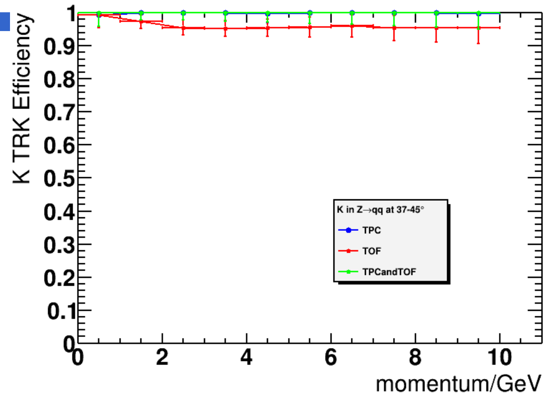
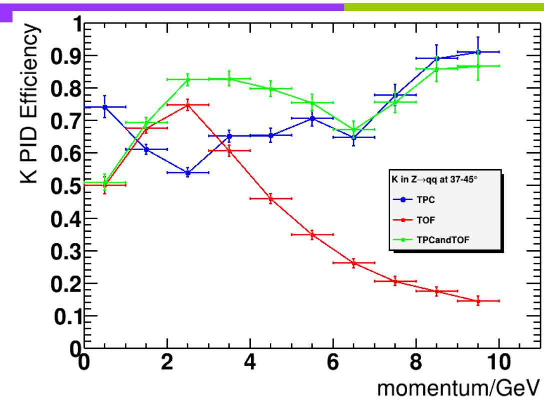
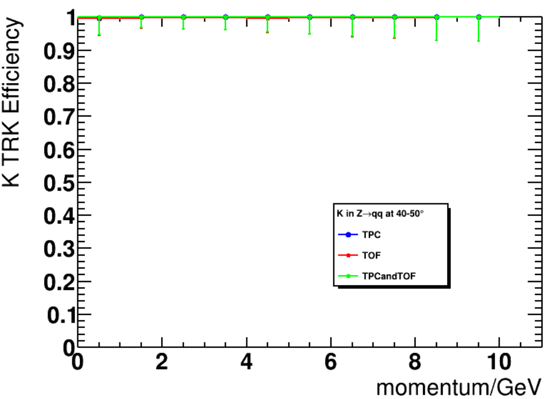
PID efficiency study

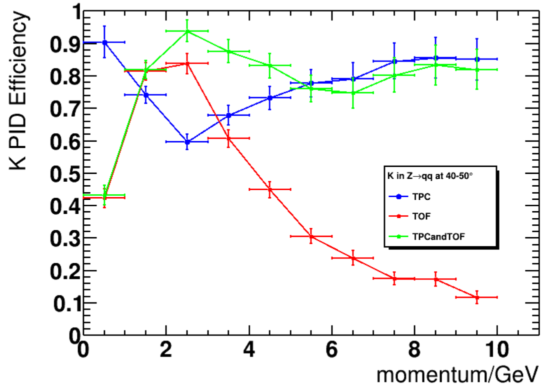
- Perform efficiency study in physical process $Z \rightarrow qq$
  - Calculate efficiency and purity in all phase space using minimum χ^2 PID
  - Lower degree has lower PID efficiency
  - To understand dip in efficiency
- Samples used
  - Release version: CEPCSW_tdr24.12.0
  - $Z \rightarrow qq$ 100000 events ($\mathrm{truth}\ \pi$: K: p = 1478354: 206389: 90225)

PID efficiency comparison with ParticleGun



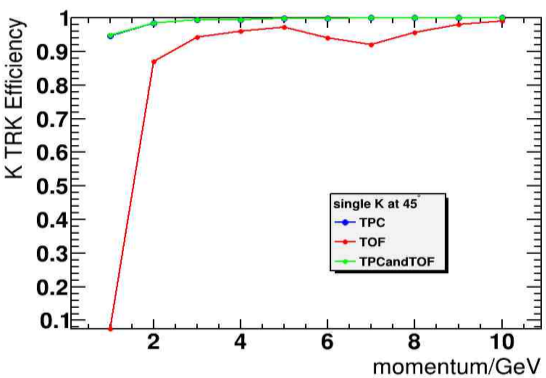


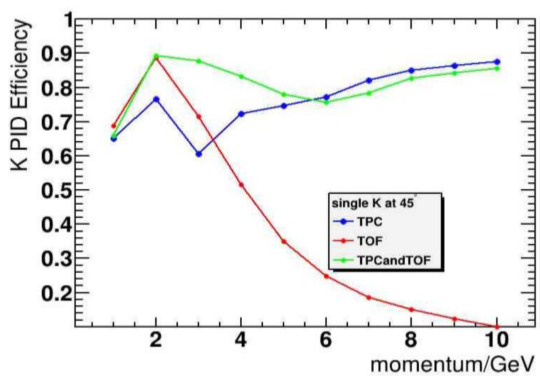




K in $Z \rightarrow qq$ efficiency at (37-45 degree)/(40-50 degree)

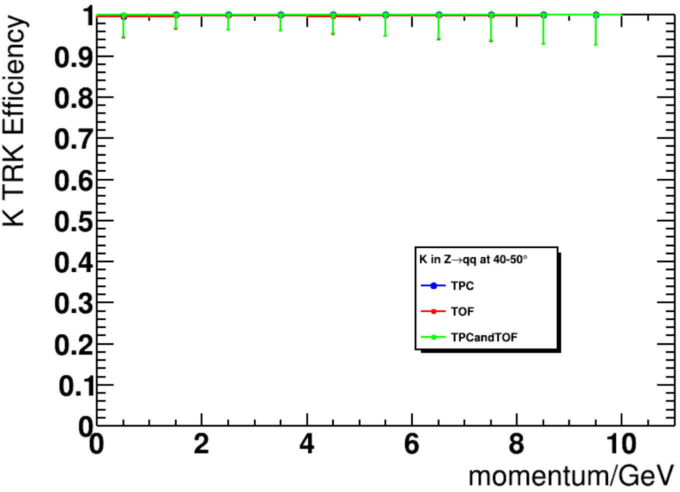
- lower degree has lower efficiency
- 40-50 degree efficiency match with particlegun at 45 degree

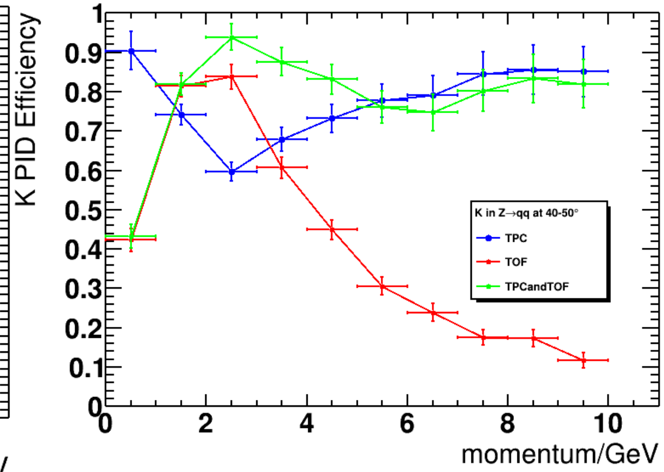


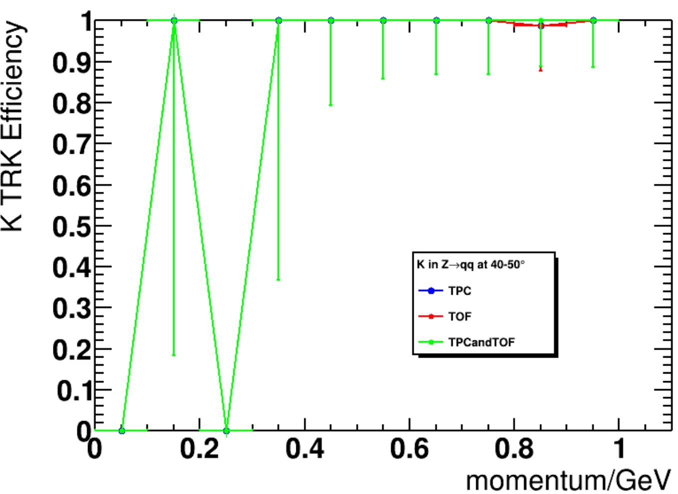


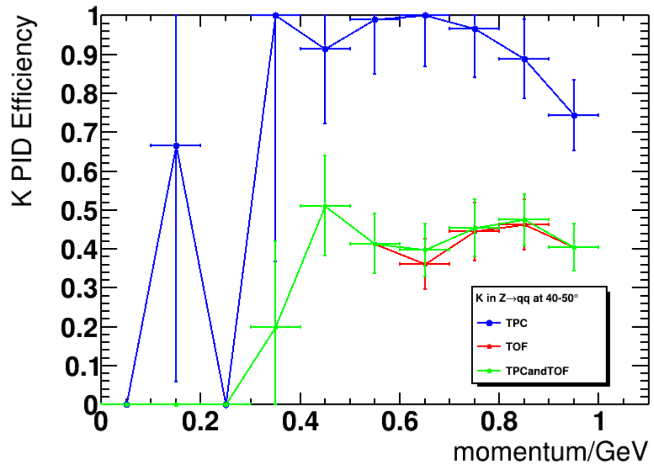
ParticleGun's K efficiency at 45 degree

PID efficiency comparison with low momentum





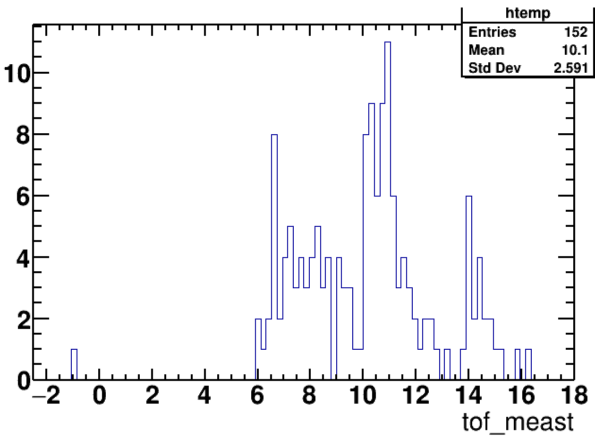




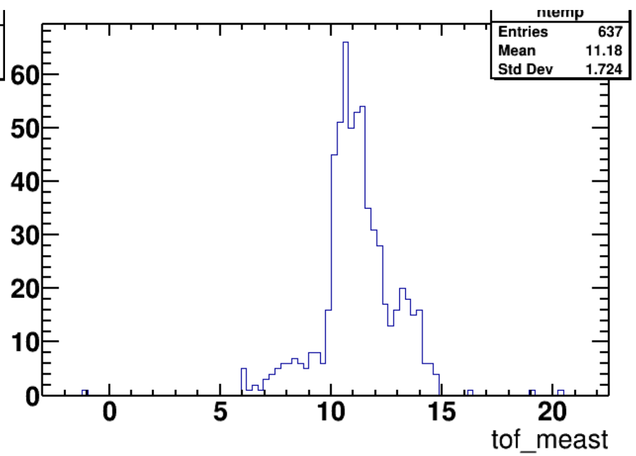
K in $Z \rightarrow qq$ efficiency at 40-50 degree

- From 0-10GeV
- From 0-1GeV

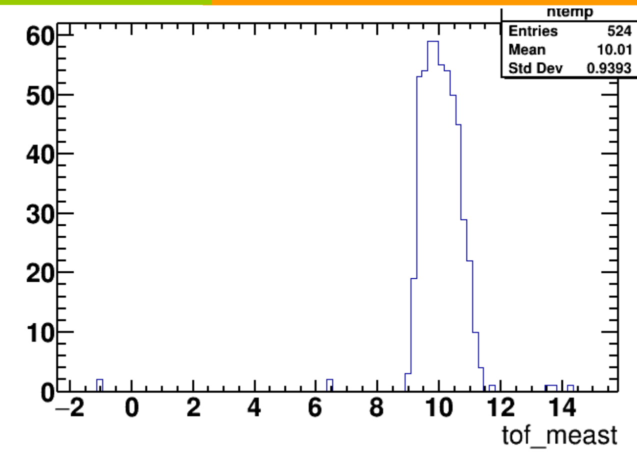
K in $Z \to qq$ at 40-50 degree



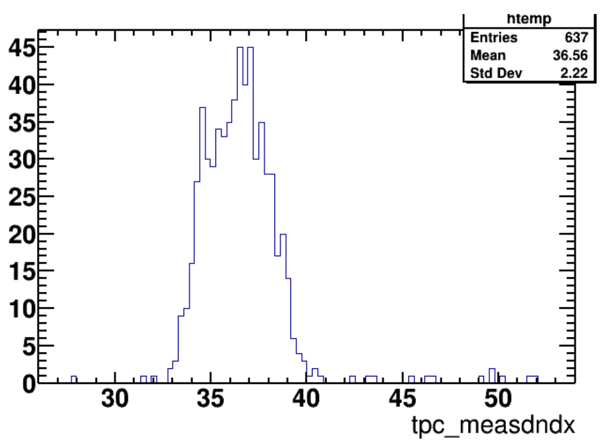
0-1GeV



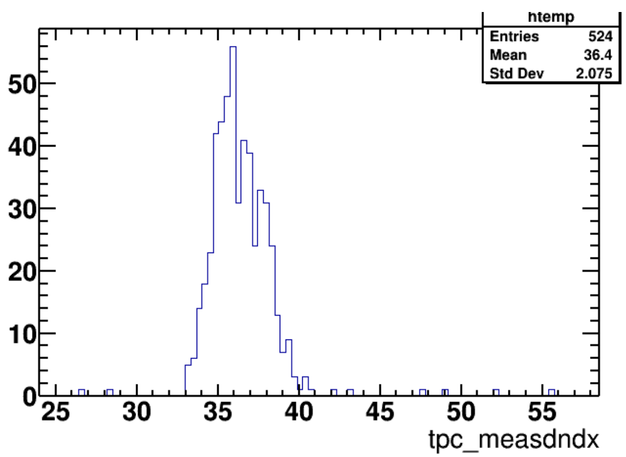
1-2GeV



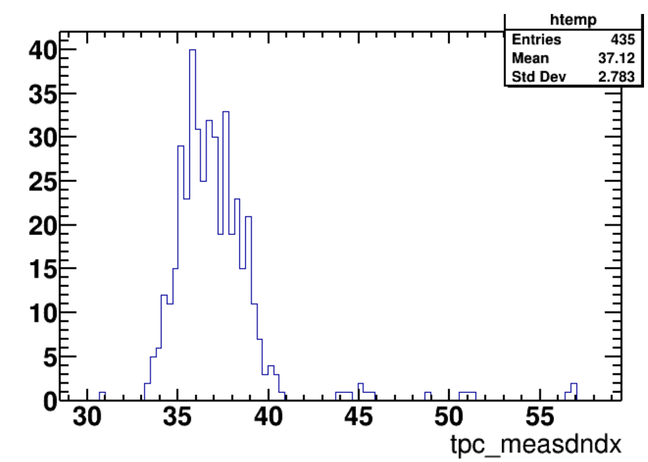
2-3GeV



1-2GeV

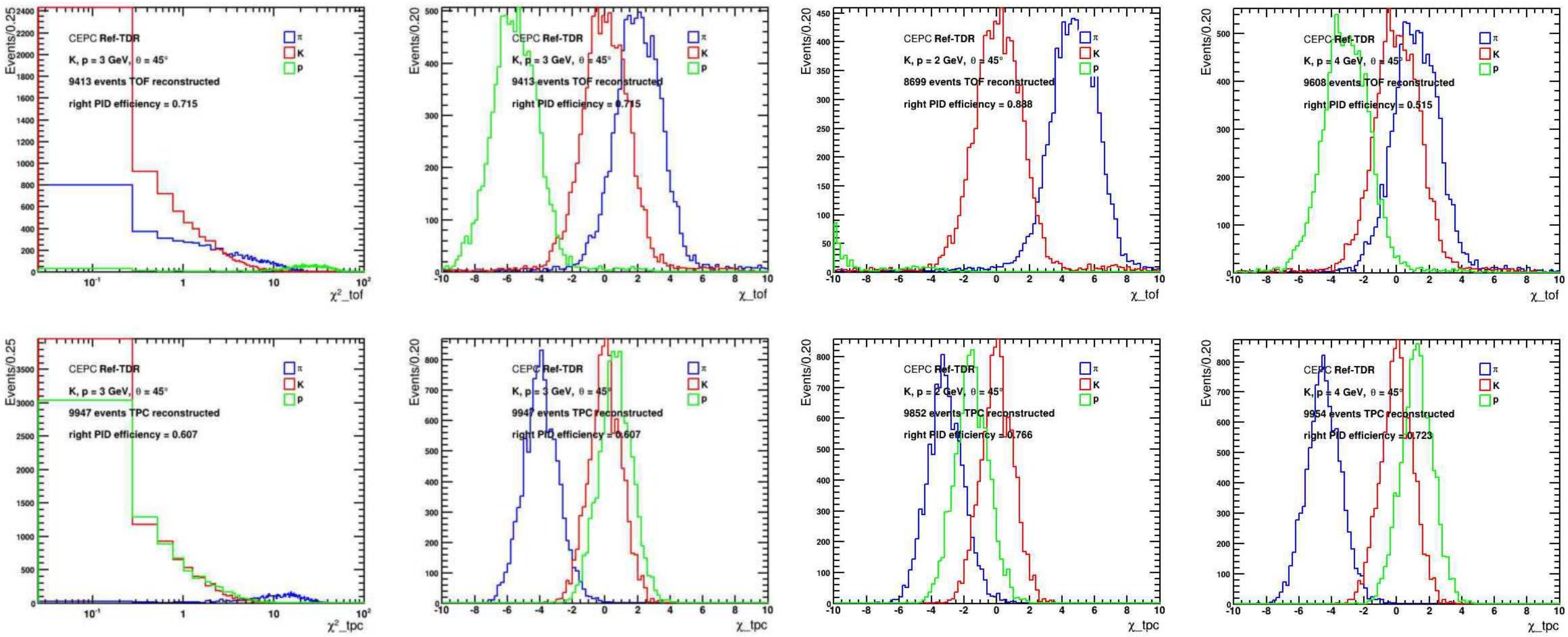


2-3GeV

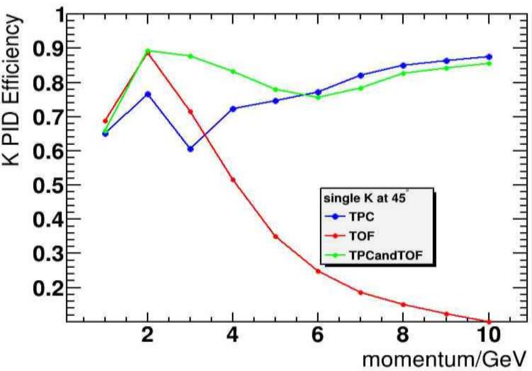


3-4GeV

PID efficiency dip around 3 GeV



Chi distribution at 3GeV/2GeV/4GeV



ParticleGun's K PID efficiency
at 45 degree

Backup

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

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

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

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

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

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

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

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

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

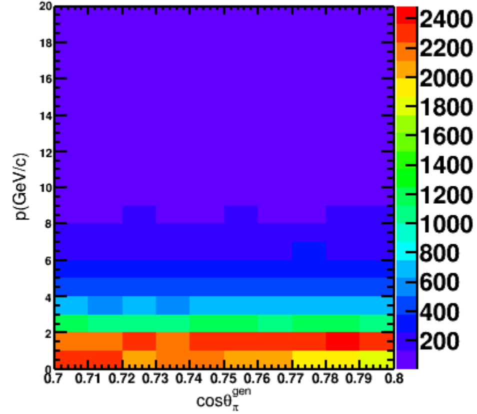
$$\mathrm{purity}_{\mathrm{opti.}}(K)$$

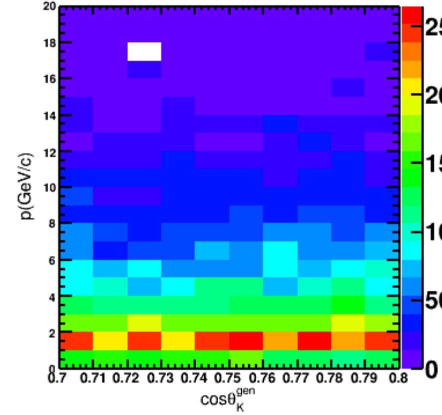
Phase space

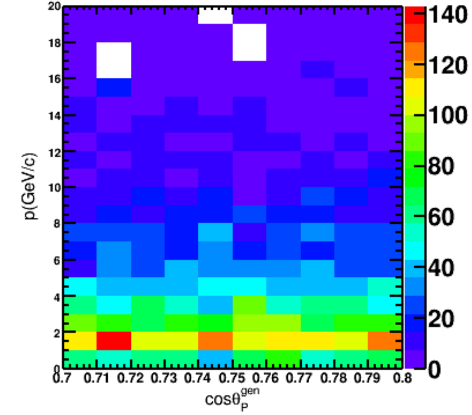
$(p_{gen}, \cos\theta_{gen})$

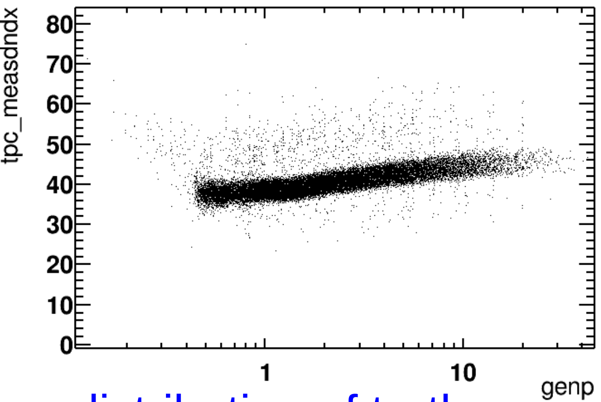
p_{gen} 0-20GeV

$\cos\theta_{gen}$ 0.7-0.8



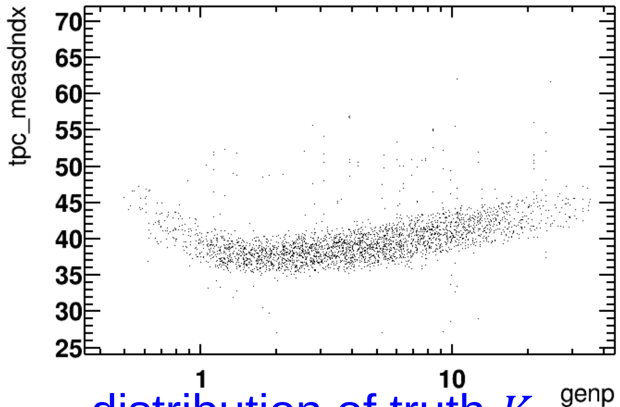






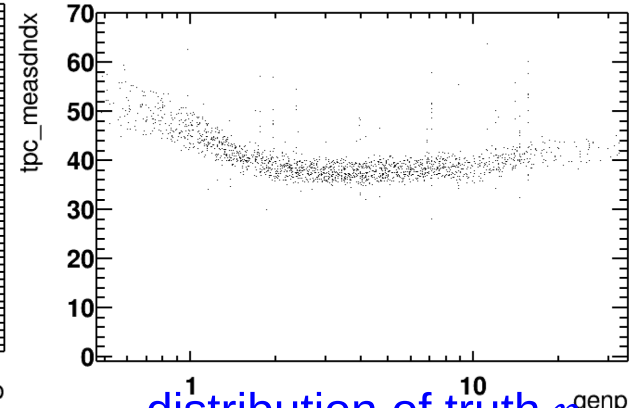
distribution of truth π

25035/26756 = 93.57%



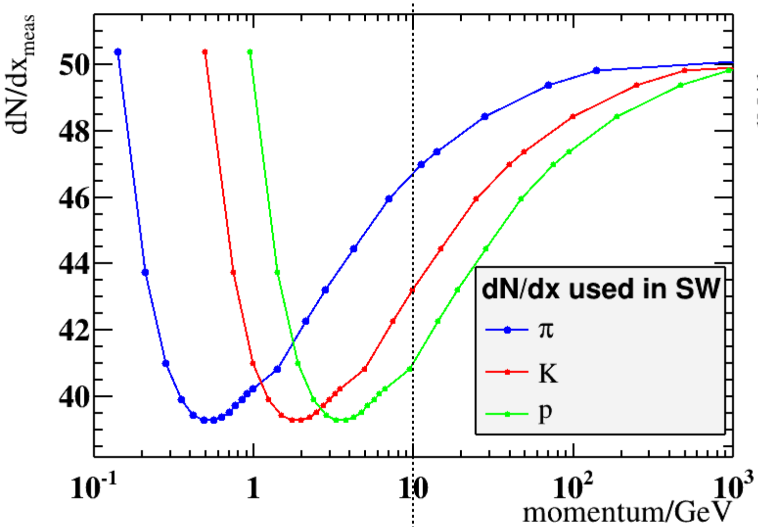
distribution of truth K

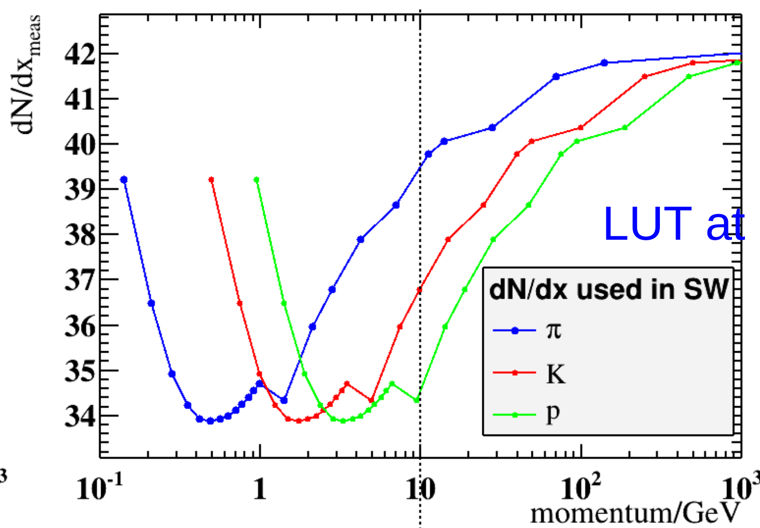
2940/3779 = 77.80%



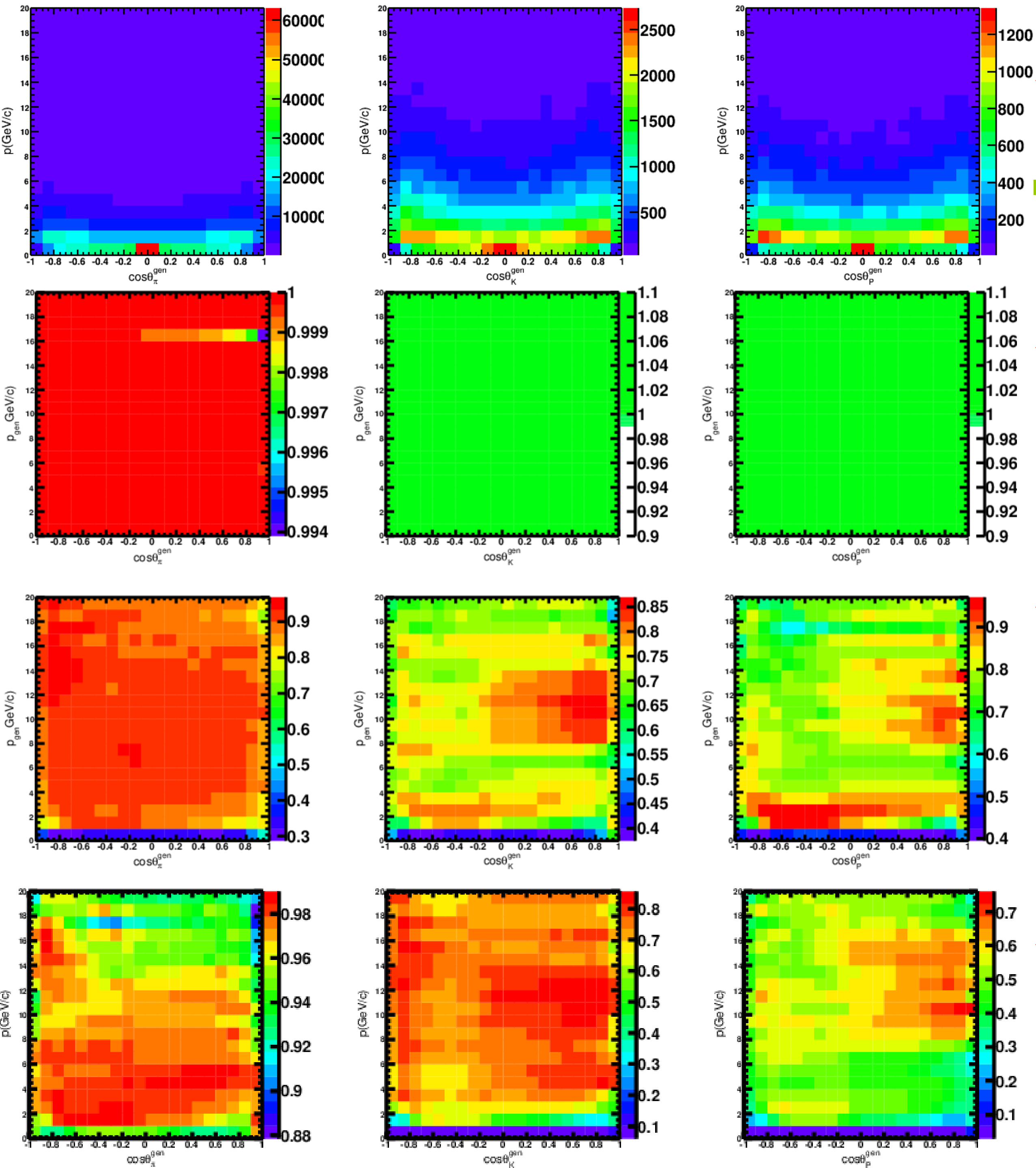
distribution of truth p

1795/1795 = 100%





LUT at $\cos\theta$=0.7 and 0.8



- Phase space $(p_{\text{gen}}, \cos\theta_{\text{gen}})$ 0-20GeV
- Track efficiency distribution of truth $\pi/K/p$ (have dN/dx or t)
- PID efficiency distribution of truth $\pi/K/p$ (minimum combined χ^2)
- Purity distribution of truth $\pi/K/p$