Update of the compilation effort at BNL

A. Mattera, A. Sonzogni, G. Fabricante, E. McCutchan,
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BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

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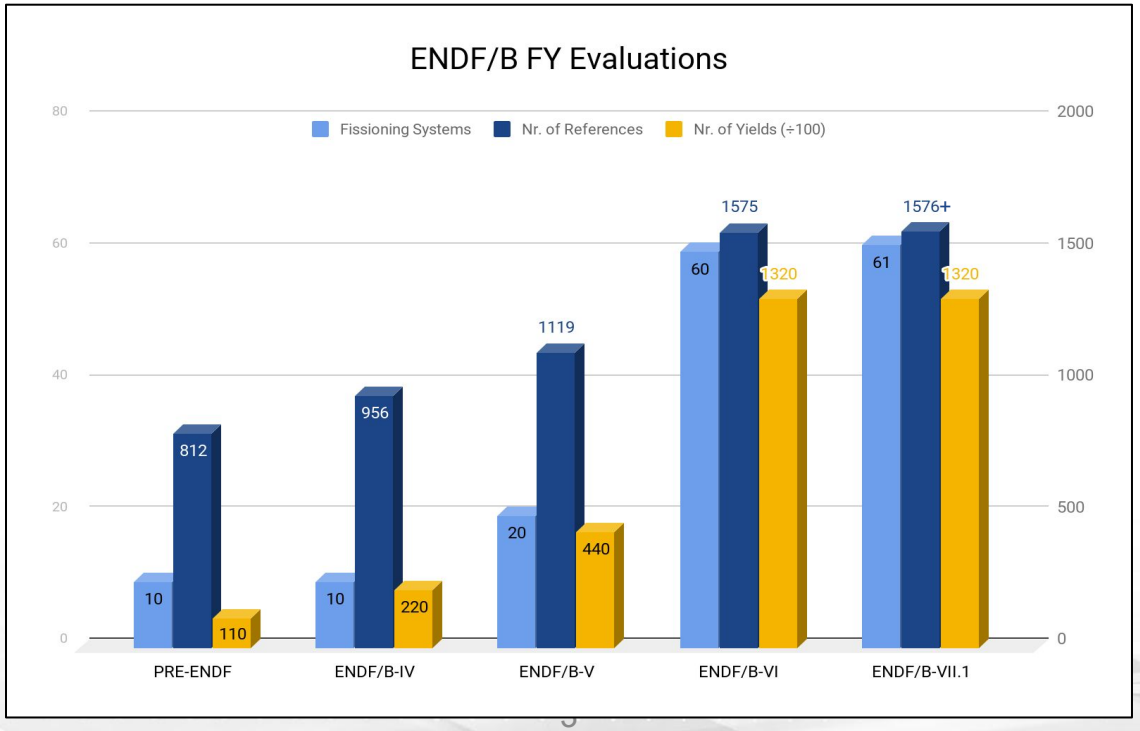
Outline

- Status of the current evaluations
- A new evaluation for ^{238}U: motivation
- Ongoing work at NNDC:
  - NSR + EXFOR compilation
  - EXFOR to JSON (G. Fabricante & V. Zerkin)
  - Status of experimental data compilation
- Summary and Timeline

Status of current evaluations of FPYs

ENDF/B-VIII inherited FPYs from ENDF/B-VII.1

- Revision and update of FYs for ^{239}Pu+n (new evaluation at 2 MeV)
- Other FYs largely based on the Eng&Rid evaluation of 1993 (that extended the 1983 evaluation from 34 to 60 fission reactions).



IAEA-TECDOC-1168

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JEFF3.3 updated FYs in the new release (UKFY3.7)

- includes new measurements (up to 2016)
- GEF used to predict mass+charge distros of FYs (superseding 5-gaussian fit & Wahl's Zp model)

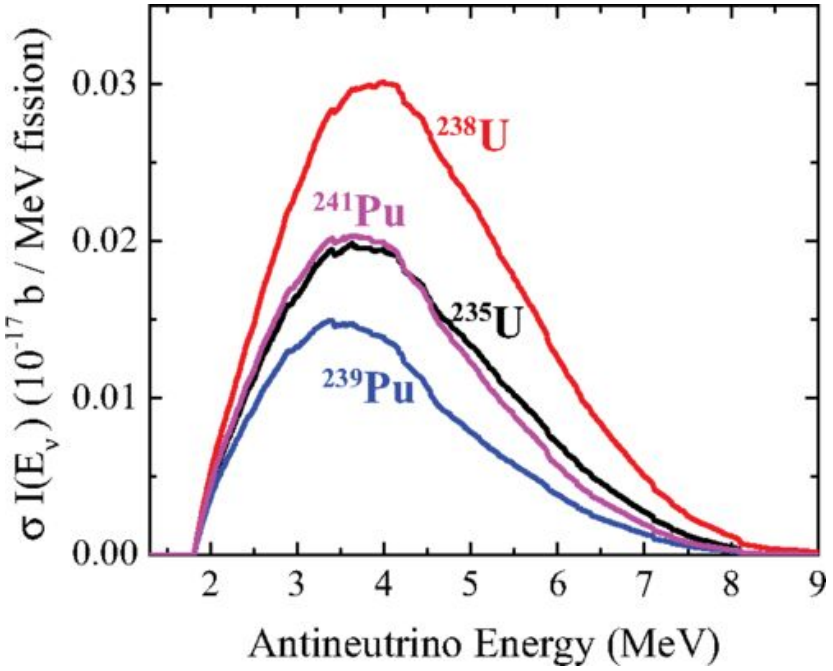
Motivation for new ^{238}U Recomm. Exp. Yields

General update/improvement of FY from a system that does not have an overwhelming amount of data

1. New experiments since the last revision (in 1990s)
2. Update of old experimental values with new nuclear data
3. New information on IYRs

Motivation for new ^{238}U Recomm. Exp. Yields

- summation calculations for reactor $\bar{\nu}$ spectra



A. A. Sonzogni, T. D. Johnson, and E. A. McCutchan
Phys. Rev. C 91, 011301

DECAY DATA + **FISSION YIELDS**

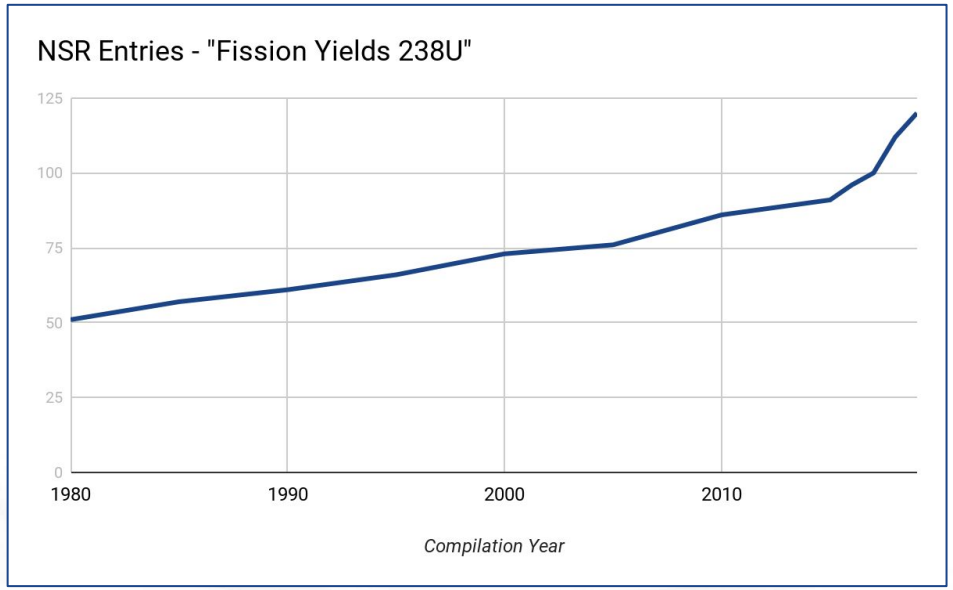
Can a new close look at CFY from ^{238}U give some insight on the reactor antineutrino anomaly?

Talks by G. Fabricante & A. Sonzogni
Friday morning

Ongoing effort at NNDC: NSR & EXFOR

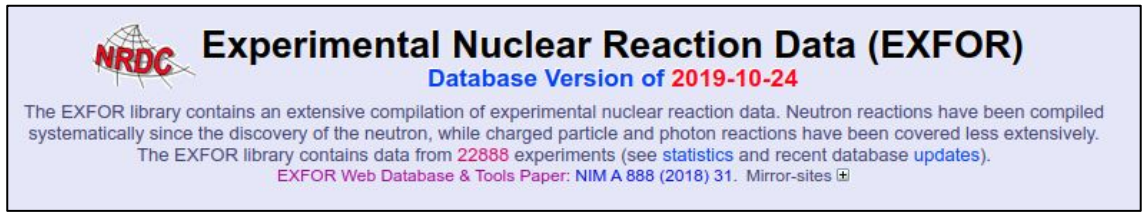
- Continued work to include new and *not-so-new* experimental datasets in EXFOR
- References of England & Rider's work
- Mills' evaluation work + references

Boris Pritychenko, J. Totans,
Olena Gritzay



A *working format* for experimental FY data

- Adapting the format of experimental files to the needs of FY compilation (simpler, lighter, more intuitive)
- Make it easier to access, plot, verify and update experimental values currently stored in the EXFOR format
- Modernizing the format to make it more human-friendly



G. Fabricante, V. Zerkin

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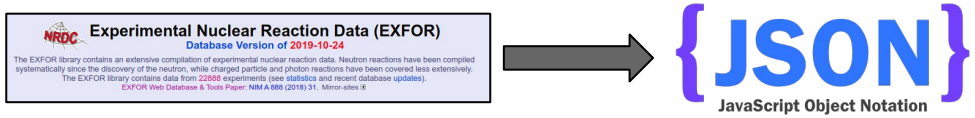


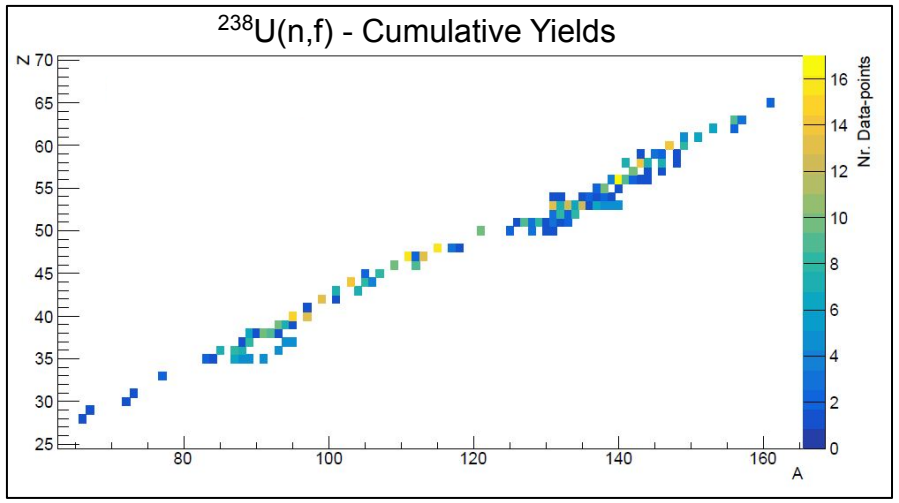
{JSON}
JavaScript Object Notation

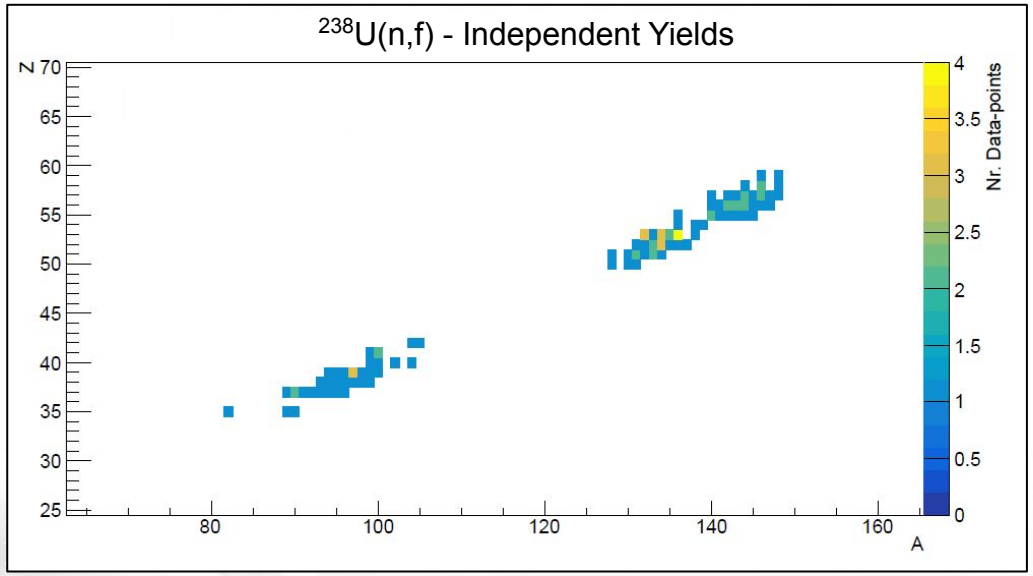
```
ENTRY            13251   20190204   20190708   20190630       1448
SUBENT        13251001   20190204   20190708   20190630       1448
BIB                 12         30
TITLE       Low-yield products from fission of Th232, U235, and
            U238 with 14.8-MeV neutrons
AUTHOR      (D.R.Nethaway,B.Mendoza,T.E.Voss)
REFERENCE   (J,PR,182,1251,1969)
            #doi:10.1103/PhysRev.182.1251
INSTITUTE   (1USALRL)
FACILITY    (NGEN,1USALRL) ICT neutron generator.
INC-SOURCE  (D-T) The neutrons are produced by the reaction of
            deuterons on tritium in a rotating target assembly.
DETECTOR    (PROPC) Gas-flow beta proportional counters.
            (NAICR) NaI(Tl) gamma detectors.
METHOD      (CHSEP,FPGAM) The irradiations were usually 8 h in
            length, producing up to 4x10**12 fissions in the
            Th232, 3x10**13 fissions in the U235, and 1.5x10**13
            fissions in the U238. After the neutron irradiations,
            the target foils were dissolved in the presence of
            10-20-mg amounts of carriers for each of the desired
            products. The samples were counted on gas-flow beta
            proportional counters or NaI(Tl) gamma counters.
MONITOR     (39-Y-89(N,2N)39-Y-88,,SIG) Flux monitor.
ERR-ANALYS  (DATA-ERR) Data uncertainties given include
            uncertainty in counting efficiencies and counting
            statistics, and standard deviation. Not included is
            6% uncertainty in number of fissions.
STATUS      (TABLE) Table II, page 1254.
HISTORY     (19890717C) VM
            (20190204A) BP: Updated to new date formats, lower
            case. Corrections according last EXFOR rules and
            Dict. Updated entry, corrected fission yields units
            from PC/FIS to PRD/FIS.
ENDBIB              30
COMMON               2          3
EN          EN-RSL
MEV         MEV
       14.8        0.3
ENDCOMMON            3
ENDSUBENT           37
SUBENT        13251006   20190204   20190708   20190630       1448
BIB                  6         20
REACTION    (92-U-238(N,F)ELEM/MASS,CUM,FY)
SAMPLE      (92-U-238,ENR=0.998) The target foils varied in
            thickness from 5 to 20 mils and in weight from 1 to
            15 g.
MONITOR     ((MONIT)92-U-238(N,F),,SIG)
MONIT-REF   ((MONIT),W.Hart,R,AHSB(S)R-124,1967)
DECAY-DATA  ((1.)28-NI-66,2.29D,B)
            ((2.)29-CU-67,2.56D,B)
            ((3.)30-ZN-72,1.94D,B)
            ((4.)39-Y-93-G,10.1HR,DG)
            ((5.)56-BA-140,12.80D,DG,1596.,0.962)
            ((6.)60-ND-147,11.04D,DG,531.,0.131)
            ((7.)62-SM-153,1.94D,B)
            ((8.)64-GD-159,0.773D,B)
            ((9.)65-TB-161,6.96D,B)
            ((10.)66-DY-166,3.40D)
```

- Not meant to substitute EXFOR
- Only storing information of interest for the compiler/evaluator
- Human-friendly format with obvious variable names
- Data stored with consistent units (normalization of FYs to 2)
- Active collaboration with V. Zerkin (IAEA): developed a code to convert from EXFOR to JSON.

G. Fabricante, V. Zerkin

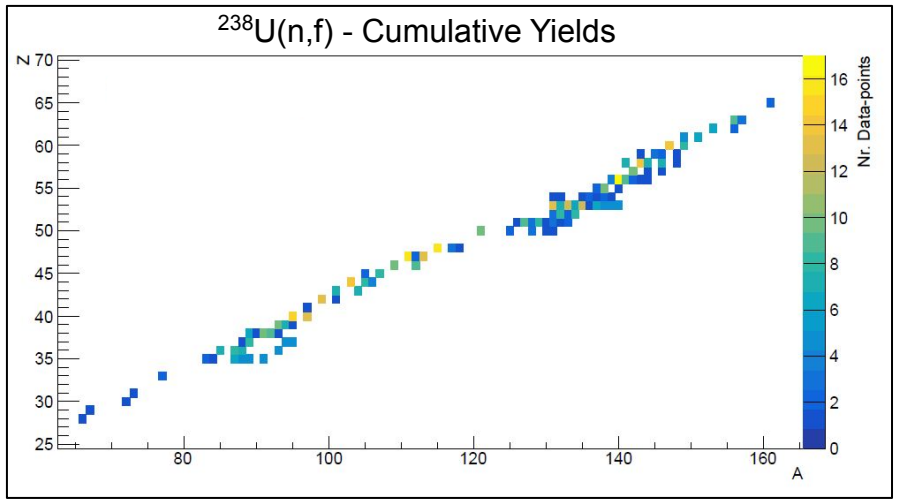
Current status of the compilation effort

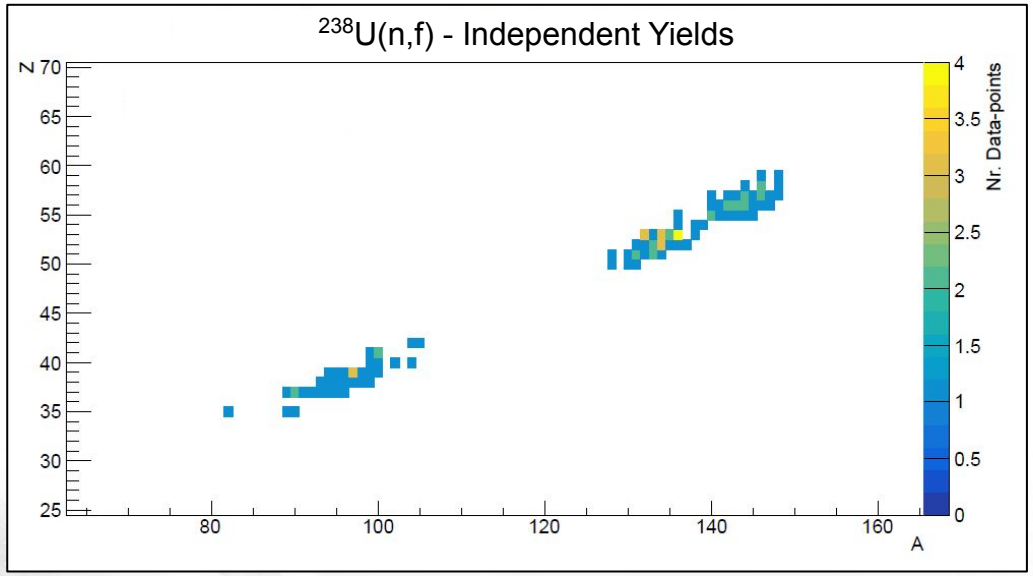




NSR - BibNr	NSR link	Exp I/O	X4 data (entrynr)			pdf I/O	Details	En / E*	Not (from
2019RA07	https://N	1	n/a		0	1	1-n transfer reaction (CN: 238U)	7.4MeV Eex	
2019RA23	https://N	1	n/a		0	1	1-n transfer reaction (CN: 239U)	near barrier fission	
2019FO04	https://N	1	https://www.n	https://www.nndc	14522	1		fast	
2017PE08	https://N	1	n/a		0	1		CoulEx	SOFIA/A
2017WI09	https://N	1	https://www.ni	https://www.nndc	23403	1	anomaly (see 2019FO04)		
2017NA17	https://N	1	https://www.ni	https://www.nndc	33106	1	charge distributions		
2017HI10	https://N	1	n/a		0	1	inv-kin | multinucleon transfer reaction | FFMD	E* > 10-20 MeV	
2017UL01	https://N	1	n/a		0	1	inv-kin | NO FY data		
2016GO02	https://N	1	n/a		0	1	FY mass distro | new data? Also see: LLNL	0.5-14.8 MeV	dual-fis
2016DU22	https://N	1	https://www.ni	https://www.nndc	14463	1	mass landscape / Fragment Y	1-30MeV	
2015NA13	https://N	1	https://www.n	https://www.nndc	33093	1	FP offline: Y, peak/valley ratio	E=6.35, 8.53, 12.52 MeV	
2015BH09	https://N	1	https://www.n	https://www.nndc	14423	1	92Sr 97Zr 99Mo 132Te 133I 140Ba 143Ce 14	8.9 MeV	TUNL
2015VO11	https://N	1	https://www.ni	https://www.nndc	0	1	inv-kin		
2014TO09	https://N	1	https://www.ni	https://www.nndc	14402	1	XS / Yields?	<200 MeV	
2014HA25	https://N	1	https://www.ni	https://www.nndc	23280	1	XS / Yields?	0.2-5 MeV	
2014GO06	https://N	1	https://www.ni	https://www.nndc	41598	1	FF yields		
2014BH11	https://N	1	n/a		0	1	FPY ratio	E=4.6, 9.0, 14.5 MeV	
2013NA18	https://N	1	https://www.n	https://www.nndc	33052	1	FY mass distro	E=3.72, 5.42, 7.75, 10.09 MeV	
2013KH11	https://N	1	https://www.ni	https://www.nndc	41483	1	FFY's	E=5, 6.5 MeV	
2013GR14	https://N	1	https://www.ni	https://www.nndc	14377	1	deduced atomic X-ray yields per fission	0.7-400MeV	
2012FI07	https://N	1	https://www.ni	https://www.nndc	14441	1	FPs mass distro	0.00001 - 10 MeV	
2012RUZZ	https://N	1	n/a		0	1			
2011RY09	https://N	e of 2011RY04?			0				
2010SE15	https://N	1	n/a		0	1	99Mo/95Zr/137Cs/140Ba/141,143Ce/147Nd	E=0.4-1.9 MeV	LANL
2010AD13	https://N	1	https://www.ni	https://www.nndc	41529	1	inv-kin --> the X4 file doesn't contain all info?		

Current status of the compilation effort





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2017WI09	https://N	1	https://www.ni	https://www.nndc	23403	1	anomaly (see 2019FO04)		
2017NA17	https://N	1	https://www.ni	https://www.nndc	33106	1	charge distributions		
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2015BH09	https://N	1	https://www.n	https://www.nndc	14423	1	92Sr 97Zr 99Mo 132Te 133I 140Ba 143Ce 14	8.9 MeV	TUNL
2015VO11	https://N	1	https://www.ni	https://www.nndc	0	1	inv-kin		
2014TO09	https://N	1	https://www.ni	https://www.nndc	14402	1	XS / Yields?	<200 MeV	
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2014GO06	https://N	1	https://www.ni	https://www.nndc	41598	1	FF yields		
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2013GR14	https://N	1	https://www				on	0.7-400MeV	
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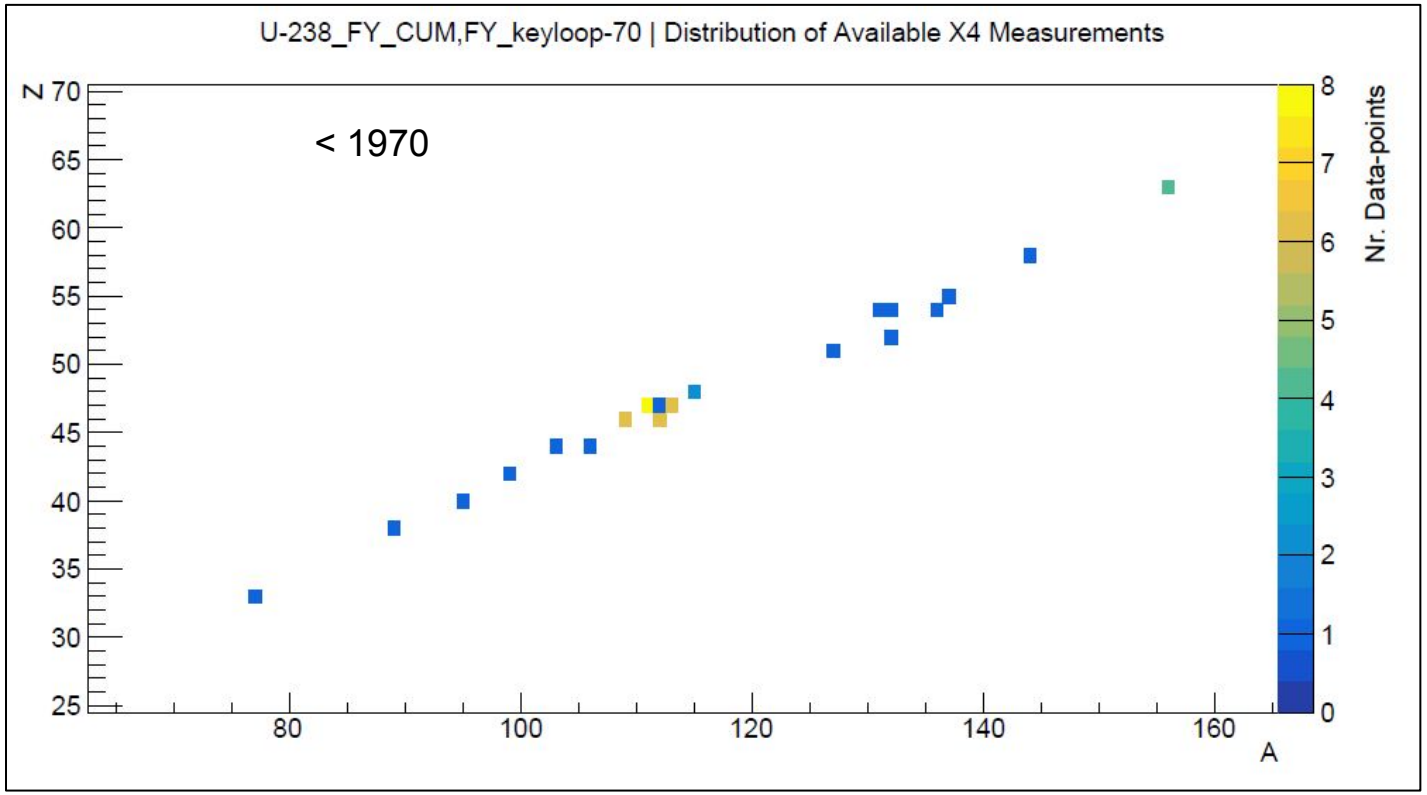
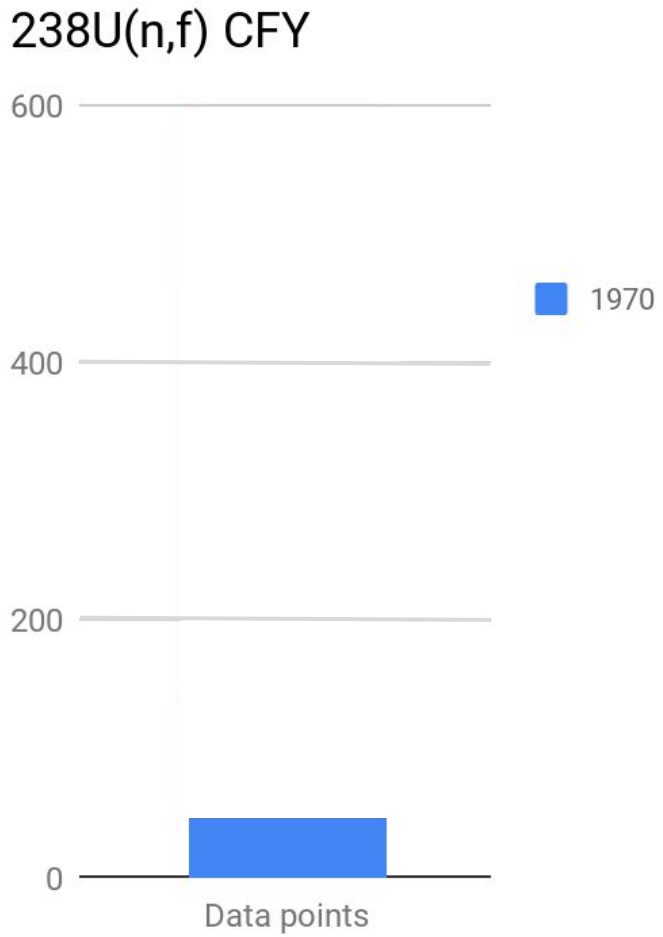
2012RUZZ	https://N	1	n/a						
2011RY09	https://N	e of 2011RY04?							
2010SE15	https://N	1	n/a				/147Nd	E=0.4-1.9 MeV	LANL
2010AD13	https://N	1	https://www				all info?		

Share with us your favourite FY values

How much *new* data?





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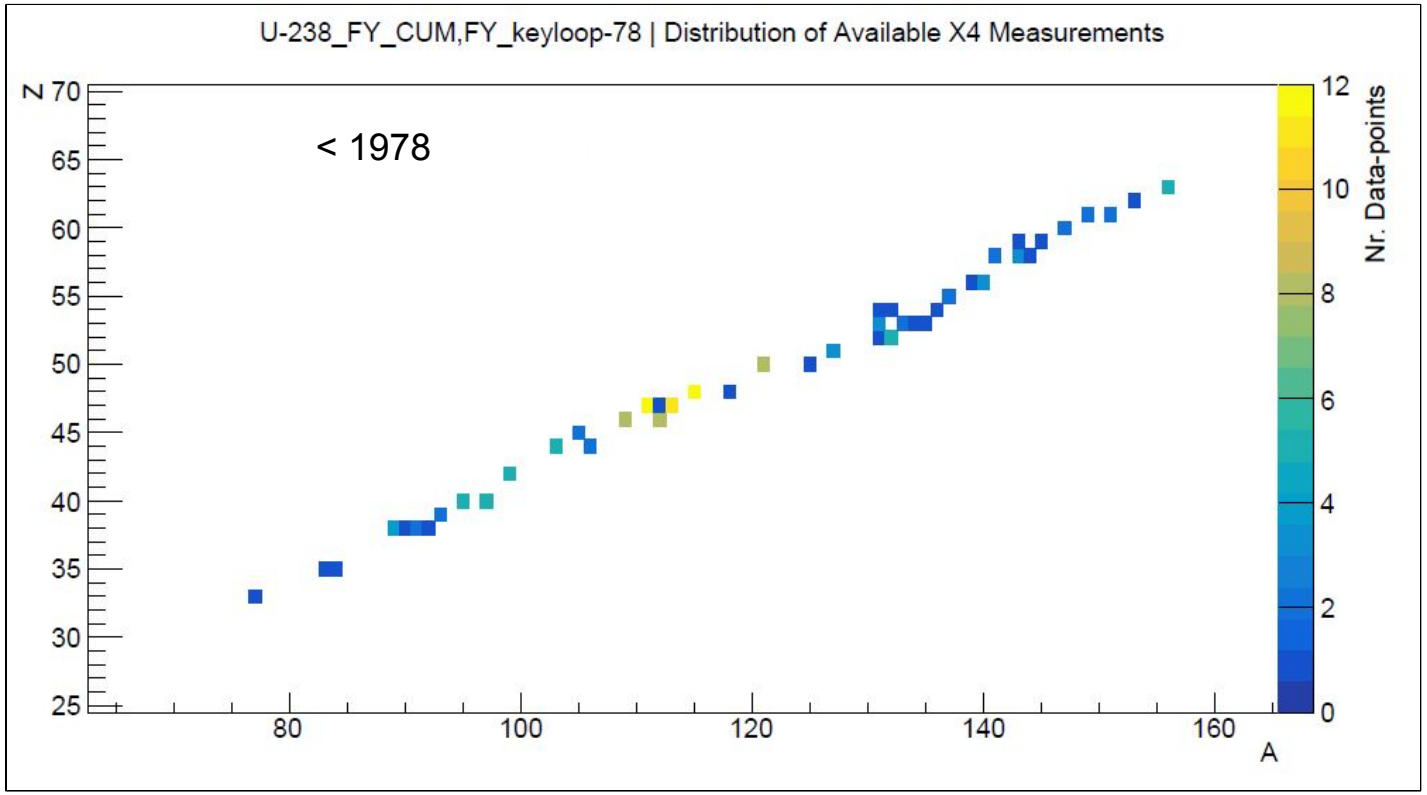

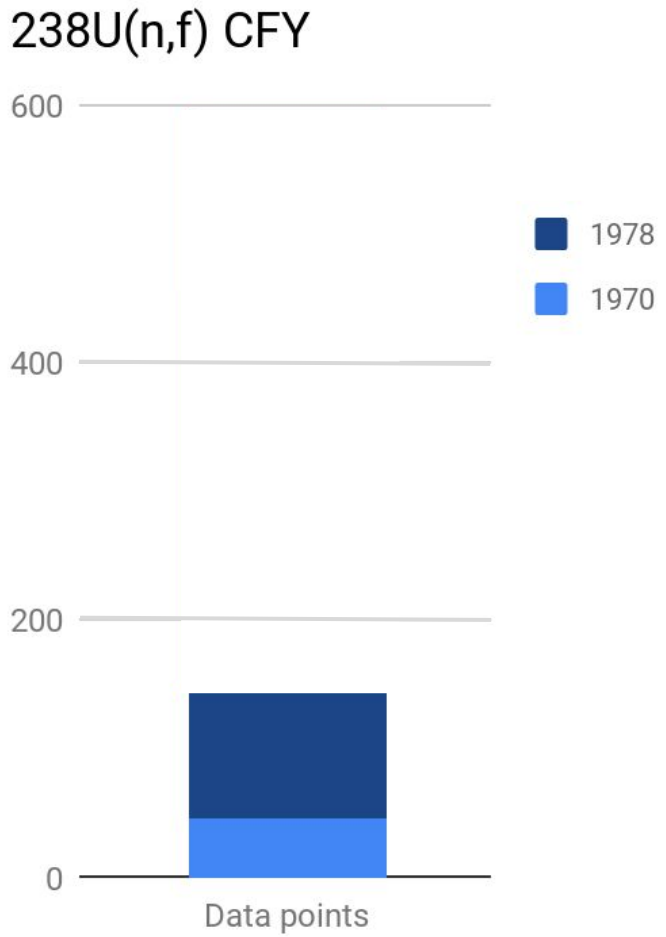

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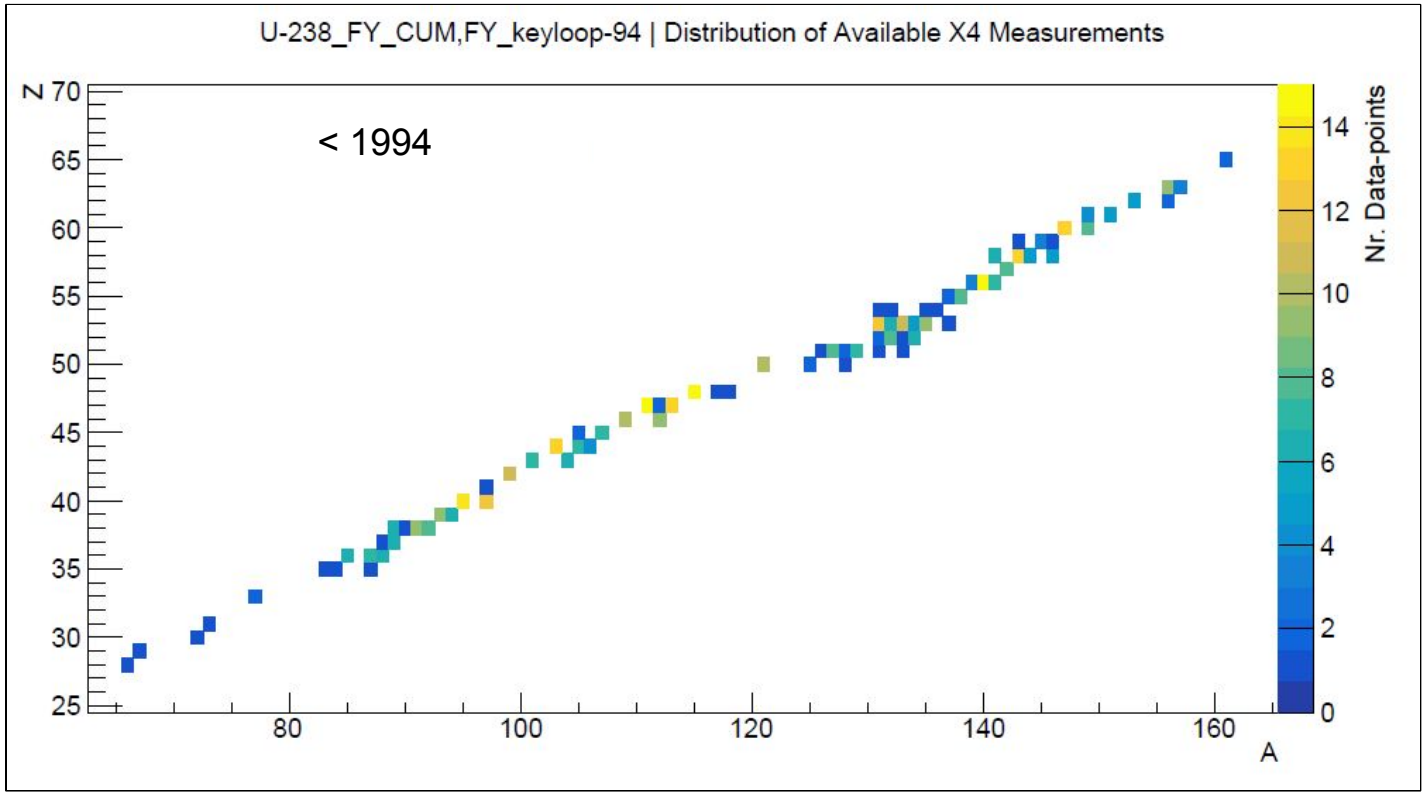

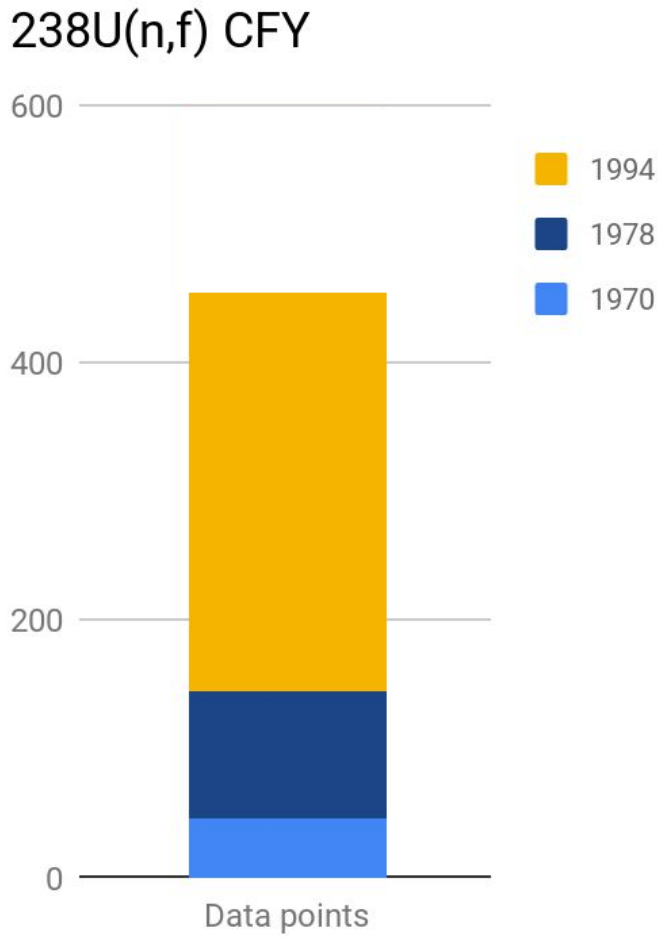

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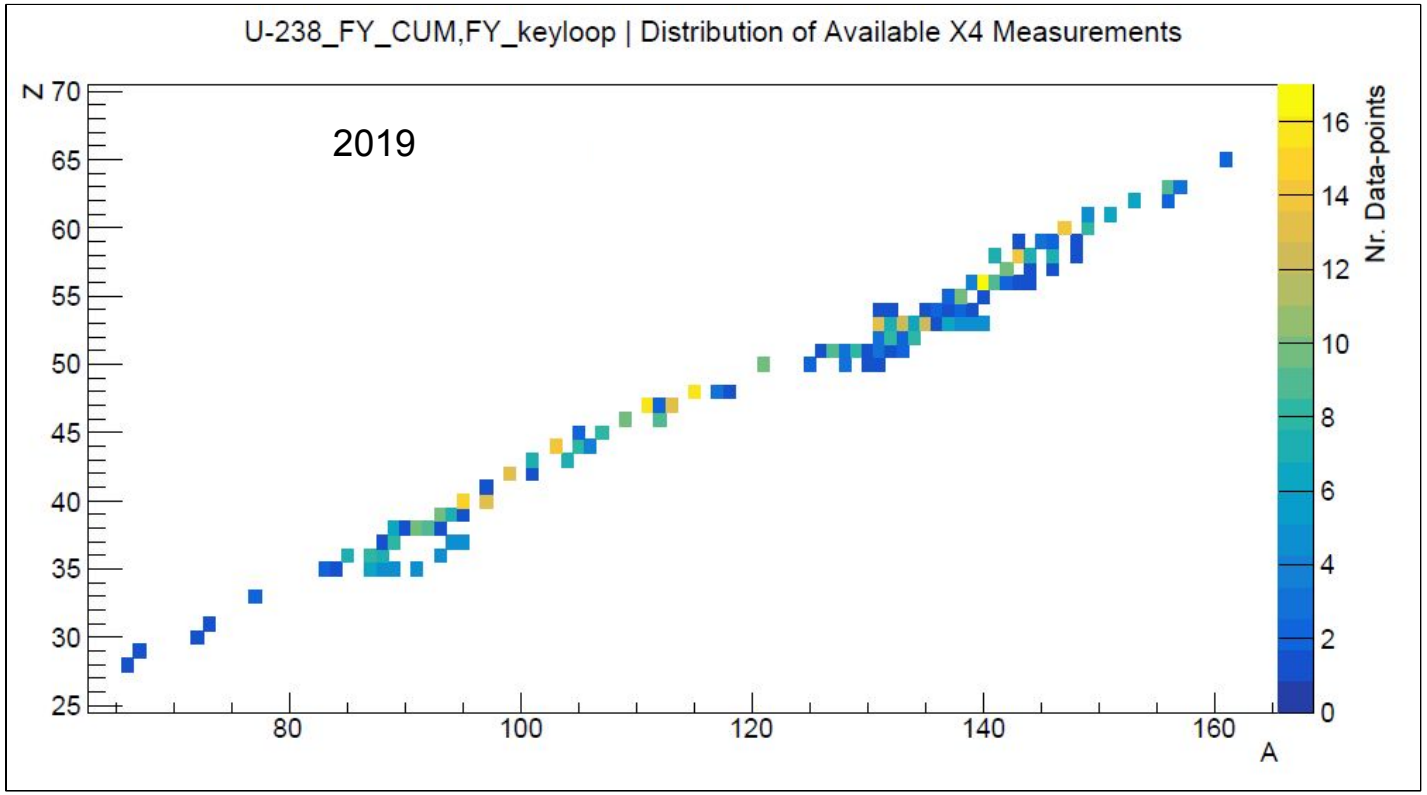
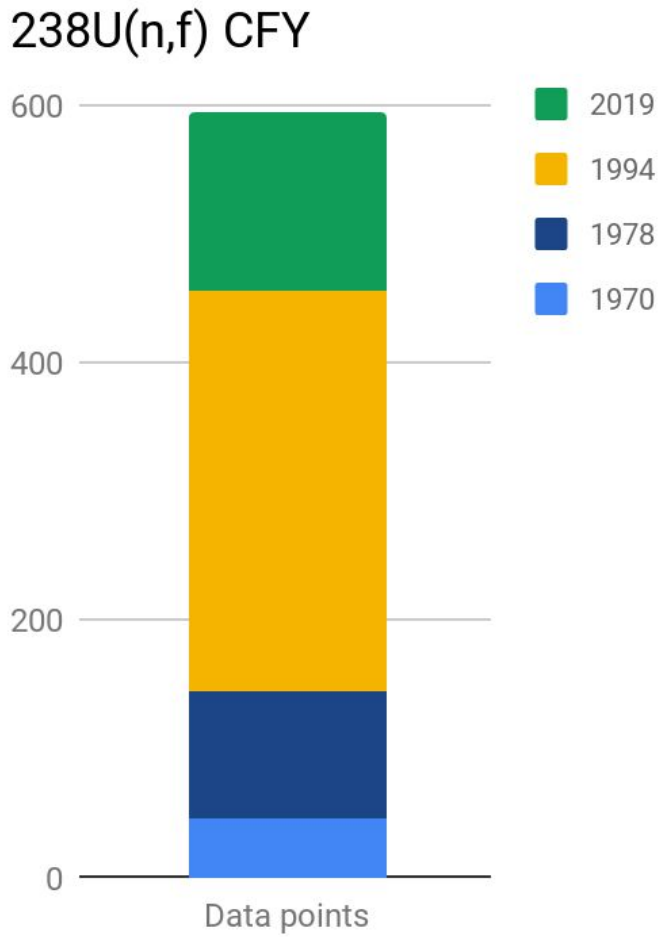
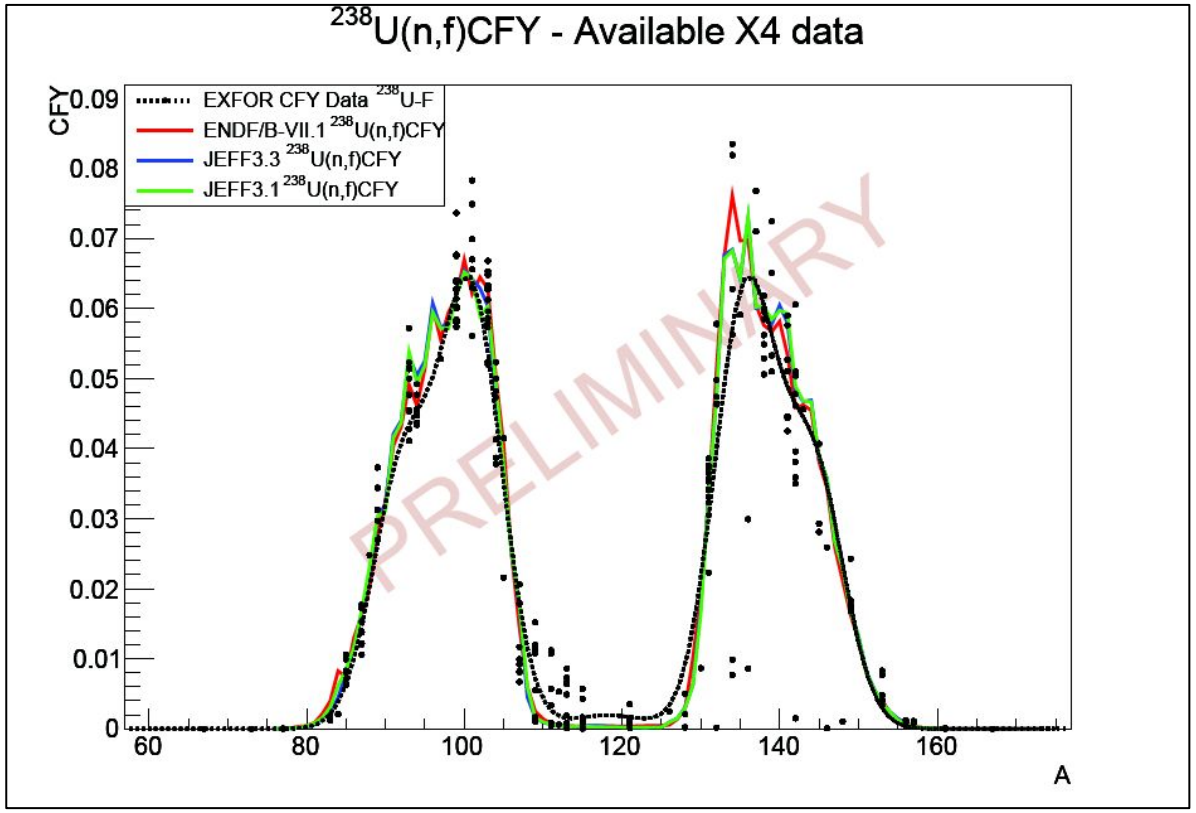




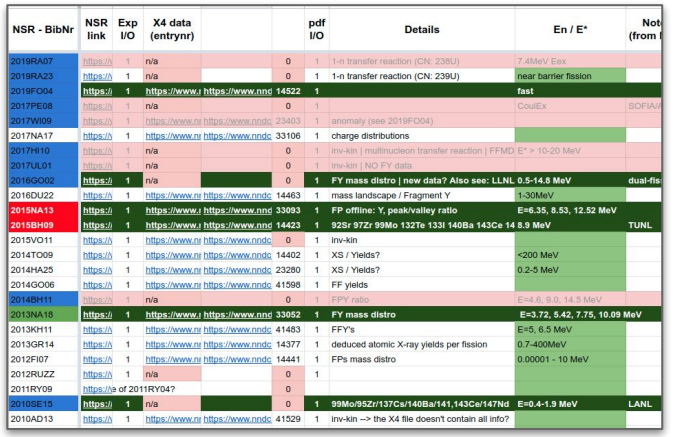
Current status of the compilation effort



- ☑ Compilation of ^{238}U(n,f) FY Bibliography + "New" data?
- ❑ Retrieval of available data from EXFOR
- ❑ Conversion to JSON
- ❑ Correction of data points
- ❑ Isomeric Yield Ratios
- ❑ Averaging / Recommended Experimental Yields

Summary and Outlook

- Continued work for EXFOR + NSR update and extension
- Bibliographic compilation of references for ^{238}U(n,f) experiments
- Conversion of existing EXFOR entries to JSON and compilation of new experiments in the new format
- Analysis & comparison of existing data to reach R.E. FYs by spring 2020.



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2014HA25	https://n	1	https://www.nj	https://www.nndc	23280	1	XS / Yields?	0.2-5 MeV	
2014GO06	https://n	1	https://www.nj	https://www.nndc	41598	1	FF yields		
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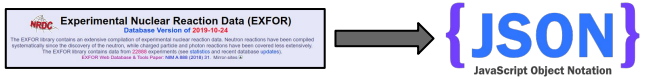
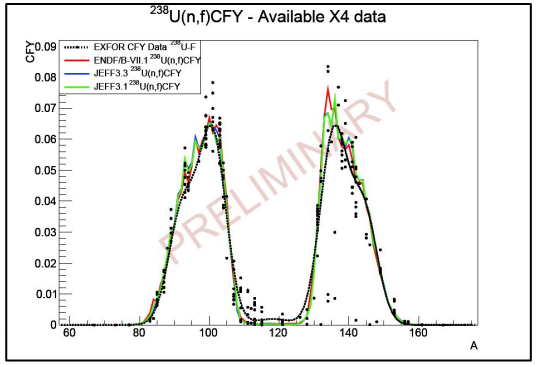
2011RY09	https://a of 2011RY04?				0				
2010SE15	https://j	1	n/a		0	1	99Mo/95Zr/137Cs/140Ba/141,143Ce/147Nd	E=0.4-1.9 MeV	LANL
2010AD13	https://n	1	https://www.nj	https://www.nndc	41529	1	inv-kin --> the X4 file doesn't contain all info?		





Update of the compilation effort at BNL

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

BROOKHAVEN SCIENCE ASSOCIATES

Current status of the compilation effort

Plots of CFY compared with libraries ...