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LA-UR-18-29873
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Title: Validating ENDF/B-VIII.0 with respect to LLNL Pulsed Sphere Measurements spanning Materials from Light Water to Plutonium

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Intended for: Nuclear Data Week-CSEWG, 2018-11-05/2018-11-07 (Upton, New York, United States)
Web

Issued: 2018-10-17

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Validating ENDF/B-VIII.0 with respect to LLNL Pulsed Sphere Measurements spanning Materials from Light Water to Plutonium

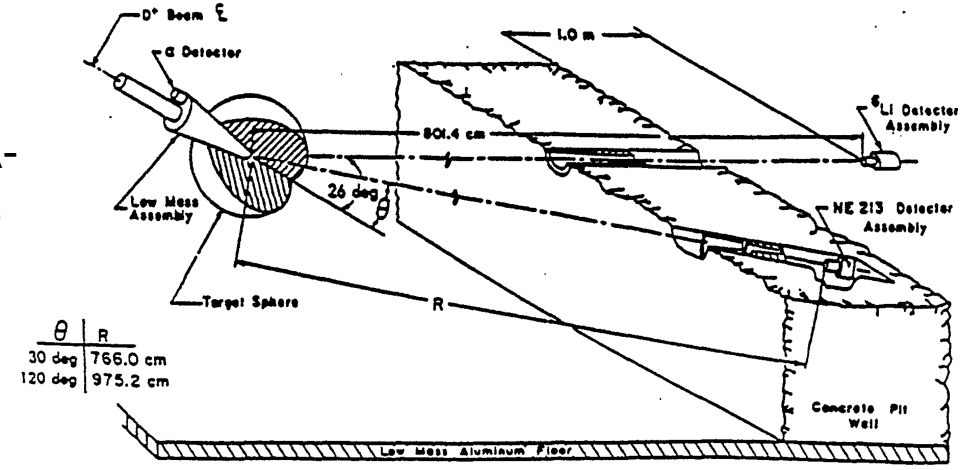
D. Neudecker, CSEWG Nov/5/2018

Thanks to: M.C. White, S. Frankle, O. Cabellos, A. Trkov, W. Haeck, J. Dominguez, R.C. Haight

LLNL pulsed spheres help validate: fission (n,f; PFNS; $\bar{\nu}$), elastic and (n,xn) observables.

- A series of pulsed sphere measurements for materials of H_2O to ^{239}Pu designed for testing of transport codes and nuclear data, e.g., C. Wong et al., UCRL-51144 (1972).
- 14-MeV neutron beam brought to the center of sphere.

Fig. from LA-UR-96-2143



- Fission and elastic obs. of ~14 MeV contribute most, while (n,xn) down-scatters to 2 MeV (O. Cabellos, WONDER 2018.)

75 pulsed spheres are simulated for 20 materials using ENDF/B-VIII.0 and ENDF/B-VII.1.

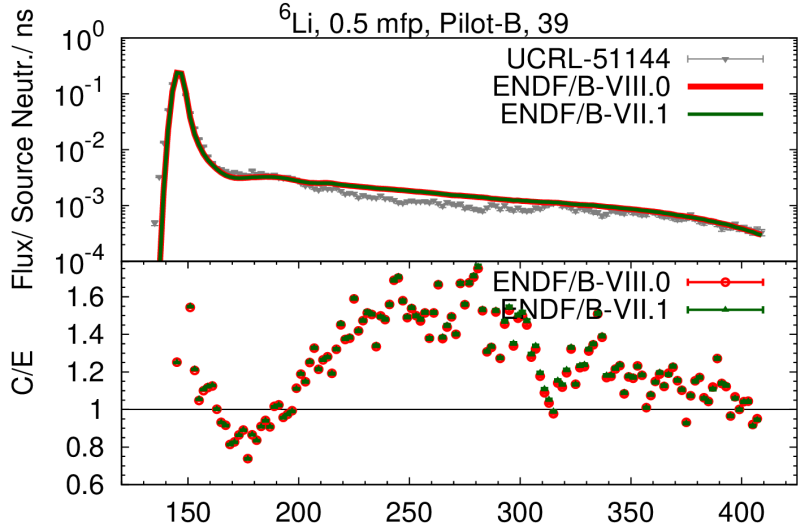
Core	# of exp.	Validates	Core	# of exp.	Validates
Light Water	6	^{1}H, ^{16}O	Teflon	3	^{19}F, ^{12}C
Heavy Water	2	^{2}H,^{16}O	Magnesium	3	$^{24\text{-}26}$Mg
^{6}Li	5	^{6}Li	^{27}Al	2	^{27}Al
^{7}Li	5	^{7}Li	Titanium	2	$^{46\text{-}50}$Ti
^{9}Be	6	^{9}Be	Iron	6	^{12}C, $^{54.56}$Fe
Polyethylene	3	^{1}H, ^{12}C	Lead	2	$^{206\text{-}208}$Pb
Carbon	4	^{12}C	Tungsten	2 (0 ok)	$^{182\text{-}184,186}$W
^{14}Ni	3 (2 ok)	^{14}Ni	^{235}U	7	^{235}U
^{16}O	2 (1 ok)	^{16}O	^{238}U	5	^{238}U
Concrete	4	^{1}H, ^{16}O, ^{28}Si	^{239}Pu	3	^{239}Pu

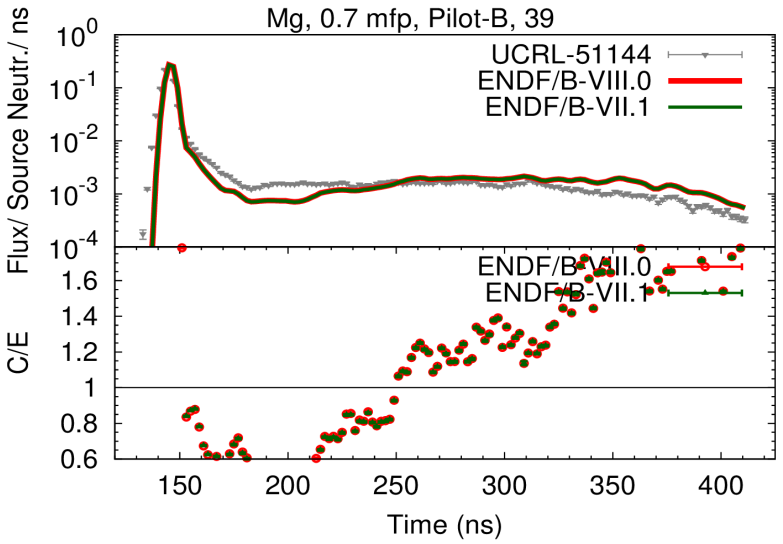
S. Frankle provided MCNP input decks for these benchmarks, LA-UR-05-5879 (2005).

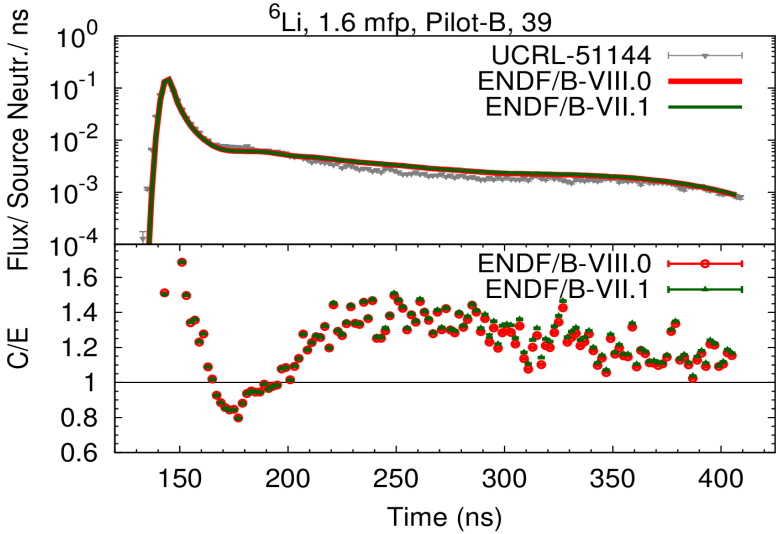
These nuclear data files did not perform perfectly in simulating LLNL pulsed spheres.

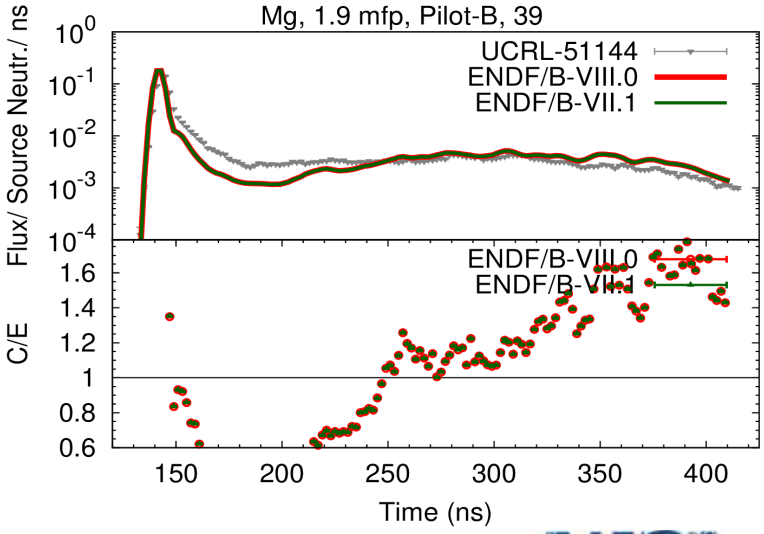
- ^{6}Li: only small changes from VII.1 to VIII.0
- Carbon: split into its isotopes and small changes from VII.1 to VIII.0
- ^{16}O: most cross-sections > 9 MeV unchanged except for capture cross-section
- Magnesium: carried over from VII.1 to VIII.0
- ^{26}Al: carried over from VII.1 to VIII.0
- Titanium: carried over from VII.1 to VIII.0
- Lead

^{6}Li: minimal change from VII.1 to VIII.0
Magnesium: no change from VII.1 to VIII.0, exp ok?

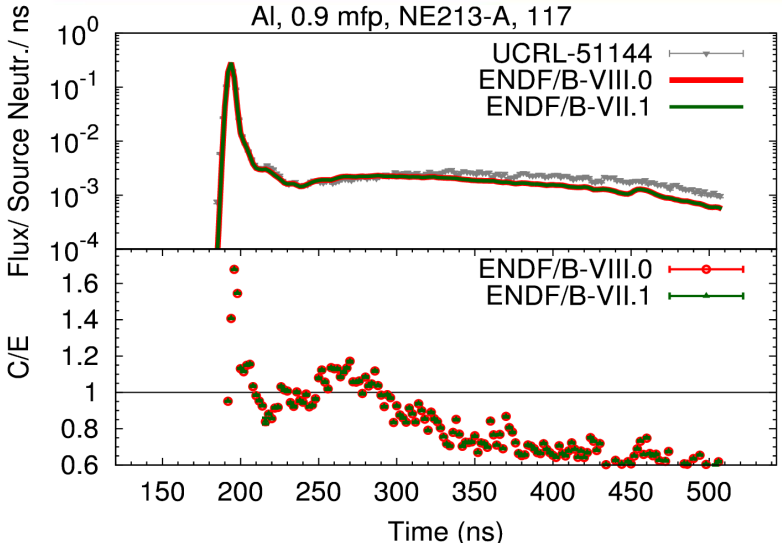


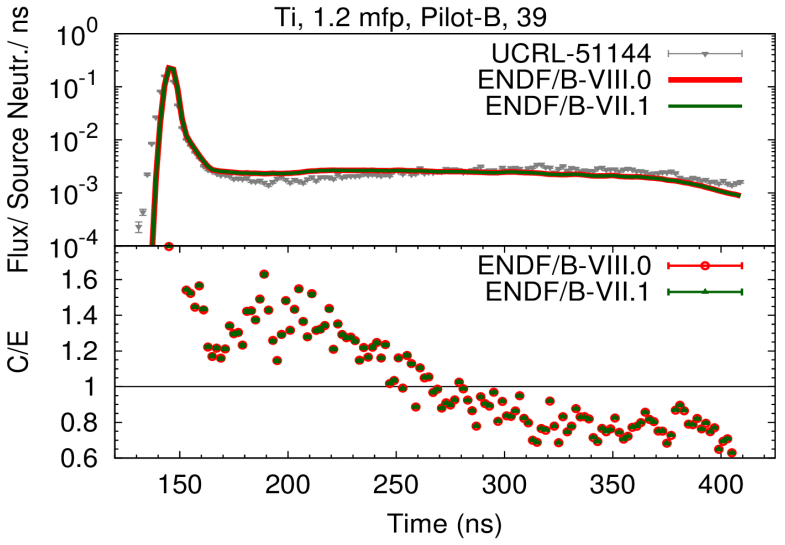


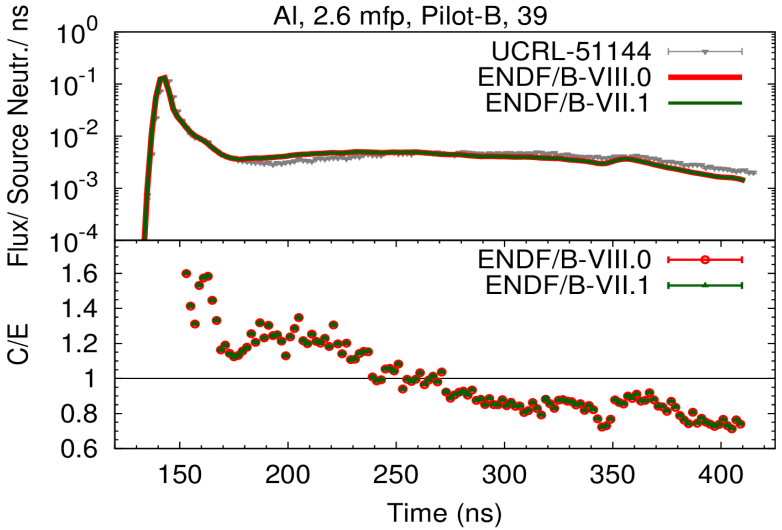


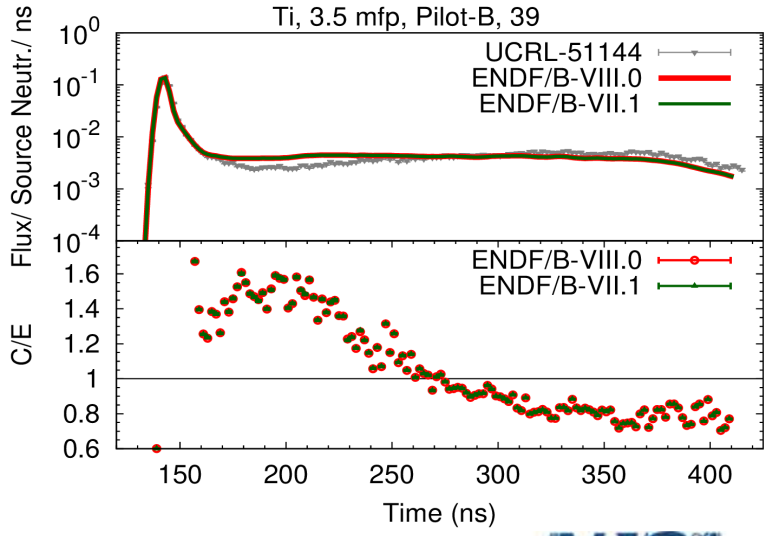


^{27}Al: no change from VII.1 to VIII.0
Titanium: no change from VII.1 to VIII.0

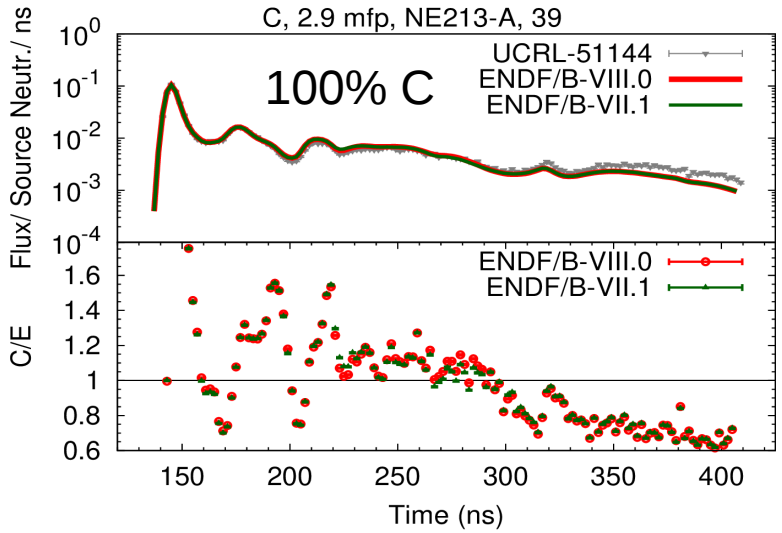


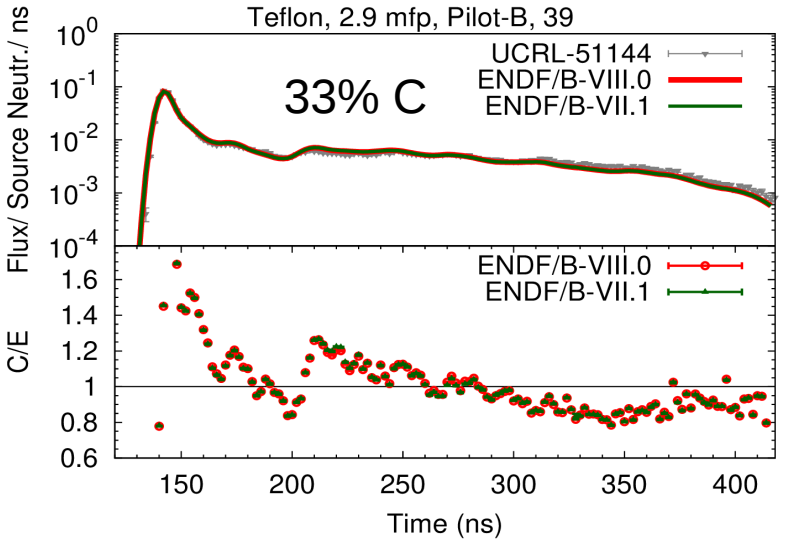


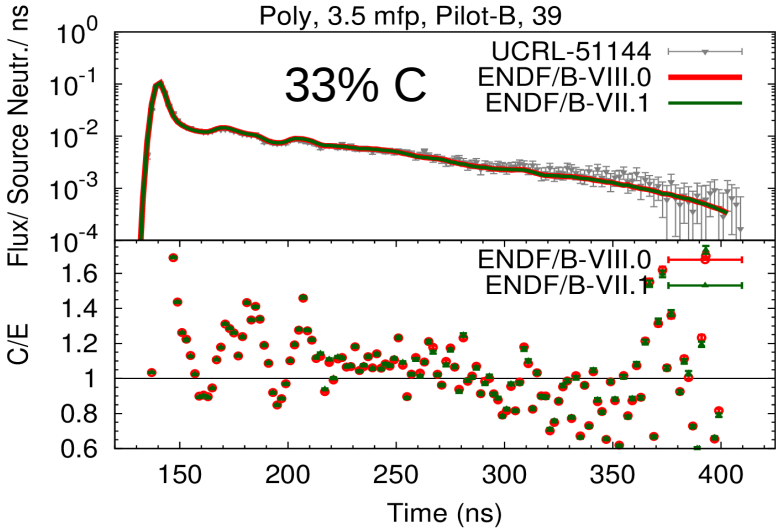


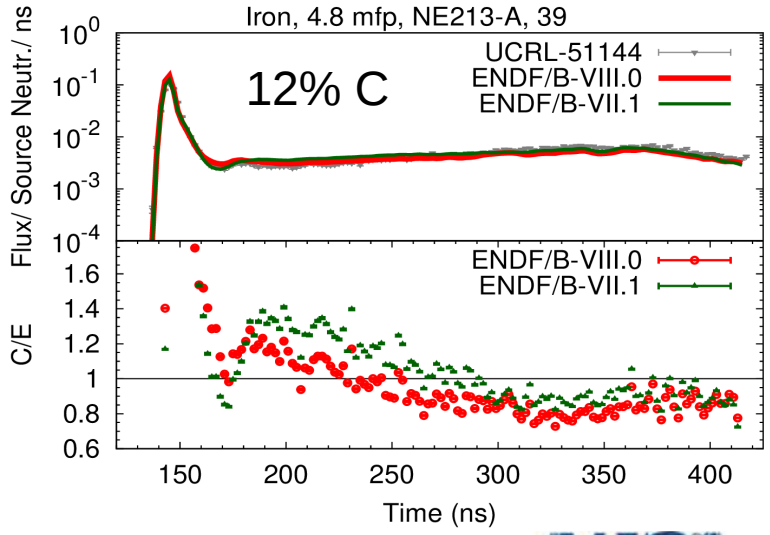


Carbon: small change from VII.1 to VIII.0, structures can be observed in many spheres containing C

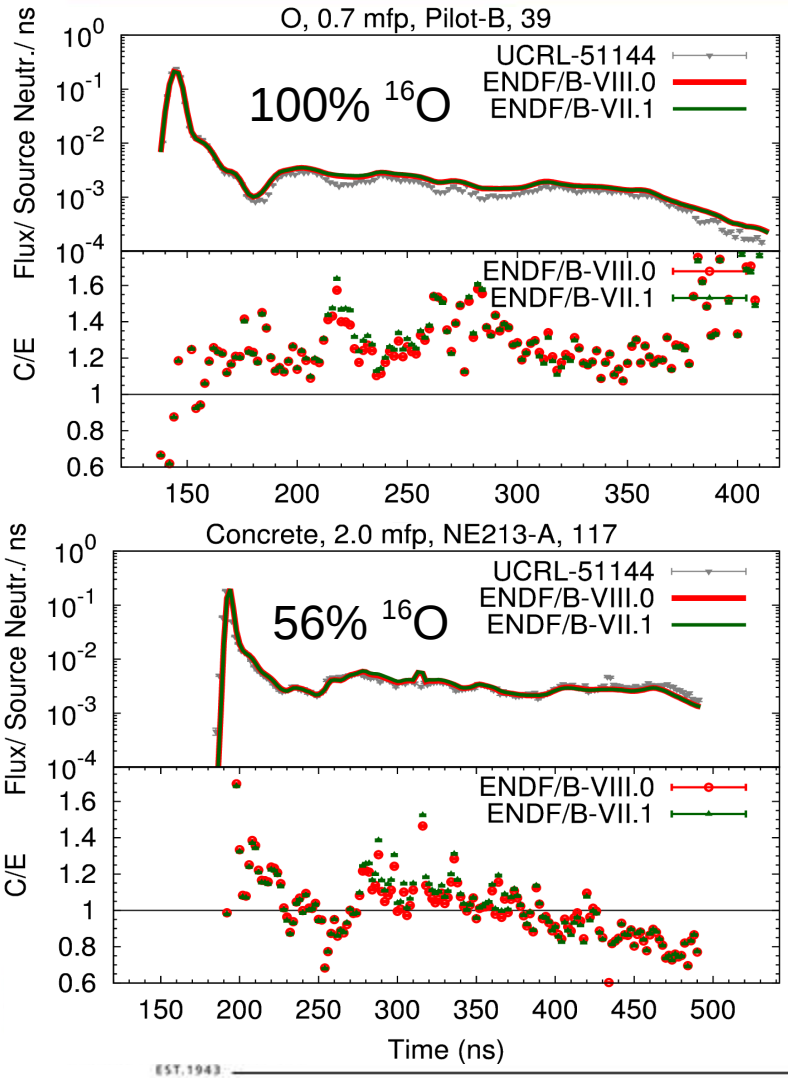


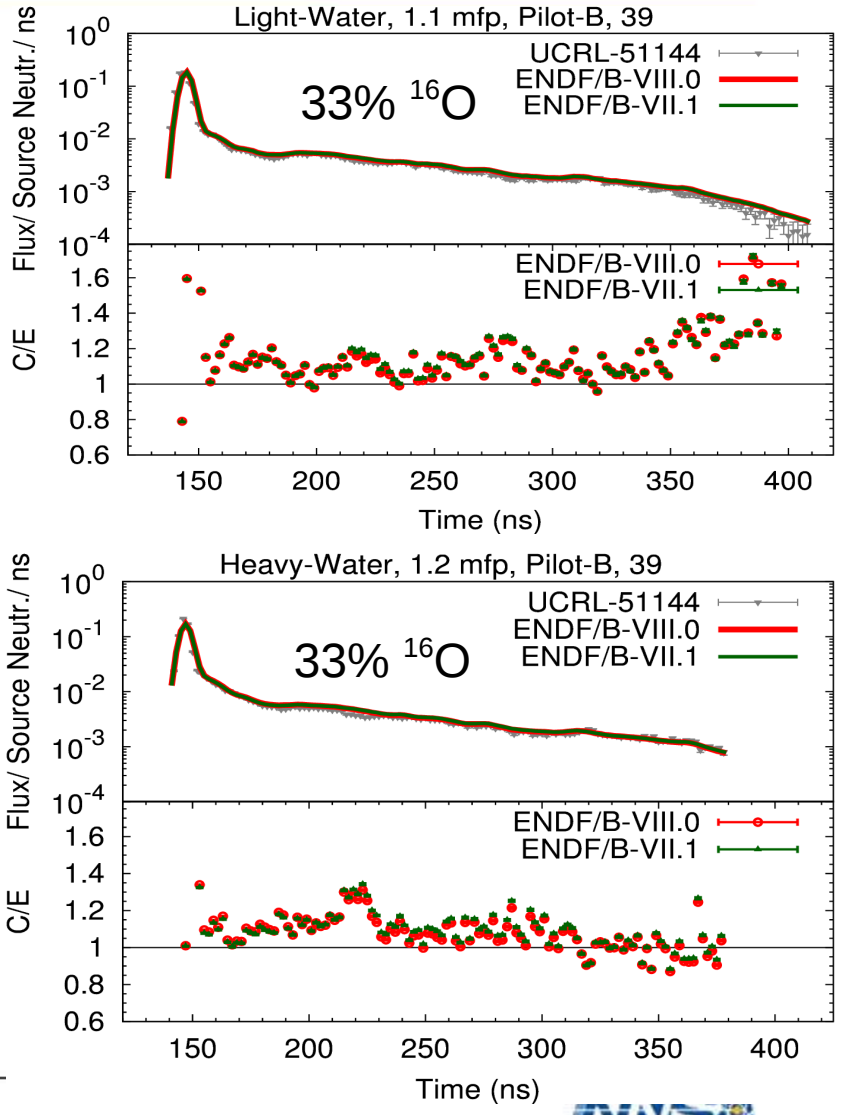




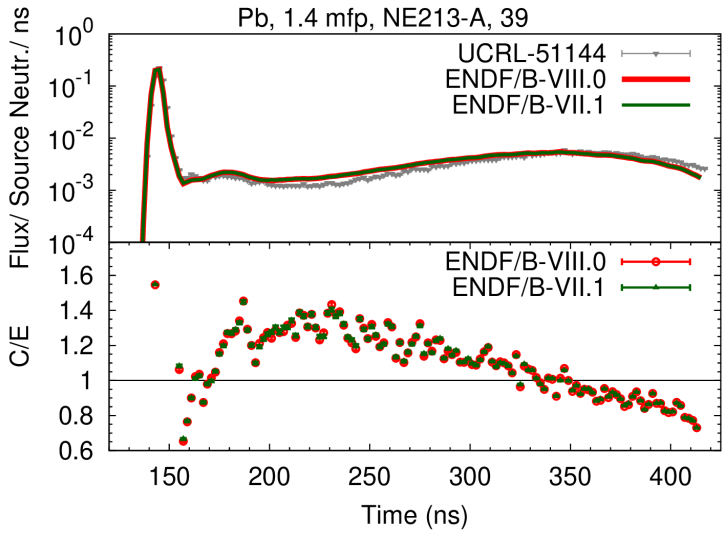


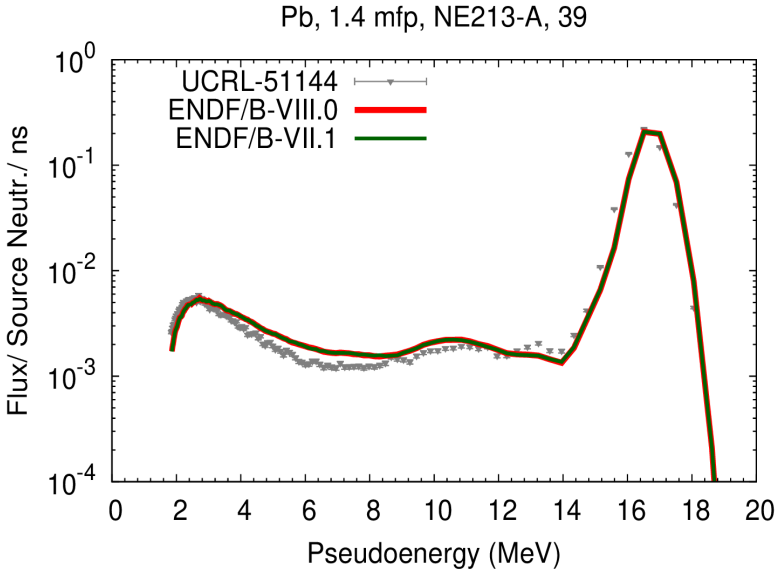
^{16}O: small improvements from VII.1 to VIII.0, structures observed in spheres containing ^{16}O





Lead: negligible changes from VII.1 to VIII.0

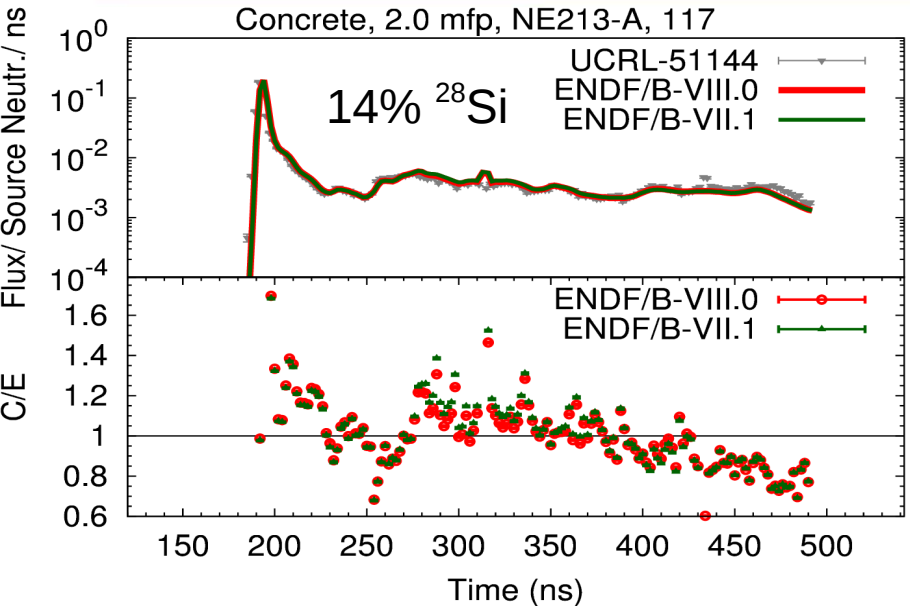


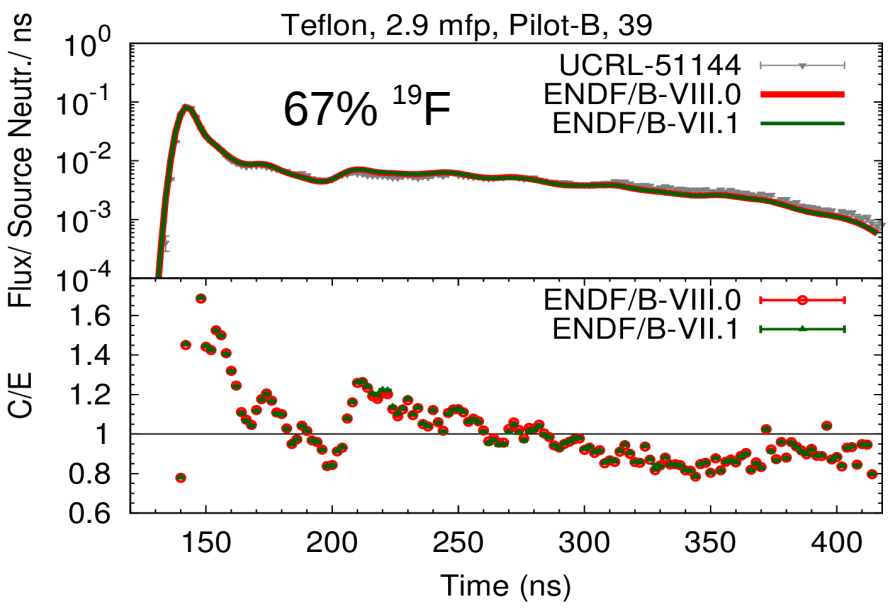


No conclusions could be drawn on these nuclear data files from simulating LLNL pulsed spheres.

- ^{28}Si: carried over from VII.1 to VIII.0
- ^{19}F: carried over from VII.1 to VIII.0
- Iron: significant work from VII.1 to VIII.0

^{28}Si: no change from VII.1 to VIII.0
^{19}F: no change from VII.1 to VIII.0

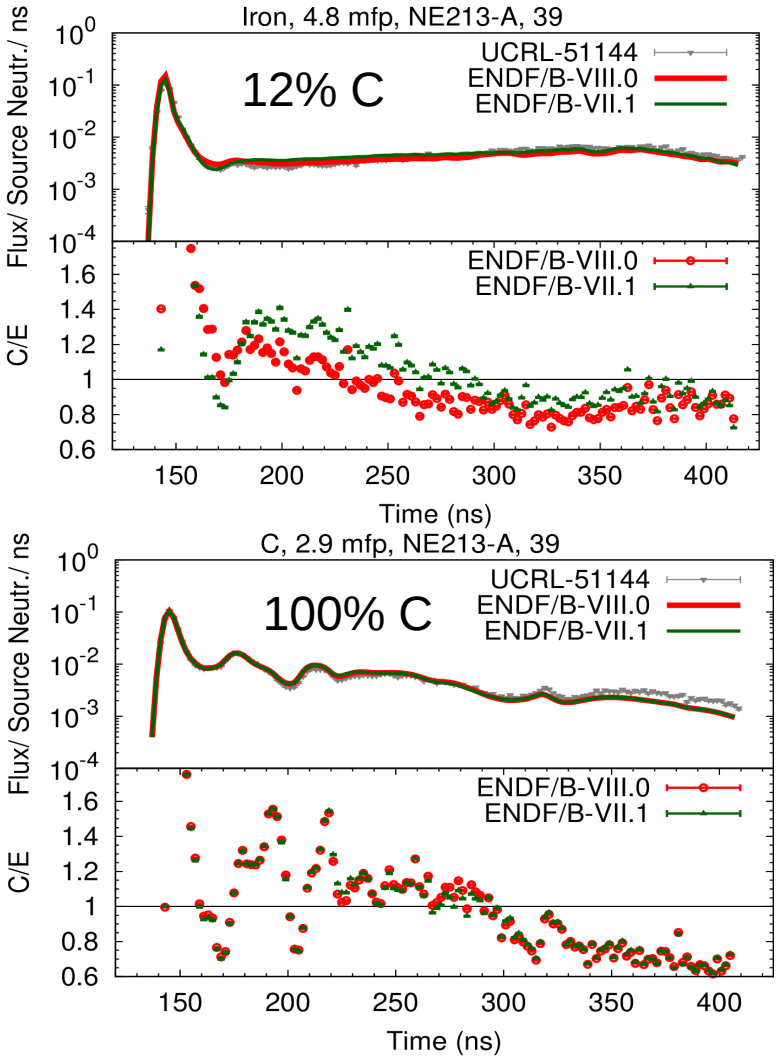




Differences between simulation and experiment could be attributed to ^{16}O only, but not fully conclusive given the small ^{28}Si content.

Differences between simulation and experiment could be attributed to C only, but not fully conclusive.

Iron: improvements from VII.1 to VIII.0, structures can be observed in many spheres containing C

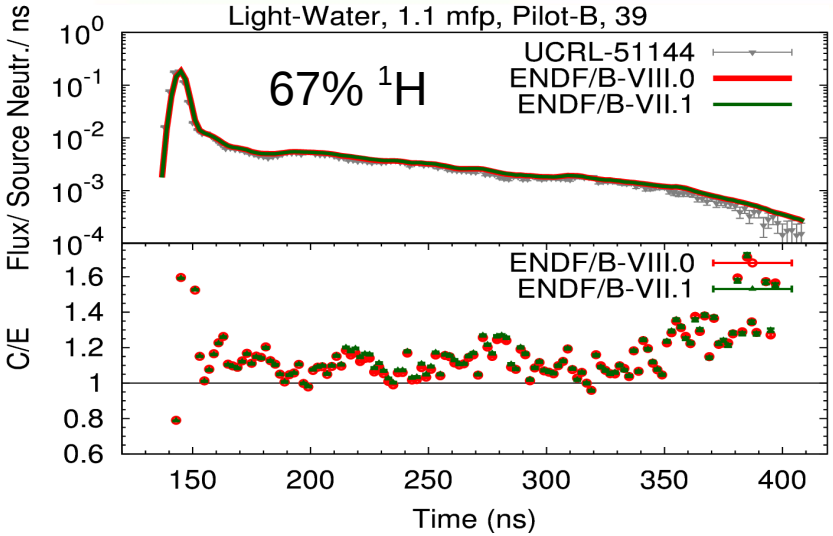


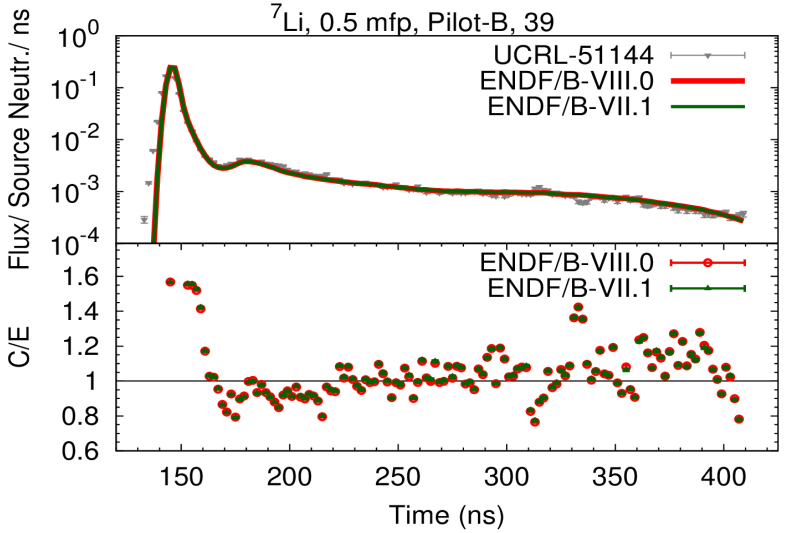
Some of the structures in the iron pulsed spheres could be caused by C. The LLNL pulsed sphere validation is not fully conclusive. Further benchmarks should be studied, e.g., Ohio pulsed spheres.

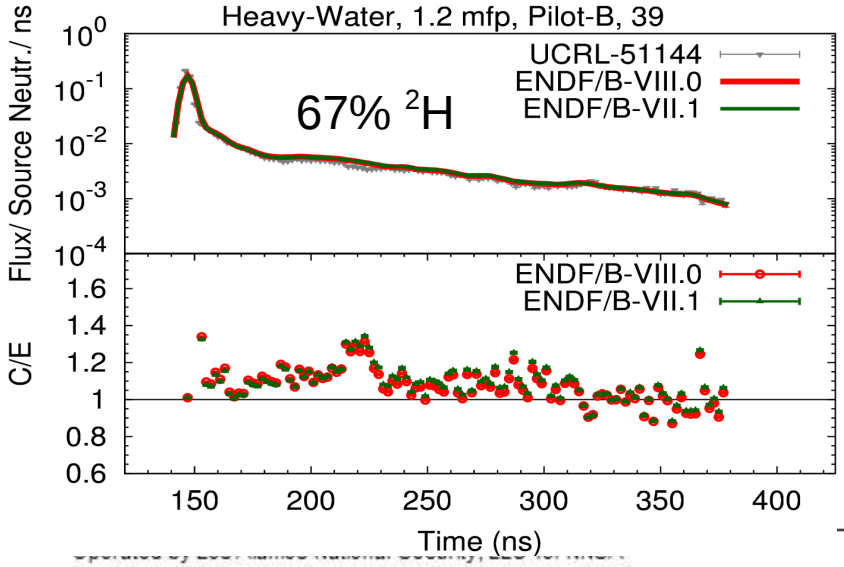
These nuclear data files performed well in simulating LLNL pulsed spheres.

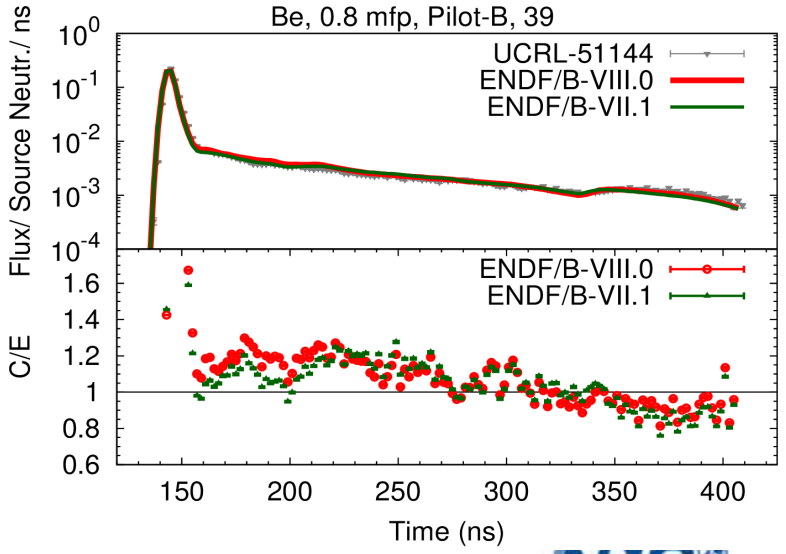
- ^{1}H: some changes from VII.1 to VIII.0
- ^{2}H: some changes from VII.1 to VIII.0
- ^{7}Li: carried over from VII.1 to VIII.0
- ^{9}Be: carried over from VII.1 to VIII.0, except for elastic and (n,2n) angular and energy distributions
- ^{14}N: carried over from VII.1 to VIII.0
- ^{235}U: significant work
- ^{238}U: significant work
- ^{239}Pu: significant work

$^{1/2}$H: small changes, ^{7}Li: no changes from, ^{9}Be: visible changes from VII.1 to VIII.0,









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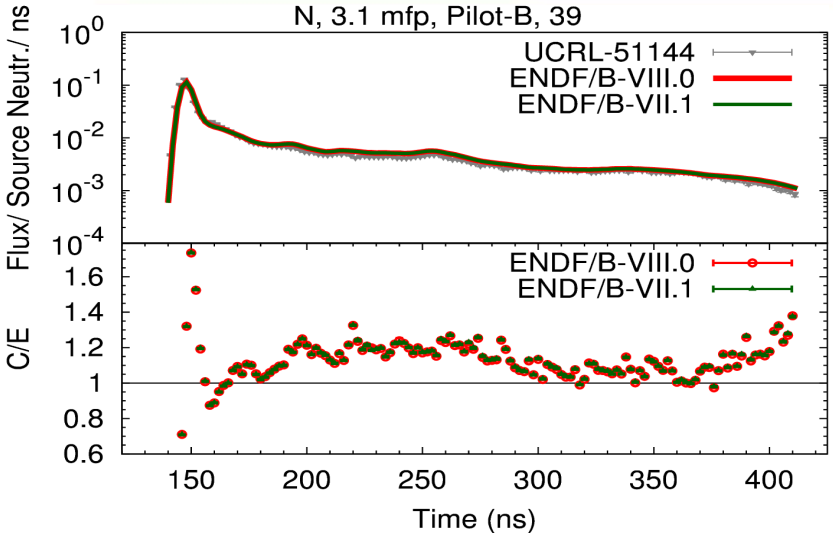
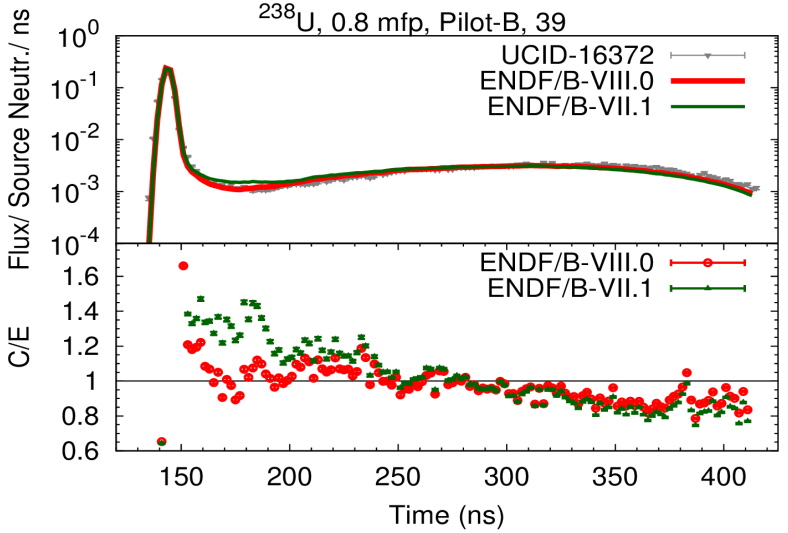
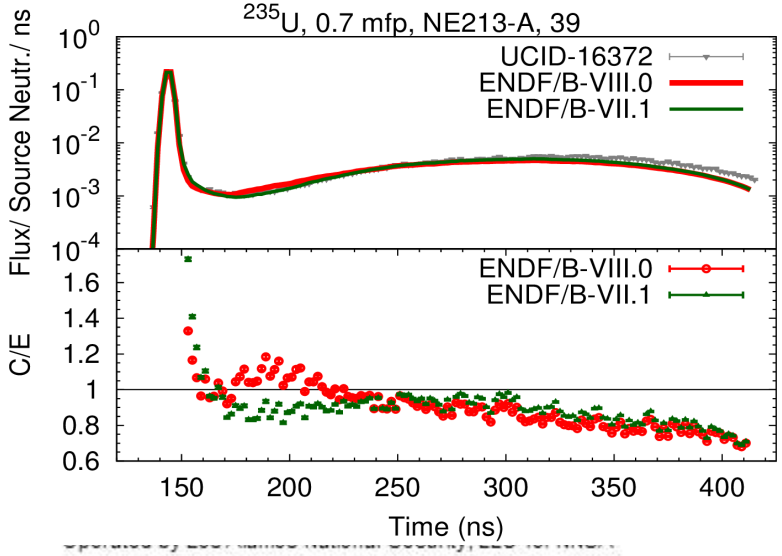
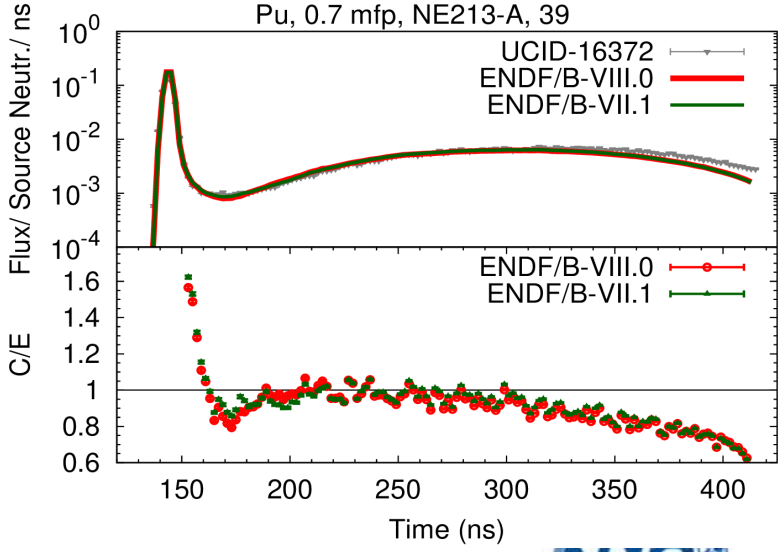
^{14}N: no changes from, ^{239}Pu: small changes, ^{235,238}U: improvements from VII.1 to VIII.0,









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Summary

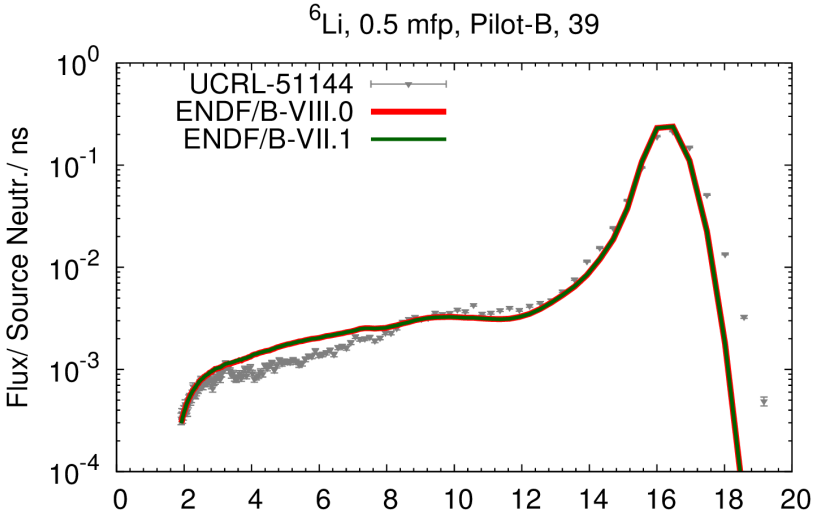
- 75 LLNL pulsed spheres of 20 materials were simulated using ENDF/B-VII.1 and ENDF/B-VIII.0 and compared to exp. data.
- **Nuclear data files performing well: ^{1,2}H,^{7}Li, ^{9}Be, ^{14}N, ^{235,238}U, ^{239}Pu**
- **Inconclusive: ^{14}F, ^{28}Si, ^{54,56}Fe**
- **Nuclear data files performing imperfectly: ^{6}Li, ^{12}C, ^{16}O, $^{24\text{-}26}$Mg, ^{27}Al, $^{46\text{-}50}$Ti,$^{206\text{-}208}$Pb**
- **Improvements in simulating LLNL pulsed spheres from VII.1 to VIII.0: ^{16}O, ^{54,56}Fe, ^{235,238}U**

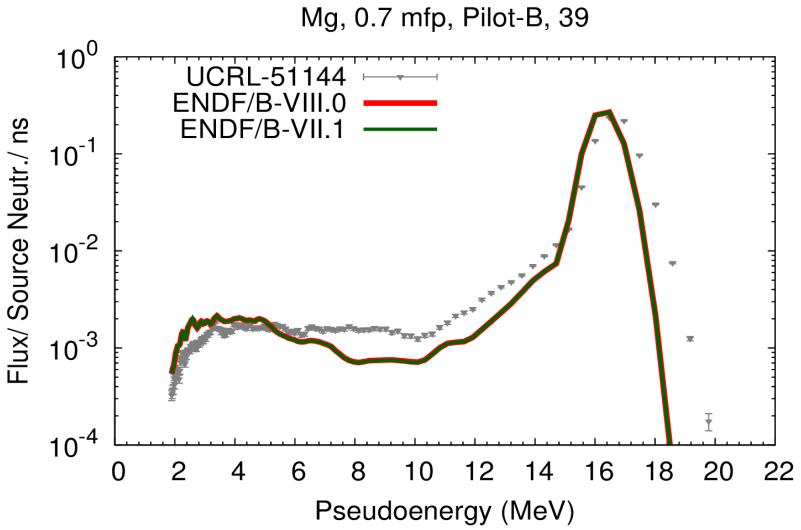
Thank you for your attention!

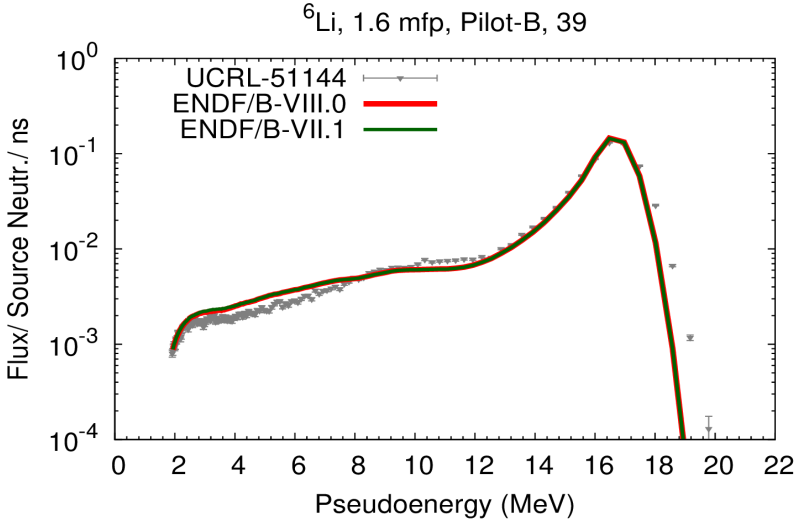
Backup.

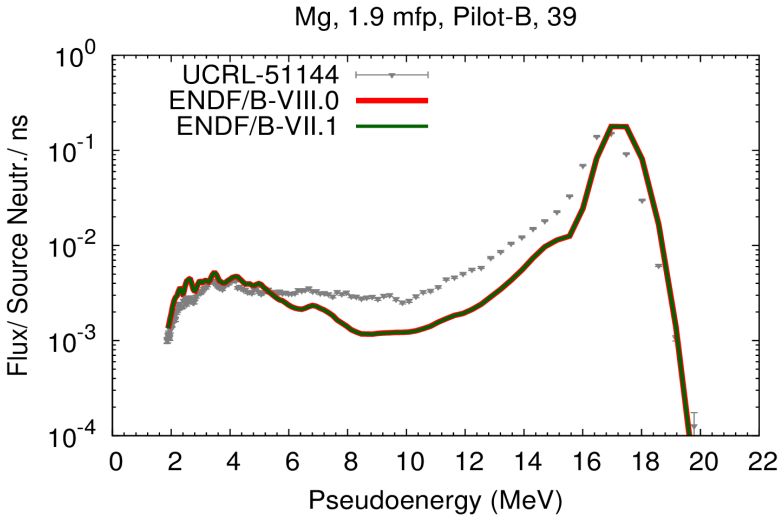
TOF spectra of experiment and calculation were converted to pseudo-energy using the same algorithm.

^{6}Li: minimal change from VII.1 to VIII.0
Magnesium: no change from VII.1 to VIII.0, exp ok?

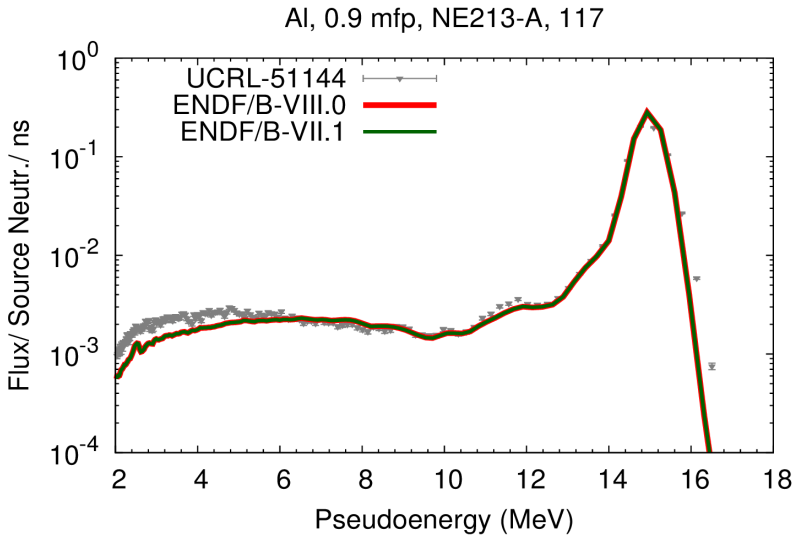


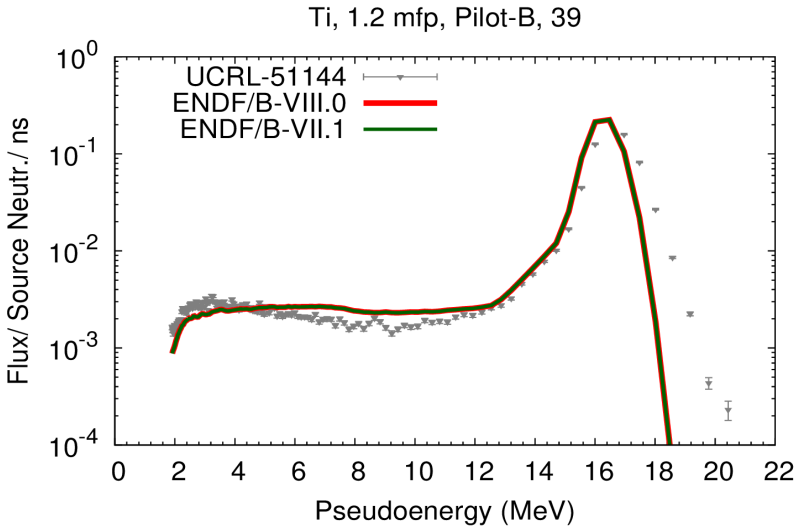


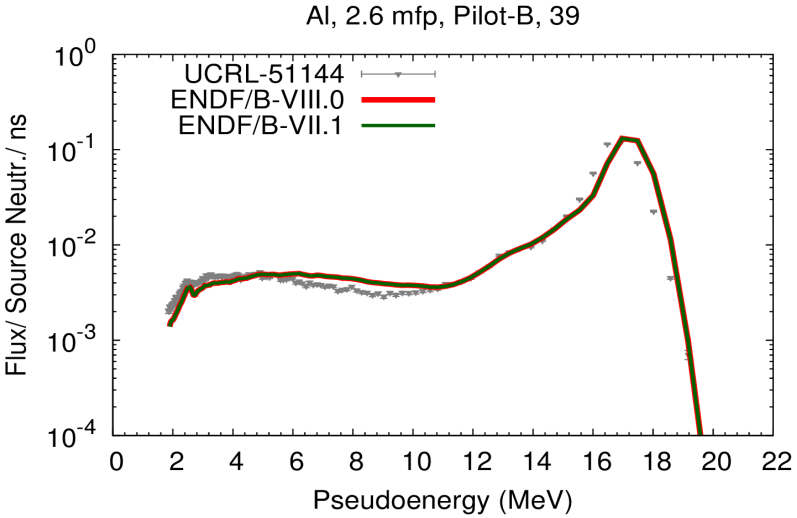


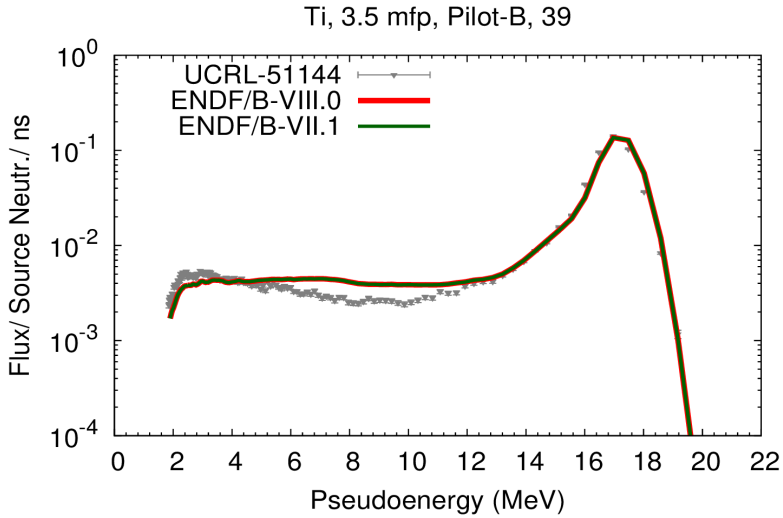


^{27}Al: no change from VII.1 to VIII.0
Titanium: no change from VII.1 to VIII.0

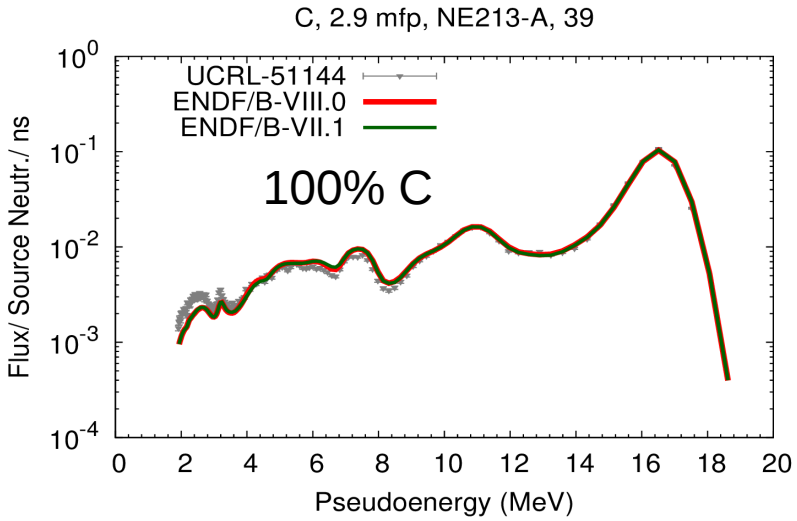


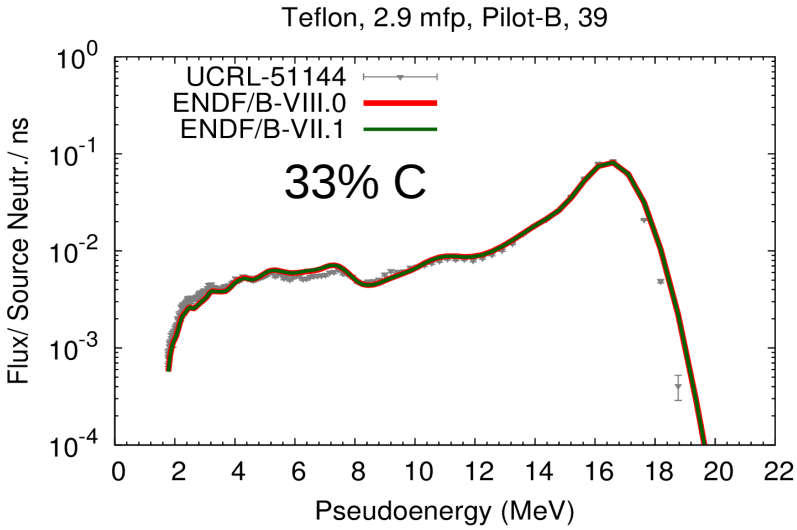


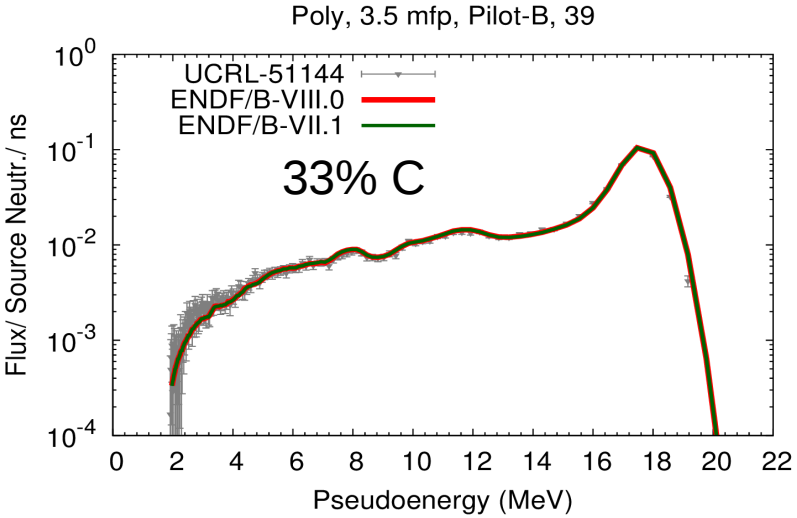


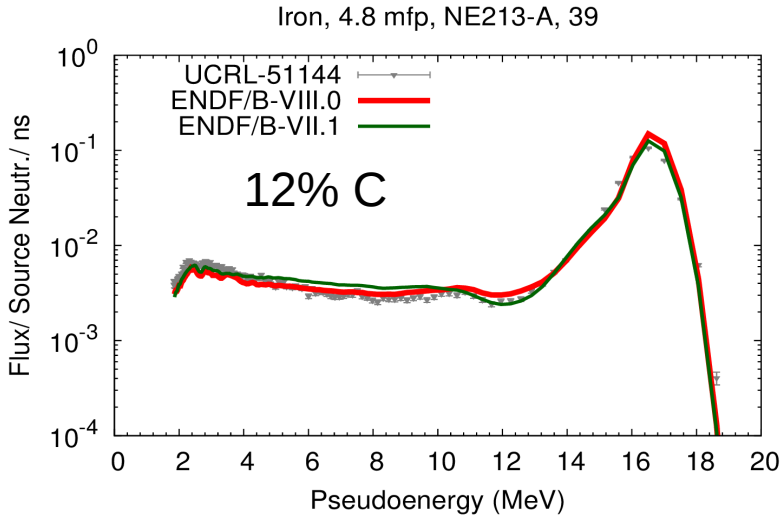


Carbon: small change from VII.1 to VIII.0, structures can be observed in many spheres containing C

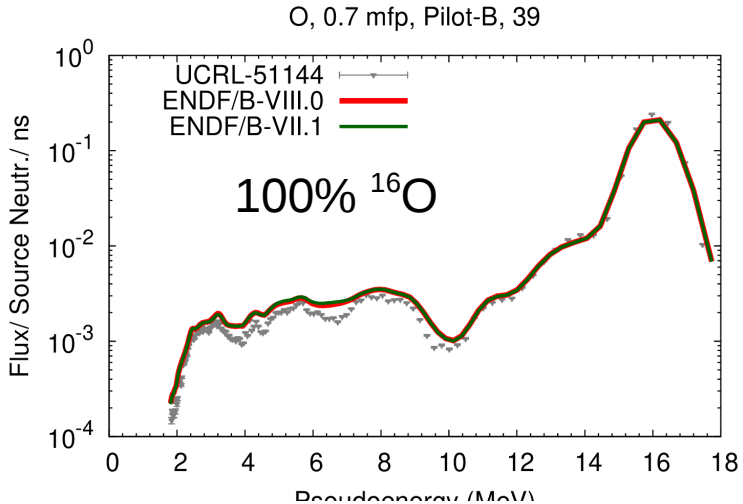


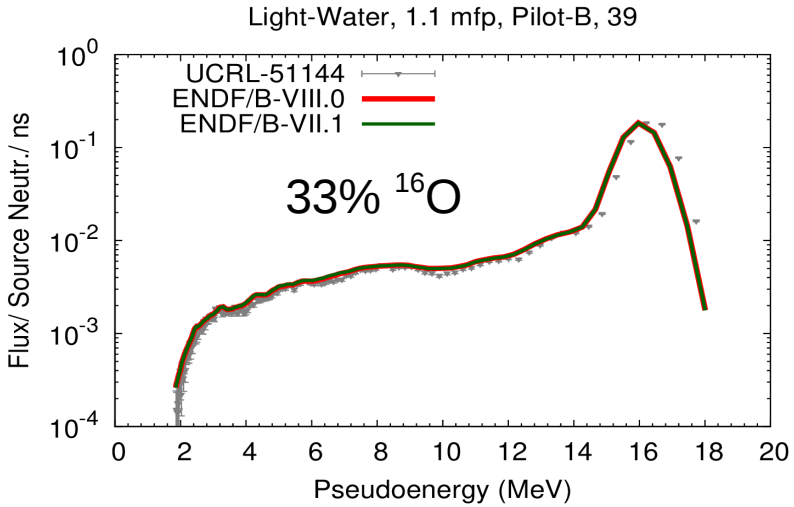


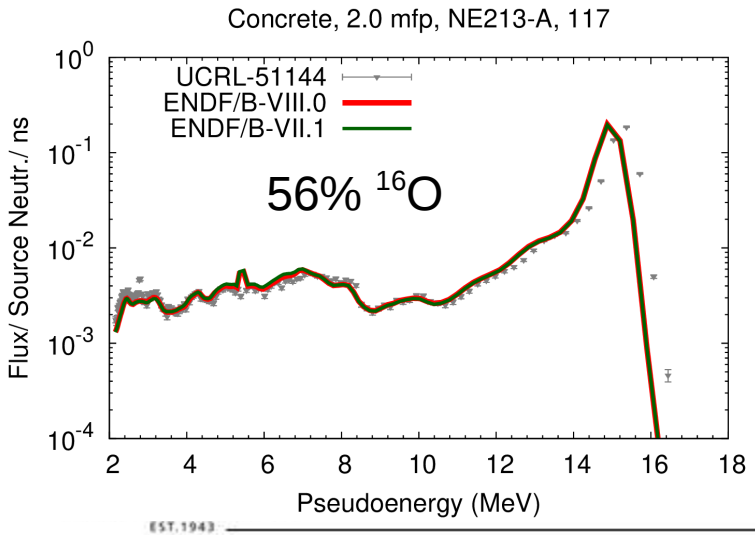


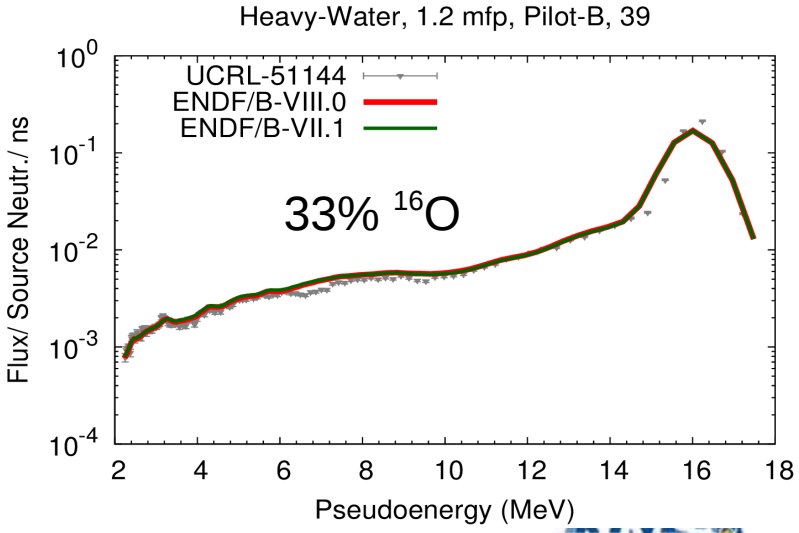


^{16}O: small improvements from VII.1 to VIII.0, structures observed in spheres containing ^{16}O

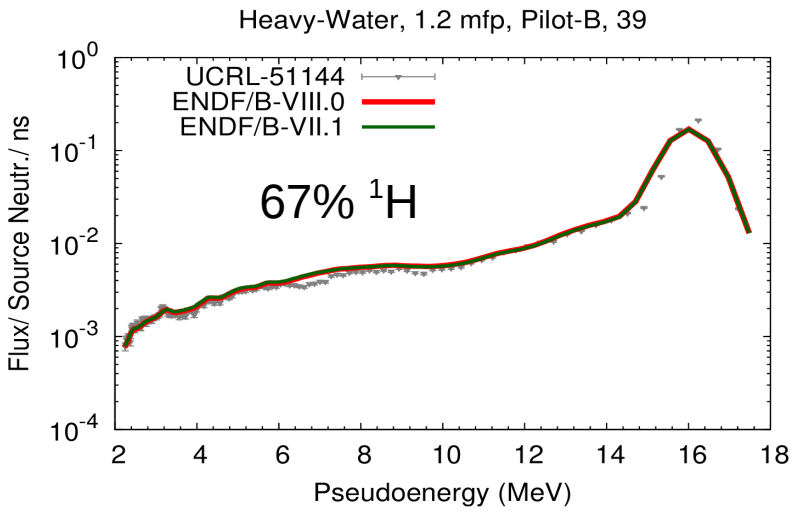


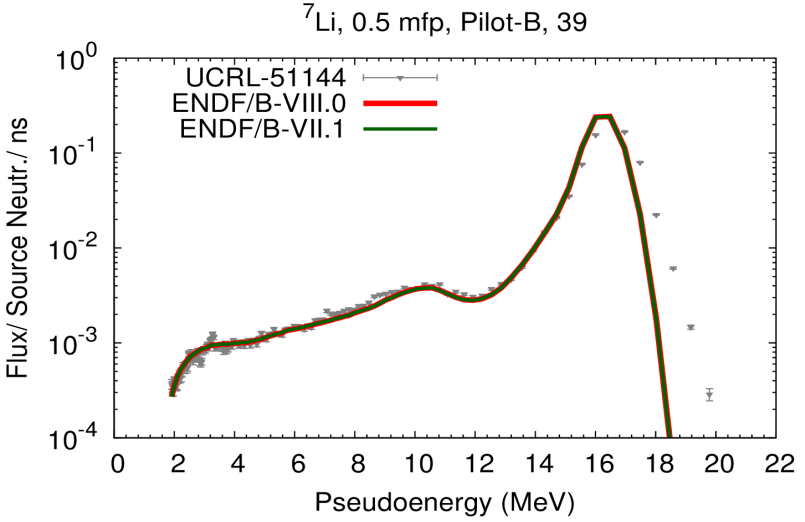


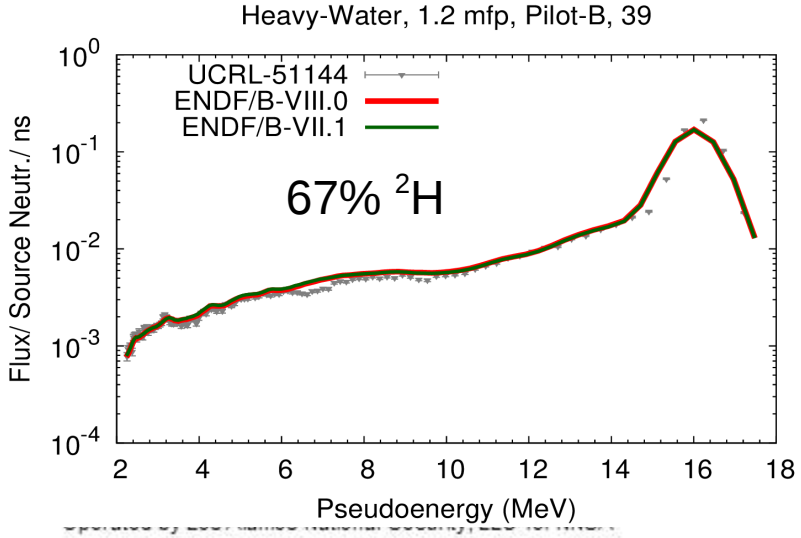


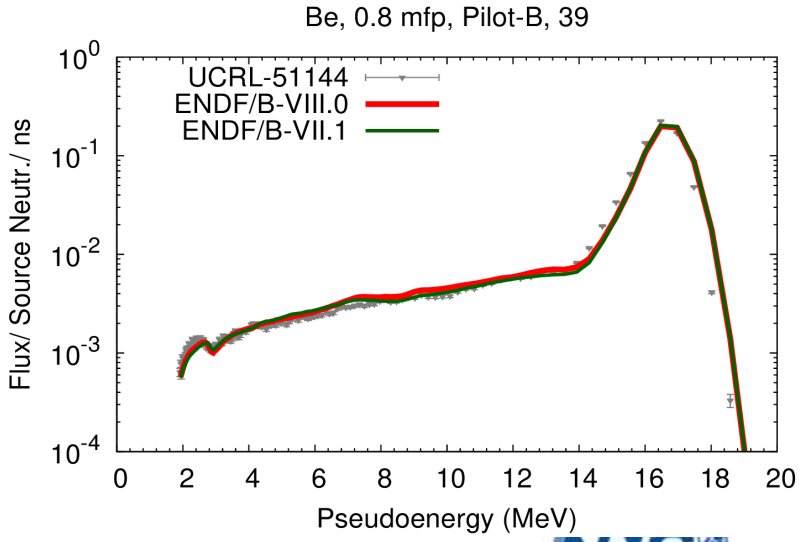


$^{1/2}$H: small changes, ^{7}Li: no changes from, ^{9}Be: visible changes from VII.1 to VIII.0,









^{14}N: no changes from, ^{239}Pu: small changes, ^{235,238}Be: improvements from VII.1 to VIII.0,