Beam test results of STS prototype modules

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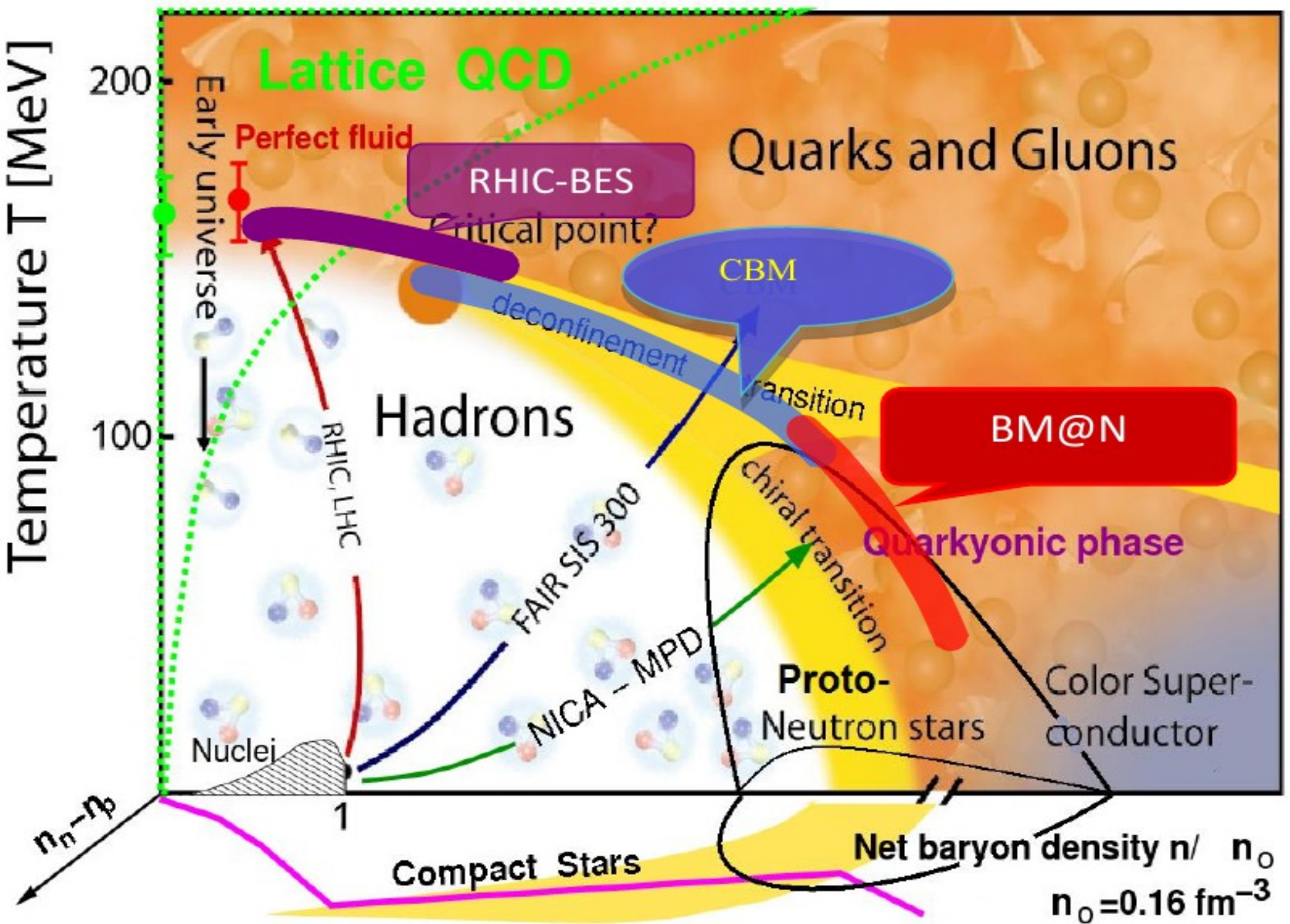
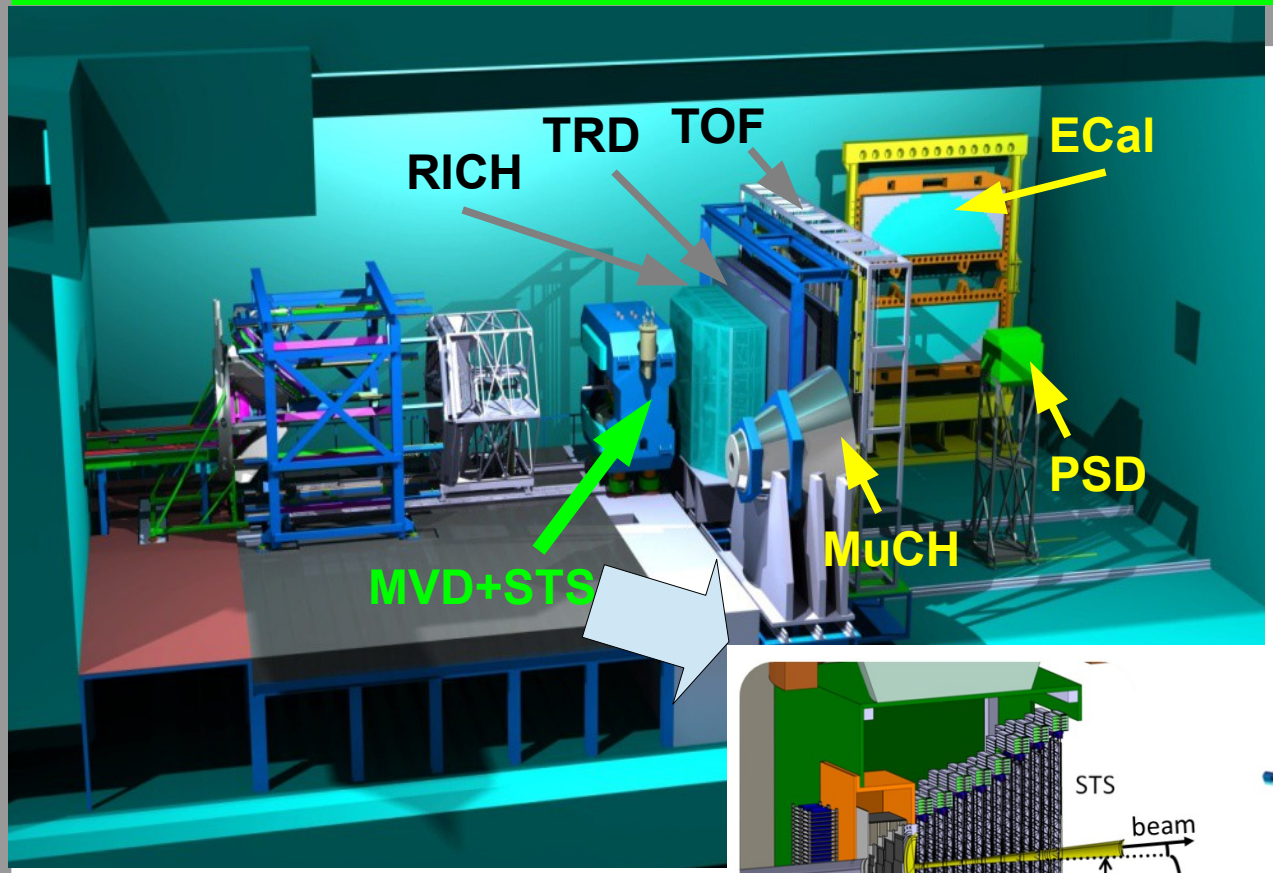
QCD phase diagram



CBM@FAIR detector

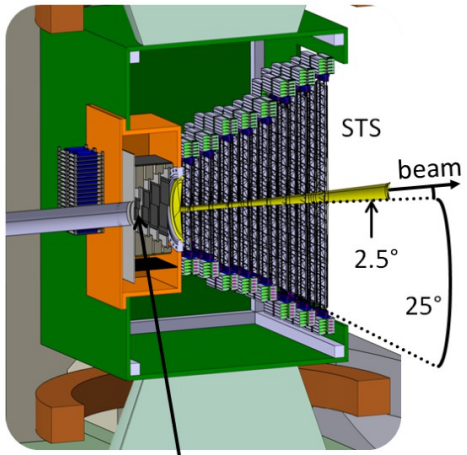


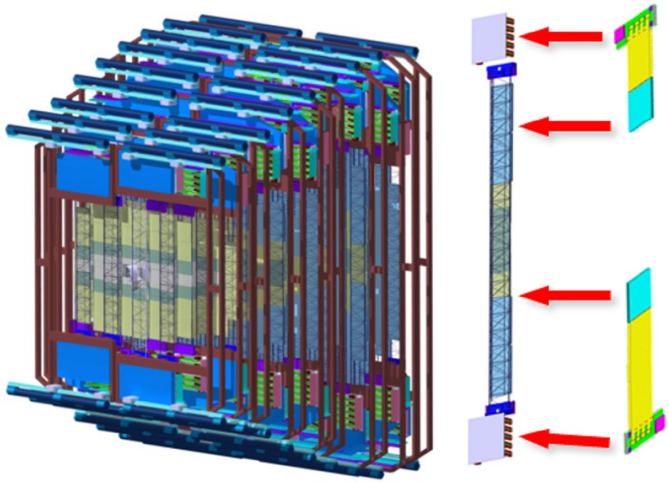
STS:

2 053k channels

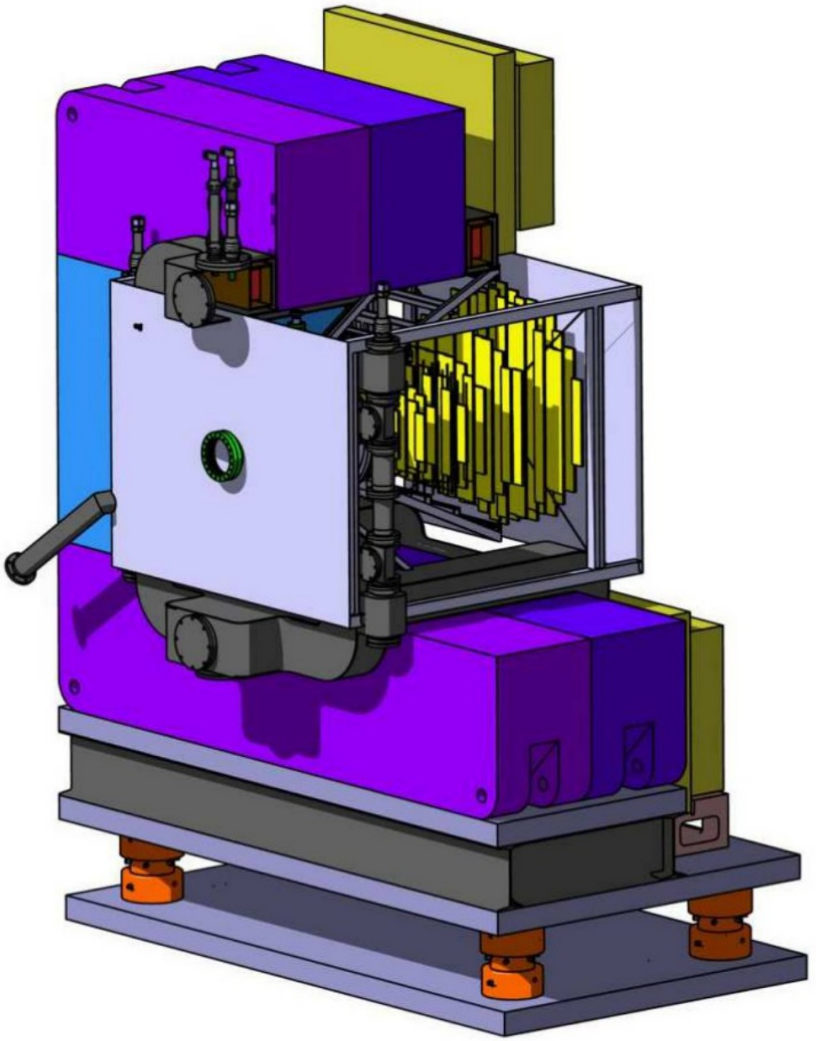
16 000 Readout chips

1292 sensors

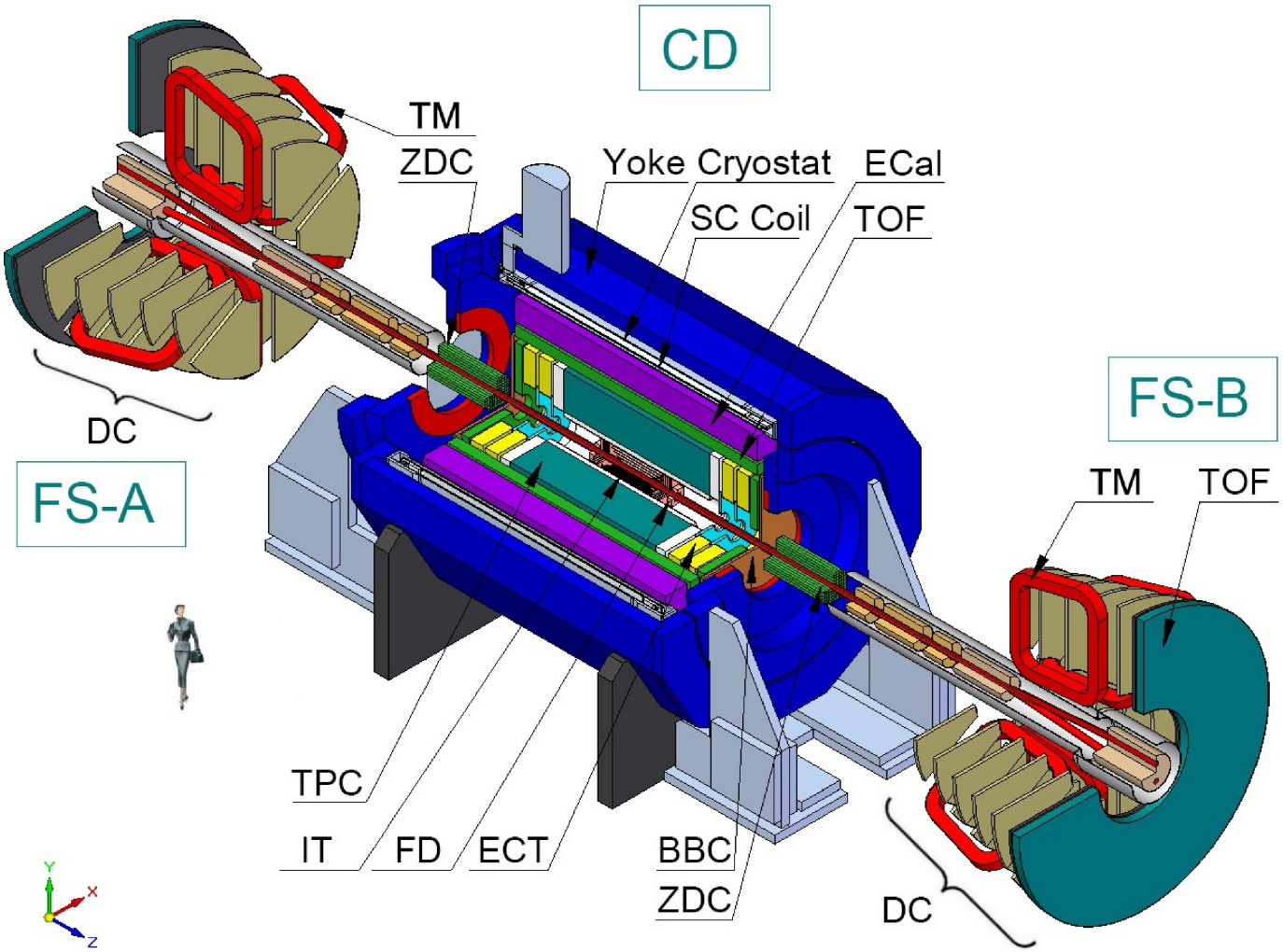




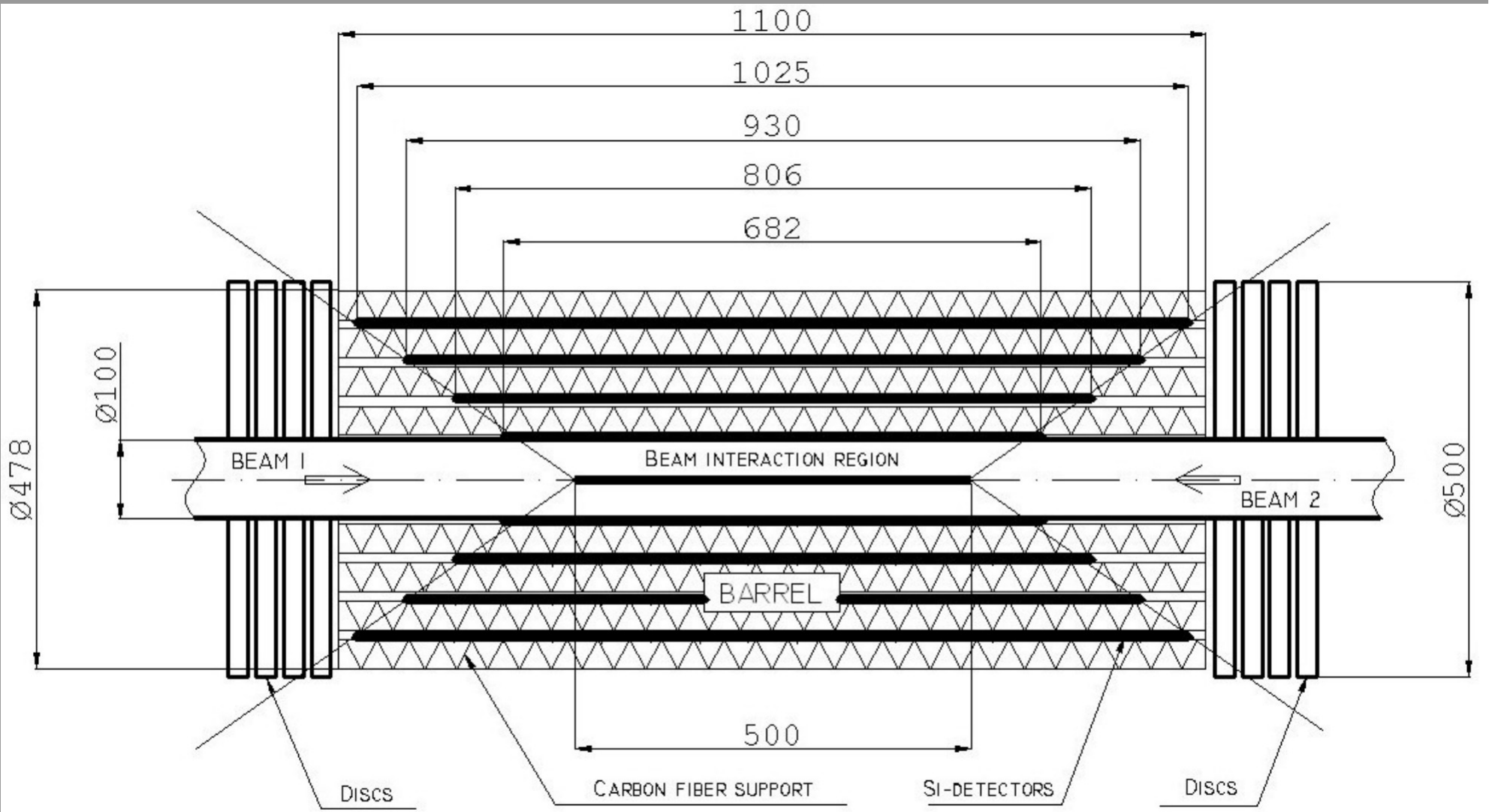
BM@N Tracking system



MPD@NICA Detector



Inner Tracker

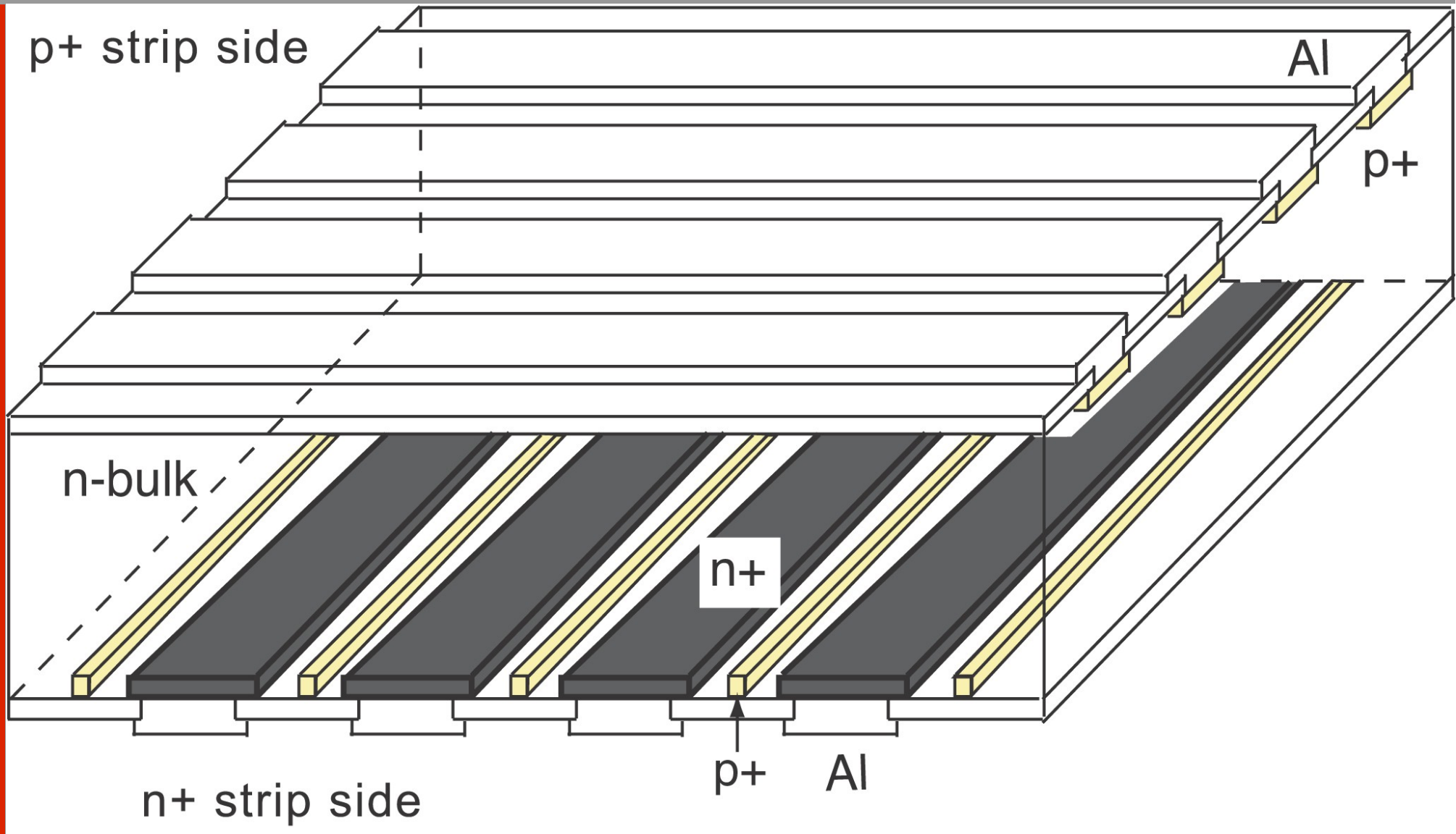


Total number of detectors 806

Important properties of semiconductors (e.g. silicon)

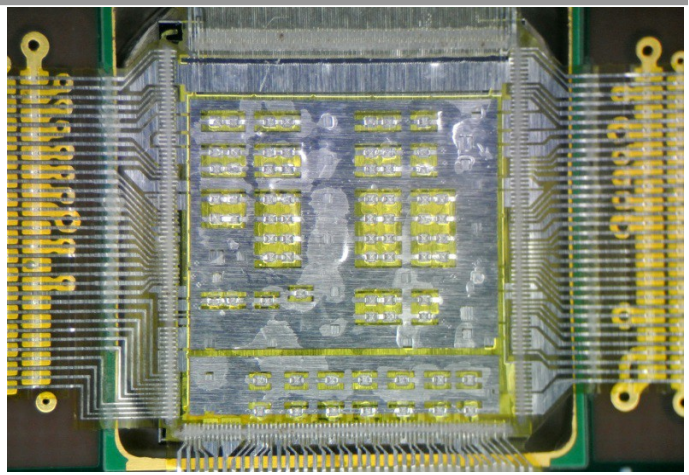
- The small band gap (1.12 eV) => large number of charge carriers per unit energy loss. The average energy for creating an electron–hole pair (3.6 eV) is an order of magnitude smaller than the ionization energy of gases (~ 30eV).
- The high density (2.33 g/cm^3) => a large energy loss per traversed length of the ionizing particle (3.8 MeV/cm for a MIP) => it is possible to build thin detectors that still produce large enough signals.
- High mobility of electrons and holes (μ_n = 1450 cm^2/V·s, μ_p = 450 cm^2/V·s) => charge can be quickly collected (~10 ns) and detectors can be used in high-rate environments.

Double-sided strip detector

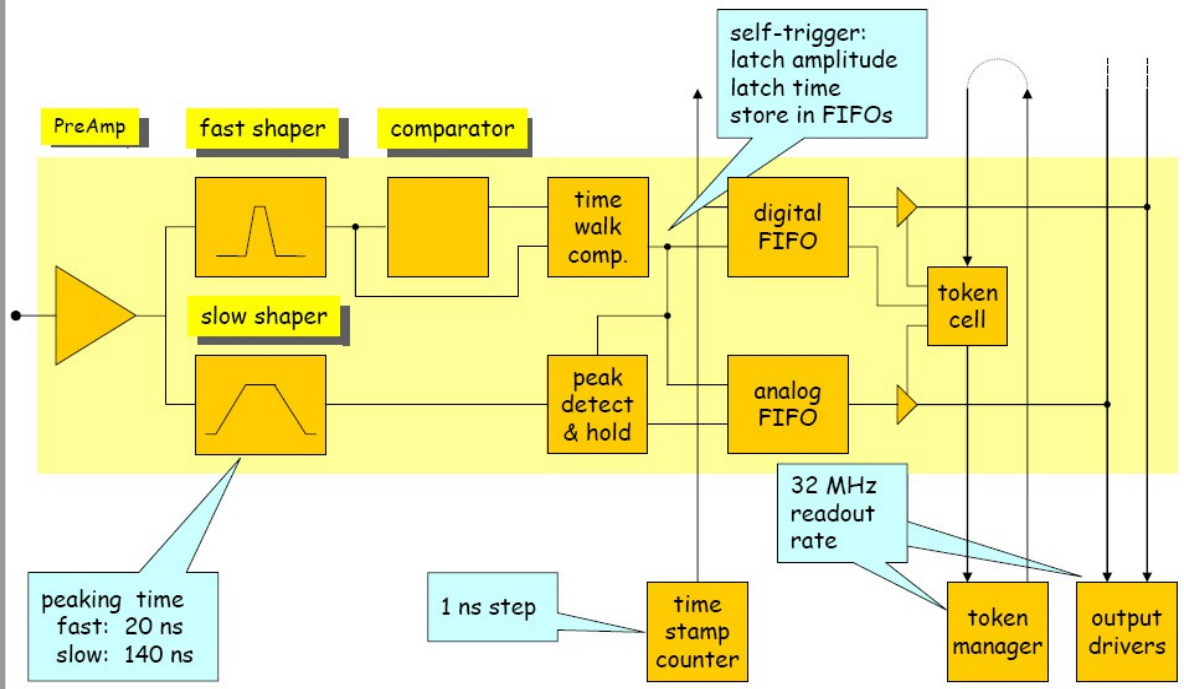


Read-out electronics n-XYTER ASIC

- Self-triggered readout chip
- 128 independent channels
- Positive and negative signals

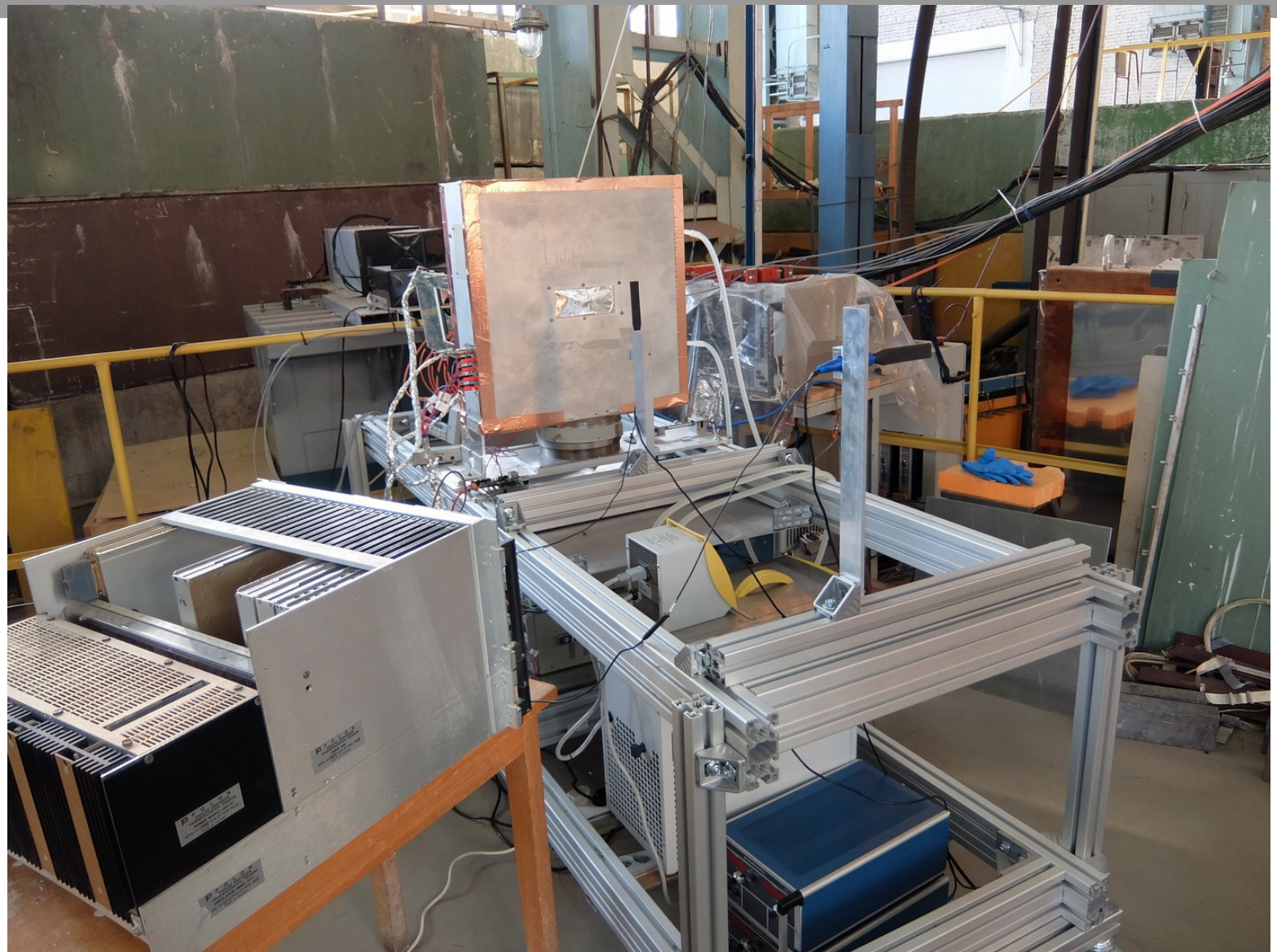


n-XYTER Architecture

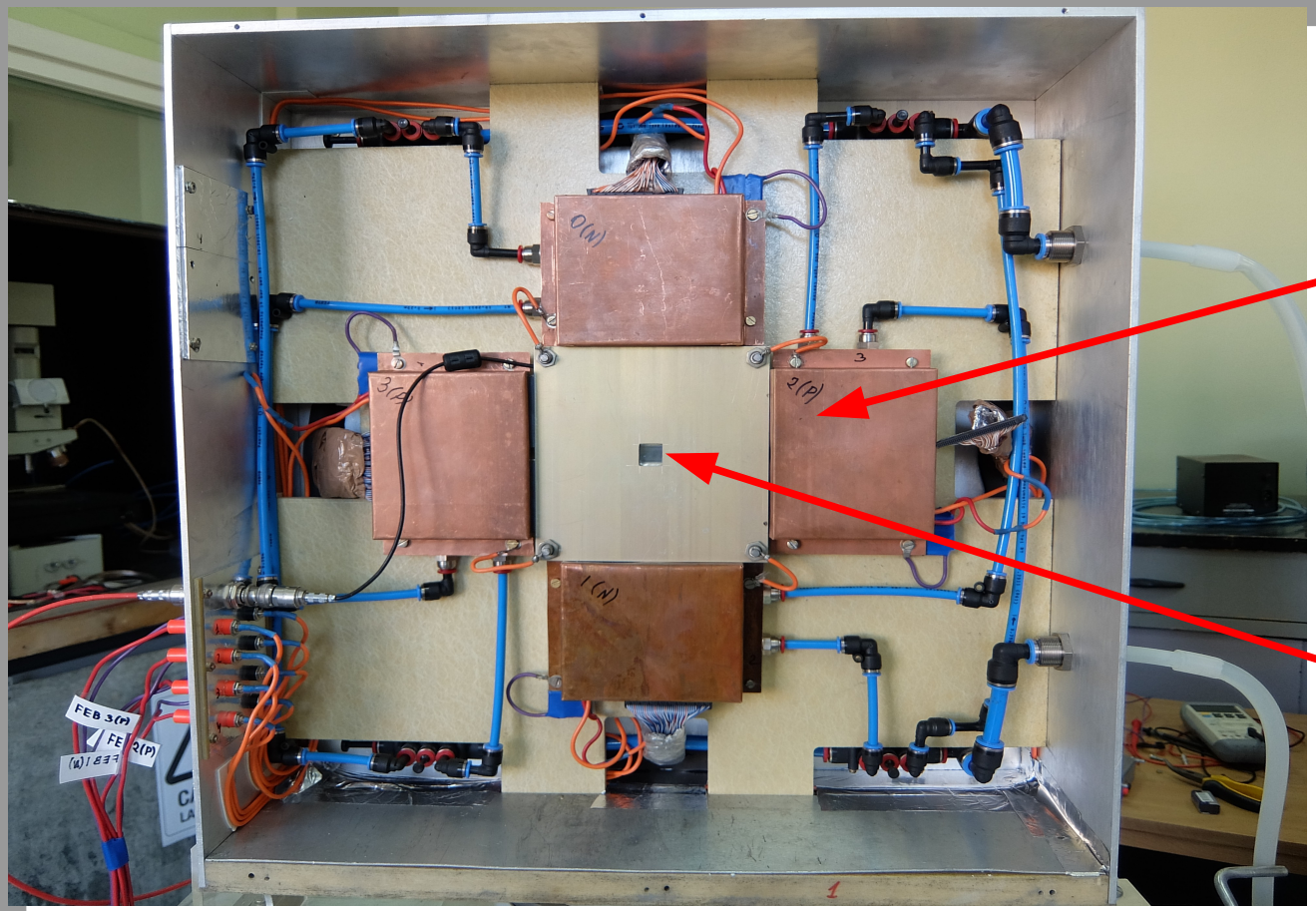


Currently only one **available** chip, based on **self-triggered** technology, which can operate with **both polarities** of input signal.

Test station (at Nuclotron)

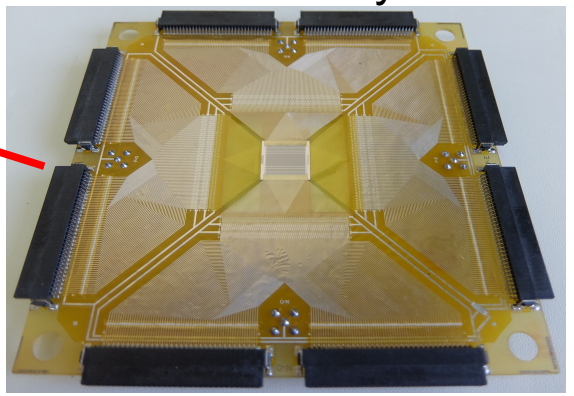


Test station



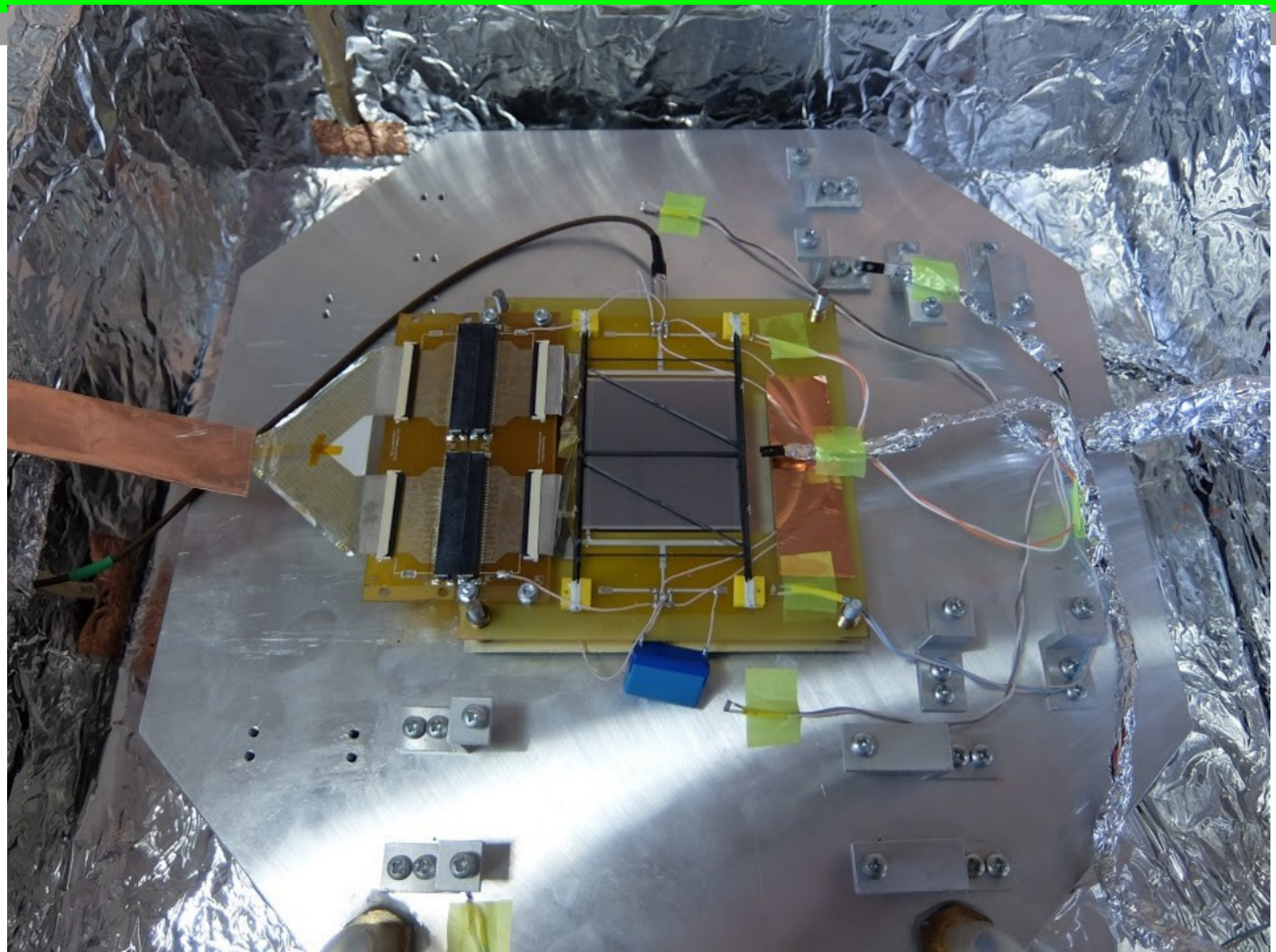
FEB with shielding

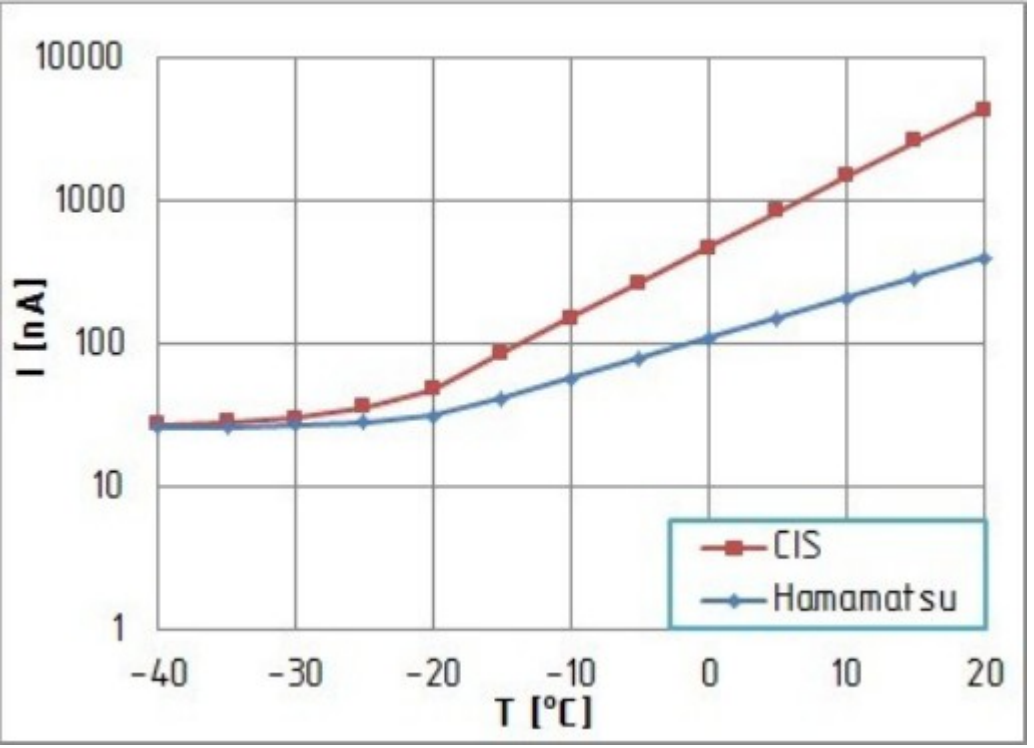
Hamamatsu baby sensor

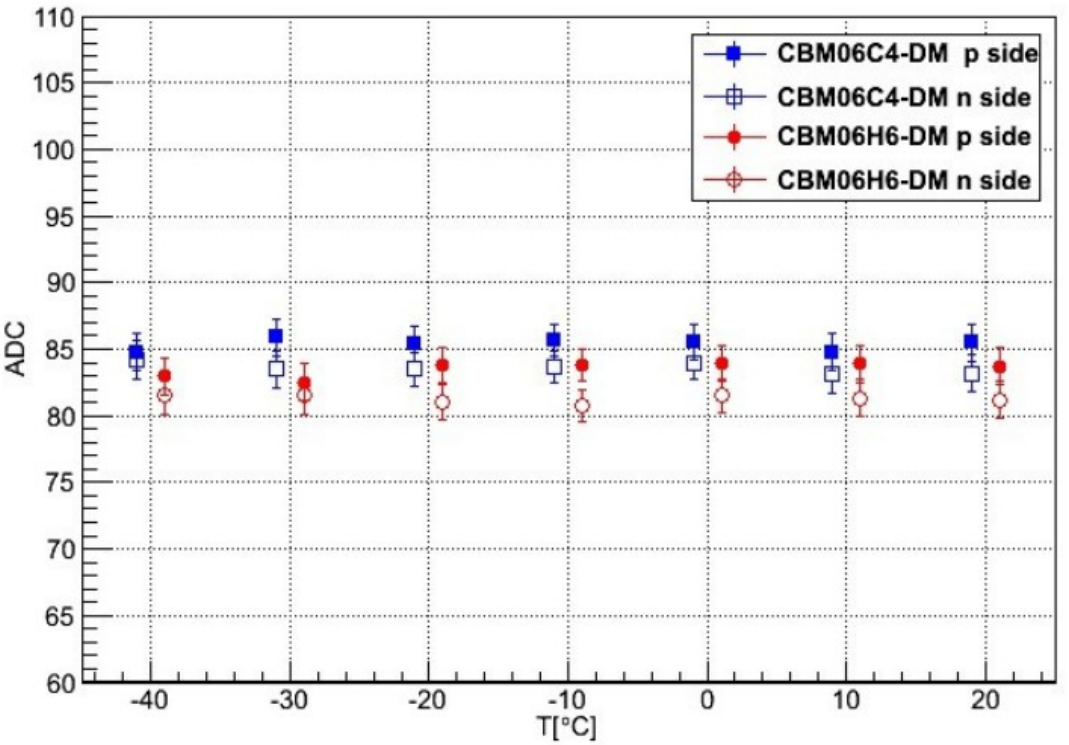


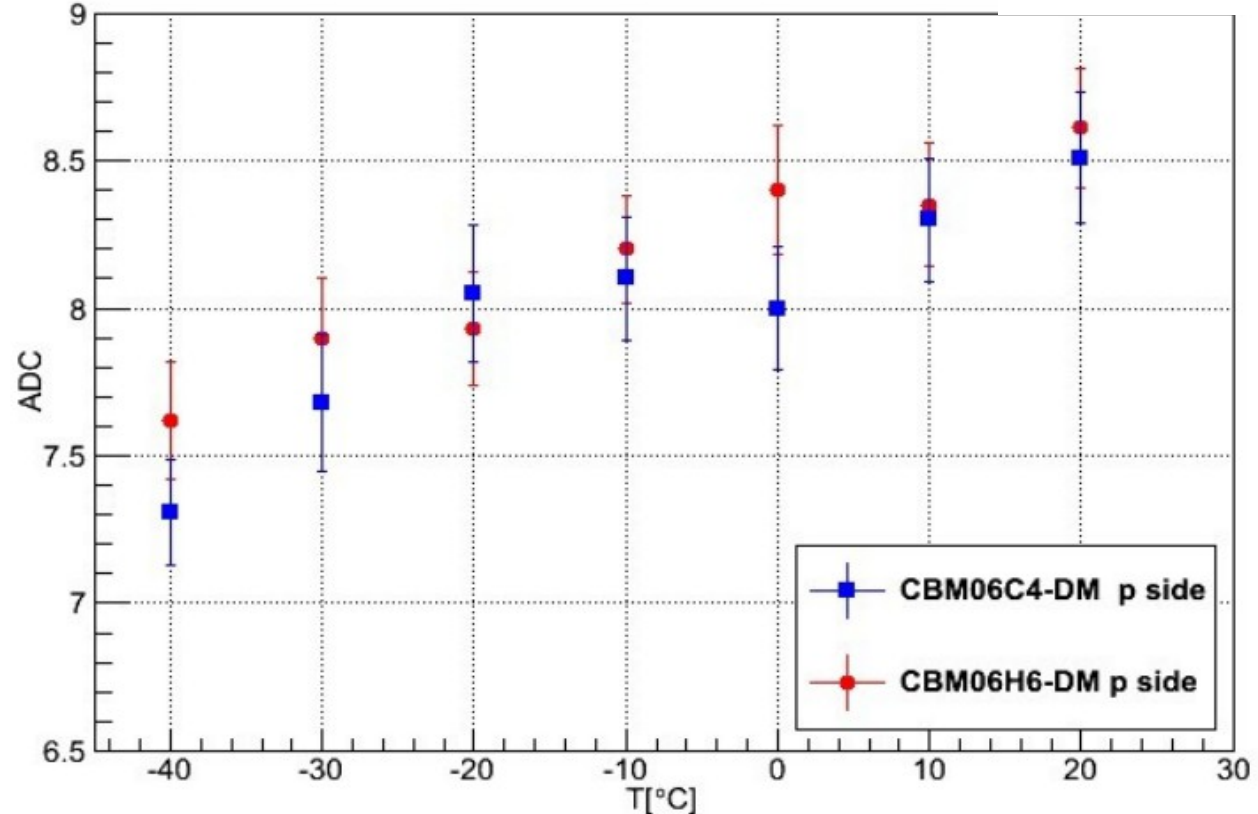
Size: 14.9×14.9 mm²
Strips per side: 256
Pitch: 50.7 µm
Stereo angle: 90°

Thermal tests of CBM06H6



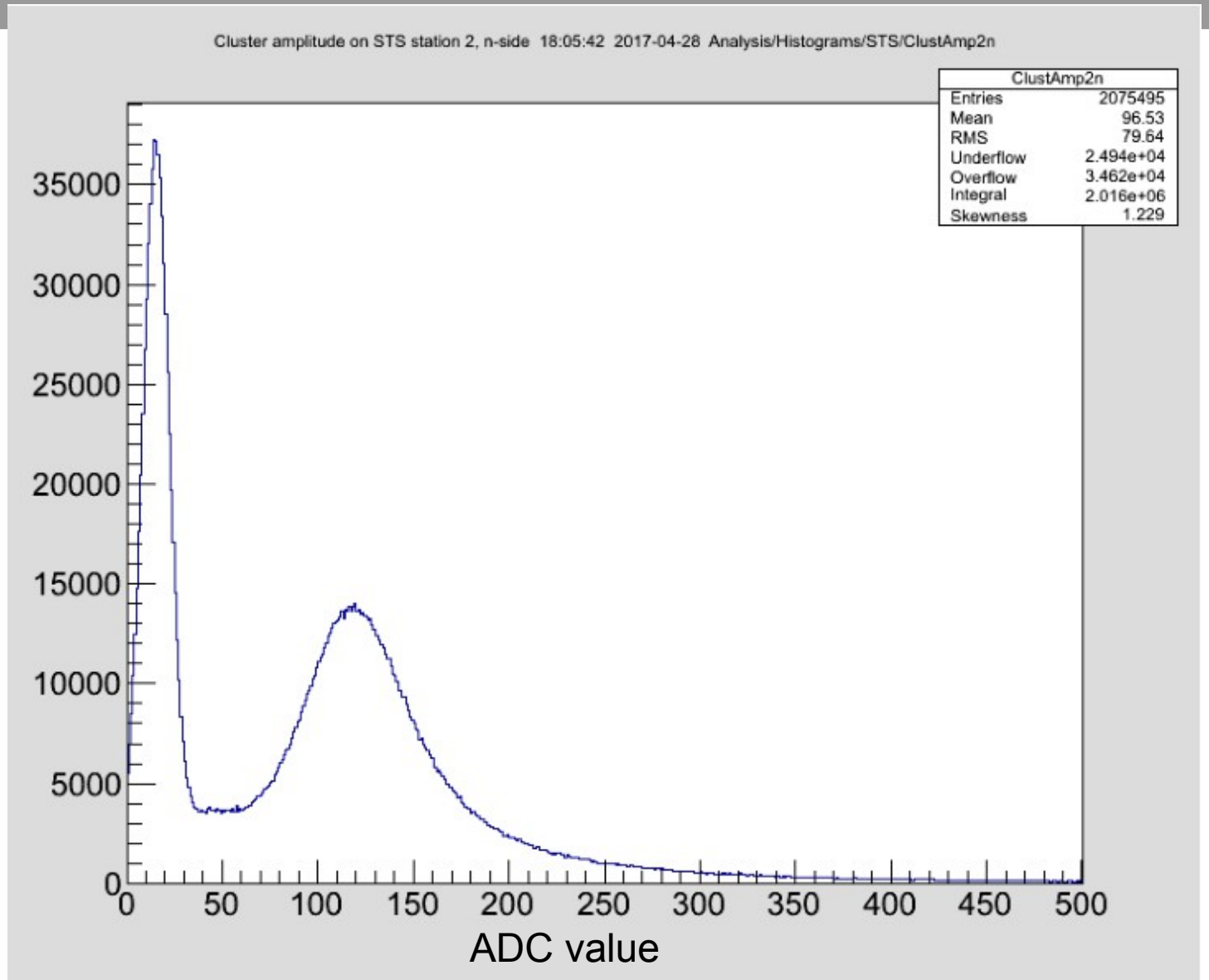




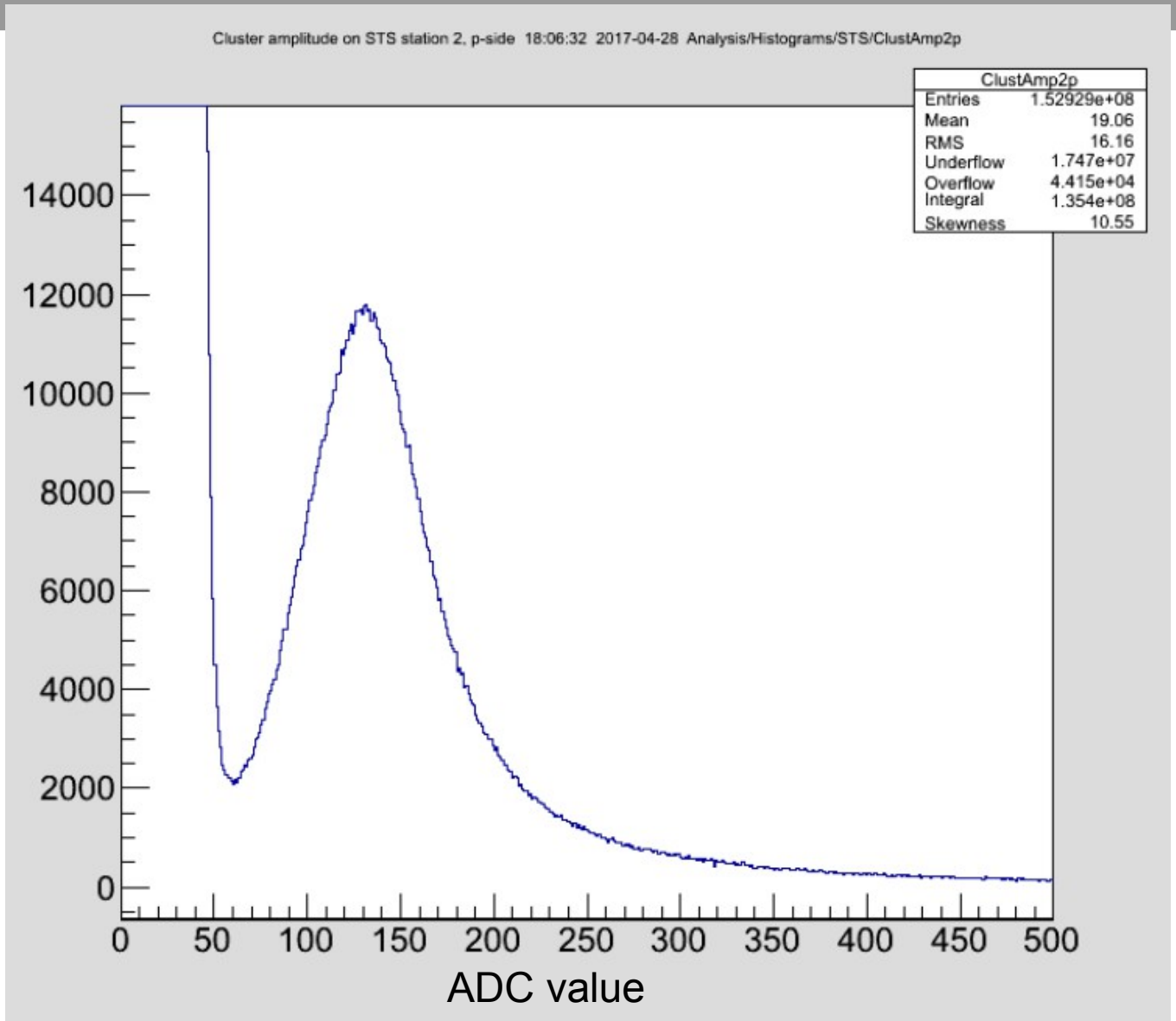


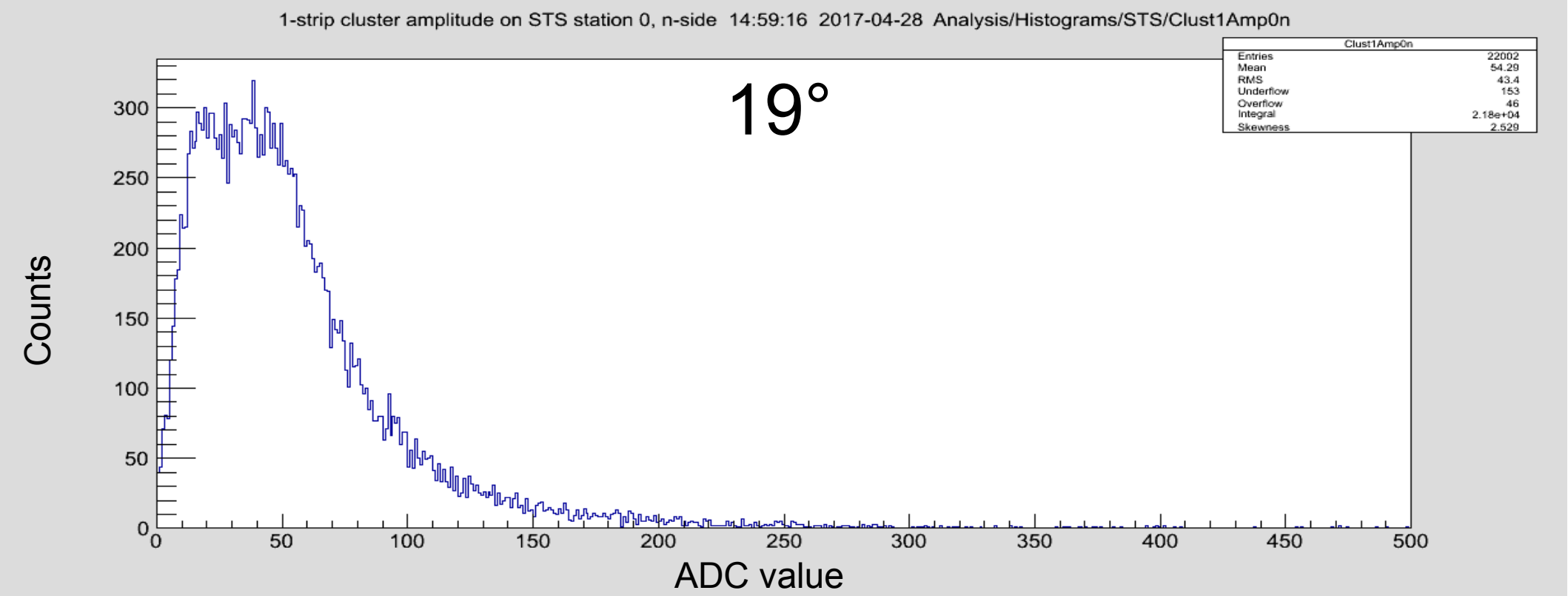
There is no dependence of the signal on temperature within the whole range. As expected, the average noise level slightly decreases with temperature. After heating-cooling cycles defects were not found.

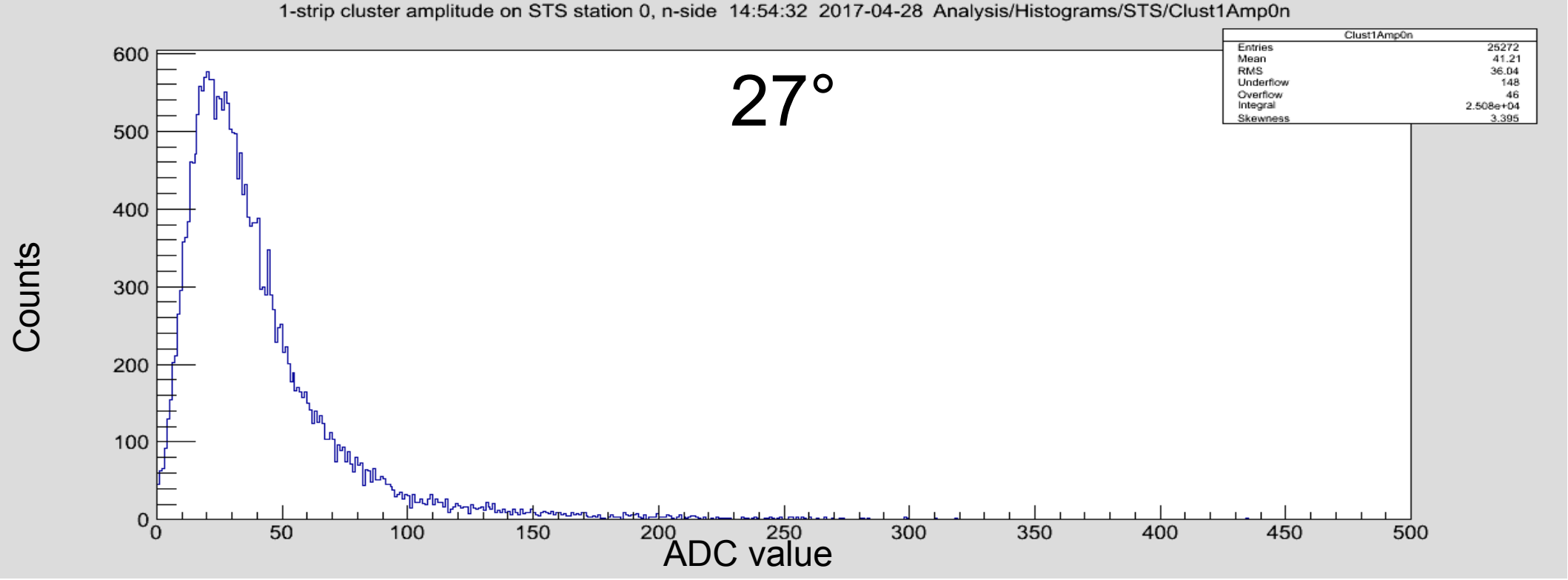
Beam test at Nuclotron
n-side of 6×6 sensor

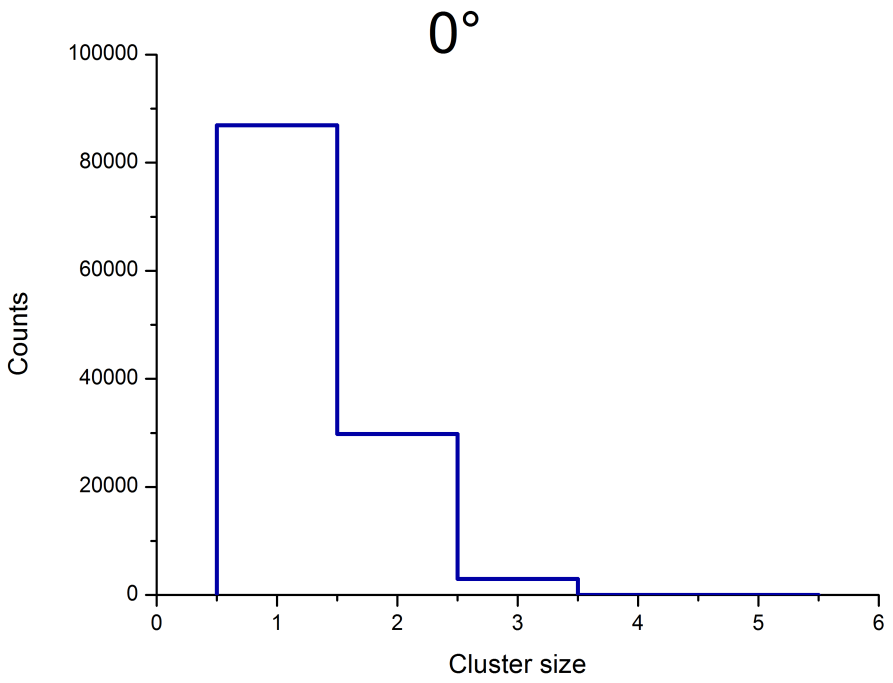


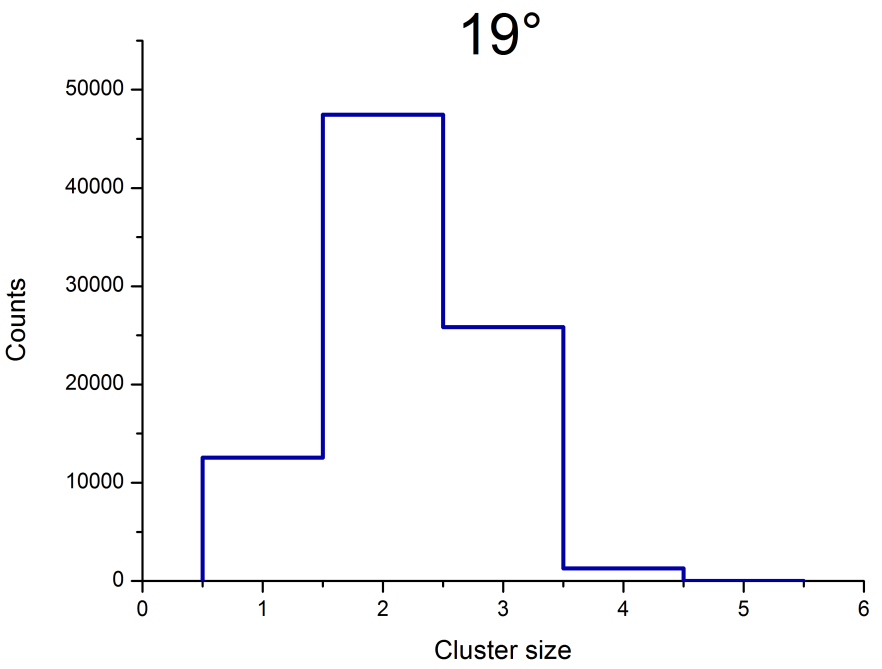
p-side of 6×6 sensor

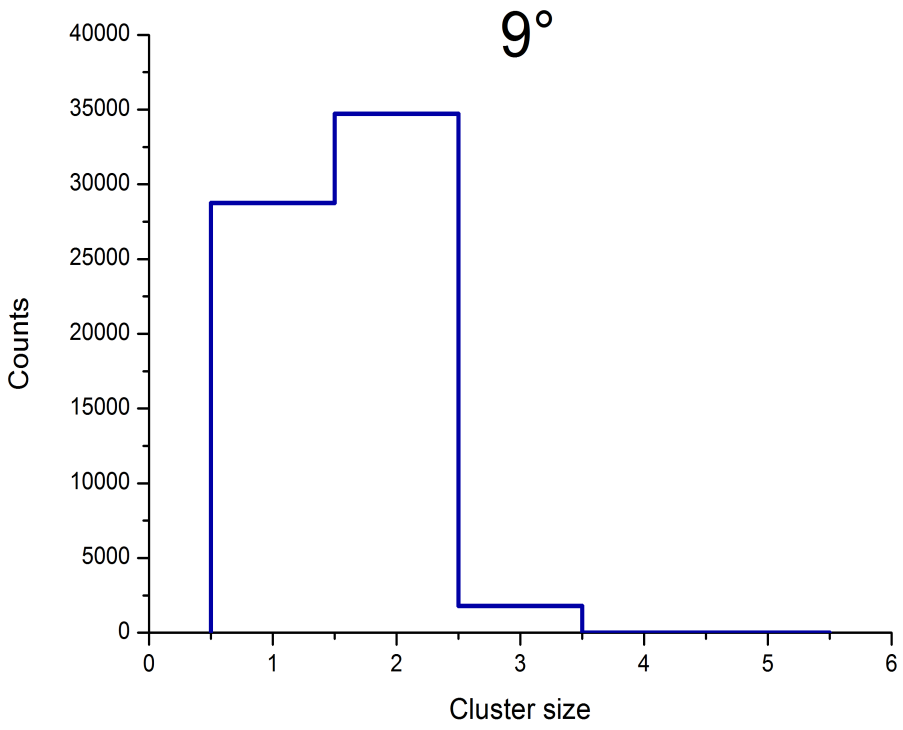


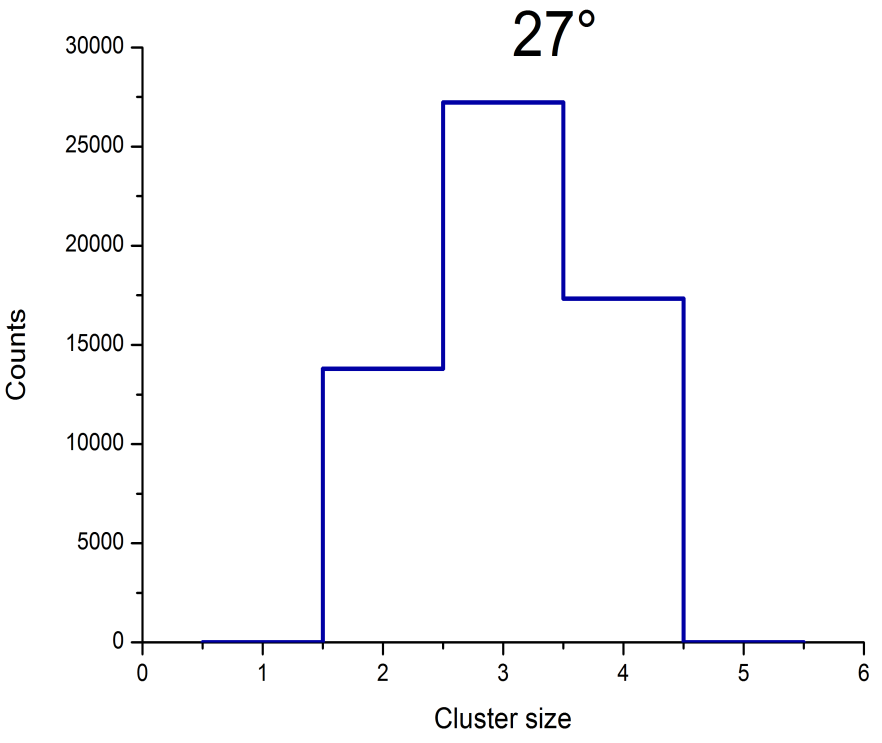

1-strip cluster amplitude on STS station 0, n-side 14:59:16 2017-04-28 Analysis/Histograms/STS/Clust1Amp0n
Clust1Amp0n
Entries 22002
Mean 54.29
RMS 43.4
Underflow 153
Overflow 46
Integral 2.18e+04
Skewness 2.529
19°
Counts
ADC value
0
50
100
150
200
250
300
350
400
450
500

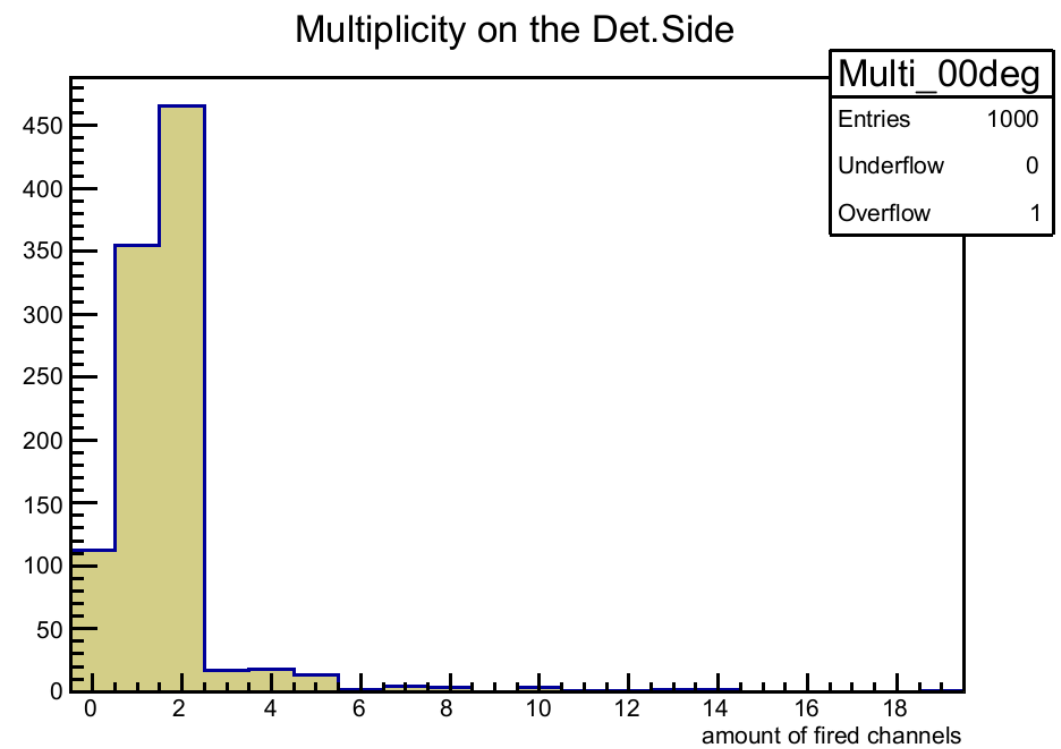

1-strip cluster amplitude on STS station 0, n-side 14:54:32 2017-04-28 Analysis/Histograms/STS/Clust1Amp0n
Clust1Amp0n
Entries 25272
Mean 41.21
RMS 36.04
Underflow 148
Overflow 46
Integral 2.508e+04
Skewness 3.395
27°
Counts
ADC value
0
100
200
300
400
500
600
50
150
250
350
450

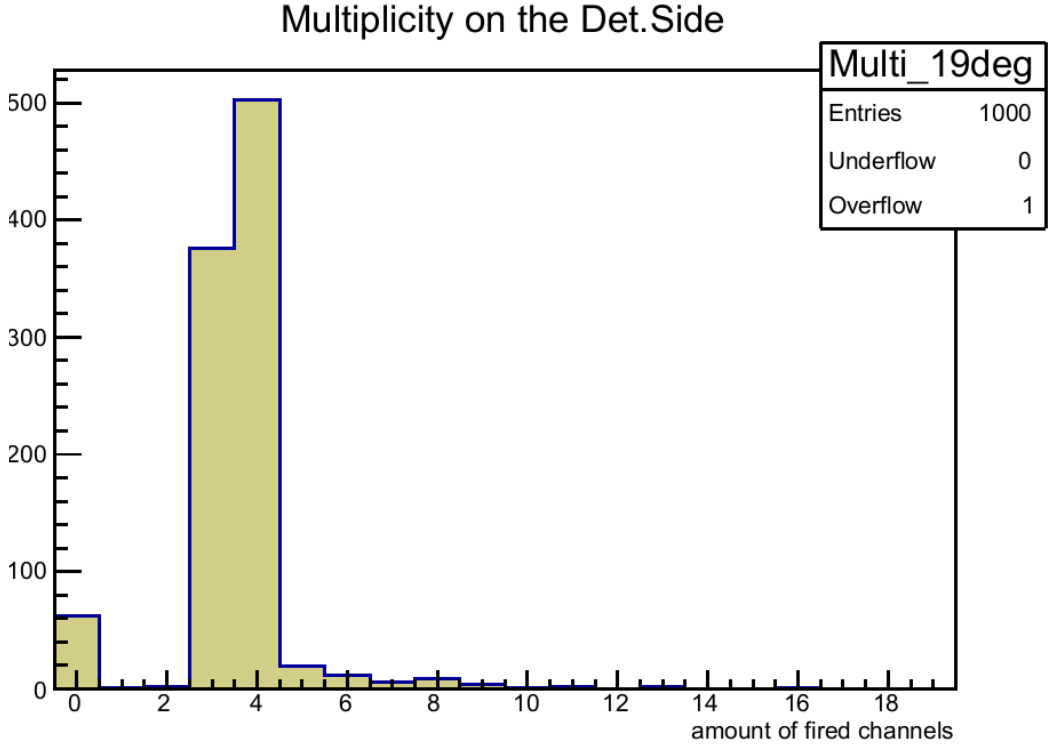

0°
Counts
Cluster size
100000
80000
60000
40000
20000
0
0
1
2
3
4
5
6

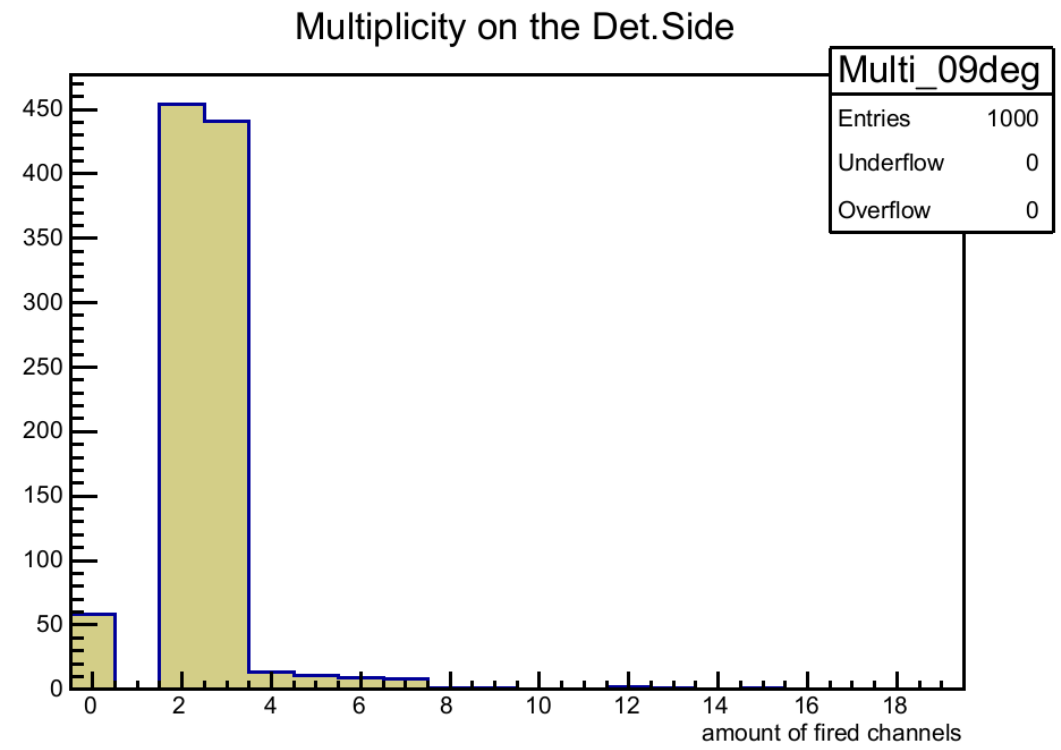

19°
Counts
Cluster size
50000
40000
30000
20000
10000
0
0
1
2
3
4
5
6

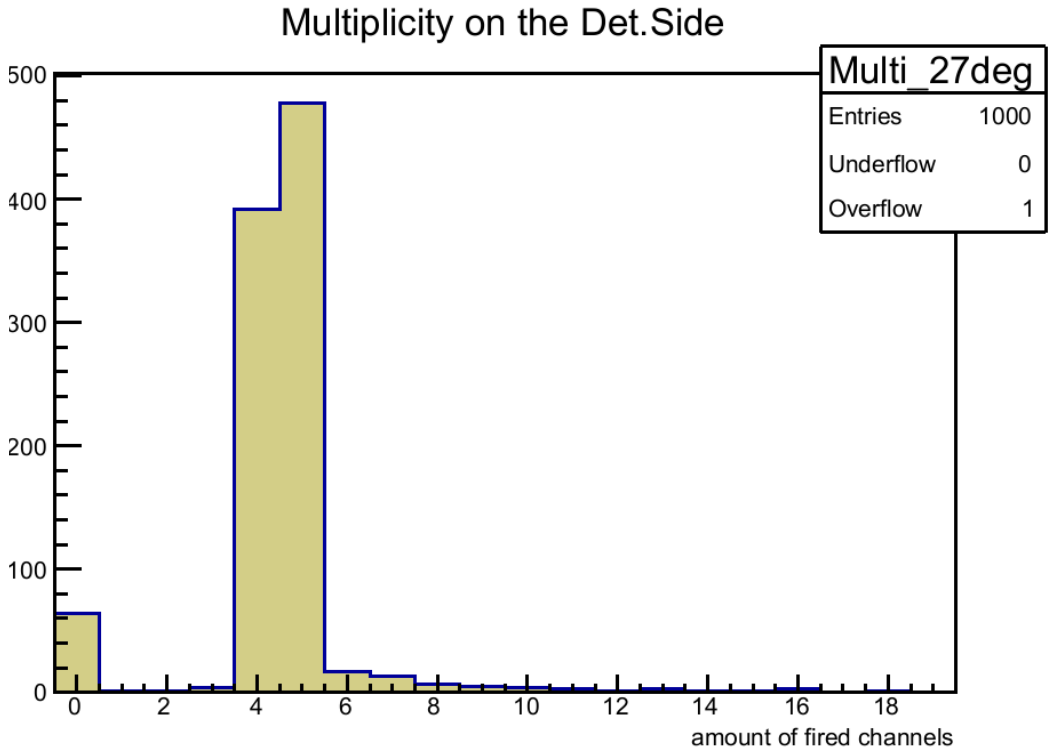

9°
Counts
Cluster size
40000
35000
30000
25000
20000
15000
10000
5000
0
0
1
2
3
4
5
6


27°
Counts
Cluster size
30000
25000
20000
15000
10000
5000
0
0
1
2
3
4
5
6


Multiplicity on the Det.Side
Multi_00deg
Entries 1000
Underflow 0
Overflow 1
amount of fired channels

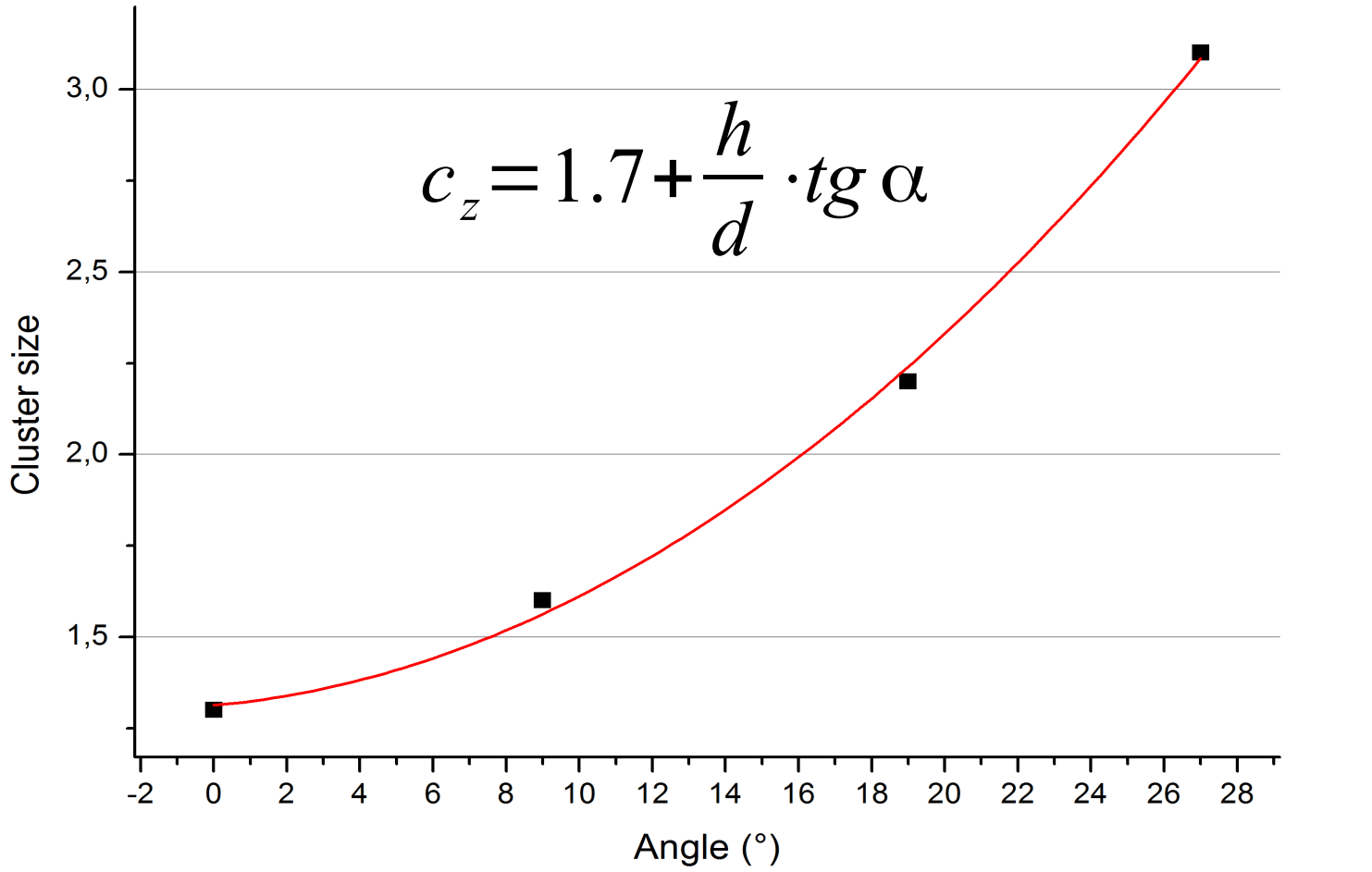

Multiplicity on the Det.Side
Multi_19deg
Entries 1000
Underflow 0
Overflow 1
amount of fired channels


Multiplicity on the Det.Side
Multi_09deg
Entries 1000
Underflow 0
Overflow 0
amount of fired channels


Multiplicity on the Det.Side
Multi_27deg
Entries 1000
Underflow 0
Overflow 1
amount of fired channels

Angle dependence of cluster size

	Intercept	Intercept	B1	B1	B2	B2	Statistics
	Value	Standard Er	Value	Standard Er	Value	Standard Er	Adj. R-Squa
Cluster size	1,3131	0,05672	0,00879	0,01038	0,0021	3,70403E-4	0,99462



Conclusions

- All systems of our experimental setup work in normal mode. Utilized techniques of detector modules manufacturing and assembling are fit for future experiments.
- In spite of the fact that n-XYTER is operational, it is necessary to test detector modules with new STS-XYTER electronics. Also it is necessary to solve general problems of self-triggered electronics — signal-to-noise ratio and synchronization.
- Thermal tests showed stability of sensors and electronics operation.
- To do: we need to test systems of data processing and track reconstruction (using more stations).

Thank you for your attention!