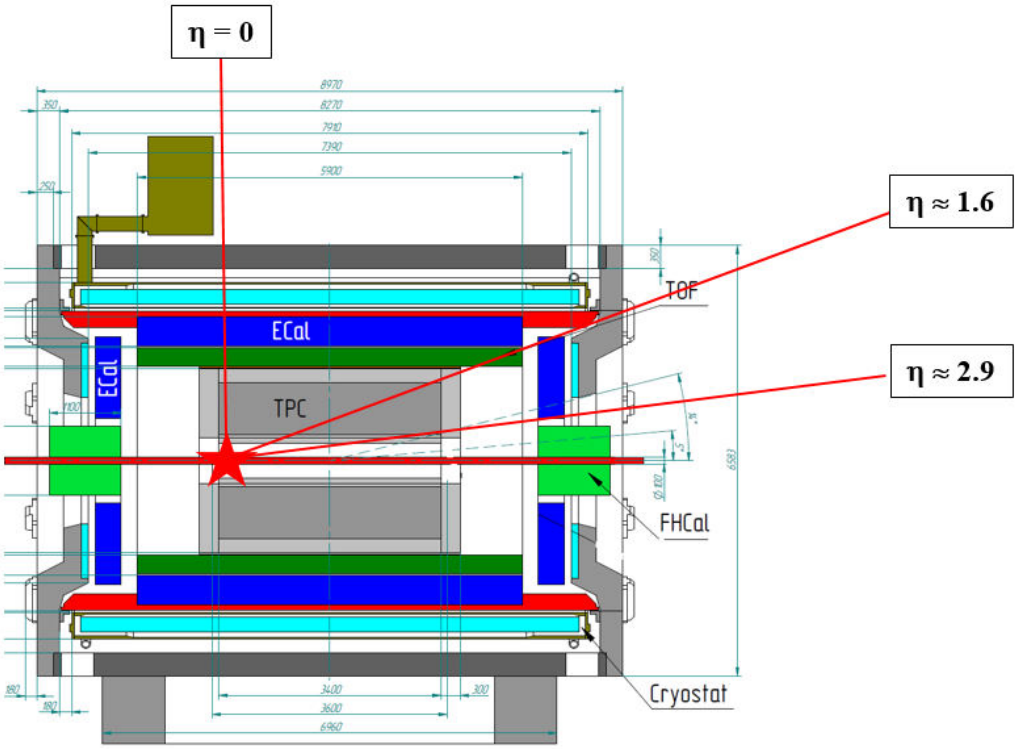
Fixed target mode for the MPD

V. Riabov

Fixed target configuration

- With a target located at z = -150 cm



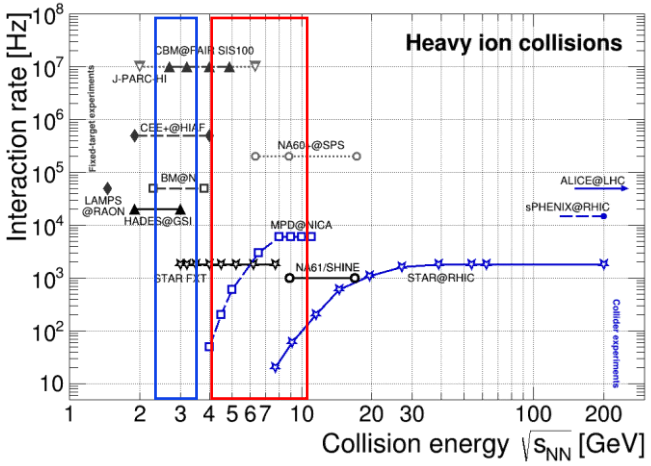


Table 2.1: The basic parameters of the TPC

Item	Dimension
Length of the TPC	340 cm
Outer radius of vessel	140 cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133 cm
Inner radius of the drift volume	34 cm
Length of the drift volume	163 cm (of each half)

- Kinematics

E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.7; 0.9 (2.2)
5.5	11	3.5	1.23	-1.23; 0.37 (1.67)

Detector coverage depends on track cuts

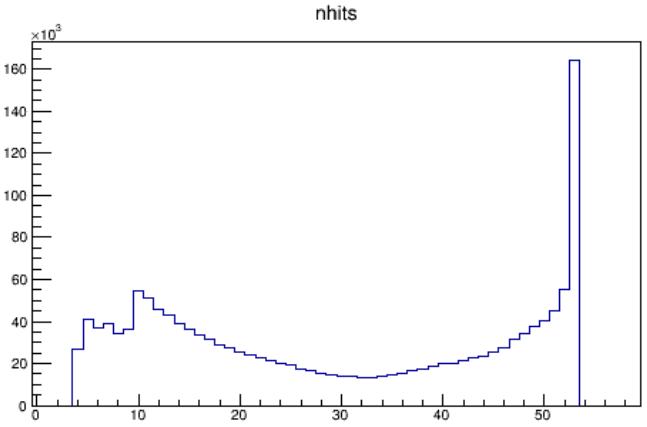
Simulation

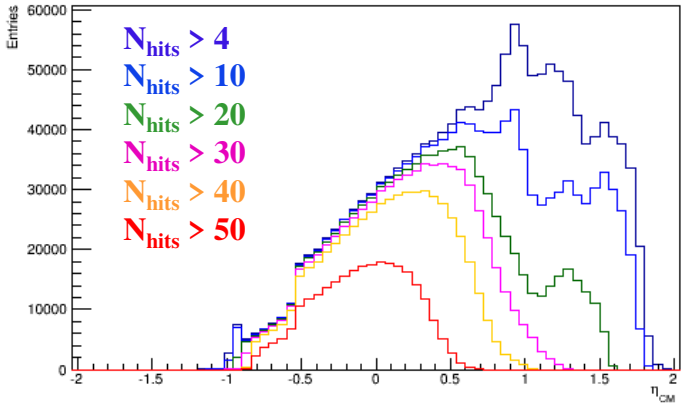
- Request 25 configuration with UrQMD event generator, Bi+Bi with b = 0-16 fm
- UrQMD is run in FXT mode at two energies: E_{lab} = 2.0·A GeV and E_{lab} = 5.5 ·A GeV
- Full detector configuration, but no FFD (stays in the way)
- Event vertex was fixed at x = 0 cm, y = 0 cm, z = -149 cm
  - ✓ current reconstruction code does not reconstruct tracks and event vertices produced at $|z| > 150$ cm
    → not a big limitation for the estimations provided
  - ✓ task for the future – z-vertex coordinate should be fixed at target position, no reconstruction needed
- ✓ 30,000 events for each energy for charged hadrons
- ✓ 300,000 for PIDed particles

Detector coverage for charged tracks

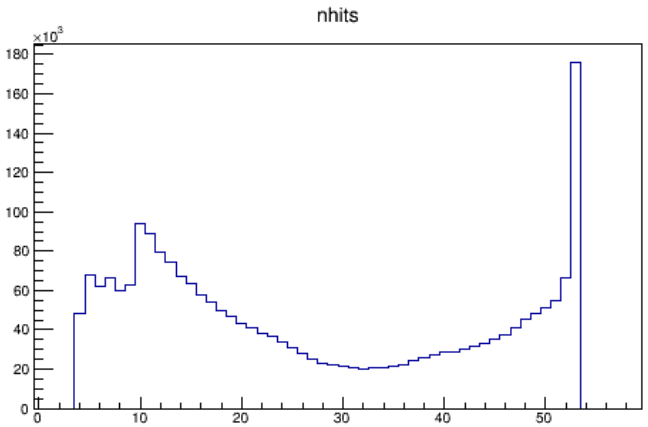
- Events with reconstructed vertex, primary tracks (produced at a distance < 1 cm from the primary vertex)

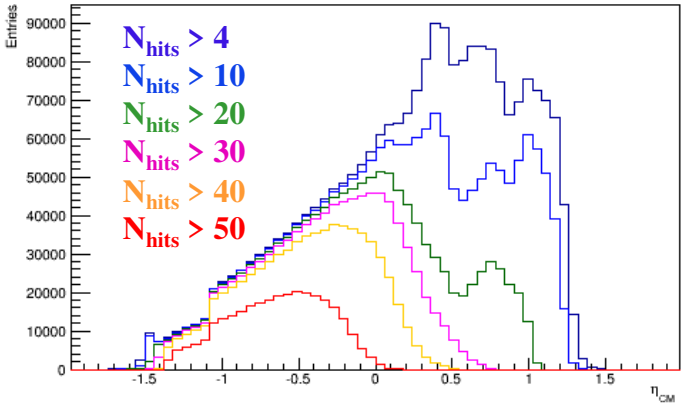
E_{lab} = 2.0·A GeV





E_{lab} = 5.5·A GeV



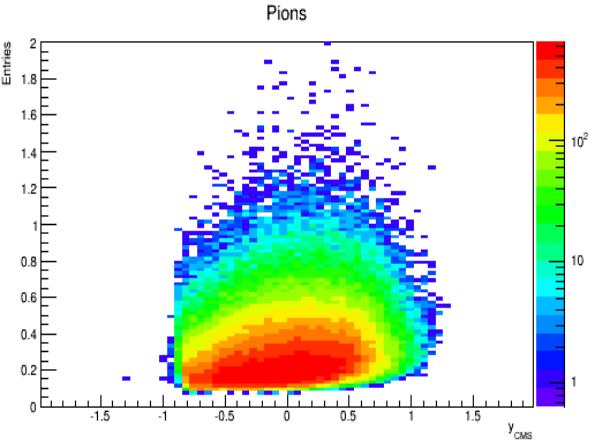


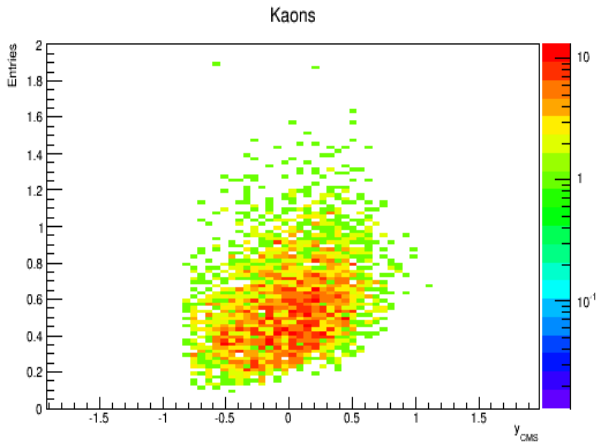
- Detector acceptance strongly depends on 'number of TPC hits' track selections
- Symmetric midrapidity coverage ($|y| < 0.5$) can be reached with track selections N_{hits} > 10-30

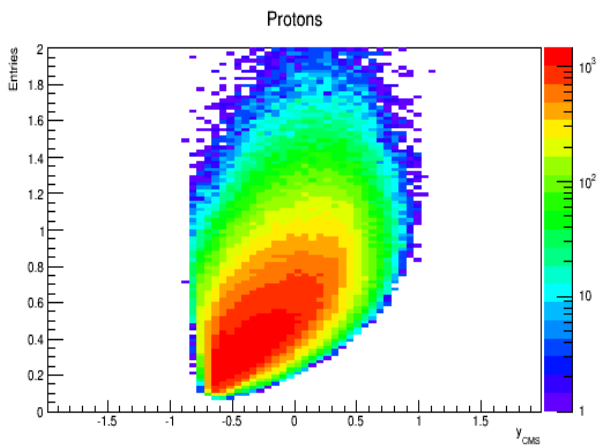
TPC phase space for π/K/p, E_{lab} = 2·A GeV

- Phase space depends on track selection cuts, results are presented for π/K/p was N_{hits} > 10 and > 30

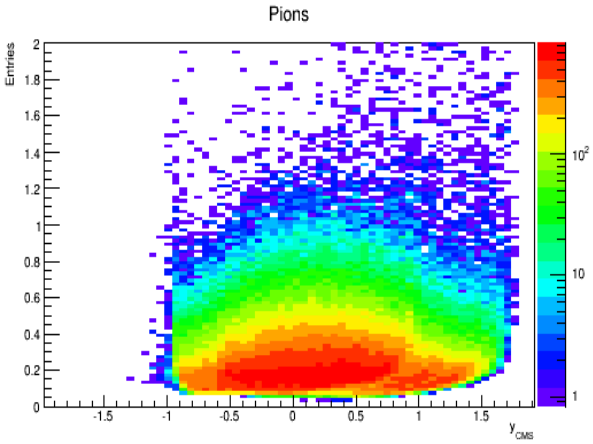
N_{hits} > 30

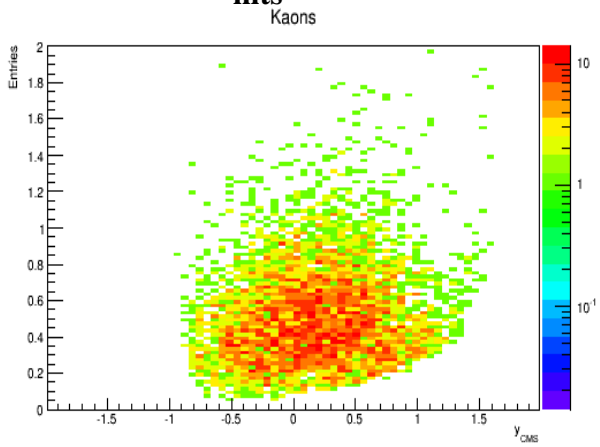


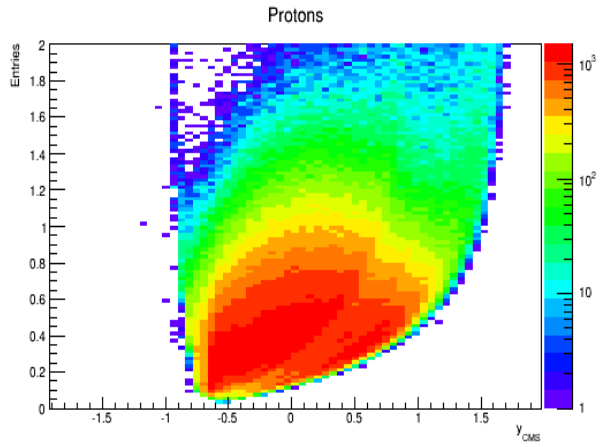




N_{hits} > 10





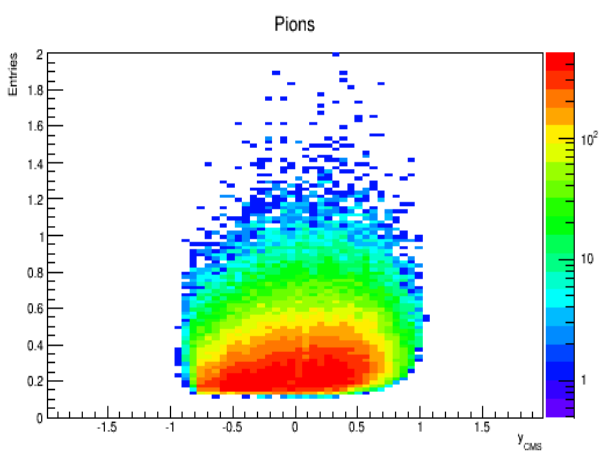


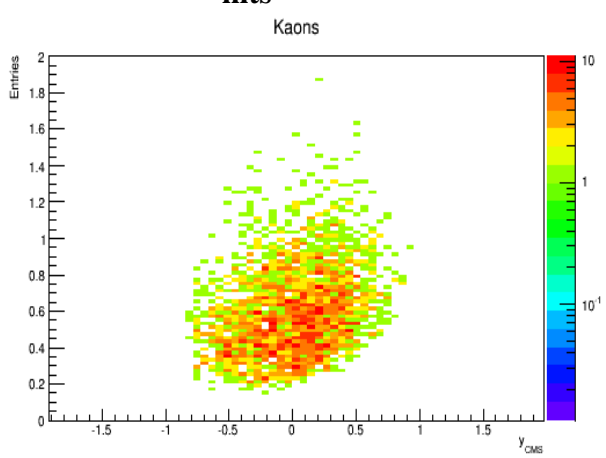
- Limited acceptance at low p_T for heavier hadrons
- Softer N_{hits} selections improve acceptance in expense of worse momentum resolution and matching to PV

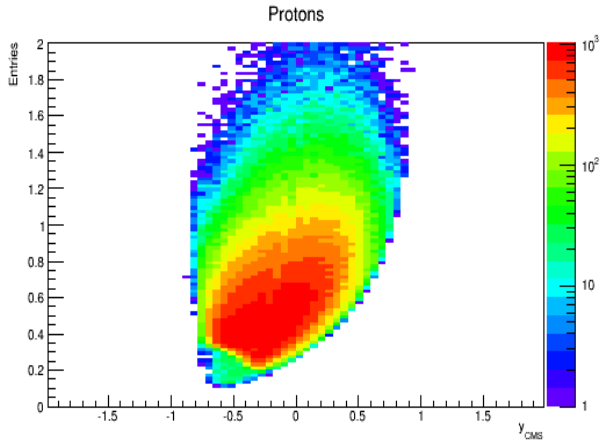
TPC+TOF phase space for π/K/p, E_{lab} = 2·A GeV

- Phase space depends on track selection cuts, results are presented for π/K/p was N_{hits} > 10 and > 30

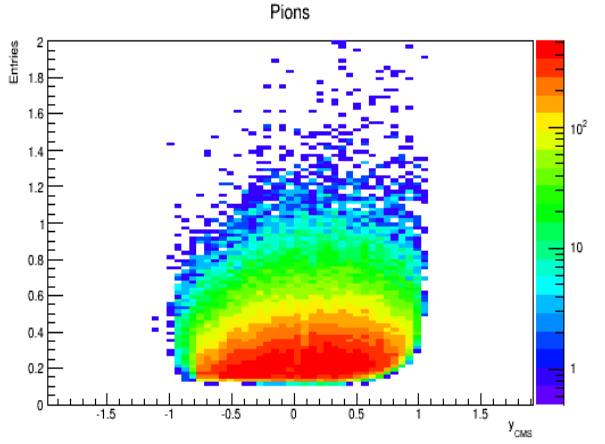
N_{hits} > 30

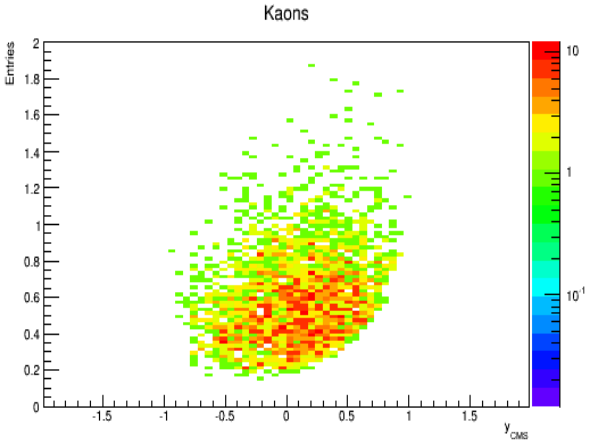


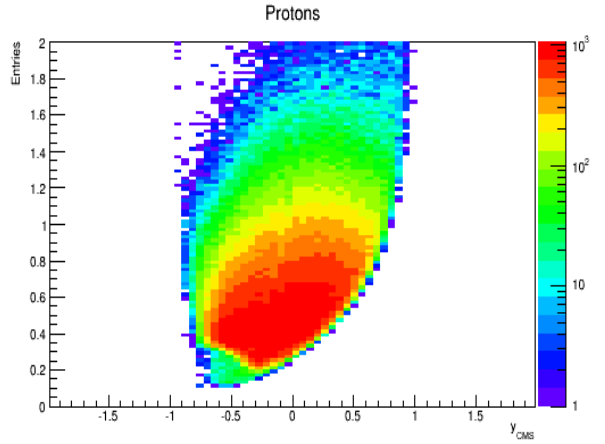




N_{hits} > 10



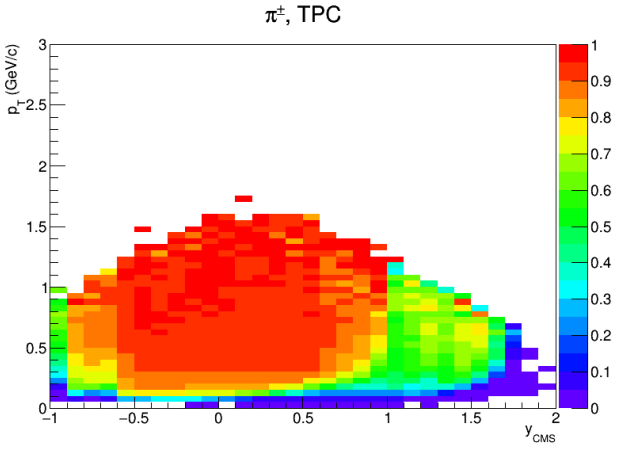


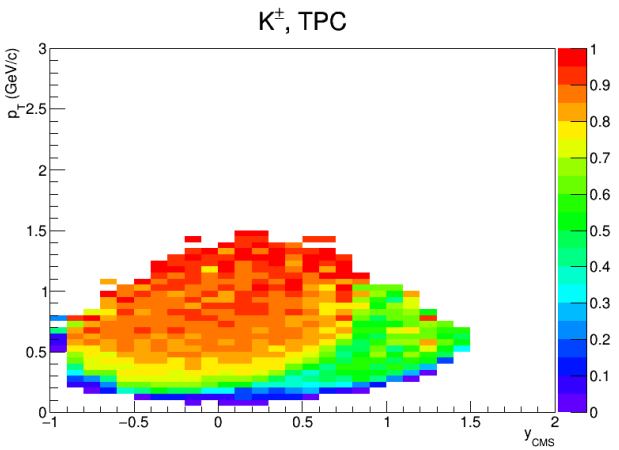


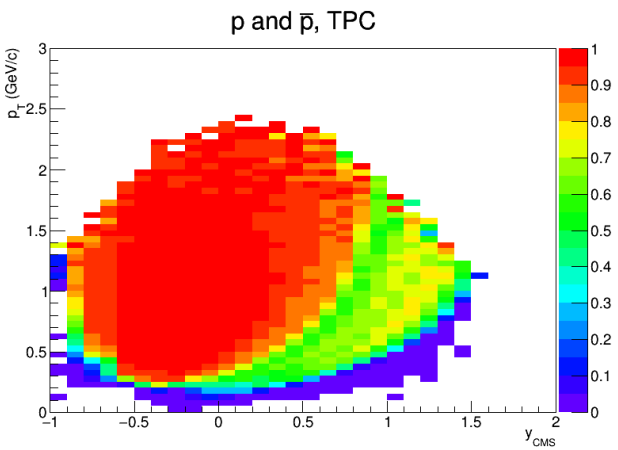
- Smaller effect of a softer N_{hits} cut since only 'full length' tracks with many TPC hits reach the TOF

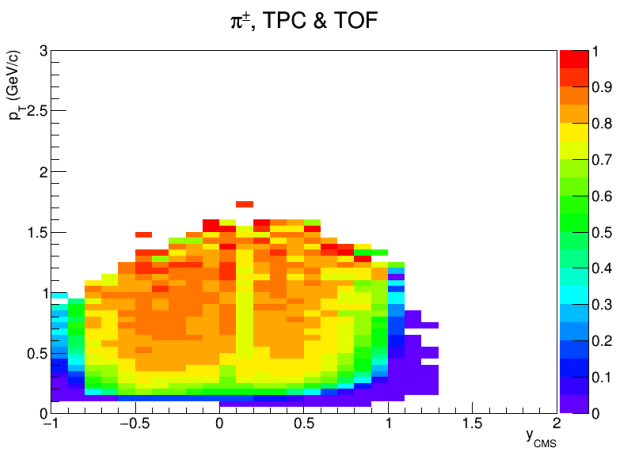
Efficiency for π/K/p, E_{lab} = 2·A GeV

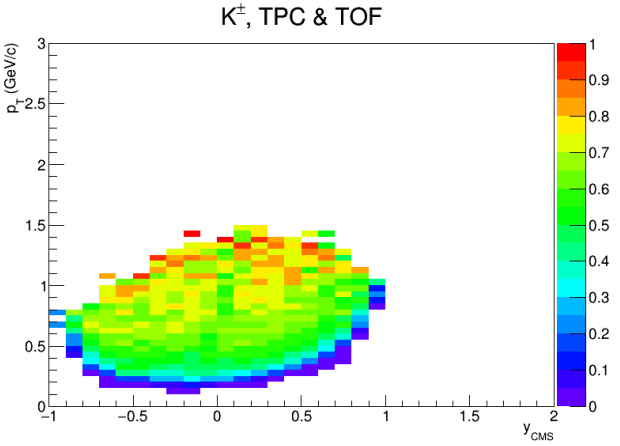
- N_{hits} > 10; DCA < 2 cm; Primary particles ($R_{production}$ < 1 cm)

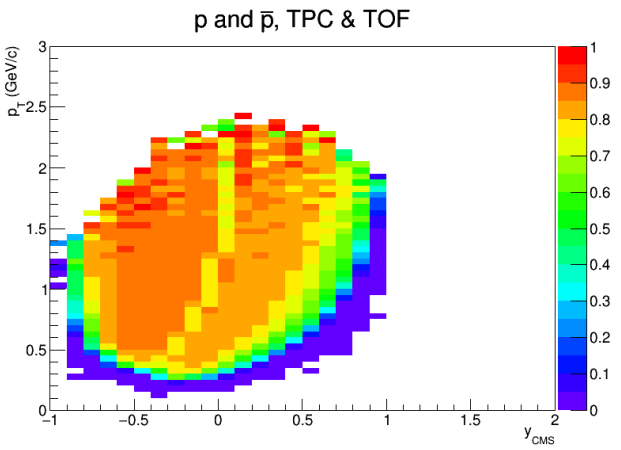






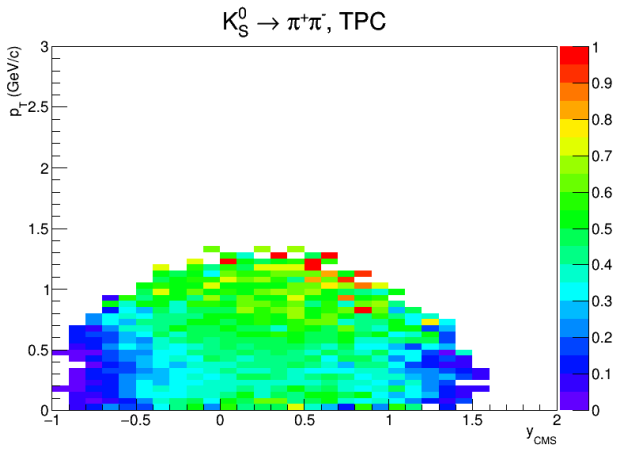


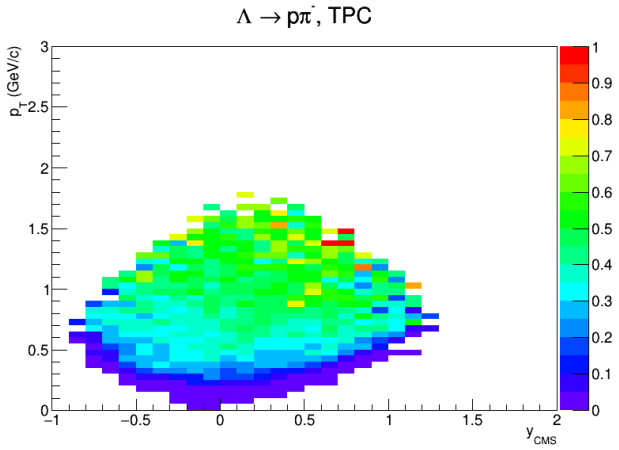


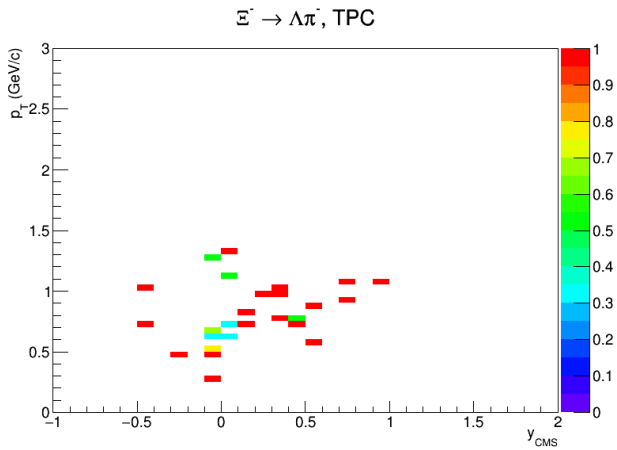


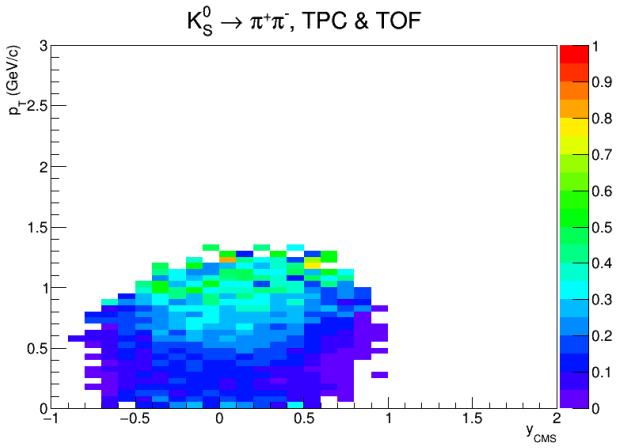
Efficiency for $K^0_s/\Lambda/\Xi^-$, E_{lab} = 2·A GeV

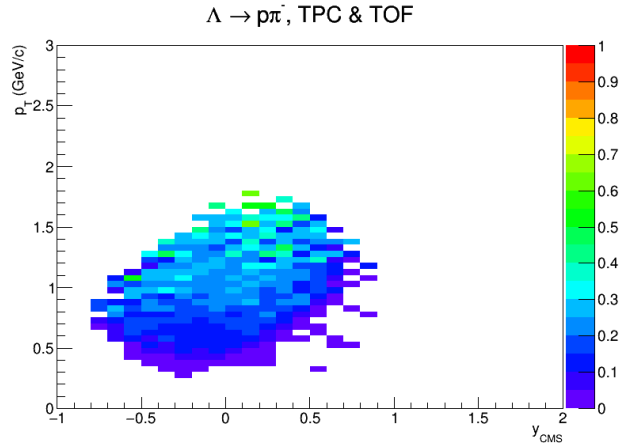
- $N_{hits} > 10$; $p_T > 0.1$ GeV/c; Primary particles ($R_{production} < 1$ cm)

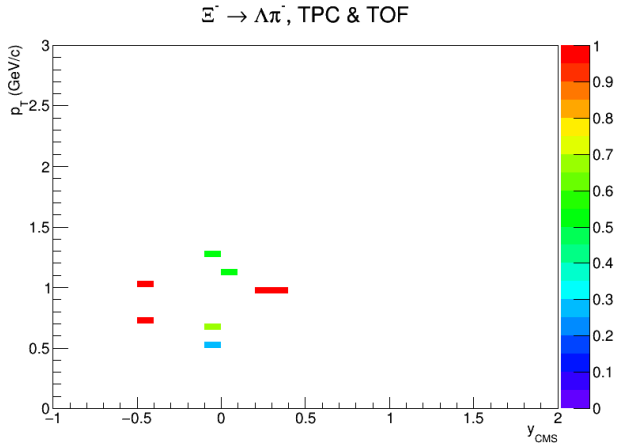






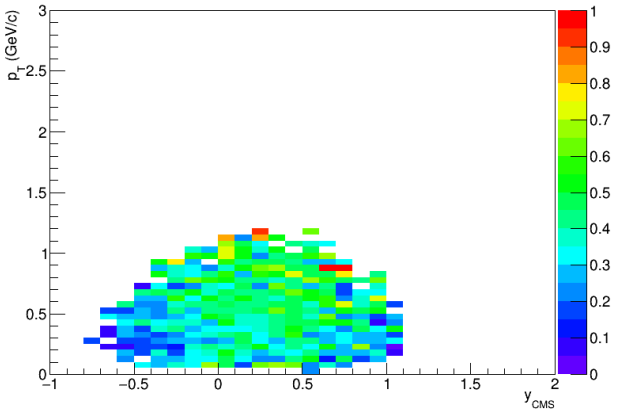


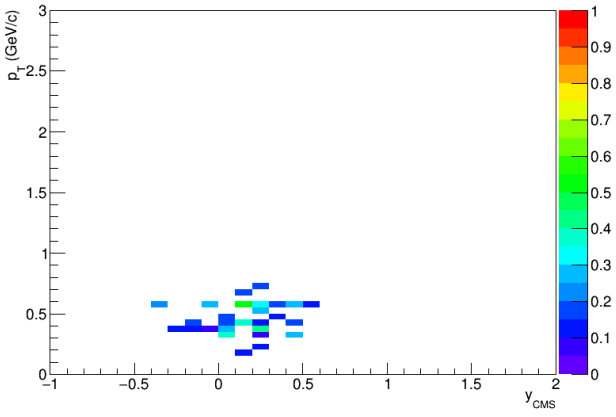


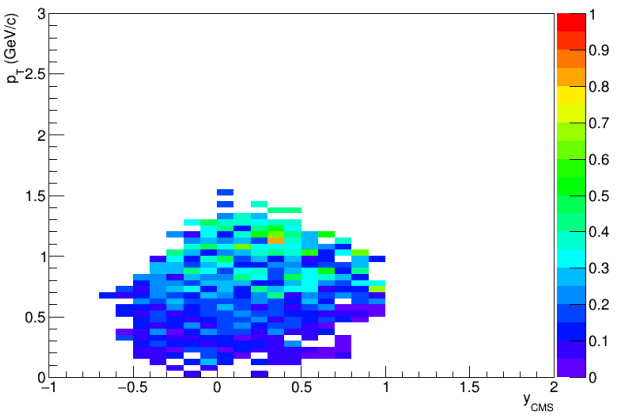


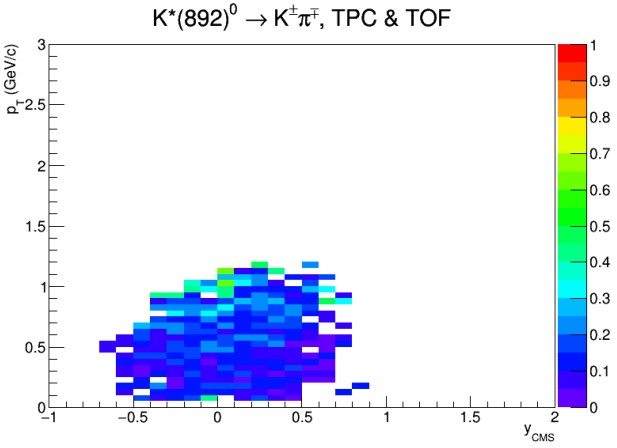
Efficiency for $K^*(892)^0/\phi(1020)/\Sigma(1385)^{\pm}$, E_{lab} = 2·A GeV

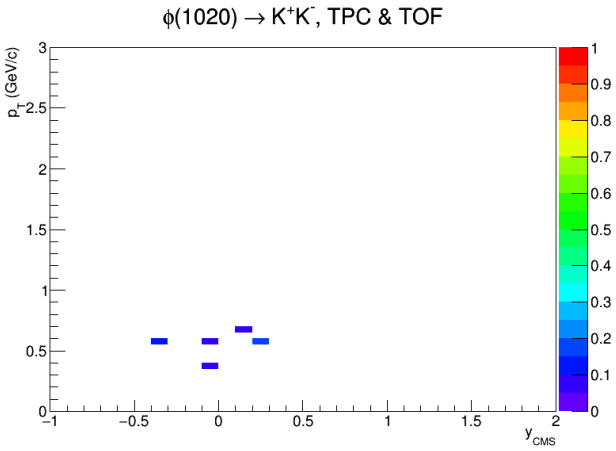
- $N_{hits} > 10$; $p_T > 0.1$ GeV/c; Primary particles ($R_{production} < 1$ cm)

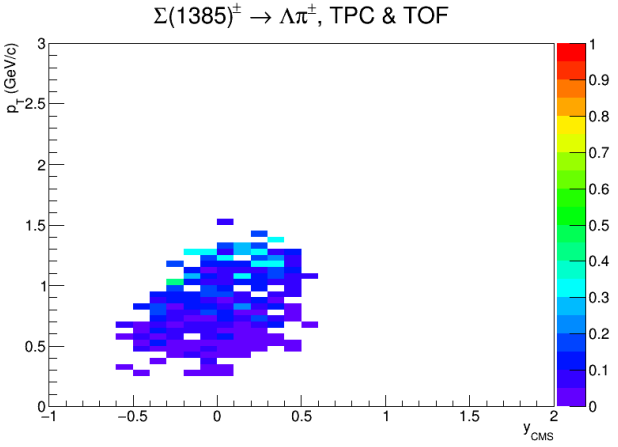








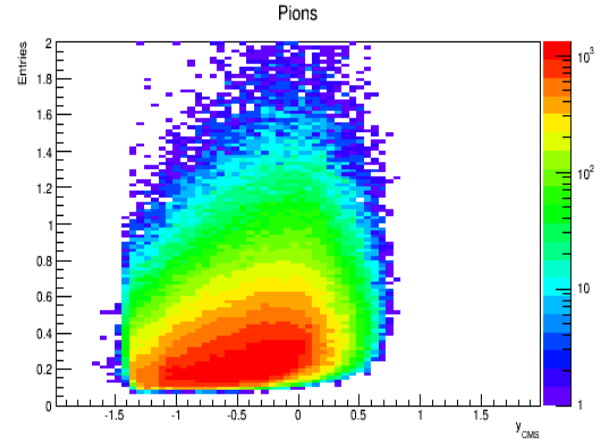


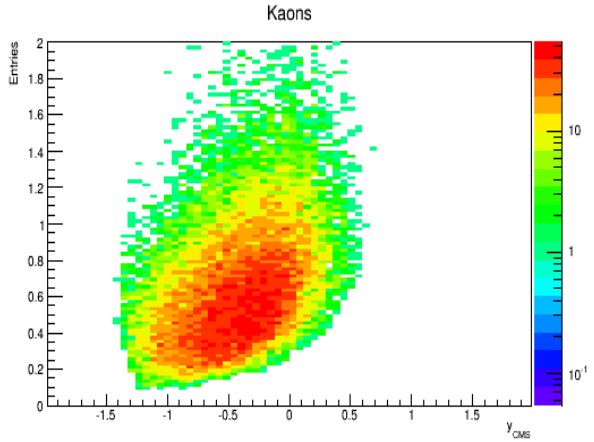


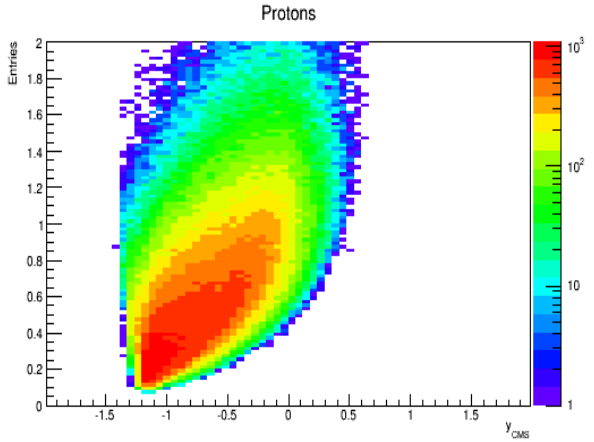
TPC phase space for π/K/p, E_{lab} = 5.5·A GeV

- Phase space depends on track selection cuts, results are presented for π/K/p was N_{hits} > 10 and > 30

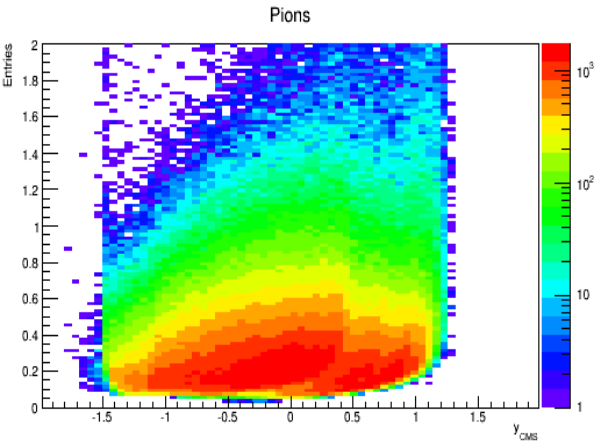
N_{hits} > 30

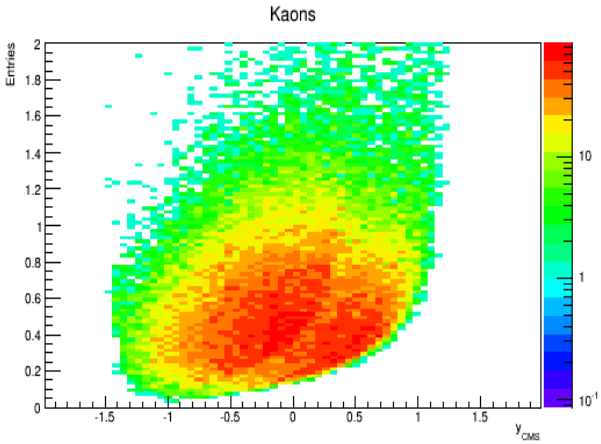


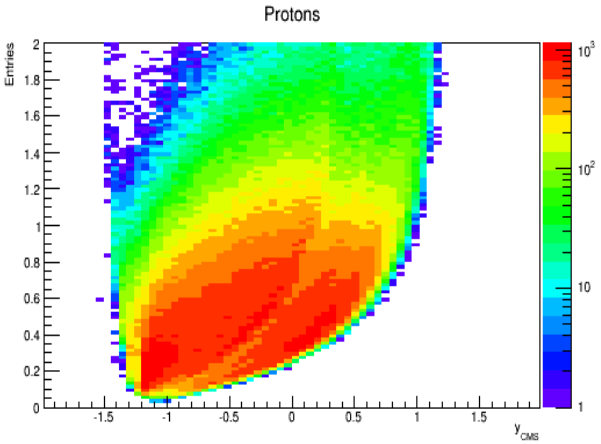




N_{hits} > 10





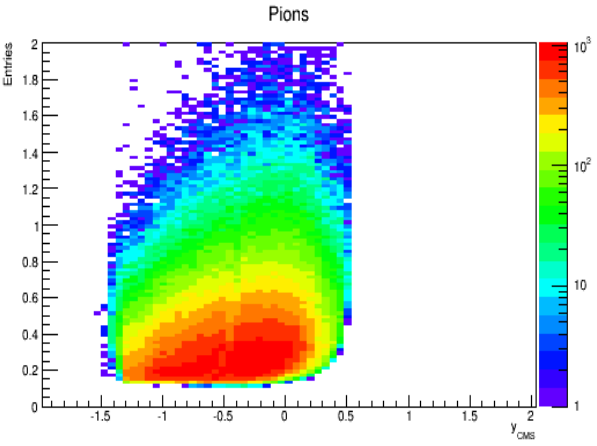


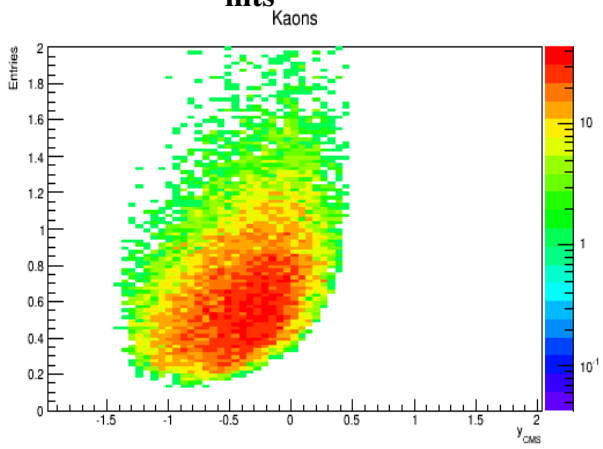
- Limited acceptance at low p_T for heavier hadrons, situation is worse at higher energy
- Softer N_{hits} selections improve acceptance in expense of worse momentum resolution and matching to PV

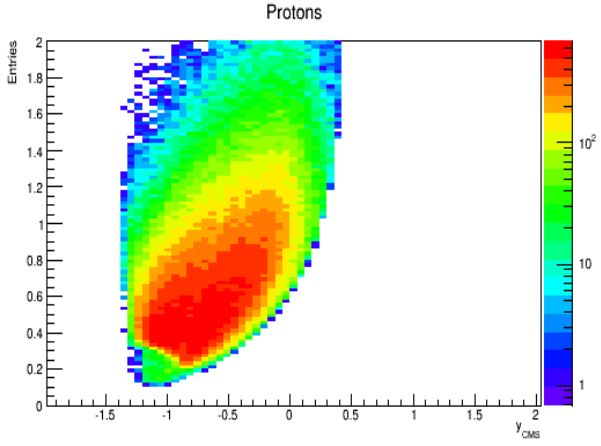
TPC+TOF phase space for π/K/p, E_{lab} = 5.5·A GeV

- Phase space depends on track selection cuts, results are presented for π/K/p was **N_{hits} > 10 and > 30**

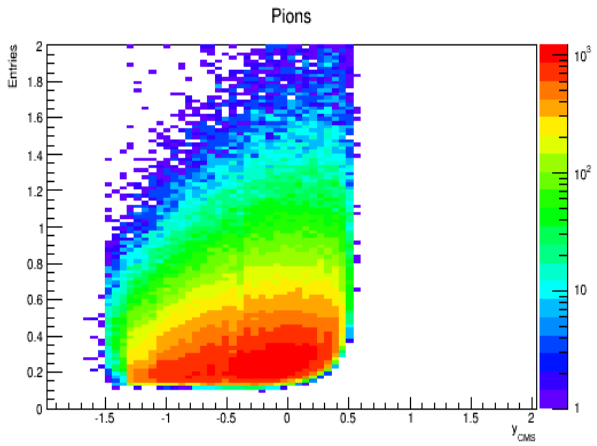
N_{hits} > 30

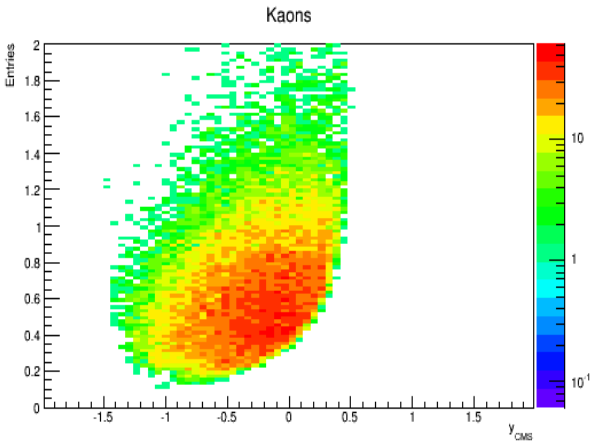


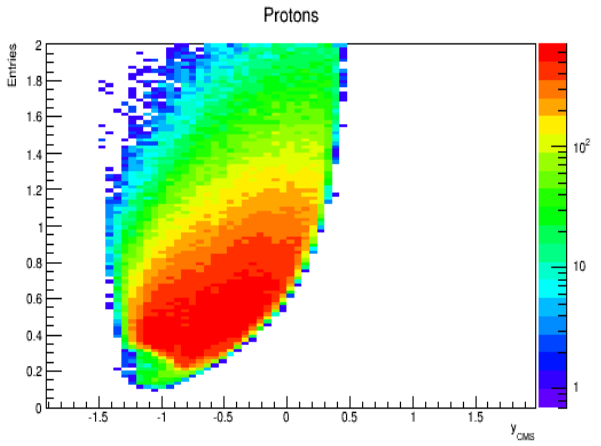




N_{hits} > 10



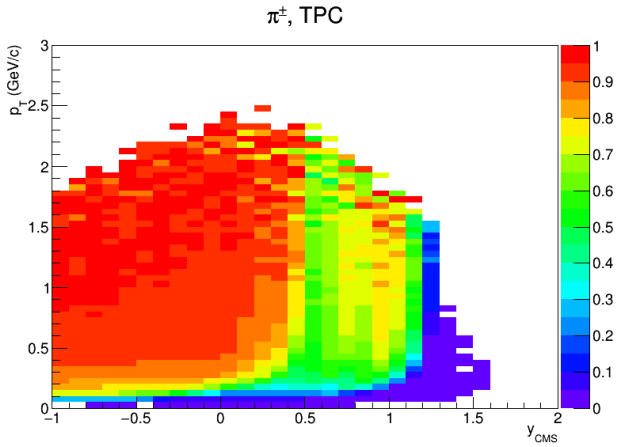


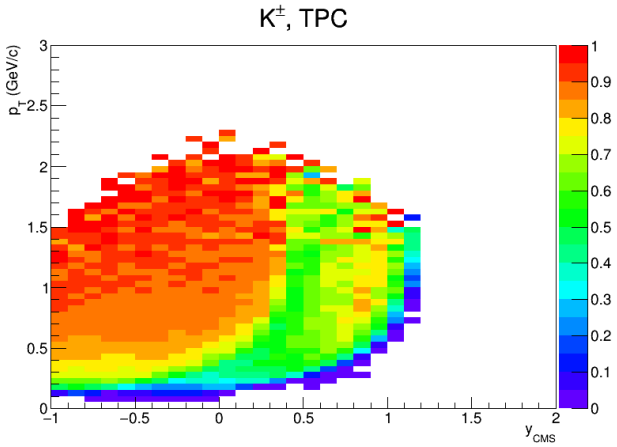


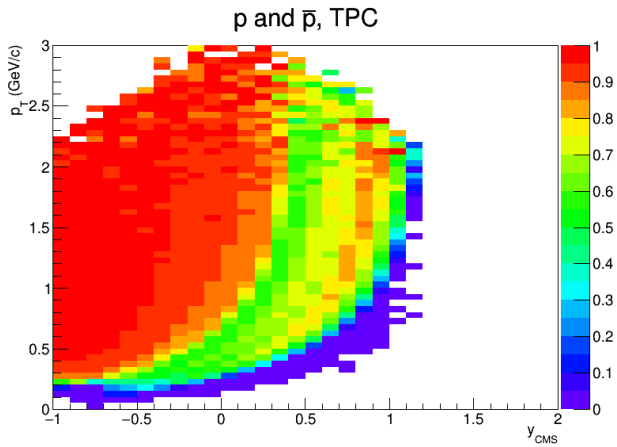
- Smaller effect of a softer N_{hits} cut since only 'full length' tracks with many TPC hits reach the TOF

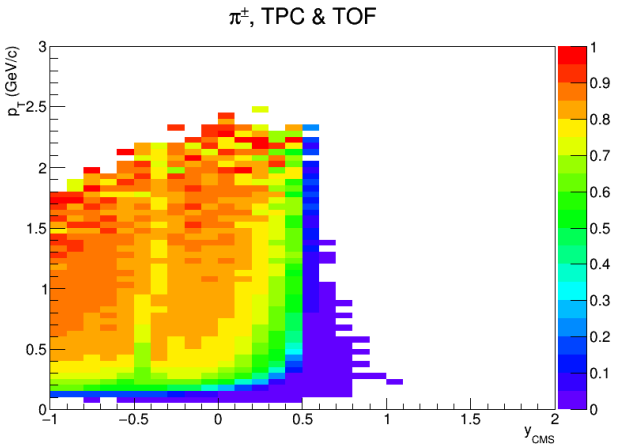
Efficiency for π/K/p, E_{lab} = 5.5·A GeV

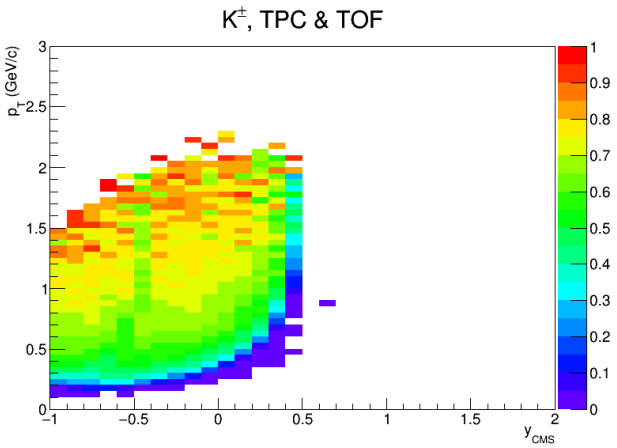
- N_{hits} > 10; DCA < 2 cm; Primary particles ($R_{production}$ < 1 cm)

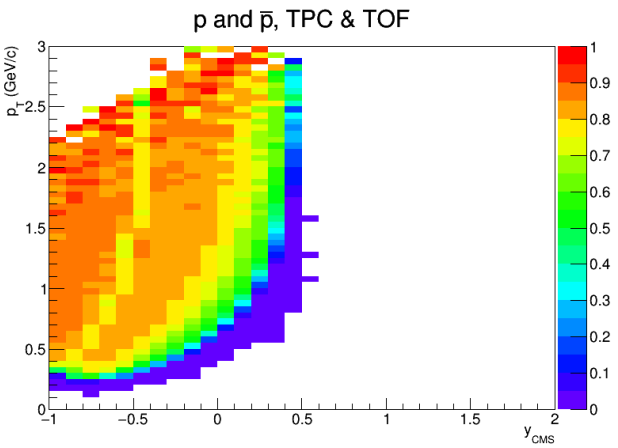






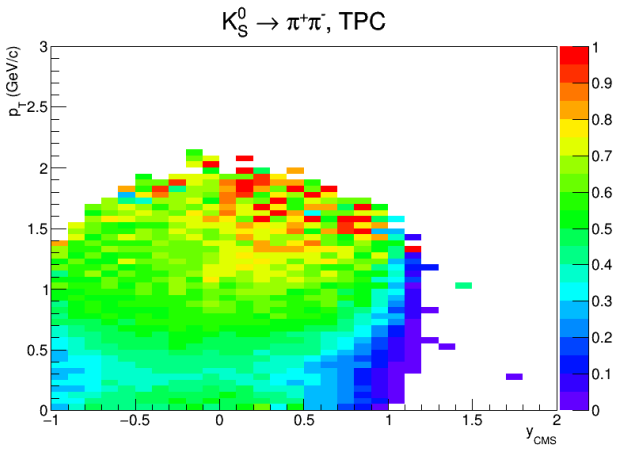


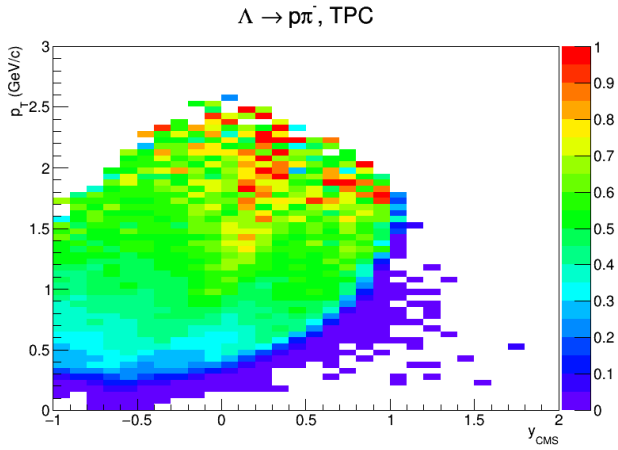


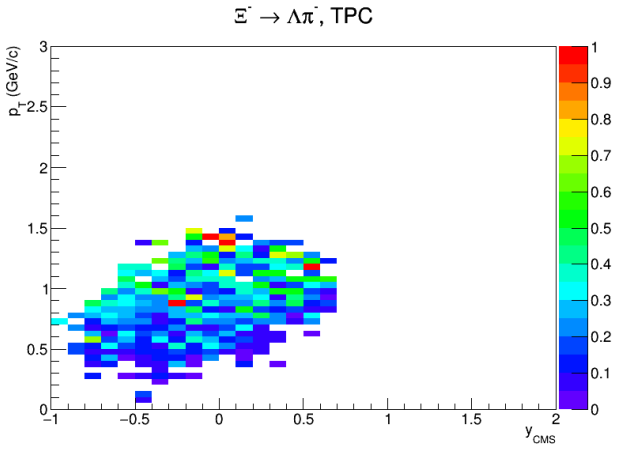


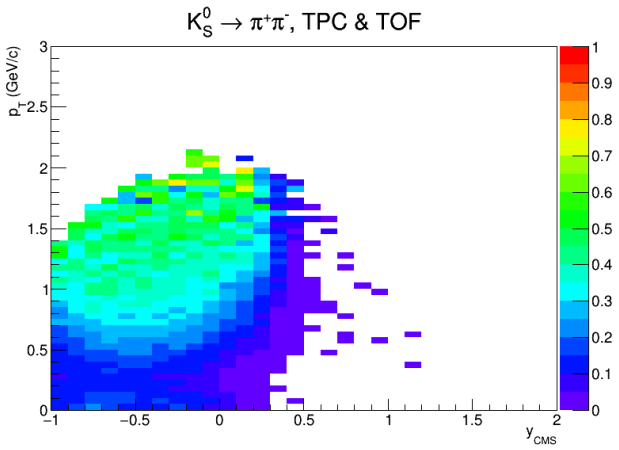
Efficiency for $K^0_s/\Lambda/\Xi^-$, E_{lab} = 5.5·A GeV

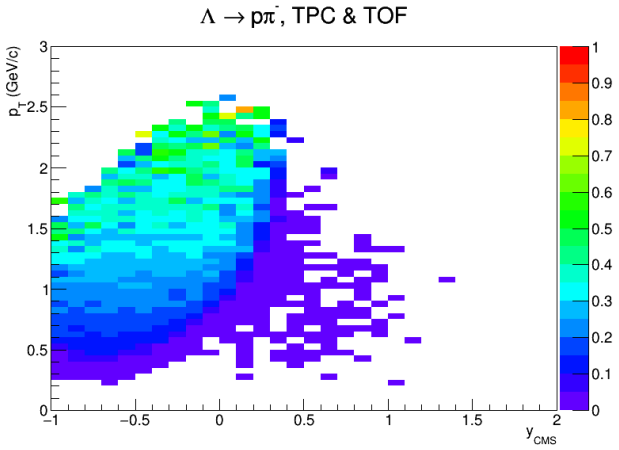
- $N_{hits} > 10$; $p_T > 0.1$ GeV/c; Primary particles ($R_{production} < 1$ cm)

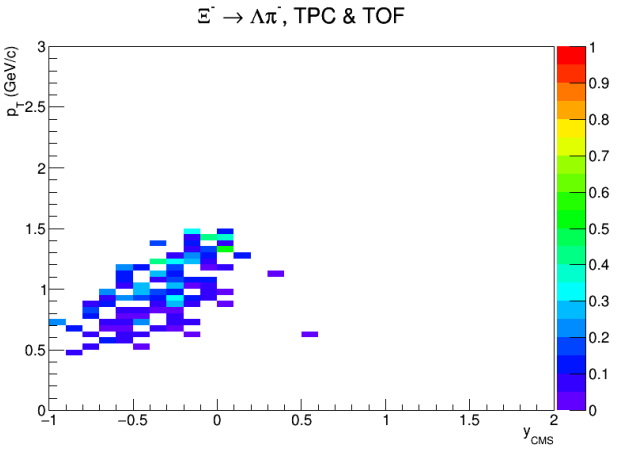






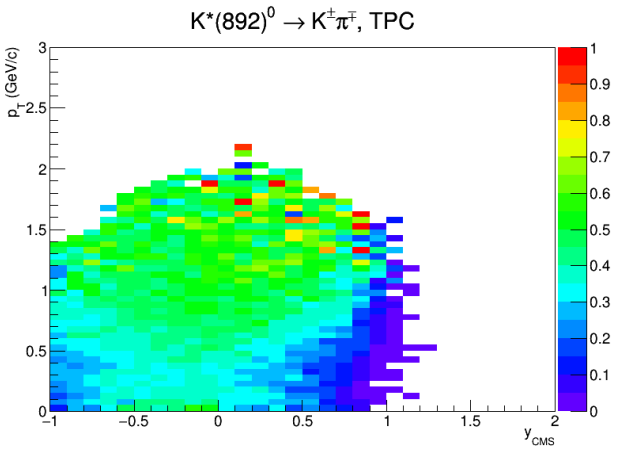


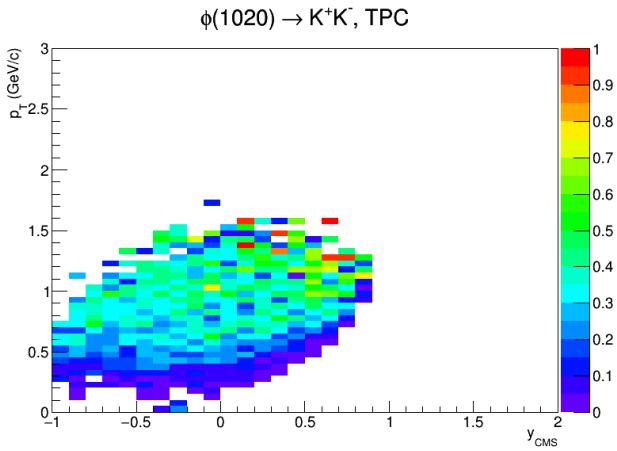


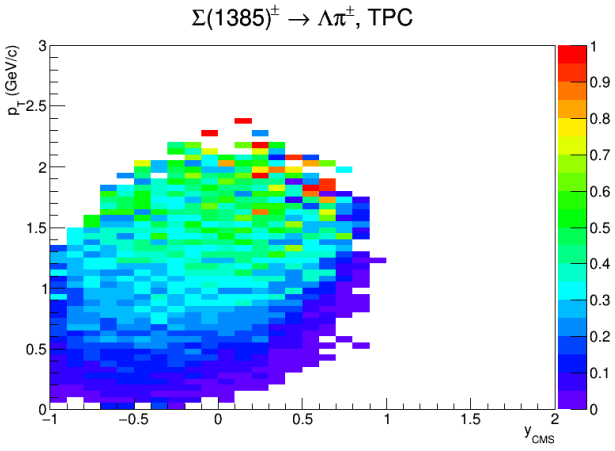


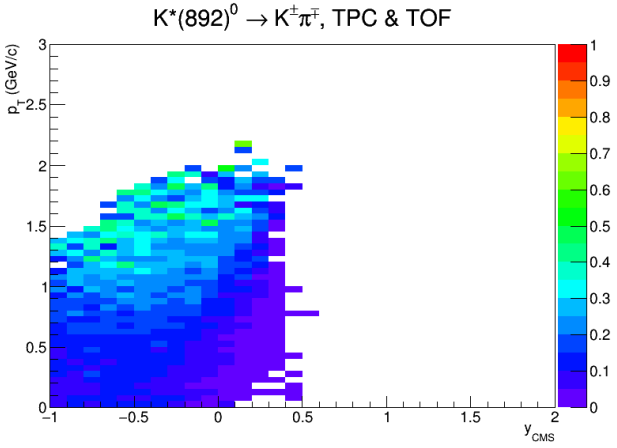
Efficiency for $K^*(892)^0/\phi(1020)/\Sigma(1385)^{\pm}$, E_{lab} = 5.5·A GeV

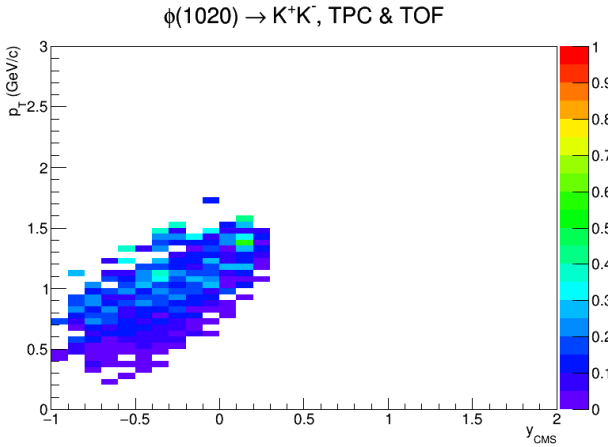
- $N_{hits} > 10$; $p_T > 0.1$ GeV/c; Primary particles ($R_{production} < 1$ cm)

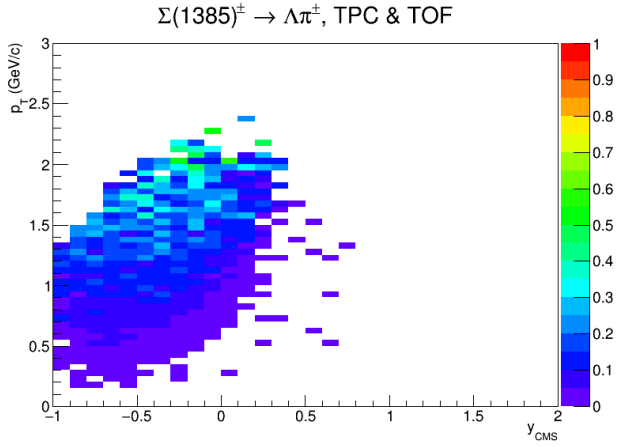












Fixed target configuration - II

- With a target located at z = -115 cm

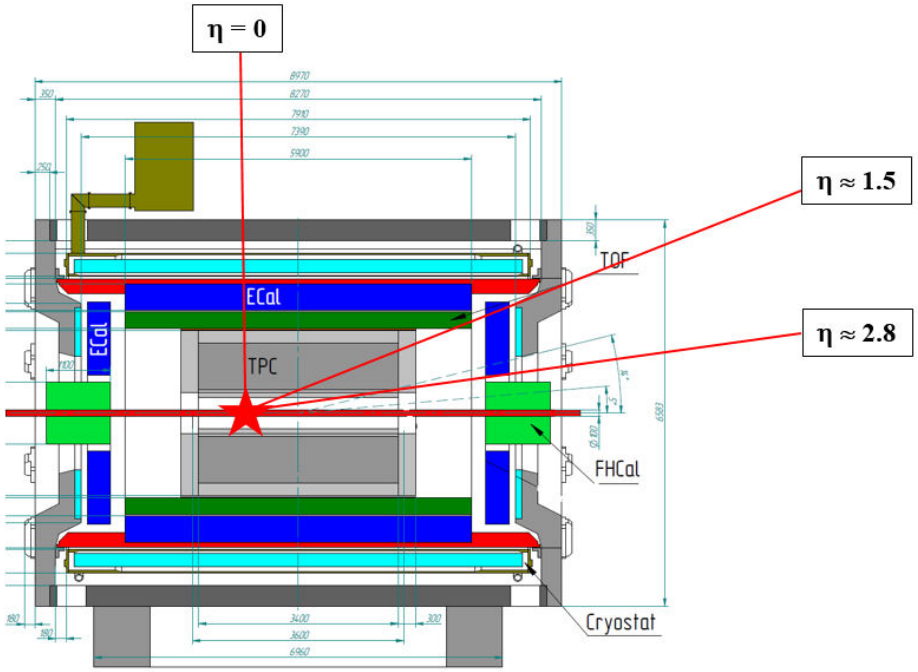


Table 2.1: The basic parameters of the TPC

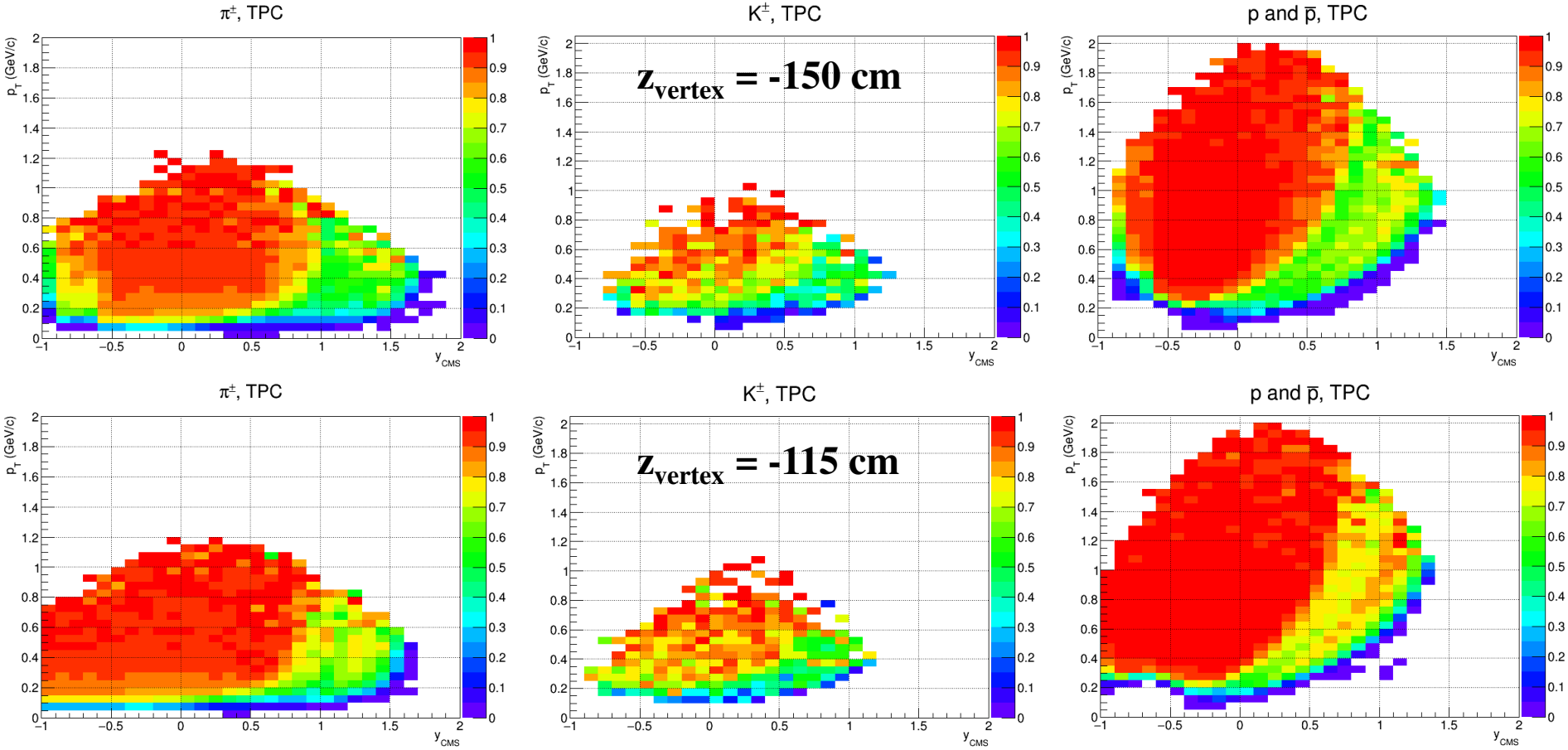
Item	Dimension
Length of the TPC	340 cm
Outer radius of vessel	140 cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133 cm
Inner radius of the drift volume	34 cm
Length of the drift volume	163 cm (of each half)

- Kinematics

E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.8; 0.8 (2.1)
5.5	11	3.5	1.23	-1.33; 0.27 (1.57)

TPC phase space for π/K/p, E_{lab} = 2·A GeV
z_{vertex} = -150 cm vs. z_{vertex} = -115 cm

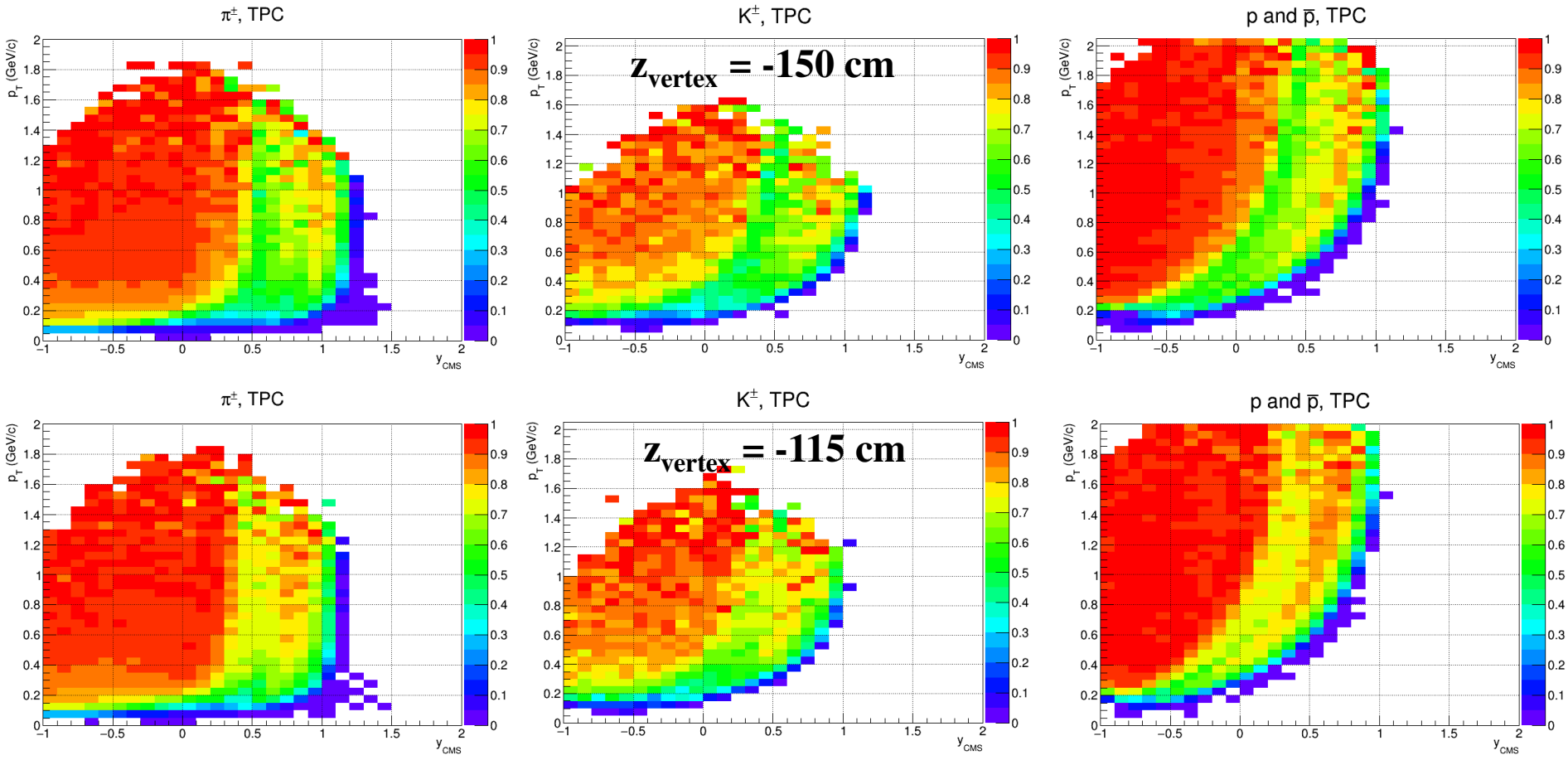
- N_{hits} > 10; DCA < 2 cm; Primary particles ($R_{production}$ < 1 cm)



- Results at z_{vertex} = -115 and -150 cm are similar
- Acceptance shifts by ~ 0.1 unit of rapidity towards negative values → consistent with slide 12

TPC phase space for π/K/p, E_{lab} = 5.5·A GeV
z_{vertex} = -150 cm vs. z_{vertex} = -115 cm

- N_{hits} > 10; DCA < 2 cm; Primary particles ($R_{production}$ < 1 cm)



- Results at z_{vertex} = -115 and -150 cm are similar
- Acceptance shifts by ~ 0.1 unit of rapidity towards negative values → consistent with slide 12

Conclusions

- MPD acceptance is good enough to work in the fixed-target mode (midrapidity acceptance is preserved)
- Two possible options for the vertex location were considered:
  - ✓ option z_{vertex} = -150 cm provides better acceptance
  - ✓ option z_{vertex} = -115 cm does not require rebuild of the detector at somewhat worse performance
- Next: trigger performance of the FFD/FHCAL/TOF ???

BACKUP

- MPD collider mode, BiBi@9.2, https://www.mdpi.com/2571-712X/6/2/27/pdf?version=1681888396

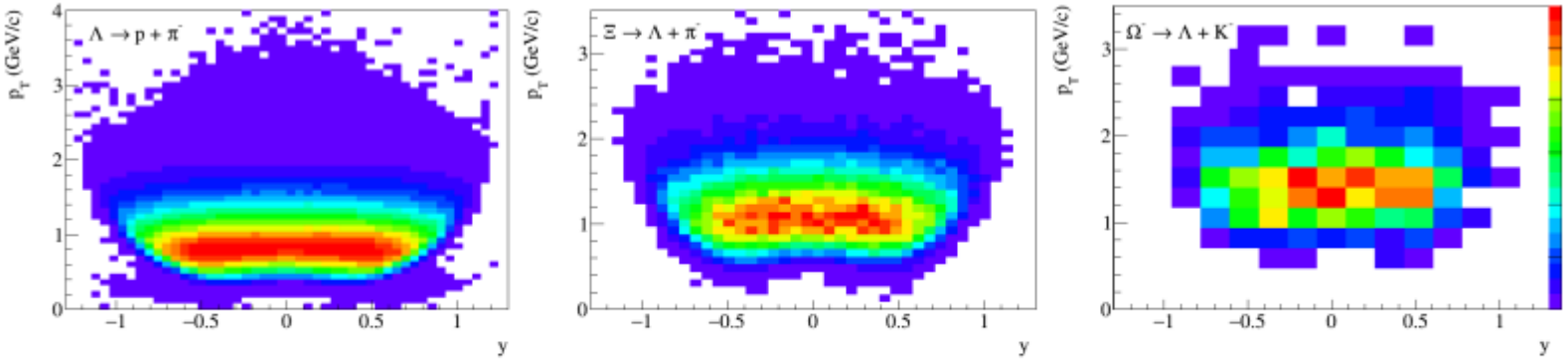
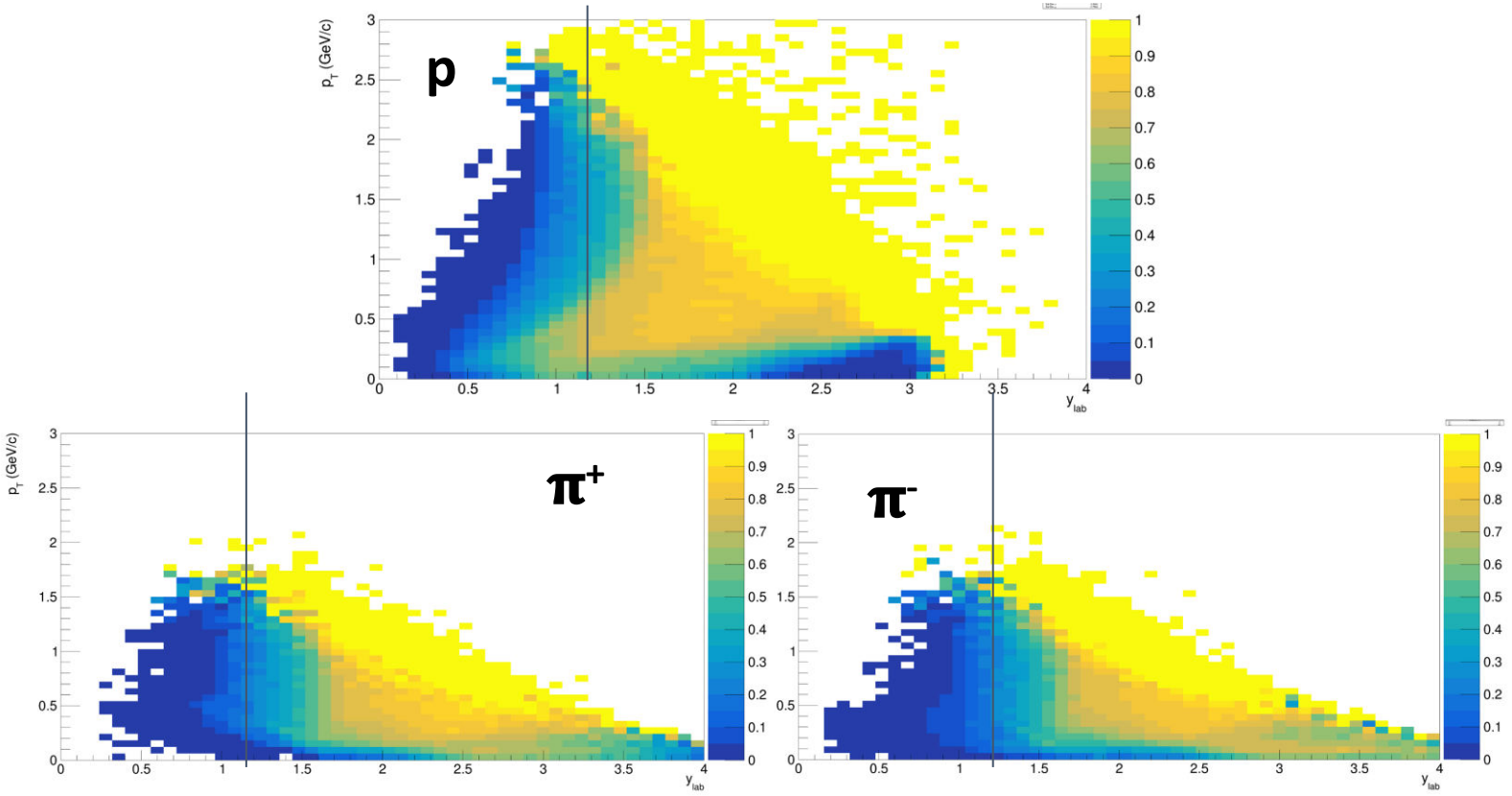


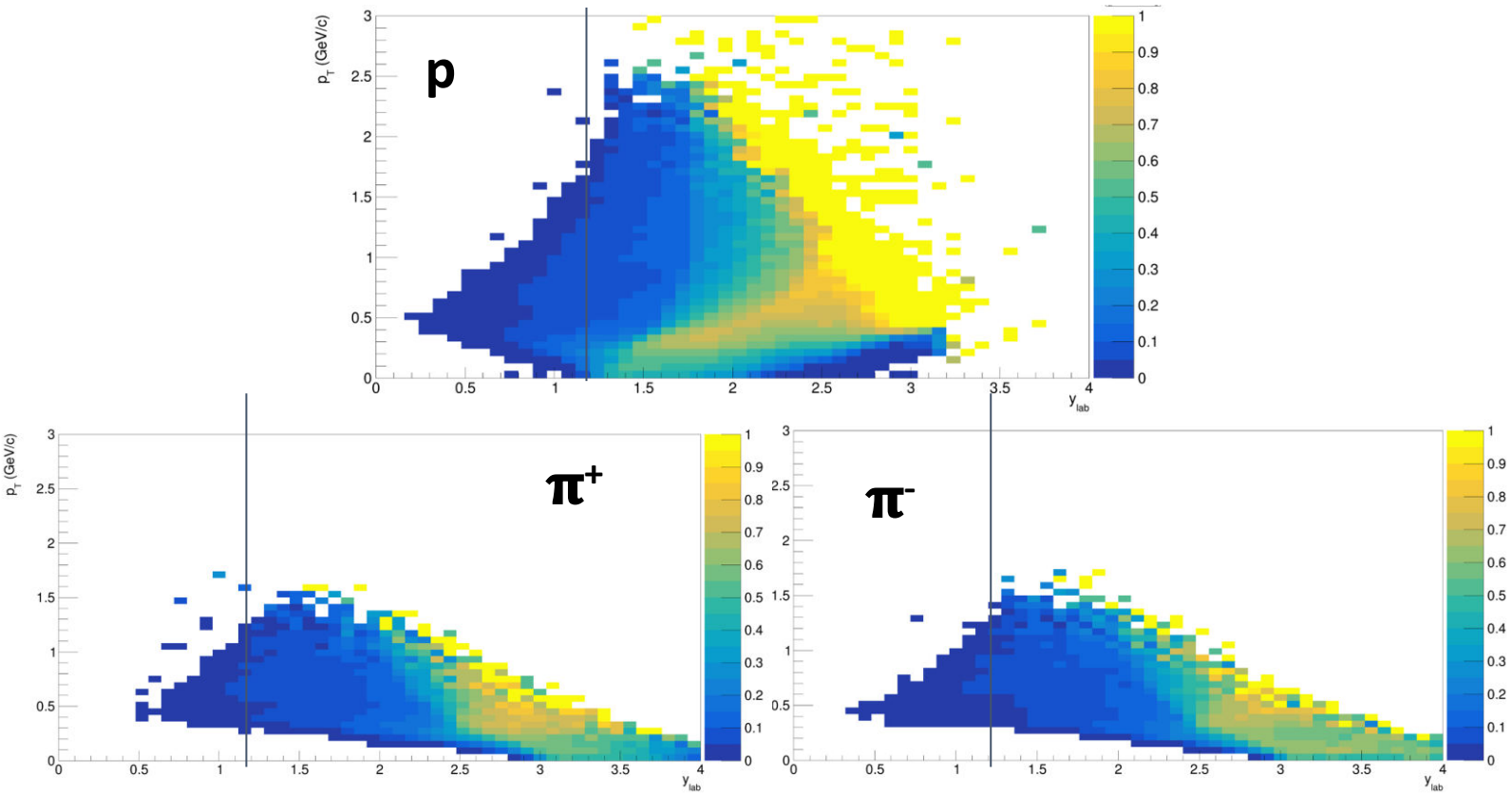
Figure 7. Transverse momentum p_T vs. rapidity y phase space of reconstructed true hyperons: **(a)** Λ, **(b)** Ξ^-, **(c)** Ω^-.

Tracking efficiency (without TOF-matching)



Limited midrapidity coverage even before identification!

Tracking efficiency (matched to TOF-400 or TOF-700)



Even worse for TOF-matched tracks

PairKK wagon

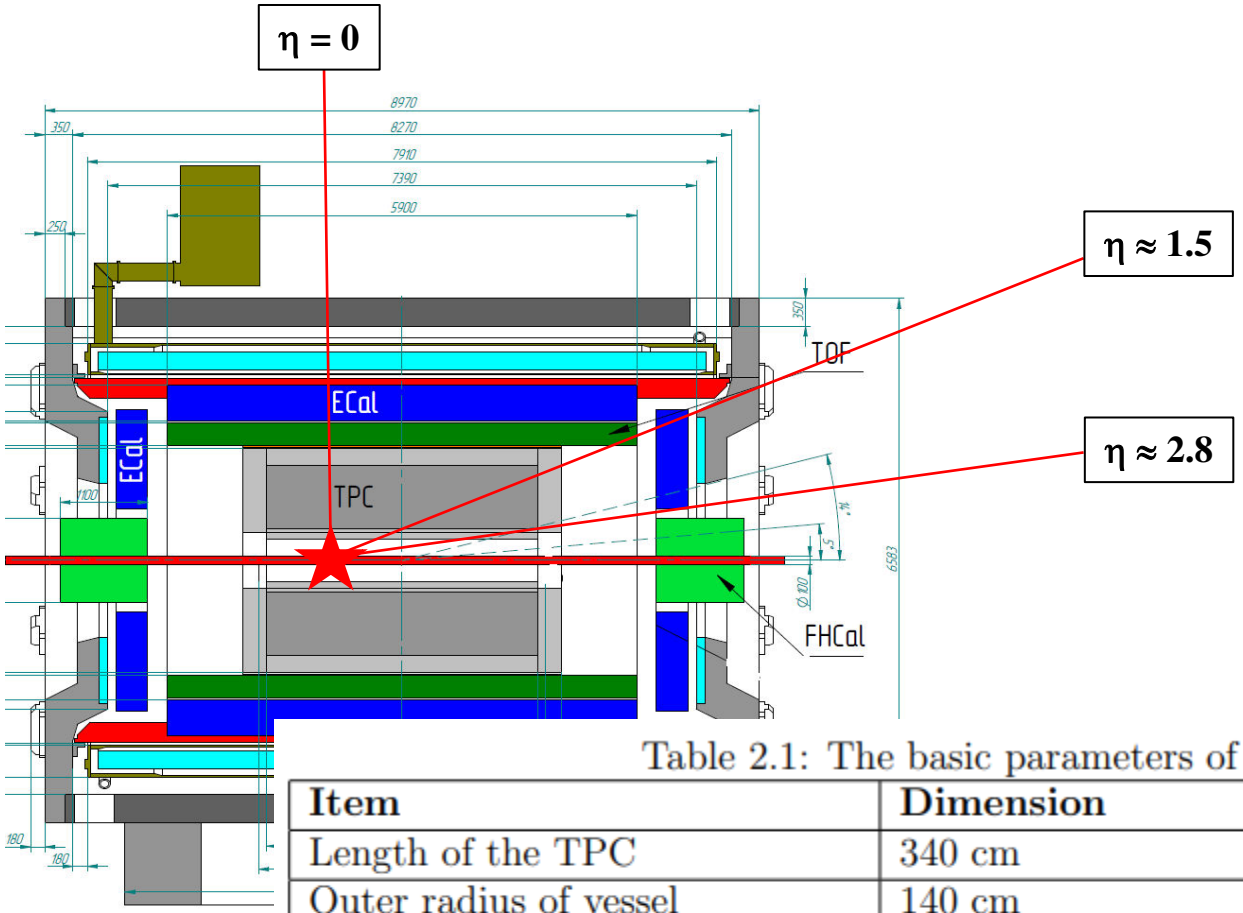


Table 2.1: The basic parameters of the TPC

Item	Dimension
Length of the TPC	340 cm
Outer radius of vessel	140 cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133 cm
Inner radius of the drift volume	34 cm
Length of the drift volume	163 cm (of each half)