Summary of the detector meeting

Sergey Sedykh for the BM@N

7th Collaboration meeting of the BM@N experiment
April 20, 2021

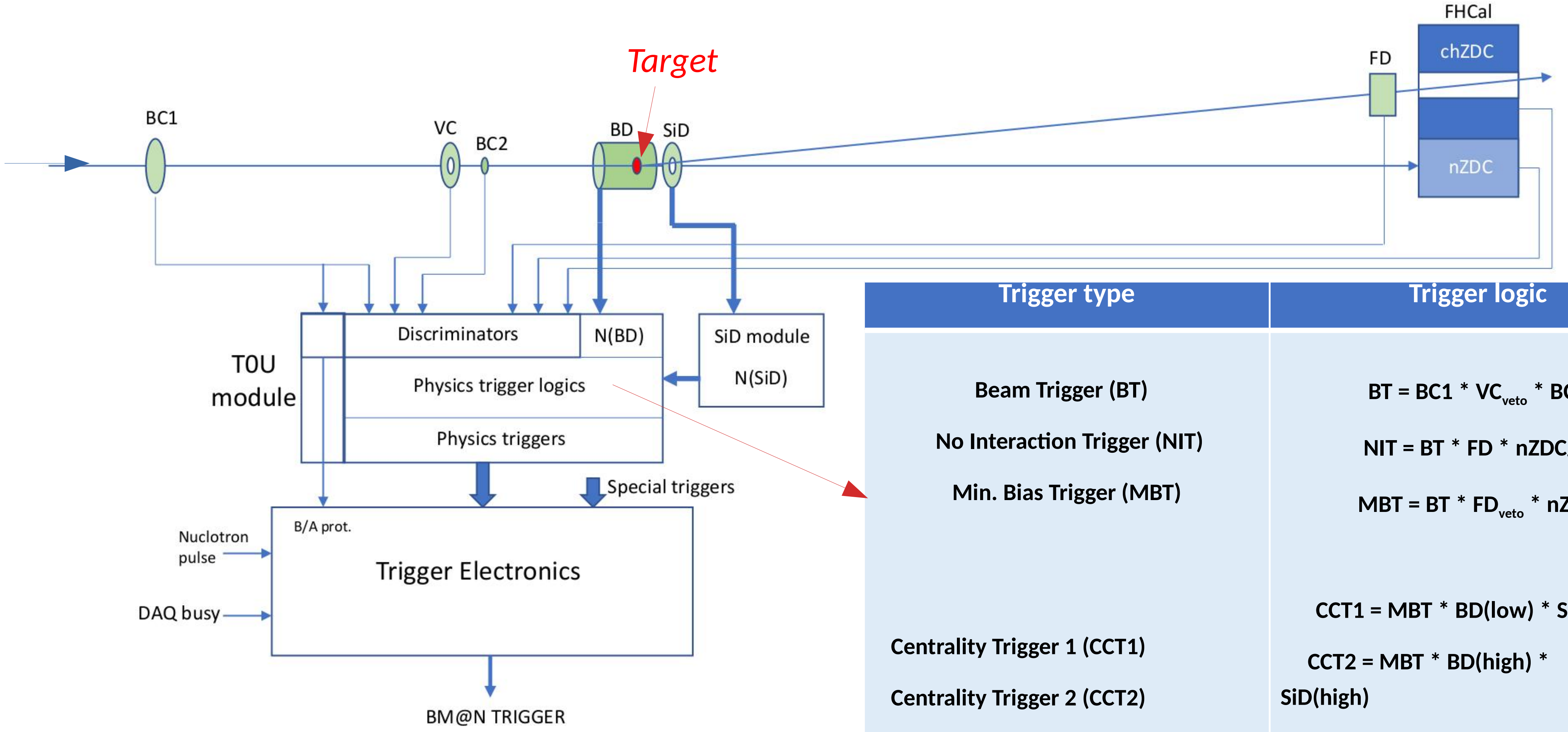
Sergey Sedykh	**Upgrade of the trigger system**
Elena Kulish	**Status of the GEM/CSC tracking systems**
Sergei Afanasiev	**Status of the ECAL**
Sergey Morozov	**Status of FHCal and forward charged fragments hodoscopes**
Aleksandr Kubankin	**Ion beam pipe for BM@N experiment, current status and schedule**
Roman Shindin	**Magnetic field measurements of the SP-41 magnet**
Sergey Nepochatykh	**The impact of materials and frames on trigger protons and recoil fragments**
Timur Atovullaev	**Simulation of magnetic shielding for PMTs next to SP-41 magnet**
Petr Chudoba	**Report on development of the carbon beam pipe for BM@N**

Upgrade of the trigger system

Sergey Sedykh for the BM@N

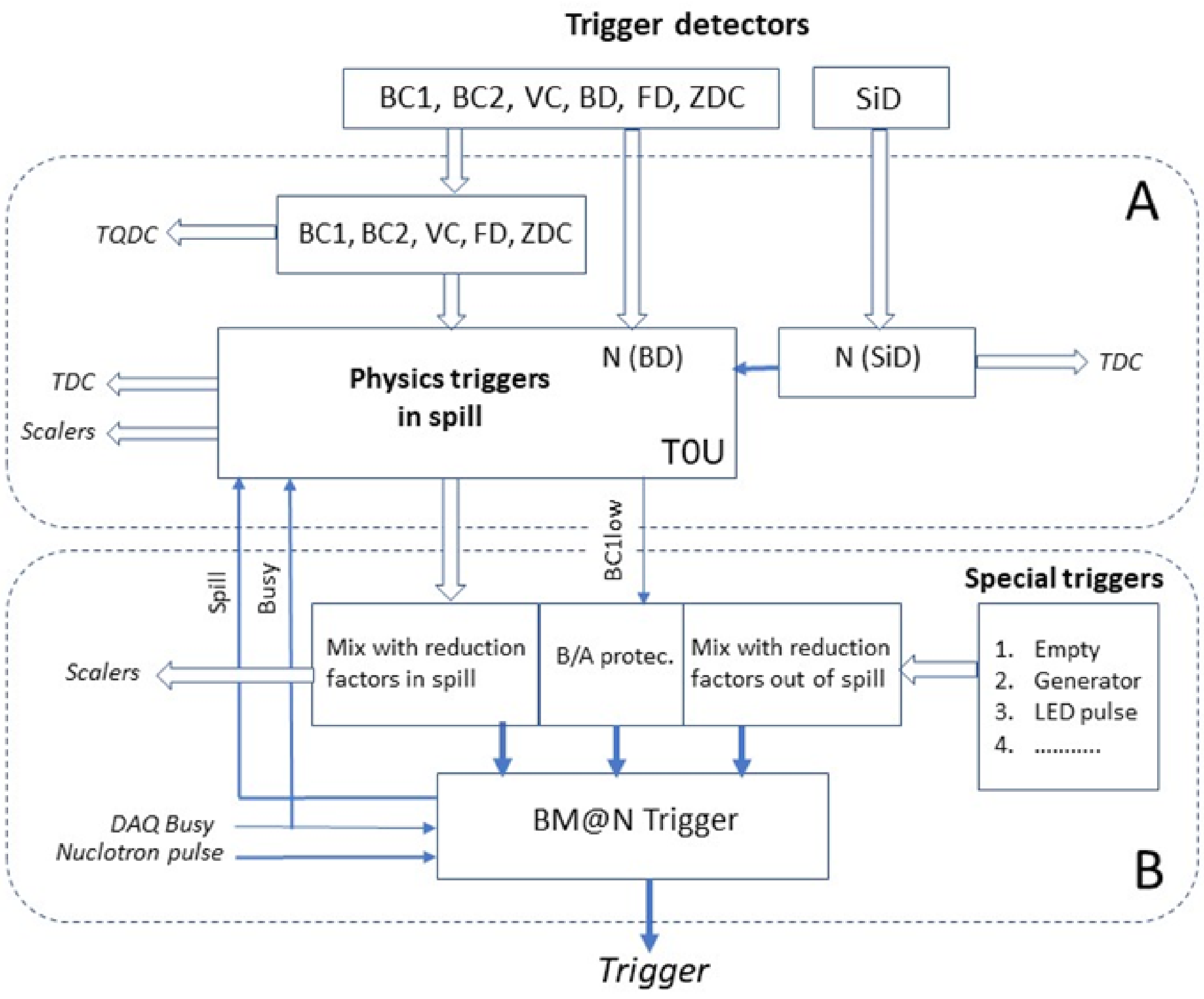
7th Collaboration meeting of the BM@N experiment
April 19, 2021

Overview of the trigger scheme



Trigger type	Trigger logic
Beam Trigger (BT)	BT = BC1 * VC_{veto} * BC2
No Interaction Trigger (NIT)	NIT = BT * FD * $nZDC_{veto}$
Min. Bias Trigger (MBT)	MBT = BT * FD_{veto} * nZDC
Centrality Trigger 1 (CCT1)	CCT1 = MBT * BD(low) * SiD(low)
Centrality Trigger 2 (CCT2)	CCT2 = MBT * BD(high) * SiD(high)

Sub-parts in trigger electronics



Part A
(managed by the trigger group):

generates physics triggers.

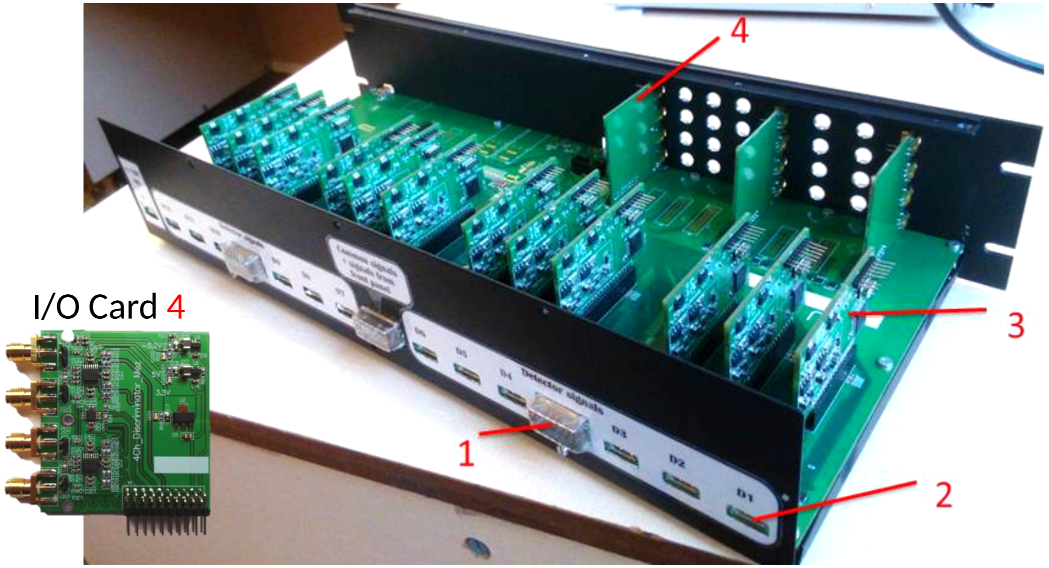
Part B
(managed by the DAQ group):

makes downscaling of
the physics triggers (up to 16 triggers can be provided);

makes Before/After protection;

generates special triggers.

Upgrade of the T0U module



I/O Card 4

T0U Module Functionality:

Implements trigger logic in FPGA;

Recieves or provides I/O analog, NIM, TTL signals via cards 4;

Recieves LVDS signals via HDMI connectors 2;

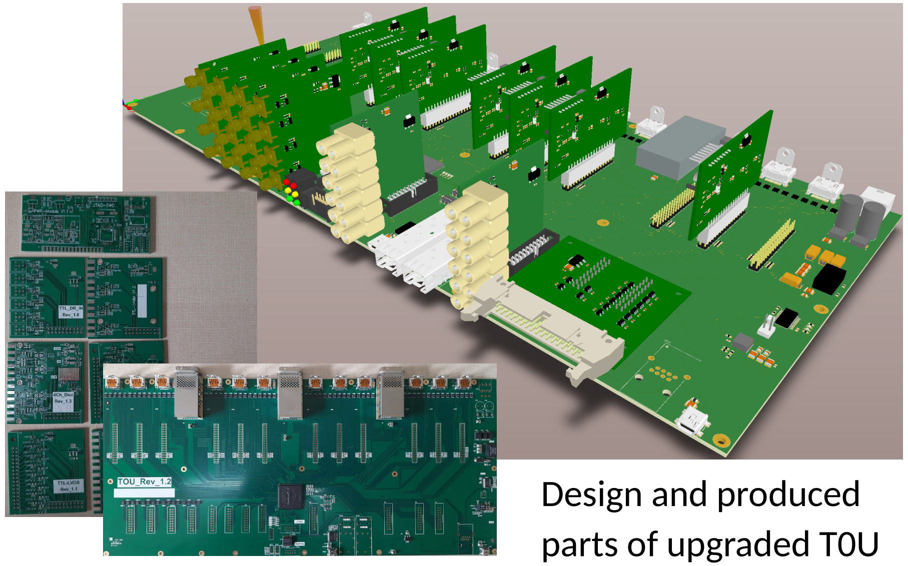
Provides LV to FEE (cards 3, HDMI connectors 2);

Forms input signals to TDC (Molex connectors 1).

Points of upgrade:

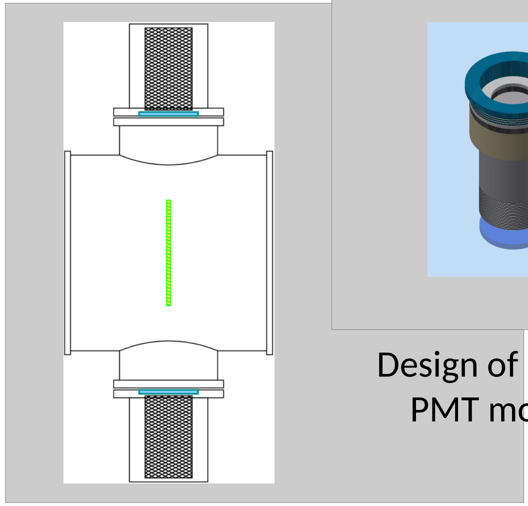
- Improved input boards with discriminators (16 inputs)
- Additional I/O boards TTL (LEMO), up to 16 (old) + 24 (new) channels can be used to provide physics triggers or signals to scalers
- New power converter, capable to drive extended set of I/O cards
- Second USB 2.0 port + 2 optical links

- **Status and plans:**
- All parts are produced and delivered
- Assembly and testing planned for May-July 2021

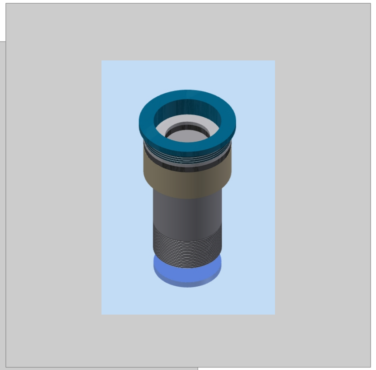


Design and produced parts of upgraded T0U

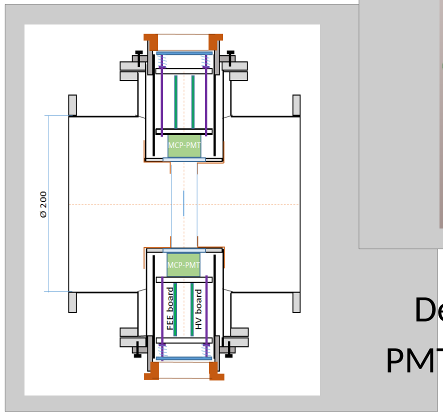
Status of beam counters



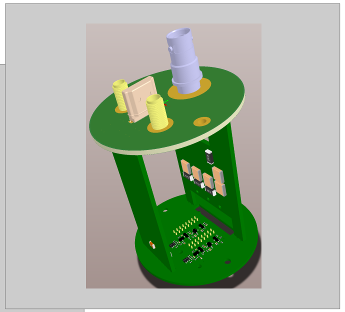
Sketch of vacuum box for BC1 and VC



Design of BC1/VC PMT mount



Sketch of vacuum box for BC2



Design of BC2 PMT base and FEE

BC1 and VC Status and plans:

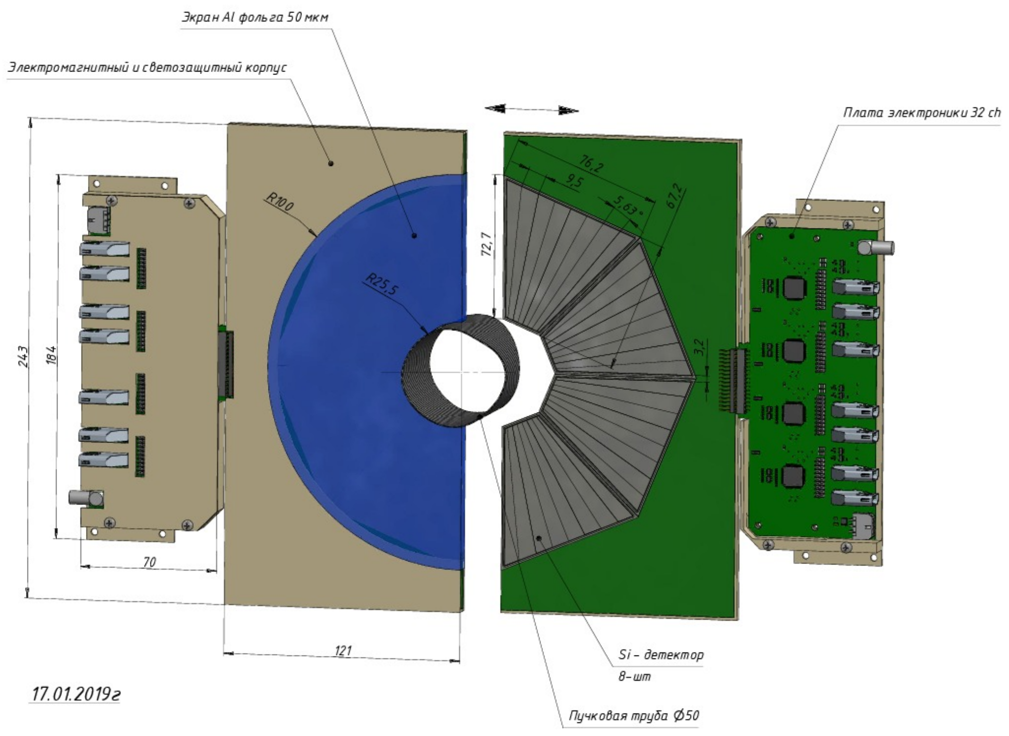
- Vacuum components ready
- PMT Hamamatsu R2490-07 available
- PMT sockets ordered, exp. May 2021
- PMT voltage dividers production, June-July 2021
- Scintillators 100x100x0.25mm^3 (BC1) and Ø100x10mm, hole Ø27mm (VC) available
- Scintillator mount design in progress

BC2 Status and plans:

- Vacuum components ready
- MCP-PMT XPM85112/A1-Q400 (Photonis) available
- PMT base and FEE parts, produced and delivered
- PMT assemby and testing, May-June 2021
- Scintillators BC400B 30x30x0.15mm^3 available
- Scintillator mount design in progress

Upgrade of Si Multiplicity Detector

Group of N.Zamjatin



Detector parameters:

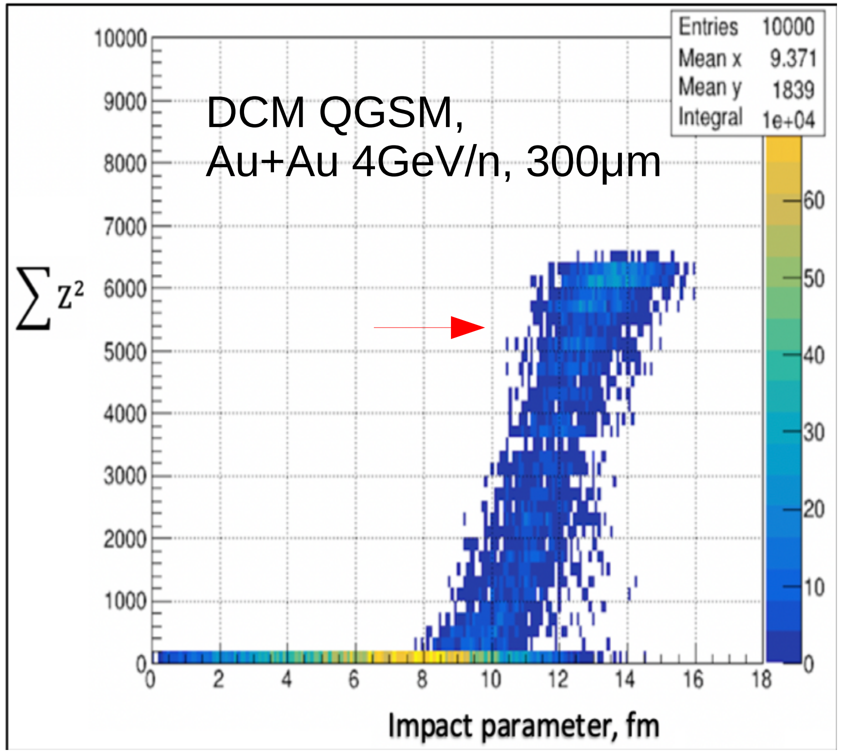
- opening for the beam. Dia. 50 mm
- 8 trapeziodal detectors
- 64 strips in total
- 525 µm thick

Current status

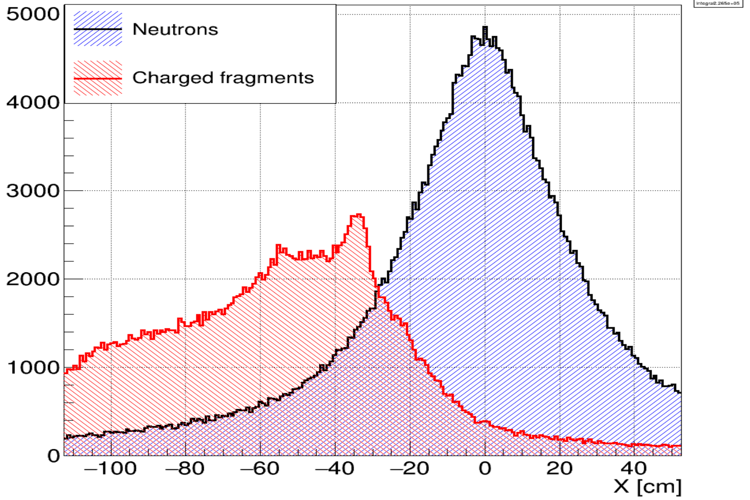
– trapezoidal detectors
  (tested, ready for mount on PCB)
– 2 PCBs (design in progress)
– 2 FEE boards 32 ch each
  (similar to what was used in 2018,
  but not the same, because of higher
  noise level due to larger strips area)
– light and EM shielding
  (design in progress)
– mechanical support
  (design in progress)

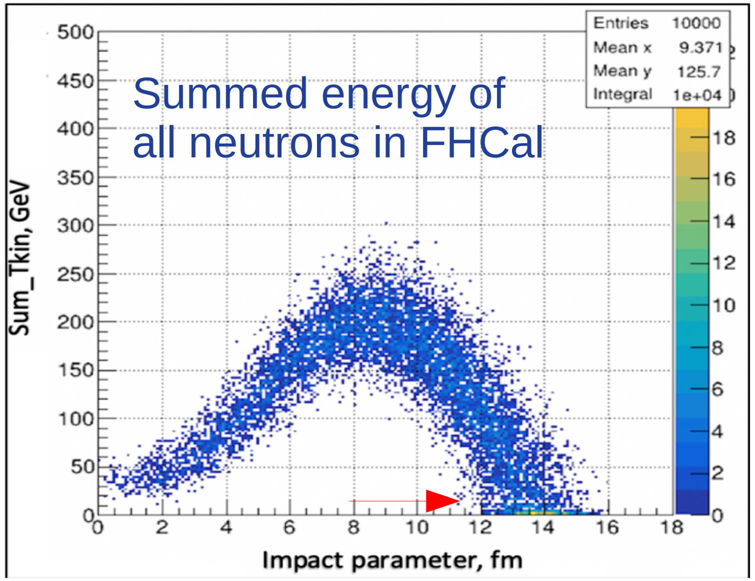
In the trigger scheme the same electronics module as in 2018 will be used for SiD

Triggers from Fragment Detector (FD) and neutron zone of FHCal (nZDC)



X position of hits in FHCal





Currently considered FD:
thin scintillator or quartz plate
viewed by single PMT
(XP2020Q or XP2041 both available)

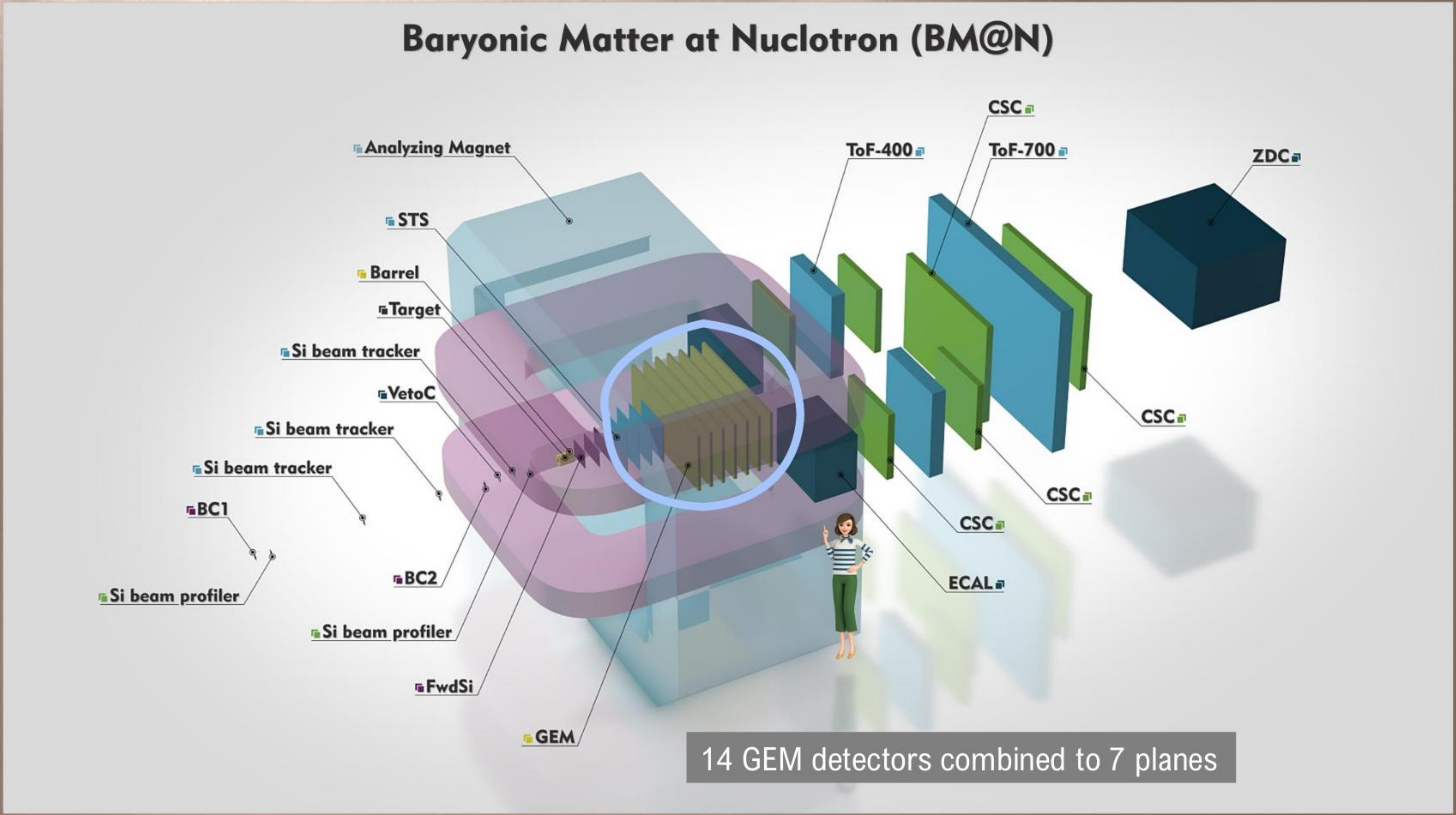
Ordered 150 x 150 x 1 mm³ quartz
150 x 150 x 0.5 mm³ BC-408

STATUS OF THE GEM/CSC TRACKING SYSTEM OF THE BM@N EXPERIMENT

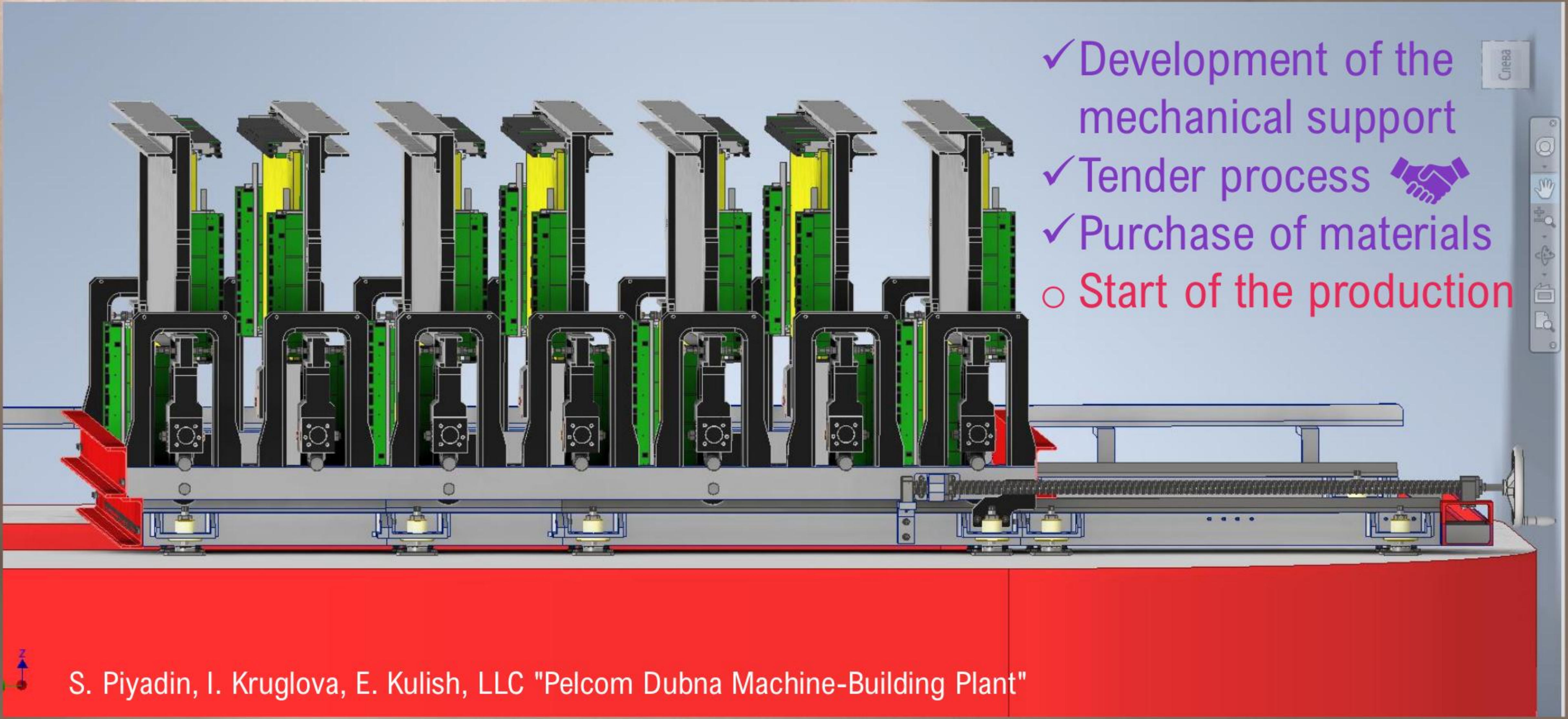
Elena Kulish on behalf of the BM@N Collaboration

7th Collaboration Meeting of the BM@N
Experiment at the NICA Facility, 19-20 April, 2021

GEM detectors in BM@N



Mechanical support for GEM detectors



- ✓ Development of the mechanical support
- ✓ Tender process
- ✓ Purchase of materials
- o Start of the production

S. Piyadin, I. Kruglova, E. Kulish, LLC "Pelcom Dubna Machine-Building Plant"

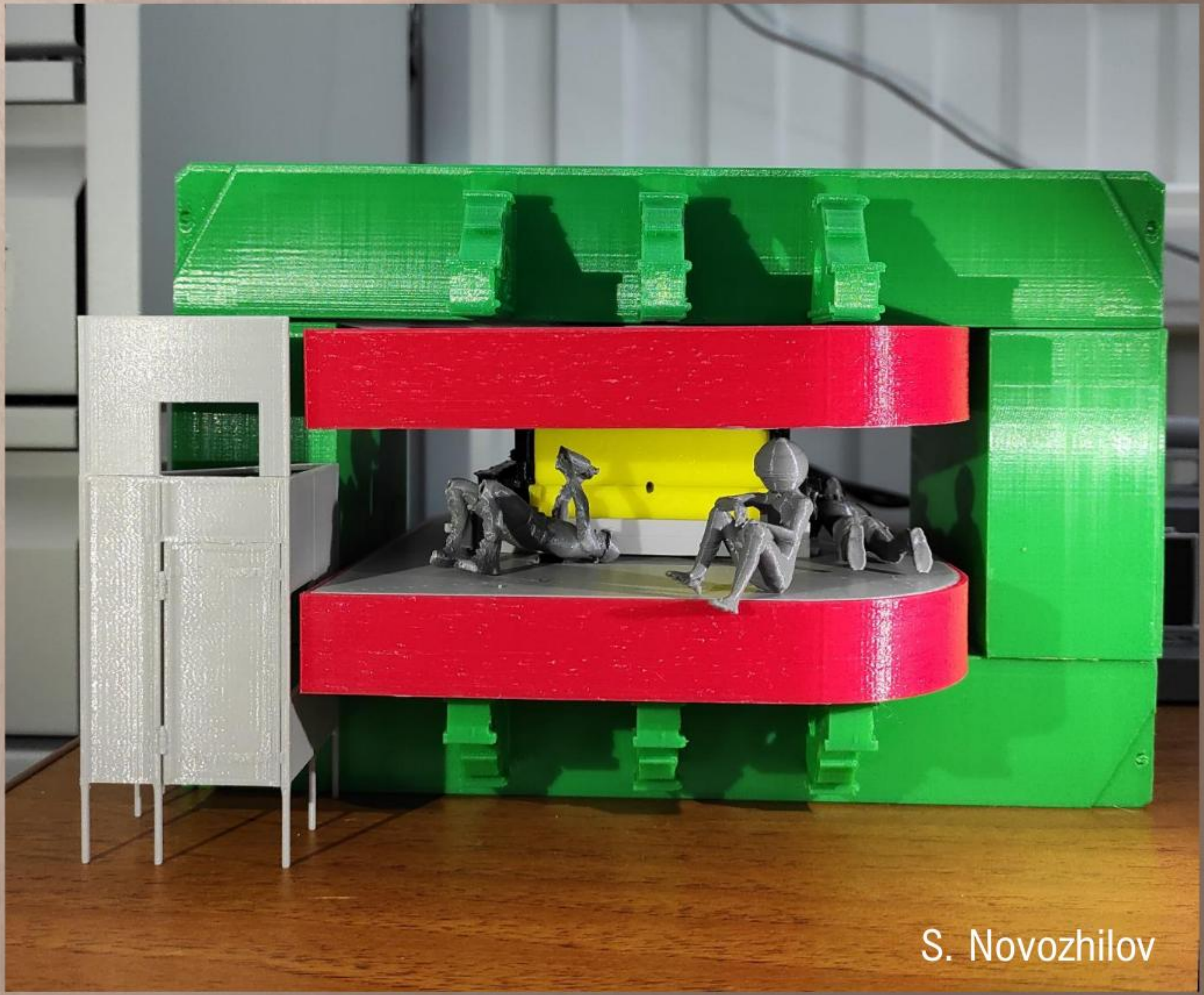
Installation to the magnet SP-41

Installation sequence:
rails, trolley, bottom detectors (starting from the front detector), carbon beam pipe, top detectors (starting from the front detector).

Tests of 14 GEM detectors should be performed during installation.

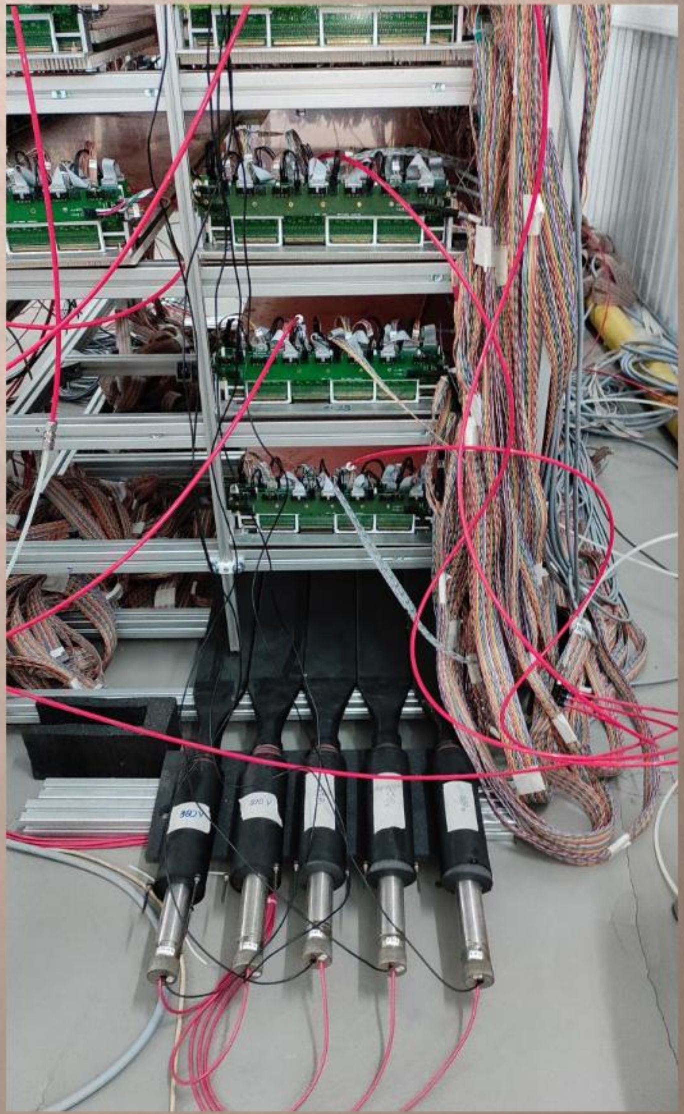
This work will take 2 monthes.

Installation will be performed from the opposite side of the magnet SP-41, therefore work should be done separetely from ToF-400 and CSC groups.

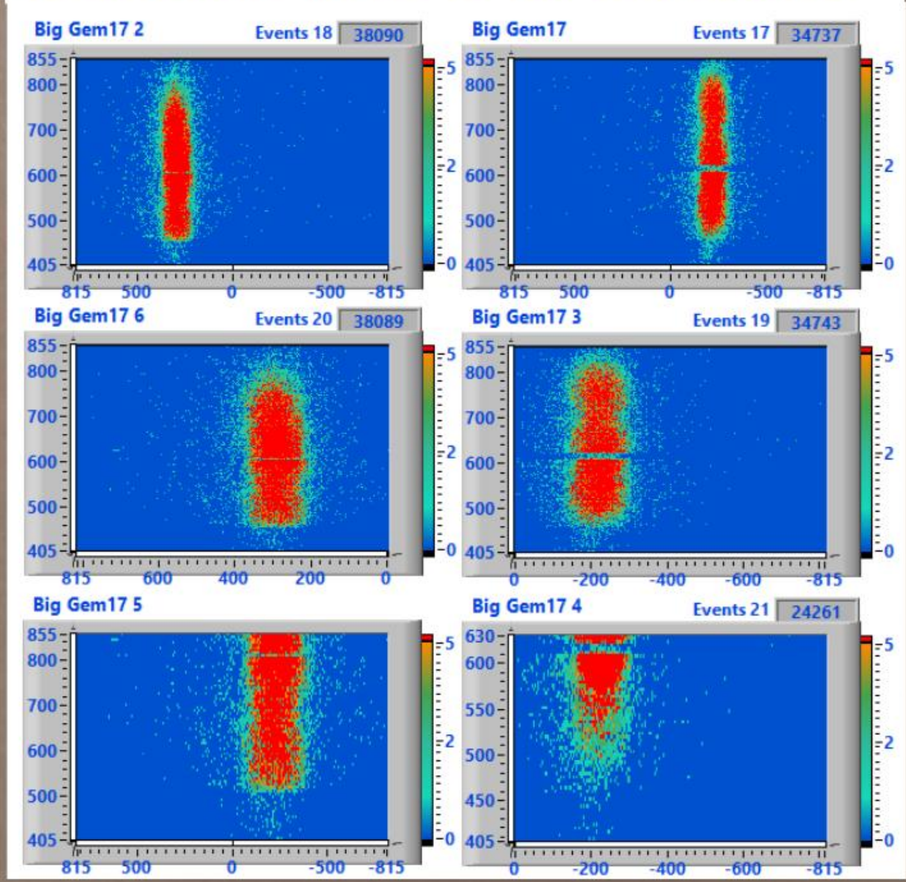


Cosmic ray tests

- 7 163×39 cm^2 GEM detectors
- 1 sector is broken in 1 detector
- Detector is delivered to CERN for repair
- Tests of FEE, cabling and patchpanels



Broken sector in 163×39 cm^2 GEM detector



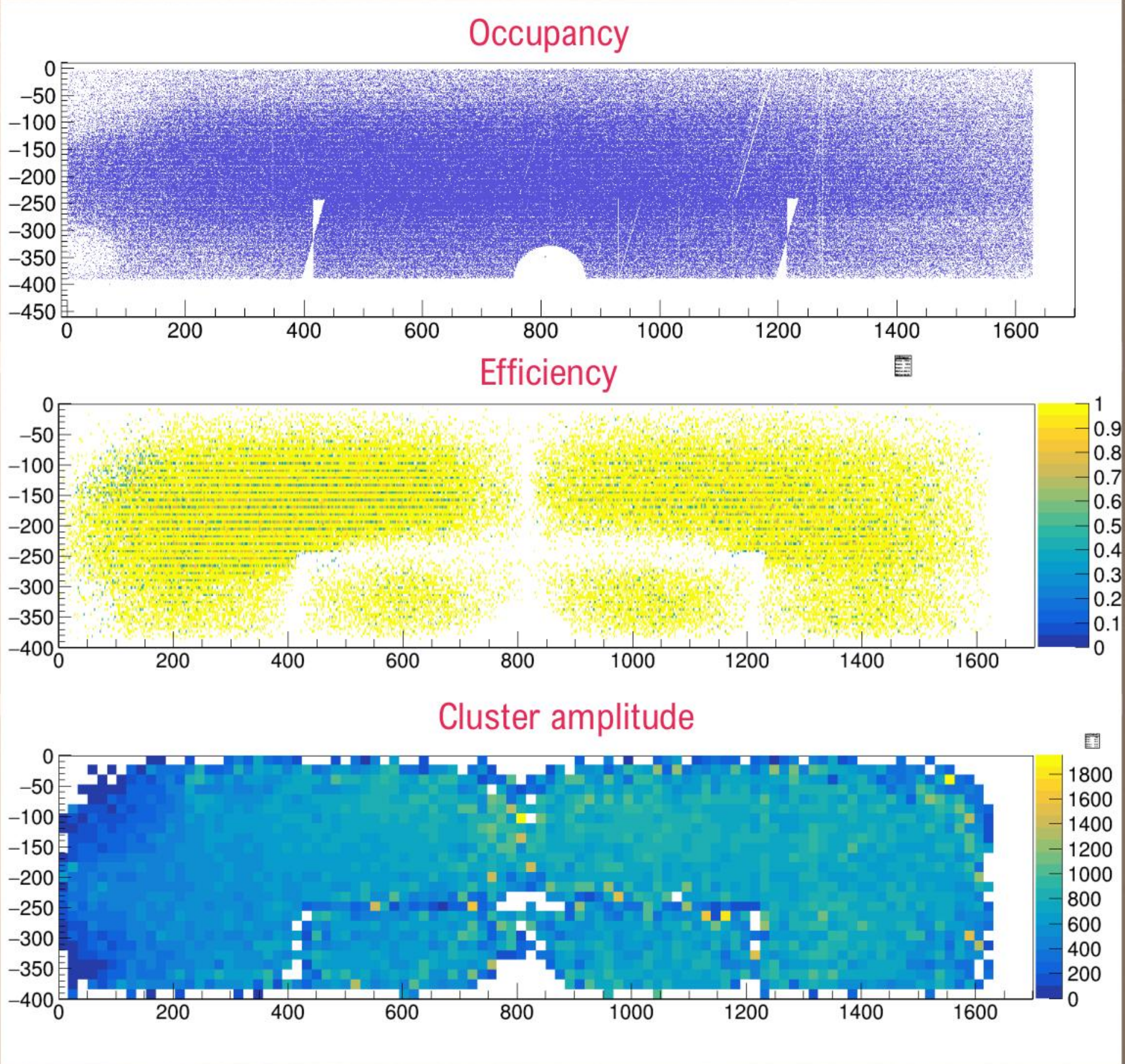
Cosmic ray tests

163×39 cm^2 GEM detectors

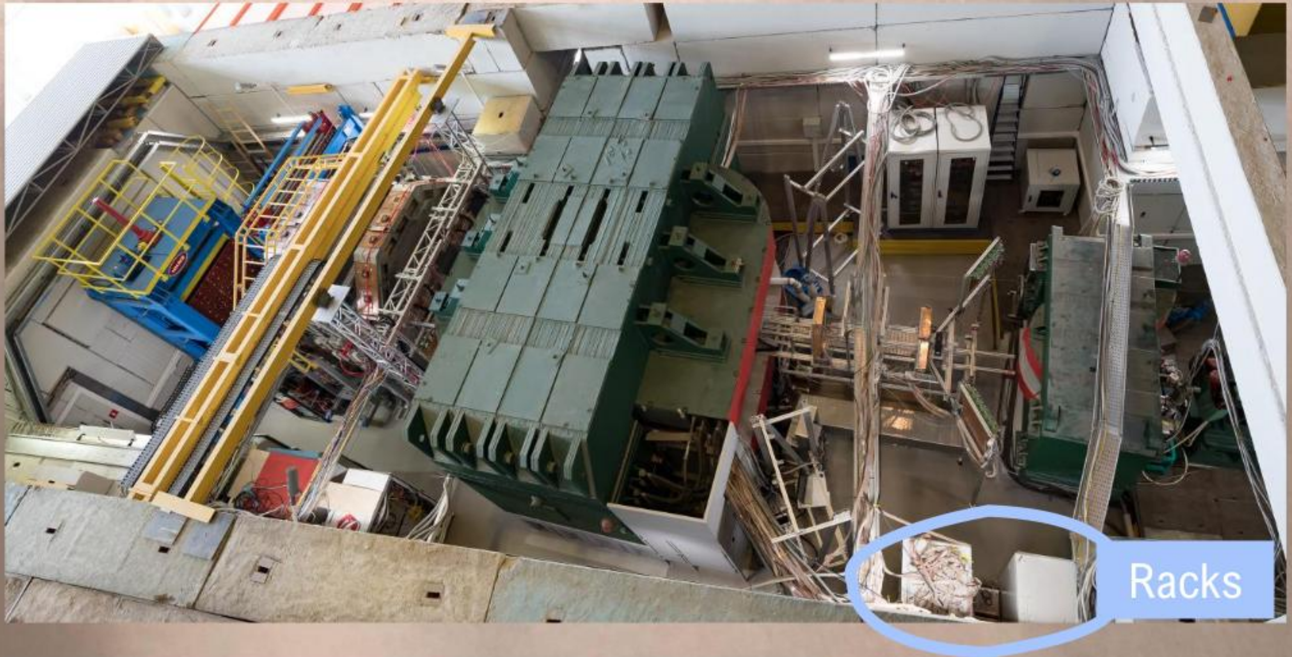
Horizontal sector design

Losses of efficiency are caused by boundaries between sectors. Inside sectors the efficiency is about 100%.

Position of each detector in the assembly will be chosen based on comparison of the location of dead channels and areas of low efficiency with simulations (S. Merts).



Racks and cables

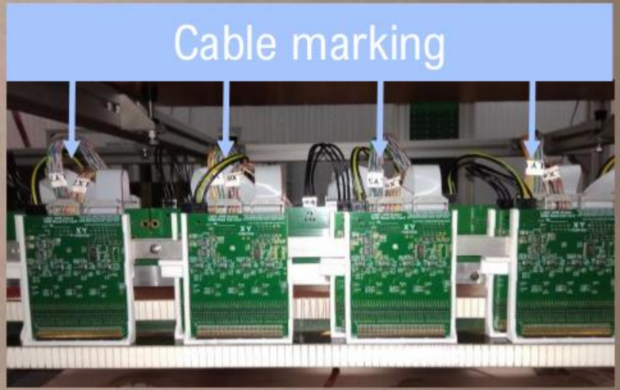


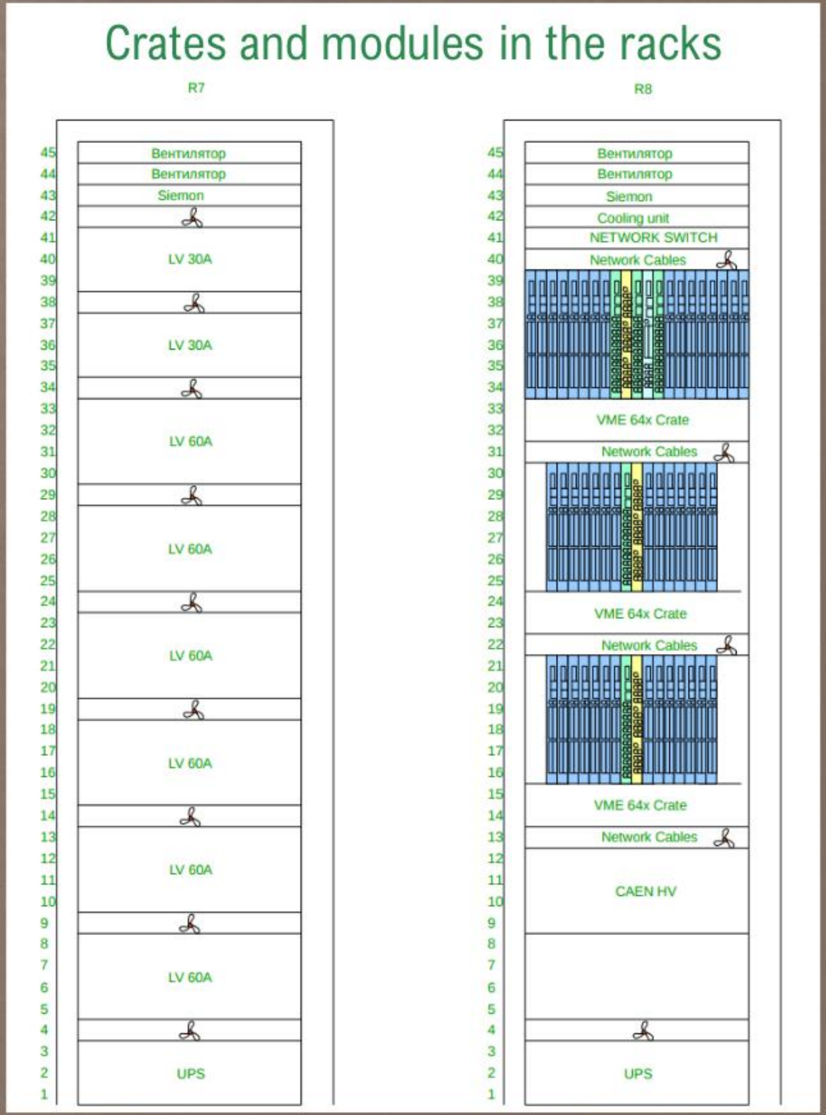
Cables are ready for all detectors.

Cable marking is 80% ready.

Number and position of the racks in the experimental hall is fixed.

Crates and modules in the racks are distributed (A. Terletsky, A. Fediunin).





FEE for heavy ion beam runs

Two types of ASICs - TIGER (INFN) and VMM3 (BNL) are considered for upgrade of FEE for GEM detectors

An evaluation board was designed and produced by DAQ group for VMM3a tests.

Currently the tests are performed with generator only. Tests with the GEM detector are not performed yet.

The possibility of buying VMM3a is still in question. Work is underway to find this opportunity.

Currently the development of the TIGER is suspended for several reasons.

As an alternative to TIGER the other ASIC ToASt is suggested by INFN.

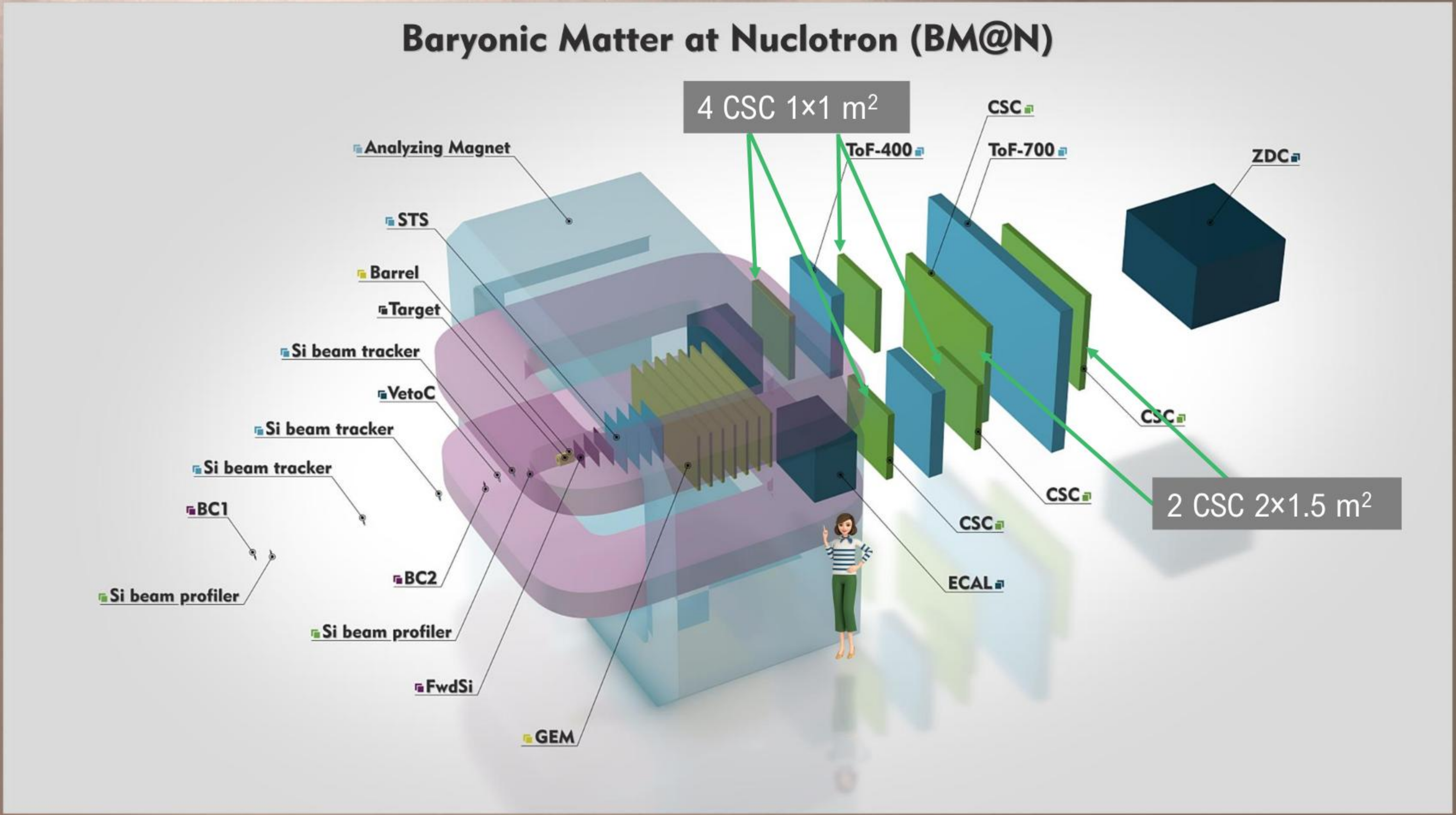
ToASt is now considered for the future FEE for FwdSi. It is planning to test it with GEM detectors also.

ToASt main characteristics

- 64 input channels
- Time of Arrival (ToA) and Time over Threshold (ToT) measurements
- Master clock frequency : 160 MHz
- Region : groups of 8 channels with local FIFO
- Second level FIFO buffering for the 8 regions
- Two output serial links at 160 Mb/s
- Serial configuration protocol at 80 Mb/s
- SEU protection for registers and FSM
- CMOS 0.11 μm technology

Specification	Min	Max	Unit
Input capacitance	2	17	pF
Max rate per strip		40	kHz
Input charge	1	40	fC
Noise		1500	e^-
Preamp peaking time	50	≥ 100	ns
Channels per chip	64		
Reference clock		160	MHz
Charge resolution	8		bits
Time resolution (pk-pk)		6.25	ns
Time resolution (r.m.s.)		1.8	ns
Power consumption		256	mW
Chip dimensions	4.2×3.5		mm^2
Pads position	On two sides only		

CSC in BM@N



Baryonic Matter at Nuclotron (BM@N)
4 CSC 1×1 m2
CSC
ToF-400
ToF-700
ZDC
Analyzing Magnet
STS
Barrel
Target
Si beam tracker
VetoC
Si beam tracker
Si beam tracker
BC1
Si beam profiler
BC2
Si beam profiler
FwdSi
GEM
ECAL
CSC
CSC
CSC
2 CSC 2×1.5 m2

CSC in BM@N

4 CSC 1×1 m² are produced, 3 are equiped with FEE and cables.

Main 2×1.5 m² components (honeycomb, cathode readout plates) are received.

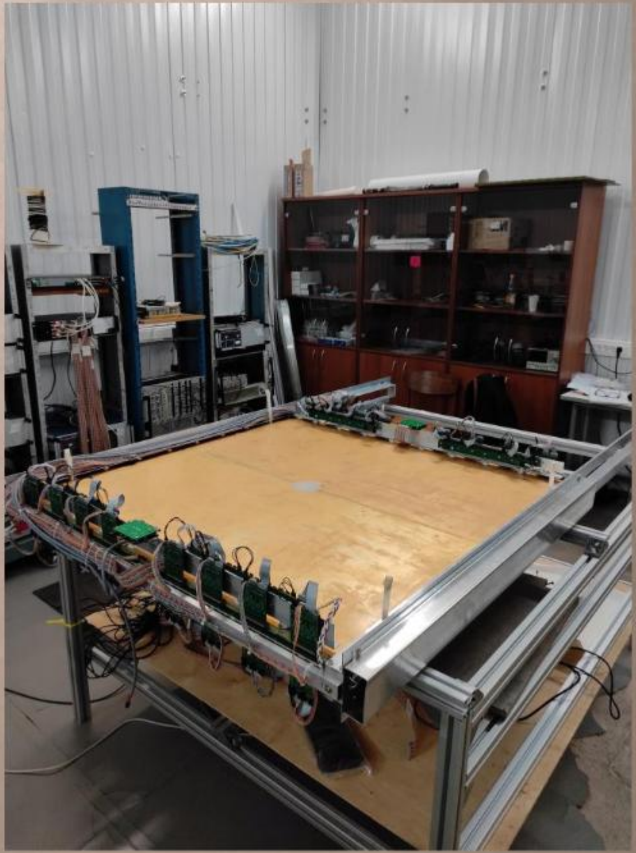
Expansion of the metal table for the chamber assembly is completed.

Making precise holes for pins in the table for positioning parts during gluing is planned on May.

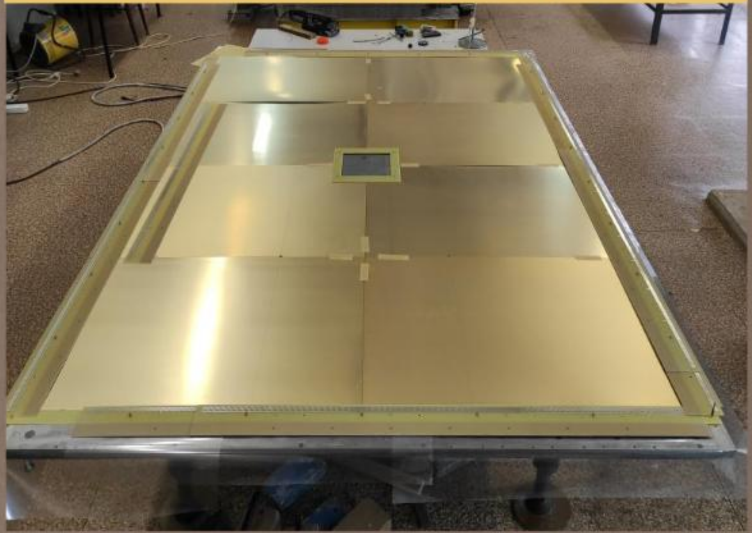
Production of fiberglass frame elements is scheduled for May - September.

Ordering and receiving thin one-side foiled fiberglass for the outer surface of the chambers – May – September.

Start of chamber assembly – October.

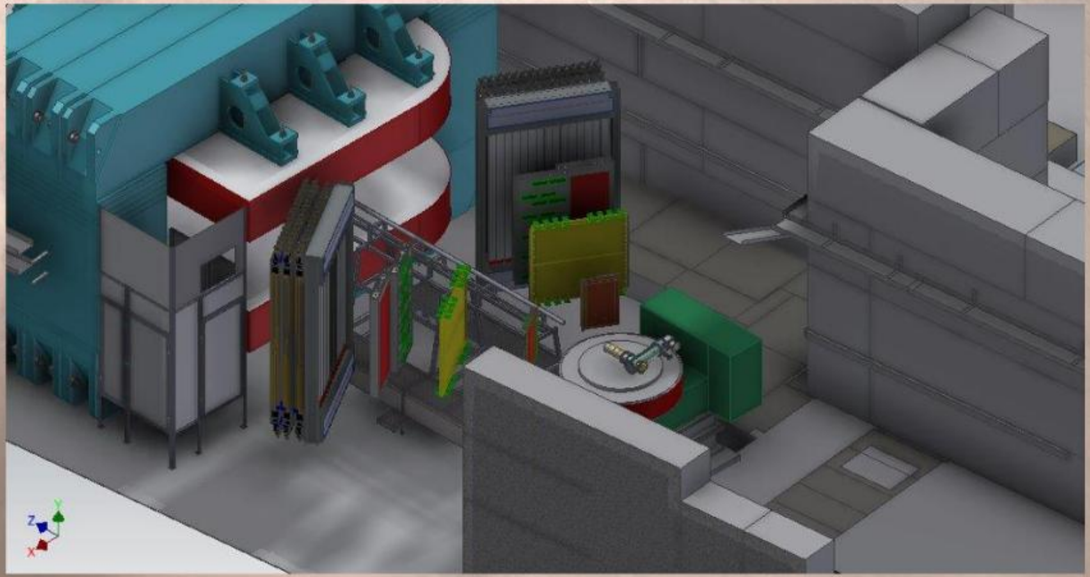


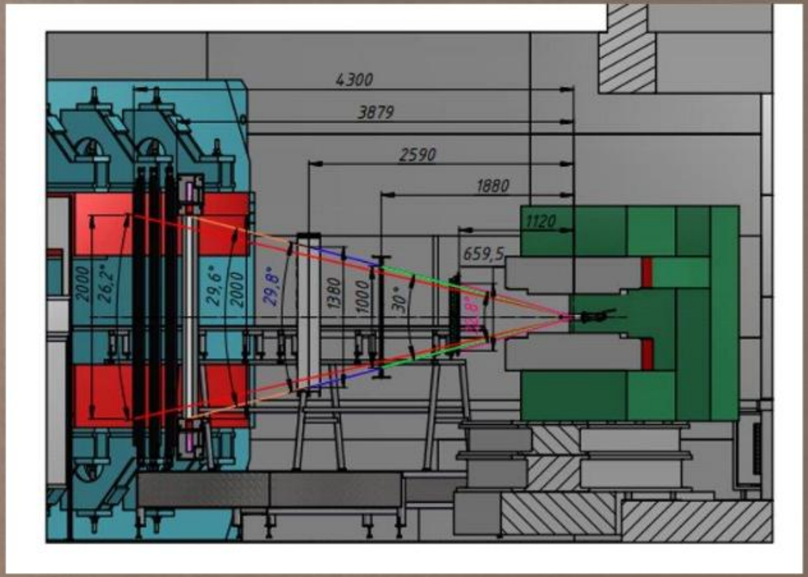
2×1.5 m² readout preparation

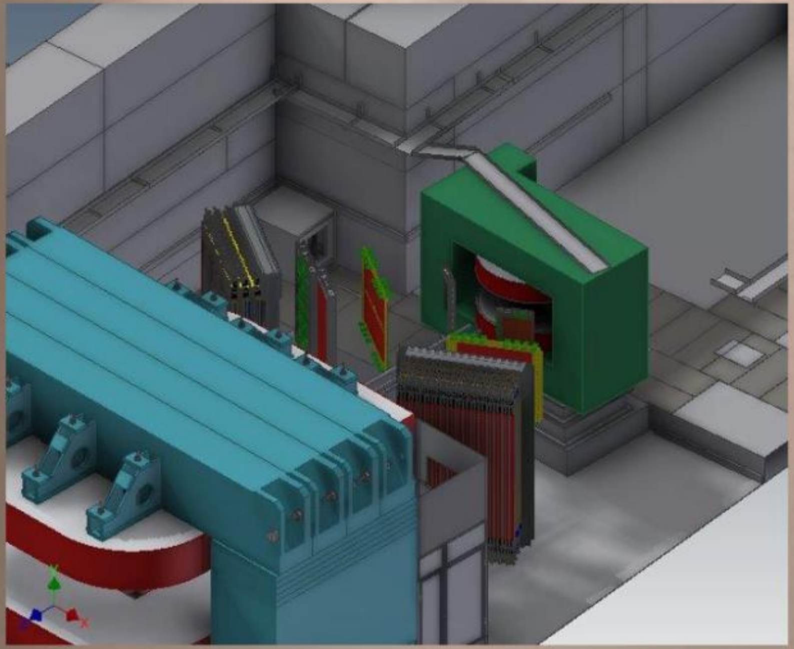


R. Kattabekov, A. Vishnevsky, A. Morozov

CSC and GEM detectors in SRC





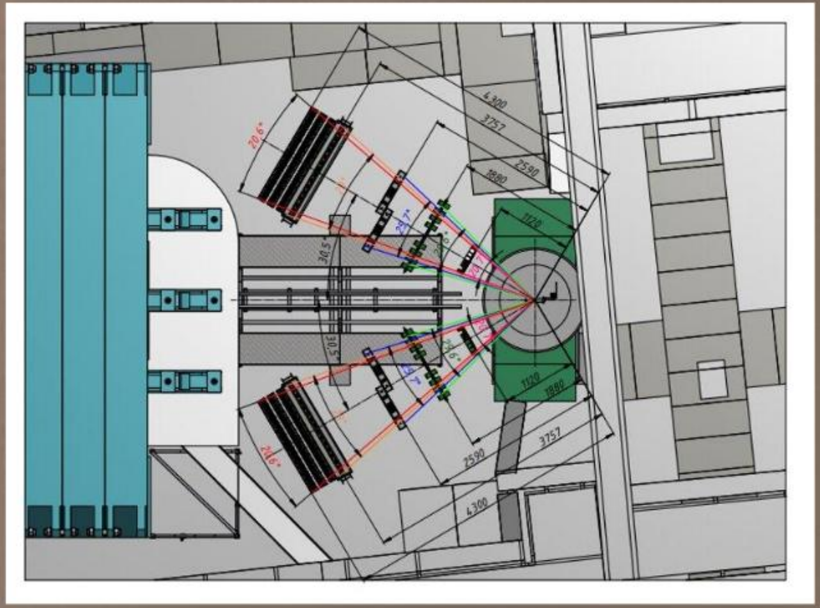


2 1×1 m^2 CSC
2 66×41 cm^2 GEM detectors

The position of CSC and GEM detectors is now fixed.

Development of the mechanical support can be started.

Cable production can be started.

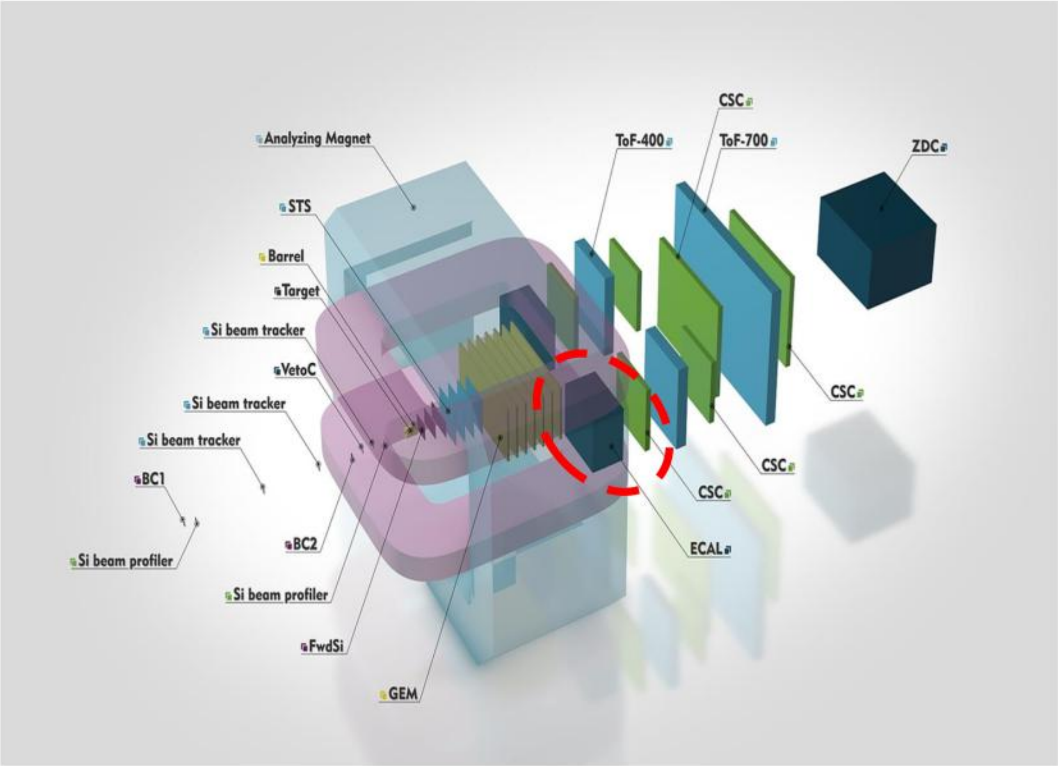


Status of the ECAL

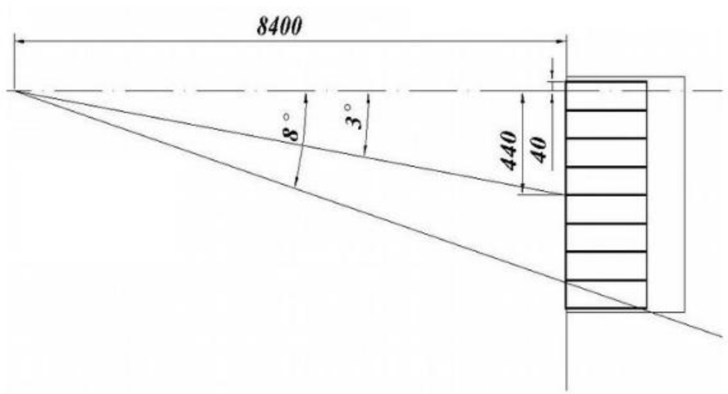
Sergey Afanasiev
on behalf of BMN ECAL group

April 19, 2021

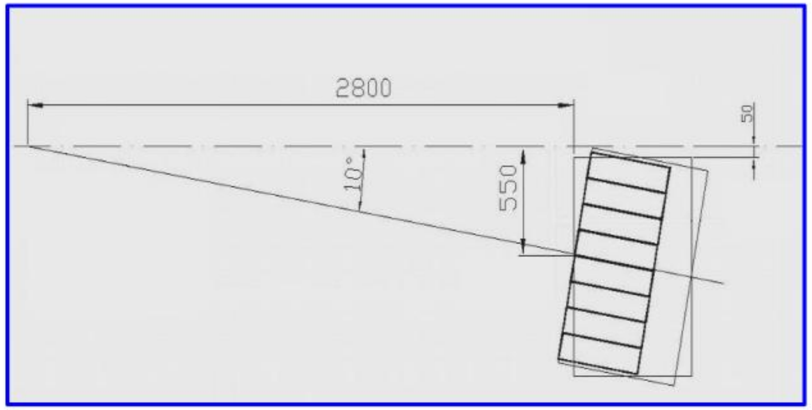
The ECAL location in the BM@N setup and positions in run 7.



Position 1, Run 7 (SRC) ECAL calibration runs
C 3.17 AGeV → Pb, run ids 3503-3511, ~2 M ev.



Position 4, Run 7 (BMN) ECAL data analysis
Kr 2.6 AGeV → Sn, run ids 4921-4966, ~5.7 M ev.

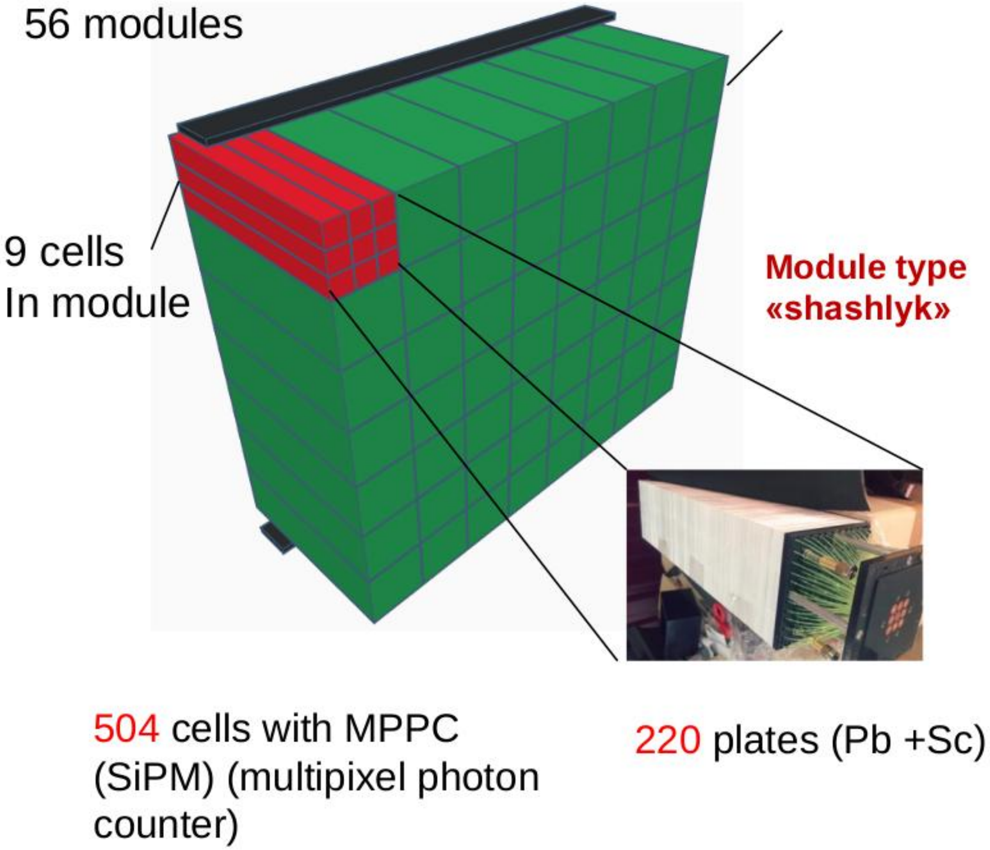


- **2018 year ECAL setup (run 7)**
  - **one swall 7x7 modules, 441 cells**
- New ECAL setup
  - two Walls of 8x7 modules, 1008 cells

ECAL BM@N

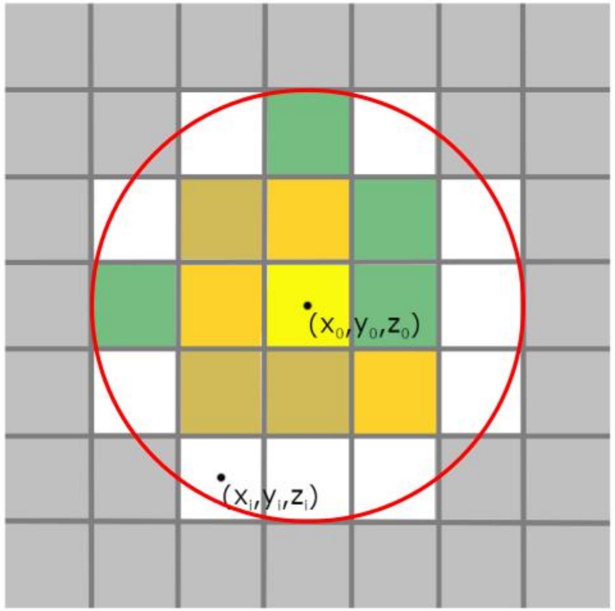
ECAL is formed from lead-scintillation modules "Shashlyk"-type in the wall size of 8x7 modules (96x84 cm2). The total number of active cells in one ECAL wall is 504. The 441 cells of one wall were used in the experimental run 2018. Modules for the second wall have been prepared and will be operated in 2021.

The «Shashlyk» module is a lead-scintillator sandwich which read out by means of wavelength shifting fibers .



Cluster parameters

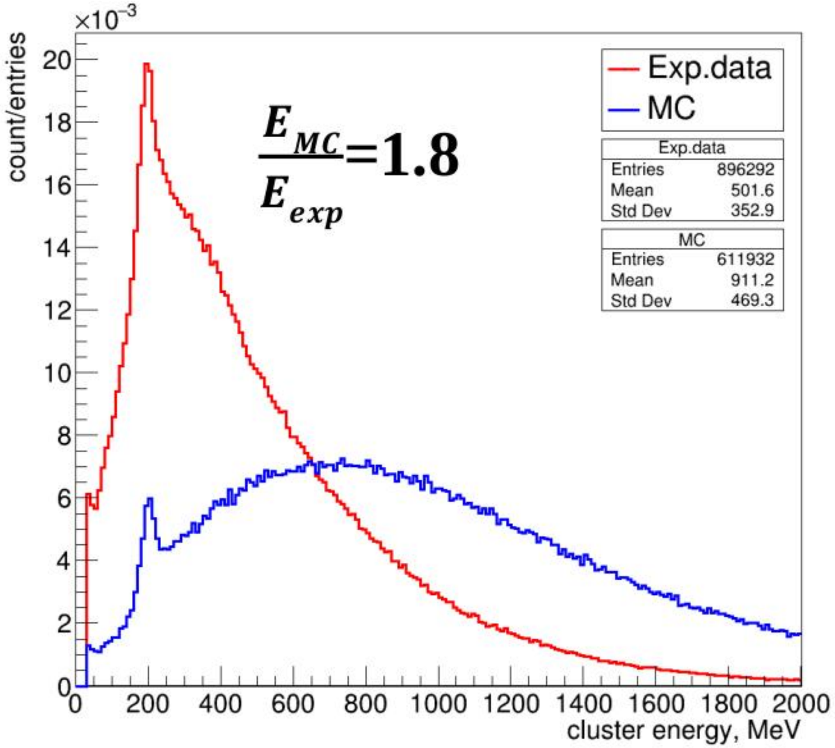
- Minimal cell energy is 30 MeV, other cells are ignored
- Cluster radius is 10 cm (21 cells of 5x5 area)
- Cluster parameters are:
  - energy
  - center gravity
  - weighted average time (t_{wa})
  - time spread (t_{sp})
  - normalized moment (M_{norm})



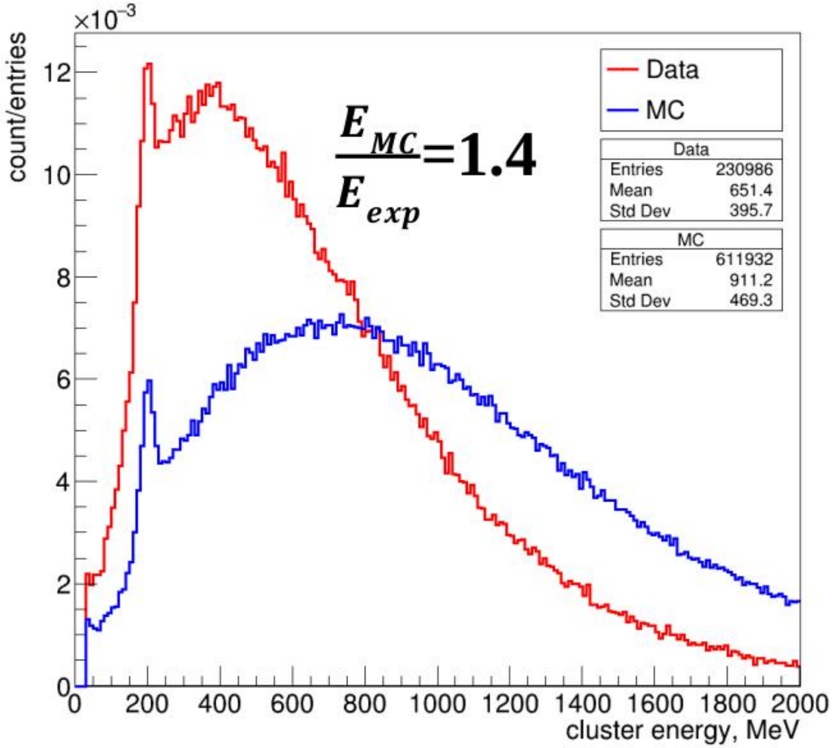
$$t_{wa} = \frac{\sum E_i \cdot t_i}{\sum E_i} \qquad t_{sp} = \frac{\sum E_i \cdot (t_i - t_0)^2}{\sum E_i}$$

$$M_{norm} = \frac{\sum E_i \times ((x_i - x_0)^2 + (y_i - y_0)^2 + (z_i - z_0)^2)}{\sum E_i}$$

ECAL clusters energy spectra with vertex cut.



Experimental data spectrum of all clusters involved into effective mass calculation

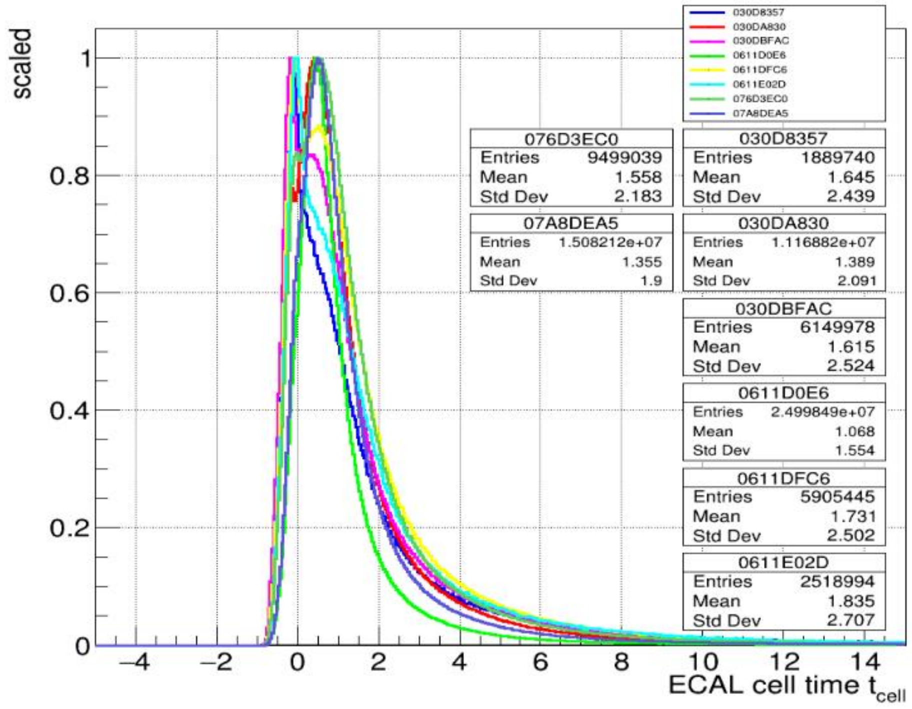


Events selected that has primary vertex found

The vertex information significantly improves the ratio of MC and experimental data, but does not fully explain.

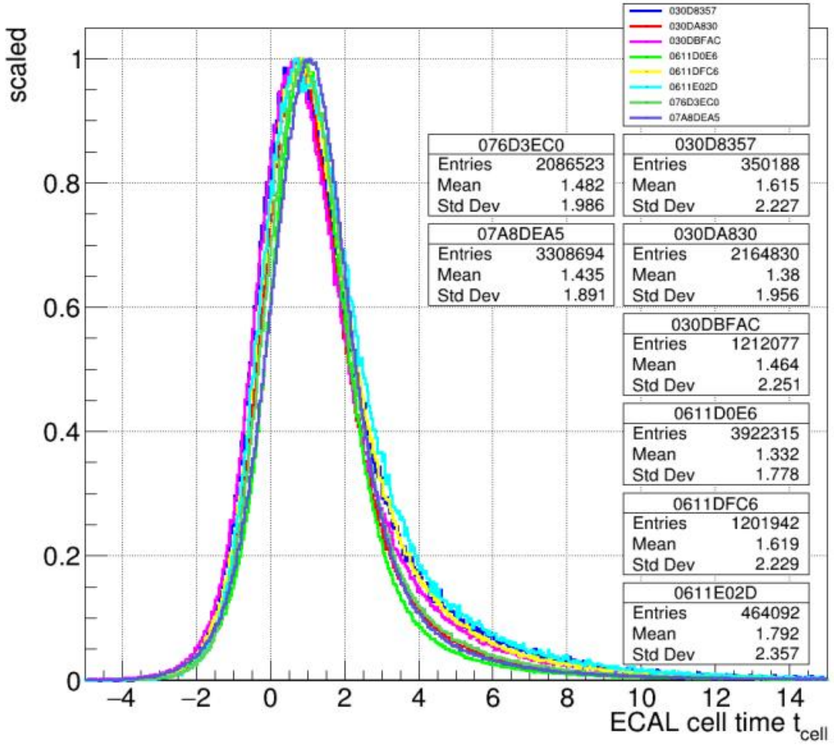
MC estimation of the experimental time resolution.

The estimation of the time resolution was performed by the method of " time distortion" of the MS calculations. Cells time distortion in MC was set to match the width of the experimental distribution.



MC KrSn 2.36AGeV mb

No distortion (original state)

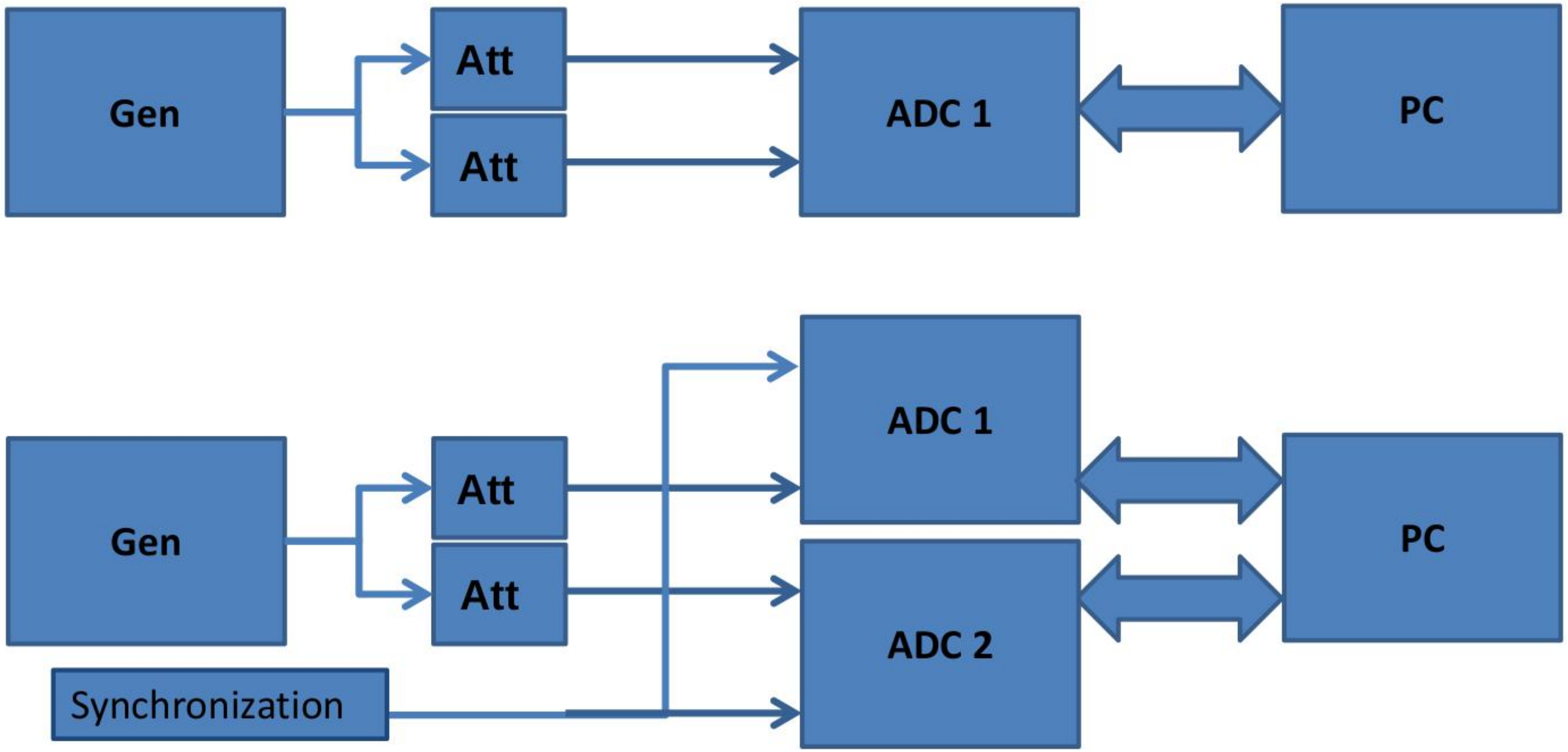


Exp.data KrSn

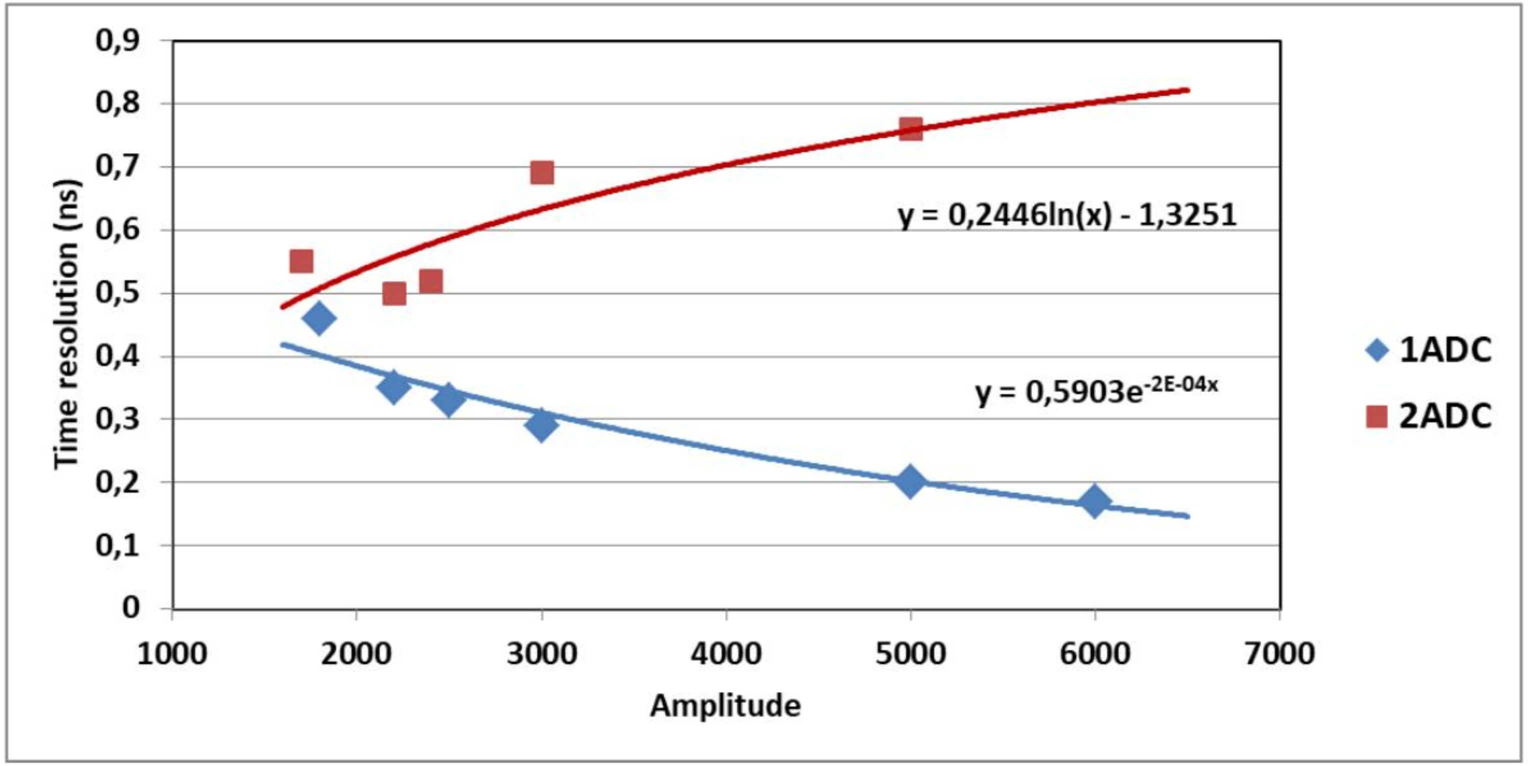
Time shifted to match MC on the half height of the rising edge

Source of the time distortion for experimental data.

The time resolution of the ADC was investigated by measuring the time difference between the two ADC channels. The times were measured both for a single ADC and for two ADCs synchronized from an external source. For a single ADC, the time resolution has good agreement with the TDR data. The time resolution of paired ADCs is significantly wider and significantly bifurcates at amplitudes of 5000.

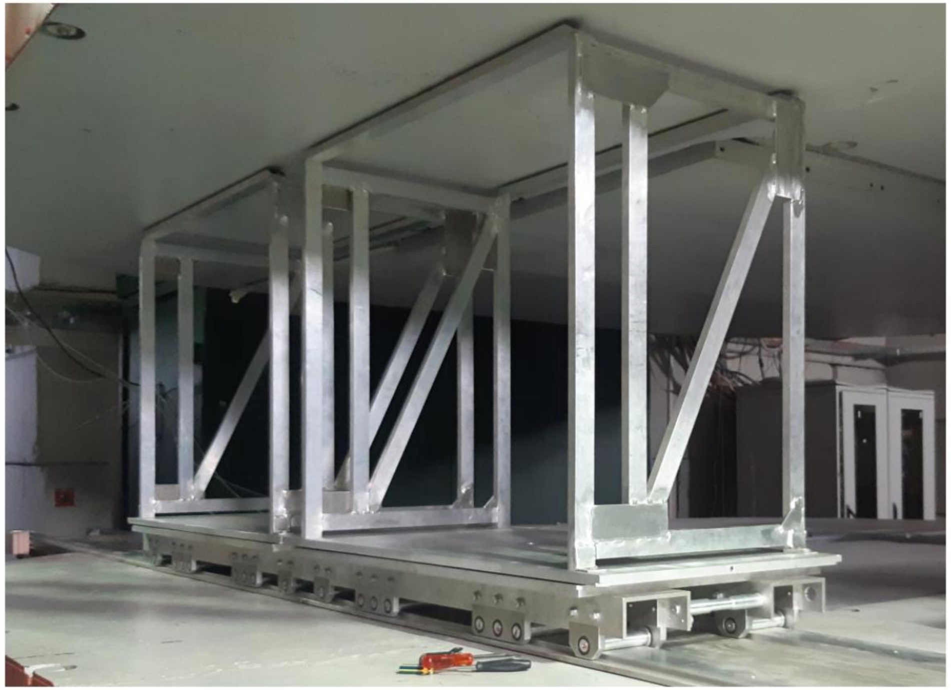


For a single ADC, the time resolution has good agreement with the TDR data. The time resolution of paired ADCs is significantly wider and sensitive bifurcates at amplitudes of 5000.



Preparation for RUN 8

New mechanics for the two-arm calorimeter is ready.



The ADC and modules for the two arms ECAL have been prepared.

The non standard modules from the right arm of the ECAL were checked and prepared for replacement.

Tested modules for the left arm of the ECAL.

Right arm

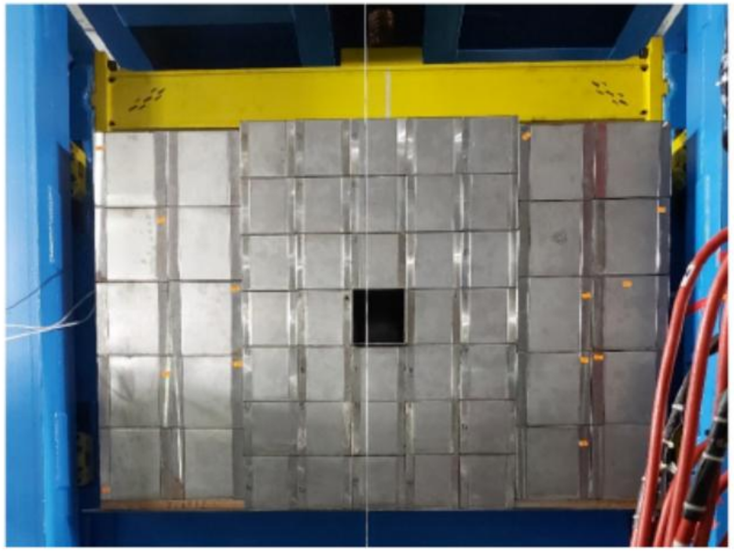
Left arm

Status of FHCal and forward charged fragments hodoscopes

Sergey Morozov
on behalf of INR RAS, Moscow

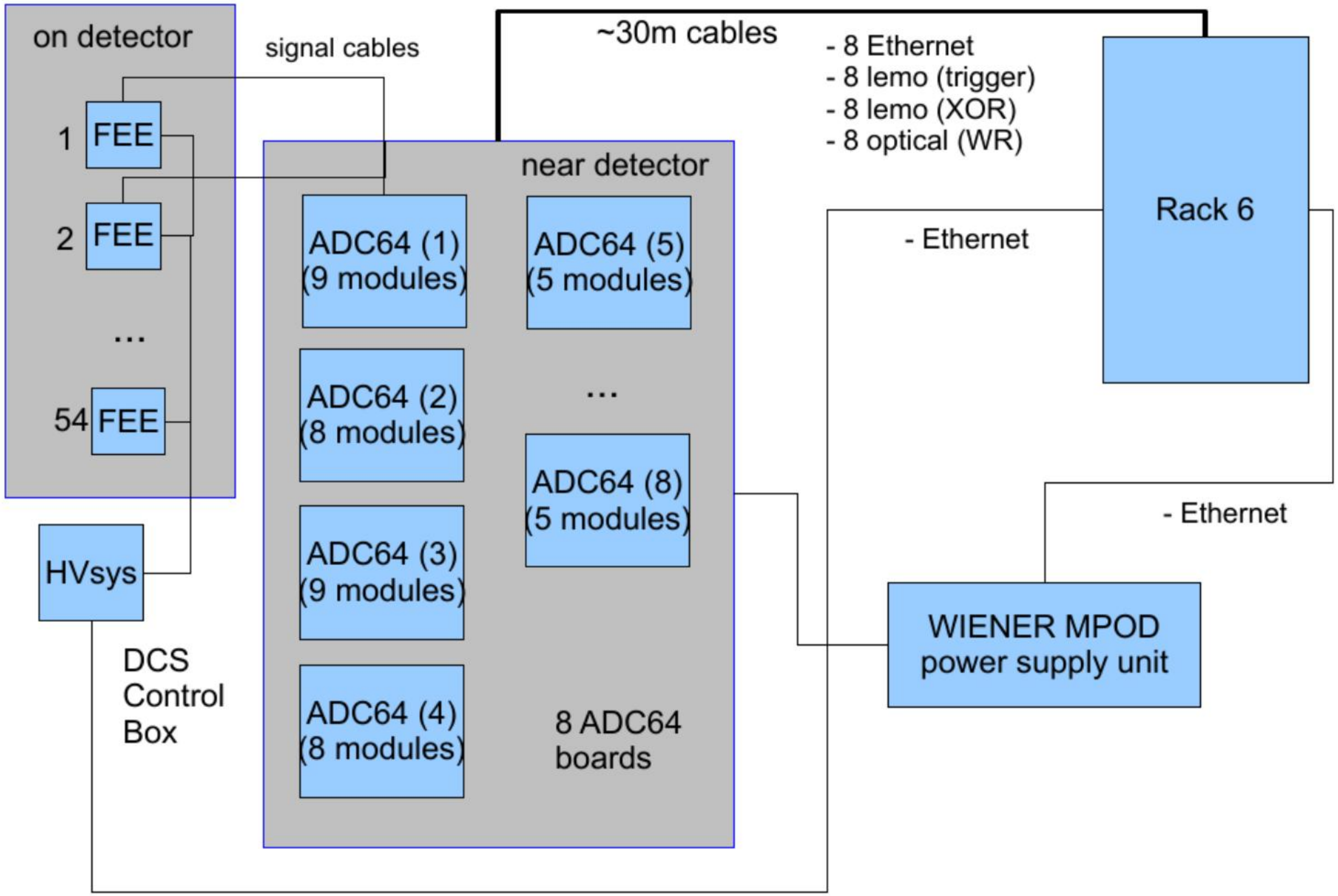
BM@N Collaboration Meeting, Dubna, 19-20 April 2021

FHCal assembled and installed in the BM@N area

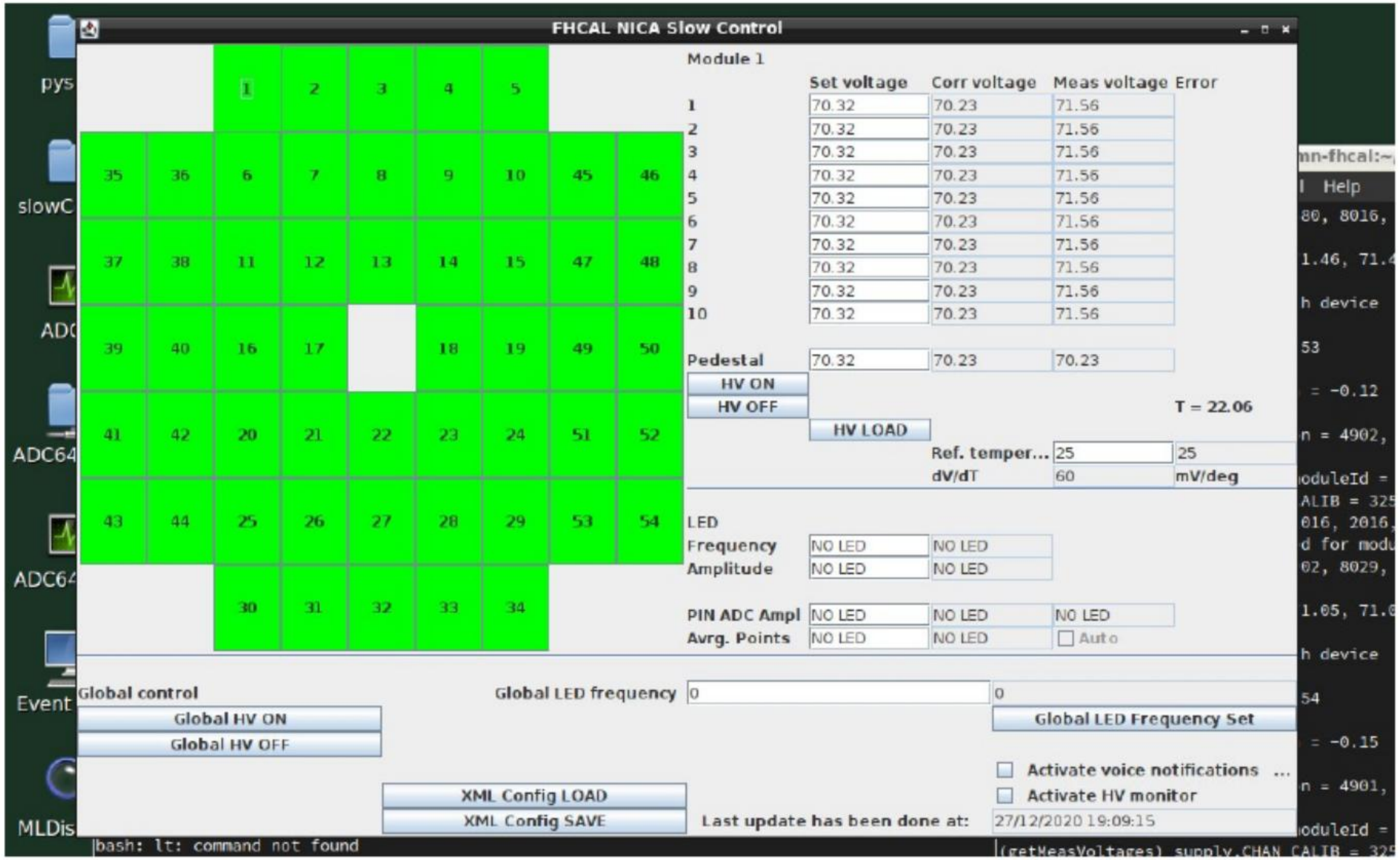


- 34 central small modules of 15cmx15cm (constructed for MPD experiment)
- 20 side large modules of 20cmx20cm (constructed for CMB experiment)
- longitudinal segmentation with 7 sections (small modules) and 10 sections (large modules), each section has an individual read-out with one MPPC (Hamamatsu)

Schematic view of connections at FHCal

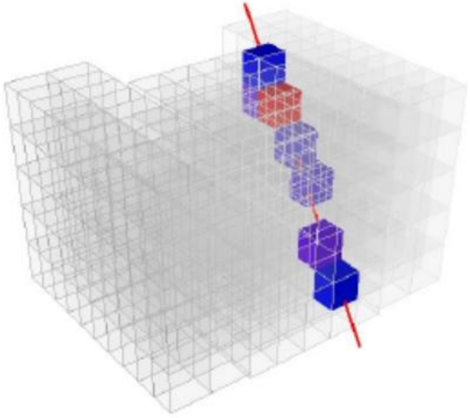


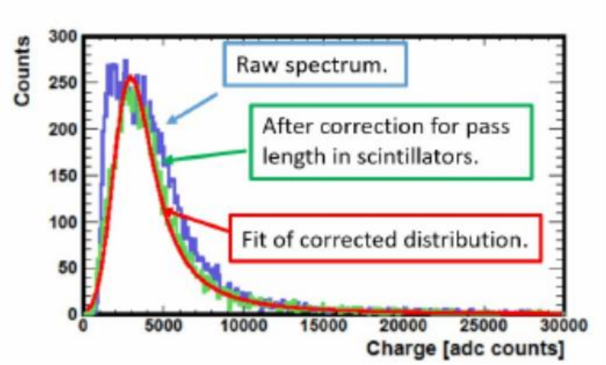
DCS for FHCal (Java version):
- control HV on MPPCs and correct it with temperature changing to maintain the gain



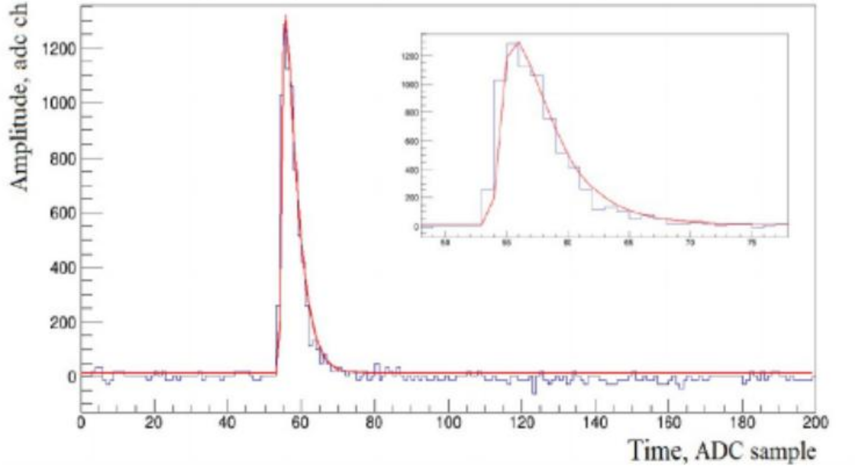
- the new version on python is under development

New cosmic muon calibration procedure based on 3D tracking with transverse and longitudinal granulation of FHCal has been developed and is under testing on cosmics with FHCal (remotely from INR)

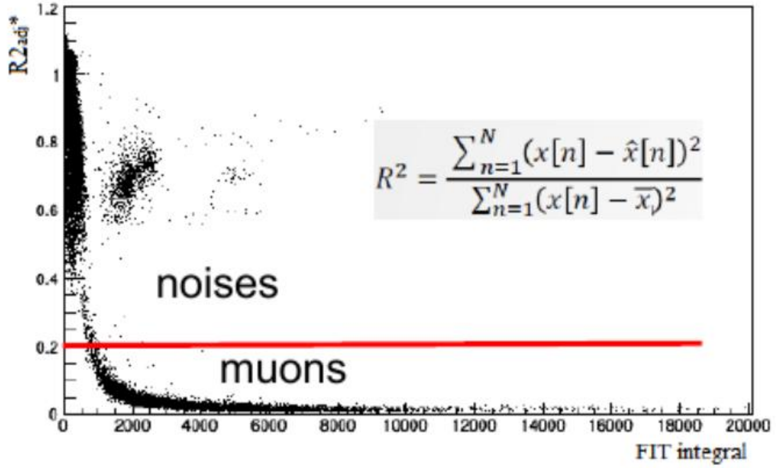




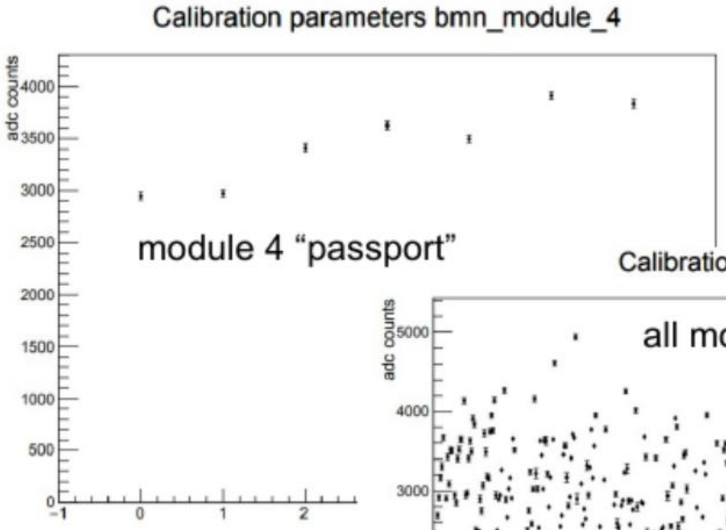
Fit signal by composition of exponents

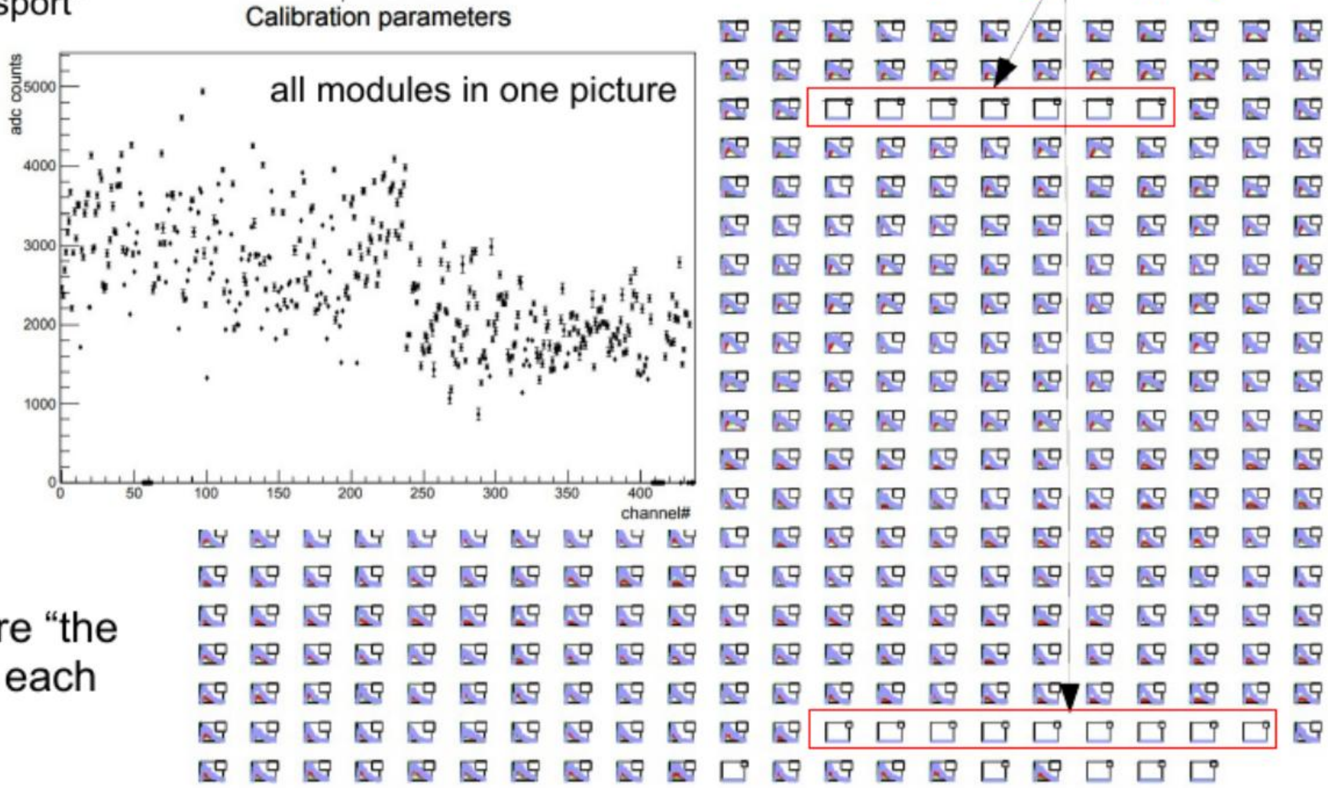


Rejection of noises with fit quality par.



Tests of 8 ADC64 read-out system (on fhcal-bmn virtual mashine at BM@N computing node)





Cosmic muon calibration results

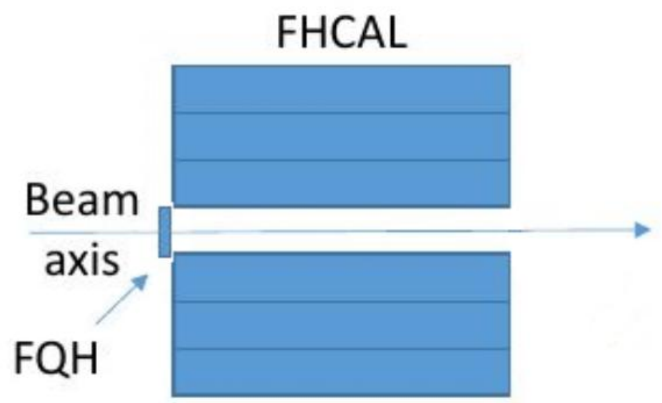
some problems?

(wrong mapping - fixed)

(bad FEE to ADC board connection- fixed)

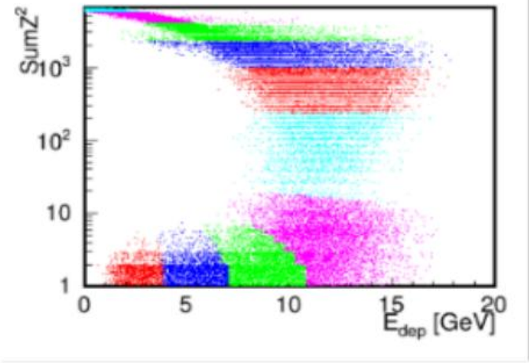
- the final goal: prepare “the quality passport” for each module of FHCal

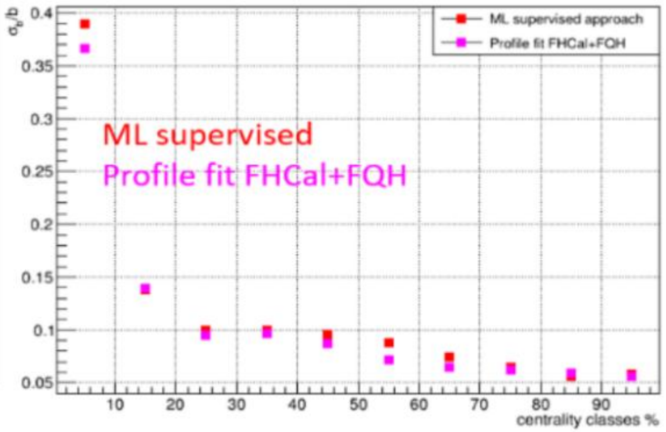
The use of the Forward Quartz Hodoscope (FQH) to measure fragments charges in the FHCal beam hole.



- Forward Quartz Hodoscope (FQH) is ready (2 variations – with scintillator and with quartz plates)
- TQDC board planned to use for read-out is under testing now with new FEE (at INR)

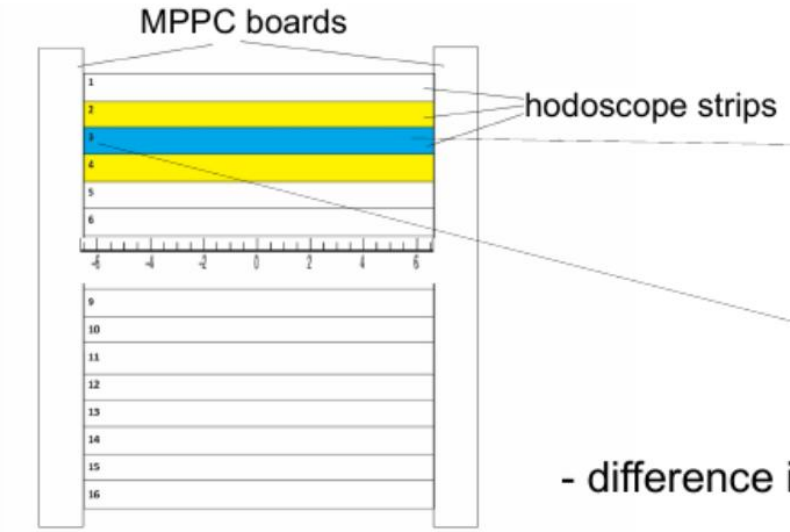
16 strips (160 x 10 x 4 mm^3) with 2-side MPPC read-out

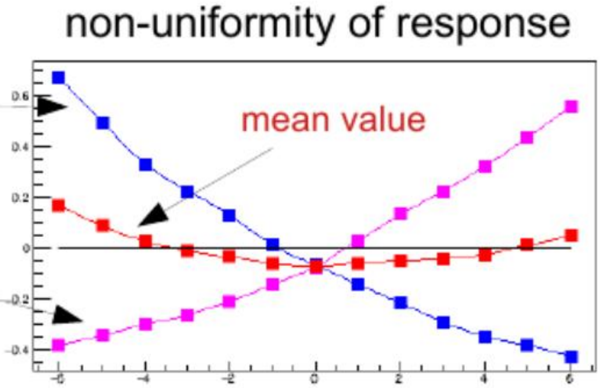




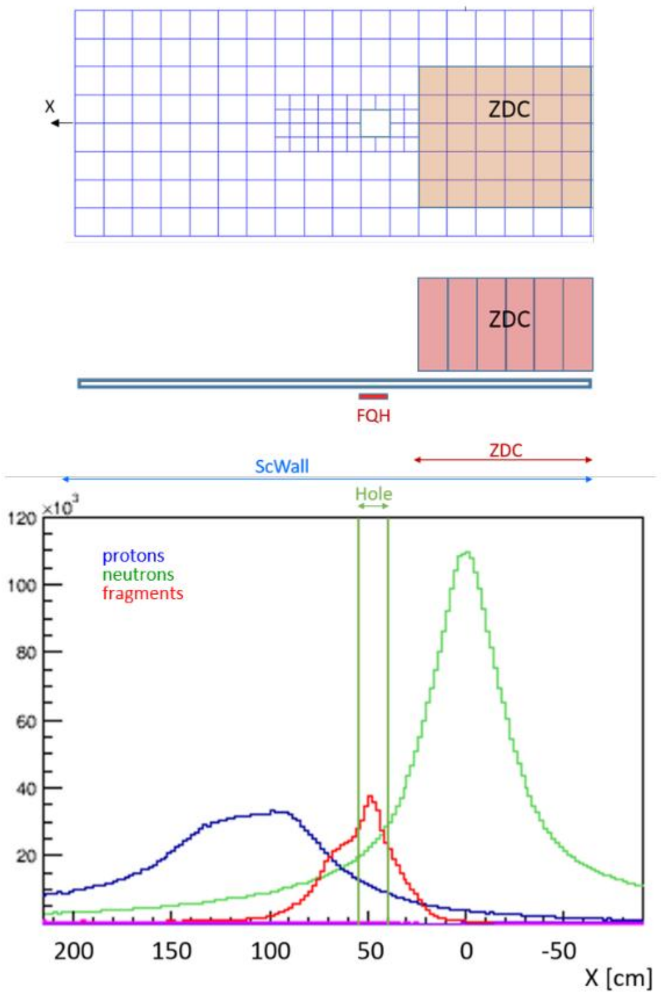
- the impact parameter resolution is slightly better when FQH+FHCal are used
- FQH will allow to measure charge fragments in the FHCal beam FHCal hole:
- can be useful to tune fragments models in event generators

Hodoscope’s tests has been performed on “PAKHRA” synchrotron at LPI (Troitsk)





- difference is not more then ~20% with dual side read-out



Proposal of new fragment registration

Additional **segmented scintillation wall** is planned:

- FHCal (36 MPD modules 15 x 15cm2) to measure neutron spectators

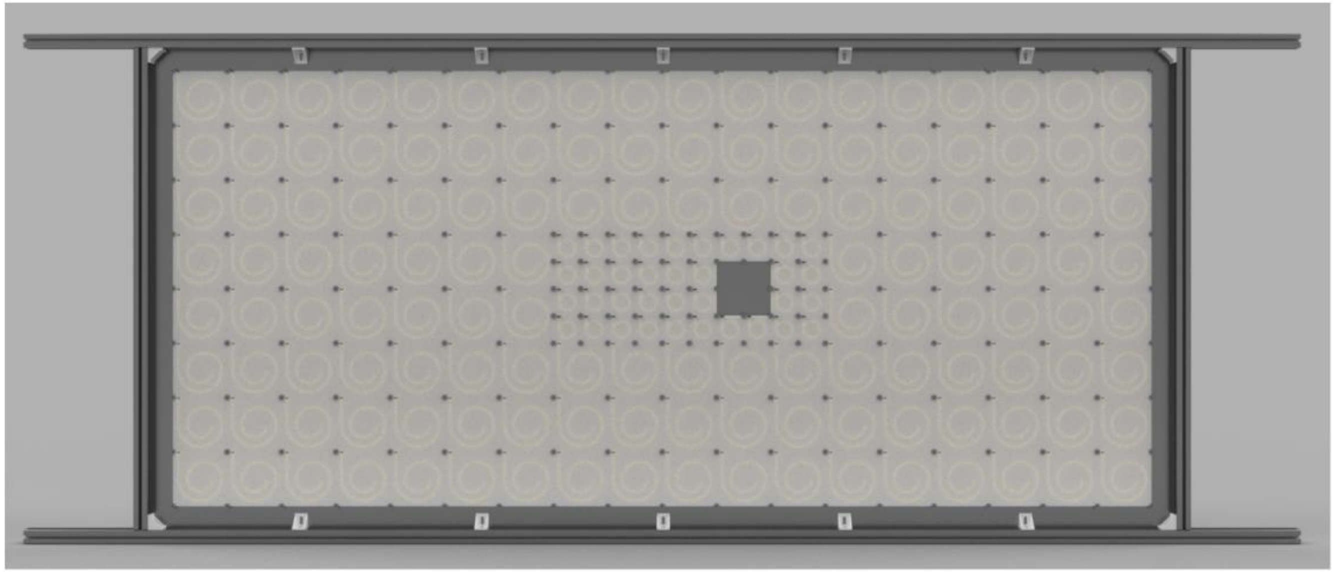
- Scint. Wall: 36 cells (75 x 75 x 10 mm 3)
+ 134 cells (150 x 150 x 10 mm 3)

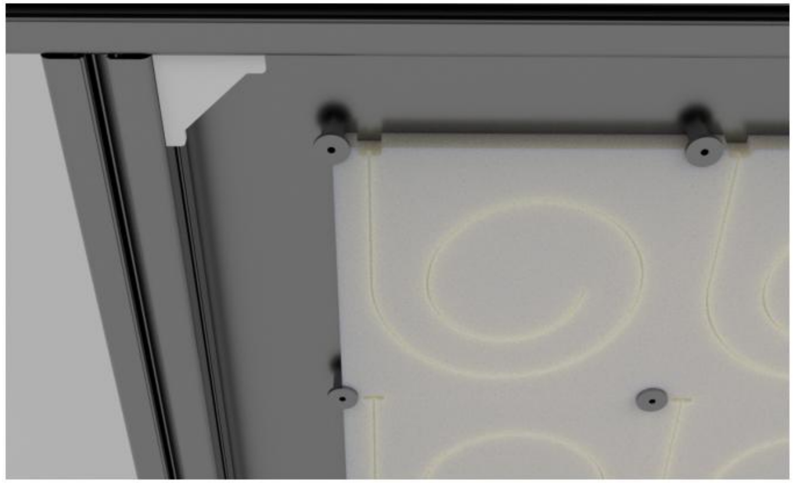
- FQH (16 quartz strips 160 x 10 x 4 mm 3) to measure heavy fragments

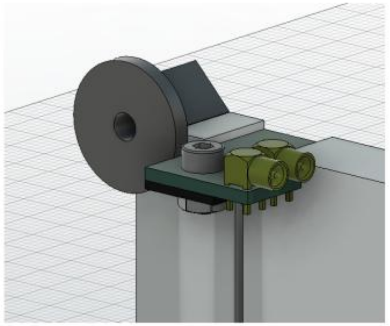
The main goal: separate measurements of the neutron, proton and fragments with this detector system.

- large spatial separation between the proton and neutron spectators on the plane located at 9m from the target for Au+Au @4.5 AGeV with different event generators.

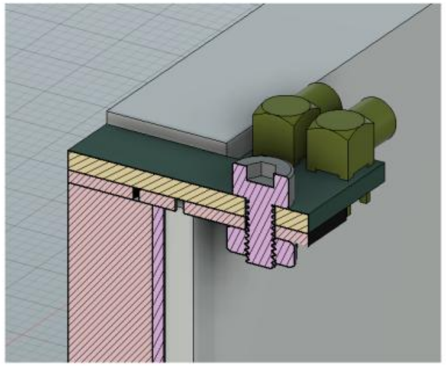
Schematic views of scintillation wall design







MPPC mounting with small PCB



Ion beam pipe for BM@N experiment current status and schedule

LLC “Vacuum systems and technologies”
A. Kubankin at all.

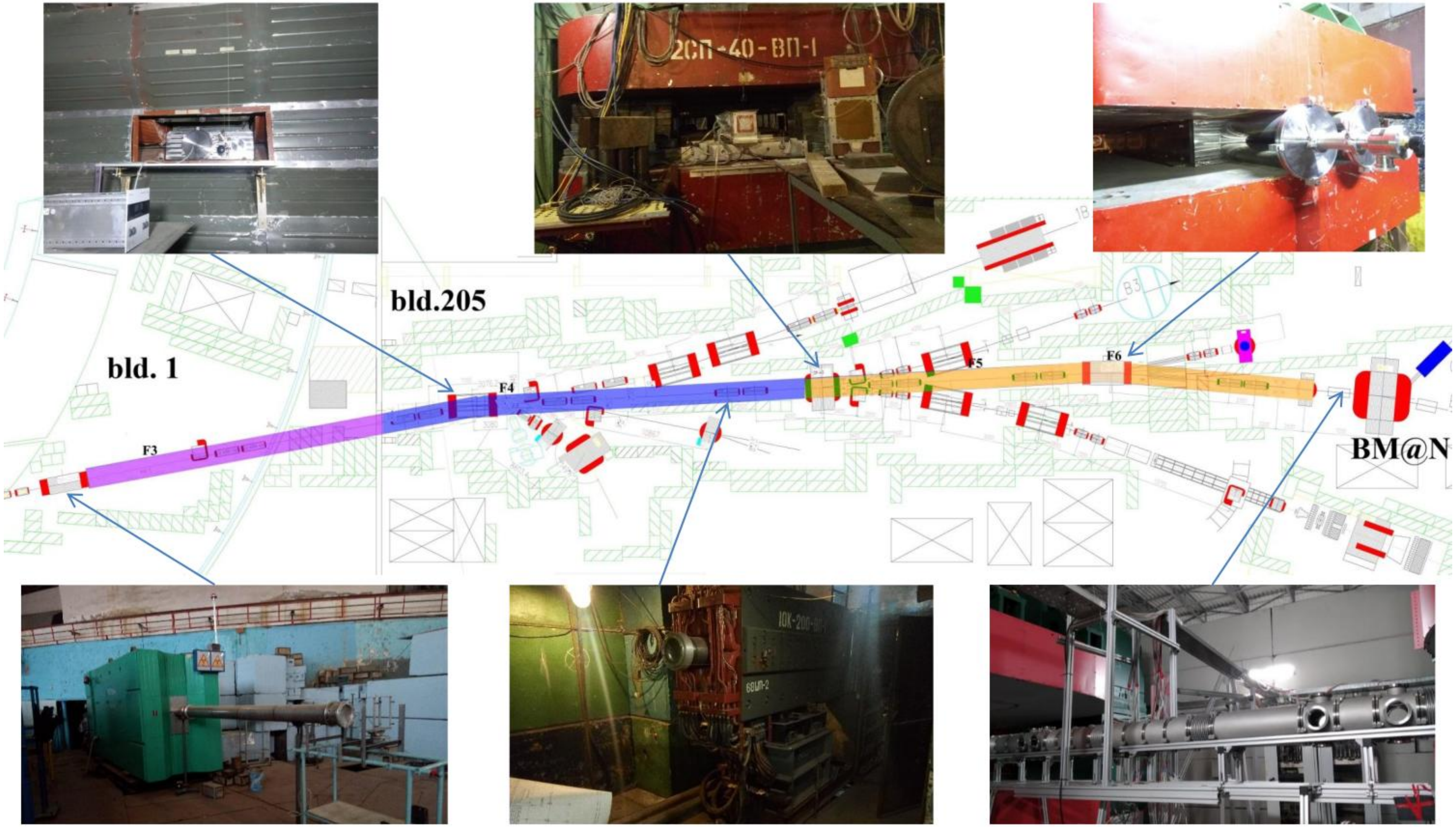
April 2021

The schedule of vacuum ion beam pipe production

- The contract signed on 25 December 2020
- The technical design report has been developed and approved
- The parts of the beam pipe are being produced
- The installation of the beam pipe will start on July 2021
- All parts of the beam pipe will be installed and tested till end of September 2021

The modernized area

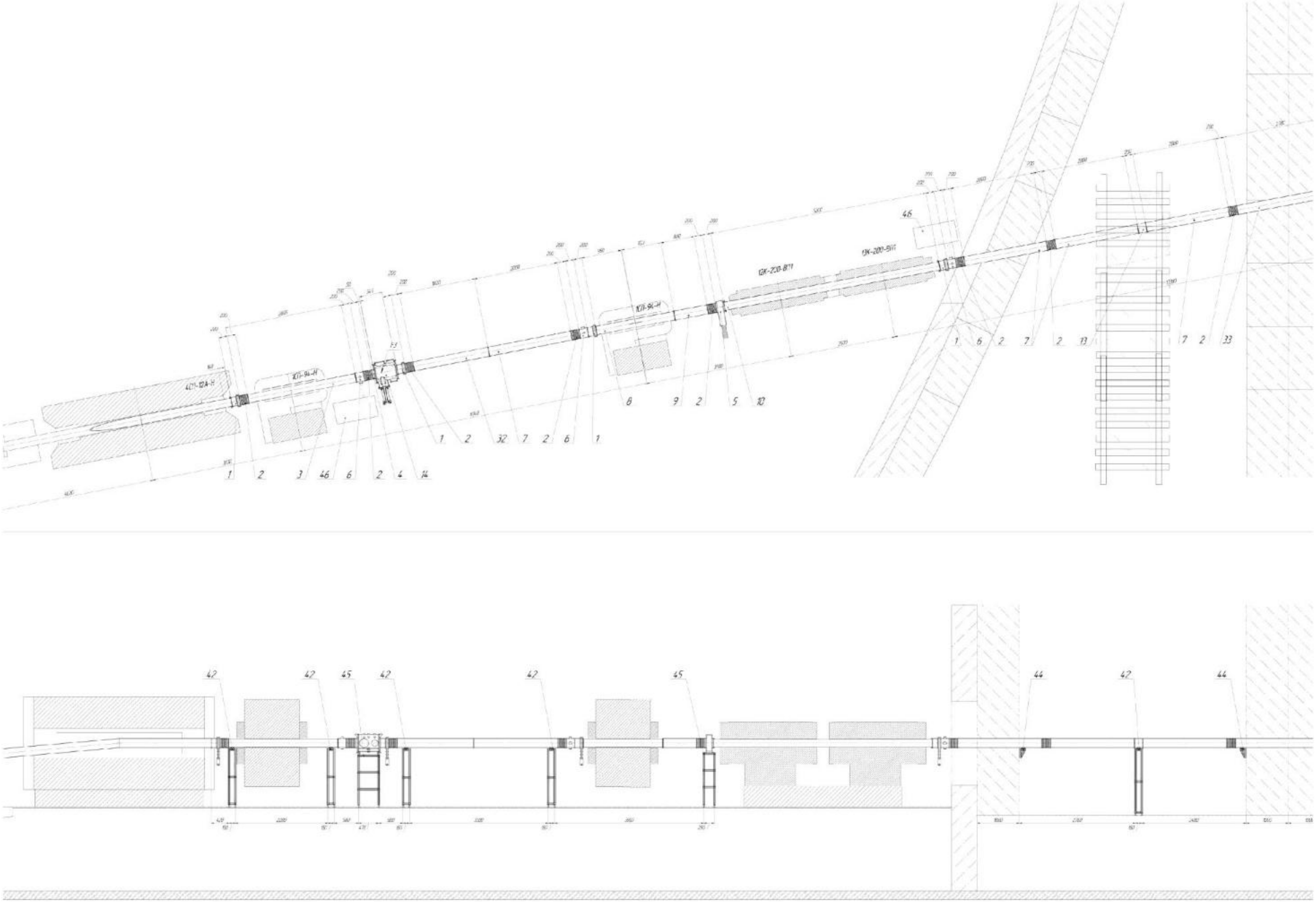
7 quadruple lenses; 6 magnets; 9 ion beam profilometers



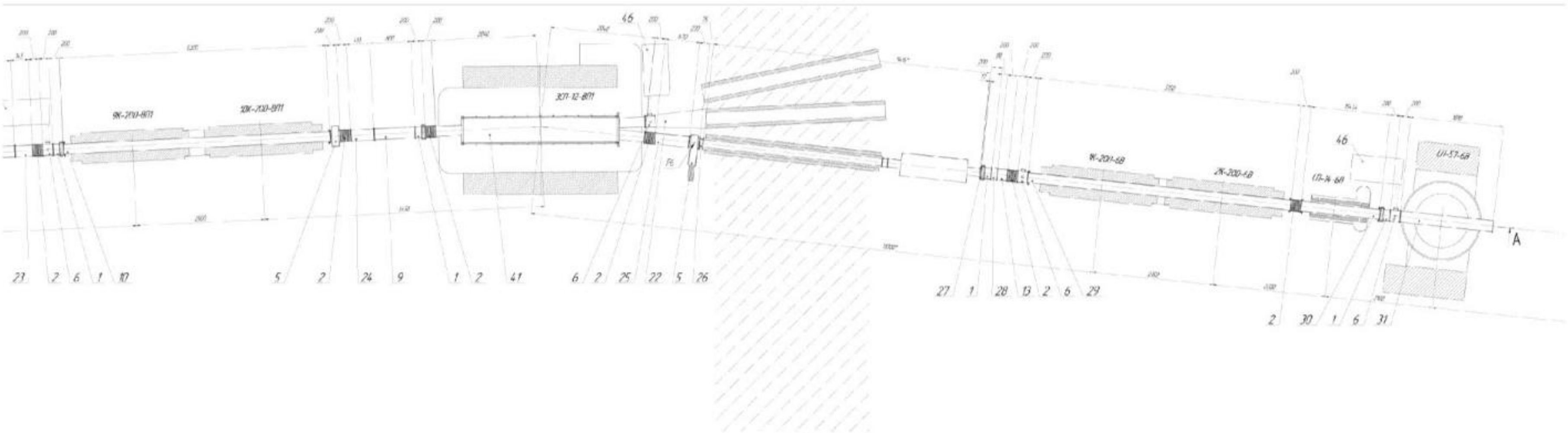
Main elements of the ion beam pipe

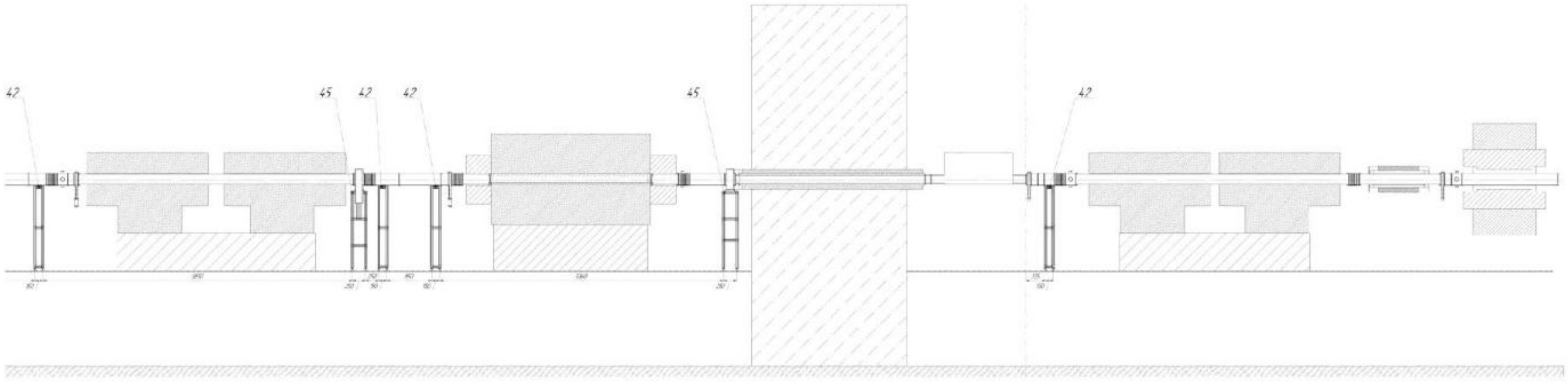
- Vacuum compatible tubes with ISO200 flanges (the total length is about of 63 m)
- Ion beam profilometers (9 pce)
- Vacuum boxes for magnets (4 pce)
- Vacuum pump stations based on roots vacuum pumps (6 pce)
- Vacuum gate valves (14 pce)
- Vacuum radiation resistant gauges with controllers (21 pce)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

The ion beam pipe crossection (from TDR)

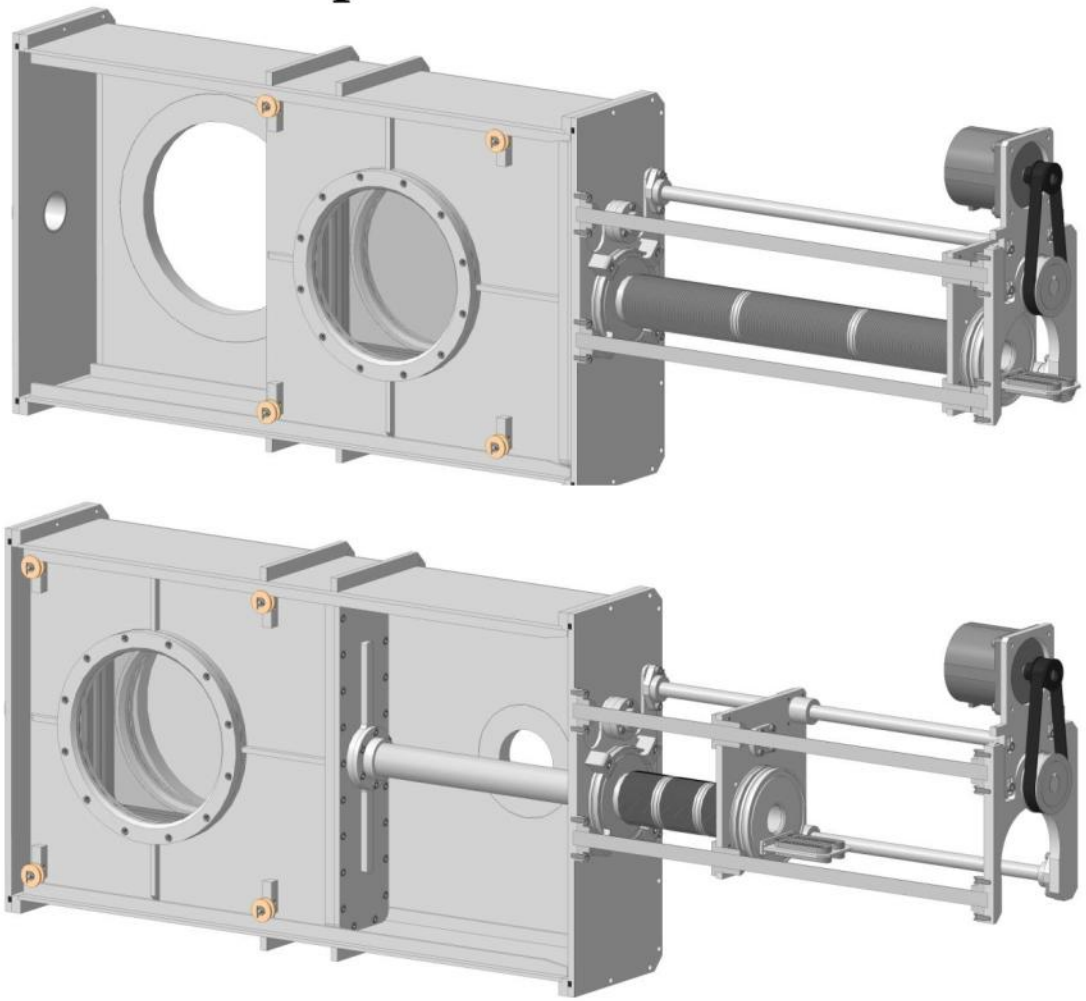


The ion beam pipe cross-section (from TDR)

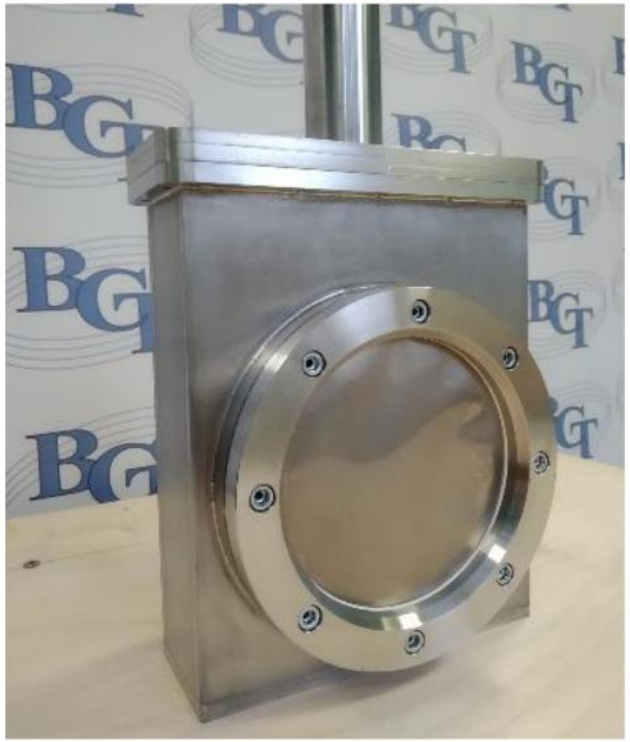




The vacuum compatible ion beam profilometers have been developed with sensitive area 80x80 mm and 200x200 mm

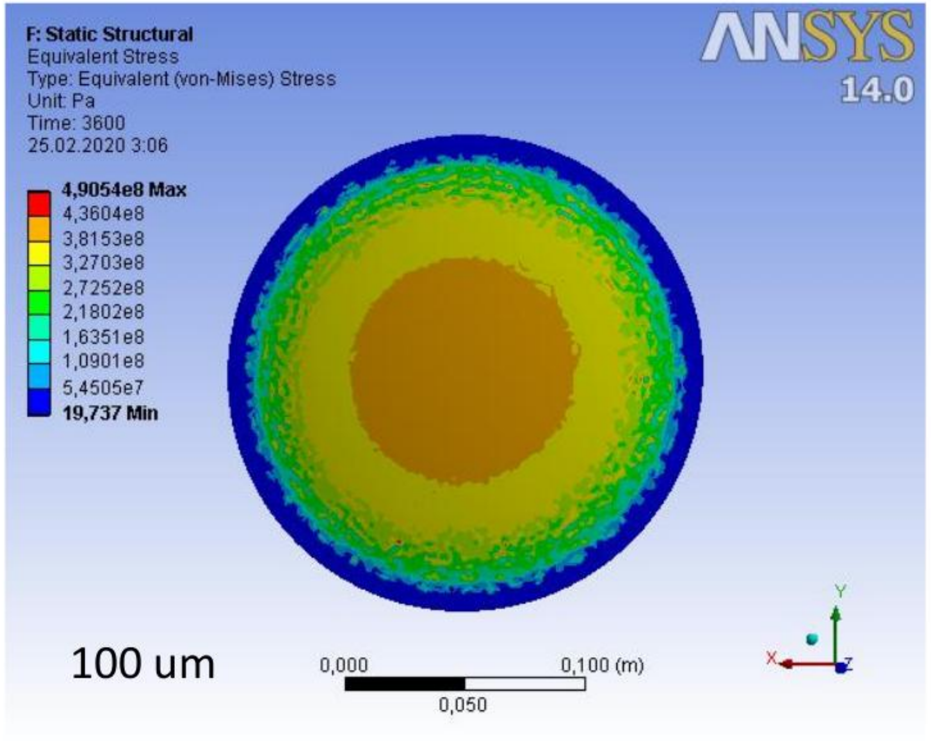


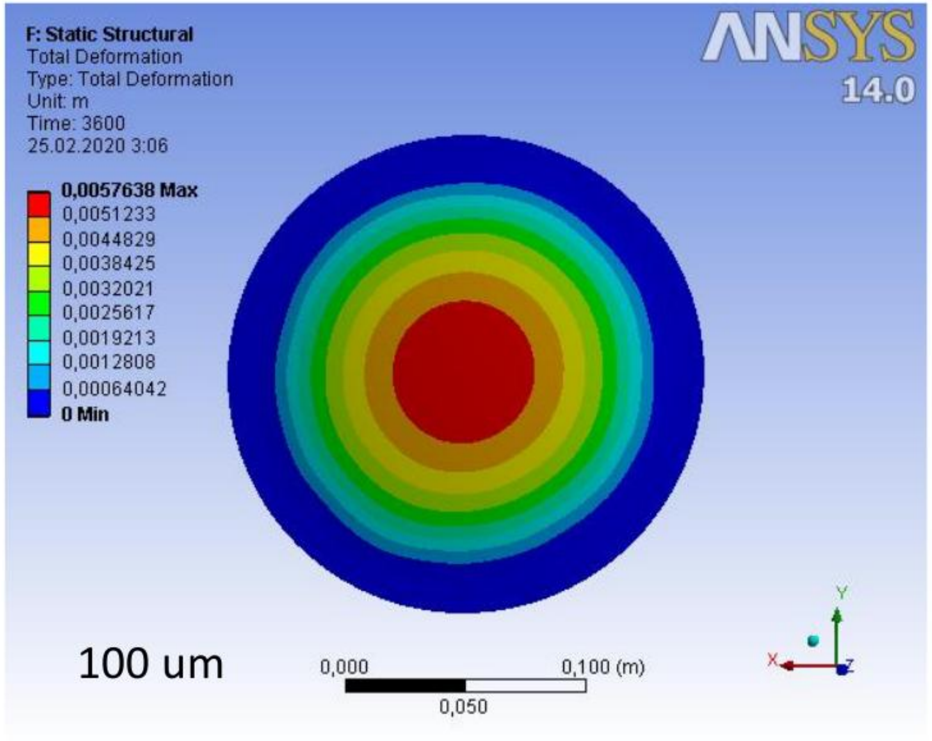
Vacuum box with the beam profilometer.
Two positions of the profilometer: in and out of the ion beam.



Vacuum body of the profilometer has a thin titanium window

Modeling of properties of the thin titanium windows





The real tests show the possibility of thin titanium windows application under pressure difference 2.5 bar.

Magnetic field measurements of SP-41 dipole magnet

Experiment BM@N

Shindin Roman

BM@N workshop, JINR LHEP

April 19, 2021

Contents

Magnetic field Cartographer

Figure: Sergey Alexeevich Dolgy
and his machine for magnetic fields measurements

Probe moving and positioning

Carriege mechanics

Figure: Mechanics of moving along the 5 meters rails

Position reader

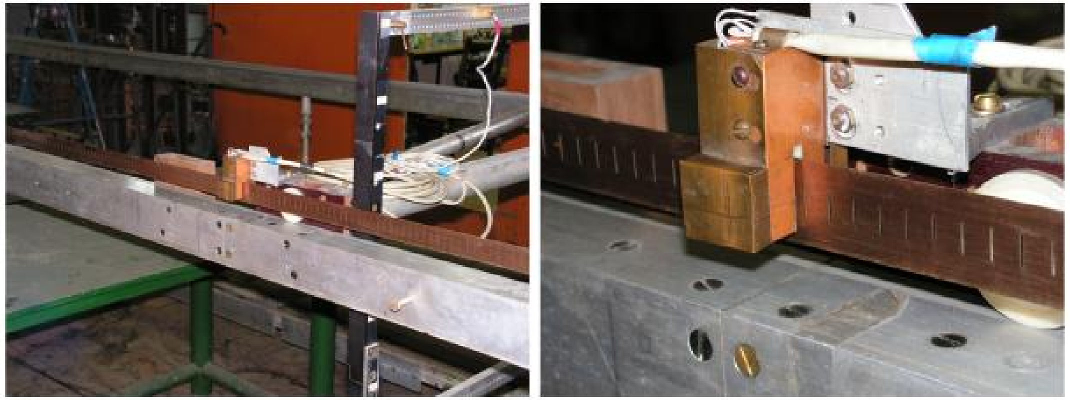


Figure: Trigger is generated by the LED-reader and perforated tape

Estimated precision ~0.2mm

Probe calibration

3D-sensor calibration

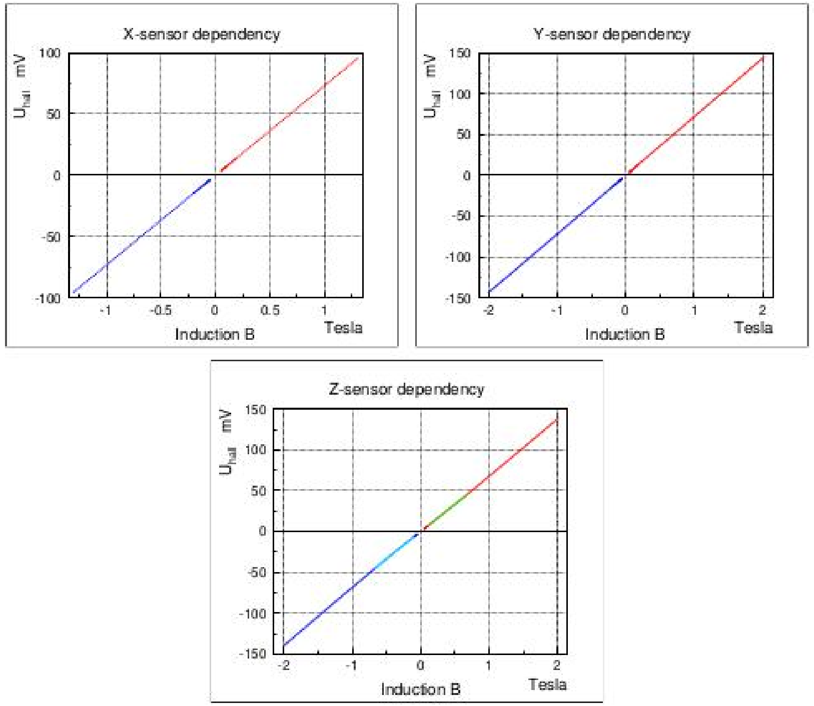


Figure: Hall-probs magnetic dependensies

Calibration factory

Figure: Calibration magnet up to 2 Tesla
Plastic box for NMR-cell and Hall-sensor fastening

Measurements of SP-41 field in 2016

Towards to measurements 2016

Figure: View to magnetic machine inside the SP-41 magnet
controll electronics and high precision current sour

Full map was measured
in ~40 hrs

Towards to measurements 2016

Figure: Magnetic machine inside the SP-41
and moving platform to change its position

Vertical field component near the poles

B_z

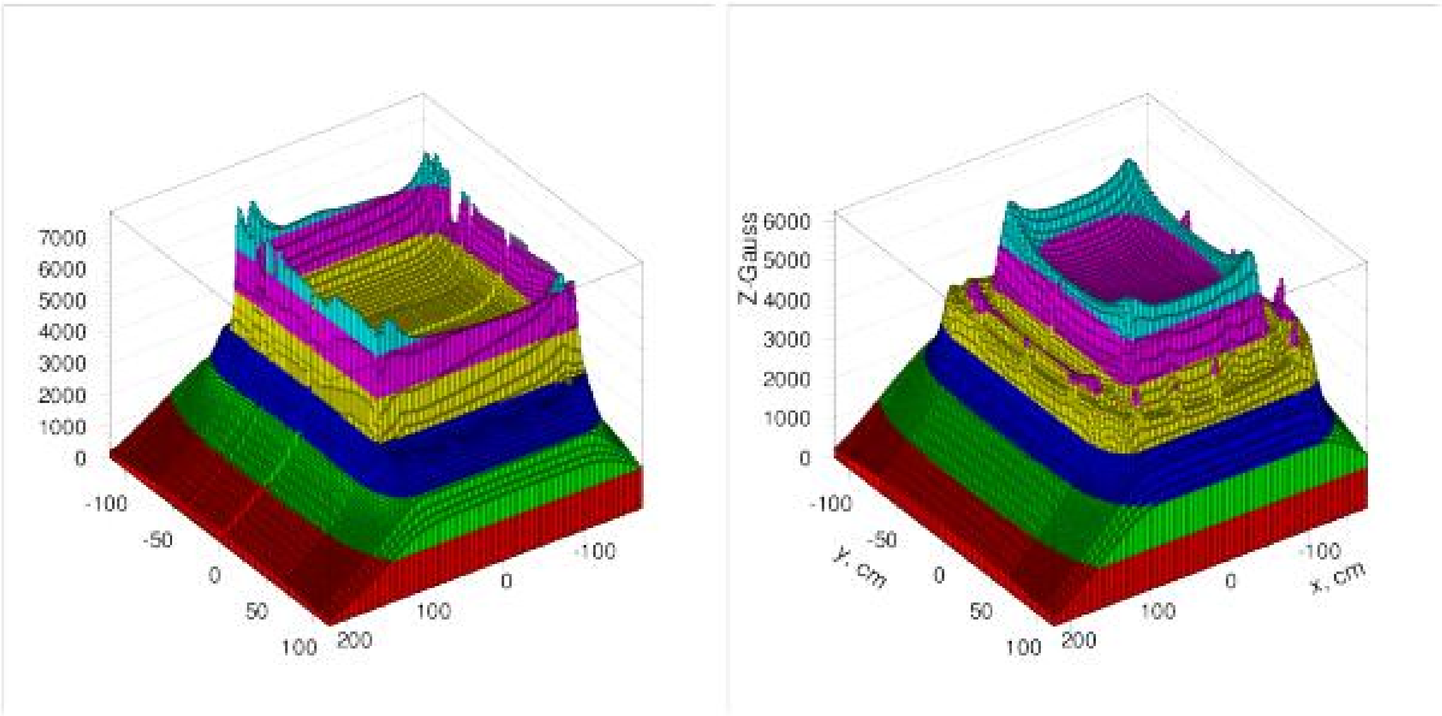


Figure: B_z projection nearby the down and top poluses

Plans for the new measurement

Wide and more long frames

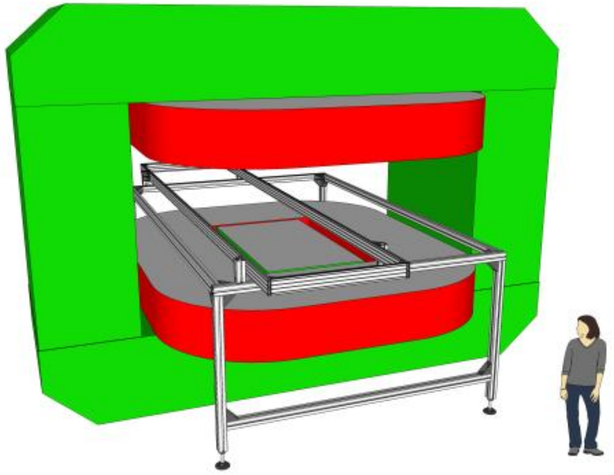


Figure: Length 7m, Width 3m

Figure: Pelcom Dubna Machine-building factory

Senis production

1. 3-axis Hall probes
2. High measurement range: 20mT to 20T
3. High magnetic resolution: $< 1uT$
4. High linearity: $< 0.05\%$
5. f-bandwidth DC - 75kHz
6. Temperature: -40°C to 155°C

Suggestion to add permanent probes inside SP-41

Sergey Nepochatykh

Joint Institute for Nuclear Research

The impact of materials and frames on trigger protons and recoil fragments

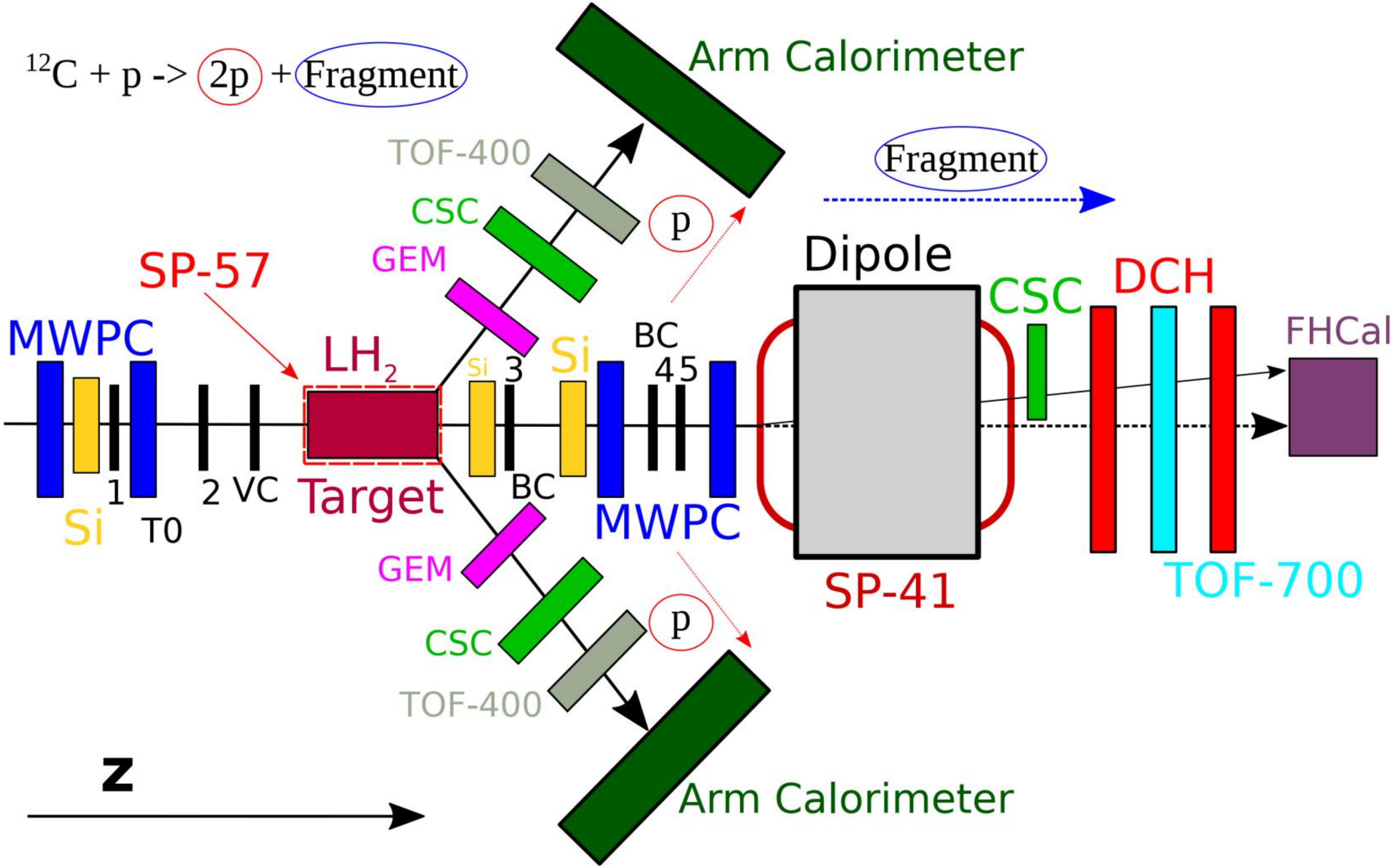
(SRC Experiment)

BM@N Collaboration Meeting

Parallel sessions: Detector Meeting

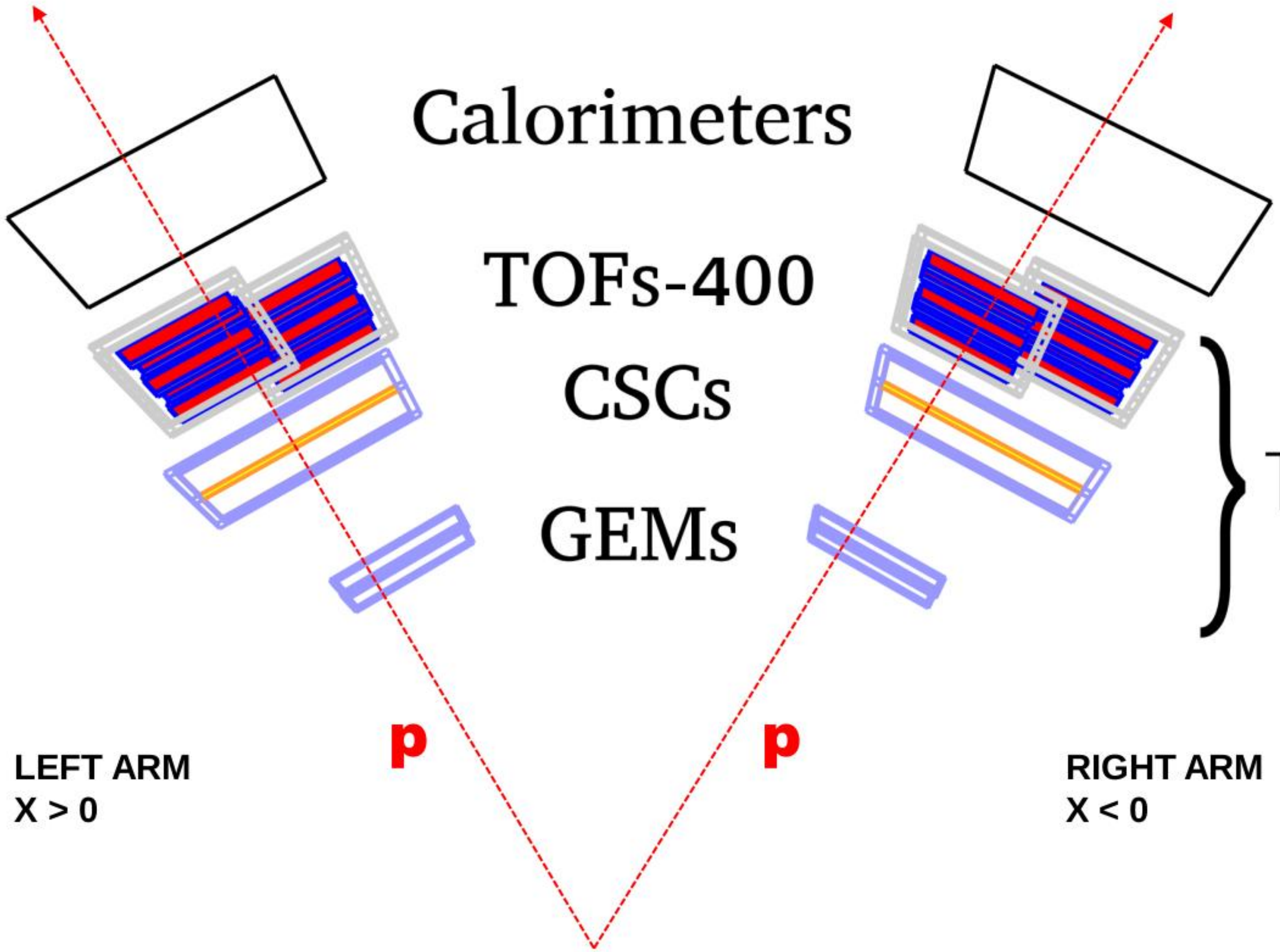
19th April 2021

SRC RUN 2021: Experimental Setup



Two-arm spectrometer configuration

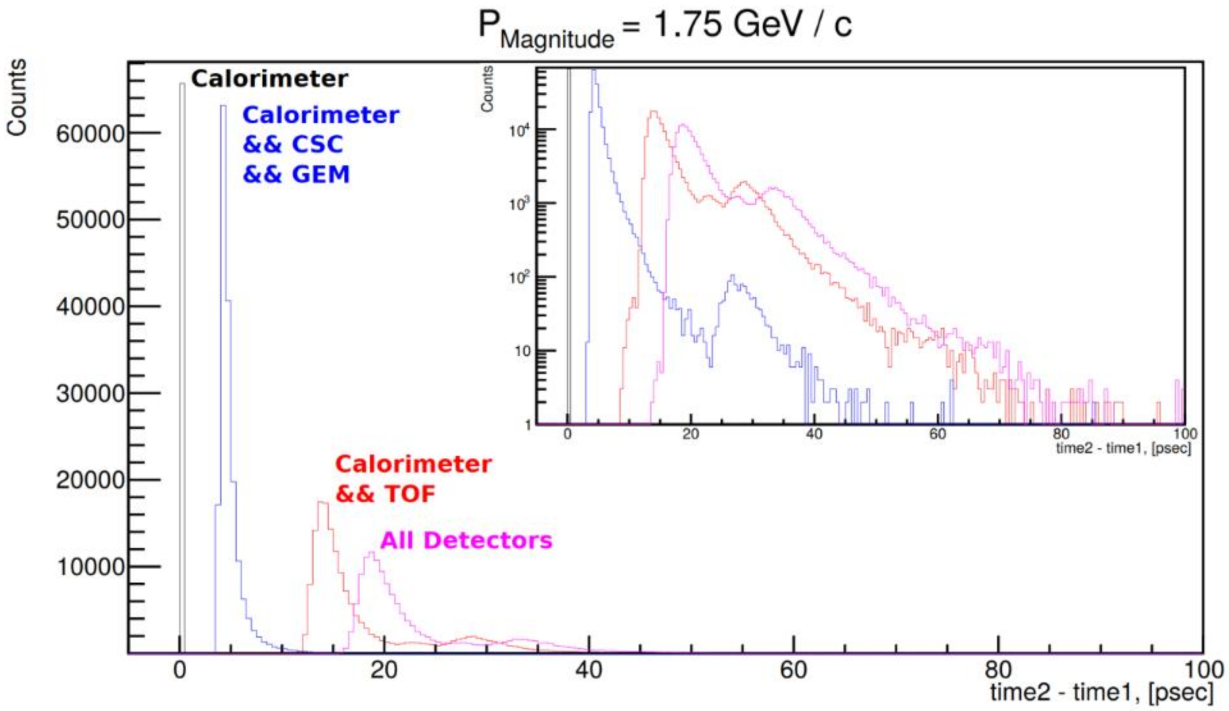
The Position from the target on z

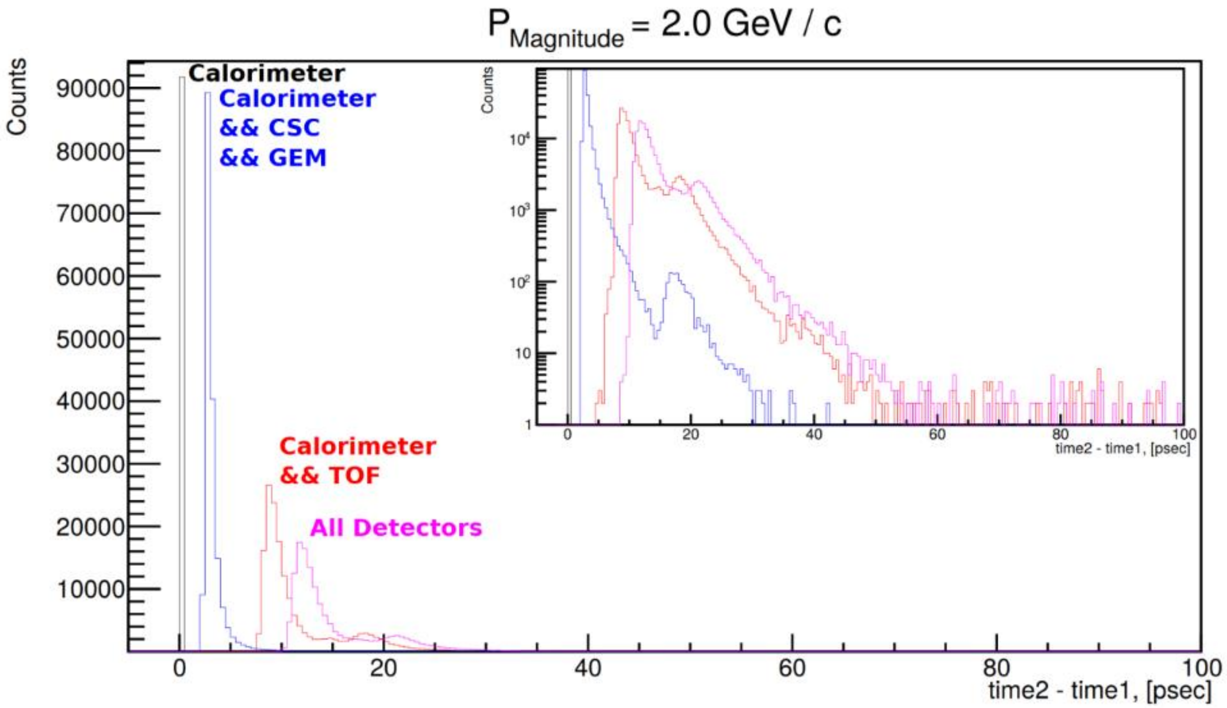


~ 4m

To cover their acceptance

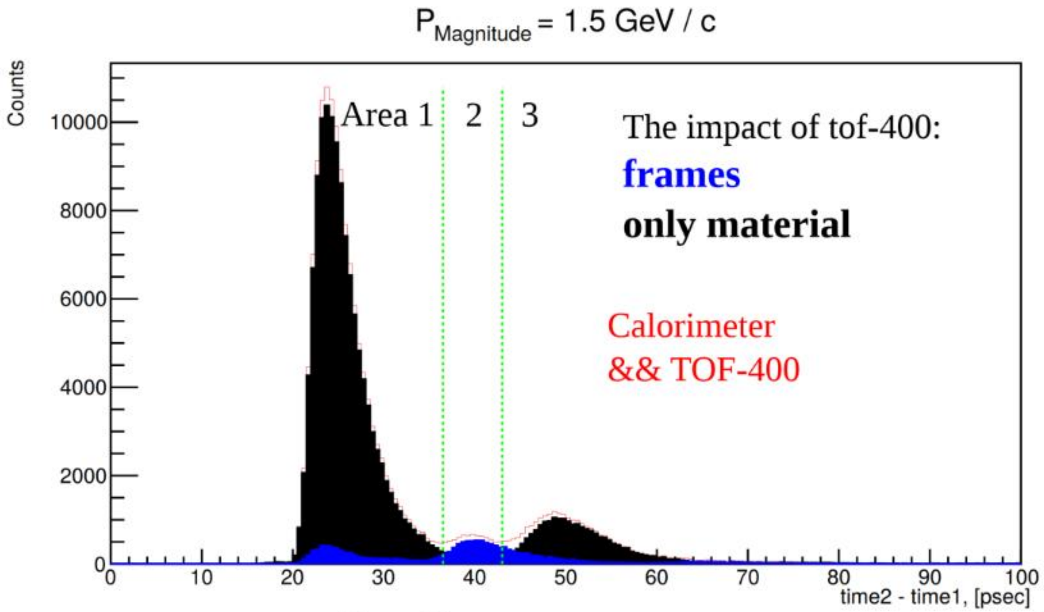
The impact of arm detectors on calorimeter time resolution

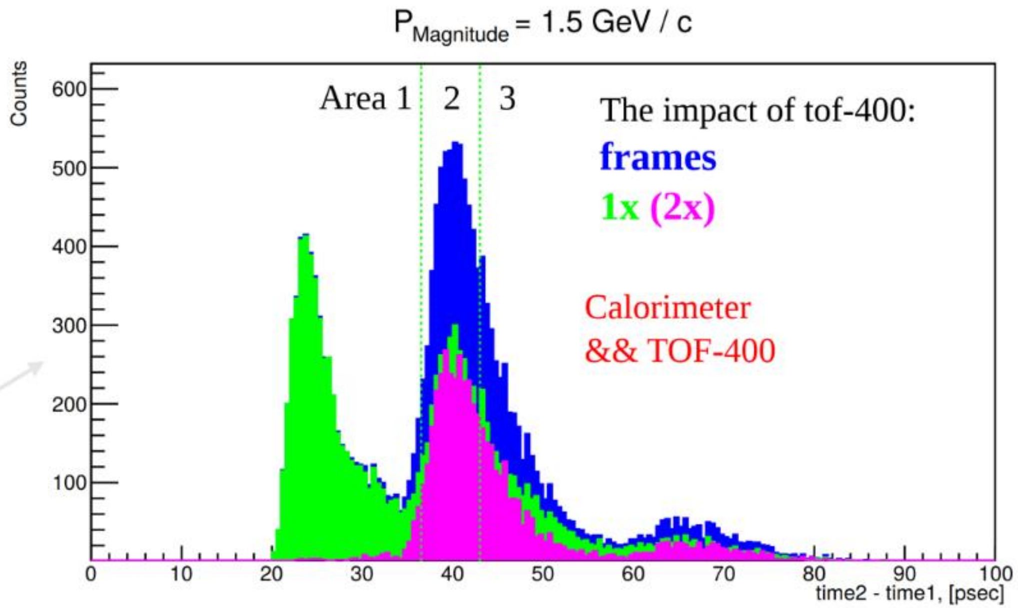


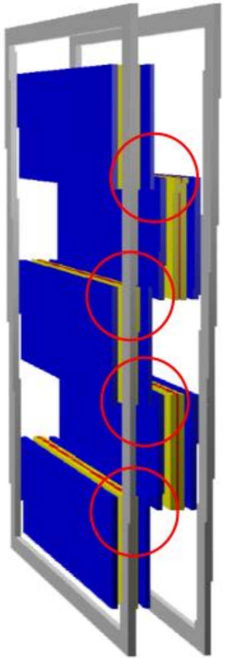


At bigger momentum the peaks get more narrow and become closer to the delta-peak

The impact of TOF materials and frames on calorimeter time resolution



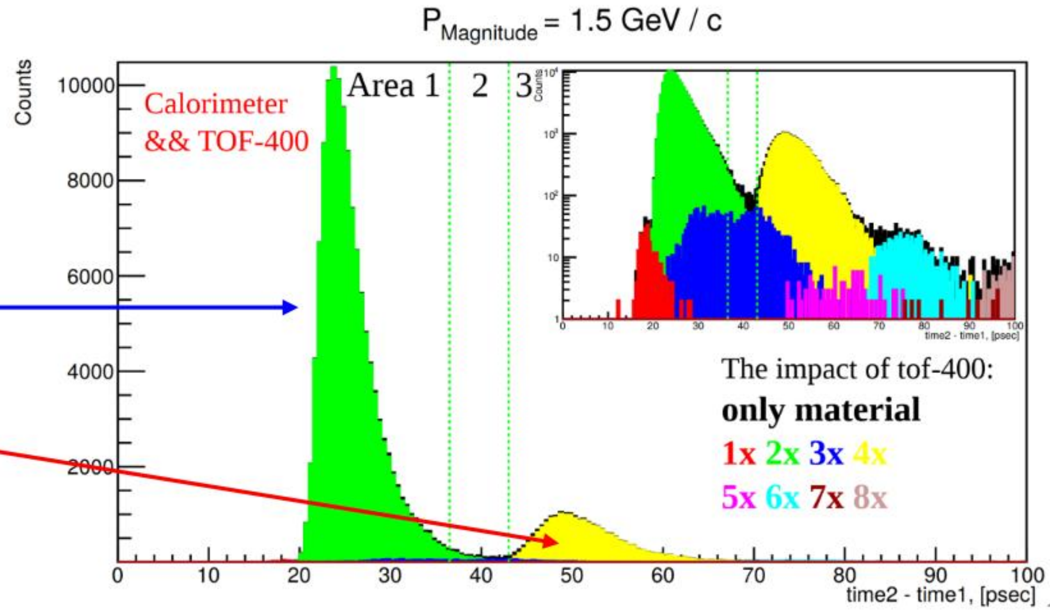




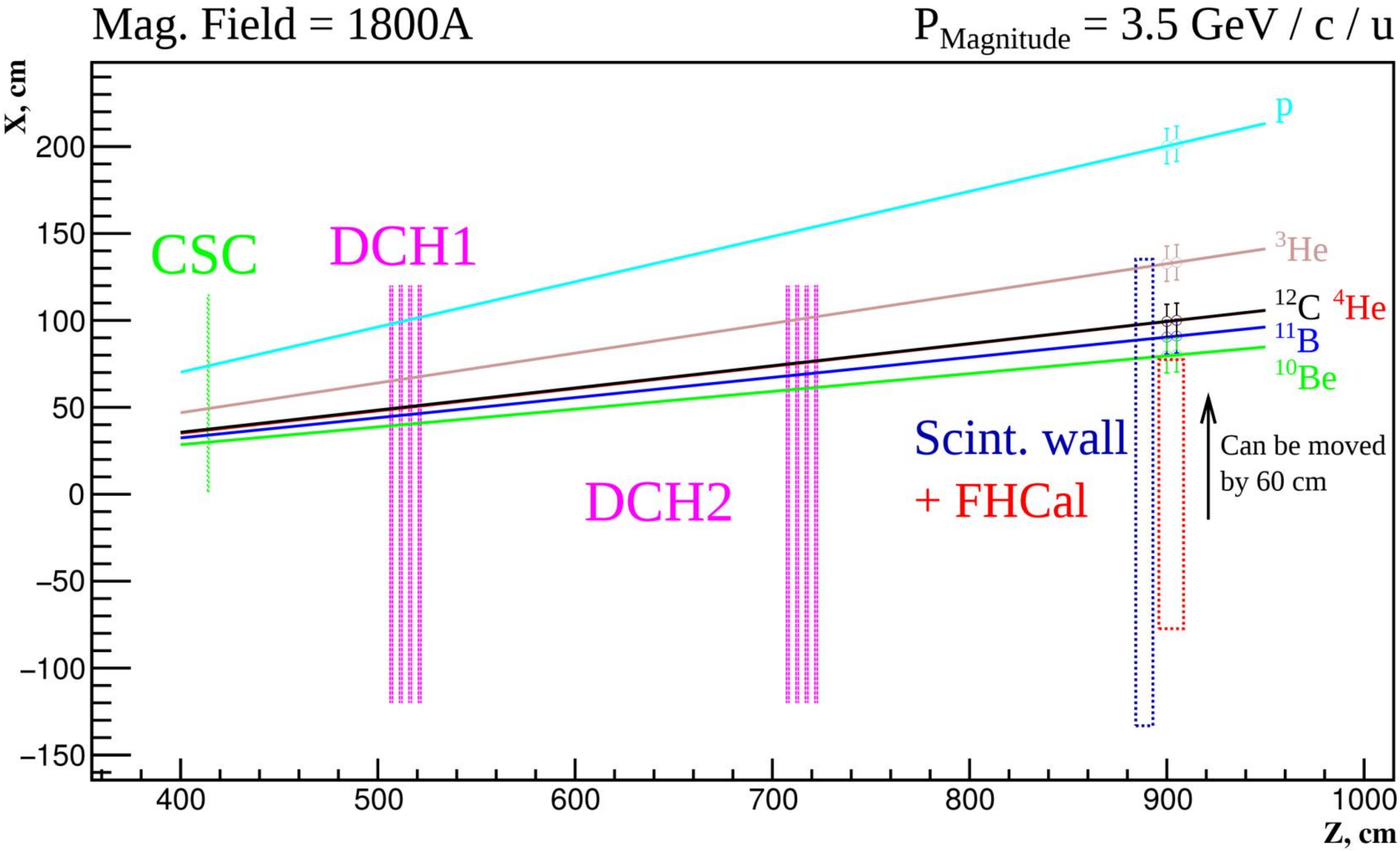
FRAMES

2X MATERIAL PER ONE MODULE

4X MATERIAL DUE TO OVERLAPPING OF 2X MODULES

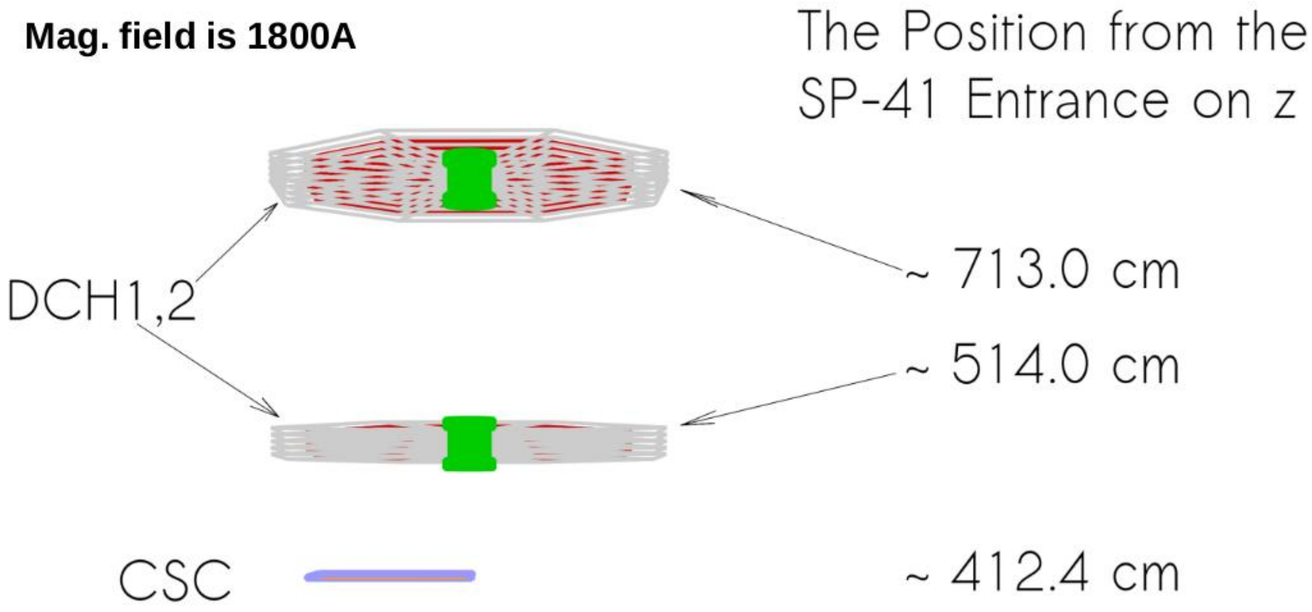


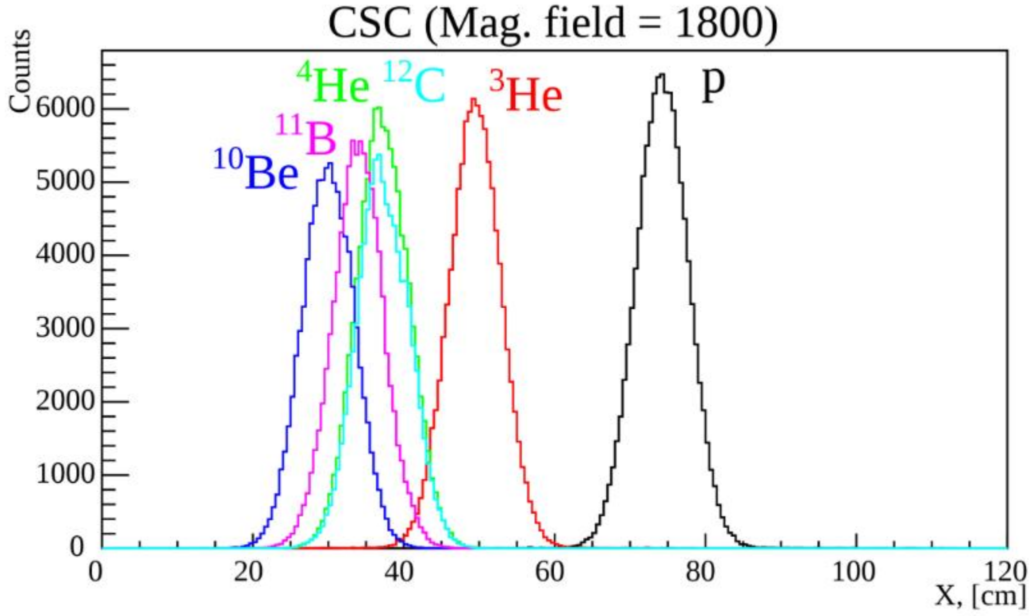
The fragments mean tracks downstream the SP-41 (X-Z Projection)

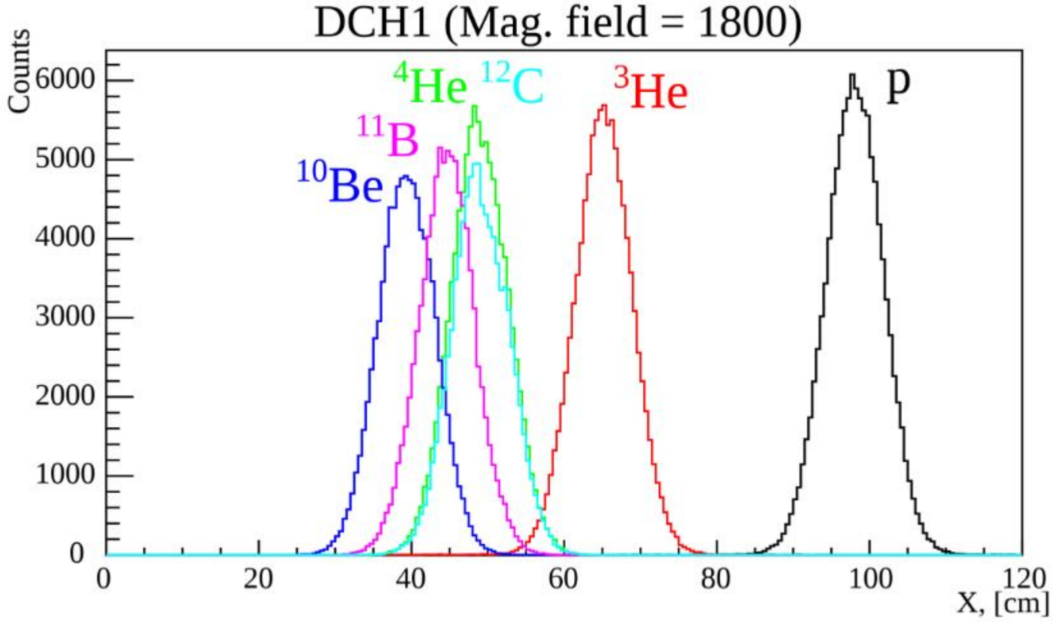


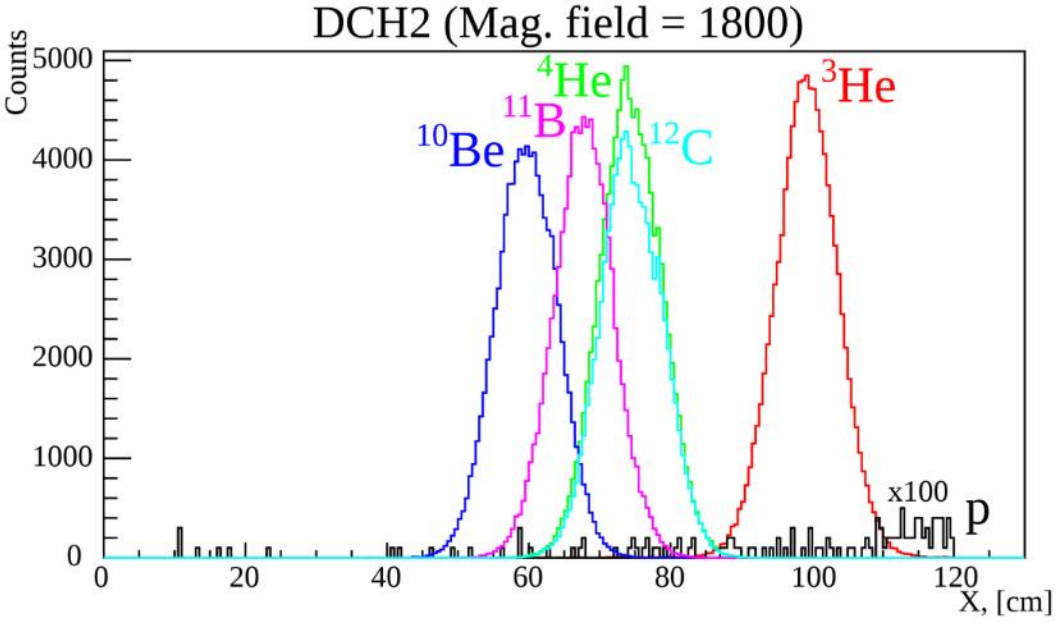
Downstream the analyzing magnet

Mag. field is 1800A







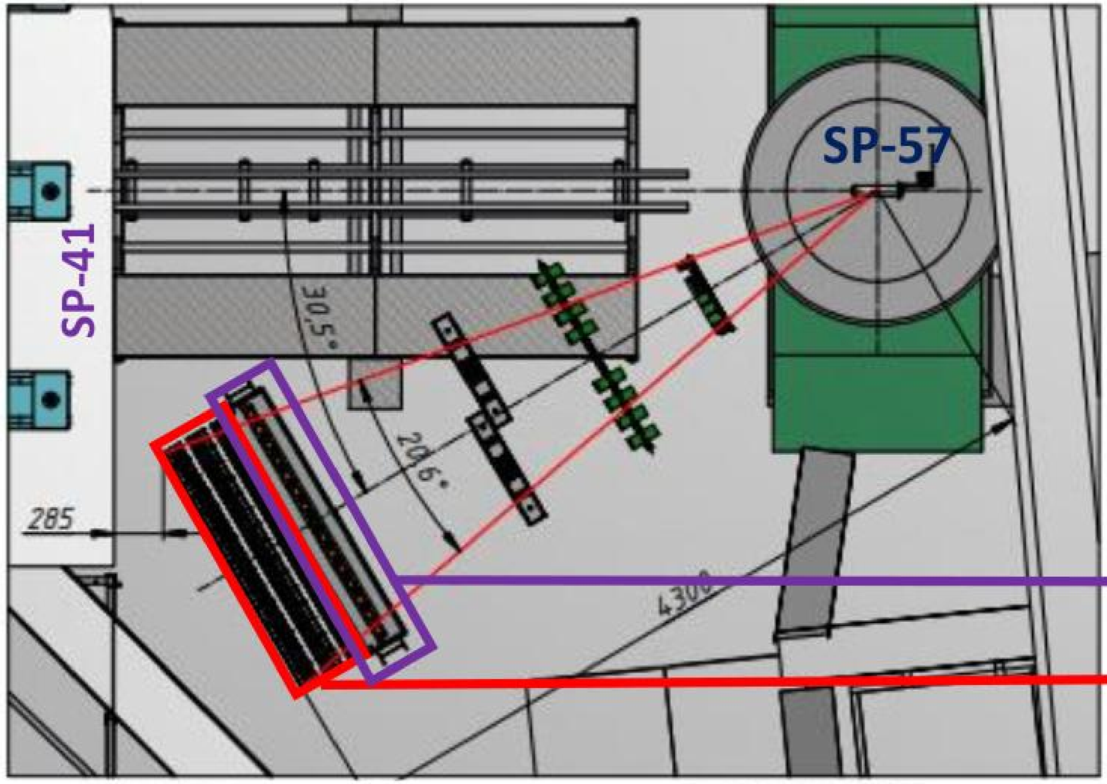


Simulation of magnetic shielding for PMTs next to the SP-41 magnet (SRC experiment)

Timur Atovullaev
Aleksey Shabunov

20th April 2021
7th Collaboration Meeting of the BM@N Experiment at the NICA Facility

Proton-pion calorimeter for SRC

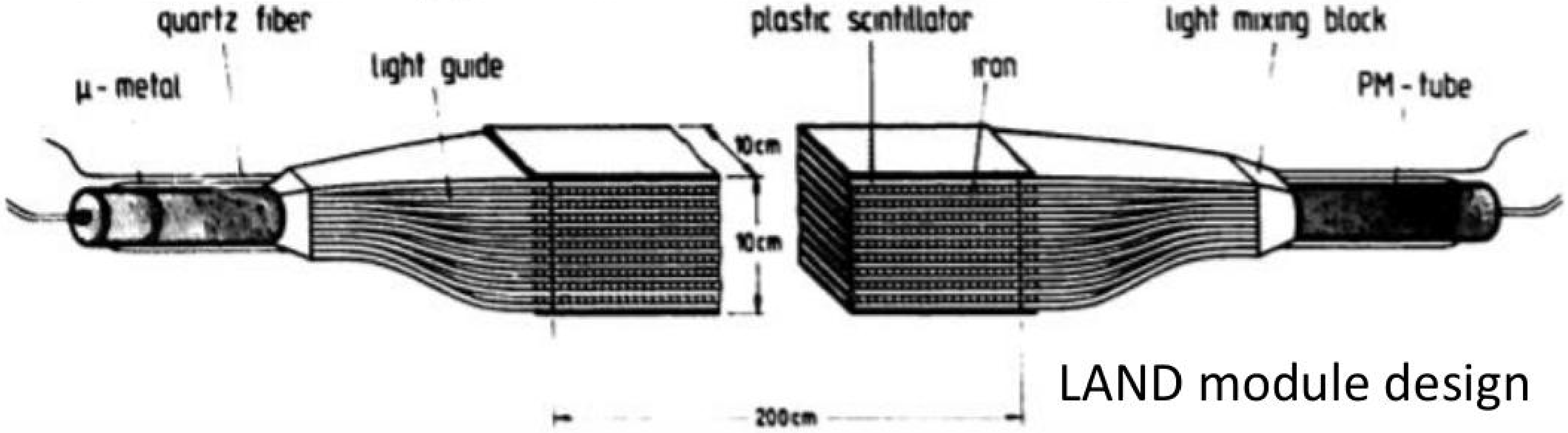


Calorimeter for proton-pion separation
LAND modules

TOF layer for time of flight measurements
6x10x200 cm^3 scintillator bars

1 layer TOF

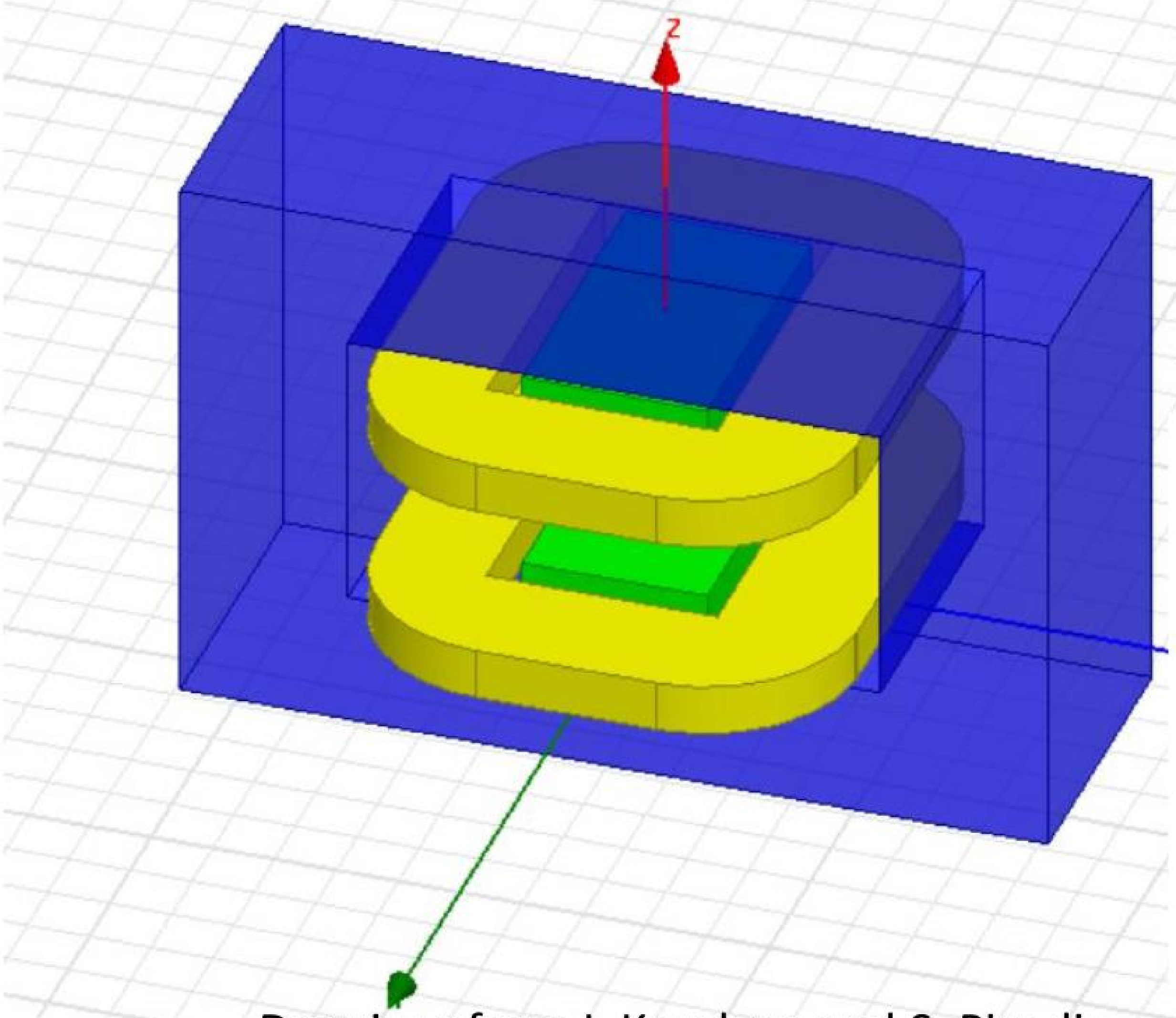
3 layers of LAND modules



LAND module design

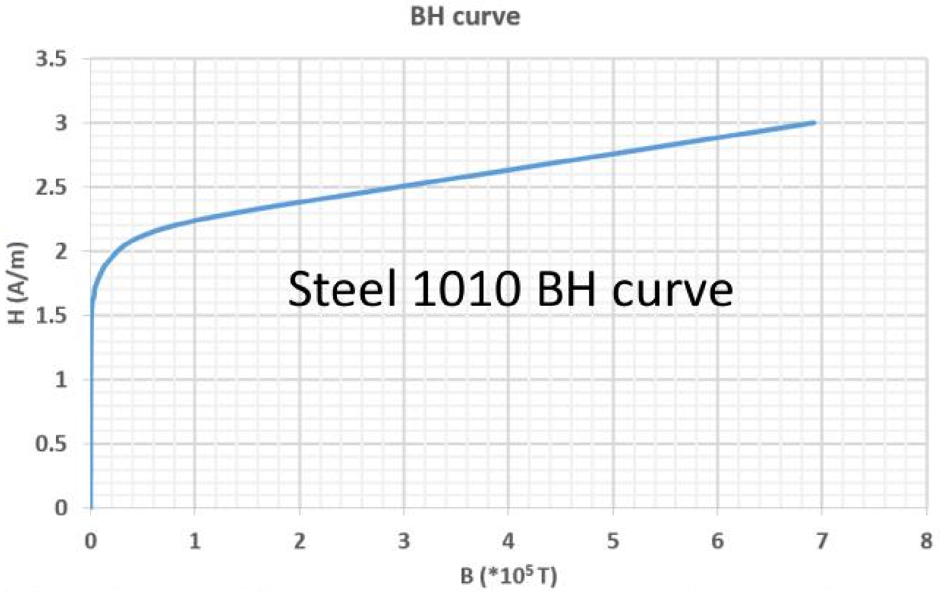
LAND modules:
alternating layers of iron and scintillator

Field inside the SP-41 magnet. Input parameters.



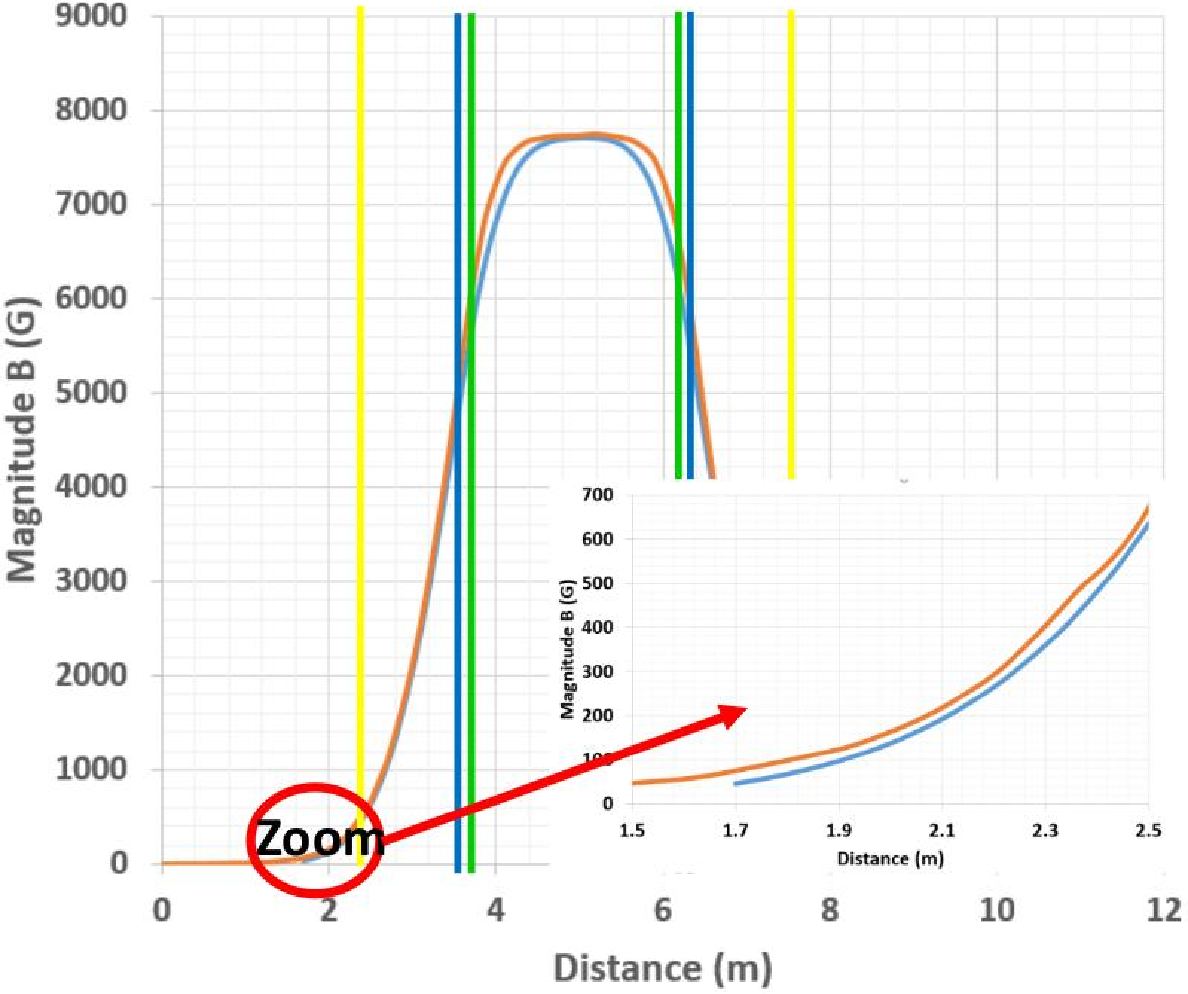
Program: Ansoft Maxwell
Solution type: Magnetostatic
Materials:
- Yoke & poles: steel 1010 (BH curve)
- Coils: copper

Current: assumed 200 turns x 1800 A



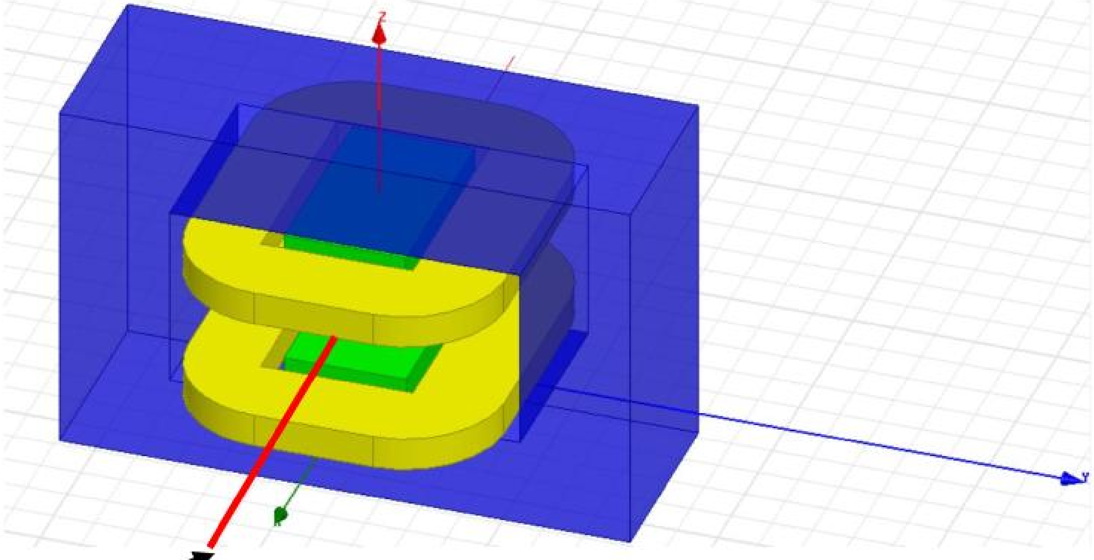
Drawings from I. Kruglova and S. Piyadin

Field inside the SP-41 magnet. Comparing to the field map



Measured data (blue line) were obtained in the limited area of the SP-41 magnet. Not including the region of the PMT.

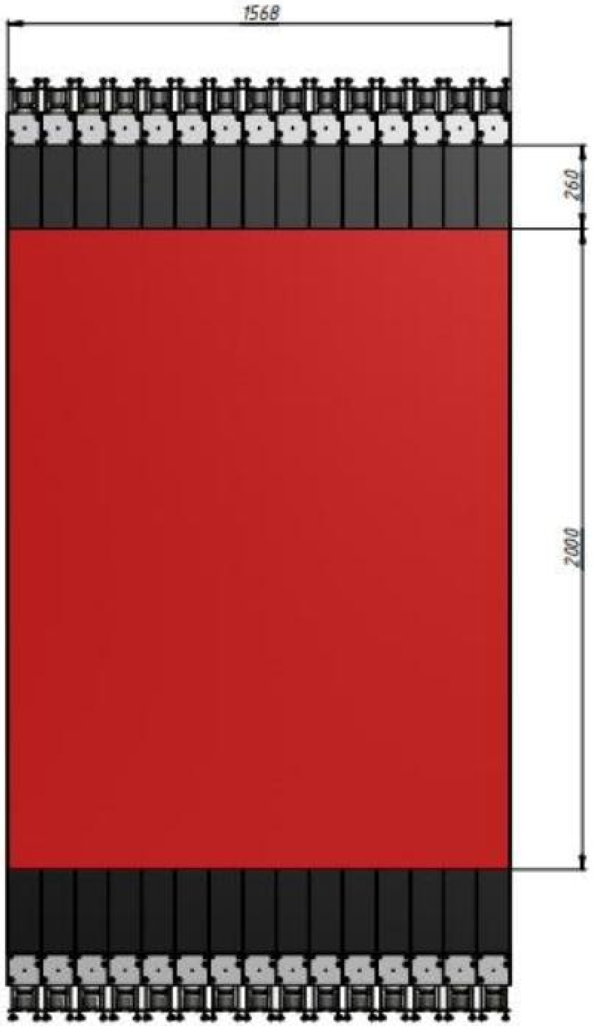
$B_{MaxM} = 1.15 * B_{MaxS}$

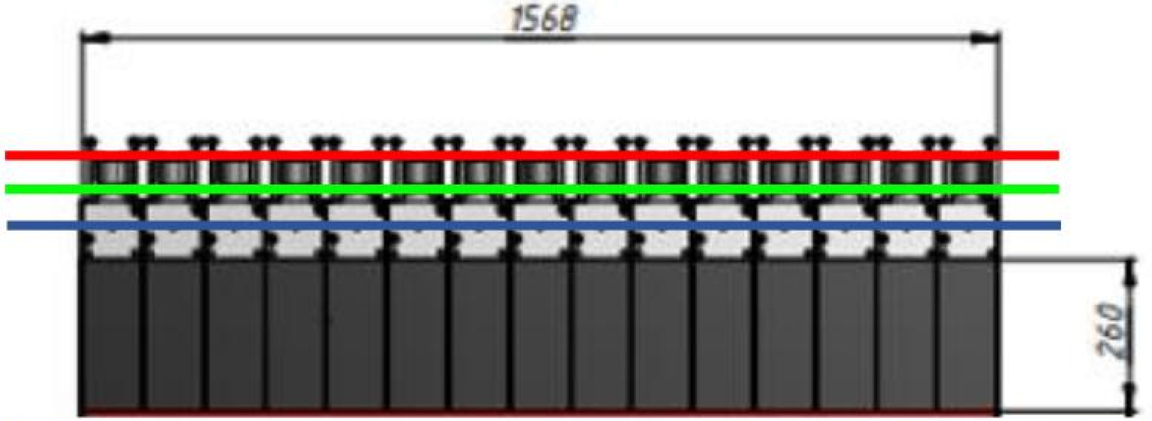


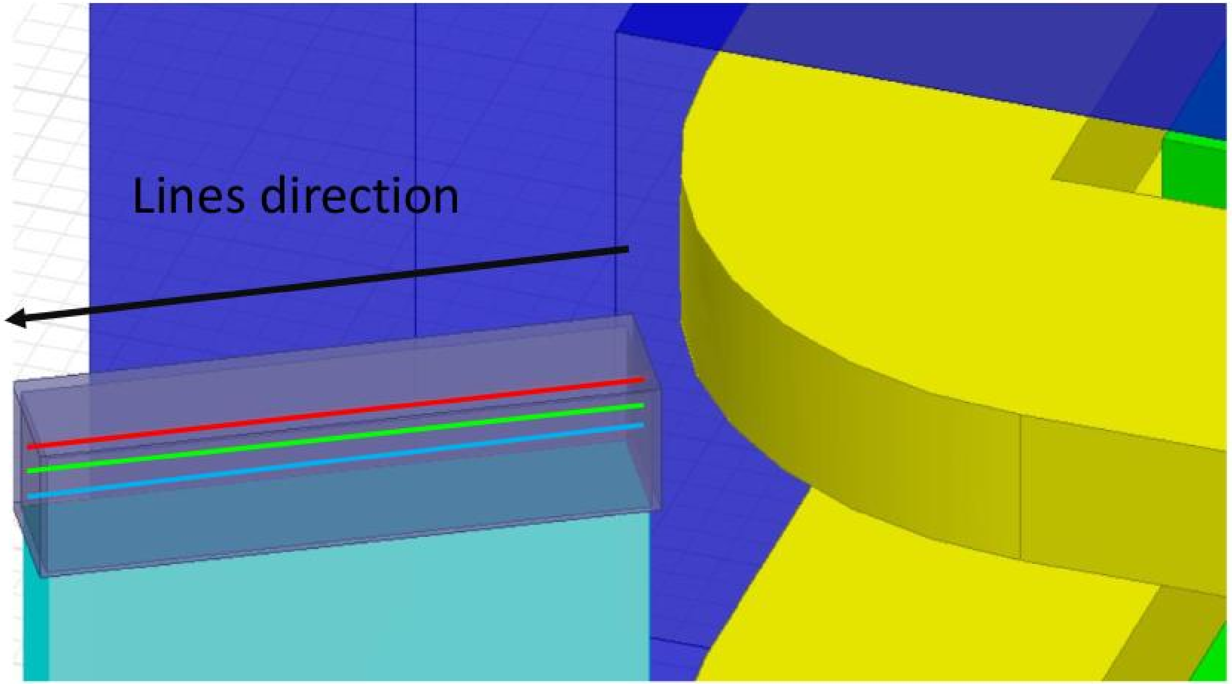
Field is measured along the line

Field at the PMTs.

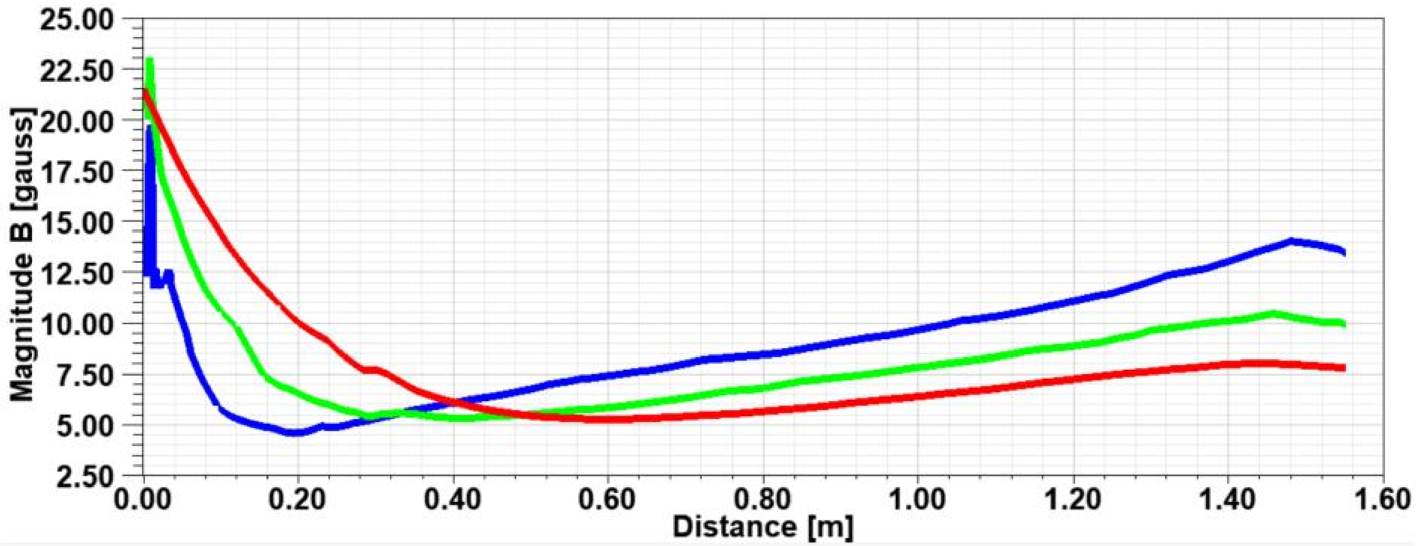
Field is measured along the line crossing the axis of each PMT near the top, middle and bottom of each PMT

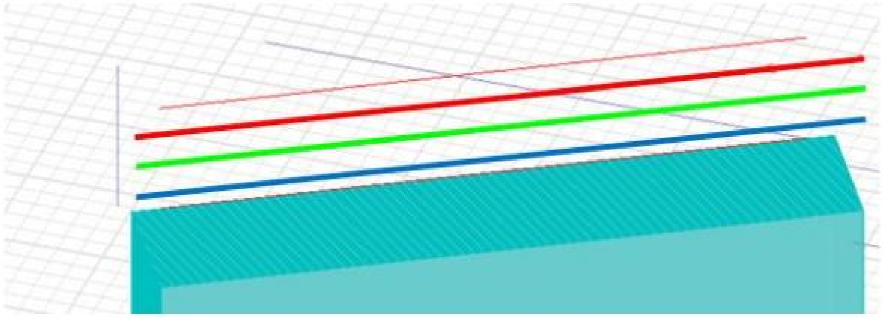




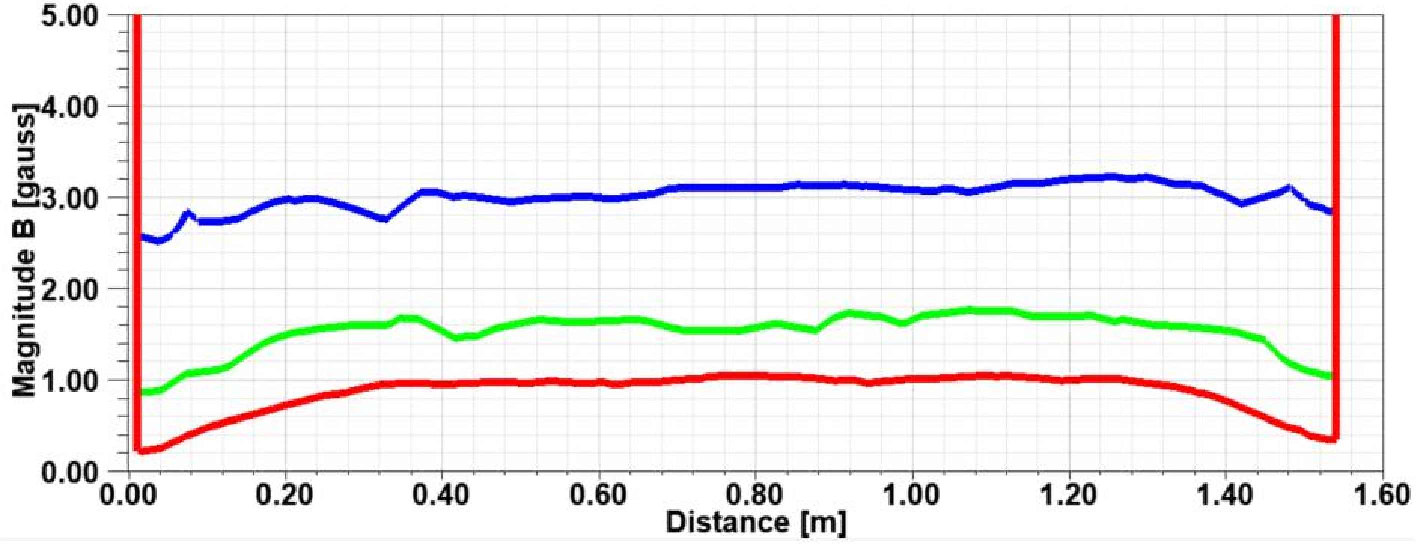


Field at the PMTs. The field in the box
Bottomless hollow box covers PMTs of the calorimeter



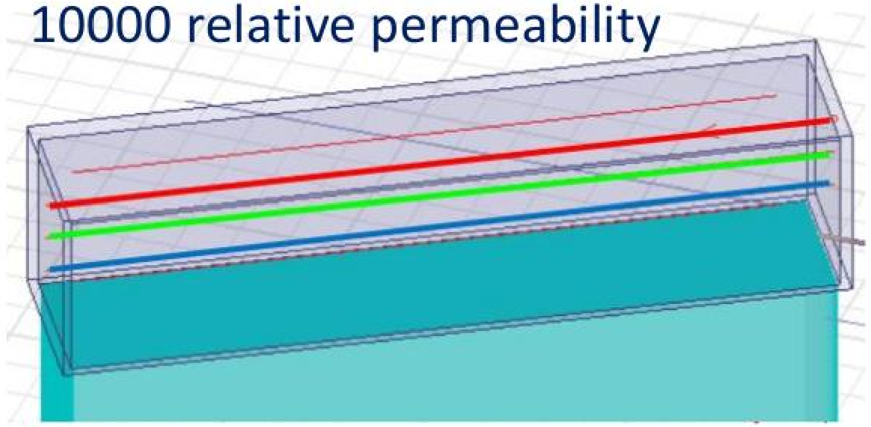


Without box



20 mm box thickness

10000 relative permeability

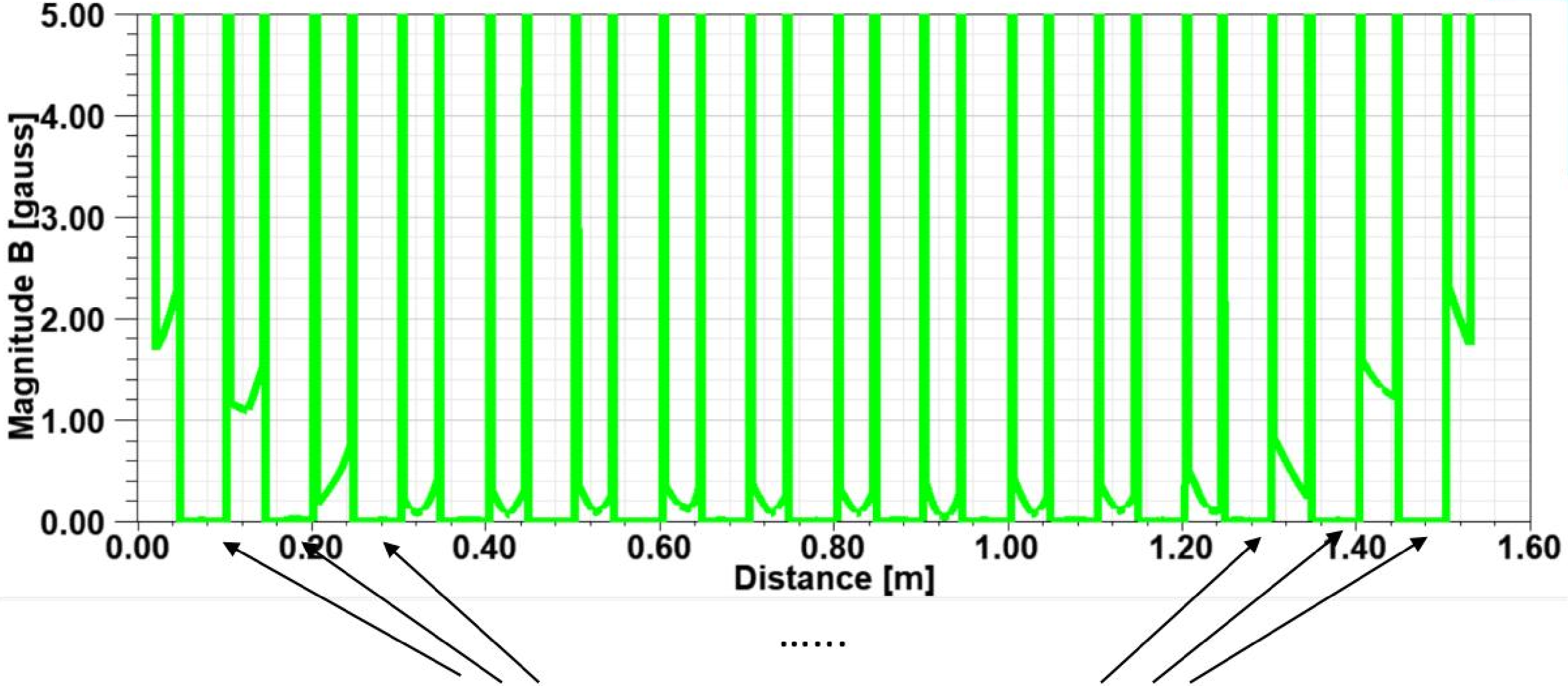


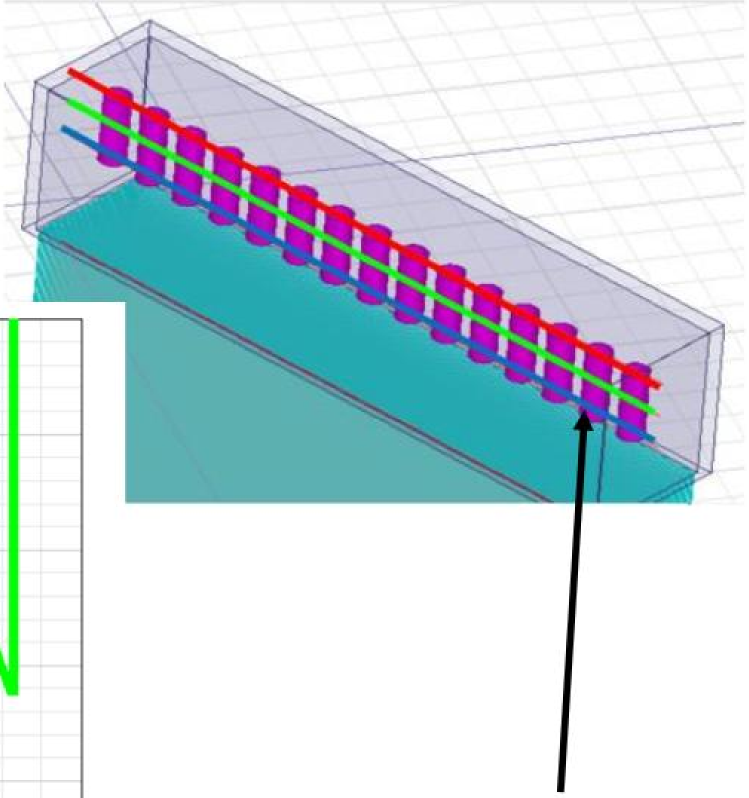
With box

The field inside the box < 5 Gauss

Field at the PMTs. Box and mu metal shielding

LAND modules include mu-metal shielding around PMTs. So that mu-metal tube have been added to the simulation.





Inside box + mu-metal the field is less than 1 Gauss

BM@N carbon beam pipe

M. Janda[1], F. Lopot[1], M. Rachac[1]
P. Chudoba[2], A. Kugler[2], V. Kushpil[2]

[1]Faculty of Mechanical Engineering of the Czech Technical University
[2]Nuclear physics institute, The Czech Academy of Sciences

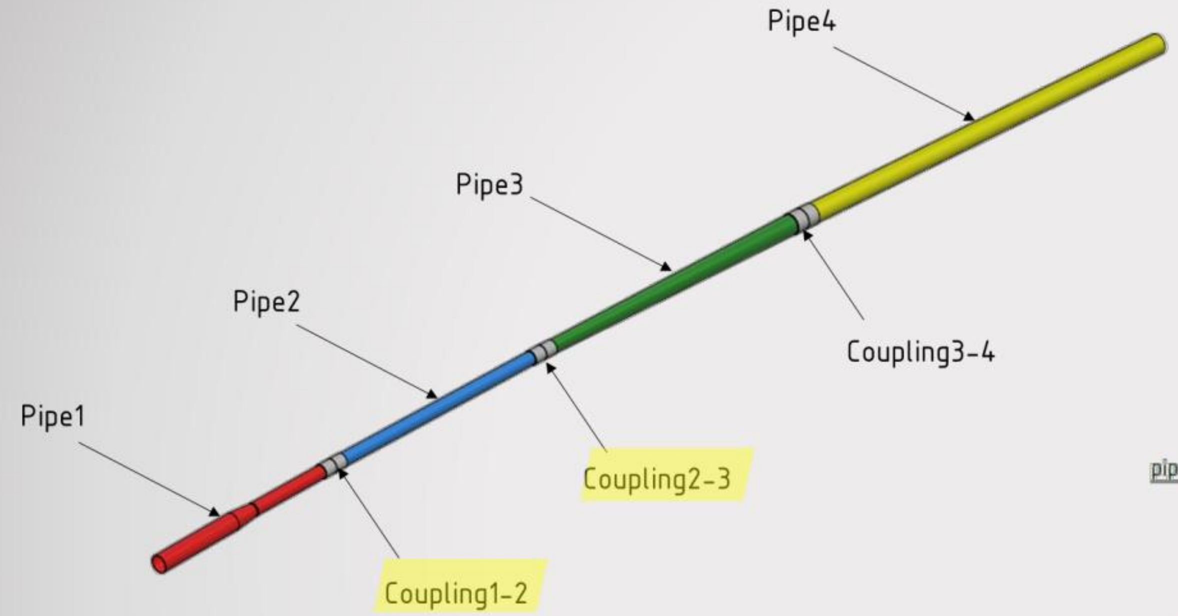
Nuclear Physics Institute

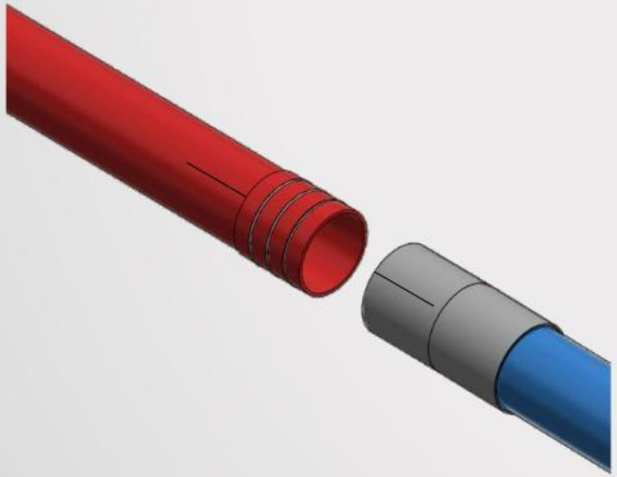
chudoba@ujf.cas.cz

April 19, 2021

CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF MECHANICAL ENGINEERING

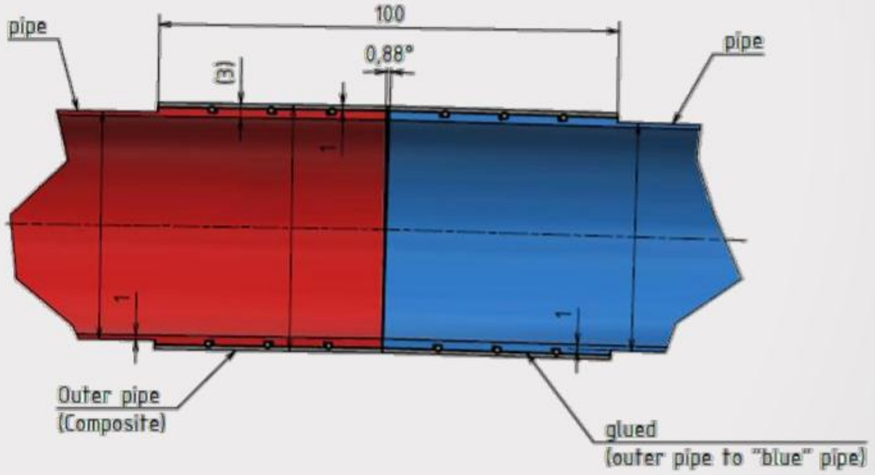
BM@N carbon PB design



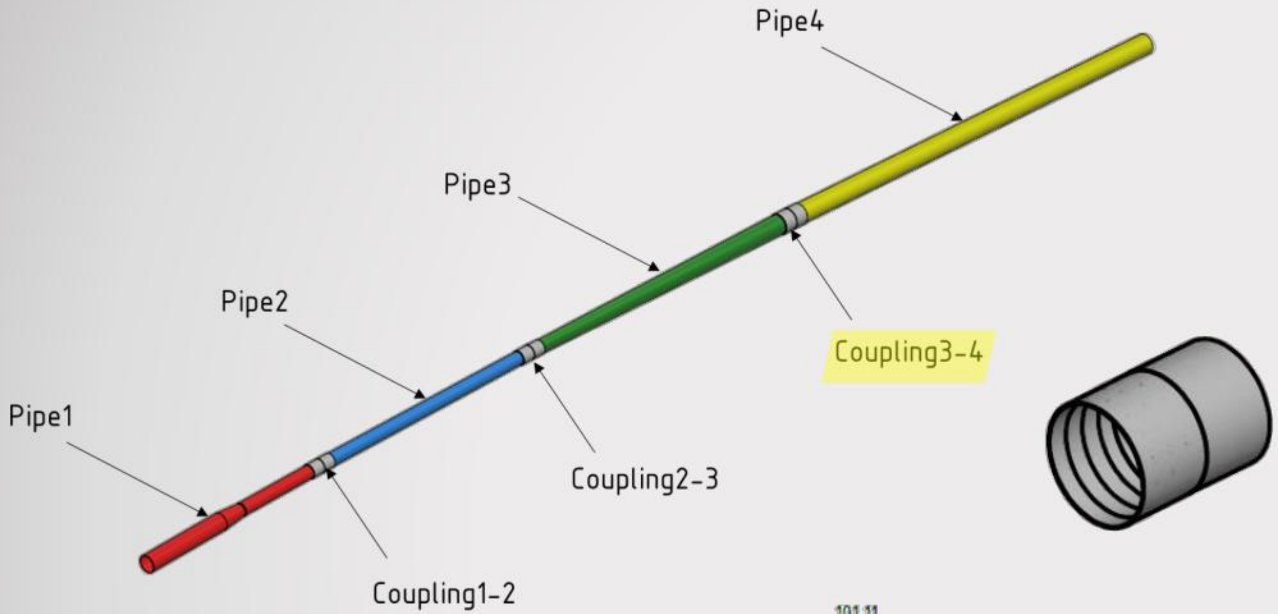


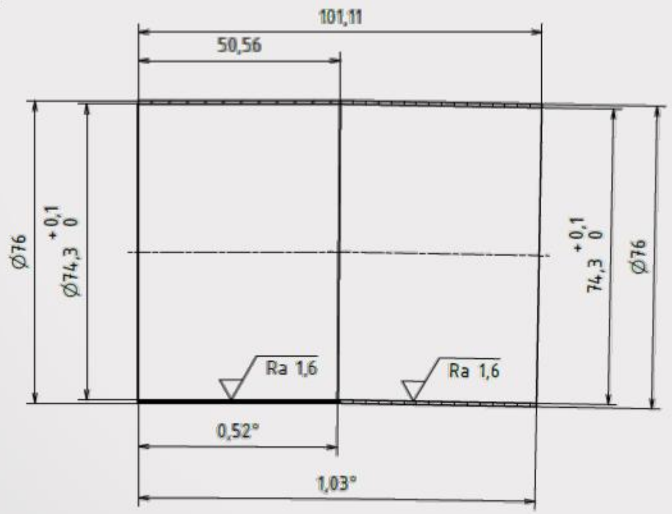
Coupling1-2, 2-3

- Glued to the Pipe2 in the correct position
- marked for correct mounting
  with Pipe1 and Pipe4



BM@N carbon PB design



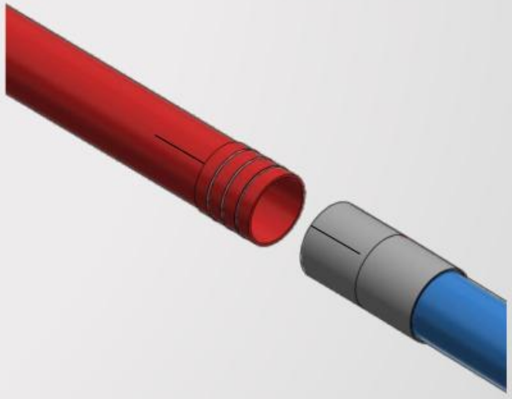


Couplin3-4

Coupling3-4

- Glued to the Pipe4 in the correct position
- marked for correct mounting with Pipe3
- You can glue Pipe 3 and Pipe4 together

- D_o = 76mm (76,3mm)
- t = 0,85mm (1mm)
- D_i = 74,3mm
- α = 1,03°



Thank you for your attention

Sergey Sedykh	**Upgrade of the trigger system**
Elena Kulish	**Status of the GEM/CSC tracking systems**
Sergei Afanasiev	**Status of the ECAL**
Sergey Morozov	**Status of FHCal and forward charged fragments hodoscopes**
Aleksandr Kubankin	**Ion beam pipe for BM@N experiment, current status and schedule**
Roman Shindin	**Magnetic field measurements of the SP-41 magnet**
Sergey Nepochatykh	**The impact of materials and frames on trigger protons and recoil fragments**
Timur Atovullaev	**Simulation of magnetic shielding for PMTs next to SP-41 magnet**
Petr Chudoba	**Report on development of the carbon beam pipe for BM@N**