Validation Testing for Ir, Y, and Tm (Bethe Spheres and Critical Assemblies)

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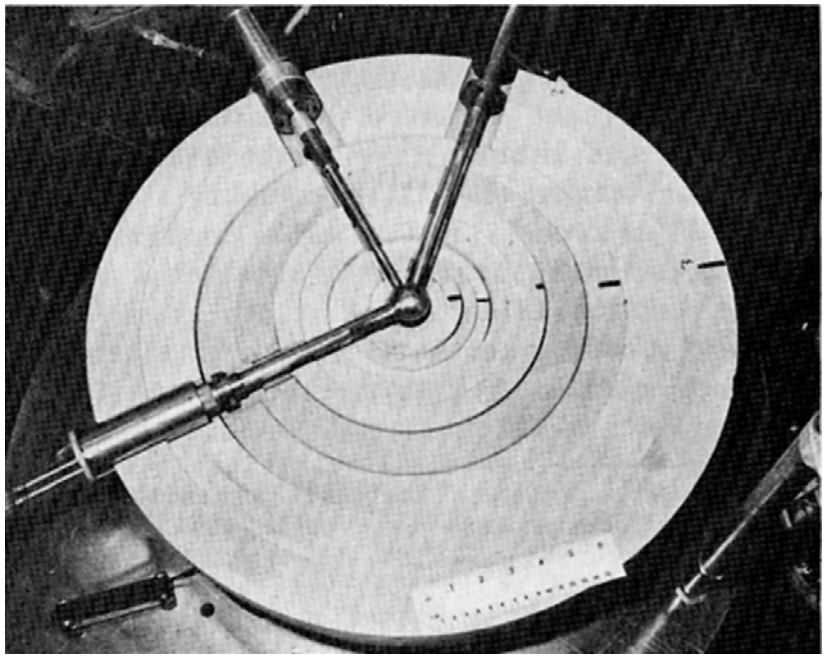
Outline

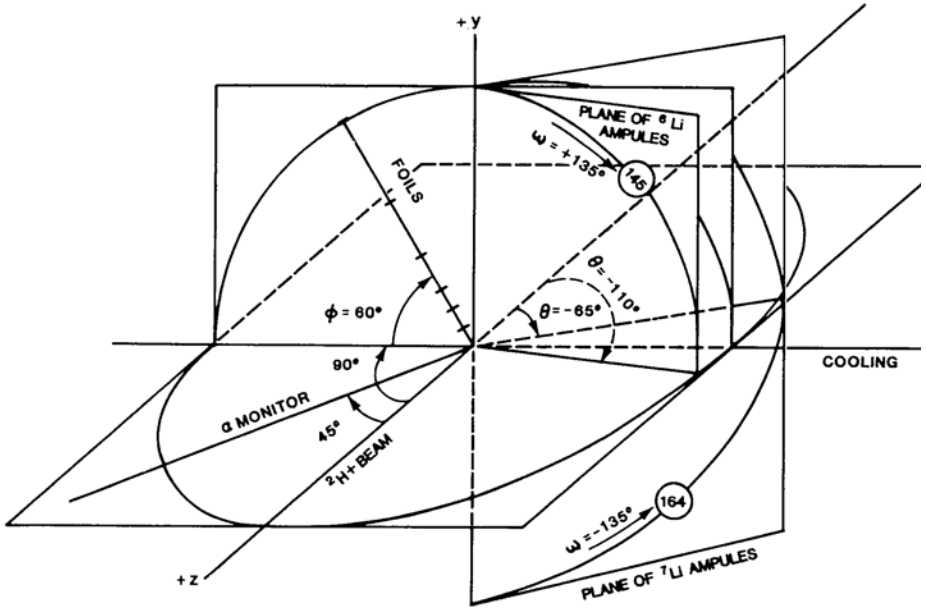
- Tritium production in ampules of ^{6}LiH and ^{7}LiH
  - 14-MeV source at center of an all-^{6}LiD sphere (30 cm), and
  - HEU sphere surrounded by ^{6}LiD
- Various reaction rates measured in both spheres
  - Focus here on Ir, Y, Tm (but others available too, eg 238U, Zr90, 197Au)
  - Testing (n,2n) particularly valuable; (also nn' and n,g)

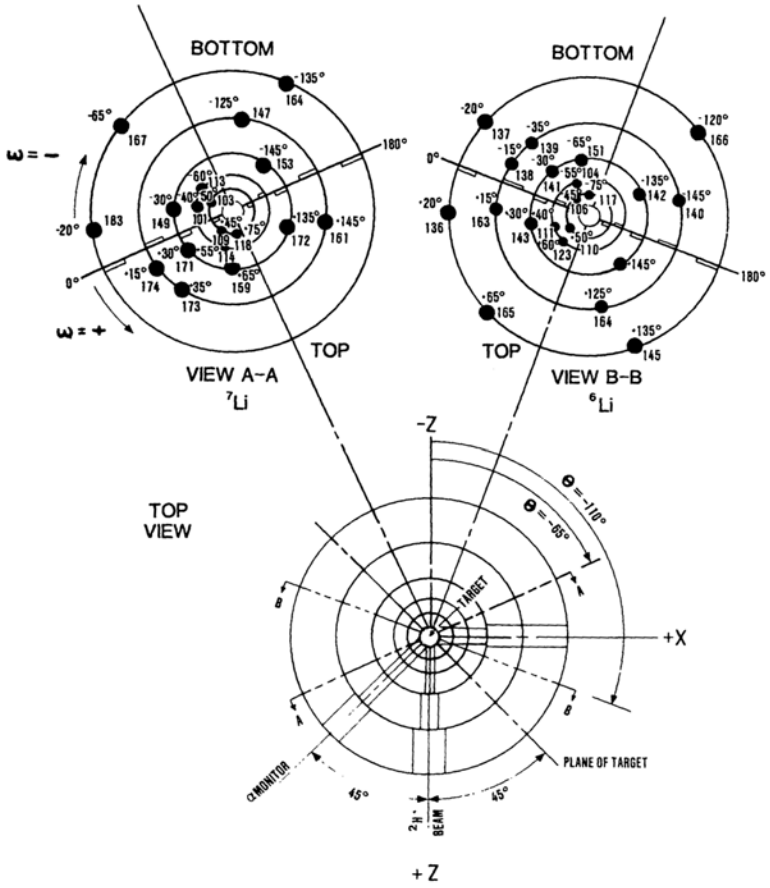
Experimental Setup.
Bethe Spheres - higher energies than critical assemblies

- Performed at the LANL Crockcoft -Walton accelerator in the 1970's
- 14-MeV neutron source using the d(t,n)α reaction in center of sphere of
  - ^{6}LiD
  - Oralloy surrounded by ^{6}LiD
- Small ampules of ^{6}LiH and ^{7}LiH located throughout spheres
- Concrete floor ~ 2 m from center of sphere, located in a metal building



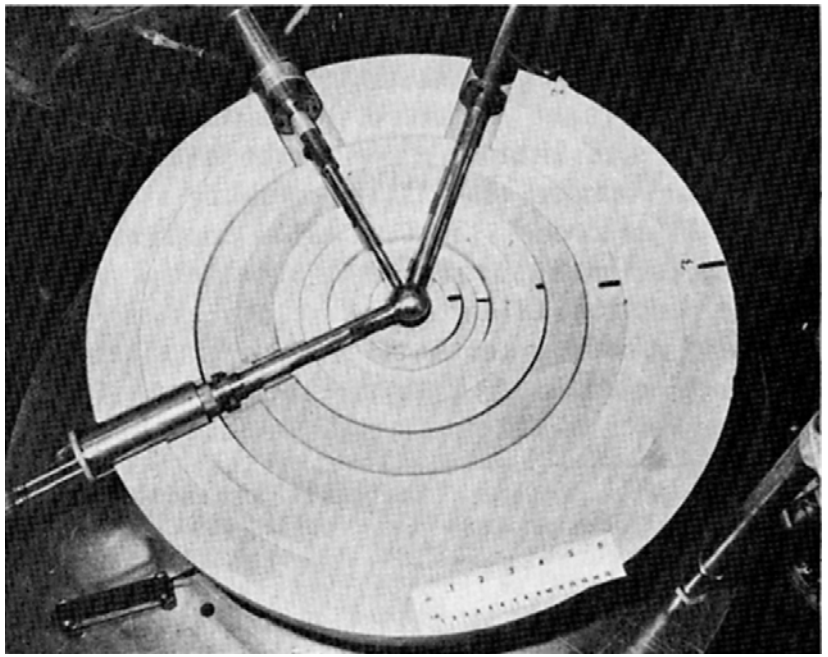
Placement of ampules for ^{6}LiD experiment





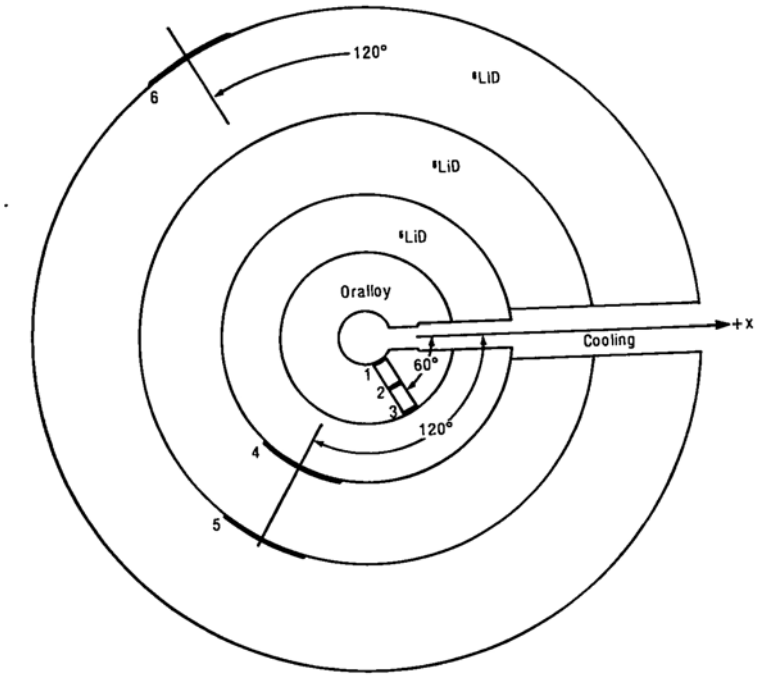
^{6}LiD Experiment

- 30-cm radius sphere of ^{6}LiD
- Tritium production measured after irradiation by $(9.42 \pm 0.28) \times 10^{18}$ neutrons

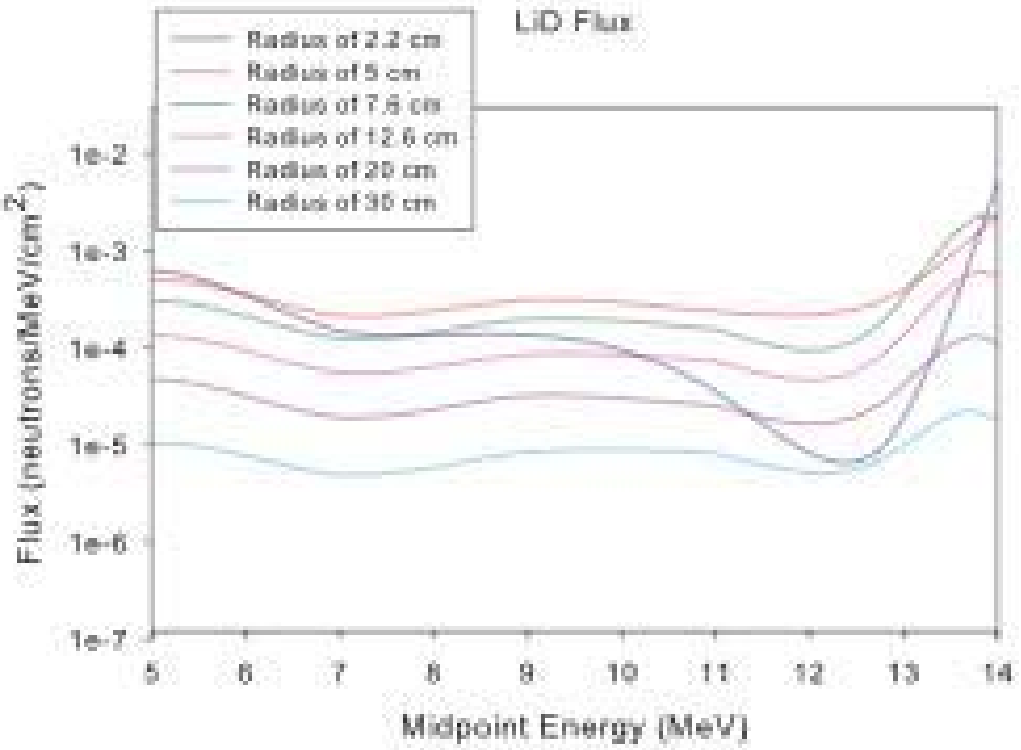


235U + ^{6}LiD experiment

- 7.62-cm radius sphere of Oralloy surrounded by a shell of ^{6}LiD out to 30 cm in radius
- Cadmium covers placed on ampules at 30-cm
- Tritium production measured after irradiation by 3.815 x 10^{15} neutrons

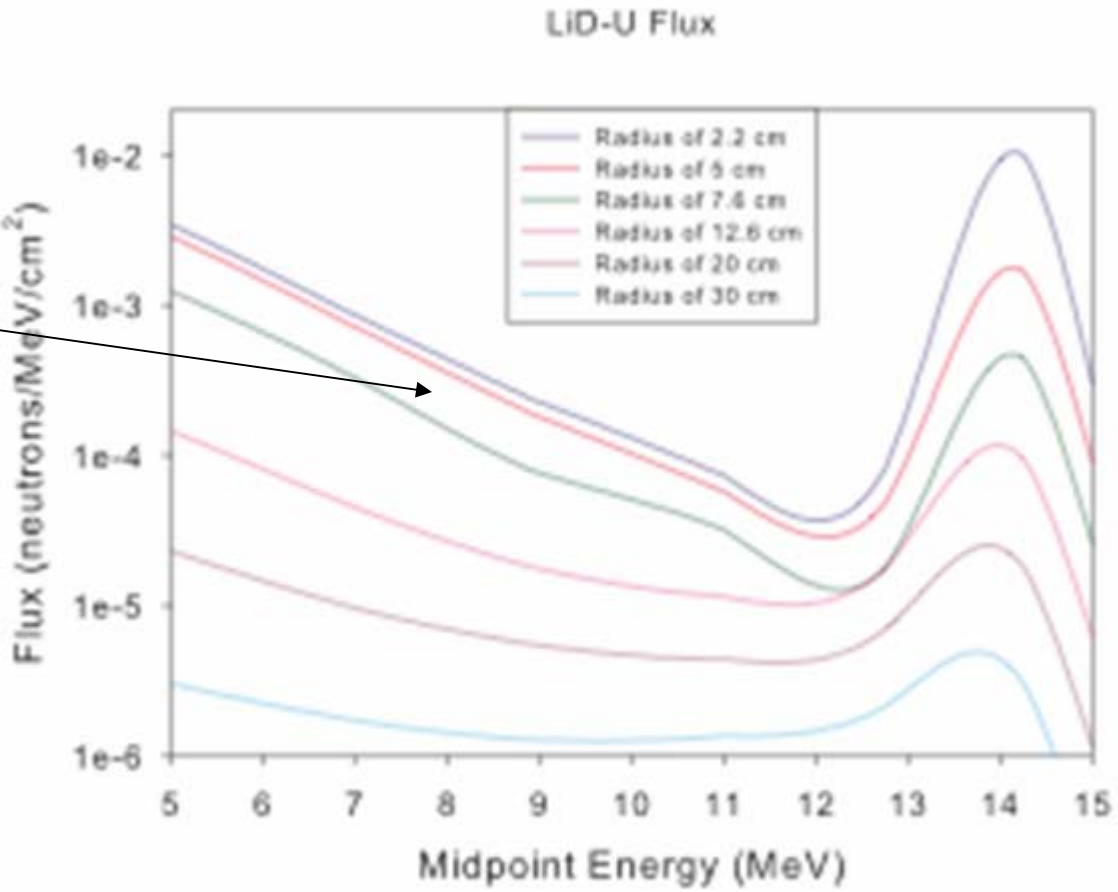


LiD sphere neutron spectra



LiD-U sphere neutron spectra

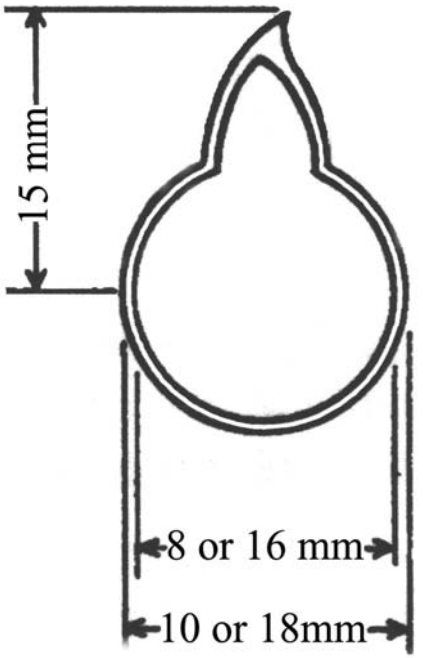
235U in
Inner locations



Improvements over previous MCNP models

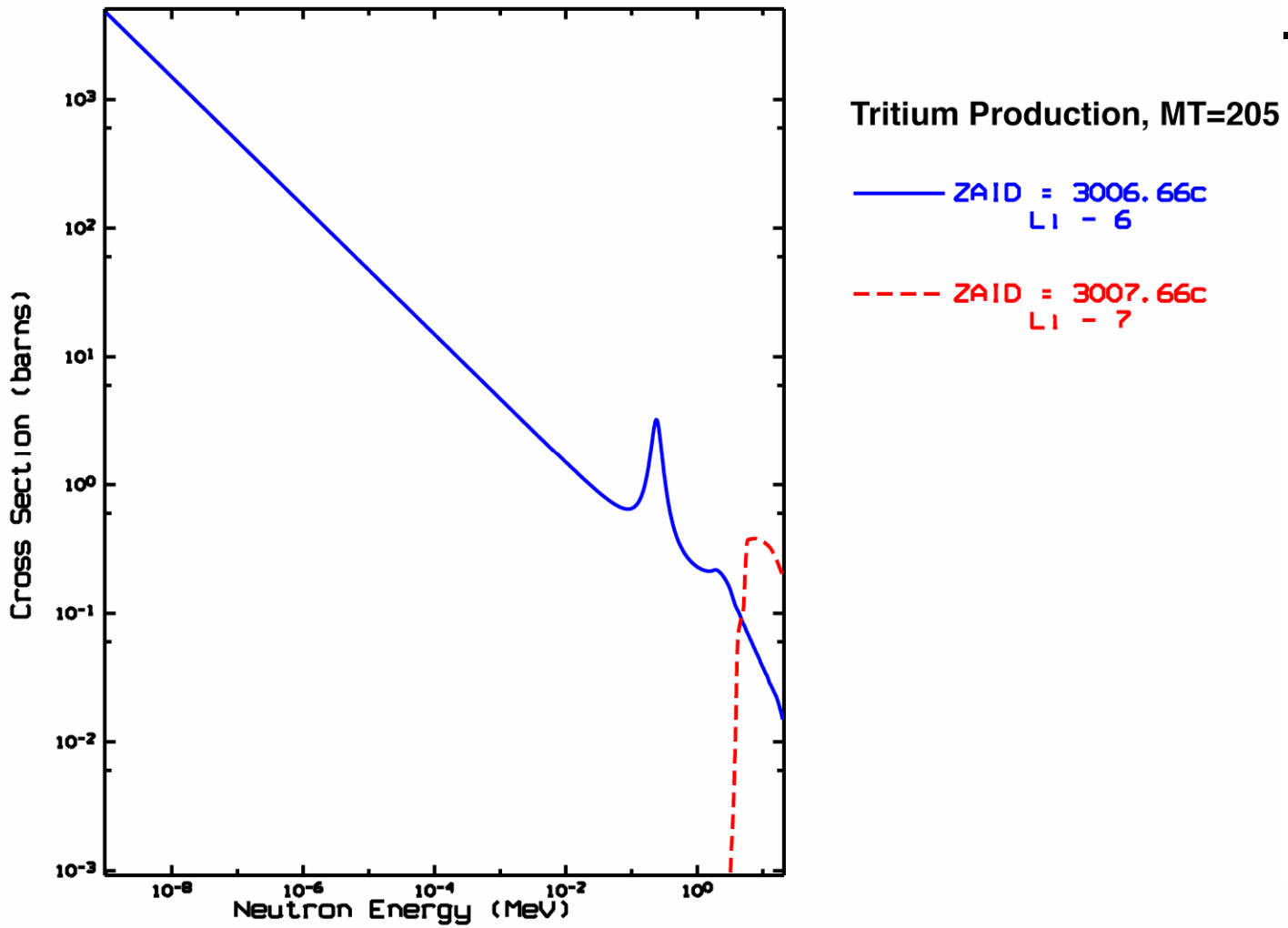
- Inclusion of
  - the quartz container in the ampule geometry
  - the beam, cooling, and alpha-monitor tubes
  - Concrete floor for room return
- Better cell importances

- Note - using the LLNL pulsed-sphere source specification since the original source specification no longer available

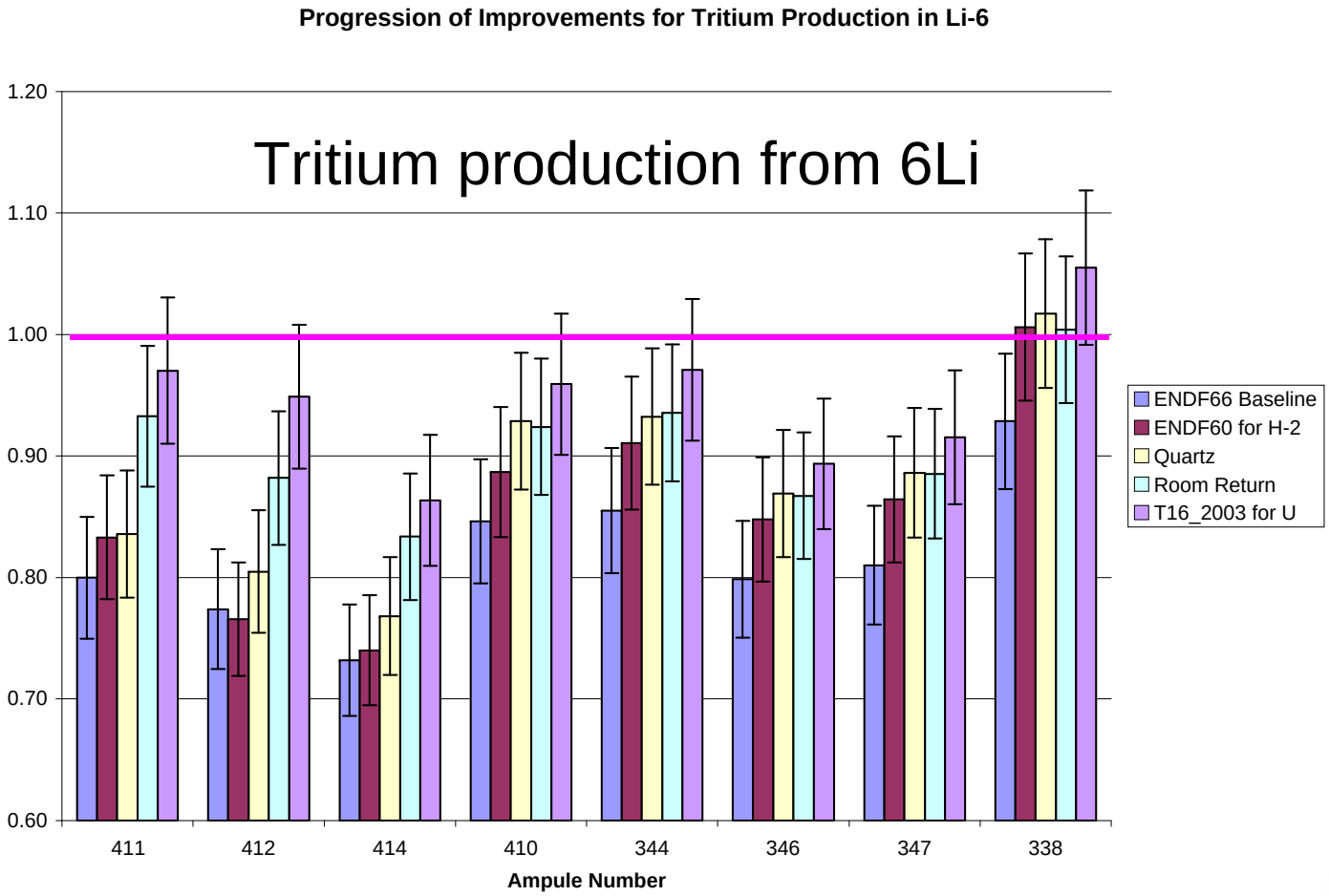


Ampule geometry

Tritium Production Cross Sections



Improvements in the MCNP models Aside - T16_2003 (precursor to B-VII.0)



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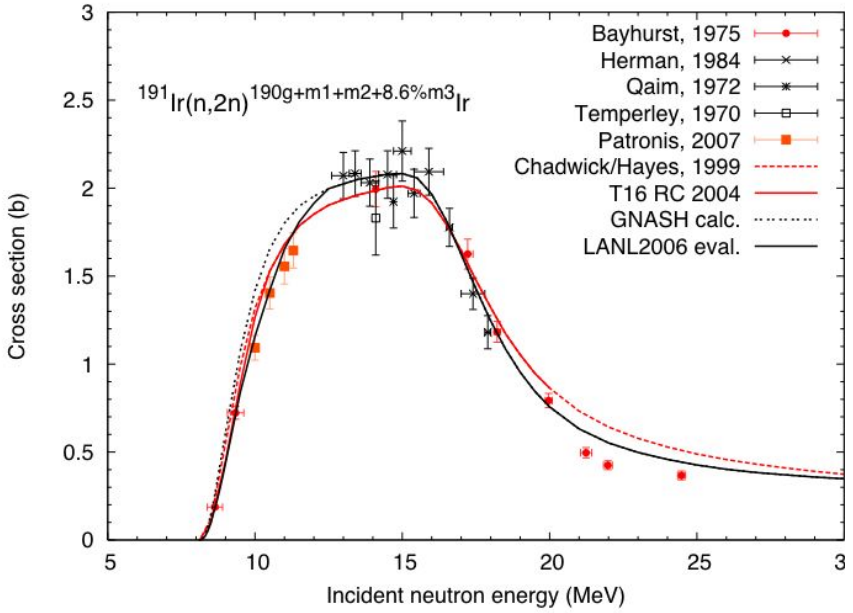
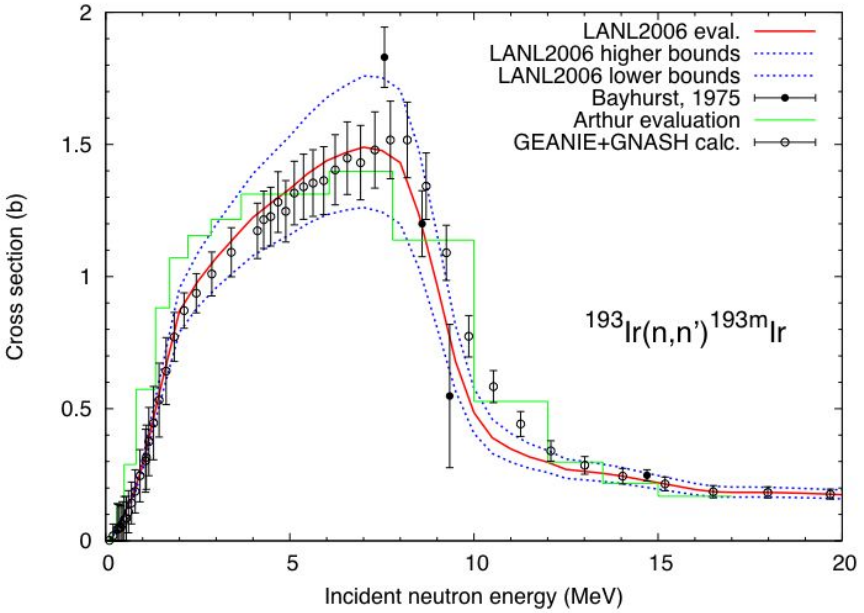
Iridium as a neutron-spectrum hardness indicator. Natural iridium has 191 and 193

n,2n making **190** responds to high energy, eg 14 MeV



n,n' making **193m** responds to fiss spectrum



193m/190 ~ measure of 14 MeV/fission

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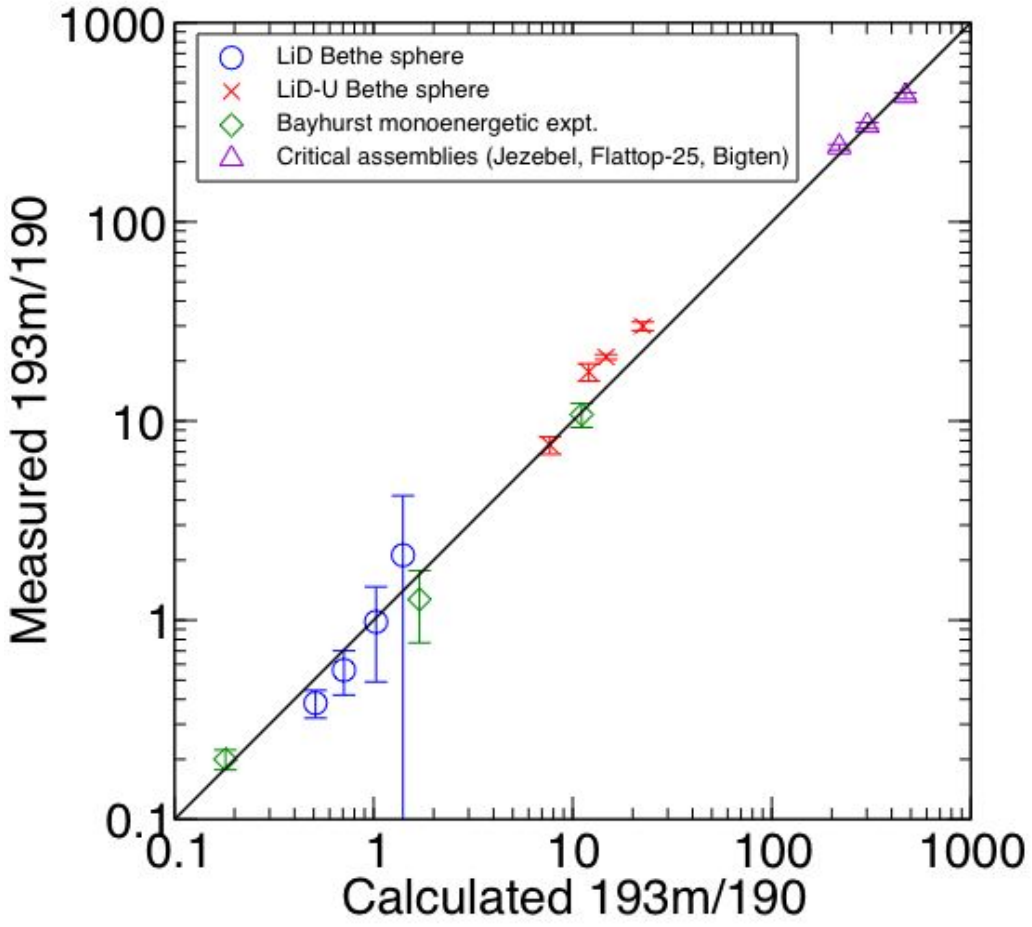
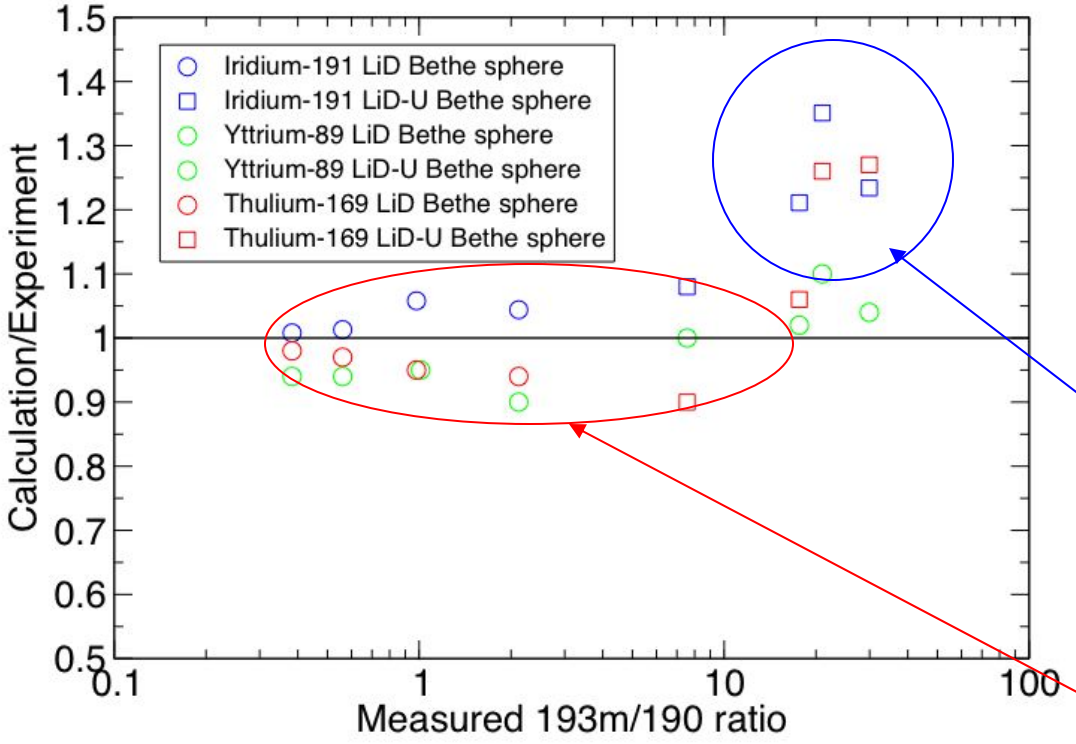
Experiment v. Calculation for 193m/190 (Over 3 Orders of Magnitude!)



n,2n testing. 14 MeV dominated fluences - look good; Issues with assemblies involving Uranium



Results for cases with HEU

Non-HEU: look good to ~ 6%

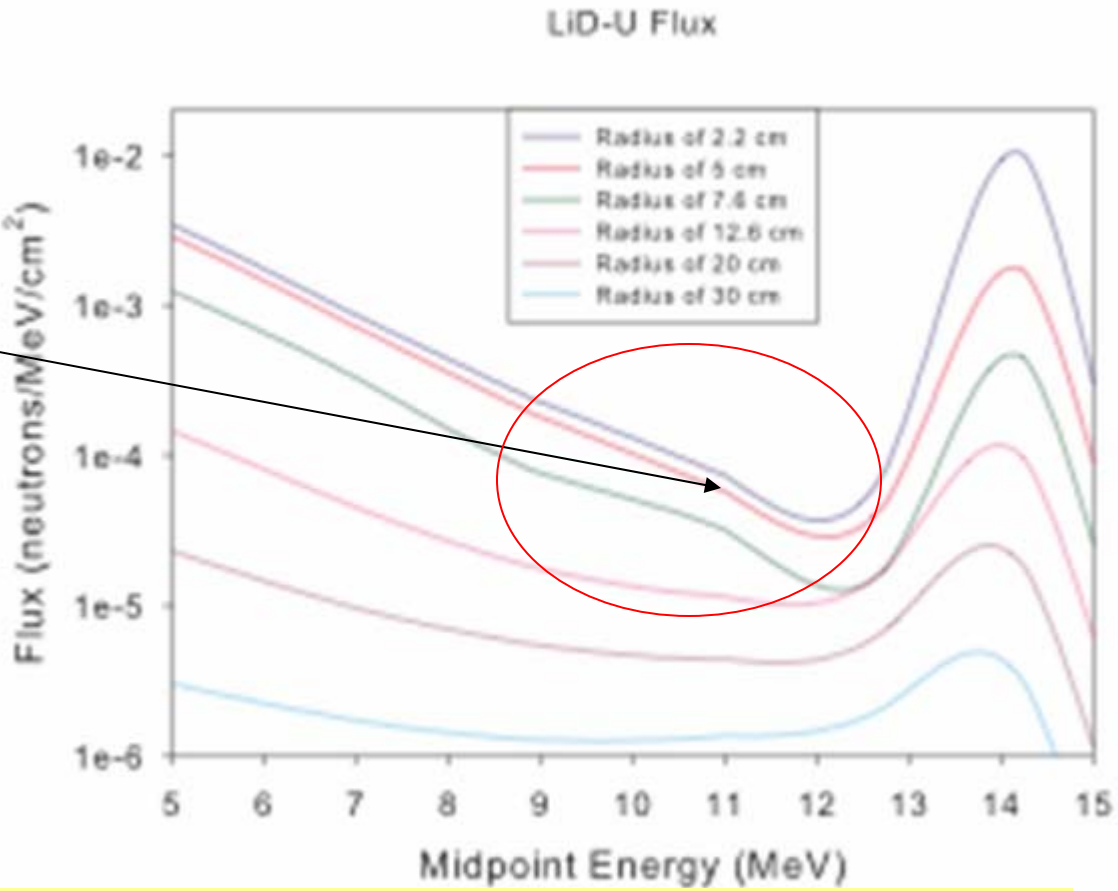
LiD-U problem with n spectra- 235 issue?

n2n product = fluence * n,2n cross section.

Possible problem with 9-12 MeV fluence:

-prompt fiss spec?

-Preeq/inelastic?



Motivates future work on ^{235}U 14 MeV induced Prompt-spectra and preeq/inelastic scattering

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