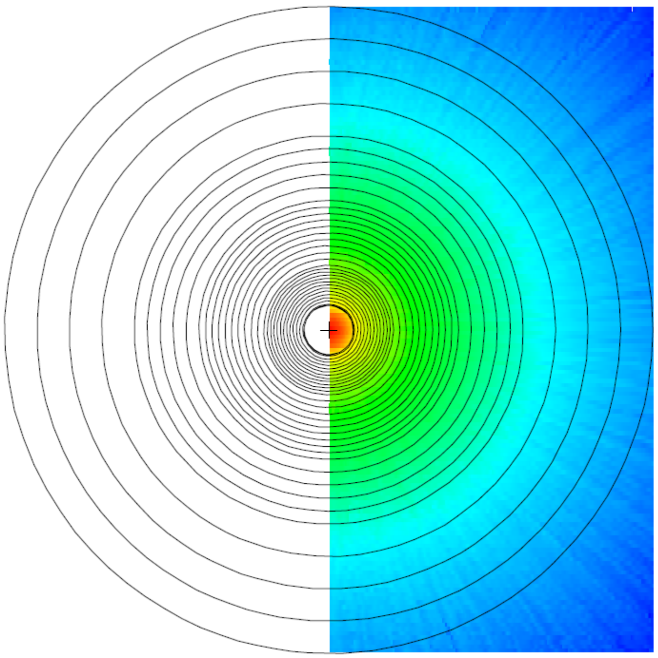

Neutron Transmission Calculations for Several Moderated Plutonium Systems

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Summary

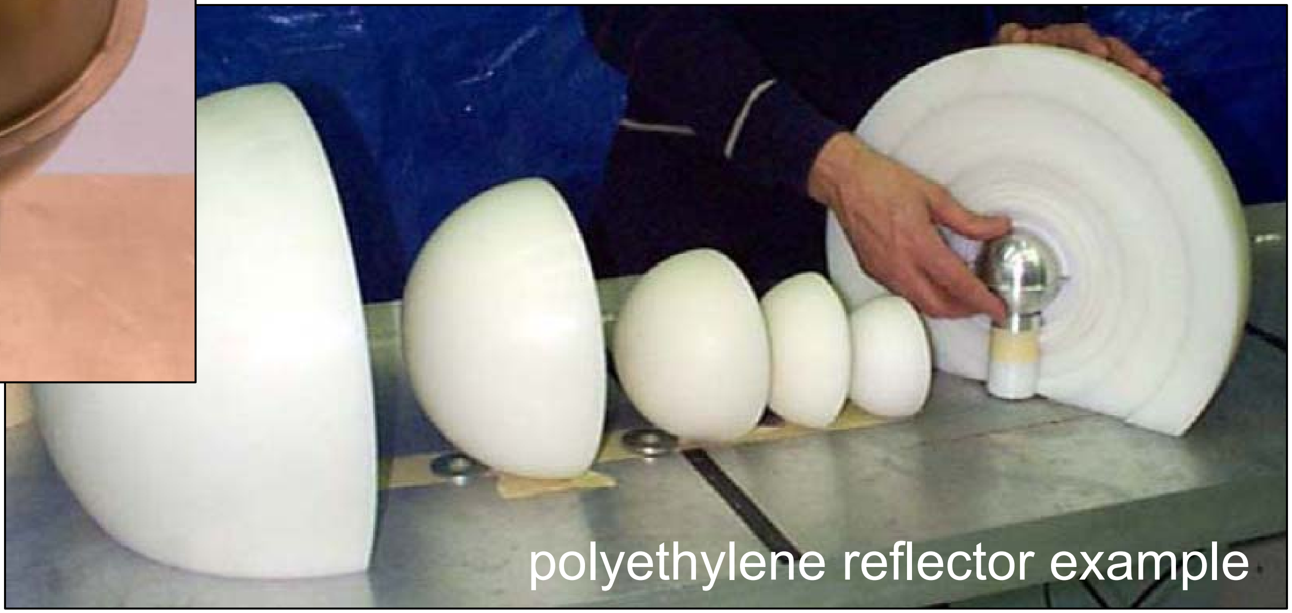
In this work we use MCNP6, the merged version of two widely used Los Alamos Monte Carlo codes (MCNP and MCNPX) to study neutron transport characteristics for several moderated plutonium systems. Public release of this new code is planned for the summer of 2010 and internal testing is ongoing at Los Alamos.

Portions of our results (e.g. KCODE results and neutron transmission, defined as the ratio of neutrons exiting the moderator to those entering) are shown in the following figures. In terms of subcritical multiplication, water behaves like the HE-related moderators and is quite similar to Composition-B. The cases considered here, save beryllium, are well subcritical. For transmission, proper normalization or scaling of tally results from a KCODE simulation is not an issue because we are interested in the ratio of two tallies. We find good agreement between KCODE and “fixed source” results.

In short, we are interested in neutron transmission effects of various hydrogenous materials

The "beryllium-reflected plutonium" sphere, or BeRP ball, has retained an earlier conceived reflector name

Fabricated in 1980, the stainless steel clad 4.484 kg α-Pu sphere has been used for multiple criticality experiments at Los Alamos and the Nevada Test Site



"BeRP Ball" Information

- E. Brandon, Assembly of ^{239}Pu Ball for Criticality Experiment, Internal LASL memorandum CMB-11-FAB-80-65 (23 Oct 1980)

  mean dia. **75.876** mm, **4483.884** g, **19.655** g/cc, composition, and impurity info

- H. Atwater, Preliminary Calculations for Beryllium Reflected Plutonium Sphere Criticality Experiment, Internal memorandum Q2-85-5045A (22 Apr 1985)

  rad. **3.7938** cm, **4.5** kg, **19.655** g/cc, SS304 IR=**3.827** OR=**3.8558** cm

wt%	**as built***	**30 yr**
238	0.02	0.0158
239	93.735	93.943
240	5.95	5.9495
241	0.2685	0.0635
242	0.028	0.0281

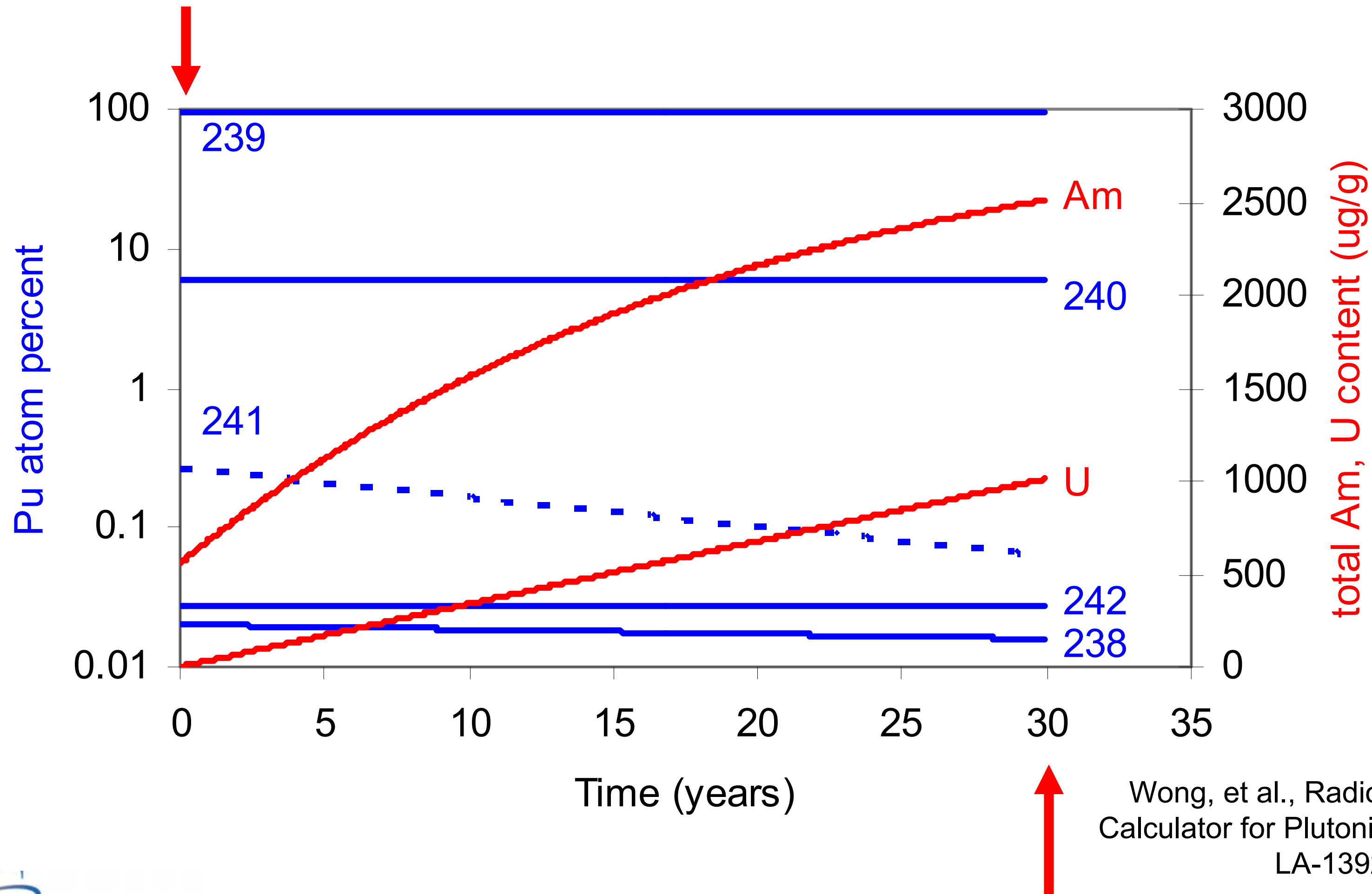
* Average of two samples

10 ppm iron, 230 ppm carbon, 335 ppm gallium, trace elements

growth	Am^{241}	U^{234}	U^{235}	U^{236}	U^{238}
ug/g	2509	41	787	183	0.015

19.604 g/cc (preserve mass, r)

"BeRP Ball" SNM Content

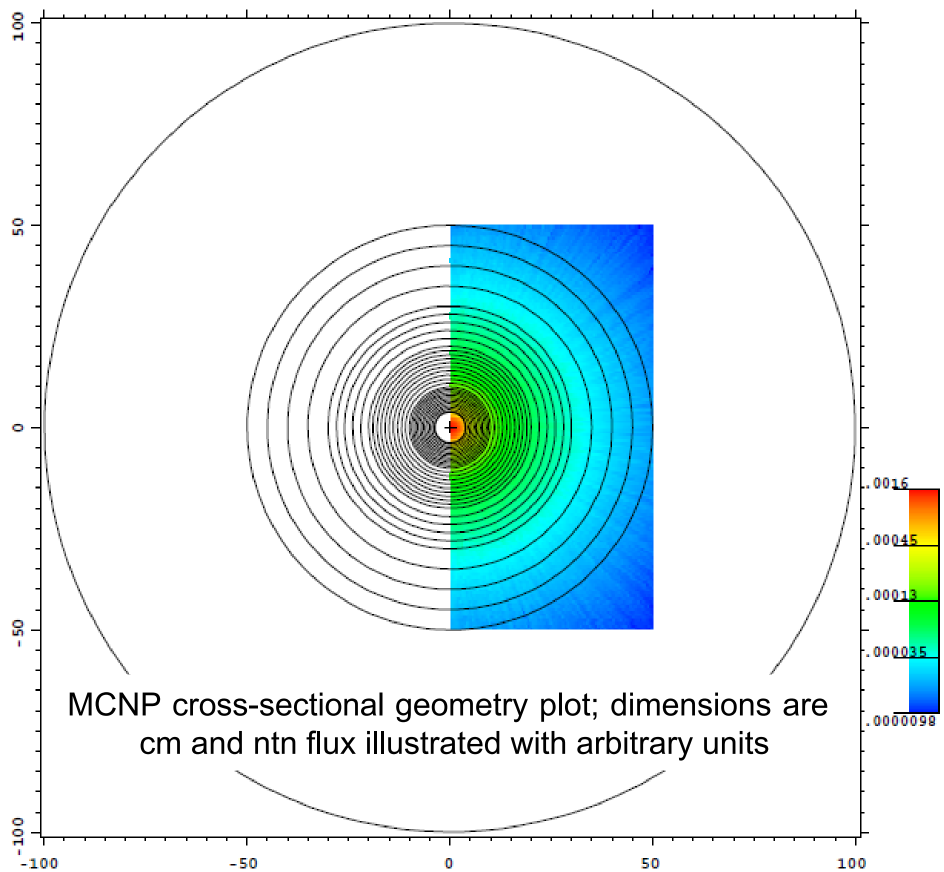


Wong, et al., Radioactive Decay Calculator for Plutonium Materials, LA-13920-MS (2002)

All calculations were made with MCNP 6.1.58 on LANL's *yellowrail* machine with this simple spherical geometry

Concentric spheres of increasing moderator thickness were placed around the plutonium with radii extending 0.5-46 cm beyond the cladding; varied increments were 0.5 cm [0:6], 1.0 cm [6:16], 2.0 cm [16:26], and 5.0 cm [26:46].

Since the outer cladding radius is ~4 cm, the main geometry thus extends to 50 cm.



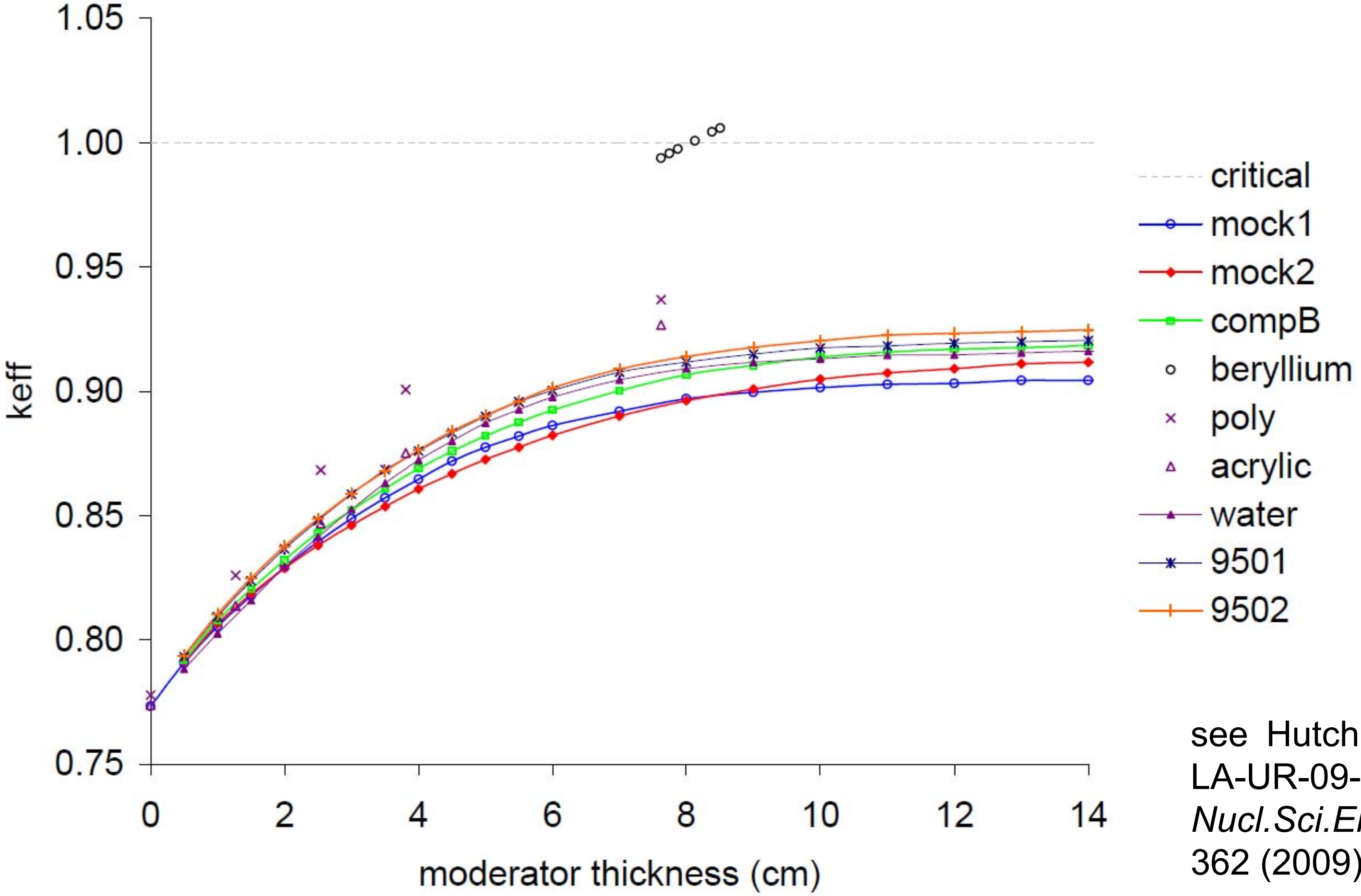
MCNP cross-sectional geometry plot; dimensions are cm and ntn flux illustrated with arbitrary units

For moderation, we arbitrarily selected several common high explosives, including two mock materials

Table I. Atom fractions for several HE moderators

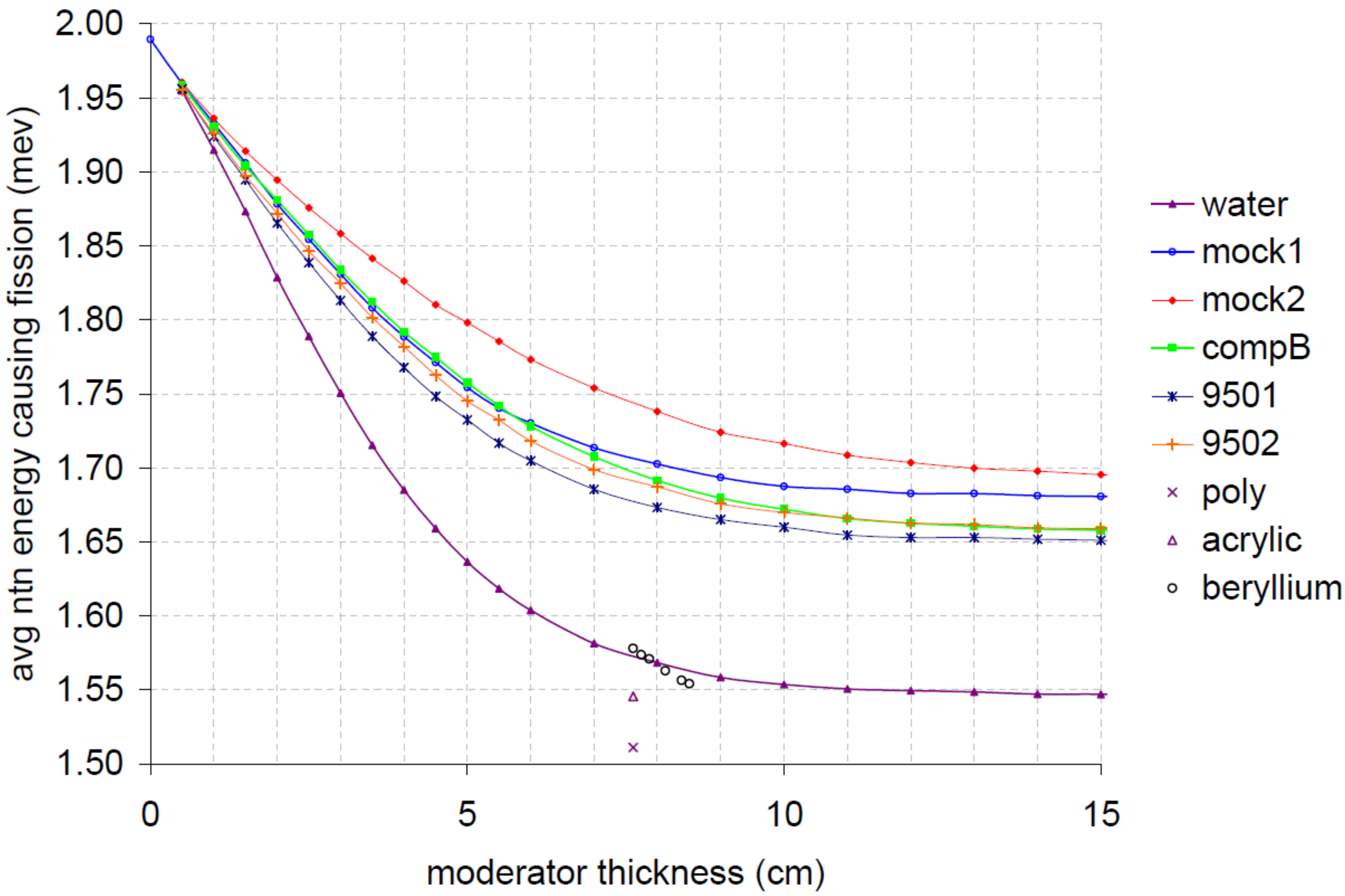
	Mock HE1	Mock HE 2	Comp B	PBX 9501	PBX 9502
g/cc	1.60	1.89	1.73	1.83	1.90
H	0.31558	0.20228	0.26639	0.29008	0.24264
C	0.22682	0.21492	0.21926	0.14599	0.25275
N	0.29586	0.17699	0.22848	0.28053	0.24236
O	0.15779	0.27813	0.28586	0.28340	0.24207
F	-	0.05057	-	-	0.01484
Mg	-	0.02528	-	-	-
Si	-	0.03793	-	-	-
Cl	0.00394	0.01391	-	-	0.00534

"KCODE" criticality calculations on an expanded scale with several additional moderators

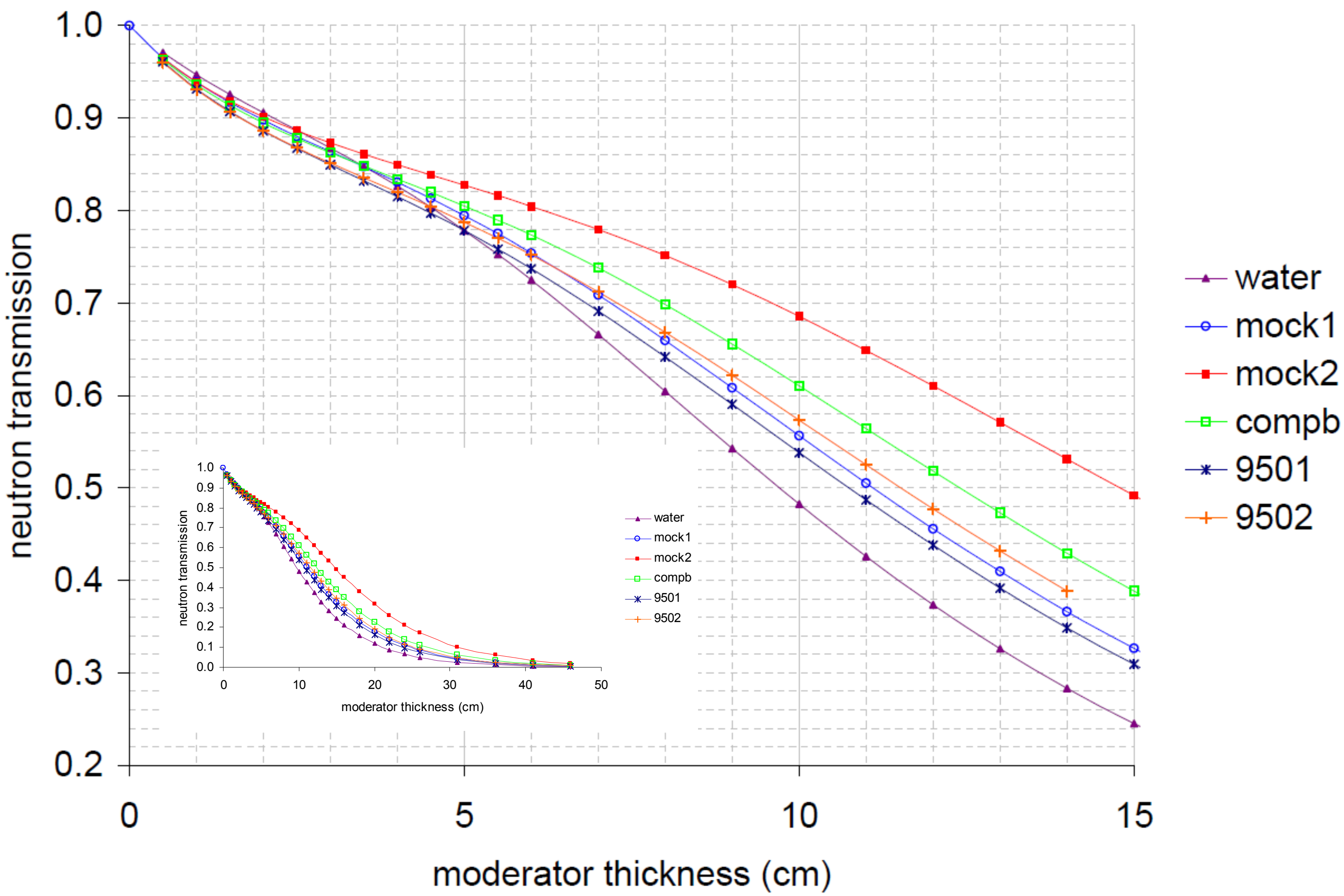


see Hutchinson, et al., LA-UR-09-03130 and *Nucl.Sci.Eng*. **161**, 357-362 (2009)

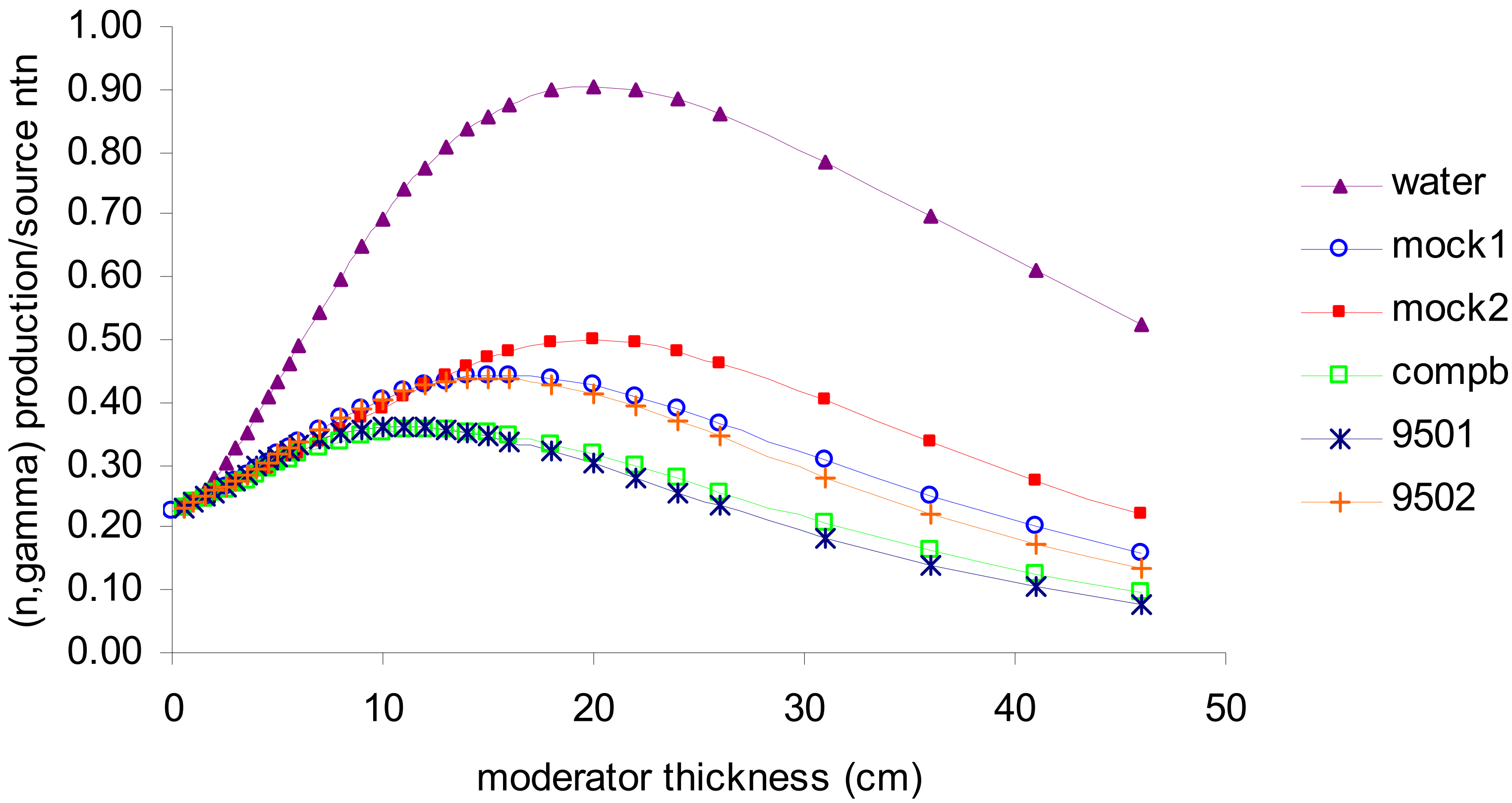
Average energy causing fission for several moderators



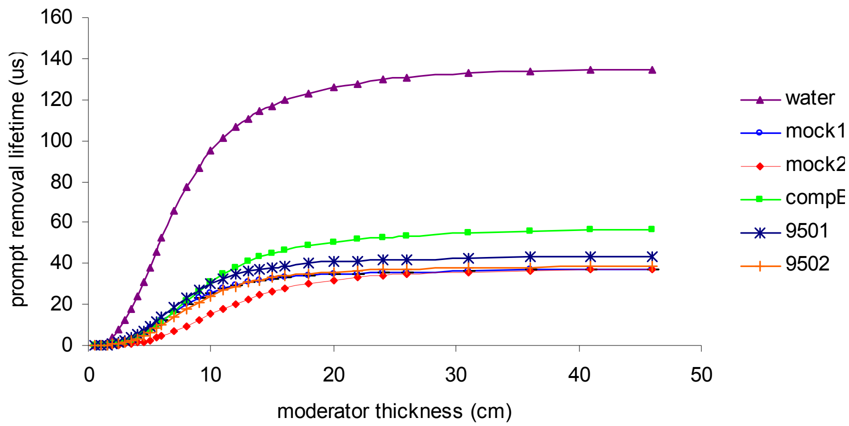
Neutron transmission for several moderators

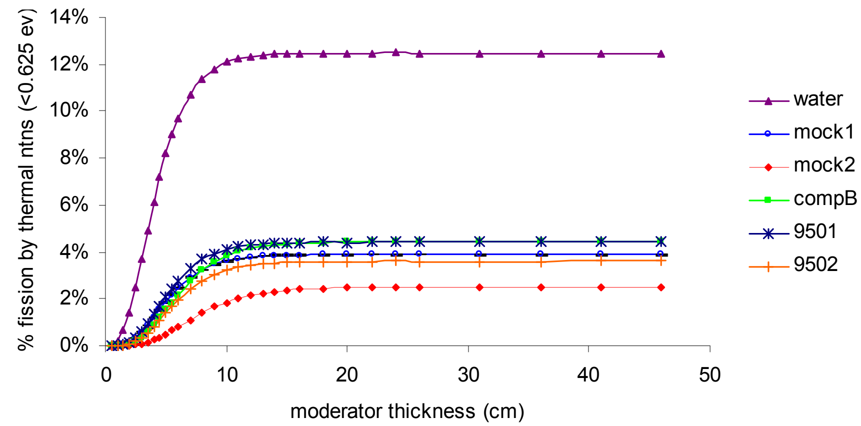


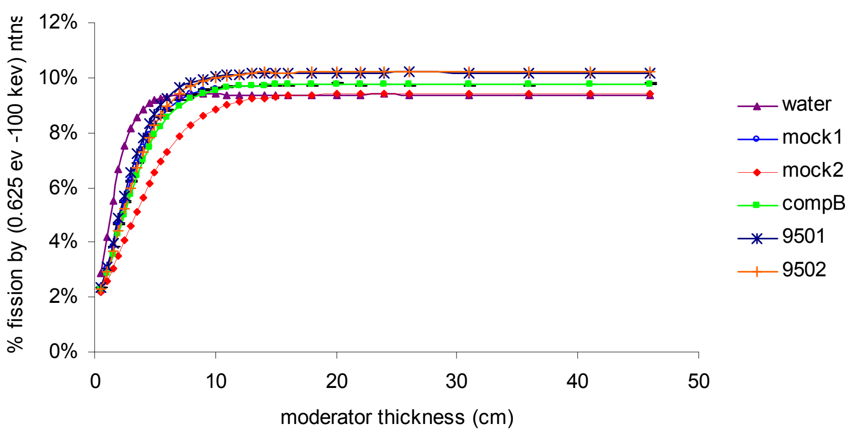
(n,gamma) production

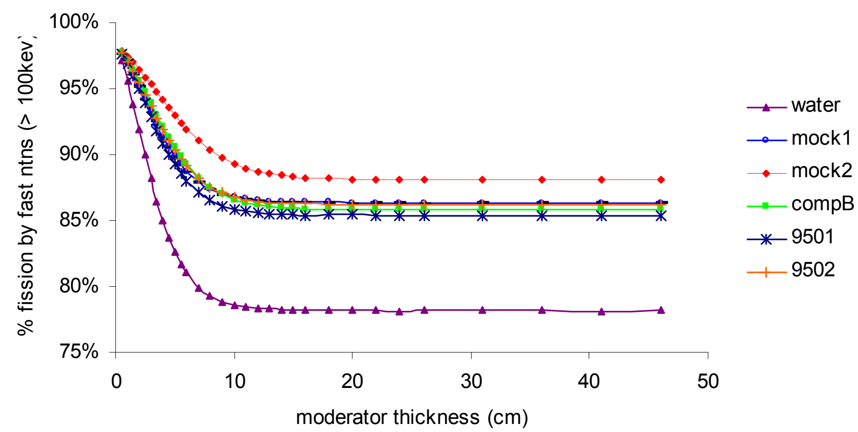


Prompt removal lifetime and fission breakdown









We find good agreement between MCNP “fixed source” and KCODE simulations for transmission and leakage