

Neutron Attenuation in CHESS Heavy Concrete

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IBD Backgrounds

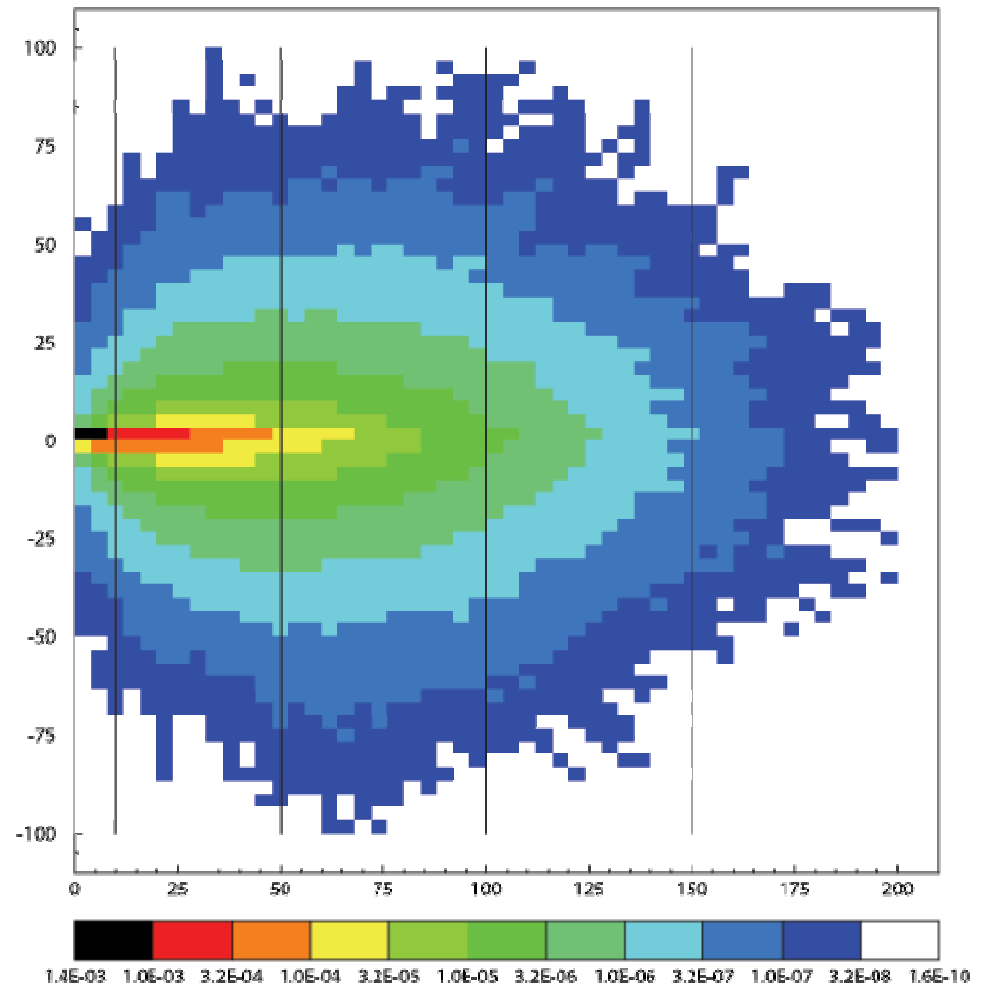
- Neutron-related IBD backgrounds have been studied for some time
 - G4, G4/RAT, MARS, FLUKA, hand calculations, increasingly sophisticated toy models
- CHES heavy concrete seems to be the leading contender for shield material
 - 36.3% O, 4.0% Si, 59.4% Fe by weight
- Some disagreement seen between simulations for neutron attenuation length in CHES concrete ($\lambda=26-27$ cm (FLUKA, G4/RAT) vs. $\lambda=19$ cm (G4/models))
- Revisit FLUKA and G4/RAT simulations from last year to confirm

Neutron Attenuation Length

- Defined as $e^{-l/\lambda}$, but criteria vary somewhat
 - Count only n's above some low-KE cutoff?
 - Include secondary n's produced by primary n's?
- Simplified criteria for simulations
 - Neutron KE spectrum from cosmic muons
 - Peaks at 80-90 MeV
 - Simulations focus on neutrons from 0-100 MeV, some above.
 - Use G4/RAT, FLUKA
 - Semi-infinite slab geometries
 - Inject primary neutrons at 100 MeV into CHESH concrete

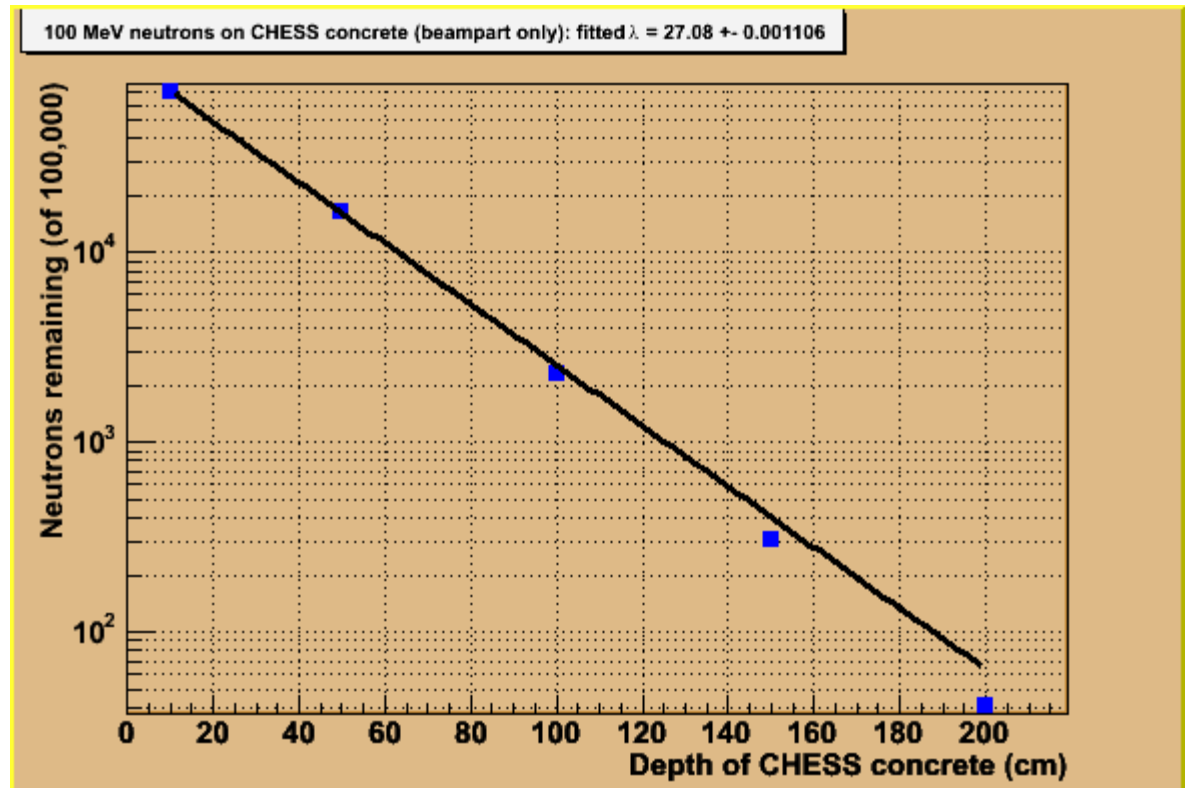
Semi-infinite Slab Geometry

- 100 MeV primary n's
- Injected at one location
- 200 cm depth CHESSE concrete
- Plot shows FLUKA simulation
 - Primary neutrons only
 - $KE > 19.6$ MeV



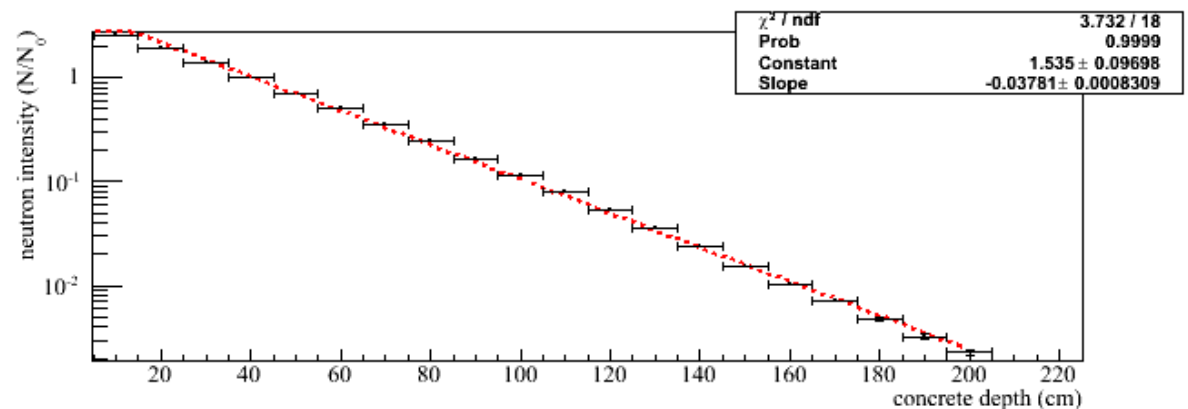
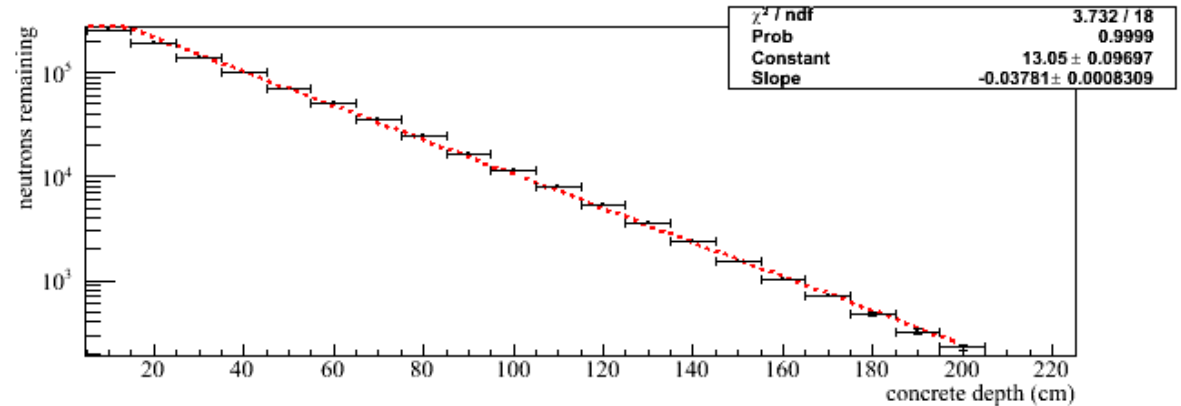
Study using FLUKA

- Counts primary neutrons
 - those that haven't undergone inelastic scatters
- KE cut:
KE > 19.6 MeV
- Result:
 $\Lambda = 27.1$ cm



Study using G4-based RAT

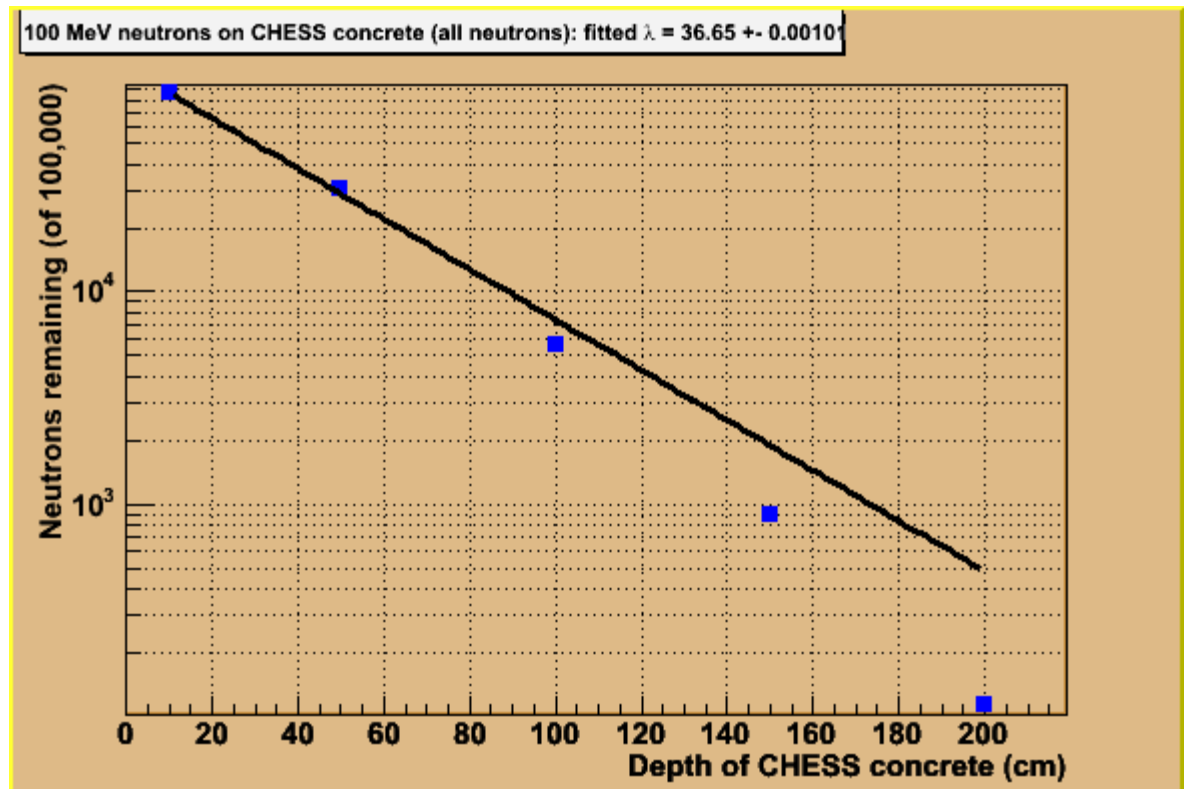
- Counts all neutrons
 - No cut on KE
 - Includes secondary neutrons
- Shows excess at shorter depths
- Result:
 $\Lambda = 26.4\text{cm}$



(Matt Worcester)

FLUKA, including secondaries

- Includes secondary neutrons
- Also shows excess at shorter penetration depths
- Not as large as G4/RAT, but
KE > 19.6 MeV



Summary

- Becoming confident that we are getting consistent neutron attenuation length estimates from FLUKA, G4/RAT in CHESS concrete
 - Quantitatively (26, 27 cm)
 - Qualitatively in terms of secondary neutron production
- Now go back and understand source of difference between G4/RAT, FLUKA and G4, toy models