

CEPC AHCAL prototype: progress and plan

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On behalf of CEPC Calorimeter working group



Outline

- CEPC AHCAL Brief Introduction
- AHCAL Progress
 - AHCAL Basic-Unit (HBU) mass production and test
 - HBU Assembled scintillators and cosmic test
 - Mechanical processing
 - Beam test in October
- Summary and Plan



Outline

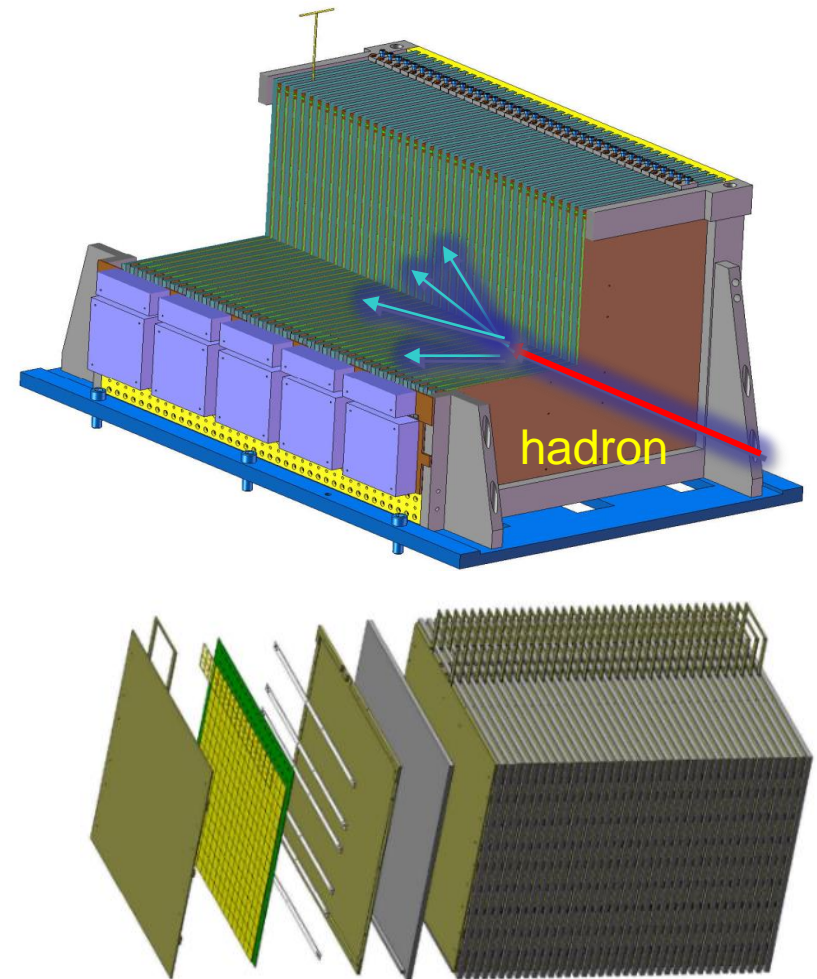
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AHCAL Prototype

- **Sampling Calorimeter**
 - 40 layers, ~ 5 N.I.L
 - $72\text{ cm} \times 72\text{ cm}$
- **Absorber**
 - Iron, 2 cm thickness
- **Sensitive Detector**
 - Scintillator+SiPM, Number:13,960
 - Cell size: $40\text{ mm} \times 40\text{ mm} \times 3\text{ mm}$
 - SiPM: HPK and NDL
- **Electronics**
 - SPIROC2E ASIC Chip

AHCAL Structure



General Progress

◆ Hcal Base Unit

- ◆ The final version (V3) HBU board was fixed and mass produced
- ◆ The HBUs after welding were tested in USTC
- ◆ After test, HBUs were assembled with scintillators in SIC
- ◆ After assembly, return to USTC for testing to prepare for assembly into a prototype

◆ Support structure processing

- ◆ Almost all HBU Cassettes have been processed
- ◆ The supporting structure of the AHCAL is being processed
- ◆ The displacement platform for beam testing is being processed



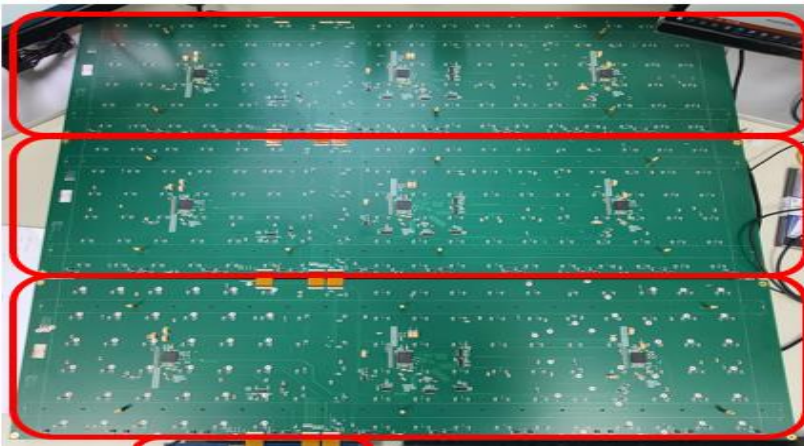
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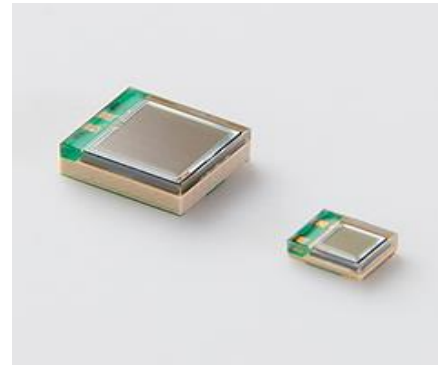


HBU Progress I

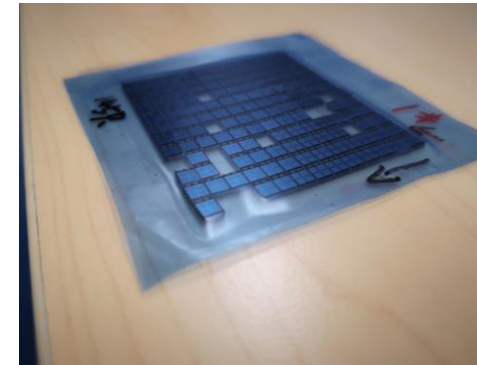
- ◆ We need to produce 43 HBUs for the prototype, 3 layers were used for backup
- ◆ Now we have produced 38 HBUs which welded by SiPM of Hamamatus
- ◆ The other 5 layers which welded by NDL SiPM are under production and welding



HBU



HAMAMATSU



NDL

HBU Progress I

- ◆ In order to ensure the consistency of SiPM performance on HBU, SiPMs with similar operating voltage need to be allocated to the same HBU
- ◆ The operation voltage of SiPMs (~13,000 pieces) which purchased is between 41.78 V - 42.34 V
- ◆ The SiPM operation voltages are sorted and then distributed
- ◆ Ensure that the SiPM operation voltage difference on each sub-HBU does not exceed 50 mV

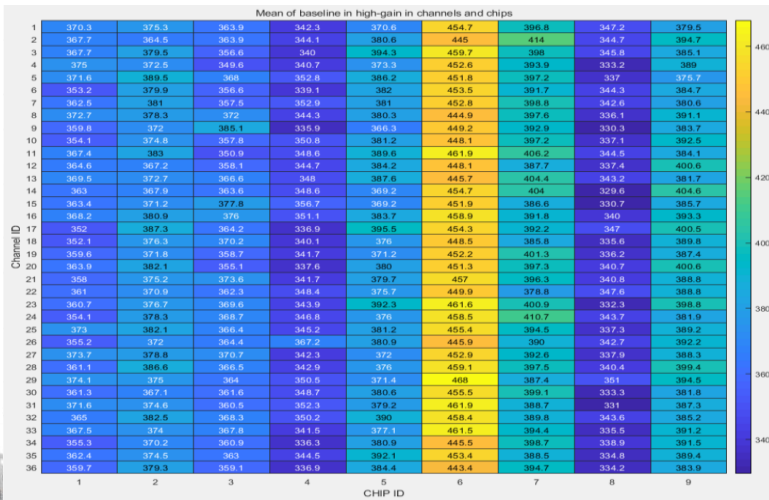


HBU Progress II

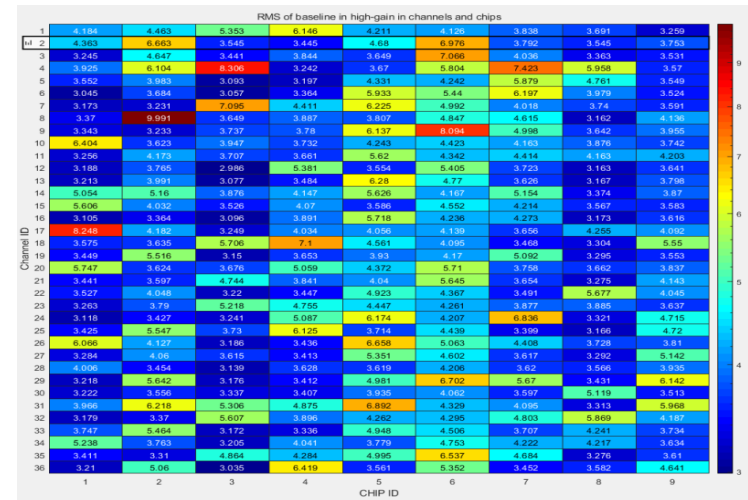
- ◆ The HBUs after welding were tested
 - ◆ Noise of each channel
 - ◆ DAC Calibration
 - ◆ LED calibration for SiPM
 - ◆ Temperature sensors response
 - ◆ Force Mode and self trigger Mode response



Pedestal position of each channel



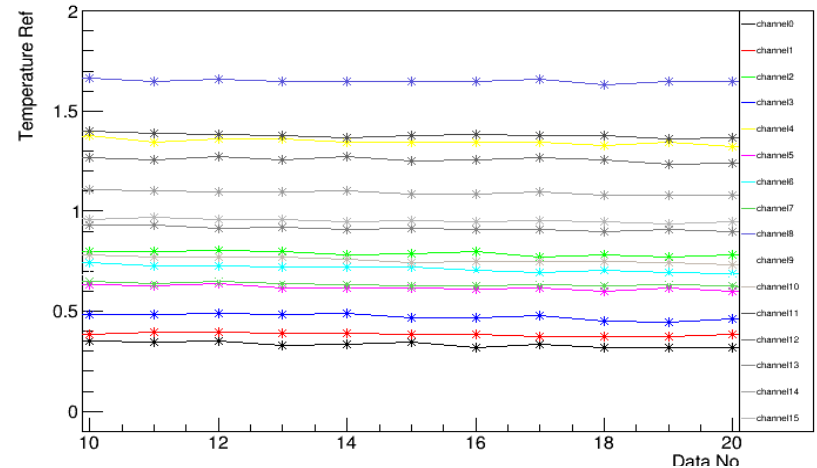
Pedestal width of each channel



Test Results

- ◆ The temperature of single-layer HBU is about 1 degree higher than the room temperature, and can be stable for a long time
- ◆ With LED, SiPM photoelectron spectrum is clearly visible
- ◆ The high-low gain ratio of each channel is about 30 times

Temperature



Ratio of Low-High gain

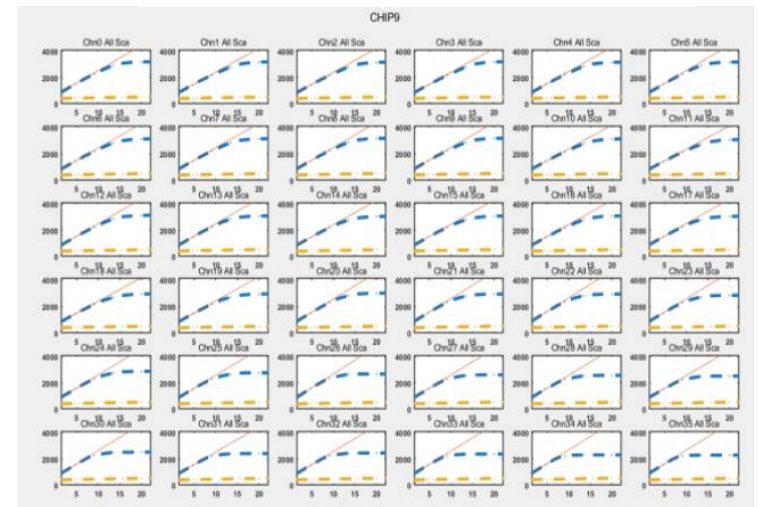
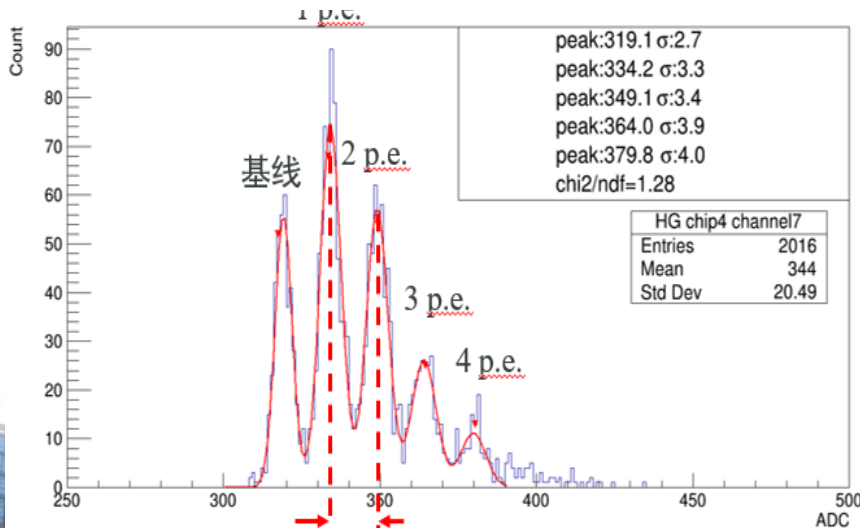


Photo-electron peak



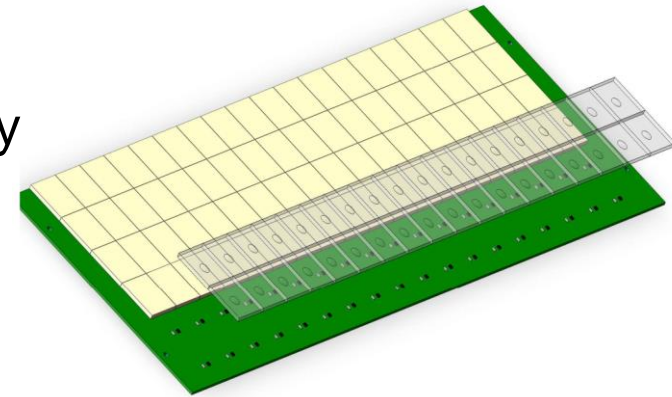
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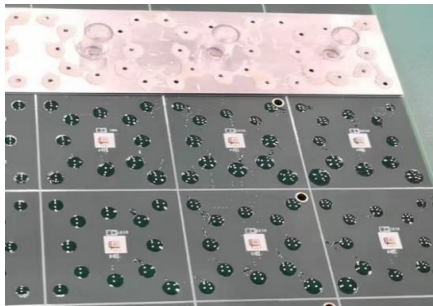


HBU Progress III

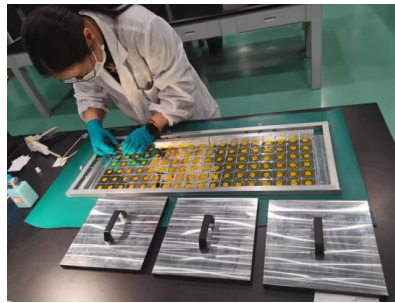
- ◆ assemble the scintillator on HBU
 - ◆ Fix the scintillators on the HBU with glue
 - ◆ press them with cover plate to make solidify
- ◆ Now, we have 8 HBUs (8 layers)
- ◆ More assembly molds are being produced, and 8 HBUs can be assembled a week from next week



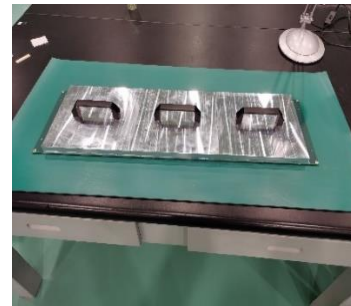
Scintillators on HBU



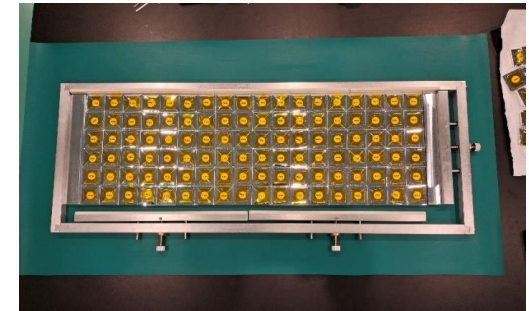
glue



assemble



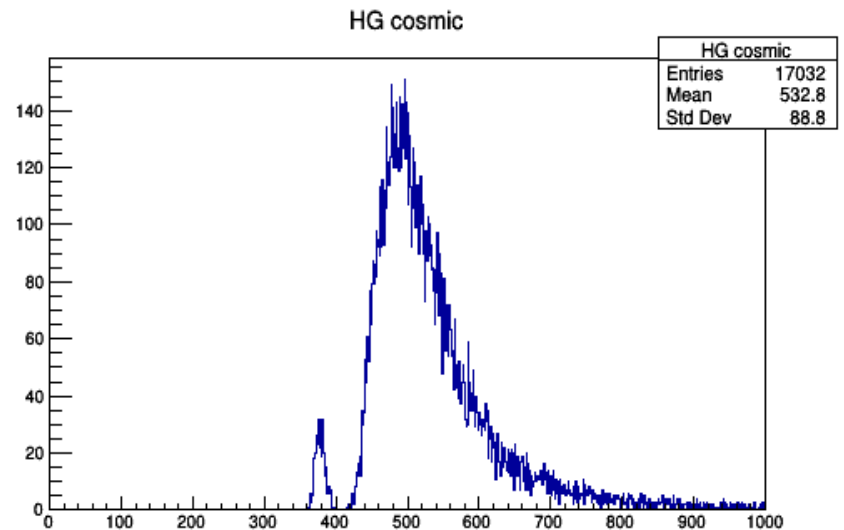
solidification



finish

HBU Progress IV

- ◆ After the scintillators assembled, an important task is to carry out cosmic ray test
 - ◆ Evaluate the performance of each unit
 - ◆ provide energy reconstruction reference for high energy beam test



Outline

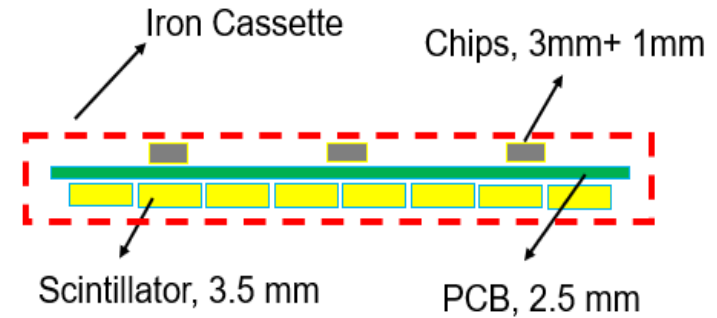
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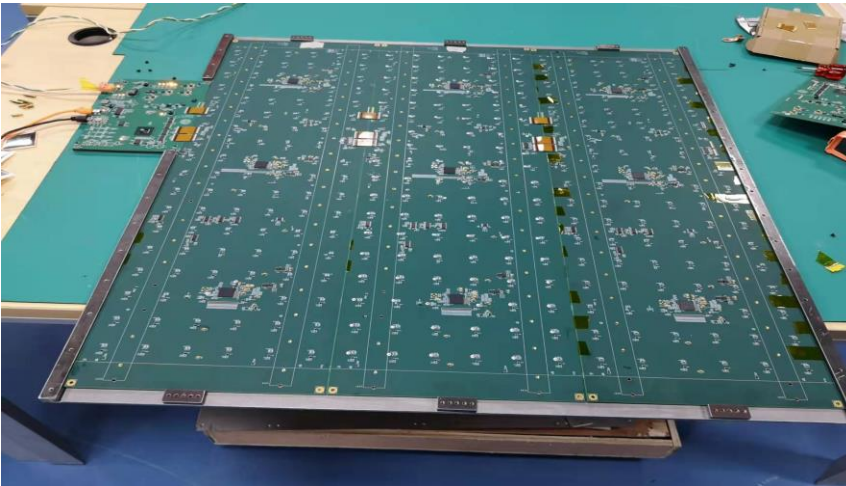
Mechanical Progress I

◆ HBU Cassettes produce

- ◆ In order to facilitate testing and transportation, each HBU has a cassette
- ◆ We choose iron as the material of the box, and the mass of this part is directly deducted from the absorber

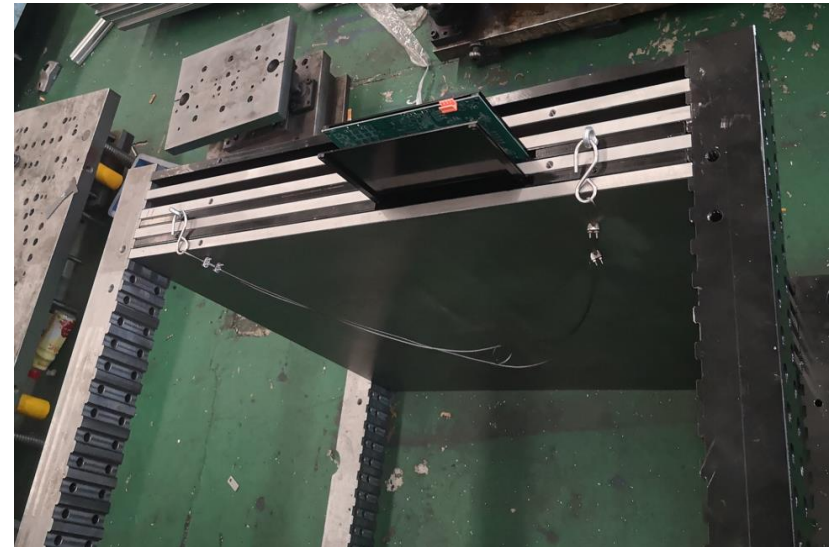
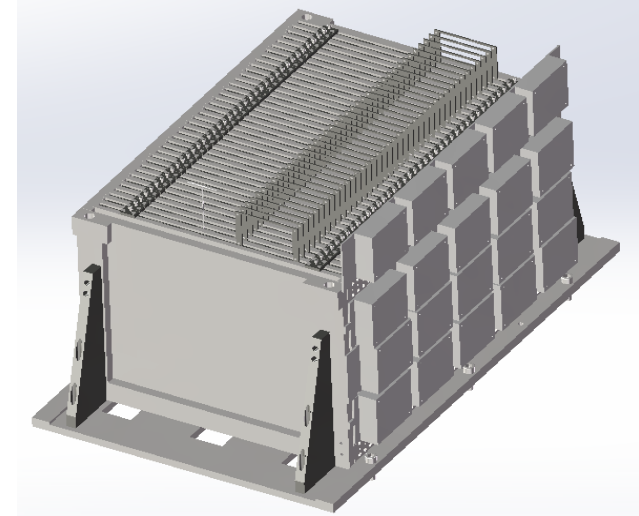


◆ Now, 40 cassettes were produced



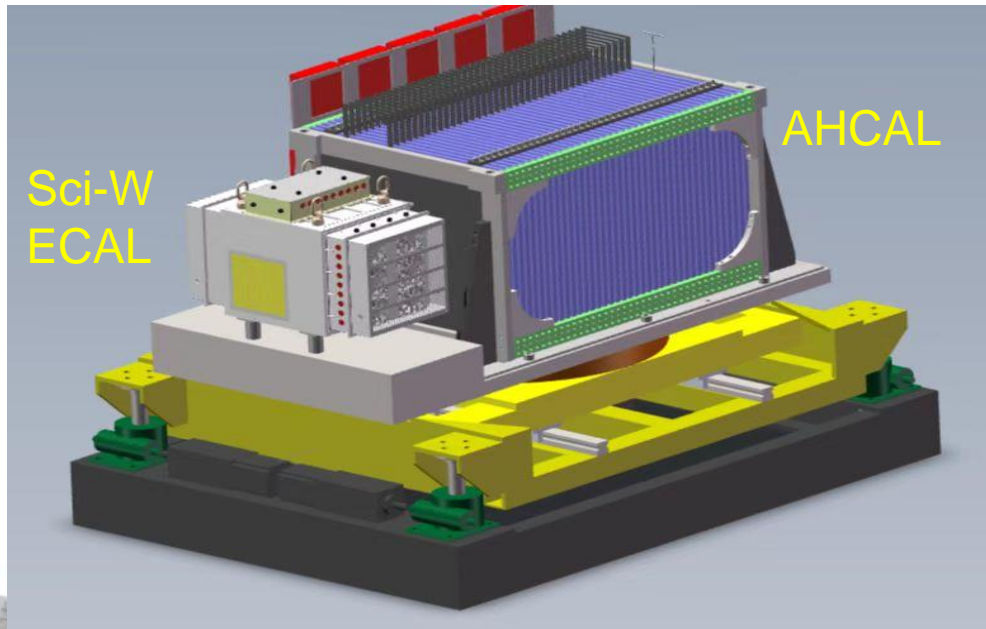
Mechanical Progress II

- ◆ The supporting structure of the AHCAL
 - ◆ In the factory, the whole prototype structure is being processed
 - ◆ The main weight is the absorbers. The cassette of HBU can be easily inserted into the gap between absorbers



Mechanical Progress III

- ◆ In order to carry out beam test better in the future, the displacement platform for beam testing
 - ◆ The platform can place AHCAL and Sci-W ECAL at the same time
 - ◆ The horizontal movement distance is 40 cm, and the up and down movement distance is 30 cm



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Beam test

➤ In mid October, there will be two weeks of high-energy particle beam testing at H8 of SPS

- The H8 beam line is a high-energy, high-resolution secondary beam line.
- The maximum momentum that can be transported in the experiments is 400 GeV/c protons or secondary mixed hadron beams within the range 10-360 GeV/c.
- the electron beams with variable purity (10 – 99 %) are also possible. The maximum $\Delta p/p$ acceptance of the line is 1.5%.

SPS: October 2022



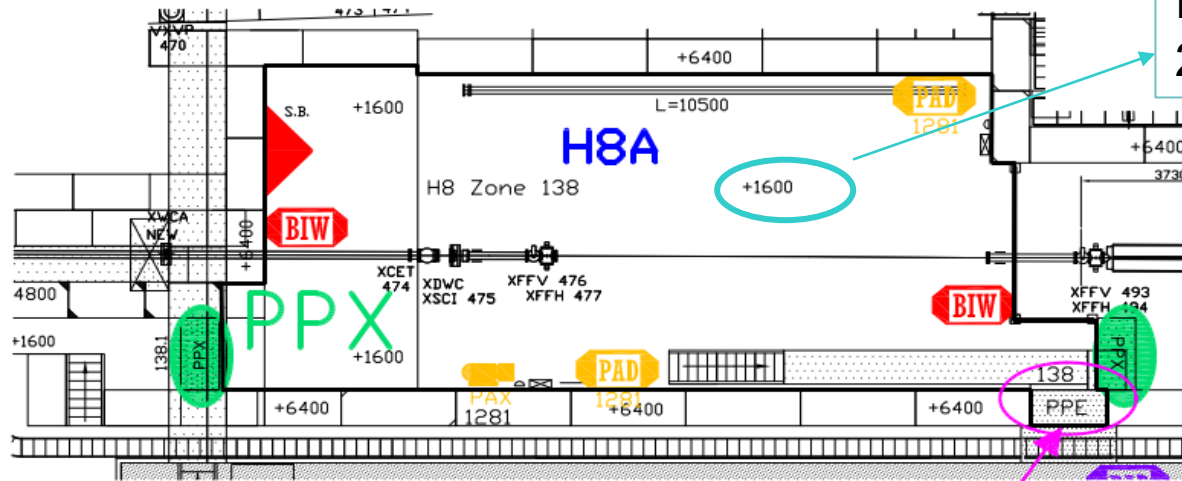
schedule issue date: 30-May-2022

Version: 1.10

	Mon 26 Sep	Tue 27 Sep	Wed 28 Sep	Thu 29 Sep	Fri 30 Sep	Sat 1 Oct	Sun 2 Oct	Mon 3 Oct	Tue 4 Oct	Wed 5 Oct	Thu 6 Oct	Fri 7 Oct	Sat 8 Oct	Sun 9 Oct	Mon 10 Oct	Tue 11 Oct	Wed 12 Oct	Thu 13 Oct	Fri 14 Oct	Sat 15 Oct	Sun 16 Oct	Mon 17 Oct	Tue 18 Oct	Wed 19 Oct	Thu 20 Oct	Fri 21 Oct	Sat 22 Oct	Sun 23 Oct	Mon 24 Oct	Tue 25 Oct	Wed 26 Oct	Thu 27 Oct	Fri 28 Oct	Sat 29 Oct	Sun 30 Oct
Week	39							40							41							42							43						
Machine																																			
North Area	T2 - H2	Calice	Sdhcal	A. Ariga	NA65				CMS HGCAL				LHCf				LHCb				ECAL														
				PPE172					D. Lazic				Y. Itow				H. Schindler				PPE172														
	T2 - H4	V. Gninenko			NA64e				EB. Holzer				Place-holder				M.R. Jäkel, E. Oliveri				GIF RD51														
		PPE134+PPE144															PPE134, PPE154																		
	T4 - H6 main user	CMS PIXELS			ATLAS ITK PIXEL				ATLAS AFP				MONO LITH				RD50				NA62														
	PPE146			A. Rummler				A. Rummler				Dannheim Dao				E. Figueras				H. Danielsson															
T4 - H6 parallel use	EP hybrid			ATLAS AFP BCM				ATLAS ITK PIXEL				ATLAS MALTA EP PIXEL				NA62 ATLAS HGTD				EP hybrid ATLAS HGTD															
	PPE146			A. Rummler				A. Rummler				V. Dao, D. Dannheim				H. Danielsson				E. Gkougkousis															
												LHCb CMS MTD (SLEDOM)				Calice				scW ECAL NA60+															
T4 - H8	UA9 Totem			UA9				H. Schindler, N. Neri				J. Liu, E. Scomparin				158 or 168, PPE138																			
	PPE128			PPE128, PPE138, PPE158, PPE168																															






Beam test

Beam H8 - PPE138



Floor height is 2860-1600=1260 mm

You are here

- 2  Exit door PPX / PPG
- 1  Patrol box
- 2  Flash Beam Imminent Warning
-  Radiation display
-  Radiation monitor

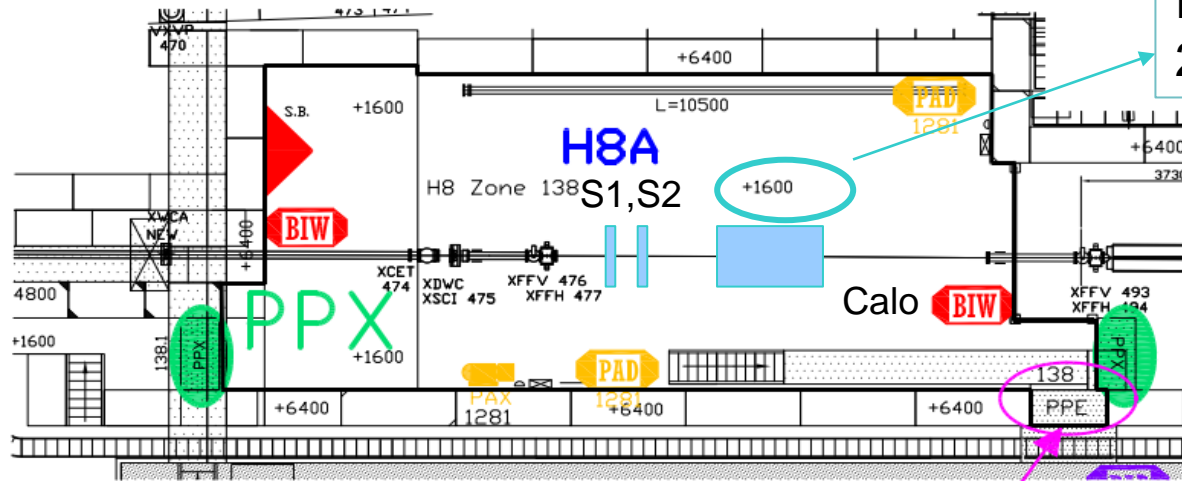
For access problems please contact CCC: 77500

EN-MEF 08/2012








Beam test

Beam H8 - PPE138



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 $2860 - 1600 = 1260$ mm

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EN-MEF 08/2012

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AHCAL development and Beam test plan

- The prototype can be completed by the end of July
 - All of the HBUs could be produced before 15th of July
 - Complete the assembly of all scintillators at the end of the July
 - The prototype structure could be finished before 15th of July
 - AHCAL trial assembly can be completed at the end of July
- We need at least 2 weeks for the cosmic ray test for the whole “prototype”, before 15th August
- Then we will pack it and send to IHEP
- Send to CERN in early September for Beam test
- Beam testing participants arrived at CERN in early October to start beam preliminary preparation



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THANKS



backup



SiPM Procurement and testing

◆ Two different types SiPM were selected in this prototype

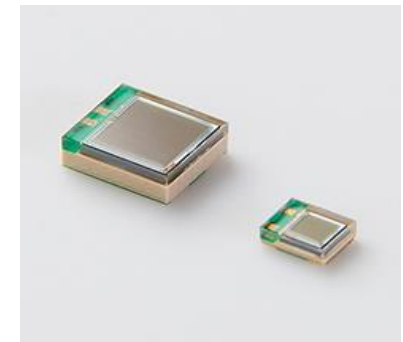
◆ NDL, 1700 pieces

◆ HAMAMATSU, ~13000 pieces



NDL

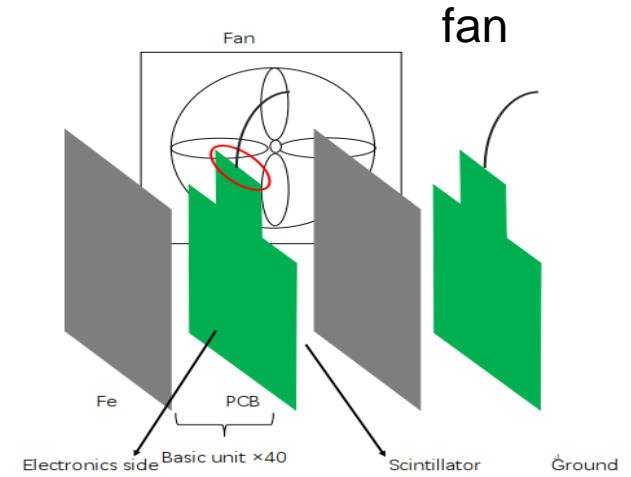
Company	NDL	HPK
Type	22-15	S14160-1315PS
Sensitive area (mm ²)	1.6*4	1.69
PDE (%)	40	32
Gain (*10 ⁵)	2.4	3.6
Pixel No.	7400*4	7284
Breakdown Voltage (V)	28	38
OverVoltage (V)	4	4
Dark Count (kHz)	330*4	120
Cross Talk (%)	8.5	1.0



S14160-1315PS

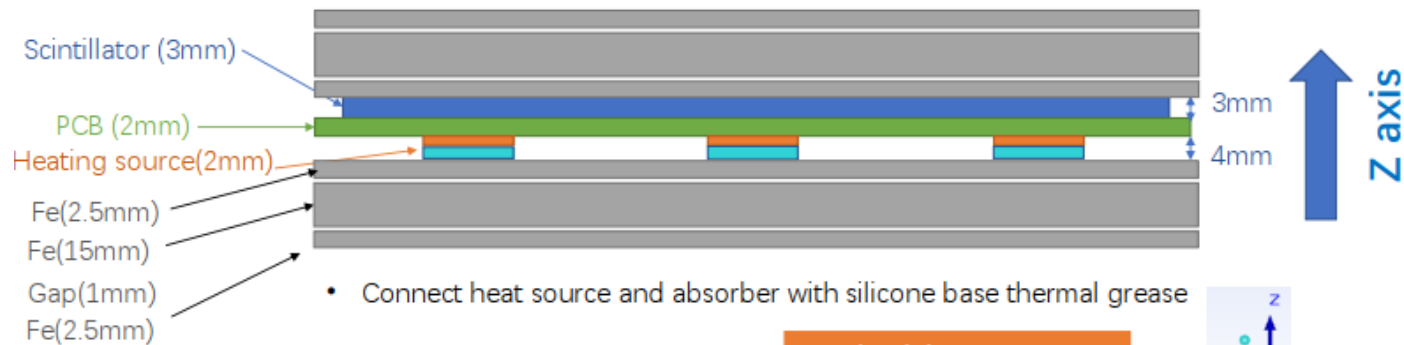
Cooling simulation

- The power consumption of each layer of HBU is about 4 W
- The main heat sources are electronic chips
- In order to reduce the influence of temperature, we add some fans next to the AHCAL



Fe-Heating source-PCB-Scintillator-Fe

(Fe-Heating source-PCB-Scintillator)*n-Fe



Conductivity
1W/m-K



6

