FHCal and hodoscopes for fragments

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on behalf of INR RAS, Moscow

8th Collaboration Meeting of the BM@N Experiment at the NICA Facility

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LHEP JINR

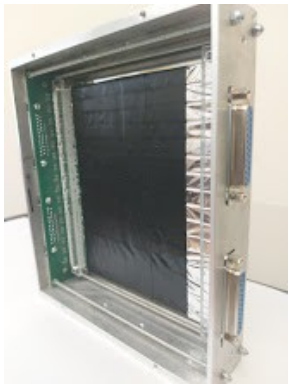
Outline:

1) Forward Hadron Calorimeter (FHCal):

- status and readiness for beam data taking
- cosmic muon calibration results

2) Quartz and scintillatior beam hodoscopes:

- status, installation at BM@N, planned tests



3) Scintillation Wall (hodoscope for fragments):

- detector development and construction at INR (Troitsk)
- light readout, signal readout and ADC electronics

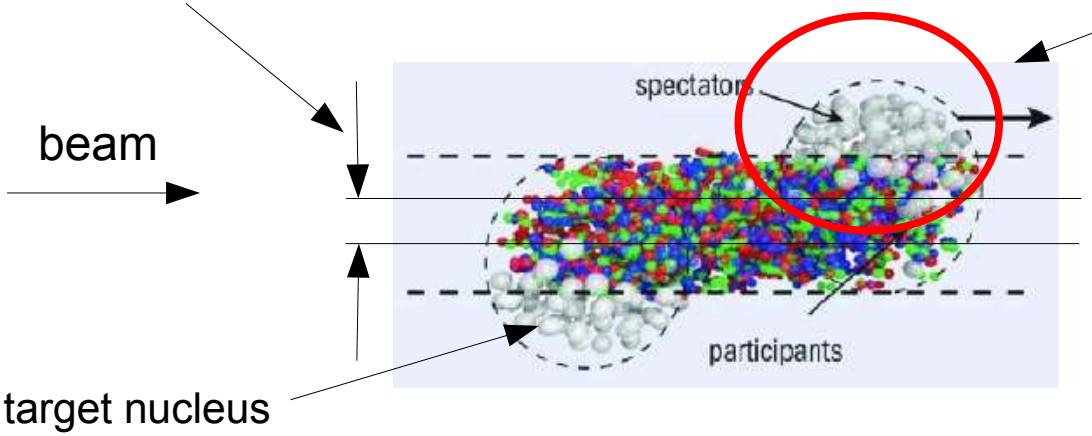
4) FHCal + hodoscopes performance

Forward Hadron Calorimeter (FHCal)
(for centrality and event plane reconstruction)

impact parameter "b"
(distance between
nuclei centers)

Fixed target experiment (ion-ion collision)

projectile spectators
(to be detected with FHCal)



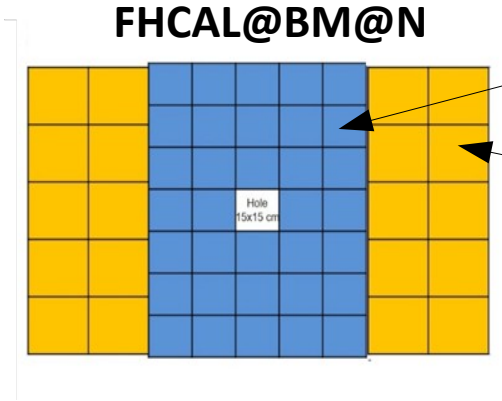
BM@N upgrade of detectors includes:

new FHCal in place of old ZDC:

- high expected dose and activation
- longitudinal segmentation of FHCal
- higher dynamic range
- reliable cosmic muon calibration

New FHCal has been installed
in the BM@N area!

Forward Hadron Calorimeter (FHCal)
(for centrality and event plane reconstruction)

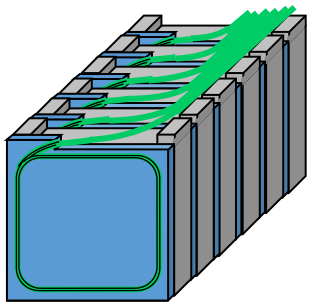


The FHCal consists of:

- 34 MPD FHCAL modules - 42 Pb/scint. samples – (16mm Pb + 4mm Scint)

- 20 CBM PSD modules – 60 Pb/scint. samples. - (16mm Pb + 4mm Scint)

Length of the MPD module ~ 4 λ_{int}
Length of the CBM module ~ 5.6 λ_{int}



Light collections – 6 WLS fibers from each 6 scint. tiles (one section) - combined to one optical connector at the end of module.

Light readout: 7 MPPC (3x3 mm^2) per MPD module and 10 MPPC per CBM module.

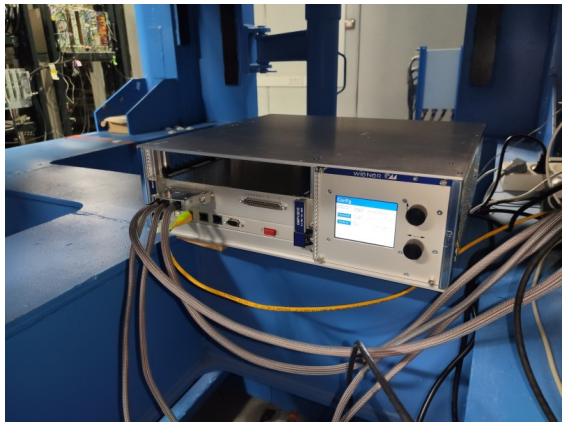
Weight of the MPD FHCAL module – 200 kg.
Weight of the CBM PSD module – 500 kg.

CBM PSD module production at INR (Troitsk)

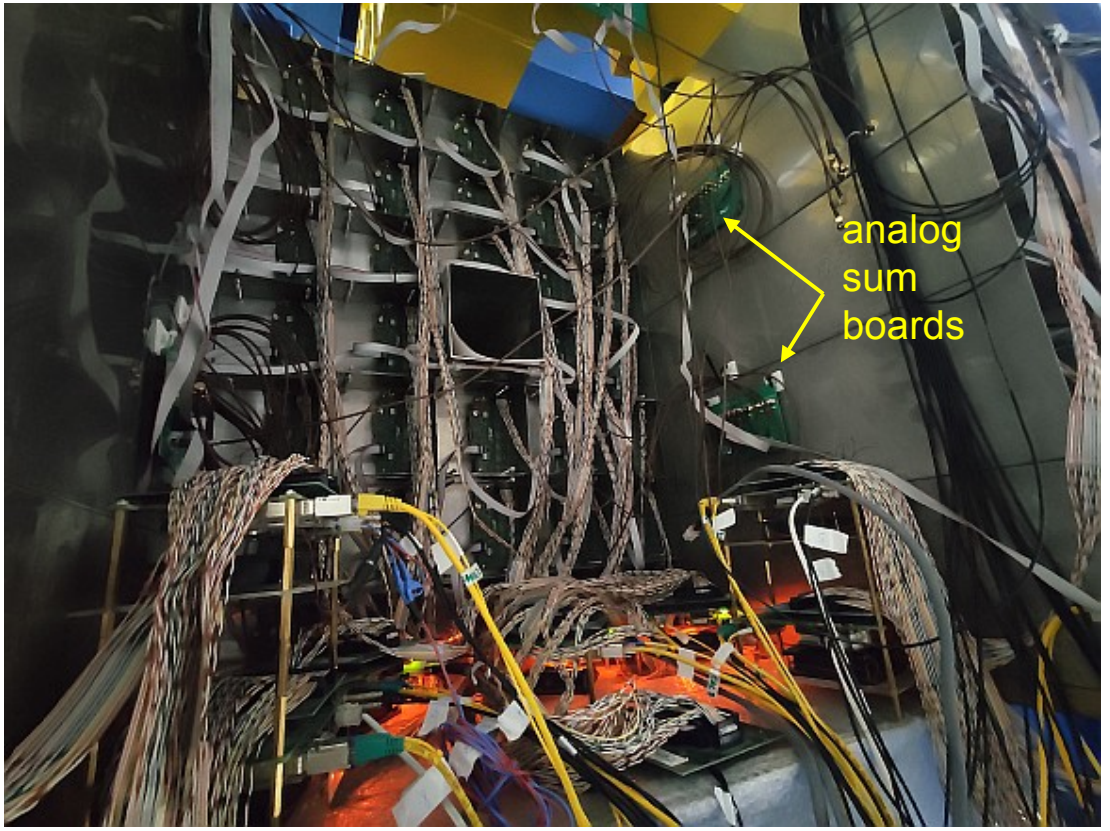
Forward Hadron Calorimeter (FHCal)

readiness for the beam data taking at BM@N

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



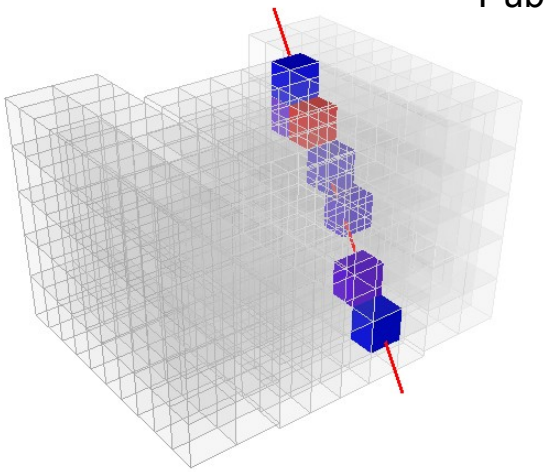
WIENER MPOD power supply unit has been installed

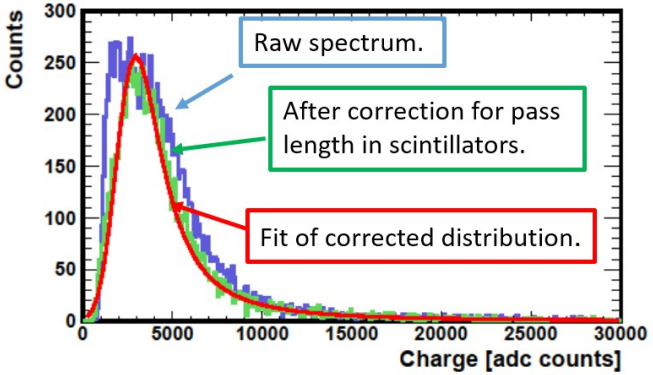


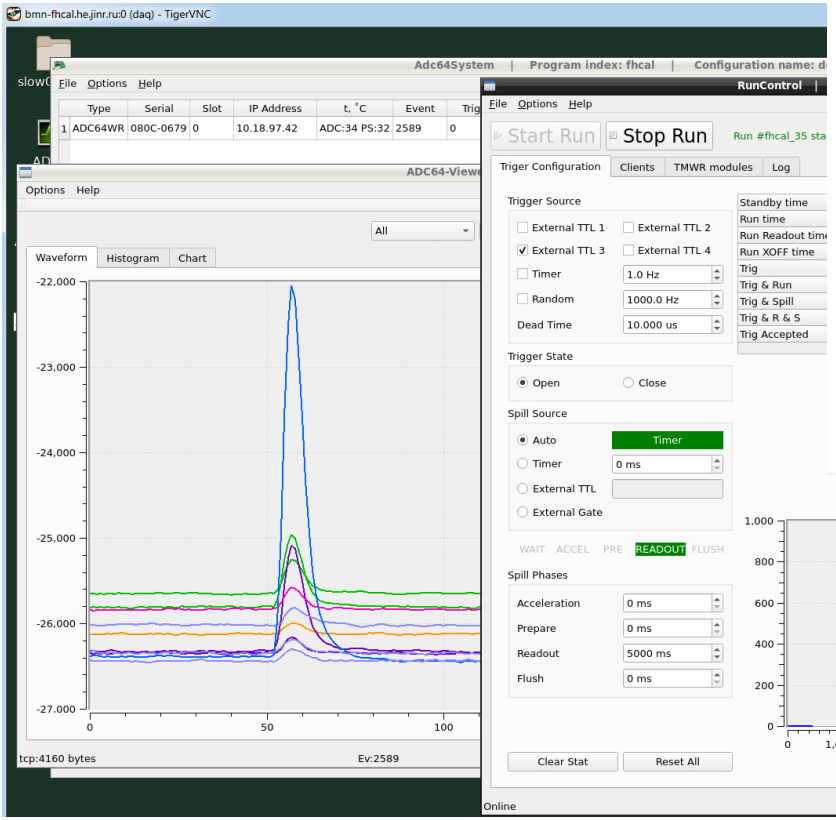
- 54 FEE boards have been connected and tested
- 8 ADC64s2 board are in places, tested, connected with new cables (yellow on foto) to Rack 6 + WR optical fibers
- 6 analog sum boards are connected to FEEs
- 6 LED generators distribution system has been installed
- power supply unit (WIENER MPOD) has been tested
- calibration on cosmics – done for all modules

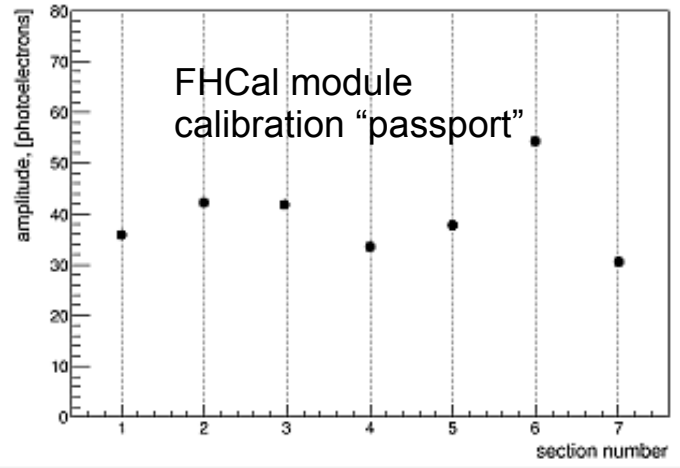
FHCal cosmic muon calibrations for modules at BM@N

Published in: S. Morozov et al 2020 JINST 15 C05050









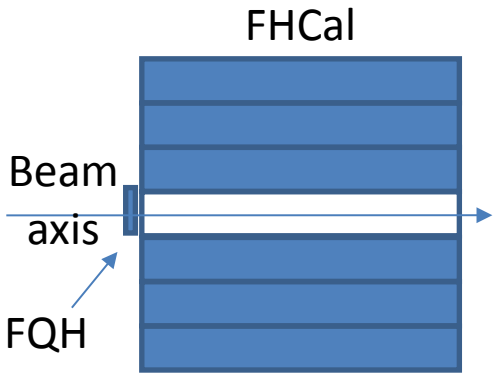
New cosmic muon calibration procedure based on 3D tracking with transverse and longitudinal granulation of FHCal has been developed and tested on cosmics with FHCal

FHCAL and fragment hodoscopes

Main goals:

- measurement of fragments charge in the FHCal beam hole (for event centrality determination)

- can be used in online trigger system



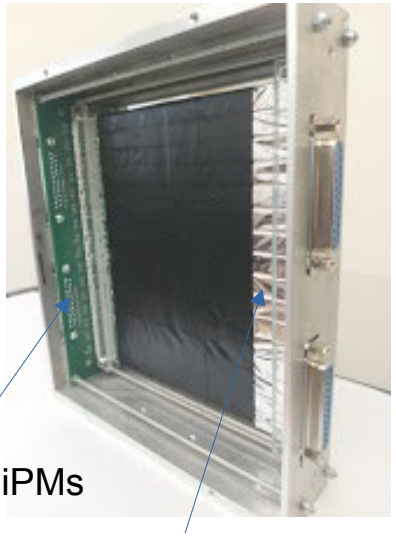
Two Forward Beam Hodoscopes are ready:

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)

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

- Xe beam time: quartz hodoscope will be placed in the FHCal beam hole



Test of hodoscopes at "PAKHRA" synchrotron (LPI, Troitsk)

Published: (PTE) DOI: 10.31857/S0032816221050190

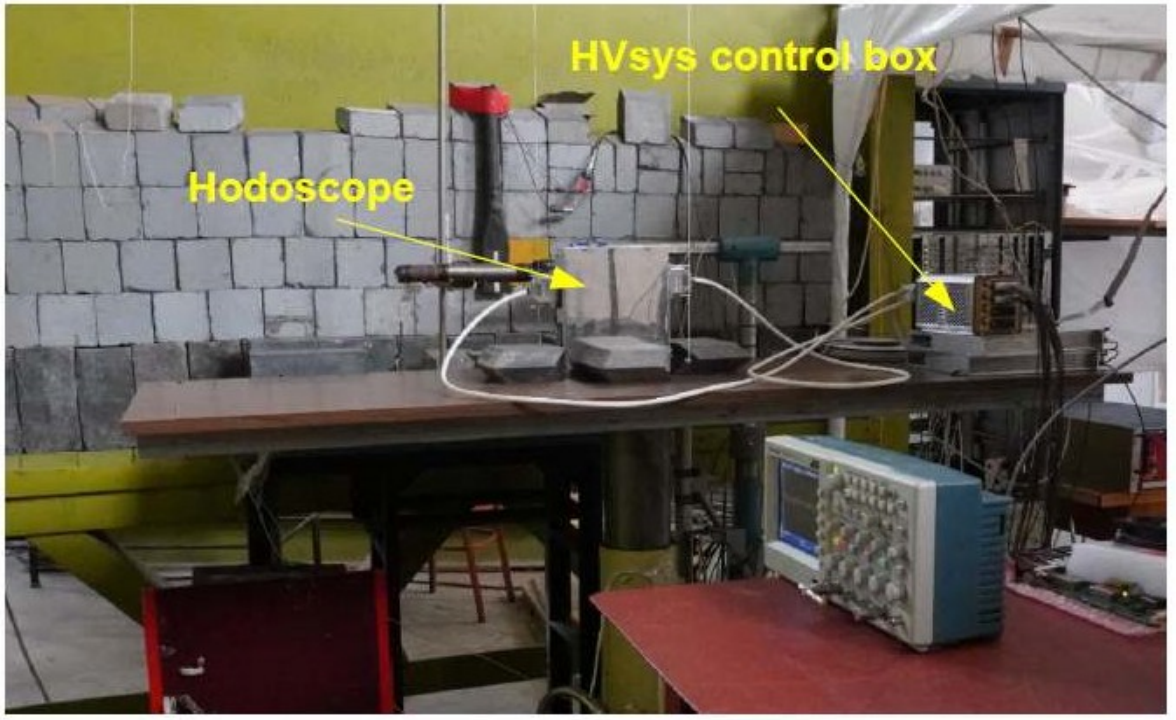
Beam hodoscopes:

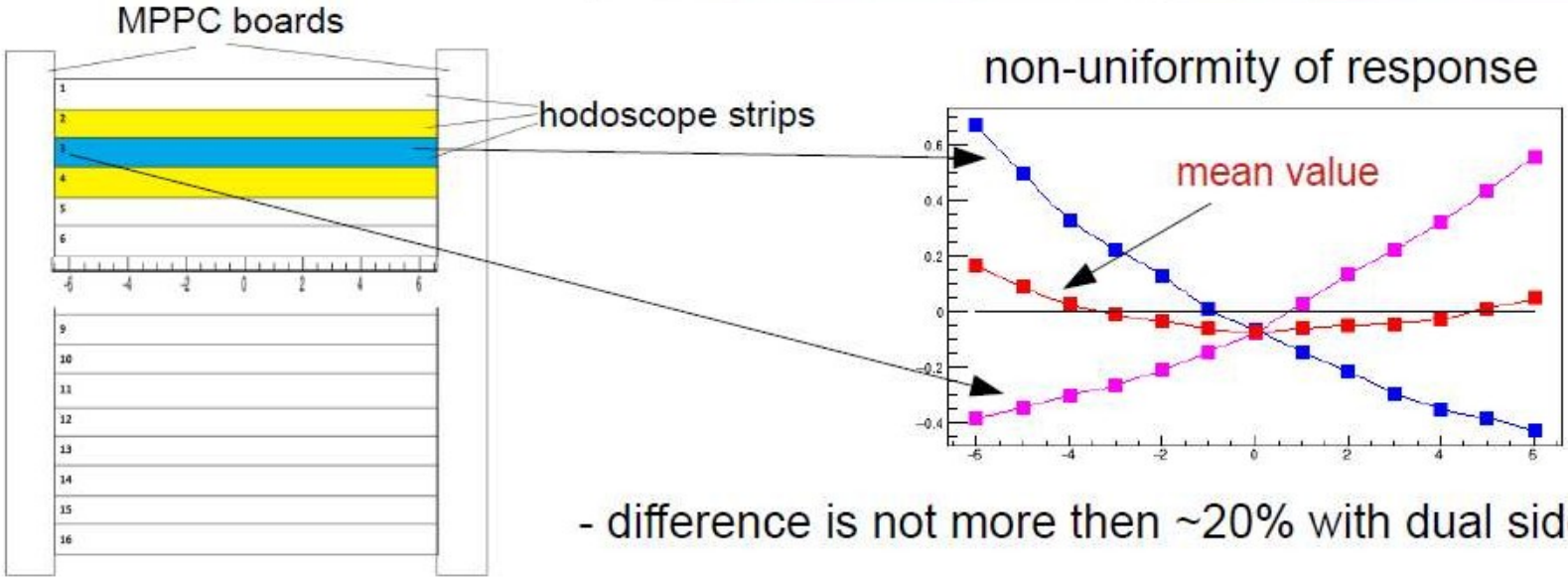
- 16 quartz/scint strips with sizes 10x160x4 mm3

- Light readout of each strip:
  2 SiPMs from each strip ends

- covers beam hole 15x15 cm2

MPPC: S14160-3010PS
pixel -10x10 μm²;
PDE~18%;
G~1.8x10⁵.



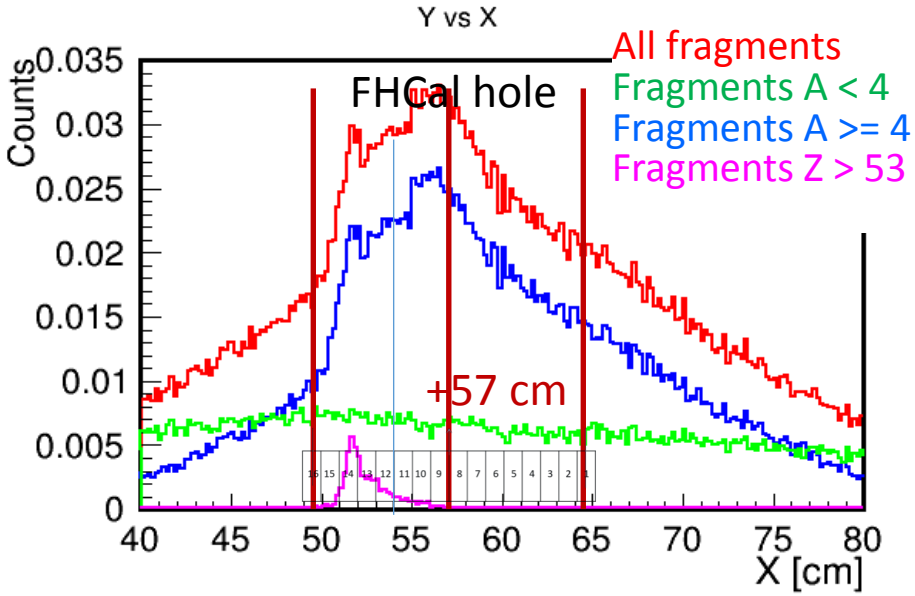


- difference is not more then ~20% with dual side read-out

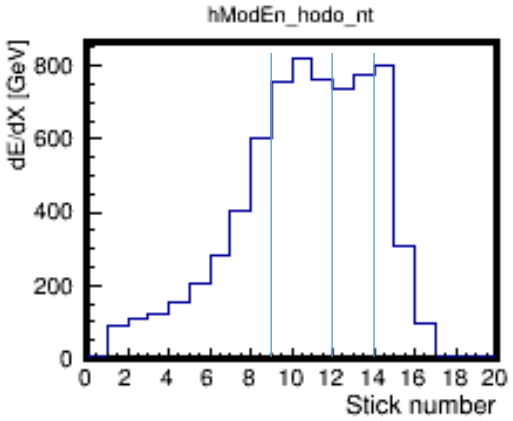
FHCAL and fragment hodoscopes

Performance of FHCal + beam hodoscope system

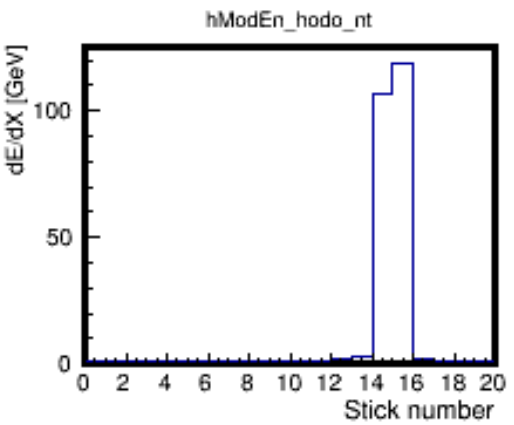
Xe+Sc@3.9A GeV, DCM-QGSM-SMM,
Mag. field scale = 2, Magnet, FHCal



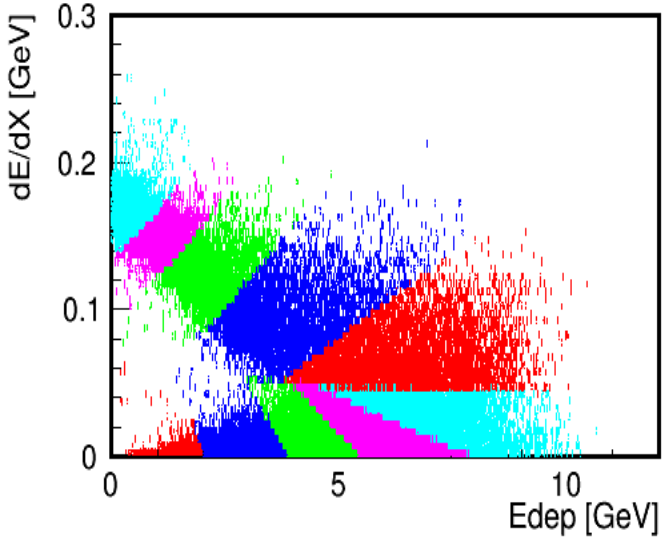
Xe+Cs@3.9A GeV



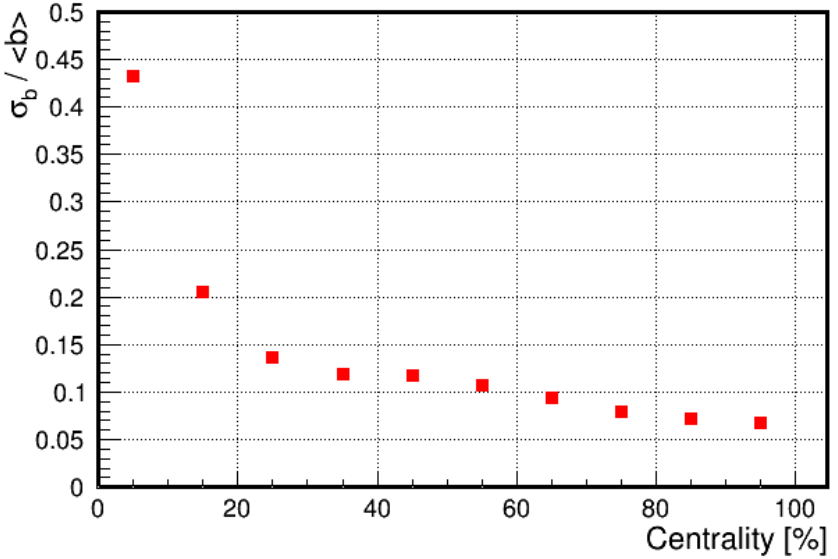
Xe@3.9A GeV



dE/dX in Hodo vs Edep in FHCal



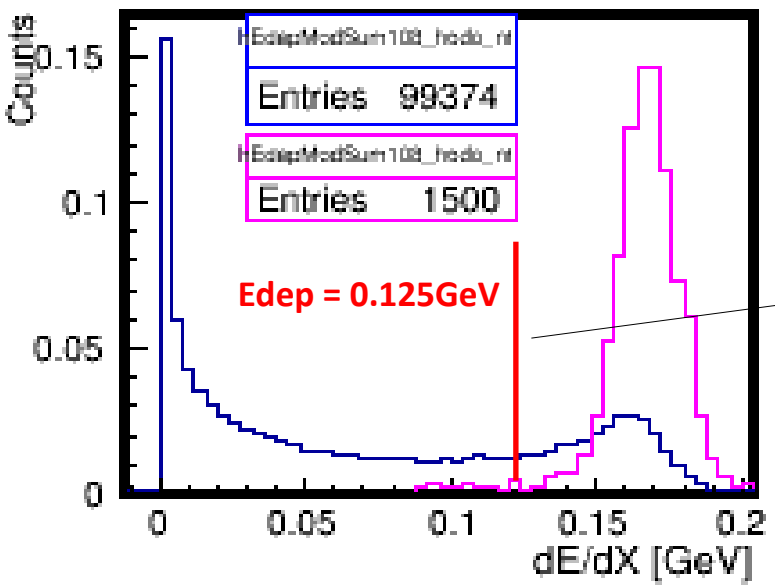
Impact parameter resolution



Performance of FHCal + beam hodoscope system

Hodo response to : Xe+Cs@3.9A GeV

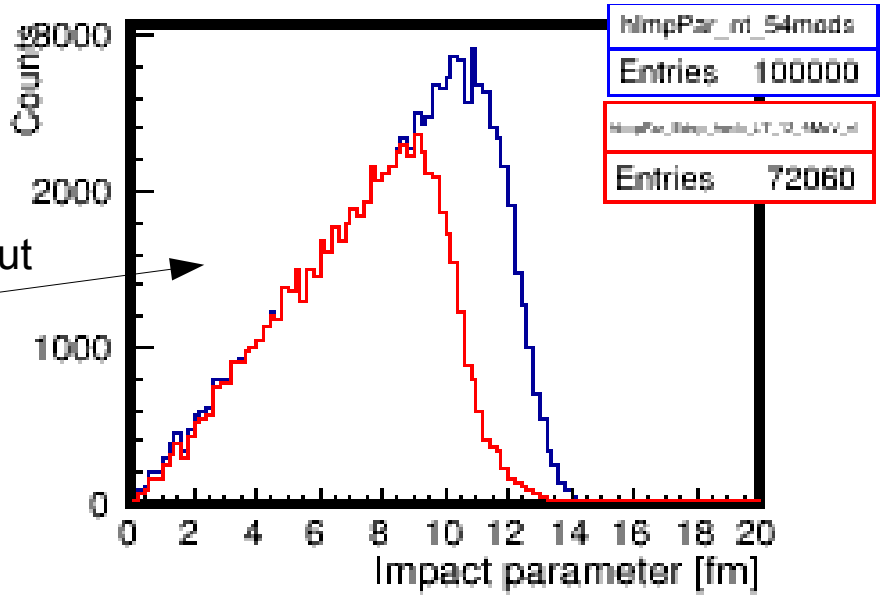
Xe@3.9A GeV ions



beam cut

Impact parameter: w/o cuts

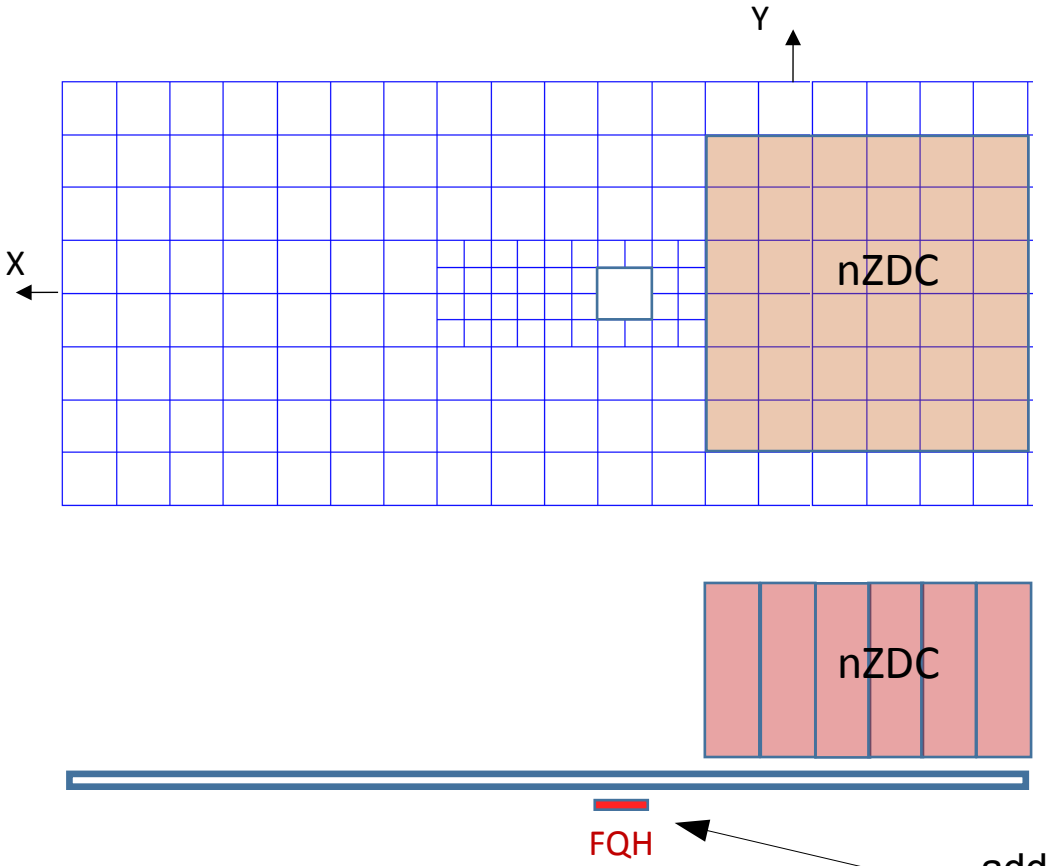
Edep Hodo < 0.125 GeV

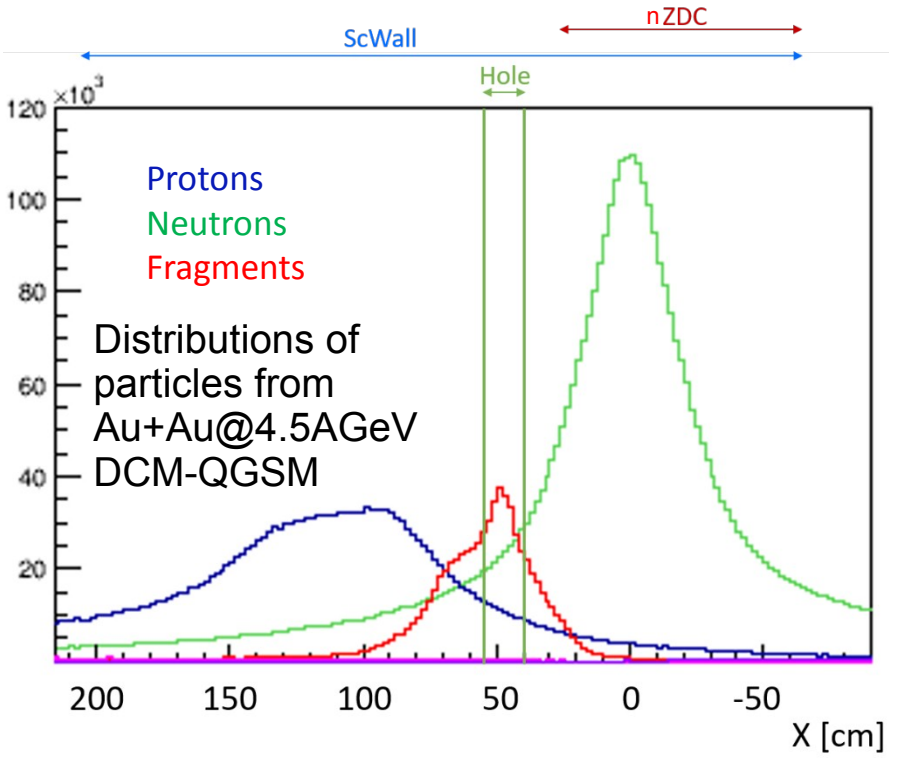


- beam hodoscope has a possibility to reject pure beam events

- remaining b-centrality after beam rejection is about 70%

Scintillation Wall Hodoscope for fragments (the idea)





Additional segmented scintillation wall:

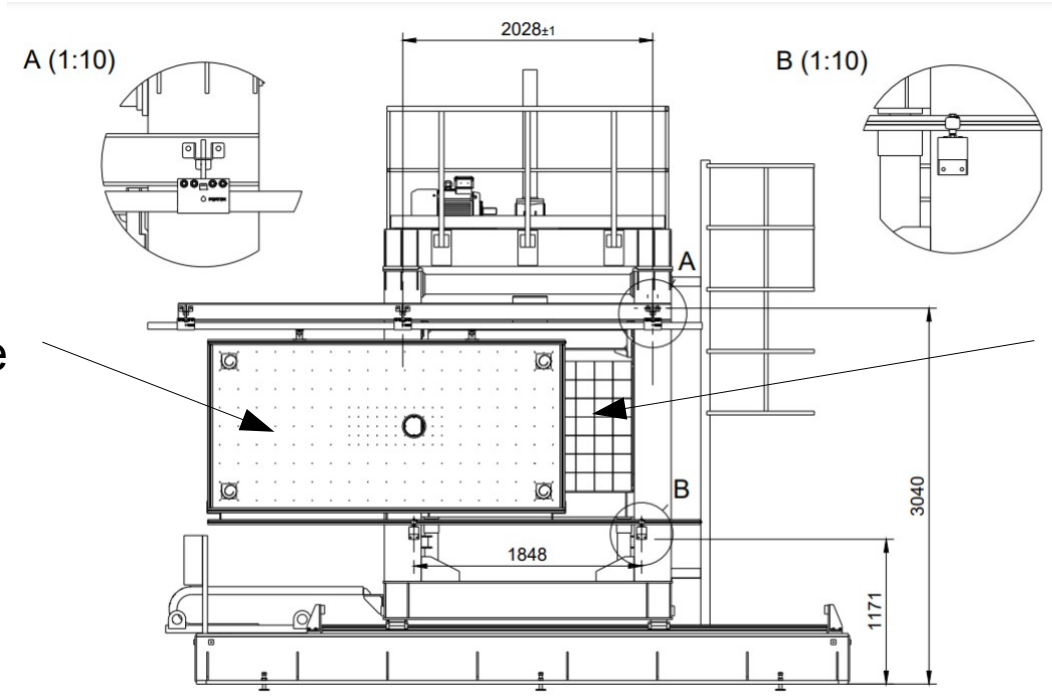
additional option to use beam hodoscope to measure charges of heavy fragments

Main goal: registration of fragments in the Scint. Wall allows to measure fragments multiplicities to tune parameters in fragmentation models

Scint. Wall: 270x120cm^2, 40 cells 7.5x7.5cm^2 + 134 cells 15x15cm^2 to measure charged fragmets
nZDC: 36 modules of 15x15cm^2 size to measure energy of neutrons

Separate measurements of the neutrons (nZDC), protons (ScintWall) and fragments (hodoscope) could be possible with this detector system.

Scintillation Wall Hodoscope for fragments



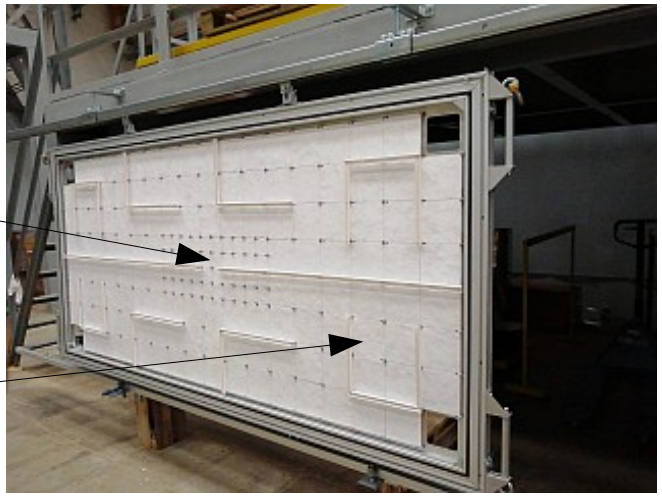
Scint. Wall Hodoscope

FHCal

Scint. Wall with a beam hole for heavy ion (additioanl quartz hodoscope is planned to be placed at the center)

central part with 7.5cmx7.5cm tiles

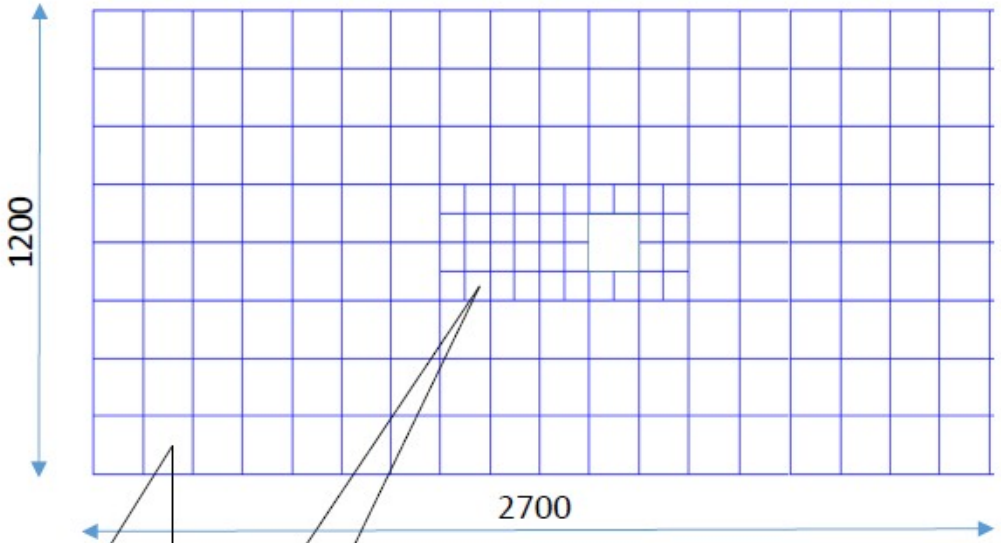
15cmx15cm tiles

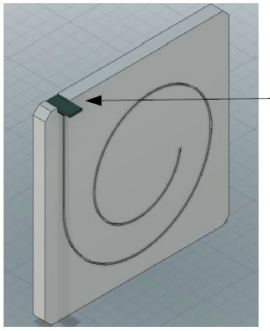


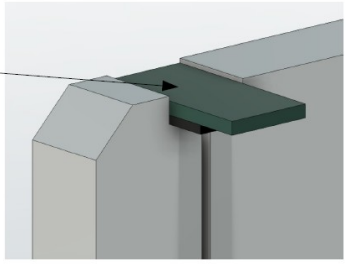
Tiles covering whole surface – for light ions

Scintillation Wall Hodoscope for fragments

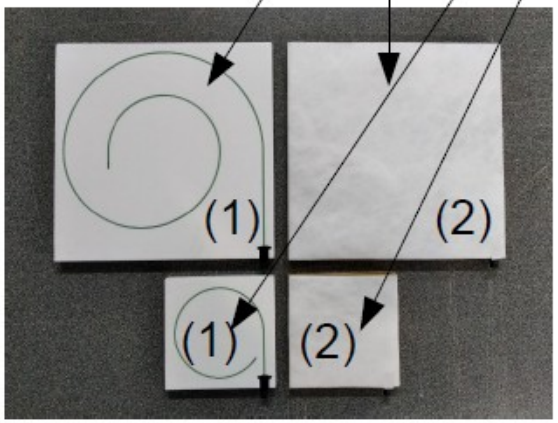
Schematic view of new BN@N Forward Scintillator Hodoscope (FScH)







light collection from tiles



Already constructed samples of scintillator cells for tests.

Tests have been done at “PAKHRA” synchrotron, LPI (Troitsk)

- uniformity of light collection w.r.t. beam spot

1) chemical prepared “foam” type reflection coating
2) tyvek’s coated plates

(results show tyvek coated plates to be better..)

Scint. Wall frame installation at INR (Troitsk)

Amplifiers + ADC64 readout module (HVsys, Dubna)

Scintillation Wall Hodoscope for fragments

Scint. Wall fully equipped with tiles (for test)

Status of Scint. Wall production:

- Scint. Wall is ready for assembling at INR
- SiPM mounting PCB has been developed and ready for tests (planned very soon)
- FEE and ADC64 read-out modules are ready, one module is at INR for tests
- Scint. Wall will be delivered to JINR after tests will be finished (cables, connectors etc.)

Conclusions & Outlook:

- FHCal for BM@N experiment has been installed at the BM@N area, commissioning is planned during SRC run (December 2021)

- beam hodoscope and Scint Wall is planned to be used in SRC run (December 2021)

- slow control (DCS) is under development, commissioning is planned in SRC run

Thank you for your attention!

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