

Monte Carlo Neutron Transport Methods Applied to an Emerging Trend in Nuclear Well Logging

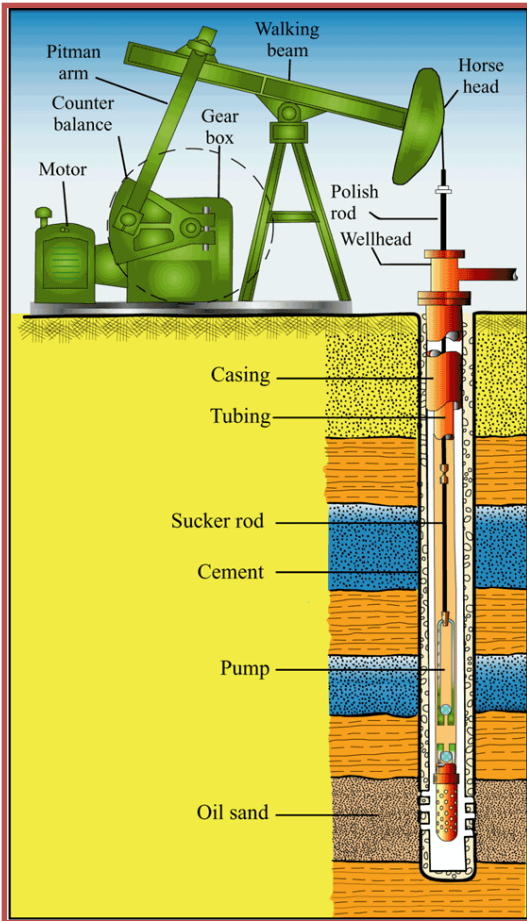
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The Main Idea

- Monte Carlo Neutron Transport has been utilized to explore and compare the performance of neutron porosity measurement tools with various neutron sources.

Compensated Neutron Logging



- Diffusion theory result:

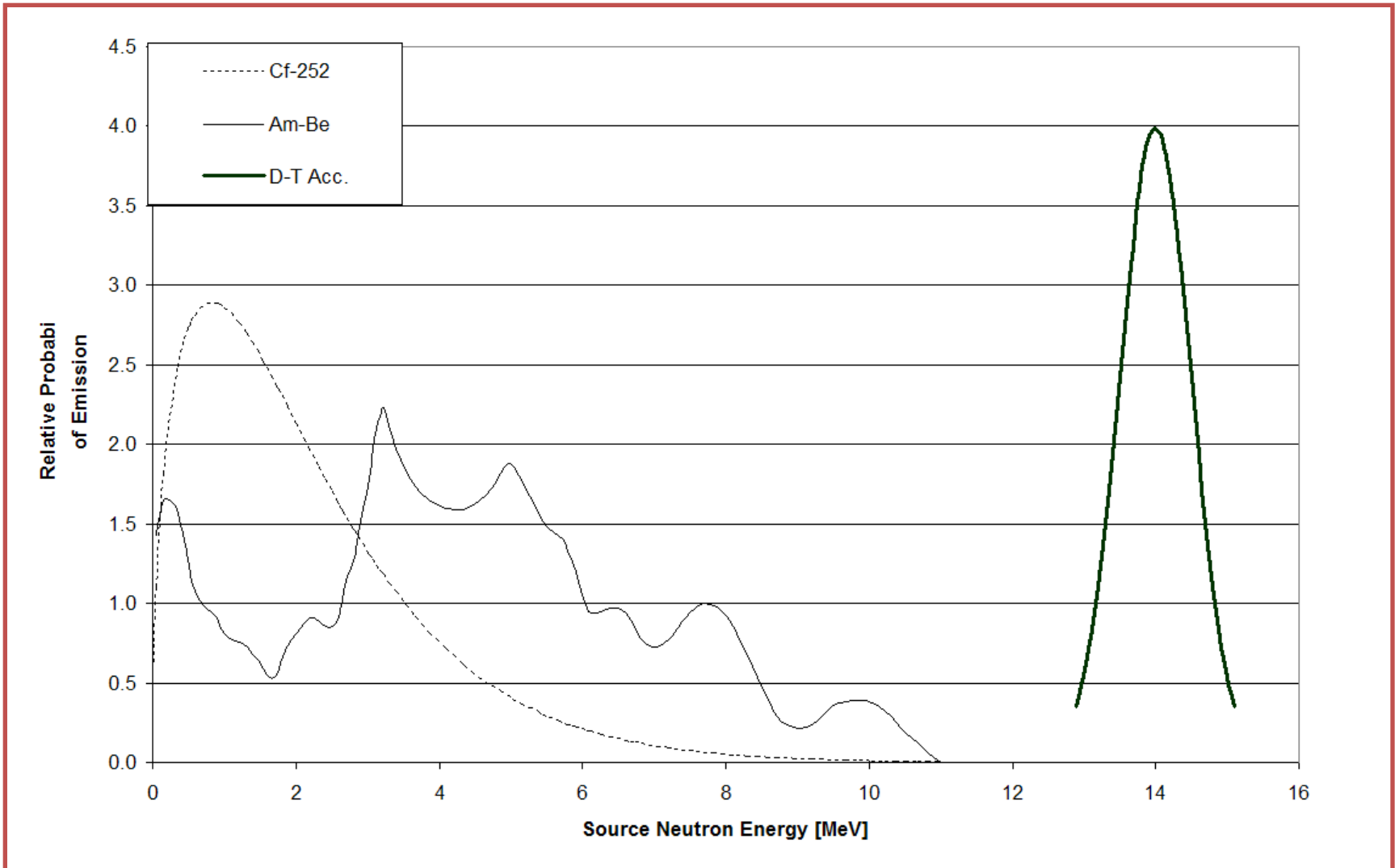
$$\frac{\Phi_{r_1}}{\Phi_{r_2}} = K \cdot \exp\left(\frac{r_1 - r_2}{L_s}\right)$$

- L_s is related to the Hydrogen Index, I_H

Neutron Sources

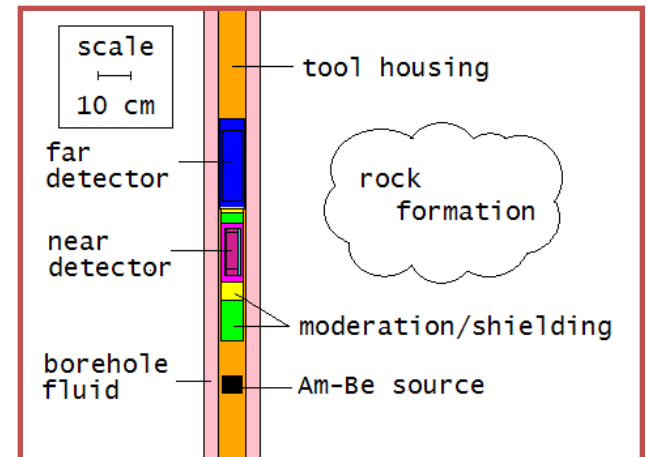
	AmBe	D-T Accelerator	Cf-252
Half-Life	Long	N/A	Short
Useful Lifetime	10 y	1000 op-hours	5 y
Proliferation Threat	Minimal	Lesser	Minimal
RDD Threat	Greater	Minimal	Lesser
Sensitivity to I_H	Moderate	Low	High
Intensity	Low (constant)	High (adjustable)	High (decaying)
Energy	4 MeV	14 MeV	2 MeV

Neutron Source Spectra

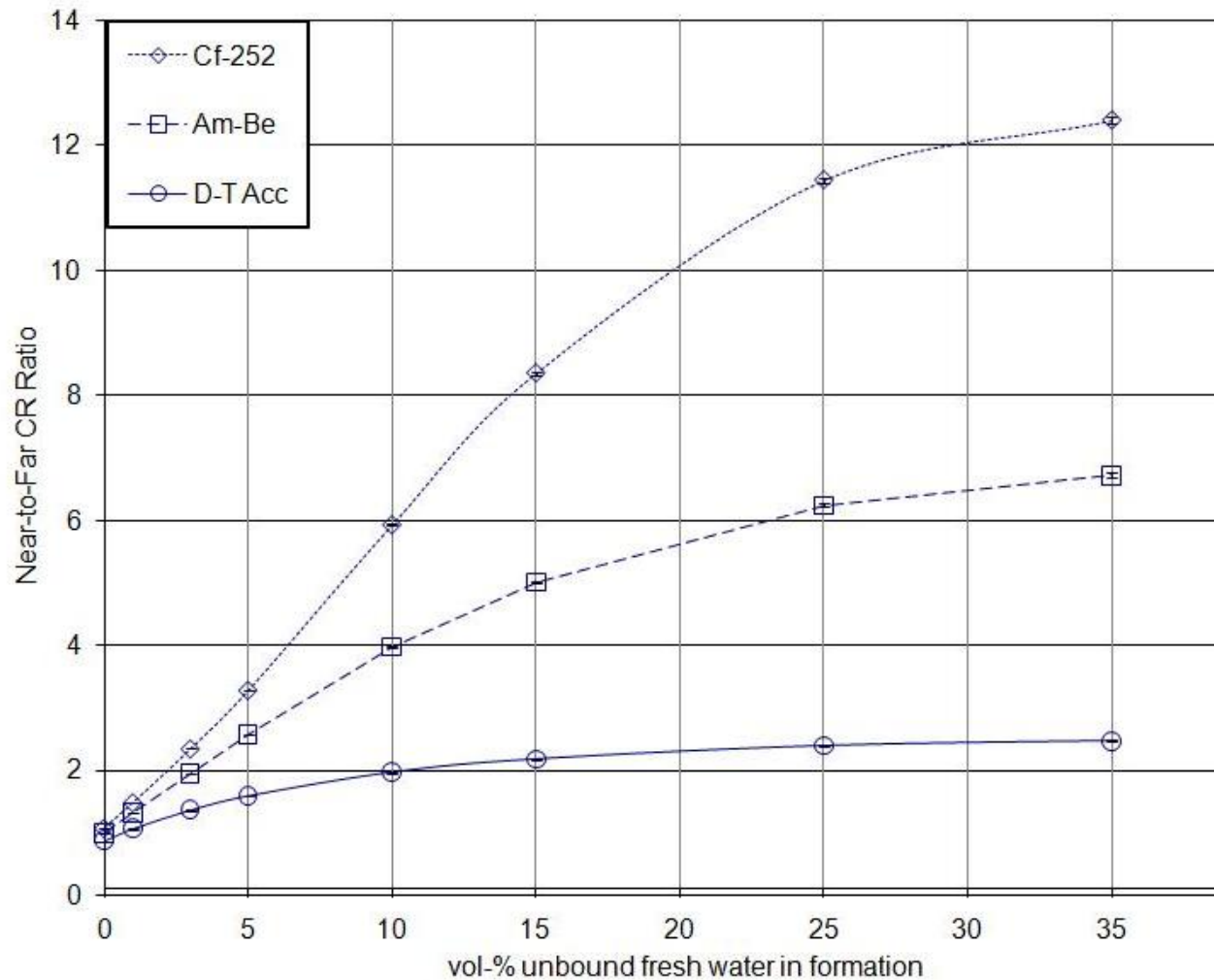


Model Description

- MCNP5 neutron transport
- Source sampling
 - Volume
 - Energy
 - Direction
- F4 neutron flux tally
 - Fm He-3 (n,p) cross section
- Principle Uncertainty
 - Counting statistics
 - MC sampling variance
 - Standard estimate of

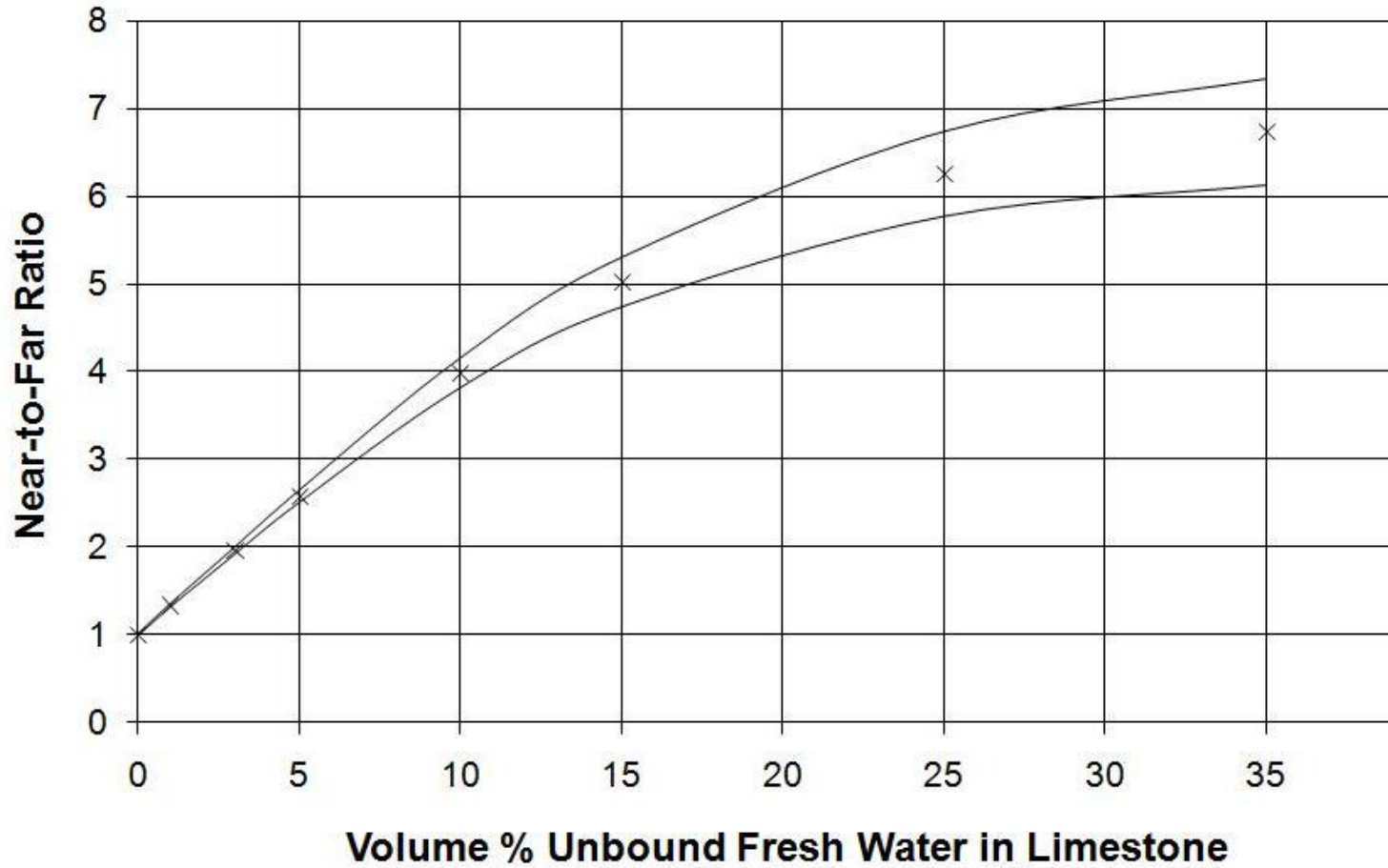


Sensitivity – MC Sample Variance

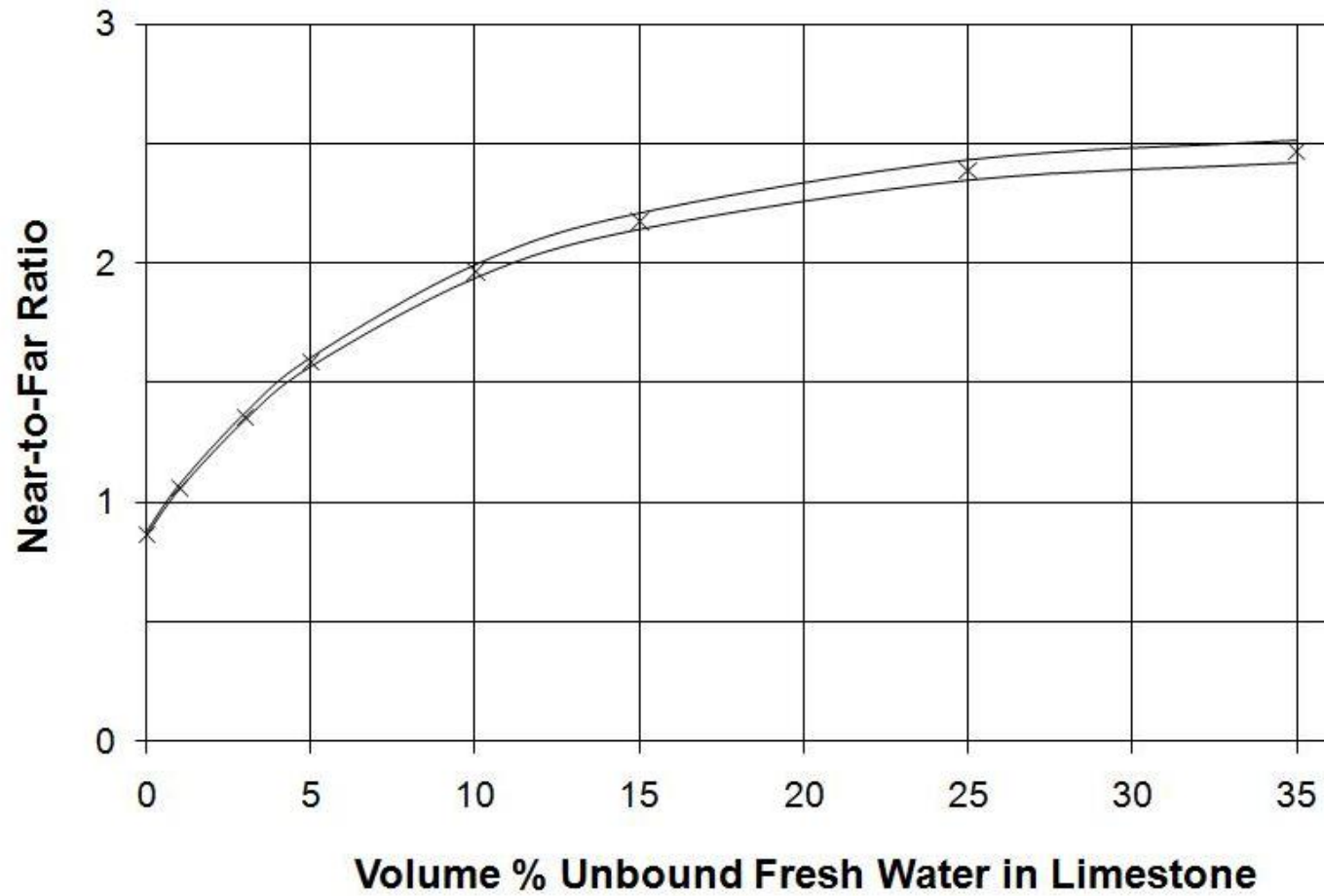


performance comparisons

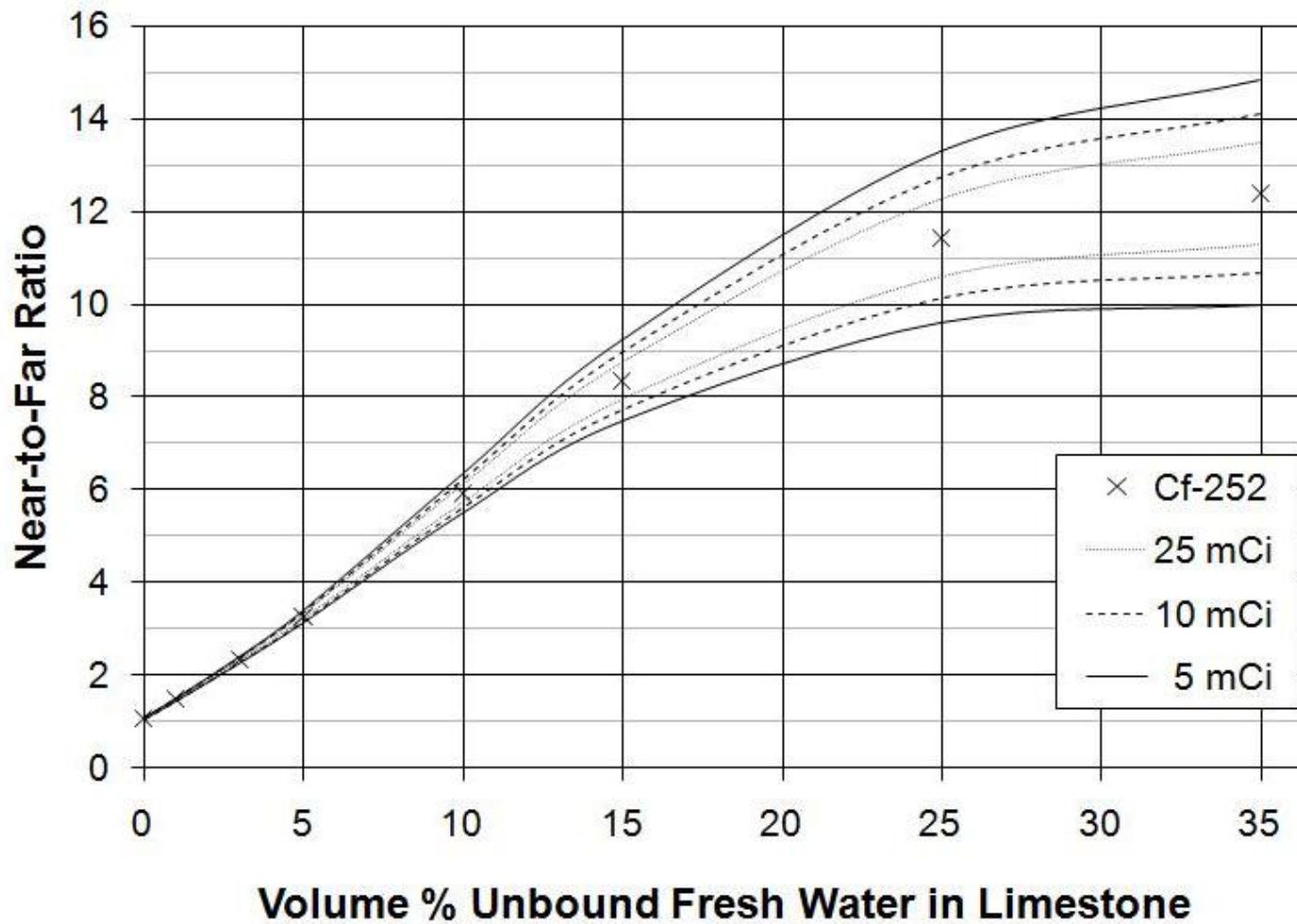
Am-Be Response with σ Bands



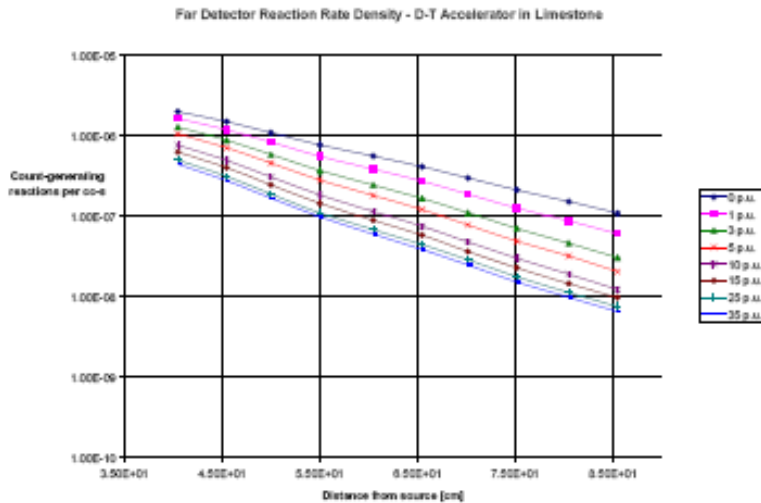
D-T Accelerator Response with σ Bands



Cf-252 Response with σ Bands



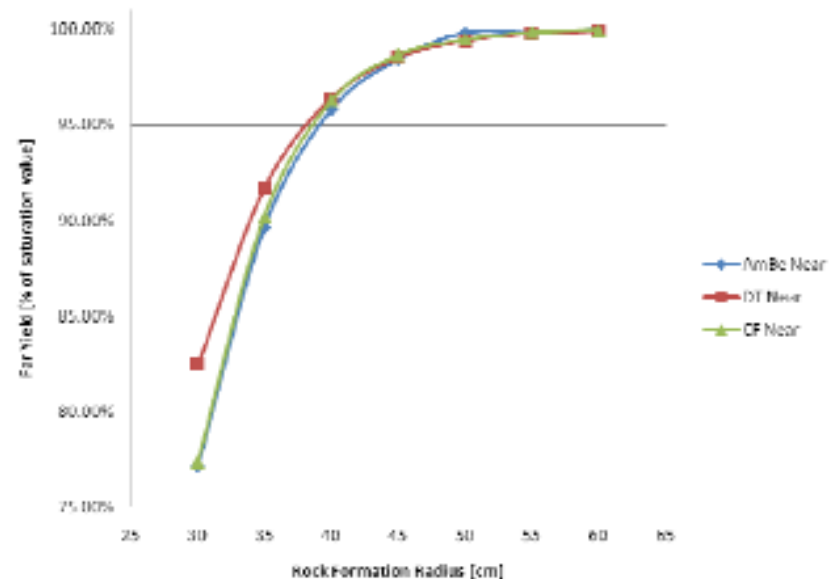
Adventurous Analyses



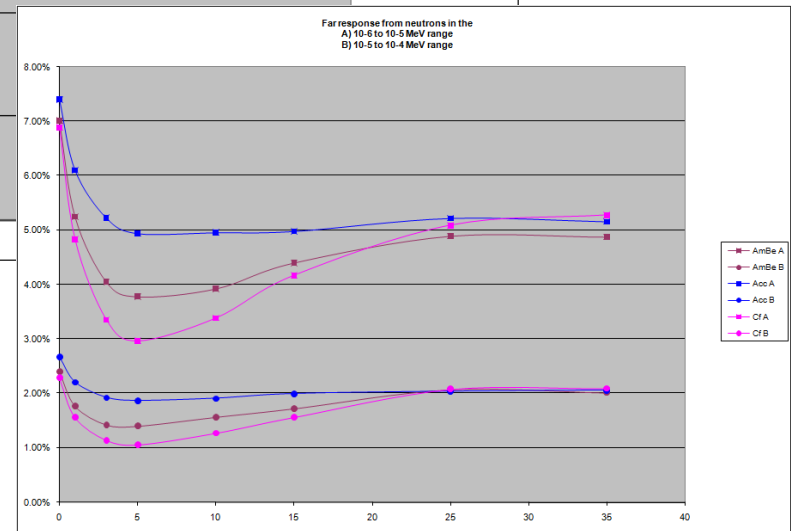
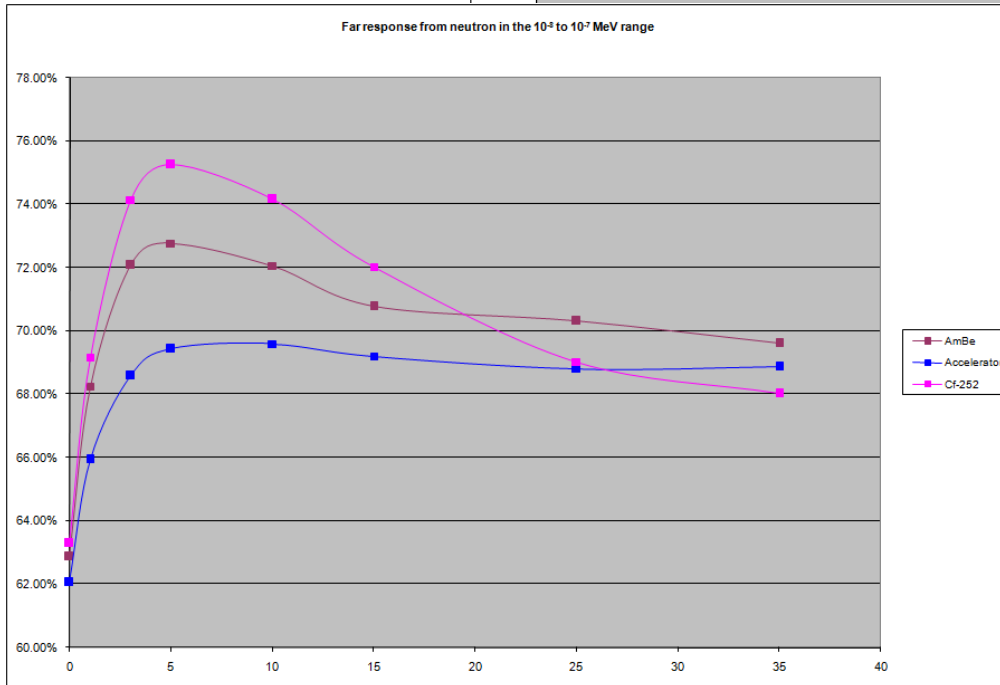
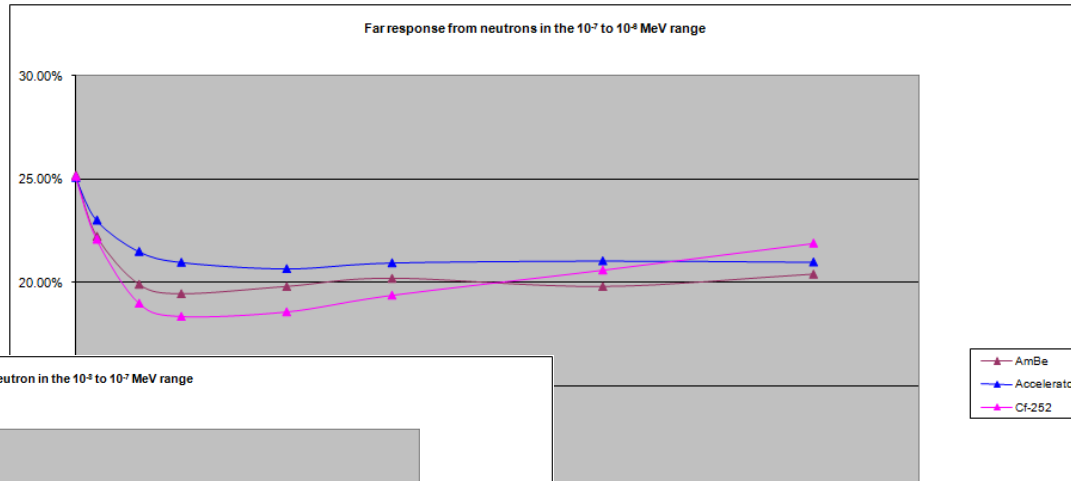
Segmented tallies

- Diffusion theory validated
- Over predicted far detector responses

- Information depth
 - Little variability
 - D-T worst



Potentially Interesting Data



Conclusions to note

- D-T source - sensitivity problem
- Cf-252 source - low count rate problem
- Neither problem seems insurmountable
- Questions?