

Simulation of the NEBULA detector using Geant4

Presentation 3.

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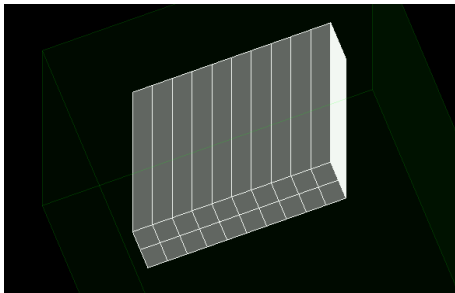
Goals and progress made so far

- ✓ Installing and setup Geant4 and other softwares and libraries needed
- ✓ Testing the configuration by running the examples provided in the Geant4 install
- ✓ Automate the complete setup pipeline of the environment for Geant4
- Implementing the NEBULA detector geometry in Geant4 using smsimulator
- ✓ Implementing the simplified NEBULA detector geometry in Geant4
- ✓ Create neutron beam runs with real physical parameters
- ✓ Create macros for the project
- ✓ Create the data analysis and explore the distribution of the energy deposit of neutrons in the detector rods
- ✗ Test the finalized detector with pre-defined particle beams originating from real physical processes (built-in in Geant4)

Making NEBULA rods susceptible for neutrons

Structure of the simulated detector

- 2×10 plastic scintillator rods in two layers
- Dimensions of rods are $12\text{cm} \times 12\text{cm} \times 180\text{cm}$



Making NEBULA rods susceptible for neutrons

G4LogicalVolume : Initialized in G4DetectorConstruction

- Geant4's G4SteppingAction can use this type of volume to identify the mother volume of the particle's position in the current step
- This type of volume contains the methods used for particle tracking

G4Accumulable : Initialized in G4RunAction

- Stores "accumulable" quantities (eg. energies) during the whole simulation
- The G4AnalysisManager reads values from this type of object



G4AnalysisManager

- Geant4 has no built-in analysis tools
- This library handles the creation, filling and I/O of user defined datasets
- Able to output XML, CSV or ROOT files

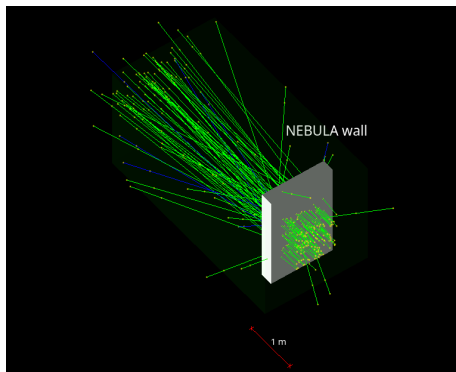
Analysis

- Using the G4AnalysisManager I've saved the accumulated energies for each rods in CSV format
- For the analysis I've used Python 3.9



Analysis of simulation results

- All neutrons are set to have the same amount of energy at the start (tested for 20, 100, 200 and 300 MeVs)
- The NEBULA rods measure the deposited energies for each particles penetrating them



Analysis of simulation results



Figure 1: Heatmap of the total deposited energy in the NEBULA detector rods during a test run of 1000 neutrons of 100 MeV.

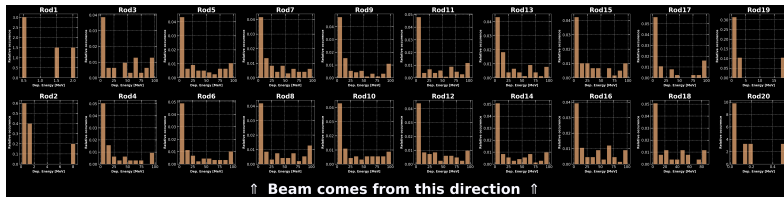


Figure 2: Histogram of the deposited energies for each NEBULA detector rods during a test run of 1000 neutrons of 100 MeV.