Analysis of K^+/π^+ at BM@N for argon run

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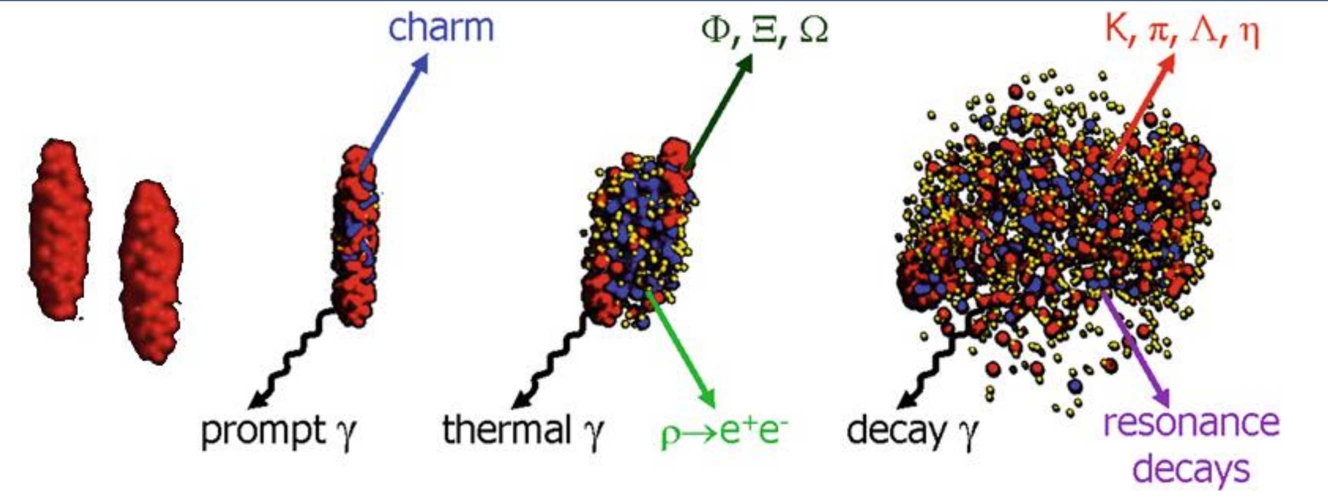
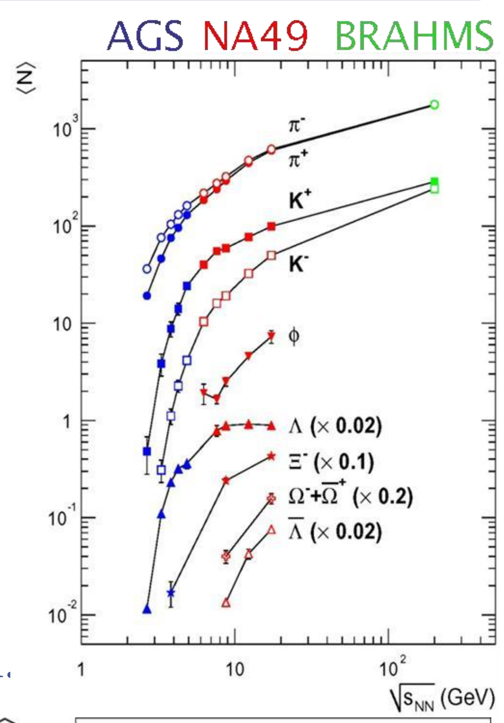
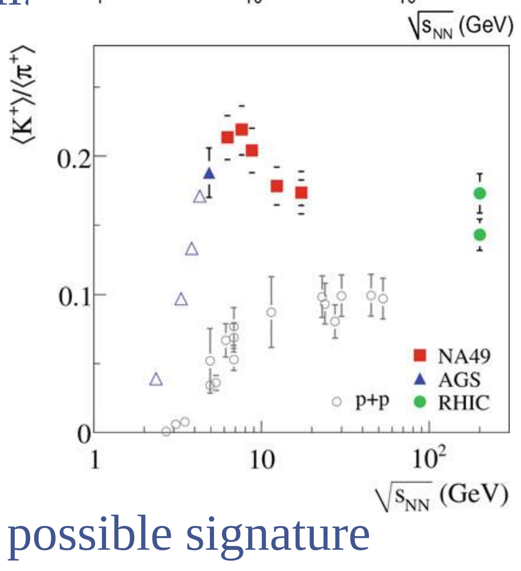
Heavy-Ion Collision







- At √s energies of 2-4.5 GeV, nucleon densities in a collision zone exceed the saturation density by the factor of 3-4.
- At these densities, nucleons start to overlap and form a fireball.
- Hadrons with strangeness are early produced in the collision and not presented in the initial state of two colliding nuclei.
- The K^+/π^+ ratio shows a rapid rise at energy increasing with a maximum ("horn") at incident √s energy of ~8 GeV and a saturation at SPS energies.
- The "horn" has been interpreted as a possible indication for the observation of deconfinement in the fireball.
- Confirmation of peak-like structure in the K^+/π^+ ratio by an independent experiment would certainly stir up the debate on a possible signature for the deconfinement phase transition.

Experimental Setup

We focus on:

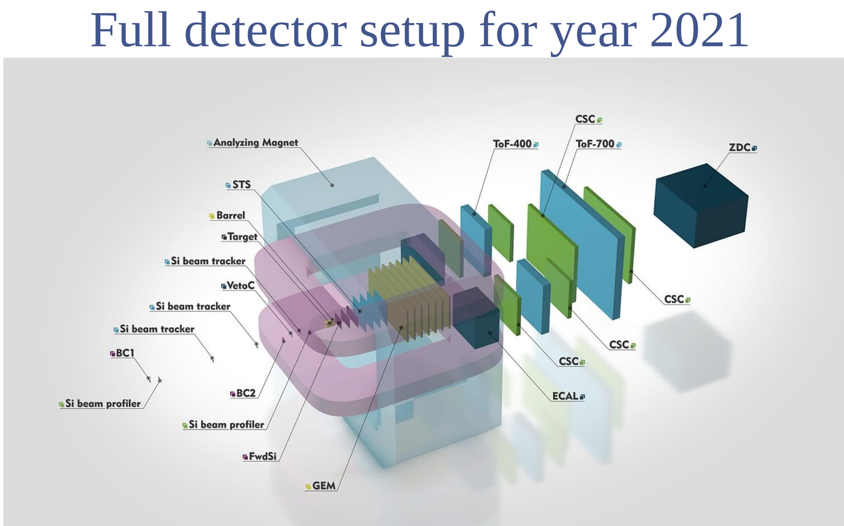
Gas Electron Multiplier (GEM) system: To measure momenta of a charged particle and reconstruct the interaction point.

Time of Flight (TOF400) system – time of flight of a charged particle.

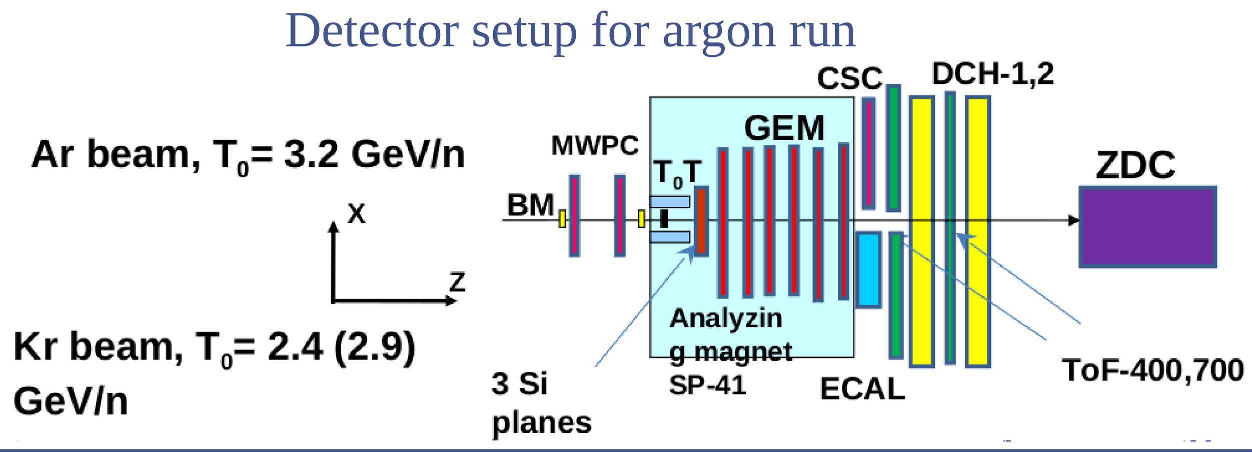
Cathode Strip Chamber (CSC): filter fake tracks.

Data were taken in March 2018.

Full detector setup for year 2021



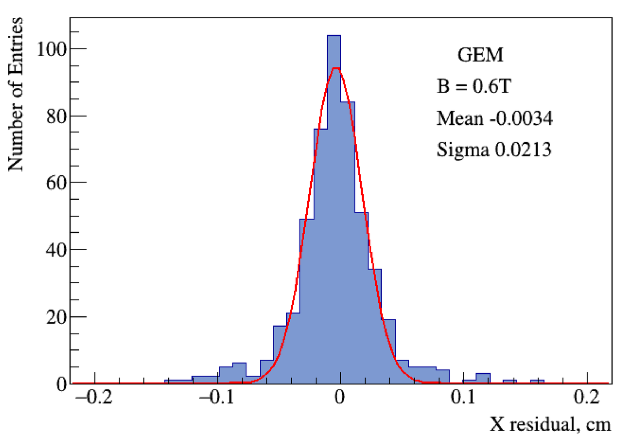
Detector setup for argon run



Matching GEM-CSC-TOF400

GEM features

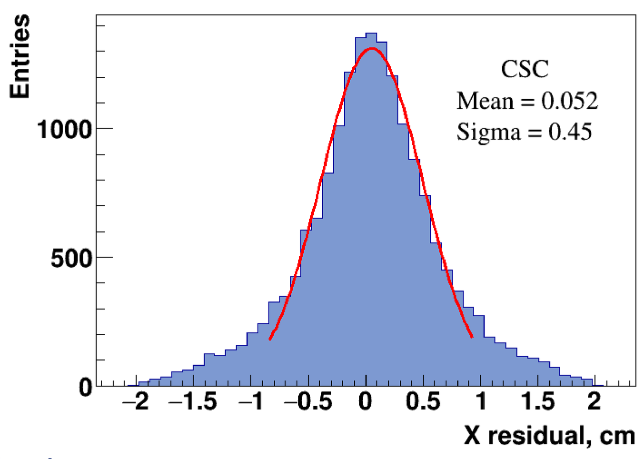
- Pitch of GEM strips is 800 μm for vertical strips and strips tilted by 15˚.



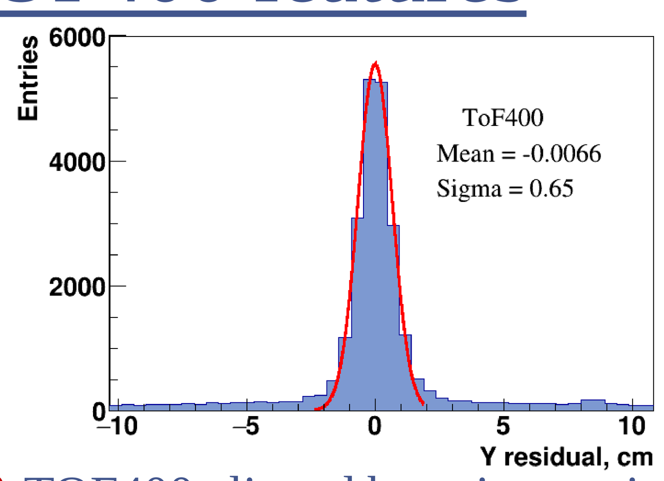
- The GEM plane thickness is 9 mm. With one drift gap, two acceleration gaps and one induction gap.
- We need to take into account Lorenz shift (variates from 0.9 to 1.5 mm from plane to plane) to reconstruct hits in GEM planes due to the magnet field ~0.5 T.

CSC features

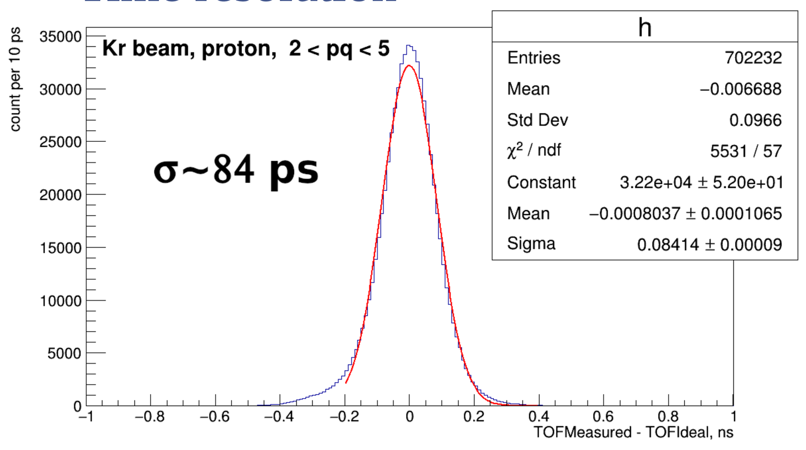
- Aligned by using straight GEM tracks with only X, Y, Z shifts (without rotation).
- Two zones which are electrically separated to get less fake hits.
- Pitch of CSC strips equal 2.5 mm for vertical strips and strips tilted by 15˚.



TOF400 features



Time resolution



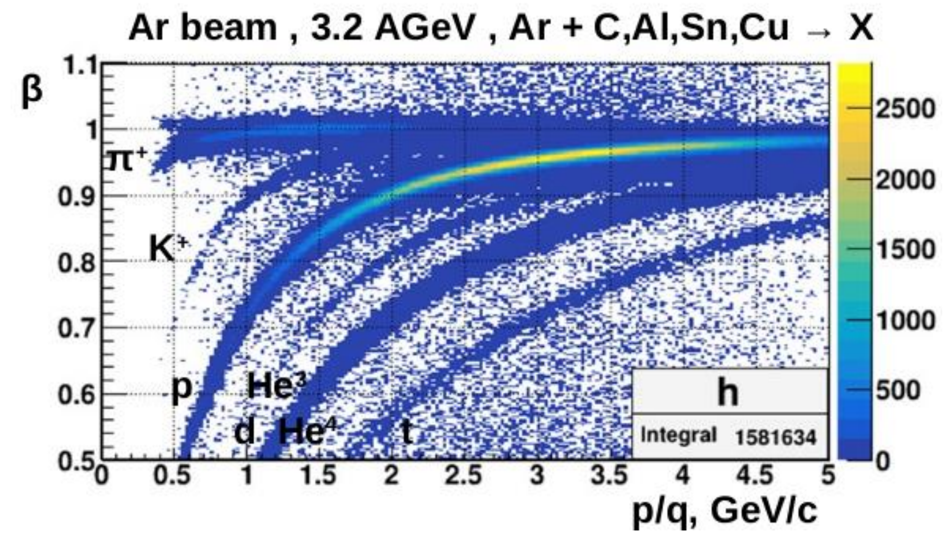
- TOF400 aligned by using straight GEM tracks with CSC hit with X, Y, Z shifts.
- Vertical strips pitch of 1.25 cm, Y-coordinate determined by left-right signal difference.

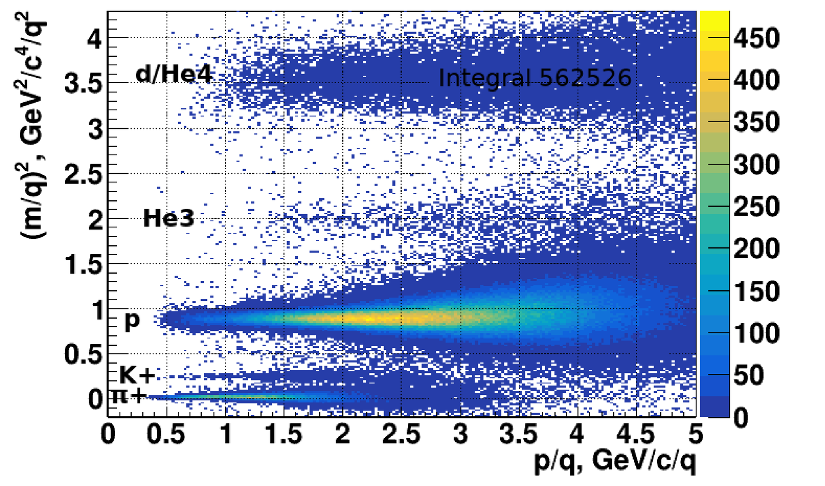
Time of Flight method

Charged particle identification was performed using the Time of Flight method.

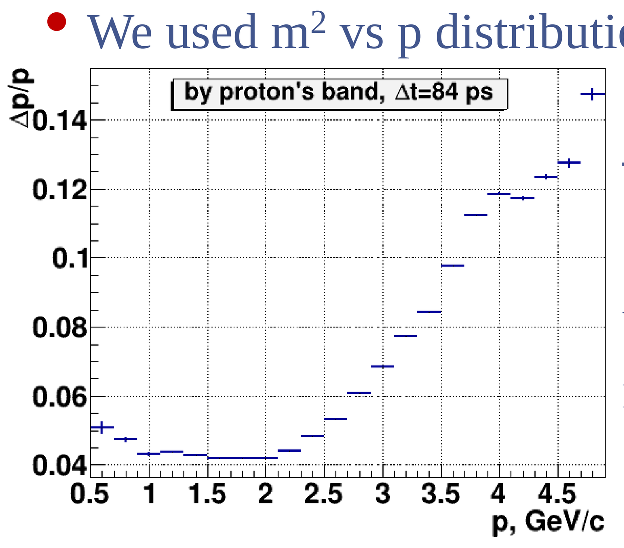
$$m = p\sqrt{\frac{1}{\beta^2} - 1}, \beta = \frac{L}{ct},$$

m – mass of the particle, p – momentum of the particle, L – length of particle track, c – speed of light, t – time of flight.



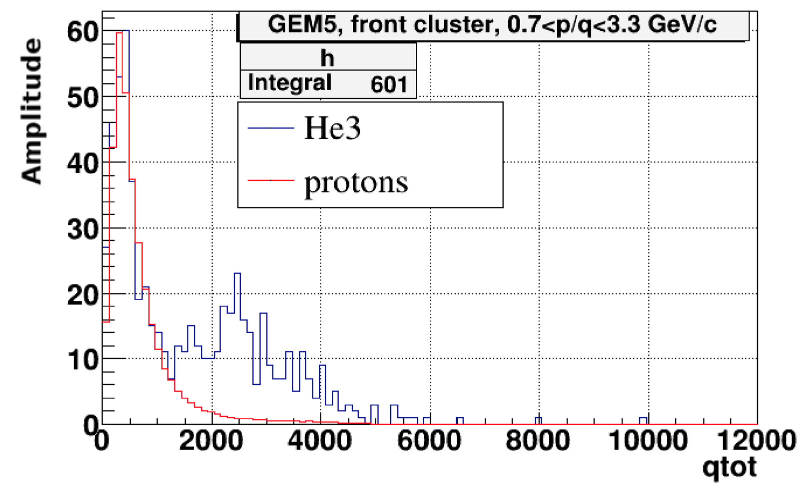


- On full Ar data, β vs p/q plot bands for π^+, K^+, p, He^3, d/He^4, t are clearly visible.
- We used m^2 vs p distribution to determine momentum resolution in our experiment.

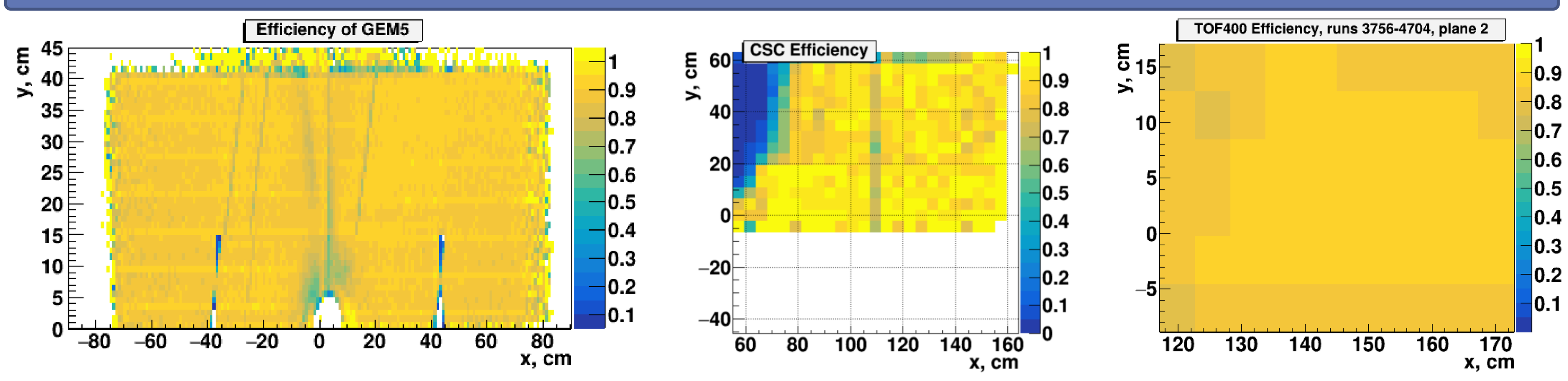


$$\frac{dm^2}{m^2} = \sqrt{\left(\frac{dp}{p}\right)^2 + \left(\frac{2}{1-\beta^2}\right)^2\left(\frac{dt}{t}\right)^2 + \left(\frac{2}{1-\beta^2}\right)^2\left(\frac{dL}{L}\right)^2}.$$

- For the low momentum, m^2 uncertainty is determined by the particle momentum uncertainty, and for the high momentum, it is determined by the time of flight due to Lorentz factor.
- The relative uncertainty of the track length is few times less than the relative uncertainty of the time so we can neglect it.
- He^3 can be separated from the background with Z=1 using cluster amplitudes in GEMs.
- The same technique can be used to separate He^4 from d.

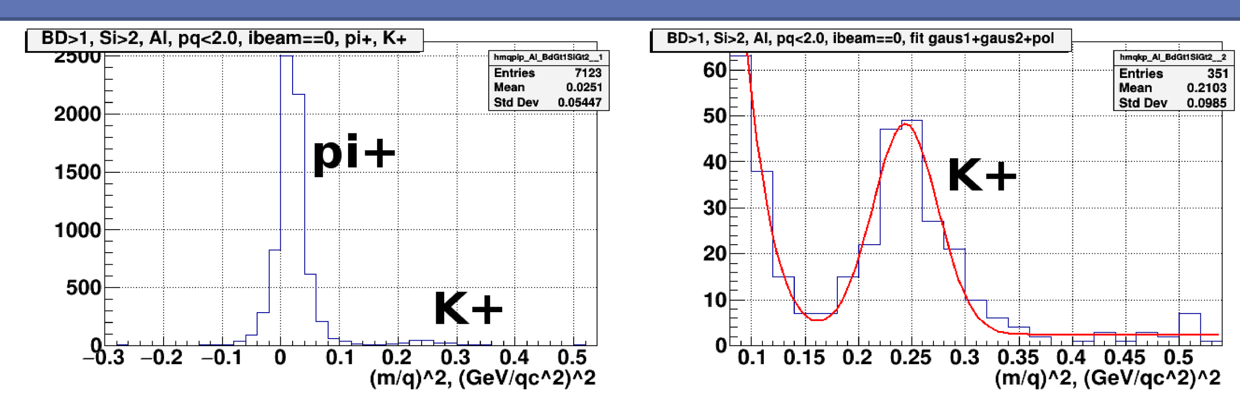


Efficiencies of GEM, CSC, TOF400



- Efficiencies for GEMs and TOF400 from all Ar data (~600 runs) are stable enough.
- Efficiency for CSC from 10 "good" runs.

K^+/π^+



- m^2 distribution is used to extract the number of K^+ and π^+.
- Two sources of background are taken into account while extracting the number of K^+: from π^+ (gaus fit) and from misidentified tracks (p0 fit).
- About $2\cdot10^3$ K^+ and 10^5 π^+ were identified in full Ar data.

Summary & Outlook

- CSC test outer tracker plane shows its good usability. Technique of CSC assembly is set up. CSC detector description is implemented into the reconstruction chain of the BM@N experiment.
- Matching of GEM central tracker, CSC outer tracker and TOF400 was successfully performed.
- During the analysis process, the TOF400 calibration was improved and high time resolution was achieved.
- As a result, good quality of charged particles identification was obtained and despite its smallness, K^+ were splitted from π^+.
- Such good CSC performance is a reason to use more planes in the next run.
- In the nearest future, we plan to include ZDC data to the present analysis to have the opportunity to choose events by centrality.