Identified Hadrons Measurements (π, K, p) in XeW@2.5 GeV (MPD-FXT) (UPDATE)

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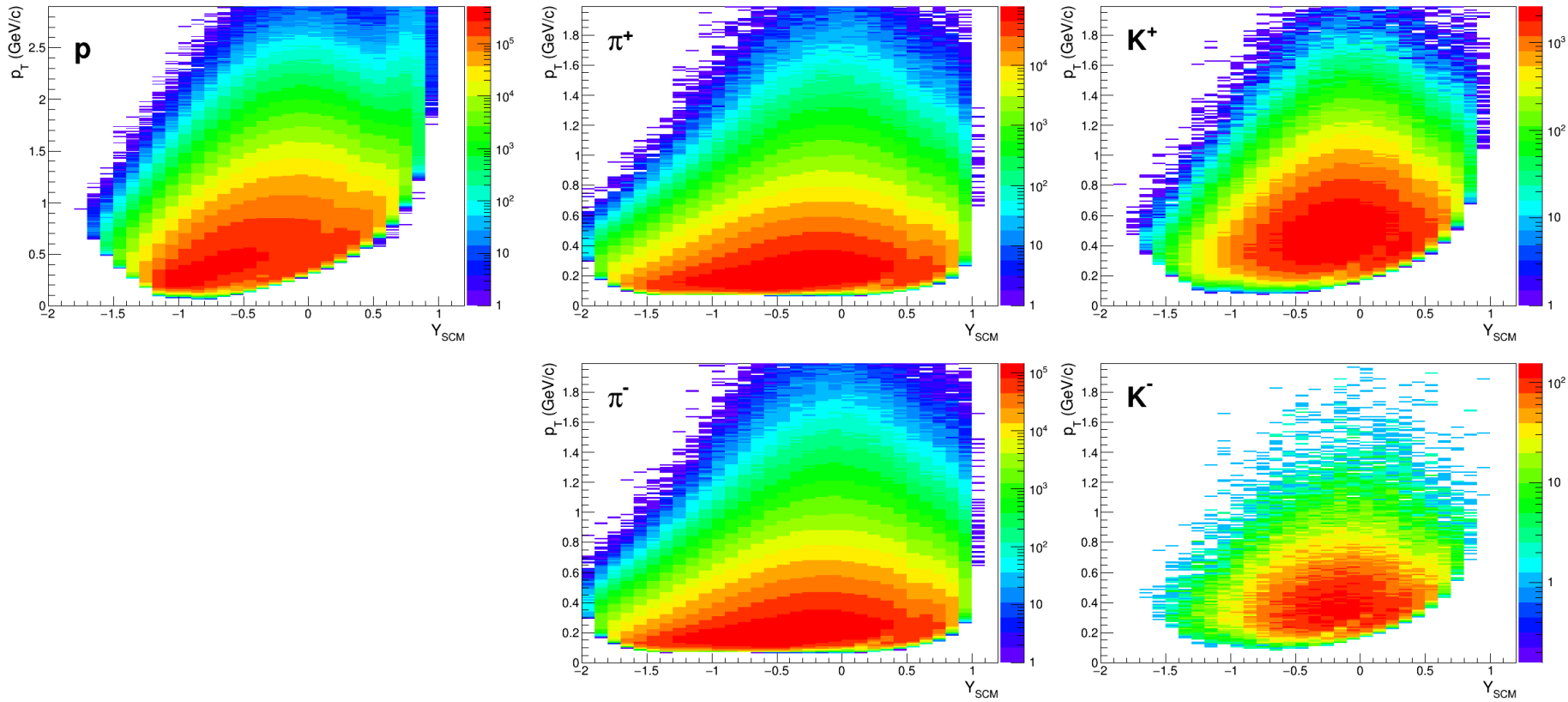
* We acknowledge support from Russian Ministry of Education and Science, state assignment for fundamental research (code FSEG-2025-0009)

Outline

- Light charged hadrons spectra (π/K/p) needed
- Simplified approach based on n-sigma method for TPC/TOF:
  - ✓ limited pT range at higher momenta
  - ✓ minimization of model-dependent corrections
  - ✓ robust → most appropriate for the first-day analysis & results
- Before: results in BiBi@9.2 collisions
- Today: analysis details and results in XeW@2.5 AGeV (fixed target mode)
- Data: Request 36, 15M UrQMD events, Xe-W(T = 2.5 GeV/n, FTX)
- …..
- Update on presentation from 1.04.25

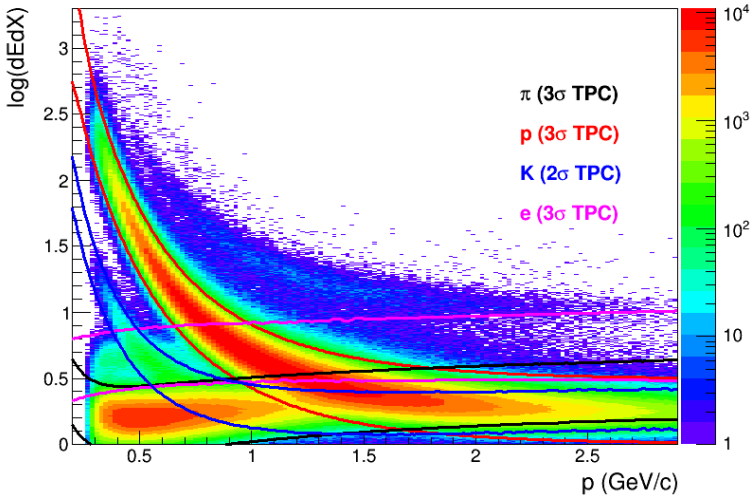
2D Acceptance

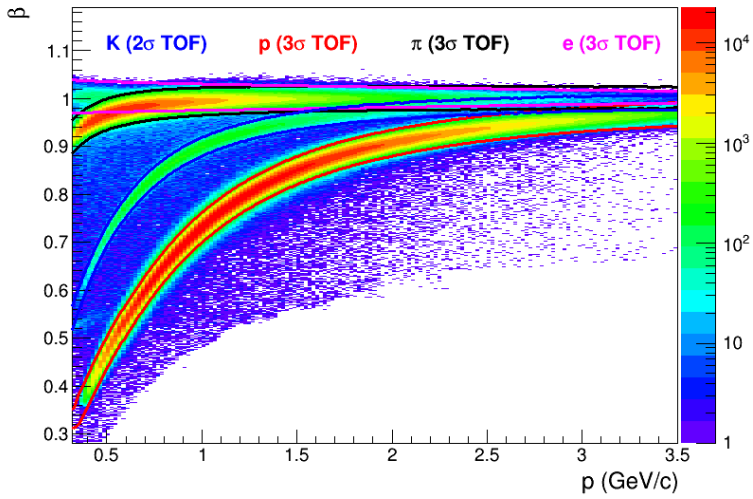


- Limit rapidity range to $-0.5 < y_{SCM} < 0$.
- Low p_T limit:
  - ✓ Pions: $p_T > 0.05$ GeV/c
  - ✓ Kaons: $p_T > 0.15$ GeV/c
  - ✓ Protons: $p_T > 0.25$ GeV/c

PID strategy (π, P)

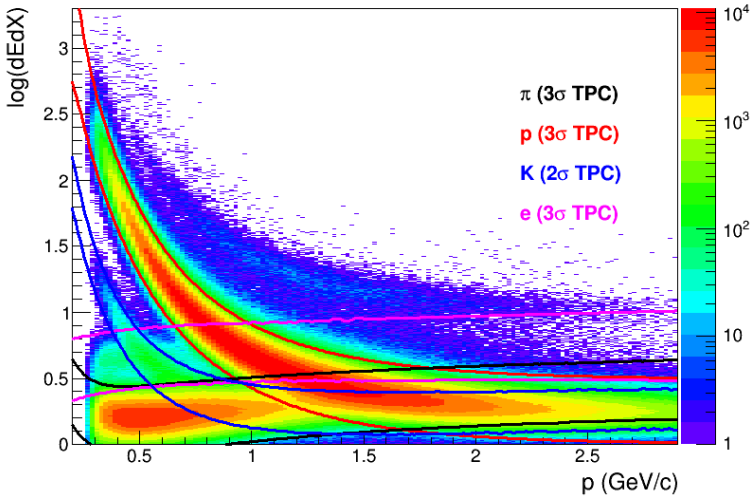
- Event selection: centrality 0-90%
- Track selection:
  TPC-hits > 28
  DCA-to-PV < $2\sigma_{x,y,z}$
  $-0.5 < y_{cms} < 0.$
- Two quasi-independent measurements for π/p:
- 1st: (**TPC-TOF**)
  TPC 2σ -PID selection for a given specie (π/p)
  If track is 3σ -matched to TOF then TOF 2σ -PID selection for a given specie (π/p)
- 2nd: (**TOF-TPC**)
  TOF 2σ -PID selection for a given specie (π/p)
  TPC 2σ -PID selection for a given specie (π/p)
- Spectra are reconstructed while purity > 95%:
  spectra are corrected for impurities → impose 50% uncertainty for the correction value = 0.5 * 5% = 2.5% pT-correlated systematic uncertainty for spectra
- **TPC-TOF** and **TOF-TPC** spectra are combined for final results for minimum total uncertainties

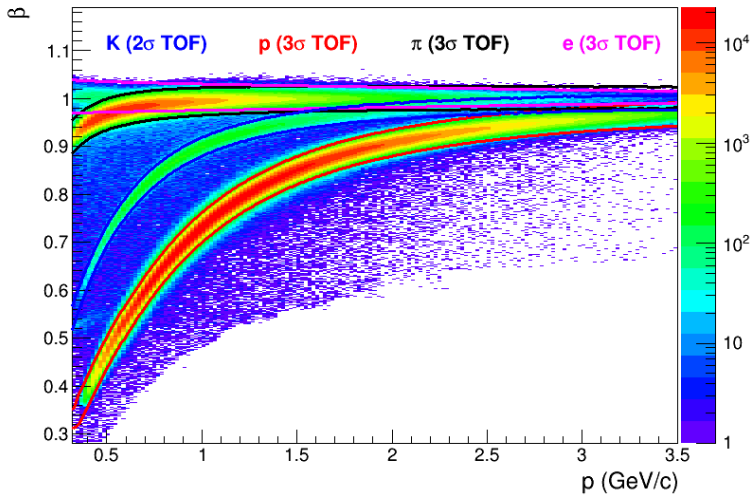




PID strategy (Kaons)

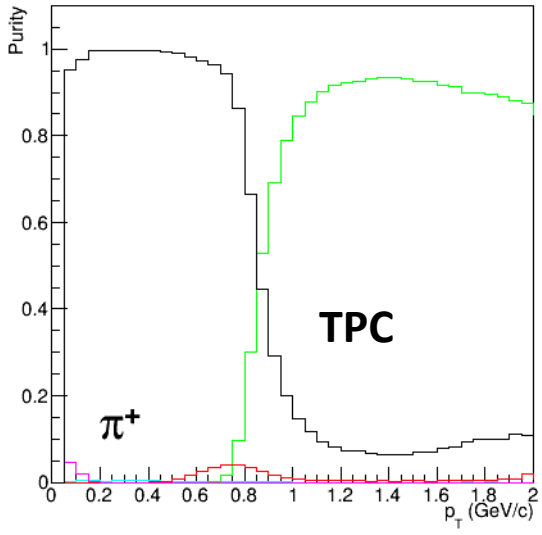
- Event selection: centrality 0-90%
- Track selection:
  TPC-hits > 28
  DCA-to-PV < $2\sigma_{x,y,z}$
  $-0.5 < y_{cms} < 0.$
- Two quasi-independent measurements for K:
- 1st: (**TPC-TOF**)
  TPC 1σ -PID selection for a given specie (K)
  If track is 3σ -matched to TOF then TOF 1σ -PID selection for a given specie (K)
  TPC 3σ -veto-PID for other species (for K - e/π/p veto)
- 2nd: (**TOF-TPC**)
  TOF 1σ -PID selection for a given specie (K)
  TPC 1σ -PID selection for a given specie (K)
  TOF 3σ -veto-PID for other species (for K - e/π/p veto)
- Spectra are reconstructed while purity > 90%:
  spectra are corrected for impurities → impose 50% uncertainty for the correction value = 0.5 * 10% = 5% pT-correlated systematic uncertainty for spectra
- **TPC-TOF** and **TOF-TPC** spectra are combined for final results for minimum total uncertainties

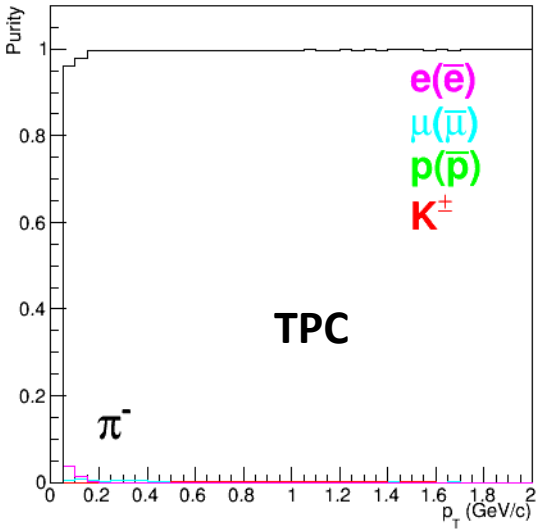


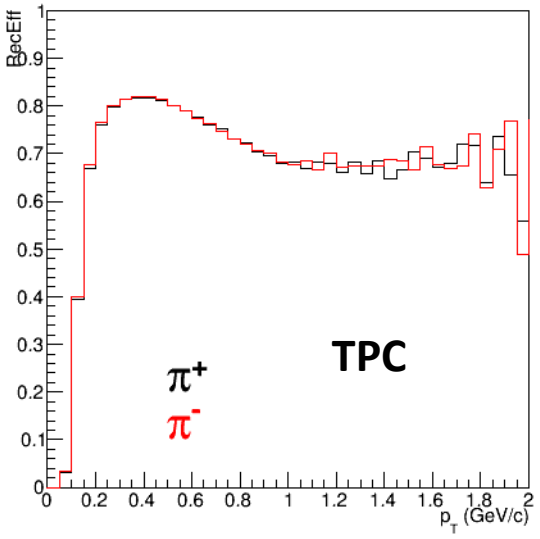


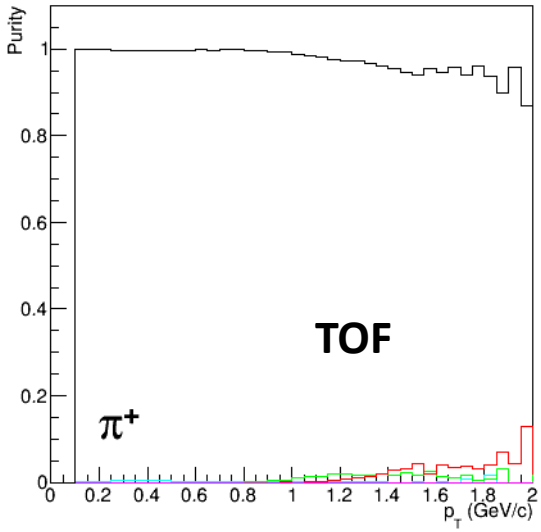
Pions (TPC+TOF→TPC; TOF+TPC→TOF)

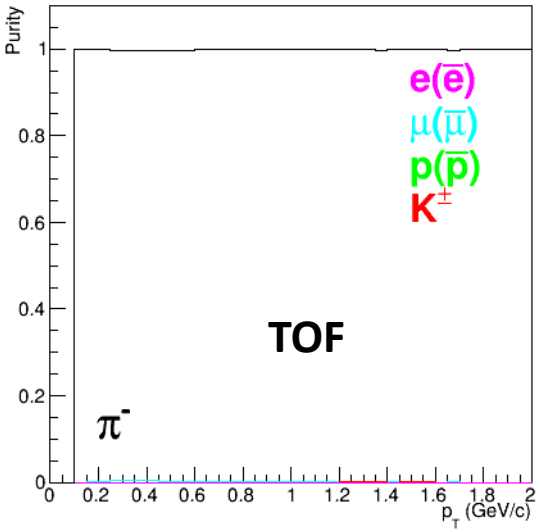
- Accepted p_T range is defined by purity > 95% → whole range is fine for π^- and limits p_T range to ~1.4 GeV/c for π^+

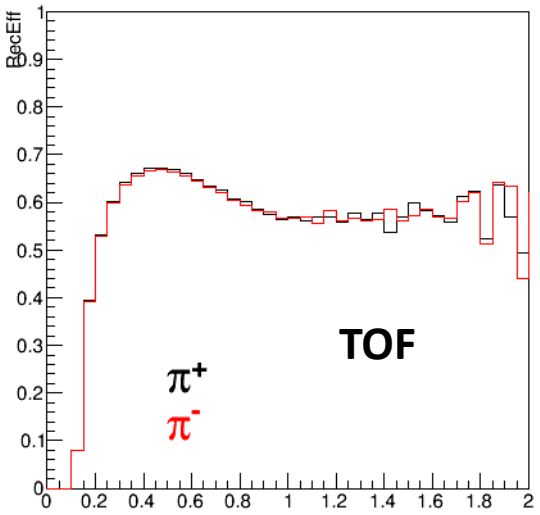






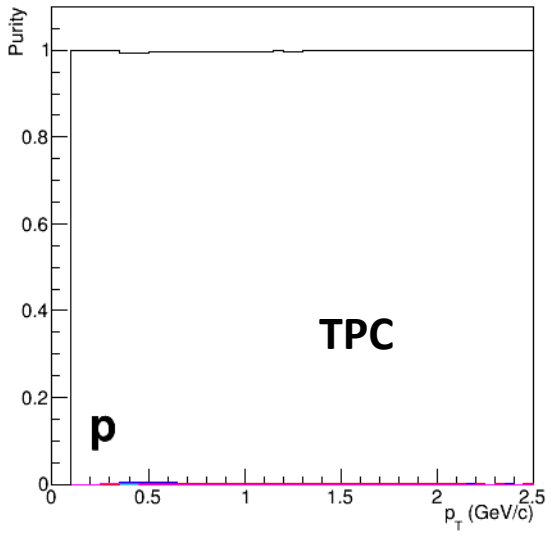


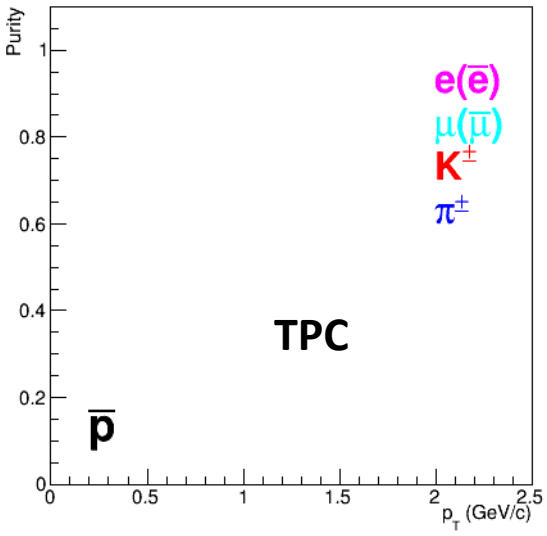


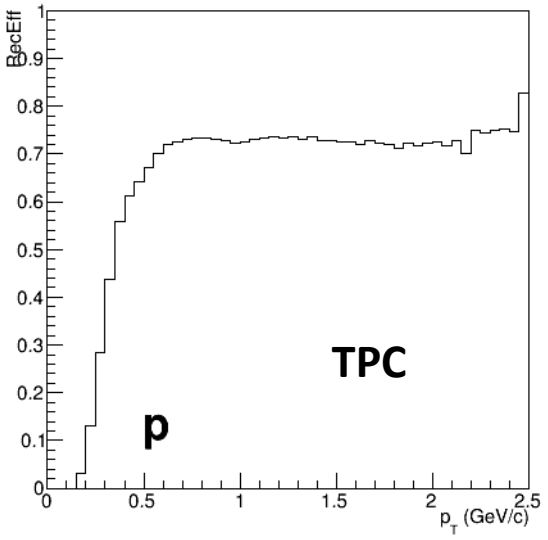


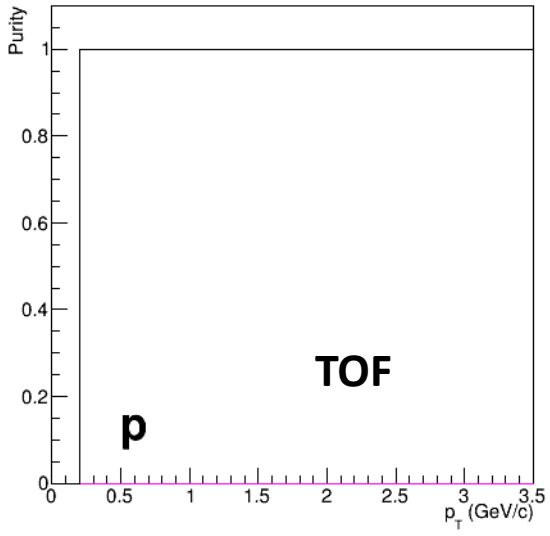
Protons

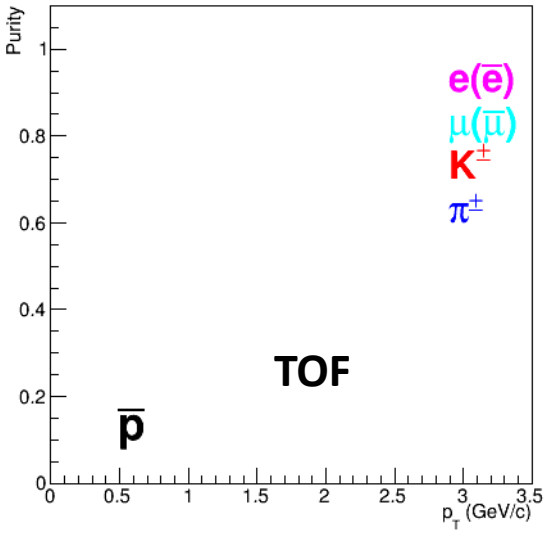
- Accepted p_T range is defined by purity > 95% → whole range is fine

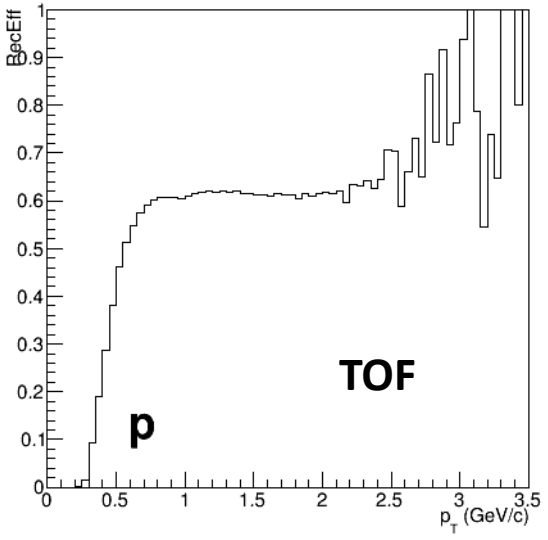






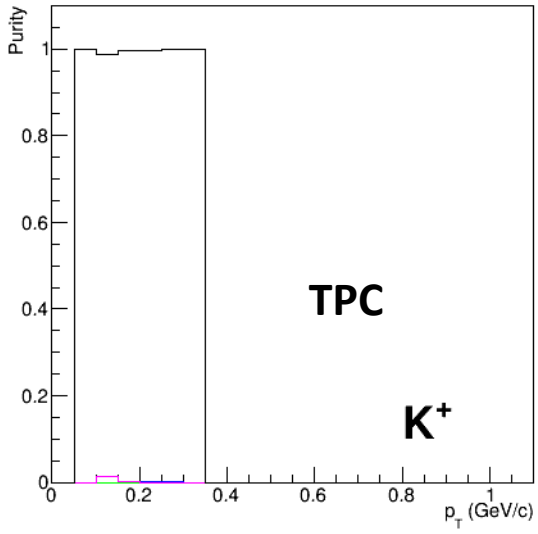


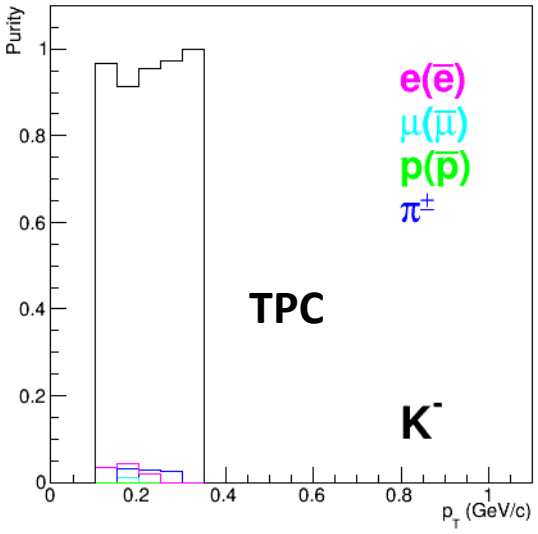


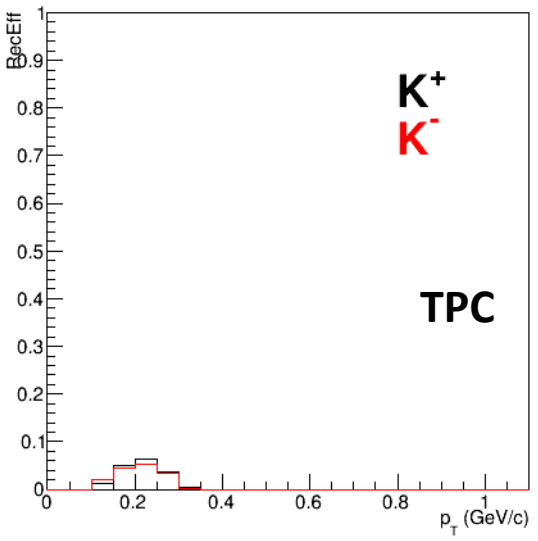


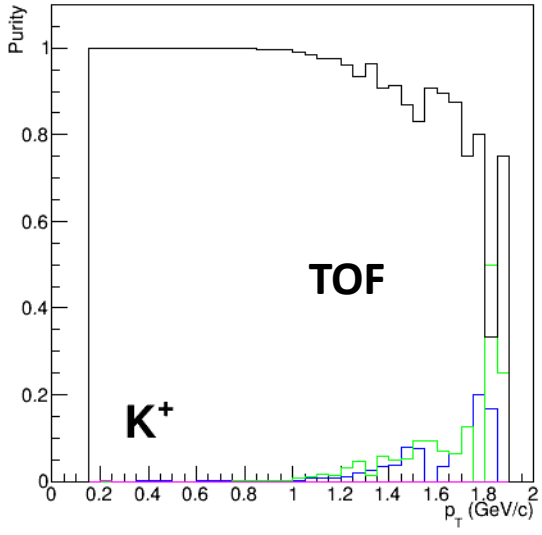
Kaons

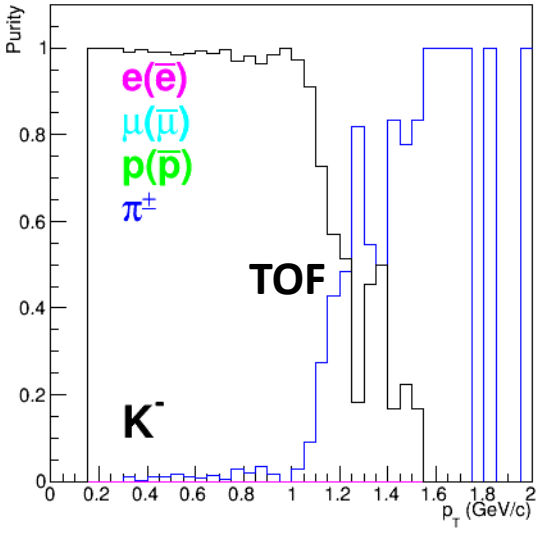
- Accepted p_T range is defined by purity > 90% → limits p_T range to ~1.4 GeV/c for K^+ and ~1 GeV/c for K^-

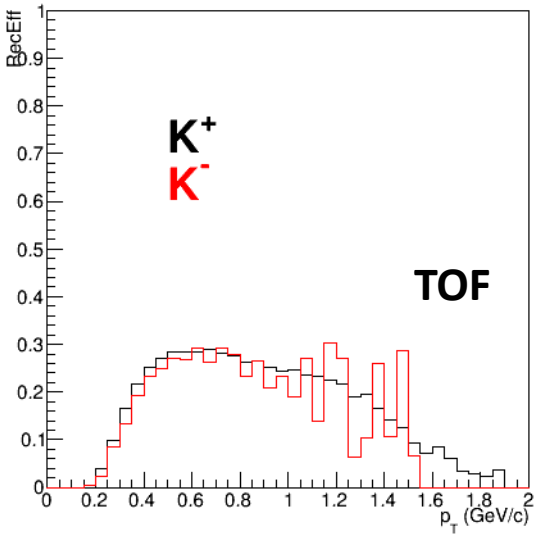






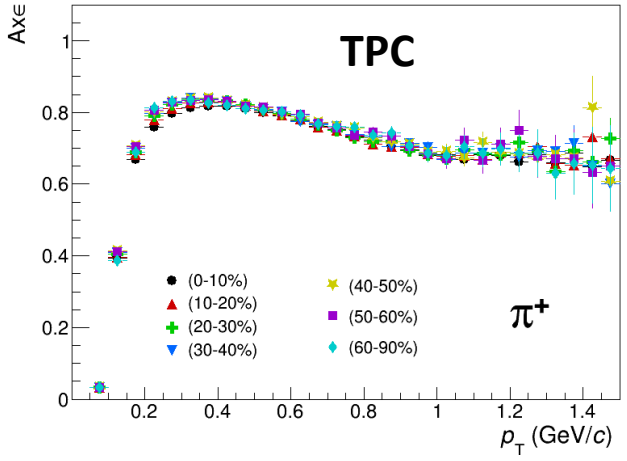


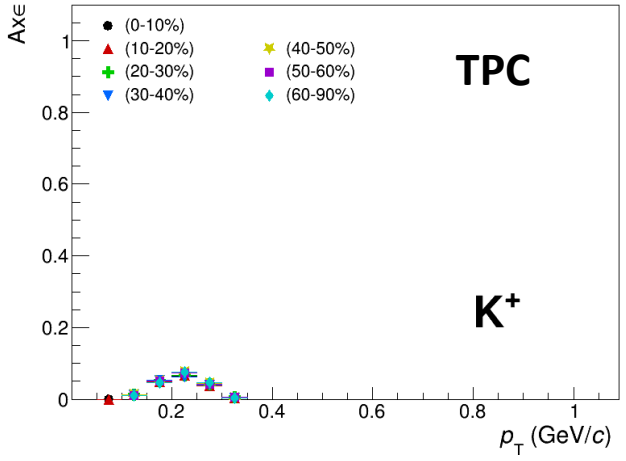


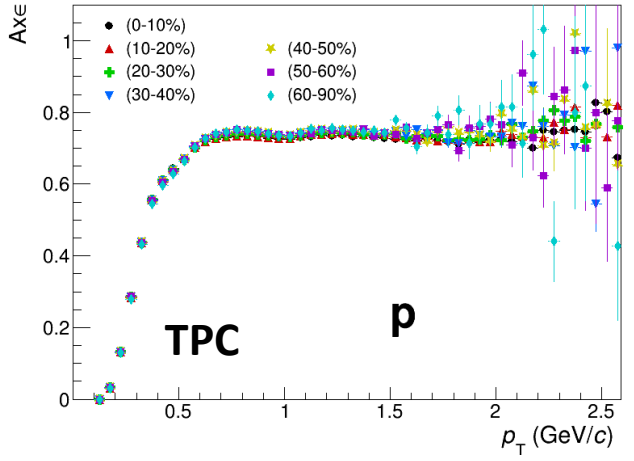


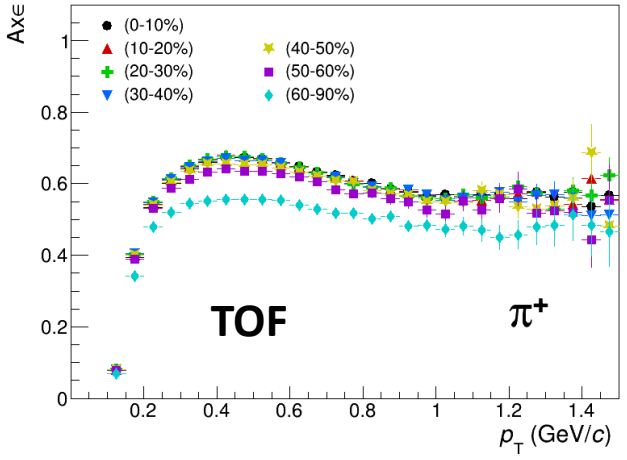
Reconstruction Efficiency

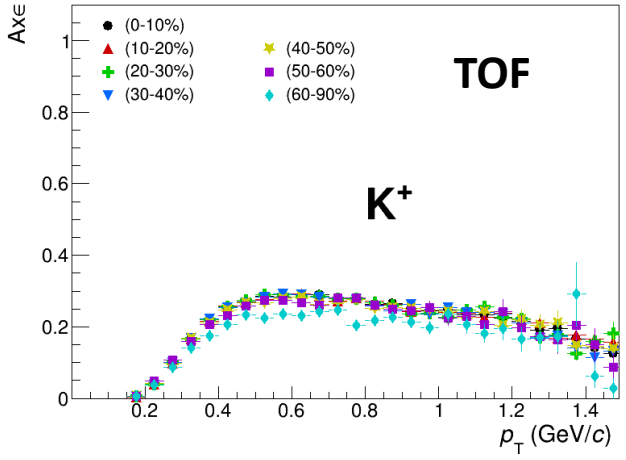
- No centrality dependance for TPC+TOF
- Clear centrality dependance for TOF+TPC (TOF matching)

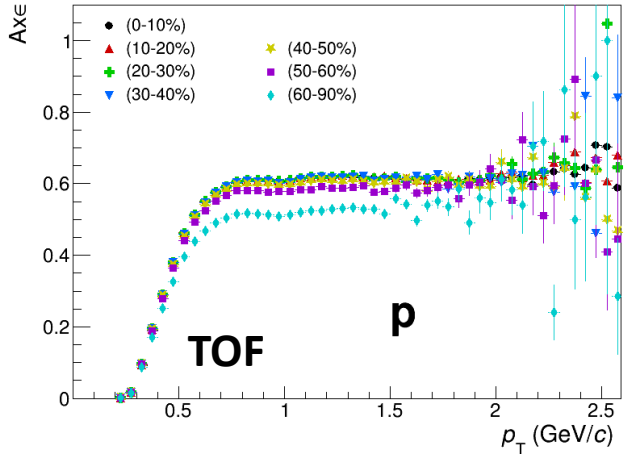






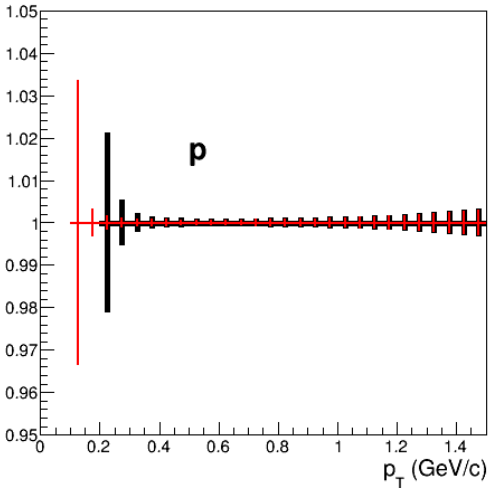


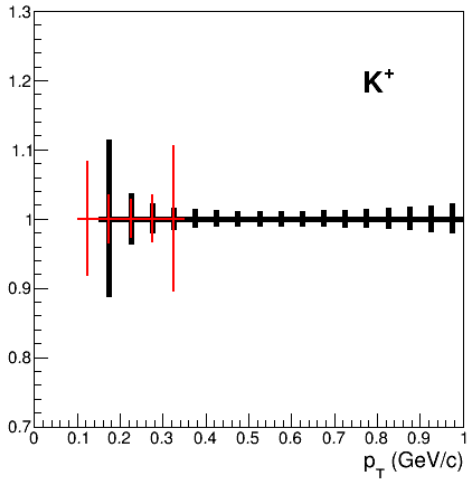


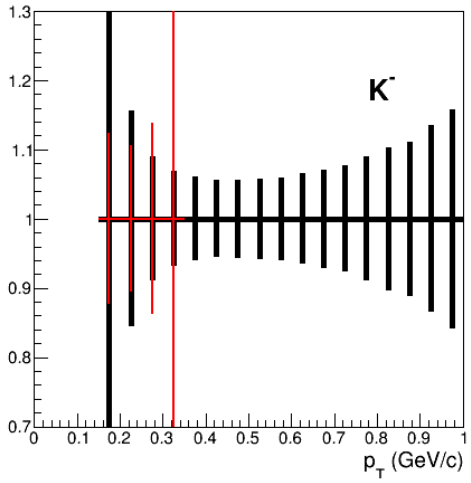


Combined spectra – transition point

❖ Relative statistical uncertainties for **TPC-TOF** and **TOF-TPC** spectra

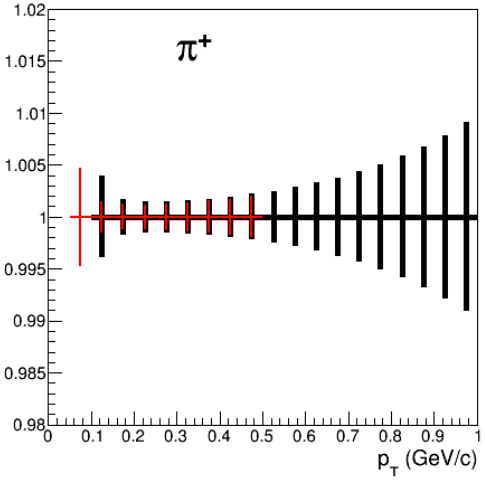


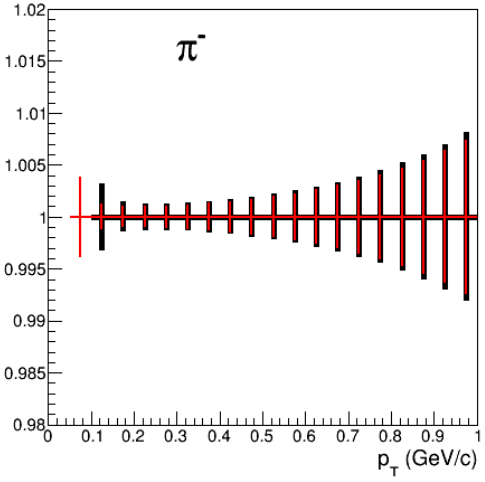




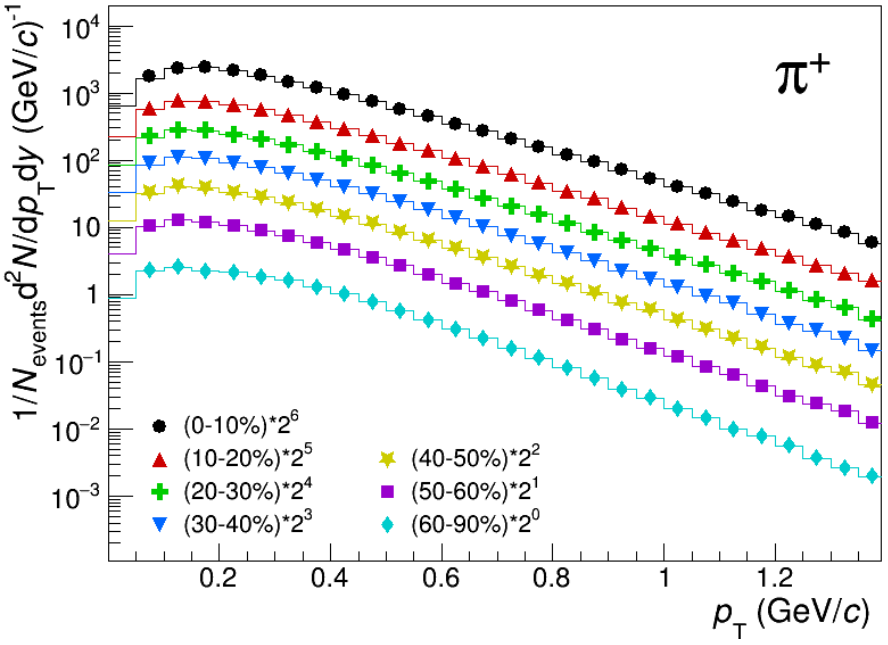
Set transition point (p_T):

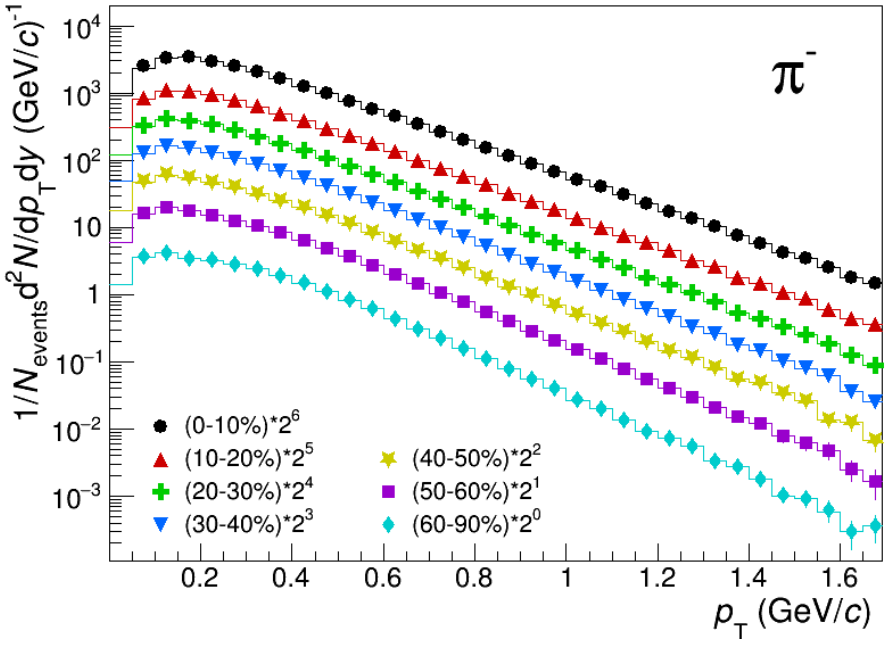
- ✓ K – 0.25 GeV/c
- ✓ P – 0.7 GeV/c
- ✓ π – 0.5 GeV/c



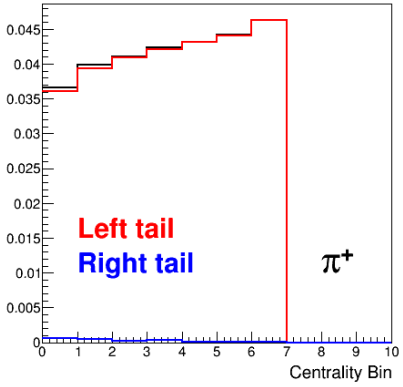


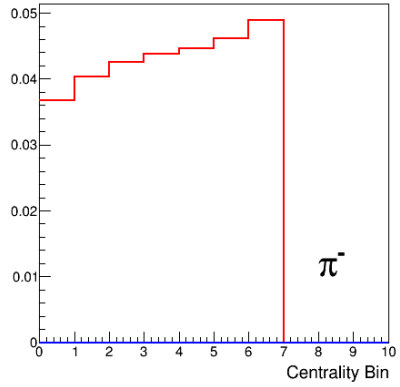
Final Spectra, pions



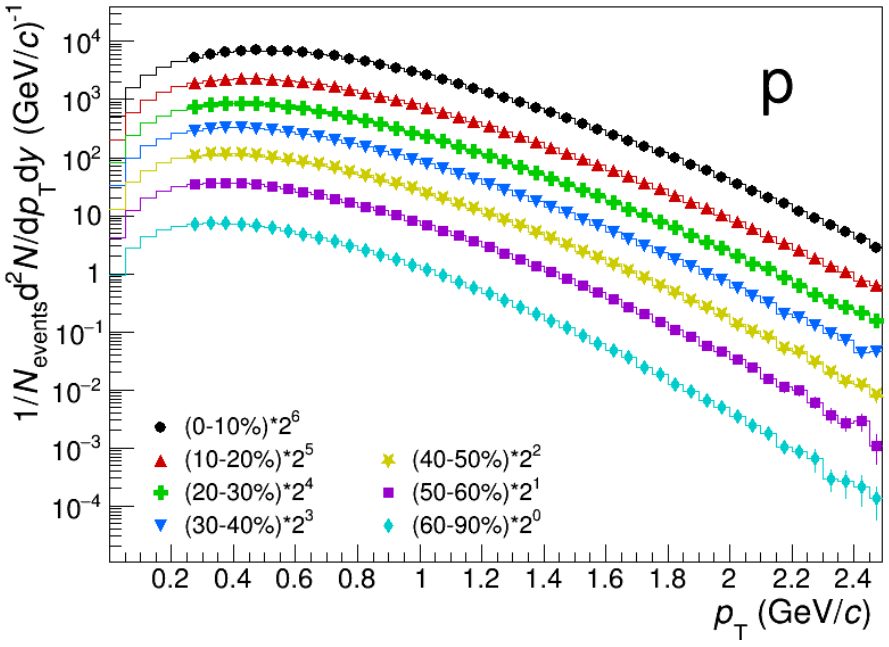


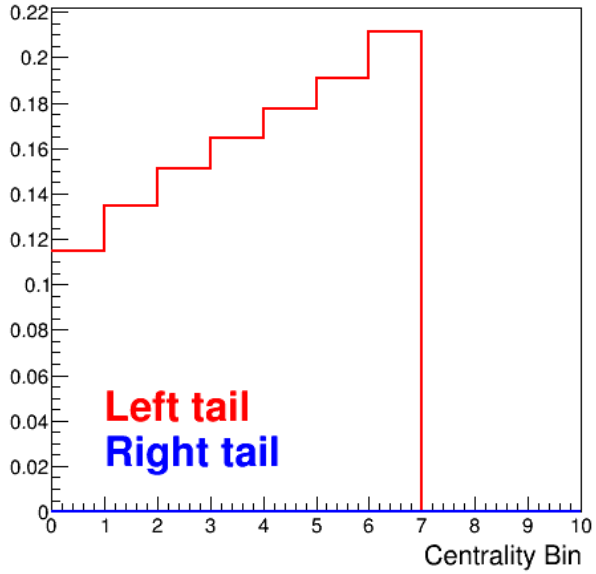
- Start at p_T ~ 50 MeV/c
- Measured spectra sample ~96% of the total yields, loose 4% at low p_T





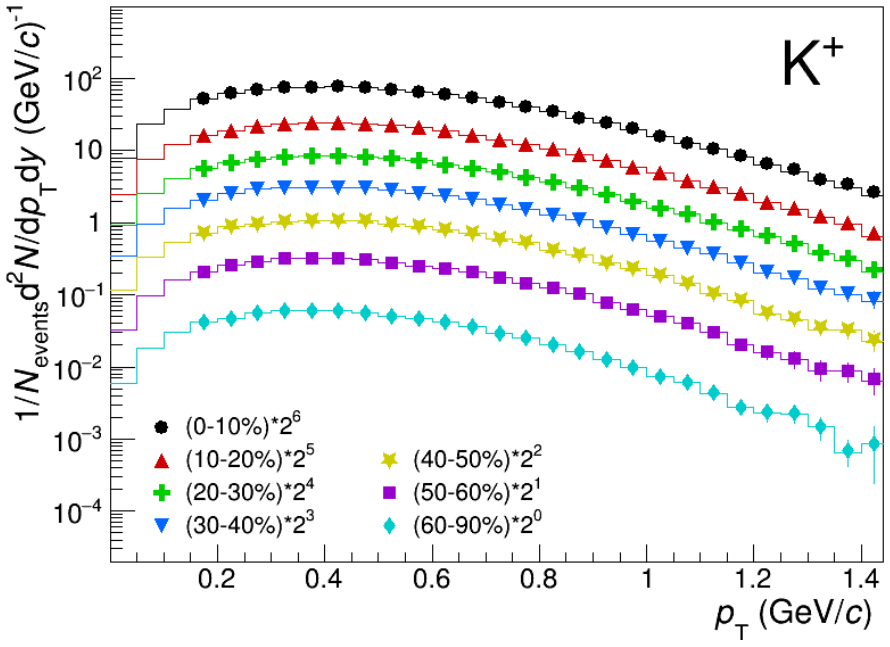
Final Spectra, protons

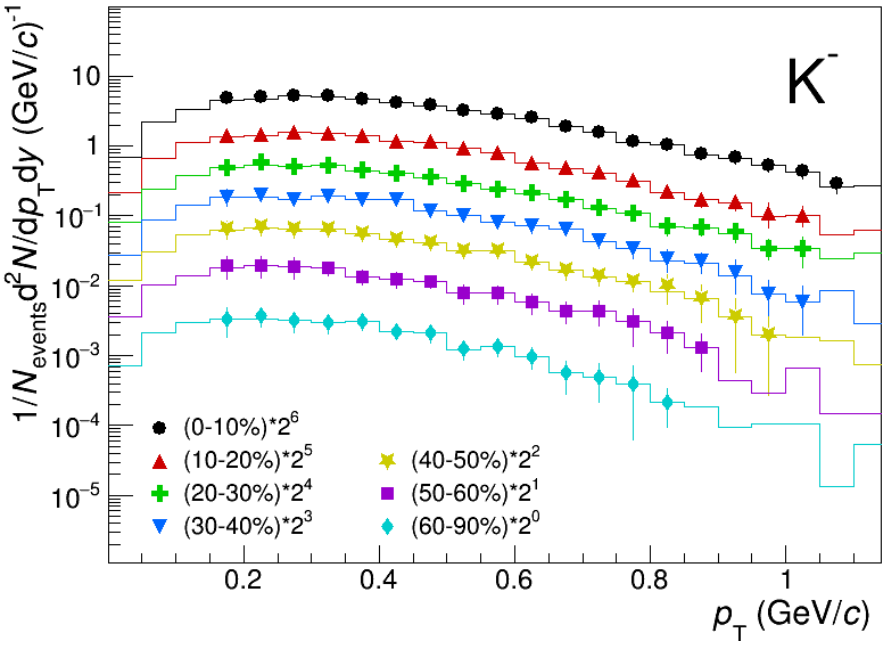




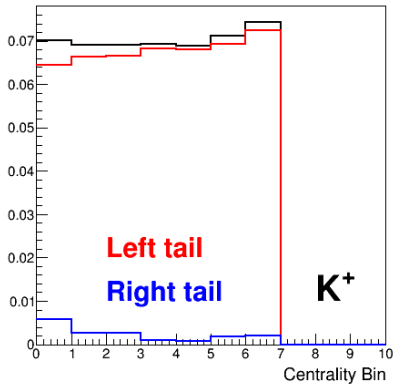
- Start at p_T ~ 250 MeV/c
- Measured spectra sample ~80-90% of the total yields, looses at low p_T, high p_T reach limited only by statistics

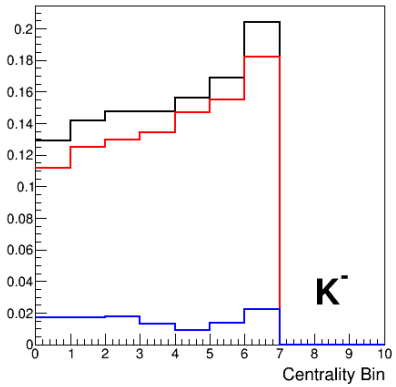
Final Spectra, kaons





- Start at p_T ~ 150 MeV/c
- Measured spectra sample ~93(80-88)% of the total yields for $K^+(K^-)$, main losses at low p_T



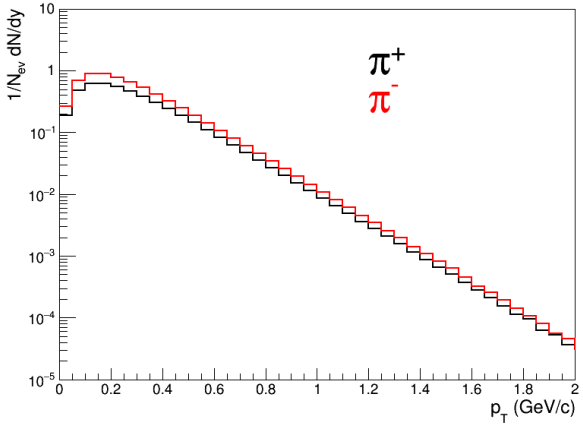


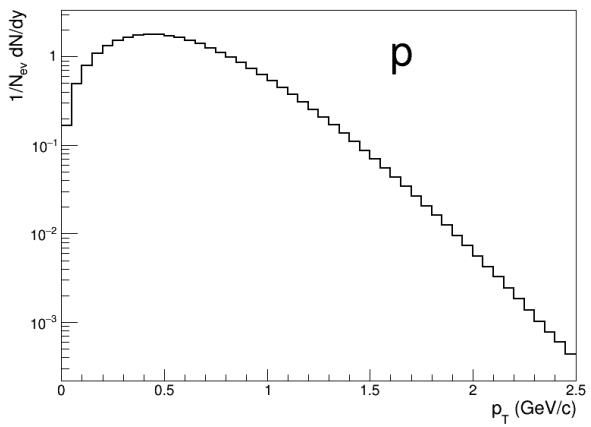
Summary

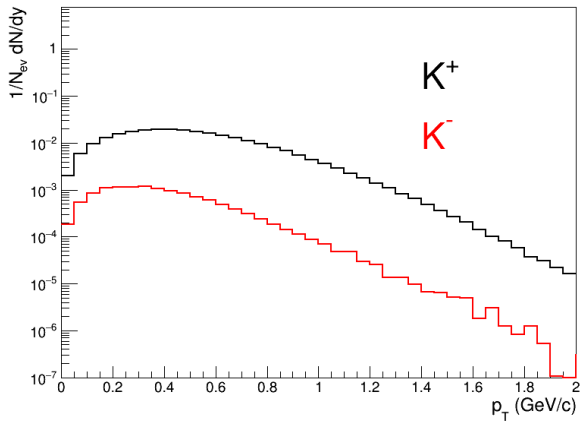
- A very straightforward approach for π/K/p measurements is proposed → good for the first-day measurements
- Generated spectra are soft → reconstruction of low p_T part is very crucial
- Losses at high p_T negligible and/or statistic dependent
- Losses at low pT is ~ 3-5% for pions, 10-20 for protons, 6-7% for K^+, ~15% for K^-

Backup

Generated spectra

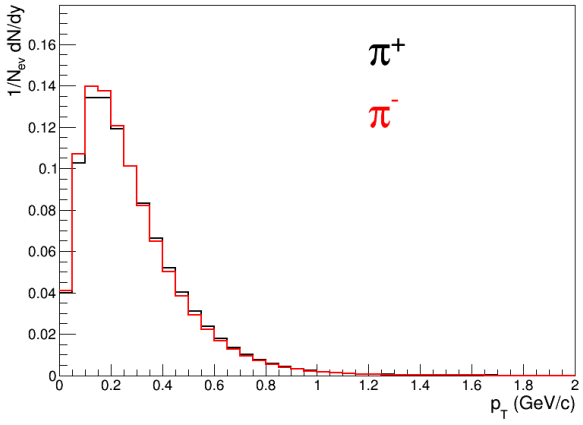


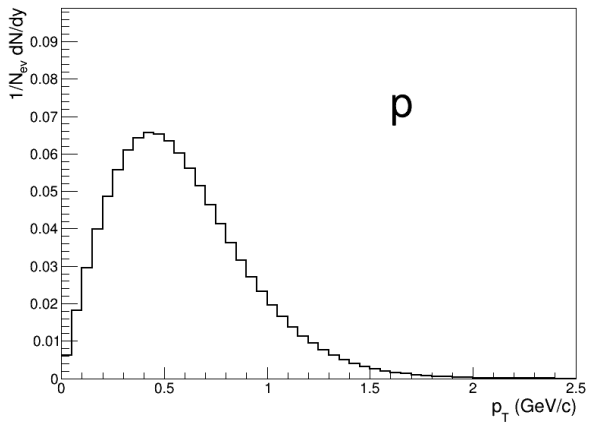


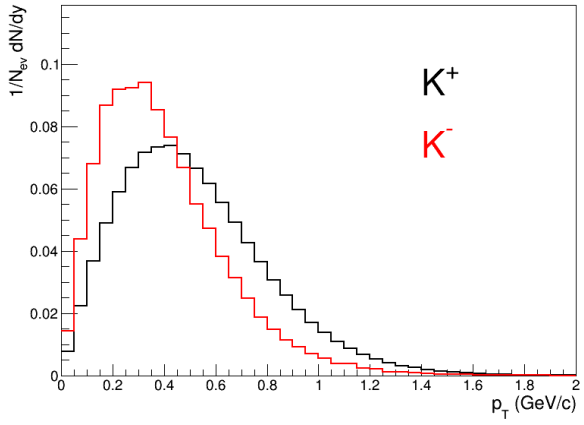


❖ Almost no difference for pions; NO antiprotons; considerable asymmetry for kaons

Normalized Spectra







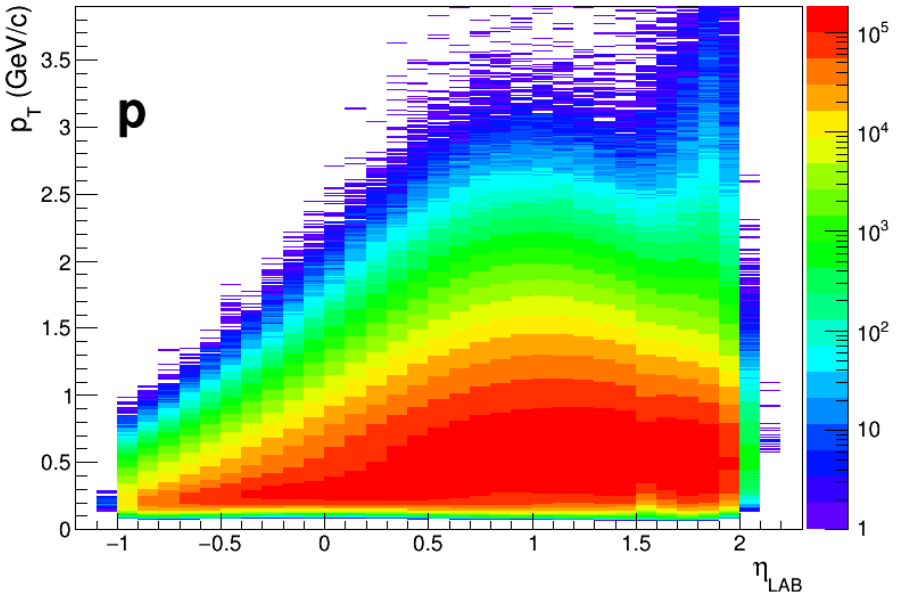
❖ Spectra are soft → low p_T part is very crutial

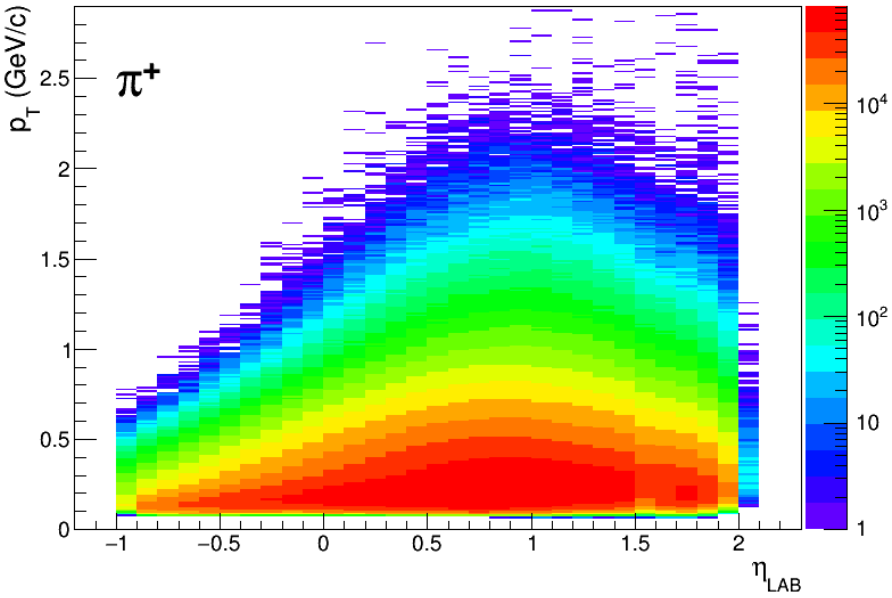
Fraction of spectrum lost (p_T dependence)

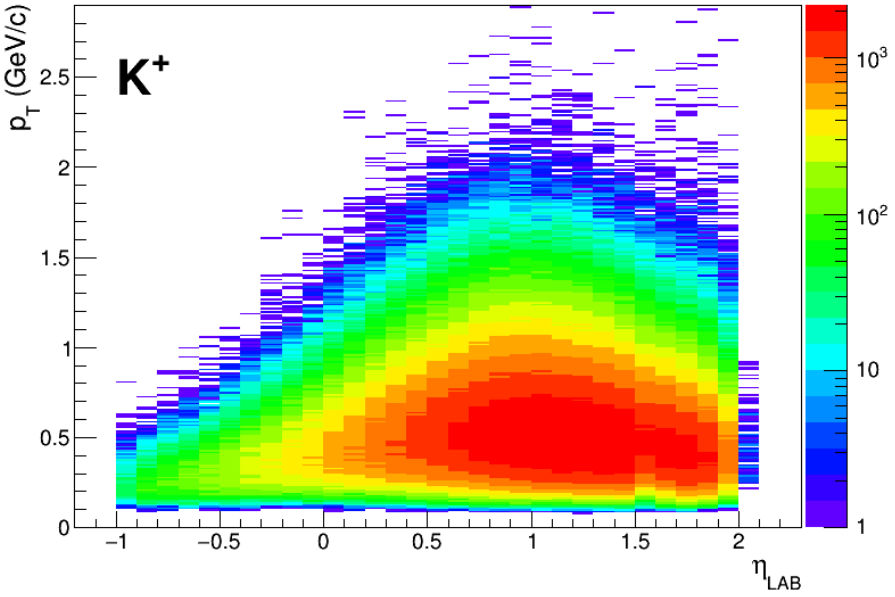
- The fraction of total spectrum lost if spectrum starts from p_T in the most left column

St pT	Proton	Pi+	Pi-	K+	K-
0.05	0.005	0.037	0.037	0.007	0.014
0.10	0.019	0.131	0.134	0.029	0.053
0.15	0.042	0.259	0.266	0.064	0.114
0.20	0.074	0.394	0.404	0.112	0.193
0.25	0.114	0.514	0.526	0.170	0.279
0.30	0.162	0.616	0.630	0.236	0.370
0.35	0.215	0.700	0.713	0.306	0.462
0.40	0.272	0.767	0.779	0.378	0.547
0.45	0.333	0.820	0.831	0.450	0.623
0.50	0.395	0.861	0.870	0.520	0.691
0.55	0.457	0.893	0.901	0.586	0.747
0.60	0.518	0.918	0.924	0.648	0.798
0.65	0.576	0.937	0.942	0.703	0.840
0.70	0.631	0.952	0.956	0.753	0.874
0.75	0.681	0.963	0.966	0.796	0.900
0.80	0.727	0.972	0.974	0.833	0.920
0.85	0.768	0.979	0.980	0.865	0.938
0.90	0.804	0.984	0.985	0.891	0.951
0.95	0.835	0.988	0.989	0.914	0.962
1.00	0.863	0.991	0.991	0.932	0.970

2D Phase Space (pT vs Eta_lab)

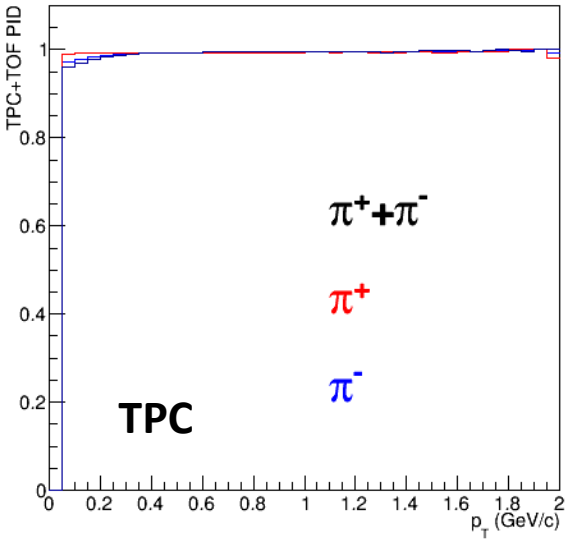


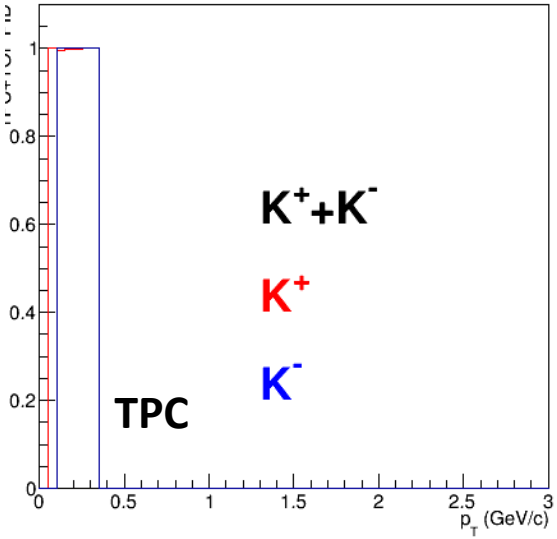


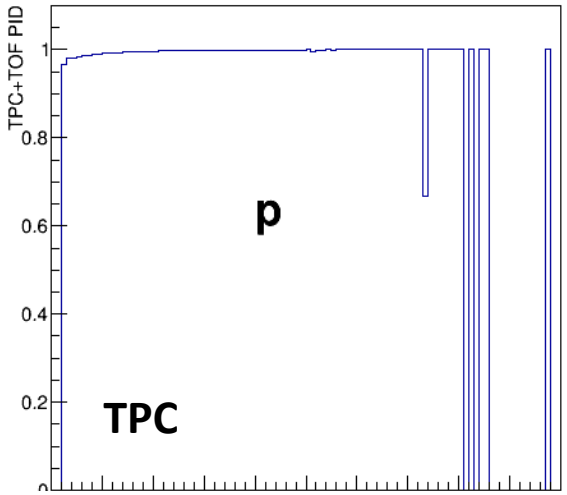


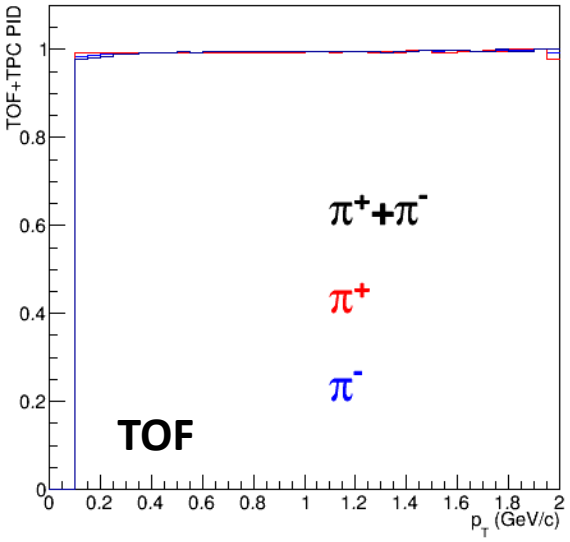
Particle sources

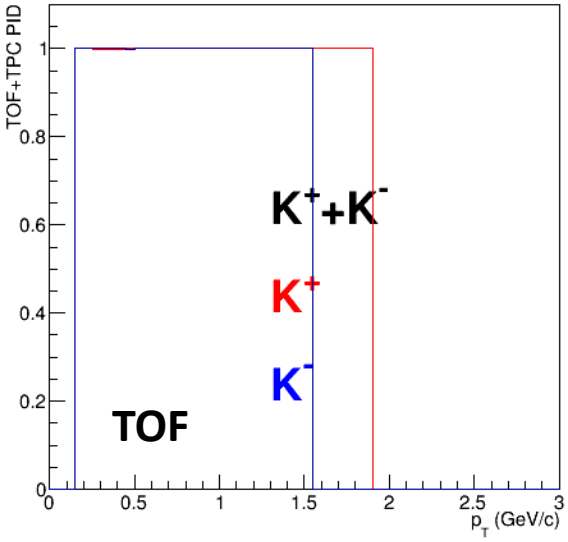
❖ Fractions of primaries in the measured spectrum (primaries – produced at dist < 1 cm from PV

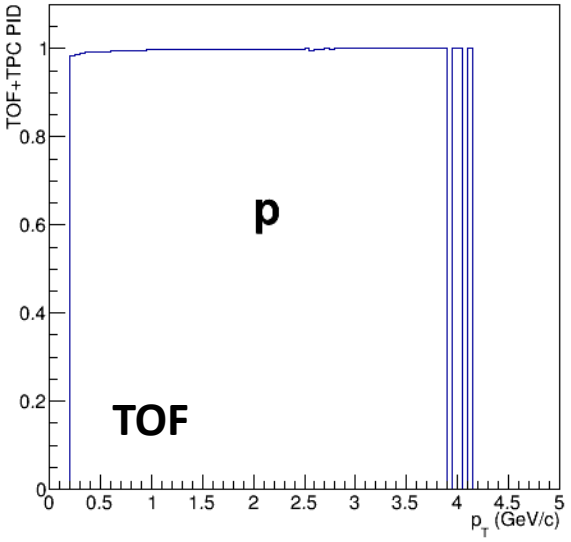












❖ Clean raw spectrum

Reconstruction Efficiency