FGT ND-ECAL Simulation

Soumya Ranjan Das

Department of Physics
Indian Institute of Technology Guwahati

November 12, 2015

Outline

- DUNE FGT Near Detector
- ND-ECAL Parameters
- Simulation Update
- Downstream ECAL Energy Resolution

DUNE FGT Near Detector

The various components of the FGT near detector for DUNE are,

- Active **straw tube tracker (STT)**
- 4π **lead-plastic scintillator Electromagnetic Calorimeter** surrounding the STT, consisting of a forward, backward and barrel type electromagnetic calorimeter
- 0.4 T **dipole magnet** inside which the STT and ECAL modules will reside
- 4π **muon-ID detector** made of **Resistive Plate Chambers (RPC)** which will surrond the dipole magnet and will also be outside the magnet

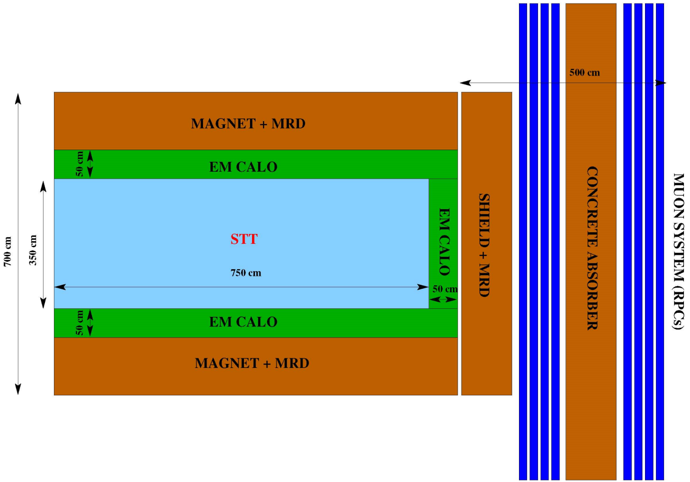
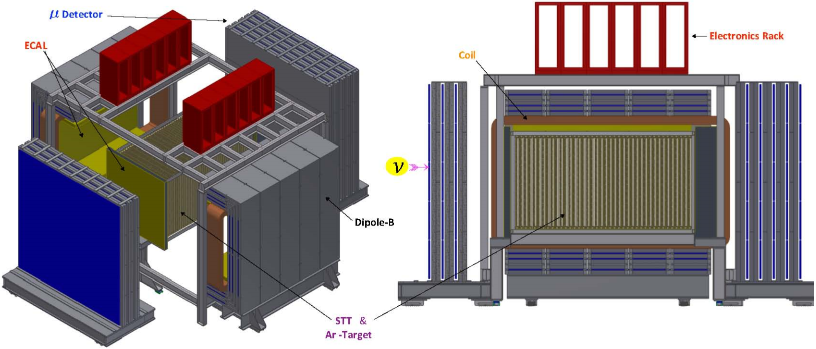


Figure : Layout of HIRESMNU with external muon detectors



- Best performance among the 4-options
- ~3.5m x 3.5m x 7.5m STT ($\rho \simeq 0.1$ gm/cm^3)

  4π-ECAL in a Dipole-B-Field (0.4T)

  4π-μ-Detector (RPC) in Dipole and Downstream

- Pressurized Ar Target ($\simeq$x5 FD-Stat) $\Rrightarrow$ *LAr-FD*

Transition Radiation ↠ e-/e+ ID ⇒ γ

dE/dx ↠ Proton, π+/-, K+/-

Magnet/Muon Detector ↠ μ+/-

{ν-e ⇒ Absolute Flux measurement}

Figure : Layout of HIRESMNU with external muon detectors

DUNE Near Detector ECAL Parameters

- **Forward ECAL:** 60 layers of alternating horizontal/vertical plastic scintillator bars per 1.75 mm of lead along the z-direction. Dimensions of each plastic scintillator bar is 3.2 m $\times$ 2.5 cm $\times$ 1 cm. 128 bars per scintillator plane and 7680 scintillator bars in total. There will be two sided readout via extruded WLS fiber and SiPM. 20 X_o.
- **Barrel ECAL:** Will surround the sides of the STT. 16 layers of plastic scintillator bars (horizontal along the axis of the magnet) per 3.5 mm of lead along the z-direction. Same dimensions of scintillator bars like forward ecal. 128 bars per scintillator plane and 16,384 scintillator bars in total. 10 X_o.
- **Backward ECAL:** 16 layers of alternating horizontal/vertical plastic scintillator bars per 3.5 mm of lead along the z-direction. Same dimensions of scintillator bars like forward ecal. 128 bars per scintillator plane and 2048 scintillator bars in total. 10 X_o.

FGT ND-ECAL Simulation Progress

- To simulate and optimize the ECAL in the HiSoft framework
  Now has a new repository called dunefgt created by Tyler.
- GDML geometry of the forward, backward and the barrel ecal has been prepared and initialized.
- The preliminary simulation has been done by shooting 2 GeV photons, electrons, positrons, pizeros and muons for 500 art events into the forward ecal
- To find the energy resolution of the forward, backward and the barrel ecal for different values of incident energy of incoming electrons and photons and for different angles of incidence

2 GeV Electron- Energy deposited and step size for all steps and for steps in scint. bars

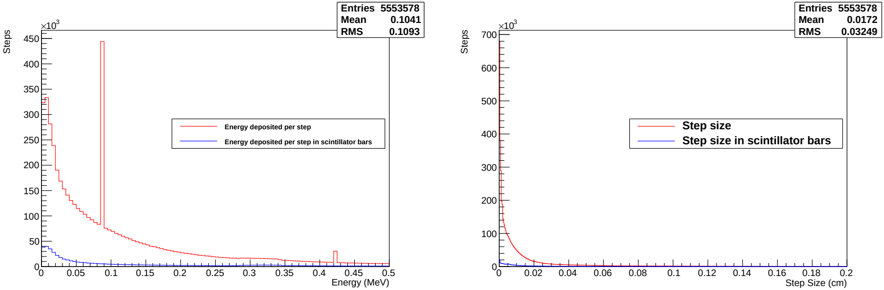


Figure : plots of energy deposited per step and step size for all G4 steps and for all G4 steps in the scintillator bars

Peak around 88-88.5 KeV! Why?

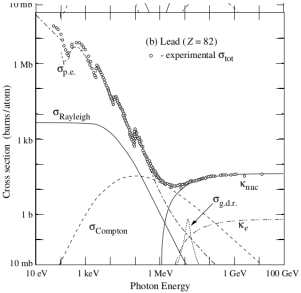
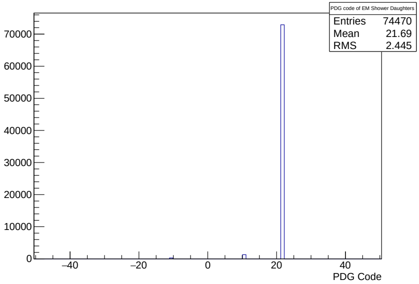


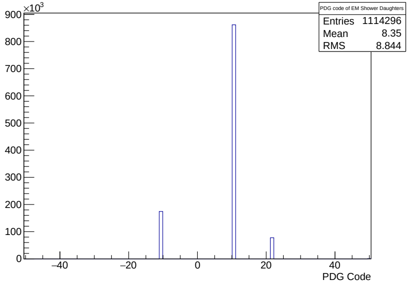
Figure 32.15: Photon total cross sections as a function of energy in carbon and lead, showing the contributions of different processes [51]:

Figure : Source: PDG Review. Peak at 88 KeV corresponds to atomic photoelectric effect (electron ejection, photon absorption)

PDG code of particles for .1 MeV G4 steps and for all steps



(a) PDG Code of particles for .1 MeV steps



(b) PDG Code of particles for all steps

Downstream ECAL Energy Resolution

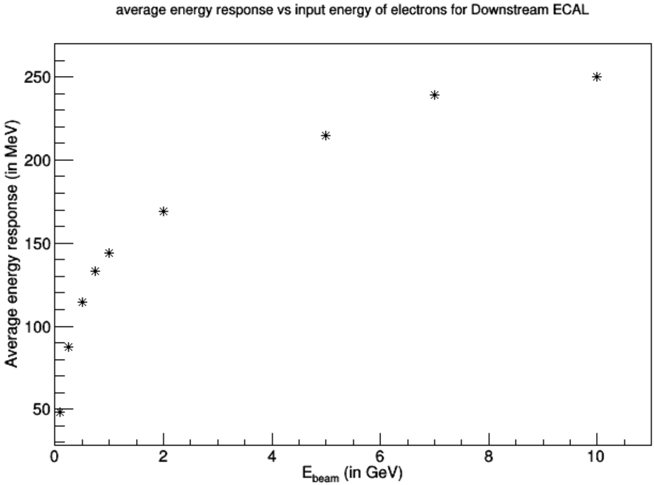
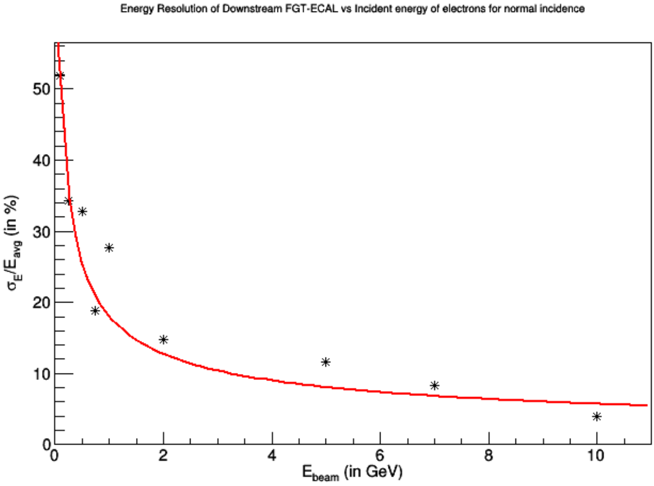
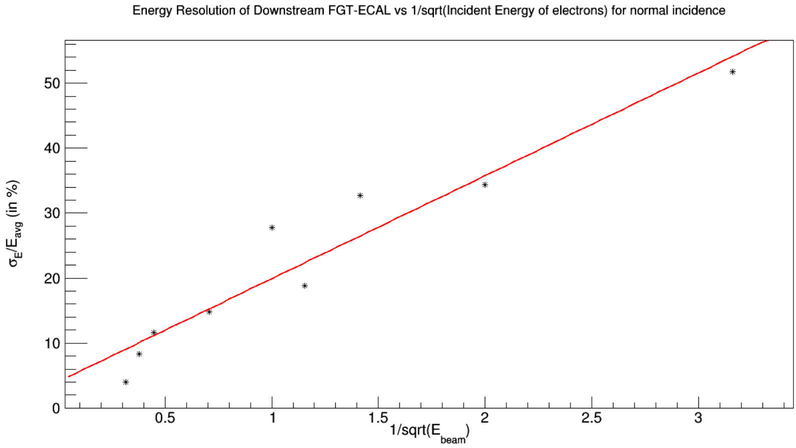


Figure : Average measured energy from all the scintillator bars per event vs the incident electron energy for normal incidence

Downstream ECAL Energy Resolution



Downstream ECAL Energy Resolution



Future Plan

- Find the energy resolution of the backward and barrel ecal
- Effect on energy resolution of ecal for varying angles of incidence of incoming beam
- Any Suggestions, please?

Thank You