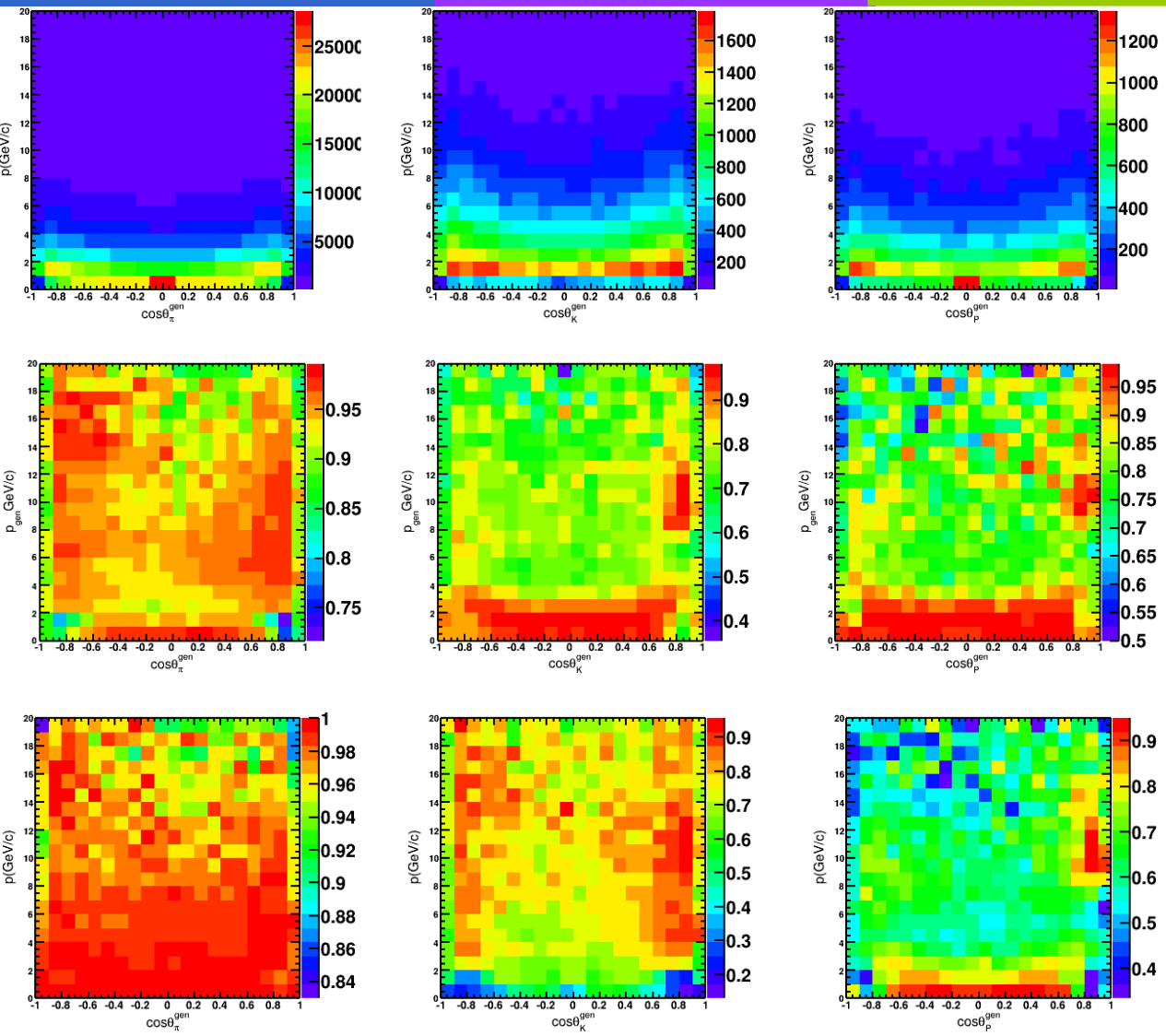
PID efficiency study

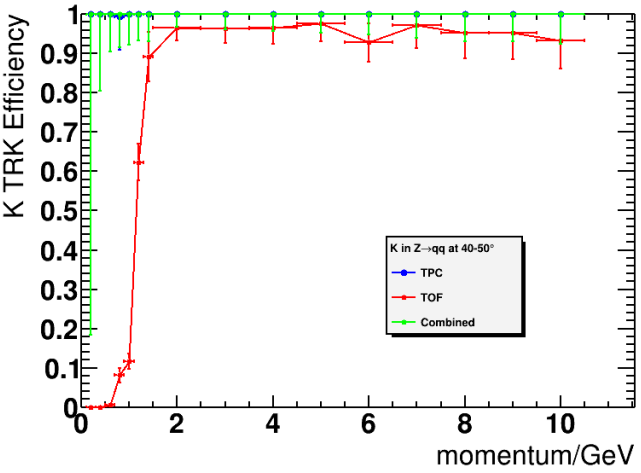
- Summary of efficiency study in physical process $Z \rightarrow qq$
  - Calculate efficiency and purity in all phase space using minimum χ^2 PID
    - Veto decay particles
    - Debug function FindToFHits() which didn's set no hit's returned bool values
    - TPC PID efficiency dips because of K/p and K/pi misidentification
  - Compare with ParticleGun single particle's results
    - Almost match
    - Low momentum multi-tracks not considered in Zqq events but in particlegun's
    - Lower degree has higher PID efficiency
  - To understand PID efficiency asymmetry and tof_meast bump of pion
- Samples used under CEPCSW_tdr24.12.0
  - ParticleGun 10000 * 22 single K^- events
  - $Z \rightarrow qq$ 100000 events (truth π: K: p = 1767358: 211458: 90572)
    - stable π: K: p = 1520685: 163926: 90572 (simulatorStatus==0)

PID efficiency and purity in $Z \to qq$

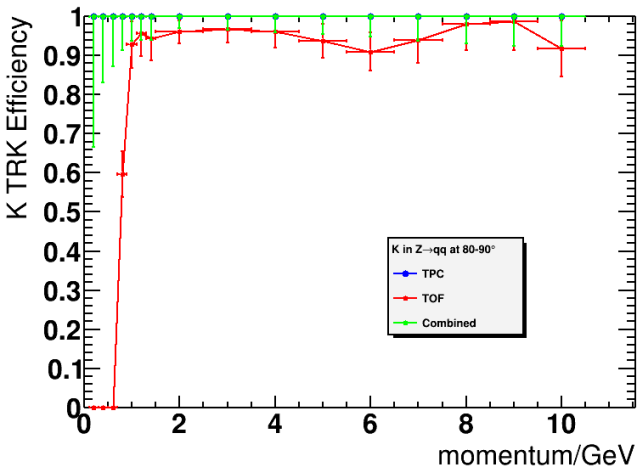


- Track truth phase space $(p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}})$ 0-20GeV
- PID efficiency distribution of track $\pi/K/p$ (minimum combined χ^2)
- Purity distribution of track $\pi/K/p$

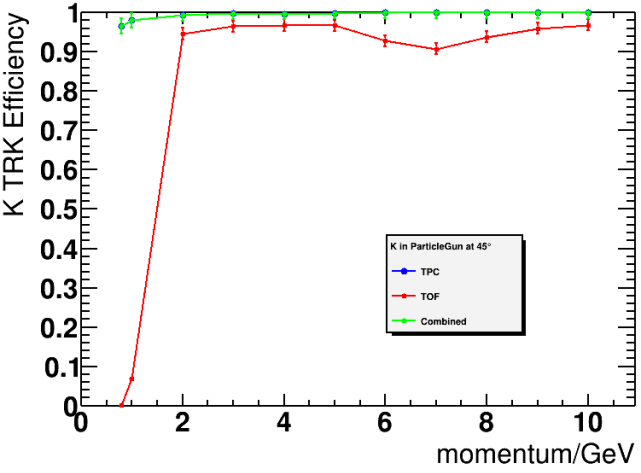
TPC/TOF TRK efficiency comparison with ParticleGun



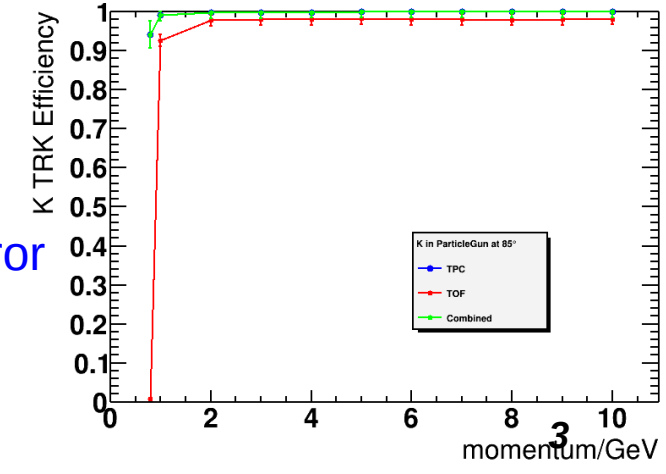
K in $Z \rightarrow qq$ efficiency
at 40-50 / 80-90 degree



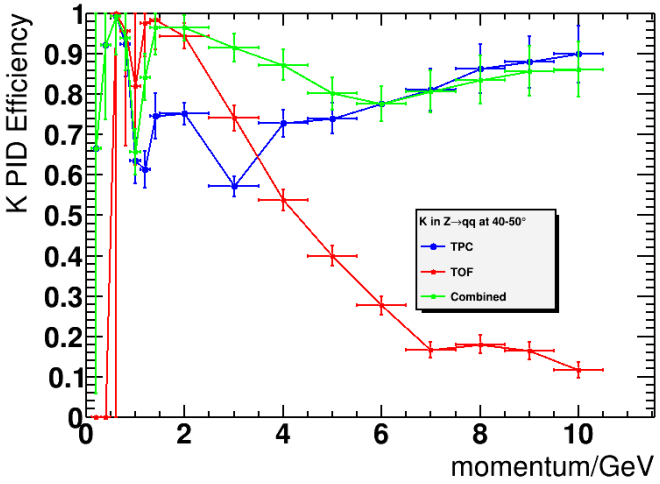
Selection: have track and no decay and truth K
To calculate efficiency of having TPC/TOF track in reco tracks



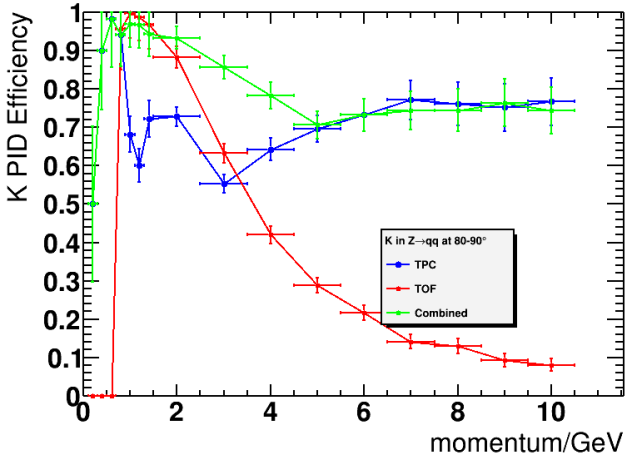
ParticleGun's K efficiency
at 45 / 85 degree
Single momentum with 0 error



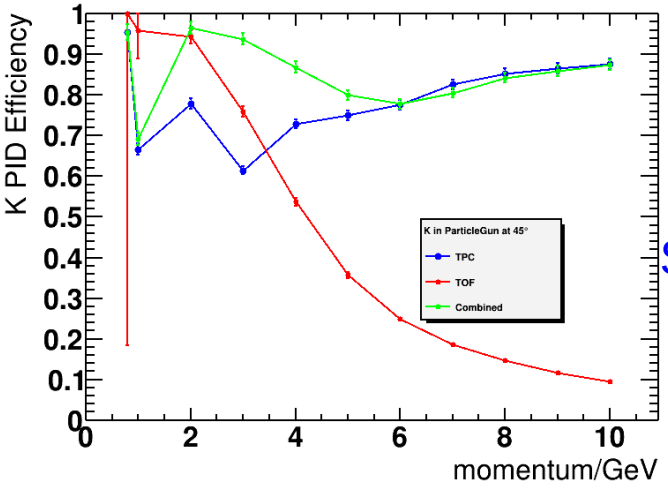
PID efficiency comparison with ParticleGun



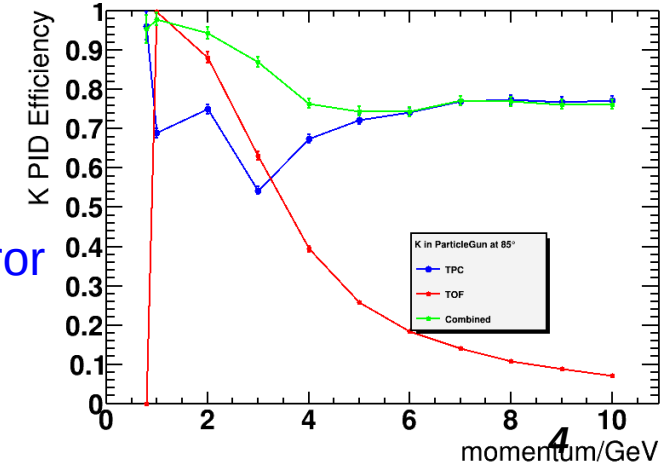
K in $Z \rightarrow qq$ efficiency
at 40-50 / 80-90 degree



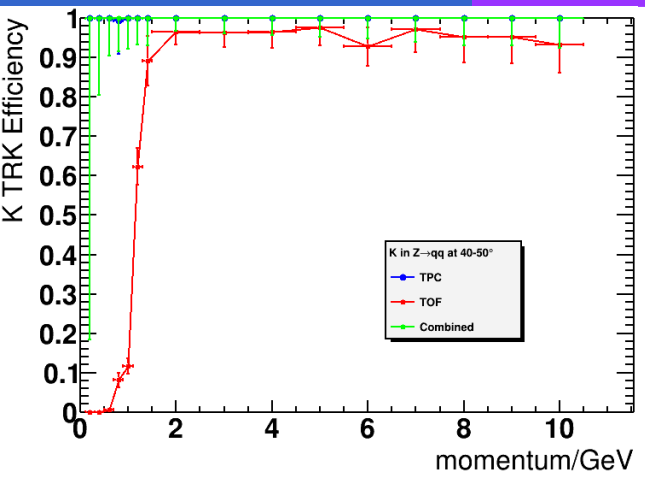
Selection: have TPC/TOF track and no decay and truth K
To calculate efficiency of right PID

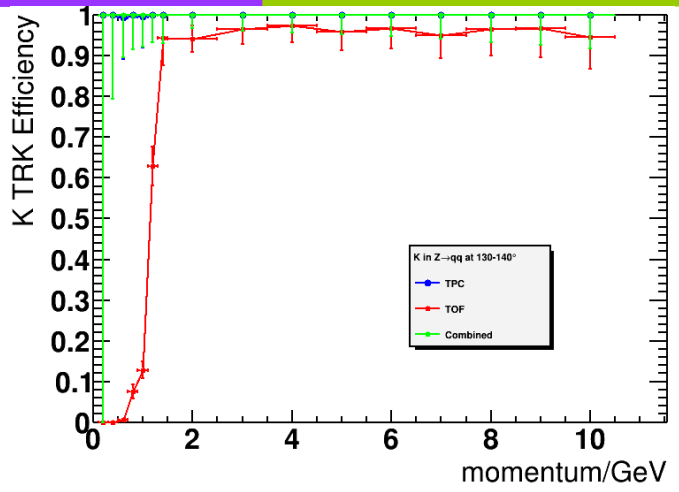


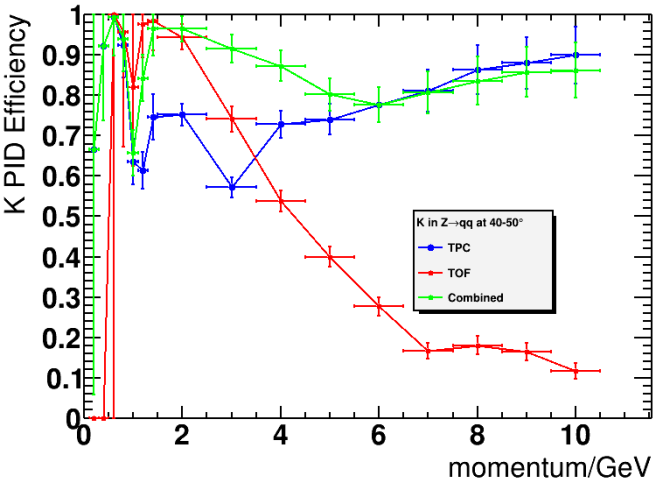
ParticleGun's K efficiency
at 45 / 85 degree
Single momentum with 0 error



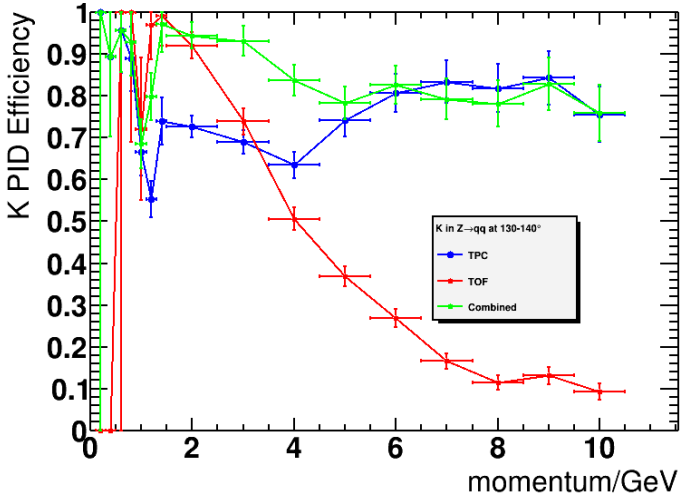
Efficiency asymmetry in $Z \rightarrow qq$





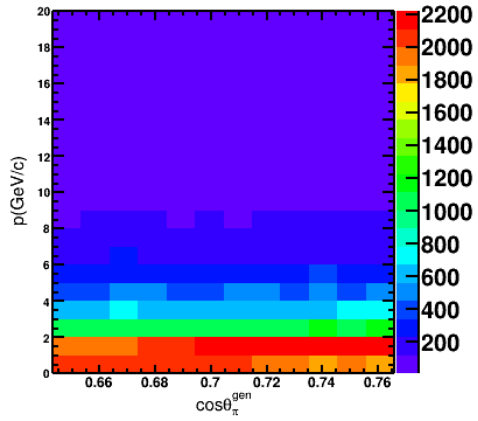


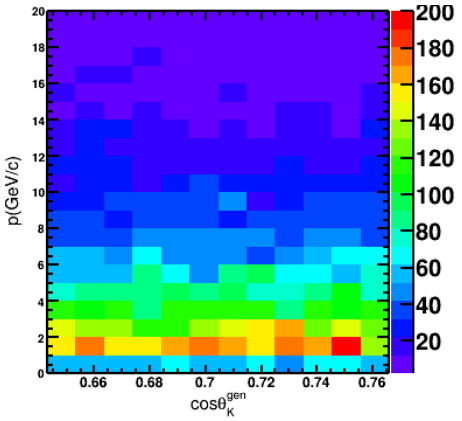
at 40-50 degree

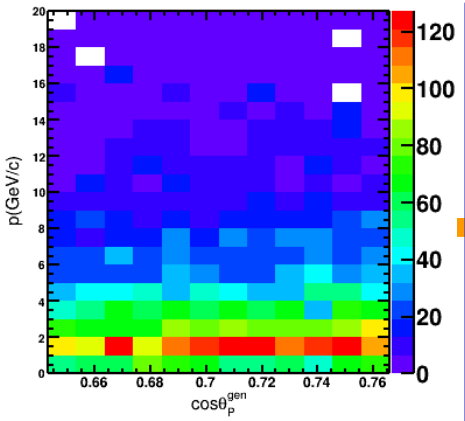


at 130-140 degree

PID efficiency not the same at 40-50 degree and 130-140 degree





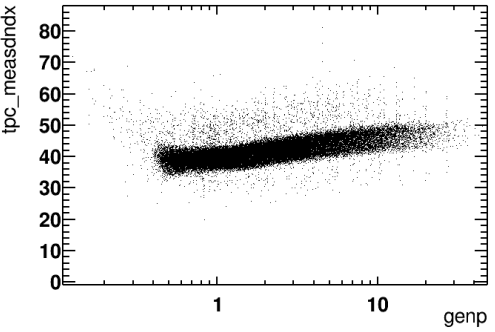


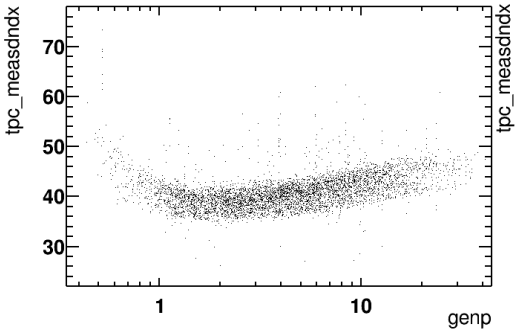
Track truth phase space

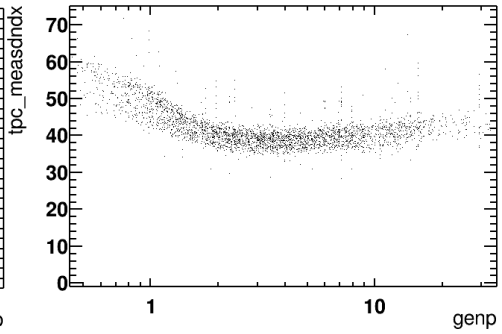
$(p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}})$

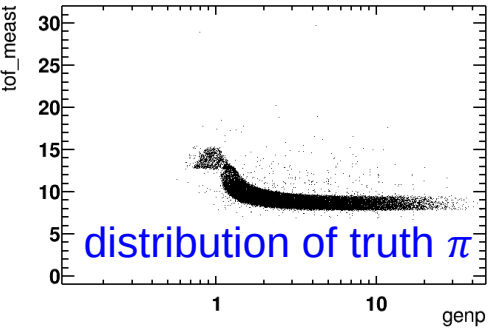
p_{gen} 0-20 GeV

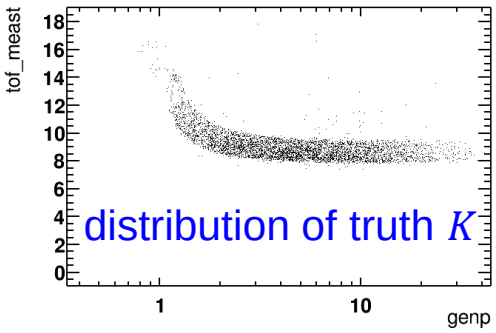
θ_{gen} 40-50 degree

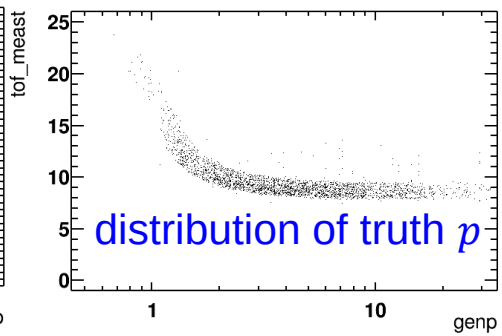




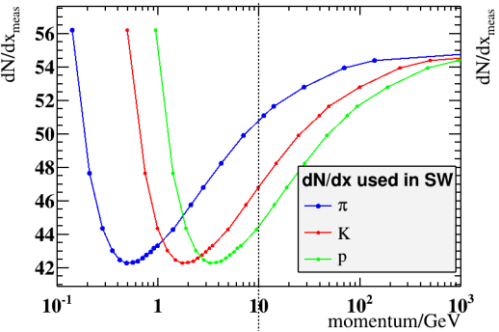


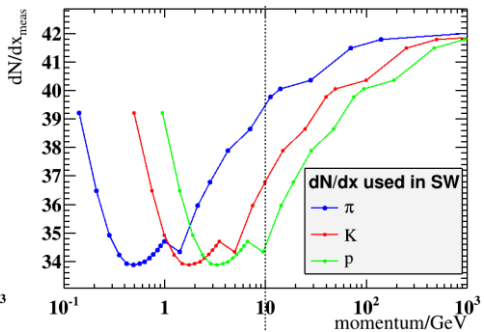






Strange bump in tof_meast of low-momentum pion





LUT at cosθ=0.643 and 0.766

Match with the dN/dx distribution

Backup

$$\chi_{\mathrm{TPC}}(i) = \frac{(dN/dx)_{\mathrm{meas}} - (dN/dx)^{i}_{\mathrm{exp}}}{\sigma_{(dN/dx)_{\mathrm{meas}}}}, i = \pi/K/p$$

$$\chi_{\mathrm{TOF}}(i) = \frac{t_{\mathrm{meas}} - t^{i}_{\mathrm{exp}}}{\sigma_{t_{\mathrm{meas}}}}, \sigma_{t_{\mathrm{meas}}} = \sqrt{0.05^2 + 0.02^2}$$

$$\chi^2(i) = \chi^2_{\mathrm{TOF}}(i) + \chi^2_{\mathrm{TPC}}(i)$$

$$\chi(i) = \sqrt{\chi^2(i)}$$

$$\mathrm{Efficiency}_{\mathrm{tot}}(i) = \mathrm{Efficiency}_{\mathrm{trk}}(\mathrm{TPC/TOF}) \times \mathrm{Efficiency}_{\mathrm{PID}}(i)$$

$$\mathrm{Efficiency}_{\mathrm{trk}}(\mathrm{TPC}) = \frac{N^{\mathrm{TPC}}_{\mathrm{trk}}}{N^{\mathrm{reco}}_{\mathrm{trk}}}$$

$$\mathrm{Efficiency}_{\mathrm{PID}}(i) = \frac{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}\left(\chi^2(i) < \chi^2(j)\right)}{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}} (j \neq i)$$

$$\mathrm{purity}(K) = \frac{N_{K\to K}}{N_{K\to K} + N_{\pi\to K} + N_{p\to K}}$$

$$\mathrm{Efficiency}_{\mathrm{opti.\ PID}}(i) = \frac{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}(a < \chi(i \to i) < b)}{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}}$$

$$\mathrm{purity}_{\mathrm{opti.}}(K)$$