Charge-dependent simplified PID for π/K/p in BiBi@9.2 GeV (part-2)

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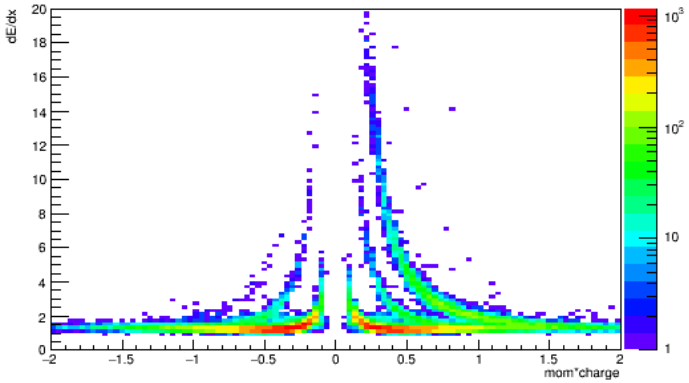
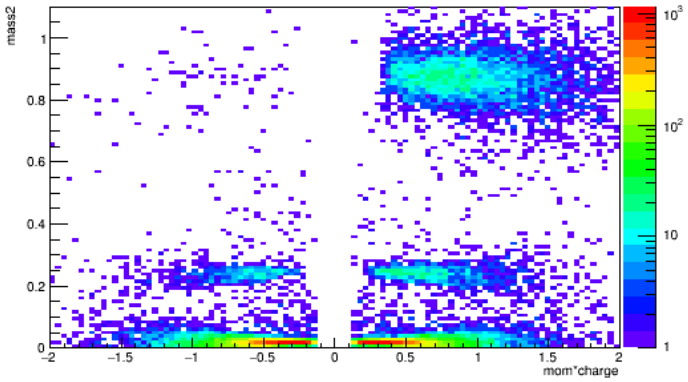
Outline

- Need $\pi^{\pm}/K^{\pm}/p^{\pm}$ results for the second collaboration paper
- Last time (17.09) presented results for charge-integrated π/K/p differential p_T spectra with simplified approach based on n-sigma method for TPC/TOF:
  - ✓ minimization of model-dependent corrections → minimization of systematic uncertainties
  - ✓ robust → most appropriate for the first-day analysis & results
  - ✓ best coverage at low-p_T, limited p_T range at higher momenta, however, > 95% of the yield sampled → good for dN/dy, $\langle p_T \rangle$ and β/T (BW-fits) measurements, bad for intermediate and high-p_T
- Background level and purities are different for "+" and "-" particles at NICA energies due to charge asymmetry of yields





- Today: charge-dependent analysis

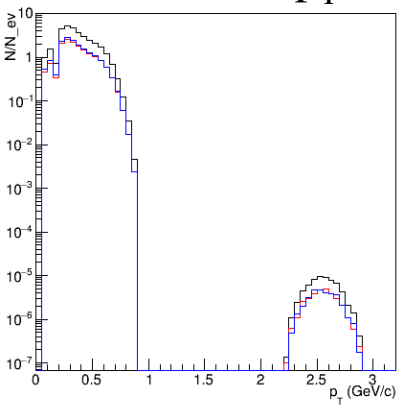
PID strategy

- Event selection: |z-vertex| < 100 cm; centrality 0-92%
- Track selection:
  - ✓ TPC-hits > 24
  - ✓ DCA-to-PV < $2\sigma_{x,y,z}$ (< $1\sigma_{x,y,z}$ for antiprotons)
  - ✓ |y| < 0.5
- Two quasi-independent measurements for π/K/p:
  - 1st: (**TPC-TOF**)
    - ✓ TPC 2σ-PID selection for a given specie (π/K/p)
    - ✓ If track is 2σ-matched to TOF then TOF 2σ-PID selection for a given specie (π/K/p)
    - ✓ TPC 3σ-veto-PID for other species (for π - e/K/p veto, for K - e/π/p veto, for p - e/π/K veto)
  - 2nd: (**TOF-TPC**)
    - ✓ TOF 2σ-PID selection for a given specie (π/K/p)
    - ✓ TPC 2σ-PID selection for a given specie (π/K/p)
    - ✓ TOF 3σ-veto-PID for other species (for π - e/K/p veto, for K - e/π/p veto, for p - e/π /K veto)
- Spectra are reconstructed while purity > 95%:
  - ✓ spectra are corrected for impurities → impose 50% uncertainty for the correction value = 0.5 * 5% = 2.5% p_T-correlated systematic uncertainty for spectra
- **TPC-TOF** and **TOF-TPC** spectra are combined for final results for minimum total uncertainties

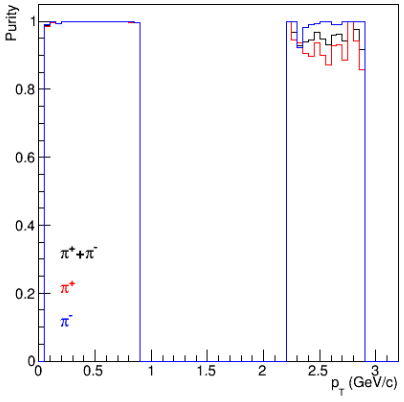
Pions

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

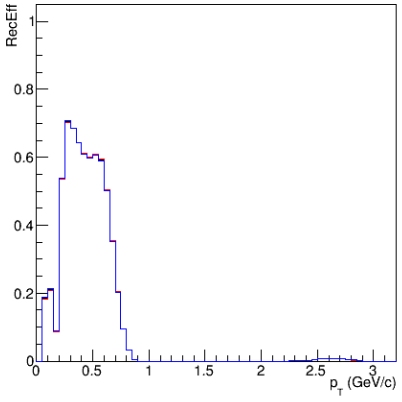
TPC raw-p_T



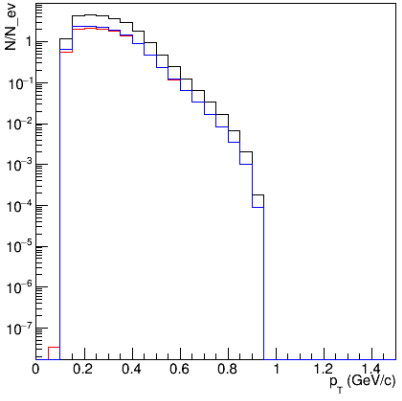
TPC purity



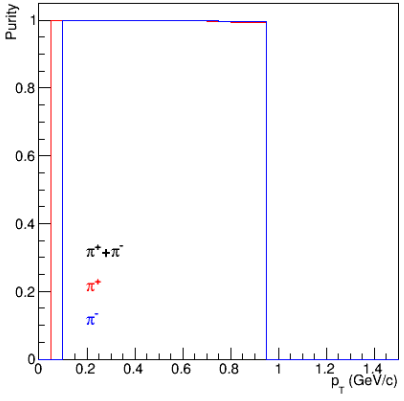
TPC efficiency



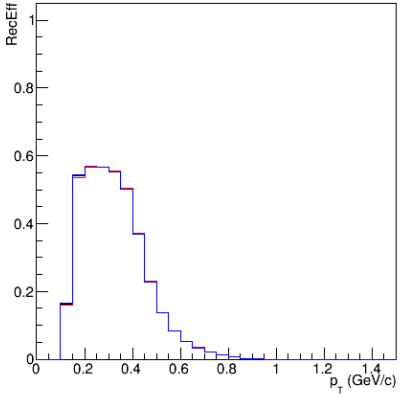
TOF raw-p_T



TOF purity



TOF efficiency

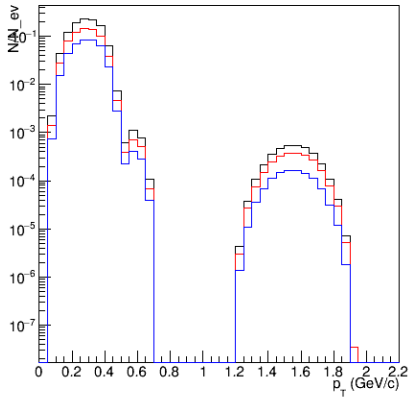


- No difference for π^+ and π^- for minimum bias (shown) and centrality intervals

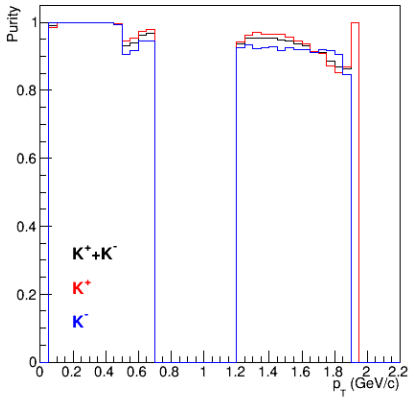
Kaons

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

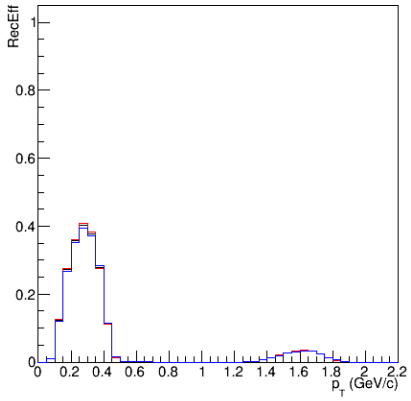
TPC raw-p_T



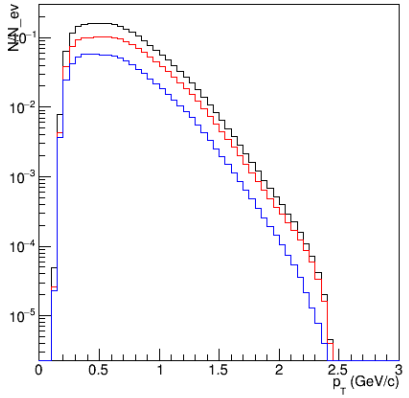
TPC purity



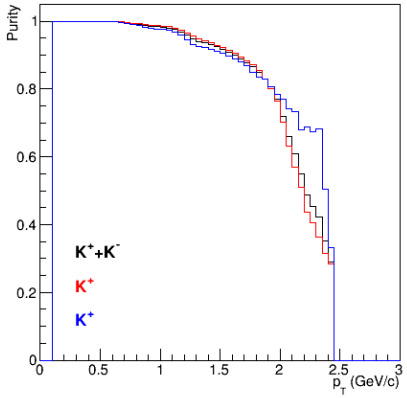
TPC efficiency



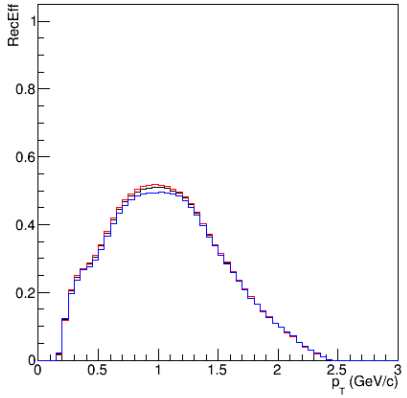
TOF raw-p_T



TOF purity



TOF efficiency

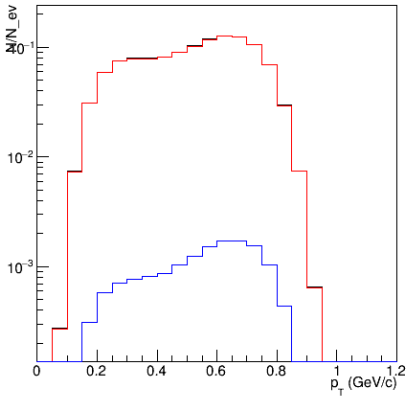


- No big difference for K^+ and K^- for minimum bias (shown) and centrality intervals

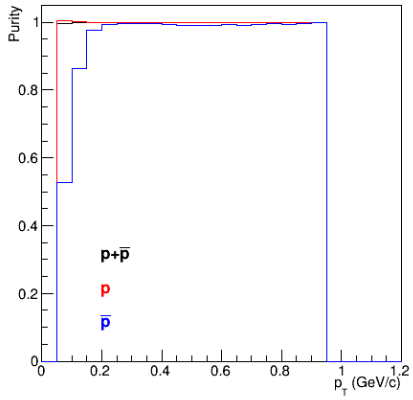
Protons

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

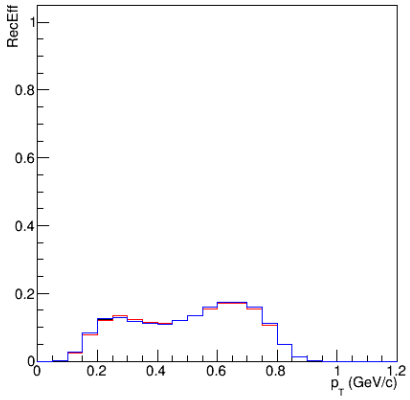
TPC raw-p_T



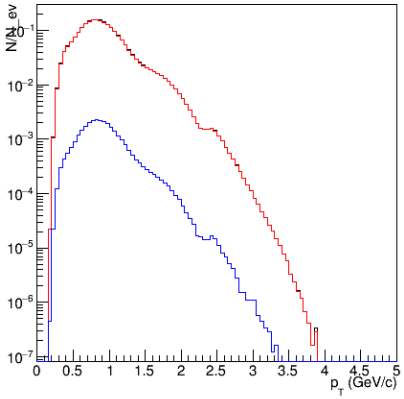
TPC purity



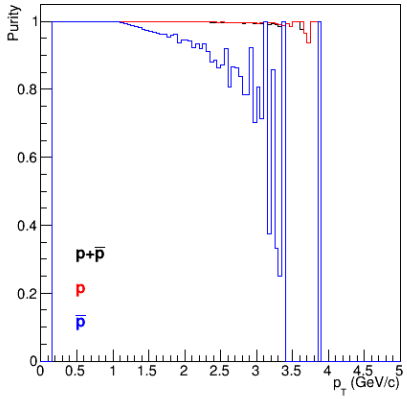
TPC efficiency



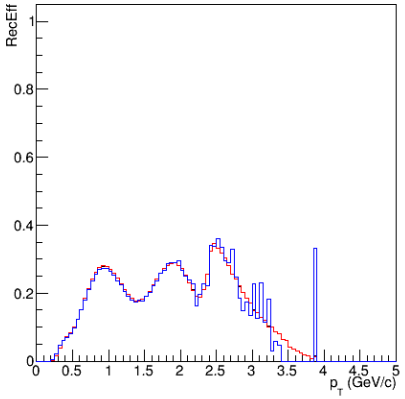
TOF raw-p_T



TOF purity



TOF efficiency

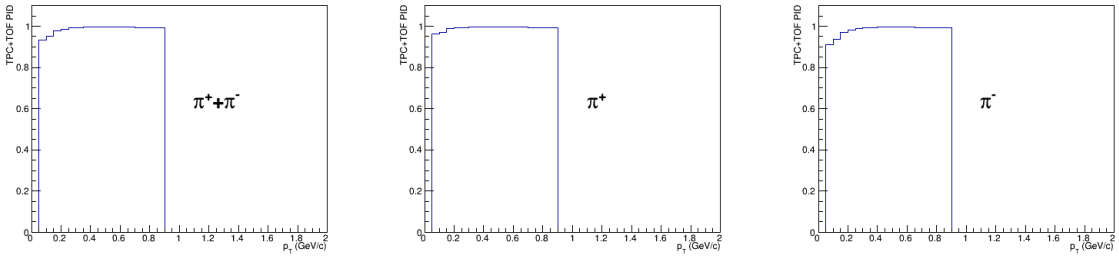


- Antiproton spectrum is mostly contaminated by back-scattered protons → no simple way of suppression by PID cuts (same selections for protons and antiprotons), use tighter DCA-to-PV cut of $|DCA| < 1\sigma_{xyz}$

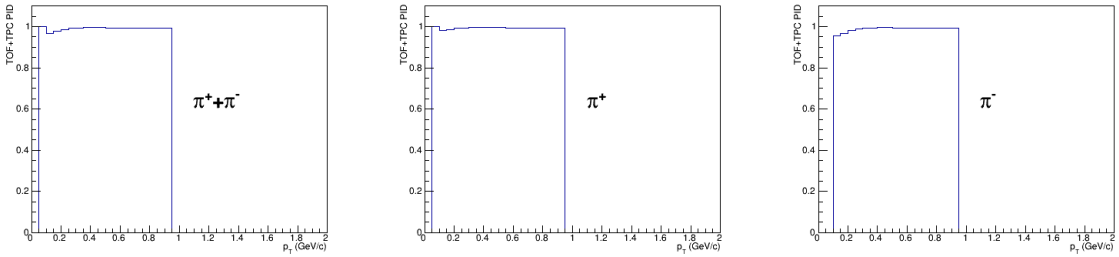
Particle sources - Pions

- Fraction of primaries in the measured spectrum (primaries – produced at a distance < 1 cm from PV)

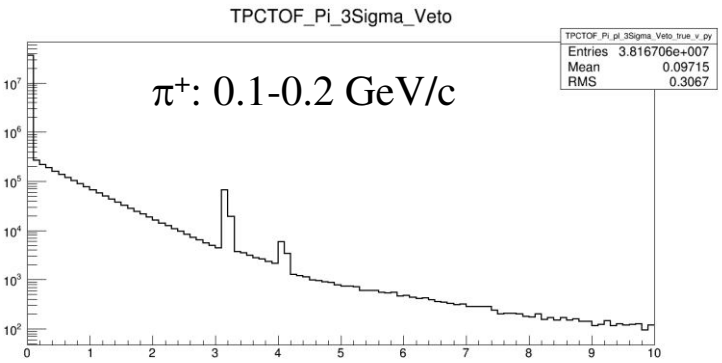
TPC-TOF

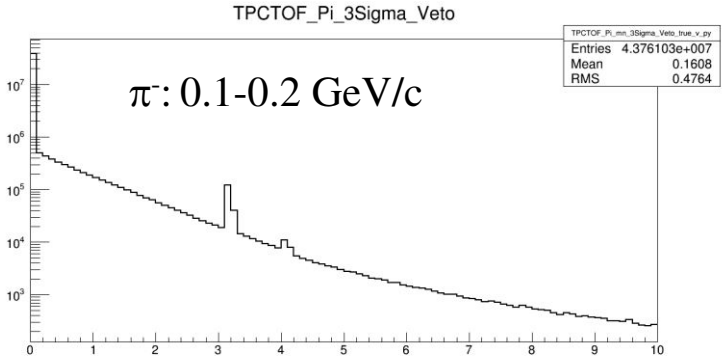


TOF-TPC



- Production radius of soft pions



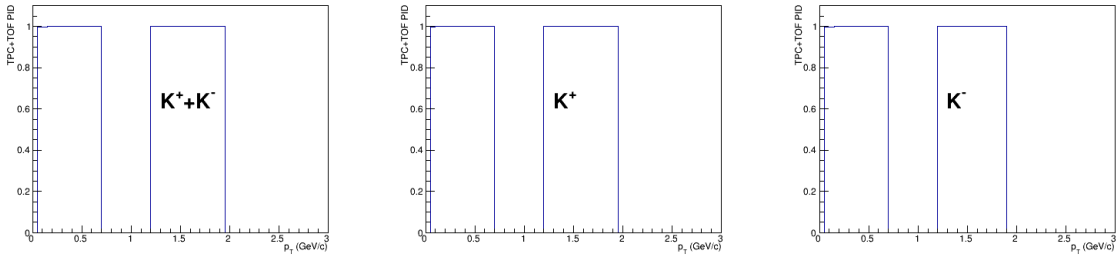


- Larger feed-down for π^-, negligible background from materials

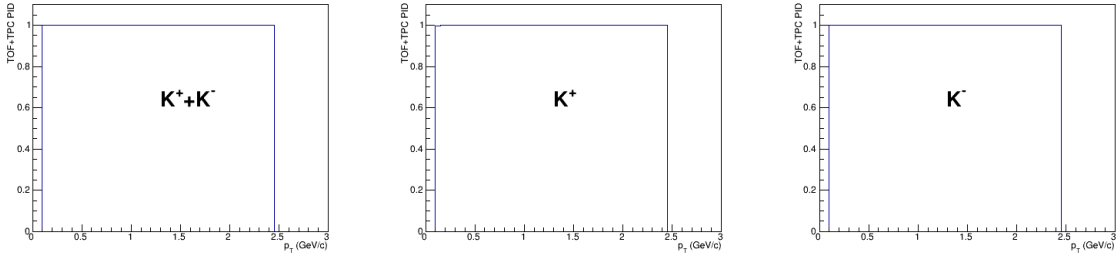
Particle sources - Kaons

- Fraction of primaries in the measured spectrum (primaries – produced at a distance < 1 cm from PV)

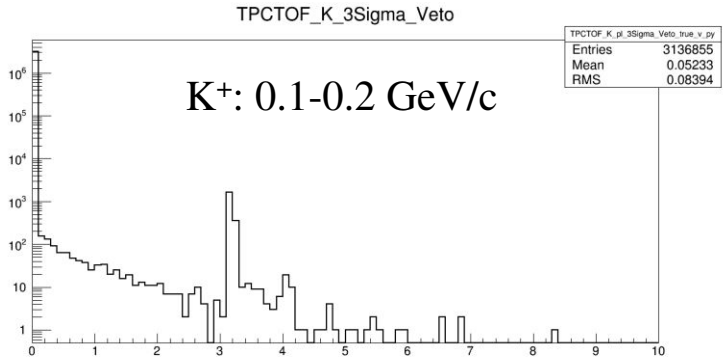
TPC-TOF

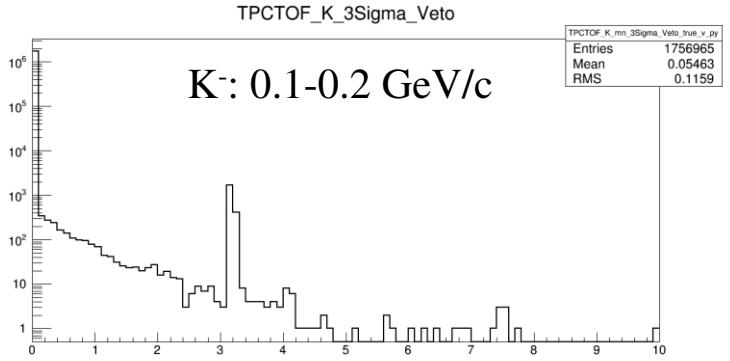


TOF-TPC



- Production radius of soft kaons



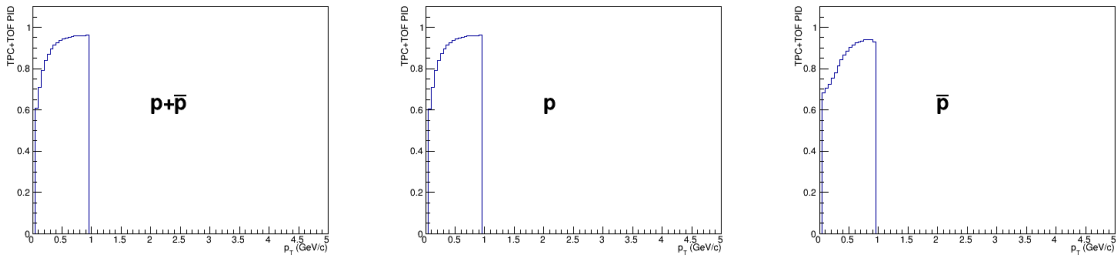


- Very clean raw sample

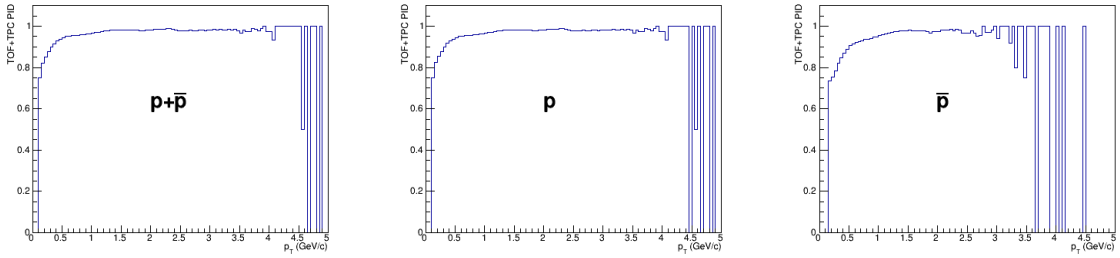
Particle sources - Protons

- Fraction of primaries in the measured spectrum (primaries – produced at a distance < 1 cm from PV)

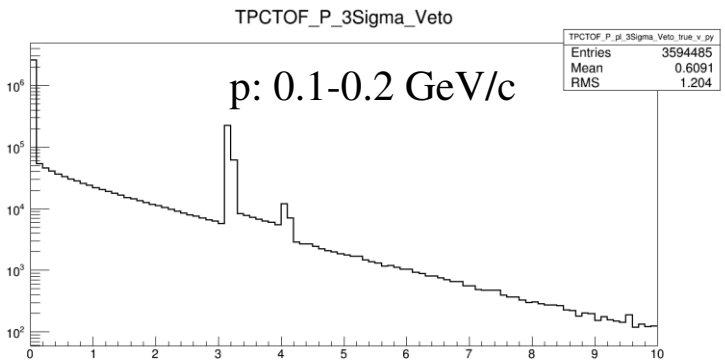
TPC-TOF

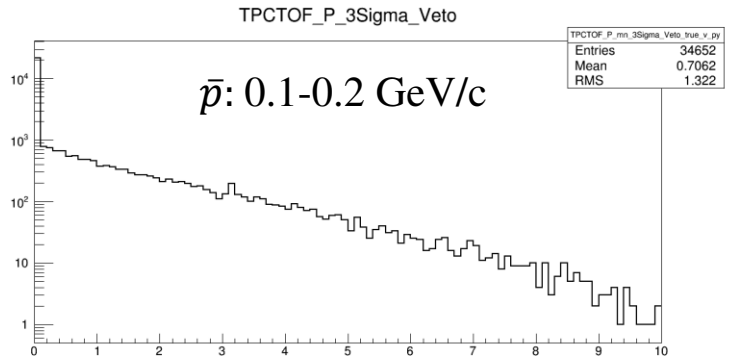


TOF-TPC



- Production radius of soft protons

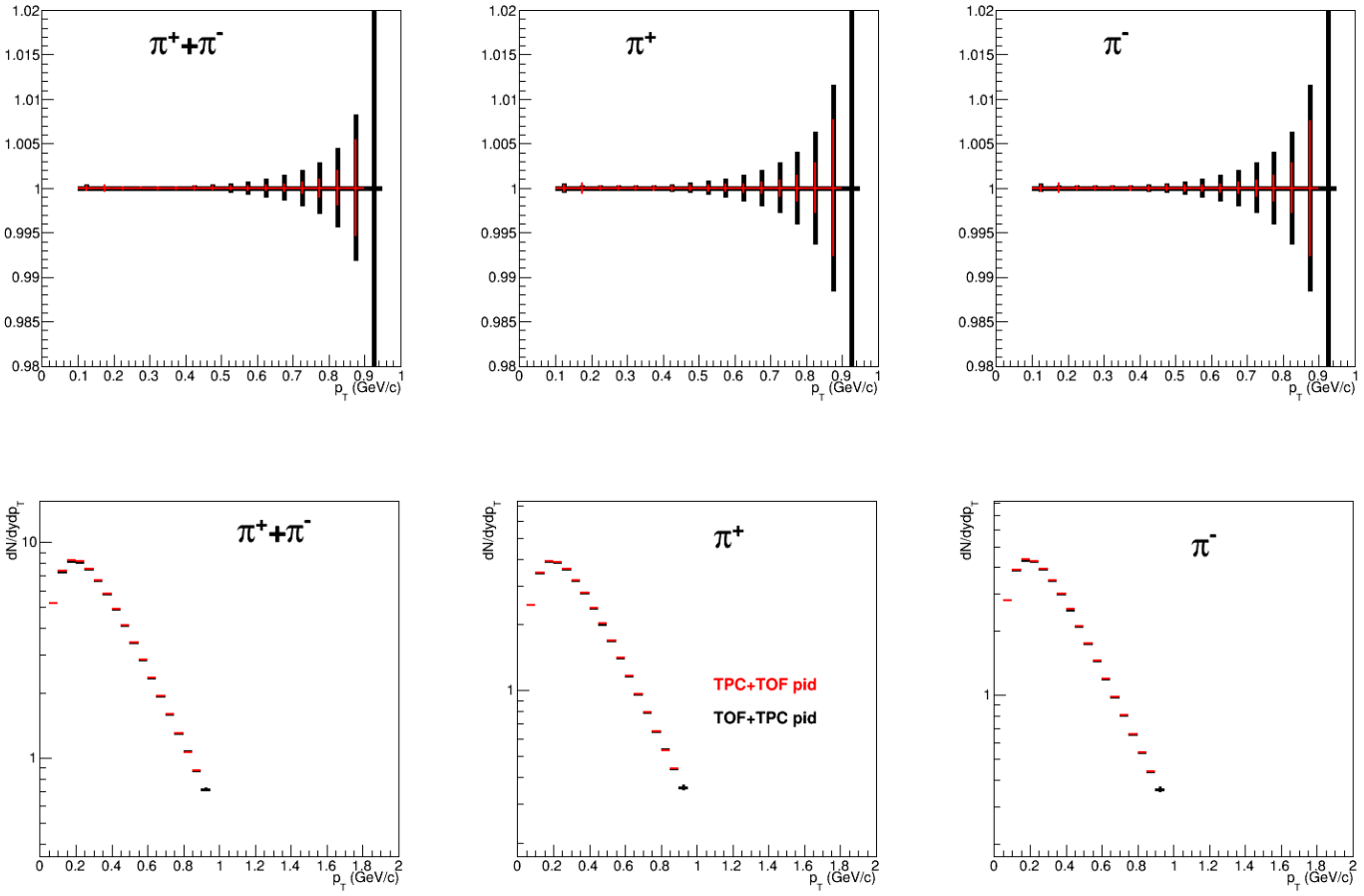




- Significant feed-down for (anti)protons, ~ 10-15% admixtures to raw protons from the beam pipe

Combined spectra - Pions

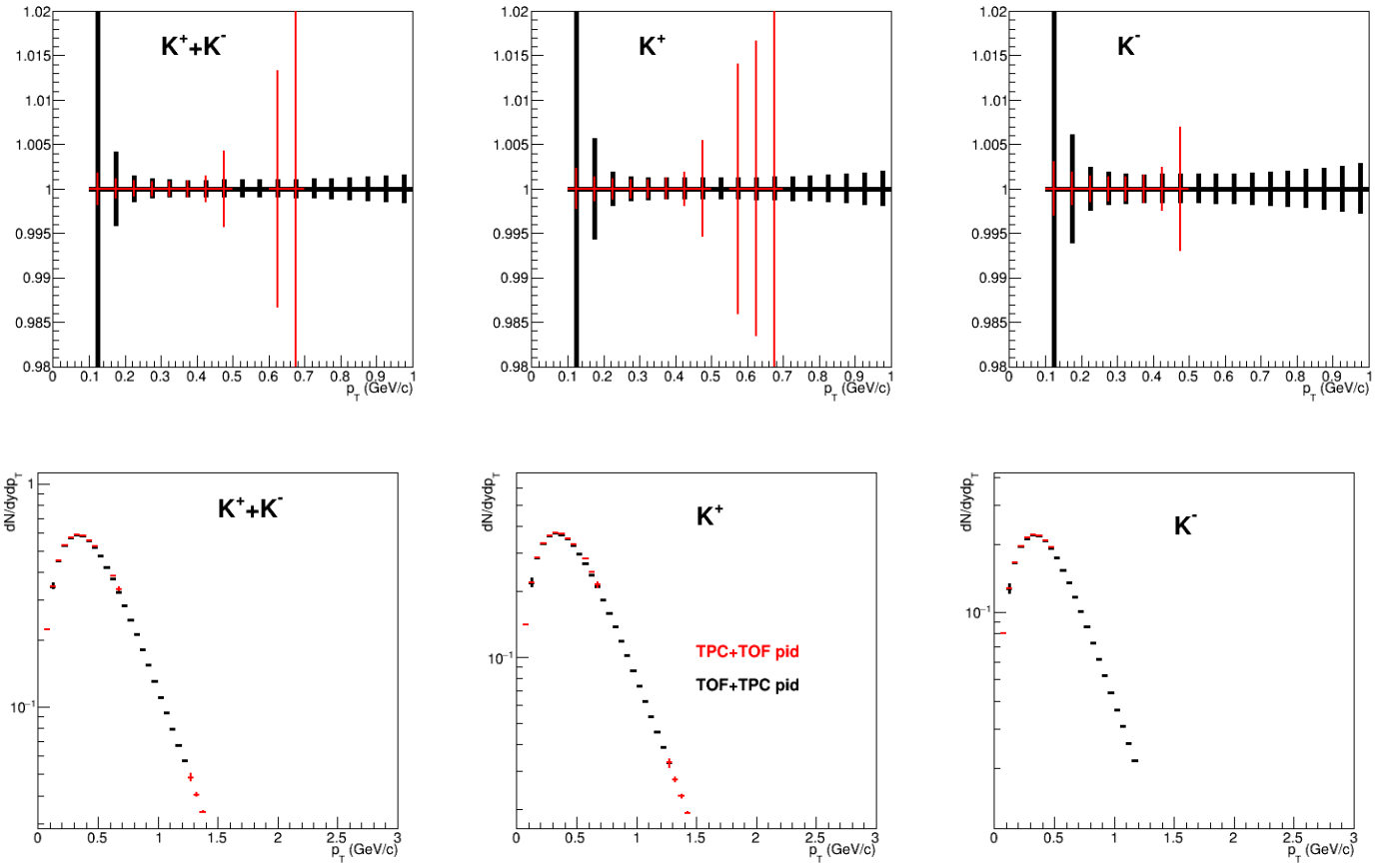
- Relative statistical uncertainties for **TPC-TOF** and **TOF-TPC** spectra



- Set transition point to $p_T = 0.95$ GeV/c

Combined spectra - Kaons

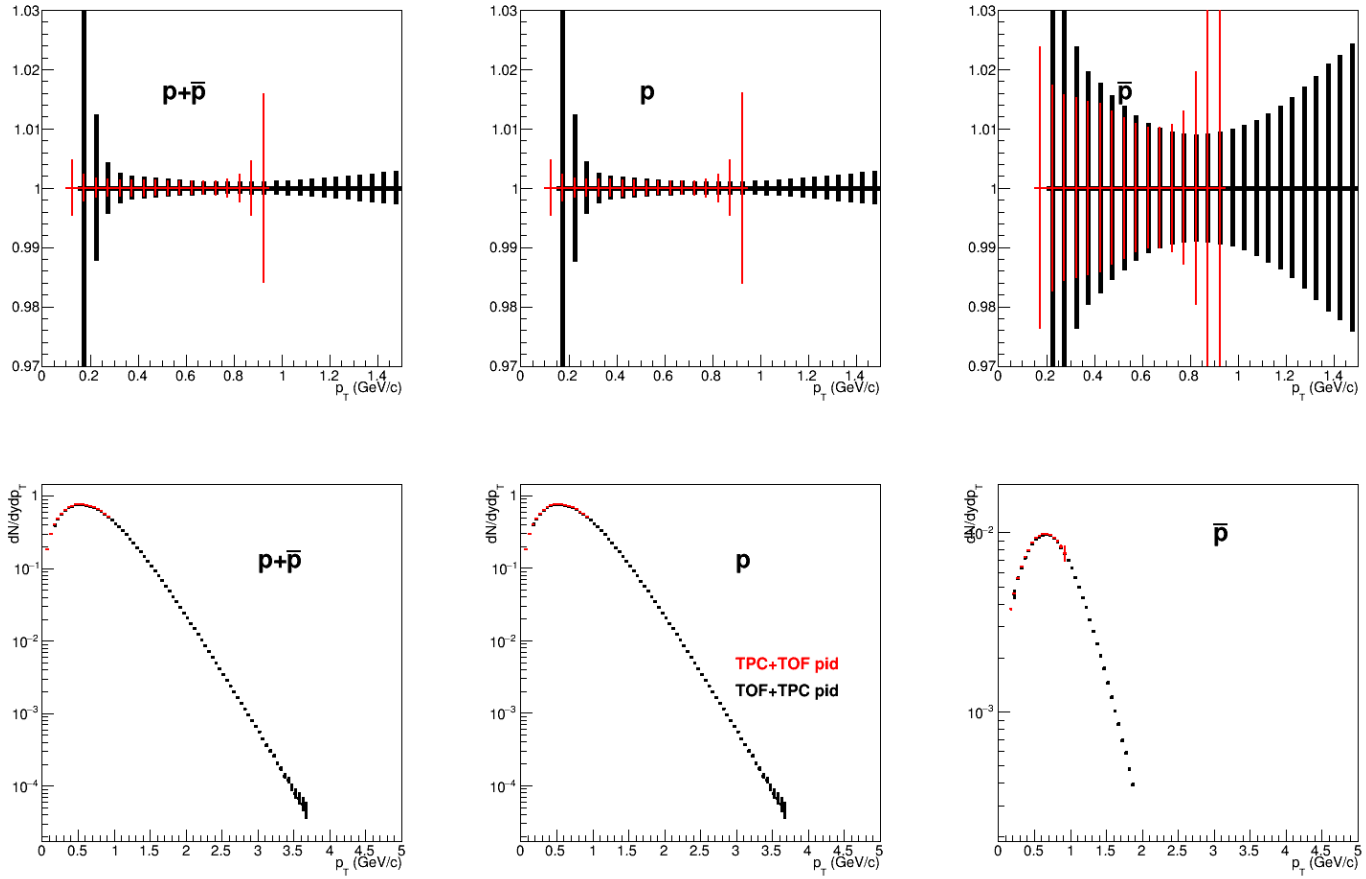
- Relative statistical uncertainties for **TPC-TOF** and **TOF-TPC** spectra



- Set transition point to $p_T = 0.4$ GeV/c

Combined spectra – (anti)protons

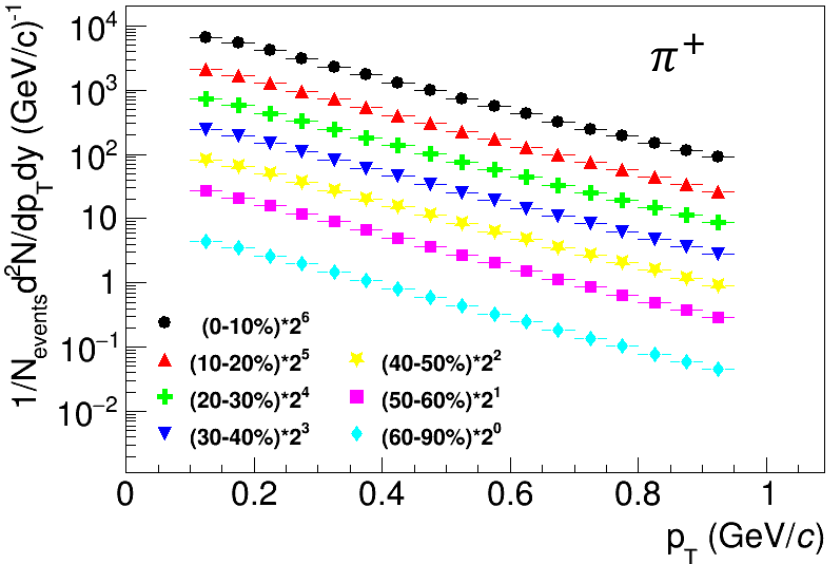
- Relative statistical uncertainties for **TPC-TOF** and **TOF-TPC** spectra

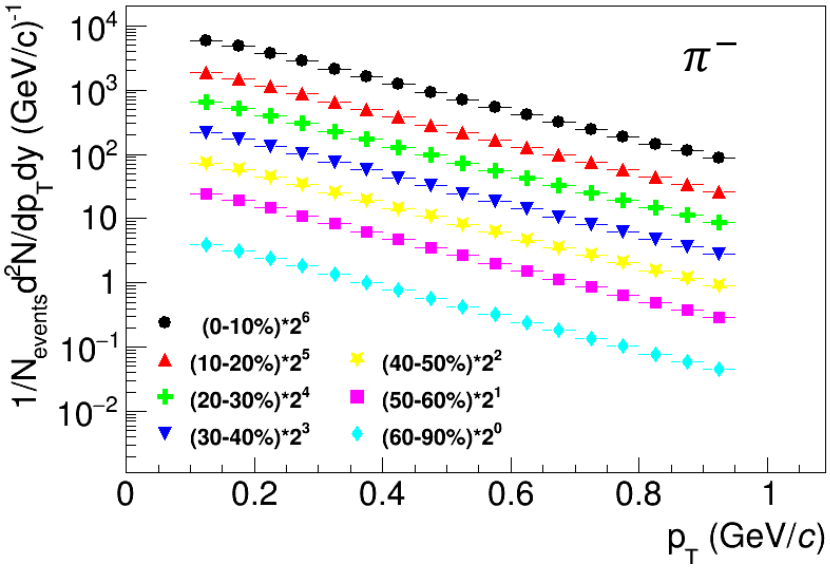


- Set transition point to $p_T = 0.7$ GeV/c

Final spectra, pions

- Combined, centrality-dependent spectra

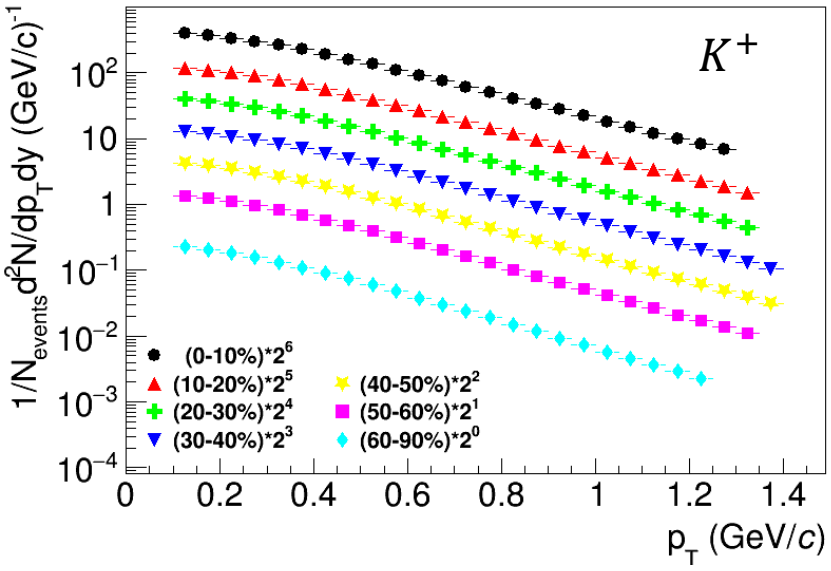


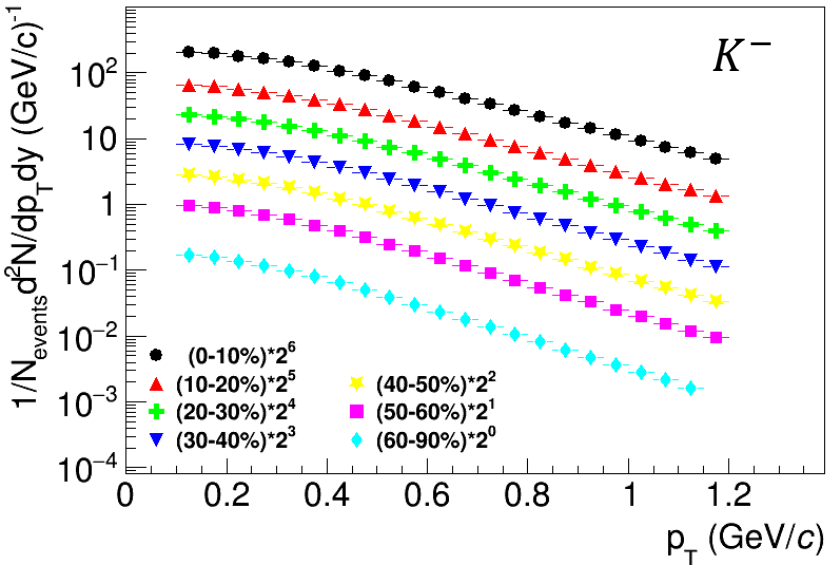


- Start at p_T ~ 100 MeV/c
- Measured spectra sample ~ 91% of the total yield, loose 4% at low p_T and 5% at high p_T

Final spectra, kaons

- Combined, centrality-dependent spectra

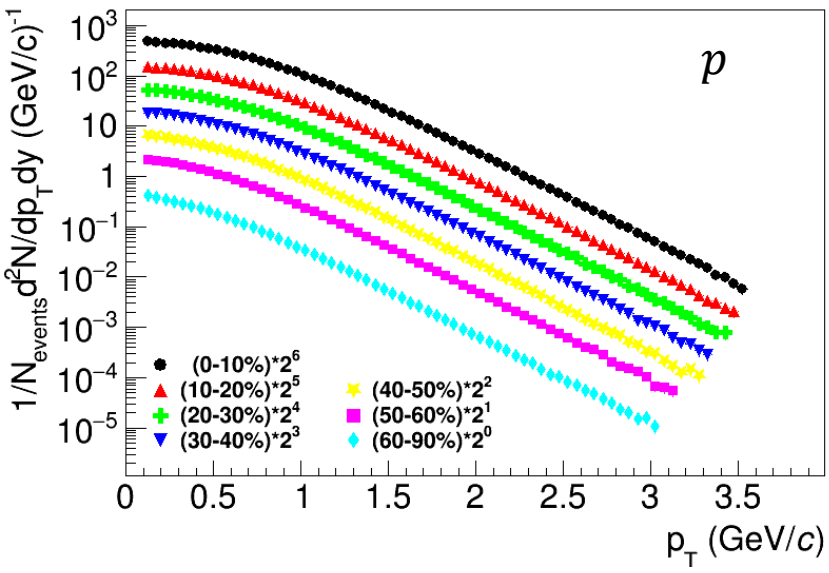


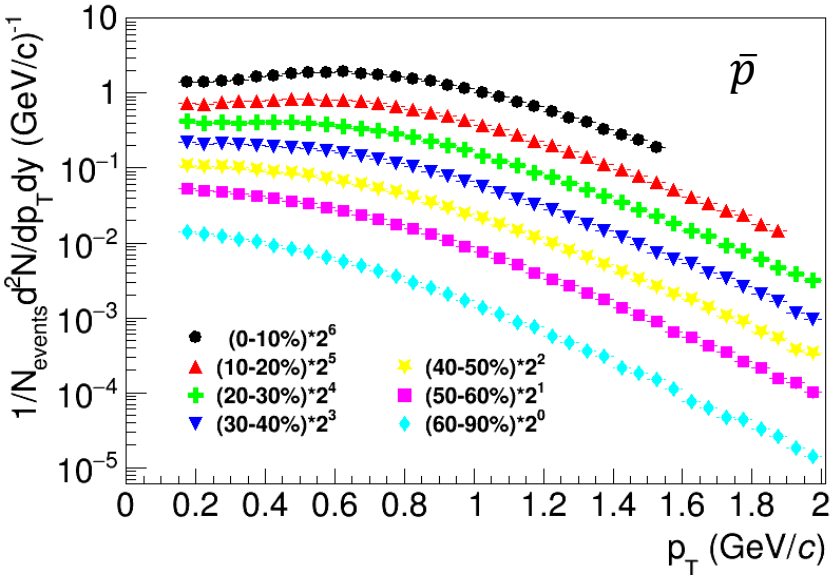


- Start at p_T ~ 100 MeV/c
- Measured spectra sample > 93% of the total yield, loose 1% at low p_T and < 6% at high p_T

Final spectra, protons

- Combined, centrality-dependent spectra





- Start at p_T ~ 200 MeV/c
- p: measured spectra sample > 98% of the total yield, loose 2% at low p_T and 0% at high p_T
- $\bar{p}$: measured spectra sample > 92% of the total yield, loose 2% at low p_T and <6% at high p_T

Summary

- A very straightforward approach for π/K/p measurements is proposed → good for the first-day measurements
- Provides good enough coverage for dN/dy, $\langle p_T \rangle$ and β/T (BW-fits) measurements, unmeasured low-p_T range is as small as possible given current track reconstruction techniques & methods, sampled yields > 92% for all species