Development and commissioning of the CEPC Sc-ECAL prototype

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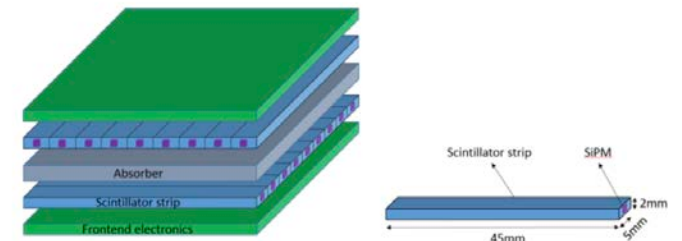CALICE Collaboration Meeting Everywhere， September 2020

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.
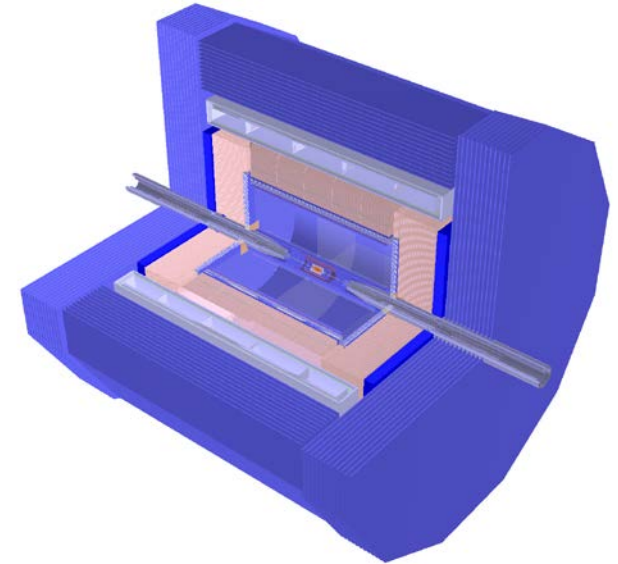
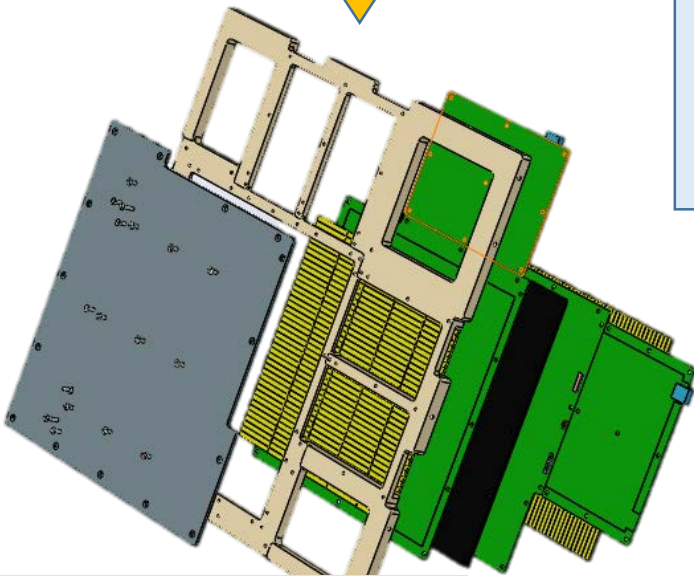CEPC detector concept

Strip Sci-ECAL concept for CEPC

Outline

- Introduction

- **CEPC Sc-ECAL prototype design and development**

- Progress of the prototype commissioning

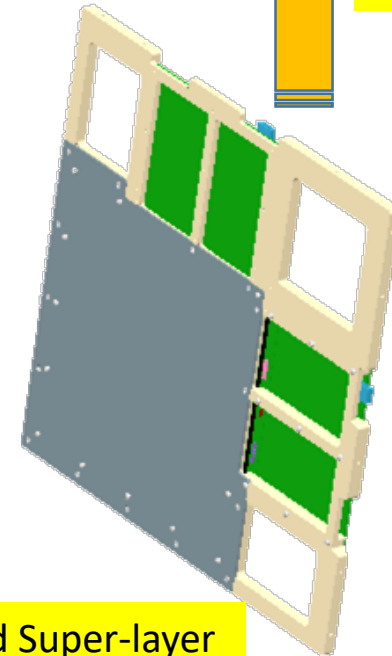- Summary and future plan

CEPC Sc-ECAL prototype design

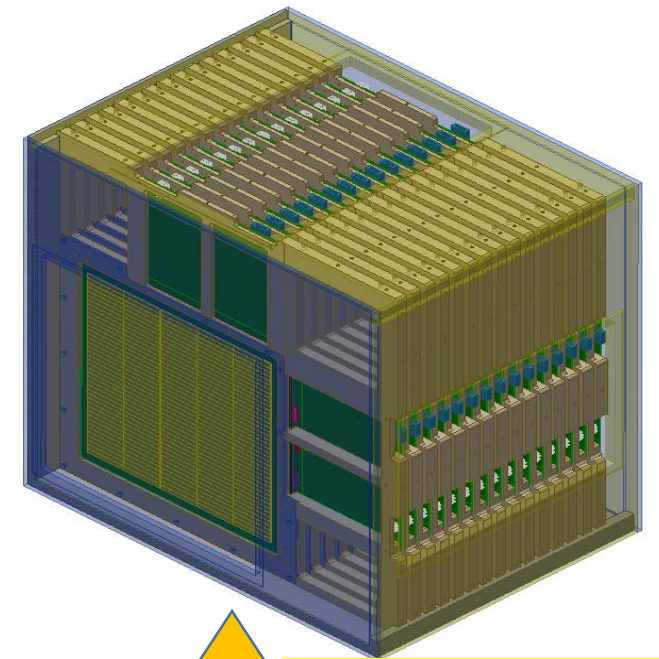SiPM coupling with scintillator strips

bottom-center embedded

➤ 210 channels / EBU

➤ 30 EBUs + 30 DIFs

➤ 15 "super-layers"

➤ Sc-ECAL prototype

Sc-ECAL prototype

Ecal Basic Unit and absorber
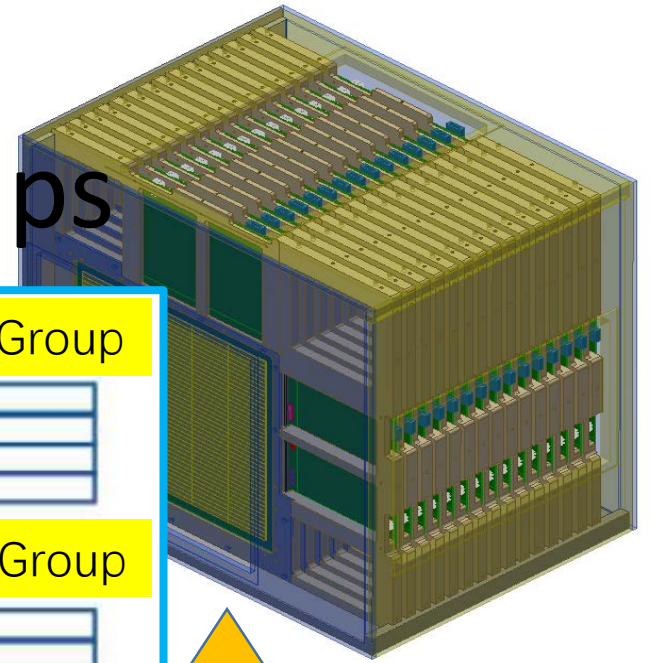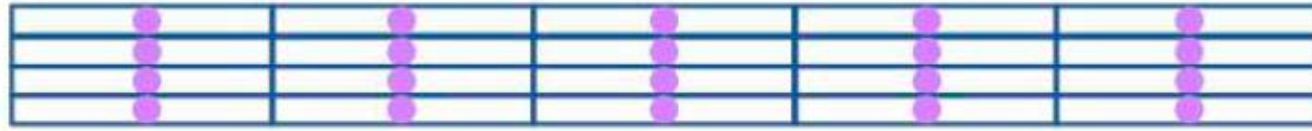
Integrated Super-layer

5

Contributions from Japanese groups
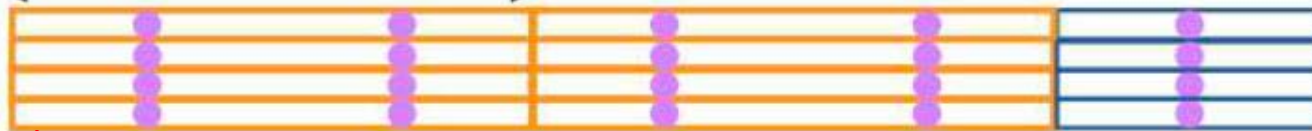

bottom-center embedded
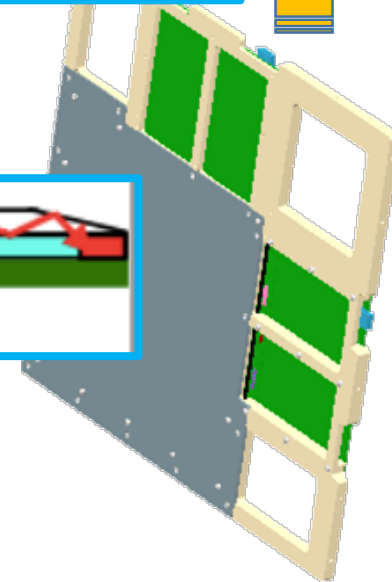
45mm

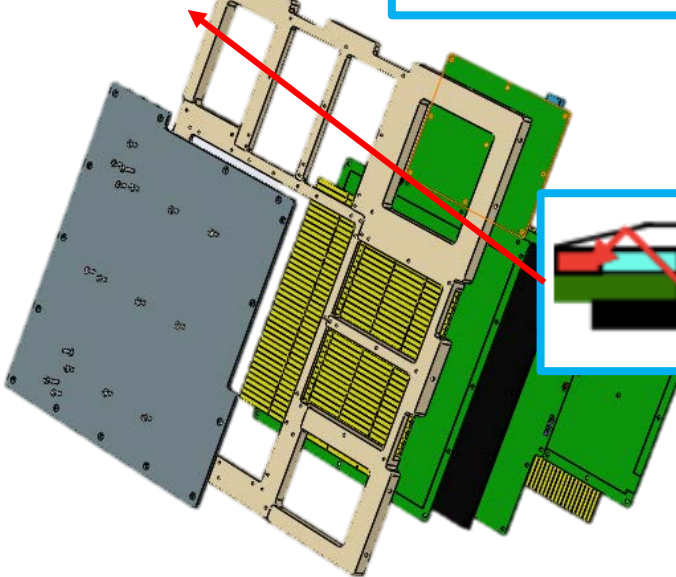Single SiPM readout by Chinese Group

90mm
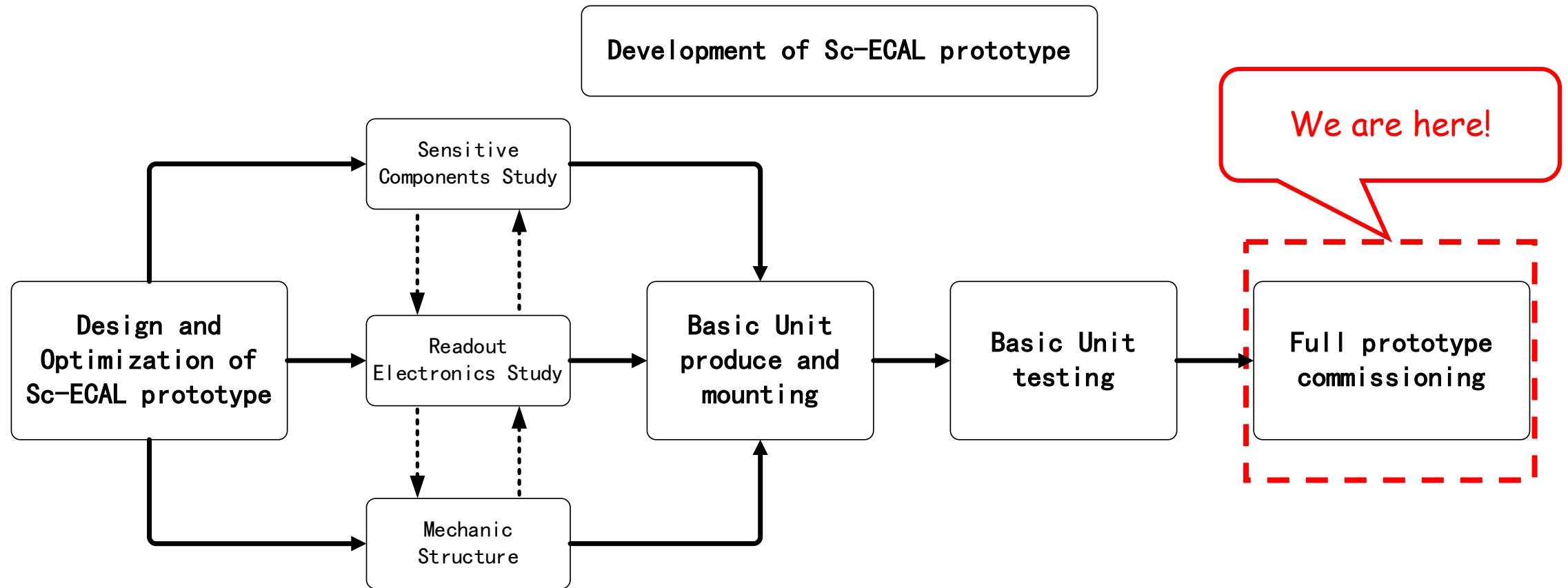
Double SiPM readout by Japanese Group

By Tokyo group (W. Ootani)

By Shinshu group (T. Takeshita)

ASIC

EBU

Overview

EBU design and development

Scintillator side

Electronics side
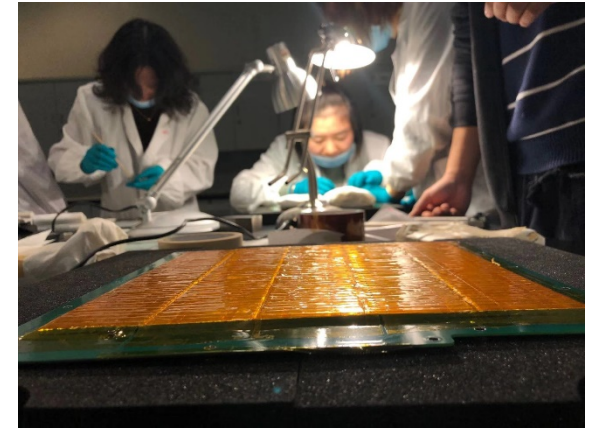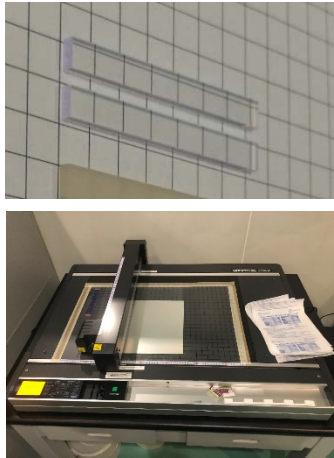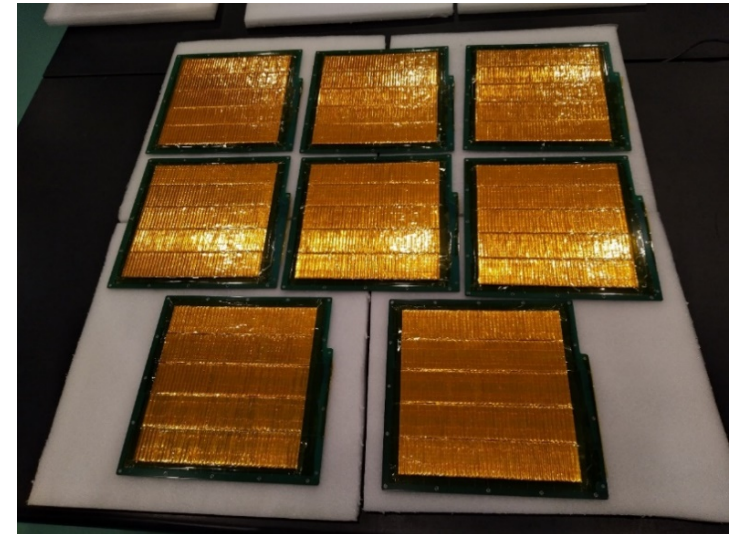
- 210 channels readout with 6 SP2E chips divided into 5 rows and 42 columns

- 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

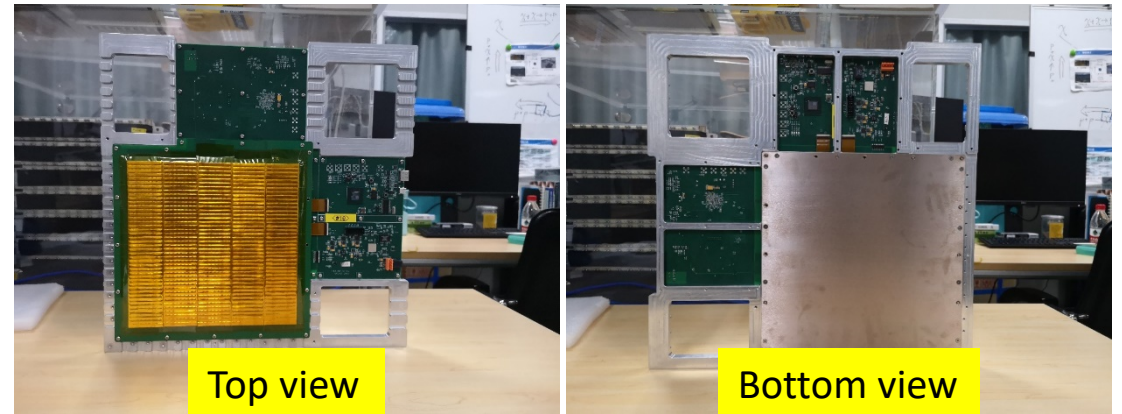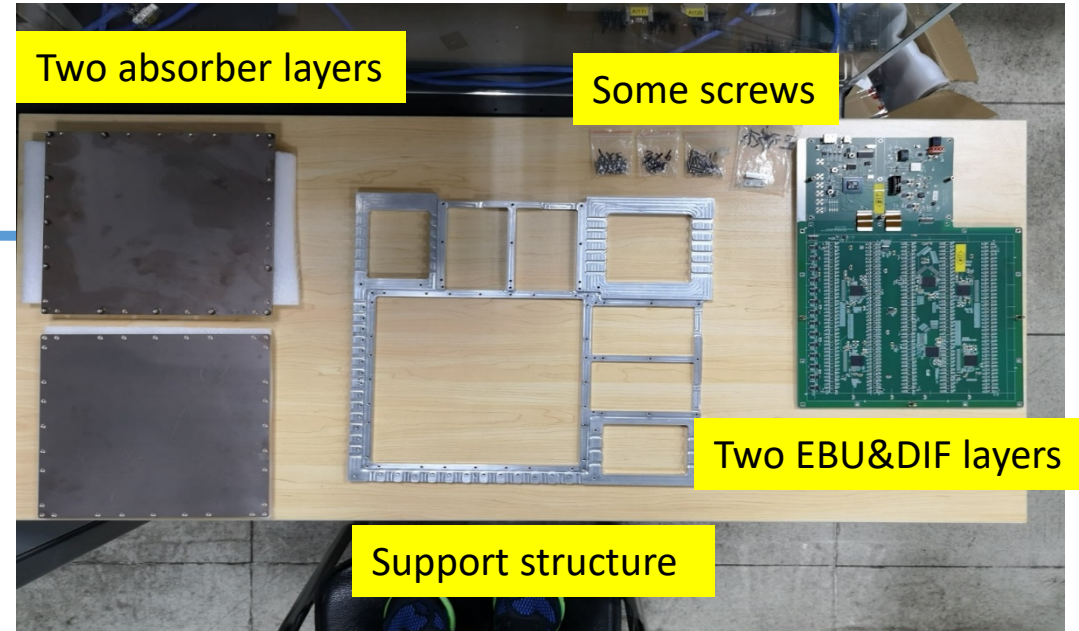- LED calibration and temperature monitoring circuits under test.
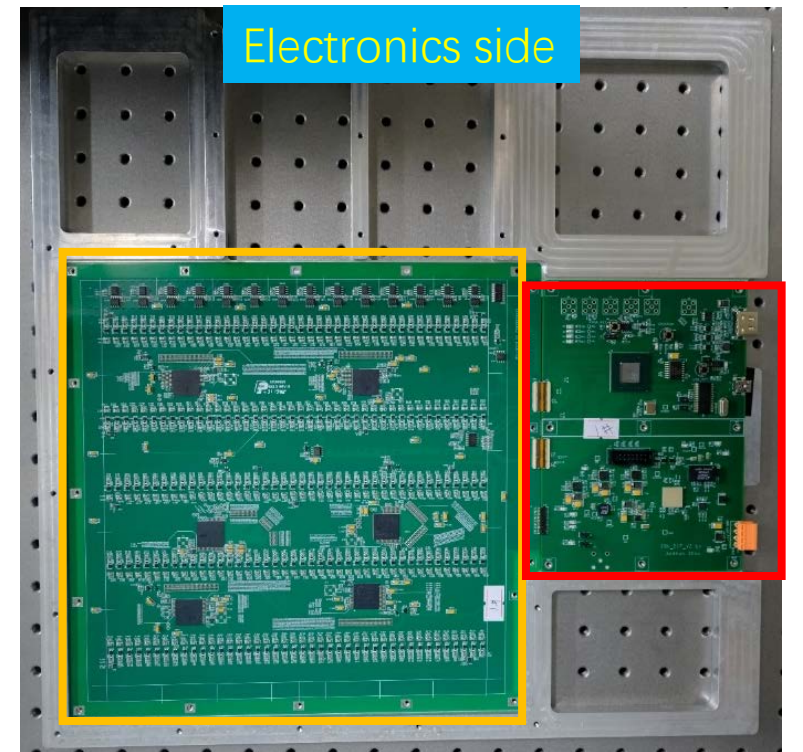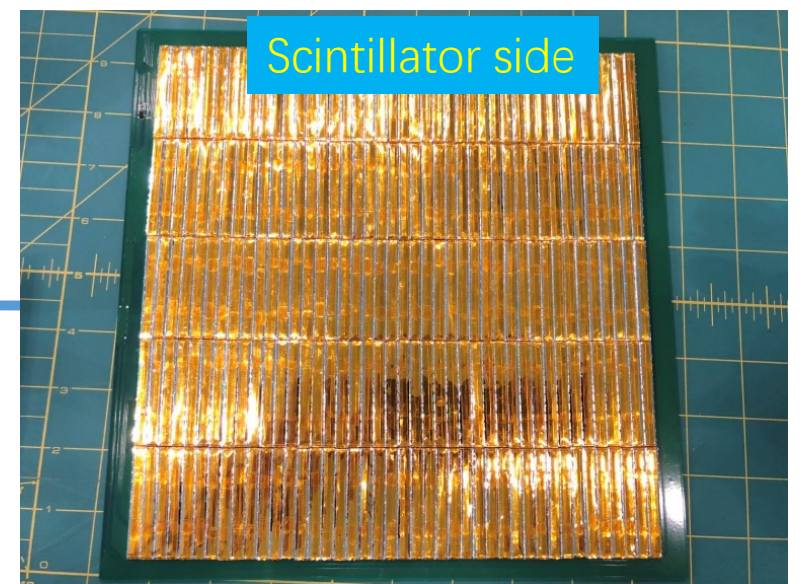
Ecal Basic Unit mass produce

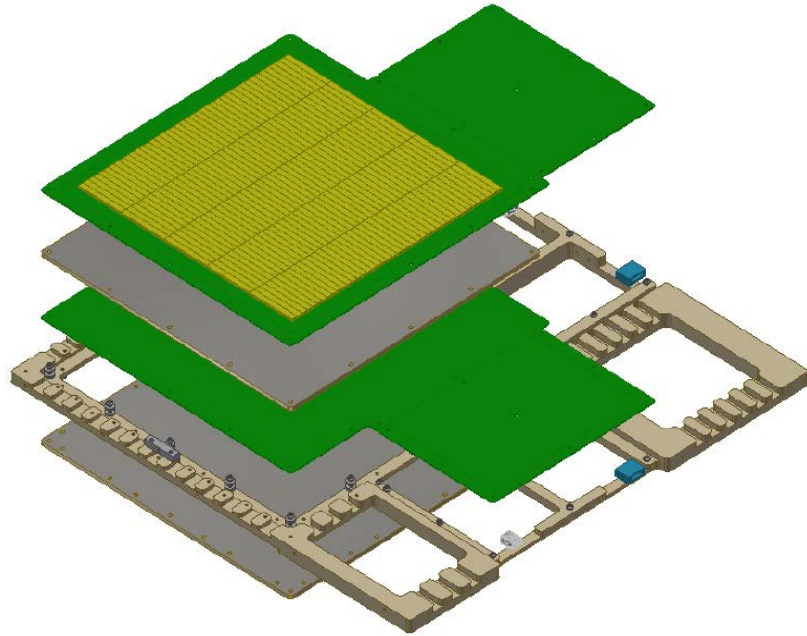- Ecal Basic Unit mass produce
  - Scintillator strip and ESR machining
  - Scintillator strips wrapping
  - PCB soldering and testing
  - Ecal Basic Unit (EBU) assembly

Super-layer mounting

Two absorber layers

Some screws

Two EBU&DIF layers

Support structure

Top view

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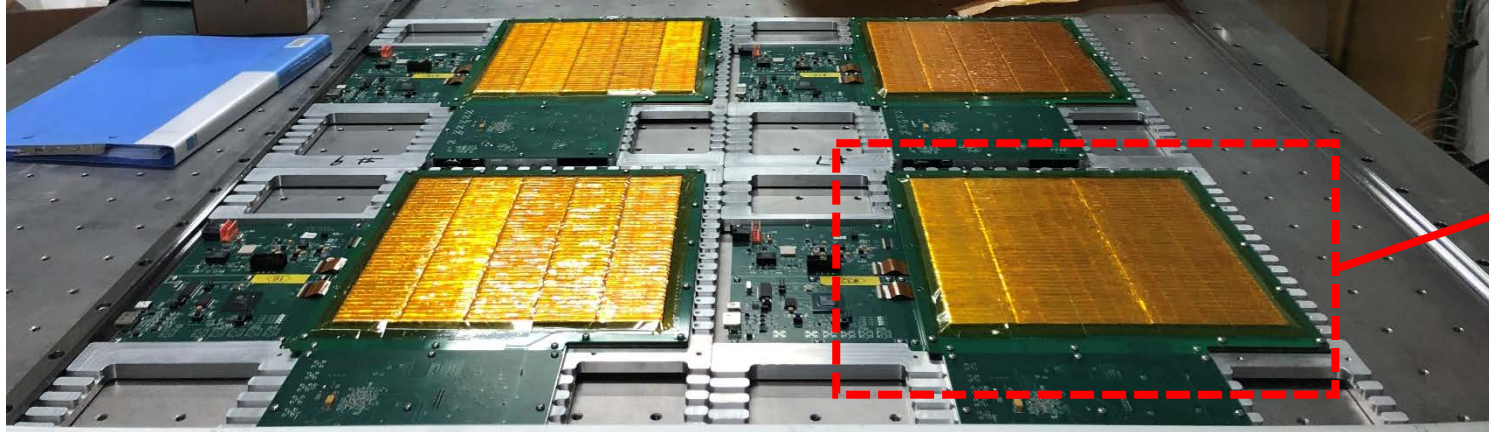
- One super-layer is an independent unit
- One super-layer consists of two EBU and inserted by two absorber layers

Super-layer mounting

Double-side readout for Wataru's group

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- **Progress of the prototype commissioning**
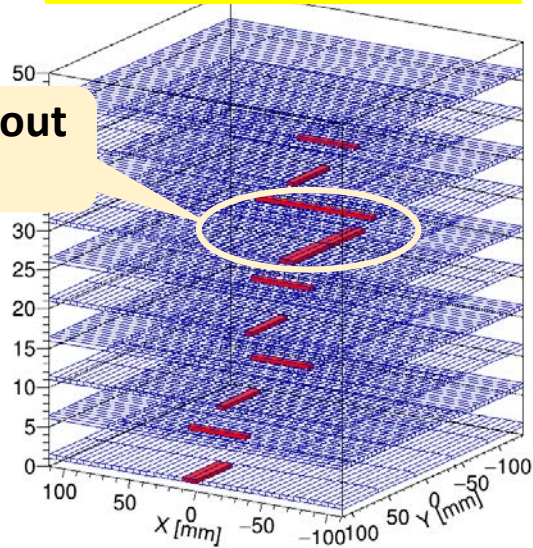
- Summary and future plan

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 platform
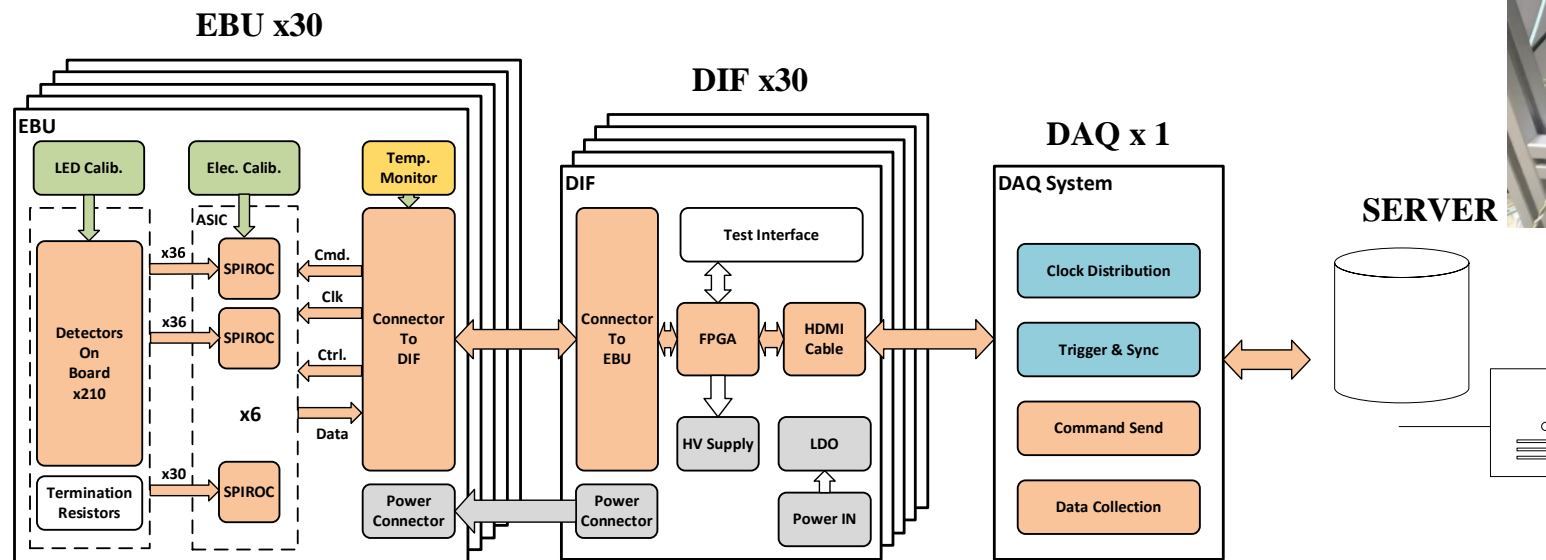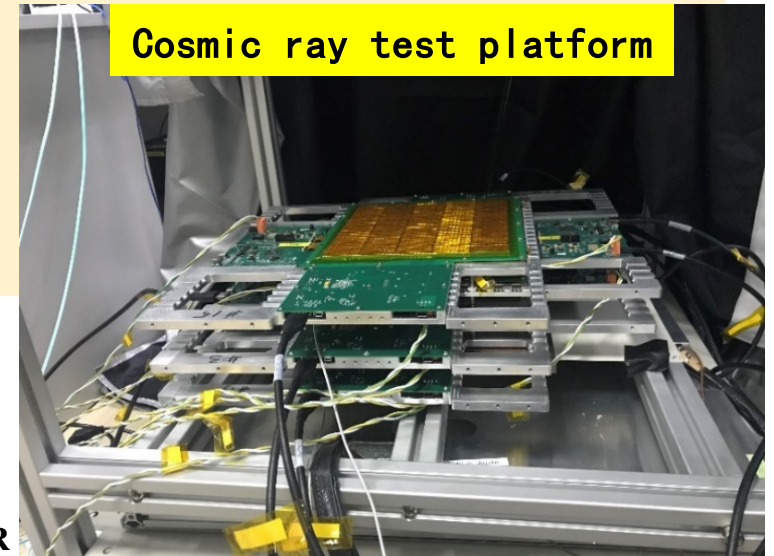
Cosmic ray test results

Event reconstruction

Double-readout layers

Track fitting

EventID : 1500

EventID : 1500
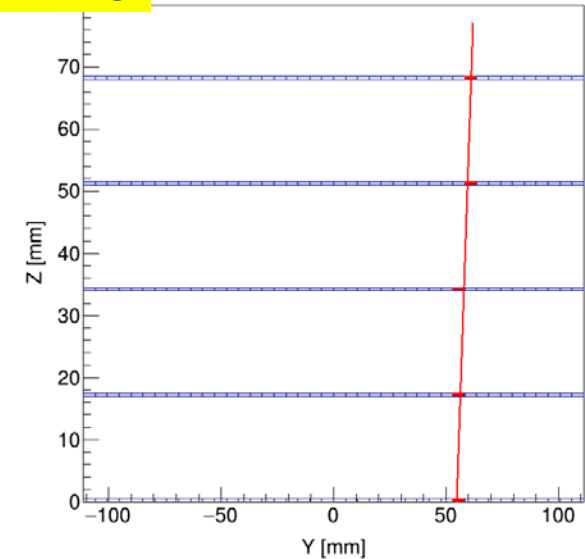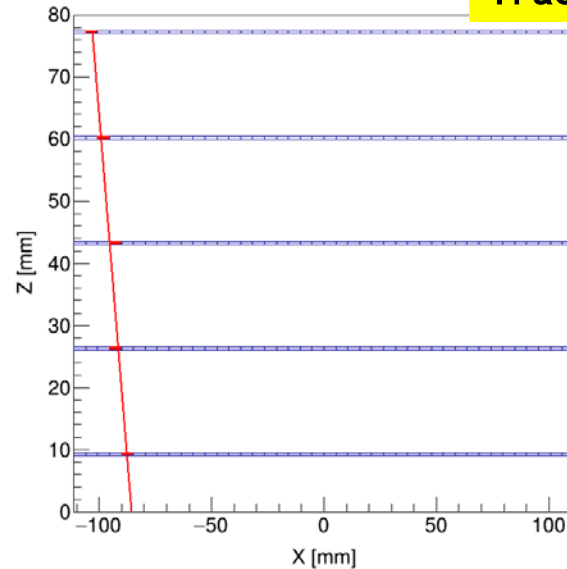
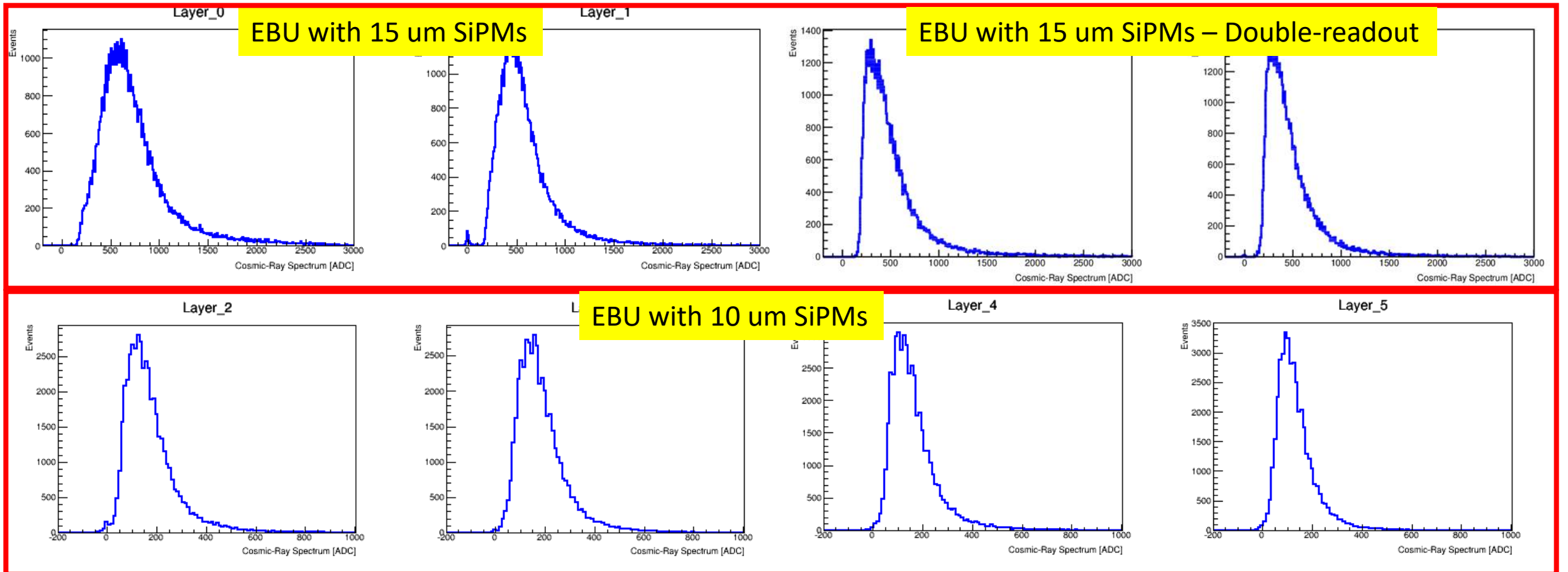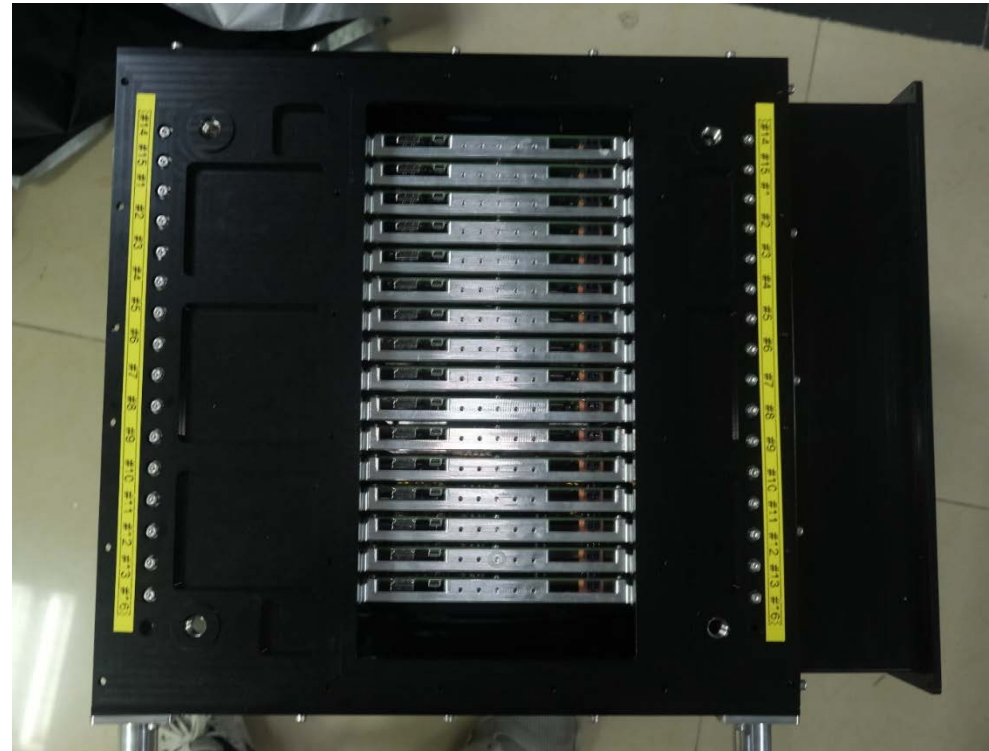- EBUs properly synchronized for each group multi EBU layers
- Event reconstructed correctly
- Cosmic finding and track fitting algorithm are performed in preliminary
- More than 95% events hit more than 5 layers

Cosmic ray test results

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

Assembly of prototype
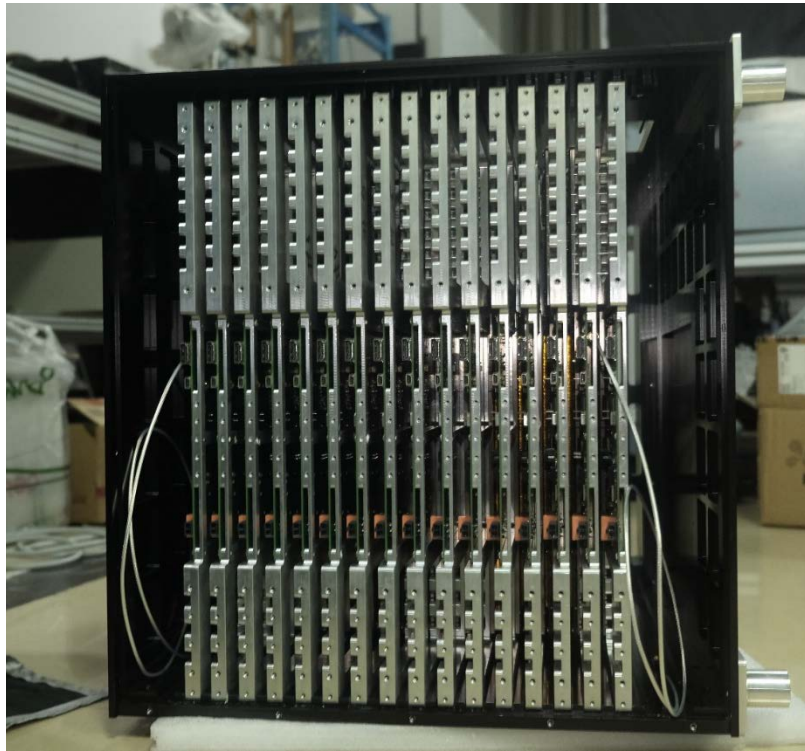
- 16 super-layers fabricated into the mechanic structure

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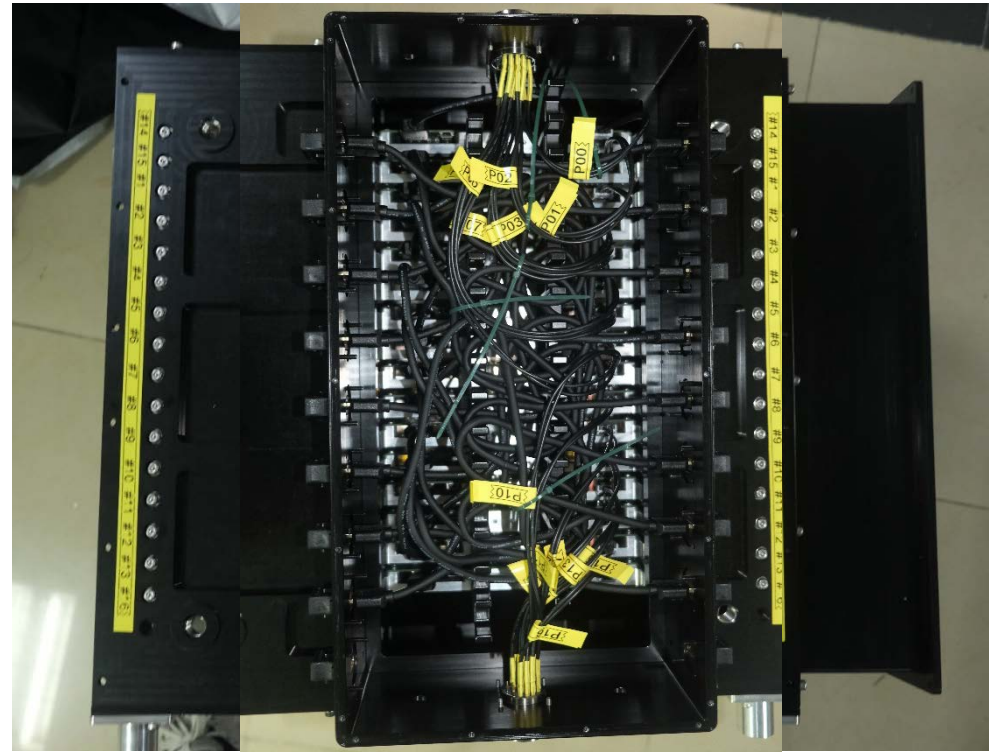
- 17 super-layers hold most in the mechanic structure
- Two directions are reserved for cables connection(signal and power cables)

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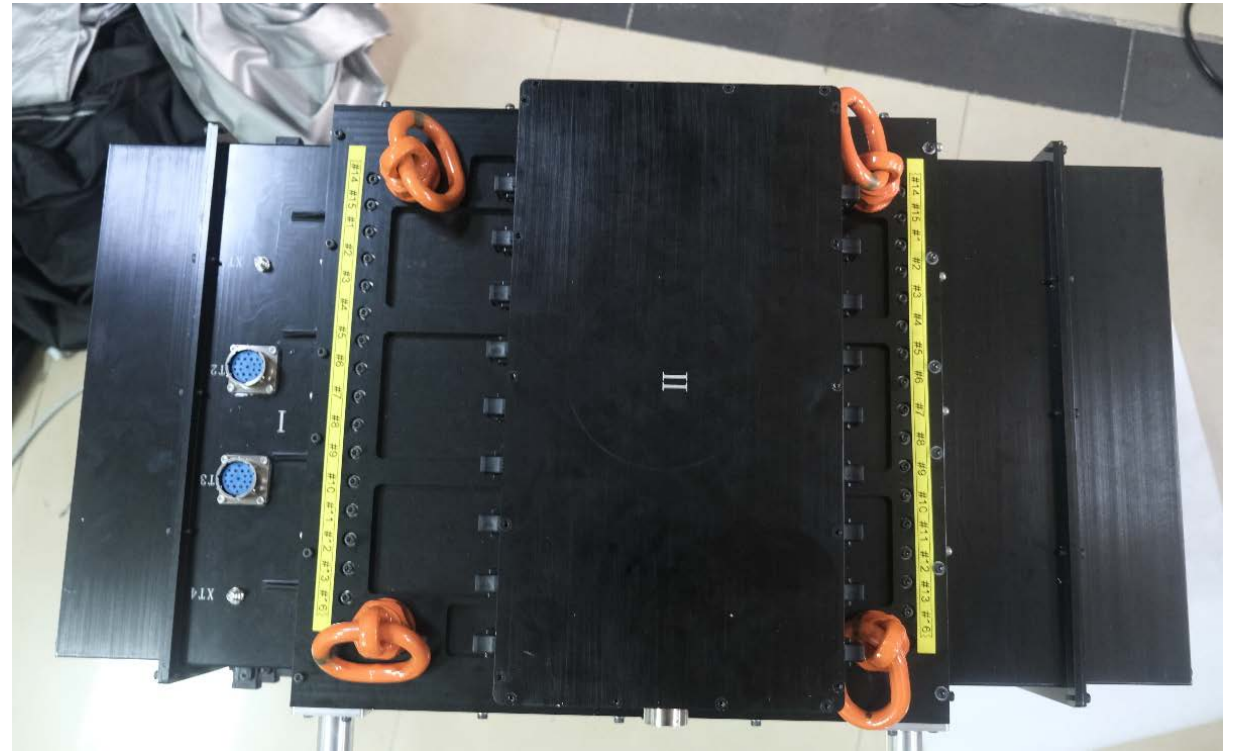
- 17 super-layers hold most in the mechanic structure
- Two directions are reserved for cables connection(signal and power cables)
- Fans cooling system and light shield also integrated

Commission of prototype

- Commission setup

Server control

GBT

Sc-ECAL

Cosmic muon

Power

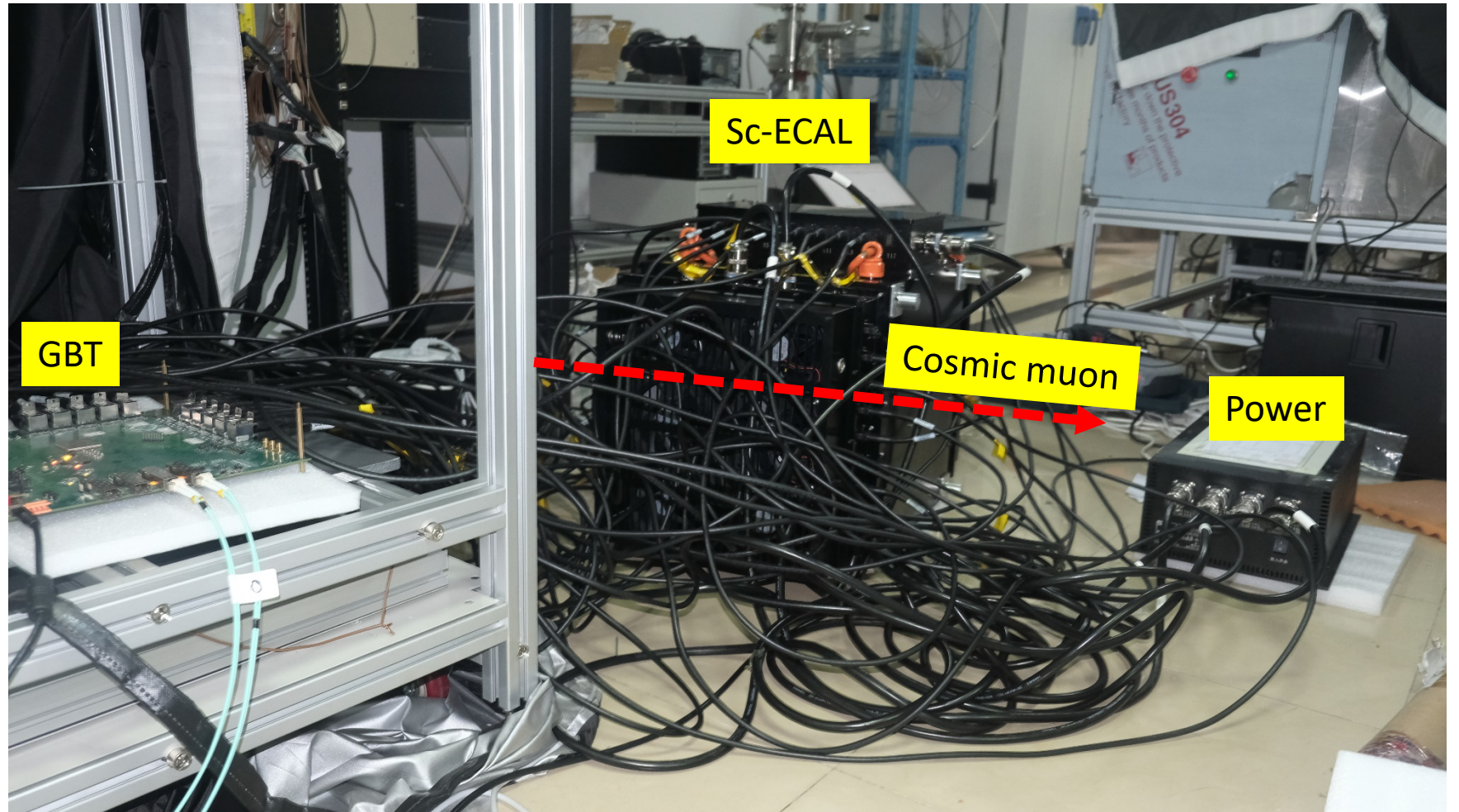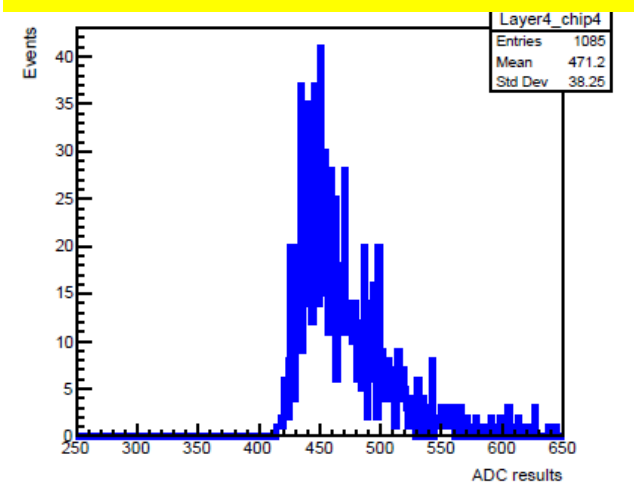# Trigger rate effect on SPIROC

- The data is not stored correctly inside the Analogue Memory, if the event rate is lower than 1Hz

- How to do ACQ when the event rate is too low
  - Readout as soon as the chip send out a Trigger information on OR36 output
  - Refresh in a few hundreds millisecond period
    a) Fill up the SCA by sending external triggers 16 times
    b) Then stop the acquisition
    c) Reset the digital part (no need to digitize and readout the data)
    d) Restart the Acquisition

- Modified the DAQ logic and waiting for verify by cosmic ray test

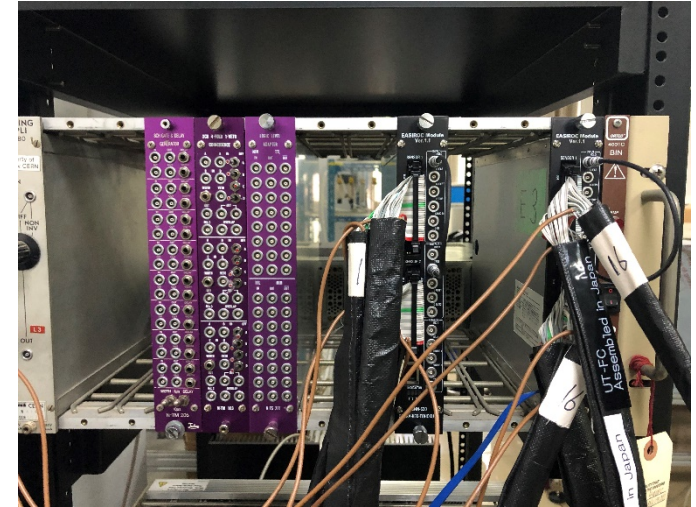Pedestal at high trigger rate

Layer4_chip4
Entries	33420
Mean	429.8
Std Dev	9.457
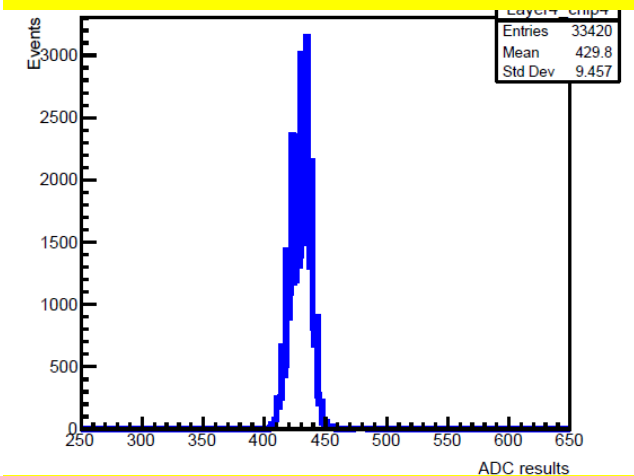
Pedestal at low trigger rate

Layer4_chip4
Entries	1085
Mean	471.2
Std Dev	38.25

Hodoscope commissioning
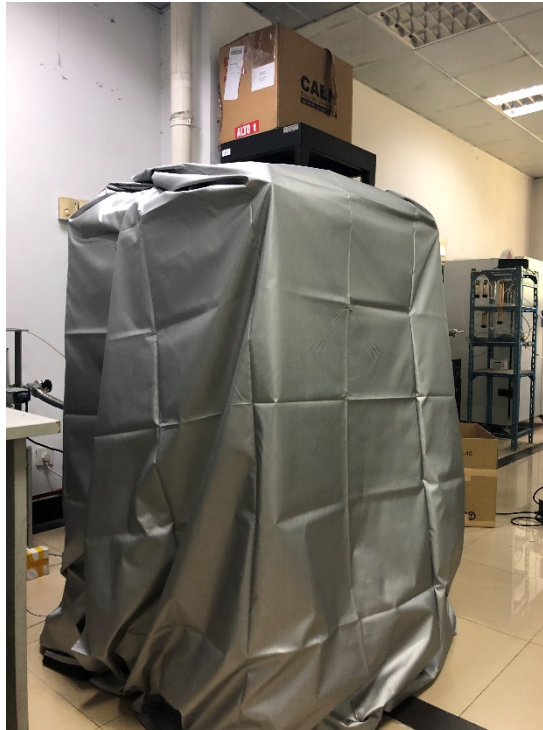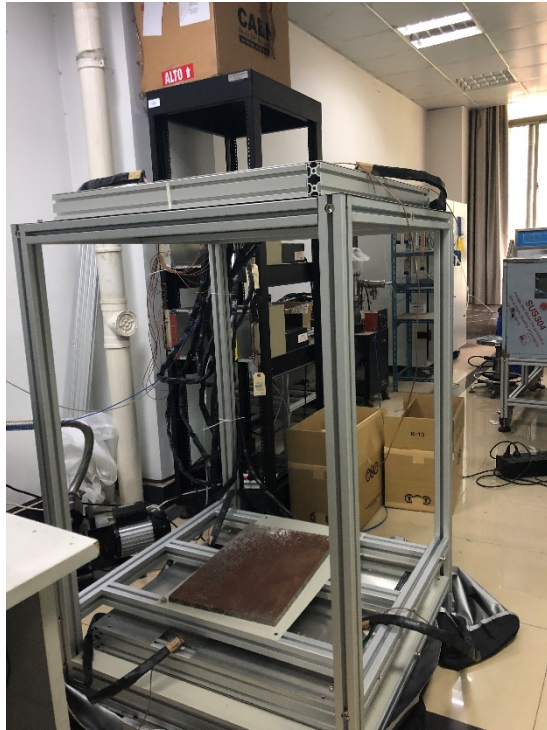
- Hodoscopes setup completed

Hodoscope commissioning

- 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

Outline

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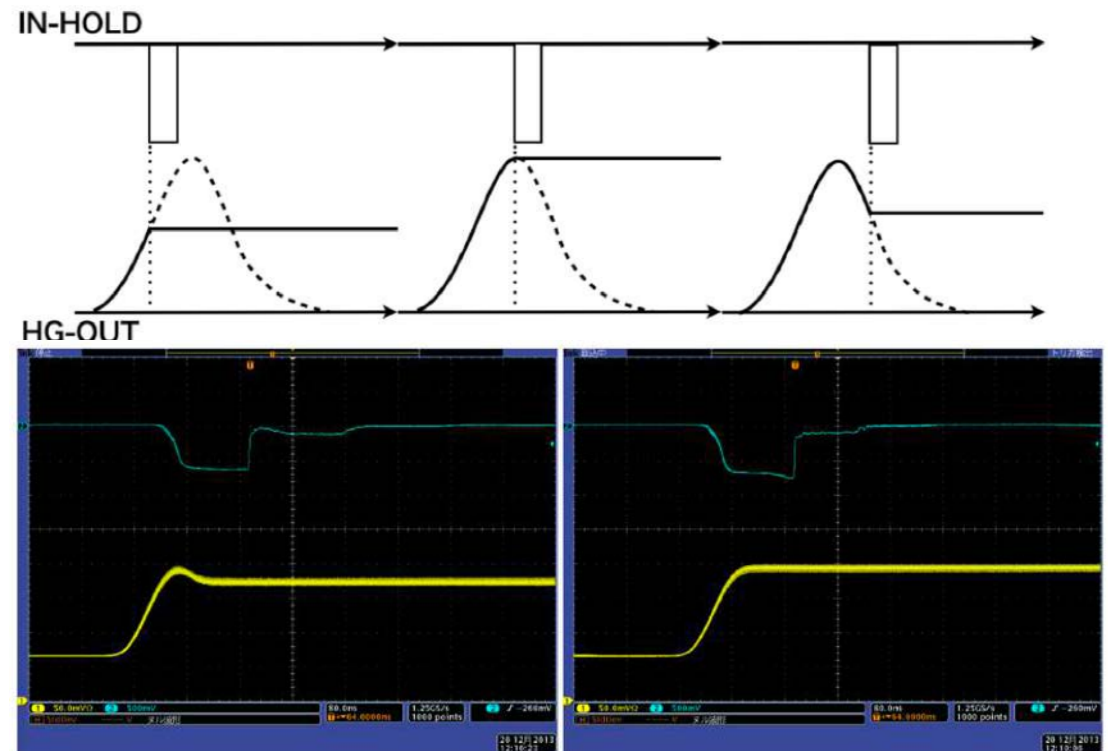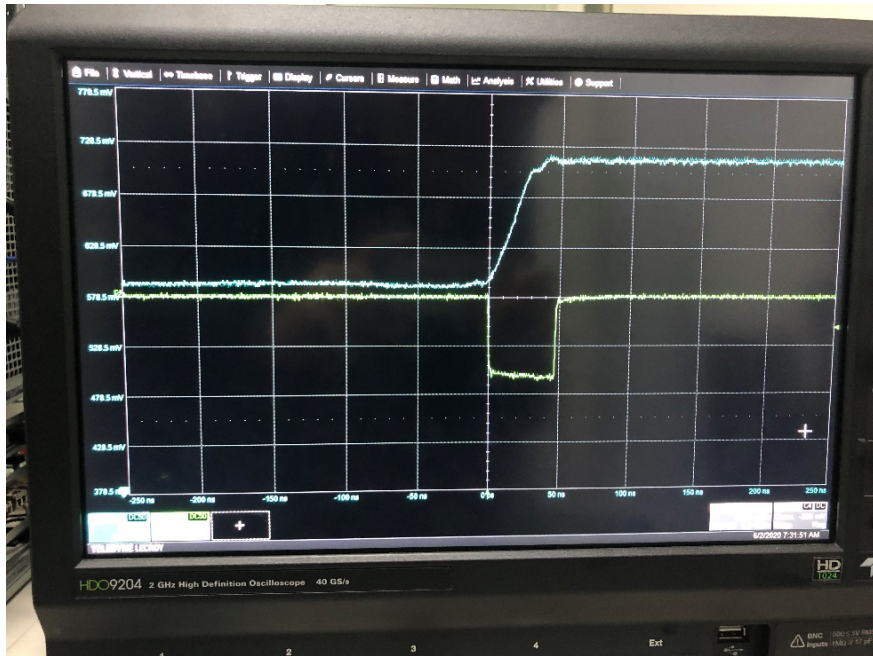- CEPC Sc-ECAL prototype design and development

- Progress of prototype commissioning

- **Summary and future plan**

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

  - ✓ Modified DAQ logic for SPIROC work improperly at very low event rate

- To do next

  - 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	

First commissioning