

Fabrications and performance test of ECal modules in China for NICA-MPD experiment

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for the MPD Collaboration



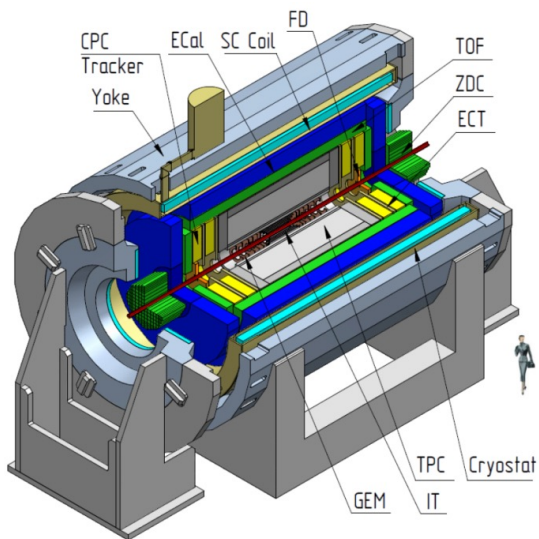
TWENTY-FIRST LOMONOSOV

CONFERENCE August, 24-30, 2023

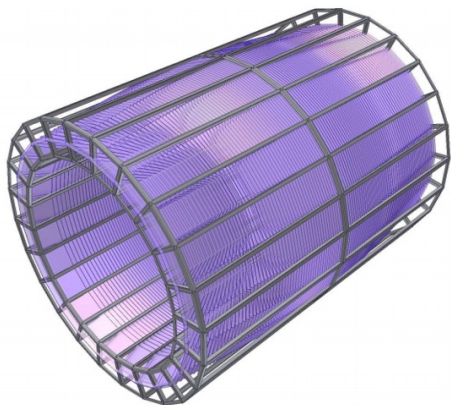
ON ELEMENTARY PARTICLE PHYSICS

MOSCOW STATE UNIVERSITY

- **MPD-ECal introduction**
- **Fabrications of ECal modules**
- **Performance test of modules**
- **Test of modules in JINR**
- **Summary**



Multi-Purpose Detector (MPD)



The Barrel of ECal

MPD aims to :

- Study of hot and dense baryonic matter at $\sqrt{s_{NN}} = 4-11\text{GeV}$
- Investigate the nucleon spin structure, polarization phenomena

MPD-ECal :

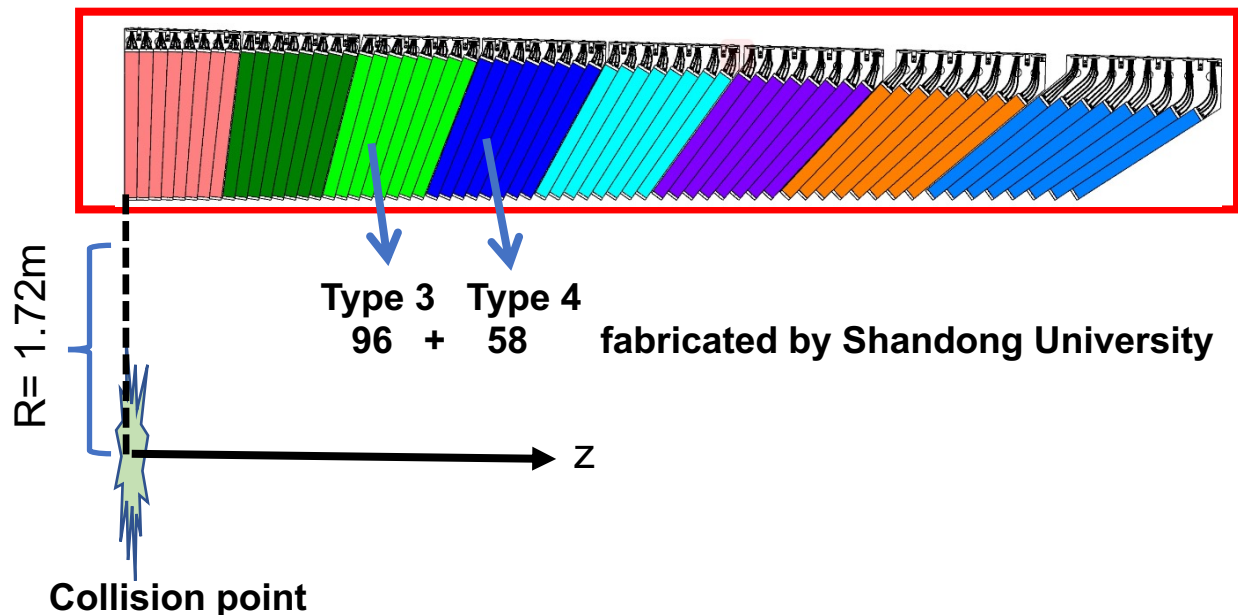
- Measure the energy and position of photons, positrons and electrons
- Particle occupancy : < 5%
 - Time resolution : < 1ns
 - Energy resolution : < 5% @ 1GeV
 - Operate in the magnetic field : ~ 0.5T
 - High segmentation and adequate space resolution
 - Dense active medium with the small Moliere radius
 - Good uniformity

Requirements

ECal module production



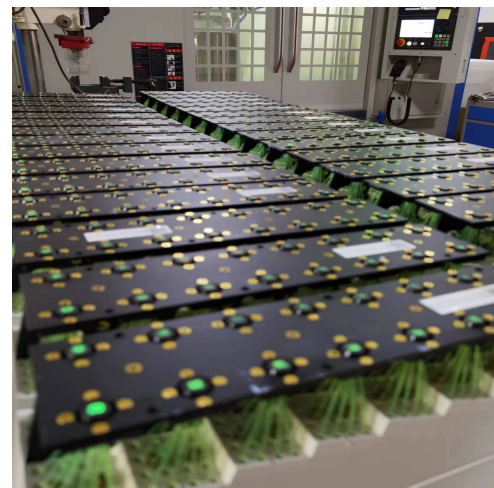
2400 Modules, 38400 Towers



768 modules produced in 4 universities of China

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

SDU



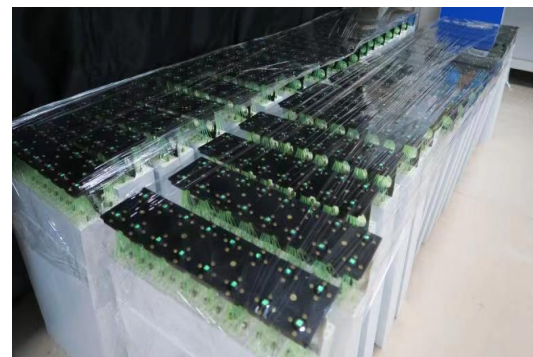
THU



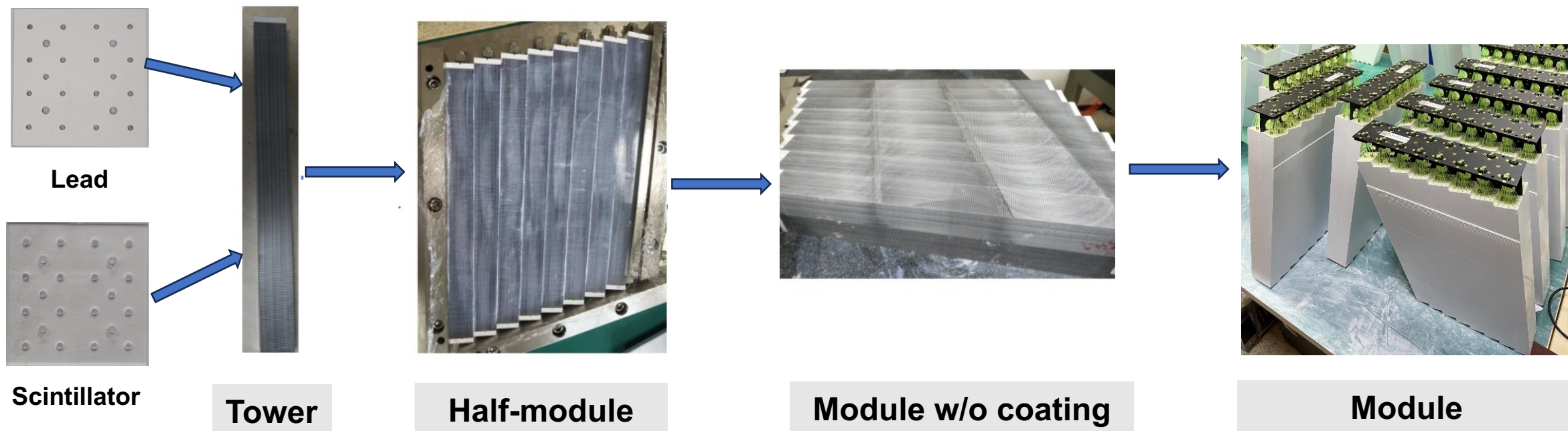
FDU



USC



Fabrications of ECal module



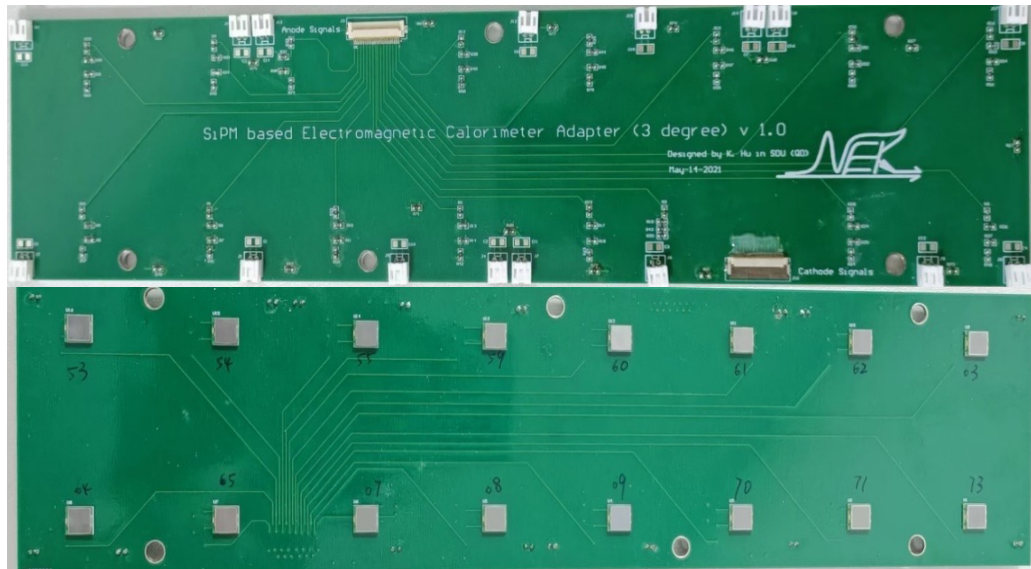
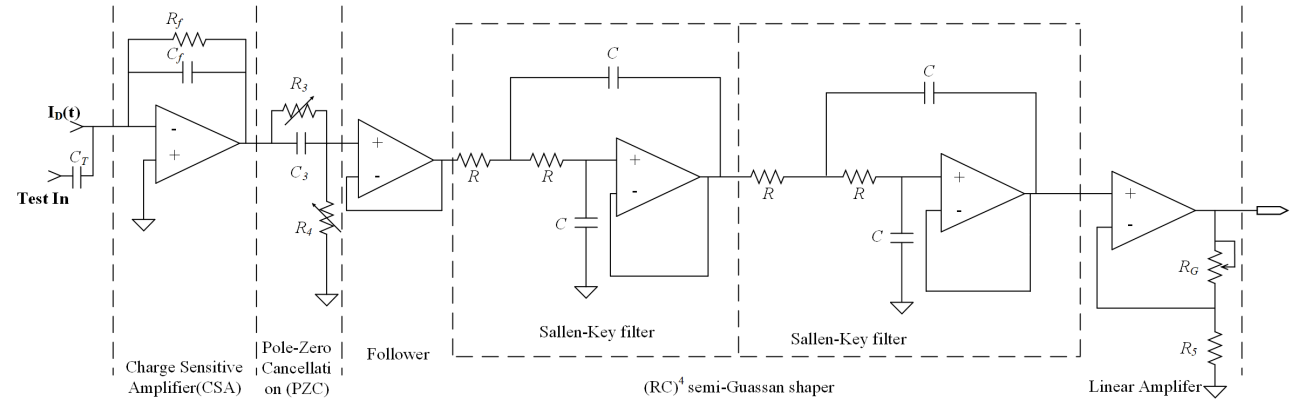
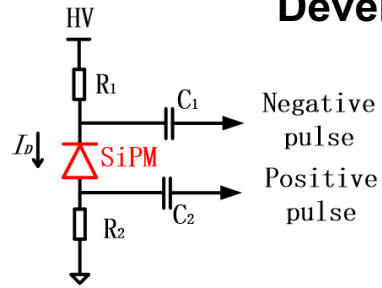
Parameters of main module

Transverse size, mm ²	40 x 40	Scintillator thickness, mm	1.5
WLS fibers	16	Moliere radius, mm	62
Number of layers	440	Radiation length, X_0	11.8
Lead absorber thickness, mm	0.3	Effective radiation length, mm	32.4

Readout electronics designed for local test

Developed by Kun Hu, Yonghong Wang and Chi Yang at SDU

K. Hu et al 2016 JINST 11 T03002



The SiPM-based adapter is used to collect the light from WLS fibers.

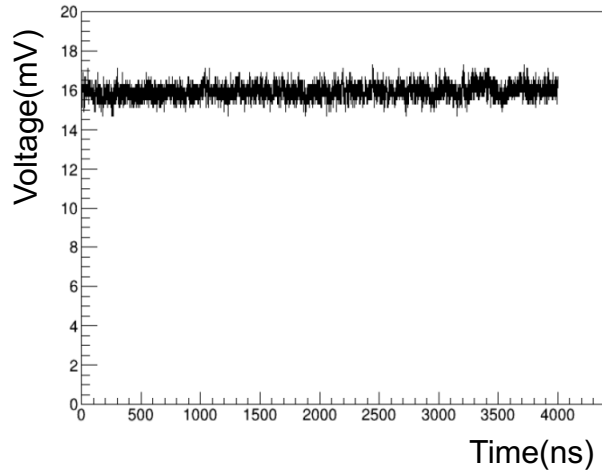
The FEB is designed to integrate and amplify the weak current pulse from the SiPM.

SiPM : S13360-6050PE

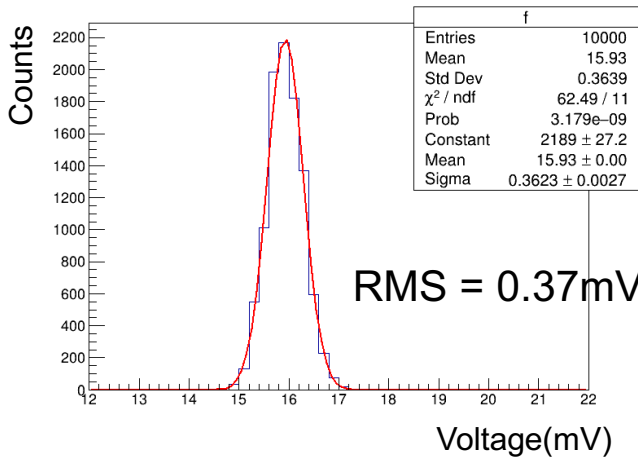
Calibration of the readout electronics



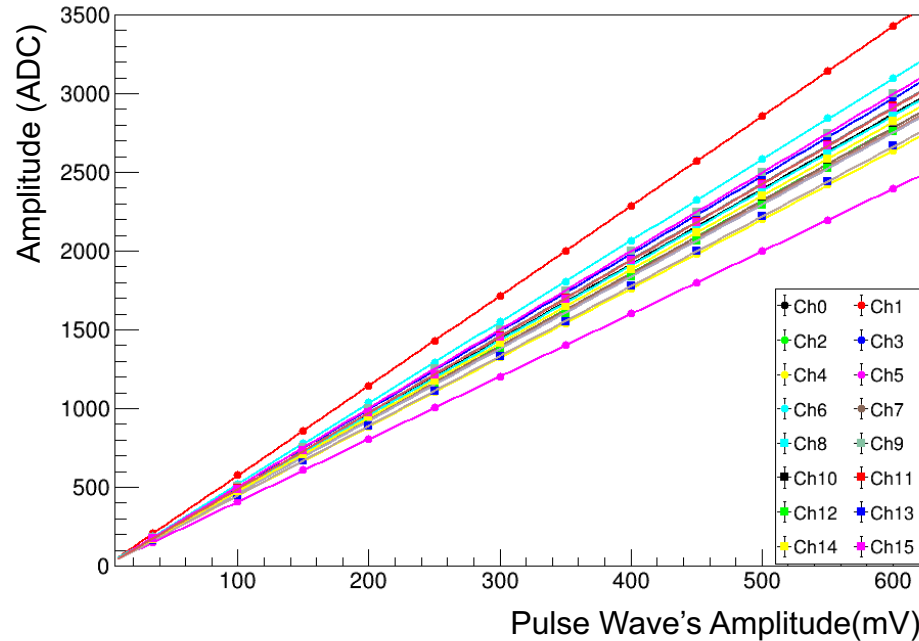
Noise vs. Time



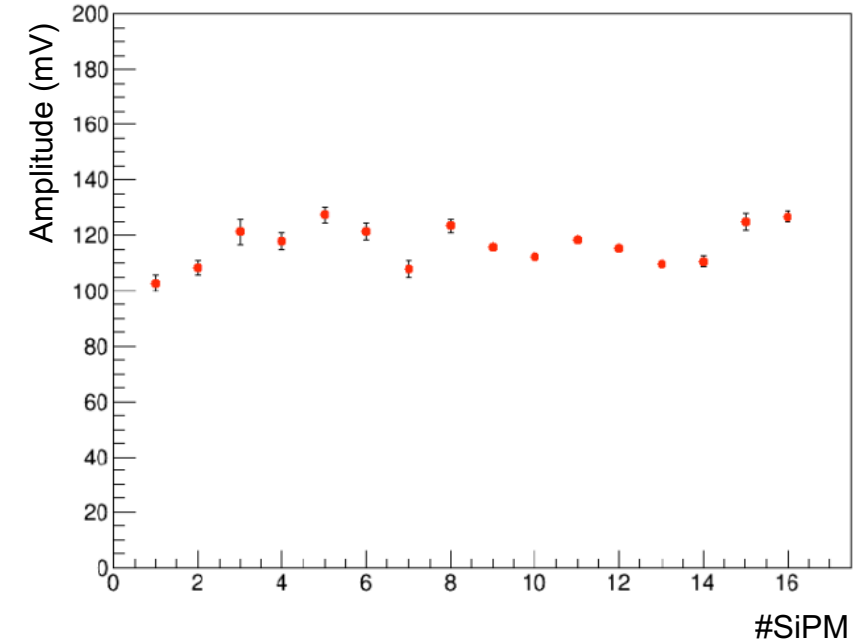
Noise Distribution



Calibrate the differences between FEB channels



Calibrate the differences between SiPMs

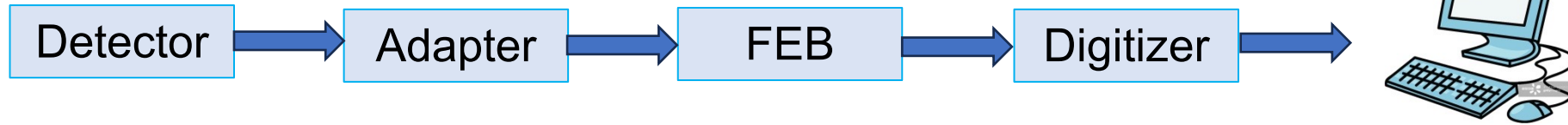


The channel differences in DAQ have been corrected:

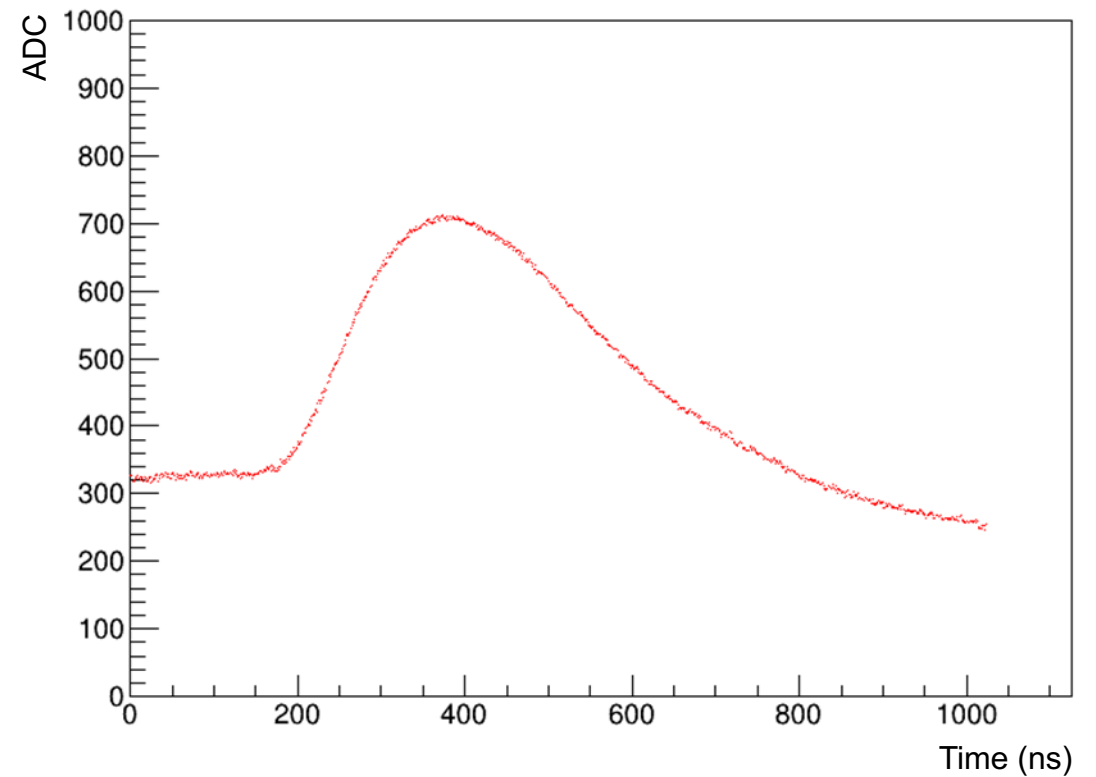
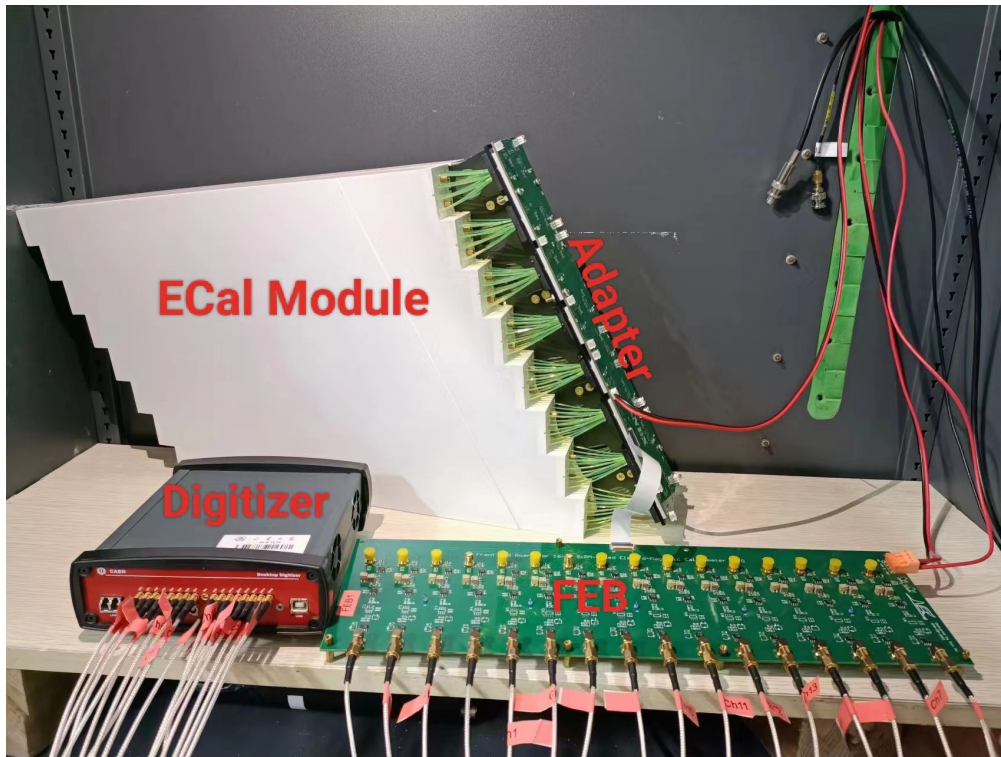
- Different FEB channels
- Different SiPMs at same bias voltage

Baseline in the test is stable.

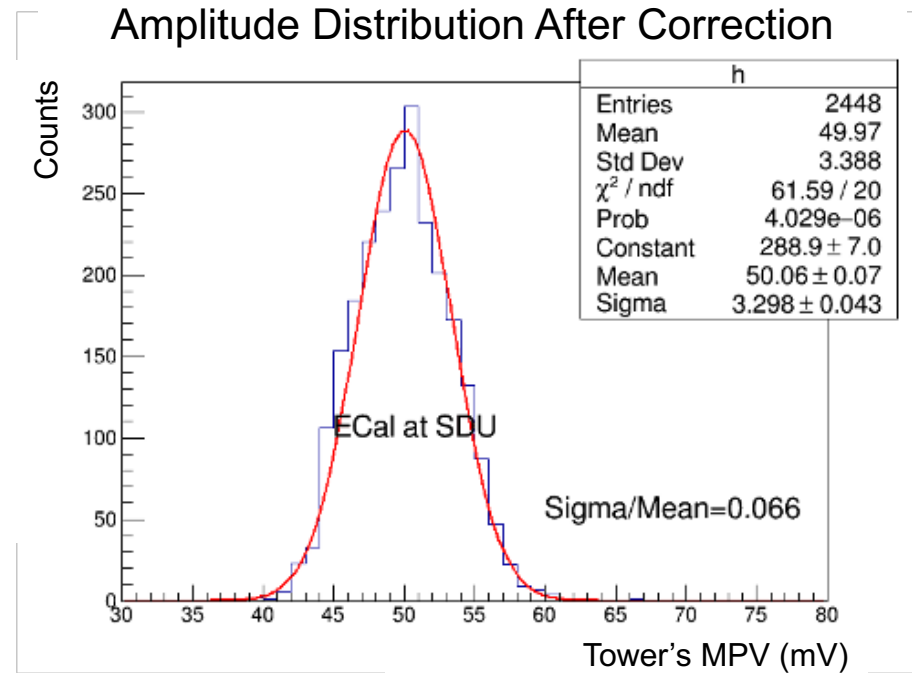
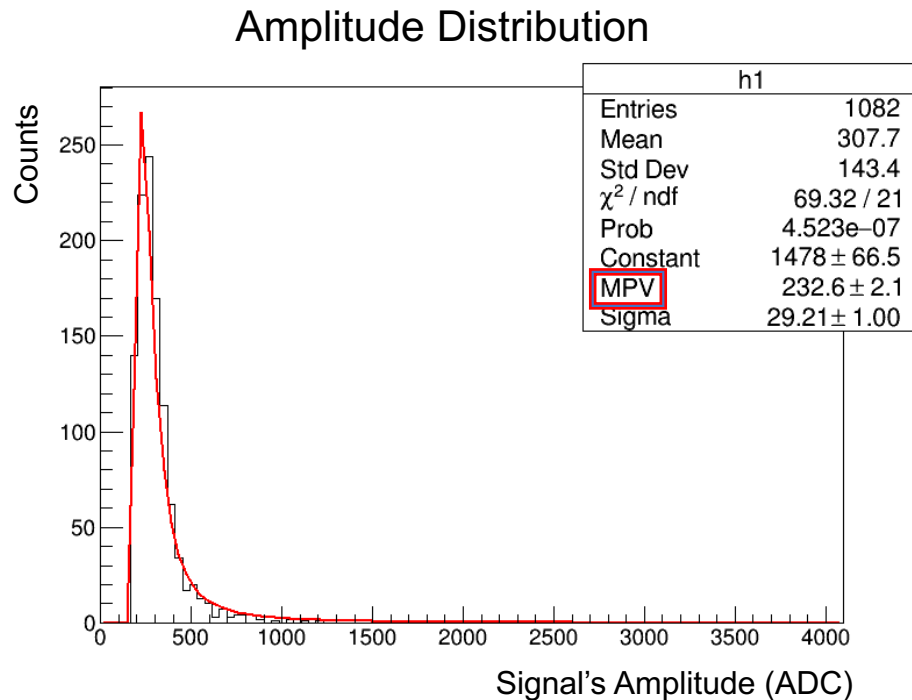
The test system



Signal of ECal cosmic ray test



Uniformity test results



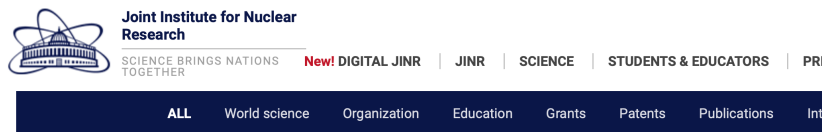
Air coupling effect differences from WLSFs to SiPMs are not corrected.

- The amplitude of signals in a single tower follows the Landau distribution.
- About **6.6% (sigma/mean)** uniformity was obtained in the cosmic ray test at SDU.

Modules shipped from China to Russia



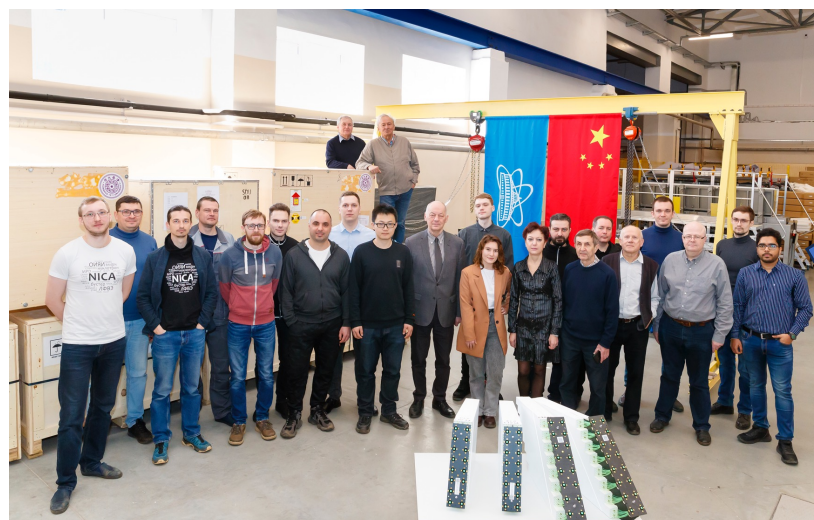
<http://www.jinr.ru/posts/equipment-for-nica-arrived-from-china/>



Equipment for NICA arrived from China

News, 31 March 2023

Today, about 300 modules of the electromagnetic calorimeter for the MPD Detector at NICA have been delivered to the Joint Institute for Nuclear Research from China. The current delivery was the last in a series of three. In total, 800 modules were produced in China.



By March 31st 2023, all 768 modules have been delivered to the JINR from China.

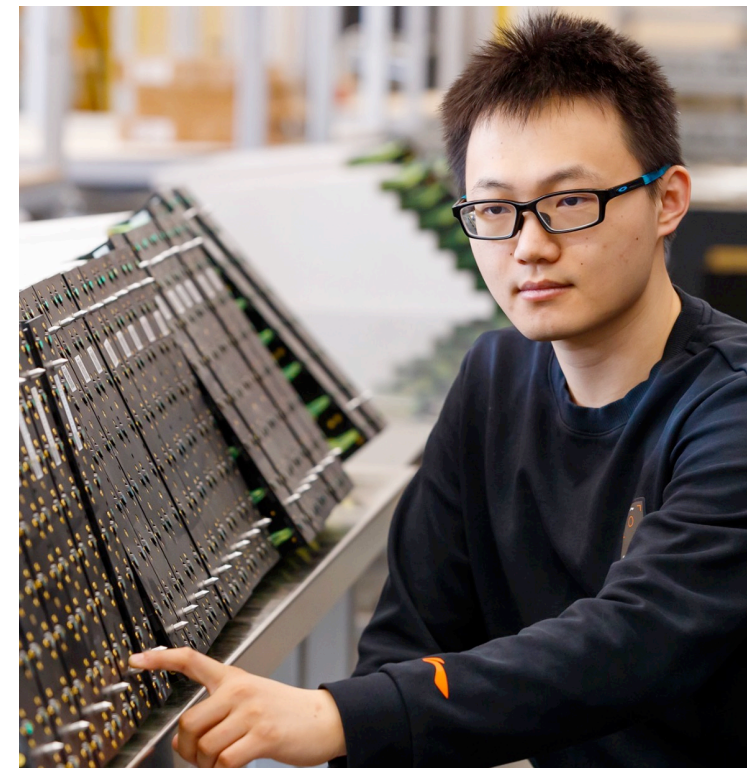
Juniors working on ECal at JINR



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
Jan.15 – Mar.15 2023 at JINR

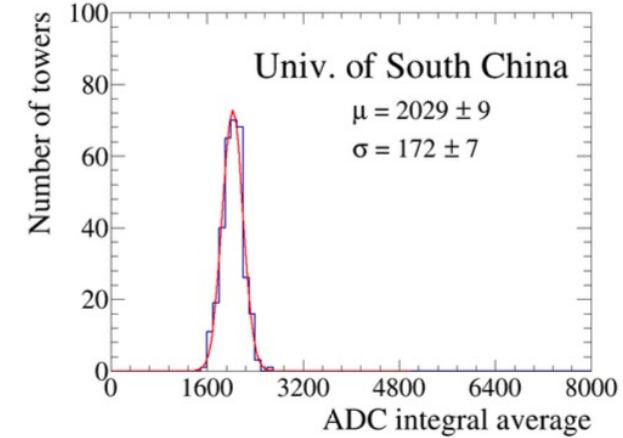
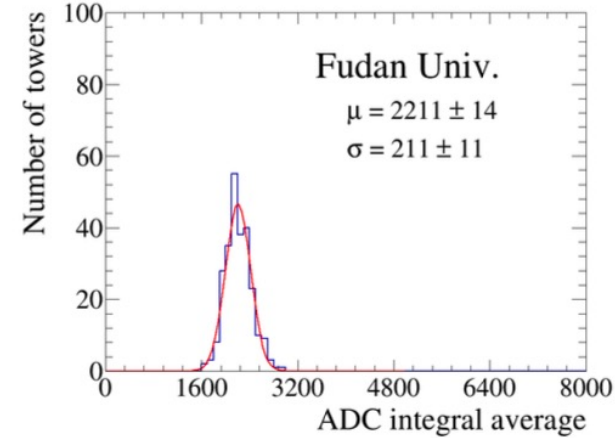
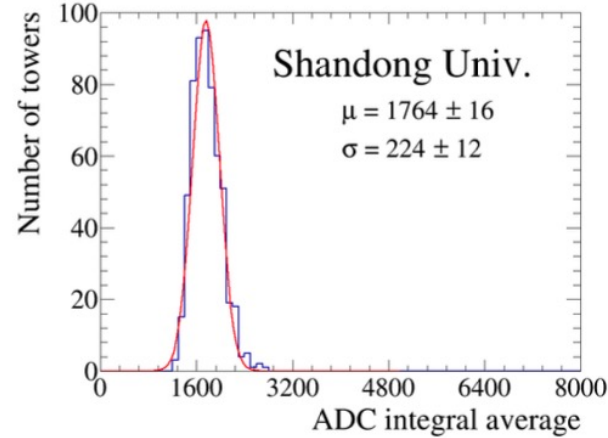
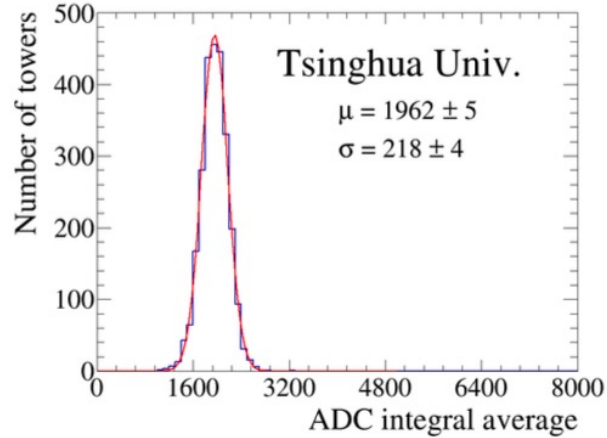
China MPD consortium will continuously contribute to ECal project and related works.

Test of modules in JINR

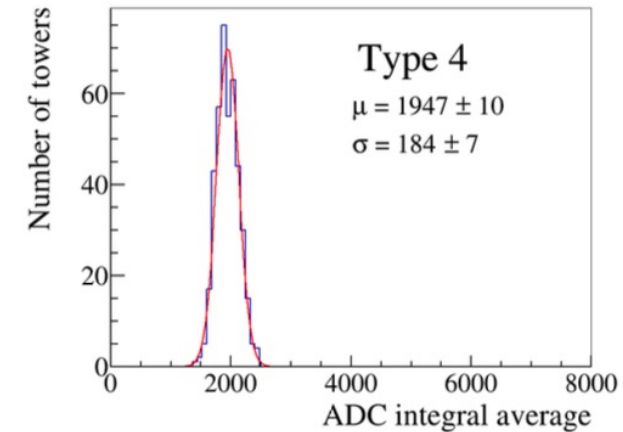
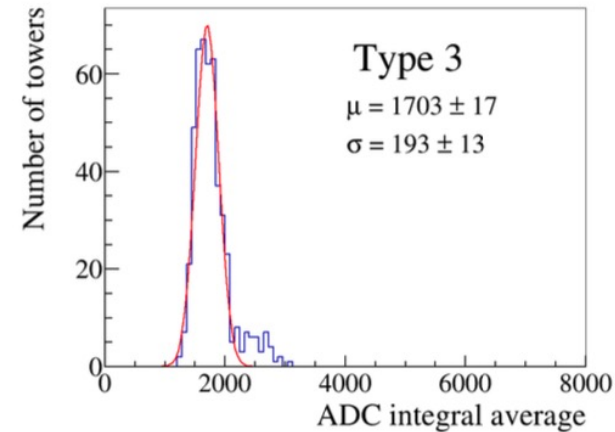
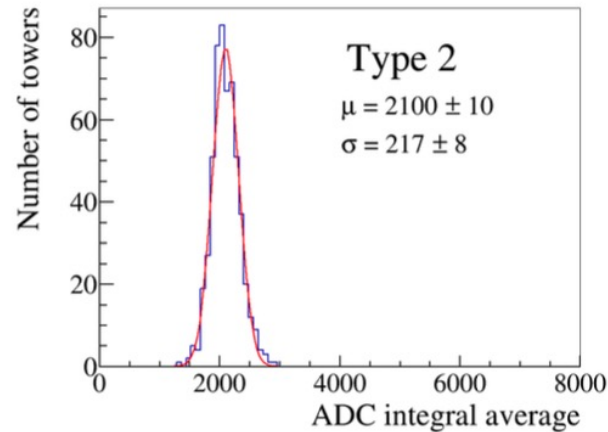
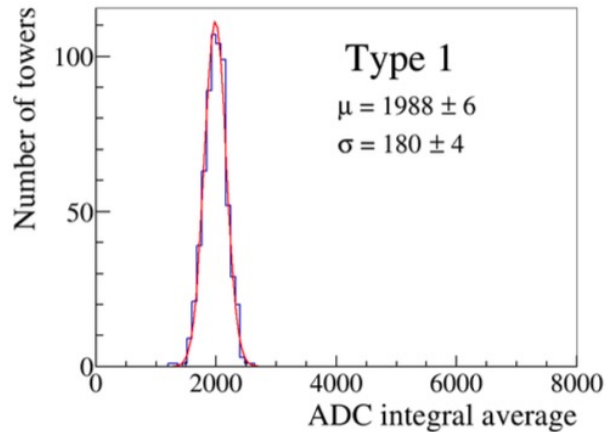


Signals amplitude distributions

From different institutions



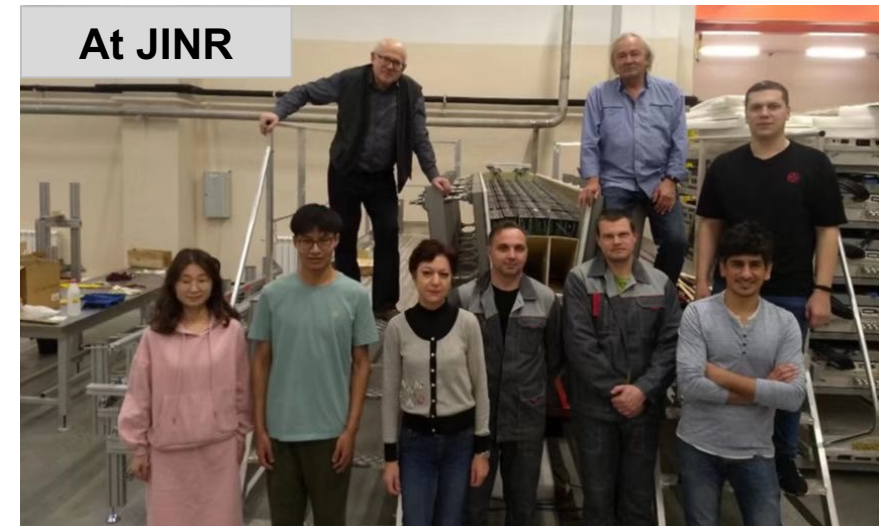
From different types



These modules work smoothly.

*From M. Bhattacharjee's talk
@ XI NICA-MPD collaboration meeting*

- The first stage mass production of ECal module in China was completed.
- By March 31st 2023 , 768 ECal modules have been delivered to JINR.
- About 6.6% (sigma/mean) uniformity was obtained in the cosmic ray test at SDU with air coupling between WLSF and SiPM.



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Thank
You !

