The Present Status of the EXFOR Project

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Nuclear Reaction Data Compilations in USA & Worldwide

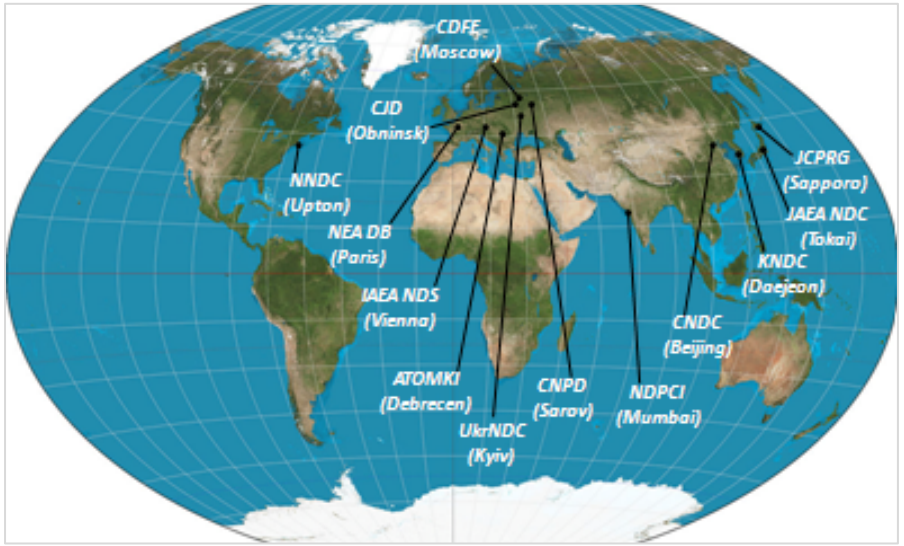
- Experimental neutron reaction data compilations have been pioneered at the Metallurgical Laboratory, University of Chicago and Los Alamos National Laboratory in 1945-1947.
- Brookhaven National Laboratory hired many *Manhattan Project* alumni when it was founded in 1947, and the lab got involved in nuclear data.
- Donald J. Hughes (1915-1960) was behind the BNL-170 (1952); it is a precursor of BNL-325 (Atlas of Neutron Resonances).
- 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 founded in 1979 under the auspices of the IAEA.

EXFOR - Experimental Nuclear Reaction Data

The largest experimental nuclear reaction database (*www.nndc.bnl.gov/exfor*)

- 23,889 experiments (multiple publications are grouped into a single measurement).
- 177,449 data sets as of October 1, 2021.
- Essential for Evaluated Nuclear Data File (ENDF) libraries worldwide.
- Presently run by the Nuclear Reaction Data Centres (NRDC) internationally. This is an IAEA network which is coordinated by the IAEA.
- Two largest contributors: NNDC & NEA-Databank.
- Every second, third and sixth data points in the library were contributed by the NNDC, NEA-Databank and the rest of NRDC network, respectively.

EXFOR philosophy is to compile data as they were published (in consultation with authors) unless obvious errors are found. Published nuclear reaction data contain outliers and discrepancies.



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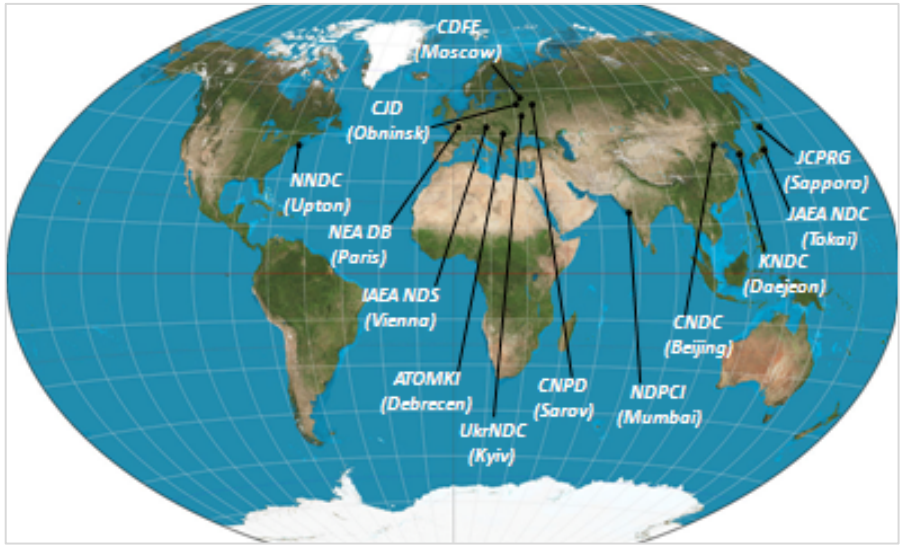
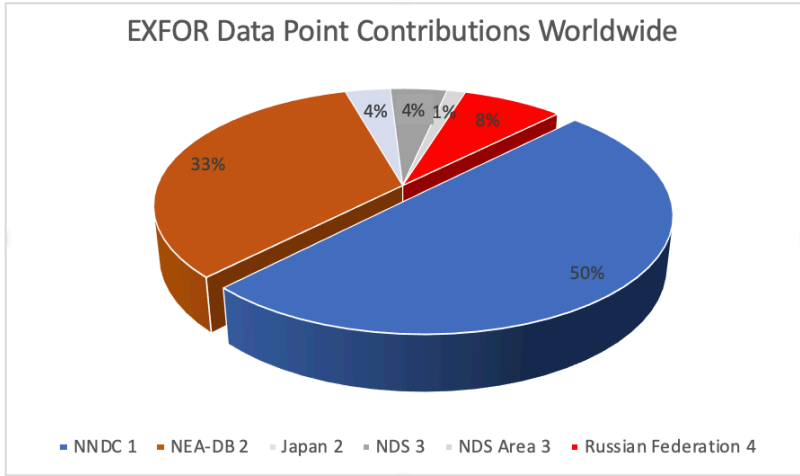




Area #1 FY 2021 Statistics

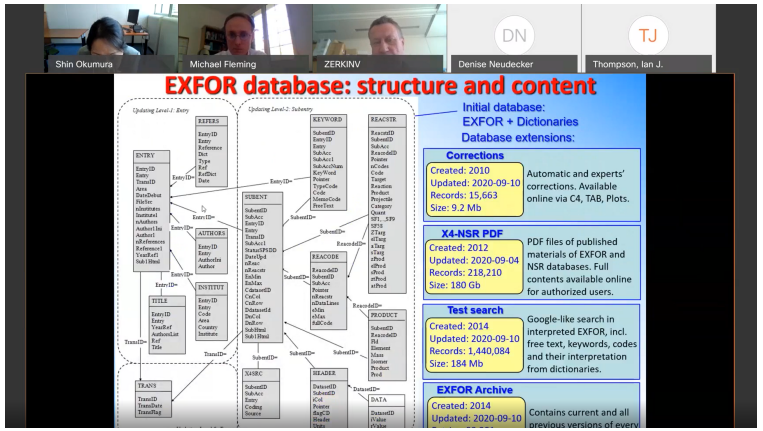
- New compilations: 131
- Updated compilations: 303
- Finished compilations of missing fission yields, NRDC memos: CP/C-0464, CP/C-0465, CP/C-0466, and CP/D-979.
- Preliminary NRDC transmissions: 26
- Final NRDC transmissions: 17
- EXFOR DB Updates: 40
- EXFOR Web retrievals
  - CINDA: 1,479
  - ENDF: 101,045
  - EXFOR: 44,387

Working Party on International Nuclear Data Evaluation Co-operation (*WPEC*) – SubGroup 50

Subgroup on developing an automatically readable, comprehensive and curated experimental reaction database (LA-UR-20-22620).

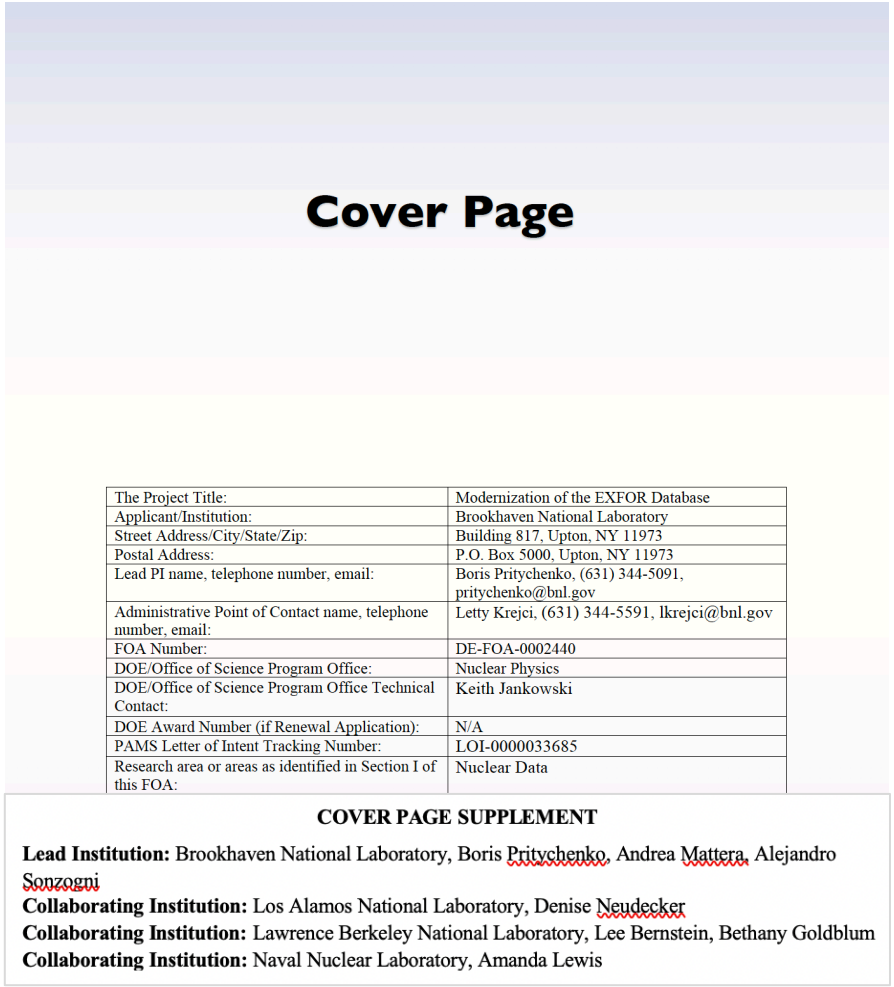
US Nuclear Data Program EXFOR modernization effort

- Create a parallel library to EXFOR that stores and incorporate corrections to data and uncertainties that were undertaken by evaluators. Also, store expert judgment on these data.
- Assess published uncertainties with templates of expected uncertainties for specific measurement types.
- Use artificial-intelligence and machine-learning algorithms in conjunction with comprehensive physics models for outlier identification.



USNDP EXFOR Modernization Proposal

- Work on SubGroup50 requires funding.
- We propose to re-analyze the EXFOR database contents, develop corrections for many data sets, flag discrepancies, introduce covariances, and store the high-quality curated data in a parallel (sister) database.
- We will employ artificial-intelligence and machine-learning (AI/ML) algorithms, re-visit nuclear reaction monitor and decay data values in conjunction with comprehensive physics models in order to enable outlier identifications in data selection.
- We will also translate the data in EXFOR from the historic exchange to JavaScript Object Notation (JSON) format and develop an application programming interface (API) to facilitate code interfacing and provide a pipeline between experimentalists, compilers and evaluators.



Cover Page

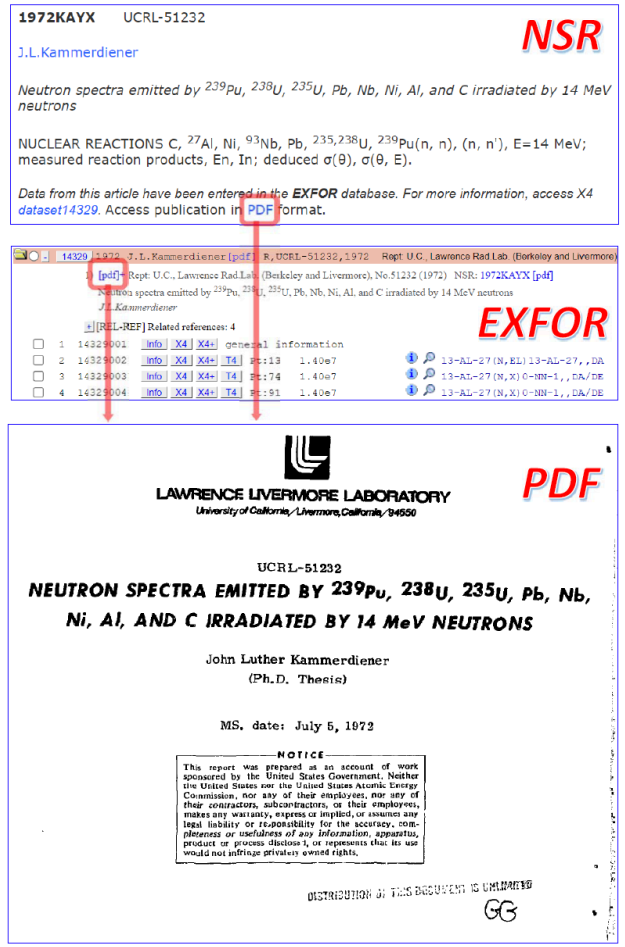
The Project Title:	Modernization of the EXFOR Database
Applicant/Institution:	Brookhaven National Laboratory
Street Address/City/State/Zip:	Building 817, Upton, NY 11973
Postal Address:	P.O. Box 5000, Upton, NY 11973
Lead PI name, telephone number, email:	Boris Pritychenko, (631) 344-5091, pritychenko@bnl.gov
Administrative Point of Contact name, telephone number, email:	Letty Krejci, (631) 344-5591, lkrejci@bnl.gov
FOA Number:	DE-FOA-0002440
DOE/Office of Science Program Office:	Nuclear Physics
DOE/Office of Science Program Office Technical Contact:	Keith Jankowski
DOE Award Number (if Renewal Application):	N/A
PAMS Letter of Intent Tracking Number:	LOI-0000033685
Research area or areas as identified in Section I of this FOA:	Nuclear Data

COVER PAGE SUPPLEMENT

Lead Institution: Brookhaven National Laboratory, Boris Pritychenko, Andrea Mattera, Alejandro Sonzogni
Collaborating Institution: Los Alamos National Laboratory, Denise Neudecker
Collaborating Institution: Lawrence Berkeley National Laboratory, Lee Bernstein, Bethany Goldblum
Collaborating Institution: Naval Nuclear Laboratory, Amanda Lewis

Database Integration

- ENSDF/XUNDL/NSR databases are integrated.
- 59,093 out of 240,594 NSR references are used in ENSDF.
- Recently, in collaboration with the NDS-IAEA (V. Zerkin), we integrated NSR and EXFOR.
- How many EXFOR compilations are used in ENDF???
- It could be nice to include relevant EXFOR accession numbers into ENDF evaluations and build better connections with the EXFOR project.
- Eventually, it would help to create a single nuclear data library.



Takeaways

- NNDC EXFOR compilation efforts are complex and well-organized: B. Pritychenko (BNL), O. Schwerer, S. Hlavac, O. Gritzay (Under contract with BNL), V. Zerkin (IAEA).
- SG50 & USNDP EXFOR Modernization project.
- 75th anniversary of nuclear reaction data compilations in 2021-2022.

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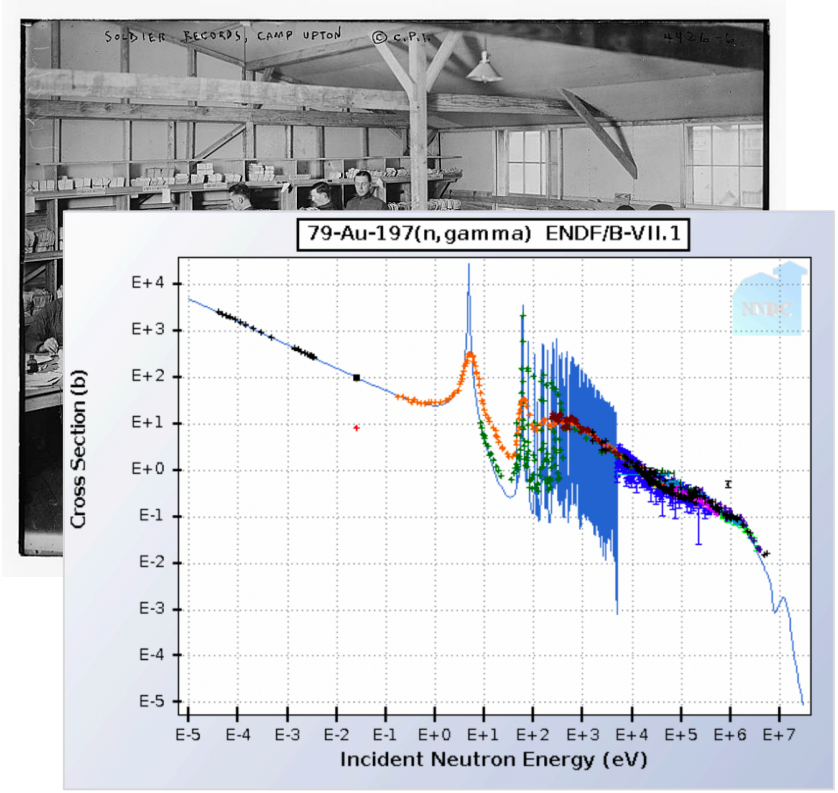

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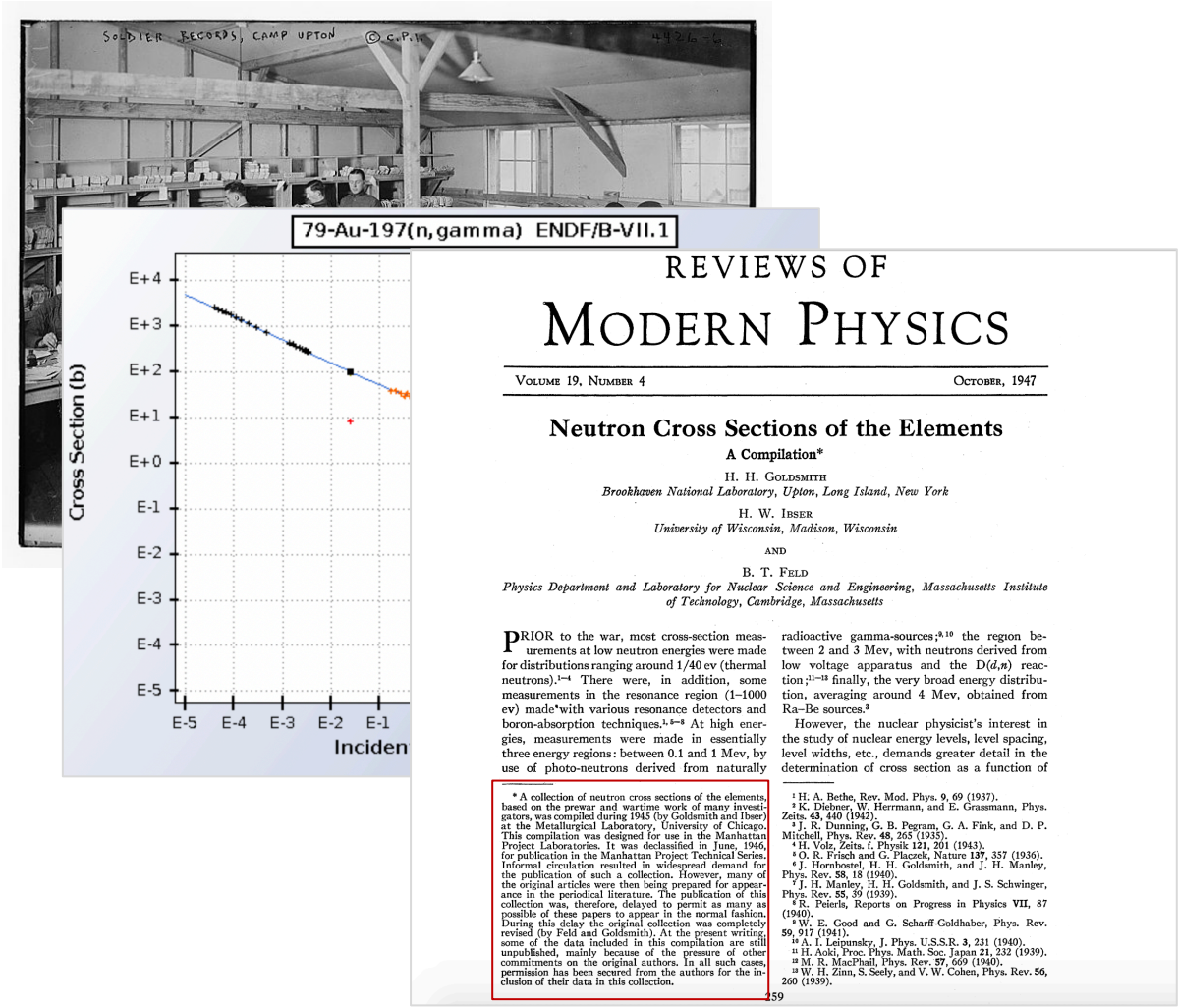

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