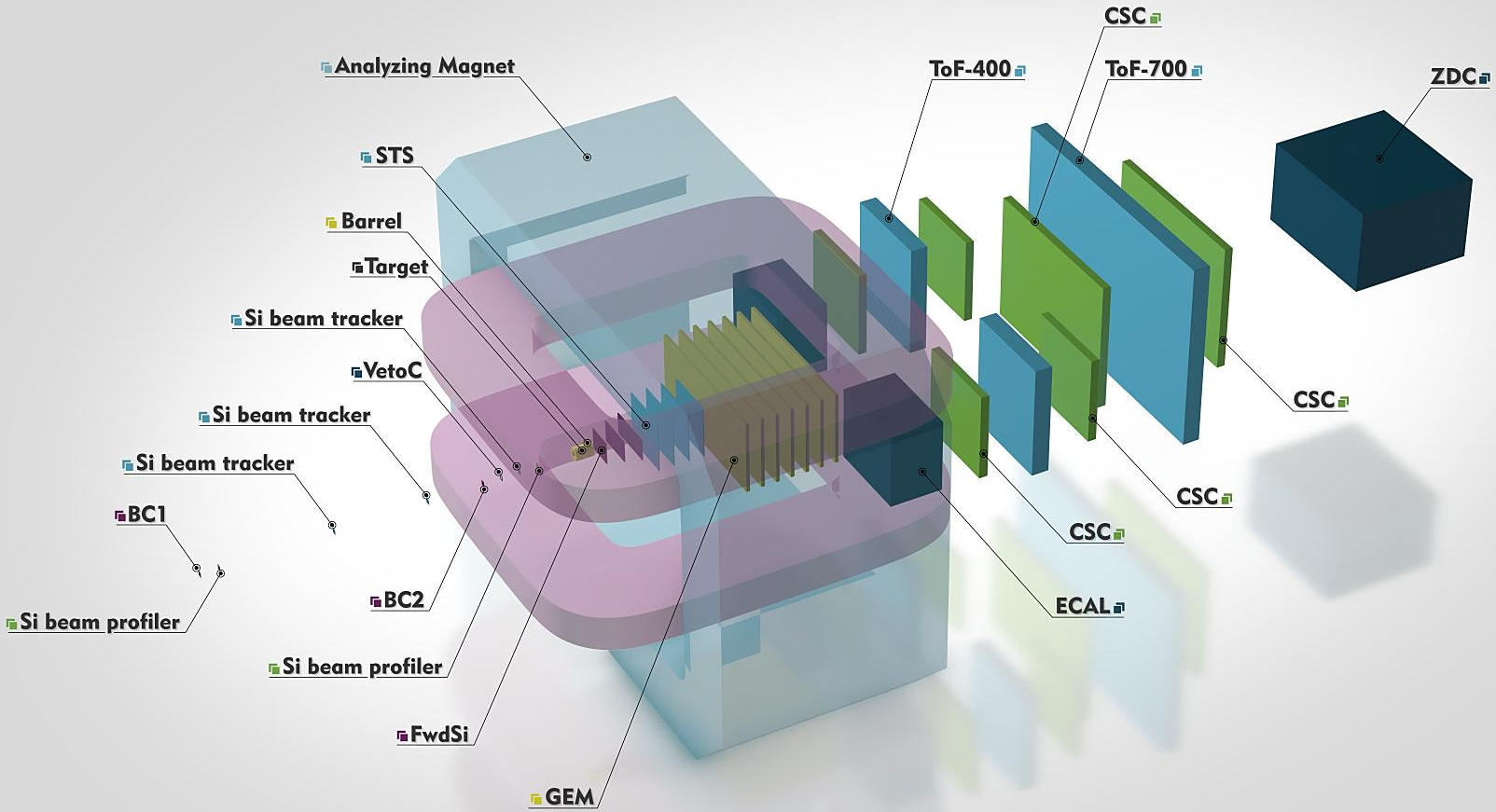
Status and upgrade of the BM@N detectors

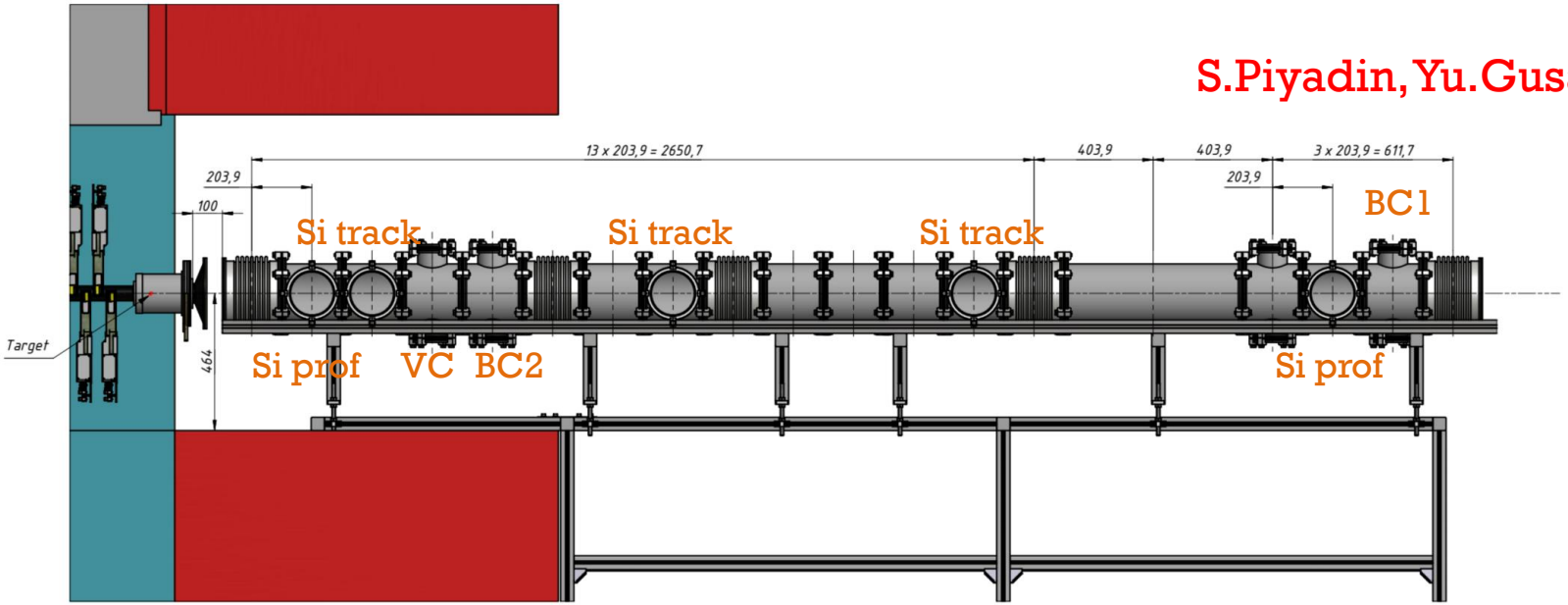
A.Maksymchuk

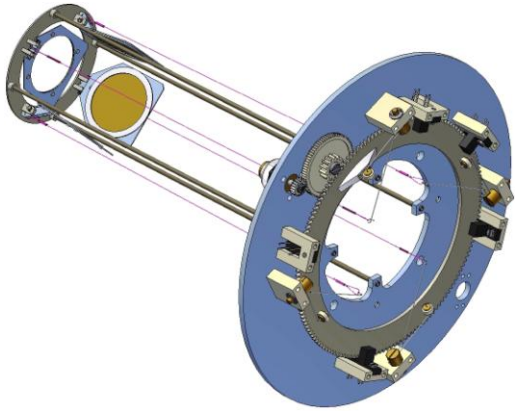
BM@N Experimental Setup



Beam pipe before the target, target station

S.Piyadin, Yu.Gusakov





Target station:

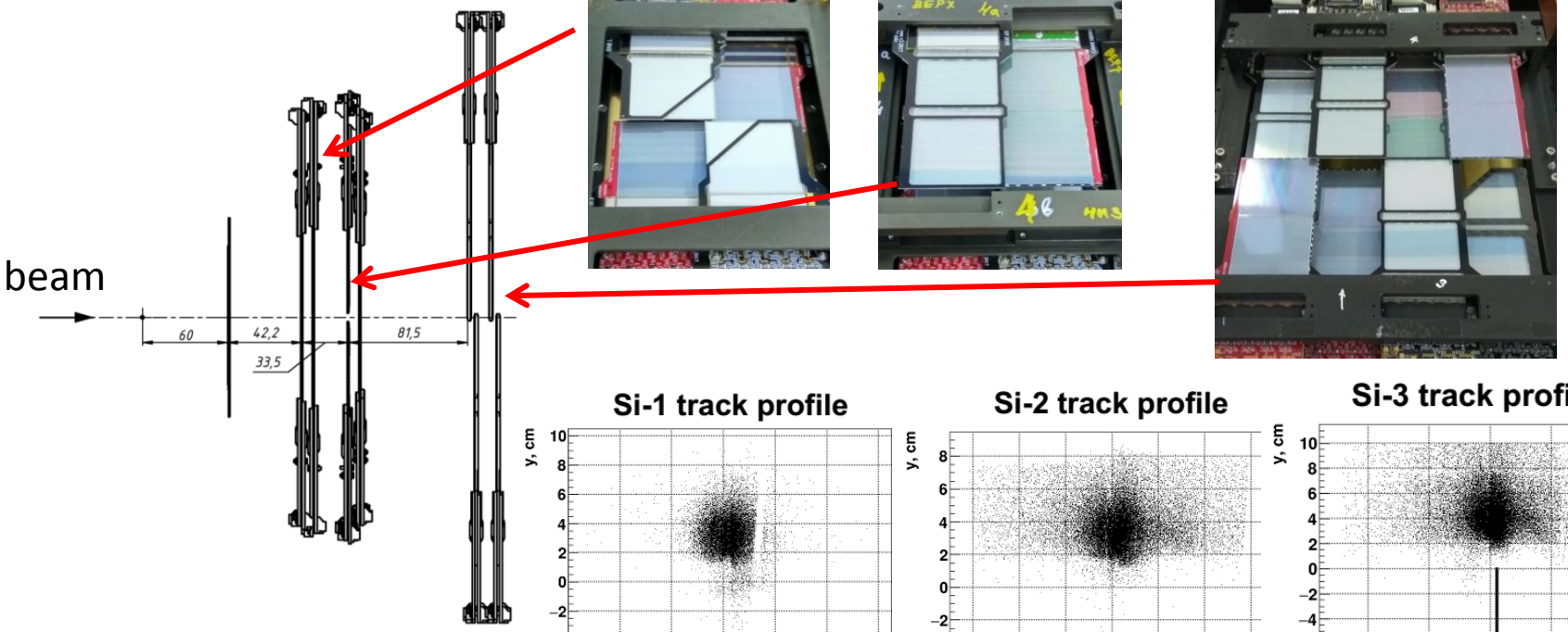
Three different target types with d = 30mm and 1 empty target are foreseen for data taking and background evaluation;

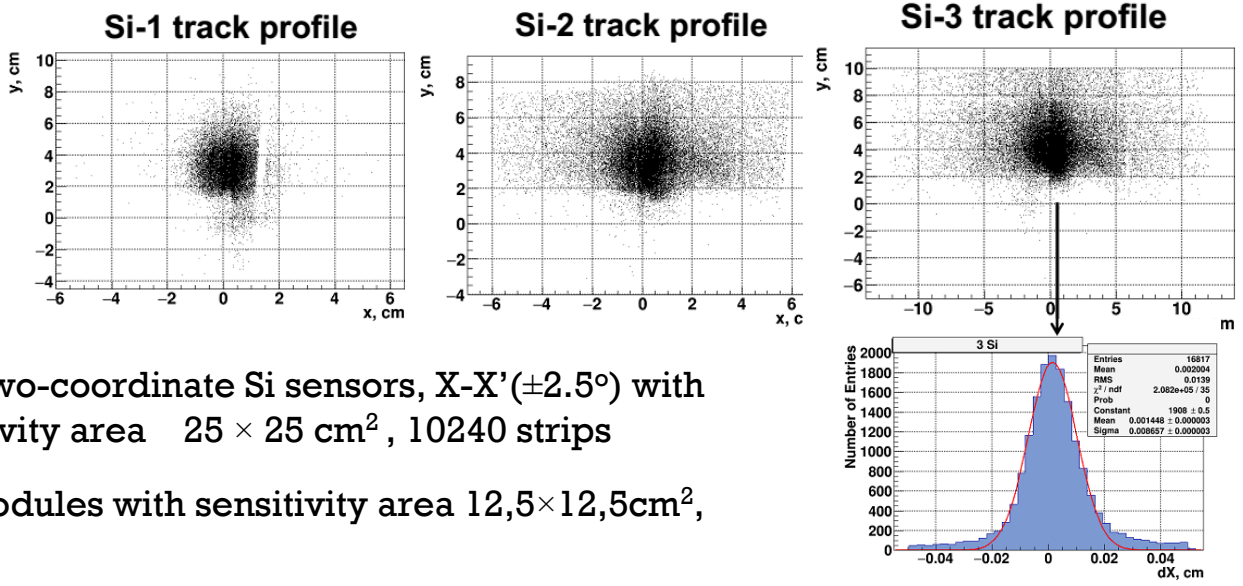
Operational in vacuum and magnetic field.

See talk of S.SEDYKH

Forward Si tracking detectors performance at Ar and Kr beams (March 2018)

group of N.Zamiatin

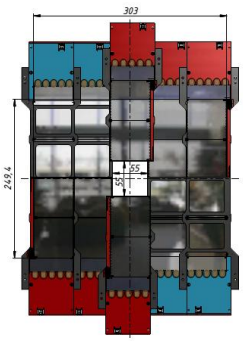


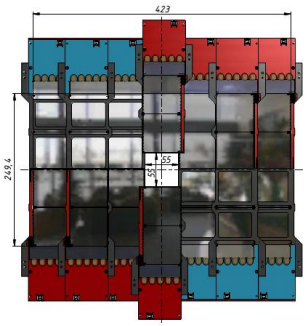


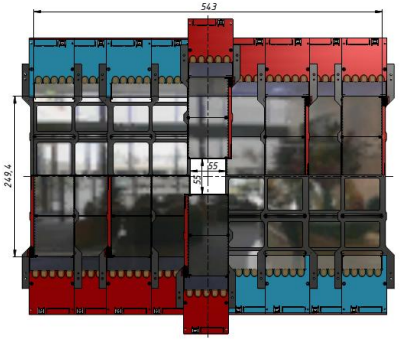
Si-3 detector residual vs GEM+Si track ~ 86 μm

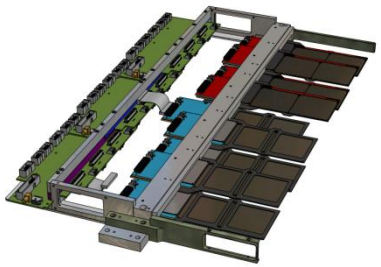
- Si-Forward plane consists of two-coordinate Si sensors, X-X'(±2.5°) with strip pitch of 95/103 μm, sensitivity area 25 × 25 cm^2 , 10240 strips
- Vertex plane-1 consists of 4 modules with sensitivity area 12,5×12,5cm^2, 5120 strips
- Vertex plane-2 consists of 2 modules with sensitivity area 12,5×12,5cm^2, 2560 strips

Upgrade of the forward Si tracking detectors

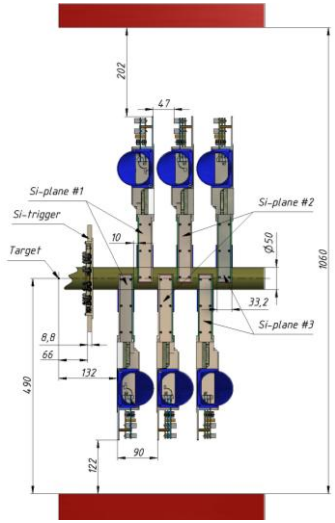


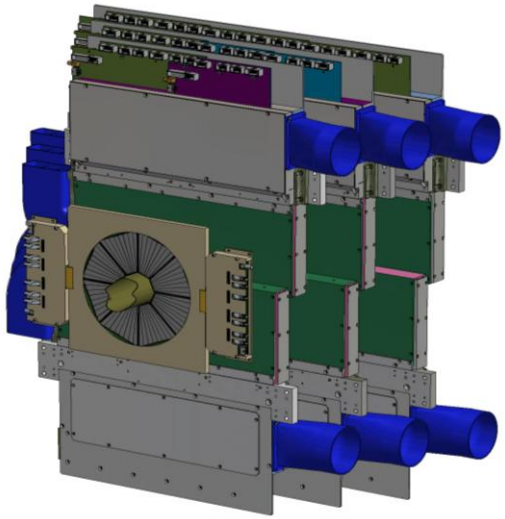






Three sizes of Si-planes





Design of the Si-planes on the BM@N beam-channel

Station#	Number of DSSD modules	DSSD station square	Number of Readout channels
Station1	10	720 cm^2	12800
Station2	14	1008 cm^2	17920
Station3	18	1296 cm^2	23040
Total	***42***	***~0.3 m^2***	***53760***

Readout ASIC VATAGP7.1.
Number of sensitive pre-amplifier (CSA) inputs - 128
Input charges (dynamic range) - -30fC ÷ +30fC
Peaking time (slow shaper) - 500ns (typ.)
Good linearity for charges up to +/- 15fC
Reading clock - 4,6MHz

Plans:
06.2019 - ASIC VATAGP7.1 delivery
02.2020 – integration of the Si forward tracking detectors into BM@N setup

Tentative Design of the BM@N STS

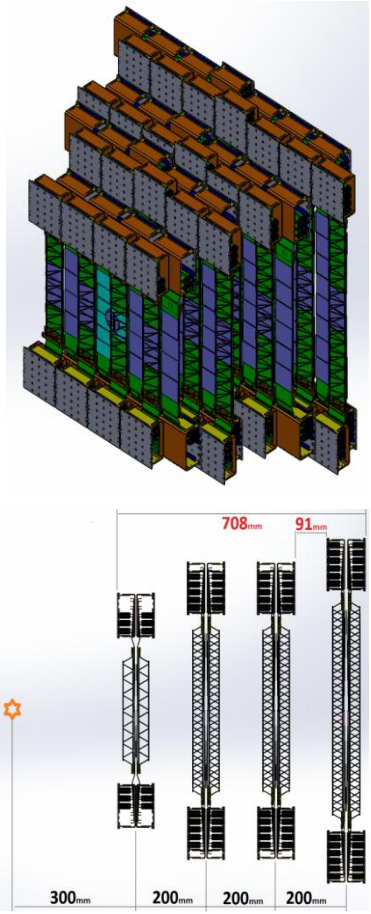
Preliminary layout of BM@N STS was developed.

Geometry was tested in simulations in CbmRoot (E. Lavrik) and BmnRoot (S. Mertz)

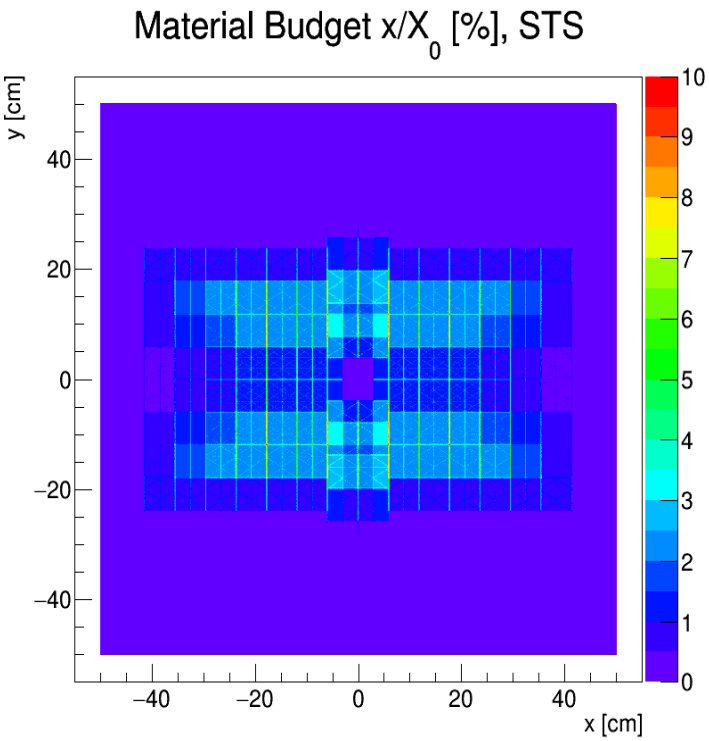
Recent progress in simulation --> talk of A.Zinchenko

Four stations are based on CBM-type modules with double-sided microstrip silicon sensors:

- Pitch 58μ
- Stereo angle 7.5°
- Thickness 300μ
- Sizes: 62x62, 62x42, 62x22 mm²
- Produced by two vendors: CiS (Germany) & Hamamatsu (Japan)



Tentative design of BM@N STS stations



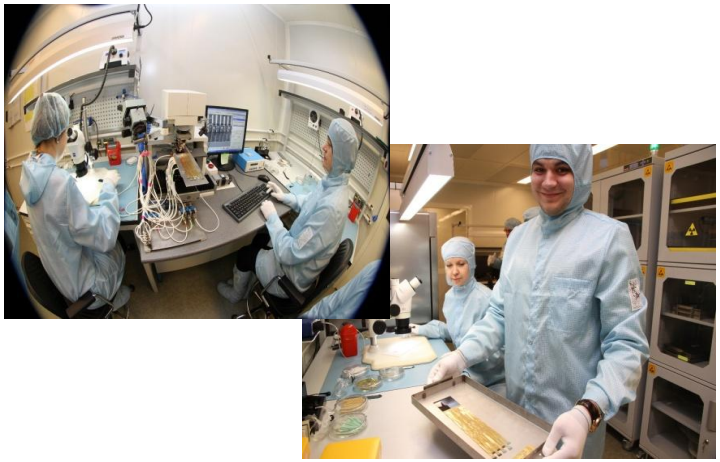
Total material budget (by E. Lavrik)

Number of modules: 292
Number of channels: ~600k
Power consumption: ~15 kW

Plans:
2021 – first 42 modules integration into BM@N;
2022 – BM@N STS full configuration (292 modules)

See talk of D. DEMENTYEV

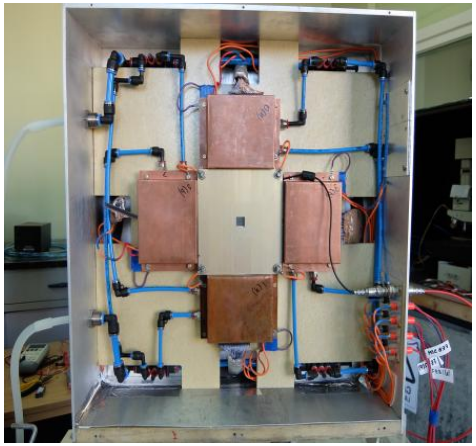
Assembling of BM@N STS modules at JINR

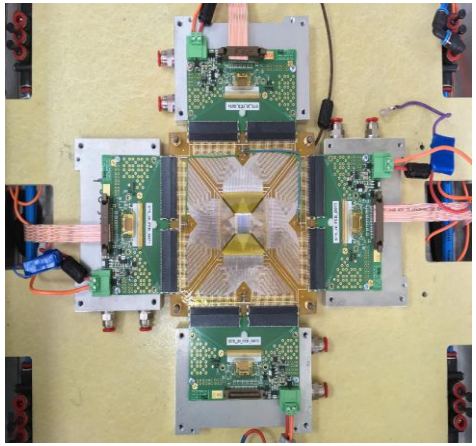


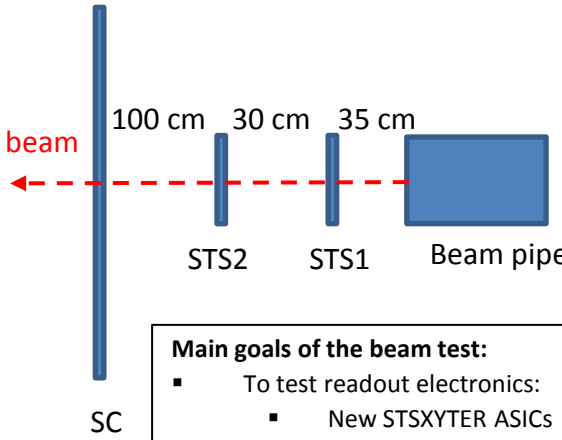
- **Two clean rooms are already equipped for the module assembly**
- **Full set of jigs was developed, produced and tested on mockups**
- **QA procedure for all steps of assembling was developed**
- **Two technicians and two engineers are currently fully involved into assembling of BM@N modules**
- **First operable module was assembled and now is under tests**

Assembling of the mockups of BM@N STS modules

Beam test of the STS modules at LINAC-200







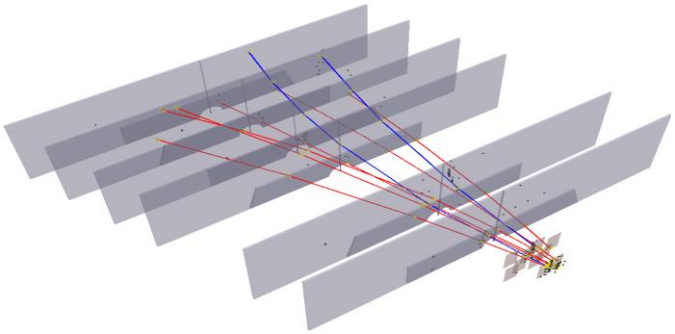
STS1,2 – Test stations with double-sided microstrip silicon sensors 15*15 mm²
SC – scintillator counter 200*200 mm²

Main goals of the beam test:

- To test readout electronics:
  - New STSXYTER ASICs
  - TS system
  - DAQ System
- Data collection in two modes:
  Free streaming and with a time reference to the trigger signal

GEM central tracking system performance at Ar and Kr beams (March 2018)

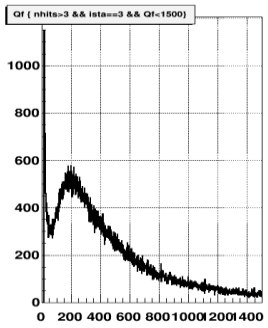
GEM group



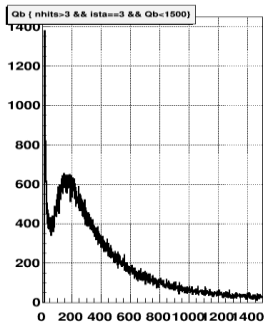
Example of the event reconstruction in the central tracker in Ar+Al interaction

Seven GEM 1632x450 mm^2 chambers produced at CERN workshop were integrated into BM@N experimental setup.

Pile-up suppression in Ar, Kr runs: 3 μs before and 0.5 μs after trigger signal

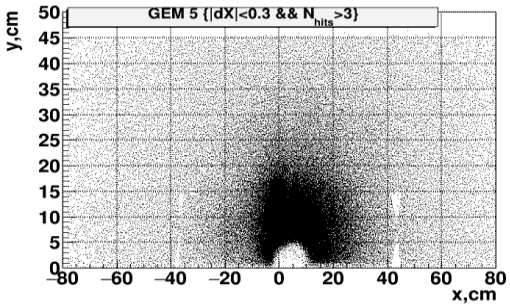


Amplitude, ADC counts

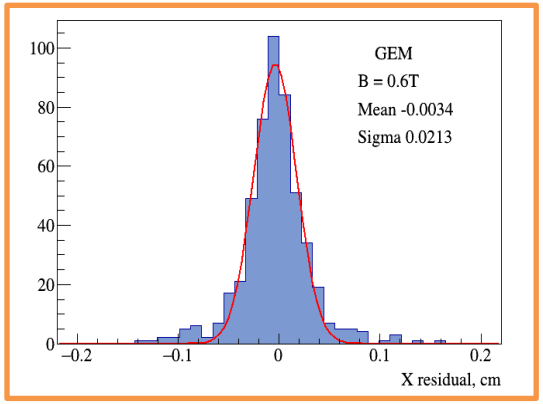


Amplitude, ADC counts

GEM X&Y amplitude distributions

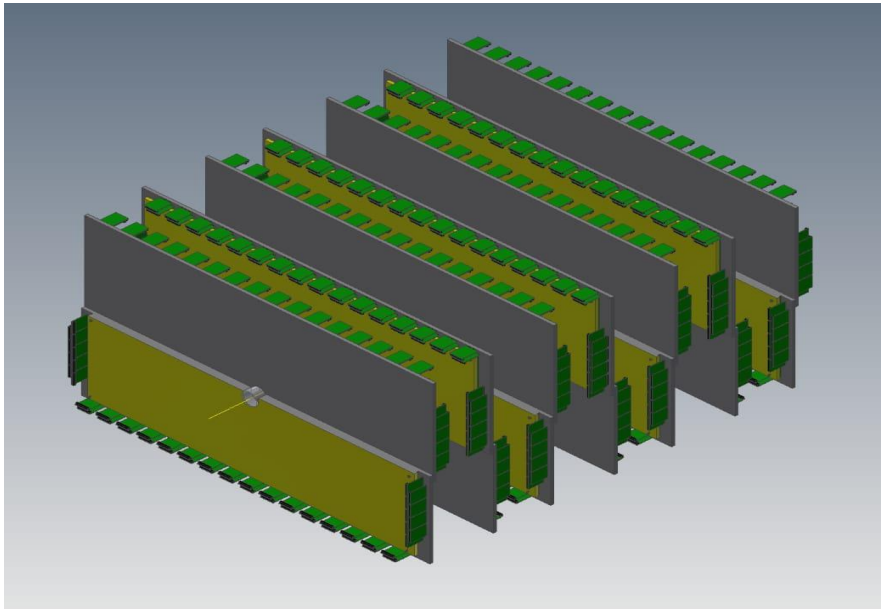


Fragments of Ar beam in one of the GEM chambers



Magnetic field 0.6 T,
Ar(80)/Isobutane(20),
Ar beam, Edrift = 1.5kV/cm

Scheme of the GEM full planes configuration inside the magnet



First half of the 2019 – development of the mechanics for GEM planes precise installation inside the magnet.

End of the 2019 – mechanics production, installation of the GEM planes.

Upgrade plans:

- First half of the 2019 year - production of 6 GEM chambers of size 1632 mm × 390 mm to cover full vertical acceptance of analyzing magnet

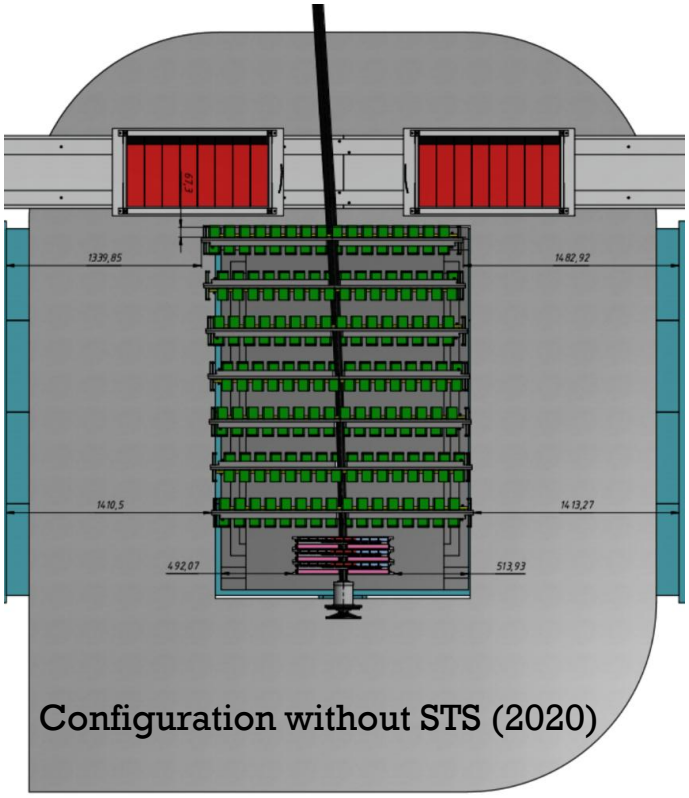
- End of the 2019 – integration of the full GEM planes into the experimental setup (electronics based on the VA-163 chips, ~90000 readout channels)

- Development and tests of FEE based on VMM3 and STSXYTER ASICs.

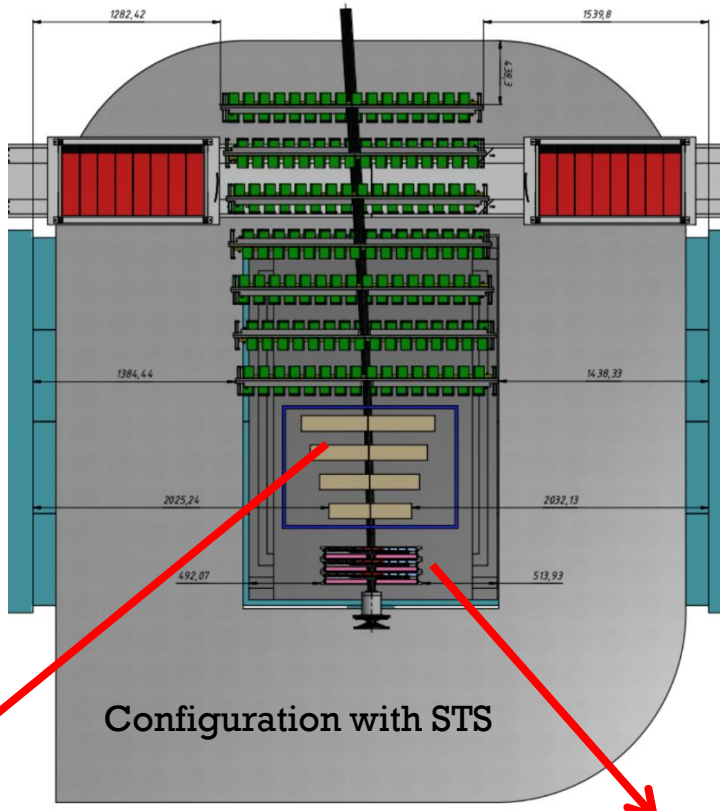
Forward Si+ STS +Gem configuration

Four configurations of the tracking detectors are foreseen:

- Forward Si + 7 GEMs: beam intensity few 10^5 Hz , 2020 - 2021
- Forward Si + 1 pilot STS station + 7 GEMs: beam intensity few 10^5 Hz , 2021
- Forward Si + 4 STS stations + 7 GEMs: beam intensity few 10^5 Hz, 2022
- 4 STS stations + 7 GEMs (fast FEE): high beam intensity few 10^6 Hz, 2022-



Configuration without STS (2020)



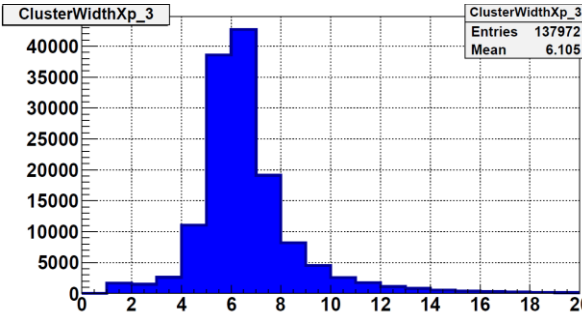
Configuration with STS

2021 year – "pilot" configuration
2022 year – full configuration

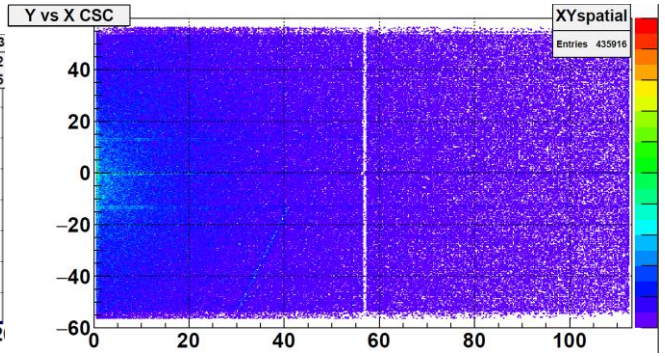
Forward Si will be removed after integration of STS full configuration into BM@N setup (2022 year, high beam intensity - few 10^6 Hz)

Performance of 1065x1065 mm^2 CSC chamber in Ar, Kr runs

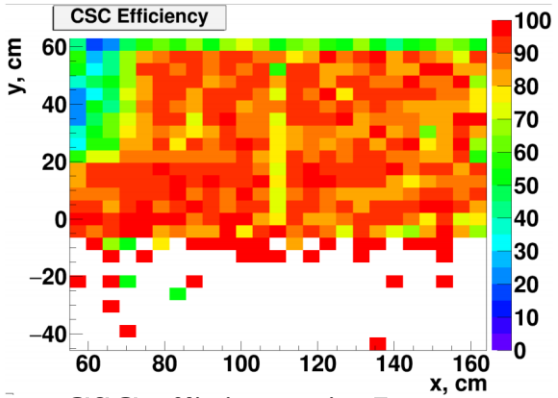
C, Ar and Kr runs in March 2018: CSC chamber is installed in front of ToF-400 to check its performance as outer tracker for heavy ions



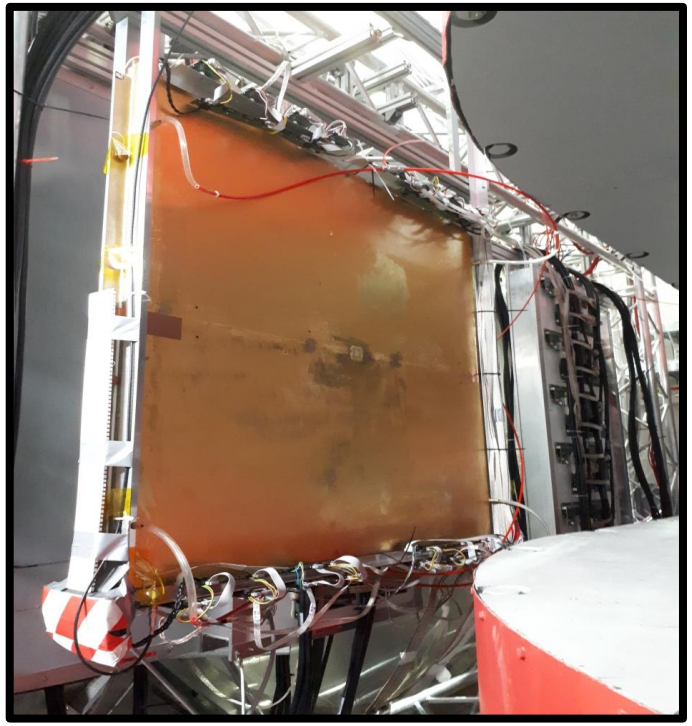
Cluster width

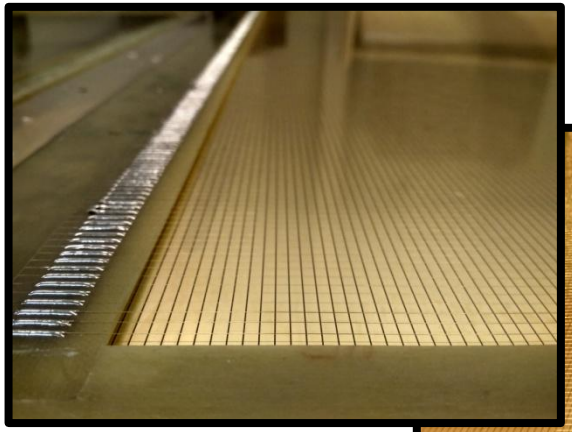


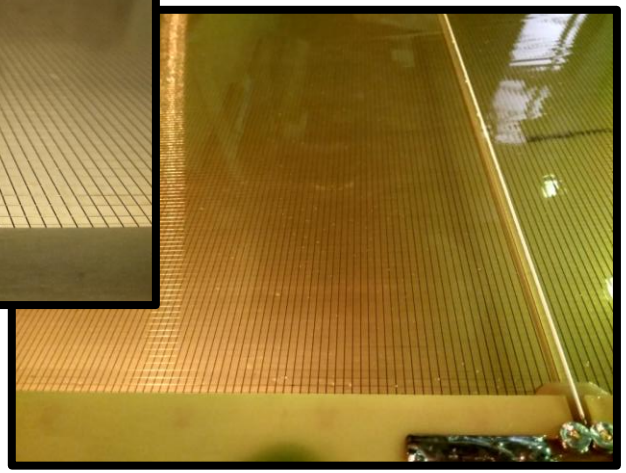
Events distribution on the chamber surface in Kr run



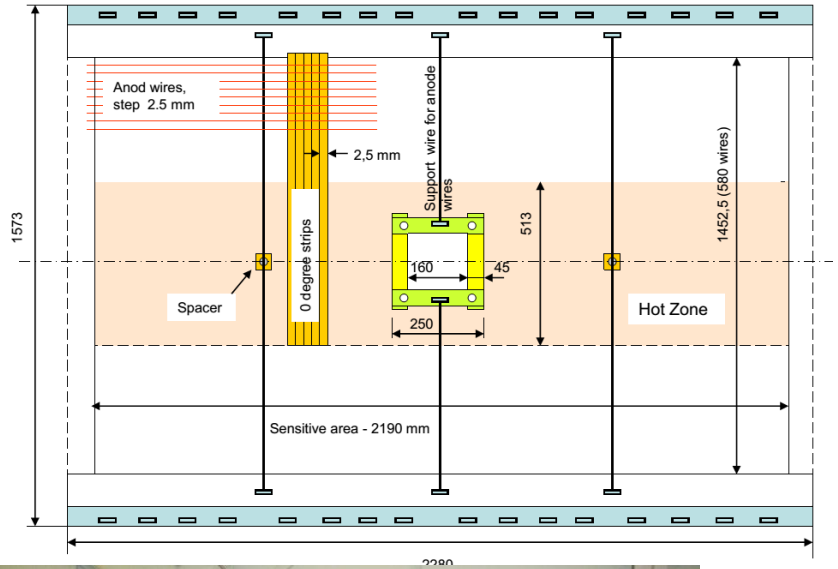
CSC efficiency in Ar run
Track extrapolated from GEM
Residual (CSC_hit – GEM) < 2cm







Schematic view of 2190x1453 mm^2 CSC



CSC group

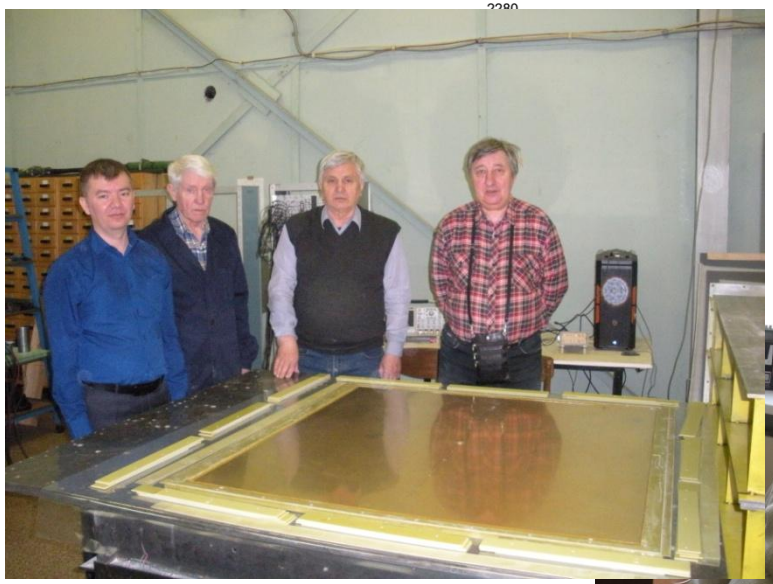
Two cathode planes with strips inclined at 0° and 15°

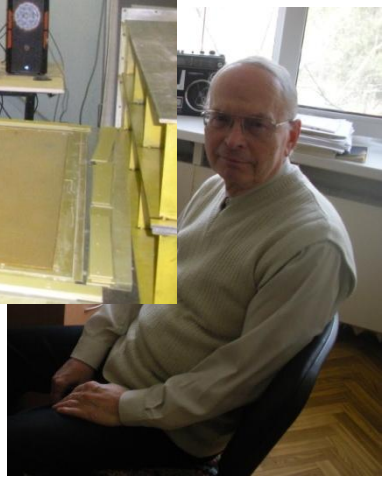
Each cathode plane consists of 8 printed circuit boards.

Each pcb is divided on hot and cold zones.

Two 2190x1453 mm^2 CSC chambers are to be installed before and after ToF-700

Design and assembly – JINR LHEP





CSC assembly team

Production plans:

- 07.2019: production of three 1065x1065 mm^2 chambers and design of the cathode planes for 2190x1453 mm^2 CSC chambers

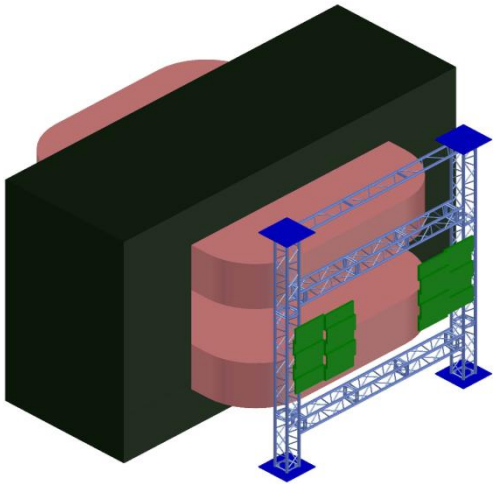
-10.2019 – production of the cathode planes for 2190x1453 mm^2 CSC chambers

- 02.2020 – Assembly of the first 2190x1453 mm^2 CSC

- 05.2020 - Assembly of the second 2190x1453 mm^2 CSC

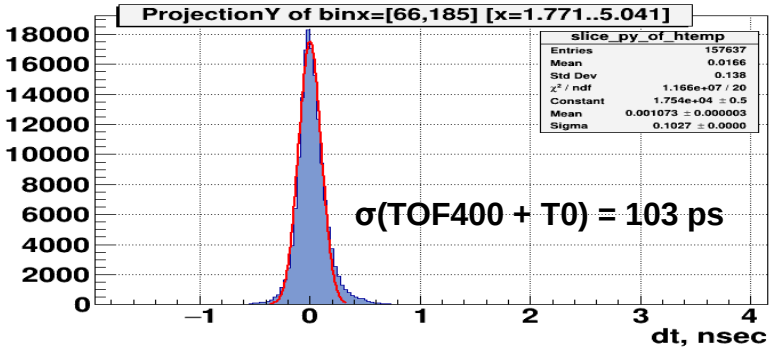
- 12.2020 – All chambers are integrated into the BM@N experimental setup

Status ToF-400

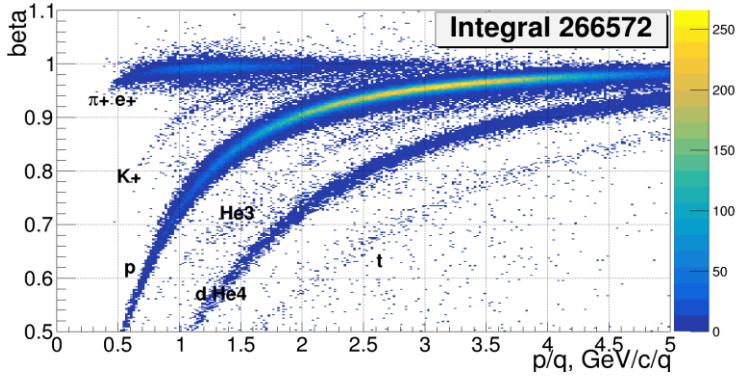


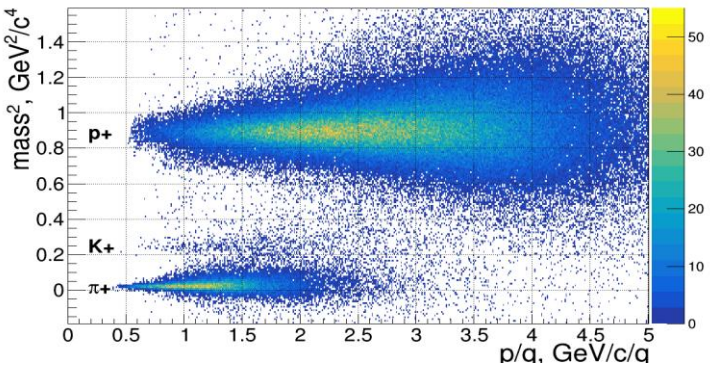
# Detectors	20
# Strips (300*10 mm^2)	960
# FEE	1920
Area total	~3,36 m^2

ToF-400
+ V.Plotnikov



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



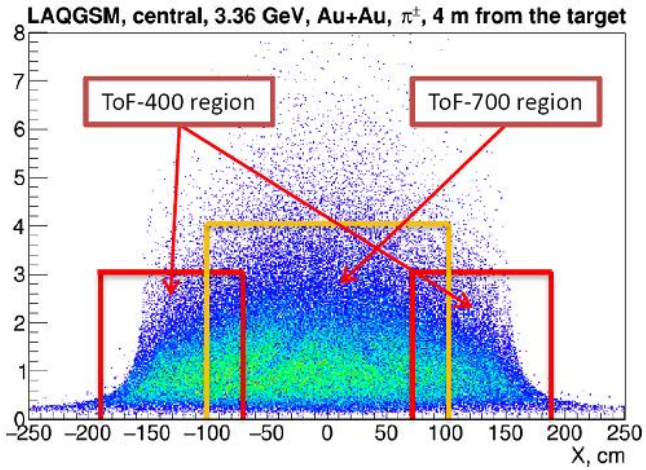


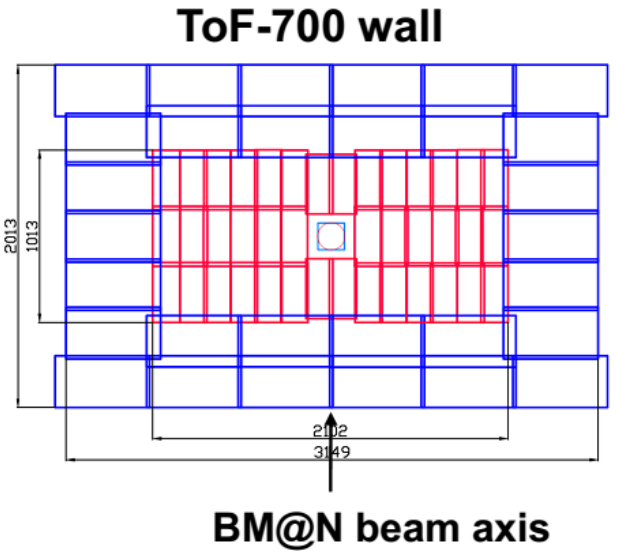
Proton Mass^2 = 0,894 +- 0,081 GeV^2/c^4, Pion Mass^2 = 0,021 +- 0,016 GeV^2/c^4

See talk of V.Plotnikov

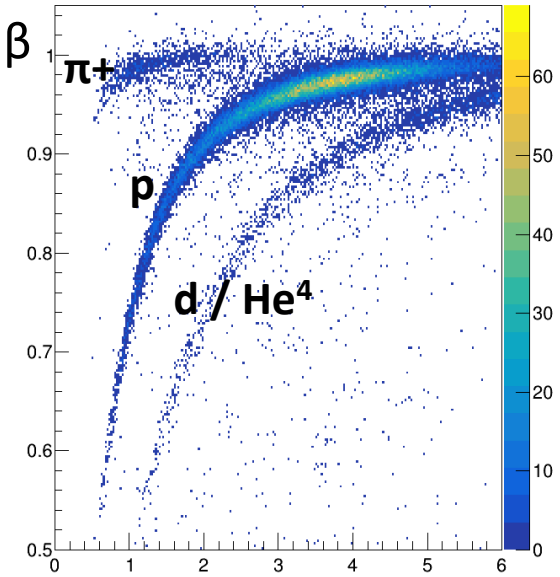
Status ToF-700

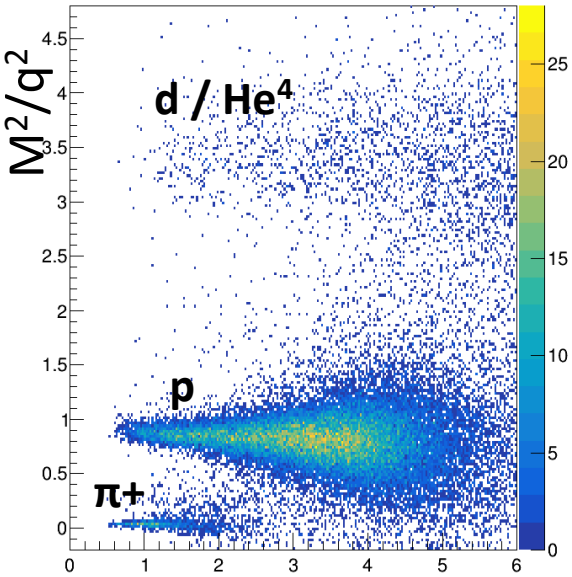
Yu.Petukhov, L.Kovachev

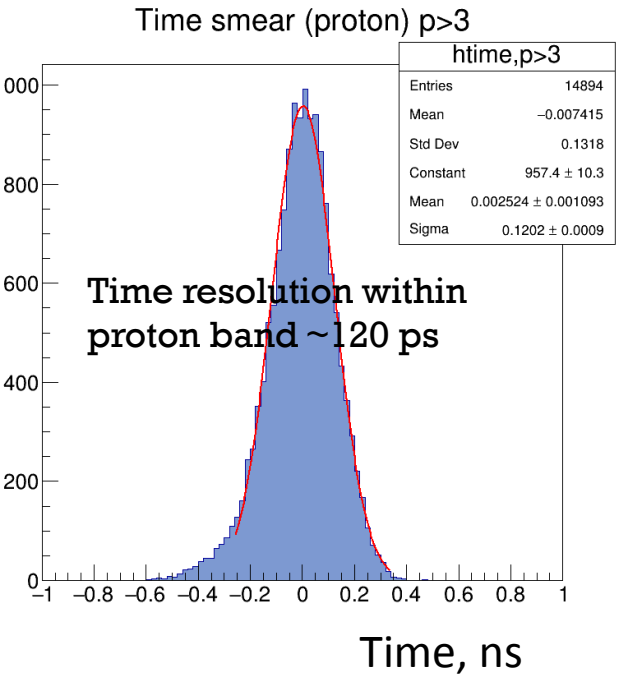




Ar beam , 3.2 AGeV , Ar + Al,Cu → X

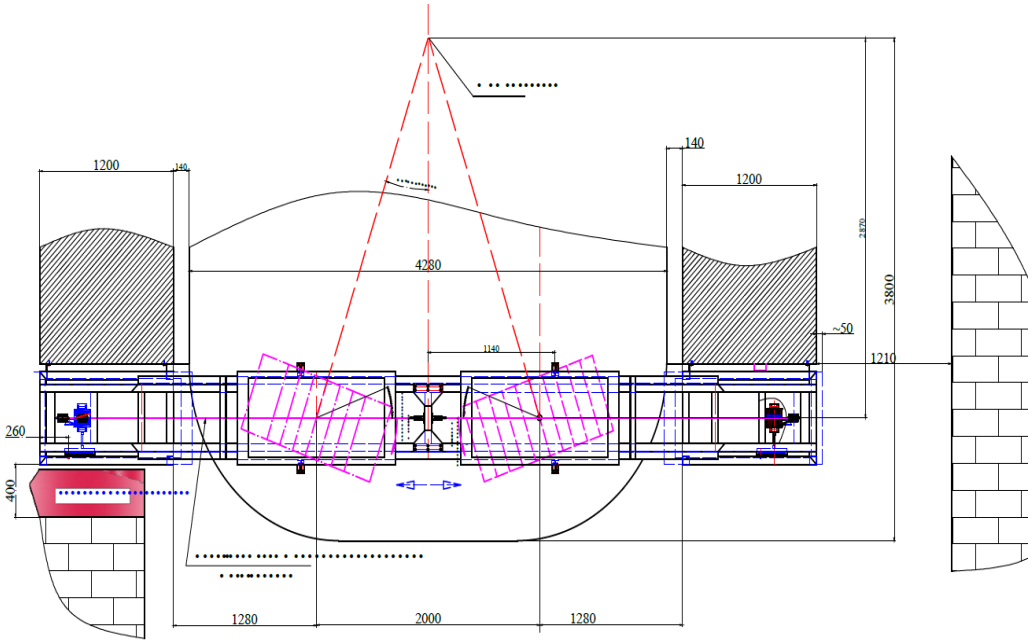






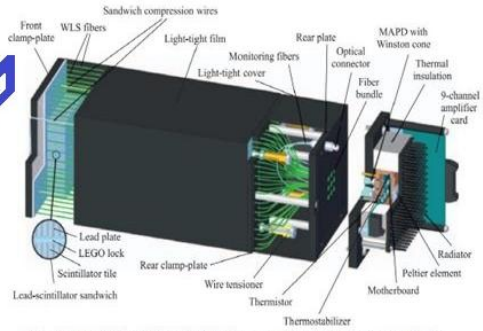
ECAL upgrade status

ECAL group



Position of the two ECAL arms

Veto system



Design of the Shashlyk type calorimeter module

Prototype of the veto-module (9 cells)

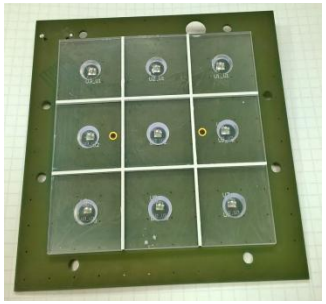
Plans for 2019:

- To perform the assembly of the two ECAL arms in the magnet

- To develop and test a veto detector for ECAL

Printed circuit board (PCB) with mounted sensors.

PCB is combined with the scintillator. The scintillator is divided into 9 cells.



ZDC Status

group of INR RAS Troitsk

To be replaced

35 FHCAL MPD modules
(16_BM@N+19_MPD)

20 PSD CBM modules

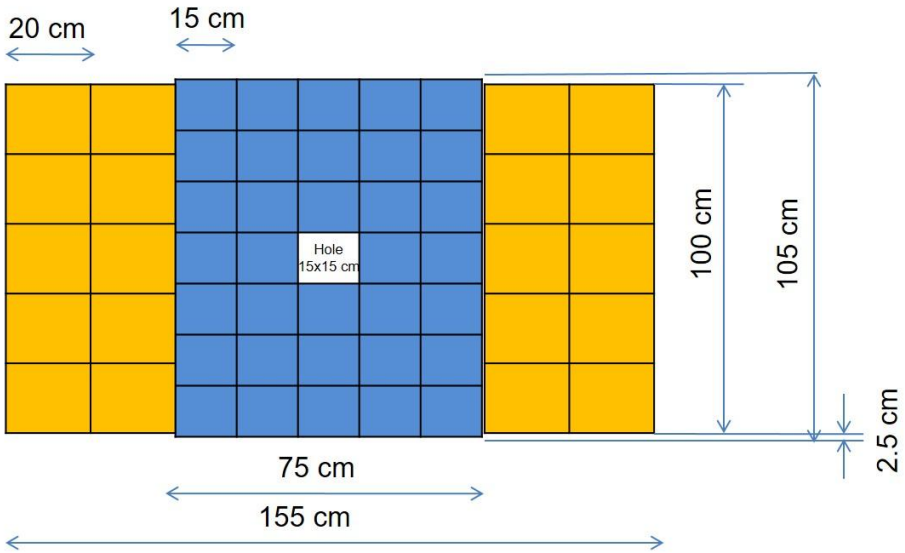
04.2019 - Transportation of CBM modules (20 pcs), FHCAL BM@N modules (16 pcs) and FHCal MPD modules (19 pcs) from INR at JINR was performed.

Plans:

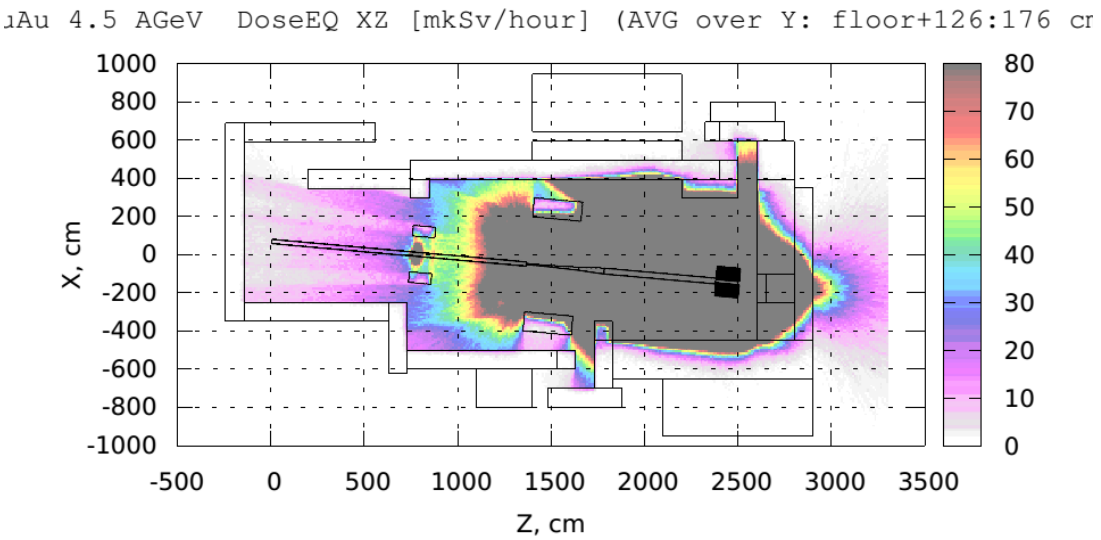
05.2019 – Assembly of FHCAL at JINR

See talk of S.Morozov

54 modules:
Yellow – CBM modules – 20x20 cm, 10 sections – 20 modules - 10 T
Blue – MPD modules – 15x15 cm, 7 sections - 34 modules - 6.8 T

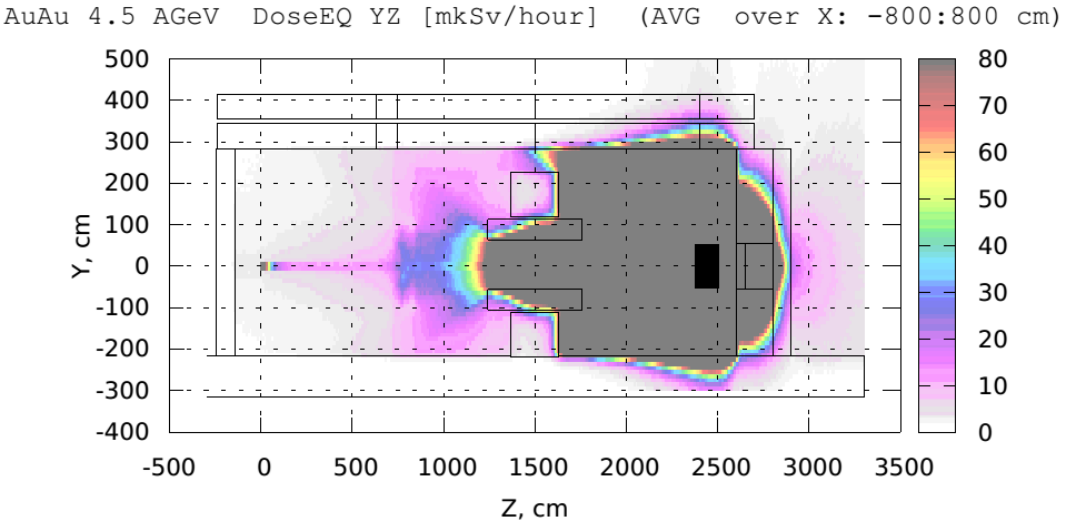


Biological Protection Calculation for Au+Au interactions



XZ projection

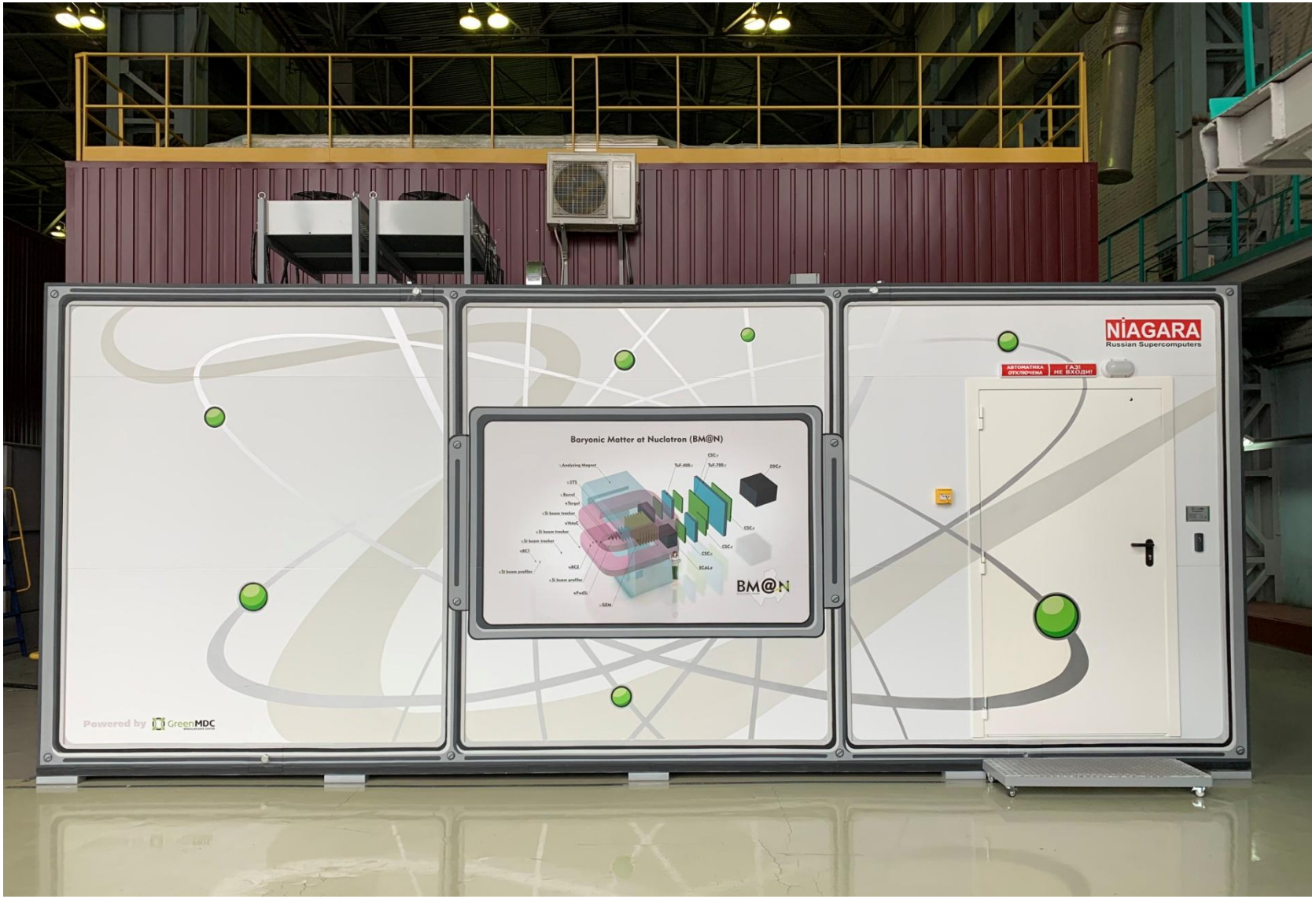
FLUKA calculations of E.Litvinenko



YZ projection

Additional protection to be built before heavy ion beams are delivered to the BM@N experimental setup

MDC(Mobile data storage and DAQ center) was installed at 205 bld.



Summary:

Detector Subsystem	Status	Upgrade Status
Beam pipe before the target, target station		end of 2019
Forward Si detectors	3 small planes	3 full-size planes (02.2020)
STS BM@N		42 modules (2021) 292 modules (2022)
GEM	7 top half-planes + 1 bottom half-plane	7 full planes (2019)
CSC	1 chamber 1065x1065 mm^2	4 chambers 1065x1065 mm^2(2019) 2 chambers 2190x1453 mm^2(2020-21)
ECAL	one arm	two arms (2019)
ToF-400	full configuration	
ToF-700	full configuration	
ZDC	ZDC Pb+Sci sandwitch	ZDC (MPD/CBM type) (2019)