

Low Energy Physics Validation Radiation Length Studies

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Collaborators

- **Hampton University**
 - Nanda Karthik, PhD student (medical physics)
 - Radiation Control Group at JLab

- **Texas Southern University (TSU)**
 - Dr. Mark Harvey, Visiting Faculty in Department of Physics
Coordinator, TSU Health Physics Program
 - Students: Samantha Everett, Brandon Georgetown, Biruk Desta

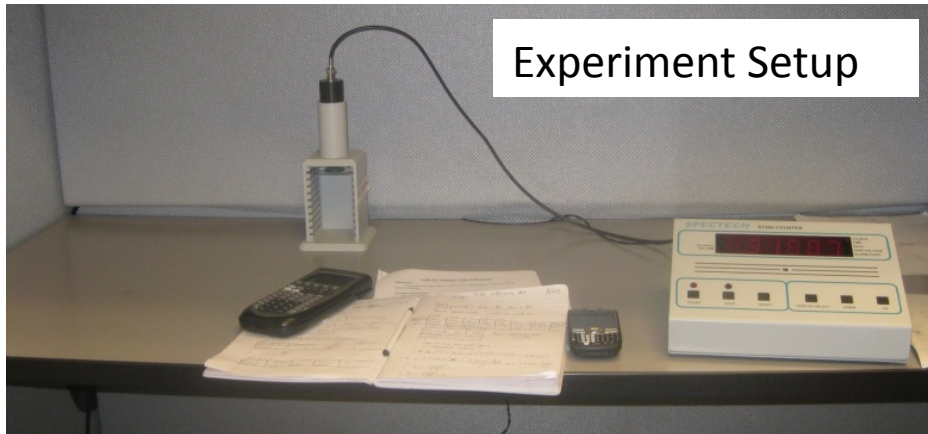
Work Description

- Materials of differing radiation lengths
- Gamma, beta and alpha sources
- Measure transmission and attenuation (see comment)
 - Beam goes through an absorber
 - In-air measurements
- Compare measured data with Geant4 9.3
 - Validation at low energy
 - Test of physics models: standard and Livermore
 - Geant4.9.3 beam production: General Particle Source (isotropic)

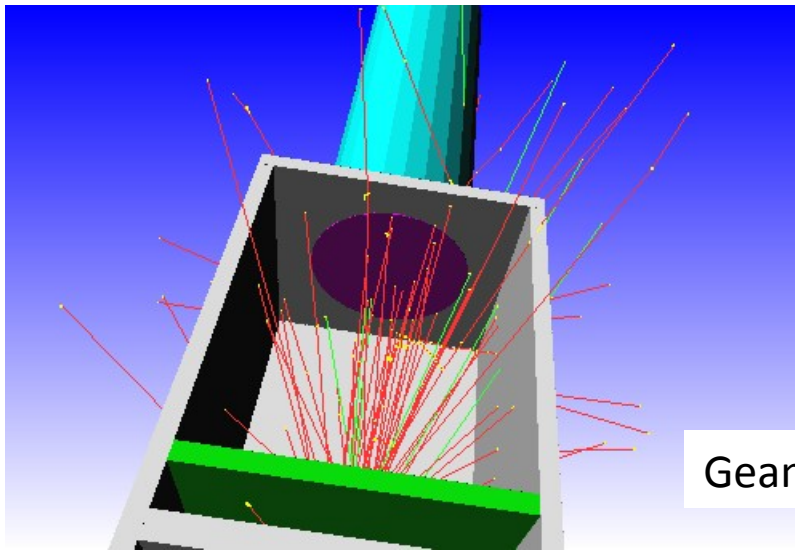
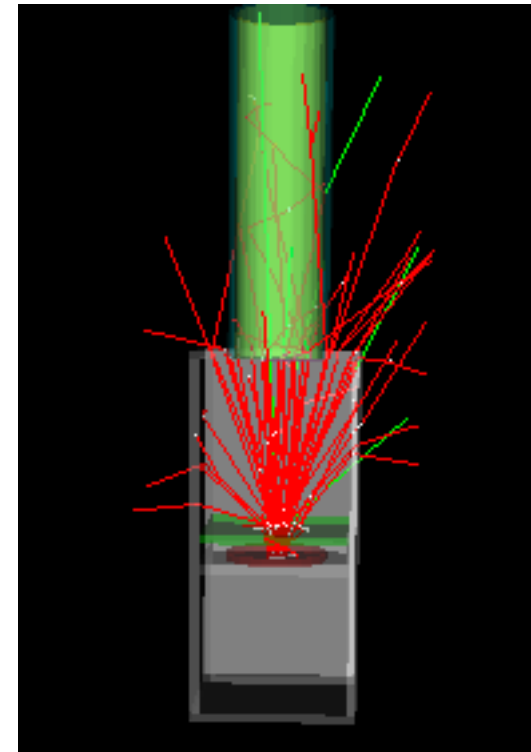
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- Equipment
 - Geiger Muller Tube
 - Dead time: $\sim 2 \times 10^{-4}$
 - Counter
- Absorbers:
 - Lead, plastic, aluminum, polyethylene
 - Varied thicknesses: 65 g/cm^2 to 1290 g/cm^2
- Radioactive Sources ($\sim 1 \text{ } \mu\text{Ci}$; $\sim \text{few MeV}$):
 - Gamma/Beta Emitter: Cs-137
 - Beta: Sr-90 and Tl-204
 - Alpha: Po-210
- Distance of source from from GM counter $\rightarrow 2 \text{ cm}$

TSU Experimental Setup

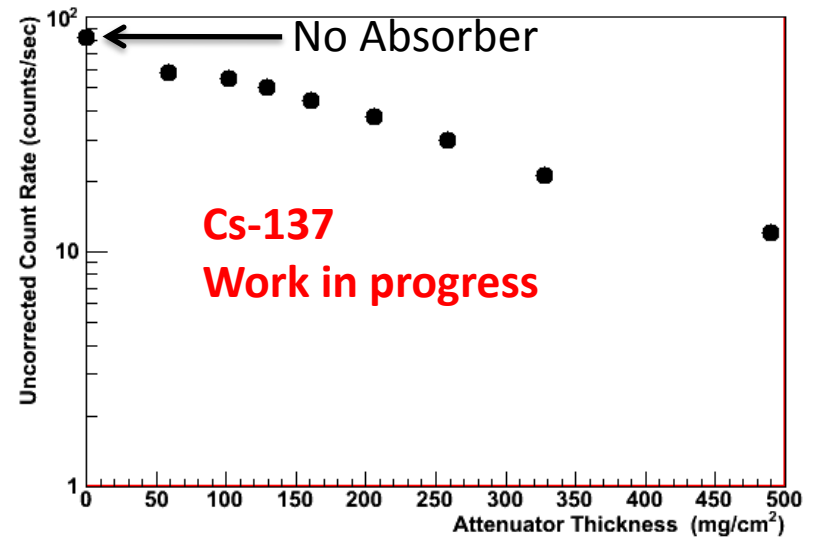
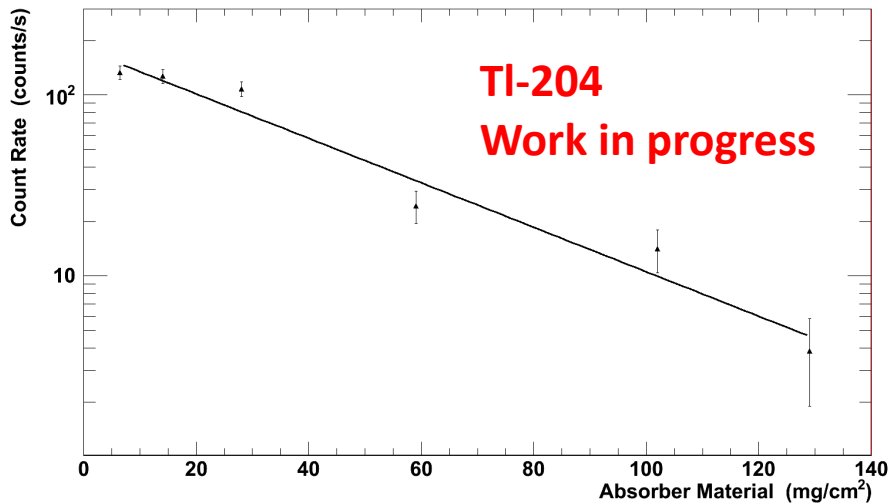
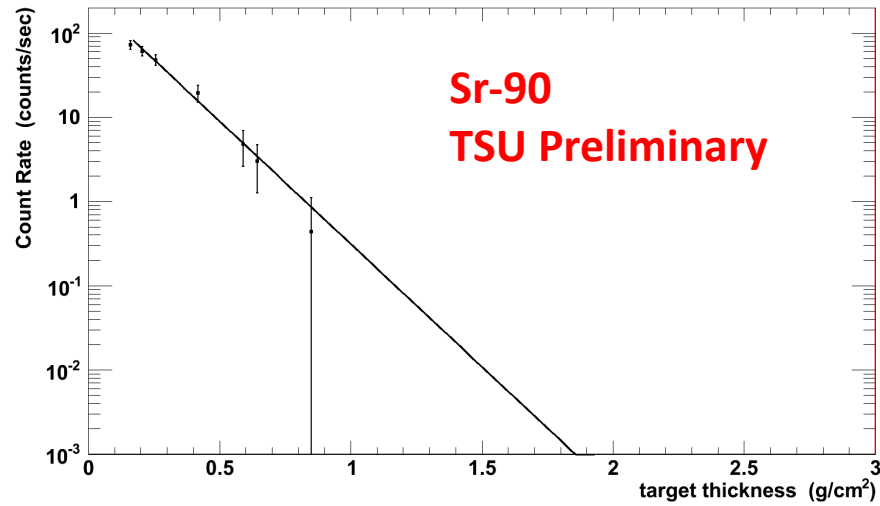


Geant Schematic

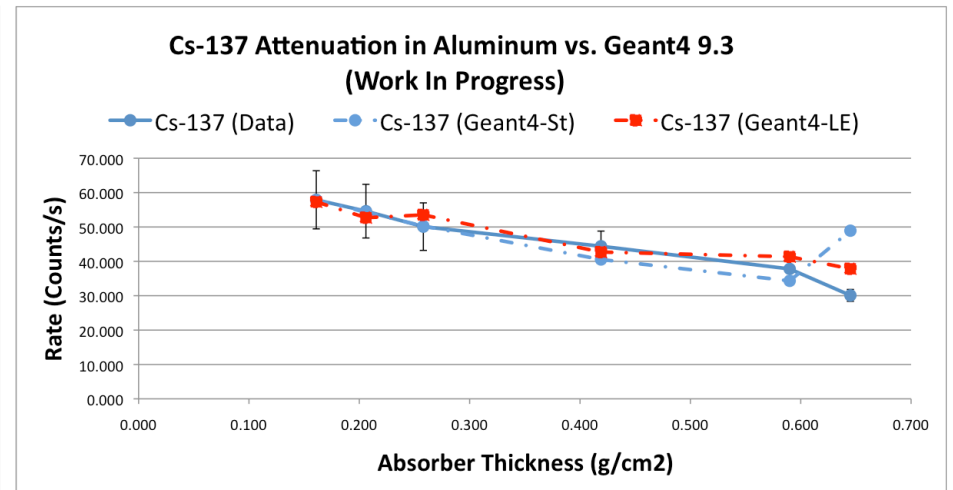
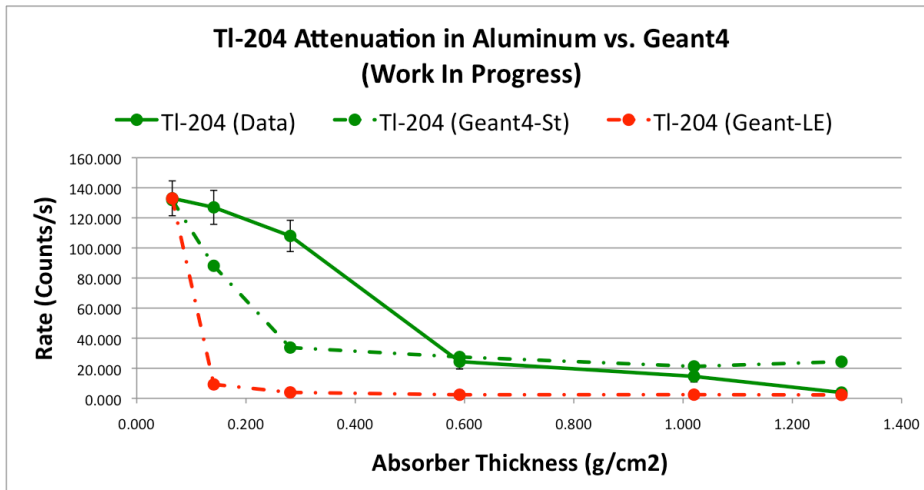
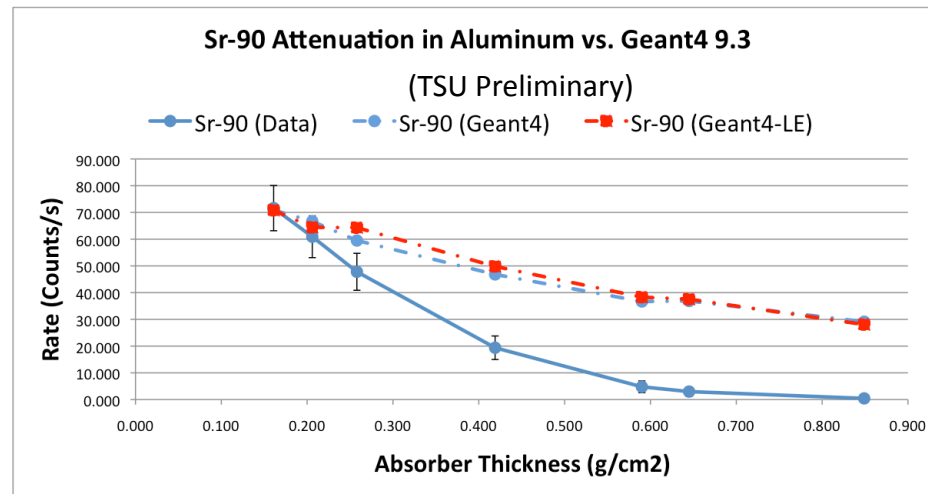


TSU Results

Semilog Plots



TSU Measured Data vs. Geant4 9.3



Hampton University

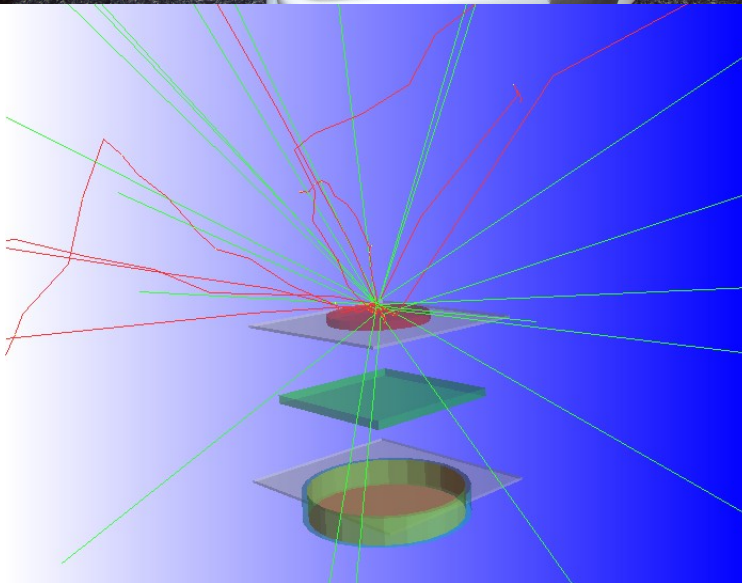
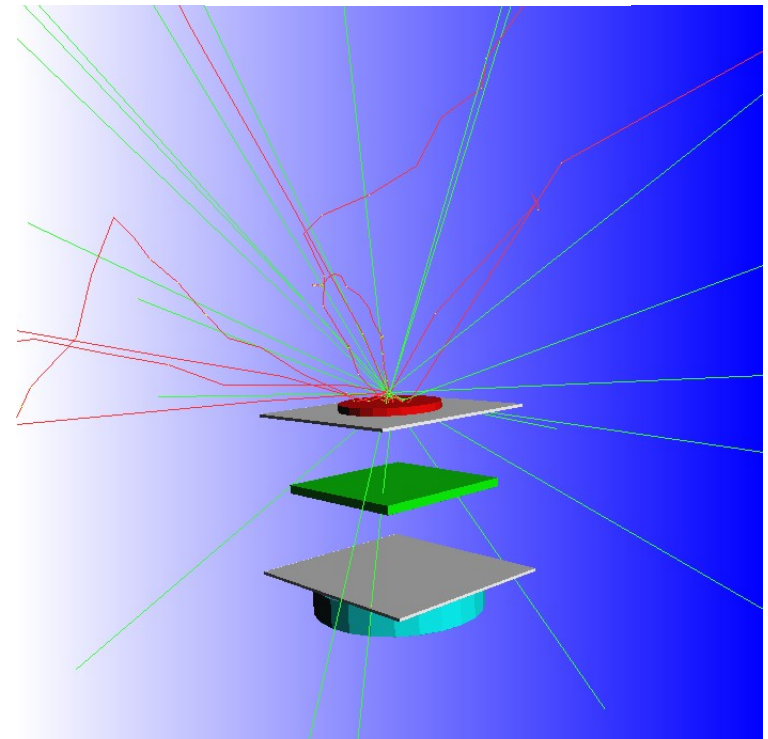
- Frisker: ionizing chamber, pancake detector
- Accuracy: about 20%
- Materials:
 - Iron powder: -200 mesh, $H = 1-6$ mm, $\rho = 3.5$ g/cm³
 - Air: distance source-frisker = 0-10 cm
- Sources:
 - Gamma: Cs-137, Co-57, Co-60, Ba-133, Na-22, Mn-54 and Cd-109
 - Beta: C-14
 - Mixed: Eu-152 and Bi-207

HU Experimental Setup



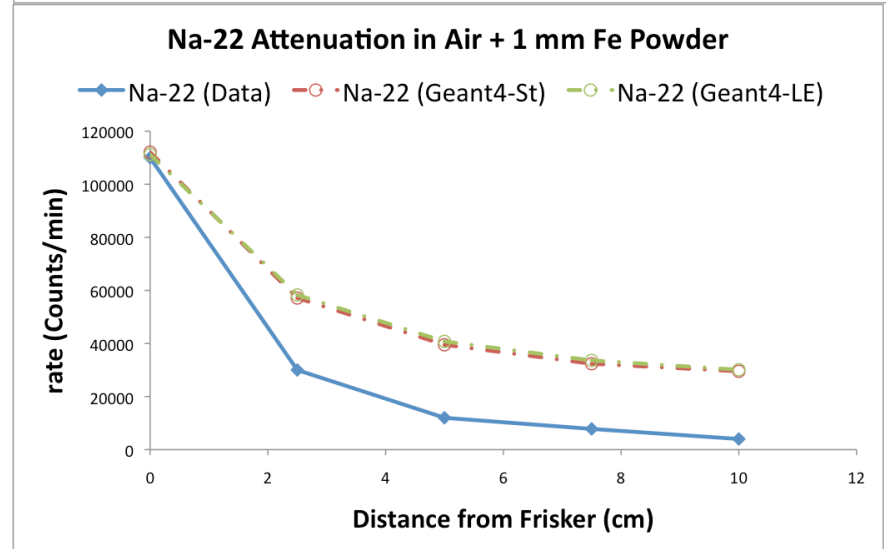
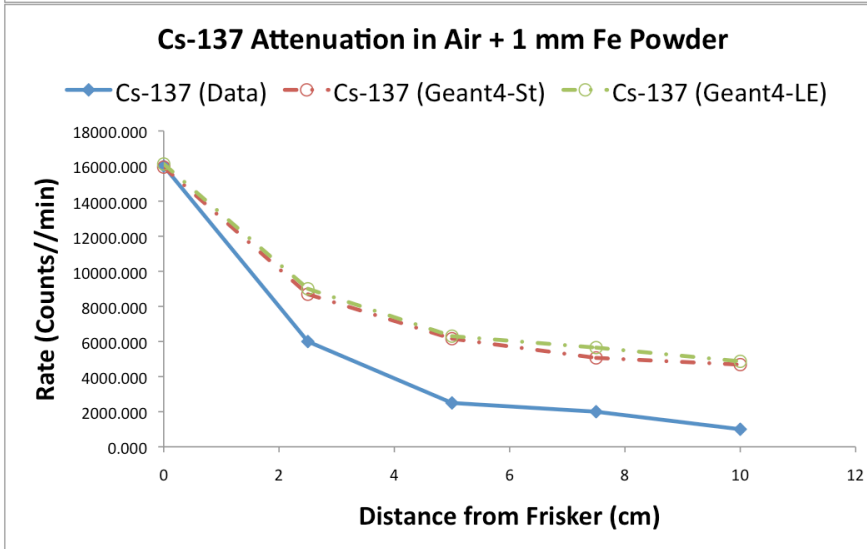
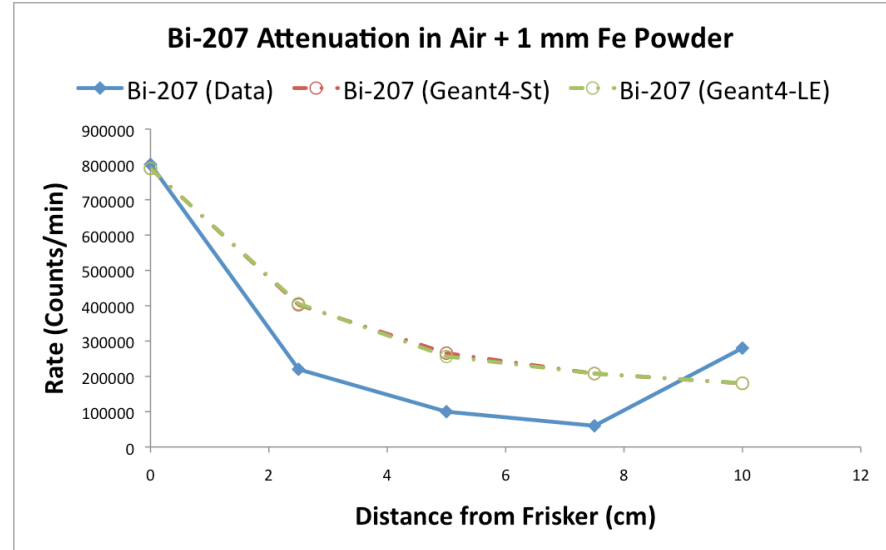
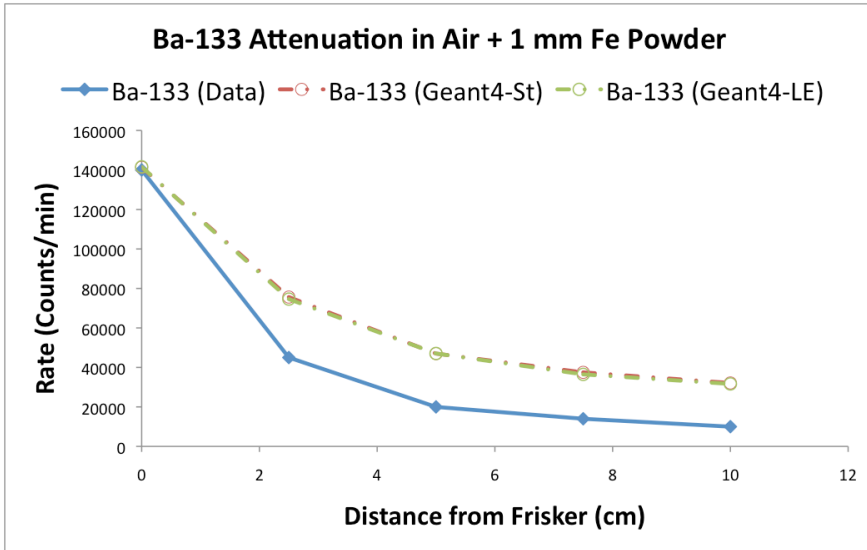
Experiment Setup

Geant4 Schematic



Geant4 Schematic

HU Data vs. Geant4 9.3



Summary

- **High quality data in low energy regime**
 - Systematic validation of Geant4 physics models using γ , β and α sources
 - Various radiation lengths (different materials)
 - Transmission data and attenuation in air
 - Work to be completed by summer 2010
- **Future**
 - Physics validation per particle type and energy
 - TSU as a systematic testing site