Preliminary results from HERA-B modules test beam at SLAC

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SBS Collaboration meeting – 08/21/2013

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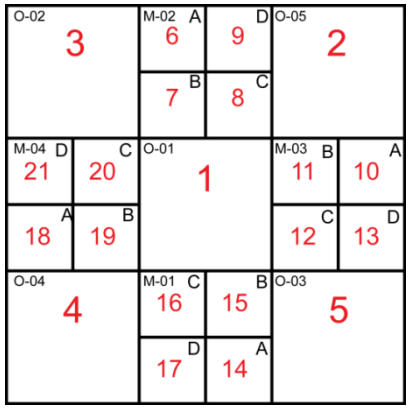
Description of the modules

- HERA-B modules are sampling calorimeter of shakshlik kind.
- Middle and outer ECal modules have the same cross-section, 11.5x11.5 cm^2 . The length is of 34 cm ($20X_0$)
- Middle sections are divided in 4 sections, outer consists in only one section
- 10 modules were brought from DESY november 2012 (SBS Collaboration Meeting – February 6^{th} 2013)

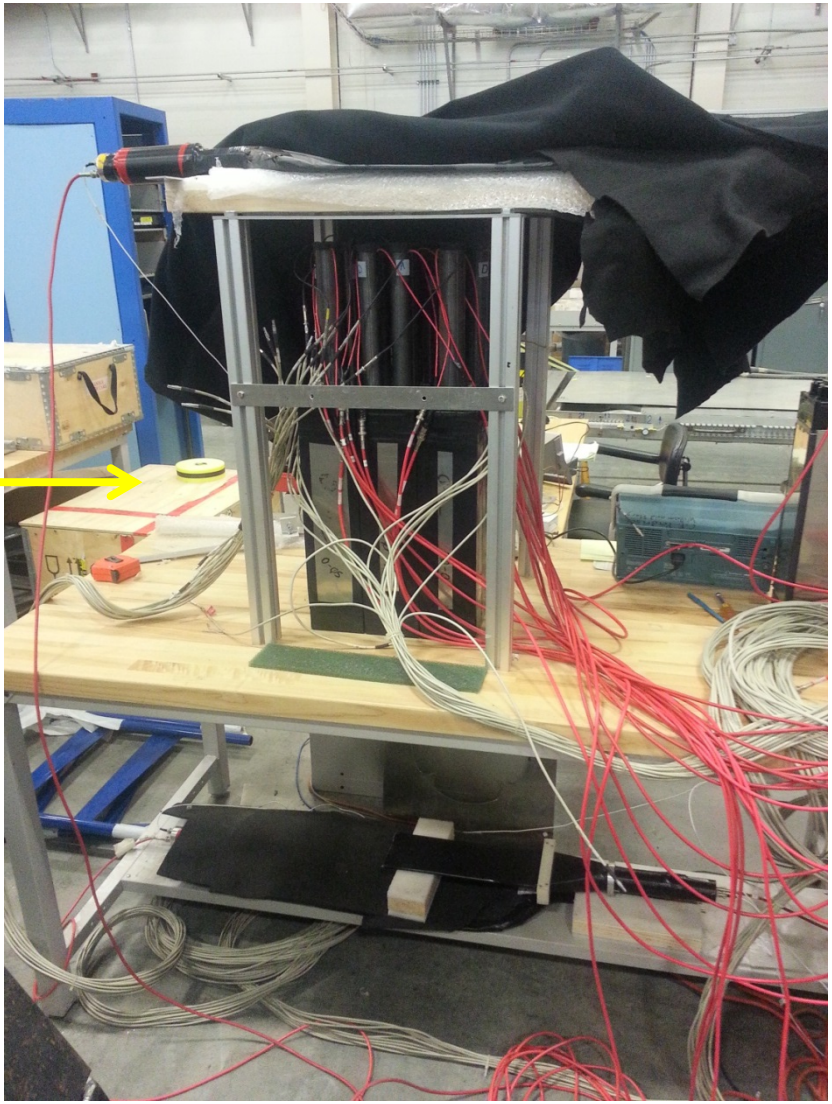
Cosmic rays test

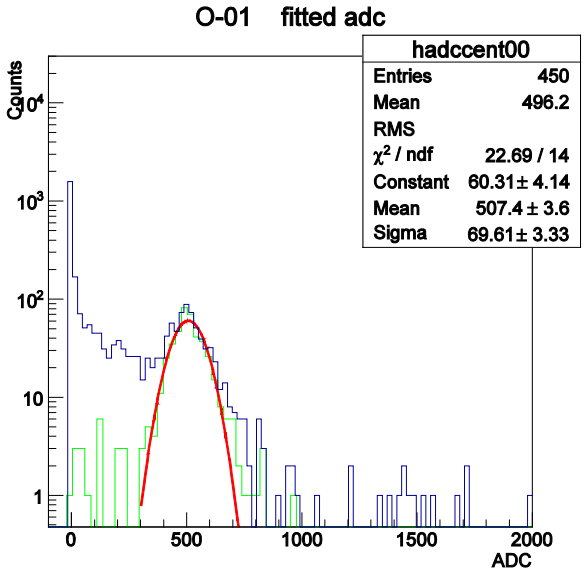
One scintillator 12’’x6’’ paddle on top

Arrangement of the modules

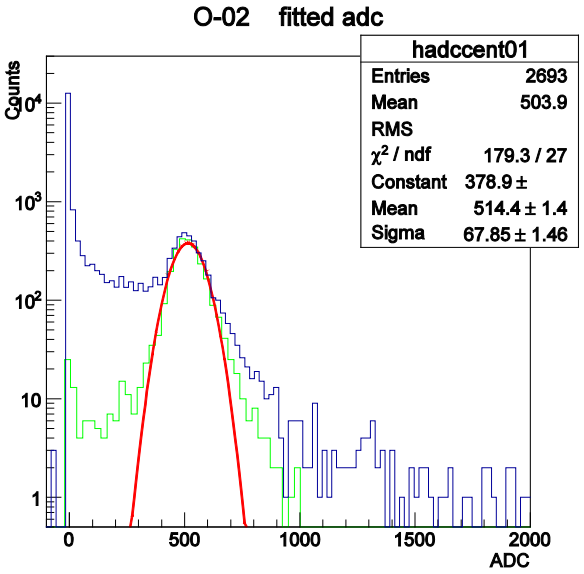


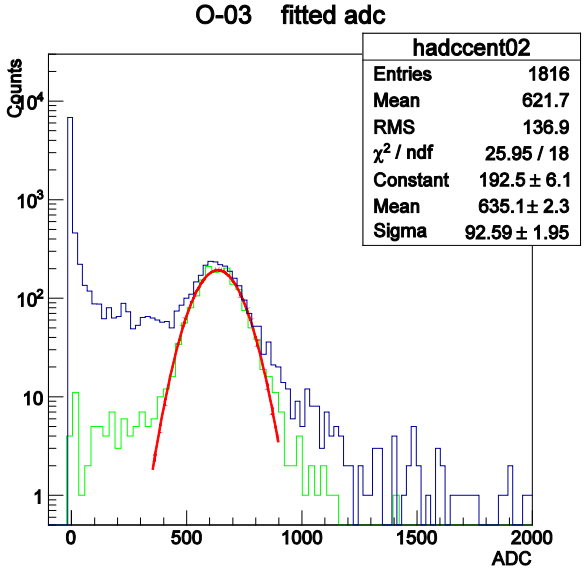
One scintillator 12’’x6’’ on bottom

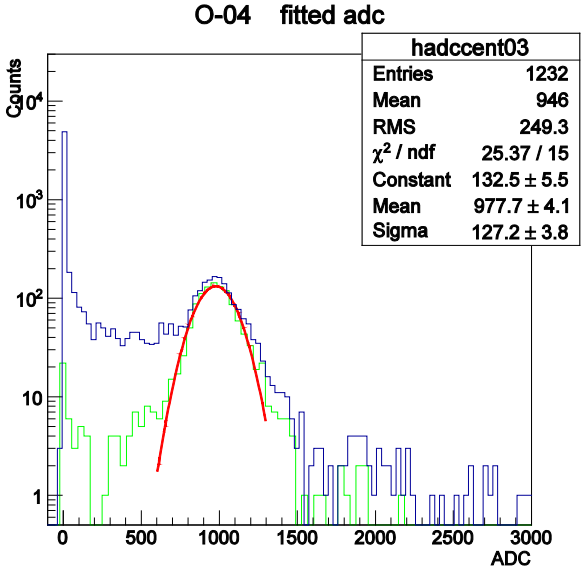


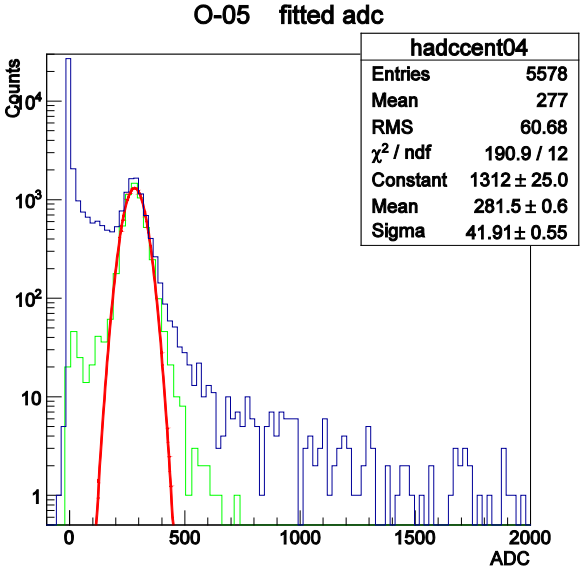


Spectra of the outer modules. Blue line the raw spectra, the green line is the spectra requesting single hit to modules. From a Poissonian approach, the number of phe is estimated





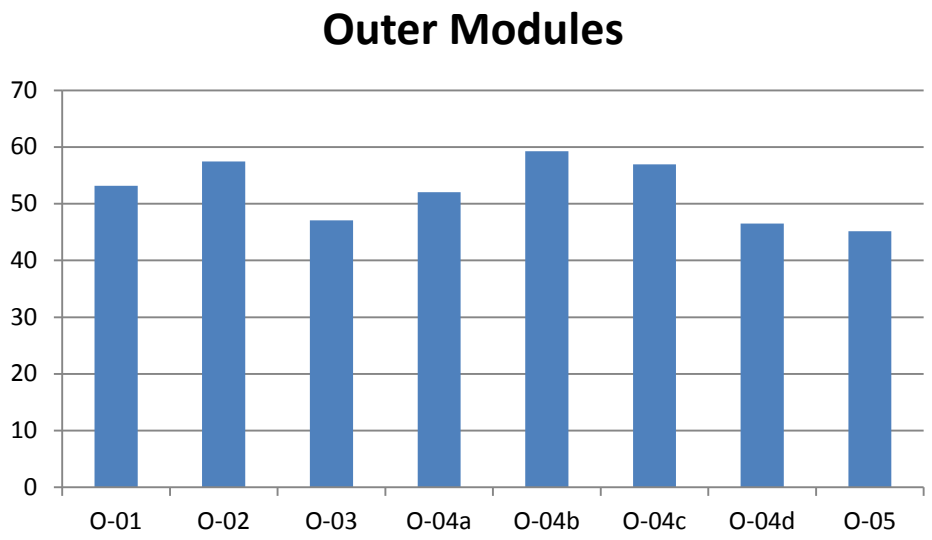




Cosmic rays test

Considering muons as mips at surface (~4GeV) the estimated energy deposited in the modules is ~50MeV ($20X_0$)

From outer modules the number of photoelectrons is between 1130-1480 phe/GeV. HERA-B reported 1300 phe/GeV



Middle modules were tested, but their results are not well understood. Since our interest lays in the outer modules, further studies and analysis had been delayed.

Objectives of the SLAC test

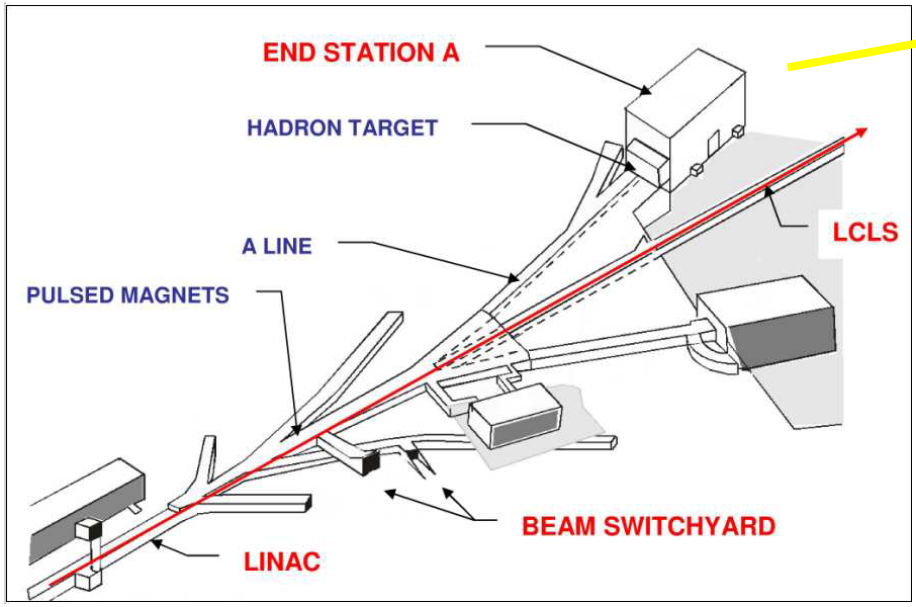
Cosmic rays test had shown that the outer modules where in good condition, but further studies were not suitable with such set-up.

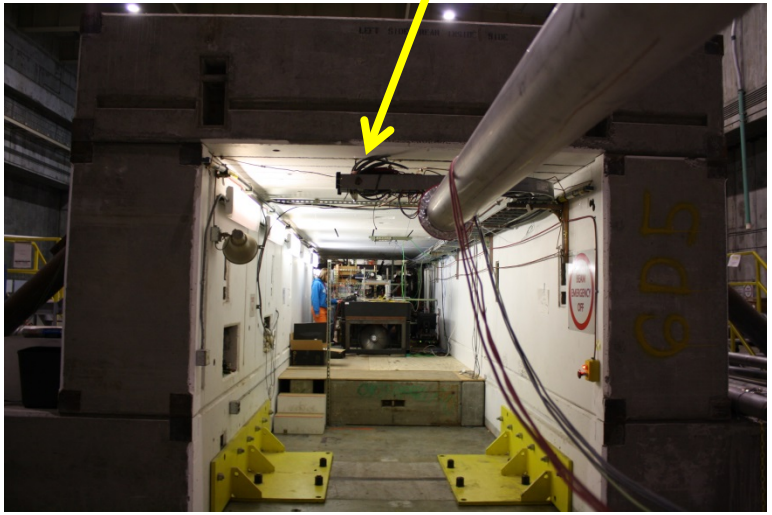
The use of a well known position beam/particle which produces em shower, could improve our knowledge of the status and behavior of the modules (energy and position resolution).

Facility at SLAC

The End Station Test Beam (ESTB) located at the old End Station A (ESA) at SLAC.

We worked piggyback of LCLS



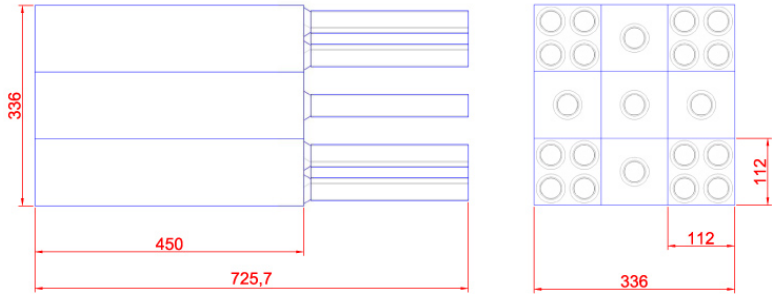


Facility at SLAC

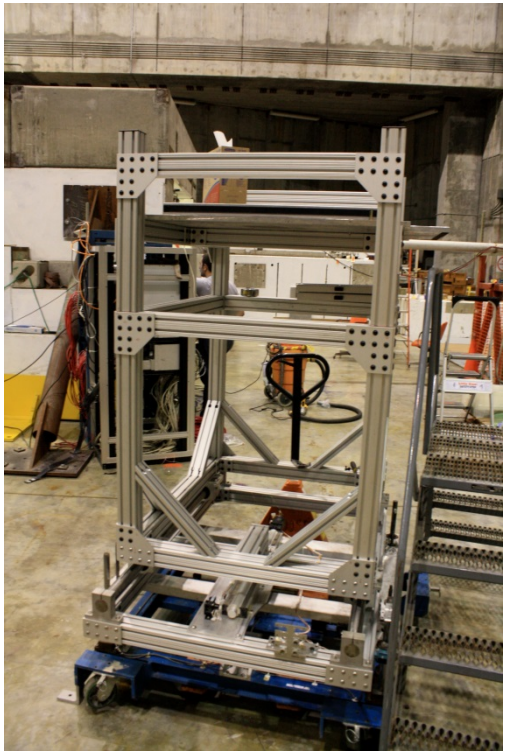
- ESTB beam
  - Kick the LCLS beam into ESA @ 5 Hz
  - Primary beam 2.5 -15 GeV
    - Determined by LCLS
    - < 1.5 x 10^9 e-/pulse = 250 pC
  - Clean secondary electrons
    - From 2 GeV to 15 GeV, 0.1/pulse to 10^9 e-/pulse
  - If LCLS experiments don't need full 120 Hz rate, the remaining beam is directed to ESTB, increasing the rate > 5 Hz
  - In our tests we used 3, 9 and 12 GeV.

Set-up

Arrangement of the modules



They were placed in a X-Y stage remotely controlled and over a rotational table (all made by SLAC technicians dedicated for our test)



Set-up

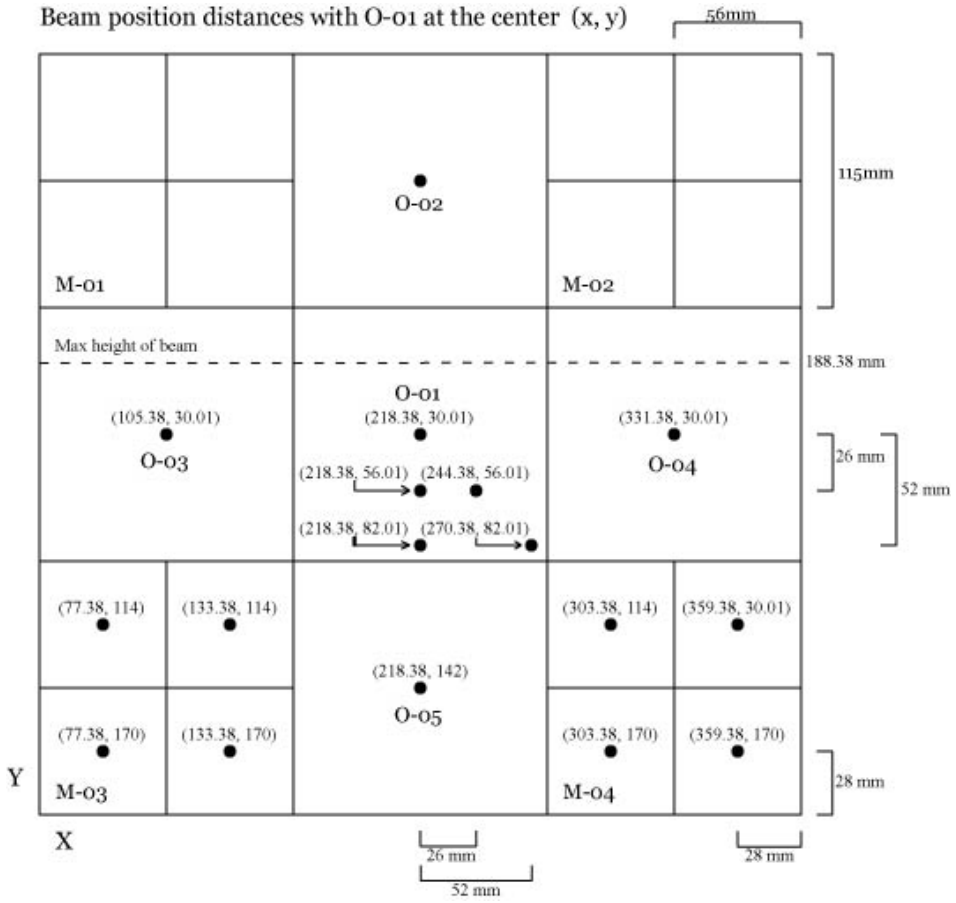
We used standard DAQ equipment taken from JLab.

- VME ADC
- VME TDC (no used)
- Logic NIM modules

TDC was planned to use with a scintillator fiber hodoscope designed by M. Burton. It showed many problems related with noise, calibration and a broken PMT at SLAC, so its use was discharged.

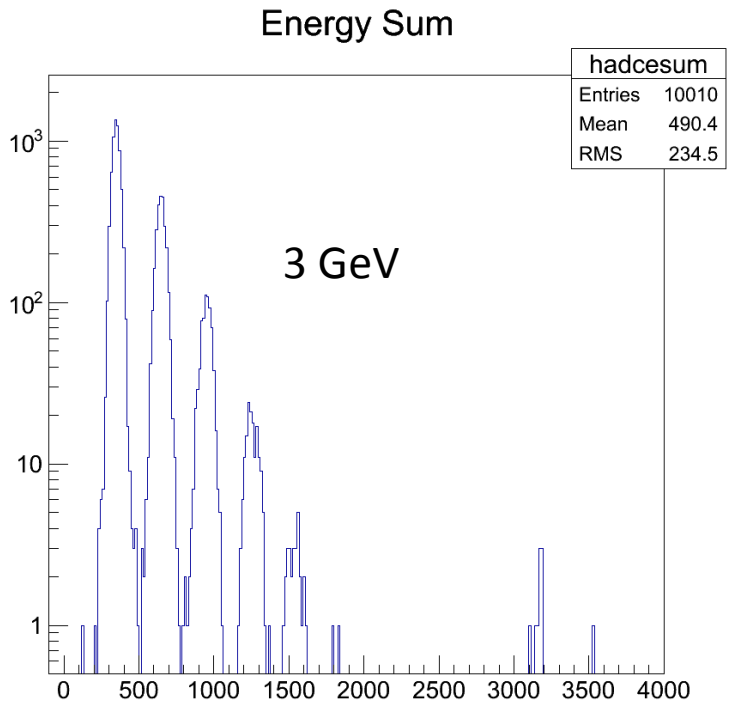
Trigger was made from signals of outer modules sent to an adder which has an OR output and set in coincidence (AND) with a signal from the machine.

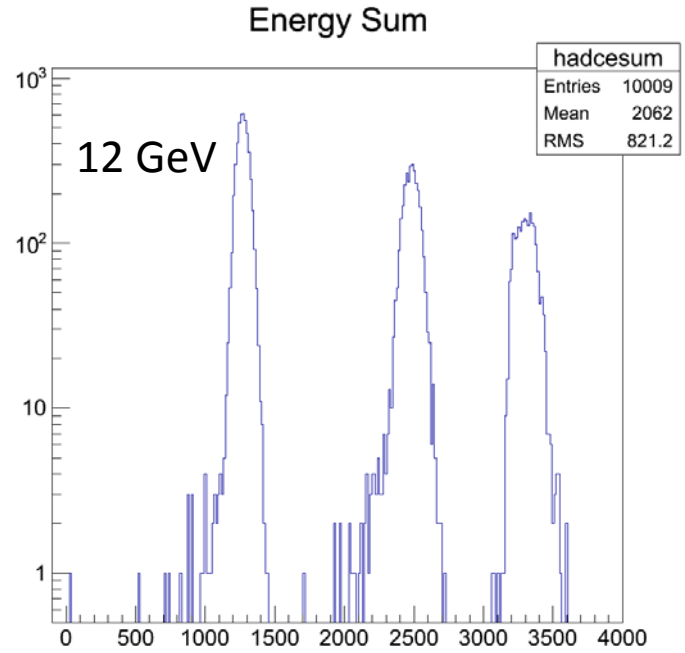
Position of the points used for the test.



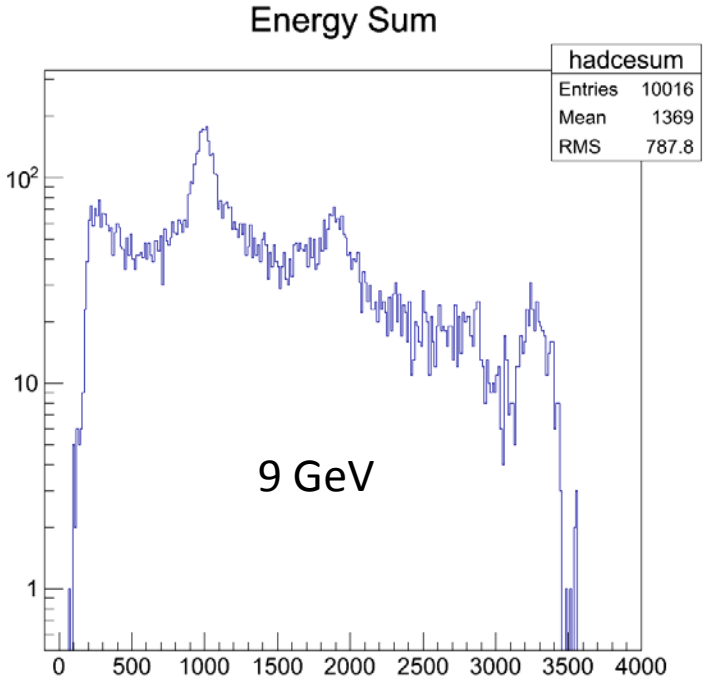
More points were taken with the modules rotated 18deg

Energy sum spectra





Three electrons peak shows some distortion. It was assumed is because it reaches the max range of ADC



Modulation of beam to 9 GeV introduces a lot of uncertainty in energy

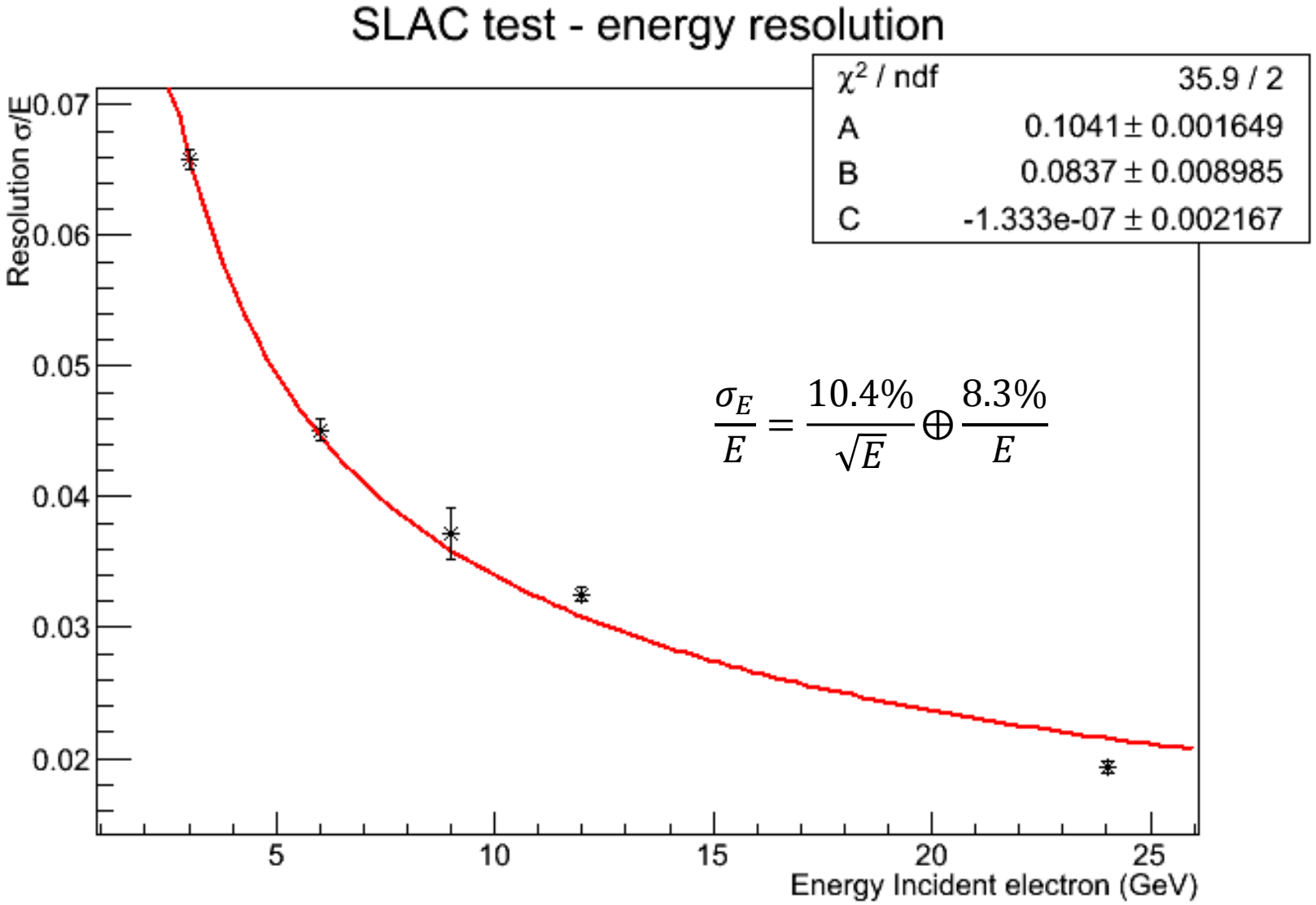
Energy resolution

Matthew Burton (W&M) had been working in the energy analysis.

Since 9 GeV spectra is hard to analyze, three peaks (corresponding to 1, 2 and 3 electrons) from the 3 GeV data had been used. In similar way, 1 and 2 electrons from 12 GeV data.

- Pedestal subtraction
- Calibration of ADC plots
- Linearity of the calibration
- Fit of the peaks
- Calculus of the energy resolution

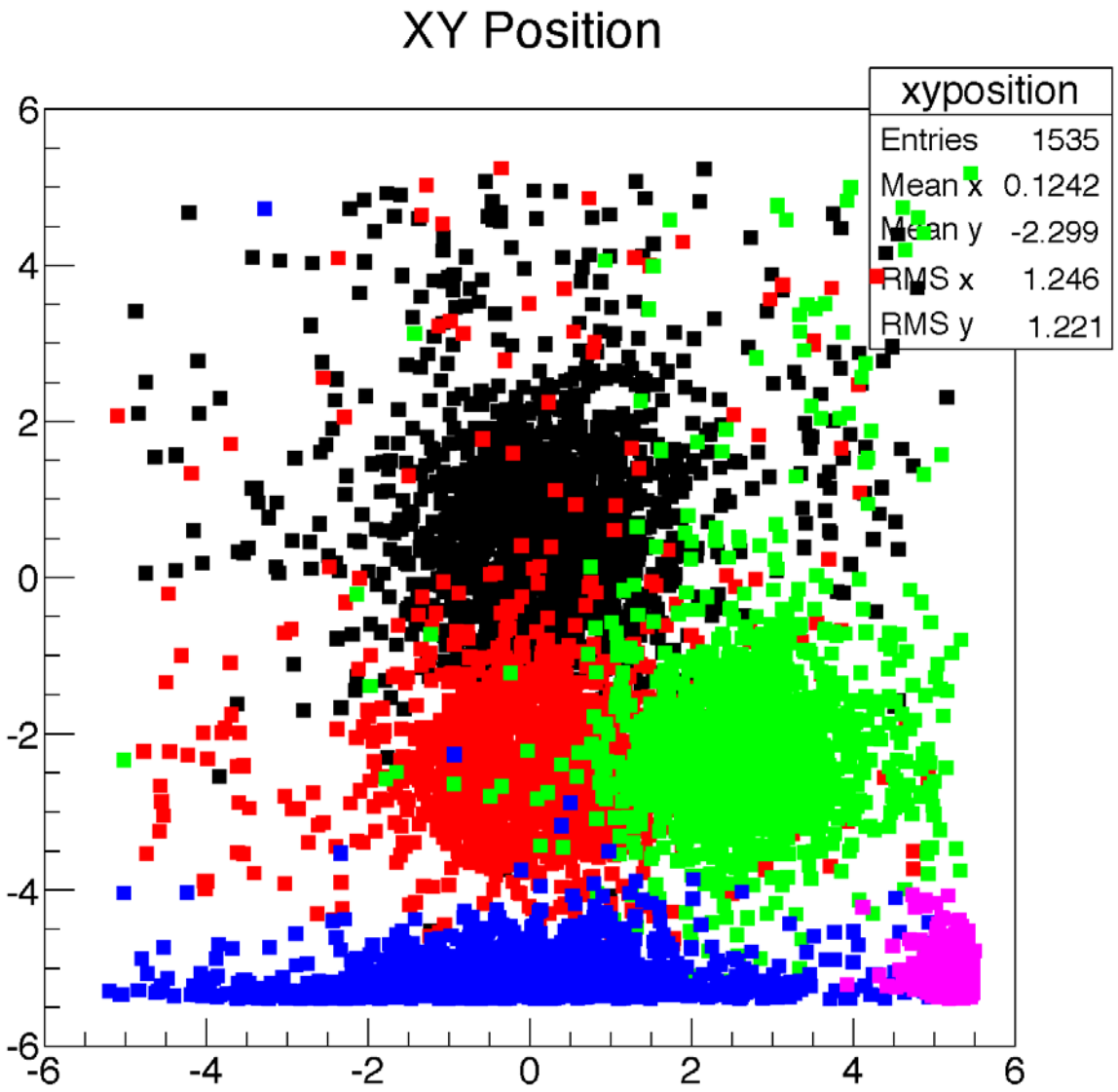
Energy resolution



Position Resolution

STILL IN PROCESS!!

A quality reconstruction of the hits in different points, shows that, position resolution improves as shower is shared by neighbors modules, i.e. closer to edges/corners.



Summary

- Test made with cosmics at Jlab shows a good agreement in light yield from HERA-B
- Test made at SLAC shows a good agreement in energy resolution as reported by HERA-B
  - Outer modules are in good condition, unlike we expected (and claimed by HERA-B Ecal owners)

Outlook

- Position resolution should be analyzed (in progress)
- Validate Geant4 simulation with such results