Analysis of low energy hadrons in the SiW ECAL with the FNAL 2008 data
CALICE Analysis meeting

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Who am I ?

- Philippe Doublet, 1st year PhD student at LAL (Orsay, France).
  Roman Pöschl is my supervisor.
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- My work for CALICE: data analysis and comparison with MC simulated data of pions in the SiW ECAL with energies from 1 GeV to 10 GeV.
- Goal: use the unprecedented granularity of the ECAL to get a better knowledge of hadronic interactions.

The SiW ECAL in 2008

Figure: 30 layers fully equipped : 1 $cm \times 1$ cm Si pixels $\sim$ 10000 channels. 3 different W depths, depth $1\lambda_I$

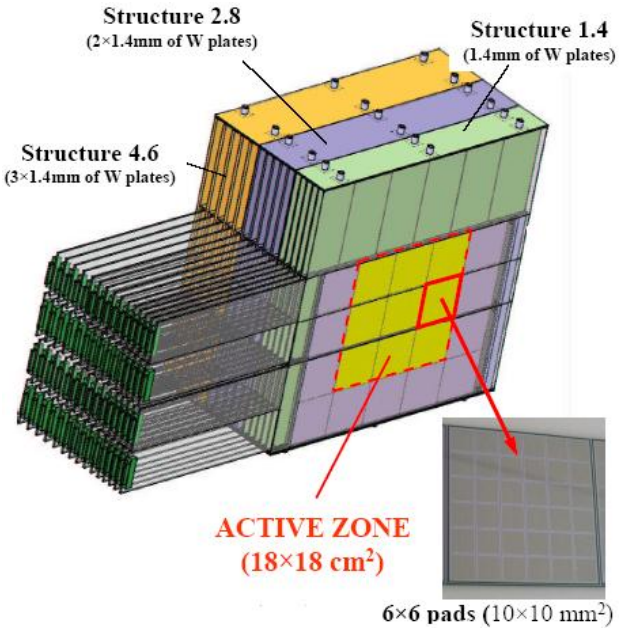


Figure: Photo of the installation at FNAL. 3 subdetectors were present : ECAL, AHCAL, TailCatcher.

Summary of data taken with pions (π^-) in July 2008

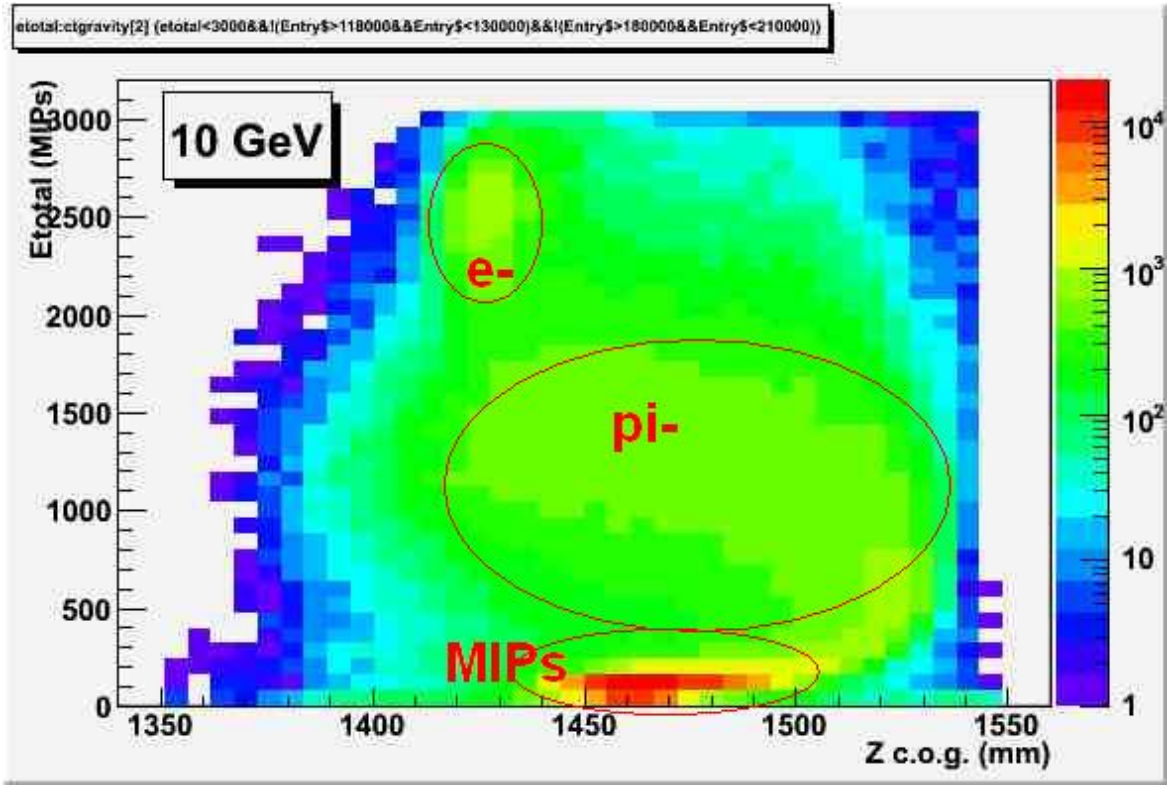
- May: instabilities of the ECAL due to some electronic noise
- July: good and stable running period

Number of events recorded (triggers)	Momentum (GeV)
460 k (-v22 & -v25)	2
820 k (-v24)	4
110 k (-v23 & -v27 & -v31)	6
540 k (-v27)	8
500 k (-v27)	10
at 30°	
310 k (-v24)	4
220 k (-v27)	8

A lot of statistics is available and will be checked and processed.
For today, the work only contains 10, 8 and 6 GeV events.
Major problem: HCAL information not available $\longrightarrow$ select the pions with the ECAL

First overview at 10 GeV

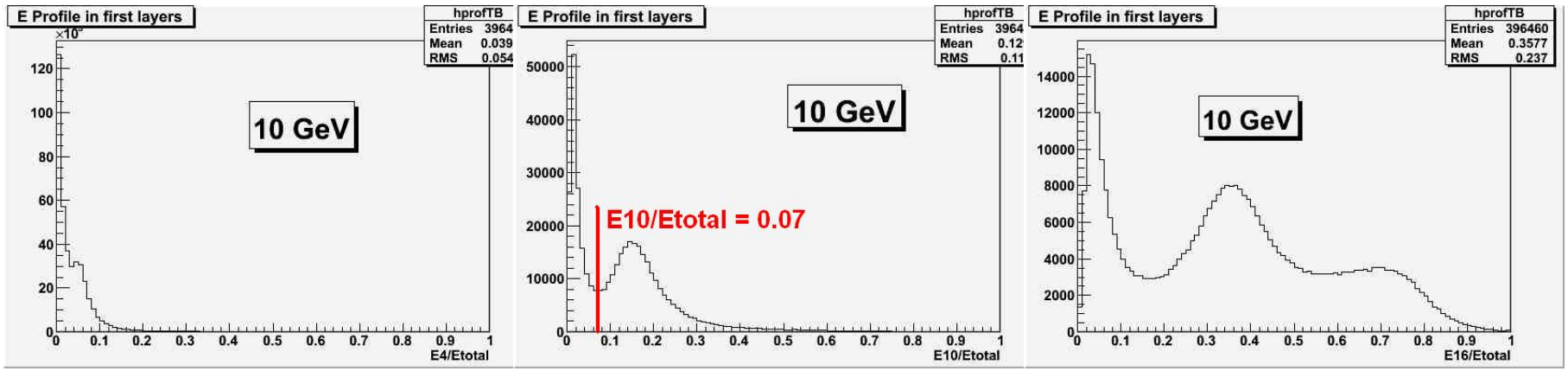
Figure: 2D histogram of the 10 GeV runs showing the total energy deposited in the ECAL versus the center of gravity of the shower. One can identify electrons, pions and MIP particles



Thanks to Hengne for preparing the reconstructed data.

Goal: have a pure sample of pions (but keep a lot of statistics)

Solution : look at the energy deposited in the first N layers $\sim 4X_0$



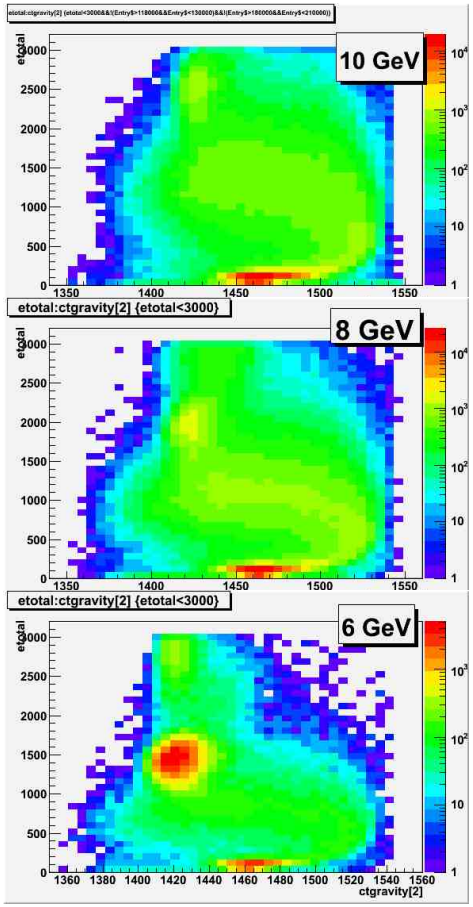
Histograms showing the fraction of the energy deposited in the first 4, 10 and 16 layers over the total deposited energy (10 GeV runs).

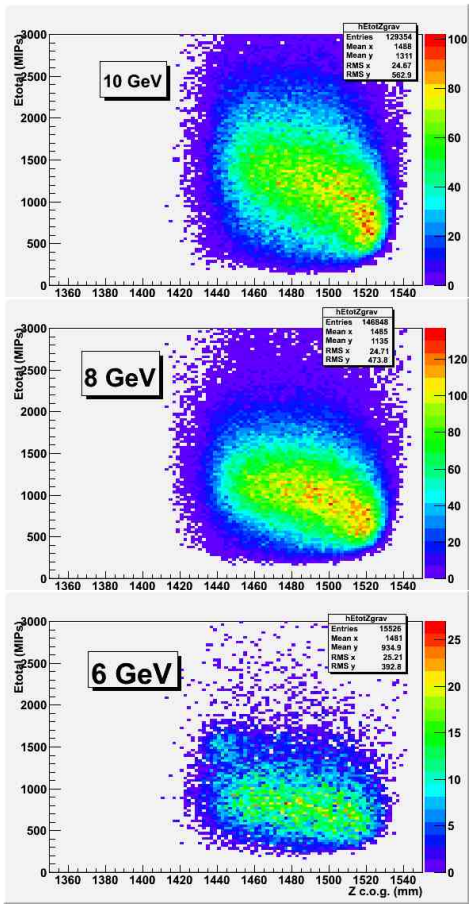
Electrons can be separated best with 10 layers : ask $E_{10}/E_{total} < 0.07$ to reject the electrons.

Then: reject the muons by demanding that $nhits > 50$.

$\Rightarrow$ 2 cuts defined.

Results of the cuts

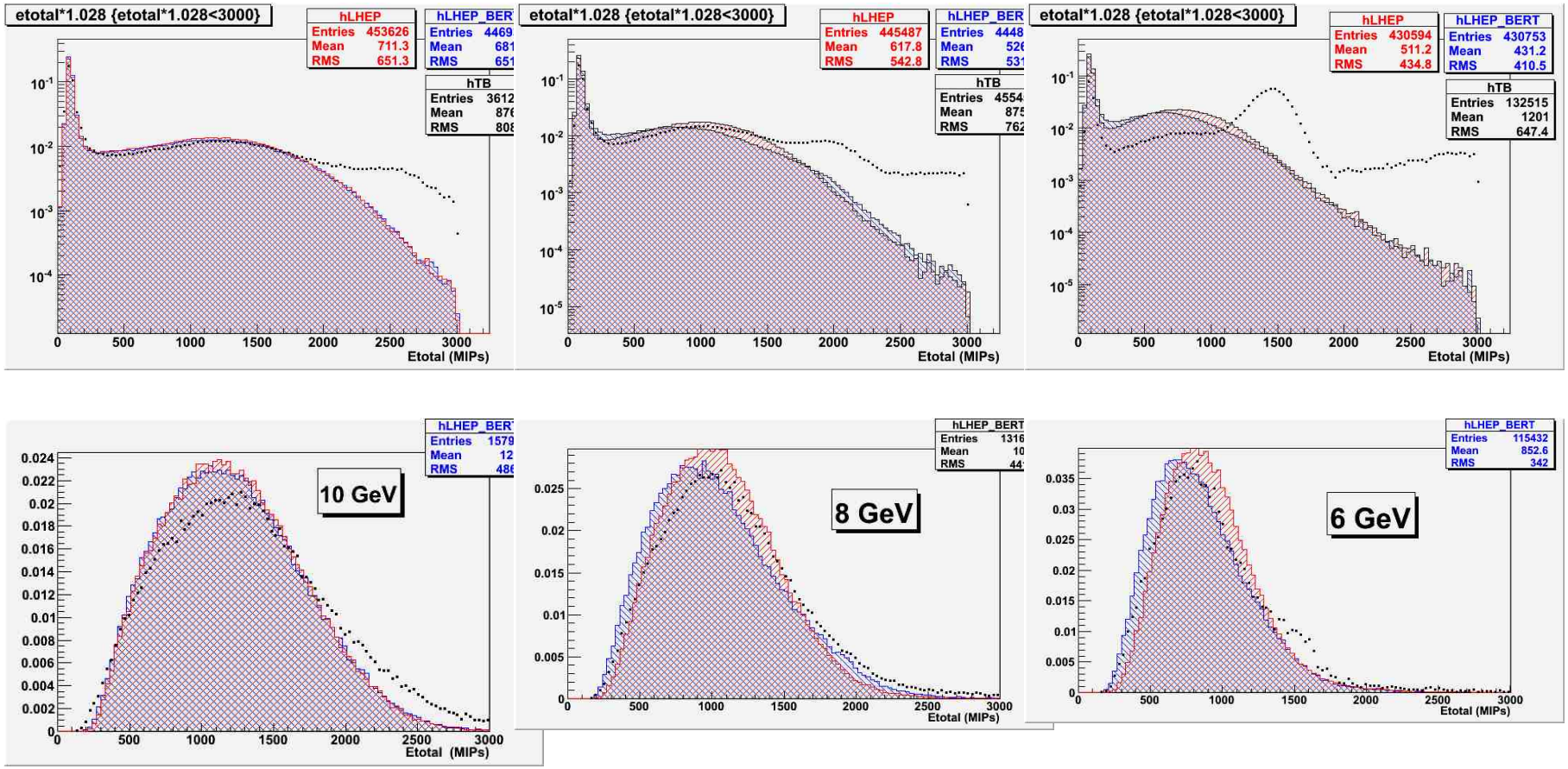




From top to bottom : 10 GeV, 8 GeV, 6 GeV. From left to right : before and after the cuts. Pions seem to be correctly selected.
Remark: During the FNAL TBs, a differential Cherenkov counter was present. Not taken into account here because of efficiency problems. (See Dec. 1st, 2008 - SiW ECAL meeting slides)

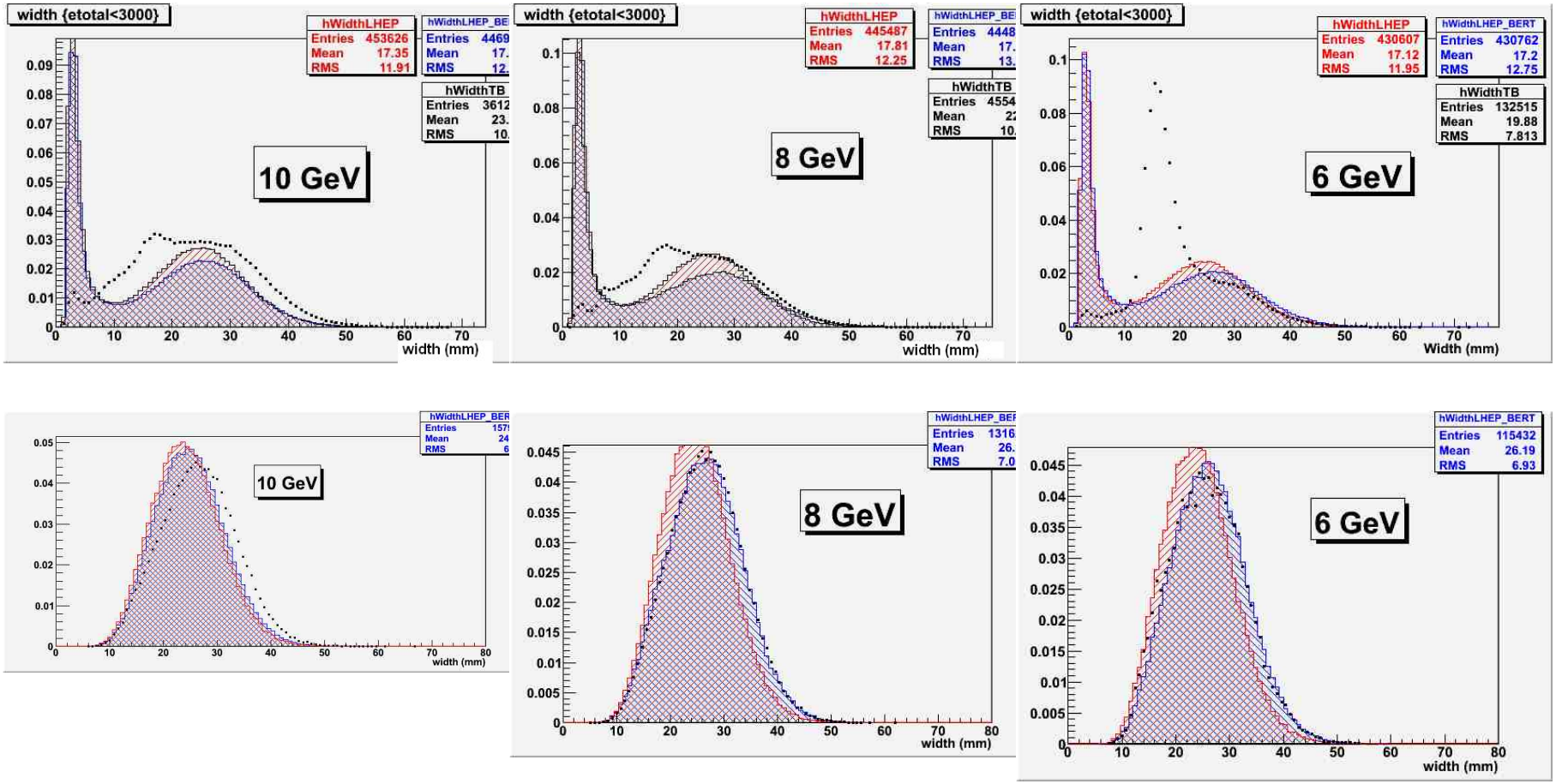
Comparison with the MC data : deposited energy

Remark: simulated data from 2006 CERN TB. Total energies of the simulated sample have been scaled so that the MIP peaks correspond to each other with the TB data.



From left to right : 10 GeV, 8 GeV, 6 GeV. Up : no cuts. Down : cuts for pions. Red=LHEP, blue=LHEP BERT, black dots=TB.

Comparison with the MC data : width of the cluster



From left to right : 10 GeV, 8 GeV, 6 GeV. Up : no cut. Down : cuts for pions.

Remark: Low TB statistics at 6 GeV.

Some difficulties encountered

Two problems are still under investigation for quantitative results : the Cherenkov study and the multiple particle events.

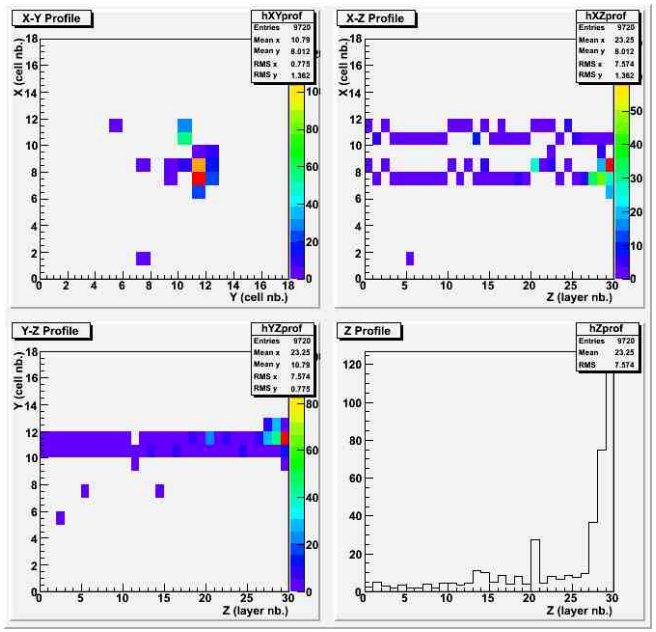


Figure: 2D profiles of a multiple particle event during a 10 GeV run.

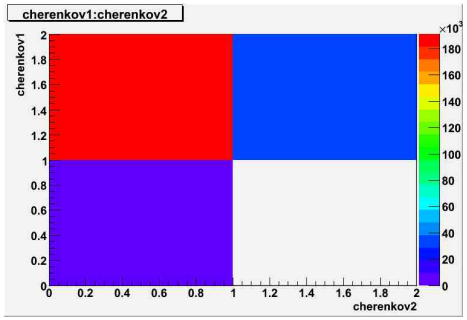
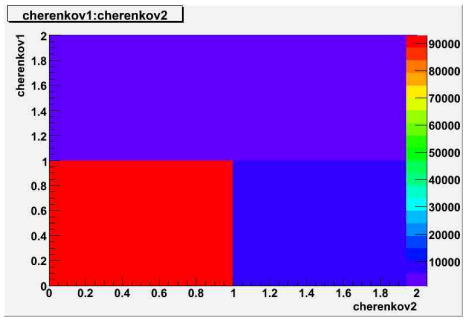
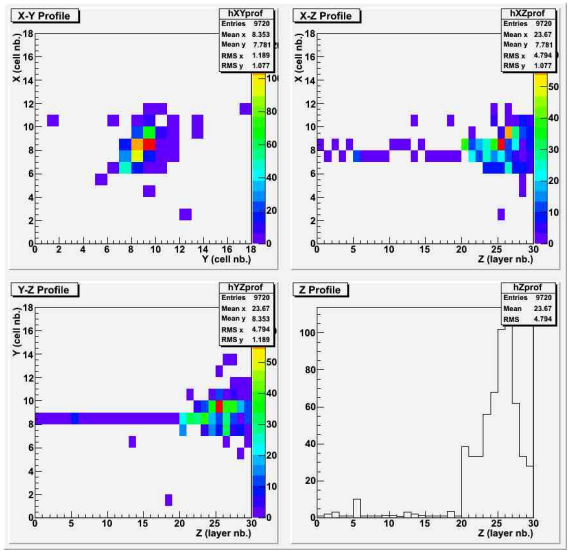


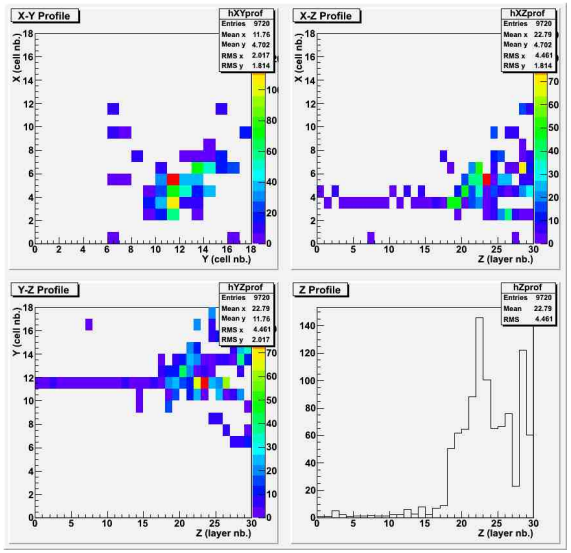
Figure: Signals of the 2 cherenkov bits : C1 vs C2



The unphysical combination !C1 & C2 occurs sometimes O(10%).

Going further : investigating the interaction





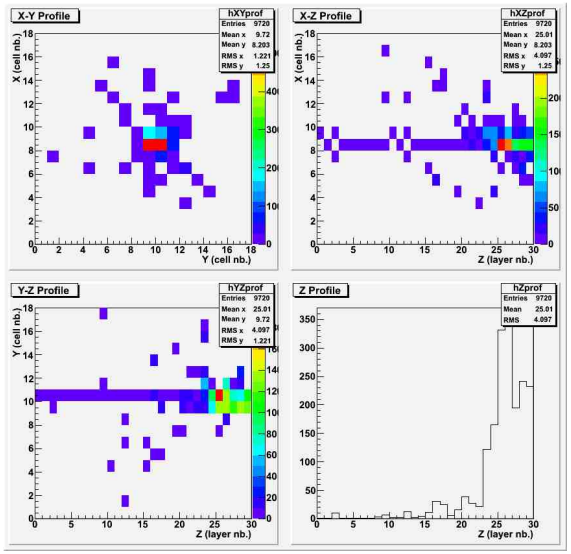
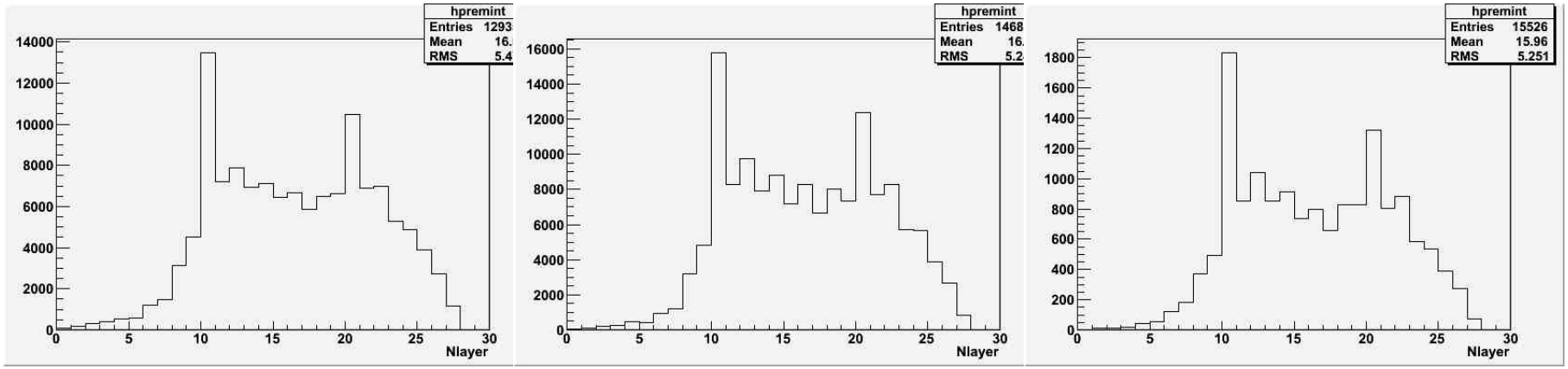


Figure: Projections in the XY / XZ / YZ planes and Z profile of the event. Energies are in MIP. Left : Real TB event at 10 GeV. Right : Simulated 10 GeV events with LHEP (up) and QGSP BERT (down).

If we can disentangle with the eyes, we may also do it informatically.

Finding the first interaction (PRELIMINARY)

Condition: $E_{layer} > 10$ MIPs for 3 consecutive layers



From left to right : 10 GeV, 8 GeV, 6 GeV.

- Two major peaks can be identified. Those corresponding to layer 10 and 20 : change in the W thickness. No idea why we see such a big change...
- Comparison to MC samples to be done.

Summary and work to be done

- First overview of the SiW ECAL FNAL data for pions
  $\longrightarrow$ aim for Daegu : present a quantitative analysis of the beam content with a study of the triggers.
- Comparisons with 2006 MC samples. 2008 MC simulation already asked to Shaojun Lu.
- Need to improve pions' selection with the cuts (Nlayer, Nhits maybe...) and continue studying the Cherenkov issues.
- Need to improve the 1st interaction finding and to go deeper in the understanding of the hadronic interactions (EM content of the shower, MIPs, energy deposition...)

Thank you for your attention, any comments are welcome.