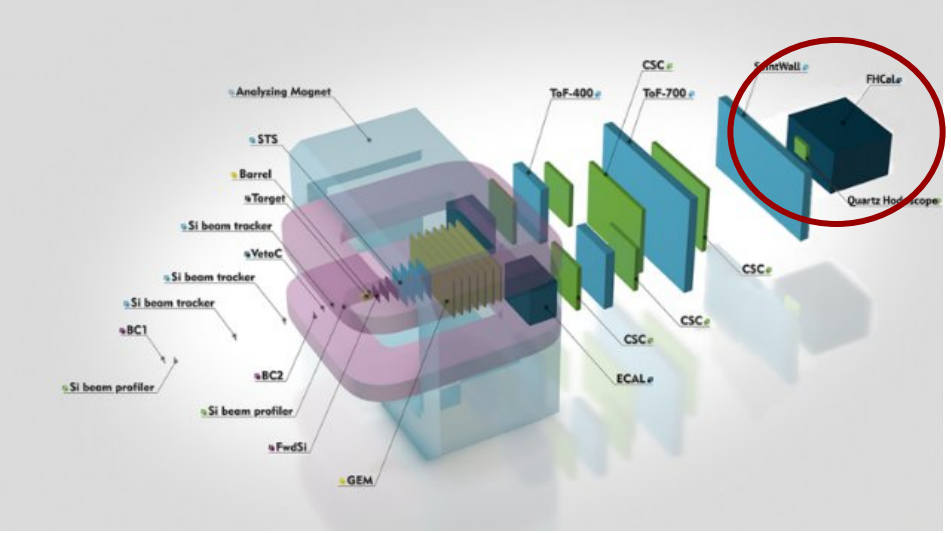
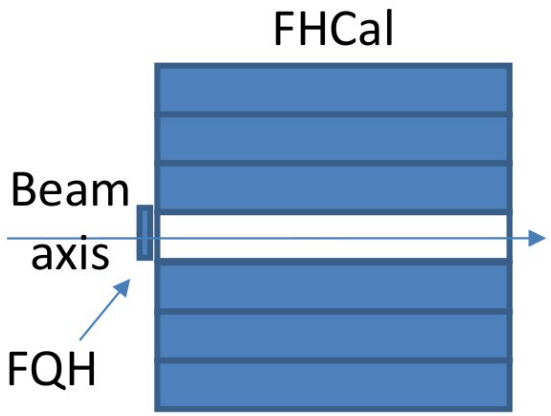
Status of FHCal and FQH for centrality determination at the BM@N Xe run.

Nikolay Karpushkin on behalf
of the INR RAS team

10th Collaboration Meeting of the BM@N Experiment at the NICA Facility
SPbU, St Petersburg, Russia, 14 - 19 May 2023



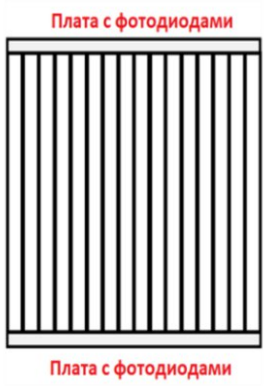


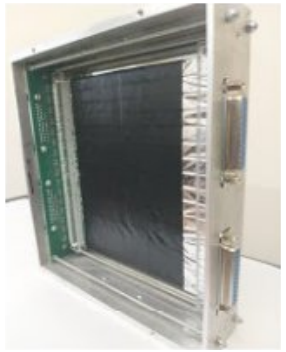
Forward detectors:

- **FQH** (**F**orward **Q**uarz **Hodo**scope)
- **FHCal (F**orward **H**adron **Cal**orimeter)

Tasks:

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





FQH - (Forward Quartz hodoscope):
16 quartz strips 10x4x160mm^3,
2+2 MPPCs per strip,
MPPC S14160-3015PS, 3 x 3 мм^2,
64 readout channels.

35	36	1	2	3	4	5	45	46
		6	7	8	9	10		
37	38	11	12	13	14	15	47	48
39	40	16	17		18	19	49	50
41	42	20	21	22	23	24	51	52
		25	26	27	28	29		
43	44	30	31	32	33	34	53	54

FHCal - (Forward Hadron Calorimeter):
34 modules (MPD-like) – 15x15cm^2; 7 sections; length – 4.0 λ_{int}.
20 modules (CBM-like) – 20x20cm^2; 10 sections; length – 5.6 λ_{int}.
Hamamatsu MPPC S12572-010P, 3x3 мм^2.
434 readout channels.

Forward detectors observables

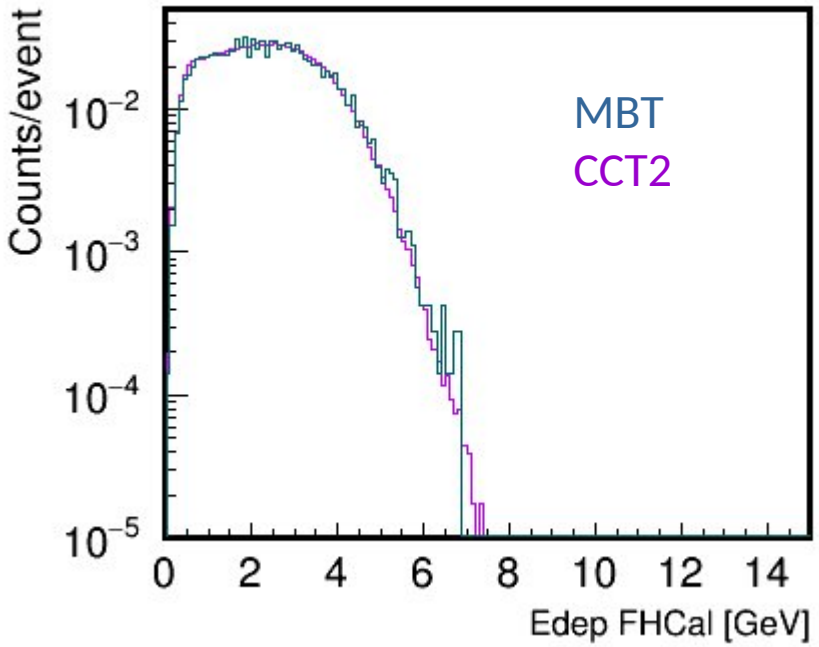
Event selection

≥2 tracks in vertex reconstruction
Single Xe ion selected with BC1S Integral
With cuts on vertex Z (-1.5cm < Z <1.5cm)

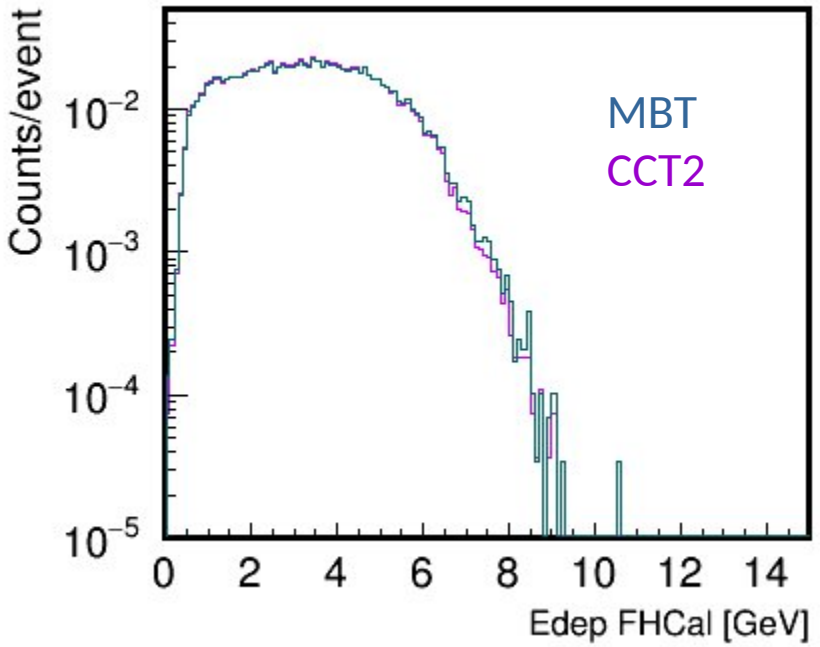
FHCal — Forward Hadron Calorimeter

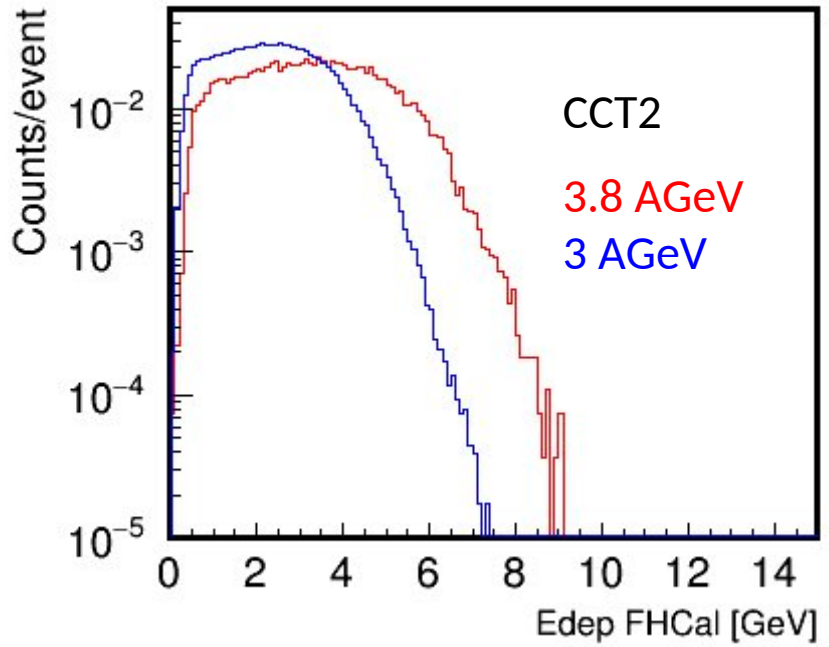
Energy visible in FHCal

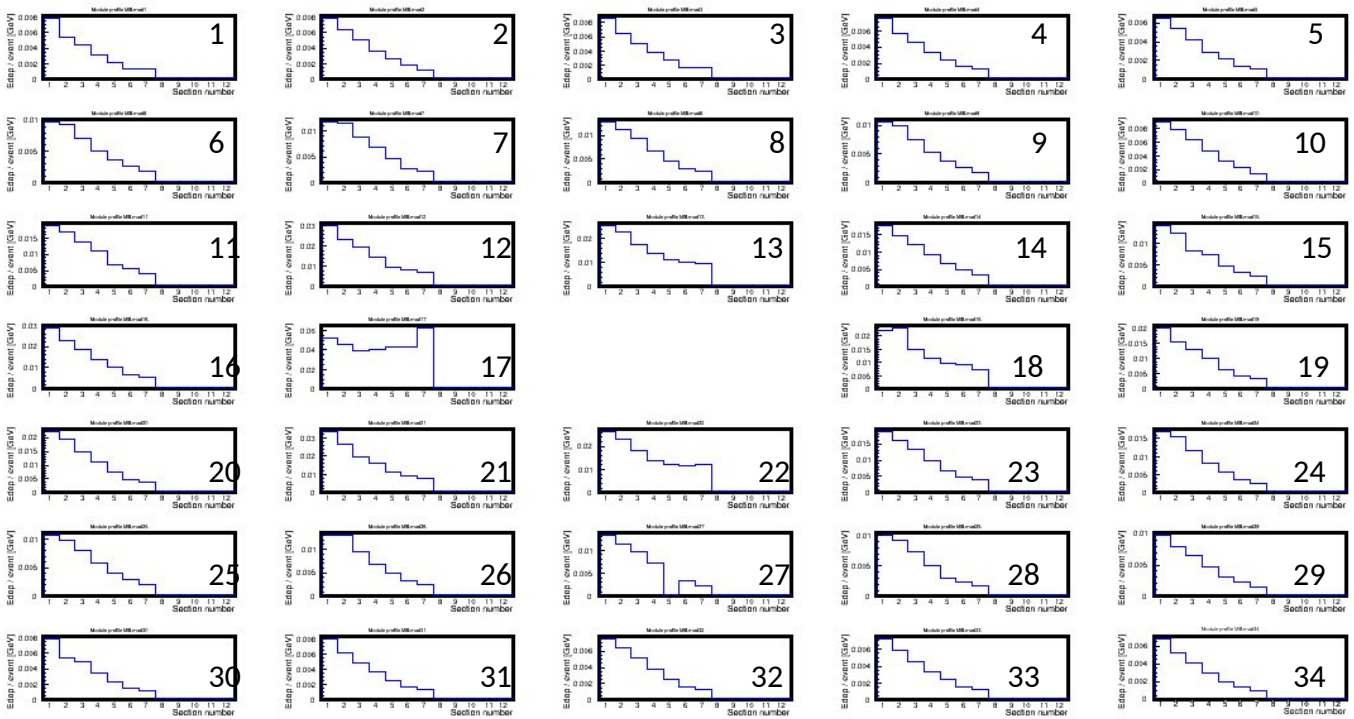
Run 8381 MIXED trigger, **3AGeV** 1024202ev

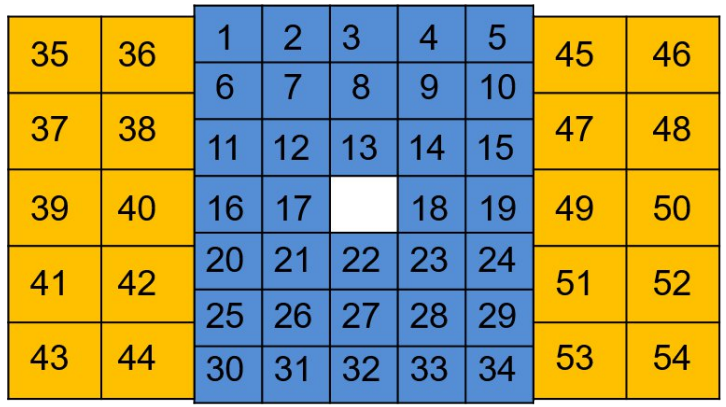


Run 7821 MBT trigger, **3.8AGeV** 200000ev



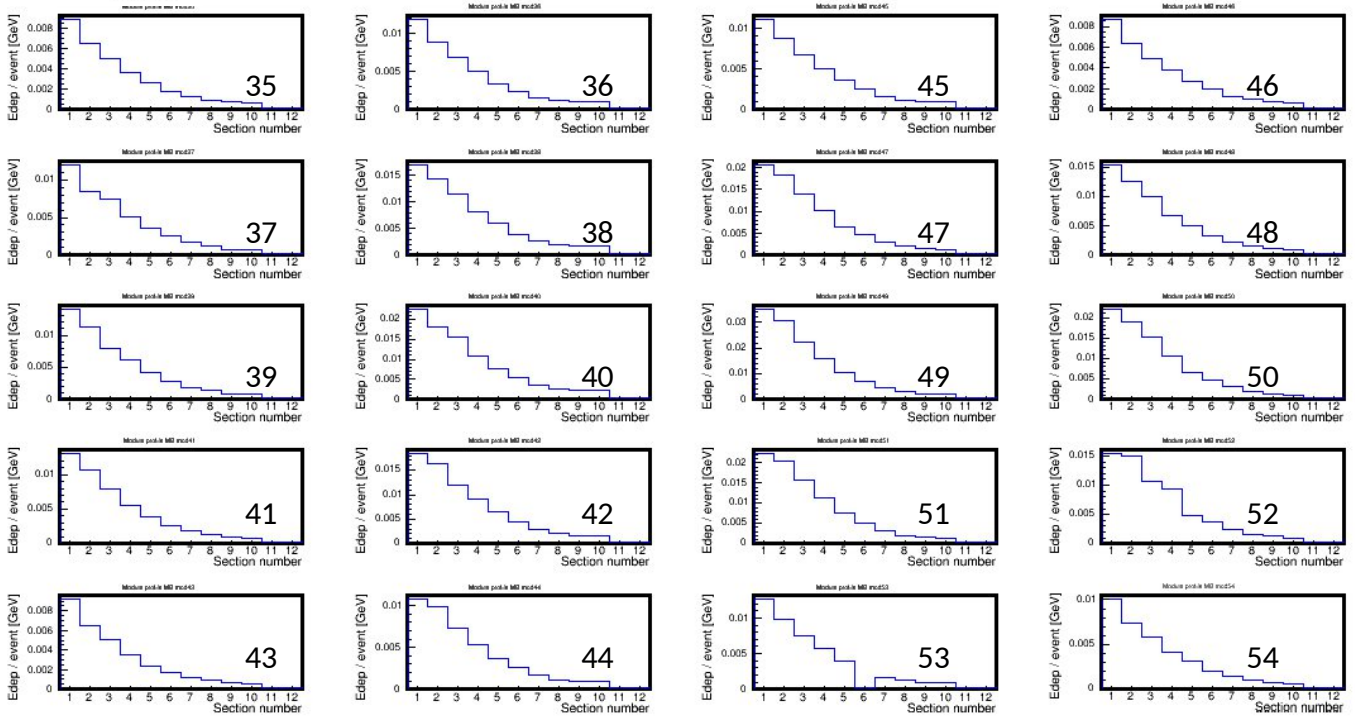


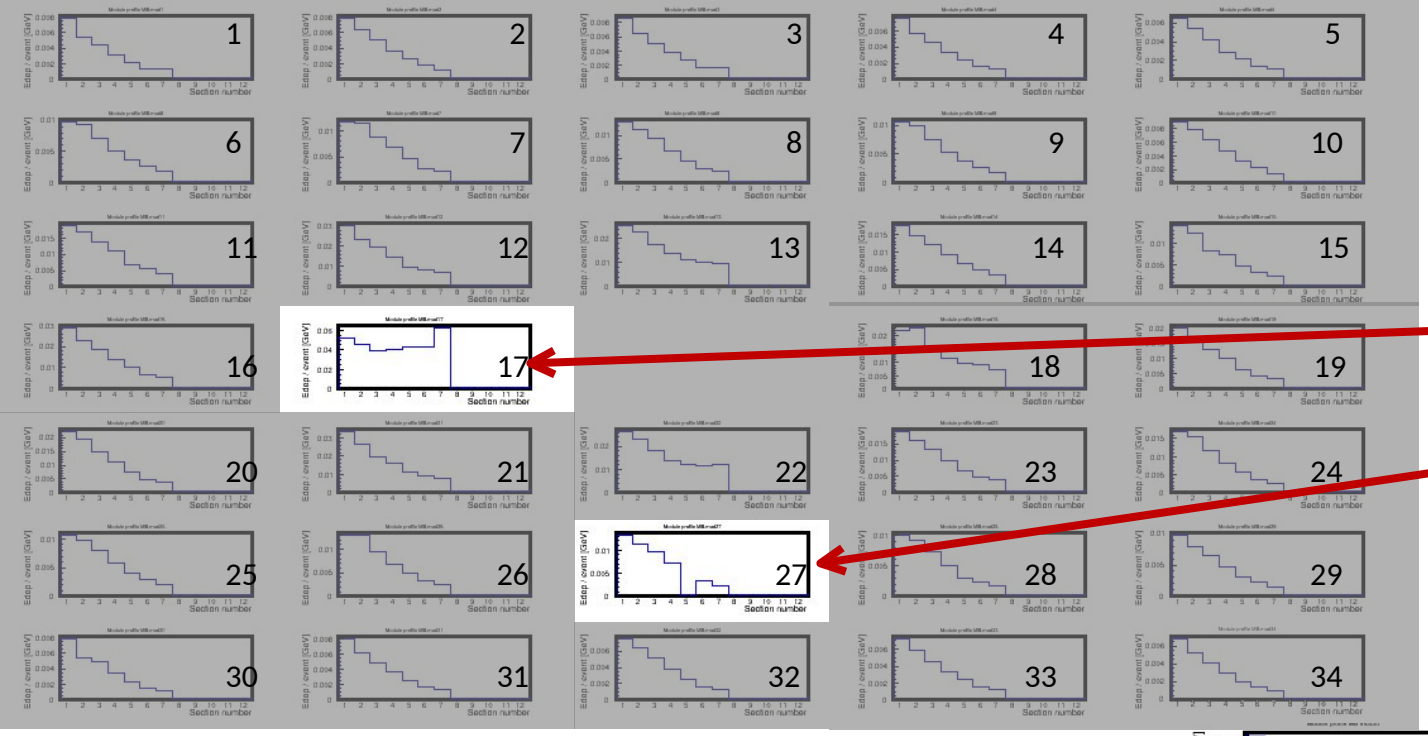




Energy profiles (**MB**)

Run 7821 MBT trigger, **3.8AGeV** 200000ev



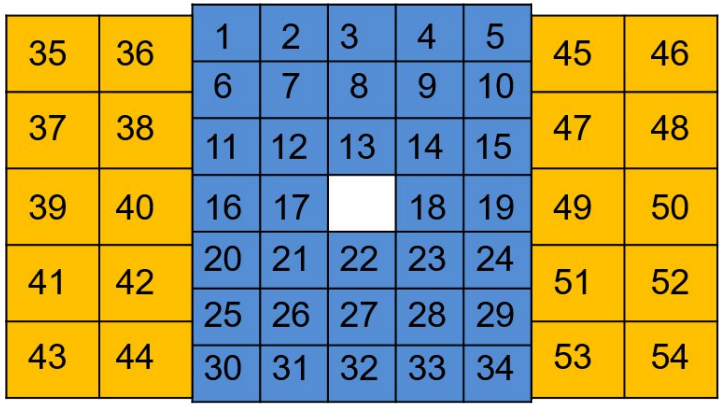


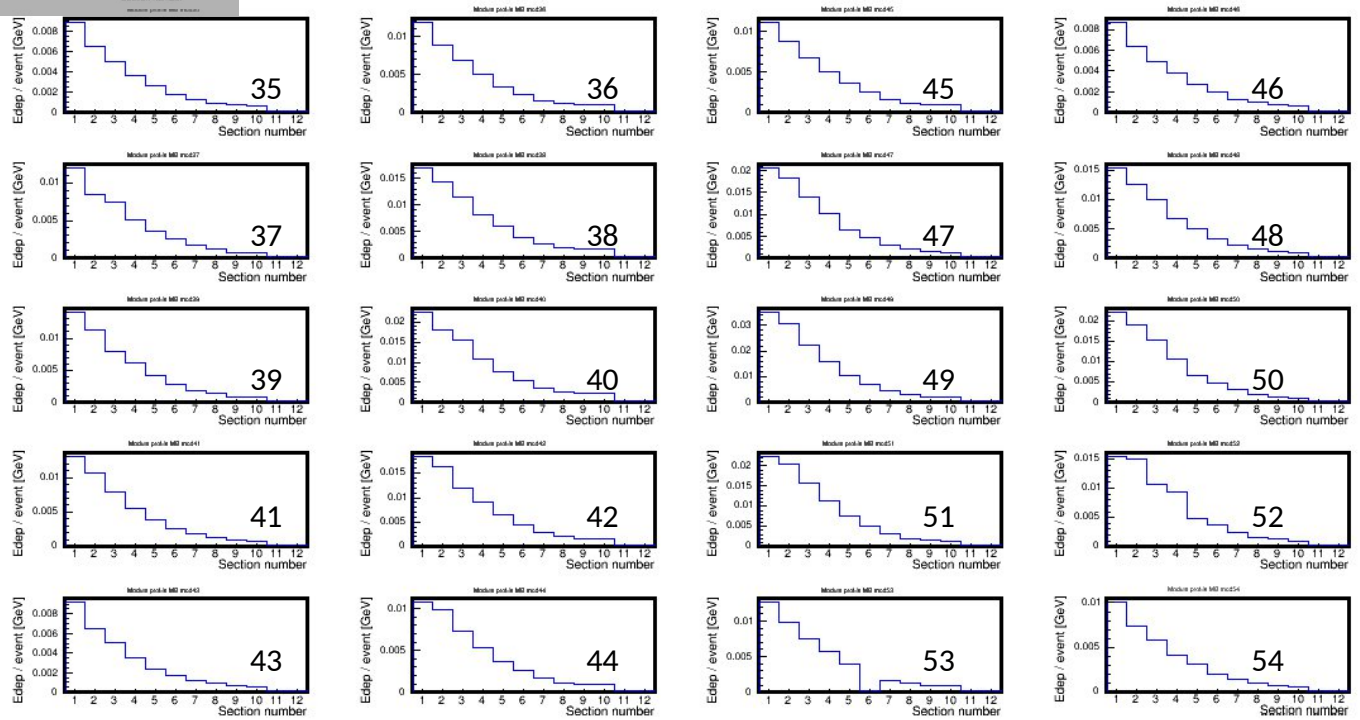
Energy profiles (**MB**)

Run 7821 MBT trigger, **3.8AGeV** 200000ev

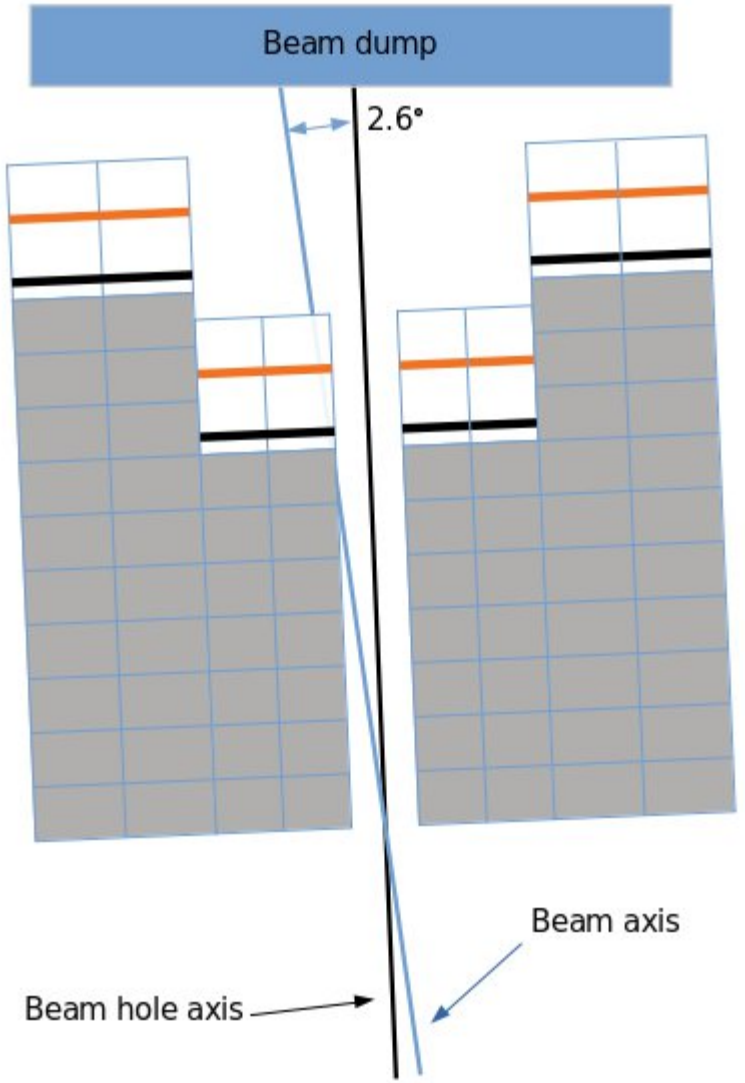
Beam affects the rear part of the 17th module

Dead readout channel



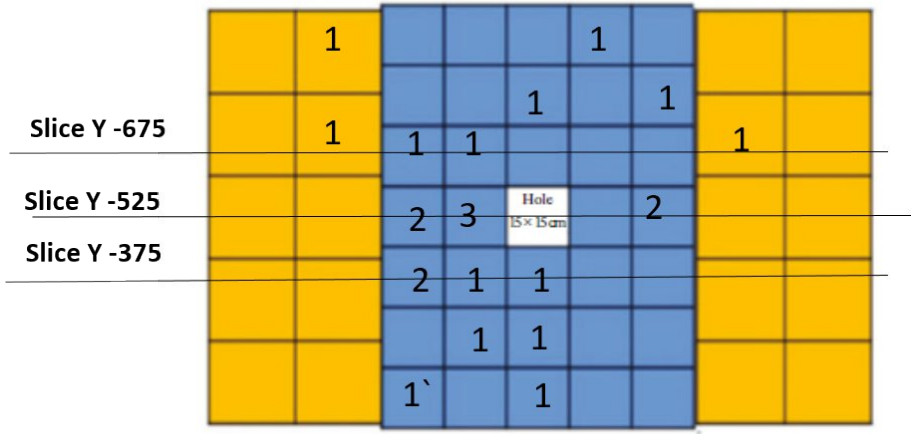


FHCal position relative to the beam axis

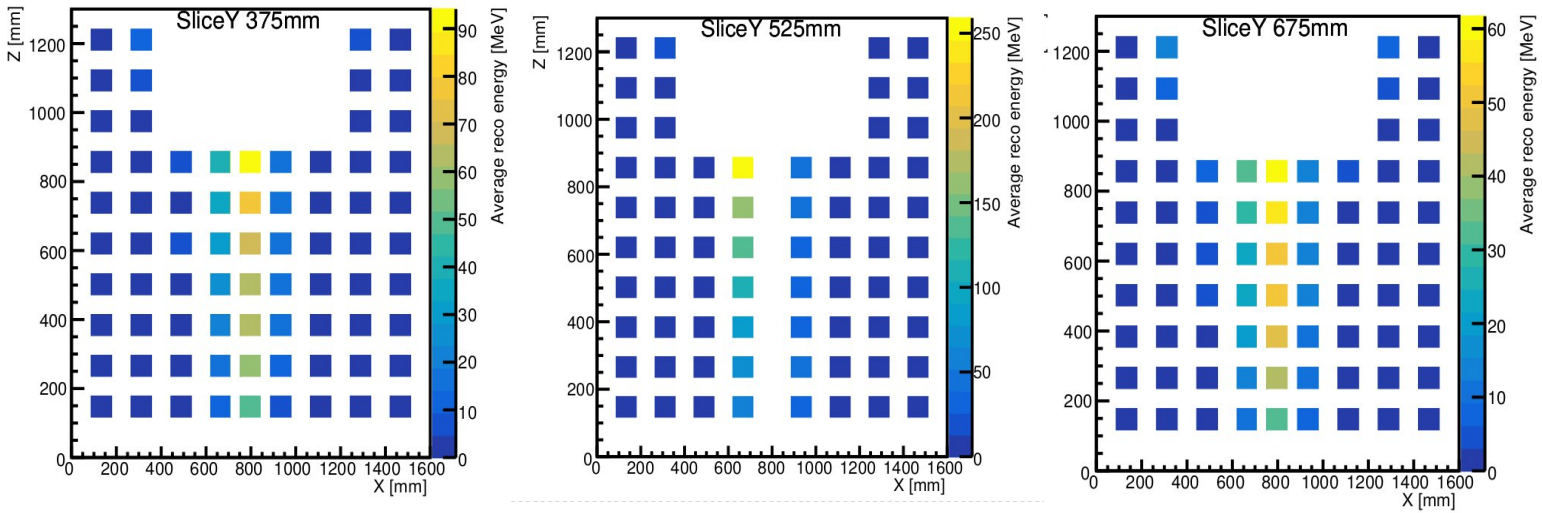


after run 8 FHCal was rotated and is now aligned to beam axis

Number of failures of FHCal modules during Run8



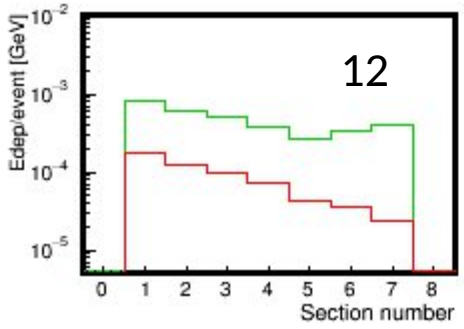
Energy distribution in calorimeter sections. Beam trigger BT

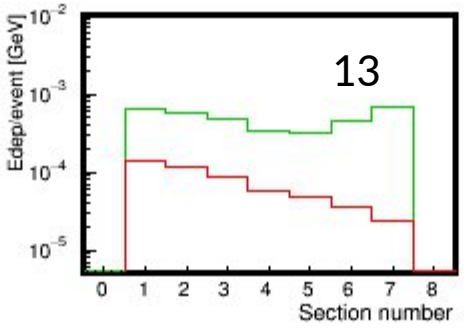


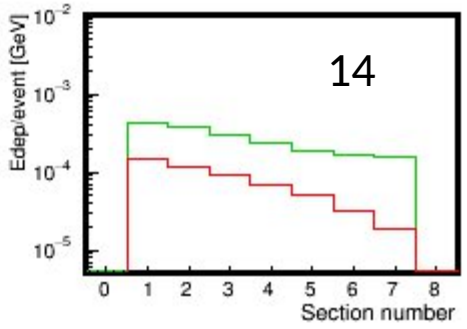
Energy profiles in FHCal modules around the beam hole (normalized to number of triggers)

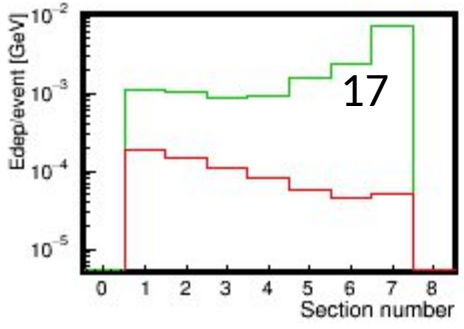
Run 7821 MBT trigger
3.8 AGeV, 200000ev

Modules

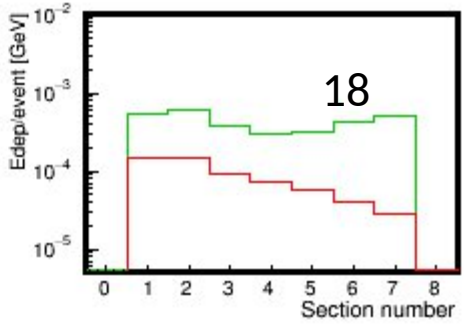


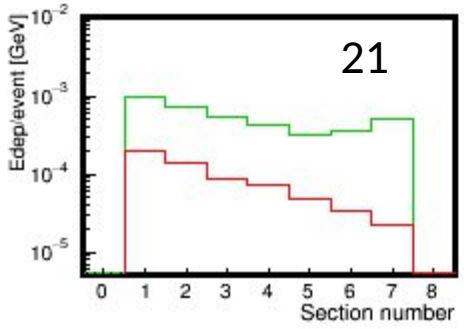


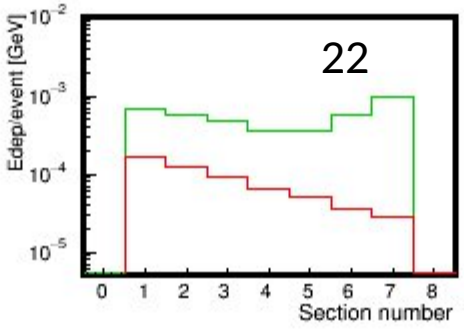


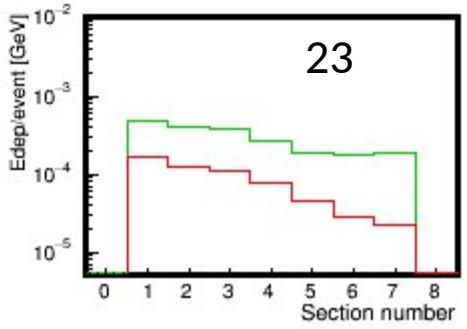


FHCal beam hole



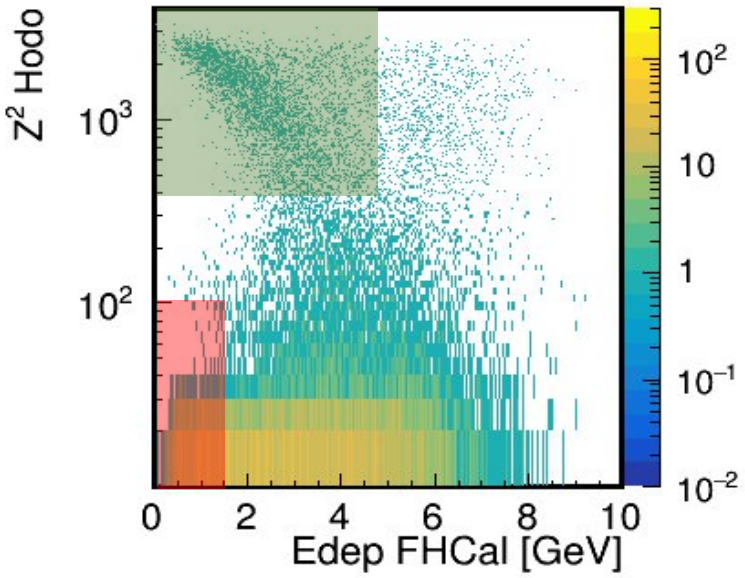






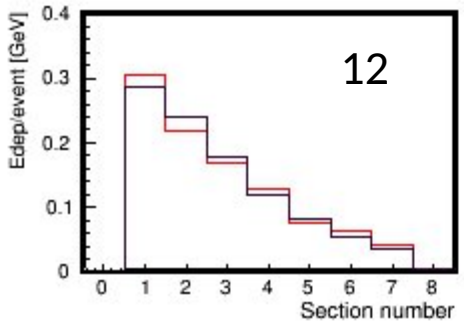
Central events:
FHCal Edep < 1.4 GeV && Z^2 < 100

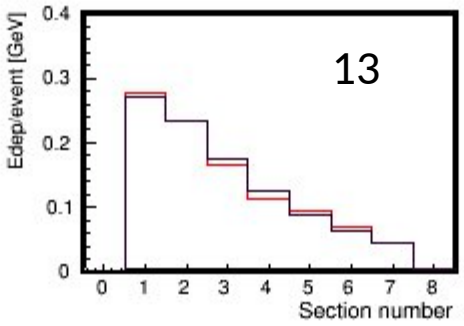
Peripheral events:
FHCal Edep < 4.7 GeV && FQH Z^2 > 400

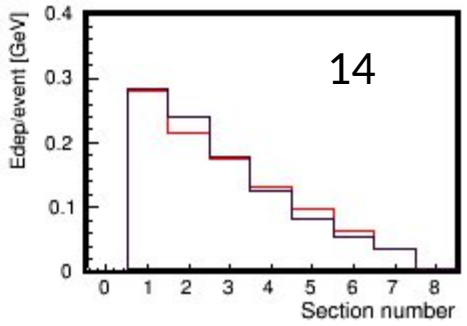


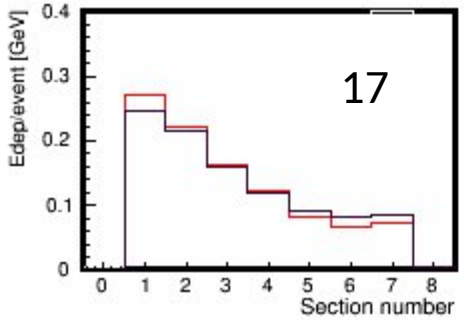
Energy profiles in FHCal modules around the beam hole: comparison with simulation

Modules

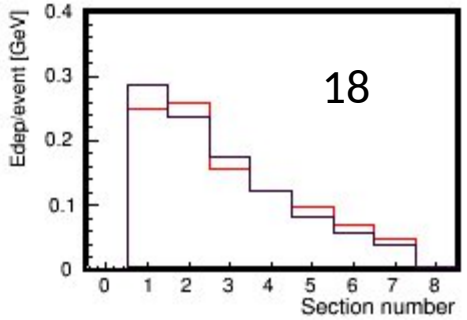


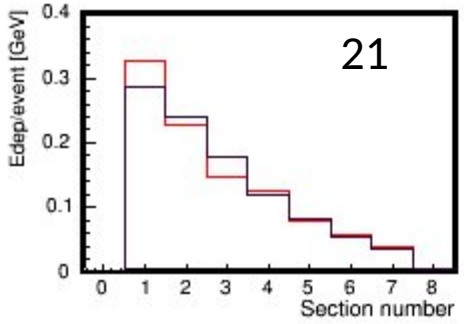


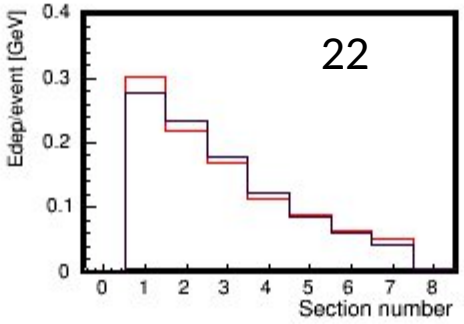


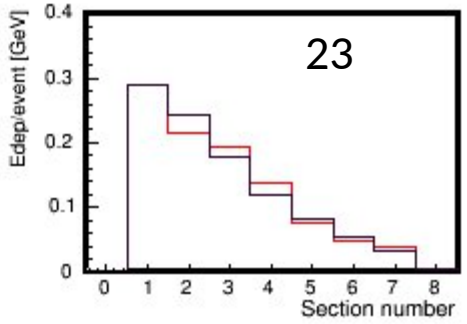


FHCal beam hole



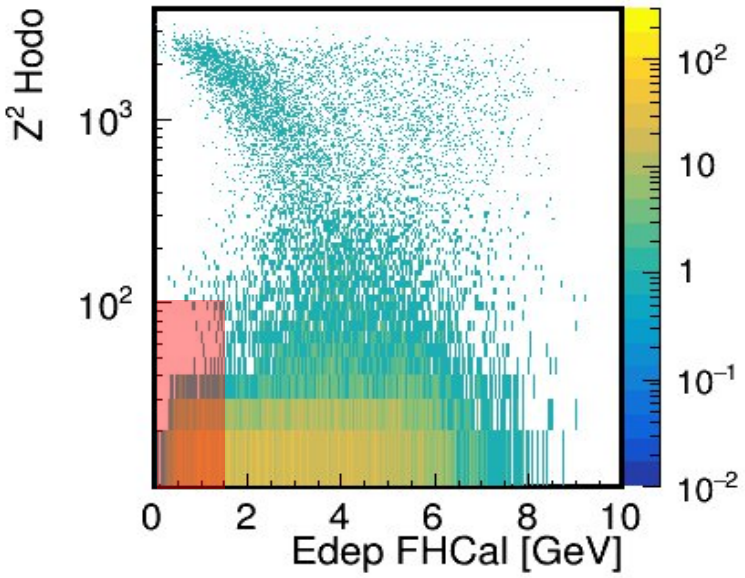






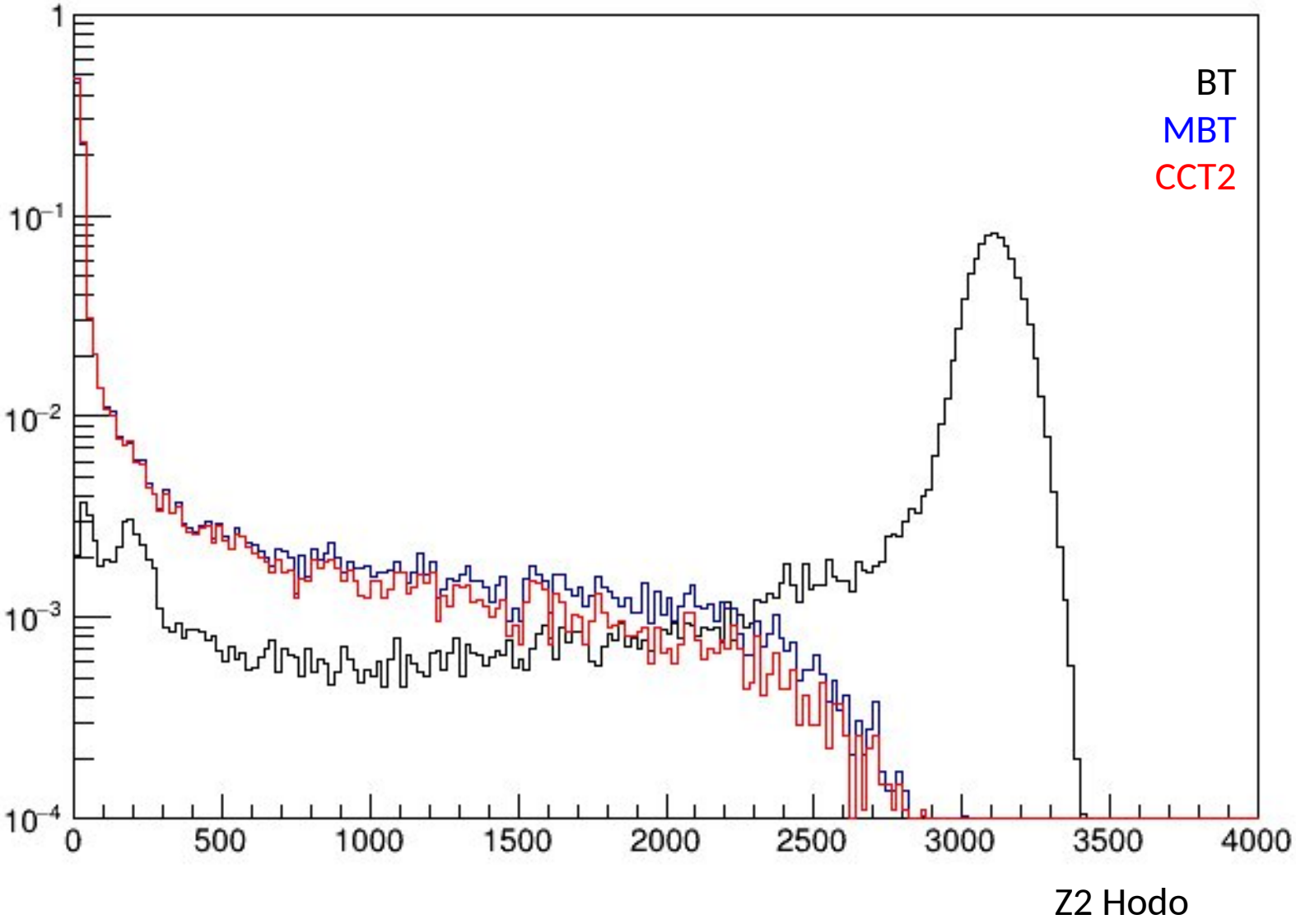
Run 7821 MBT trigger 3.8 AGeV
Central events:
FHCal Edep < 1.4 GeV && Z^2 < 100

Simulation Xe+CsI@3.26 AGeV cms
DCM-QGSM-SMM (UNIGEN)
all BMN detectors
Central events:
FHCal Edep < 1.4 GeV && Z^2 < 100

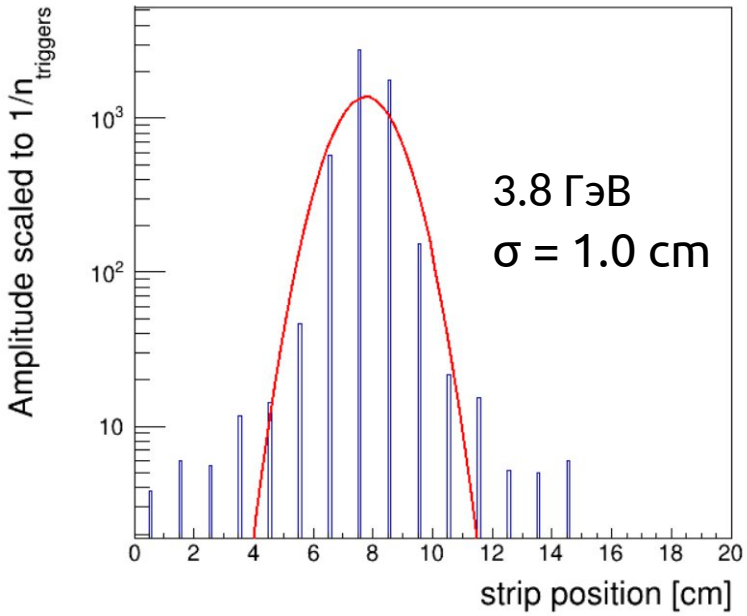


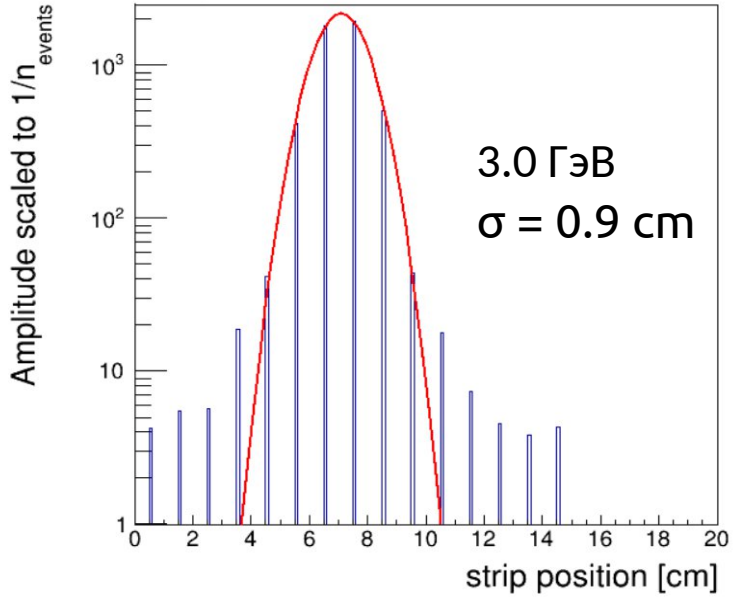
FQH — Forward Quarz Hodoscope

Fragments charge distribution in FQH



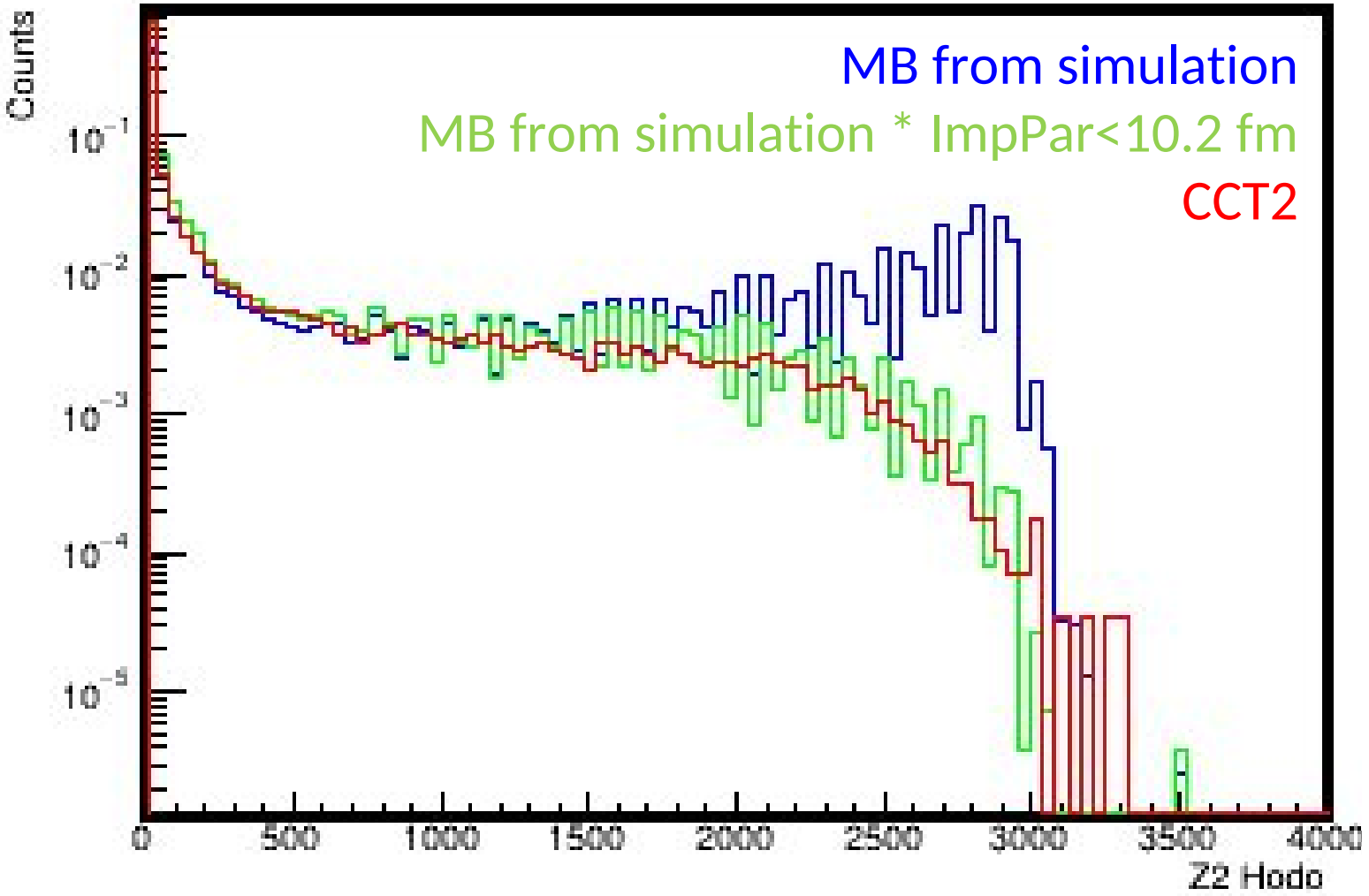
Beam profile. BT





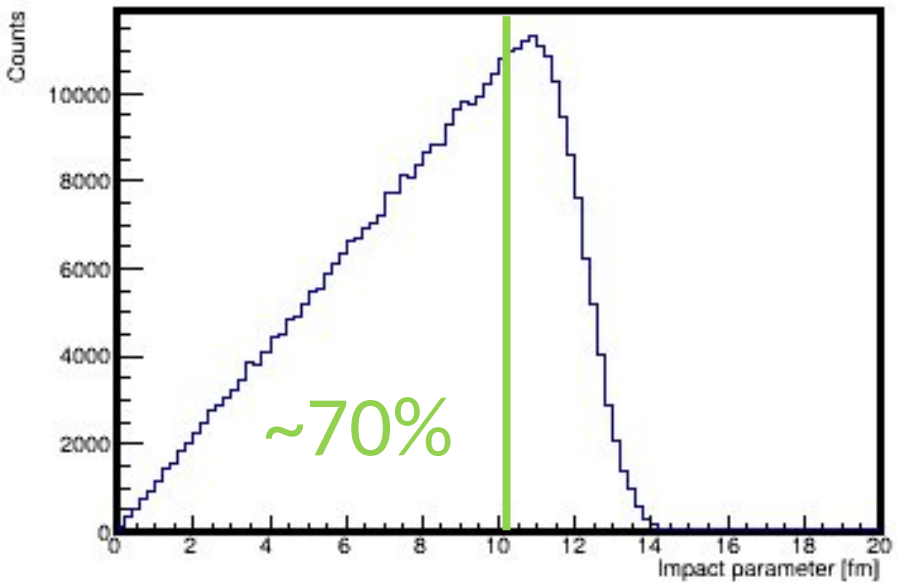
Fragments charge distributions in FQH: Estimating true minimum bias fraction

Preliminary



CCT2 trigger selects up to ~70% of most central events relative to true minimum bias

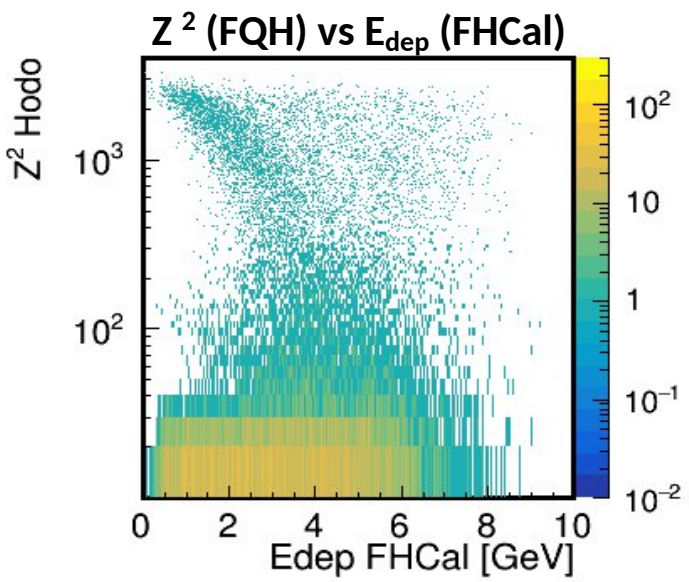
Impact parameter

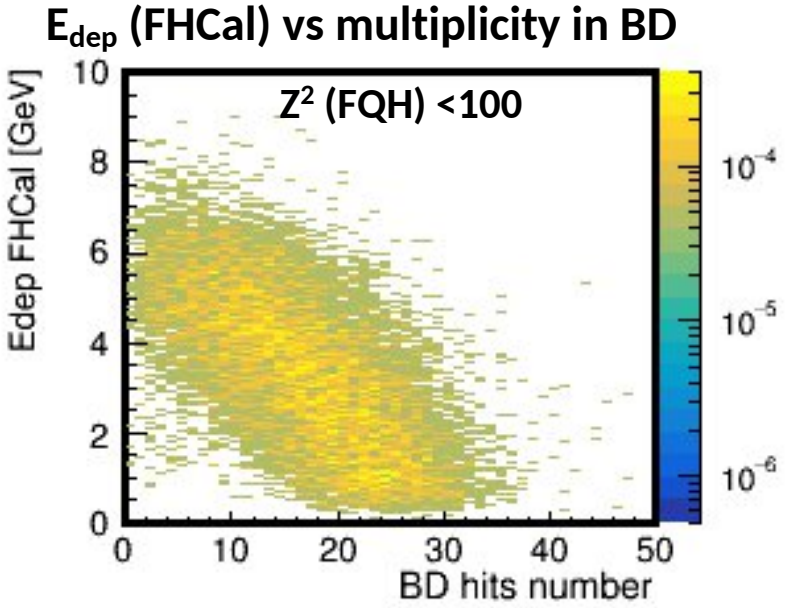


Centrality determination
from correlations of forward detectors observables

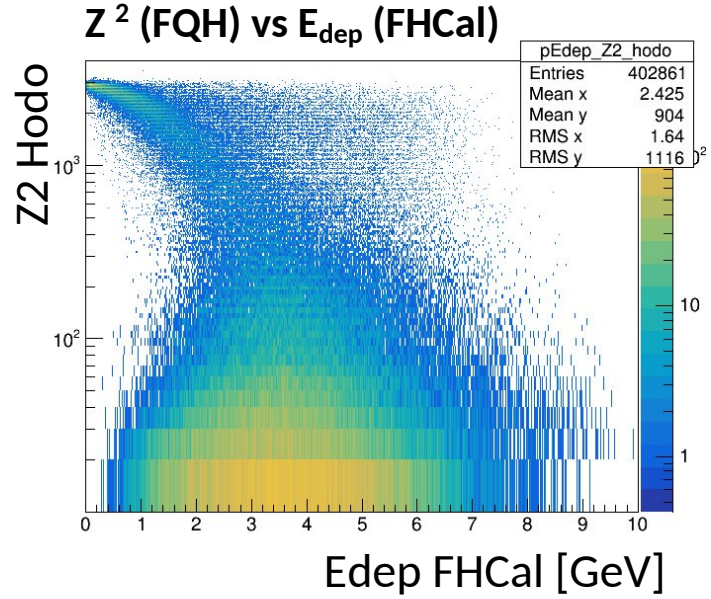
Correlations of forward detectors observables

XeCsI@**3.8A GeV**. Run 7821 2% CsI target, MBT trigger.

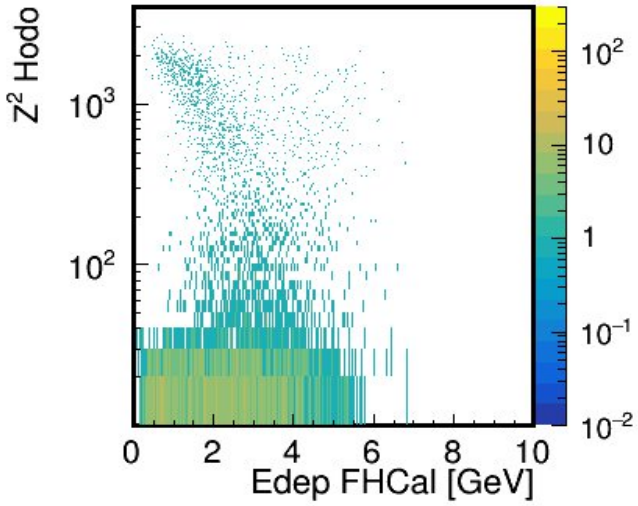


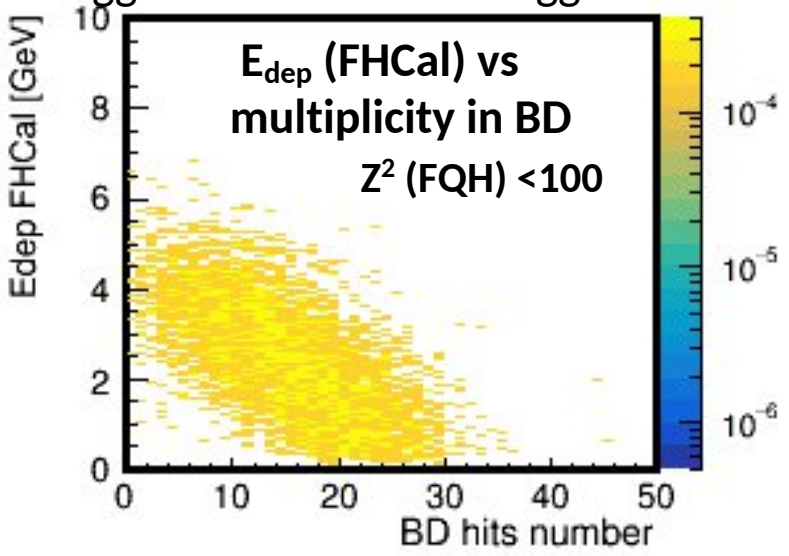


DCM-QGSM-SMM minbias



XeCsI@**3.0A GeV**. Run 8381 2% CsI target, Mixed trigger. Selection MBT trigger.





No simulation available yet

Conclusion and next steps

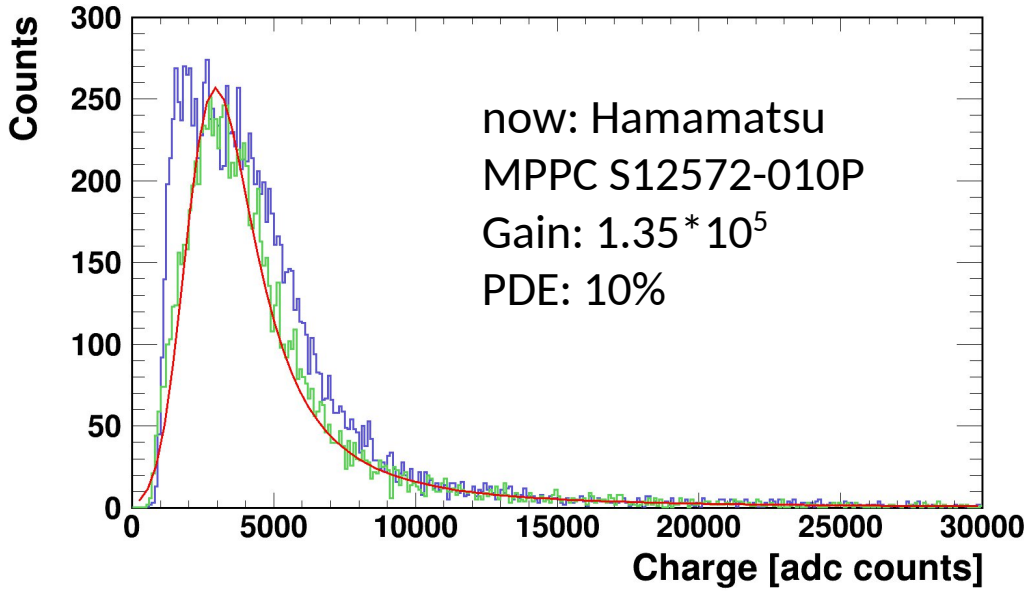
Conclusions:

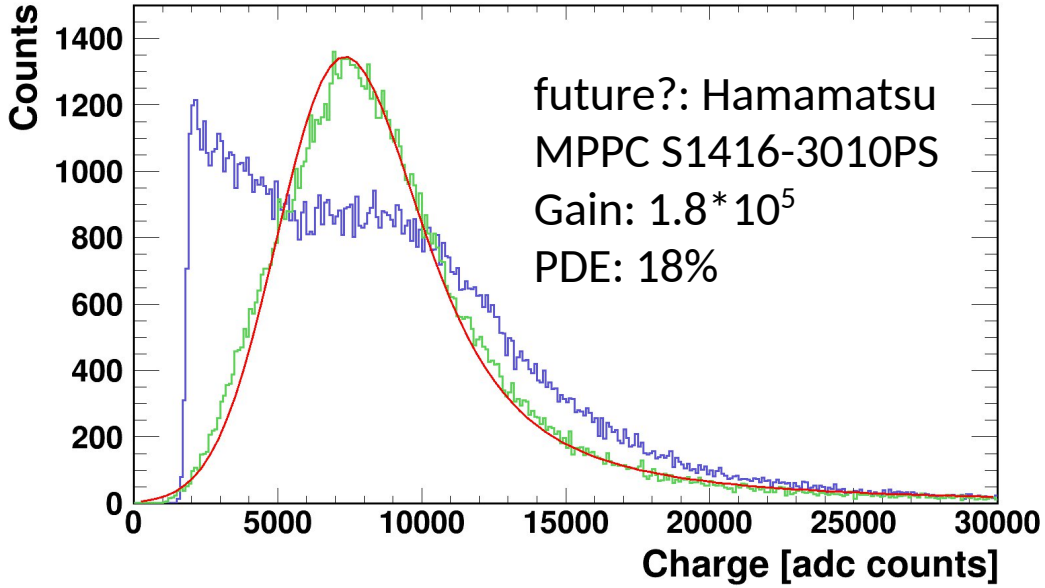
- **FHCal and FQH were operational during the experimental session.**
- **Online monitoring software for the FHCal and FQH was developed and used during the run.**
- **Misalignment of the FHCal was observed. This is the main reason for the failure of the module's electronics. The FHCal was properly aligned after the run 8.**
- **The FQH response agrees well with the simulated data. Preliminary estimation gives about 70% of the true minimum bias obtained from the CCT2 trigger.**
- **The correlations between forward detectors observables show the possibility of centrality selection.**

Conclusion and next steps

Next steps:

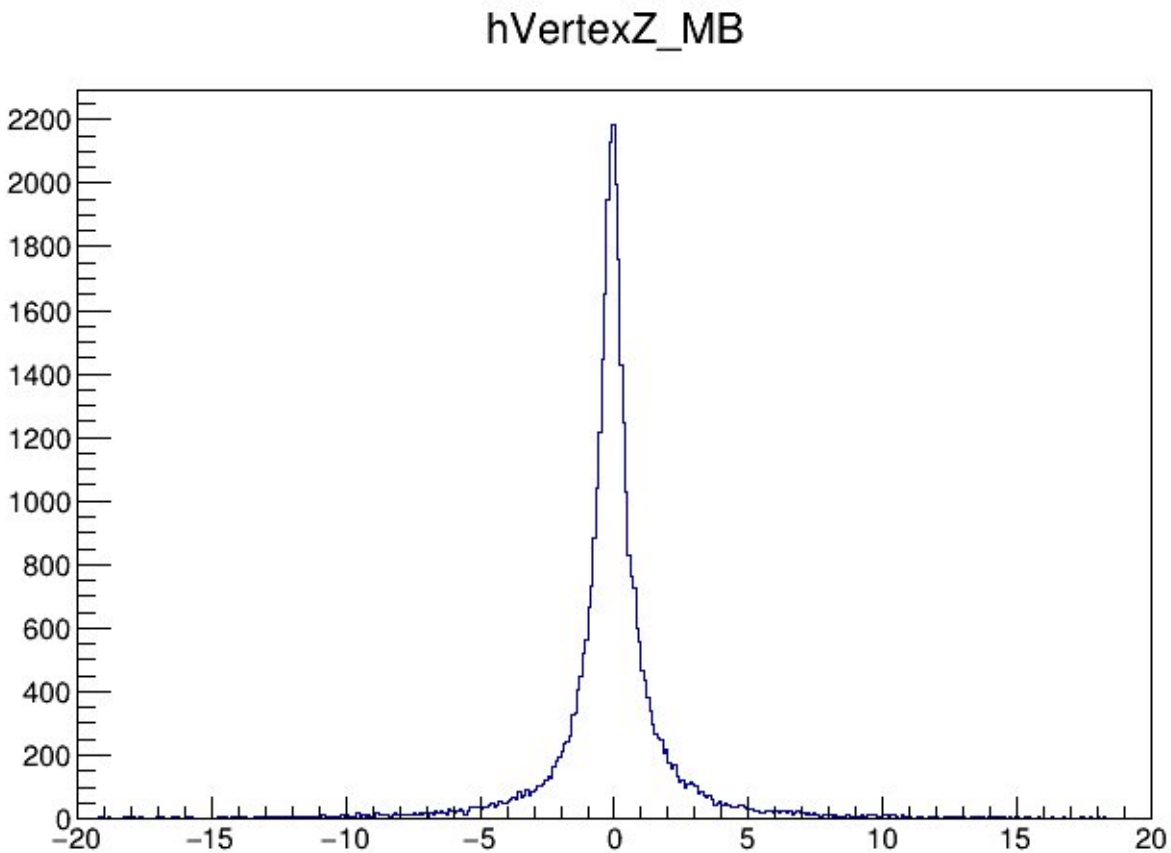
- **More detailed investigations of detector's response is needed.**
- **Pile-up study with FQH is underway.**
- **A replacement of SiPMs is being considered as a possible upgrade to FHCal. This will significantly improve the reliability of the FHCal calibration.**



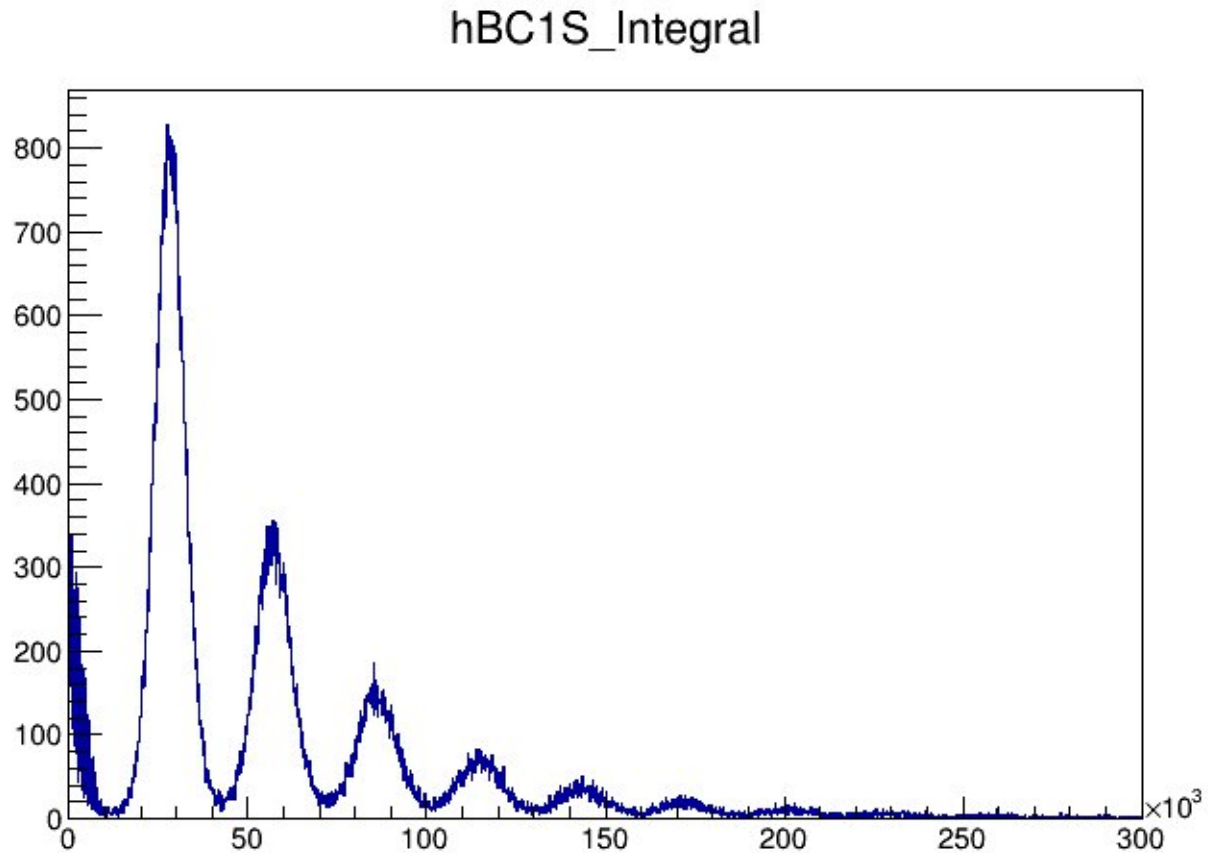


Thank you for your attention!

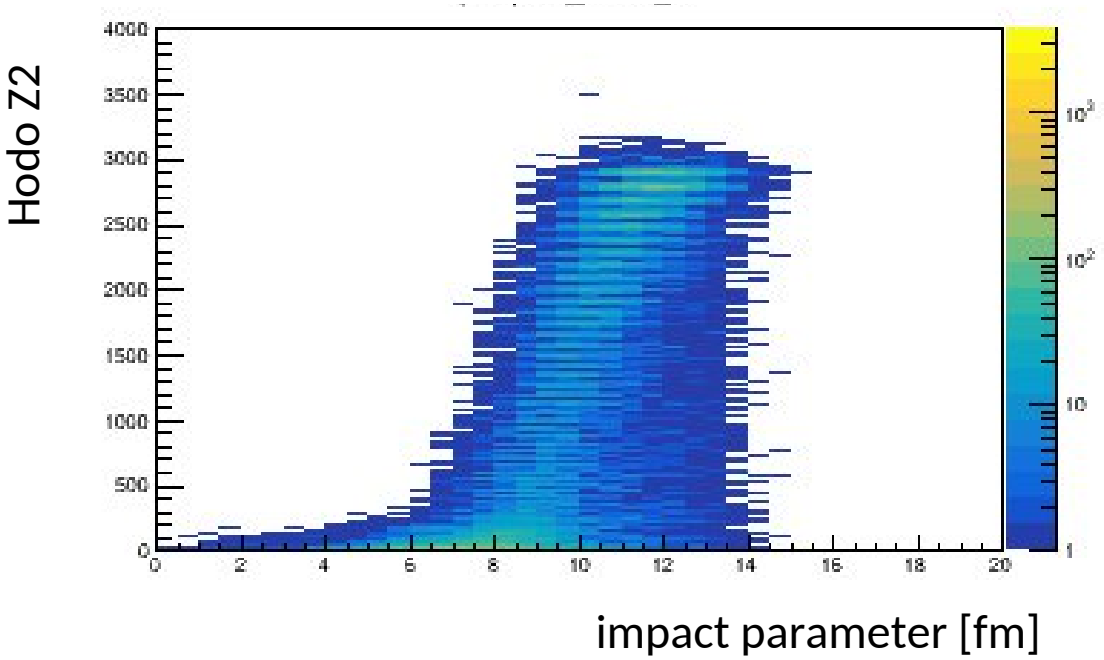
BACKUP

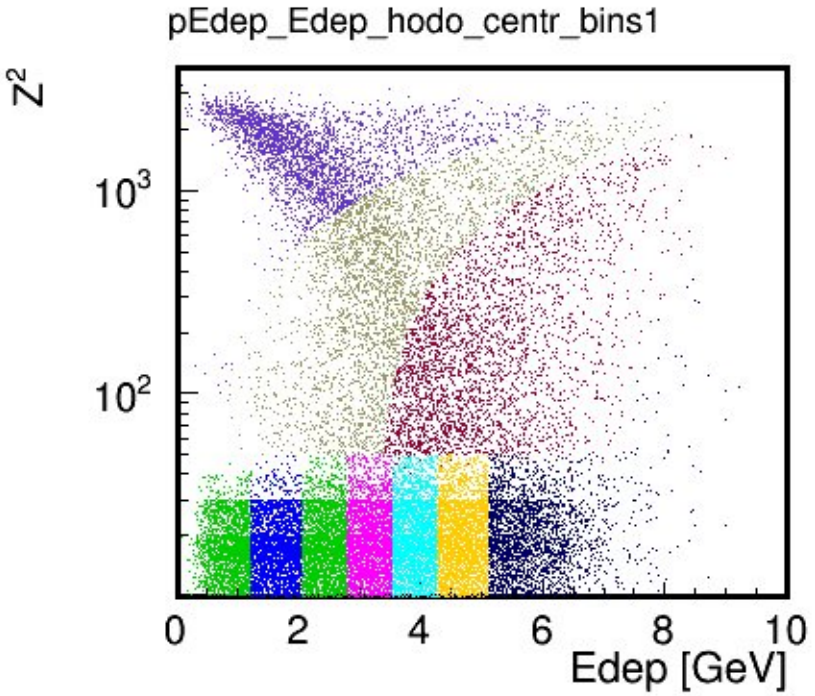


Vertex Z position [cm]



BC1S counter [a.u.]


Hodo Z2
impact parameter [fm]


pEdep_Edep_hodo_centr_bins1
Z²
Edep [GeV]