Commissioning of the forward spectators detectors at SRC run. Readiness for Xe run

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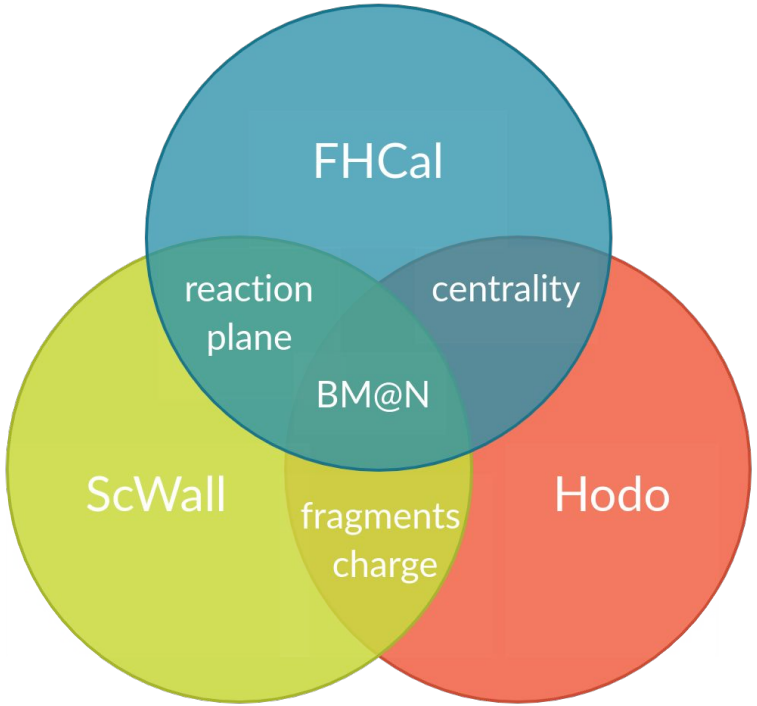
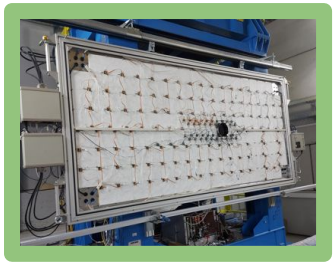
of the INR RAS team

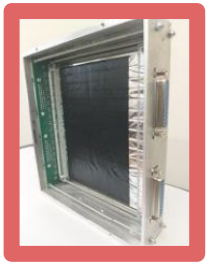
9th Collaboration Meeting of the BM@N Experiment at the NICA Facility
13-16 September 2022 LHEP JINR

Outline

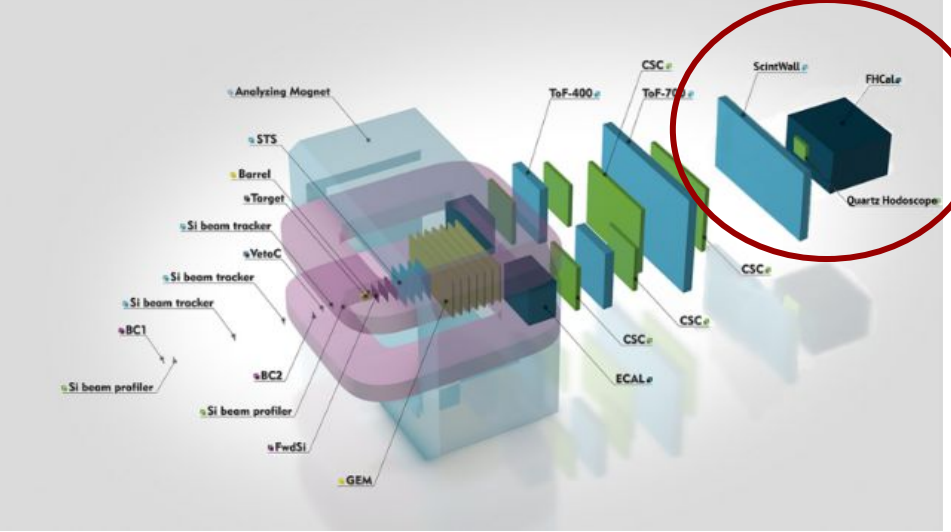
- Forward spectators detectors in BM@N
  - Forward Hadron Calorimeter (FHCal)
  - Scintillation Wall (ScWall)
  - Forward Hodoscope (Hodo)
- Commissioning at the SRC run
- Status & readiness for Xe run







Introduction

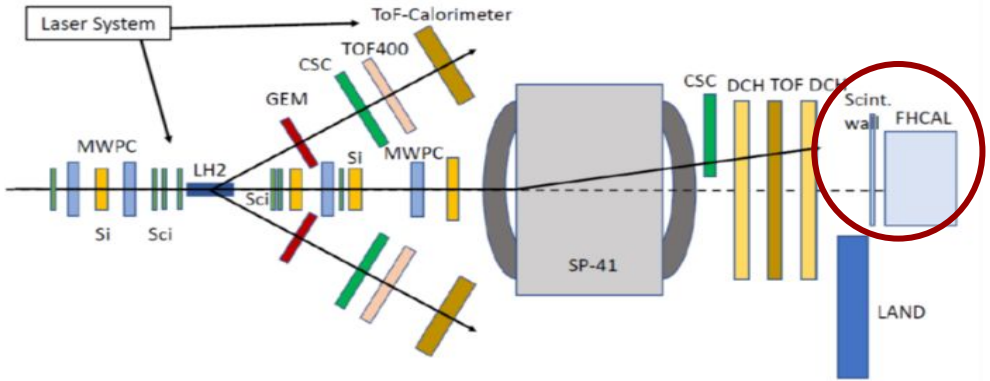


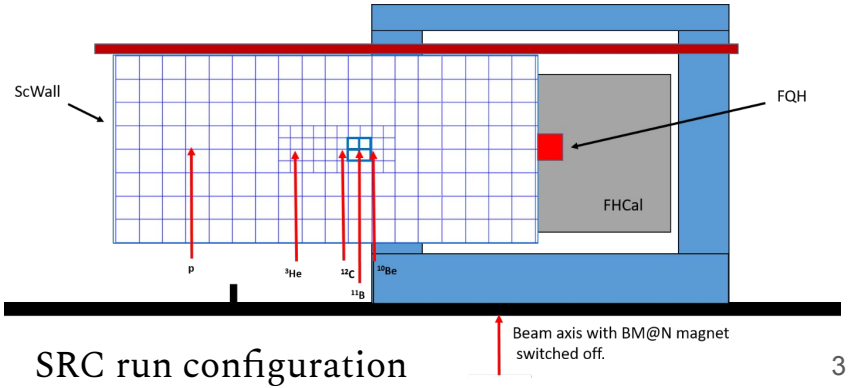
Forward detectors:

- **ScWall** (**Sc**intillation **Wall**)
- **Hodo** (Quarz / Scint **Hodo**scope)
- **FHCal** (**F**orward **H**adron **Cal**orimeter)

Tasks:

- charge distributions of spectator fragments
- centrality determination
- reaction plane orientation

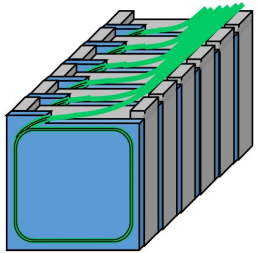




SRC run configuration

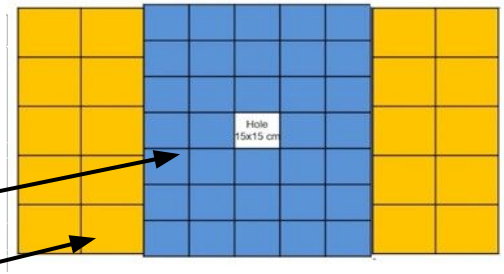
FHCal (**F**orward **H**adron **Cal**orimeter)
(for centrality and reaction plane reconstruction)

CBM PSD
module production

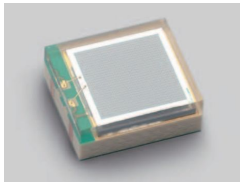


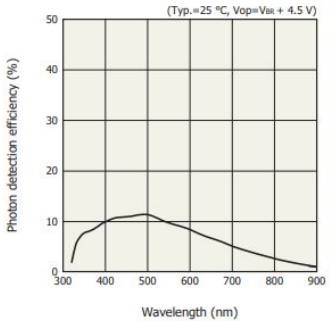
one section

- 34 MPD FHCal modules – 42 Pb/scint samples
  (16mm Pb + 4mm Scint)
- 20 CBM PSD modules – 60 Pb/scint samples
  (16mm Pb + 4mm Scint) – to be replaced after run 8
- Length of the MPD module ~ 4 λ_{int}
  Length of the CBM module ~ 5.6 λ_{int}
- Light collection – 6 WLS fibers from each 6 conseq. scint tiles (one section) combined to one optical connector at the end of module
- Light readout:
  7 MPPCs per MPD module
  10 MPPCs per CBM module
- Weight of MPD module – 200kg
  Weight of CBM module – 500kg



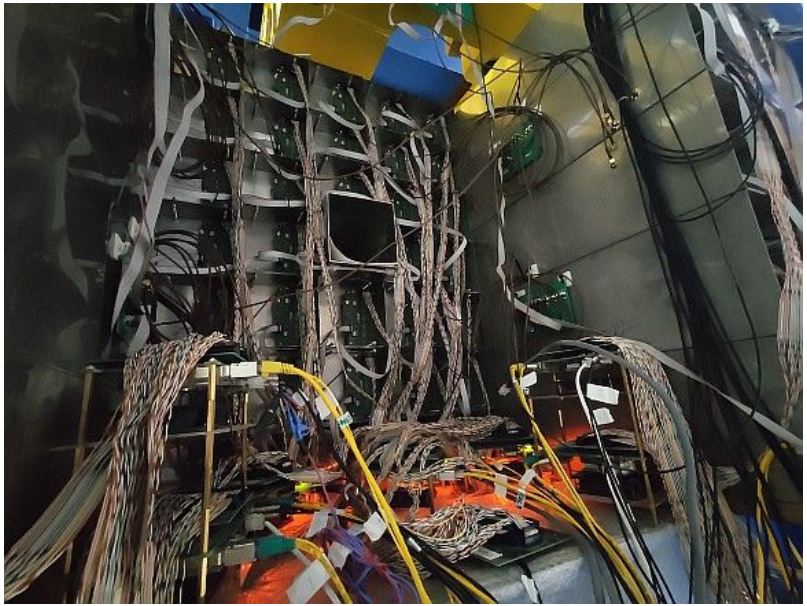
BM@N FHCal





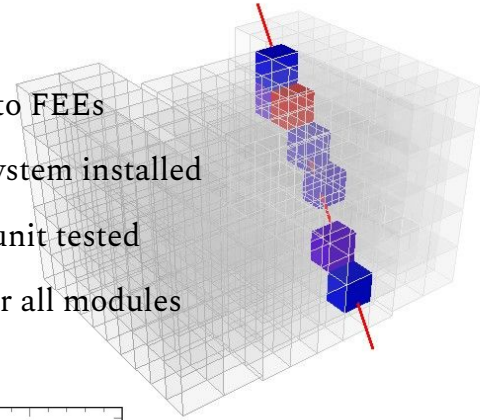
Hamamatsu MPPC
S12572-010P 3*3mm^2
Number of pixels: 90000
Gain: 1.35*10^5
PDE: 12%

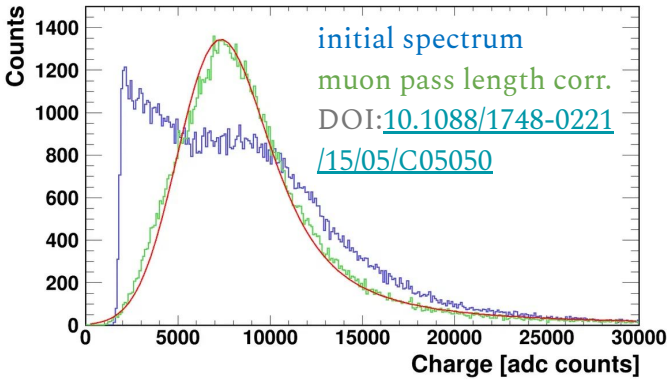
FHCal: commissioning & status



FHCal FEE & readout electronics
at the SRC run

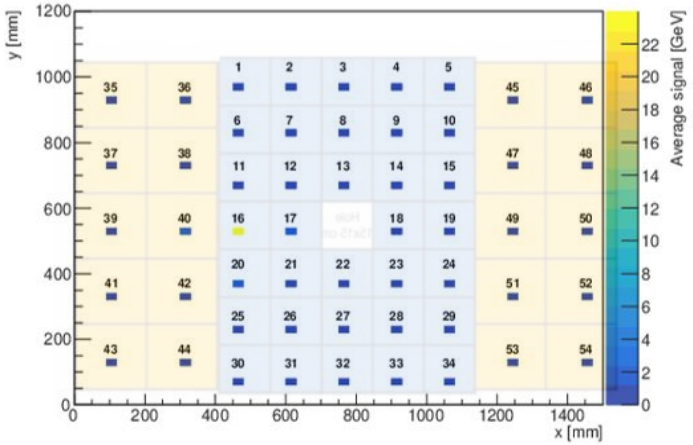
- FHCal was assembled and installed in the BM@N area
- 54 FEE bards connected and tested
- 8 ADC64s2 boards used
- 6 analog sum boards connected to FEEs
- 6 LED generators distribution system installed
- WIENER MPOD power supply unit tested
- calibration on cosmics – done for all modules

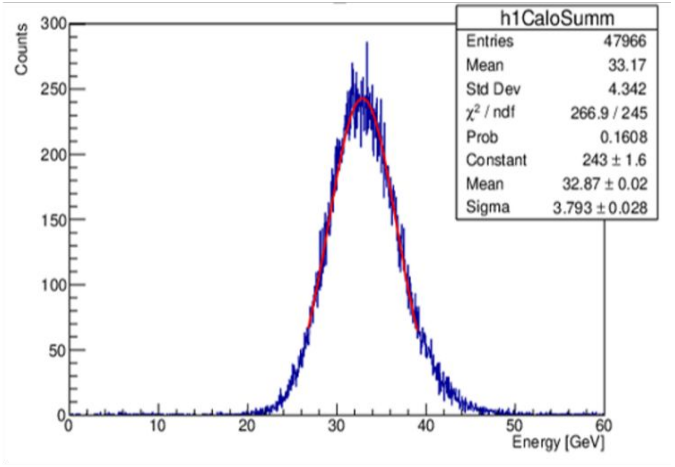




FHCal: commissioning & status

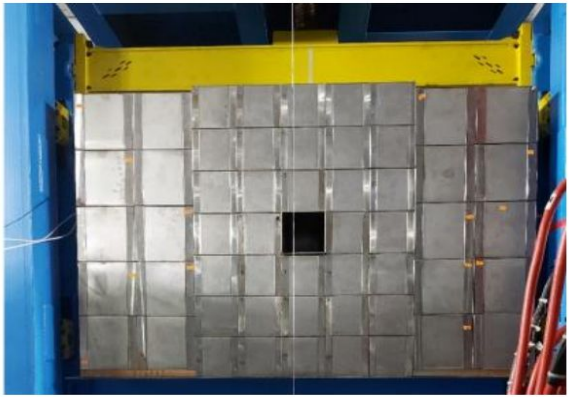
FHCal Beam response ^{12}C 3.5 AGeV/c . Beam trigger no target





FHCal response measured in beam position scan at SRC:

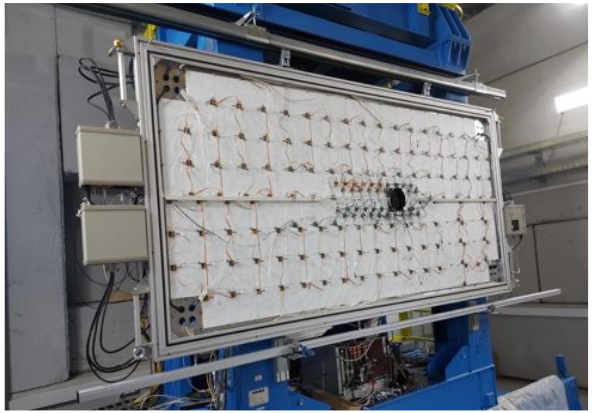
- All channels working with temperature stabilisation via DCS
- Achieved resolution 11.5% for ^{12}C ions 3.5 AGeV/c



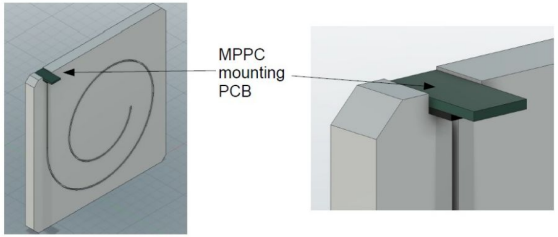
Status:

- ❖ fully assembled & installed in BM@N area
- ❖ readout with DCS checked and working
- ❖ all channels calibrated on cosmic muons
- ❖ software developed and used in data analysis
- ❖ repeat & check calibration right before physics run
- ❖ DCS monitoring system (Voltage, Temperature, Notification)

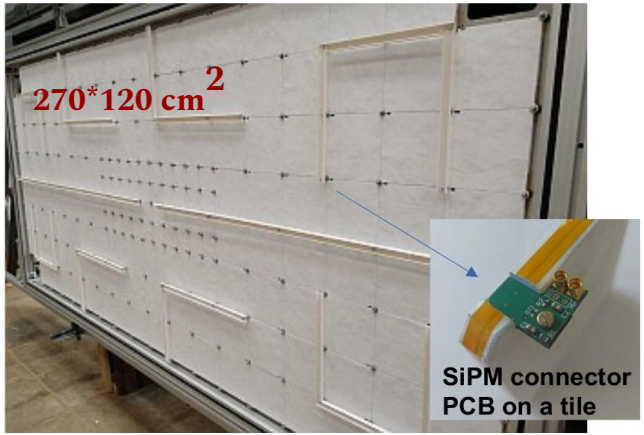
ScWall (**Sc**intillation **Wall**)
(for fragments charge measurements and reaction plane estimation)

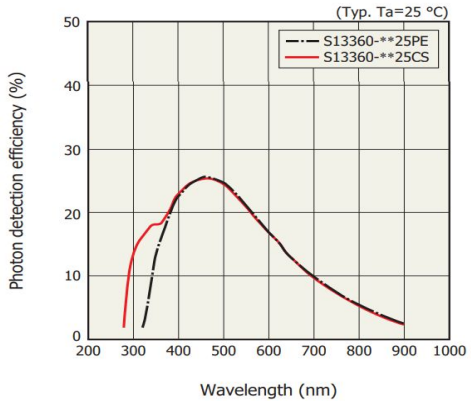


- 36 small inner cells 7.5*7.5*1 cm^3 + 138 big outer cells 15*15*1 cm^3
- light yield for MIP signal – small cells 55 p.e.±2.4%; big cells 32 p.e.± 6%.
- optional beam hole (covered with 4 small cells for the SRC run)
- covered with a light-shielding aluminum plate
- light collection by WLS fibers
- light readout with SiPM mounted on the PCB at each scint. cell



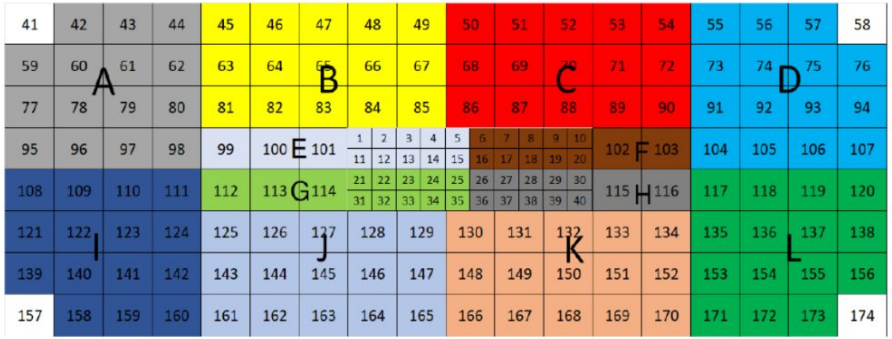
light collection from tiles



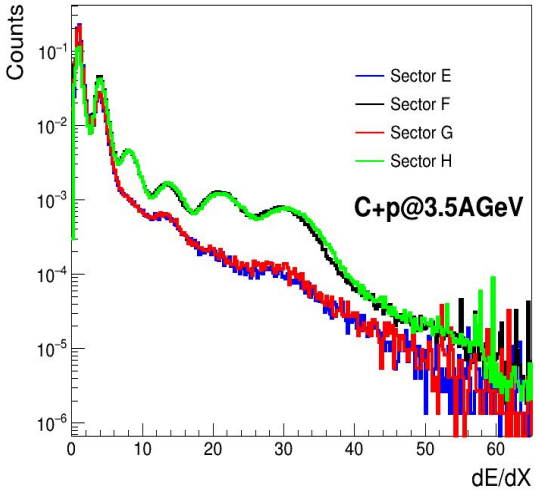


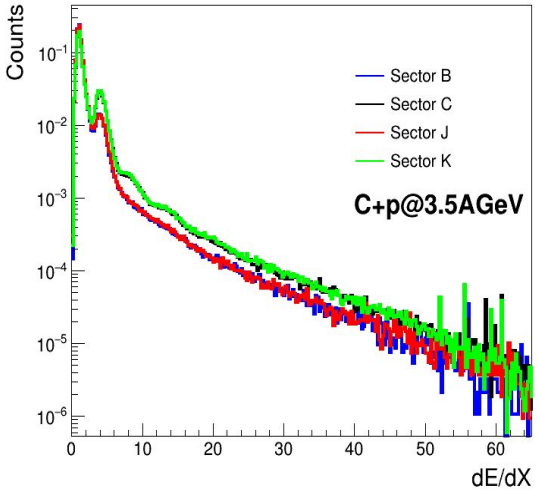
Hamamatsu MPPC
S13360-1325CS 1.3*1.3mm^2
Number of pixels: 2668
Gain: 7*10^5
PDE: 25%

ScWall: commissioning & status



- readout divided into 12 sectors each one equipped with single temperature sensor
- each 4 sectors are read by combined electronics unit:
  - One ADC64s2 board
  - Four 16-channels FEE boards
  - Voltage control unit



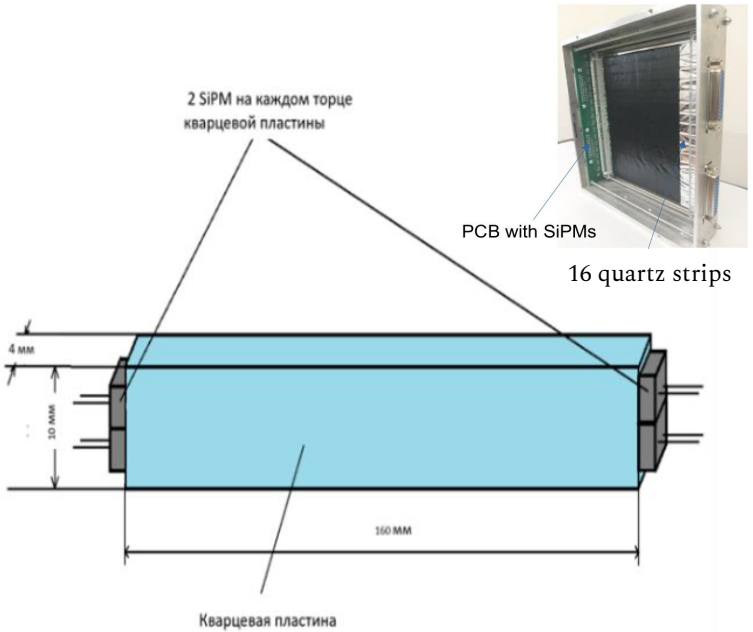


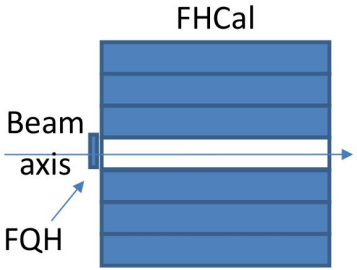
Status:

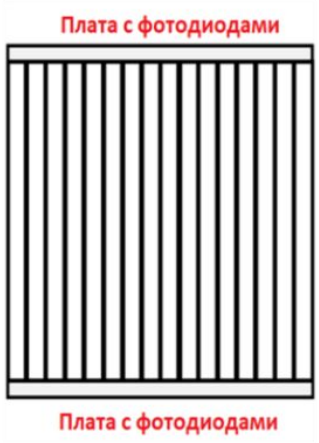
- all channels & readout are operational
- peaks from Z=1 to Z=6 are distinguishable in charge distributions
- failure of the DCS operation during data collection – no user notification
- peak's positions are not consistent with simulation data – research in progress
- charge distribution analysis ongoing
- reconstruction software part missing

Beam Hodo (Scintillator / Quarz Beam **Hodo**scope) (for centrality and fragments charge measurements)

measurement of fragments charge in the FHCal beam hole – very forward rapidity region (for event centrality determination)

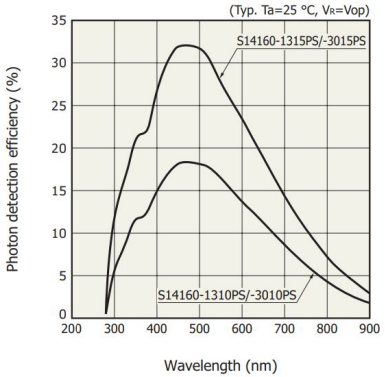




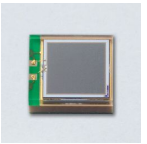


Two forward beam hodoscopes available:
1) with quartz strips (for heavy ions)
2) with scintillator strips (for light ions)

- 16 strips 160*10*4 mm^3 with mylar reflector
- cover beamhole 15*15cm^2
- light readout from both edges of each strip
- 2 MPPCs connected in parallel on each side
- each MPPC pair is read with gains x1 and x4

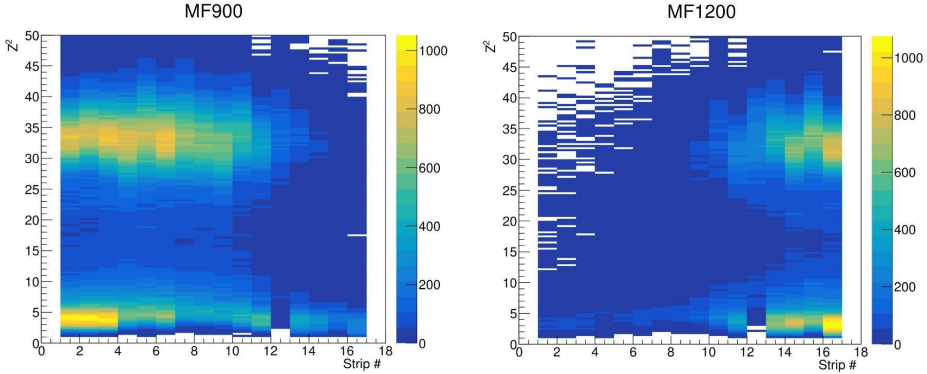


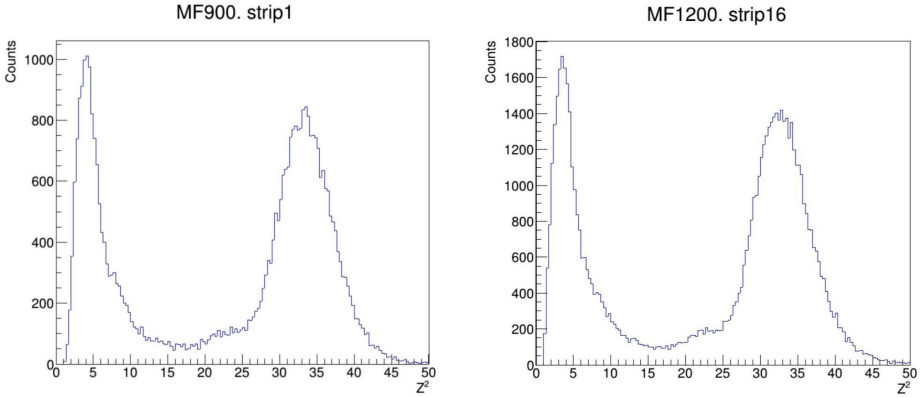
Hamamatsu MPPC
S14160-3015PS 3*3mm^2
Number of pixels: 39984
Gain: 3.6*10^5
PDE: 32%

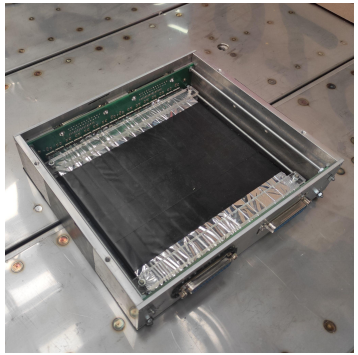


Beam Hodo: commissioning & status

Quarz Hodo Beam response ^{12}C 3.5 AGeV/c .
Beam trigger no target



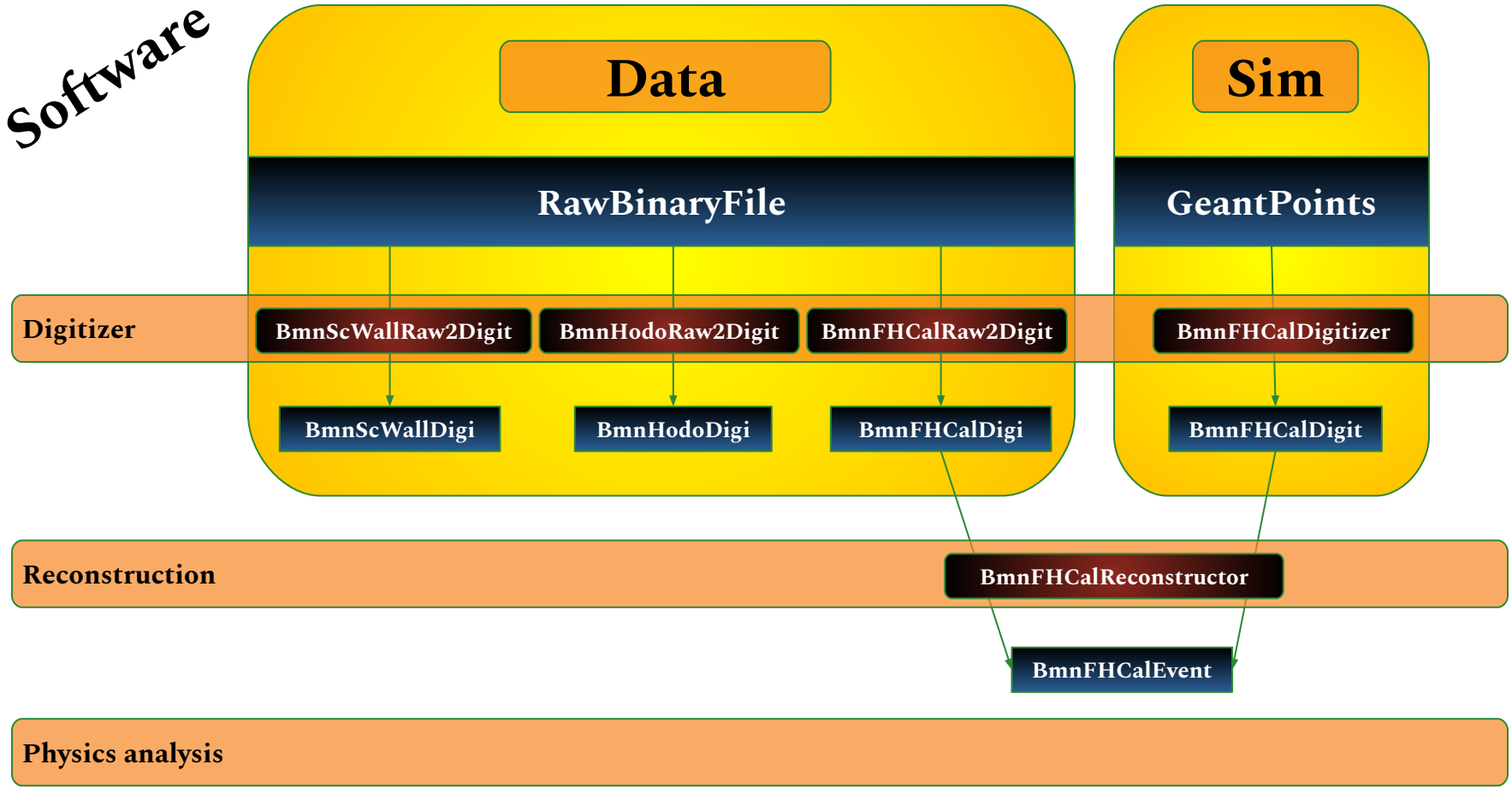




- 4 TQDC-16 boards used for read-out (one VME crate)
- Quarz and Scint. hodoscopes both used at the SRC run
- Xe beamtime: Quarz hodoscope will be installed at the beamhole of the FHCal

Status:

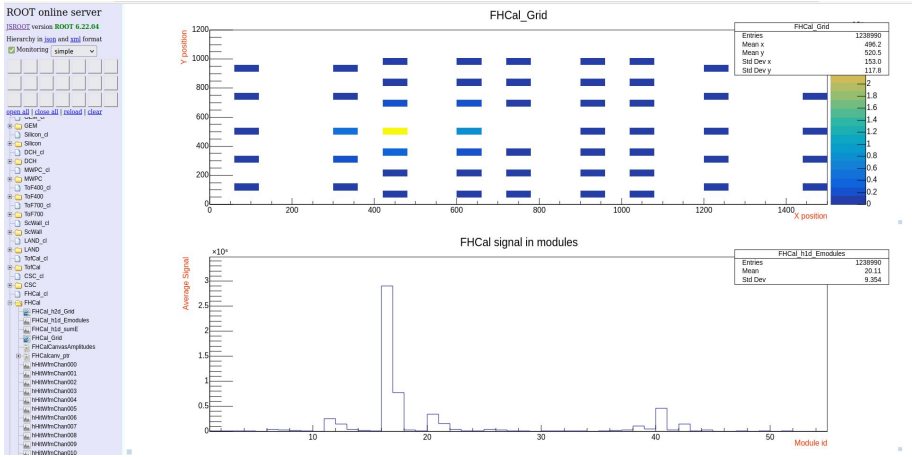
- all channels & readout are operational
- peaks from Z=2 to Z=6 are seen in charge distributions of the quarz hodoscope
- intermediate peaks are hard to distinguish
- reconstruction software part missing



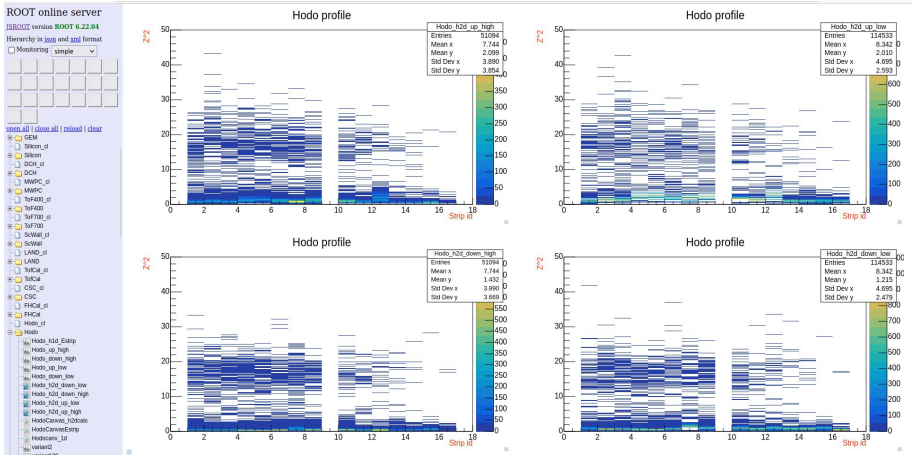
Work partially funded by NICA students support programme

Online monitoring

FHCal



Hodo



BM@N simulation:

- Reaction **Xe+CsI@3.9 AGeV**
- Event generator **DCM-SMM**
- Transport code **GEANT4** (FTFP_BERT physics list)
- **bmnroot framework**

Status:

MB and centrality trigger with FHCal & Beam Hodo ?

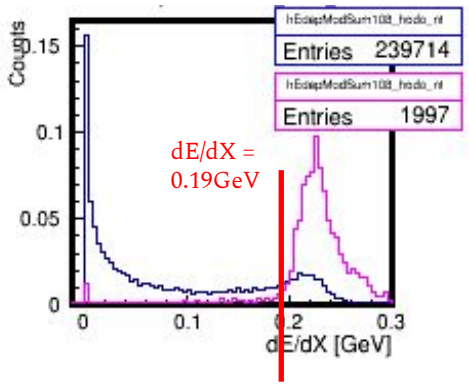
- **Beam rejection:** leaving up to **79%** of events. 21% (the most peripheral events) are lost
- **Central trigger: 18%** of the most central events + 1.1% peripheral pollution

How about splitting into centrality classes?

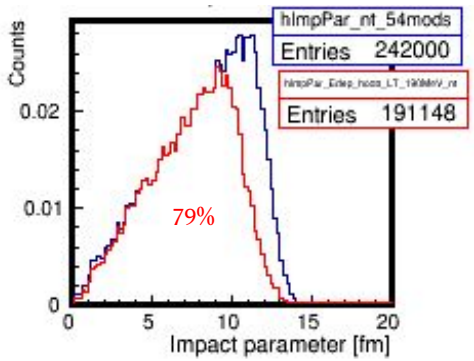
Beam Hodo & FHCal: trigger organization

Beam rejection

Hodo dE/dx
Xe+CsI@3.9A GeV
Xe@3.9A GeV ions

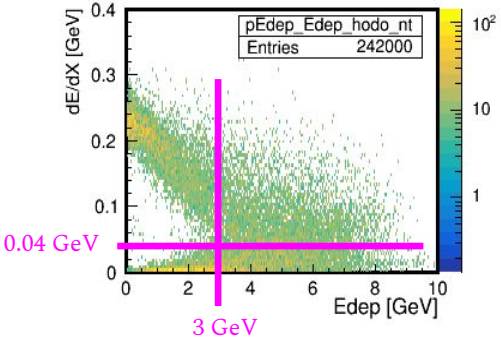


Impact parameter
w/o selection
Hodo dE/dx < 0.19 GeV

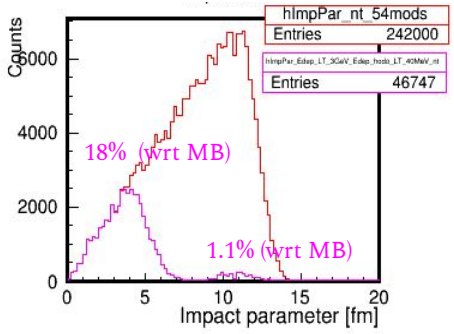


Central Events

Hodo dE/dx vs FHCal Edep
Xe+CsI@3.9A GeV

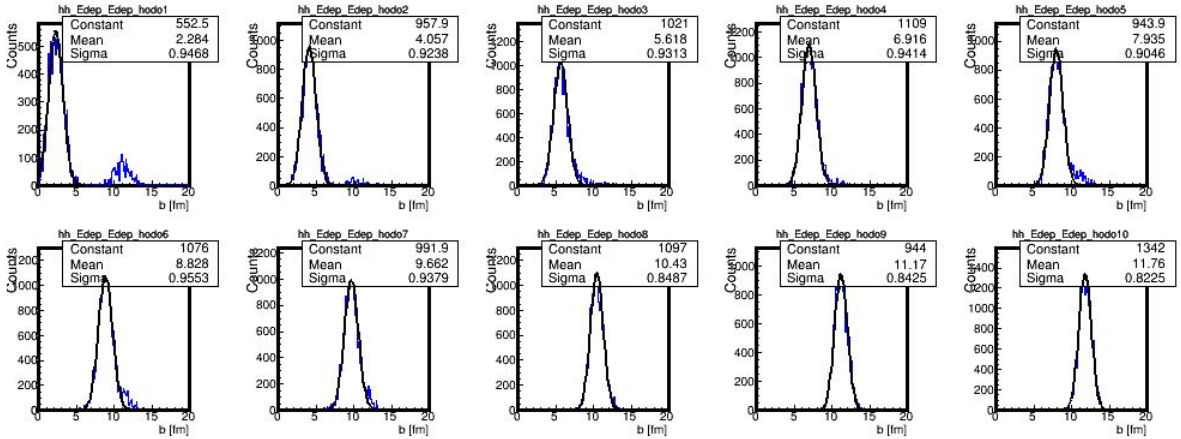


Impact parameter
w/o selection
Hodo dE/dx < 0.04 GeV && FHCal Edep < 3 GeV

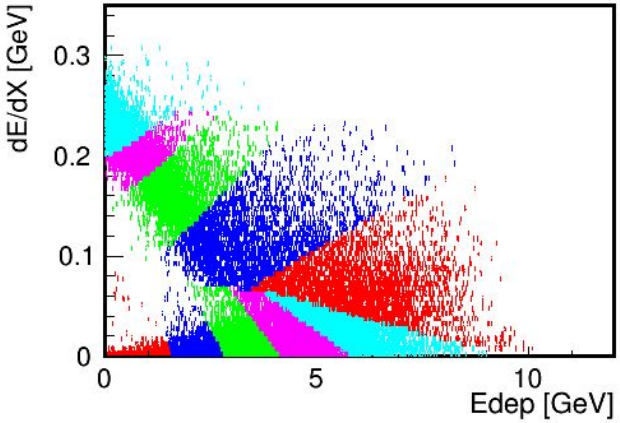


Beam Hodo & FHCal: centrality selection

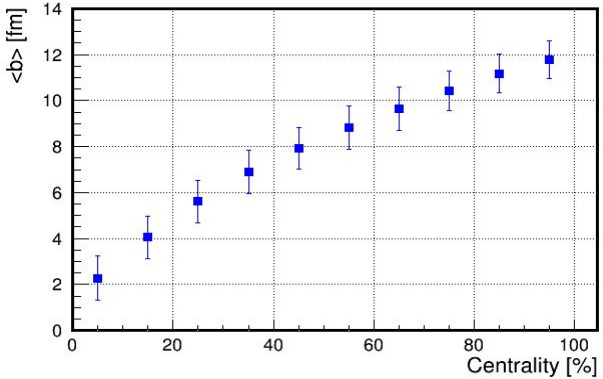
Impact parameter distributions in centrality classes



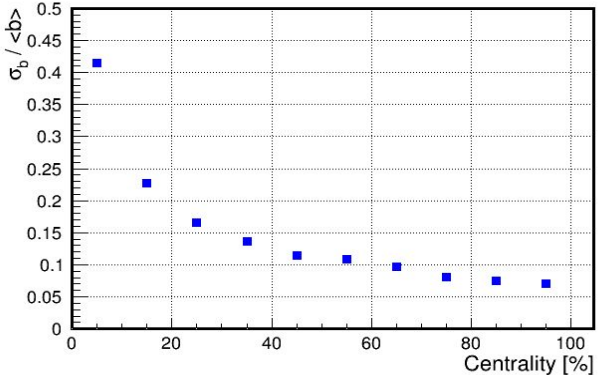
Hodo dE/dx vs FHCal Edep
Xe+CsI@3.9A GeV



<impact parameter> vs centrality



impact parameter resolution



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- Event generator **DCM-SMM**
- Transport code **GEANT4** (FTFP_BERT physics list)
- **bmnroot framework**

Conclusions

- FHCal, ScWall and Beam Hodoscope responses were measured during the SRC beamtime.
- the detector's internals, FEE and readout electronics have proven to be operational during test runs. Some work with DCS is needed.
- software ready at the digitizer level, ⅓ ready at reconstruction level.
- online monitoring is under active development.
- the possibility to use FHCal & Beam Hodo for beam rejection and as Central trigger is shown as well as the centrality selection option
  – Correlation of Z^2 vs Edep.

Thank you for your attention!

Backup

Kuraray Y11 (200) WLS fiber