

ToF-700 π^+ and π^- analysis

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The main goal of the analysis

- Identifying π^\pm
- Estimation of the π meson production cross section



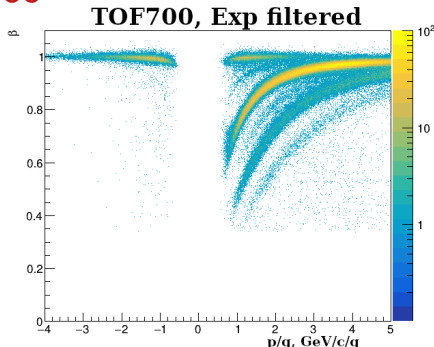
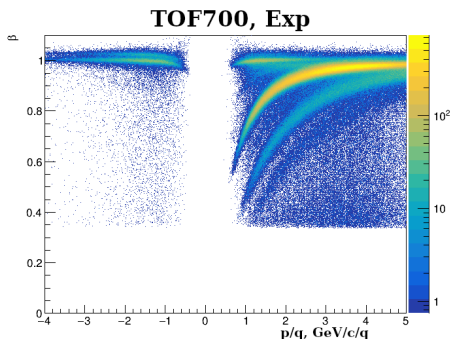
- Previous results
- Track selection algorithm
- Filtering experimental data
- Momentum dependence matching parameters
- Efficiency corrections for TOF700 and DCH
- Evaluation of trigger efficiency
- Summary



Previous results

- Algorithms for filtering experimental data have been implemented

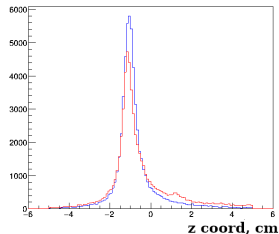
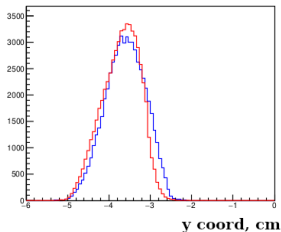
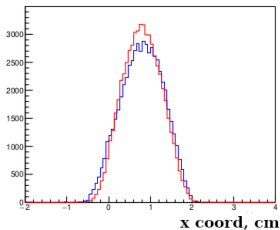
Statistics were collected for the argon beam on **all targets and triggers.**





Previous results

- **Realistic effects** have been added to the modeling process
 - Angle of beam
 - Gaussian smearing vertex
 - Lorentz shifts
 - Dead strips, hits





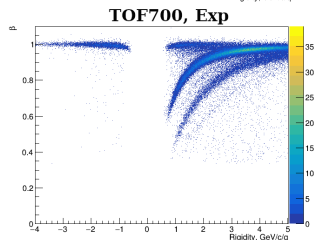
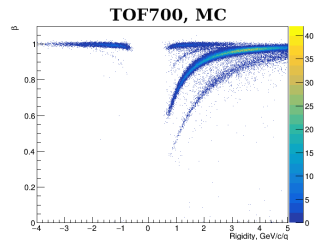
Run: 7 and Tracking: CellAuto

Monte Carlo

- Generator: DCM-SMM
- System: Ar + Cu
- Energy: 3.2 AGeV
- Smearing Vertex
- Lorentz Shifts
- Dead strips, hits

Exp data

- System: Ar + Cu
- Energy: 3.2 AGeV



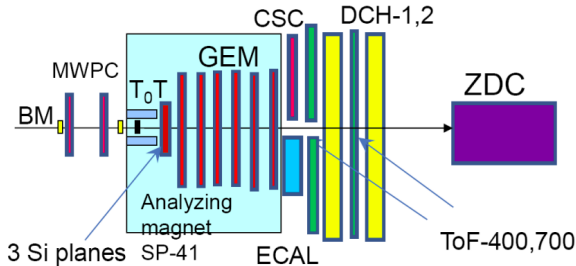


Filtering experimental data

Selection criteria for reliable experimental tracks:

- Vertex in range
 $V_x \in (-2, 4)\text{cm}$; $V_y \in (-6, -1)\text{cm}$; $V_z \in (-5, 5)\text{cm}$.
- Minimum **2 hit in silicon** stations and min **4 hits in GEM**.
- The track is confirmed in the first **drift chamber**

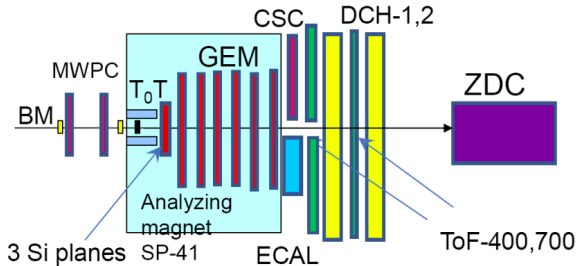
For the **TOF700** detector, we associate the track with the **hit**,
and for the **DCH1** with the **track segment**





The Station Skip Algorithm

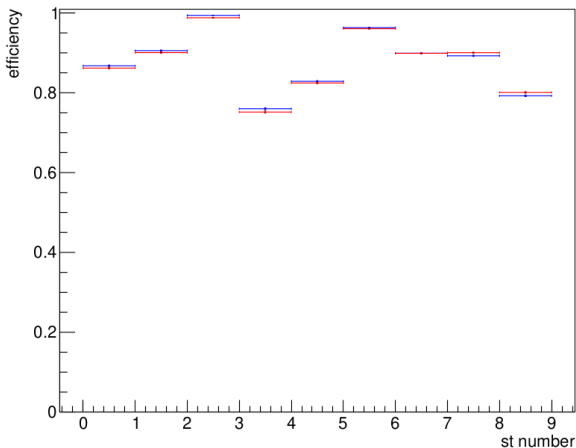
- Let station i is station where we want to calculate efficiency
- Propagate $SIL \rightarrow GEM \rightarrow DCH1 \rightarrow TOF700 \rightarrow DCH1 \rightarrow GEM \rightarrow SIL \rightarrow Vertex$ by KF with parameters update (skip station i)
- Propagate $Vertex \rightarrow SIL \rightarrow GEM$ by KF with getting residuals and calculating efficiencies





Stations efficiency inside the magnet

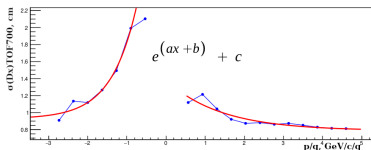
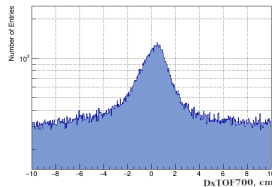
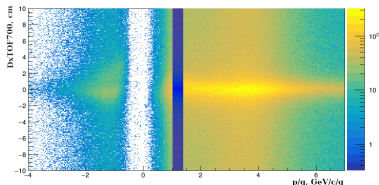
Station skip + hits disable + station acceptance





Alignment algorithm: momentum corrections

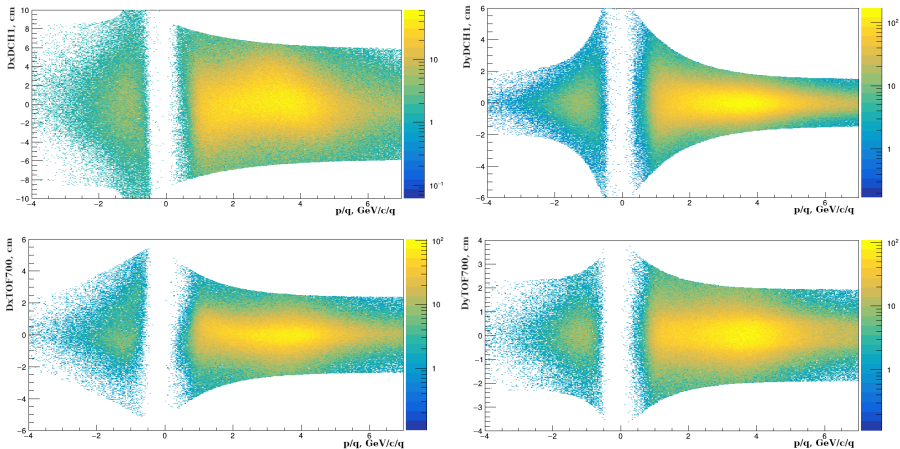
- **Propagate** each track to the detector plane
- Create histograms with **all** track-to-hit(track) **connections** from momentum
- Every 350 MeV, project the residuals onto the Y plane
- **Fit** distributions by $\text{gaus} + \text{pol2}$ to get $\mu_{D_x}(\rho/q)$ and $\sigma_{D_x}(\rho/q)$
- **Fit** all μ_{D_x} and σ_{D_x} by exponential function





Selected tracks after momentum correction

Matching criteria: $\pm 3\sigma_{D_x}(\rho)$, $\pm 3\sigma_{D_y}(\rho)$

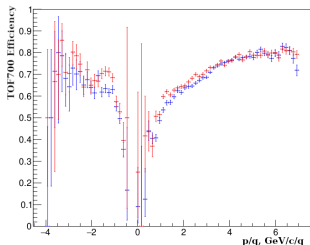
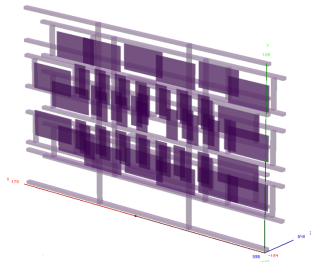




TOF700 Efficiency correction

TOF700 eff constants: **by modules**

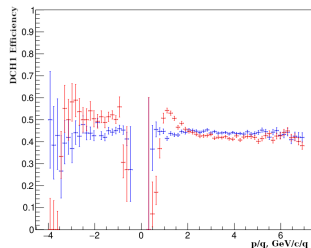
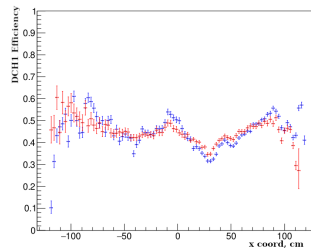
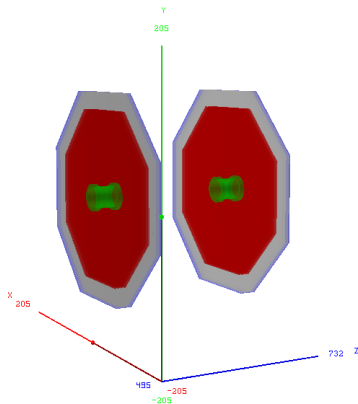
- From the **exp data** get the efficiency of **each module**: Mod_{eff}
- At the **stage of creating hits**, choose a random uniformly distributed number (Mod_{rnd})
- If $\text{Mod}_{\text{rnd}} > \text{Mod}_{\text{eff}}$, then the hit for the given module **is not recorded**





DCH Efficiency correction

Alignment by **x coordinate**





Cross section of π^\pm mesons

$$\sigma_{\pi^\pm}(\gamma, \rho_t) = \frac{N_{\text{rec}}^{\pi^\pm}(\gamma, \rho_t)}{\varepsilon_{\text{rec}}(\gamma, \rho_t)\varepsilon_{\text{trig}}L}$$

where

- γ is the **rapidity**
- ρ_t is the **transverse momentum**
- N^{π^\pm} is the **number of reconstructed π^\pm**
- ε_{rec} is the **efficiency of the π^\pm reconstruction**
- $\varepsilon_{\text{trig}}$ is the **trigger efficiency**
- L is the **luminosity**



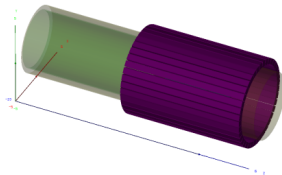
Estimation of trigger efficiency

$$\varepsilon(\text{BD} > k) = \frac{N_{\pi}(\text{BD} > k, \text{FD} > N, N_{\text{tr}})}{N_{\pi}(\text{FD} > N, N_{\text{tr}})},$$

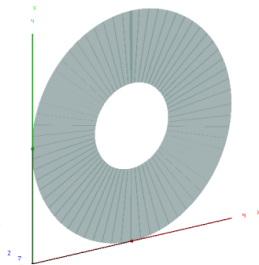
where

- $k = 1, 2, 3$ **reading from digits**
- N_{tr} is the **number of tracks in primary vertex**
- $\text{FD} > N$ is the trigger condition **for writing data**
- N_{π} is the **number of pions**

BD (barrel detector)



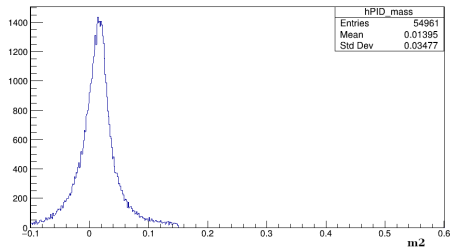
FD (forward silicon detector)



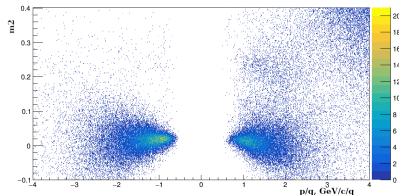
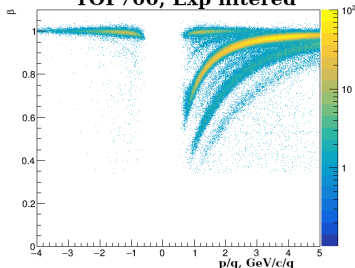


Momentum and mass range selection

- Calculate the efficiency **without dividing by targets**
- Momentum:
 $-2.6 < p/q < 2.4$
- Mass squared:
 $-0.1 < m^2 < 0.15$

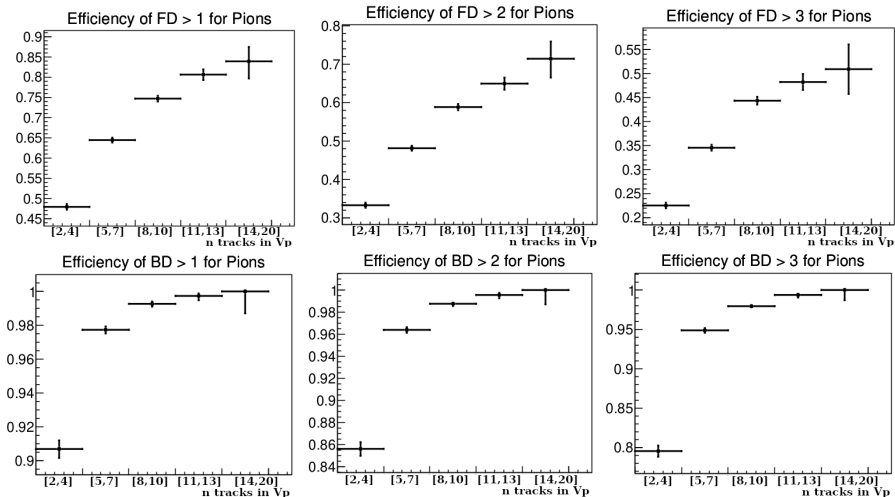


All targets and triggers.
TOF700, Exp filtered





Trigger efficiency for pions





General efficiency table

N Tracks in V_ρ	FD>1	FD>2	FD>3	BD>1	BD>2	BD>3
[2, 4]	48	33	23	91	86	80
[5,7]	64	48	35	98	96	95
[8,10]	75	59	44	99	99	98
[11,13]	81	65	48	100	100	99
[14,20]	84	71	51	100	100	100





Summary

- The efficiency inside the magnet are **in good agreement**.
- Accounting for **dynamic matching ranges and hit corrections**.
- **Efficiency corrections** for TOF700 and DCH have been added.
- The **efficiency of triggers** was evaluated.

Thank you for the attention!



Backup

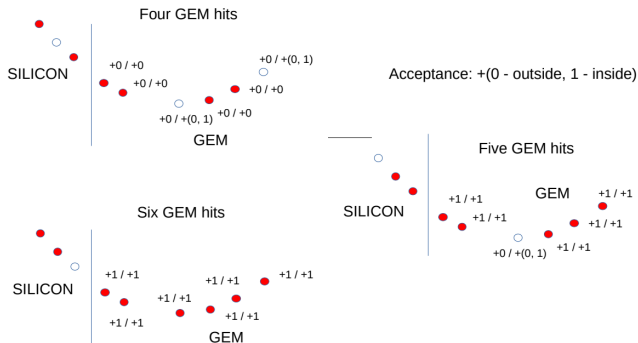


Efficiency calculation scheme

Silicon Tracks (Min 2 hit)

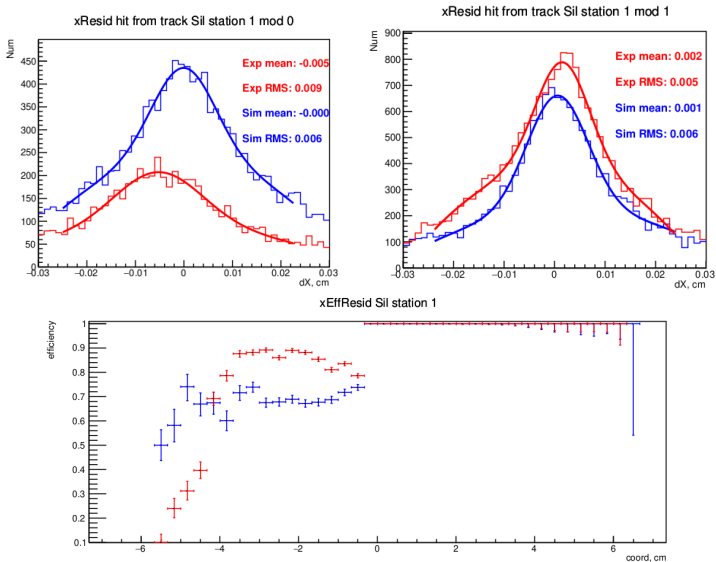
GEM Tracks (Min 4 hits)

$$\text{Efficiency}_i = \frac{\text{Numerator}_i}{\text{Denominator}_i}$$



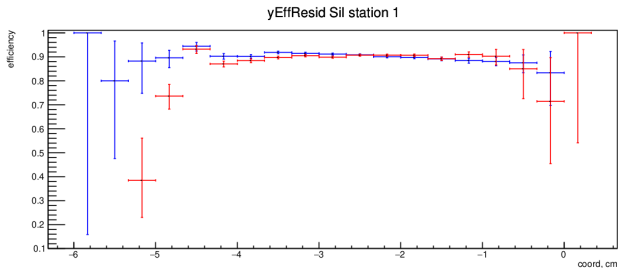
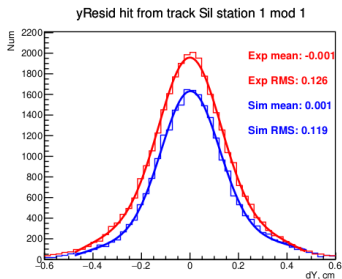
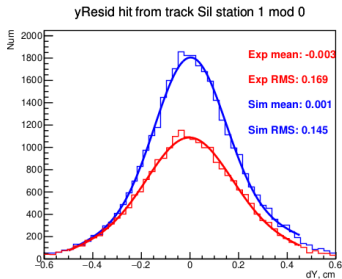


Silicon residuals: x coordinate



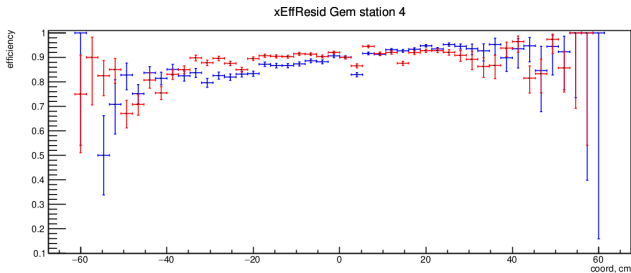
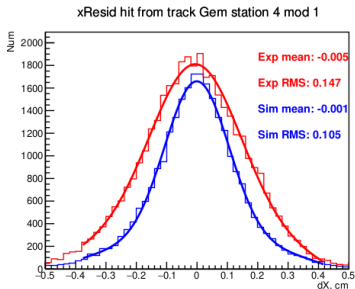
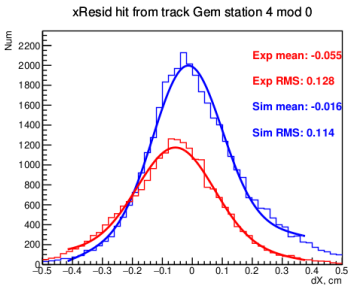


Silicon residuals: y coordinate





GEM residuals: x coordinate





GEM residuals: y coordinate

