SEMIDIGITAL HADRONIC CALORIMETER
TEST BEAM 2012. A VERY PRELIMINAR ANALYSIS

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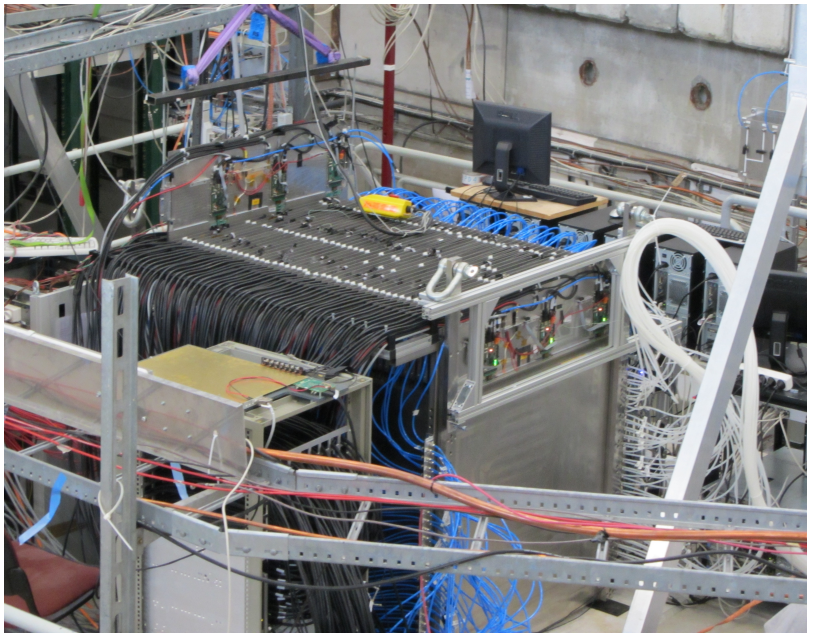
INTRODUCTION (I)

Brief Description

The SemiDigital HCAL prototype has approximately 1 m^3 size in order to contain most of the hadronic shower. It was constituted mainly of by GRPC's (48 planes) but a couple of Micromegas were used too in the Test Beam. The absorber among detectors is stainless steel 2 cm width.

Both types of chambers are segmented in 1x1 cm^2 pads and have a readout based in three thresholds (SemiDigital readout). It registers which pads have a signal bigger than each threshold. In the analysis, it is possible to consider the three thresholds as only one and use the information as a pure digital calorimeter.



INTRODUCTION (II)

Test Beam 2012

Between April and May of this year the SDHCAL prototype has been tested in particle beams at CERN with different particle types and several energies.

Two different test beam periods:

PS area: → PS period where pions at low energy from 2 GeV to 12 GeV were used.

SPS area: → SPS period where both pions and electrons were taken at higher energy from 10 GeV to 120 GeV.

Goals

In this talk, a very preliminary Linearity and Energy Resolution will be calculated with the pion data taken during the SPS period considering the digital approach without distinguishing between thresholds.

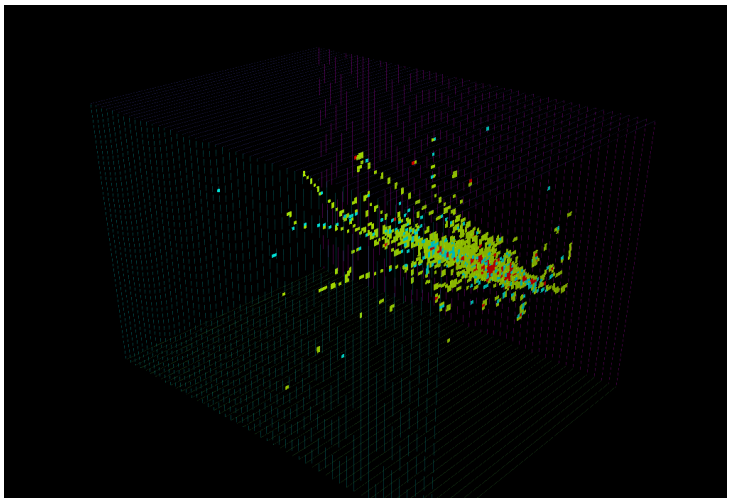
Data analyzed were pion runs from 20 GeV until 110 GeV.

Other studies ongoing within the SDHCAL Group (not present here)

- Electron studies.
- Efficiency and multipicity.
- Simulations in order to compare with data results.

FAST LOOKING AT DATA

Pion from Run 714486 @ 100 GeV



Left image shows a single pions shower taken at 100 GeV. This display was obtained with Druid.

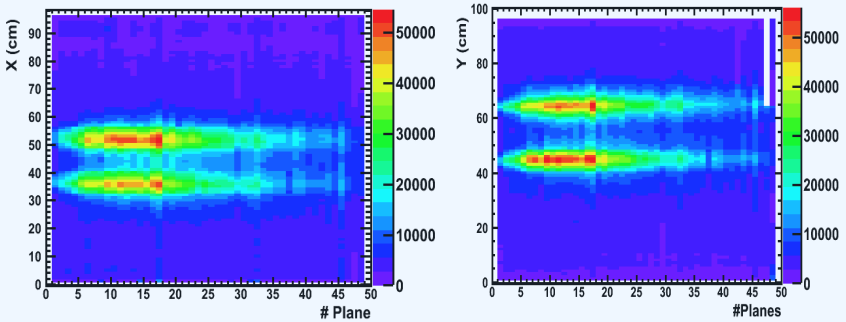
Each color corresponds with one threshold:

Green: first threshold.

Blue: second threshold.

Red: third threshold, describing the core of the shower.

Pion run @ 50 GeV Run 714556



Shower longitudinal profile

Left plots show the longintudinal beam profile for a pion run (data taken in different positions) .

It can be observed the pion shower is almost fully contained within the calorimeter limits.

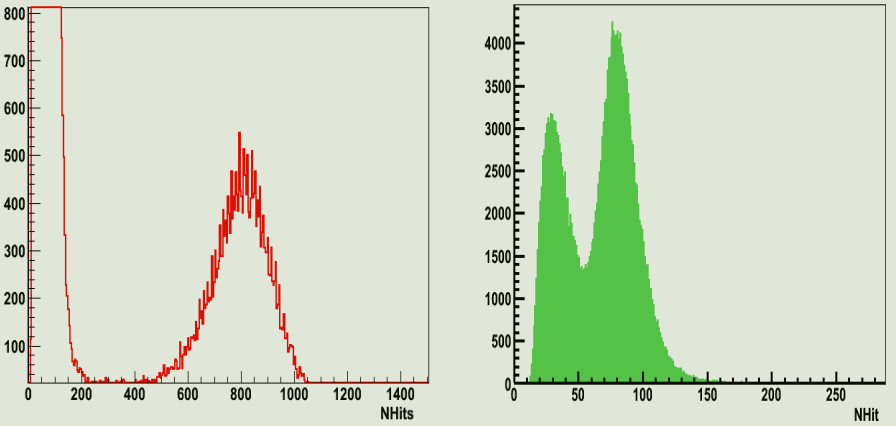
SELECTING PION HITS

Total Hits distribution

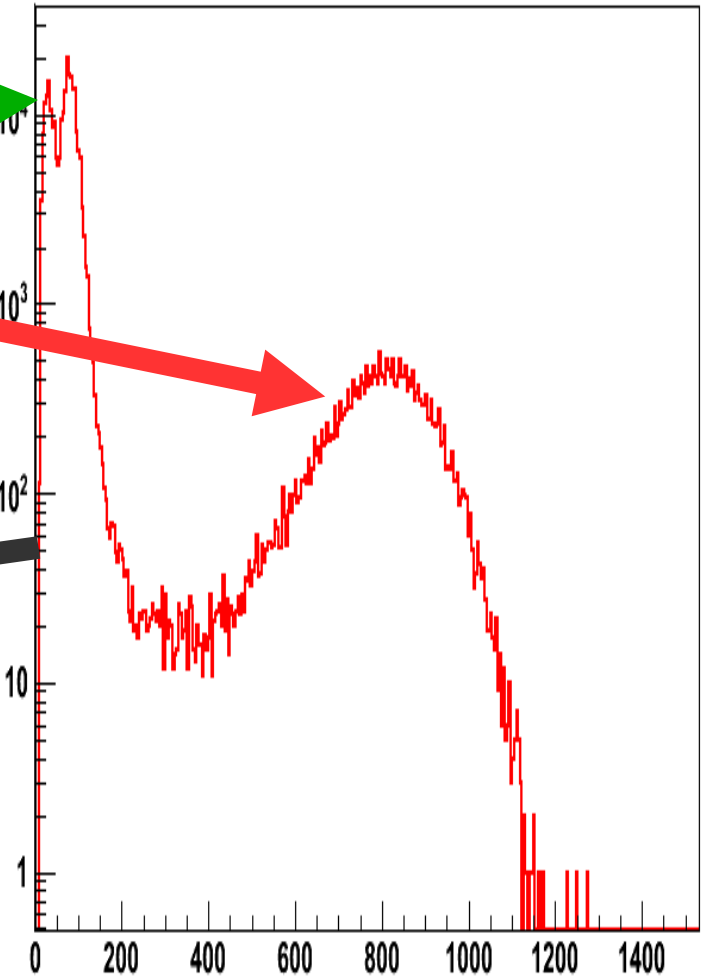
We can obtain the total hits distribution:

the **first two peaks** correspond respectively to **cosmic and beam muons.**

the **last peak belongs to pions.**



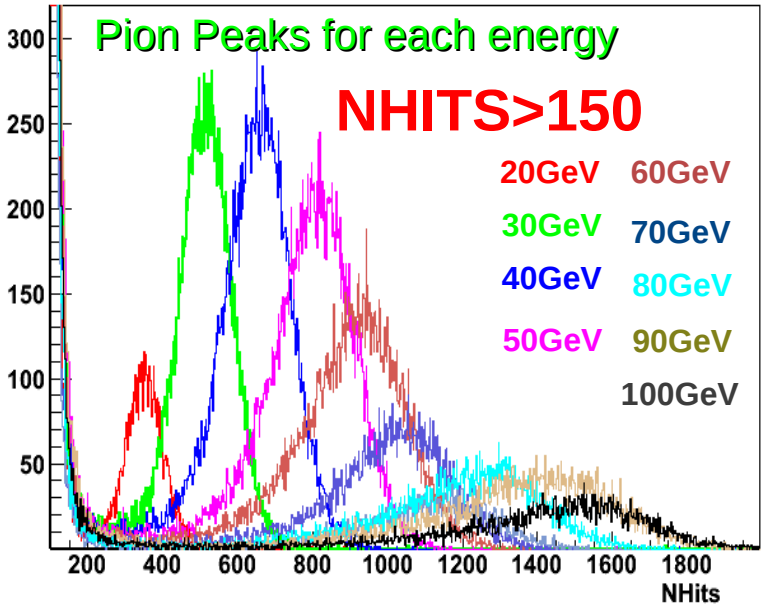
ZOOM & Linear Scale



Logarithmic Scale

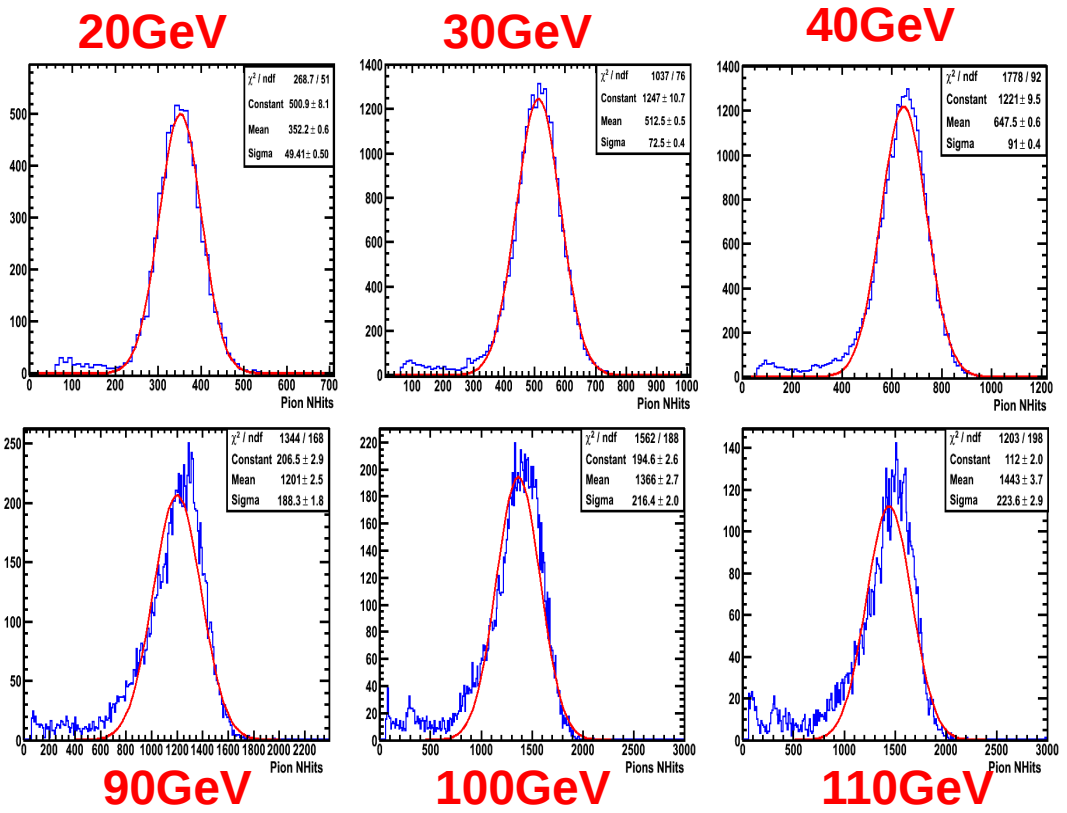
SELECTING PION HITS (II)

Particles can be separated in a first attempt just by looking at the distribution of total number of hits.



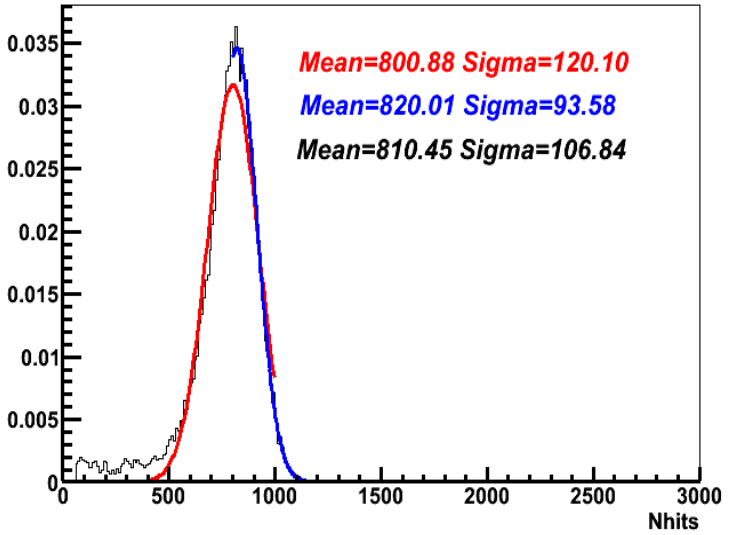
Nhits distribution is basically gaussian for intermediate energies. The gausian behaviour is ost as we increase the energy.

For energies above 50 GeV the separation is even clearer, and muons can be easily cut off from pion contribution.



METHOD FOLLOWED

Pion @ 50 GeV Distribution for all hits



Total number of hits distribution

Linearity and energy resolution were calculated with these values for each situation.

In order to study this effect, the Nhits distributions were fitted to two independent gausian distributions, left and right of the maxmun.

In this case, three mean and sigma values could be obtained:

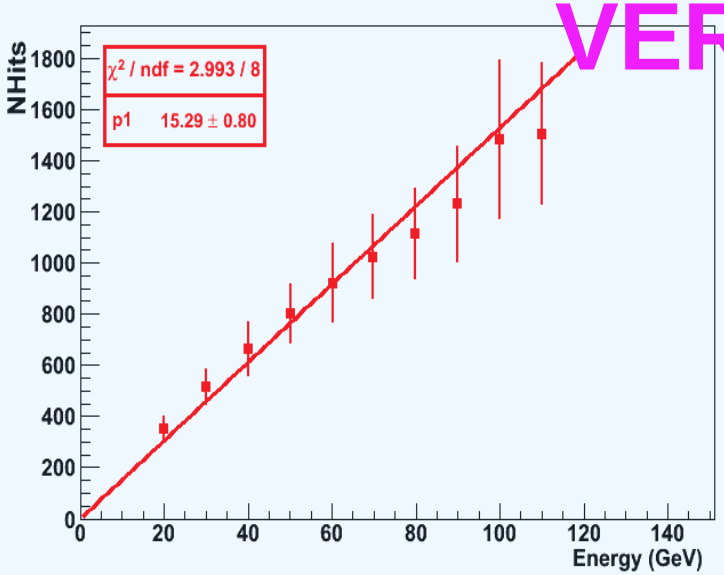
Red: Left fit Parameters

Blue: Rigt fit Parameters

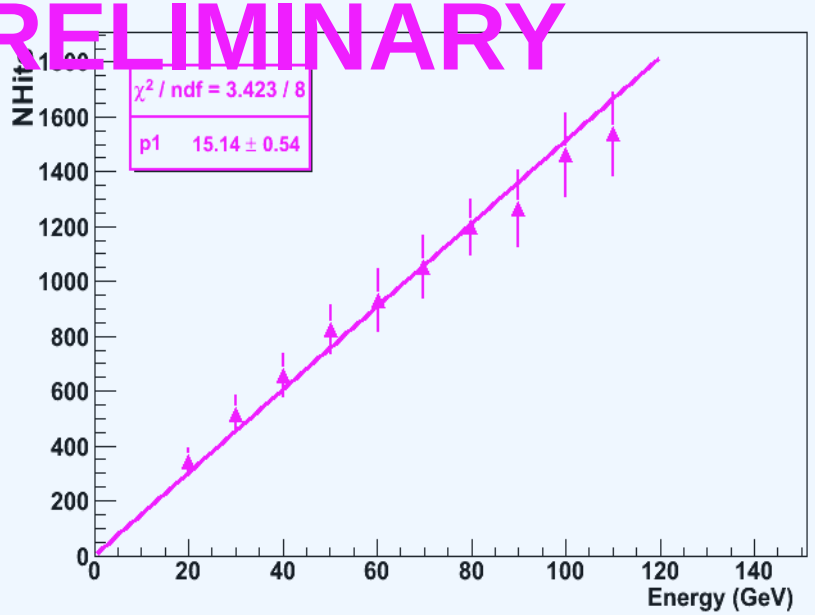
Black: Average Parameters

LINEARITY

VERY PRELIMINARY



LEFT FIT

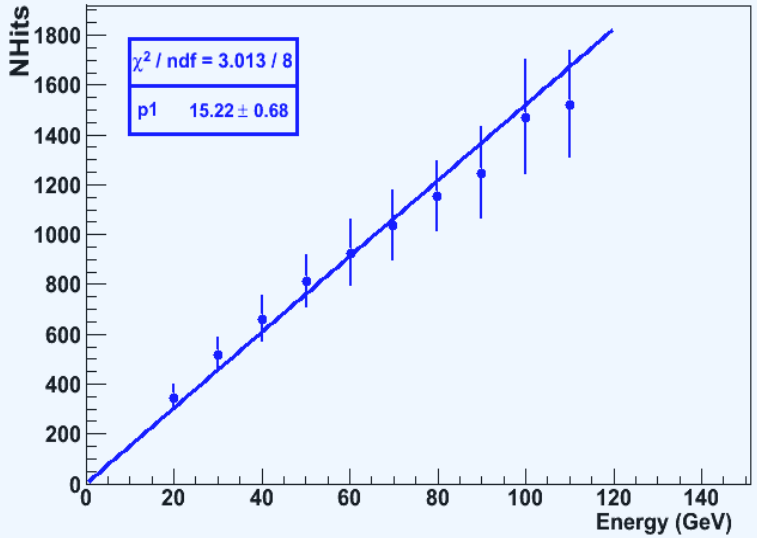


RIGHT FIT

Linearity for for each fit are represented in these plots.

The error bars in the plots corresponds To the sigma of the fit.

It can be seen, the mean value increases when energy is rising.

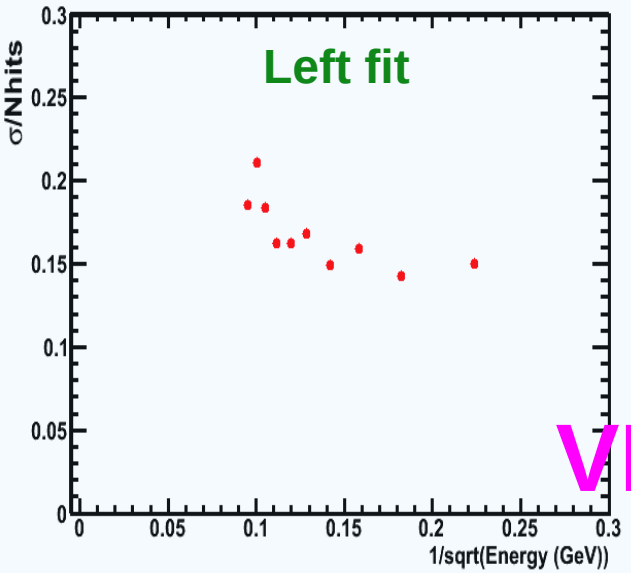


AVERAGE VALUES

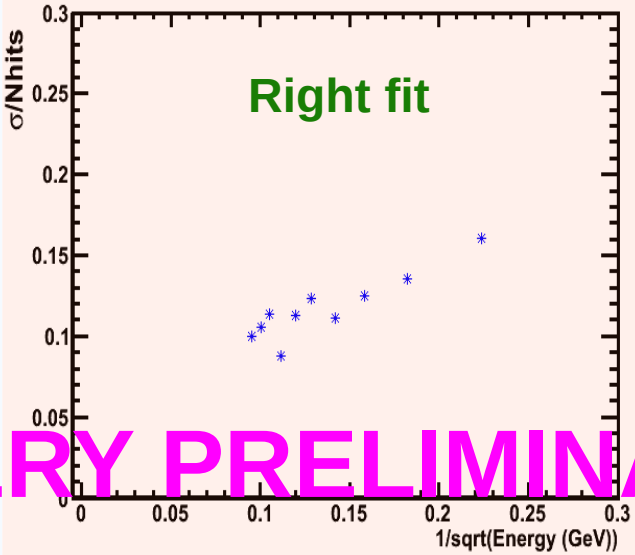
ENERGY RESOLUTION

Energy resolution was calculated for each fit.

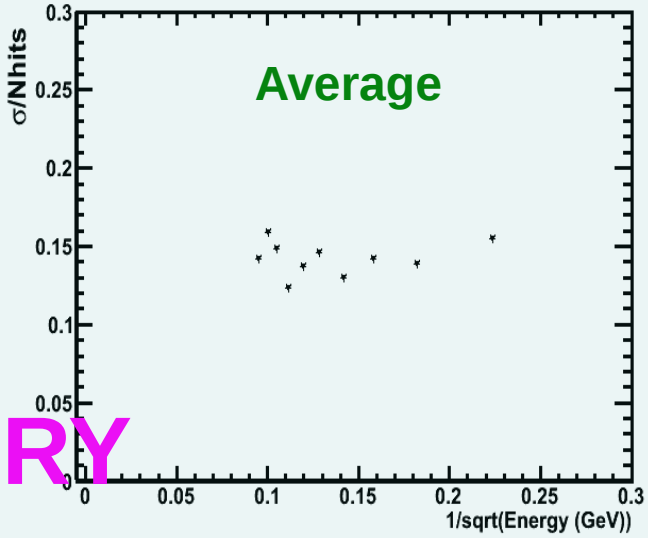
Energy Resolution for any thrshold hits is plotted as **σ/NHits vs 1/sqrt(E).**



For the left fit the resolution goes from around 15% at low energies to ~20% for high energies.



For the right fit a straight linear trend is obtained.
Resolution is better at high energies than at low energies.

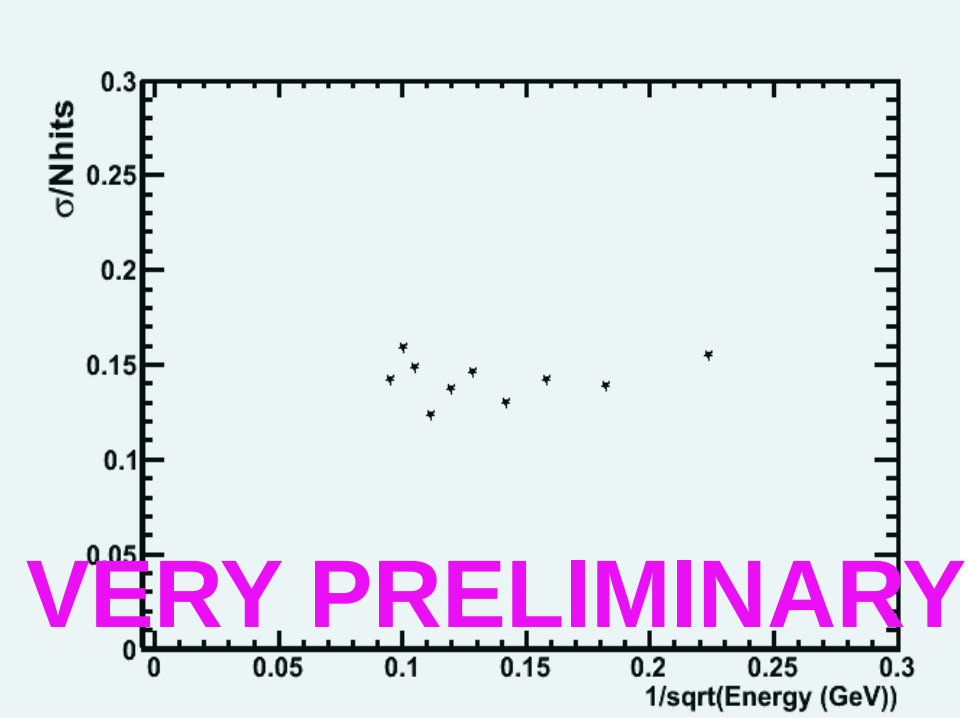


For the average, the resolution is almost flat ~15%.

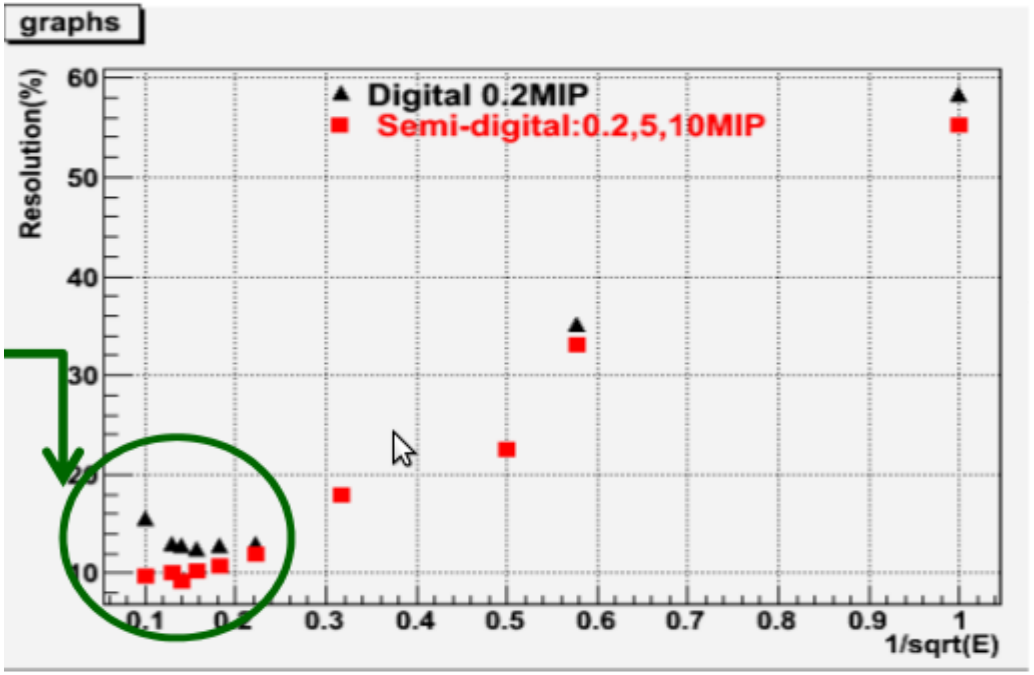
VERY PRELIMINARY

ENERGY RESOLUTION (II)

In the resolution plots of the previous slide, we can observe saturation effects at high energies.
We can compare the average resolution plot with the resolution plot obtained with simulations.



VERY PRELIMINARY



Zone which should be compared is **1/sqrt(E) < 0.2.**
In the simulation we can see a resolution arround 13% in this zone that increase with Energy. Allthough these results are very preliminary and need improvements, resolution obtained has a behaviour similar to the simulation.
We must still check the behavior for lower energies using the PS data.

SUMMARY

SemiDigital HCAL was tested in particle beams with different particle types and several energies at Cern between April and May of 2012 in two periods in PS and SPS areas.

This linearity and energy resolution results are a preliminary glimpse on SPS data.
Digital behaviour of the prototype has been tested
First results look promising, but further tests are required.

A non-gaussian behaviour of the energy resolution has been observed and it is being studied.

Next steps

Better understanding of our data.
We must complete this preliminary study with data taken in PS area.
Complete studies with electrons

Study the contributions of each threshold in order to get an improvement of the resolution and study of the device as a semi-digital calorimeter.
Try to do a better particle ID.