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Title:	Multiple scattering effects in fission neutron outputs
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Form 836 (7/06)

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

NE-213 detector response ratio fission spectrum @ 1m

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

Terry Taddeucci
Los Alamos National Laboratory

Fission Program Review
28 Feb – 1 Mar 2011
LLNL

LA-UR-11-xxxxx

Introduction

Sources of multiple scattering that can distort measured fission spectra:

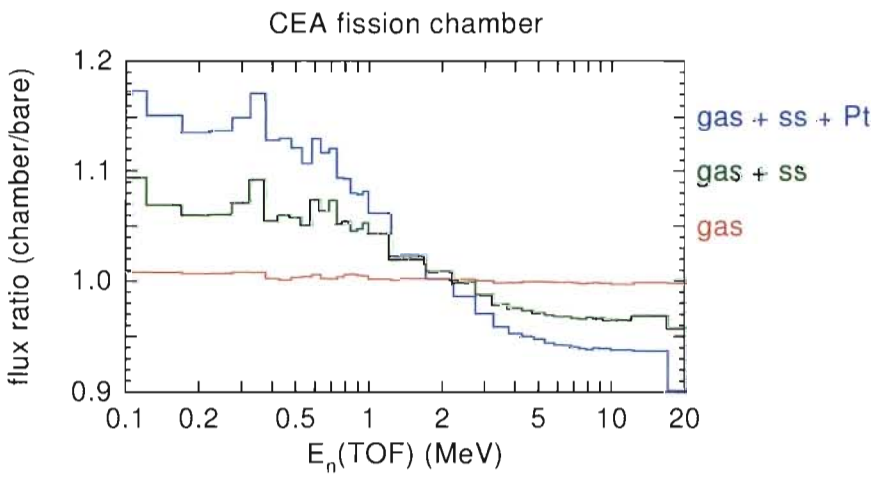
- down scattering in the target assembly (PPAC and supports)
- room return (elastic back scatter)
- detector mounts and encapsulation (efficiency)
- beam interactions
  - in the target (non fission)
  - in the collimator

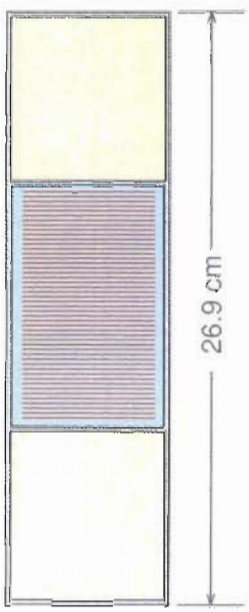
Three versions of MCNP were used

Three MCNP versions:

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

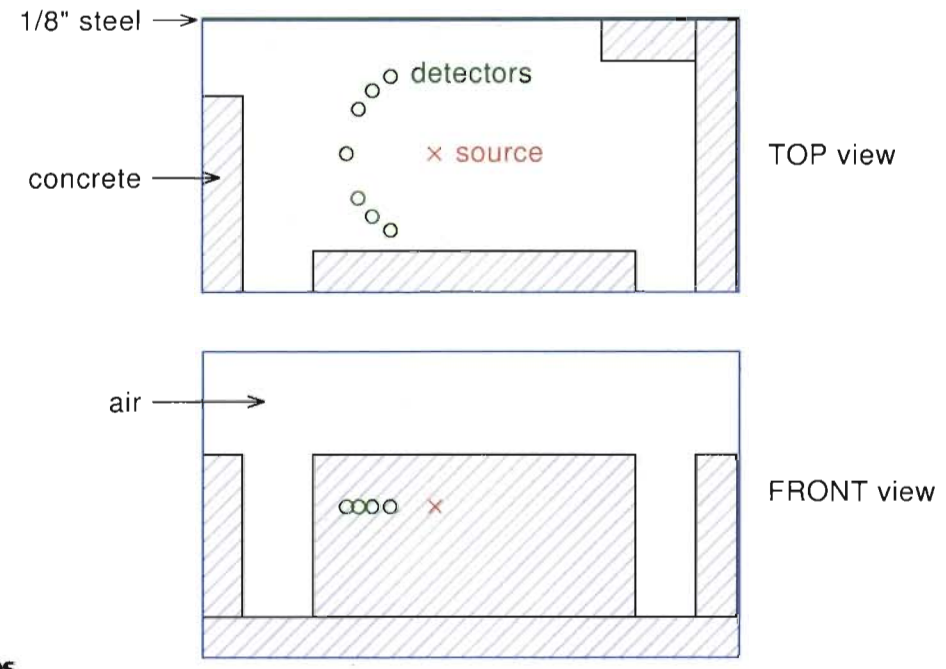
Downscattering in the target chamber is a significant effect (5 – 15%)





similar results obtained by Chris Hagmann for new LLNL PPAC

Simplified geometry for MCNPX modeling of scattering effects on 4FP30R



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

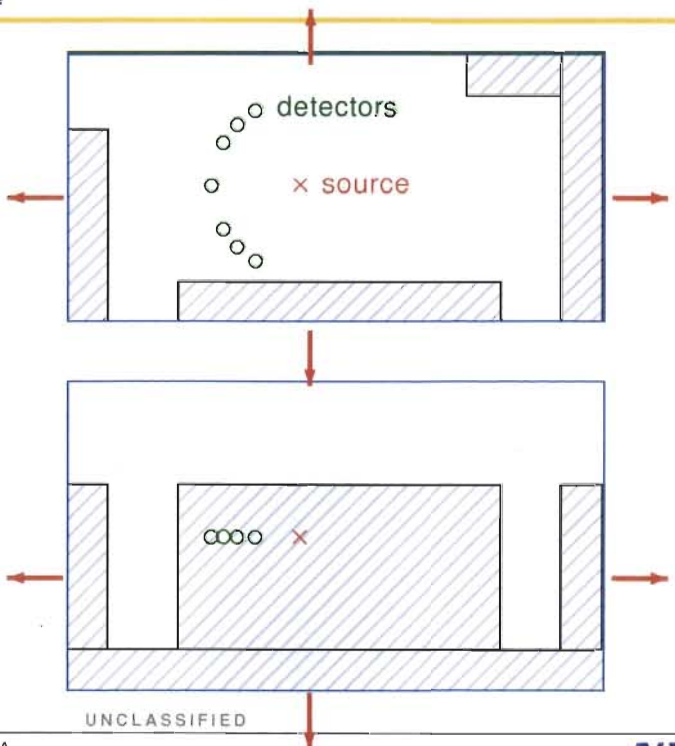
The walls and floor were moved outward in +1-m and +2-m steps

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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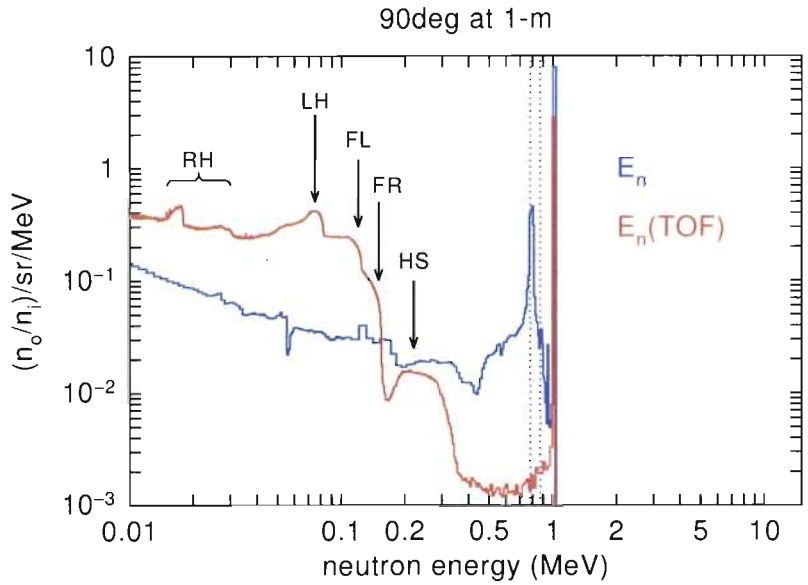
geom2.plt: 05 Mar 2010 12:10:12

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



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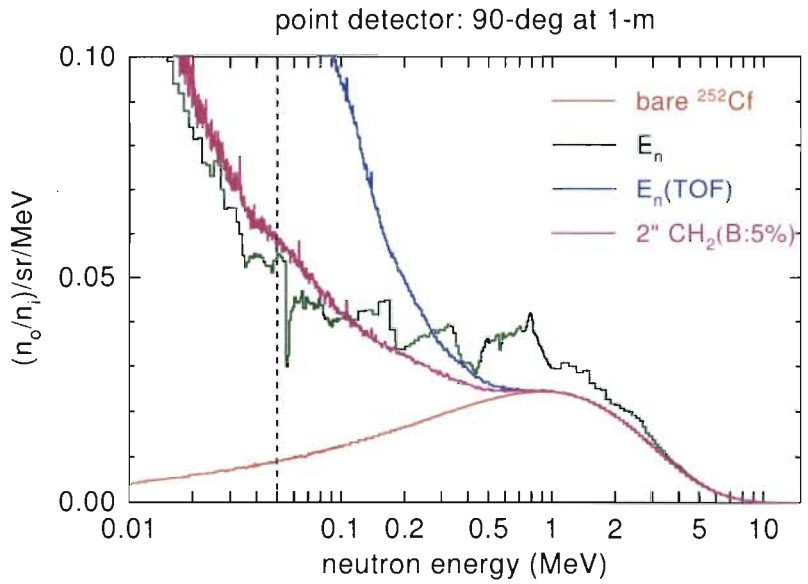
Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall



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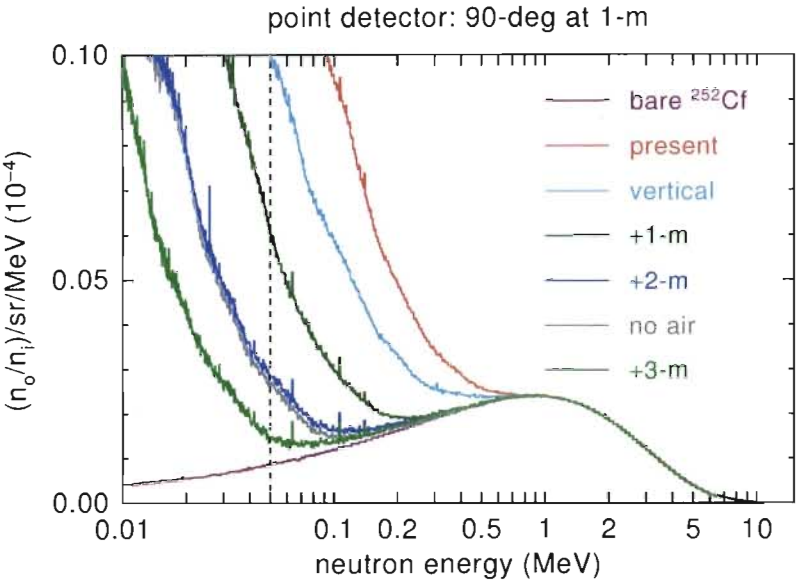
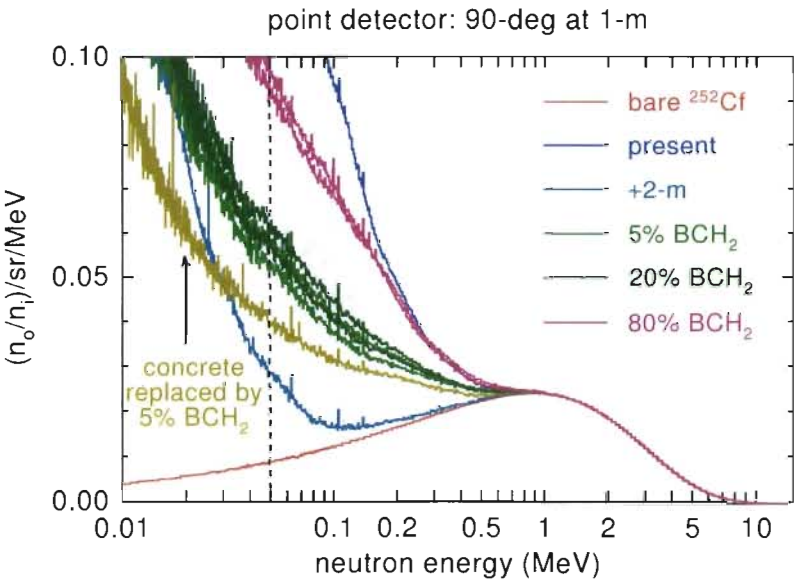
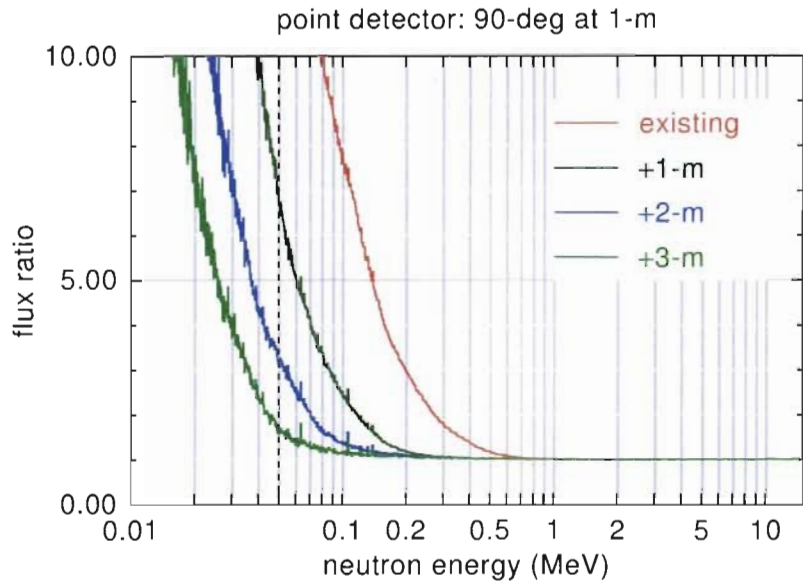
Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall



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



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



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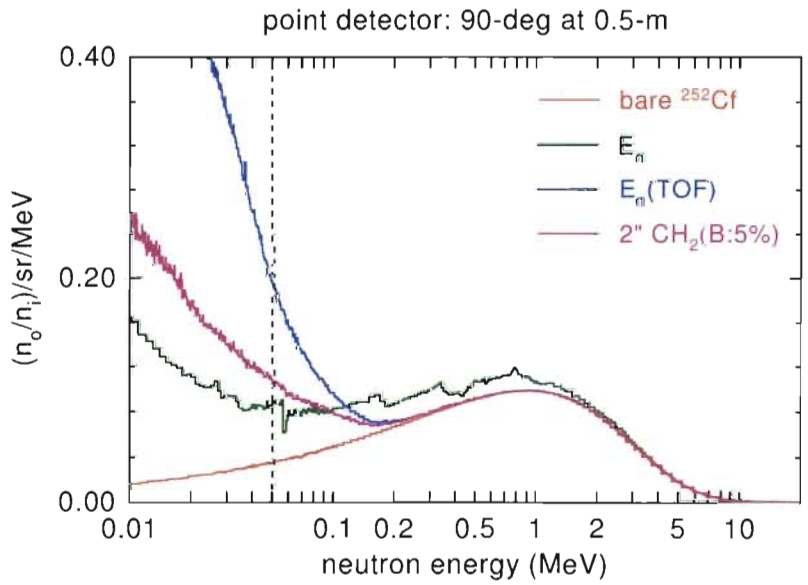
90deg_1m_ratios.plt: 05 Mar 2010 13:12:56

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



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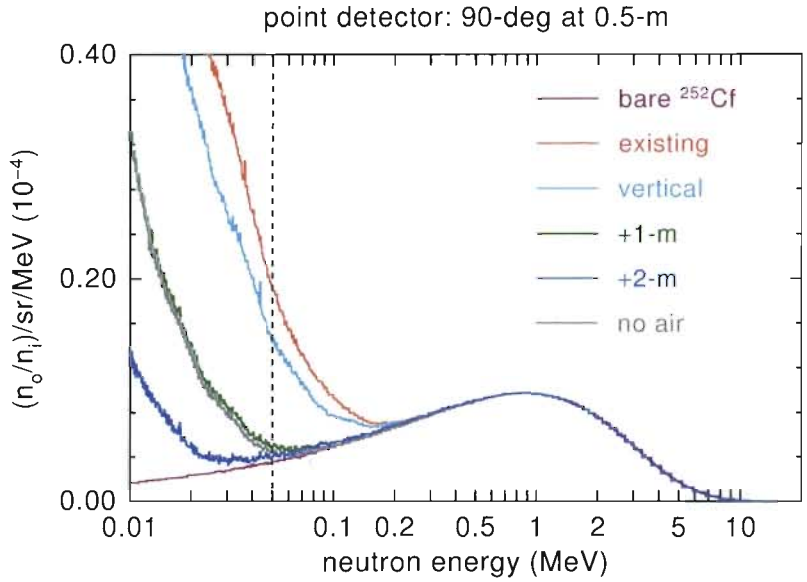
90deg-0.5m.plt: 23 Feb 2011 15:31:05

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



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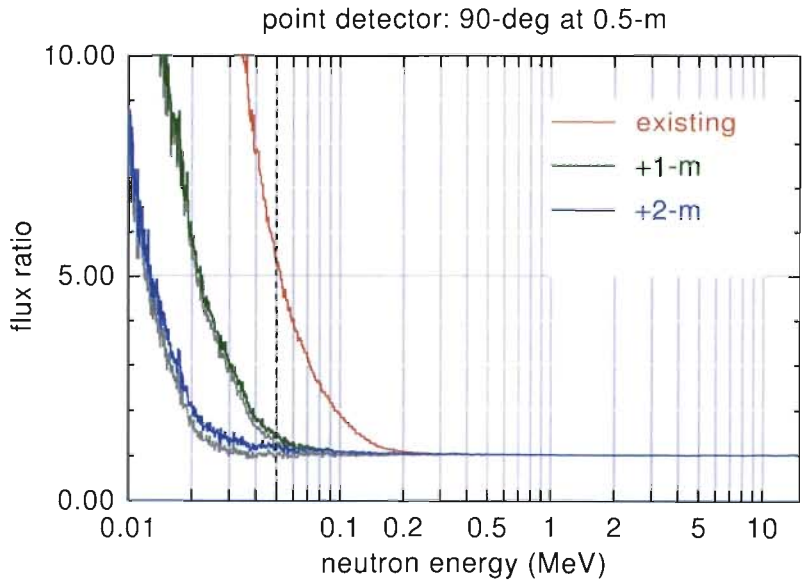
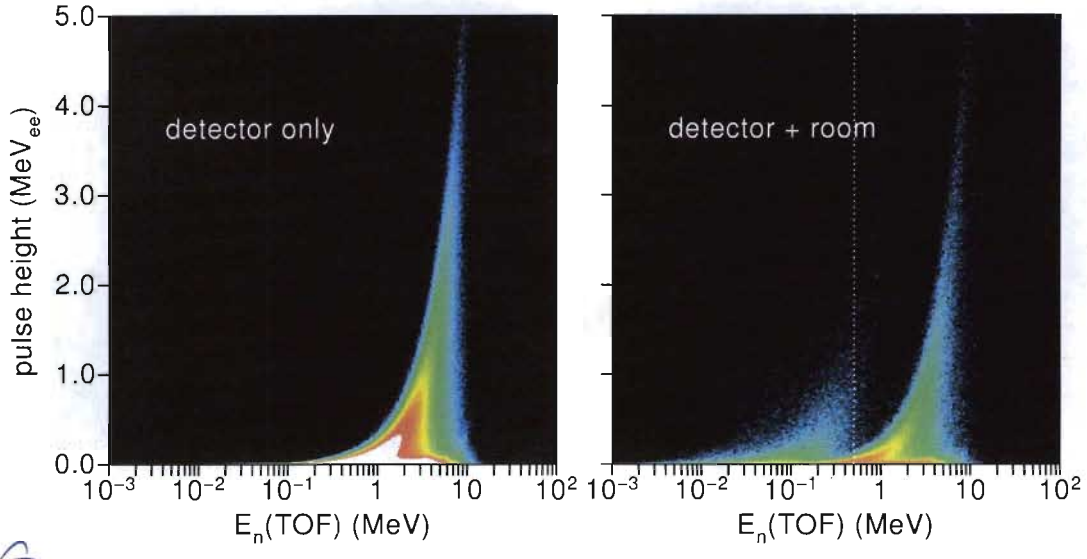
Re-scattering effects on 4FP30R: bare source + air + concrete + steel wall



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



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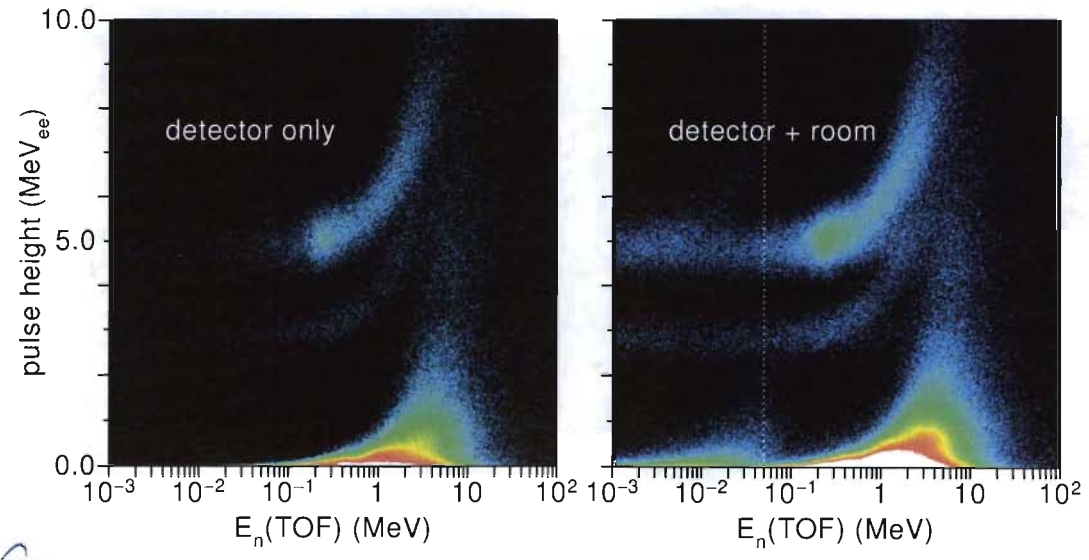
ne-213.plt: 23 Feb 2011 13:40:57

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

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



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Li-g.plt: 23 Feb 2011 13:41:01

Ohio University liquid scintillation (NE-213) detectors

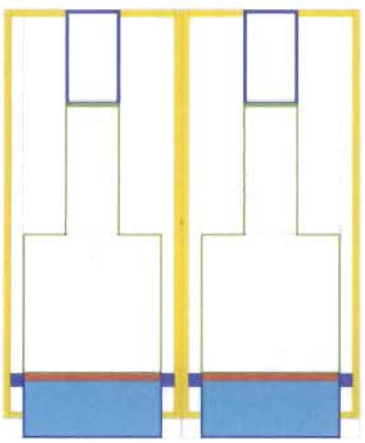
- similar to FIGARO detectors
- shown in 8-m location
- collimated beam is slightly larger than detector stack

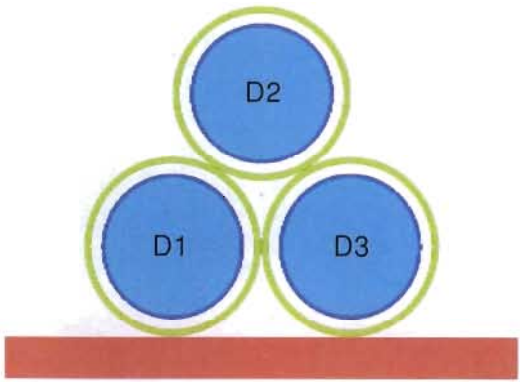
UNCLASSIFIED

Ohio University liquid scintillation (NE-213) detectors

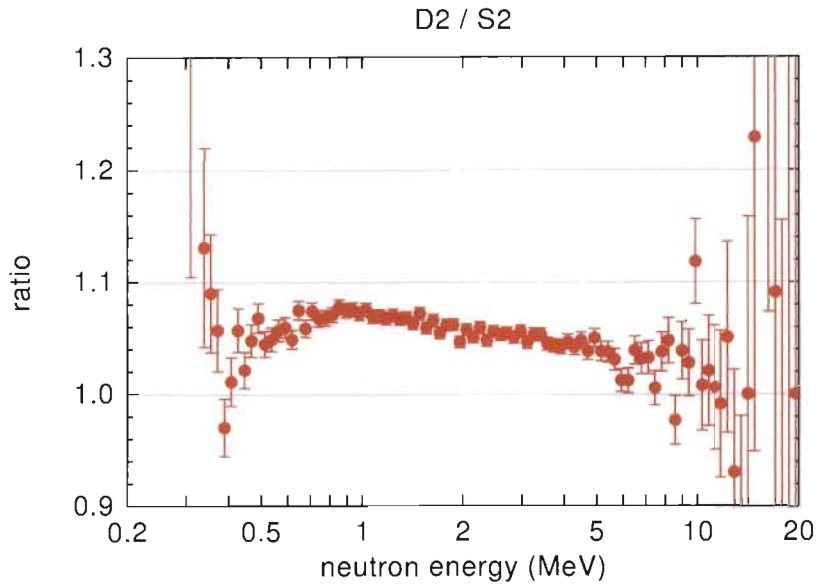
MCNP model:

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





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



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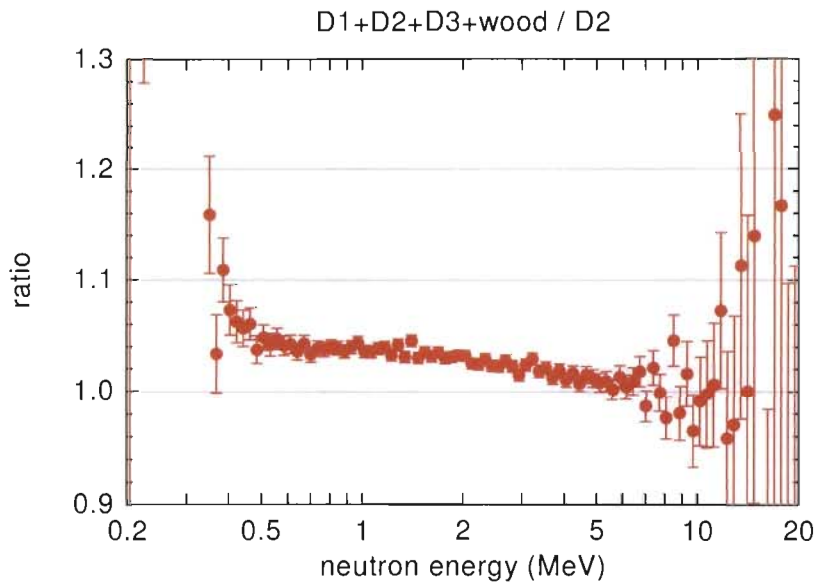
229_230.plt: 08 Sep 2010 14:45:51

NE-213 detector response ratio fission spectrum @ 1m



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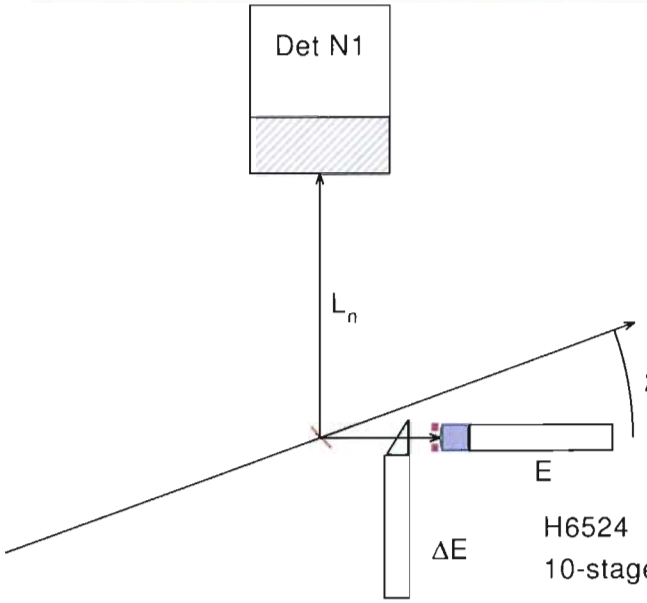
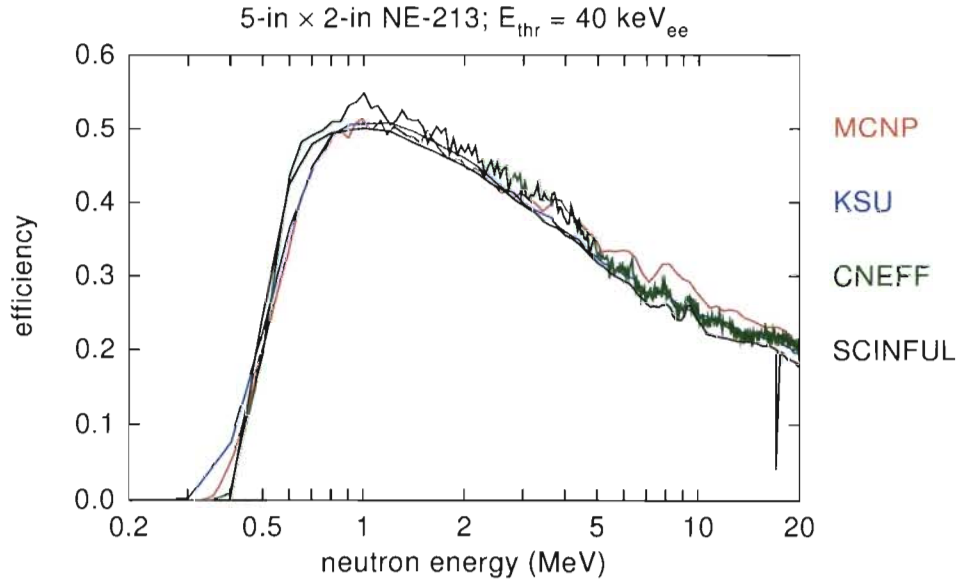
235_329.plt: 06 Sep 2010 14:41:25

Geometry for tagged-neutron measurements (2010)

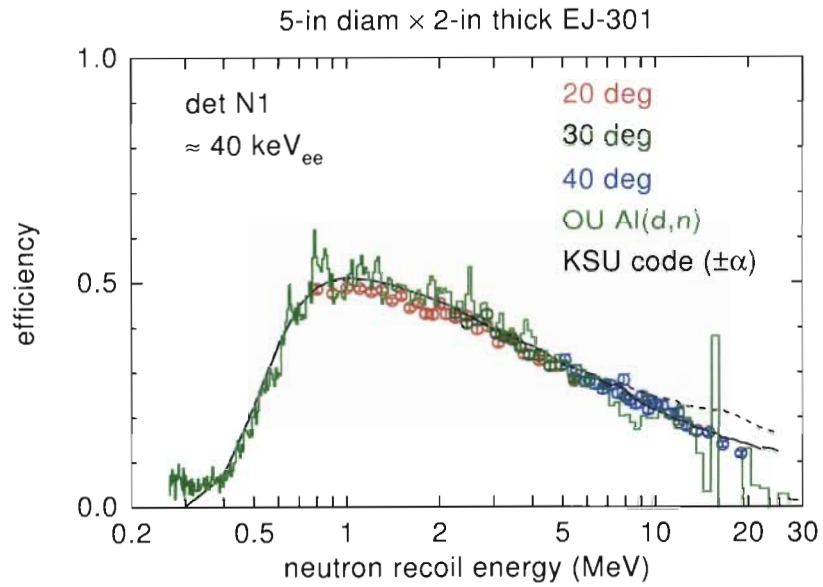


E = 25-mm EJ-212
(0.5" collimator)
ΔE = 0.25-mm EJ-212
L_n = 10.6 – 47.5 cm
L_p = 11 cm
μ_T = 70 mg/cm^2 CH_2

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: ≈ 5 – 10%
  - detectors: ≈ 4 – 8%
  - relative position is critical for detectors
- need improved Monte Carlo simulations benchmarked to data
  - MCNP
  - GEANT