



**Joint Institute for Nuclear Research**  
*Laboratory of High Energies Physics*

**Dubna State University**  
*Department of Physical and Technical Systems*



# Calibration systems of the NICA-MPD electromagnetic calorimeter modules

Speaker:

4<sup>th</sup> year student

**Kutinova Olga Vasil'evna**

on behalf of

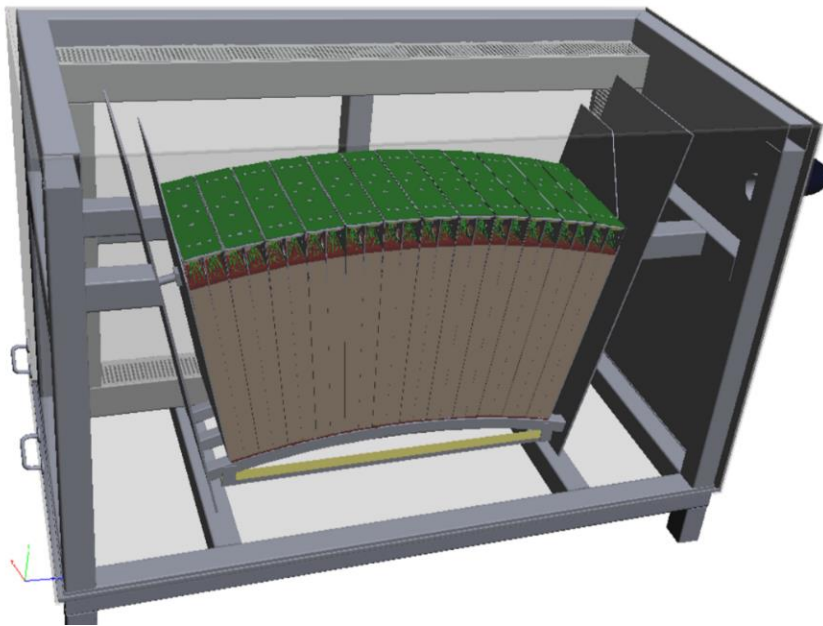
**Ustinov V.V. and Sukhov E.V.**

# Abstract

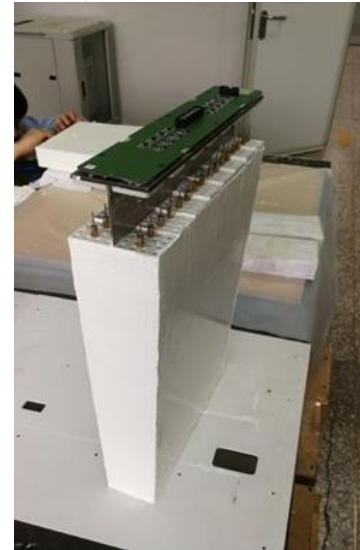
The purpose of this work is to development of calibration systems of the MPD electromagnetic calorimeter modules. Various approaches to developing monitor systems are considered.

One of these systems consists of two large-area scintillation counters with mounted SiPM photodetectors. Another system is an Side Glow fiber that will illuminate optical part of the calorimetric module with a constant intensity light signal. Both implementations of such monitoring systems use SiPM technology to ensure high particle detection efficiency and possibility to work in high-intense magnetic fields.

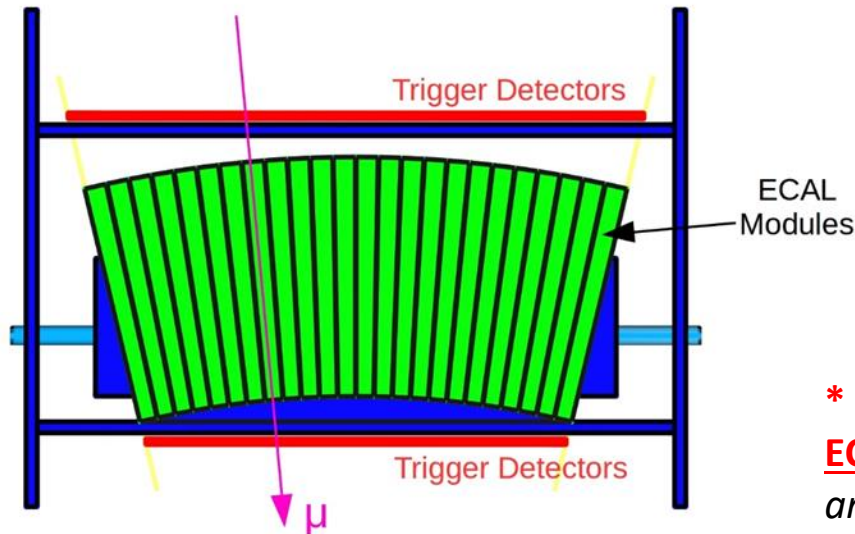
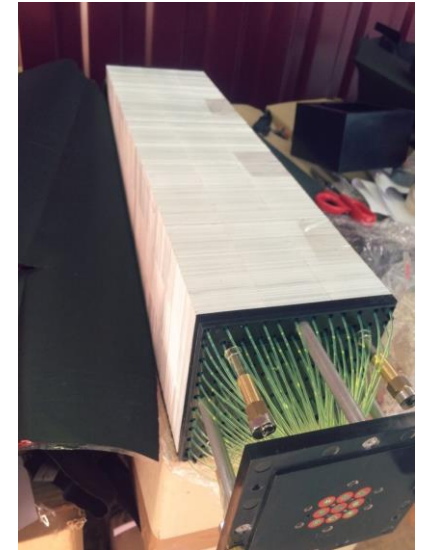
# The test bench for calibration of ECal modules



1 module  
16 towers (MPD)



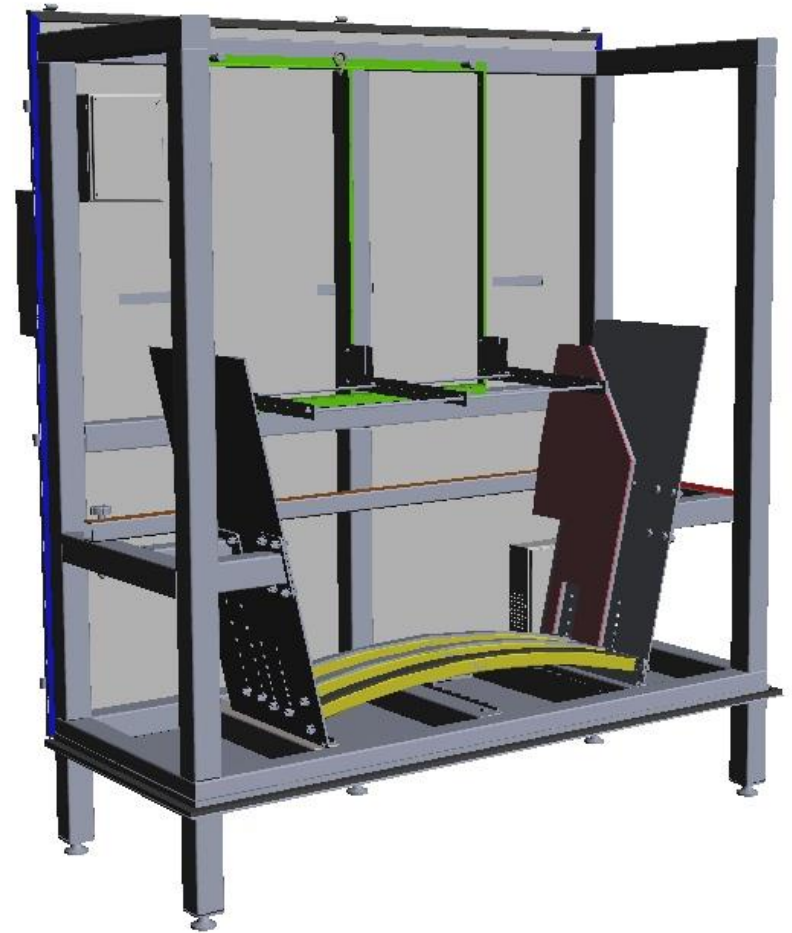
1 module  
9 towers (BM@N)



Cosmic rays is the only constant source of relativistic particles for the stand

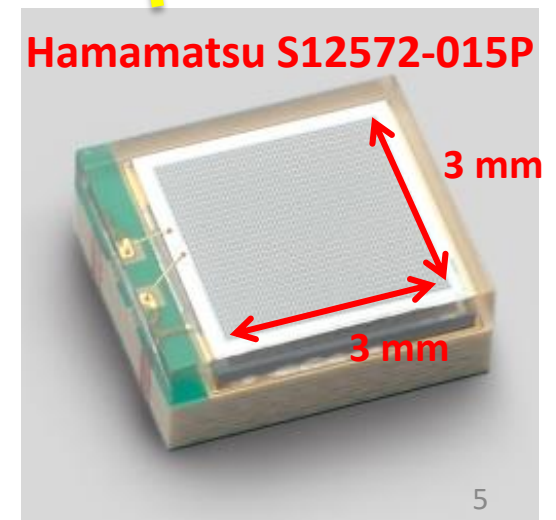
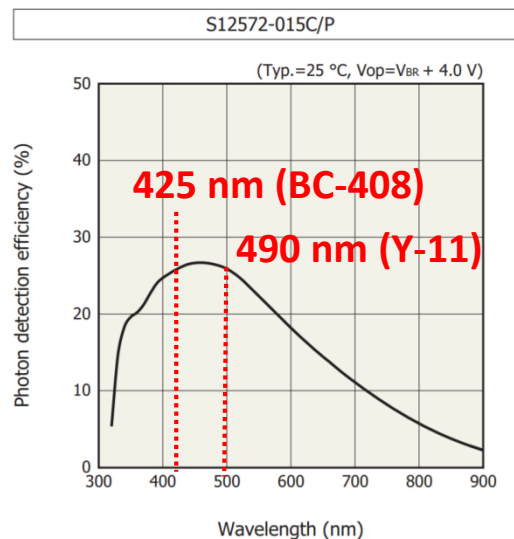
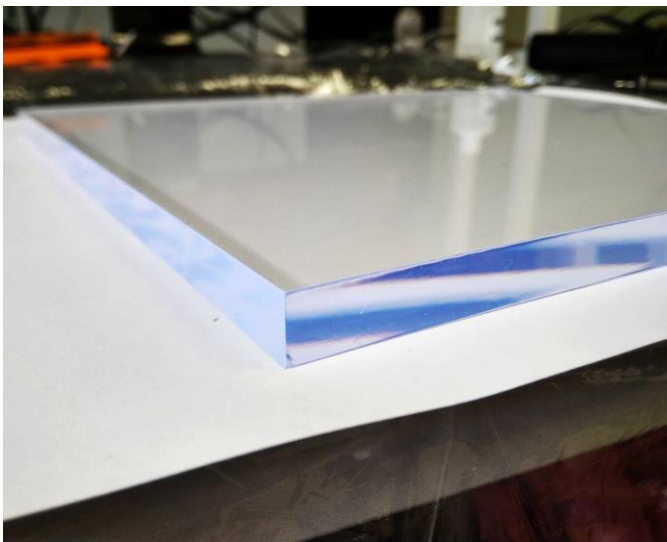
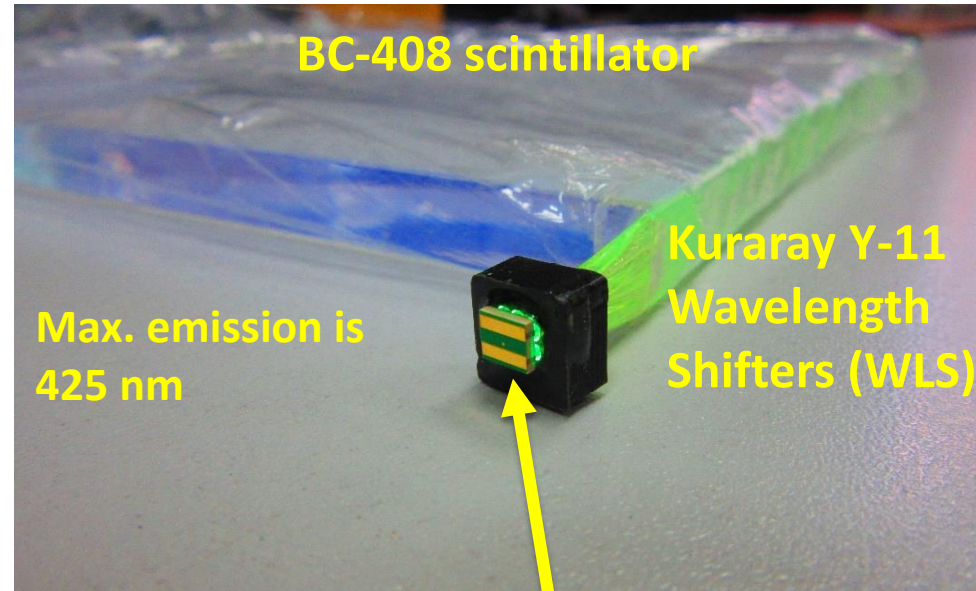
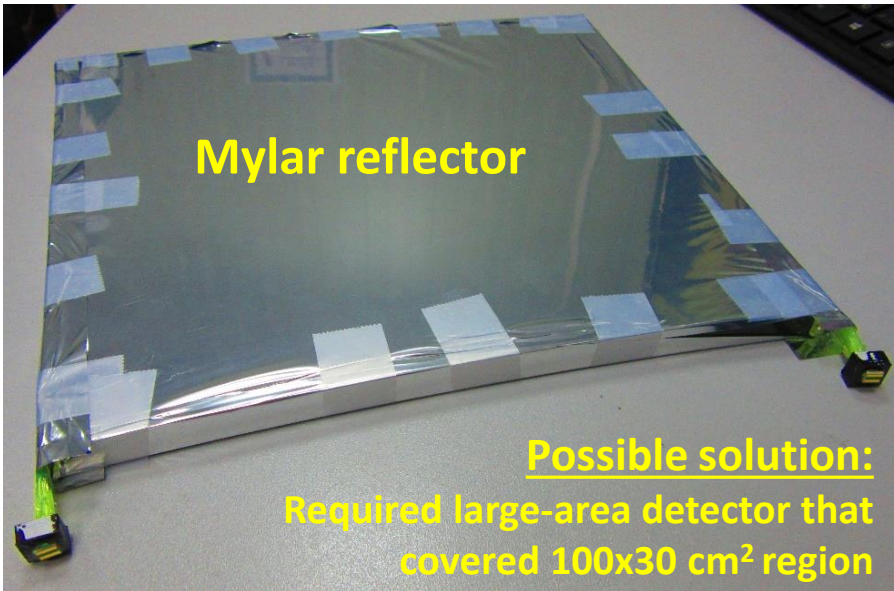
\* More details in the [Yury Krechetov and MPD ECAL Group report](#), Workshop on NICA/MPD, ECal and Software, April 8-10 (2019), Beijing, China

# The test bench for calibration of ECal modules

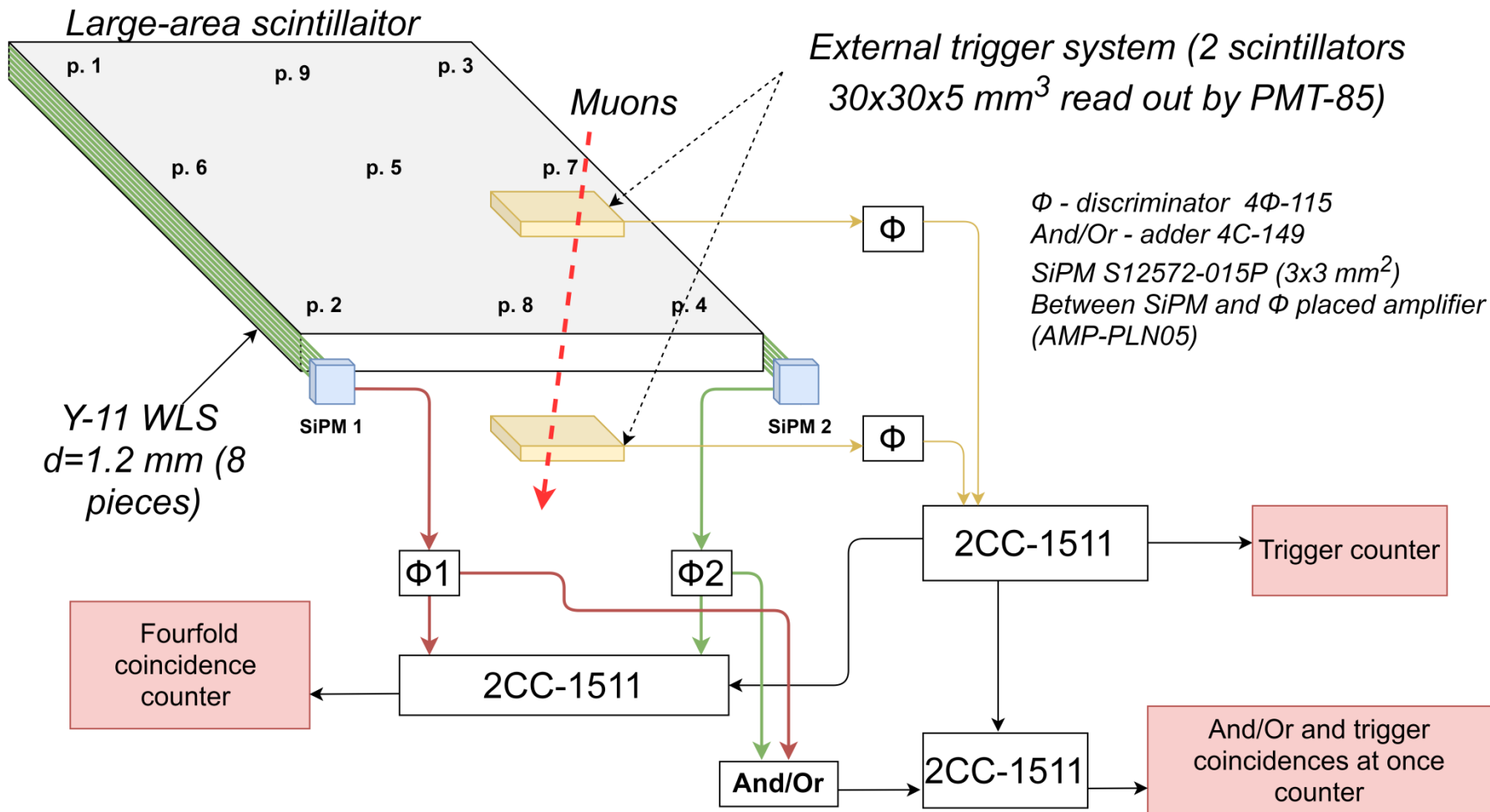




# Test of the monitoring counter large square



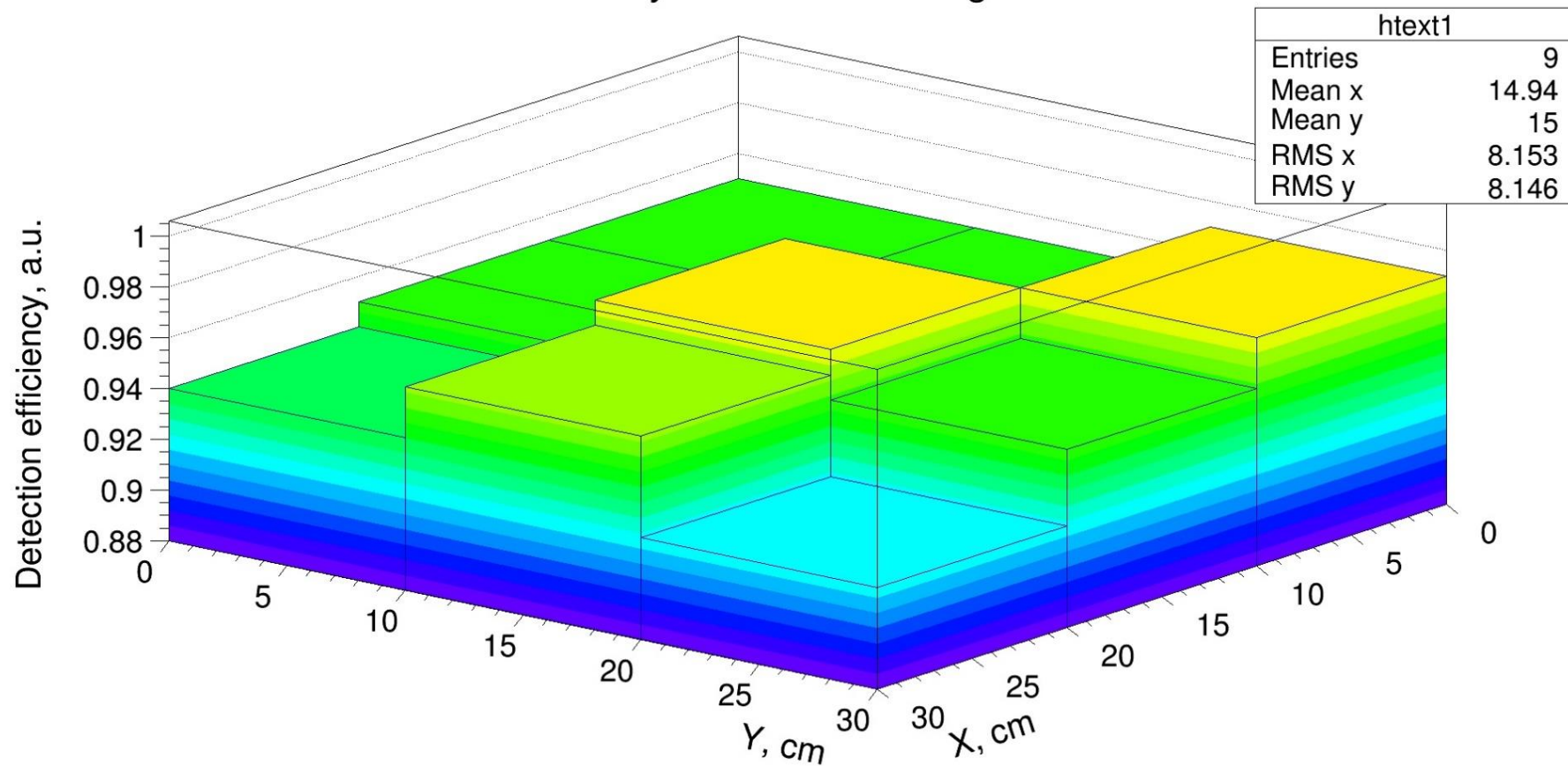
# Block-scheme of measurements



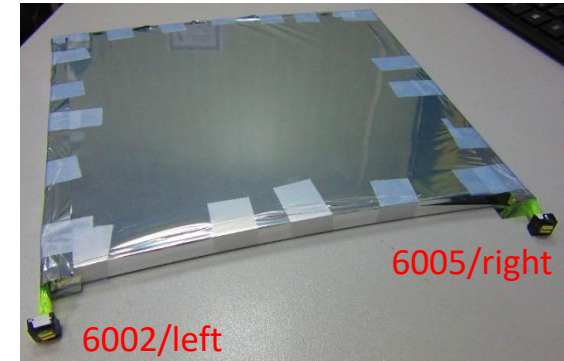
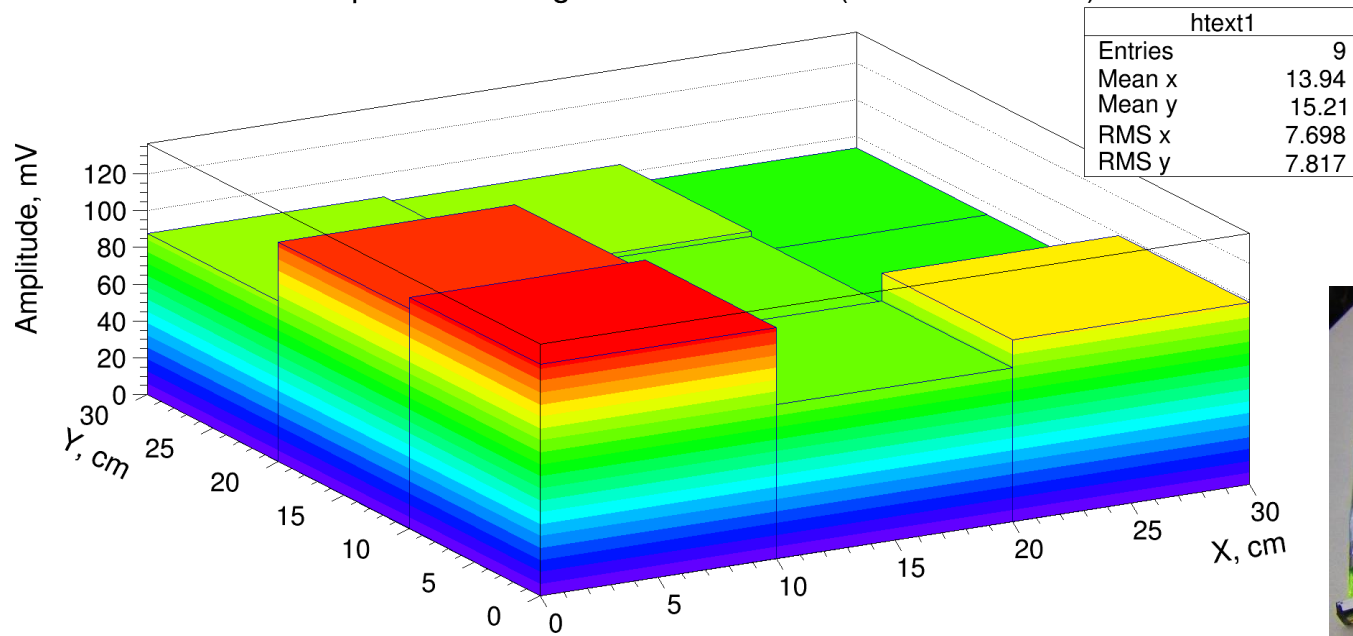
$$\epsilon_{\text{per}} = \frac{N_{\text{зарег}}}{N_{\text{прошедших}}}$$

$N_{\text{прошедших}}$  – total number of particles that passed through external trigger system

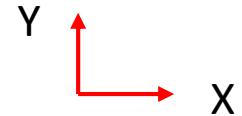
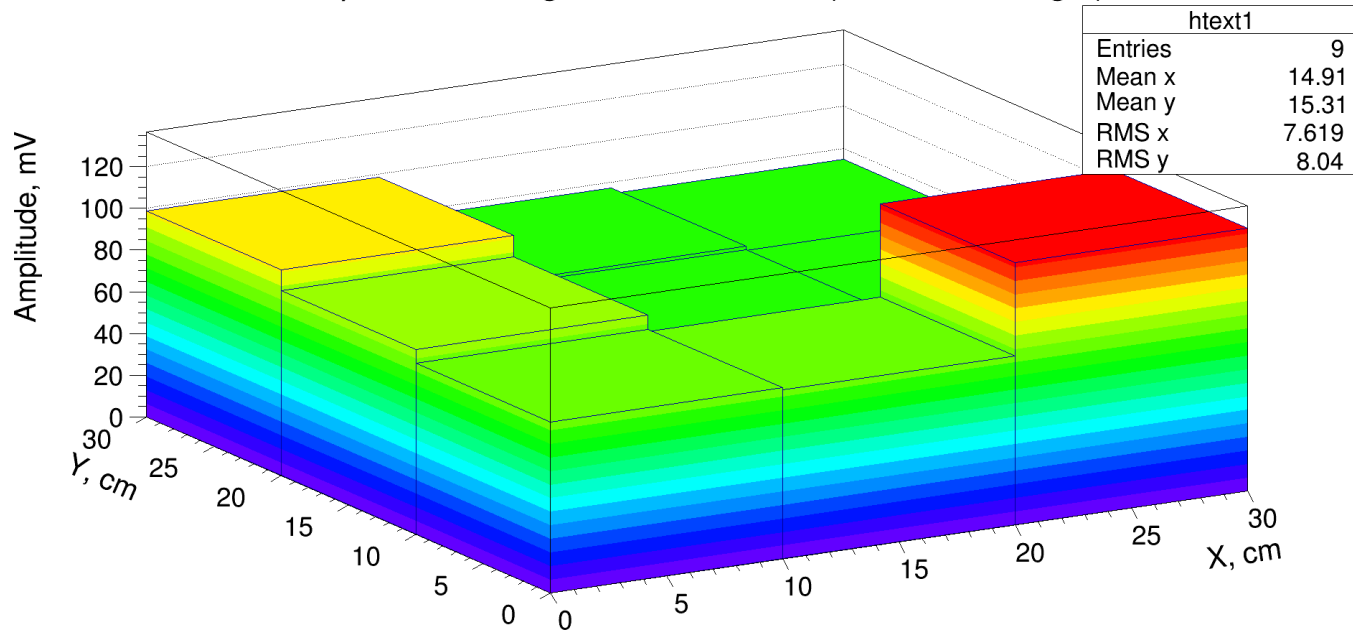
# Detection efficiency distribution of large-area scintillator



Amplitudes of large-area scintillator (SiPM #6002/left)

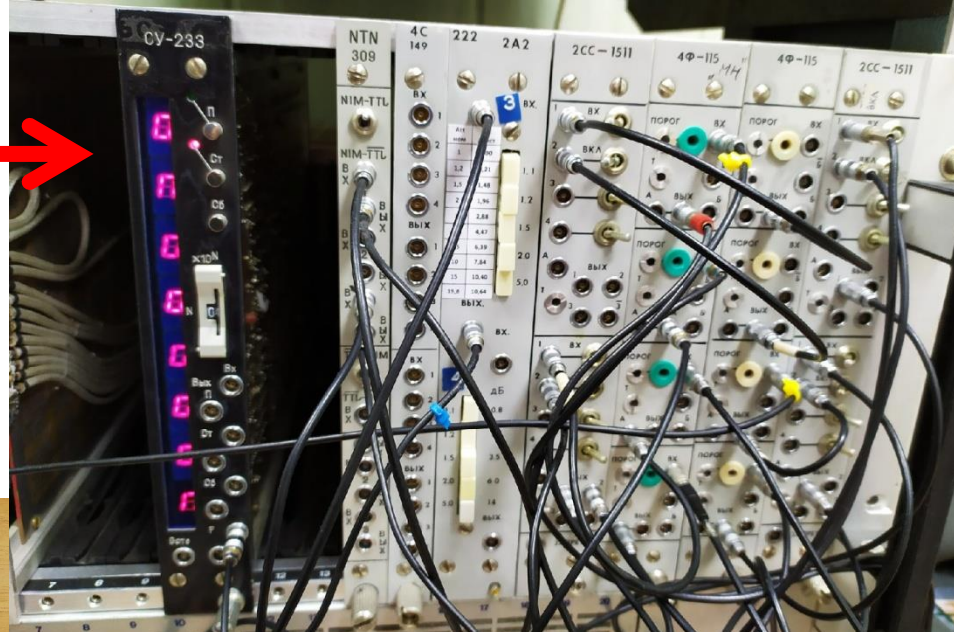


Amplitudes of large-area scintillator (SiPM #6005/right)





CAMAC electronics



Розмер робочої обл.  
230x280x10 мм<sup>3</sup>

SiPM №  
6002  
← LEND1

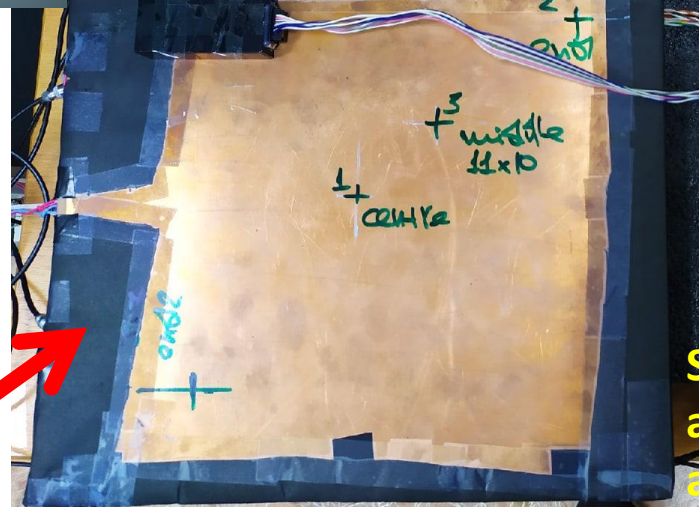
н.в. (30V)  
← +SV n

SiPM №  
6005  
← LEND2

The main view of the counter

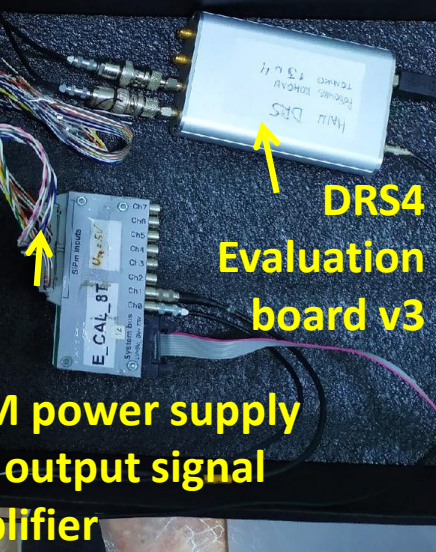


Measurements



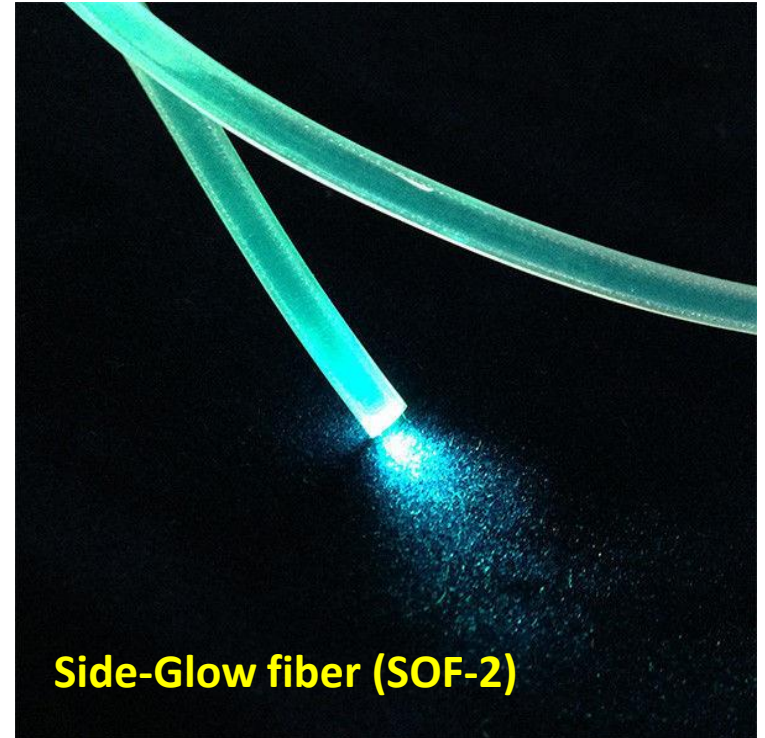
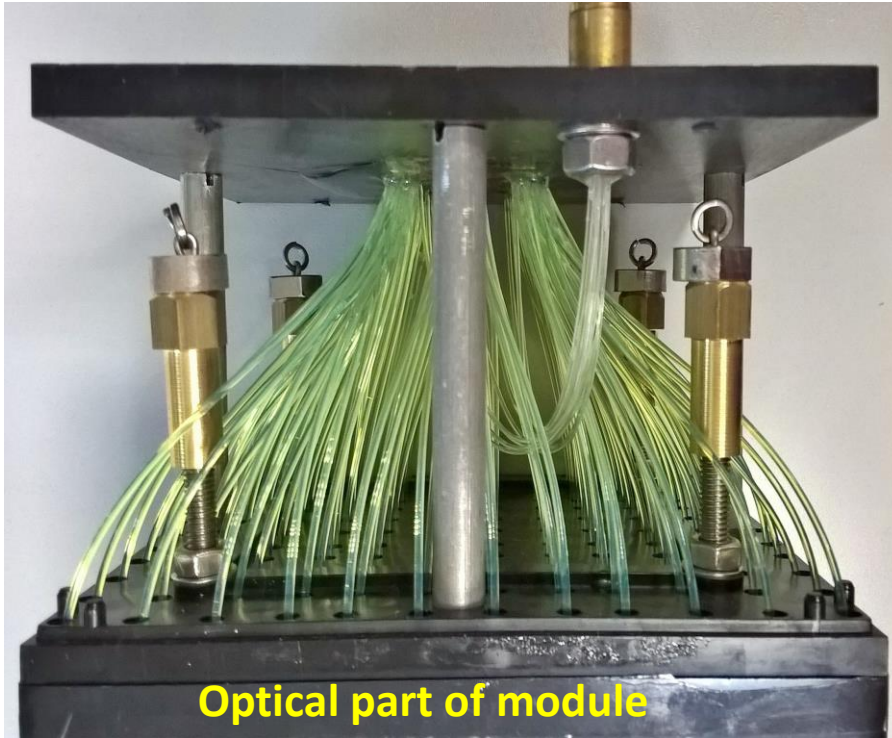
Trigger counter

SiPM power supply  
and output signal  
amplifier

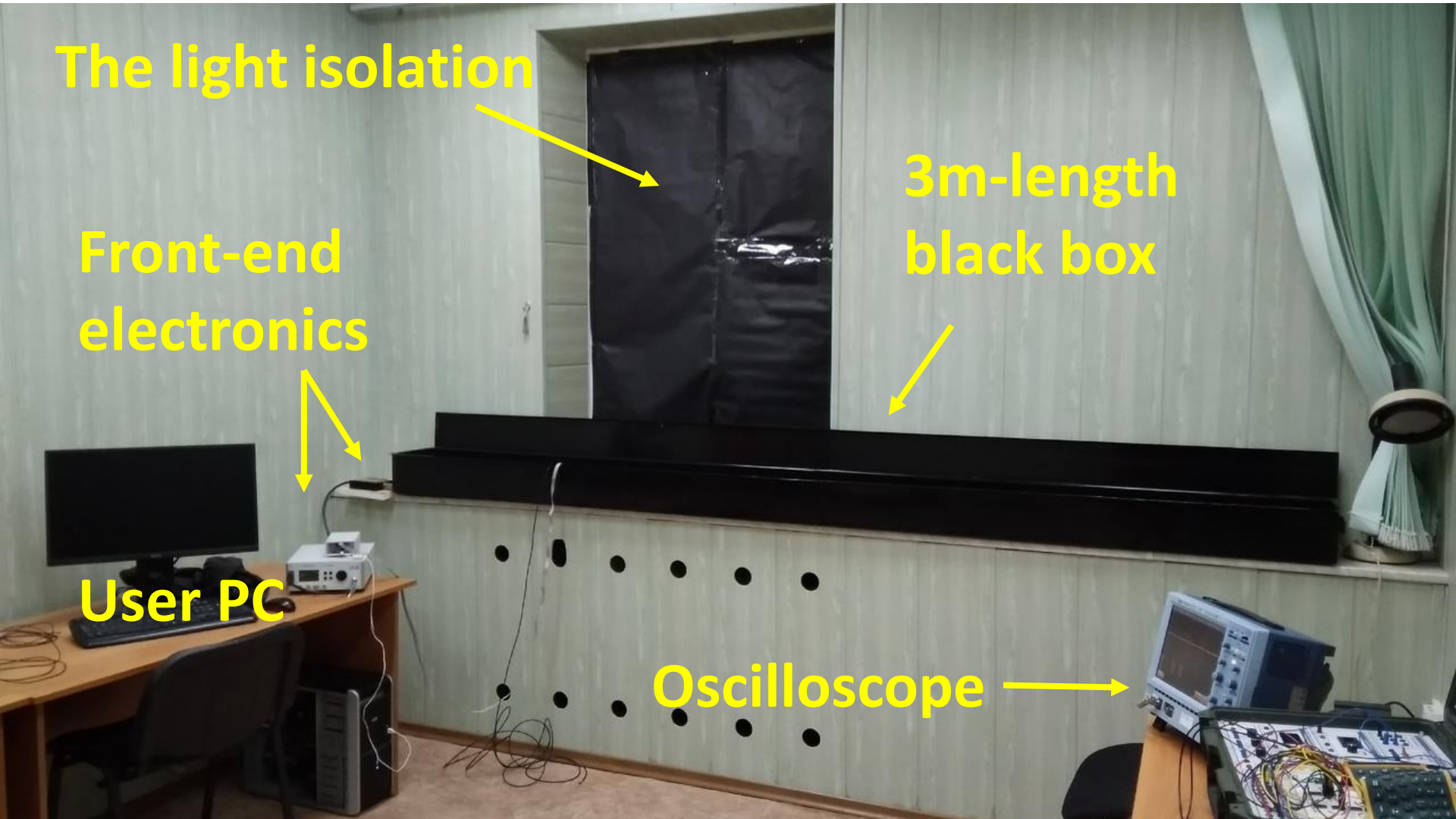




# Development of optic fiber monitoring system



# The test bench for calibration of optical fibers



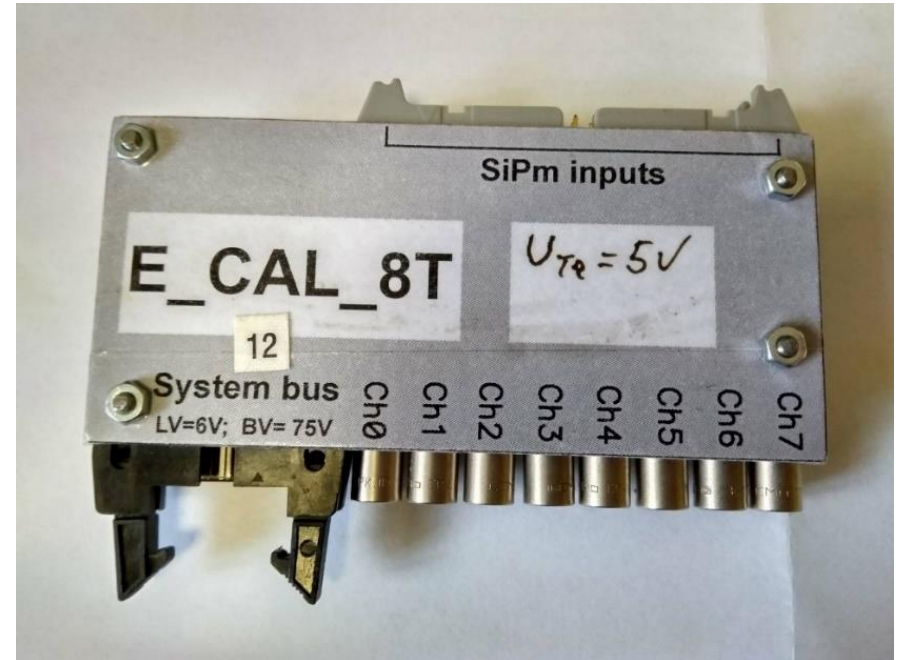
# Front-end electronics

## Advanced Laser Diode Systems



Powerful: 1 W  
Wavelength: 455 nm  
User frequency: 100 Hz

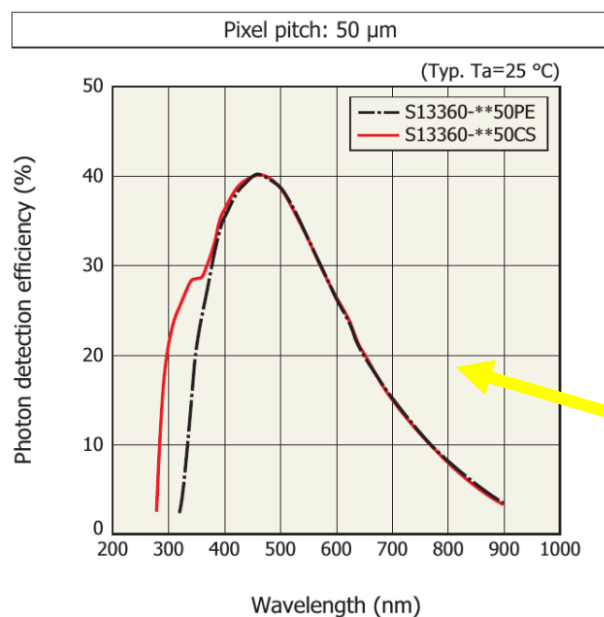
## 8-ch. trigger cell



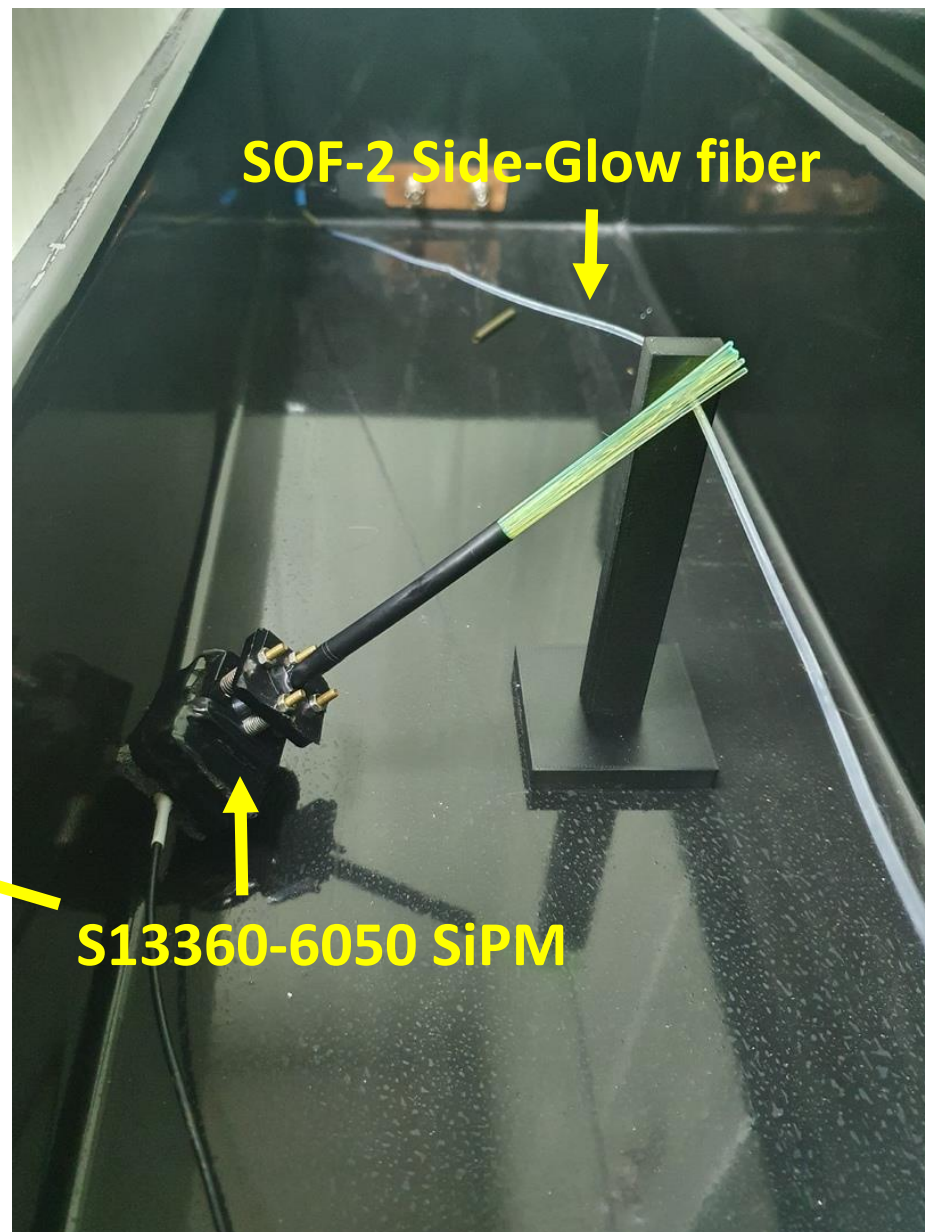
8-channel trigger cell is both a power supply and an amplifier for the captured signal



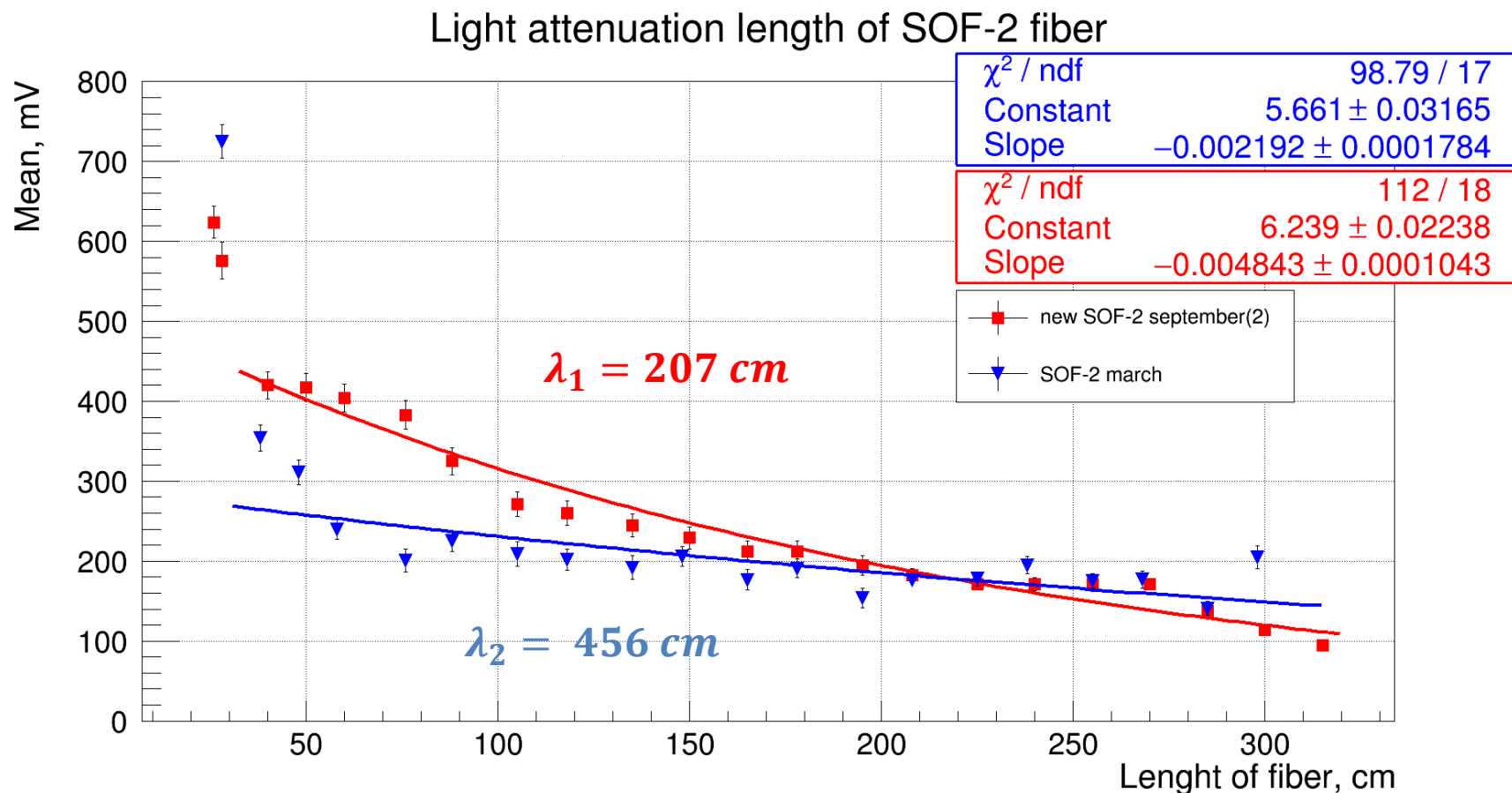
Light extraction by a beam  
of Y-11 wavelength-shifting  
fibers (WLS)  
[light extraction simulator of  
Ecal].



We can observe signals with  
an amplitude well  
distinguishable from noise.



# The dependence of the amplitude of the signals on the SOF-2 fiber length



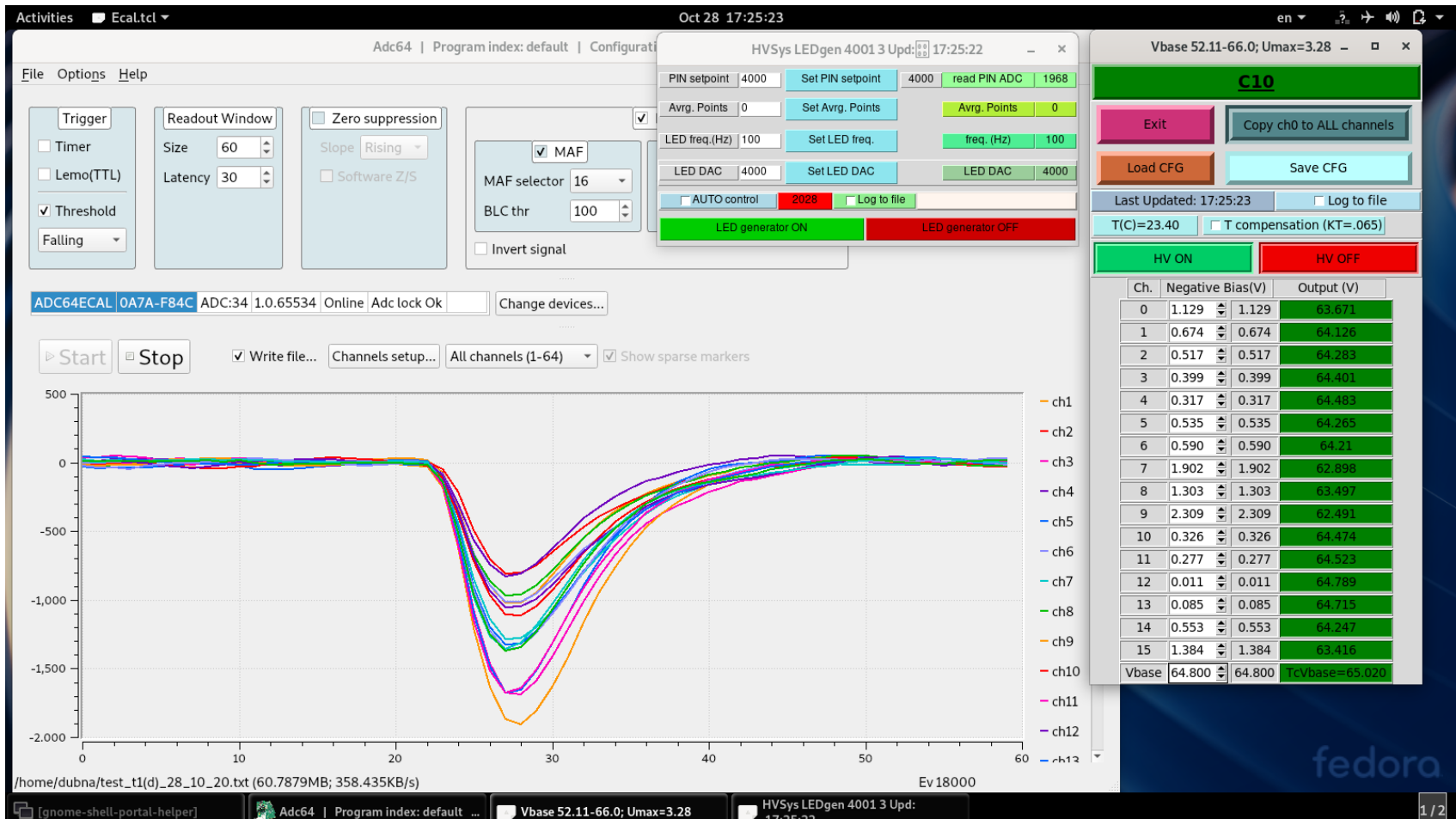
# Summary

1. A large-area prototype of trigger counter has been development and tested. The counter is based on Bicron BC-408 plastic scintillator; light extraction was carried out by an Y-11 WLS, that ensures high uniformity of the output signal.
2. The mean efficiency of minimally ionizing particles registration of all counters is 95%.
3. The light attenuation length of the SOF-2 SideGlow fiber was measured by 455 nm picosecond laser with using an Y-11 WLS as light collection simulator of ECal.
4. Measurements shows that the light attenuation length is about 456 cm for SOF-2 fiber

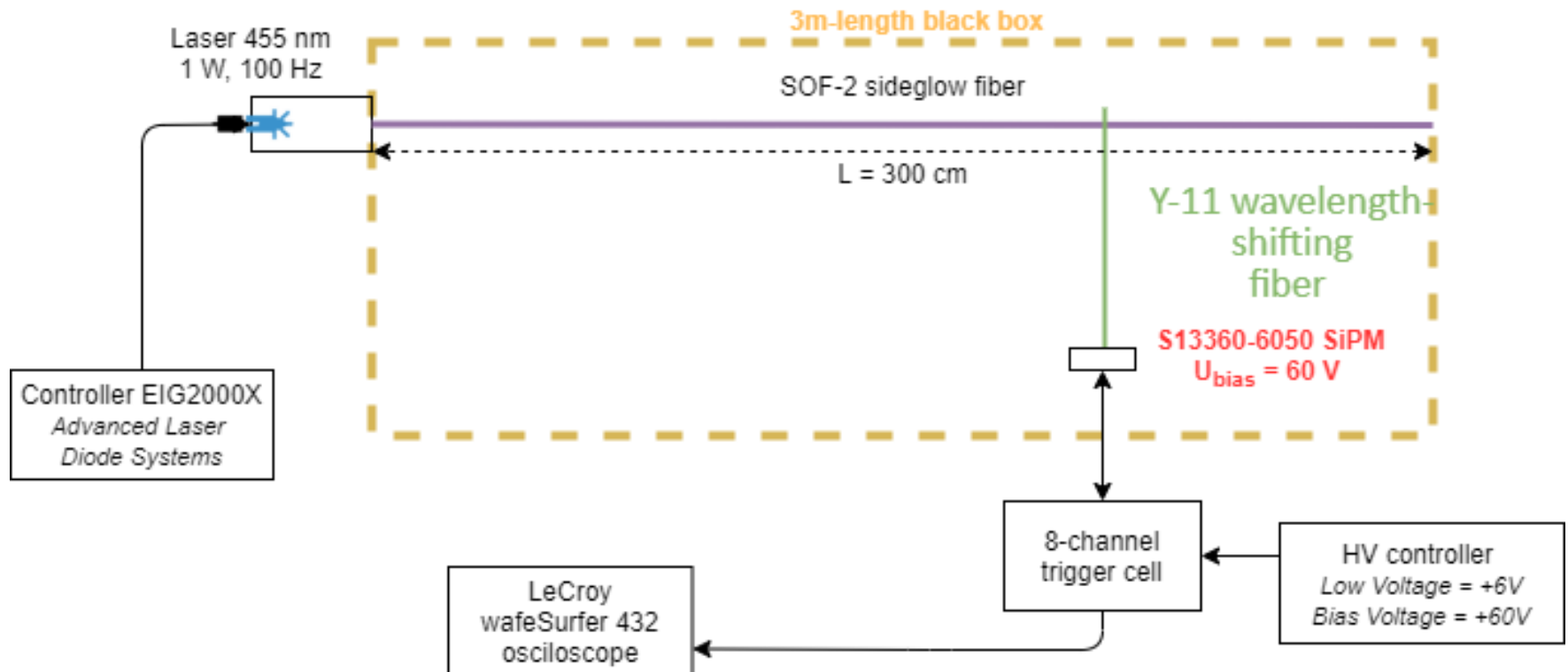
**Thank you for attention!**



# Signals from calorimeter module from the optic-fiber system (SOF-2 x2 + LED)



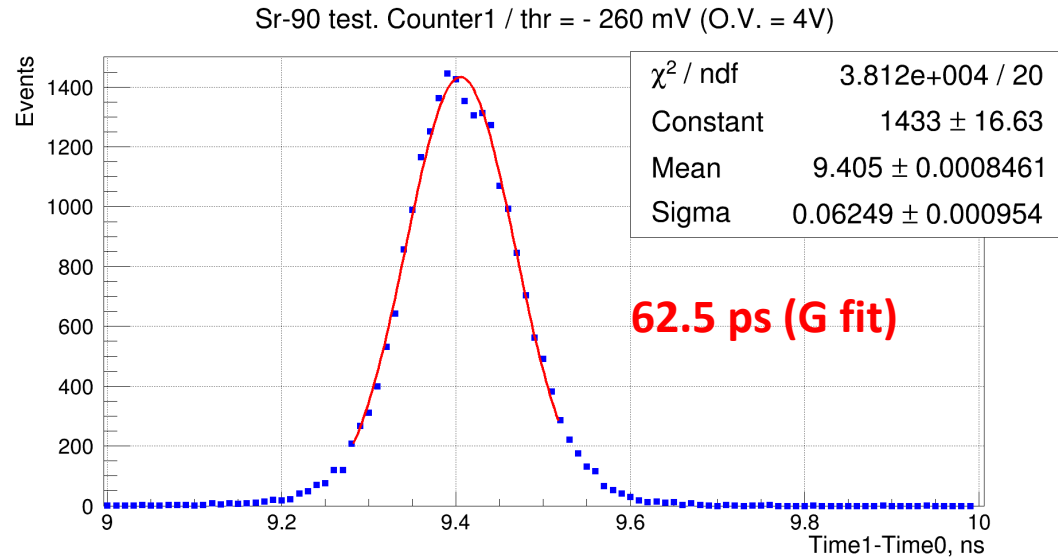
# Block-scheme of study SOF-2 optic fibers



# Development of the fast beam counters

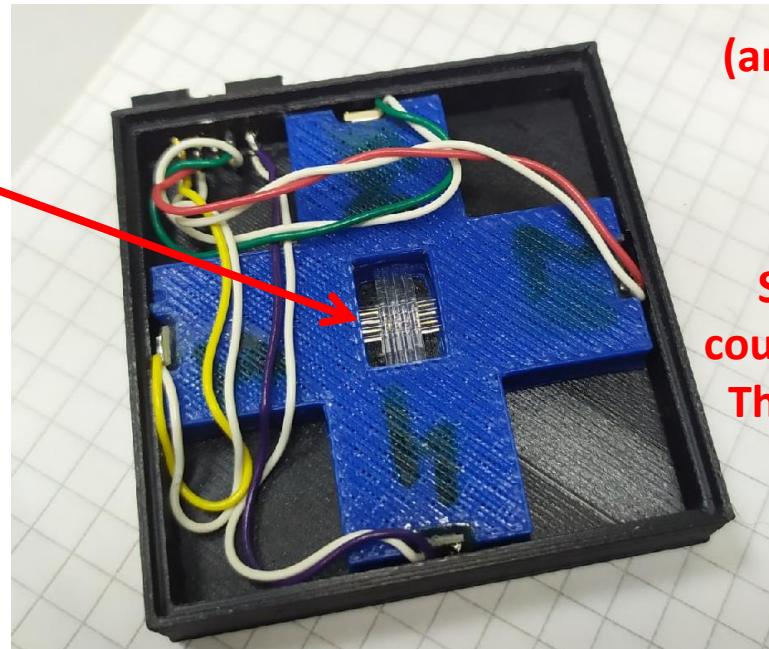
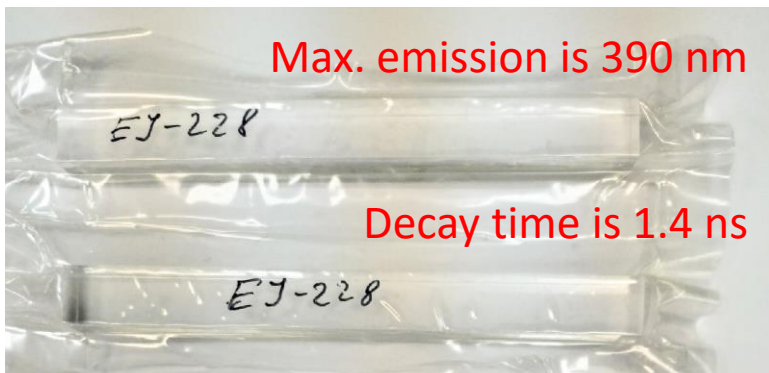
ELJEN EJ-228 read out by

Hamamatsu S13360-6050



Max. emission is 390 nm

Decay time is 1.4 ns

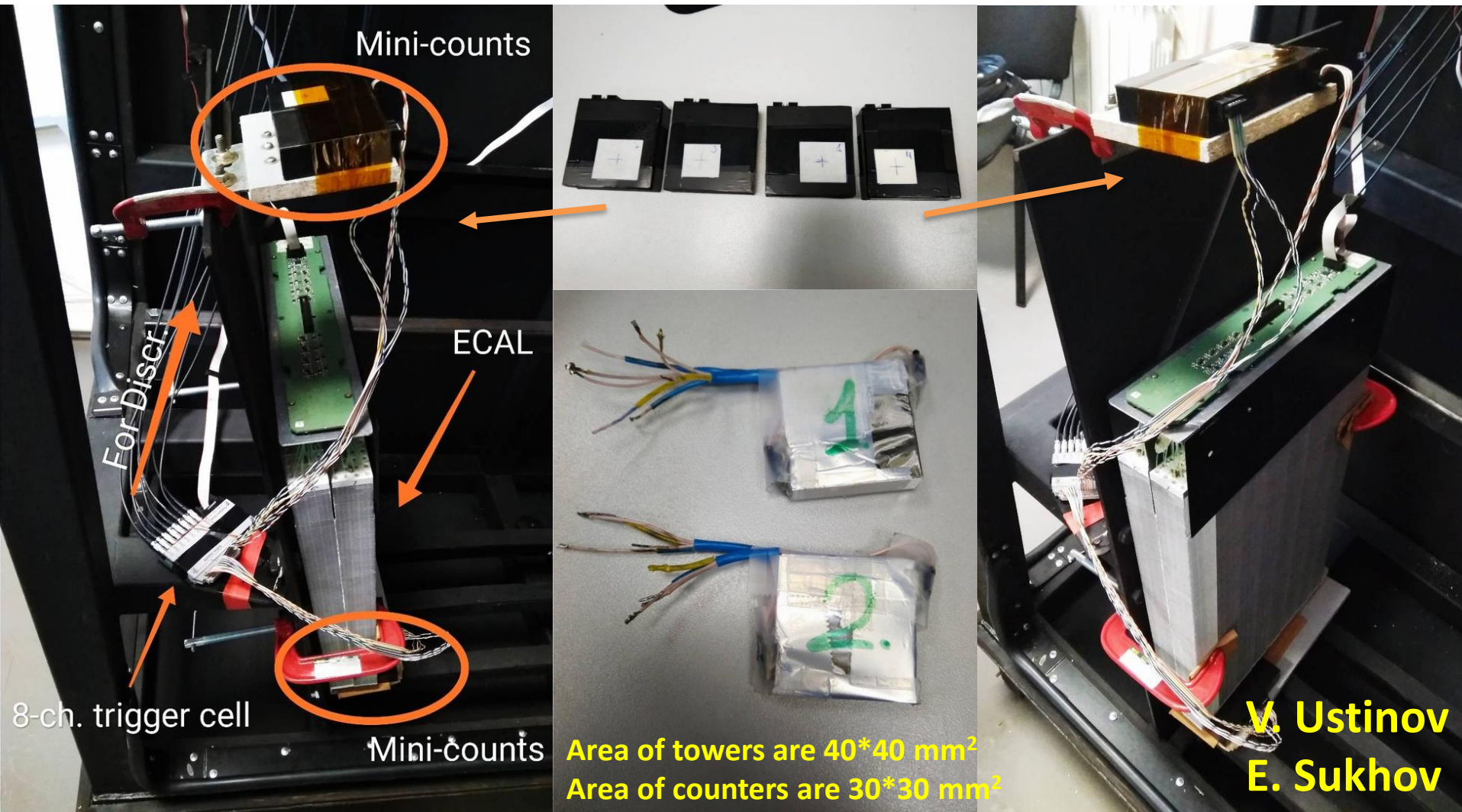


**Bicron BCF-10  
(analogue BC-408)  
read out by  
S12572-015P**

**Sensitive area of  
counter is 4x4 mm<sup>2</sup>  
Thickness is 2 mm**



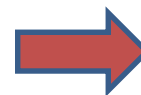
# Individually calibrate of each tower using mini-trigger counters



1 module = 16 towers

1 test bench = 12 modules = 192 towers

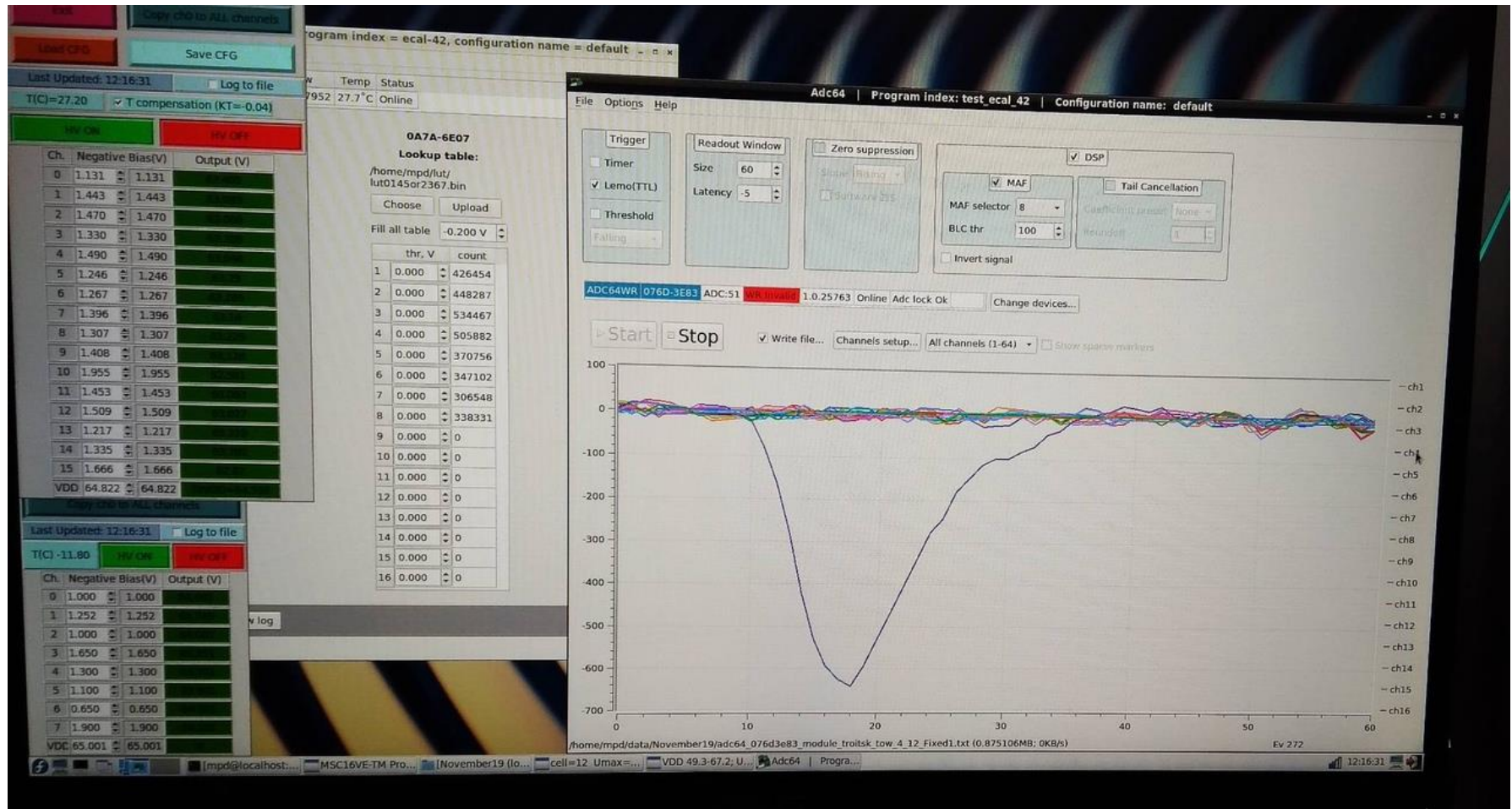
There are two counters for each tower = 384 piece



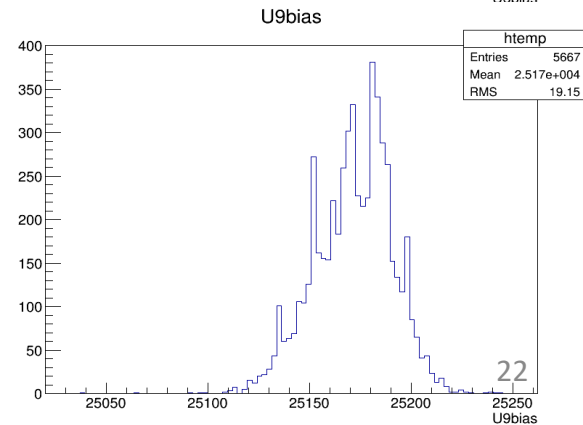
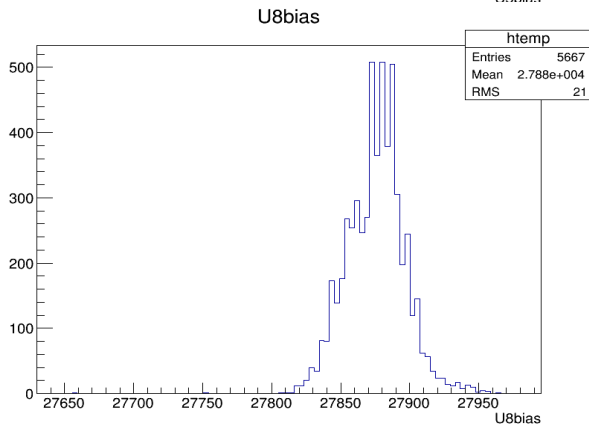
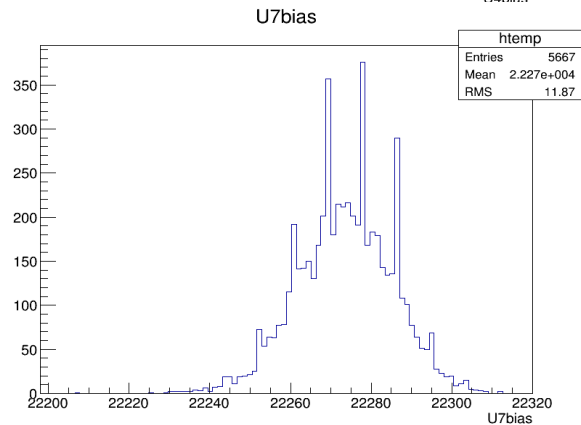
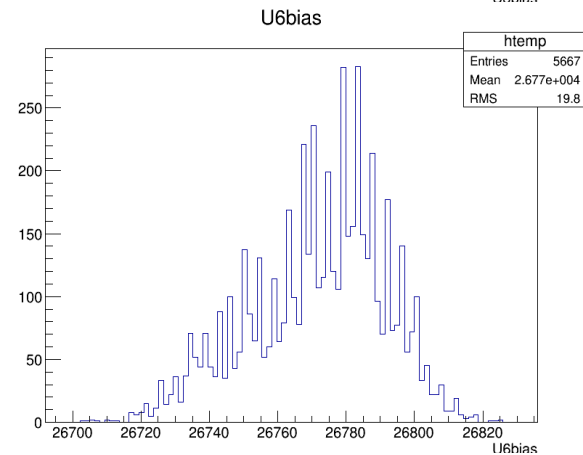
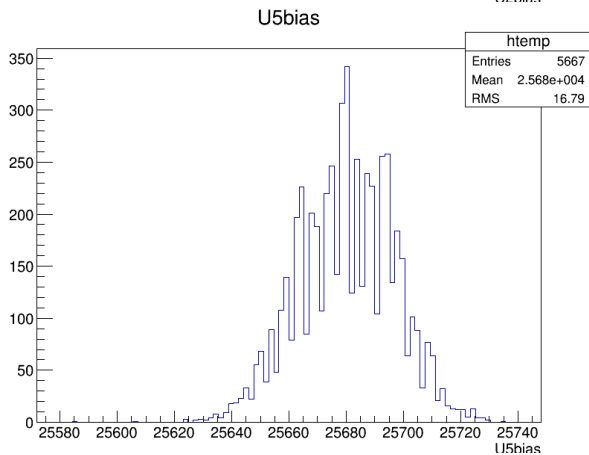
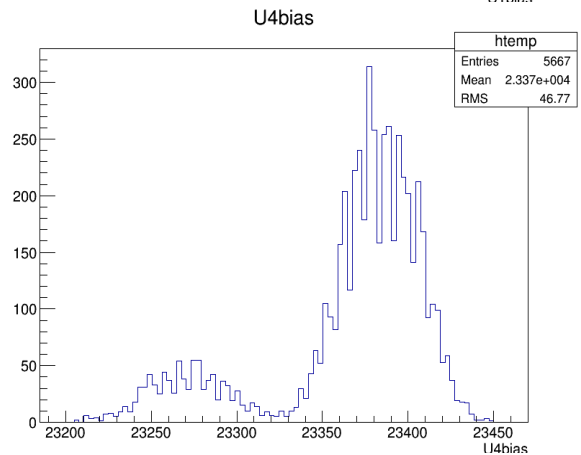
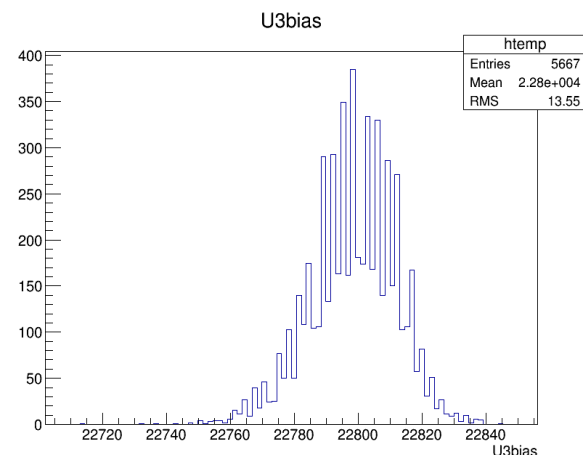
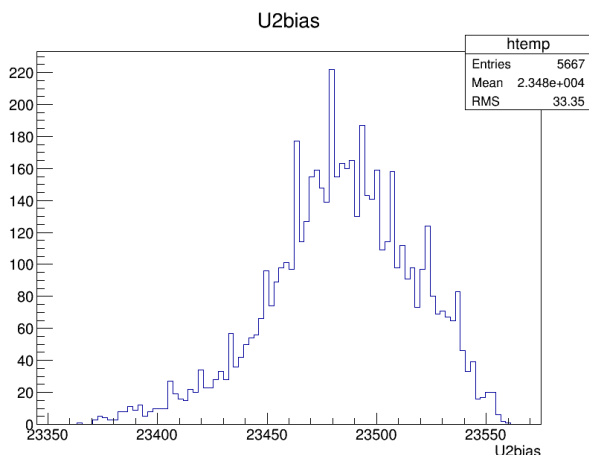
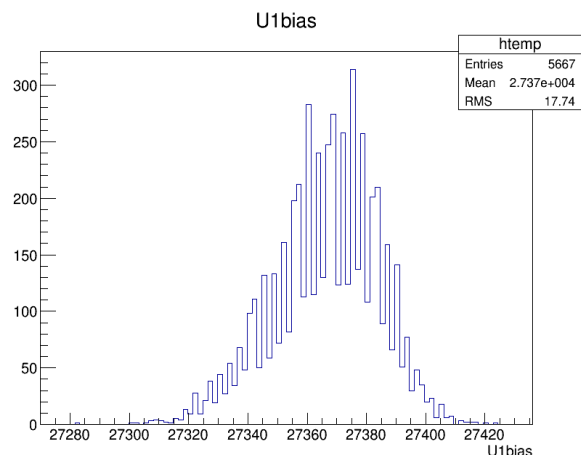
This is too much electronics ->  
Unprofitable



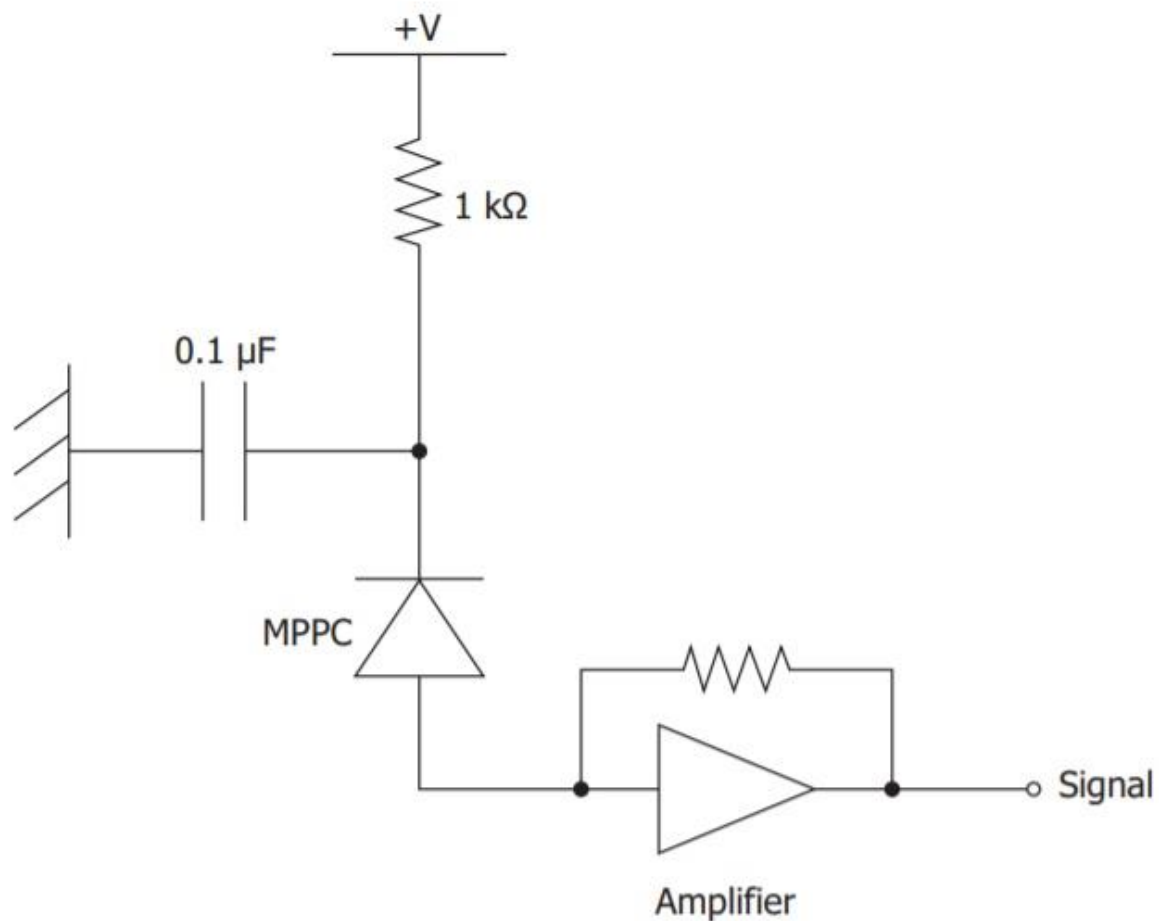
# Signals from calorimeter module selected by the monitoring system (3\*3 cm counters)



# Amplitudes of signals when muon pass through module



## Connection example



KAPDC0024EB

**HAMAMATSU**  
PHOTON IS OUR BUSINESS

# Example of detected amplitudes (centre of counter)

Test scintillator detector on cosmic rays

