Test beam studies of the W-Si tracking calorimeter for the PHENIX forward upgrade

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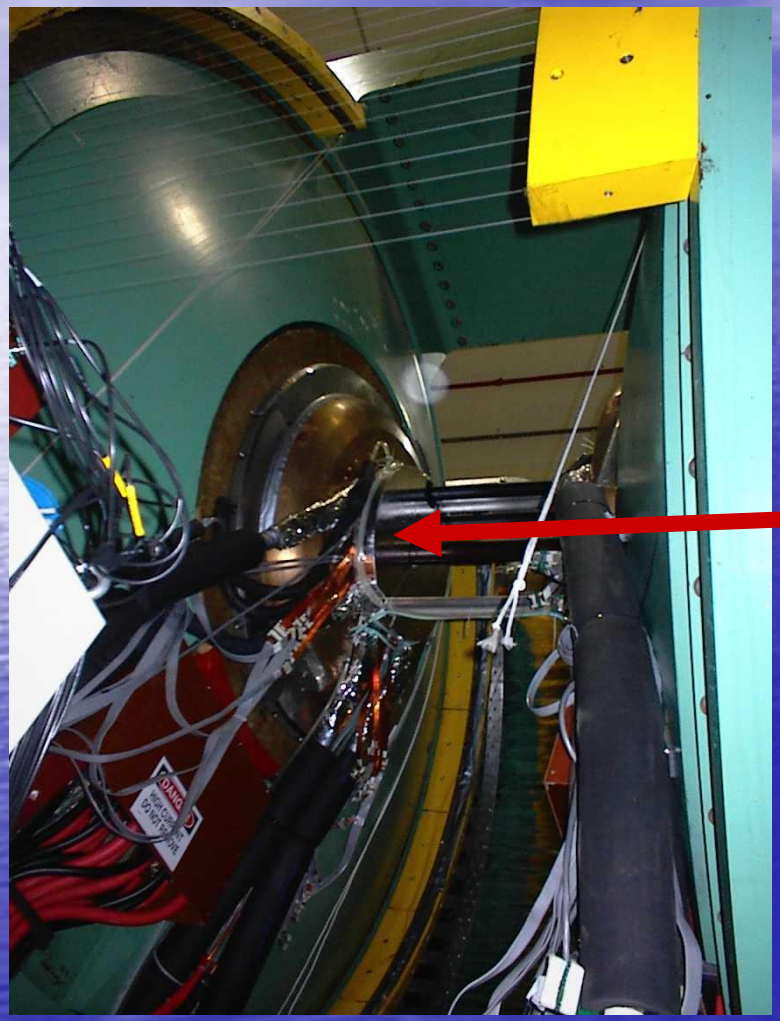
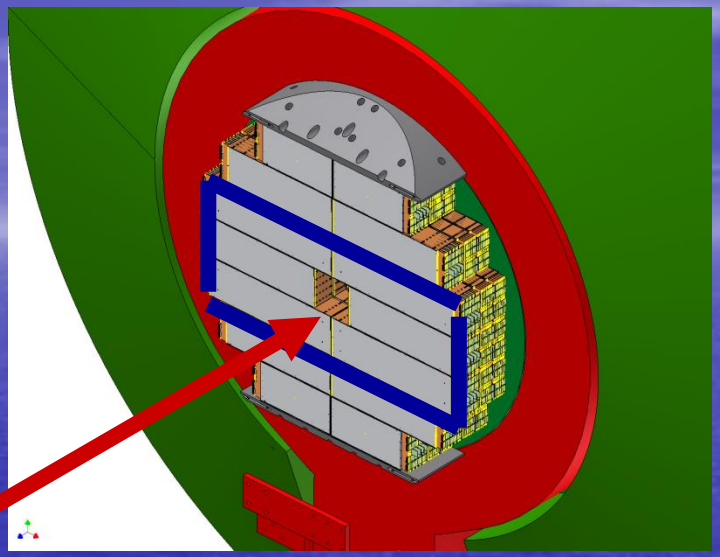
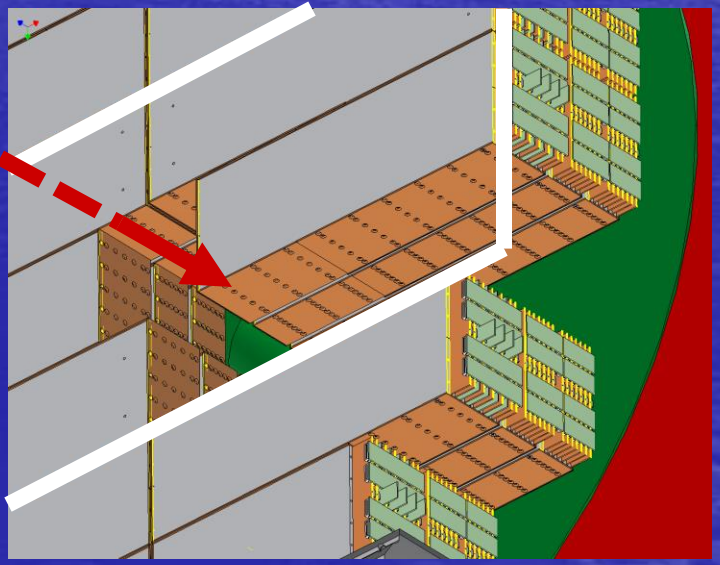
PHENIX forward upgrade in consideration



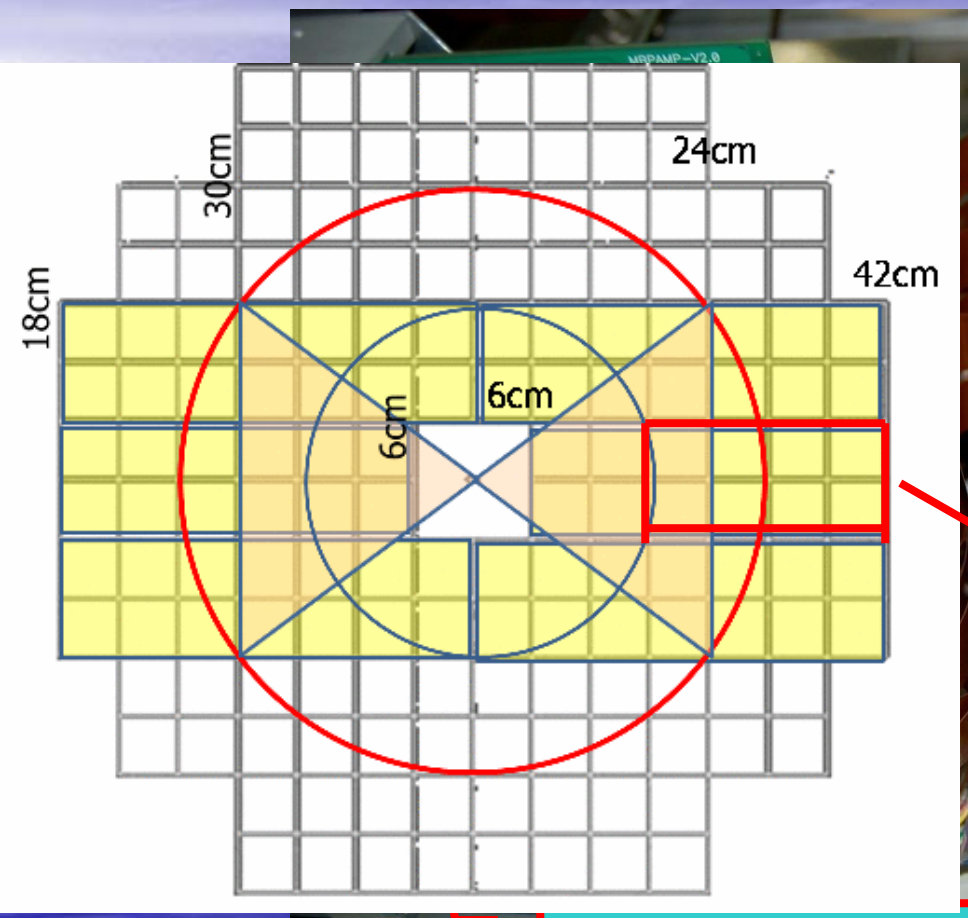


Beam



~ 44cm from the interaction point, η = 1.2-2.7

Calorimeter geometry & test setup



Beam

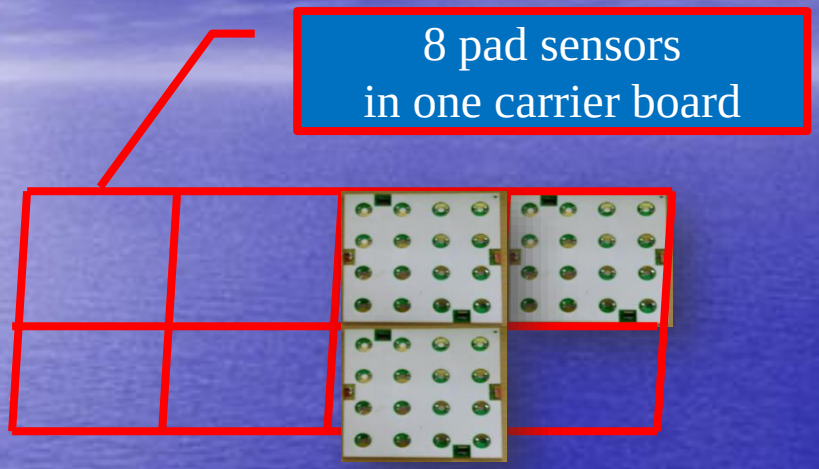
7 vertical channels grouped (cost issue)

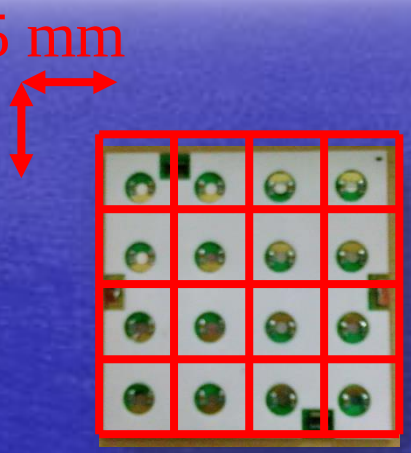
8 pad sensors in one carrier board

Preamp hybrid

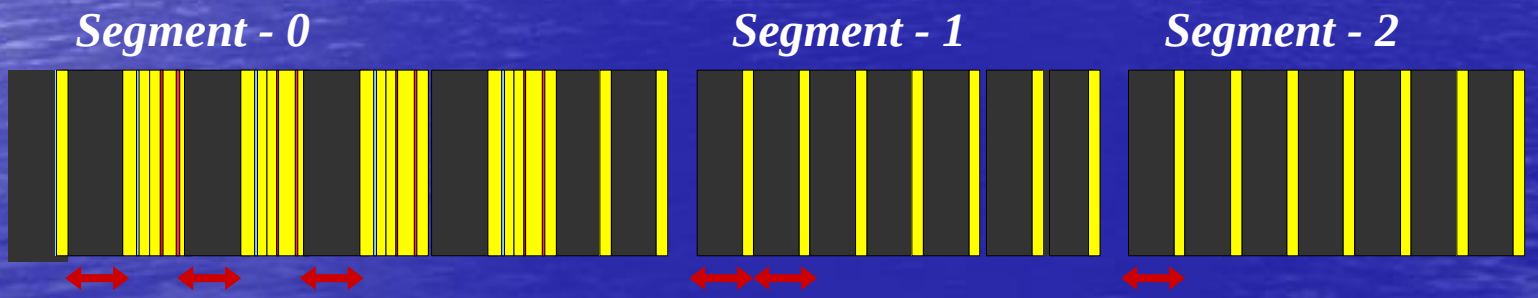
Schematics

Lateral

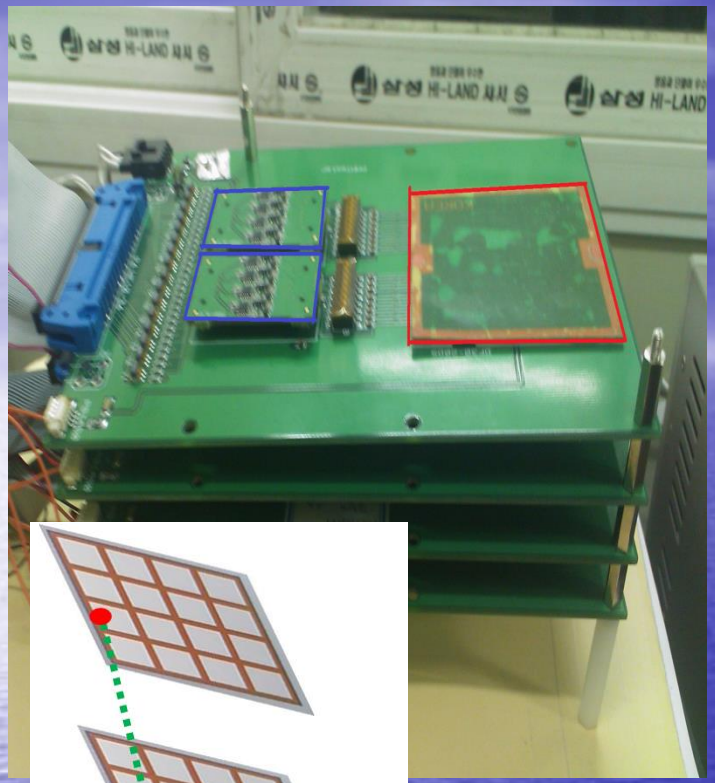


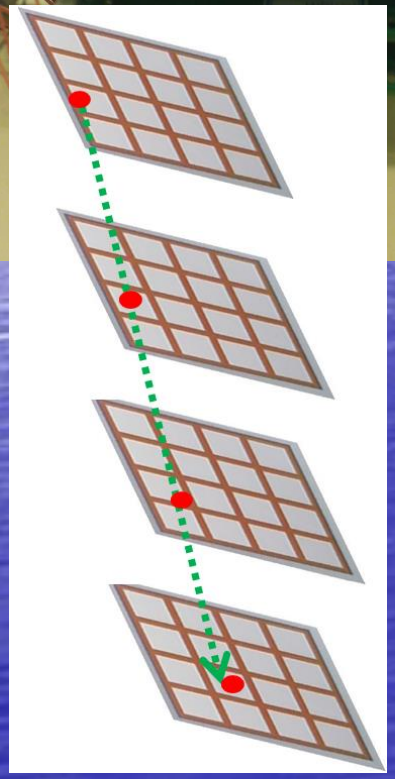


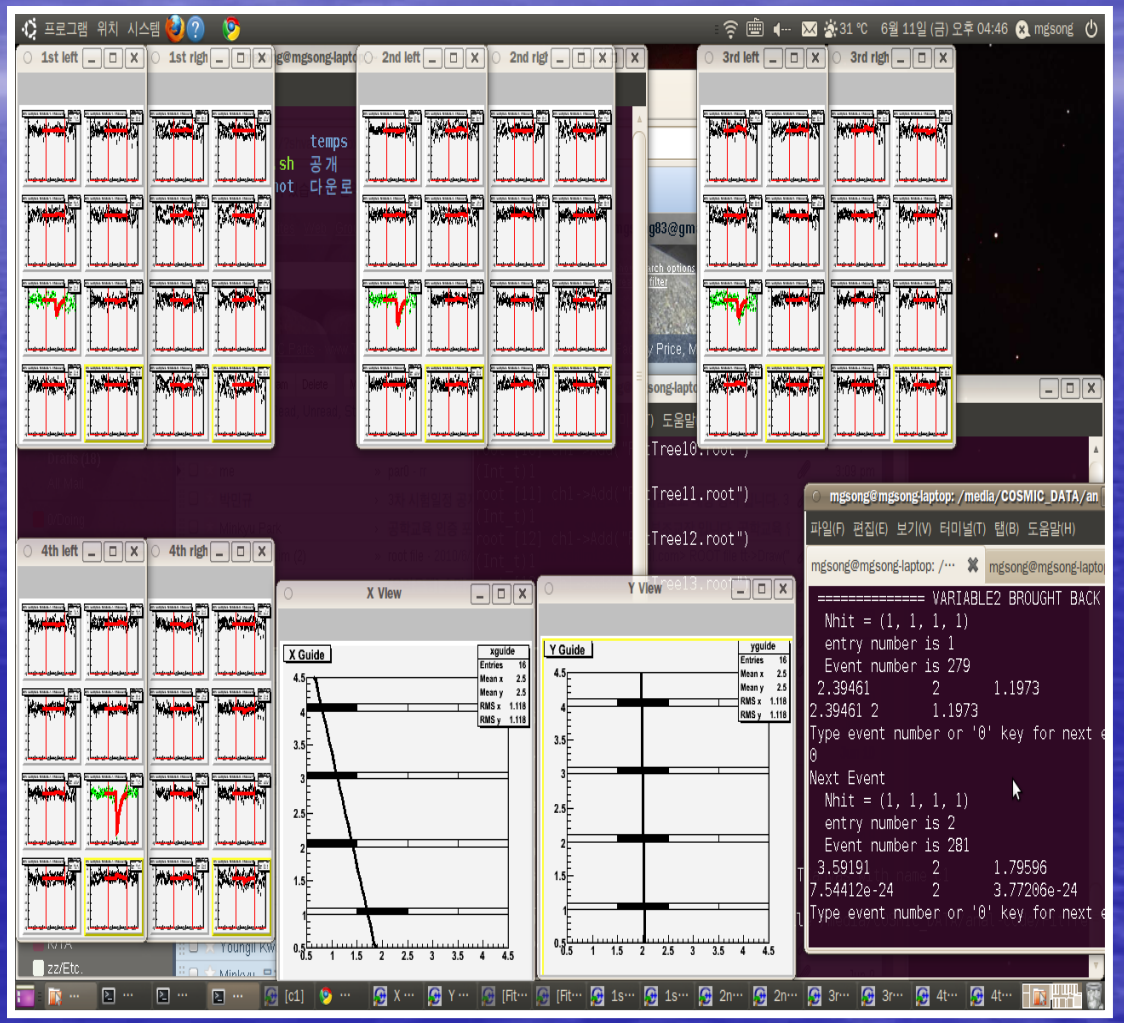
Longitudinal



Cosmic muon test

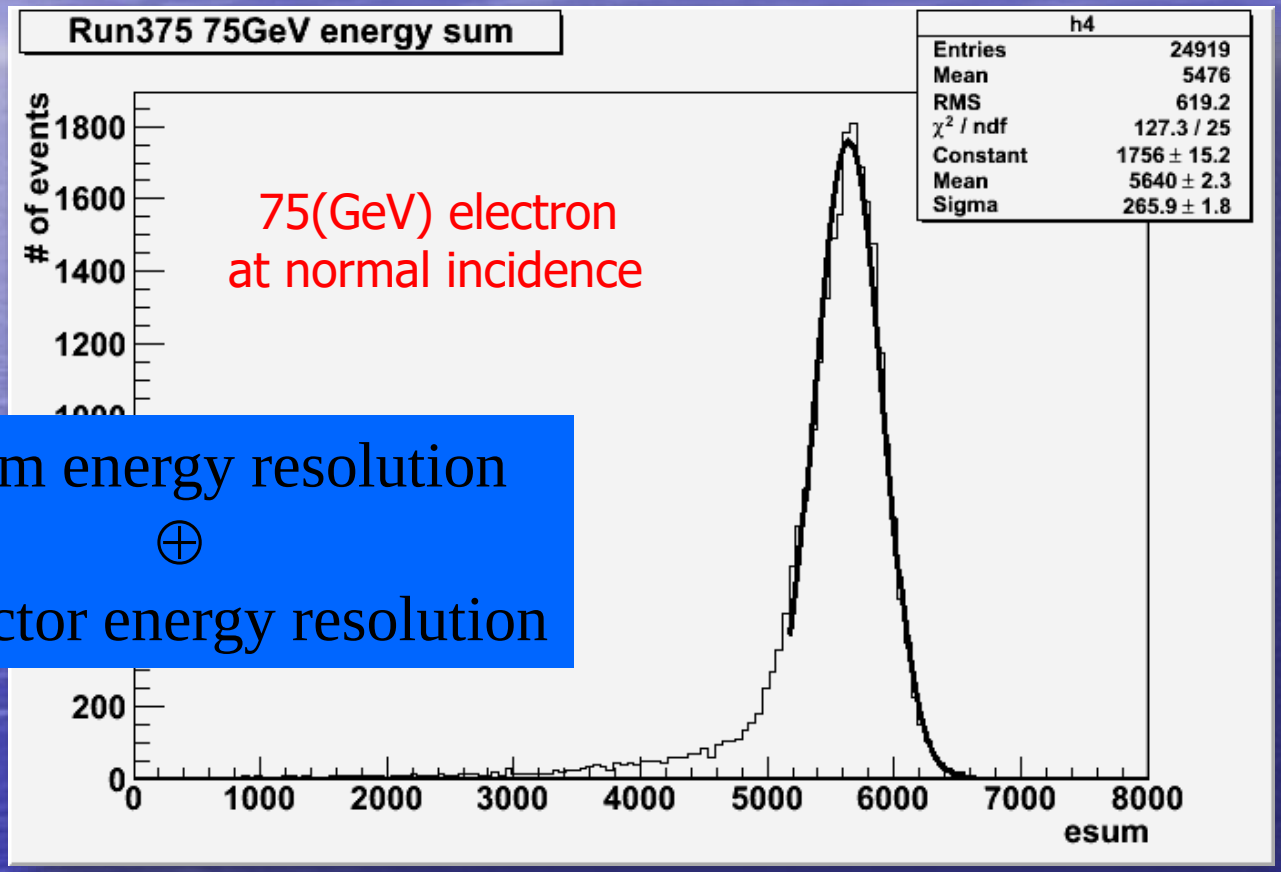






Test results

Energy distribution fits with Gaussian function (with highly suppressed low energy tail)



Beam energy resolution

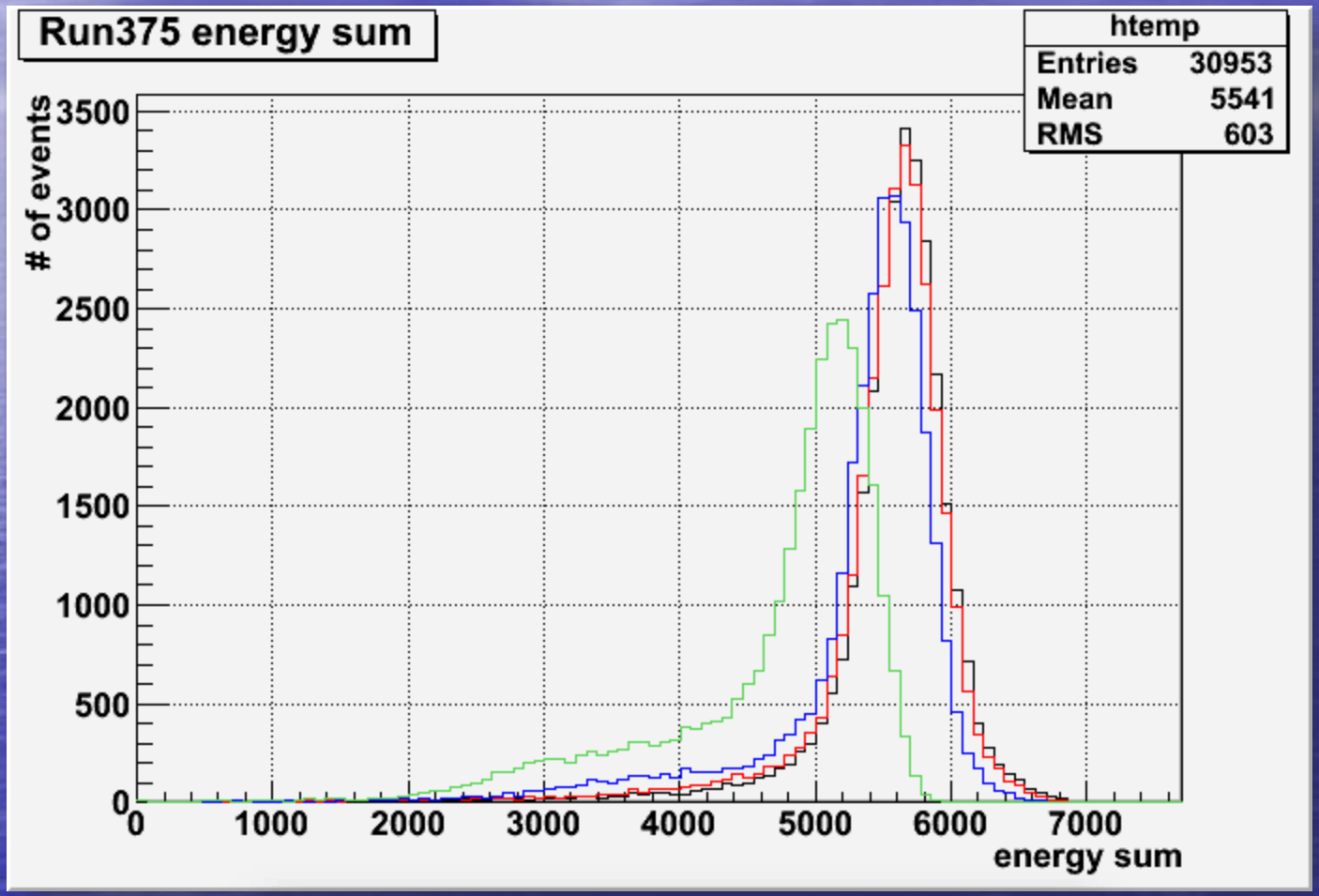
$\oplus$

Detector energy resolution

$$\frac{\sigma_{ADC}}{\langle ADC \rangle} = \frac{265.9}{5640} \cong 0.047$$

Limited energy sum and reconstructed energy

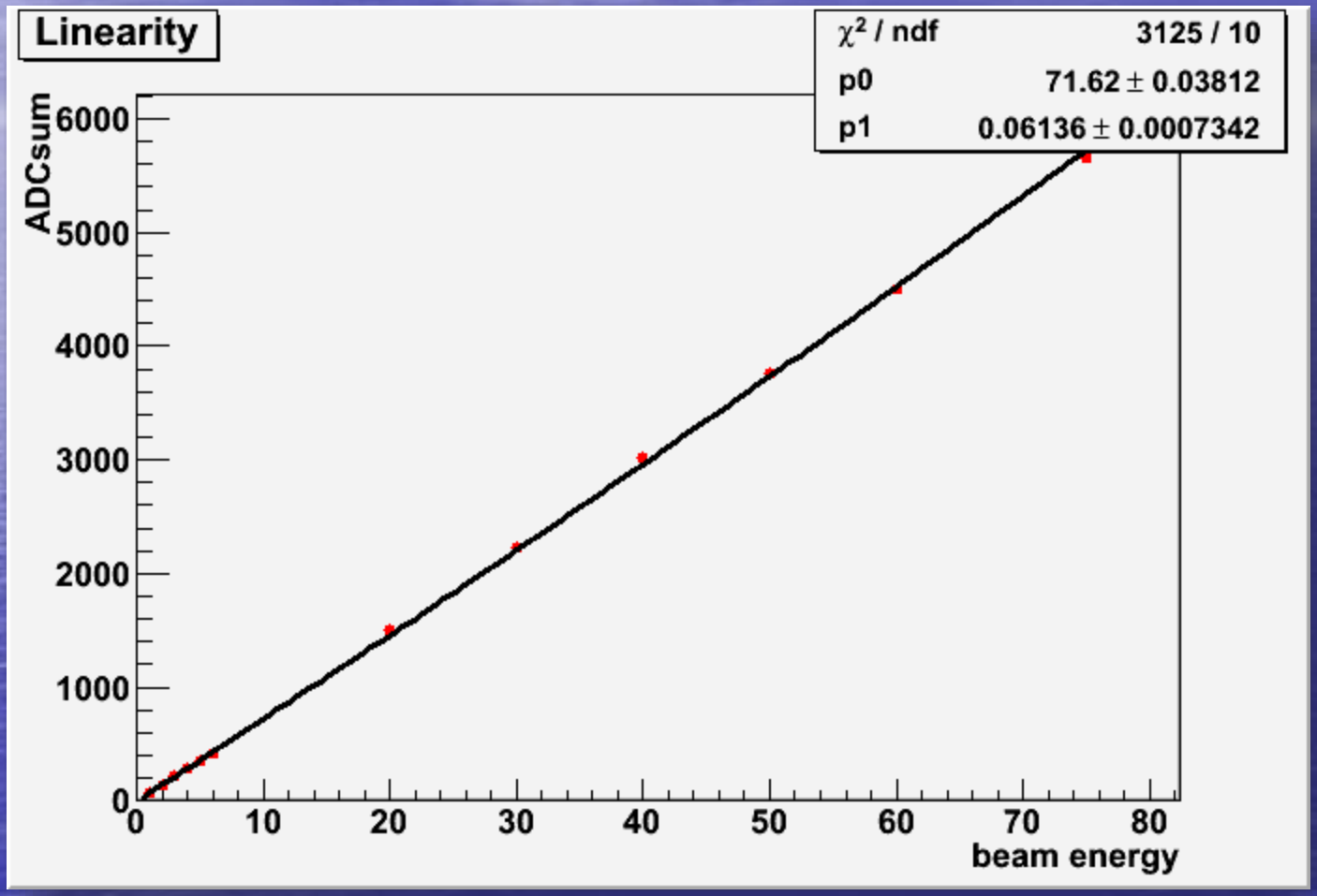
Energy sum over 3x3, 5x5, 7x7, all pad



E.M. Shower

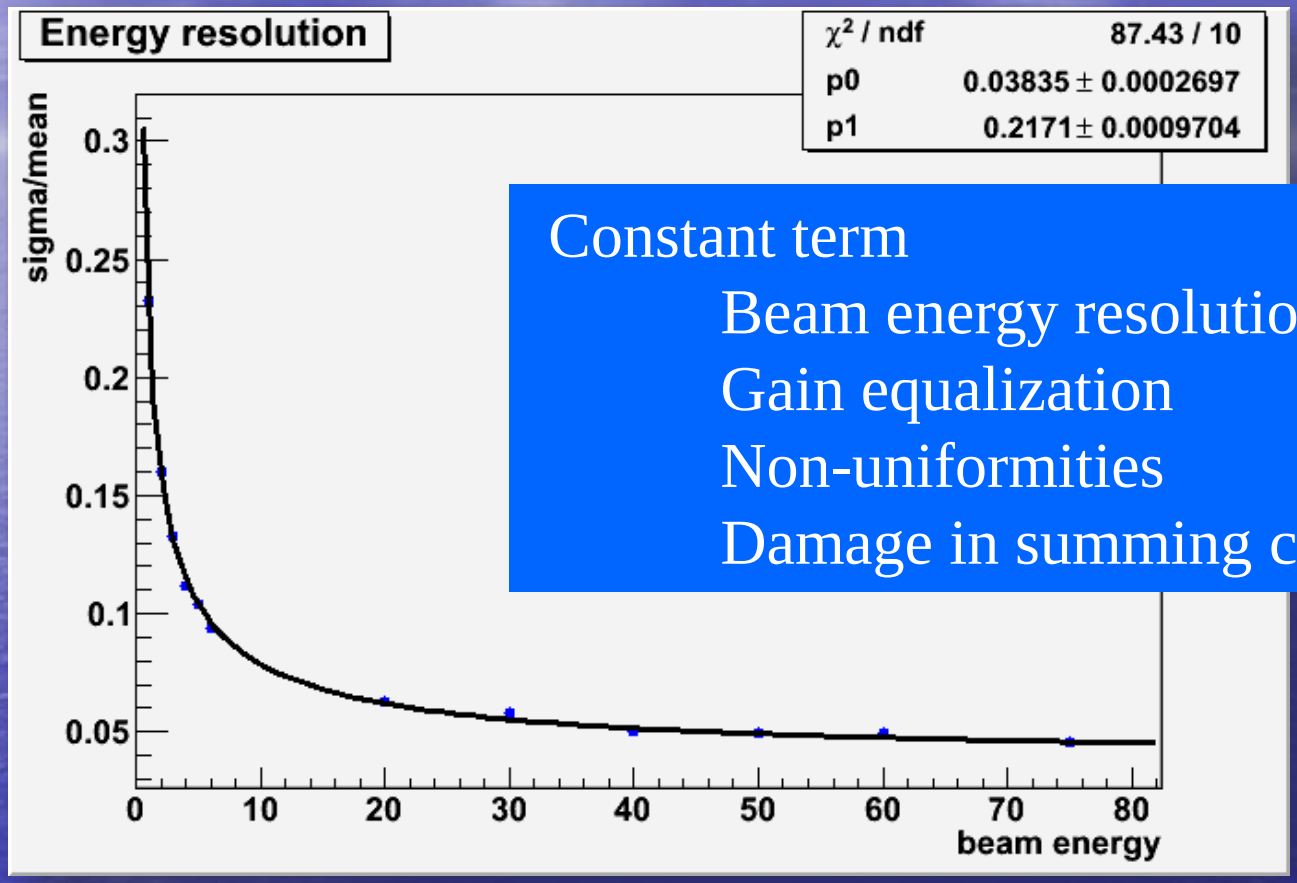
$E_{core} < 0.9\ E$, E_{core} : Energy within $\pm 1\ R_M \sim \pm 1$ pad

Linearity



$<ADC_{sum}> = p_0 \times E + p_1 \times E^2$, (Good beam, e)

σ(E)/E as a function of Energy



Constant term

- Beam energy resolution
- Gain equalization
- Non-uniformities
- Damage in summing cables

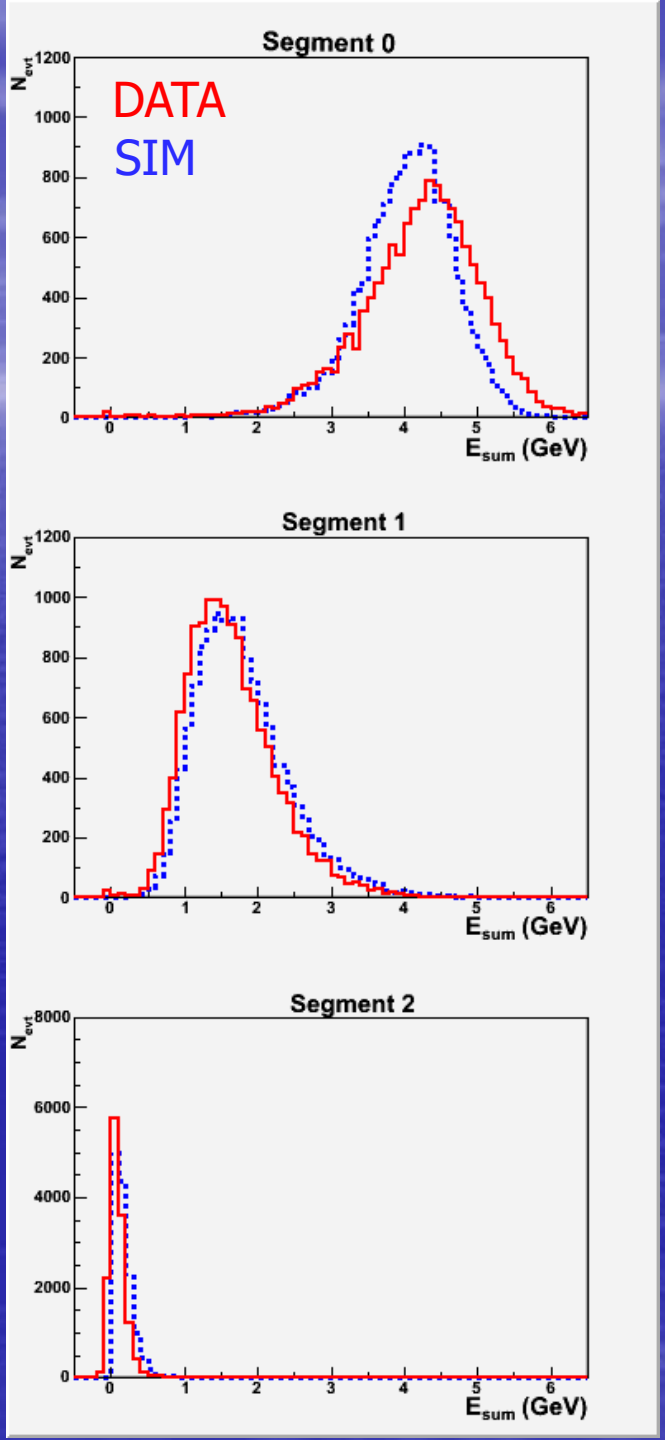
$$\frac{\sigma_E}{E} = p_0 \oplus \frac{p_1}{\sqrt{E}} = \sqrt{(p_0)^2 + \left(\frac{p_1}{\sqrt{E}}\right)^2}$$

Longitudinal energy deposition profile

6 GeV electron
at normal incidence

Largest energy in segment 0.

Very small energy deposition in segment 2.

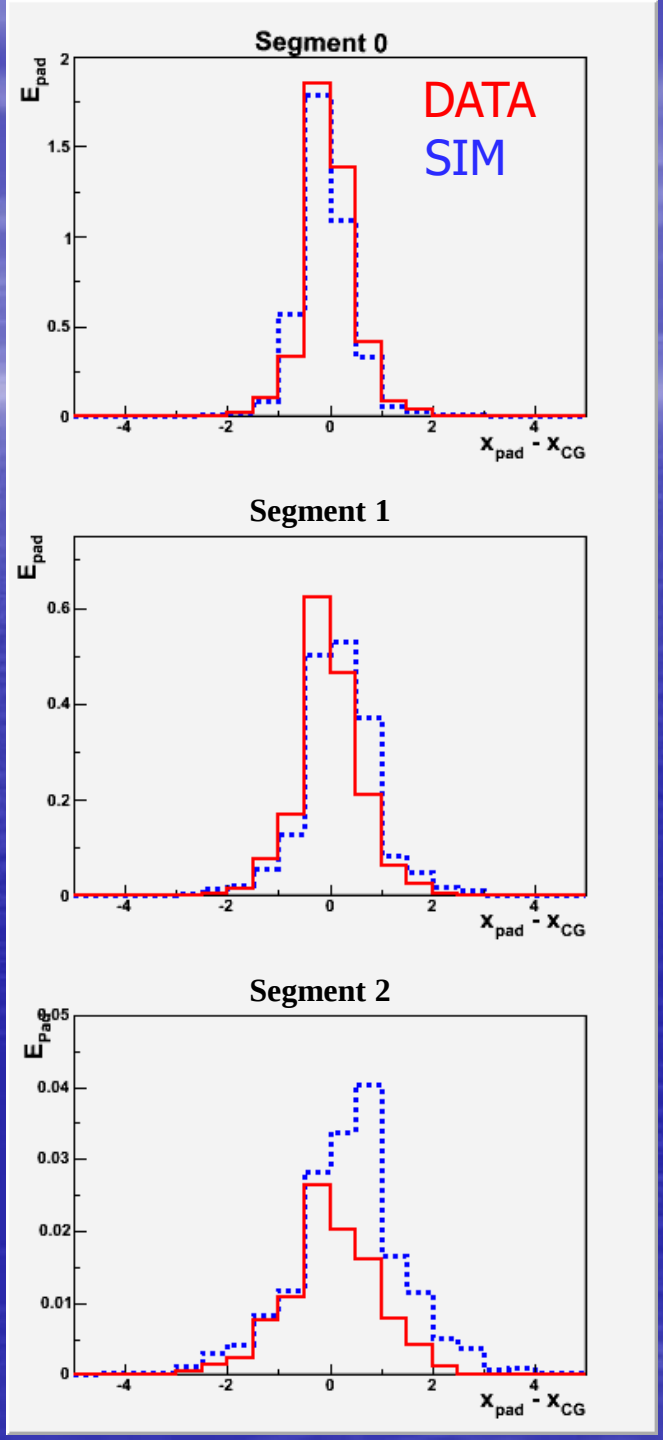


Lateral energy deposition profile

6 GeV electron

at normal incidence

- Good agreement in general (Note energy in segment 2 is about 1% of that in segment 0).

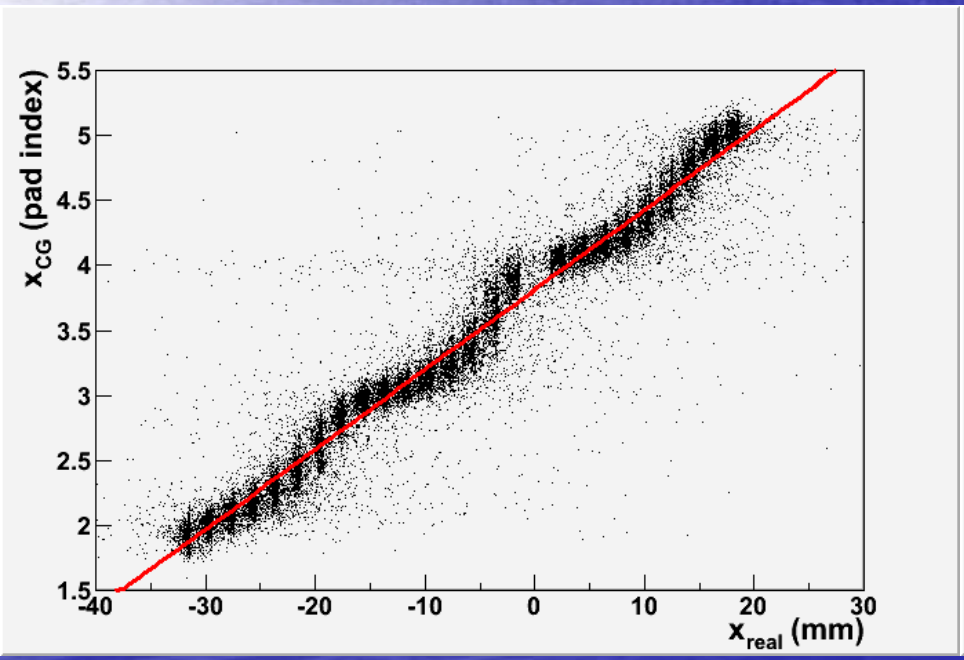


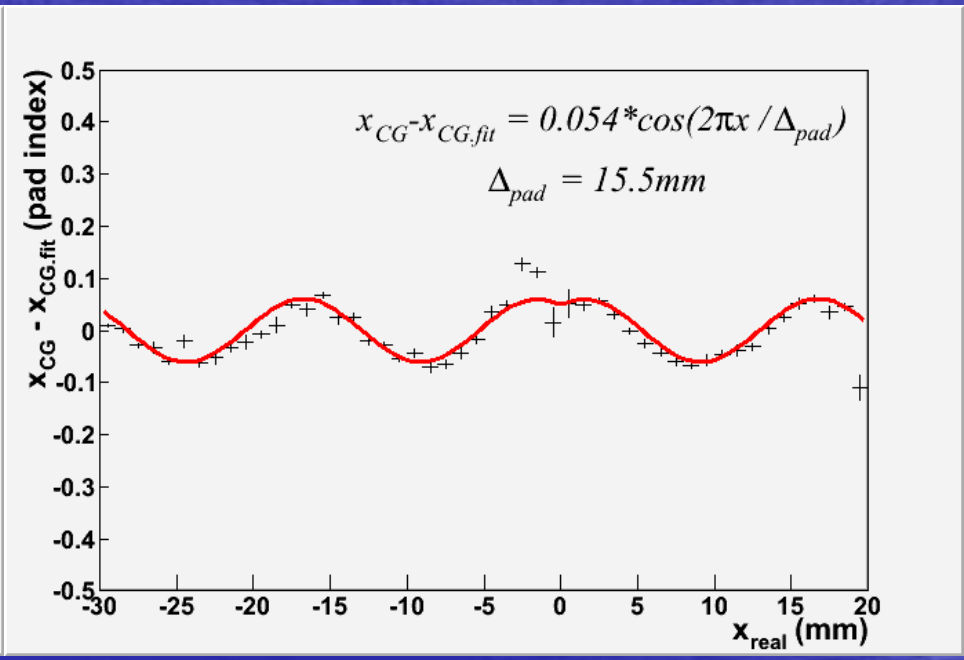
Real position vs. x_{CG} from Pad

x_{real} :

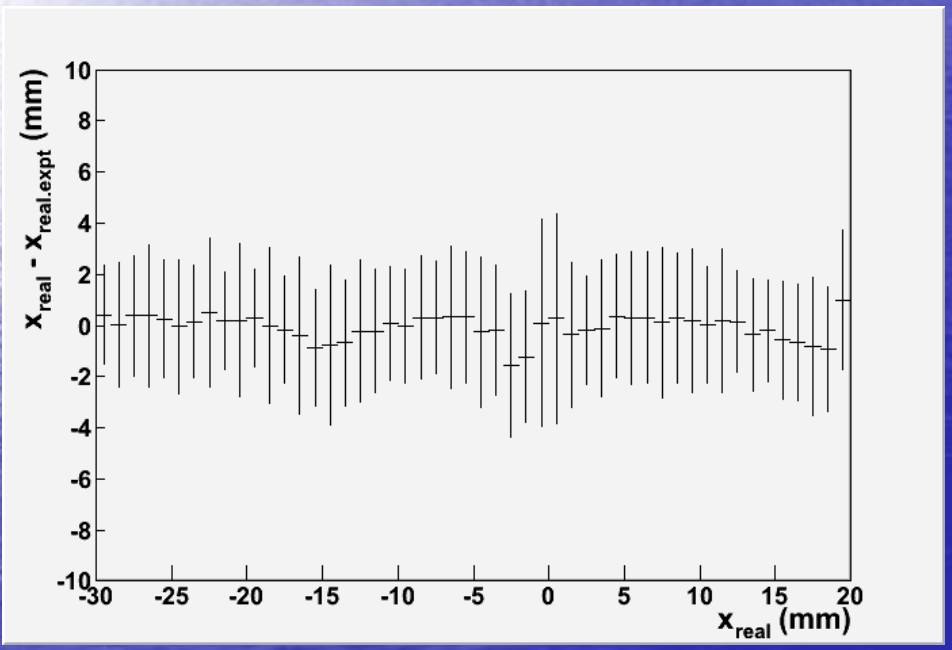
position of incidence,
front of segment 0.

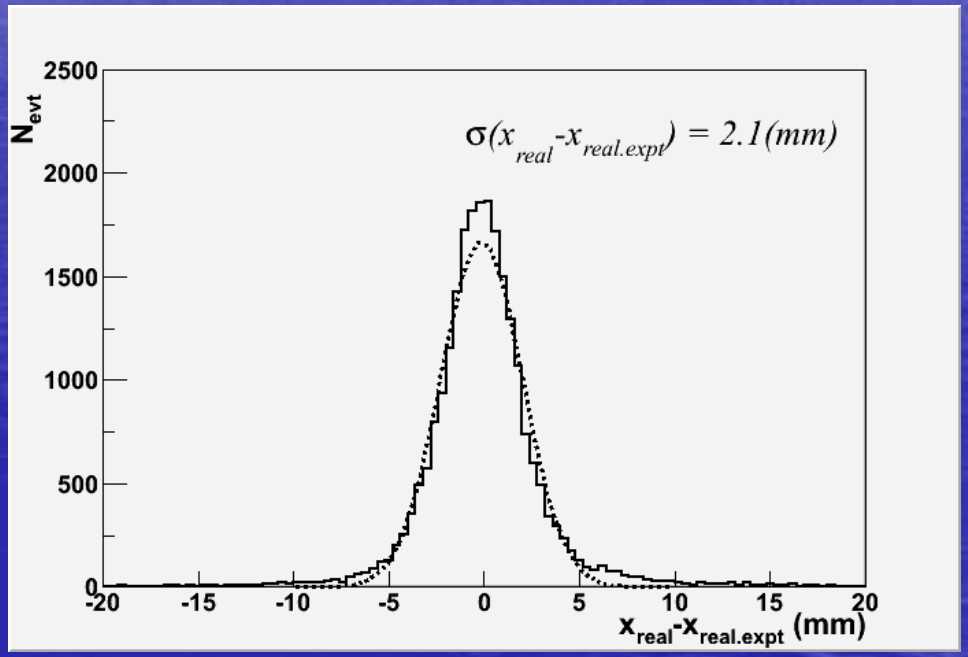
$$x_{CG} = \frac{\sum_i x_i E_i}{\sum_i E_i}$$





$x_{real\ expected}$ obtained from x_{CG} and previous result





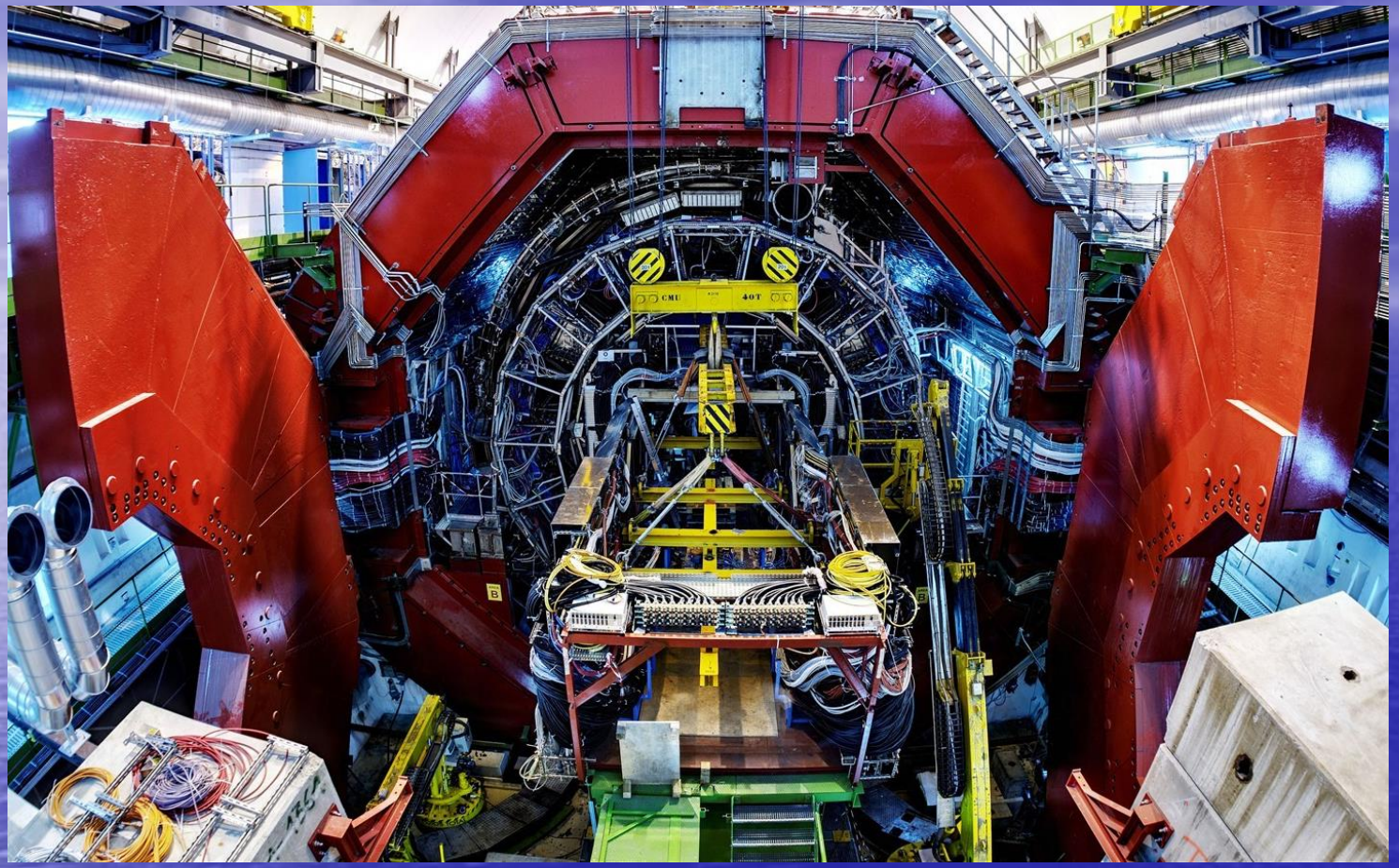
Summary

- Deposited energy distribution ~ Gaussian
- Lateral shower containment in 5 x 5 pads
- Good linearity
- Energy resolution for electron

$$\frac{\sigma_E}{E} = 0.038 \oplus \frac{0.22}{\sqrt{E}}$$

- Longitudinal/Lateral shower development : Good agreement with simulation
- Position resolution from pad : 2.1 mm

The detector performs as designed.

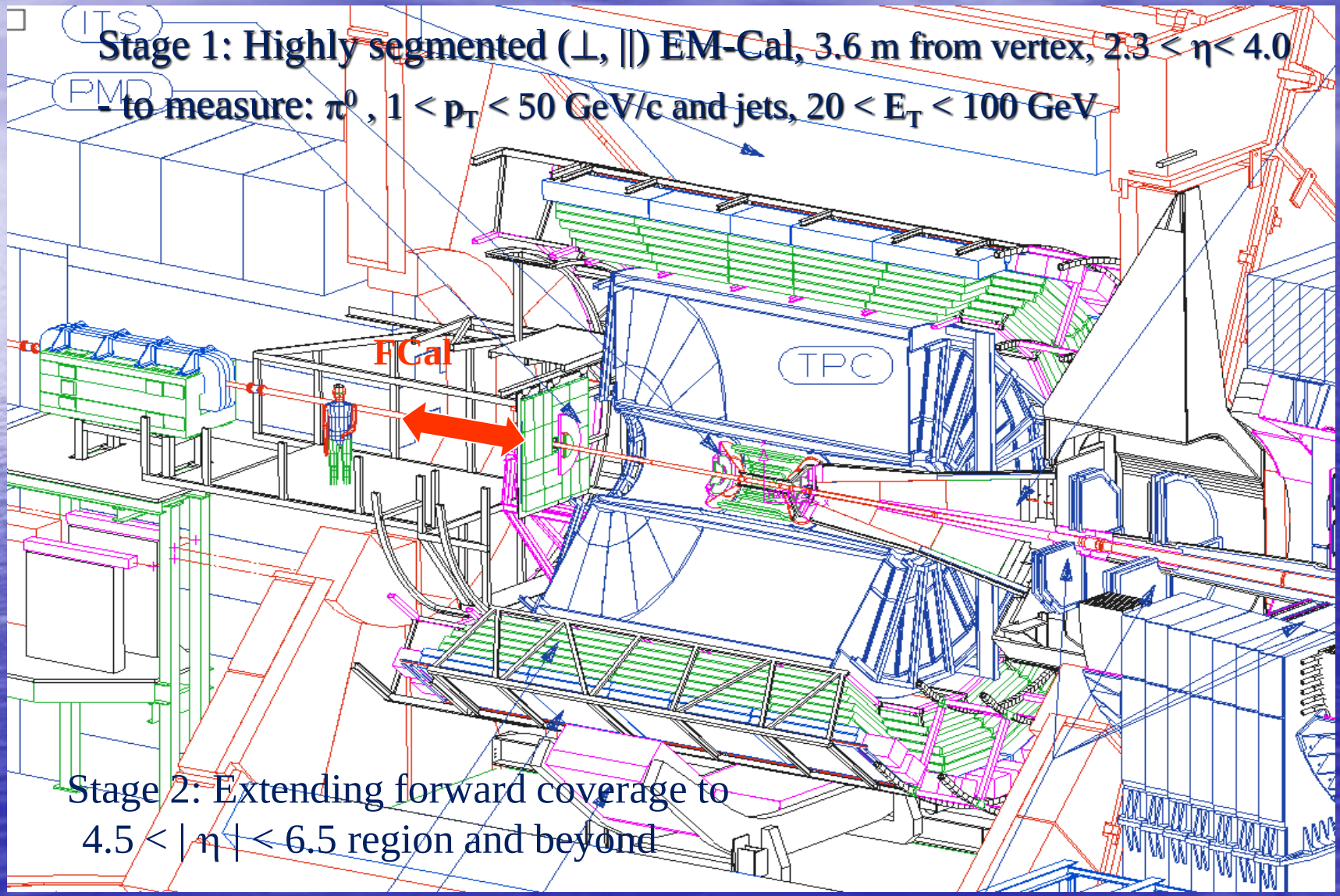


Beam test of a prototype Si/W calorimeter

Y. Kwon
(Yonsei Univ.)

ALICE upgrade workshop, Mar. 2011

ALICE Forward Calorimeter Upgrade

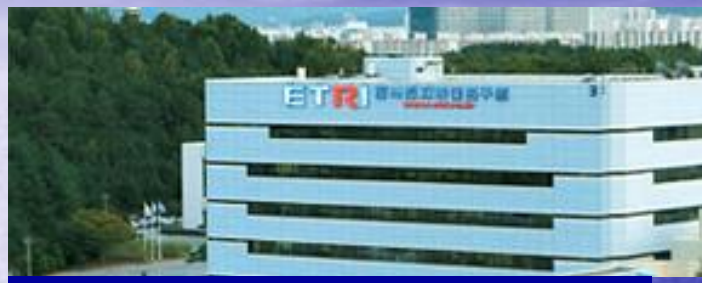


Stage 1: Highly segmented (⊥, ||) EM-Cal, 3.6 m from vertex, $2.3 < \eta < 4.0$

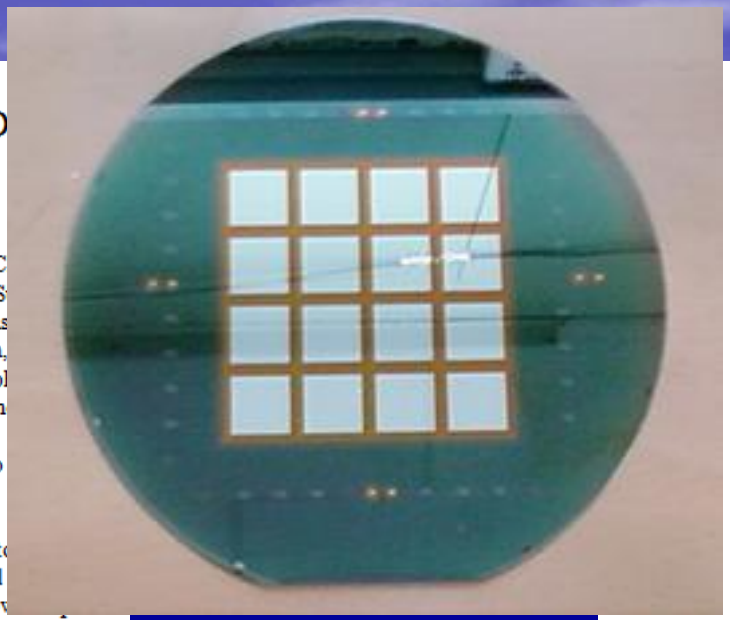
- to measure: π^0 , $1 < p_T < 50$ GeV/c and jets, $20 < E_T < 100$ GeV

Stage 2: Extending forward coverage to $4.5 < |\eta| < 6.5$ region and beyond

R&D environment



6 inch fabrication line



300 cm^2 ~ $ 500

8 inch fabrication line

MEMORAND

(1) Youngil Kwon, Mann-Ho C
(2) Edward Kistenev, Andrey S
(3) John Lajoie, Physics and As
(4) Yongsun Yoon, BT division,
(5) Kwun-bum Chung, Elecropl
(6) Zheng Li, SDDPL, Instrum

(7) Jinsoo Kim, National Nano

I. Purpose & Scope

The purpose of this MOU is t
the '**Radiation damage and**
planning to contribute their ov
studies. This MOU clarifies the areas of pa rties will
collaborate by sharing their expertise and se ticipating
parties for the stated academic goal.

II. Responsibilities Under this MOU

A. Dr. E. Kistenev, and Prof. J. Lajoie, and Prof. Y. Kwon will propose silicon semiconductor detectors/devices to achieve academic goals in their field of interest in the experimental nuclear and high energy physics.

B. Dr. Z. Li will design the proposed silicon semiconductor detectors/devices using standards approved by industry for large area radiation hard Si devices and will advice on the radiation induced defects in Si devices.

C. Dr. A. Sukhanov will advice on the electronic design and implementation of the readout electronics for silicon semiconductor device testing.

D. Dr. Yoon will inspect designs of the proposed detectors/devices and advise on matching design ideas to fabrication technologies. He will also perform his own radiation hardness testing of the devices he develops.

E. Prof. M.-H. Cho, Prof. G. T. Park, and Prof. K. B. Chung will advise on possible defects in silicon sensors/devices and will study radiation defects in the produced sensors/devices exposed to different kinds of radiation.

F. Mr. Kim, leader of nano patterning process team in National Nanofab Center, will assist in fabrication of the silicon sensors/devices with university discount program and consult on details of silicon detector/device fabrication process.

Outlook

- STRIPAD development with BNL utilizing Korean fabrication facility
  - Continue the journey towards the tracking calorimetry (π^0)
  - Collaboration with PHENIX and BNL
  - ALICE FOCAL?
  - Continue the journey started with Prof. Shim