Muon detectors for the gamma-observatory TAIGA

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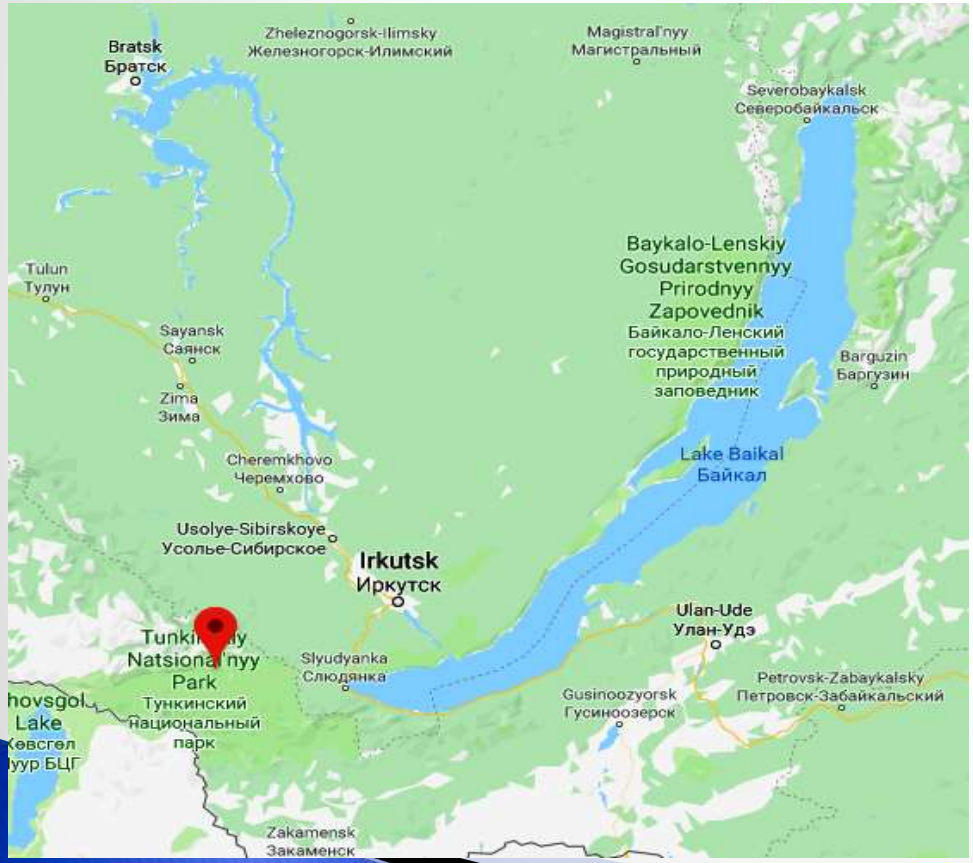
Outline

1. TAIGA project
2. TAIGA–Muon setup
3. Muon scintillation detector
4. My work
5. Conclusion and outlook

TAIGA

Tunka Advanced Instrument for cosmic rays and Gamma Astronomy observatory

Tunka valley, the Republic of Buryatiya



Research area:

- Primary cosmic rays with energies in PeV–EeV region
- Primary gamma rays with energies of TeV–PeV, their sources

TAIGA

Tunka-133

Setups for registration of

- Secondary cosmic particles
- Cherenkov light
- Radio emission

from air showers

Tunka-Grande scintillators

Tunka-Rex antennas

TAIGA

TAIGA-IACT
(Imaging Atmospheric Cherencov Telescope)

TAIGA-HiSCORE
(High-Sensitivity Cosmic ORigin Explorer)

+ TAIGA-Muon

TAIGA-Muon

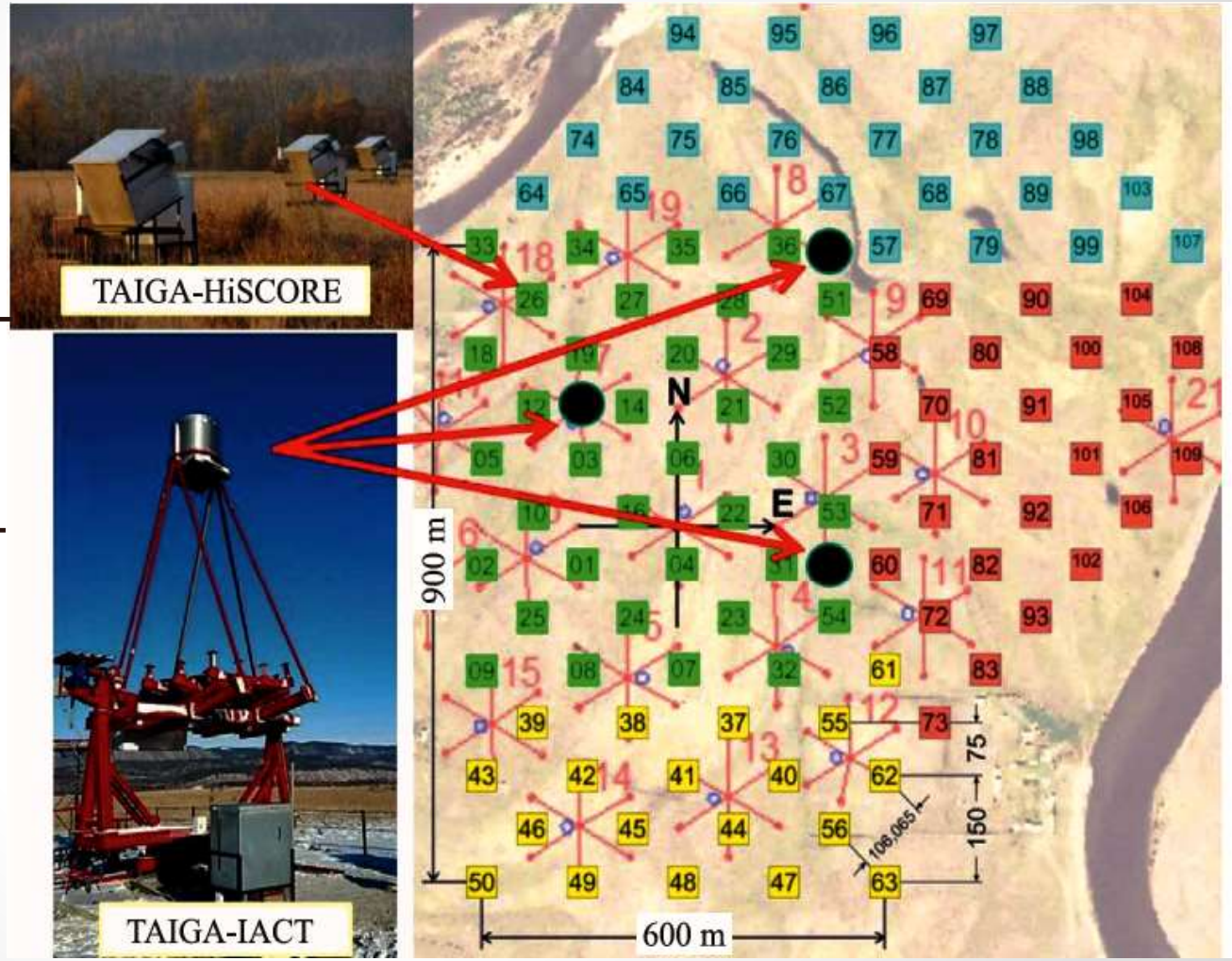
PLAN

Setup area – 1 km²

Total scintillator area– 2000 m²

Improving of gamma–hadron separation

Continuous collection of statistics



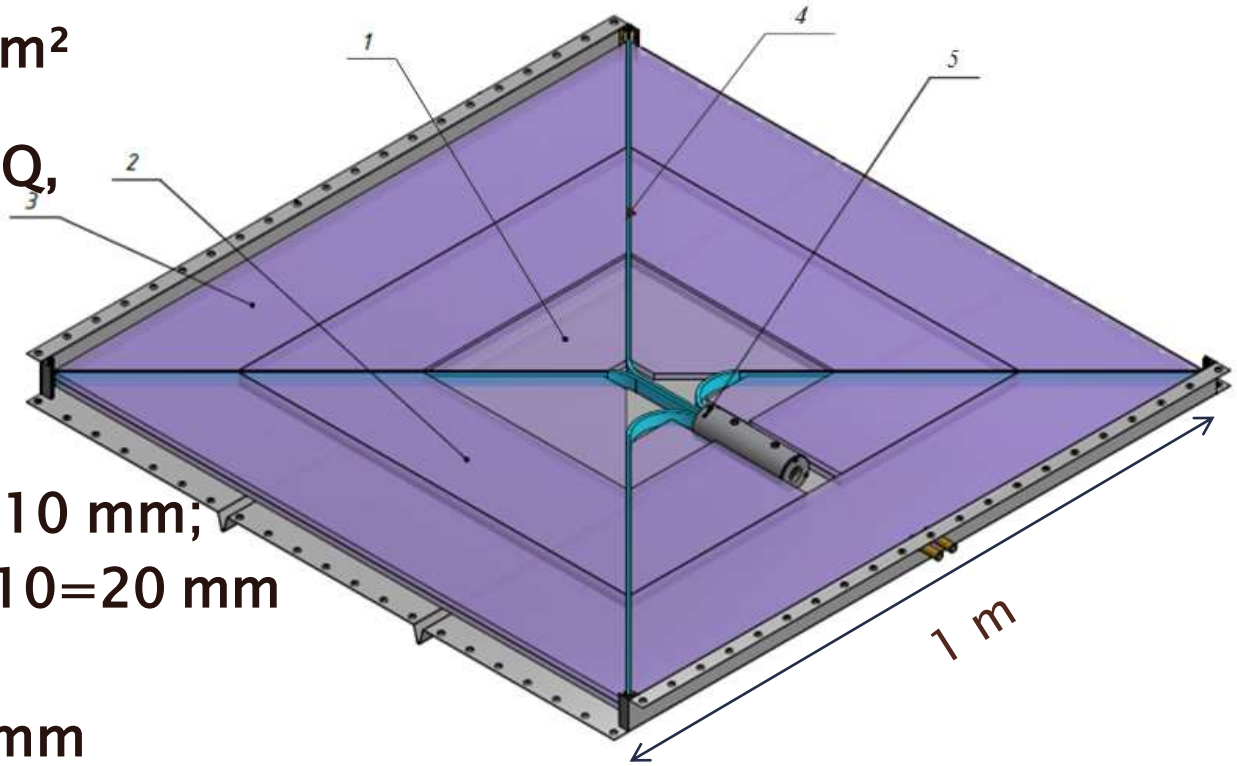
Muon scintillation detector

Cross section
of the shifters – 5x20 mm²

Reemitting addition – BBQ,
n = 0.1 g/kg

Thickness of
scintillation plates 1,2 – 10 mm;
scintillation plates 3–2x10=20 mm

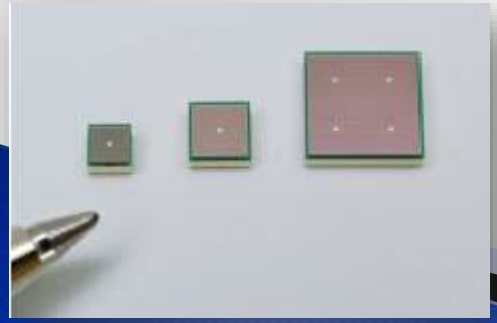
PMT entry window – 25 mm



1, 2, 3 – scintillator based on polystyrene,
4 – reradiating light guide plates (shifters),
5 – PMT

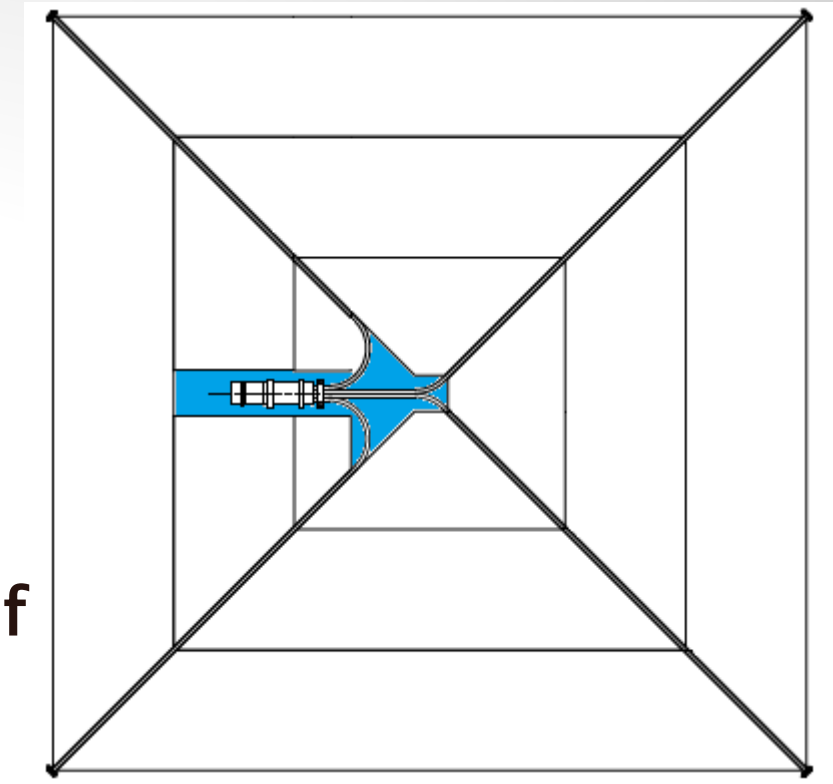
PMT vs SiPM

	PMT	SiPM
Size	10 cm	6 mm
Sensitivity to magnetic fields	yes	no
Operating Voltage	~ 1 kV	~ 50 V
Quantum efficiency	~ 20% (420 nm)	~ 40 %



- SiPM has a long service life, high operation speed and a wide spectral range

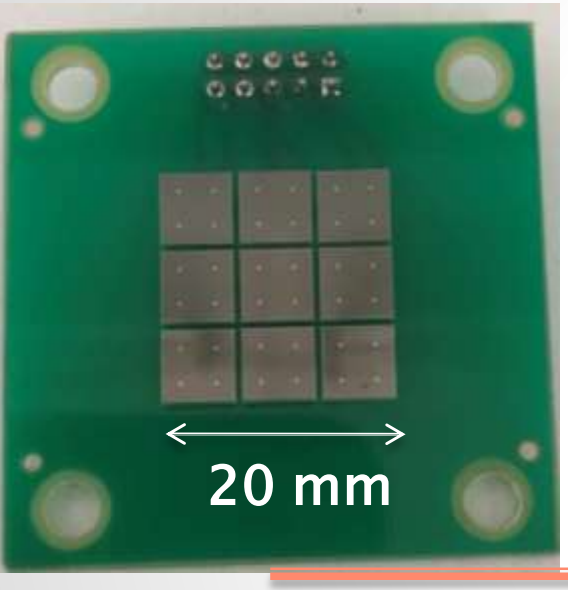
SiPM instead PMT

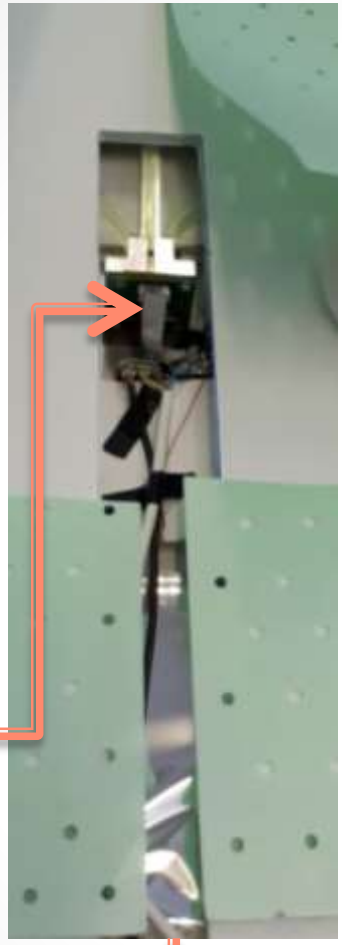


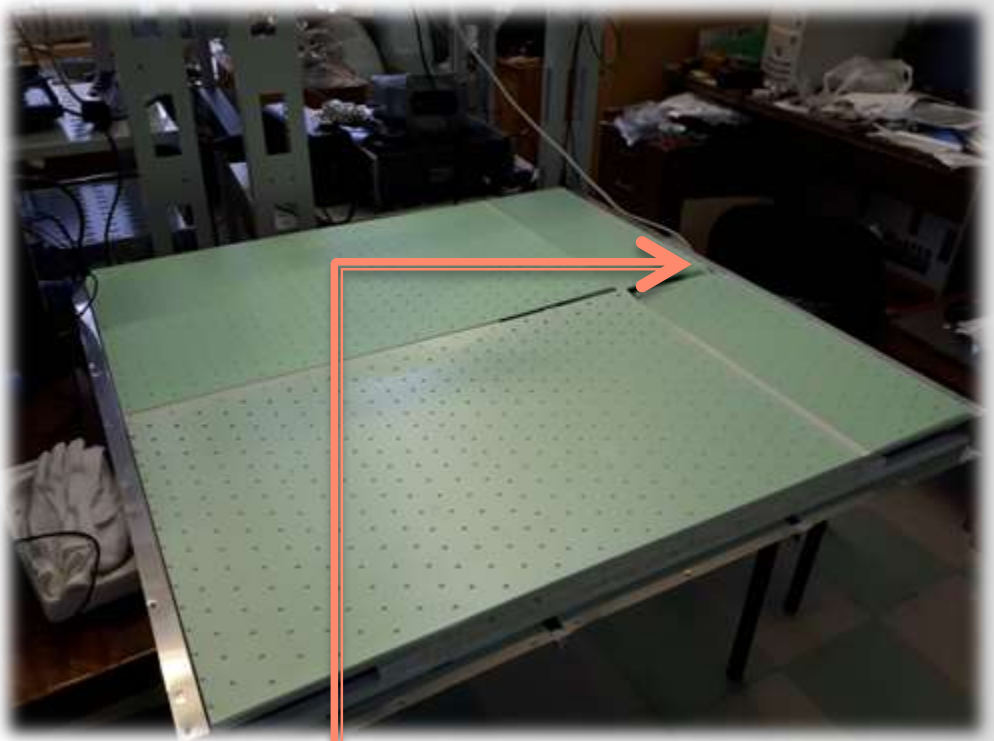
- Higher photon registration efficiency
- Increase the sensitive area
- Decrease the transverse size of the detector
- Simplification of its design

Evaluation of the possibility of replacement the vacuum PMT with the SiPM

My work

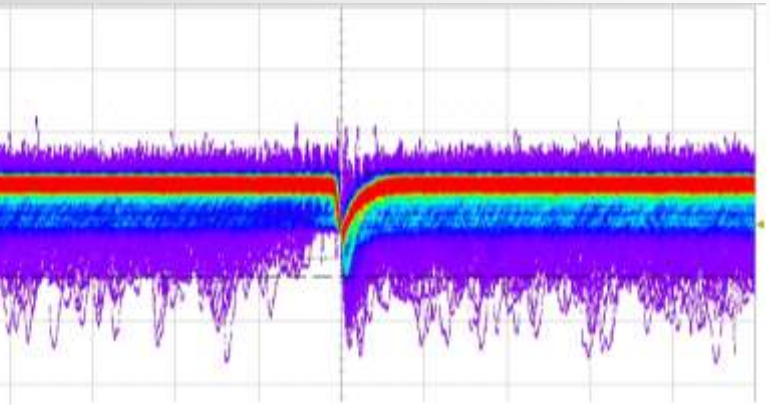




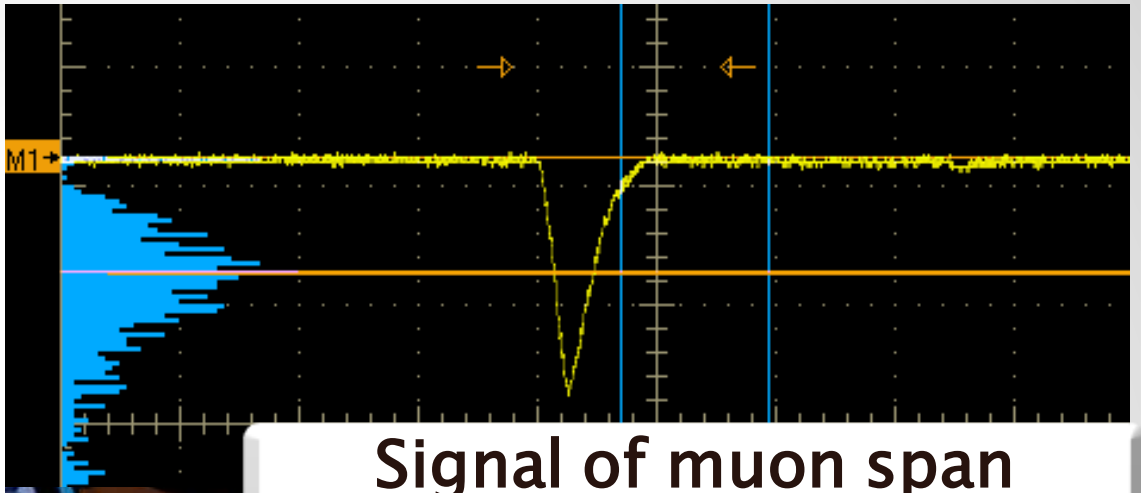


Hamamatsu
s13360-6050 ve

My work



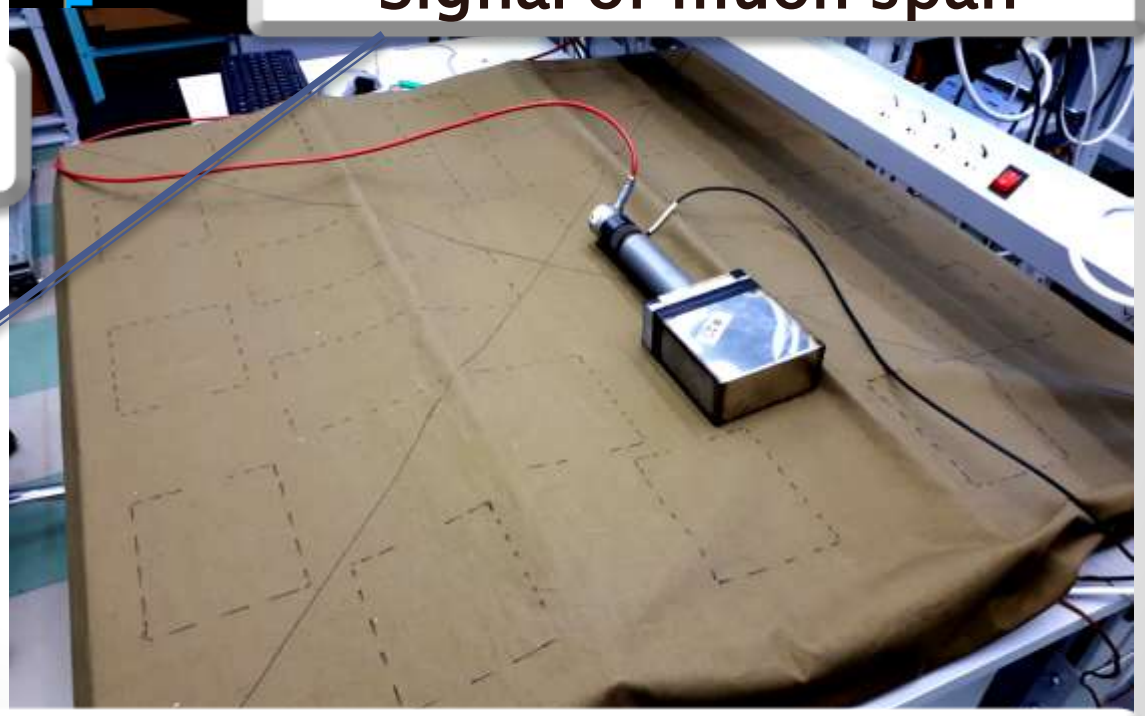
Oscillogram of noise signals of SiPM



Signal of muon span

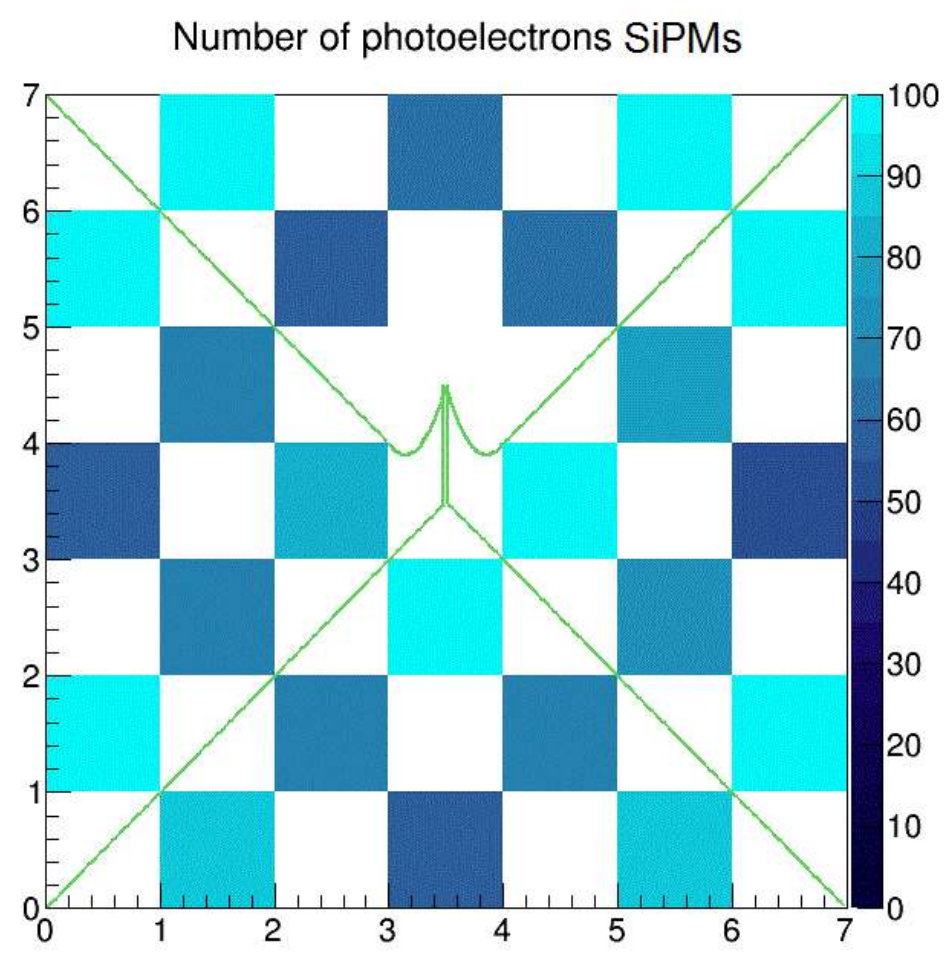
Calibration

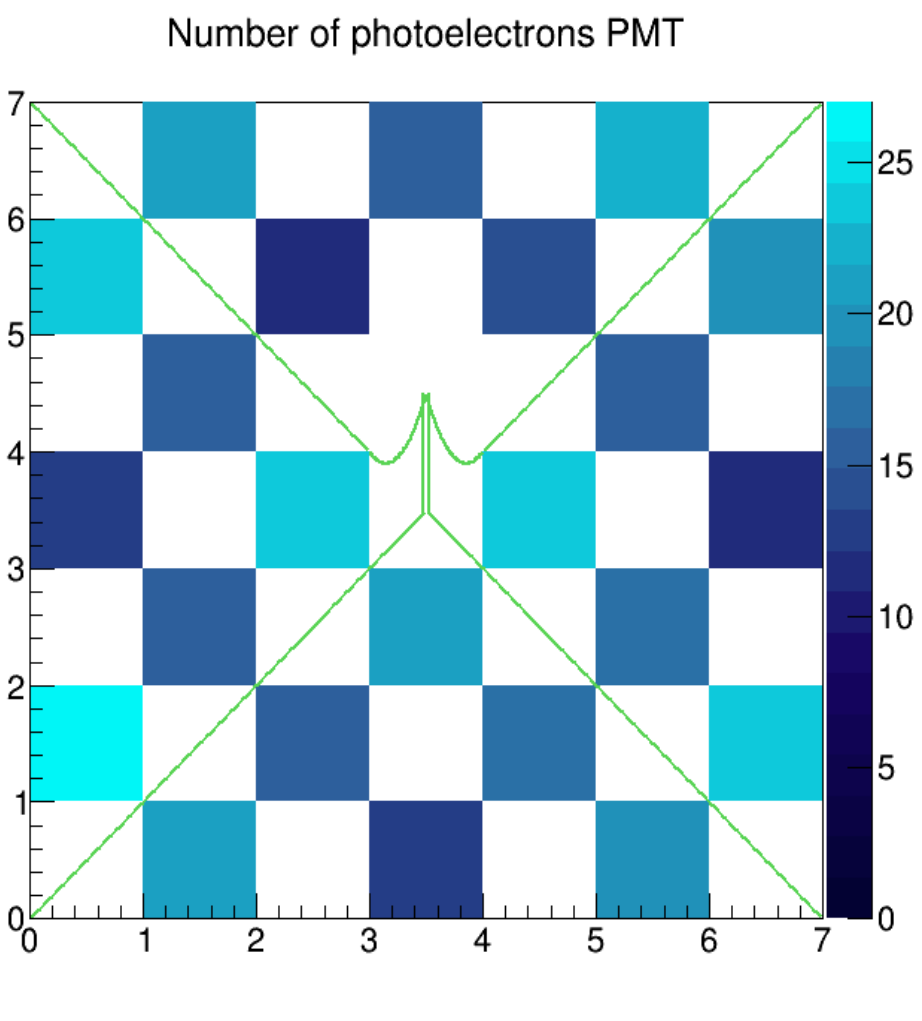
Number of photoelectrons measurements



Coincidence Muon detector 1x1 m^2 and scintillation counter 10x10 cm^2

My work


Number of photoelectrons SiPMs
0
1
2
3
4
5
6
7
100
90
80
70
60
50
40
30
20
10
0


Number of photoelectrons PMT
0
1
2
3
4
5
6
7
25
20
15
10
5
0

Conclusion

- Possibility of muon signal registration via matrix of SiPMs have been demonstrated
- More photoelectrons

Outlook

- **Simplification of the design**
- **Mass production of improved detectors for the TAIGA**


Thank you!