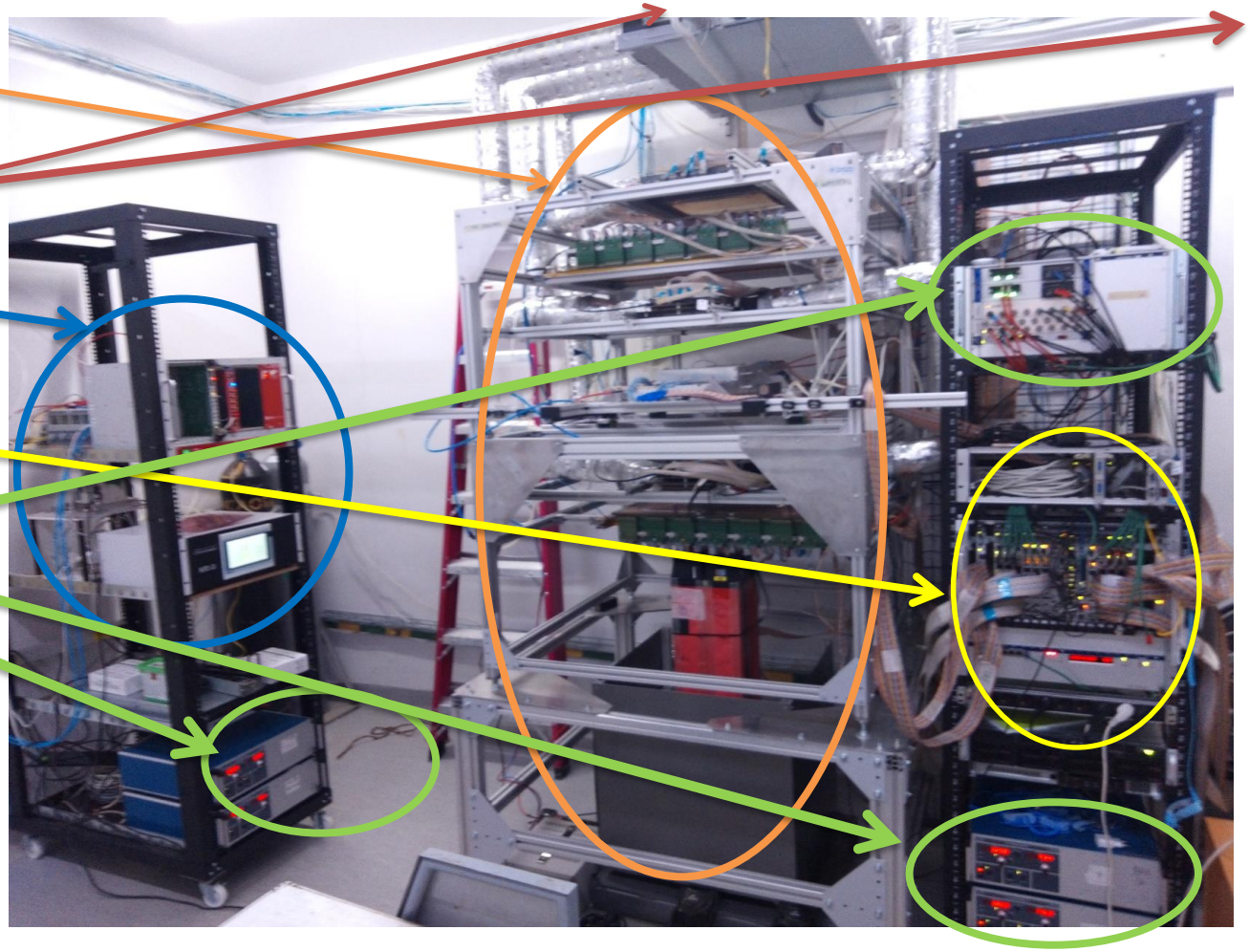
MiniSPD testing facility

Motivation

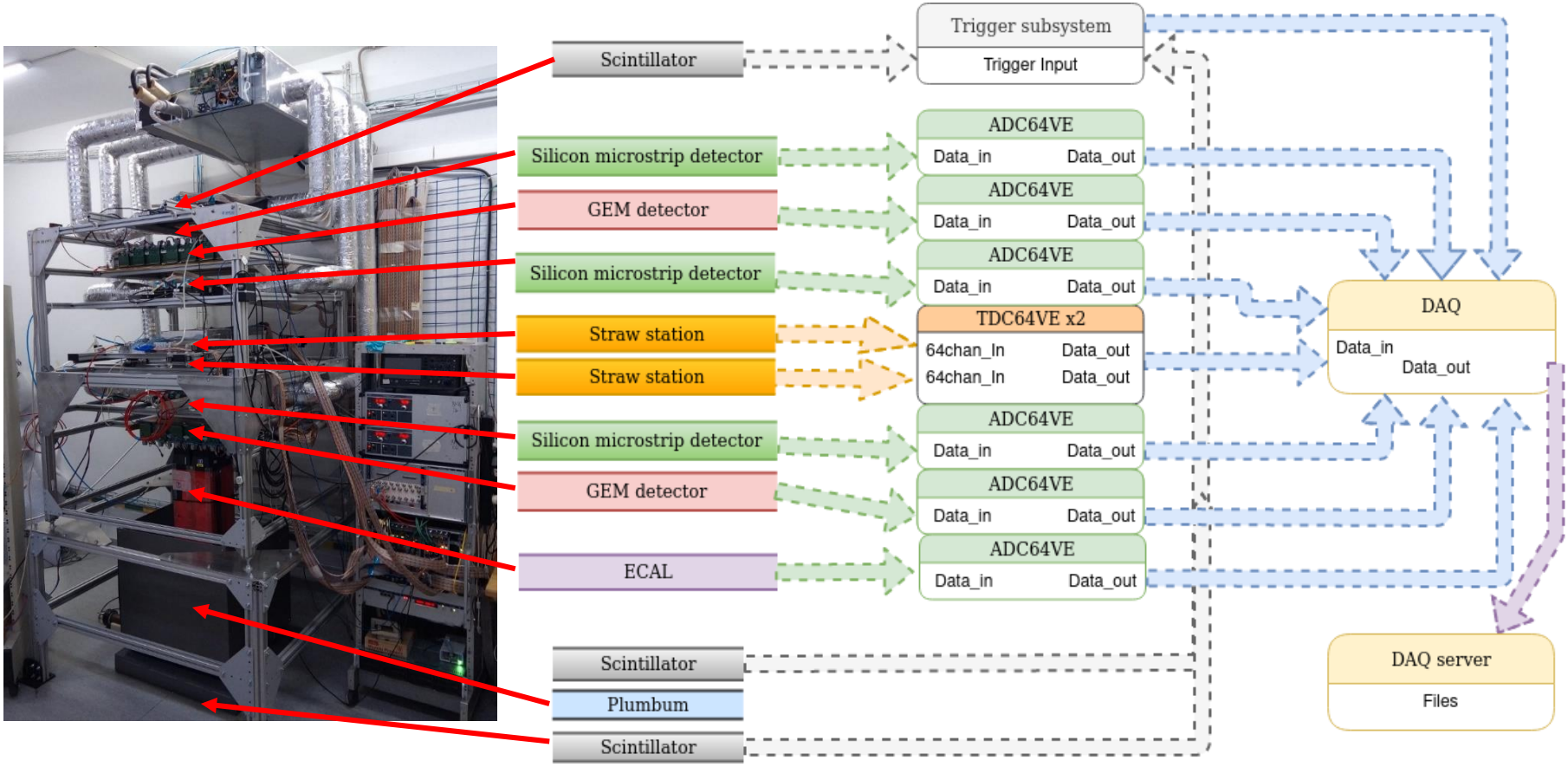
- Getting real data from cosmic rays
- Using prototype SPD detectors for track reconstruction
- MiniSPD simulation and comparison with the real data
- Measurement of detector characteristics
- Checking the stability of the detector and stand components over a long period of operation
- For almost 3 years (2018-2021), there will be no relativistic beam at LHEP, and the space stand being created allows research work with real detectors

miniSPD setup

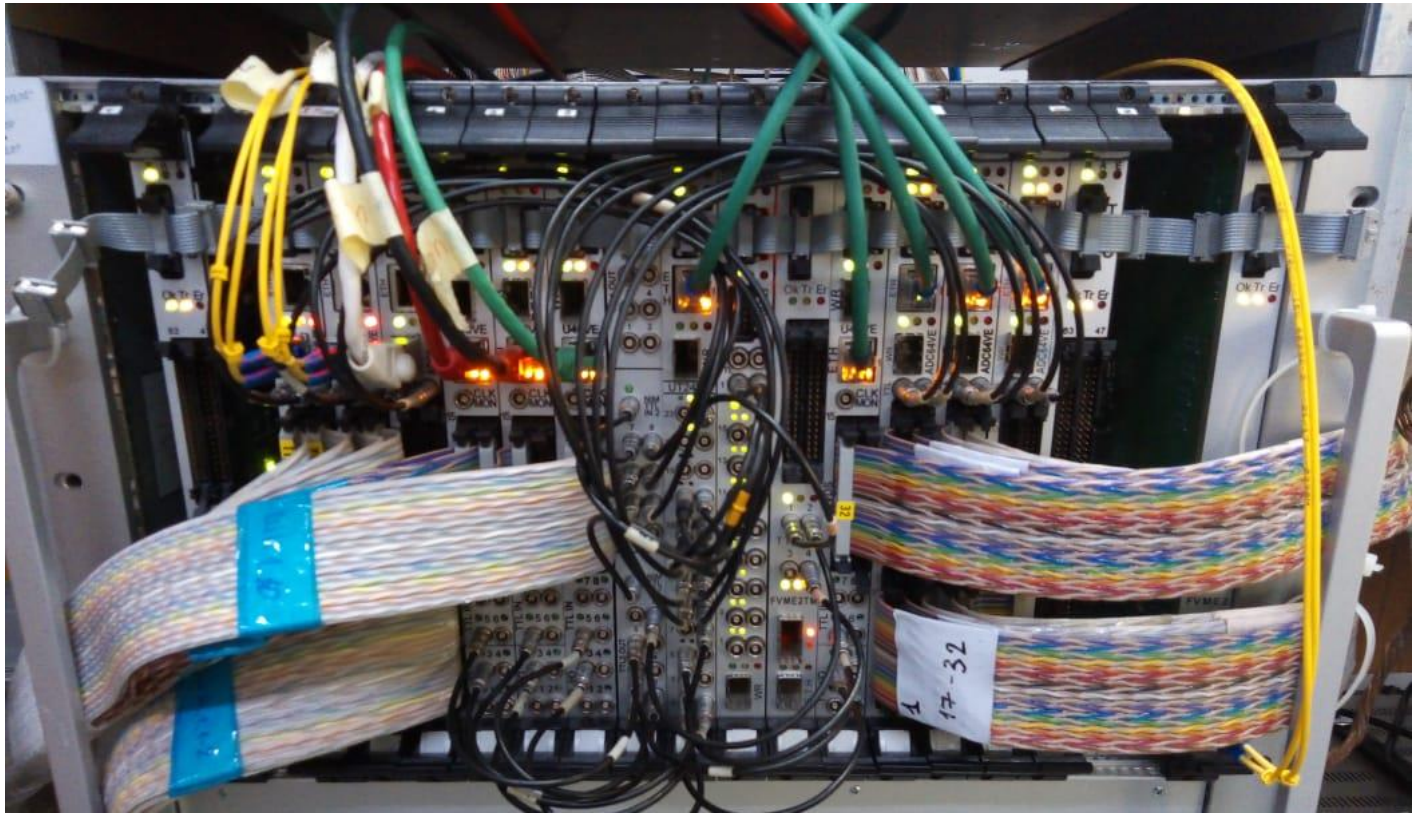
- Detectors
- Climate control
- Gas system
- DAQ
- Detector power systems



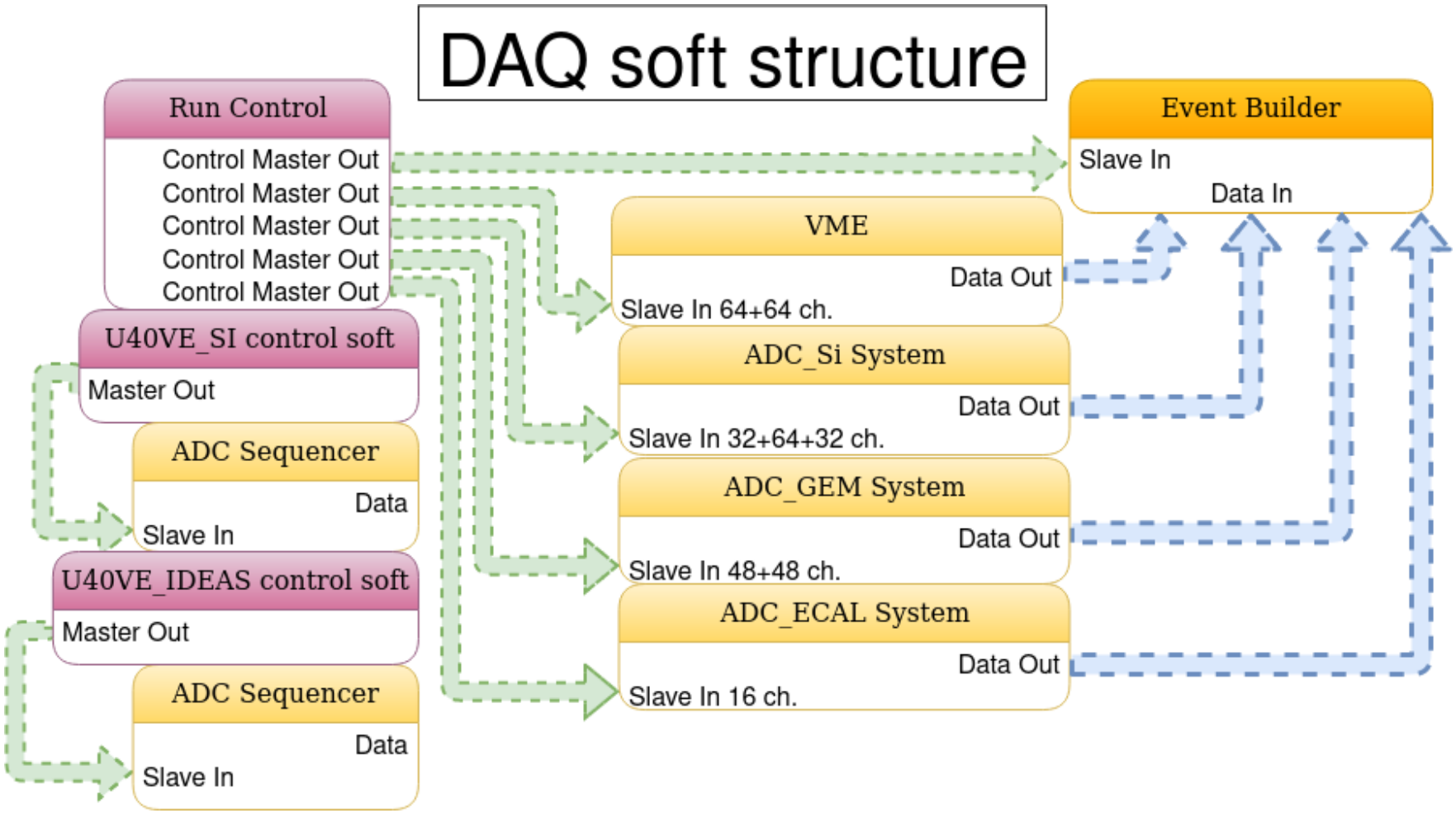
Functional structure of the stand



DAQ



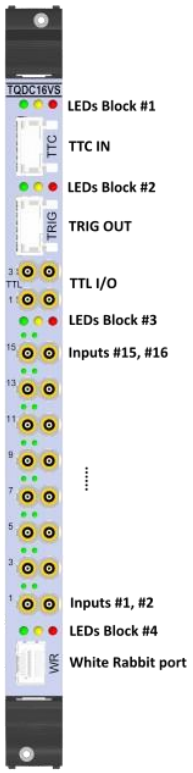
The DAQ system from the BM&N experiment is used as a basis (ADS,TDC,TQDS,U40VE etc.)

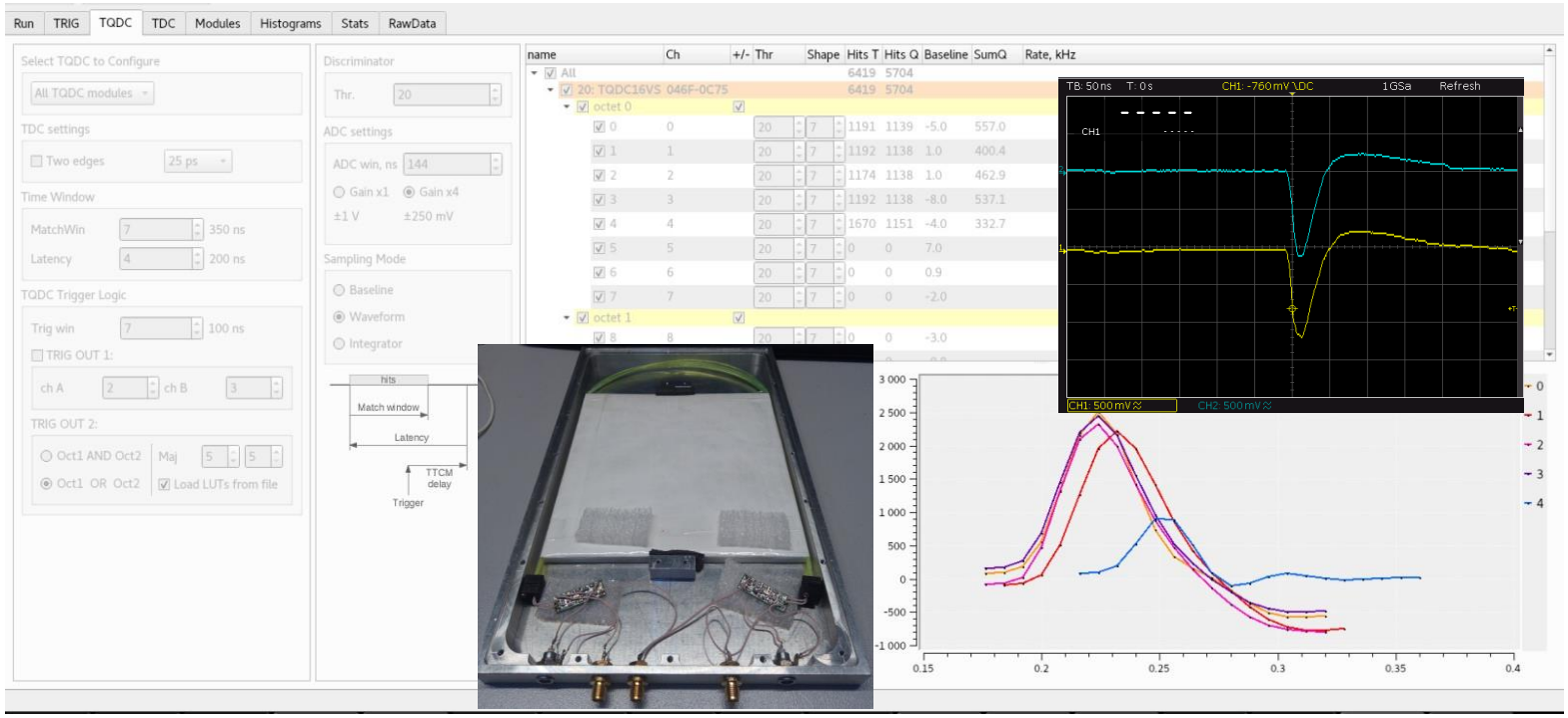

DAQ soft structure
Run Control
Control Master Out
Control Master Out
Control Master Out
Control Master Out
Control Master Out
U40VE_SI control soft
Master Out
ADC Sequencer
Data
Slave In
U40VE_IDEAS control soft
Master Out
ADC Sequencer
Data
Slave In
Event Builder
Slave In
Data In
VME
Data Out
Slave In 64+64 ch.
ADC_Si System
Data Out
Slave In 32+64+32 ch.
ADC_GEM System
Data Out
Slave In 48+48 ch.
ADC_ECAL System
Data Out
Slave In 16 ch.

Trigger

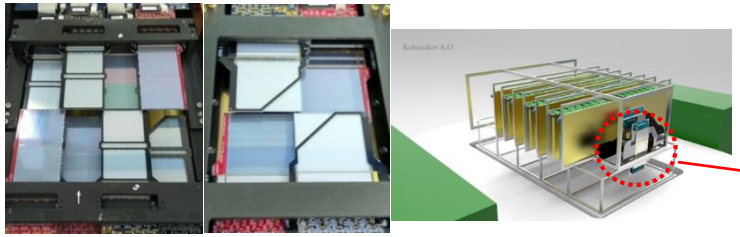
- 2 Scintillators ((SiPm 4ch)
- 1 Scintillator (Pmt 1ch)
- TQDC

- 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

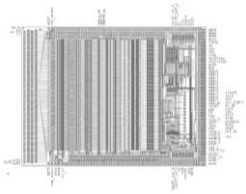




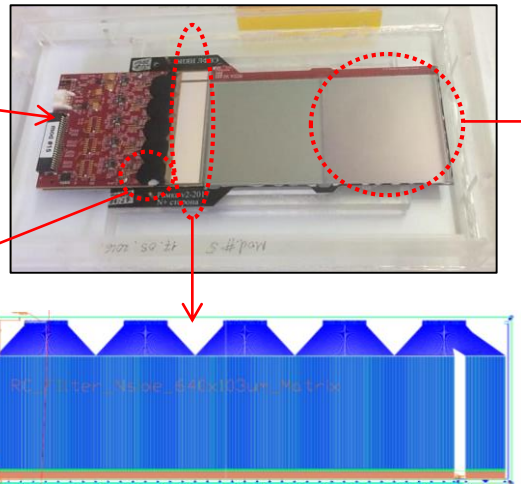
BM@N Silicon detector module design



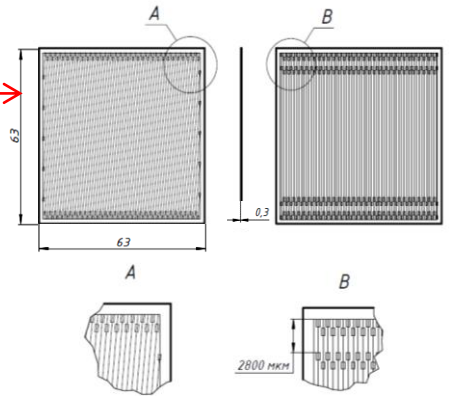
Positions of Forward and Vertex Silicon Detector at BM@N technical run March 2018
[M.Kapishin , Status of Baryonic Matter at Nuclotron, October 2018]



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 Si-epitaxial layer Silicon On Insulator (SOI)
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

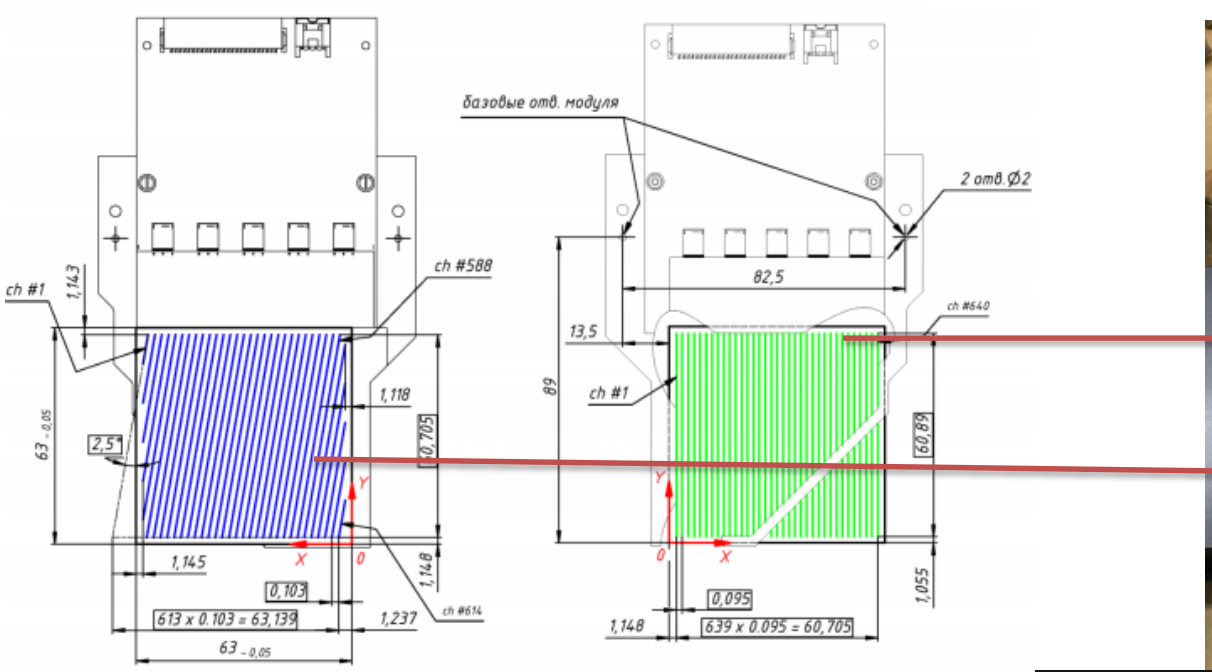


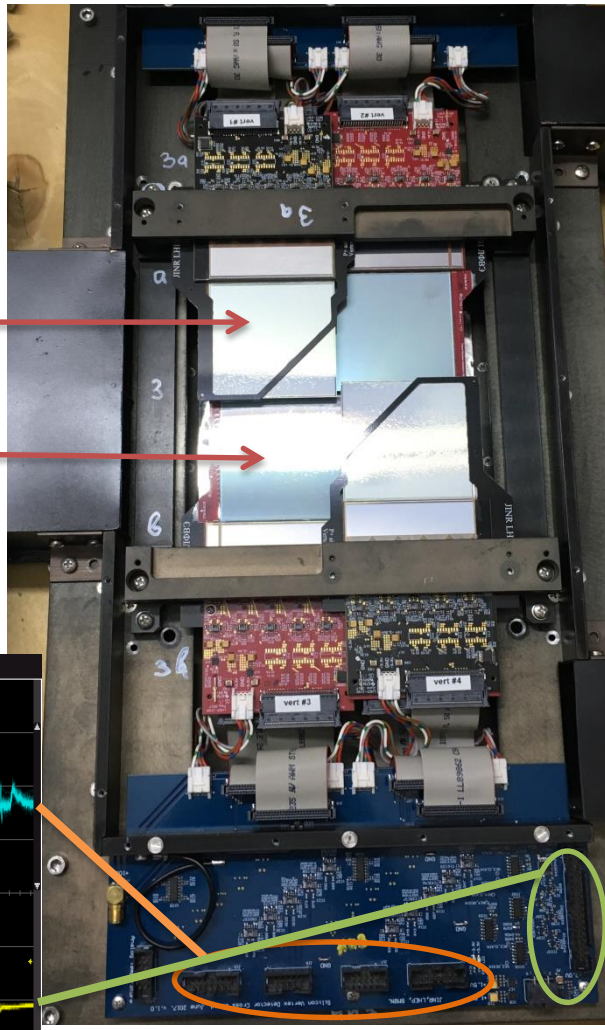
Size: 63x63x0,3 mm^3 (on 4" – FZ-Si wafers)
Topology: double sided microstrip (DSSD) (DC coupling)
Pitch p^+ strips: 95 μm;
Pitch n^+ strips 103 μm;
Stereo angle between p^+/n^+ strips: 2.5^0
Number of strips/DSSD: 640 (p^+)× 614(n^+)
Number of strips/module: 640 (p^+)× 640(n^+)

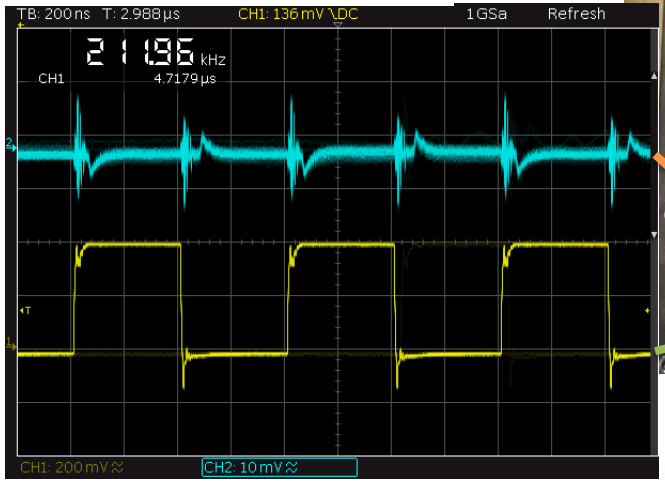
Silicon detector

Сторона наклонных стрипов

Сторона параллельных стрипов







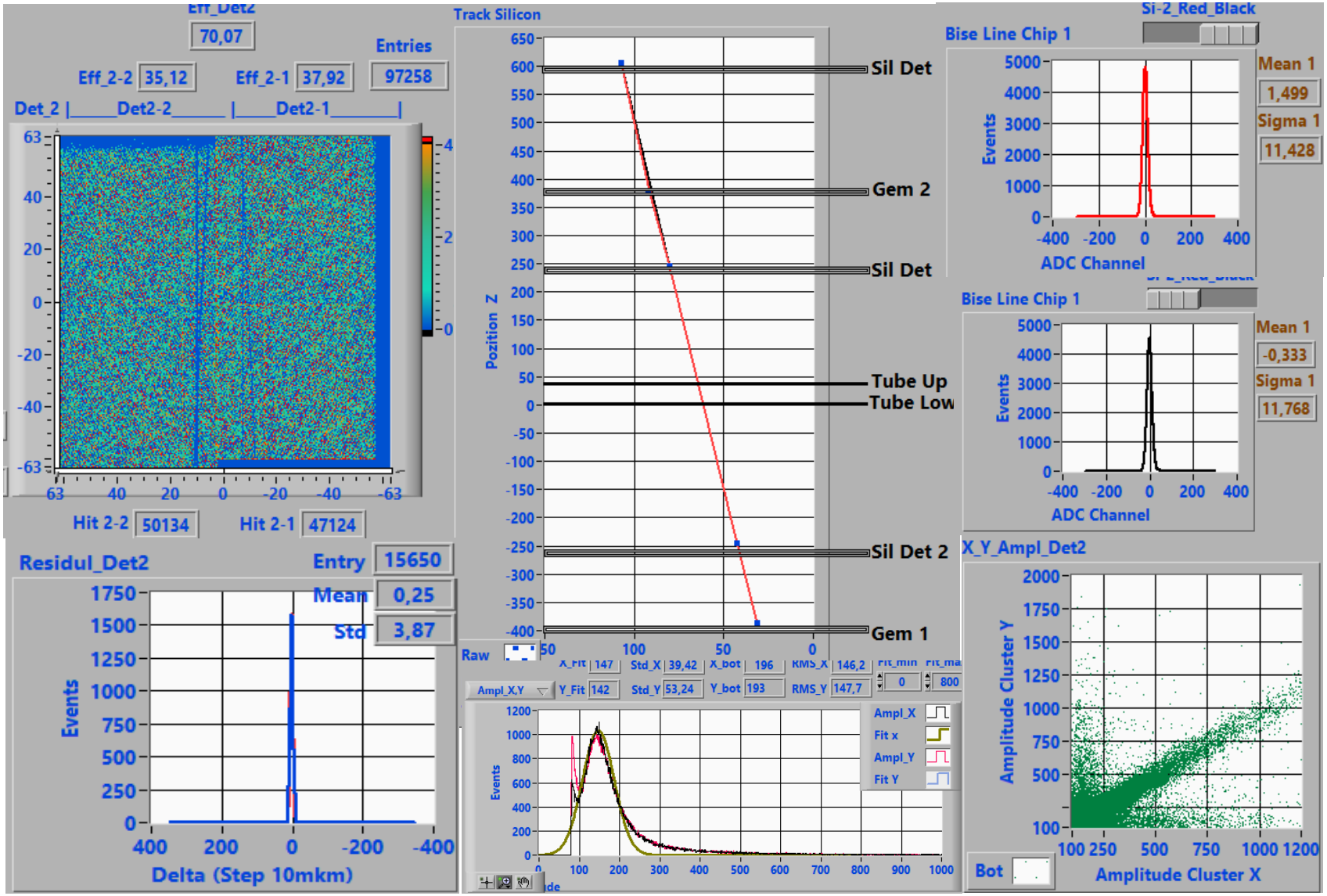
ADC_Si System

Slave In 32+64+32 ch.

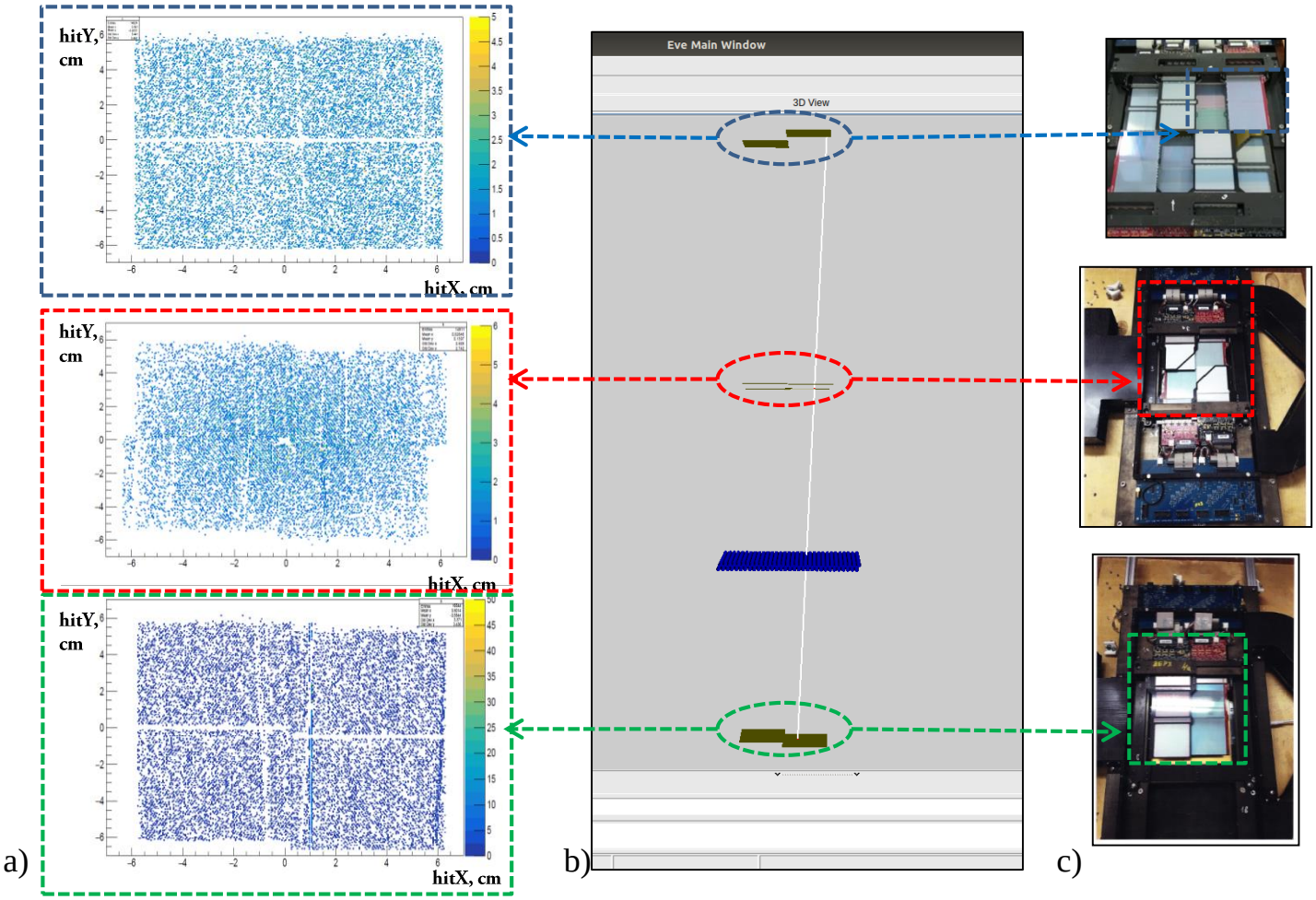
U40VE_SI control soft

Master Out

Silicon detector data monitoring

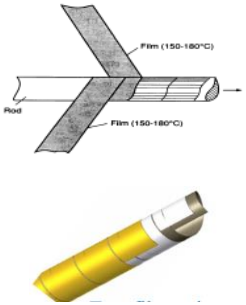


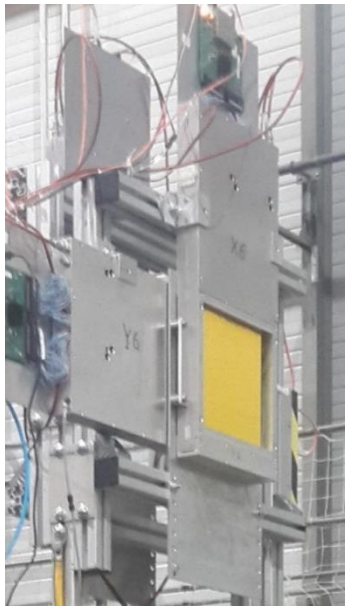
Events reconstruction

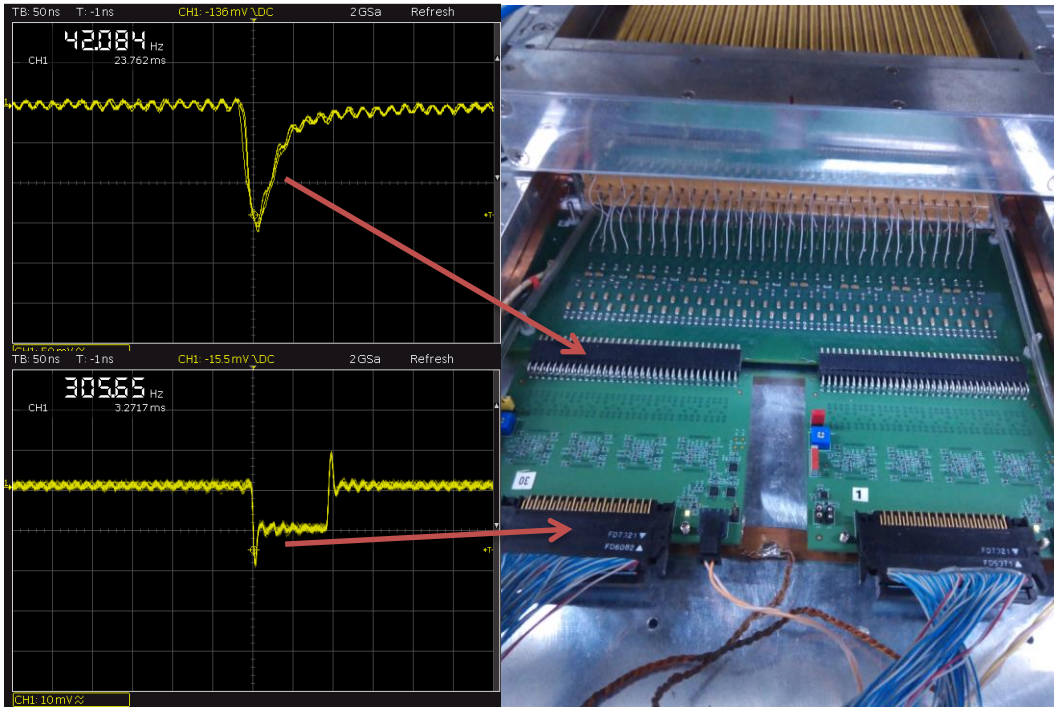


a) Hits plots in BM@N Si-modules;
b) Reconstructed track in muon stand (based on bmnroot framework);
c) BM@N Silicon modules;

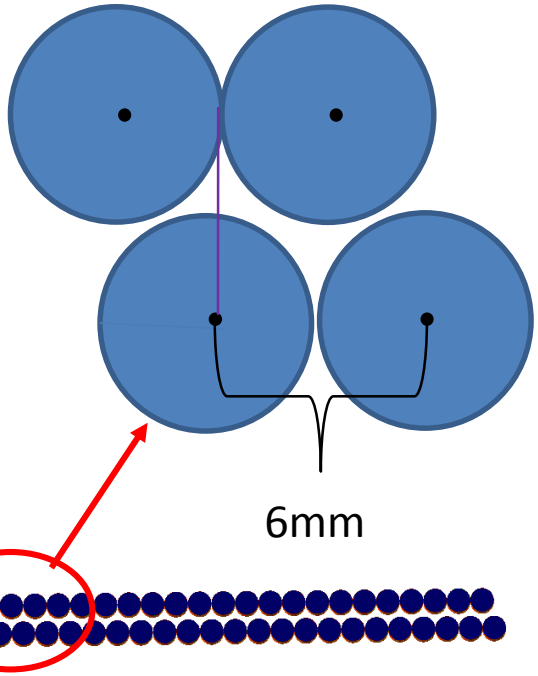
STRAW





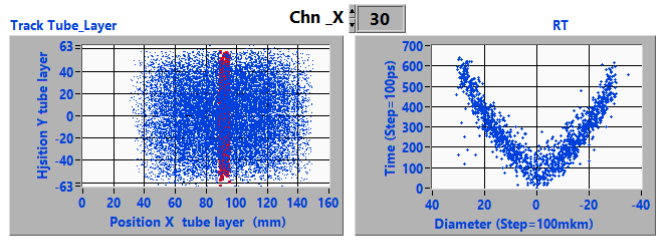


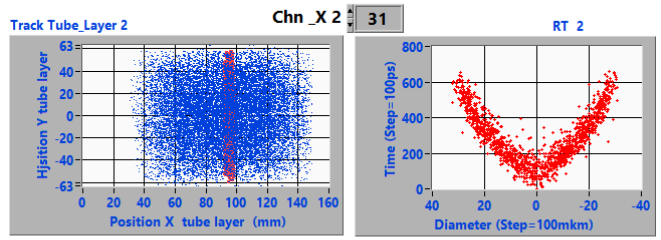
Straw winding. Two film strips are wound around the mandrel

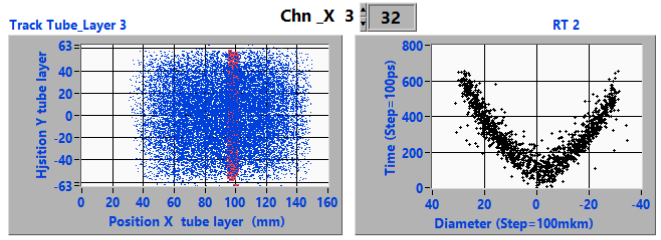


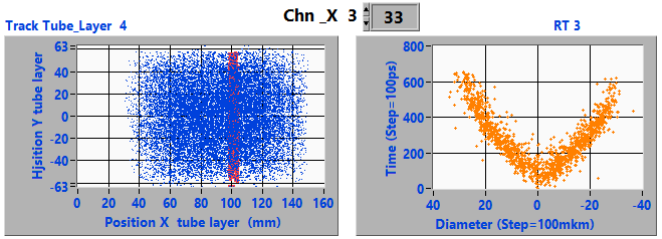
- 2 station from the NA64 experiment
- straw tube with 6mm diameter, in the centre a 30mrm diameter gold-plated tungsten wire
- Length straw 20 cm
- Precision measurement of 0.2 mm

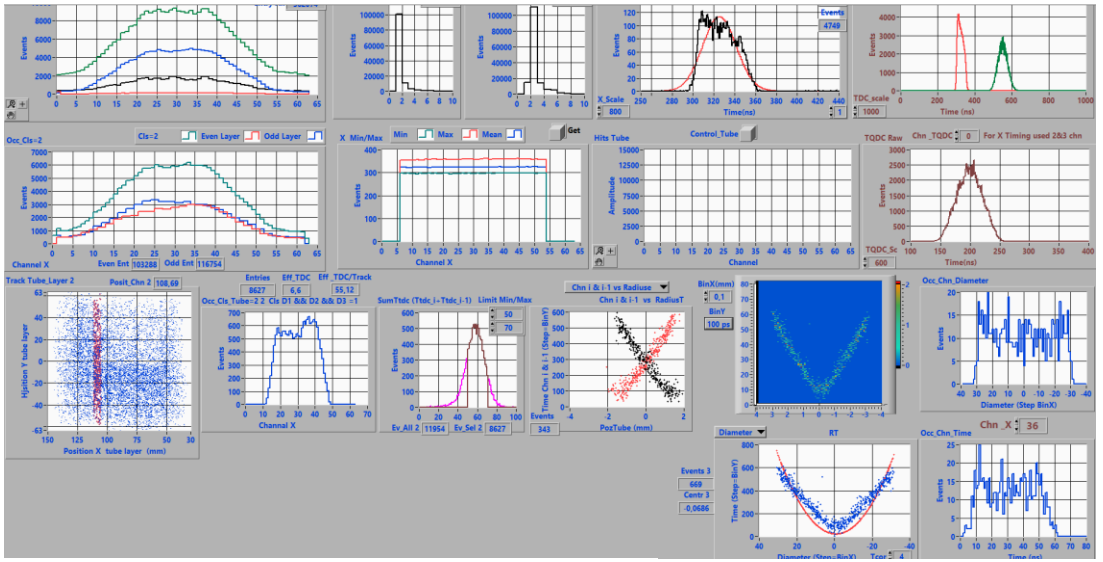
STRAW data monitoring

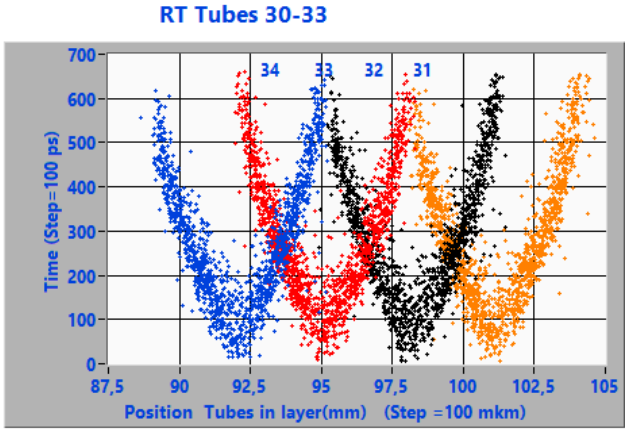








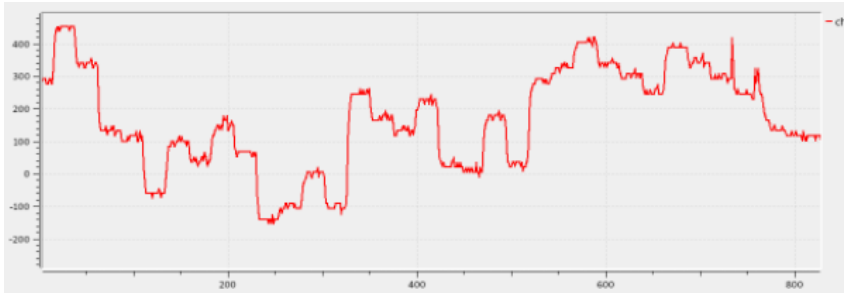


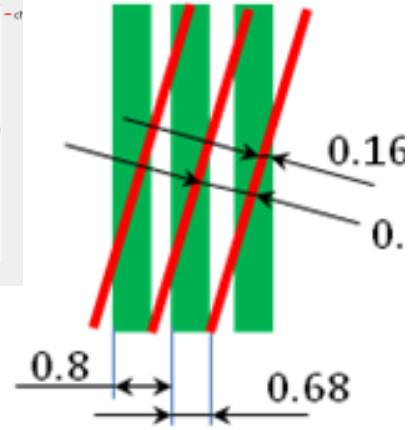


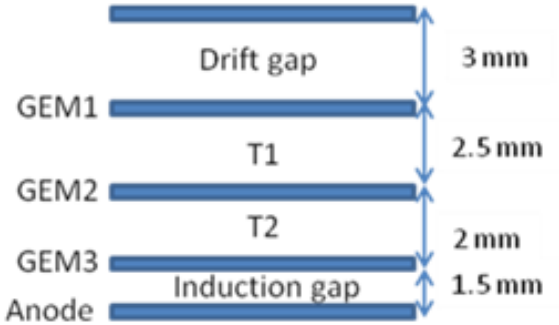
The r(t) relation (isochrone relation or “V-shape”) for straw tubes 30-33

GEM

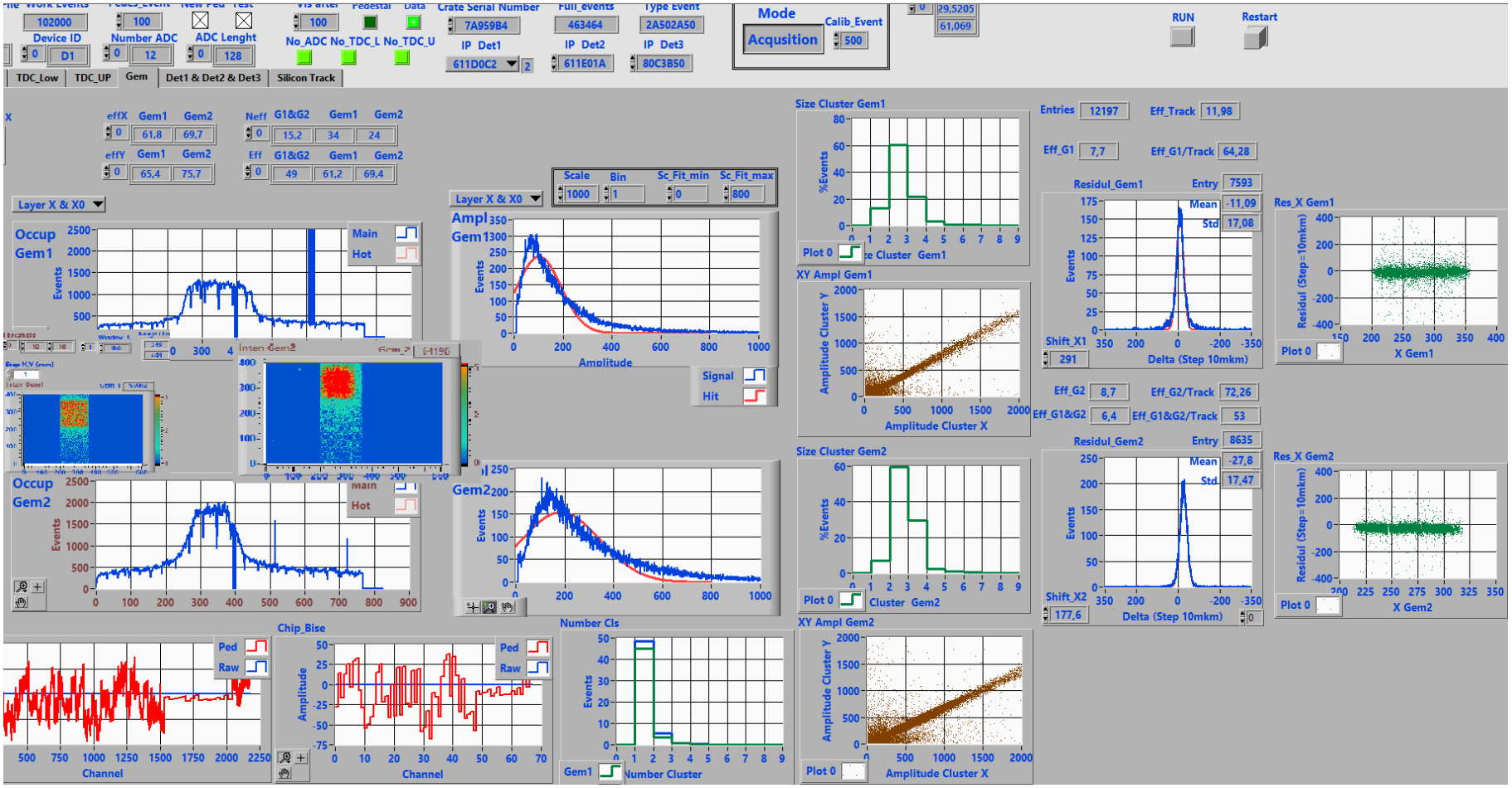

КРЕПЛЕНИЕ


400
300
200
100
0
-100
-200
200
400
600
800

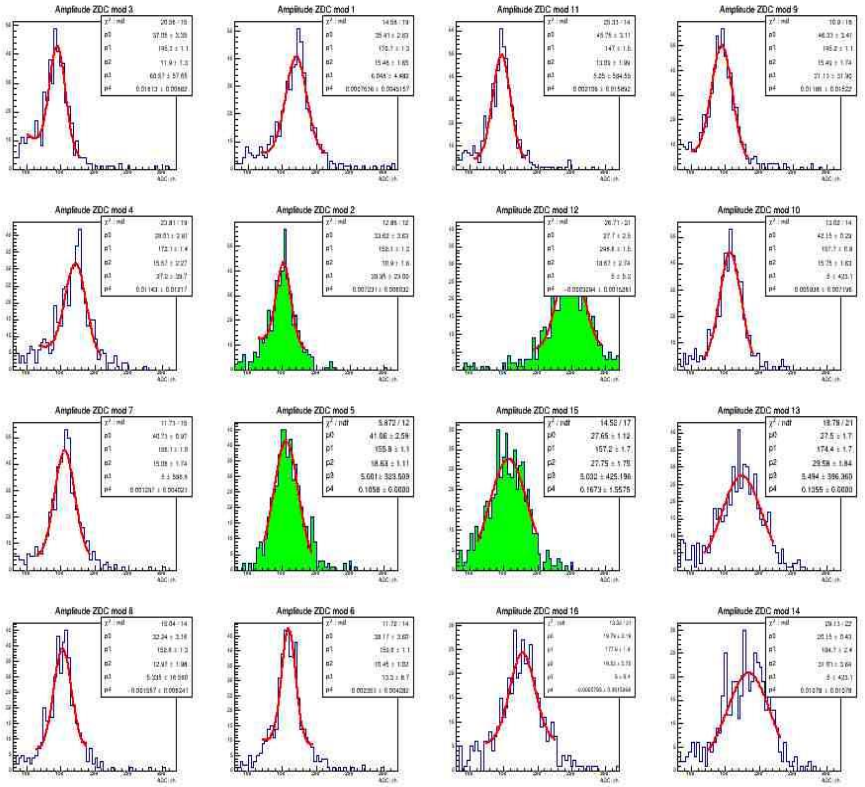

0.16
0.
0.8
0.68


Drift gap
3 mm
GEM1
T1
2.5 mm
GEM2
T2
2 mm
GEM3
Induction gap
1.5 mm
Anode

GEM data monitoring



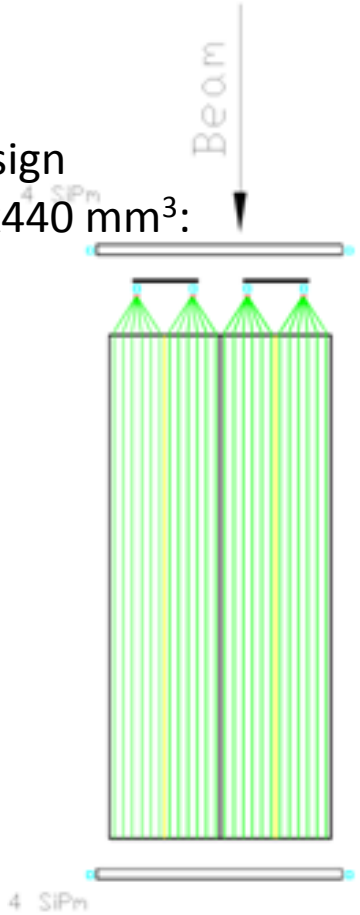
ECAL

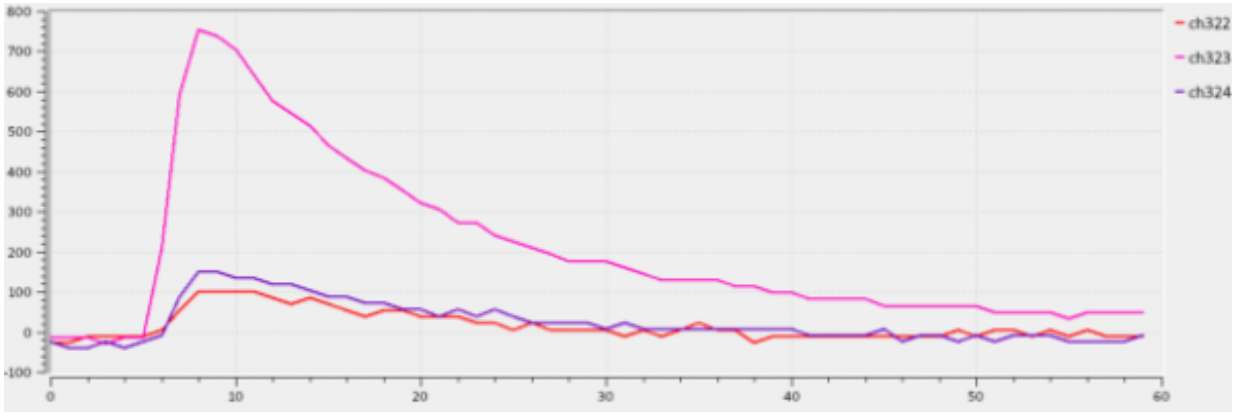


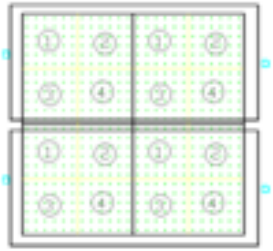
ECAL MIP spectra in corresponding cells (top view)

ECAL

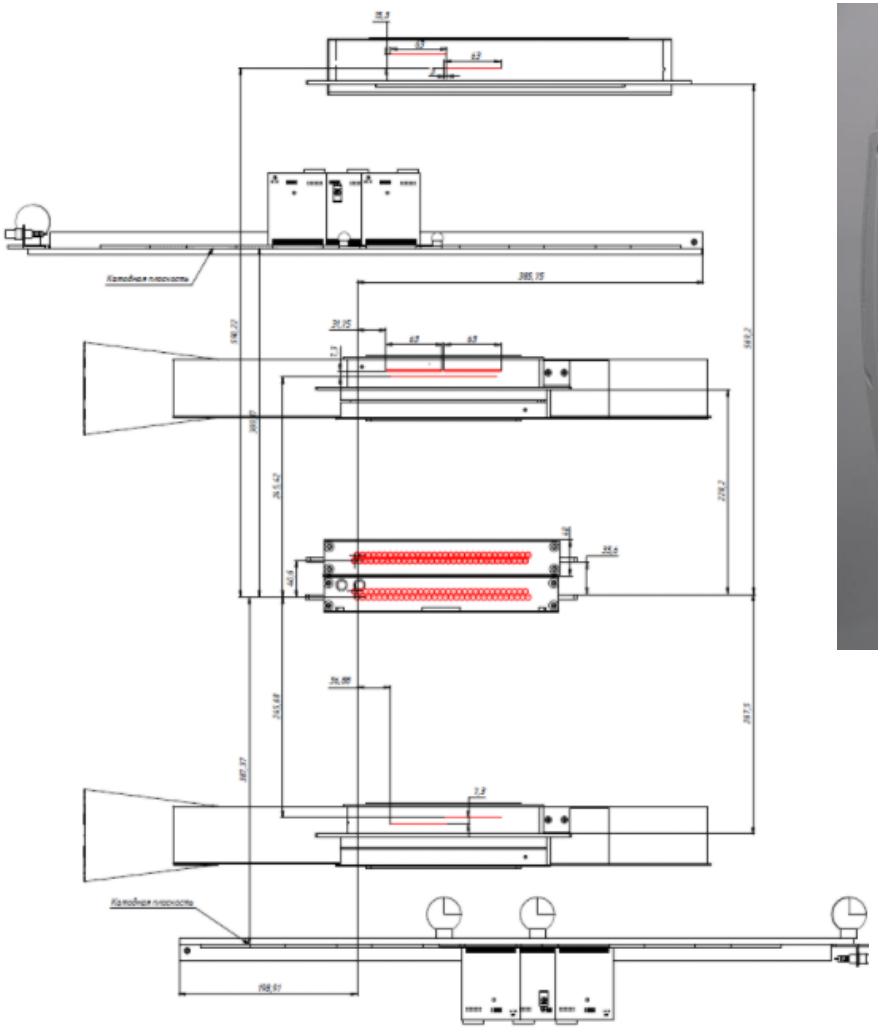
ECAL module (110x110 mm^2)design
Module consist of 4 cells 55x55x440 mm^3:
220 Layers Lead and Scintillator
1.5 mm – Scintilator
0.3 mm - Lead

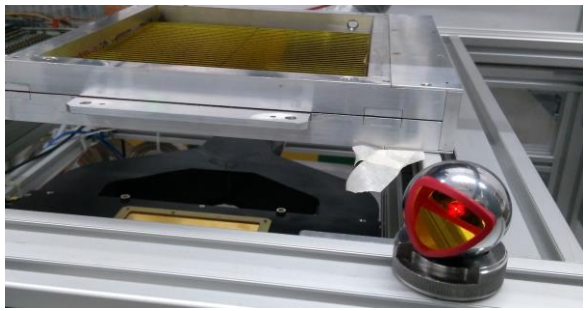




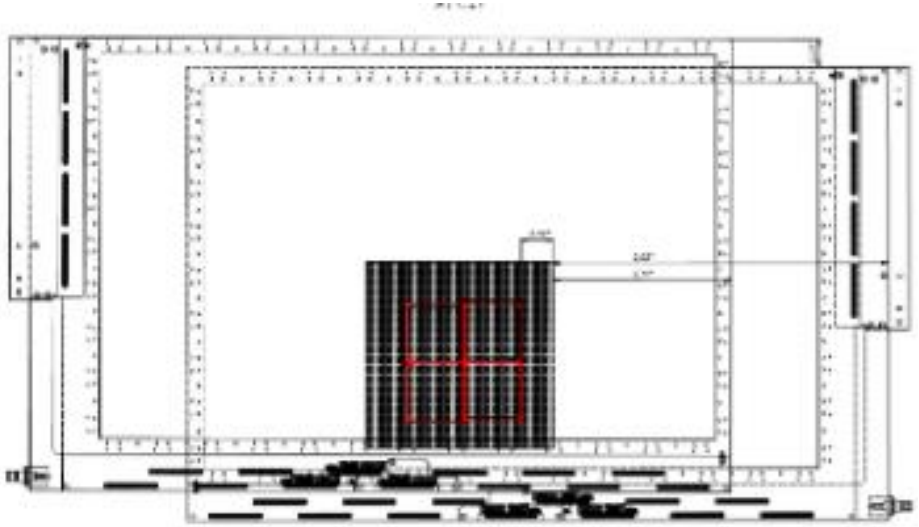


Alignment





measurement accuracy
50mkm

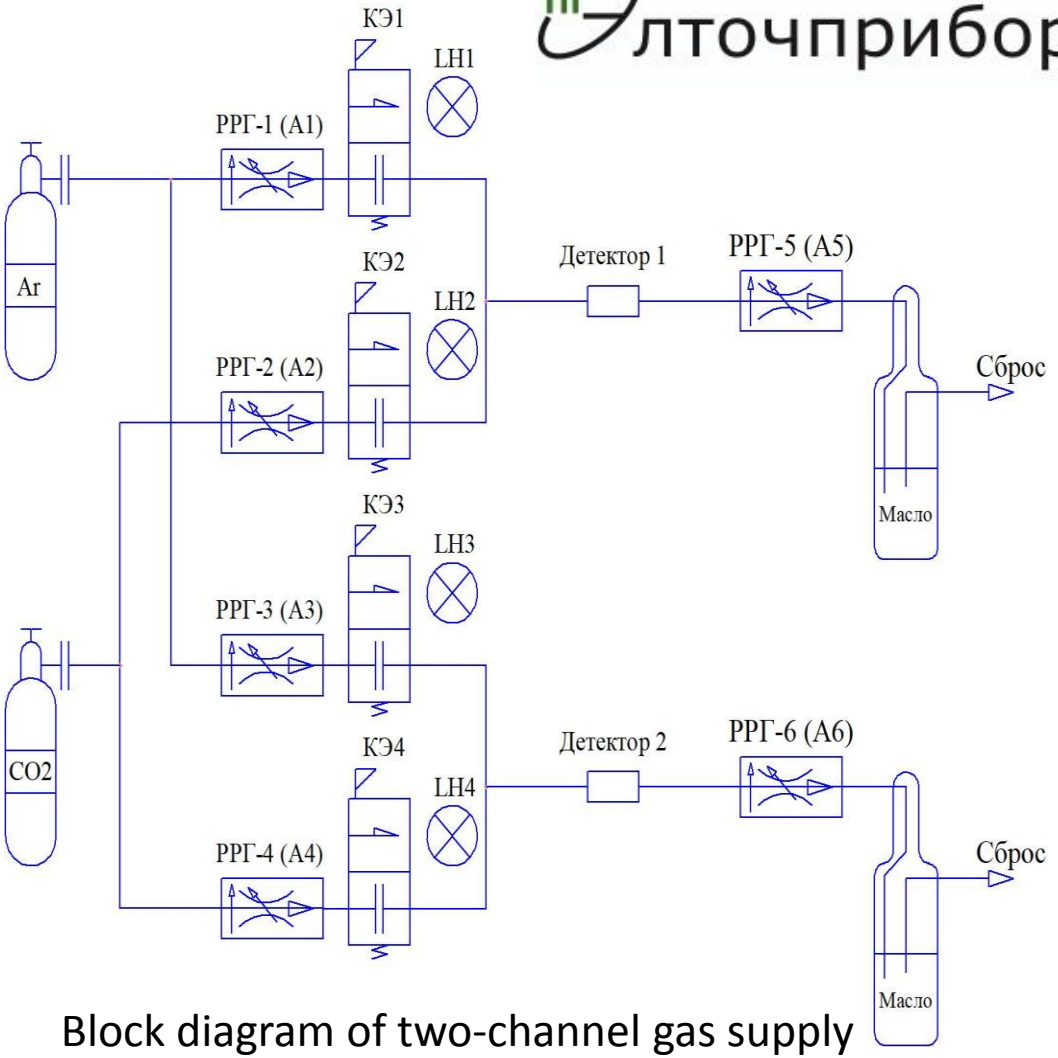


Gas supply system

Controller for gas mixing systems KGS-3

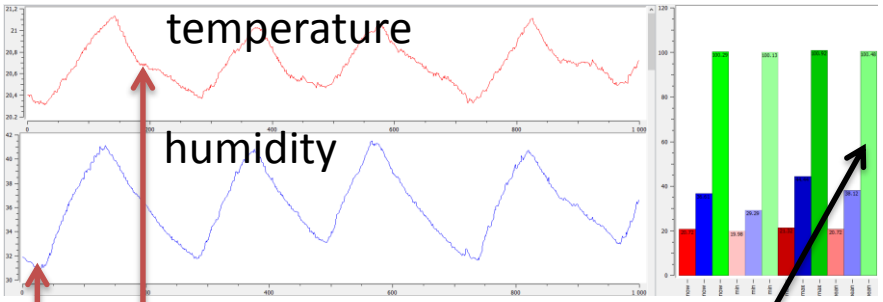
Gas-Feeding Systems elements (material – st.steel)

Mass Flow Controllers(MFC)

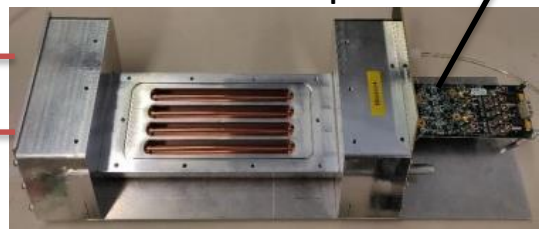


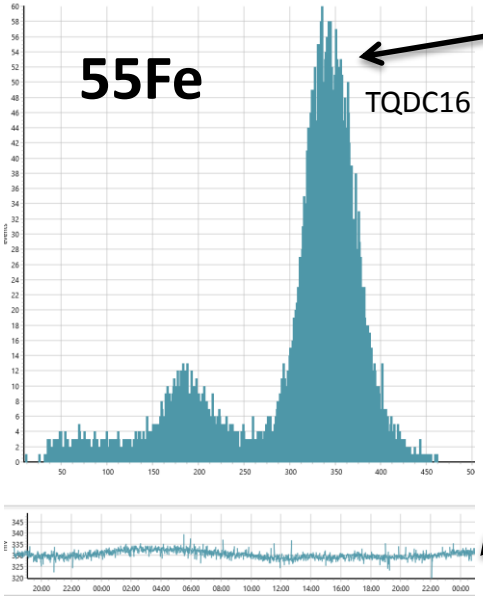
Block diagram of two-channel gas supply

Slow control



GAS GAIN Monitor
from the NA62 experiment





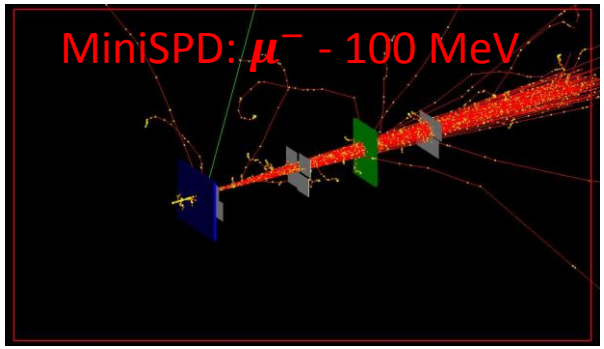
reference peak

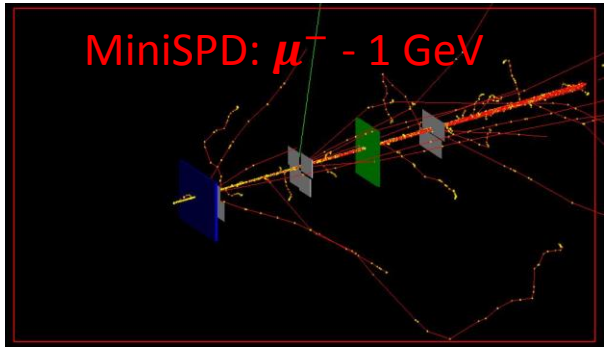
the histogram of
the change in
gas gain value

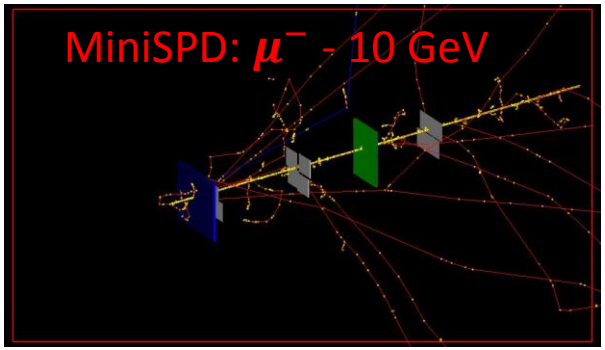
HV & LV-slow control
windows
Tango Controls

Geant4

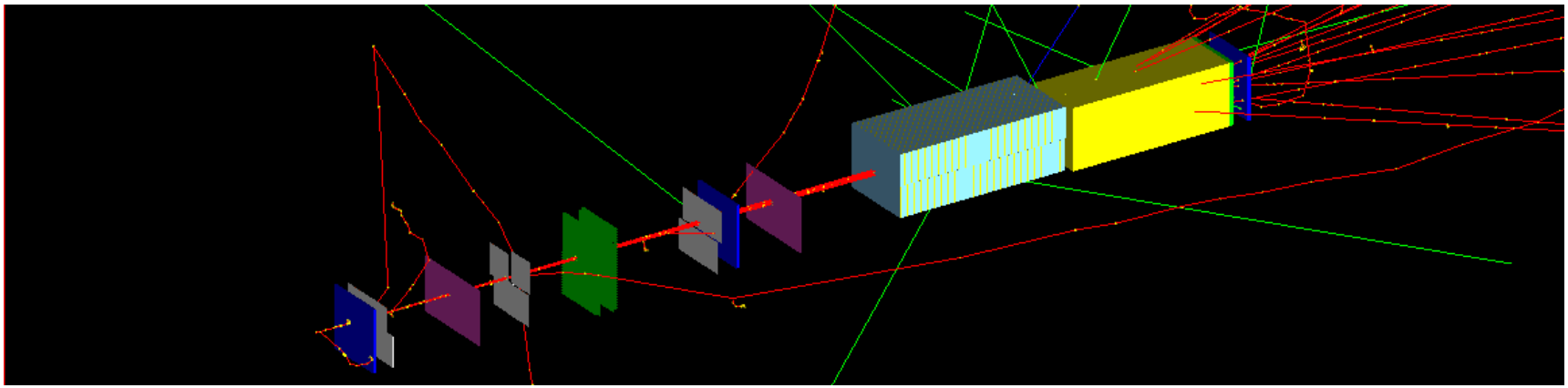
The old version of the miniSPD model stand is implemented using the Geant4 package for a 100 MeV, 1 GeV,and 10 GeV μ - beam.
The model consists of 2 scintillators, 3 Si detectors, 1 straw station







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



Conclusions:

- 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 allow to detect 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
- Use Garfield to simulate a straw tube signal