Study of the GEM detector performance in BM@N experiment

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JINR LHEP

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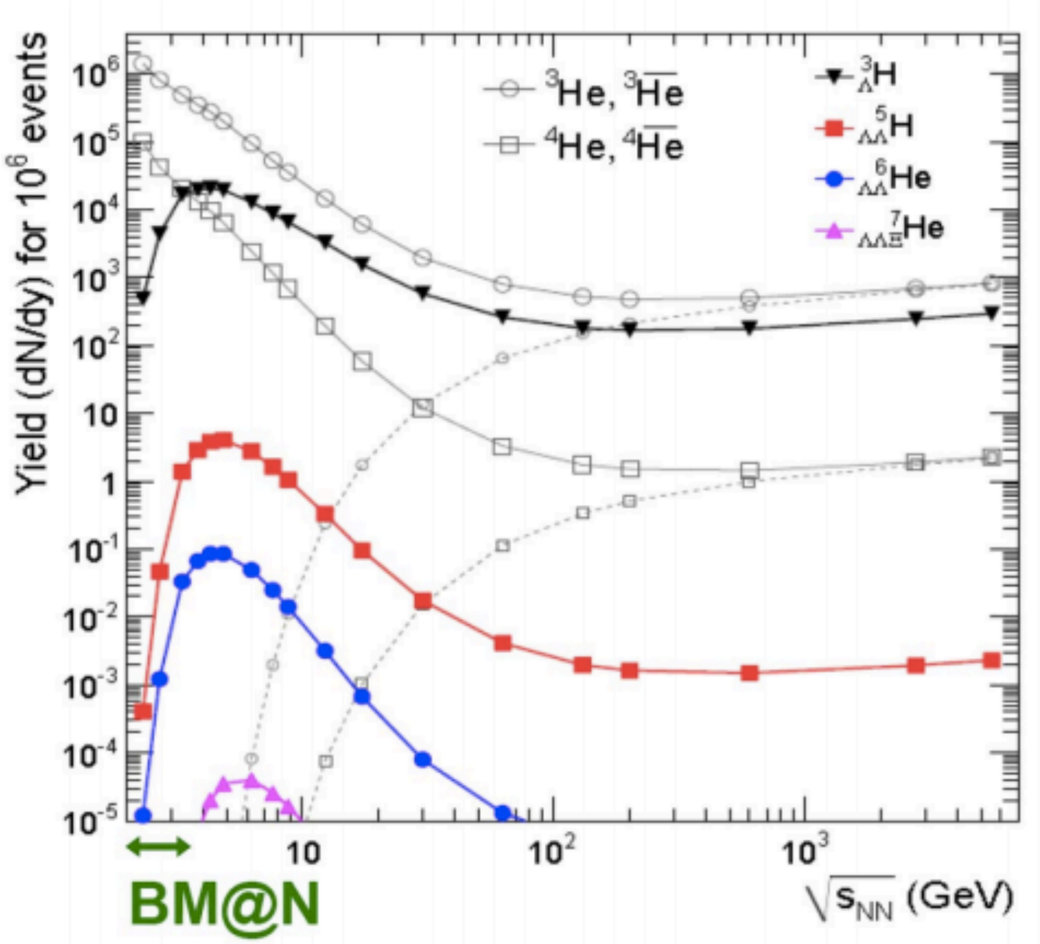
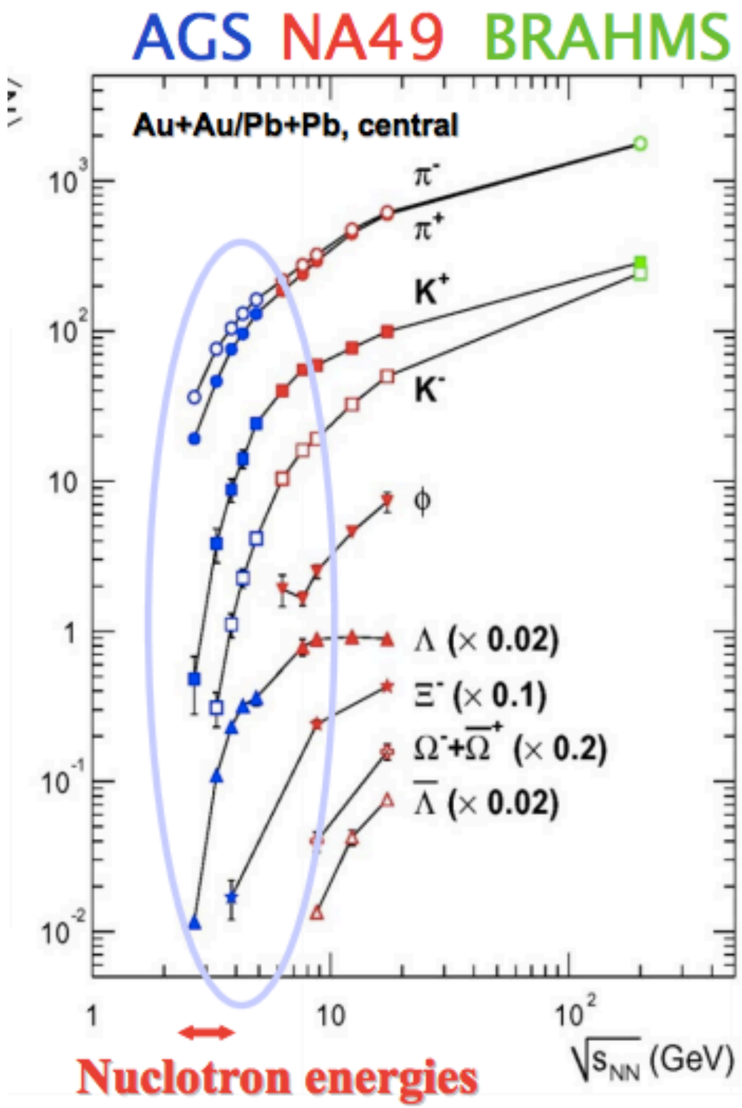
Outline

- BM@N overview
- The principle of GEM detectors working
- Gas Electron Multiplier (GEM) for trajectories reconstruction
- Investigation of the GEM performance
  (hit efficiency and spatial resolution)

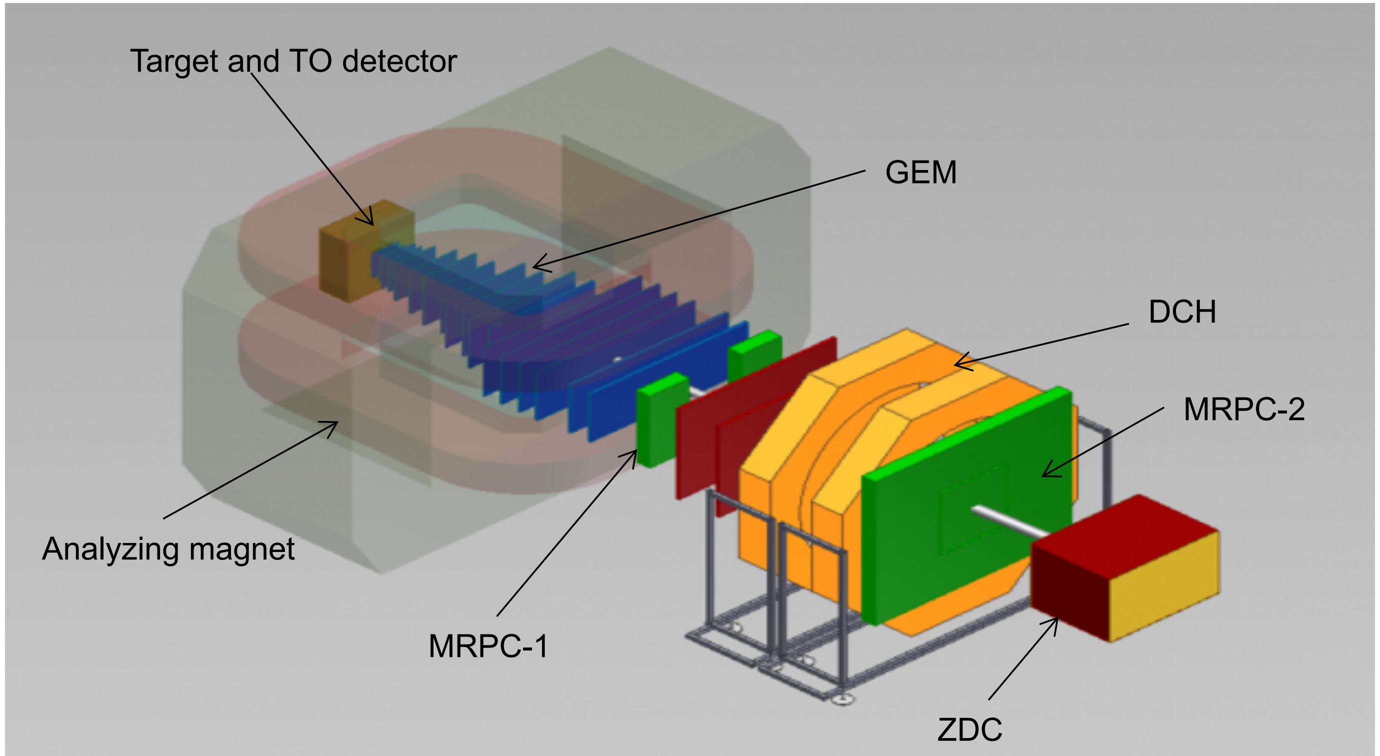
Physics possibilities at the Nuclotron





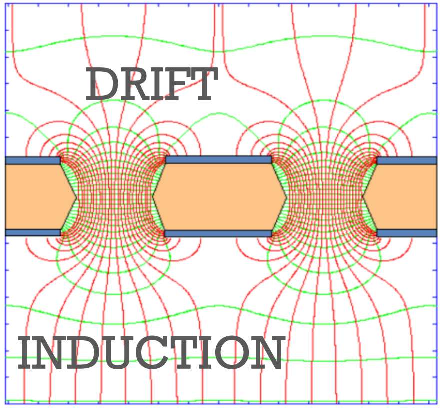
➔BM@N energy range is suited for the search of hypernuclei

BM@N setup

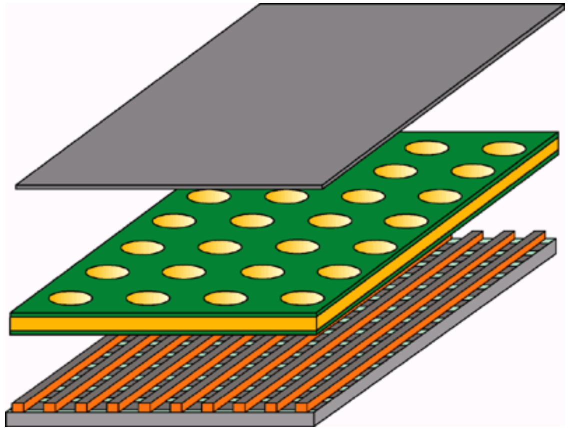


- Central tracker (GEM) inside analyzing magnet to reconstruct AA interactions
- Outer tracker (DCH, CPC) behind magnet to link central tracks to ToF detectors
- ToF system based on mRPC chambers and T0 detectors to identify hadrons and light nucleus
- ZDC calorimeter to measure centrality of AA collisions and form trigger
- Detectors to form T0, L1 centrality trigger and beam monitors
- Electromagnetic calorimeter for γ,e+e-
- MWPC chambers were used as beam trajectory detectors

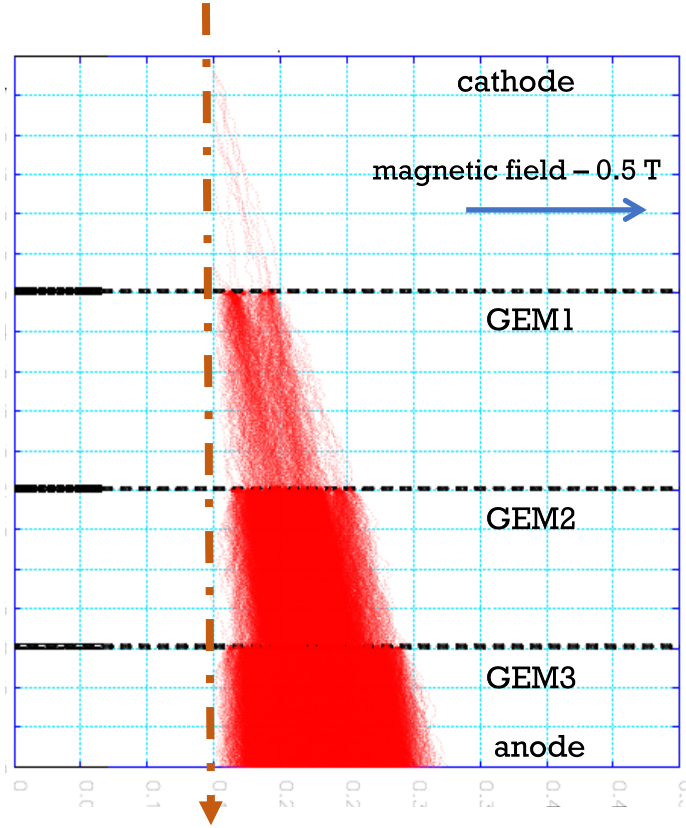
The Gas Electron Multiplier (GEM)



Electric field in the region of the holes of a GEM electrode



Schematics of single GEM detector with Cartesian two-dimensional strip readout.

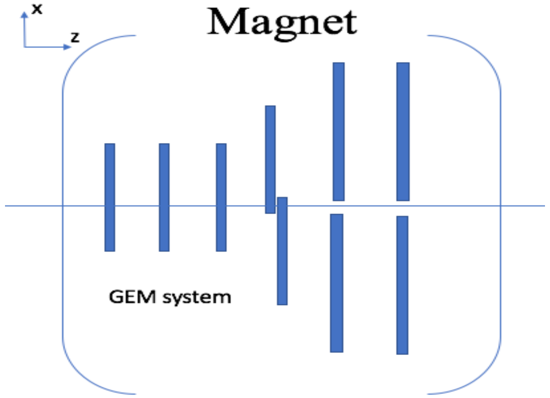


Simulation of electron shift in magnetic field

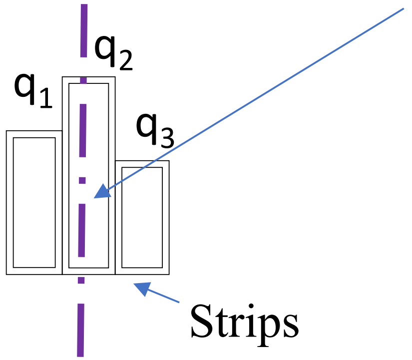
The basic requirements for the tracking system are:

- capability of stable operation in conditions of high radiation loadings up to 10^5 Hz/cm^2;
- maximum possible geometrical acceptance within the BM@N experiment dimensions;
- good timing (5-10ns) and spatial resolution (100 -150 microns).

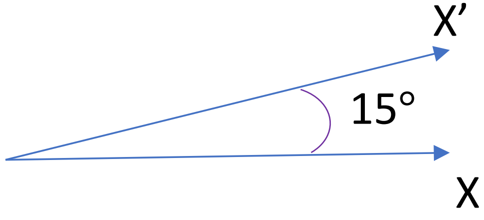
Track-segment building algorithm (Mag.field off)



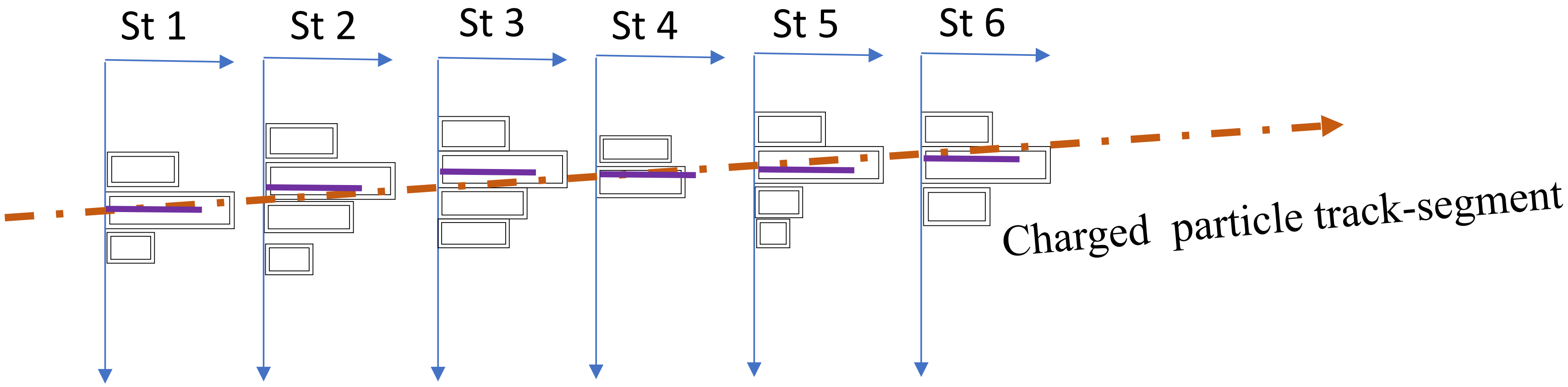
Reconstructed hit coordinate (measurement) :



$$CoG_x = \frac{\sum q_i * x_i}{\sum q_i}$$



X & X’ layers in each station



Collecting X & X’ hits located around straight line we build spatial track-segments.

GEM Spatial Resolution & Hit Efficiency

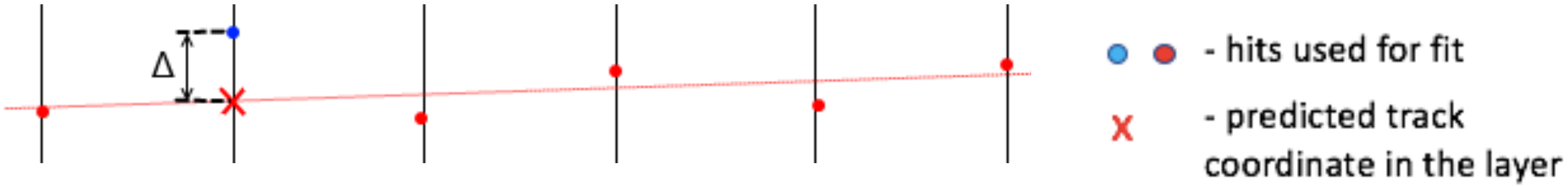
Hit Efficiency per layer (from segments):

GEM hit efficiency per Layer is calculated for events where track-segments were reconstructed and defined as ratio:

(Number of the reconstructed hits in a Layer) / (Number of track-segments).

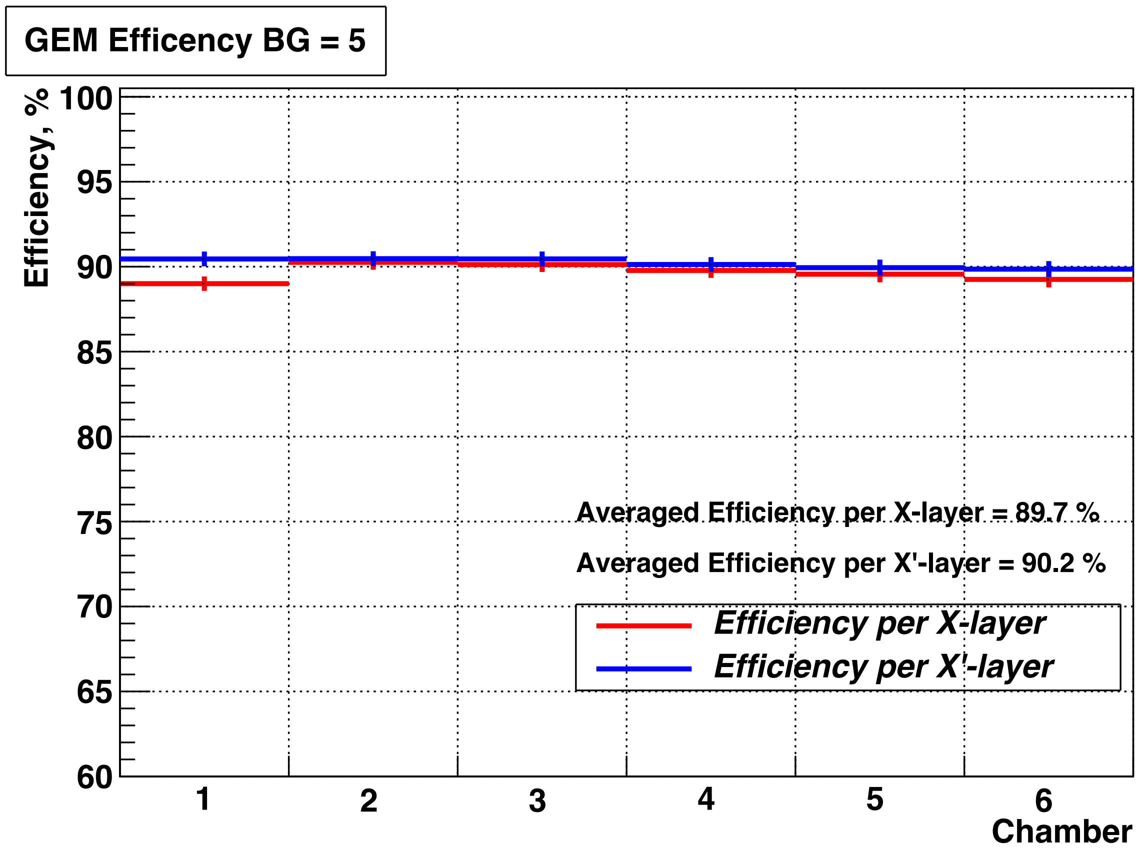
Spatial resolution calculation:

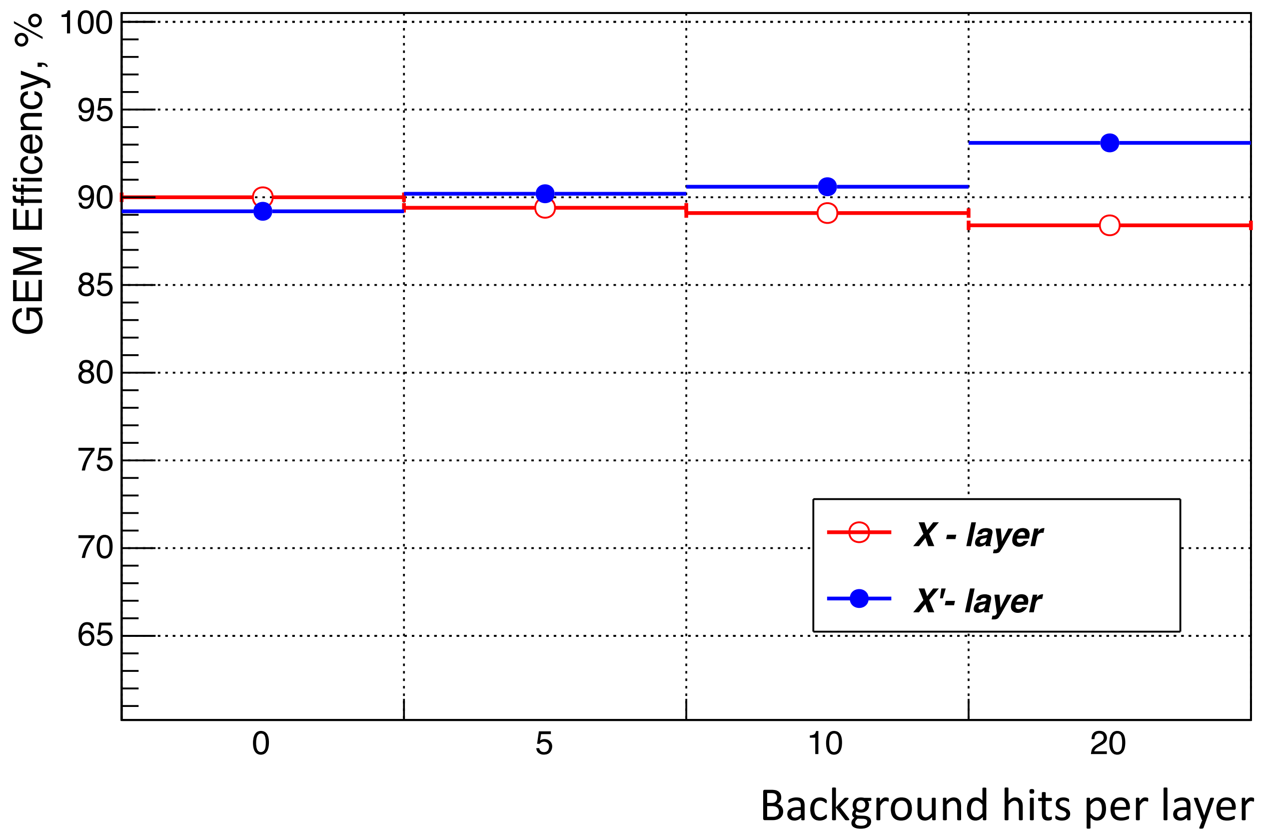
Resolution in the current layer calculated from the residual (Δ) between the measured coordinate (hit) and the predicted track coordinate from straight line fit .



Testing of efficiency calculation algorithm with MC

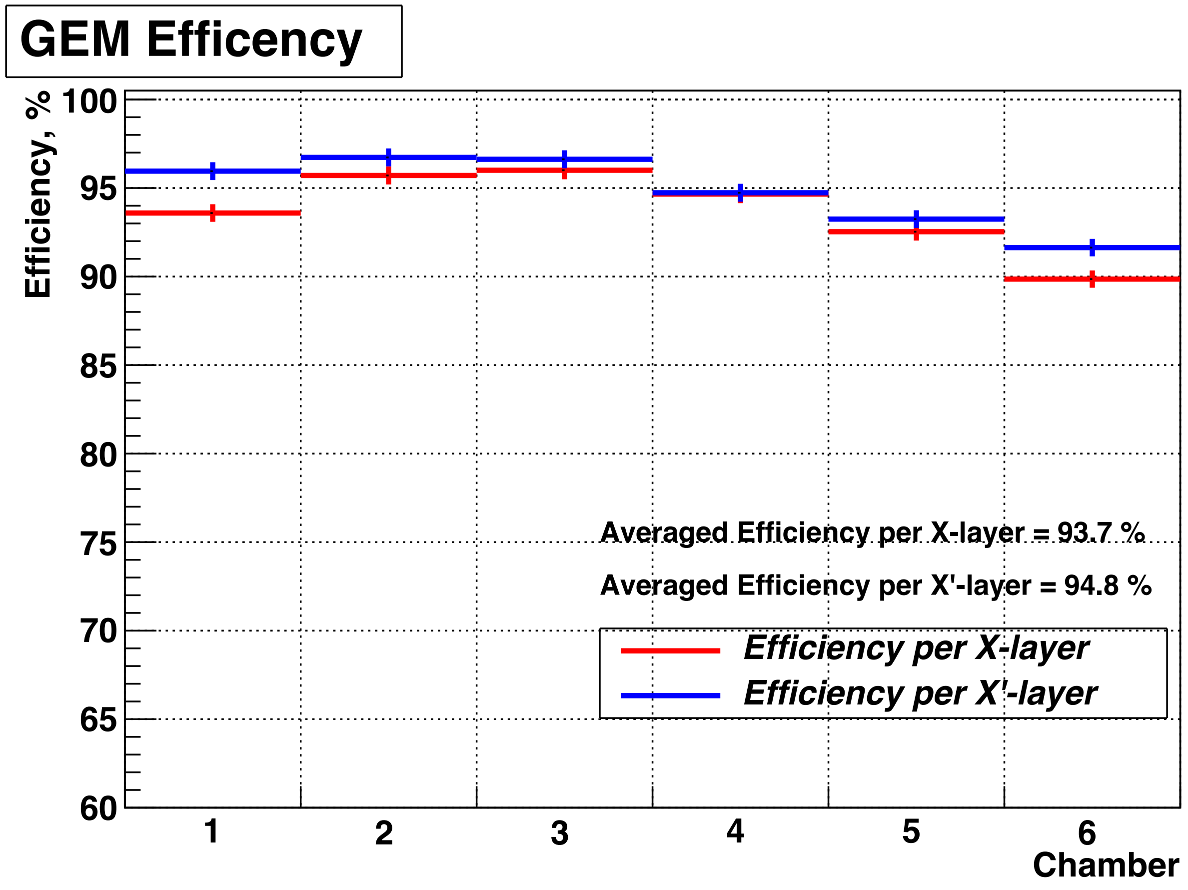
Established Efficiency per layer is 90%



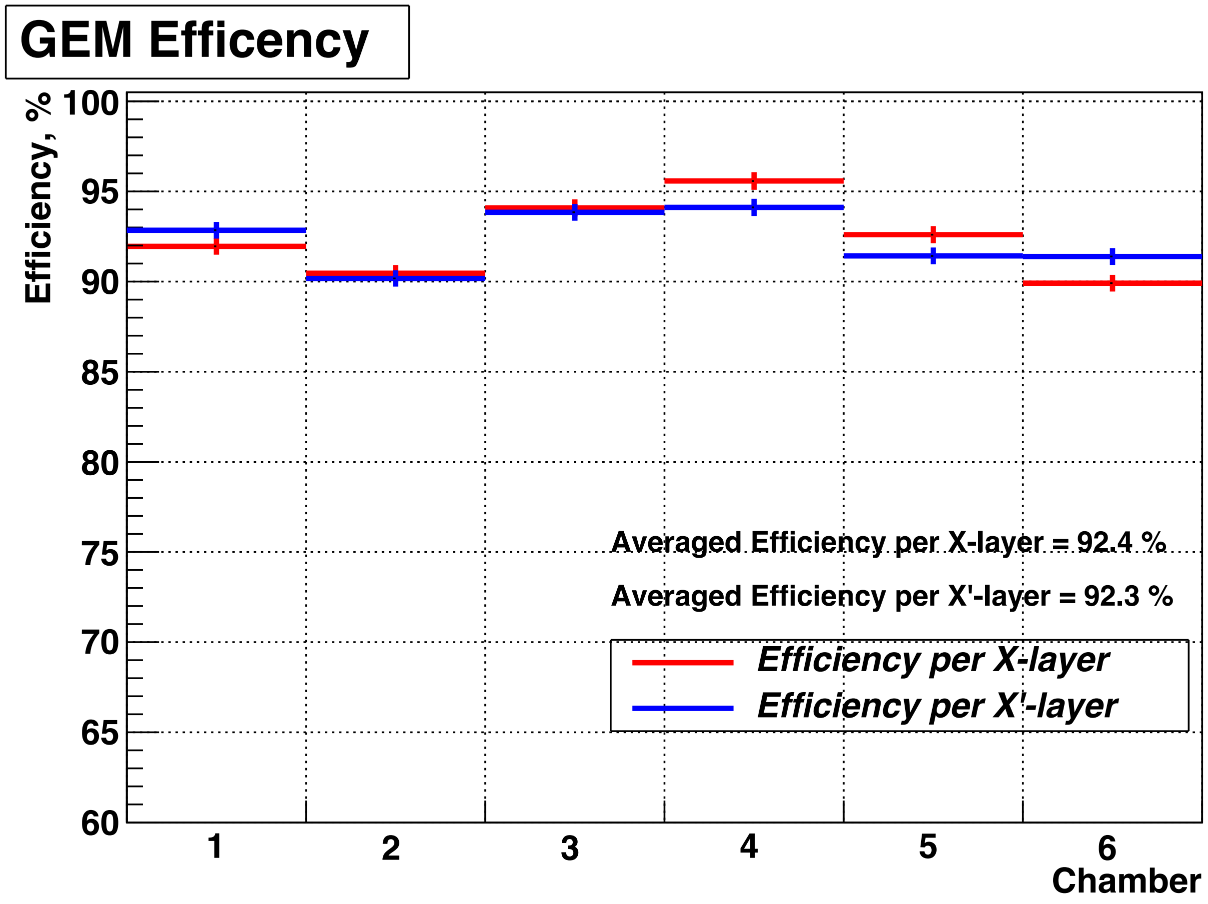


GEM hit efficiency per layer with Nuclotron data

Ar + CO_2



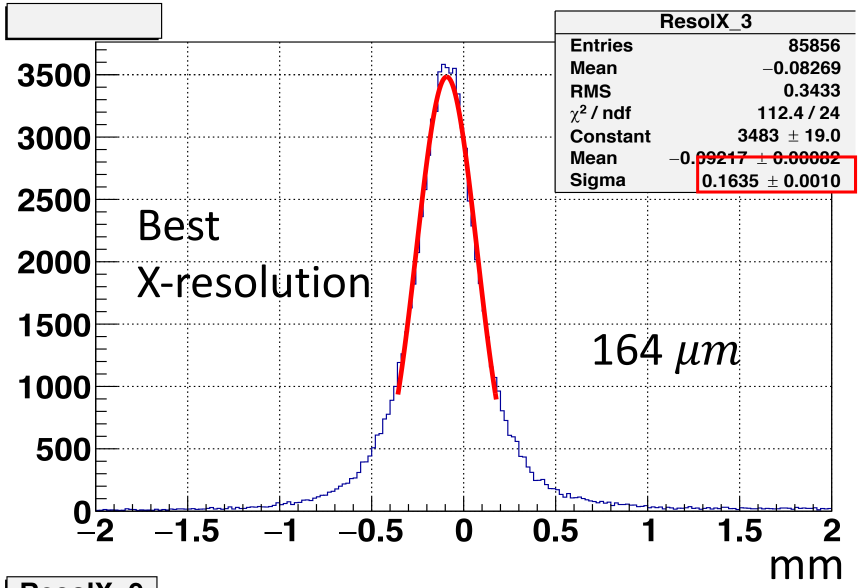
Ar + Isobutane

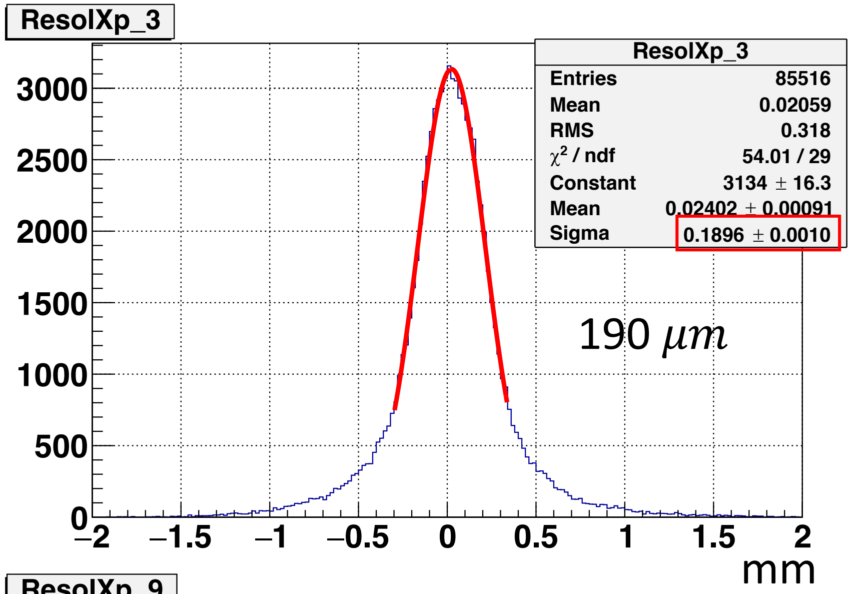


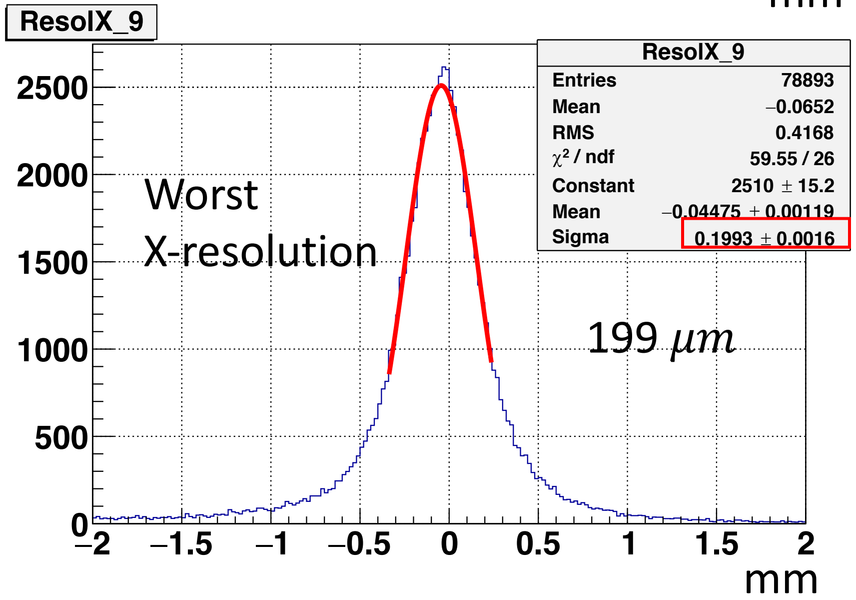
Resolution for GEM with Ar + CO_2 (Nuclotron data)

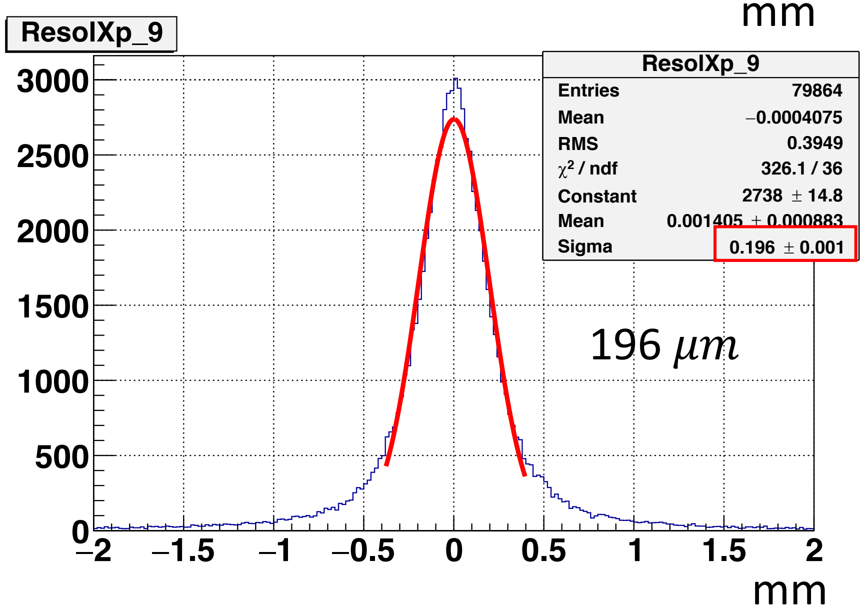
X layers

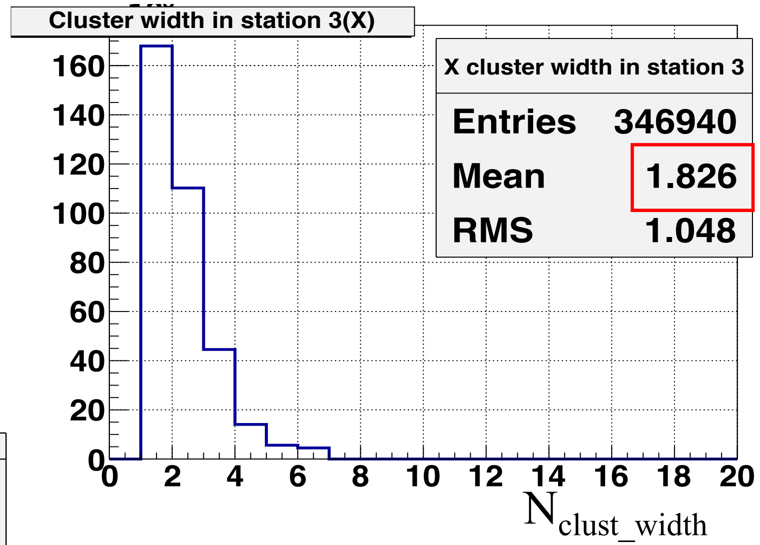
X' layers









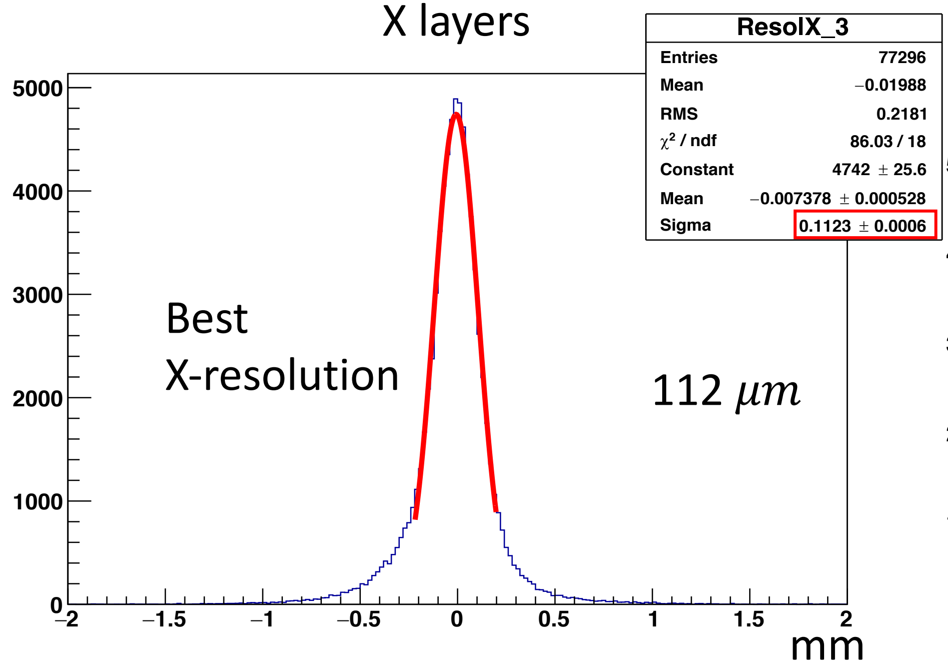


$$\frac{\Delta}{\sqrt{12}} = \frac{800\mu m}{\sqrt{12}} = 231\ \mu m$$

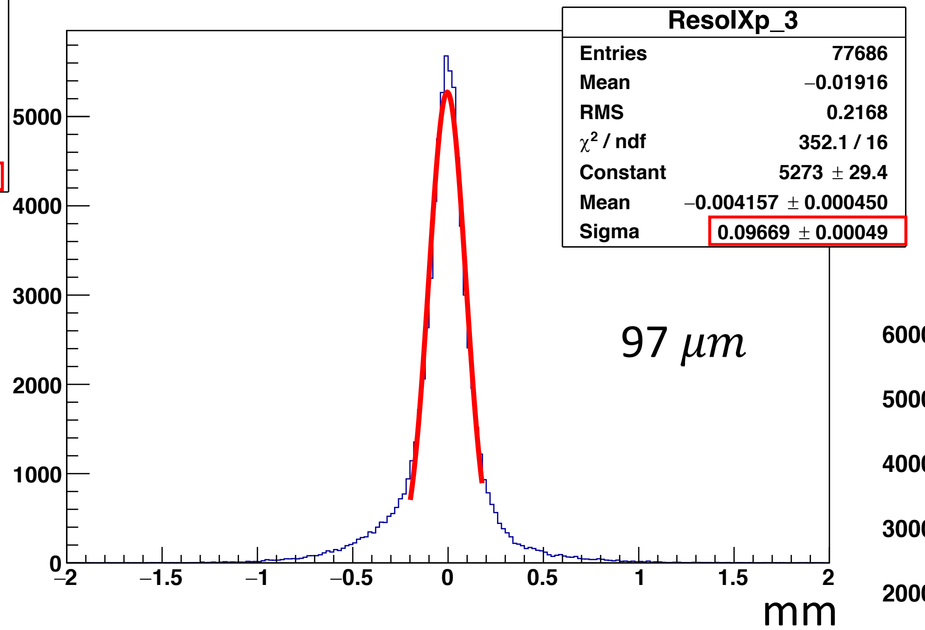
Δ - GEM strip width

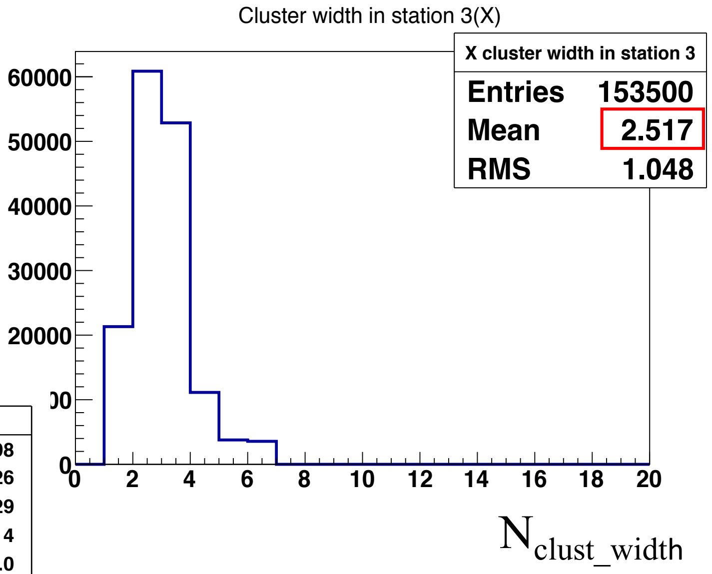
Resolution for GEM with Ar + Isobutane (Nuclotron data)

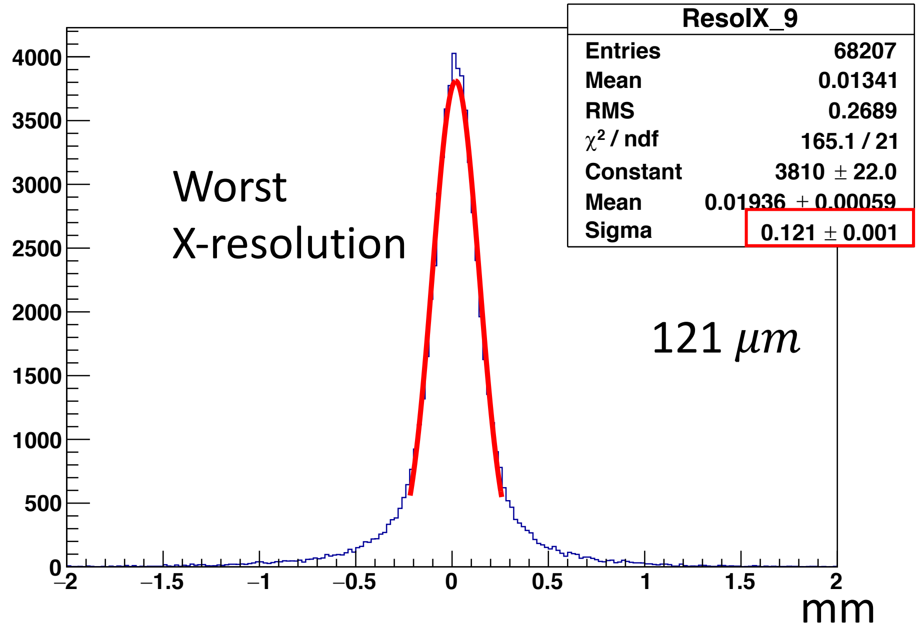
X layers

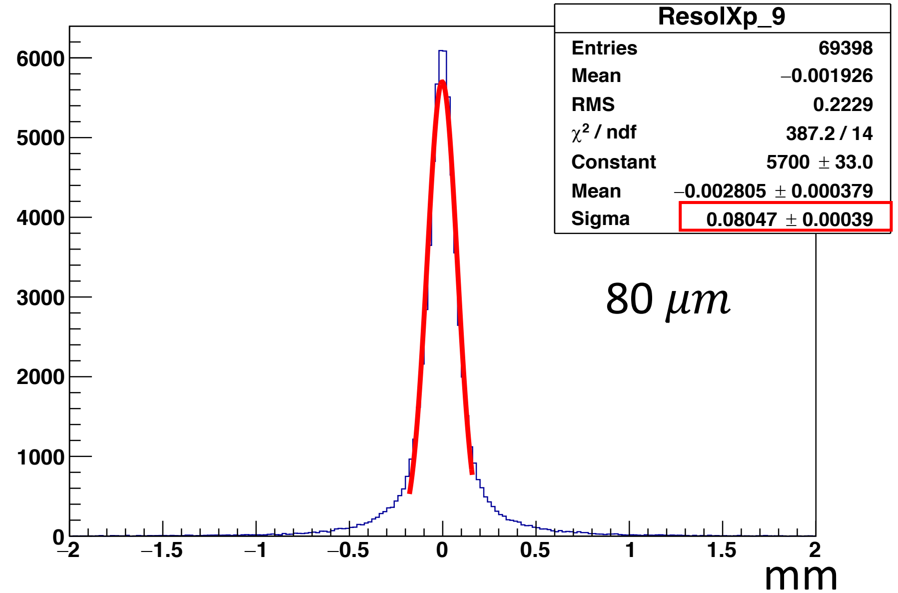


X’ layers









Conclusions

GEM detector performance in BM@N experiment with Nuclotron data was studied:

- Satisfied hit efficiency per layer 90-97%;
- Spatial resolution 160-200 microns with gas mixture Ar + CO_2;
- Good spatial resolution 80-120 microns with gas mixture Ar + Isobutane.

Next step: physical processes reconstruction with mag.field data.

Thank you for your attention!