The Progress of Ecal Production in China

Chi Yang （杨驰）
Shandong University （山东大学）

for the MPD-ECal group in China

The XI MPD Collaboration meeting, Apr.18th-20th 2023, Dubna, Russia

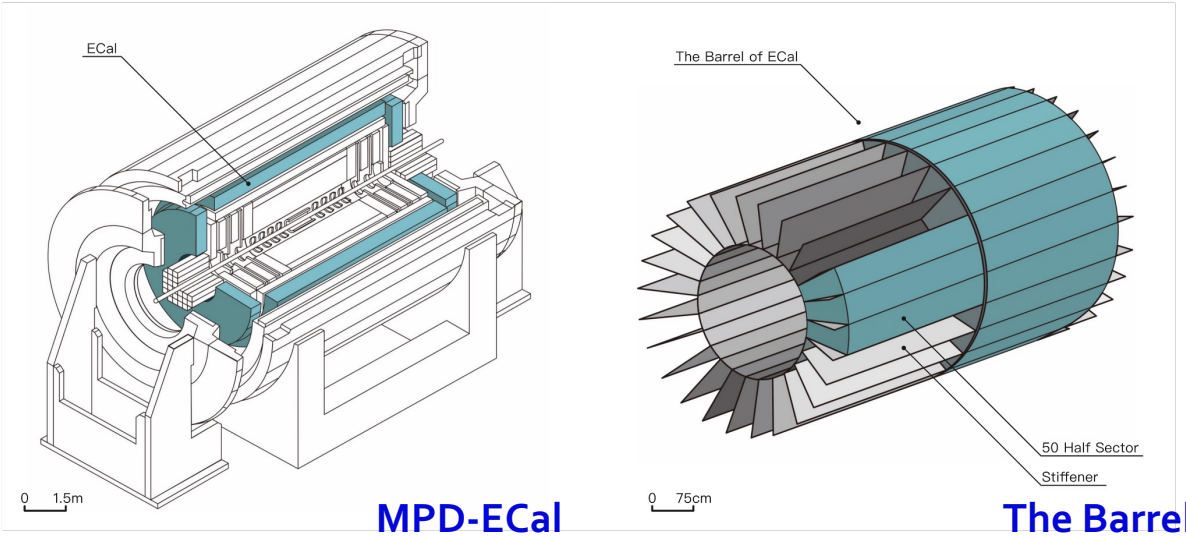
Outlines

- MPD-ECal introduction
- ECal module production
- Cosmic test of module
- Simulation of ECal related PID
- Summary

Introduction on MPD Ecal

MPD-ECal requirements:

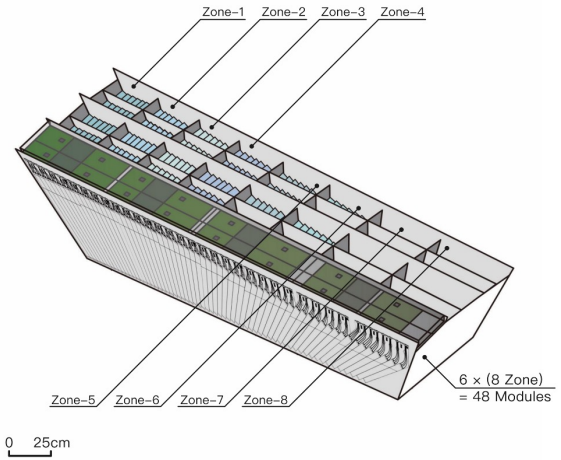
- particle occupancy : < 5%
- Time resolution : <1ns
- Energy resolution : < 5% @ 1GeV
- Operate in the magnetic FIELD : ~ 0.5T
- Adequate space resolution



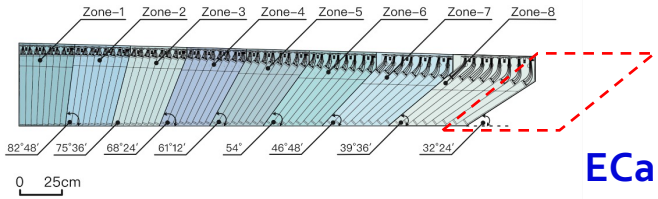
MPD-ECal

The Barrel of ECal

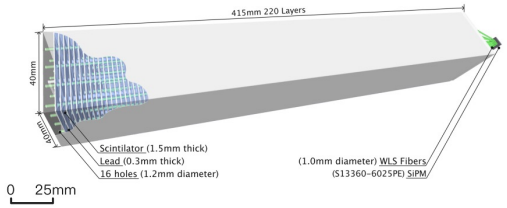
ECal Half-Sector



ECal 8-Zone



ECal Module



ECal Tower

MPD-ECal
1 Barrel
50 Half-sectors
300 8-Zone modules
2400 Modules
38400 Towers

Scope of China MOST MPD-ECal Project

- **Hardware:**
  - Construction of 8 sectors. 768 modules in total.
  - Production of FEE PCB (1200 FEEs)
  - R&D on fast readout electronics, time resolution is less than 150ps
- **Software and simulation**
- **Schedule:** 2020.6-2024.5

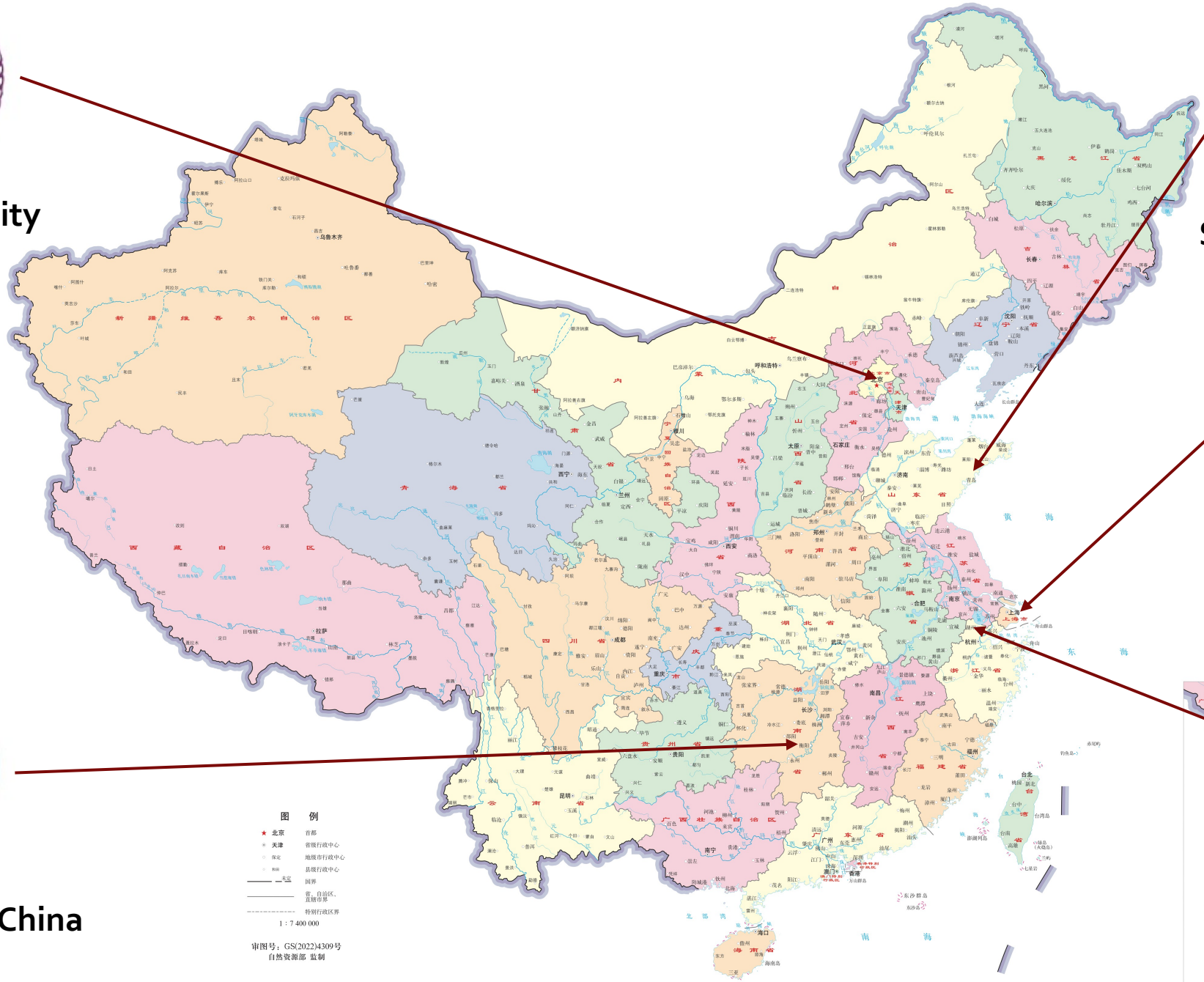
Tsinghua University

Shandong University

Fudan University

University of South China

Huzhou University



Module production in China

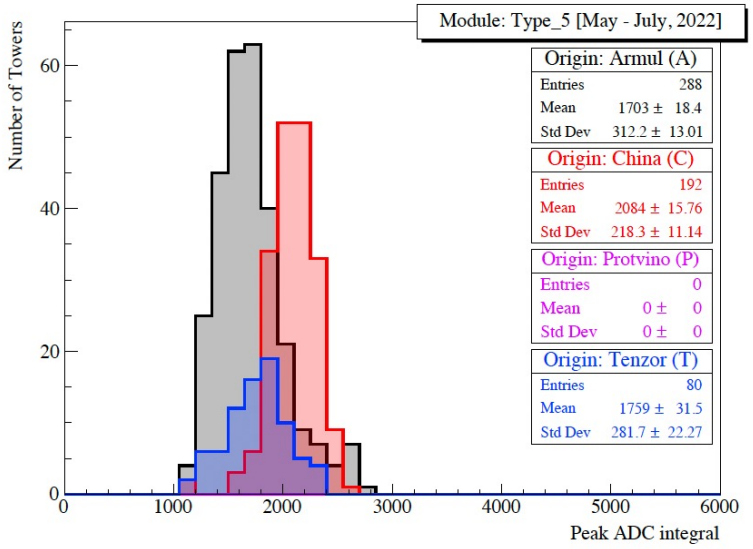
8 sectors, 768 modules, 12288 towers

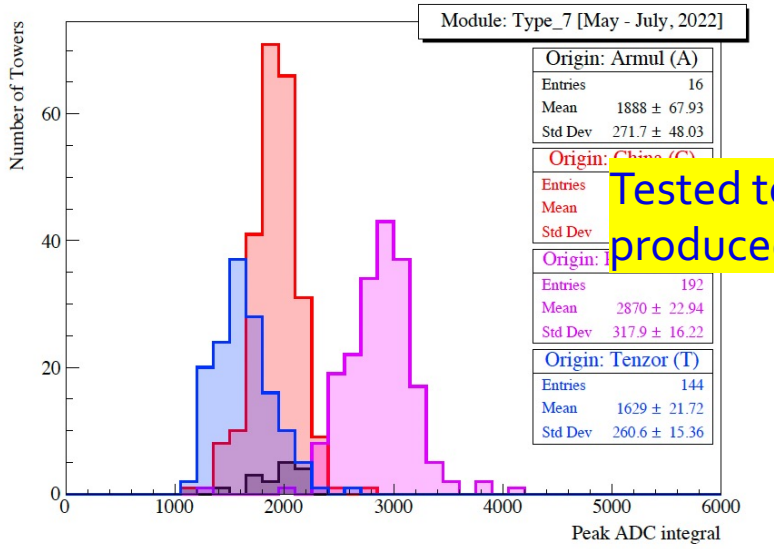
Tasks of each institute

	Zone	1	2	3	4	5	6	7	8	Total
Institute	THU	19	19		38	96	96	96	96	460
	SDU			96	58					154
	FDU		77							77
	USC	77								77

- In the first stage (2020.6-2022.5), 8 sectors have been produced in China

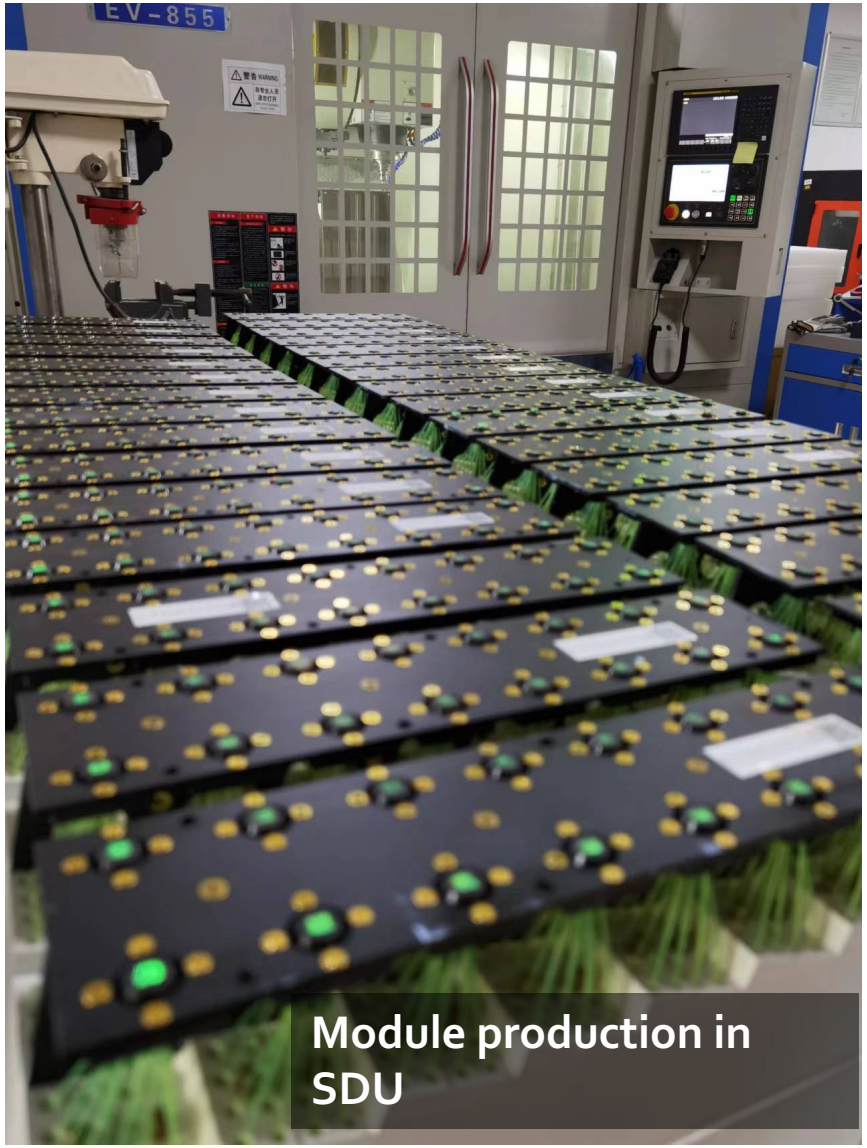
ZONE1 2 // ZONE3
ZONE5 1 // ZONE6
ZONE7 1 // ZONE8
Total: 8 modules



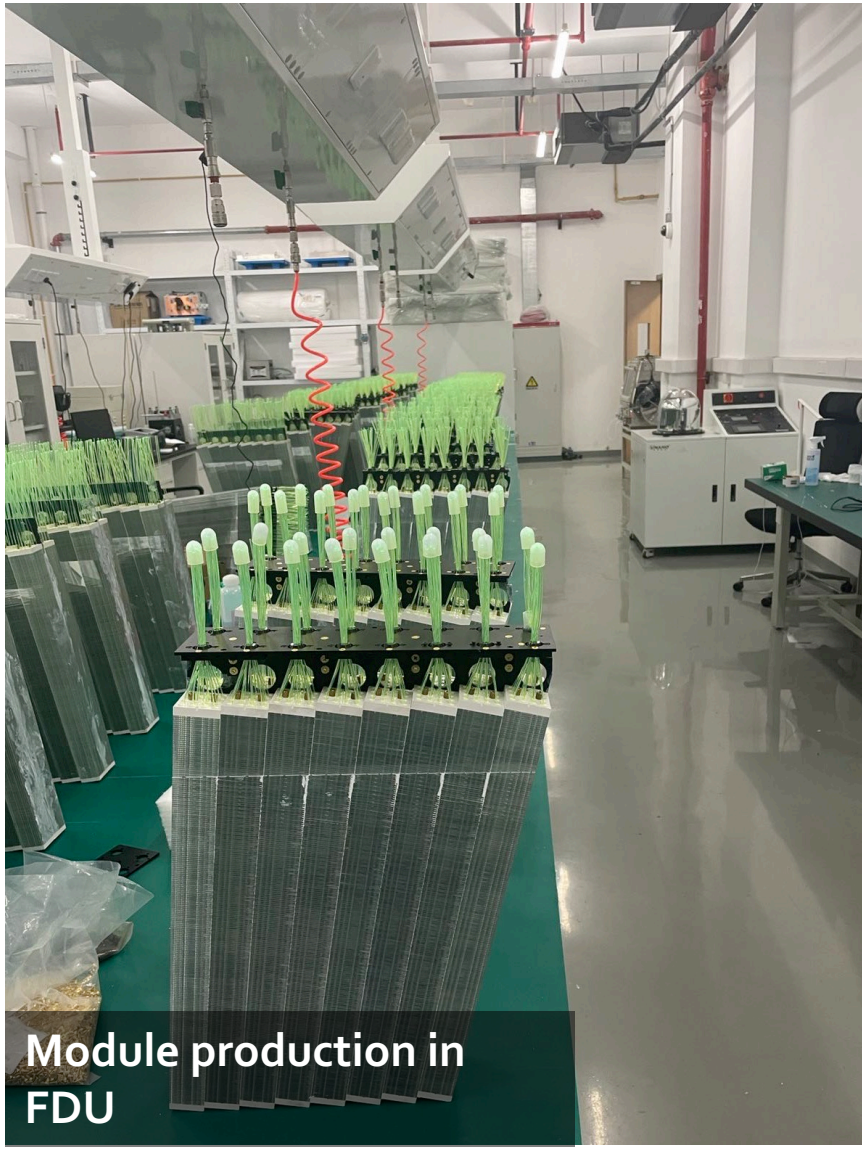


Tested together with the modules produced in Russia at Dubna

Module production in China



Module production in China


Module production in FDU


Module production in USC


Module production in USC

Previous shipments from China to Russia

Via the China-Europe train

First shipment

- 279 modules (31 boxes)
- Shipped to JINR on **2022.04.21**

ZONE5 91 // ZONE6 90
ZONE7 81 // ZONE8 17
Total: 279 modules

NICA/MPD电磁量能器交付发车仪式
Delivery and Departure Ceremony of Electromagnetic Calorimeter for NICA/MPD Project.

From THU

Second shipment

- 293 modules (32 boxes)
- Shipped to JINR on **2022.09.17**

ZONE1 19 // ZONE2 19
ZONE3 94 // ZONE4 96
ZONE5 4 // ZONE6 5
ZONE7 5 // ZONE6 51
Total: 293 modules

From SDU

Latest shipment

Third shipment

- 188 modules (22 boxes)
- Shipped to JINR on **2023.02.14**
- **Arrived at 2023.03.15**

ZONE1 75 // ZONE2 77
ZONE7 9 // ZONE8 27

Total: 188 modules

Joint Institute for Nuclear Research
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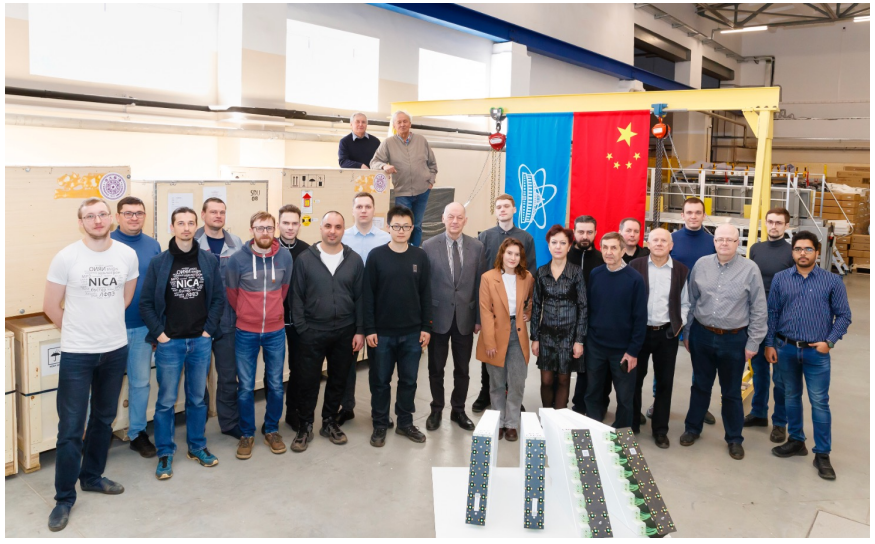
ALL | World science | Organization | Education | Grants | Patents | Publications | Interview | Culture | Media | Agenda

Equipment for NICA arrived from China

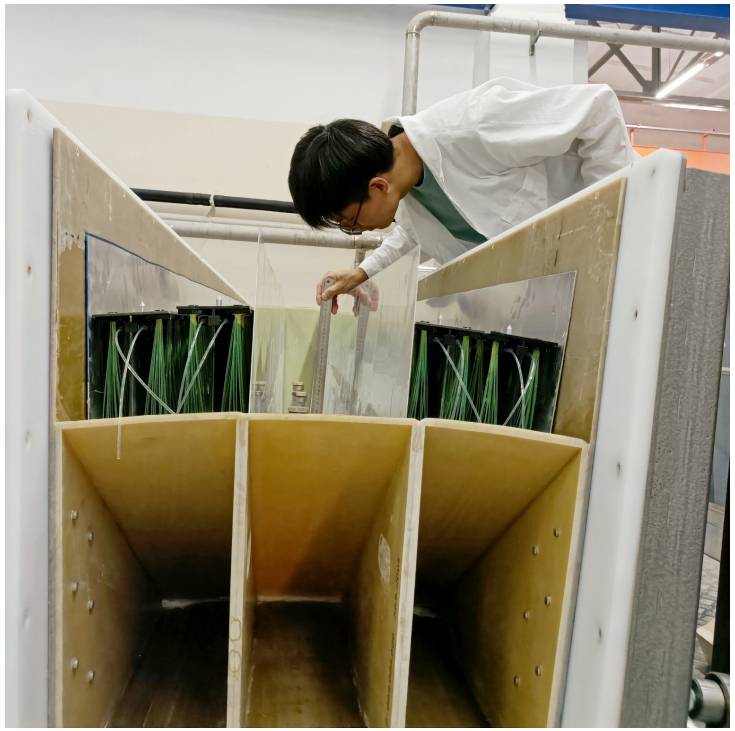
News, 31 March 2023



From FDU

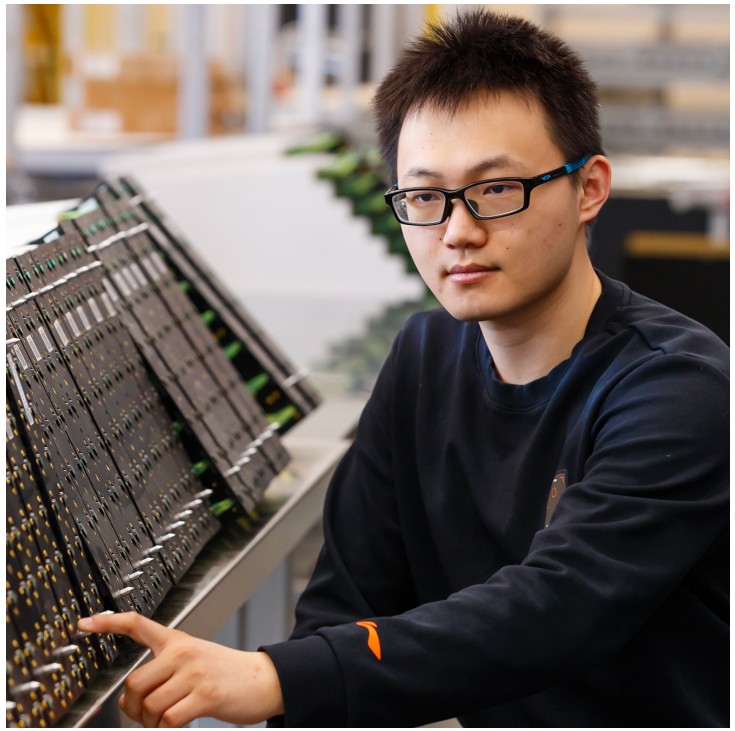
From USC

Juniors working at JINR



Ping Su
Ph.D. Student
Fudan University
Oct.20 – Dec.17 2022 at JINR

Yonghong Wang
Ph.D. Student
Shandong University
Oct.20 – Dec.17 2022 at JINR



Linmao Li
Ph.D. Student
Tsinghua University
Working now at JINA

We will continuously contribute to ECal project and relate.

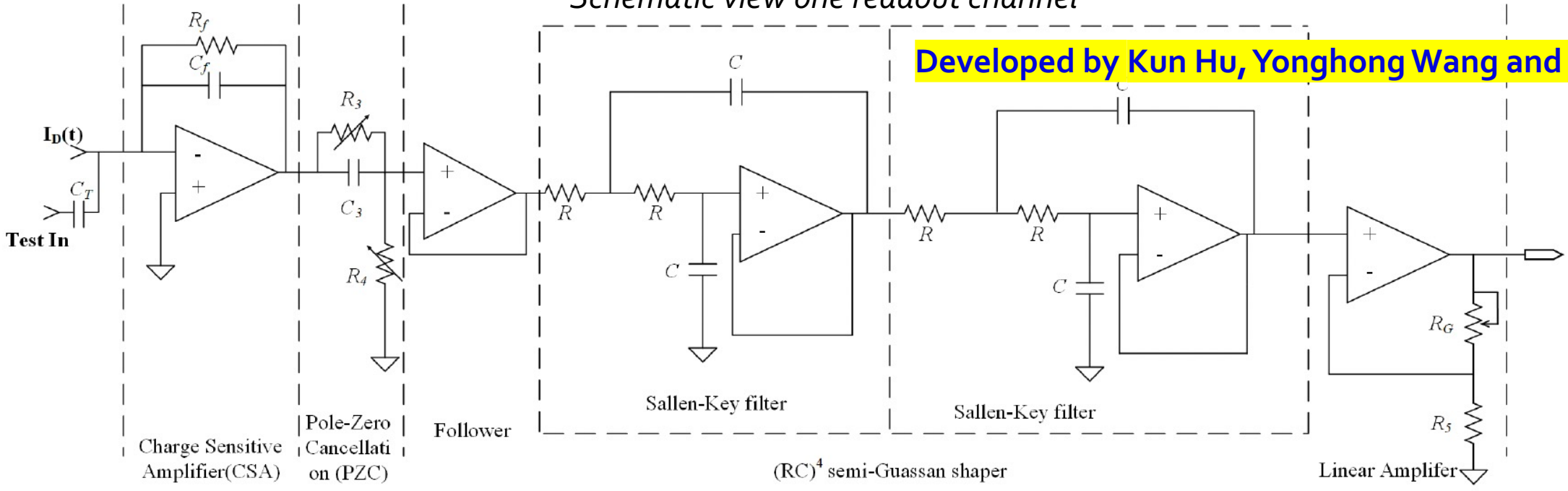
ECal module test

- Many module tests were done by THU and SDU
- Only part of results were selected to be shown in this talk, focusing on the test at SDU
- More results and details can be found in previous talks from China MPD-ECal group

Electronics developed at SDU

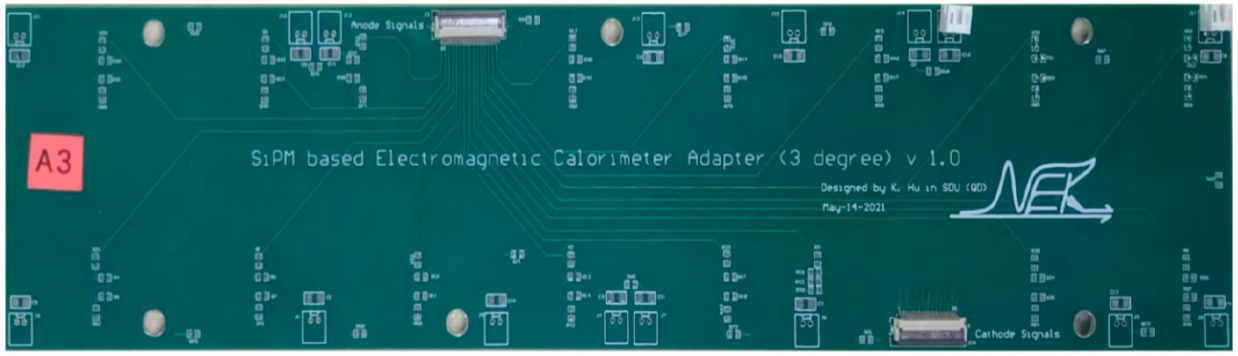
Schematic view one readout channel

Developed by Kun Hu, Yonghong Wang and Chi Yang

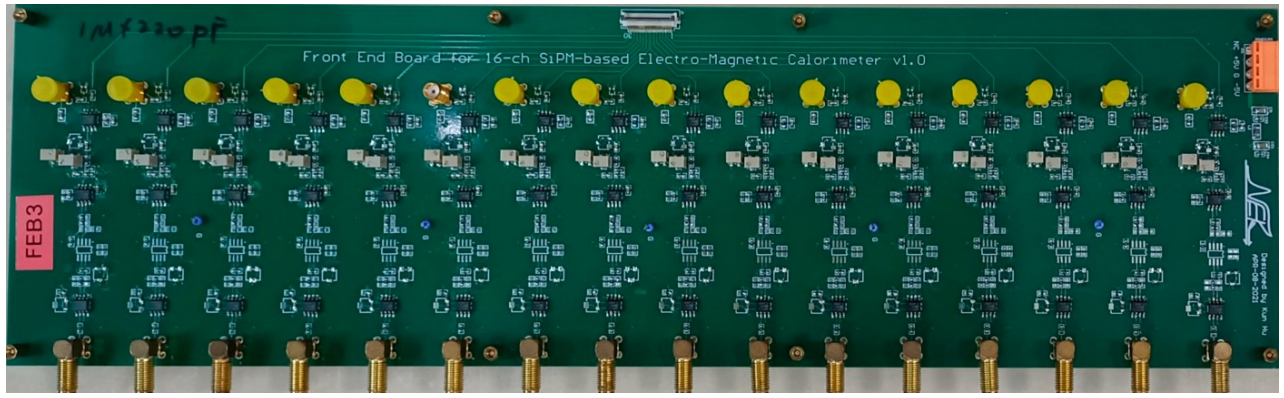


SiPM-based Adapter

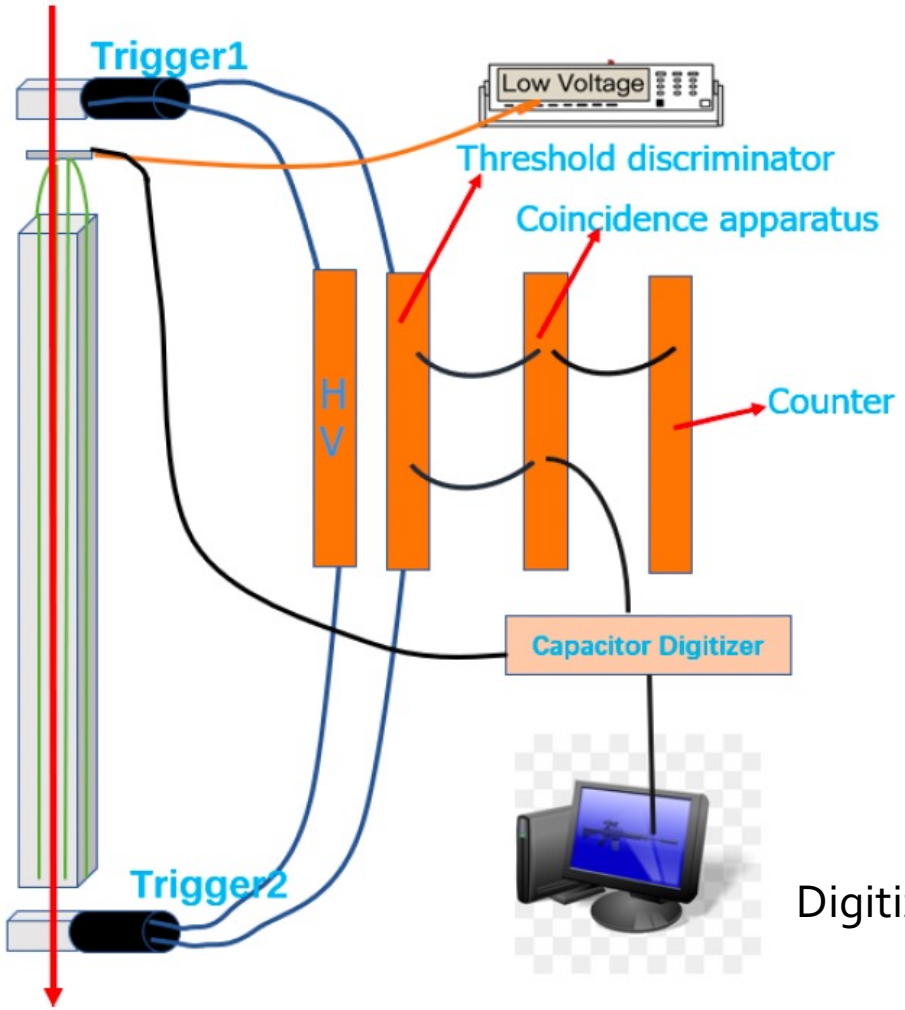
SiPM S13360-6050PE



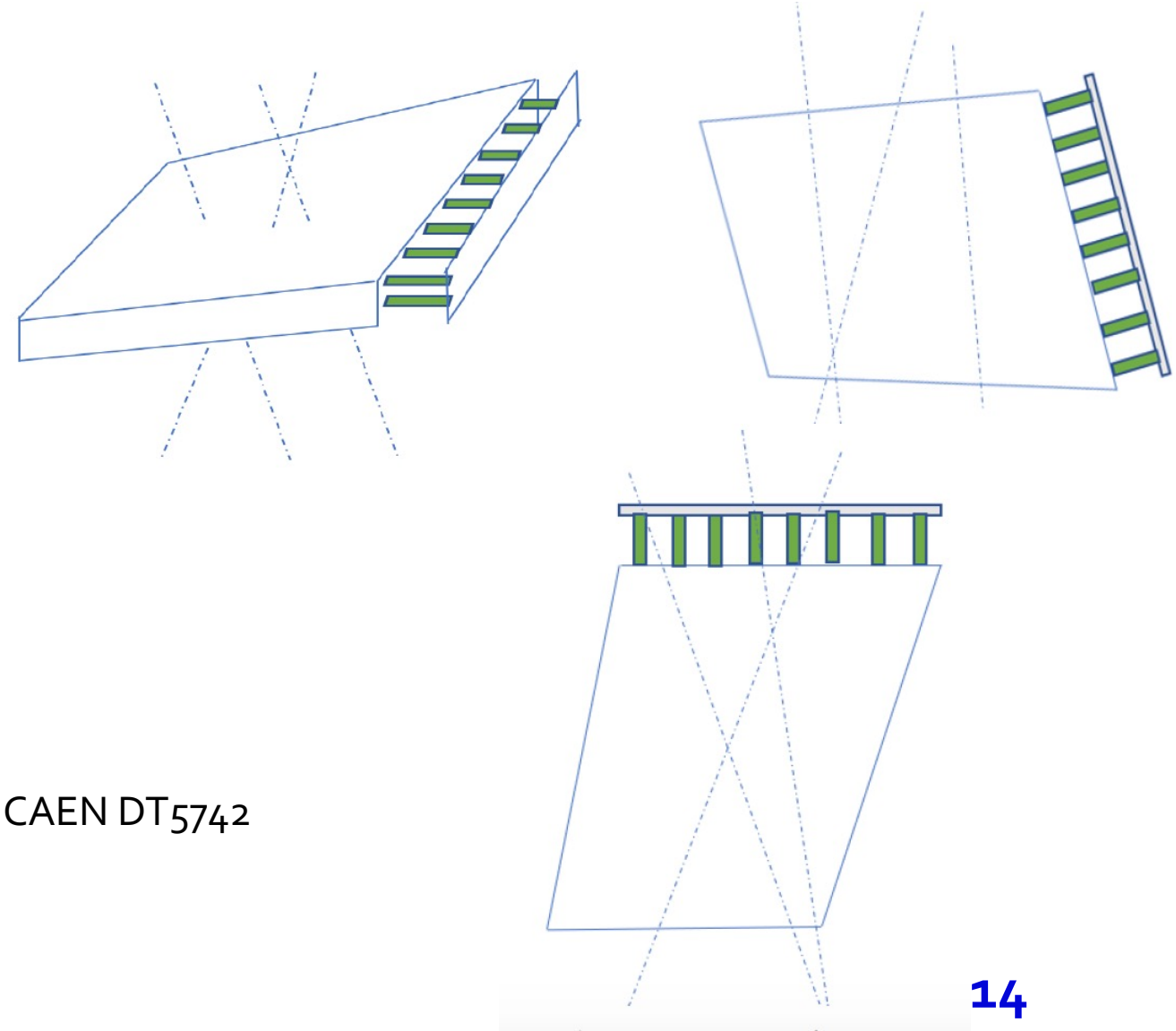
Front End Board



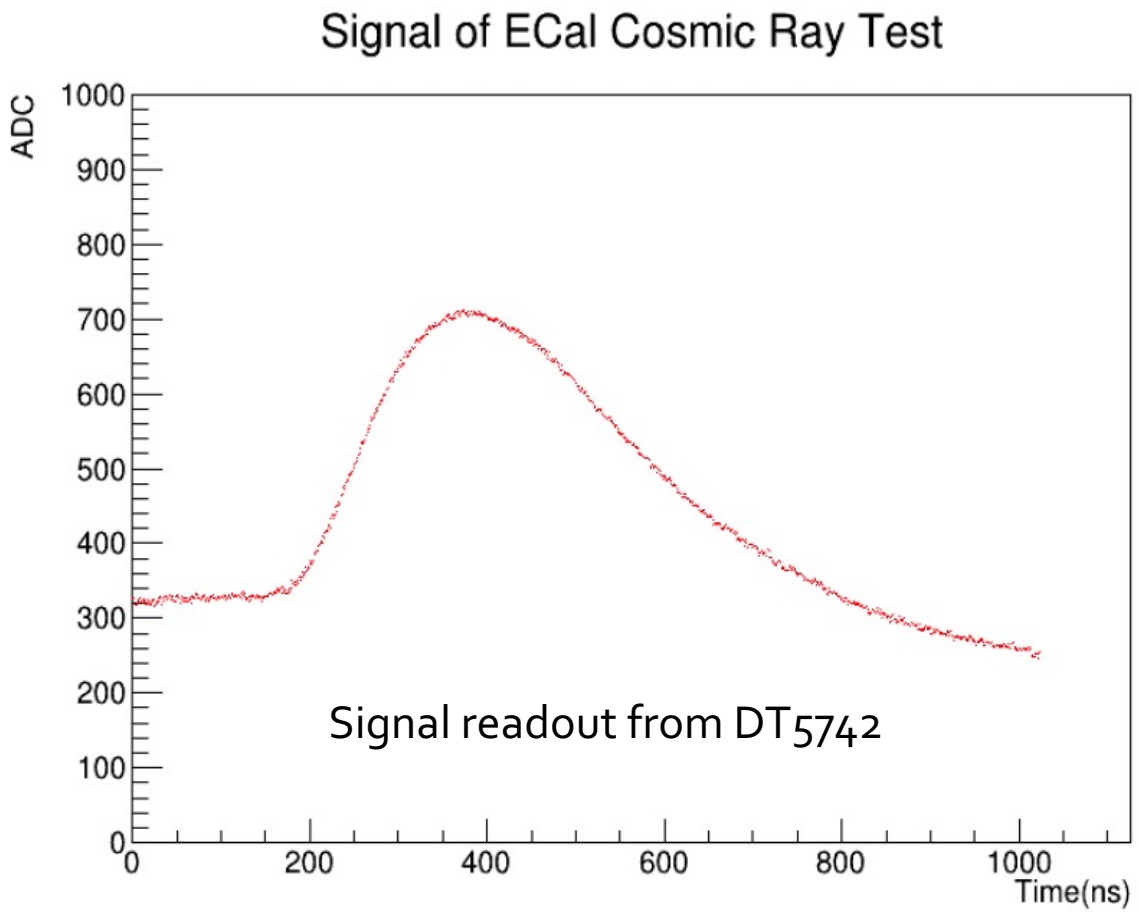
Test system at SDU

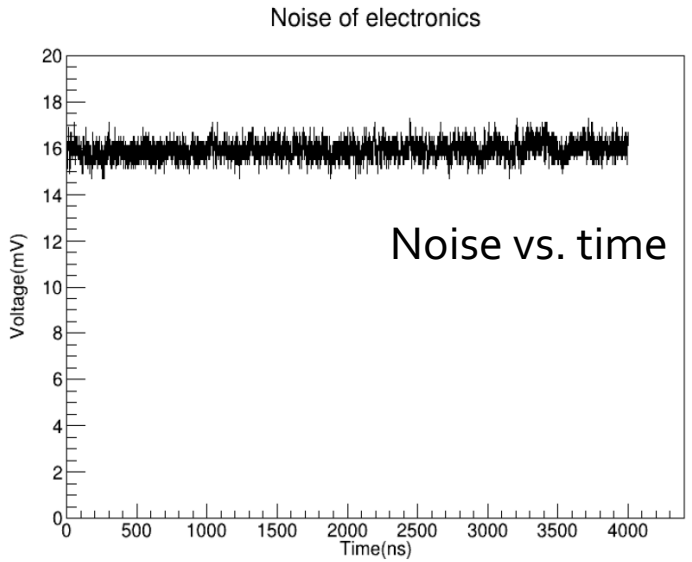


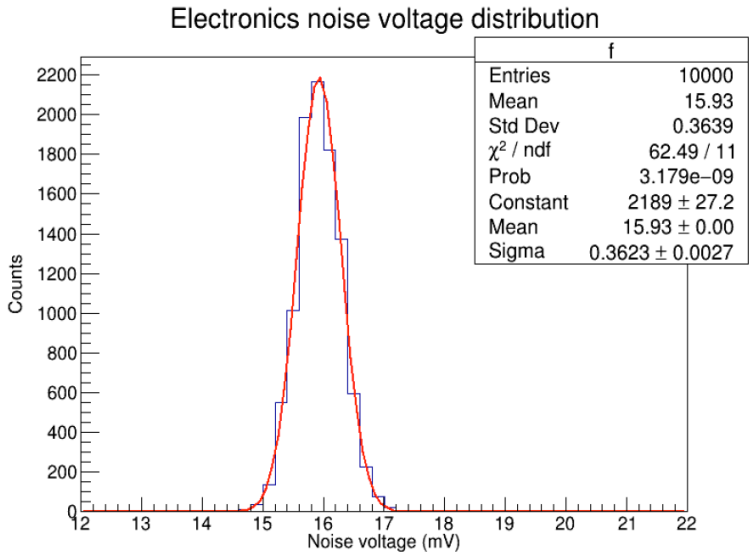
Digitizer: CAEN DT5742



Test system at SDU

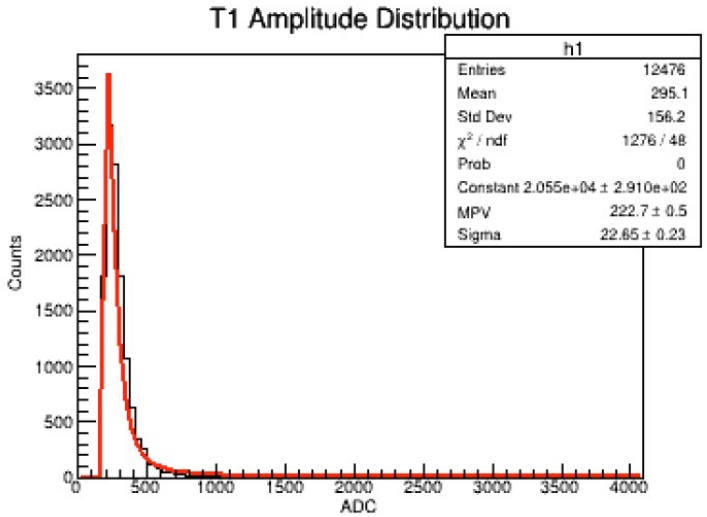


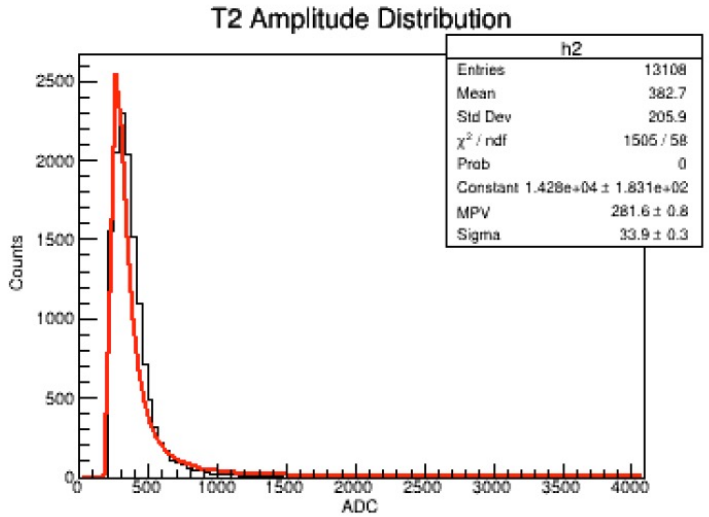


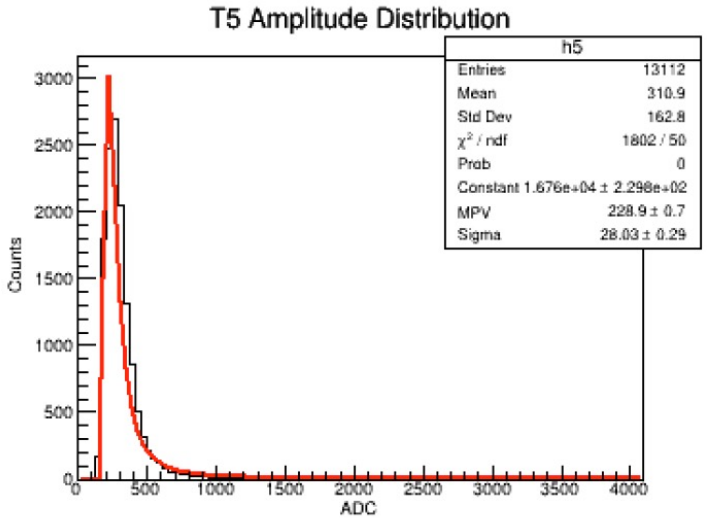


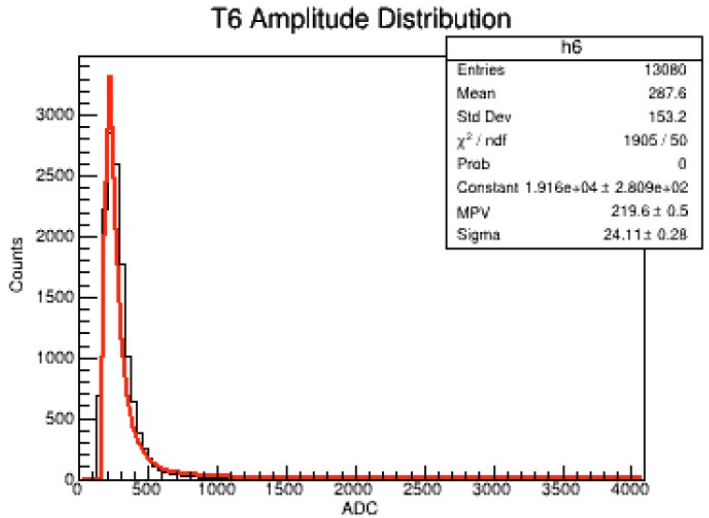
Signal

Red line:
Landau distribution fitting



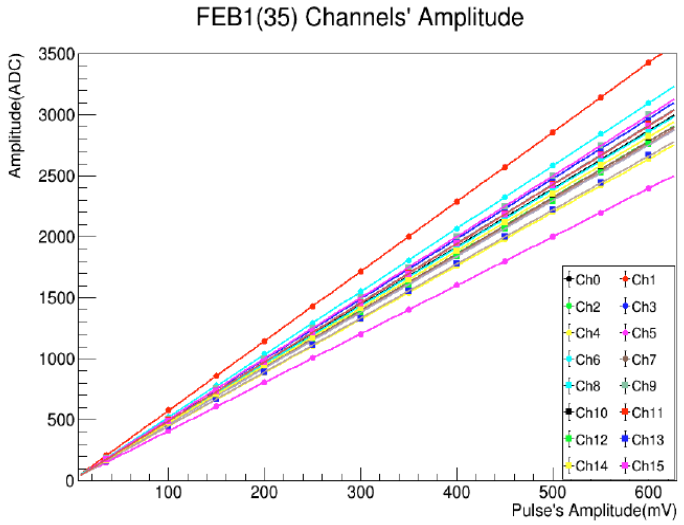


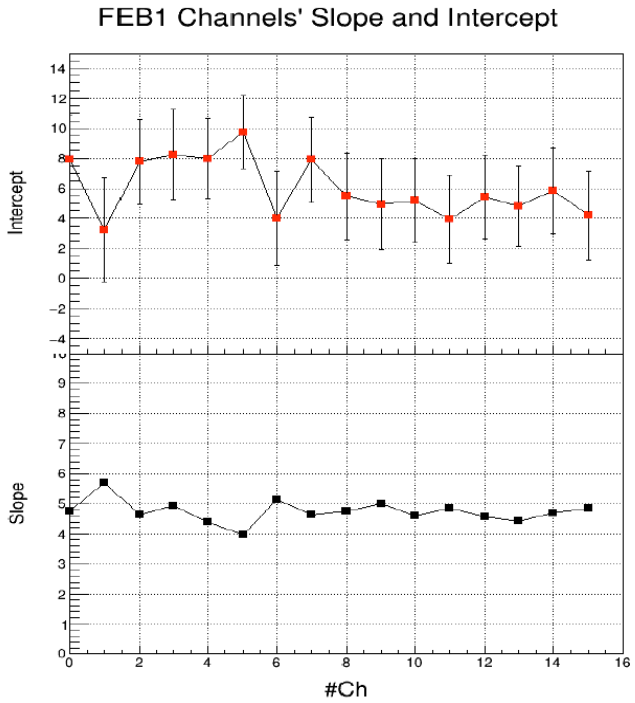




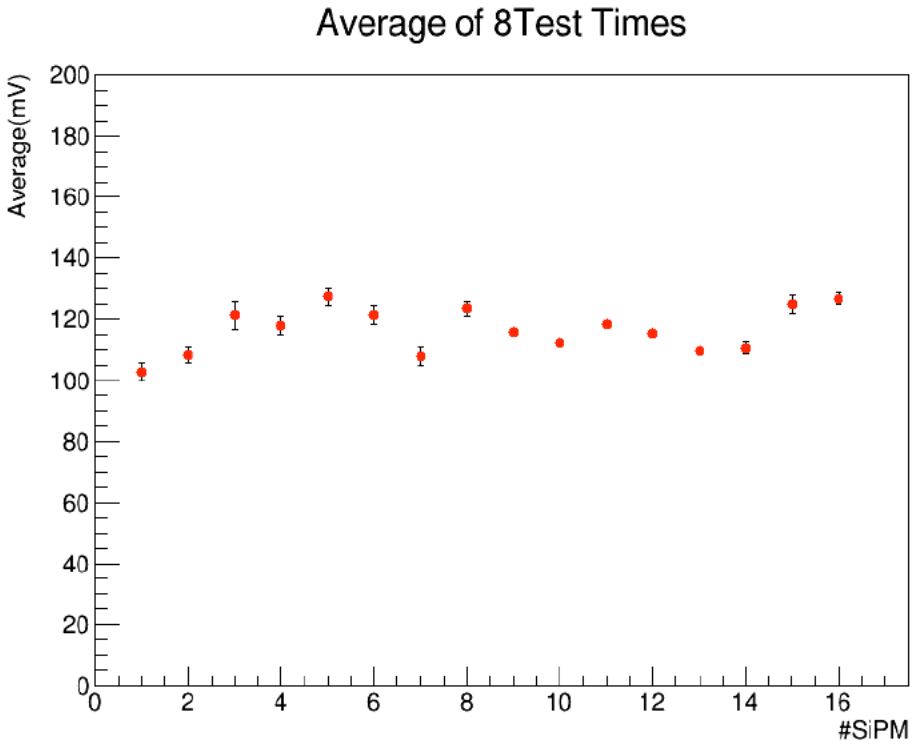
Calibration and correction

Calibrate the differences between SiPMs

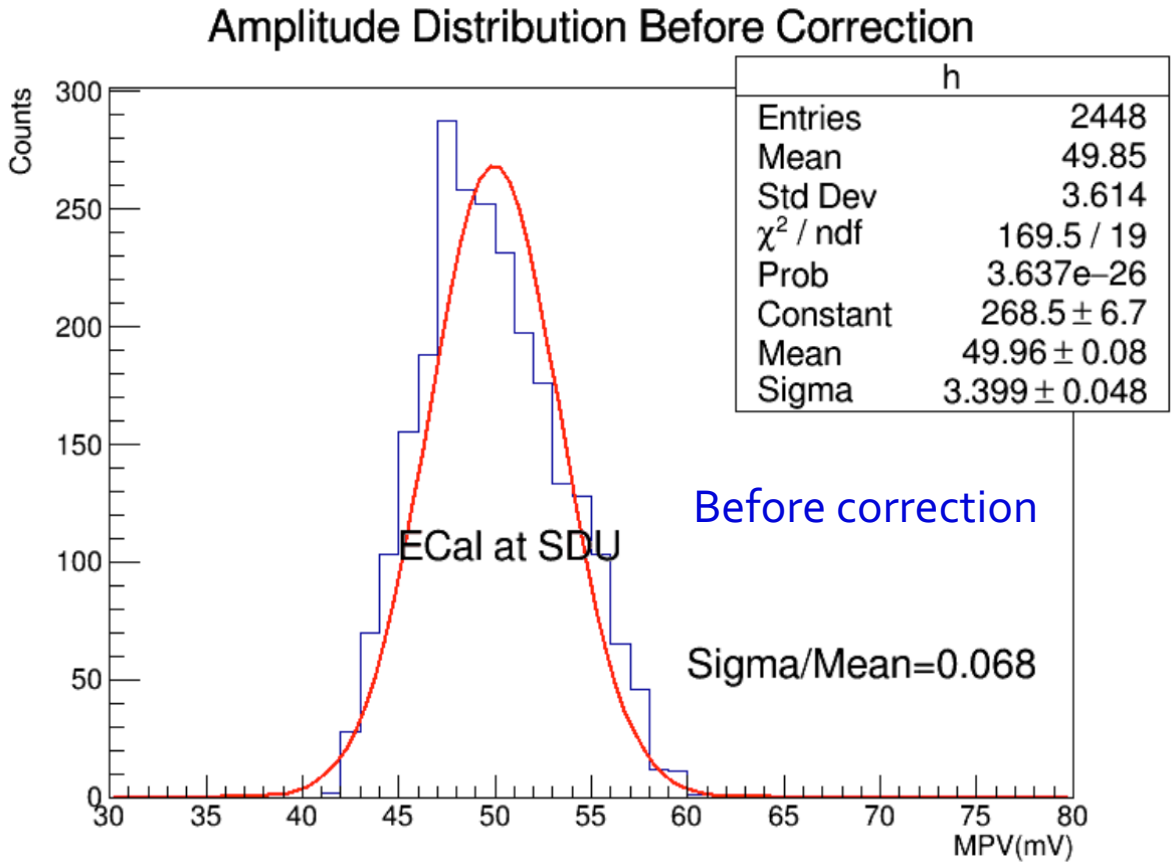


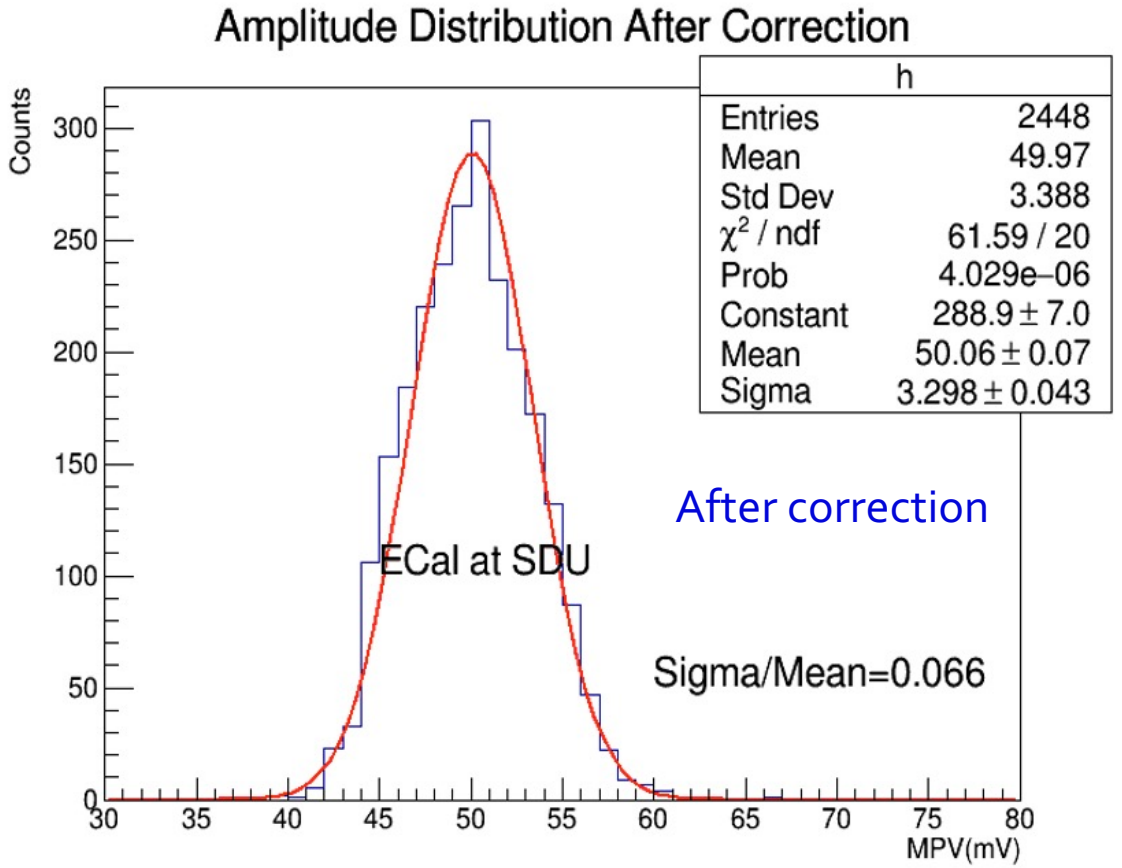


Check the stability of test system



Uniformity





Sigma/Mean ~ 6.6%

- All 154 ECal modules produced at SDU were tested
- Coupling effect differences from WLSFs to SiPMs are not corrected

MOST project mid-term review

Mid-term review: March 3rd, 2023

No negative comments for ECal project from the review committee

Photon identification

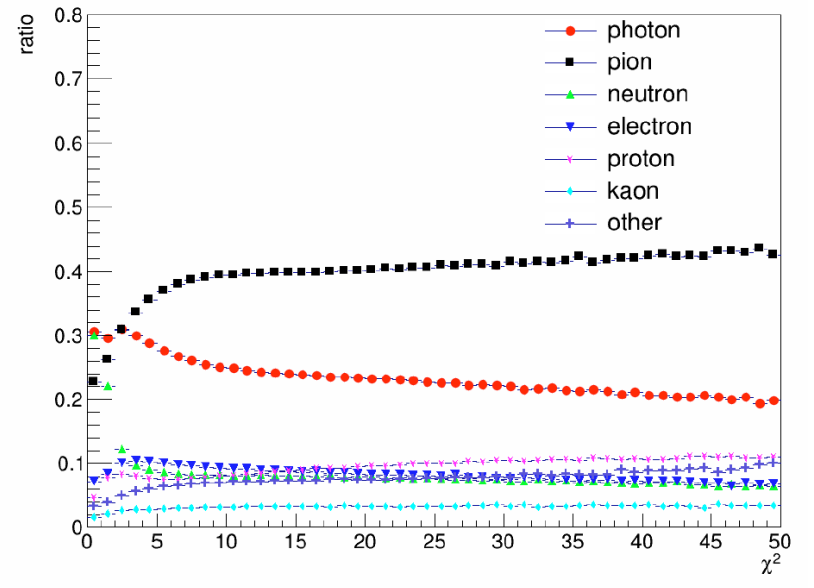
- The ECal related physics simulation has been started in China
- Contribute from THU, SDU and HZU

By Yulin Wang (PhD student) from SDU and Xiangrong Zhu from HZU

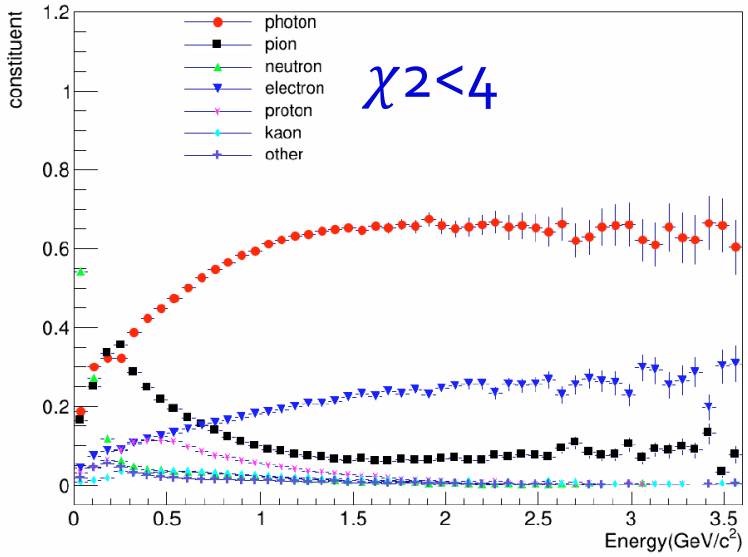
UrQMD, 11GeV Au+Au data

Shower shape: $\chi 2 < 4$

$$\chi^2 = \sum_i \frac{(E_i^{pred} - E_i^{meas})^2}{\sigma_i^2}$$

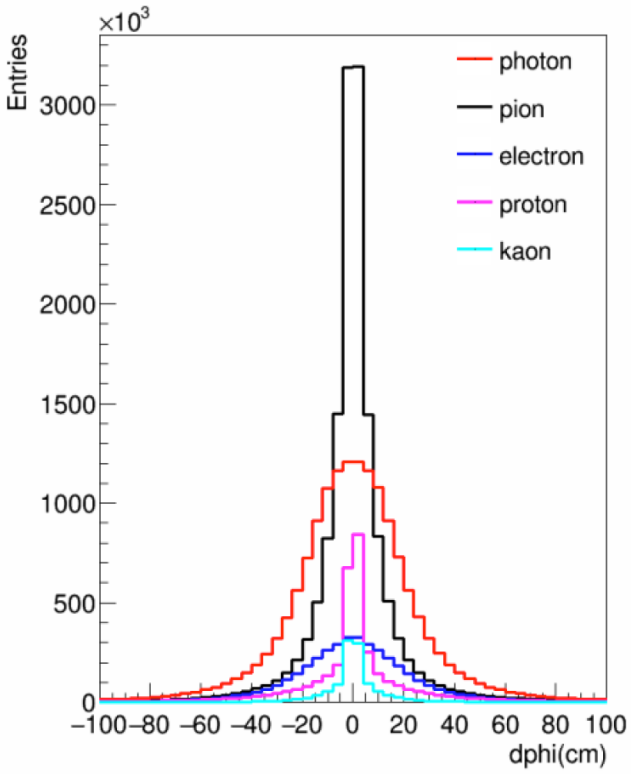


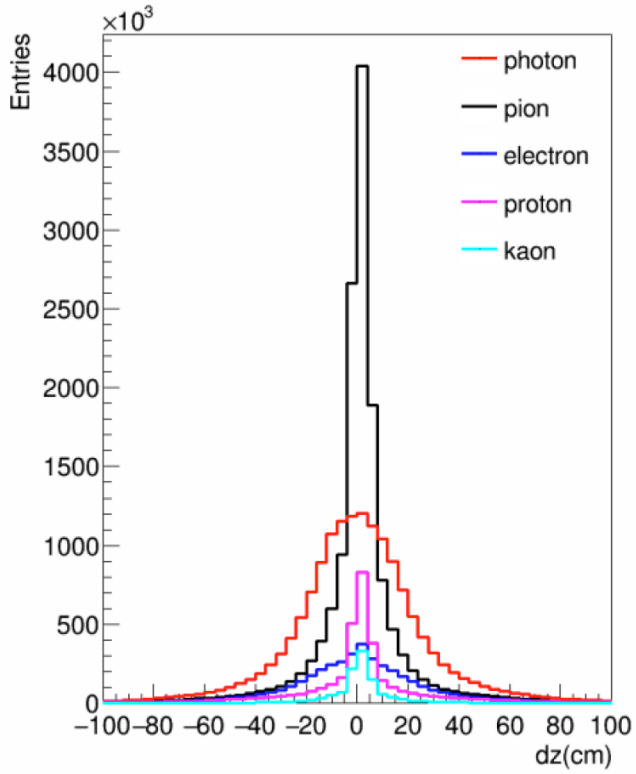
Fraction of photon increased



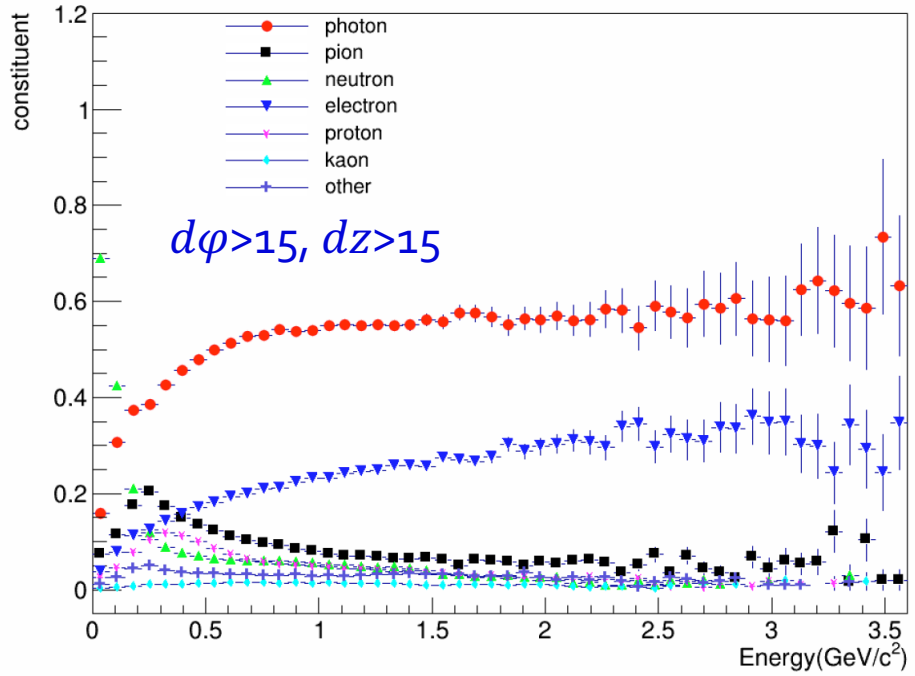
Photon identification

Charge particle veto: $d\varphi$>15, dz>15



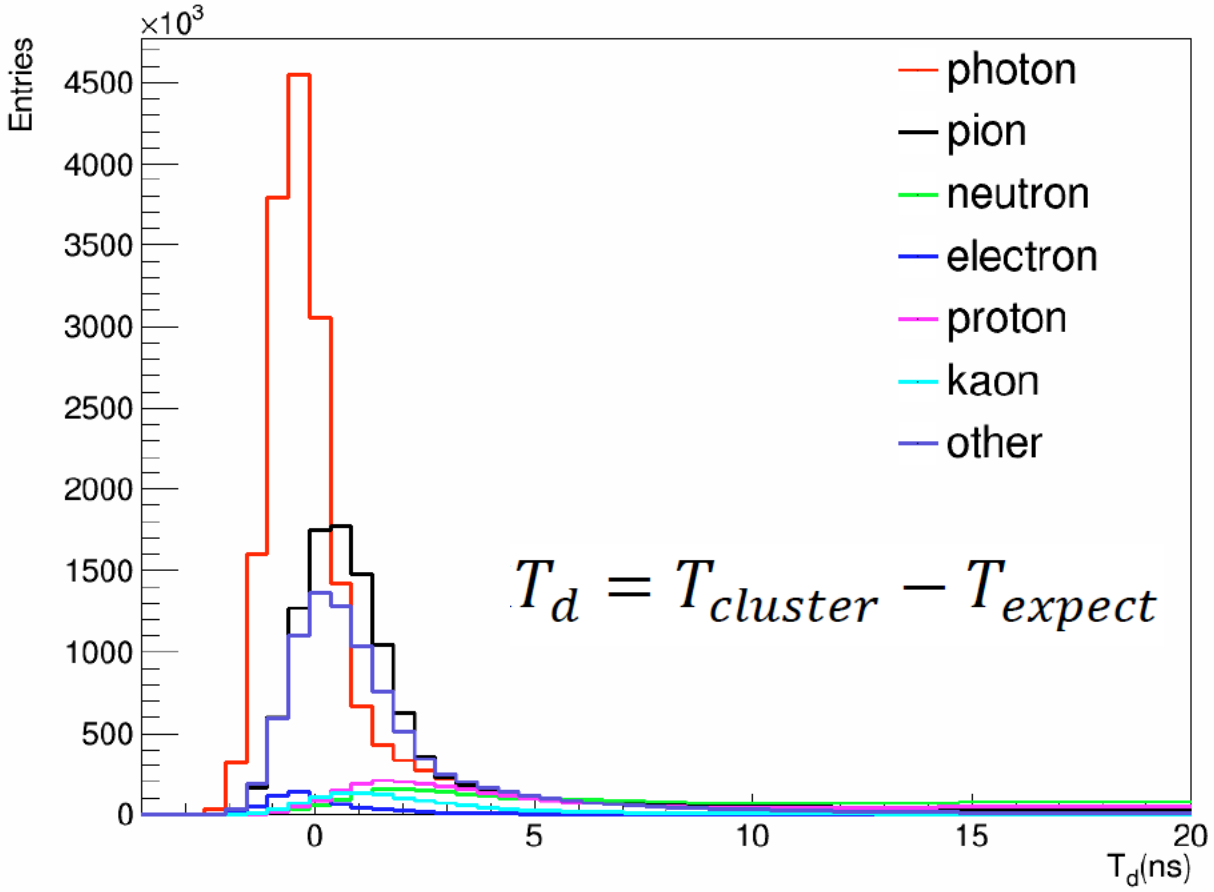


Fraction of photon increased

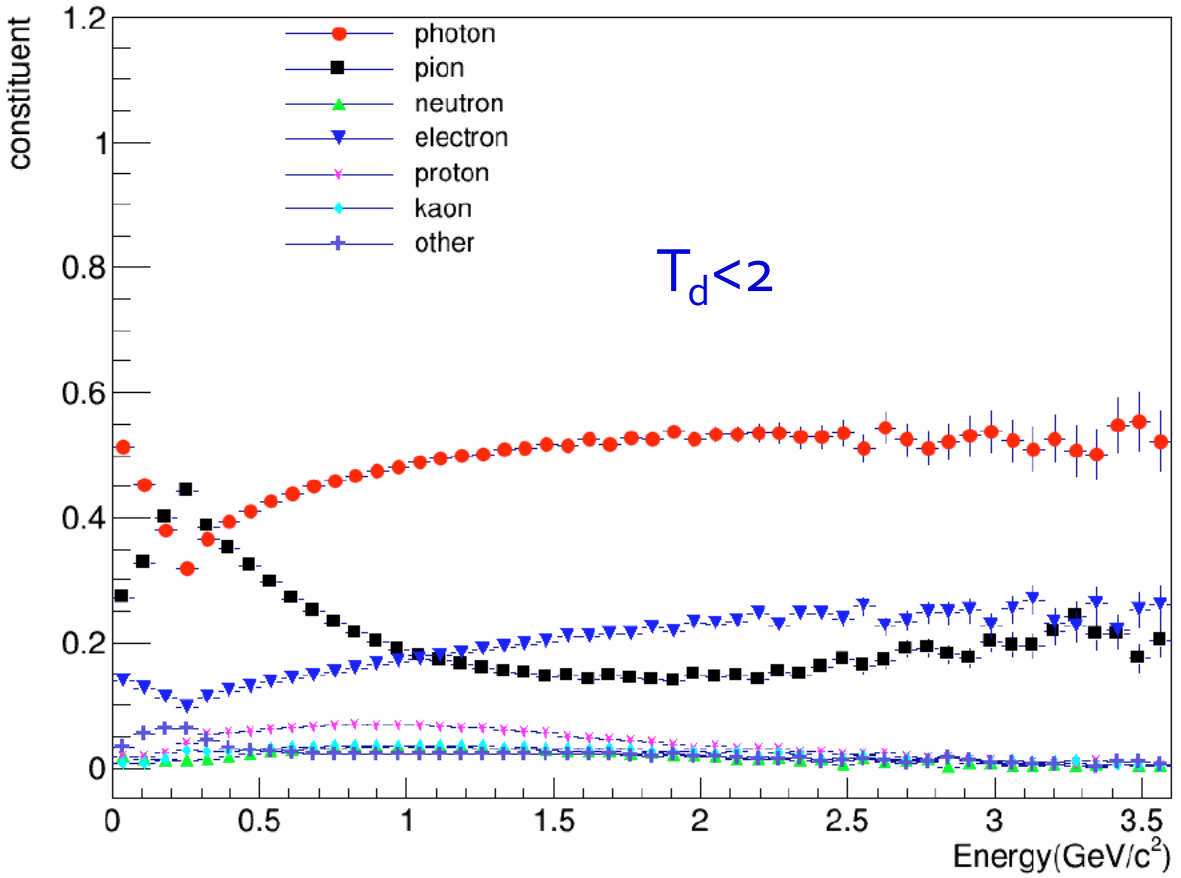


Photon identification

Time of flight difference: T_d<2 ns

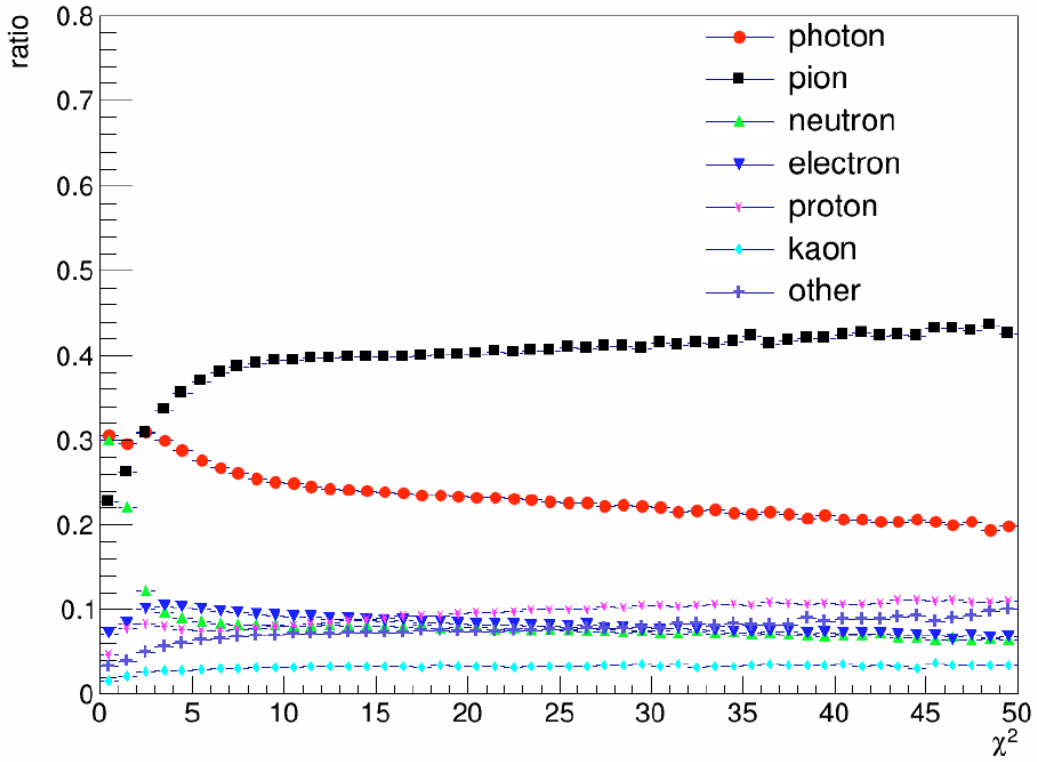


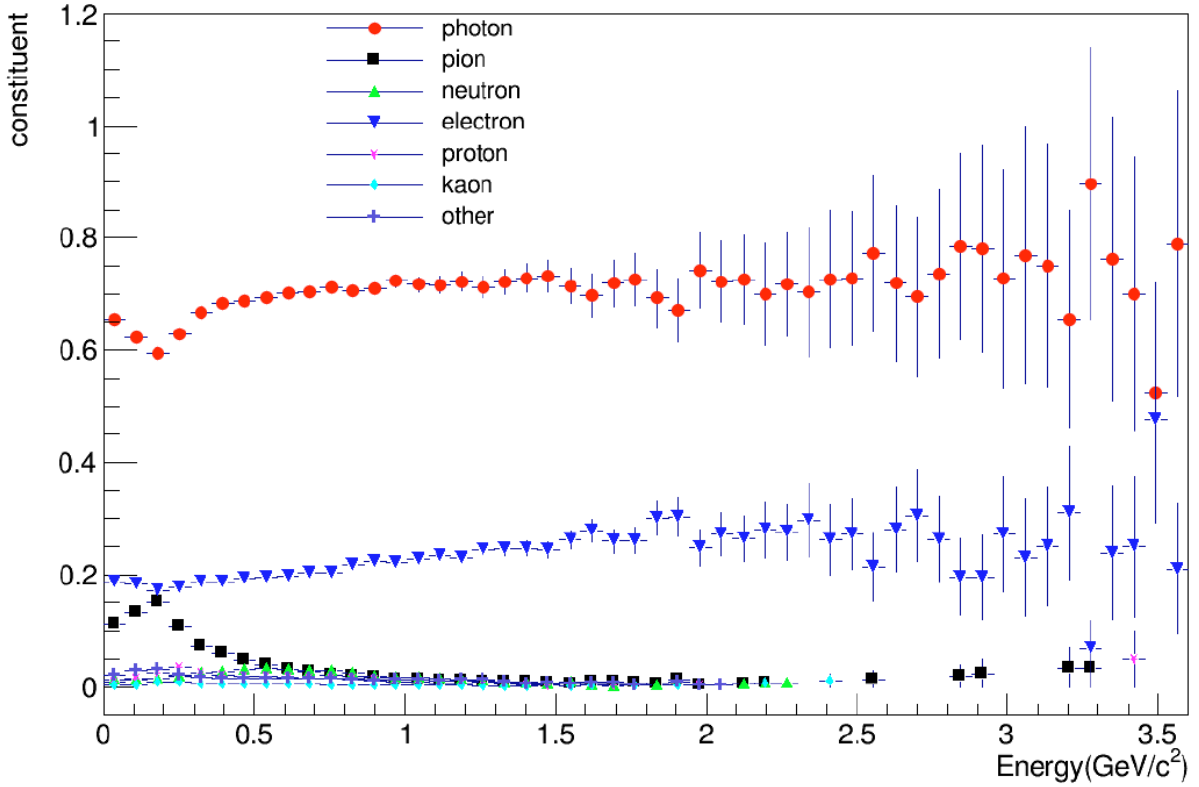
Fraction of photon increased



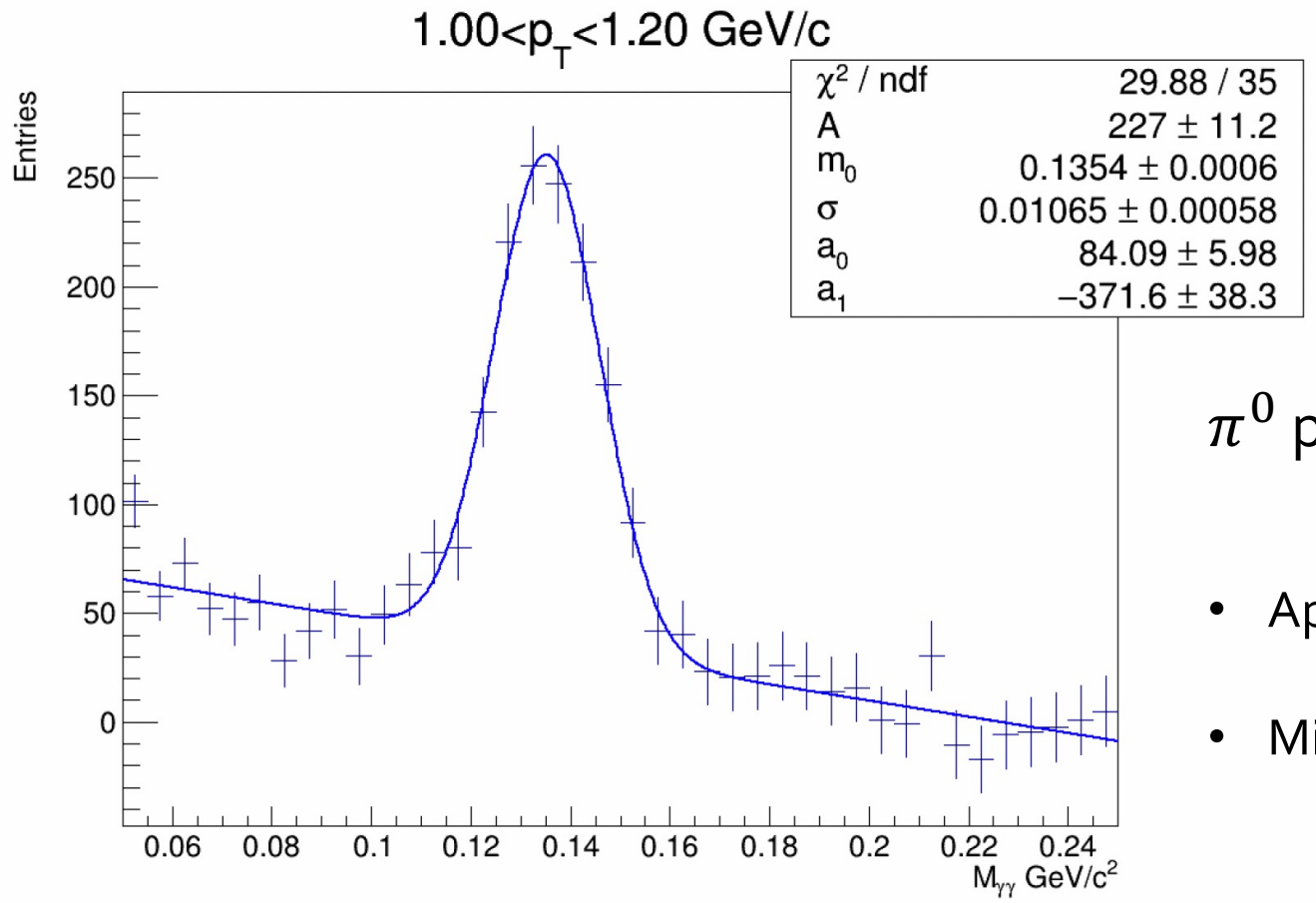
Photon identification

- With PID, fraction of photon clusters increased from ~30% to 60%
- Need more detail study on the photon ID strategy





Neutral particle reconstruction



π^0 peak observed

- Apply the photon identification cuts shown above
- Mixed event technique

Summary

- ✓ ~800 modules have arrived at JINR
- ✓ The first stage mass production of ECal module in China was completed and it is best to continue production for the rest 800 modules !
- ✓ About 6.6% (sigma/mean) uniformity was obtained in the cosmic ray test at SDU with air coupling between WLSF and SiPM
- ✓ Simulation study on photon identification and neutral particle reconstruction has been started
- ✓ China MPD consortium will continuously contribute to the ECal related works

Thank you!