

HCAL Test Beam Simulation

Outline:

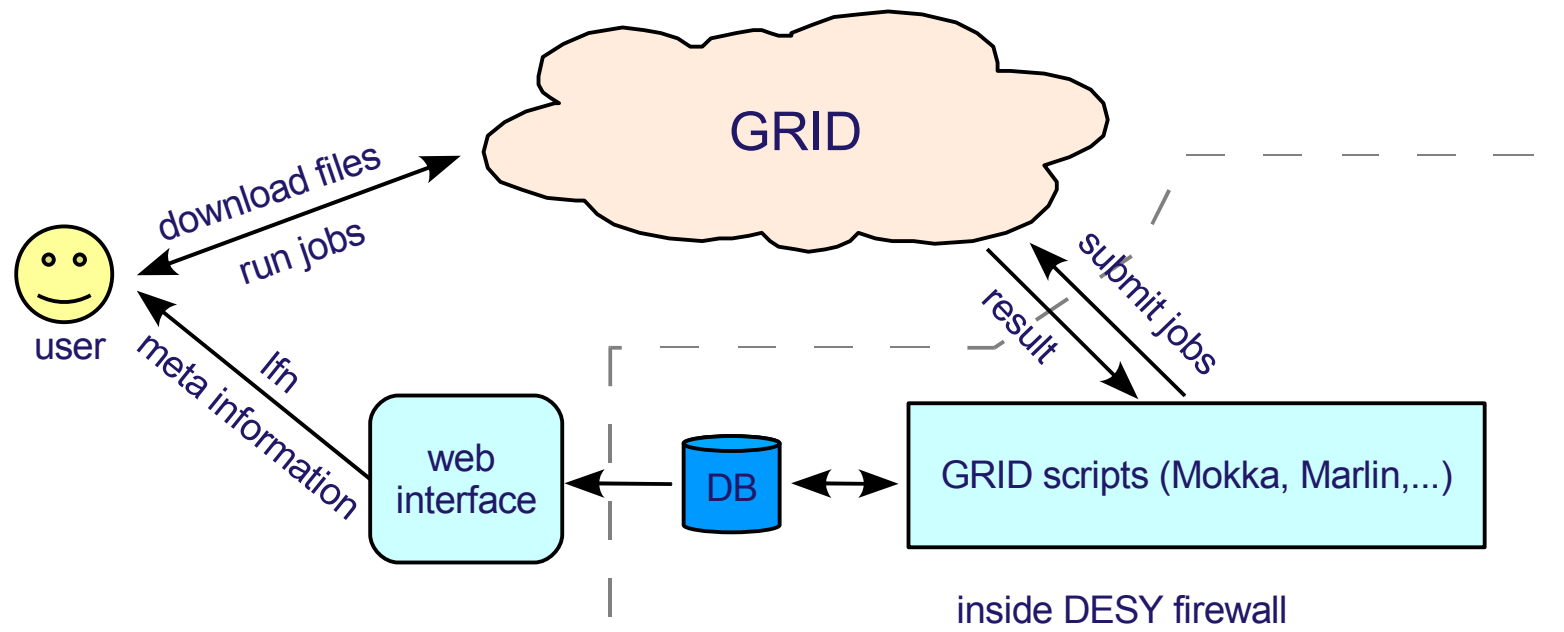
- Database for MC Production
- Sampling Fraction(s) in the HCAL
- HCAL Response for Electrons and Pions
- Conclusion and Outlook



Database for MC Production

provide Meta-Information of data simulated with Mokka

- logical filename, RunID, particle type, energy, Mokka version, detector model, Physics List, # of events ...
- helps to keep track on simulation effort
- provide simulated data to community
- MySQL database plus a web front-end to search and browse the data



Database for MC Production

- database and web interface **ready**
- **72 data-sets** for different detector models, particle types, energies available
- low statistics (2000 to 20000 events per data-set)

open issues:

- access of GRID scripts to database
- automated backup and restart of the database
- enhance statistic of simulated data for the 'full' parameter space

The top screenshot shows the main page of the CALICE Monte Carlo Database. It features a search bar and two buttons: "Search Database" and "Browse Database". Below the buttons, there is a section for "MC data files stored in database:" with a table listing various data sets.

Run ID	Particle Type	Energy [GeV]	Date of Production
Electron_10GeV_2000evt_TB04_hcalcatch	e-	10.0	2006-11-29
Electron_10GeV_2000evt_TBCern0806_woECAL	e-	10.0	2006-12-28
Electron_10GeV_2000evt_TBCern1006_woECAL	e-	10.0	2006-12-12
Electron_15GeV_2000evt_TB04_hcalcatch	e-	15.0	2006-11-29
Electron_15GeV_2000evt_TBCern0806_woECAL	e-	15.0	2006-12-28
Electron_15GeV_2000evt_TBCern1006_woECAL	e-	15.0	2006-12-12
Electron_20GeV_2000evt_TB04_hcalcatch	e-	20.0	2006-11-29
Electron_20GeV_2000evt_TBCern0806_woECAL	e-	20.0	2006-12-28
Electron_20GeV_2000evt_TBCern1006_woECAL	e-	20.0	2006-12-12

The bottom screenshot shows a search results page with a table of MC data files. The table has columns for Run ID, Particle Type, Energy [GeV], and Date of Production. The data is organized into a table with 10 rows, each representing a different data set. The table is titled "MC data files stored in database:" and includes a "Physics List:" section.

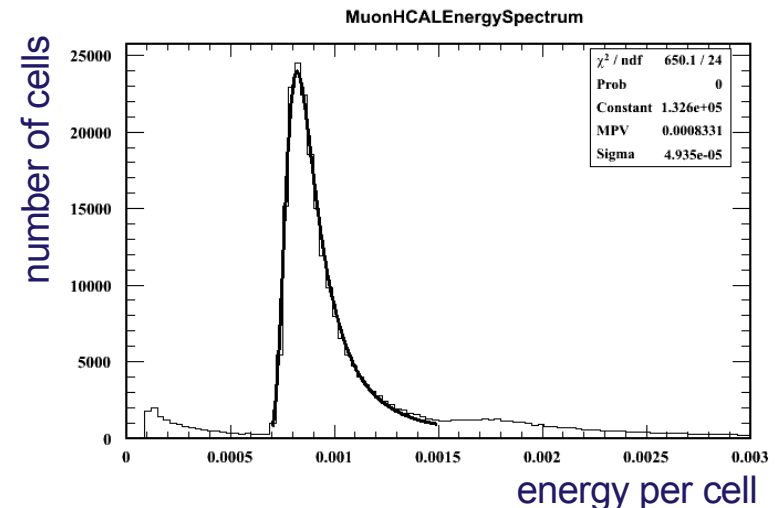
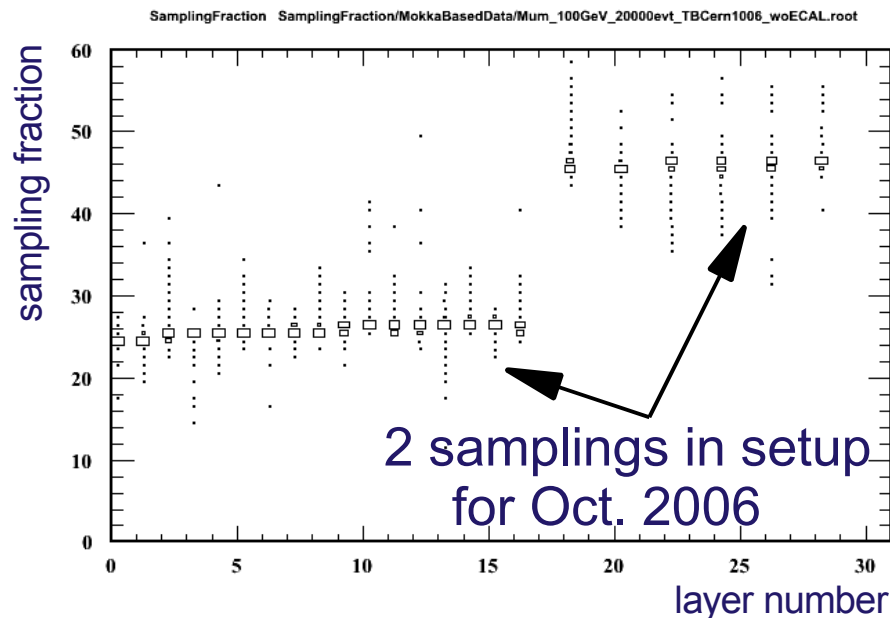
<http://www-flc.desy.de/hcal/tilehcal/simulationDB/index.html>
<http://www-flc.desy.de/hcal/tilehcal/>

put link on David's homepage as well

Sampling Fraction(s) in the HCAL

Determine Sampling Fraction from Simulation (**layer-by-layer**):

- Mokka plugin calculates Sampling Fraction during simulation
- Sampling Fraction = (energy dep. full layer / energy dep. Scintillator)
- 100 GeV Muons with geometry for Oct. 2006 (TBCern1006)
- low statistic, 2000 events only

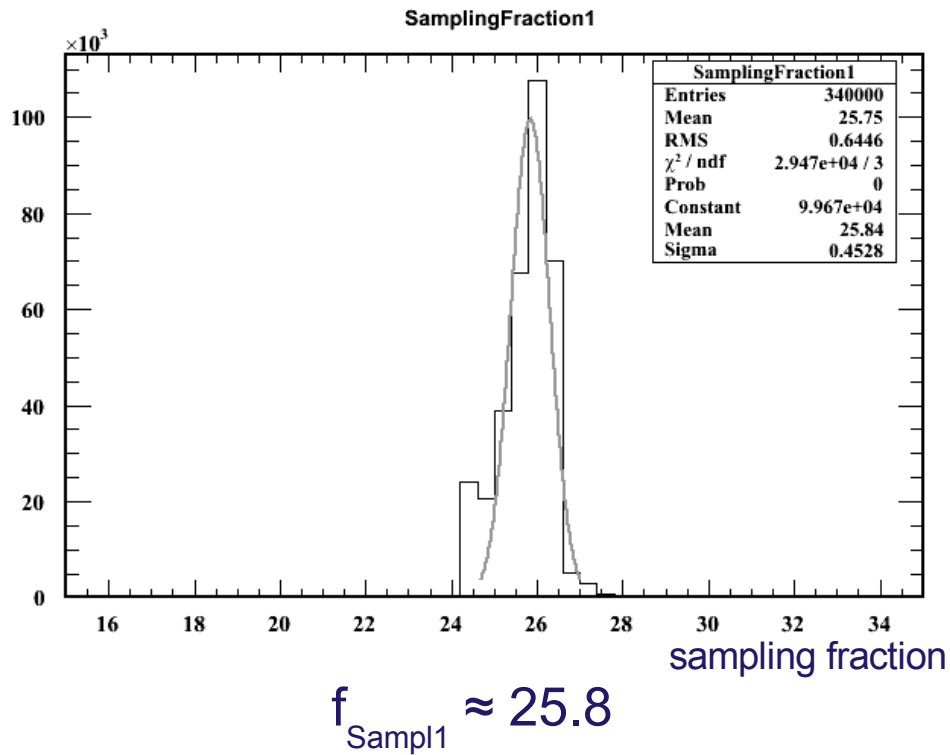


E^{Beam}	MPV
10 GeV	833.2 keV
80 GeV	857.5 keV
100 GeV	859.9 keV

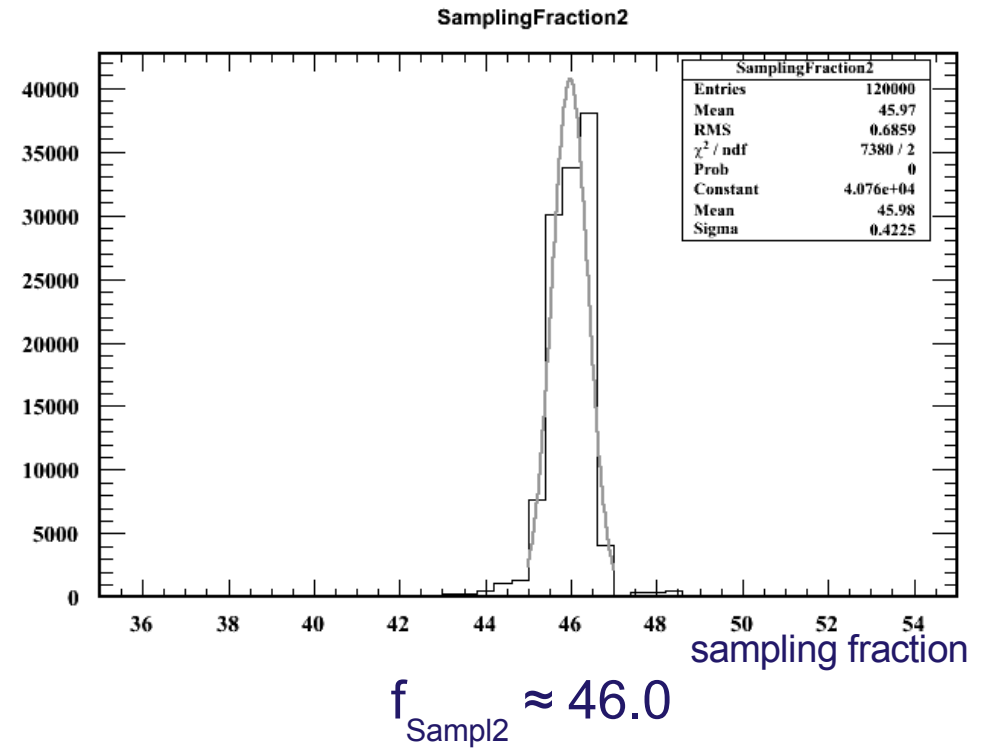
Sampling Fraction(s) in the HCAL

TBCern1006 with 100 GeV Muons:

Sampling 1:



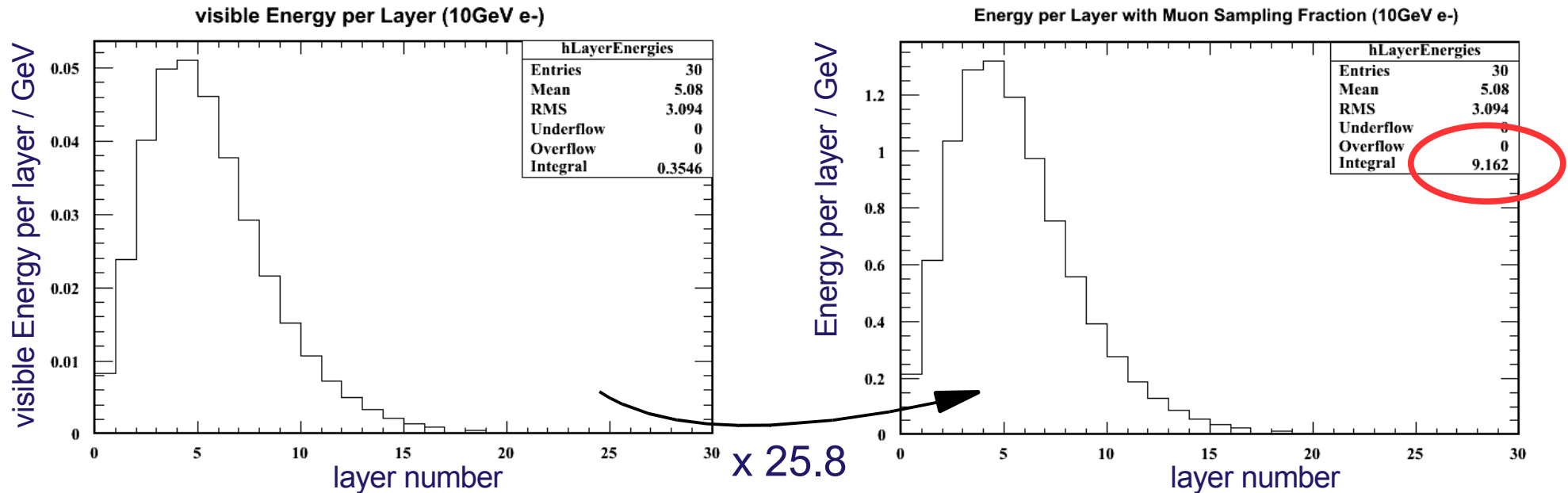
Sampling 2:



- apply Sampling Fraction to energy deposition of 10 GeV electrons
- shower contained in the first 17 layers, only f_{Sampl1} needed

Sampling Fraction(s) in the HCAL

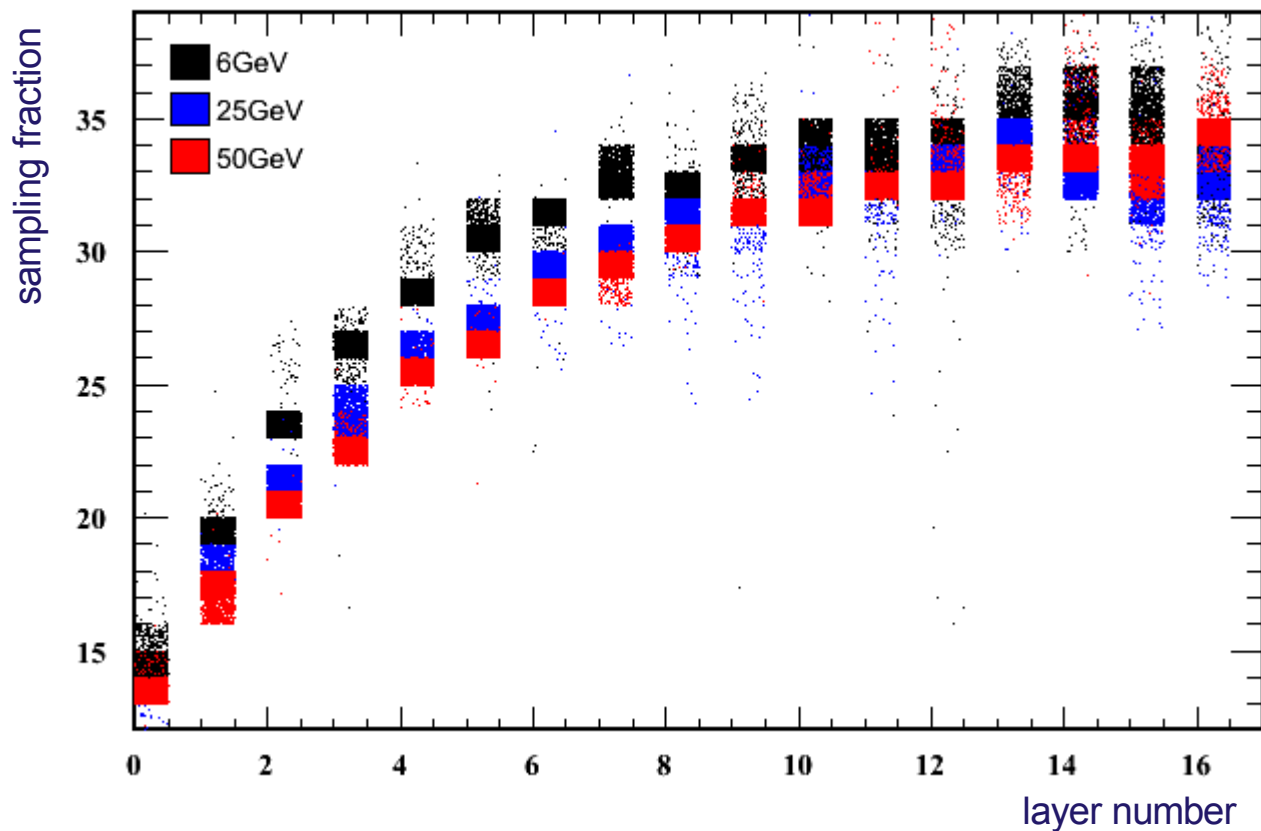
TBCern1006 w/o ECAL, 10 GeV Electrons:



- electron shower should be completely contained in HCAL
- 'reconstructed' energy sum differs by $\approx 9\%$ from beam energy
- have a look at the Sampling Fractions per layer calculated for electrons at different energies

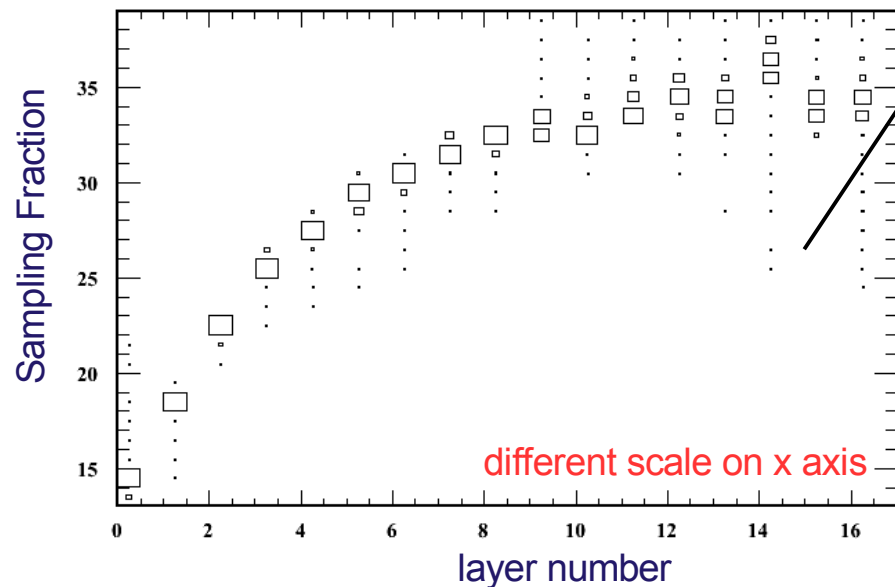
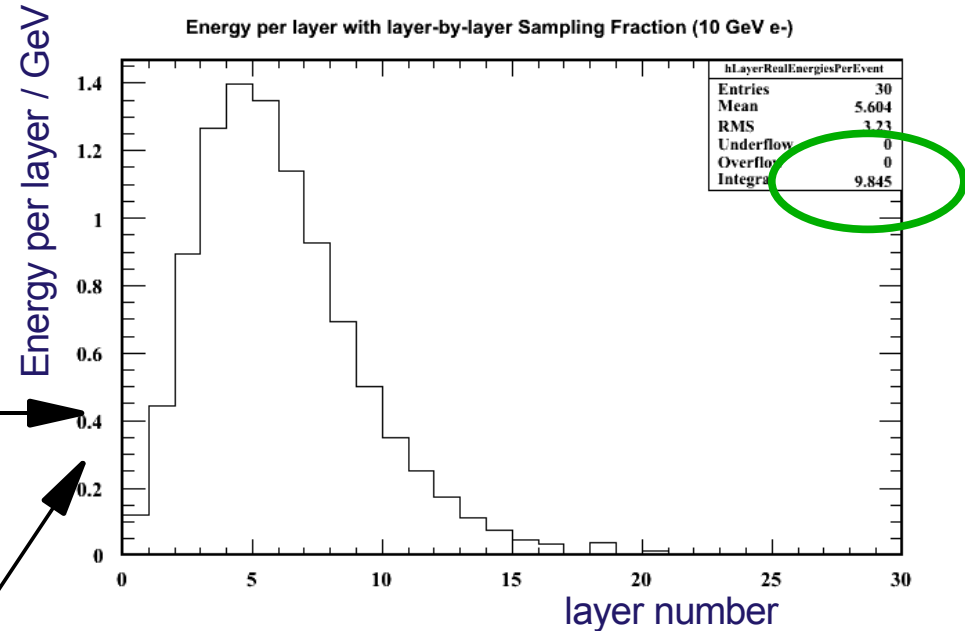
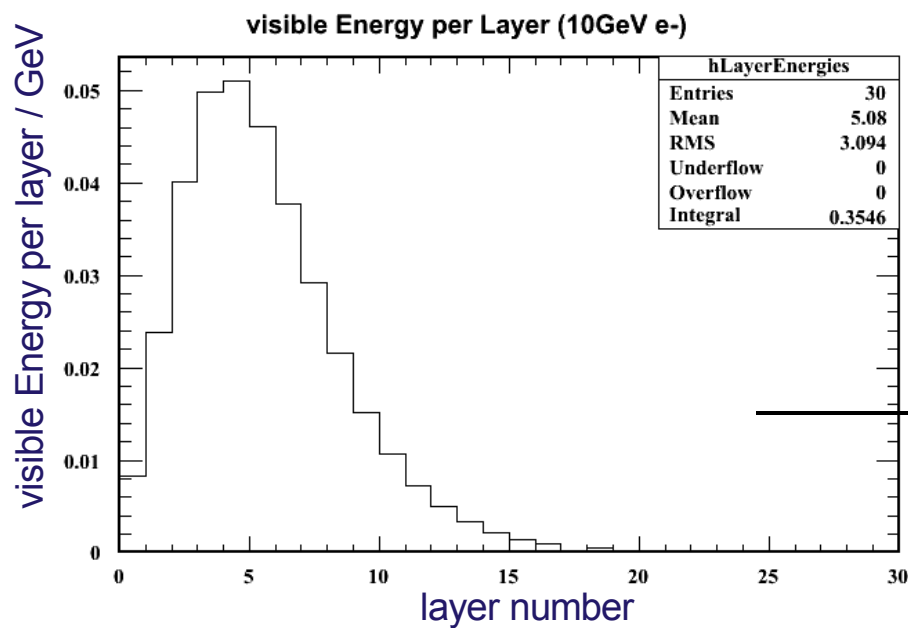
Sampling Fraction(s) in the HCAL

Sampling Fraction for 6, 25 and 50 GeV Electrons (TBCern1006 w/o ECAL)



- sampling fraction layer / energy dependent
- apply different sampling fraction per layer and energy

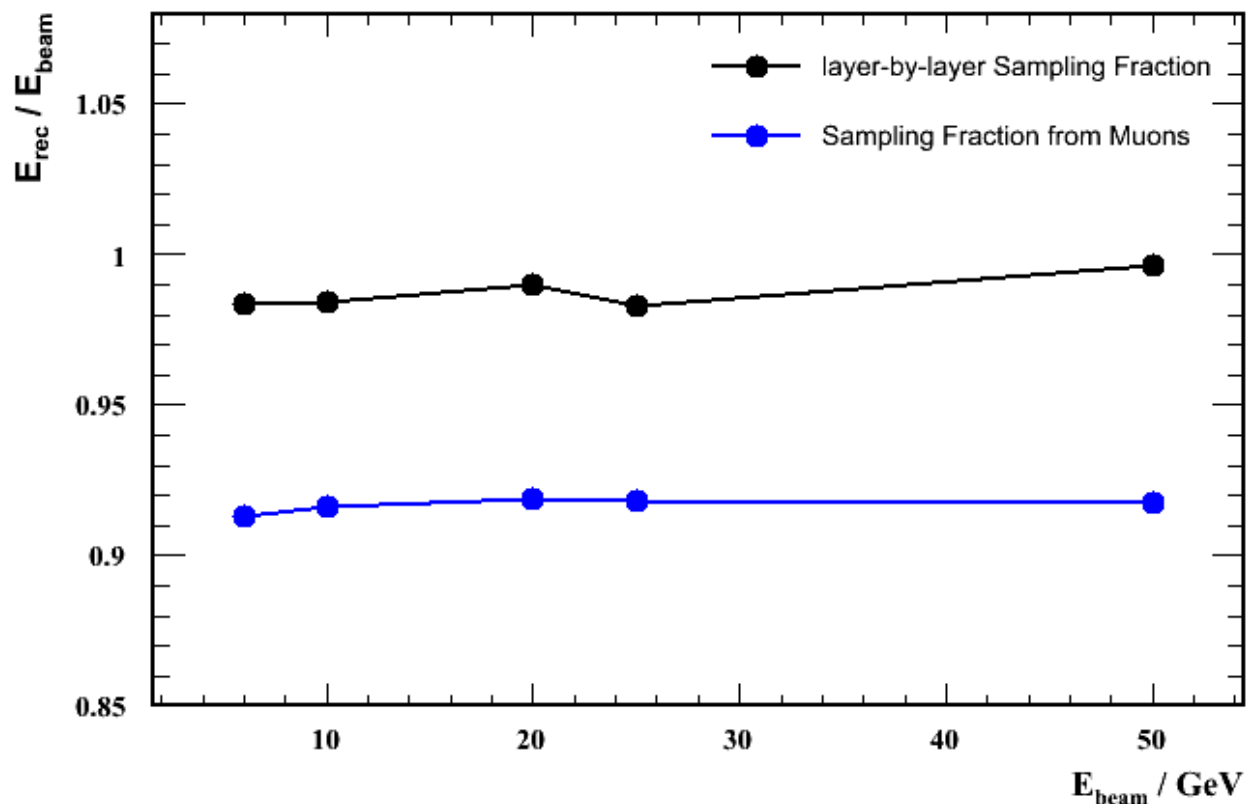
Sampling Fraction(s) in the HCAL



- 'reconstructed' energy: 9.85 GeV
- before: 9.16 GeV
- remaining 0.15 GeV lost in DCs, Triggers and surrounding air
- needs to be checked

Sampling Fraction(s) in the HCAL

calculate $E_{\text{rec}} / E_{\text{beam}}$ for both methods as function of energy

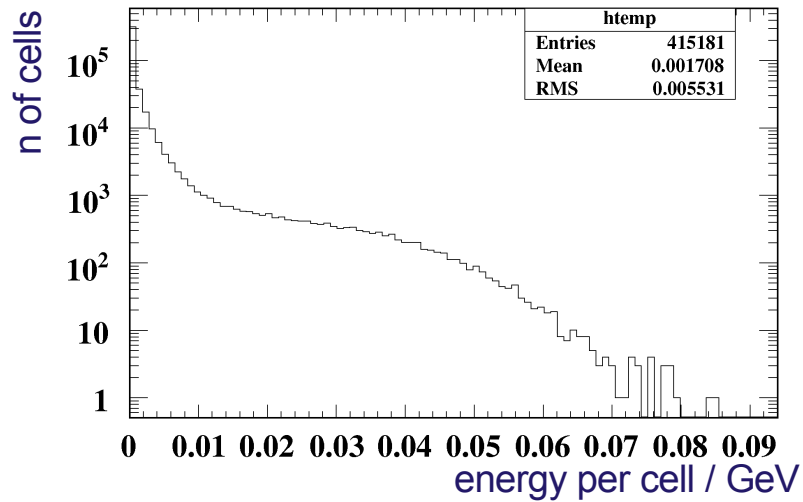


- effect can be corrected by calibration, nevertheless
- Sampling Fractions from MC might be interesting for data analysis

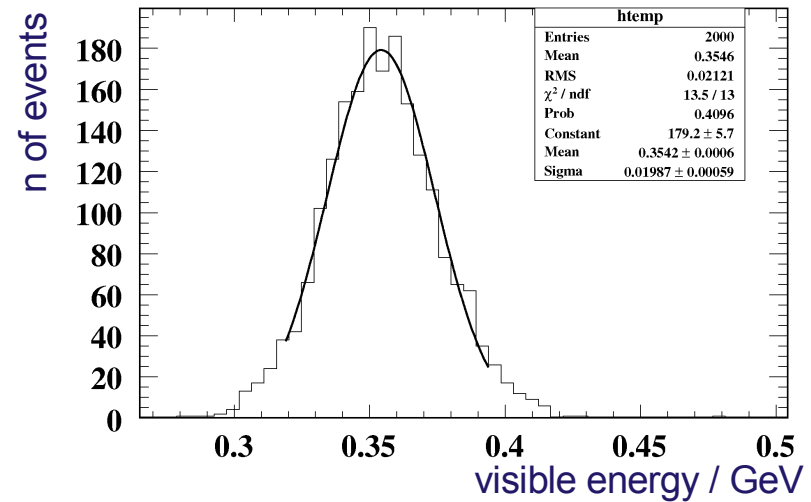
HCAL Response for Electrons

10 GeV Electrons (TBCern1006 w/o ECAL)

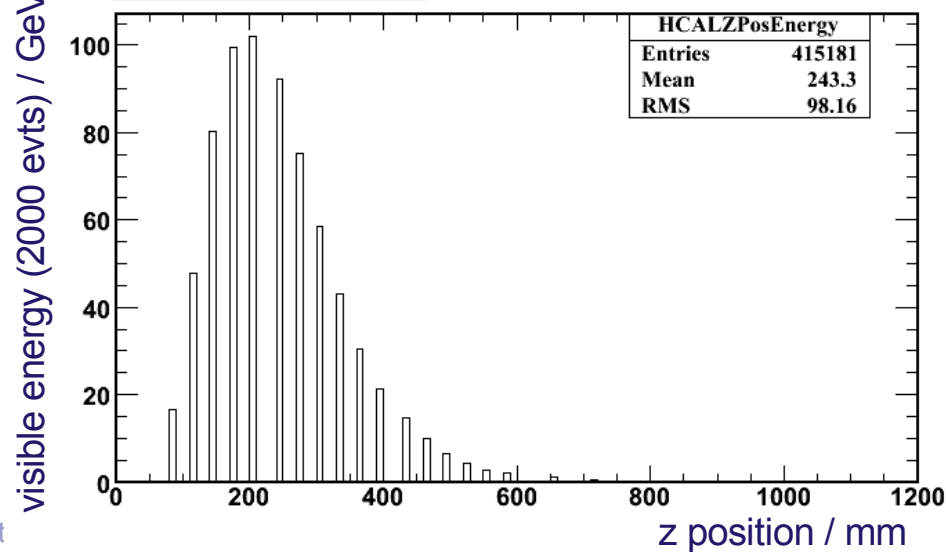
Electron 10GeV Energy per Cell



Electron 10GeV Energy Sum



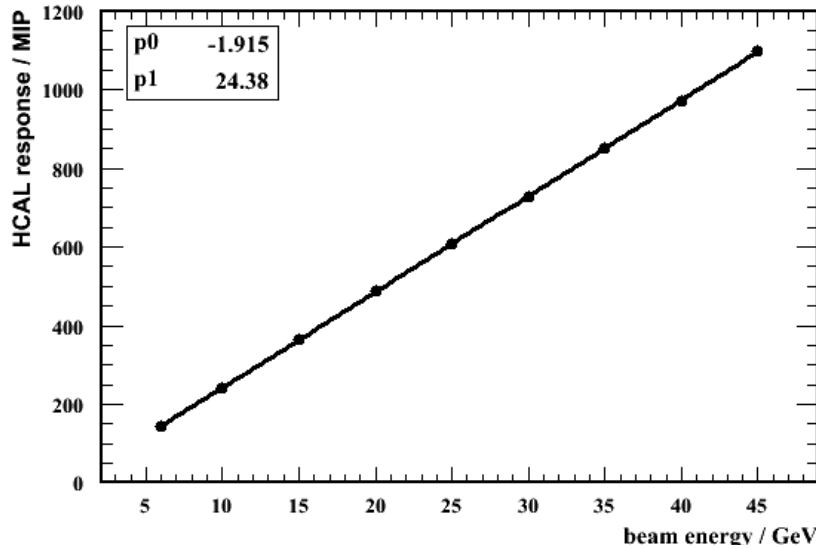
e- 10GeV (2000 events)



HCAL Response for Electrons

August 2006 (TBCern0806)

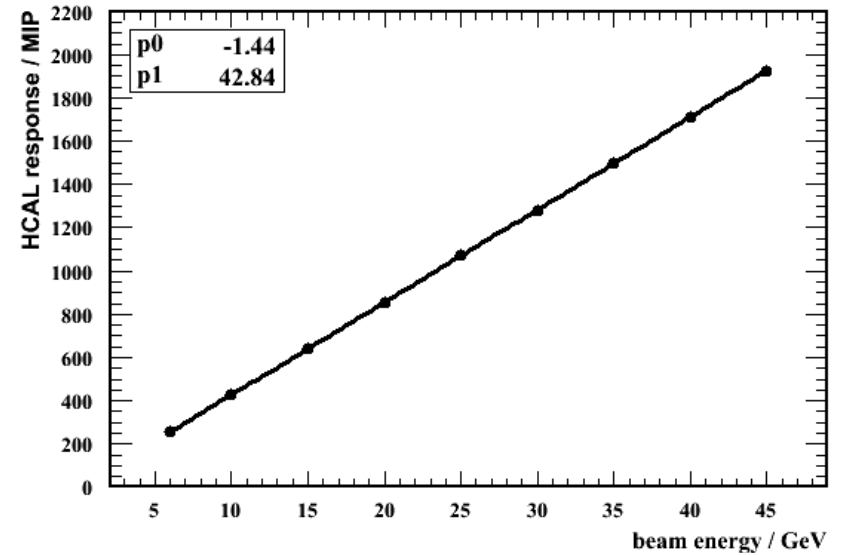
beam energy vs. HCAL response (simulation)



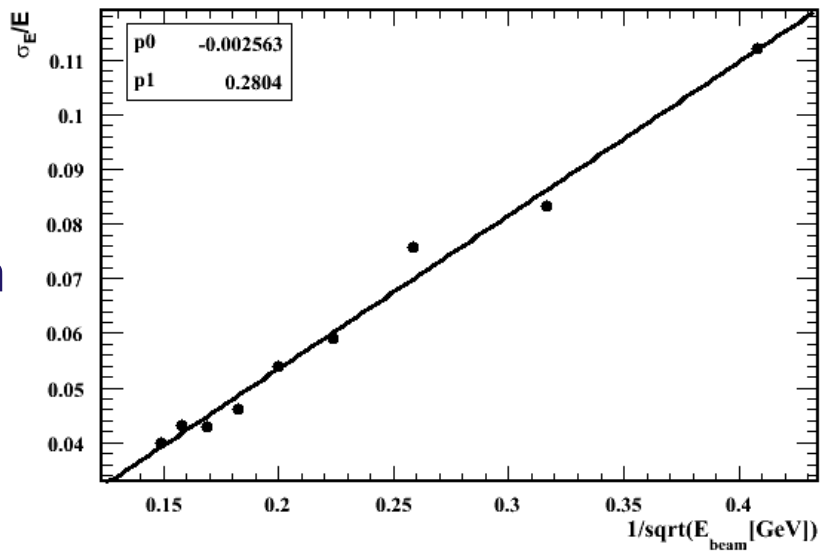
HCAL
Response

October 2006 (TBCern1006)

beam energy vs. HCAL response (simulation)

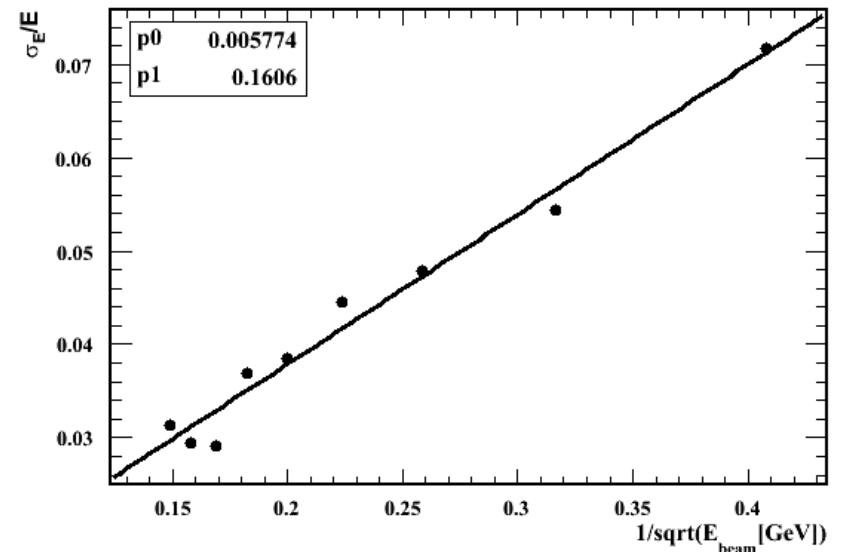


HCAL Energy resolution (simulation)



Energy
Resolution

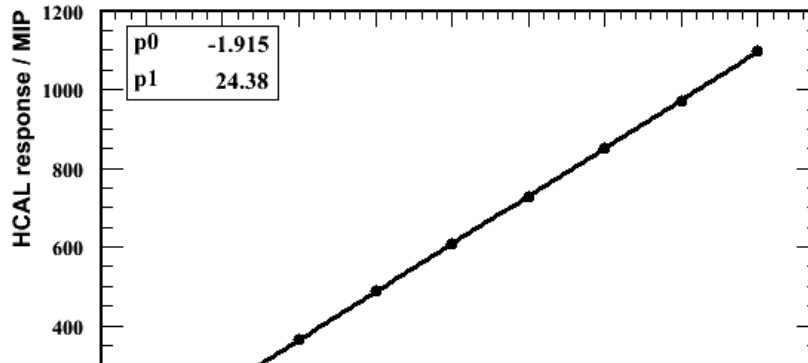
HCAL Energy resolution (simulation)



HCAL Response for Electrons

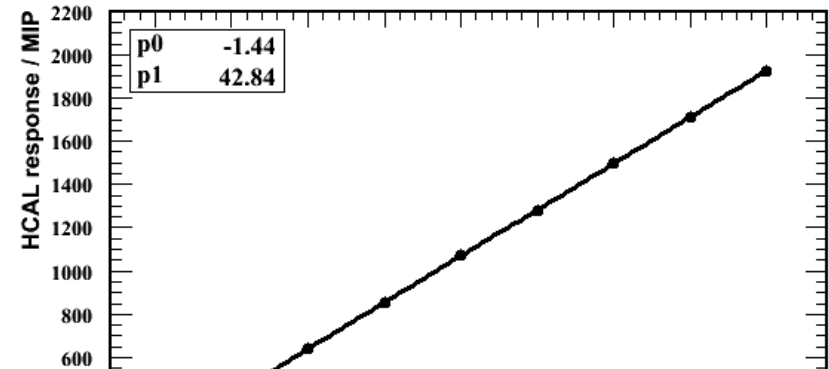
August 2006 (TBCern0806)

beam energy vs. HCAL response (simulation)



October 2006 (TBCern1006)

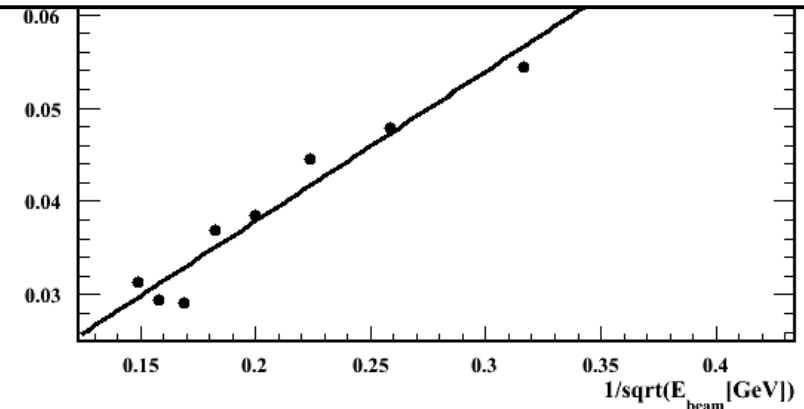
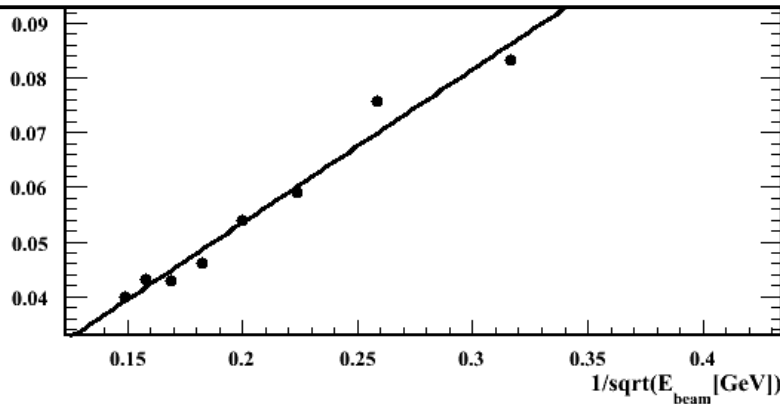
beam energy vs. HCAL response (simulation)



HCAL
Response

*more details on the electromagnetic response and
comparison with data see talk of Nanda*

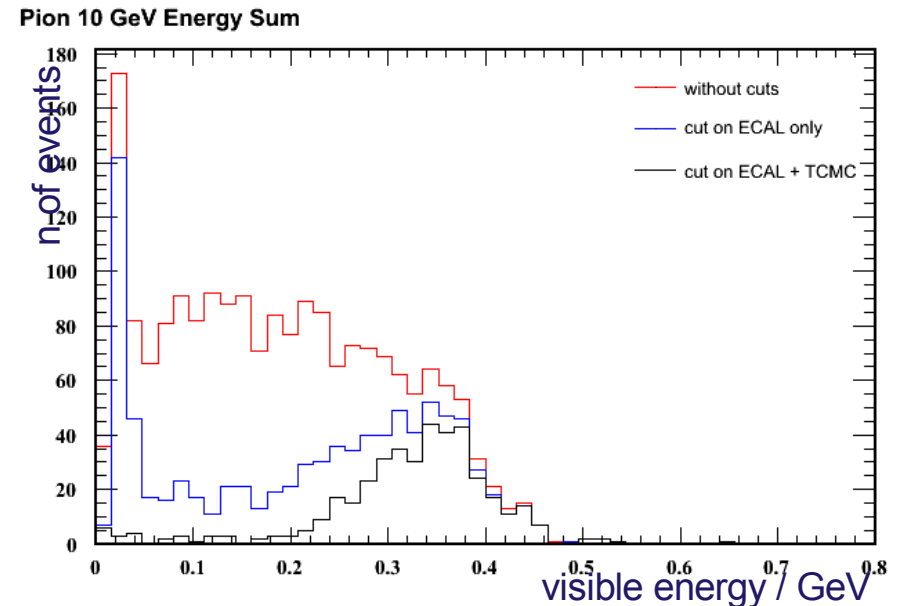
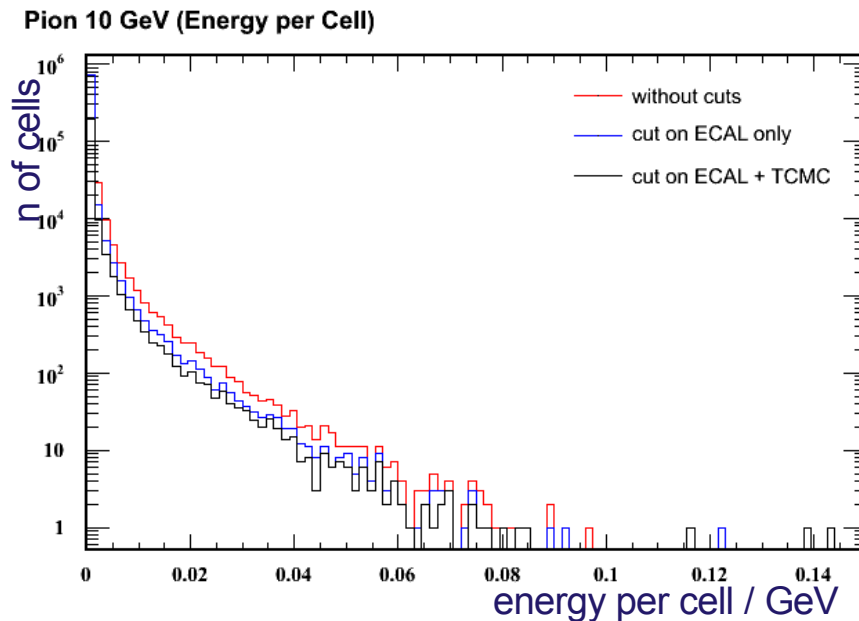
Energy
Resolution



HCAL Response for Pions

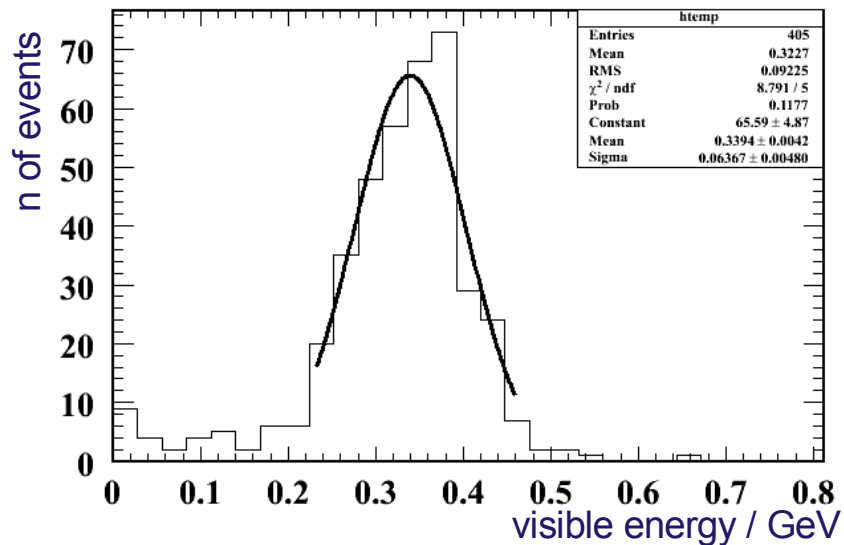
- selection: less than 40 hits in the ECAL, maximal 5% of deposited energy in Tail Catcher
- low statistic (2000 events) and low efficiency (20%): only 400 events to analyse
- very preliminary results, just a first look

e.g. 10 GeV Pions with geometry for Oct. 2006 (TBCern1006)

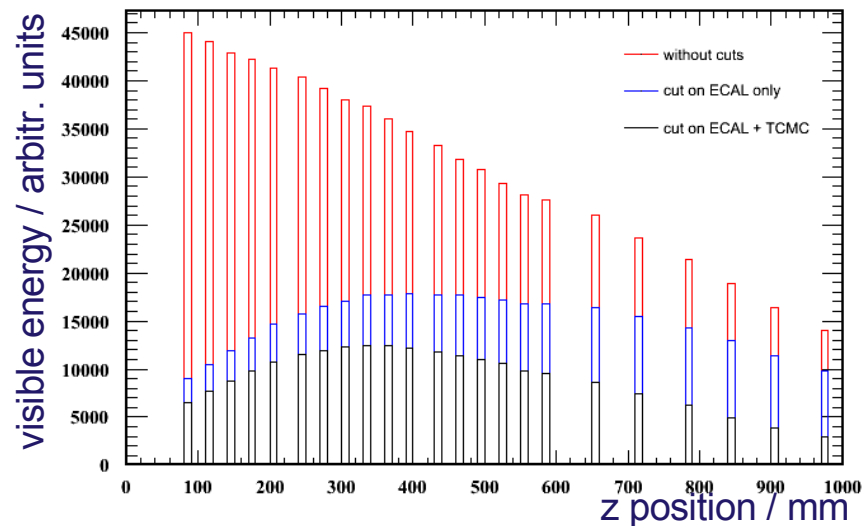


HCAL Response for Pions

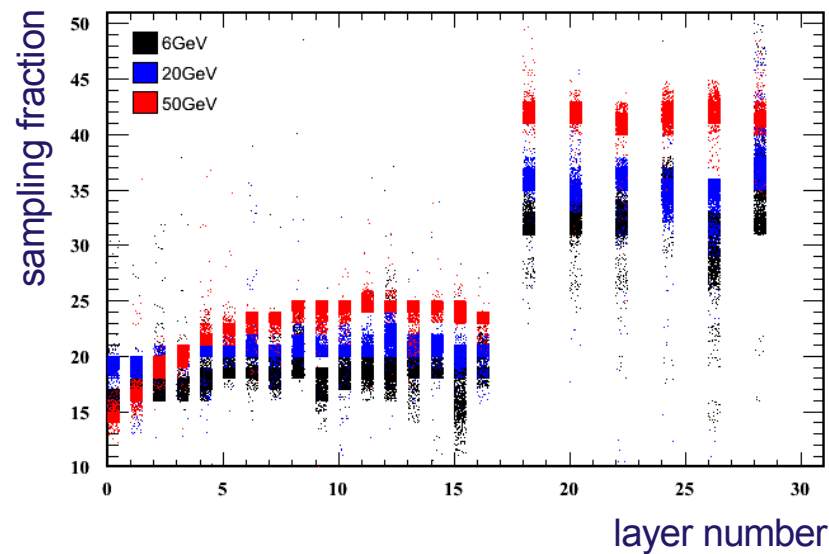
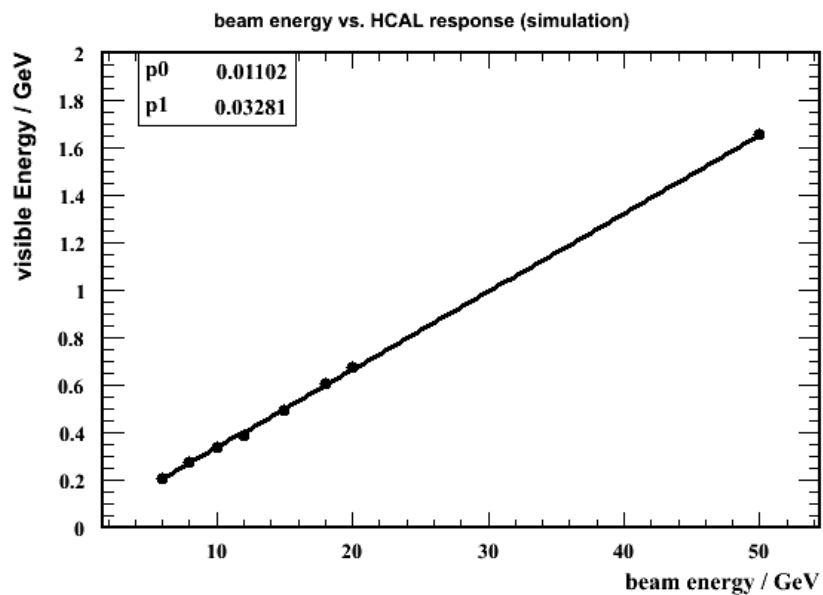
Pion 10GeV Energy Sum



Pion 10 GeV (2000 events)



HCAL Response and sampling fraction for different beam energies (TBCern1006)



Conclusion and Outlook

- general and comprehensive approach to accomplish a full scale MC effort for the Test Beam experiments is needed
- system is sufficient for our needs here at DESY (but for CALICE?)
- simulation effort has started for different detector models, energies and particle types
- need more statistic and simulations for missing parameter points
- Sampling Fractions calculated from MC might of interest for the data analysis
- further studies are ongoing

Outlook

- improve 'realism' of detector models (vacuum tube, detector effects)
- start a 'full' scale simulation effort
- comparison of data and MC for electromagnetic and hadronic events

backup slides ...

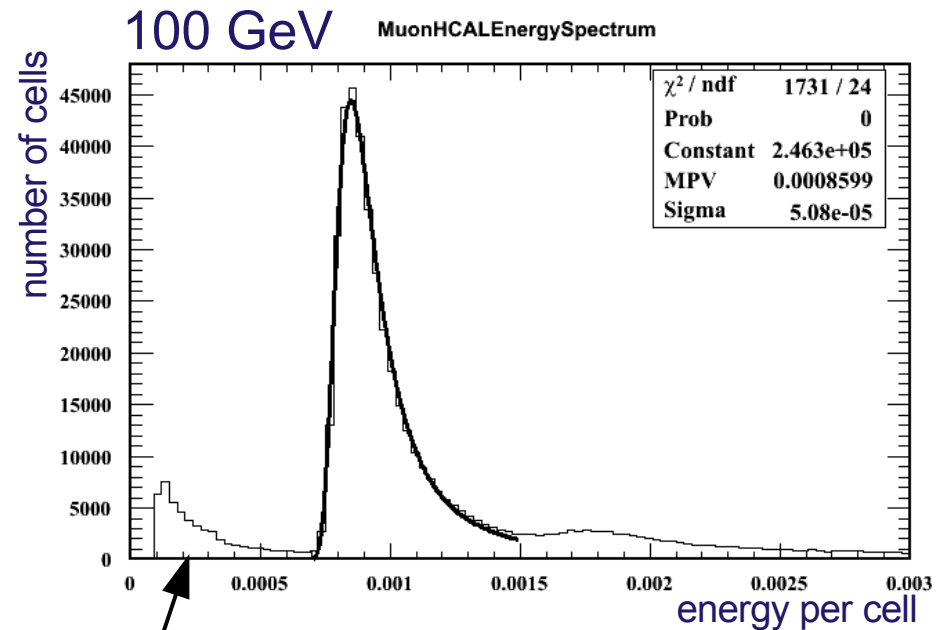
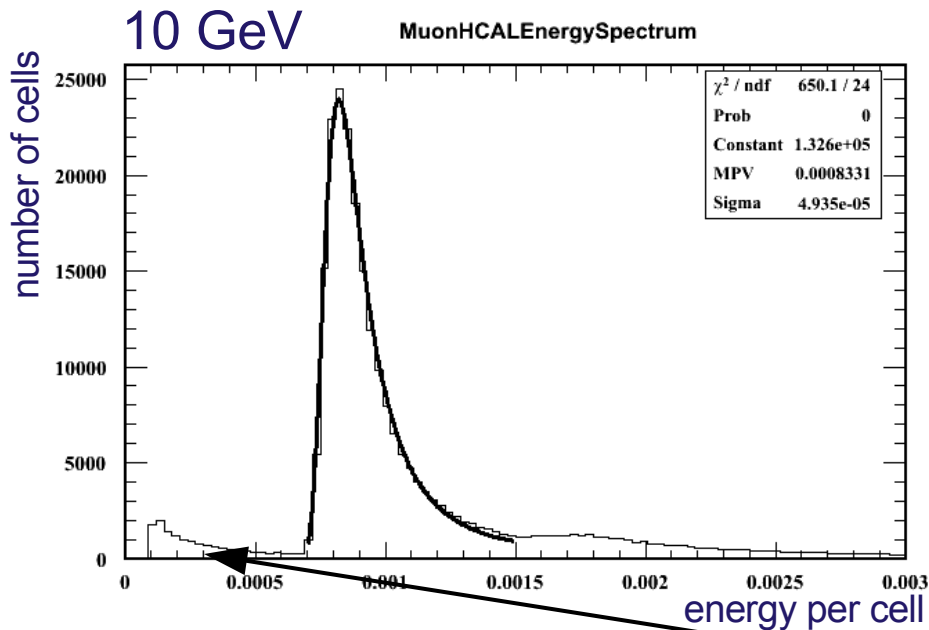
Simulation of MIPs for different Beam Energies

Energy scale (GeV \leftrightarrow MIP) taken from Simulation

- simple Landau Fit on muon spectra
- different beam energies: 10, 80 and 100 GeV
- done for the Models TBCern0806 and TBCern1006 with and w/o ECAL in front of the HCAL
 - get MIP energies as a 'function' of beam energy
 - compare with results of Nicola's simulation

Simulation of MIPs for different Beam Energies

For the model TBCern1006:

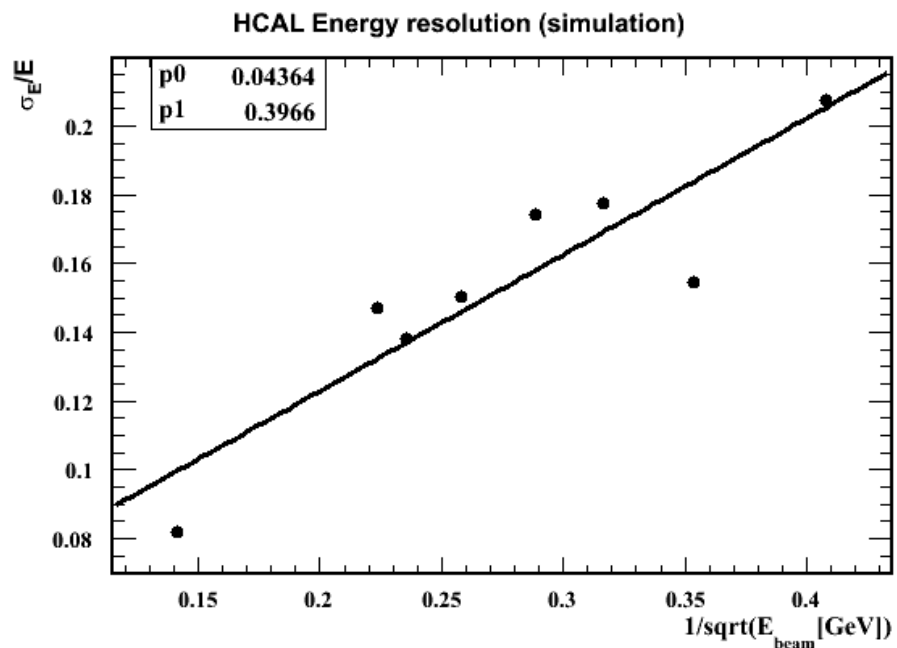


E^{Beam}	MPV
10 GeV	833.2 keV
80 GeV	857.5 keV
100 GeV	859.9 keV

- no 'tower-like' cut in the calorimeter cells
- due to δ s in the neighboring cells

HCAL Response for Pions

HCAL Resolution (TBCern1006)



very preliminary