

Studies for the SiD Hadron Calorimeter

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Introduction

- The University of Texas at Arlington joined the SiD optimization in plans to design and calibrate the AHCAL
- Initial calibration using single particle studies
- Studying the energy deposits in HCal & ECal Barrel

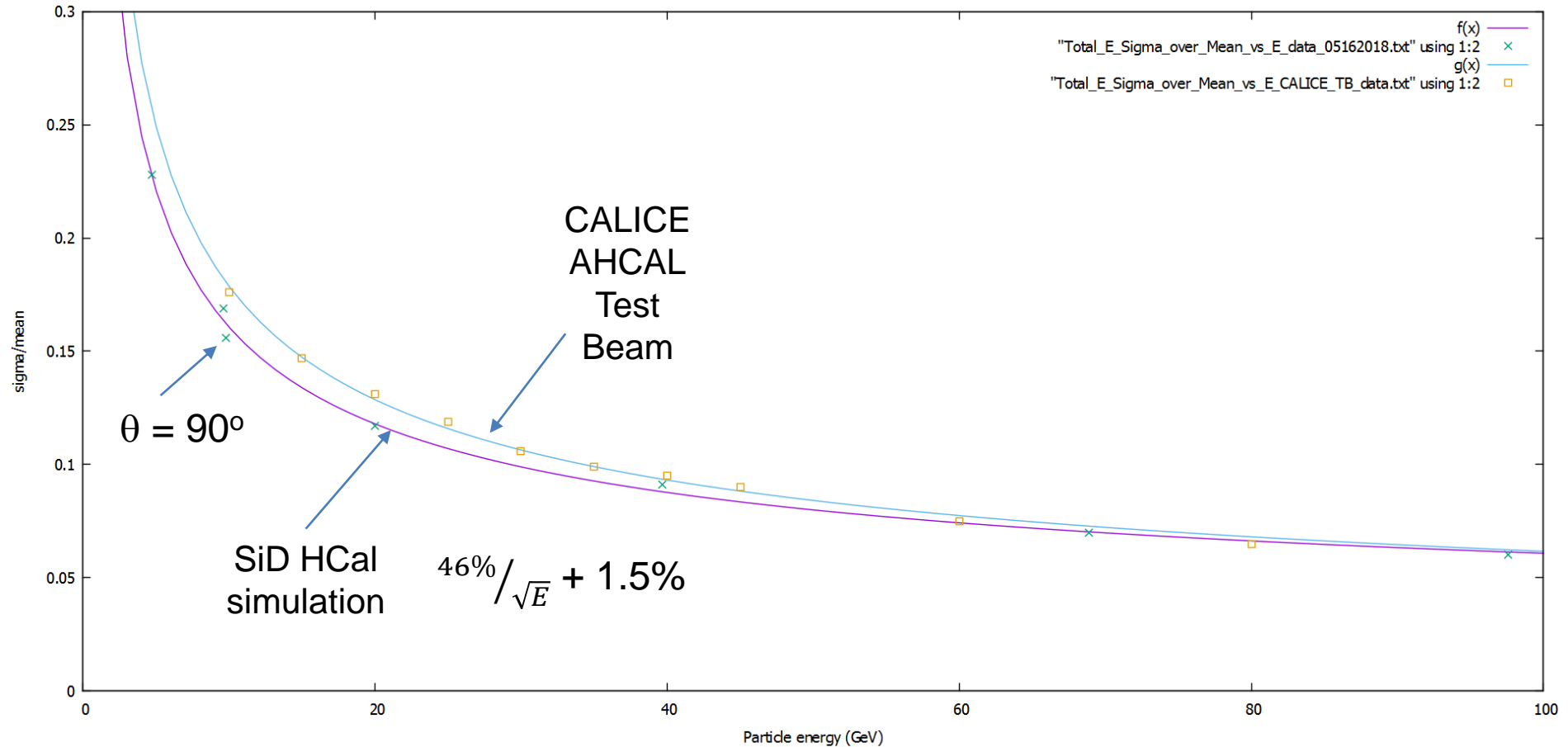
Data File Specifics

- Detector Version: SiD_o2_v03
- Physics list: FTFP_BERT
- Particles: Muons, Pions, K0Long
- Sample Size: 10,000 events (max.)
- All events were run with full simulation and reconstruction process
- Analysis performed using C++, Python, and Modular Analysis and Reconstruction for the Linear Collider (MARLIN)

SiD AHCAL Calibration

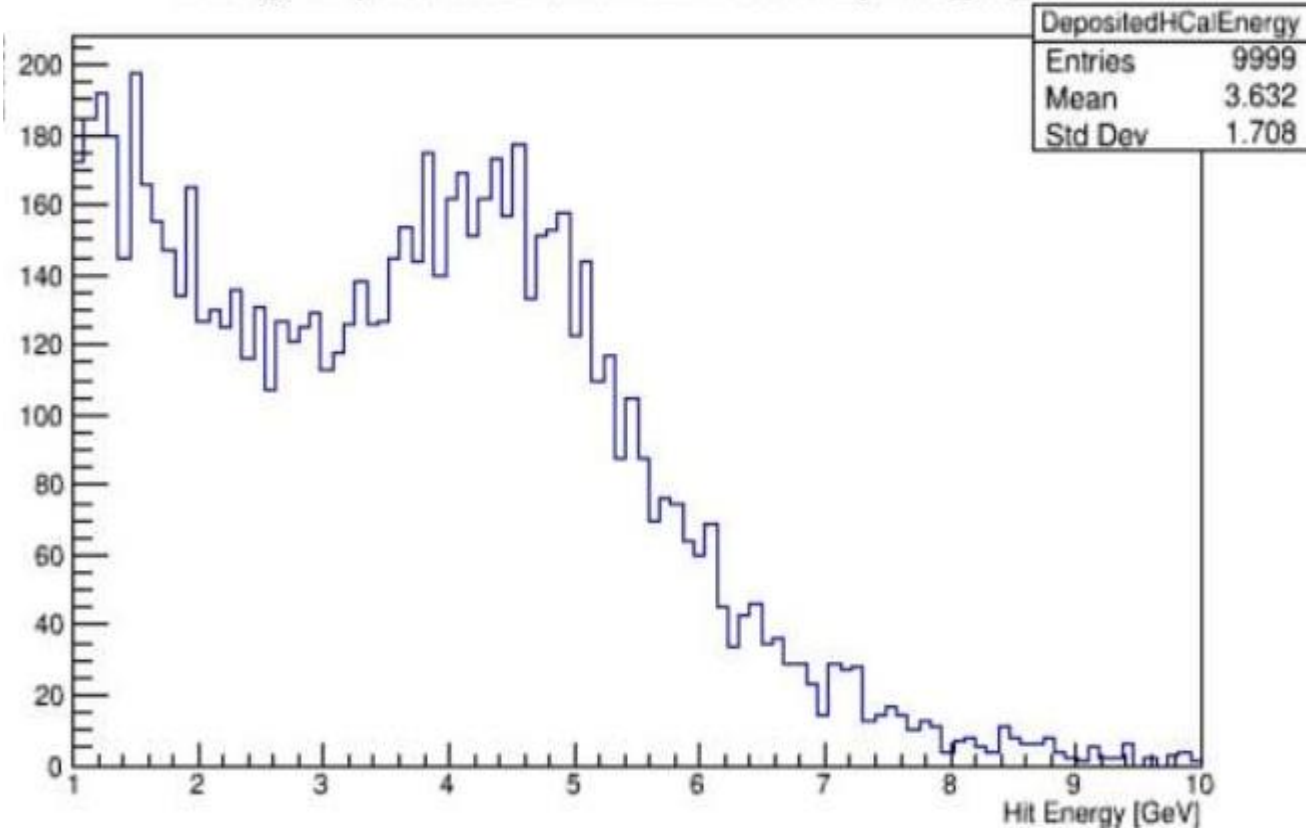
- Results from the simulation are lower than the test beam data. This is expected.
- These were performed using the SiDReconstruction_o2_v03_calib1ct1.xml file.

5-100 GeV charged pions: SiD simulation and CALICE 1m3 test beam results

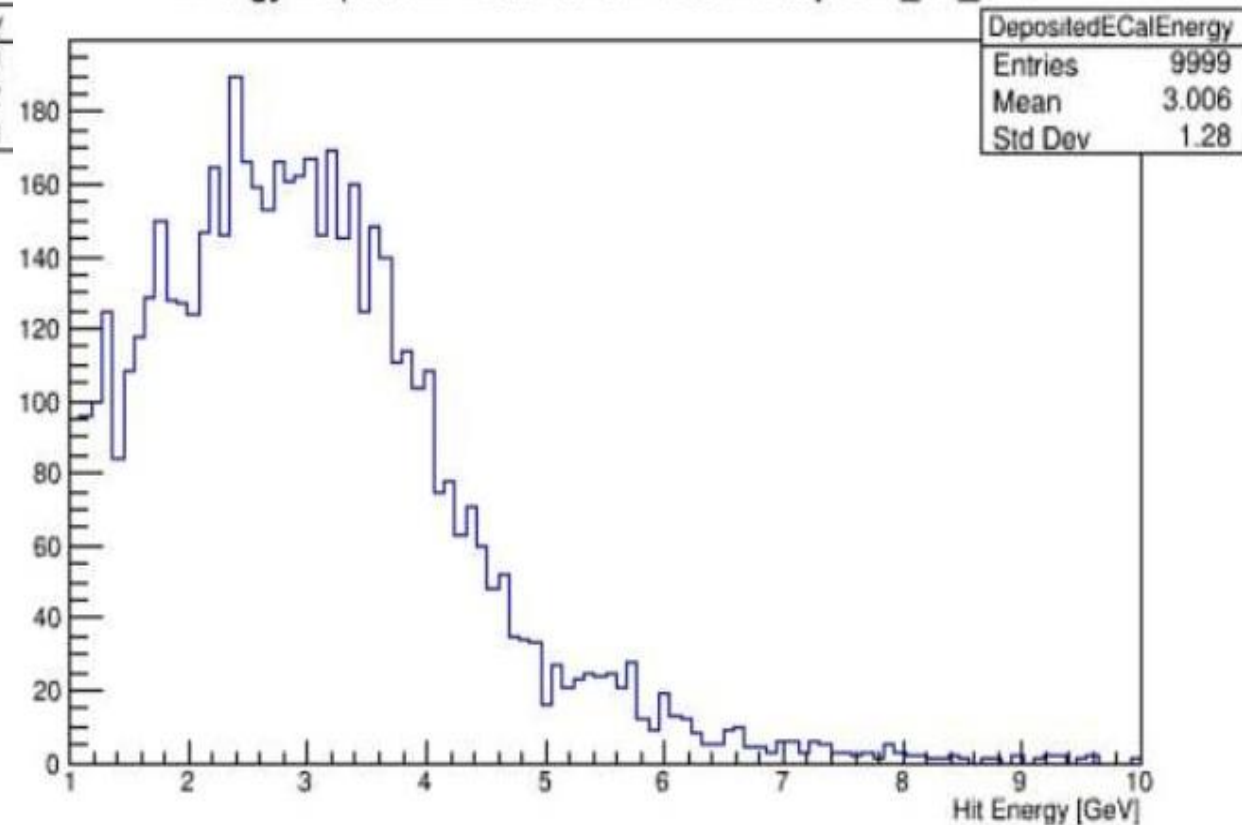


5 GeV Pions, 10,000 events

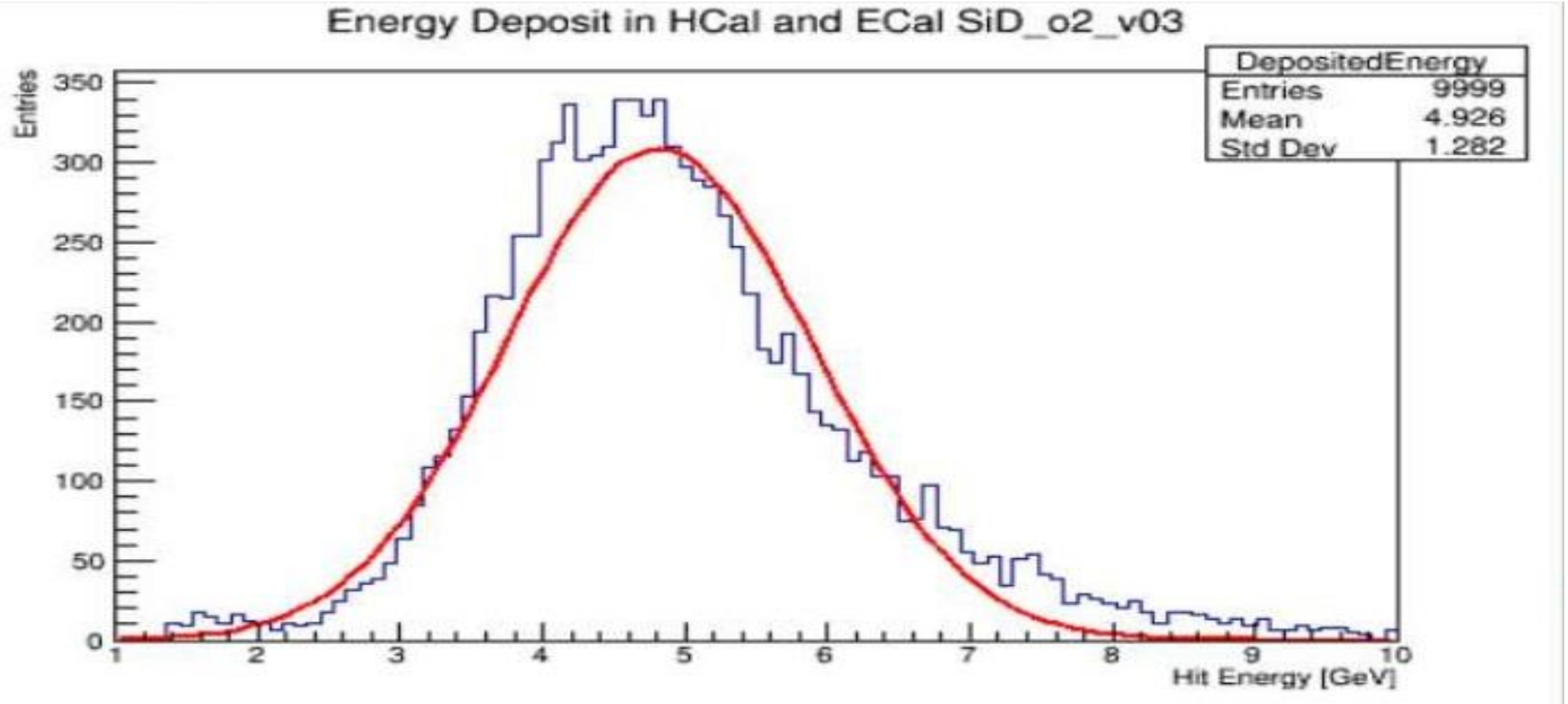
Energy Deposit in HCalBarrel HCalEndcap SiD_o2_v03



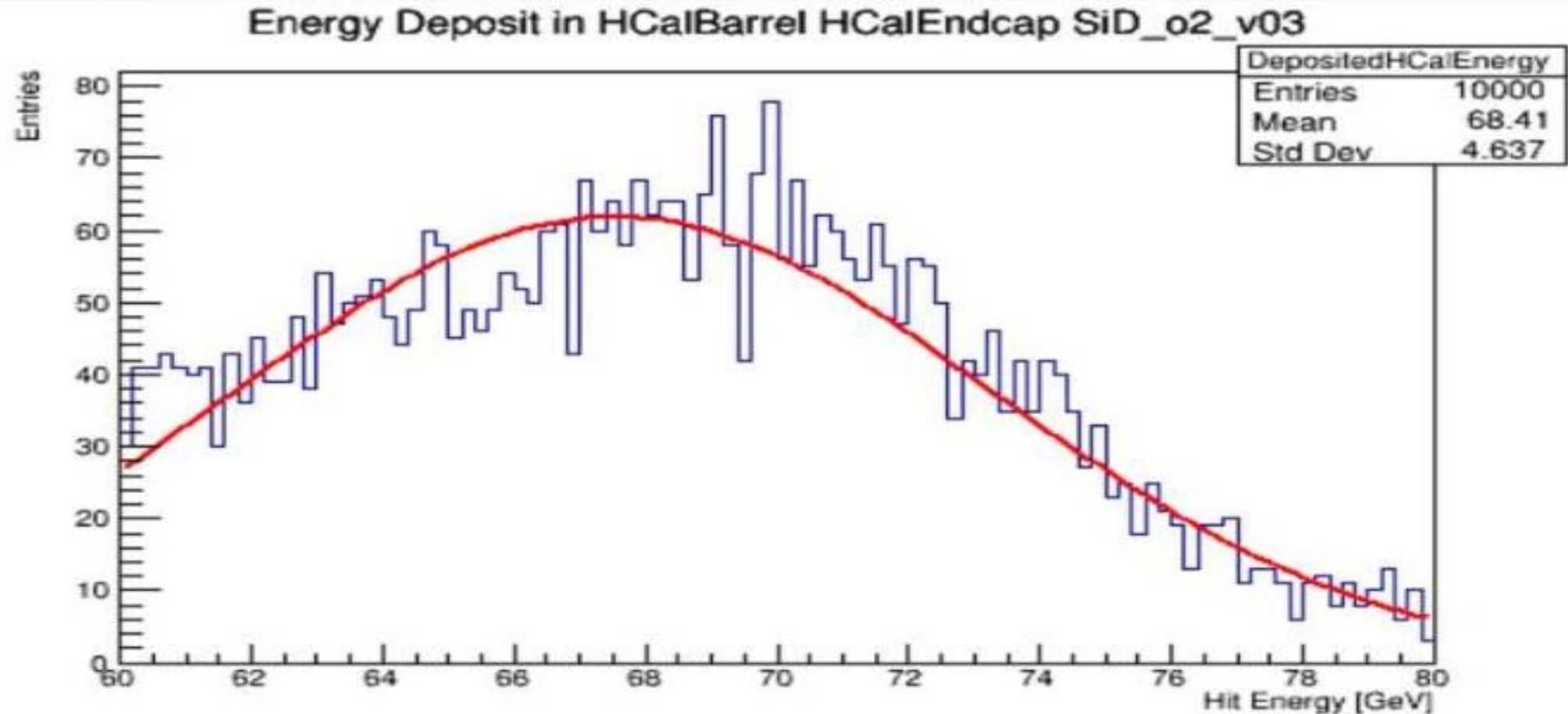
Energy Deposit in ECalBarrel ECalEndcap SiD_o2_v03



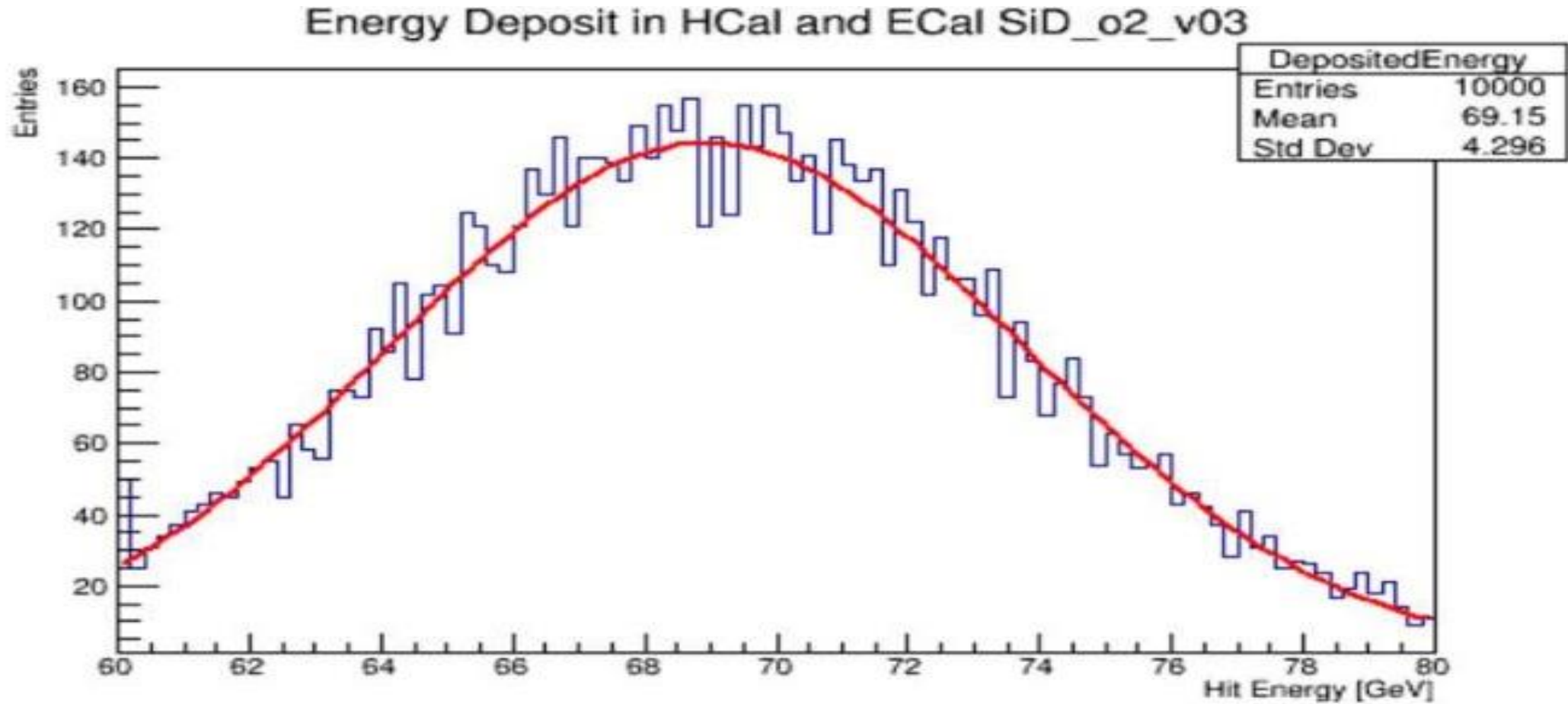
5 GeV Pions, 10,000 events



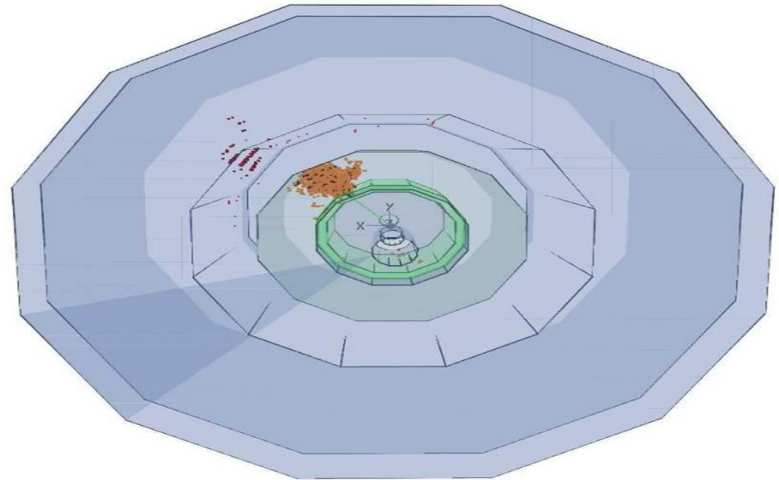
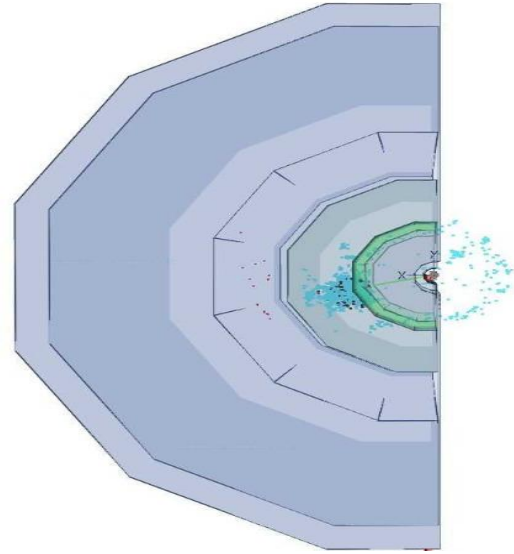
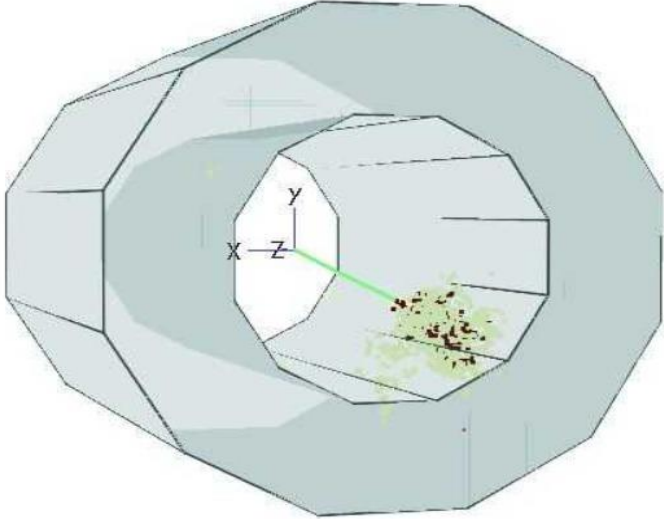
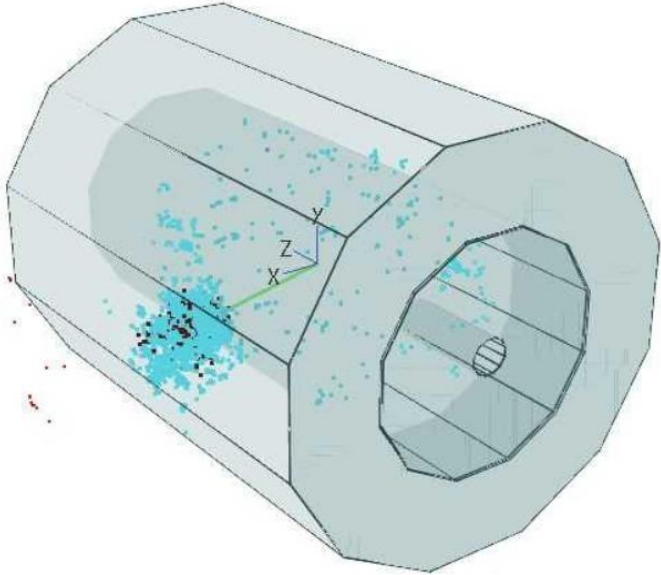
70 GeV Pions, 10,000 events



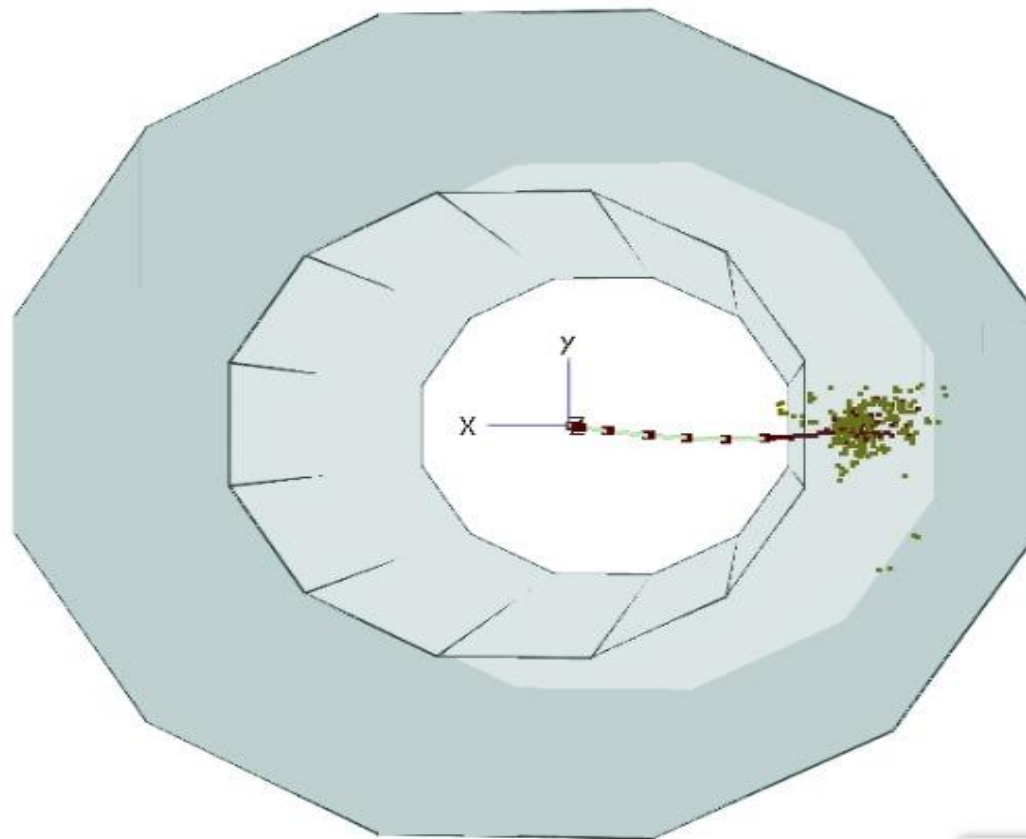
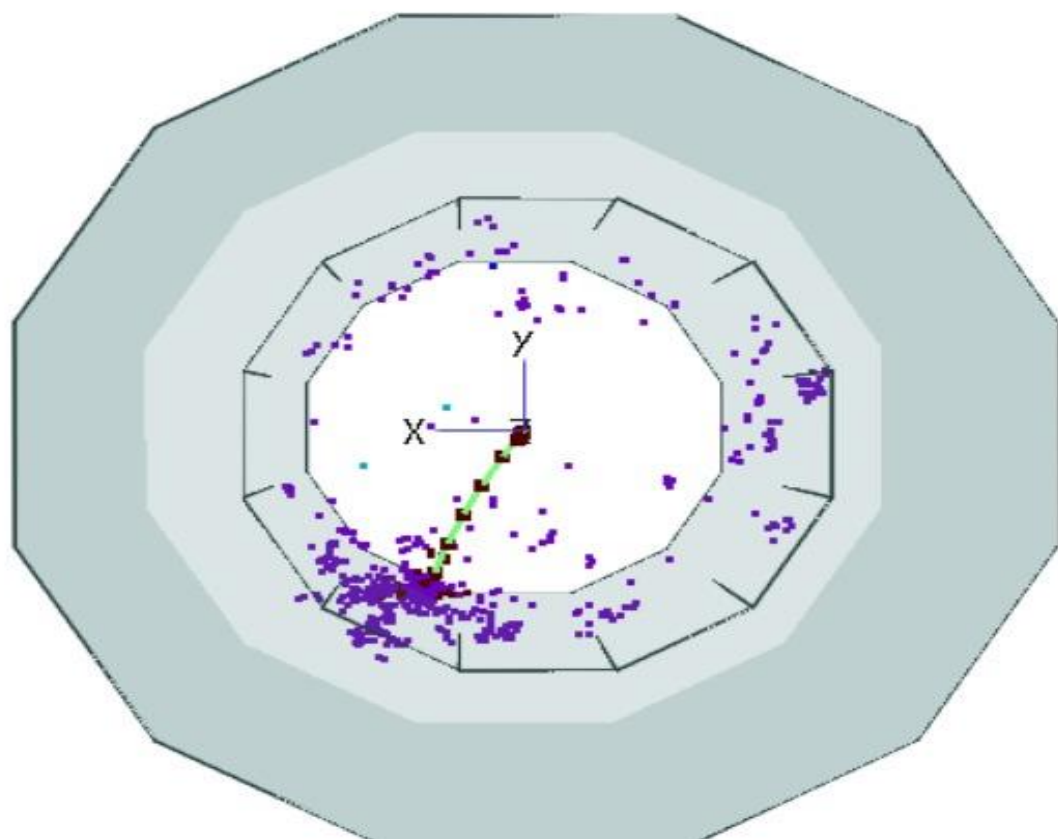
70 GeV Pions, 10,000 events



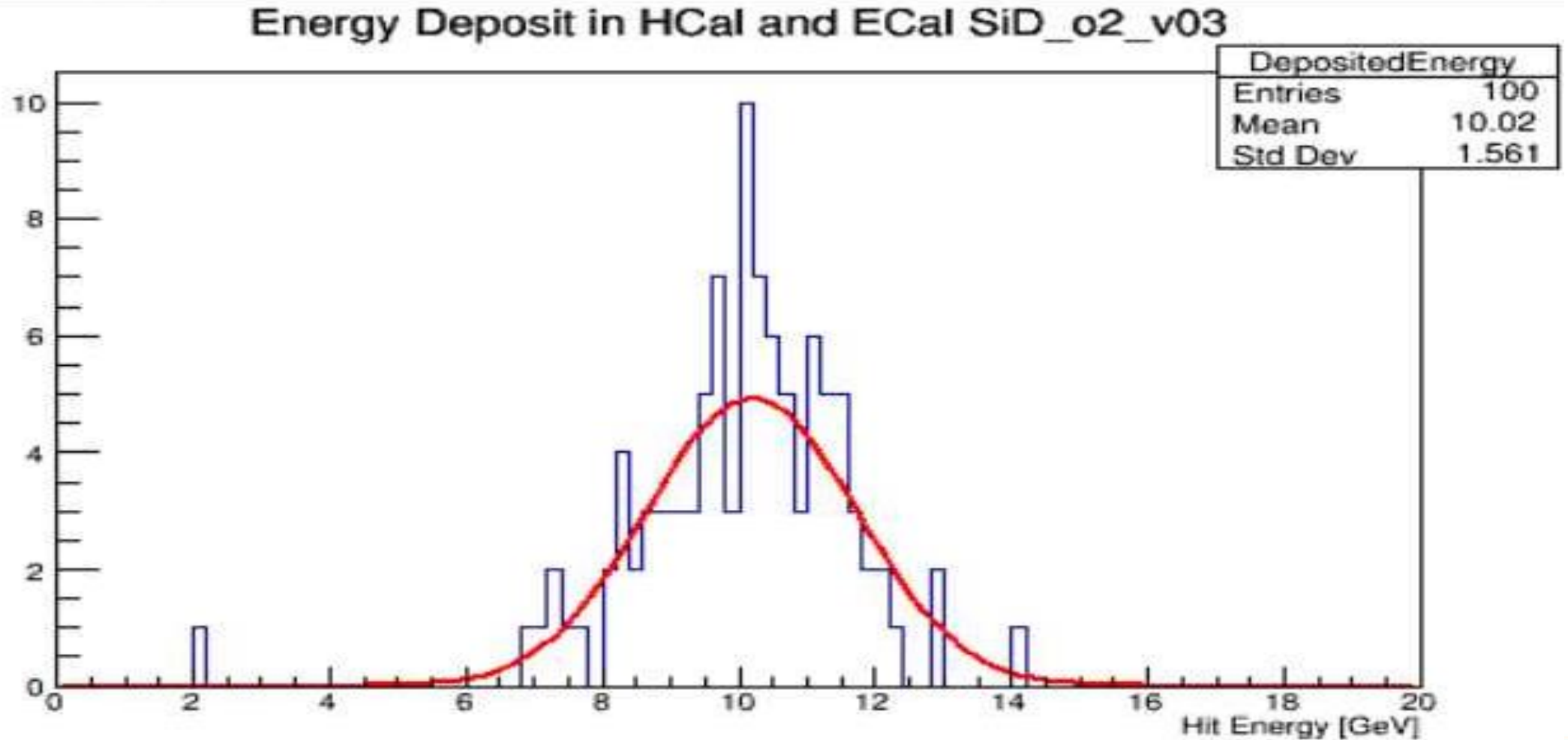
HCal Barrel



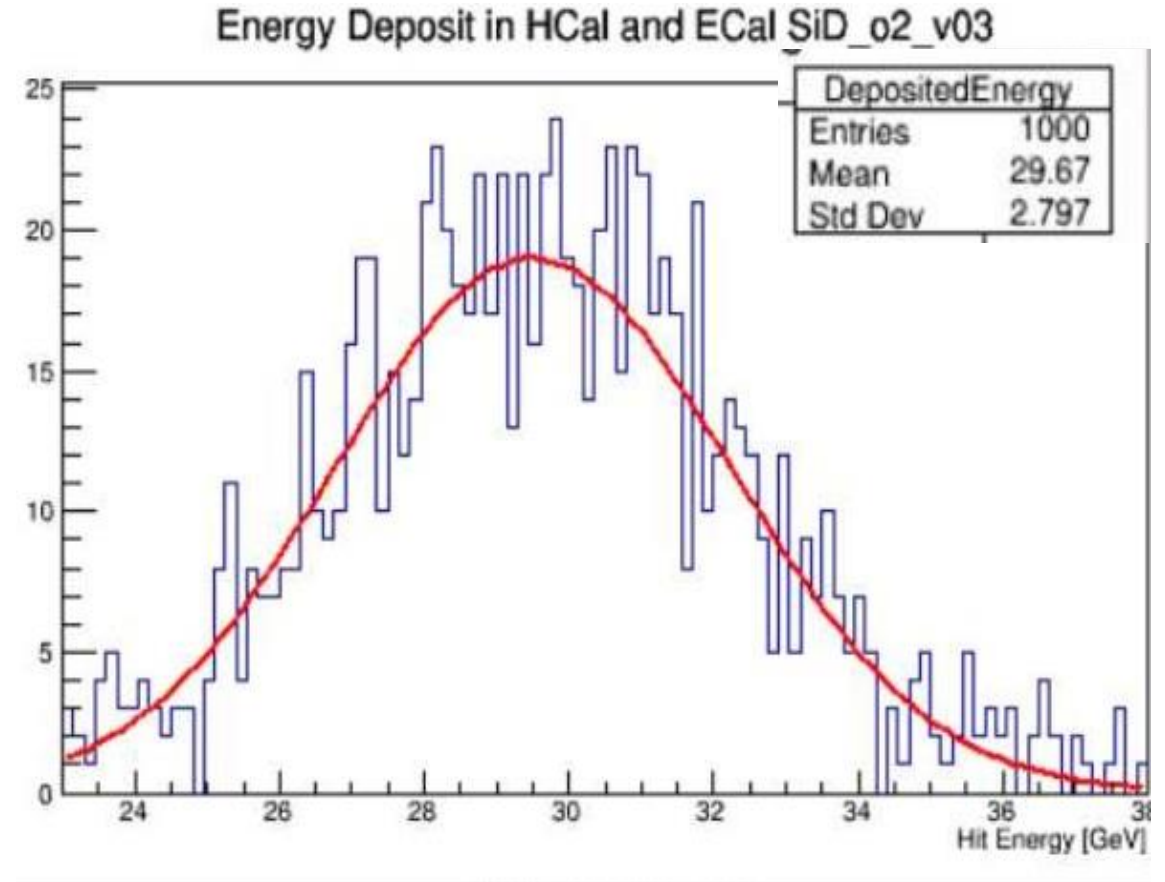
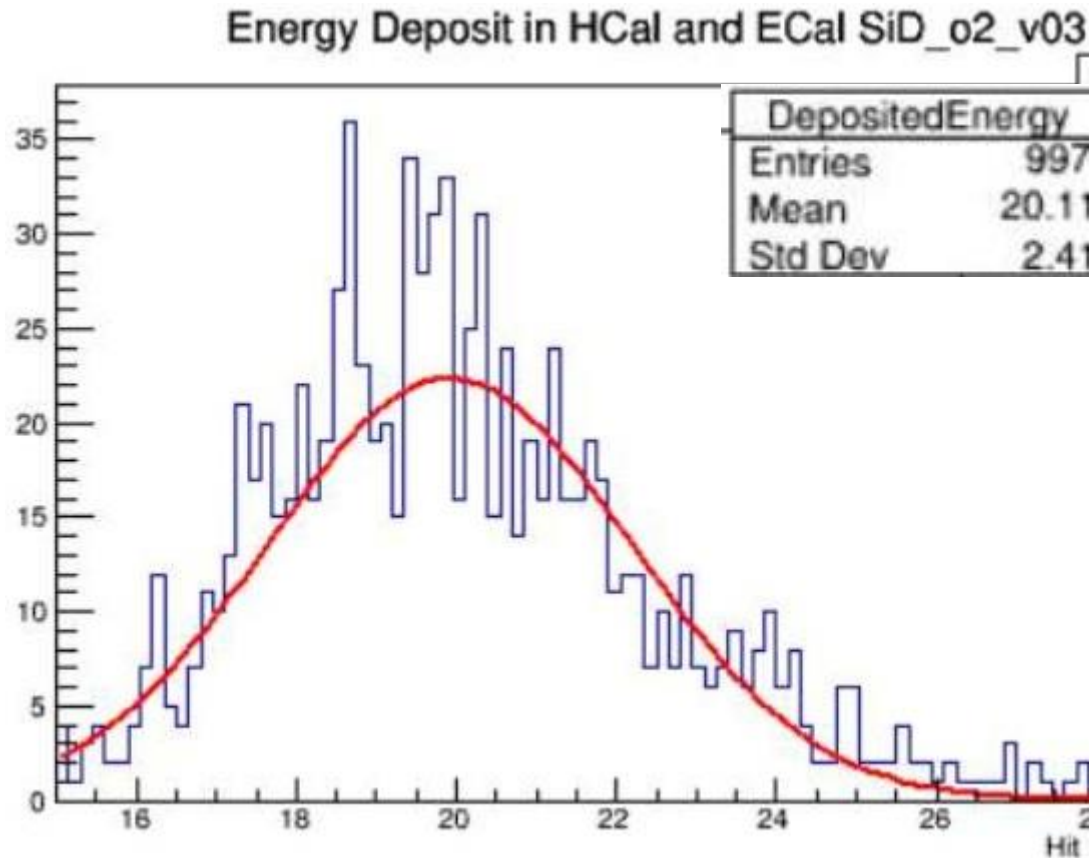
Hcal Barrel



New plots: 10GeV, 100 events

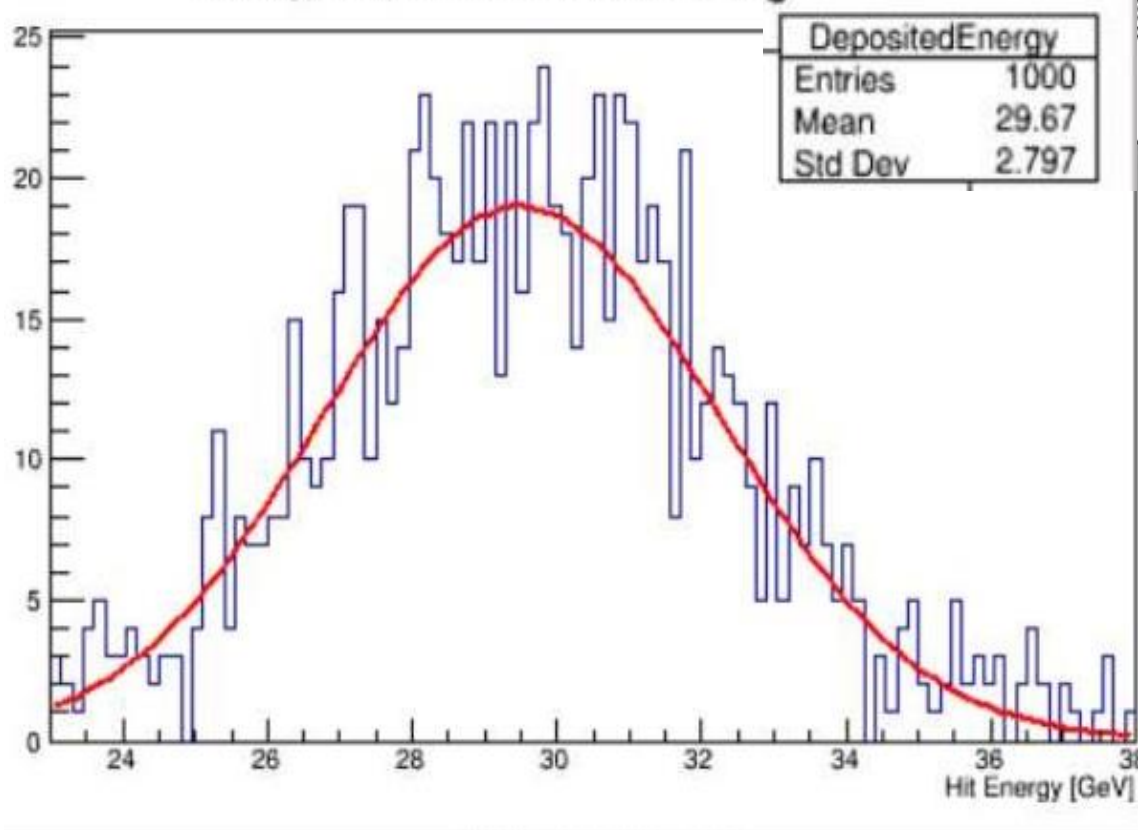


New Comparisons: 20GeV vs. 30 GeV

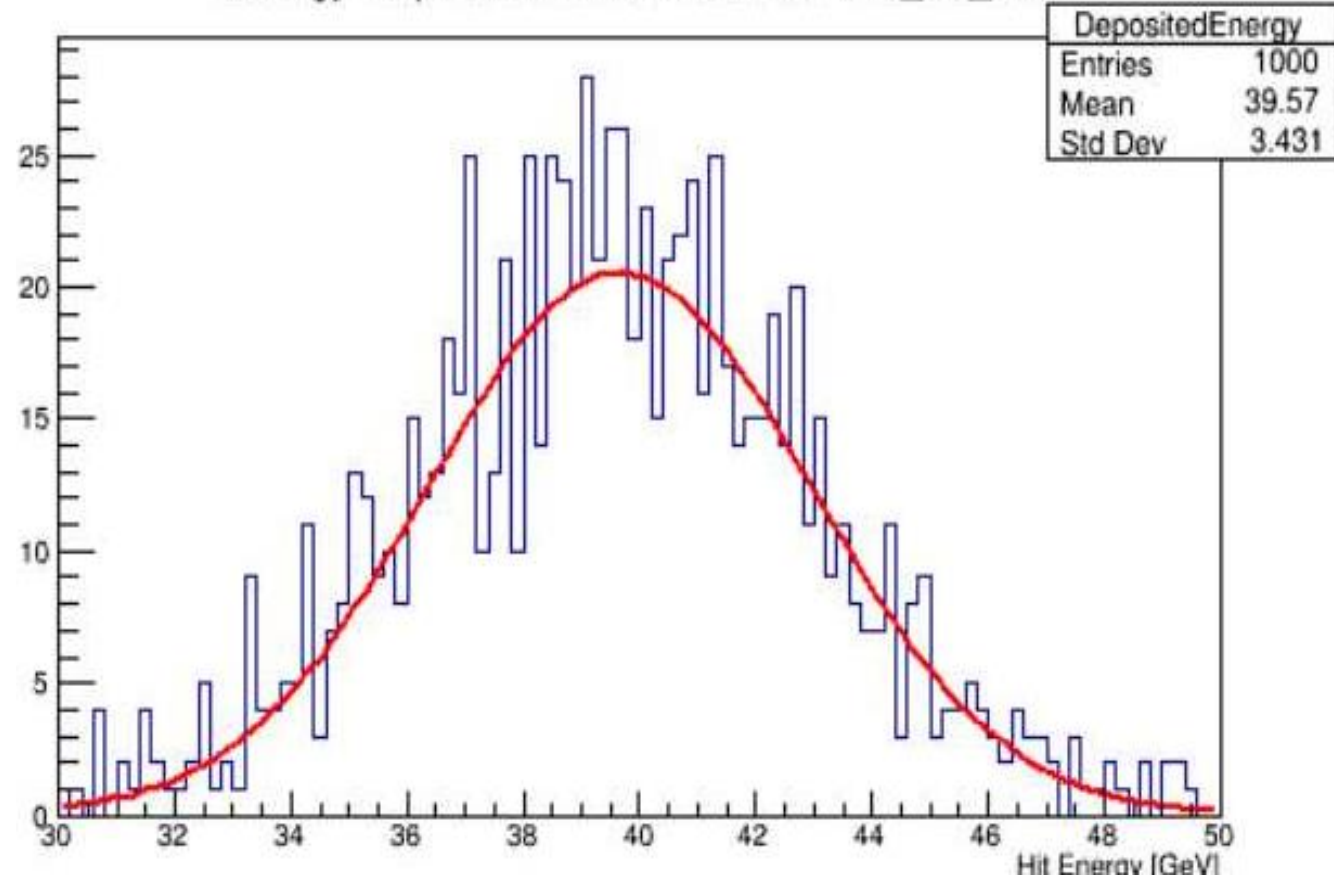


New Comparisons: 30GeV vs. 40 GeV

Energy Deposit in HCal and ECal SiD_o2_v03



Energy Deposit in HCal and ECal SiD_o2_v03



Errors Encountered

- Marlin crashed for 10 GeV Pions at 1000 events, endcap.

```
A runtime error occurred - (uncaught exception):  
vector::_M_range_check: __n (which is 1) >= this->size() (which is 1)  
Marlin will have to be terminated, sorry.  
*****
```

```
t-10, -1.432505e+01, +1.000000e+02  
DEBUG4 "MyConformalTracking"]  
DEBUG5 "MyConformalTracking"] >>>>>>>>>MarlinTrk::finaliseLCIOTrack: create TrackState AtFirstHit  
DEBUG5 "MyConformalTracking"] >>>>>>>>> MarlinTrk::finaliseLCIOTrack: create TrackState AtLastHit : using trkhit @x90e6bf0  
DEBUG5 "MyConformalTracking"] >>>>>>>>> createTrackStateAtCaloFace : using trkhit ----- TrackerHit -----  
DEBUG5 "MyConformalTracking"] Id 16224  
DEBUG5 "MyConformalTracking"] CellID0 168051203  
DEBUG5 "MyConformalTracking"] CellID1 0  
DEBUG5 "MyConformalTracking"] Position (x,y,z) -901.745, 360.506, -371.4  
DEBUG5 "MyConformalTracking"] E_deposited 0.000164449  
DEBUG5 "MyConformalTracking"] Time 44.6267  
DEBUG5 "MyConformalTracking"] Type 00000000000000000000000000000000  
DEBUG5 "MyConformalTracking"] Quality 00000000000000000000000000000000  
DEBUG5 "MyConformalTracking"] tanl_is_positive = 1  
DEBUG4 "MyConformalTracking"] MarlinTrk::createFit ndof_added = 2  
DEBUG4 "MyConformalTracking"] MarlinTrk::createFit ndof_added = 4  
DEBUG4 "MyConformalTracking"] MarlinTrk::createFit ndof_added = 6  
DEBUG4 "MyConformalTracking"] MarlinTrk::createFit ndof_added = 8  
DEBUG4 "MyConformalTracking"] MarlinTrk::createFit ndof_added = 10  
DEBUG8 "MyConformalTracking"] MarlinTrk::finaliseLCIOTrack: number of degrees of freedom less than 0 track dropped : NDF = -4
```

Errors Encountered

- After facing this error, we rebuilt LCGEO and used the most updated version of SiDReconstruction_o2_v03_calib1ct3.xml file.
- Events which ran successfully:
 - 10 GeV, 100 events, 89 Degrees (Pions)
 - 20 GeV 996 on 1000 events, 89 Degrees (Pions)
 - 30 GeV 1000 events, 89 Degrees (Pions)
- Events which errored out:
 - 40 GeV 1000 events, 20 Degrees
 - 10 GeV 1000 events, 89 Degrees

New Error

```
[ DEBUG4 "MyConformalTracking"] Omega 7.745506e-05
[ DEBUG4 "MyConformalTracking"] Z0 -5.581125e-01
[ DEBUG4 "MyConformalTracking"] Tan Lambda 1.117912e-01
[ DEBUG4 "MyConformalTracking"] ReferencePoint 0, 0, 0
[ DEBUG4 "MyConformalTracking"] Cov matrix: +2.041820e-05
[ DEBUG4 "MyConformalTracking"] -6.033735e-07, +1.945256e-08
[ DEBUG4 "MyConformalTracking"] -4.659383e-09, +1.541068e-10, +1.345944e-12
[ DEBUG4 "MyConformalTracking"] +2.415098e-07, -5.993062e-09, -4.442561e-11, +1.468781e-05
[ DEBUG4 "MyConformalTracking"] -5.067418e-09, +1.271802e-10, +9.473800e-13, -3.488530e-07, +9.315590e-09
[ DEBUG4 "MyConformalTracking"]
[ DEBUG5 "MyConformalTracking"] >>>>>>>>>MarlinTrk::finaliseLCIoTTrack: create TrackState AtFirstHit
[ DEBUG5 "MyConformalTracking"] >>>>>>>>> MarlinTrk::finaliseLCIoTTrack: create TrackState AtLastHit : using trkhit 0x99bad00
[ DEBUG5 "MyConformalTracking"] >>>>>>>>> createTrackStateAtCaloFace : using trkhit ----- TrackerHit -----
[ DEBUG5 "MyConformalTracking"] Id 2783807
[ DEBUG5 "MyConformalTracking"] CellID0 131585
[ DEBUG5 "MyConformalTracking"] CellID1 0
[ DEBUG5 "MyConformalTracking"] Position (x,y,z) -22.5154, -42.3056, 4.79558
[ DEBUG5 "MyConformalTracking"] E_deposited 5.23437e-06
[ DEBUG5 "MyConformalTracking"] Time 0.160707
[ DEBUG5 "MyConformalTracking"] Type 00000000000000000000000000000000
[ DEBUG5 "MyConformalTracking"] Quality 00000000000000000000000000000000
[ DEBUG5 "MyConformalTracking"] tanL_is_positive = 1
*****
A runtime error occured - (uncaught exception):
vector::M_range_check: __n (which is 2) >= this->size() (which is 1)
Marlin will have to be terminated, sorry.
*****
[sakshi.nag@hep-sid lcgeo]$ █
```

Future Plans

- Try to get past the Marlin Error in tracking.
- Compare energy resolution in endcaps with CALICE results.
- Move onto actual physics studies with jets.

