

The 2020 International Workshop on the High Energy Circular Electron
Positron Collider (Oct. 26-28, 2020)

Development of the CEPC Scintillator- tungsten ECAL prototype

Yazhou Niu, USTC

On behalf of the *CEPC-CALO* working group

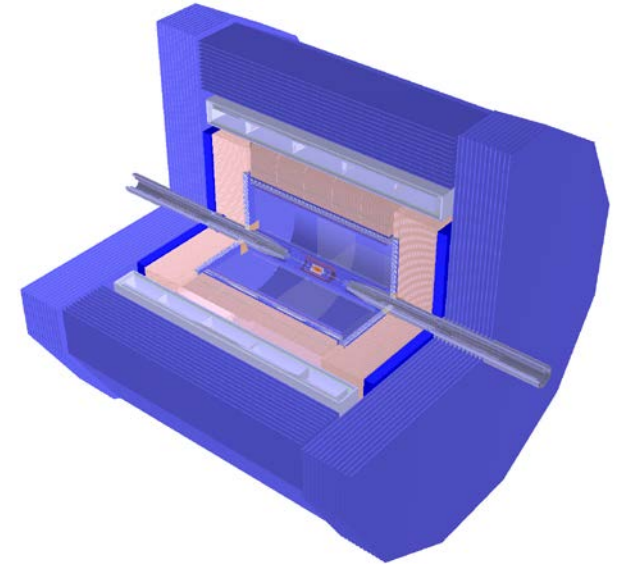
CEPC Workshop 2020, TDLI/SJTU, Shanghai

Outline

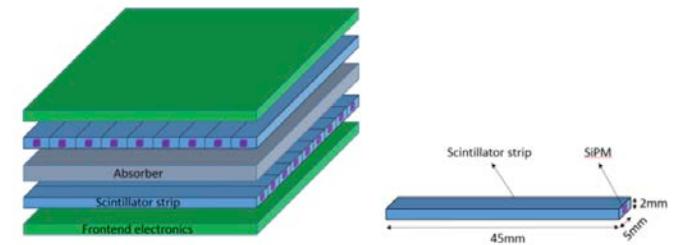
- Introduction
- CEPC Sc-ECAL prototype design and development
- Progress of the prototype commissioning
- Summary and future plan

Introduction

- A fine-grained Sci+W calorimeter concept has been adopted as one of the CEPC ECAL options.
- There is a R&D program dedicated to the CEPC Sci-ECAL option that was started in 2016.
- The R&D goal is to build and characterize a technological Sci-ECAL prototype to validate the CEPC Sci-ECAL design.
- Collaborating with the Sci-ECAL effort in Japan to fully explore the synergy between CEPC and ILC in detector R&D.



CEPC detector concept



Strip Sci-ECAL concept for CEPC

Joint Snowmass Lol on ScW-ECAL

- Both for ILC and CEPC

Development of Highly Granular Scintillator Strip Electromagnetic
Calorimeter

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August 30, 2020

Abstract

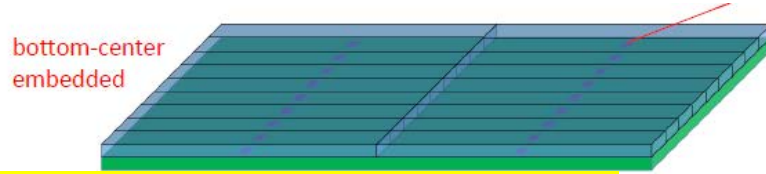
Highly granular electromagnetic calorimeter based on scintillator strip with SiPM readout (Sc-ECAL) is under development in the framework of the CALICE collaboration for future electron-positron colliders such as ILC and CEPC. After the validation of the concept with the physics prototype, a technological prototype with full layers is being constructed to demonstrate the performance of Sc-ECAL with more realistic technical implementation. The status and prospects of the R&D of Sc-ECAL are briefly described.

[SNOWMASS21-IF6 IF0 CALICE-058.pdf](#)

Outline

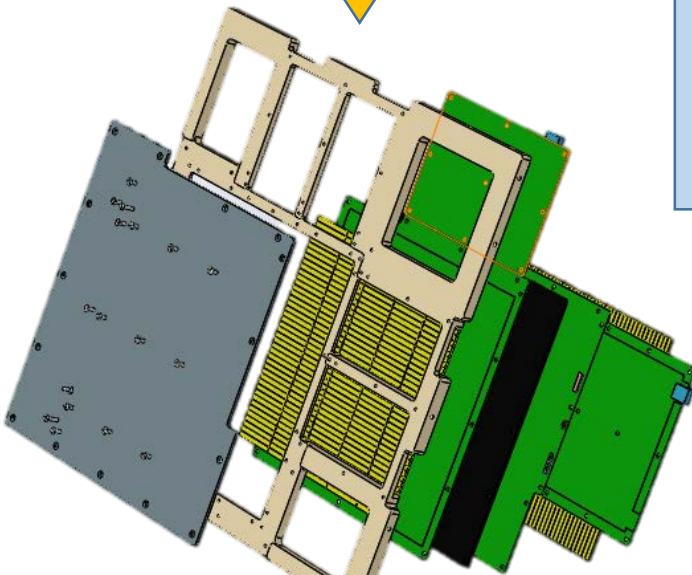
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CEPC Sc-ECAL prototype design



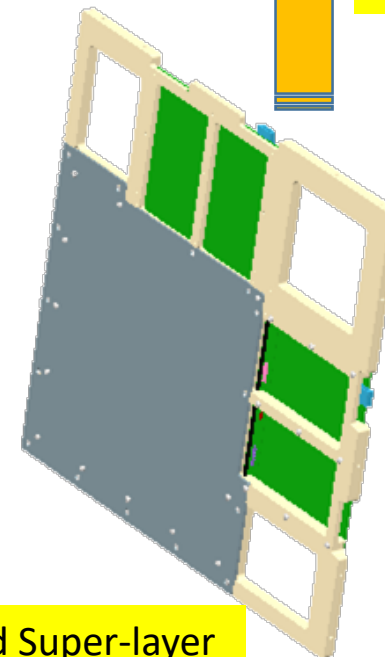
bottom-center
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SiPM coupling with scintillator strips

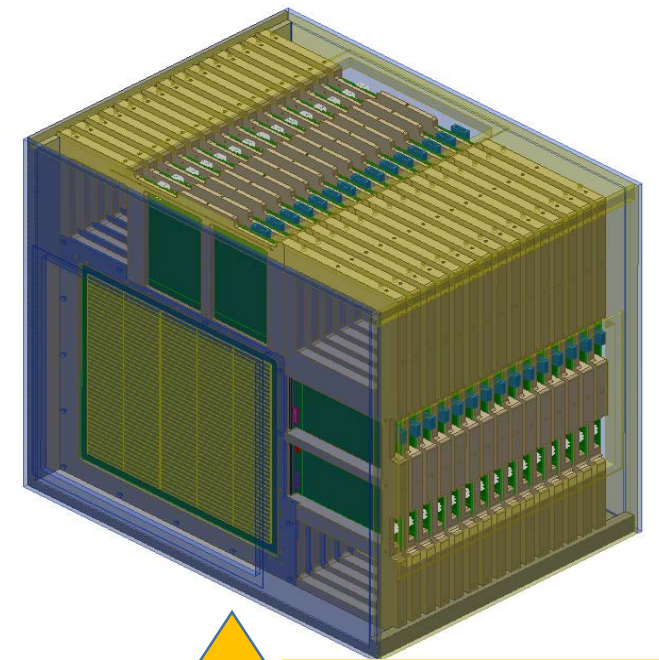


Ecal Basic Unit and absorber

- 210 channels / EBU
- 30 EBUs + 30 DIFs
- 15 "super-layers"
- Sc-ECAL prototype



Integrated Super-layer



Sc-ECAL prototype



Contributions from Japanese groups

bottom-center
embedded

By Tokyo group (W. Ootani)

By Shinshu group (T. Takeshita)

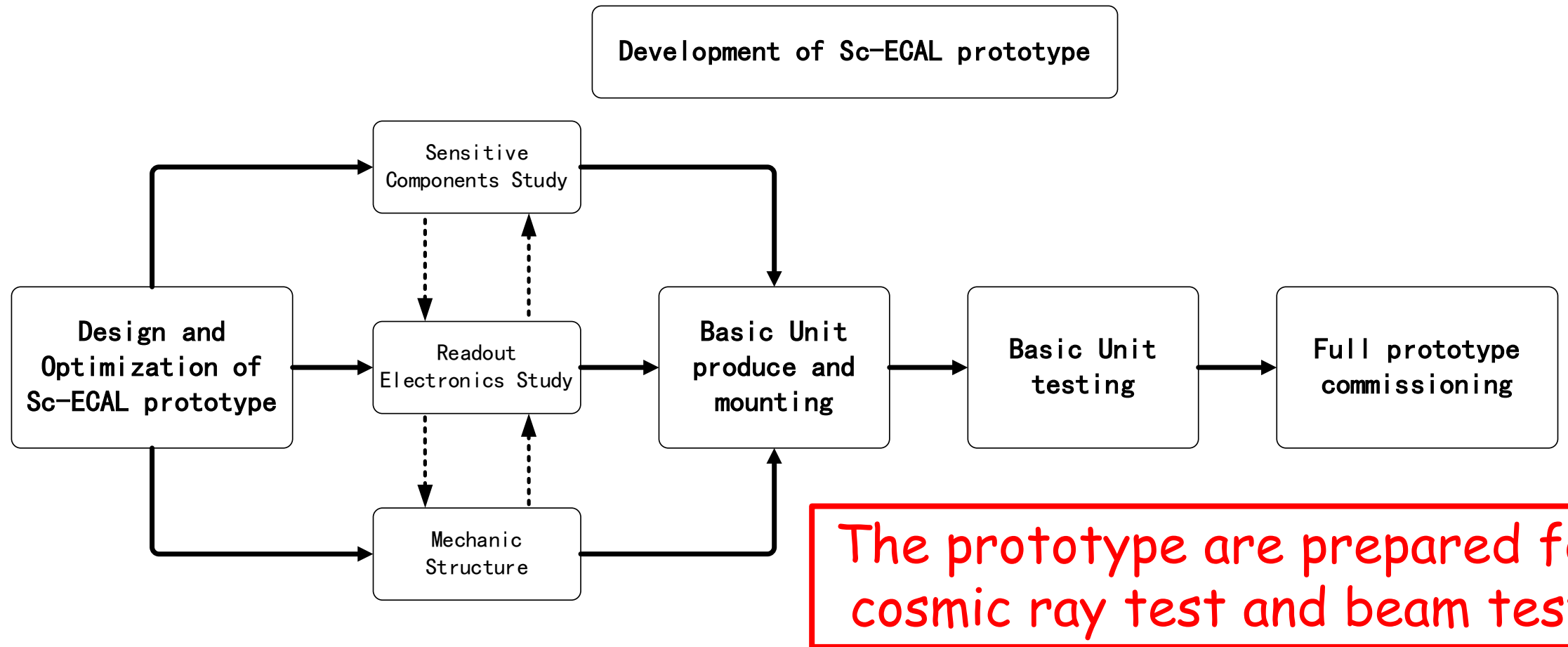
Single SiPM readout by Chinese Group

Double SiPM readout by Japanese Group

ASIC

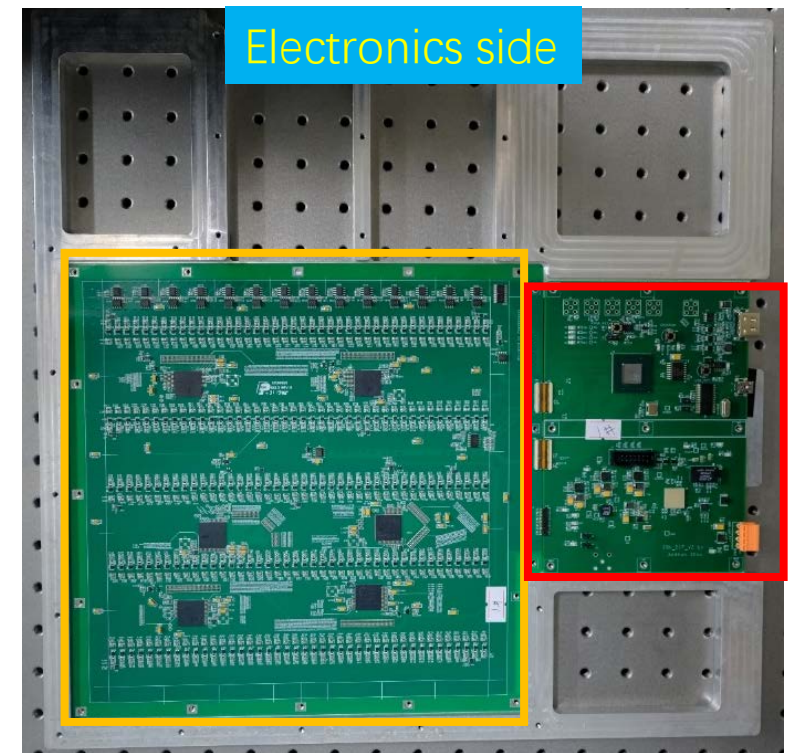
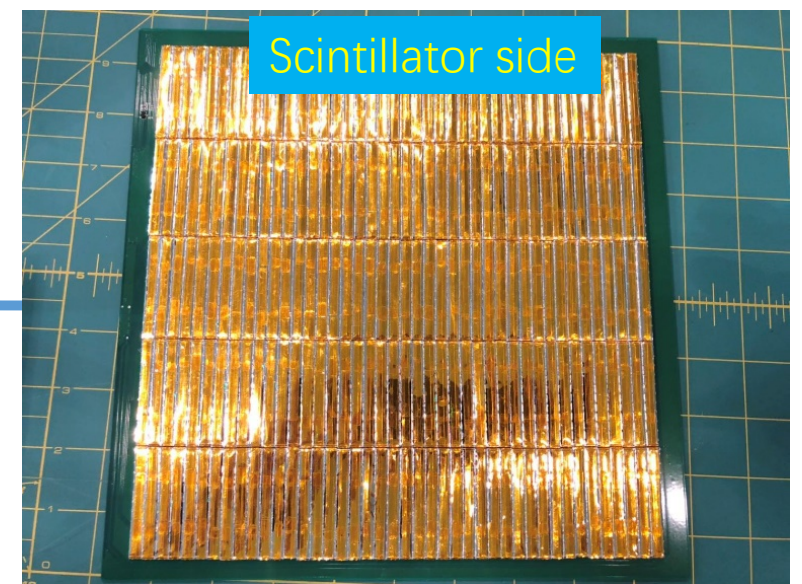
EBU

Overview

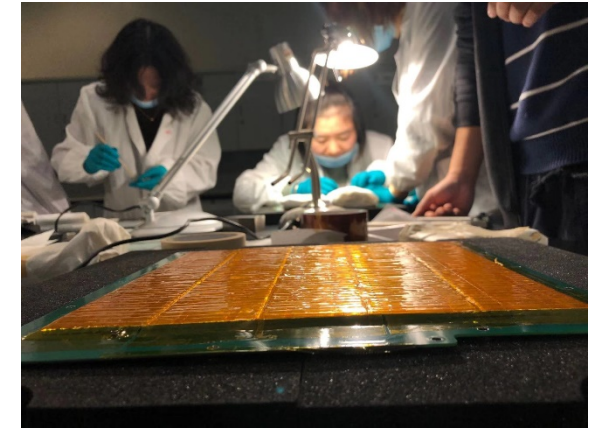
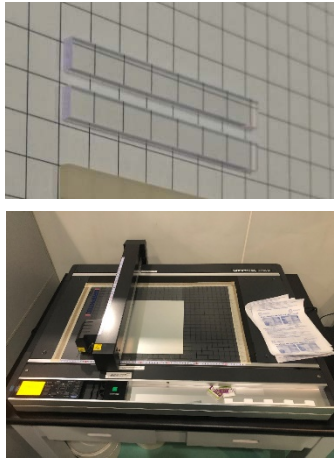


EBU design and development

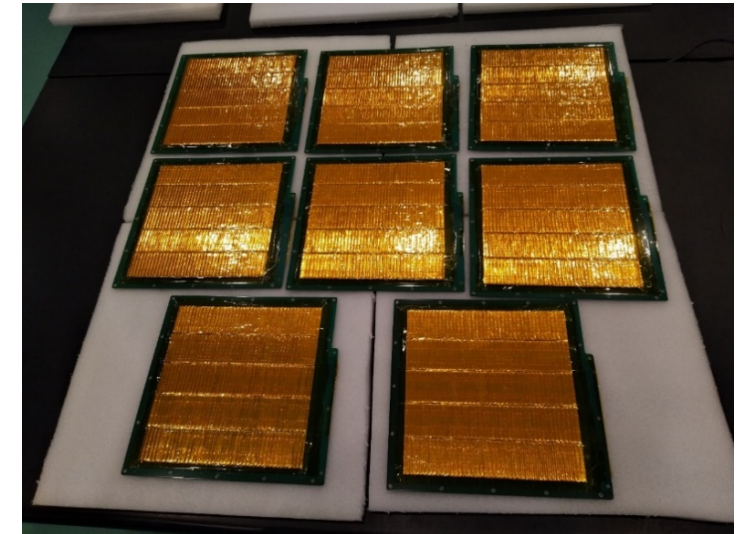
- 210 channels readout with **6 SP2E chips** divided into 5 rows and 42 columns
- 24 layers of EBU with **10um SiPMs** and 6 layers EBU with **15um SiPMs**
- Total thickness is controlled **under 6mm excluding DIF**
- **Electronics calibration** and **SiPM operation** voltage adjustment realized
- **LED calibration** and **temperature monitoring** circuits under test.



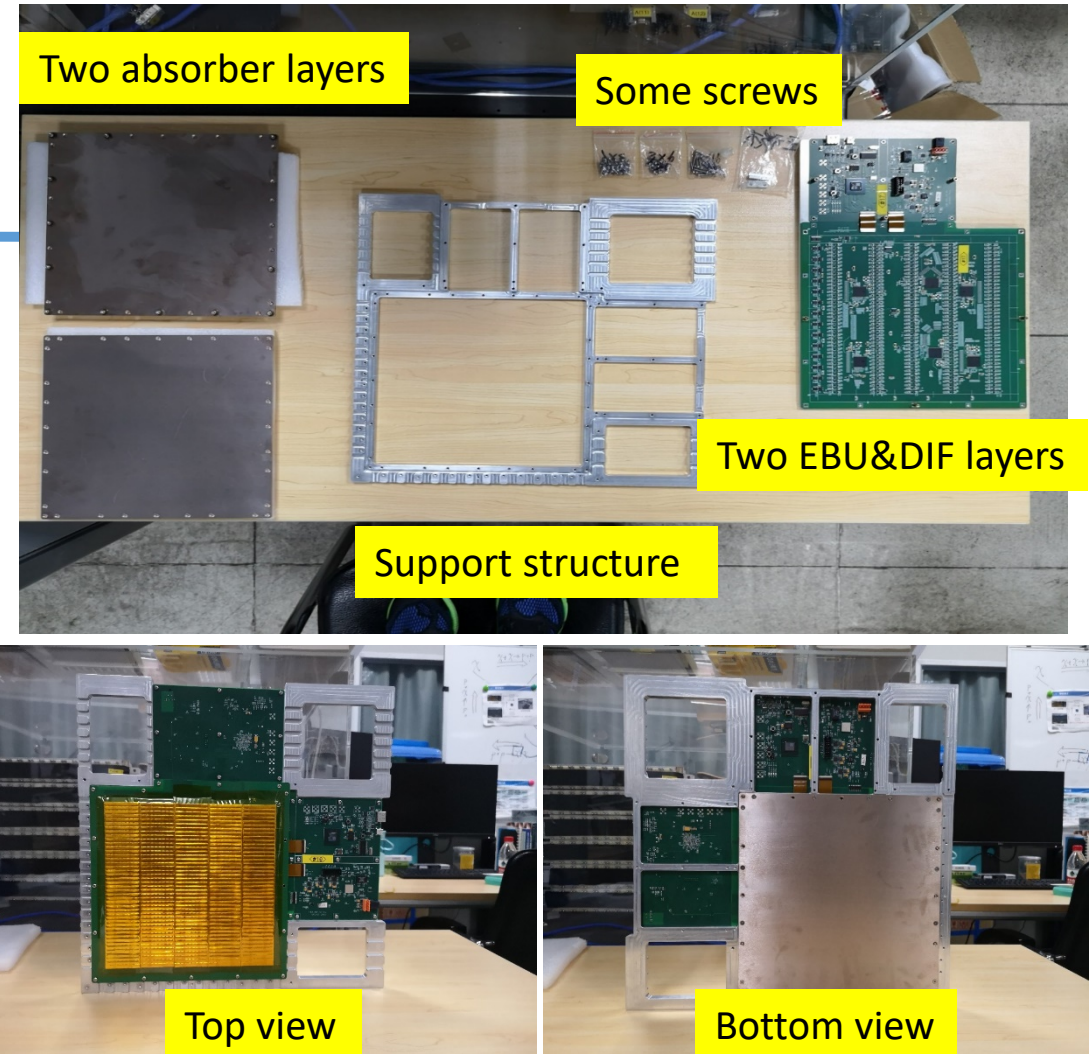
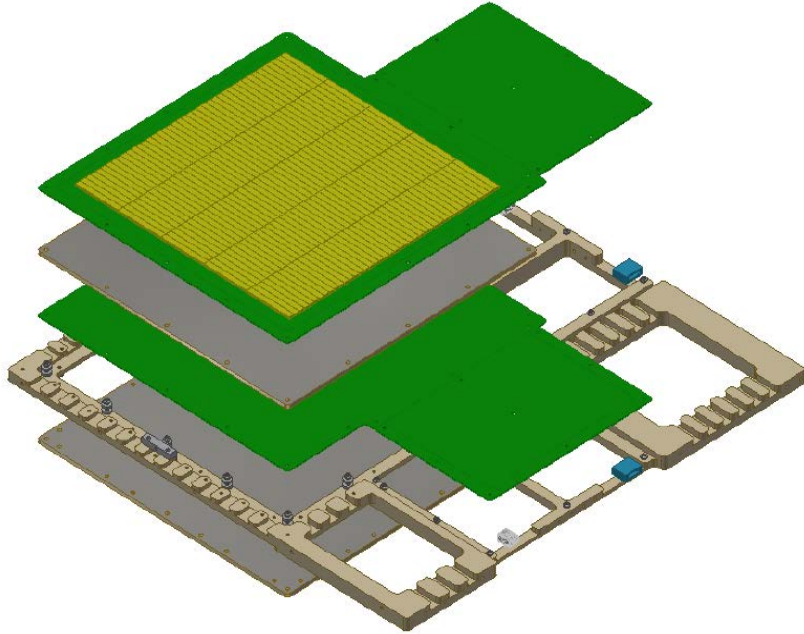
Ecal Basic Unit mass produce



- Ecal Basic Unit mass produce
 - Scintillator strip and ESR machining
 - Scintillator strips wrapping
 - PCB soldering and testing
 - Ecal Basic Unit (EBU) assembly



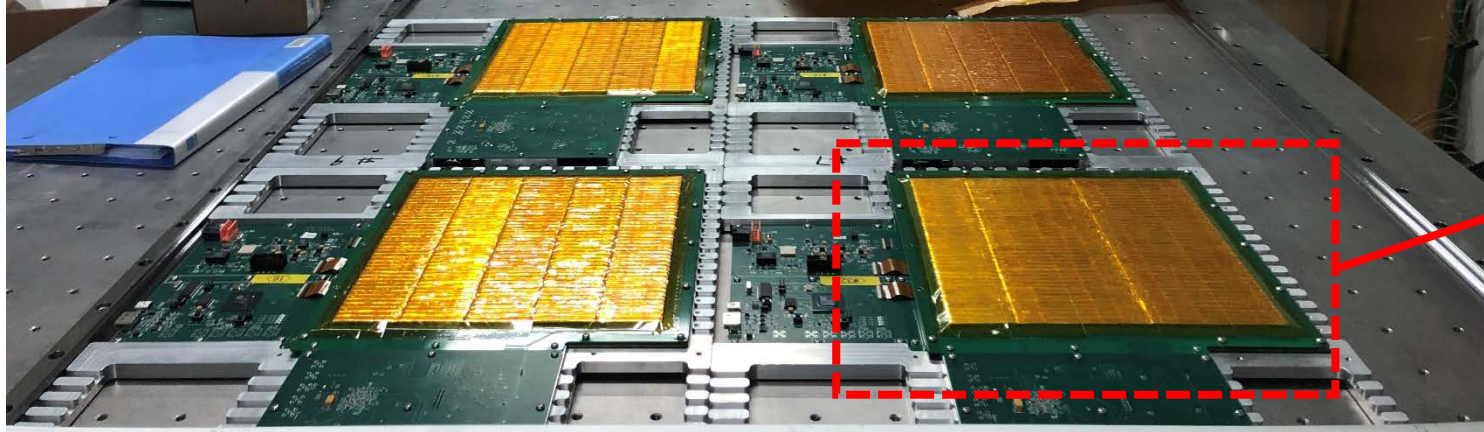
Super-layer mounting



- One super-layer is an independent unit
- One super-layer consists of two EBU and inserted by two absorber layers

Super-layer mounting

- 16 super-layer in total



Double-side readout
for Wataru's group

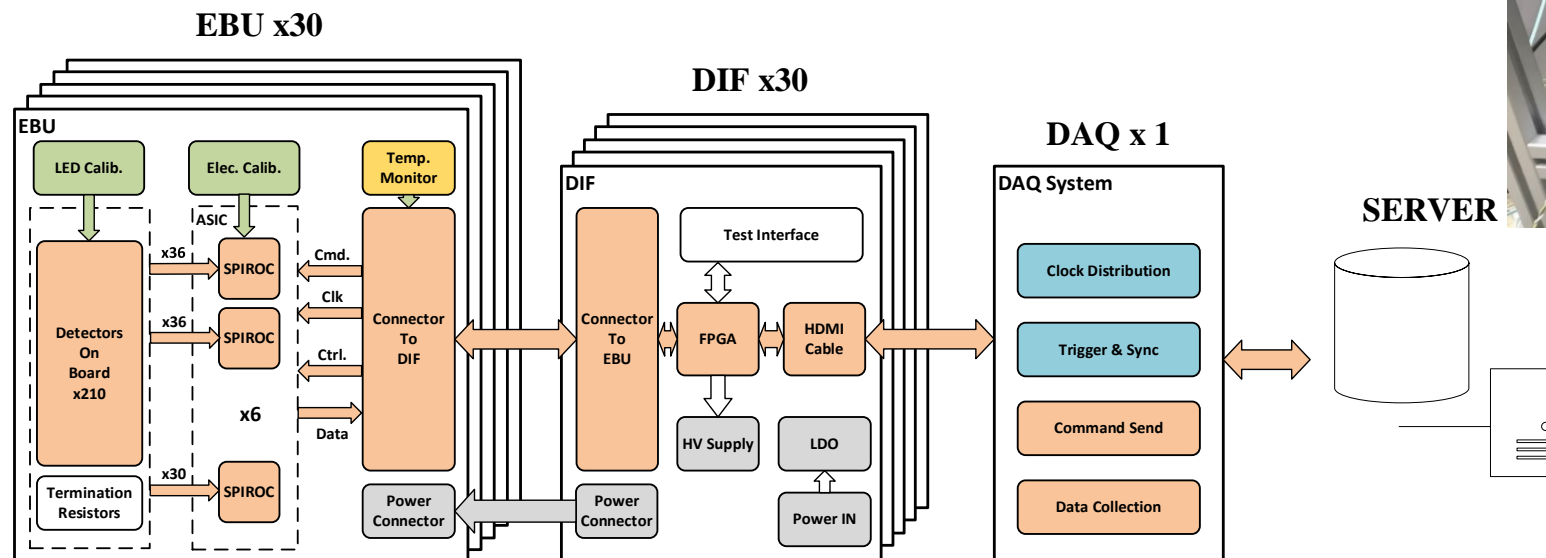
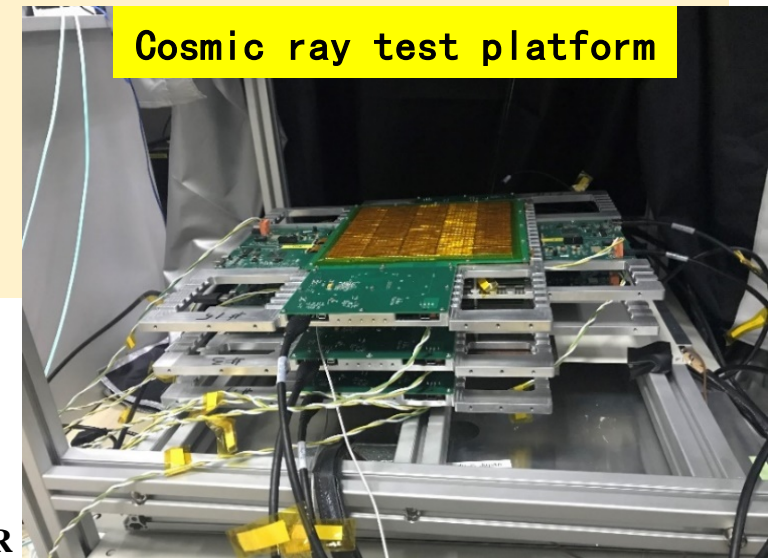


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- **Progress of the prototype commissioning**
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Grouping combined test

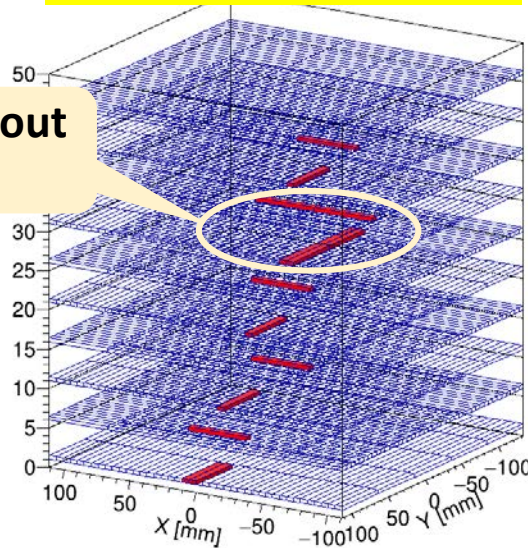
- 5/4 super-layers grouped and combined test with DAQ system
 - Trigger with the coincidence of 2 EBU layers
 - Data acquisition and synchronize work properly
 - All 32 EBU layers have tested and functioned well



Cosmic ray test results

Event reconstruction

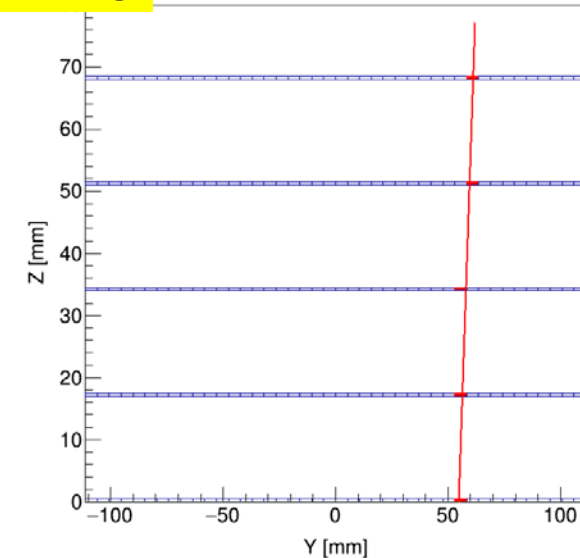
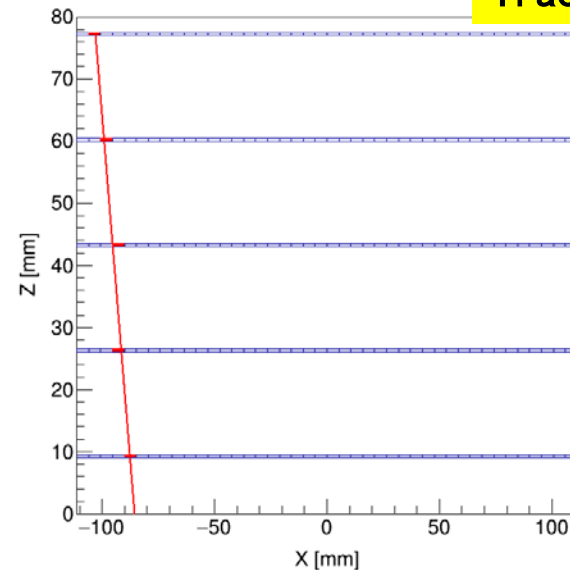
Double-readout
layers



EventID : 1500

Track fitting

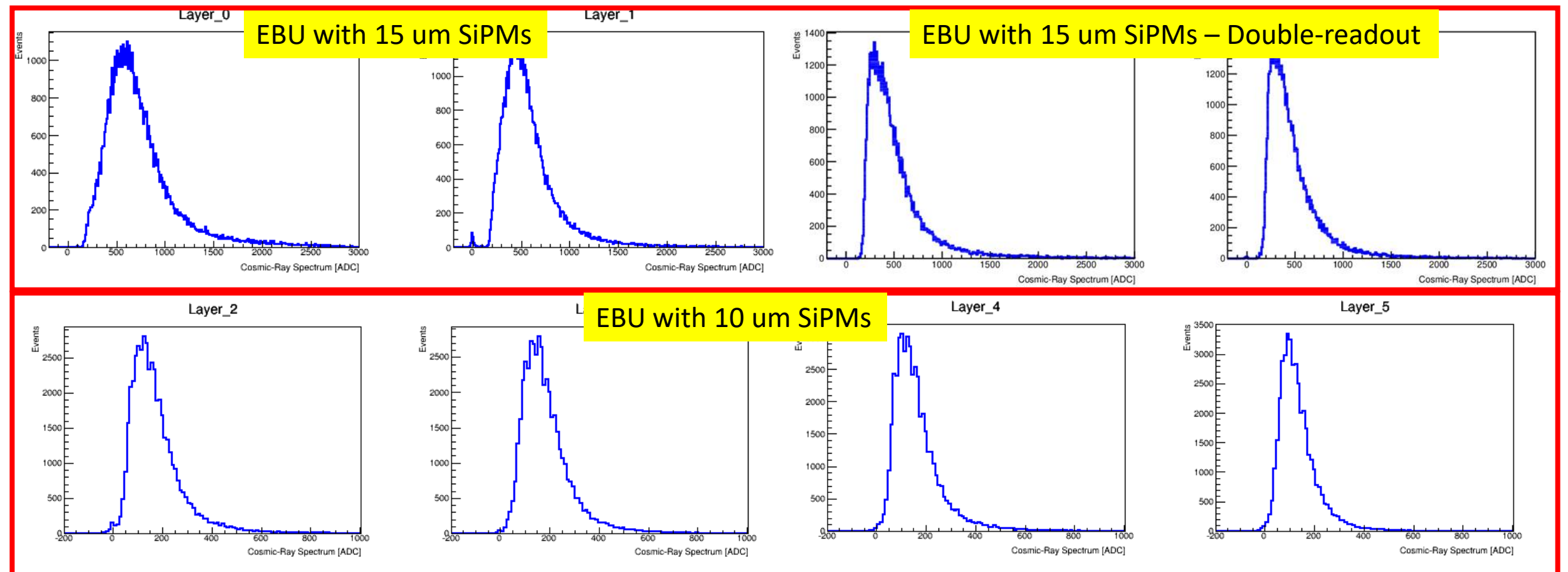
EventID : 1500



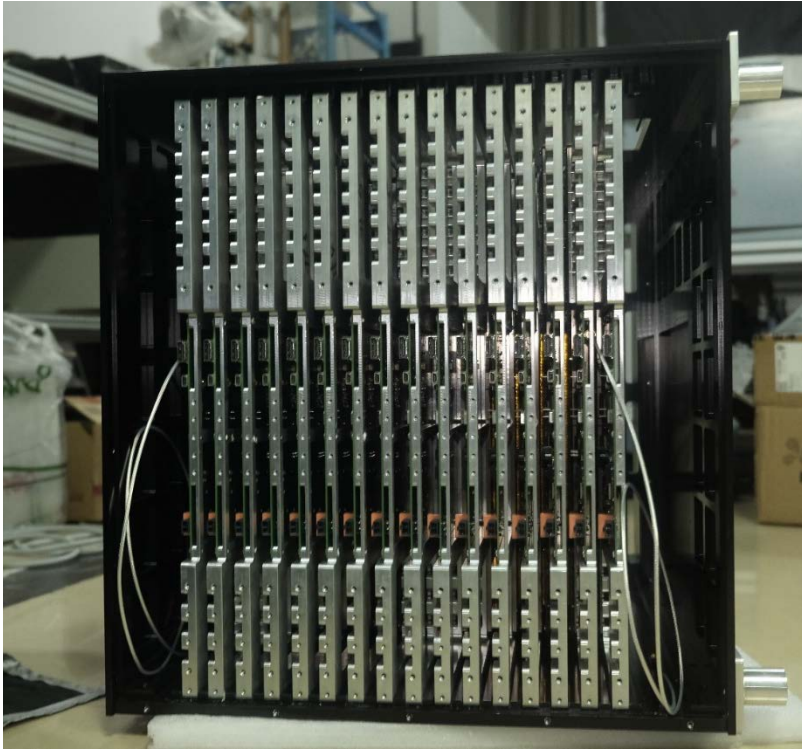
- EBUs properly synchronized for each group multi EBU layers
- Event reconstructed correctly
- Cosmic finding and track fitting algorithm are performed in preliminary
- More than 95% events hit more than 5 layers

Cosmic ray test results

- Distinct MIP signals in both SiPMs types, namely 15 μm SiPMs and 10 μm SiPMs

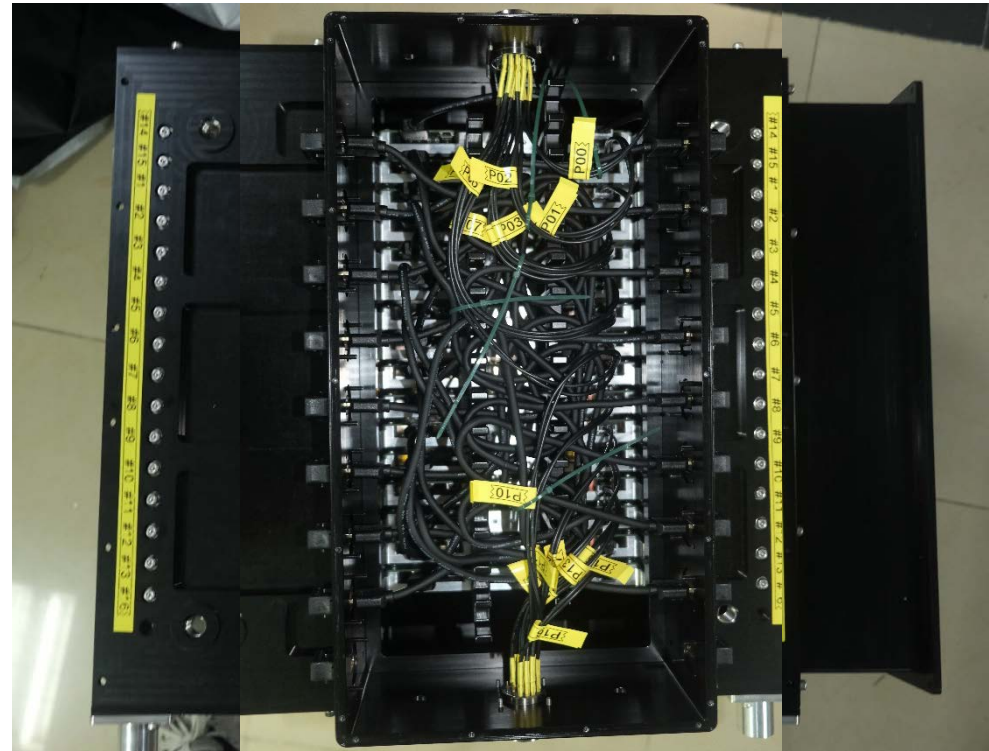


Assembly of prototype



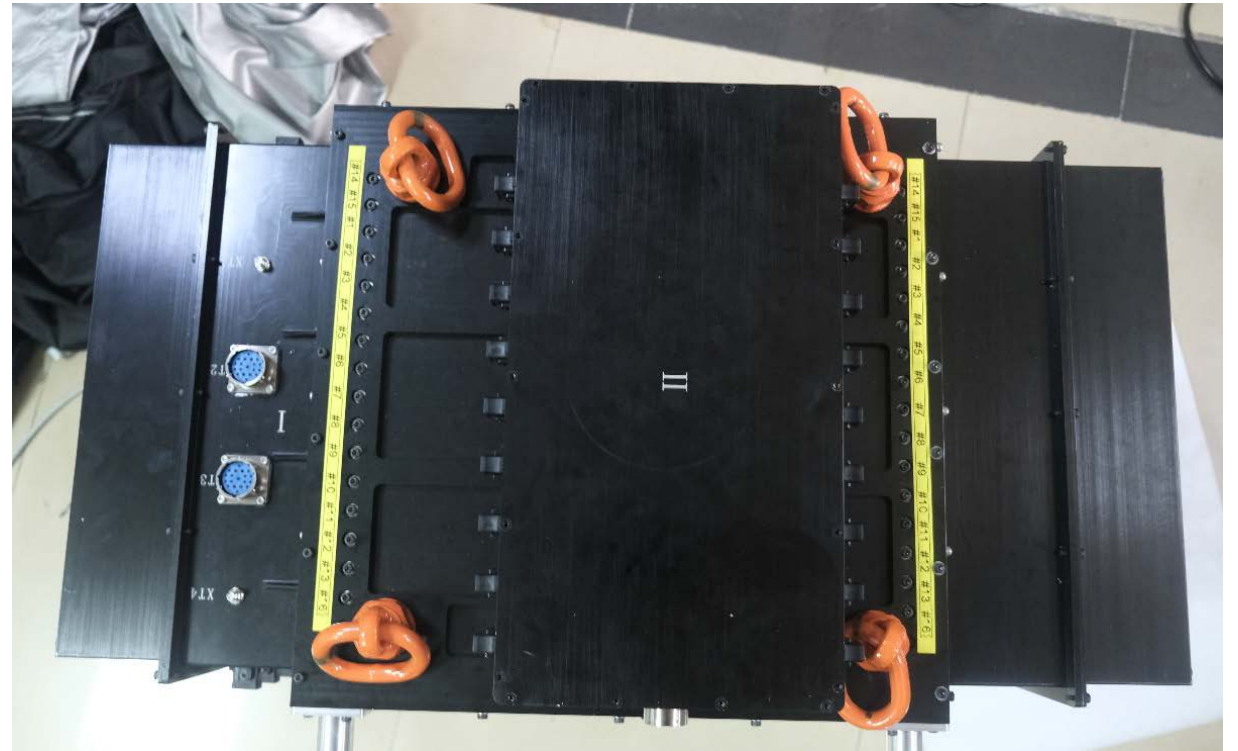
- 16 super-layers fabricated into the mechanic structure

Assembly of prototype



- 17 super-layers hold most in the mechanic structure
- Two directions are reserved for cables connection(signal and power cables)

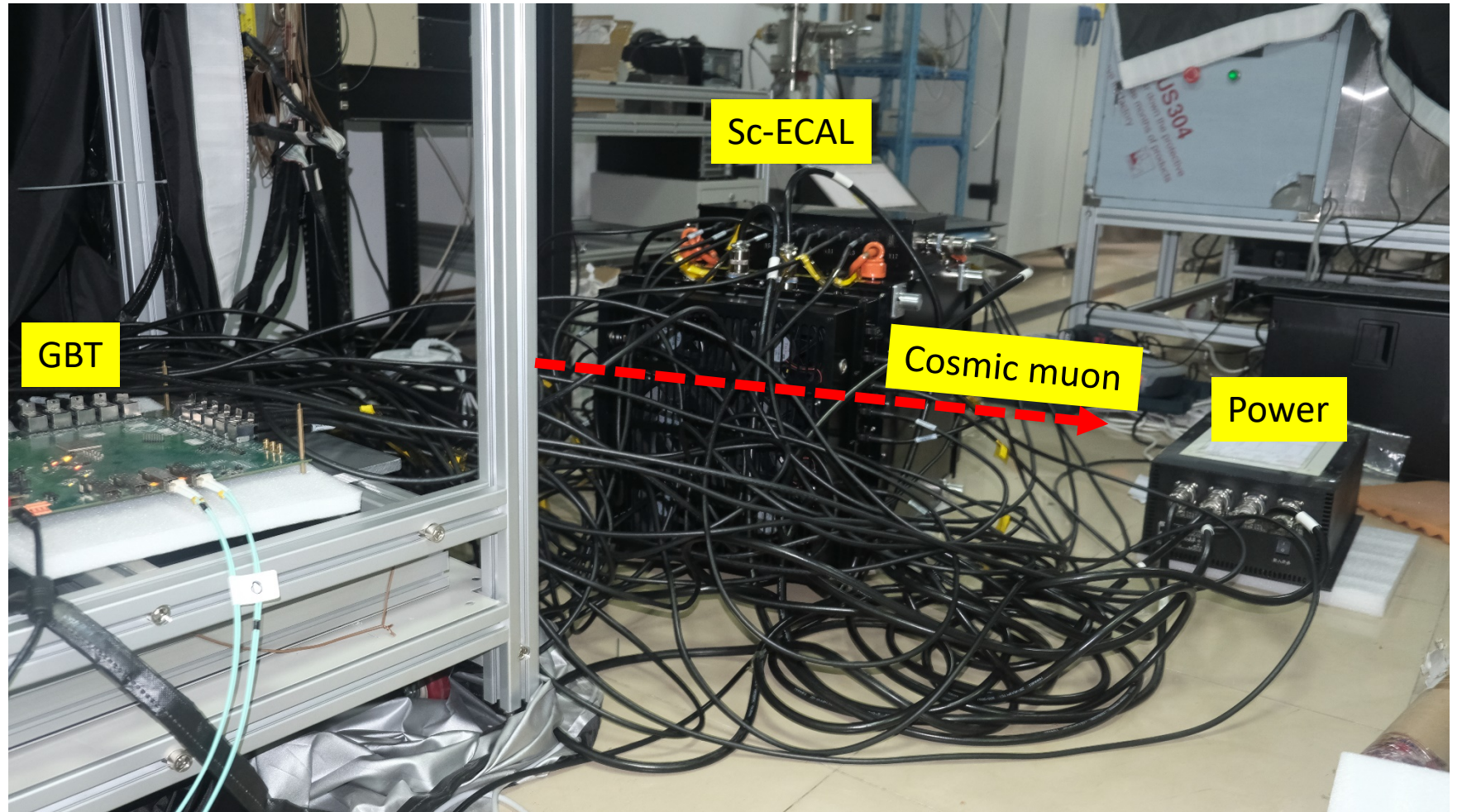
Assembly of prototype



- 17 super-layers hold most in the mechanic structure
- Two directions are reserved for cables connection(signal and power cables)
- Fans cooling system and light shield also integrated

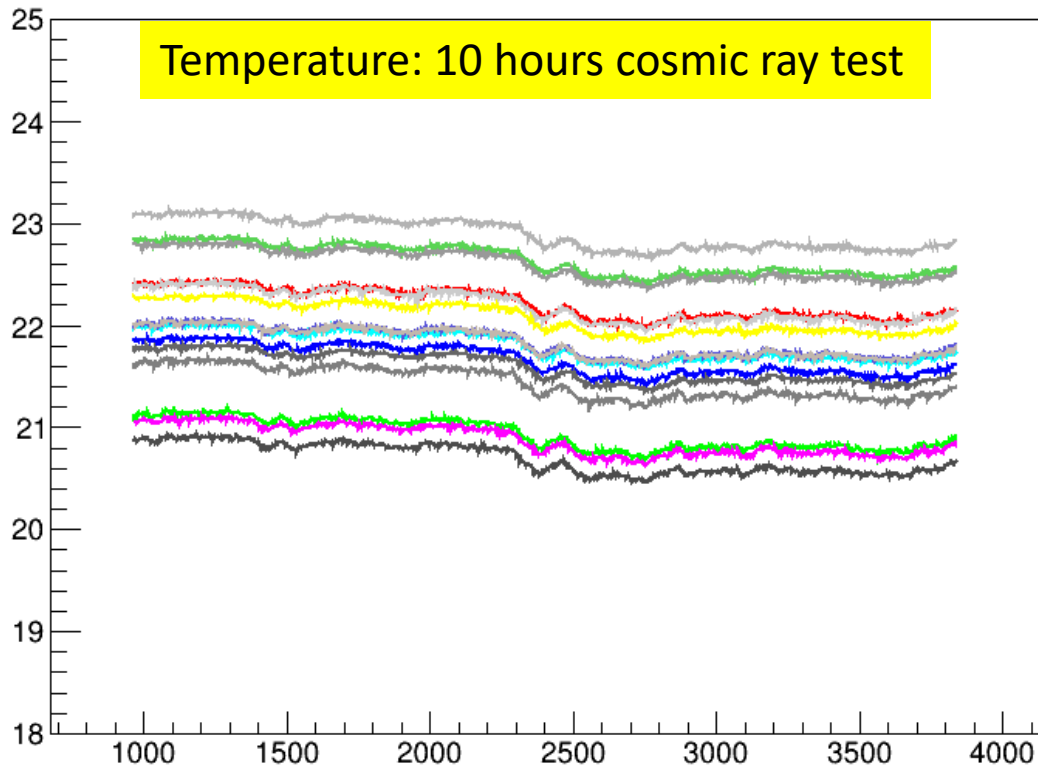
Commission of prototype

- Commission setup

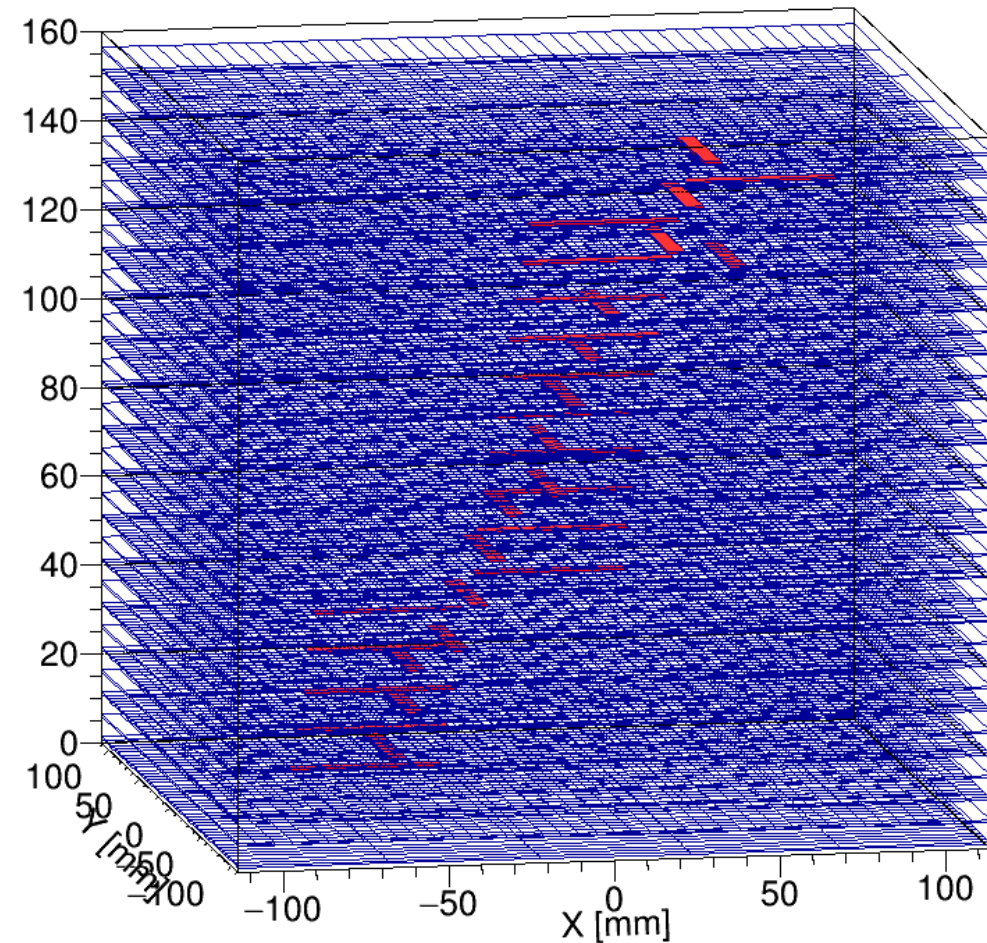


Commission of prototype

LayerID_15

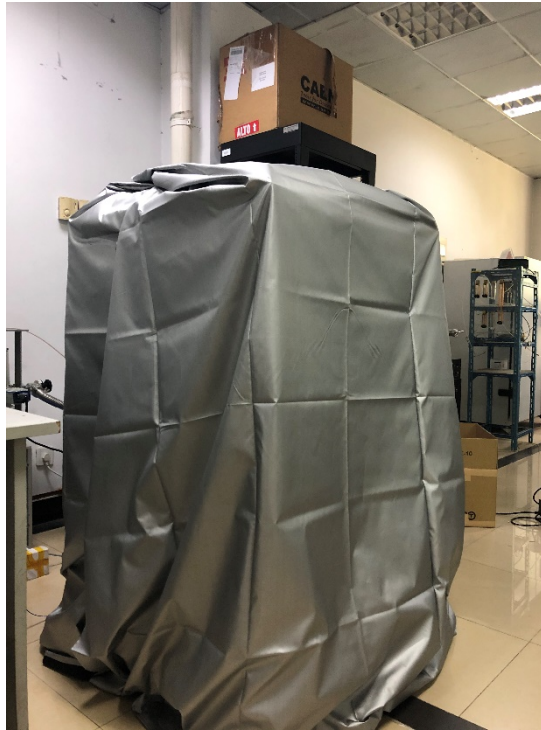
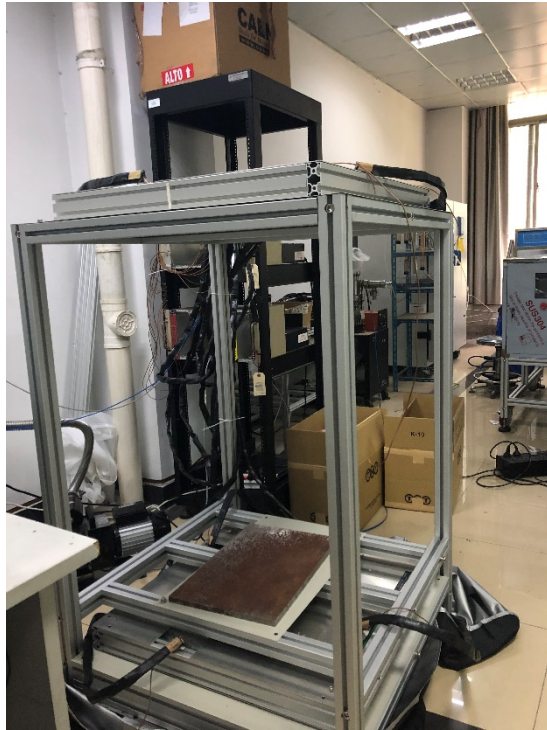


EventID : 10



Hodoscope commissioning

Wataru's group developed

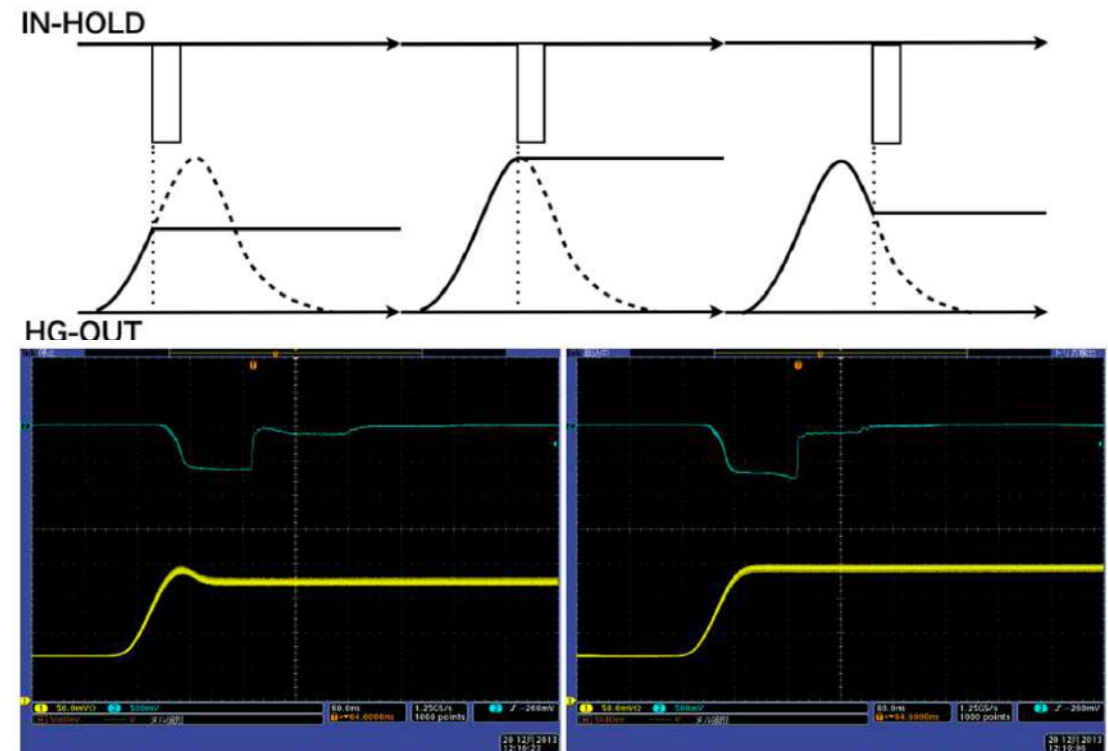
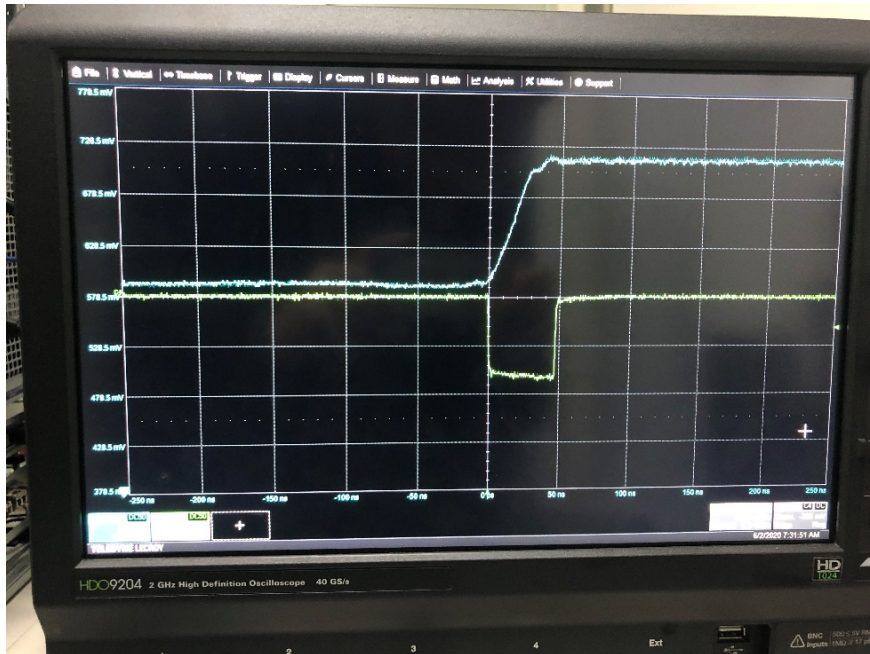


- Hodoscopes setup completed

Hodoscope commissioning

Wataru's group developed

- Check the waveform of HG-OUT on EASIROC using the test charge



- Now working on some problems of EASIROC modules
- Joint with Sc-ECAL prototype CR test in preparation

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Summary and future plan

- CEPC Sci-W ECAL technological prototype is commissioning
 - ✓ DAQ tested with multi-EBUs and the combined system work synchronized
 - ✓ 32 EBU layers have been tested and functional well
 - ✓ Prototype integrated with mechanic structure, fans cooling and light shield function well
 - ✓ The prototype system work properly and validated by preliminary cosmic ray test
- To do next
 - Beam test at IHEP E3 with low energy mixed beam in next two weeks
 - cosmic ray test of the full prototype and calibration for all channels
 - preparation for the test beam at DESY planned in February 2021

Thanks !

Additional

Sc-ECAL prototype

weight	W-Cu alloy	3750 g * 32	> 200 Kg
	Support structure	1220 g * 16	
	EBU	500 g * 32	
	Mechanic, power and cables	~ 50 Kg	
Connectors	HDMI	36	46
	Power (EBU & fans)	4+4	
	Trigger	2	
Cables	Power for EBU (inside + outside)	32+4	104
	HDMI	32*2	
	Fans and trigger	2+2	
Screws	HDMI connector	2*18*2	> 1290
	Fans and EBU power connector	4*6*2+4*4	
	Mechanic framework	(4+16+16+6)*2+(22+12)*2+18+16	
	Support for supper layer	16*8	
	Supper layer	(16+12+24)*16	