Development of technology for production of double-sided silicon microstrip modules for upgrade of NICA BM@N Silicon Tracking System

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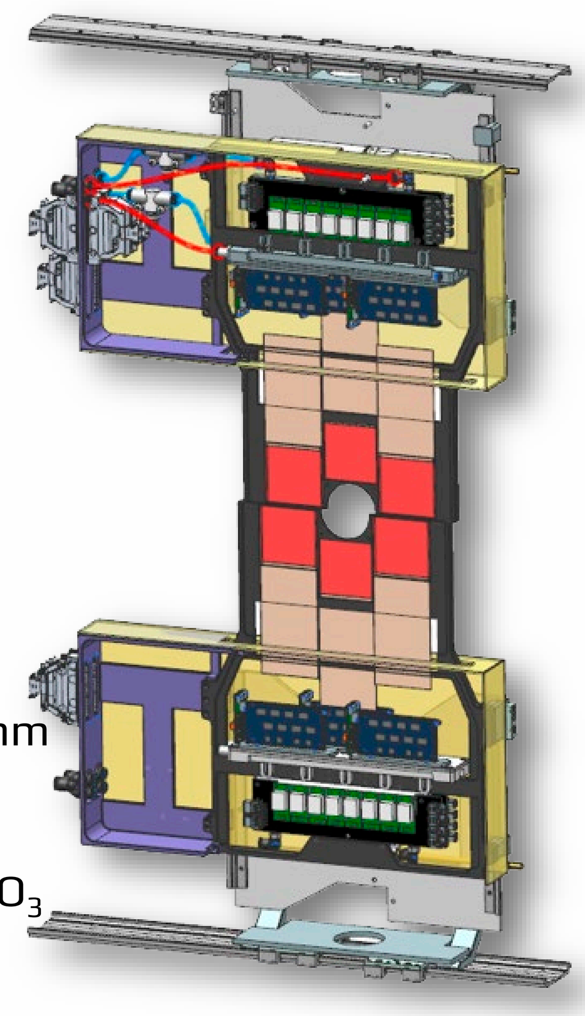
The DSSD Tracking Module

The Silicon Tracking System (STS) for the upgraded BM@N setup of NICA will comprise modules of Double-Sided microstrip Silicon Detectors (DSSD) with front-end electronics connected to sensor pads via lengthy custom designed ultralight microcables.

- **Size of Si – sensor** 62 × 62 mm;
- **Readout channels** 2048;
- **STS XYTER ASIC per module** 16 pcs;
- **Length of analog cable** 115 – 360 mm;
- **Self-triggering front-end electronics**
- **Hit spatial resolution** ≈ 17 μm;
- **Time stamp resolution** ≈ 12,5 ns;

Conceptual design of vertex Si-plane for the BM@N

The vertex detector will be installed inbetween target and forward Silicon tracking system of the BM@N setup to improve track and momentum resolution for particles produced in high multiplicity collisions of relativistic heavy-ions.

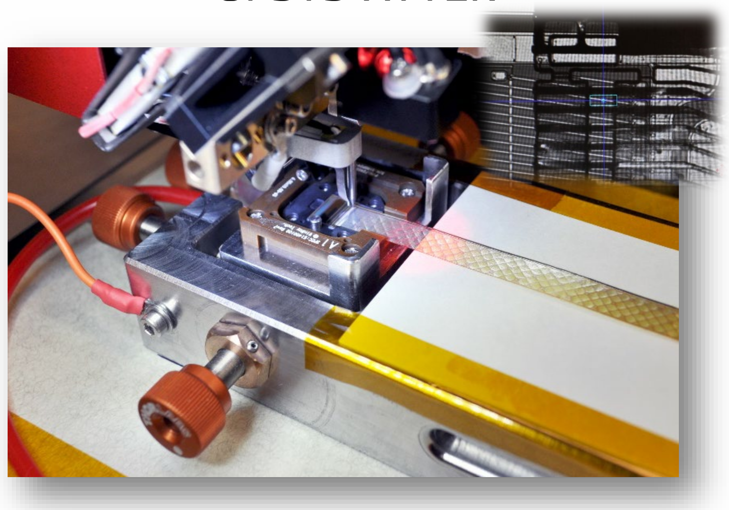


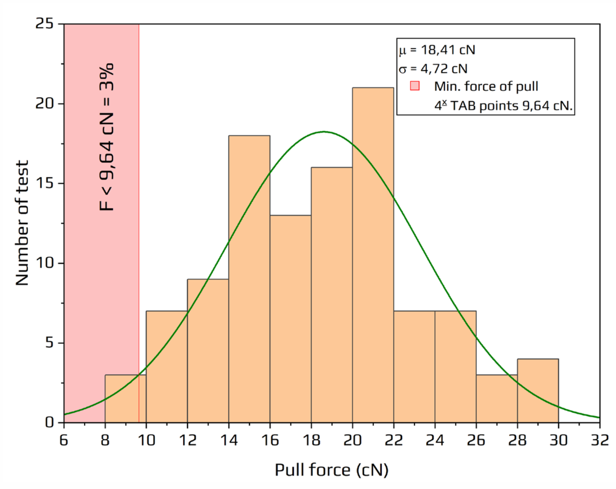
- **Total number of channels:** 12k channels
- **Pitch:** 58 μm, 7.5° stereo-angle;
- **Distance from target to STS station:** 115 mm
- **Thickness of sensor:** 320 μm ±15 μm;
- **Mainframe for sensor:** Alumina Ceramic Al_2O_3
- **Material per station** ≈ 0.3% – 1.5% X_0

Multistep assembly procedures

The design of the STS module makes possible building of large aperture tracking systems, but results in a challenge for developing methods for high-yield assembly technology of modules of such complexity.

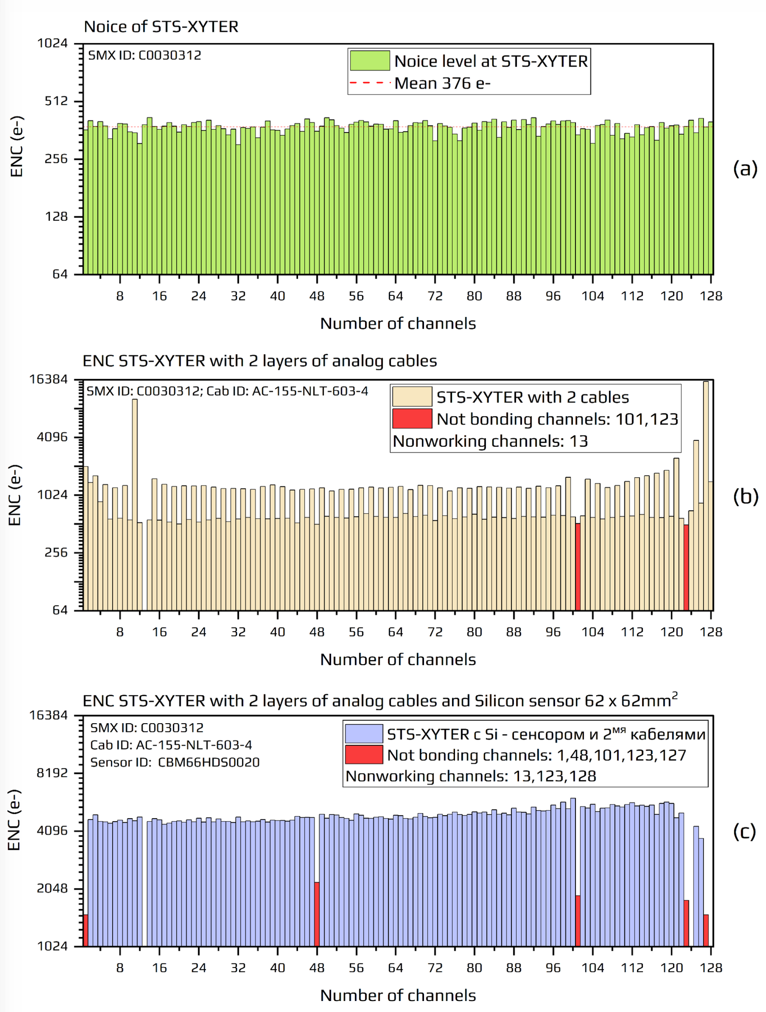
Ultrasonic TAB - bonding process of STS-XYTER



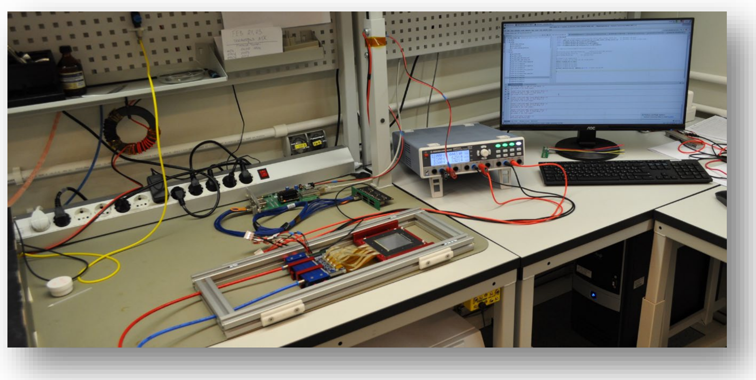


The result of mechanical test of TAB-bonding between aluminum cable and STS-XYTER ASIC

The result of signal-to-noise ratio measurements of the STS-XYTER during the assembly of module



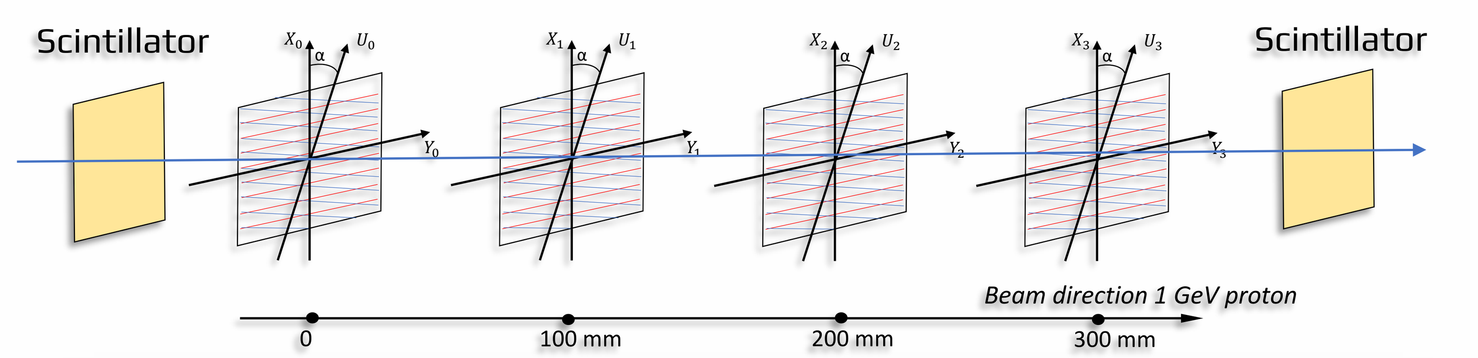
The requested technology has been finally developed at LHEP as a multistep process with each step followed by the quality assurance test controlled and monitored by a dedicated Construction Managing Information System (CMIS) to favor maximum yield of the STS detector-graded modules.

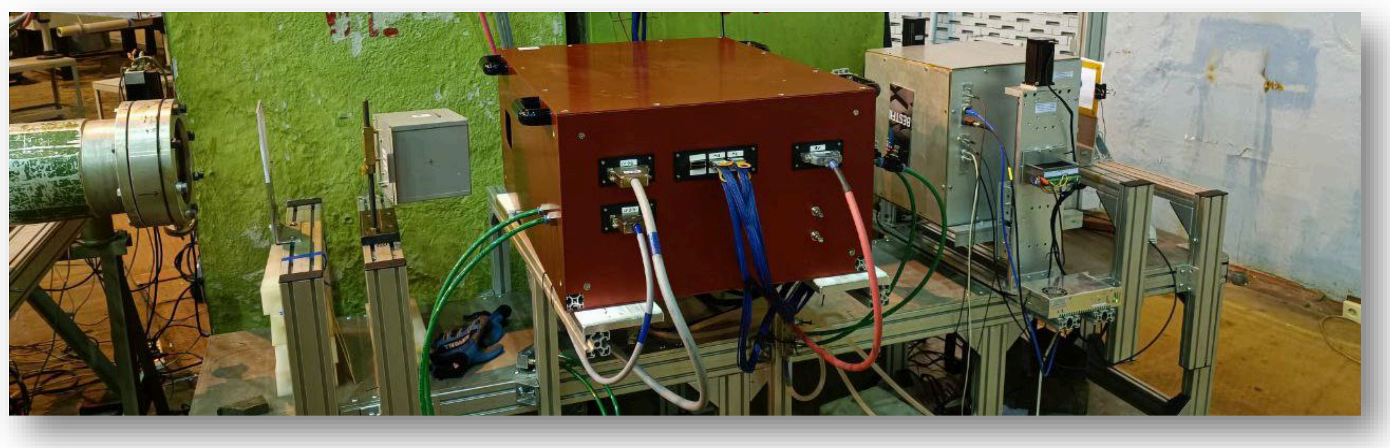


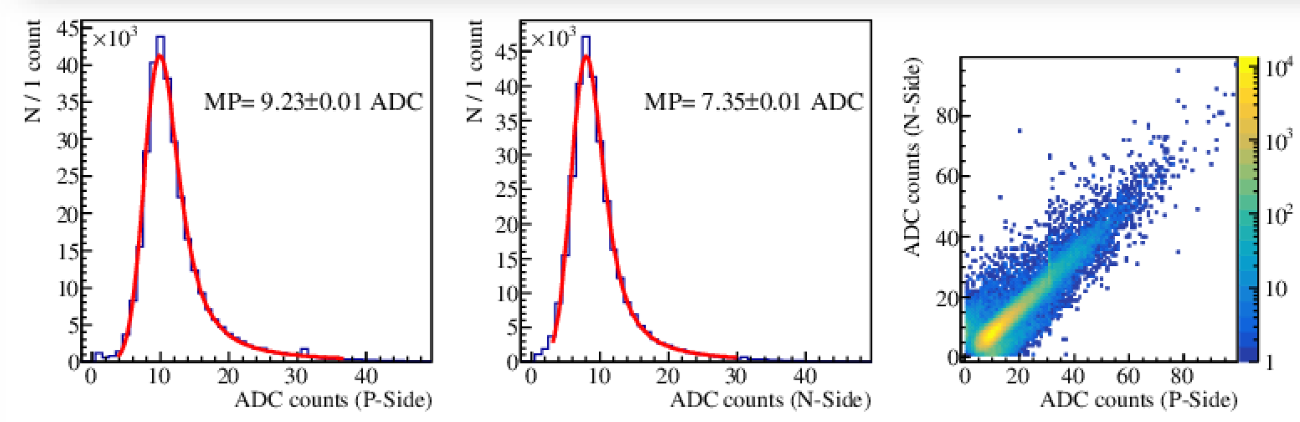
A bench for QA tests during ultrasonic bonding of STS modules

Results of the in-beam tests with 1 GeV proton

Layout of STS telescope at extracted proton beam of PNPI Synchrocyclotron

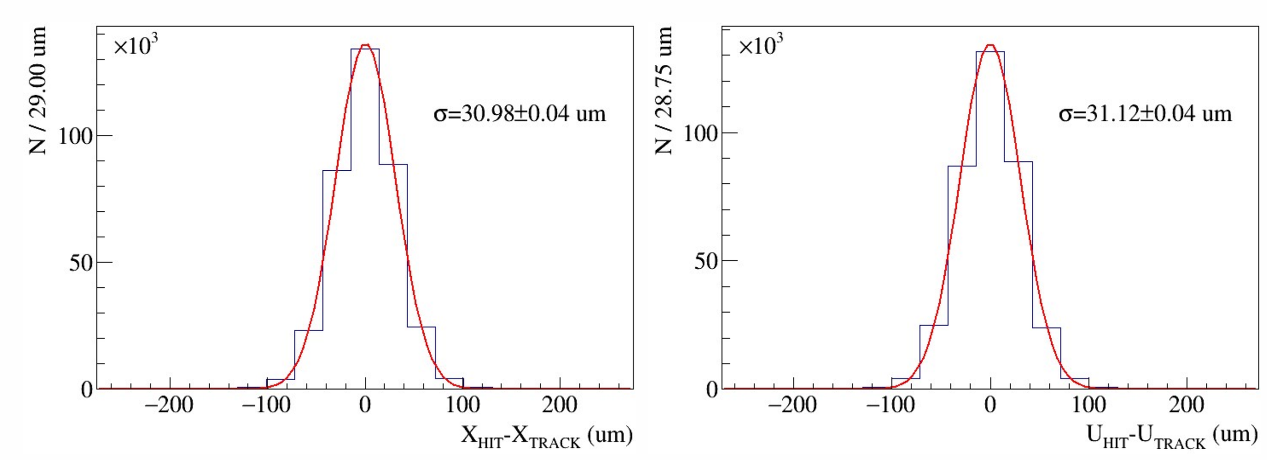






Signal Amplitudes from n- and p-sides of module #1.

Correlations between amplitudes on both sides of the module (right)



Residuals distribution for module #1

Measured parameters of assembled Modules:

- **Signal/Noise** > 23;
- **Thresholds** 4600 - 6300 e-;
- **Gain discrepancy** < 15%;
- **Spatial resolution** 17±0.4 um;
- **Efficiency** > 99% (for the areas without nonworking channels)