MPD performance in the fixed target mode

(Xe (T = 0.5, 2.5, 4.0 GeV/n) + W wire at z = -85 cm)

V. Riabov

Kinematics

- Xe (T = 0.5 GeV/n) + W:
  - ✓ $\sqrt{s_{NN}}$ = 2.1 GeV
  - ✓ y_{CMS} = 0.50

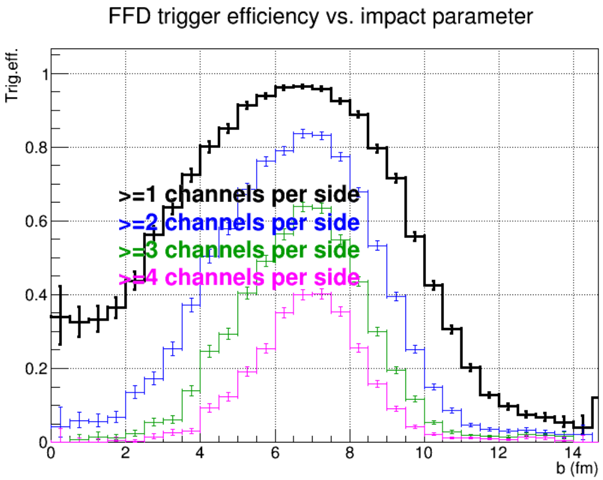
- Xe (T = 2.5 GeV/n) + W:
  - ✓ $\sqrt{s_{NN}}$ = 2.9 GeV
  - ✓ y_{CMS} = 0.99

- Xe (T = 4.0 GeV/n) + W:
  - ✓ $\sqrt{s_{NN}}$ = 3.3 GeV
  - ✓ y_{CMS} = 1.17

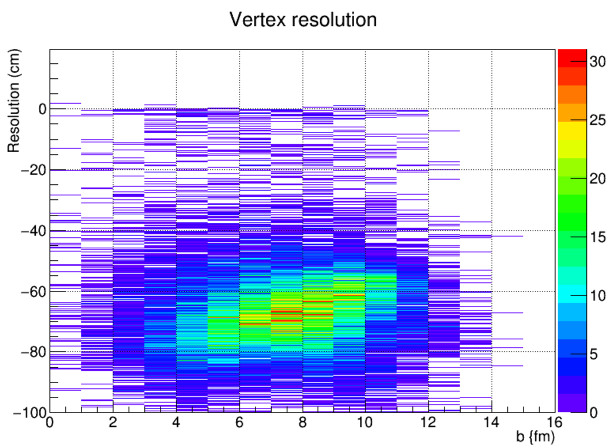
Trigger system: DCM-QGSM-SMM + Geant4

FFD trigger performance

T = 0.5 GeV/n

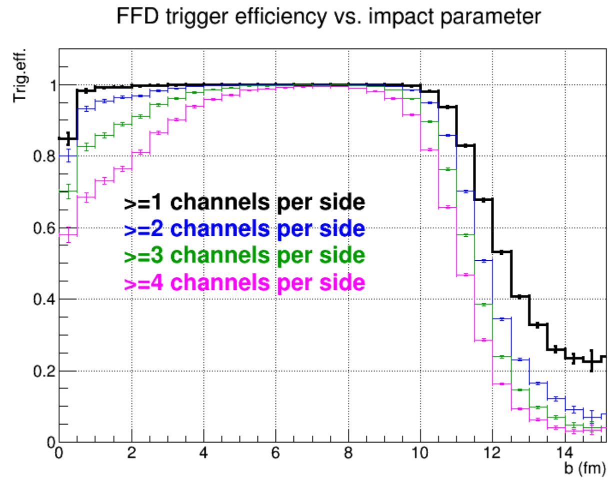


Eff = 12, 22, 35, 55%

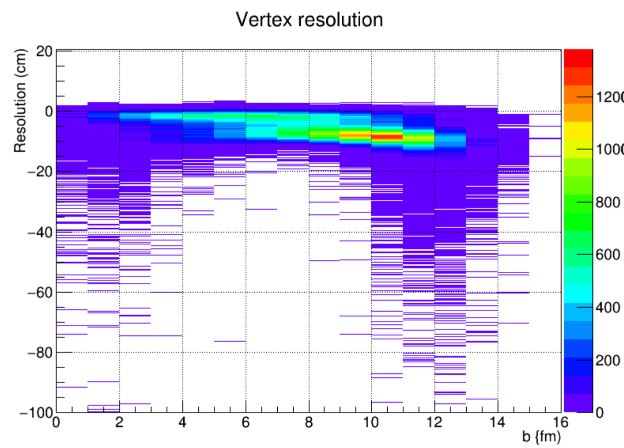


Resolution ~ 20 cm
Huge centrality bias → no ultra relativistic particles

T = 2.5 GeV/n

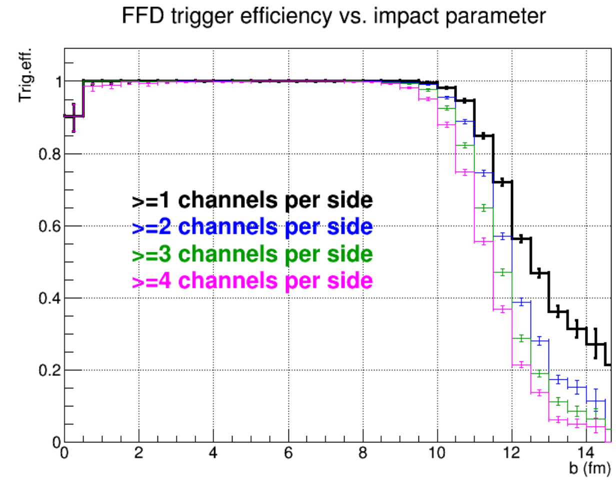


Eff = 73, 78, 83, 88%

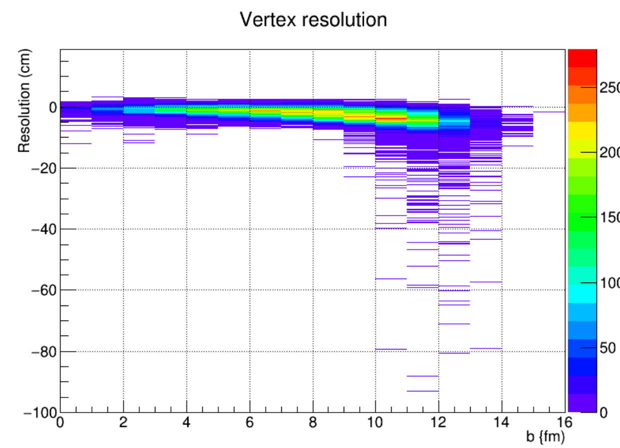


Resolution ~ 10 cm
Noticeable centrality bias → deficiency of ultra relativistic particles in peripheral collisions

T = 4.0 GeV/n



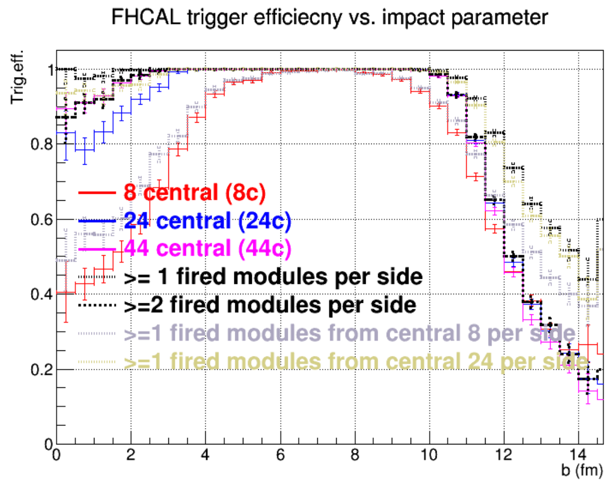
Eff = 78, 82, 85, 89%



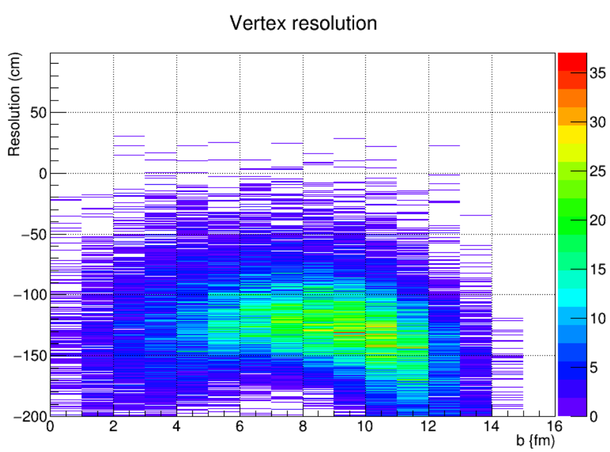
Resolution ~ 2 cm
Minimum centrality bias

FHCAL trigger performance

T = 0.5 GeV/n

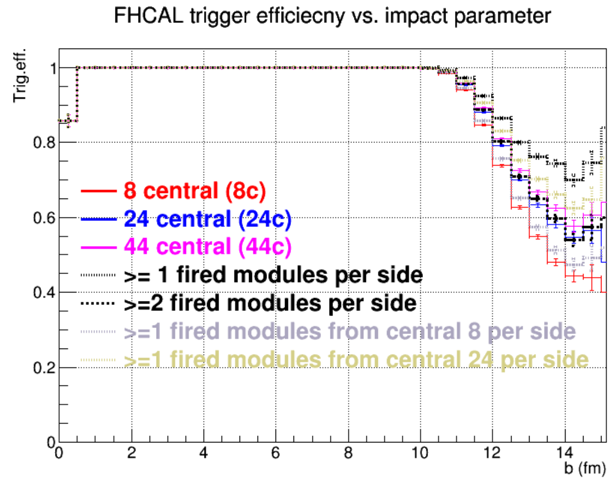


Eff = 82-94%

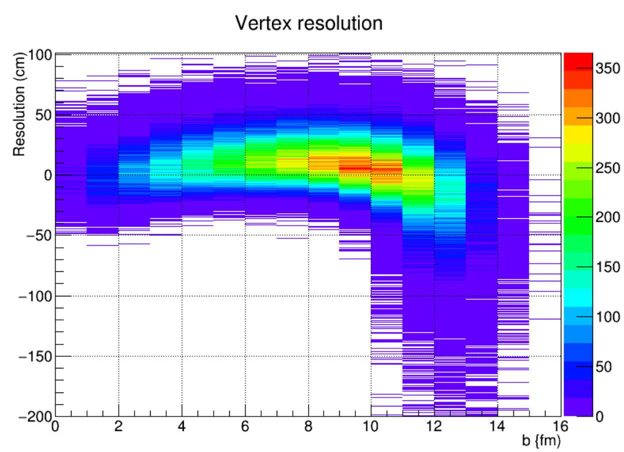


Resolution ~ 40 cm
Noticeable centrality bias → slow particles

T = 2.5 GeV/n

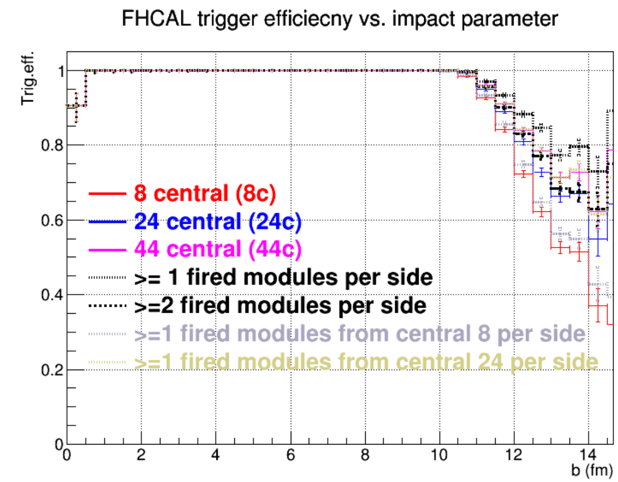


Eff = 93-96%

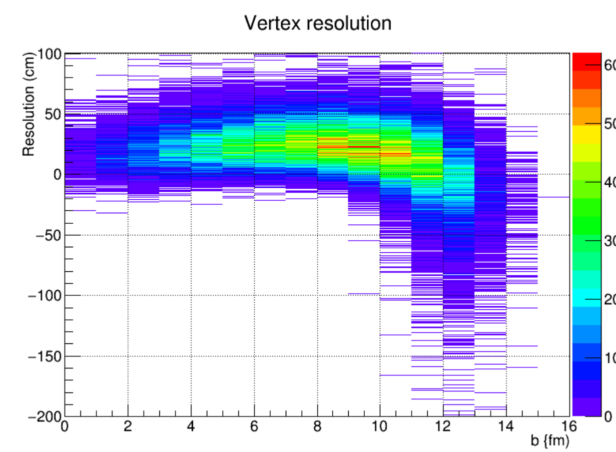


Resolution ~ 25 cm
Some centrality bias ~ resolution

T = 4.0 GeV/n



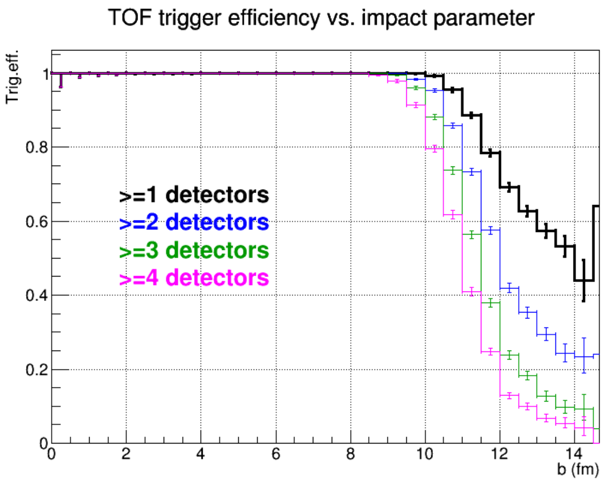
Eff = 93-97%



Resolution ~ 20 cm
Some centrality bias ~ resolution

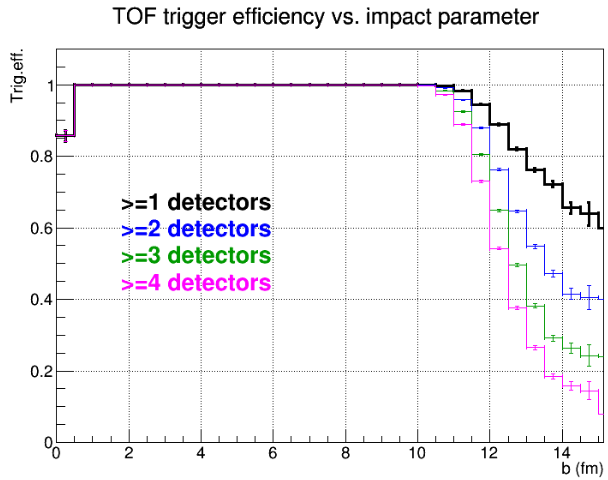
TOF trigger performance

T = 0.5 GeV/n



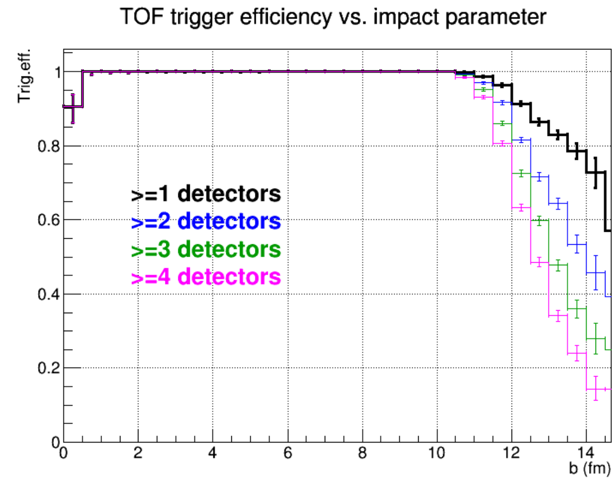
Eff = 75, 80, 85, 93%

T = 2.5 GeV/n



Eff = 89, 91, 94, 97%

T = 4.0 GeV/n



Eff = 91, 93, 95, 98%

Summary for trigger system

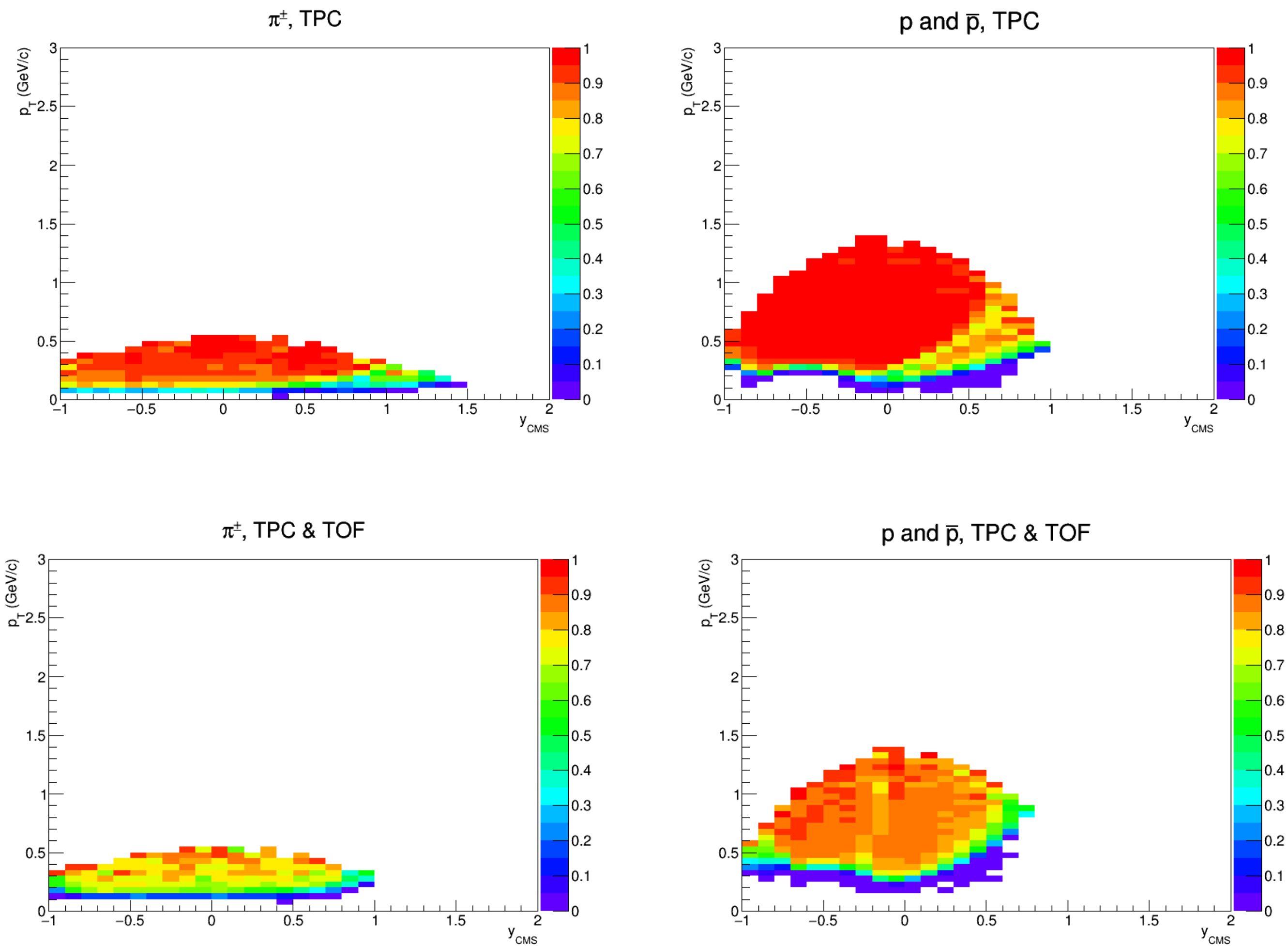
- Trigger configuration in the FXT mode:
  - ✓ FHCAL will need extra studies to be included in the trigger decision → do we have time for this???
  - ✓ TOF alone does not provide (online) vertex and T0 measurements → lots of beam-gas-pipe background ???
  - ✓ Most probably FFD will be the main trigger detector → rely on FFD performance
  - ✓ To reject background from the photo-production and electromagnetic dissociation, FFD and FHCAL trigger decisions should be used in coincidence with TOF → (FFD && TOF), (FHCAL && TOF)

- Trigger performance for physics & technical runs:
  - ✓ best performance at T = 4.0 GeV → good for physics
  - ✓ acceptable performance at T = 2.5 GeV → potentially good for physics
  - ✓ poor performance at T = 0.5 GeV → only performance studies and technical run, will see 10-30% of collisions

Acceptance: UrQMD (mean field) + Geant4

$T = 0.5$ GeV/n: π/K/p

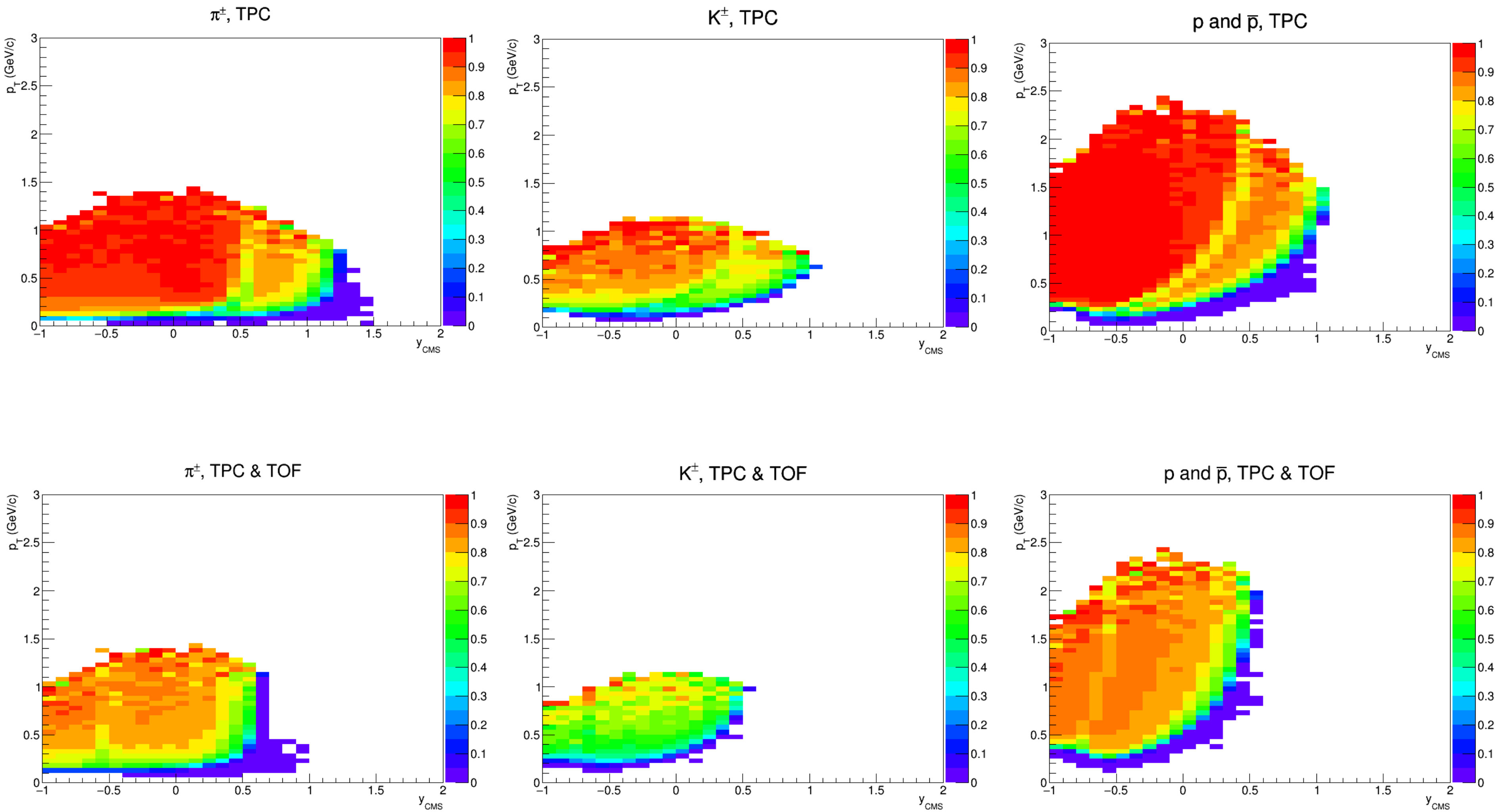
- Basic track selections: $N_{hits} > 10$; DCA < 2 cm; Primary particles ($R_{production} < 1$ cm)



- That's it ☹ No other particles are produced in measurable numbers, even kaons are missing

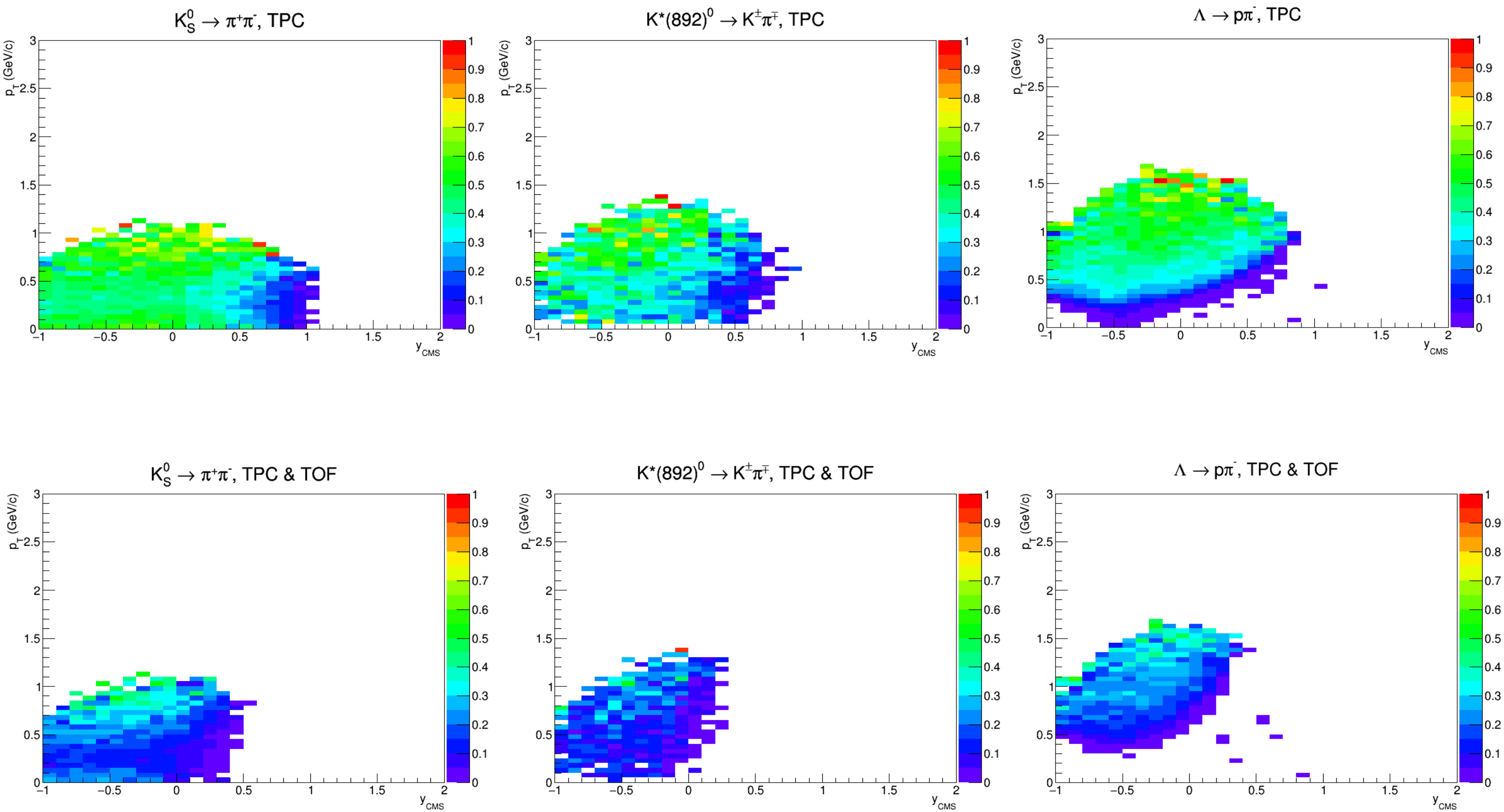
T = 2.5 GeV/n: π/K/p

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



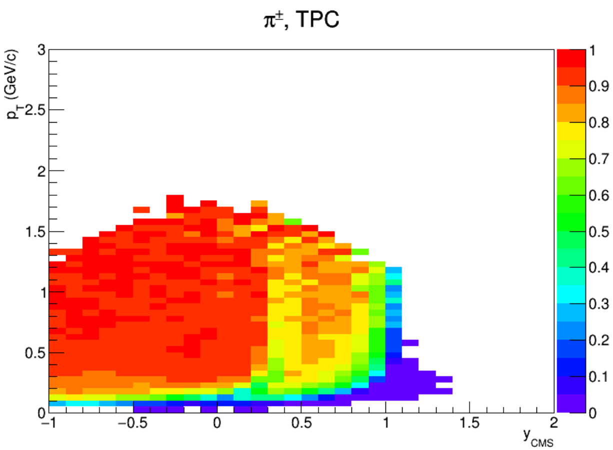
T = 2.5 GeV/n: Ks/ K*(892)/ Λ

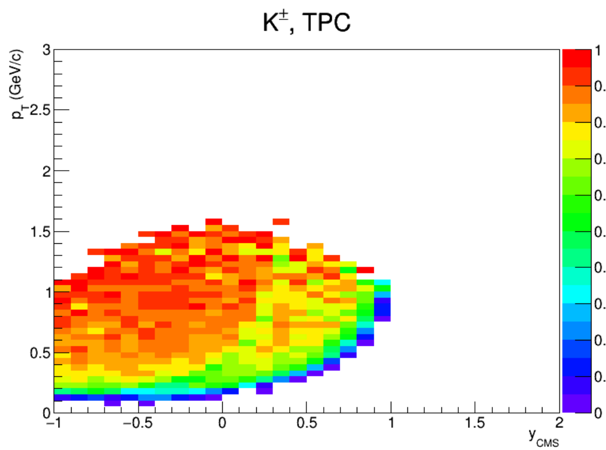
- Basic track selections: $N_{hits} > 10$; DCA < 2 cm; Primary particles ($R_{production}$ < 1 cm)

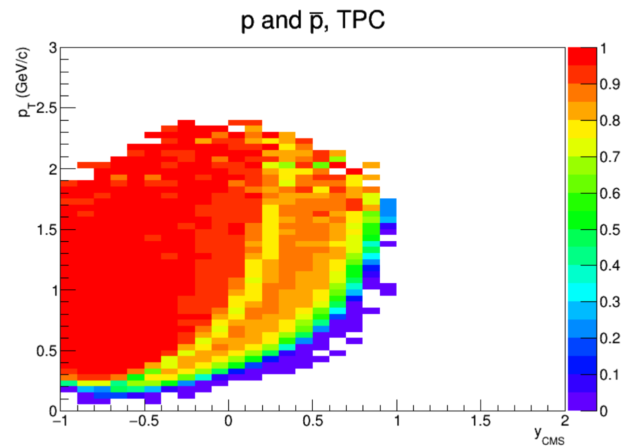


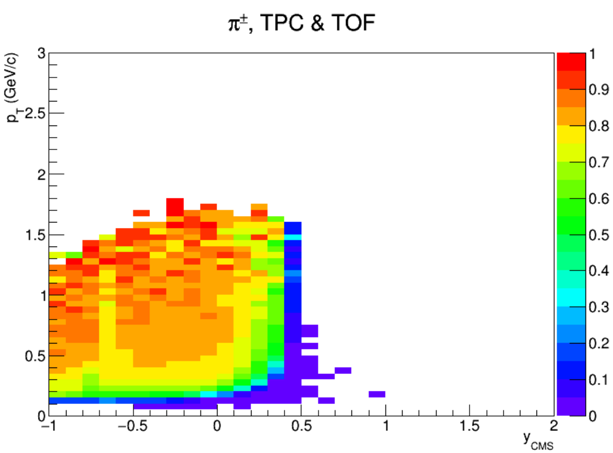
T = 4.0 GeV/n: π/K/p

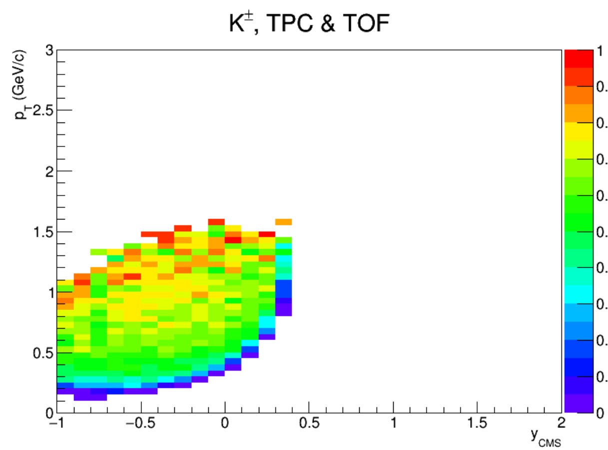
- Basic track selections: $N_{hits} > 10$; DCA < 2 cm; Primary particles ($R_{production} < 1$ cm)

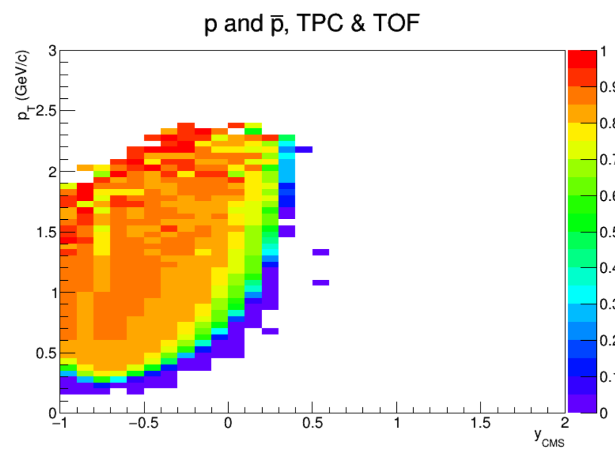






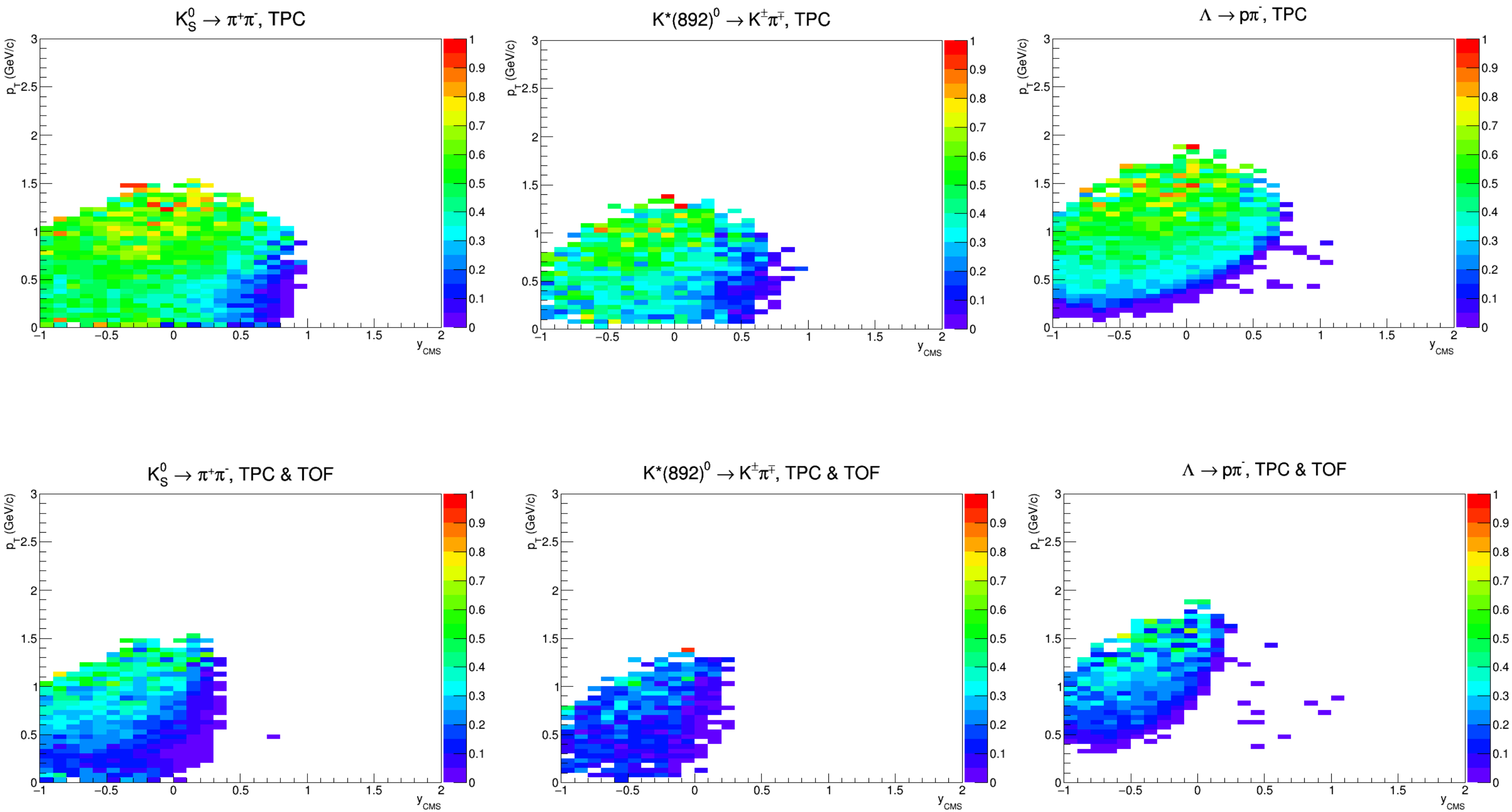






T = 4.0 GeV/n: Ks/ K*(892)/ Λ

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



Particle yields per event

- UrQMD v.3.4, mean-field configuration, minbias Xe+W, $|y_{CMS}| < 0.5$

Yield / event	T = 0.5 GeV/n	T = 2.5 GeV/n	T = 4.0 GeV/n
Pions	5.0e-001	6.9e+000	1.1e+001
Kaons	1.3e-005	1.0e-001	5.6e-001
Protons	8.1e+001	1.9e+001	1.5e+001
Lambda	-	1.4e-001	6.6e-001
Ks	-	6.3e-002	3.2e-001
Xi	-	2.7e-004	5.2e-003
Phi(1020)	-	1.5e-003	1.7e-002
Kst(892)	-	1.1e-002	1.3e-001
Lambda(1520)	-	1.1e-002	1.3e-001
Sigma(1395)	-	1.4e-002	1.1e-001

- For number of reconstructed particles, the numbers must be multiplied by reconstruction efficiency (~ 50% for charged hadrons, ~ 20% for resonances, ~ 10% for hyperons)
- Estimations may vary with event generators

Summary acceptances and physics

- The smaller the energy the better the acceptance (smaller y_{CMS})
- T = 0.5 GeV:
  - ✓ no NICA-type physics with phase transition(s), domain of pure hadronic cascade and mean-field models
  - ✓ only pions and protons are produced, no kaons in measurable quantities, no hyperons, etc.

- T = 2.5 GeV:
  - ✓ threshold energy for NICA-type physics, $\sqrt{s_{NN}}$ = 2.9 GeV is close to STAR-FXT point of $\sqrt{s_{NN}}$ = 3. GeV
  - ✓ wide variety of measurable identified hadrons (pi/K/p + resonances + hyperons) and physics signals
  - ✓ good detector acceptance at midrapidity
  - ✓ Requires larger integrated luminosity compared to higher collision energies (cross sections are smaller)

- T = 4.0 GeV:
  - ✓ threshold energy for NICA-type physics, $\sqrt{s_{NN}}$ = 3.3 GeV is close to STAR-FXT point of $\sqrt{s_{NN}}$ = 3. GeV
  - ✓ wide variety of measurable identified hadrons (pi/K/p + resonances + hyperons) and physics signals
  - ✓ limited detector acceptance may be a problem for some of the signals to measure

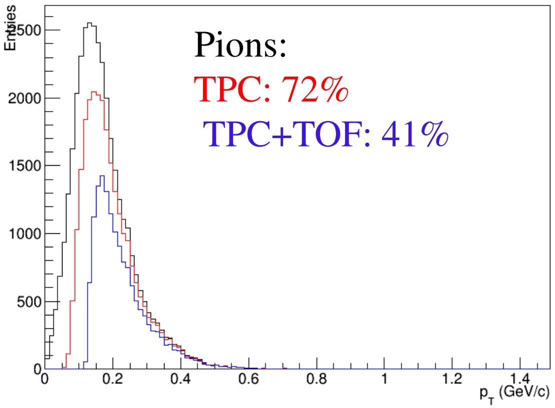
Field: full vs. reduced

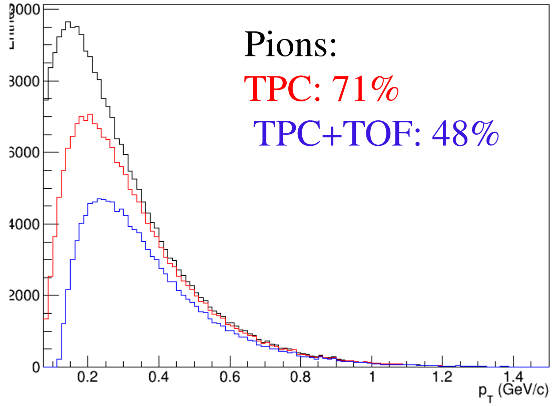
Generated, TPC and TPC-TOF reconstructed, $|y_{CMS}| < 0.5$

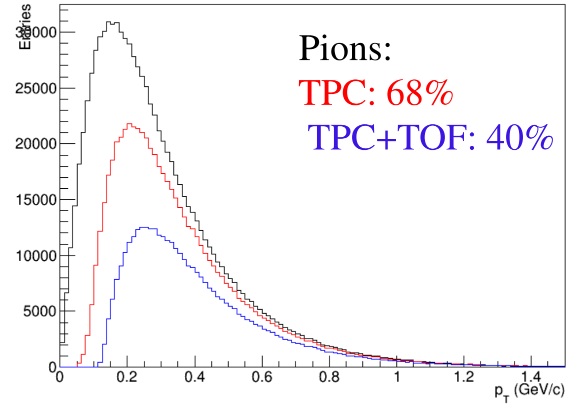
T = 0.5 GeV/n

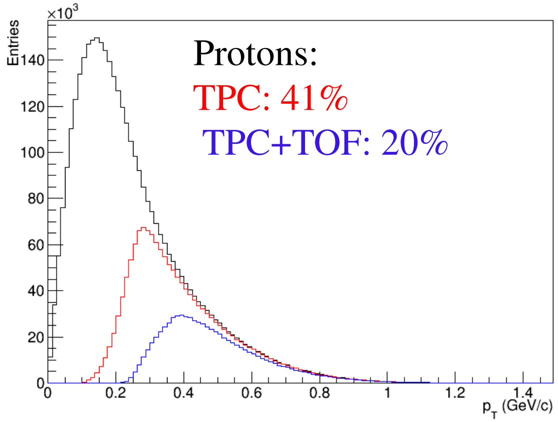
T = 2.5 GeV/n

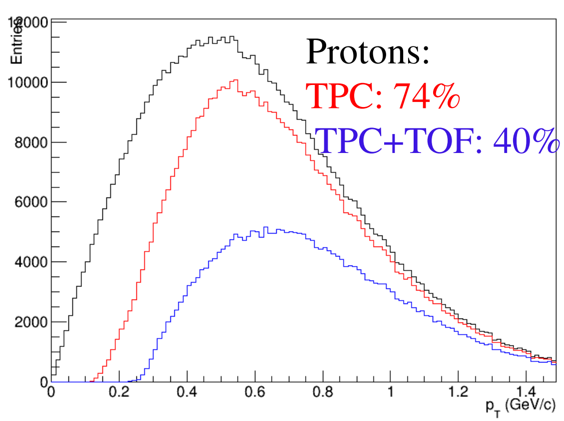
T = 4.0 GeV/n

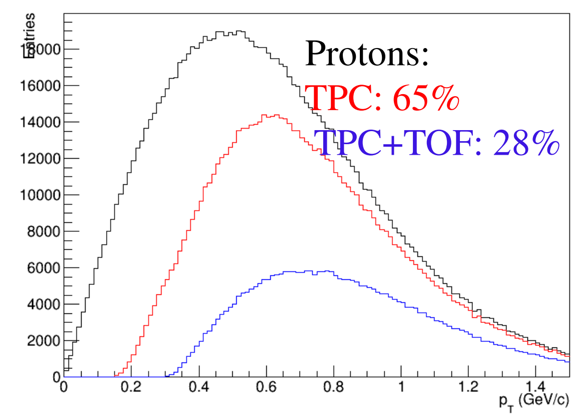






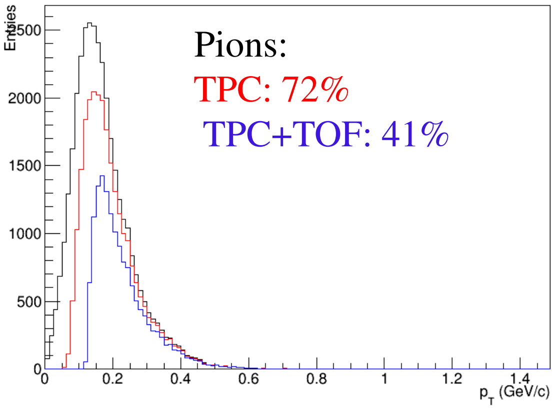


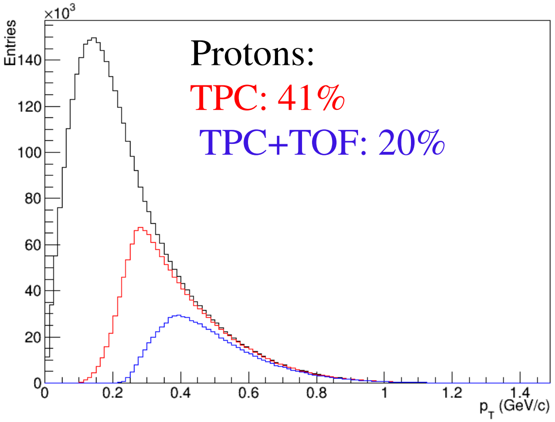




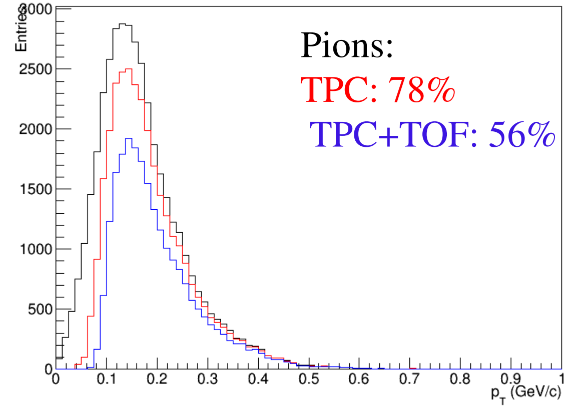
T = 0.5 GeV; MF = 0.5 T vs. MF = 0.2 T

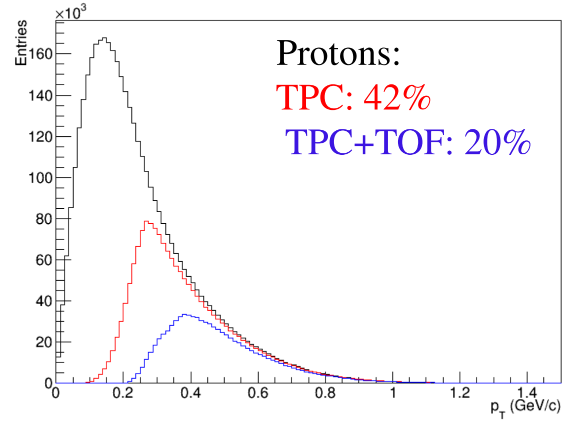
MF = 0.5 T





MF = 0.2 T





Summary for field

- No clear necessity for reduced magnetic field running:
  - ✓ Only T = 2.5 and 4.0 GeV are suitable for physics
    → fractions of reconstructed particles at midrapidity are similar ~ 70 (35) % for pions and protons
  - ✓ T = 0.5 GeV is good only for detector studies
    → most of produced particles are pions, which are detected with comparable efficiency of ~ 70 (40) %
  - ✓ Reduced field will improve acceptance for lower-pT tracks but will reduce momentum resolution
    → not a fair trade???

Conclusions

- T < 1.0 GeV/n – невозможно делать физику из-за низкой эффективности триггера
- T = 2.5/n и 4 ГэВ/n – потенциально походят для физики
- Ожидаемый ран будет для MPD техническим, при T < 1.0 GeV/n исключительно техническим, но не бесполезным
- Максимальные ожидаемые результаты – запись нескольких тысяч событий, соответствующих реальным столкновениям с частично включенными детекторами:
  - ✓ Демонстрация возможности наблюдения столкновений
  - ✓ Демонстрация возможности восстановления вершины (положения проволоки)
  - ✓ Демонстрация возможности восстановления треков, dE/dx
  - ✓ Демонстрация возможностей TOF, beta/mass2
  - ✓ Демонстрация загрузки калориметра, пи0 пик оптимистично

BACKUP