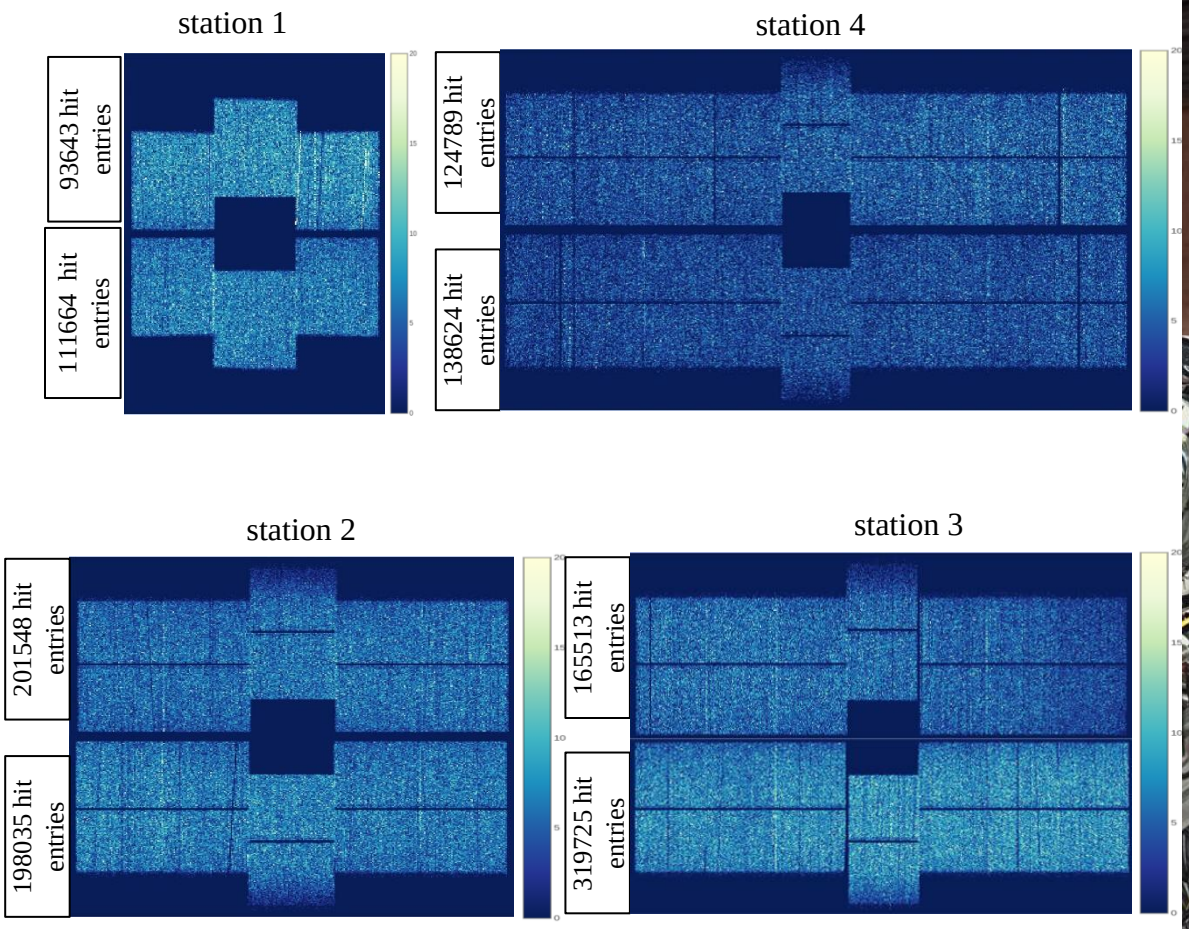
Waiting for the beam of relativistic nuclei ^{124}Xe at BM@N

N. Zamyatin *on behalf of Forward Silicon Detector team*

14th Collaboration Meeting of the BM@N Experiment at NICA, 13-15 May 2025

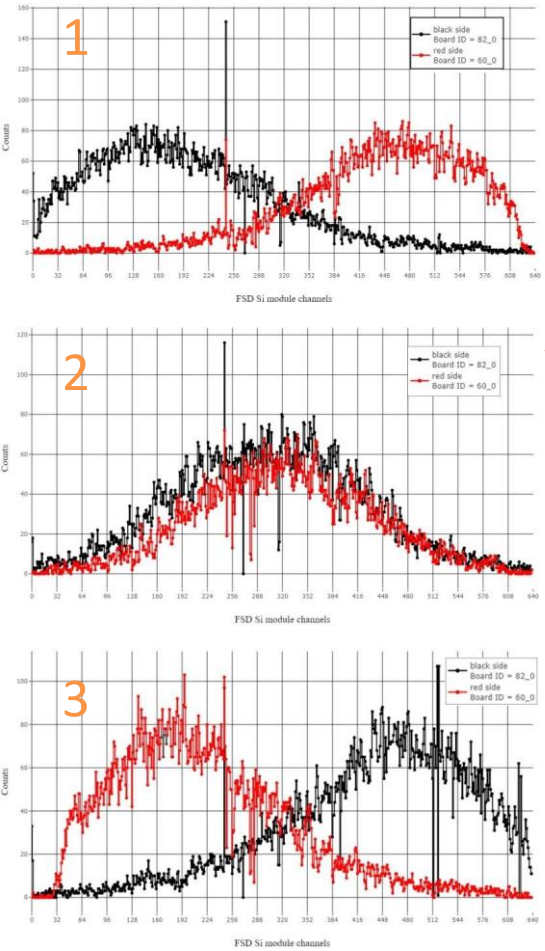
1. FSD на канале BM@N для сеанса май-июнь-2025

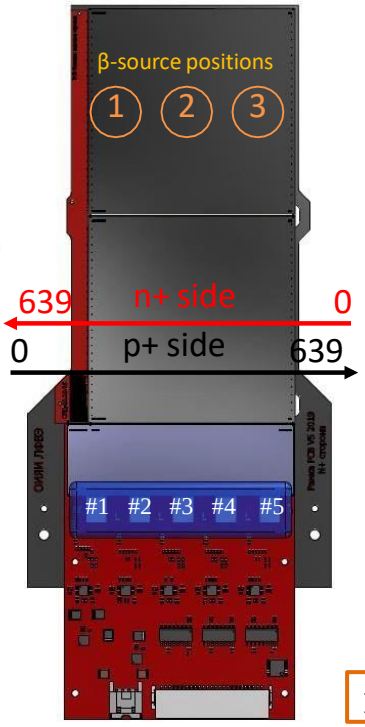


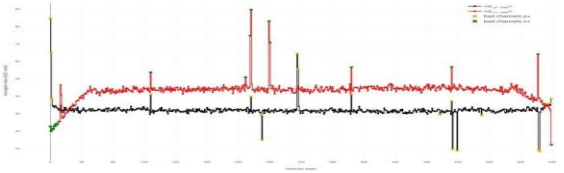
FSD Si module test results

(module #41)

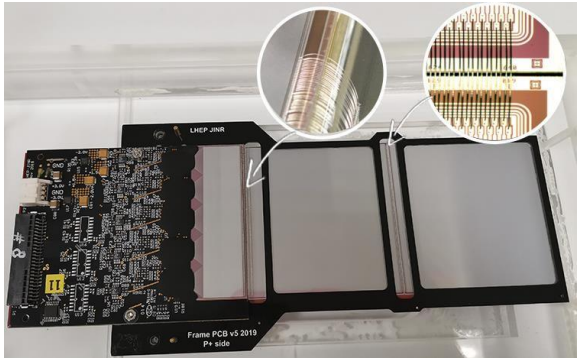
Occupancy distributions in FSD Si module channels after noise suppresion





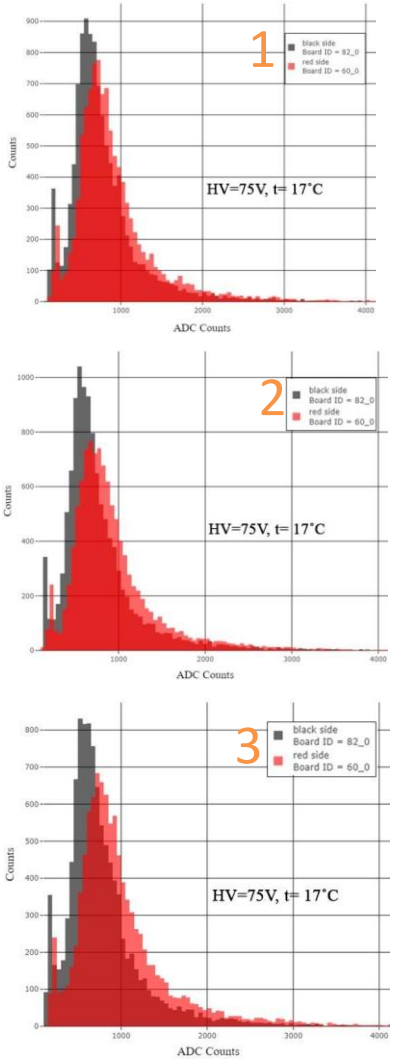


Sigma values of each FSD Si module channels at 75 V



Module view after US- Bonding detectors and PAs, number of US- Bonding – 640, Ø Al wire – 25 μm

1ch. ADC_{p+} = 45 e, 1 ch.ADC_{n+}= 42 e

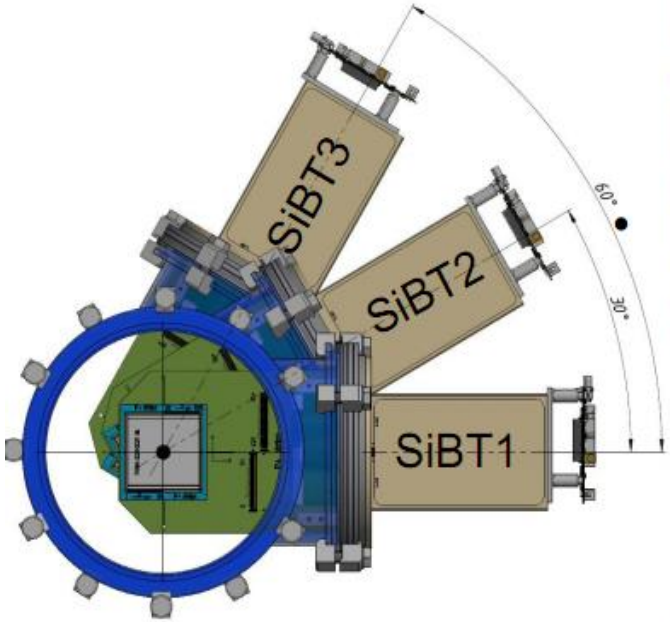


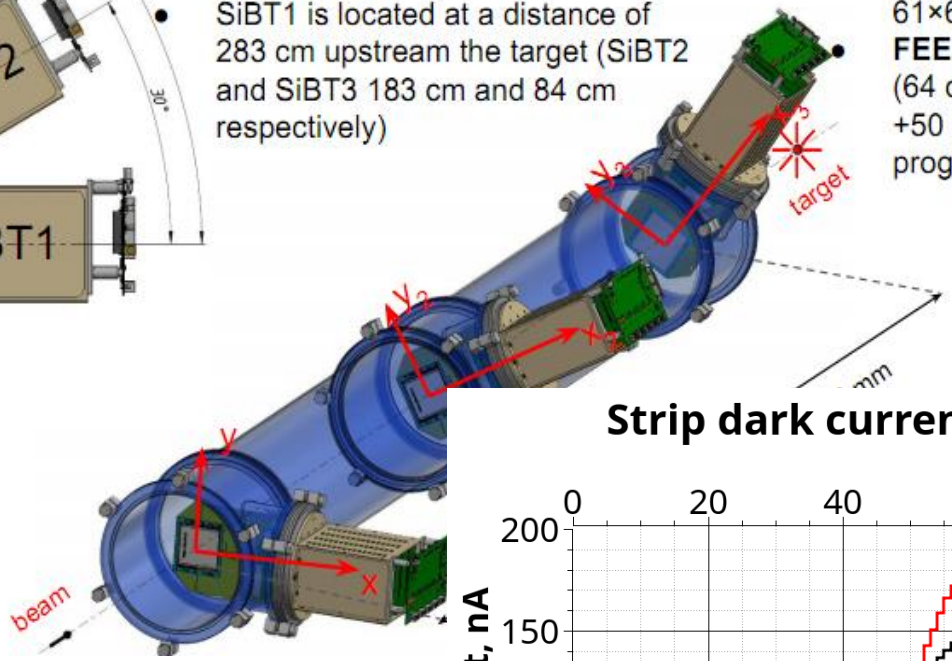
Module ID	Dark current (50V), nA	Mean noise ($^{+}$p), ch.ADC	Mean noise ($^{+}$n), ch.ADC	MPV ($^{+}$p), ch.ADC	MPV ($^{+}$n), ch.ADC	S/N p^{+} side	S/N n^{+} side	Bad channels ratio, %
41_0	3 584,00	36,93	50,76	536,20	578,89	14,09	13,32	0,55

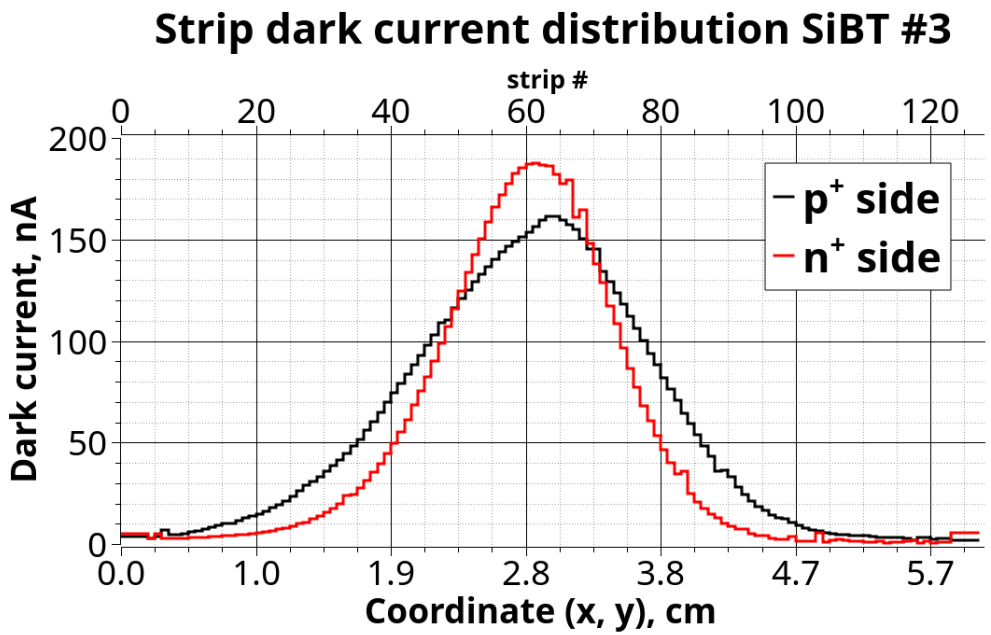
2. Пучковый трекер SiBT1÷SiBT3 к сеансу 2025

- SiBT1 is positioned inside the beam pipe such that the strips are aligned along the X and Y axes whereas the plates of the SiBT2 and SiBT3 detectors are rotated azimuthally by 30◦ and 60◦ respectively;
- SiBT1 is located at a distance of 283 cm upstream the target (SiBT2 and SiBT3 183 cm and 84 cm respectively)

- **Physical purpose**: determination of the reaction plane, *refinement of the vertex definition*, beam profilometry
- **detector:** DSSD, 128×128 strips, pitch p+ / n+ strips 0.47 mm, thickness 175 μm, active area 61×61 mm^2
- **FEE**: based on VATA64HDR16.2 (64 ch, dynamic range: -20 pC ÷ +50 pC; 50, 100, 150, 300 ns programmable shaping time)



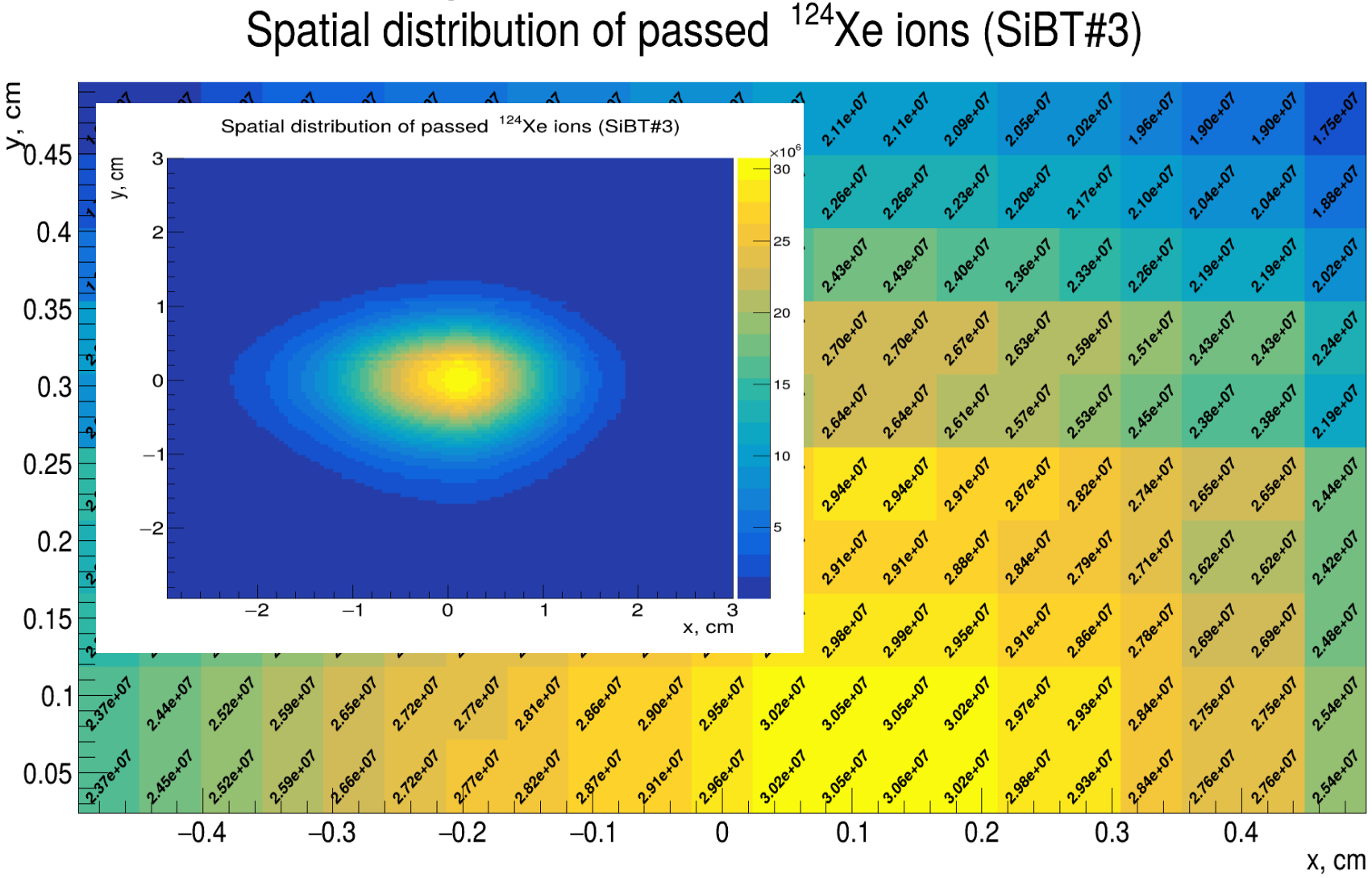




Радиационный автограф пучка ^{124}Xe(3.8ГэВ/н) за сеанс 2022-2023г.

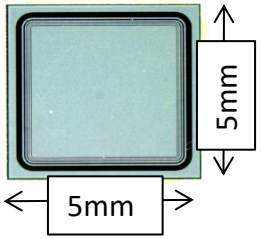
Прогноз на ресурс у ДССД детекторов при интеграле ядер за сеанс N = 4.44×10[10]:

- **^{124}Xe**(3,8 ГэВ/н): **10 сеансов** (N_{Xe} = 4.44×10[11]), I_{strip}(max) = 2 мкА;
- **^{197}Au**(3,8 ГэВ/н): **5 сеансов**, I_{strip}(max) = 2 мкА;
- **^{209}Bi**(3,8 ГэВ/н): **4 сеанса**, I_{strip}(max) = 2 мкА .



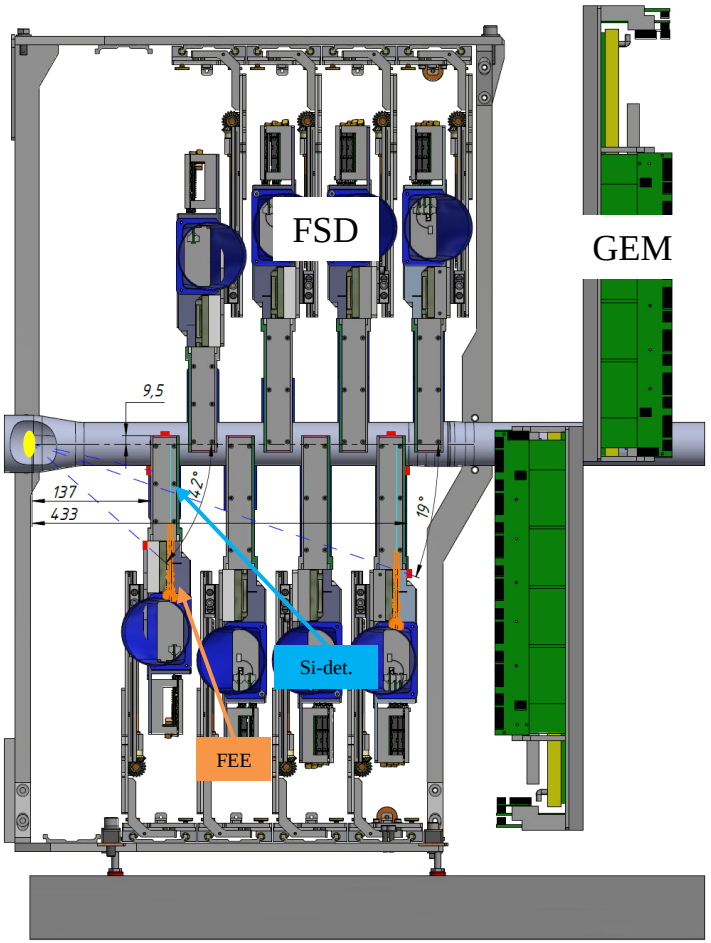
3. Radiation Si-monitors on FSD region for equivalent neutron fluence measurement

Si- pin-detector (rad_monitor) :
- Detectors size**: (5×5×0,3) mm^3**
- Detectors thickness: **300 µm**
- Active area: **13 mm^2**



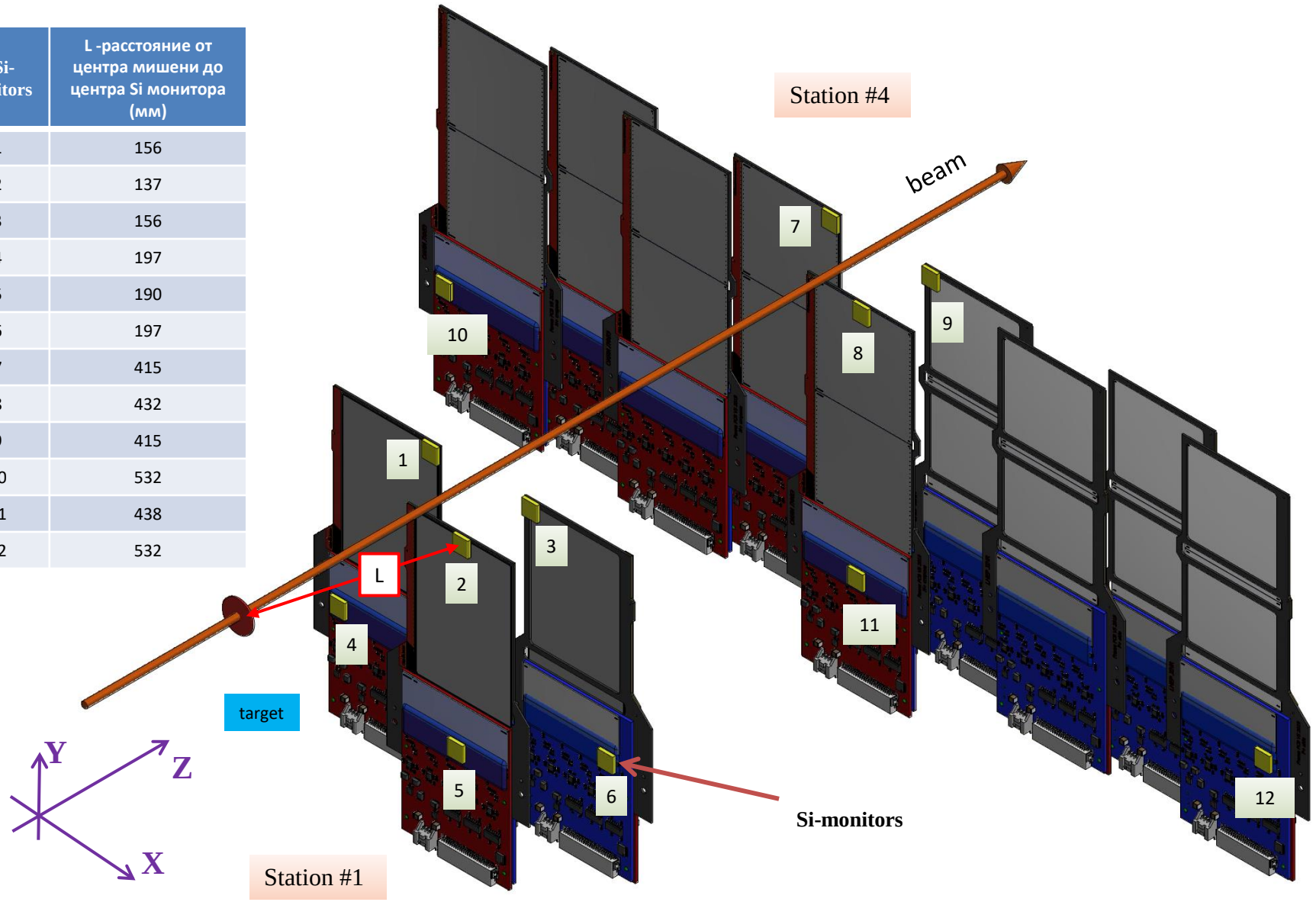
$$\Delta I = \alpha_I \times V \times \Phi$$

$\Delta I = I_\phi - I_0$, (A):
- **I_ϕ** – dark current after irradiation;
- **I_0** - dark current before irradiation;
- **α_I** = $(5\pm0,5)\cdot10^{-17}$ (A×cm^{-1}) – radiation damage constant-Si (for neutrons 1MeV at +20°);
- **V**, (cm³) – volume of SCR (spice charge region at U_{fd});
- **Φ,** (cm^{-2}) – eq. neutron fluence (1 MeV)

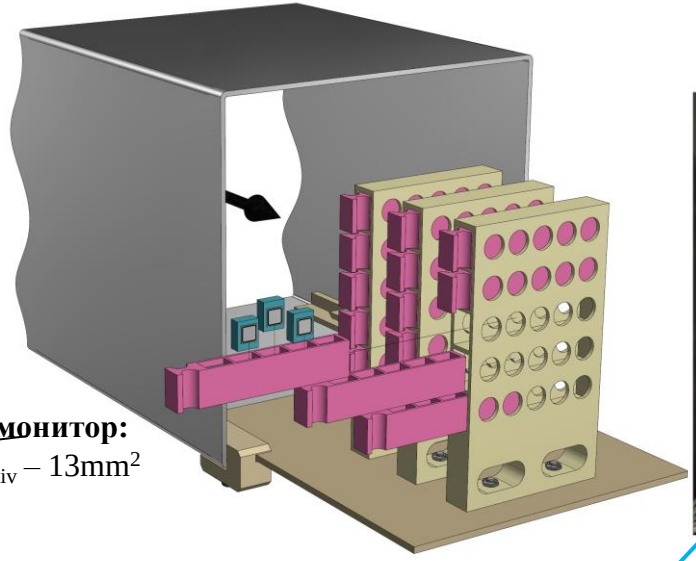


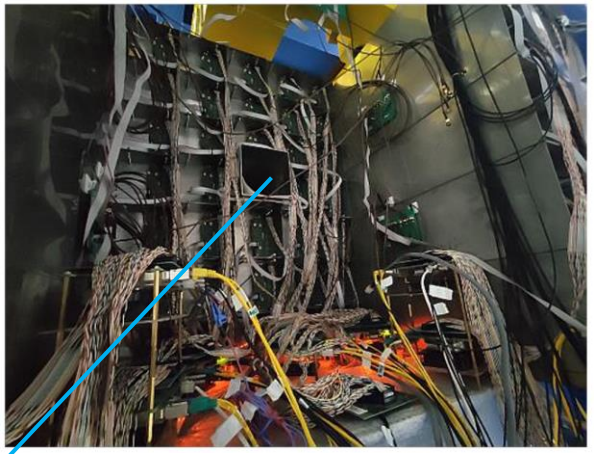
Radiation Si-monitors on FSD region for equivalent neutron fluence measurement

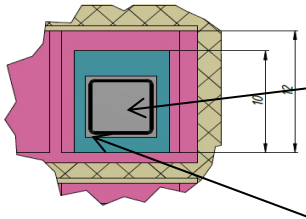
# Si-monitors	L -расстояние от центра мишени до центра Si монитора (мм)
1	156
2	137
3	156
4	197
5	190
6	197
7	415
8	432
9	415
10	532
11	438
12	532



4. Облучение LYSO (ФИАН) crystals

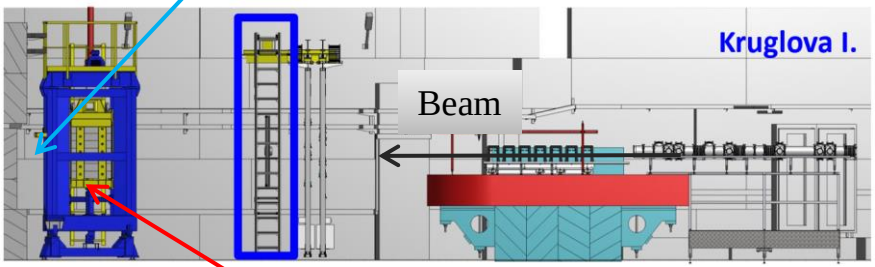






Si-монитор:
S_{activ} – 13mm^2

LYSO crystals 8x10x4мм^3
Кристаллы $Lu_2SiO_{5-z}:Y^{3+}:Ce^{3+}:Ca^{2+}$
($Lu_{1.961}Y_{0.037}Ce_{0.00068}Ca_{0.00038}Si_1O_{5-z}$, z=0.00038.)

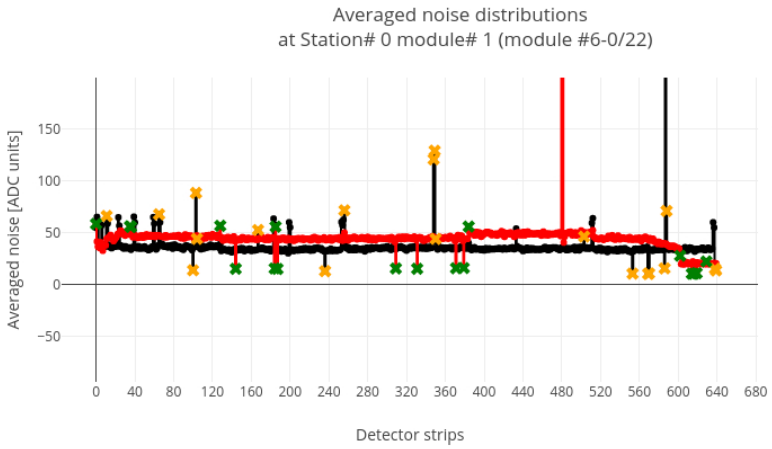


Forward hadron calorimeter FHCal

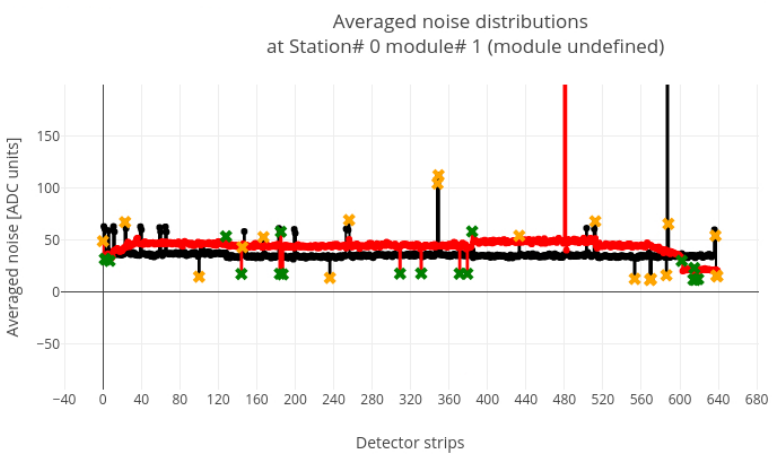
По инициативе коллег из ФИАН:
Козлов В.А., Завертяев М.В.
и согласованию с сотрудниками ЛФВЭ:
Капишин М.Н., Замятин Н.И. было принято решение облучения на пучке ядер Xe установки BM@N сцинтилляционных кристаллов LYSO

5. Modernization of power grids on BM@N experimental hall (bld.205) (March 2025)

Run 444 (***10.02.2025***)



Run 542 (***28.04.2025)***



Before modernization of power grids:

$\sigma_{mean}^{red} \approx 44.9\ ch.ADC = \mathbf{1886\ rms.e}$
$\sigma_{mean}^{black} \approx 34.6\ ch.ADC = \mathbf{1557\ rms.e}$
$\mathbf{t_{measure} = 22°}$

After modernization of power grids:

$\sigma_{mean}^{red} \approx 46.41\ ch.ADC$= **1949 *rms.e***
$\sigma_{mean}^{black} \approx 35.3\ ch.ADC = \mathbf{1589\ rms.e}$
$\mathbf{t_{measure} = 26°}$

Conclusion

1. FSD is ready for data taking with relativistic ^{124}Xe beam
2. Coordinate planes position accuracy is 0.3 mm with XYZ axes
3. SiBT#1÷ SiBT#3 are ready for operation in the direct beam of heavy ions
4. Level of the FEE FSD pedestal noises did not increase **after modernization of power grids** *(for Semen Piyadin)*
5. *Applied R&D:*

- *measurements of the radiation background on the area of FEE and Si-detectors of FSD*
- *Irradiation with Xe ions of the LYSO-crystals (ФИАН)*