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Title: Multiple scattering effects in fission neutron outputs

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LANL

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LLNL
28Feb - 01 Mar
Livermore, CA



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ABSTRACT

Measured fission neutron output spectra can be affected by multiple scattering in the target chamber, from room surfaces, and from detector housings. These effects are studied using MCNP.

SLIDE TITLES:

Multiple Scattering Effects in Fission Neutron Outputs

Introduction

Three versions of MCNP were used

Downscattering in the target chamber is a significant effect (5–15%)

Simplified geometry for MCNPX modeling of scattering effects on 4FP30R

The walls and floor were moved outward in +1-m and +2-m steps

1-MeV response functions: 4FP30R (with handstack)

Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

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Re-scattering effects on 4FP30R: 2" and 4" thickness of 5%, 20%, and 80% BCH2

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Room return for NE-213 detectors becomes important in the range from 0.5–1.0 MeV

Room return for ^6Li -glass detectors can be eliminated by software cuts

Ohio University liquid scintillation (NE-213) detectors

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NE-213 detector response ratio: fission spectrum @ 1m

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Geometry for tagged-neutron measurements (2010)

NE-213 efficiency with four codes: MCNP-PoliMi, KSU, SCINFUL, CNEFF

Tagged-neutron efficiency results

Summary

Multiple Scattering Effects in Fission Neutron Outputs

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Fission Program Review
28 Feb – 1 Mar 2011
LLNL



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intro.plt: 23 Feb 2011 21:51:31

Introduction

Sources of multiple scattering that can distort measured fission spectra:

- down scattering in the target assembly (PPAC and supports)
- room return (elastic back scatter)
- detector mounts and encapsulation (efficiency)
- beam interactions
 - in the target (non fission)
 - in the collimator



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intro.plt: 23 Feb 2011 18:48:26

Three versions of MCNP were used

Three MCNP versions:

- MCNP5 V1.40
- MCNPX V2.7b
- MCNP-POLIMI
 - based on MCNP4c
 - S. Pozzi, E. Padovani, M. Marseguerra, NIM A513, 550 (2003)



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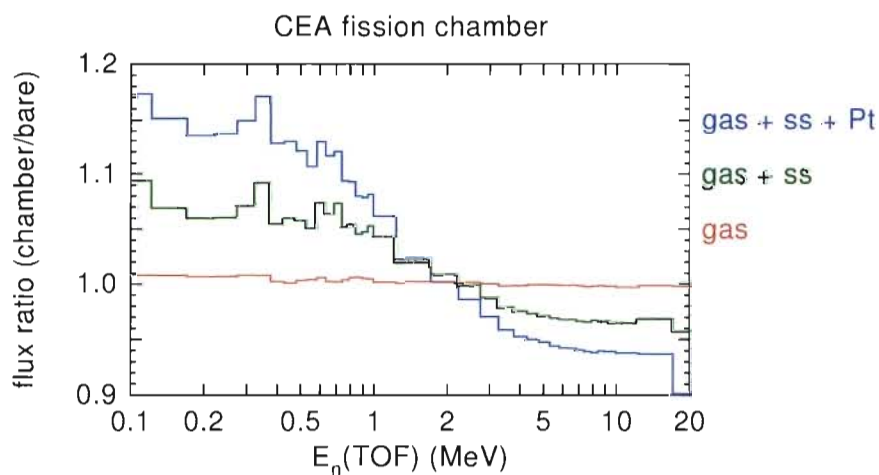
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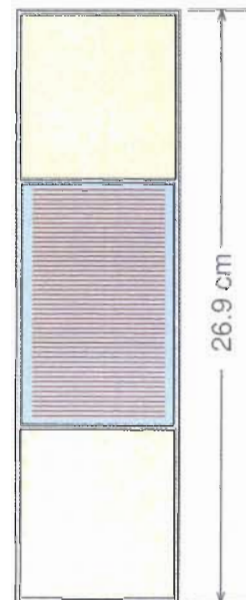
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Downscattering in the target chamber is a significant effect (5 – 15%)



similar results obtained by Chris Hagmann for new LLNL PPAC



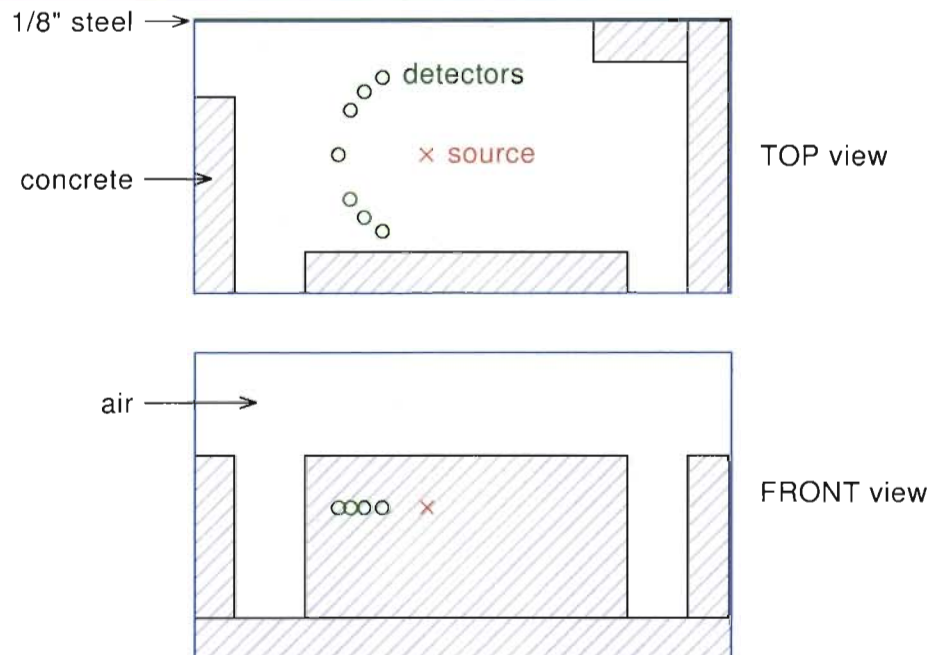
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Simplified geometry for MCNPX modeling of scattering effects on 4FP30R



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geom2.plt: 05 Mar 2010 11:43:39

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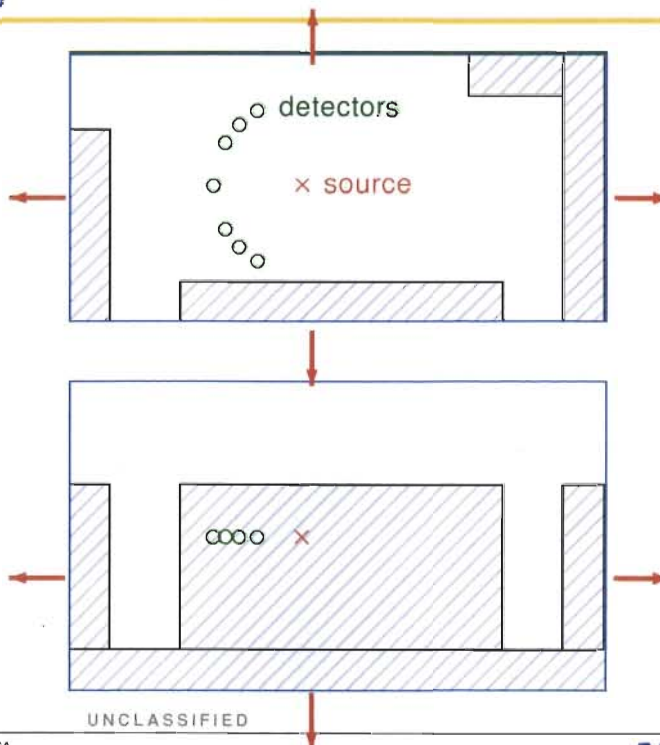
The walls and floor were moved outward in +1-m and +2-m steps

1-m step:

- front wall
- left wall
- floor
- front wall same width

2-m step:

- front wall
- left, right walls
- back wall
- floor
- front wall wider



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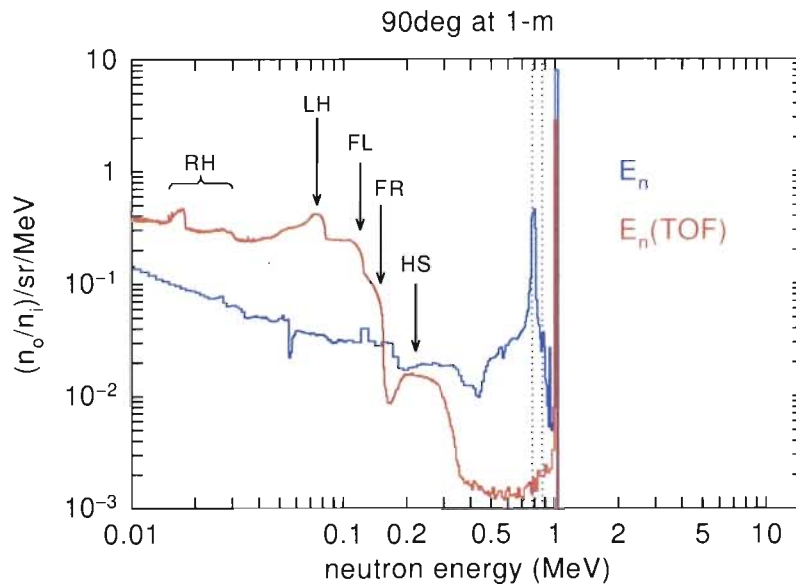
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1-MeV response functions: 4FP30R (with handstack)



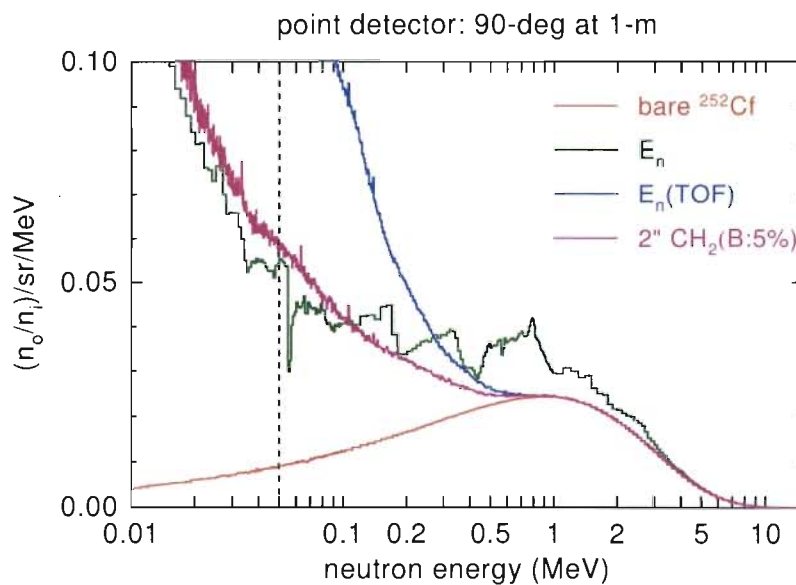
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1-MeV.plt: 23 Feb 2011 14:44:40

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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall



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90deg-1m.plt: 23 Feb 2011 13:26:12

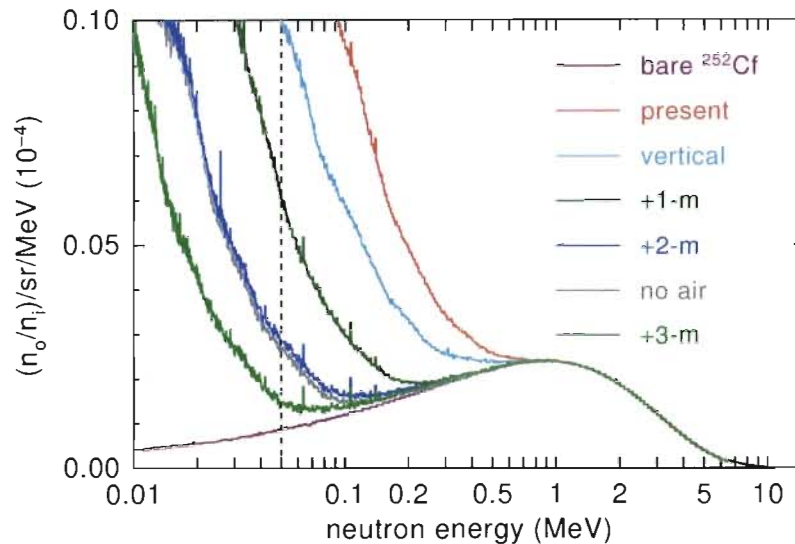
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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

point detector: 90-deg at 1-m

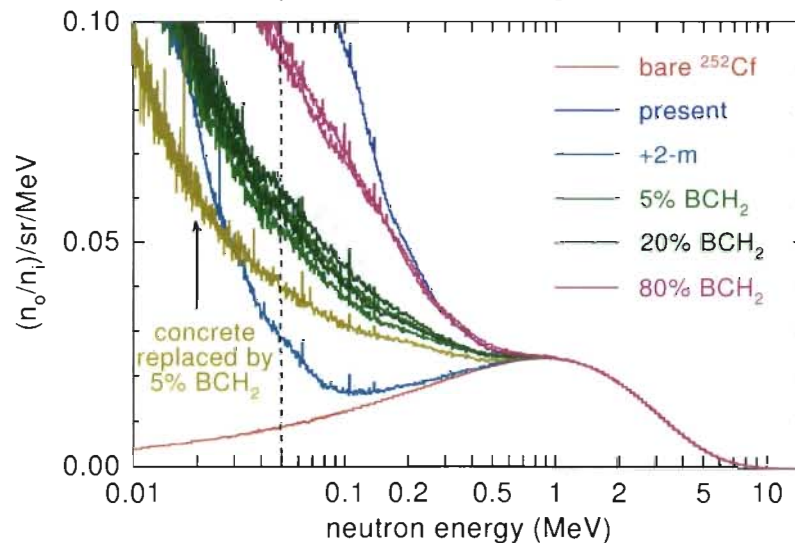


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Re-scattering effects on 4FP30R: 2" and 4" thickness of 5%, 20%, and 80% BCH_2

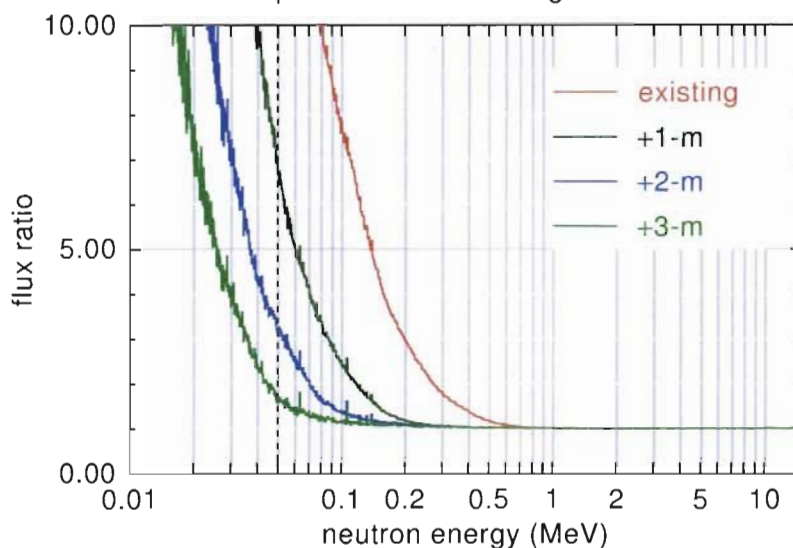
point detector: 90-deg at 1-m



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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

point detector: 90-deg at 1-m



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90deg_1m_ratio.plt: 05 Mar 2010 13:12:56

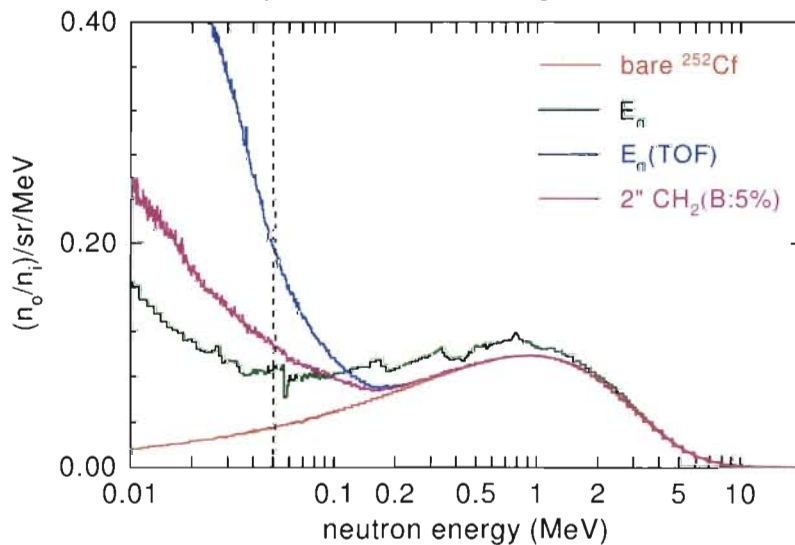
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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

point detector: 90-deg at 0.5-m



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90deg-0.5m.plt: 23 Feb 2011 13:31:05

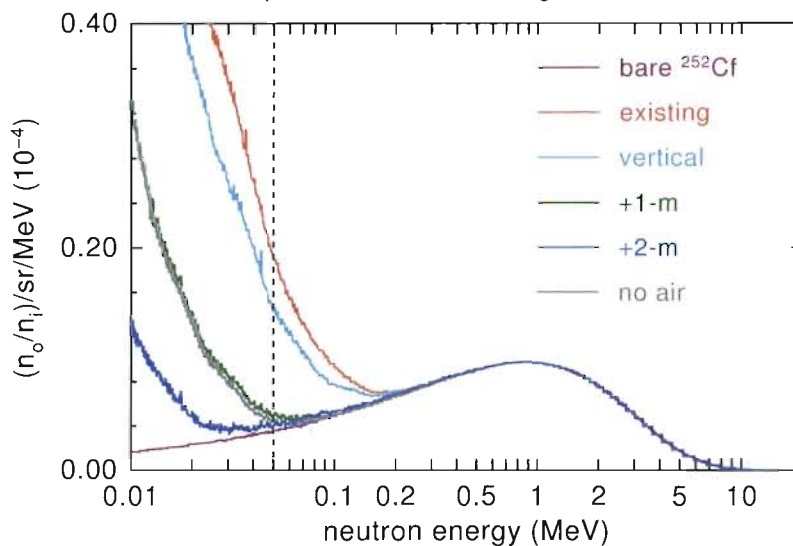
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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

point detector: 90-deg at 0.5-m



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90deg_0.5m.ppt: 23 Feb 2011 13:53:27

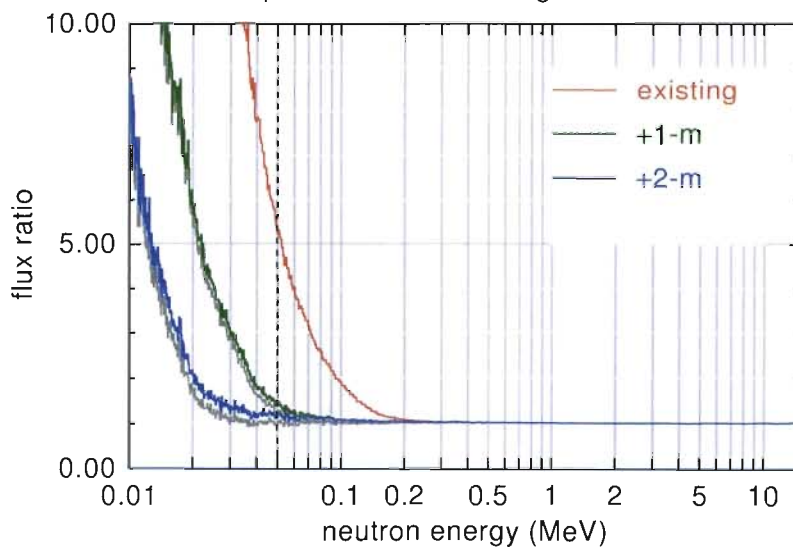
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Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall

point detector: 90-deg at 0.5-m



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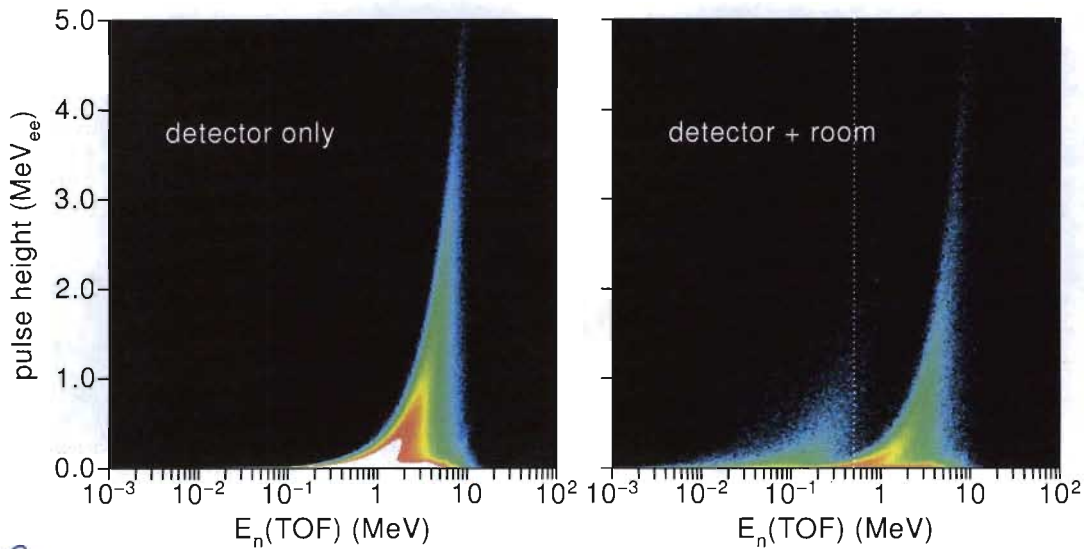
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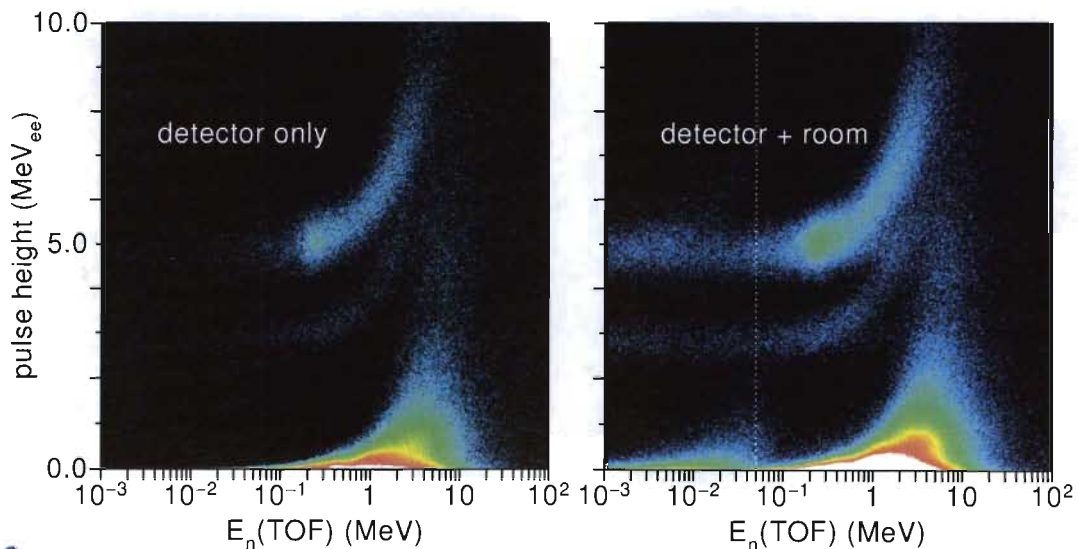
Room return for NE-213 detectors becomes important in the range from 0.5 – 1.0 MeV

NE-213 detector assembly @ 1-m and 90 deg



Room return for ⁶Li-glass detectors can be eliminated by software cuts

⁶Li-glass detector assembly @ 32-cm and 90 deg



Ohio University liquid scintillation (NE-213) detectors



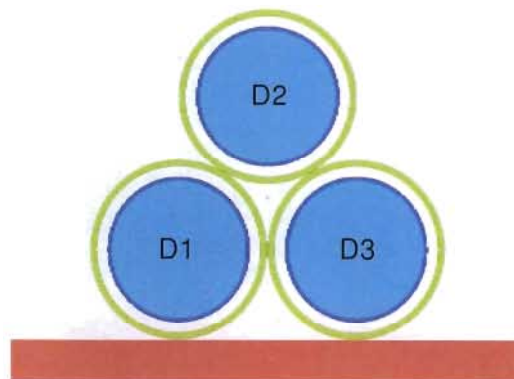
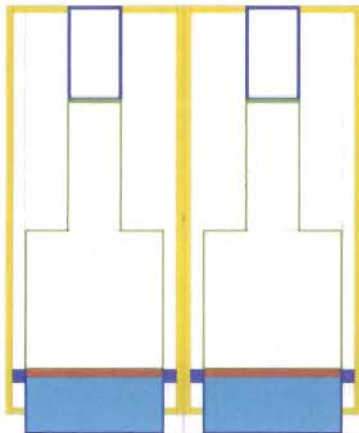
- similar to FIGARO detectors
- shown in 8-m location
- collimated beam is slightly larger than detector stack



Ohio University liquid scintillation (NE-213) detectors

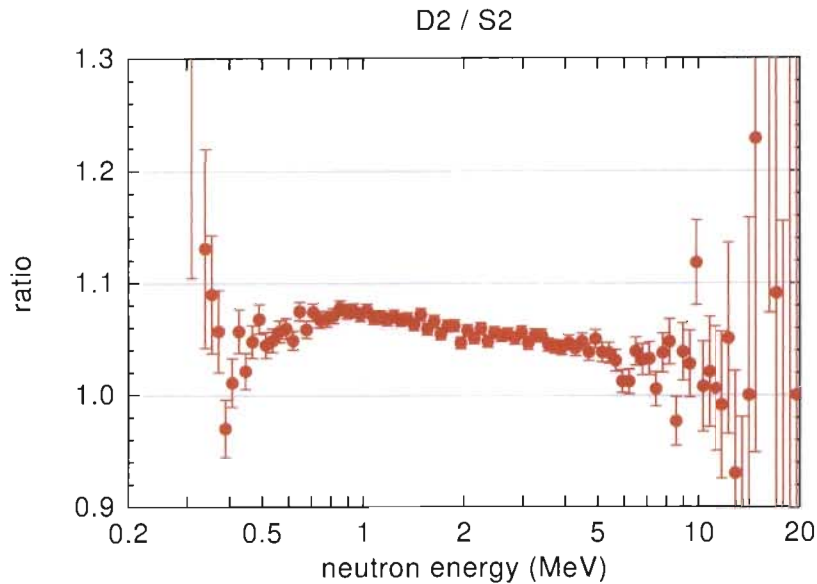
MCNP model:

- Al, glass, PVC, NE-213
- wooden base



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NE-213 detector response ratio: fission spectrum @ 1m



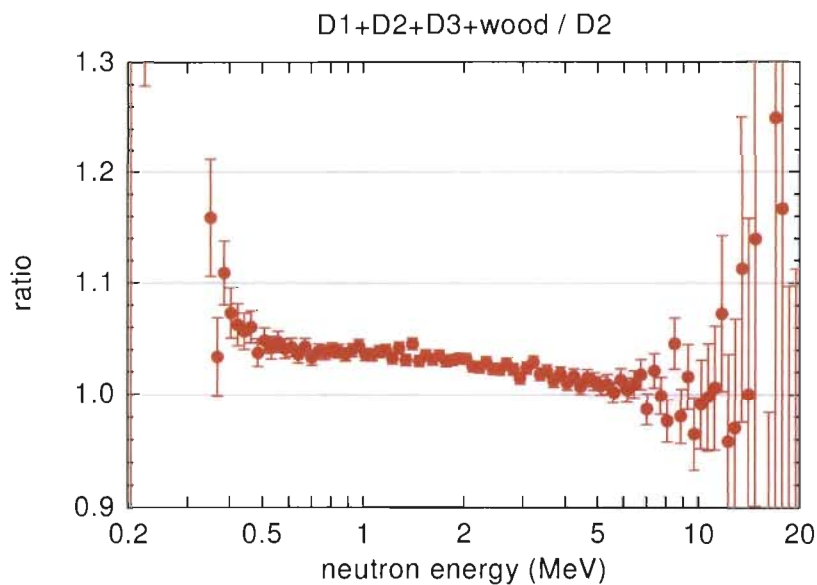
EST. 1944
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229_230.plt: 08 Sep 2010 14:45:51

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NE-213 detector response ratio fission spectrum @ 1m

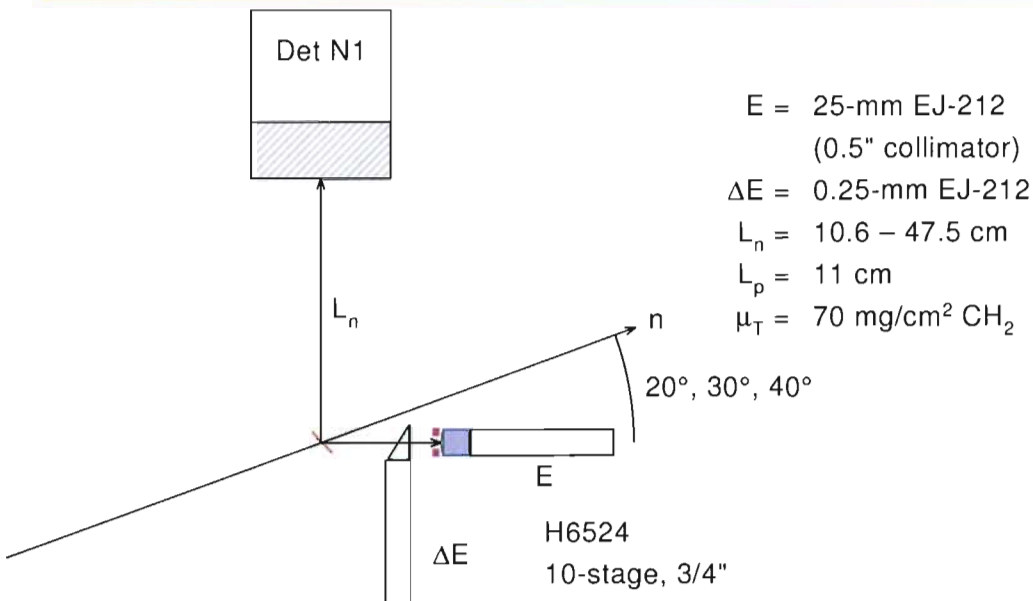


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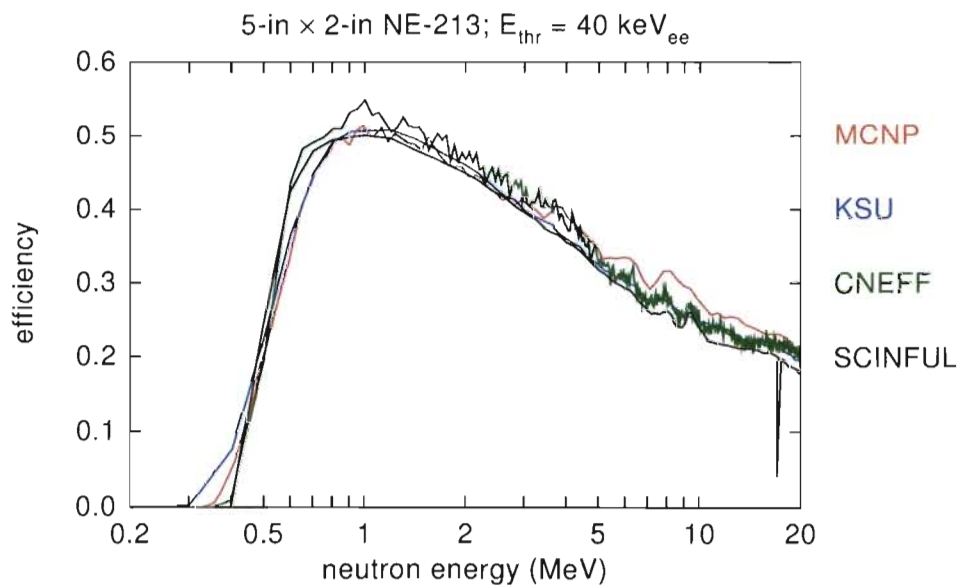
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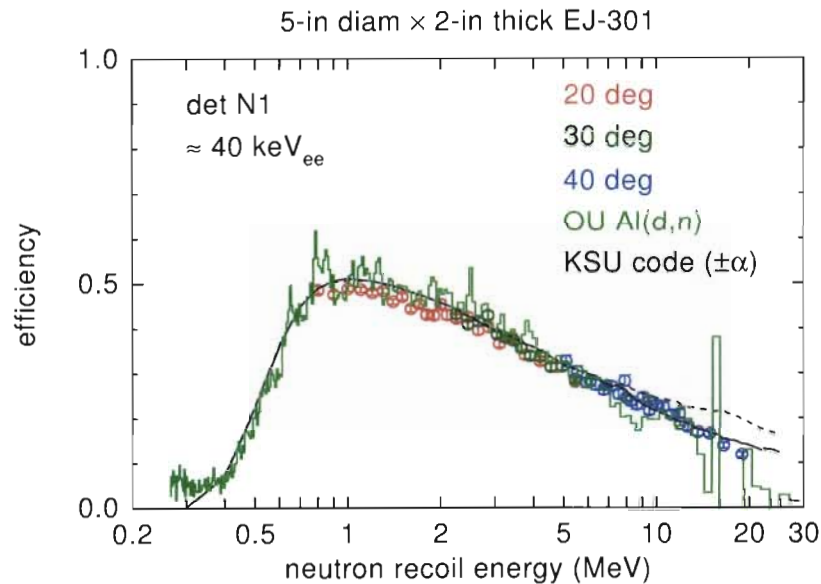
Geometry for tagged-neutron measurements (2010)



NE-213 efficiency with four codes: MCNP-PoliMi, KSU, SCINFUL, CNEFF



Tagged-neutron efficiency results



Summary

- There are two solutions to the room-return problem:
 - expanded room (all surfaces > 2 m away)
 - software cuts
- multiple scattering is important in the PPAC and detectors
 - PPAC: $\approx 5 - 10\%$
 - detectors: $\approx 4 - 8\%$
 - relative position is critical for detectors
- need improved Monte Carlo simulations benchmarked to data
 - MCNP
 - GEANT