INDEN evaluations of F, Si, Cr, Fe, and Cu: The importance of experimental data

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

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

Outlook

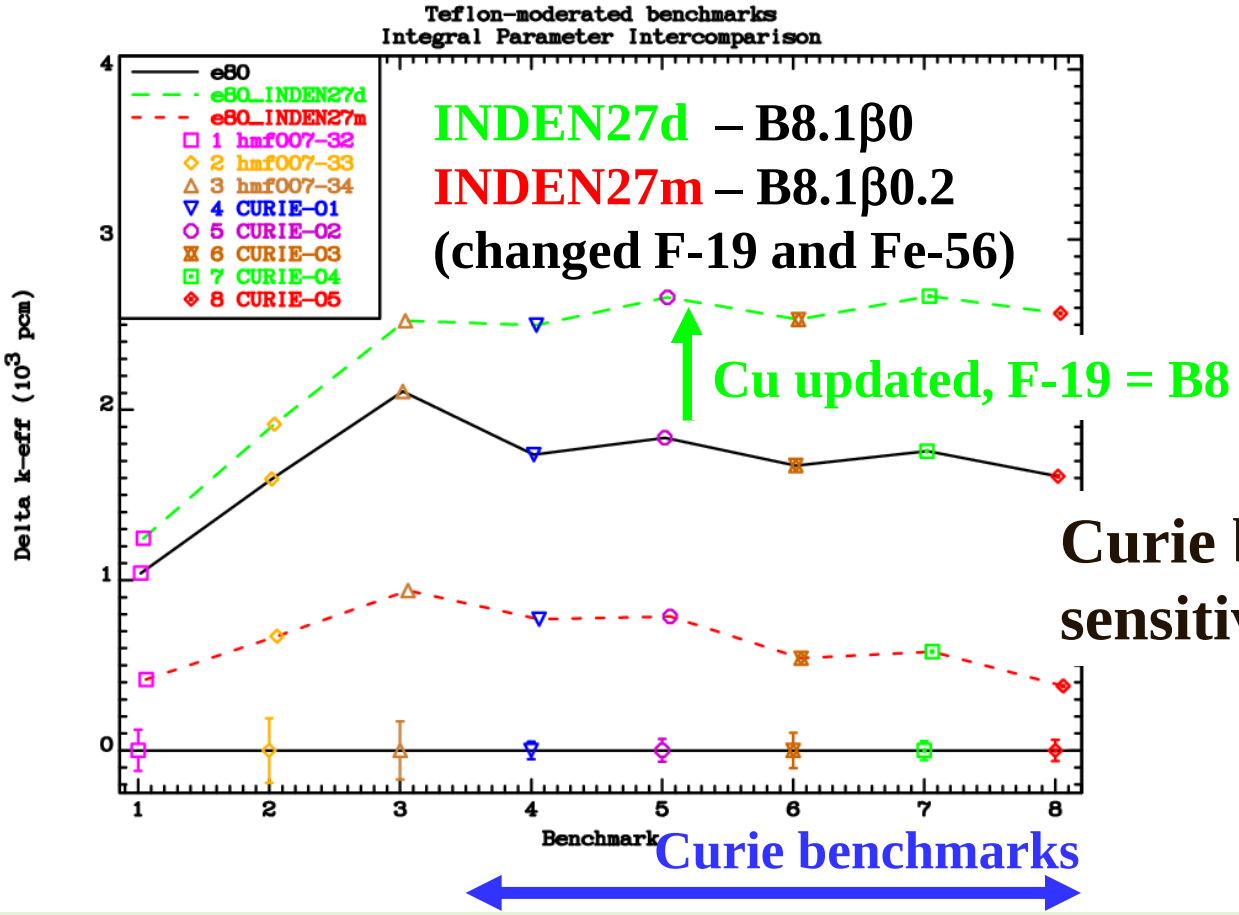
- ^{28,29,30}Si eval : M. Pigni et al, ORNL/LTR-2018/1044
- Cr isotopes, , G.P.A. Nobre et al, Nucl. Data Sheets 173 (2021) 1
- ^{233,235}U and ^{239}Pu in the RRR will be covered by M. Pigni later
- F-19
- Cu isotopes
- Fe isotopes, A. Trkov et al, ND2022

**“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

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

^{19}F: Teflon moderated Curie benchmarks



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

Integral data hints at data problems

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

^{19}F: EXFOR retrieval and data selection

Dickens 1974

ORNL-TM-4538

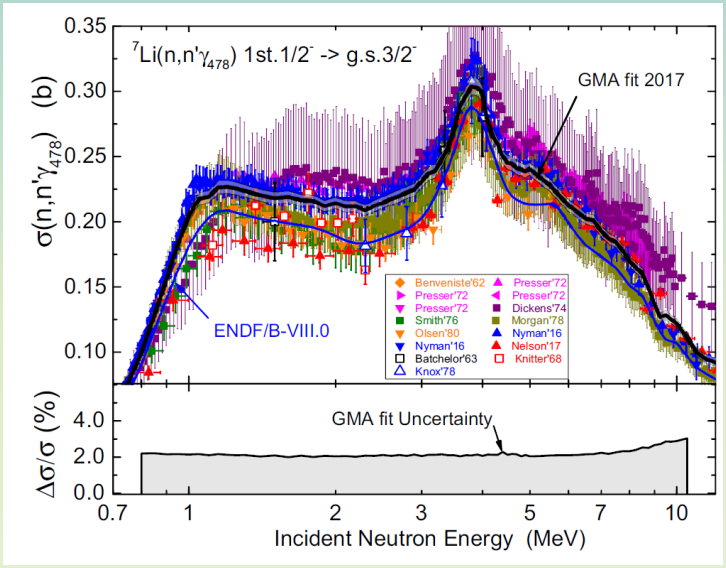
Contract No. W-7405-Eng-26

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)



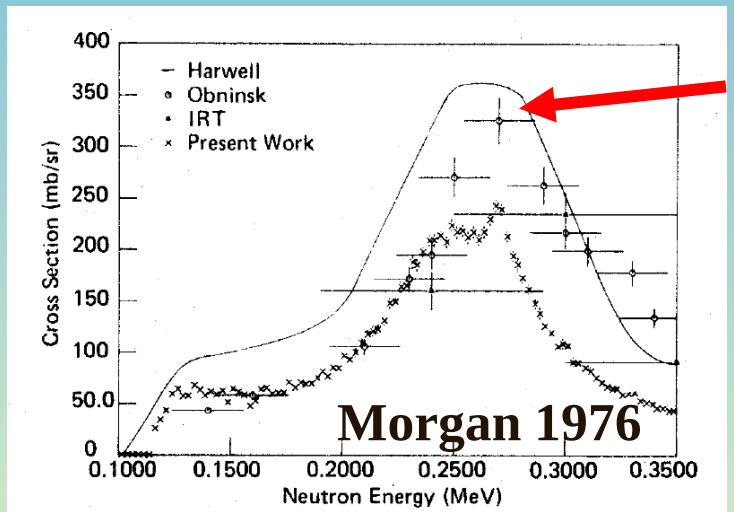


Fig. 4. Differential cross section at 92 deg for the production of the 110-keV gamma ray for E_n between 0.1 and 0.35 MeV. Shown for comparison are the data from Refs. 1, 8, and 10.

Broder
REF Fe !

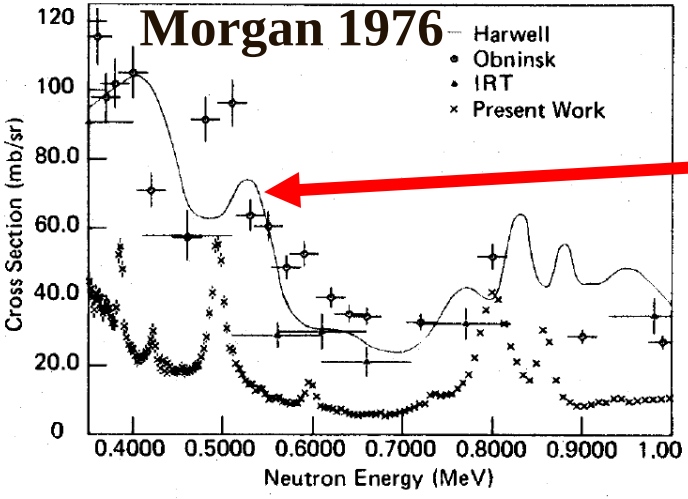


Fig. 5. Differential cross section at 92 deg for the production of the 110-keV gamma ray for E_n between 0.35 and 1.0 MeV.

Broder
REF Fe !

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

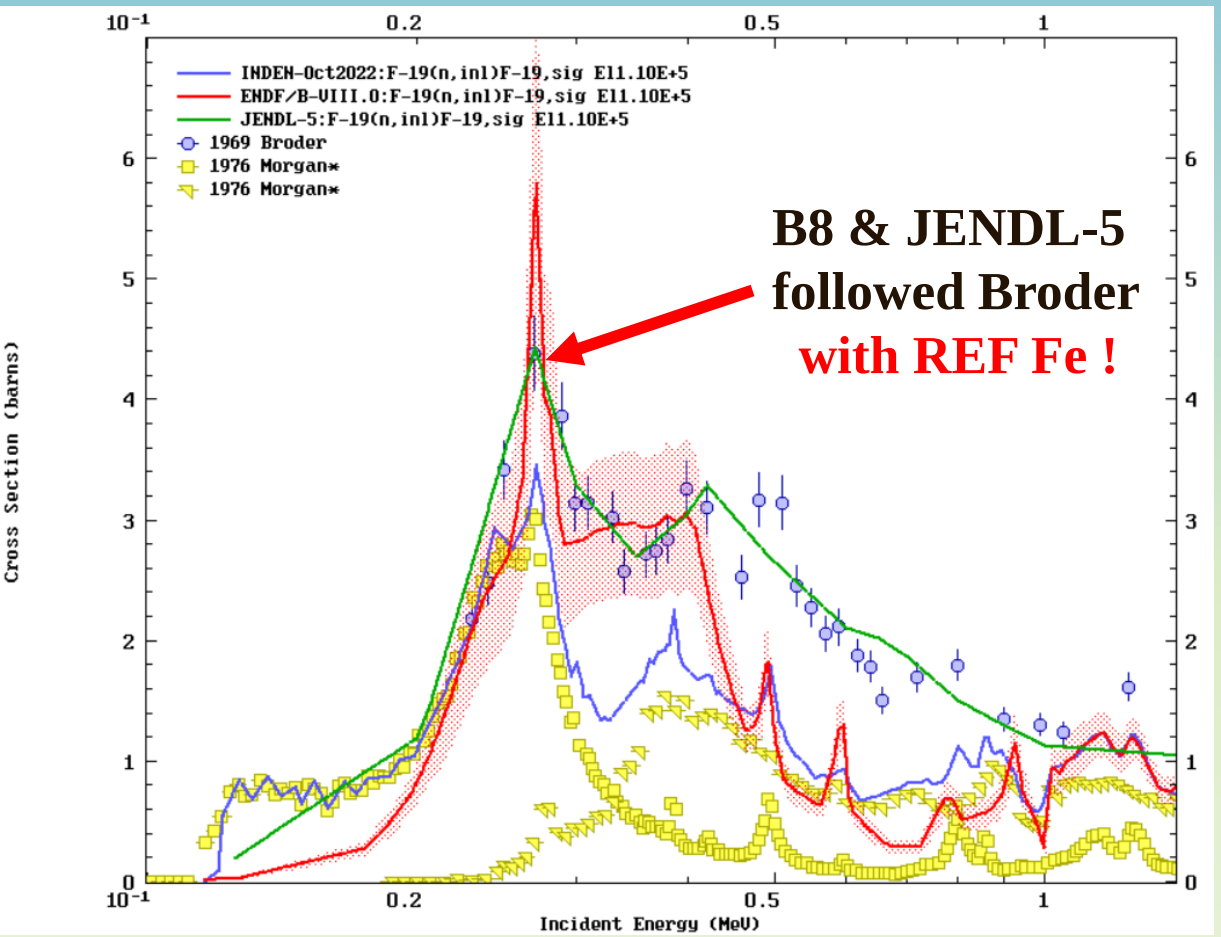
G. L. Morgan and J. K. Dickens

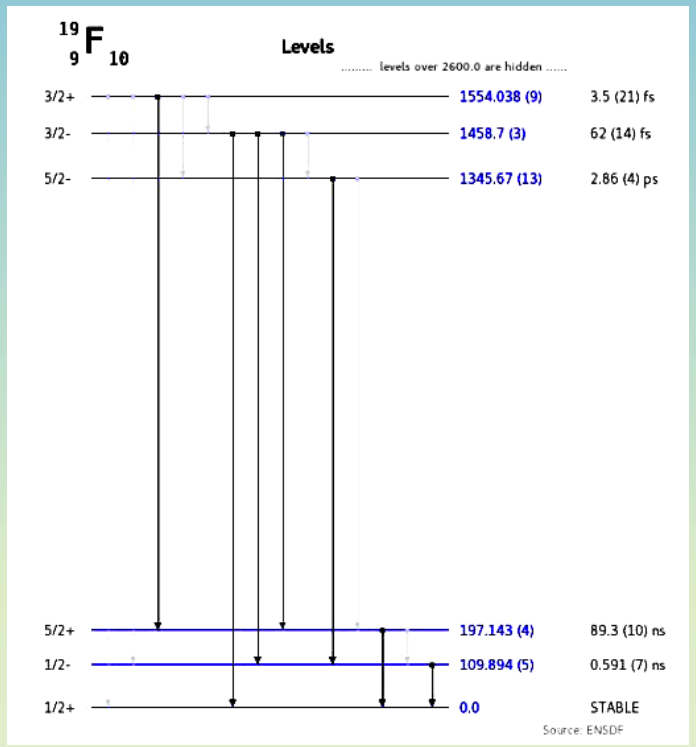
Oak Ridge National Laboratory, Neutron Physics Division, Oak Ridge, Tennessee 37830

Received June 18, 1975
Revised November 19, 1975

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Morgan 76 data adopted << Broder data

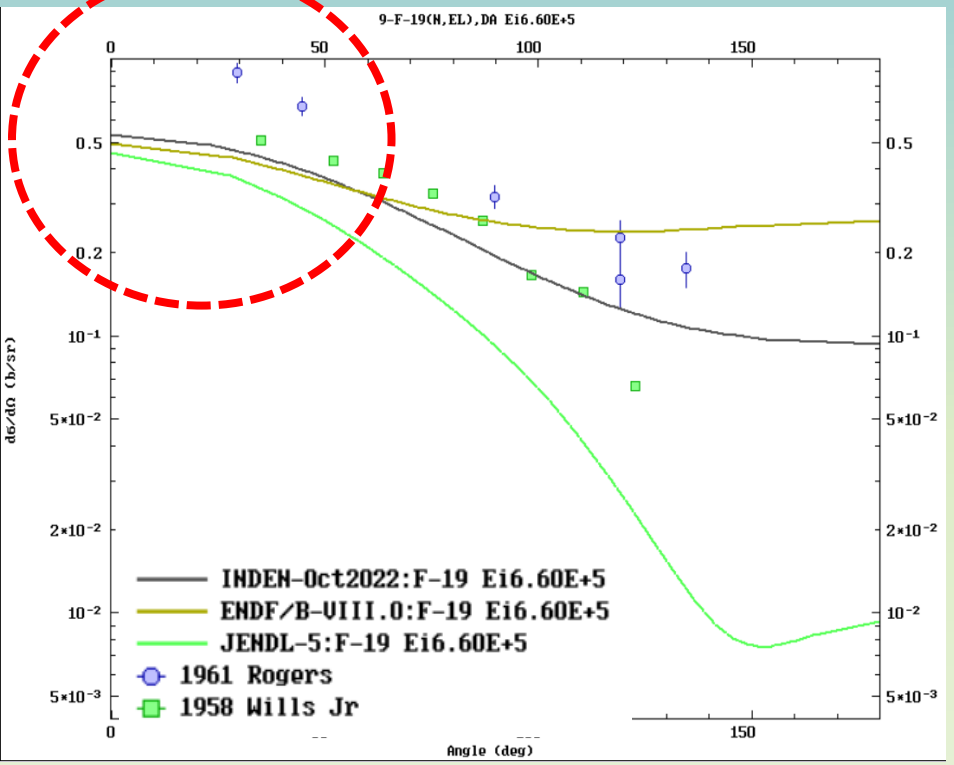


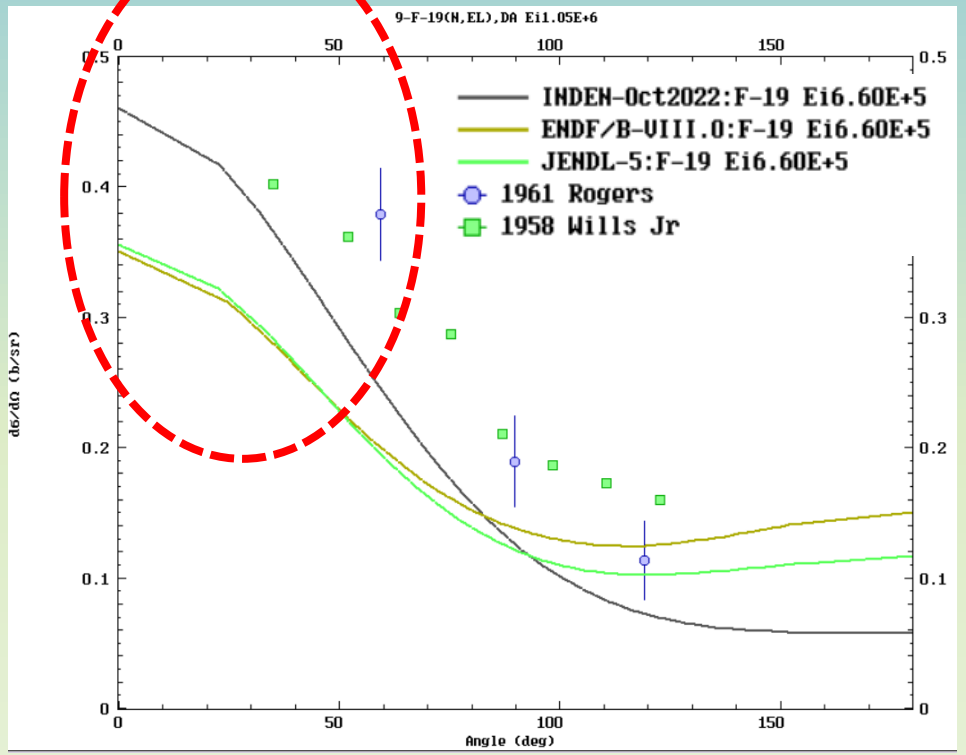


By using Morgan derived INL data (nng x 4pi)
F-19(n,inl) reduced by ~40% from 300 keV

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

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

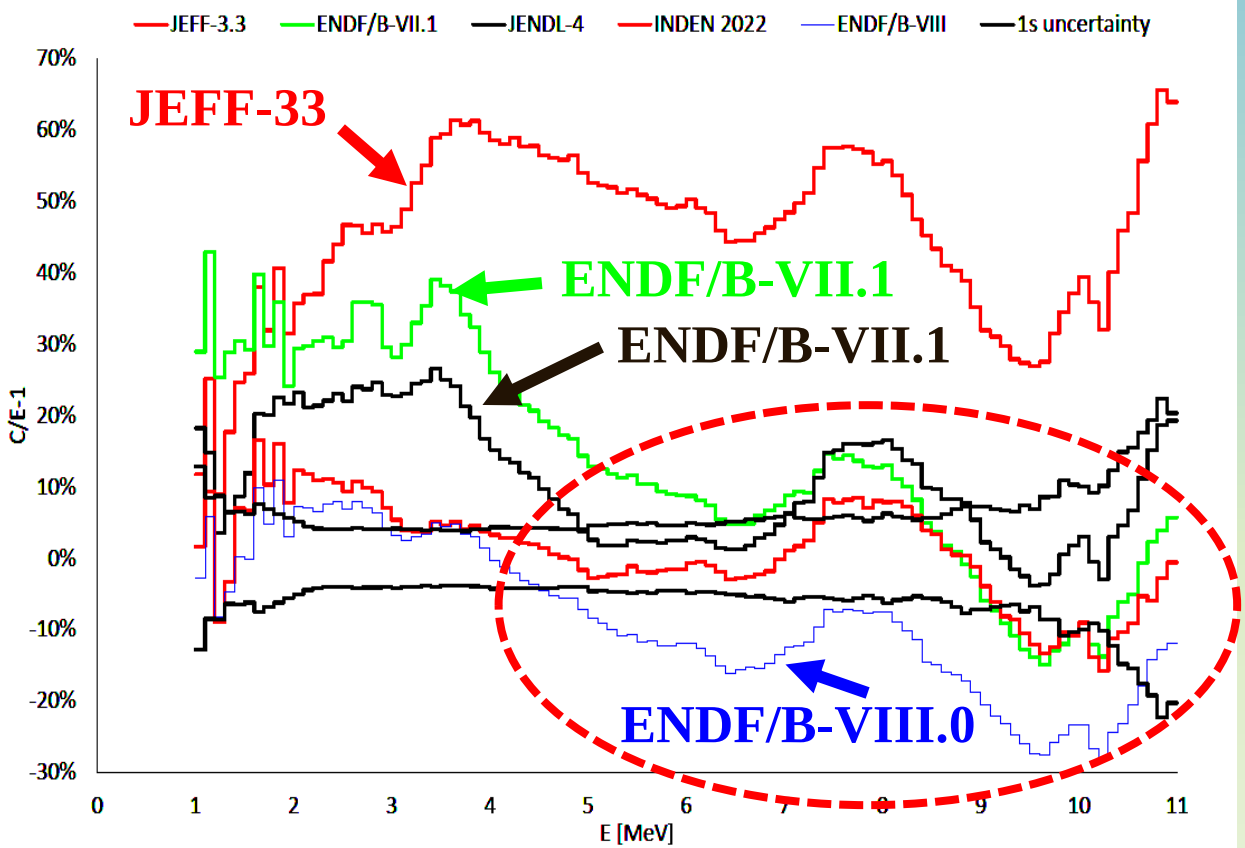




Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

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



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

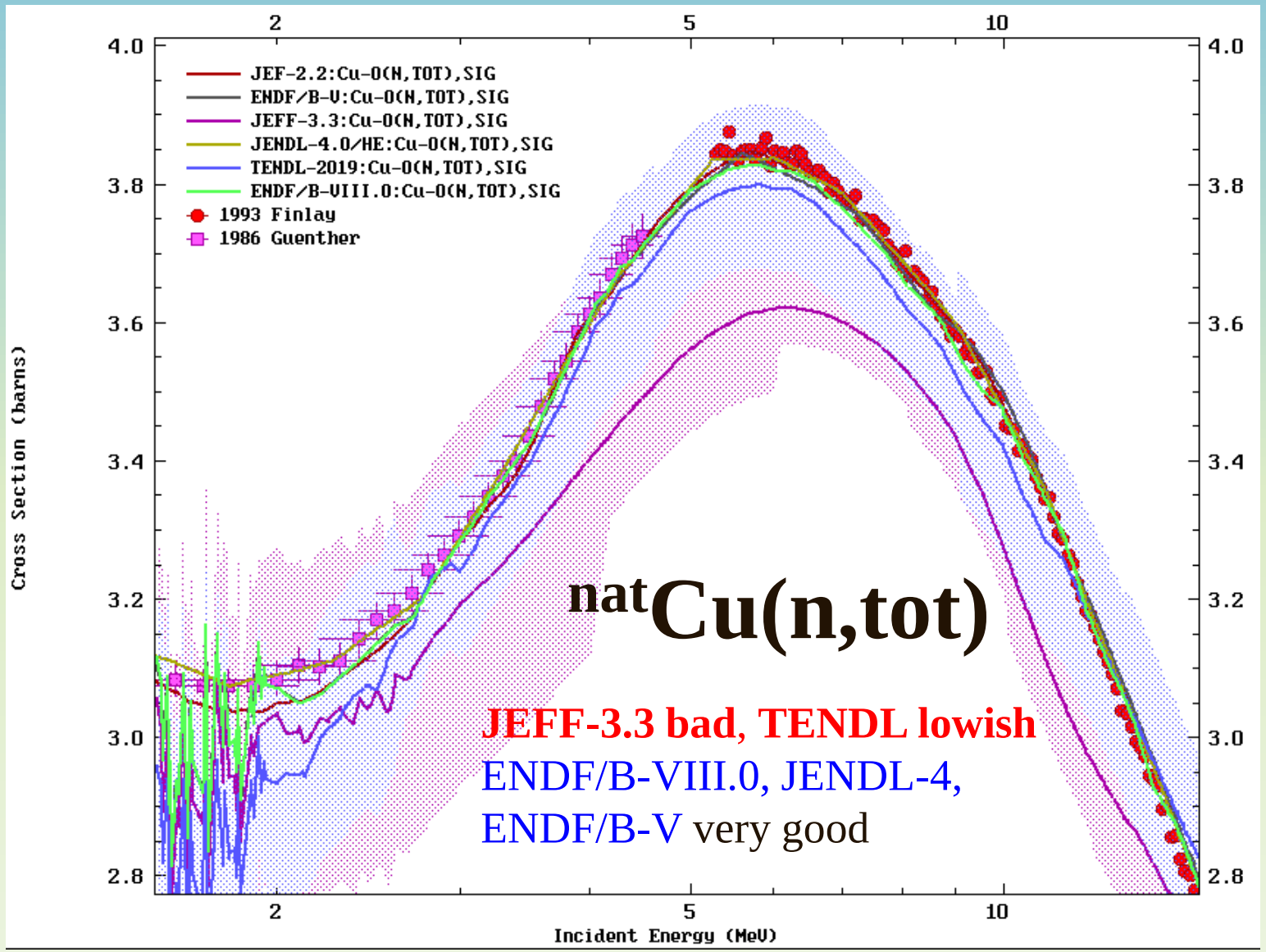
B8 low, JENDL-5 ok above 4 MeV JEFF-33 bad

Integral data hints at data problems

Leakage sensitive to el/inl/total

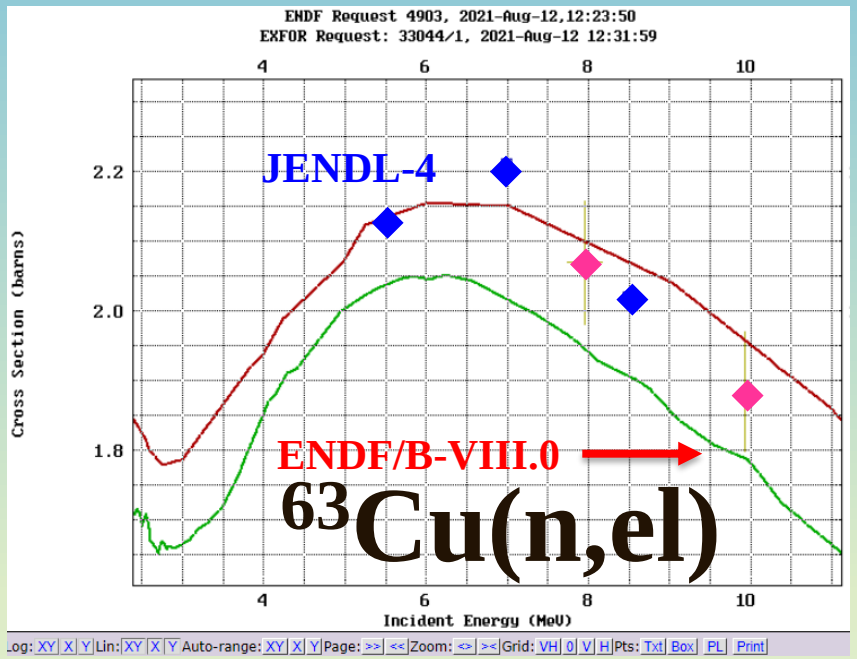
Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

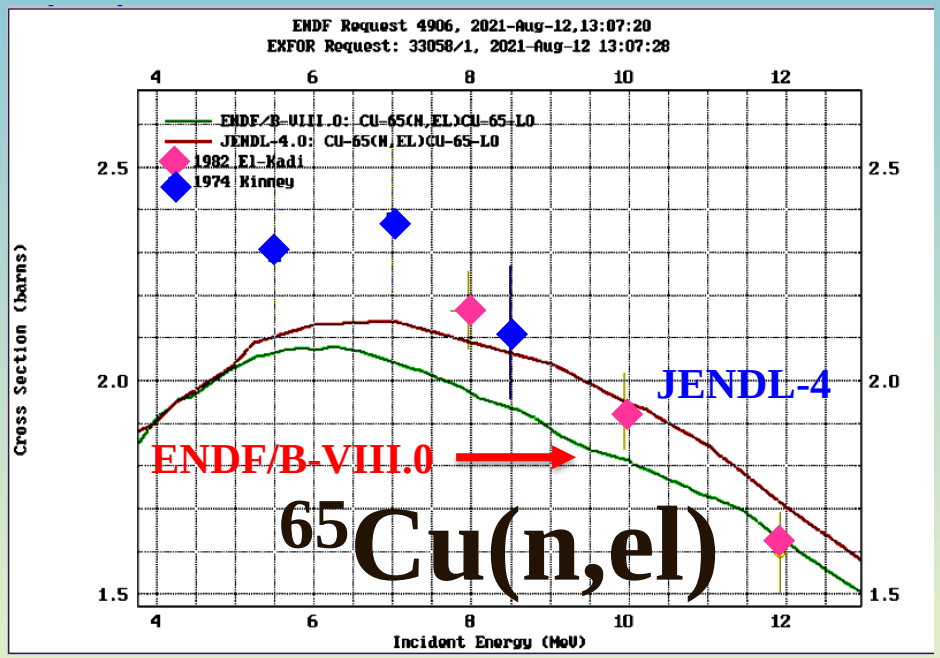
Cu: Differential total cross-section data



Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Cu: Differential elastic cross-section data





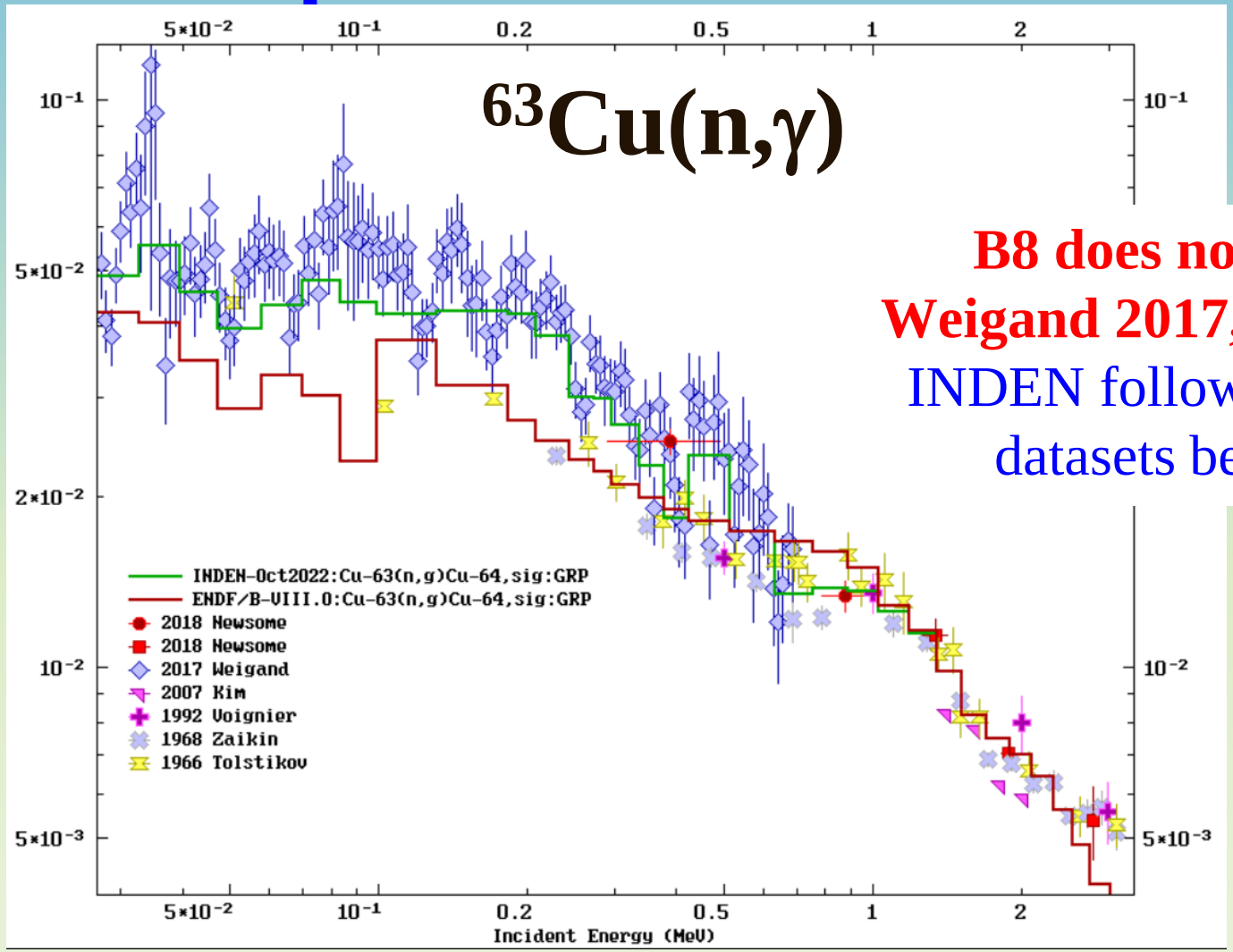
B8 does not agree with elastic EXP data above ~4 MeV

JENDL-4 much better !

Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Capture on Cu-63: New exp. data



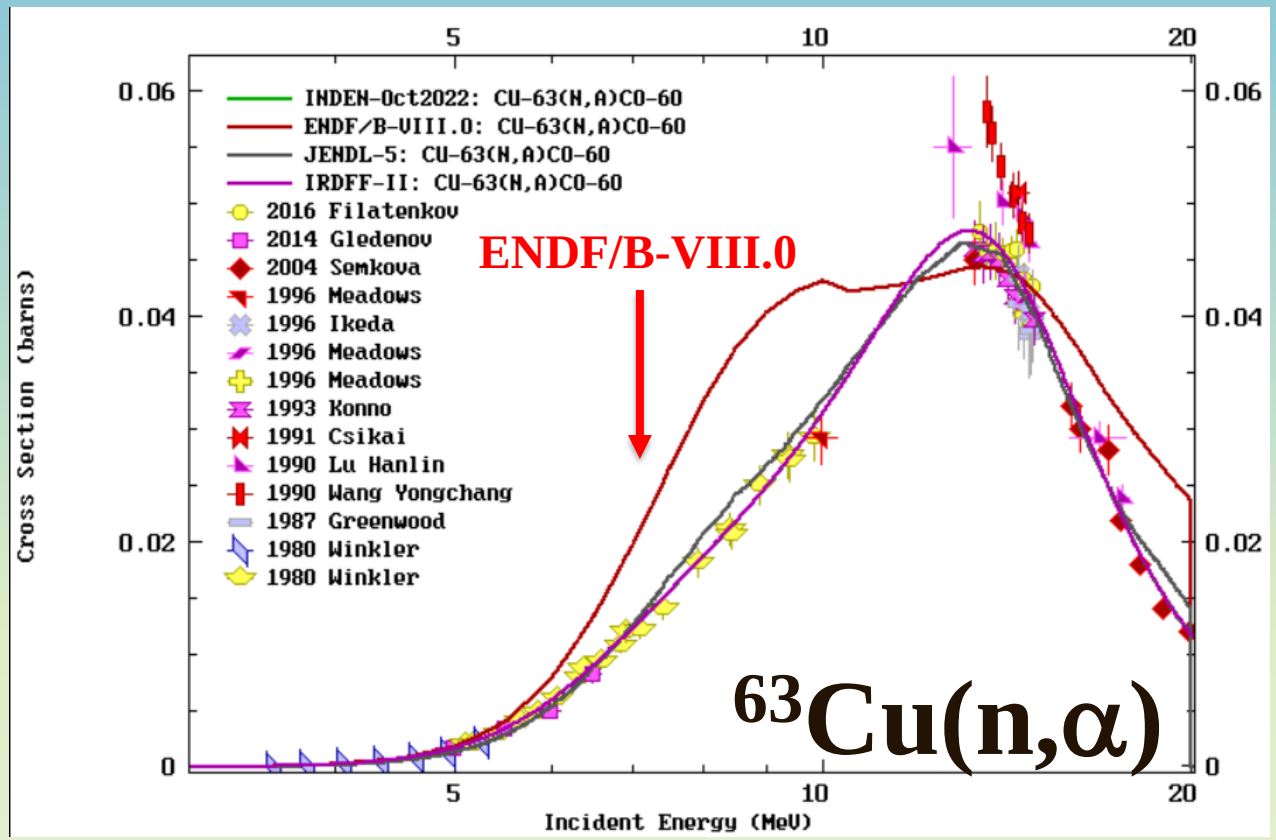
B8 does not agree with Weigand 2017, Newsome 2018

INDEN followed those newer datasets below 1 MeV

Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Alpha emission from Cu-63: IRDFF-II



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

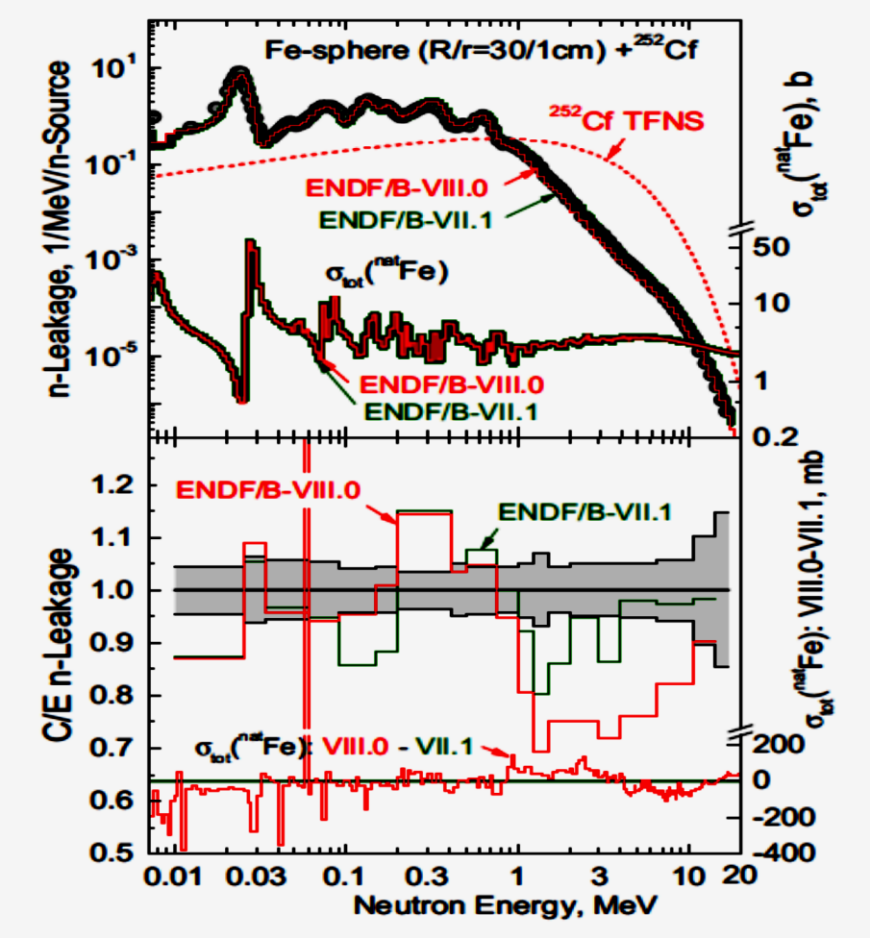
INDEN adopted the IRDFF-II evaluation (GLSQ fit)

Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Problems with ENDF/B-VIII.0 (CIELO) ^{56}Fe

Underestimation of neutron leakage at 1-4 MeV, overest.near 300 keV



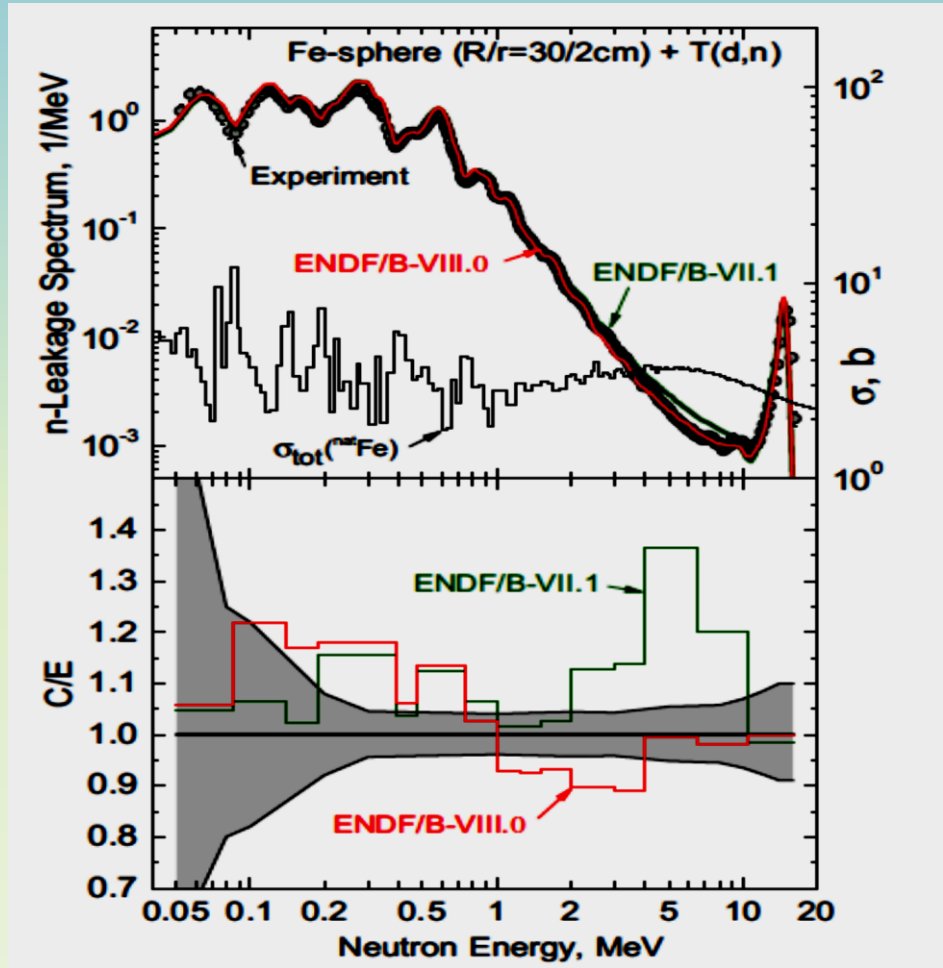
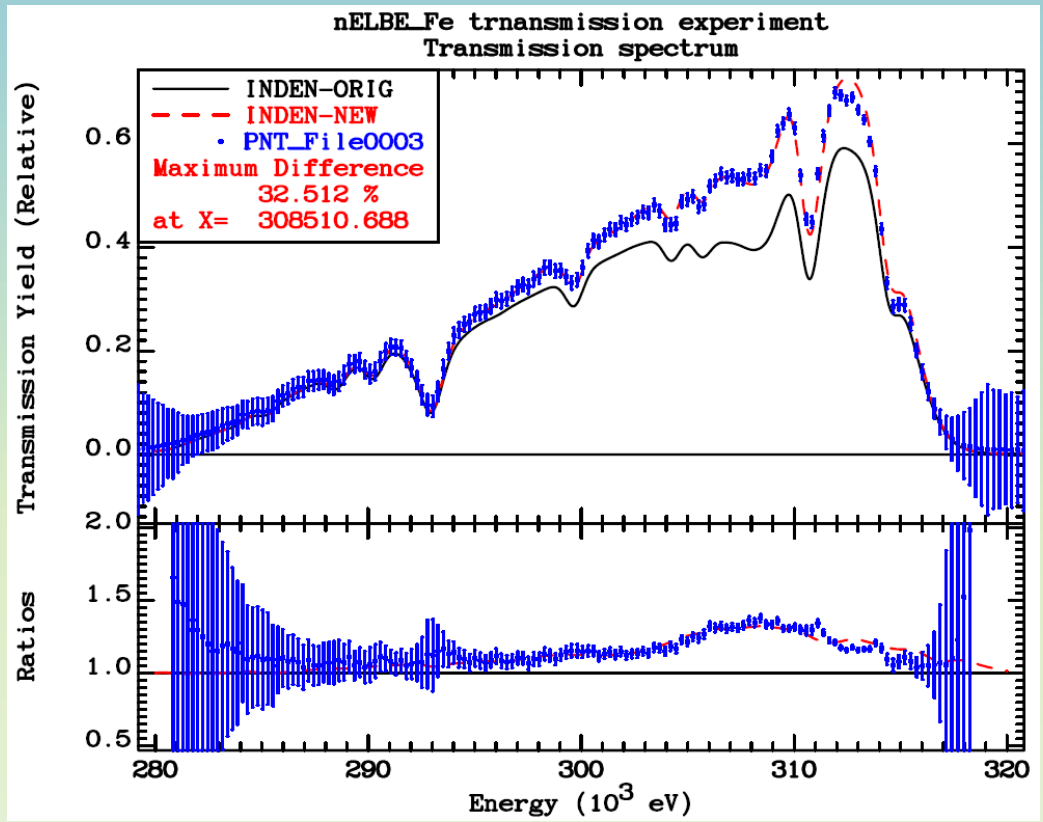


Fig. 32, 35, Nuclear Data Sheets,148 (2018) 214-253

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

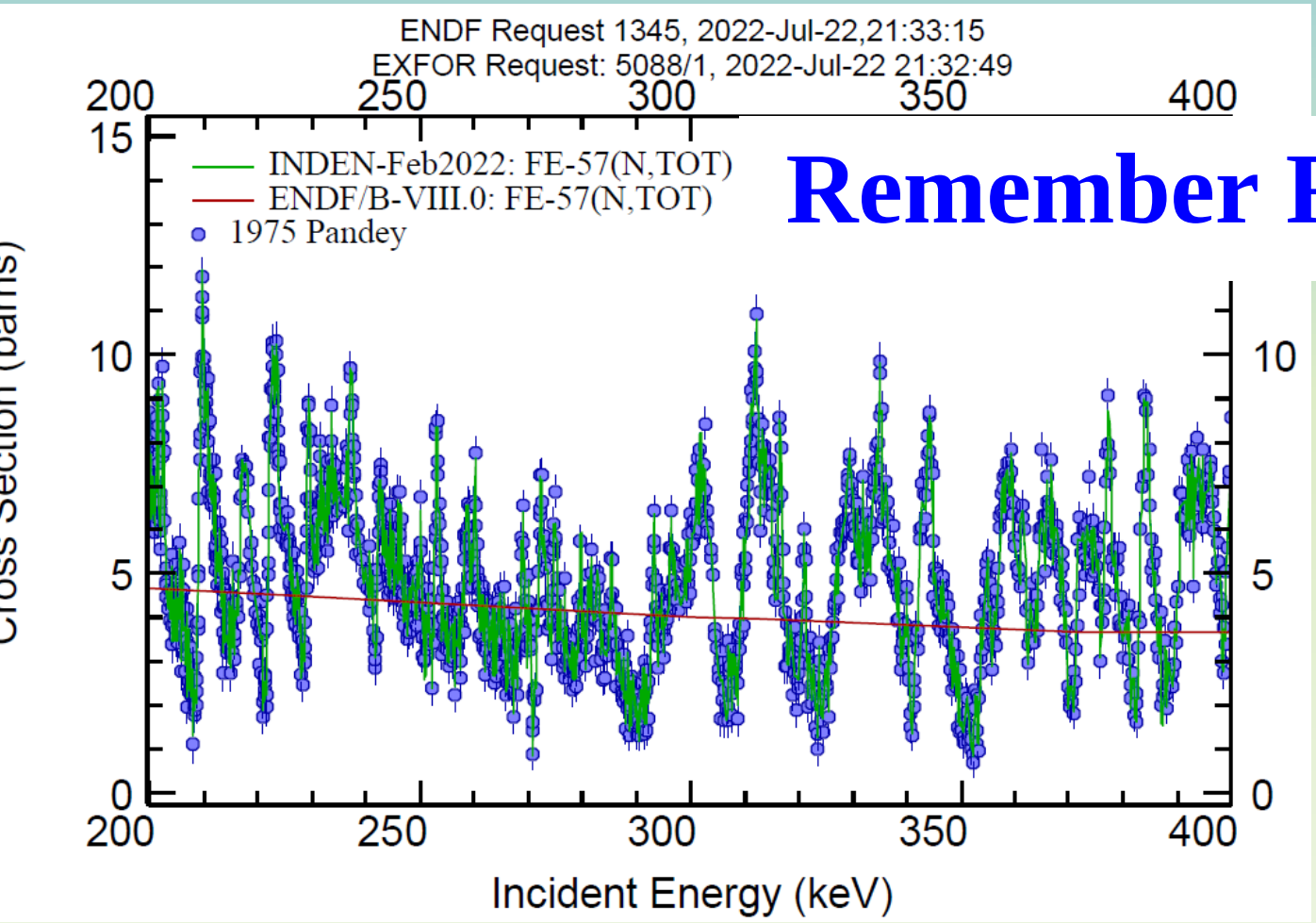
New transmission measurement at nELBE

- 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**).
- Very good agreement with n-ELBE data was achieved.



Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Fe-57 evaluation does not describe Pandey (n,tot) data having fluctuations up to 7 barn

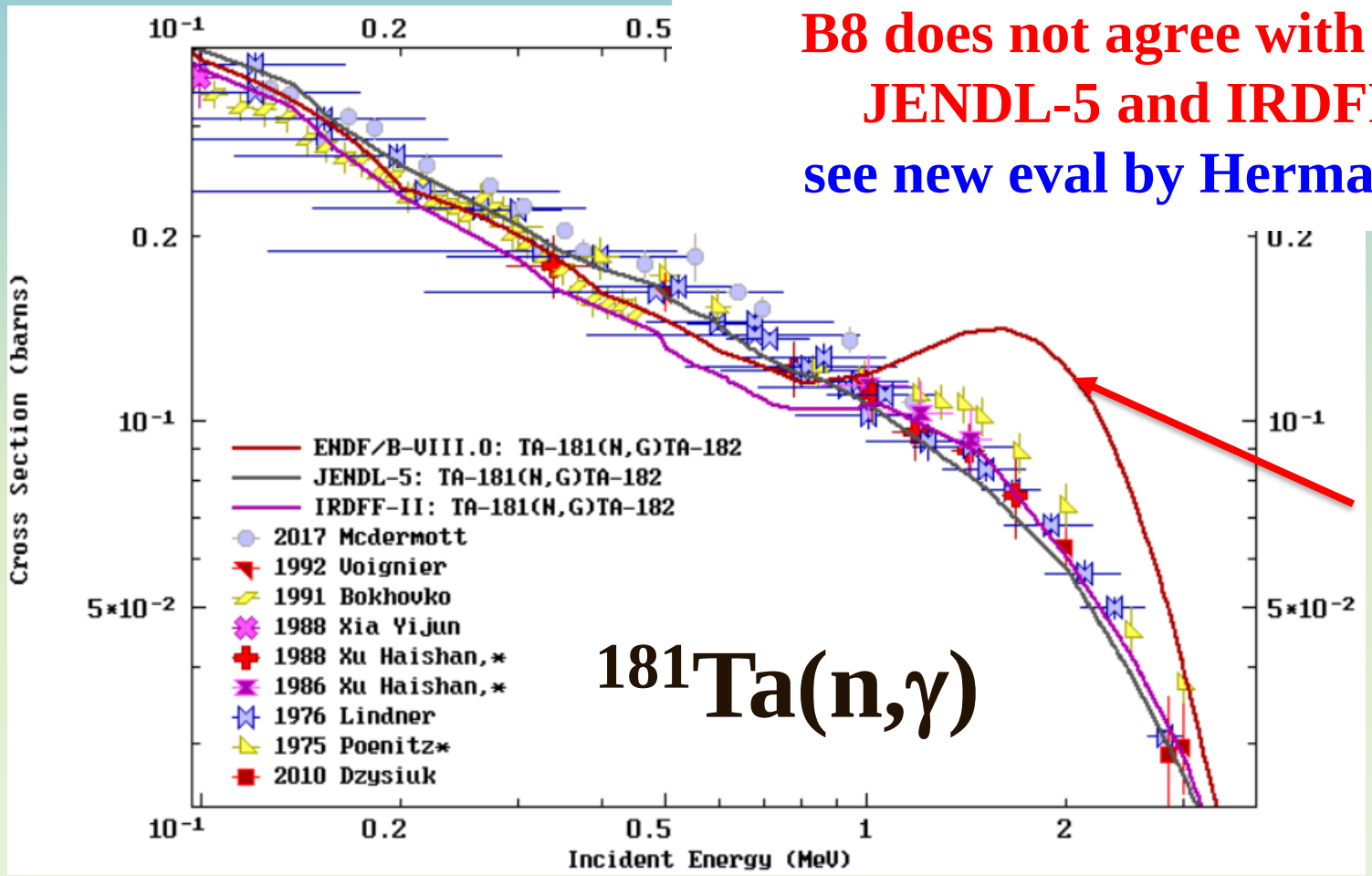


Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

Example: ^{181}Ta(n,γ) evaluation vs exp. data

Large impact on Pu-TeX benchmark
B8 does not agree with data!!
JENDL-5 and IRDFF-II
see new eval by Herman et al



Is B8 a calc.? probably

Remember Feynman?

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

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

Of course, we do remember Feynman!

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org