

FPY Data Compilations

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Experimental Nuclear Reaction Data (EXFOR)

- Manhattan Project alumni continued reaction compilations at Brookhaven in early 1950s.
- International cooperation in compilation areas #1, 2, 3 and 4 or NNDC, NEA-Databank Paris, NDS IAEA and IPPE, respectively, since 1969.
- Presently run by the Nuclear Reaction Data Centres (NRDC), internationally. This is an IAEA network which is coordinated by the IAEA.
- EXFOR team: B. Pritychenko (BNL), S. Hlavac, O. Gritzay, O. Schwerer (contractors), V. Zerkin (collaborator).



Missing Data in EXFOR

Not all experiments were compiled to SCISRS (Sigma Center Information Retrieval System, EXFOR precursor) database at Brookhaven in 1950s for historical (scope defined by applications) & technological (data were requested from authors or taken from published tables) reasons.

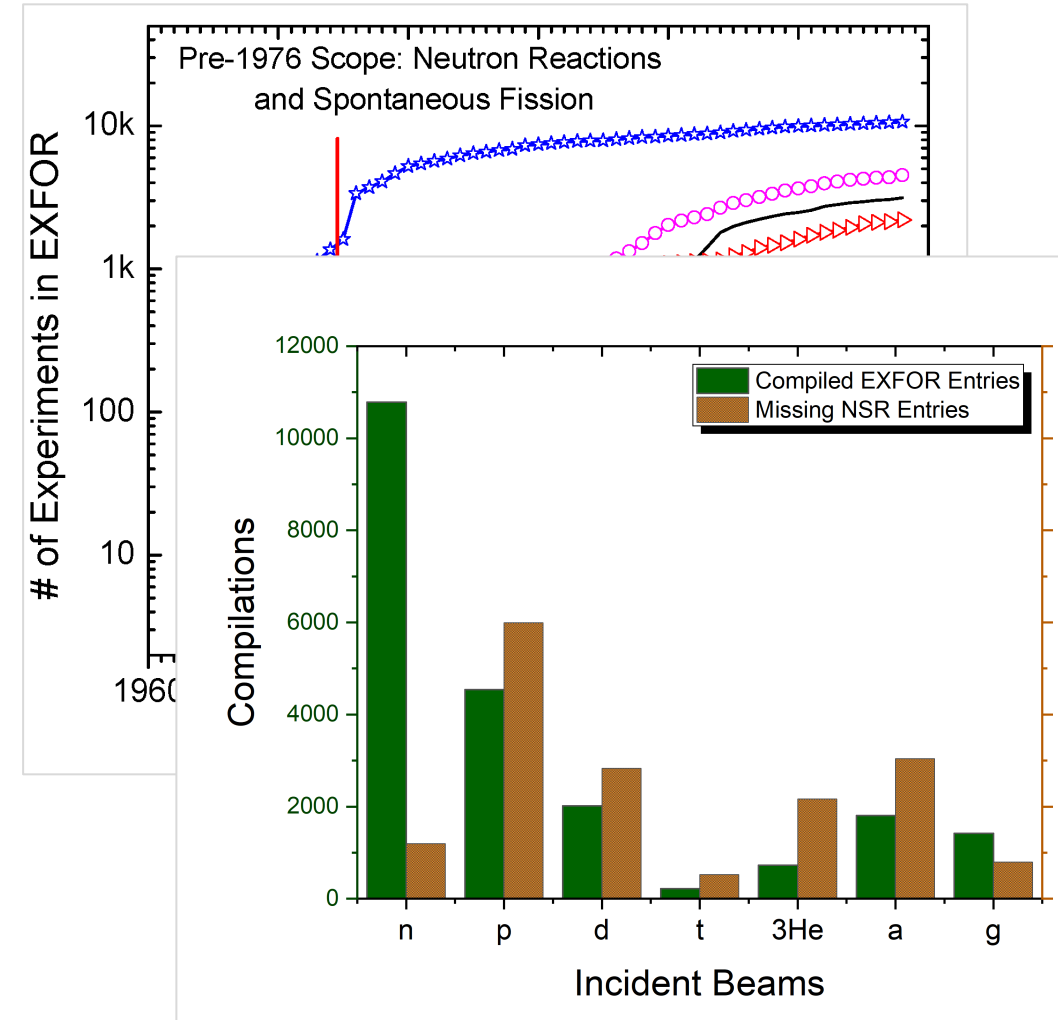
EXFOR project started to compile neutron cross sections and spontaneous fission since 1970, no FY until 1976.

Many important data sets were missed; comparison between EXFOR & Nuclear Science References (NSR) databases indicates that EXFOR could have 40,000+ experiments instead of 23,000.

Present day cost of a single experiment, LBL 88" Cyclotron example:

- \$2,500 /hour beam time => \$420 K/week
- Cost of ^{36}S and ^{48}Ca for ECR source are \$47 K/gram and \$250 K/gram, respectively
- Total price tag, conservatively, is \$1 M

It is cost effective to recover previous results than run new.



Missing FY Data

NNDC is responsible for experimental nuclear reaction data in the Area #1.

Nuclear structure-like search for FY NSR references was conducted at NNDC, Fall 2017:

- Potentially Missing Neutron FY: 384
- Potentially Missing Spontaneous FY: 142
- Potentially Missing Photo FY: 126

Results were initially reported

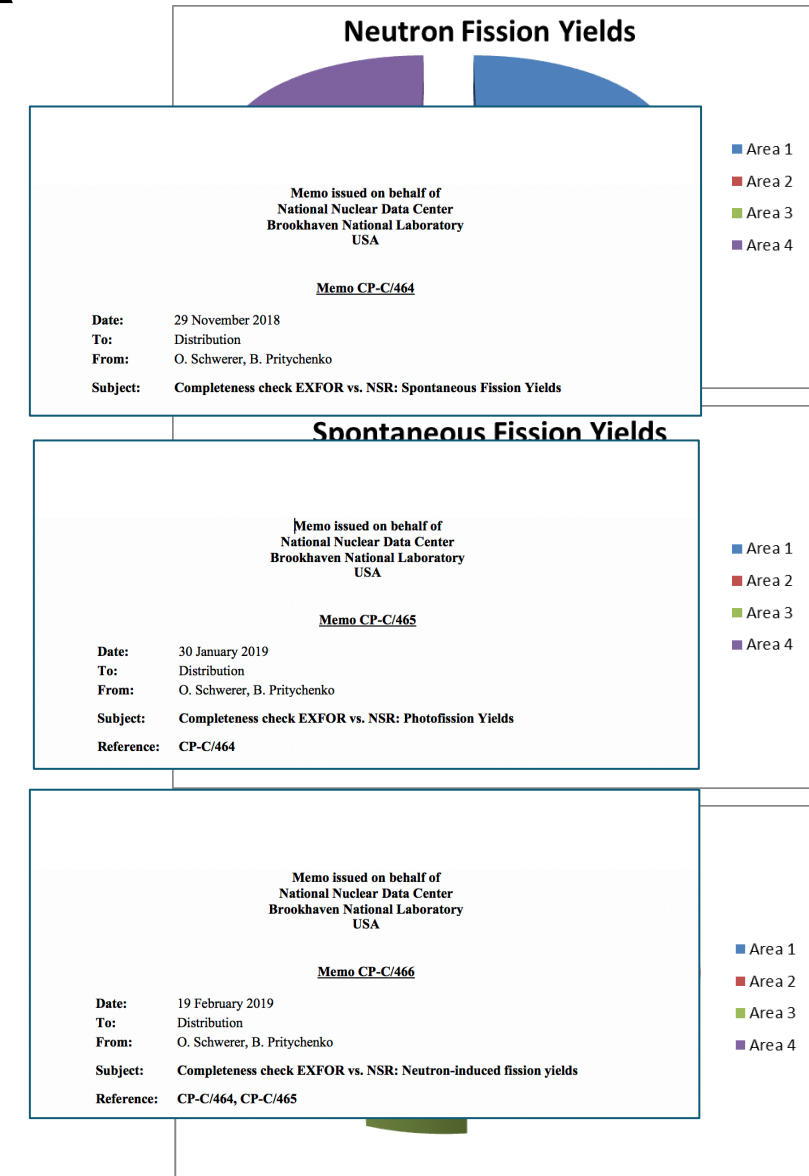
- Informal NNDC-Los Alamos meeting, April 2018
- Workshop on Fission Product Yield Experimental Data, Los Alamos, August 20-23, 2018
- NRDC workshop, Vienna, October 22-25, 2018
- NRDC memos: CP-C 464, 465, 466, 469 (November 2018 – April 2019)

We analyzed the data, identified missing entries and collected PDFs (Not a trivial task but essential for compilations). **It took us 1 year to complete.**

The IAEA group started checking Mills, England & Rider for missing references in the Fall of 2018.

ND 2019 contributions, Beijing, May 19-24, 2019: NNDC & IAEA efforts.

Workshop on Fission Product Yield Experimental Data, Santa Fe, September 30 - October 3, 2019: NNDC & IAEA efforts.



Status of FPY Compilations

- Since 12/19/2019 the IAEA runs Updating Fission Yields Data for Applications CRP: <https://www.iaea.org/projects/crp/f42007>
- The CRP specific objective: Compile all available experimental data on independent and cumulative fission yields, measured total kinetic energies and total neutron yields, mass and charge-yield data.
- NRDC runs FY compilations worldwide in support of the CRP.
- NNDC finished four NRDC memos compilations by March 31, 2021.
- NNDC proactively finds and compiles other fission data.



IAEA
International Atomic Energy Agency

INDC International Nuclear Data Committee

Progress in Compilation of Fission Yields Data

(N. Ot)

The number of articles on the Article Allocation System (N. Ot) for CP-D/979 (=revision of WP2019-20) is summarized in the table below.

	To
CDFE (Varlamov)	3
CJD (Mikhailukova)	9
CNDC (Wang)	1
JCPRG (Tada)	1
NDPCI (Devi)	1
NDS (Okumura)	4
NEADB (Fleming)	20
NNDC (Pritychenko)	10
Any	3
Total	60

*The two outstanding articles assigned to CJD were transmitted in PRELIM.4194 on 19 April 2021.

INDC(NDS)-0817
Date: 31 March 2021

Dr. Olena Gritzay: During 1 April 2019 – 31 March 2021

All entries from CP-C/464, CP-C/465, CP-D/979 were done: **85** (70+8+6+1) new compilations and **90** (32+58) updated compilations.

Two entries (13313 and 10821) from CP-D/979 were updated, but the 2-nd and 3-rd REFERENCE were not added, as and Lidja and JoAnn could not find publications (JACS, 28, 1972) and (RUCRL-80020, 1977).

81 entries found by me were done: **78** updated compilations and **3** new compilations.

So, **256** entries were done: **88** new and **168** updated. For these 256 entries:

Compilation without mark (**bold black colour**) are included in EXFOR or Prelims (203 entries).

24 (marked by yellow) Sent Otto, but not revised (I received his comments only 27 March). 5 from them (*) were included by Otto in Prelim.1478.

29 (marked by blue) Ready (as you can see from Time Tables), but they did not sent Otto (I was waiting comments on the previous 24 compilations). There are the last seven entries (6 updated & 1 new) from Memo CP-D/979 and 22 updated entries found by me.]

Also, for today I see 35 entries, which needed to update (the last column in the table), but I had not time to do these compilations.

#	New compilations CP-C/464, CP-C/465, CP-C/465, CP-D/979		Updated CP-C/464 CP-C/465, CP-C/466	Memo CP- D/979	Updated/new, found by me	Needed to update (my search)
1.	14531	C2452	10516	10026	10864	13259
2.	14532	C2468	10605	10030	10918	13300
3.	14533	C2469	10894	10433	12610	13449
4.	14534	C2470	10995	10722	13040	13451
5.	14535	C2471	12709	10798	13056	13439
6.	14536	C2472	12813	10996	13059	10067
7.	14537	C2501	12843	12729	13060	13452
8.	14538	C2502	12945	12771	13061	13460
9.	14539	L0249	13183	13053	13064	13477
10.	14540	L0250	13267	13063	13065	13486
11.	14541	L0251	13274	13077	13070	13473
12.	14542	L0252	13278	13083	13071	13441
13.	14543	L0253	13280	13085	13076	13487
14.	14544	L0254	13282	13092	13078	13343
15.	14545		13283	13093	13079	13349
16.	14546		13291	13095	13097	13344 no pdf
17.	14547		13292	13102	13213	13256 ? no pdf (See tab 13259)

NNDC Charged Particle FY Compilations

- Charged particles (p, d, t, ^3He , ^4He , ...) were extensively used to study FY at Berkeley, Los Alamos, Argonne, University of Washington, ...
- Many fissioning systems could be produced in charged particle reactions (Bohr-Independence Hypothesis):
 - $^{232}\text{Th} + ^4\text{He} \rightarrow ^{236}\text{U}$
 - $^{238}\text{U} + ^4\text{He} \rightarrow ^{242}\text{Pu}$
- NSR contents were analyzed for charged particle fission reactions.
- NNDC raw compilation in FY2020 using NSR charged particle contents: 114 new and 7 updated.
- Compiled all works of J. Wilhelmy (LANL) and G. Seaborg (LBNL) into EXFOR.



DE GRUYTER

Radiochim. Acta 2018; 106(8): 627–630

Narek Gharibyan*, Ken Moody, Scott Tumey, Tom Brown, Pat Grant, Graham Bench and Dawn Shaughnessy

Development of a “fission-proxy” method for the measurement of 14-MeV neutron fission yields

https://doi.org/10.1515/ract-2017-2889

Received October 20, 2017; accepted February 23, 2018; published online March 24, 2018

of fission products with known cumulative fission yields allows deconvolution of the fission-product distributions. This result is termed the fission split [1]. Thus, the fidel-

Abstract: Relative fission-yi

for 50 fission products from

sion of Th-232. Quantitative

mentally measured yields w

from 14-MeV neutrons on U

tion of the Bohr-independe

fission yields. As optimum

may be impossible or comp

new approach, fission-proxy

ENTRY

14653

20200420

20201130

20201124

1471

SUBENT

14653001

20200420

20201130

20201124

1471

BIB

8

20

TITLE

Energetics of Charged Particle-Induced Fission Reactions

AUTHOR

(H.C.Britt, H.E.Wegner, J.C.Gursky)

REFERENCE

(J, PR, 129, 2239, 1963)

#doi:10.1103/PhysRev.129.2239

REL-REF

(0, C2522001, H.C.Britt+, J, PR, 133, B603, 1964) The subsequent study.

(0, C2524001, H.C.Britt+, J, PR, 129, 2239, 1963) Charged particles data.

INSTITUTE

(1USALAS)

DETECTOR

(SIBAR) Two 300 Omega-cm gold-surface barrier semiconductor detectors.

METHOD

The 252Cf spontaneous fission source was used to determine the pulse-height defects for the two detectors and the energy loss for the fragments in the 50-microg/cm2 Ni absorbers in front of the detectors, by a comparison between the observed pulse heights for the two 252Cf energy groups and the time-of-flight results.

HISTORY

(20200420C) BP

ENDBIB

20

NOCOMMON

0

0

ENDSUBENT

23

SUBENT

14653002

20200420

20201130

20201124

1471

BIB

2

2

REACTION

(98-CF-252(0, F) MASS, PRE, FY)

STATUS

(CURVE) Fig. 2, page 2242.

ENDBIB

2

NOCOMMON

0

0

DATA

2

45

MASS

DATA

NO-DIM

PC/FIS

82.000

0.052

83.000

0.065

84.000

0.065

85.000

0.091

1963BR34

Phys.Rev. 129, 2239 (1963)

H.C.Britt, H.E.Wegner, J.C.Gursky

Energetics of Charged Particle-Induced Fission Reactions

NUCLEAR REACTIONS ¹⁹⁷Au, ²⁰⁶Pb, ²⁰⁹Bi(³He, F), F), E=6.8, 8 MeV; ²³³U(α, F), E=25.5 MeV; measured

RADIOACTIVITY ²⁵²Cf(SF); measured decay products;

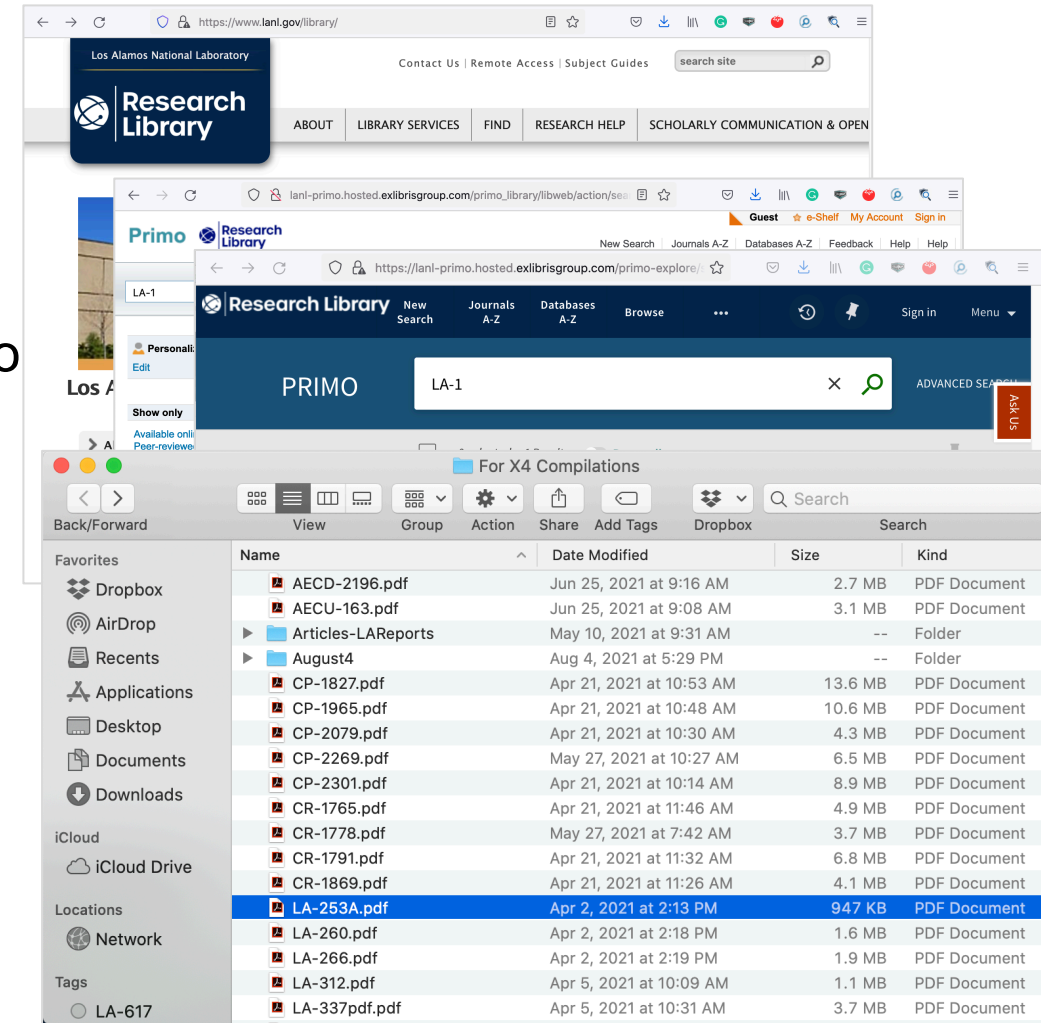
doi: 10.1103/PhysRev.129.2239

Citations: PlumX Metrics

Data from this article have been entered in the EXFOR database

Manhattan Project Data

- Fission yields and cross sections were produced by the Manhattan Project.
- Los Alamos National Laboratory library.
 - ~500 Los Alamos National Laboratory Reports were compiled into NSR database using the Primo library.
 - Nuclear reaction data reports from Los Alamos, Metallurgical and Pupin laboratories have been identified.
- Compilations of these data will start in December 2021.



Takeaways

- EXFOR FY compilation effort is complex and well-organized.
- Missing FY articles have been identified using NSR database (NNDC), R. Mills thesis and England & Rider (IAEA).
- NNDC (Area #1) finished four NRDC memos compilations and charged-particle FY by March 31, 2021.
- Further work will include extensive fission data search of the Manhattan Project laboratory reports to achieve completeness.

