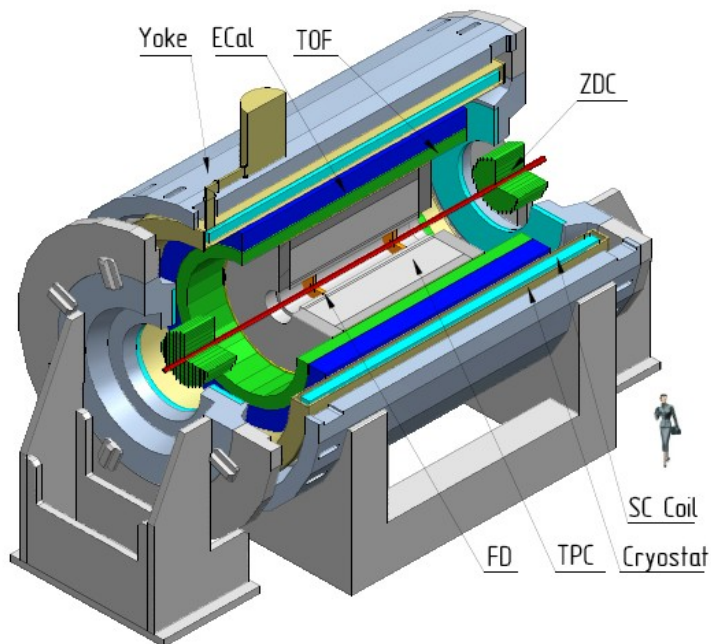




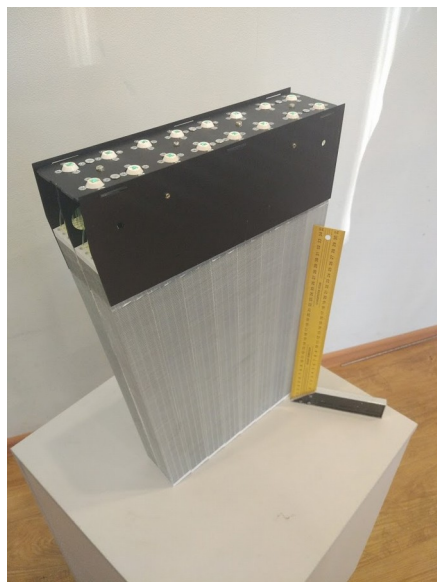
# ECal Mass Production

A.Yu. Semenov  
& MPD ECal Group

# Electromagnetic Calorimeter (ECal)



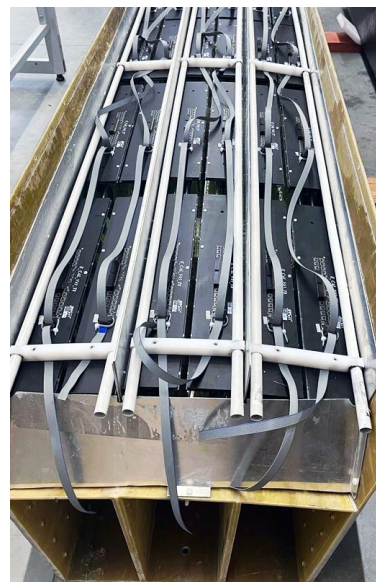
- “Shashlyk”-type calorimeter with projective geometry
- 38400 cells (“towers”)
- 2400 modules (with 16 towers each) of 8 types
- 50 half-sectors (each consists of 48 modules in a robust container – “basket”)
- Each module is connected with “HV” board (SiPMs, power distribution, slow control, temp. correction)
- 12 ADCs per half-sector
- Cooling systems of 2 types (by air and by water)



Module



Gluing of basket

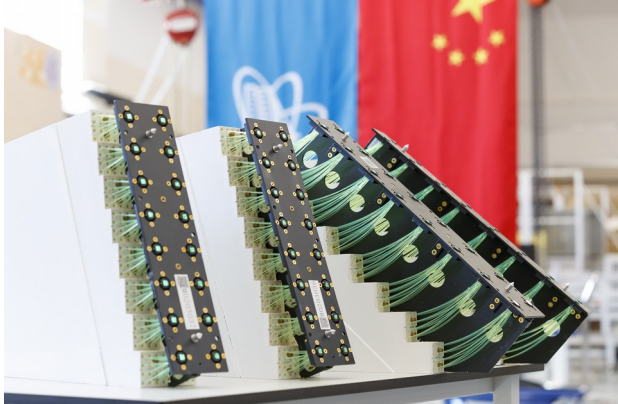


HV boards



ADCs & cooling system

# Modules Production



## *Production in Russia:*

*IHEP (Protvino)*

*Armul*

*TENZOR company*

## *Production in China:*

*Tsinghua University*

*Huzhou University*

*Shandong University*

*Fudan University*

*University of South China*


- At the moment, 1600 modules out of 2400 have been produced and glued into 32 half-sectors. 800 more modules are needed to complete ECal building.
- Production of additional 400 modules in Russia have been finished.
- Because the problem with funding of Tsinghua University for another 400 modules, JINR plan to produce these modules in Russia. All materials (except WLS fibers), equipment and competencies are in our hands for that. However, the company in Tver can not produce WLS fibers for these modules till the end of this year.
- A mass assembly of half-sectors is under way with about 10 baskets-per-month production rate.

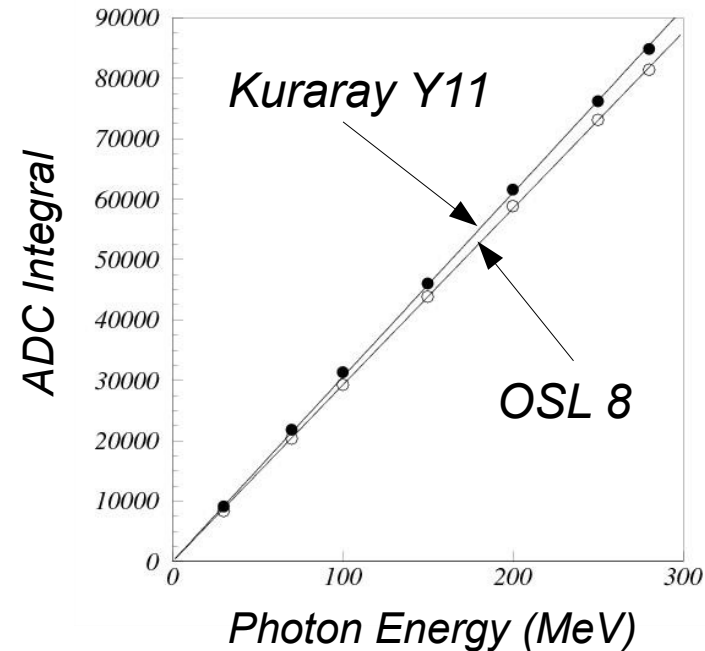
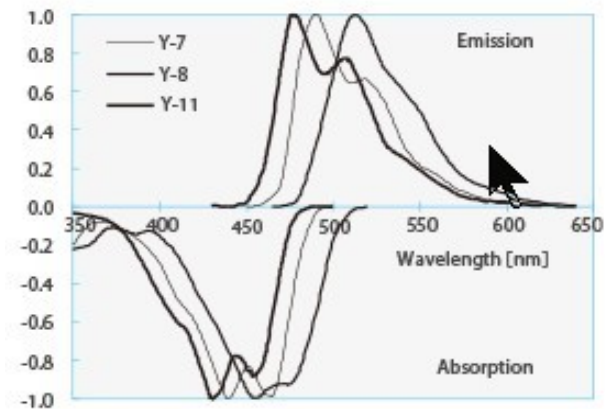
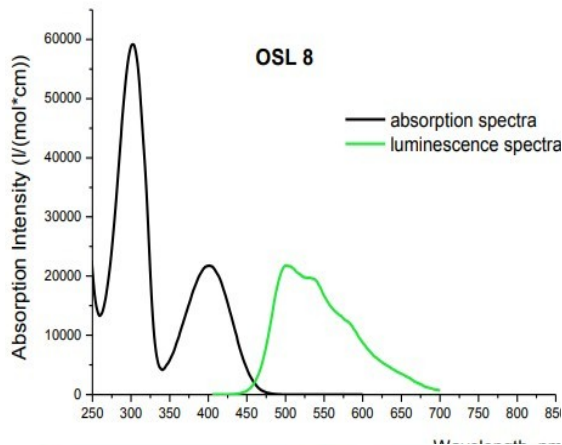
**Anyway, about 83% of calorimeter (41-42 half-sectors) is expected to be ready in November 2024.**

# WLS Fibers from Russia



ТЕХНОЛОГИЧЕСКИЙ ЦЕНТР  
ПОЛИМЕРНОГО ОПТИЧЕСКОГО  
ВОЛОКНА

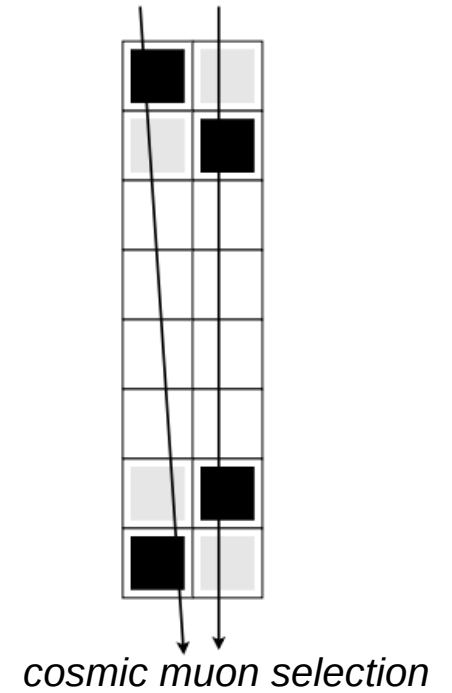
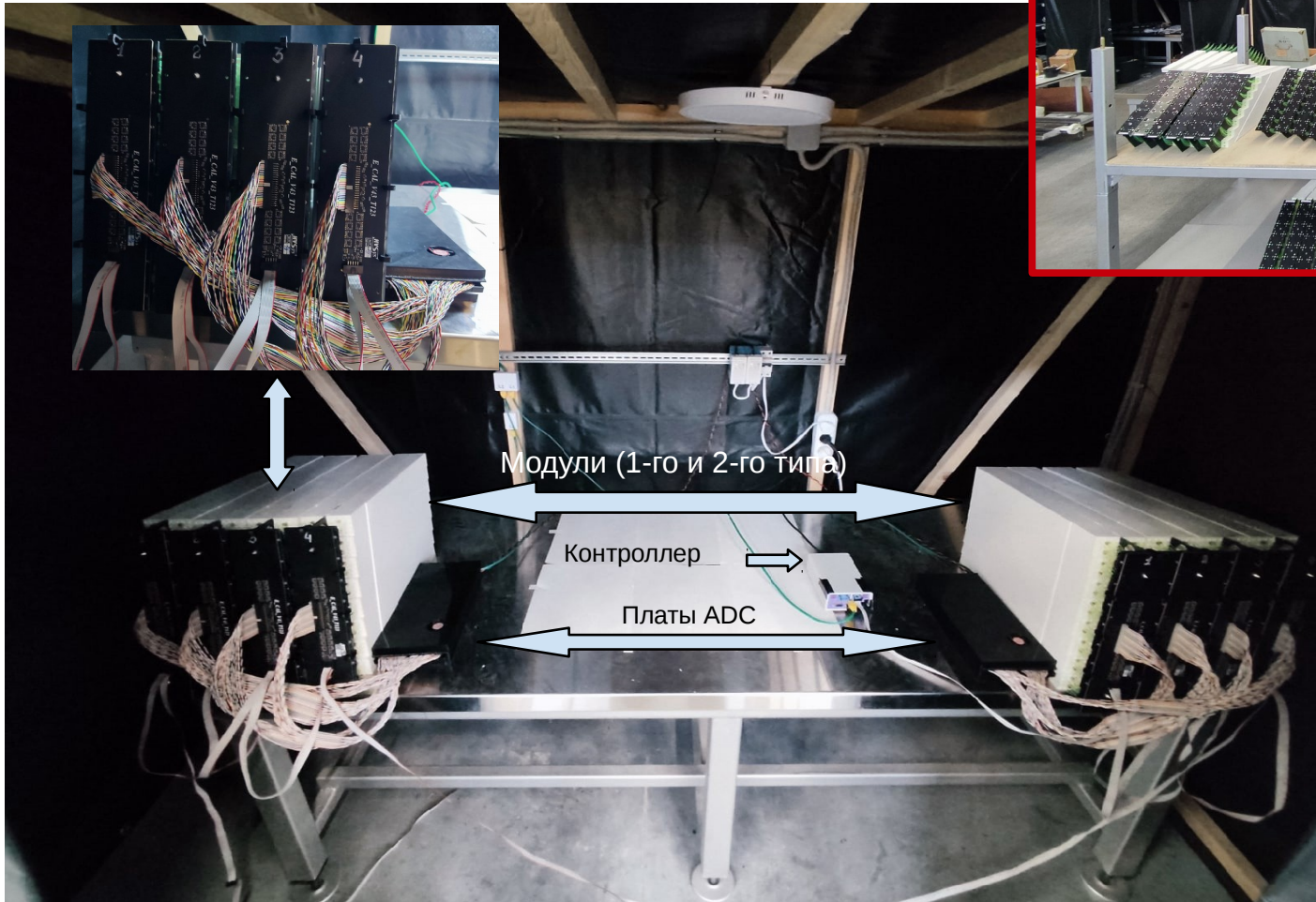
Cat No.	Absorption $\lambda_{\text{max}}$ , nm	Ext max, $I/(\text{mol} \cdot \text{cm})$	Luminescence $\lambda_{\text{max}}$ , nm	PLQY, %	PL decay time, ns	Emission colour
OSL8	302 401	51000 21800	501	84	5.39	



Present production rate is about 6 km (viz., 40 modules) per month.

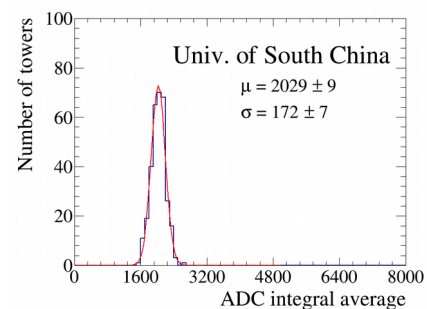
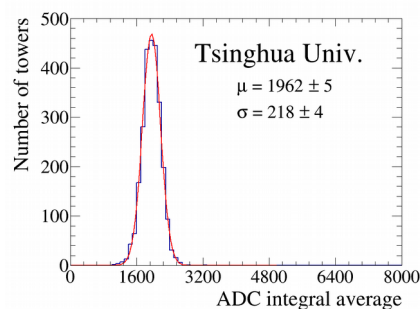
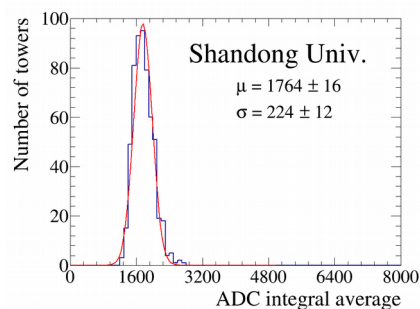
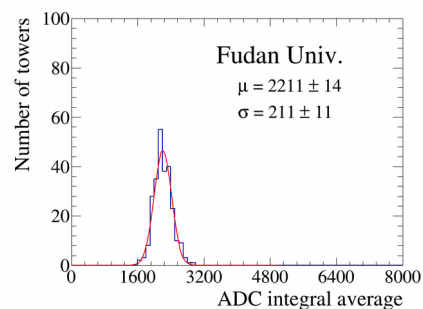
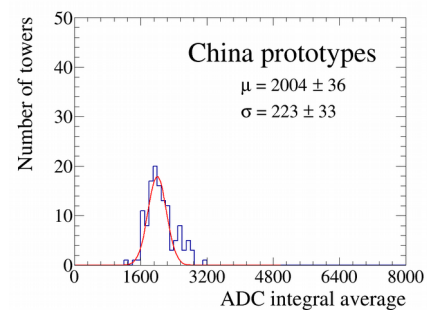
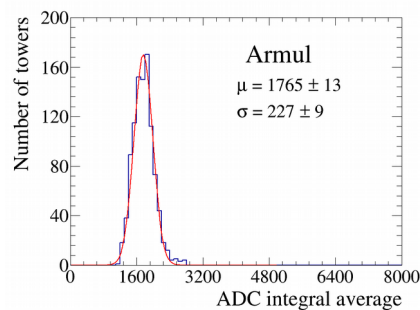
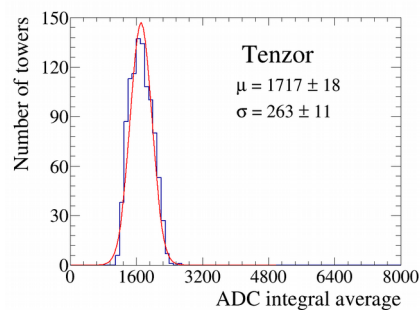
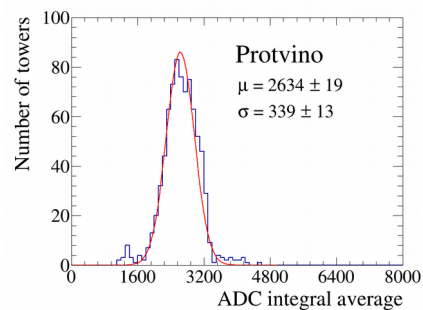
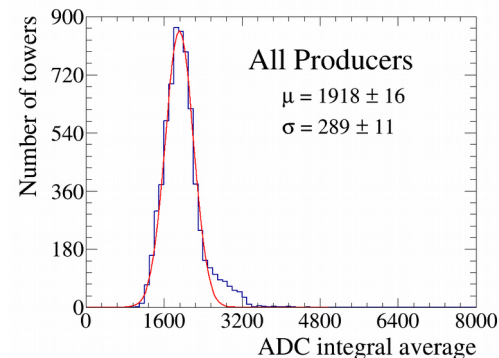
There is a hope for some increase.

# Module Testing with Cosmics



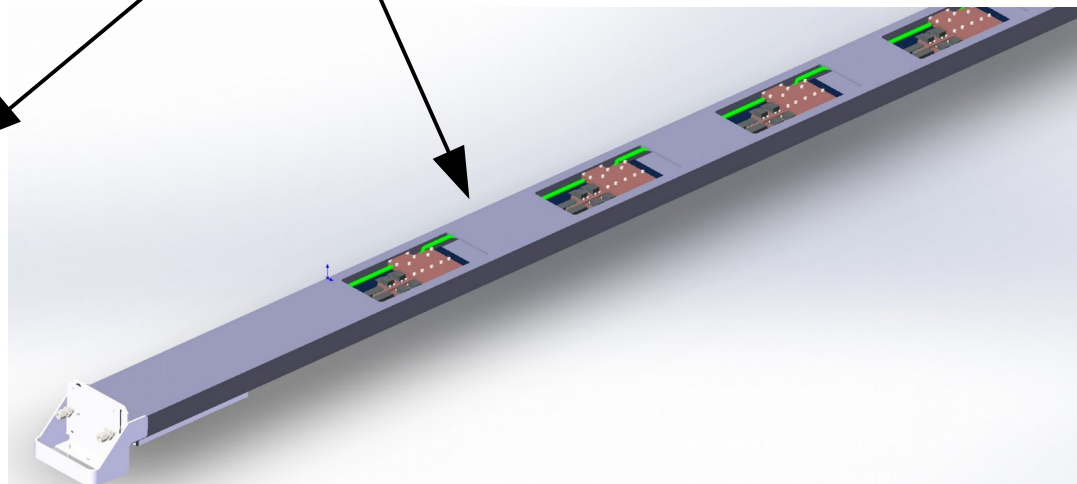
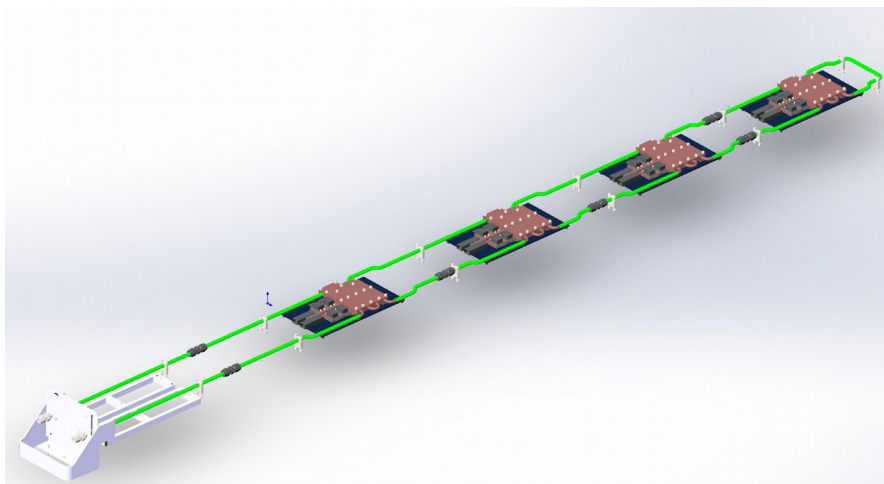
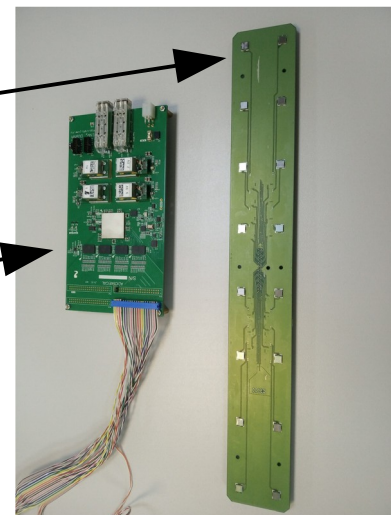
# Module Testing with Cosmics

- 1600 or 66% of total modules are produced and calibrated already. All modules are good.
- Production of another 400 modules with Russian WLS fibers (Tver fibers) is almost finished in Armul and Protvino.
- This completes 83% of total production.
- Testing capacity is 32 modules/day in 8 test-stands using cosmics in self-trigger mode.

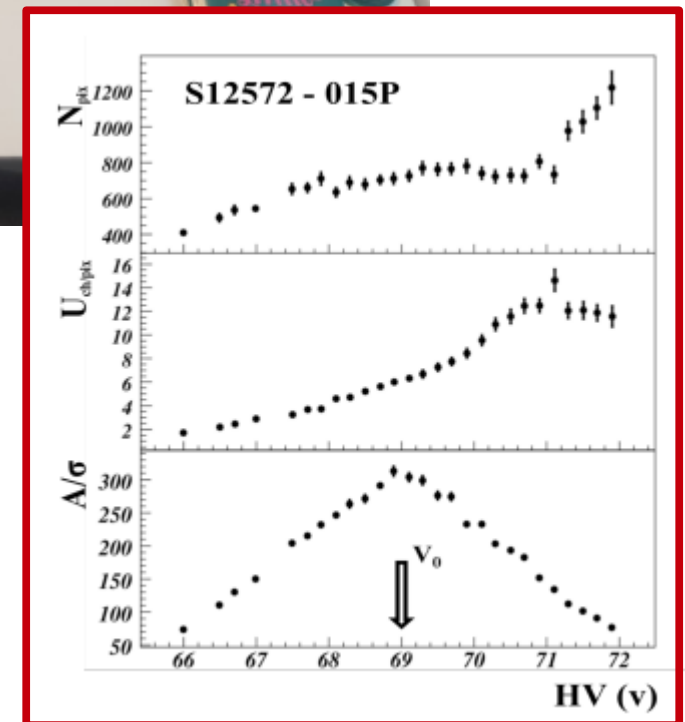
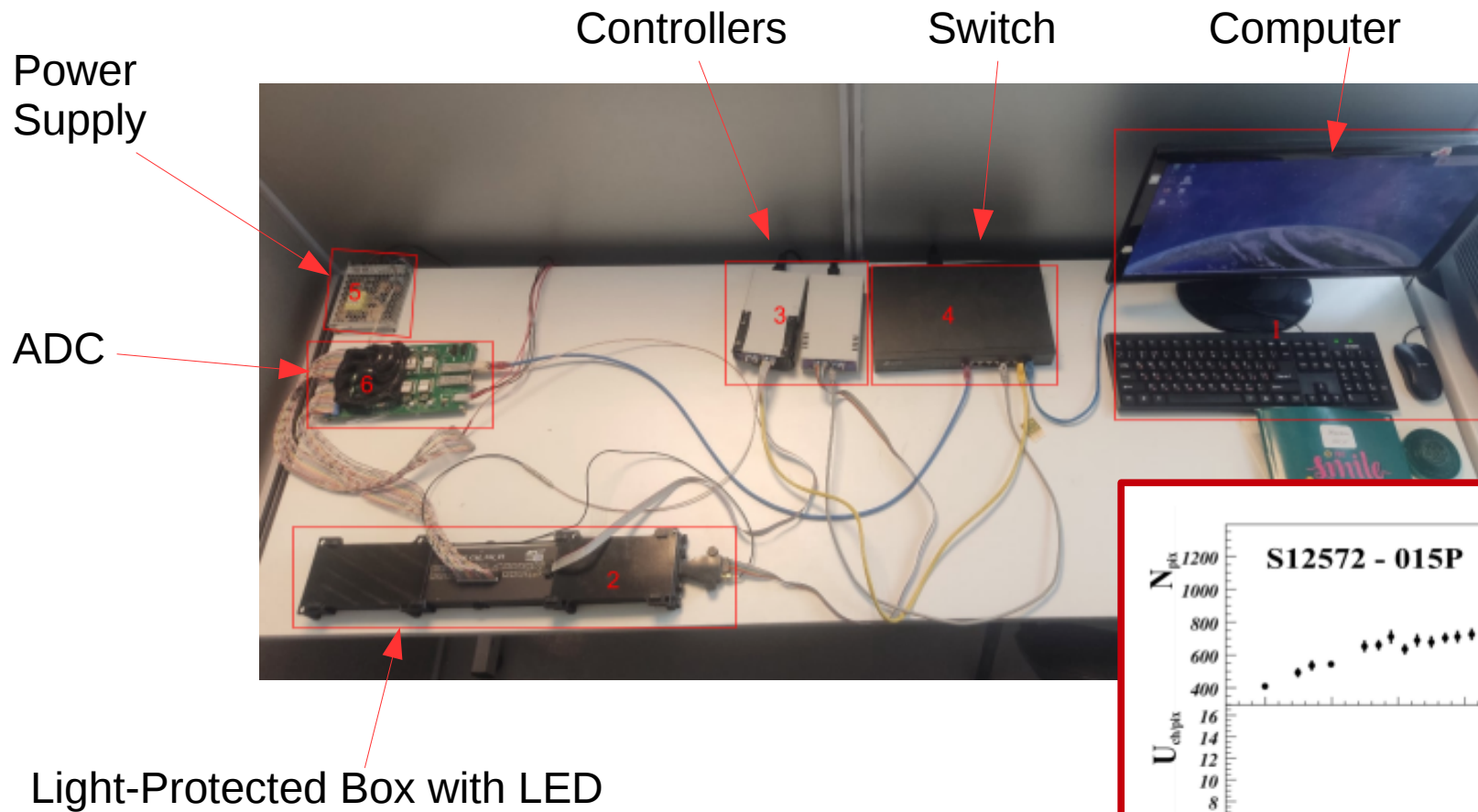


## Readout Electronics

- JINR-designed readout boards with 16 SiPMs, HV, preamplifiers, slow control (1 board per module).
- JINR-designed 64ch 14-bit 62.5MS/s ADC64ECAL Boards (1 sample per 16 ns).
- Water cooling & heat-isolated boxes for ADCs.
- Mass production in Russia & Belorussia.



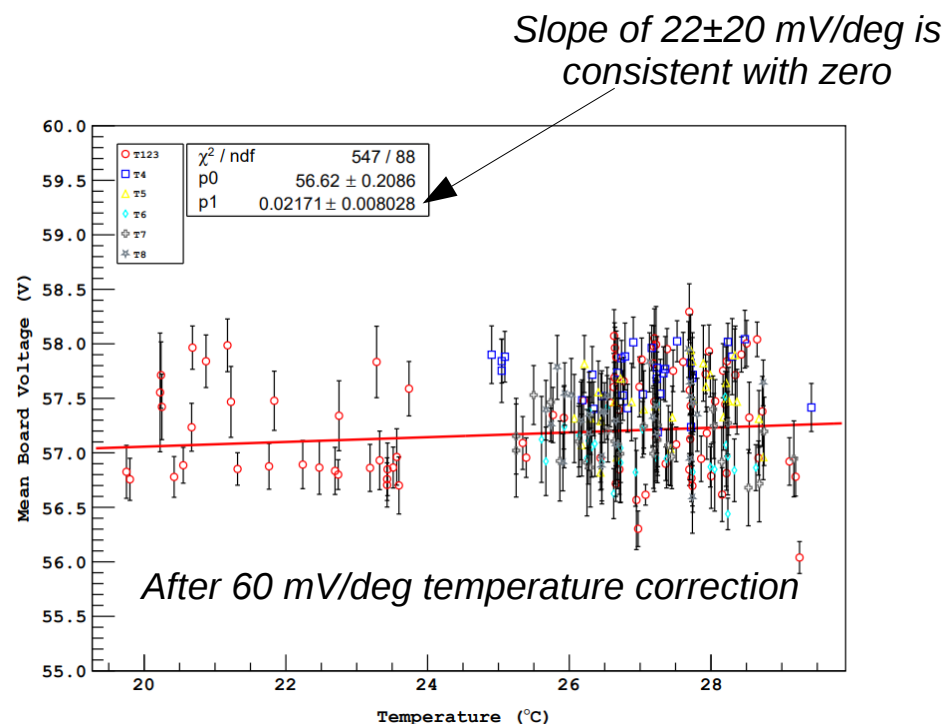
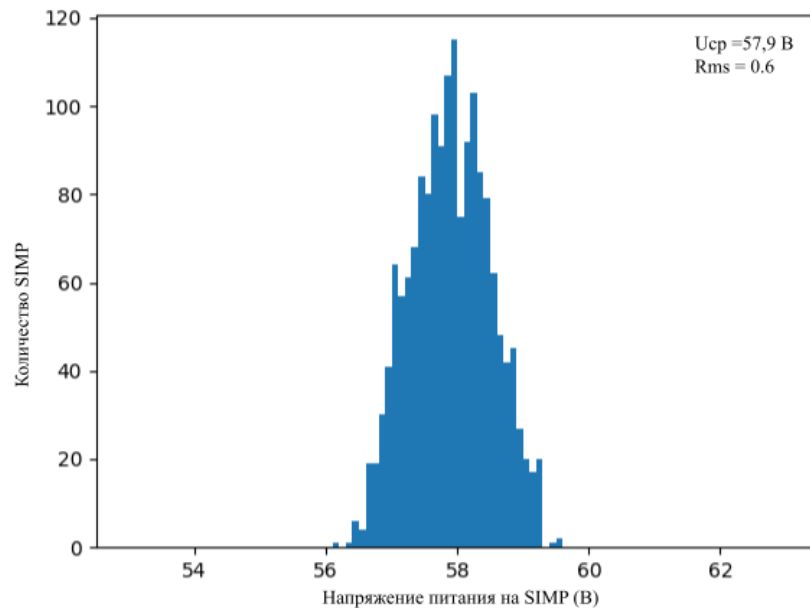
# HV (Readout) Boards Calibration





# HV (Readout) Boards Calibration

- Calibration time is  $\sim 30$  min for single HV board using LED in a dark box.
- 589 boards are successfully calibrated.
- 528 boards are installed in 12 half-sectors.
- 6 boards (1%) have problems.
- 983 boards with SiPMs are delivered but not calibrated yet.
- Another 1200 boards without SiPMs are delivered from China. SiPMs installation is in progress.

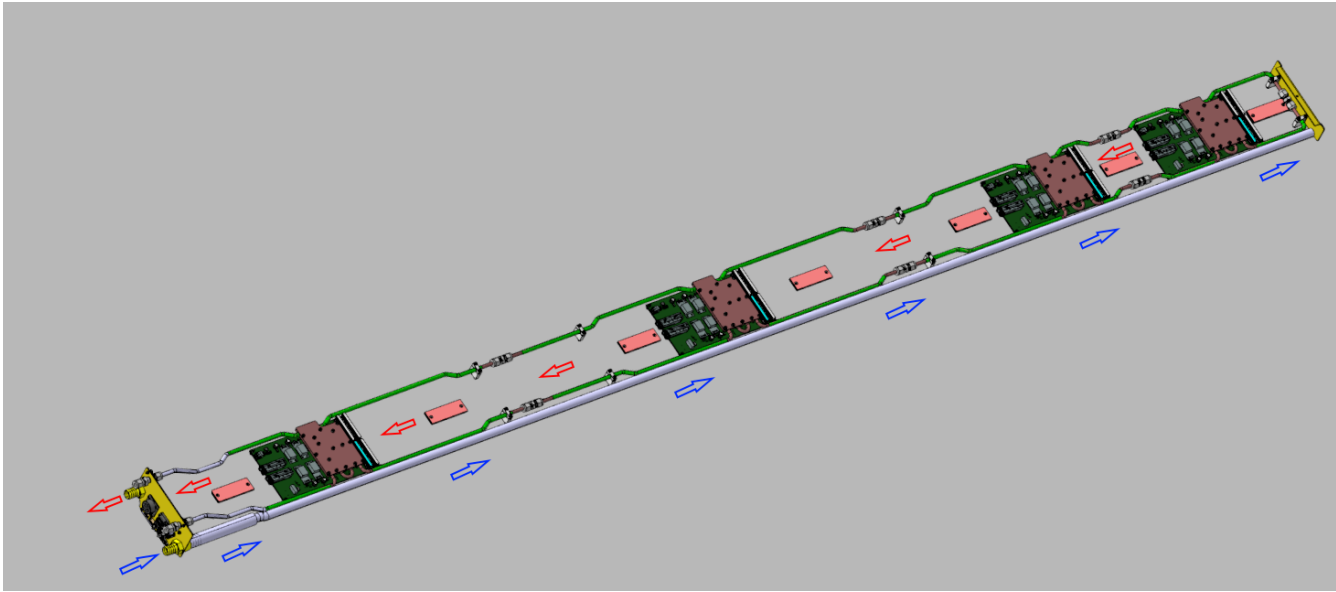


# Electronics and Water-Cooling System installation

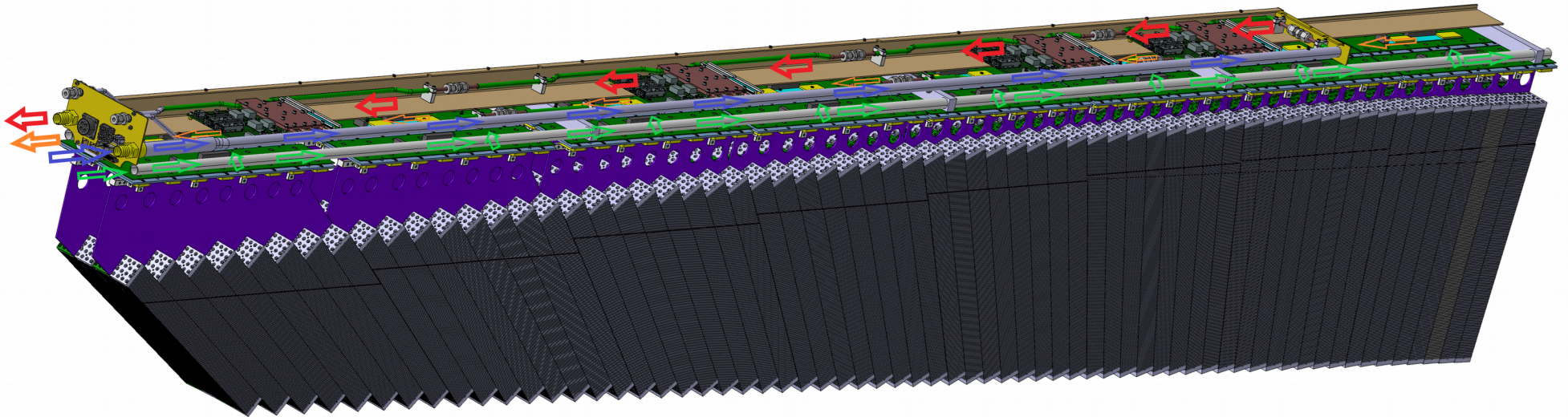
- Due to rather high power dissipation, ADC boards are separated from the detector volume, and placed in heat-isolated boxes with water and air cooling.
- Mass assembling of electronics is in progress. With enough manpower, the expected production rate is about 2 boxes per day.
- All materials and components (ADC boards, water cooling elements etc.) are produced and delivered.



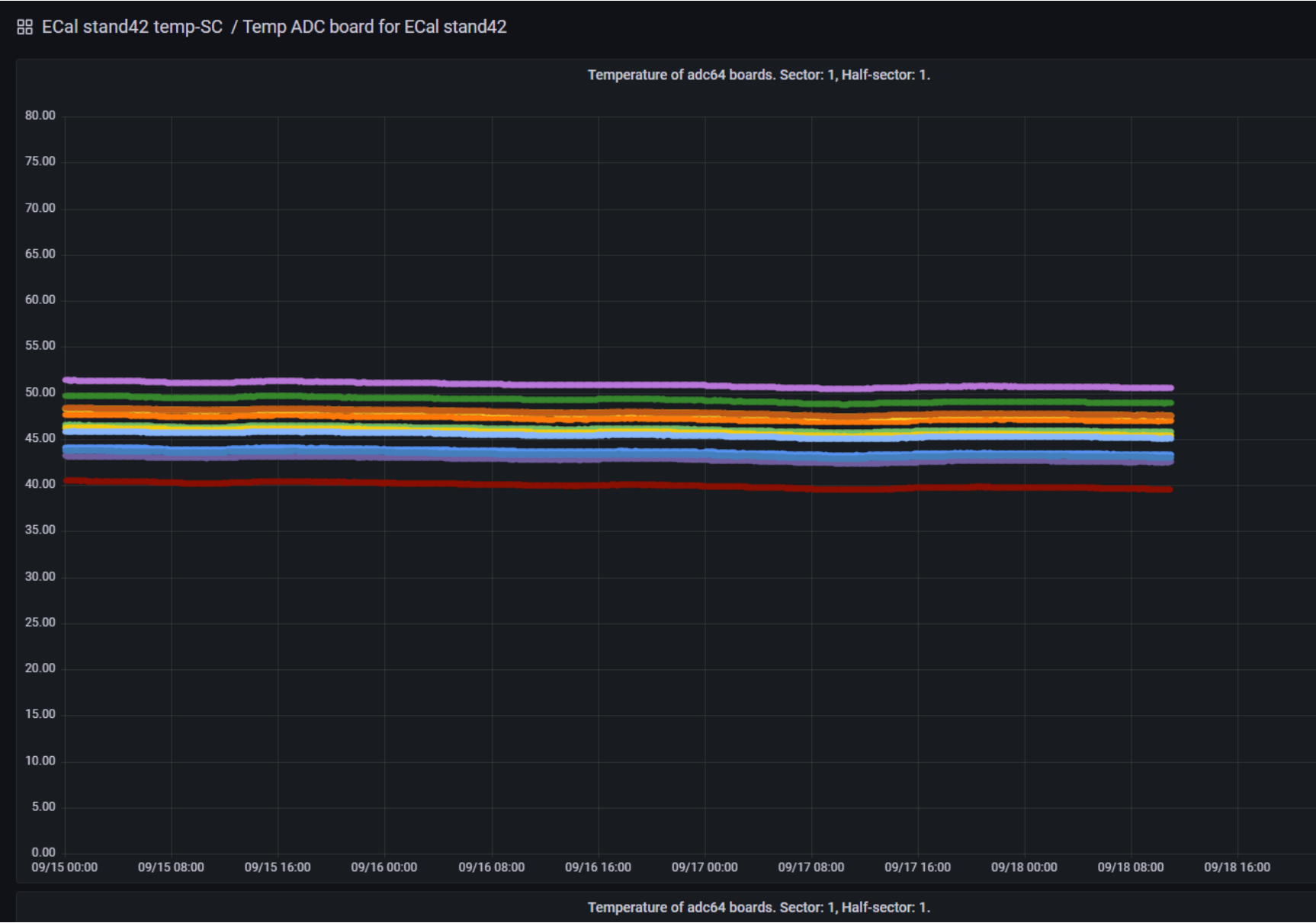
# Air Cooling System



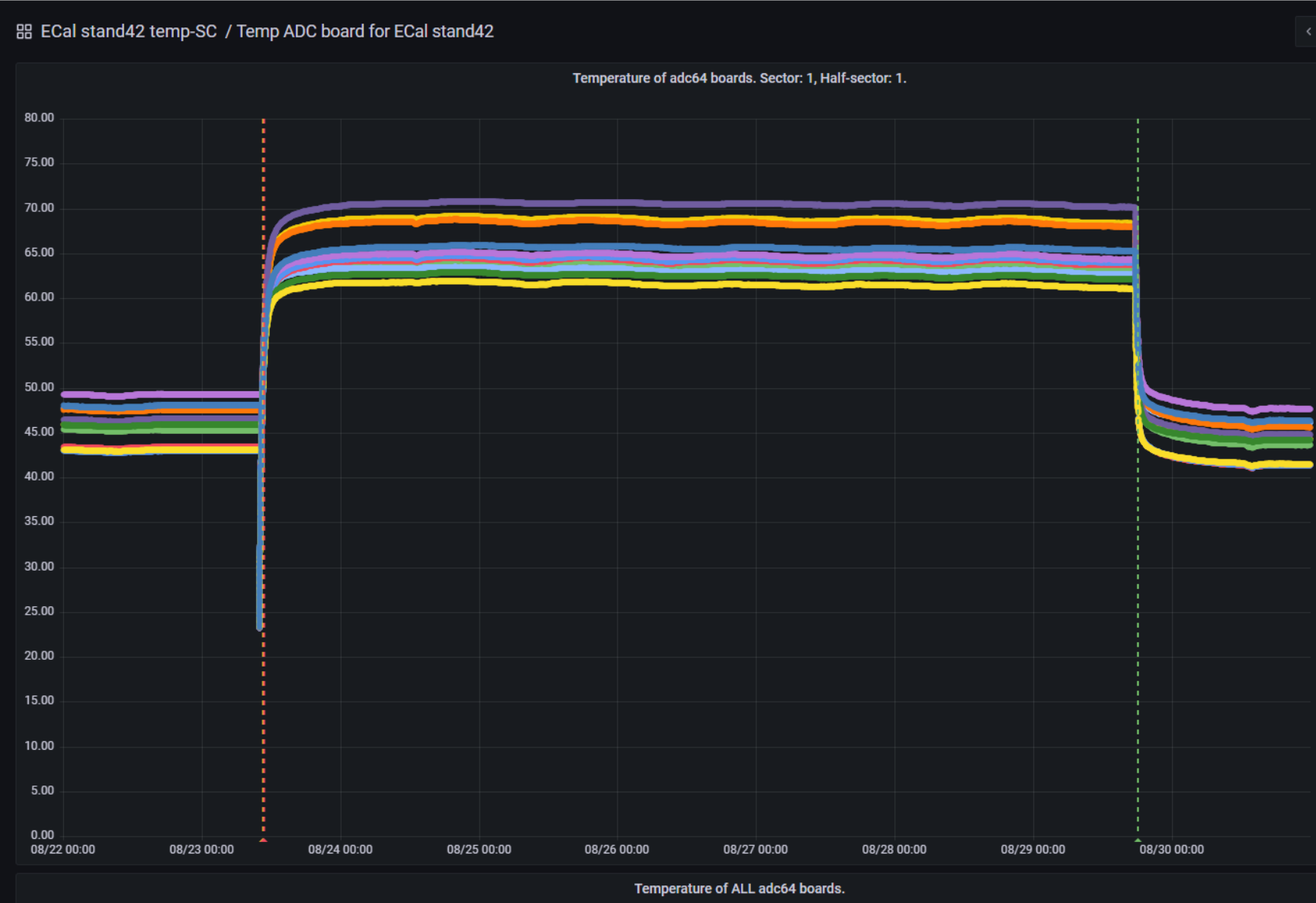
- The heat production from ADCs is estimated as about 150 W per half-sector (or about 7.5 kW for whole ECal).
- Main air cooling system is for SiPMs. Reserve air cooling is system for ADCs (in addition to the water cooling system).
- Air flow of 30 m<sup>3</sup> per hour per half-sector is needed.
- Air cooling systems for both SiPMs and ADCs provided the stable operation without the water cooling system during a few-month cosmics run.



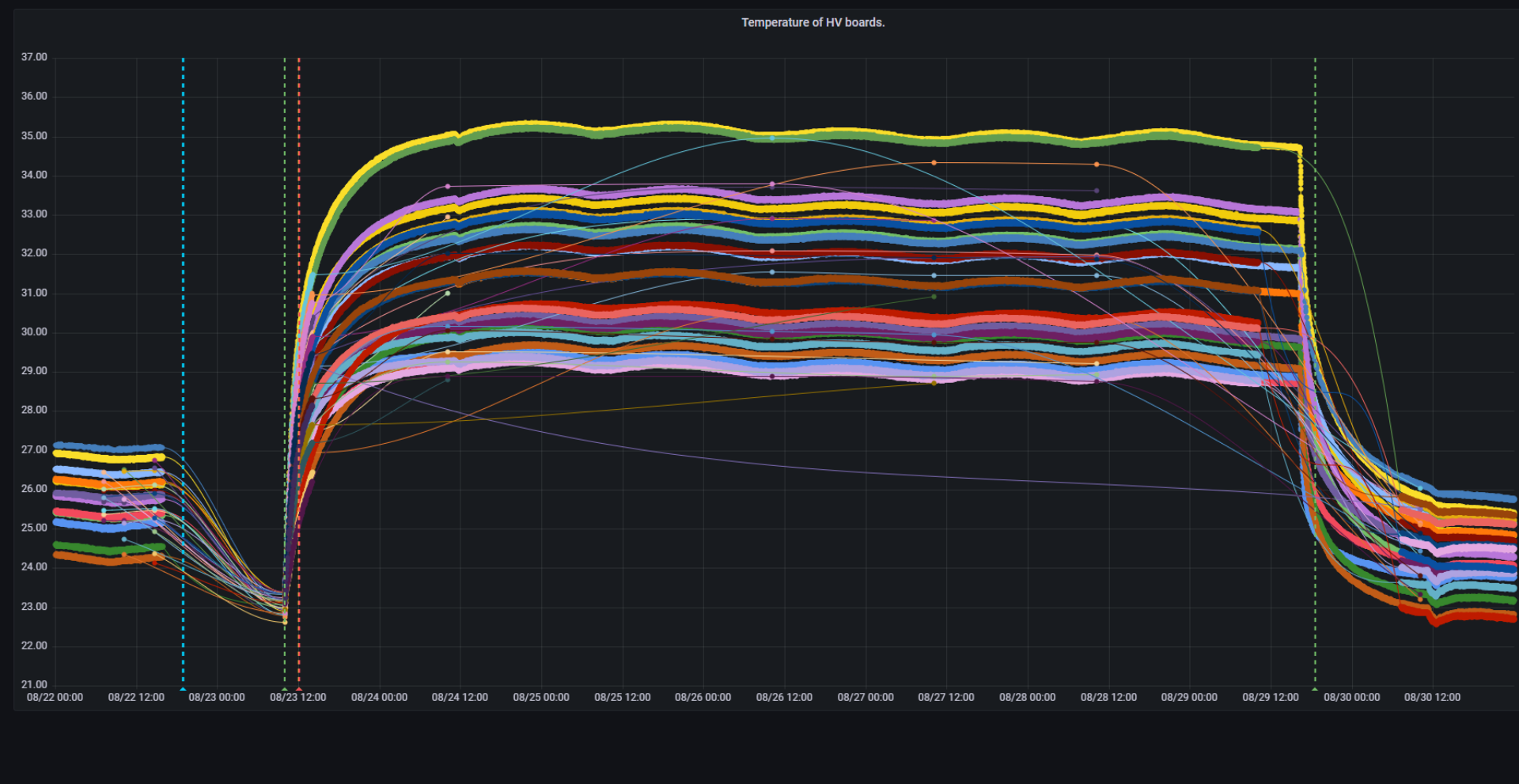
# Air Cooling System: ADC Boards



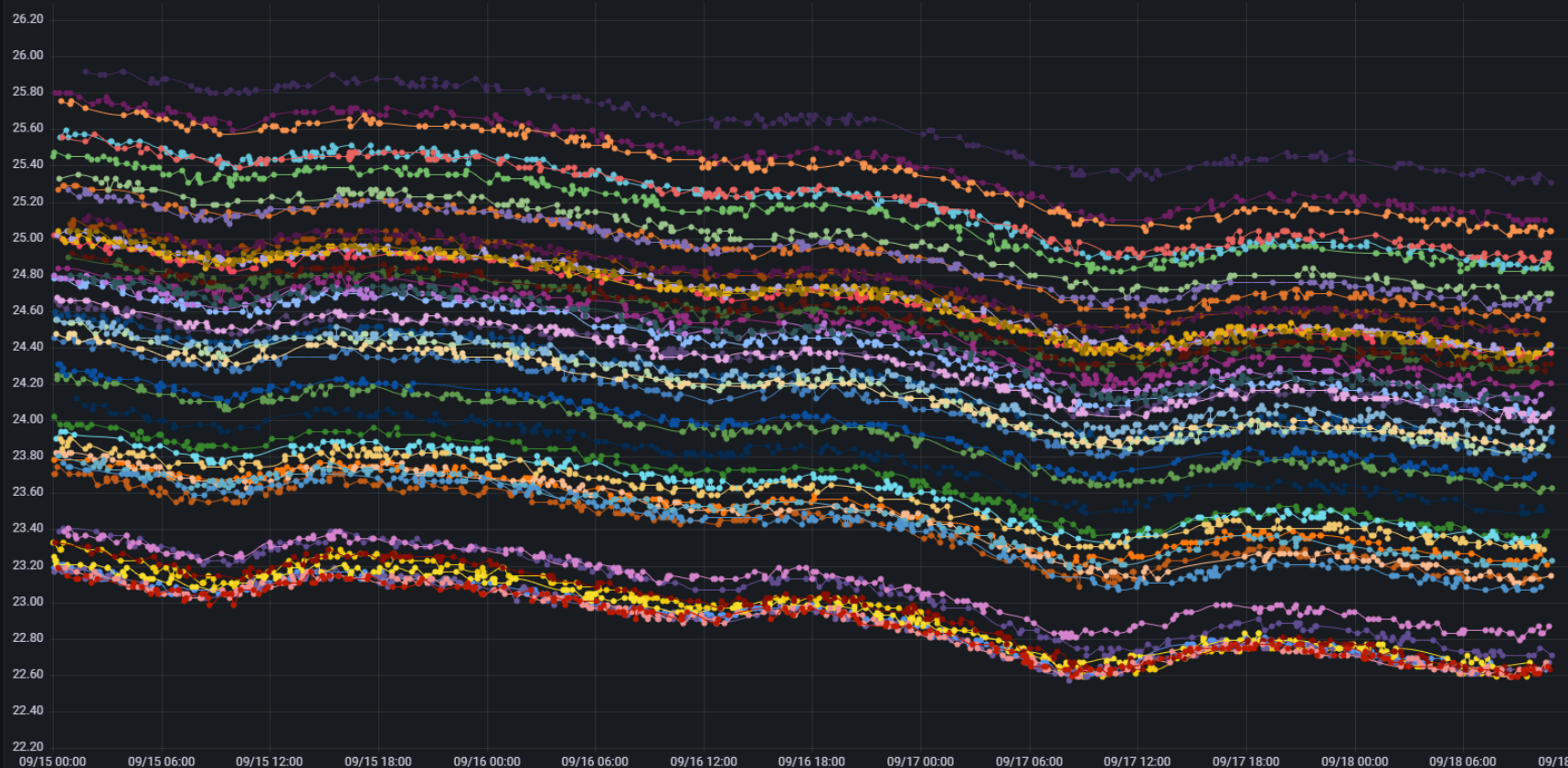
# No Air Cooling System: ADC Boards



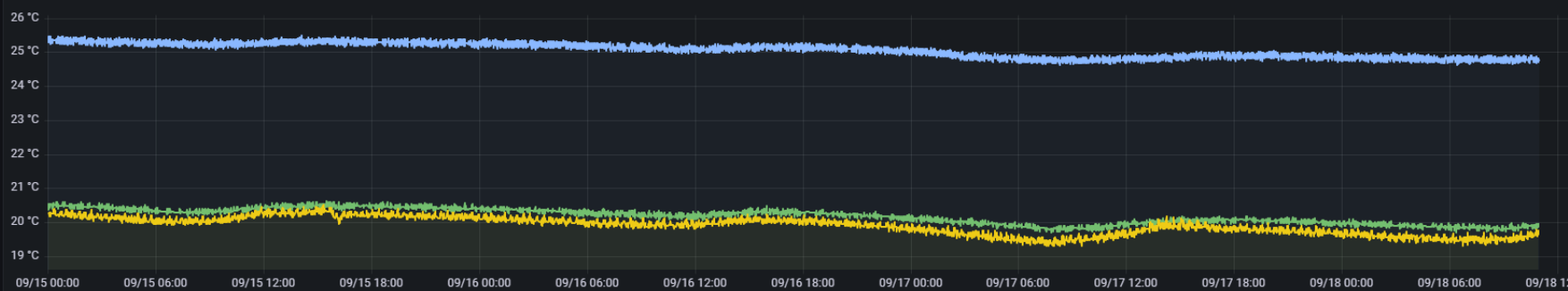
# No Air Cooling System: HV Boards



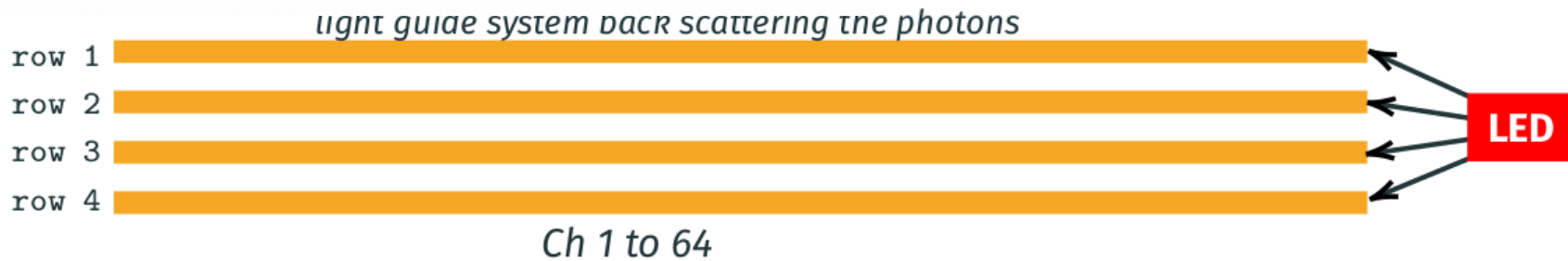
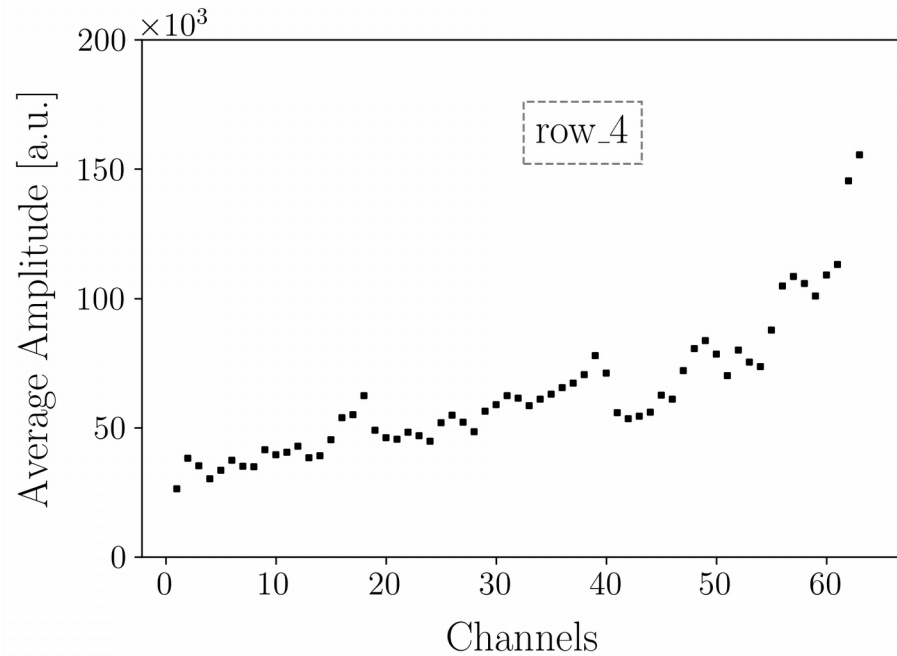
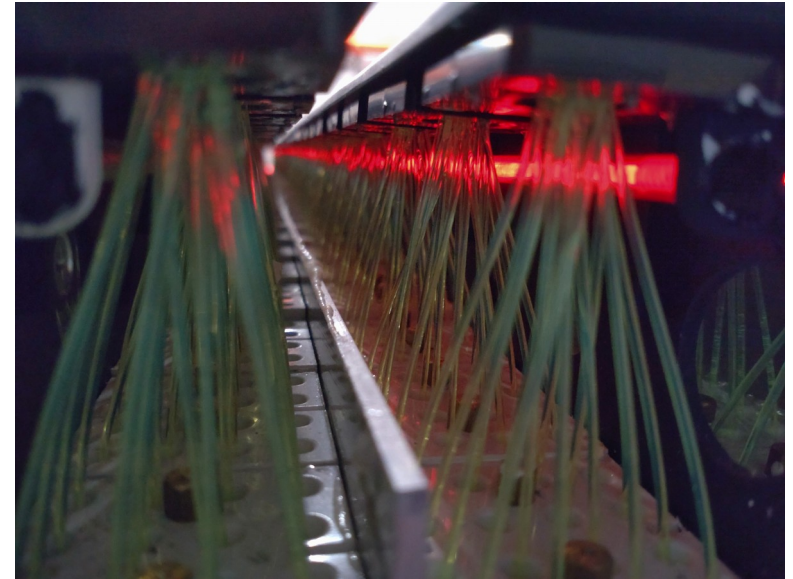
Temperature of HV boards.



Temperature



# LED Stability Control

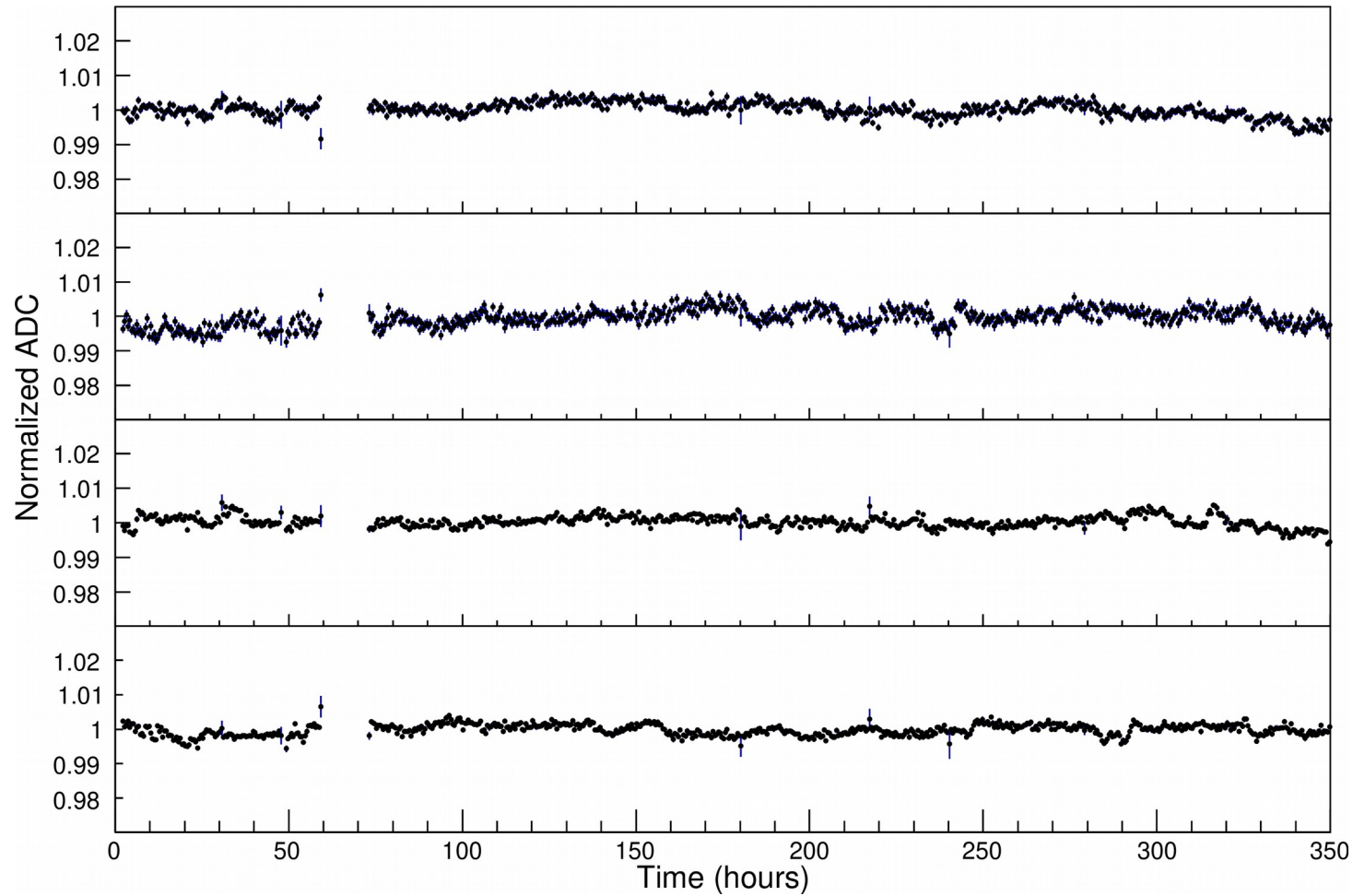


Solid Side Glow SOF-2 fiber (Ø2mm)

LED L7113PBC-A (470 nm)



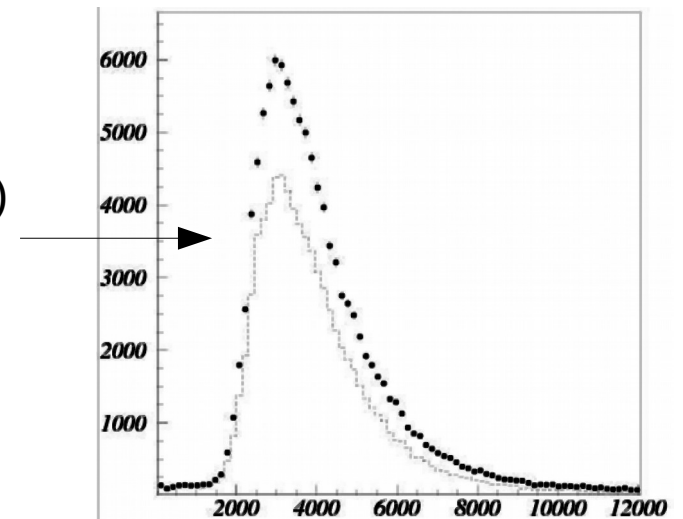
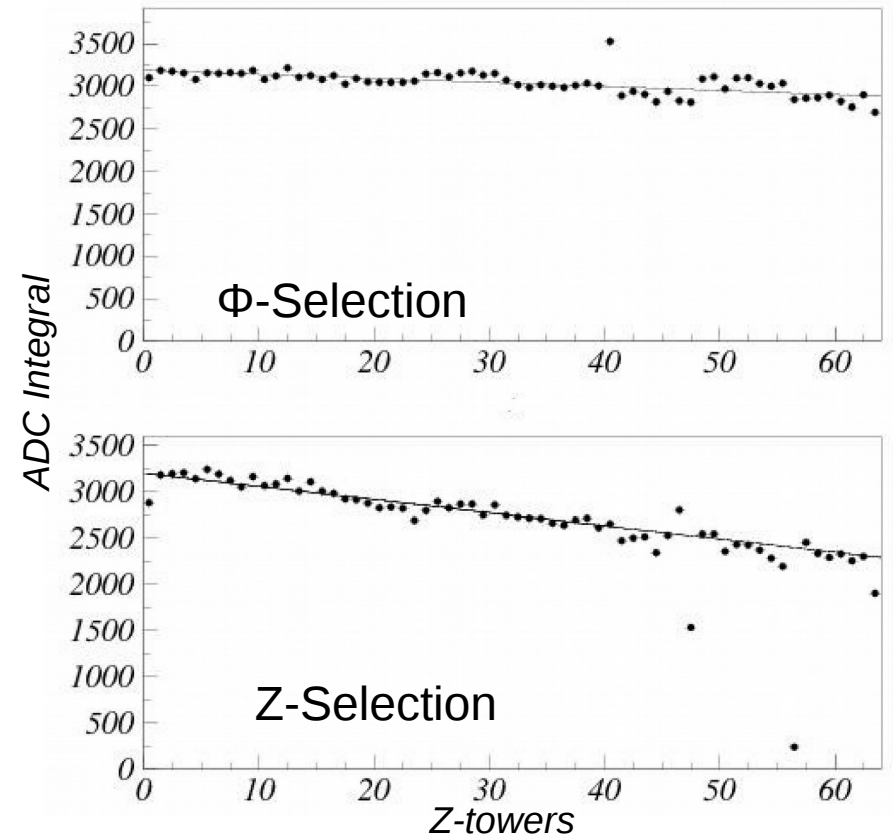
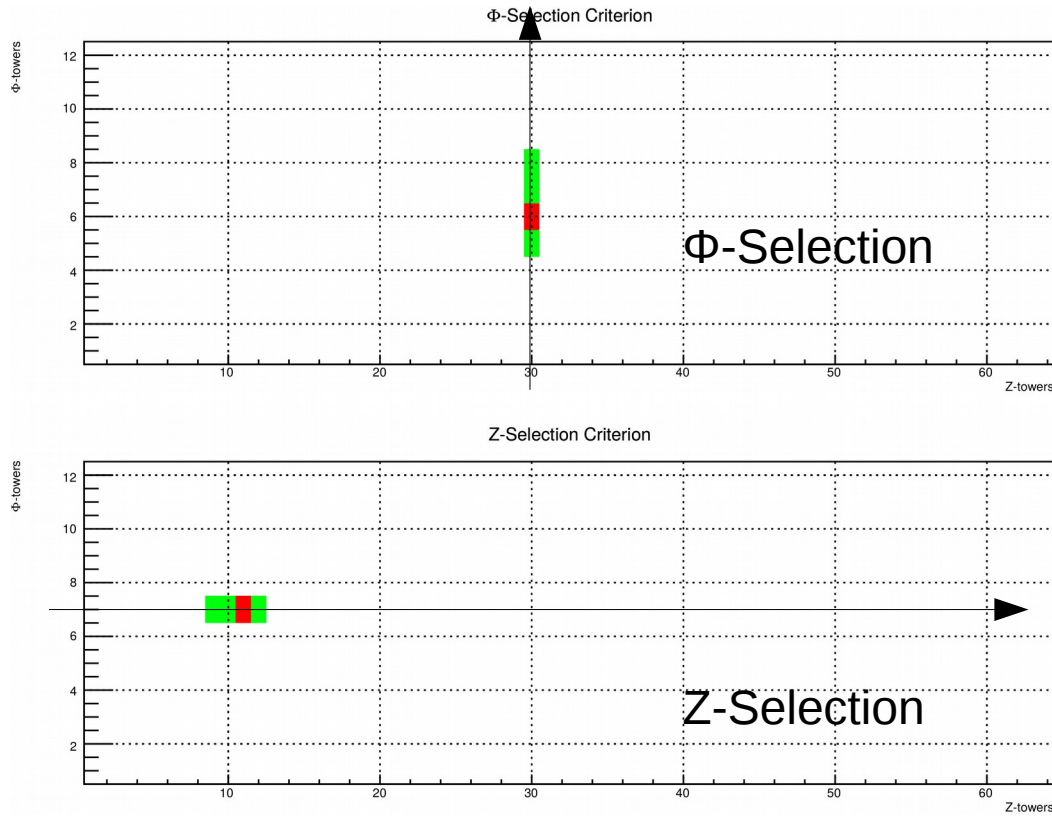
# LED Stability Control



Stability better than 1% for almost all channels.

LED system will be used as a part of ECal slow control.

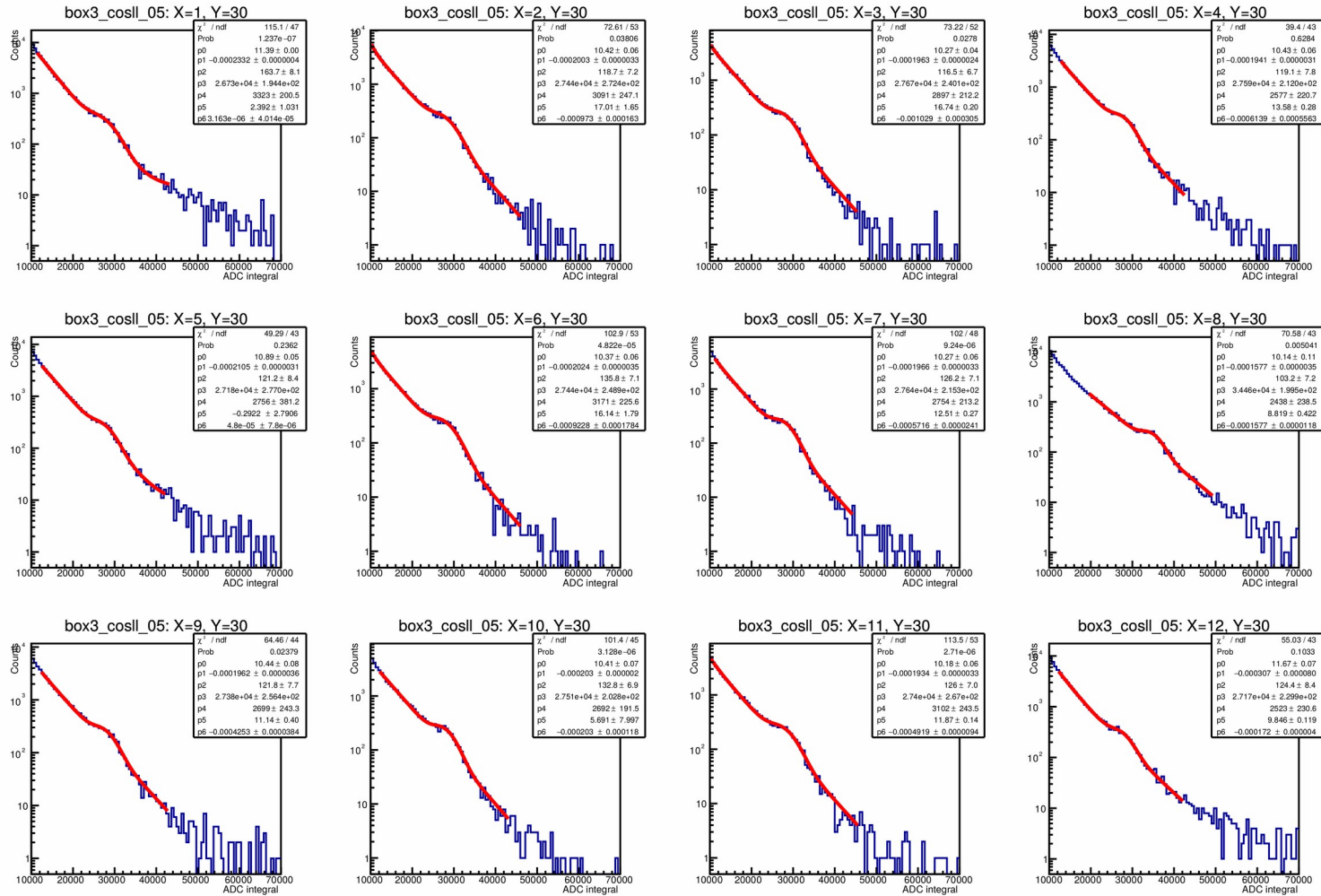
# Half-Sector Calibration with “Transverse” Muons



Pros: Relatively high statistics in relatively short time (500 h) and clean spectra

Cons: Z-dependence of results  
Not very sensitive to imperfections inside towers

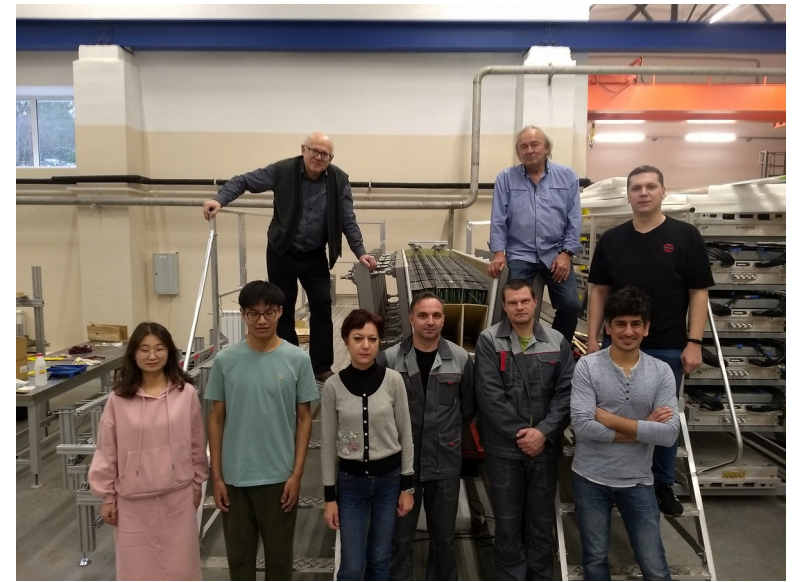
# Half-Sector Calibration with “Longitudinal” Muons



No signals around “signal of interest” → Selection of muons that are going along towers axes  
 Visible signal, but big contamination from SiPM noise → Long DAQ time is needed  
 Work on selection criteria is in progress

# Conclusions:

- 1600 modules out of 2400 have been produced and glued into 32 half-sectors. Production of additional 400 modules in Russia have been finished.
- Production of HV boards is in the final stage. About 25% of needed boards are calibrated. Calibration is in progress.
- Mass assembling of electronics is in progress. All materials and components for electronics and water cooling system are produced and delivered.
- Air cooling system demonstrated a high efficiency during a few-months test of the half-sector with cosmic muons.
- The development of first-level ECal calibration (equalization of signals) with cosmics is in progress.



**About 83% of calorimeter (41-42 half-sectors) is expected to be ready in November 2024.**