Sci-W ECAL Status for CEPC

Yunlong Zhang

State Key Laboratory of Particle Detection and Electronics, China

University of Science and Technology of China
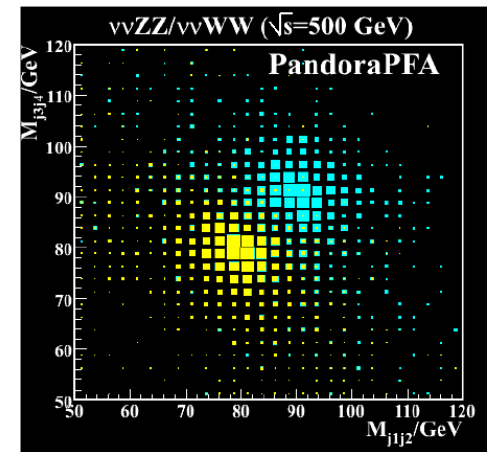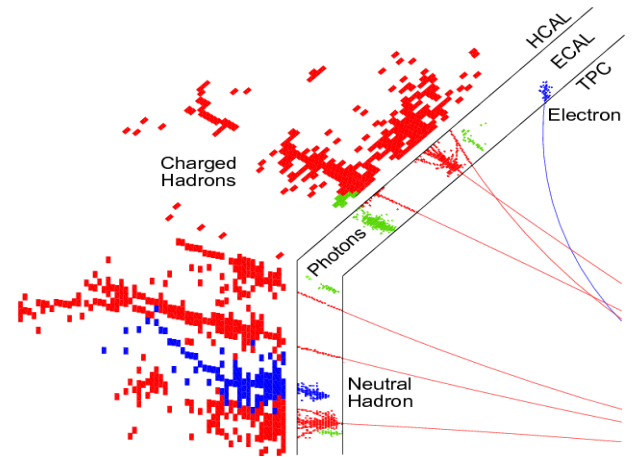
On behalf of CEPC Calorimeter working group

Outline

- ➢ Brief review of Sci-W ECAL of CEPC

- ➢ CEPC Sci-ECAL Status
  - ➢ LED test batch analysis
  - ➢ MIPs spectra batch analysis
  - ➢ DAC calibration batch analysis
  - ➢ Low gain and high ratio
  - ➢ Stability of Sci-ECAL

- ➢ Summary and outlook

PFA Calorimeter

- Good separation of particles

- Compact showers to minimize overlap

  - Small moliere radius

- Minimum amount dead material

  - inside the magnet coil

- Detailed information of showers
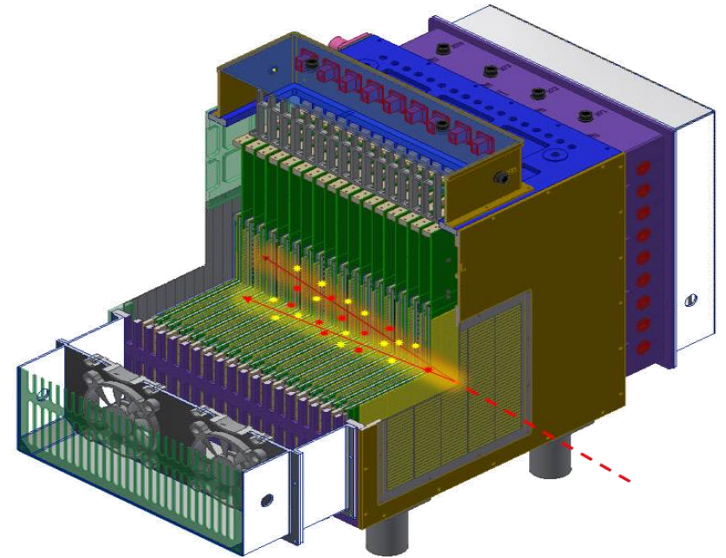
  - High granularity

An Imaging calorimeter could meet the requirements

Sci-W PFA ECAL of CEPC

- A sampling calorimeter based-on plastic scintillator and W absorber was built last year

  - 32 layers, ~22 r.l

  - Each layer has 210 channels, total number of readout is 6720

  - Layer area：226mm×226 mm

 - Cell size：5mm×45mm×2mm

  - power consumption：4.8 w/layer

Outline

➢ Brief review of Sci-W ECAL of CEPC

➢ CEPC Sci-ECAL Status

  ➢ LED test batch analysis

  ➢ MIPs spectra batch analysis

  ➢ DAC calibration batch analysis

  ➢ Low gain and high ratio

 ➢ Stability of Sci-ECAL

➢ Summary and outlook

Cosmic Ray test

- Long term cosmic ray test: ~3 months
  - ScECAL has been rotated by 90 degree
  - Coincidence trigger of Layer1 & Layer29
  - Event rate : ~ 16 per minute
  - ~1.5 million cosmic ray events collected

- Purpose
  - Function verification (stability, temperature correction, etc)
  - EBU efficiency and Position resolution
  - Cell-to-cell MIP calibration
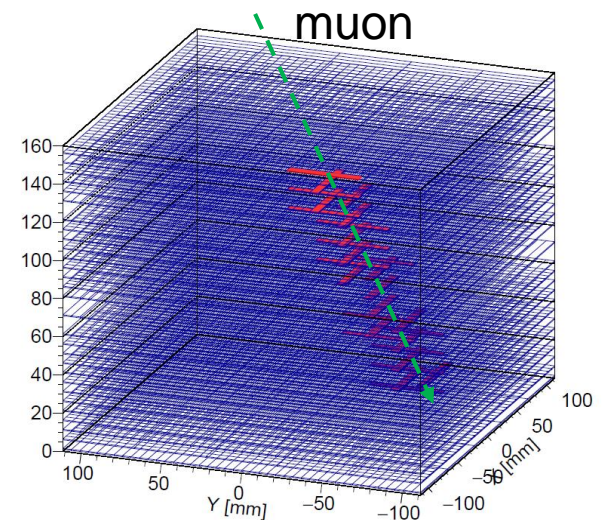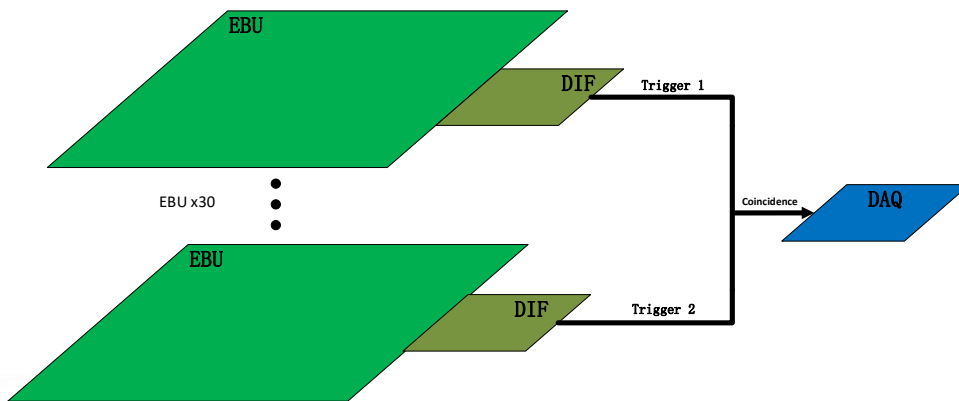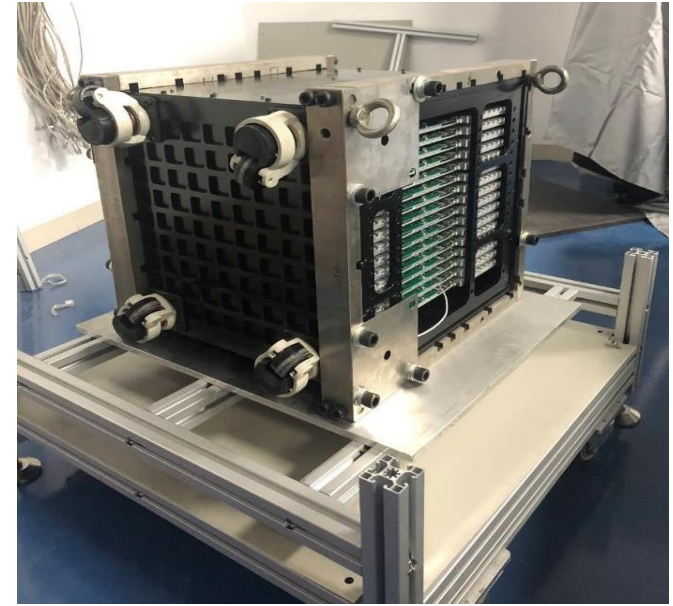
LED test

- The S.PE is a very important parameter to monitor the stability of the SiPM gain

- A circuit was designed to drive LED to calibrate S.PE of SiPM, also it could be used to test the ratio of low gain and high channels
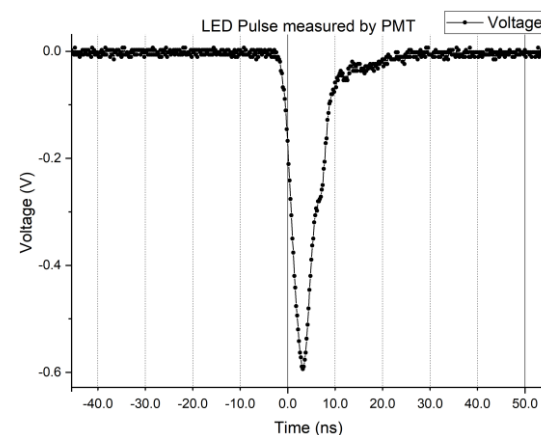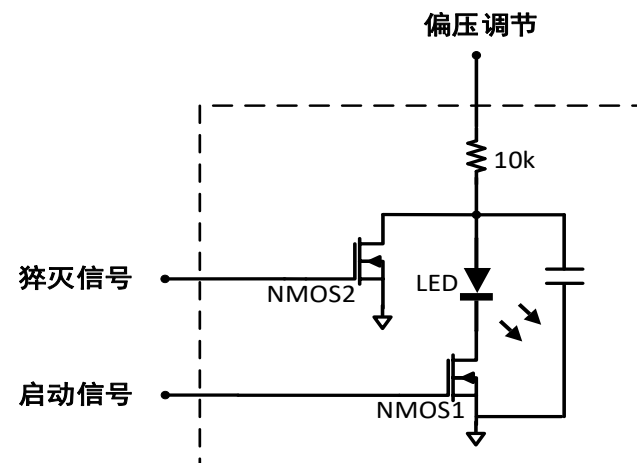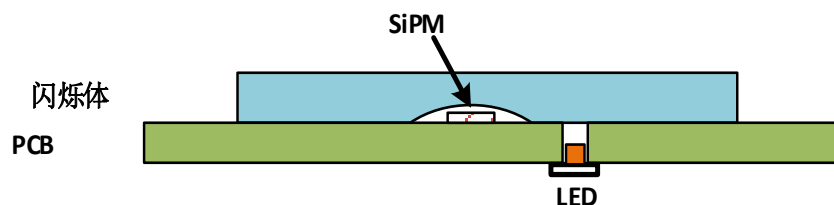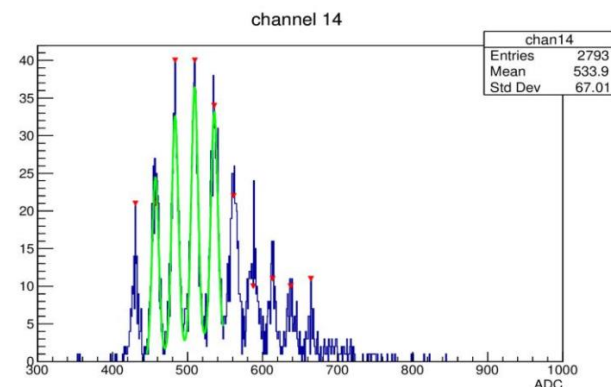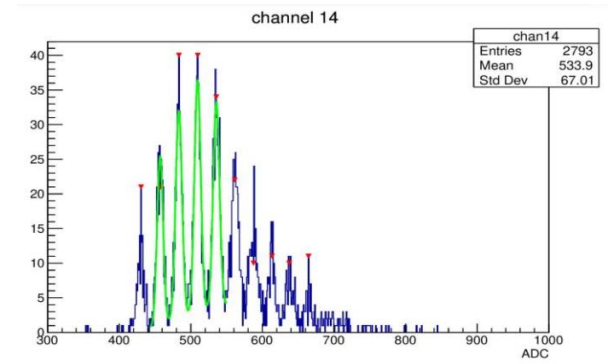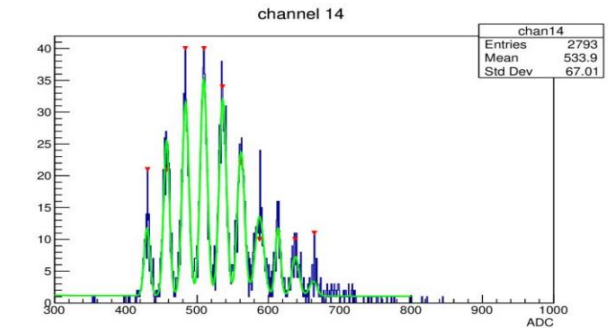

LED light spectrum

- Multi-gaussian fit

- Three different fitting methods

  – All the parameters are free

  – Considering the correlation of photoelectric peak position

  – It is approximately considered that the width of photoelectric peaks are consistent

From the total number of channels successfully fitted, we selected the 3rd method

➤ In order to reconstruct the total energy deposition in calorimeter of incident event, we should know the deposition in each SD element

➤ MPV value of MIPs is the reference for SD energy reconstruction

➤ Landau convolution Gaussian function is used to fit

  ➤ Landau describes the energy fluctuation

 ➤ Gauss describes the fluorescence process, electronic gain and so on

EventID : 117

Layer1_Chip1_ Chn15

Layer1_Chip1_ Chn15	
Entries	7356
Mean	726.7
RMS	377.6
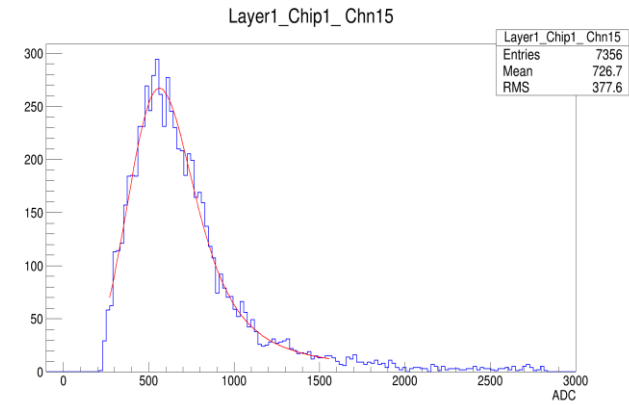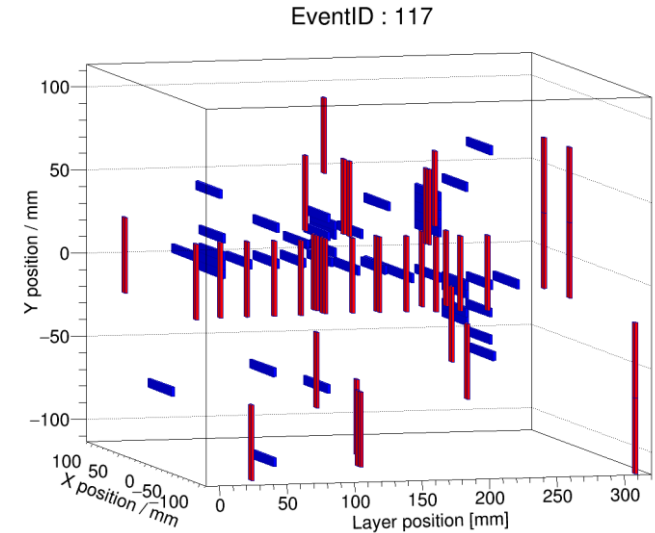
How to batch fit the MIPs spectra

➤ Because the signal amplitude of each channel is different, it introduces trouble for channel by channel fitting

➤ We put all channels of one layer into a hist for fitting, and let the parameters free.

➤ Then, the parameters obtained by fitting are sent to these channels for the second step of fitting
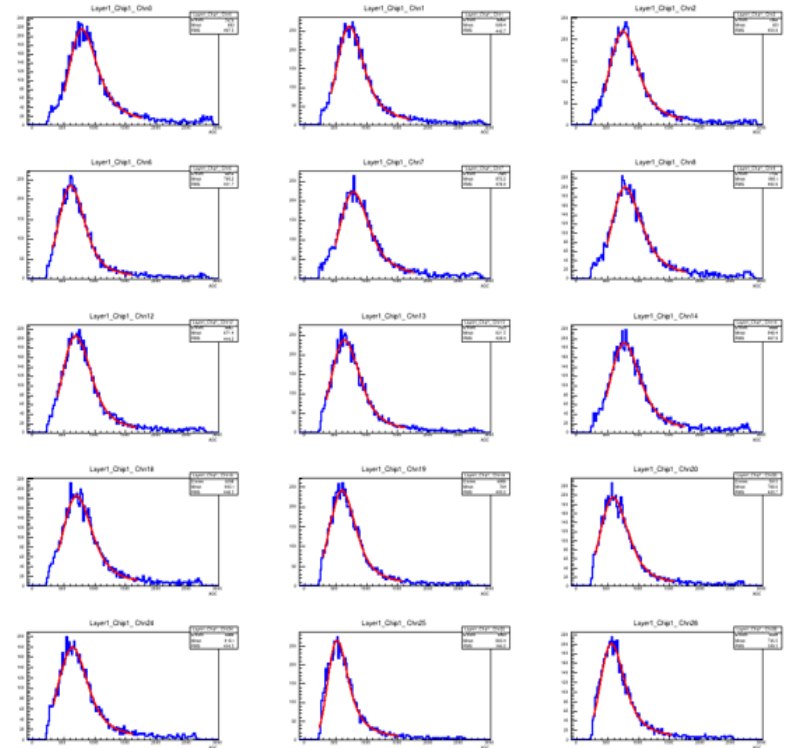
DAC Calibration

➢ Digital-to-Analog Conversion (0 – 5 V) driver was designed to test the linearity of readout channels

➢ The input signal waveform is similar to SiPM signal, $\tau \sim 3.5\ ns$

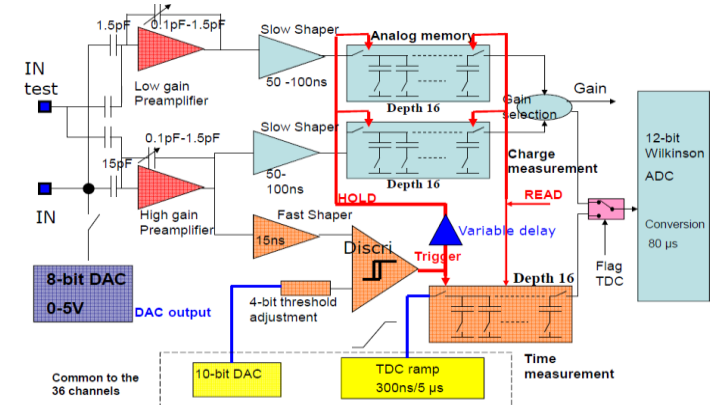➢ One SP2E chip has one probe pin, can select to connect with 36 channels
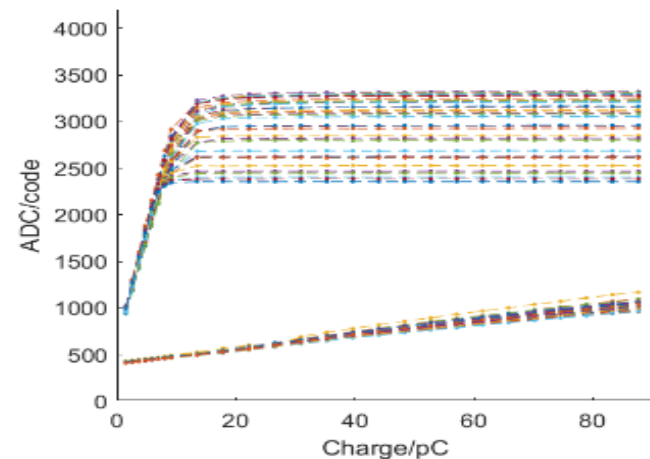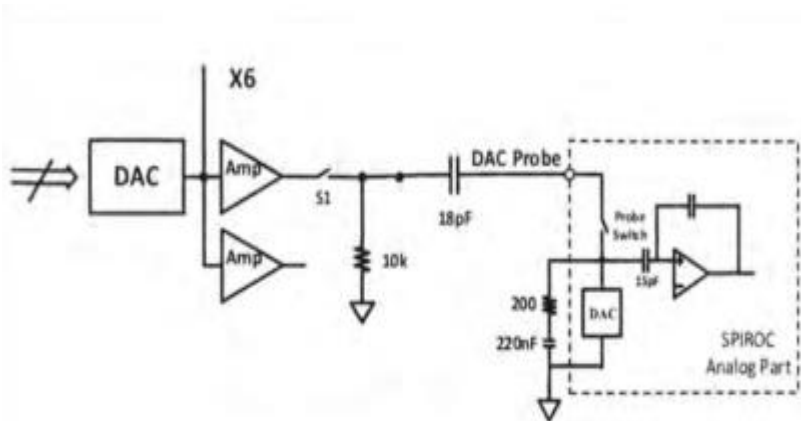
Linearity Calibration based-on DAC

➢ The DAC test results are fitted channel by channel

➢ The high gain channel factor is 0.19 ADC/pC, and the low gain channel is 6.1 ADC/pC
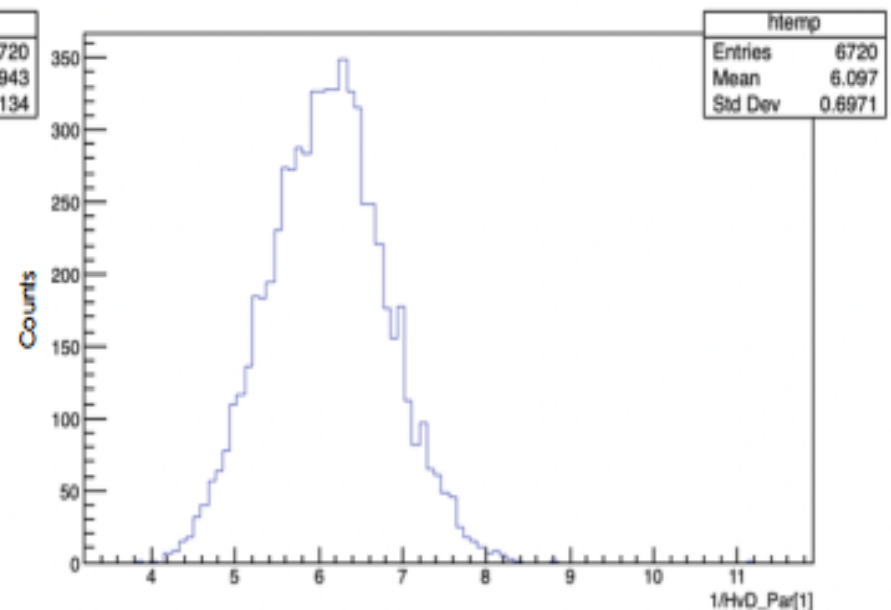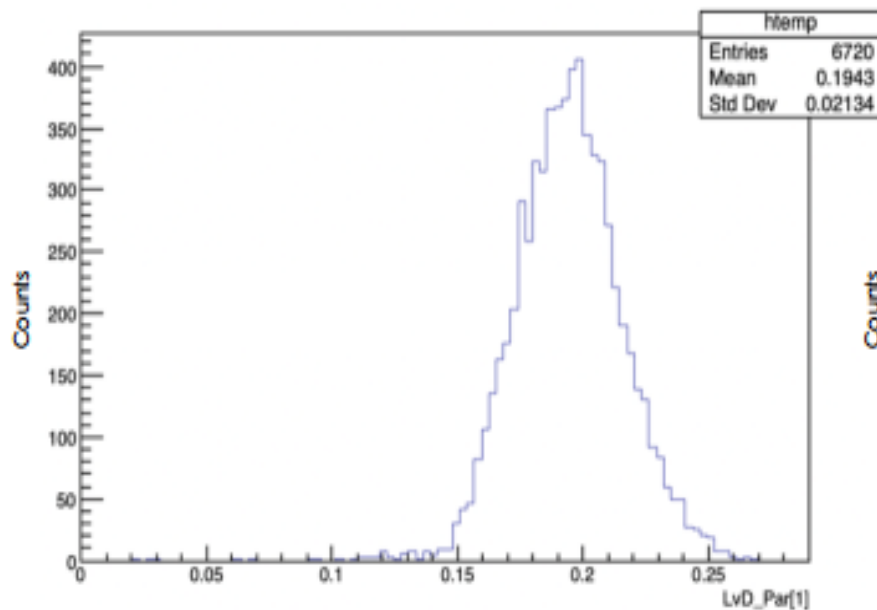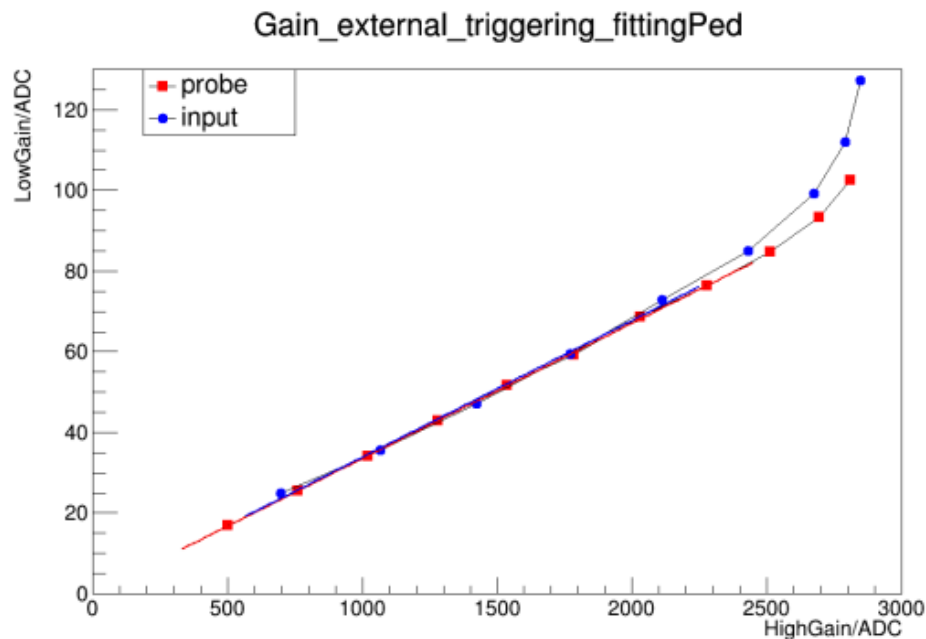
High gain and low gain ratio

➢ SPIROC2E chip has two different gain channel

➢ Cosmic ray test can only obtain the relationship between energy and ADC in high gain channel, but there is no signal in low gain channel

➢ The coefficients of high and low gain are very important to realize the conversion of high and low gain channels

➢ Three different methods were used to calibrate the ratio

　　➢ DAC test

　　➢ LED test

　　➢ Cosmic ray test

Gain_external_triggering_fittingPed

The ratio of LED (blue) is 29.5, and DAC (red) is 29.8, the two test results are almost the same
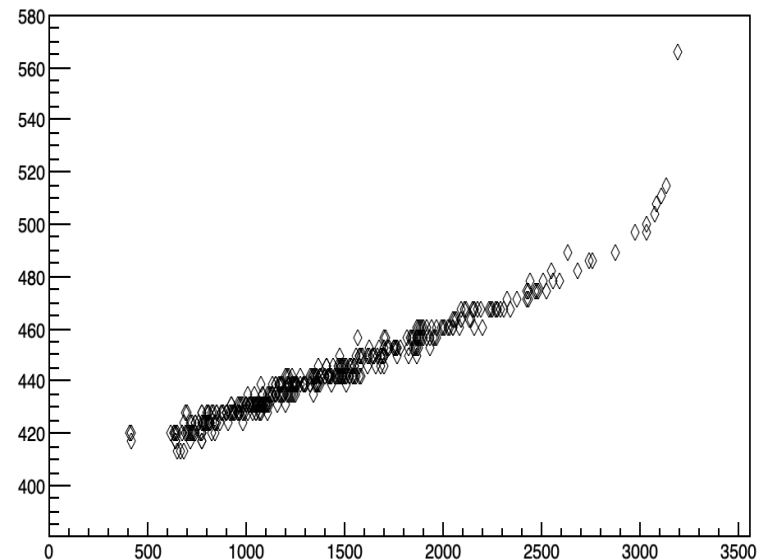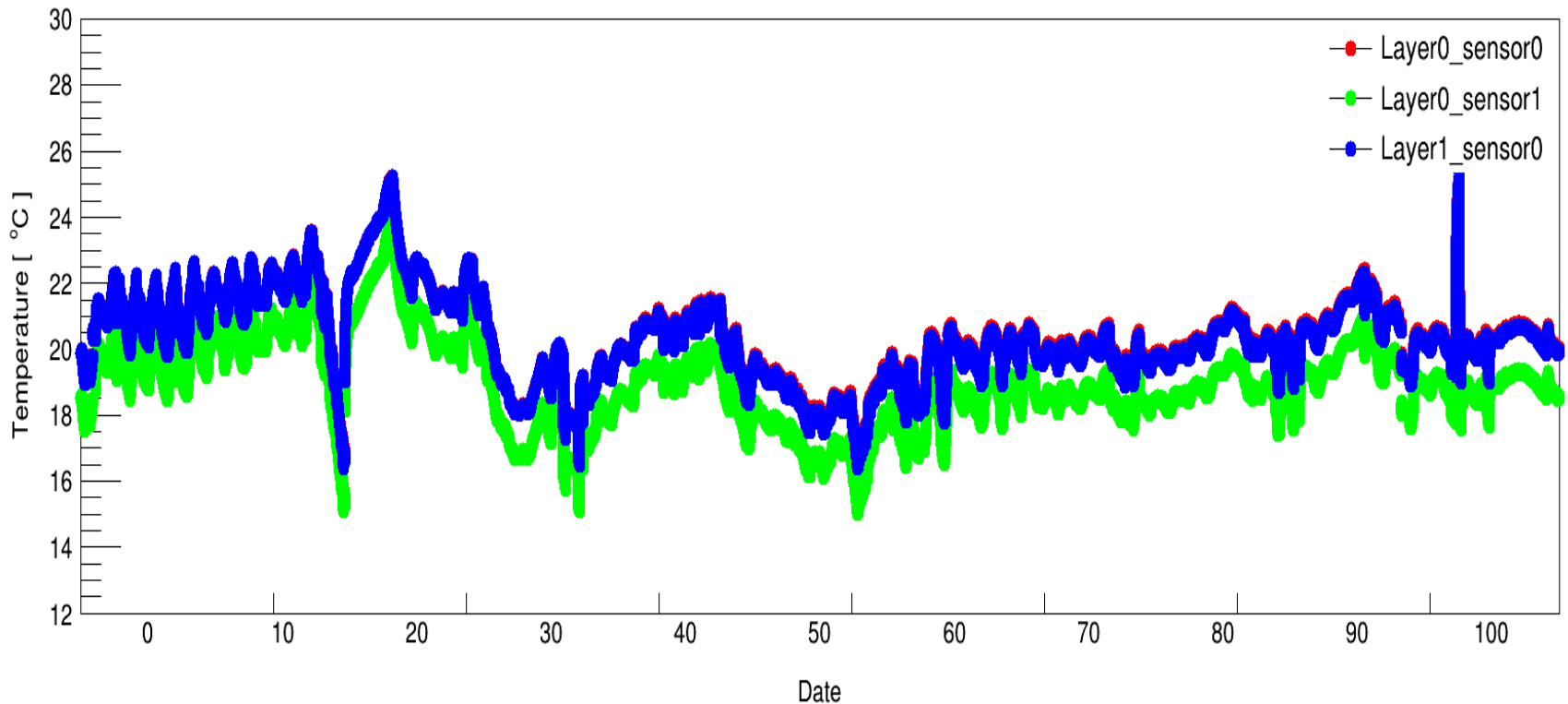
The cosmic ray test results were analyzing now

2021/7/29   14

- ➢ Stability is an important index of the detector
- ➢ We monitor some parameters in this test period, ~3 month
  - ➢ Temperature
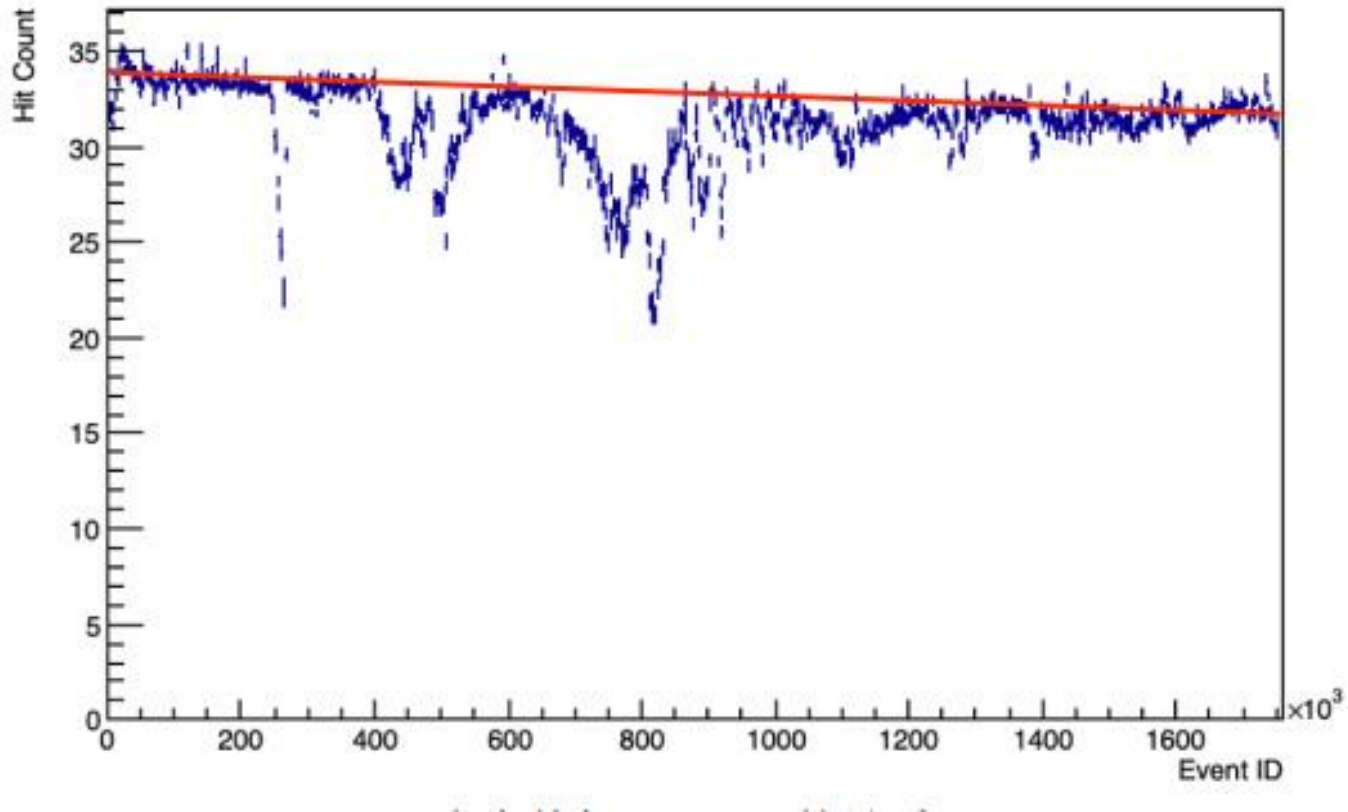 - ➢ Pedestal, MIPs spectra, detection efficiency..

muon
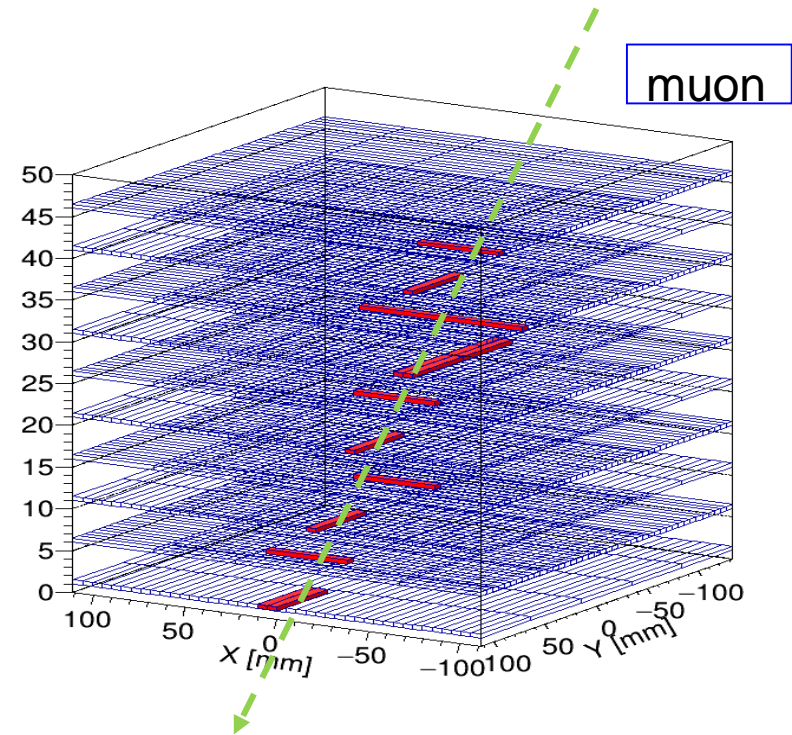
Temperature

- The temperature is between 14 and 26 degrees, with an average of 20 degrees

- At first the test room with relatively good temperature control conditions

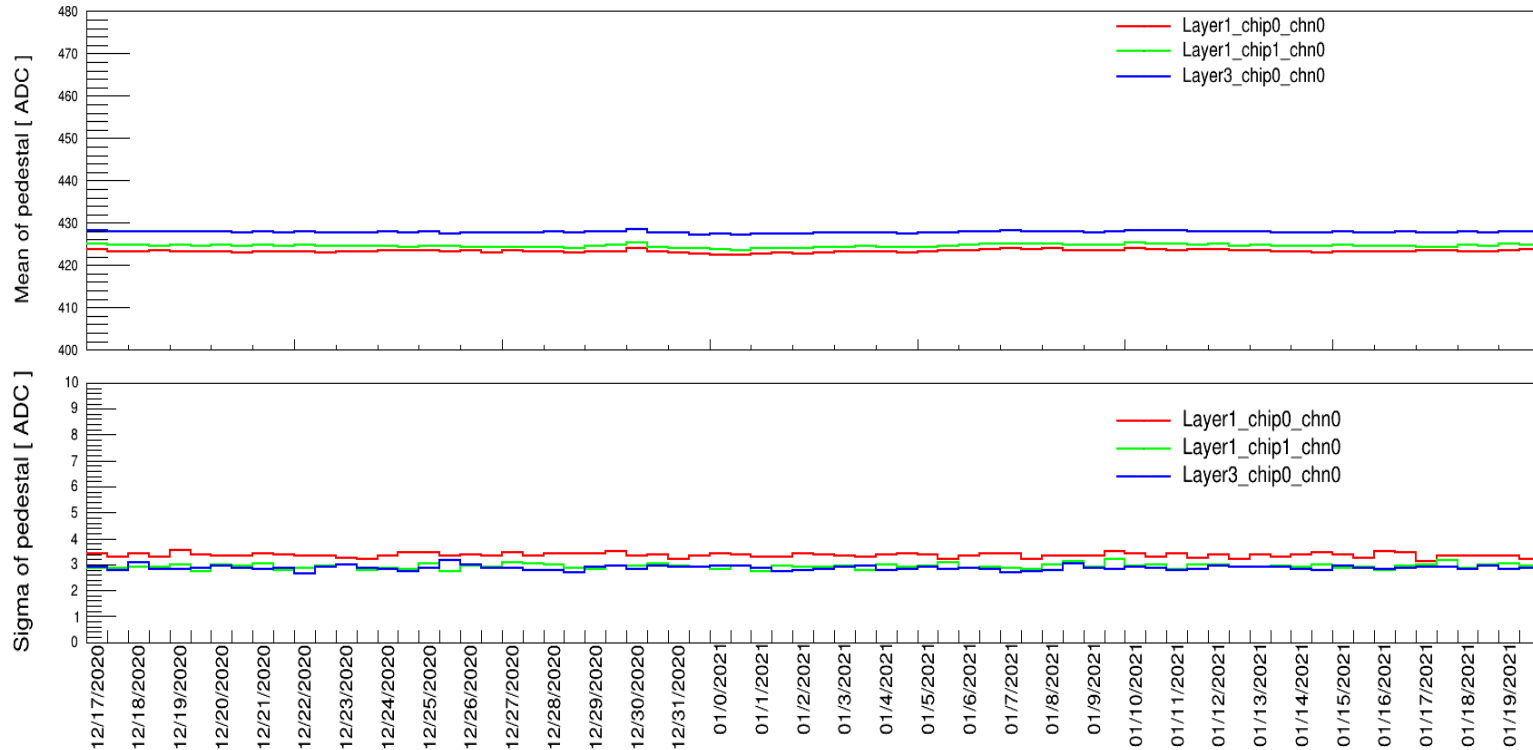- Most of the time, the temperature control condition of the room is not very good

- The hit number is between 20 and 40 hits, with an average of 32

- There are two obvious decreases in the middle, which are related to the temperature
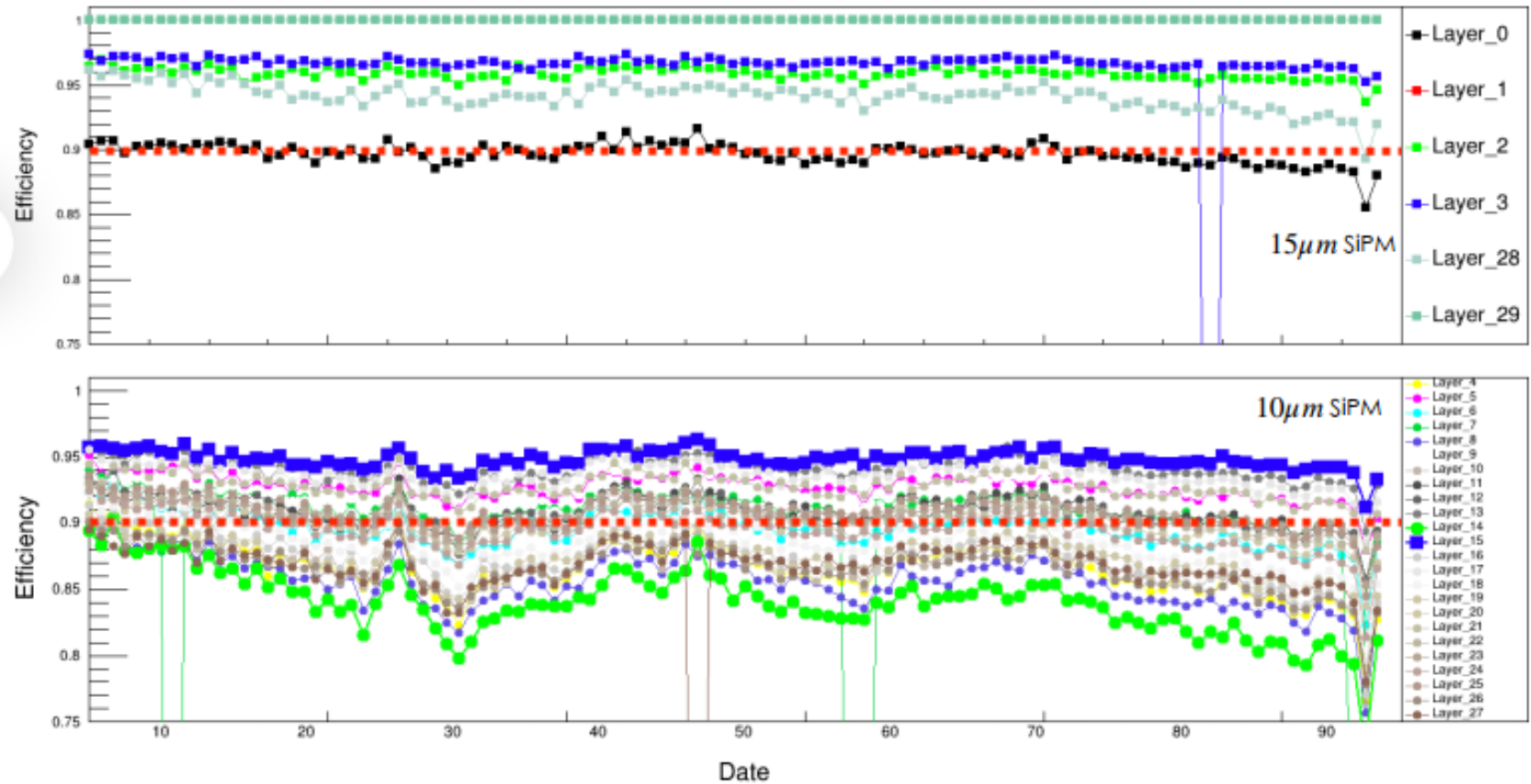
- The pedestal position and width are both very stable
- The noise (pedestal width) are about 4 ADC

- The detection efficiency is generally stable
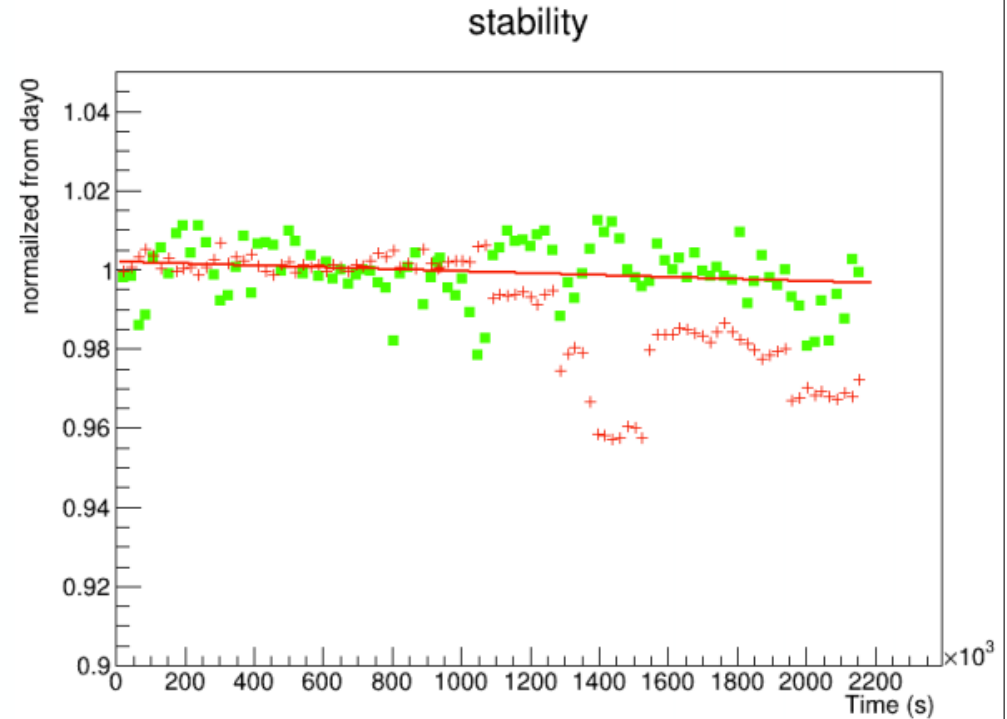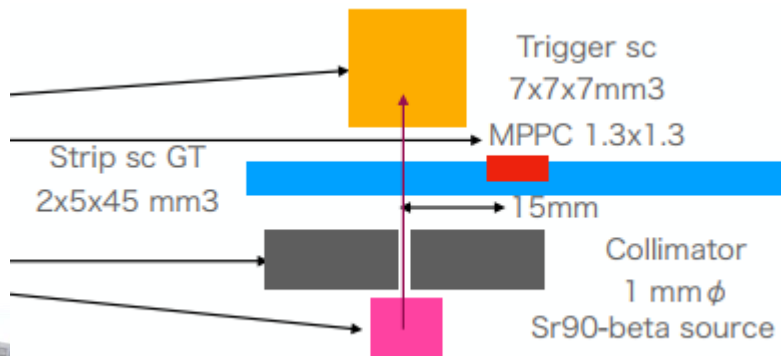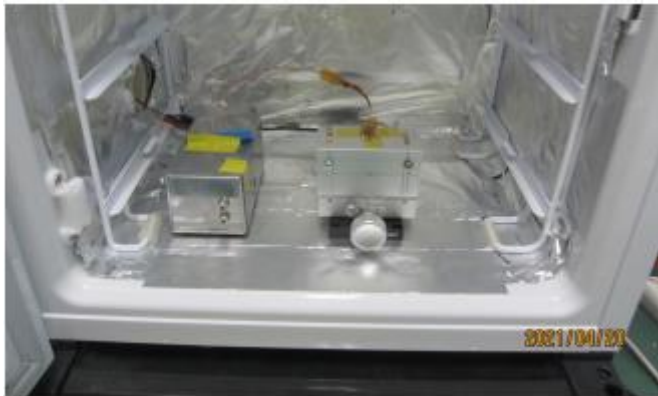
- the efficiency seems to decrease gradually for 10 um SiPM

Shinshu group

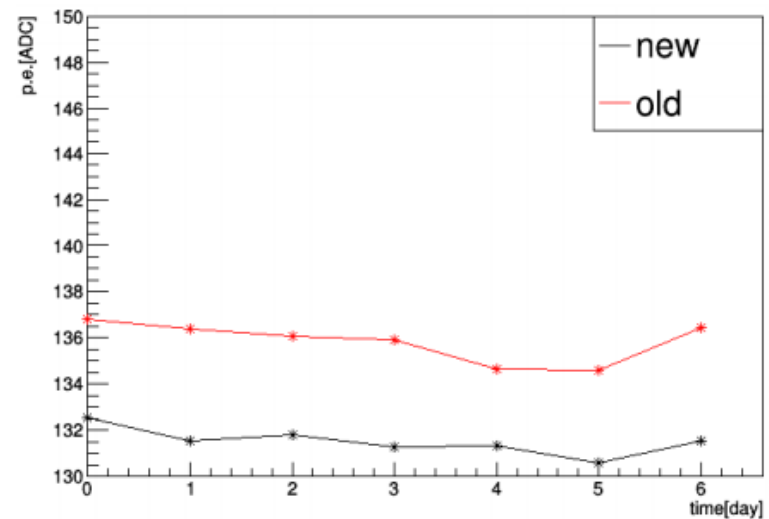A Sr-90 source was used to monitor the MIPs peak position stability

Trigger sc
7x7x7mm3
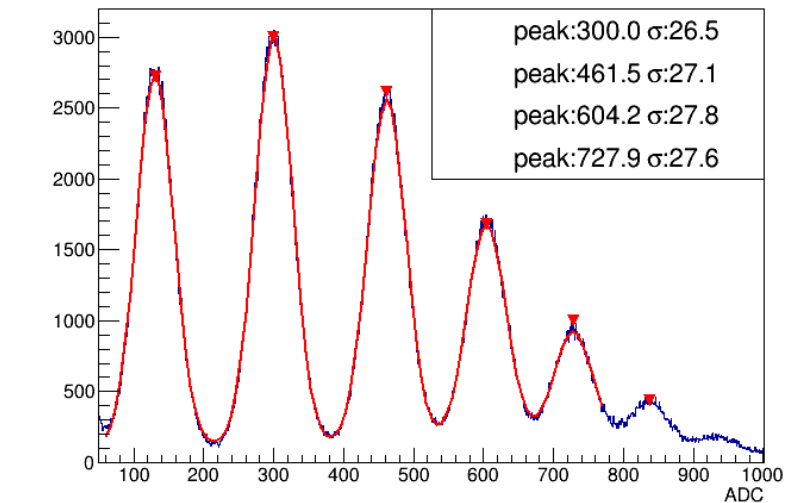
MPPC 1.3x1.3

Strip sc GT
2x5x45 mm3

15mm

Collimator
1 mm φ

Sr90-beta source
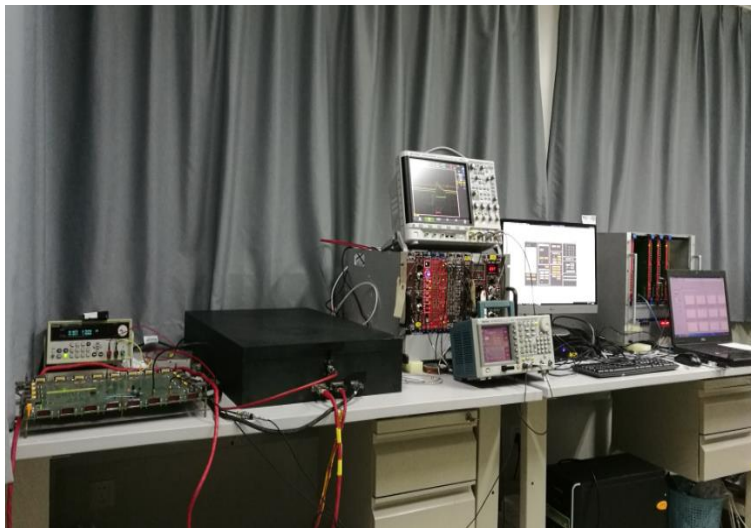
USTC group

An LED test system was
used to calibrate the SPE

peak:300.0 σ:26.5
peak:461.5 σ:27.1
peak:604.2 σ:27.8
peak:727.9 σ:27.6
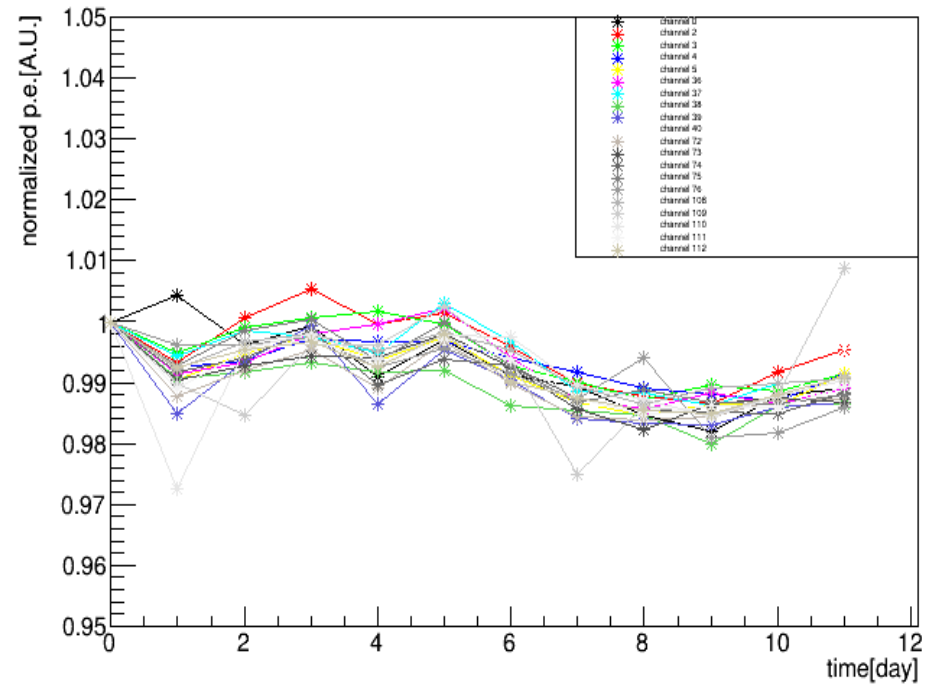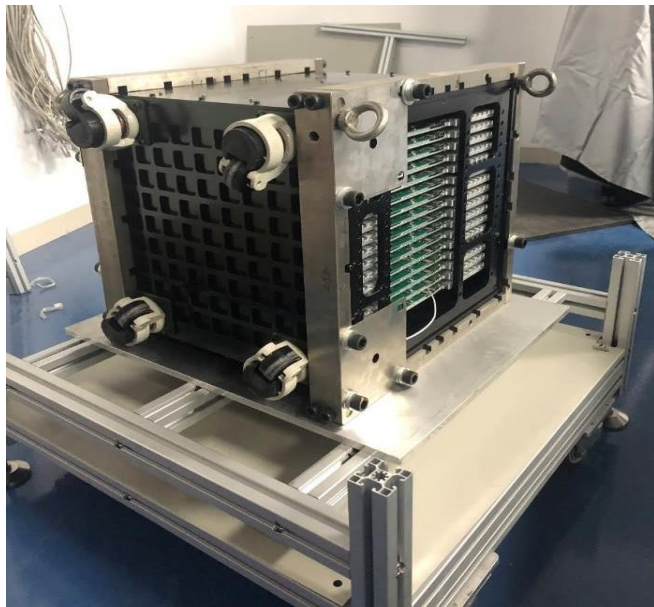
USTC group

The AHCAL scintillator batch
test system was also used to
test the stability of SiPM
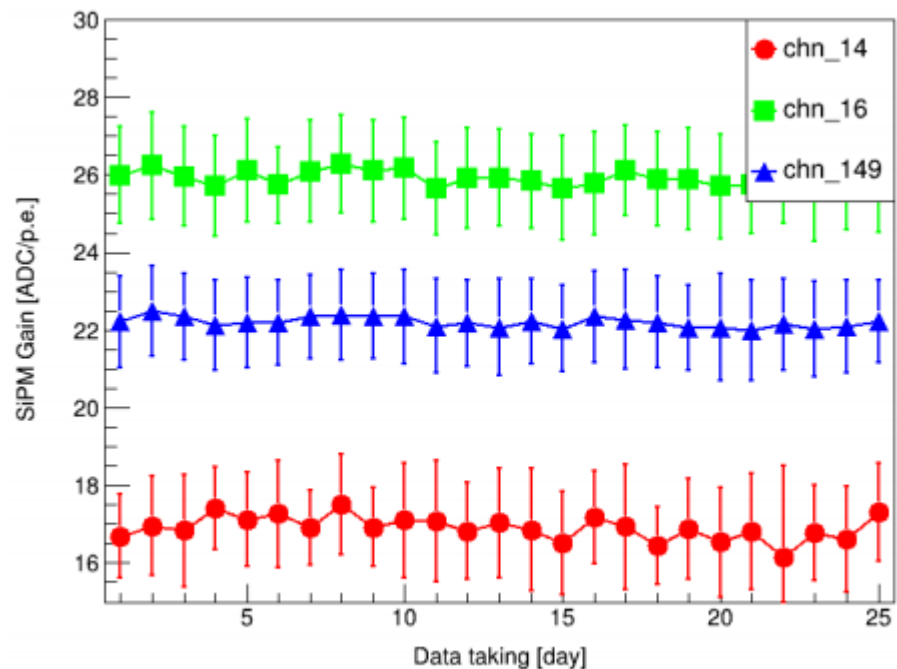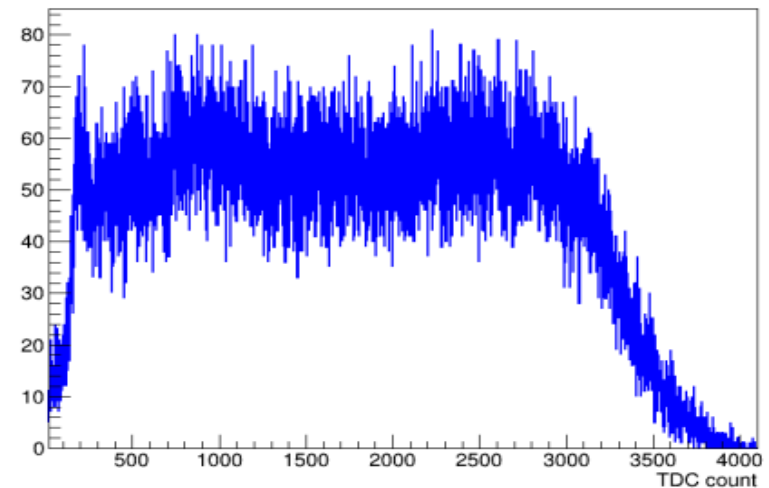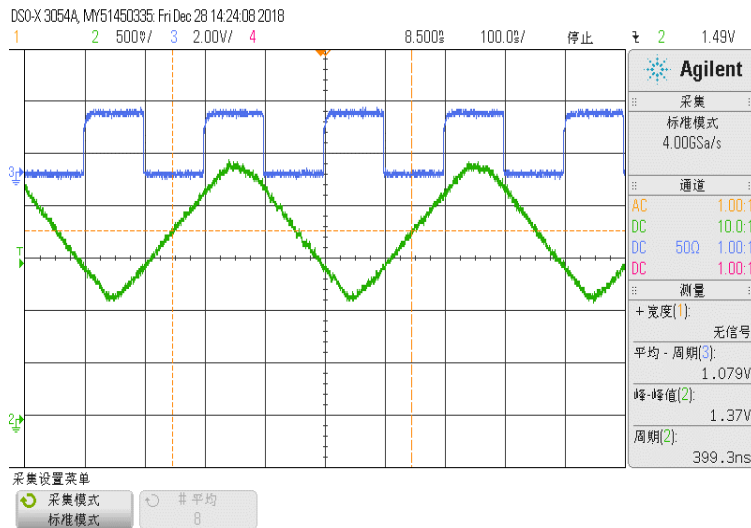
USTC group

The Sci-ECAL was used LED driver to monitor the SiPM gain day by day

Time Mode Test

◆SP2E chip has a function of time measurement

◆In the previous test, we used high/low gain mode for test

◆and now we use time measurement mode

SPIROC2E chip

Cosmic ray events fall randomly in
the time measurement interval

Summary and outlook

- The cosmic ray test provides us with a lot of data

- Develop analysis methods to facilitate channel by channel analysis of calorimeter, and batch analysis of data

- Some important parameters are analyzed channel by channel

- Next step, we hope to reconstruct the beam test data of last year in IHEP according to these parameters

- And, continue to carry out time mode testing in the laboratory

Summary and outlook

- The cosmic ray test provides us with a lot of data

- Develop analysis methods to facilitate channel by channel analysis of calorimeter, and batch analysis of data

- Some important parameters are analyzed channel by channel

- Next step, we hope to reconstruct the beam test data of last year in IHEP according to these parameters

- And, continue to carry out time mode testing in the laboratory

THANKS

backup

ECAL test trigger

muon

Ex-trigger