

Current Status of ENDF FPY Data Sublibrary

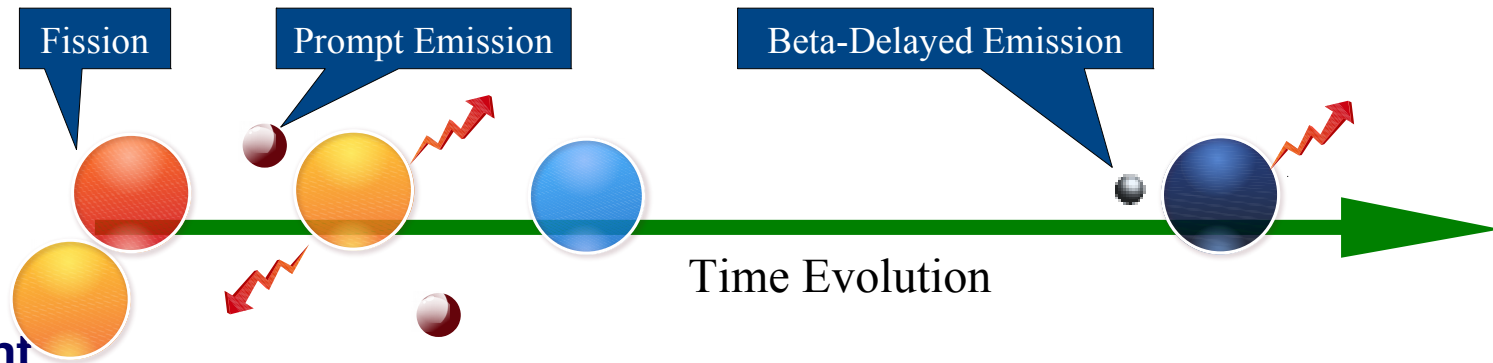
T. Kawano
Los Alamos National Laboratory

work with
M.R. Mumpower, I. Stetcu, M. Verriere, A. Lovell

FPY Evaluation and Experiment, Cross Lab Effort

■ Evaluation

- EXFOR compilation (BNL, IAEA)
- Evaluation of experimental FPY data (BNL)
- FPY model development, and production of the final evaluation (LANL)
- Coordination with international FPY evaluation efforts, such as IAEA consultancy meeting, CRP, JENDL, and JEFF (LANL)
- Micro/Macro (LANL) or Microscopic fission model development (LLNL)



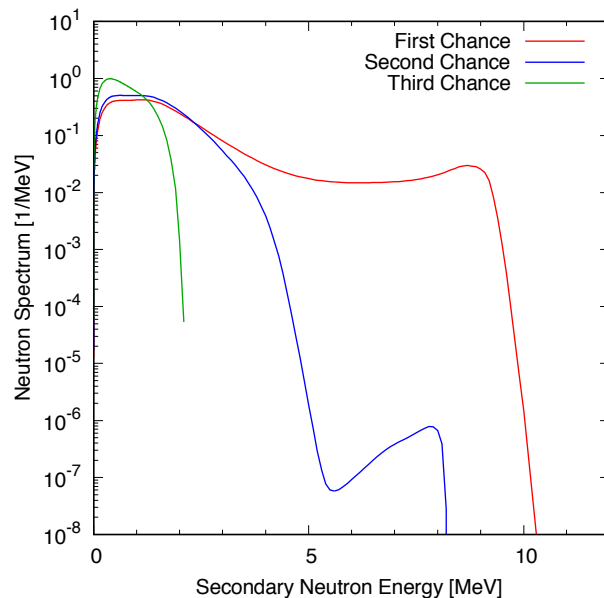
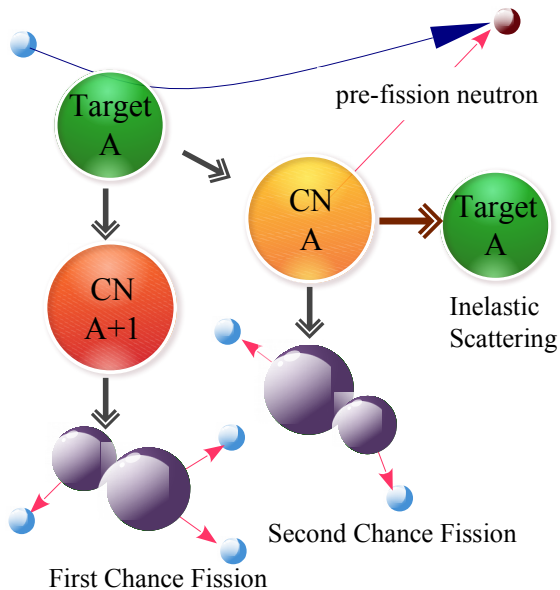
■ Experiment

- FPY measurements in critical assemblies, R-value (LANL)
- Energy dependent FPY measurements (LLNL, LANL, TUNL)
- FPY measurements with several neutron sources (PNNL), [see Pierson's talk]
- SPIDER and TPC measurements (LANL, PNNL)
- Measurements at LBNL cyclotron (LBNL, U. Berkeley)

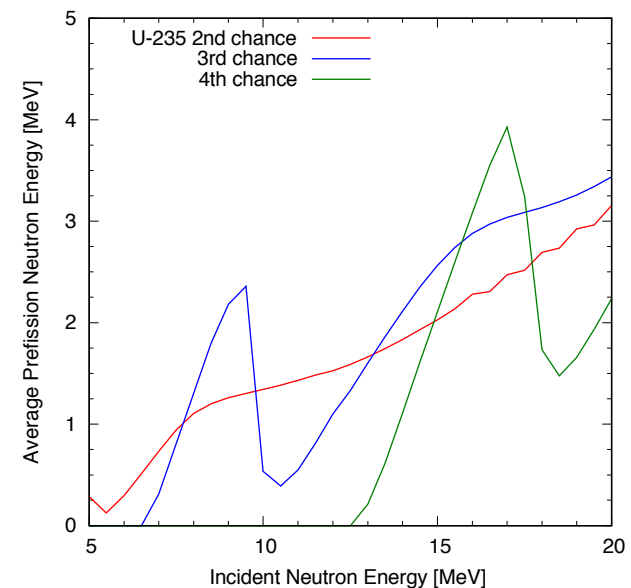
FPY Model Extension to Higher Energies

■ Inclusion of multi-chance fission

- A few neutrons can evaporate from CN prior to fission
- Calculate pre-fission neutron energy spectra and average energies with the statistical Hauser-Feshbach theory
 - Pre-fission neutron spectrum should be “exclusive”



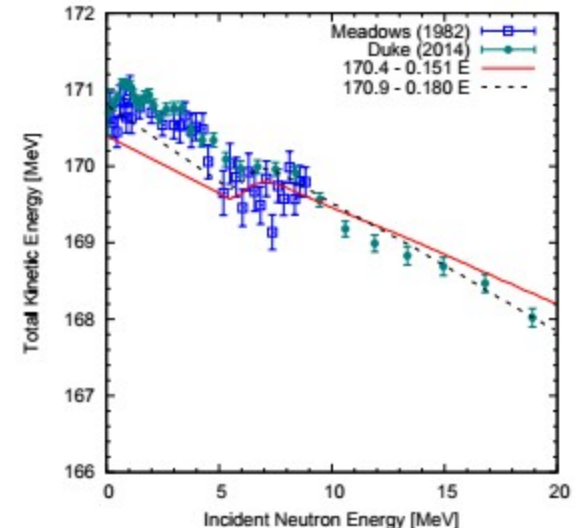
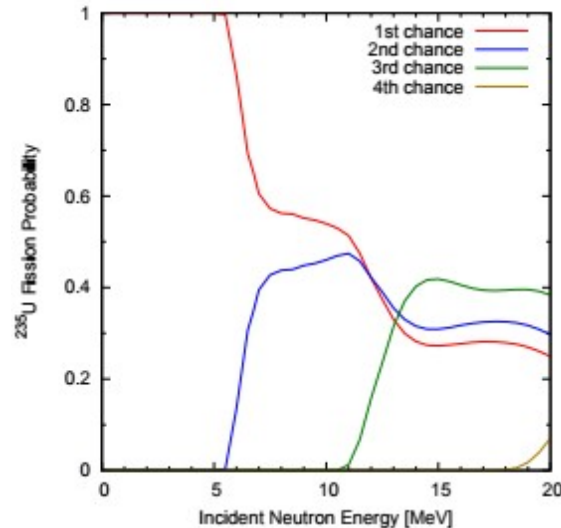
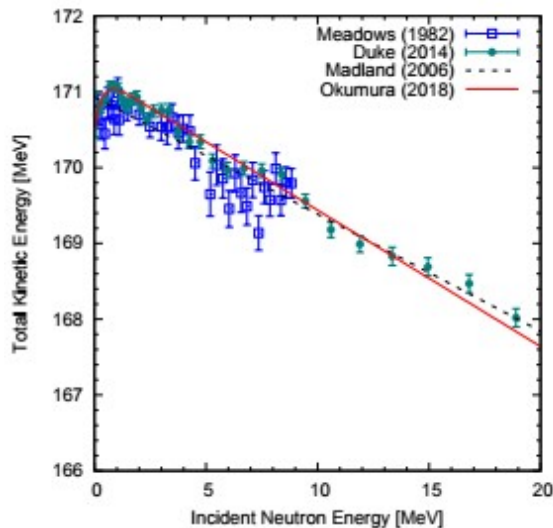
pre-fission neutron spectra for 15-MeV
neutron induced reaction on ^{235}U



average energy of pre-fission neutron
spectra for ^{235}U fission

Energy Dependence of Total Kinetic Energy (TKE)

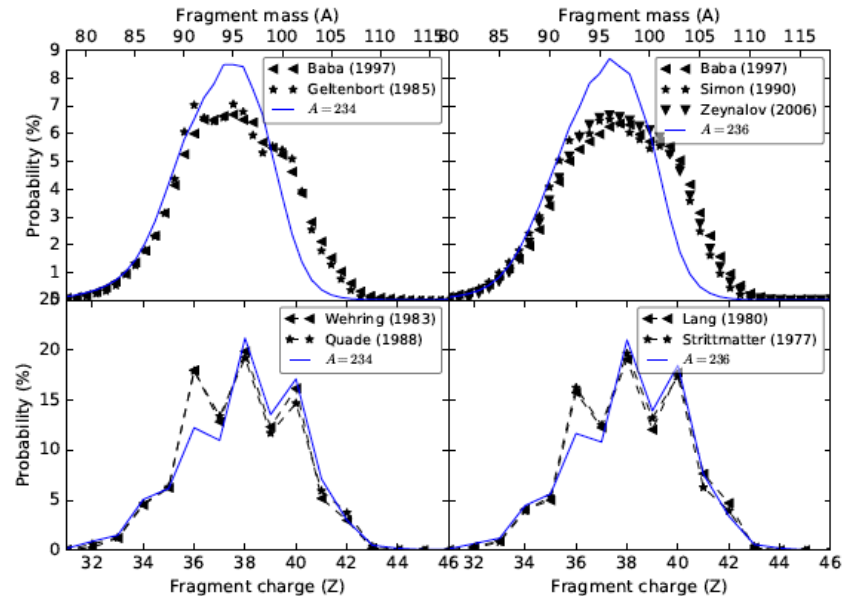
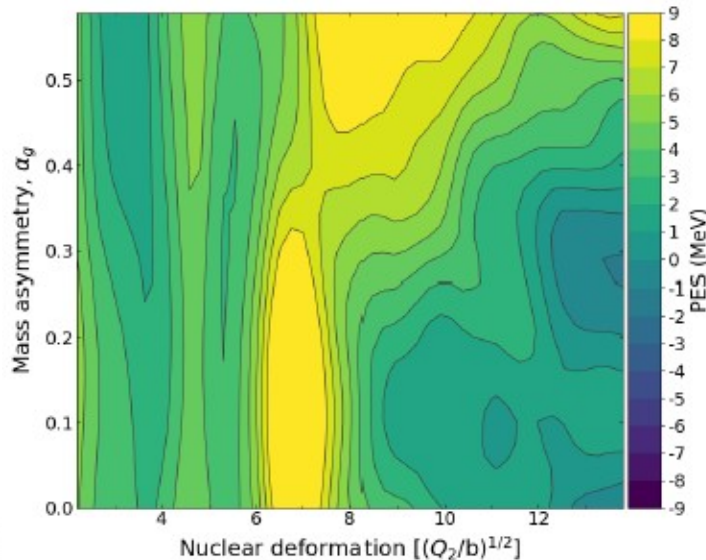
- **TKE determines excitation energies available in two fission fragments**
 - This is one of the key quantities for our FPY modeling
- **Measured TKE data**
 - They should be understood to be a weighted-average of multi-chance components



Preliminary!
We need to improve

Microscopic / Macroscopic Approach to Fission

- **Angular momentum of fission fragments**
 - Bertsch, Kawano, Robledo, PRC **99**, 034603 (2019)
- **Finite-Range Liquid Drop Model (FRLDM) potential energy surface**
- **Fission dynamics calculation on PES**
- **Charge-distribution by the number projection technique**
 - Verriere, Schunck, Kawano, PRC **100**, 024612 (2019)



Fission Product Yield Experimental Data (FPYEx) Meetings

- **Coordination with IAEA Nuclear Data Section (N. Otsuka)**
 - Los Alamos, NM, USA, 8/20-23 (2018), [LA-UR-18-28309](#)
 - 12 participants from 4 countries (Austria, Japan, Korea, US)
 - Tokyo Inst. Tech, Tokyo, Japan, 5/27-30 (2019), [INDC\(NDS\)-0793](#)
 - 15 participants from 6 countries (Austria, China, France, Japan, Korea, US)
- **Prepare a common experimental database of FPY for new evaluations, and share it among the nuclear data community**

Appendix A Fission product yield data coverage in EXFOR

Field definitions

- Mills: The reference number in the R.W. Mills's thesis[3].
- E-R: The reference number in the T.R. England and B.F. Rider's report[2].
- Author: 1st author's name.
- Reference: EXFOR format reference.
- EXFOR: Entry number is listed if the related EXFOR entry has already existed, entry number in parentheses indicates that related or partial data is already in EXFOR but without clear indication of the specified Reference, and 'new' indicates that the new entry must be created from the Reference.

Mills	E-R	Author	Reference	EXFOR
	78BYA1	A.A.Byalko+	R,INIS-SU-38,1978	40257
159	68DEL1	A.A.Delucchi+	J,PR,173,1159,1968	13232
77	70DEL1	A.A.Delucchi+	J,PR,C,1,1491,1970	13266
2092	85HAS1	A.A.Hasan+	J,ANS,49,209,1985	32667
	80NAQ1	A.A.Naqvi	R,KFK-2919,1980	21661
2044	84TEP1	A.A.Solonkin+	C,83KIEV,2,251,1983	40877

Area	E-R's list	Already in EXFOR	New entry	Another action	No action
1 United States	610	413	68	41	88
2 OECD countries	303	171	83	14	35
3 Others	155	103	24	8	20
4 Former Soviet Union countries	91	69	15	3	4
Not specified*	443				443
	1602**	756	190	66	590

Area	Mills' list	Already in EXFOR	New entry	Another action	No action
1 United States	321	248	26	17	30
2 OECD countries	149	70	63	9	7
3 Others	82	53	22	3	4
4 Former Soviet Union countries	73	37	28	5	3
Not specified*	20				20
	645	409	139	34	64
Total (exclude overlaps)		720	194	54	

International Workshop on Fission Product Yields 2019

■ LANL hosted workshop in Santa Fe, Hotel Loretto

- Sep. 30 - Oct. 3 (and a closed session on Oct. 4 in LANL)
- 41 talks and 60+ participants from Austria, France, Japan, US
- Experiments (21), Database (2), Theory (6), Application (4), Evaluation (8)
- Early career scientists, postdocs, and students participated
- Special talk by J. Wilhelmy “**Fifty Years of Fission**”

