Design of readout electronics of scintillators and SiPMs for CEPC ECAL preresearch

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Abstract

This poster shows the research of readout electronics for CEPC-ECAL based on SPIROC2b. There are three main phase in this research, ASIC test, single layer readout system and prototype. This poster is mainly about the result of ASIC test and part of single layer research.

The phase I readout system achieve above goals:

1. 144 channels of Scintillators and SiPMs readout
2. 46fC - 290pC dynamic range @ S/N = 2 with 3% nonlinearity
3. Successful distinct MIPs signal from pedesetal with detectors

Requirement

The prototype of ECAL is designed with followed requirements.

1. Granularity : **5mm x 5mm**
2. Dynamic Range : 1 - 800MIPs -> 10 p.e. - 8000 p.e -> **160fC - 100pC**
3. Size: 1m x 1m , 30 layers

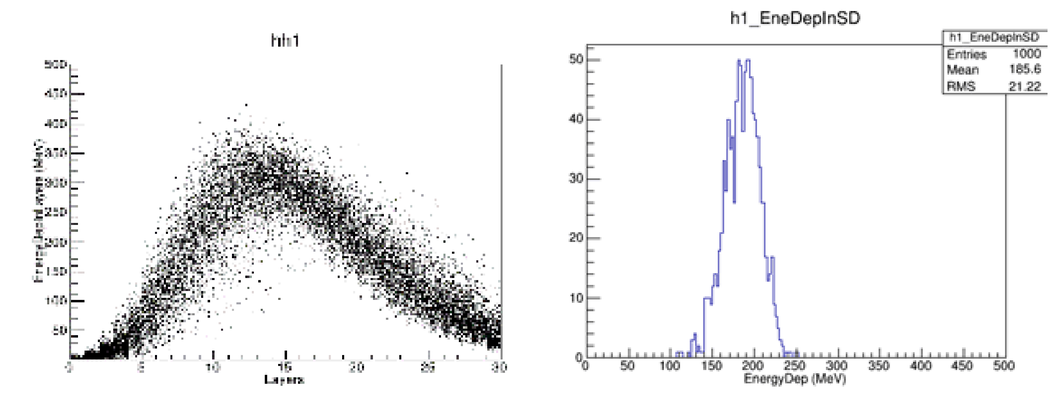

Fig. 1: MentoCarlo simulation shows that with 30 layers, most energy of 100GeV electron is absorbed and maximum energy deposit in one detector cell is about 250MeV

System overview

FEB is integrated with detectors which consists of scintillants and SiPMs and is surround with steel or tungsten plate which is as absorber. DIF is connected with FEB outside by connector.

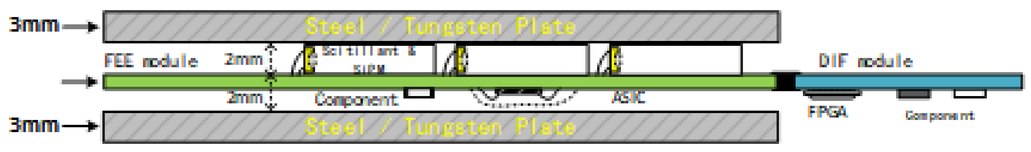

Fig. 2: Structure that integrated scintillators SiPMs and electronics together

The whole readout system mainly consists of Front-End Board (FEB), Data Interface board (DIF) and Data Acquisition Board (DAQ). This system is extensible when amount of channels is increased.The first testboard is only with one asic on board. This testboard is used for testing the performance of asic and whole system with detectors.

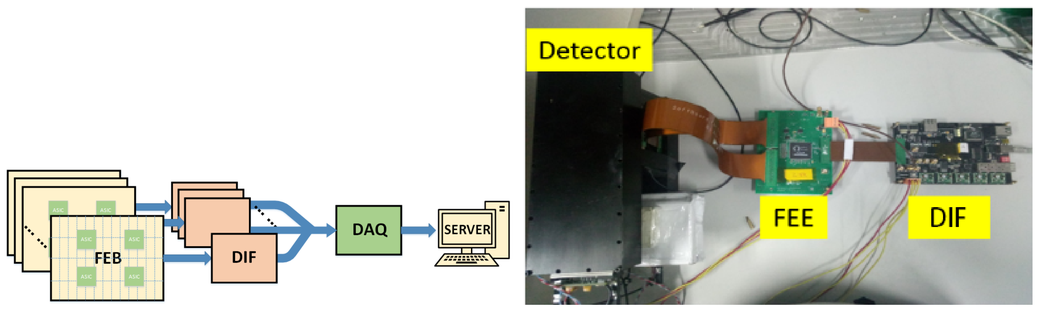

Fig. 3: Readout electronics system design and development

Dynamic Range

Figure above shows the noise of pedestal when input is floated. So the sigma of pedestal is about 3.5 ADC code. Corresponding the result of calibration Figure.(b), we can get the conclusion that the **rms of pedestal noise is 23fC.** If we keep the SNR at 2, the minimum signal we can detect is about 46fC.
Figure on the right shows the gain of low gain is about 10.3 ADC code/pC. In the test, we observe that system saturate at 3000 ADC code. So the system is measured and provide **46fC–290pC dynamic range**.

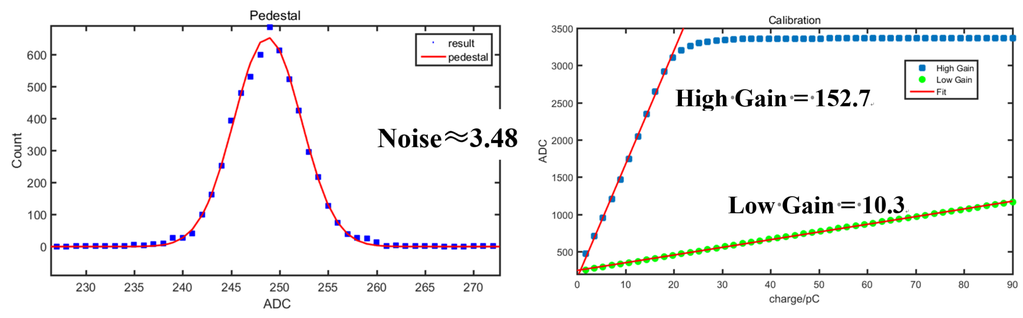

Fig. 4: Electrnoics Calibration, pedestal noise and gain

Cosmic Ray Test

Using PMT as external trigger, we detect cosmic ray by various scintillators and this simplified system.

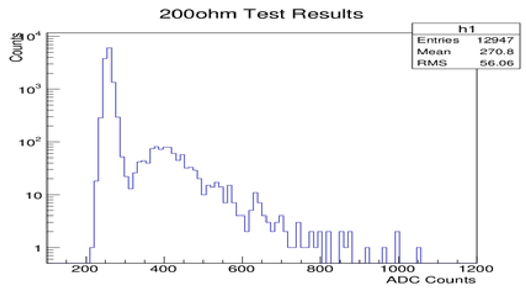

Fig. 5: Electrnoics Calibration, pedestal noise and gain

According to results of calibration, the MIPs peak mean charge is about 1pC which equivalent to 30 p.e

Multichip EBU Status

An EBU have 4 chips on board while support 144 channels readout has been development and simply tested. Readout system which insists of EBU and DIF can work well, and further cosmic ray results of single layers will be done recently.

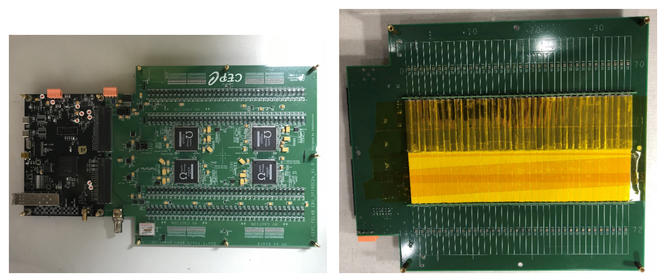

Fig. 6: Electrnoics Calibration, pedestal noise and gain

Conclusion We designed the readout electronic system for CEPC ECAL and development two testboard for validating this design. The first testboard with one asic chip on performance well and achieve the dynamic range of 46fC - 290pC. In the cosmic ray test, this FEB can distinct MIPs signal from pedestal well. After that, we also develop a testboard called EBU which has fore chips on while support 144 channels readout. This EBU is as one single layer of the prototype of ECAL. The preliminary test results show that the EBU can work well.