Overview of selected INDEN evaluations

^{56,57}Fe, ^{63,65}Cu, and ^{19}F

R. Capote (IAEA) on behalf of the INDEN collaboration

https://www-nds.iaea.org/INDEN

Outlook

- ❑ Fe isotopes ($^{54,56,57}Fe$)
- ❑ Cu isotopes ($^{63,65}Cu$)
- ❑ Fluorine (^{19}F)

“It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.”

Richard Philips Feynman,

Nobel Prize in Physics 1965

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INDEN Fe evaluation

Fe-56 from 850keV up to 4 MeV based on exp. data alone
20-30% leakage underestimation found
(ENDF/B-VIII.0 updated in 2018-2019, inelastic reduced
-> INDEN, leakage problem solved)

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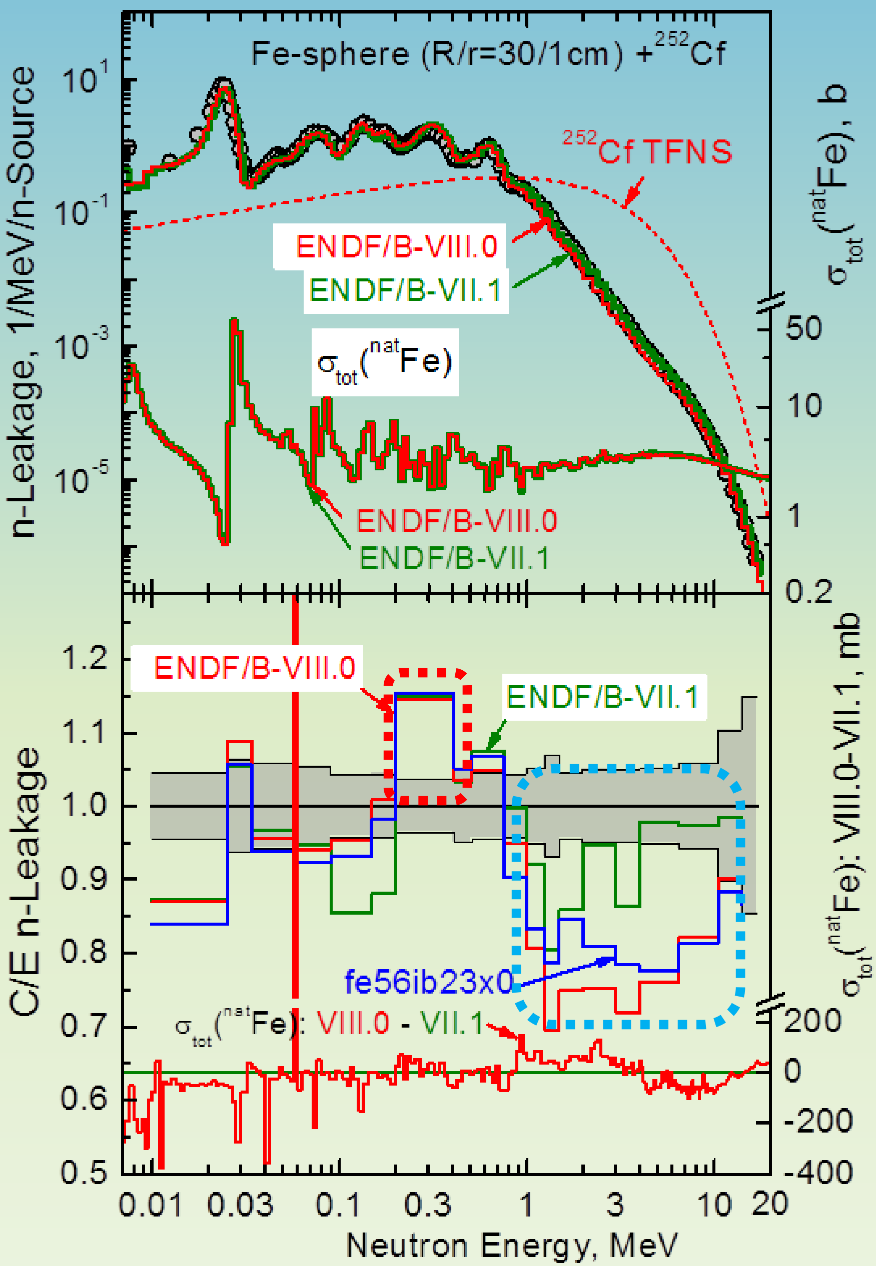
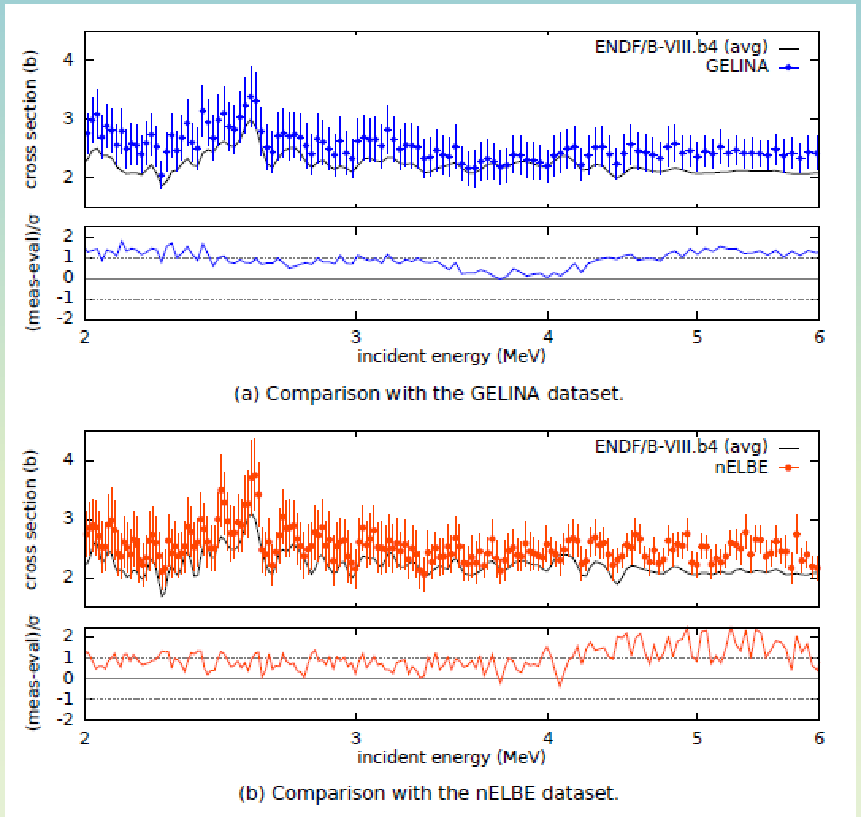
^{56}Fe evaluation



M. Herman et al, Nucl. Data Sheets 148 (2018) 214–253



New measurements ^{56}Fe(n,el)
E. Pirovano et al,
Phys.Rev.C99 (2019) 024601

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Improvements of ^{nat}Fe total cross section minima

Tab.1 Assembly FE DIA100, R53; 200gpd, integral values, C/E
(Jansky, ND 2013, New York, [1])

	En.range[MeV]		main peak [keV]	Library used for MCNP Calculation					
No.	from	to	in measurement	ENDF/B-VII.1	BROND-3	JENDL-4.0	JEFF-3.2T2	TENDL-2012	CENDL-3.1
0	0.013	1.290	total range	1.031	1.036	1.049	1.053	1.031	1.040
1	0.013	0.030	24.4	0.918	0.836	1.029	0.989	1.221	0.891
2	0.030	0.075		0.909	0.835	0.903	0.967	0.858	1.146
3	0.075	0.090	82	1.008	0.912	0.999	1.017	1.119	1.402
4	0.090	0.150	137	0.845	0.828	0.920	1.004	0.970	0.732
5	0.150	0.200	167+183	0.907	0.898	0.974	1.015	1.012	0.909
6	0.200	0.250		1.012	1.051	1.024	1.018	0.872	1.196
7	0.250	0.289	272	1.075	1.097	1.011	1.015	0.948	1.115
8	0.289	0.333	309	1.423	1.366	1.338	1.245	1.317	1.129
9	0.333	0.410	350	1.269	1.256	1.278	1.235	1.335	1.474
10	0.410	0.520		1.044	1.177	1.046	1.085	0.779	1.036
11	0.520	0.780	610+650+703	1.147	1.366	1.122	1.064	0.835	1.152
12	0.780	1.060		0.946	1.017	0.863	1.050	0.730	0.681
13	1.060	1.290		0.910	0.710	0.834	0.866	0.826	0.777

M/C>1.15
0.97<M/C,1.03
important regions

- Leakage neutron measurements in thick iron spheres
  (M. Schulc ARI 130, 224, Fig. 4, and JEFFDOC-1918)
  shortcomings found in several cross section minima between 50 and 700 keV

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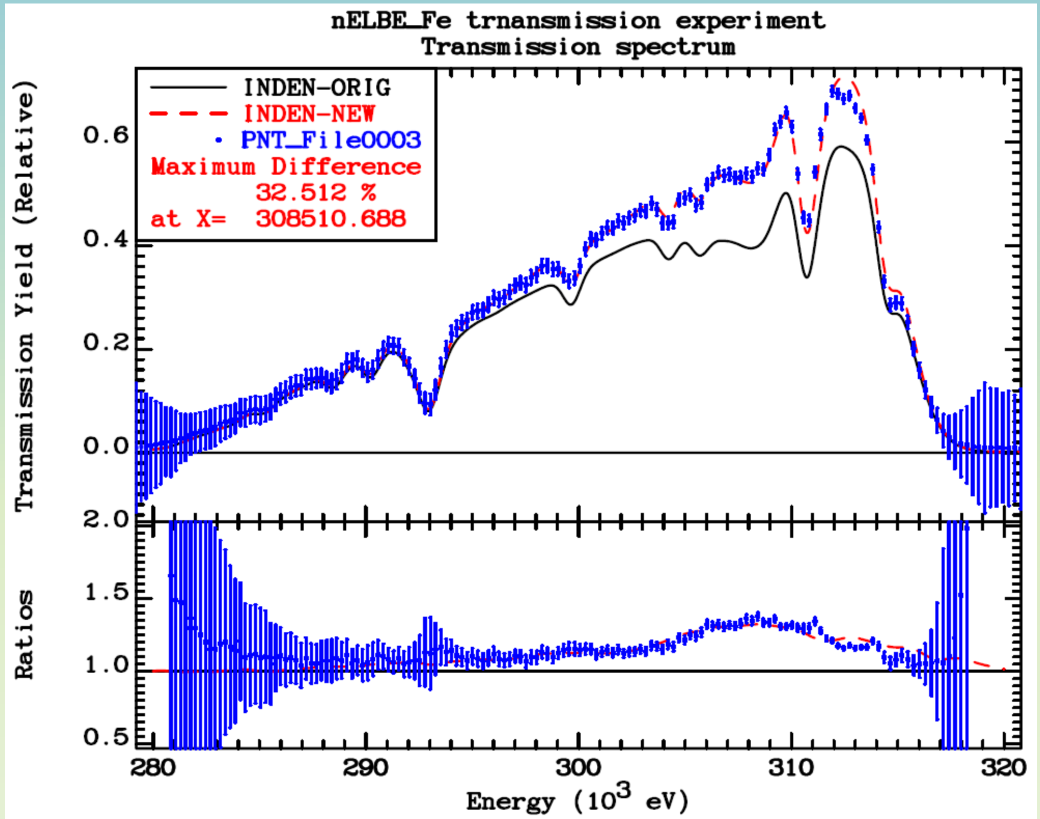
New transmission measurement at nELBE

- A dedicated transmission measurement on very thick target by Arnd Junghans and Roland Beyer at the nELBE facility was performed.
- The assumption about the cross-section minima in Fe-56 is not supported (**black line**).
- An alternative solution was sought: a deficiency in the Fe-57 cross sections was identified as the major cause of the problem (**dashed-red line**). See the next slide.
- Very good agreement with n-ELBE data was achieved.



INDEN-SM CM, 18-21 December 2023,
IAEA HQ, Vienna, Austria (hybrid)
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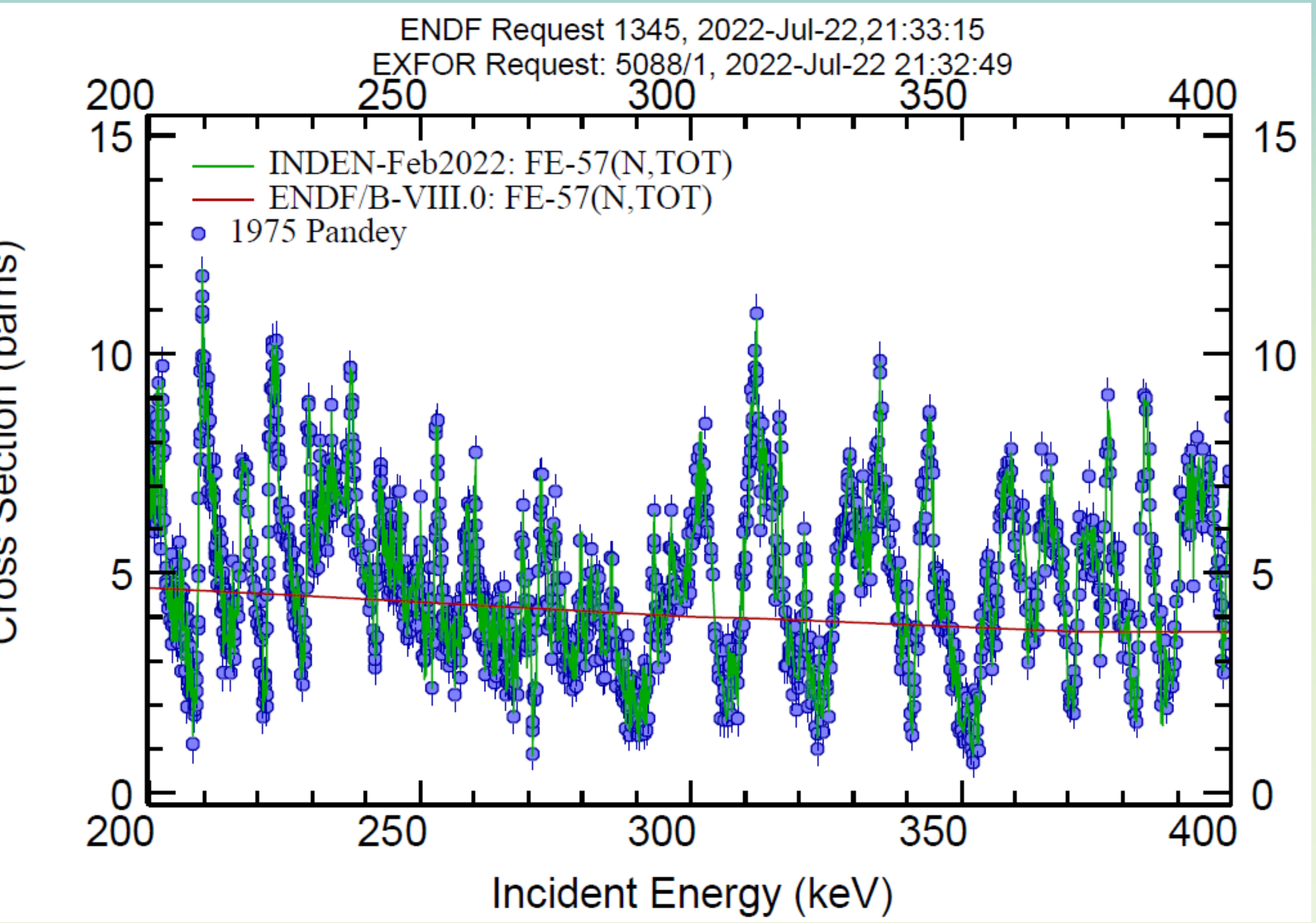
Fe-57 evaluation does not describe Pandey (n,tot) data having fluctuations up to 7 barn



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INDEN natFe comparison: (n,γ) 600-2000 keV

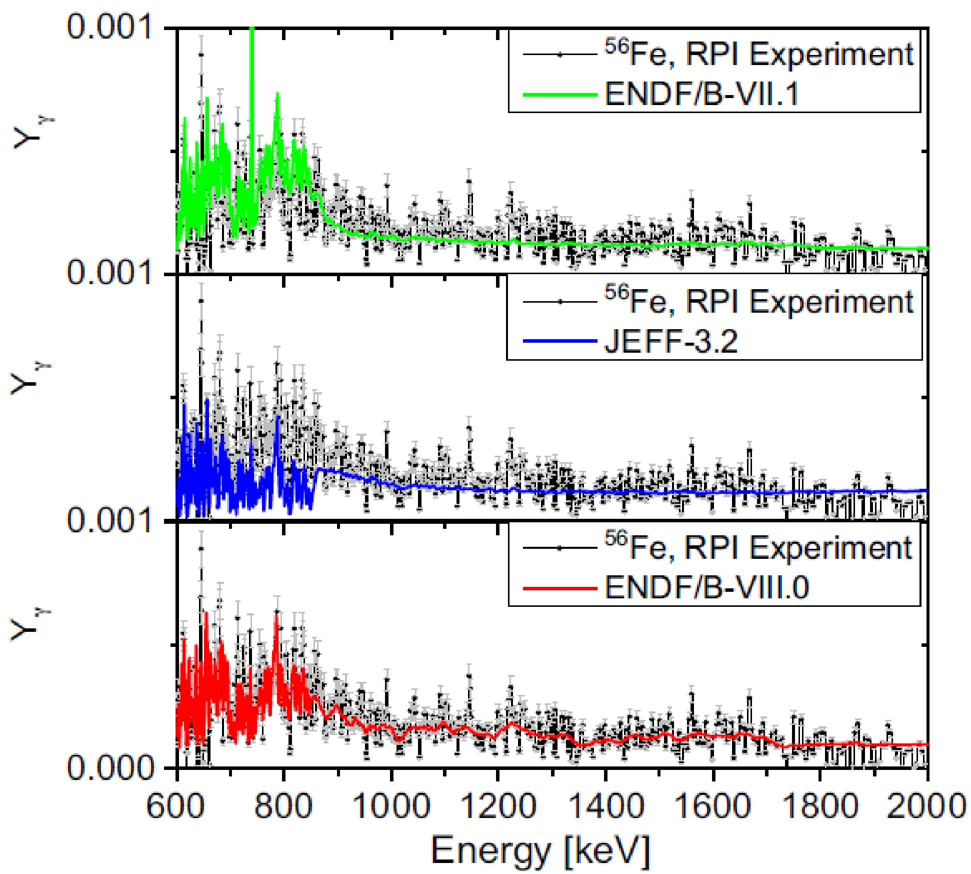

FIG. 12. (Color online) Comparison of calculated yields of γ from a semi-integral (thick target) experiment at RPI on ^{56}Fe.

ENDF/B-VIII.0 reproduces RPI measurement above 400 keV

B/VII.1 high, JEFF-3.3 low in 400-850 keV region

M. Herman et al, Nuclear Data Sheets 148 (2018) 214–253

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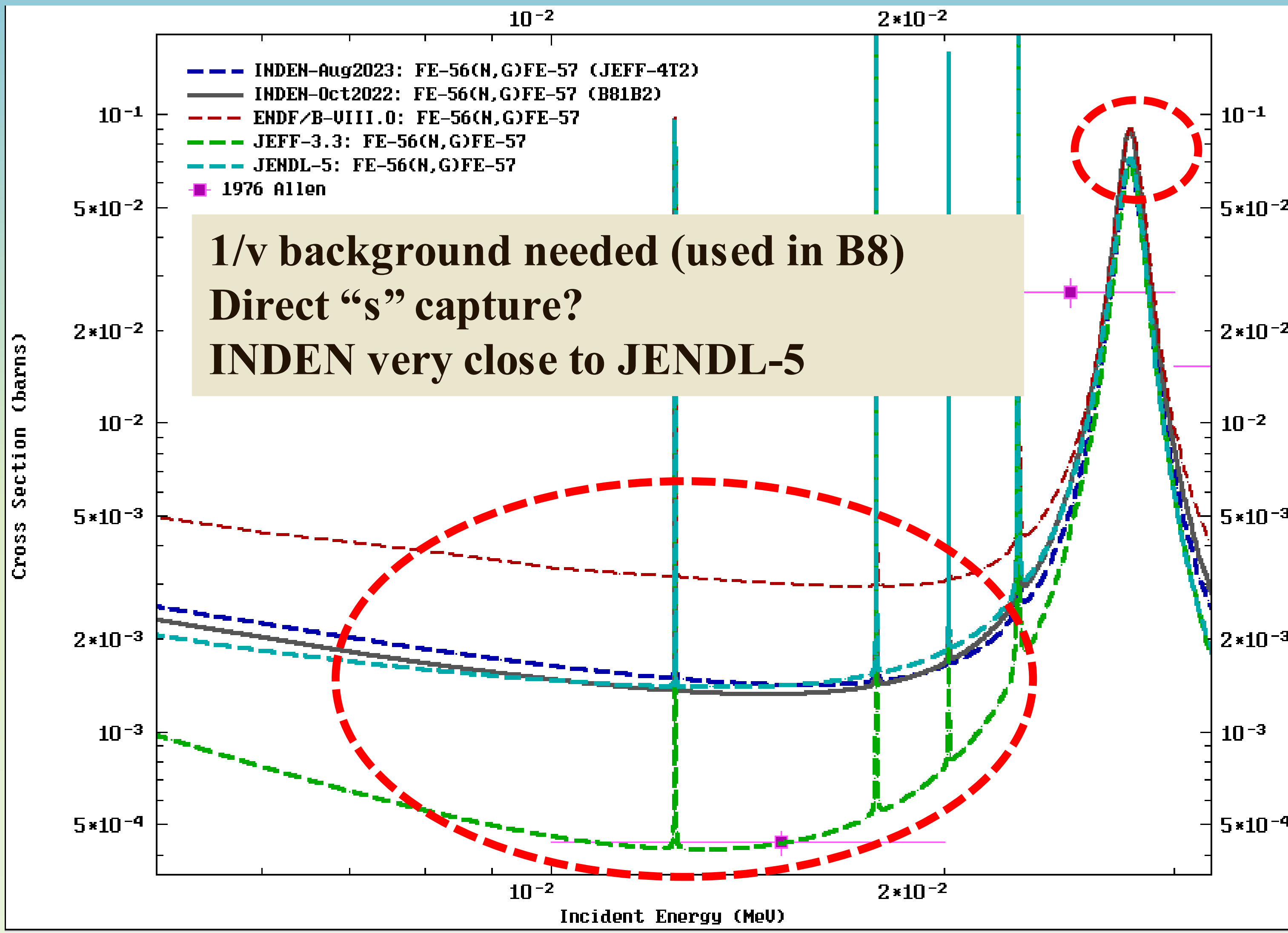
INDEN natFe comparison: (n,γ) near 28 keV



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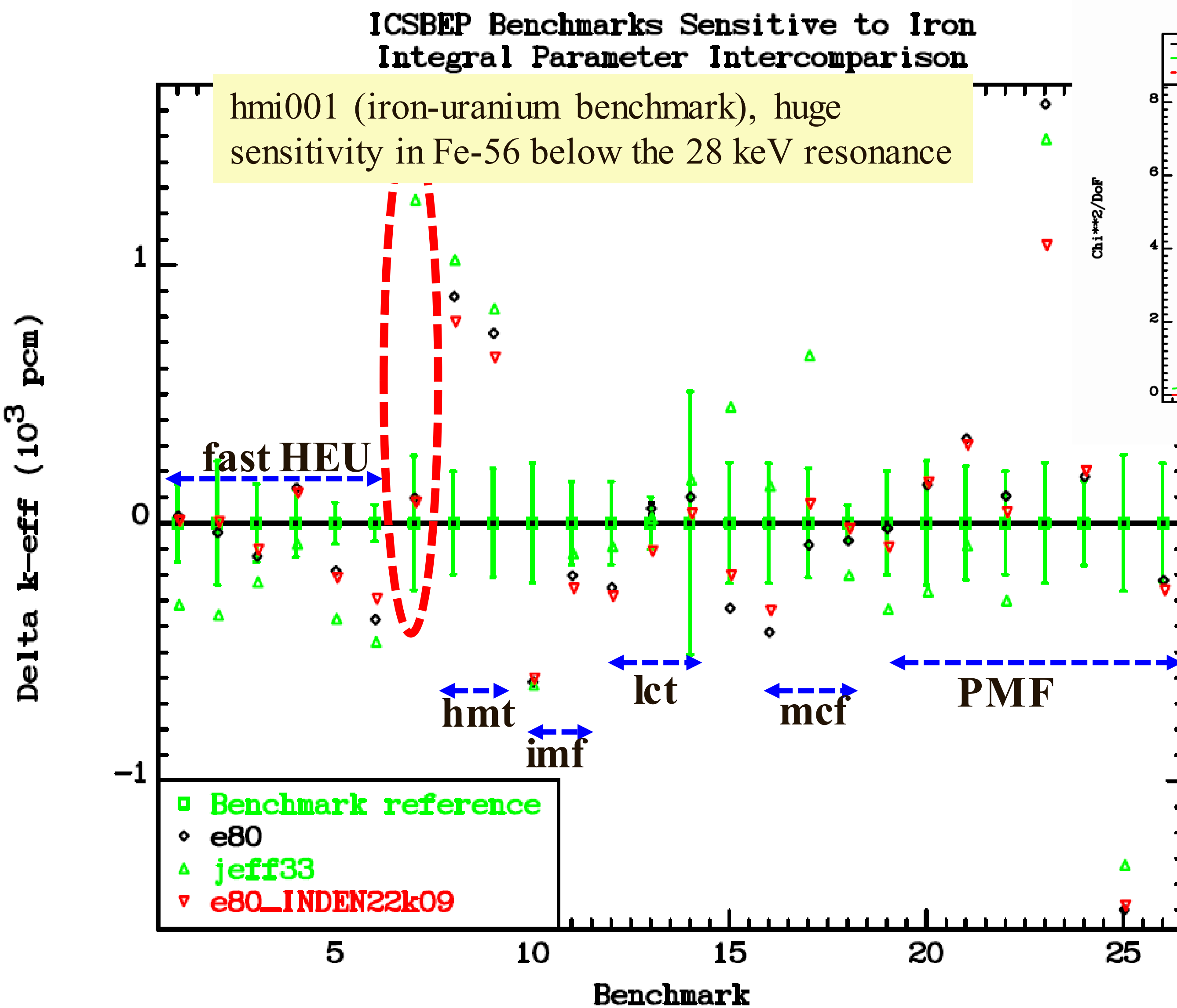
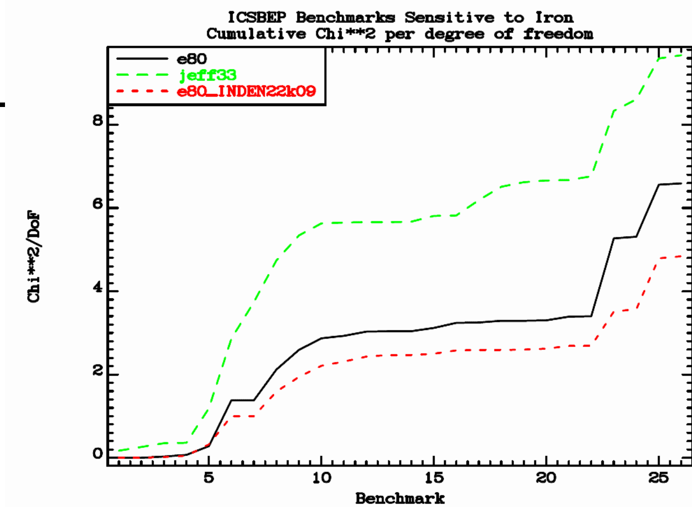
INDEN Fe evaluation: crit. benchmarks





No.	ICSBEP Label	Short name	Common name
1	HEU-MET-FAST-013	hmf013	VNIITF-CTF-SS-13
2	HEU-MET-FAST-021	hmf021	VNIITF-CTF-SS-21
3	HEU-MET-FAST-024	hmf024	VNIITF-CTF-SS-24
4	HEU-MET-FAST-087	hmf087	VNIITF-CTF-Fe
5	HEU-MET-FAST-088	hmf088-001	FKBN-2/SS-PE-1
6	HEU-MET-FAST-088	hmf088-002	FKBN-2/SS-PE-2
7	HEU-MET-INTER-001	hmi001	ZPR-9/34
8	HEU-MET-THERM-013	hmt013-002	Planet_Fe-2
9	HEU-MET-THERM-015	hmt015	Planet_HEU/Fe/PE
10	IEU-MET-FAST-005	imf005d	VNIIEF-CTF-5
11	IEU-MET-FAST-006	imf006	VNIIEF-CTF-6
12	LEU-COMP-THERM-042	lct042-001	lct042-001
13	LEU-COMP-THERM-042	lct042-002	lct042-002
14	LEU-COMP-THERM-043	lct043-002	IPEN/MB-01
15	LEU-MET-THERM-015	lmt015-001	RB-Vinca(01)
16	MIX-COMP-FAST-001	mcf001	ZPR-6/7
17	MIX-COMP-FAST-005	mcf005s	ZPR-9/31
18	MIX-COMP-FAST-006	mcf006s	ZPPR-2
19	PU-MET-FAST-015	pmf015	BR-1-3
20	PU-MET-FAST-025	pmf025	pmf025
21	PU-MET-FAST-026	pmf026	pmf026
22	PU-MET-FAST-028	pmf028	pmf028
23	PU-MET-FAST-032	pmf032	pmf032
24	PU-MET-INTER-002	pmi002	ZPR-6/10
25	PU-MET-INTER-003	pmi003-001s	ZPR-3/58(U)
26	PU-MET-INTER-004	pmi004-001s	ZPR-4/59(Pb)
27	IEU-COMP-INTER-005	ici005	ZPR-6/6A

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INDEN Fe/Cr evaluation: SS reflectors

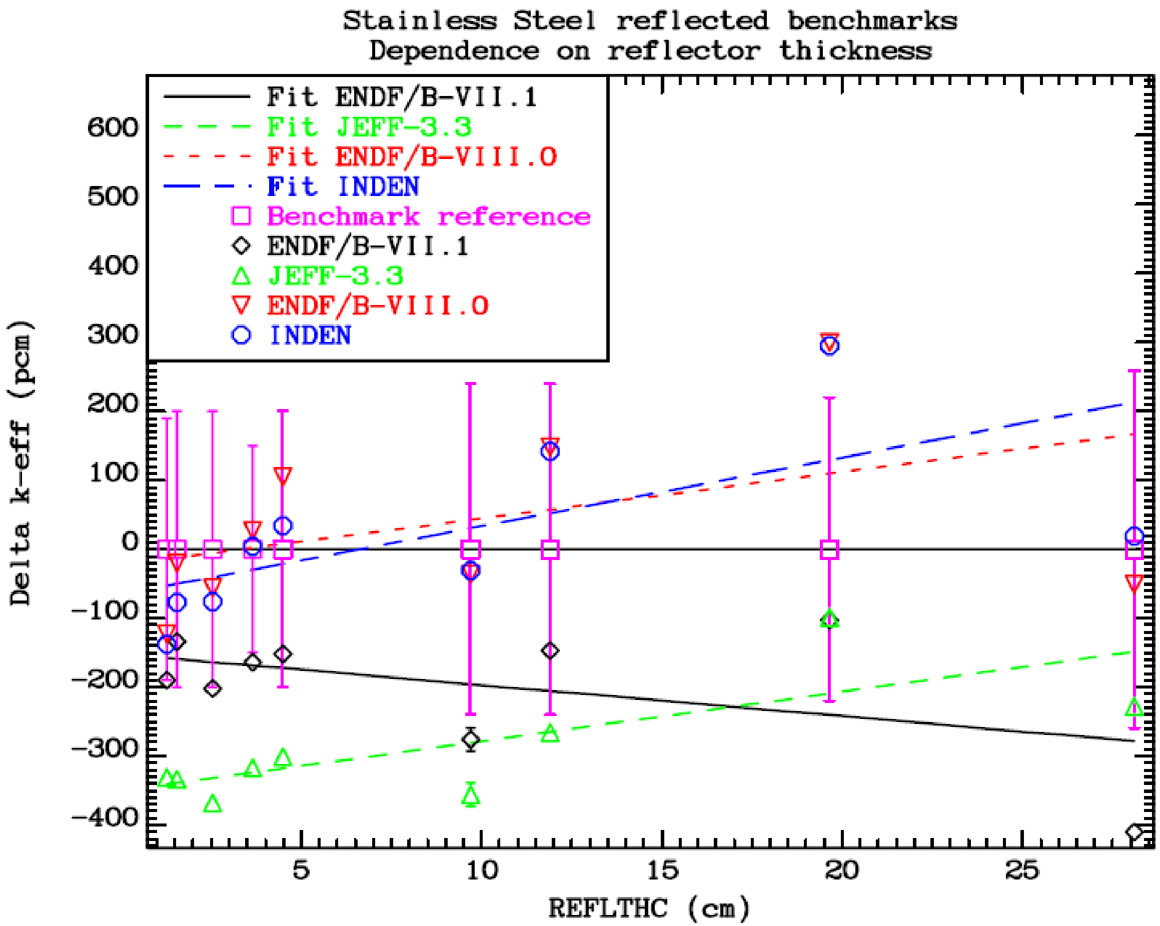

Table 2. Short list of ICSBEP criticality fast benchmarks with different thicknesses of stainless steel reflectors.

ICSBEP Label	Short name	Common name	Reflector thickness [cm]
HEU-MET-FAST-084	hmf084-019	Comet-Fe	1.27
PU-MET-FAST-025	pmf025	pmf025	1.55
HEU-MET-FAST-084	hmf084-007	Comet-Fe	2.54
HEU-MET-FAST-013	hmf013	VNIITF-CTF-SS-13	3.65
PU-MET-FAST-032	pmf032	pmf032	4.49
HEU-MET-FAST-021	hmf021	VNIITF-CTF-SS-21	9.70
PU-MET-FAST-026	pmf026	pmf026	11.9
PU-MET-FAST-028	pmf028	pmf028	19.7
PU-MET-FAST-015	pmf015s	BR-1-3	28.1

A. Trkov et al, EPJ Web of Conferences **284**, 12002 (2023)

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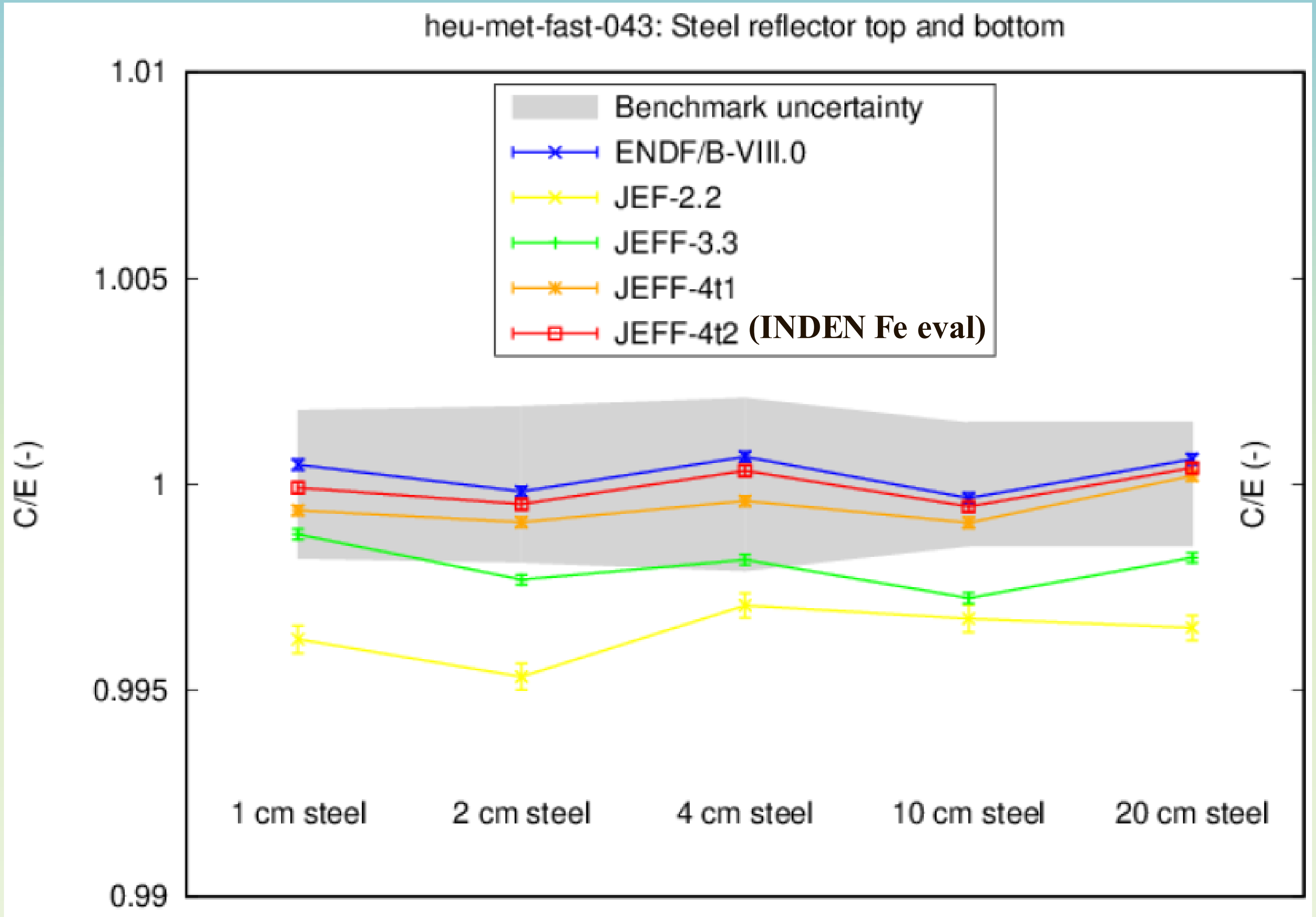
heu-met-fast-043 (steel reflector)



Courtesy of S. Vandermarck, @ JEFF meeting 24-27 April 2023

The Pool Critical Assembly (PCA) Pressure Vessel Simulator experiment was performed in the early 1980s as part of the NRC's LWR Pressure Vessel Surveillance Dosimetry Improvement Program (LWR-PV-SDIP)

Benchmark was recently re-analyzed with exact geometry by Dr. Kulesza (LANL/X-5), and MCNP inputs were published and available for use:
- NUCLEAR TECHNOLOGY · VOLUME 197 · 284–295 · MARCH 2017
- Paper: https://doi.org/10.1080/00295450.2016.1273711
- MCNP Inputs: https://doi.org/10.2172/1601379

Pool Critical Assembly Benchmarking

- C/E Results (ENDF/B-VIII.1b1):
  - MC uncertainty ~= 1%

Depends on U-235, water & SS

	al27a	ni48p	rh103n	in115n	u238f	np237f	avg	std dev
	0.97	0.96	1.04	1.00			**0.99**	**3.9%**
	1.02	0.98	1.08	1.01			**1.02**	**4.3%**
	1.05	1.01	1.07	1.06			**1.05**	**2.5%**
	1.03	0.96	1.00	1.01	0.98	1.03	**1.00**	**2.7%**
	1.03	0.96	0.95	1.00	0.98	1.05	**0.99**	**4.0%**
	1.04	1.02	0.93	1.03	0.98	1.03	**1.00**	**4.1%**
			0.96	0.99	0.99	1.13	**1.02**	**7.6%**
avg	**1.02**	**0.98**	**1.01**	**1.01**	**0.98**	**1.06**	**1.01**	
std dev	**2.8%**	**2.9%**	**6.4%**	**2.1%**	**0.1%**	**1.0%**		**4.2%**

Presented by Greg Fischer, Westinghouse @ miniCSWEG April 2023

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INDEN updated "structural" evaluations: see nds.iaea.org/INDEN/ - Validation

- ✓ Fe isotopes (IAEA/JSI), fe57e80m, fe56e80X29r41, fe54e80o
- ✓ Cr isotopes, BNL/ORNL/IAEA/JSI/CEA, v2.3.2

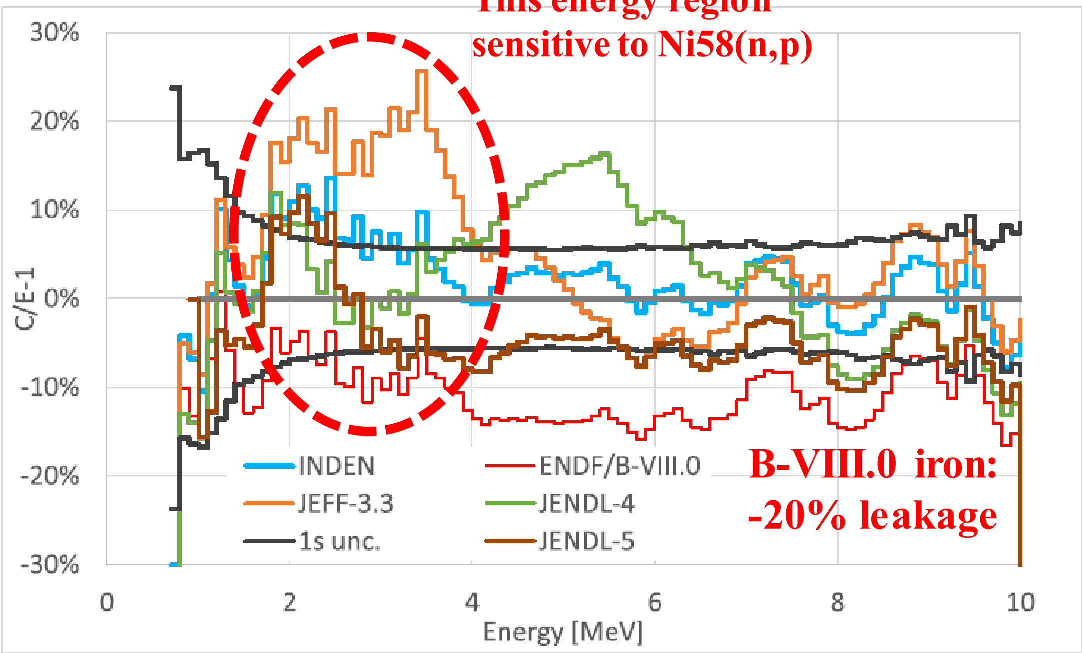

Fig. 12. C/E-1 for different stainless steel neutron transport libraries. One sigma uncertainty is displayed as a bold black curve.

ALARM-CF-STAINLESS-STEEL-321-SHIELD-001

Figure 4. Photo of Stainless steel Block with Shielding Cone and Stilbene Detector.

SS neutron leakage (Rez, CZ, 11/2021)

M. Schulc et al, Ann. Nucl. En. **179** (2022) 109433

https://nds.iaea.org/INDEN/data/ALARM-CF-steel-SHIELD-001-final.pdf

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INDEN updated Fe evaluations:

see nds.iaea.org/INDEN/ - Validation

- ✓ Fe isotopes (IAEA/JSI), fe54e80o, fe56e80X29r41, fe54e80o
- ✓ Cr isotopes, BNL/ORNL/IAEA/JSI/CEA, v2.3.2

Reaction	Position	ENDF/B-VIII.0	JEFF-3.3	INDEN	ENDF/B-VII.1	CENDL-3.1	Unc.
$^{197}Au(n,g)^{198}Au$	5 cm	4.2%	-3.5%	-4.2%	3.4%	-11.0%	3.1%
	10 cm	1.9%	-4.7%	-6.9%	2.4%	-13.5%	3.2%
	15 cm	0.6%	-6.0%	-8.5%	1.5%	-14.3%	3.2%
	20 cm	0.6%	-5.2%	-7.9%	1.0%	-13.7%	3.3%
$^{58}Ni(n,p)^{58}Co$	10 cm	-9.4%	0.8%	-2.9%	-2.7%	1.7%	3.8%
	15 cm	-10.0%	5.3%	-0.1%	-0.2%	6.5%	4.1%
	20 cm	-13.7%	5.1%	-0.4%	-2.0%	4.4%	4.2%
$^{181}Ta(n,g)^{182}Ta$	5 cm	2.1%	-6.6%	-4.2%	3.8%	-6.9%	3.8%
	10 cm	2.5%	-5.6%	-5.2%	3.1%	-10.2%	3.9%
	15 cm	-0.3%	-4.6%	-9.6%	-0.6%	-11.1%	3.9%
	20 cm	1.4%	-2.0%	-4.1%	4.7%	-5.4%	4.0%
$^{197}Au(n,2n)^{196}Au$	5 cm	0.7%	2.5%	2.4%	2.1%	1.9%	5.4%
$^{93}Nb(n,2n)^{92m}Nb$	10 cm	-9.1%	-6.1%	-5.8%	-5.9%	-5.5%	4.1%

ALARM-CF-STAINLESS-STEEL-321-SHIELD-001

Figure 4. Photo of Stainless steel Block with Shielding Cone and Stilbene Detector.

Stainless steel, neutron leakage (Rez, CZ, 2021/2022)

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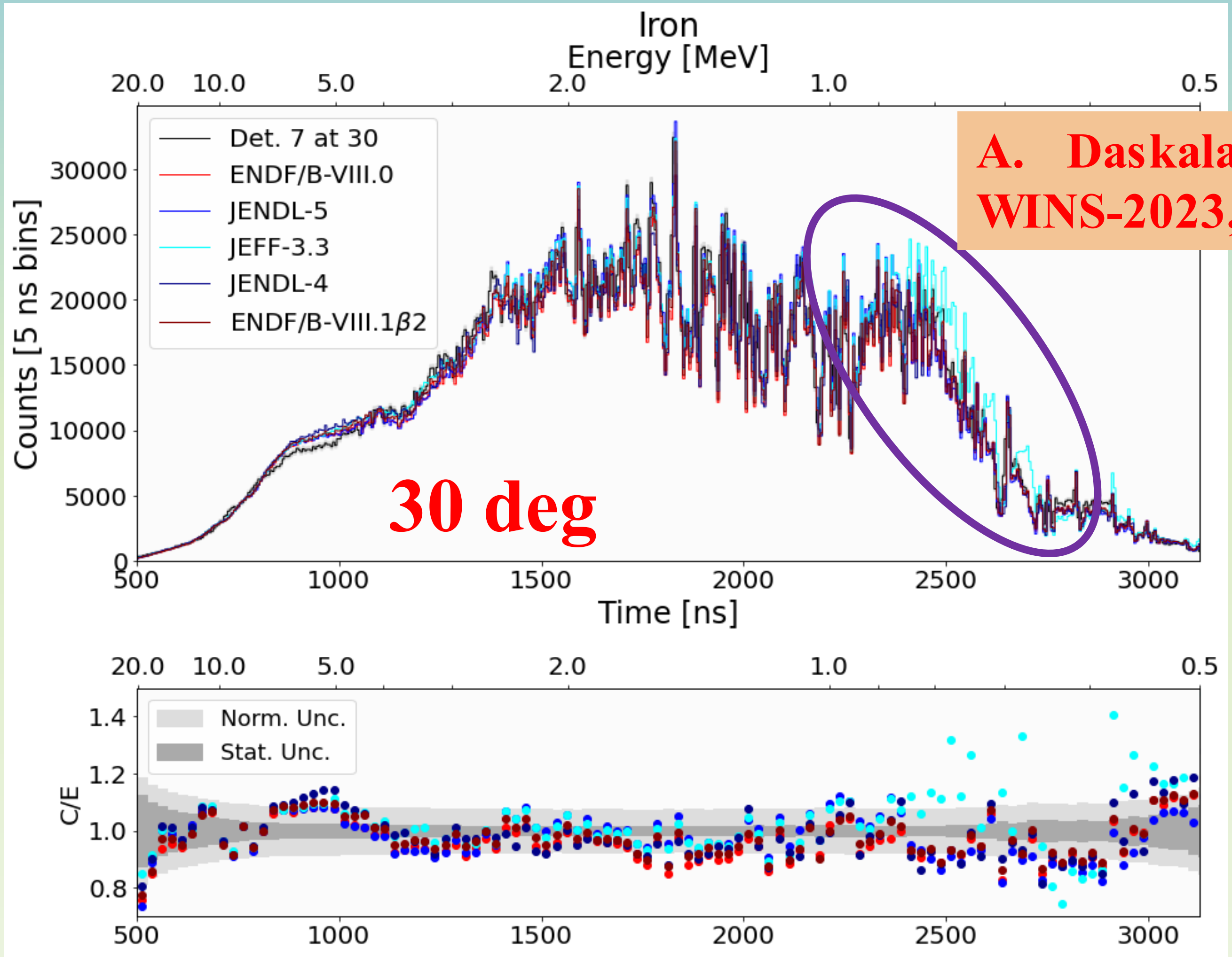
RPI quasi-diff. test on Natural Iron

Additional iron data, poor JEFF performance below 1 MeV, INDEN (B81beta2) is good



A. Daskalakis et al
WINS-2023, October 2023, RPI

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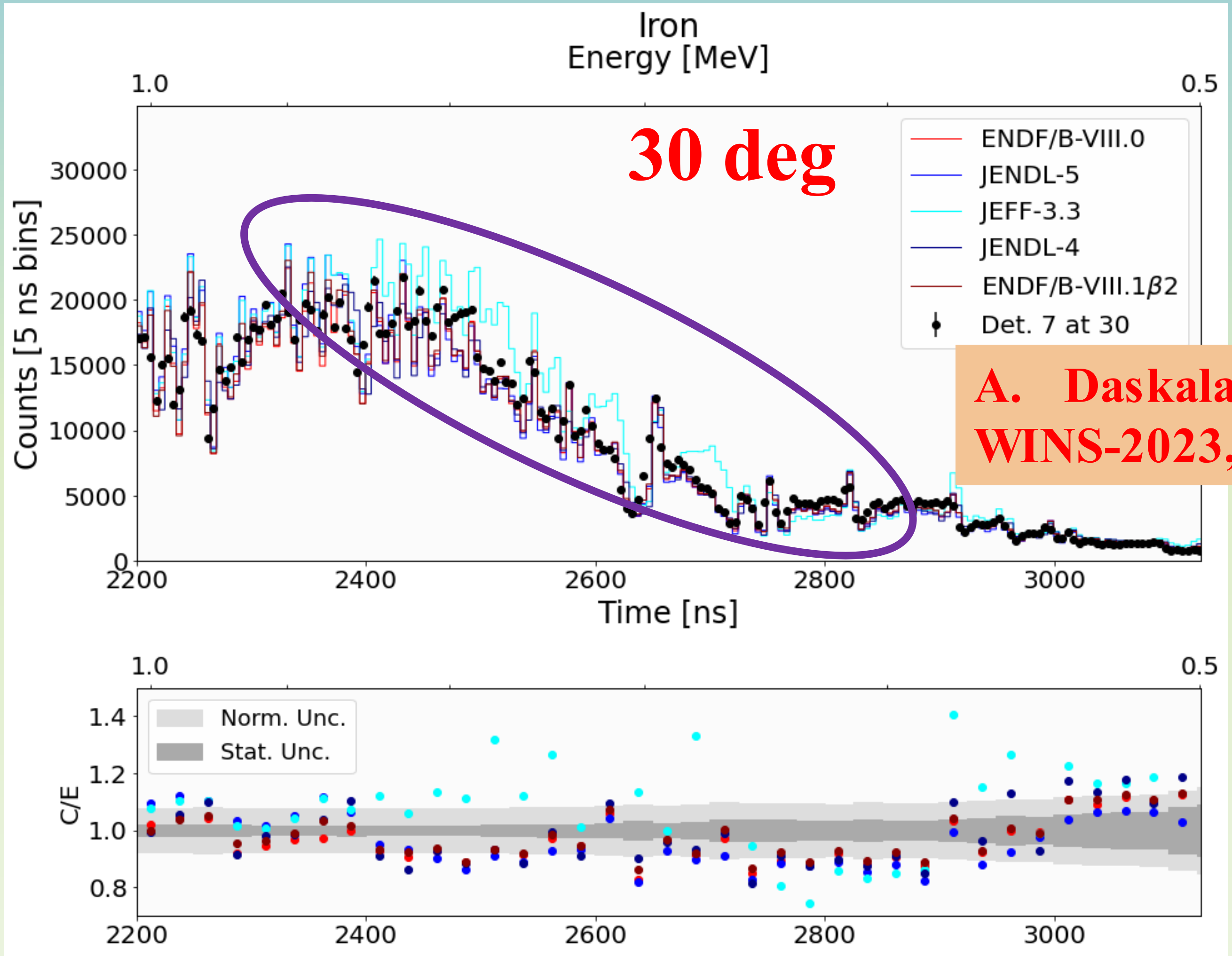
RPI quasi-diff. test on Natural Iron

Additional iron data, poor JEFF performance below 1 MeV, INDEN (B81beta2) is good



A. Daskalakis et al
WINS-2023, October 2023, RPI

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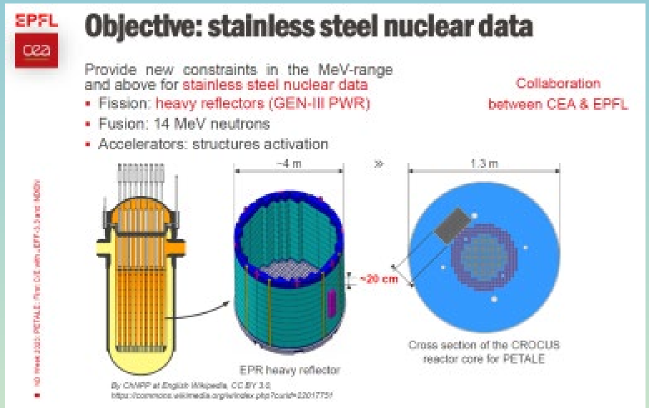
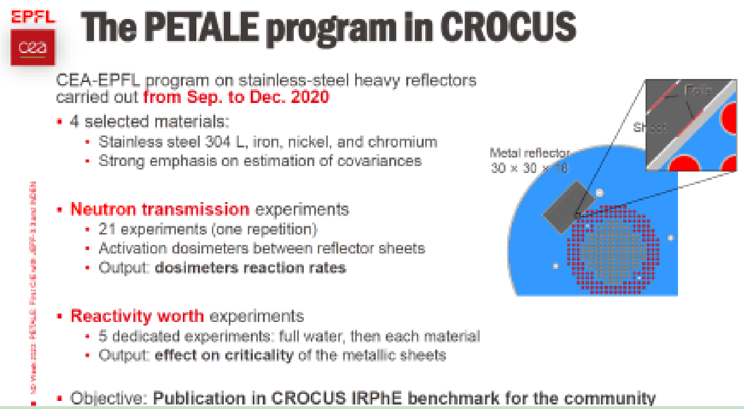
jefdoc-2269: T. Ligonnet et al (2023)



Objective: stainless steel nuclear data

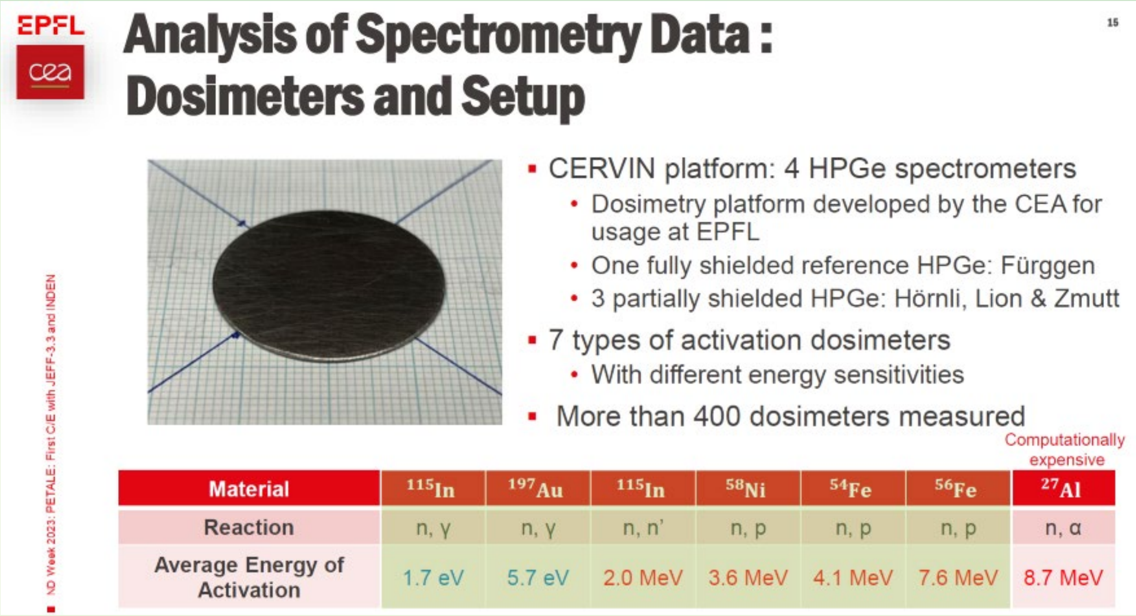
Provide new constraints in the MeV-range and above for stainless steel nuclear data
- Fission: heavy reflectors (GEN-III PWR)
- Fusion: 14 MeV neutrons
- Accelerators: structures activation

Collaboration between CEA & EPFL



The PETALE program in CROCUS

CEA-EPFL program on stainless-steel heavy reflectors carried out from Sep. to Dec. 2020
- 4 selected materials:
  - Stainless steel 304 L, iron, nickel, and chromium
  - Strong emphasis on estimation of covariances
- Neutron transmission experiments
  - 21 experiments (one repetition)
  - Activation dosimeters between reflector sheets
  - Output: dosimeters reaction rates
- Reactivity worth experiments
  - 5 dedicated experiments: full water, then each material
  - Output: effect on criticality of the metallic sheets
- Objective: Publication in CROCUS IRPhE benchmark for the community



Analysis of Spectrometry Data : Dosimeters and Setup

15

- CERVIN platform: 4 HPGe spectrometers
  - Dosimetry platform developed by the CEA for usage at EPFL
  - One fully shielded reference HPGe: Fürggen
  - 3 partially shielded HPGe: Hörnli, Lion & Zmutt
- 7 types of activation dosimeters
  - With different energy sensitivities
- More than 400 dosimeters measured

Computationally expensive

Material	^{115}In	^{197}Au	^{115}In	^{58}Ni	^{54}Fe	^{56}Fe	^{27}Al
Reaction	n, γ	n, γ	n, n'	n, p	n, p	n, p	n, α
Average Energy of Activation	1.7 eV	5.7 eV	2.0 MeV	3.6 MeV	4.1 MeV	7.6 MeV	8.7 MeV

T. Ligonnet et al, presented at JEFF meeting. November 2023, jefdoc-2269

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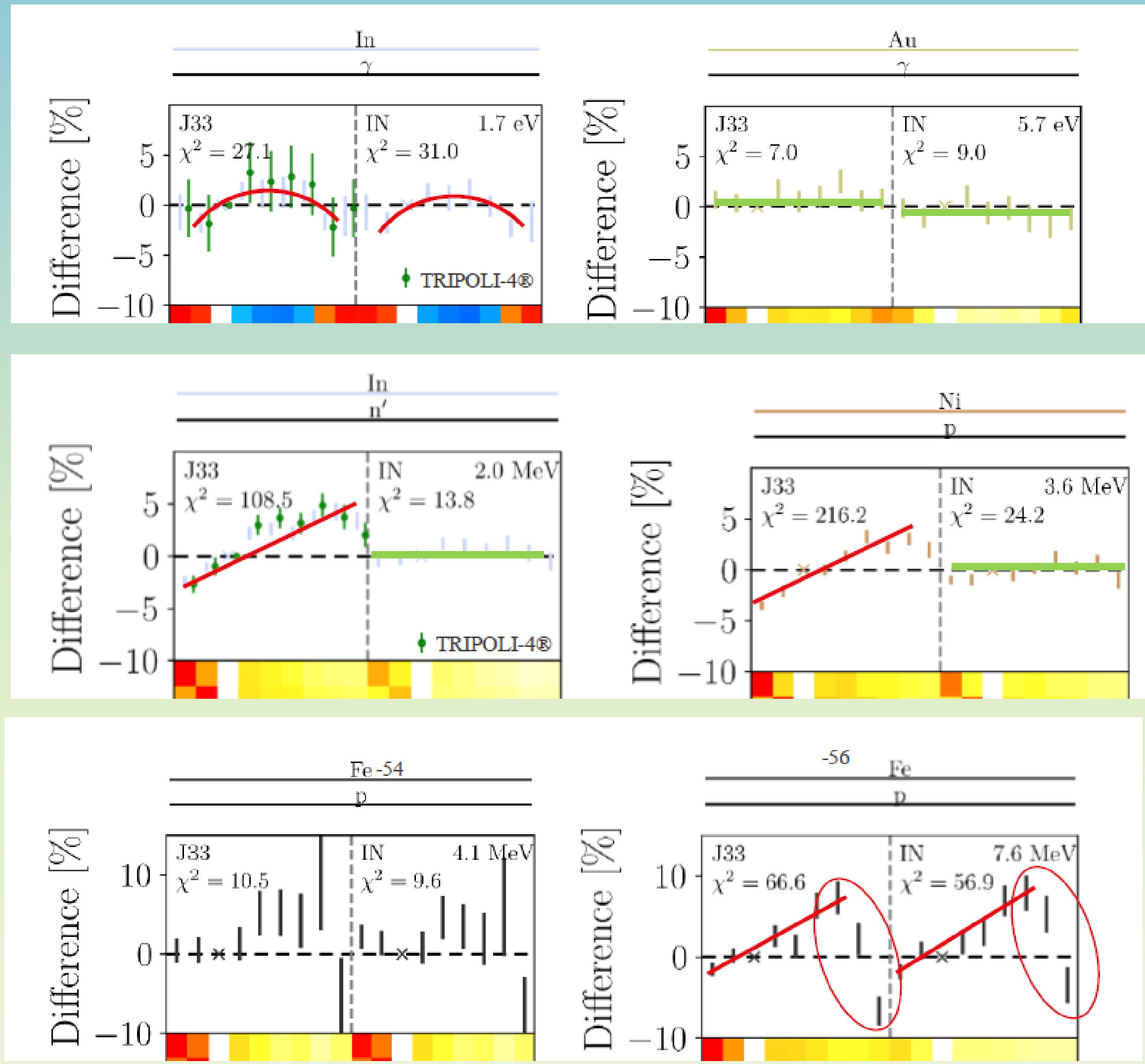
PETALE: Fe reflector (preliminary)



"Near thermal" range
Au-197(n,g), In-115(n,g)

Fast range
In-115(n,n'), Ni-58(n,p)

Fast range
Fe-54(n,p), Fe-56(n,p)

T. Ligonnet et al, presented at JEFF meeting. November 2023, jefdoc-2269

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Conclusions - Fe

- ✓ **INDEN files show very good performance in PETALE, leakage & criticality**
- ✓ **Fe-54 inelastic may be improved.**

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INDEN Cu evaluation

Fast evaluation patched, a new evaluation highly desirable

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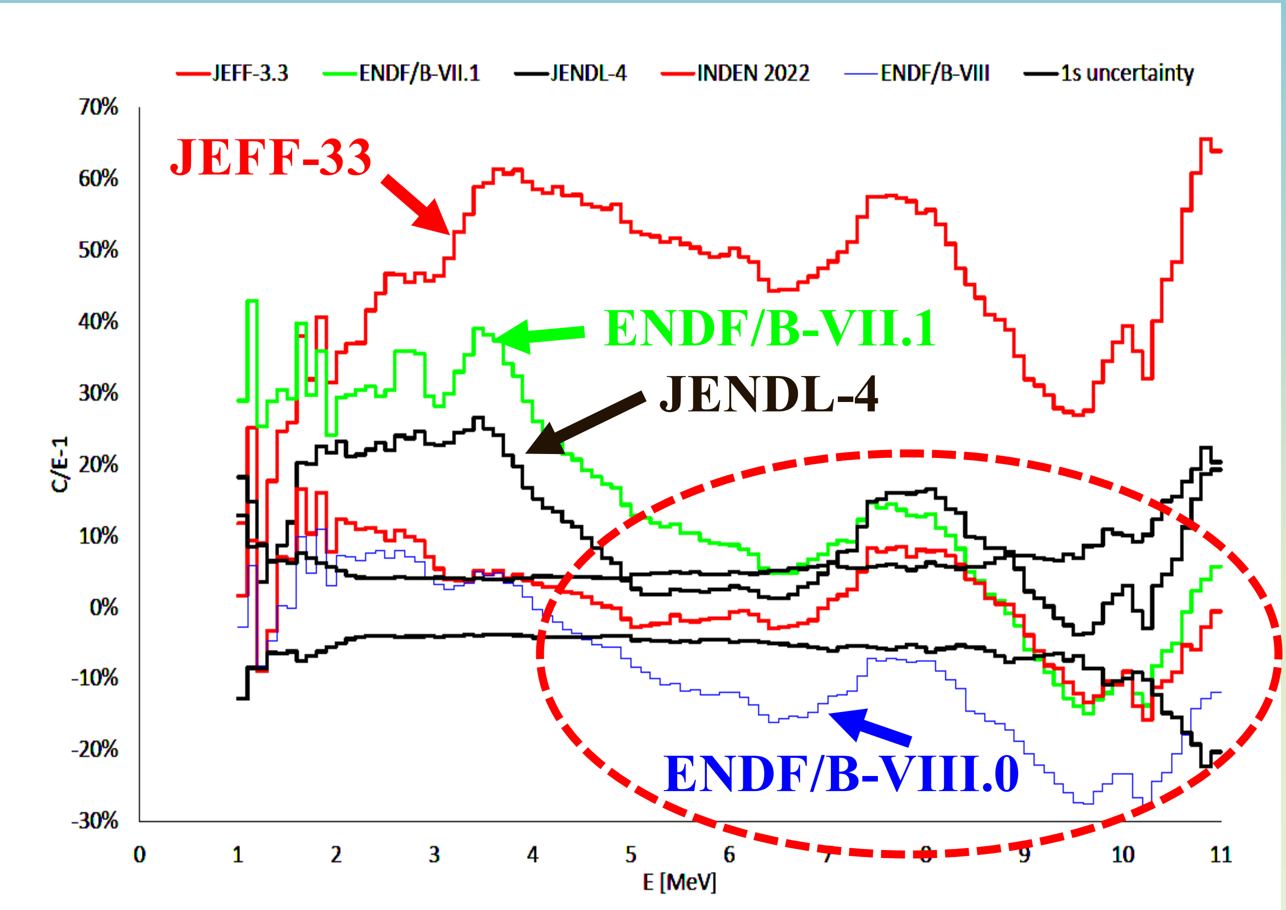
^{252}Cf(sf) neutron leakage of a Cu cube



50x50x50 cm^3 Cu cube Cf-252(sf) source, neutron leakage, Rez, CZ

B8 low, JENDL-5 ok above 4 MeV JEFF-33 bad

Integral data hints at data problems

Leakage sensitive to el/inl/total

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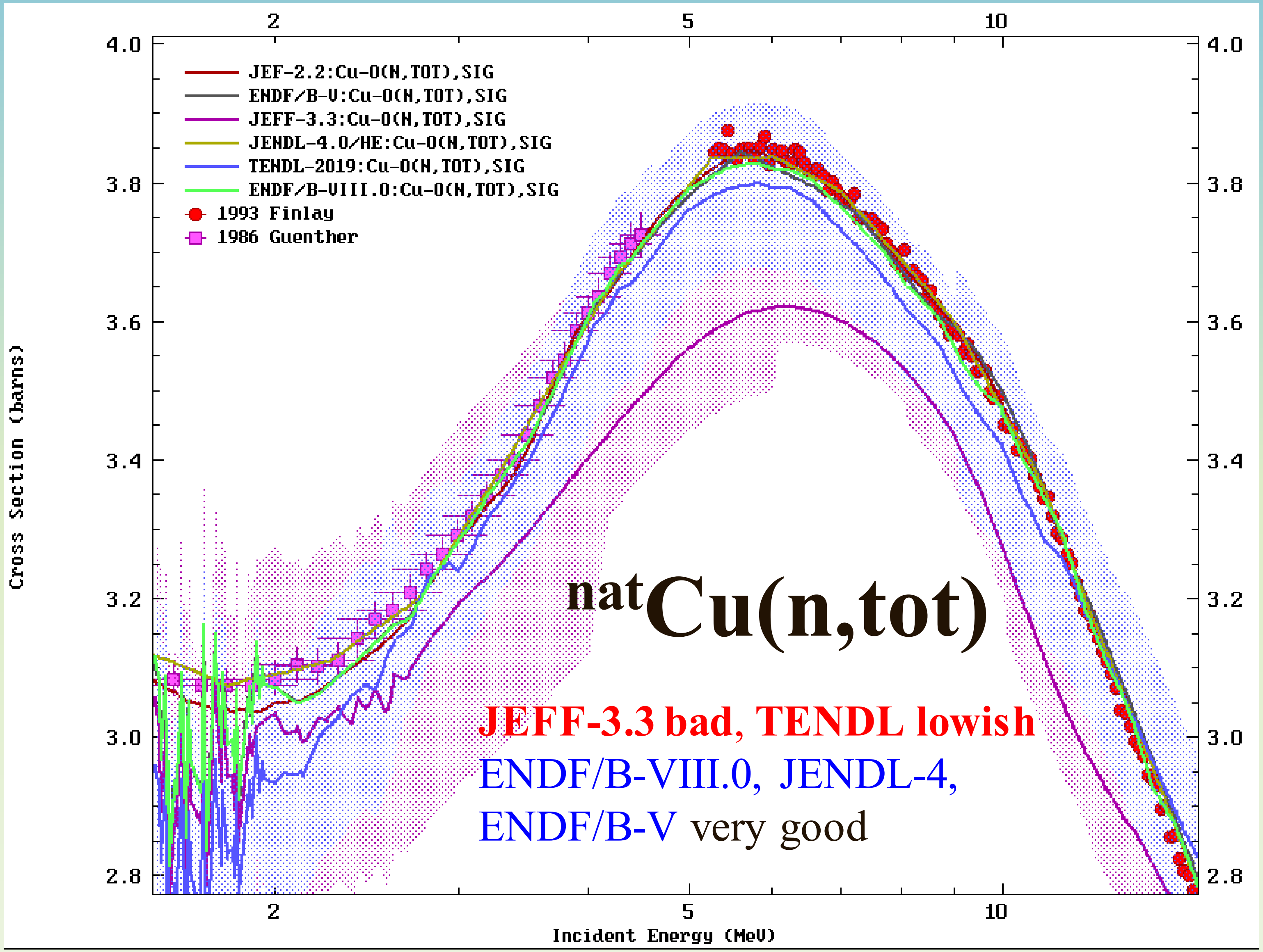
Cu: Differential total cross-section data



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RPI quasi-differential experiment (2021)

NUCLEAR SCIENCE AND ENGINEERING

DOI: https://doi.org/10.1080/00295639.2021.1961542
Check for updates
ANS

Measurements of Neutron Scattering from a Copper Sample Using a Quasi-Differential Method in the Region from 2 keV to 20 MeV

E. Blain,[a]* Y. Danon,[a] D. P. Barry,[b] B. E. Epping,[b] A. Youmans,[a] M. J. Rapp,[b] A. M. Daskalakis,[b] and R. C. Block[a]

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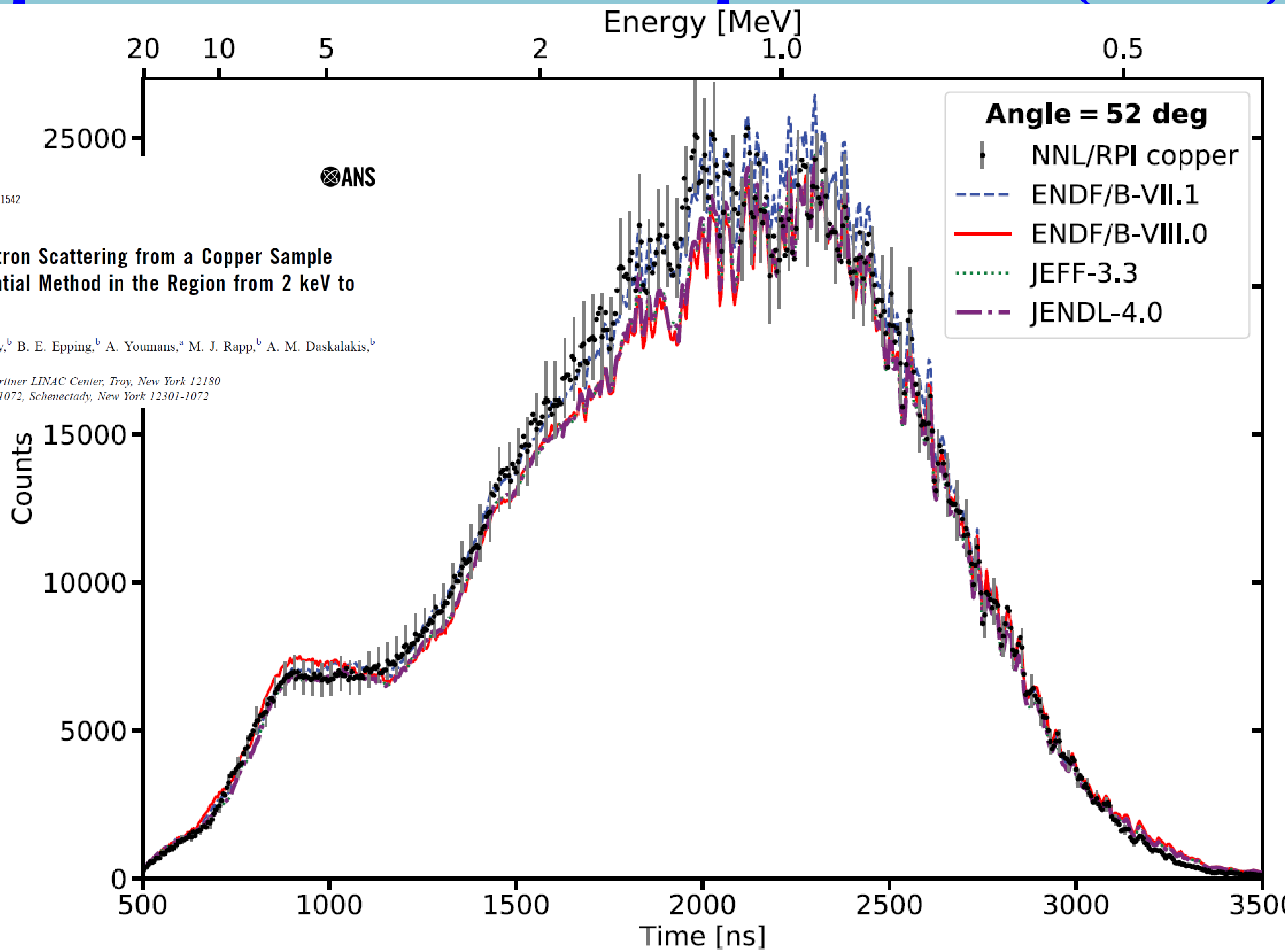
[b]*Naval Nuclear Laboratory, P.O. Box 1072, Schenectady, New York 12301-1072*



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RPI quasi-differential experiment (2021)

NUCLEAR SCIENCE AND ENGINEERING

DOI: https://doi.org/10.1080/00295639.2021.1961542

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Measurements of Neutron Scattering from a Copper Sample Using a Quasi-Differential Method in the Region from 2 keV to 20 MeV

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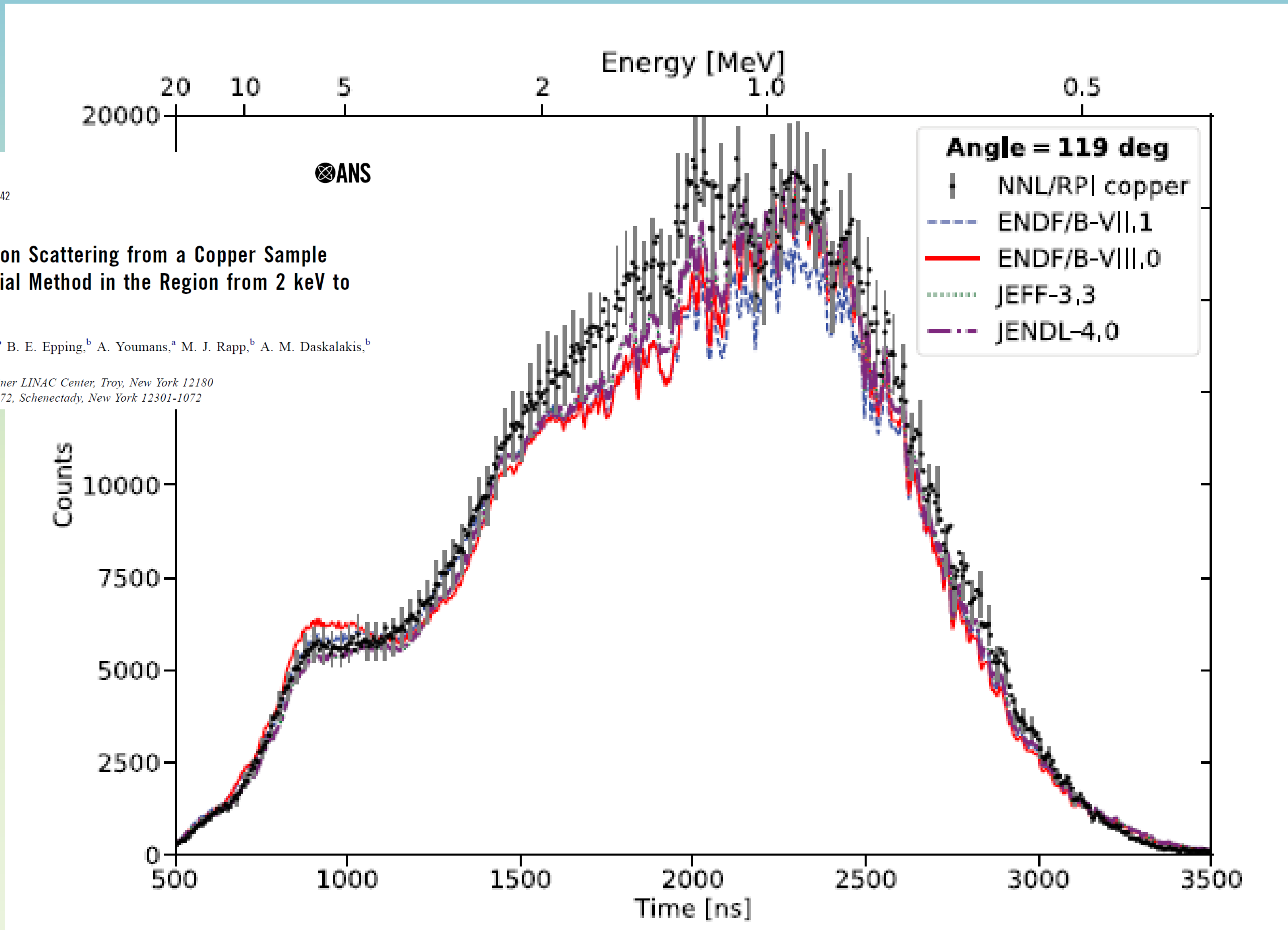
[a]*Rensselaer Polytechnic Institute, Gaerttner LINAC Center, Troy, New York 12180*
[b]*Naval Nuclear Laboratory, P.O. Box 1072, Schenectady, New York 12301-1072*



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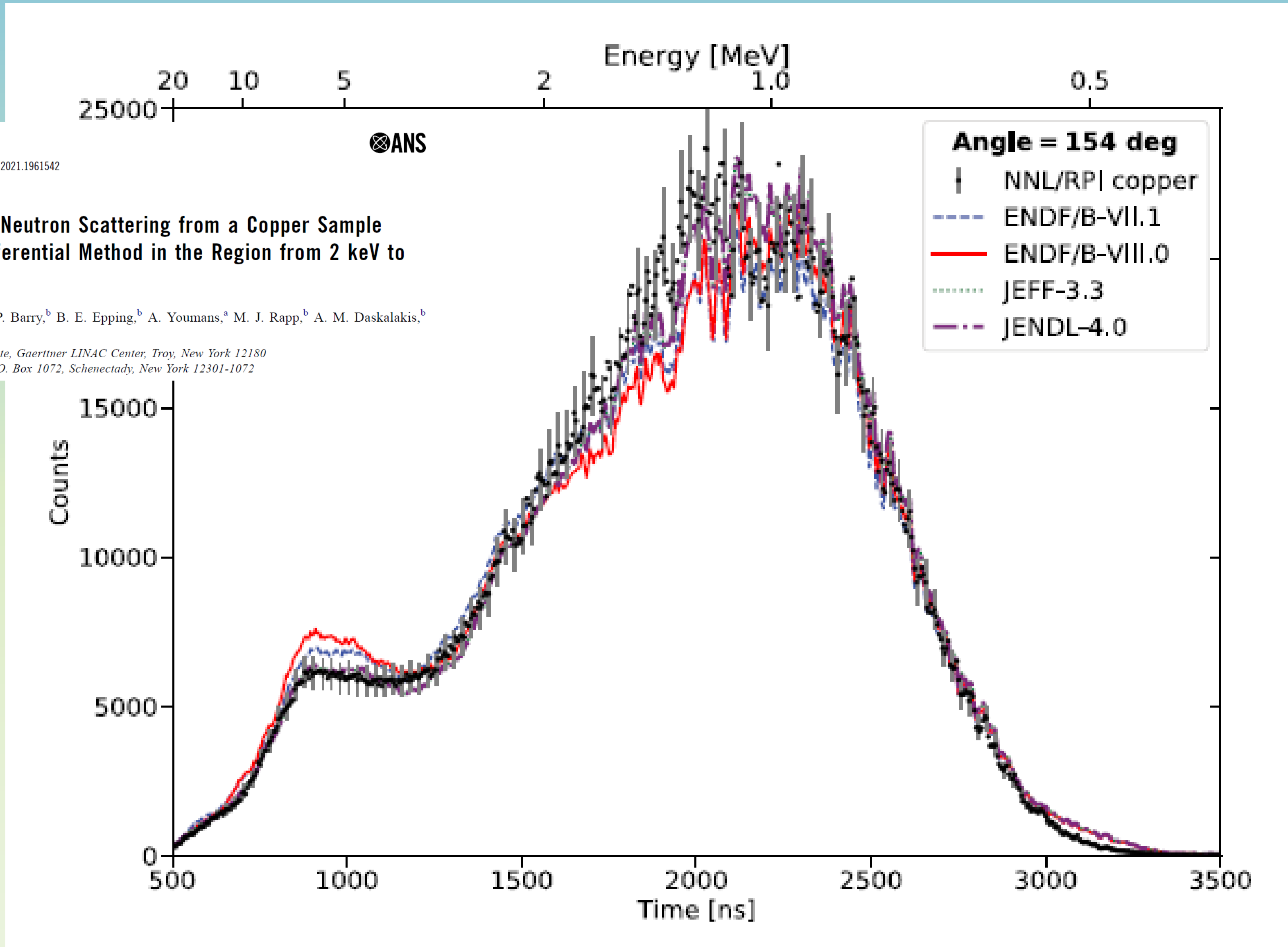

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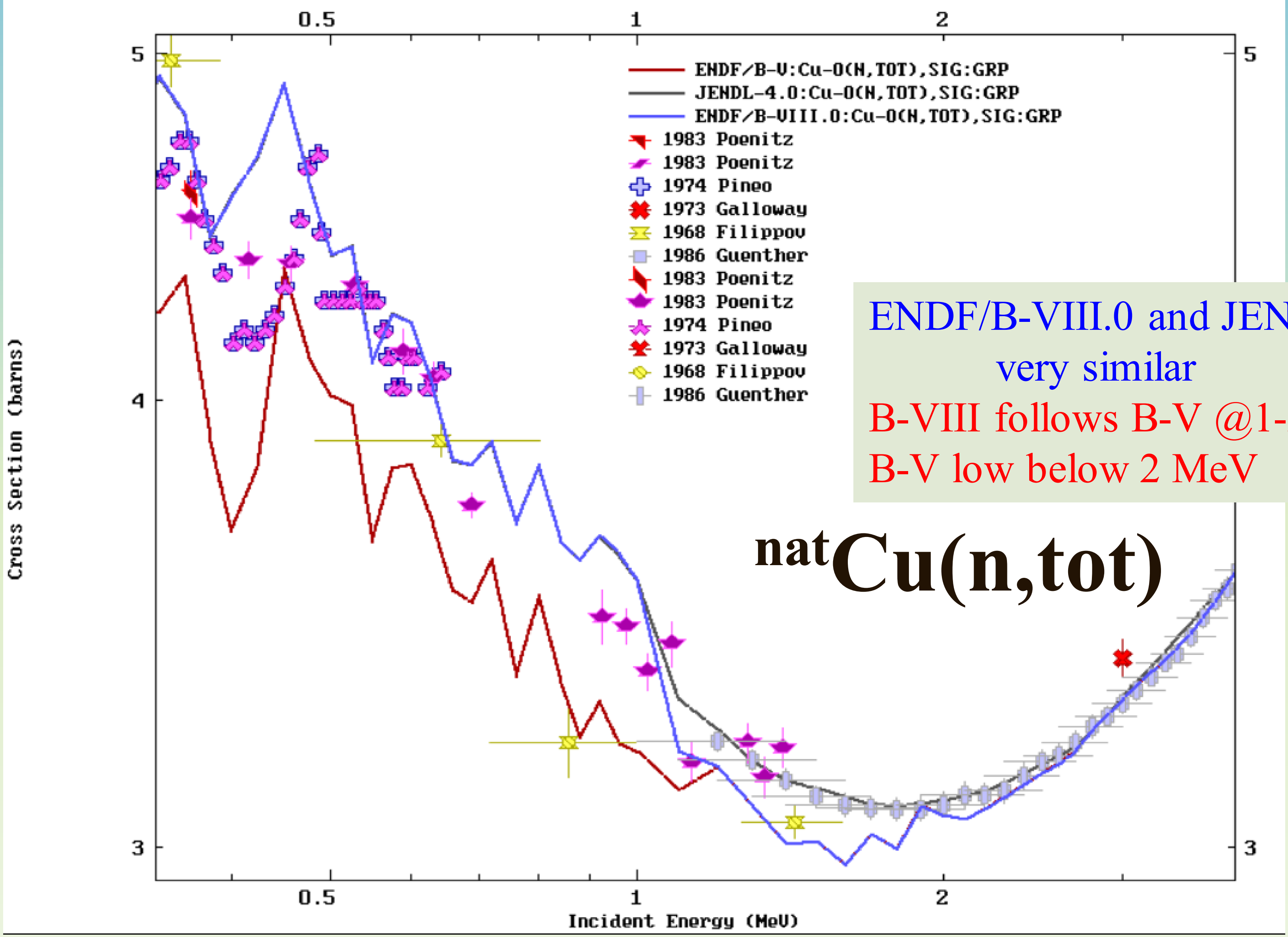
Differential XS total cross section data



ENDF/B-VIII.0 and JENDL-4 very similar

B-VIII follows B-V @1-2 MeV

B-V low below 2 MeV

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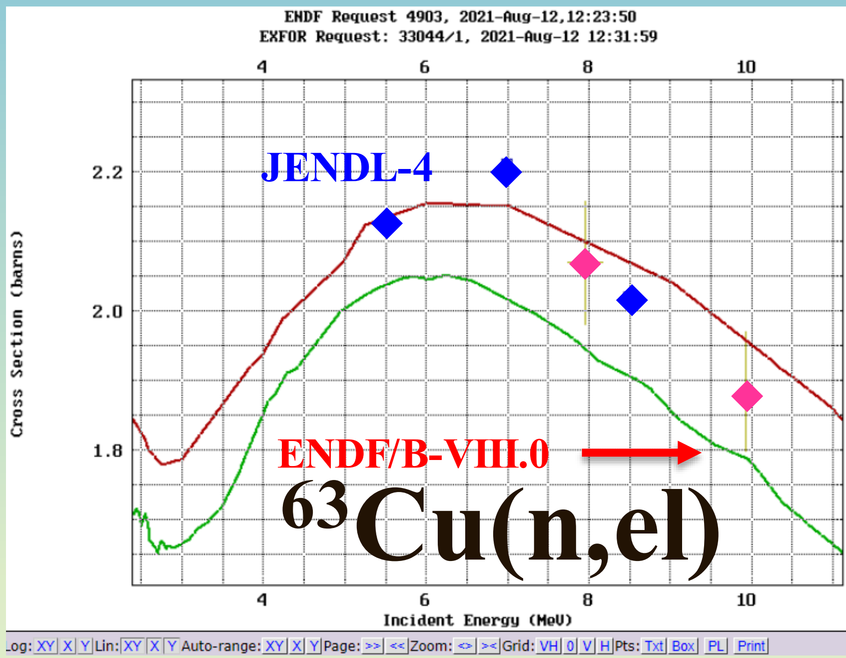
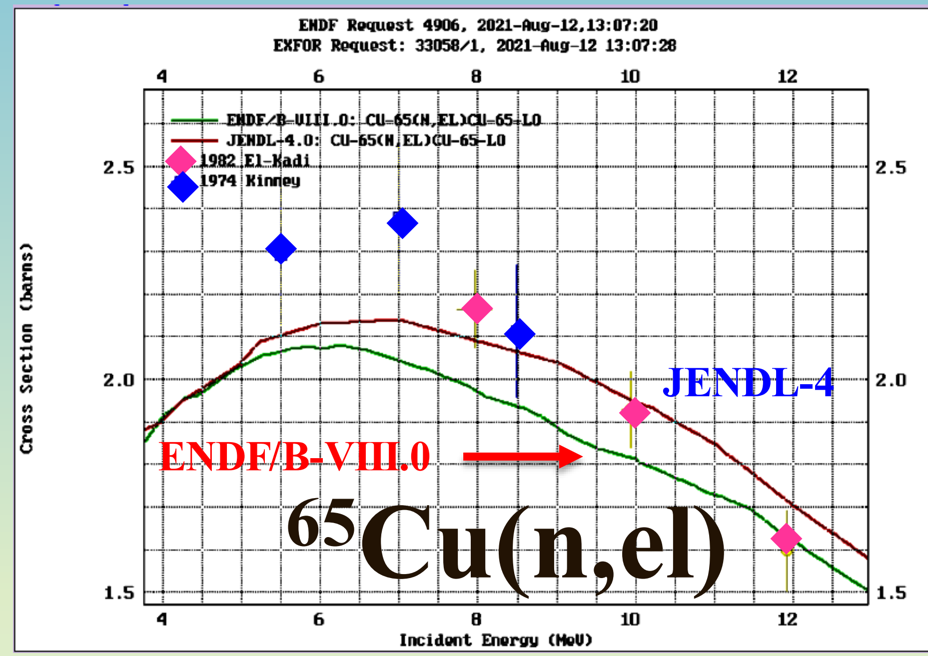
Cu: Differential elastic cross-section data





B8 does not agree with elastic EXP data above ~4 MeV

JENDL-4 much better !

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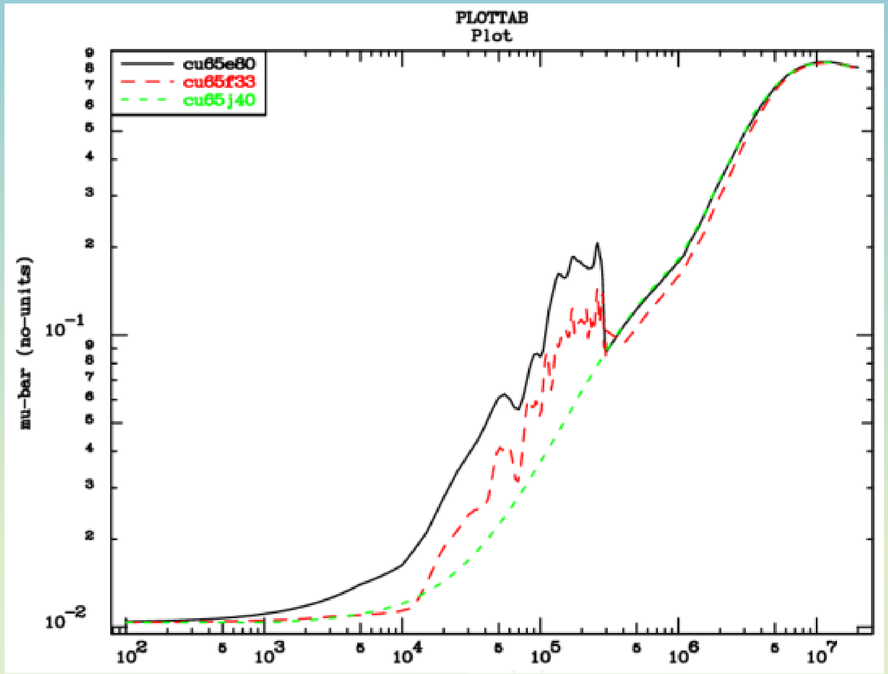
^{65}Cu(n,el) mubar



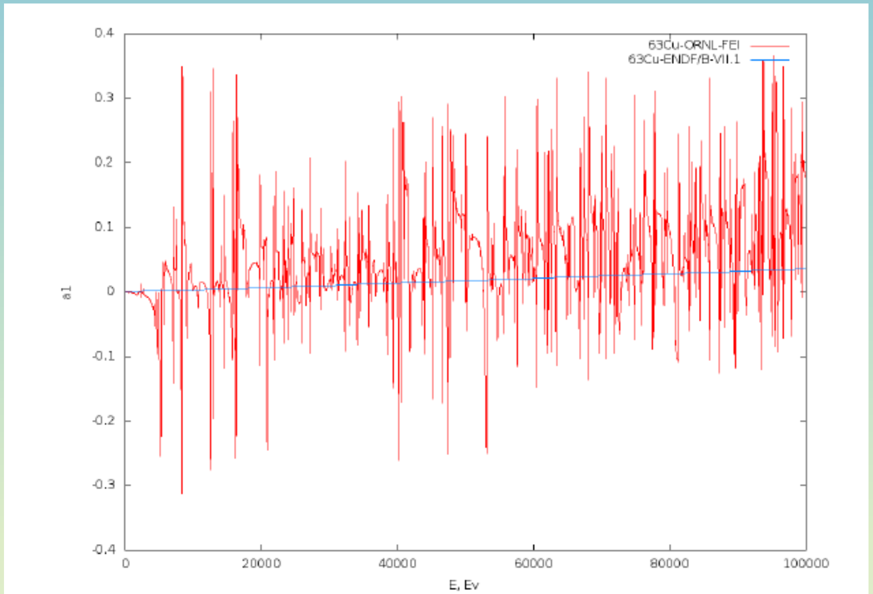


Рис. 9. Зависимость a1 от энергии нейтрона для ^{65}Cu из библиотеки ENDF/B-VII.1 (плавная зависимость от энергии) и нового файлов оцененных данных

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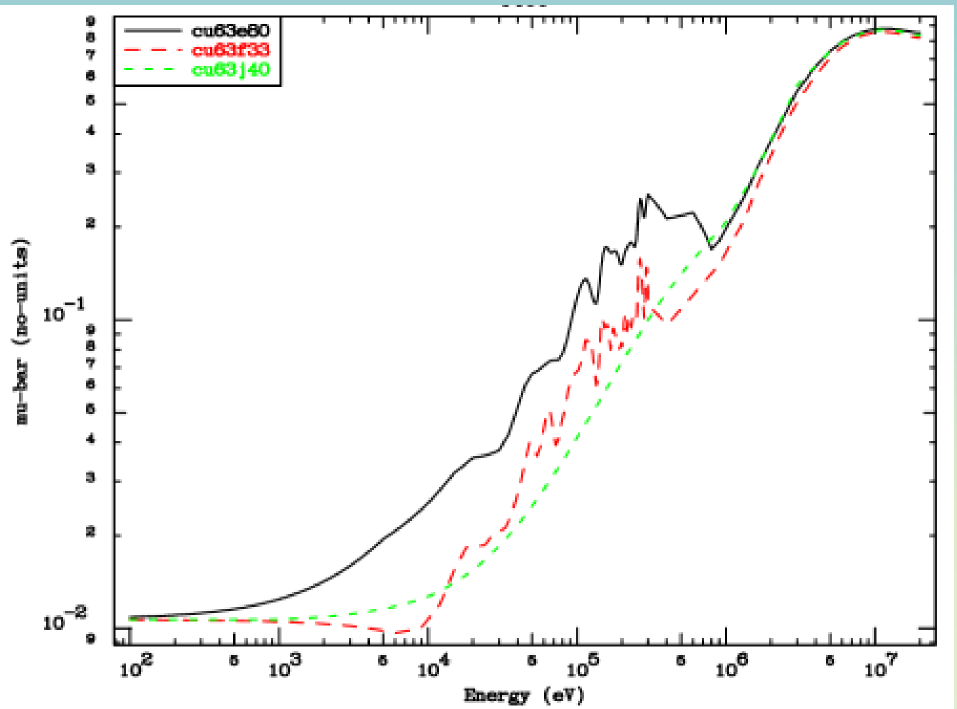
^{63}Cu(n,el) mubar



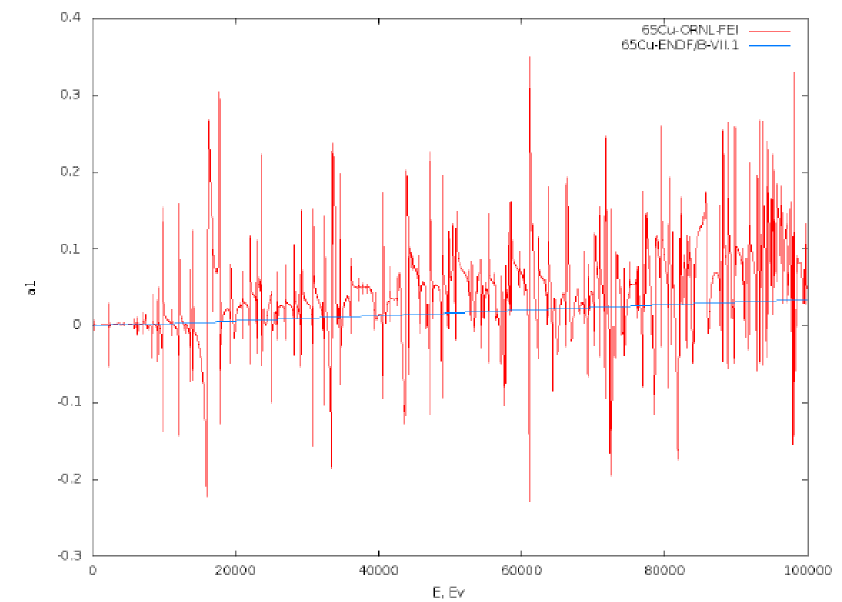


Рис. 8. Зависимость a1 от энергии нейтрона для ^{63}Cu из библиотеки ENDF/B-VII.1 (плавная зависимость от энергии) и нового файлов оцененных данных

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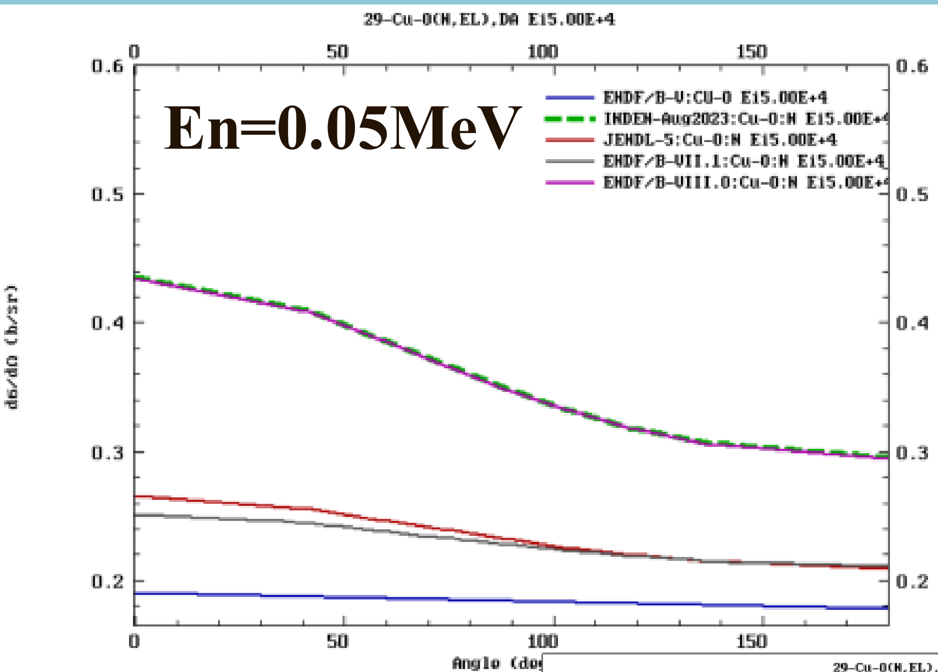
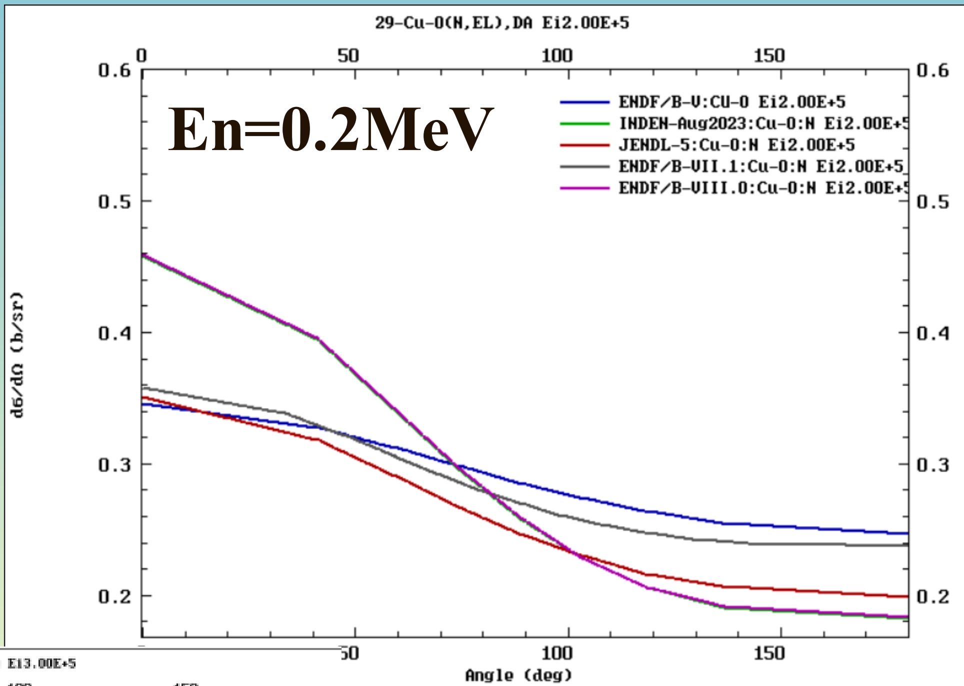
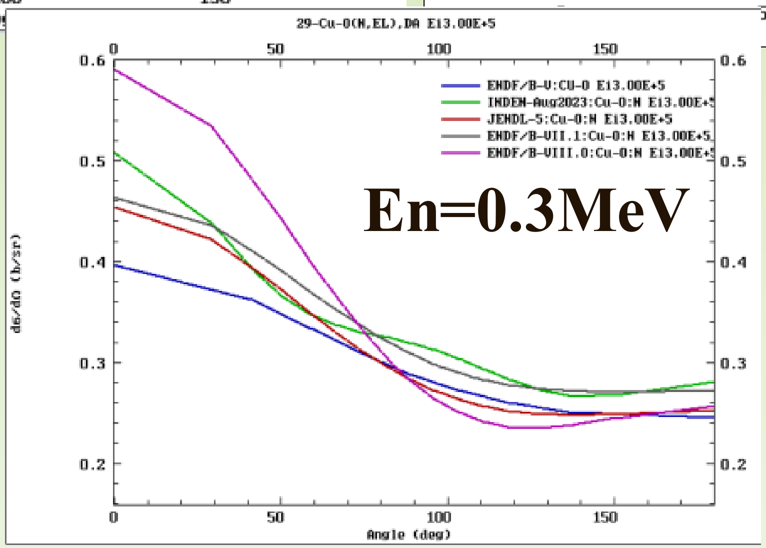
Differential XS angular distributions





^{nat}Cu(n,el)



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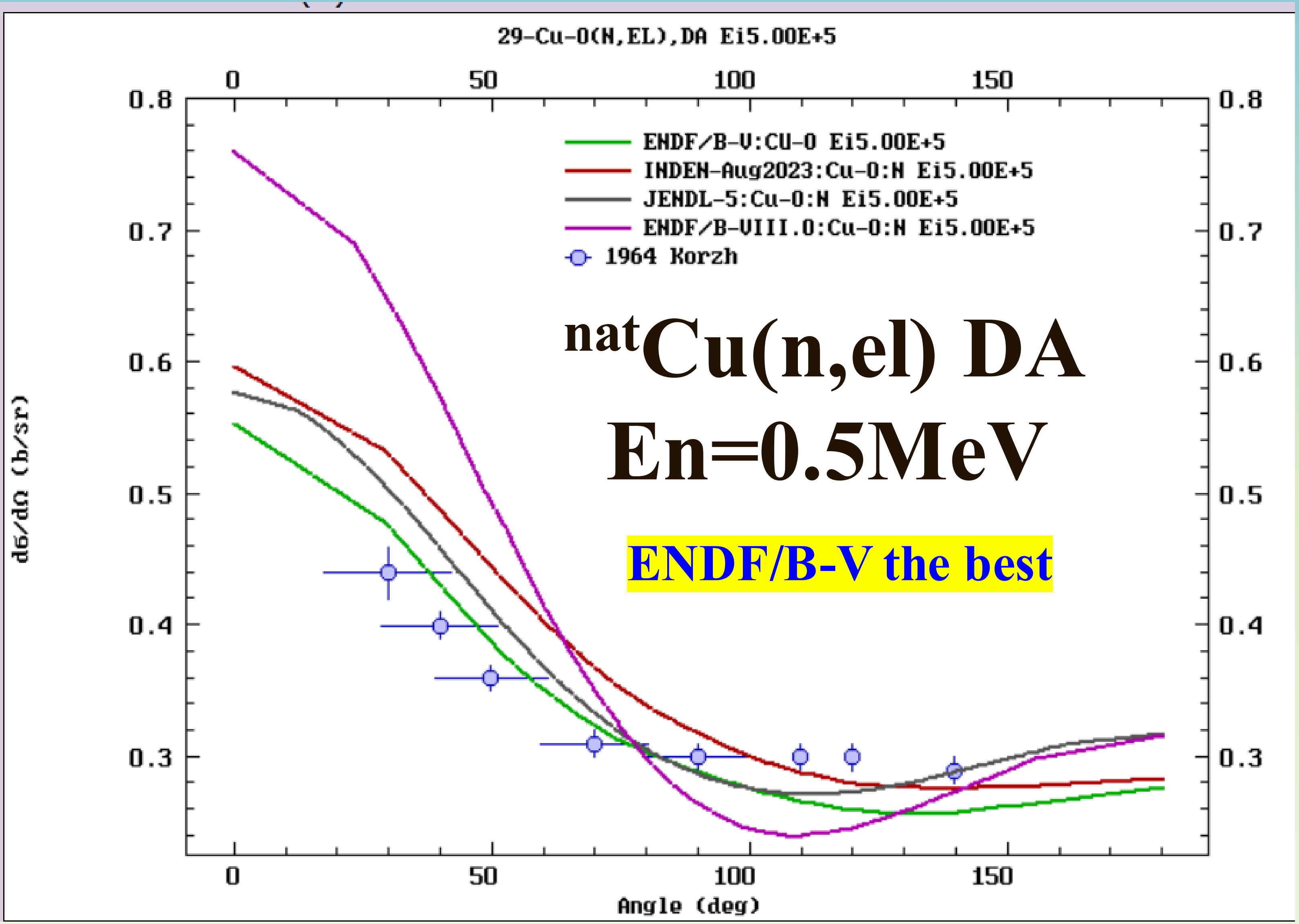

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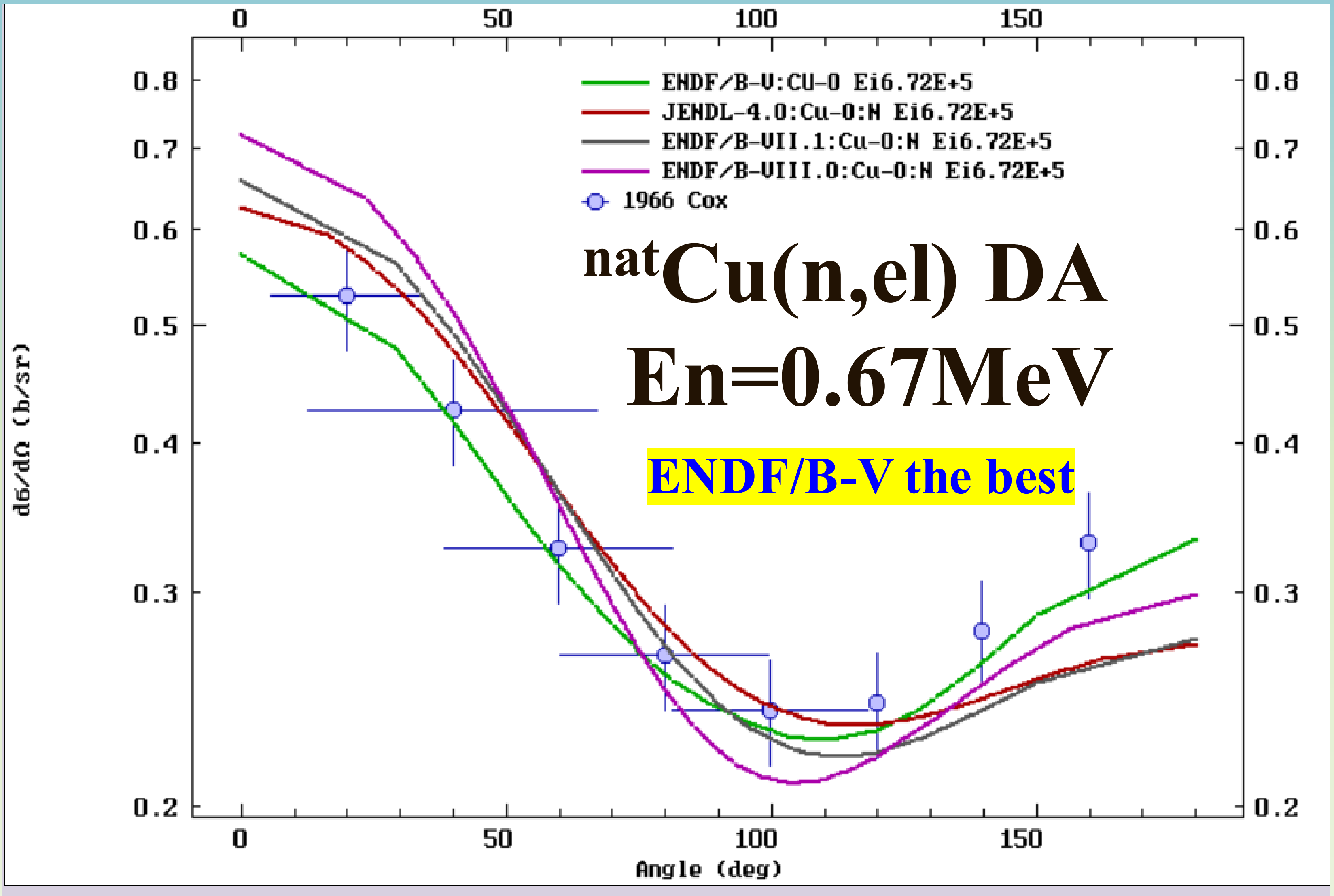

INDEN-SM CM, 18-21 December 2023,
IAEA HQ, Vienna, Austria (hybrid)

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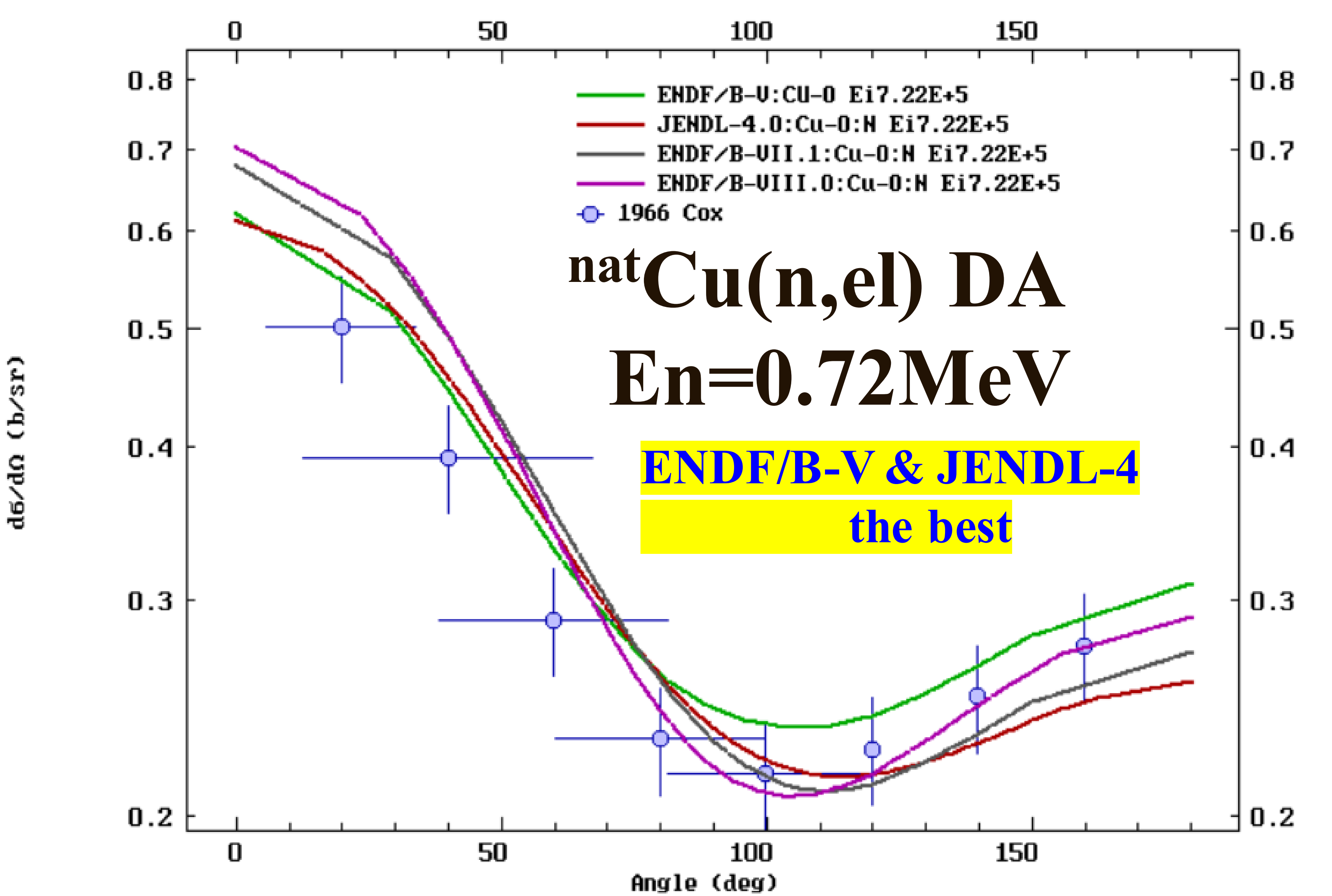

^{nat}Cu(n,el) DA

En=0.72MeV

ENDF/B-V & JENDL-4 the best

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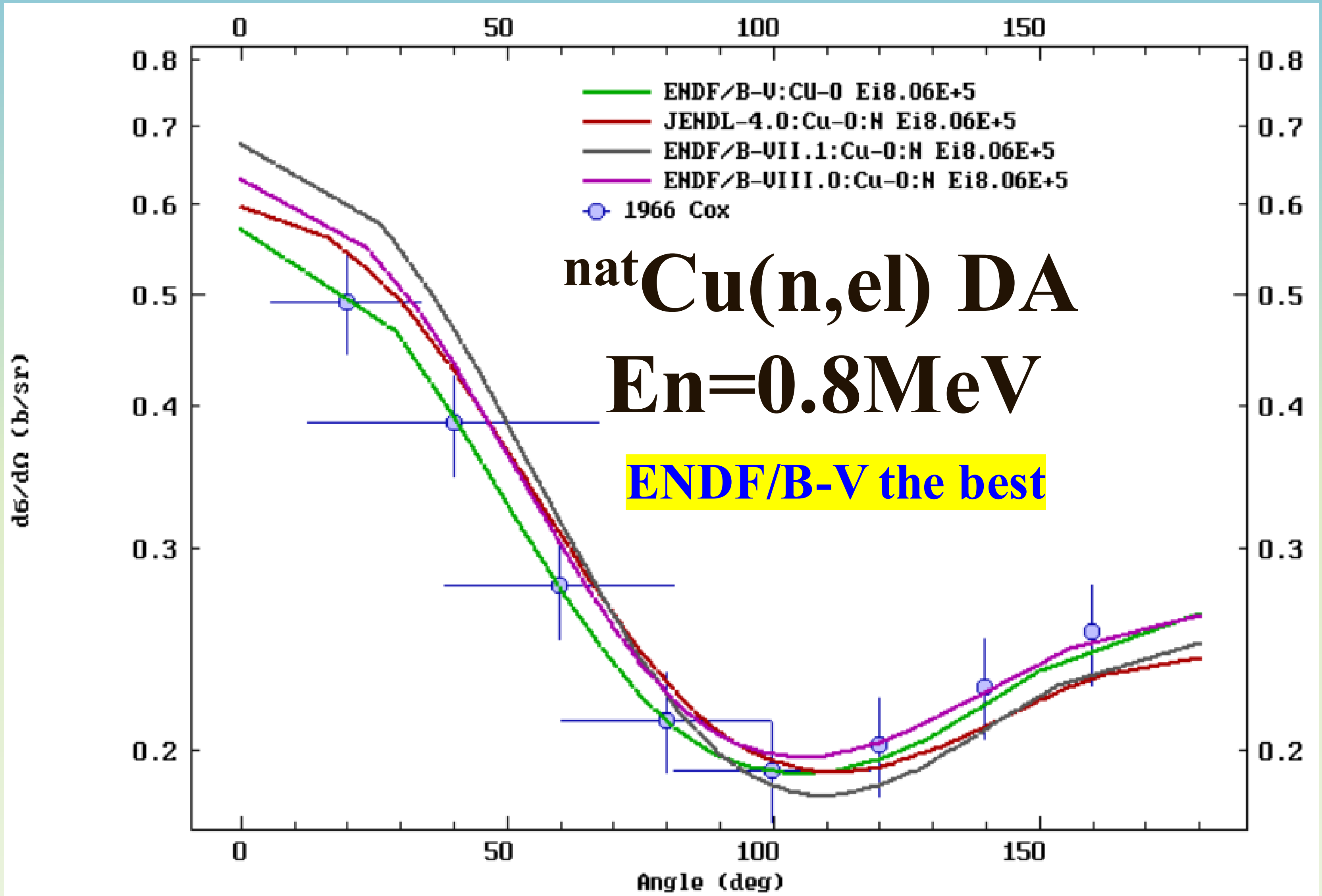

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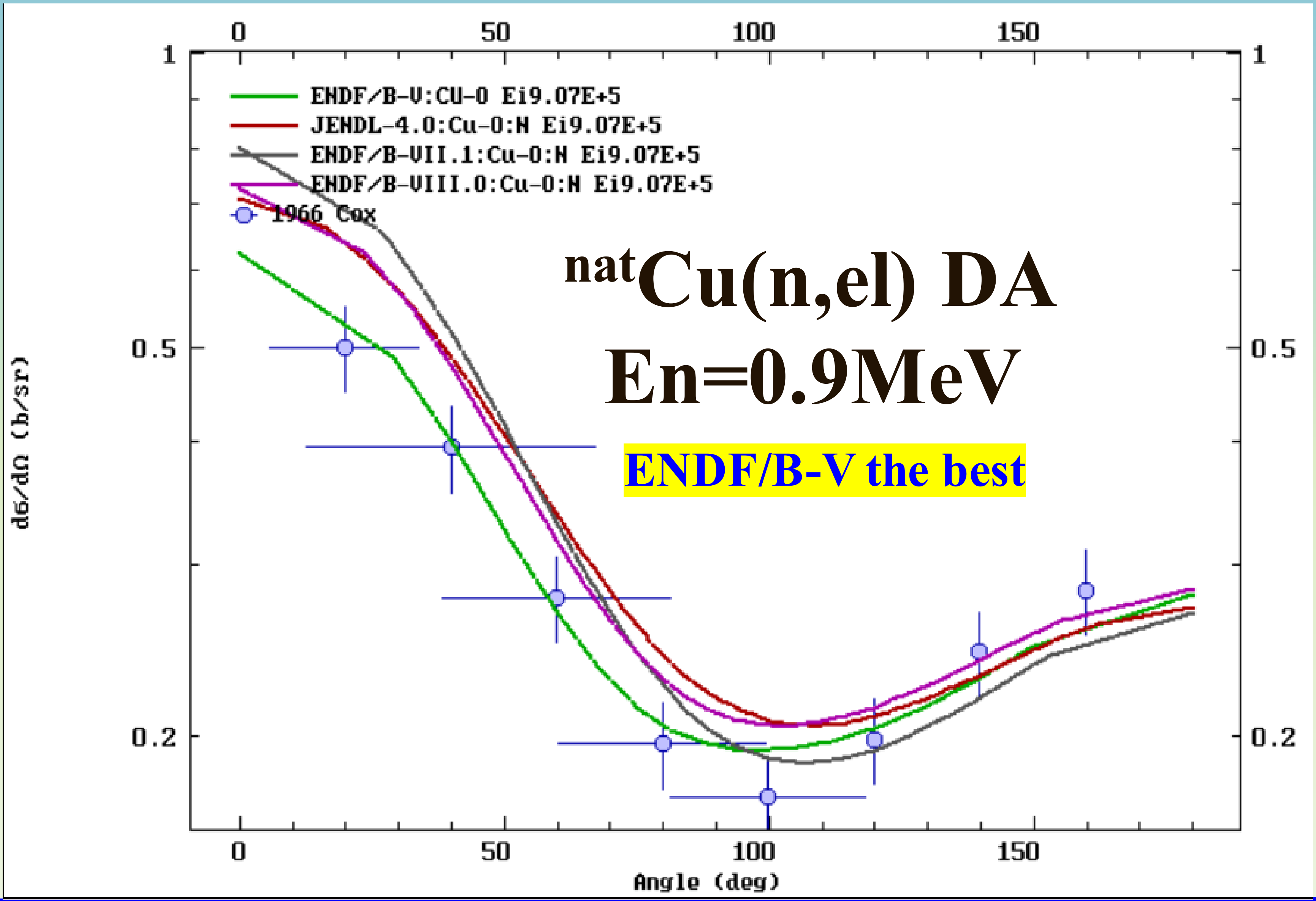

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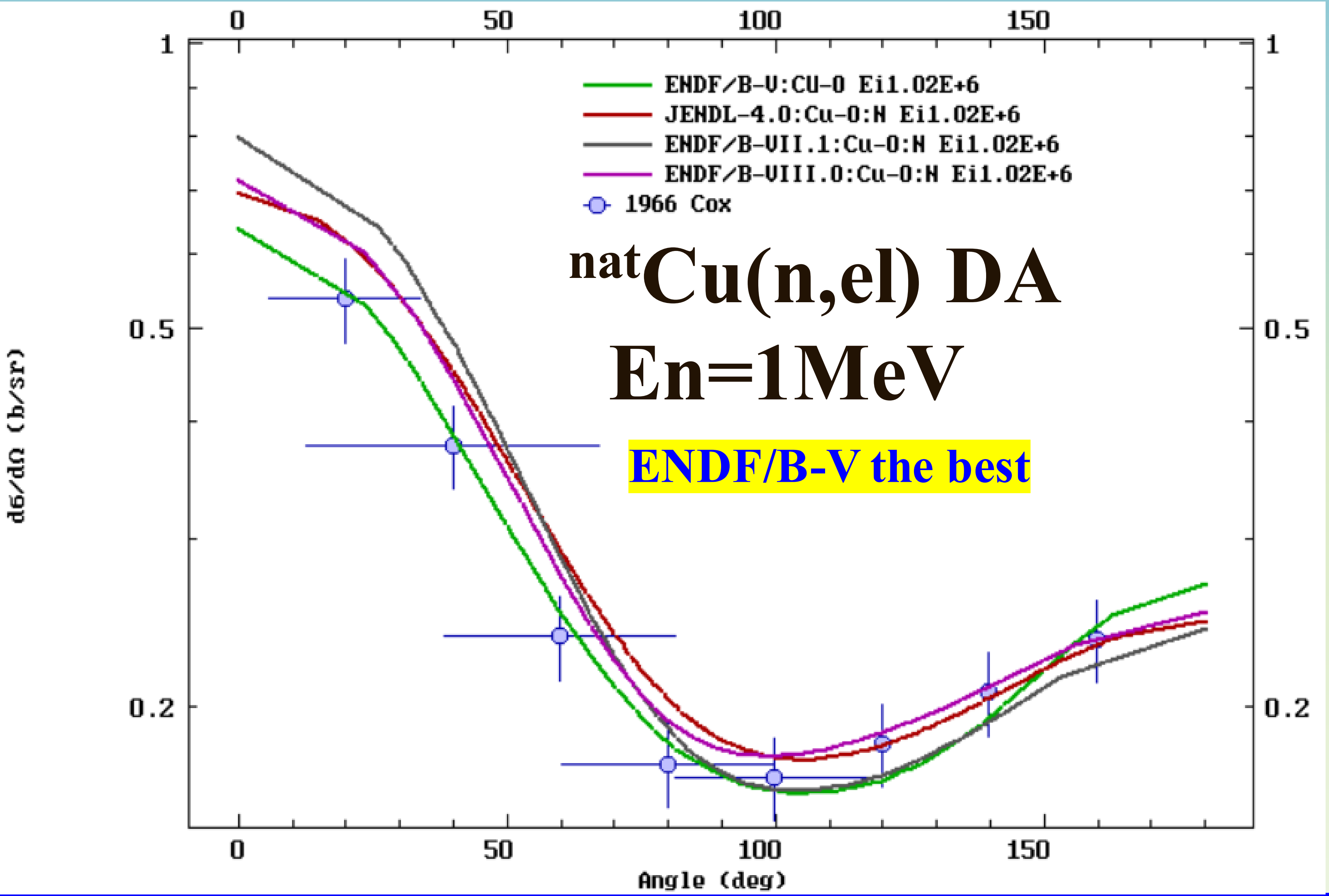

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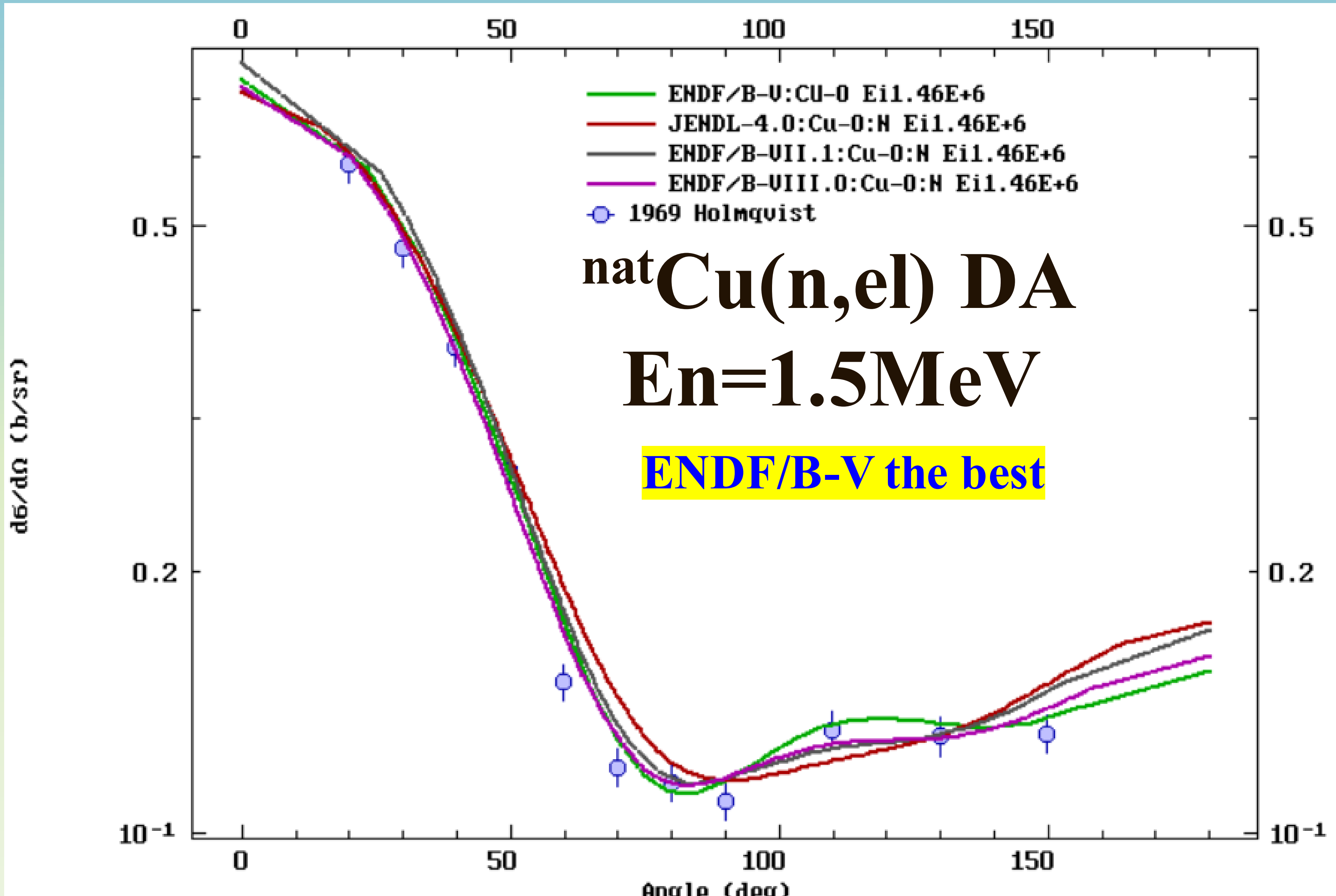

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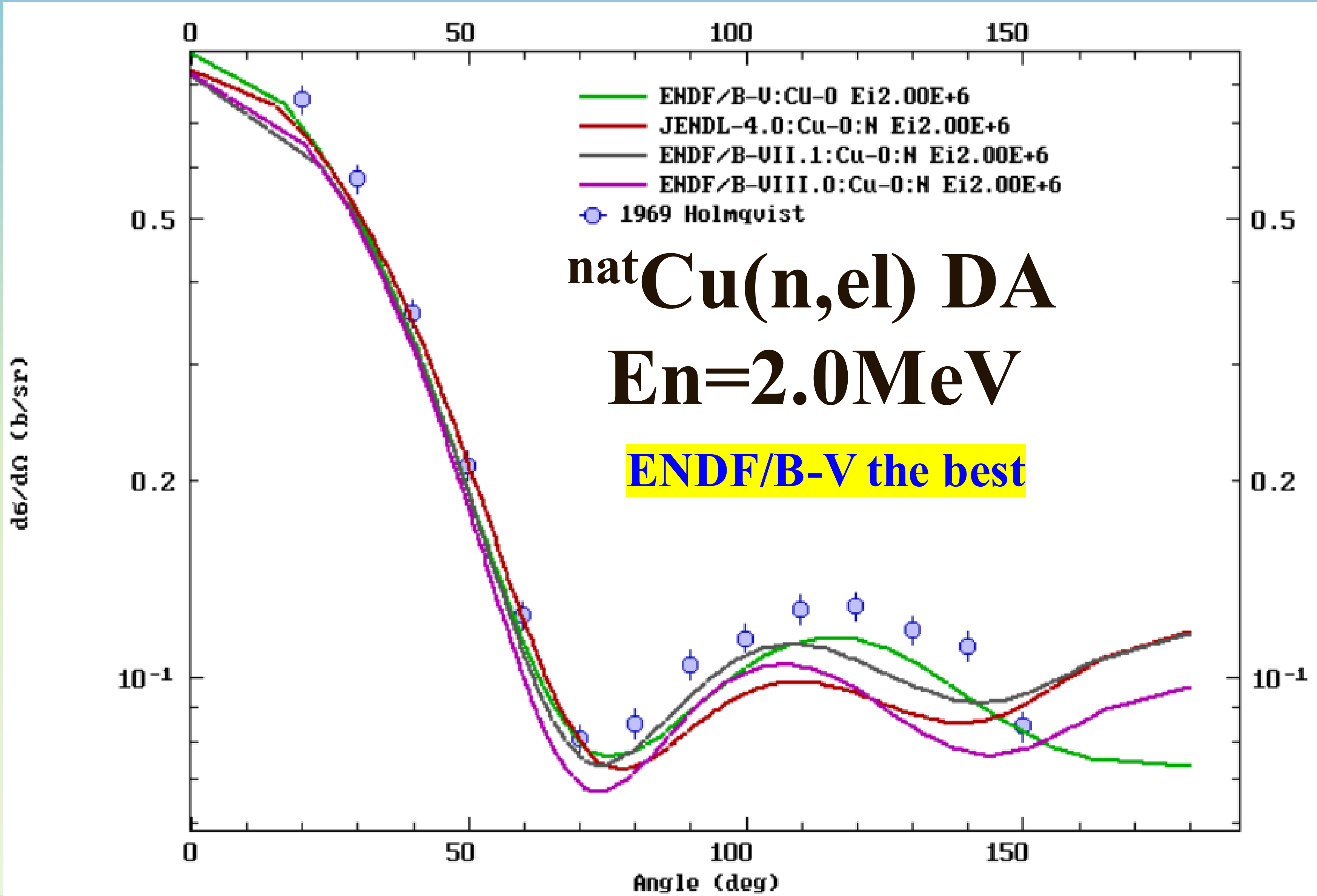

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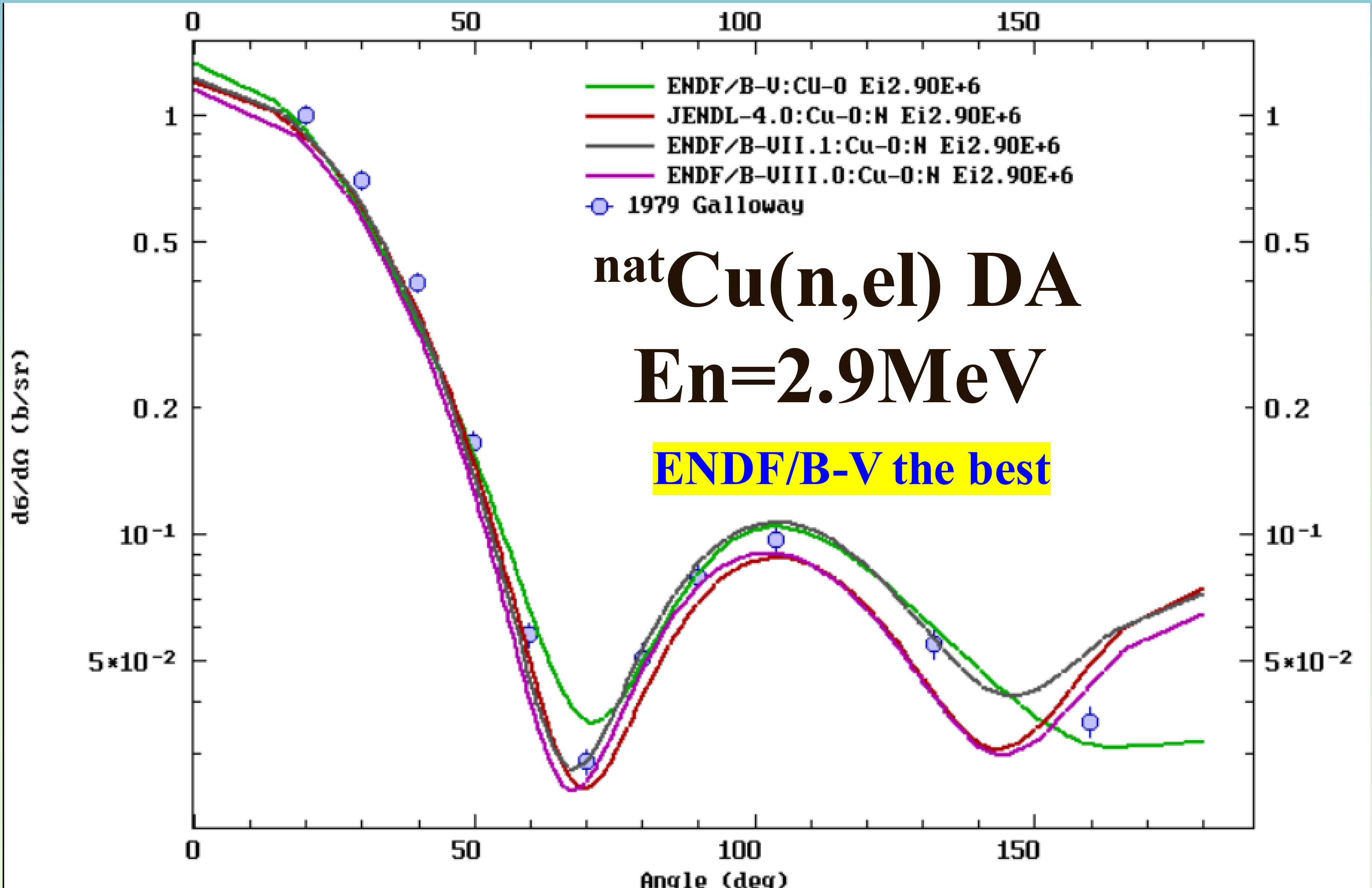

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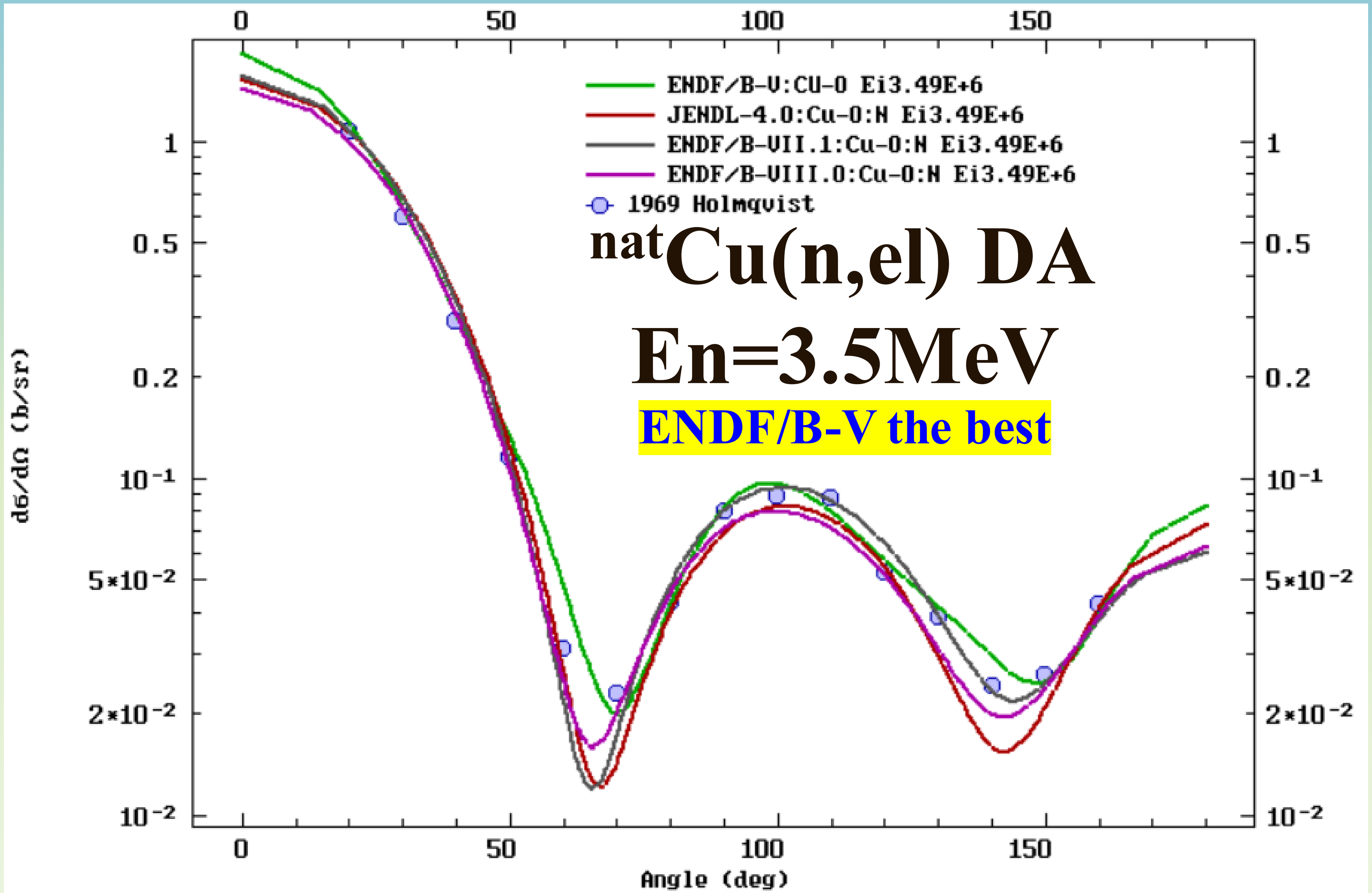

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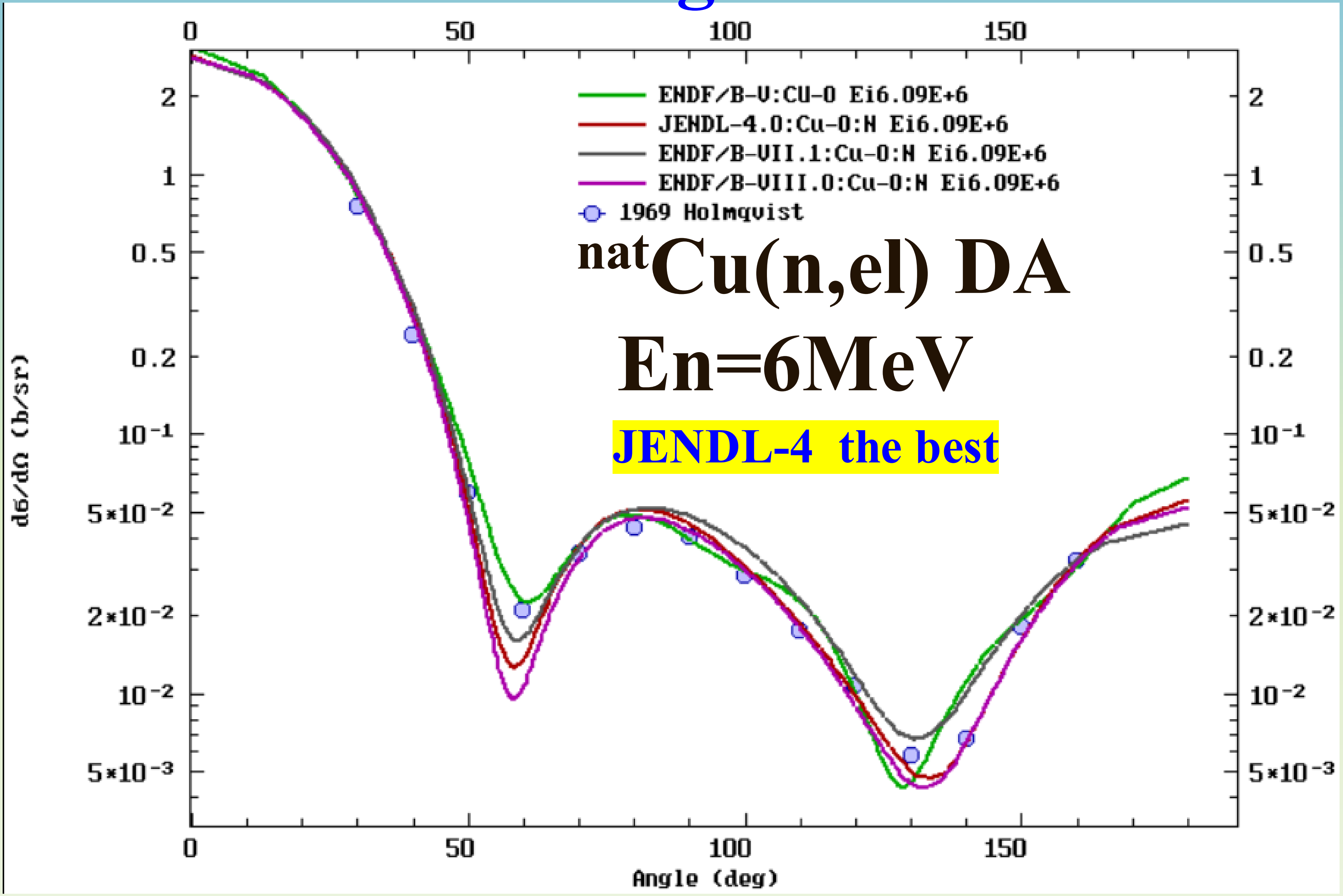

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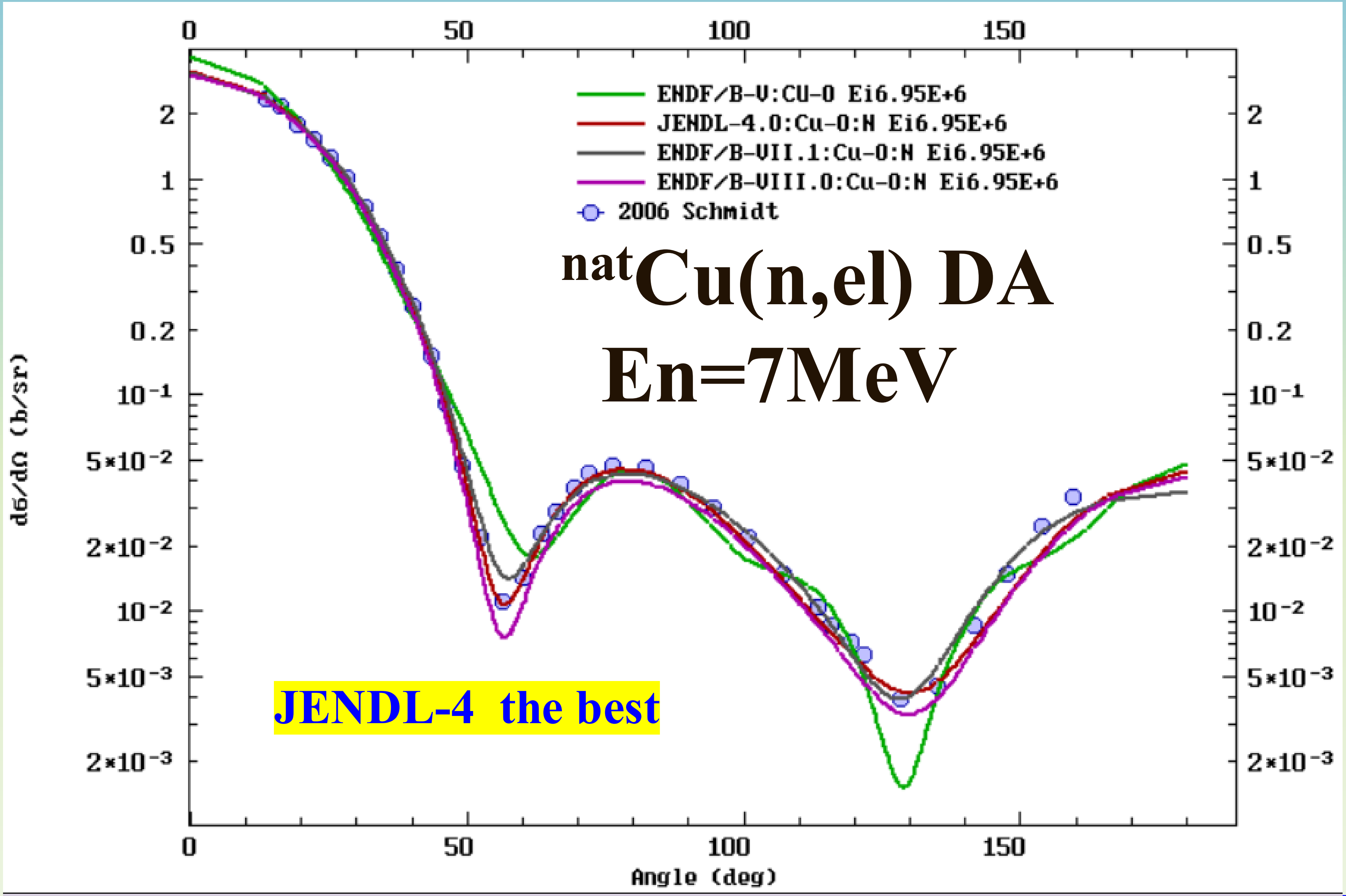

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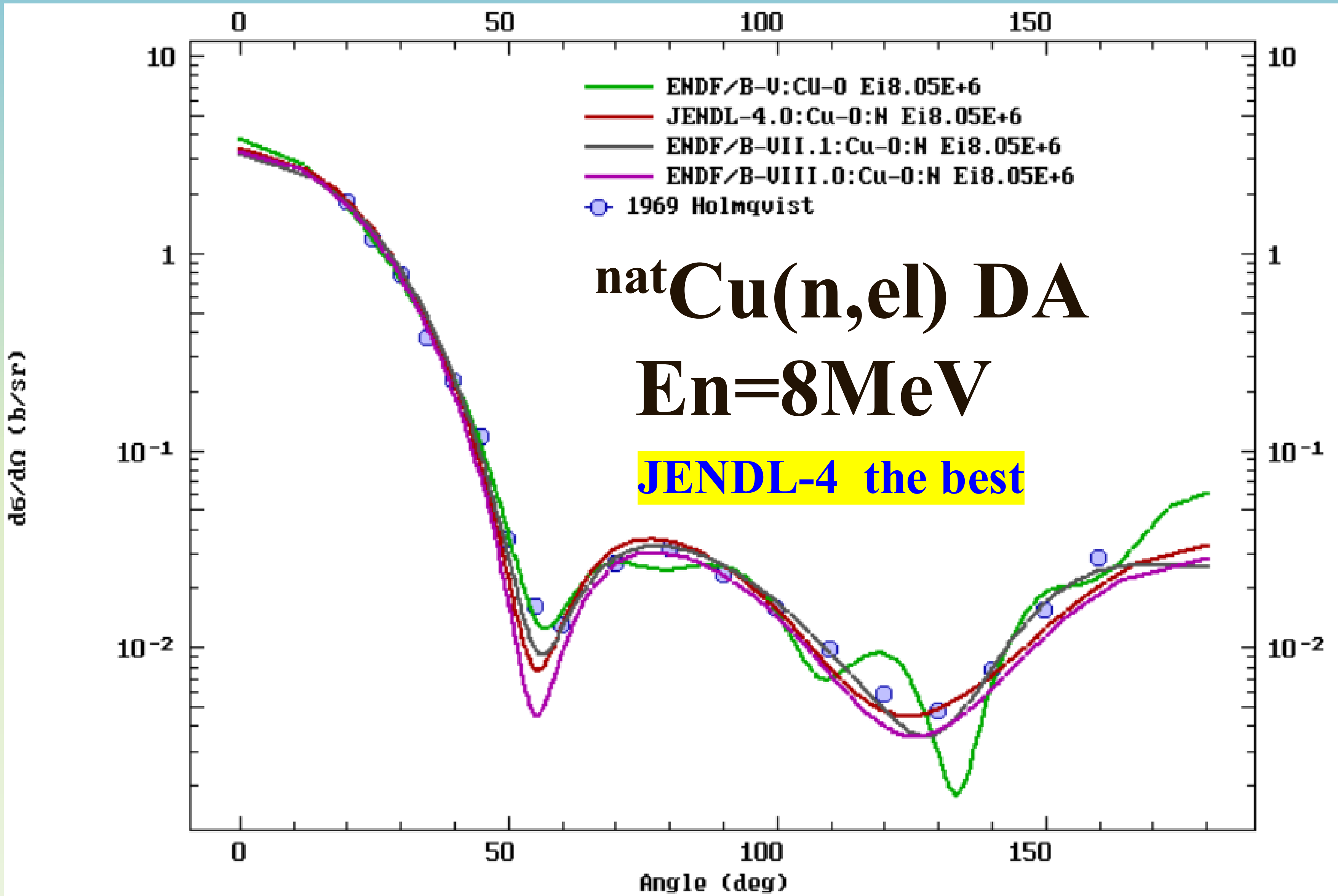

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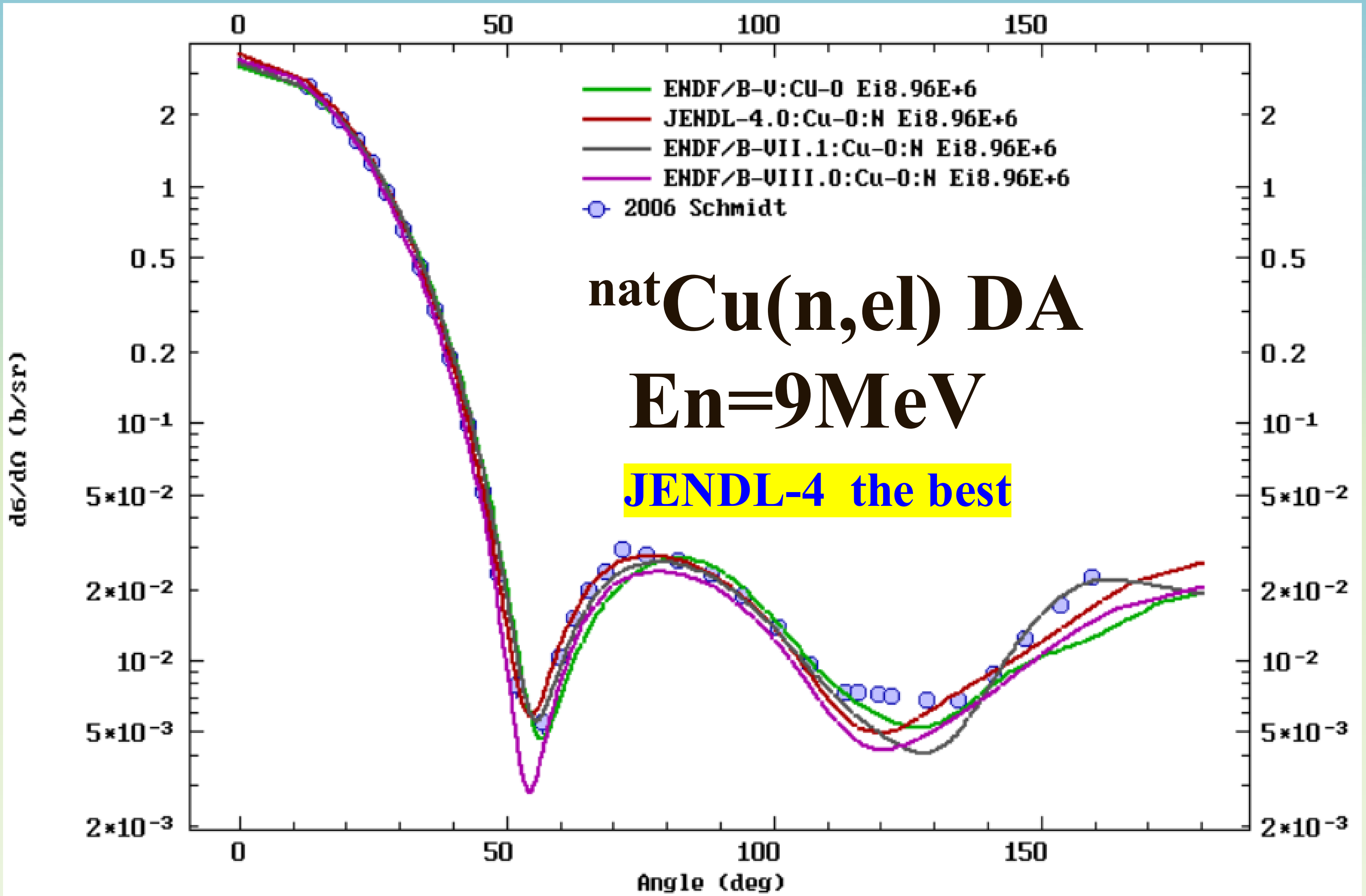

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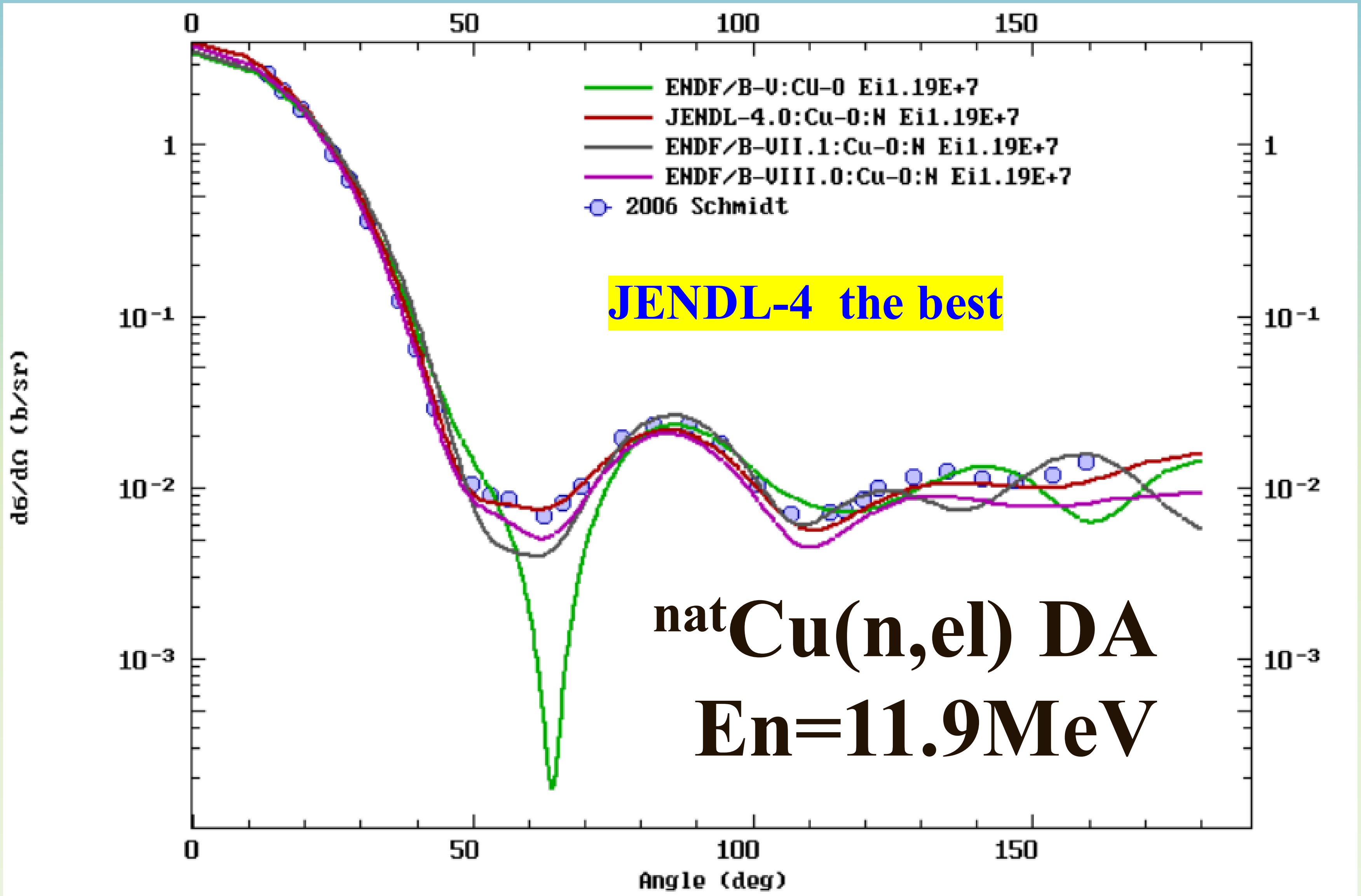

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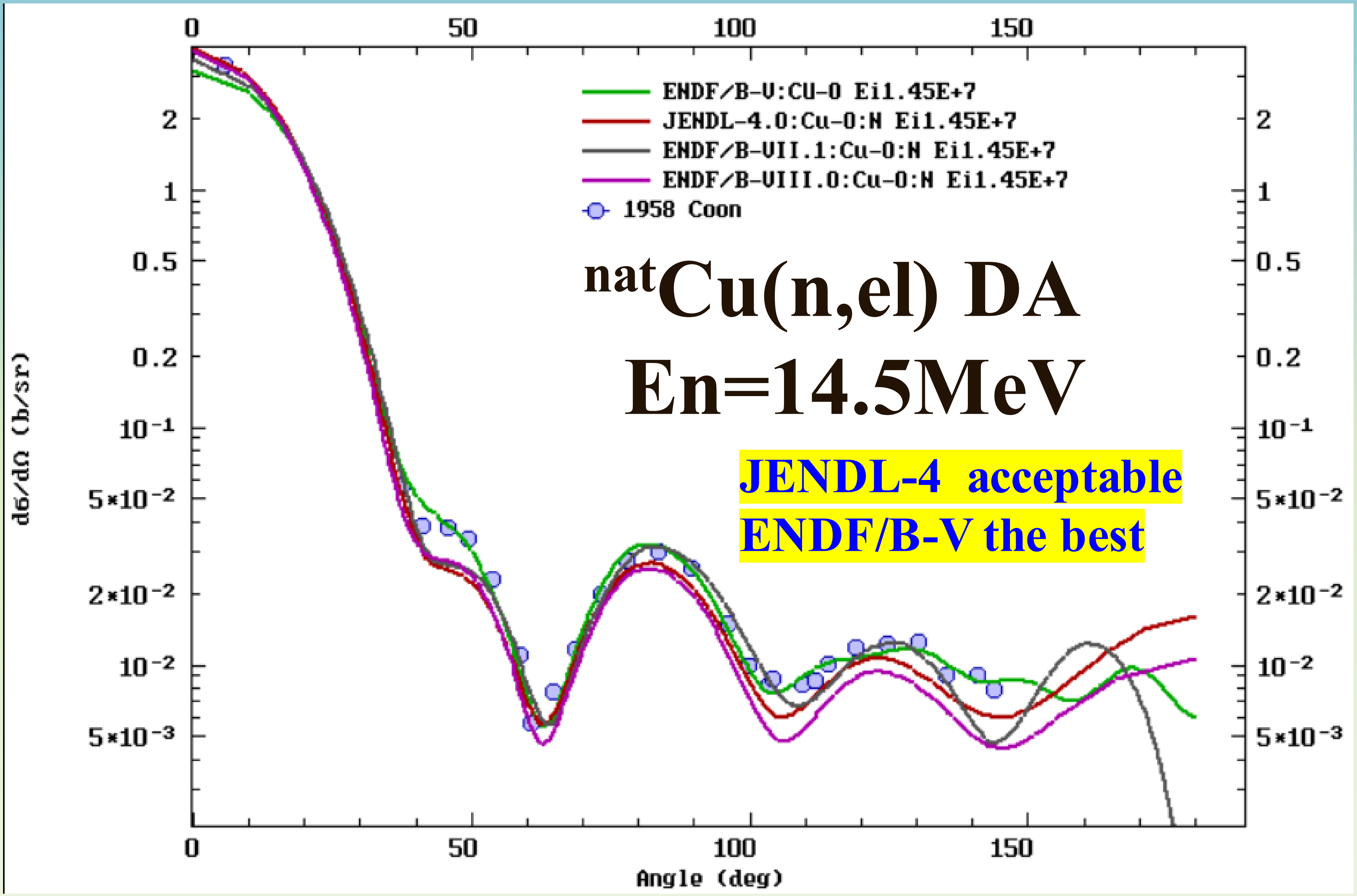

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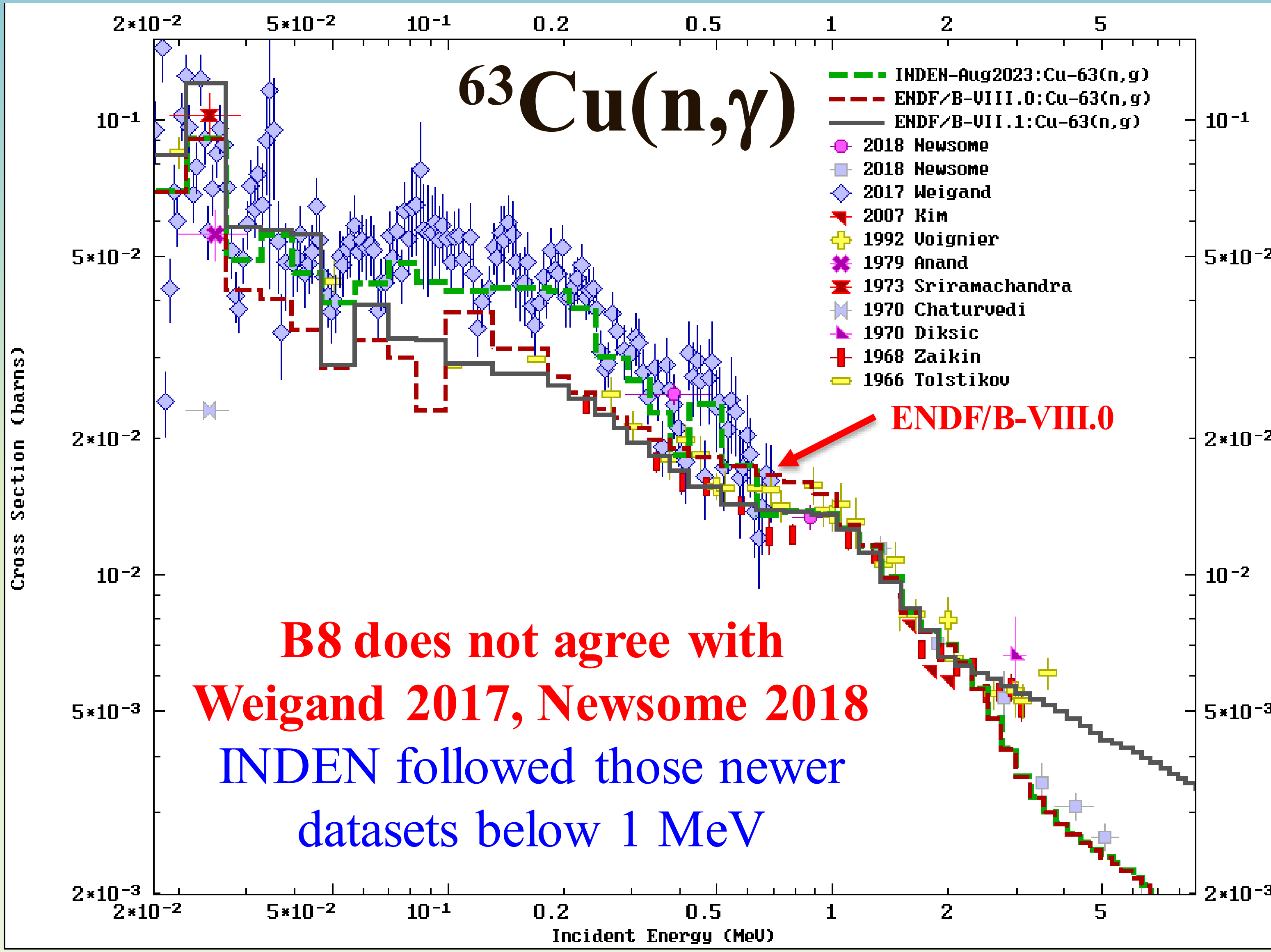
Capture on Cu-63: New exp. data



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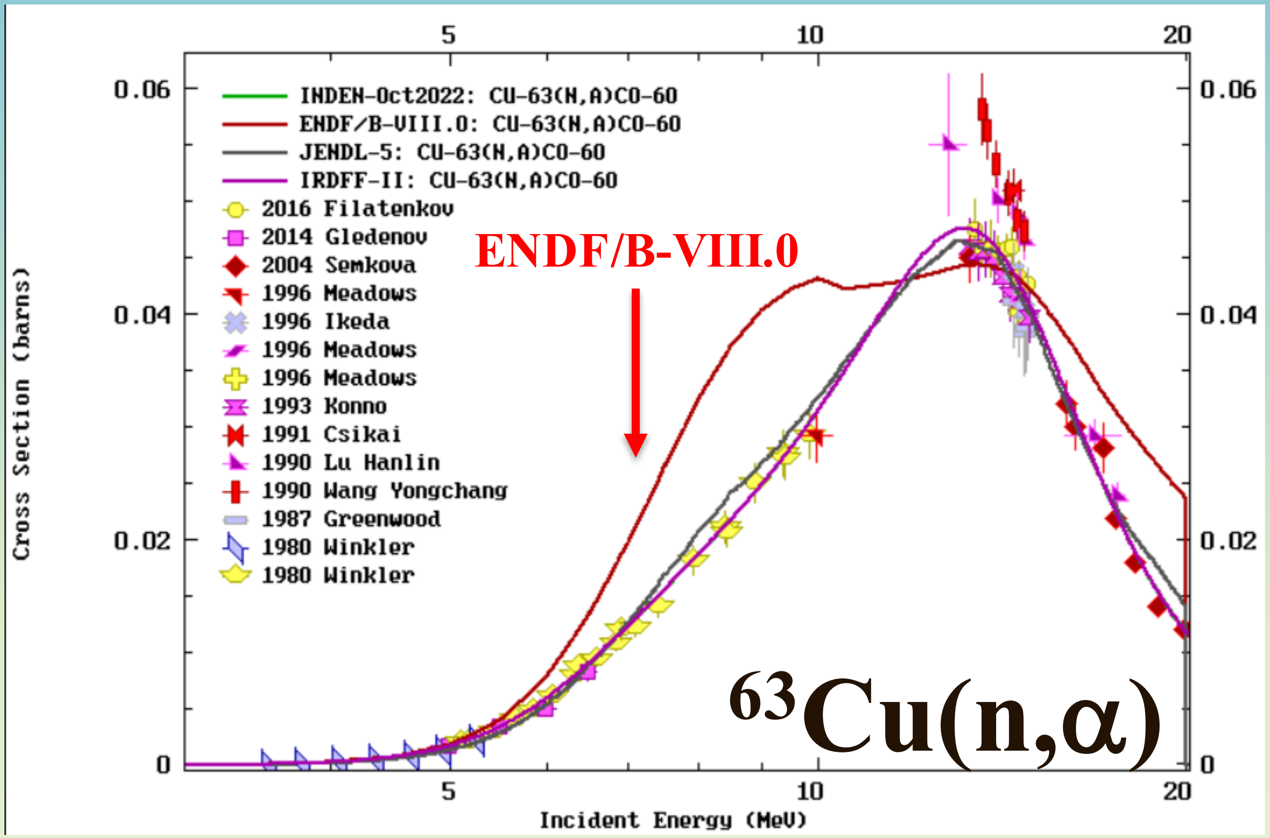
Alpha emission from Cu-63: IRDFF-II



B8 disagrees with (n,α) – probably a model calc.

INDEN adopted the IRDFF-II evaluation (GLSQ fit)

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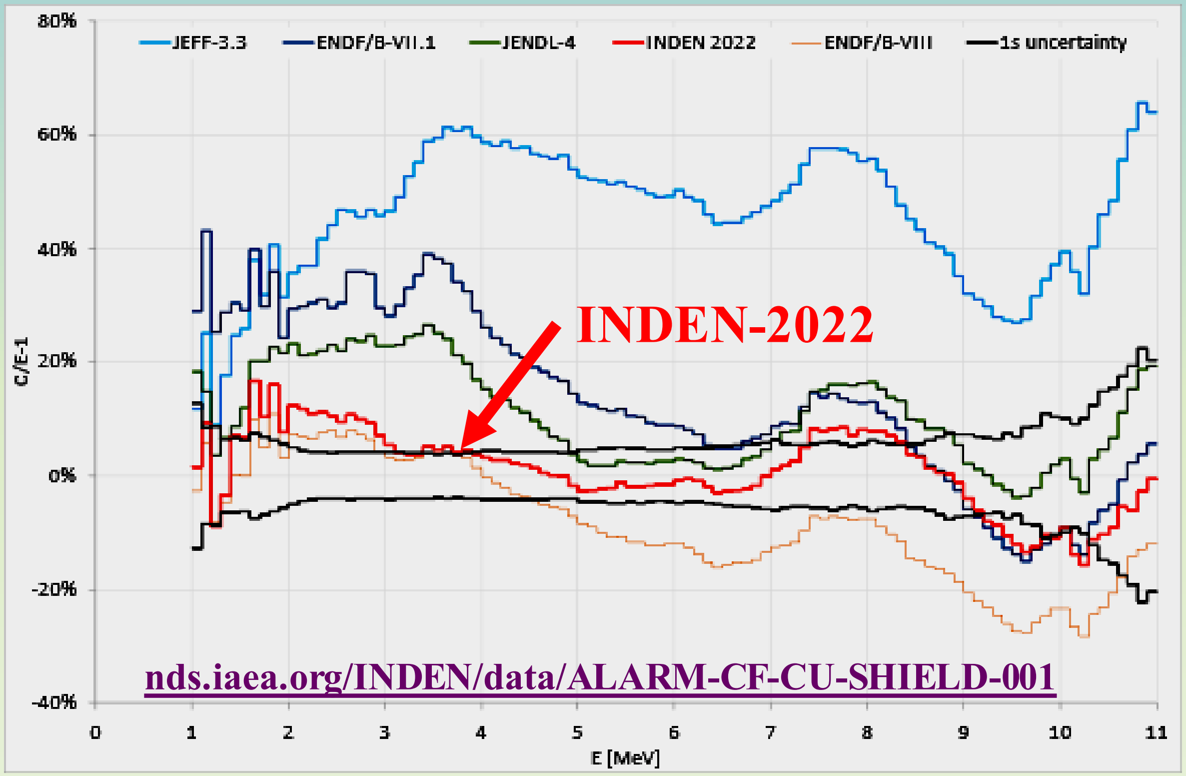
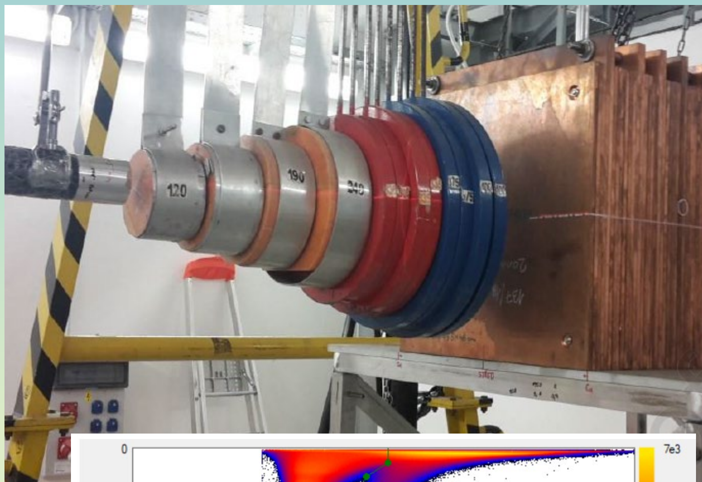
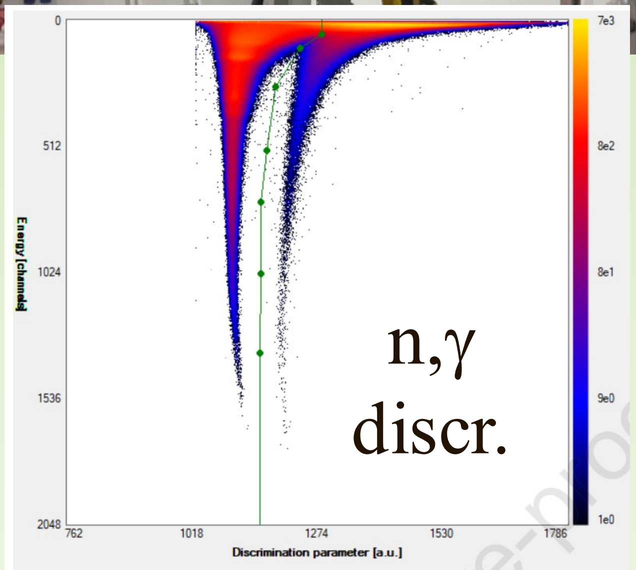
INDEN updated "structural" evaluations: see nds.iaea.org/INDEN/ - Validation

- ✓ Cu isotopes, ORNL/IAEA/JSI (in progress)







Cu cube, neutron leakage (Rez, CZ)
Schulc et al, Rad.Phys.Chem. 2021

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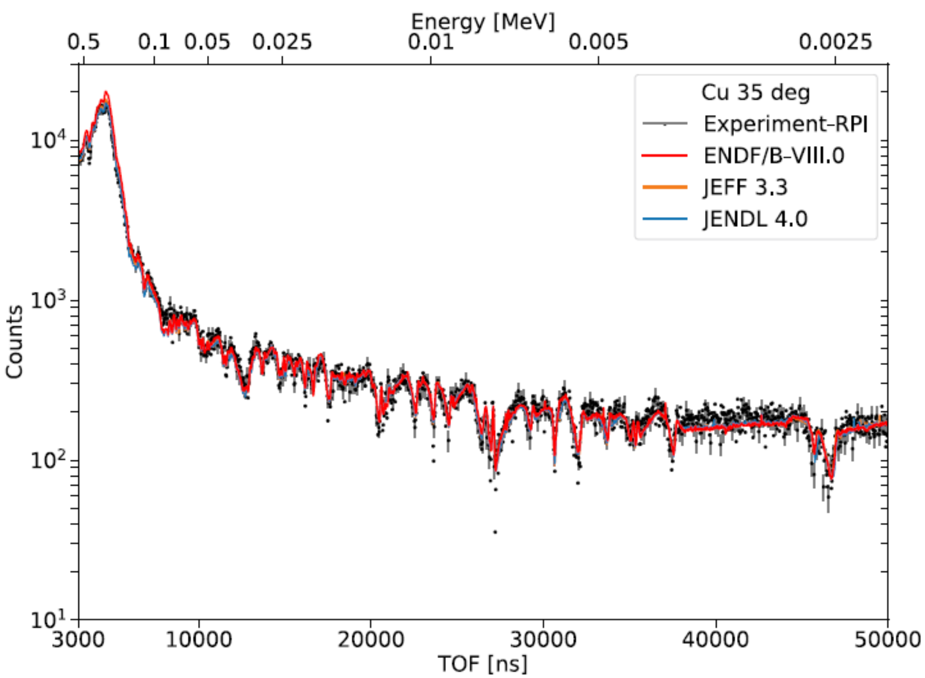

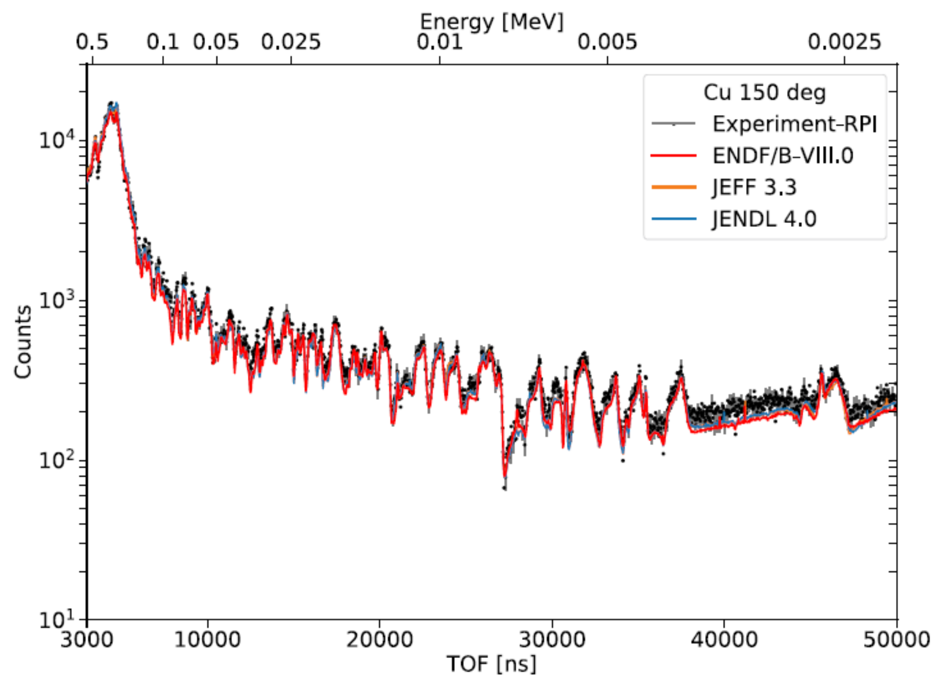

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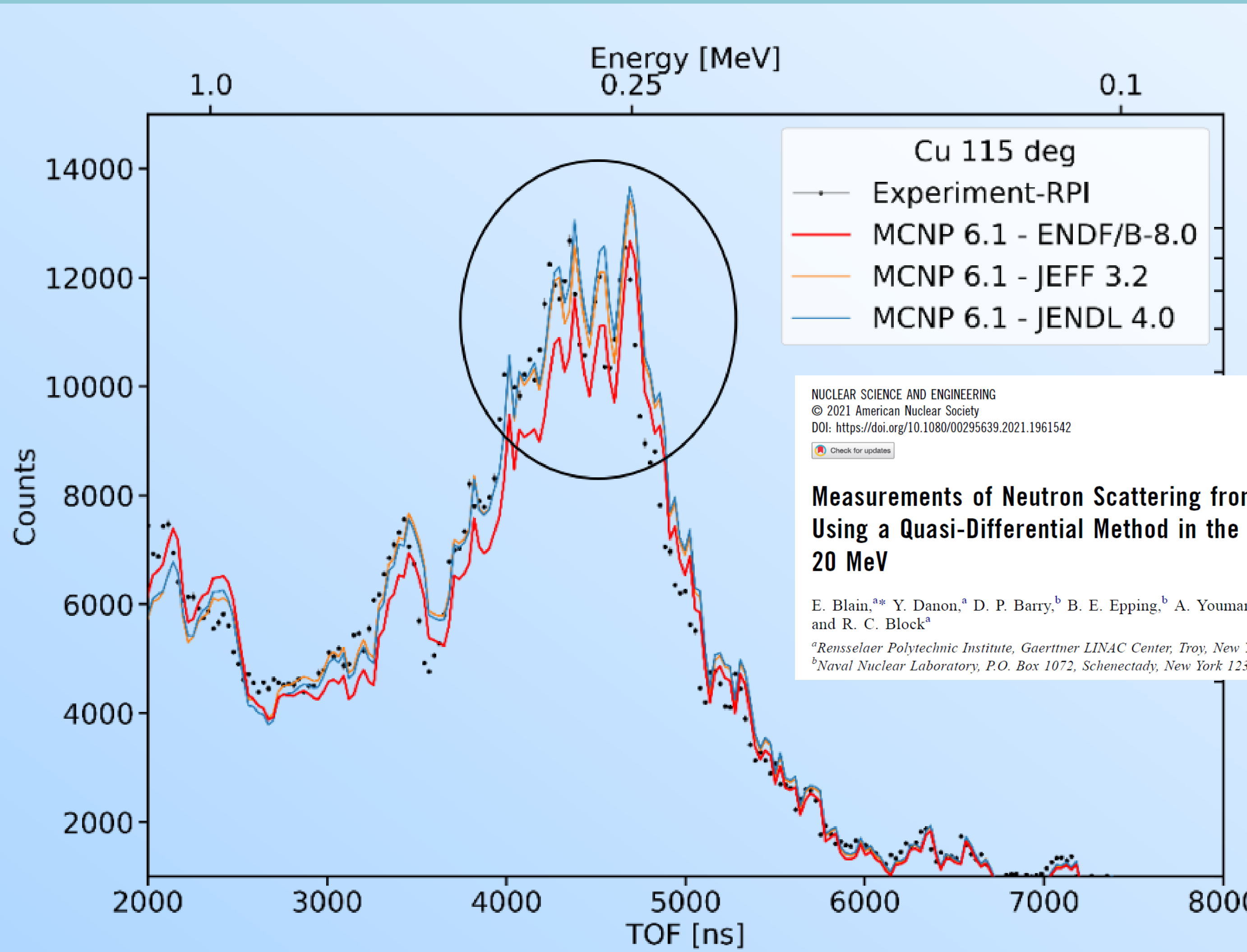

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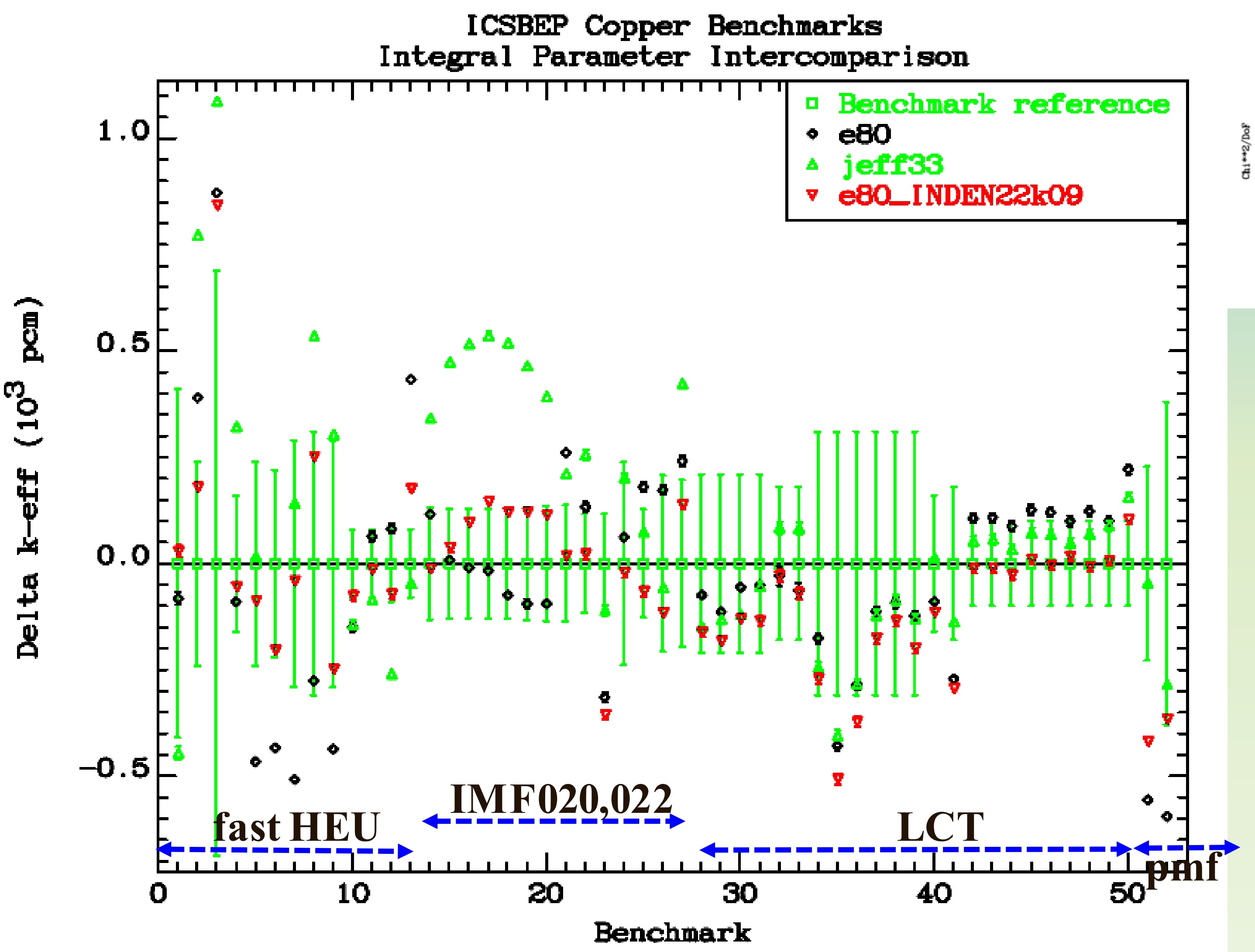
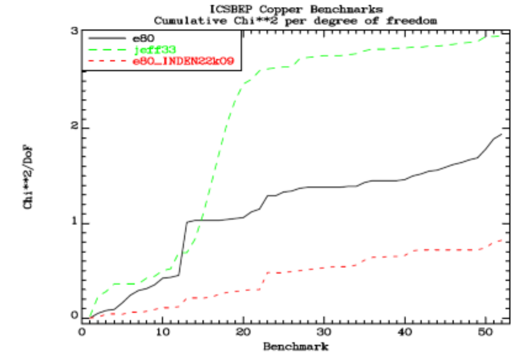
Y. Danon, presented at INDEN-SM meeting, 2022

INDEN Cu evaluation: crit. benchmarks





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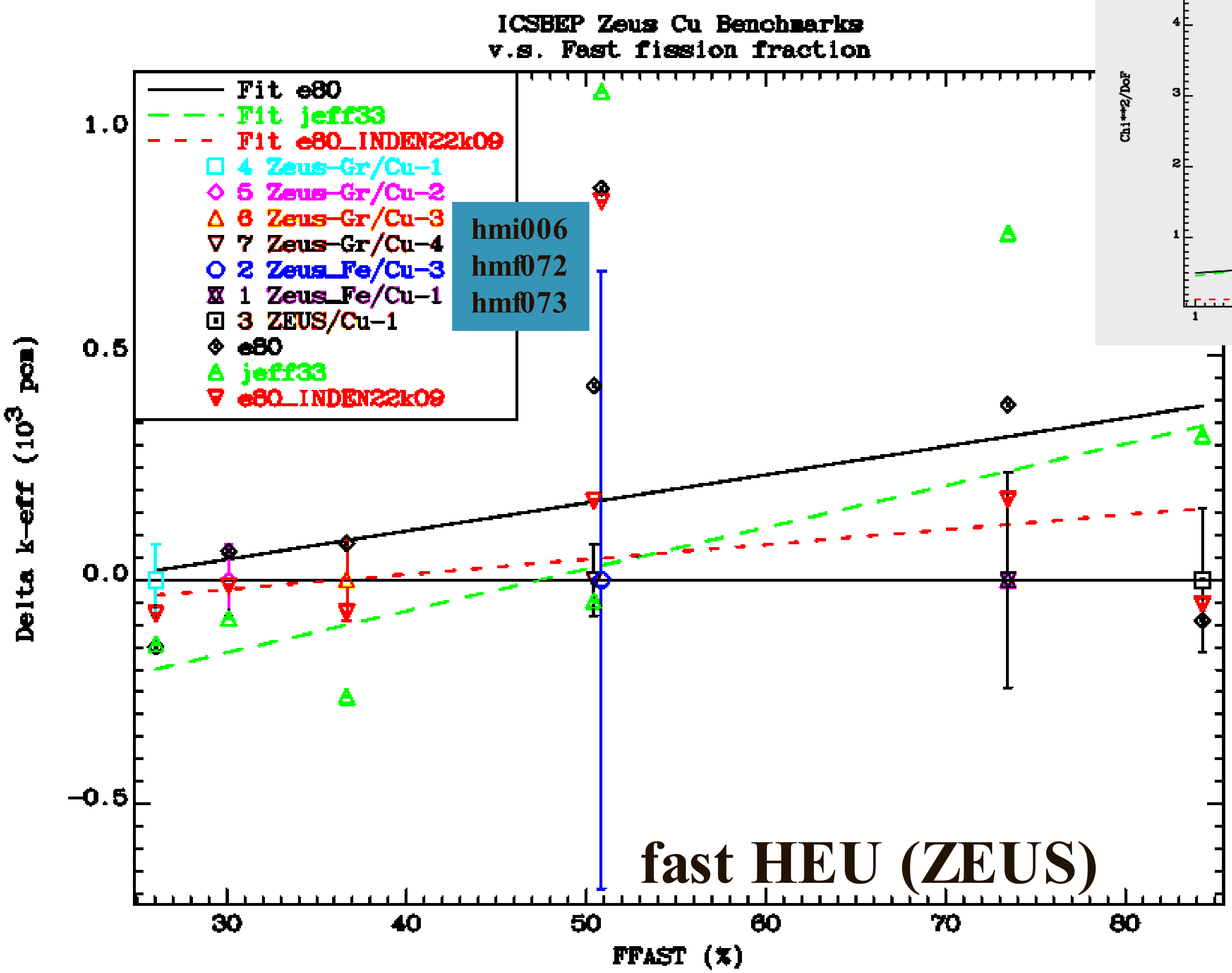
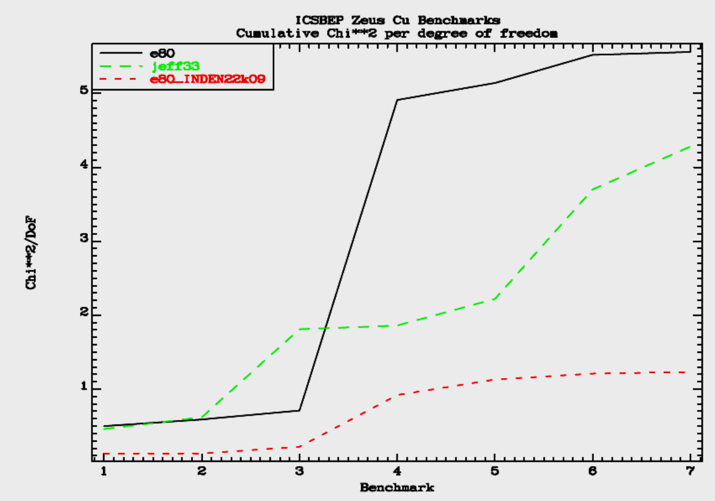
INDEN Cu evaluation: Zeus benchmarks





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Conclusions - Cu

- ✓ INDEN file that combines ENDF/B-VIII.0 evaluation below 4 MeV and JENDL-4 evaluation above performs well both in shielding and criticality experiments.
- ✓ ^{nat}Cu(nel) angular distributions reviewed vs existing experimental data from 600 keV up to 15 MeV:
  - ENDF/B-V evaluation fitted to data and shows an excellent agreement below 4 MeV
  - JENDL-4 shows good agreement above 4 MeV, but overestimates the data below 4 MeV (this probably explains the overestimation of leakage in the Rez benchmark)
  - Popov data should be used below 300 keV

Actions:

- ➢ Replace angular distributions in the INDEN file by ENDF/B-V (equal to Cu-63,65) below 4 MeV
- ➢ Improve total below 4 MeV, spectra and DDXS above 5 MeV (adopt from JENDL)
- ➢ Check impact on RPI quasi-differential benchmark

Expectations:

- ➢ New evaluation in the fast neutron region desirable.
- ➢ Important to preserve/improve the achieved criticality performance of ENDF/B-VIII.0 (JENDL-4)
- ➢ Important to achieve good fusion performance
- ➢ JENDL has a good balance, can we improve it?

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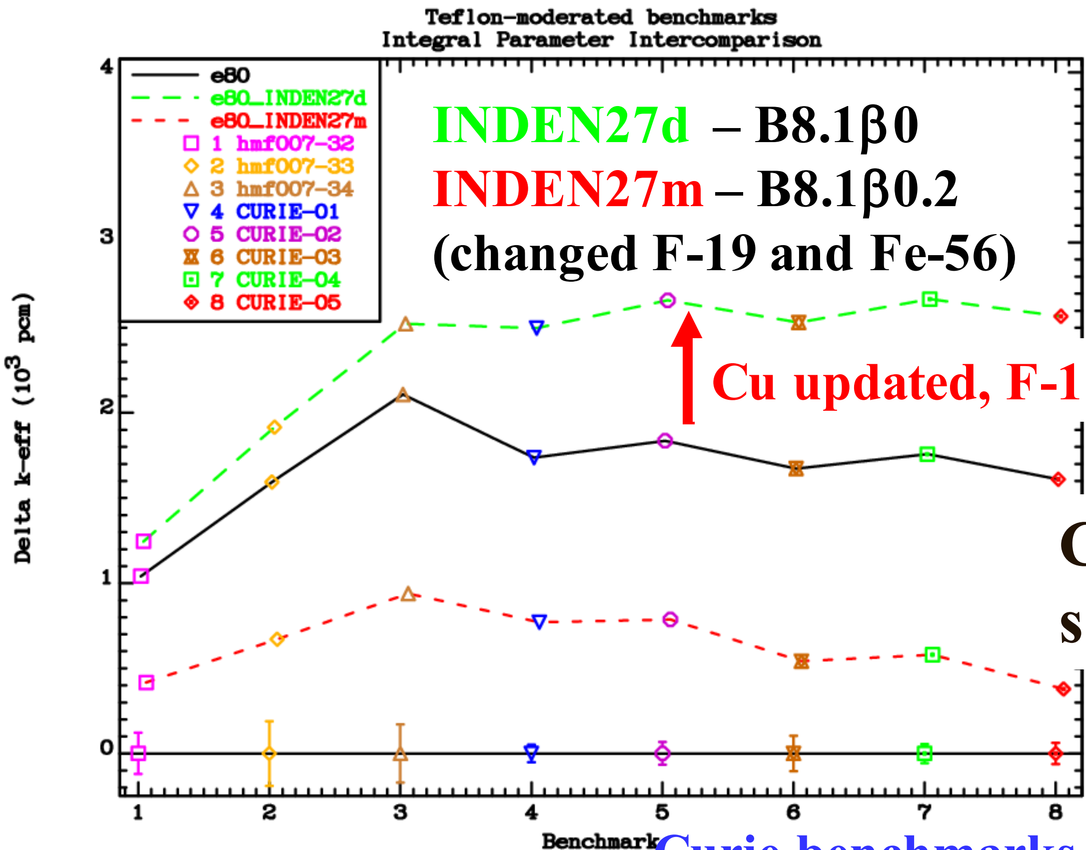
^{19}F: Teflon moderated Curie benchmarks



INDEN27d – B8.1β0
INDEN27m – B8.1β0.2
(changed F-19 and Fe-56)

Cu updated, F-19 = B8

Curie benchmarks

Curie benchmarks highly sensitive to Cu and F-19 !!

Integral data hints at F-19 data problems

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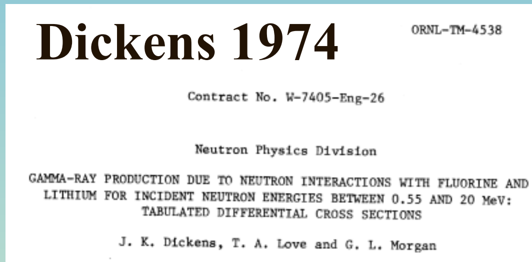
^{19}F: EXFOR retrieval and data selection


Dickens 1974

ORNL-TM-4538

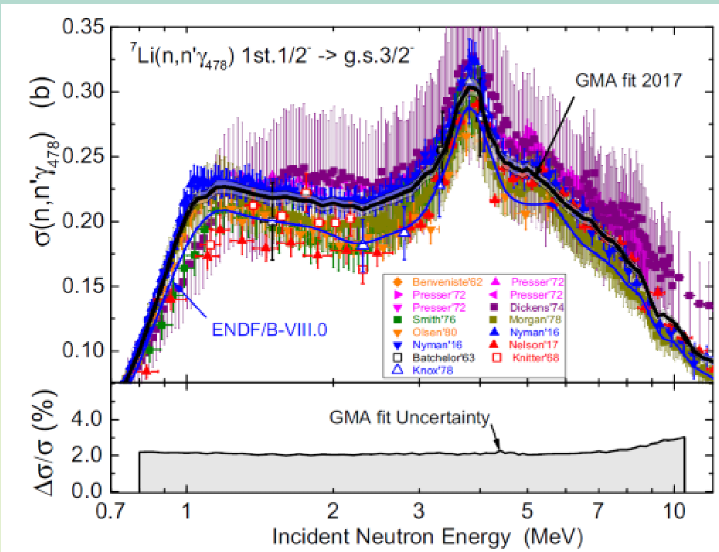
Contract No. W-7405-Eng-26

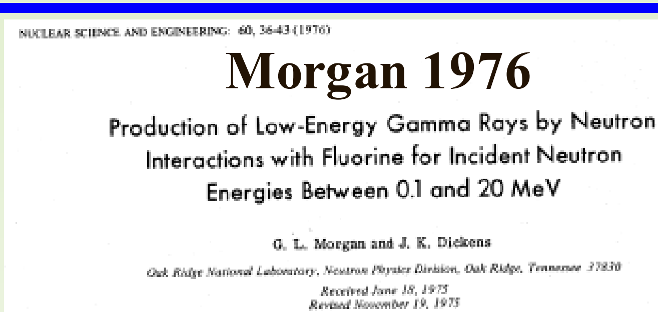
Neutron Physics Division

GAMMA-RAY PRODUCTION DUE TO NEUTRON INTERACTIONS WITH FLUORINE AND LITHIUM FOR INCIDENT NEUTRON ENERGIES BETWEEN 0.55 AND 20 MeV: TABULATED DIFFERENTIAL CROSS SECTIONS

J. K. Dickens, T. A. Love and G. L. Morgan

^{19}F(n,ng)
^{7}Li(n,ng)




NUCLEAR SCIENCE AND ENGINEERING: 60, 36-43 (1976)

Morgan 1976

Production of Low-Energy Gamma Rays by Neutron Interactions with Fluorine for Incident Neutron Energies Between 0.1 and 20 MeV

G. L. Morgan and J. K. Dickens

Oak Ridge National Laboratory, Neutron Physics Division, Oak Ridge, Tennessee 37830

Received June 18, 1975
Revised November 19, 1975

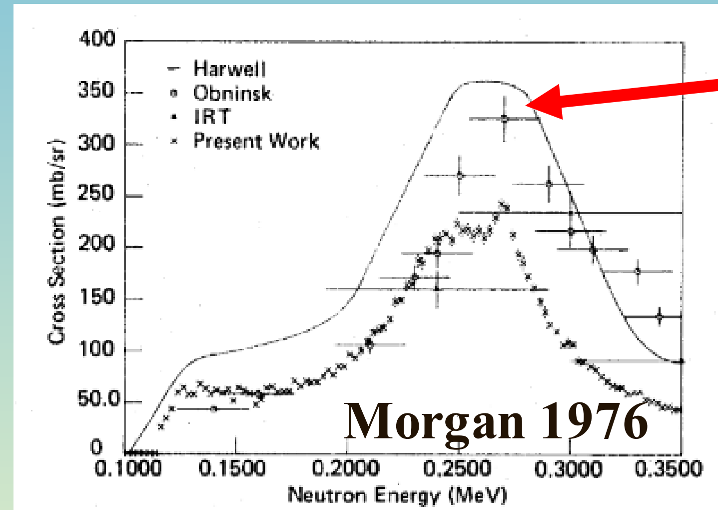


Fig. 4. Differential cross section at 92 deg for the production of the 110-keV gamma ray for E_n between 0.1 and 0.35 MeV. Shown for comparison are the data from Refs. 1, 8, and 10.

Broder
REF Fe !

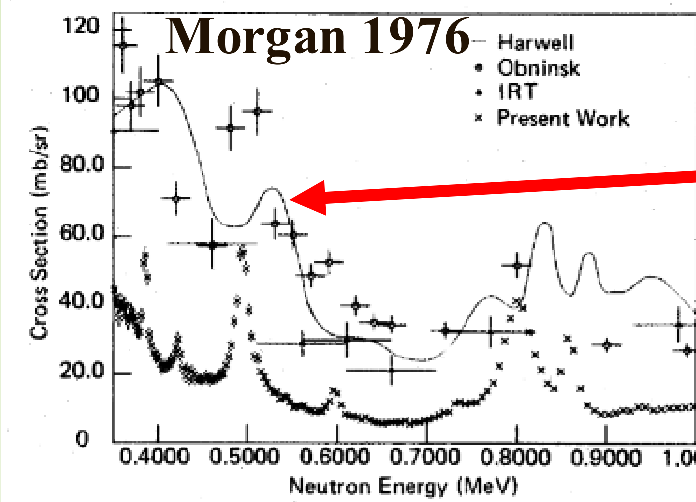


Fig. 5. Differential cross section at 92 deg for the production of the 110-keV gamma ray for E_n between 0.35 and 1.0 MeV.

Broder
REF Fe !

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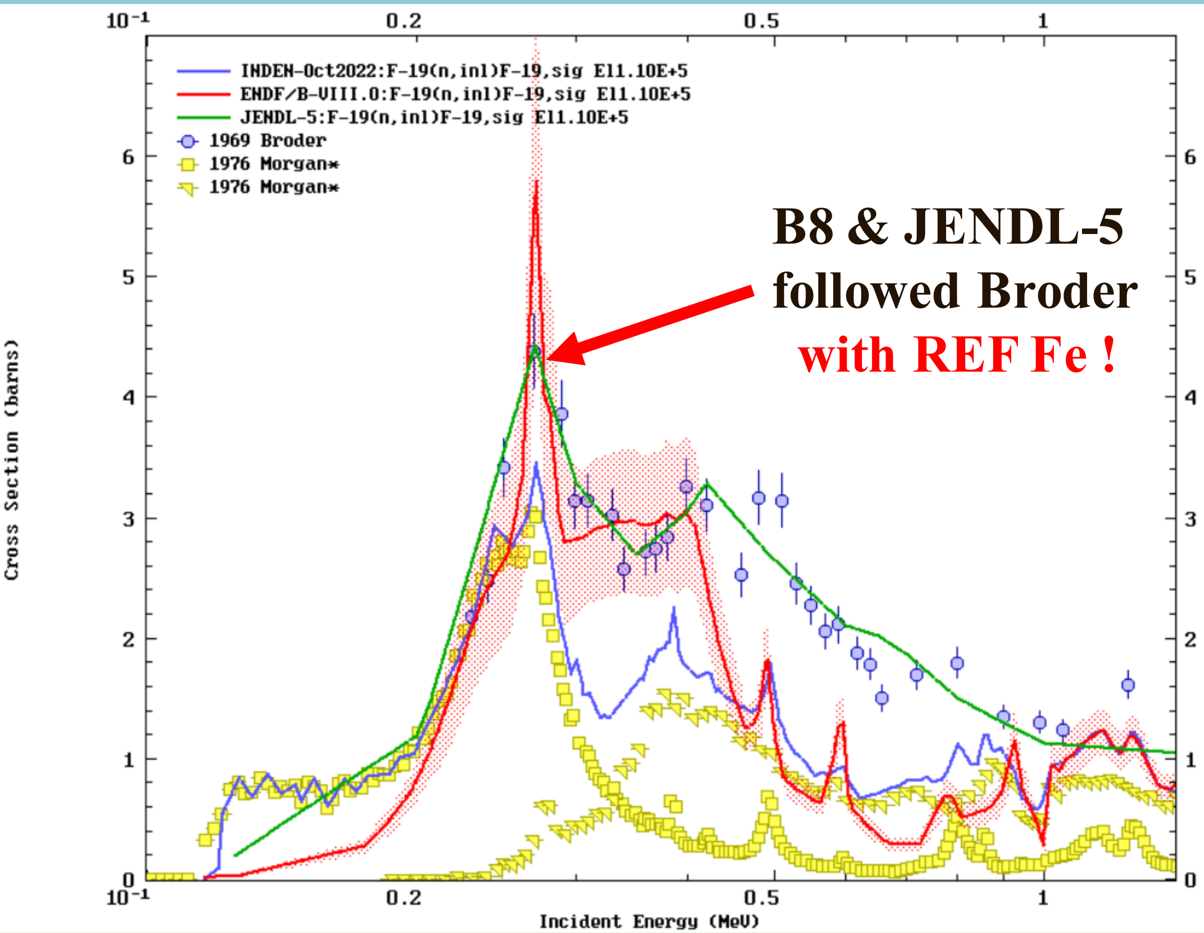
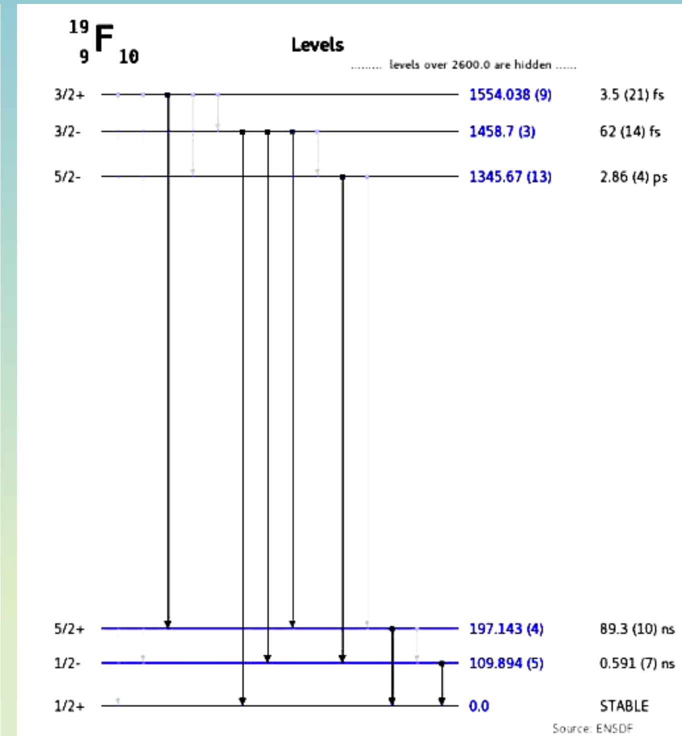
Morgan 76 data adopted << Broder data





By using Morgan derived INL data (nng x 4pi)
F-19(n,inl) reduced by ~40% from 300 keV

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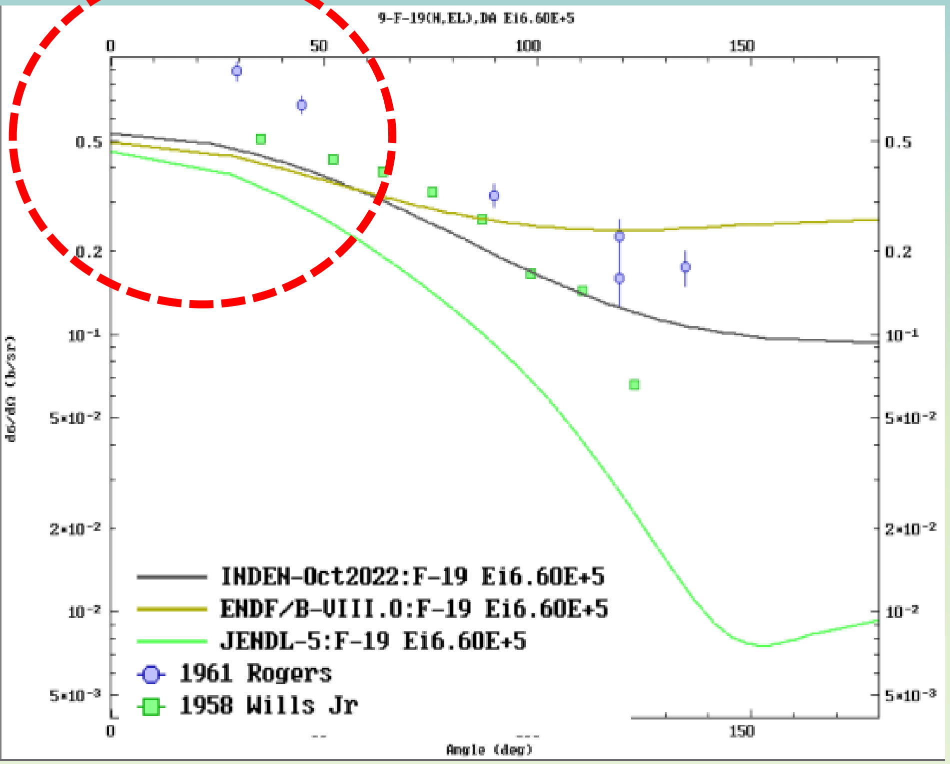
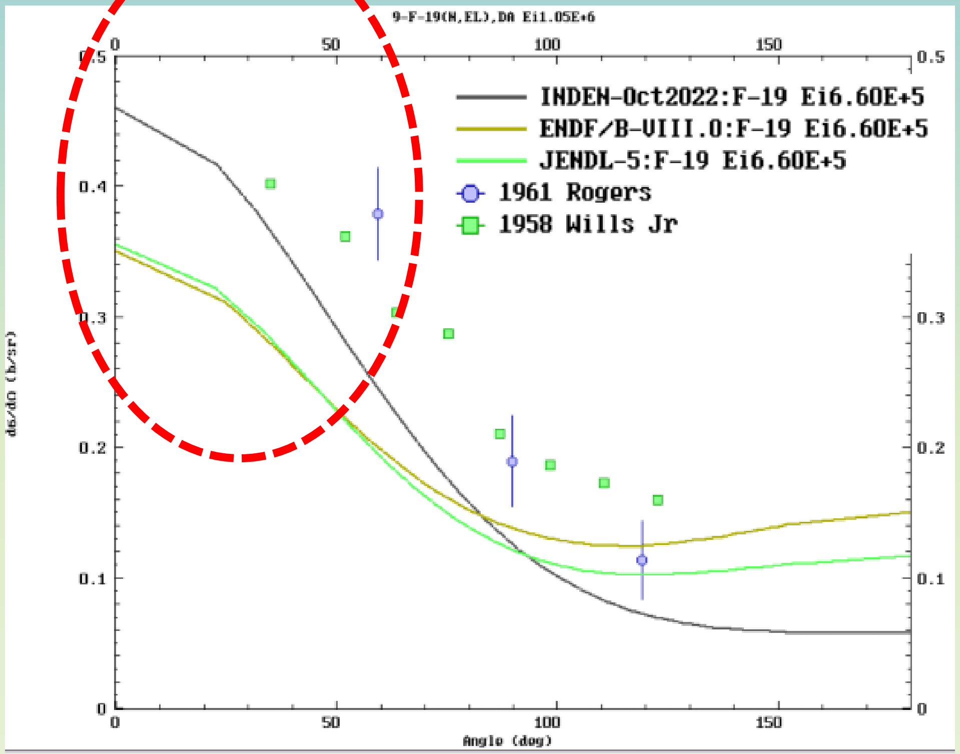
Issues in ^{19}F(n,el) AD below 1 MeV at forward angles





Issues in ^{19}F(n,el) AD below 1 MeV pointed out by our Japanese colleagues

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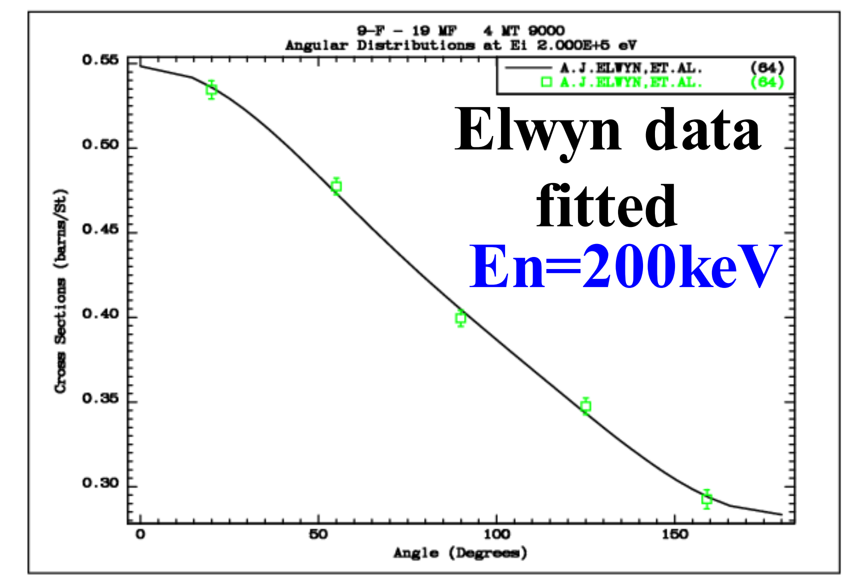
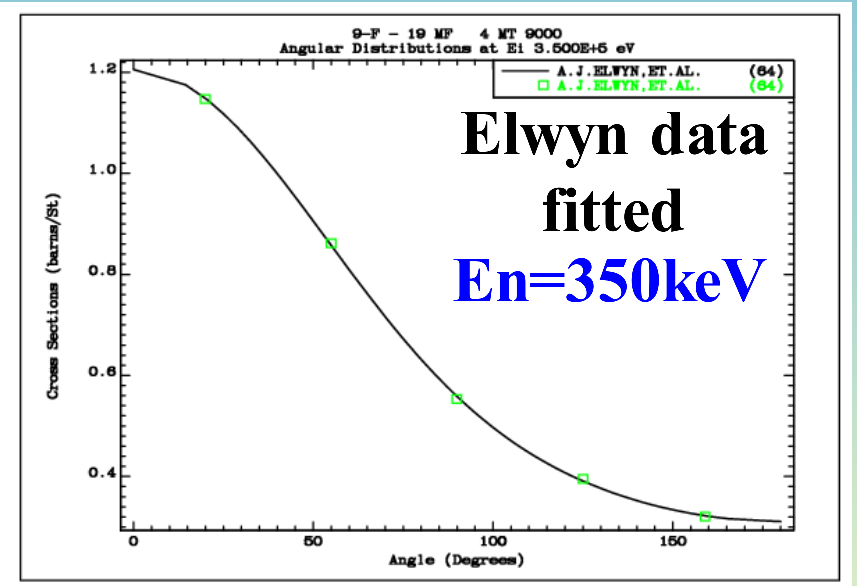
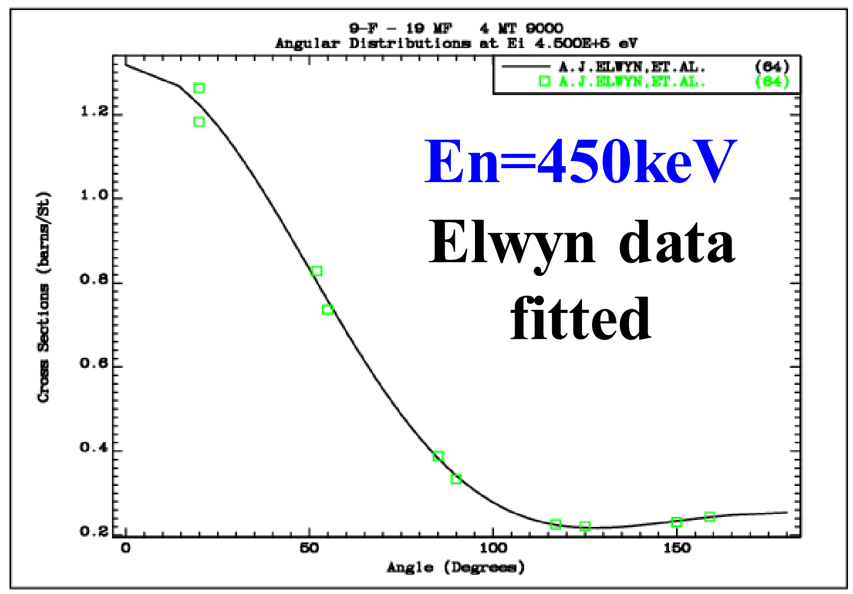
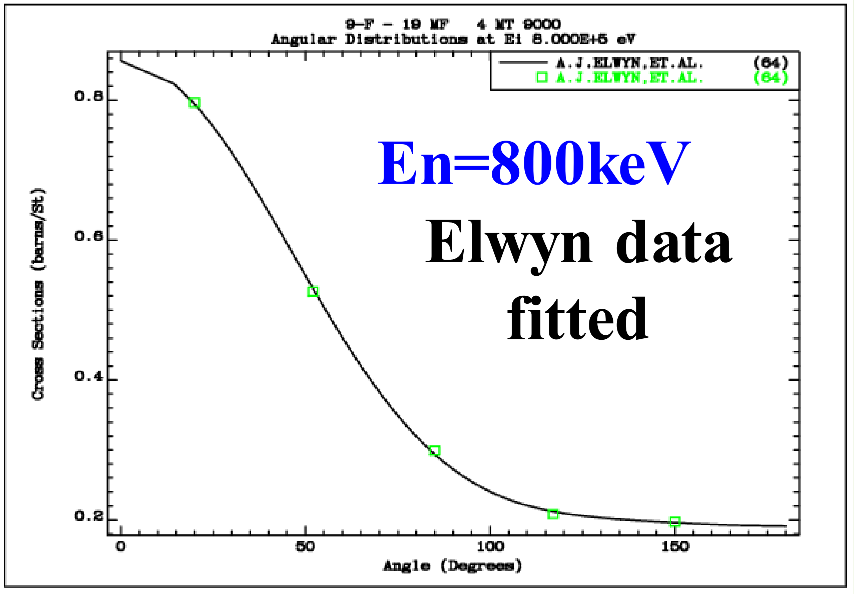
INDEN F-19 evaluation (f19e80_zt9)









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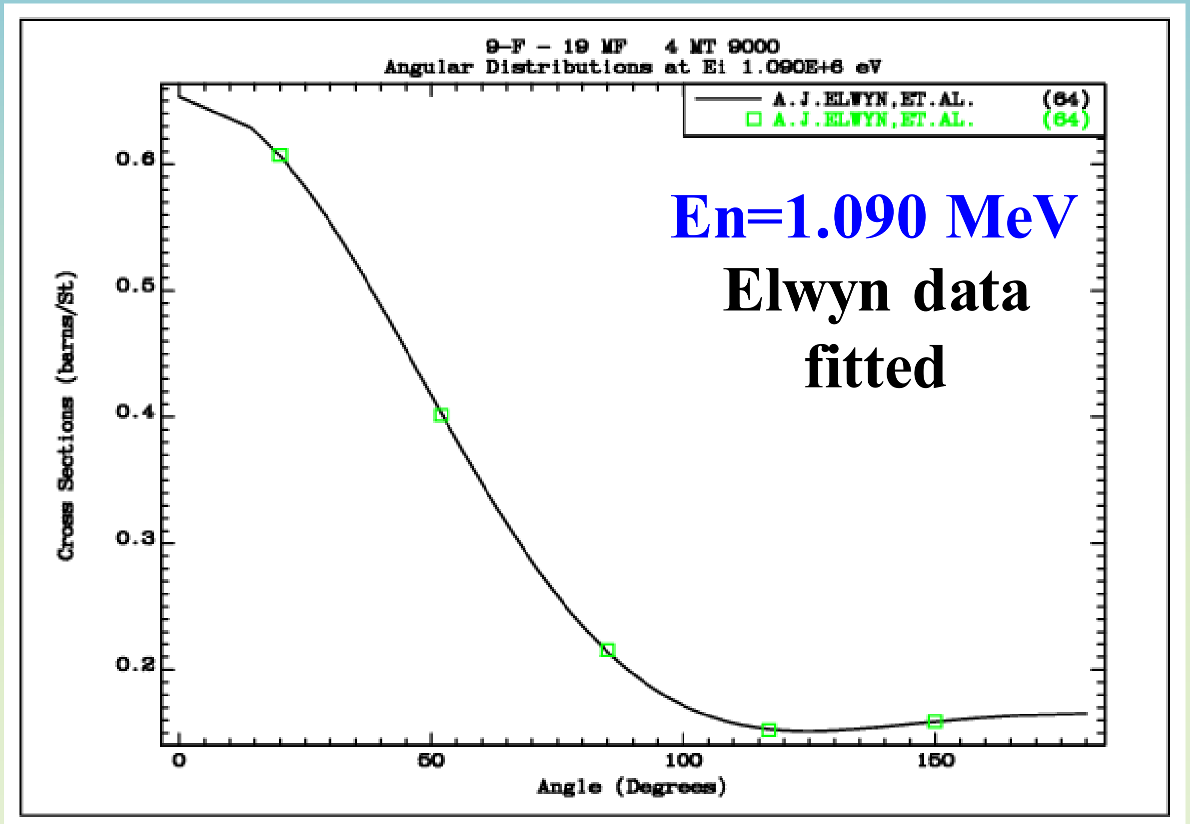
INDEN F-19 evaluation (f19e80_zt9)



Check updated INDEN F-19 evaluation

f19e80_zt9 vs f19j50_zq

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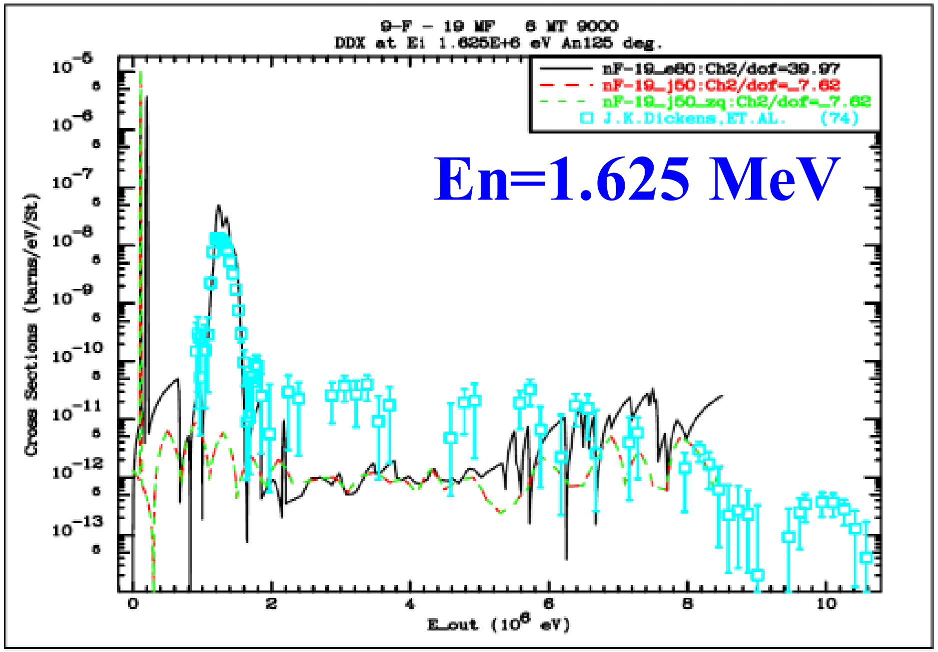
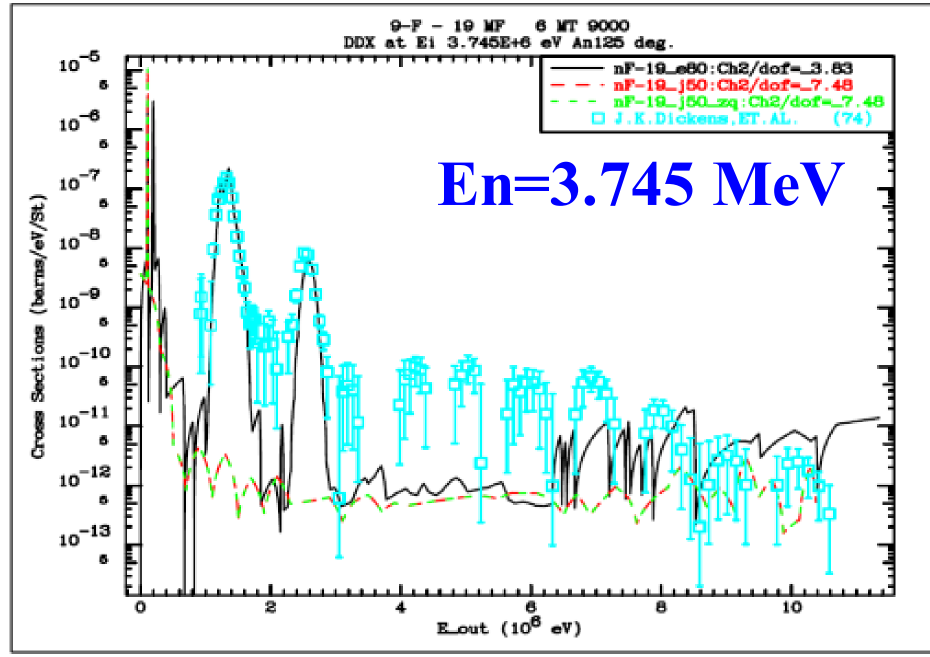
INDEN F-19 evaluation (f19e80_zt9)





Improved gamma emission in updated INDEN F-19 evaluation

f19e80_zt9

(vs f19j50_zq)

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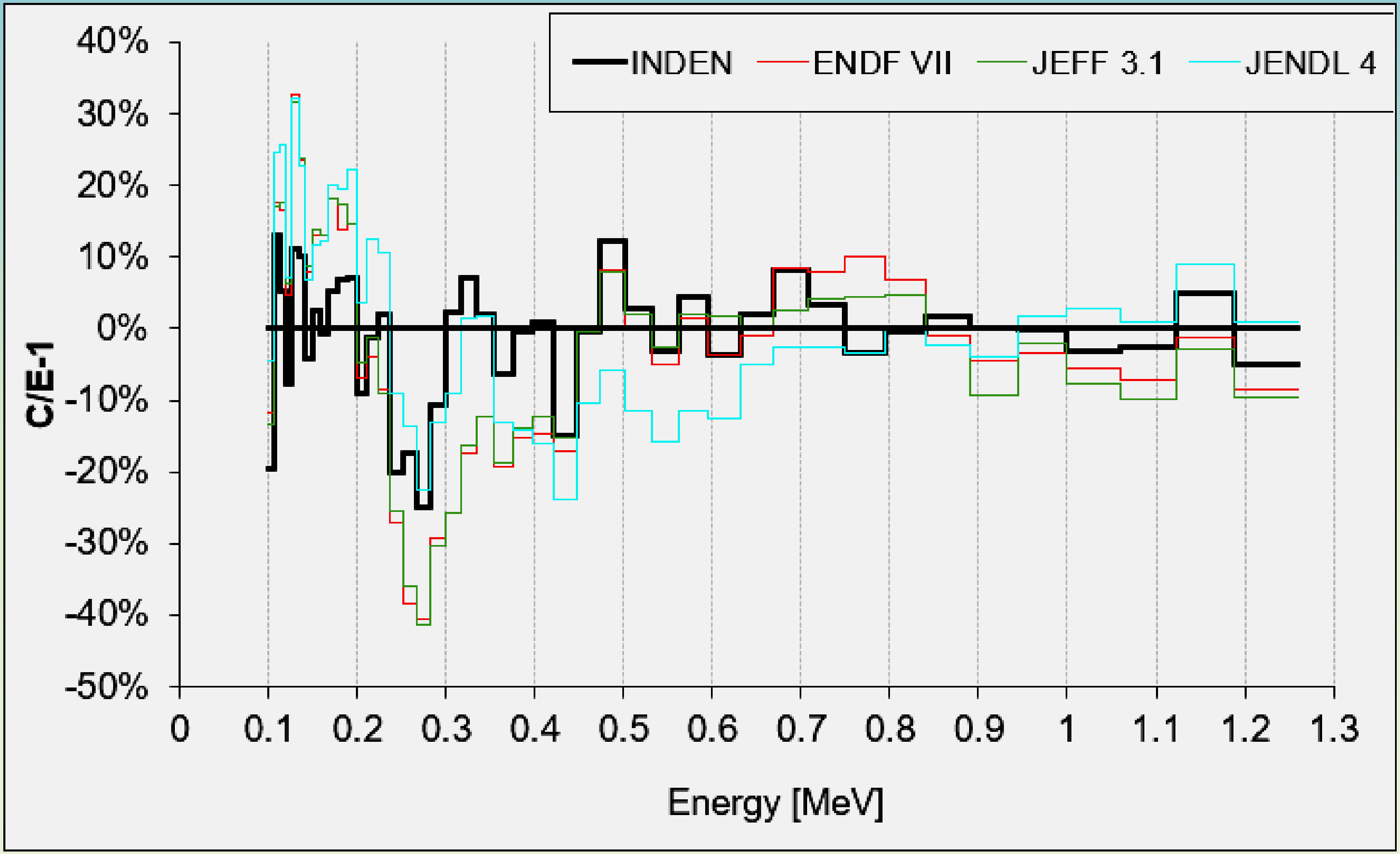
^{19}F: FLINA 2015 Rez experiment (HFD)



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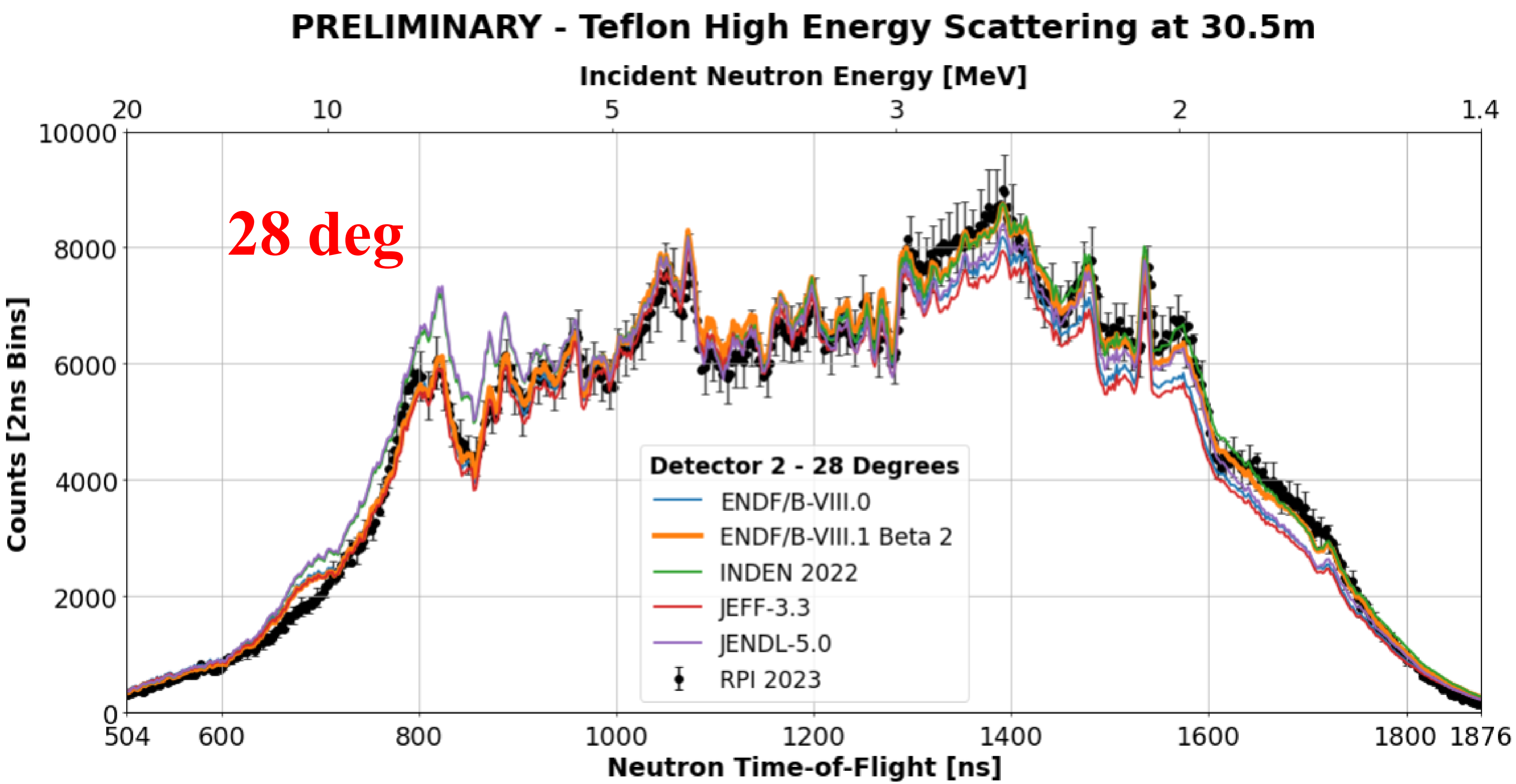
RPI quasi-diff. test on Teflon



G. Siemers et al, presented at WINS-2023, October 2023, RPI

30.10.-2.11.2023

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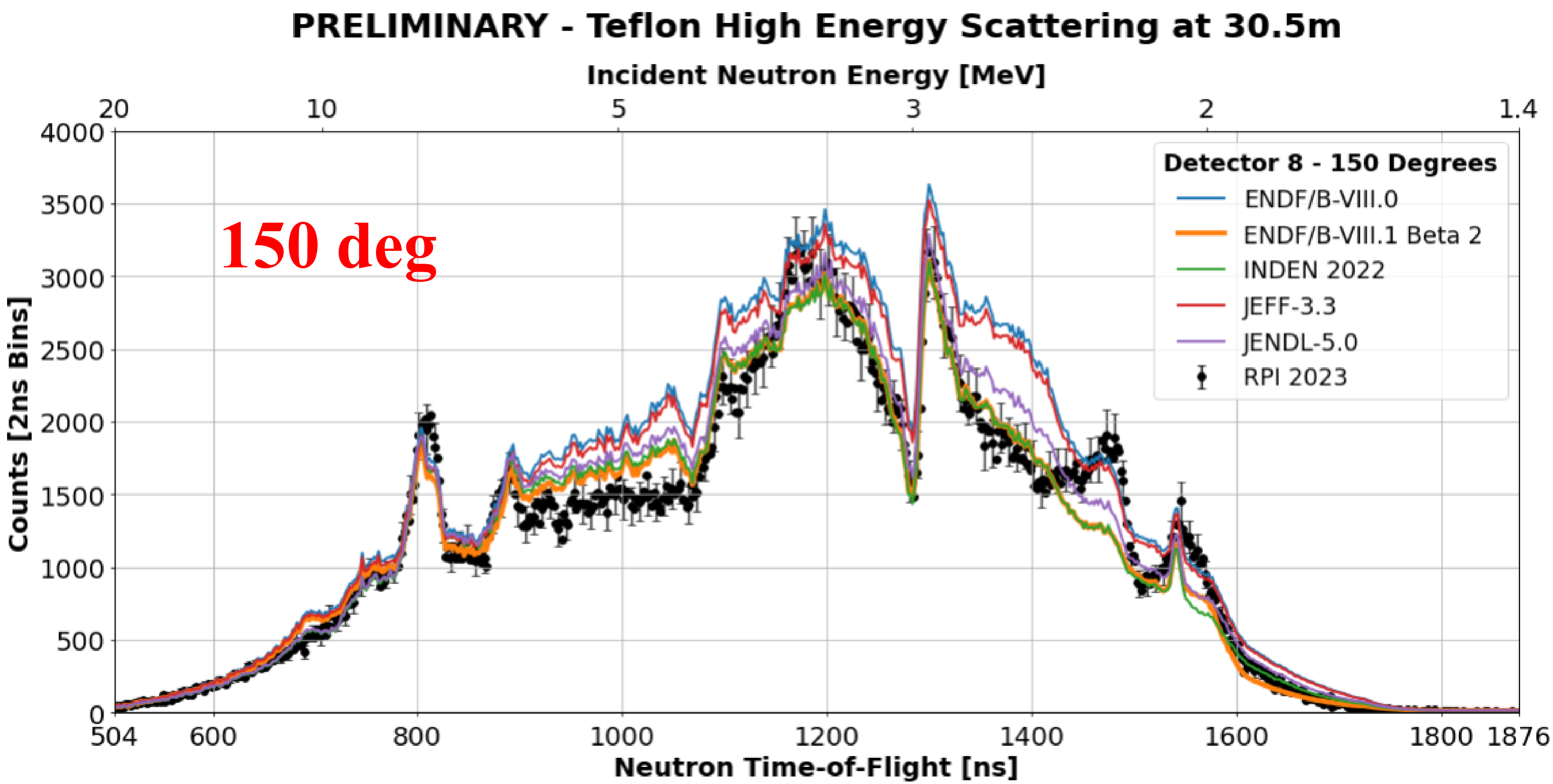

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30.10.-
2.11.2023

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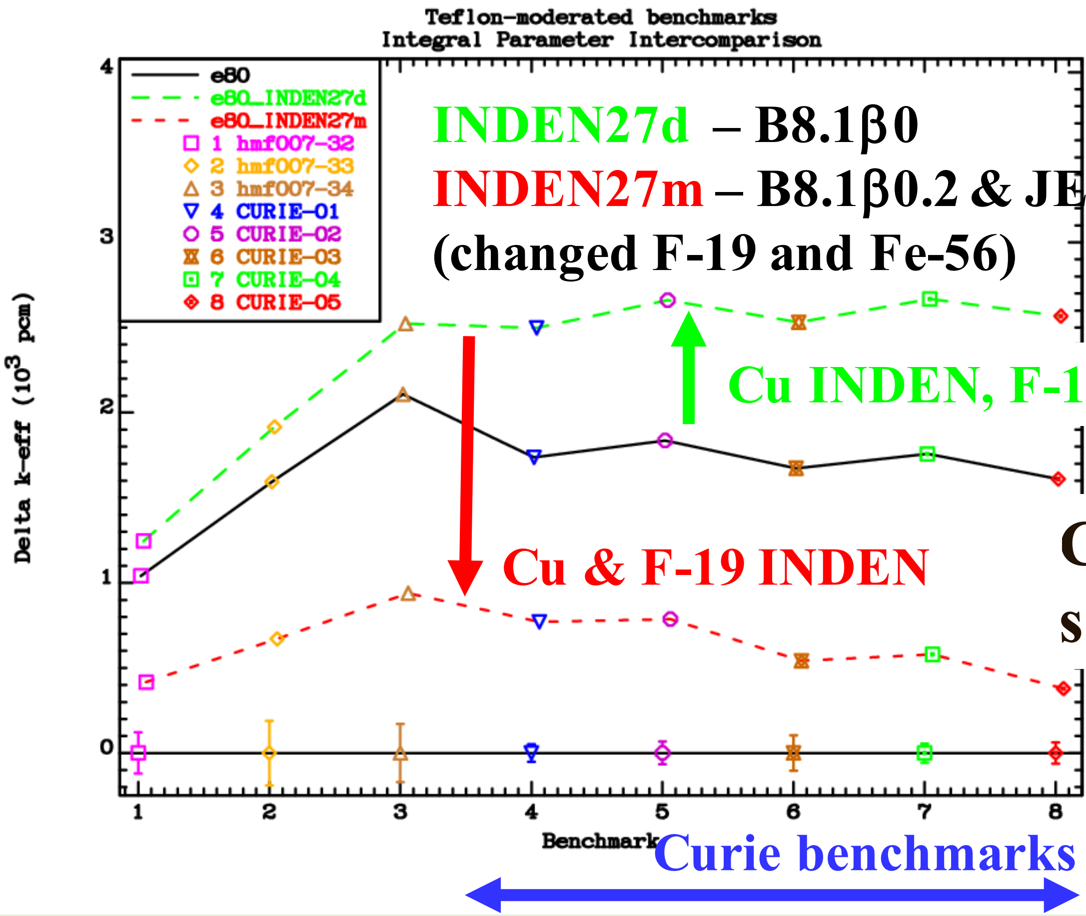
^{19}F: Teflon moderated Curie benchmarks



Curie benchmarks highly sensitive to Cu and F-19 !!

Curie is in the latest ICBESP

See also LCT033 (UF4 with paraffin) performance shown by S. Vandermarck

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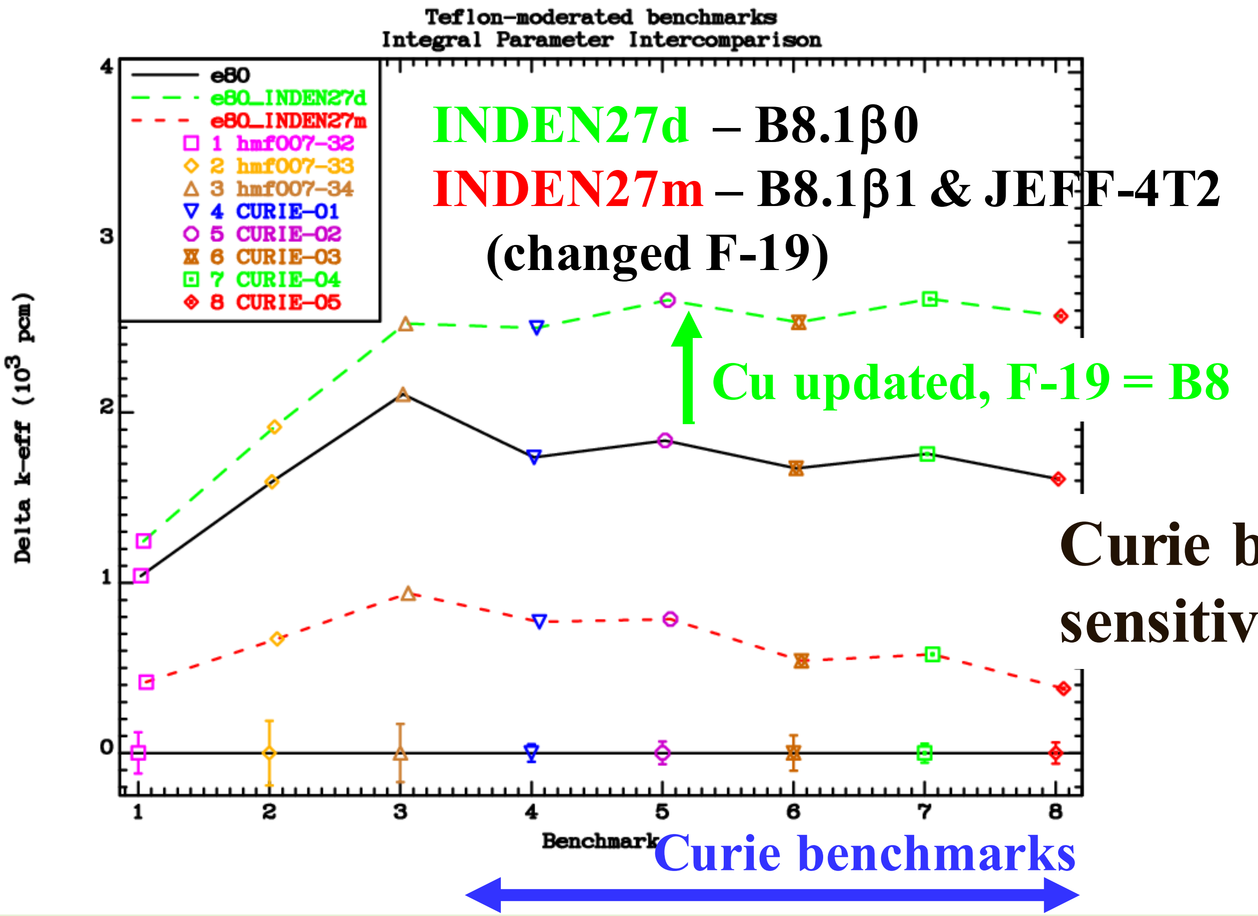
^{19}F: Teflon moderated Curie benchmarks



Curie benchmarks highly sensitive to Cu and F-19 !!

Check also HST039 !

Curie is in the latest ICBESP

See also LCT033 (UF4 with paraffin) performance shown by S. Vandermarck

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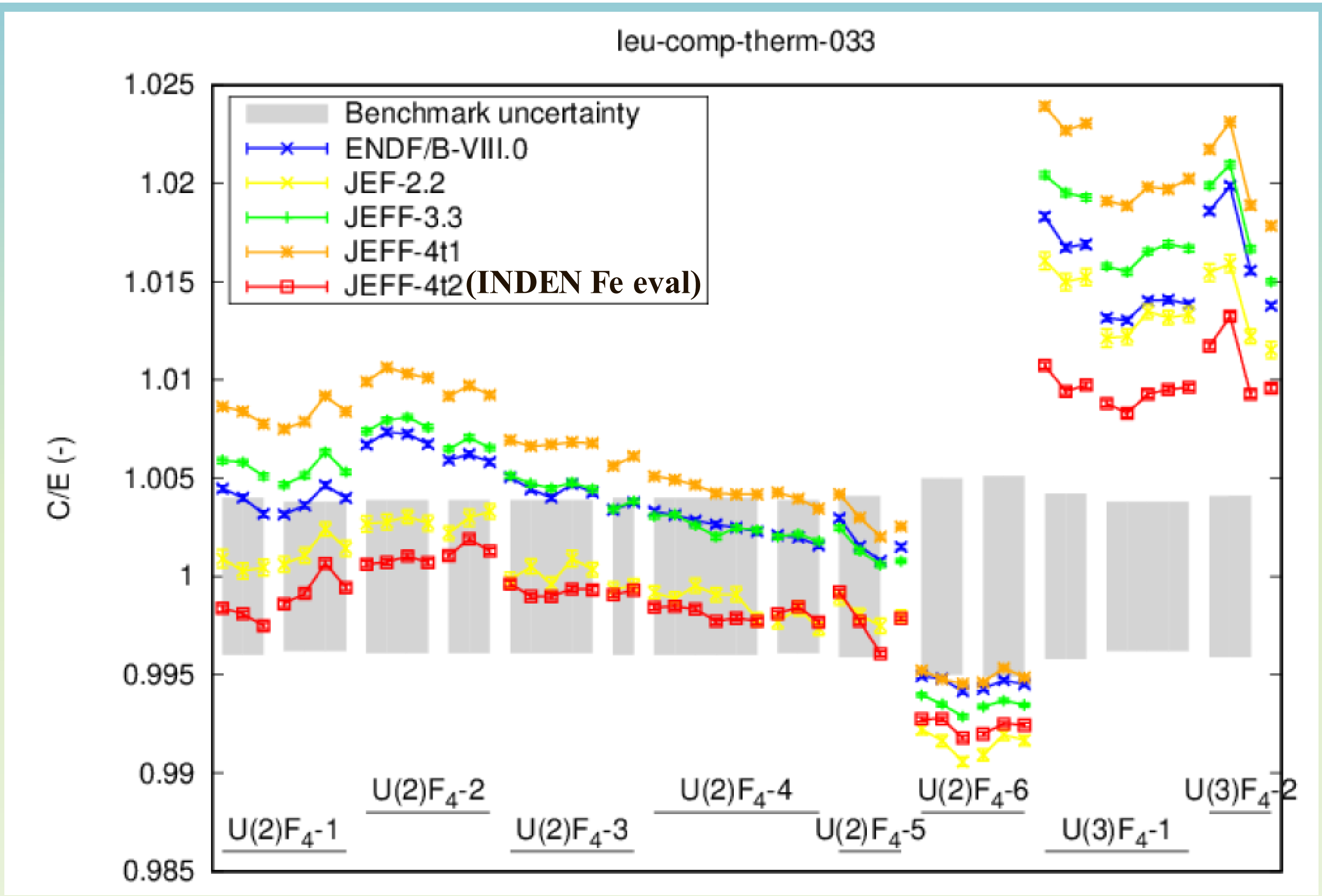
leu-comp-therm-033: UF_4 with paraffin



Courtesy of S. Vandermarck, @ JEFF meeting 24-27 April 2023

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Conclusions – F-19

- ✓ A new full evaluation using Morgan/Dickens data and Elwyn DA data needed
- ✓ Patched ENDF/B-VIII.0 (INDEN) dramatically improved the performance
- ✓ RPI quasi-differential data show deficiencies of some resonances

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Summary and Conclusions

INDEN collaboration is addressing data issues with the following strategy:

- ✓ **Identify data problems through integral validation and feedback**
- ✓ **Identify underlying data issues in differential data evaluation (sensit)**
- ✓ **Assess available experimental differential data to find alternative solutions to improve integral benchmarks**
- ✓ **Update selected experimental data to the latest standards/references**
- ✓ **A GLSQ fit of available comprehensive datasets is the preferred solution**
- ✓ **If model is available, use model including correlations as prior**

**“It doesn't matter how beautiful your theory is,
it doesn't matter how smart you are.
If it doesn't agree with experiment, it's wrong.”**

Richard Philips Feynman, Nobel Prize in Physics 1965

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