中国科学技术大学
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CEPC AHCAL Prototype Status

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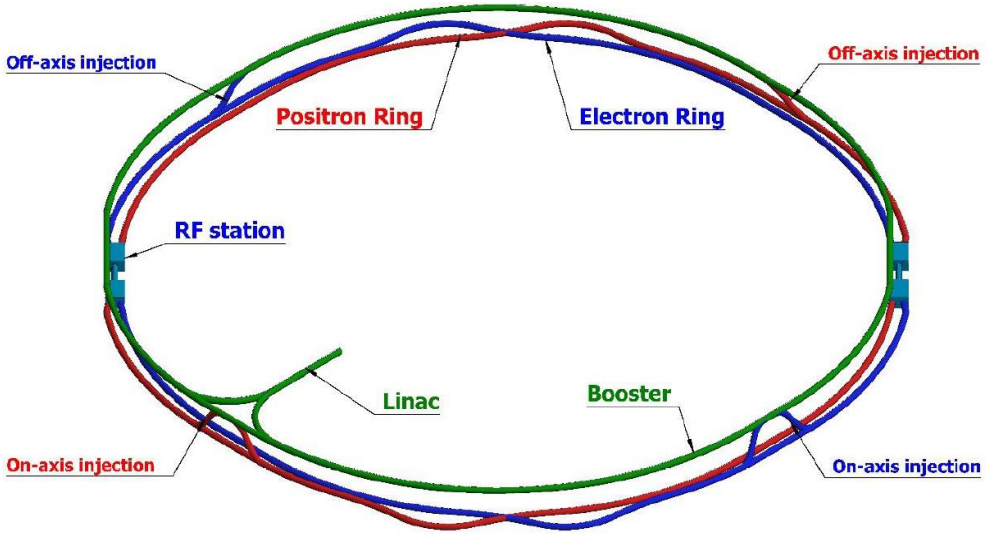
On behalf of the CEPC Calorimeter Group

OutLine

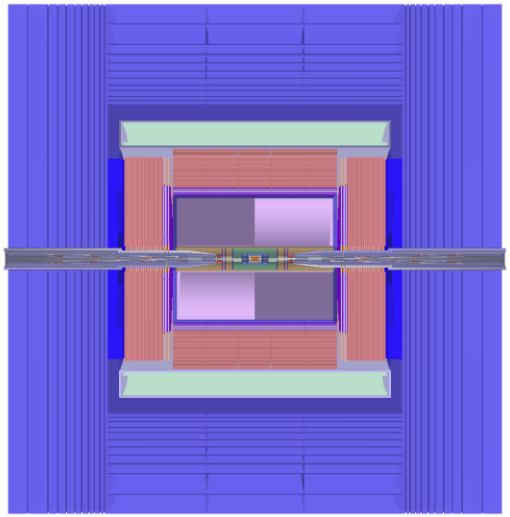
- Background
- Mass production and test
- Prototype integration
- Summary and outlook

Background

- CEPC
  - The CEPC is designed as the Higgs factory
  - The baseline detector option for the CEPC is guided by the particle flow algorithm(PFA)



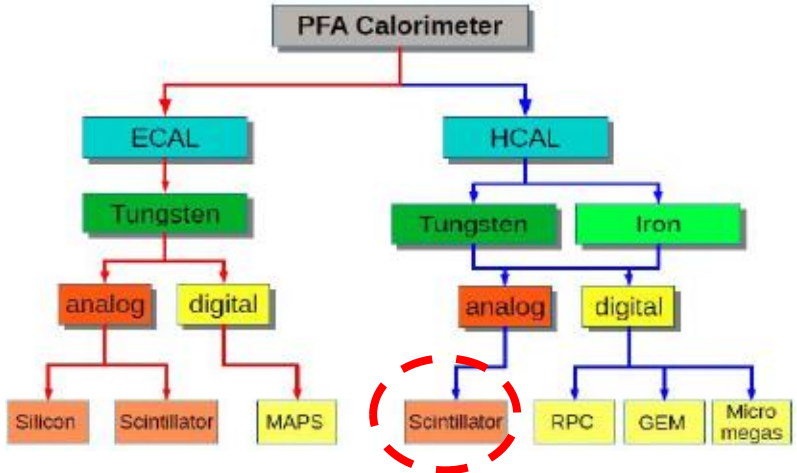
Design of the CEPC Accelerator



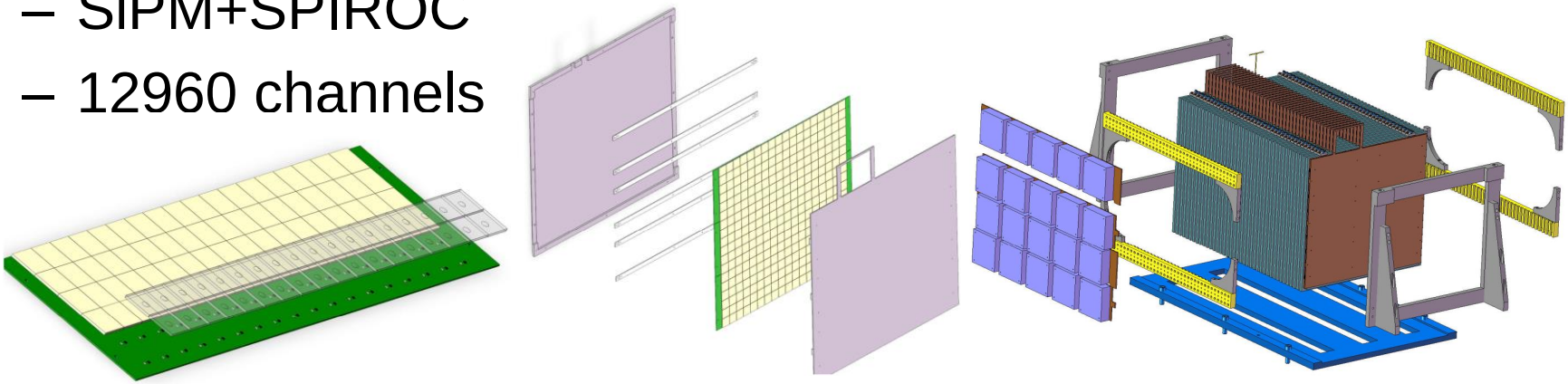
CEPC baseline detector

Background

- The Scintillator-Steel AHCAL option
- $72 \times 72\mathrm{cm}^2$ prototype
- 40 sampling layers
  - $20\ mm$ Fe
  - $40 \times 40 \times 3\ mm^3$ scintillator
- Analog readout
  - SiPM+SPIROC
  - 12960 channels



CEPC baseline calorimeter options



AHCAL single layer and prototype structure

Status of AHCAL prototype

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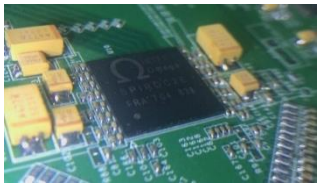
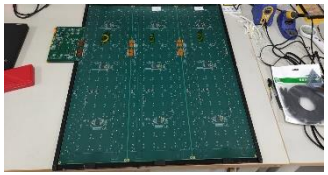
Design and optimization of AHCAL(done)

Study of the sensitive module(done)

14160-1315PS

Study of the readout electronics(done)

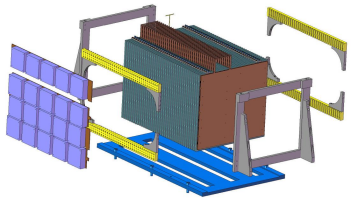


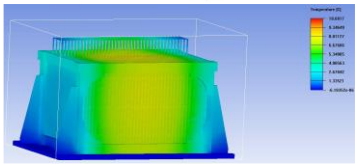


Mass production (26/43 layers)

Integration and test of prototype

Mechanics design and cooling simulation(done)





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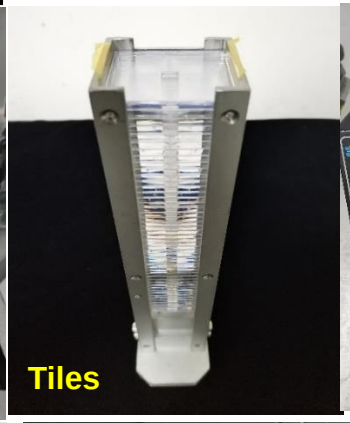
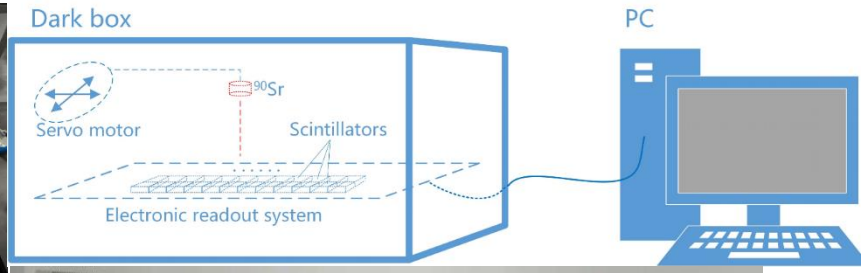
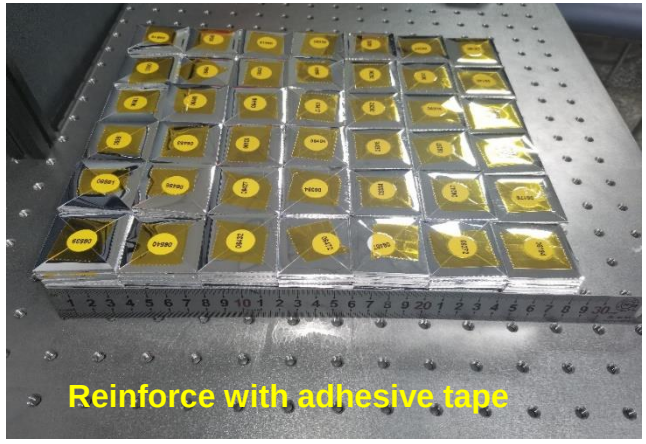
scintillators

- The scintillators are produced with injection molding technique
- The scintillators are then wrapped automatically
- The scintillators are test by a system carrying the Sr-90 source
- The mass production and test of scintillators are finished

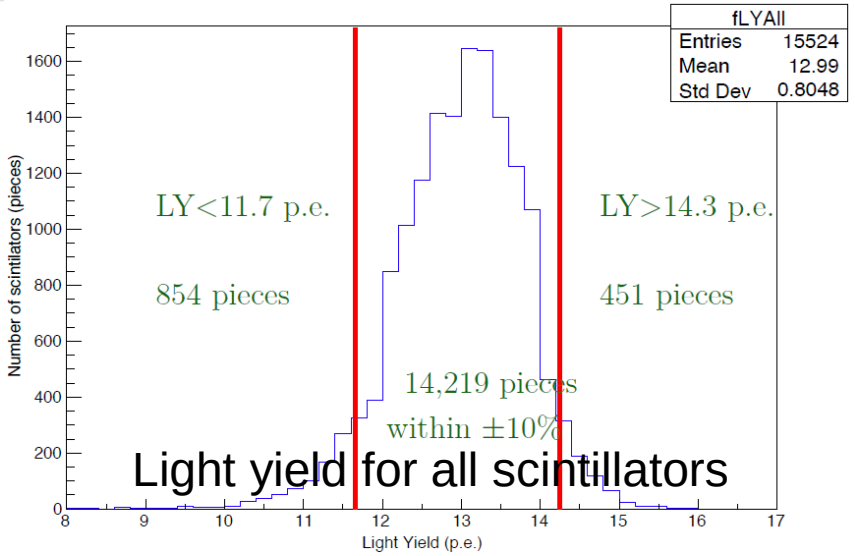




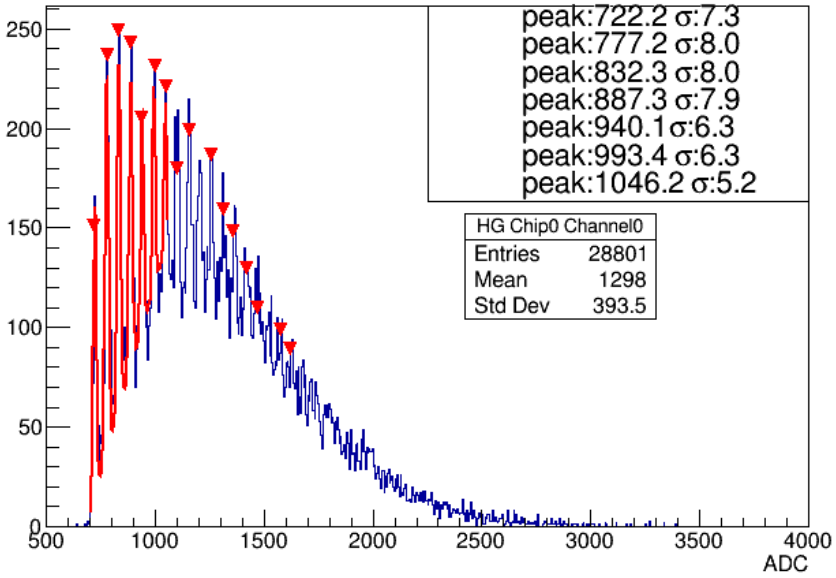


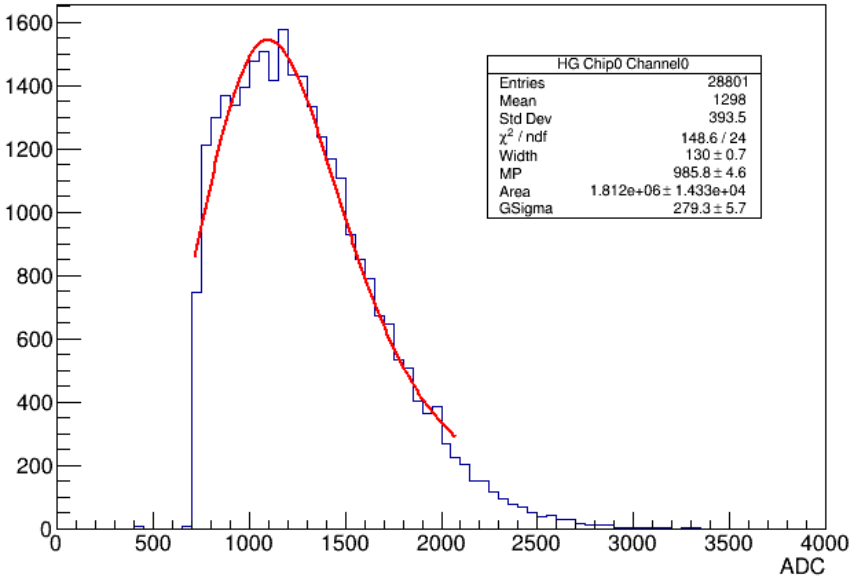
scintillators

- The test system
  - 13360-1325PE SiPM + SPIROC readout
  - 144 channels
  - The light yield is given by landau-gauss fit
- 14219 of the 15524 scintillators are selected for the prototype



Light yield for all scintillators

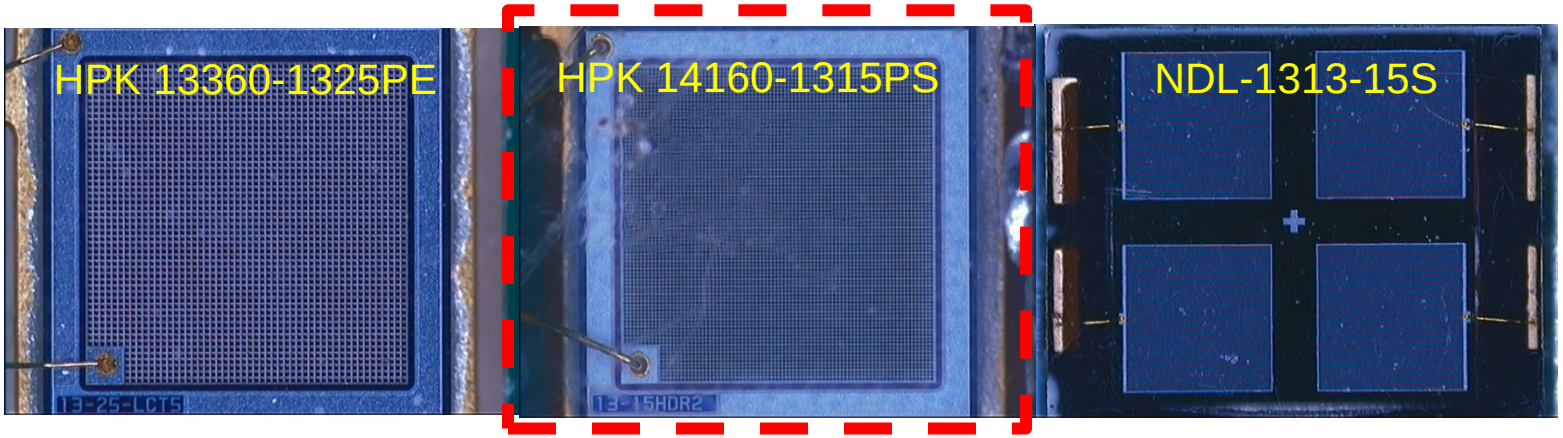




Sr-90 Spectrum: multi gauss fit and landau-gauss fit

SiPM

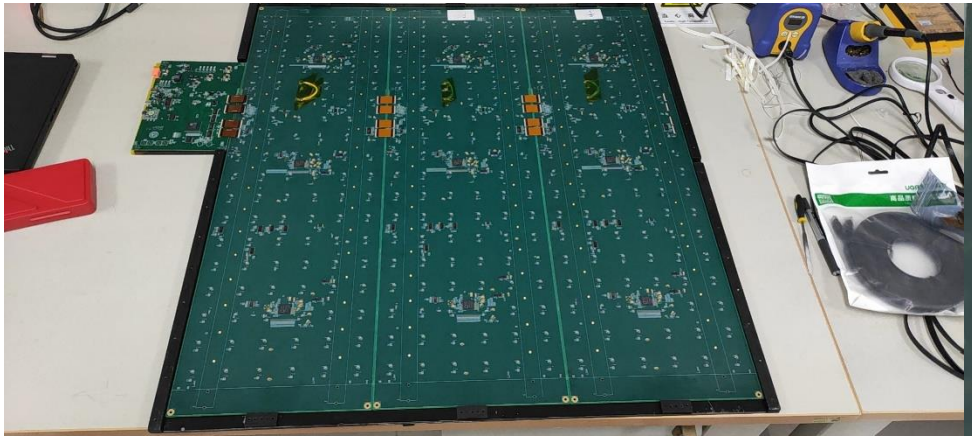
- **HPK-SiPM**
  - Low PDE,dark rate and crosstalk
  - High breakdown
  - Better quality control
  - 38 layers
- **NDL-SiPM:**
  - High PDE, dark rate and crosstalk
  - Low breakdown
  - Low price
  - 5 layers

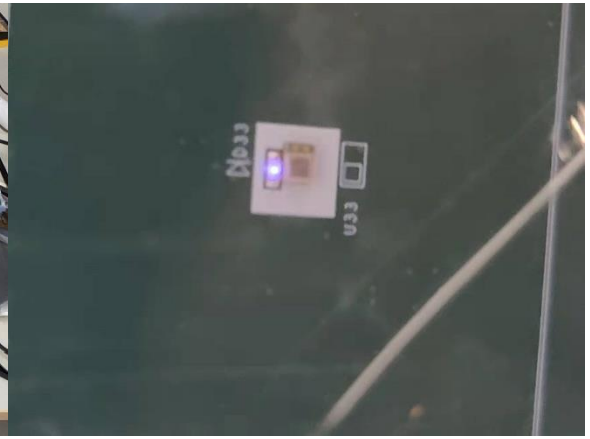


Company	HPK		NDL
Type	13360-1325PE	14160-1315PS	22-1313-15S
Light output [p.e.]	13	17	40
Crosstalk[%]	1.59	1.17	4.4
Dark Counts [kHz]	120	290	550
Breakdown[V]	53	38	27.5

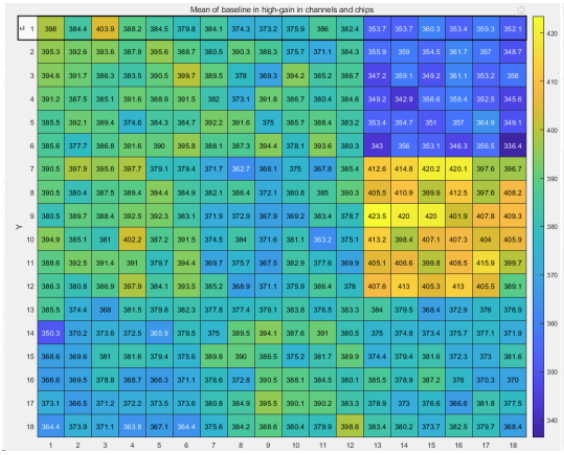
HBU

- Each layer is composed of 3HBU and1DIF
  - A layer has 324 channels thus has 324 SiPMs
  - Each SiPM has a LED side by side for calibration
  - The 324 channels are readout by 9 SPIROC chips
  - There are 48 temperature sensors on one layer

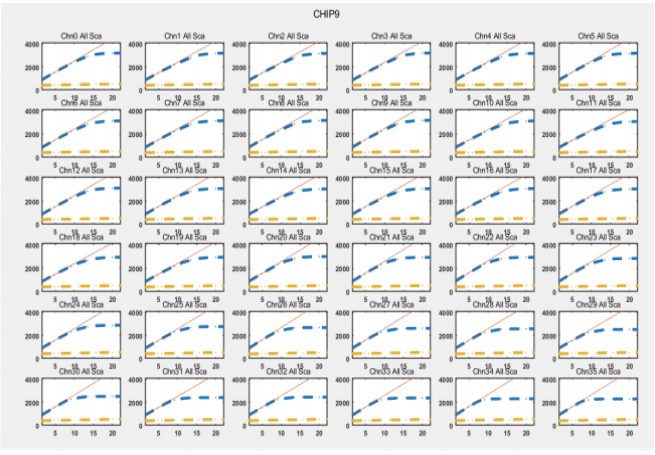




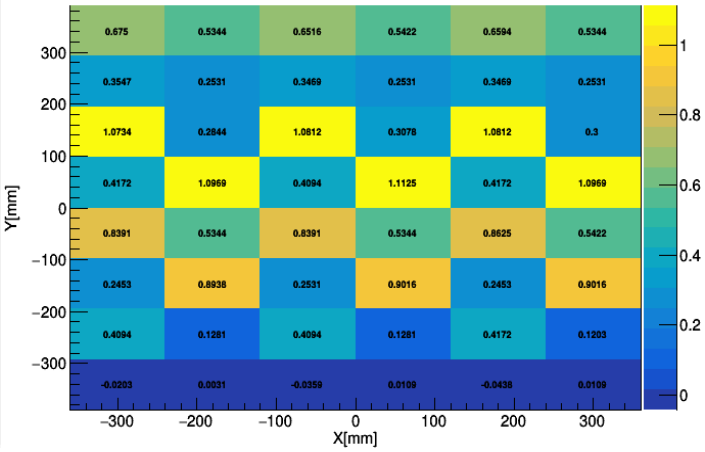
- Electronic test will be done before assembling the scintillators
  - Pedestal test: the pedestals are around 380 ADC
  - Electronic calibration: the Low/High gain ratio are calibrated
- Temperature test has been done for single layer
  - The temperature is close to room temperature: within ±1.5 degree



pedestal

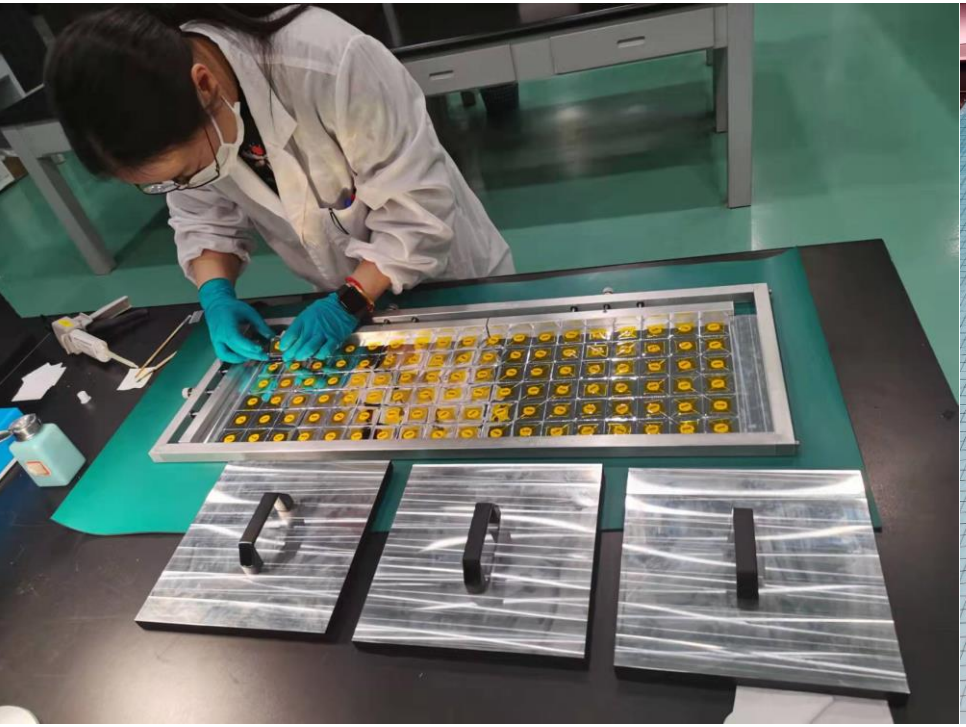


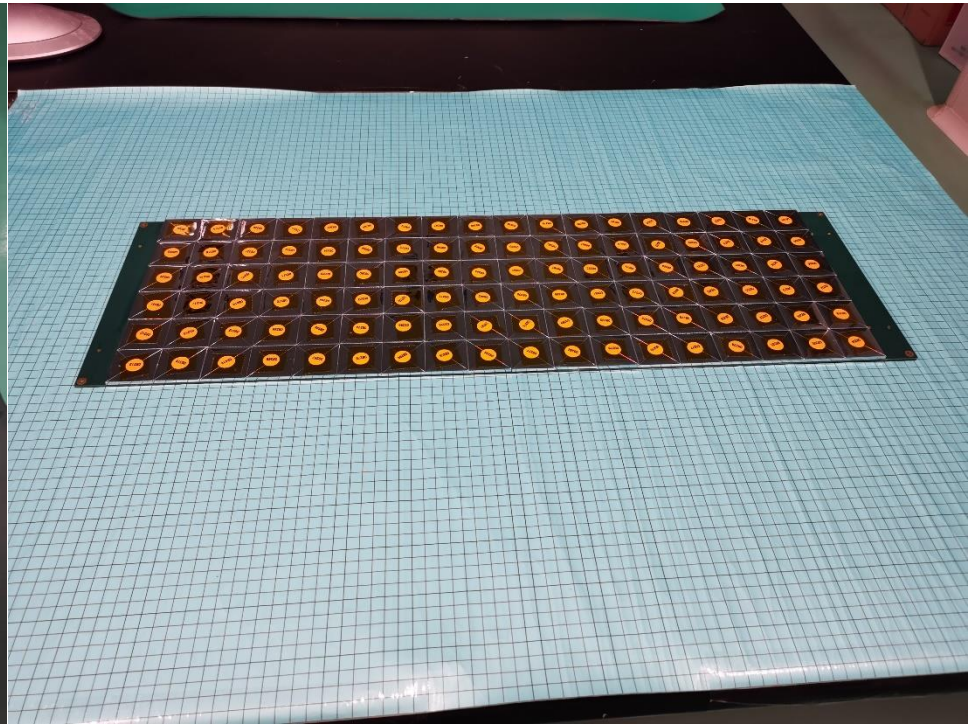
Low/High gain calibration



reference temperature

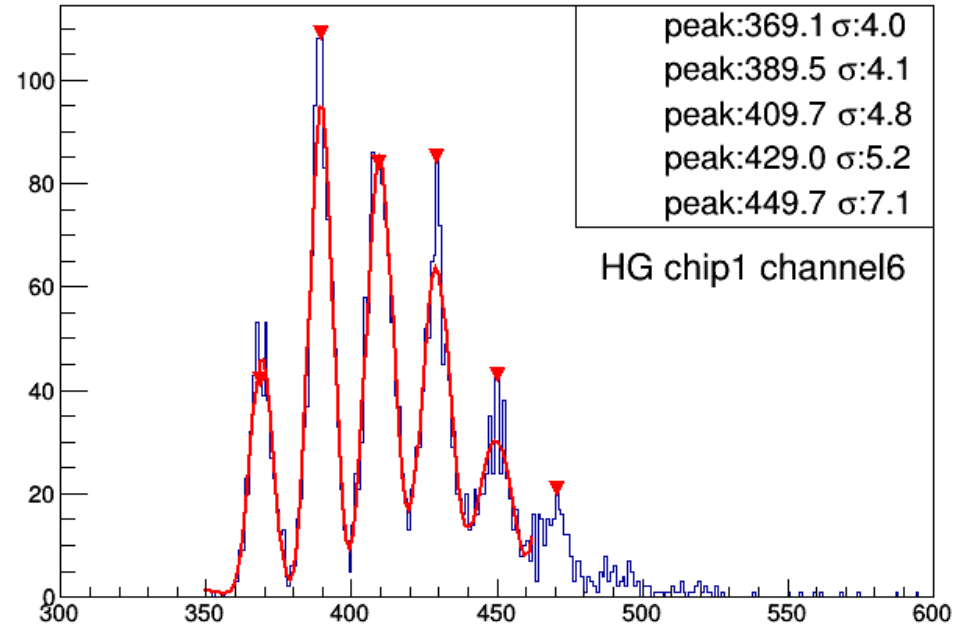
- The scintillators are assembled by SIC
- The scintillators are fixed on PCB by glue

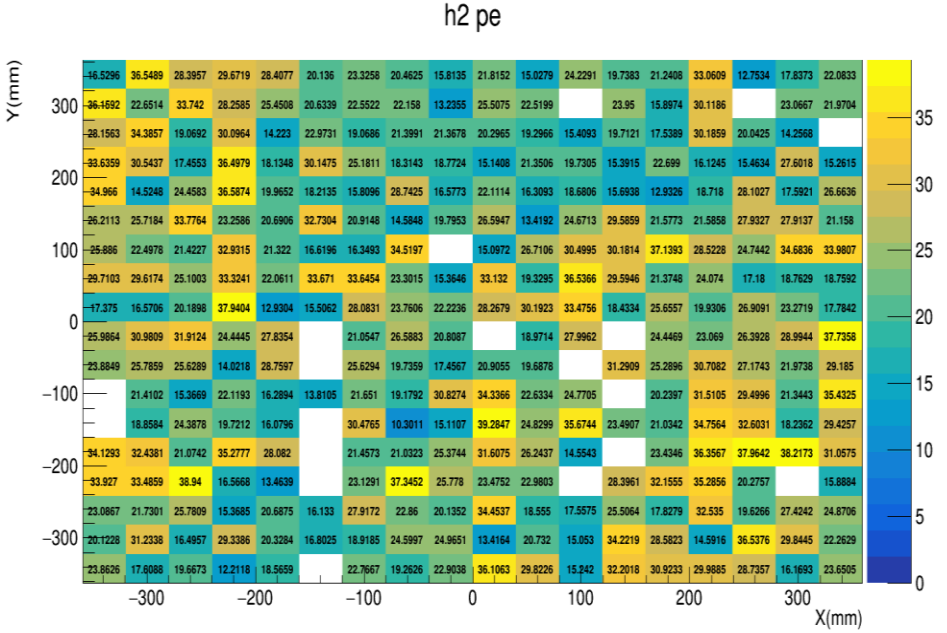




Assembling process

- LED calibration is done after the assembling
- Different SiPM voltage and LED voldtage are scanned, 19(5.9%) channels fail the fitting till now

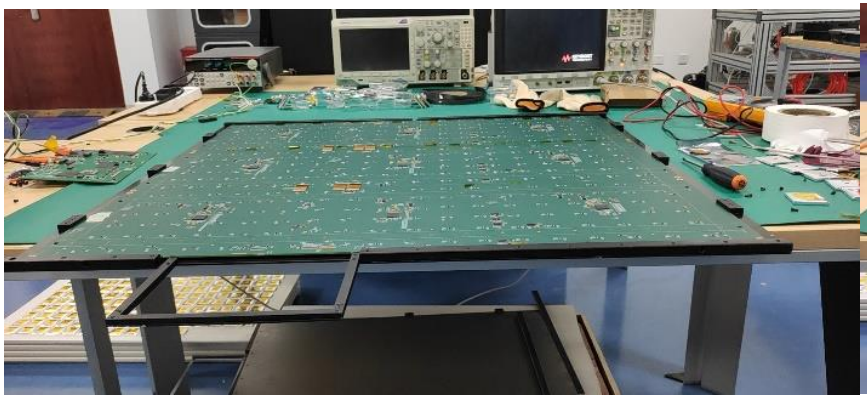


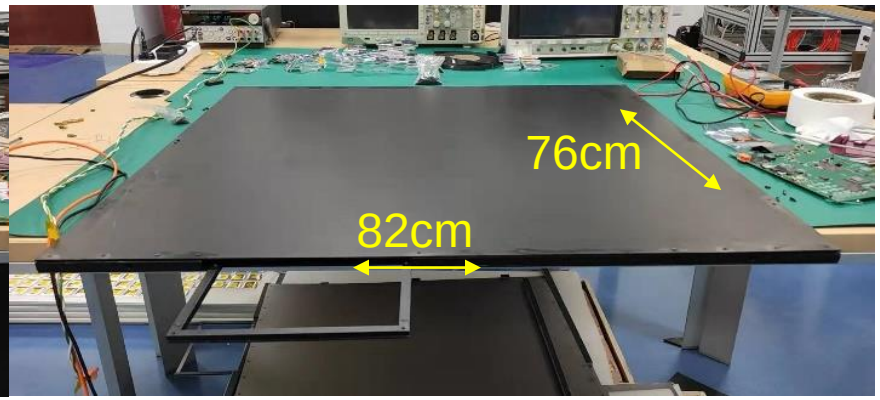


LED calibration results

HBU

- A steel cassette is made to contain the electronics
- the size of the cassette is $76 \times 82\mathrm{cm}^2$
- the cassette is 14mm thick
  - Up and bottom plate: 2mm each
  - Scintillator: 3mm
  - HBU: 2mm PCB + 4mm electronic parts
- 26 layers are produced till now, all 43 layers will be finished by June





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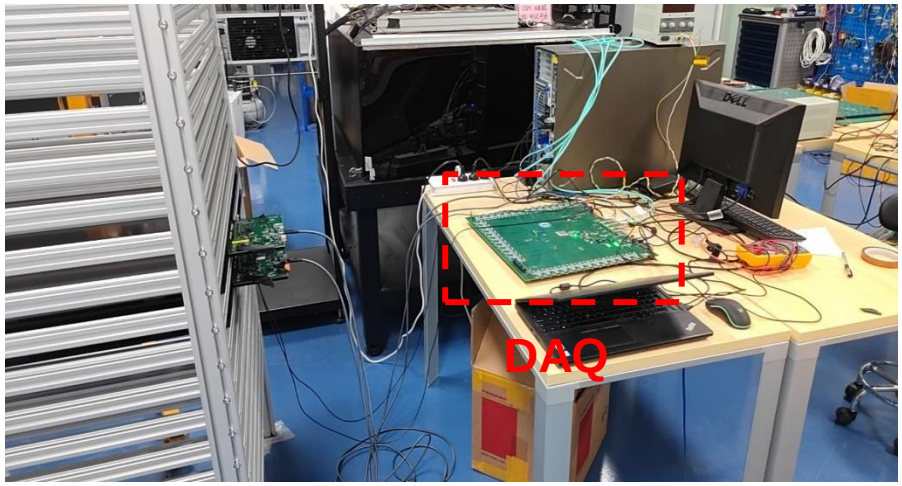
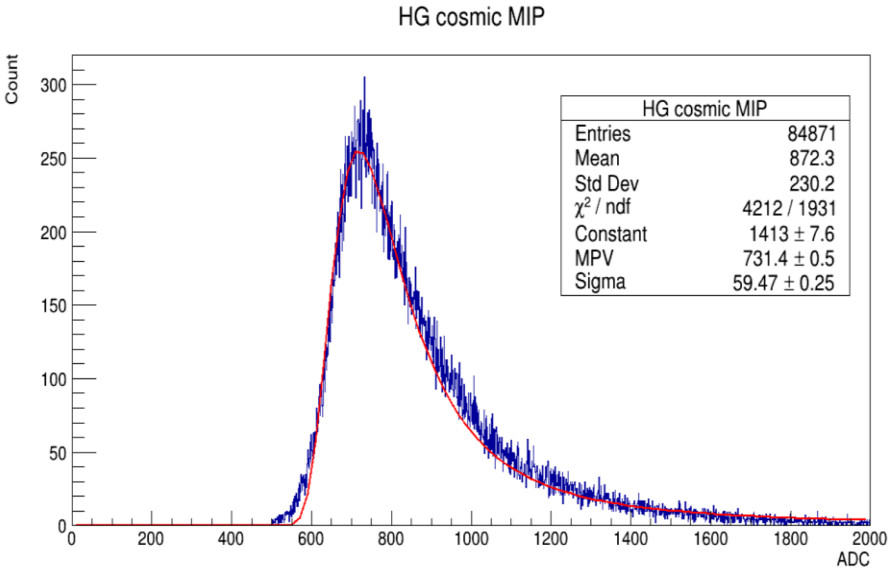
DAQ

- The DAQ could support 40 layers at once, sending commands and collecting data
- Cosmic ray test using 2 layers and DAQ has been done to verify its function



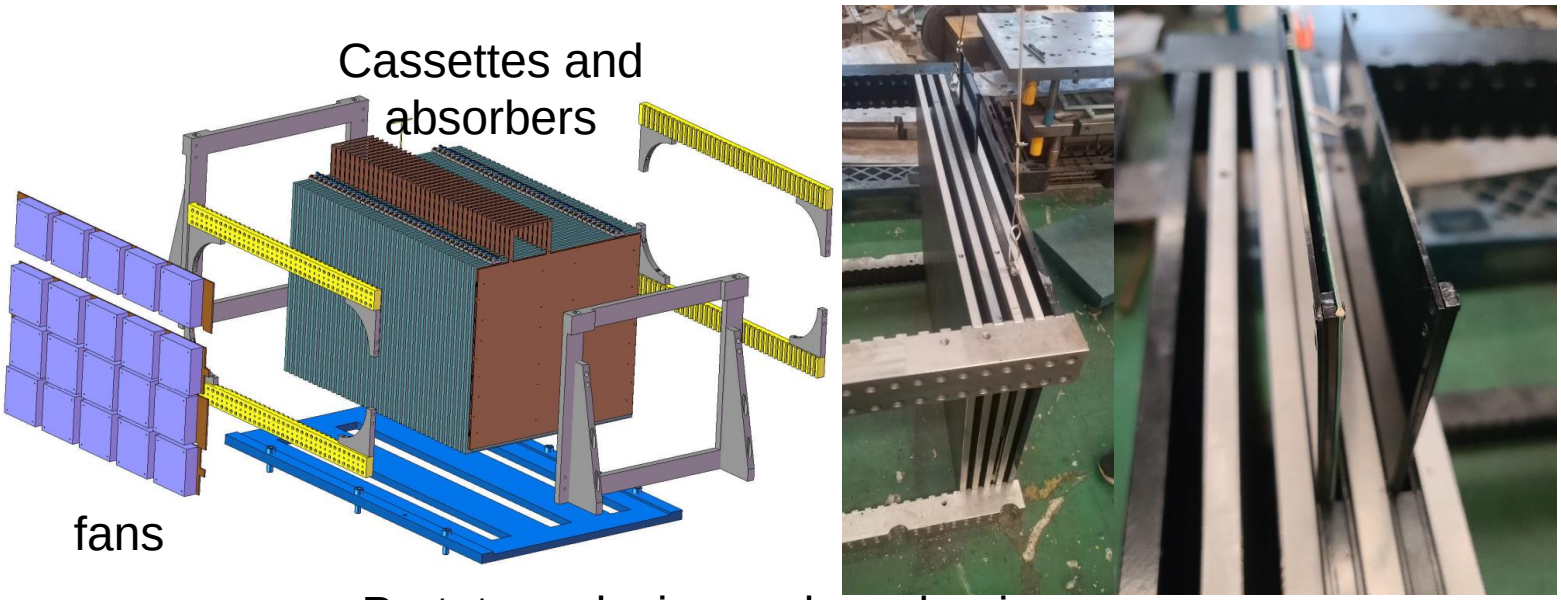
DAQ with 2 layers



The cosmic ray spectrum

mechanics

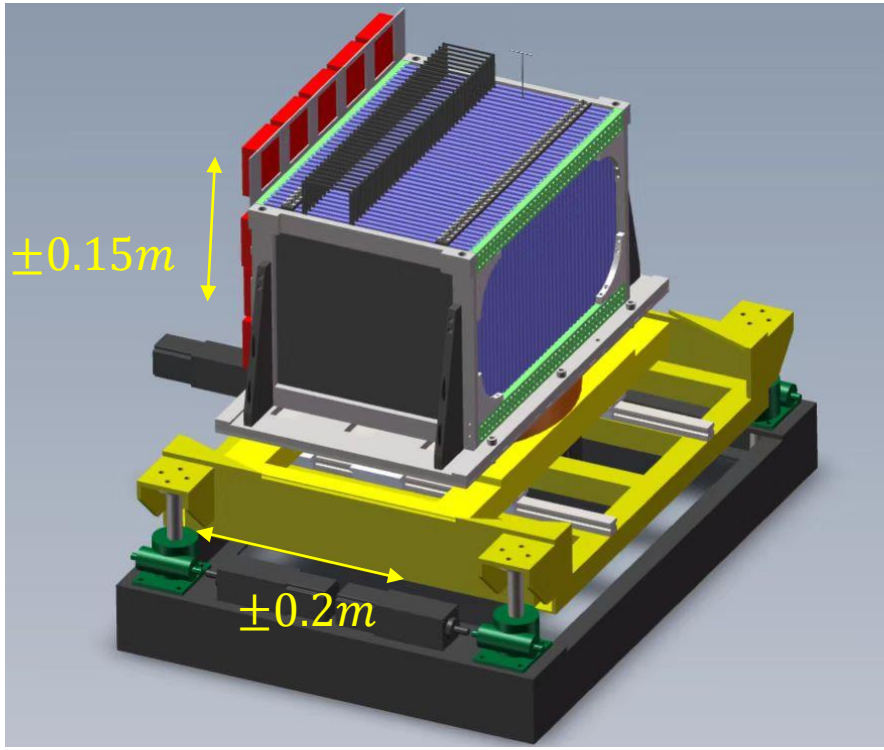
- The prototype structure has been designed and is under construction
- The total weight reaches 5 ton
- The prototype structure is planned to be finished by June



Prototype design and mechanics

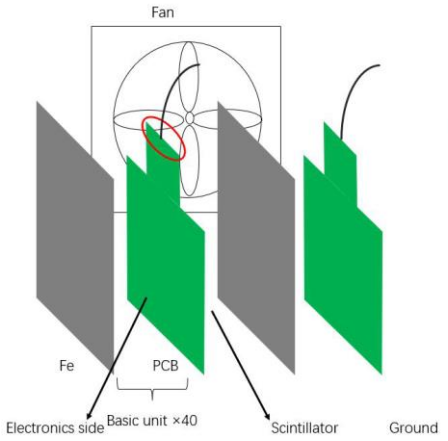
Supporting table

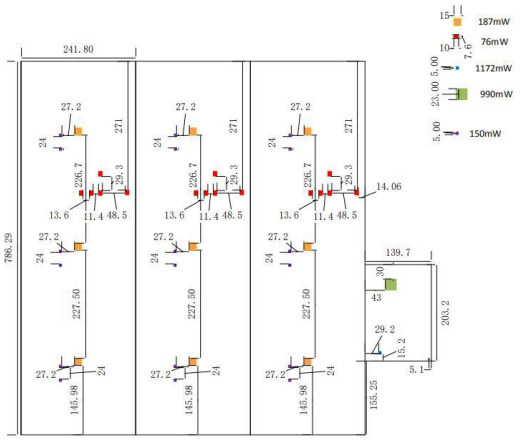
- A supporting tableis designed for beam test and will be finished by July
- Platform size: $1.7 \times 2.35m^2$
- Hight: $0.81 \pm 0.15m$
- Transverse: $\pm 0.2m$
- Standard load: $5.5t$
- Angle range: $\pm 30°$

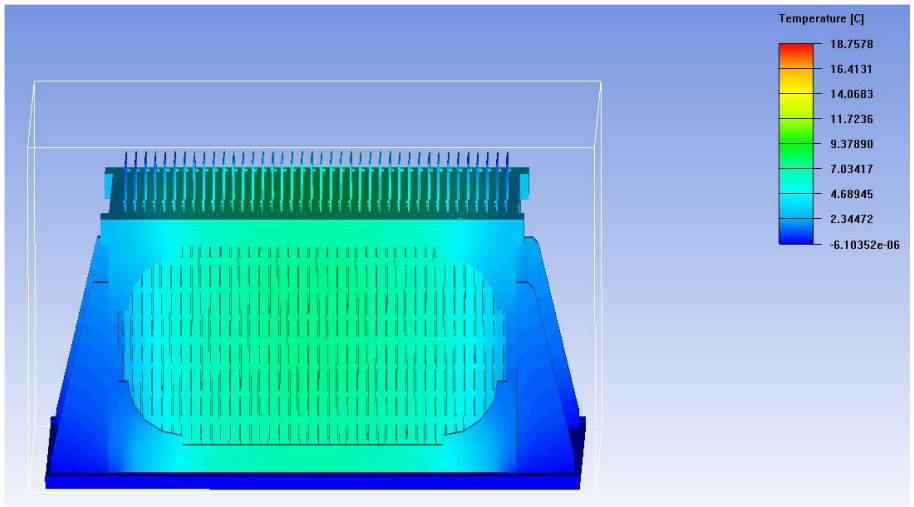


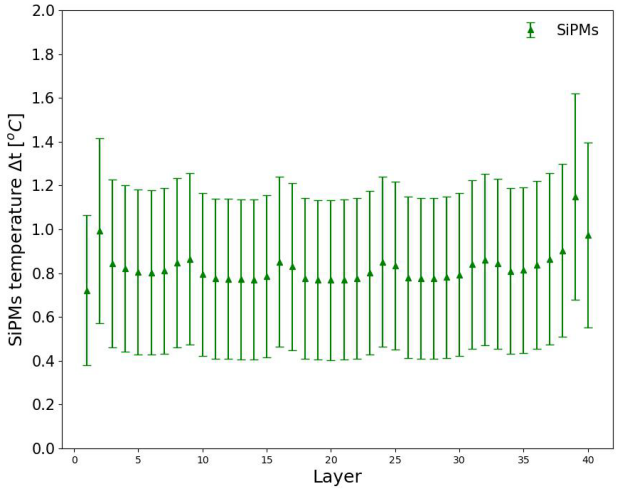
Cooling

- Simulation has been done using ANSYS according to HBU design
- The SiPMs's temperature are below 2 degree+room temperature
- Temperature test will start once HCAL layers are produced









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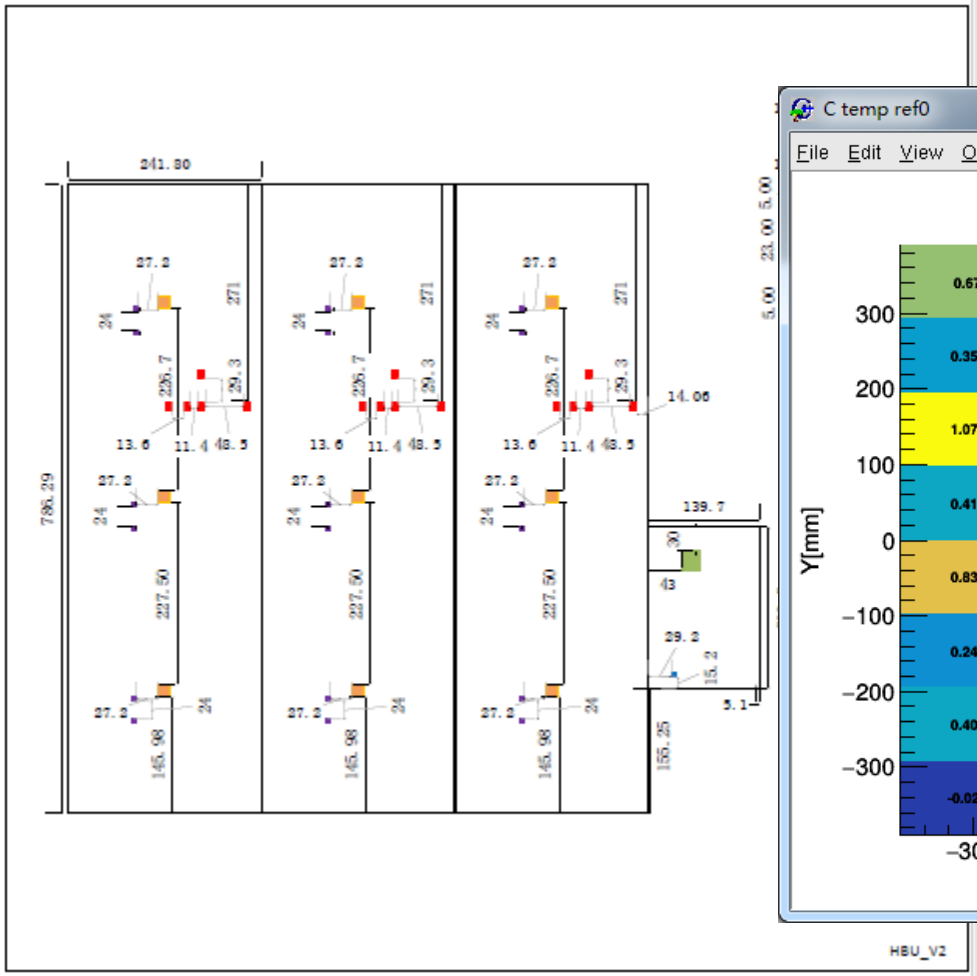
Summary and outlook

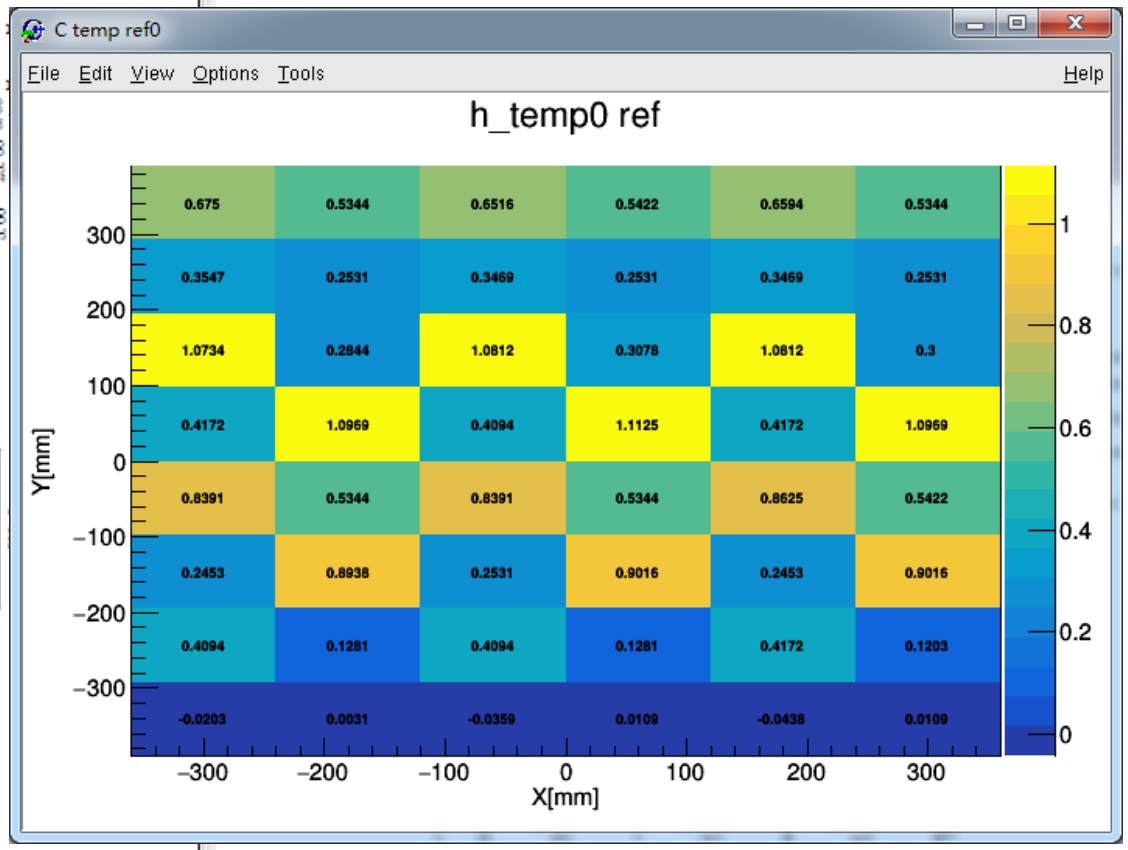
- We are at the stage of mass production
  - 26 layers are ready,17 are under production, will be finished by June. The scintillators will be assembled on to HBU by July
  - The mechanics will be finished by June
- The cosmic ray test will start once the layers are ready, probably in August
- The integration and shipment of the prototype are planned to start in September
- We plan to do a beam test this October at CERN

Back up

Time schedule

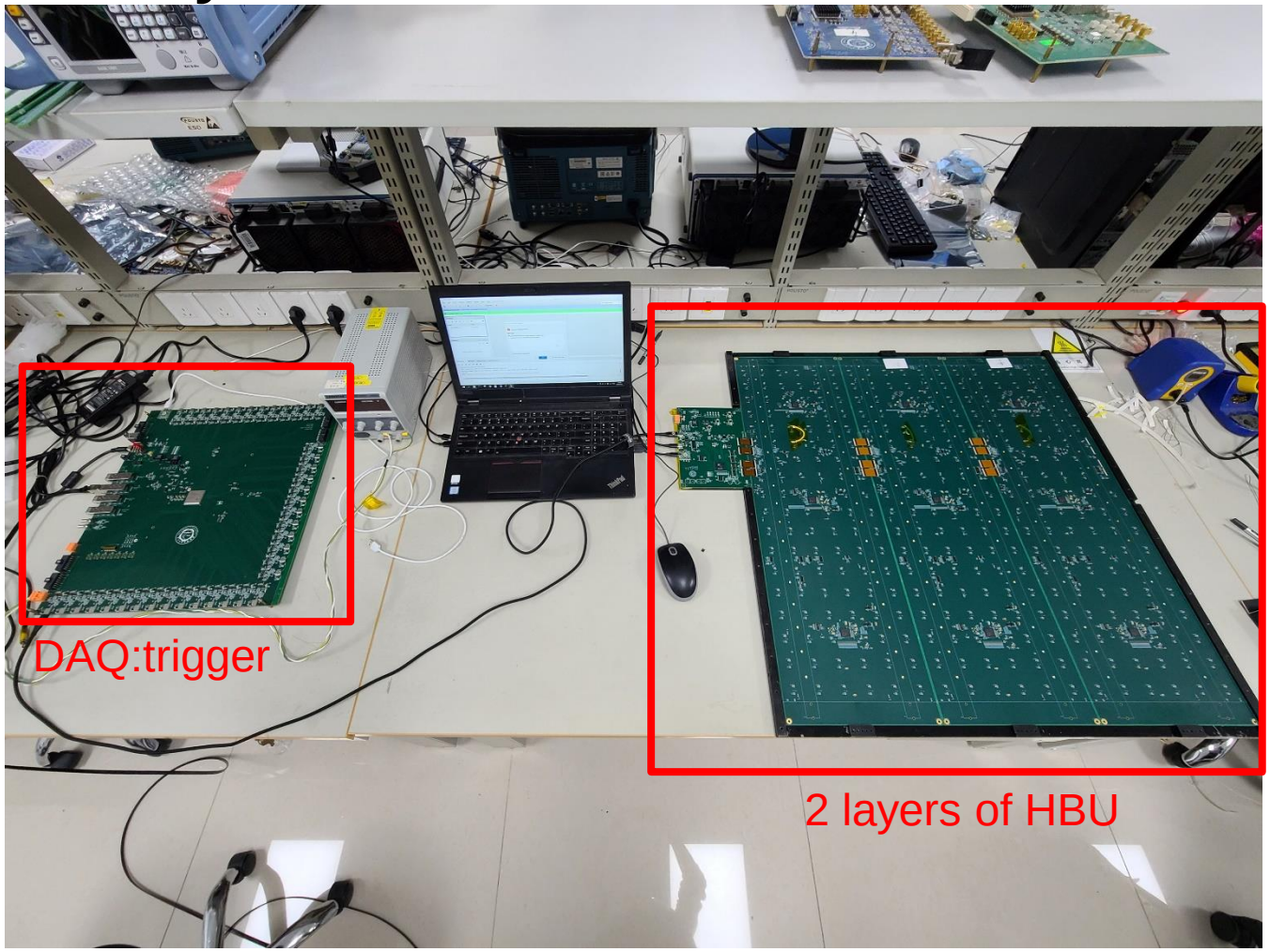
- The mass production of HBU will be finished by June, the scintillator will be assembled onto HBU by July
- Cosmic ray test and thermal test will be done during August
- The mechanics will be finished by June, the related test will start once the mechanics and HBU layers are ready the integration will start in September in IHEP, shipment will start once the integration is over.


241.80
796.29
27.2
271
24
235.7
29.3
13.6
11.4
48.5
227.50
145.98
26
14.06
139.7
43
29.2
15.24
5.1
155.25
HBU_V2


C temp ref0
File Edit View Options Tools Help
h_temp0 ref
0.675 0.5344 0.6516 0.5422 0.6594 0.5344
0.3547 0.2531 0.3469 0.2531 0.3469 0.2531
1.0734 0.2844 1.0812 0.3078 1.0812 0.3
0.4172 1.0969 0.4094 1.1125 0.4172 1.0969
0.8391 0.5344 0.8391 0.5344 0.8625 0.5422
0.2453 0.8938 0.2531 0.9016 0.2453 0.9016
0.4094 0.1281 0.4094 0.1281 0.4172 0.1203
-0.0203 0.0031 -0.0359 0.0109 -0.0438 0.0109
Y[mm]
300
200
100
0
−100
−200
−300
X[mm]
−300 −200 −100 0 100 200 300
1
0.8
0.6
0.4
0.2
0

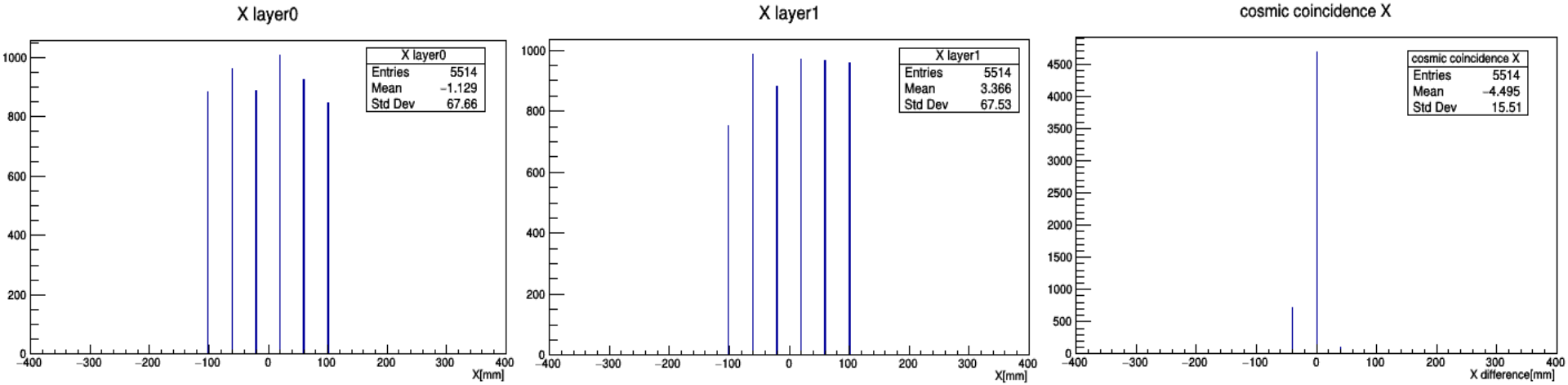
2 layer cosmic test

- Test system



results

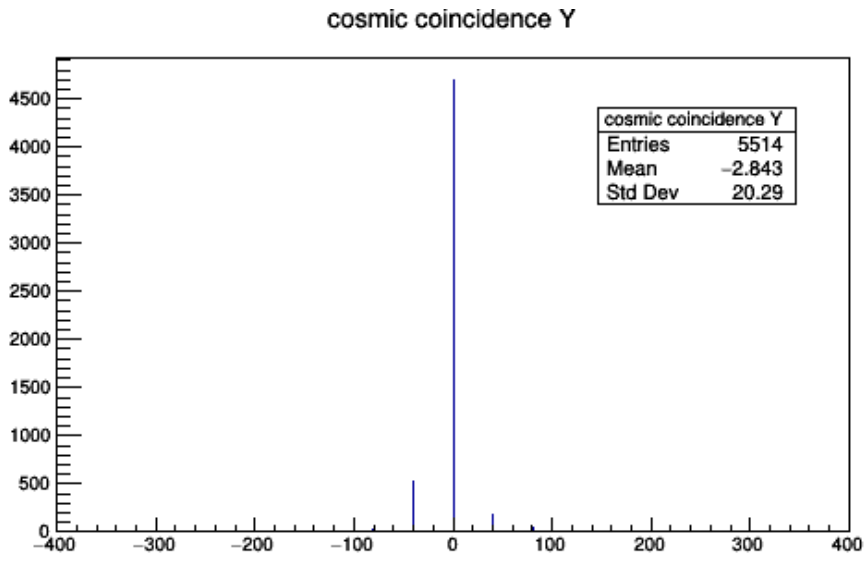
- Coincidence
  - The X/Y distance between 2 layers show that the events are triggered by cosmic ray



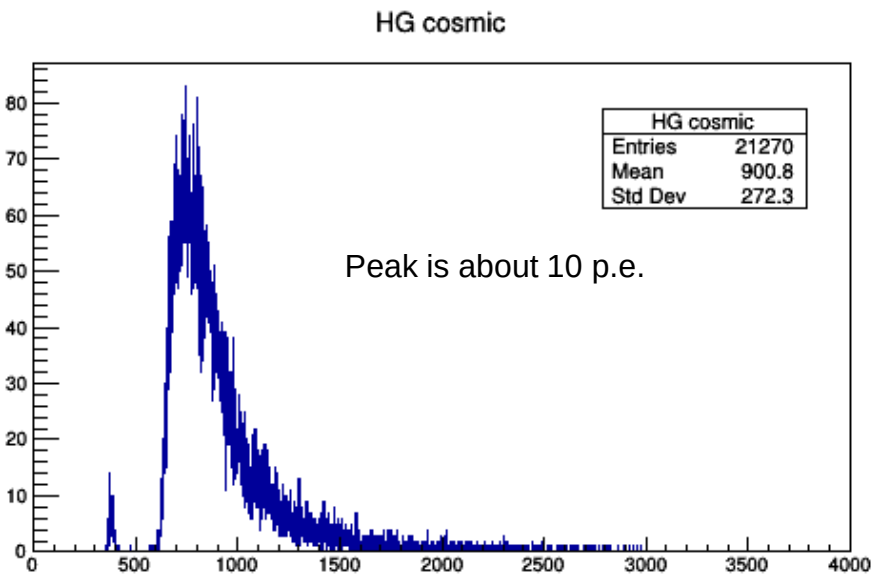
X position of 2 layers and their D-value event by event

results

- The function of DAQ and HBU has been verified



D-value in Y direction



Cosmic ray spectrum