PID efficiency study -- Status

- Summary of efficiency study in physical process $Z \rightarrow qq$
  - Analysis package “AnalysisPIDAlg” is ready for PID studies with more info.
    - Usage: ./run.sh AnalysisPID.py (waiting for being merged to master)
    - Input: track.toot ("CompleteTracks“, "CompleteTracksParticleAssociation“, "DndxTracks”, "RecTofCollection")
    - Output: pid.root

genp	PDG	tpcrecoPD	tofrecoPD	recoPDG
2.0160632	-211	13	11	13
12.237938	-211	-211	-2212	-211
7.4308529	-2212	-2212	11	-321
1.4640836	-211	-211	11	-211
0.9093410	211	321	9999	321

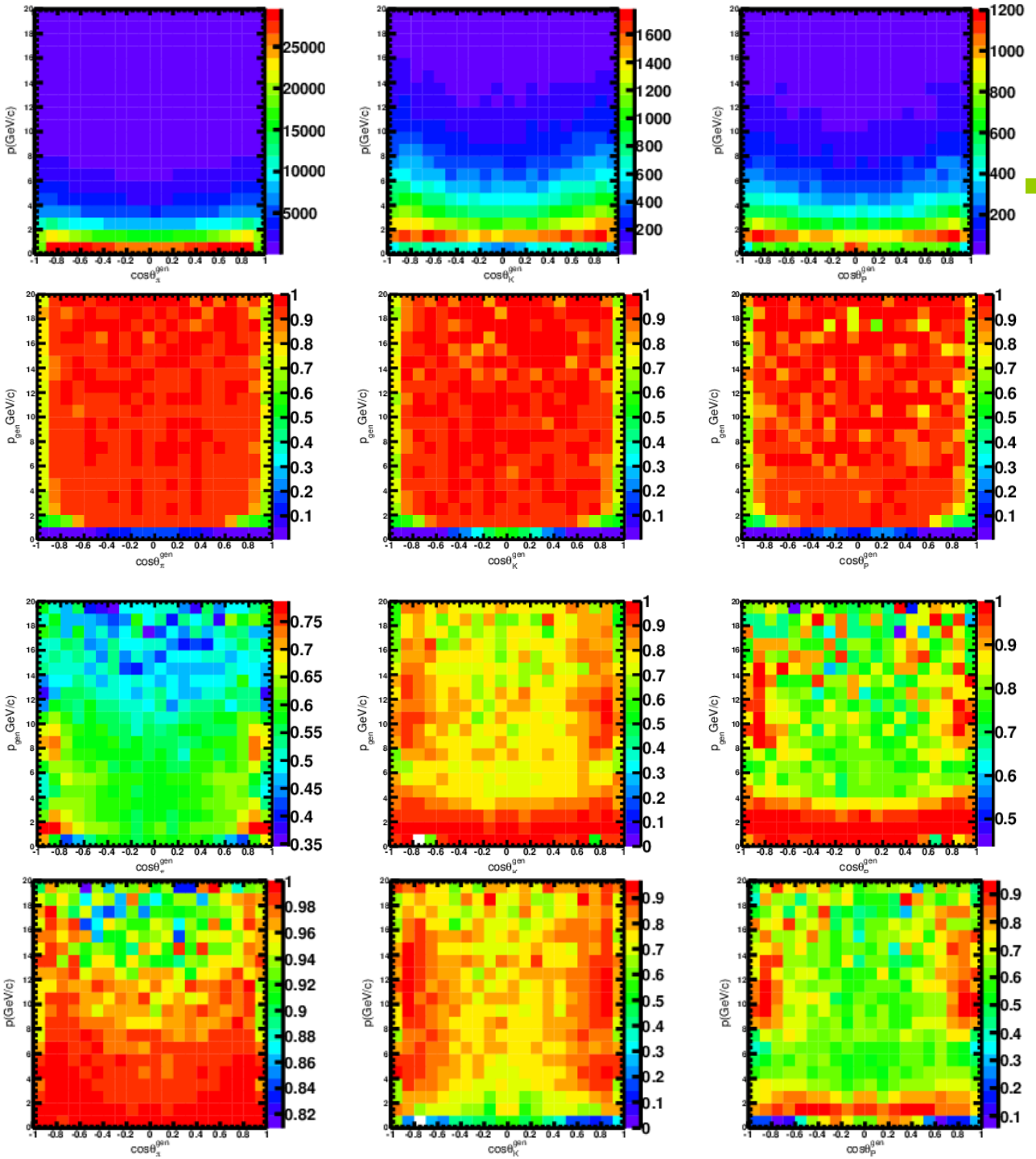
tpc_chi2s	tof_chi2s	tot_chi2s
58.271472	0.0041644	58.275637
1.738e-05	0.0726111	0.0726285
0.9978665	0.1780346	1.1759011
16.148244	20.041910	36.190155
6.2707228	238.66332	244.93404

matchedto	matchedtp
1	1
1	1
1	1
1	1
0	1

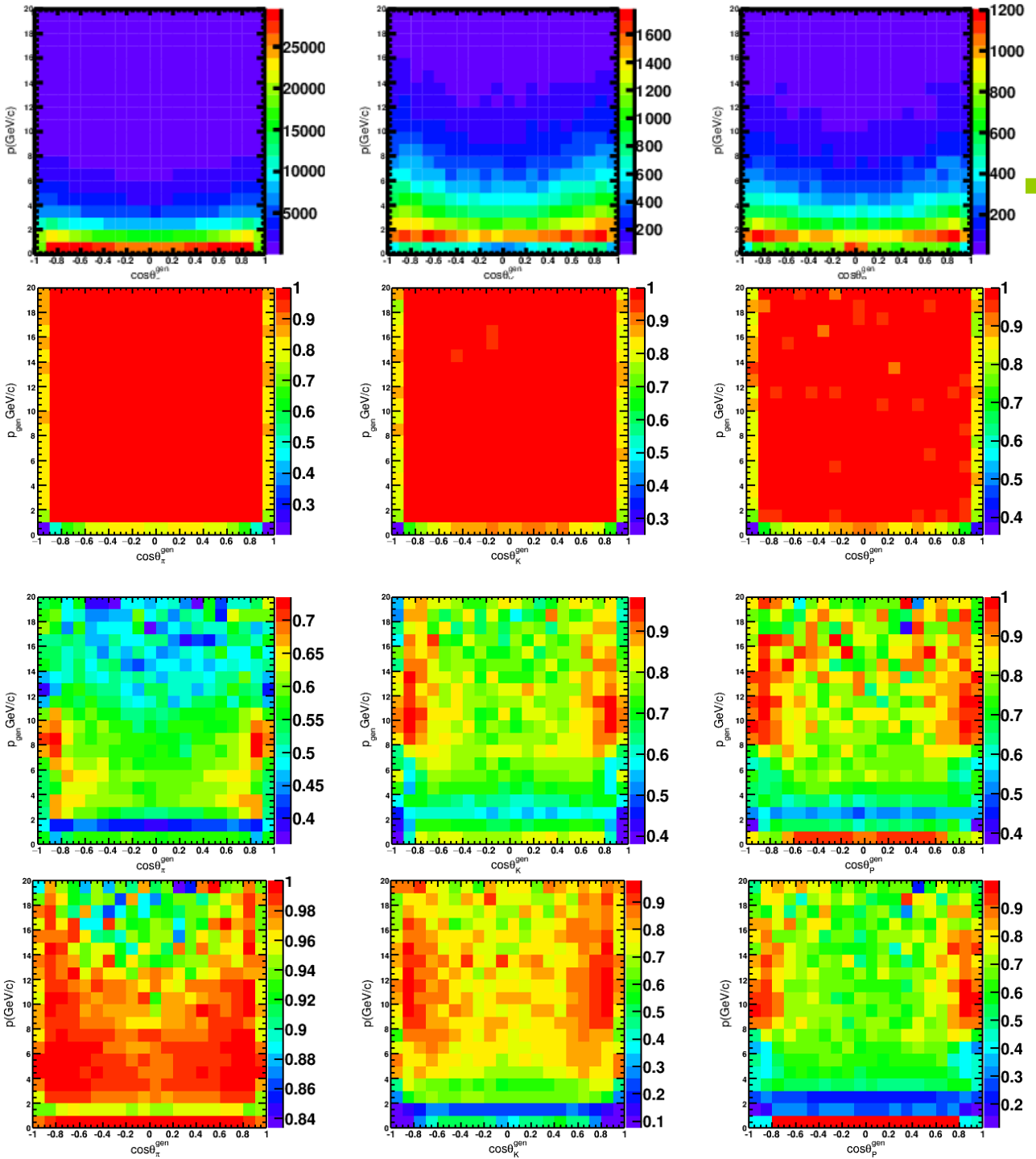
  - TPC/ToF PID performance of stable $\pi/K/p$ identification
    - Asymmetry in dndx fixed by G. Z.
    - PID chi2 comparison include e/mu instead of pi/K/p only

- Samples used under CEPCSW_tdr24.12.0 -- master
  - $Z \rightarrow qq$ 100000 events (truth π: K: p = 1717145: 226778: 93635)
    - stable π: K: p = 1494874: 167837: 93635 (simulatorStatus==0)

Efficiency and purity in $Z \to qq$



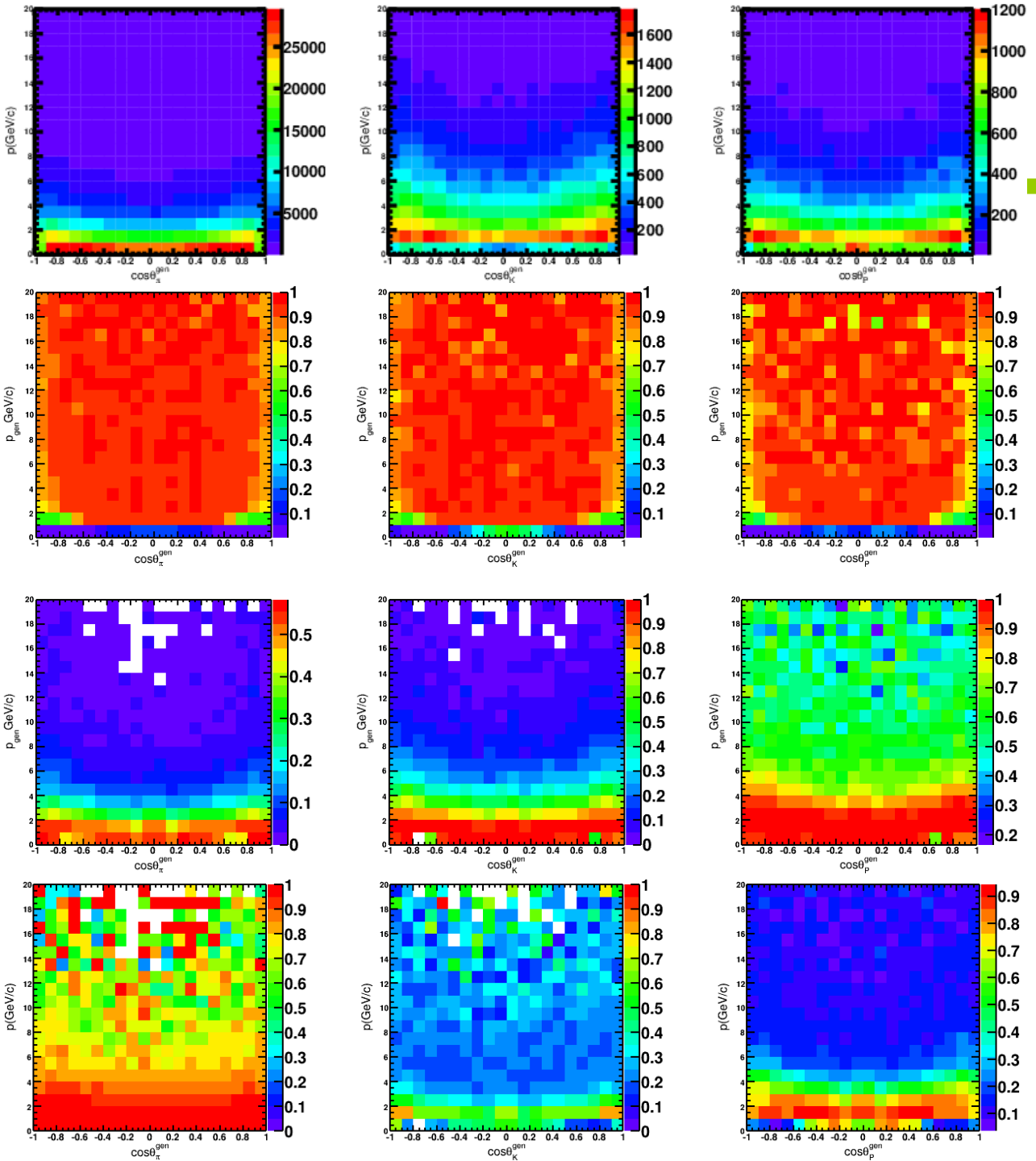
- Track truth phase space ($p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}}$)
- TPC + ToF Track efficiency in reco tracks
- PID efficiency distribution (minimum TPC + ToF χ^2)
- Purity distribution of track $\pi/K/p$ (have TPC + ToF hit)



Efficiency and purity in $Z \to qq$ TPC only

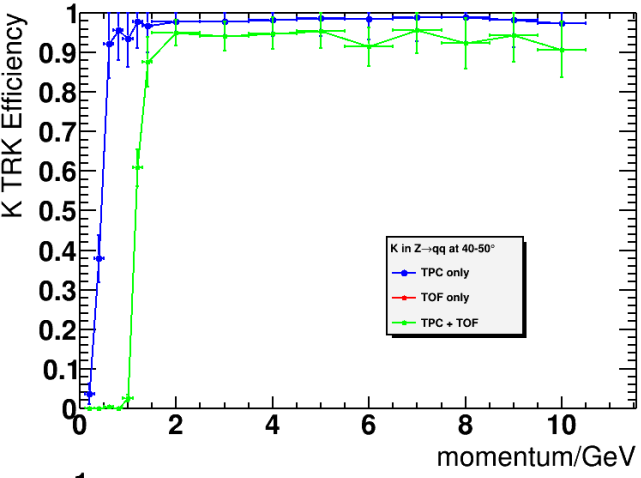
- Track truth phase space ($p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}}$)
- TPC Track efficiency in reco tracks
- PID efficiency distribution (minimum TPC χ^2)
- Purity distribution of track $\pi/K/p$ (have TPC hit)

Efficiency and purity in $Z \to qq$ ToF only

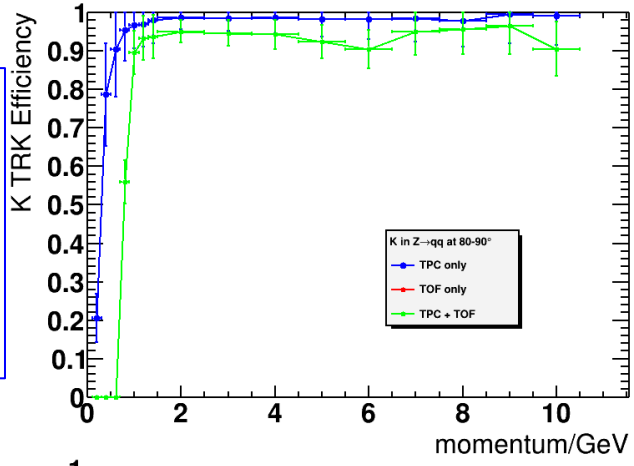


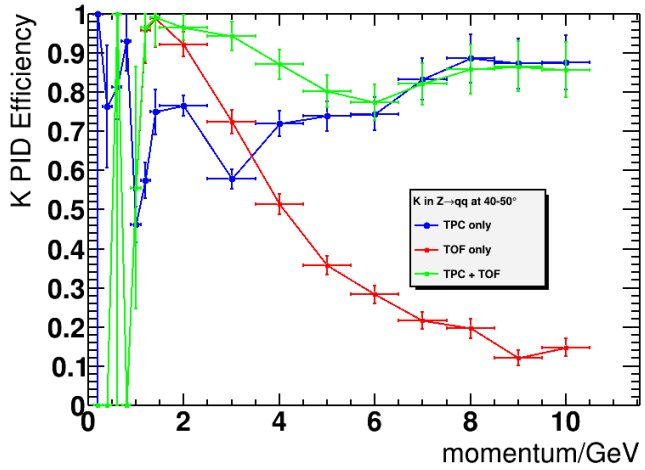
- Track truth phase space ($p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}}$)
- ToF Track efficiency in reco tracks
- PID efficiency distribution (minimum ToF χ^2)
- Purity distribution of track $\pi/K/p$ (have ToF hit)

TPC/ToF TRK/PID efficiency at 40-50 / 80-90 degree for K in $Z \rightarrow qq$

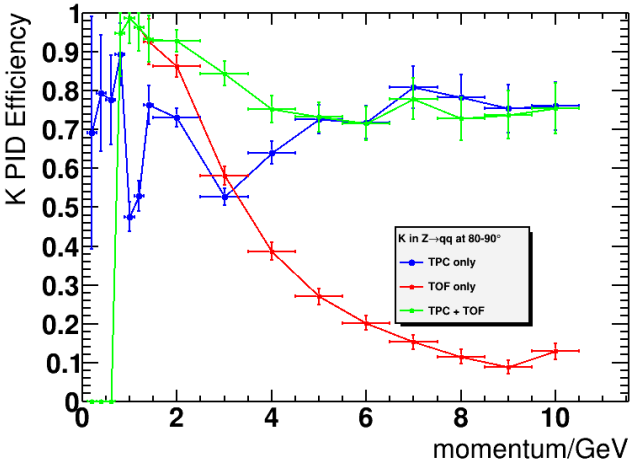


Selection: have track and no decay and truth K
To calculate efficiency of having TPC/ToF track in reco tracks



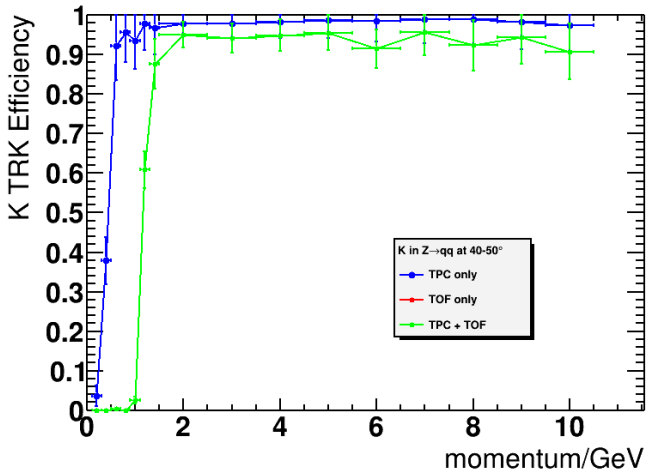


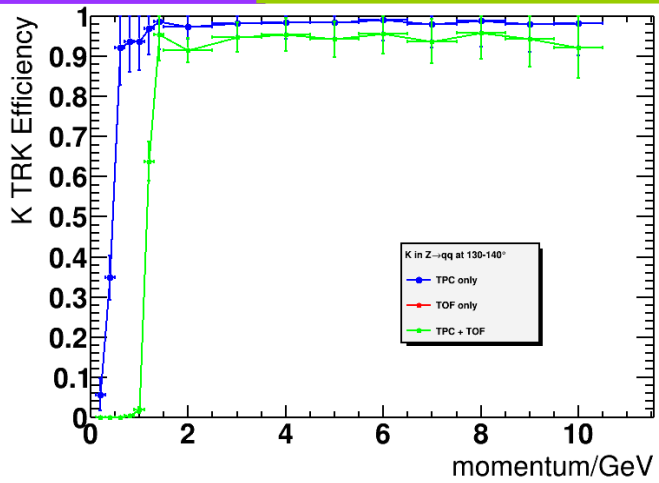
Selection: have TPC/ToF track and no decay and truth K
To calculate efficiency of right PID

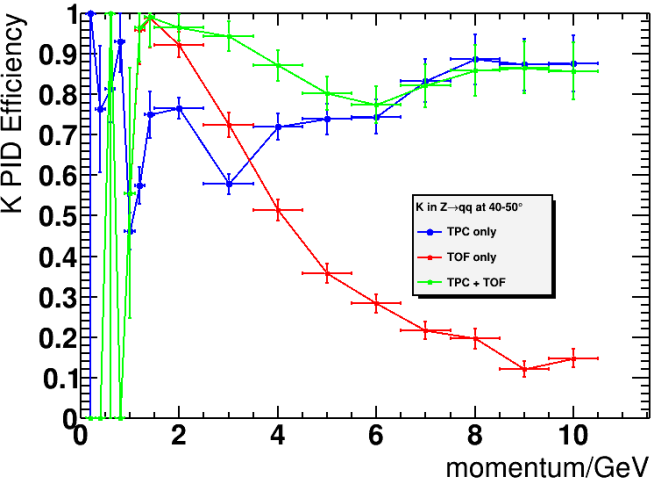


K in $Z \rightarrow qq$ efficiency at 40-50 / 80-90 degree

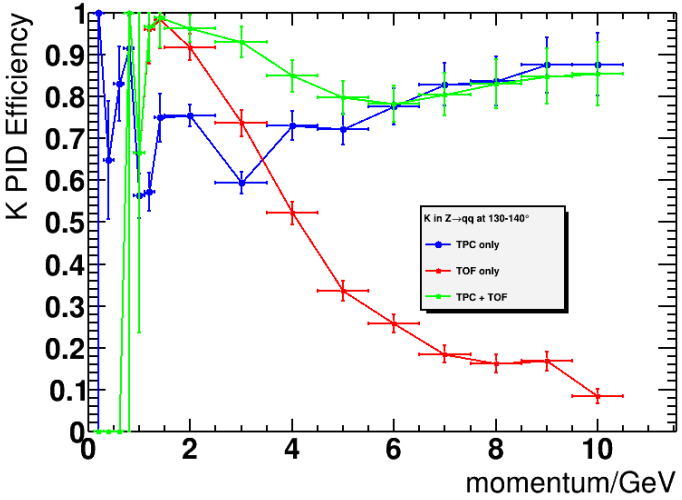
Efficiency asymmetry in $Z \rightarrow qq$







at 40-50 degree



at 130-140 degree

PID efficiency almost the same at 40-50 degree and 130-140 degree

Backup

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

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

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

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

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

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

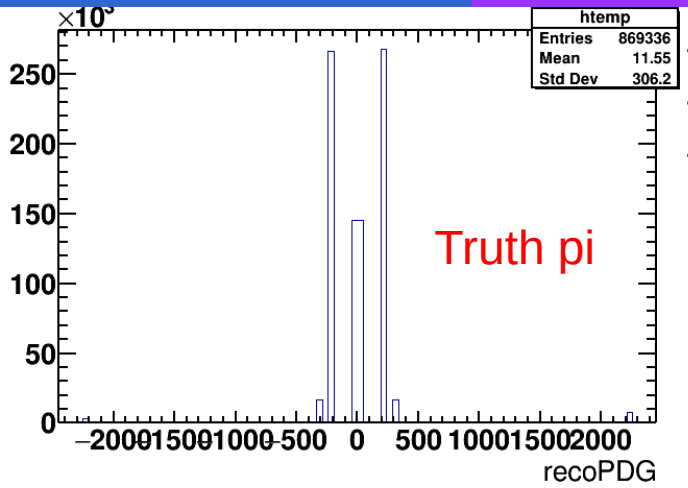
$$\mathrm{Efficiency}_{\mathrm{PID}}(i) = \frac{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}\left(\chi^2(i) < \chi^2(j)\right)}{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}} (j \neq i)$$

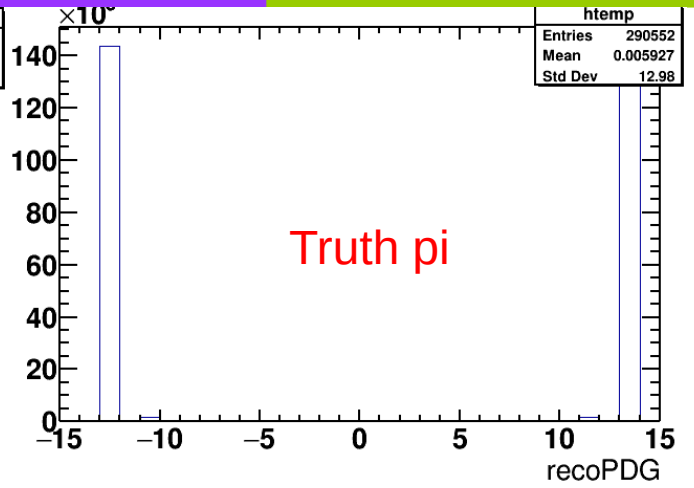
$$\mathrm{purity}(K) = \frac{N_{K\to K}}{N_{K\to K} + N_{\pi\to K} + N_{p\to K}}$$

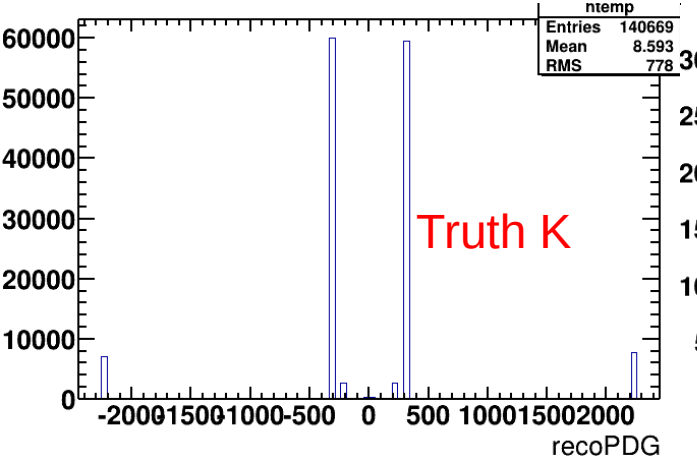
$$\mathrm{Efficiency}_{\mathrm{opti.\ PID}}(i) = \frac{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}(a < \chi(i \to i) < b)}{N^{\mathrm{TPC}}_{\mathrm{trk}(i)}}$$

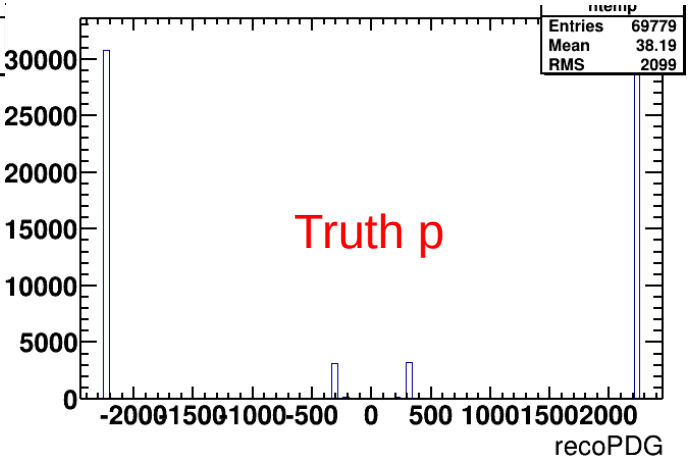
$$\mathrm{purity}_{\mathrm{opti.}}(K)$$

Truth pi/K/p and no decay









TPC && ToF Hit
pi
K/p