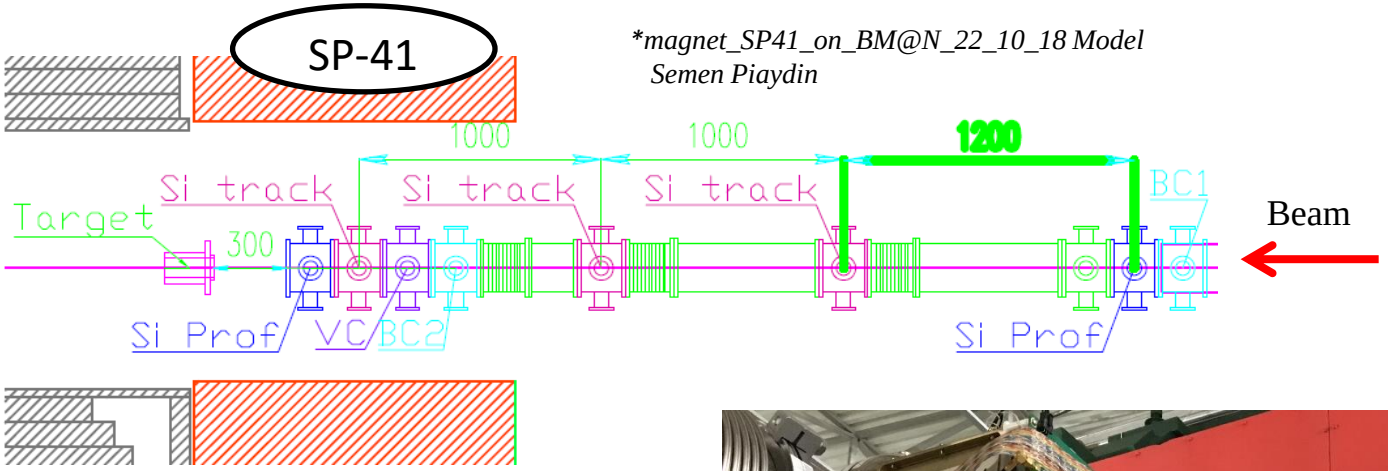
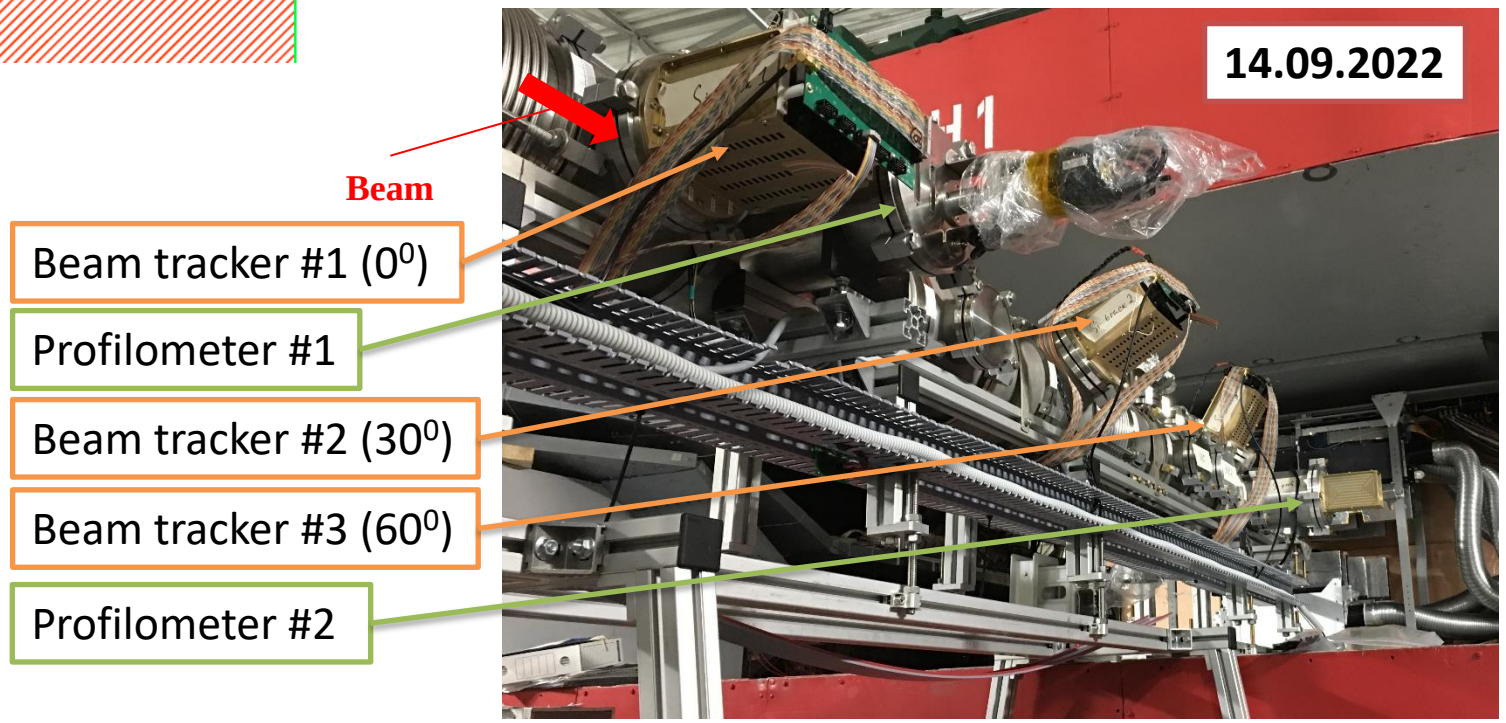
Forward Silicon Tracker and beam detectors for *Xe* run - 2022

N. Zamiatin behalf on Si – detectors team

9th Collaboration Meeting of the BM@N Experiment at the NICA Facility,
14 September 2022

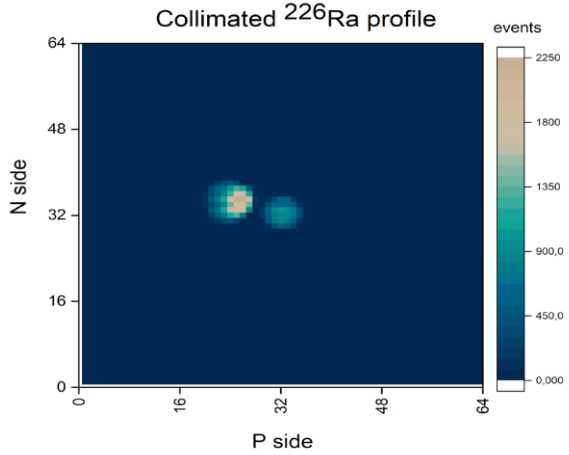
Position of beam Si detectors before a target

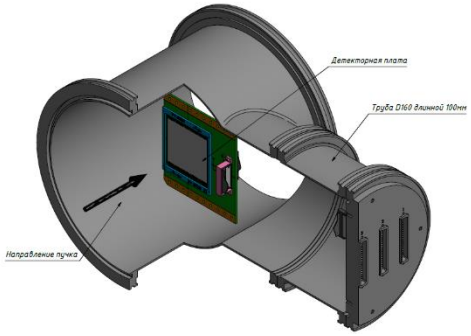




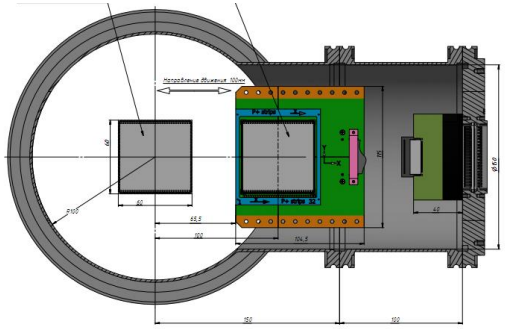
Beam profilometer

is necessary for beam tuning (alignment of the center beam with the center of the target)





working position



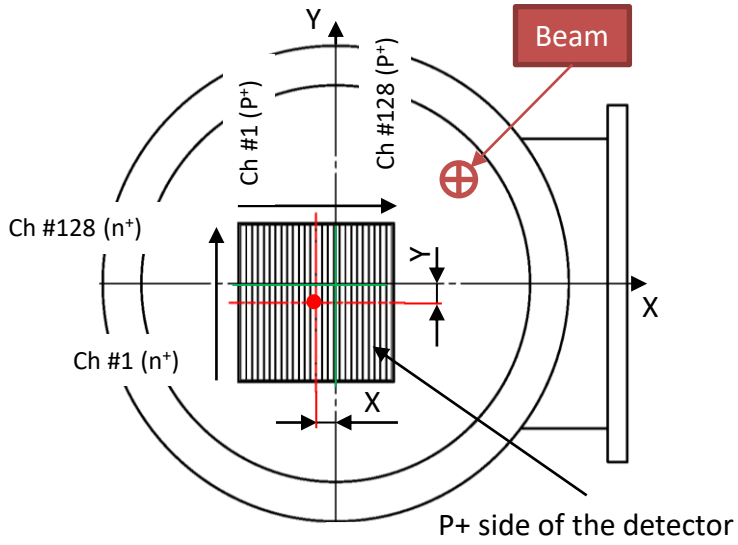
parking position

- **detector:** DSSD, ($32p^{+}\times32n^{+}$), strips pitch = 1.8 mm, thickness (Si) -175 μm, active area (60 × 60) mm^2;
- **mechanical design:** the plane of the profilometer is automatically removed from the beam zone to the parking position;
- **FEE:** for light ($_6C \div {}_{18}Ar$) ions based on **VA163 + TA32cg2 (32 ch, dynamic range (DR): -750fC ÷ +750fC) desing in progress**;
- **current status:**

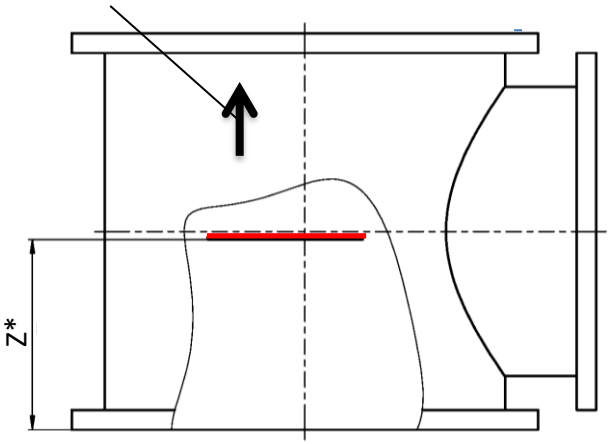
  - two vacuum stations with flanges and cable connectors are ready, Silicon Detectors assembled on PCBs and tested with alpha-source (5.5 MeV), autonomus (ADC+DAQ) subsystem ready;

  - for heavy (Kr ÷ Au) ions will be developed another version of the FEE with DR = ± 20 pC.

Position of double-coordinate Si-detectors relative to the axis of the ion guide



Beam directions



*Distance between the flange surface and the detector surface.
Detector rotation in the coordinate plane no more than 0.5^0

Beam tracker detector center coordinates relative to the ion guide axis (mm)

#	X	Y	Z*
#1	0.0	0.9	94.7
#2	2.7	-0.3	96.9
#3 (Al)	0.4	0.1	94.9

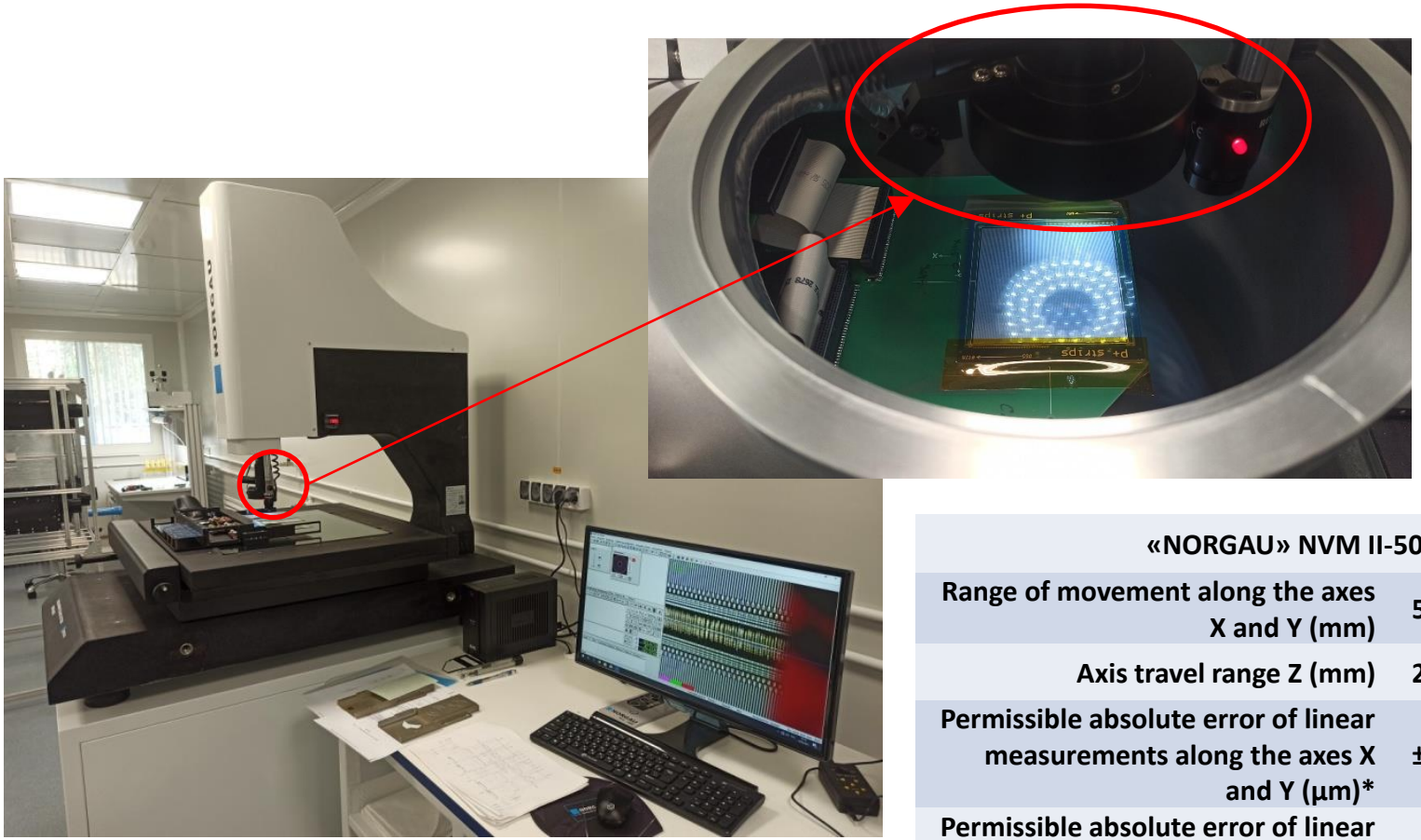
Strip pitch in the detector: 0.45 mm
Number of strips: 128x128
Thickness: 175 μm
Size: 63 x 63 mm^2

Beam profilometer detector center coordinates relative to the ion guide axis (mm)

#	X	Y	Z*
#1 (electric)	-1.3±0.1	0.7±0.1	99.7
#2 (pneumatic)	-2.7±0.5	1.4±0.2	100.7

Strip pitch in the detector: 1.87 мм
Number of strips : 32x32
Thickness: 175 μm
Size: 60 x 60 mm^2

Measurement of the position of Si-detectors relative to the axis of the beam pipe on a video-measuring microscope "NORGAU" NVM II-5040D.



«NORGAU» NVM II-5040D	
Range of movement along the axes X and Y (mm)	500 x 400
Axis travel range Z (mm)	250
Permissible absolute error of linear measurements along the axes X and Y (µm)*	±(2.5+L/200)
Permissible absolute error of linear measurements along the axis Z (µm)*	±(2.5+L/100)
* L –measured length in mm	

Si-trigger multiplicity (64ch)

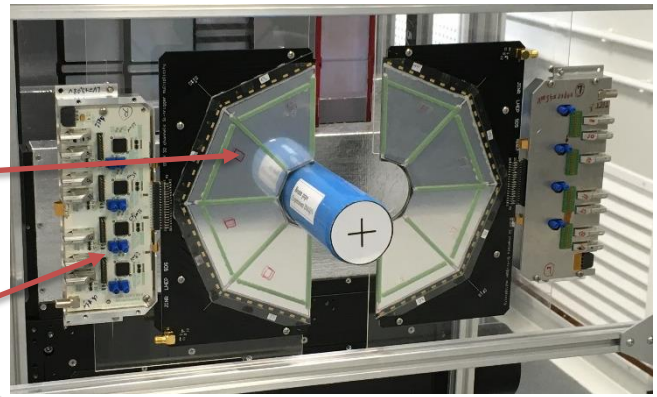
Si trigger development v.2022

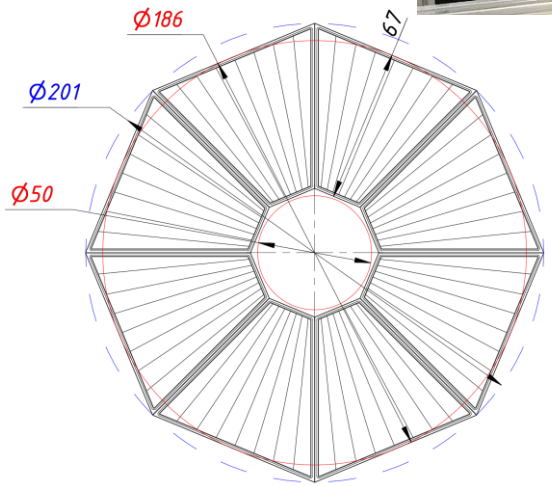
The detecting plane of the silicon trigger is assembled from 8 trapezoidal one-sided detectors:

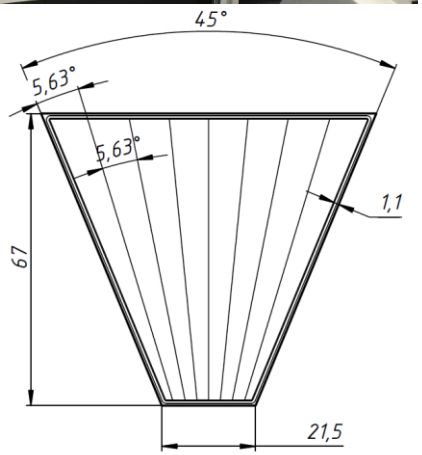
- Total 64 radial strips with 5.630 angle
- Diameter of inner hole for ion guide Ø50 mm (dead zone Ø55 mm)
- External diameter of the sensitive zone 186mm
- Max diameter 201mm
- Detector thickness 500 µm
- S_{strip} – 3.55 cm^2

Half plane 32 channels, consists of four trapezoidal Si detectors, eight strips each.

FE - electronics

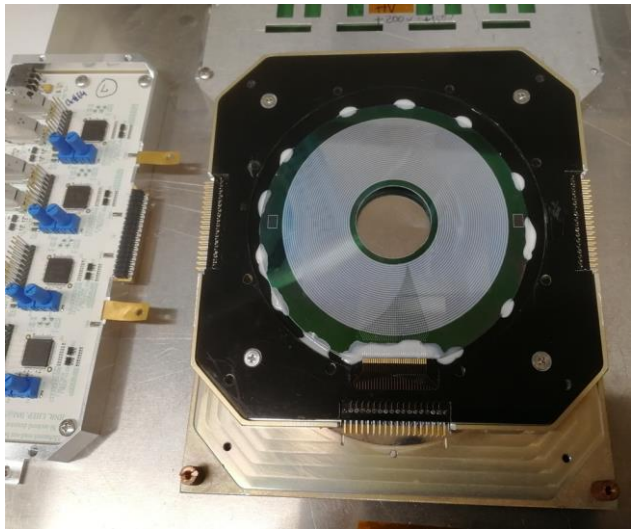






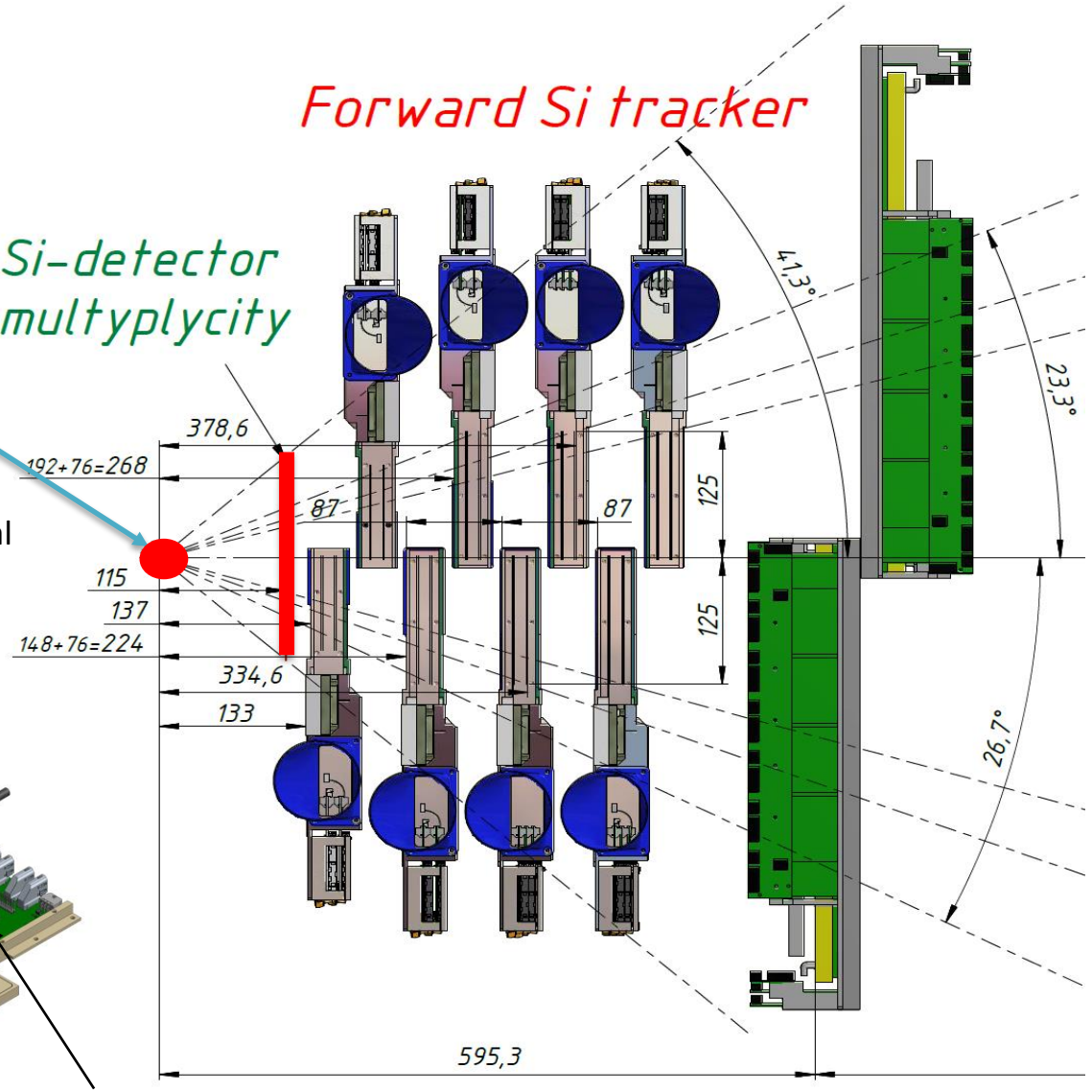
Si trigger development v.2018

- Double sided detector: 64 strips × 32 rings
- Diameter of inner hole for beam Ø28 mm (dead zone Ø32 mm)
- External diameter of the sensitive zone 86mmDetector thickness 520 µm
- Detector electronics 64 channels
- The sensitive area of the entrance window is covered with Al-foil, 50 µm thick
- S_{strip} 0.73 cm^2

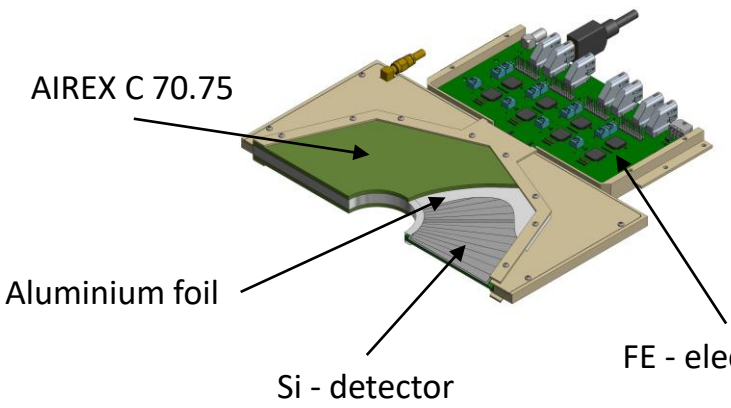


Aperture of the Si-trigger multiplicity and Si-FW tracker (Y - cross section)

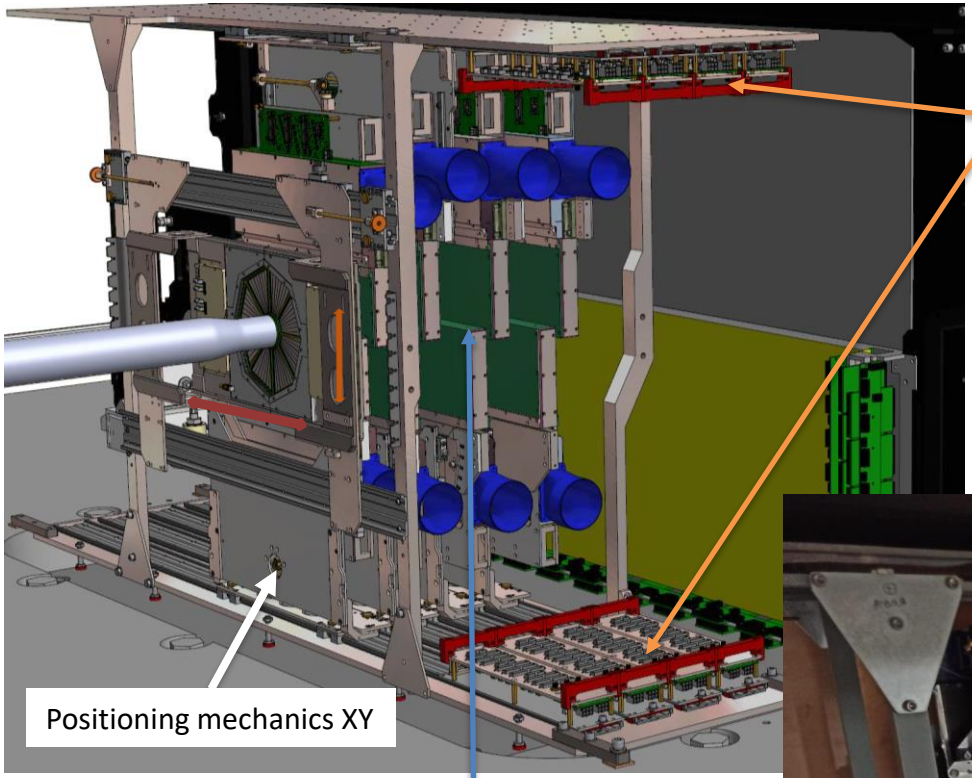
Si trigger is located at a distance of 115 mm from the target. The light-shielding housing Si of the trigger and the ion guide are not shown.

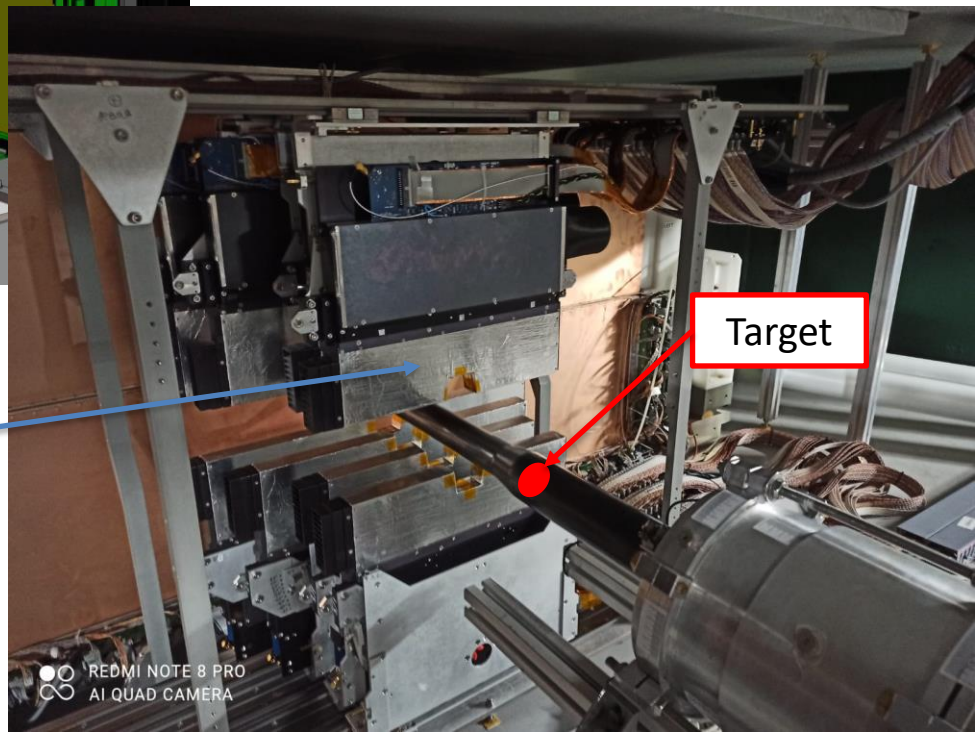


Al foil (20 µm) + foam wall as a mechanical support (AIREX C 70.75, 3mm thickness, Density 80 kg/m^3).
Per unit area (one wall of shielding):
0.010 g/ cm^2 (Al) + 0.024 g/cm^2(foam)



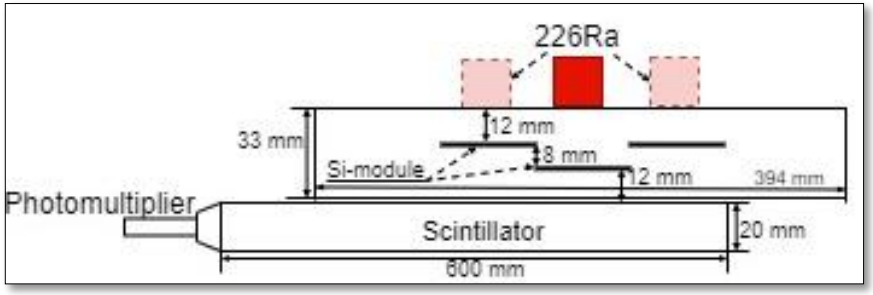
View Si-trigger multiplicity and Si-FW tracker



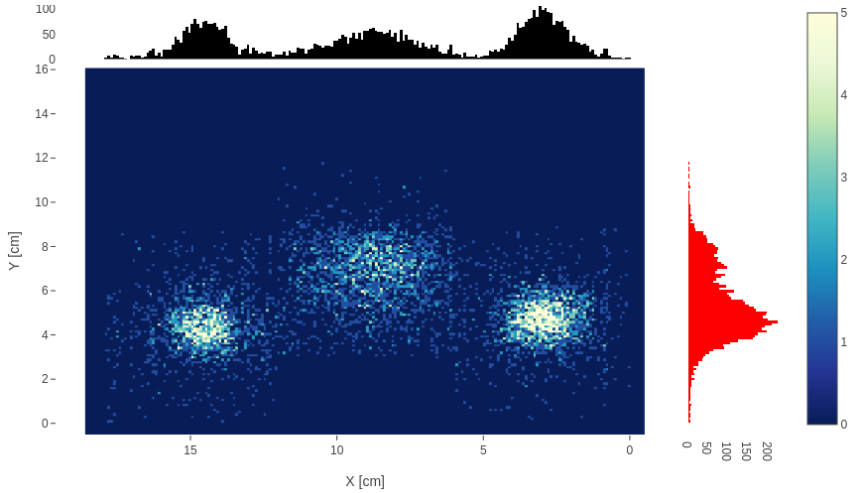


Silicon Modules development on the new Si – detectors/2020 (63x93 mm^2) Plane #3/1

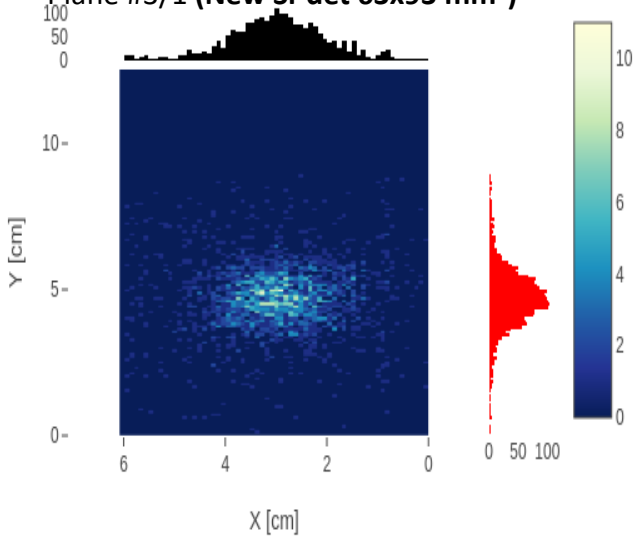
Test with β (Ra^{226})



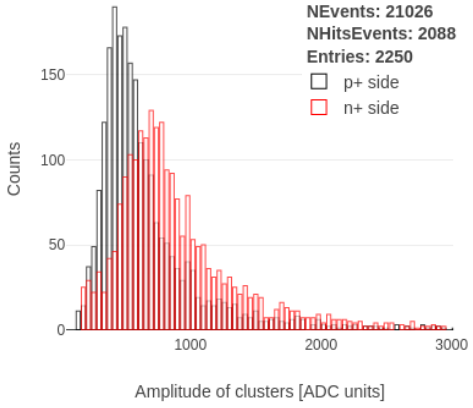
Hits distribution at Plane #3/1



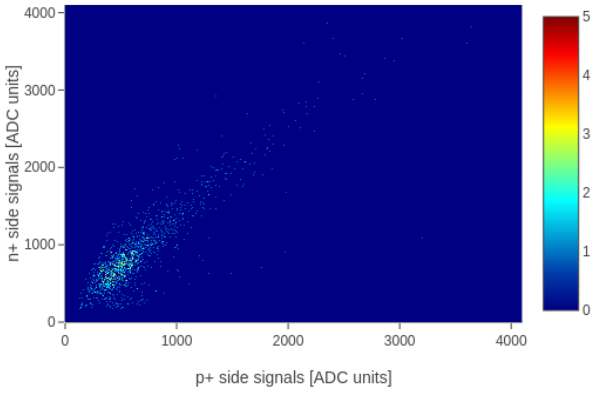
Hits distribution
Plane #3/1 **(New Si-det 63x93 mm²)**



Amplitude of clusters distributions
at Plane #3/1 **(New Si-det 63x93 mm²)**

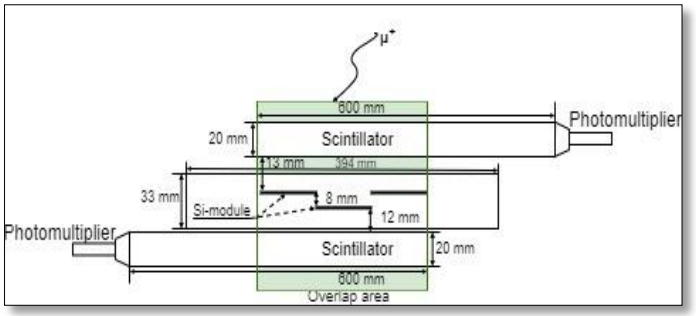


Correlation plot
at Plane #3/1 **(New Si-det 63x93 mm²)**

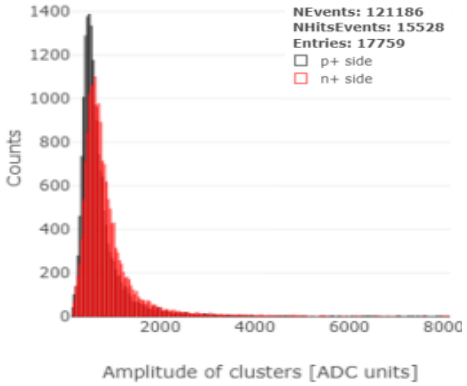


Silicon Modules development on the new Si – detectors/2020 (63x93 mm^2) Plane #3/1

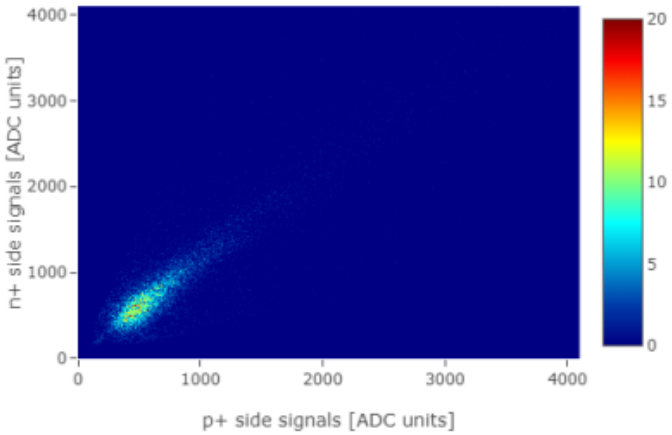
Cosmic test



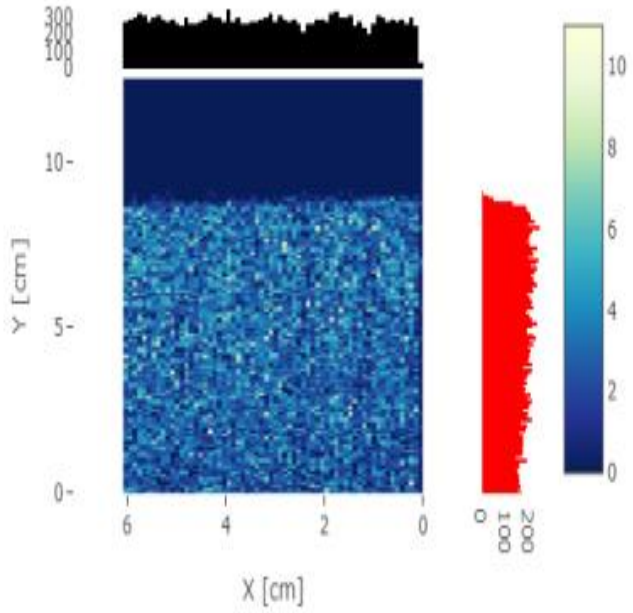
Amplitude of clusters distributions
at Plane #3/1 **(New Si-det 63x93 mm^2)**



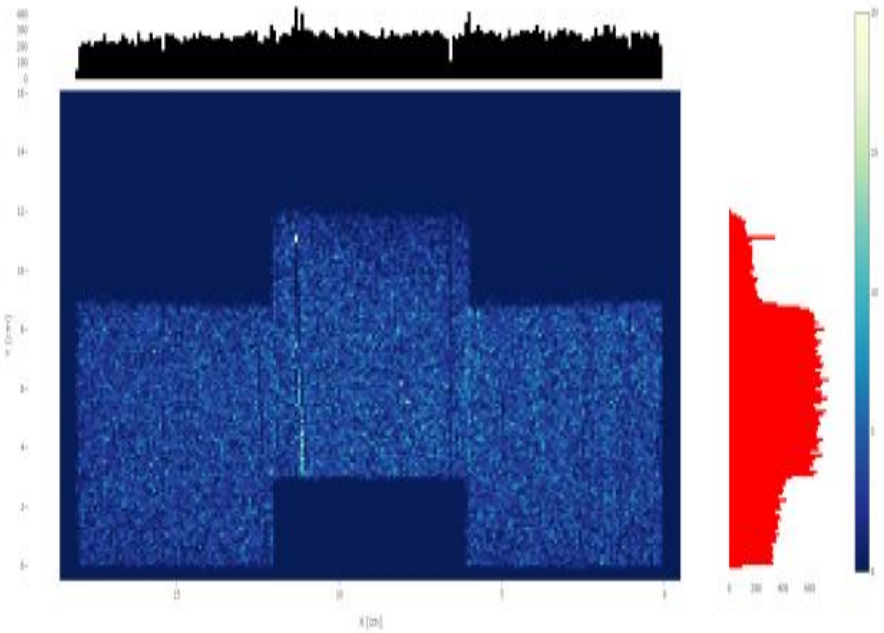
Correlation plot
at Plane #3/1 **(New Si-det 63x93 mm^2)**



Hits distribution
Plane #3/1 **(New Si-det 63x93 mm^2)**

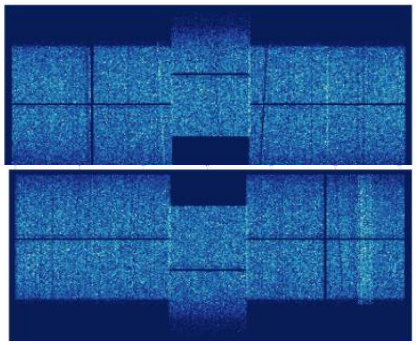


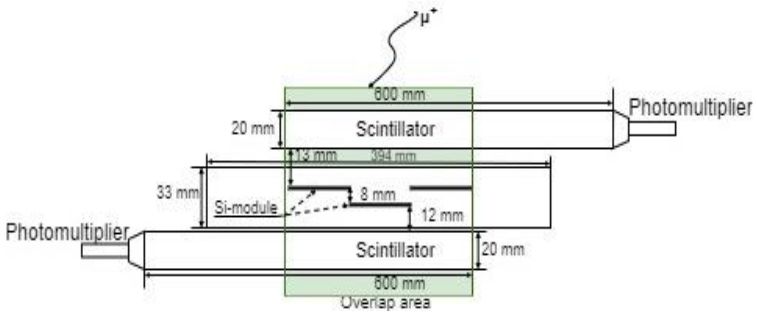
Hits distribution at Station #3/1



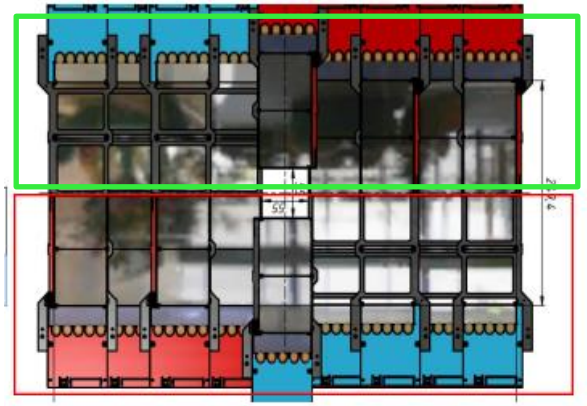
Cosmic test of Silicon Planes

2×5 modules

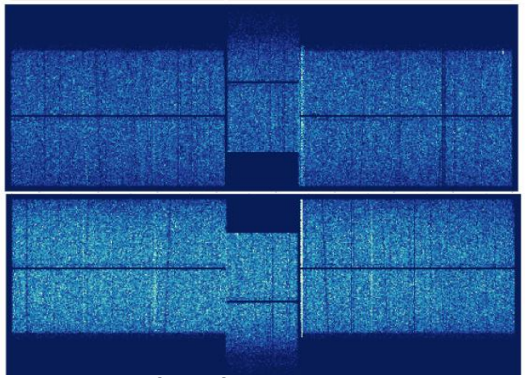




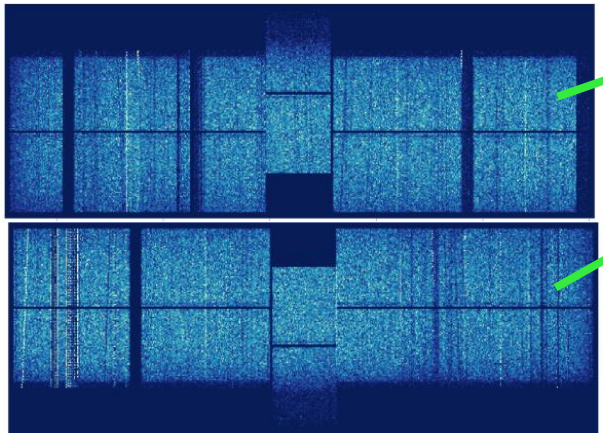
Setup for cosmic tests

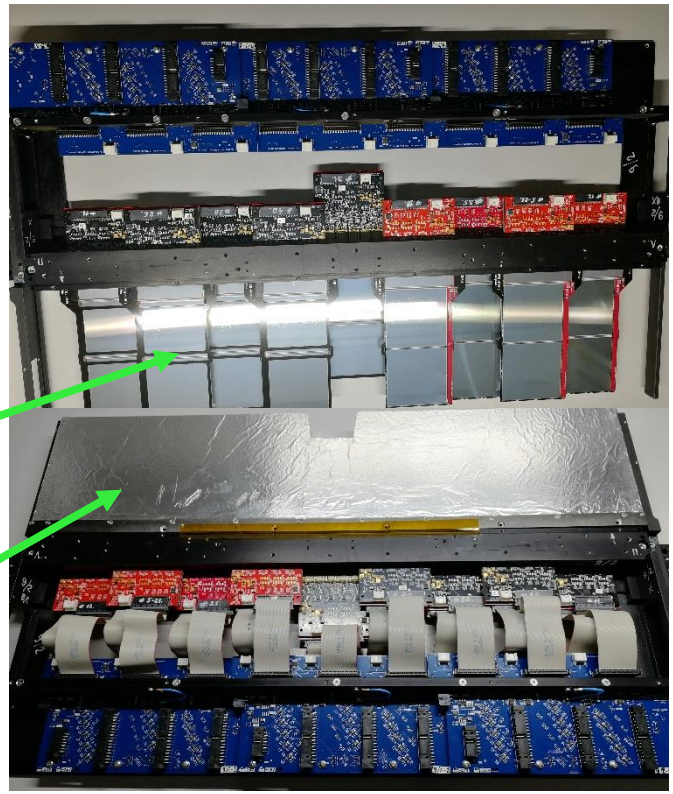


2×7 modules



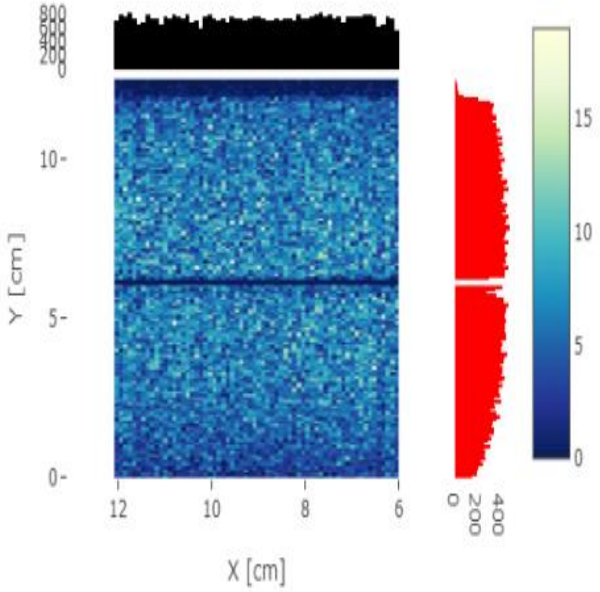
Si-plane (2×9) modules

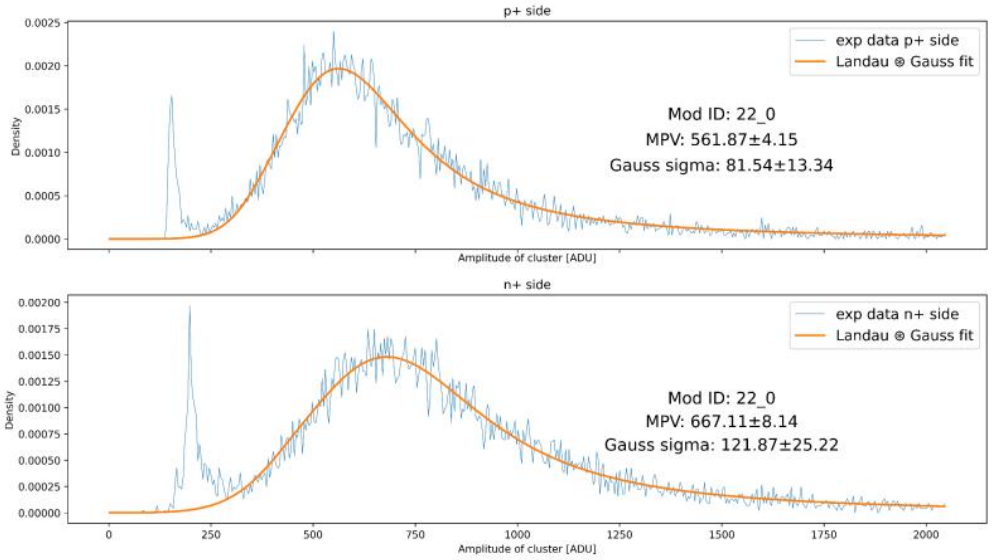




Silicon Modules Plane #9/1
(cosmic test)

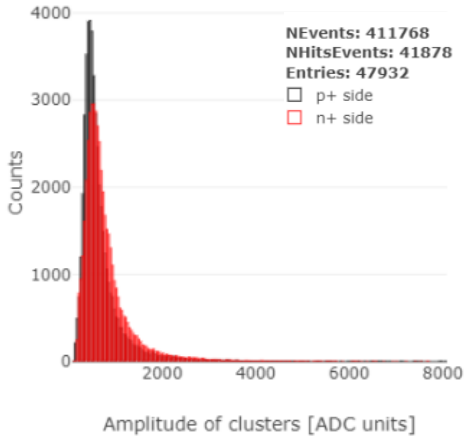
Hits distribution
at Plane #9/1 module #1



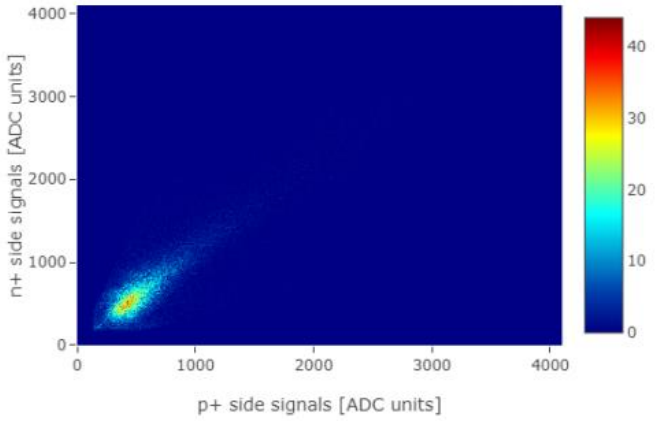


Amplitude of cluster distribution 50V cosmic muon

Amplitude of clusters distributions at Plane #9/1



Correlation plotat Plane #9/1



Summary:

- Все кремниевые пучковые детекторы (2 профилометра + 3 пучковых трекера) смонтированы на ионопроводе BM&N и готовы для проведения тестов (измерение пьедесталов, шумов, темновых токов (I_d), HV и LV = ON/OFF);
- Все четыре плоскости (60 000 каналов) передней части вершинного детектора смонтированы на ионопроводе BM&N и готовы для проведения тестов (измерение пьедесталов, шумов, темновых токов (I_d), HV и LV = ON/OFF, температура охлаждения, slow control);
- Передняя Si – часть триггера множественности находится в стадии тестирования с β – источником на стенде, готовность к монтажу на канале BM&N к 01.10.2022.