MiniSPD testing facility

Vitalii Burtsev

AFI Electronics
LHEP, JINR

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Motivation

For almost three years (2018-2021), there will be no relativistic beam at LHEP, and the space muon stand has created allows research work with real detectors and subsystems.
Getting real data from cosmic rays
Using prototype SPD detectors for track reconstruction
MiniSPD simulation and comparison with the real data
Measurement of detector characteristics
Checking the stability of the detector and stand components over a long period of operation
Include all prototype detectors from SPD or elements of these detectors in the stand

miniSPD setup

Climate control

Slow control crate

Gas system

Slow control server

Detector power systems

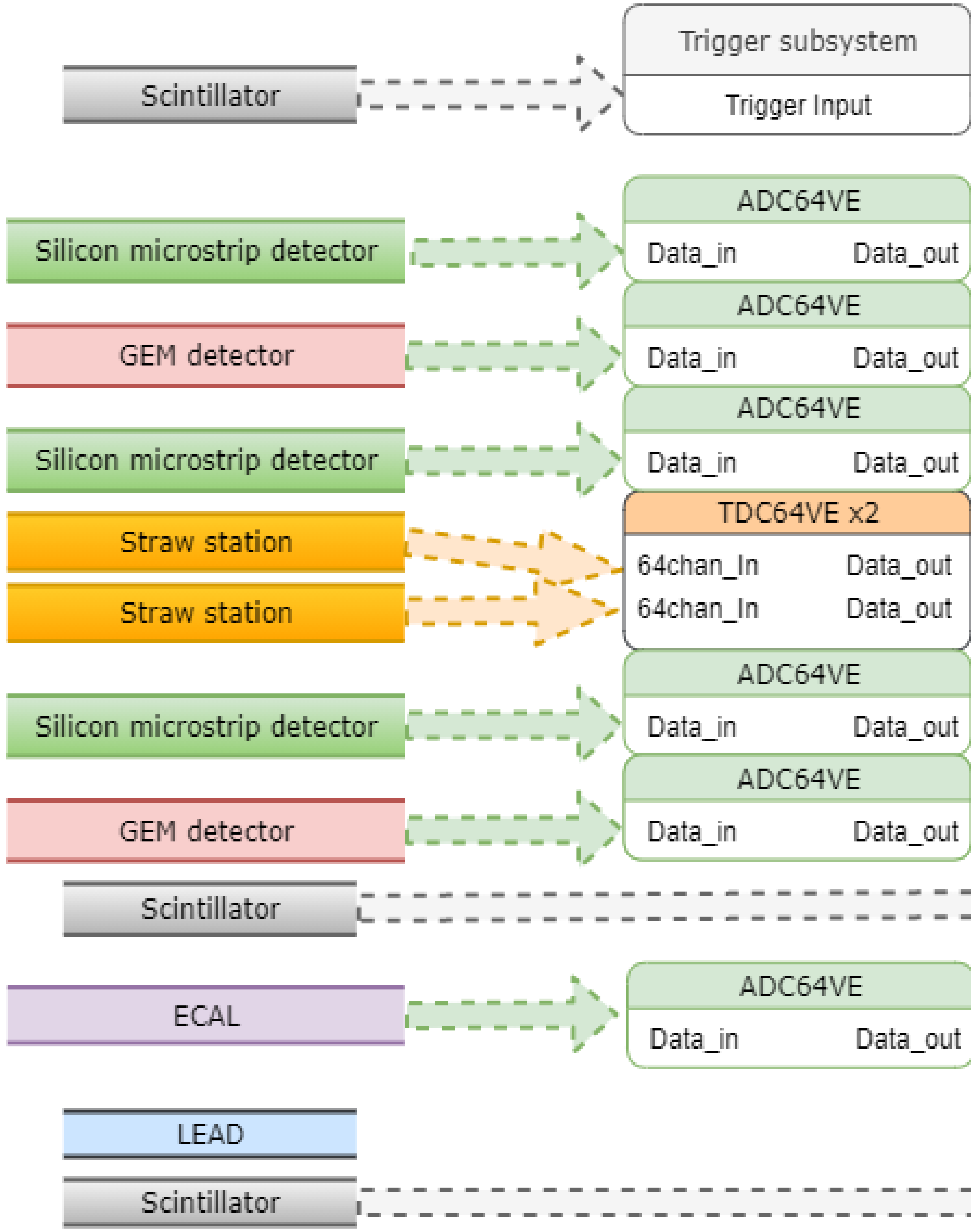
Detector power systems

DAQ

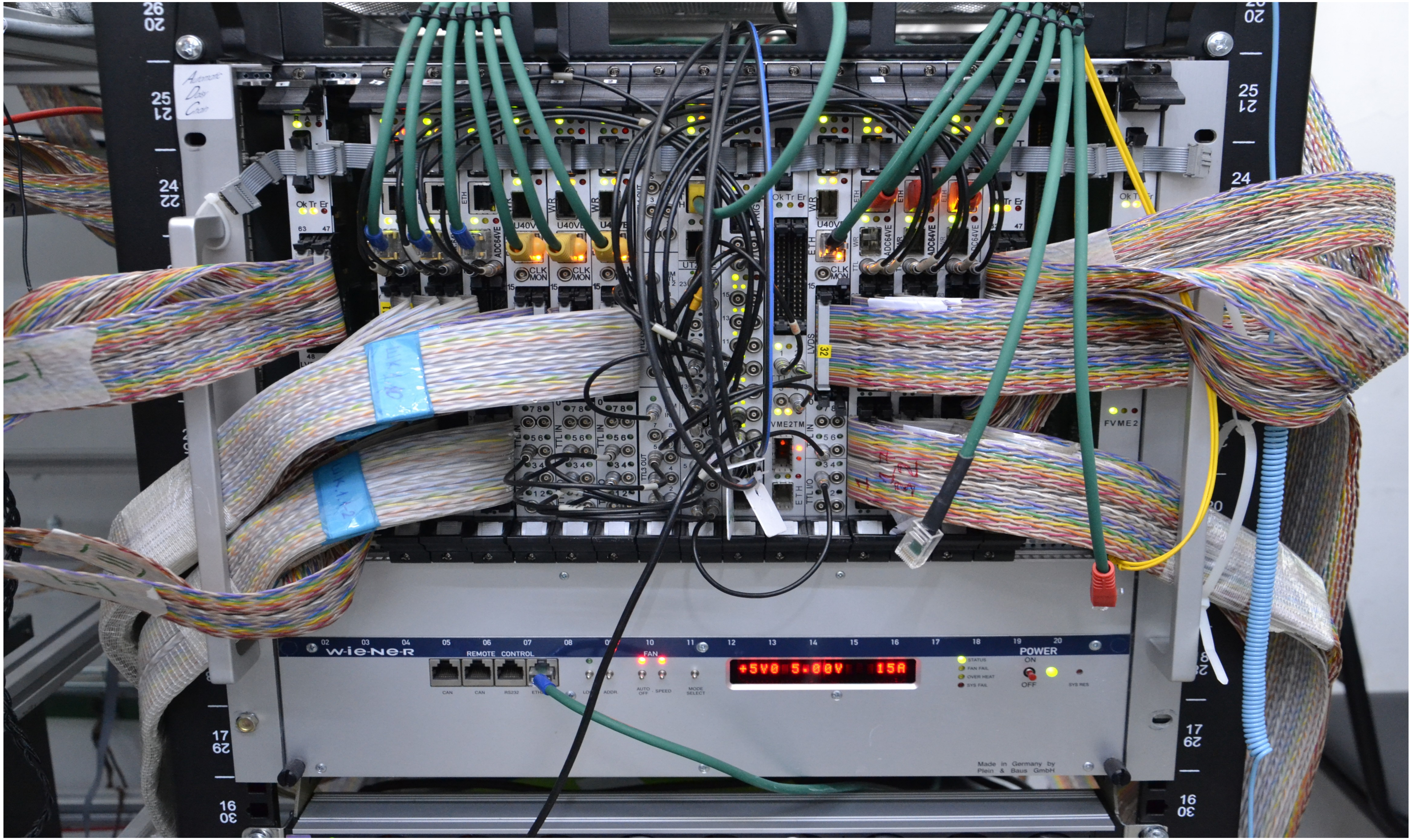
Detector power systems

Detectors

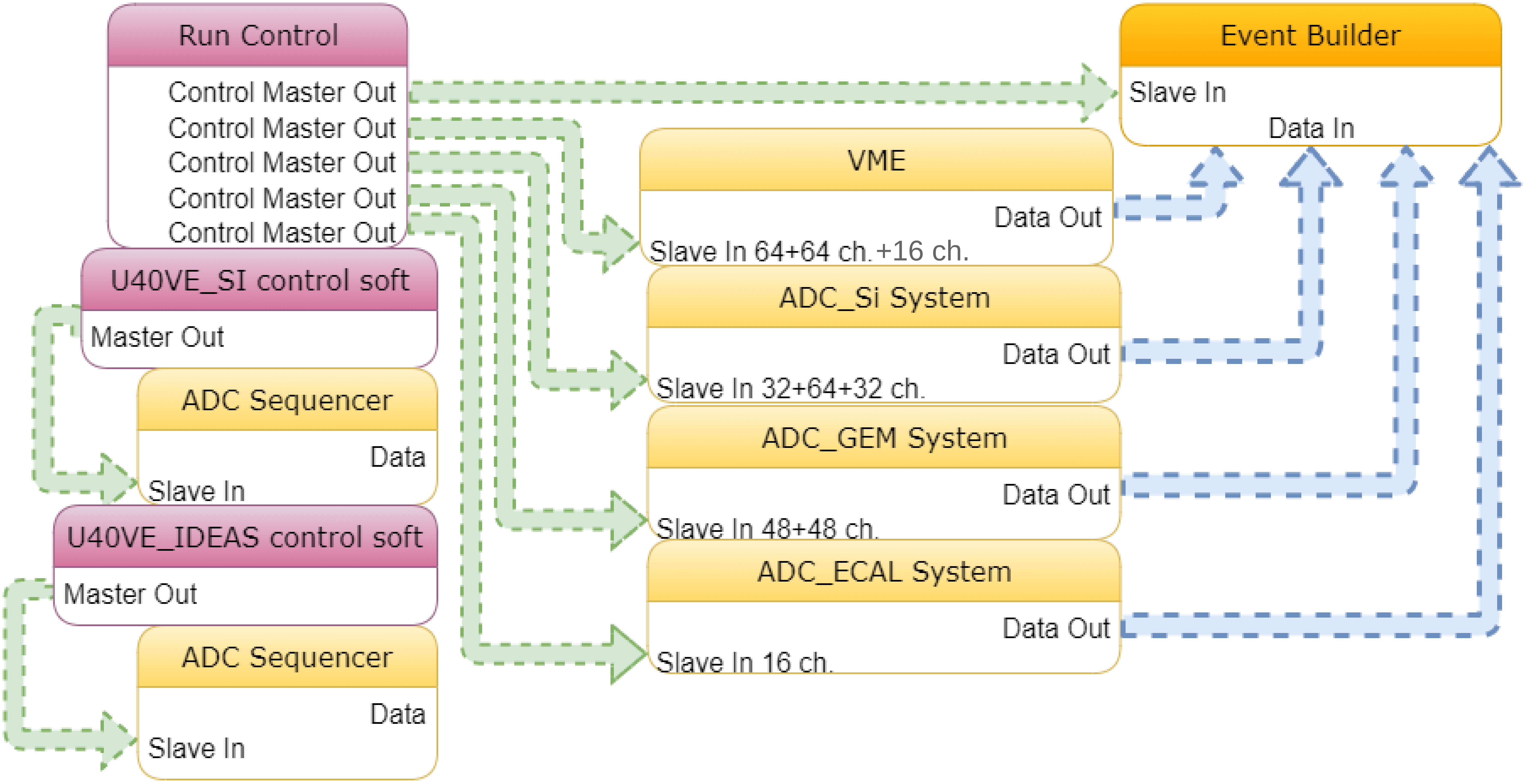
Functional structure of the stand



DAQ


W-IE-NE-R
REMOTE CONTROL
FAN
+5V0 5.00V 15A
POWER
ON
OFF
VME2TM
FVME2
Made in Germany by Plein & Baus GmbH

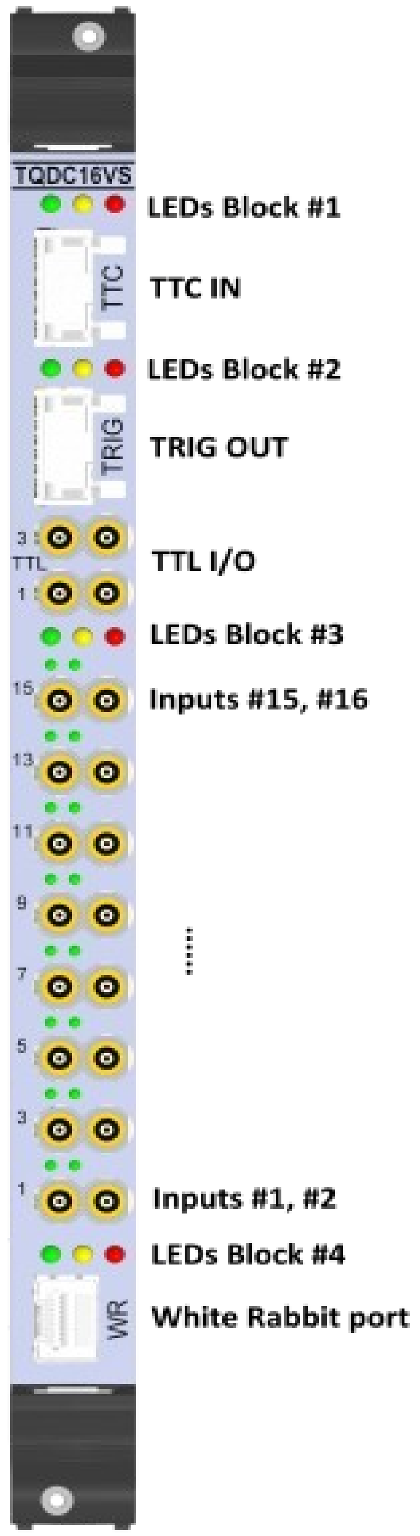
DAQ soft structure

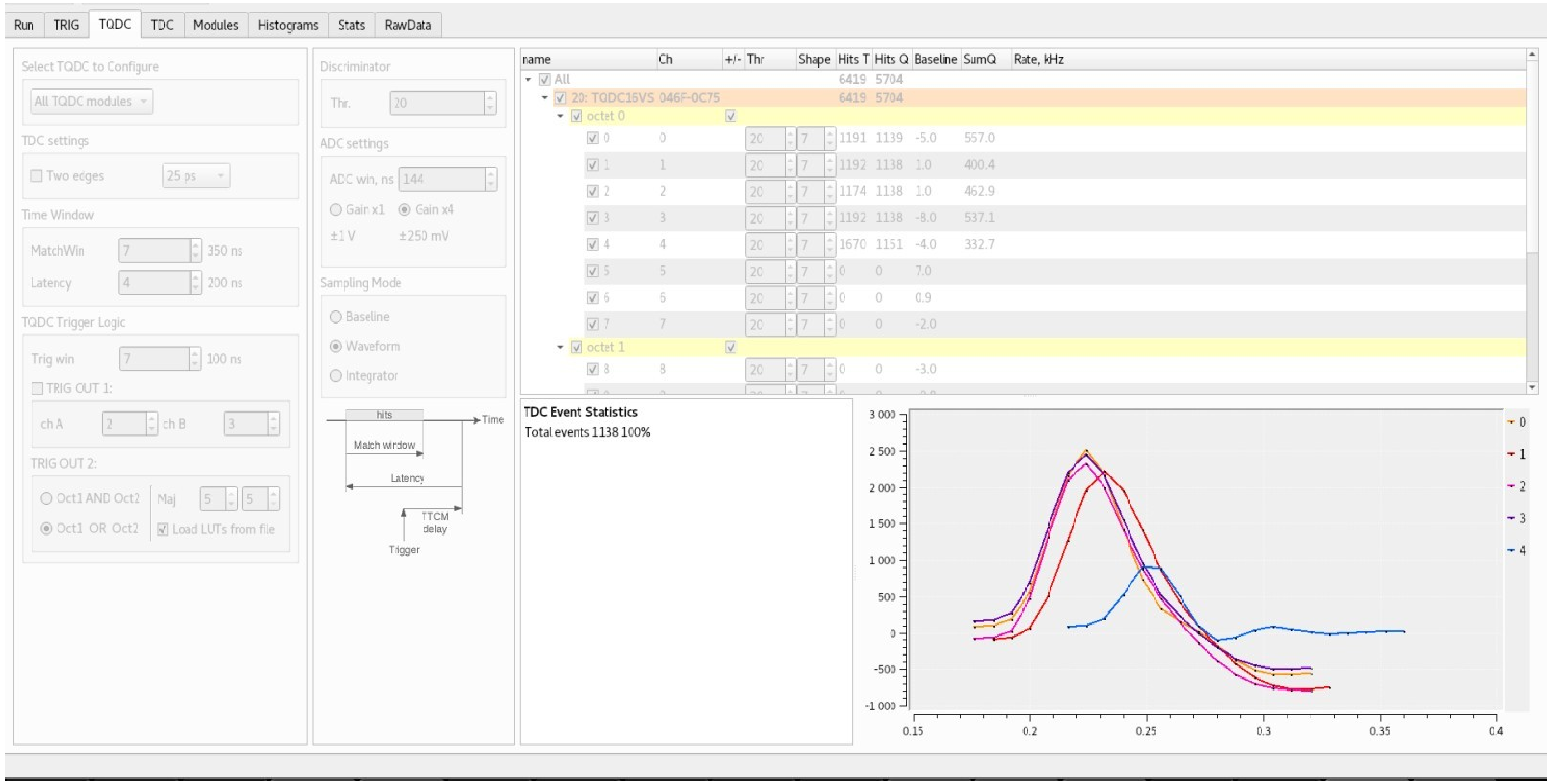


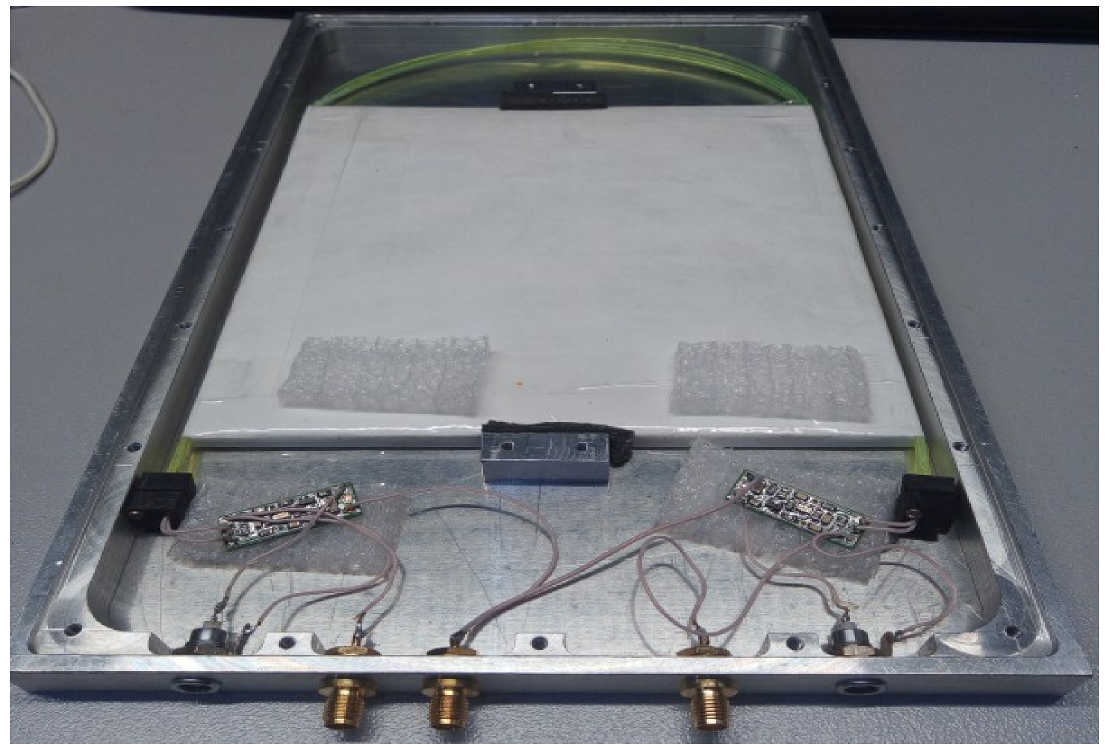
Trigger

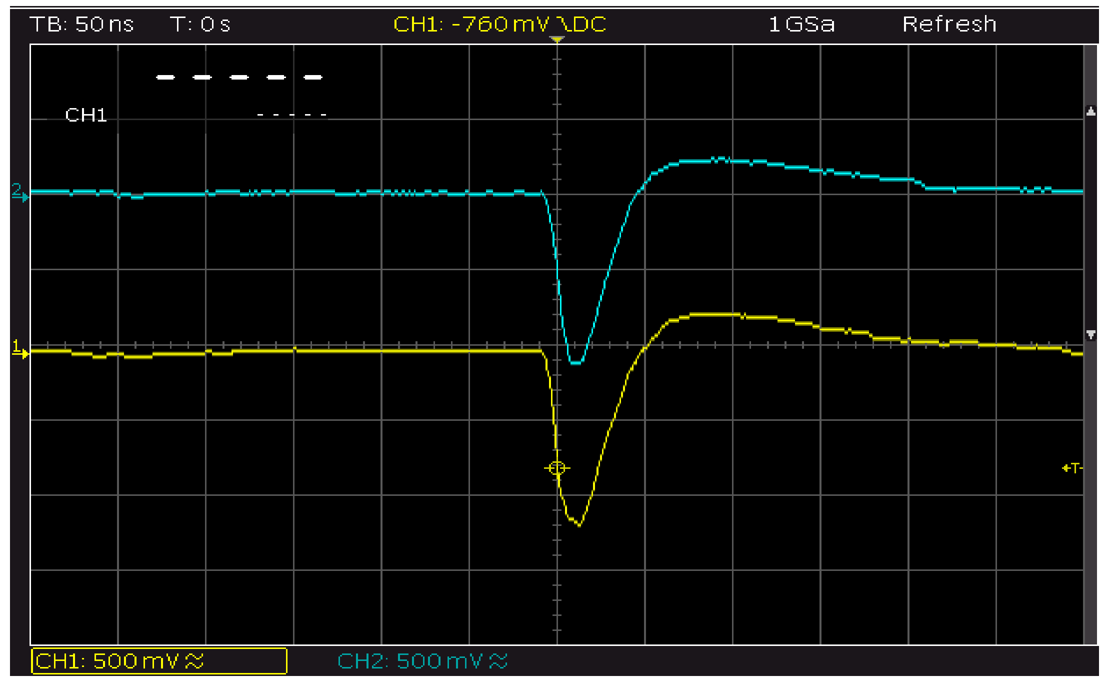
- 2 Scintillators (SiPm 4ch)
- 1 Scintillator (Pmt 1ch)
- TQDC

- 16 channels, 50 Ohm
- TDC: time-stamping, 25ps bin size
- Amplitude (charge) measurement: 10/14 bit, 80 MS/s ADC
- On-board trigger matching logic







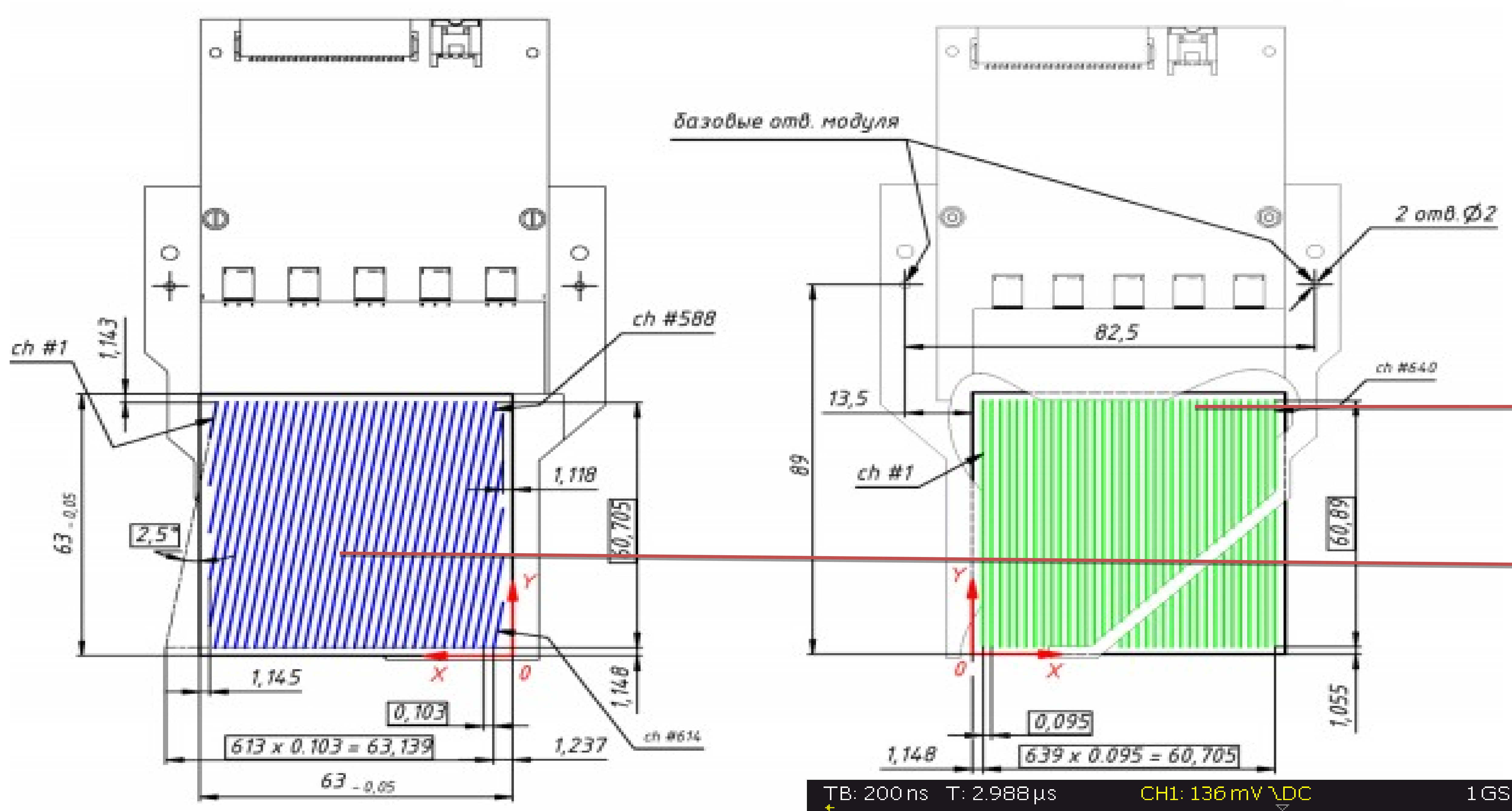


https://afi.jinr.ru/TQDC16VS-E

Silicon detector

Сторона наклонных стрипов

Сторона параллельных стрипов

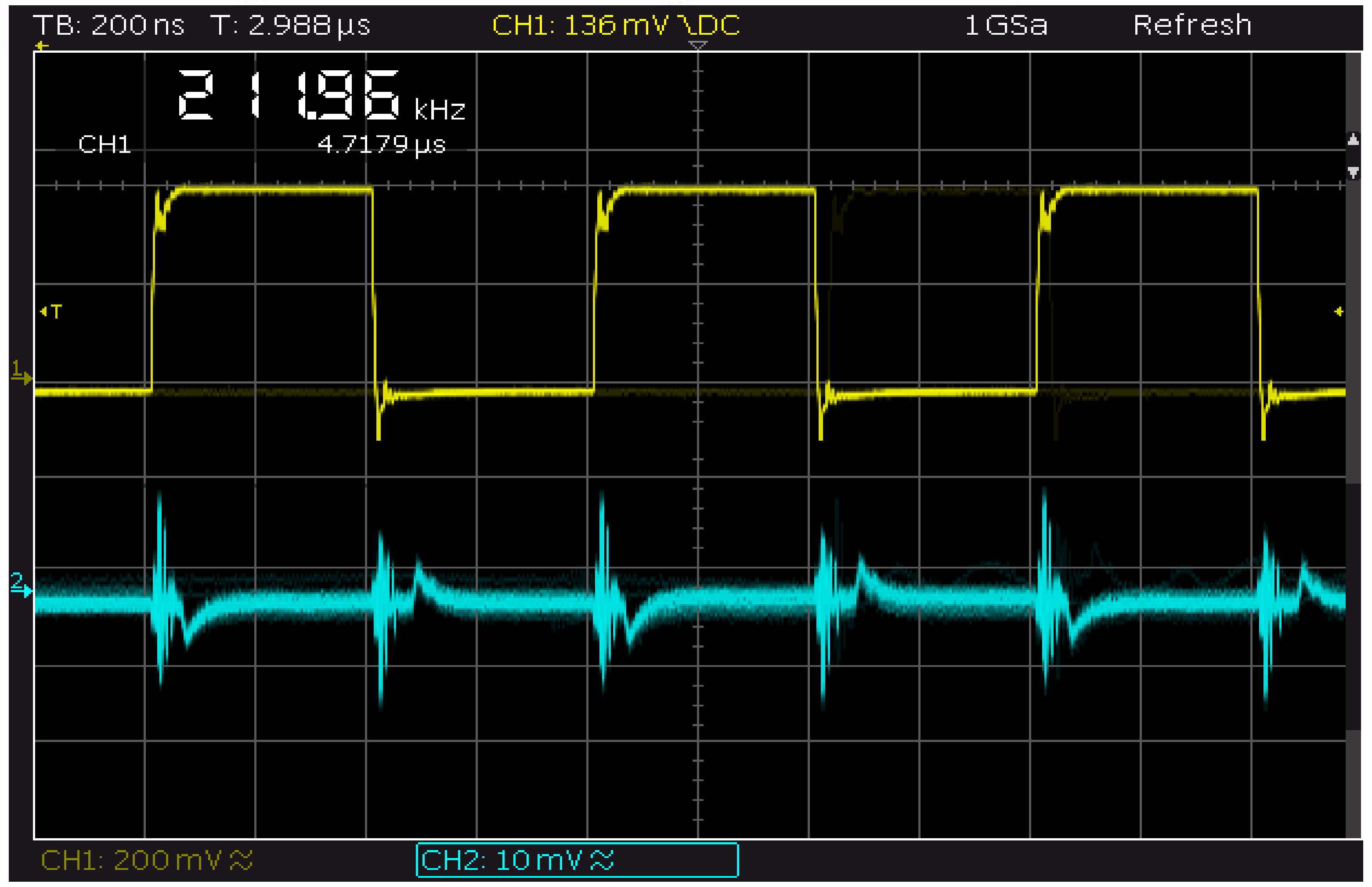


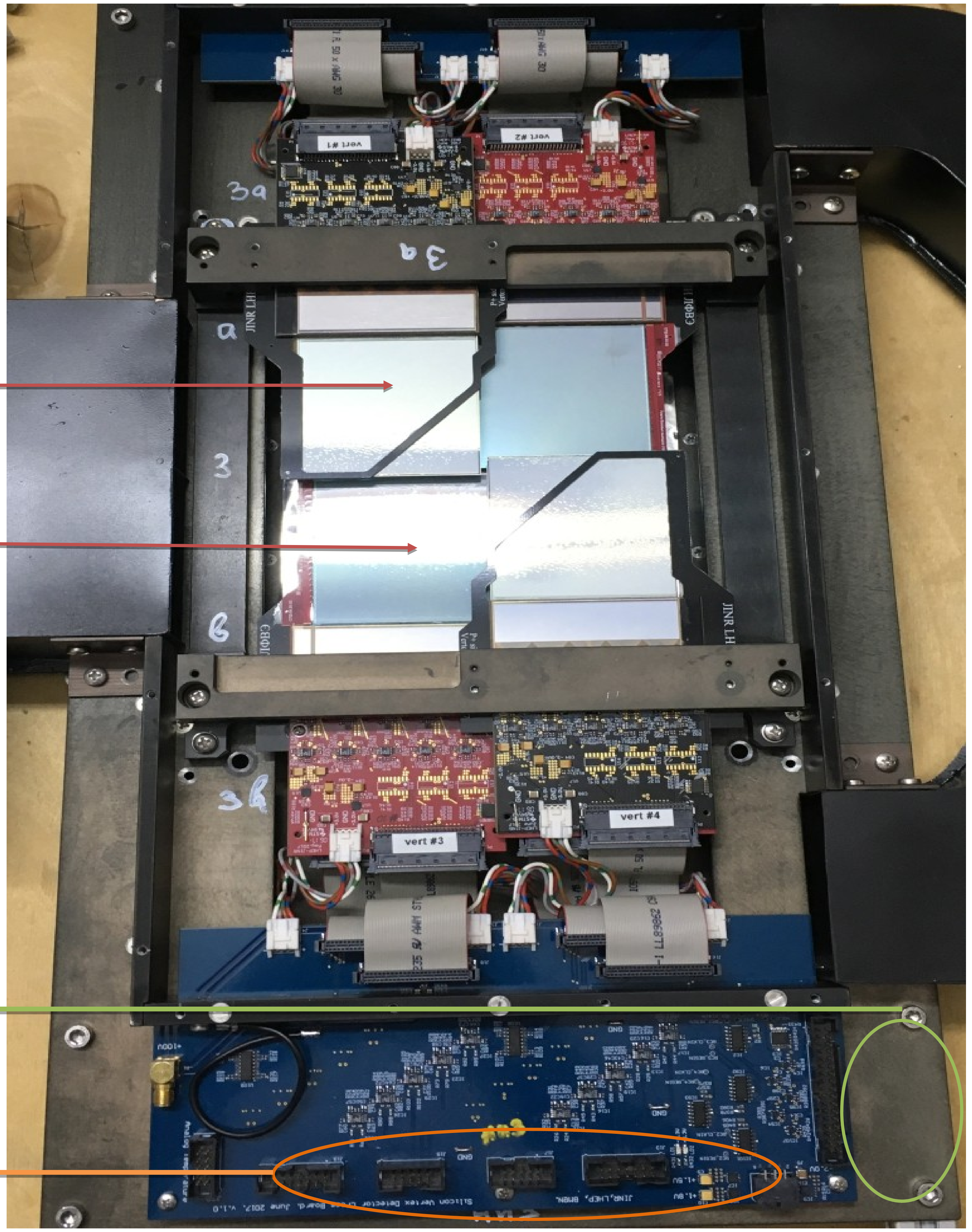
U40VE_SI control soft

Master Out

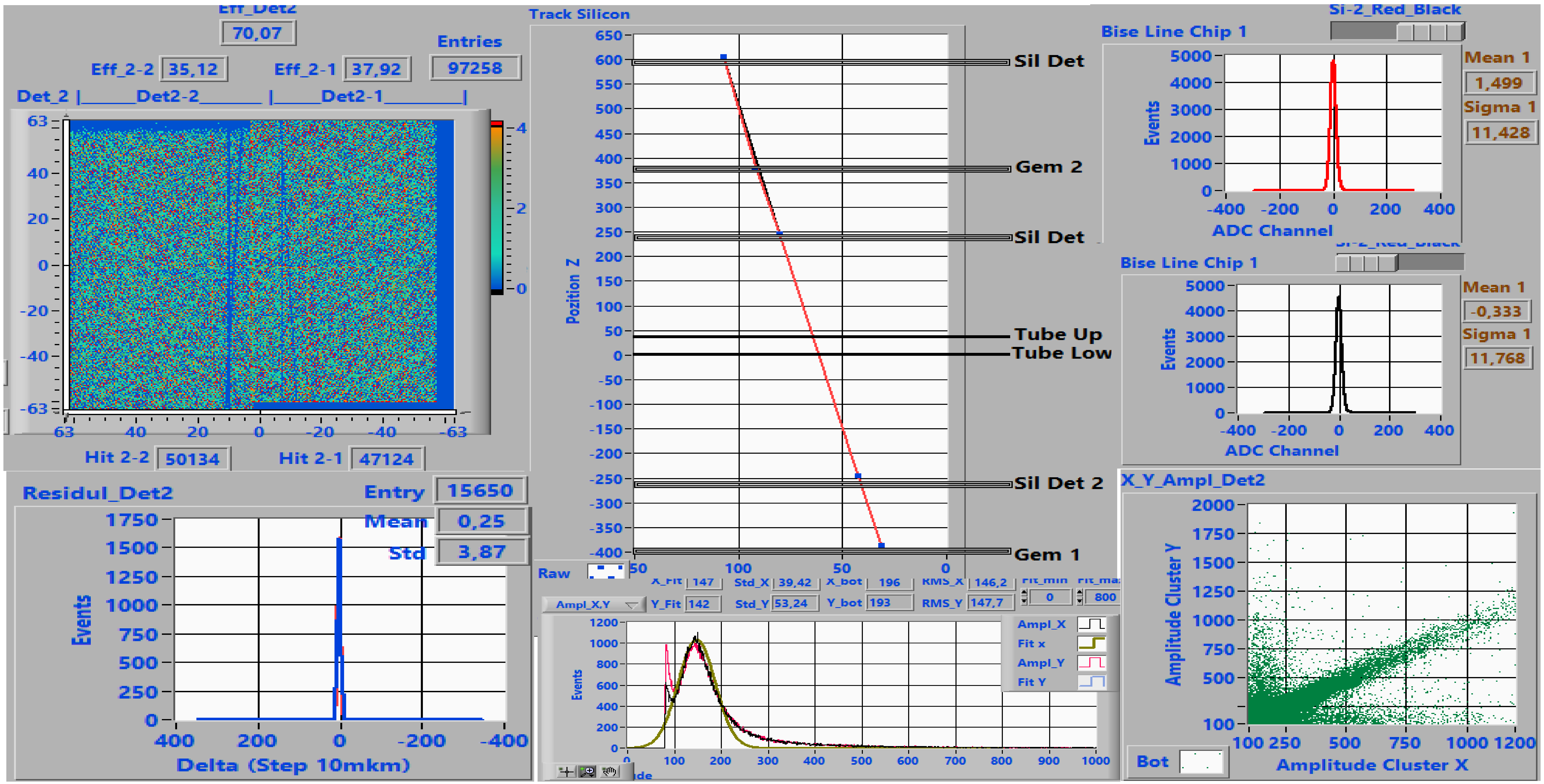
ADC_Si System

Slave In 32+64+32 ch.

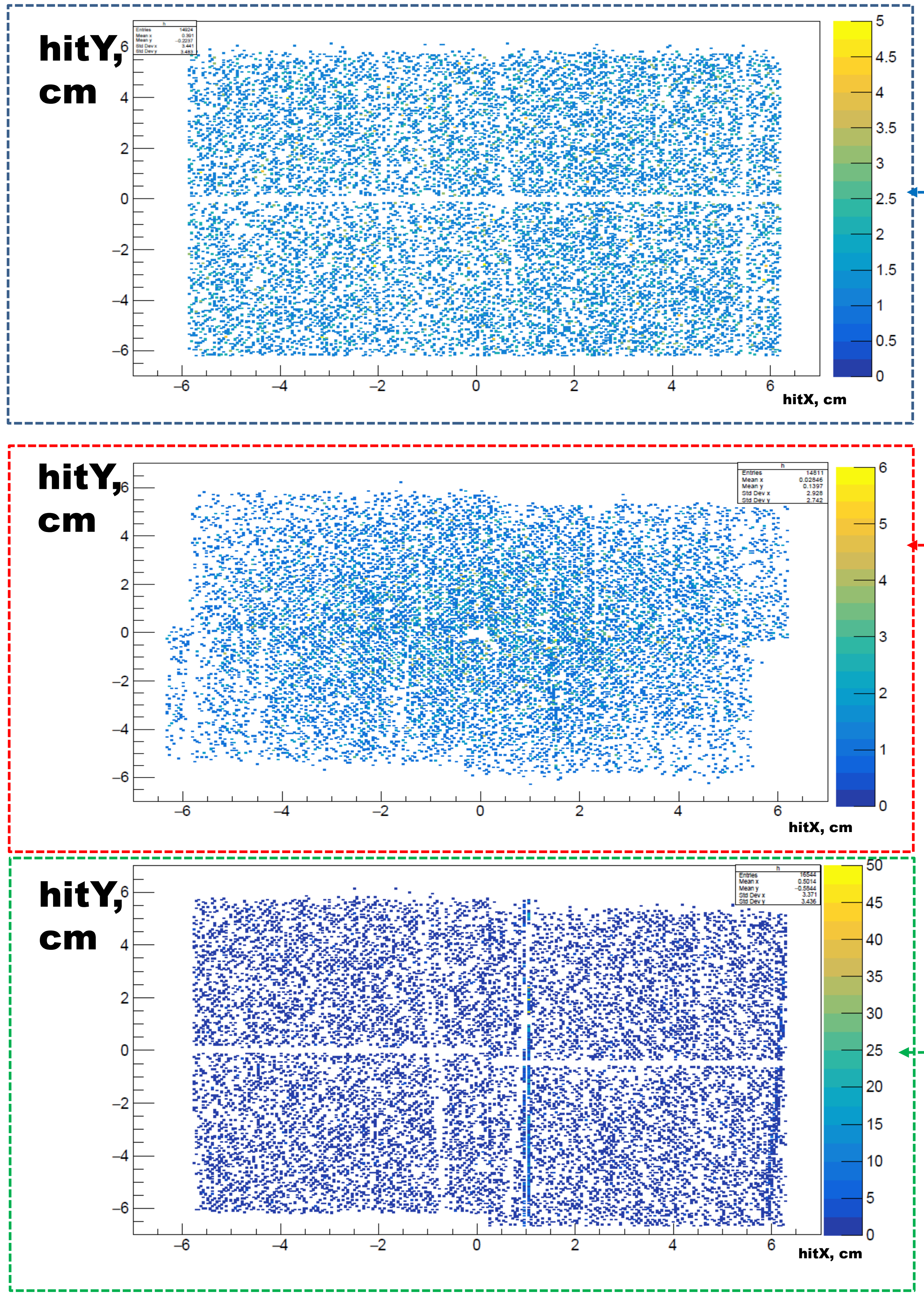




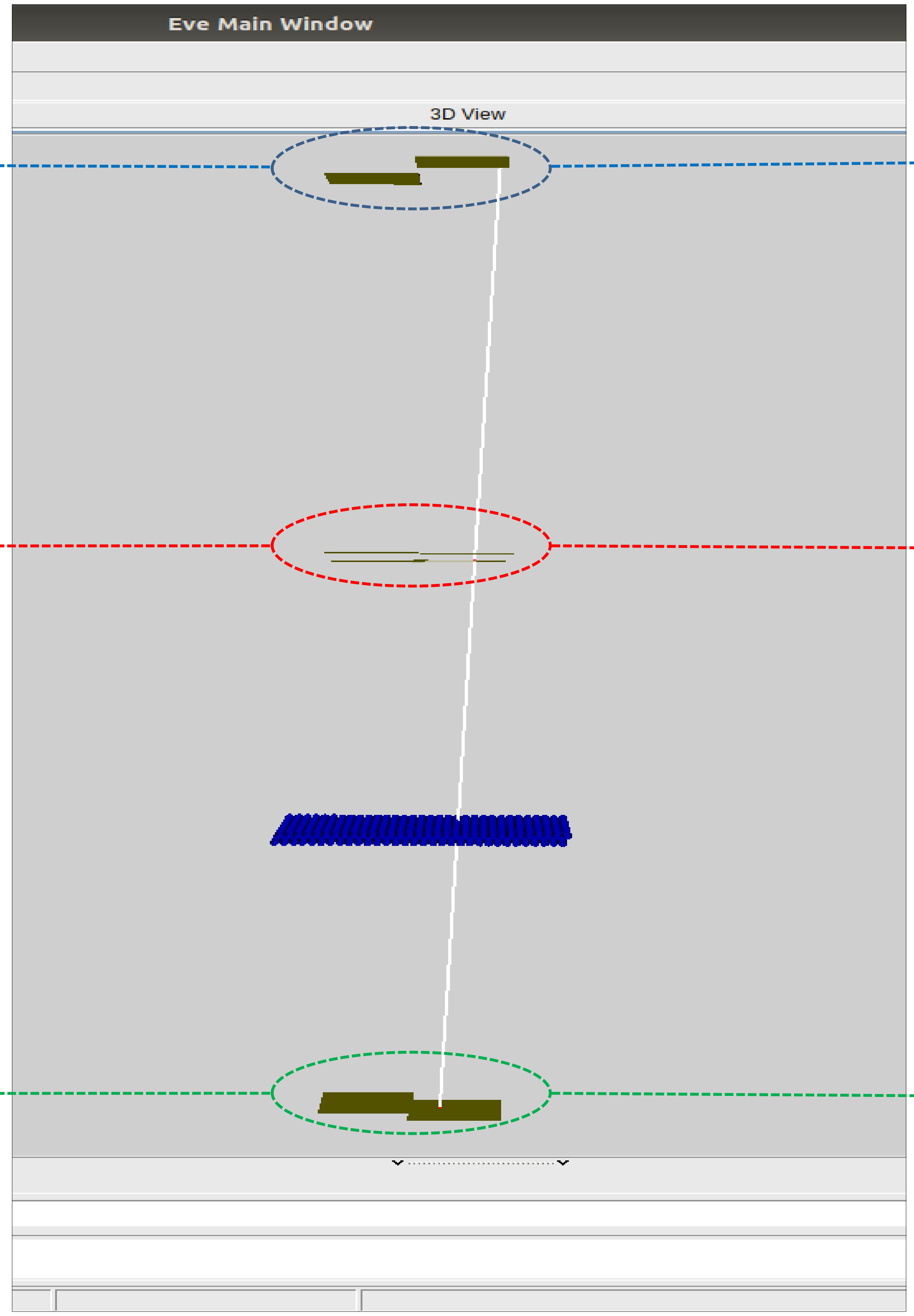
Silicon detector data monitoring



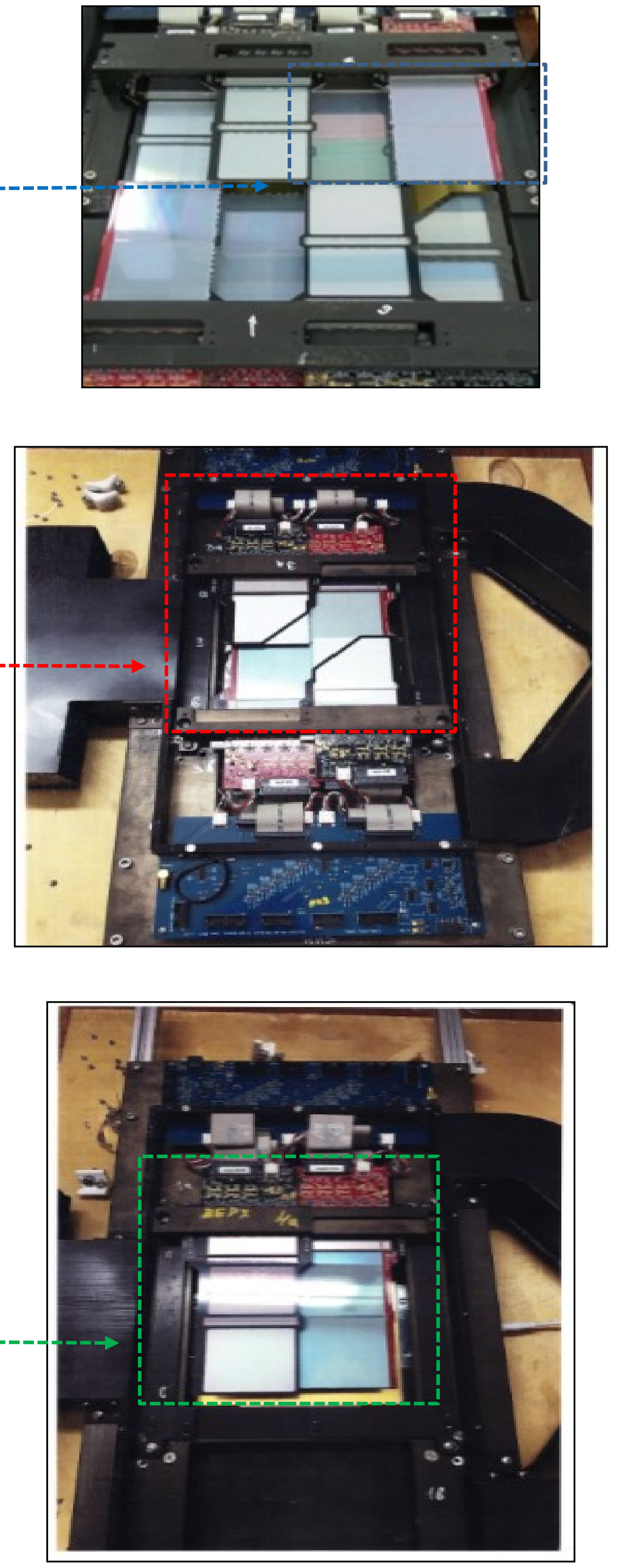
Events reconstruction



Hits plots in BM@N Si-modules

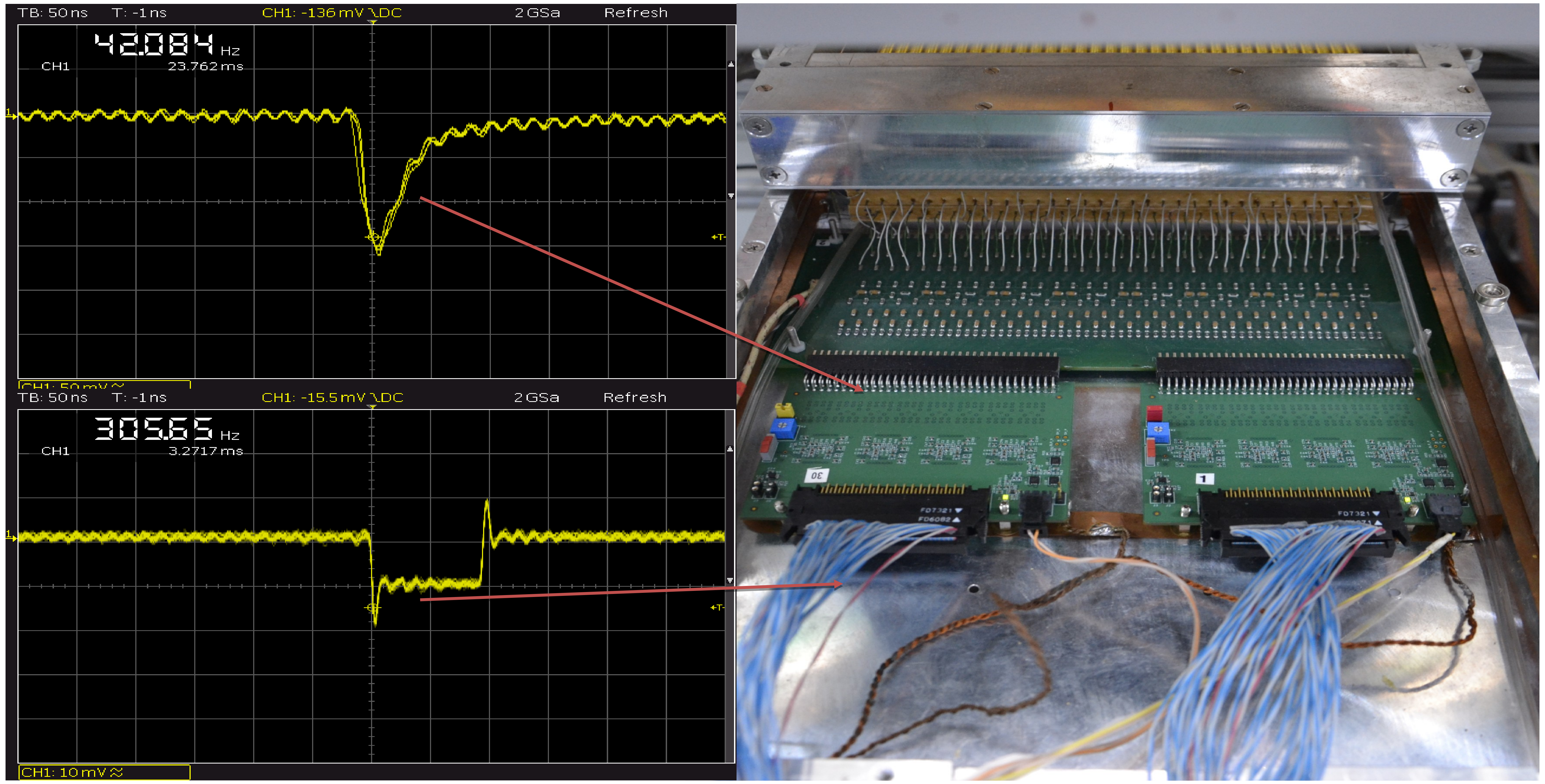


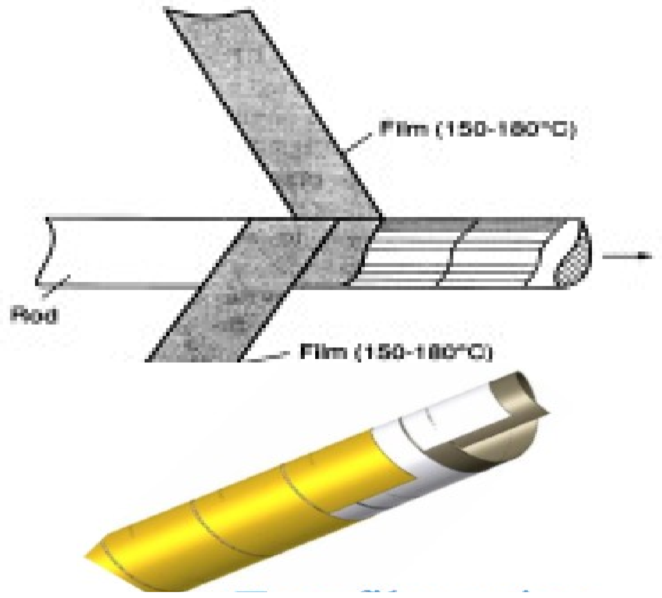
Reconstructed track in muon stand (based on bmnroot framework)



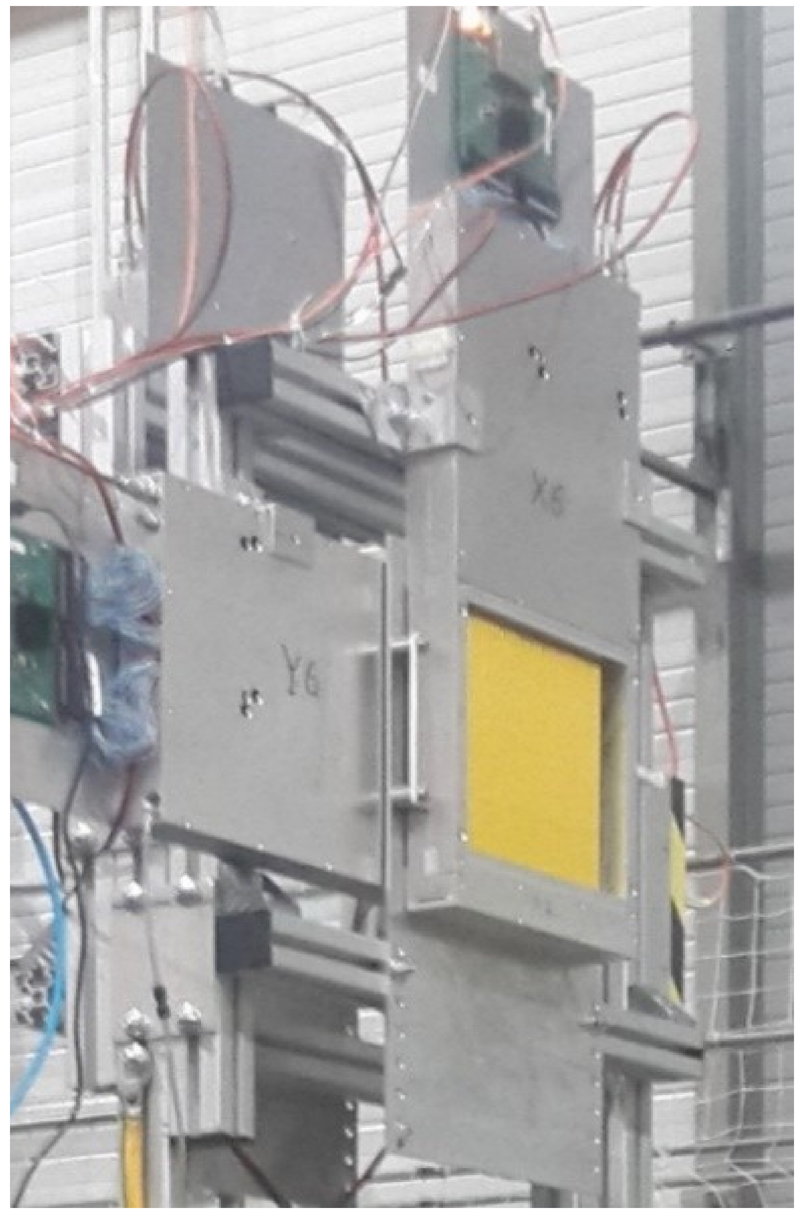
BM@N Silicon modules

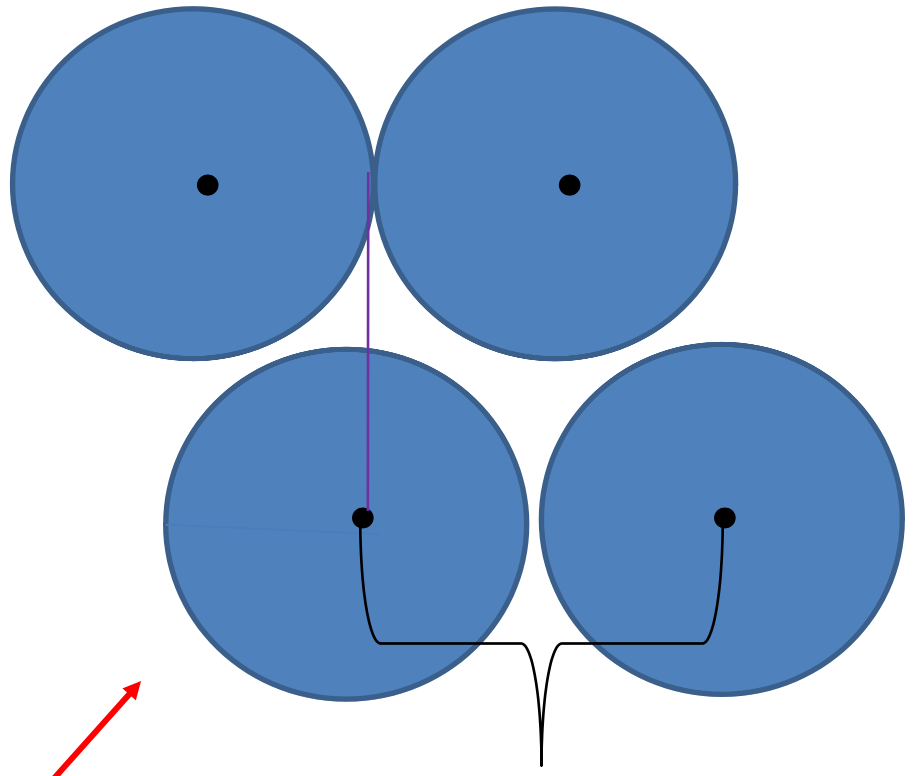
Straw tubes detector



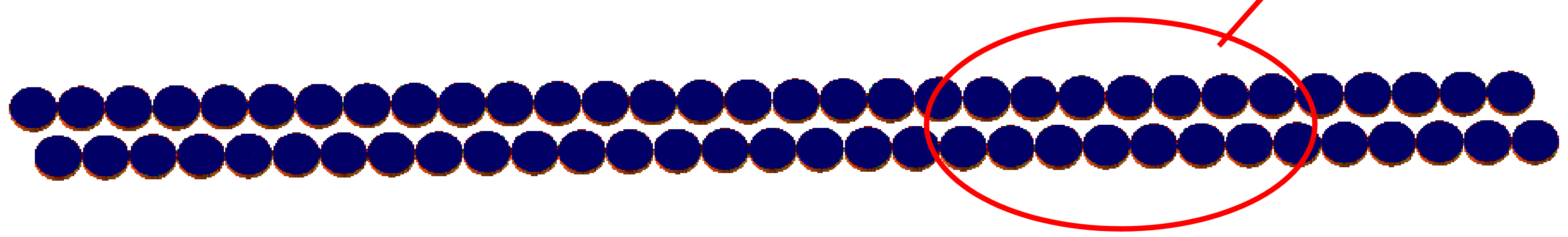


Straw winding. Two film strips are wound around the mandrel



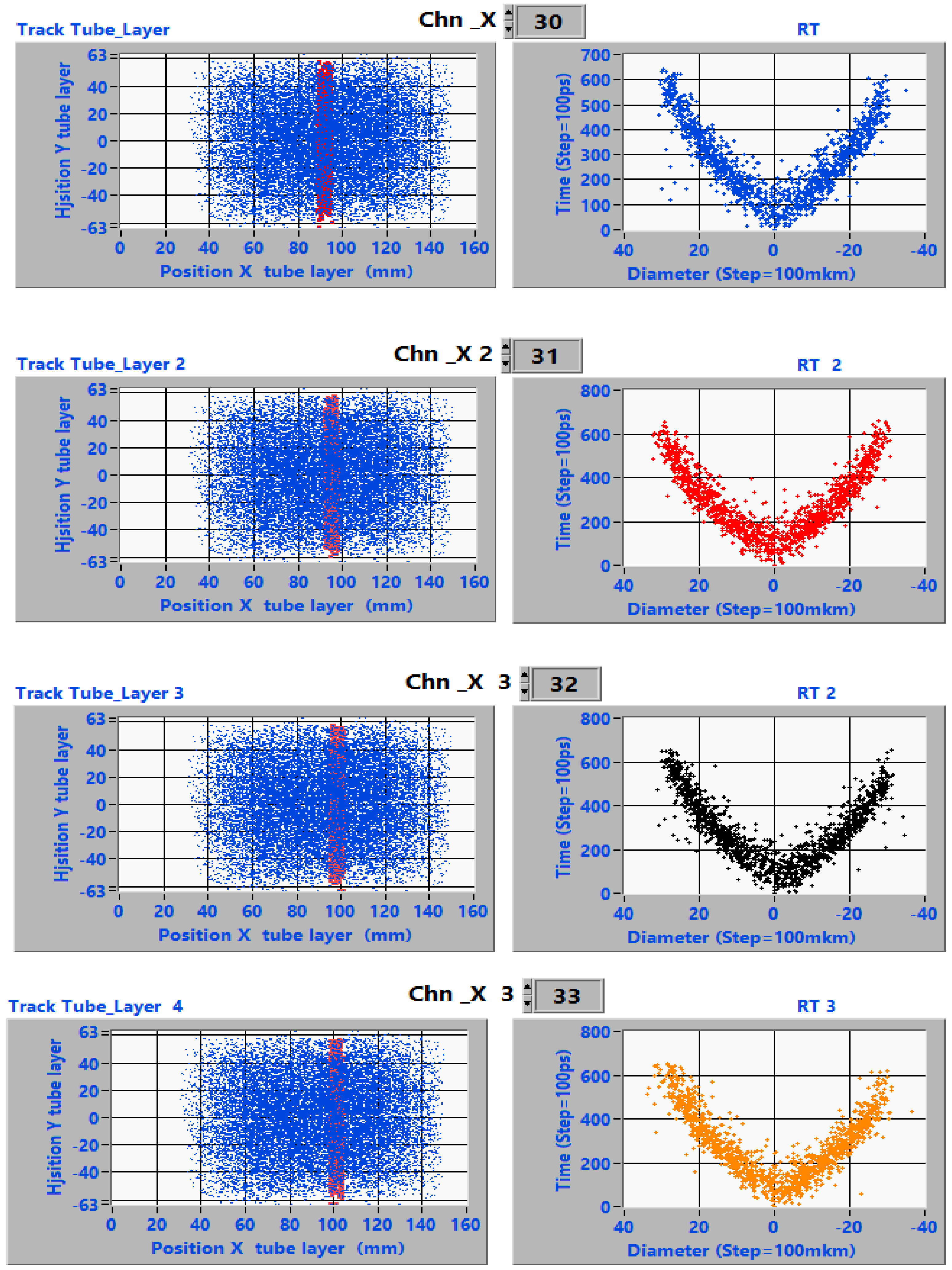


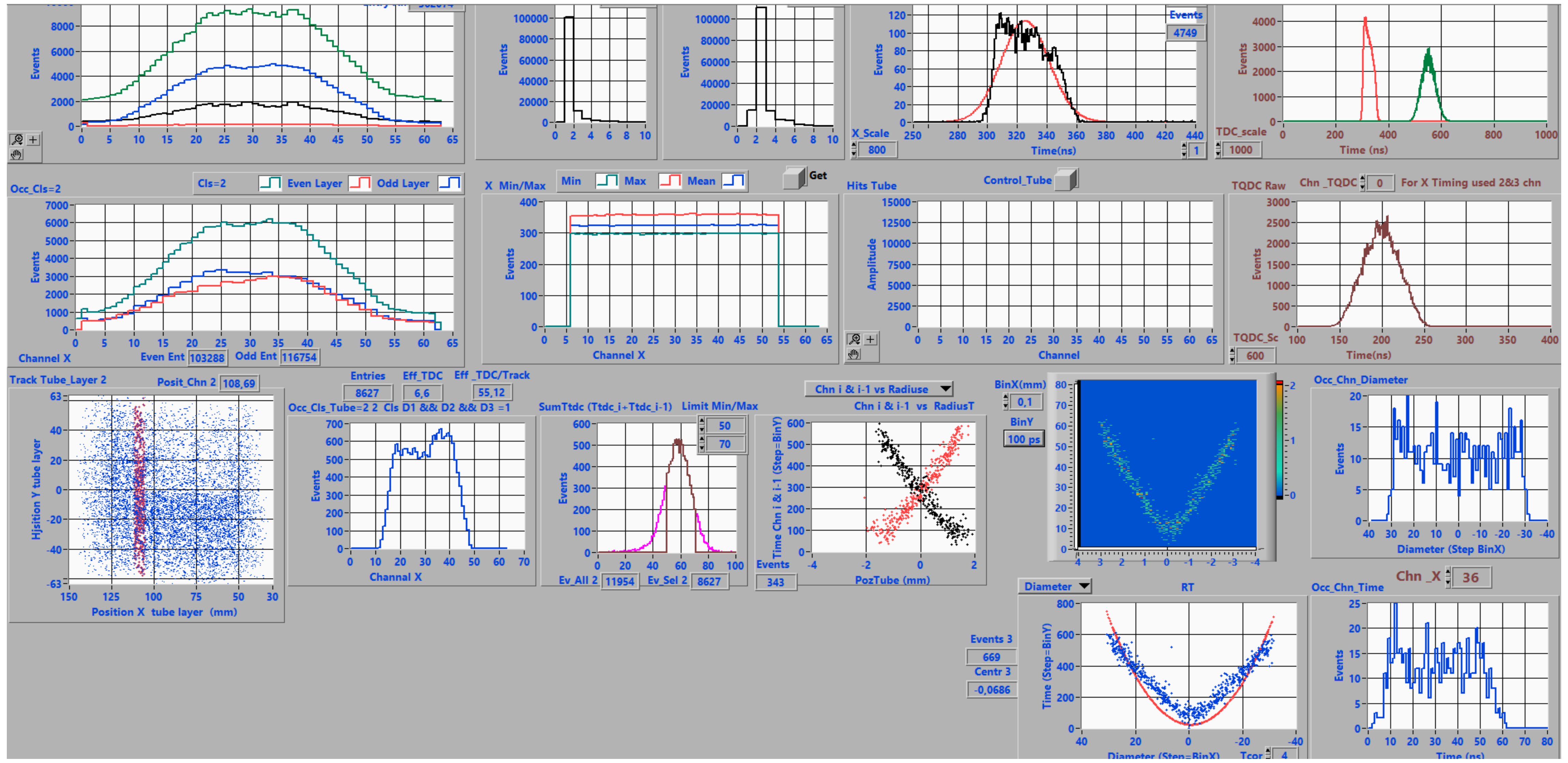
6mm

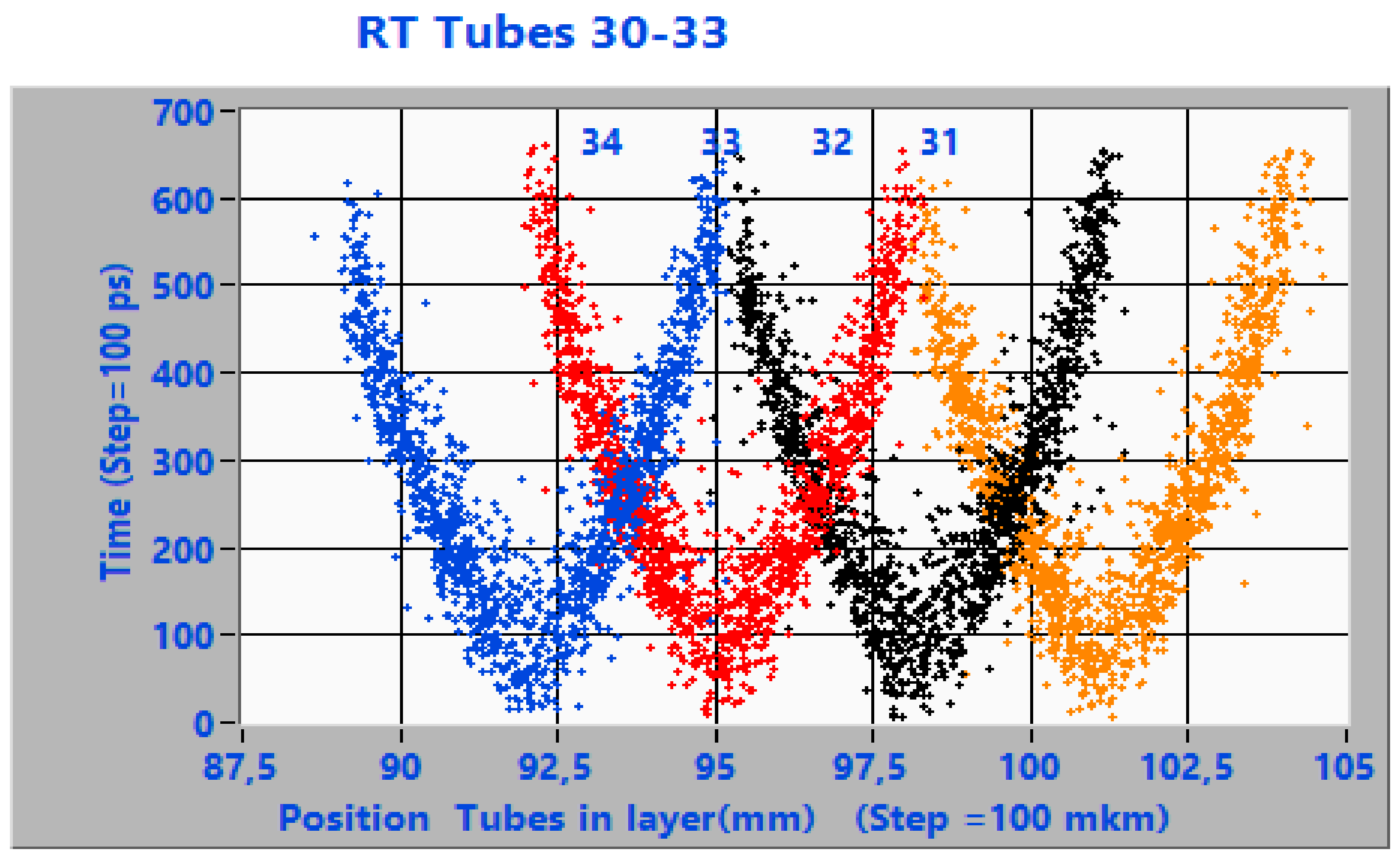


- 2 station from the NA64 experiment
- straw tube with 6mm diameter, in the centre a 30mkm diameter gold-plated tungsten wire
- Length straw 20 cm
- Precision measurement of ~200 mkm

Straw tubes data monitoring

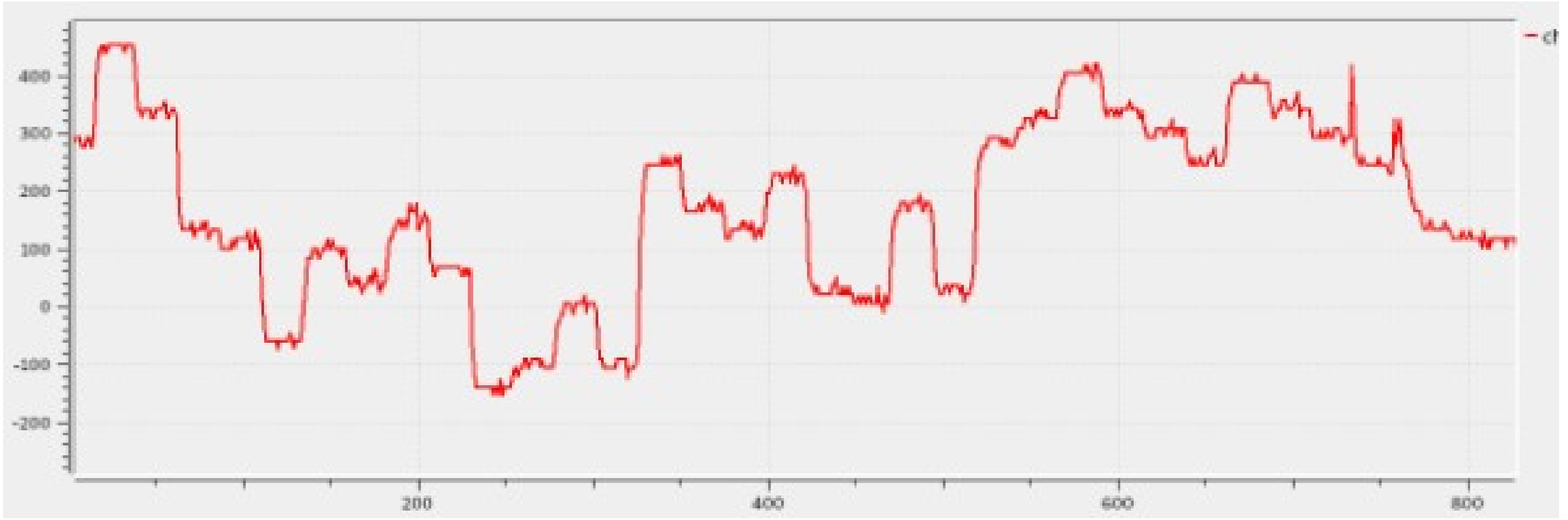


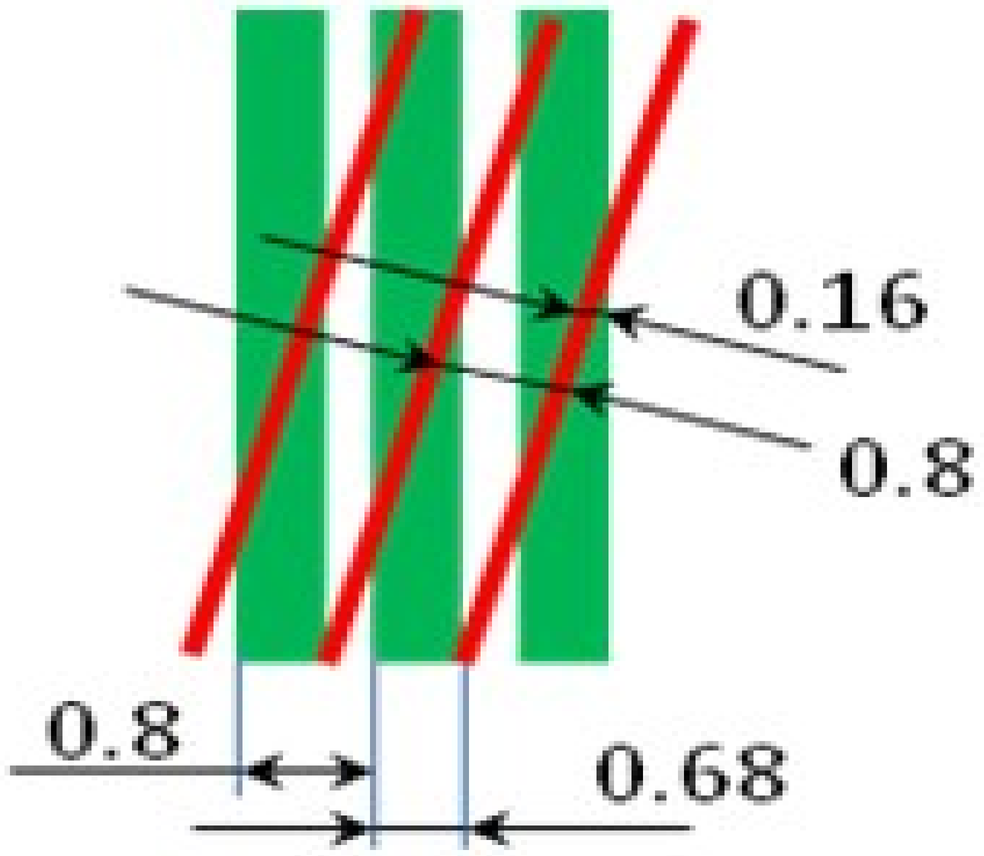


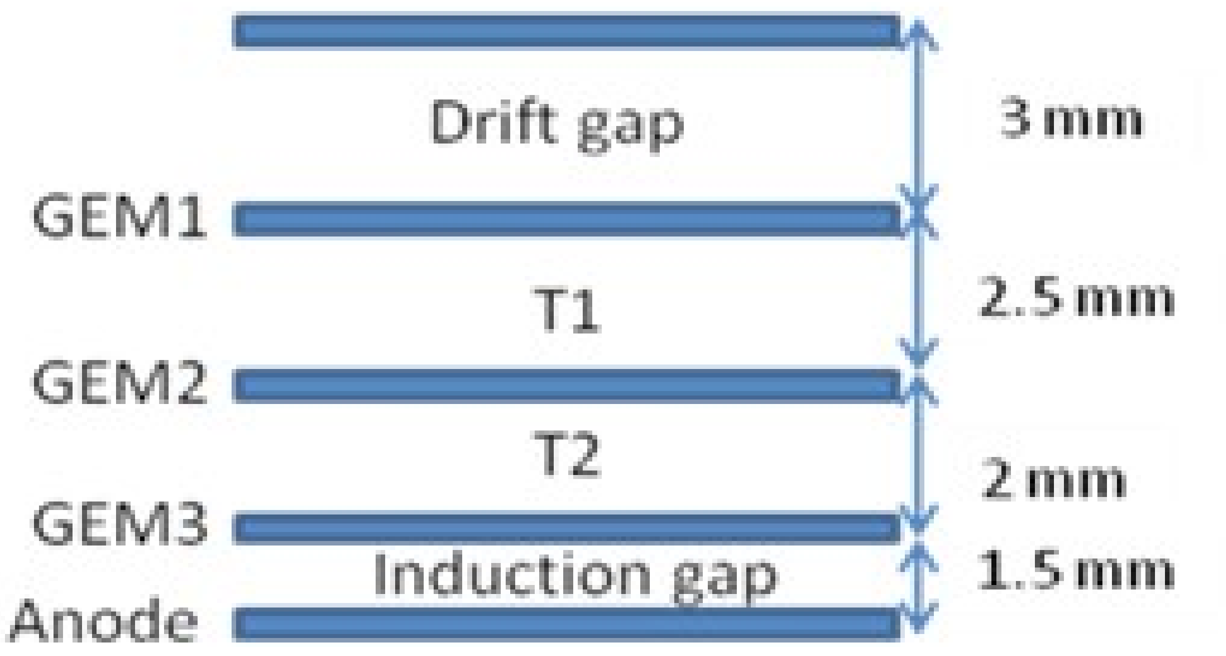


The r(t) relation (isochrone relation or "V-shape") for straw tubes 30-33

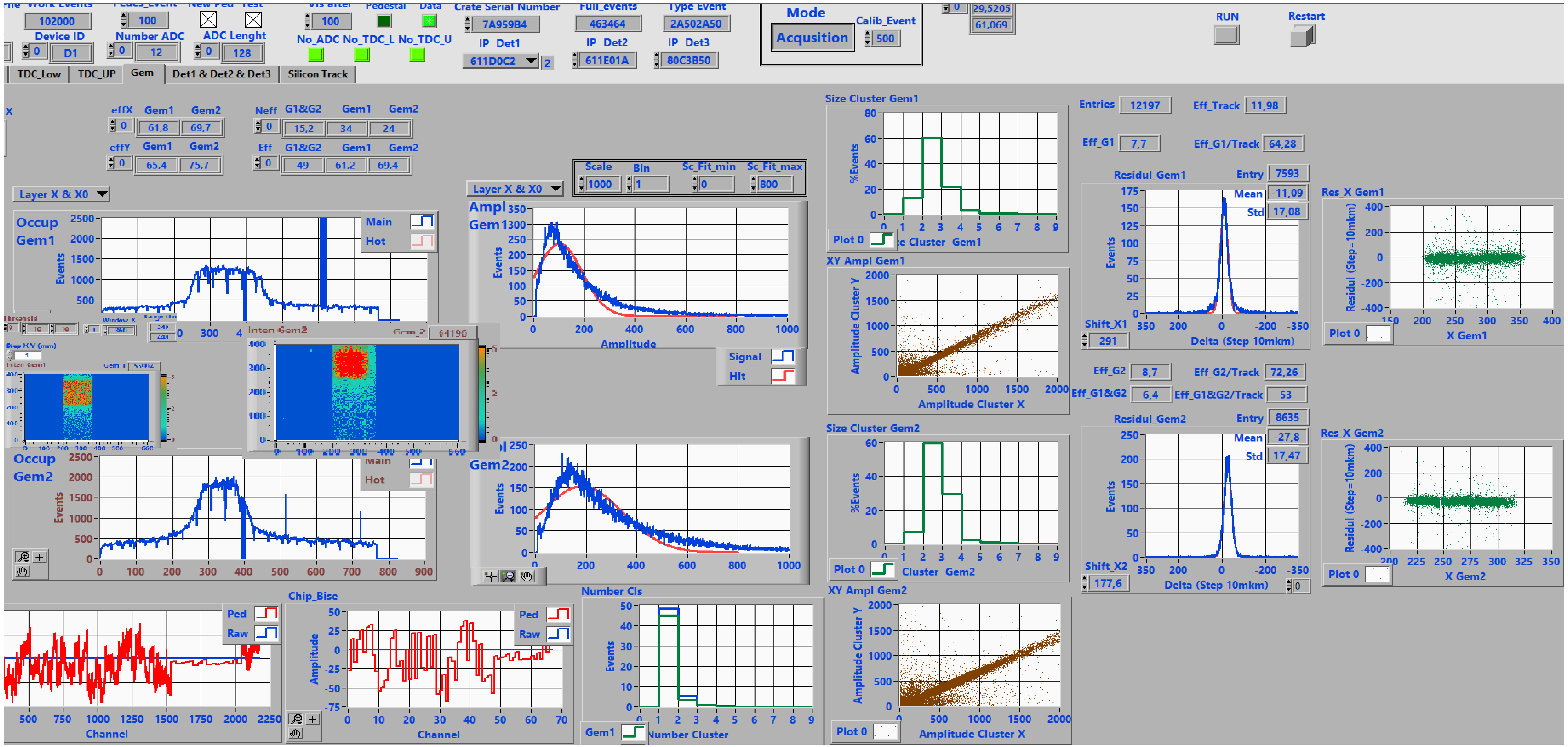
GEM detector



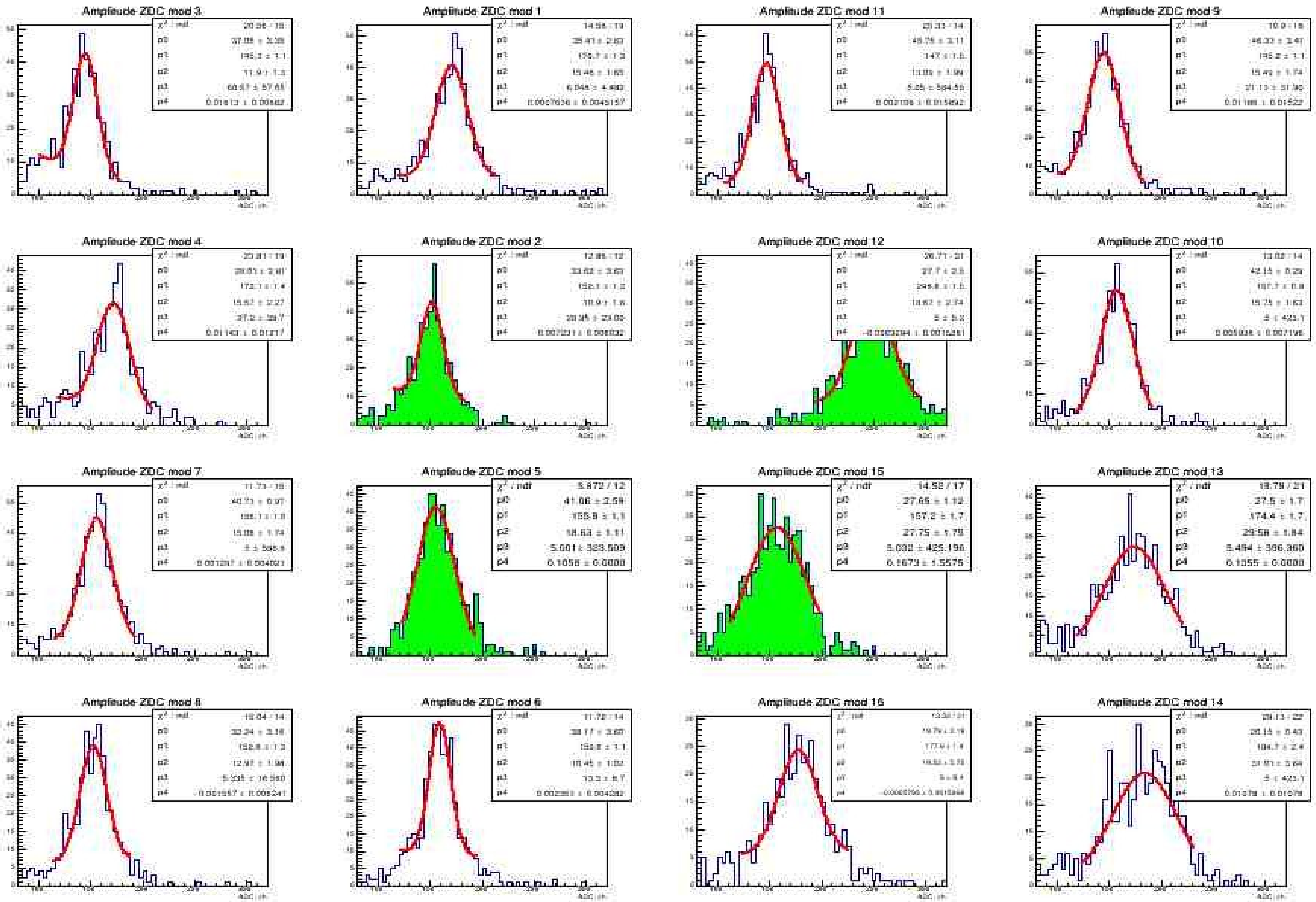




GEM data monitoring

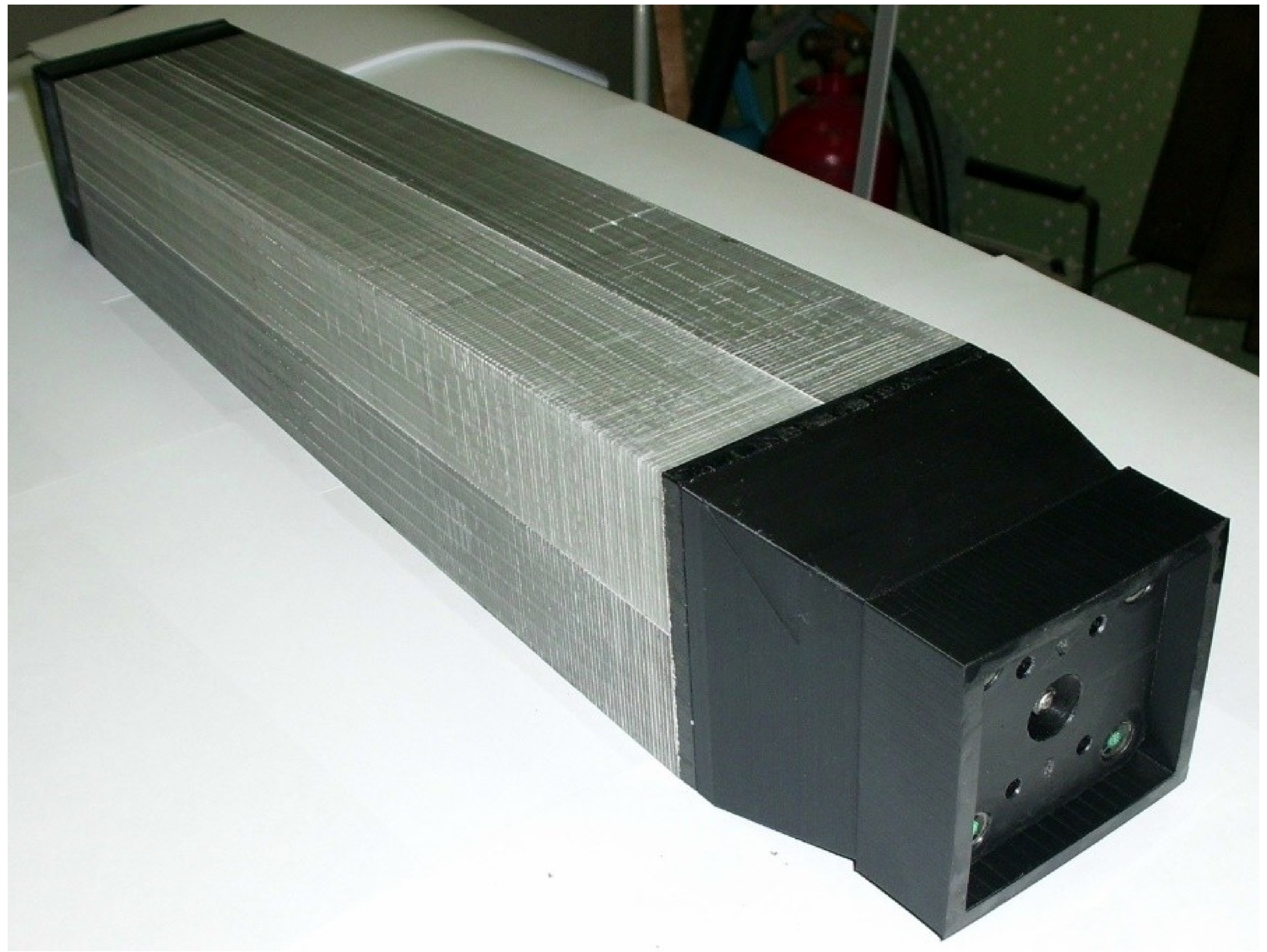


Electromagnetic calorimeter

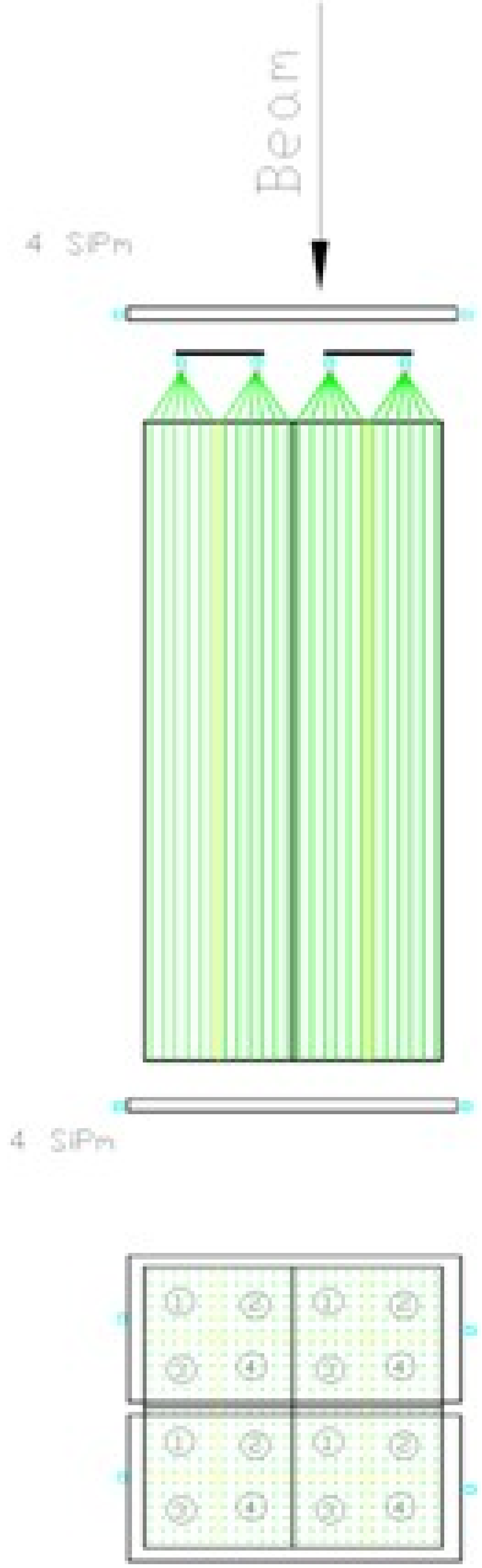


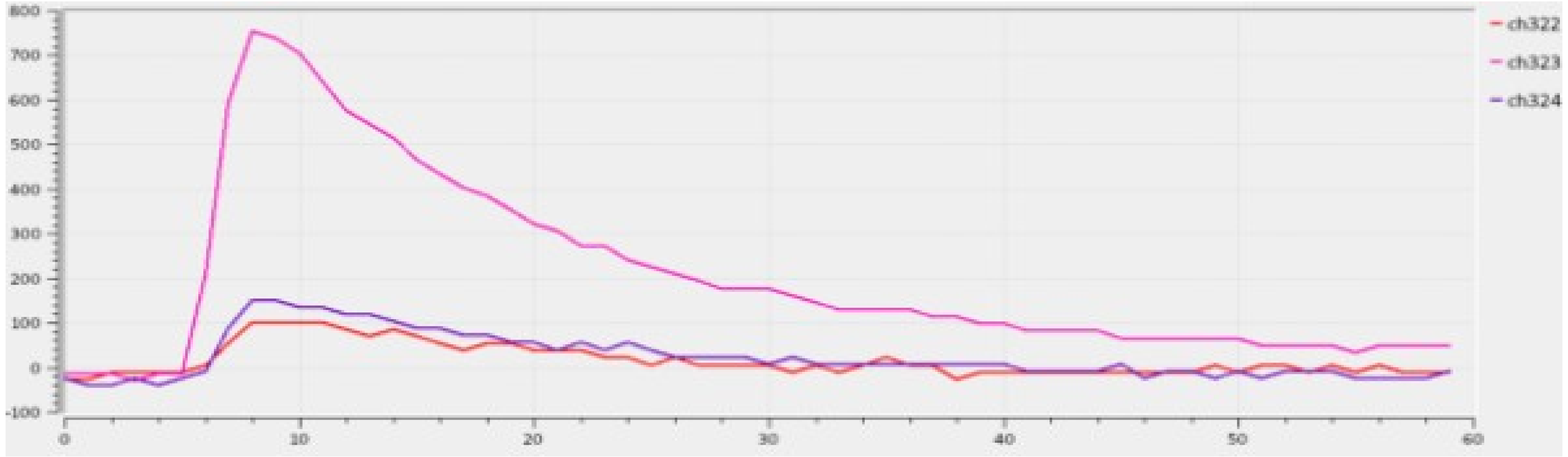
ECAL MIP spectra in corresponding cells (top view)

ECAL base element

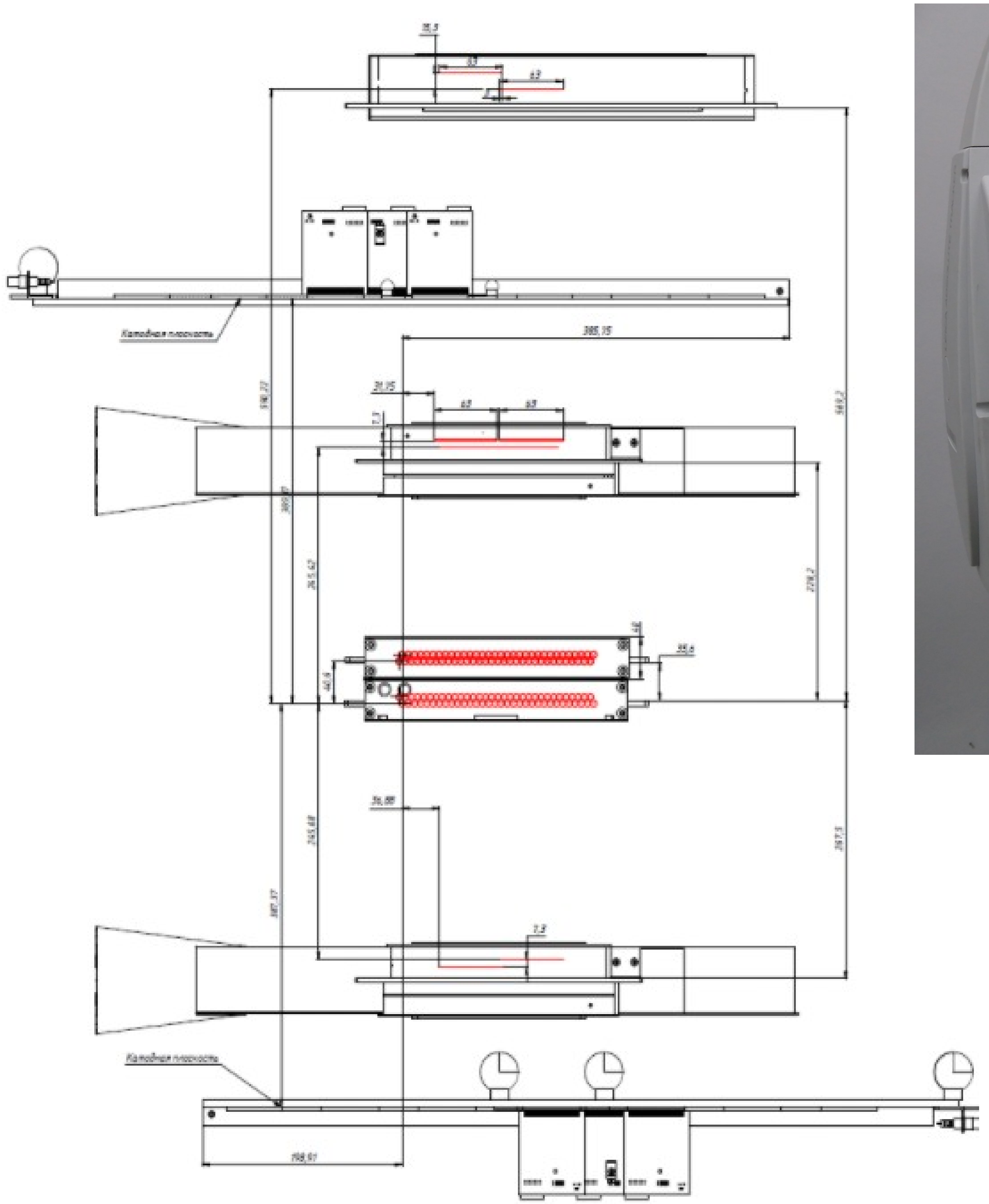


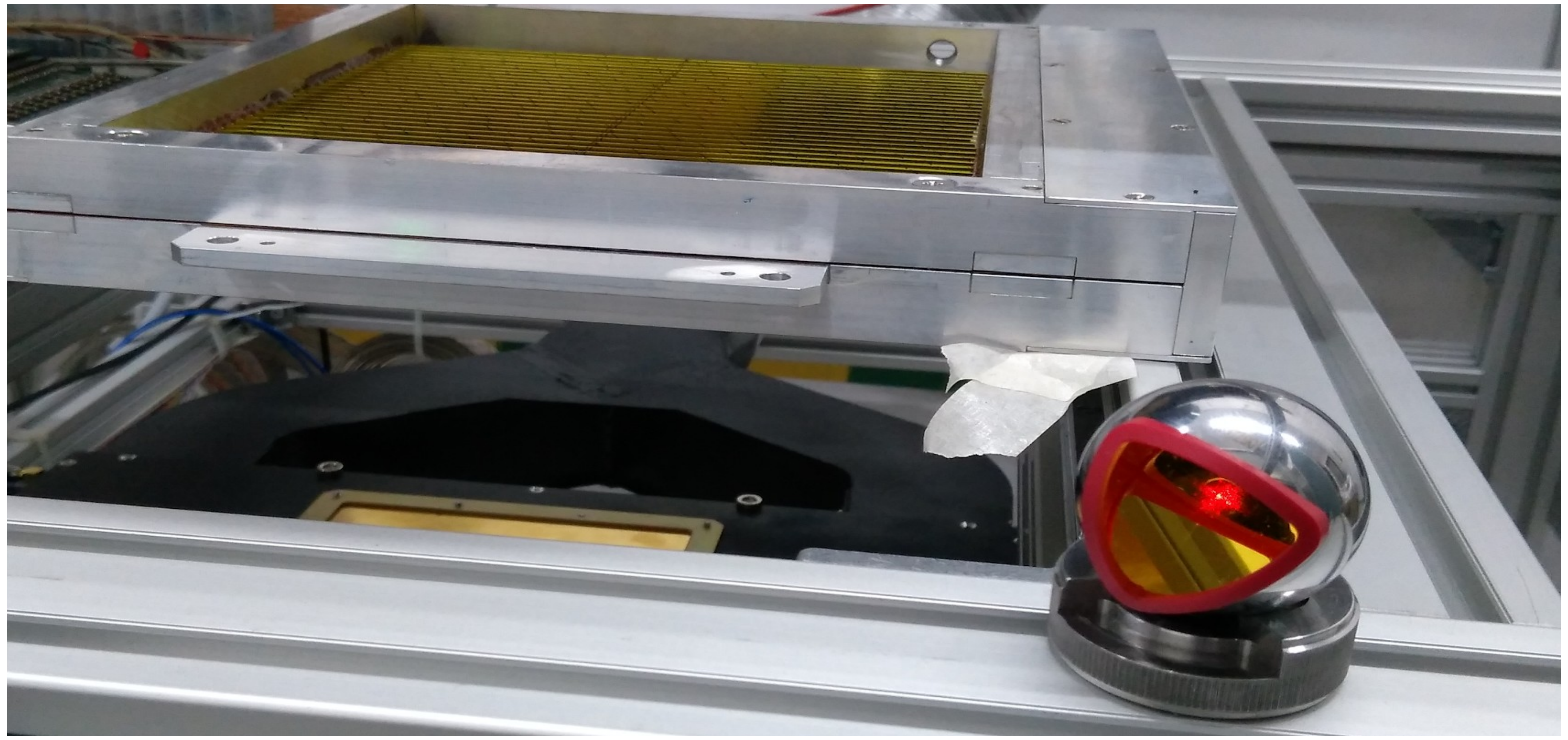
ECAL module (110x110 mm^2)design
Module consist of 4 cells 55x55x440 mm^3
- 220 Layers Lead and Scintillator
- 1.5 mm – Scintilator
- 0.3 mm - Lead

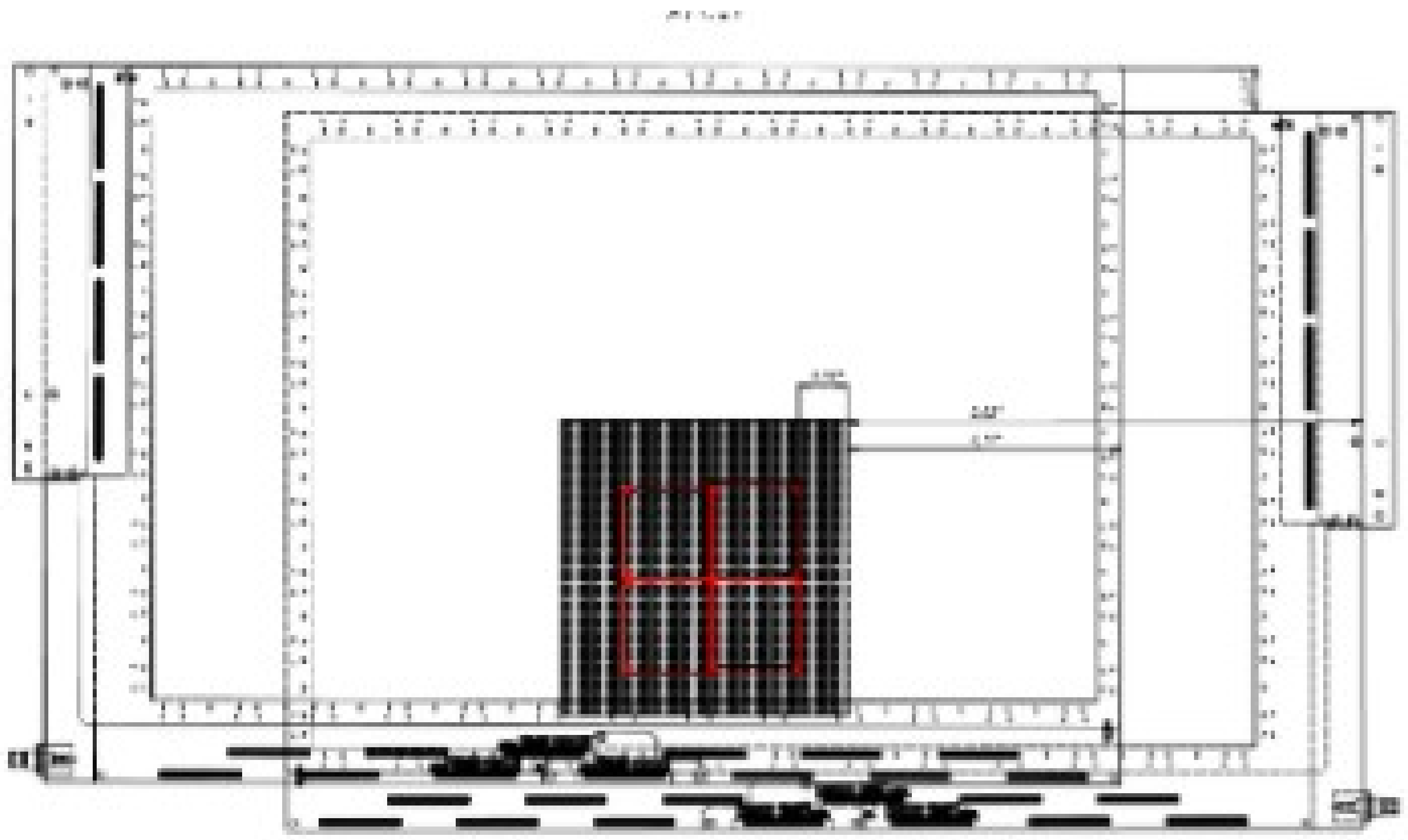




Alignment







measurement accuracy
50 um

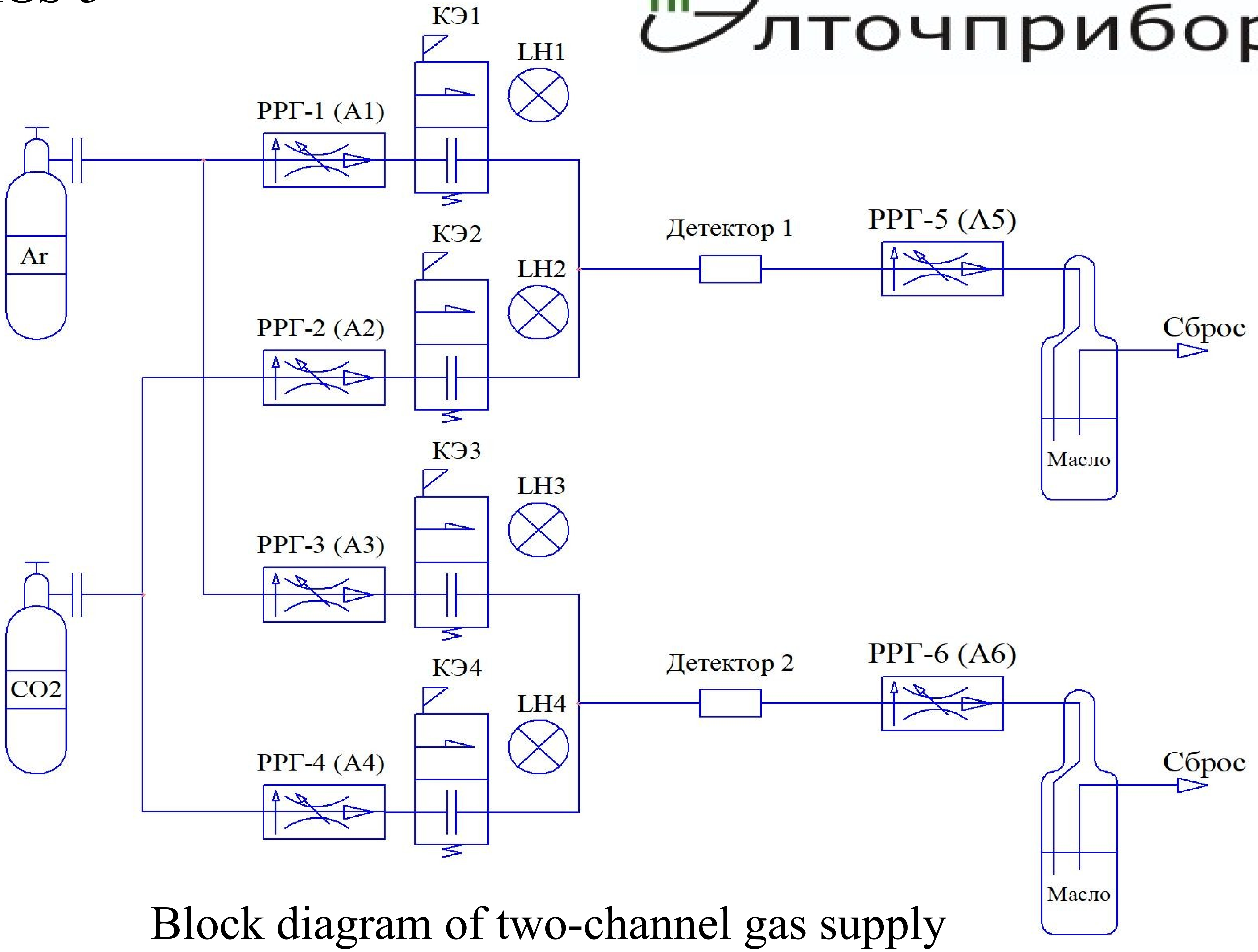
Gas supply system

Controller for gas mixing systems KGS-3

Gas-Feeding Systems elements (material – st.steel)

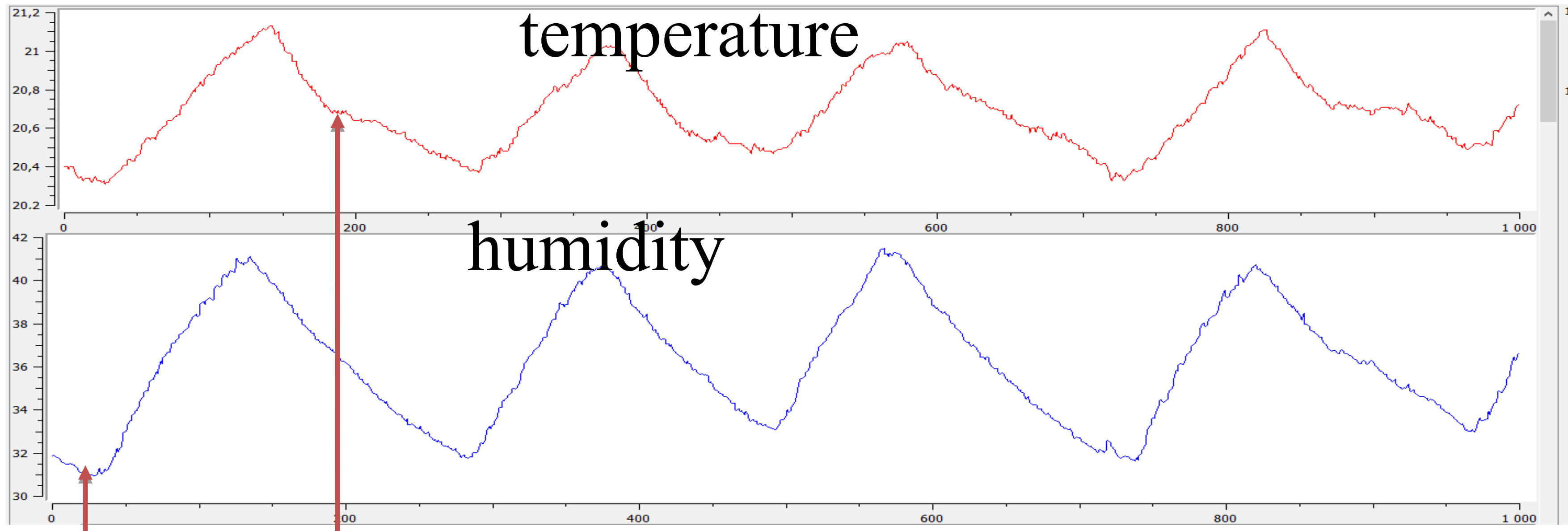
Mass Flow Controllers(MFC)

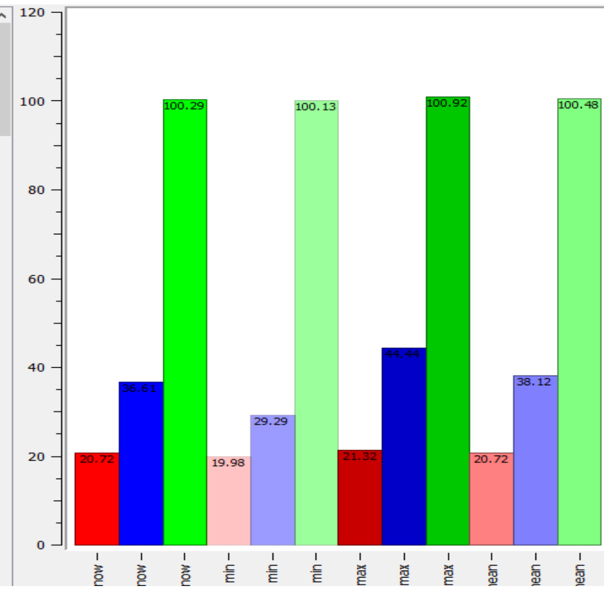
системы технологического газоснабжения
ТП Элточприбор



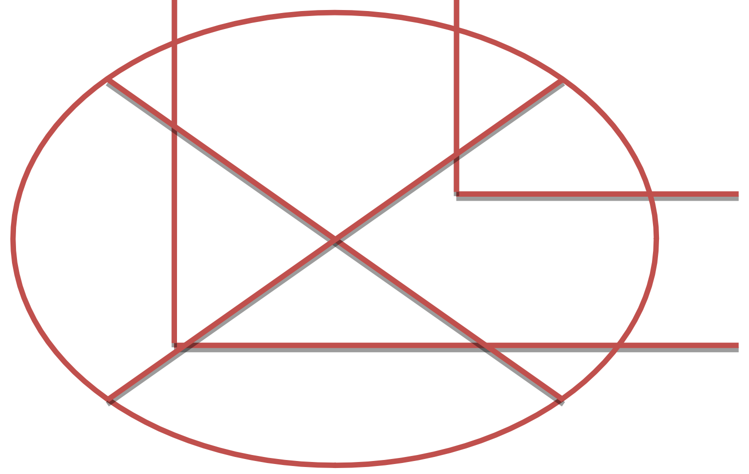
Block diagram of two-channel gas supply

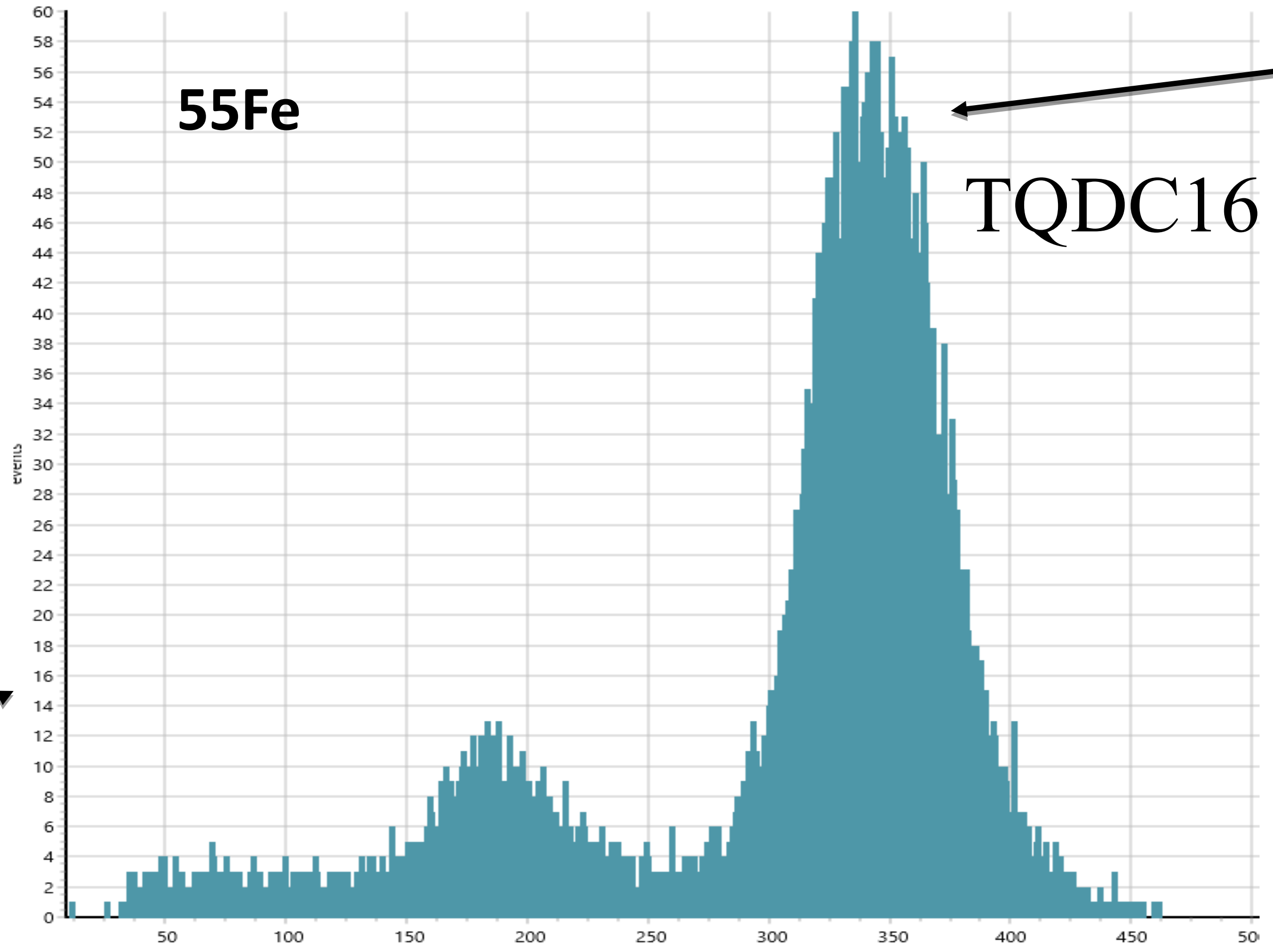
Slow control



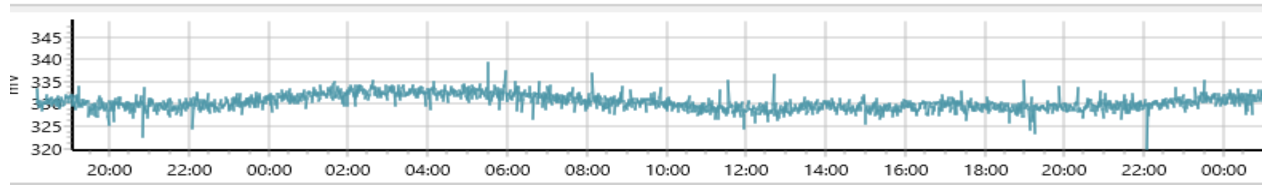


GAS GAIN Monitor
from the NA62 experiment





reference peak



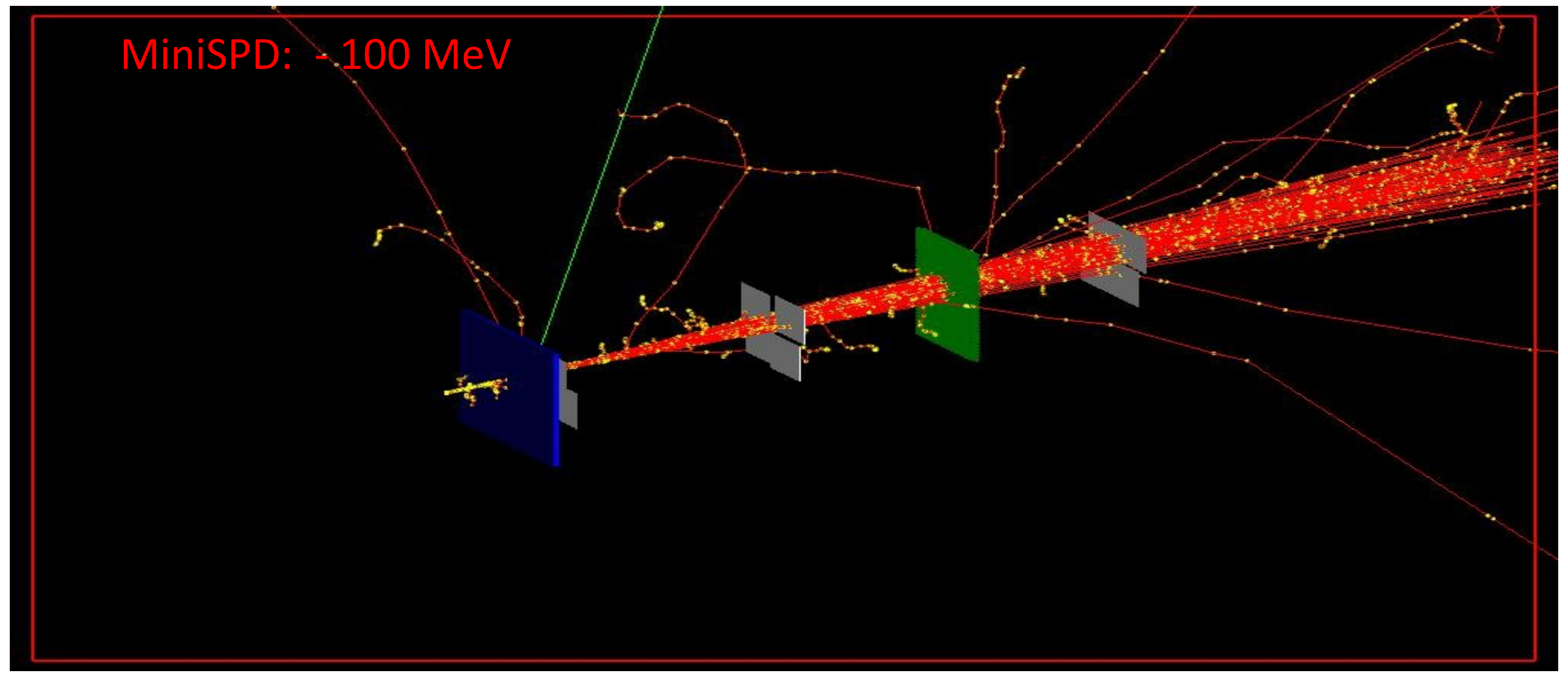
the histogram of
the change in gas gain
value

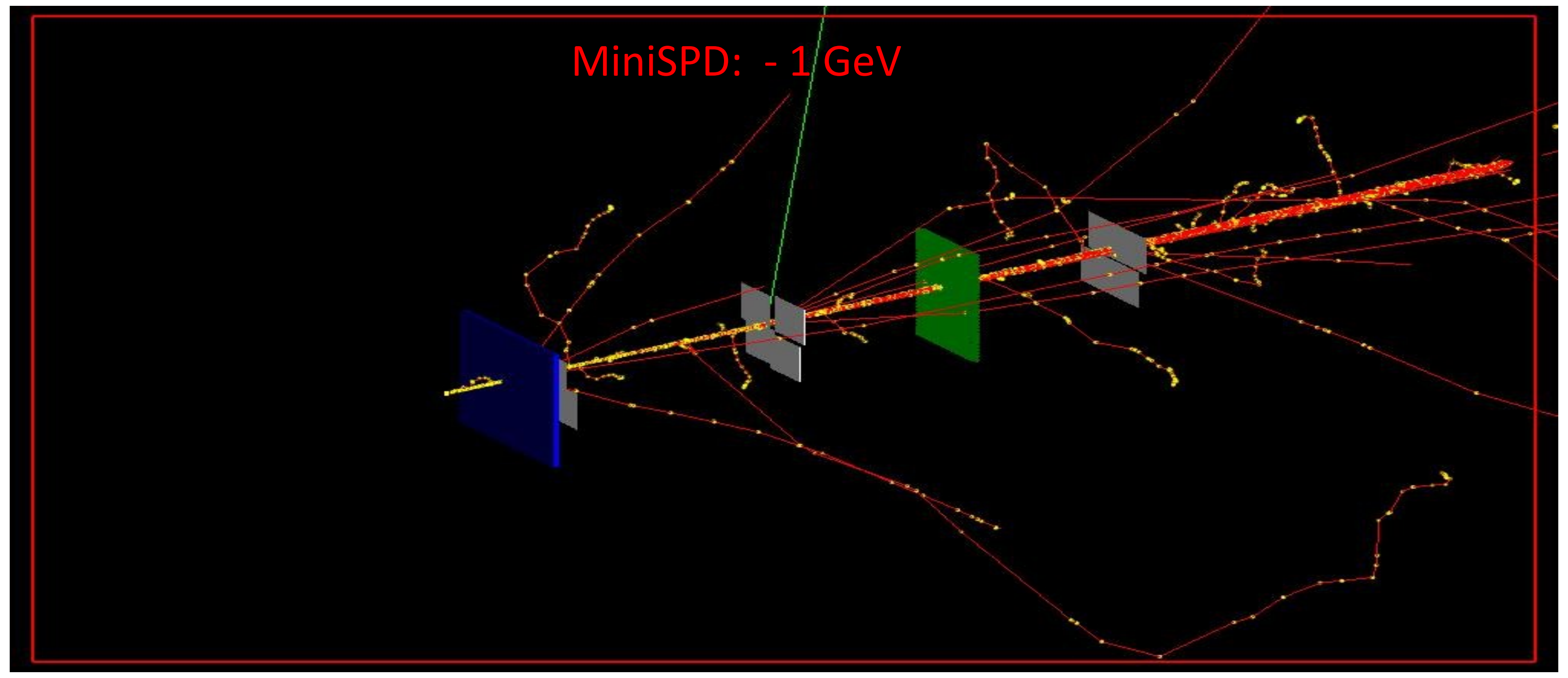
HV & LV-slow control
windows
Tango Controls
Grafana observation dashboard

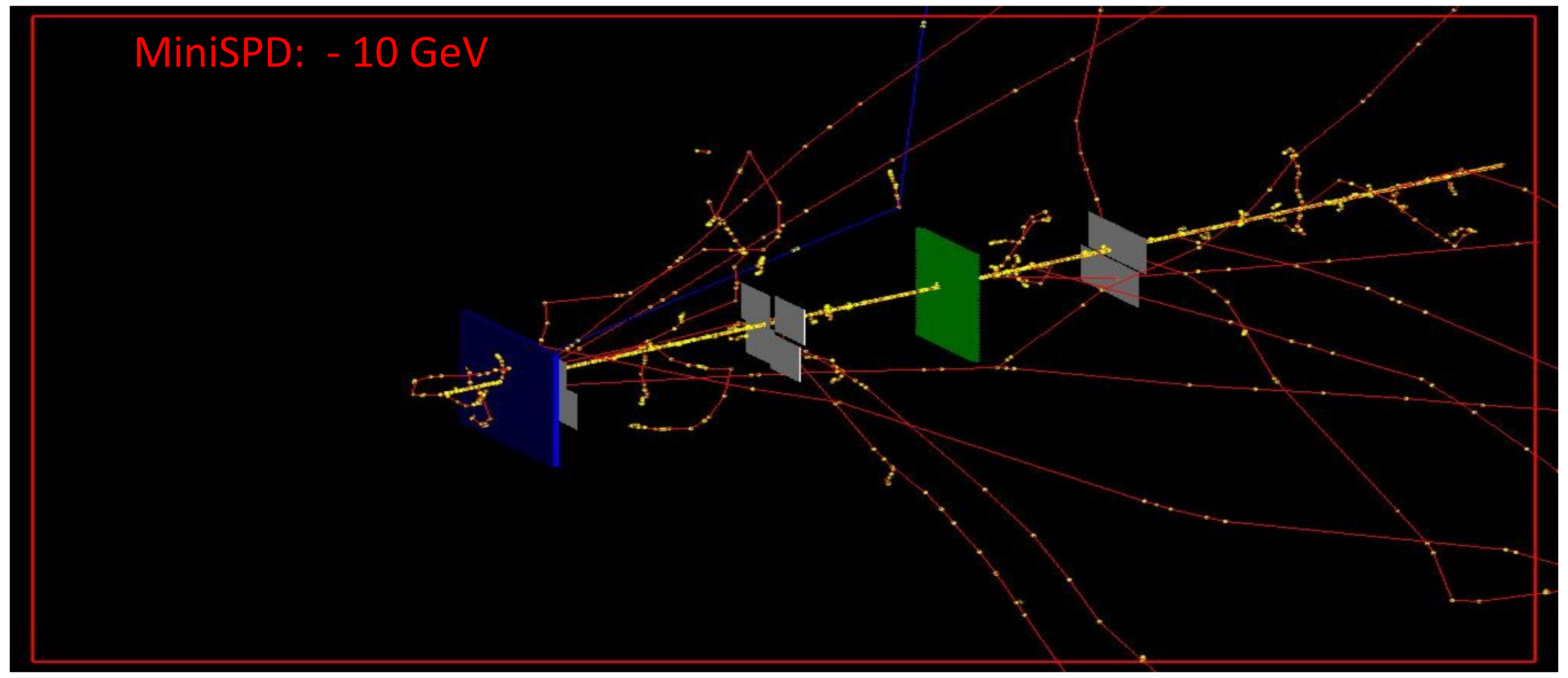
Geant4

The old version of the miniSPD model stand is implemented using the Geant4 package for a 100 MeV, 1 GeV,and 10 GeV μ - beam.

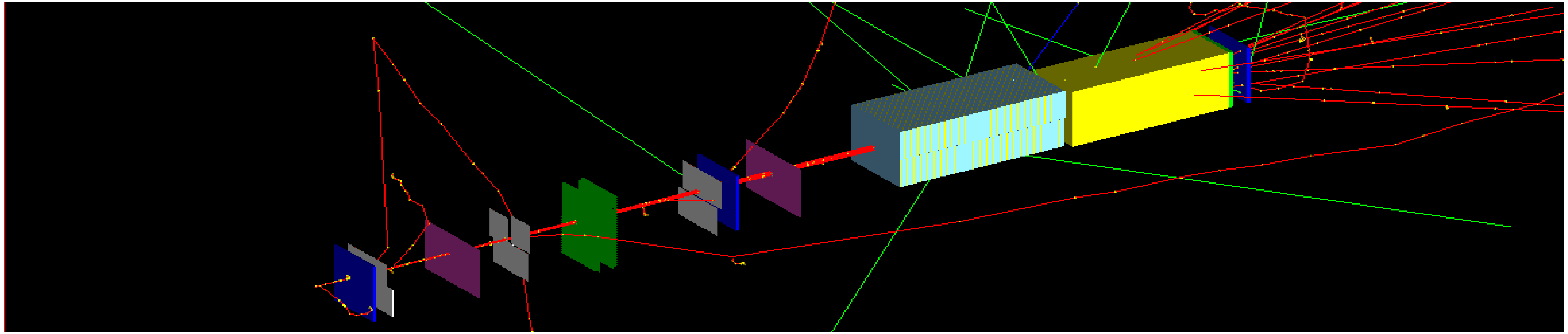
The model consists of 2 scintillators, 3 Si detectors, 1 straw station







The new model consists of 3 scintillators, 3 Si detectors, 2 straw stations, 2 GEM detectors, ECAL, Pb-filter



Conclusions:

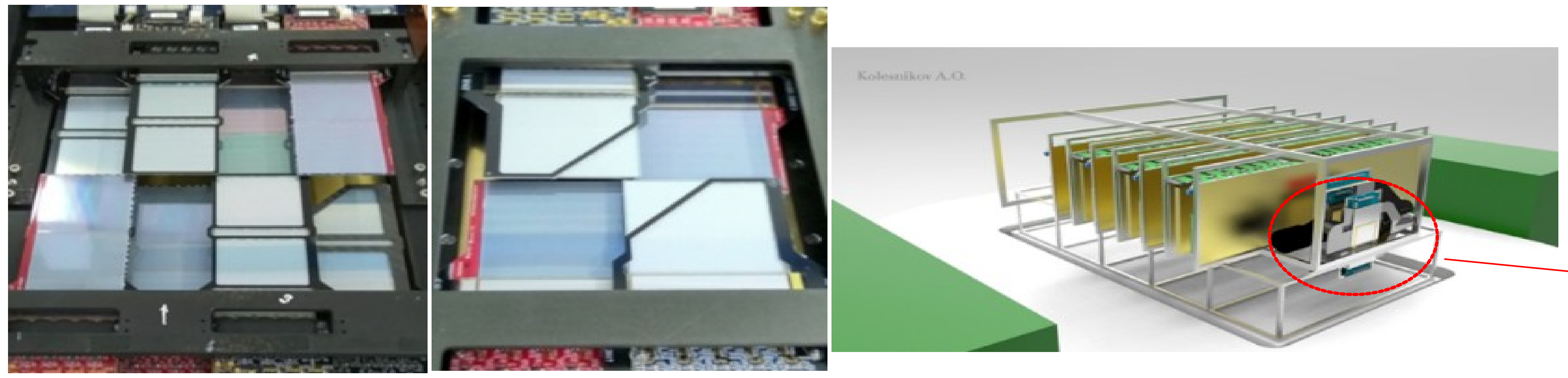
- The first version of cosmic muon stand for testing straw detectors based on external BM@N Si detector tracking system – designed and produced
- Software for track reconstruction is developed based on BMNRoot framework
- BM@N Silicon detector allows detecting coordinate and amplitude of m.i.ps signals
- First straw detector testing results (Time and R-T distributions) are obtained at different pressure

Plans

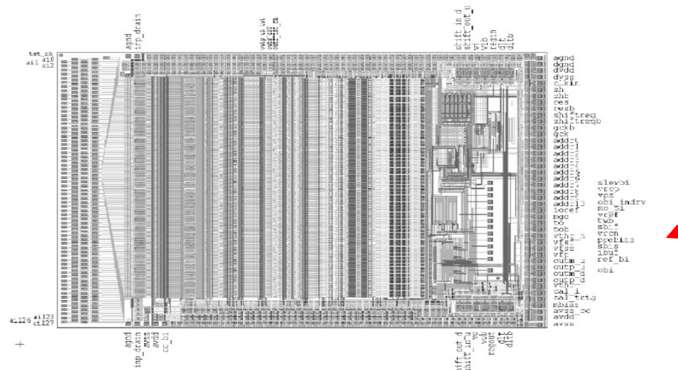
- Develop software for alignment
- Add new tracking detectors to increase measurement accuracy
- Add elements of the muon range system from SPD
- Add calorimeter to scan trigger events by energy
- Collect more data to build R-T for each straw detector
- Develop software for track reconstruction based on SPDRoot
- Update online-monitoring programs
- Develop DAQ system, based on AFI Electronics and COMPASS DAQ
- Use Garfield to simulate a straw tube signal

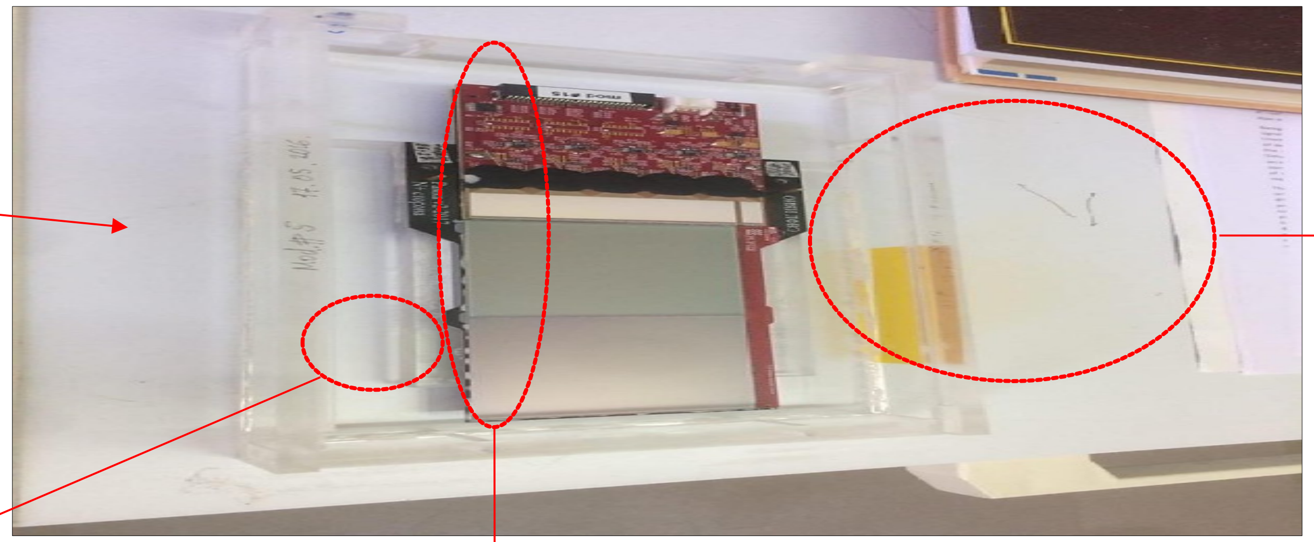
Backup slides

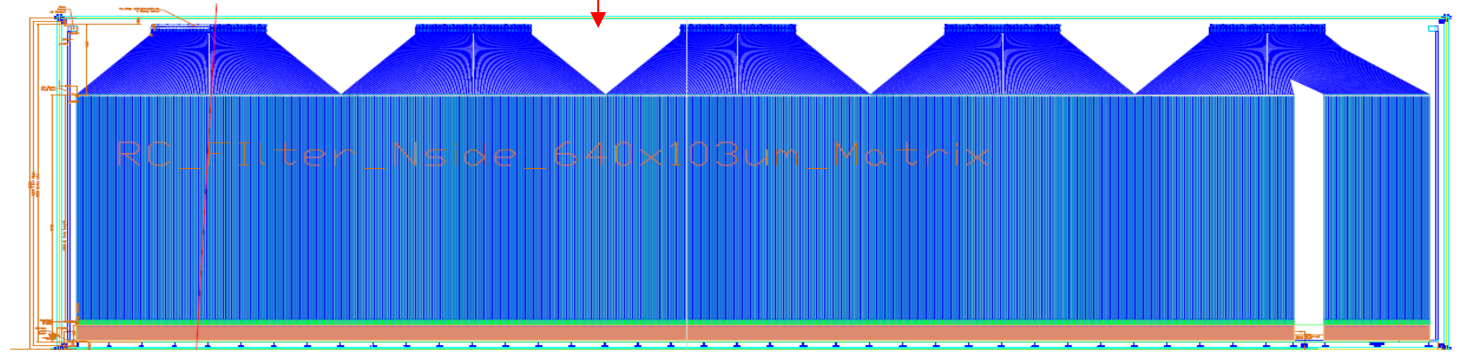
BM@N Silicon detector module design

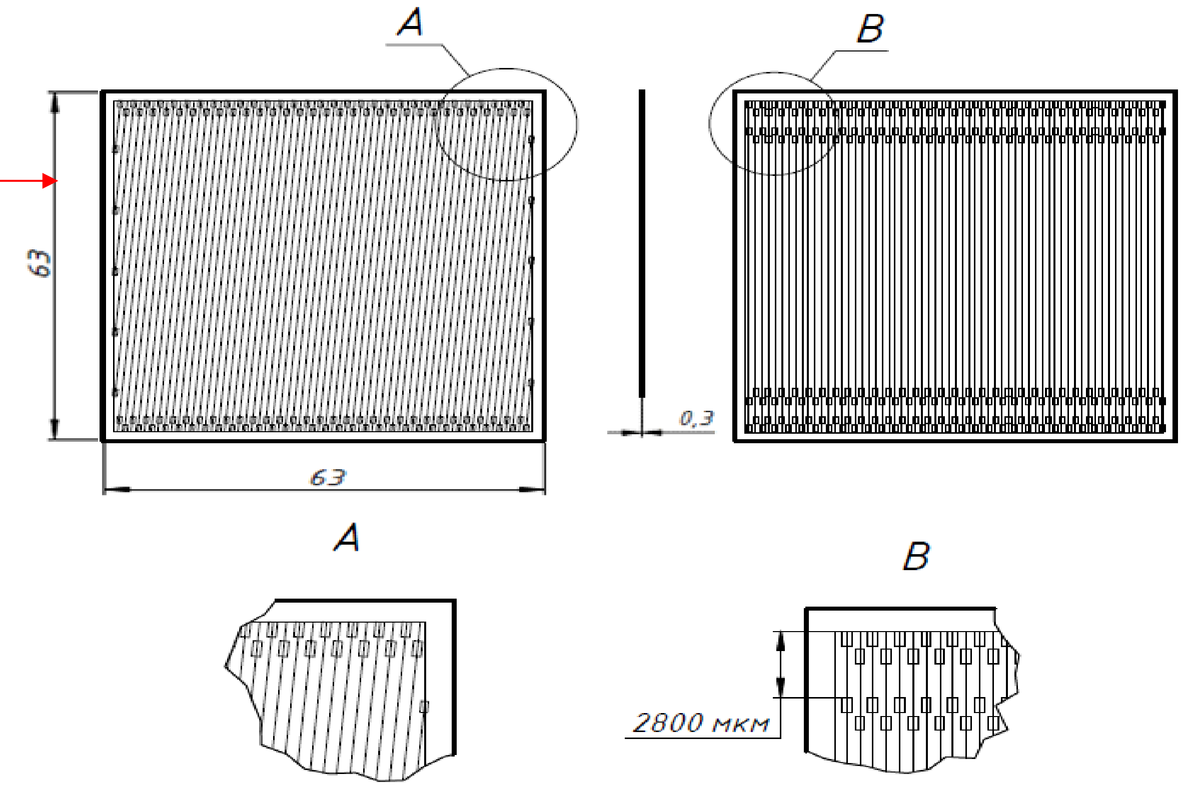


Positions of Forward and Vertex Silicon Detector at BM@N technical run March 2018
[M.Kapishin , Status of Baryonic Matter at Nuclotron, October 2018]









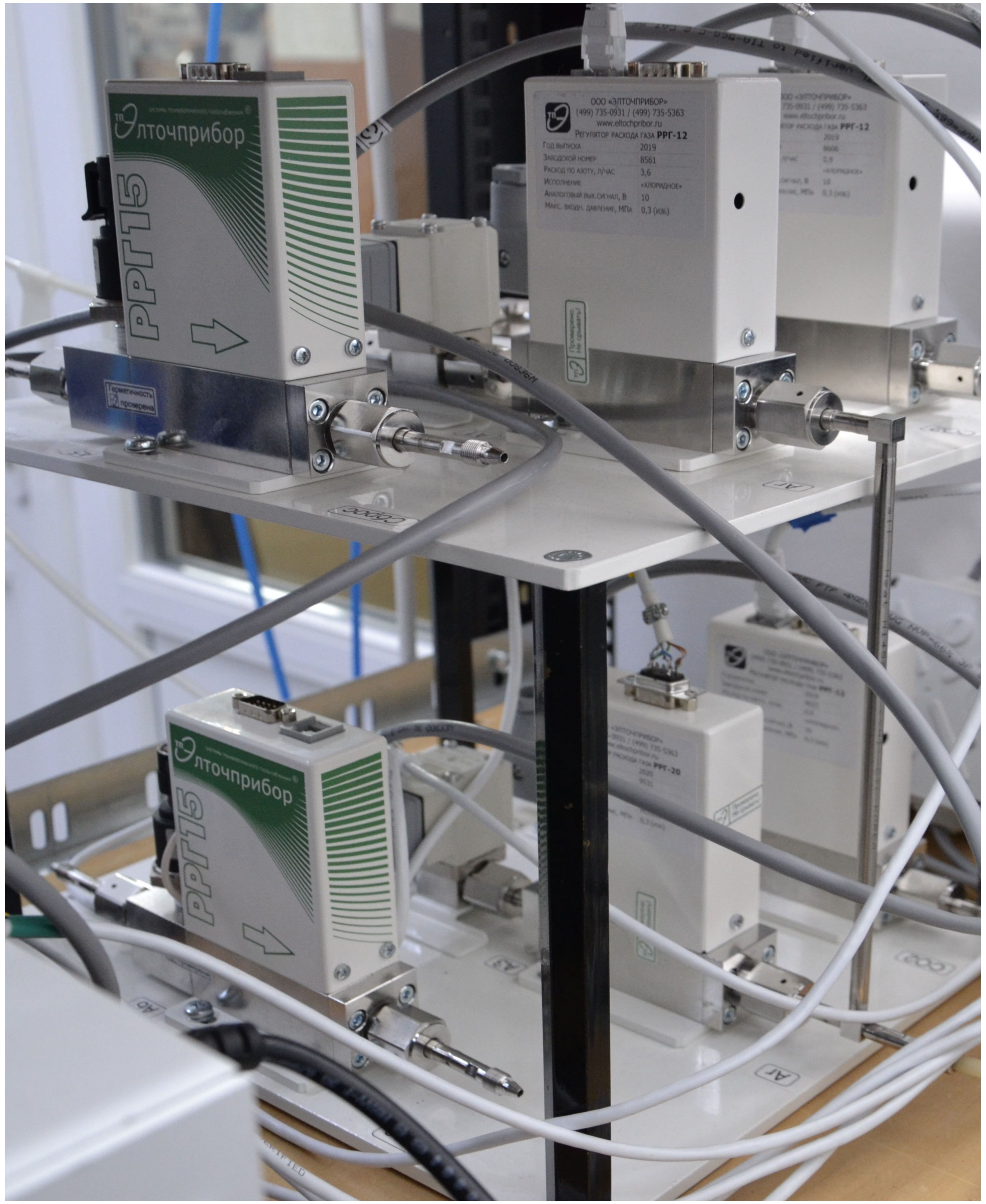
ASIC VATAGP7.1 (5 chips on each side of module)
Number of CSA: 128 channels
Dynamic range: 30 fC
Peaking time (slow/fast shaper): 500 ns/ 50ns
Noise (ENC): 70e +12e/pF (typ.)
Voltage supply: +1.5 V, -2.0 V
Gain from input to output buffer: 16.5 µA/fC
Output Serial analog multiplexer clock speed: 3.9 MHz
Power dissipation per channel: 2.2 mW

Pitch Adapter (n+) side
sapphire plates with (SOI)
Si-epitaxial layer Silicon On Insulator
Number of channels: 640
Value of poly-Si resistors: 1 MΩ
Value of integrated capacitors: 120 pF
Capacitor working voltage: 100 V
Capacitor breakdown voltage: >150 V

Size: 63x63x0,3 mm³ (on 4” – FZ-Si wafers)
Topology: double sided microstrip (DSSD) (DC coupling)
Pitch p^+ strips: 95 µm;
Pitch n^+ strips 103 µm;
Stereo angle between p^+/n^+ strips: 2.5^0
Number of strips/DSSD: 640 $(p^+)(n^+)$
Number of strips/module: 640 $(p^+)(n^+)$

Gas system

ЭЛТОЧПРИБОР
КГС-3
Газовая схема смесителя 2
Назад
ЭЛТОЧПРИБОР
КГС-3
СИСТЕМА ГАЗОСМЕШЕНИЯ КГС-3
ЭЛТОЧПРИБОР
ЭЛТОЧПРИБОР
КГС-3
Управление РРГ-3
Назад



Элточприбор
РРГ15
Элточприбор
РРГ15

GEM and Silicon detector power supply

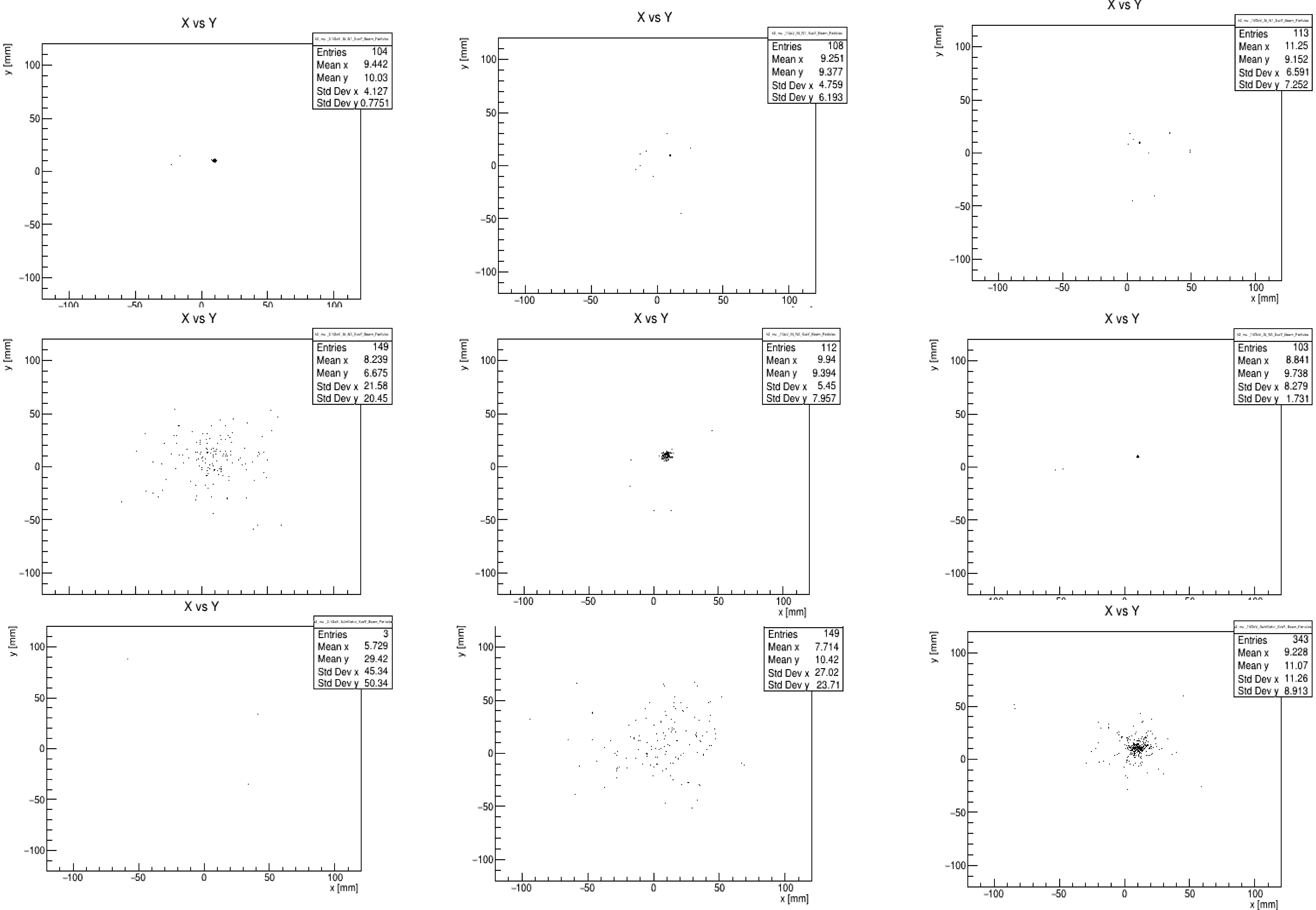
μ- пучок + вт частицы

100MeV | 1 GeV | 10 GeV

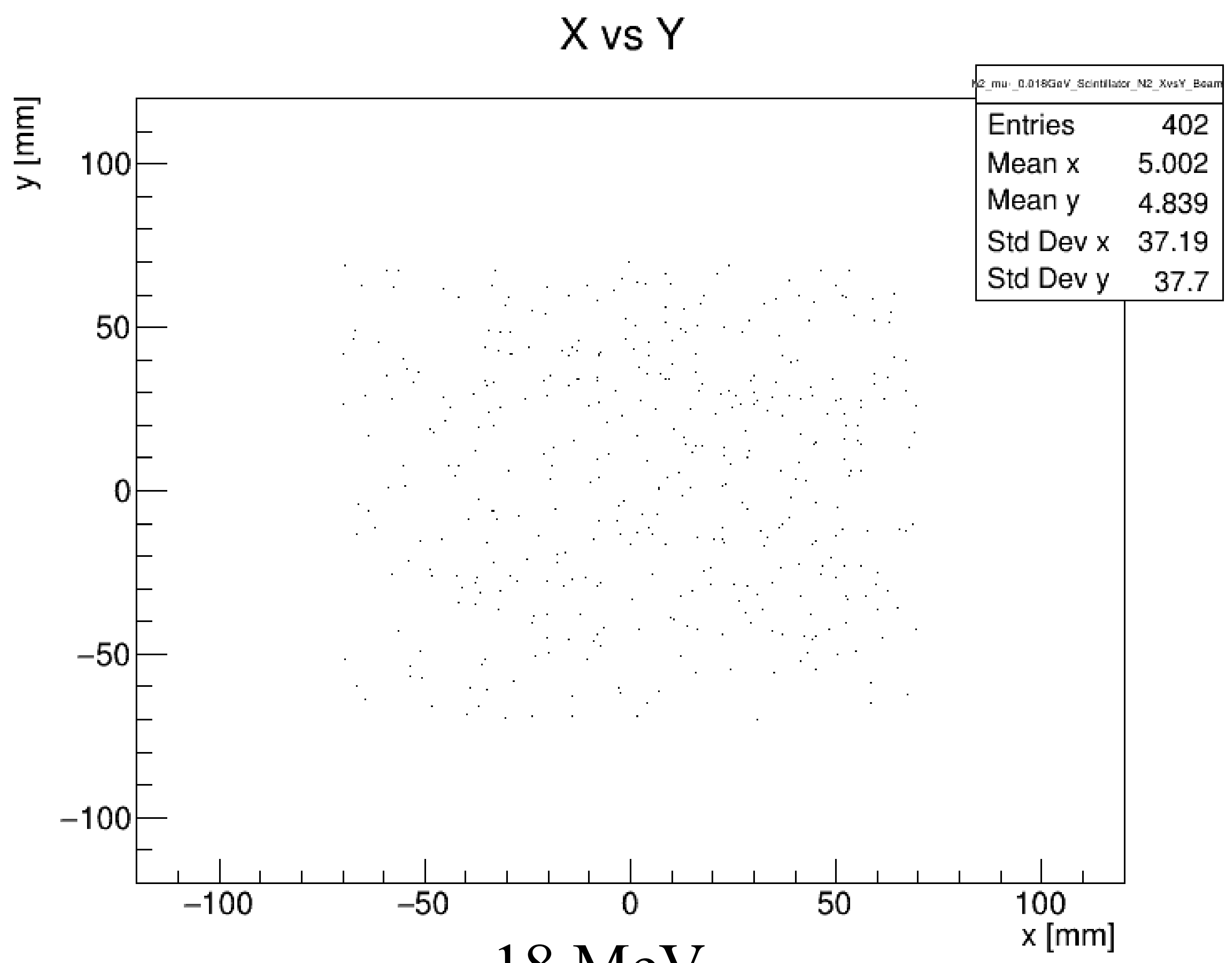
Силикон 1

Силикон 3

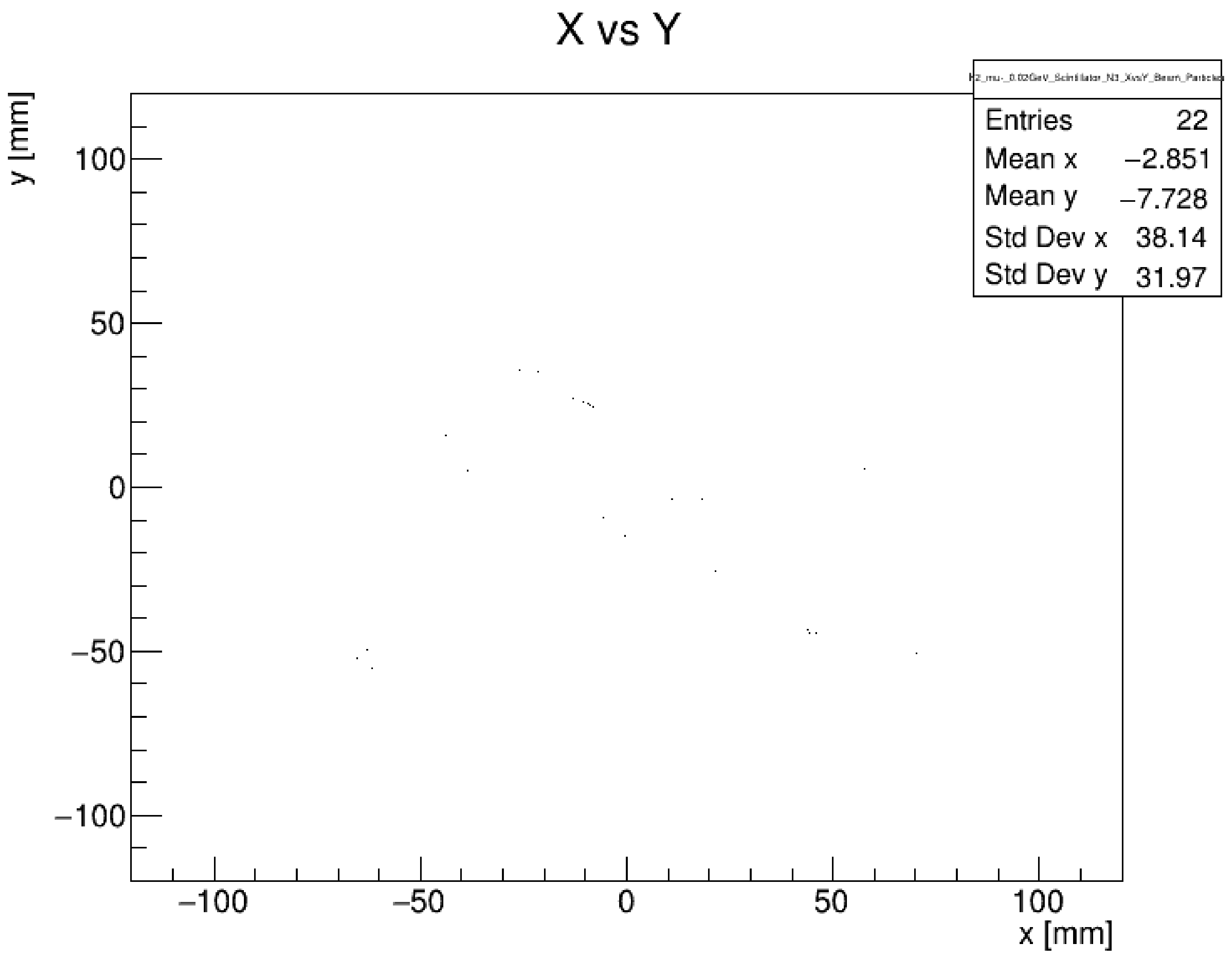
Сцинтиллятор 3



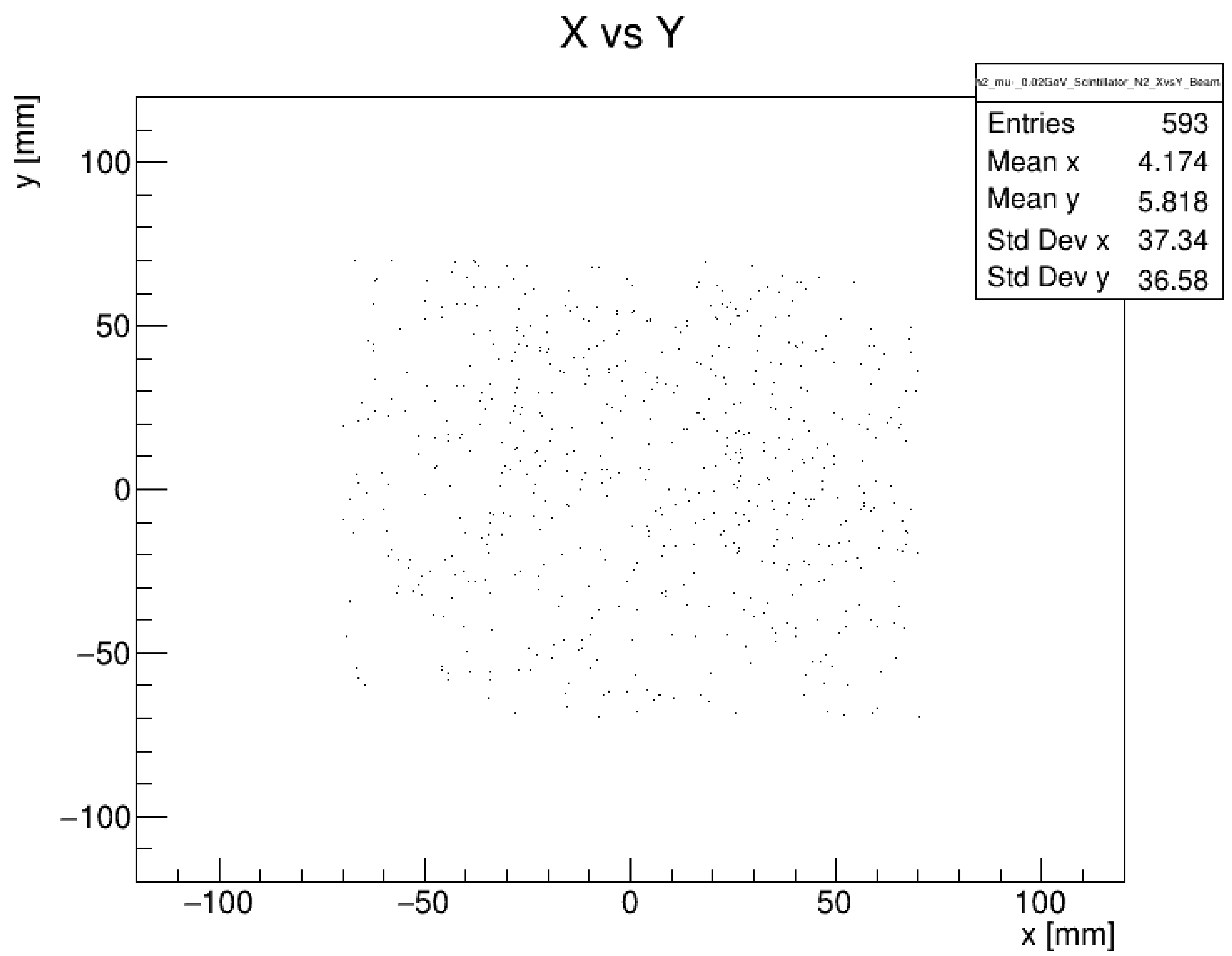
Scintillator 2



18 MeV



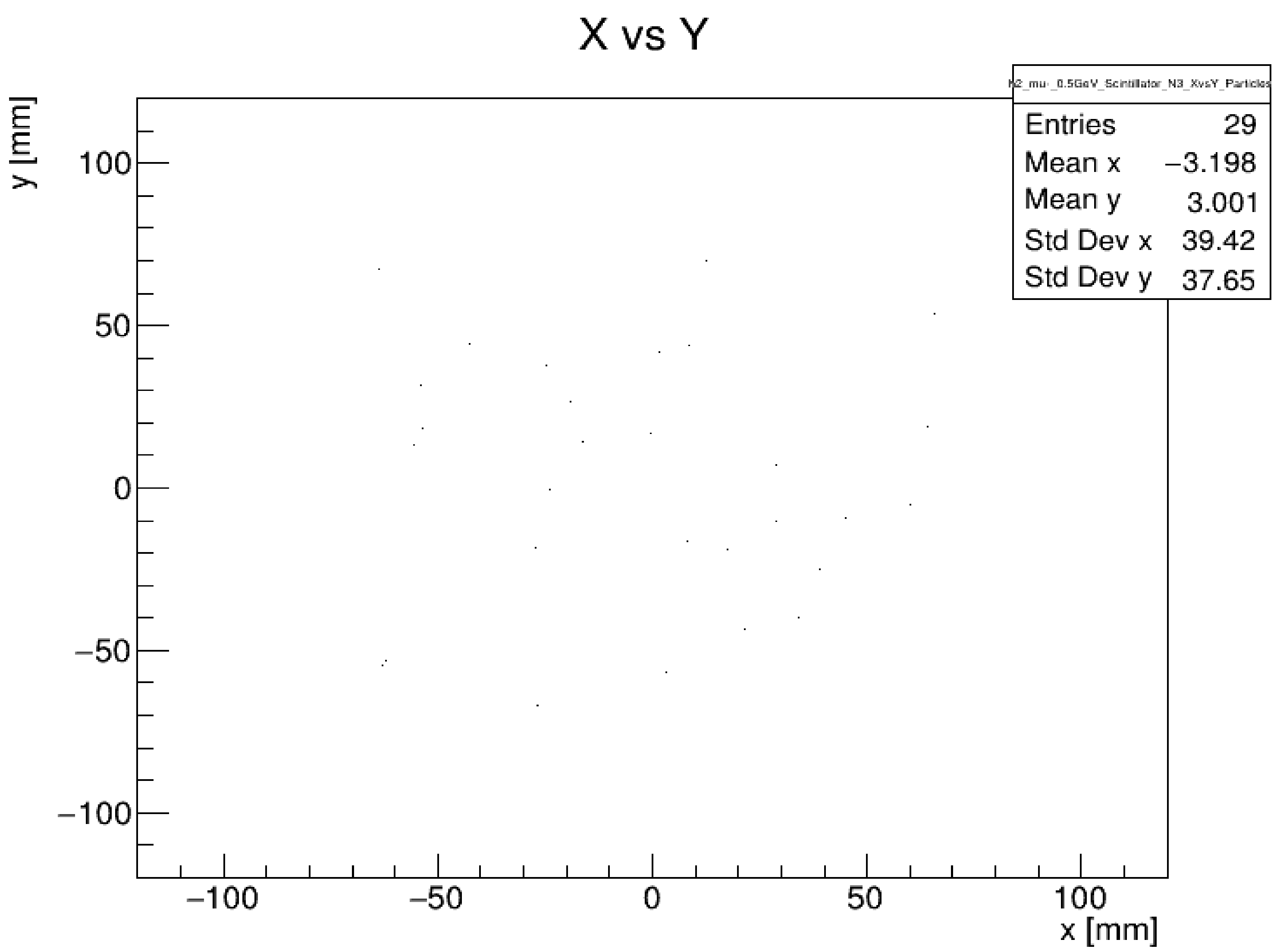
20 MeV до Сцинт.3 долетают только вторичные частицы



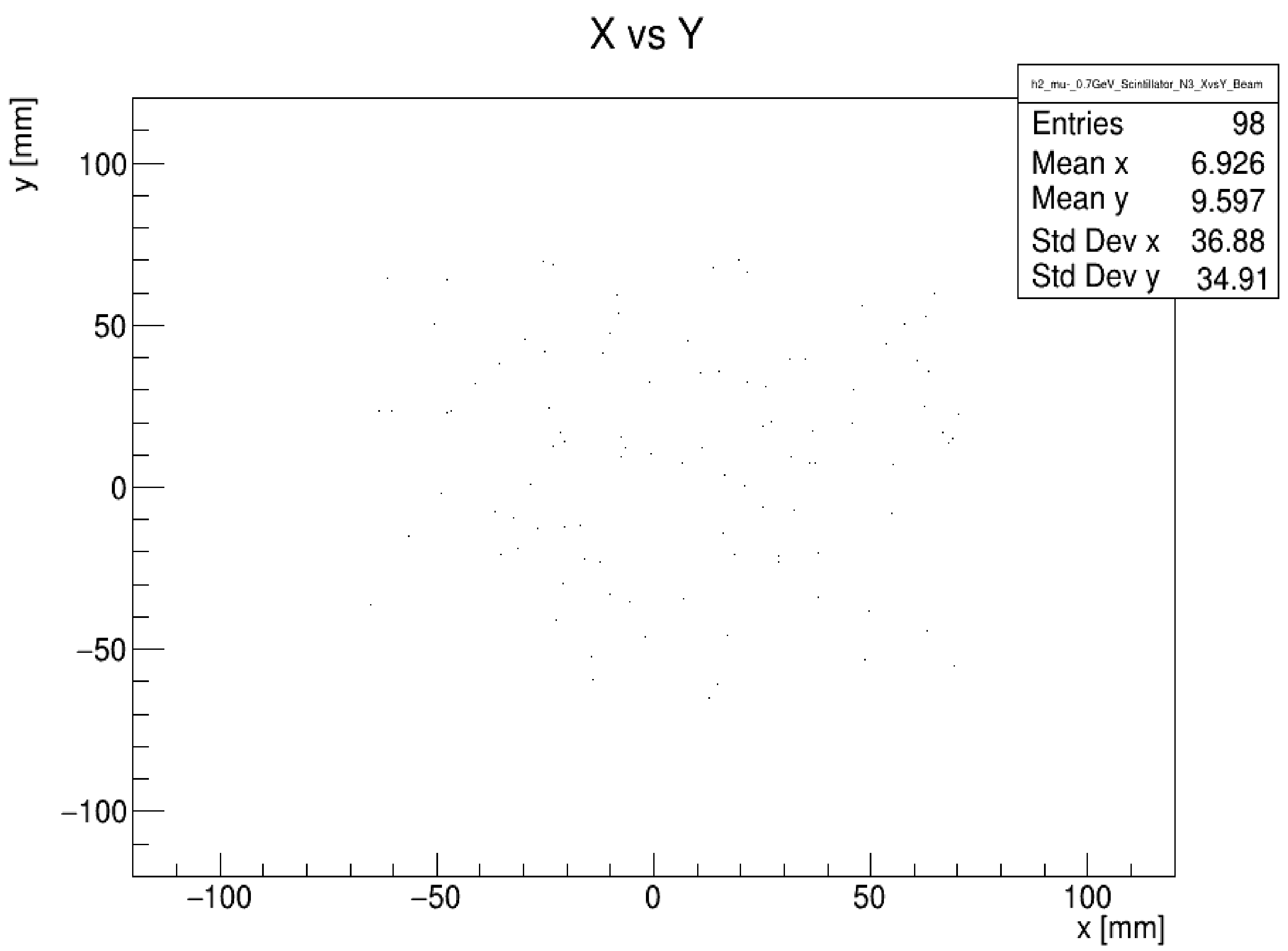
20 MeV

- начиная с 18-20 MeV первичные частицы долетают до Сцинтиллятора №2

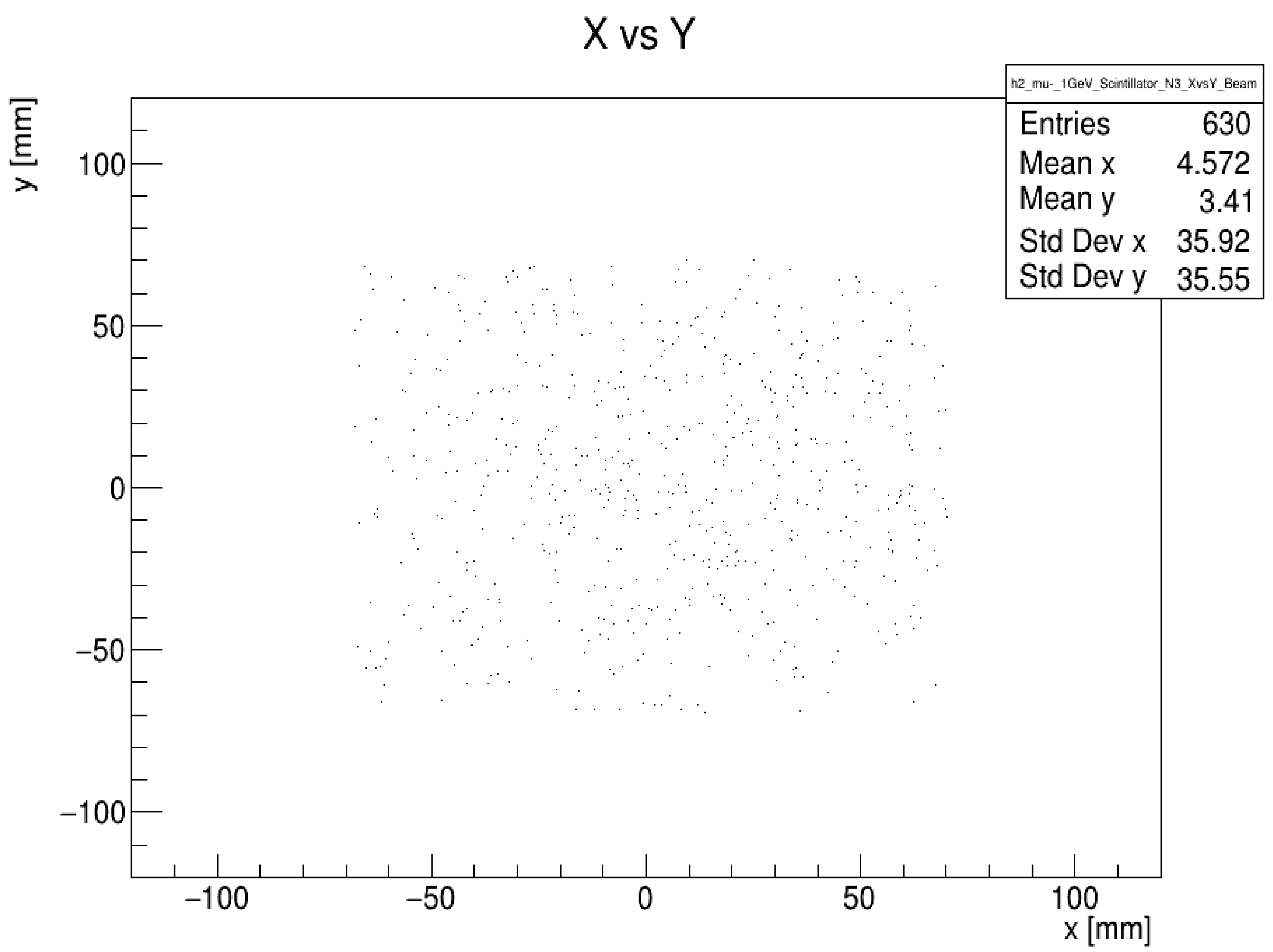
Scintillator 3



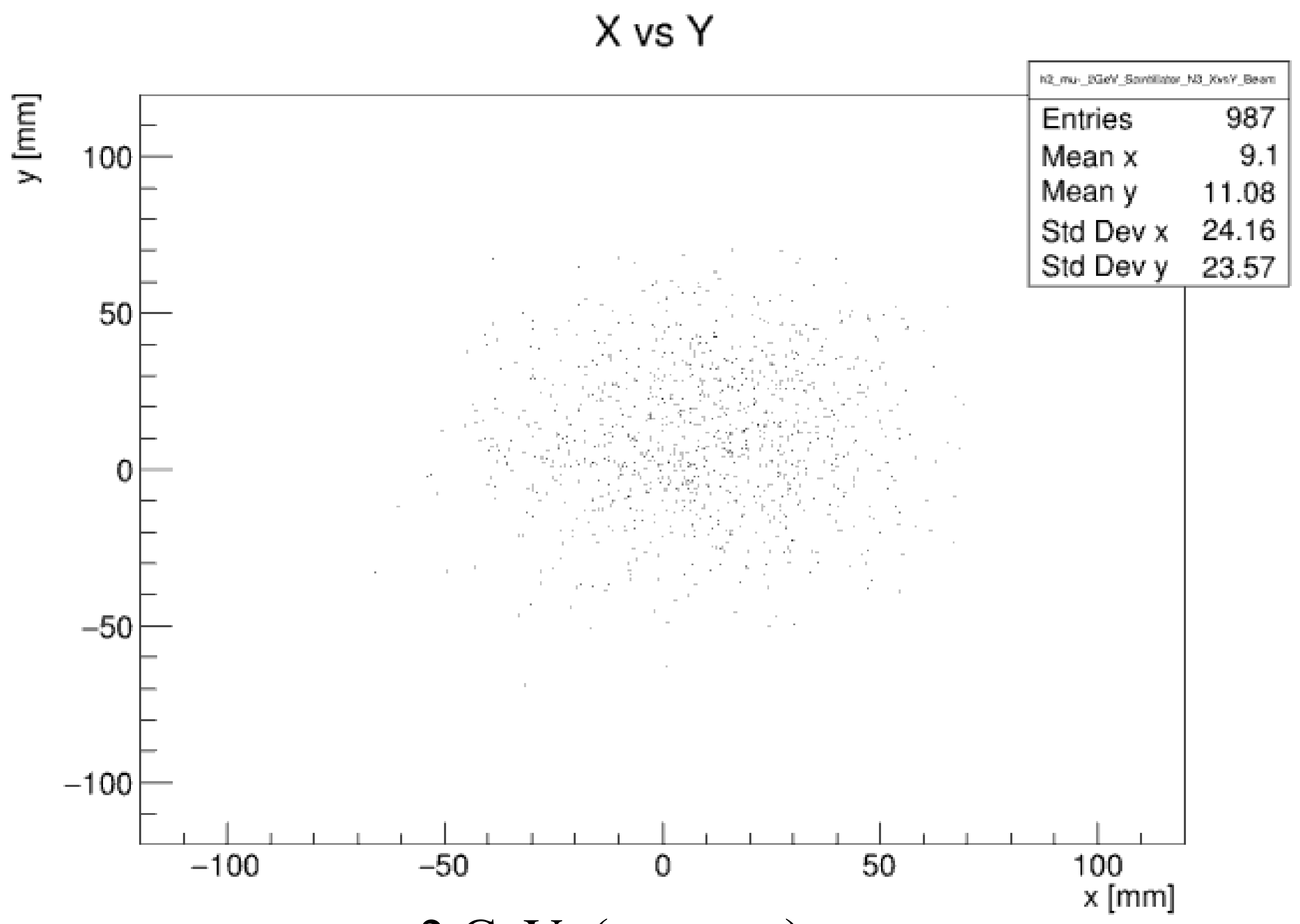
500 MeV (вторич.)



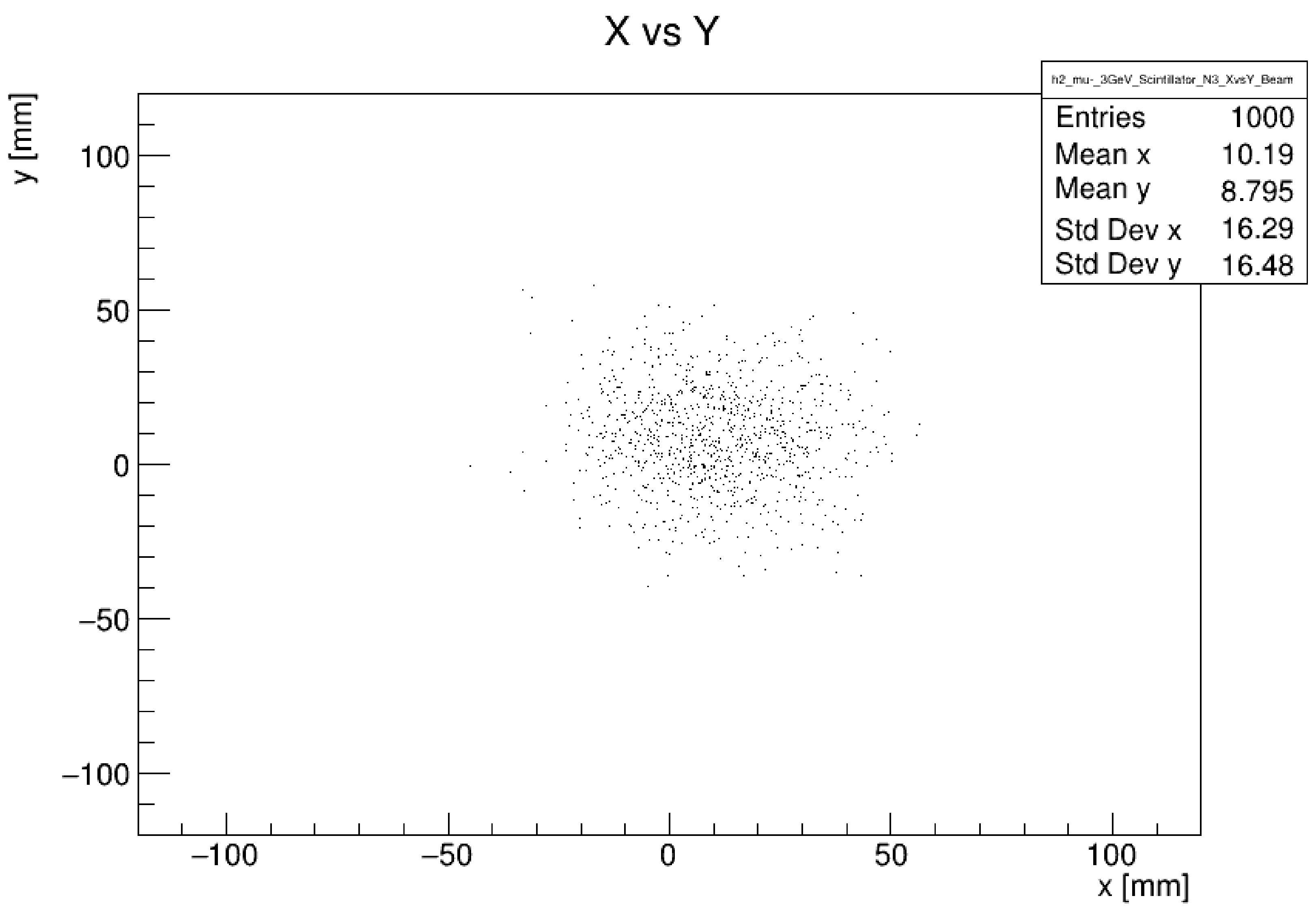
700 MeV (первич.)



1 GeV (первич.)



2 GeV (первич.)



3 GeV (первич.)

- с 500 MeV долетают только вторичные частицы
- начиная с 700 MeV первичные частицы доходят до Сцинт.3
- с 3 GeV доходит весь пучок первичных част.