NE697: Introduction to Geant4

Geant4: Basic Event Reconstruction

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Today's Agenda

- Assignment 7 questions?
- Scintillation / optics questions?
- Event reconstruction

Geant4: Event Reconstruction

- We've covered how to generate data with Geant4 (**Hit**)
  - We get a **Hit** for every **G4Step** in the volume with the SensitiveDetector attached
  - We must reconstruct what happened at a high level
- It is critically important that you understand the physics!
- How you do this depends on what information you need
- What is the **signal** that you'll observe experimentally?
  - Electronically induced? Photodetection?
- What goes in Geant4 vs what goes in post-processing?

Geant4: Event Reconstruction

- Geant4
  - As much of the real-deal physics as you can
  - Generates perfect/ground truth information
  - Each run has a random number seed → reproducible re-runs
  - More data than you think you'll need until you're sure you don't need it
- Post-processing
  - Any sort of blurring (energy → Gaussian blur, FWHM ~ resolution)
  - Uncorrelated backgrounds; even if modeled, it's nice to separate
  - Randomness not easy to model in Geant4 (e.g. quantum efficiency)
    - Imagine you need to change it. Rerun the sim (GB++, days)? Bummer!

Geant4: Event Reconstruction

- The **Hit** class is entirely our own creation
  - G4Track and G4Step have additional information (current kinetic E? at a boundary?)
  - Tried to make something simple but generally useful for this course
- Mold your **Hit** and **SensitiveDetector** to your application
  - If you only care about what's happening to "e-", then *just* track those
- Start verbose and slim it down as you build confidence that it's working
- Test with small-medium #s of events in simple scenarios

Geant4: Spectrum Reconstruction

- [DEMO]
  - Reconstructing energy spectra
    - 50x50x50 cm^3 NaI at (0,0,0)
  - Monoenergetic beam – capturing all the energy
    - Different energies
    - Cutting on e-
  - Cs-137 ion
    - Take a look at hits.csv – can we spot the events we're looking for?
    - How can we use the physics of Cs-137 decay?
      - Add a logic filter to avoid the beta decay

Geant4: Alternative Approach

- It turns out, radioactive decay is kind of complicated
- Much of the time, we *really* just want the gammas!
- It's fine to use monoenergetic sources for the prominent photopeaks
  - Can do different .mac – just use the branching ratios to determine the # of events for each gamma line
  - Add back together in post
  - Saves time (fewer dice to roll, etc)
  - Avoids issue with timestamp precision for very large numbers

Next Class

- We'll be doing review
- Send me questions **before class** (in 1 week)
- Otherwise, we can discuss final projects, or anything else we want to touch on before we finish