

Validating ENDF/B-VIII.1beta1 with LLNL pulsed-sphere neutron-leakage spectra

D. Neudecker

CSEWG April 26, 2023

Might be presented by N. Kleedtke

LA-UR-23-24085

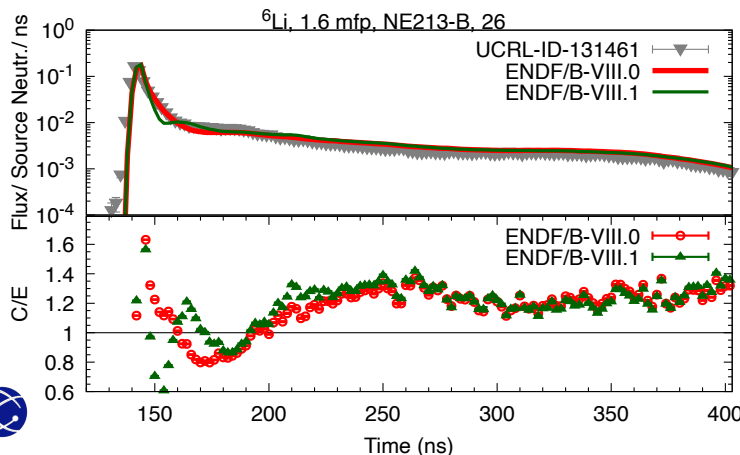
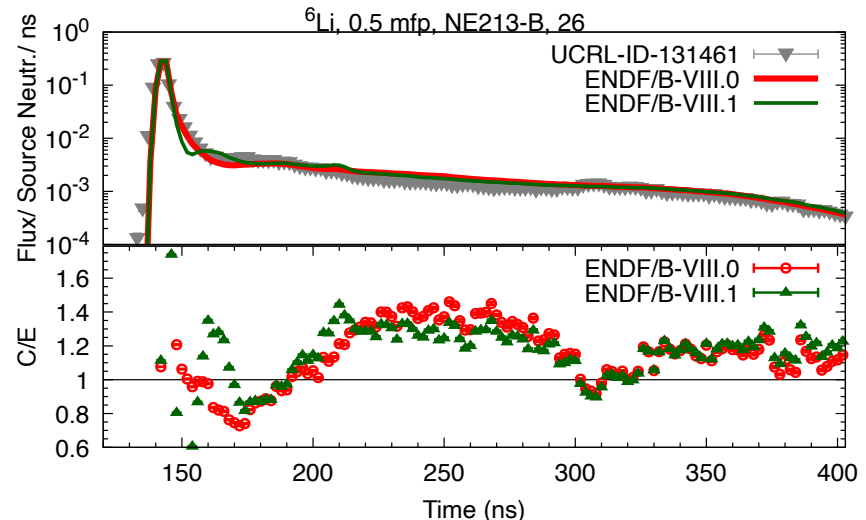
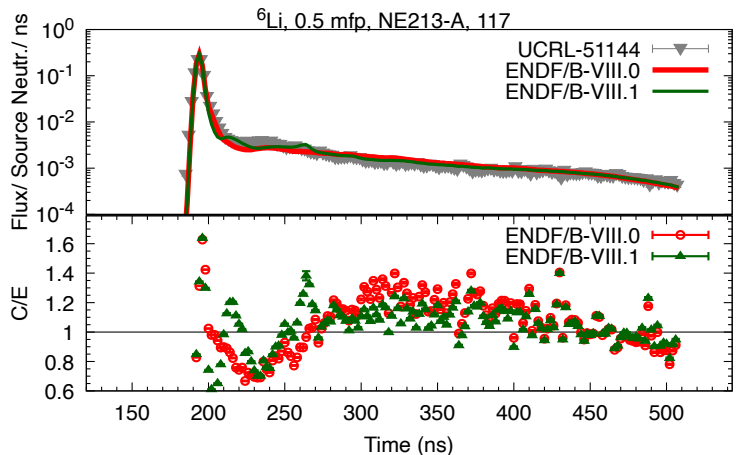
Thanks to: Stephanie Frankle,
Oscar Cabellos, Gerry Hale, Mark
Paris, Roberto Capote, Alex
Clark, Andrej Trkov.

Significant changes

- ${}^6\text{Li}$
- ${}^{235}\text{U}$
- ${}^{239}\text{Pu}$



${}^6\text{Li}$: Distinct changes are observed.

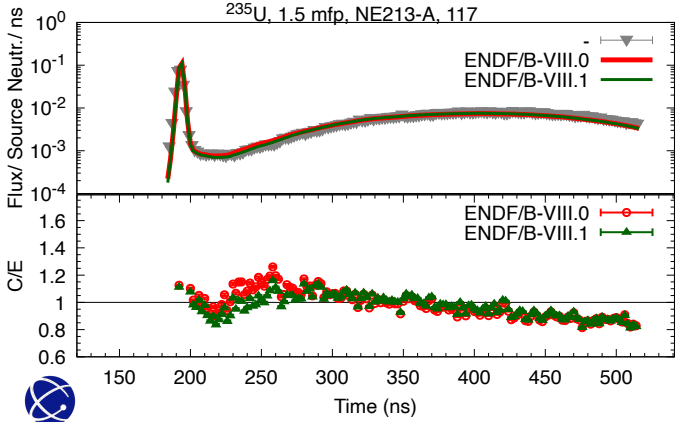
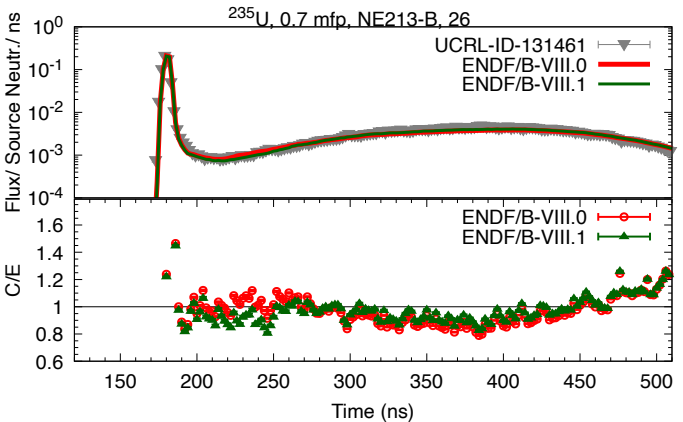
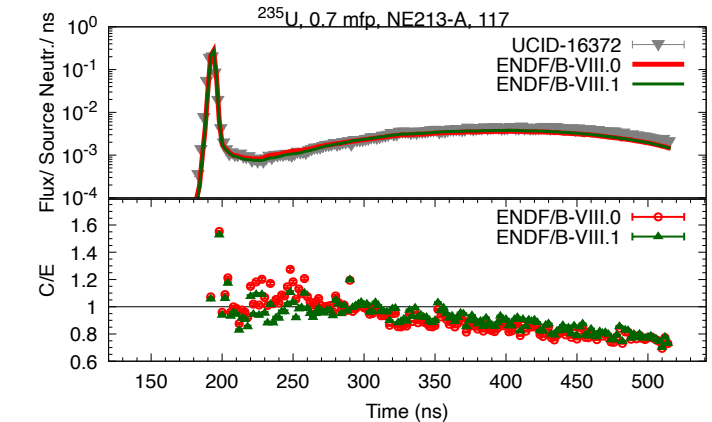


We discussed with G. Hale and M. Paris whether changes after peak could be caused by change of spectra for the ${}^6\text{Li}(n,n')d$ alpha reaction from the laboratory to the c.m. system.

MF = {3,4} MT=53 could be studied.



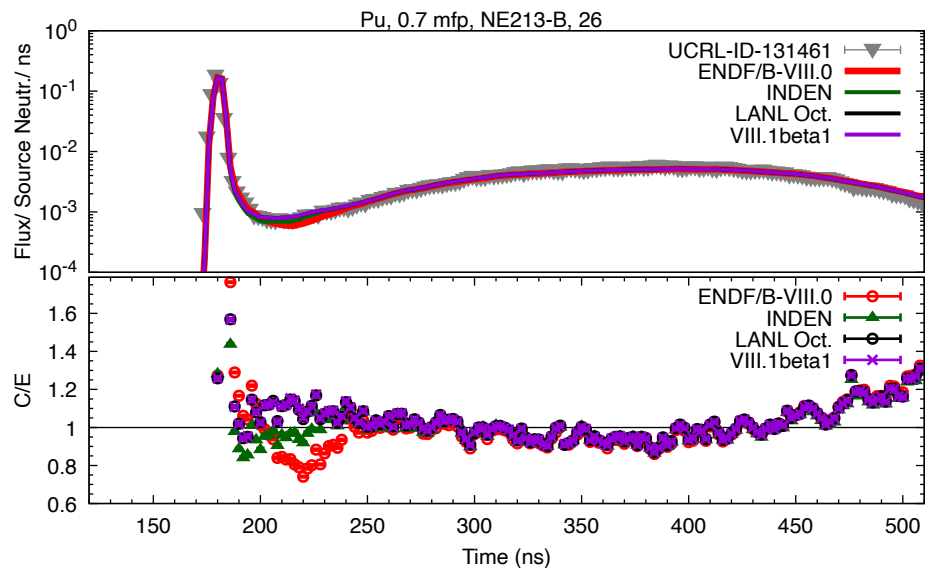
^{235}U : Improvements (seen in VIII.1beta0) are coming from new PFNS informed by Chi-Nu experimental data.



Chi-Nu data provided for the first time high-precision PFNS at $E_{inc} = 14 \text{ MeV}$ -> changed PFNS in a direction that leads to better simulation of pulsed-sphere spectra.



^{239}Pu : large changes coming from inelastic scattering.



INDEN ... from ENDF/B-VIII.1beta0
LANL Oct ... in-house LANL version that provided inelastic cross sections and angular distributions now in ENDF/B-VIII.1beta1

VIII.1 Beta1:

- (n,2n), (n,gamma) ... INDEN
- (n,inl), (n,el) ... LANL Oct.
- Fission source term ... same as for ENDF/B-VIII.1beta0

The changes we see are coming from inelastic cross sections and angular distributions (MF={3,4,6}). The continuum spectrum could play a large role.

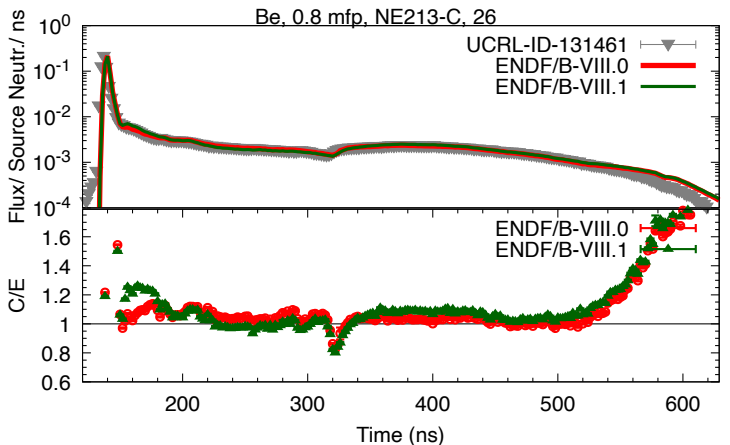
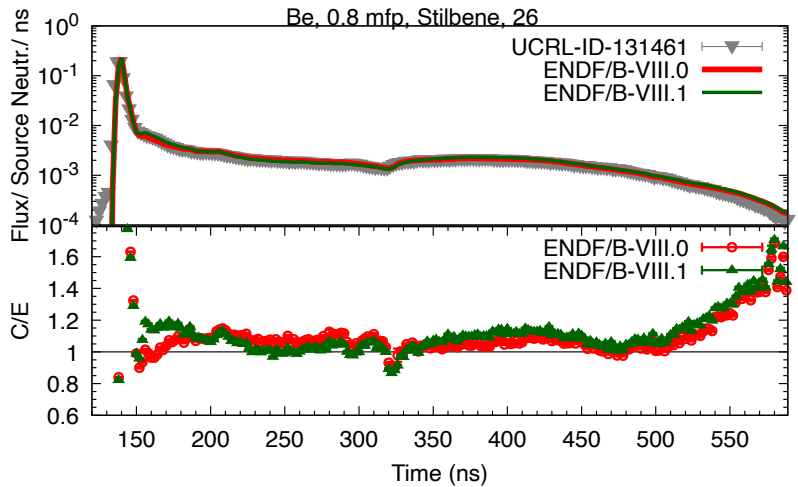
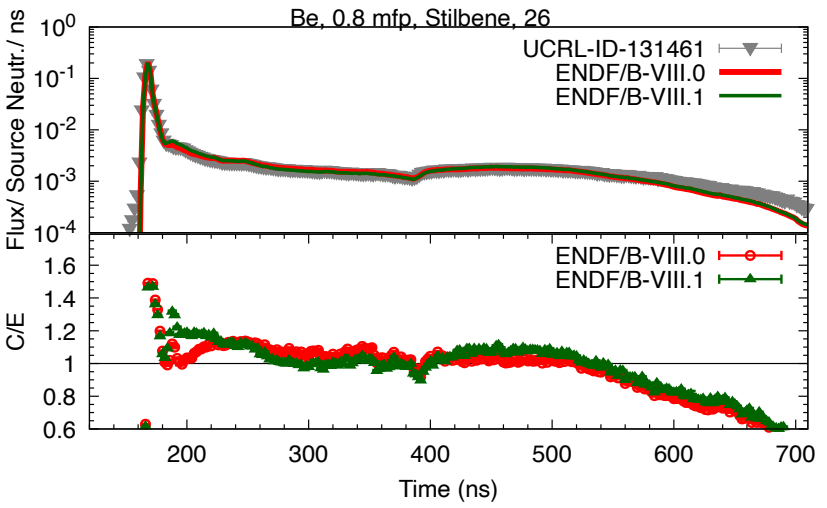


Small to medium-sized changes

- ${}^9\text{Be}$
- ${}^{16}\text{O}$
- ${}^{19}\text{F}$
- ${}^{56}\text{Fe}$



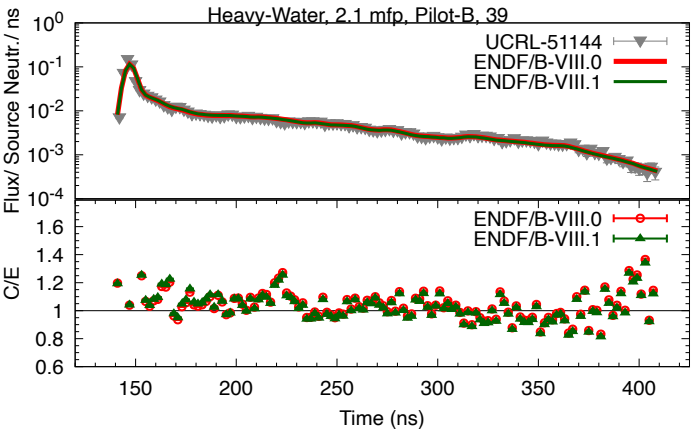
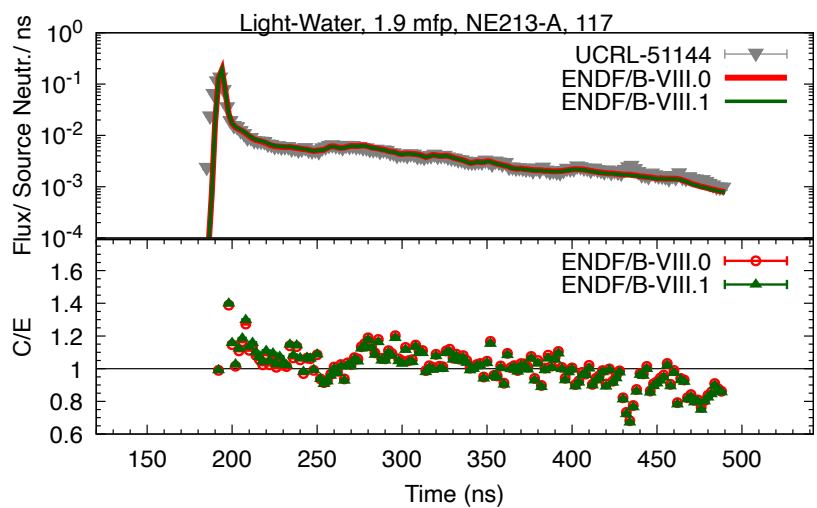
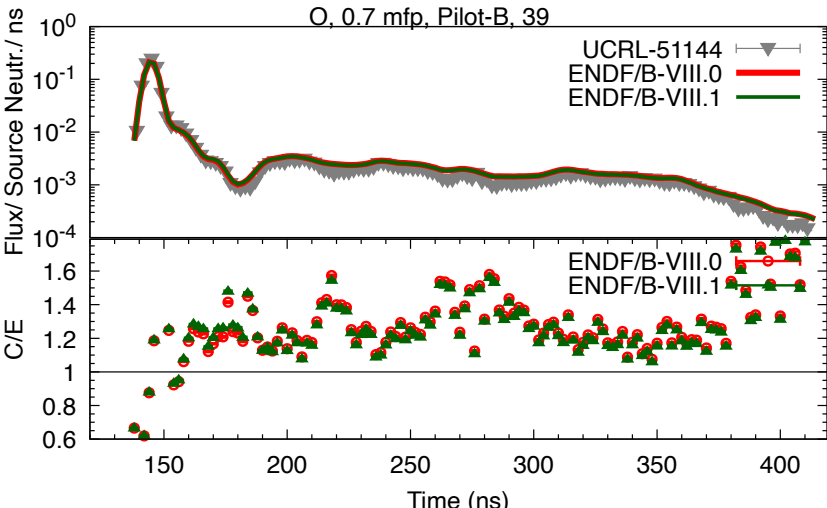
⁹Be: ENDF/B-VIII.0 better right after elastic peak.



- Less than 1 mfp -> on average < 1 scatter.
 Changes could come from:
- (n,2n) cs/ angular distribution,
 - elastic angular distribution, or
 - new (n,inl) cs/ angular distribution (small).



^{16}O : Slight changes.

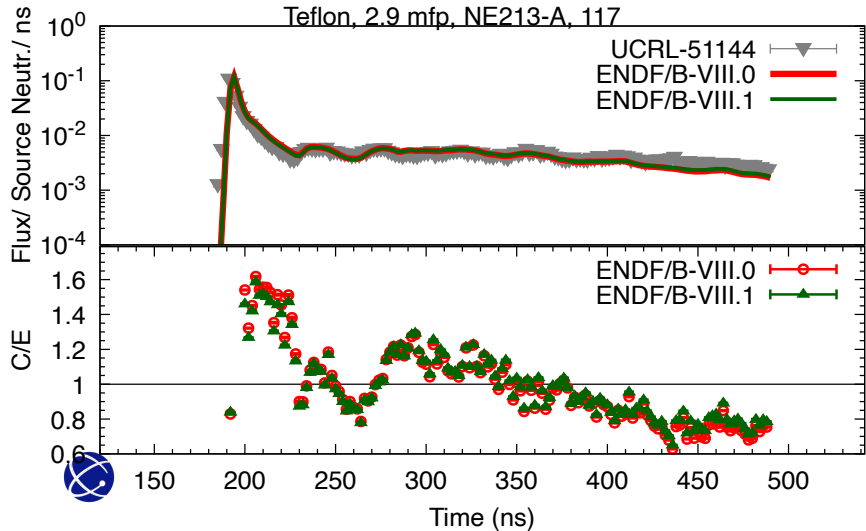
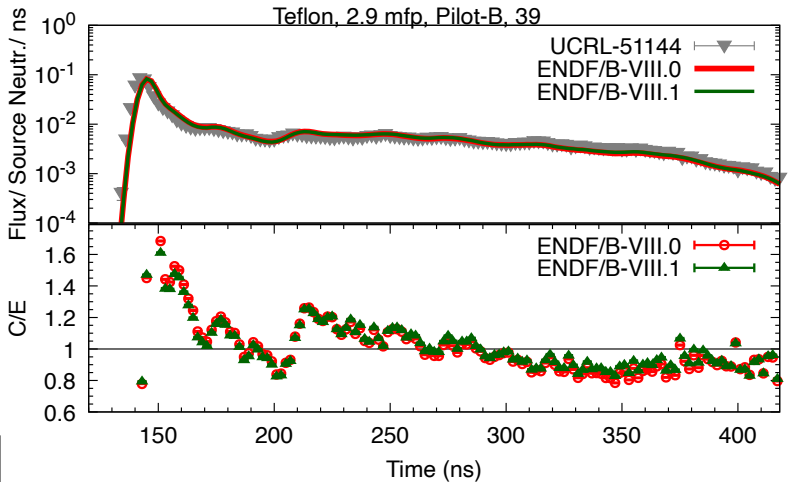
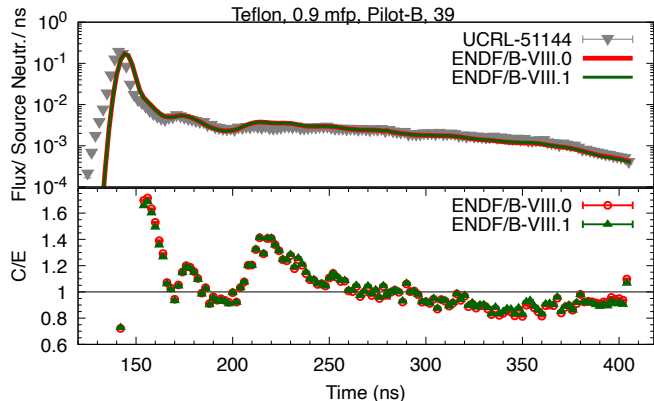


After the peak to 220 ns:

- MF=4, MT2,
- MF={3,4}, MT=52,
matter most.

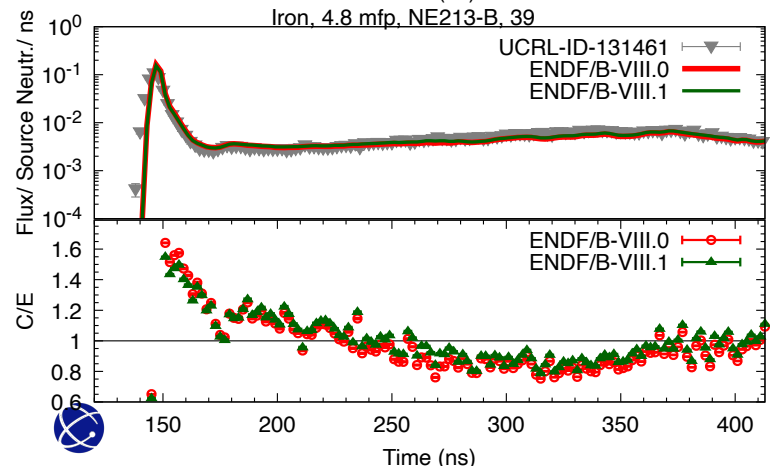
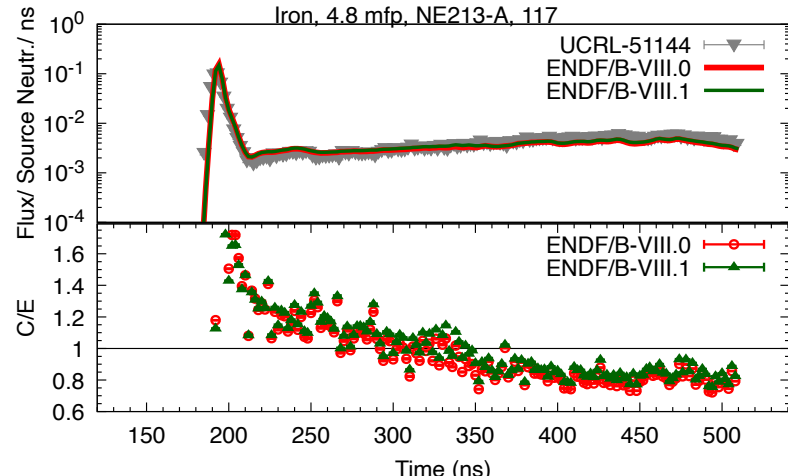
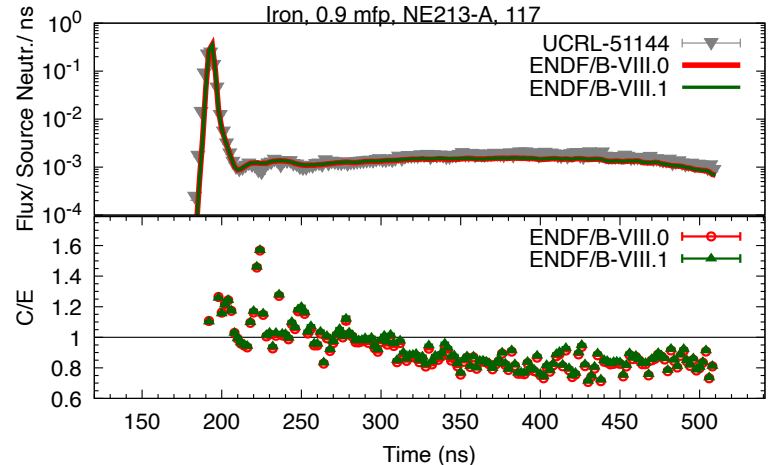


¹⁹F: small improvements in ENDF/B-VIII.1



- After the peak to :
- MF=4, MT2,
 - MF={3,4}, MT=51,55,
matter most.

⁵⁶Fe: noticeable changes in thicker spheres.



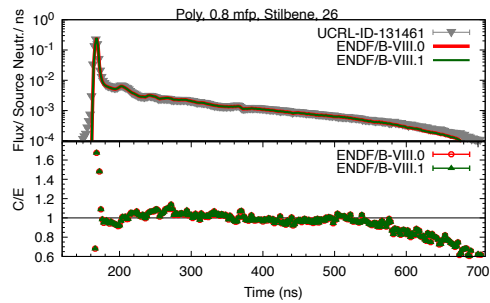
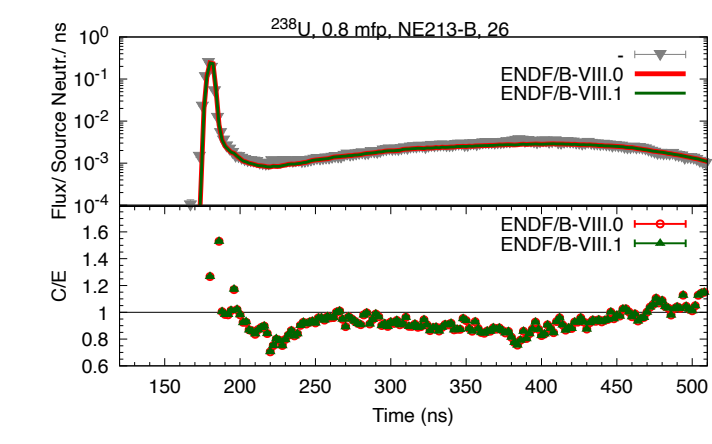
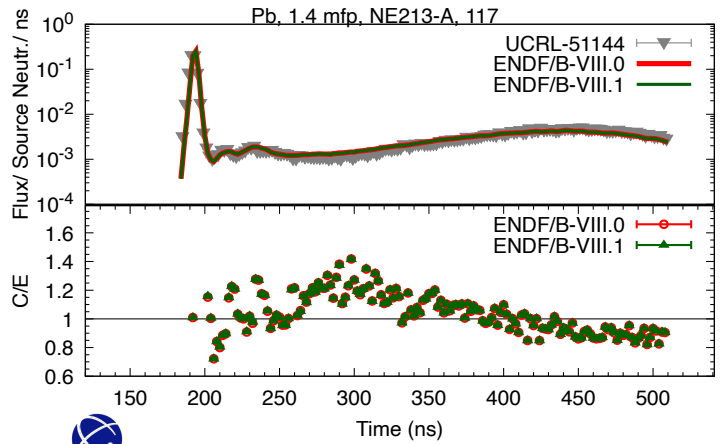
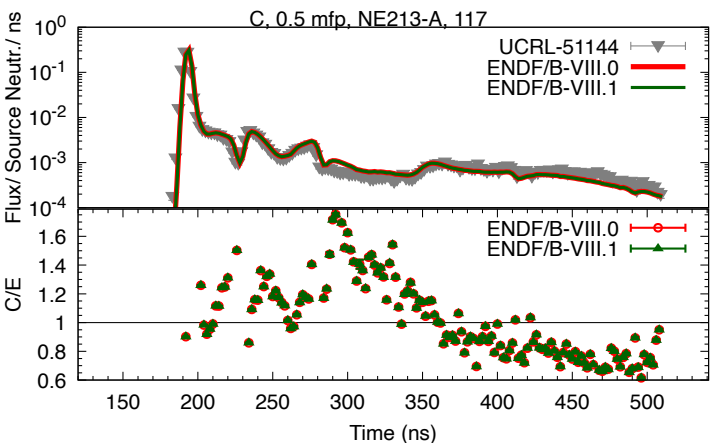
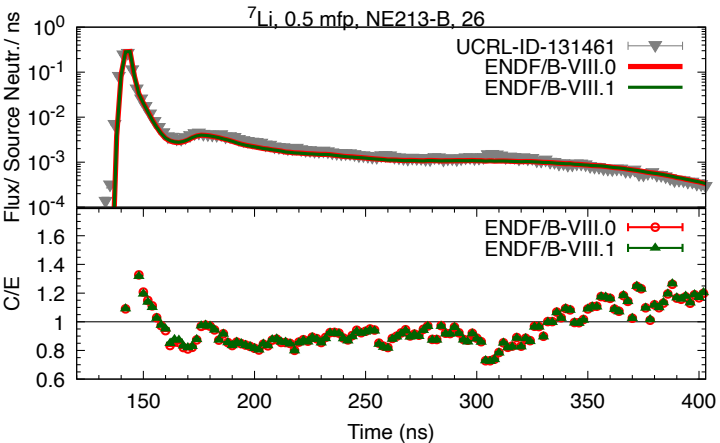
Given more distinct changes in thicker spheres, inelastic multiple scattering (MF={3,4,6}) is likely an important contributor to changes. Look especially at MF=6, MT=91 for later times (after 200 ns).

Negligible changes

- ${}^7\text{Li}$
- ${}^{12,13}\text{C}$
- Pb
- ${}^{238}\text{U}$



Examples of negligible changes for the sake of completeness.



Acknowledgements

- Research reported in this publication was supported by the U.S. Department of Energy ASC and LDRD program at Los Alamos National Laboratory.
- NCERC is supported by the DOE Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the Department of Energy.

