

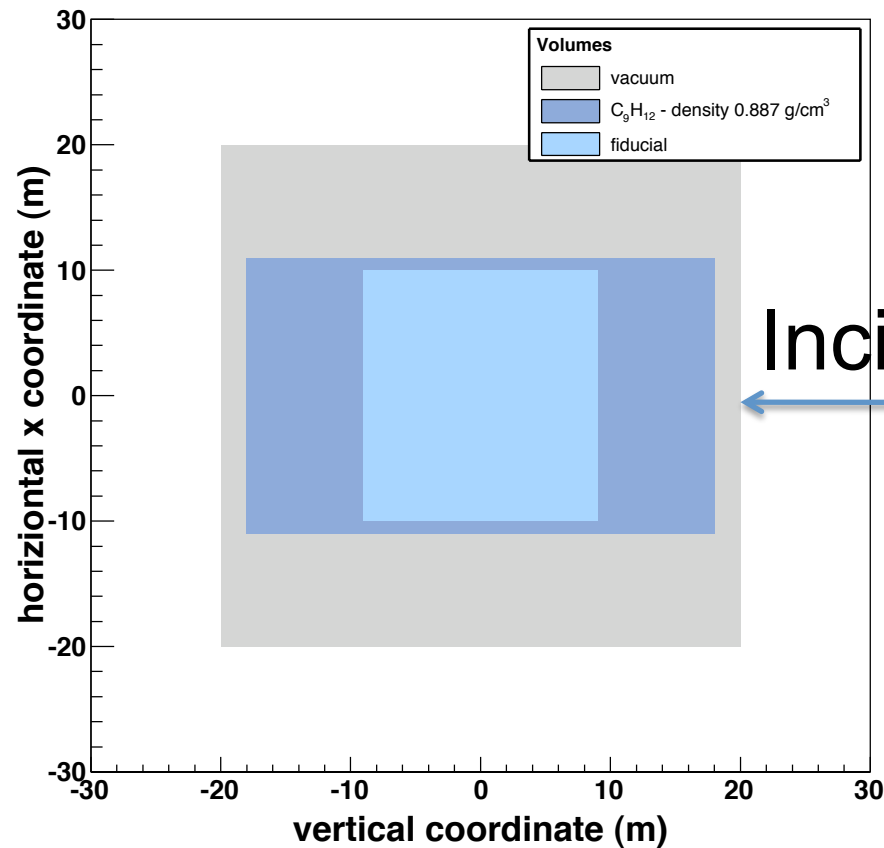
Comparing Geant4 and FLUKA

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Geometry

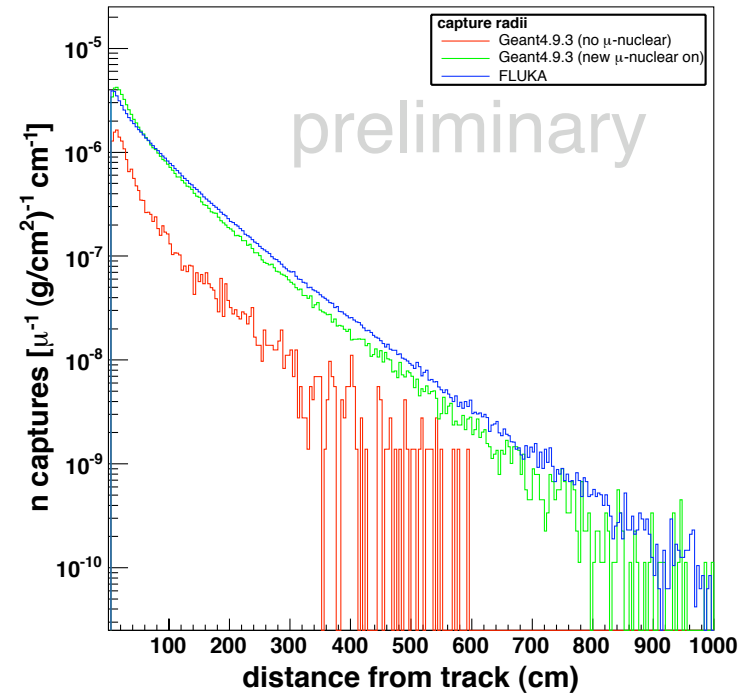
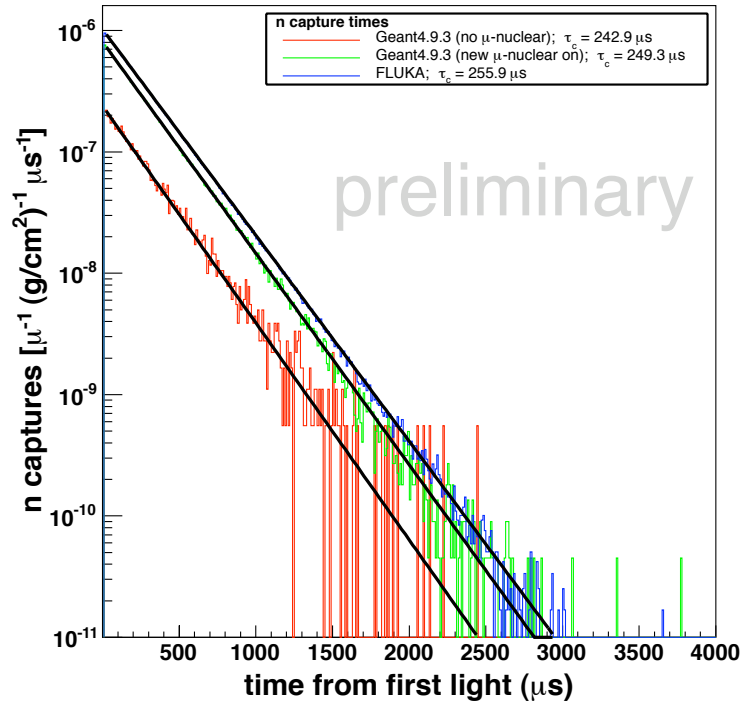


- Using various energies (10 – 1000 GeV)

• Light and heavy materials (water, salt, iron, lead, etc.)

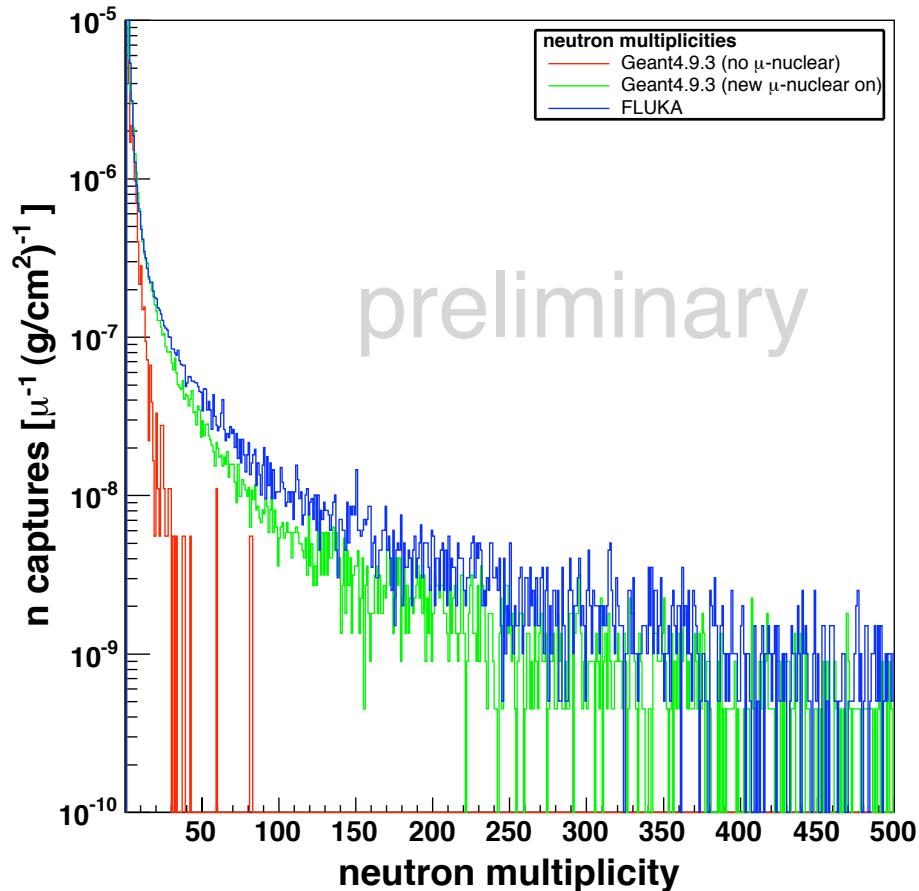
- Some specialized materials (liquid scint.)

Scintillator Results



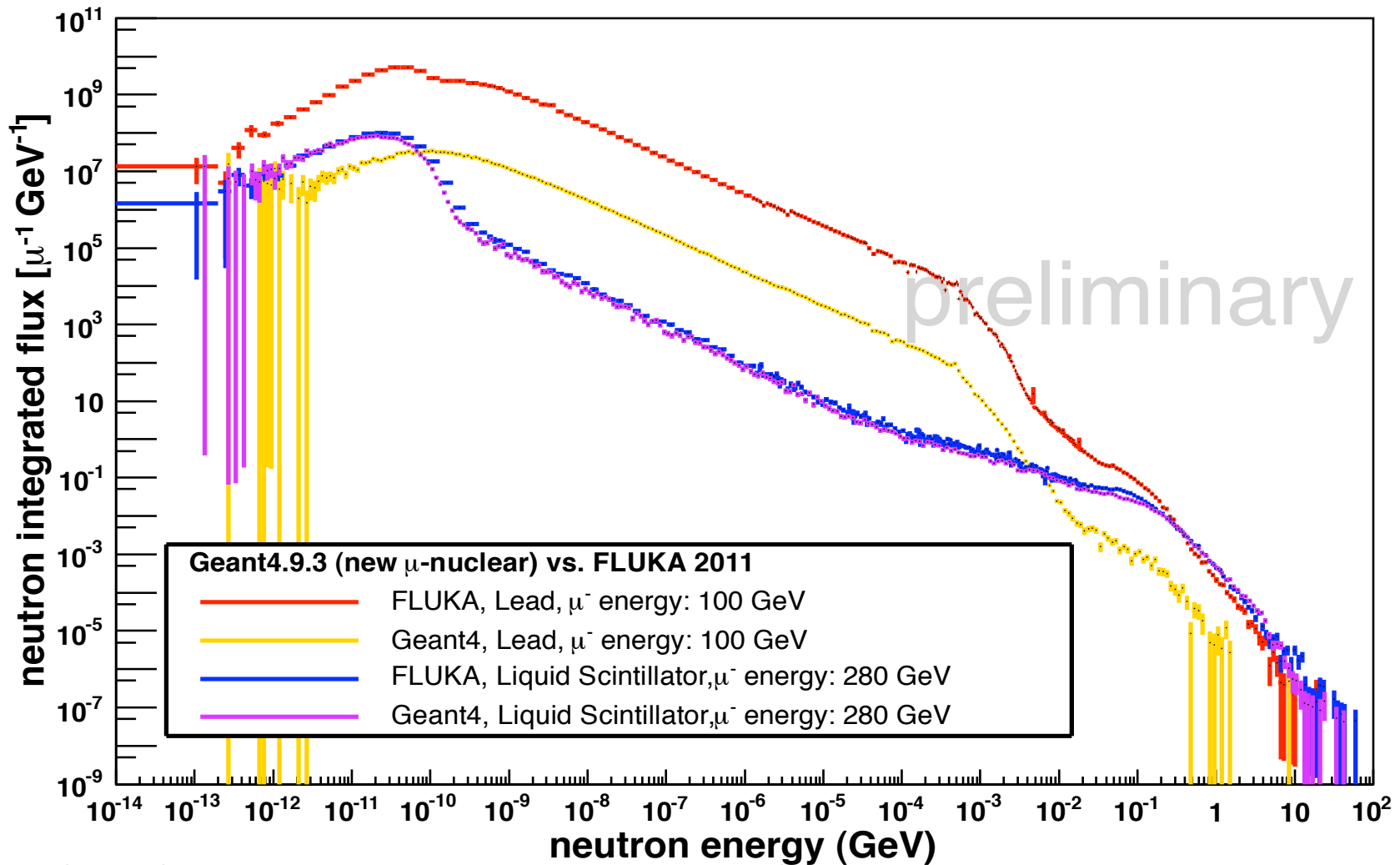
- Timing distributions look correct in size and gets capture time within $\sim 10\%$
- Distance from track distribution has small discrepancies at small radii

Scintillator Results



- When μ -nuclear included, fair matching
- High multiplicity events good probe of μ direct interactions
- Geant4 seems to give smaller rates for very high multiplicity events

Flux Results (Scintillator & Lead)



Versions of Geant4 and FLUKA

- FLUKA: has always used version v2011.2.5
- Geant4 started with v4.9.3+ and has large amounts of 280 GeV and 100 GeV data there
 - The “+” means there was a non-standard code upgrade related to muon nuclear interactions
- Geant 4 moved to version v4.9.5 with official “Shielding” physics list for a “full run” of all materials

Comparison Variables

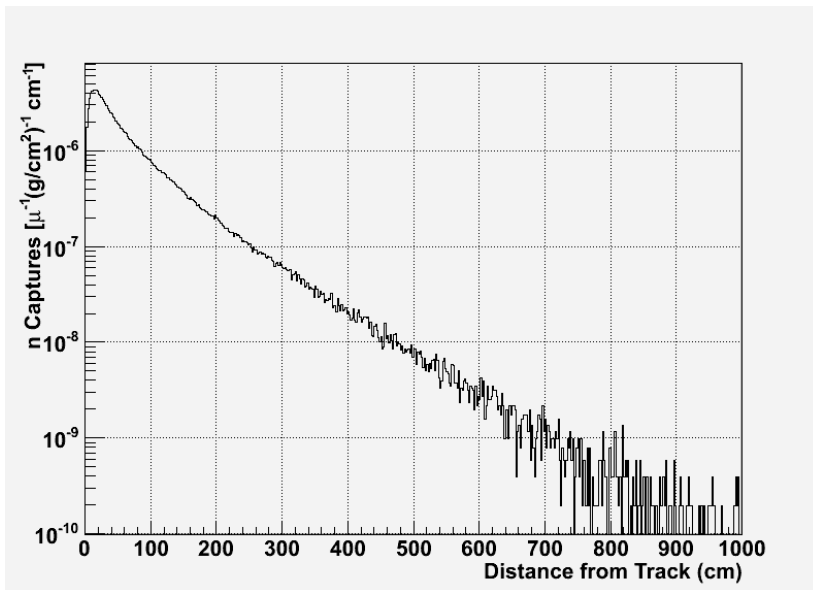
- Numbers
 - total neutron yield
 - neutron yield separated by hadronic prod mode
 - isotope production
- Plots
 - neutron flux vs. energy
 - same as above but separate by production mode
- Histograms of normalized counts
 - vs. capture/thermalization time
 - vs. capture/thermalization multiplicity
 - vs. capture/thermalization radial distance

Materials Completed

Material Name	Chemical Composition	Density (g/cm ³)
Liquid Scintillator	C ₉ H ₁₂	0.887
Water	H ₂ O	1.0
Salt	NaCl	2.17
Carbon	C	2.267
Calcium Carbonate (calcite)	CaCO ₃	2.71
Iron	Fe	7.874
Lead	Pb	11.342

- Energies (GeV): 10, 30, 100, 280, 1000
- Geant4: 1M muons and anti-muons for all materials at all energies
- FLUKA: 3M muons for most materials at all energies
- Took some time to work out scoring and efficient data readout, but now in a position where a full run could be generated in a month or so

Radial Distribution: Scint. C_9H_{12}

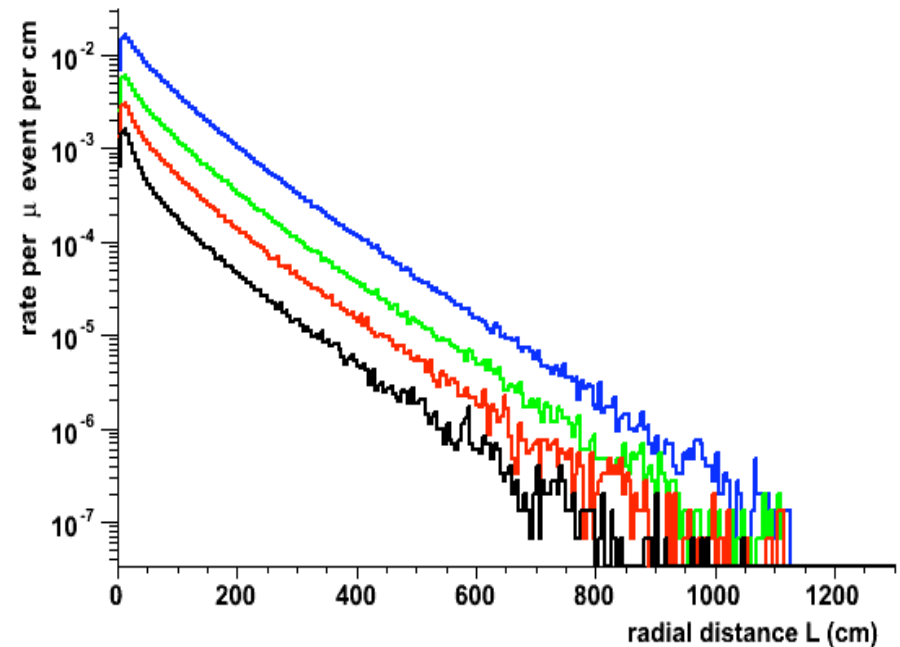


FLUKA: 30, 100, 280, 1000 GeV

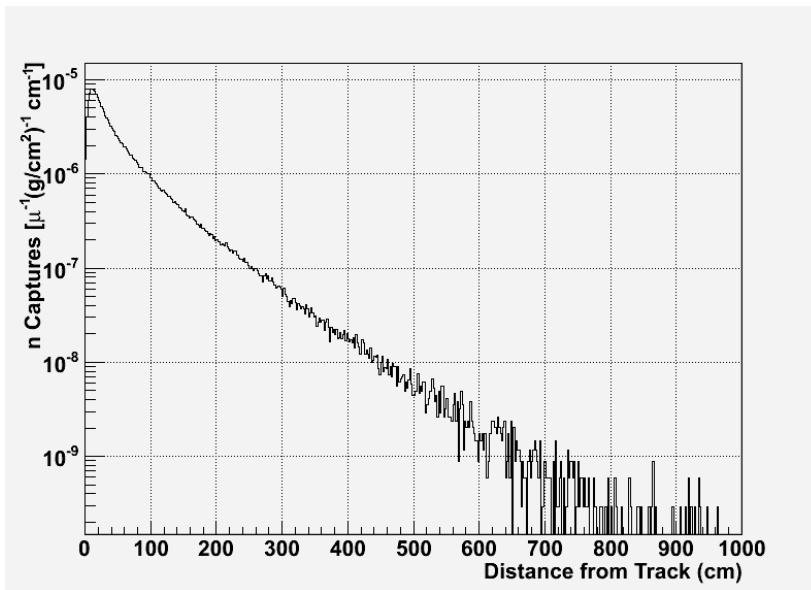
Figure: A. Empl

Geant4: 280 GeV

Figure: A. Kennedy



Radial Distribution: Water

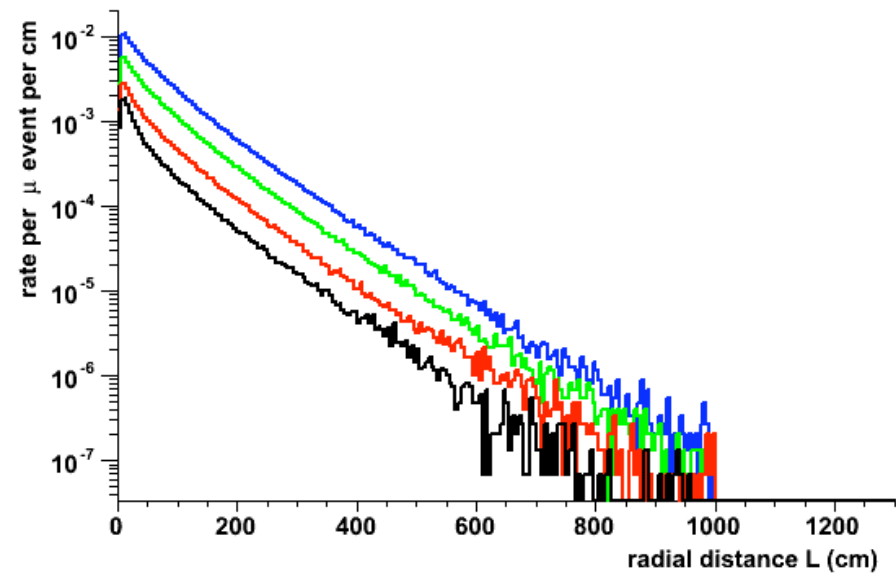


Geant4: 280 GeV

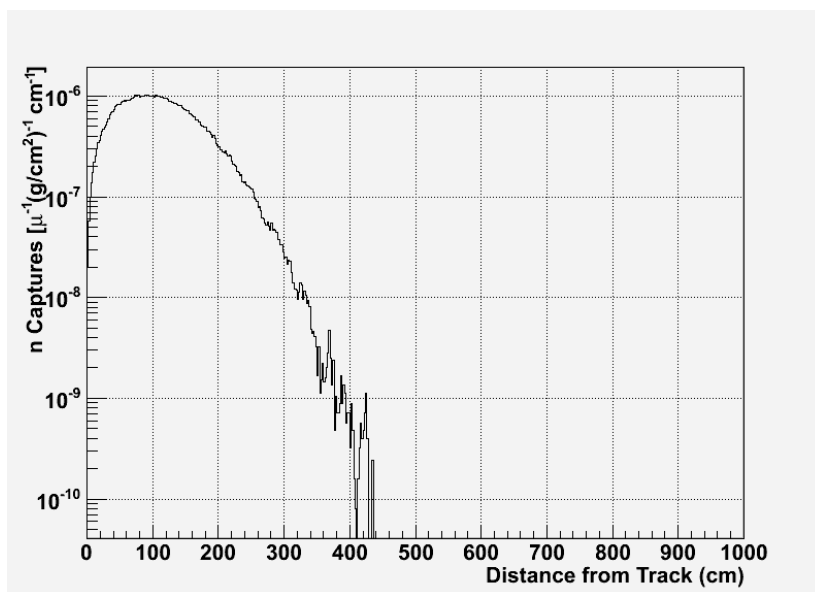
Figure: A. Kennedy

FLUKA: 30, 100, 280, 1000 GeV

Figure: A. Empl



Radial Distribution: Lead

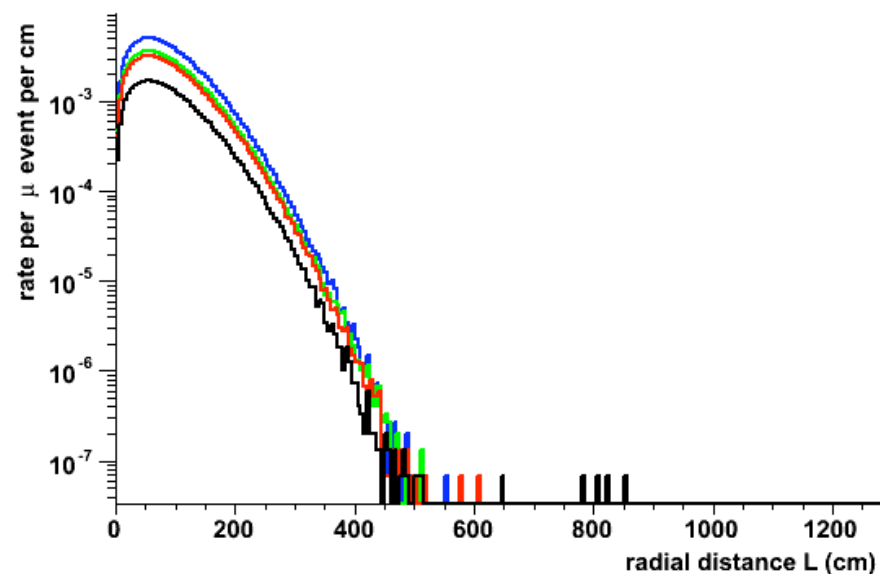


Geant4: 280 GeV

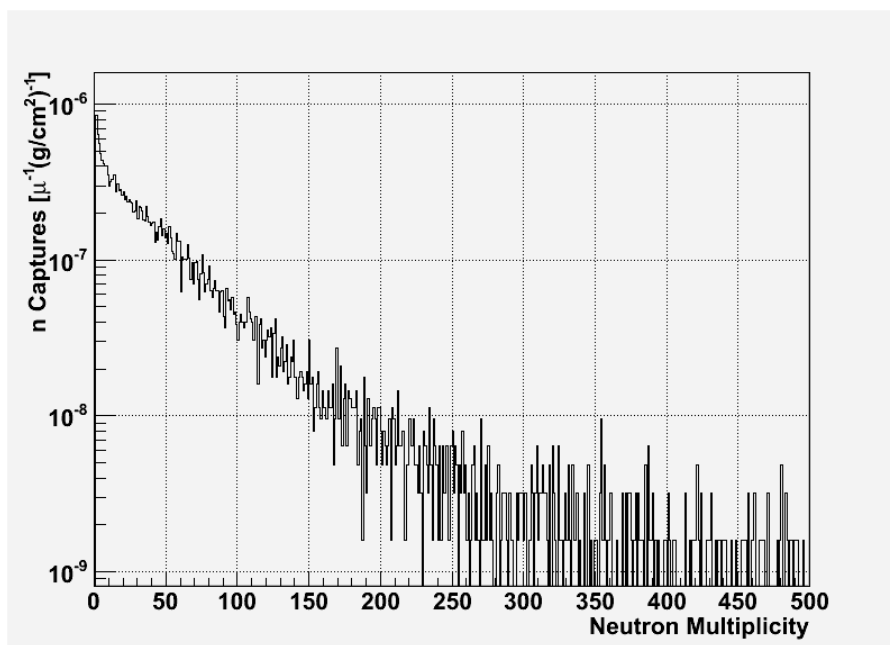
Figure: A. Kennedy

FLUKA: 30, 100, 280, 1000 GeV

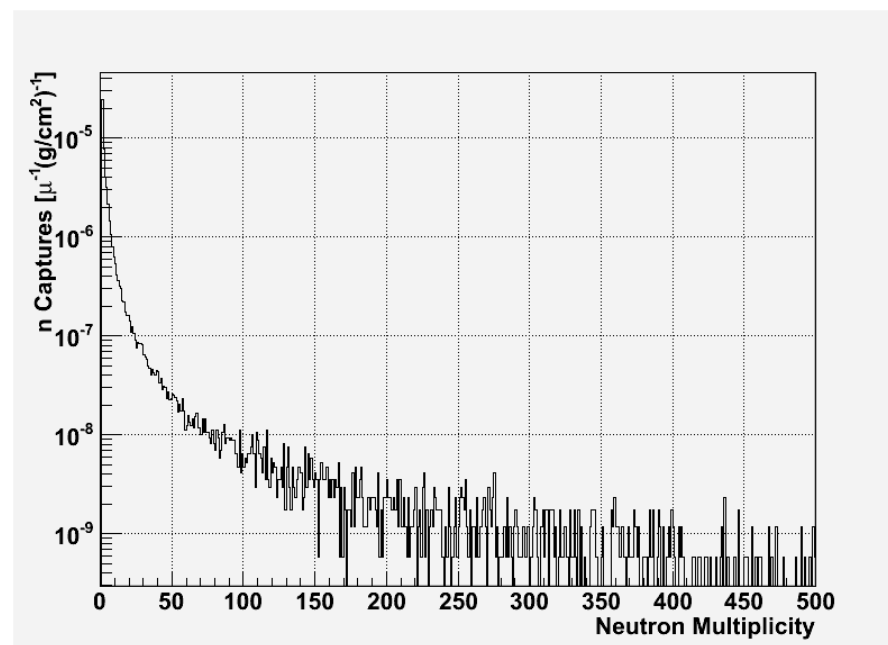
Figure: A. Empl



Geant4 Multiplicity



Geant4 Lead at 280 GeV



Geant4 Water at 280 GeV

Status/Summary

- Geant v4.9.5 release and FLUKA v2011.2.5 have data for comprehensive comparison which is being worked out for presentation at LRT
- Another full run could be completed for both sims in a much faster time than previously – conceptual and scoring bugs worked out
- Suggest to have this full simulation automatically done for each new release and vetting data made available
- The comparison will move on to a detailed understanding of each simulations models and comparison to existing and future data

Status/Summary

- Geant4 data updates:
<https://zzz.physics.umn.edu/lowrad/flukageant>
- FLUKA data updates:
<http://pametime.dyndns.org/pame/index.html>
- The plan is for these sites to host not only the distributions but some data in more “raw” form for people to do customized plotting
- Simulation output is sometimes large but can be made available to people.