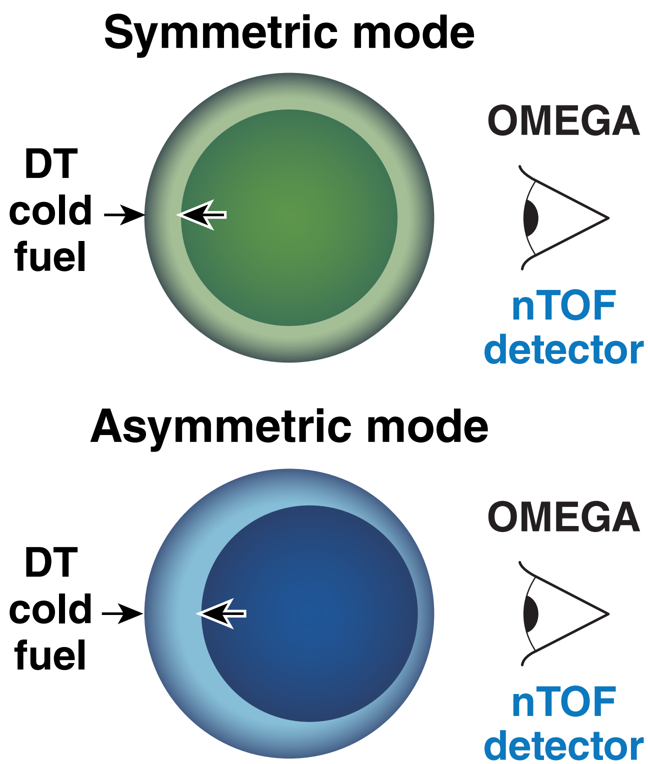
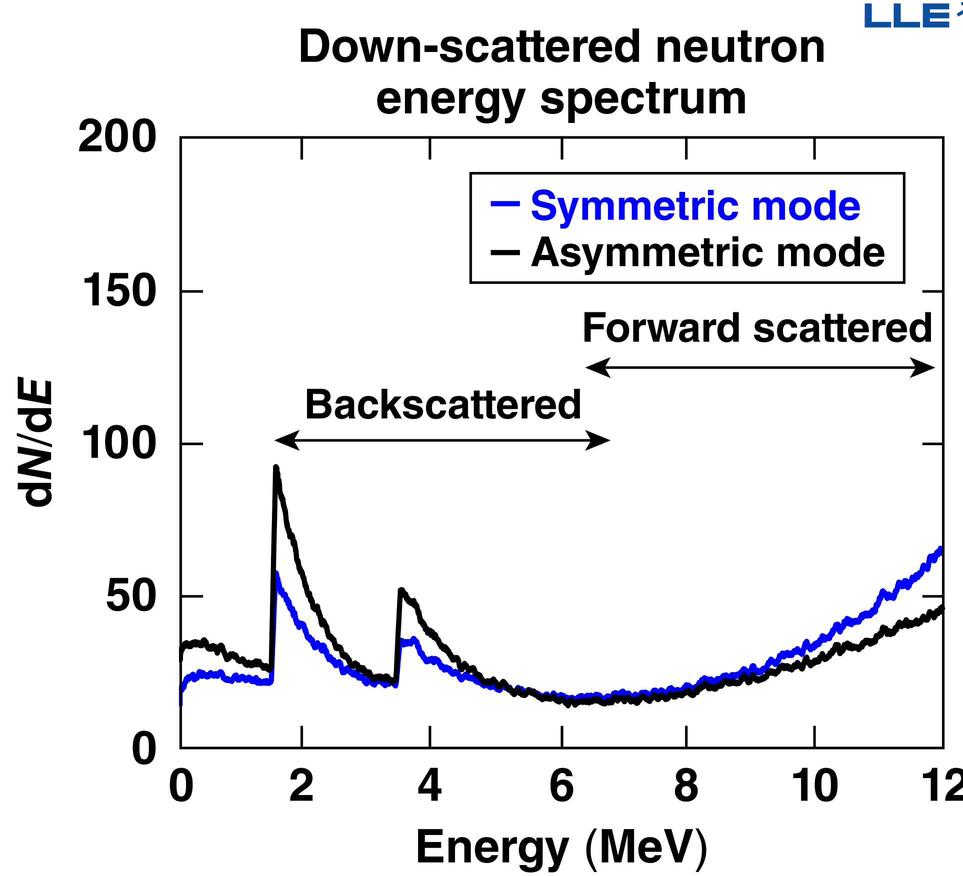
Areal-Density Variations from Cold-Fuel Distributions in Layered Cryogenic-DT Implosions





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Summary

Modeling shows that (low-mode) cold-fuel distributions can be inferred from the down-scattered neutron energy spectrum

- The neutron spectrum in the (1- to 6- meV) range is used to infer the areal density of cryogenic-DT implosions on OMEGA*
- The Monte Carlo neutron-particle (MCNP) is used to understand the down-scattered neutron energy spectrum from DT implosions (1 to 14 MeV)
- MCNP simulations show that areal-density measurements on OMEGA are not affected by the multiple scattering background process

*C. J. Forrest *et al.*, Rev. Sci. Instrum. 83, 10D919 (2012).

Collaborators

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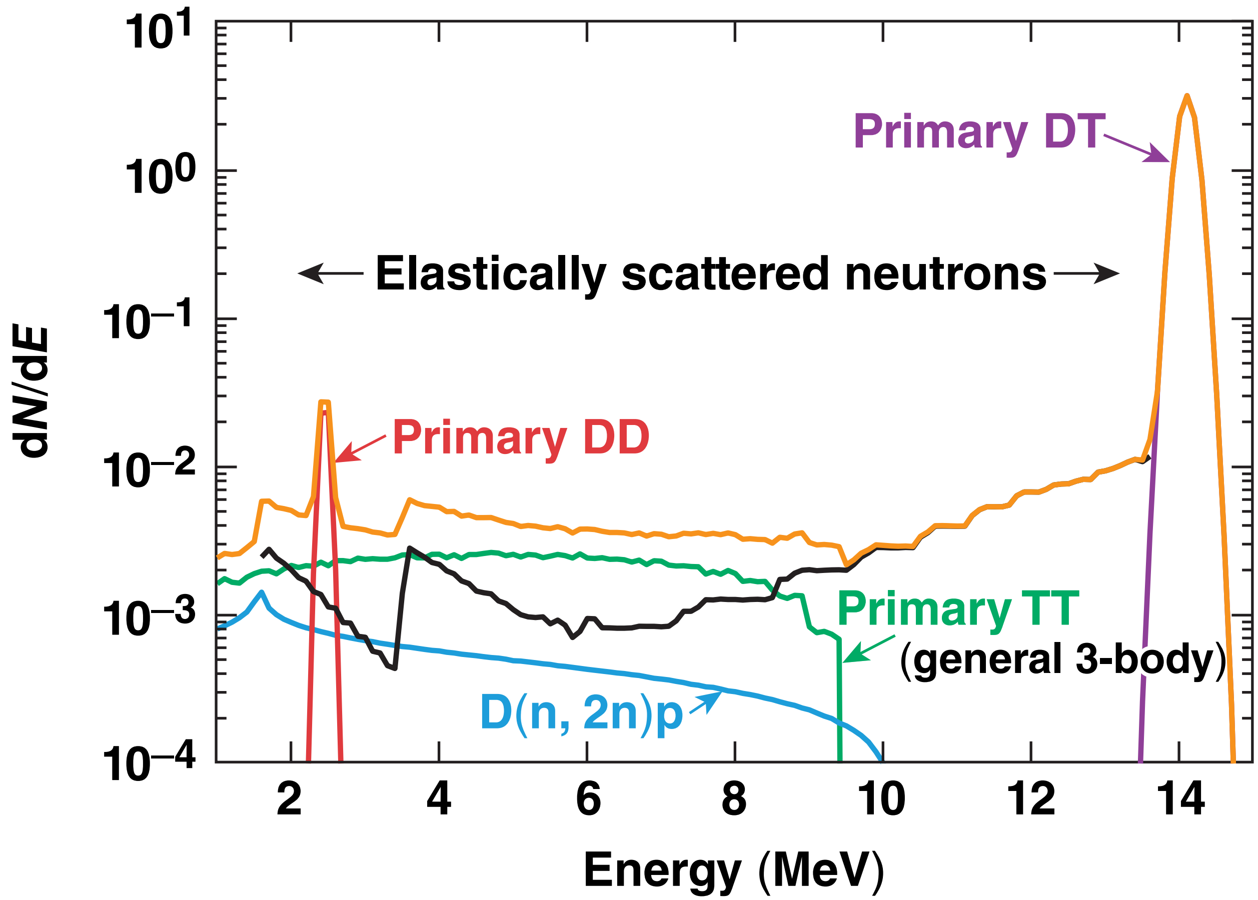
The neutron energy spectrum in ICF implosions depends on well-understood nuclear processes in the fuel



Hydro simulations

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*IRIS**

The total neutron energy spectrum is required to infer the fuel ρR in the backscattered region (1 to 6 meV).

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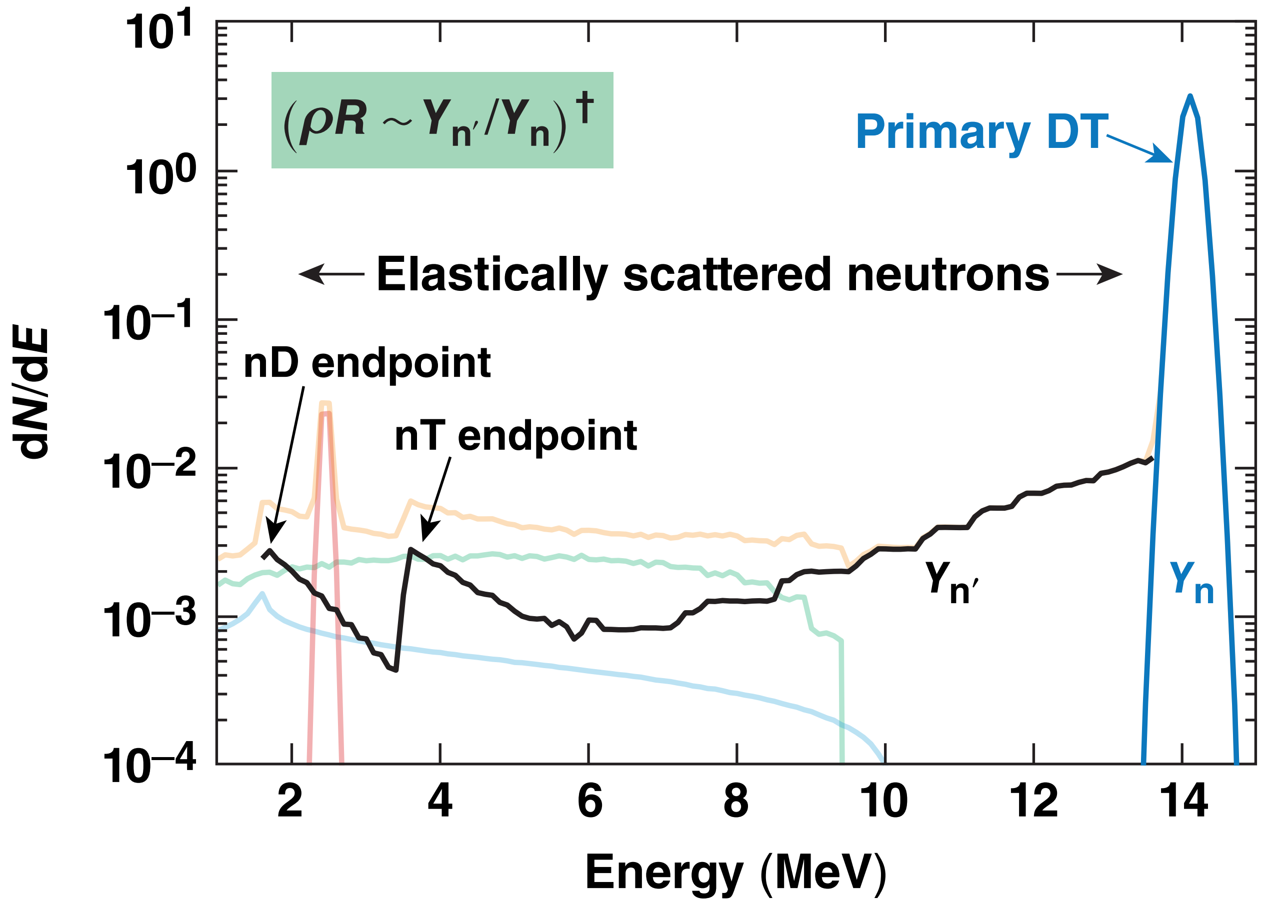
*P. B. Radha *et al*., Bull. Am. Phys. Soc. 12, 056307 (2005).

The theoretical down-scattered neutron energy spectrum is based only on the elastic scattering cross sections



Hydro simulations
⬇
*IRIS**

MCNP is used to determine possible modifications to the measured neutron energy spectrum caused by multiple scattering.

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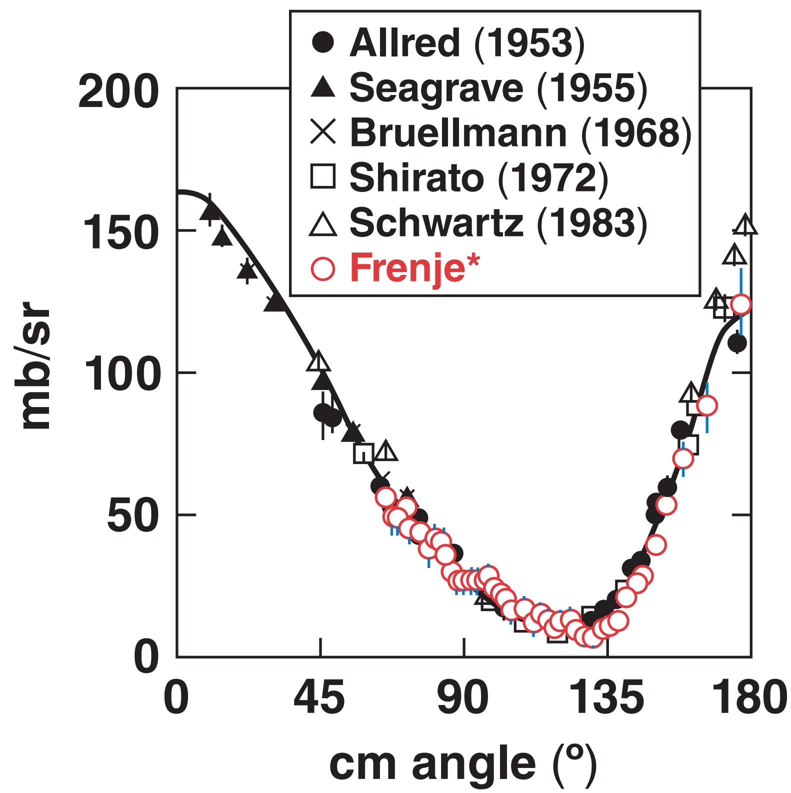
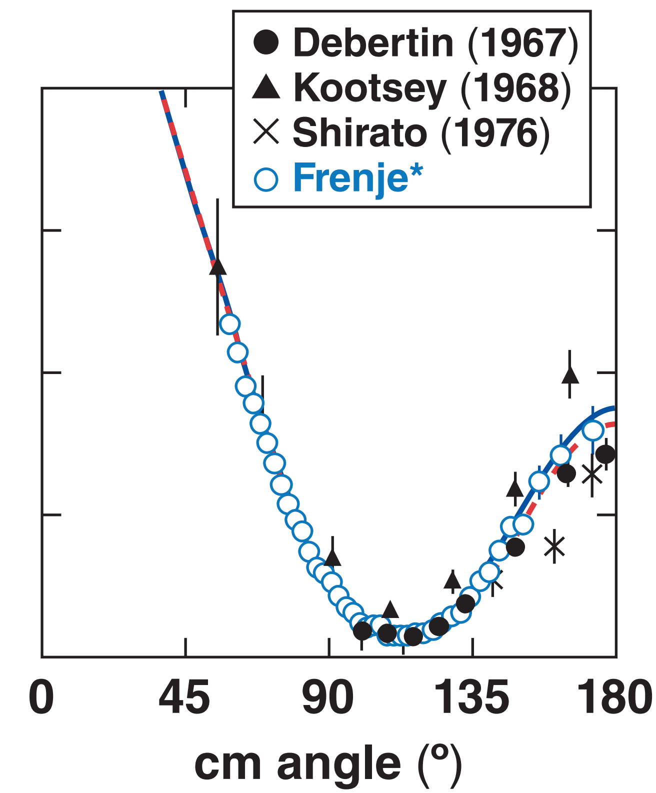
†C. K. Li *et al.*, Phys. Plasmas 8, 4902 (2001).
*P. B. Radha *et al.*, Bull Am. Phys. Soc. 12, 056307 (2005).

The shapes of the elastic neutron scattering cross sections have been confirmed with high accuracy





The accuracy of the scattering cross sections is the basis for the ρR measurements.

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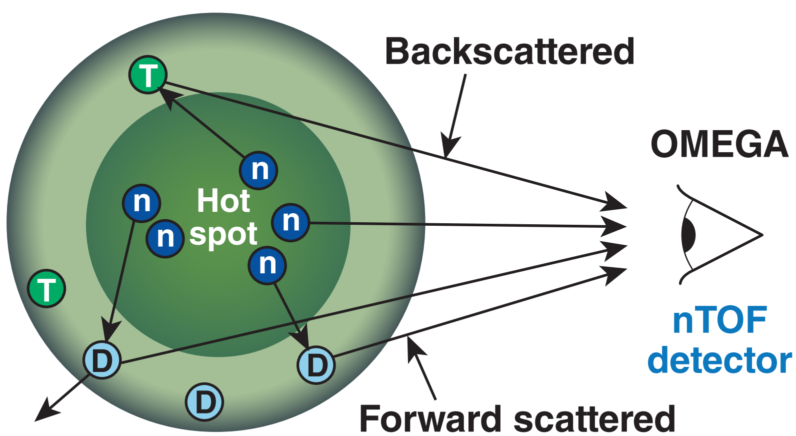
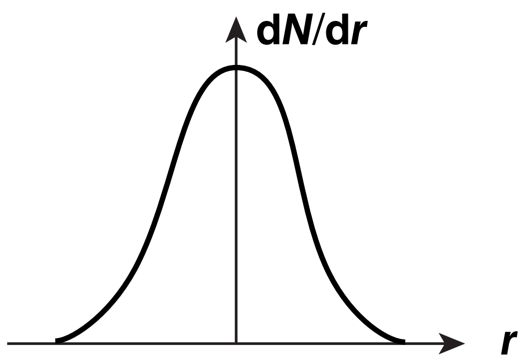
*J. A. Frenje *et al*., Phys. Rev. Lett. 107, 122502 (2011).

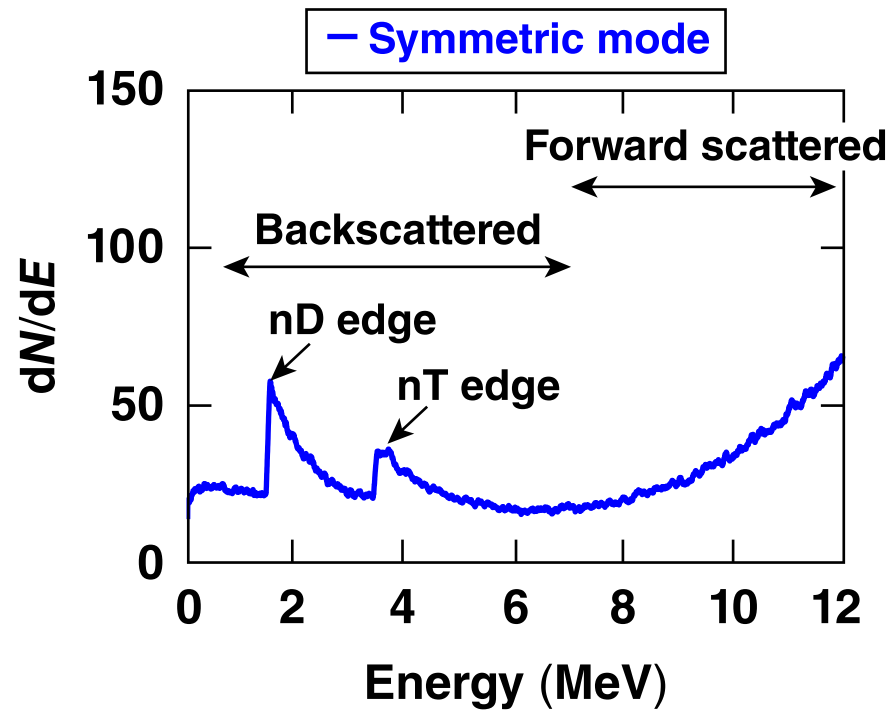
MCNP is a standard tool for neutron transport simulations

MCNP geometry





Monoenergetic spatially distributed source



Custom tallies in the code record the last position and energy of the particle as seen by the nTOF.

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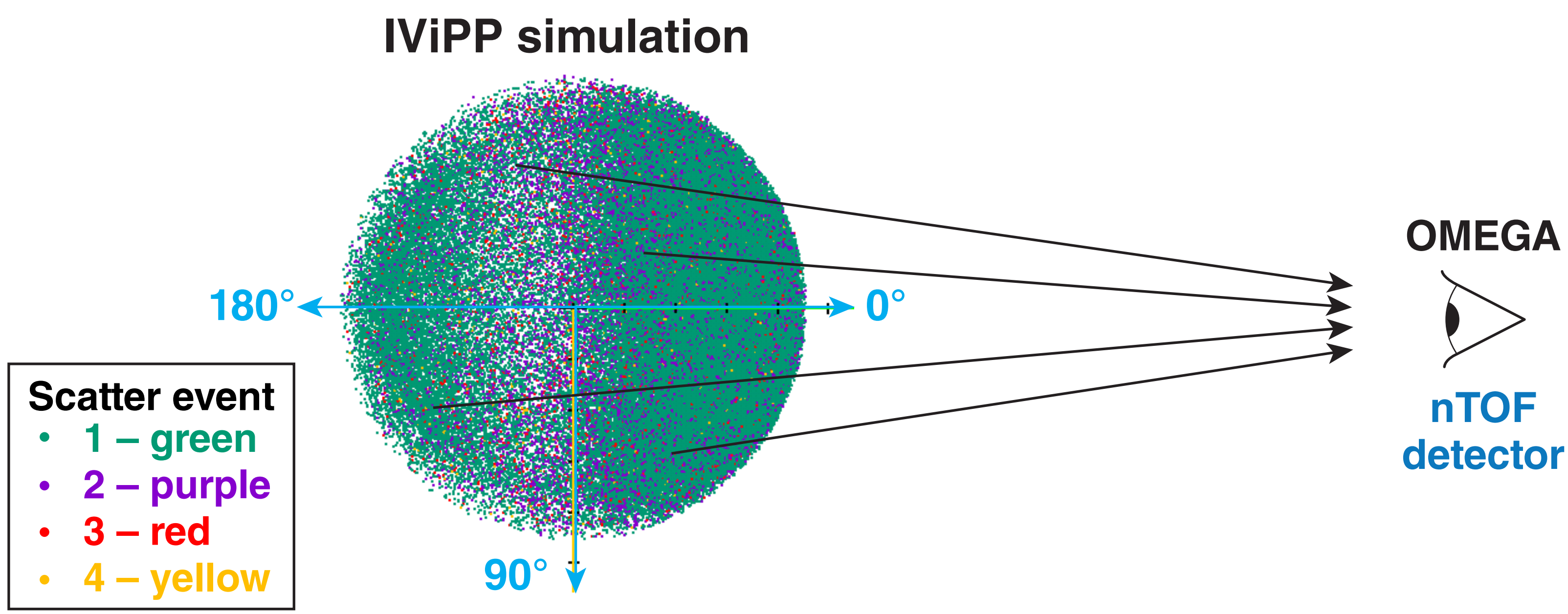
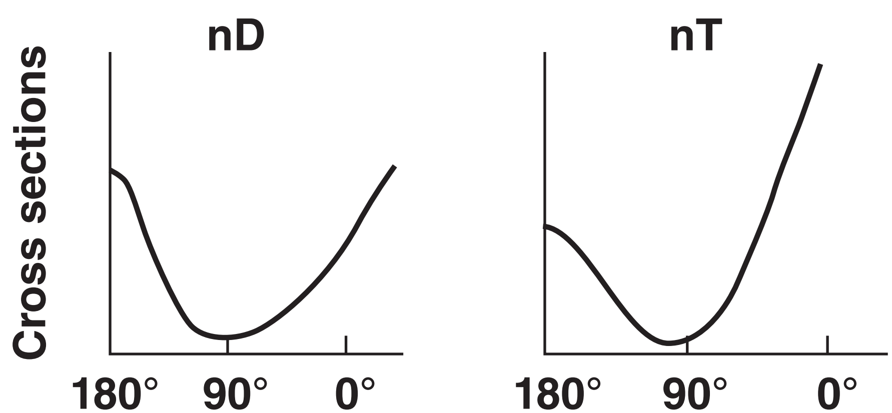
A visualization tool (IViPP)* is used as a consistency check on the MCNP recorded output



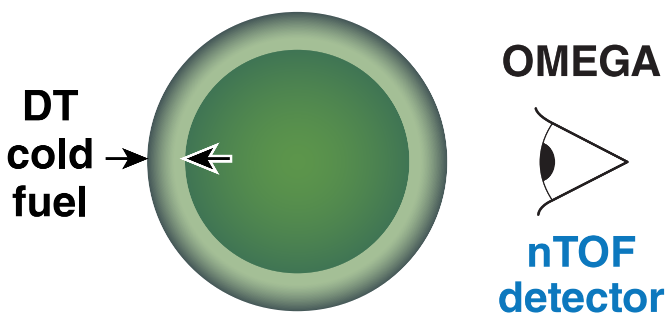


E21592

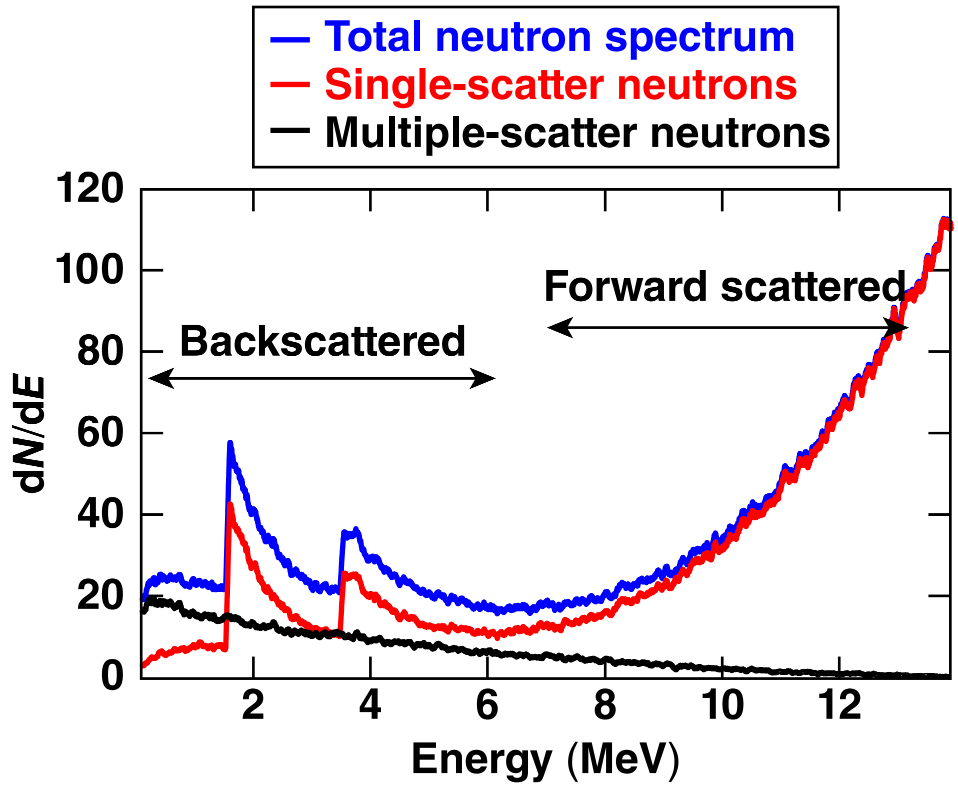
*D. Baldwin, IViPP, http://cs.geneseo.edu/~baldwin/ivipp/

Simulations show that the multiple scattering component does not affect the backscattered neutron measurement

Symmetric mode

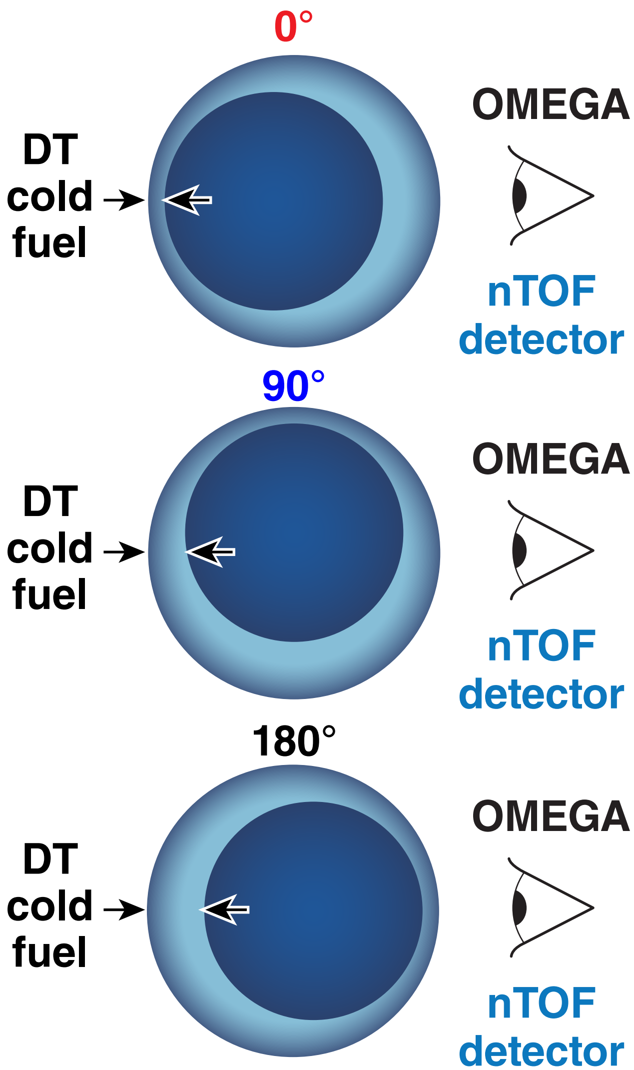


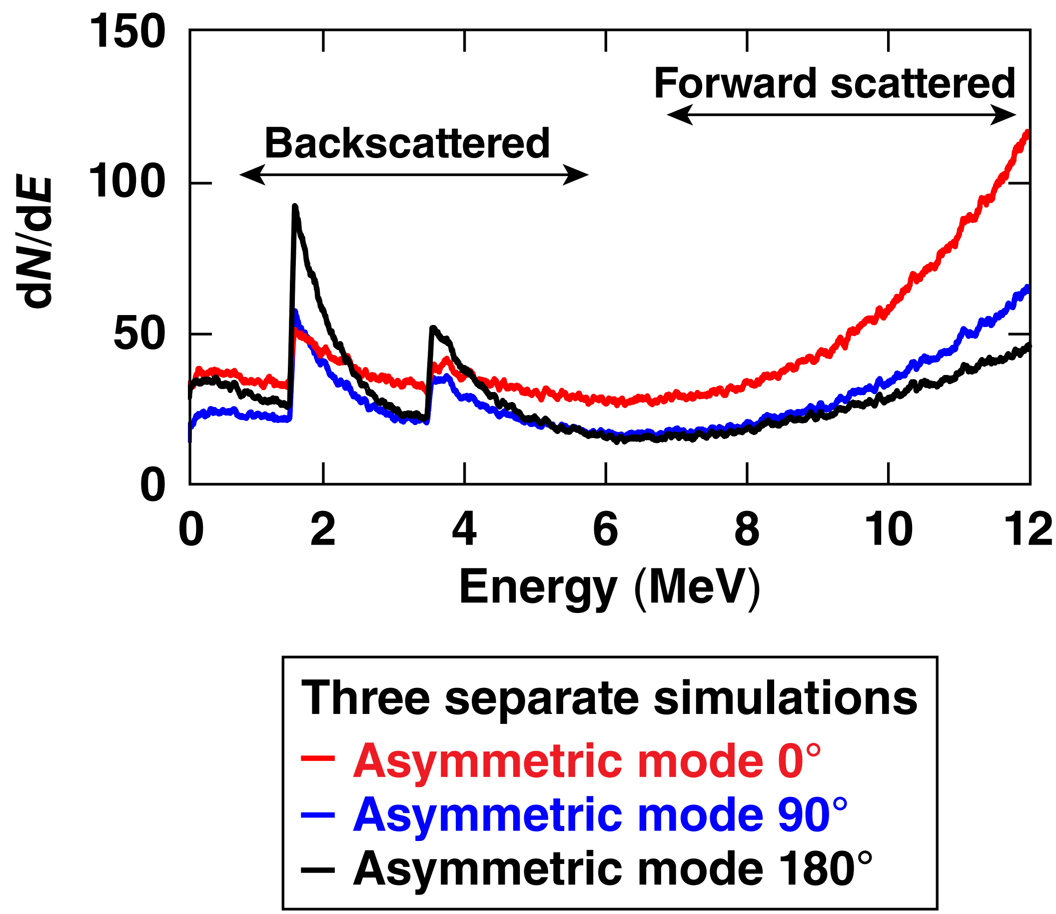
- Average ρR on OMEGA 200 mg/cm^2



The multiple scattering component becomes nonlinear with higher areal densities (ρR > 300 mg/cm^2).

An asymmetric (low-mode) cold-fuel distribution does affect the neutron energy spectrum





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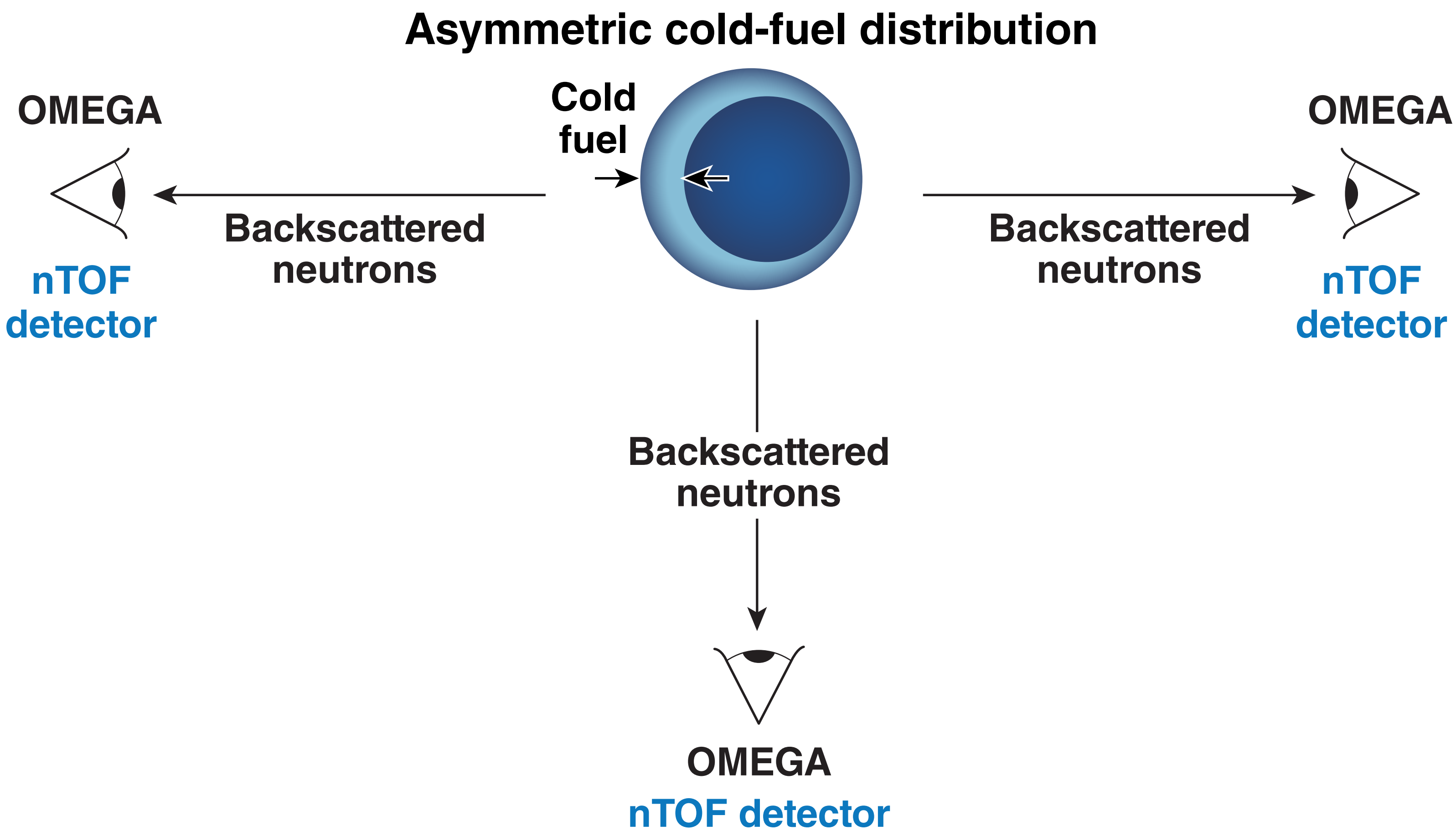
Asymmetries in the cold-fuel distribution can be measured with specific detection positions



A single line of sight that measures both the forward and backscattered neutron energy spectrum is another approach to infer ρR asymmetries

E21697

Summary/Conclusions

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