Activities	Status
Maintain and upgrade ENSDF checking and physics programs for format changes as required.	Completed.
Work on the development of the next generation ENSDF format and develop applications that apply Machine Learning techniques to the new format.	Proposal submitted to ND FOA to modernize ENSDF format was accepted and funded to begin in FY2021.

LLNL Planned Activities	Status
Collaborate with BNL in the development of the next generation ENSDF format and develop applications that apply Machine Learning techniques to the new format.	A proposal to modernize ENSDF has been funded starting in FY21.

MSU Planned Activities	Status
Maintain and improve the ENSDF utility and analysis codes in Java developed at MSU: JAVA-NDS, ConsistencyCheck, Java-RULER, Excel2ENSDF, and KeynumerCheck.	Ongoing.
Develop new Java codes to replace the legacy ENSDF codes in Fortran that lack maintenance; for example, the Gamma to Level Scheme Code (GLSC), with all functions of the GTOL and GABS Fortran codes and more.	Ongoing and goal (the GLSC code) for FY20 completed

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.	214 new entries were compiled, 226 existing entries were corrected.
Explore possibilities of recovering previously unobtainable reaction data and proactively respond to users' needs.	Ongoing activity.

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 the GitLab version of the ENDF-6 formats manual current with CSEWG-endorsed format changes. Issue official release of the manual.	Four format proposals were made in FY20 and shepherded through the ENDF-6 format proposal process. The process completed during FY21 during the 2020 CSEWG meeting.
Automate the generation and posting of the latest unofficial version of the ENDF-6 formats manual.	Ongoing.
Chair the WPEC Generalized Nuclear Database Structure (GNDS) Expert Group and maintain the format specification for the GNDS, the successor format to ENDF-6.	Development of GNDS-2.0 began in earnest in FY20. Five format proposals were approved at the May 2020 WPEC meeting. GNDS-2.0 is expected to be complete in late FY21.

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.	Received, organized and processed evaluated files contributed by the community to the ENDF/B library, fixing errors on roughly 30 files and the entire three atomic sublibraries. These were staged for review and ultimate approval.
Complete evaluations for Cr isotopes in the frame of the INDEN project, the successor project to CIELO. Work with CSEWG on upgraded evaluations for future release of the ENDF/B library.	Coordinated and actively participated in the evaluation effort of 50,52,53,54Cr, generating well-performing files that addressed many important validation issues. Files were submitted to ENDF library for review and distributed through ENDF and IAEA web portals. An article describing the evaluations was prepared and submitted to Nuclear Data Sheets for publication.
Improve methodology for providing covariance data in the resonance and fast neutron region to the next release of ENDF.	Covariance generation hampered by both missing resonances and resonance quantum number misassignment. We began an AI/ML project with

	SULI students to correct these issues before attempting to generate covariance data.
Update the Decay Data Sub-library as new data for neutron-rich nuclides become available.	Completed.
Maintain the Atlas of Neutron Resonances electronic files in preparation for a future update of the Atlas of Neutron Resonances.	Under NCSP funding, an API for the Atlas electronic files was developed. This has enabled identification and correction of numerous errors in the Atlas. We are considering future work in the context of various USNDP database modernization projects.
Participate in the Fission Yield evaluation CRP at the IAEA.	Attended CRP on Fission Yield evaluation held remotely in September 2020. Two talks were presented by NNDC staff.

LANL Planned Activities	**Status**
Upgrade the LANL ENDF evaluations for major actinides as well as some other structural materials that perform well in criticality benchmarks, including new theoretical development of statistical model for deformed systems. Close collaboration with international nuclear data library activities at the IAEA and OECD/NEA.	234U capture cross section was updated based on newly analyzed DANCE experimental data. The evaluated file was entirely replaced by the CoH3 calculations. Theoretical calculations for tantalum performed, and the evaluation is underway.
Provide upgraded ENDF for light- and medium-mass elements and perform criticality benchmarks.	Due to budget limitations, this task was performed with funding from another source.
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.	The prompt fission neutron spectra for U and Pu were calculated with both the CGMF and BeoH codes, which includes the pre-equilibrium contribution at high energies. A PRL paper was published by the ChiNu collaboration. A PRC(R) was also published on this subject.
Improve photon production data for neutron capture and inelastic scattering, which will be used in prompt gamma-ray spectroscopy.	Gamma-ray production from neutron inelastic scattering off 238U produced, which includes the quantum mechanical pre-equilibrium process. A paper is under preparation. To incorporate the most updated ENSDF data into the photon production calculations, an ENSDF convertor program CENS was written.
Improve angular distributions and energy spectra for neutron-induced charged-particle reactions.	Improved angular and energy distributions for structural materials produced in collaboration with LANSCE and KAERI. A NIM paper was published (2020KI03).

LLNL Planned Activities	Status
Perform new evaluations as per LLNL customer requests and submit these as well as other LLNL-generated evaluations into ENDF.	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.	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.

BNL Planned Activities (Allan Carlson)	Status
Complete the analysis of the angular distribution of 14.9 MeV neutrons scattered by hydrogen.	Completed. See reference 2020KO12 Nucl. Sci. Eng, 194, 335 (2020) in Appendix B
Publish an article devoted to improving the understanding of the interpolation rules in our standards paper that was published in 2018.	Completed. A.D. Carlson, et al., "Corrigendum to: Evaluation of the Neutron Data Standards" [Nucl. Data Sheets 148, p. 143 (2018)]" Nuclear Data Sheets 163 280 (2020).
Publish an article defining templates for experiments so an evaluator can determine if all sources of uncertainty is accounted for in experiments, including cross sections and ^{252}Cf nubar.	Completed, see reference 2020NE03 Nucl. Data Sheets 163, 228 (2020) in Appendix B.

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 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
Develop a new coupled-channels code using modern coding techniques for use in future evaluation work. Model (n,g) spectra to address a major shortcoming in the ENDF library as noted in WANDA 2020.	The code has been developed with a general structure easily extendable to deal with any kind of nucleus-nucleus reactions. The current purpose is to implement the coupled-channel equations to describe the inelastic excitations. The general structure of the code is already implemented and all the tests for elastic scattering were successful. The implementation of the inelastic excitation is in progress. Tested modeling of the 55Mn(n,g) spectrum with a SULI student using RAINIER code from LBNL.

LANL Planned Activities	Status
Continue to develop a microscopic description of the 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	Modeling for fission penetration through arbitrary fission barrier shapes was made, and implemeted into CoH3. The actual fission cross section calculation under preparation.
Continue to develop a coupled-channels Hauser-Feshbach method for better prediction of neutron-induced reactions on deformed nuclei, with particular emphasis on fission, capture, and inelastic scattering channels.	The coupled-channels Hauser-Feshbach code development continued. Average excitation energies causing fission for multi-chance fission process extracted, which will be used for energy-dependent fission product yield calculations.
Continue to develop the Monte-Carlo Hauser-Feshbach code, CGM, for evaluating major actinides, which has a unique capability to produce prompt fission neutron and gamma-ray spectra.	Development of Monte Carlo Hauser-Feshbach technique continued, and prompt fission neutron and gamma-ray spectra calculated. The fission gamma-ray result was published in NDS.
Develop a semi-microscopic model based on the Gaussian Orthogonal Ensemble.	The semi-microscopic level density model based on GOE developed, and effective interaction of M3Y potential tested.

F. Nuclear Reaction Data Measurements

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	The high precision measurements on prompt fission neutron spectra for 235U and 239Pu were performed at LANSCE using the ChiNu arrays. The

array, the measurement will be extended to the outgoing neutrons up to 12 MeV.	final result of PFNS on 239Pu was published in PRC (2020KE05).
Perform transmission experiments on oxygen or neon isotopes at neutron energies from 1 MeV to 200 MeV in the interest of the Dispersive Optical Model potential investigation and some level information near particle thresholds.	The final analyses and results were reported in PRC (2020PR10).
Perform the precision measurement on the ^{16}O(n,α) reaction cross section at LANSCE.	LENZ data analysis for 16O(n,α) performed at LANSCE has been progressing including detailed MCNP simulations for characterizing beam-induced backgrounds for reducing systematic uncertainties.
Measure energy-dependent reaction cross sections on ^{35}Cl(n,p) and (n,α) reactions for improving insufficient experimental data.	The measurement was performed using LENZ at LANSCE and nonstatistical phenomenon in (n,p) cross sections was observed at neutron energies from 0.6 to 6 MeV, and the final result was published in PRC (2020KU17).
Perform double-differential cross sections of 54Fe(n,p) reaction in respect to incoming neutron energies and outgoing particles angles for the neutron energy range of 0.5 - 20 MeV.	The data analyses using the ratio-constrained fitting procedure for deducing differential cross sections have been finalized and being compared with the ENDF/B.VIII.0.

LBNL Planned Activities	**Status**
Study the ^{56}Fe(n,n'gamma) and ^{238}U(n,n'gamma) reactions using the Gamma Energy Neutron Energy Spectrometer for Inelastic Scattering (GENESIS).	Continuing.
Perform energy-dependent measurements of short-lived fission fragments on ^{235,238}U using the Fast Loading and Unloading Facility for Fission Yields (FLUFFY).	Continuing. See similar task in nuclear structure measurements.
Measurement of the decay of ^{68m,g}Cu populated via ^{nat}Zn(n,px) using FLUFFY. This experiment will run "piggyback" on the ^{235,238}U(n,f) measurements mentioned above.	Continuing.

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	Finished, results published in Nuclear Data Sheets 167, 76 (2020).

Evaluate nuclear astrophysics potential of EXFOR library.	Ongoing activity, work on Karlsruhe MACS updates is in progress.

LANL Planned Activities	Status
Continue improvement of neutron capture, beta-delayed neutron and fission modellings for s- and r-process hydro-dynamics simulations.	Improvement of astrophysical reaction rates continued. For the r-process, both neutron induced and beta-delayed fission processes were included.
Develop a Monte Carlo simulation using Geant4, to be implemented for radioactive nuclear reaction analysis at Time of Flight facilities, in the interest of providing direct reaction cross sections for better understanding of heavy element productions.	The progress was made to validate the Geant4 modeling against MCNP and LENZ experimental data. Results and lessons learned from this effort are being prepared for publishing in a NIM journal.

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.	Progress was made on converting central thermonuclear reaction rate values with uncertainties in the STARLIB and NACRE II collections into the REACLIB parameterized format. Appropriate temperature averaging over hydrodynamic profiles was made for use of uncertainties by the research community. Improvements for REACLIB were proposed that would enable the incorporate of rate uncertainties. Detailed examination of reactions in the sd-shell were made that are critical for nova nucleosynthesis, and some of these are planned for measurements with the new SECAR system at FRIB.

H. Covariances Development

BNL Planned Activities	Status
Develop low-fidelity fission yield covariances consistent with the ENDF decay sub-library and with measured yields. This project would allow us to develop expertise for the upcoming Fission Yields CRP.	Continuing, several presentations were made on this topic.

LBNL Planned Activities	Status
Continue to develop an experimentally driven fission covariance database.	Continuing.

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.	Continue working on the use of cumulative fission yield correlations.
Perform decay-heat calculations in collaboration with experimental groups.	No requests were made.
Possibly participate in relevant experiments.	Participated in experiment at ANL using the MTAS setup.

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
Maintain automatic, real-time verification and validation of new/modified ENDF evaluations submitted to the NNDC GitLab server.	Ongoing task. A new server replaced an older, less capable one.

Appendix A

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 2020 Selected Articles authored by USNDP staff

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

2019AH05 Phys.Rev. C 100, 044613 (2019)
S.Ahn, D.W.Bardayan, K.L.Jones, A.S.Adekola, G.Arbanas, J.C.Blackmon, K.Y.Chae, K.A.Chipps, J.A.Cizewski, S.Hardy, M.E.Howard, R.L.Kozub, B.Manning, M.Matos, C.D.Nesaraja, P.D.O'Malley, S.D.Pain, W.A.Peters, S.T.Pittman, B.C.Rasco, M.S.Smith, I.Spassova
Direct neutron capture cross section on 80Ge and probing shape coexistence in neutron-rich nuclei

2019BE41 Ann. Rev. Nucl. Part. Sci. 69, 109 (2019)
L.A.Bernstein, D.A.Brown, A.J.Koning, B.T.Rearden, C.E.Romano, A.A.Sonzogni, A.S.Voyles, W.Younes
Our Future Nuclear Data Needs

2019GA29 Phys. Rev. C 100, 044309 (2019)
E.R.Gamba, A.M.Bruce, S.Lalkovski, M.Rudigier, S.Bottoni, M.P.Carpenter, S.Zhu, J.T.Anderson, A.D.Ayangeakaa, T.A.Berry, I.Burrows, M.Carmona-Gallardo, R.J.Carroll, P.Copp, D.M.Cullen, T.Daniel, G.Fernandez-Martinez, J.P.Greene, L.A.Gurgi, D.J.Hartley, R.Ilieva, S.Ilieva, F.G.Kondev, T.Kroll, G.J.Lane, T.Lauritsen, I.Lazarus, G.Lotay, C.R.Nita, Zs.Podolyak, V.Pucknell, M.Reed, P.H.Regan, J.Rohrer, J.Sethi, D.Seweryniak, C.M.Shand, J.Simpson, M.Smolen, E.A.Stefanova, V.Vedia, O.Yordanov
Fast-timing measurements in the ground-state band of 114Pd

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
Reference database for photon strength functions

2019GU29 Phys. Rev. C 100, 044305 (2019)
V.Guadilla, J.L.Tain, A.Algora, J.Agramunt, D.Jordan, M.Monserrate, A.Montaner-Piza, E.Nacher, S.E.A.Orrigo, B.Rubio, E.Valencia, M.Estienne, M.Fallot, L.Le Meur, J.A.Briz, A.Cucoanes, A.Porta, T.Shiba, A.-A.Zakari-Issoufou, A.A.Sonzogni, J.Aysto, T.Eronen, D.Gorelov, J.Hakala, A.Jokinen, A.Kankainen, V.S.Kolhinen, J.Koponen, I.D.Moore, H.Penttila, I.Pohjalainen, J.Reinikainen, M.Reponen, S.Rinta-Antila, K.Rytkonen, V.Sonnenschein, A.Voss, L.M.Fraile, V.Vedia, E.Ganioglu, W.Gelletly, M.Lebois, J.N.Wilson, T.Martinez
Total absorption γ-ray spectroscopy of the β-delayed neutron emitters 137I and 95Rb

2019MA71 Phys.Rev. C 100, 044610 (2019)

H.Makii, K.Nishio, K.Hirose, R.Orlandi, R.Leguillon, T.Ogawa, T.Soldner, U.Koster, A.Pollitt, F.-J.Hambsch, I.Tsekhanovich, M.Aiche, S.Czajkowski, L.Mathieu, C.M.Petrache, A.Astier, S.Guo, T.Ohtsuki, S.Sekimoto, K.Takamiya, R.J.W.Frost, T.Kawano
Effects of the nuclear structure of fission fragments on the high-energy prompt fission γ-ray spectrum in 235U(nth,f)

2019SP06 Phys. Rev. C 100, 061303 (2019)
M.Spieker, D.Weisshaar, A.Gade, B.A.Brown, P.Adrich, D.Bazin, M.A.Bentley, J.R.Brown, C.M.Campbell, C.Aa.Diget, B.Elman, T.Glasmacher, M.Hill, B.Longfellow, B.Pritychenko, A.Ratkiewicz, D.Rhodes, J.A.Tostevin
Experimental identification of the T=1, Jπ=6+ state of 54Co and isospin symmetry in A=54 studied via one-nucleon knockout reactions

2019ZH49 Phys. Lett. B 799, 135036 (2019)
G.X.Zhang, H.Watanabe, G.D.Dracoulis, F.G.Kondev, G.J.Lane, P.H.Regan, P.-A.Soderstrom, P.M.Walker, K.Yoshida, H.Kanaoka, Z.Korkulu, P.S.Lee, J.J.Liu, S.Nishimura, J.Wu, A.Yagi, D.S.Ahn, T.Alharbi, H.Baba, F.Browne, A.M.Bruce, M.P.Carpenter, R.J.Carroll, K.Y.Chae, C.J.Chiara, Zs.Dombradi, P.Doornenbal, A.Estrade, N.Fukuda, C.Griffin, E.Ideguchi, N.Inabe, T.Isobe, S.Kanaya, I.Kojouharov, T.Kubo, S.Kubono, N.Kurz, I.Kuti, S.Lalkovski, T.Lauritsen, C.S.Lee, E.J.Lee, C.J.Lister, G.Lorusso, G.Lotay, E.A.McCutchan, C.-B.Moon, I.Nishizuka, C.R.Nita, A.Odahara, Z.Patel, V.H.Phong, Zs.Podolyak, O.J.Roberts, H.Sakurai, H.Schaffner, D.Seweryniak, C.M.Shand, Y.Shimizu, T.Sumikama, H.Suzuki, H.Takeda, S.Terashima, Zs.Vajta, J.J.Valiente-Dobon, Z.Y.Xu, S.Zhu
Interplay of quasiparticle and vibrational excitations: First observation of isomeric states in 168Dy and 169Dy

2020AU03 Nucl. Data Sheets 168, 117 (2020)
K.Auranen, E.A.McCutchan
Nuclear Data Sheets for A=212
2020BA07 At. Data Nucl. Data Tables 132, 101323 (2020)
J.C.Batchelder
Recommended values for β+-delayed proton and α emission

2020BA12 Phys.Rev. C 101, 024309 (2020)
A.Basu, A.K.Singh, S.Nag, G.B.Hagemann, G.Sletten, B.Herskind, A.N.Wilson, J.Rogers, I.Ragnarsson, H.Hubel, S.Chmel, R.V.F.Janssens, M.P.Carpenter, T.L.Khoo, F.G.Kondev, T.Lauritsen, S.Zhu, A.Korichi, P.Fallon, B.M.Nyako, J.Timar
Evolution of collective and noncollective structures in 123Xe

2020BA21 Nucl. Data Sheets 165, 1 (2020)
S.K.Basu, E.A.McCutchan
Nuclear Data Sheets for A = 90

2020BA30 Phys.Rev. C 101, 064619 (2020)
M.S.Basunia, J.T.Morrell, M.S.Uddin, A.S.Voyles, C.D.Nesaraja, L.A.Bernstein, E.Browne, M.J.Martin, S.M.Qaim
Resolution of a discrepancy in the γ-ray emission probability from the β decay of 137Ceg

2020BE02 Nucl.Instrum.Methods Phys.Res. B468, 81 (2020)
K.V.Becker, E.Vermeulen, C.J.Kutyreff, E.M.O'Brien, J.T.Morrell, E.R.Birnbaum, L.A.Bernstein, F.M.Nortier, J.W.Engle
Cross section measurements for proton induced reactions on natural La

2020BO24 Scientific Reports 10, 17183 (2020)
P.Boller, A.Zylstra, P.Neumayer, L.Bernstein, C.Brabetz, J.Despotopulos, J.Glorius, J.Hellmund, E.A. Henry, J.Hornung, J.Jeet, J.Khuyagbaatar, L.Lens, S.Roeder, T.Stoehlker, A.Yakushev, Y.A. Litvinov, D.Shaughnessy, V.Bagnoud, T.Kuehl, D. H.G. Schneider
First on-line detection of radioactive fission isotopes produced by laser-accelerated protons

2020CA02 Nucl.Data Sheets 163, 191 (2020)
R.Capote, S.Badikov, A.D.Carlson, I.Duran, F.Gunsing, D.Neudecker, V.G.Pronyaev, P.Schillebeeckx, G.Schnabel, D.L.Smith, A.Wallner
Unrecognized Sources of Uncertainties (USU) in Experimental Nuclear Data

2020CH10 Nucl. Data Sheets 164, 1 (2020)
J.Chen, B.Singh
Nuclear Data Sheets for A=98

2020DE09 Phys. Rev. C 101, 034612 (2020)
V.V.Desai, A.Pica, W.Loveland, J.S.Barrett, E.A.McCutchan, S.Zhu, A.D.Ayangeakaa, M.P.Carpenter, J.P.Greene, T.Lauritsen, R.V.F.Janssens, B.M.S.Amro, W.B.Walters
Multinucleon transfer in the interaction of 977 MeV and 1143 MeV 204Hg with 208Pb

2020DE12 Phys.Rev. C 101, 045802 (2020)
R.J.deBoer, C.R.Brune, M.Febrarro, J.Gorres, I.J.Thompson, M.Wiescher
Sensitivity of the 13C(α, n)16O S factor to the uncertainty in the level parameters of the near-threshold state

2020DE18 Eur. Phys. J. A 56, 150 (2020)
V.V.Desai, W.Loveland, R.Yanez, G.Lane, S.Zhu, A.D.Ayangekaa, J.P.Greene, F.G.Kondev, R.V.F.Janssens, P.A.Copp
The 136Xe + 198Pt reaction: a detailed re-examination

2020DIZW EPJ Web of Conf.Vol.239 (2020)
P.Dimitriou, S.Basunia, L.Bernstein, J.Chen, Z.Elekes, X.Huang, A.Hurst, H.Iimura, A.K.Jain, J.Kelley, T.Kibedi, F.Kondev, S.Lalkovski, E.McCutchan, I.Mitropolsky, G.Mukherjee, A.Negret, C.Nesaraja, N.Nica, S.Pascu, A.Rodionov, B.Singh, S.Singh, M.Smith, A.Sonzogni, J.Timar, J.Tuli, M.Verpelli, D.Yang, V.Zerkin
International network of nuclear structure and decay data evaluators

2020FE06 Phys.Rev.Lett. 125, 062501 (2020)
M.Febbraro, R.J.deBoer, S.D.Pain, R.Toomey, F.D.Becchetti, A.Boeltzig, Y.Chen, K.A.Chipps, M.Couder, K.L.Jones, E.Lamere, Q.Liu, S.Lyons, K.T.Macon, L.Morales, W.A.Peters, D.Robertson, B.C.Rasco, K.Smith, C.Seymour, G.Seymour, M.S.Smith, E.Stech, B.Vande Kolk, M.Wiescher
New 13C(α, n)16O Cross Section with Implications for Neutrino Mixing and Geoneutrino Measurements

2020GR01 Phys.Rev.Lett. 124, 032502 (2020)
T.J.Gray, J.M.Allmond, A.E.Stuchbery, C.-H.Yu, C.Baktash, A.Gargano, A.Galindo-Uribarri, D.C.Radford, J.C.Batchelder, J.R.Beene, C.R.Bingham, L.Coraggio, A.Covello, M.Danchev, C.J.Gross, P.A.Hausladen, N.Itaco, W.Krolas, J.F.Liang, E.Padilla-Rodal, J.Pavan, D.W.Stracener, R.L.Varner
Early Signal of Emerging Nuclear Collectivity in Neutron-Rich 129Sb

2020GU18 Phys.Rev. C 102, 034316 (2020)
A.C.Gula, E.A.McCutchan, C.J.Lister, J.P.Greene, S.Zhu, P.A.Ellison, R.J.Nickles, M.P.Carpenter, S.V.Smith, A.A.Sonzogni
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