# Update of the CEPC AHCAL Prototype

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On behalf of CEPC Calorimeter working group



- ➢ Brief review of AHCAL of CEPC
- CEPC AHCAL Status
  - Scintillators mass production and test
  - ➢SiPM procurement and test
  - ➤HBU design and test
  - Assembly of scintillator to HBU
  - ➤ Mechanical Design
- Summary and outlook

# AHCAL Prototype

#### Sampling Calorimeter

- 40 layers, ~ 5 N.I.L
- -72 cm $\times$ 72 cm
- Absorber
  - Iron, 2 cm thickness
- Sensitive Detector
  - Scintillator+SiPM
  - Cell size: 40 mm×40 mm×3mm
  - SiPM: HPK and NDL

#### • Electronics

- SPIROC2E ASIC Chip



**AHCAL Structure** 



#### Scintillator mass production and packaging

- More than 10000 scintillators were produced based on ejection molding and packaging using ESR film
- Another 5000 tiles will be finished in the end of June







All the packaged scintillators (~10000) have been tested
SJTU, USTC, IHEP

 After the remaining 5000 pieces are produced, batch testing will be started

tit is planned to be completed by the end of July



#### SiPM Procurement and testing

- Two different types SiPM were selected in this prototype
  - ♦ NDL, 3000 pieces, end of June
  - ◆ HAMAMATSU, ~12000 pieces, end of August



Company	NDL	НРК
Туре	22-15	S14160-1315PS
Sensitive area (mm <sup>2</sup> )	1.6*4	1.69
PDE (%)	40	32
Gain (*10 <sup>5</sup> )	2.4	3.6
Pixel No.	7400*4	7284
Breakdown Voltage (V)	19	38
OverVoltage (V)	4	4
Dark Count (kHz)	330*4	120
Cross Talk (%)	8.5	1.0

NDL



S14160-1315PS

### SiPM bench test system

- SiPM test platform
  - Batch testing
  - I-V curve, dark count, gain
  - For best operating conditions







#### SiPM photon electron spectrum

- SiPM cell difference
  - Completely same operation







# SiPM Dark Counting Rate

- S curve at 1 p.e.
  - 1 p.e. ~ 45ADC
  - Close to Pedestal
- DCR of SiPMs
  - OR-16 counter for 1s
  - Tested at 22.7V
  - 440~680 kcps





## SiPM I-V curve

- I-V curves of 16 channels
  - Operated from 21.5V to 27.5V
  - I can be measured when  $V_{op}$ >23V







## **HCAL Baseboard Unit Status**

- One layer has 3 sub-HBUs
- One sub-HBU is  $78.5 \times 24$  cm<sup>2</sup>
- Flexible boards are used to transmit power and signal between the 3 sub-HBUs and DIF
- Each sub-HBU has 3 SPIROC2E chips
  - The chips were packaged in China





AHCAL



2021/6/9

Data InterFace (DIF) board

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### Pedestal of HBU

- The pedestal of each channel was calibrated using random trigger
- The pedestal positions are differences between chips
- The channels of the same chip are relatively uniform
- The pedestal width has little to do with the chip



The pedestal of one channel



The pedestal of each channel in HBU

# **HBU LED Calibration**

- LED calibration system was used to calibrate the gain of SiPM, and monitor the stability
- The driving circuit excites the LED to emit light
- The light will incident on the SiPM
- The single photon electron spectrum could be calibrated while the light is weak











#### **HBU** temperature Monitor

- Each sub–HBU has 16 temperature sensors to monitor the temperature real time
- The temperature data could be used to adjust the operation voltage of SiPM on line or to correct it off line



# **HBU Support Frame**

- The size of HBU is so large
- a supporting structure is needed to protect the chips and components from the deformation of HBU



#### Gravity causes deformation of HBU





Thickness of supporter (mm)	Deformation (mm) Al vs. Fe
3	2.5 / 1.4
4	1.4 / 0.7
5	0.8 / 0.4



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## **HBU Support Frame**

- A 5mm thick AI support frame is machined for trial assembly and testing with HBU
- The optimization of the support frame will be discussed next step







#### **Prototype Mechanical design**

- A preliminary discussion was done about the AHCAL design with the mechanical expert of IHEP, and further discussion will be carried out
- Pro. Haijun Yang arranged students to do temperature simulation about AHCAL





## Assembly of scintillator to HBU

#### Assembly process



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- 2021.7.31 the remaining 5000 scintillators production and testing could be finished
- 2021.8.31 the mechanical design should be completed
- 2021.9.30 the SiPMs should be tested completed, and prepared for HBUs
- 2021.12.31 The mechanical structure should be finished
- 2021.12.31 HBUs need to complete electrical installation and testing
- 2022.1.31 The assembly of scintillators to HBUs are completed
- 2022.6.30 cosmic test and AHCAL assembly
- 2022.7.31 The calorimeter is ready for the beam test

# backup

