Current status of event reconstruction and data analysis in Carbon and Argon runs

Yu.Gornaya, M.Kapishin, G.Pokatashkin, I.Rufanov, V.Vasendina, A.Zinchenko

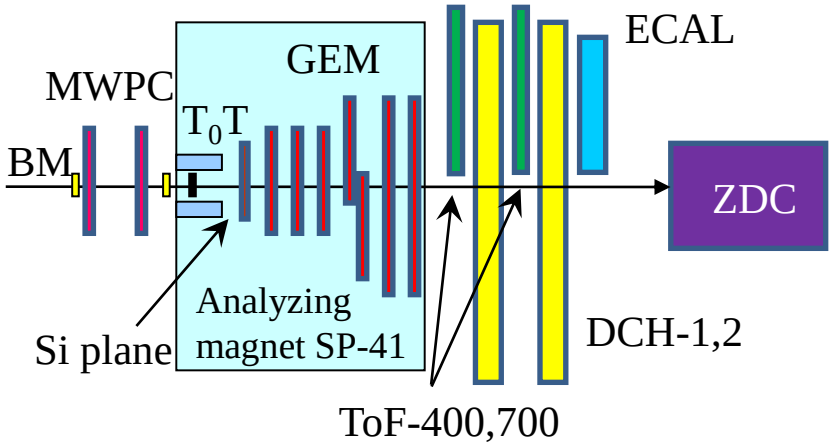
for the BM@N collaboration
VBLHEP, JINR, Dubna, Russia

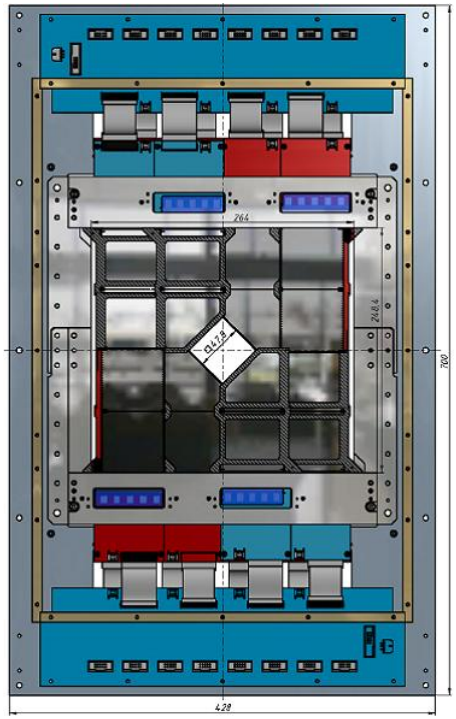
DAC meeting
23.01.2019

Outline

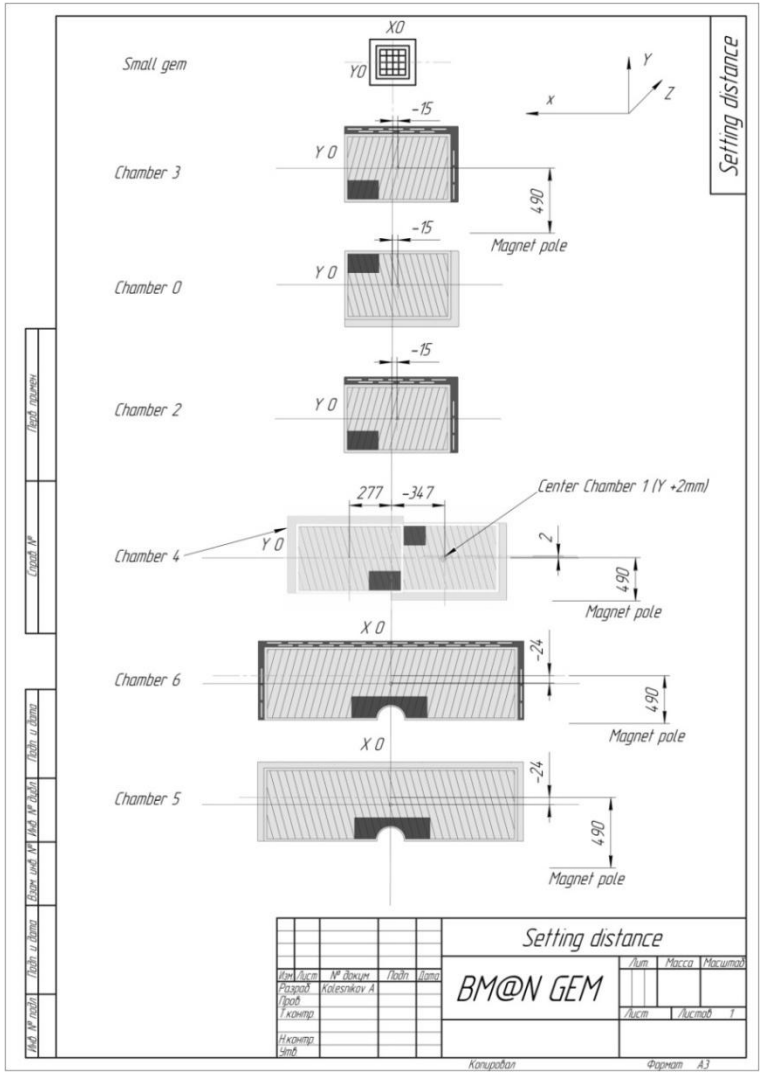
1. Technical run with carbon beam (March 2017)
   - ✓ BM@N detector set-up
   - ✓ Λ reconstruction (update)
   - ✓ Embedding of Λ (step 0.5)
2. Technical run with argon beam (March 2018)
   - ✓ BM@N detector set-up
   - ✓ Operation of Si trigger and Si detectors
   - ✓ Tracker residuals and PV reconstruction
   - ✓ Λ reconstruction: Data vs MC (ideal)
3. Summary & Plans

BM@N set-up in carbon run





2-coordinate Si detector X-X'(±2.5°) with strip pitch of 95/103 μm, full size of 25 x 25 cm^2 , 10240 strips

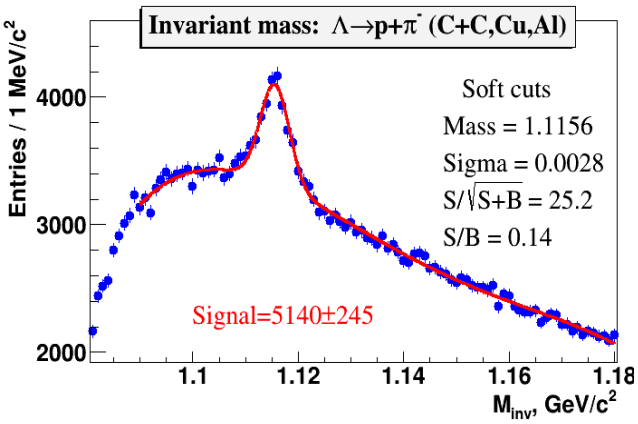


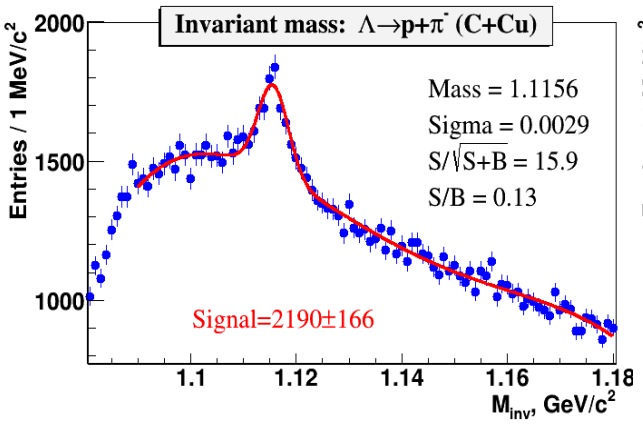
Fine tuning for the 2017 run

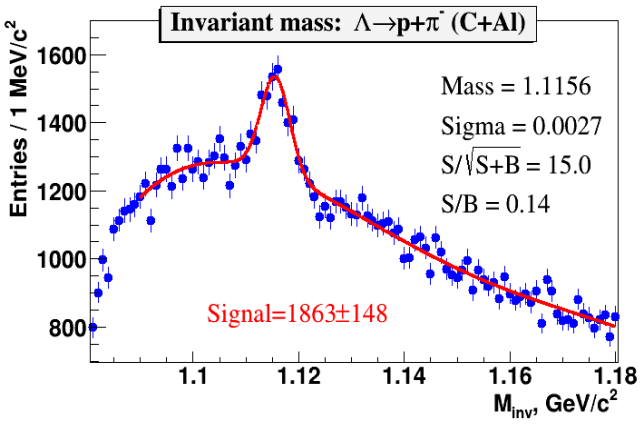
1. Event reconstruction parameter tuning.
2. Using detector measurement errors extracted from hit residuals.
3. Magnetic field adjustment.
4. Magnetic field correction for each run (from the database of the magnet current).
5. Better event selection - pileup rejection (using information from trigger detectors and cut on the maximum number of clusters in STS).
6. Si strip number jitter correction.

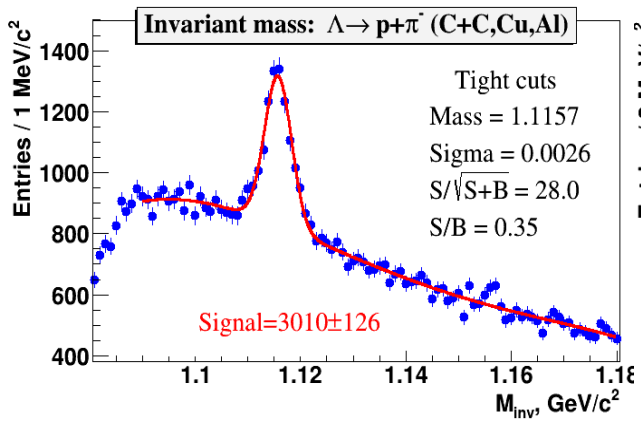
Λ & K^0_s reconstruction

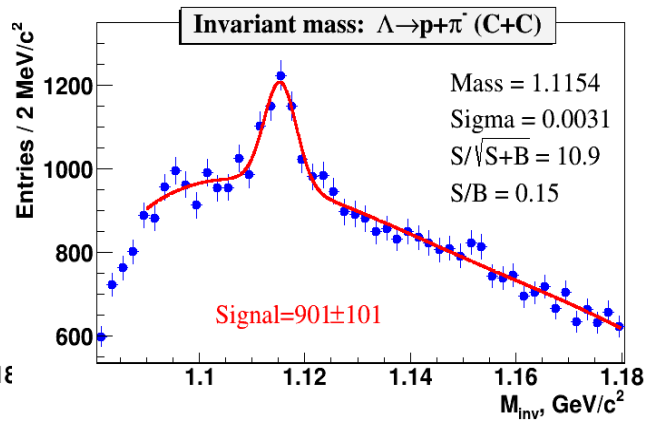
Beam /Target: C/C,Al,Cu; E_{kin} = 4.0A GeV, No PID, only GEM+Si

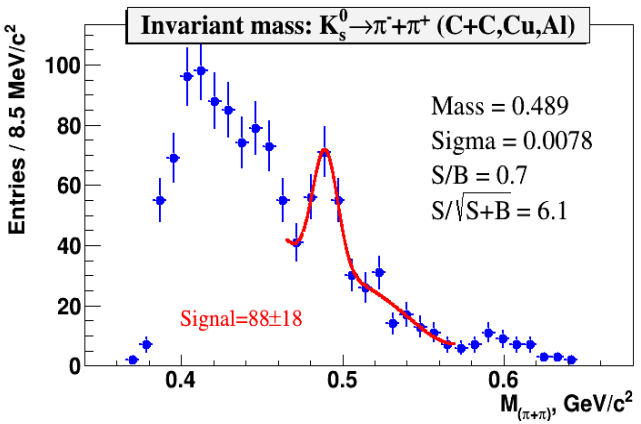






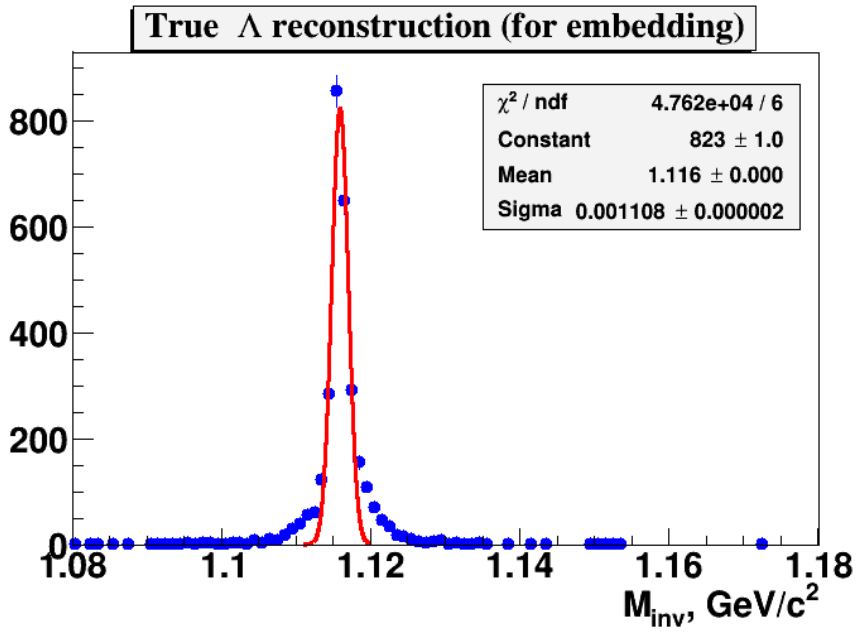






Since the GEM tracker configuration was tuned to measure relatively high-momentum beam particles, the geometric acceptance for relatively soft decay products of strange V0 particles was rather low. The Monte Carlo simulation showed that only **~4%** of Λ and **~0.8%** of K_s^0 could be reconstructed.

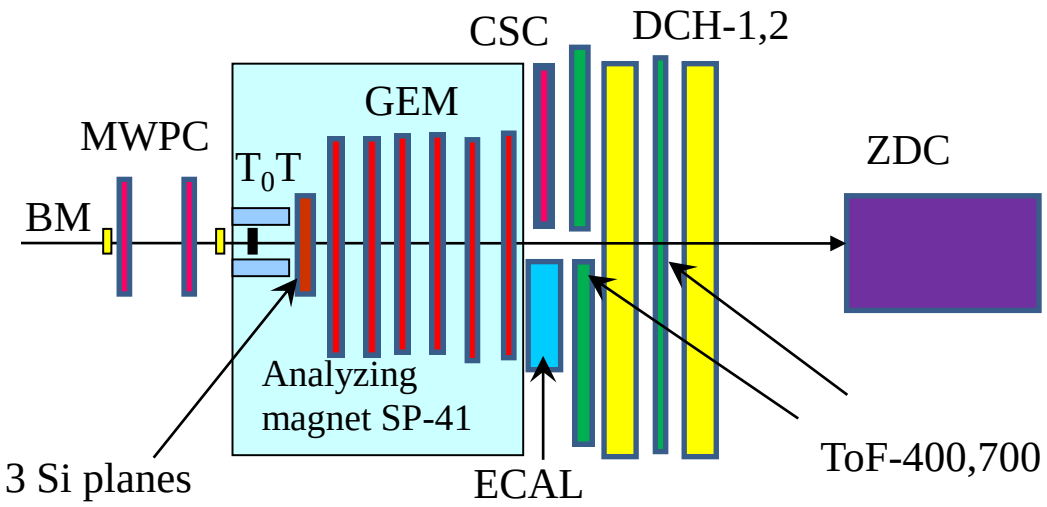
Embedding of Λ (step 0.5)



Reconstructed invariant mass of MC proton and pion from lambda decays using real data reconstruction chain (starting from detector digits).

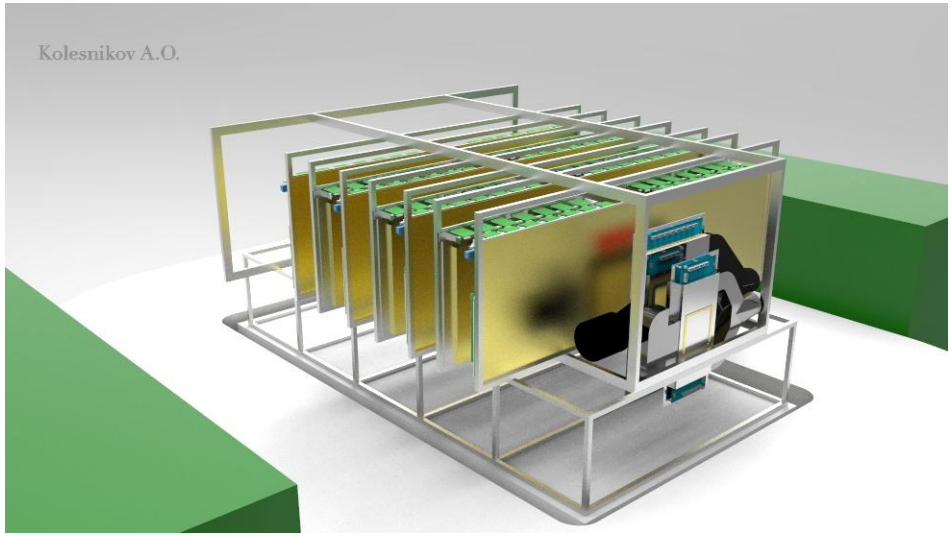
Argon run in March 2018

BM@N set-up in argon run



Ar beam, E_{kin} = 3.2A GeV

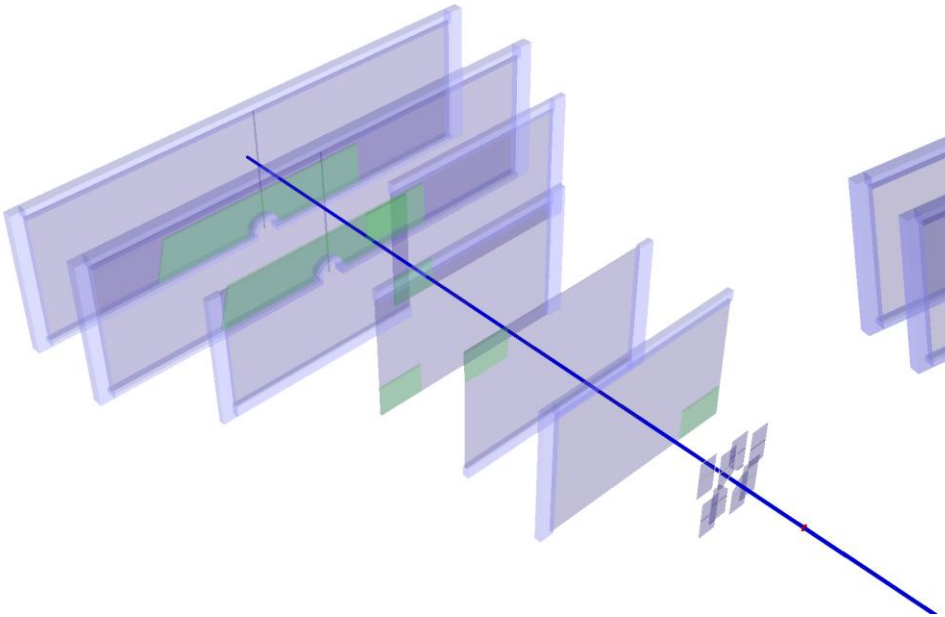
Kr beam, E_{kin} = 2.3 (2.9)A GeV



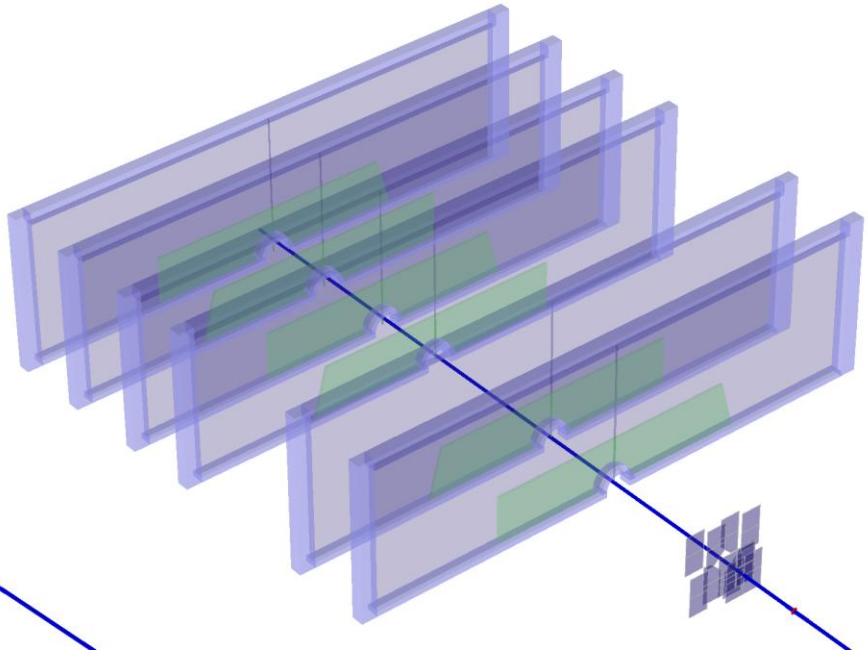
7 planes of big GEM detectors
3 planes of Si detector in front of GEMs

Beam crosses Si detectors in center,
big GEMs – in beam hole
→ configuration is based on results of Λ and K^0_S simulation

Central tracker: 2017 vs 2018

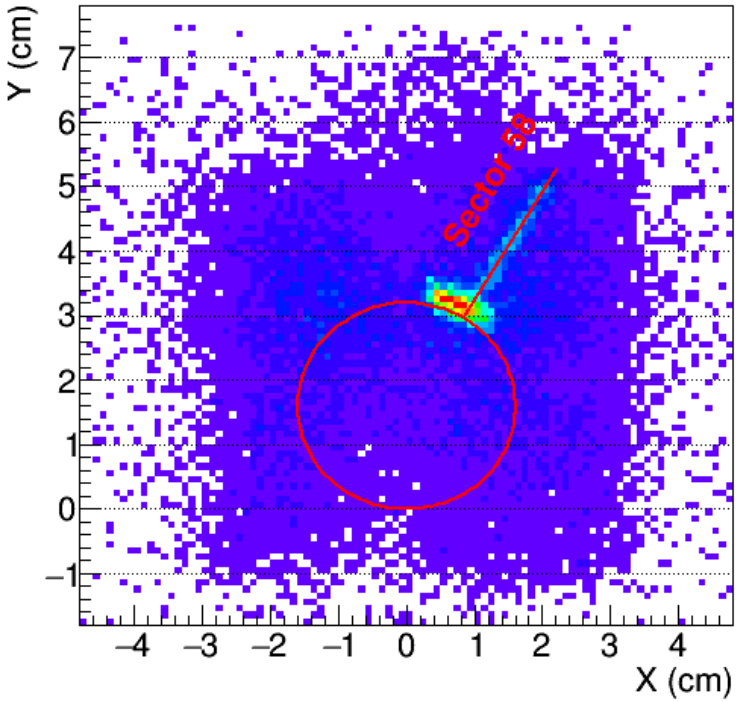


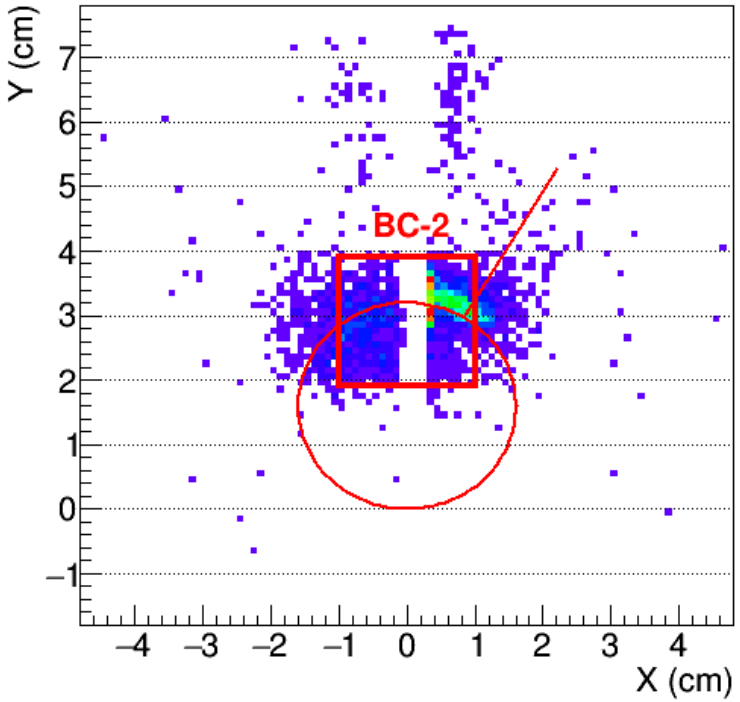
March 2017, C beam

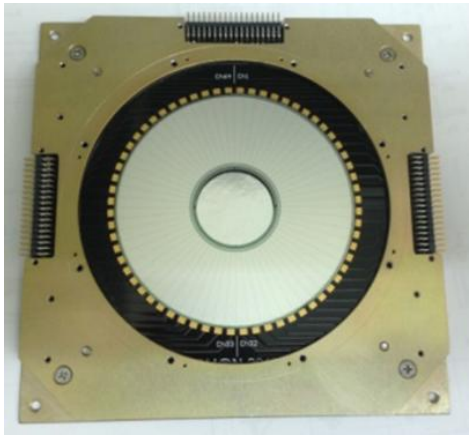


March 2018, Ar beam

Hits in Si trigger w/out magnetic field

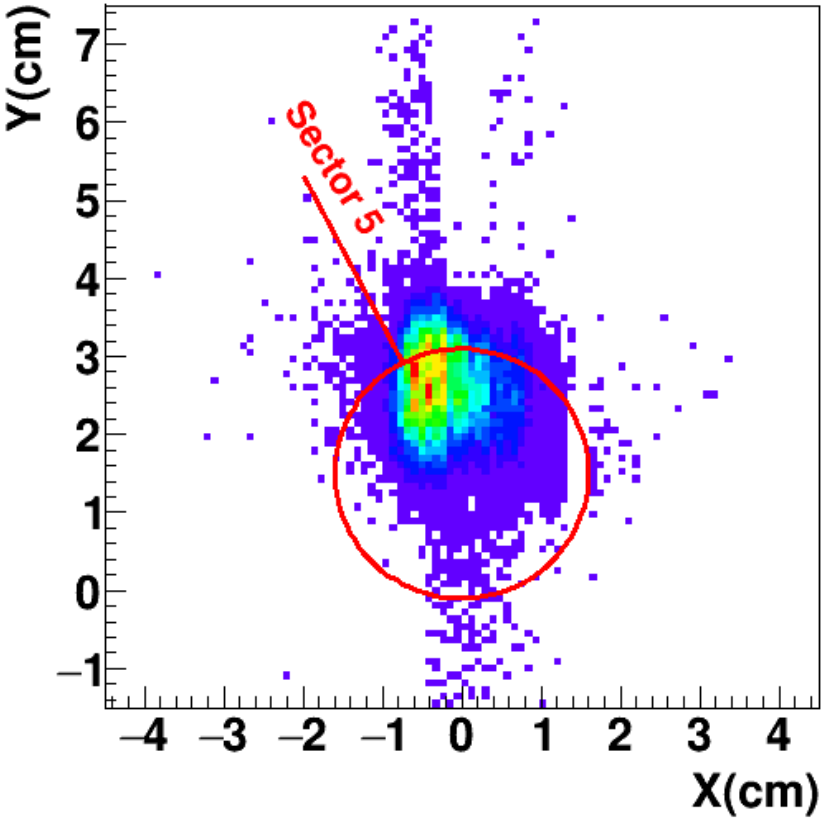


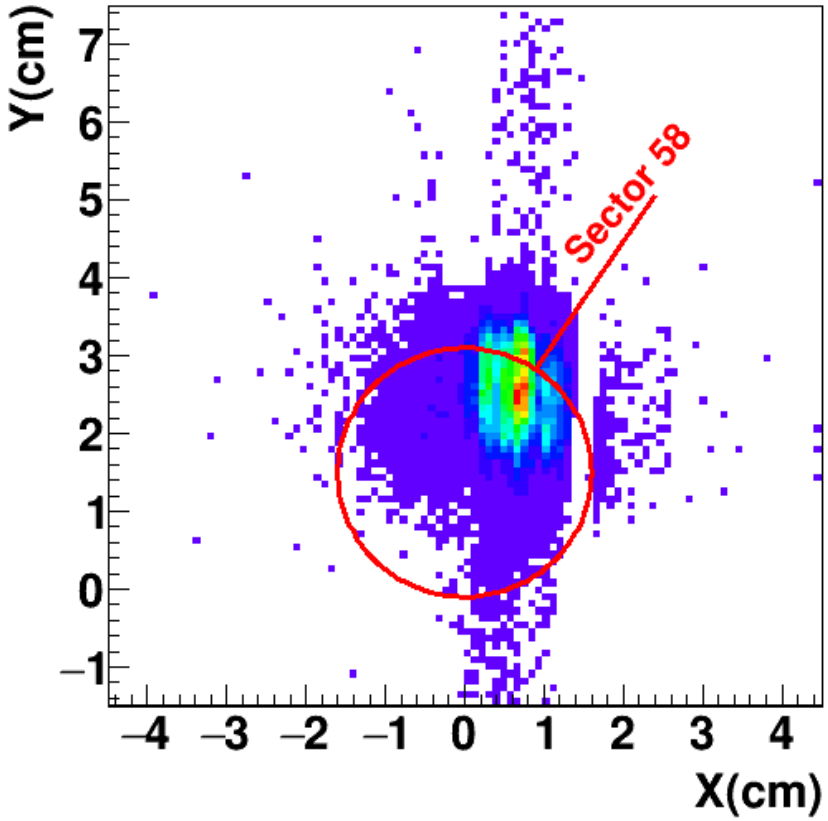




Extrapolated track positions to the Si trigger detector in events with fired sector 58: left – all tracks, right – tracks with large signal in Si tracking stations.

Hits in Si trigger with magnetic field

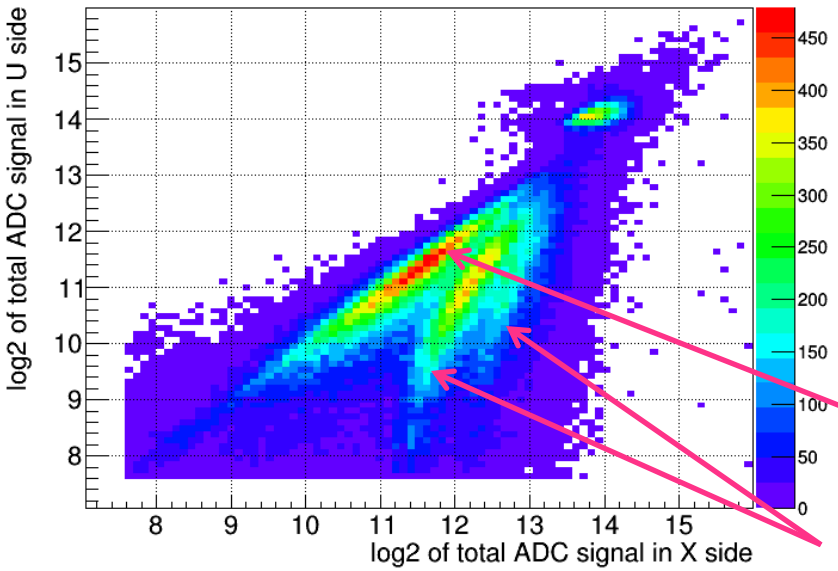




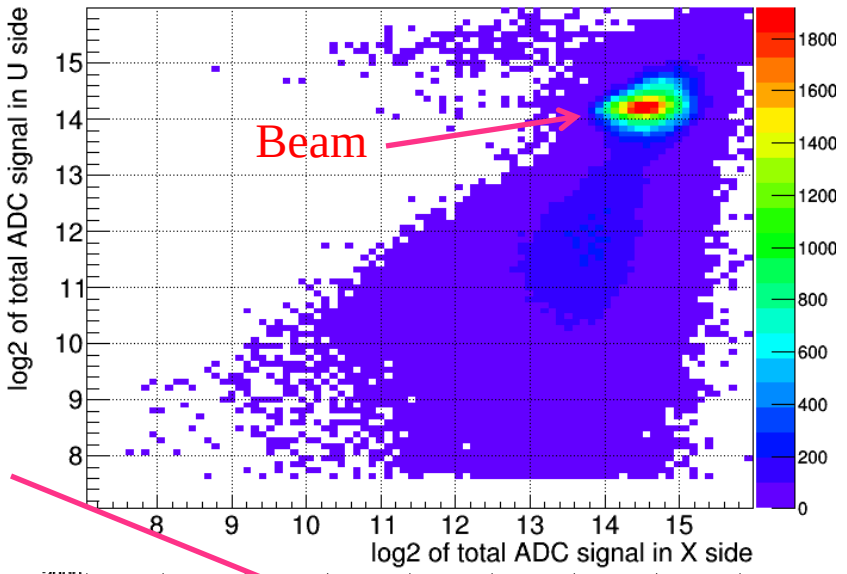
Extrapolated track positions to the Si trigger detector in the magnetic field for events with either sector 5 (left) or 58 (right) fired. Tracks are built from hits with large signals. This event topology can be used to reject the beam trigger.

Si detectors: lost U-side data (?)

Station 1, Sector 4

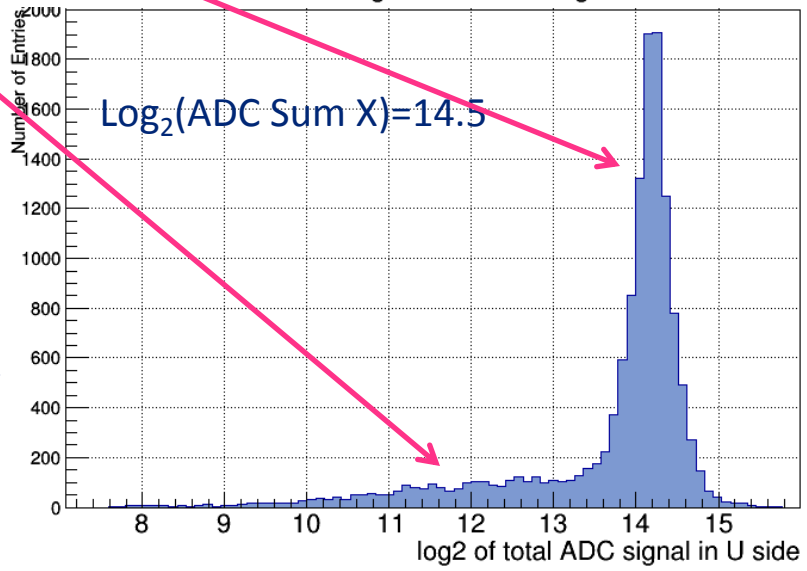


Station 3, Sector 3



Correct

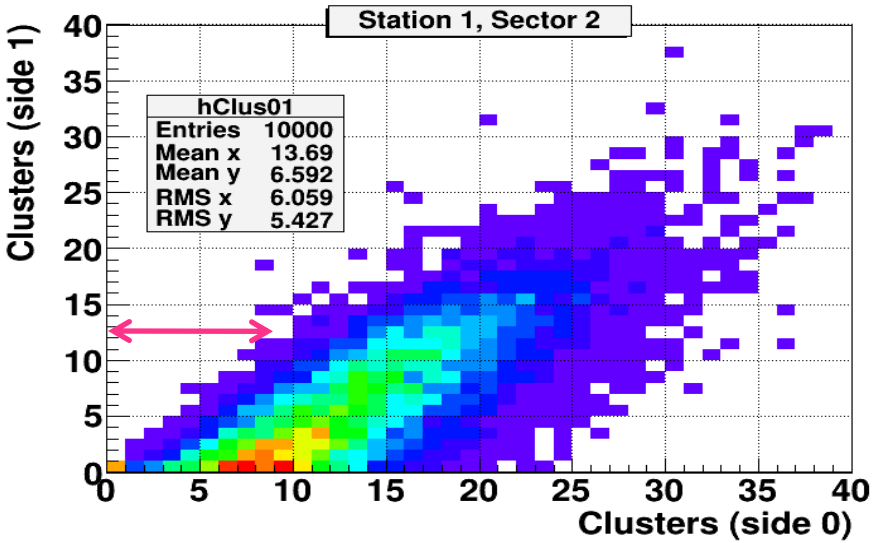
Missing



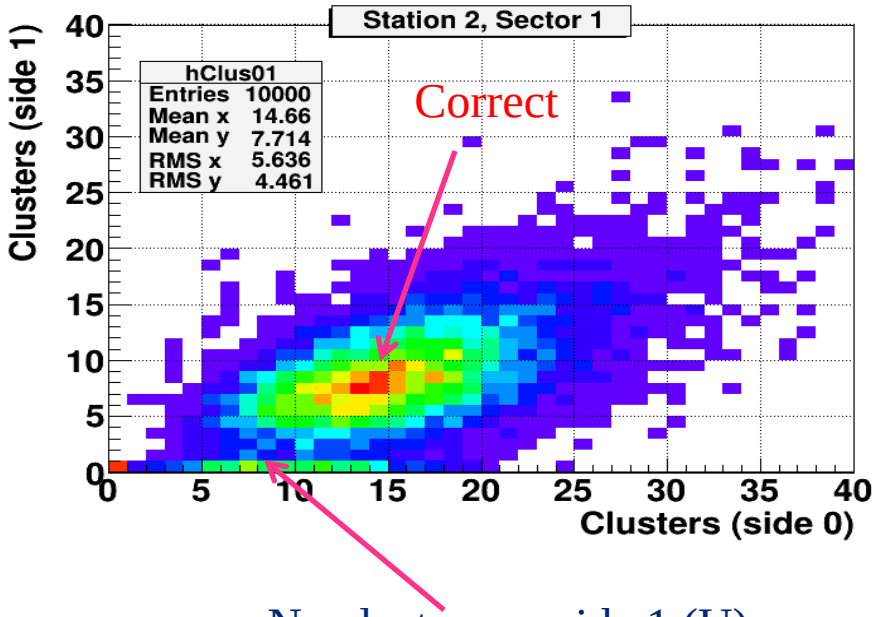
Loss of data from tilted side of Si wafers.
Looks like an incomplete readout.

In 1-5 % of events depending on wafer there is evident signal on X side and no signals on U side.
X clusters with large amplitude have no partners on U side.

Si detectors: Nr of clusters on each side

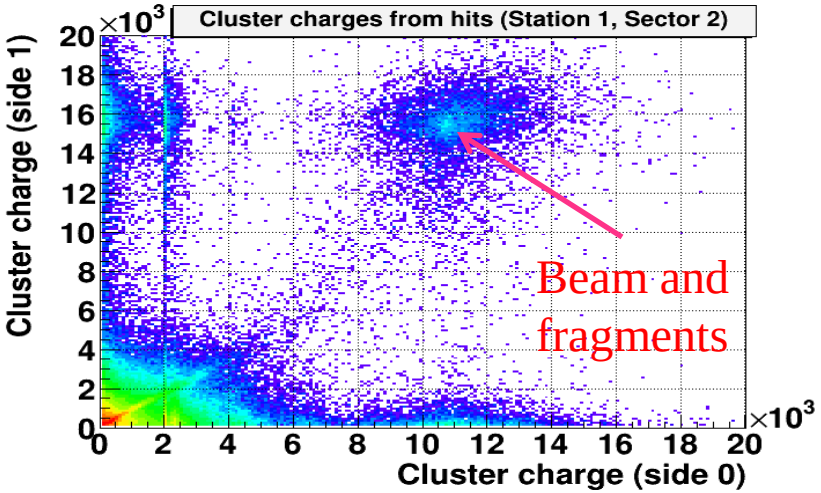


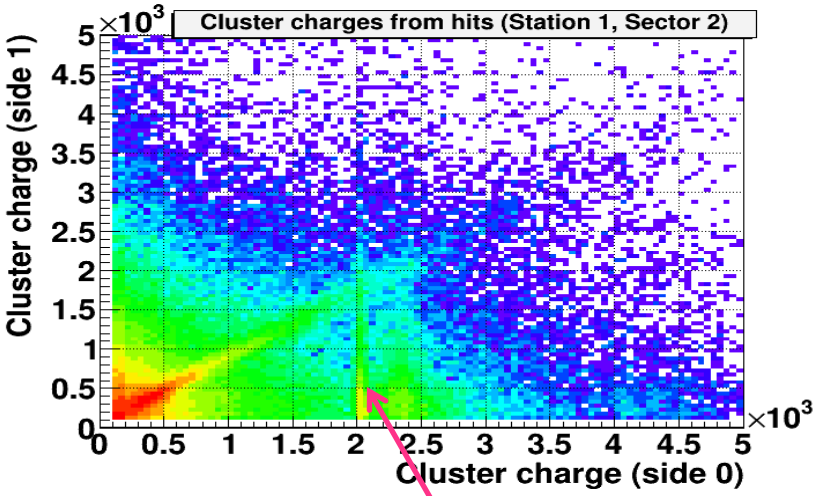
Cluster deficit on side 1 (U).

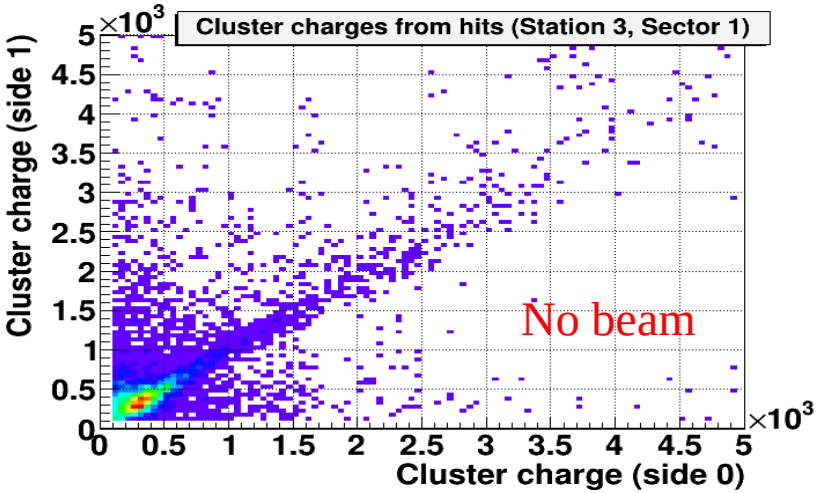


No clusters on side 1 (U).

Si detectors: hit charges





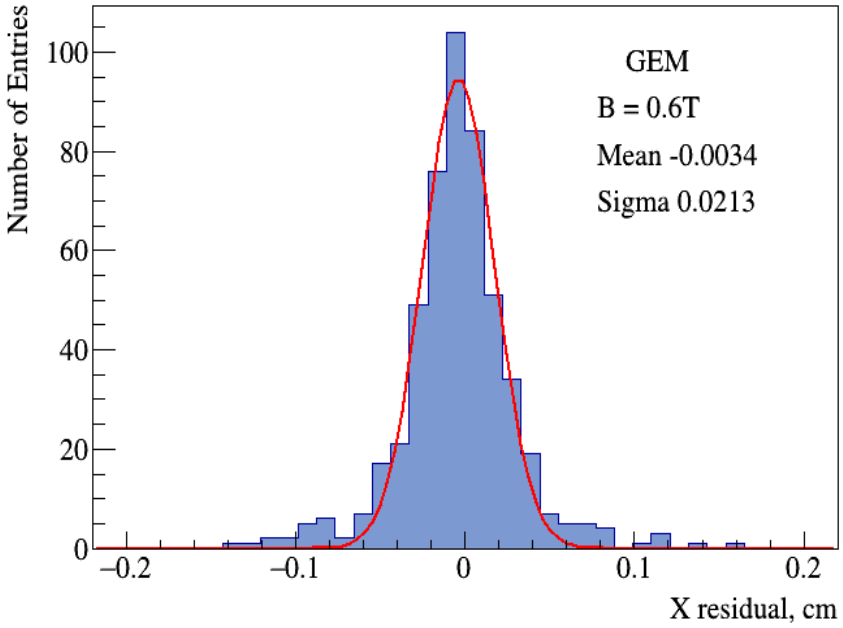


On side 0 (vertical strips) there are 1-2 strip clusters with overflows (which create quite some ghost activity – fake hits).

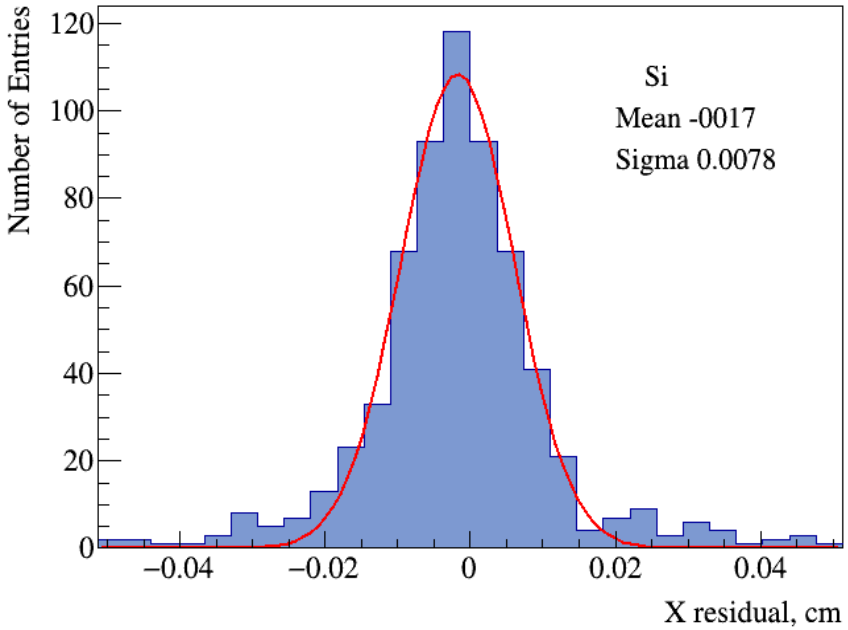
Charge distributions in Si detector hits.

Residuals in central tracker

X-residuals in GEM and Si

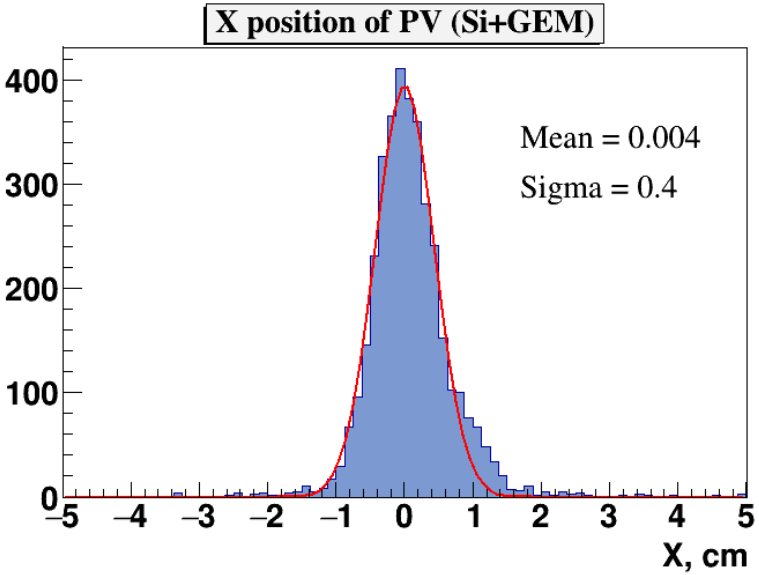


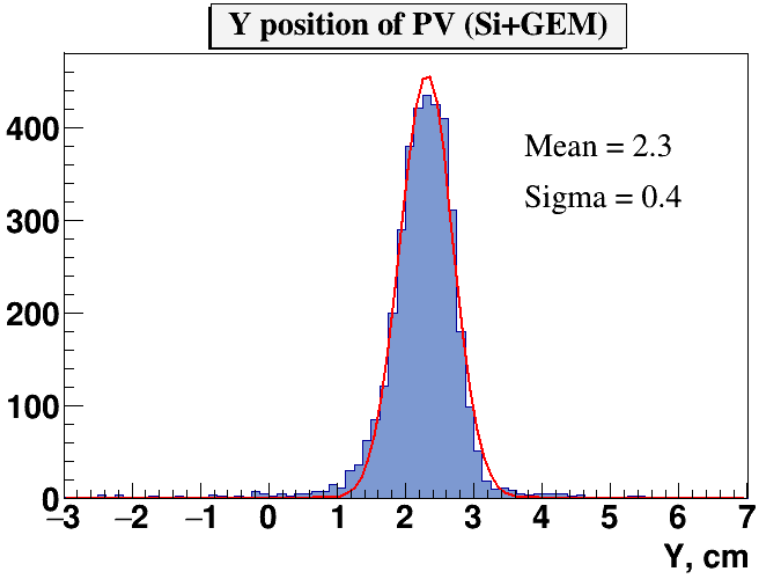
GEM detectors (pitch 800μm)

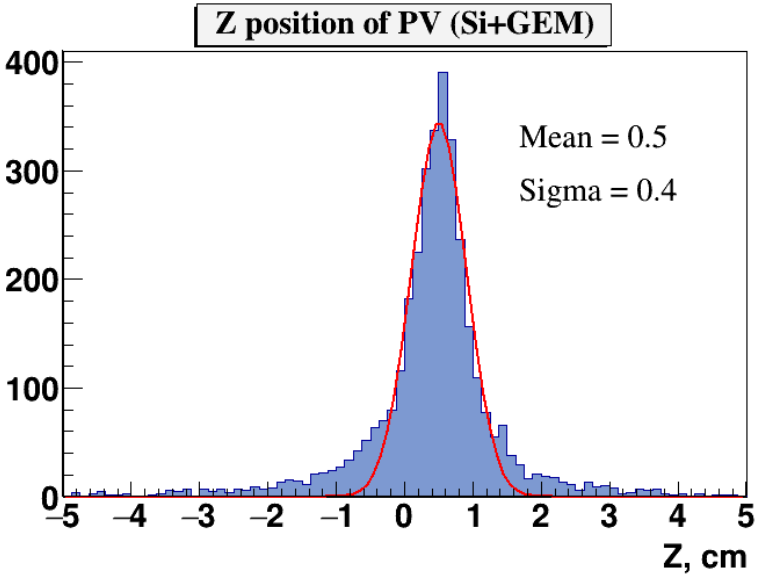


Si detectors (pitch 103μm)

PV reconstruction







Magnetic field: 1250 A

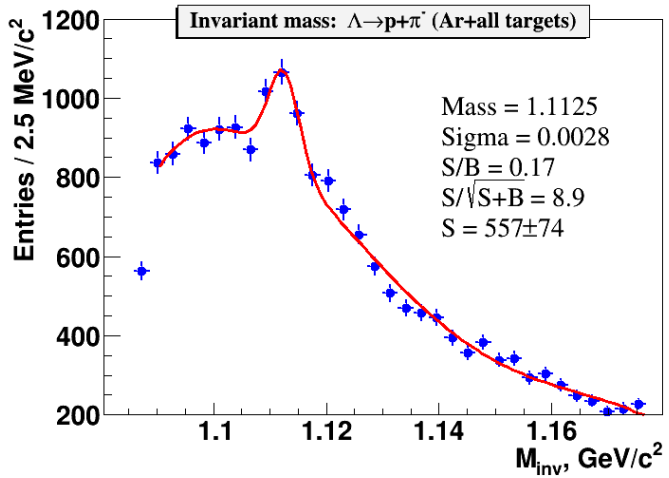
Target: Pb (2.5 mm)

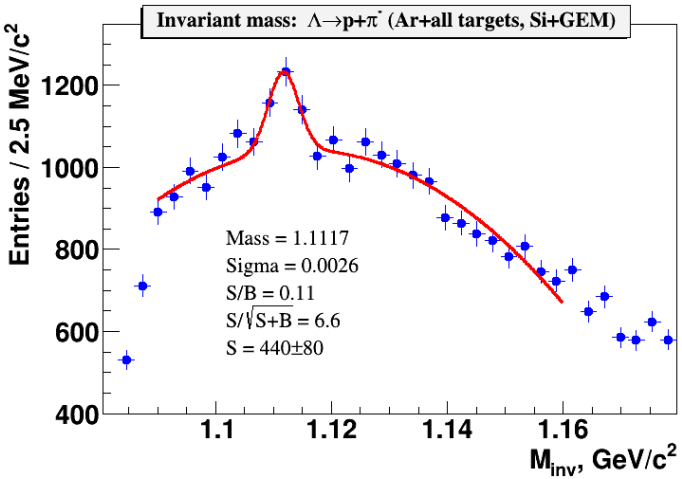
Detectors: Si + GEM

With long tracks

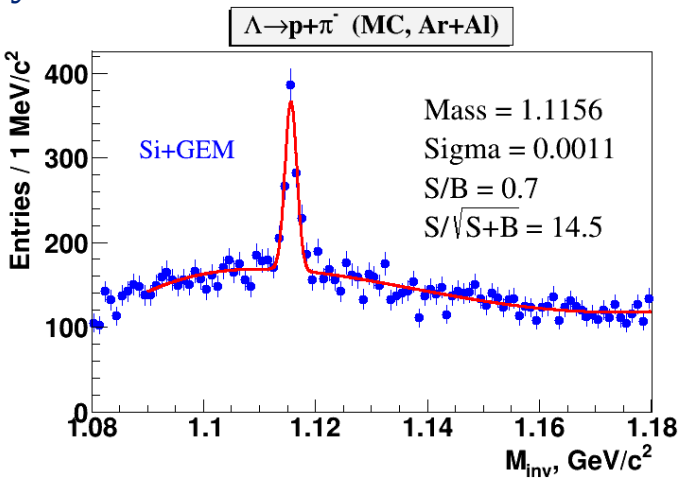
Λ reconstruction: Data vs MC (ideal)

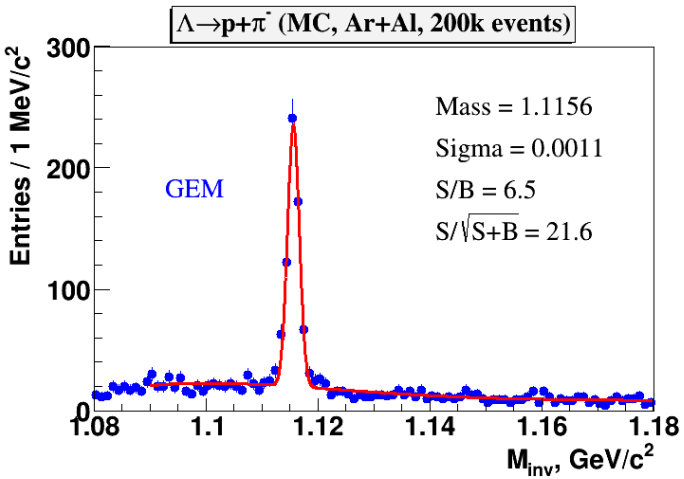
Data: Si+GEM, No PID





MC: QGSM, Ar+Al, E_{kin}= 3.2A GeV, 200k events minbias
(only **~6%** of Λ could be reconstructed)





Summary 1

Carbon beam data:

1. Main characteristics of the central tracker have been determined: coordinate resolution, momentum resolution for beam particles, primary vertex reconstruction accuracy.
2. V0 decay reconstruction and selection have been improved.
3. Realistic effects have been added to MC simulation (detector efficiency, dead channels and zones).
4. Embedding procedure is ready to be used.

Summary 2

Argon beam data:

1. First pass of the detector alignment is done (Si, GEM, CSC, ToF400, DCH) using data w/out magnetic field; dead channels and zones have been added to MC.
2. Coordinate reconstruction correction in magnetic field is done.
3. Coordinate reconstruction precision has been determined (w/out and with magnetic field).
4. Event reconstruction procedures have been tested. Preliminary results on V0-reconstruction have been obtained.
5. Event selection approaches have been tried.
6. Outer detectors (CSC, DCH and ToF400) have been added to the reconstruction. They can be used to improve results in the central tracker.

Plans

1. Run 6 - proceed with the embedding to cross-check the efficiency.
2. Run 6 – still some reconstruction ideas to check (to improve results).
3. Run 7 – understand issues with Si data.
4. Run 7 - validate track reconstruction procedure for Si detectors and tune it.

Thank you for attention!

Backup slides

Carbon run (2017) vs Argon run (2018)

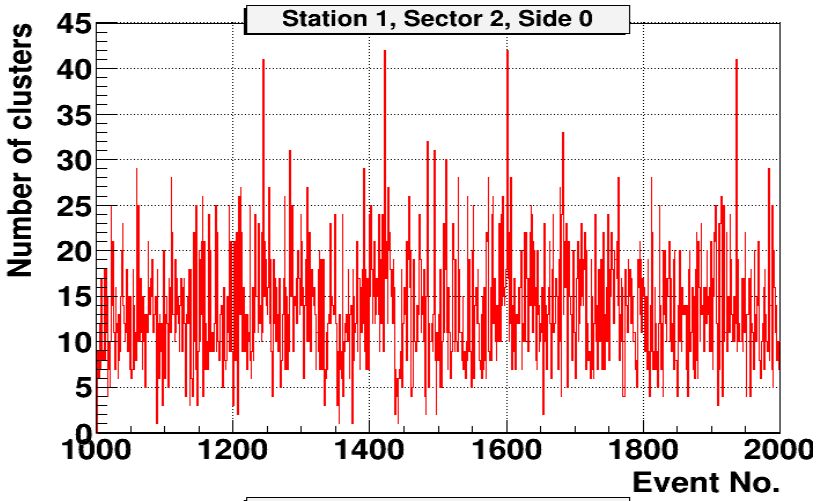
Table 1. BM@N experimental parameters in 2017-2018.

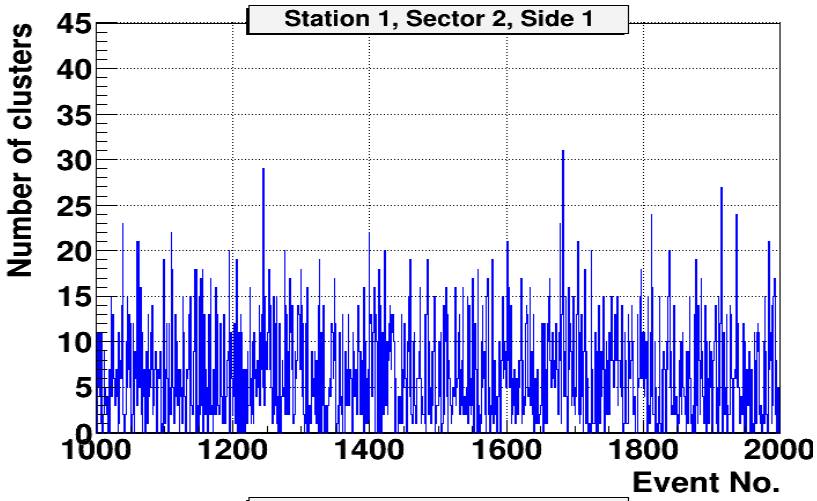
Run	Beam/E_{kin}, AGeV	Targets	Field, T	Tracker	Gas in GEM
№6 / 2017	*C*/3.5, 4, 4.5	*C, Cu, Al*	0.59	1 Si+6 GEM	*Ar*:CO_2 (70:30)
№7 / 2018	*Ar*/3.2 , Kr/2.4	*C, Cu, Al, Sn*	0.59	3 Si+6 GEM	*Ar*:C_4H_{10} (80:20)

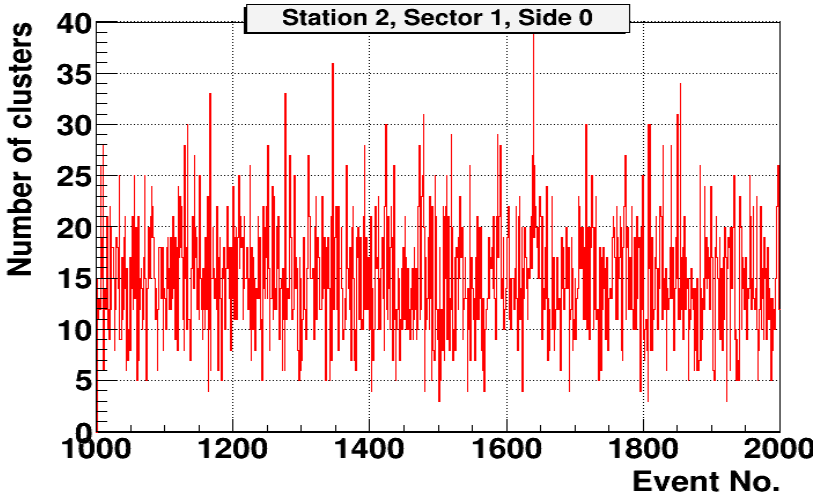
Table 2. Lorentz-shift corrections (cm) in GEMs in 2017-2018. 2018 gas mixture *Ar*:C_4H_{10} (80:20) gives smaller Lorentz-angle.

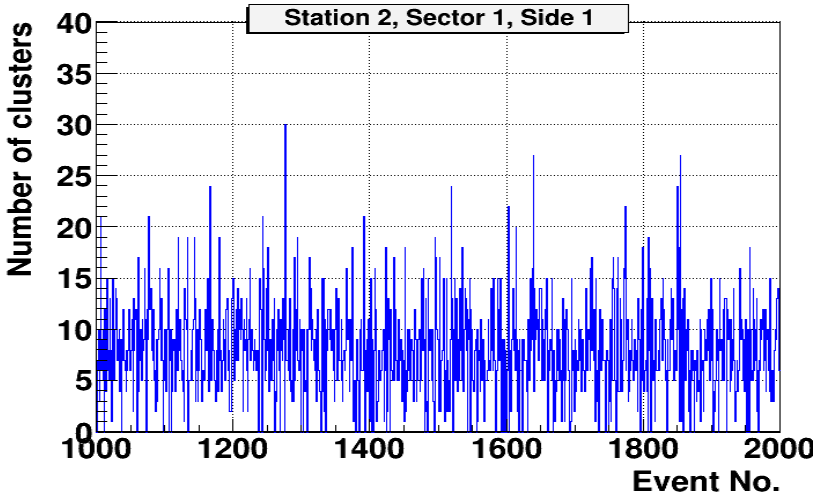
Run	GEM1	GEM1	GEM2	GEM2	GEM3	GEM3	GEM4	GEM4	GEM5	GEM5	GEM6	GEM6
2017	0.135		0.176		0.169		0.136	0.166	0.140	0.11	0.110	0.164
2018	0.100	0.100	0.125	0.127	0.100	0.111	0.128	0.132	0.109	0.106	0.116	0.106

Number of clusters vs event number



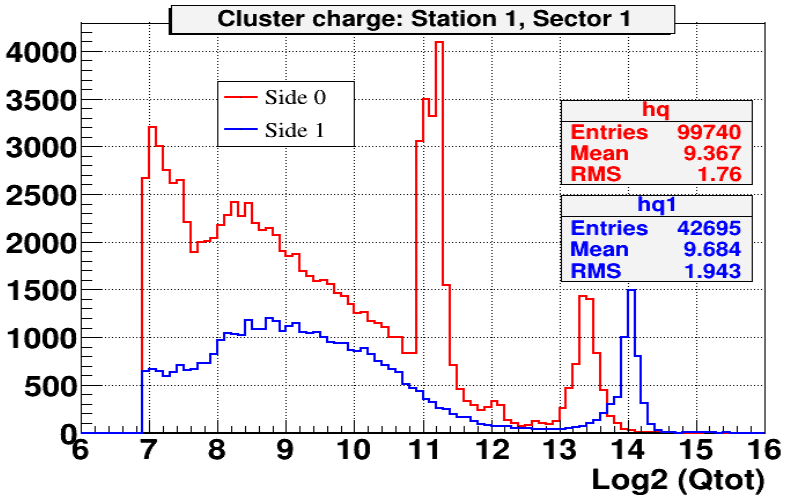


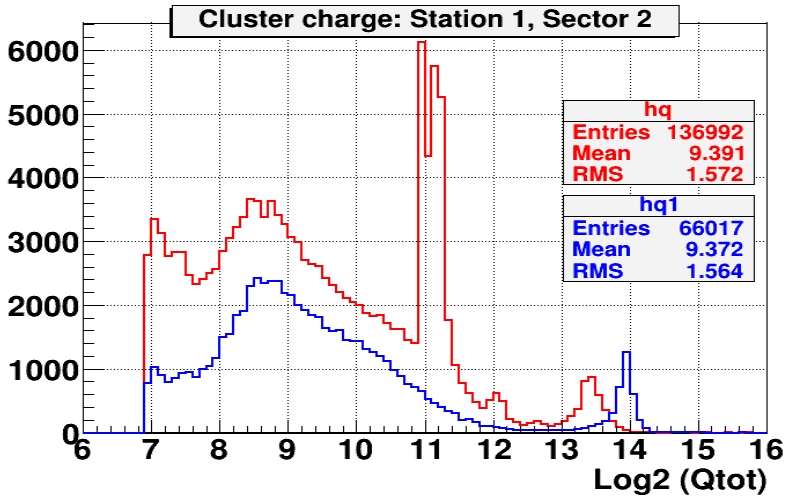


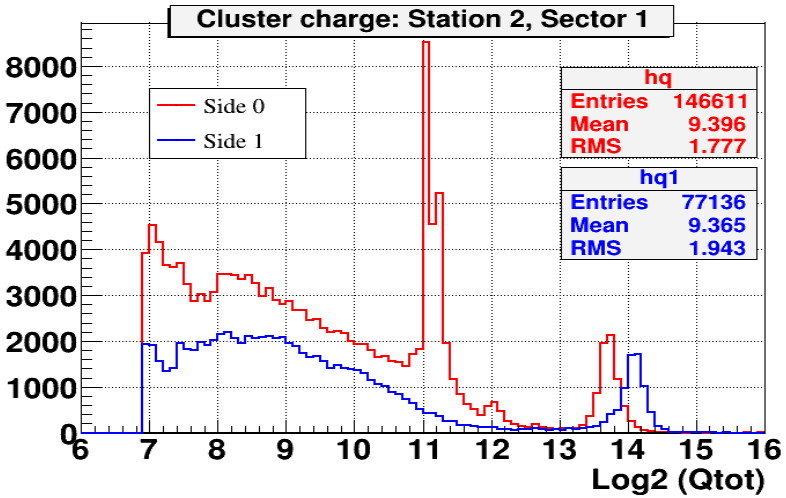


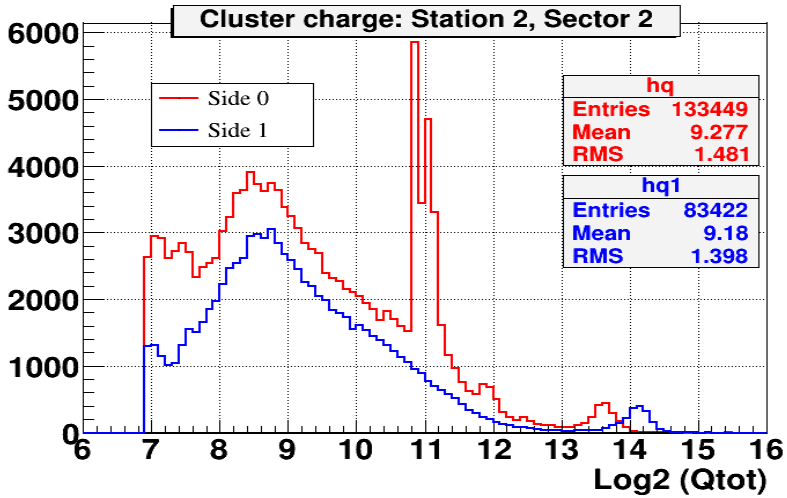
There is a cluster deficit on the U-side of Si detectors.

Si detectors: cluster charge distribution



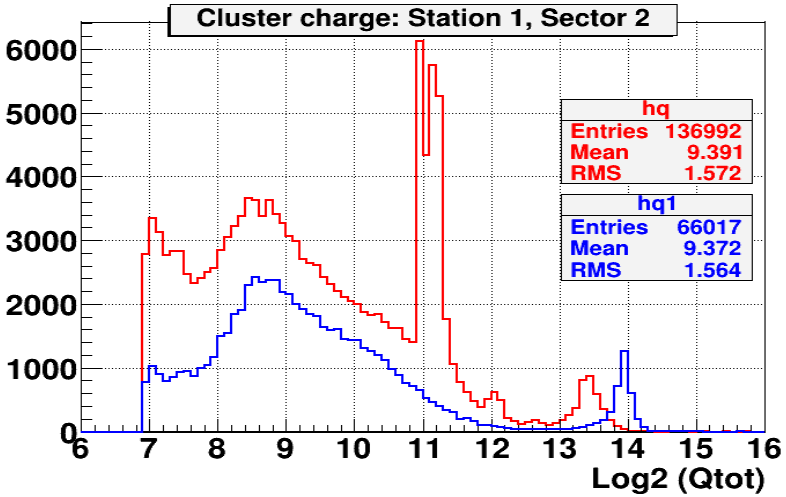


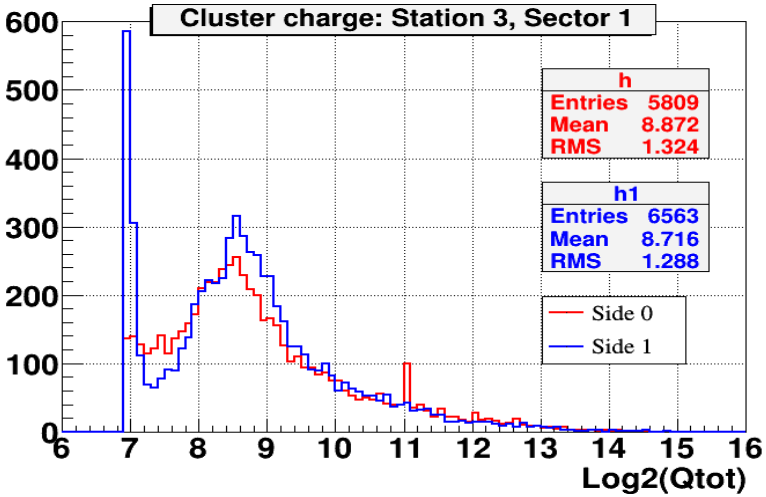


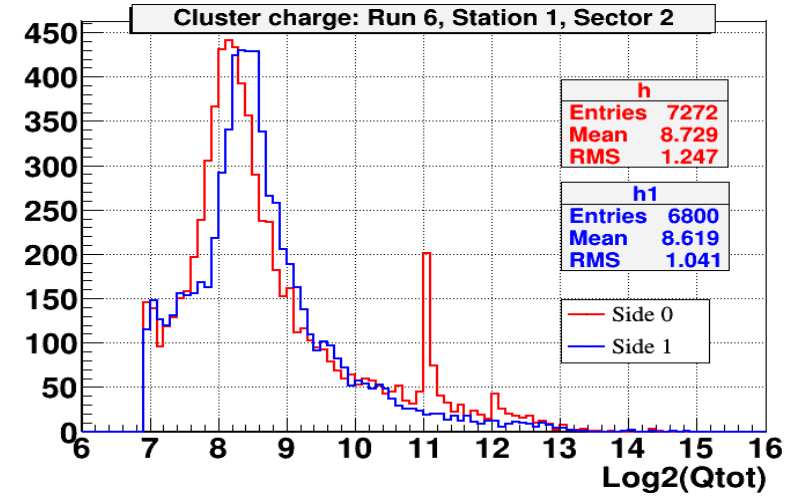


Cluster charge distributions on X- and U-sides of Si detectors. The rightmost peaks are due to the beam particles. There are some unpaired 1- or 2-strip clusters with overflows on X-side.

Si detectors: cluster charge distribution







Top row – cluster charge distributions on Si station 1 sector 2 (hit by beam) and station 3 sector 1 (outside the beam region). Bottom – Si station 1 sector 2 in Run 6 (with a beam hole). The “anomalous” 1-2 strip clusters with overflows on X-side seem to correlate with the beam.