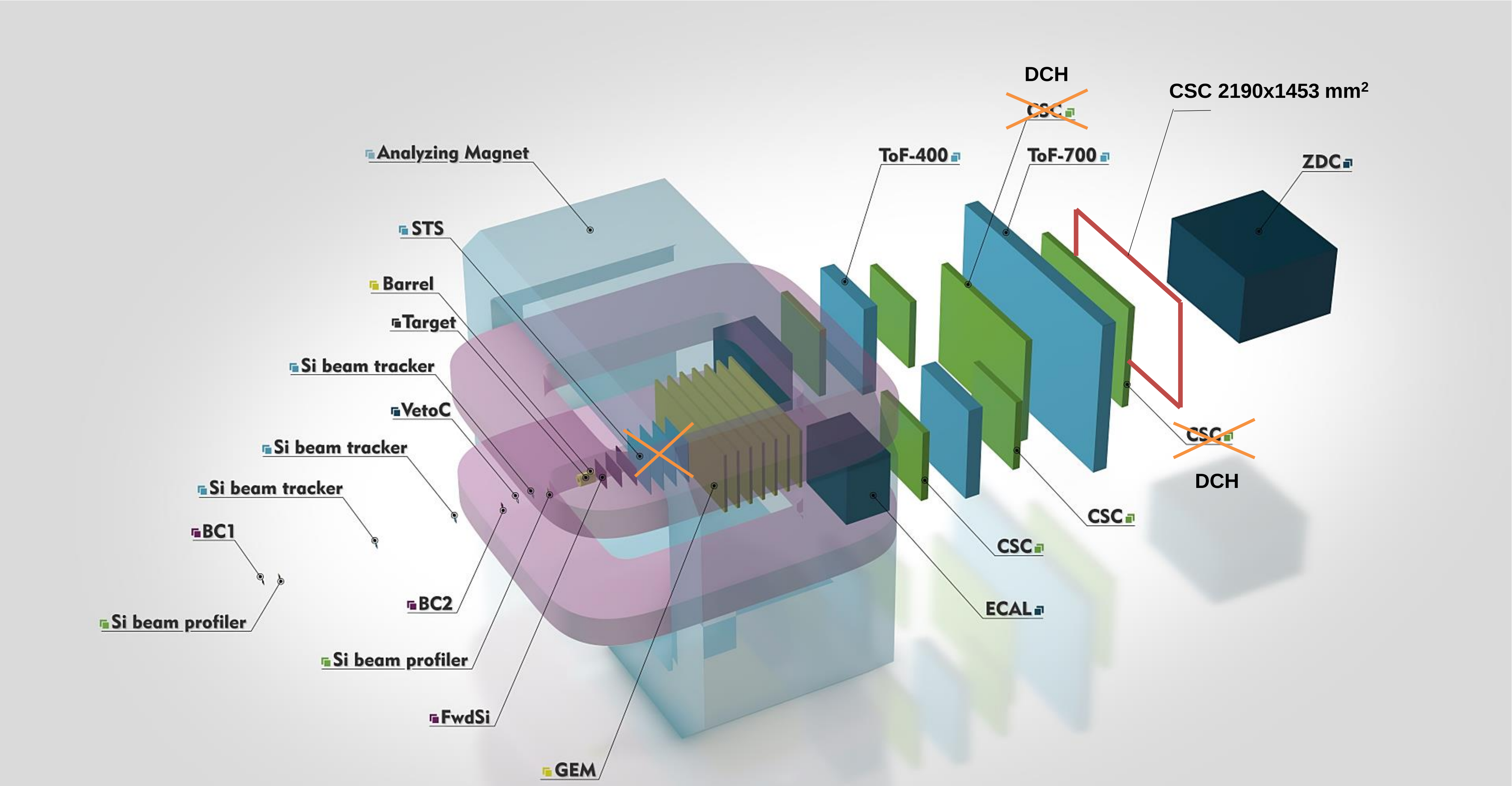
Status of the BM@N upgrade and preparation for the heavy ion run

Anna Maksymchuk on behalf of the BM@N Collaboration
25/01/2022

BM@N experimental setup after upgrade for heavy ion beam run in spring 2022

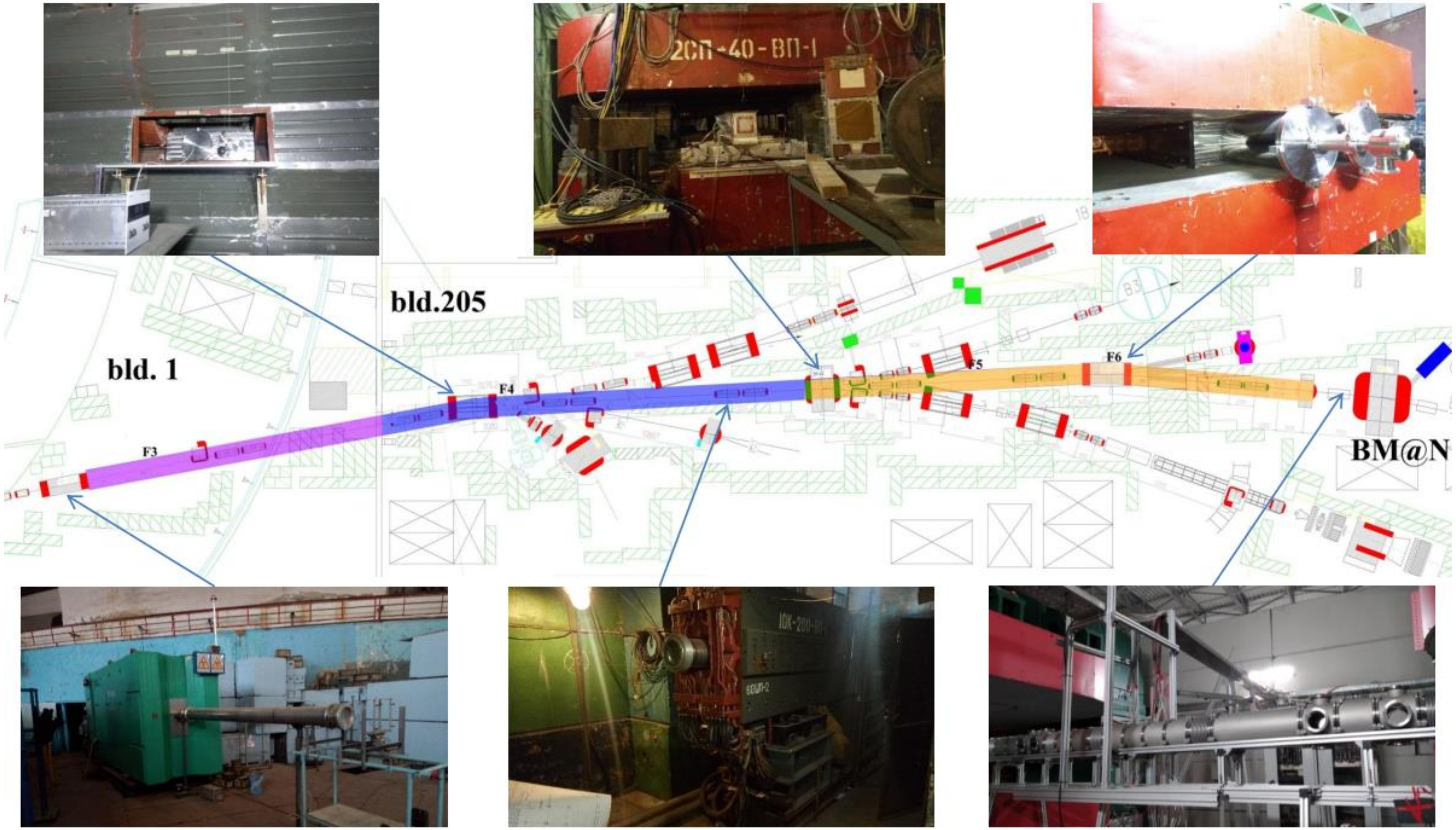


+ beam pipe upstream, inside and downstream SP-41magnet

Development of the ion beam pipe from Nuclotron to BM@N

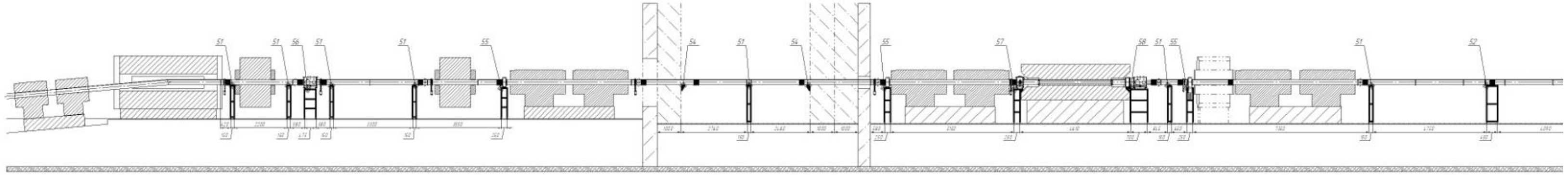
The modernized area

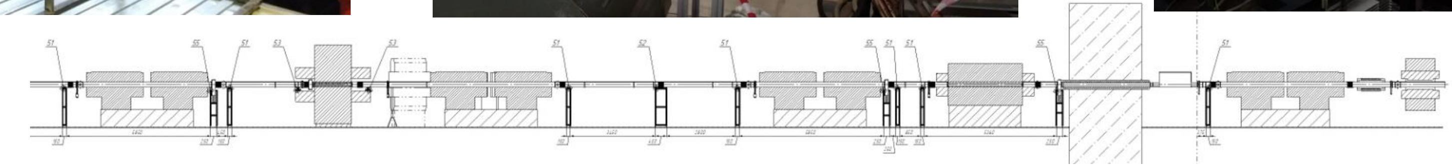
LLC "Vacuum systems and technologies"



7 quadruple lenses; 6 magnets; 9 ion beam profilometers

Development of the ion beam pipe from Nuclotron to BM@N





Development of the ion beam pipe from Nuclotron to BM@N

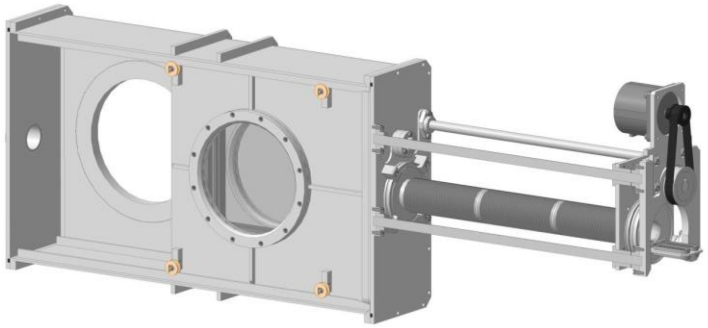
Main elements of the beam pipe:

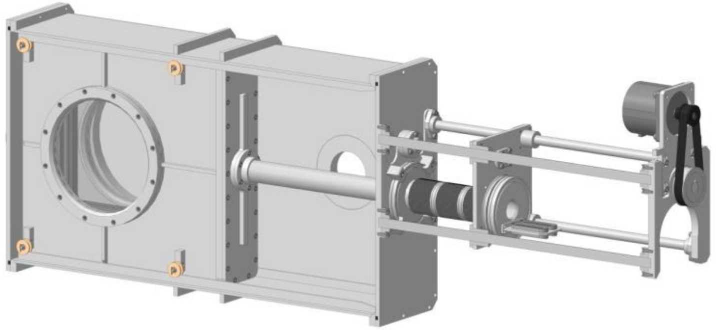
- Vacuum compatible tubes with ISO200 flanges (the total length is about of 63 m)
- Ion beam profilometers (9 pcs)
- Vacuum boxes for magnets (4 pcs)
- Vacuum pump stations based on roots vacuum pumps (6 pcs)
- Vacuum gate valves (14 pcs)
- Vacuum radiation resistant gauges with controllers (21 pcs)
- Support stages for the ion beam pipe elements (29 pcs)

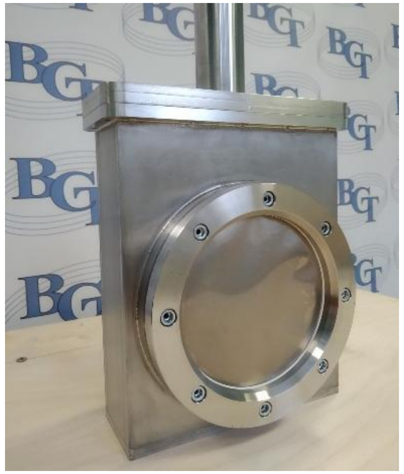
Vacuum tests of the assembled beam pipe – 10^{-6} Torr

LLC "Vacuum systems and technologies"

The vacuum compatible ion beam profilometers

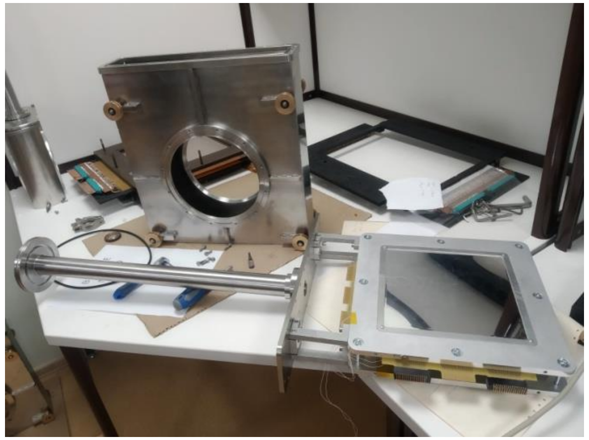






Vacuum body of the profilometer
has a thin titanium window.
Thickness 100 mkm,
aperture sizes 100 mm, 150 mm and 180 mm.

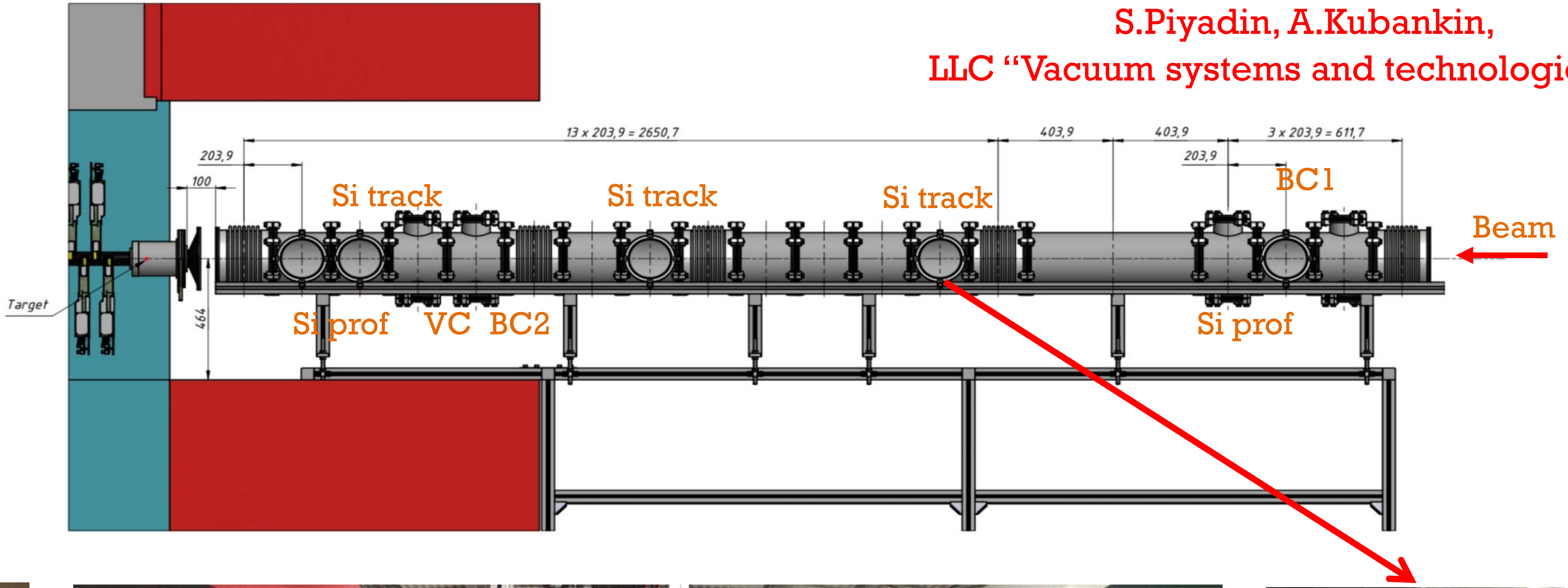
Vacuum box with the beam profilometer:
two positions of the profilometer.
Travel range is 0-300 mm.

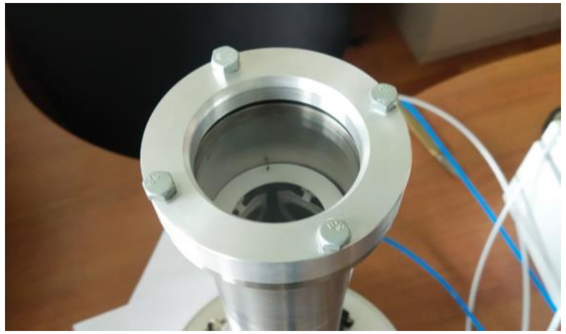


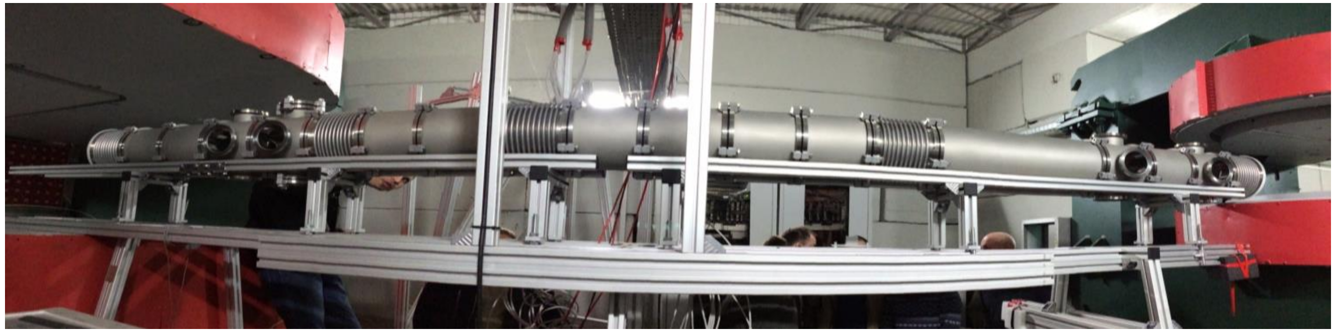
Ion beam profilometers. Effective area 80x80 mm^2, 128x128 mm^2 and 192x192 mm^2.

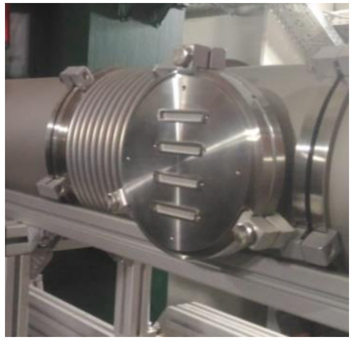
Beam pipe before the target

S.Piyadin, A.Kubankin,
LLC "Vacuum systems and technologies"





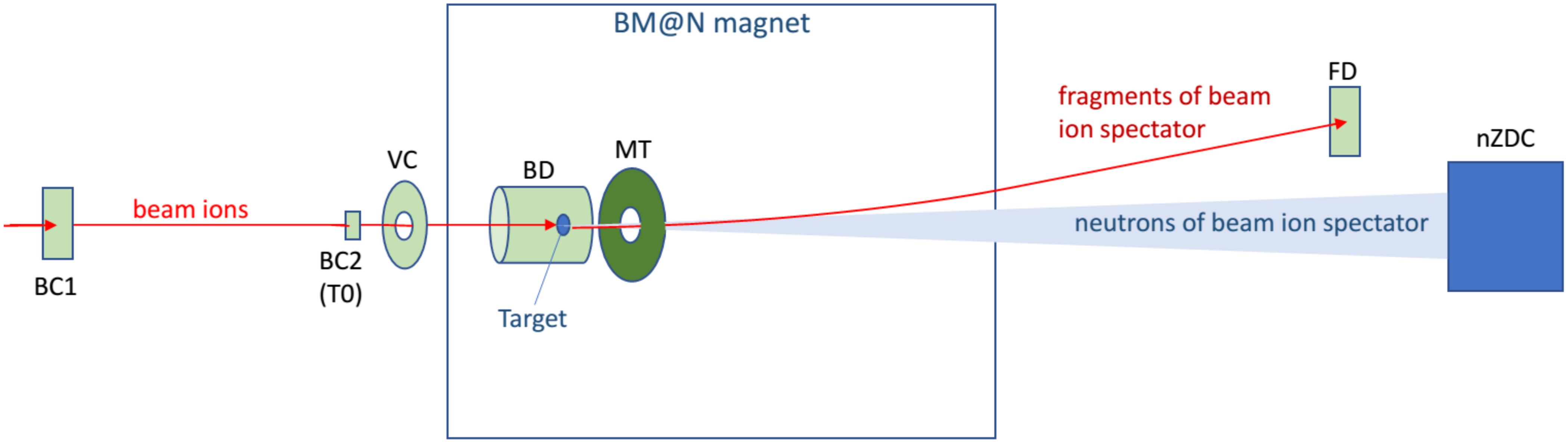




The beam pipe, vacuum boxes and target station are ready. The design and production of the target station control system and pneumatic actuator mechanics was performed by A.Kubankin group.

Trigger group

Status of Trigger System Upgrade



Trigger type	Trigger logic
Good Beam Trigger (BT)	$GBT = BC1 * VC_{veto} * BC2$
Min. Bias Trigger (MBT)	$MBT = BT * FD_{veto} * FHCal$
Centrality Trigger L (CCT1)	$CCT_L = MBT * BD(low) * MT(low)$
Centrality Trigger H (CCT2)	$CCT_H = MBT * BD(high) * MT(high)$
No Interaction Trigger (NIT)	$NIT = BT * FD * nZDC_{veto}$

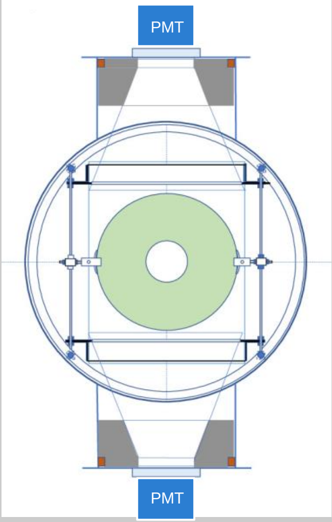
BC1 – scintillation beam counter
BC2 – scintillation beam counter and T0 detector
VC – scintillation veto-counter
BD – barrel detector with scintillation strips
MT – multiplicity trigger detector
FD – scintillation fragment detector
nZDC – neutron zero-degree calorimeter

Trigger group

Status of BC1 and VC

Vacuum and PMT components

VC scintillator mount



Vacuum components

- major components (boxes, quartz windows, PMT holders) ready ✓
- minor items (O-rings, clamps, etc.))will be supplied by Belgorod team

PMT and bases

- PMT Hamamatsu R2490-07 available ✓
- PMT sockets Hamamatsu E678-21C available ✓
- new base prototype tested, stable with beam rate up to 1 MHz
- housing designed, all parts are produced ✓

Scintillators

- 100x100x0.25mm^3 (BC1) and Ø100x10mm, hole Ø27mm (VC) available ✓
- scintillator mounts design done, all parts are produced

Electronics

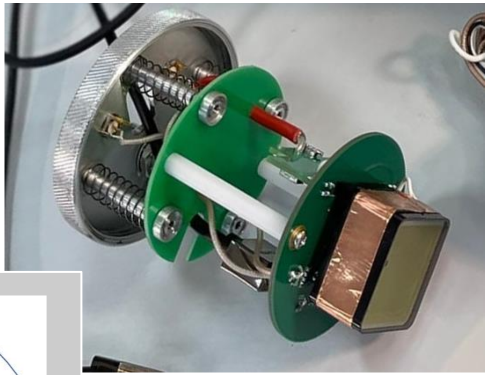
- cables, HV and signal, HV power supply available ✓
- additional linear fan-out modules produced ✓
- amplifier CAEN N979 available ✓
- TQDC, TDC, CAEN digitizer N6742 available ✓

Ongoing and planned commissioning tests

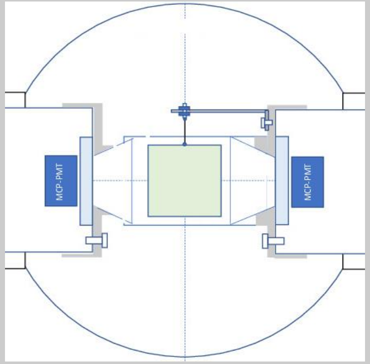
- gain change at high beam intensity ongoing tests with LED and laser
- gain change in magnetic field (VC) will be tested on site

Overall status: no major delays

Status of BC2



PMT, FEE and base



Scintillator mount design

Vacuum and PMT components

Vacuum components
- major components (boxes, quartz windows, PMT holders) ready ✓
- minor items (O-rings, clamps, etc.) will be supplied by Belgorod team

PMT and FEE
- MCP-PMT XPM85112/A1-Q400 (Photonis) available ✓
- FEE produced, time resolution with laser system better than 40 ps ✓
- housing designed, all parts are produced ✓

Scintillators
- BC400B 30x30x0.15mm^3 available ✓
- scintillator mounts designed, all parts are produced

Electronics
- cables, HV and signal, HV power supply available ✓
- additional linear fan-out modules produced ✓
- TQDC, TDC, CAEN digitizer N6742 available ✓

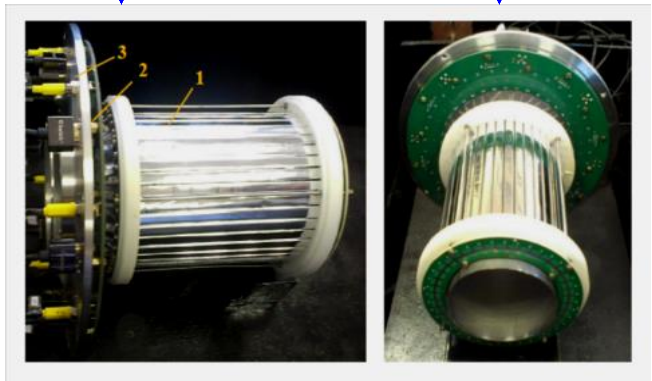
Ongoing and planned commissioning tests
- time resolution tests with laser after the SRC run
- gain change at high beam intensity no visible change up to 1MHz (scope)
- gain change in magnetic field will be tested on site

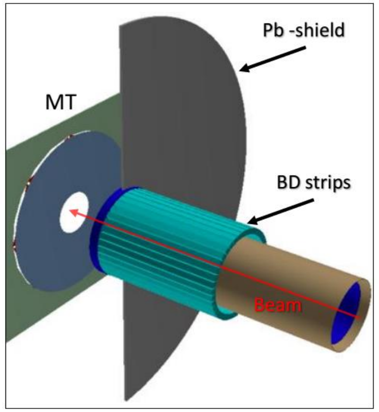
- the same PMTs, FEE and read-out chain are being prepared for the SRC T0 counters, performance will be checked in the SRC run

Overall status: similar to BC1, VC – i.e., no major delays

Status of BD upgrade

View of the BD:
1 – scintillation strips
2 – board with SiPMs
3 – board of FEE

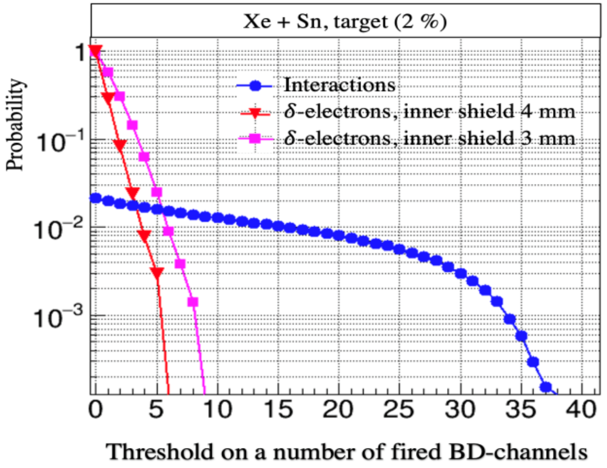




New FEE board
- less noise, more flexibility to set thresholds
- increased pulse width >12 ns
- additional inputs for test pulses

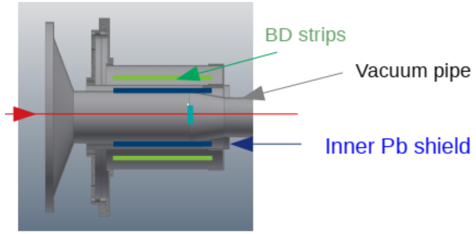
upgrade is finished ✓
Ongoing tests with cosmics

Inner Pb shield
(cylinder 15 cm long, 4 mm thick)
inner dia. of the shield is 70 mm
i.e., radial gap between the shield and vacuum pipe is 2 mm,
plan to glue 4 mm thick Pb layer directly to the inner surface of the BD pipe



Simulation of δ-electron background for different thickness of inner shield

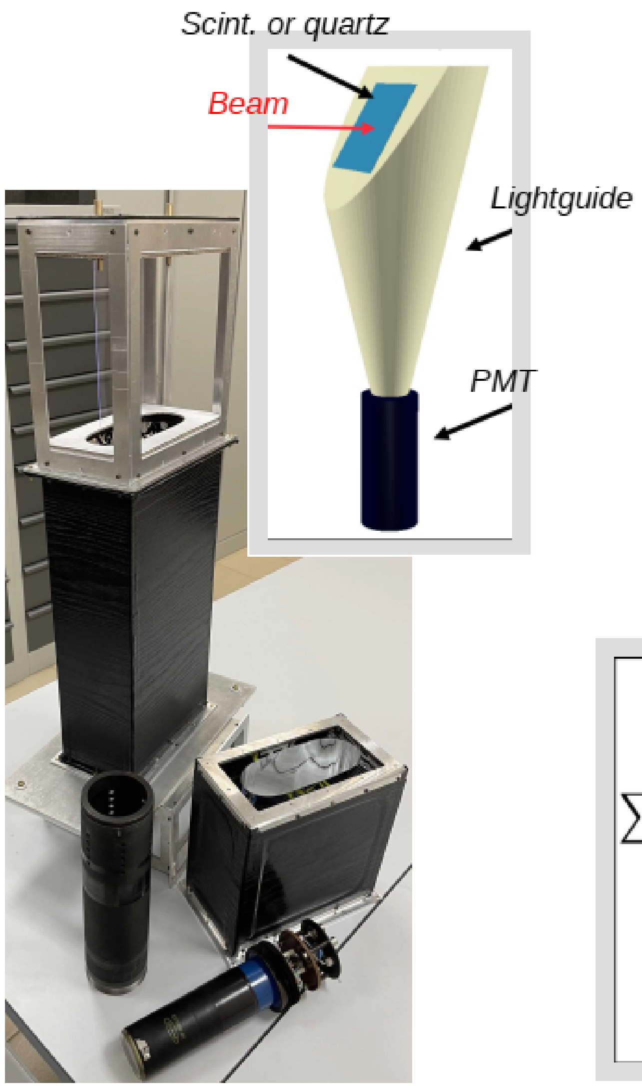
Outer Pb shield
(half-disc R=25 cm, 1 cm thick)
Plan to optimize design for Xe beam,
i.e. minimize material
where it is not essential, and then produce



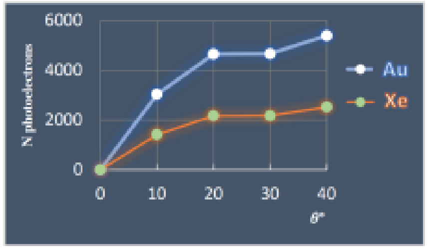
Target section of carbon vacuum pipe and BD

Overall BD upgrade status: on schedule, design and production of the Pb shields is now given more attention

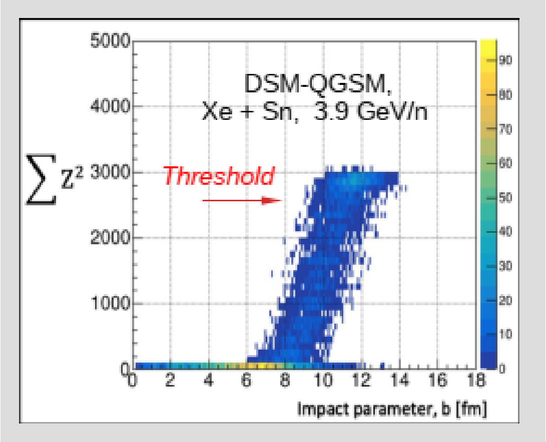
Status of Fragment detector



FD design and parts



Expected photoelectron statistics with quartz radiator



Selection of Min.bias events in trigger

Radiators

- scintillators BC-408 150x150x1mm^3 available ✓
- Čerenkov quartz 150x150x1mm^3 available ✓

PMT

- PMT XP2020 (for scintillator) available ✓
- PMT XP2020Q (for quartz) available ✓
- base and housing available ✓

Assembly and support

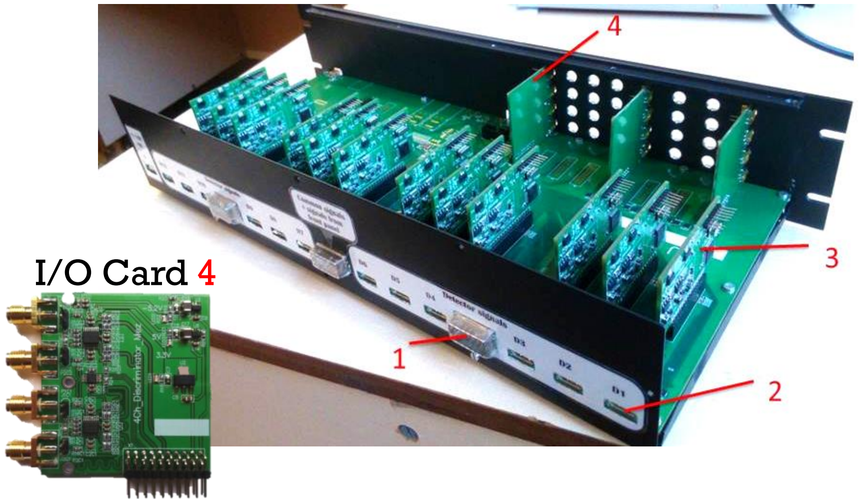
- lightguide (Al-mylar + Air) ready ✓
- changeable radiator heads ready ✓
- overall counter assembly close to completion
- support structure parts are available, currently in producti

Ongoing and planned commissioning tests

- version with scintillator will be tested in ^{12}C beam during the SRC run

Overall status: on schedule

Upgrade of the T0U module



I/O Card 4

T0U Module Functionality:

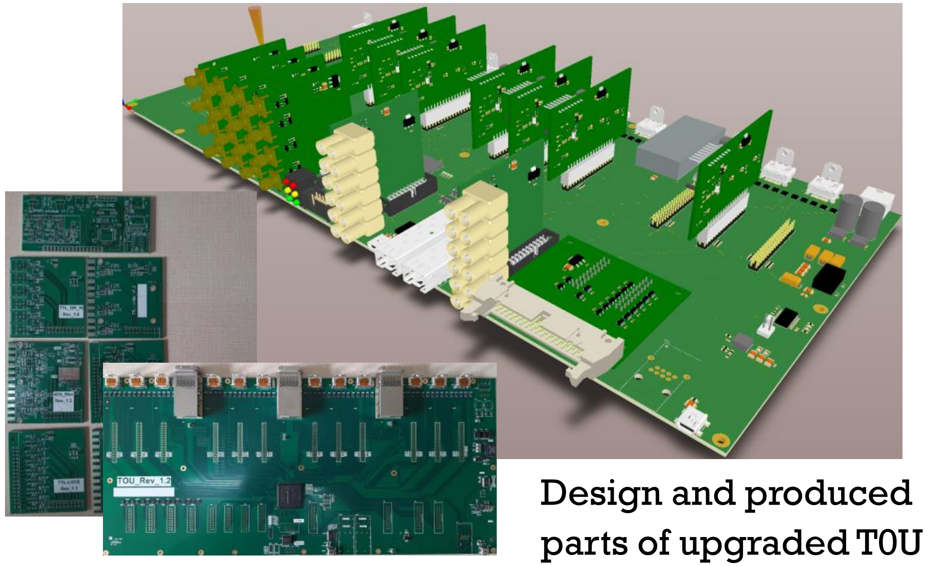
- implements trigger logic in FPGA
- receives or provides I/O analog, NIM and TTL signals via cards 4
- receives LVDS signals via HDMI connectors 2
- provides LV to FEE (cards 3, HDMI connectors 2)
- forms input signals to TDC (Molex connectors 1)

Points of upgrade:

- improved input boards with discriminators (16 inputs)
- additional I/O boards TTL (LEMO)
  up to 16 (old) + 24 (new) channels can be used to provide physics triggers or signals to scalers
- new power converter, capable to drive extended set of I/O cards
- second USB 2.0 port + 2 optical links

Upgrade status:

- all parts are produced and delivered ✓
- initial tests of functionality of the parts done ✓
- fix of minor defects done ✓
- assembly of complete unit done ✓ (tests ongoing)
- software preparation done for SRC ✓, ongoing for BM@N

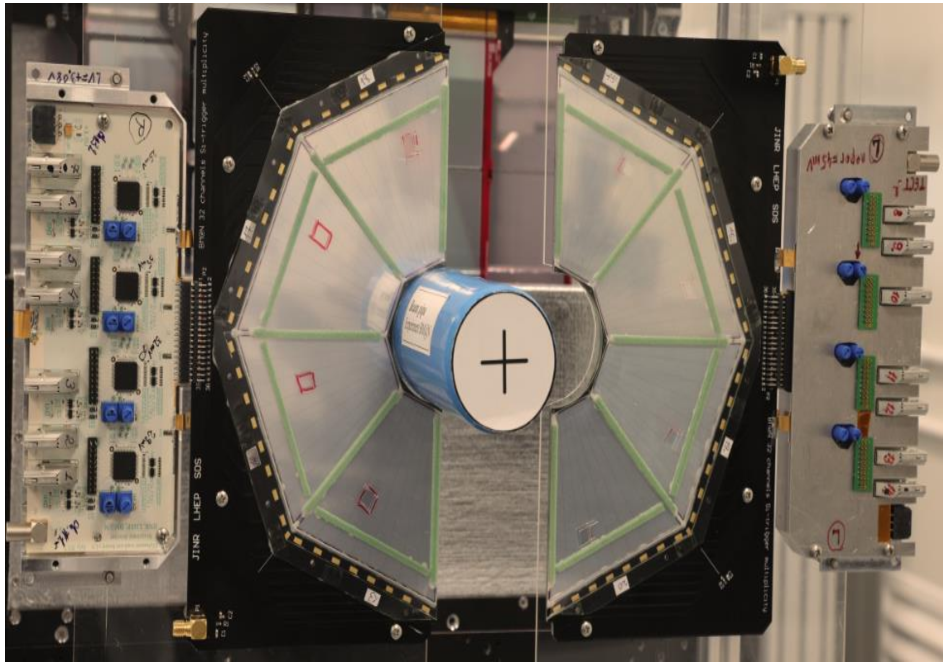


Design and produced parts of upgraded T0U

See talk of B. Topko

Multiplicity trigger upgrade

FSD group

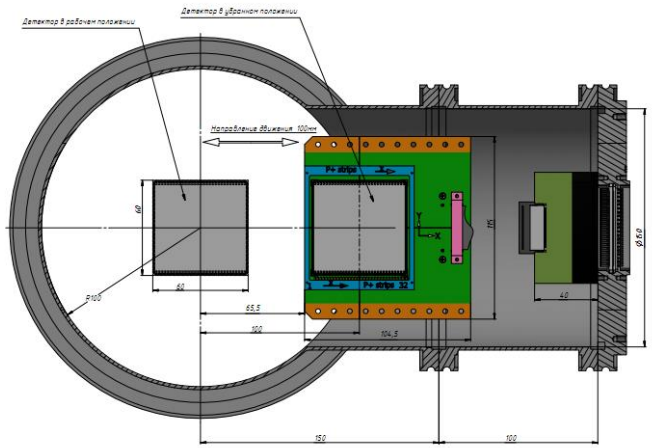


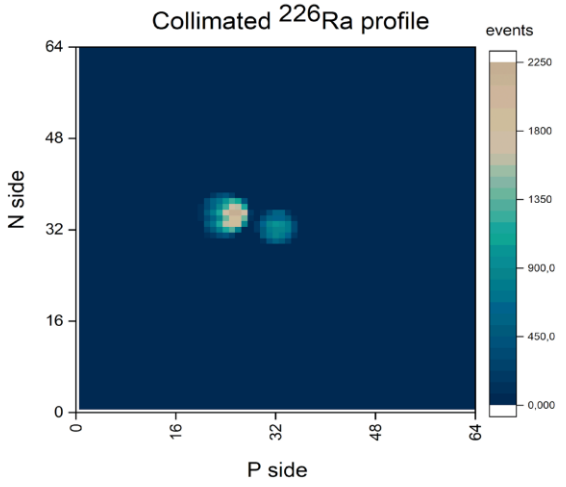
- **detector:** Silicon single-sided Detector, 525 μm thickness, 8 strips located at an angle with an interval of 5.63° and is an isosceles trapezoid in shape (45°) and active area 30.8 cm^2 (5 times bigger than previous Si-multiplicity trigger 2018).
- **mechanical design :** new design is based on 2 symmetric half-planes (inner diameter Ø52 mm), which simplify multiplicity trigger assembling process around installed beam pipe. Multiplicity trigger is located at 62 mm downstream the target.
- **FEE:** based on 32 channel IC-AST-1-1 (Minsk) with adjustable threshold.
- **current status:** two half-planes assembled and tested with previous FEE (2018). New FEE design with new gain parameters is under development (due to strip capacitance 5 times increase).

FSD group

Beam profilometer

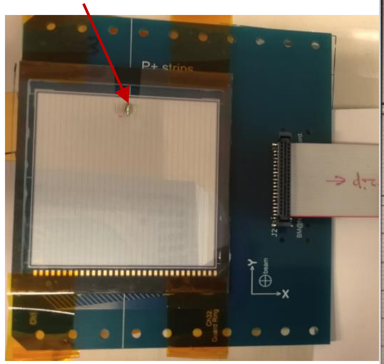
See talk of B. Topko

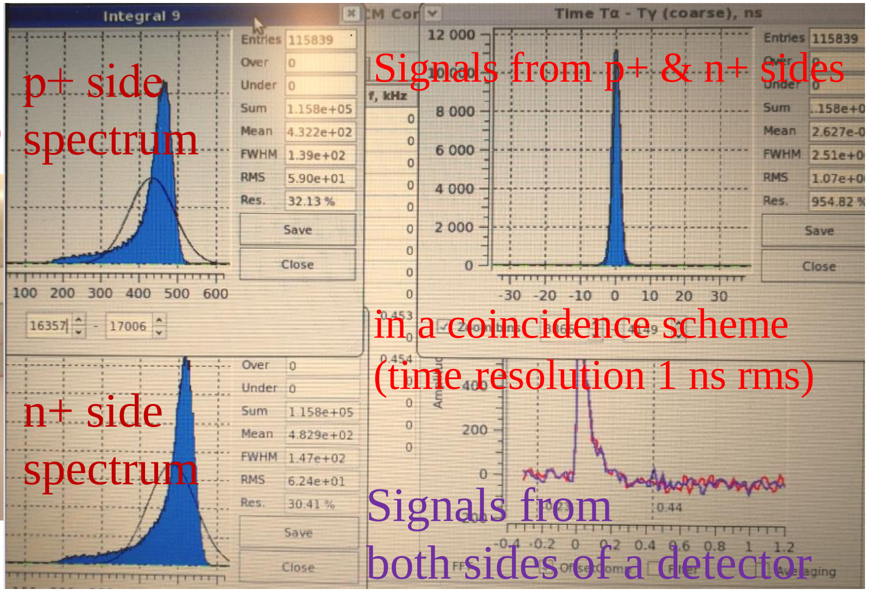




- **detector:** DSSD, 32×32 strips, pitch p+ / n+ strips 1.8 mm, thickness 175 μm, active area 60 × 60 mm^2;
- **mechanical design:** The mechanical construction supports an automatic removal of the profilometer planes from the beam zone to a special branch pipe after the beam tuning;
- **FEE:** for the light ions based on **VA163 + TA32cg2 (32 ch, dynamic range: -750fC ÷ +750fC)**;
- **current status:**
  - two vacuum stations with flanges and cable connectors are ready;
  - Silicon Detectors were assembled on PCBs and tested with an alpha-source (5.5 MeV);
  - FEE PCBs were designed and produced;
  - Cross-board PCBs were designed and will be produced at the beginning of February 2022;
  - autonomous DAQ was designed, produced and tested.

^{241}Am (E=5.5 MeV)

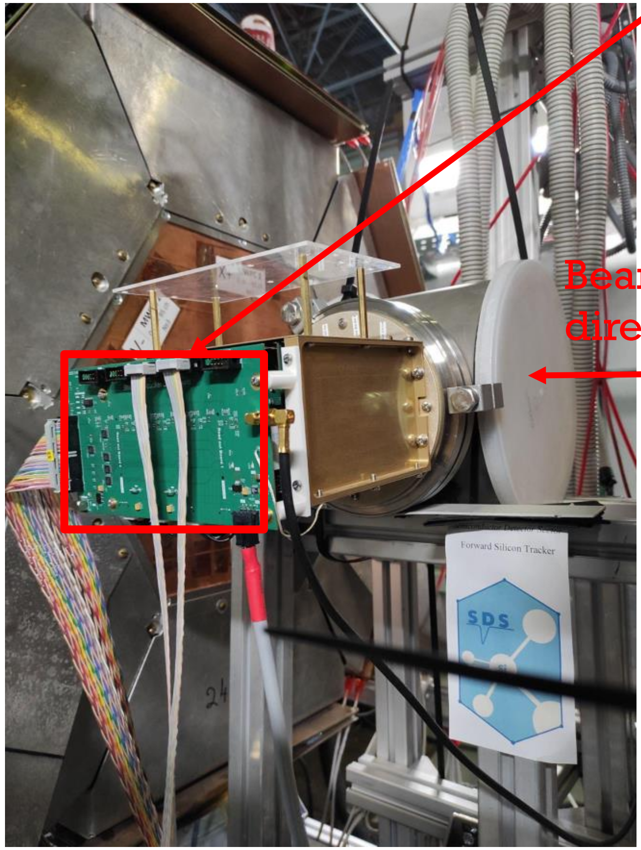


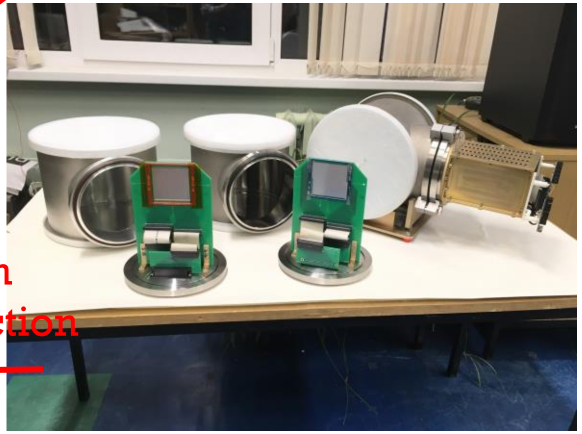


Silicon detector (32x32 strips) assembled at PCB. ^{241}Am is placed on p+ side

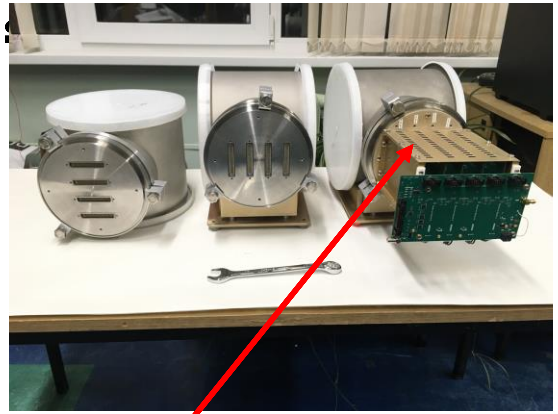
Beam tracker

Beam tracker Cross-board





3 beam tracker vacuum



Beam tracker station (connected to the autonomous DAQ) at the beam line of SRC setup

Beam tracker FEE board inside the shielding box

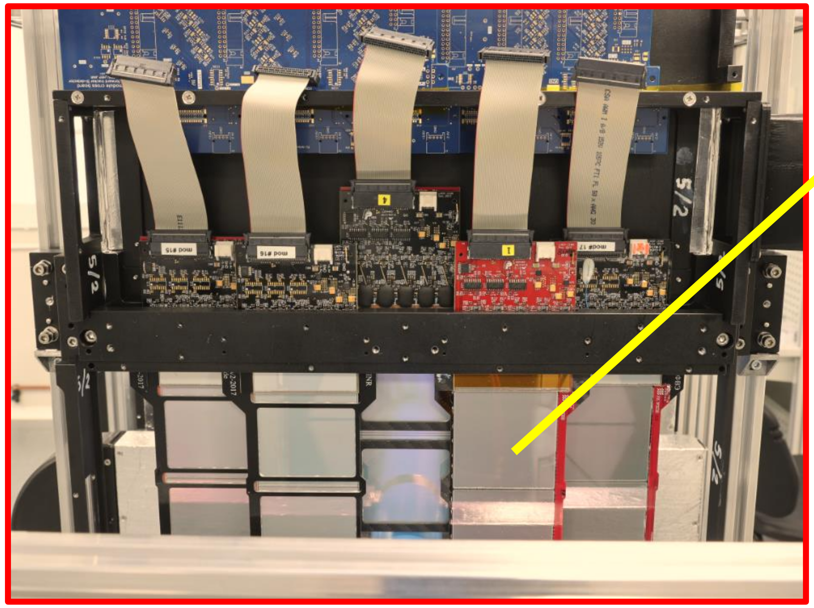
- **detector:** DSSD, 128×128 strips, pitch p+ / n+ strips 0.47 mm, thickness 175 μm, active area 61×61 mm^2;
- **FEE:** based on **VATA64HDR16.2 (64 ch, dynamic range: -20 pC ÷ +50 pC)**;
- **current status:**
  - three vacuum stations with flanges and cable connectors are ready;
  - Silicon Detectors assembled on PCBs and tested with an alpha-source (5.5 MeV);
  - Cross-boards were designed and produced;
  - FEE PCBs were designed and produced;
  - Mechanical support and FEE cooling was designed and produced.
  - 1 of 3 beam tracker station is fully assembled and tested with an alpha-source (the test results will be discussed further);
  - 1 of 3 beam tracker station now is assembled at the beam line of the SRC setup to perform a beam test with 4 AGeV $_6C$ ions.

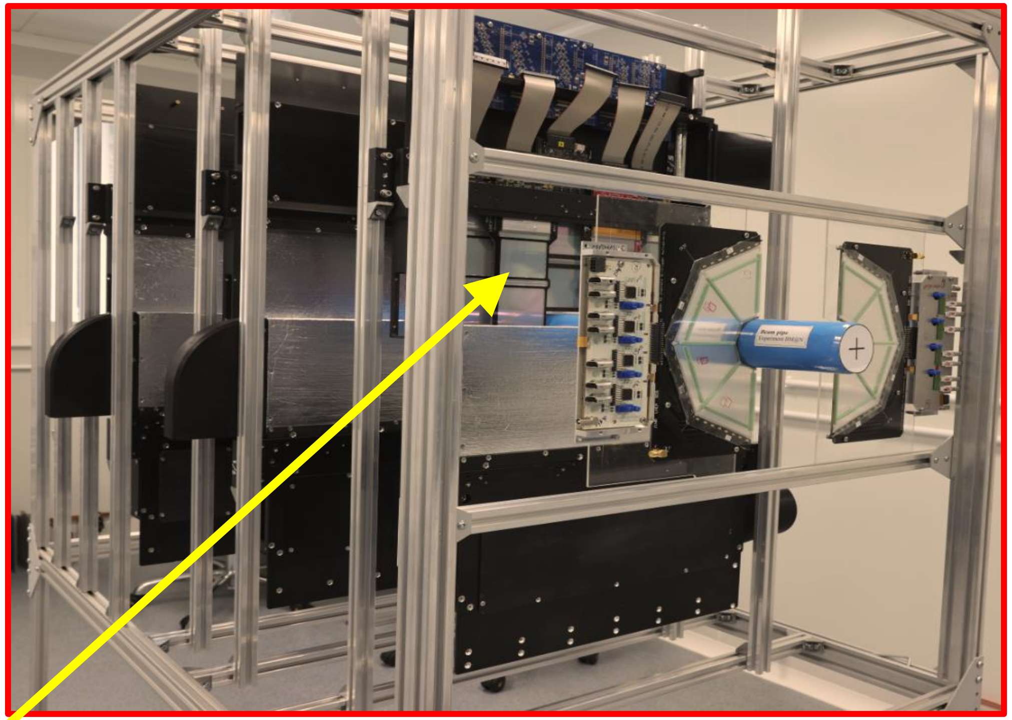
See talk of B. Topko

Forward Silicon detectors

FSD group

Upper half-plane without EM
+ light shielding (5 modules)



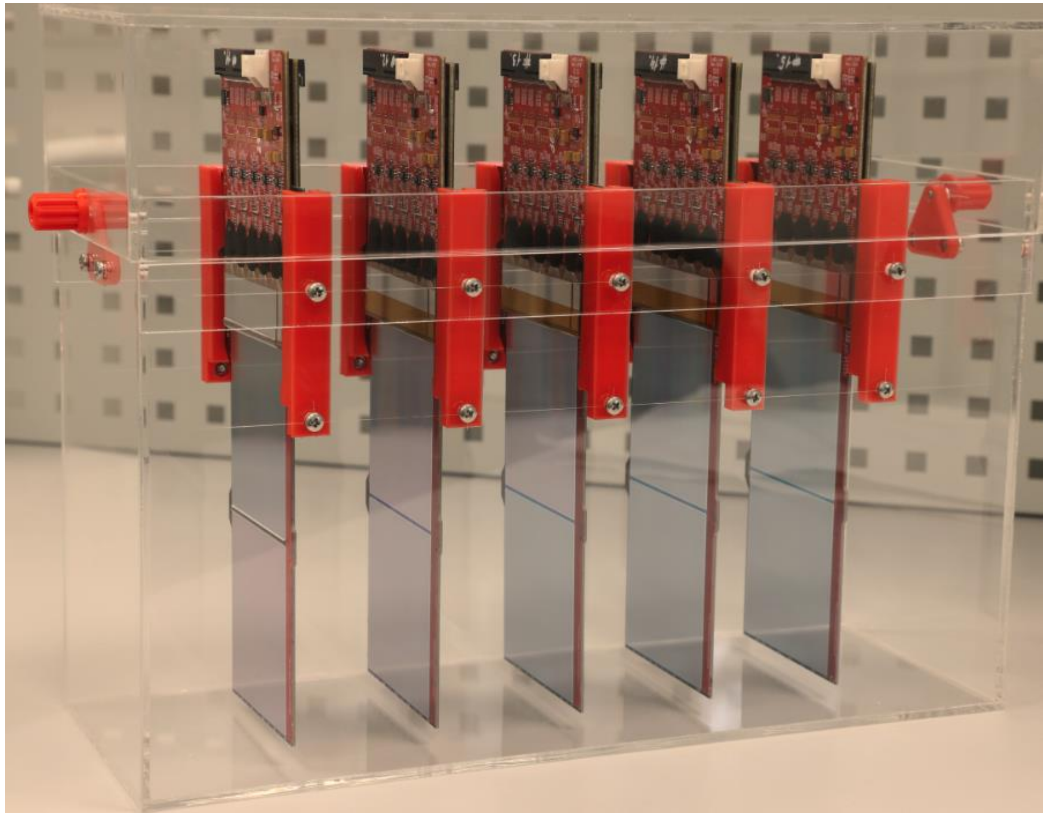


- **Detector:** DSSD, 640×614 strips, pitch p+ / n+ strips 95/103 μm, thickness 300 μm, stereo angle between strips: 2.5^0, active area 63×63 mm^2;
- **FEE:** based on VATAGP7.1 (128 ch., dynamic range: ±30fC). 5 ASIC per PCB.

See talk of B. Topko

Forward Silicon Tracker status summary

FSD group

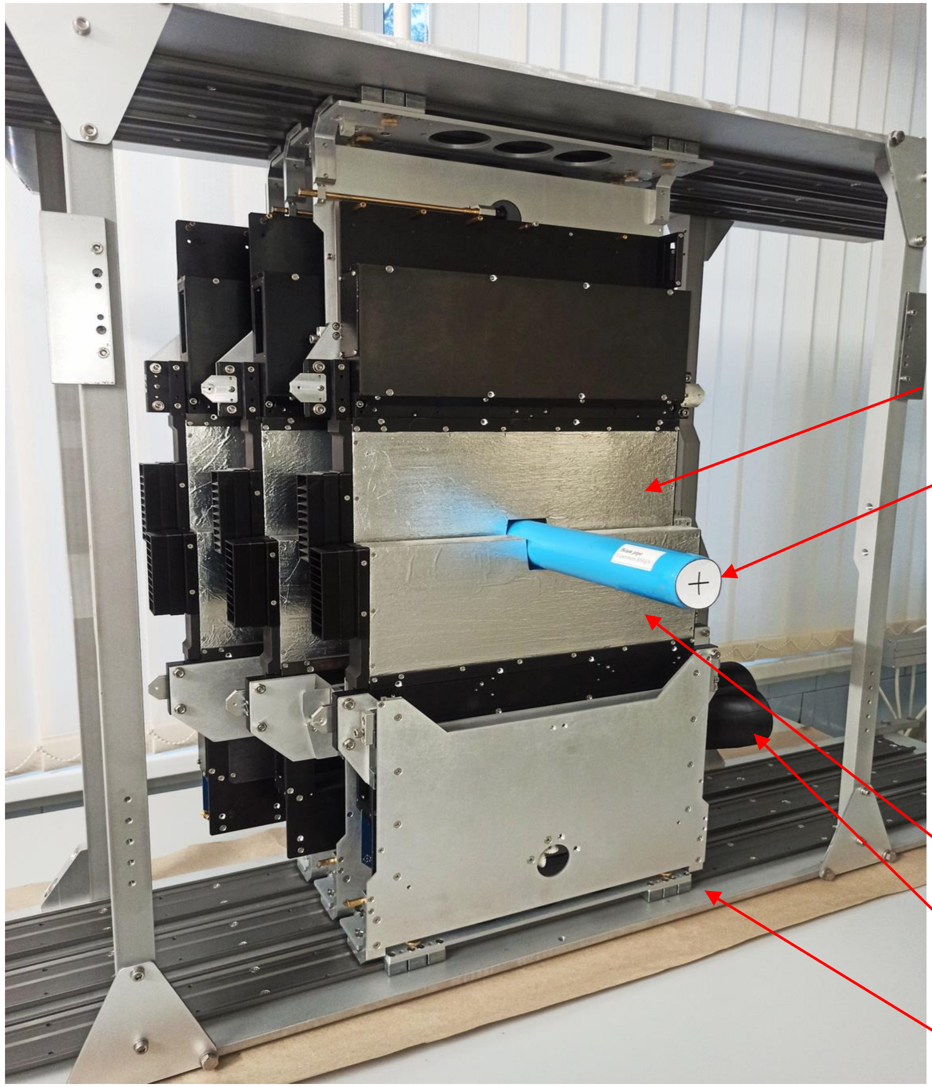


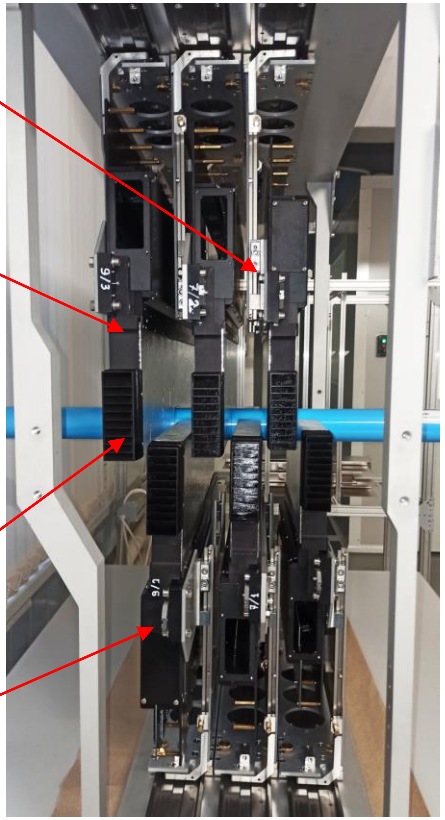
- Forward Silicon Tracker FEE and Si modules test bench was designed and assembled;
- All 84 FEE PCB were fully assembled (100%);
- 72 from 84 FEE PCB were tested (86%);
- All tested PCB have $<ENC_{PCB}>$ less than 1500 ē RMS;
- 67 from 72 tested PCB have a bad channels ratio ≤ 3%;
- 32 from 42 FST Si modules fully assembled (76%);
- 29 from 42 FST Si modules were tested (69%);
- 27 from 29 tested modules have $<ENC_{side}>$ less than 2500 ē RMS;
- Most Si modules have mean SNR_{side} > 10 (a mip signal amplitude distribution is separated from the noise);
- 25 from 29 tested Si modules have a bad channels ratio ≤ 3%

See talk of B. Topko

Forward Silicon Tracker mechanical support

FSD group





Y positioning mechanism

upper half-plane

detectors active area

beam pipe

FEE cooling system output

bottom half-plane

electromagnetic/light shielding (0.0019X0 for a half-plane)

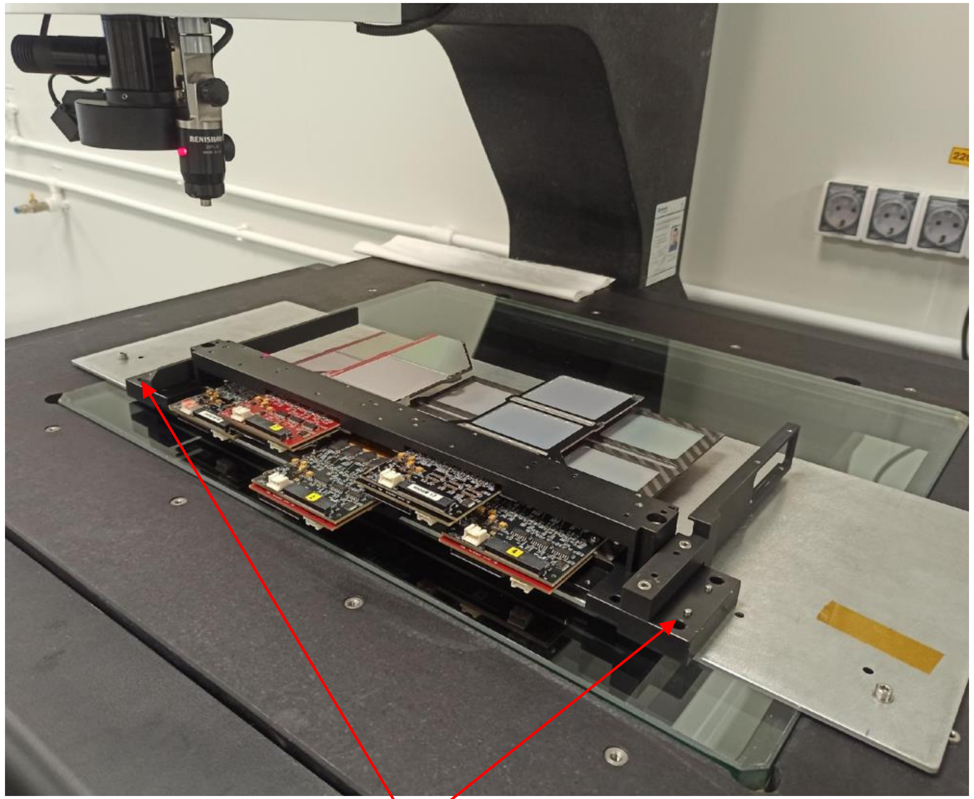
FEE cooling system input

X positioning mechanism

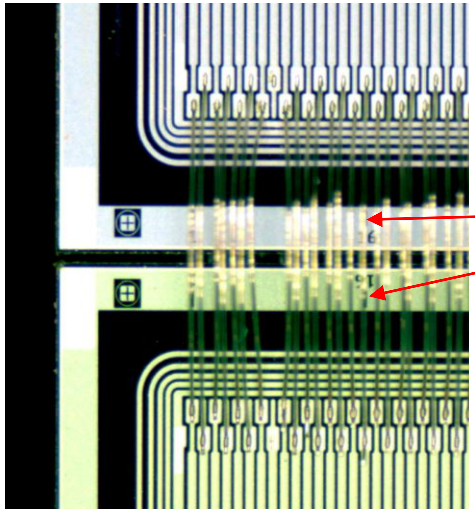
See talk of B. Topko

Forward Silicon Tracker alignment procedures

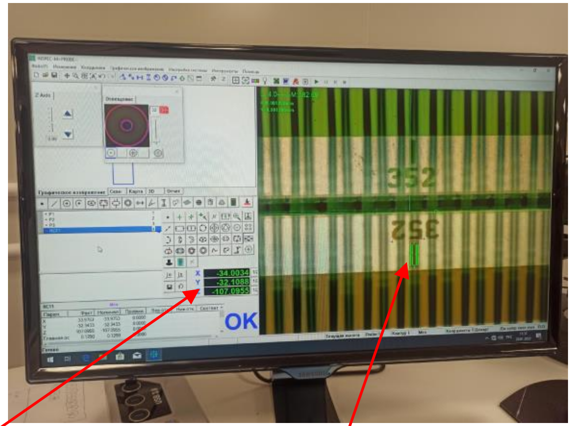
FSD group



External reference points of half-plane (pins)



Reference points of wire-bonded detectors



Measured reference point coordinates

Measured reference point

The position of the Silicon detectors relatives to the external reference points of protective box is measured precisely using a video microscope (after assembling the Si modules into a half-plane).

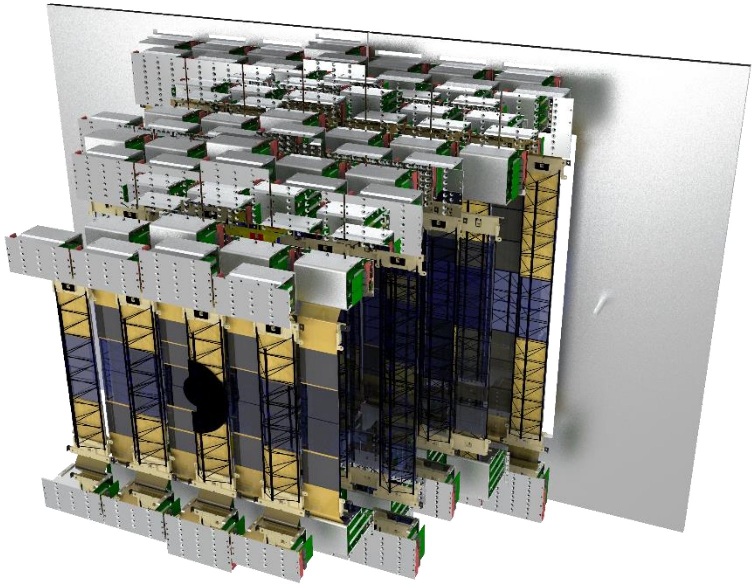
Video microscope absolute errors:

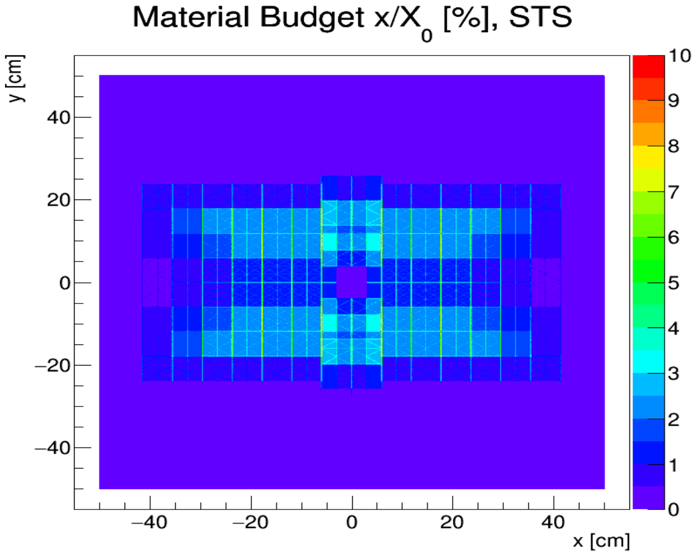
X/Y: $\pm(2.5 + L/200)$ μm; Z: $\pm(2.5 + L/100)$ μm

**L - measured length (mm)*

See talk of B. Topko

Silicon Tracking System of BM@N experiment



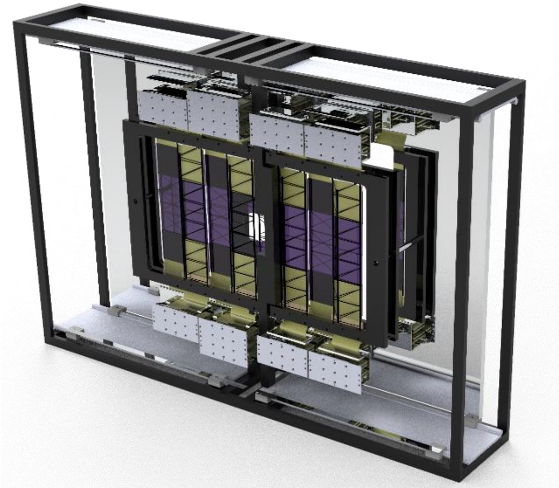


STS material budget

Technical solutions:

- double-sided silicon microstrip sensors
  - hit spatial resolution ≈ 25 μm
  - material budget per tracking station: ≈ 0.3% – 2% X_0
  - radiation tolerance up to 1×10^{14} n/cm^2 (1 MeV equivalent)
- 100% track-hermetic
- self-triggering front-end electronics, time-stamp resolution ≈ 12,5 ns
- low-mass detector modules/ladders

The project is being implemented as a joint effort of CBM and BM@N STS teams under the GSI-JINR Roadmap Agreement



4 x STS stations

34 x Ladders

292 x Modules

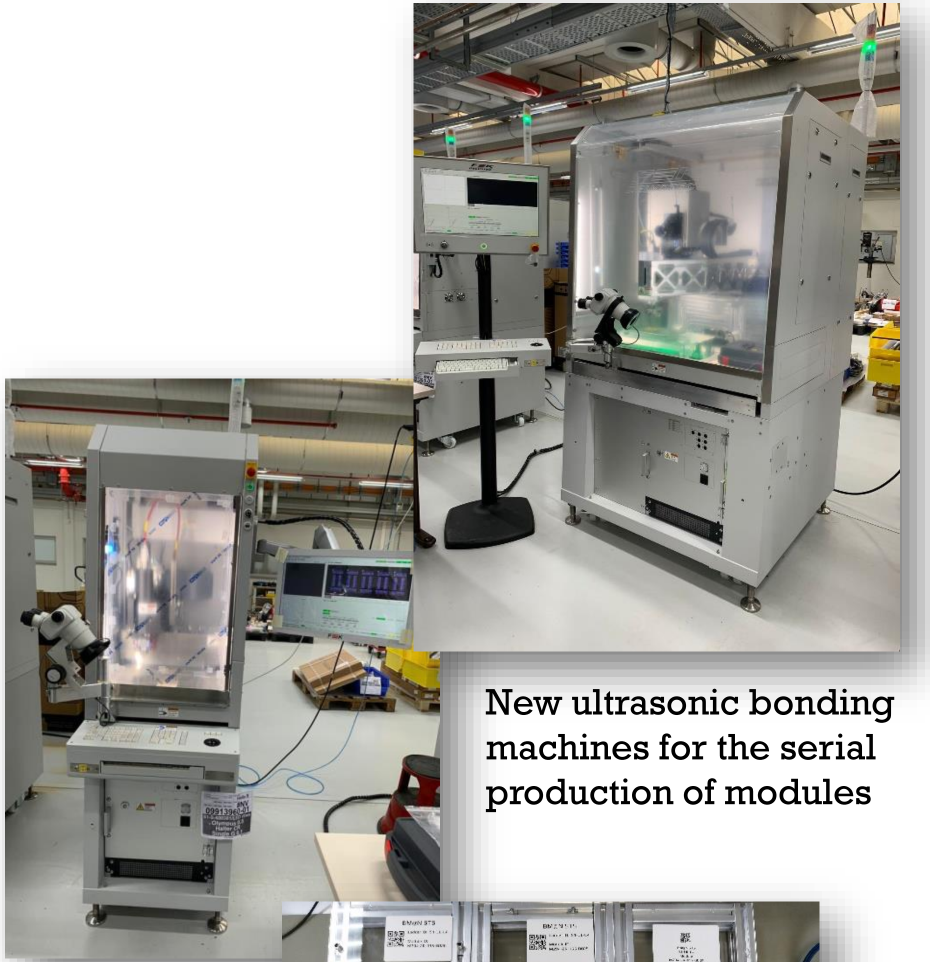
See talk of STS team

See talk of STS team

STS module assembly

Status:

- Eight modules were assembled and tested with the aim to tune the assembly workflow and tooling;
- Modified set of assembling jigs was produced for the serial production. New jigs will provide the possibility to assemble up to 4 modules in parallel;
- Assembly site is being extended to be ready to house series production of the BM@N STS modules *(additional Delvotec bonding machines to be received soon):*
  - Civil construction works is over (Bldg.2016 #103);
  - Installation of the climatic equipment has started;
- Two more technicians joined the team in September 2021 and are now being trained.



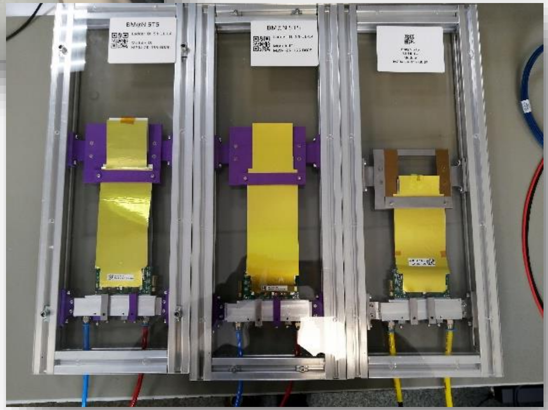
New ultrasonic bonding machines for the serial production of modules

Perspective:

Start of the pre-serial (30 pcs) module production for BM@N as soon as all needed components will be delivered

Problems identified:

Delays in the delivery of the components due to the Covid

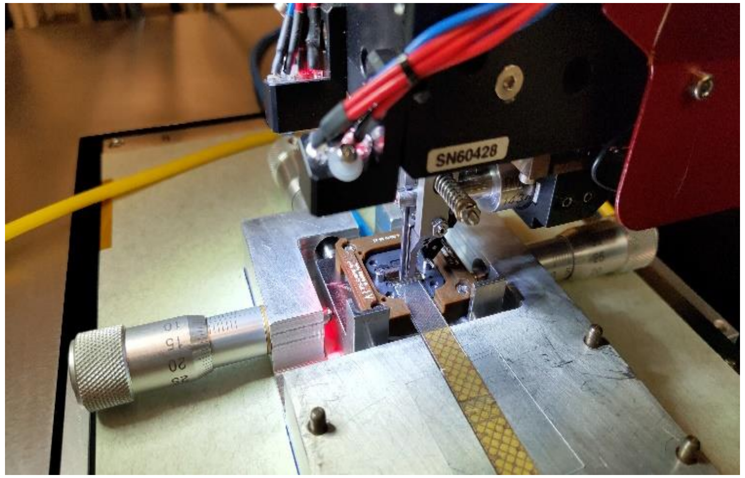


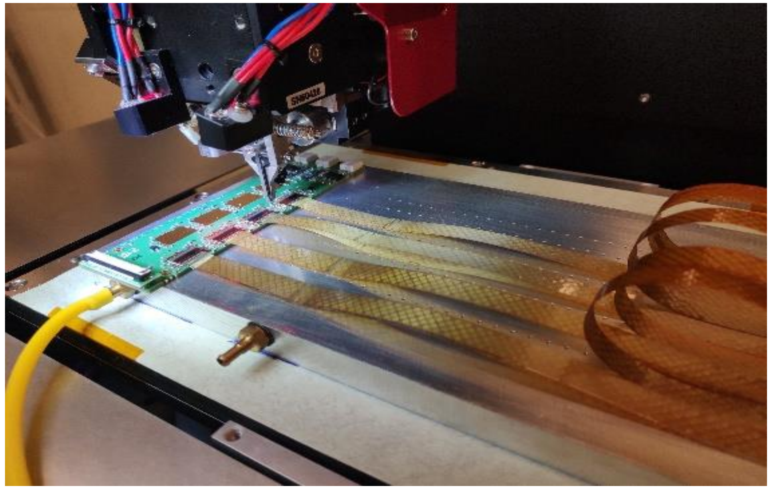
First assembled modules

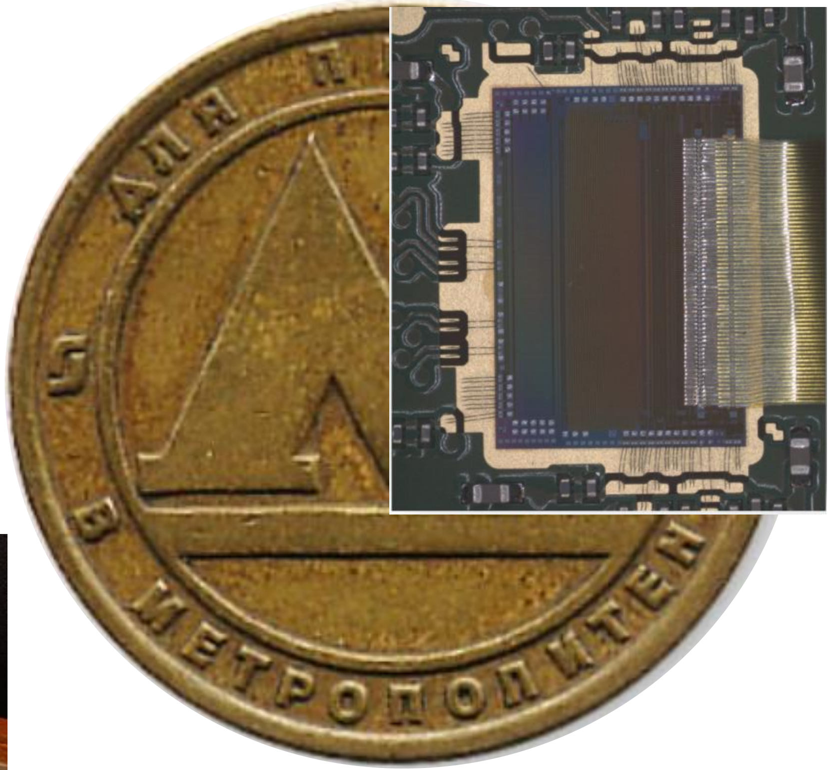
Funding source: CremlinPlus EC Grant & GSI-JINR Roadmap Agreement

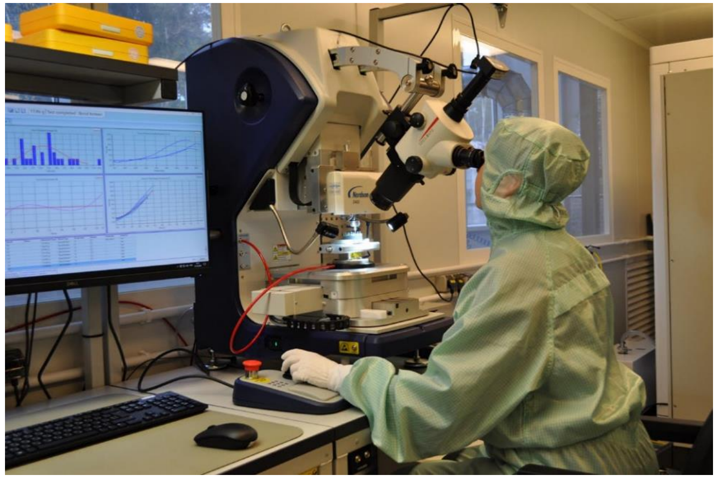
STS module assembly workflow

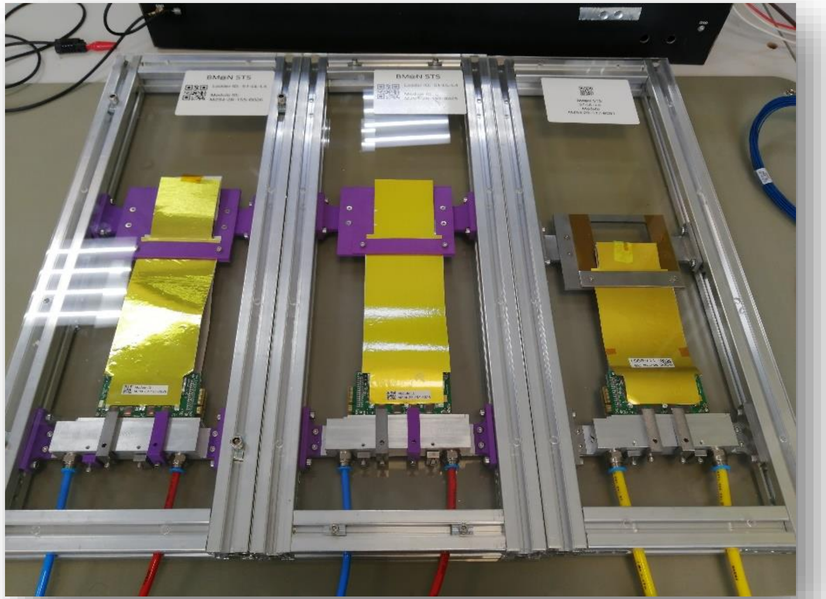
See talk of STS team





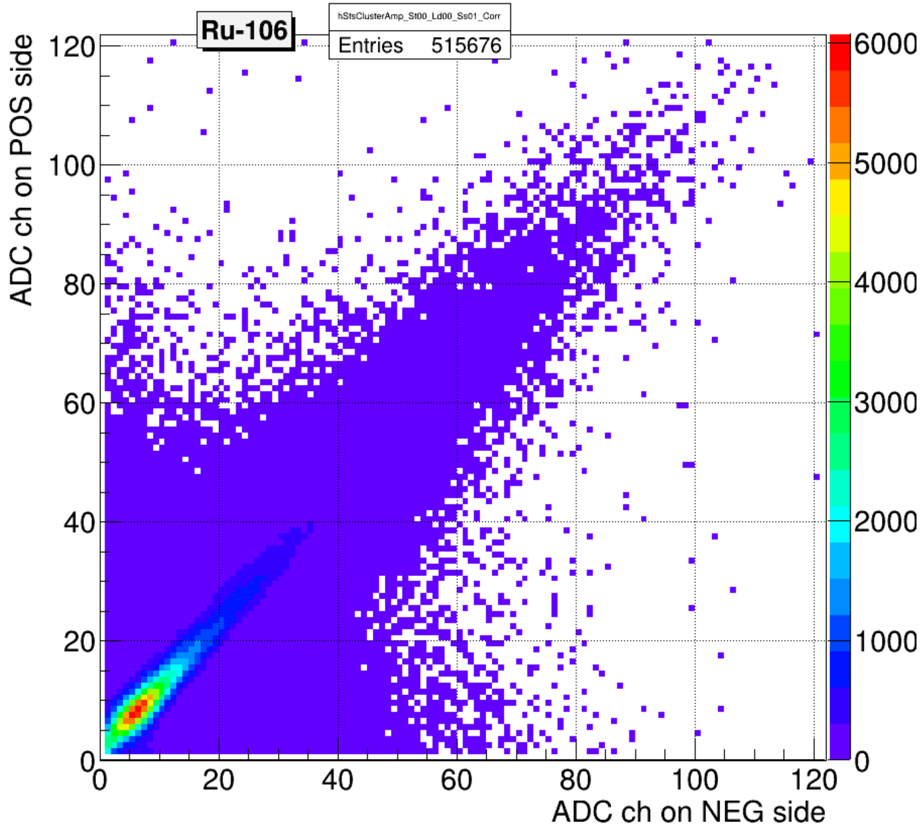




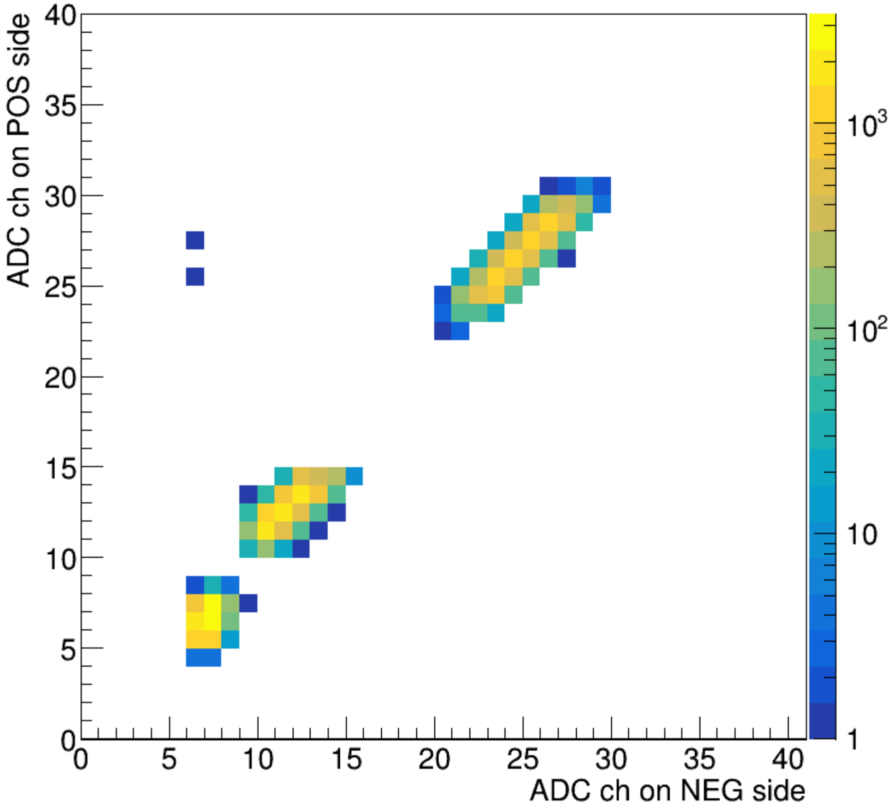


Tests of the assembled modules

See talk of STS team



Measured signal from the Ru-106 radioactive source

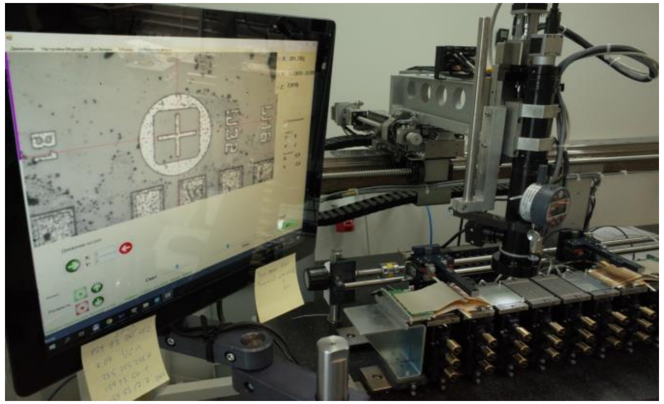


Measured signal from the IR laser (three different amplitudes of laser pulses)

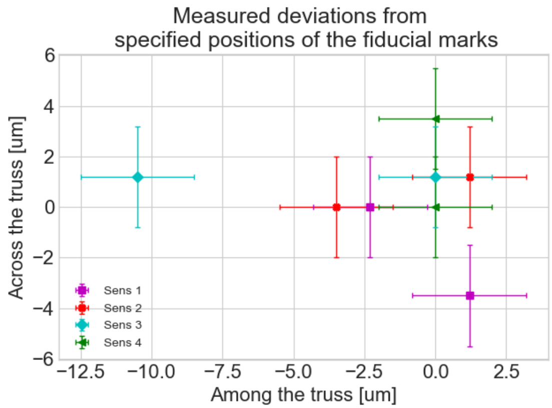
STS ladder assembly

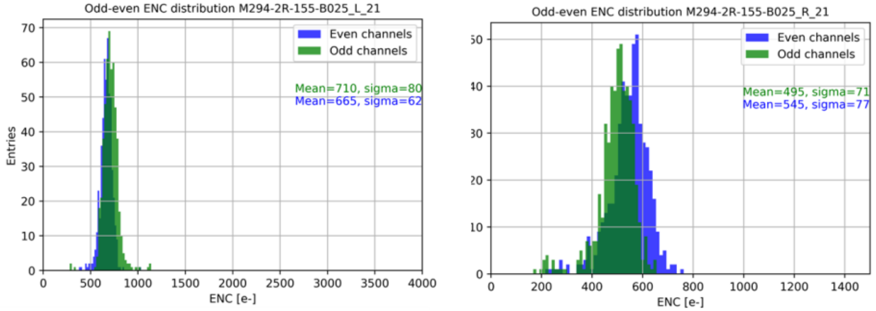
See talk of STS team

- Final set of jigs for the ladder assembly was produced and is now ready for the assembly of all types of the BM@N ladders;
- Software for the Ladder Assembly Device (LAD) was upgraded for the final specification of sensor positions on the ladders for all types of modules comprising the BM@N STS;
- Assembly process was tried and tested during the assembly of few mockups and one operational ladder:
  - Measured accuracy of sensor positioning < 15 microns;
  - Measured S/N ratio for the modules on the ladder > 25



Measuring of the sensors positions on the ladder





Measured noise per channel distribution

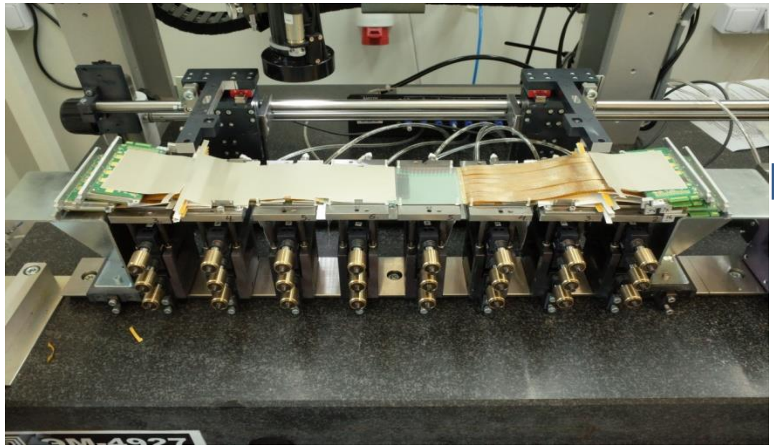
Signal/Noise > 25

Assembled ladder on the LAD

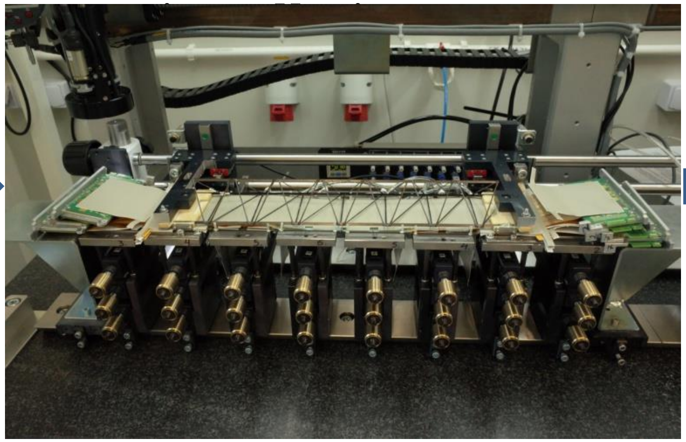
STS ladder assembly workflow

See talk of STS team

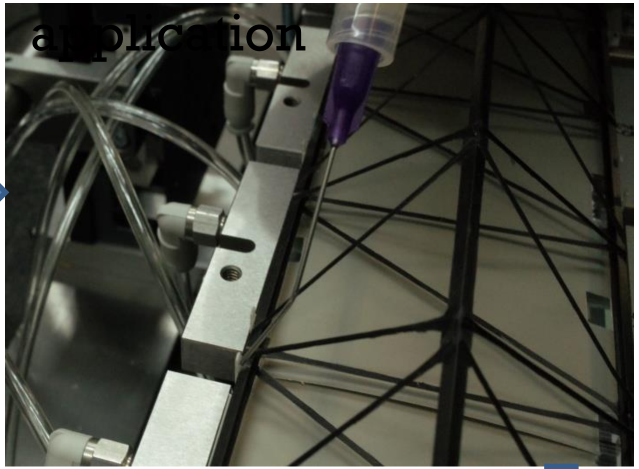
Stacking of the shielding and final alignment



Truss

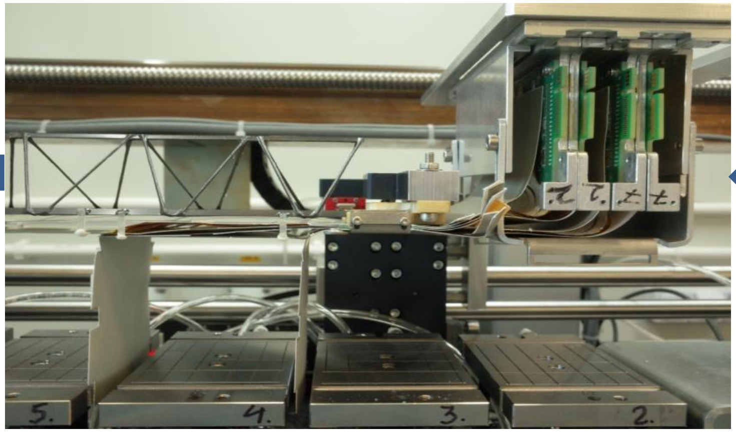


Glue application



Assembly of the FEB boxes

Lifting-up the assembled ladder



Ladder in the storage and mounting jig

GEM central tracking system

GEM group

GEM cosmic stand

Cosmic stand for long-term GEM tests:
First stage – tests of 1632*390 mm^2 detectors (finished)
Second stage – tests of 1632*450 mm^2 detectors (finished)

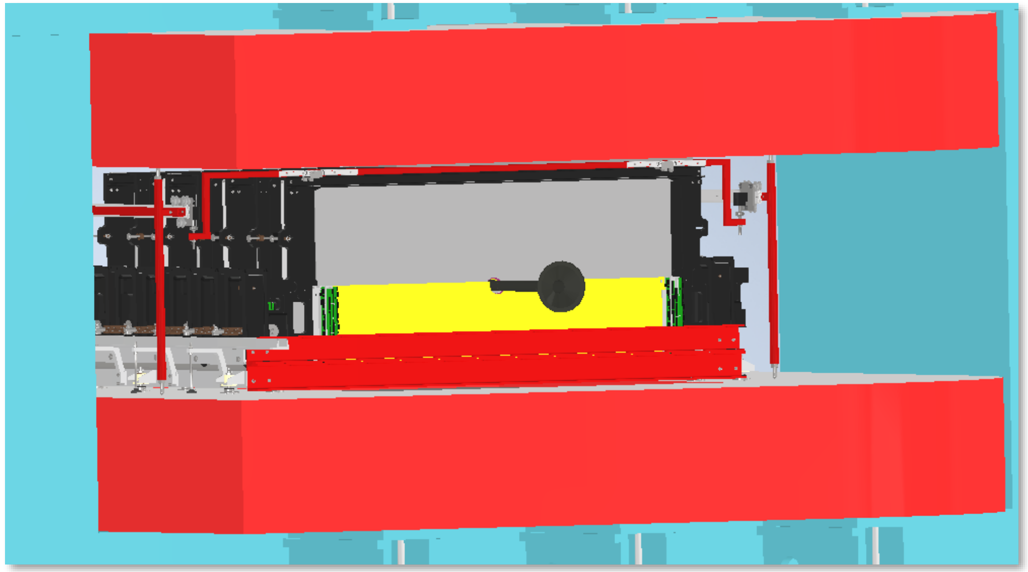
Goals:
1. Long term tests of the detectors, FEE, patch-panels.
2. Quality "passport" for every module:
   - less then 1 % of corrupted r/o channels in one chamber.
3. Determination of the detectors leakage level with OXI.iq oxygen sensors:
   - less then 500 ppm for the pair of GEM detectors at flow 3 l/h.
4. Tests of the gas distribution system.

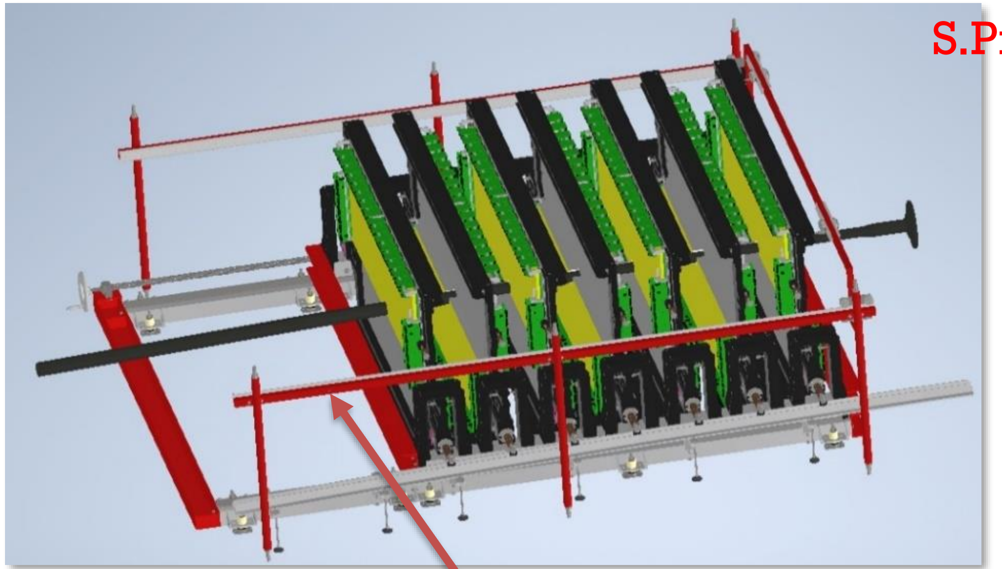
Status and plans:

- 13 GEM detectors are assembled and have passed long-term quality tests at cosmic test-bench;
- 1 defected GEM detector was repaired at CERN. Now it is back at JINR and tested;
- 14 GEMs are fully equipped with electronics and ready for installation;
- 2 spare detectors are planned to be assembled at CERN at 2022 (all parts are ready);
- Development and production of the mechanics for GEM planes precise installation inside the magnet ("Pelcom", Dubna) is finished;
- Test assembly of the new mechanics with the GEM detectors and vacuum beam pipe mock up was performed at December 2021;
- Gas control system is under construction, all components are delivered;
- New electronics based on VMM3a chips is planned to be integrated after 2022.

GEM central tracking system

GEM group
S.Piyadin





GEM support mechanics inside the SP-41 magnet. Red parts are needed only for installation and will be removed afterwards.

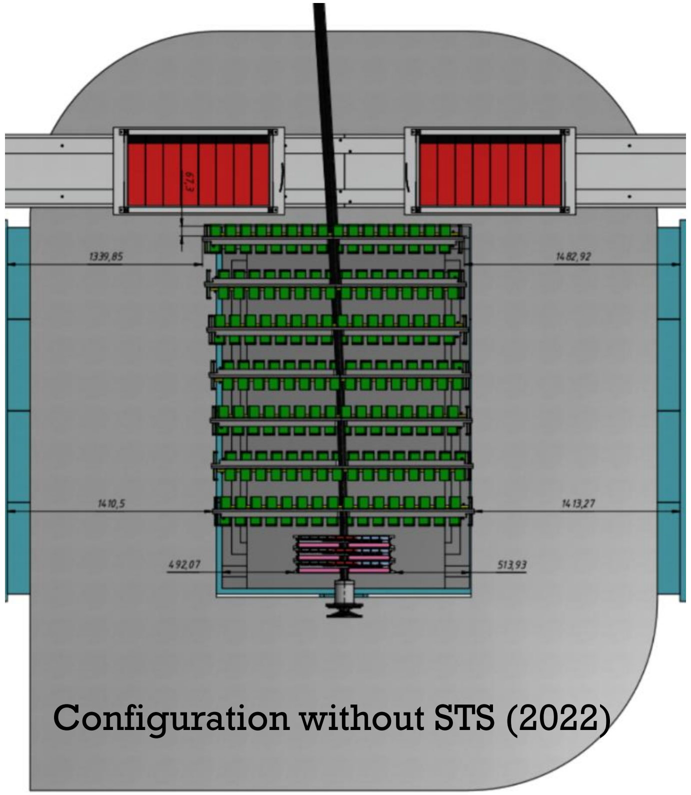
Stages of GEMs & carbon beam pipe assembly:

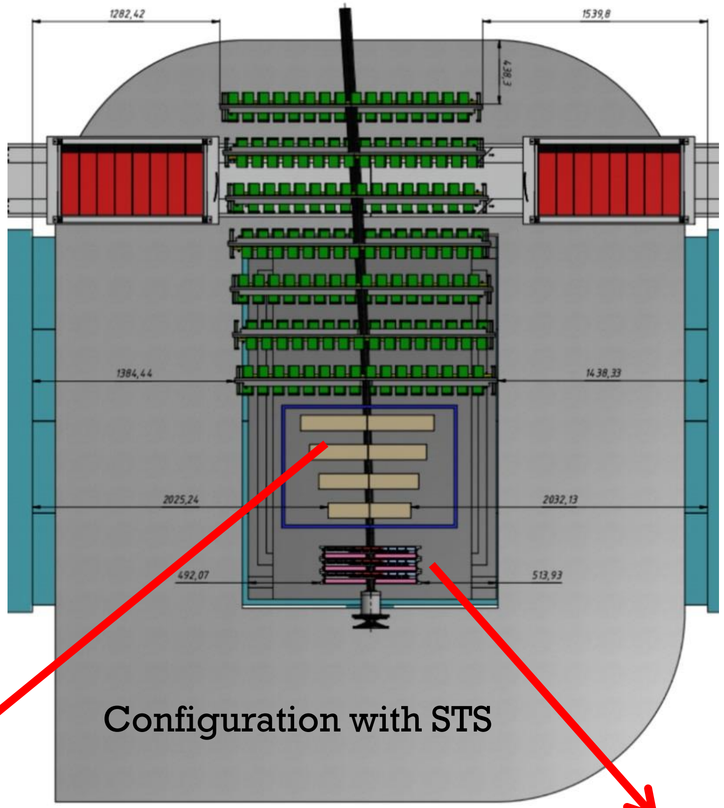
- Installation of the 1632*390 mm^2 detectors (lower part of the tracker);
- Installation of the carbon beam pipe;
- Precise measurements of the detectors and pipe positions ("Promtech izmereniya");
- Installation of the 1632*450 mm^2 detectors (upper part of the tracker);
- Precise measurements of the detectors positions.

Forward Si+ STS +Gem configuration

Four configurations of the tracking detectors are foreseen:

- Forward Si + 7 GEMs: beam intensity few 10^5 Hz , 2022
- Forward Si + "pilot" STS station + 7 GEMs: beam intensity few 10^5 Hz , 2024
- Forward Si + 4 STS stations + 7 GEMs: beam intensity few 10^5 Hz, after 2024
- 4 STS stations + 7 GEMs (fast FEE): high beam intensity few 10^6 Hz, after 2024-


Configuration without STS (2022)

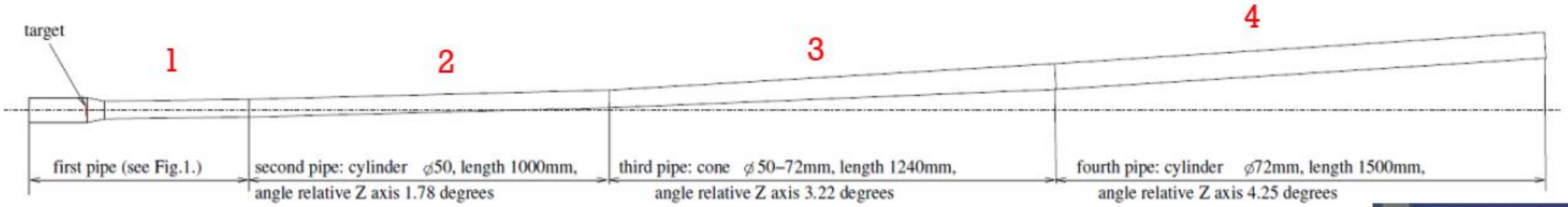

Configuration with STS

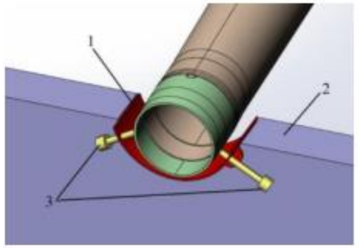
2024 year – "pilot" configuration
After 2024 year – full configuration

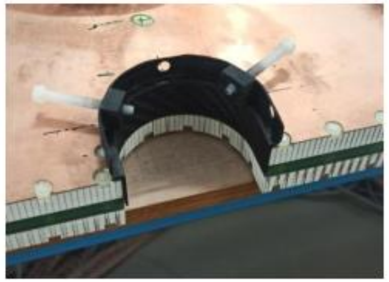
Forward Si will be removed after integration of STS full configuration into BM@N setup (after 2024 year, high beam intensity - few 10^6 Hz)

Carbon beam pipe inside the analyzing magnet

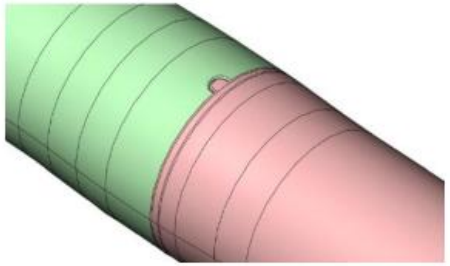
S.Piyadin,
V.Spaskov,
"KB Arkhipov"







Design of the support system, which uses the surface of GEMs



Design of the non-flange connections (Butyl rubber sealing tape)

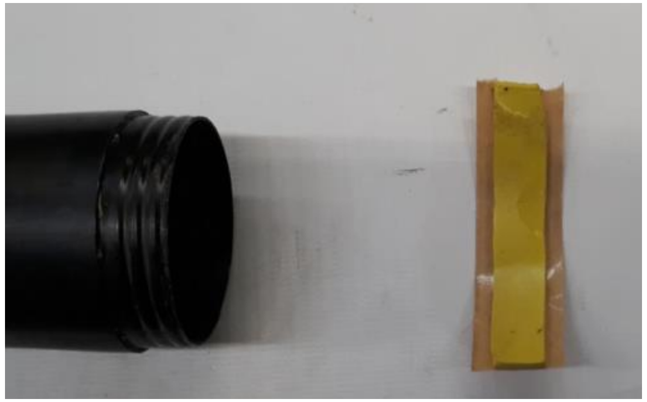
Current status:
- all four segments are produced by "KB Arkhipov" (Moscow) and delivered to JINR;
- total leakage flux was measured in vacuum laboratory;
- tests of the leakage level and precise measurements of the geometry of the pipe are going on at the test bench at JINR;
- joint assembly of carbon beam pipe + target station are to be performed during SRC run.

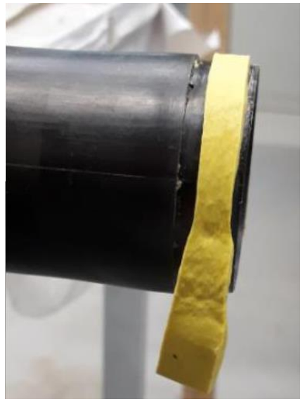
Butyl rubber sealing tape for non-flange connections

S.Piyadin,
"KB Arkhipov"

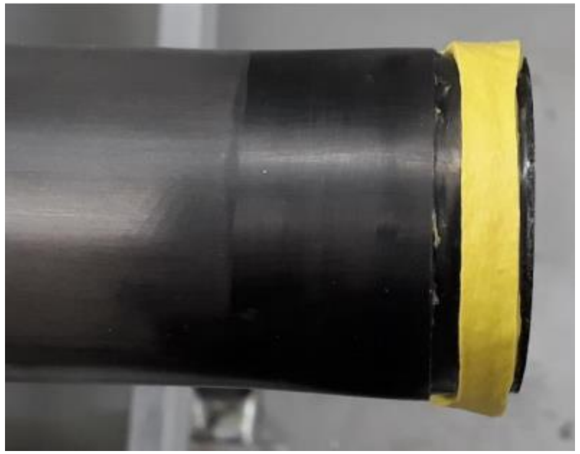
Butyl rubber tape

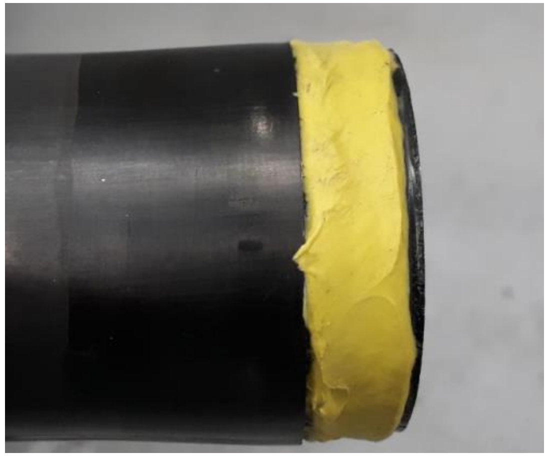
The connections are cleaned before sealing



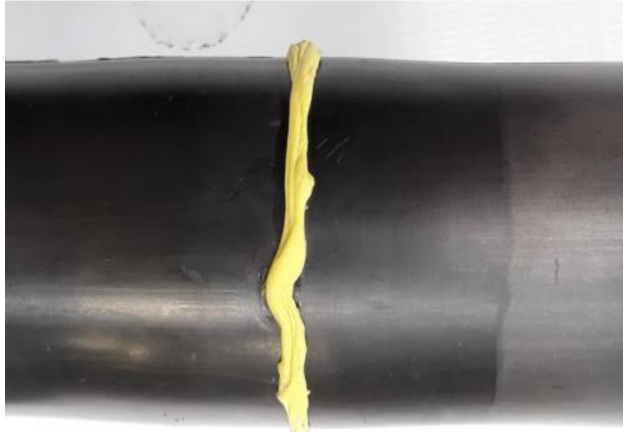


The sealing process

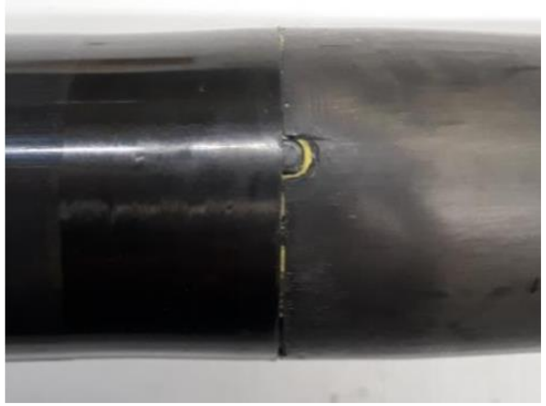




The tape is carefully compressed around the surface to avoid the unsealed zones



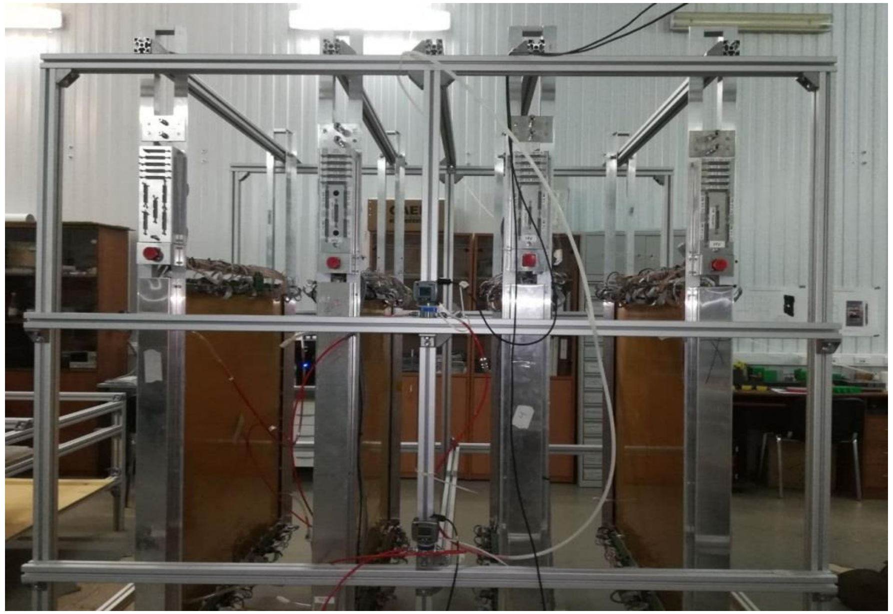
The adjacent segments are attached



After preliminary vacuumization spare tape is removed

1065x1065 mm^2 CSC chambers

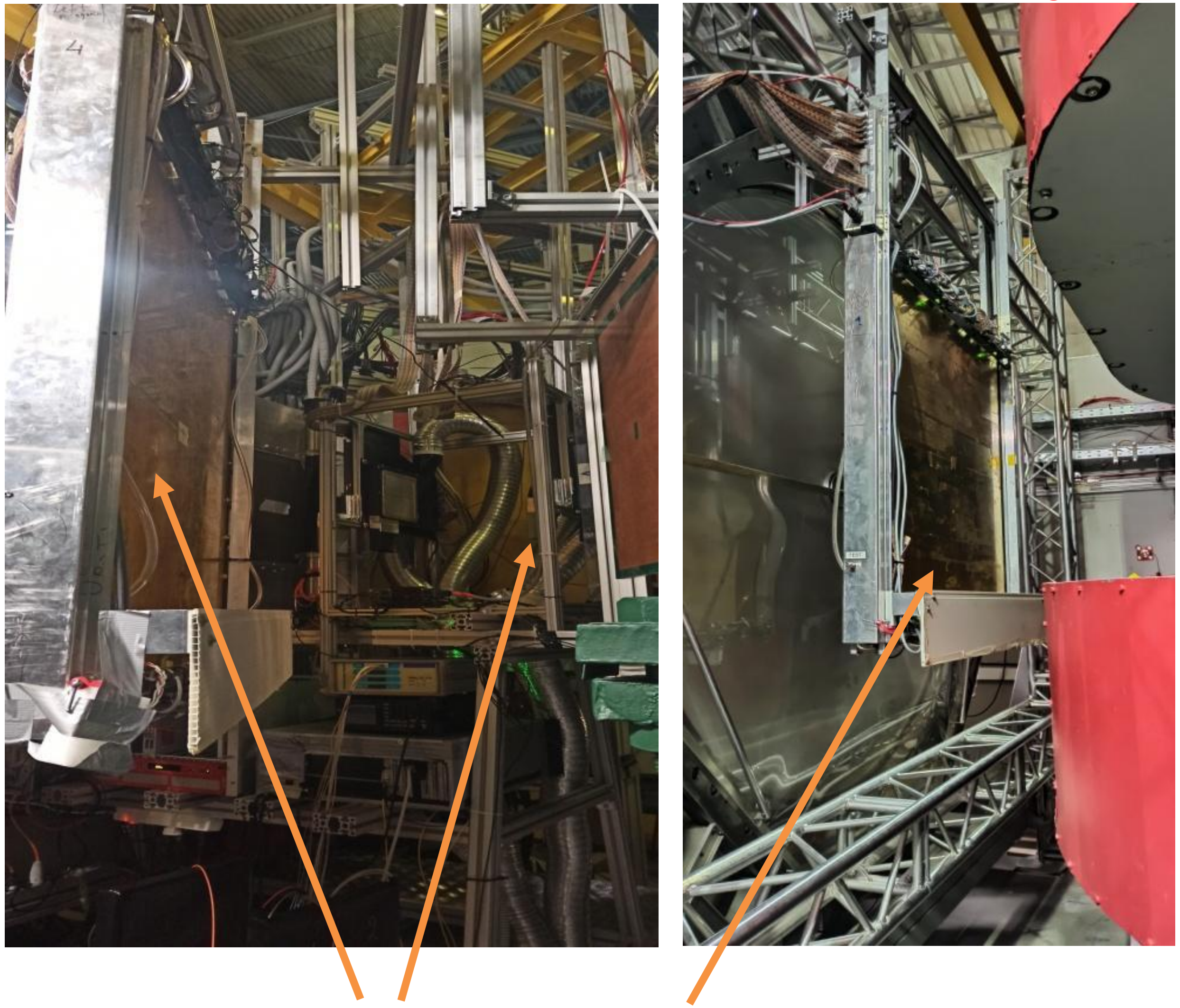
CSC group



CSC stand

CSC 1065x1065 mm^2 status and plans:

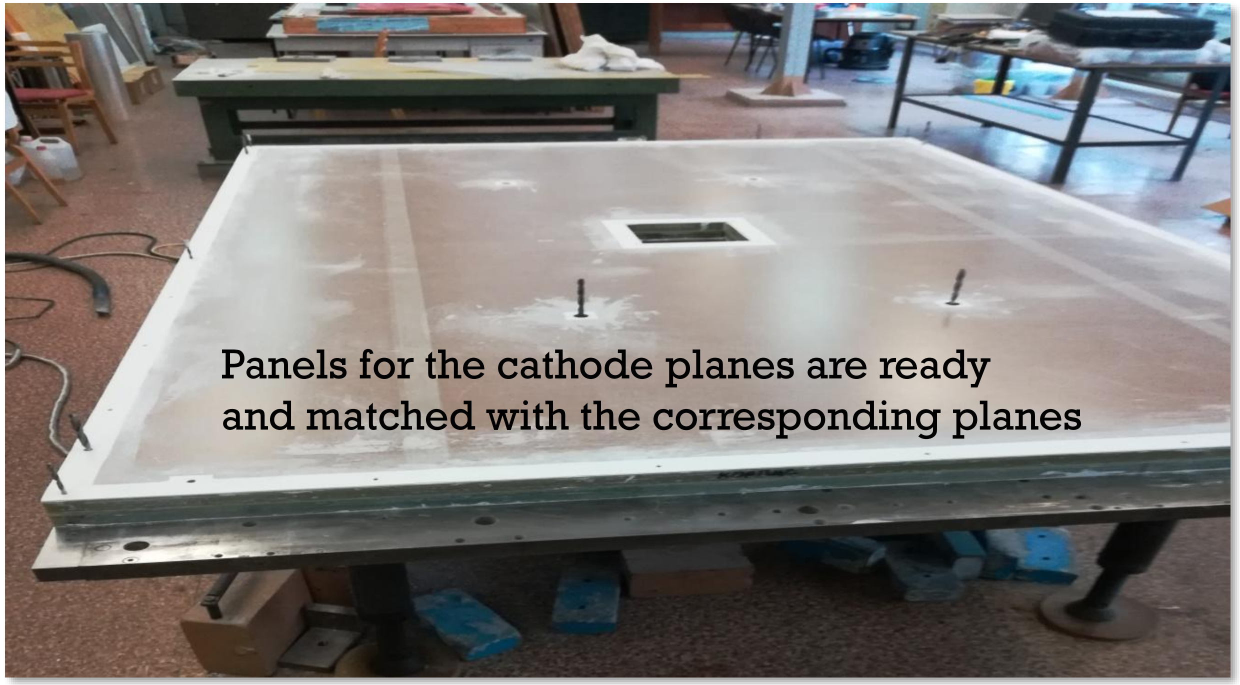
- One CSC 1065x1065 mm^2 is produced and tested at Nuclotron beam;
- Assembly of the three1065x1065 mm^2 chambers is finished;
- Tests of the assembled chambers with r/a source and cosmic rays are performed;
- Three chambers are fully equipped with electronics and will be tested during the the SRC run.



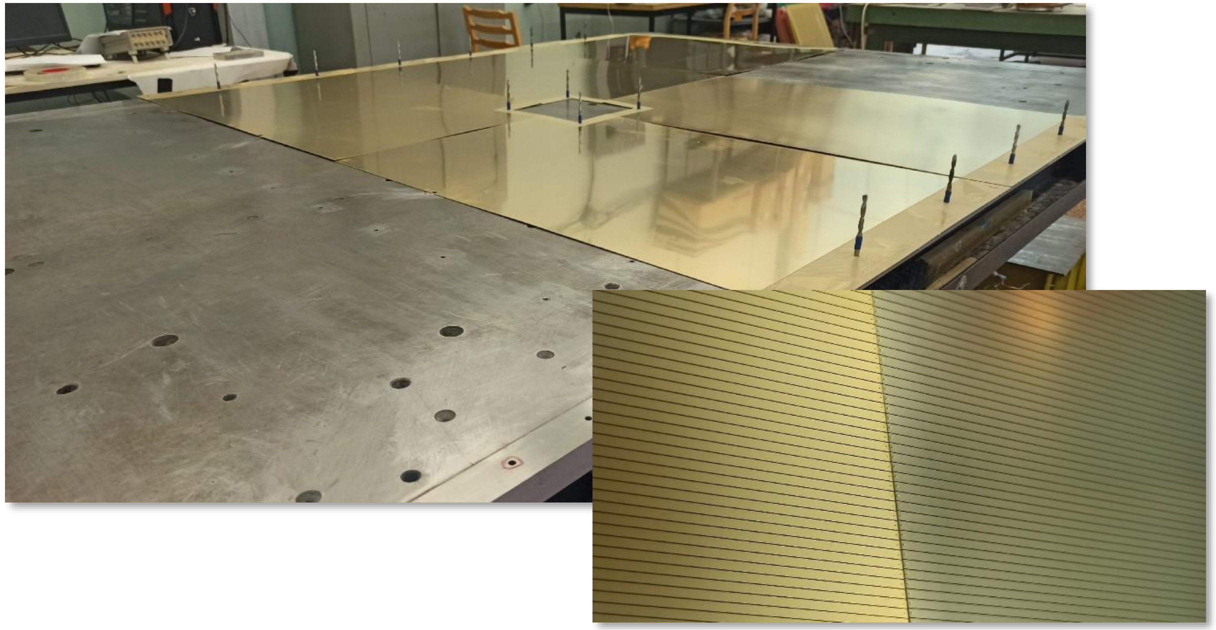
Three CSC chambers are installed into the SRC setup

2190x1453 mm^2 CSC chambers

CSC group



Panels for the cathode planes are ready and matched with the corresponding planes



Cathode planes matched on the assembly table

Bonding of the protective resistors

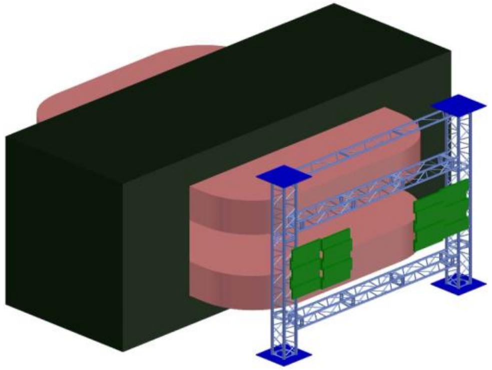
CSC 2190x1453 mm^2 status and plans:

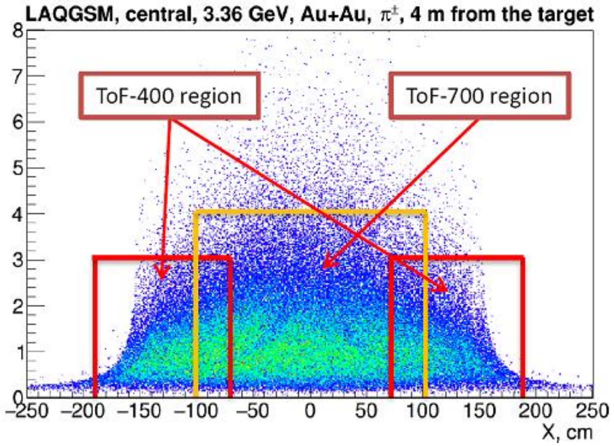
- Cathode planes and honeycomb panels are delivered to JINR;
- The assembly table is ready;
- FEE for both chambers is available;
- Assembly and tests of the first 2190x1453 mm^2 CSC chamber – 03.2022 (to be installed before BM@N run in 2022);
- Assembly and tests of the second 2190x1453 mm^2 CSC chamber – middle 2022;

Status of ToF-400 & ToF-700

ToF-400 group

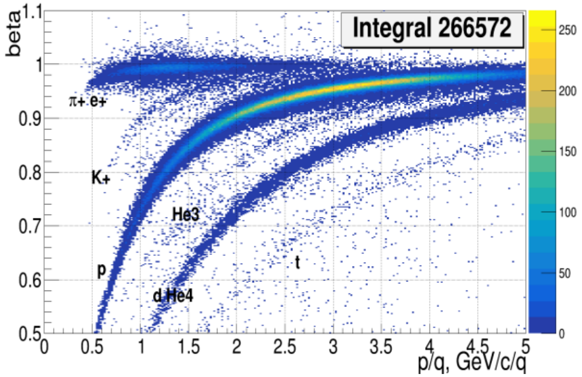
ToF-700 group

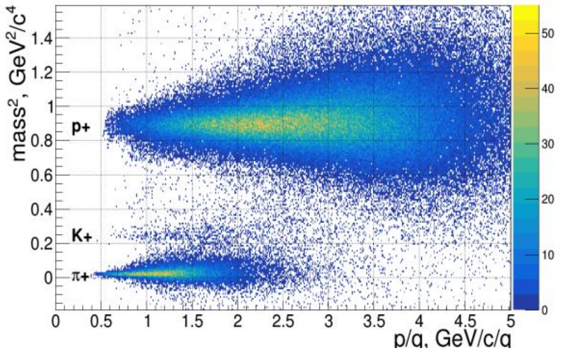


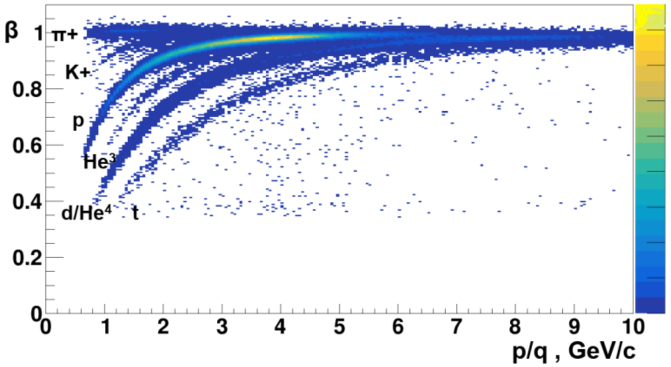


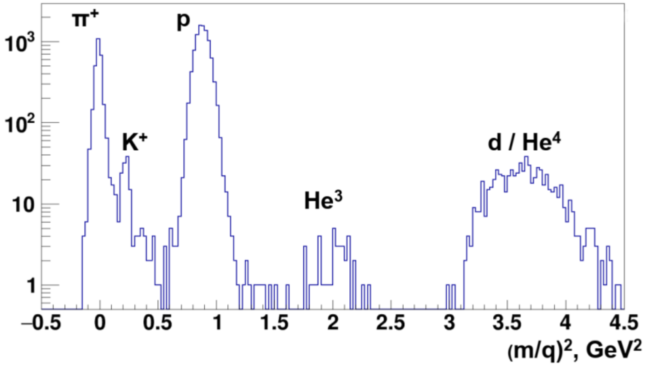
Preliminary result of identification, GEM+CSC track extrapolated to ToF-400

Preliminary result of identification, GEM+DCH track extrapolated to ToF-700







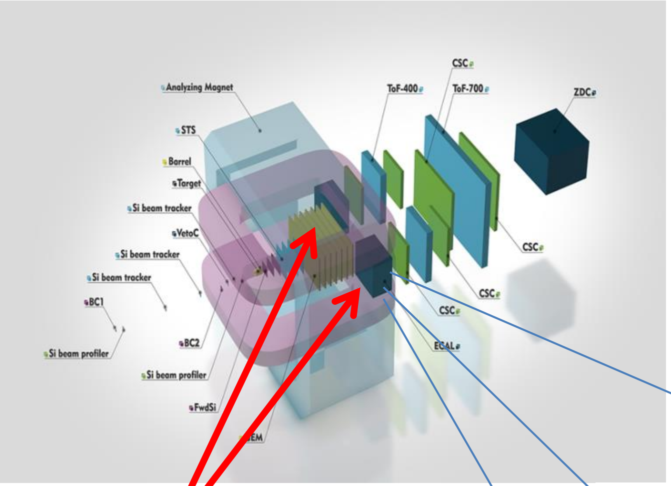


Both time-of-flight systems were are installed in full configuration and were tested during previous Nuclotron runs. Both systems are ready for the heavy ion beam program. Performance will be checked during the SRC run.

ECAL Status

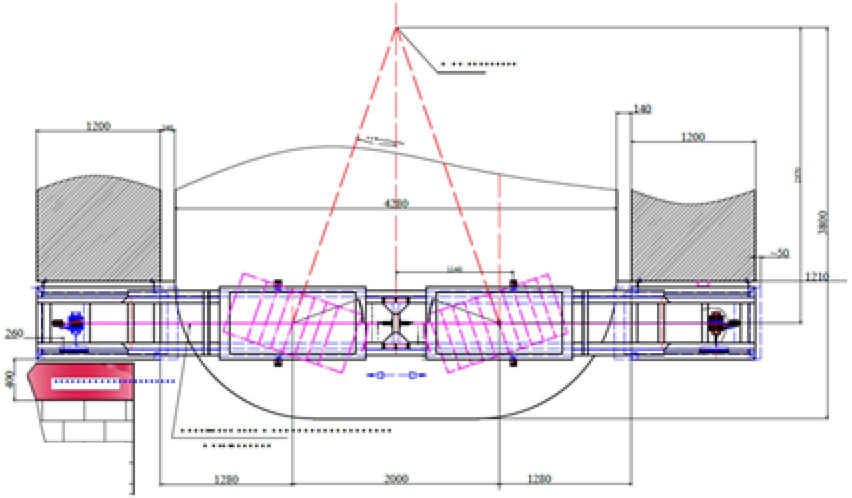
ECAL group

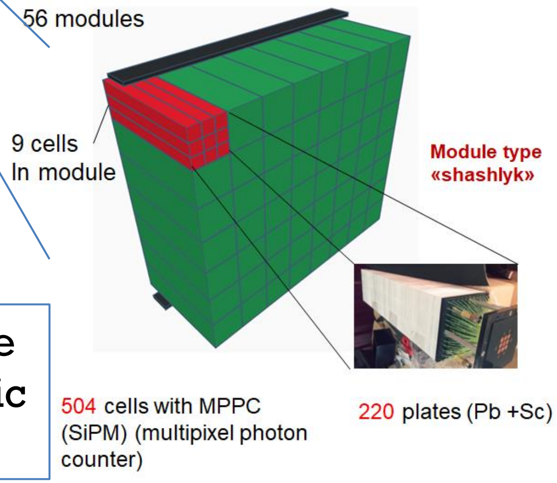
ECAL is formed from lead-scintillation modules "Shashlyk"-type in the wall size of 8x7 modules (96x84 cm^2). The total number of active cells in one ECAL wall is 504. The total number of detectors in the two walls is 1008 cells.



The ECAL location in the BM@N

ECAL setup: two Walls of 8x7 modules, 1008 cells





Structure of the electromagnetic calorimeter

The calorimeters are located between the coils of the SP-41 magnet directly behind the GEM chambers.

ECAL Status

ECAL group

All parts of ECAL are ready for installation on site BM@N and work in heavy ion beam run.

- New mechanics for the two-arm calorimeter is ready.
- All ADC are manufactured and ready for operation in the DAQ.

- All modules were checked and prepared for ECAL.

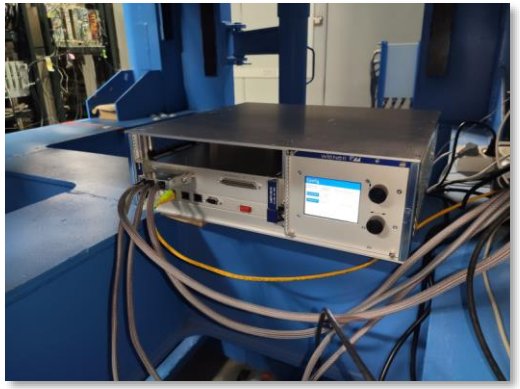
Right arm

Left arm

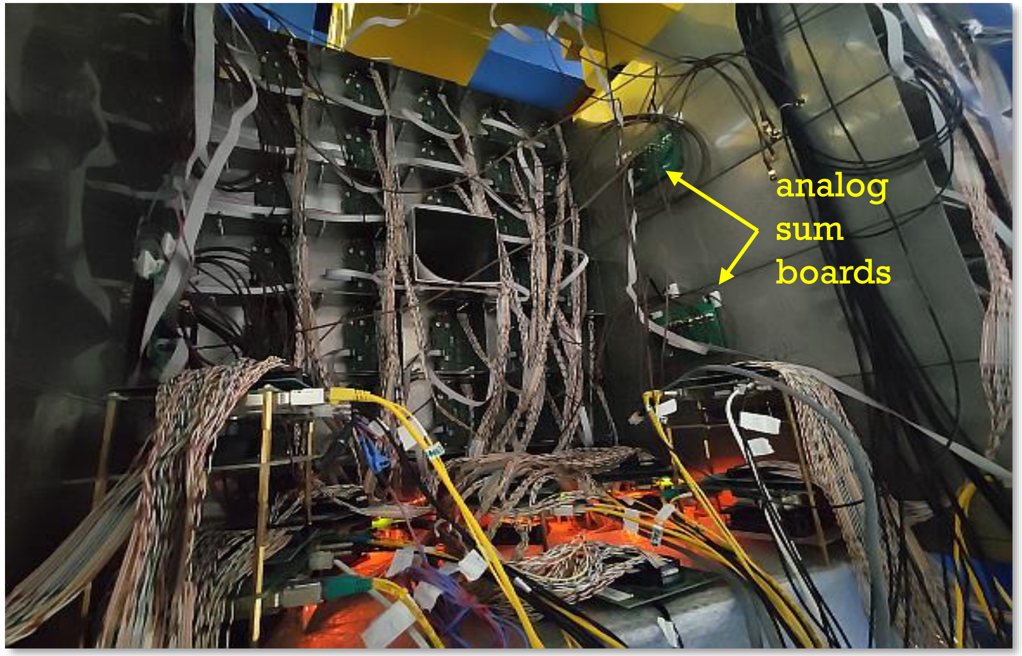
FHCal status

group of INR RAS Troitsk

FHCal has been assembled and installed in the BM@N area



WIENER MPOD power supply unit has been installed



- 54 FEE boards have been connected and tested;

- 8 ADC64s2 board are in places, tested, connected with new cables (yellow on photo) to Rack 6 + WR optical fibers;

- 6 analog sum boards and 6 LED generators are connected to FEEs;

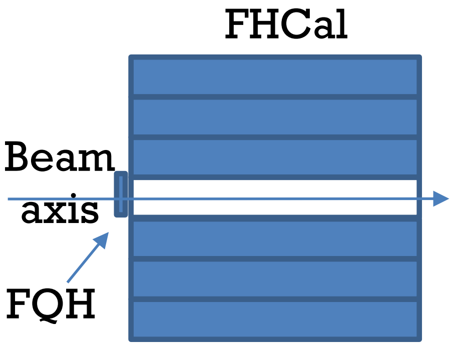
- power supply unit (WIENER MPOD) has been tested;

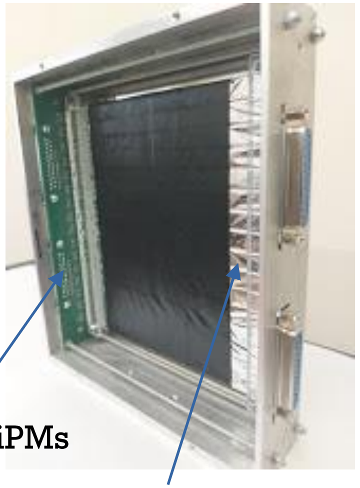
- calibration on cosmics – done for all modules;

- read-out system has been tested in SRC dry runs.

Beam hodoscope status

group of INR RAS Troitsk





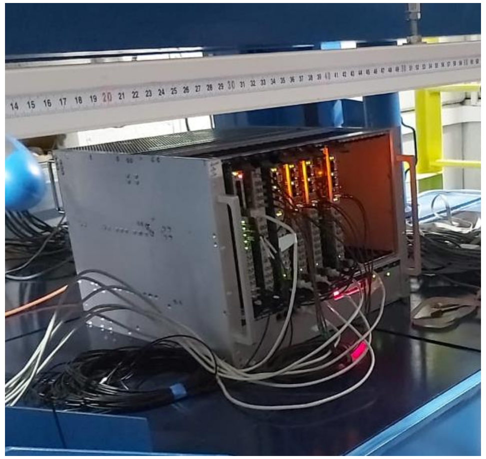
- two Forward Hodoscopes are ready:

  1) with quartz plates (for heavy ions)
  2) with scint. plates (for light ions)

- 4 TQDC board planned to use for read-out (one VME crate - installed)

- SRC beam time: scint. hodoscope will be used with Scint. Wall hodoscope - installed

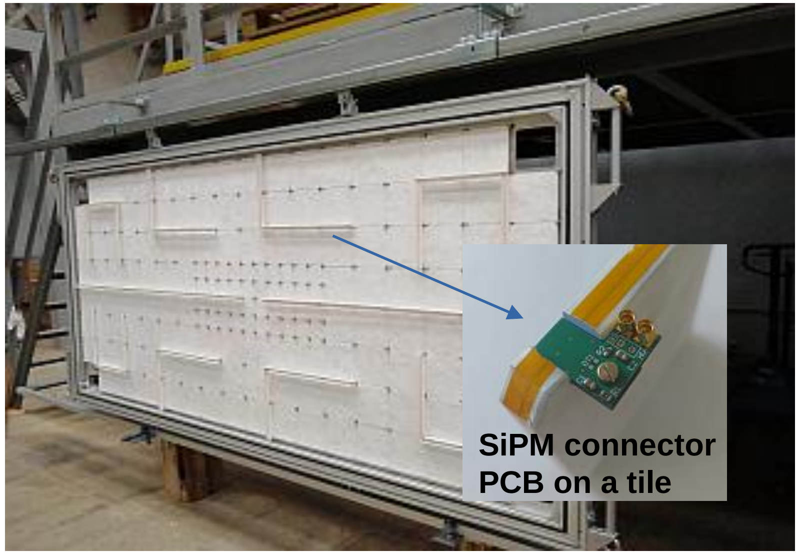
- BM@N beam time: quartz hodoscope will be placed in the FHCal beam hole



VME crate for beam hodoscope installed on FHCal platform

Scintillation Wall hodoscope status

Scint. Wall assembly at INR (Troitsk)



Scint. Wall fully equipped with tiles (for tests at INR)

FHCal and scWall installed at the BM@N

Status of Scintillation Wall detector (scWall):

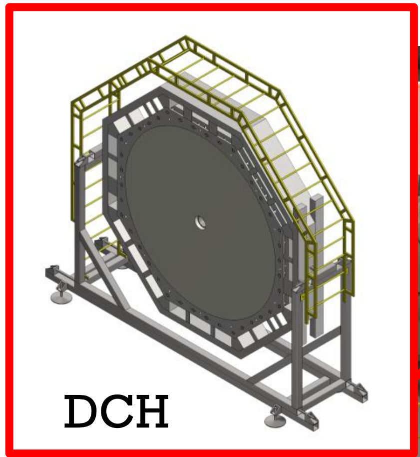
- ScWall is assembled at INR, transported and installed at BM@N;

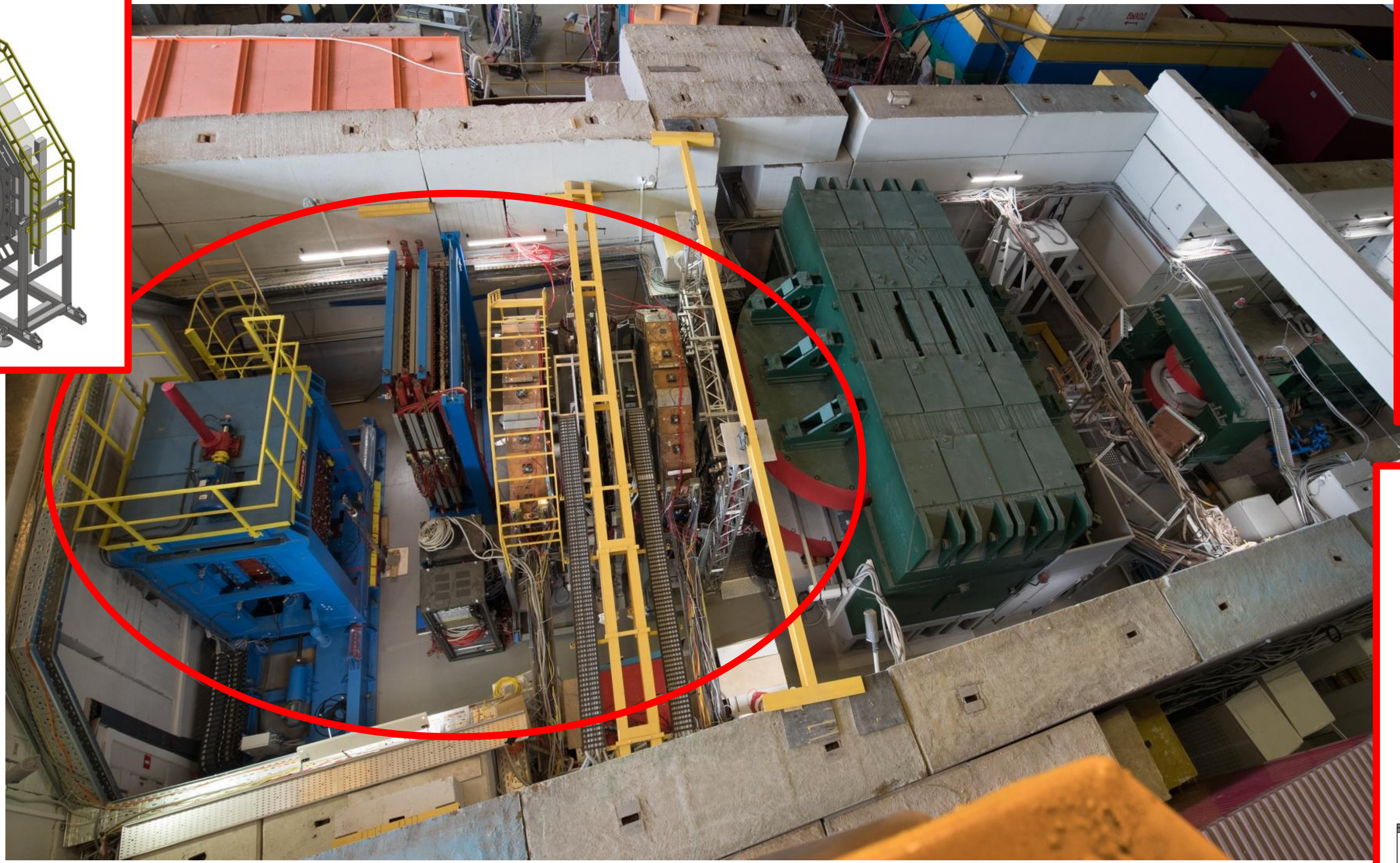
- FEE and ADC64 read-out modules have been tested during SRC dry runs.

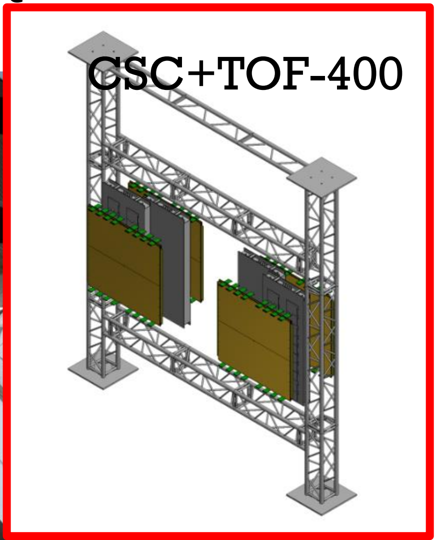
group of INR RAS Troitsk

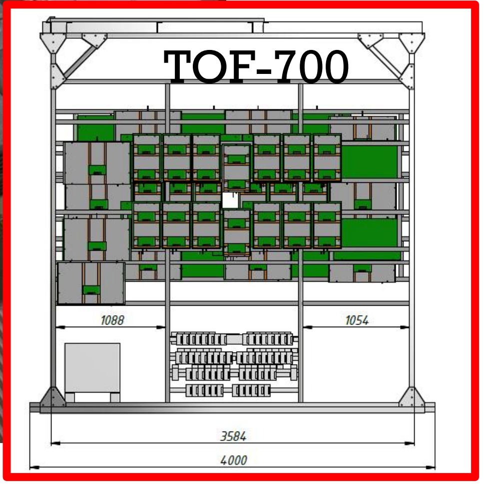
S. Piyadin, A. Kubankin

Beam pipe downstream the SP-41 magnet









Production of the aluminum beam pipe downstream the SP-41 magnet will be performed by A. Kubankin

Slow Control System

Slow control group

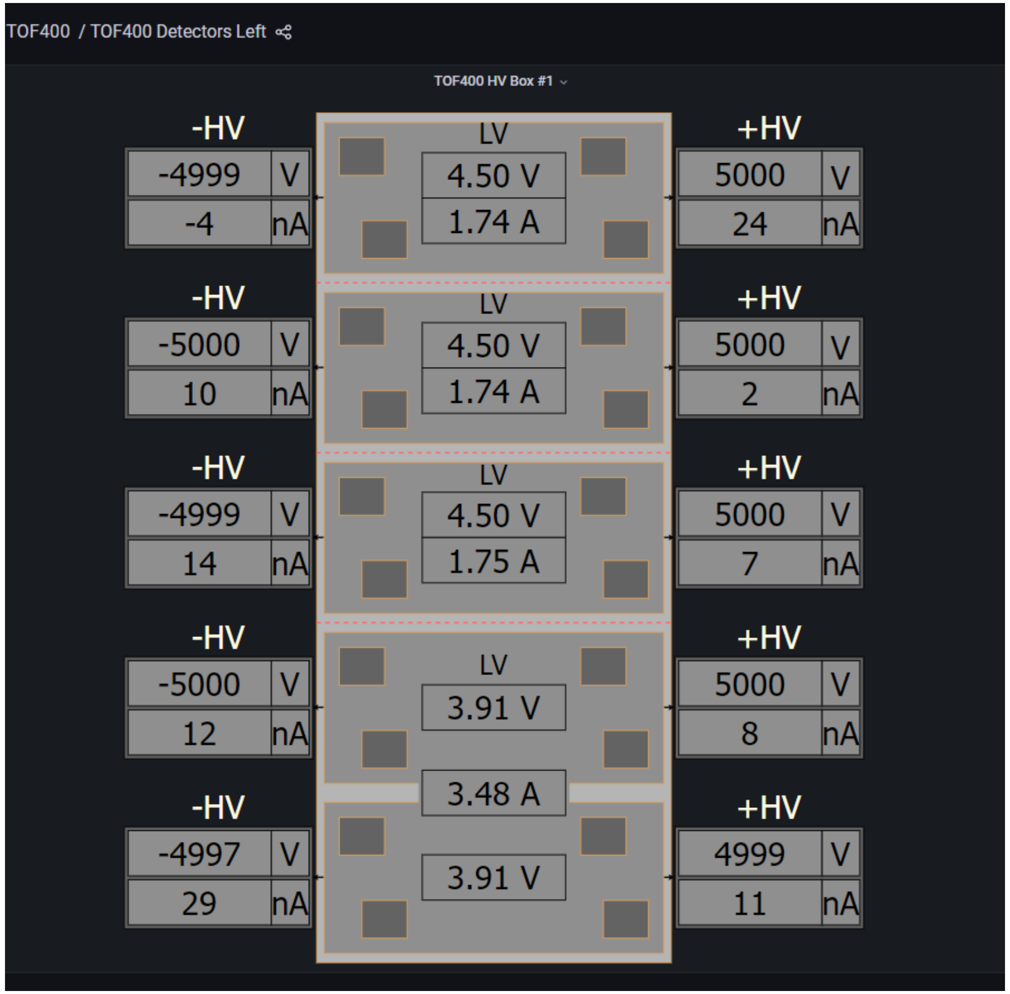
Subsystems status

High Voltage	Wiener (Iseg)	+
	Caen	+
	HvSys	±
Low Voltage	Wiener	+
	Fug	+
	Rigol	-
Gas	MKS Pac 100	+
	MKS 647C	+
Target stations	Solid targets	in progress
	Hydrogen target	in progress
Environment	Temperature	+
	Humidity	+

+ web visualization (status, graphs), new archiving process, etc.

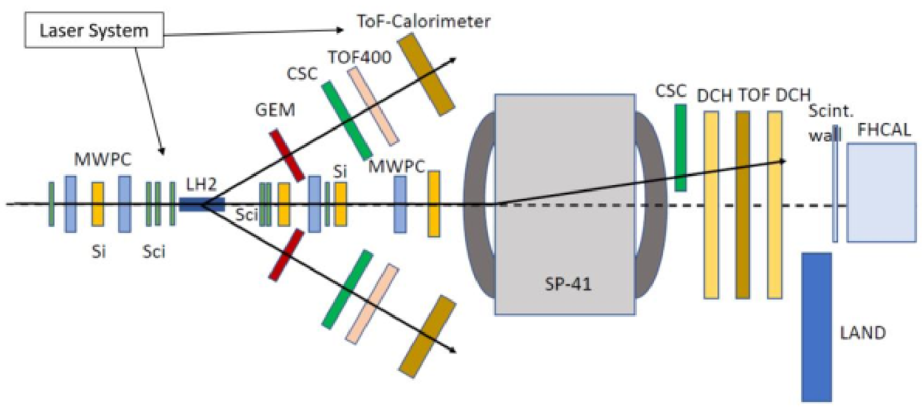
Slow Control System

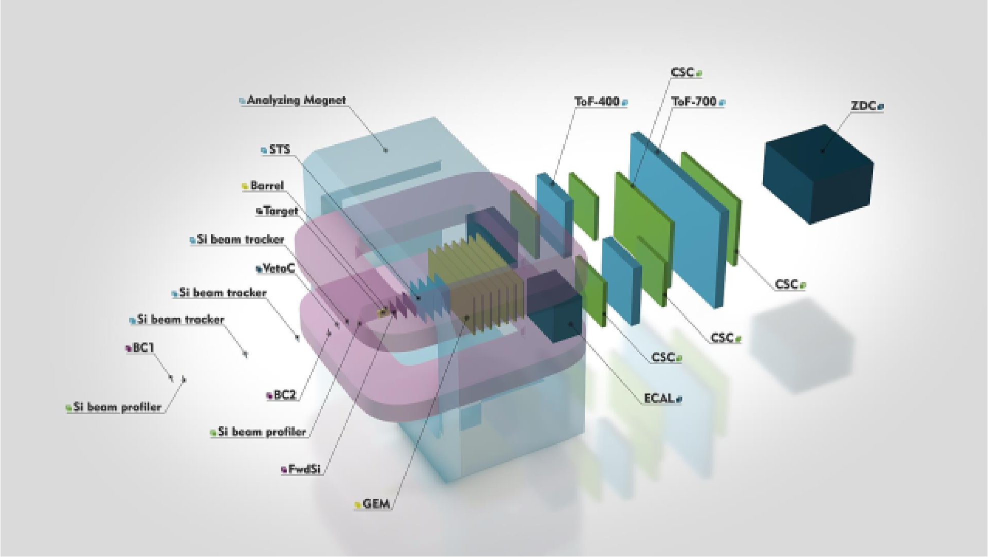
Slow control group

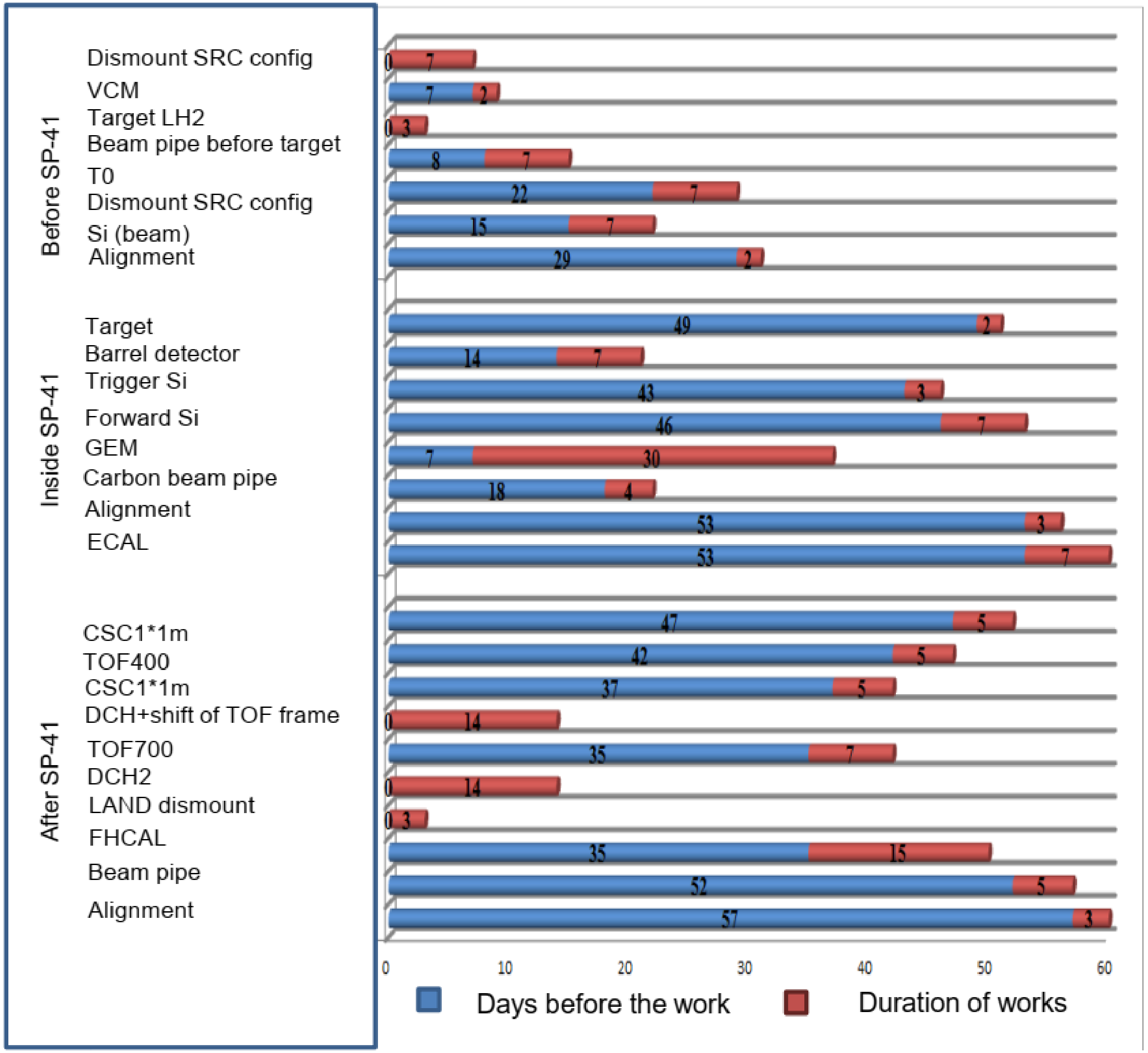


Online monitoring of HV, LV and gas status for ToF-400 & ToF-700

Transition from SRC to BM@N setup







S.Piyadin

Back-up slides

Beam tracker radiation hardness FAQ

1. Radiation damage caused by δ-electrons and X-rays (damage caused by secondary electrons produced by photons):
   a. Bulk damage can be neglected:
      i. electrons energy should be > 200 keV to produce Si atom displacement;
      ii. NIELs for the electrons energy range from 200 keV to 10 GeV are $2.5*10^{-6}$ to $1.34*10^{-4}$ $MeV*cm^{2}*g^{-1}$ (15 times lower than 1 MeV neutron);
   b. Surface damage:
      i. SiO_2 layer is placed between strips and near a guard ring region. δ-electrons and X-rays irradiation will cause an increase of the total oxide charge $+N_{ox}$ in SiO_2 layer, which leads to an increase of the surface current I_{sur}. To compensate this effect the inner guard ring (GR_1) is biased to the same potential as of the detector strips.

1. Radiation damage caused by ions:
   a. The main macro effects of bulk damage by ions are the dark current and full depleted voltage increasing (expected values are shown on previous slides without self-annealing effects) these lead to:
      i. Detector ENC increasing. Due to the high particle signals it can be neglected;
      ii. Power dissipation increasing. To compensate this effect the 175 μm detector thickness was chosen and the detector is placed on PCB thermal pads to effectively heat sink.