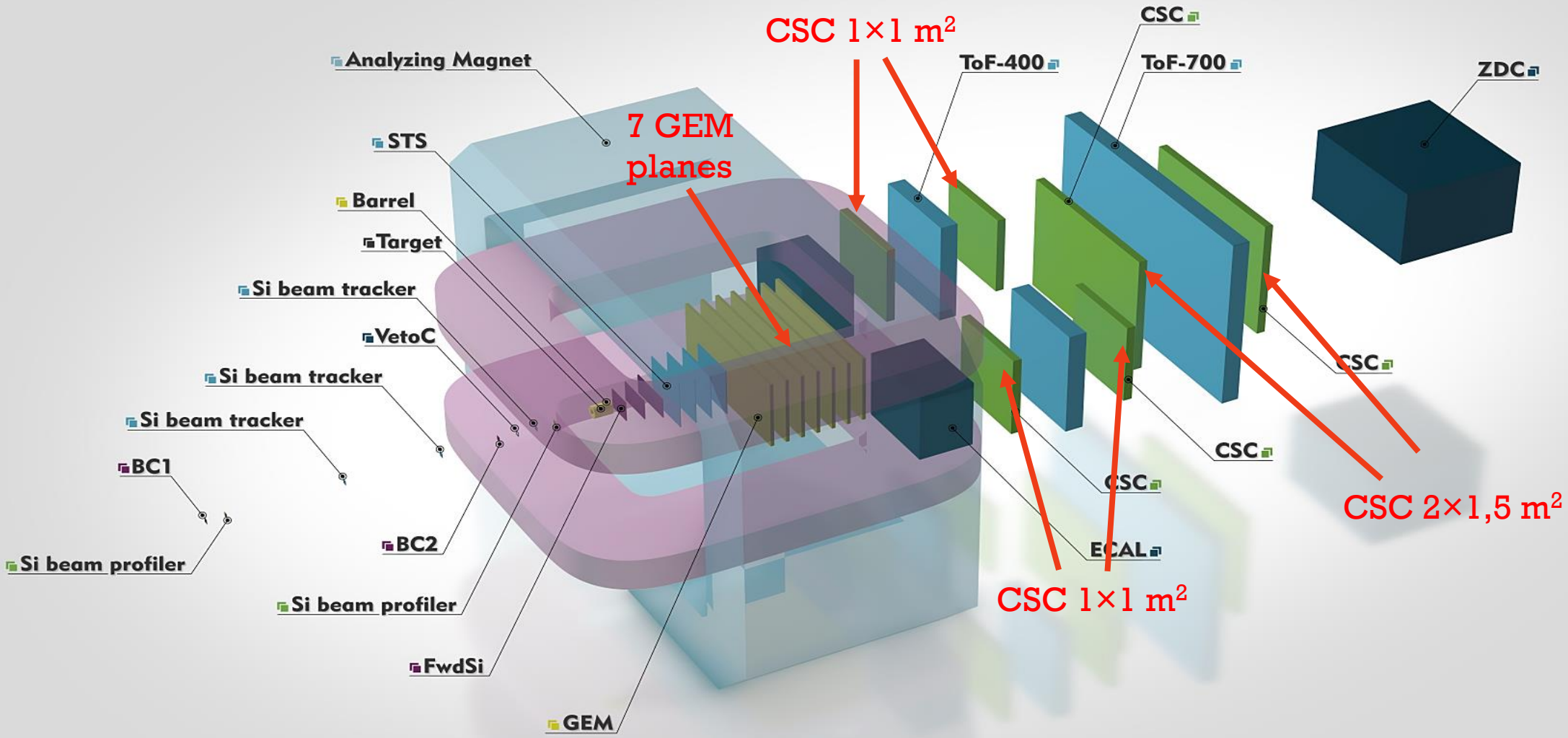
GEM+CSC upgrade

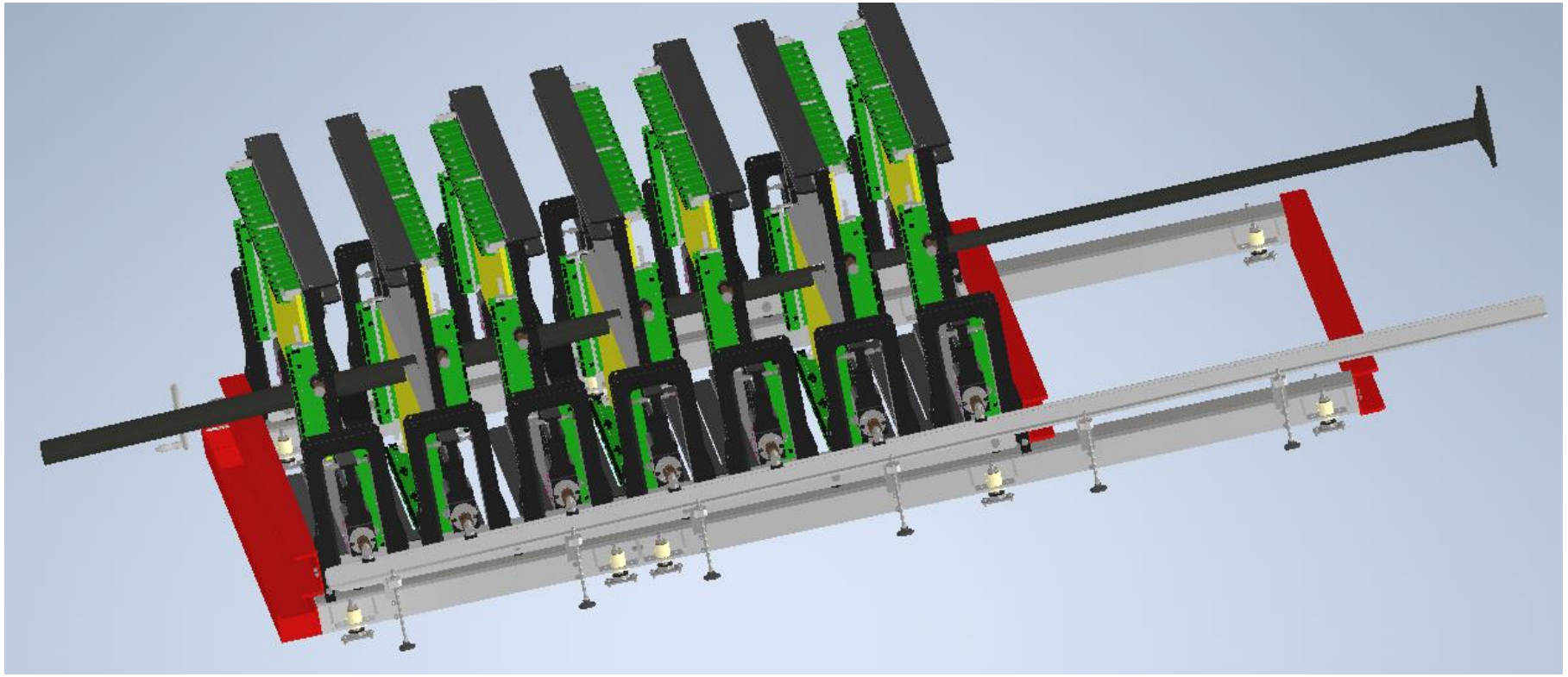
Andrei Galavanov on behalf of BM@N Collaboration

8th Collaboration Meeting of the BM@N Experiment at the NICA Facility, 03.10.2021

BM@N experiment



Full planes configuration inside the SP-41 magnet



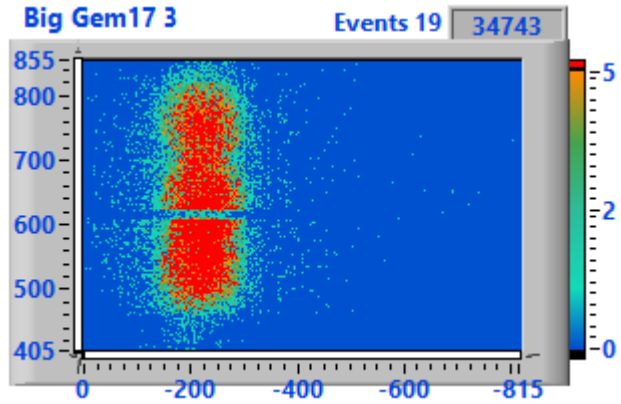
Active area of the GEM tracking system ~ 9.5 m^2.
Space for installation and alignment is limited by the aperture of our magnet.
Required some mechanical system for detectors mounting.

- Development of the mechanics design for GEM planes precise installation inside the magnet was done by "Pelcom" (Dubna) - finished;
- Production of the mechanics is currently performed by "Pelcom" (Dubna) – 09.2021.
  Delay on 2 weeks - difficulties with some technological process during manufacturing.

Assembly of the stand for long-term GEM tests

Tests of 1632*390 mm^2 detectors - finished
Tests of 1632*450 mm^2 detectors - finished

Trigger system – ten 10*200 cm^2 scintillation detectors



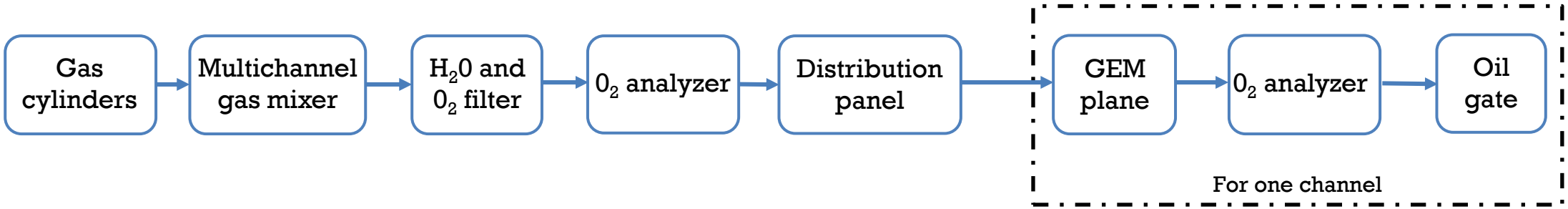
The broken sector in GEM-detector №17.
Sent this detector to CERN for repairing.
On next two week it will delivery back to JINR.

Gas system

Gas system requirements :

- stable flow and mixture parameters;
- 7 independent channels to each GEM-plane;
- reducing and control oxygen impurities in gas mixture;

Gas mixture: Argon (80)/Isobutane (20)



Distribution panel:

- 10 channels gas collector;
- On 8 channels – rotameter for gas mixture flow control (7 GEM planes + 1 channel to test room);
- One channel for pressure control;
- One spare channel.

Gas mixer.

Flow rate is 3 l/h on each channel – 21 l/h for seven channels.

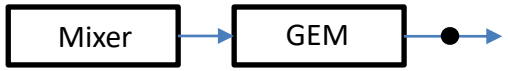
Now (max): 12 l/h for Argon + 2,4 l/h for Isobutane

Need to change the mass flow controllers at gas mixer on more productive.

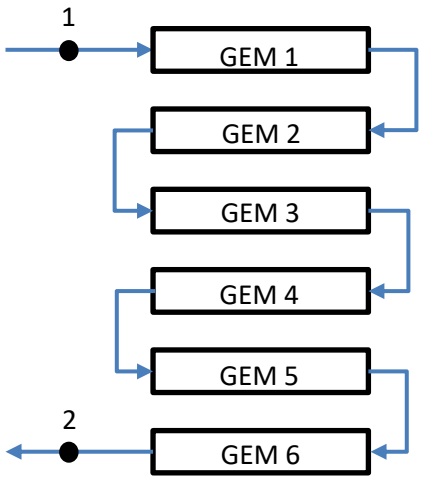
Gas system. Oxygen measurement

Polyamide tube

After one GEM



Coincidence level



Tube length	O_2, ppm (flow = 3 l/h)	O_2, ppm (flow = 6 l/h)
7,6 meters	69	50
50 meters	130	76

	O_2, ppm (flow = 3 l/h)	O_2, ppm (flow =6 l/h)
Mean	477	238

3 l/h: increase on 408 ppm; 6 l/h: increase on 188 ppm

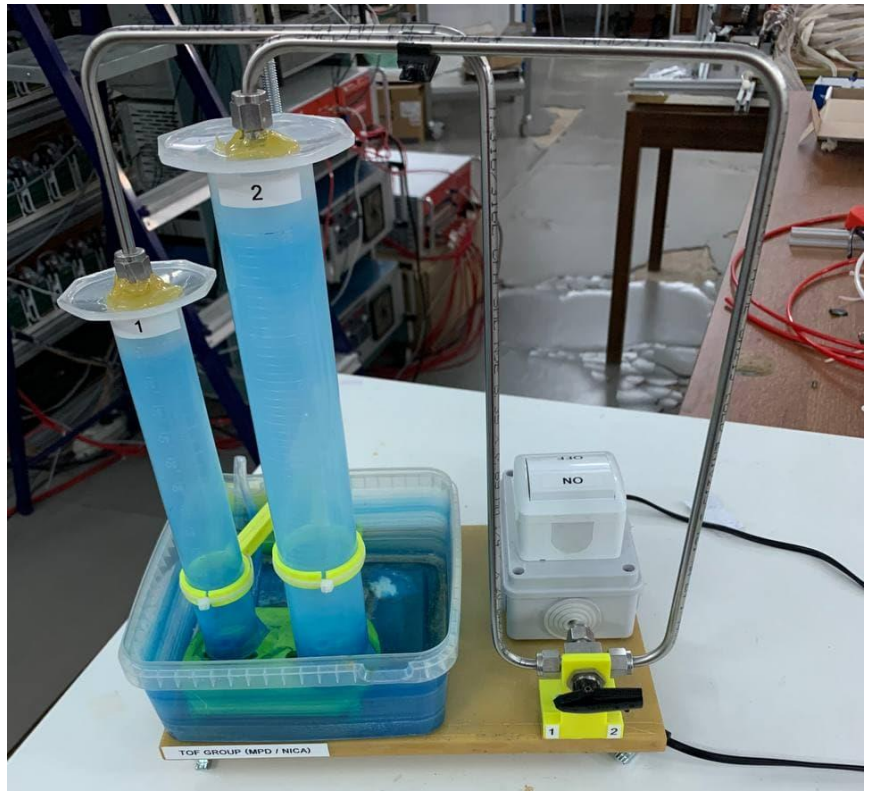
	Analyzer 1, ppm	Analyzer 2, ppm
50 meters tube, flow = 3 l/h	129	128

	Analyzer 1, ppm	Analyzer 2, ppm
3 l/h	217	4045
6 l/h	117	1610

Flow = 3 l/h: each GEM-detector adds around 550 ppm O_2
Flow = 6 l/h: each GEM-detector adds around 220 ppm O_2

Gas system. Gas mixer check

Choose the value of flow → connect the gas pipe with cylinder → fill the cylinder by water → measure the time it takes to displace the certain volume of water by gas mixture.



Thanks to P. Dulov (TOF-400)

Argon

Mixer, cc/min	20	30	40	60	80
Measure, cc/min	23,6	34,4	45,3	66,8	90,5
% difference	18	14	13	11	13

Isobutane

Mixer, cc/min	5	10	15	20	30	40
Measure, cc/min	5,5	10,8	16,1	21,1	30,6	41,4
% difference	10	8	7	6	2	4

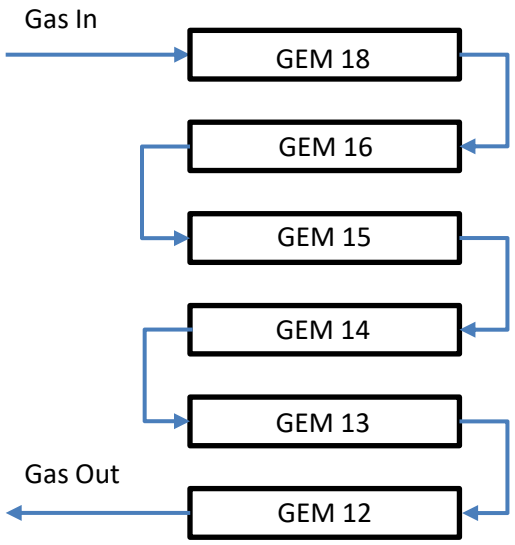
Mixture

Mixer, cc/min	40/10	60/15	80/20
Measure, cc/min	55,9	77,9	114,1
% difference	12	4	14

The gas mixer produce the gas mixture in slightly larger values, but the composition of gas mixture is about the same – Argon 80% +Isobutane 20%

Detectors amplitudes puzzle

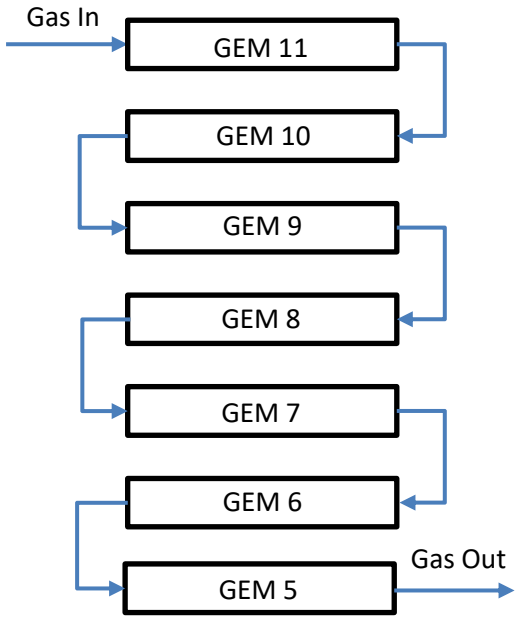
39 cm GEMs

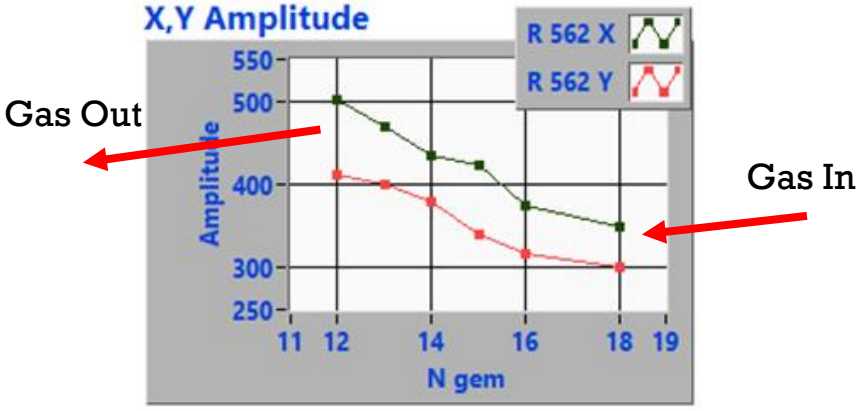


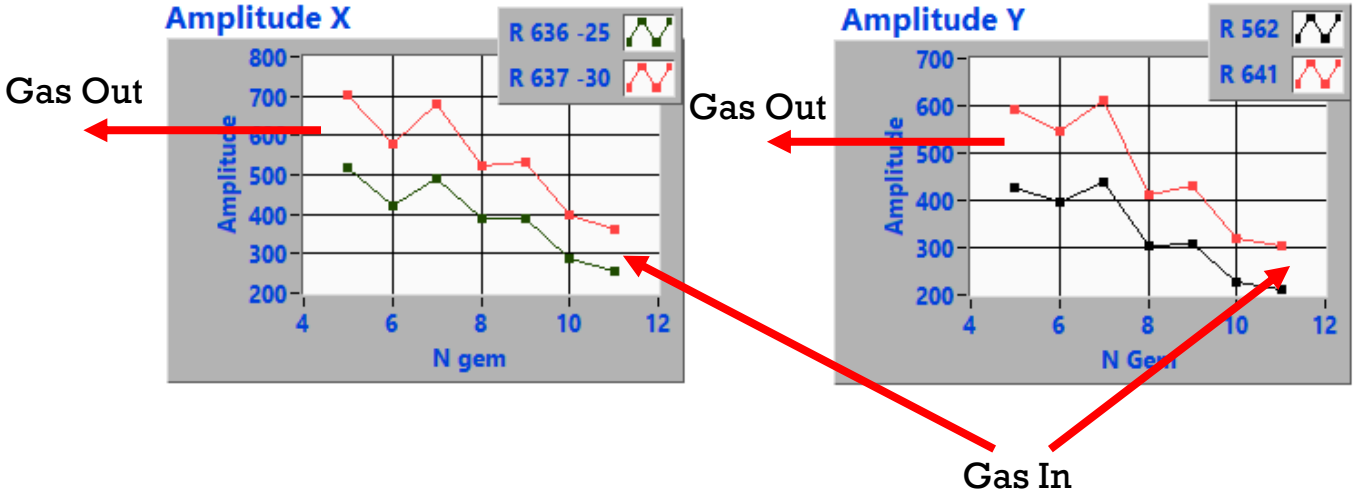
Gas mixture go through all detectors in series.

In general - the amplitude of the signals increases from the first detector to the last detector.

45 cm GEMs





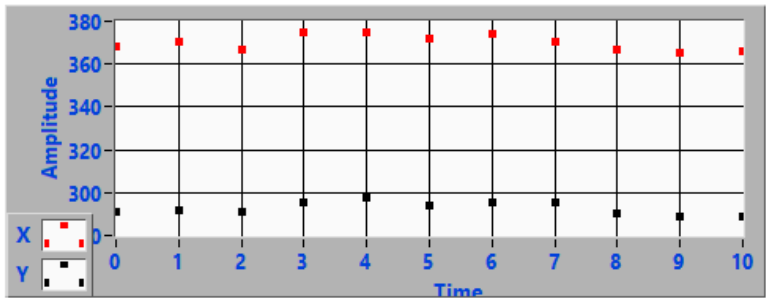


Temperature influence

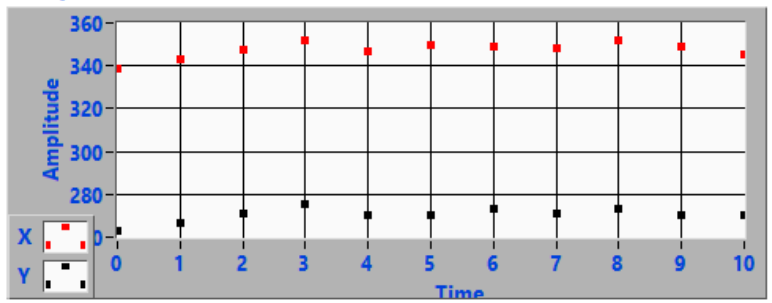
Temperature of Gas Cylinder = 19 ℃, temperature in GEM test room = 24 ℃

Flow = 3 l/h

Mean X = 369
Mean Y = 292

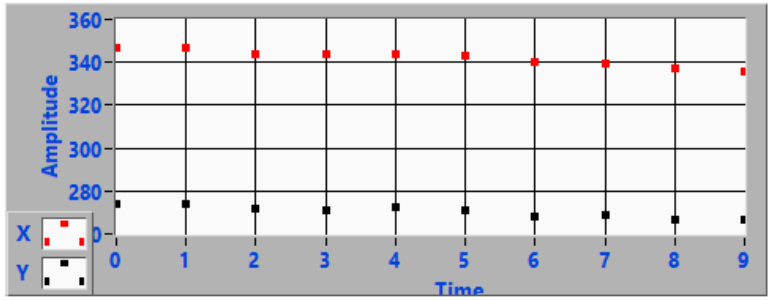


Mean X = 347
Mean Y = 270

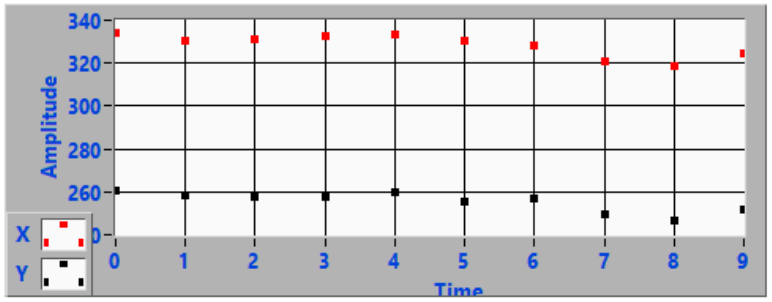


Flow = 4,5 l/h

Mean X = 342
Mean Y = 270

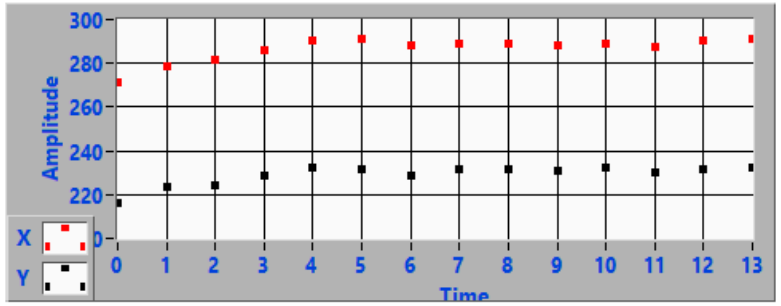


Mean X = 328
Mean Y = 255

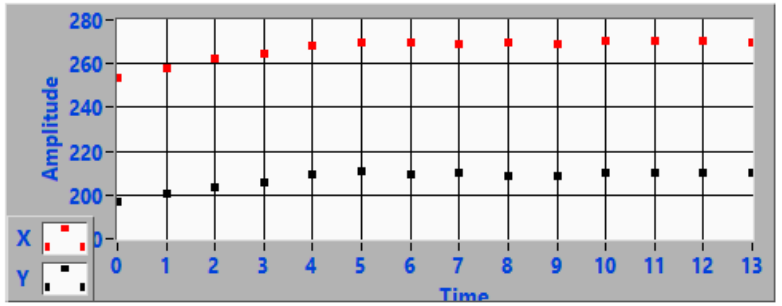


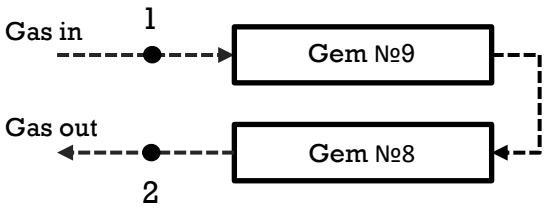
Flow = 6 l/h

Mean X = 286
Mean Y = 228



Mean X = 266
Mean Y = 207



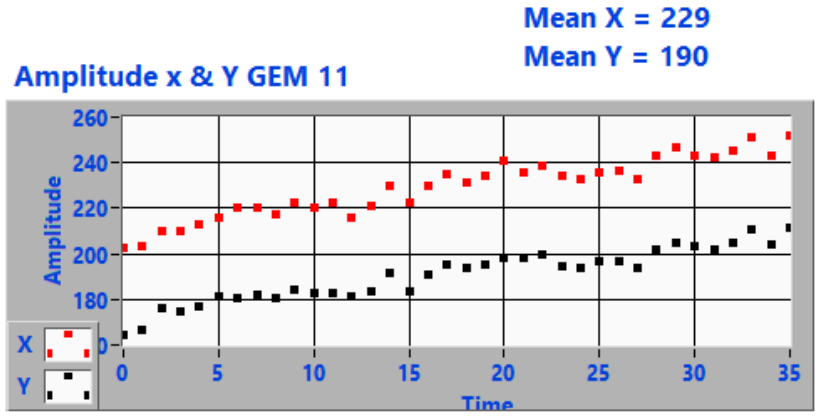


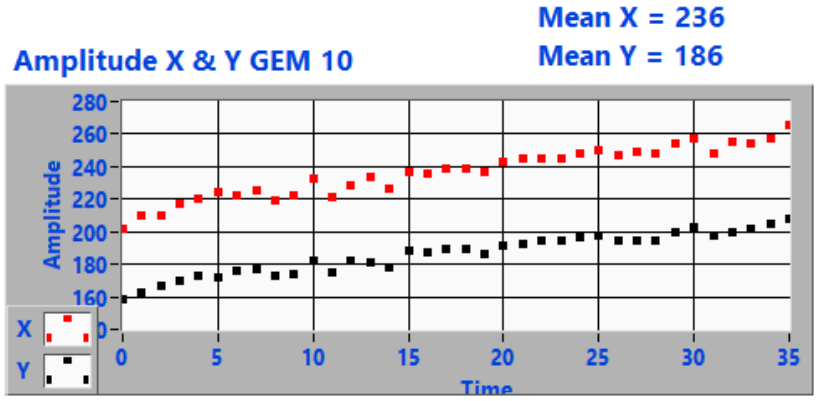
Analyzer	O_2 ppm (3 l/h)	O_2 ppm (4,5 l/h)	O_2 ppm (6 l/h)
1	245	151	105
2	670	429	308

Amplitude is decrease when we increase the flow

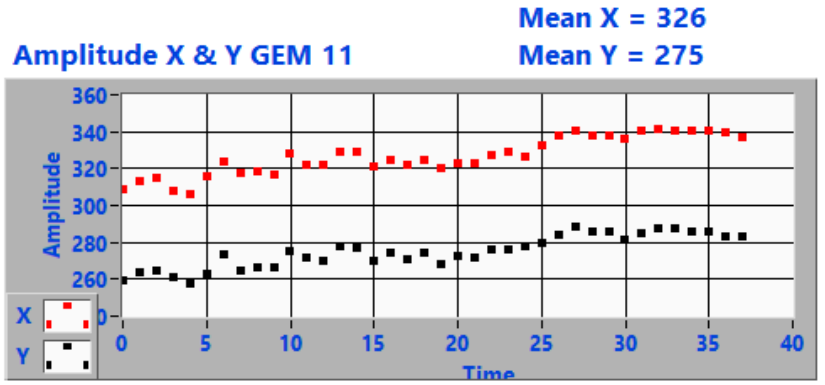
Temperature influence

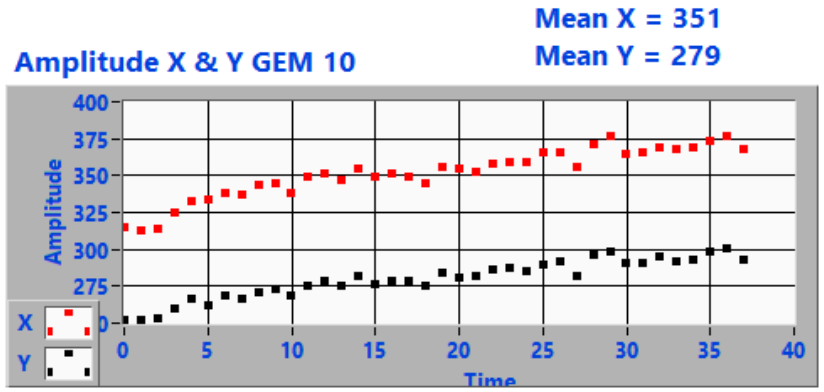
Flow = 3 l/h, T_{cyl} = 19C,
T_{room} = 20C

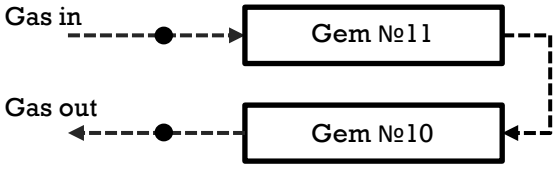




Flow = 3 l/h, T_{cyl} = 19C,
T_{room} = 25C



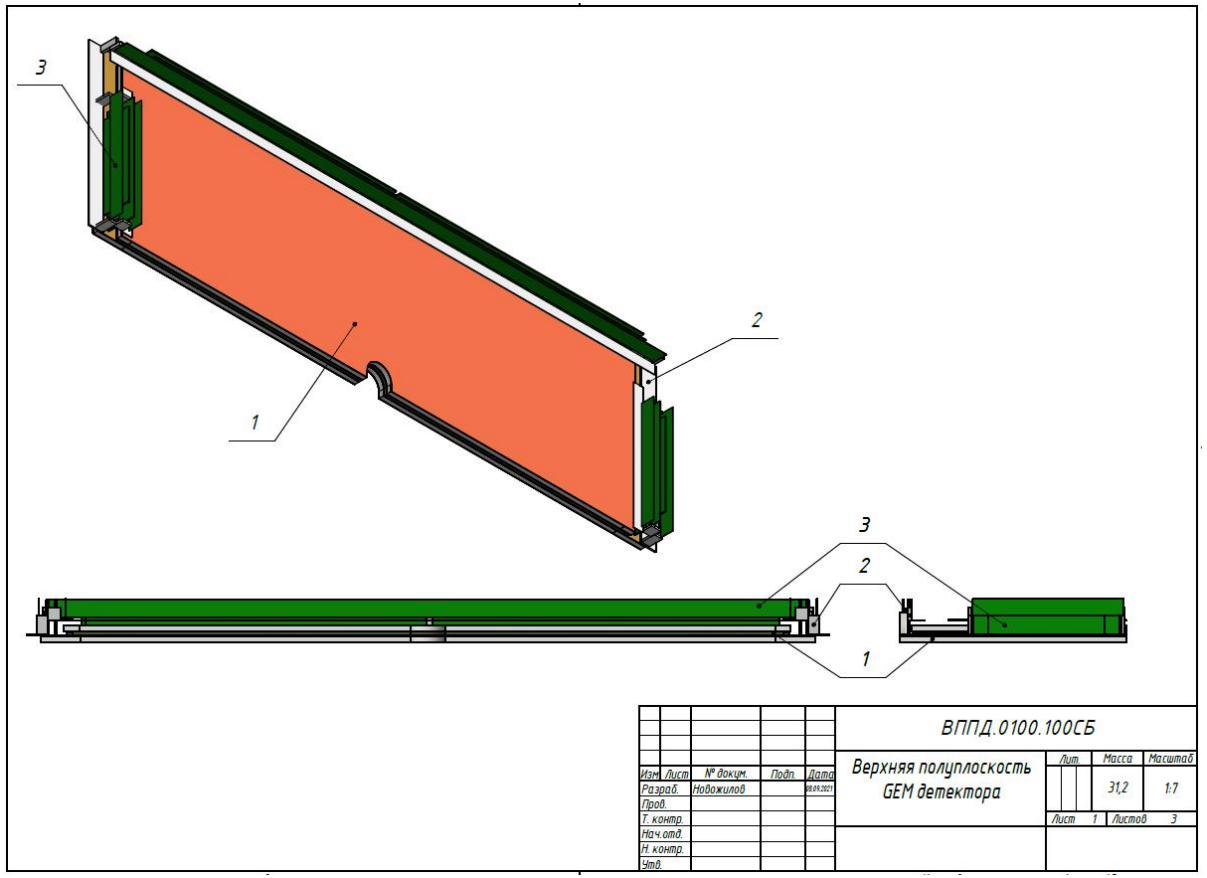


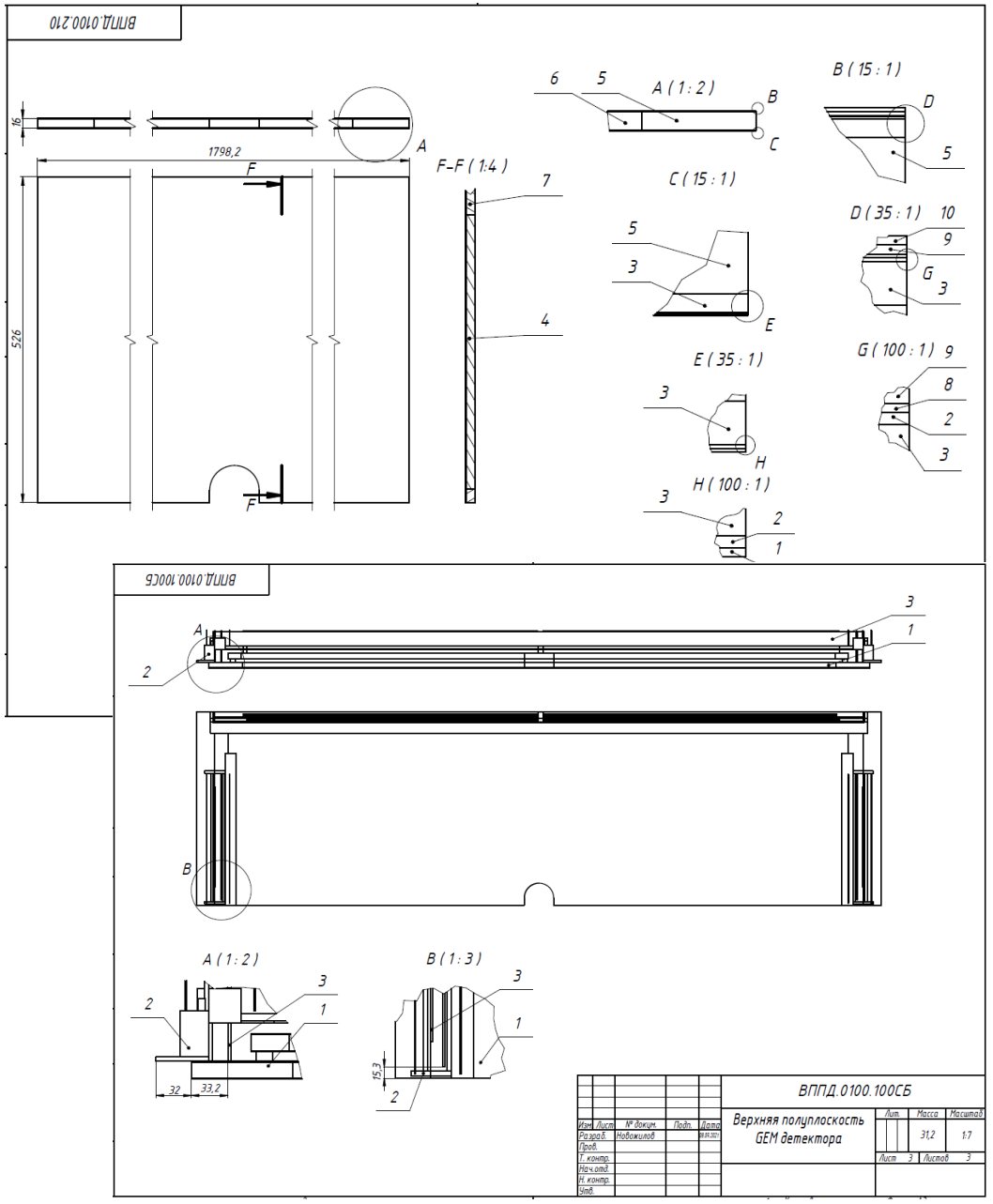


Amplitude is increase when we increase the temperature

With low flow rate gas doesn't have time to hit up

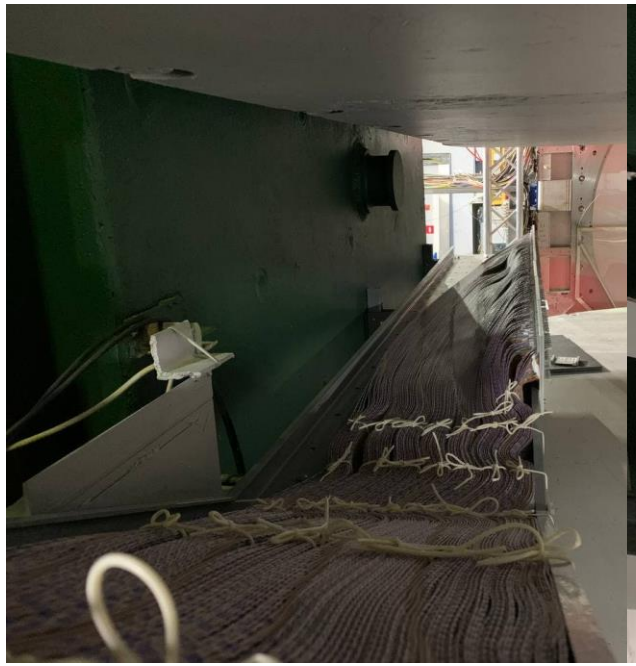
Precise models of GEM-detectors





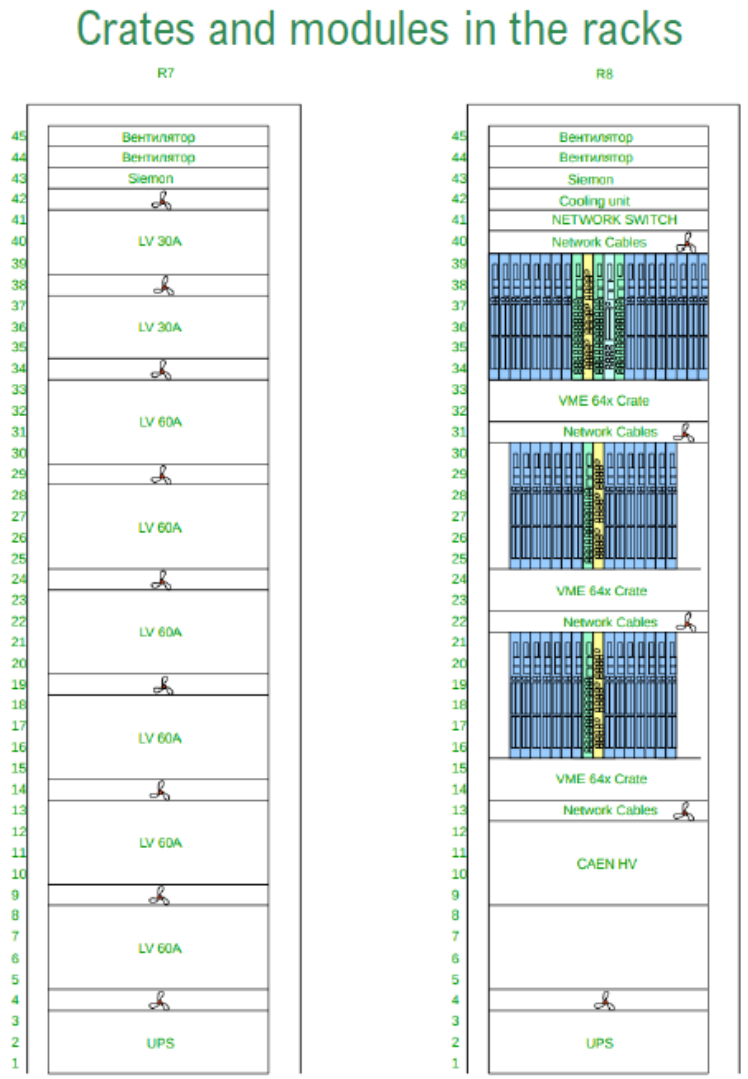
The quality of the models are improved. Drawings contain the information about materials, densities and thicknesses. Total - 84 drawings for one type of GEM-detector.
The main goal – simplified, but realistic model for BMNroot.

Racks an cables

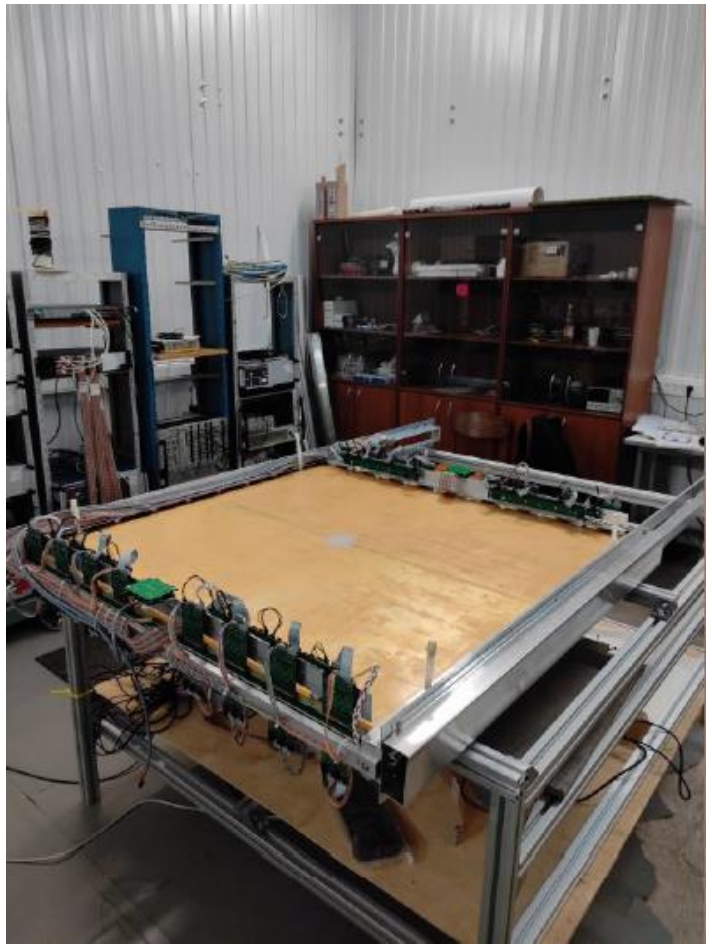


175 cables from ADC to patch-panels was laying in the cable duct.

- All cables (signal, high-voltage, low-voltage) was produced;
- Cables marking was completed;
- Number and position of the racks in the experimental hall is fixed;
- Location of the crates and modules in the racks are fixed.



CSC 1×1 m^2



Cosmic rays tests (single CSC)

Tests of two CSC

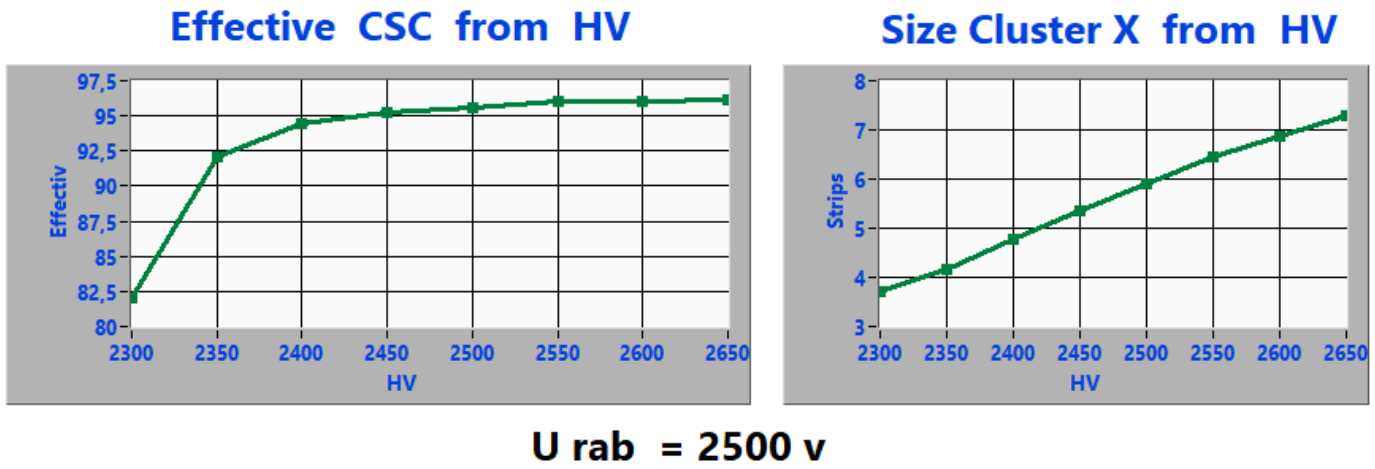
One CSC 1×1 m^2 was tested at Nuclotron beam in 2018.

Four CSC 1×1 m^2 were tested on cosmic rays and radiation source at summer 2021.

The oxygen impurities in gas mixture before and after the chambers was measured. O_2 level ≥ 150 ppm.

Three CSC 1×1 m^2 are ready to SRC run – HV and LV systems are ready, detectors were equipped with front-end electronics, cables and gas tubes.

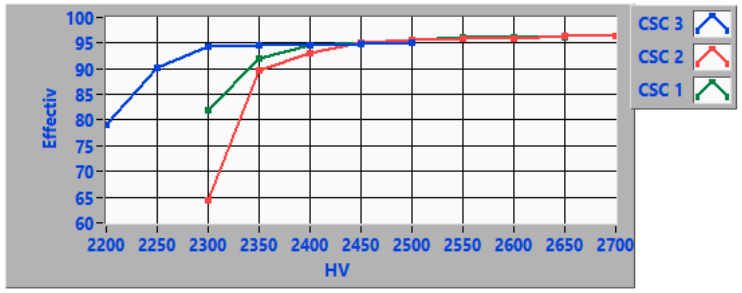
CSC 1 × 1 m²

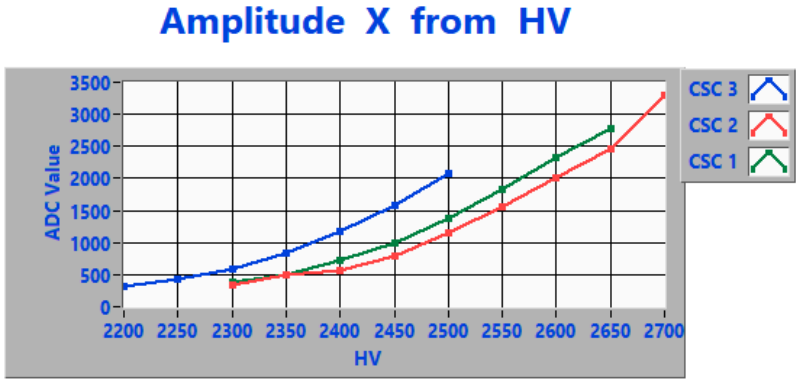


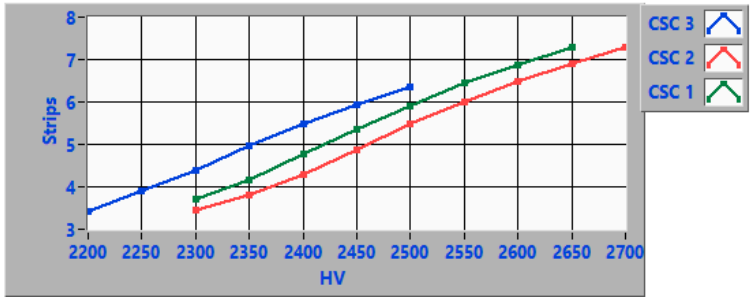
Software for online checking of CSC performance and parameters: efficiency, cluster size, amplitudes, 2D distribution of the detector occupancy.

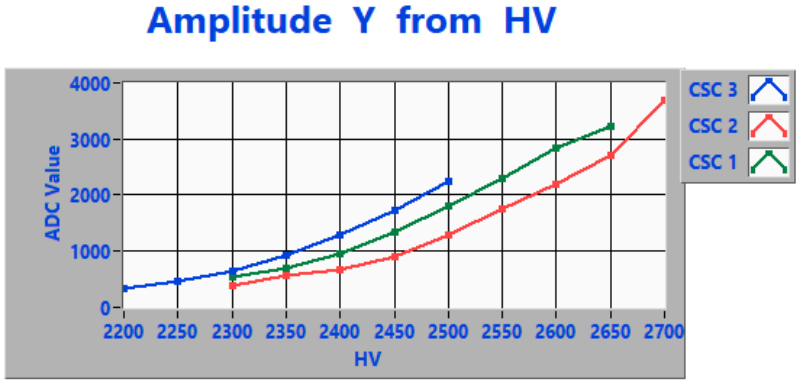
CSC 1 × 1 m^2

Blue – CSC with 3,5 mm gap
Red and Green – CSC with 3,8 mm gap





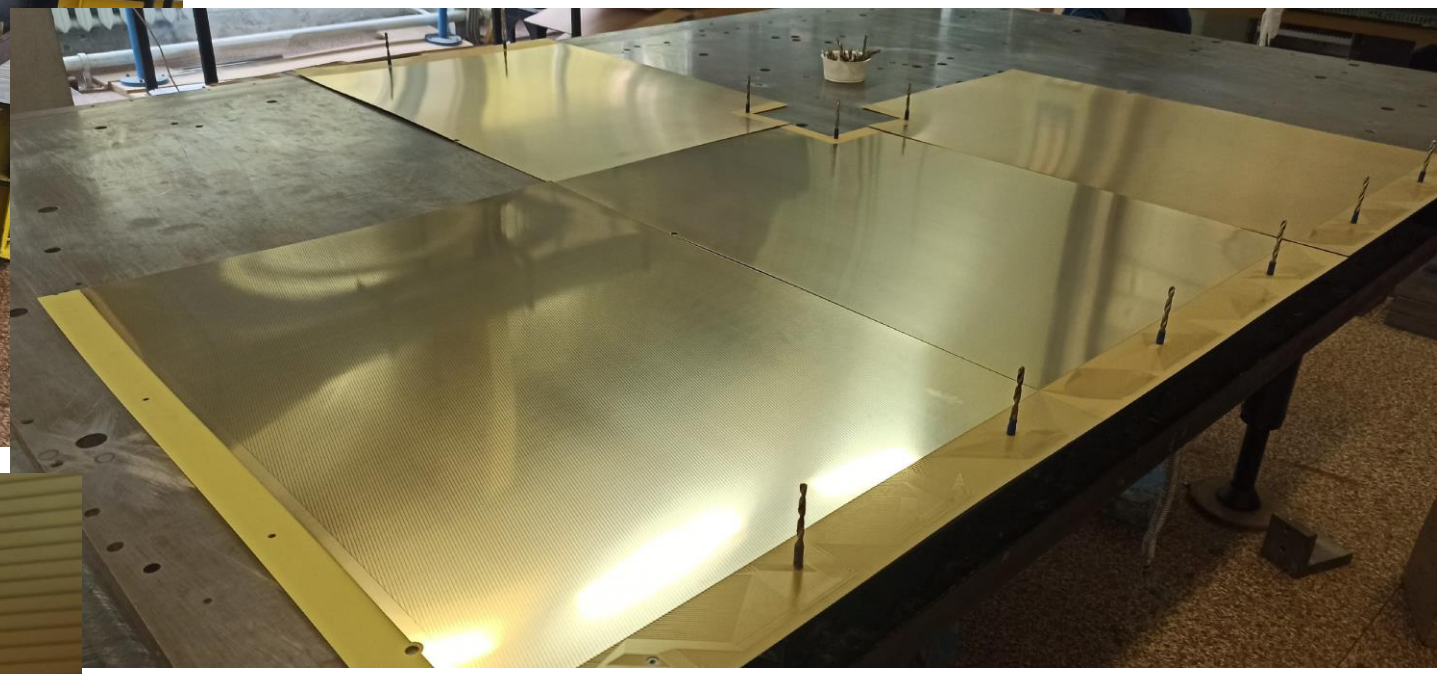


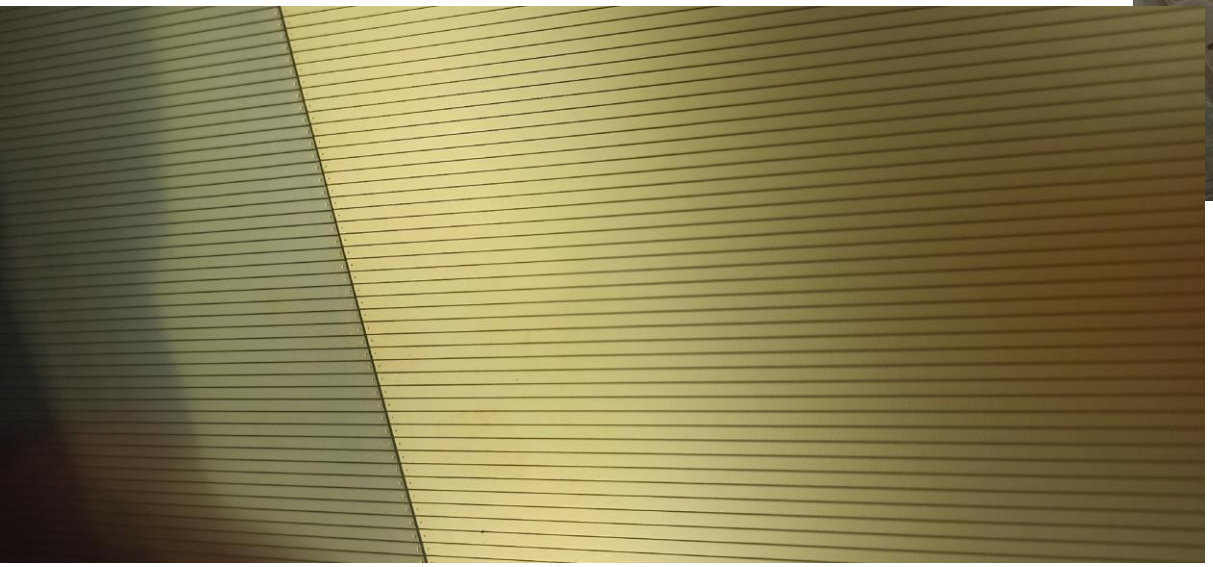


Comparison of the CSC with 3.5 mm gap on the CSC with 3.8 mm gap efficiency, the amplitudes and the cluster size characteristics.

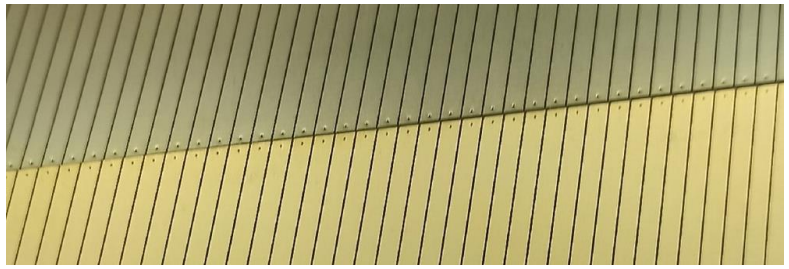
CSC 2 × 1.5 m^2

Expanded assembly table with precise hole pattern





Preliminary matching of cathode panels

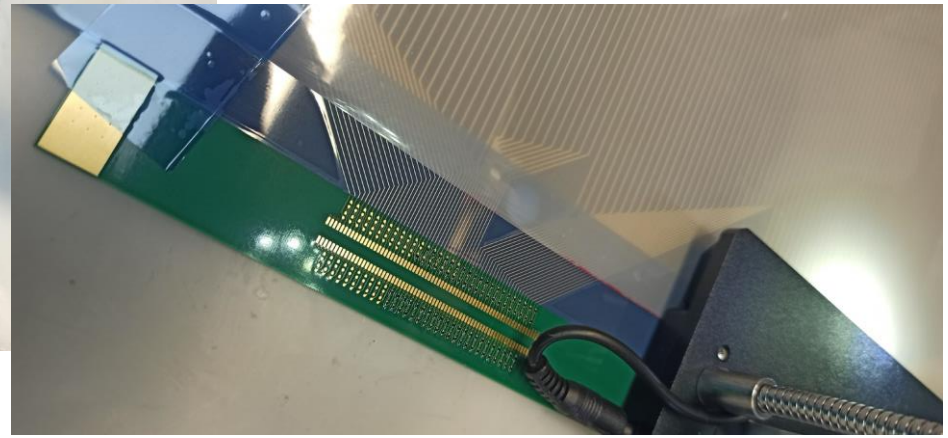


CSC 2 × 1.5 m^2

Assembly and tests of the first big CSC – 03.2022
Preparing to assembly of the first big Cathode Strip Chamber was started:

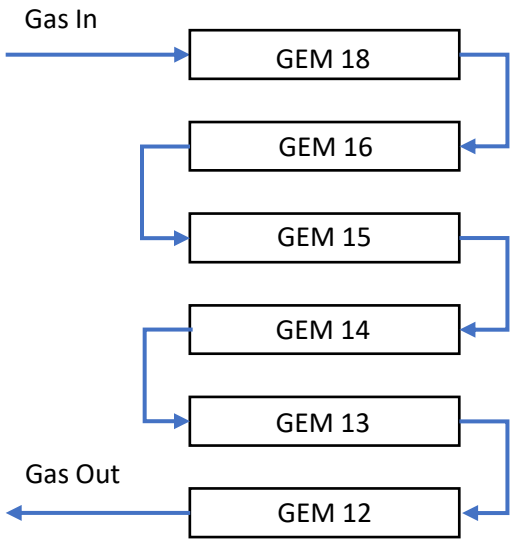
- All parts of detectors are delivered to JINR;
- Expanded assembly table is ready;
- Protective resistors are soldered to the cathode boards.

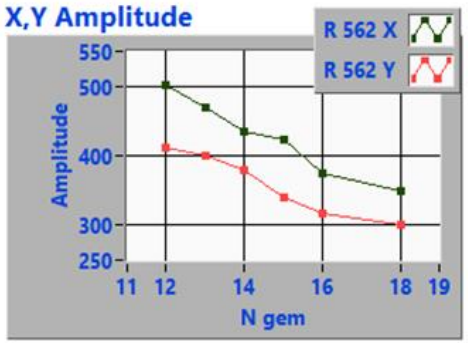
Soldering the protection resistors on front-end electronics connectors



Thanks you for your attention!

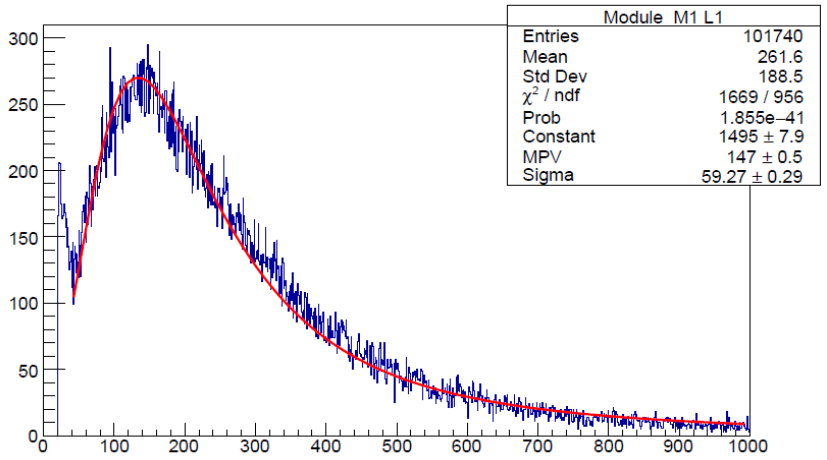
Amplitudes with different flow



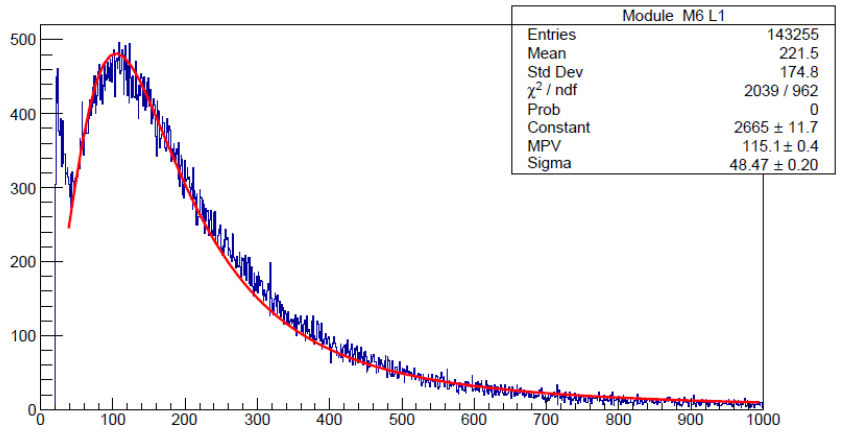


Hypothesis – the oxygen is collect in gas mixture and reduce the signal at low value of flow rate

Flow = 3 l/h

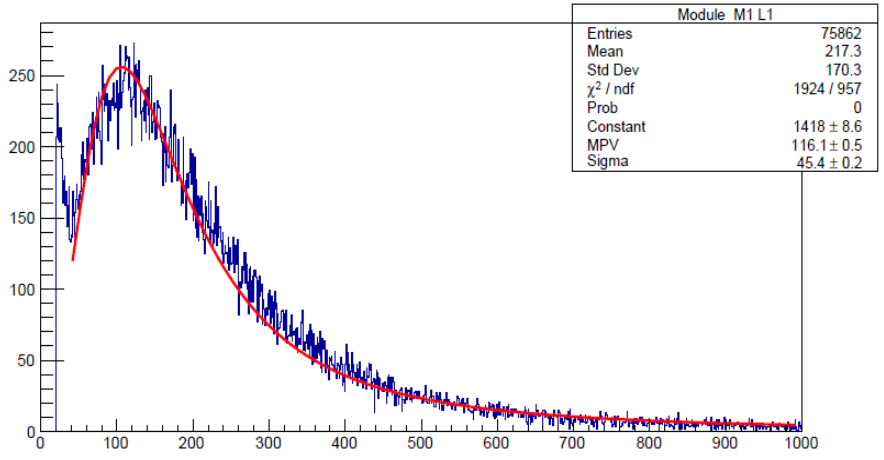


GEM 1. Amplitude MPV=147

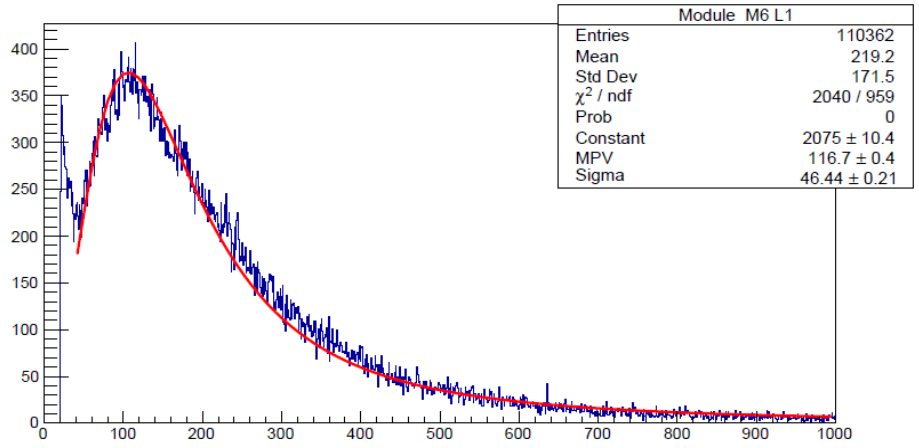


GEM 6. Amplitude MPV=115.1

Flow = 6 l/h



GEM 1. Amplitude MPV=116.1



GEM 6. Amplitude MPV=116.7