Joint Institute for Nuclear Research
Laboratory of High Energies Physics

Dubna State University
Department of Physical and Technical Systems

Development of monitoring methods for MPD electromagnetic calorimeter modules

Speaker:
4th year student
Kutinova Olga Vasil'evna
Supervisors:
Ustinov V.V. and Sukhov E.V.

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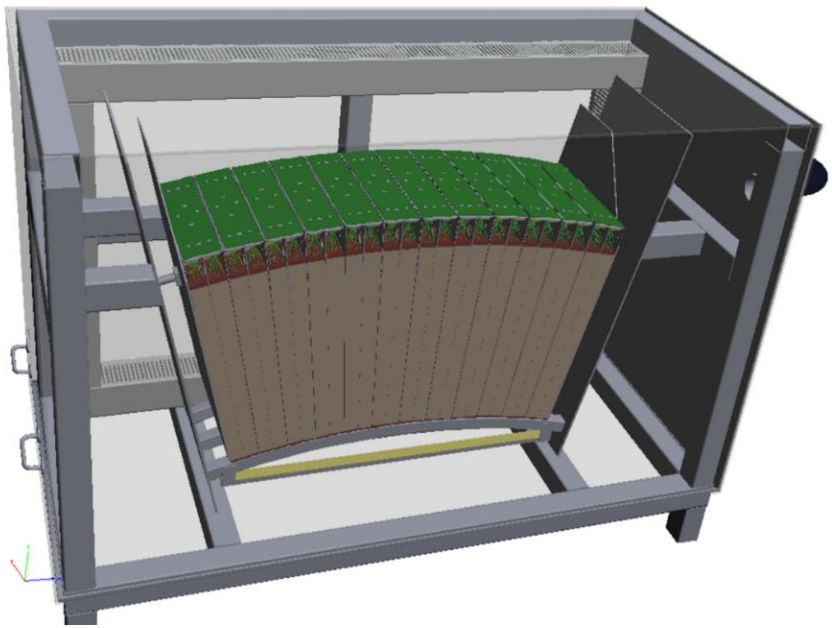
Abstract

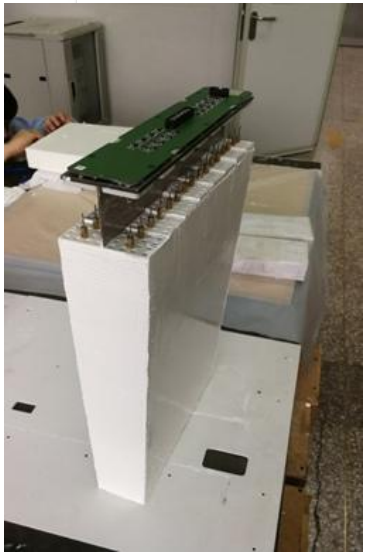
The development process of two scintillation monitoring systems for testing «Shashlyk» electromagnetic calorimeter modules (ECal) is considered.

One version of the system involves the use of small-area fast scintillation detectors in the trigger for testing Ecal using electron beams. In another version, it is proposed to use large-area scintillation detectors for testing modules on cosmic rays. Both implementations of such monitoring systems use SiPM technology to ensure high particle detection efficiency and possibility to work in high-intense magnetic fields.

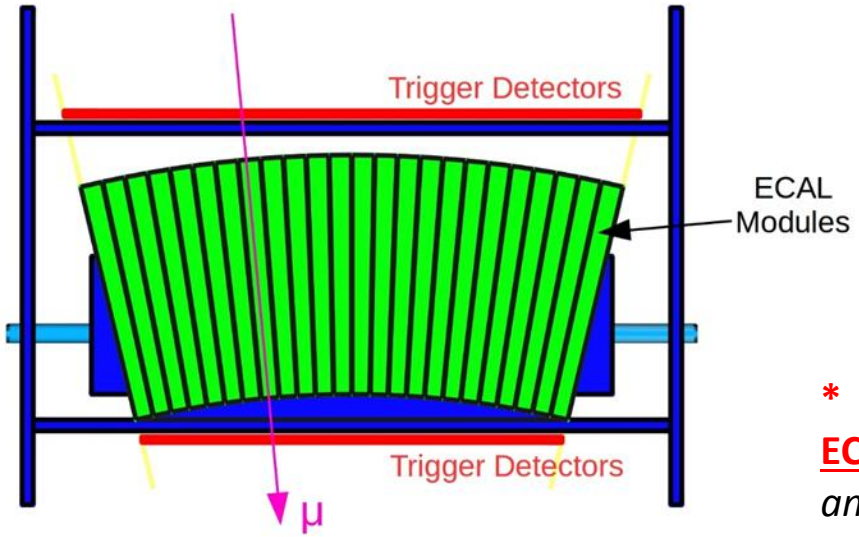
The test bench for calibration of ECal modules



1 module
16 towers (MPD)



1 module
9 towers (BM@N)

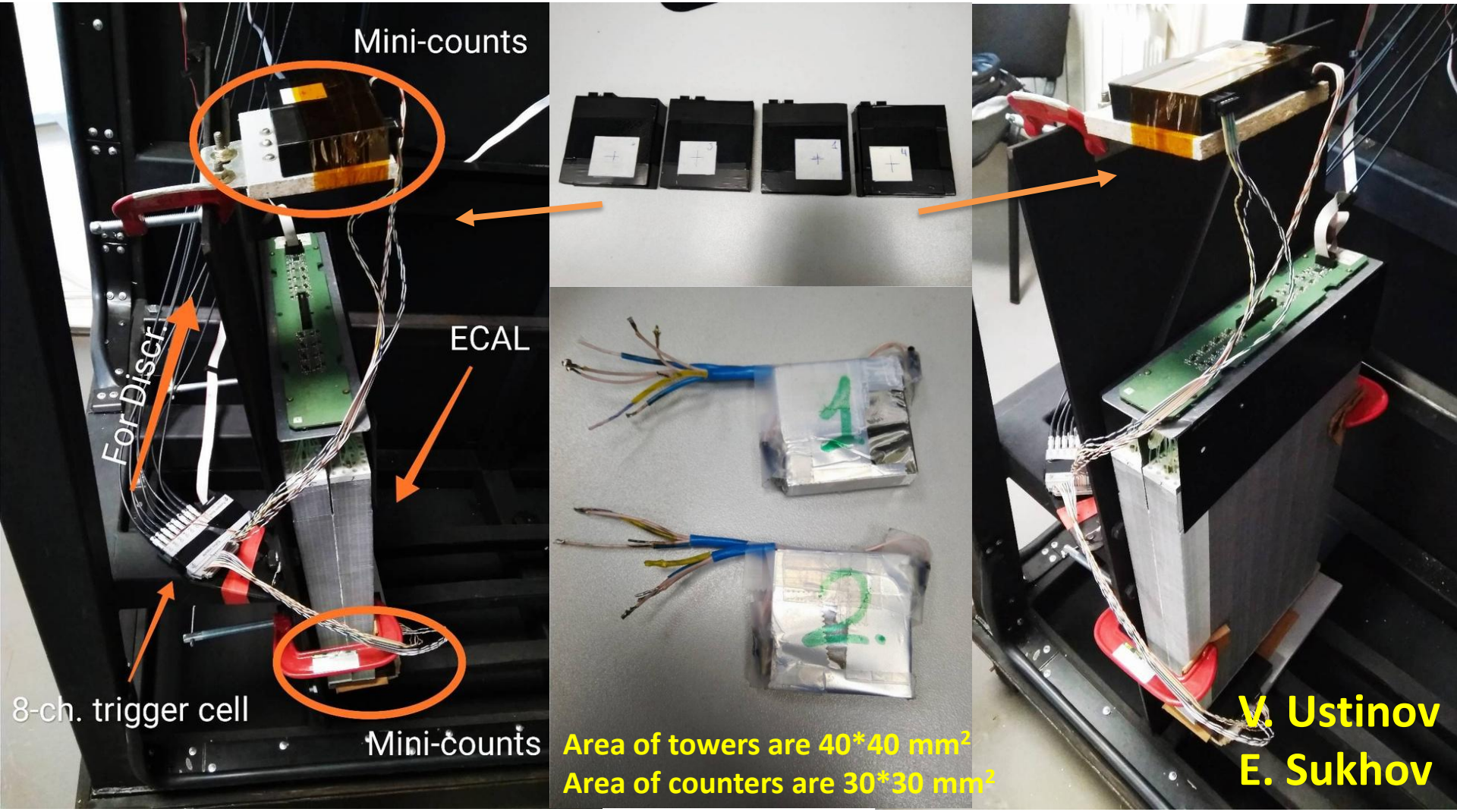


Cosmic rays is the only constant source of relativistic particles for the stand

* **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

Individually calibrate of each tower using mini-trigger counters



1 module = 16 towers

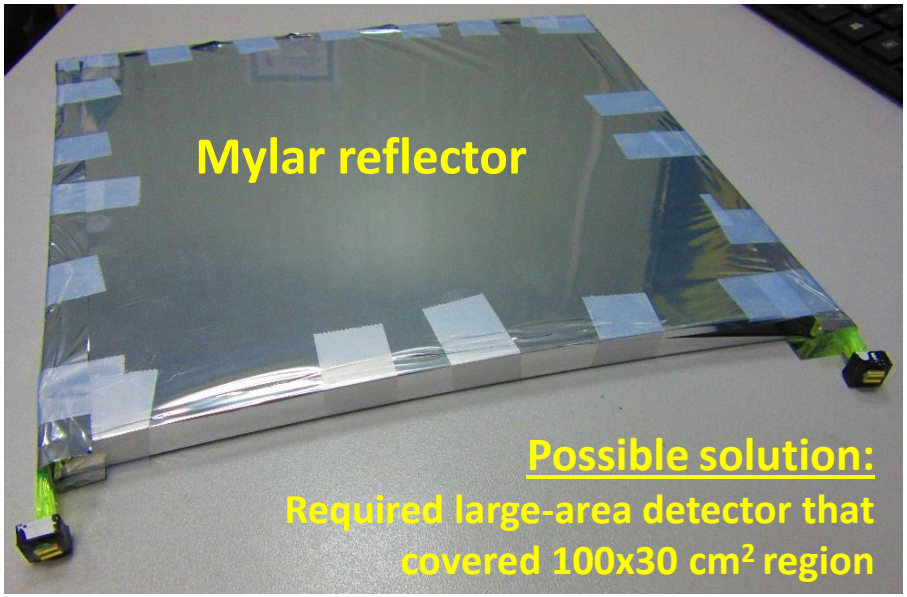
1 test bench = 12 modules = 192 towers

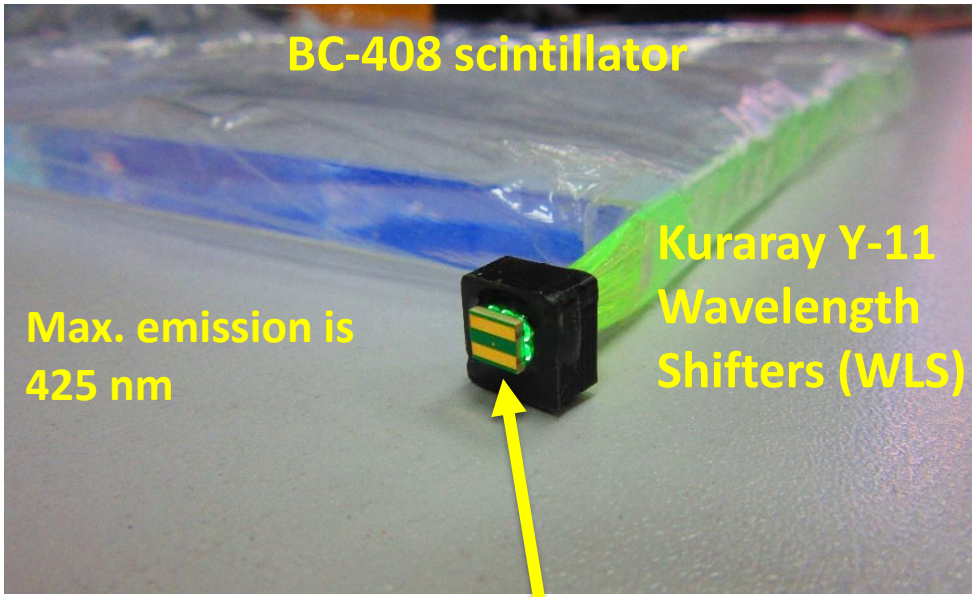
There are two counters for each tower = 384 piece

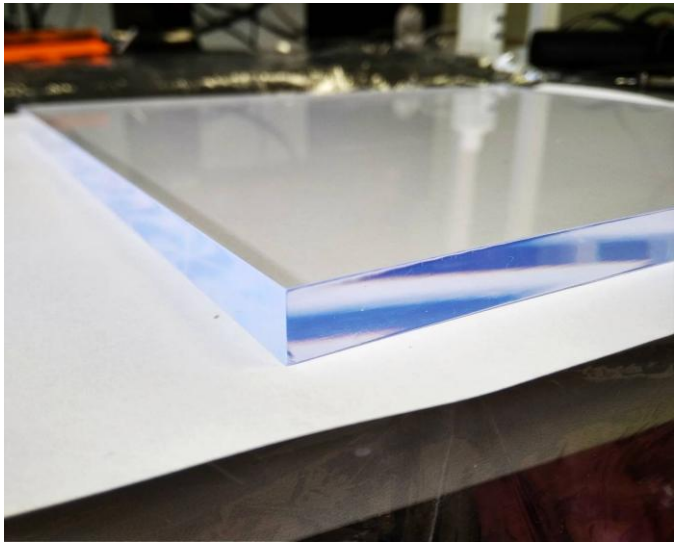
This is too much electronics ->

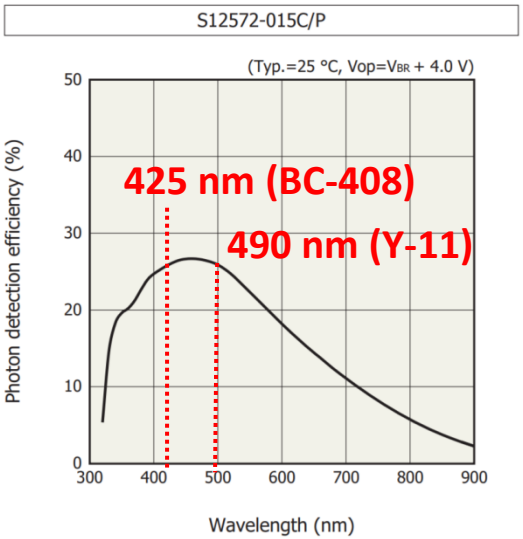
Unprofitable

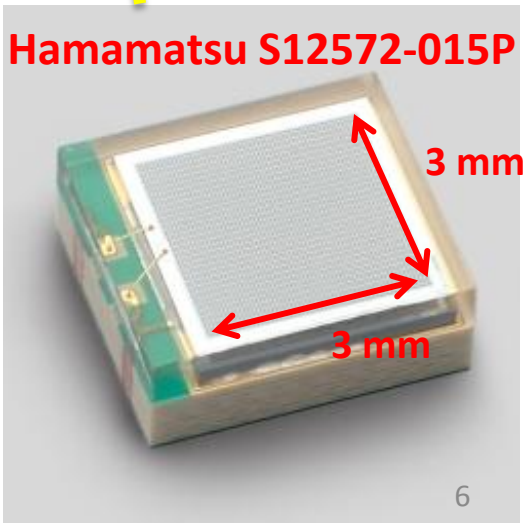
Test of the monitoring counter large square



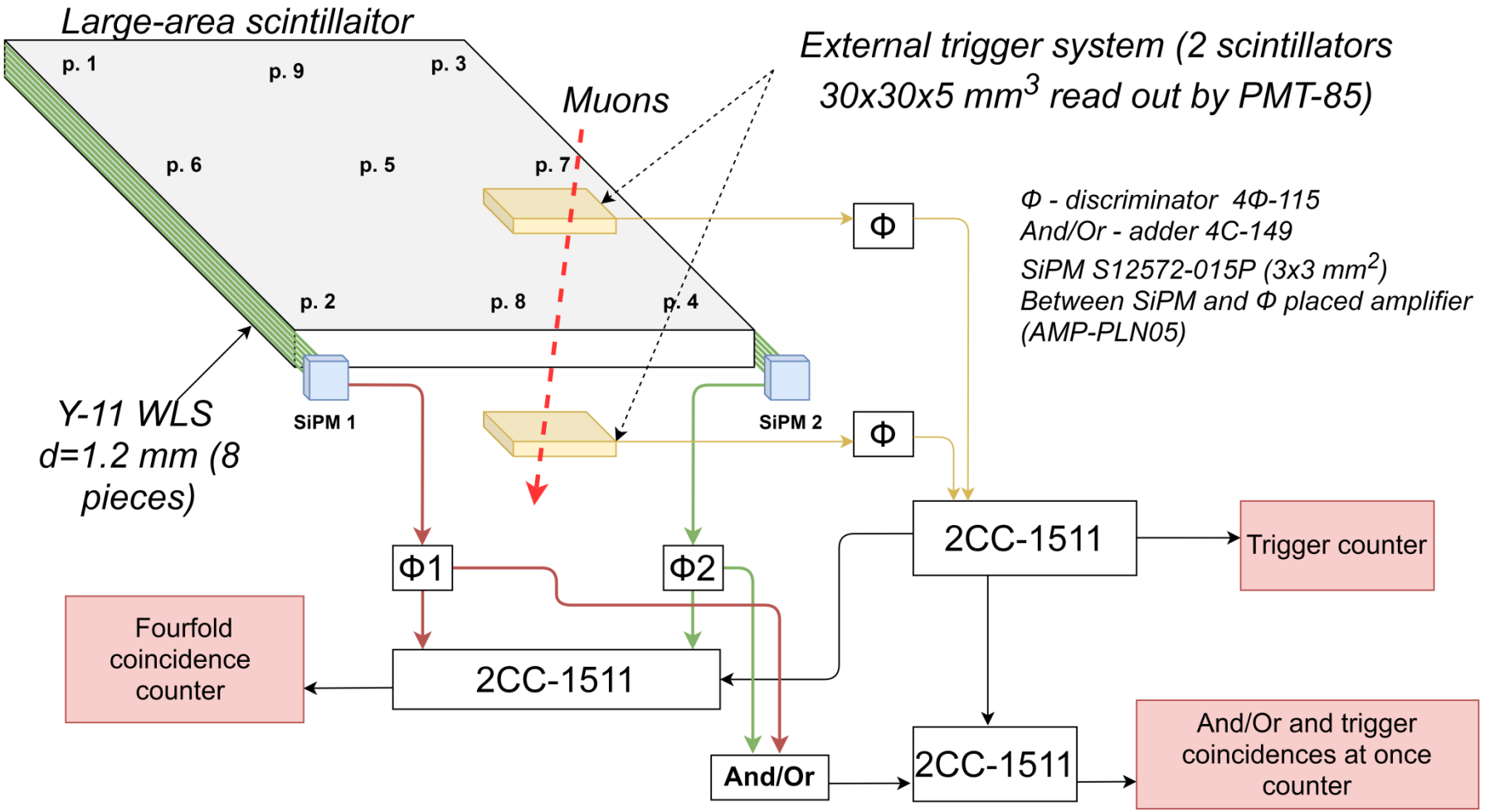






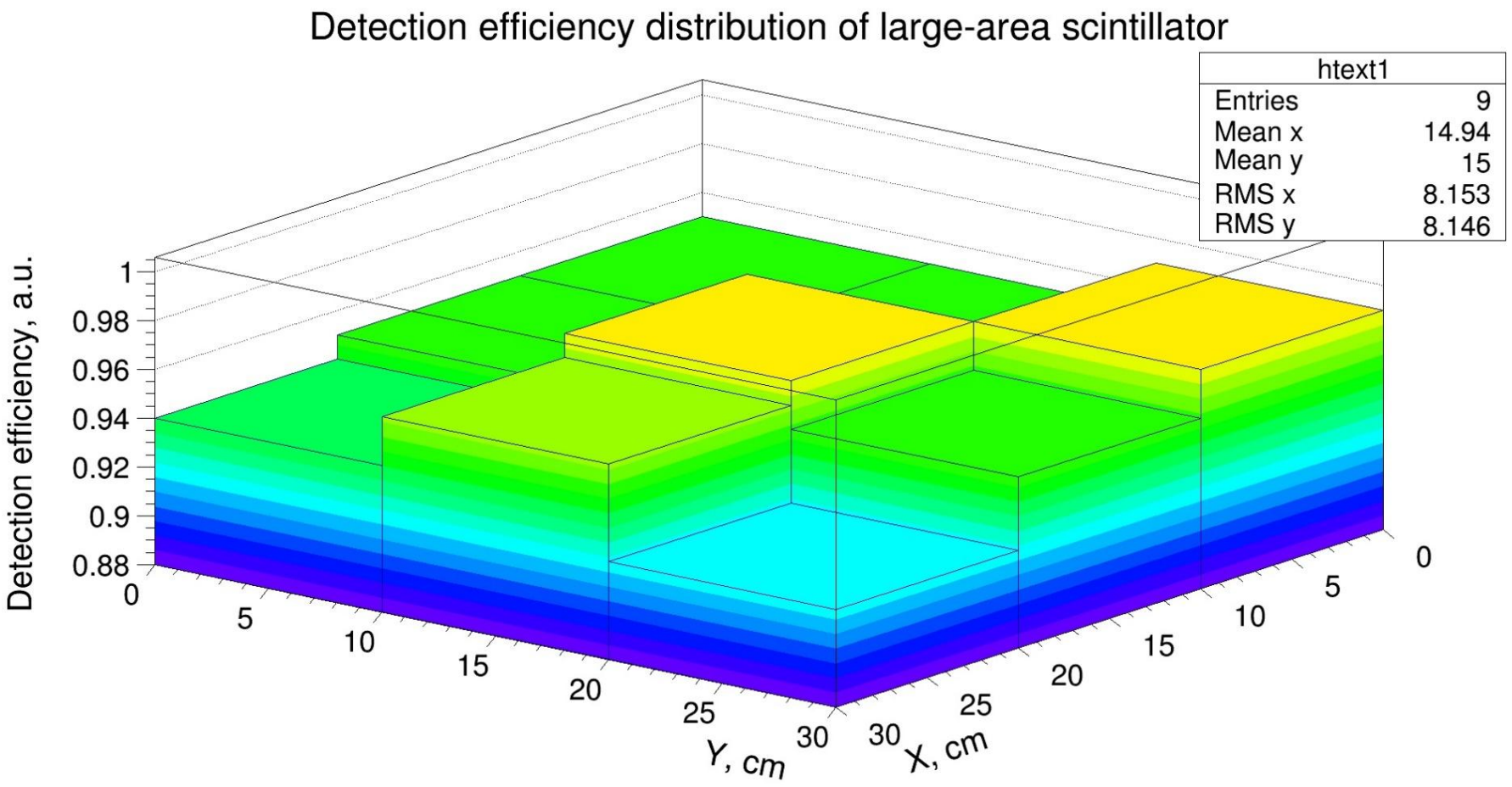


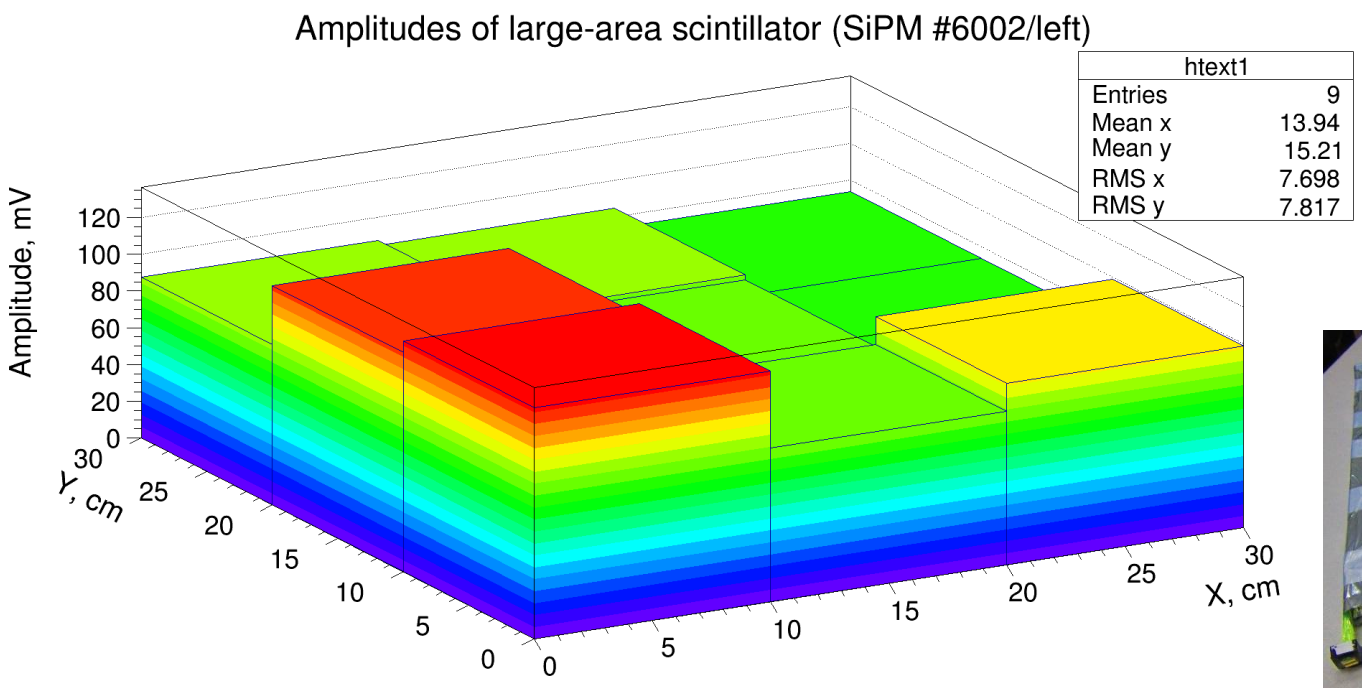
Block-scheme of measurements

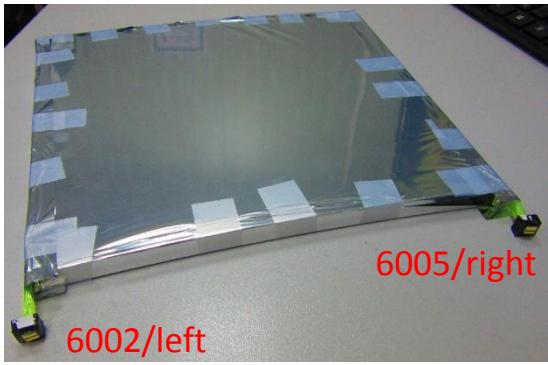


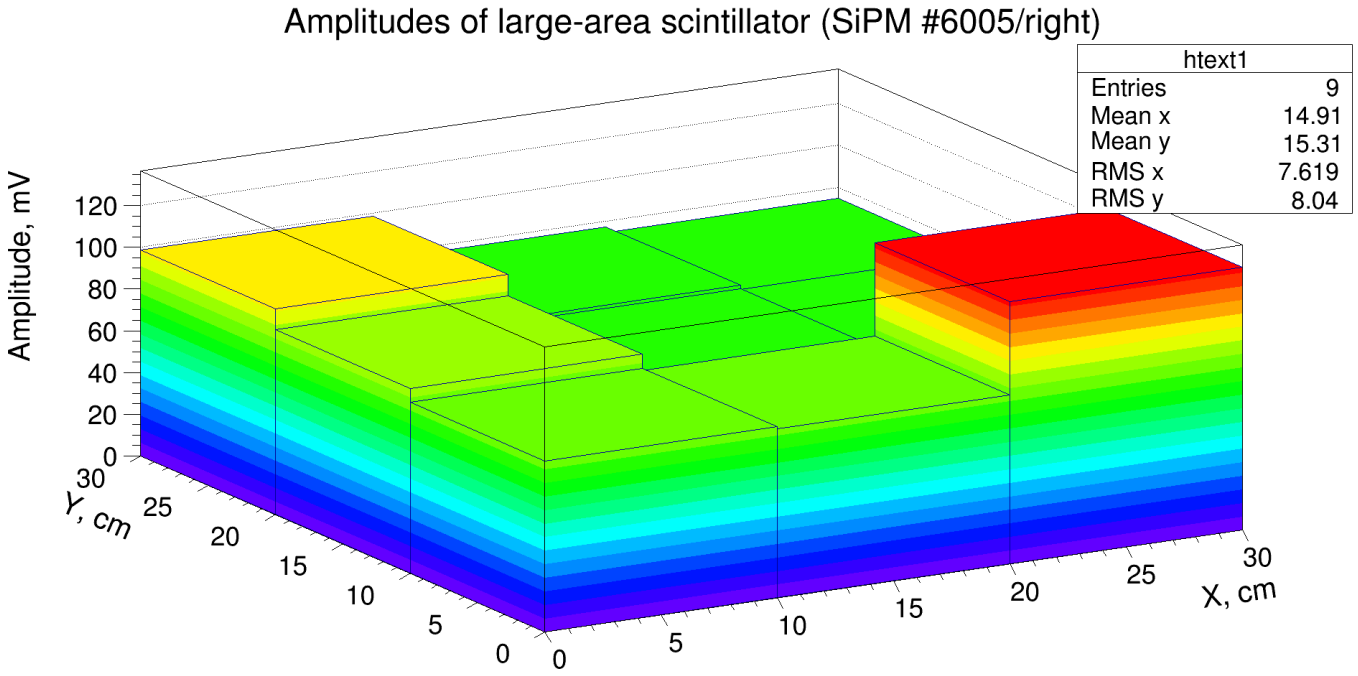
$$\varepsilon_{\text{рег}} = \frac{N_{\text{зарег}}}{N_{\text{прошедших}}}$$

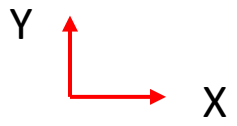
$N_{\text{прошедших}}$ – *total number of particles that passed through external trigger system*

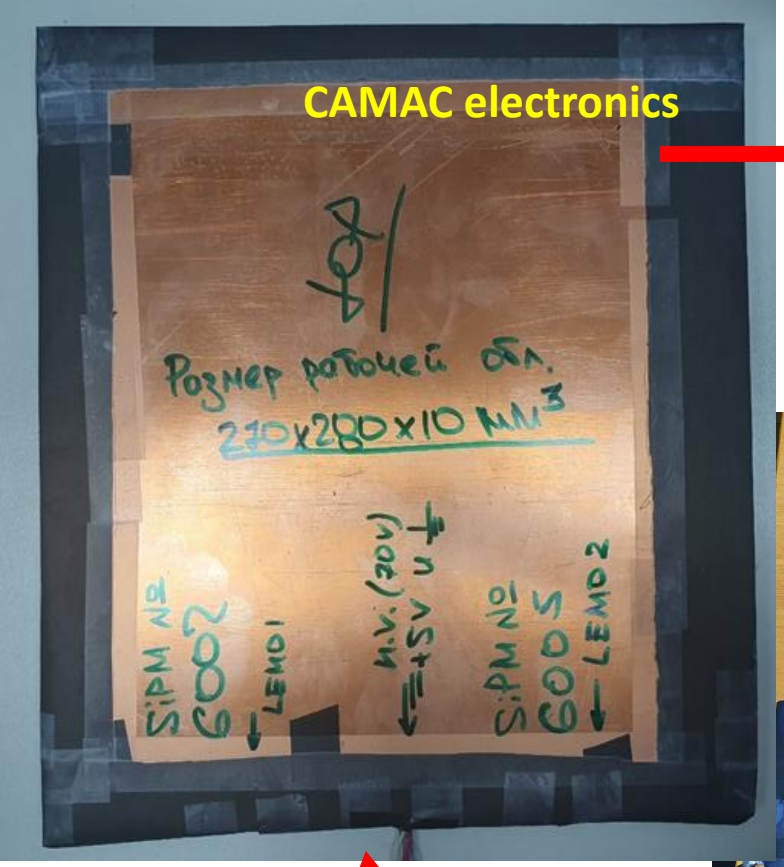

Detection efficiency distribution of large-area scintillator
htext1
Entries 9
Mean x 14.94
Mean y 15
RMS x 8.153
RMS y 8.146
Detection efficiency, a.u.
1
0.98
0.96
0.94
0.92
0.9
0.88
0
5
10
15
20
25
30
Y, cm
0
5
10
15
20
25
30
X, cm

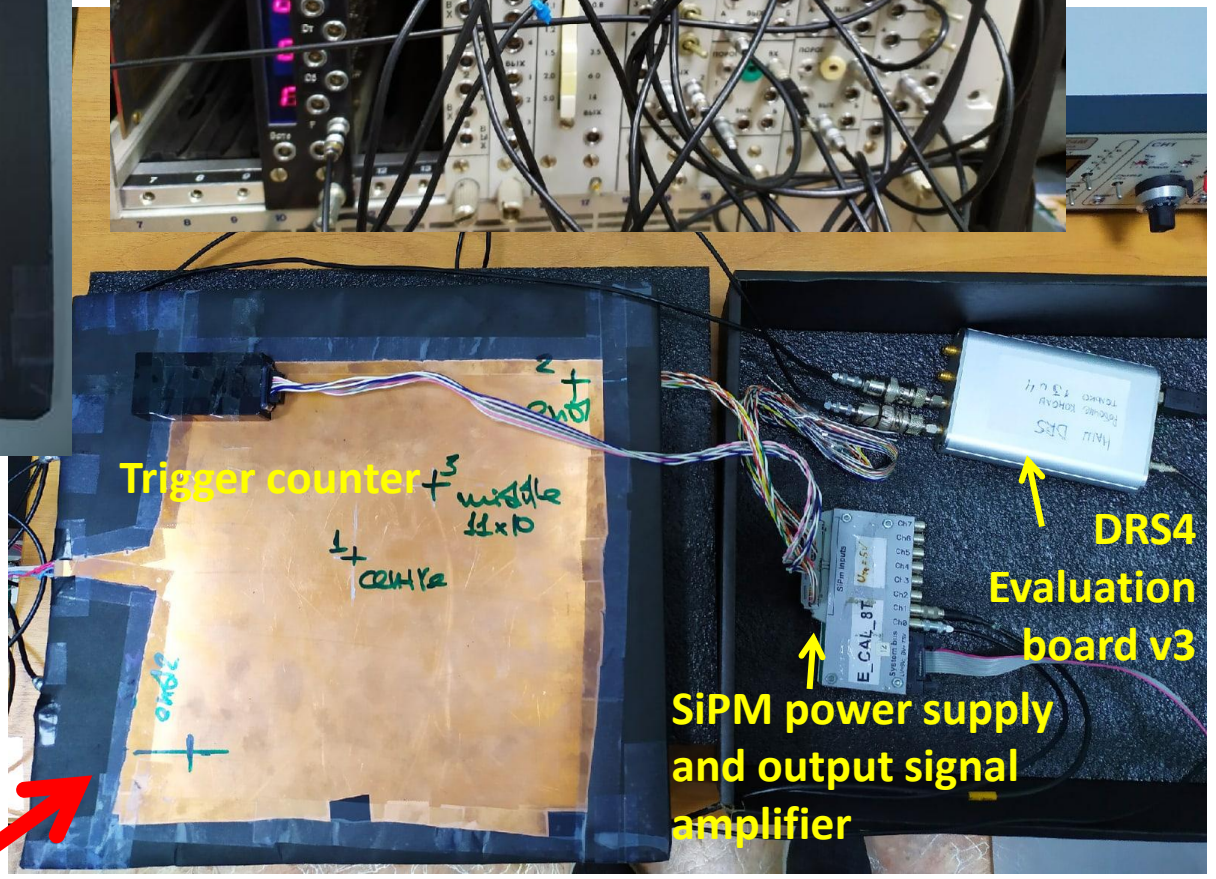

Amplitudes of large-area scintillator (SiPM #6002/left)
htext1
Entries 9
Mean x 13.94
Mean y 15.21
RMS x 7.698
RMS y 7.817
Amplitude, mV
Y, cm
X, cm


6005/right
6002/left


Amplitudes of large-area scintillator (SiPM #6005/right)
htext1
Entries 9
Mean x 14.91
Mean y 15.31
RMS x 7.619
RMS y 8.04
Amplitude, mV
Y, cm
X, cm


Y
X

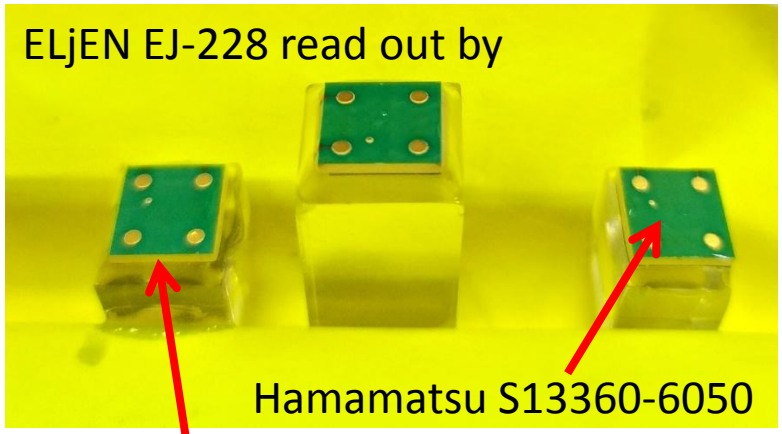


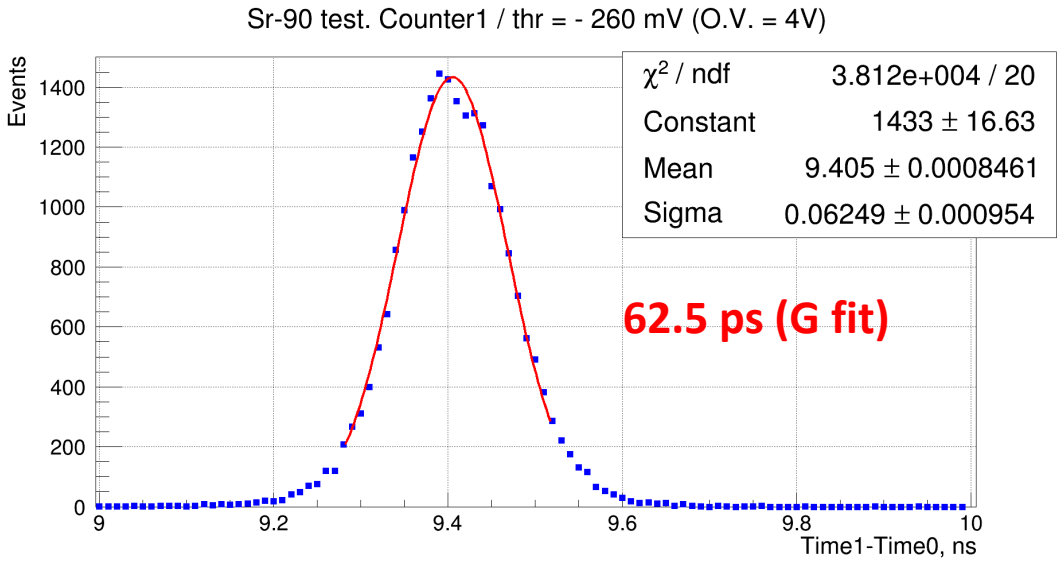


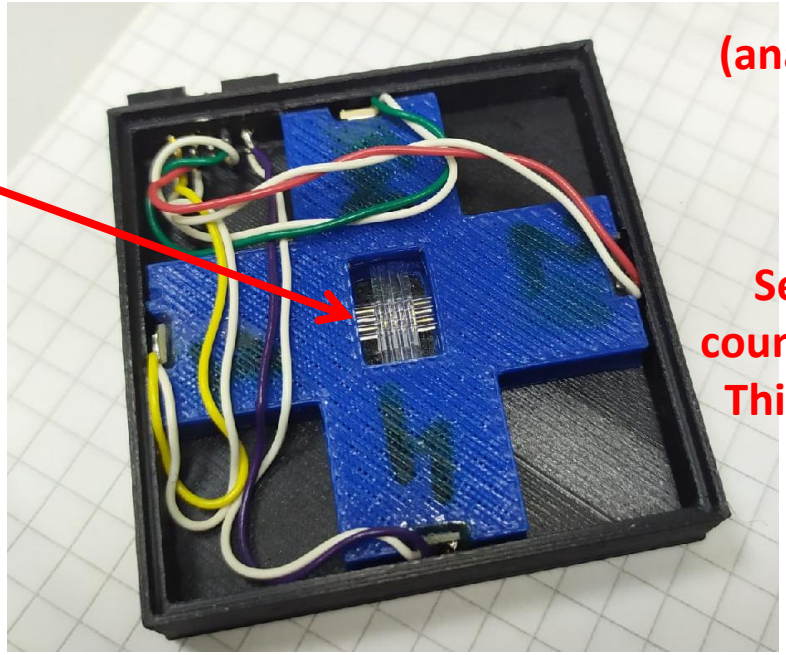
The main view of the counter

Measurements

Development of the fast beam counters

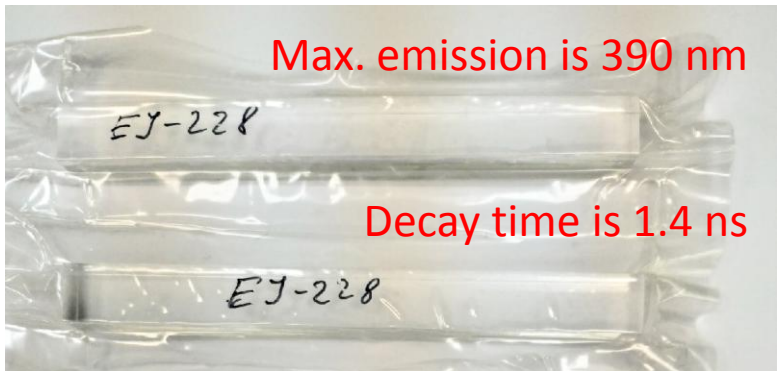






Bicron BCF-10 (analogue BC-408) read out by S12572-015P

Sensitive area of counter is 4x4 mm^2
Thickness is 2 mm



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. Developed 6 fast mini-counters based on Eljen UV scintillators for beam tests. The counters have a high temporal resolution from 60 up to 80 ps.
3. A special beam counter based on Bicron BCF-10 scintillating fibers with a working area of 4x4 mm^2 (thickness is 2 mm) has been developed.
4. The efficiency of minimally ionizing particles registration of all counters is close to 100%.

Thank you for attention!

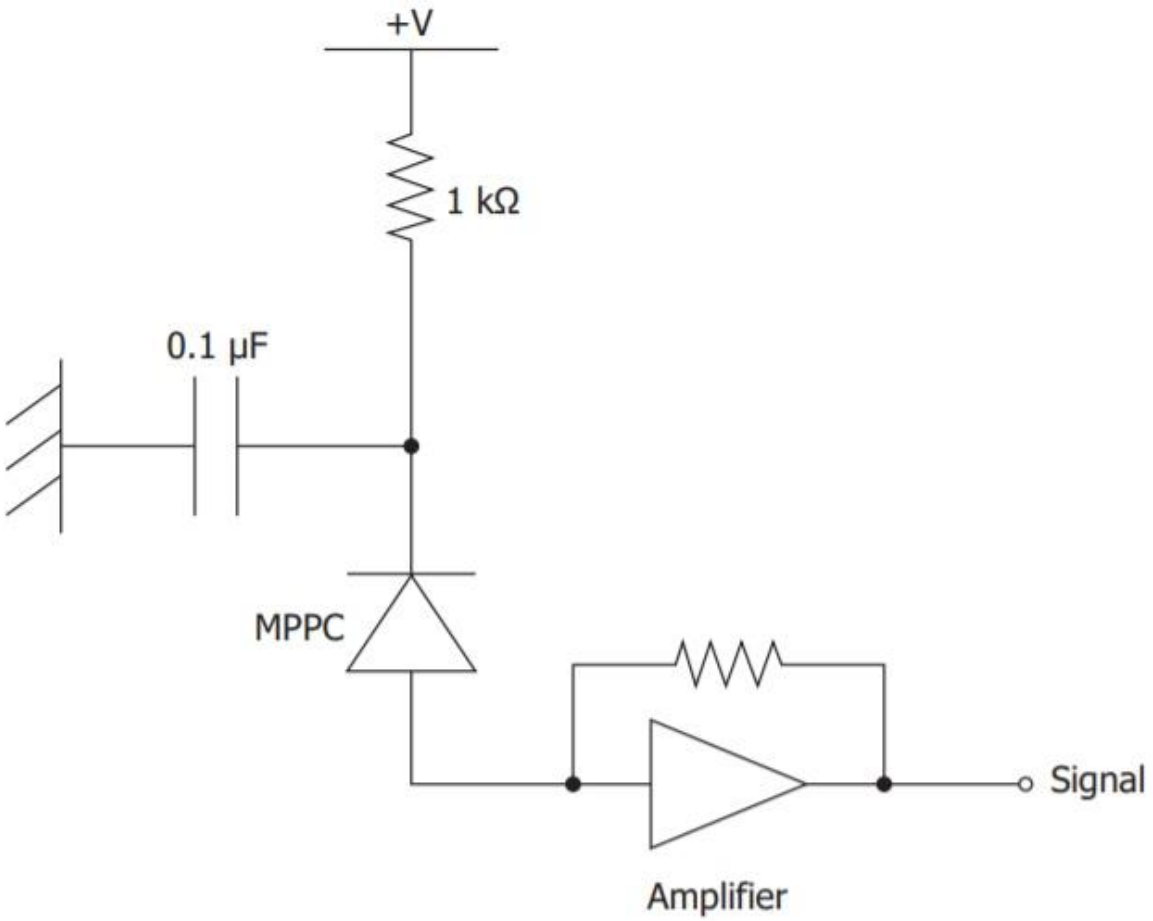
References:

- V. Ustinov and S. Afanasiev

«A system of ECAL/BM@N monitoring with wavelength shifting fibers readout for operation in a magnetic field»

Memories of the Faculty of Physics, Lomonosov Moscow State University, issue № 3, 1830204 (2018)

Connection example



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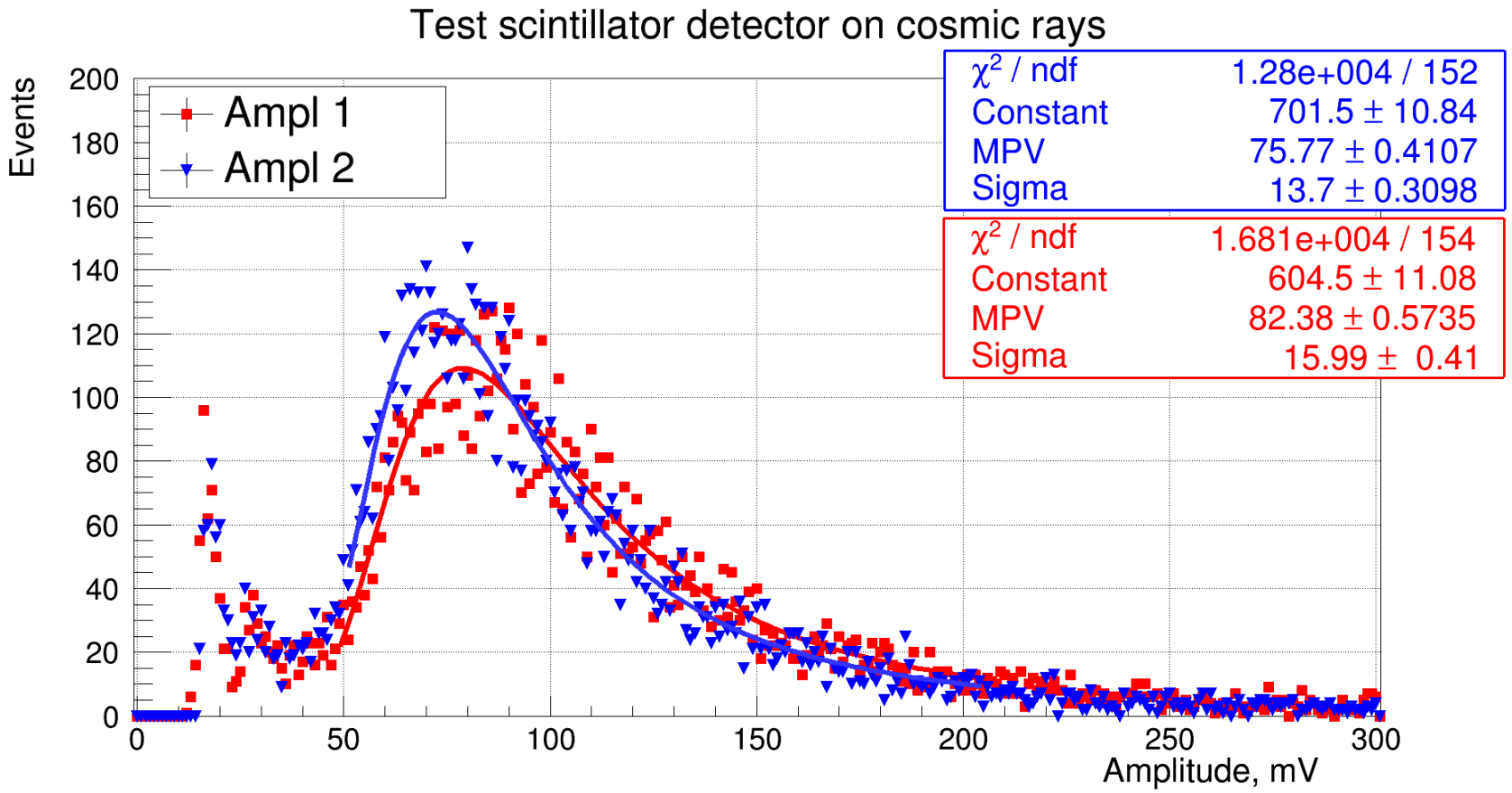
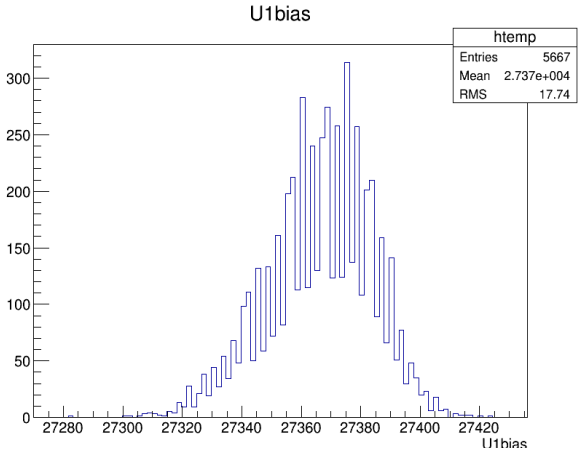
HAMAMATSU

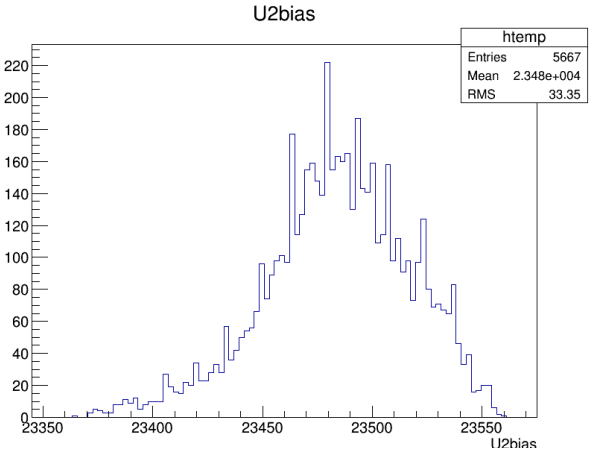
PHOTON IS OUR BUSINESS

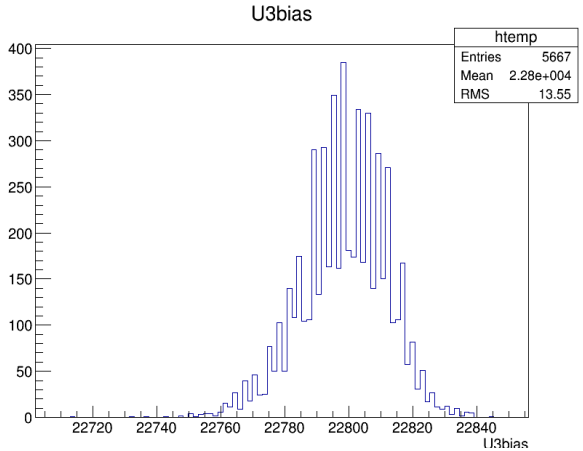
Example of detected amplitudes (centre of counter)

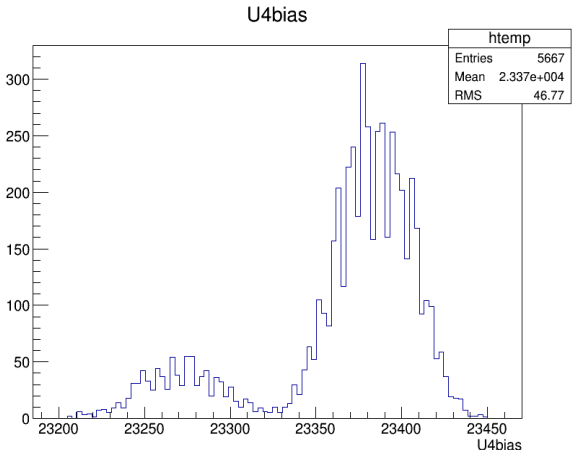


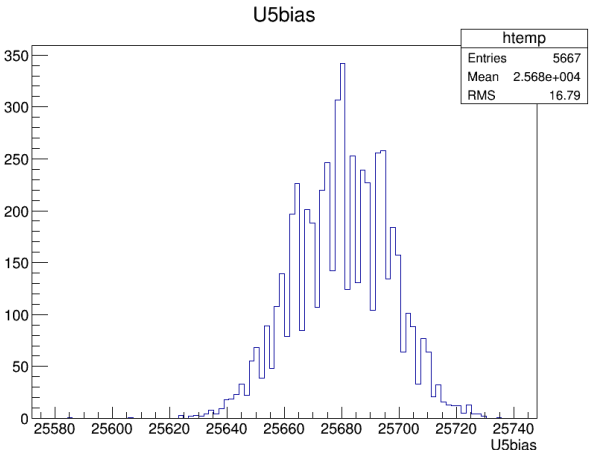
Amplitudes of signals when muon passing

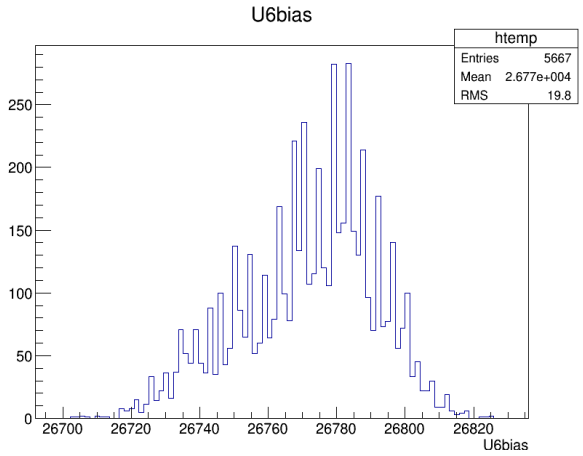


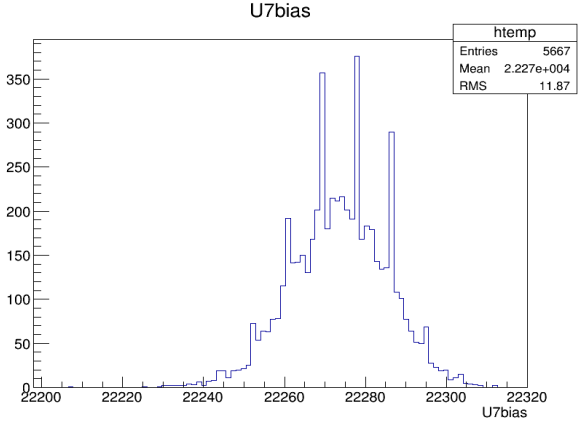


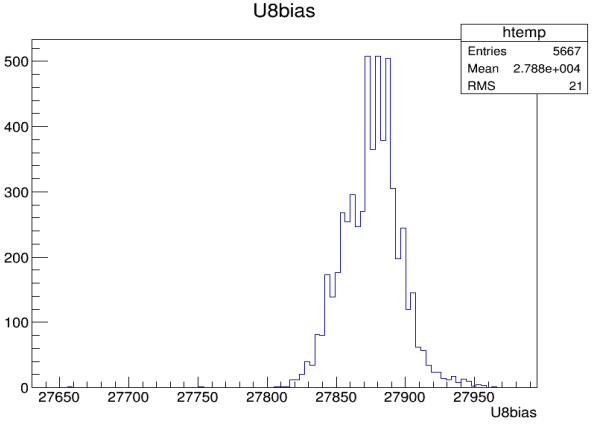


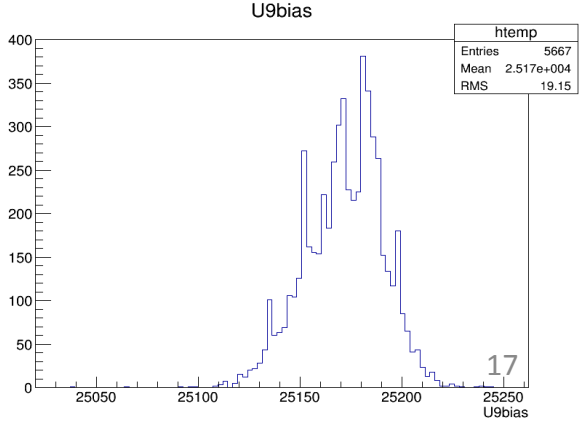




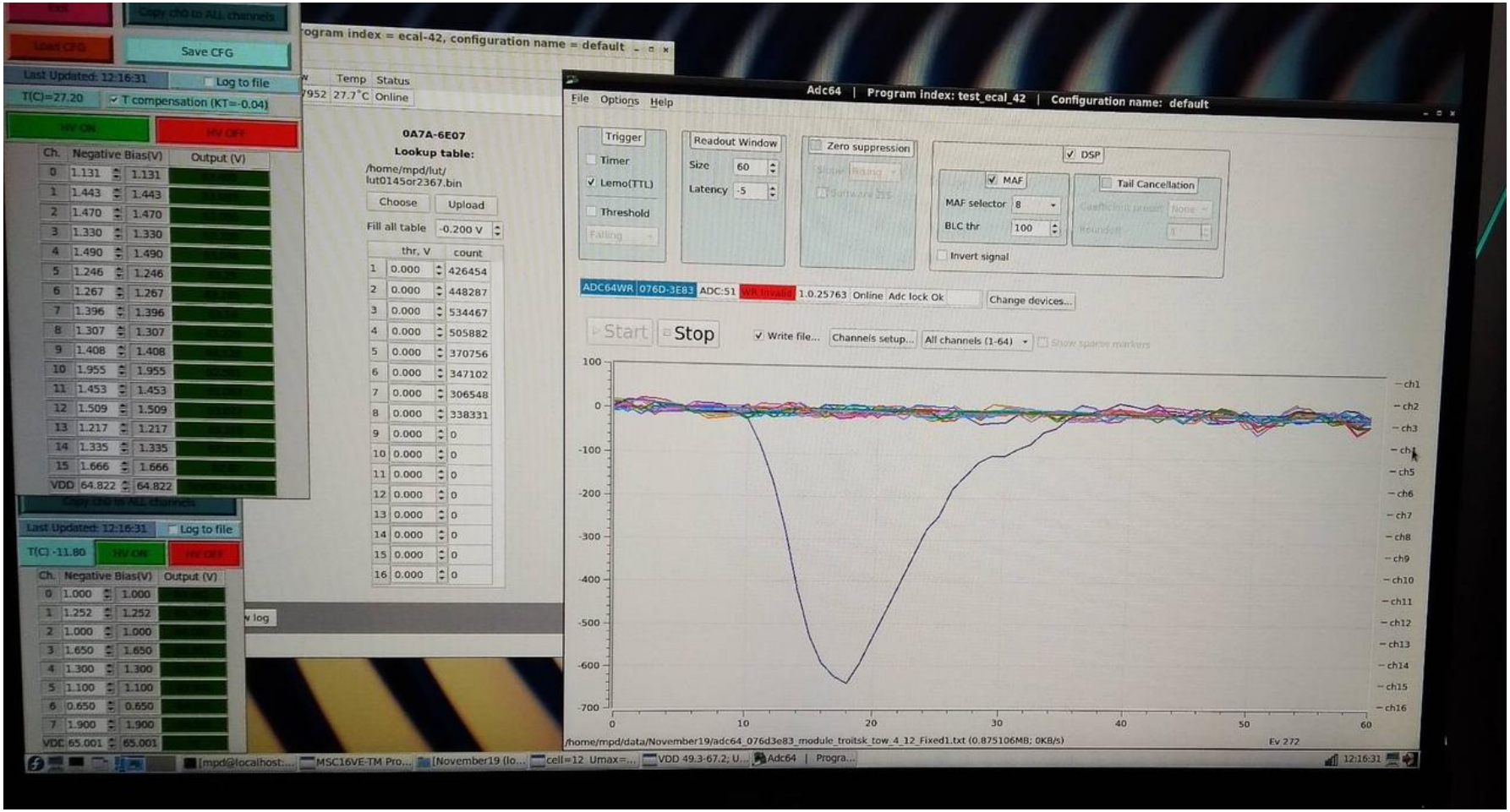








Signals from calorimeters selected by the trigger system



Calculation results

Studies have shown that the efficiency of light registration is equally high over the entire area of the counter and does not depend on the passage of minimally ionizing particles.

№ точки измерения	Кол-во триггеров	Кол-во совпадений	Кол-во И/ИЛИ	Эффективность 4х-кратных совпадений	Эффективность И/ИЛИ
1	387	368	-	0.95	-
2	2074	1953	2028	0.94	0.98
3	6862	6669	-	0.97	-
4	200	184	188	0.92	0.94
5	2057	2000	-	0.97	-
6	276	261	269	0.95	0.97
7	267	256	260	0.96	0.97