NSR & EXFOR Compilations

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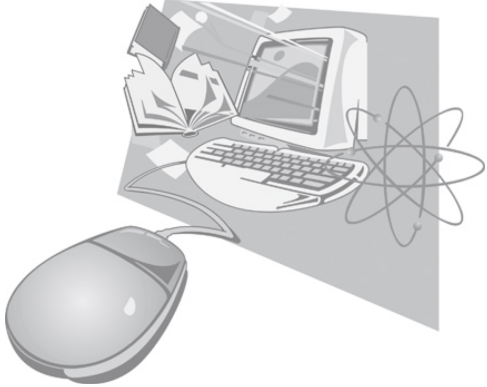
U.S. DEPARTMENT OF ENERGY

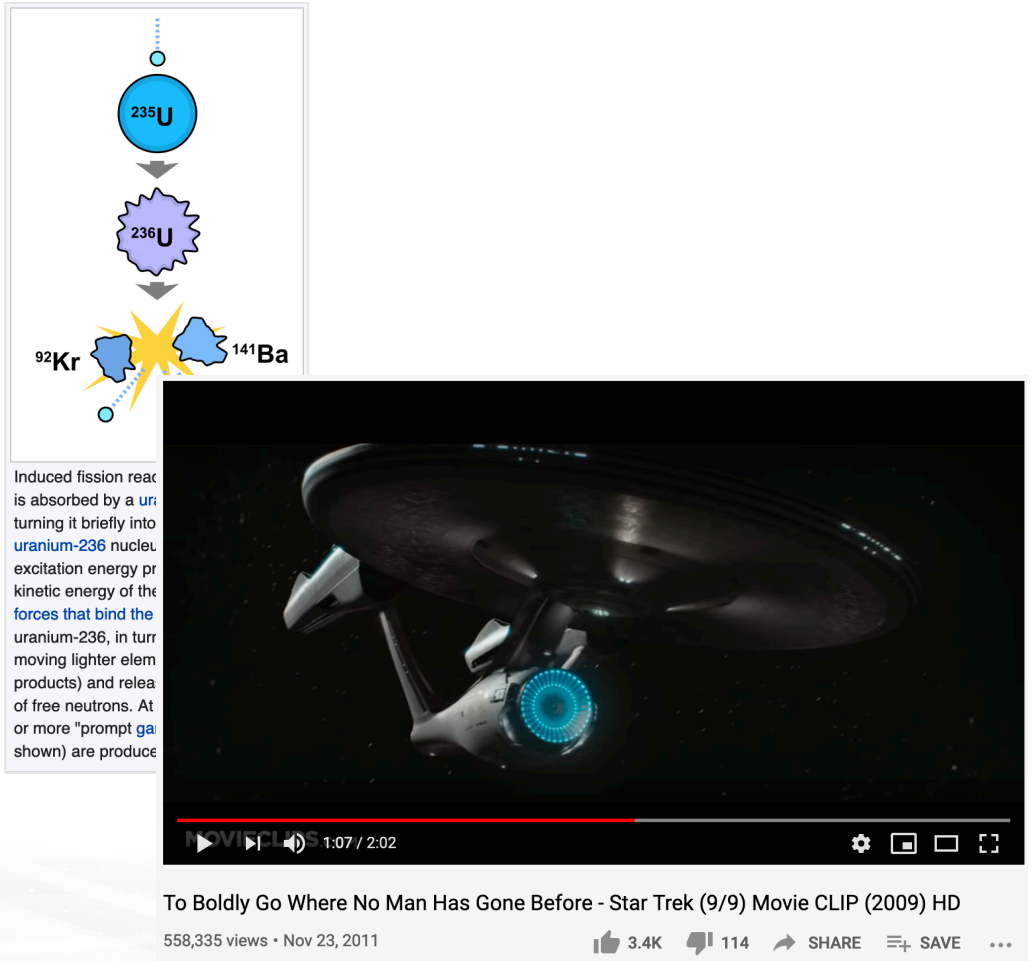
Compilation Databases



- There are three major and two minor compilation databases at NNDC: NSR, EXFOR, XUNDL and B(E2)↑, ββ-decay.
- In this presentation, we will concentrate on NSR and EXFOR databases:
  - Nuclear Science References (NSR): all low- and intermediate-energy references for a broad use, not just nuclear structure and decay as before 90ies.
  - Experimental Nuclear Reaction Data (EXFOR): all low- and intermediate-energy reaction data sets for neutron-, charged- and photo-induced reactions, not just neutron-induced as before 80ies.
- The compilation scope and quality controls for NSR and EXFOR database have evolved over the many years of operation. These facts plus lack of advanced computer tools in the past are responsible for missing references and data sets.

Database Operations During COVID-19

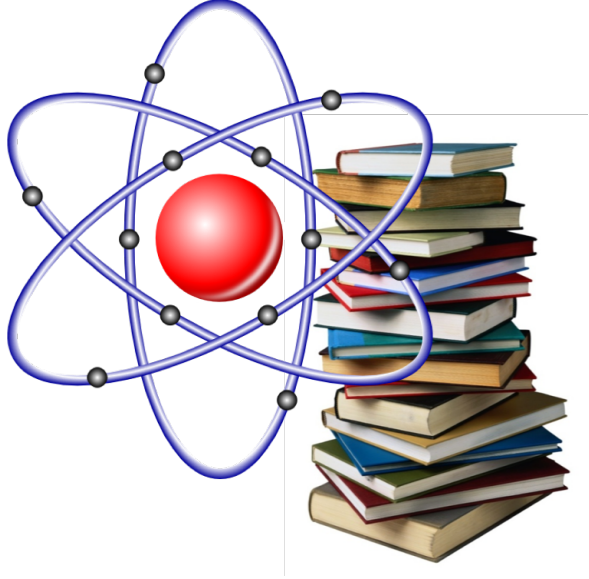
- In early summer of 2020 we observed drop in publication rates.
- NSR team covered new articles and included many previously missed publications, including fission yields references from England & Rider evaluation, and Mills Ph.D. thesis.
- More than 500 references were compiled, and PDF files were collected.
- EXFOR project was affected by publishing issues.
- Large number of previously missed FY experiments were compiled into EXFOR database.
- Missing References/Experiments: To Boldly Go Where No Man Has Gone Before.



NSR Compilations

- Nuclear Science References compilation creates a foundation for nuclear structure, decay and reaction data efforts and impacts research activities.
- FY 2020 NSR team: 1.5 NNDC (B. Pritychenko, J. Totans), 2 contractors (B. Singh, E. Betak), 1 Berkeley collaborator (J. Batchelder) and 1 IAEA collaborator (V. Zerkin).
- Our goal is provide the coverage for current publications; we are also proactively recovering previously missed references.
- One of our major requirement is speed, prompt creation of entries and quality keywords for ENSDF: NSR is always up-to-date (it is updated 2-3 times a week).
- NSR Quality Assurance: Manager + Users + Evaluators + Compilers inputs. We do not have a bug database, we just fix bugs immediately.
- Direct communication with Phys. Rev. C: ~10% of authors submit keywords to NSR.

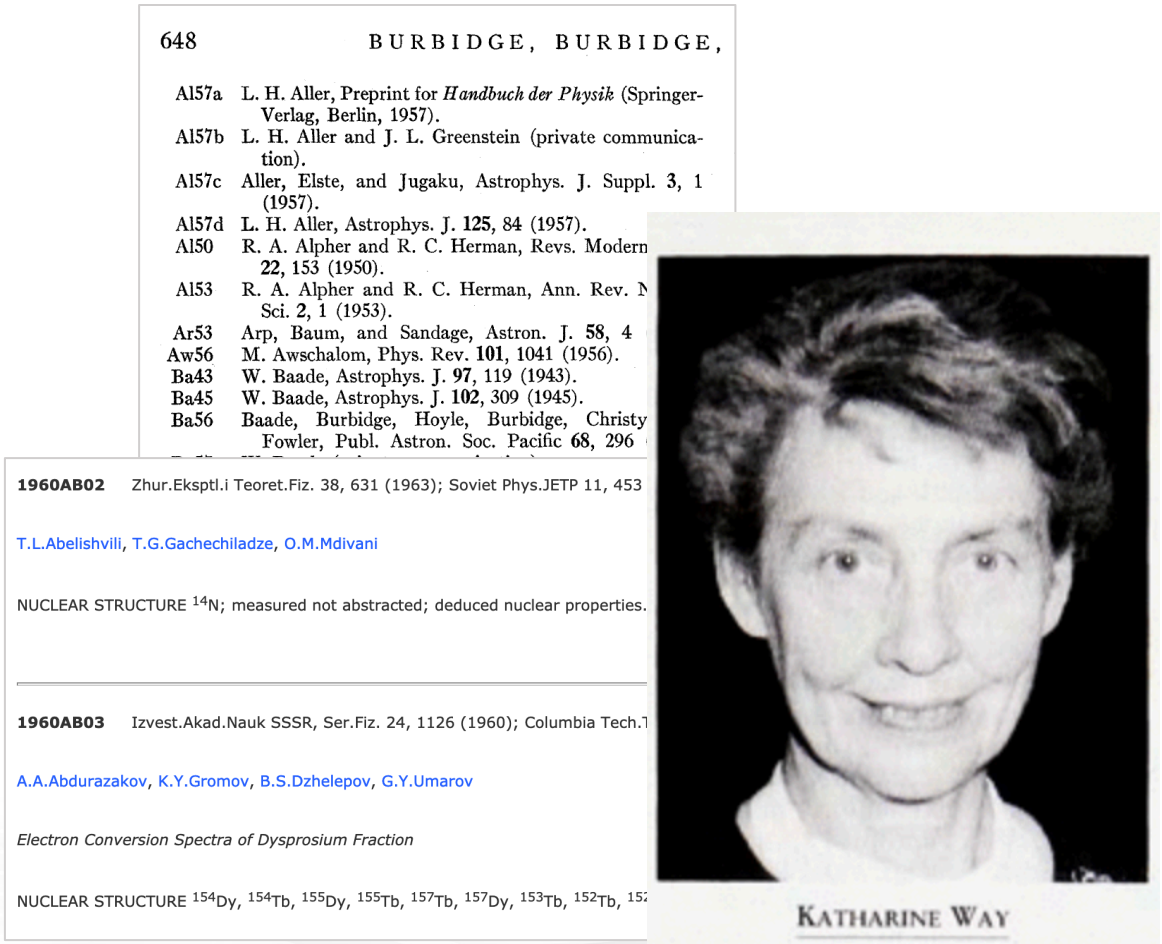
FY 2020 NSR Statistics



- NSR References:
  - 3,102 new article entries (compare 3,337 in FY 2019).
  - 179 modified (corrected) article entries.
  - 1,801 keyworded article abstracts (September 30, 2020) => 1,970 (November 25, 2020), takes time to prepare the keywords.
- NSR Dictionaries updates:
  - 2,087 new authors (compare to 1,000 in FY 2019).
  - 17 new journals (compare to 12 in FY2019).
  - 112 new reactions (compare to 160 in FY 2019).
  - 191 new nuclides (compare 689 in FY 2019).
  - 11 new decays (compare 16 in FY 2019).
- NSR Database updates: 148 times (compare with 129 in FY 2019).
- NSR Web retrievals: 208,498, or 136 references/retrieval.
- Total number of retrieved references was 28,501,548.

Original NSR

- NSR was started around 1960 at the ORNL.
- Katherine Way recognized the importance of keywords and convinced several journals to include them.
- Early NSR entry consisted of authors, journal and simple nuclear structure keywords; title was often missing.
- References were stored at the ORNL library for ENSDF evaluations.
- Original NSR keynumbers had a 2K bug issue, they were upgraded to the present state by 2000.



648 BURBIDGE, BURBIDGE,

Al57a L. H. Aller, Preprint for *Handbuch der Physik* (Springer-Verlag, Berlin, 1957).
Al57b L. H. Aller and J. L. Greenstein (private communication).
Al57c Aller, Elste, and Jugaku, Astrophys. J. Suppl. **3**, 1 (1957).
Al57d L. H. Aller, Astrophys. J. **125**, 84 (1957).
Al50 R. A. Alpher and R. C. Herman, Revs. Modern **22**, 153 (1950).
Al53 R. A. Alpher and R. C. Herman, Ann. Rev. N Sci. **2**, 1 (1953).
Ar53 Arp, Baum, and Sandage, Astron. J. **58**, 4
Aw56 M. Awschalom, Phys. Rev. **101**, 1041 (1956).
Ba43 W. Baade, Astrophys. J. **97**, 119 (1943).
Ba45 W. Baade, Astrophys. J. **102**, 309 (1945).
Ba56 Baade, Burbidge, Hoyle, Burbidge, Christy Fowler, Publ. Astron. Soc. Pacific **68**, 296

1960AB02 Zhur.Eksptl.i Teoret.Fiz. 38, 631 (1963); Soviet Phys.JETP 11, 453

T.L.Abelishvili, T.G.Gachechiladze, O.M.Mdivani

NUCLEAR STRUCTURE ^{14}N; measured not abstracted; deduced nuclear properties.

1960AB03 Izvest.Akad.Nauk SSSR, Ser.Fiz. 24, 1126 (1960); Columbia Tech.

A.A.Abdurazakov, K.Y.Gromov, B.S.Dzhelepov, G.Y.Umarov

Electron Conversion Spectra of Dysprosium Fraction

NUCLEAR STRUCTURE ^{154}Dy, ^{154}Tb, ^{155}Dy, ^{155}Tb, ^{157}Tb, ^{157}Dy, ^{153}Tb, ^{152}Tb,

KATHARINE WAY

NSR at BNL

- In 1980 NSR operation was transferred from Oak Ridge to Brookhaven.
- Titles became mandatory and keywords more sophisticated.
- Digital Object Identifiers (doi) were introduced in 2000 and implemented in NSR.
- In subsequent years the database was integrated with XUNDL/ENSDF.
- By 2011 it was integrated with EXFOR.
- However, evaluators worldwide were still spending plenty of time for references location because not everyone had access to good library resources.

2001BA39 Eur.Phys.J. A 10, 145 (2001)

A.Bauchet, I.Deloncle, M.-G.Porquet, A.Astier, N.Buforn, M.Meyer, S.Perries, N.Redon, B.J.P.Gall, F.Hoellinger, N.Schulz, G.Duchene, S.Courtin, Ts.Venkova, P.A.Butler, N.Amzal, R.D.Herzberg, A.Chewter, R.Cunningham, M.Houry, R.Lucas, W.Urban, A.Nowak, E.Piasecki, J.Duprat, C.Petrache, T.Kroll

First Identification of Rotational Bands in ^{103}Tc: Evolution of intrinsic proton states of the $_{43}^{97\text{-}105}$Tc Isotopes

NUCLEAR REACTIONS ^{176}Yb(^{37}Cl, F), E=170 MeV; measured Eγ, Iγ, γγ-coin. ^{103}Tc deduced high-spin levels, possible J, π. Level systematics in neighboring nuclides discussed. Euroball III array.

NUCLEAR STRUCTURE ^{97,98,99,100,101,102,103,104,105}Tc; analyzed levels, J, π; deduced band head configurations.

doi: 10.1007/s100500170126
*Data from this article have been entered in the **XUNDL** database. For more information, click here.*

2012AD05 Phys.Rev. C 85, 037601 (2012)

A.S.Adekola, C.R.Brune, D.W.Bardayan, J.C.Blackmon, K.Y.Chae, J.A.Cizewski, K.L.Jones, R.L.Kozub, T.N.Massey, C.D.Nesaraja, S.D.Pain, J.F.Shriner, M.S.Smith, J.S.Thomas

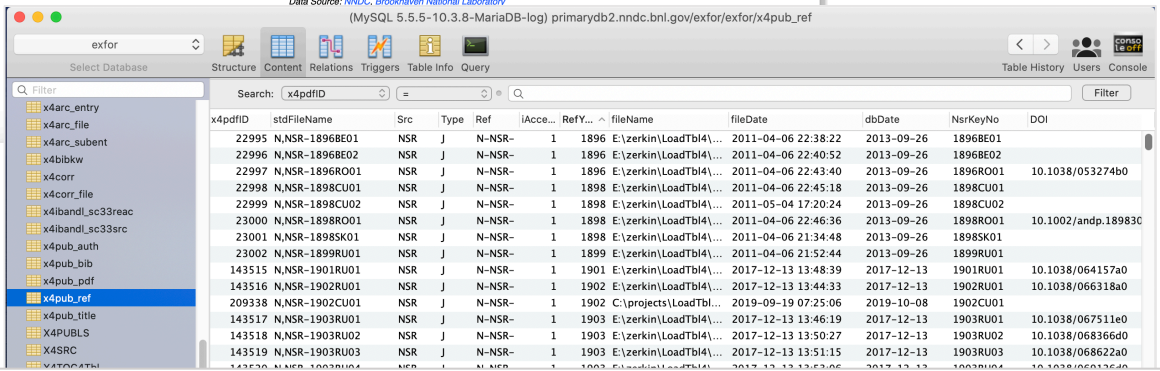
^{19}Ne levels studied with the ^{18}F(d, n)^{19}Ne*(^{18}F+p) reaction

NUCLEAR REACTIONS ^{2}H(^{18}F, n), E=150 MeV; measured α and proton spectra from ^{19}Ne breakup, p(^{18}F)-, α(^{15}O)-coin, angular distributions. ^{19}Ne; deduced resonances, levels, proton widths, α widths, spectroscopic factors, decay branching ratios. DWBA analysis. Comparison with earlier studies. Relevance to destruction of long-lived ^{18}F in novae.

doi: 10.1103/PhysRevC.85.037601
*Data from this article have been entered in the **EXFOR** database. For more information, access X4 datasetC1906. Data from this article have been entered in the **XUNDL** database. For more information, click here.*

NSR-EXFOR Library on Web

- Collaborative effort with the NDS, IAEA.
- ~75-78.8% bibliography coverage using EXFOR/NSR PDF library.
- User login to PDF files for structure and reaction evaluators: www.nndc.bnl.gov/nsr/login.htm.
- Default access at the BNL and IAEA campuses.
- NSR citations: PlumX Metrics.



PDF Statistics:

DB	*#PDF/#References*	*#PDF+*	*Total #PDF+*	*Todo #PDF*
NSR:	185911/236221 ~78.8%	+578 from EXFOR	186489	49732
EXFOR:	25435/33923 ~75%	+1410 from NSR	26845	7078

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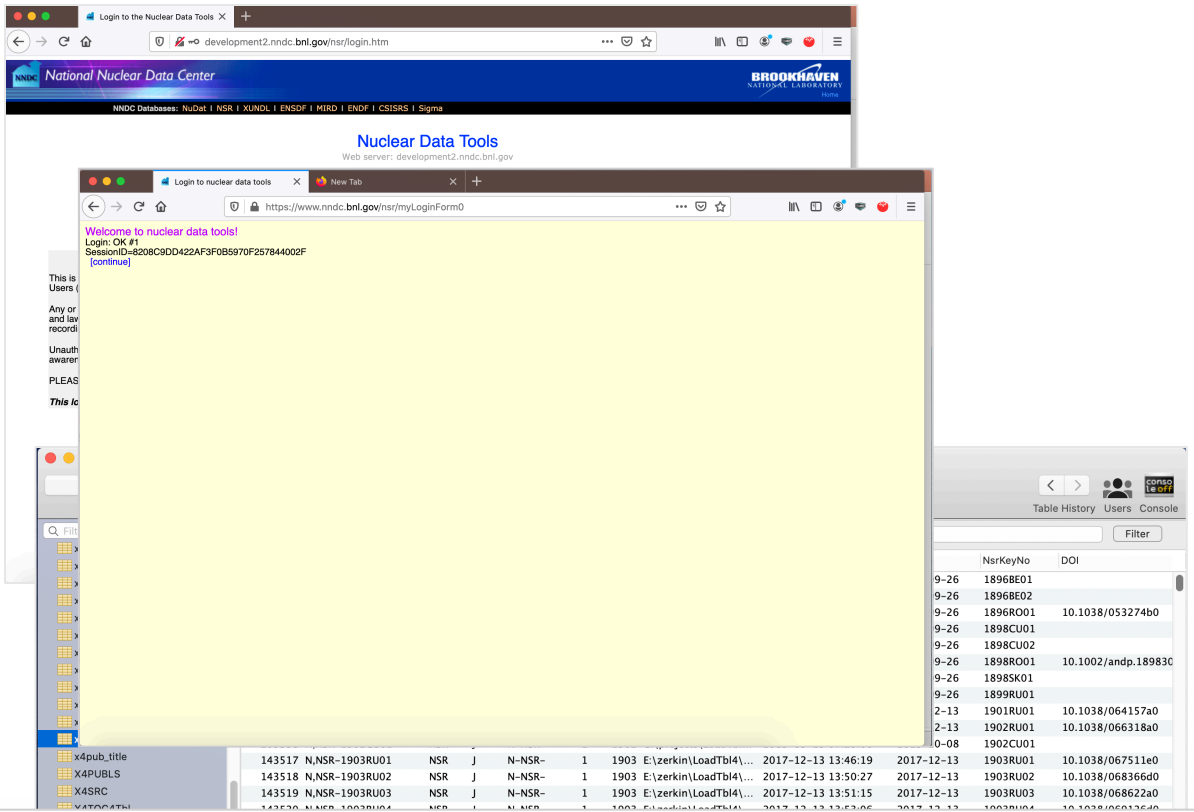

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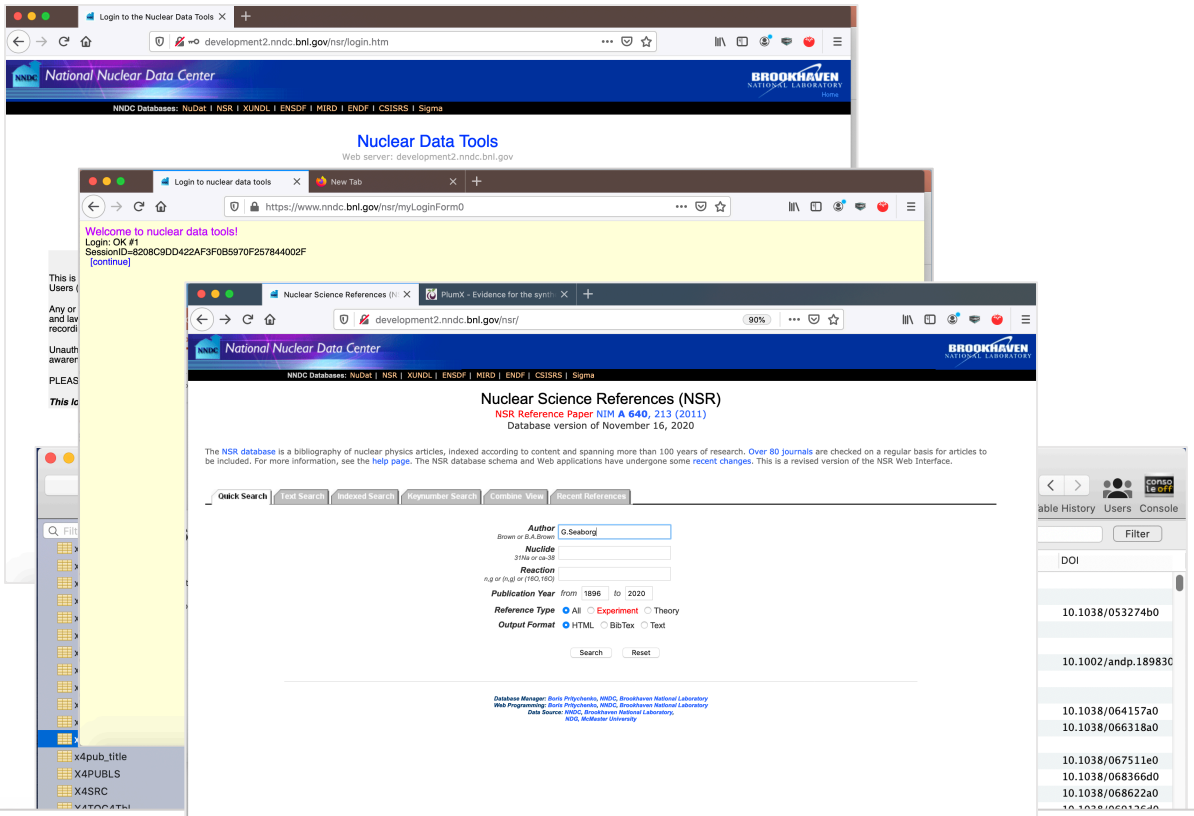

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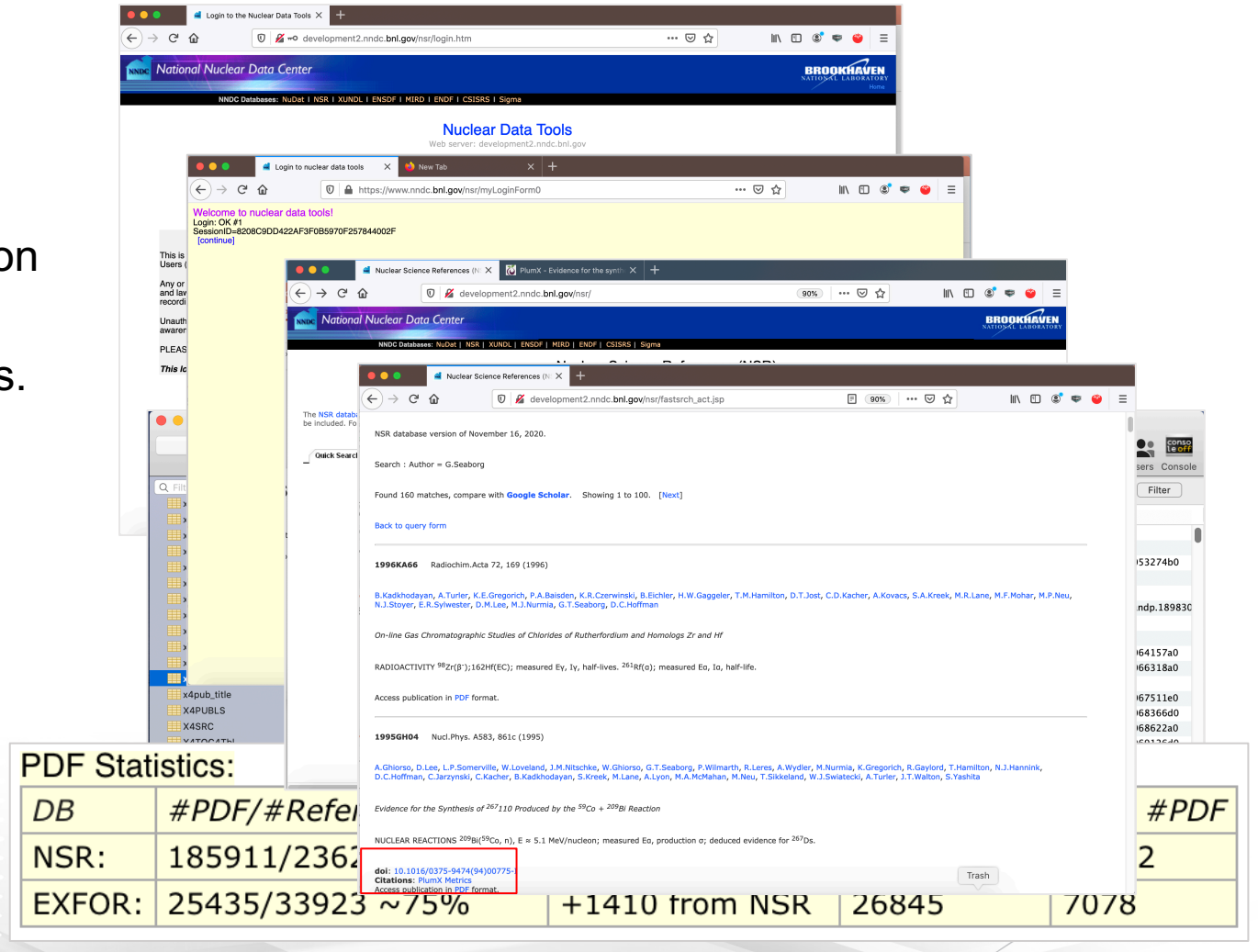

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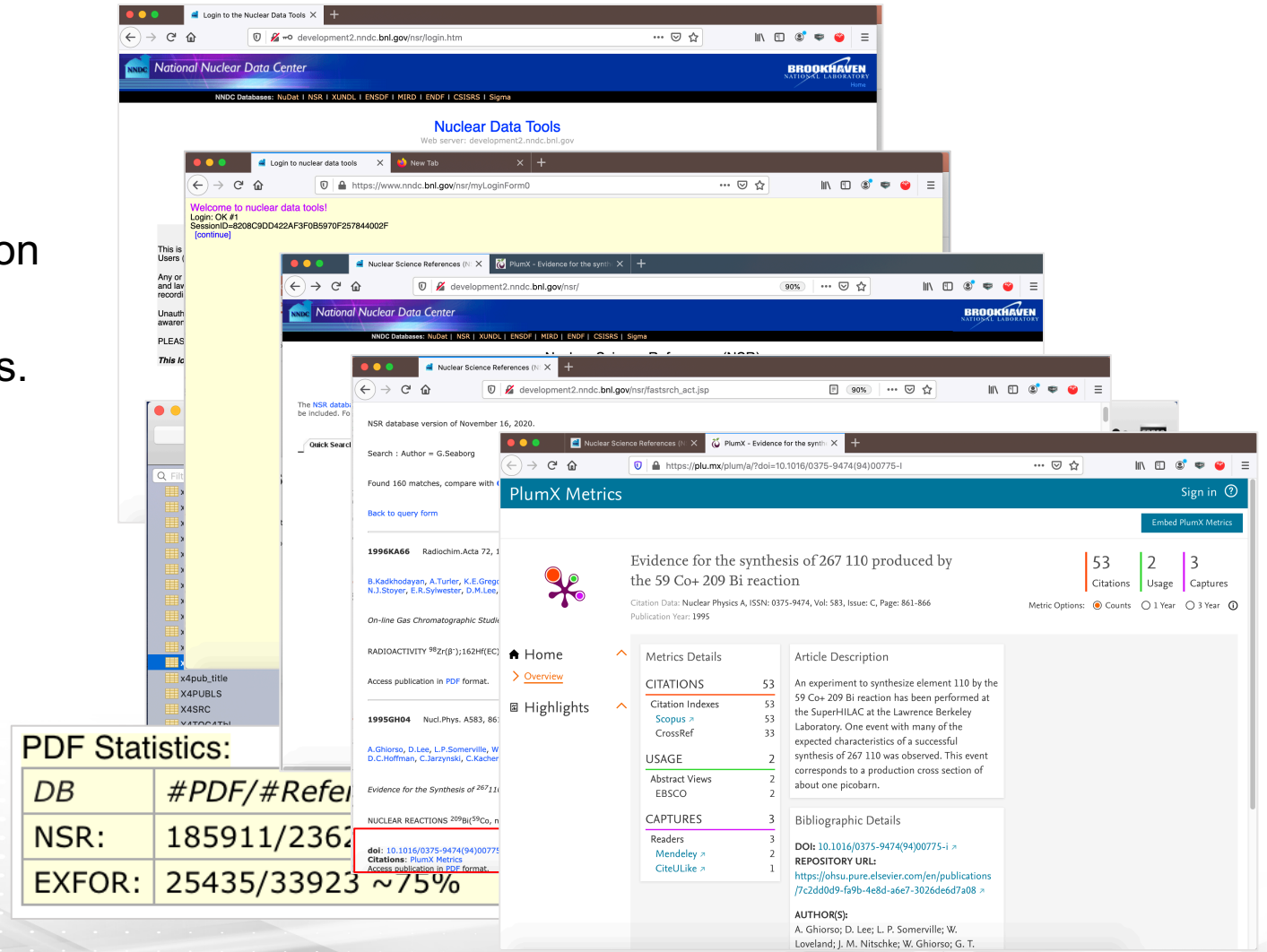

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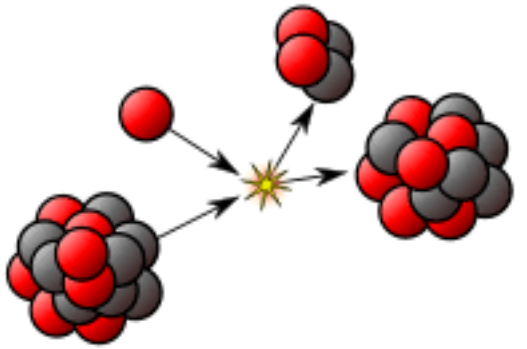
Unique Data References

- NNDC collects and processes rare nuclear physics publications.
- We collected unique references from the Oak Ridge National Laboratory (ORNL) library and many other sources.
- NNDC acquired a new scanner and mirofiche reader.
- NNDC librarian (J. Totans) is leading this effort.

EXFOR Effort in the U.S. and Canada

- Nuclear Reaction Data Centers (NRDC) oversee EXFOR compilations worldwide, NNDC is responsible for the Area #1 (USA & Canada).
- NNDC EXFOR Team: B. Pritychenko, S. Hlavac, O. Schwerer, O. Gritzay, and V. Zerkin (IAEA).
  - NNDC: Overall database and contracts management, website support, compilation and correction of missing and older references.
  - Bratislava: Mainly new references compilation.
  - Kyiv: Fission yields compilation.
  - Vienna: Overall quality assurance and transmission handling.
  - IAEA: Web and database software development.
- Smooth operation based on efforts of BNL stuff, contractors and collaborators.
- Contractors (S. Hlavac, O. Gritzay and O. Schwerer) are essential for the overall success of the NNDC EXFOR effort.

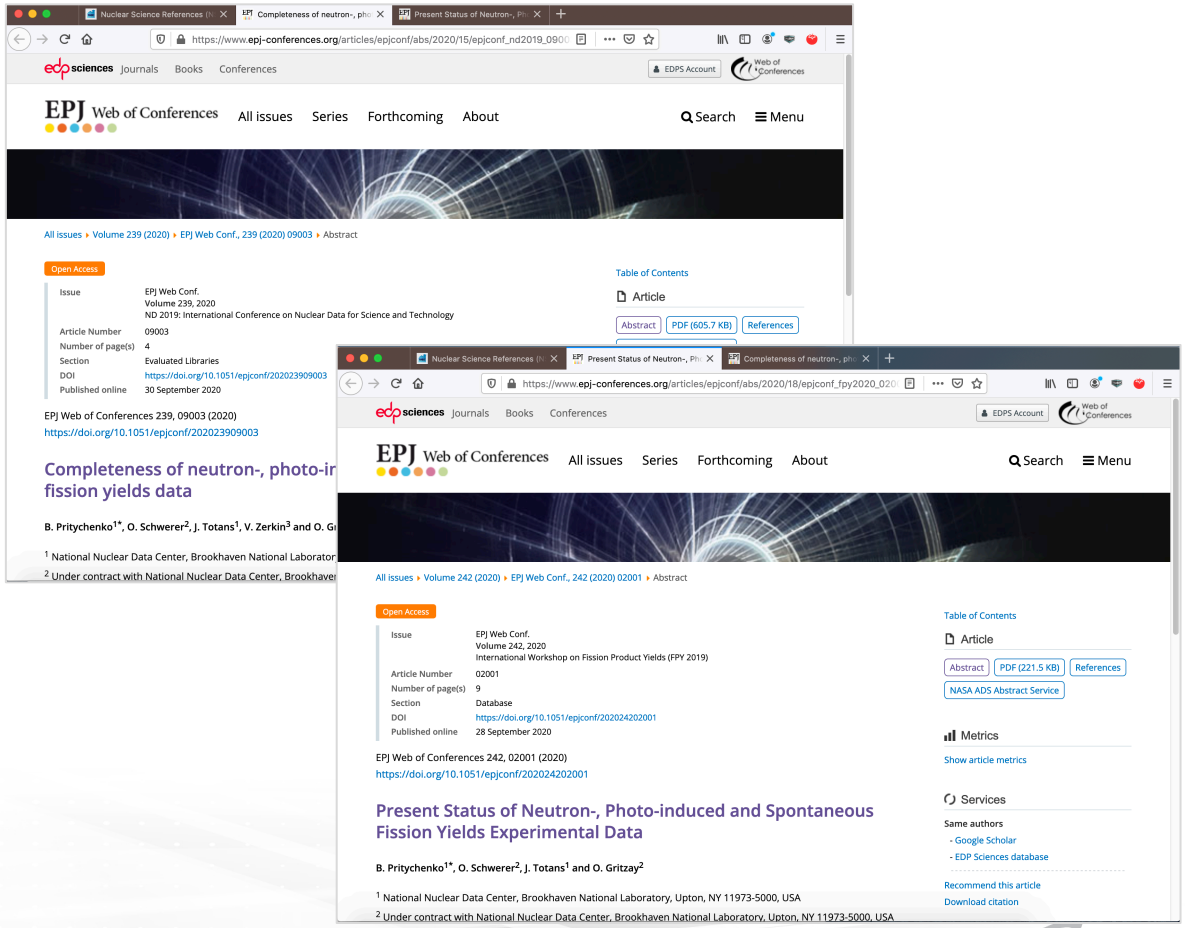
Area #1 EXFOR Statistics



- New entries: 86 + 128 (BNL) = 214.
- Corrected entries: 208 + 18 (BNL) = 226.
- Lack of new publications, during the COVID-19 times, was compensated by proactive recovery of the previously missed entries.
- EXFOR database was updated on a regular basis.
- EXFOR Web retrievals in FY2020: 38,459.
- More compilation details in the IAEA system are based on calendar years: http://www-nds.iaea.org/exfor-master/x4compil/.
- Fission yields compilation project based on Nuclear Science References (NSR) database, England & Rider and Mills references is underway.

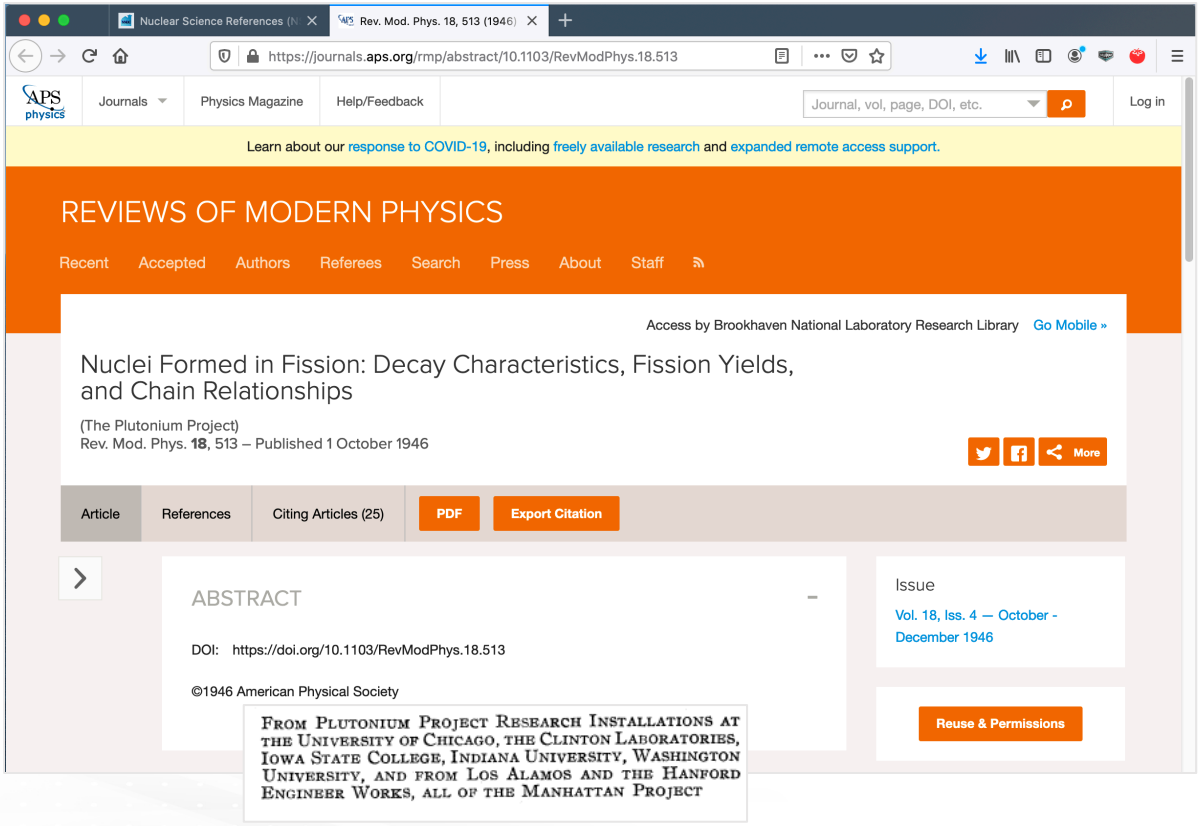
Fission Yields Compilations

- NSR FY are finished in FY2020: three NRDC memos on NSR database analysis: CP-C/464 (Spontaneous fission), CP-C/465 (photo fission), and CR-C/466 (Neutron-induced fission).
- England & Rider/ Mills FY (IAEA analysis) are in progress.
- Charged Particle Induced FY are finished in FY 2020.
- Results were reported at ND 2019, FPY Workshop in Santa Fe, NM.
- We joined FY CRP and SG 50 to ensure the high quality of FY in databases.
- This work was sponsored by the Office of NP, Office of Science of the U.S. DOE, under Contract No. DE-AC02-98CH10886, and supported by the Office of Defense Nuclear Nonproliferation Research & Development (DNN R&D), National Nuclear Security Administration, U.S. DOE.



Nuclear Reaction Data Compilations in USA & Worldwide

- Experimental neutron reaction data compilations have been pioneered at the Metallurgical Laboratory, University of Chicago and Los Alamos National Laboratory in 1945-1947.
- Brookhaven National Laboratory hired many *Manhattan Project* alumni when it was founded in 1947, and the lab got involved in nuclear data.
- Donald J. Hughes (1915-1960) was behind the BNL-170 (1952); it is a precursor of BNL-325 (Atlas of Neutron Resonances).
- Second UN International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958.
- SCISRS (Sigma Center Information and Retrieval System) at BNL (1964) was a precursor of EXFOR.
- Other data centers were created in Paris, France (NEA-Databank), Vienna, Austria (NDS-IAEA), and Obninsk, USSR (IPPE) in 1963-1964.
- Around 1970 four neutron data centers agreed on the data interchange format (EXFOR). The four centers could store data locally in its formats. The Nuclear Data Centres Reaction (NRDC) network was later formed under the auspices of the IAEA.



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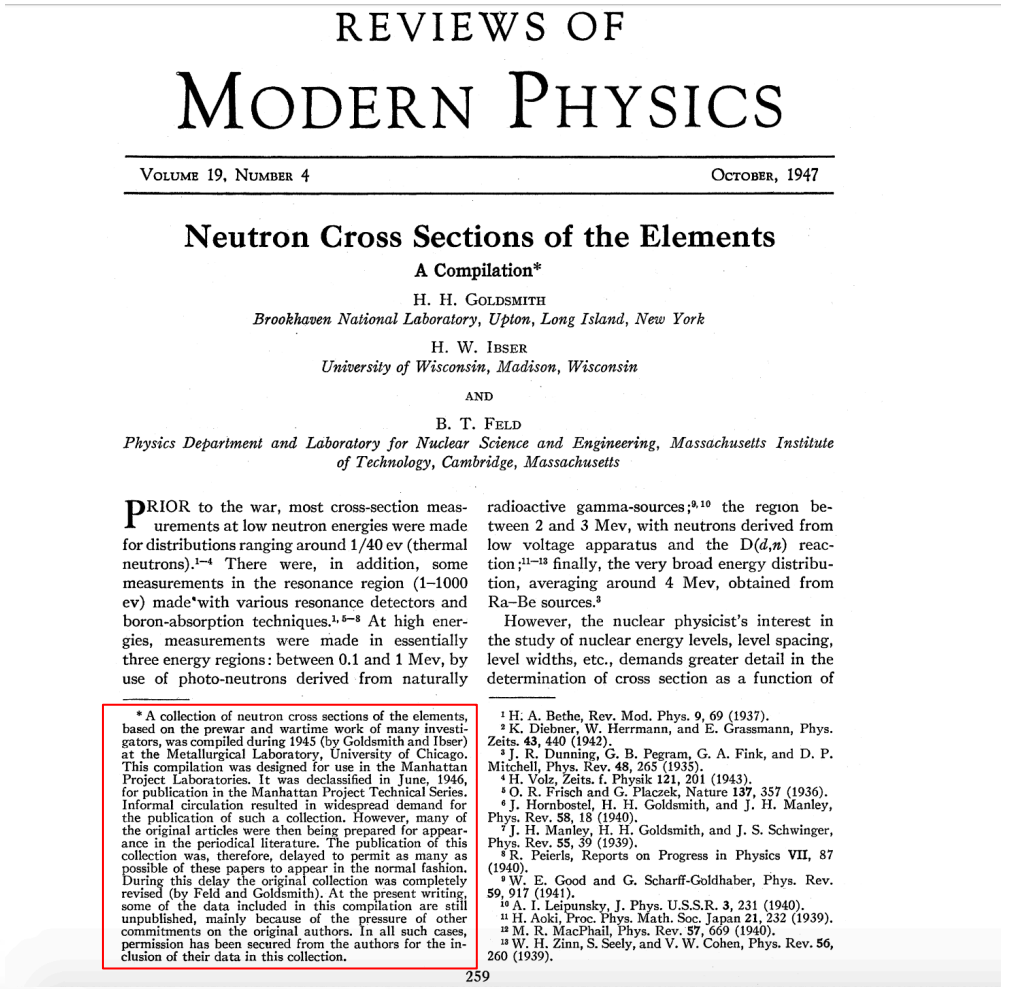

REVIEWS OF
MODERN PHYSICS

VOLUME 19, NUMBER 4 — OCTOBER, 1947

Neutron Cross Sections of the Elements

A Compilation*

H. H. GOLDSMITH
Brookhaven National Laboratory, Upton, Long Island, New York

H. W. IBSER
University of Wisconsin, Madison, Wisconsin

AND

B. T. FELD
Physics Department and Laboratory for Nuclear Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts

PRIOR to the war, most cross-section measurements at low neutron energies were made for distributions ranging around 1/40 ev (thermal neutrons).[1–4] There were, in addition, some measurements in the resonance region (1–1000 ev) made with various resonance detectors and boron-absorption techniques.[1,6–8] At high energies, measurements were made in essentially three energy regions: between 0.1 and 1 Mev, by use of photo-neutrons derived from naturally radioactive gamma-sources;[9,10] the region between 2 and 3 Mev, with neutrons derived from low voltage apparatus and the D(d,n) reaction;[11–13] finally, the very broad energy distribution, averaging around 4 Mev, obtained from Ra–Be sources.[2]

However, the nuclear physicist's interest in the study of nuclear energy levels, level spacing, level widths, etc., demands greater detail in the determination of cross section as a function of

* A collection of neutron cross sections of the elements, based on the prewar and wartime work of many investigators, was compiled during 1945 (by Goldsmith and Ibser) at the Metallurgical Laboratory, University of Chicago. This compilation was designed for use in the Manhattan Project Laboratories. It was declassified in June, 1946, for publication in the Manhattan Project Technical Series. Informal circulation resulted in widespread demand for the publication of such a collection. However, many of the original articles were then being prepared for appearance in the periodical literature. The publication of this collection was, therefore, delayed to permit as many as possible of these papers to appear in the normal fashion. During this delay the original collection was completely revised (by Feld and Goldsmith). At the present writing, some of the data included in this compilation are still unpublished, mainly because of the pressure of other commitments on the original authors. In all such cases, permission has been secured from the authors for the inclusion of their data in this collection.

[1] H. A. Bethe, Rev. Mod. Phys. **9**, 69 (1937).
[2] K. Diebner, W. Herrmann, and E. Grassmann, Phys. Zeits. **43**, 440 (1942).
[3] J. R. Dunning, G. B. Pegram, G. A. Fink, and D. P. Mitchell, Phys. Rev. **48**, 265 (1935).
[4] H. Volz, Zeits. f. Physik **121**, 201 (1943).
[5] O. R. Frisch and G. Placzek, Nature **137**, 357 (1936).
[6] J. Hornbostel, H. H. Goldsmith, and J. H. Manley, Phys. Rev. **58**, 18 (1940).
[7] J. H. Manley, H. H. Goldsmith, and J. S. Schwinger, Phys. Rev. **55**, 39 (1939).
[8] R. Peierls, Reports on Progress in Physics **VII**, 87 (1940).
[9] W. E. Good and G. Scharff-Goldhaber, Phys. Rev. **59**, 917 (1941).
[10] A. I. Leipunsky, J. Phys. U.S.S.R. **3**, 231 (1940).
[11] H. Aoki, Proc. Phys. Math. Soc. Japan **21**, 232 (1939).
[12] M. R. MacPhail, Phys. Rev. **57**, 669 (1940).
[13] W. H. Zinn, S. Seely, and V. W. Cohen, Phys. Rev. **56**, 260 (1939).

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75 Years of Nuclear Reaction Data Compilations

- Compilations started during the Manhattan project (U. Chicago, Los Alamos National Laboratory).
- In 1947 camp Upton was transformed from the U.S. military base to Brookhaven National Laboratory, and compilations were pioneered by Goldsmith and Hughes at Brookhaven.
- International cooperation in data compilation.
- In 2021-2022 we will celebrate the 75th anniversary of nuclear reaction data compilations.