



Φ -meson polarization study in pp collisions at 5.02 TeV with multiplicity

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Polarisation in Helicity and Collins-Soper frame

- Polarisation will help to understanding the production mechanisms of vector particles

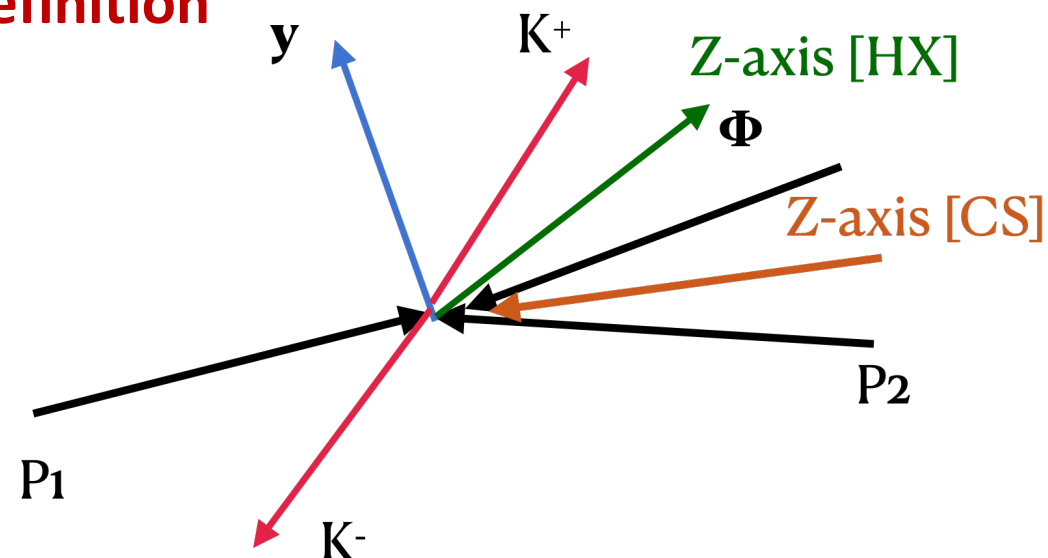
Two reference frames $\Rightarrow$ depending on the z-axis definition

Helicity frame: ✓

Fight direction of the Φ meson in the overall center-of-mass frame

Collins-Soper frame:

The bisector of the angle between the beam and the opposite of the other beam in Φ rest frame



Two body decay angular parametrization

✓

$$W(\cos(\theta), \phi) \propto \frac{1}{3 + \lambda_\vartheta} \cdot [1 + \lambda_\vartheta \cdot \cos^2 \theta + \lambda_\varphi \cdot \sin^2 \theta \cdot \cos(2\phi) + \lambda_{\theta\varphi} \cdot \sin(2\phi)]$$

$\theta \rightarrow$ polar production angle in the Φ meson rest frame

$\varphi \rightarrow$ azimuthal production angle in the Φ meson rest frame

$\lambda \rightarrow$ represents various polarization parameters depended on the Φ meson production spin density matrix elements

$(\lambda_\vartheta, \lambda_\varphi, \lambda_{\theta\varphi}) = (0, 0, 0,) \rightarrow$ no polarisation

$(\lambda_\vartheta, \lambda_\varphi, \lambda_{\theta\varphi}) = (-1, 0, 0,) \rightarrow$ longitudinal polarisation

$(\lambda_\vartheta, \lambda_\varphi, \lambda_{\theta\varphi}) = (1, 0, 0,) \rightarrow$ transverse polarisation

Event and track cut details

Decay Channel: $\phi \rightarrow K^+ K^-$

Data Period: LHC17p pass1 (pp@5.02 TeV) and LHC18q, r pass3 (Pb-Pb@5.02 TeV) [AOD]

Event selection (Standard Run-2 Selection)

- kINT7 trigger
- Pileup Rejection using AliAnalysisUtils::IsPileUpEvent()
- event has a track or SPD primary vertex identified
- vertex z position: $|V_z| < 10$ cm

- TPC 2σ with TOF veto 3σ cut is used for the analysis

Centrality: V0M [AliMultSelection Task]

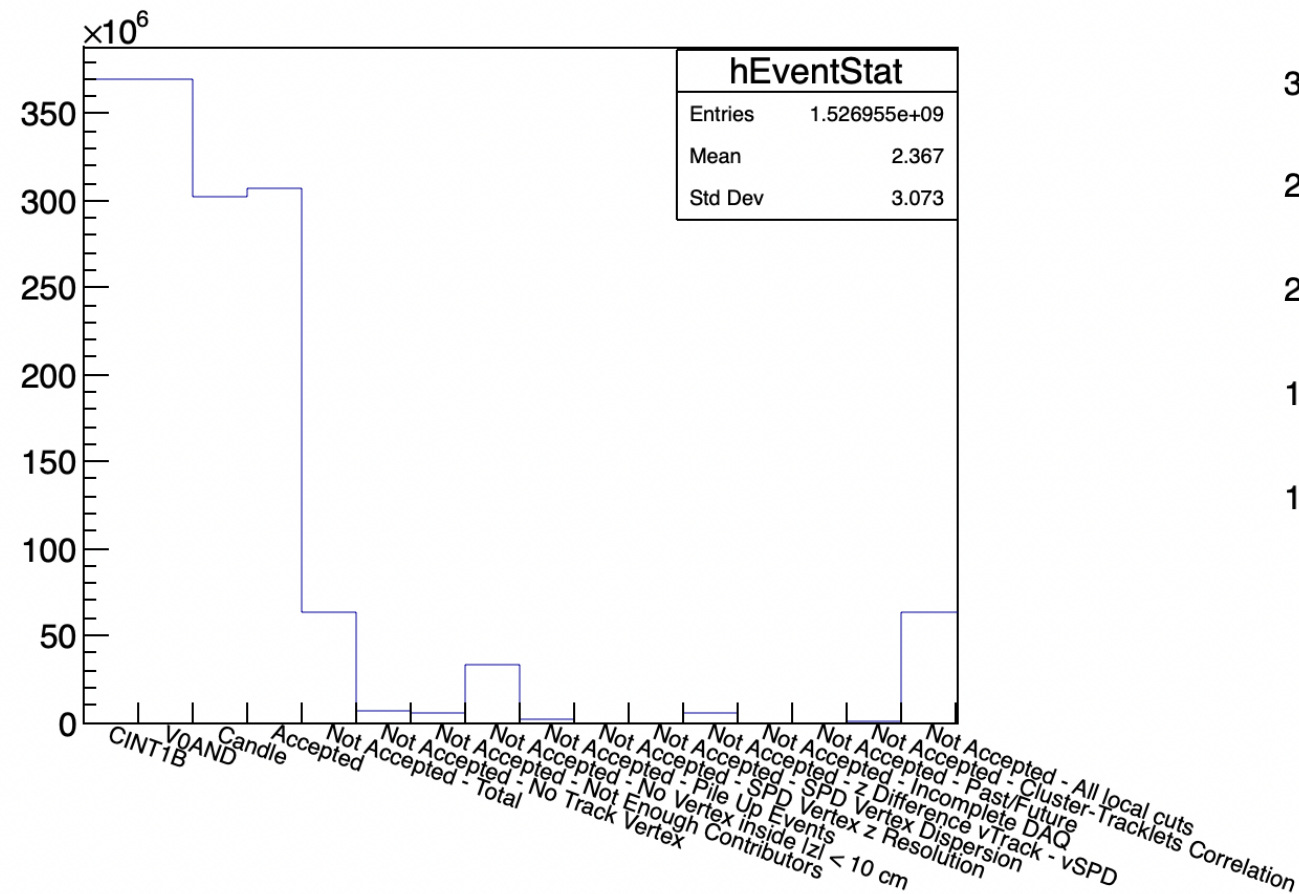
Track selection:

- ✓ Standard ITS TPC TrackCuts 2011
- ✓ η : -0.8 - 0.8 for reconstructed tracks
- ✓ $p_T > 0.15$ GeV/c
- ✓ $|y_{\text{pair}}| < 0.5$

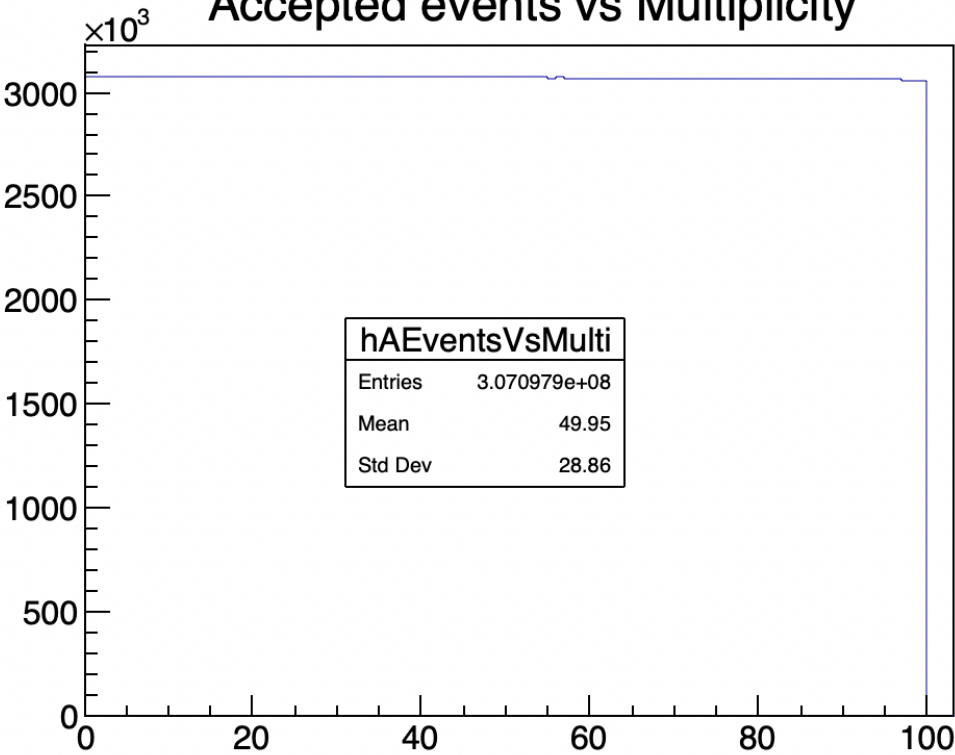
Multiplicity bins: 0-5%, 0-10%, 10-20%, 10-20%, 20-30%, 30-40%, 40-60%, 60-100% and INEL > 0

- Huge statistics with LHC17p pass1 (Accepted events are ~ 300 M)

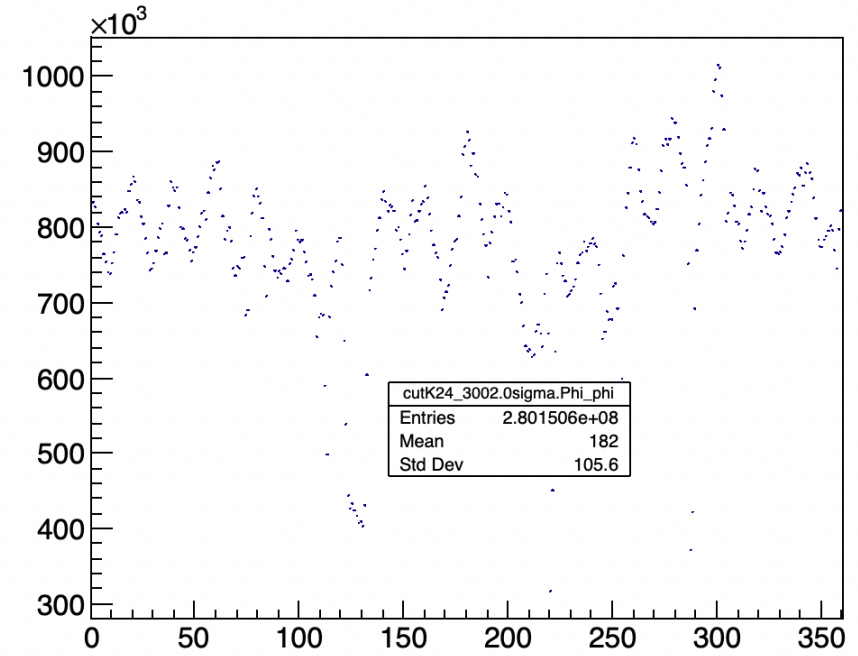
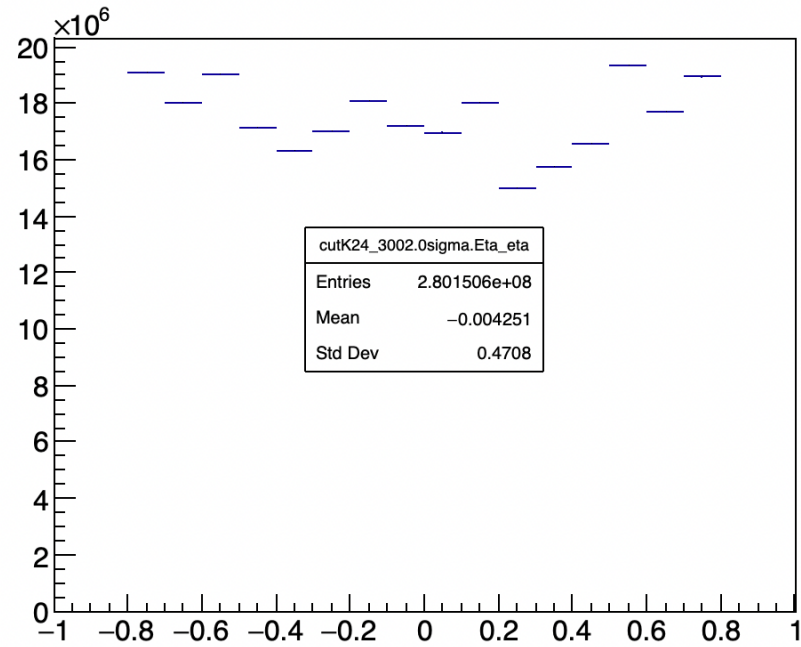
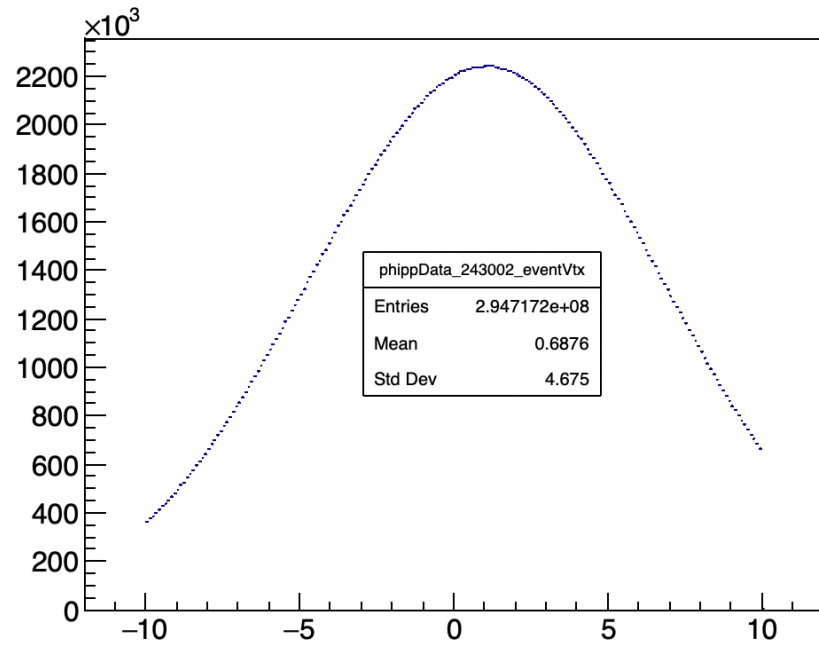
Event statistics



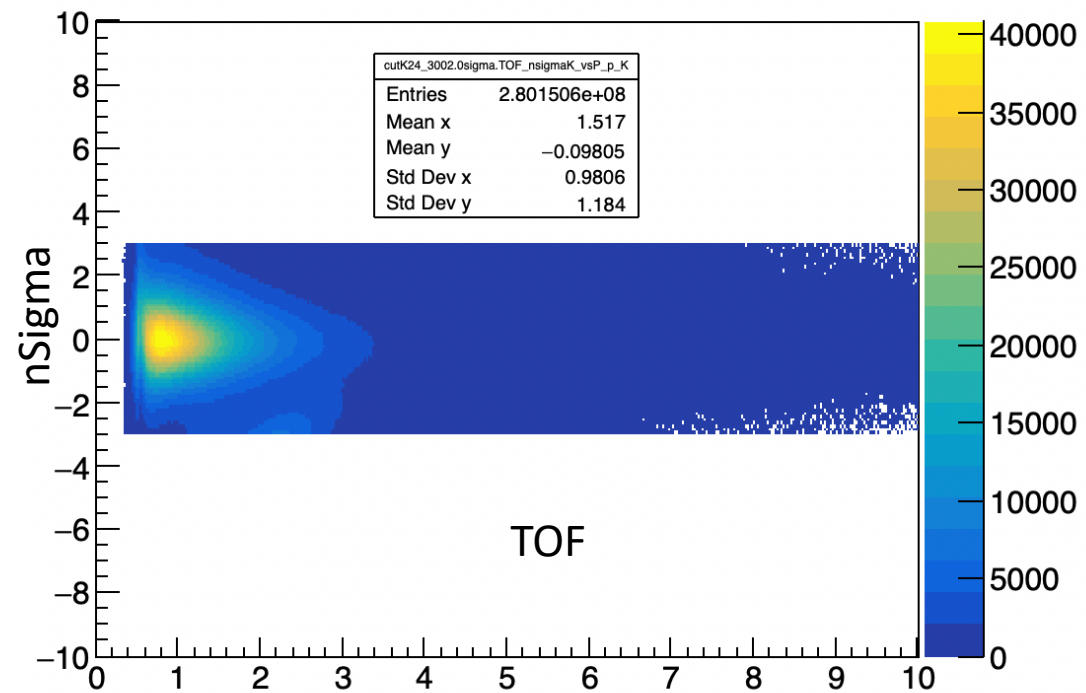
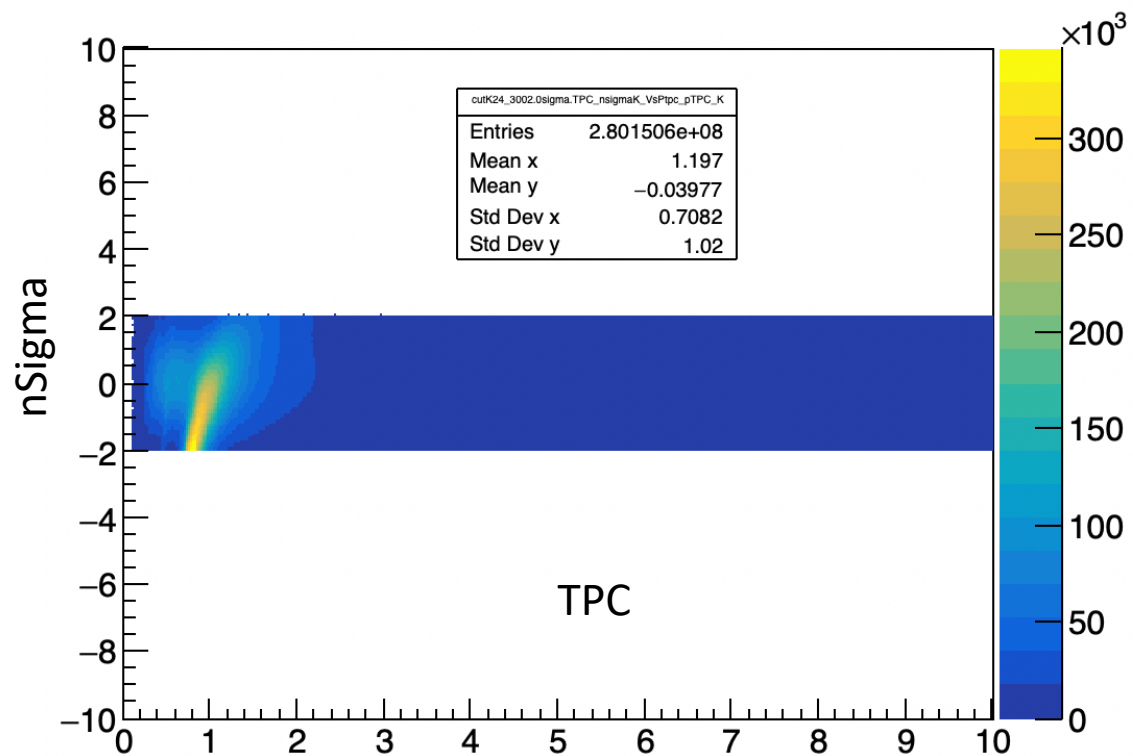
Accepted events vs Multiplicity



Event and track QA

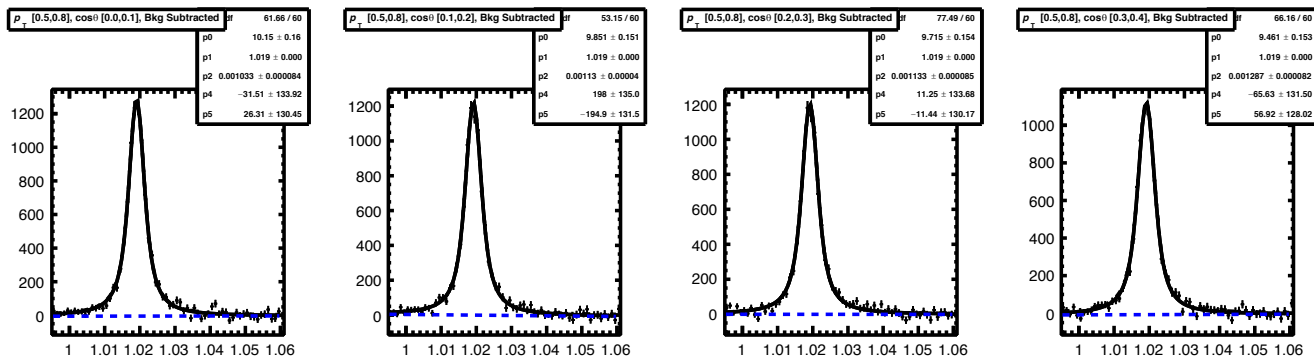


PID QA

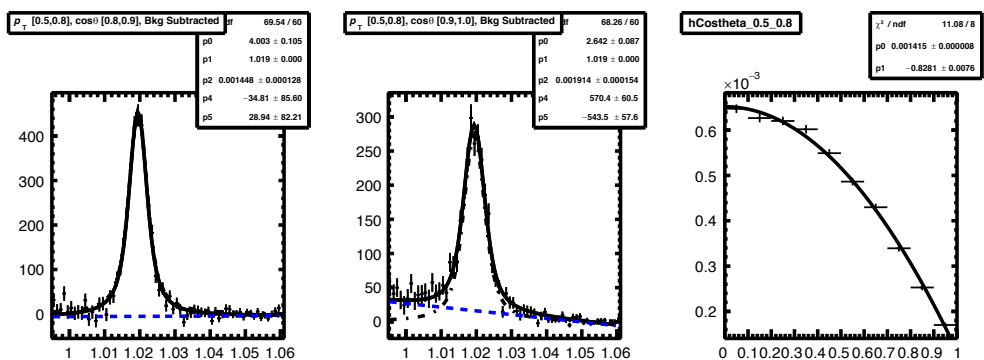
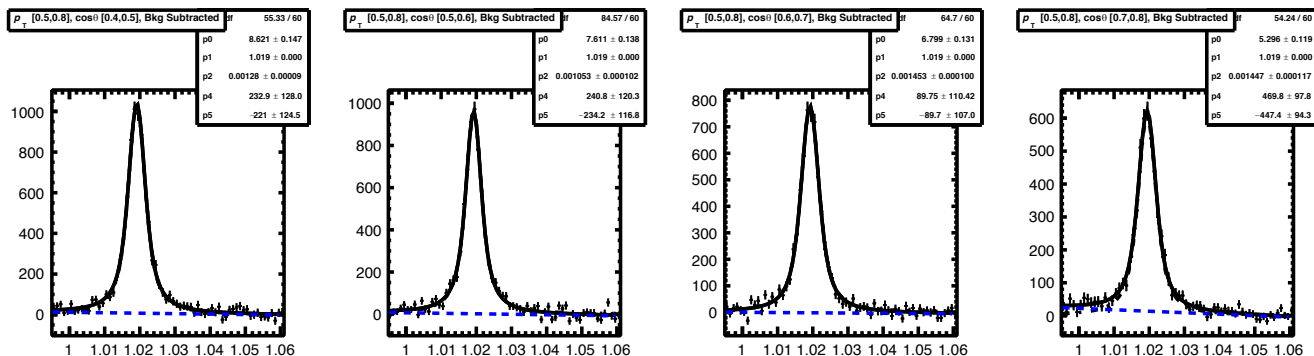


Invariant mass (INEL > 0)

Invariant mass (INEL > 0)

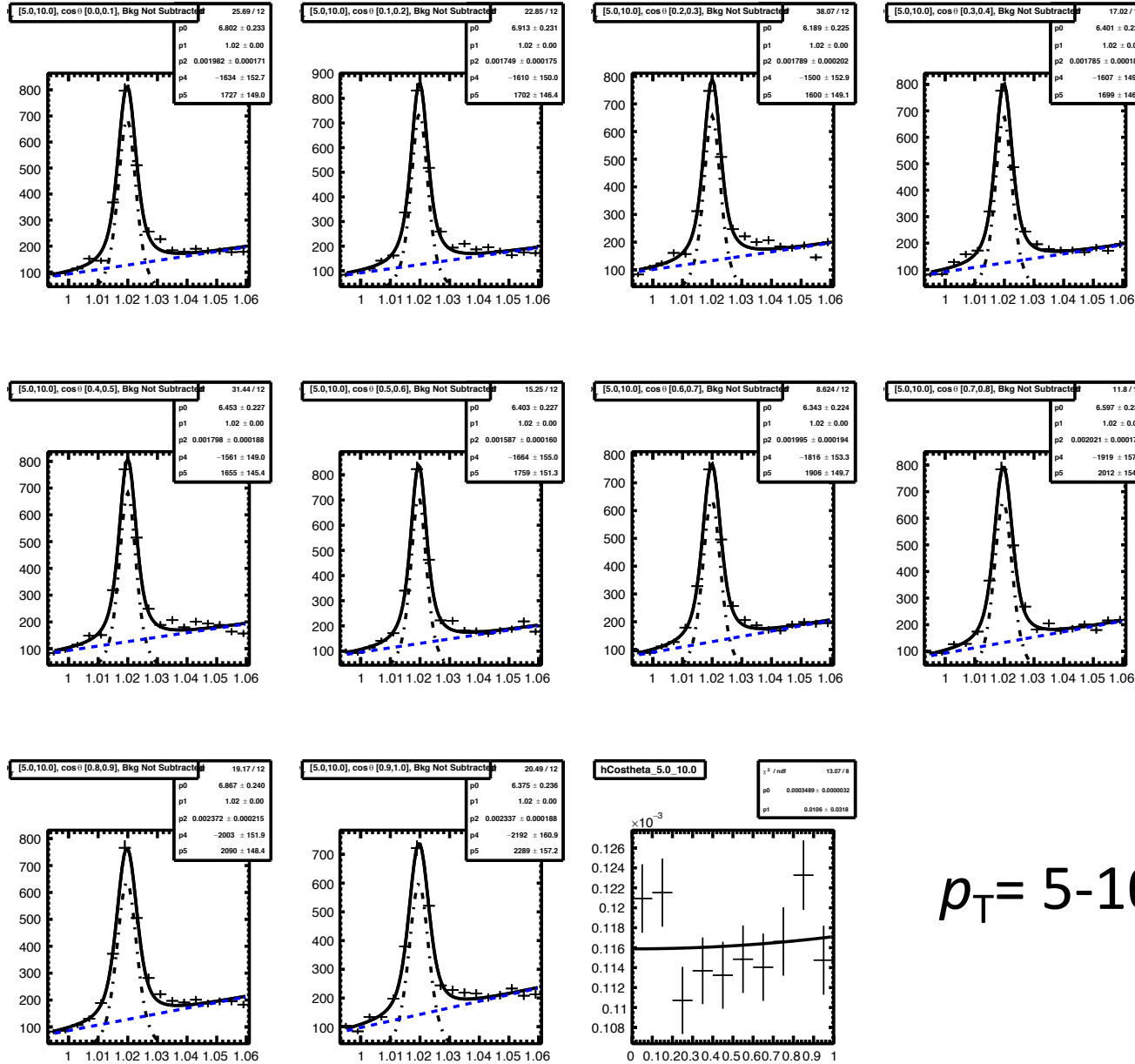


- Very good signal for this analysis in pp collisions



$p_T = 0.5-0.8 \text{ GeV}/c$

Invariant mass (INEL > 0)

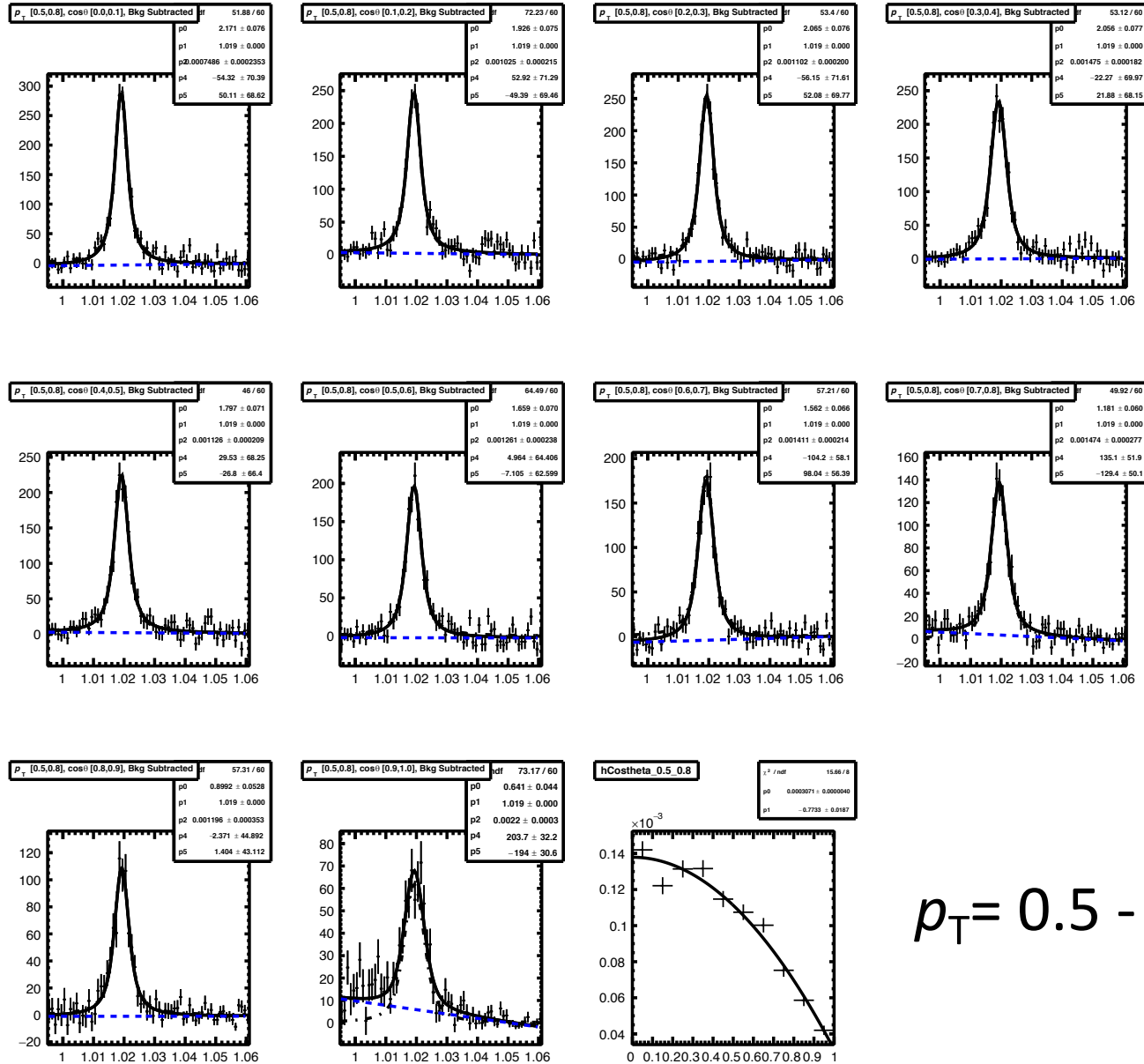


- Very good signal for this analysis in pp collisions

$$p_T = 5-10 \text{ GeV}/c$$

Invariant mass (0-10%)

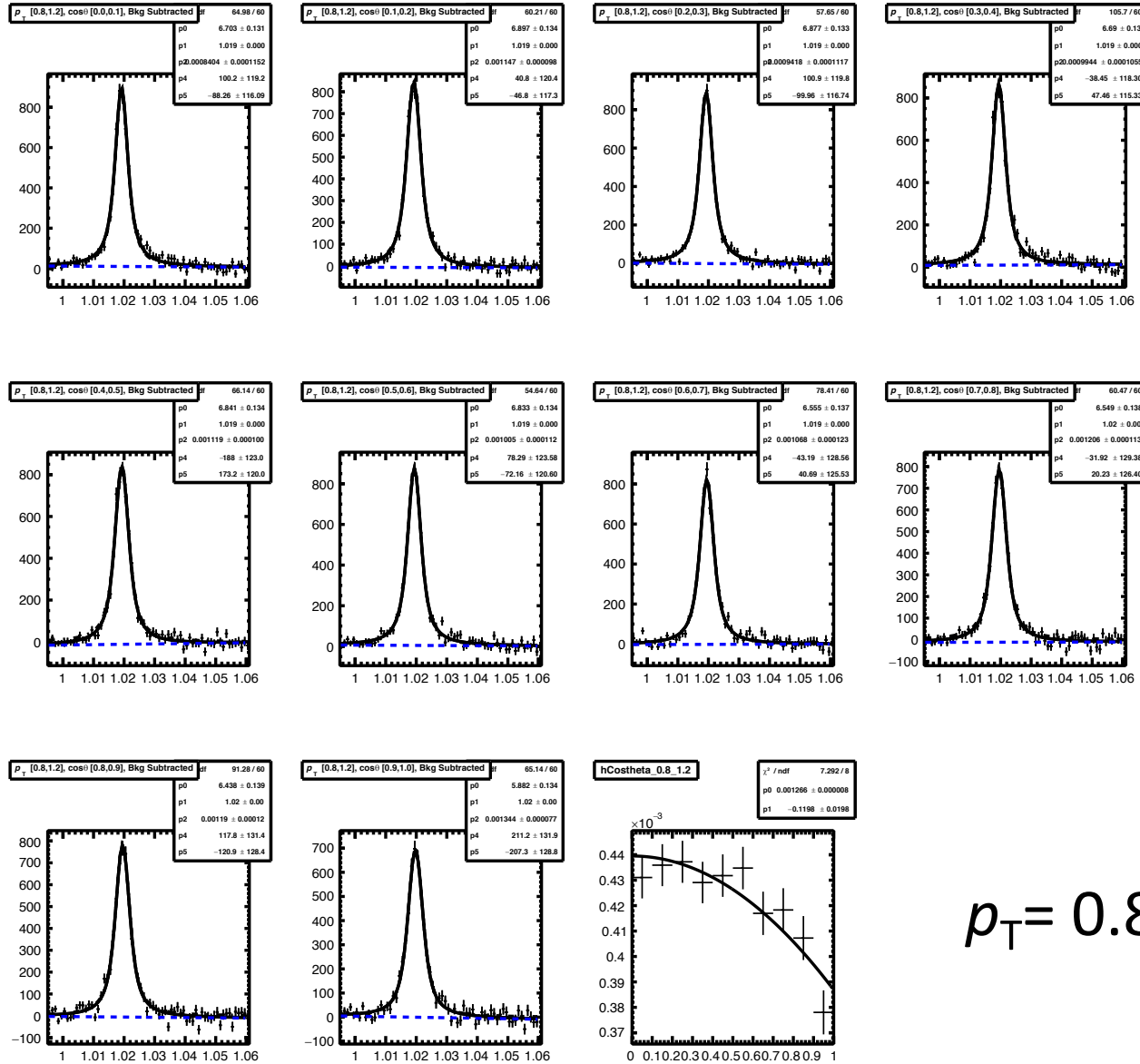
Invariant mass (0-10%)



- Very good signal for this analysis in pp collisions

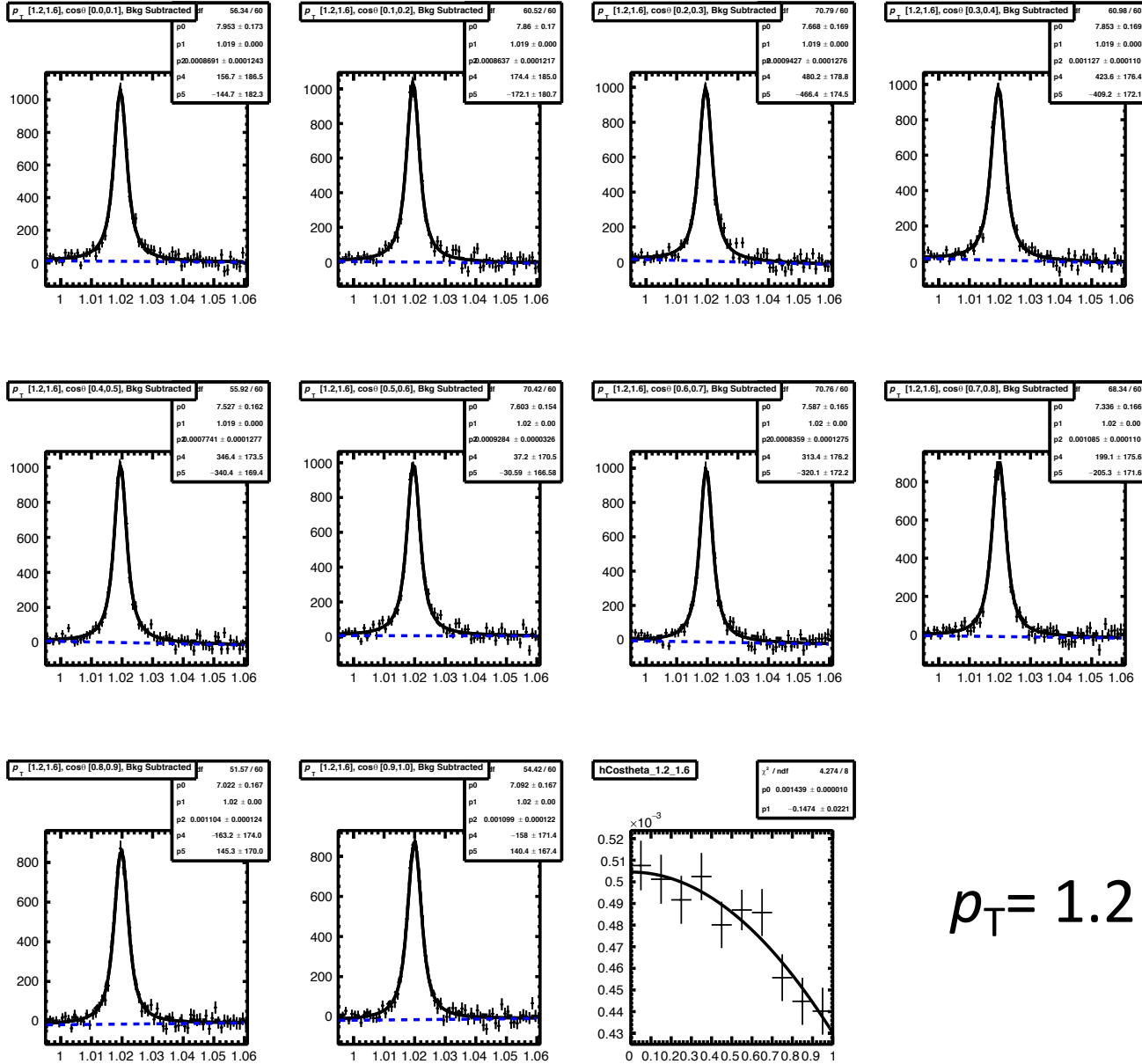
$p_T = 0.5 - 0.8 \text{ GeV}/c$

Invariant mass (0-10%)



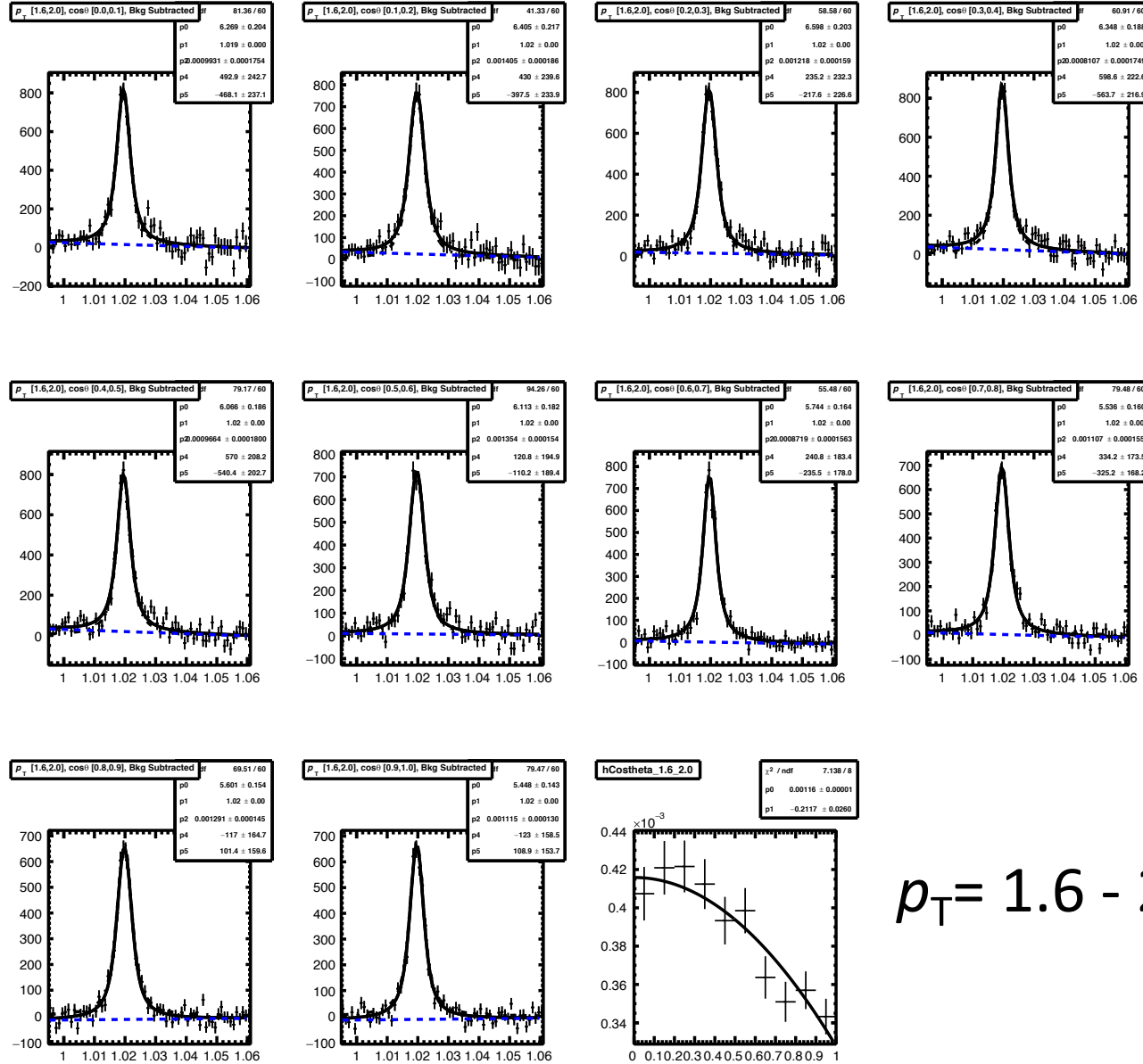
$p_T = 0.8 - 1.2$ GeV/c

Invariant mass (0-10%)



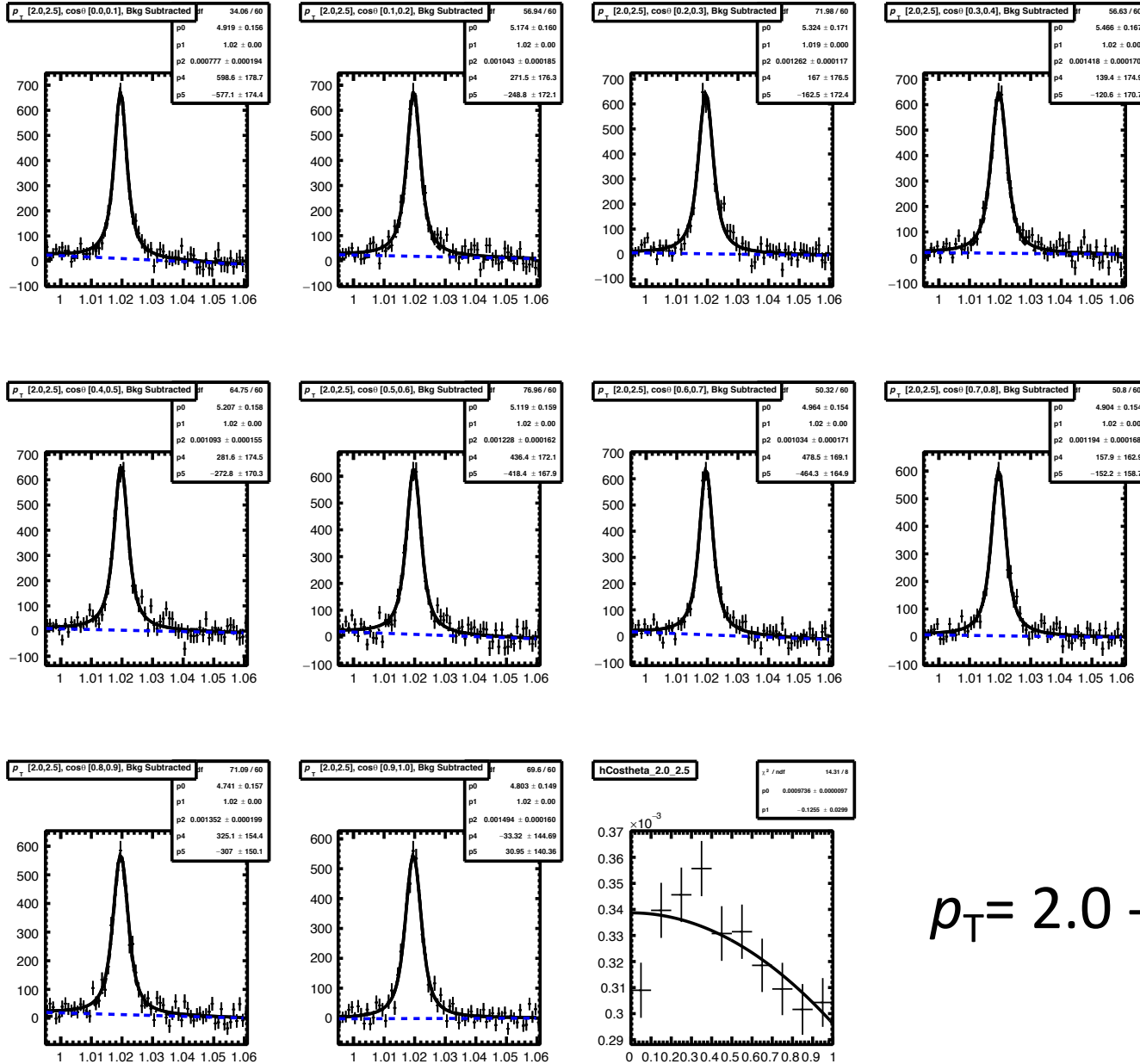
$p_T = 1.2 - 1.6 \text{ GeV}/c$

Invariant mass (0-10%)



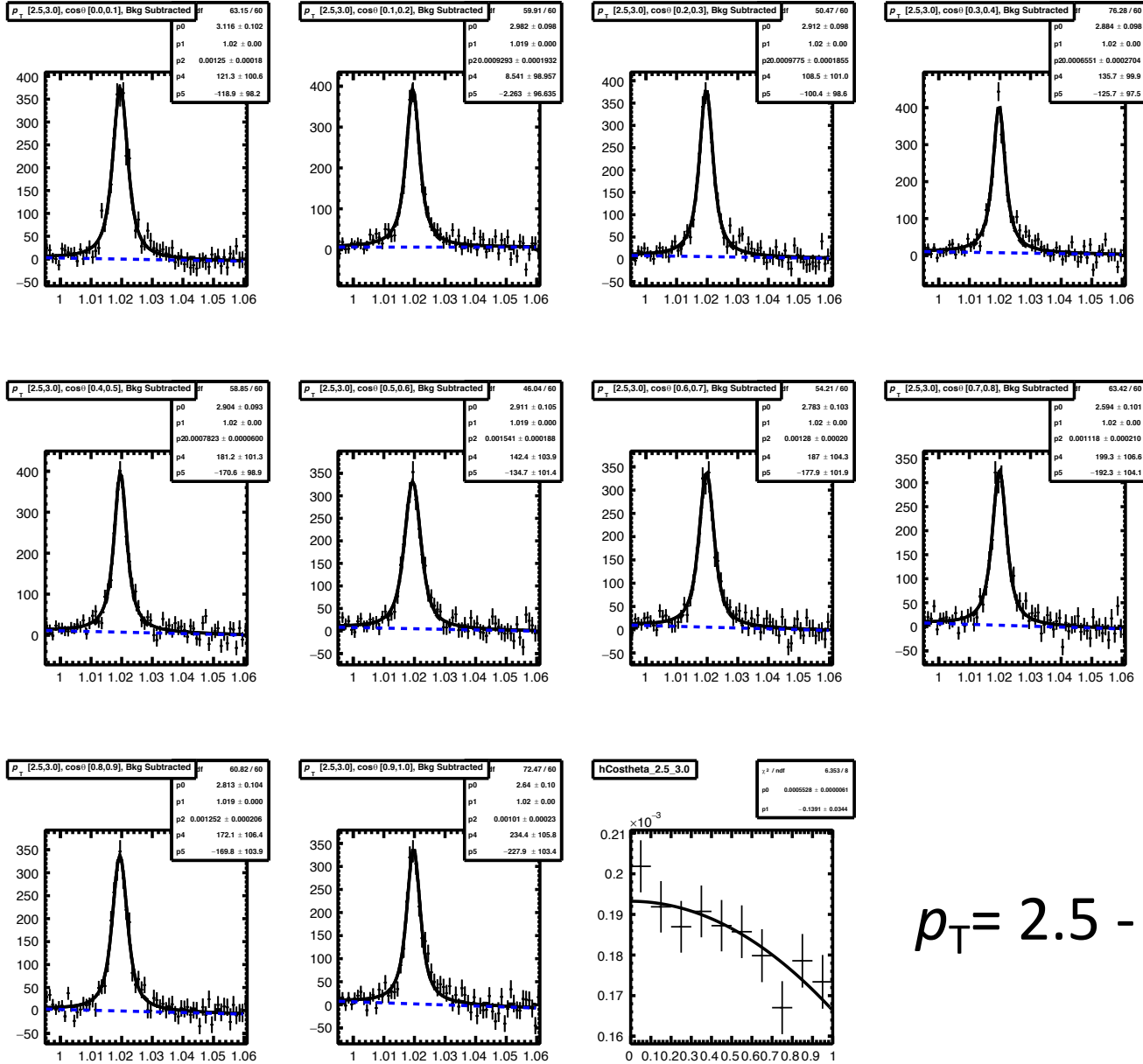
$p_T = 1.6 - 2.0$ GeV/c

Invariant mass (0-10%)



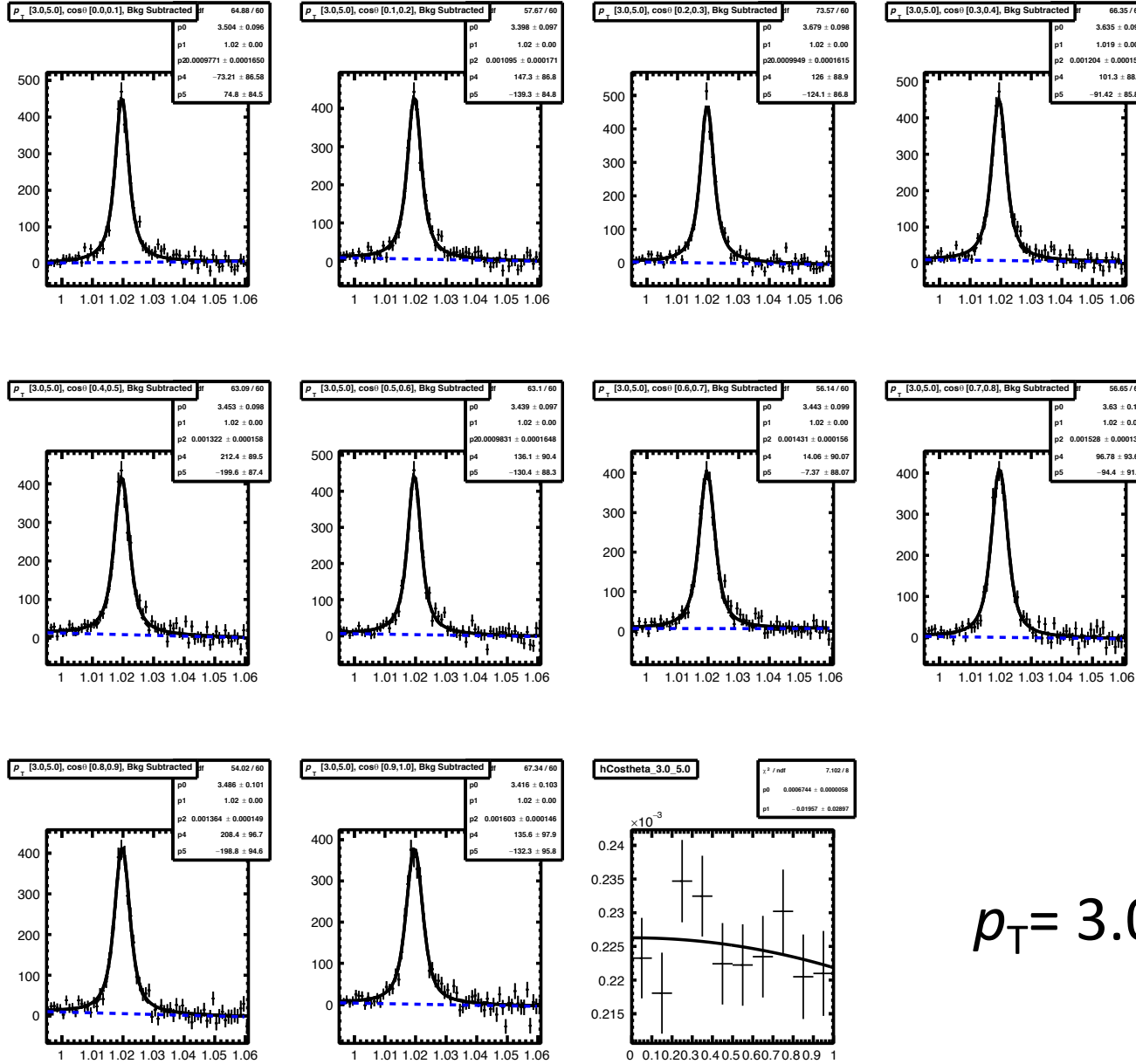
$p_T = 2.0 - 2.5 \text{ GeV}/c$

Invariant mass (0-10%)



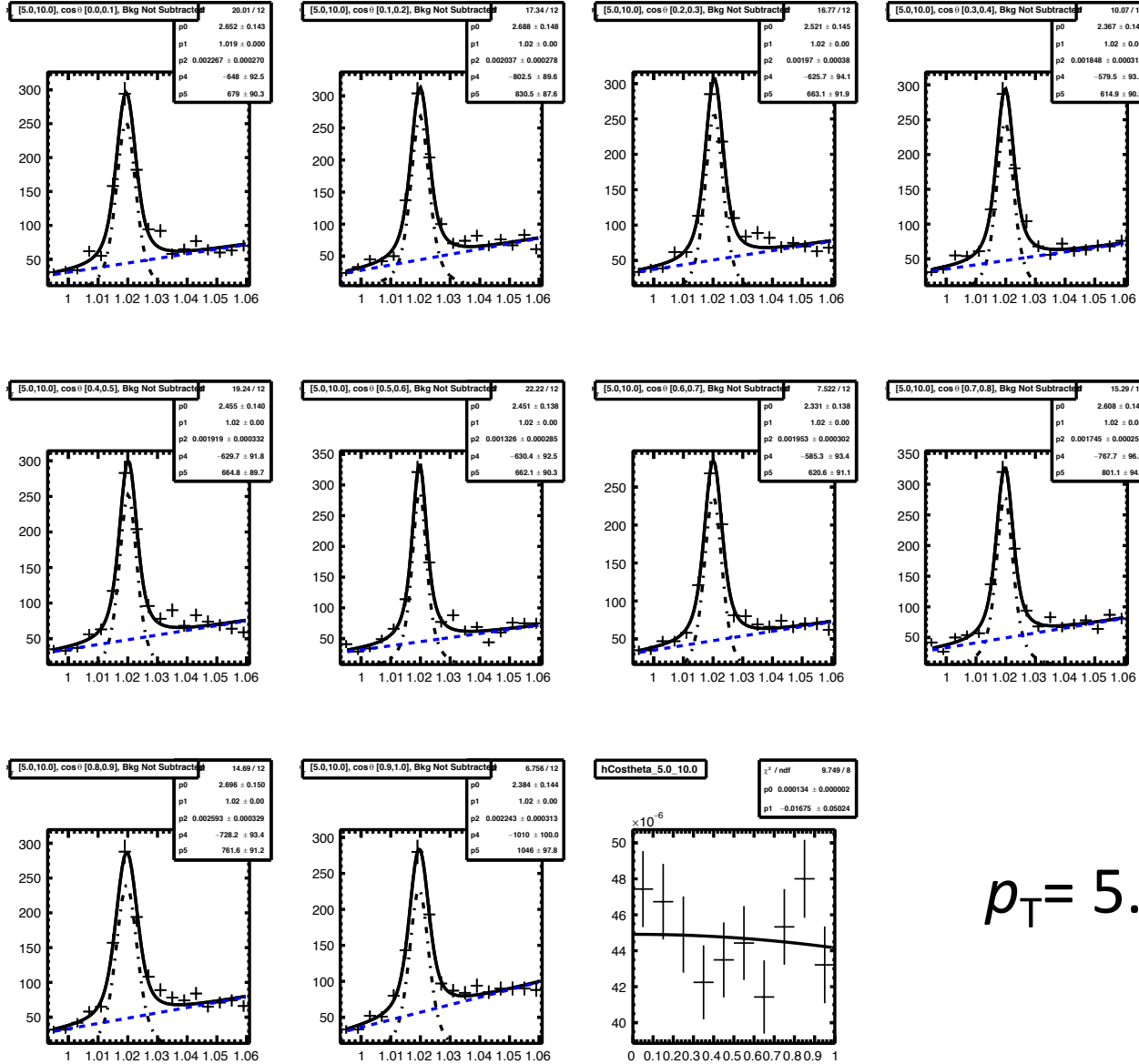
$$p_T = 2.5 - 3.0 \text{ GeV}/c$$

Invariant mass (0-10%)



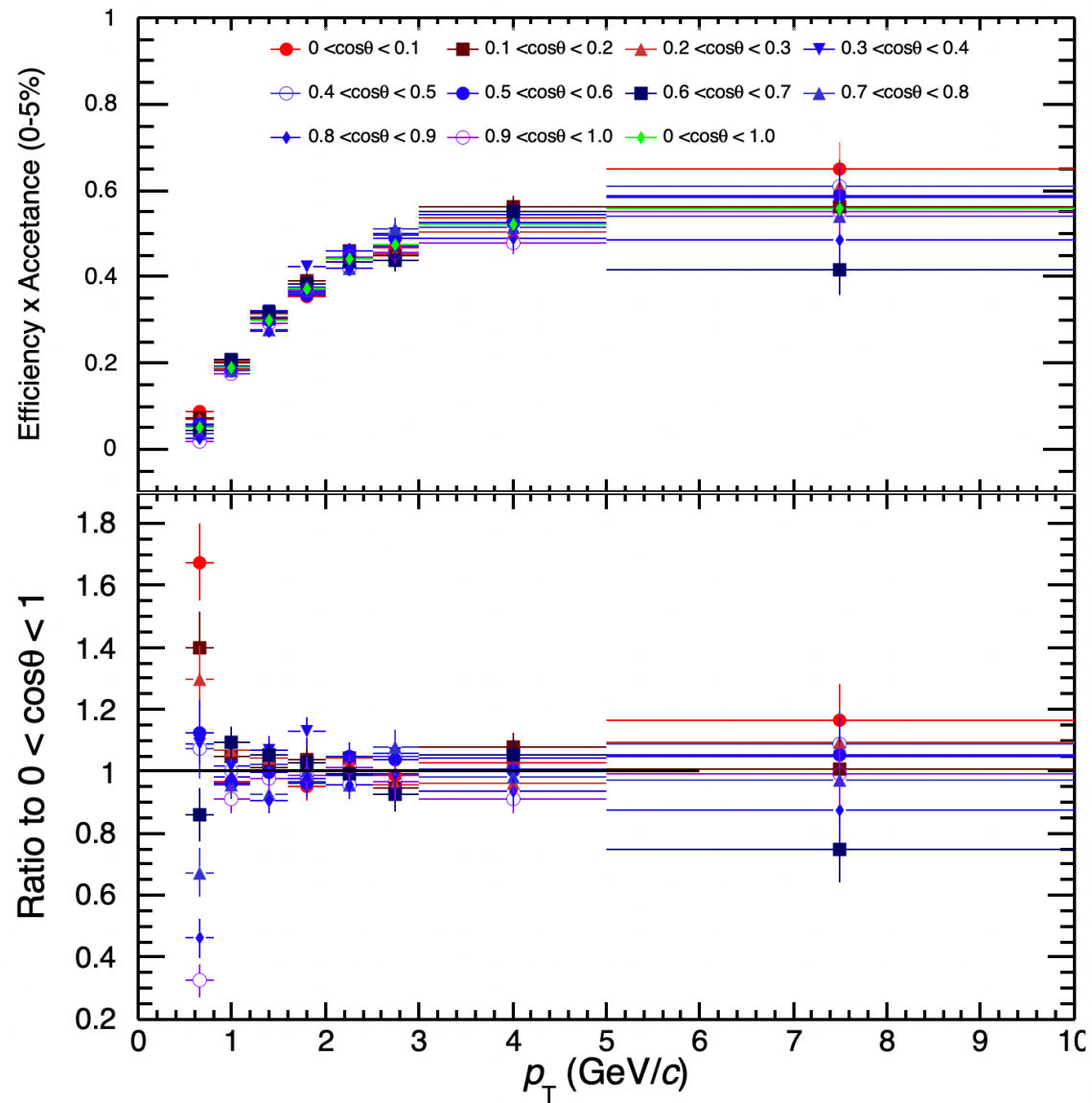
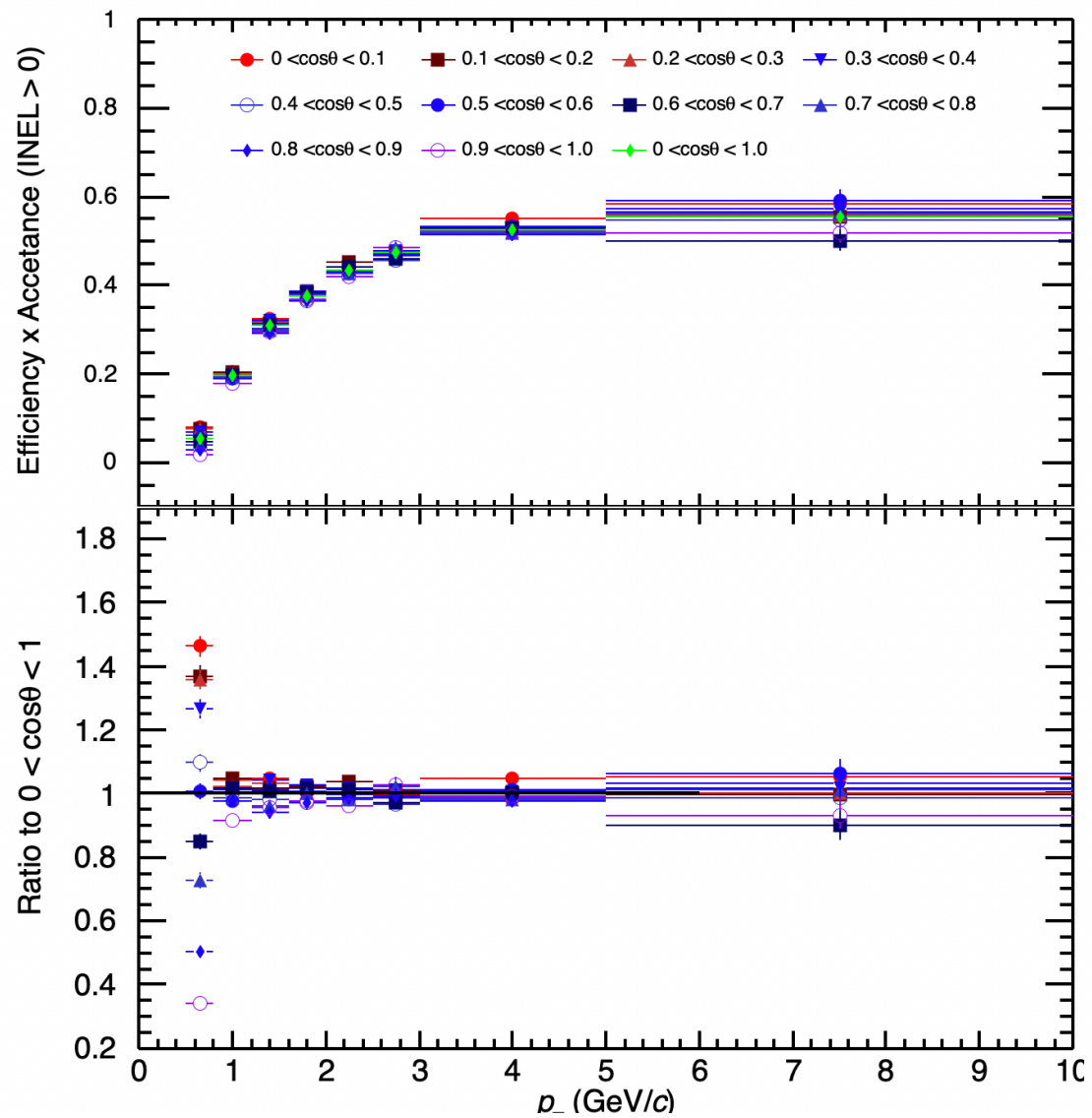
$p_T = 3.0 - 5.0 \text{ GeV}/c$

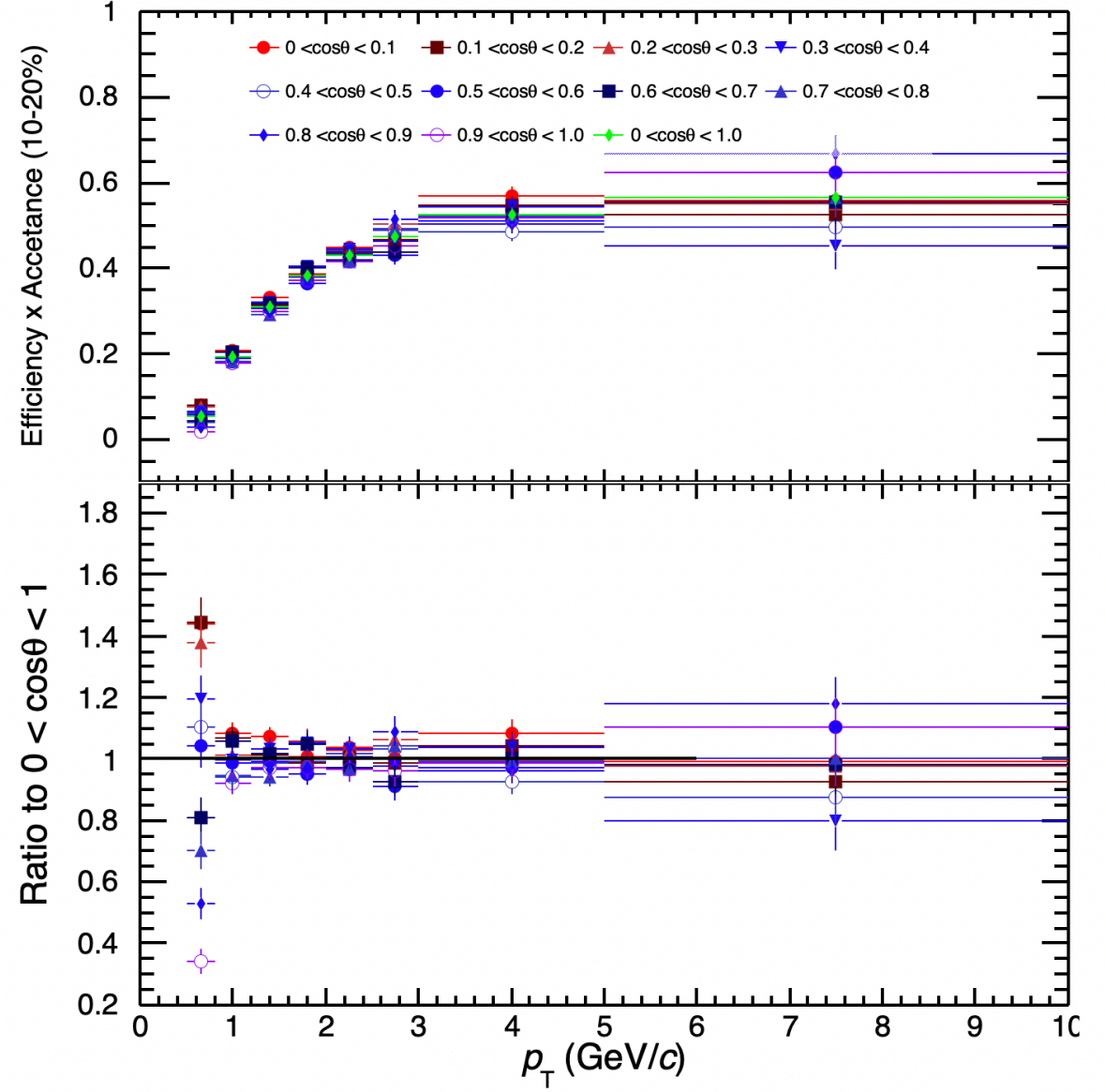
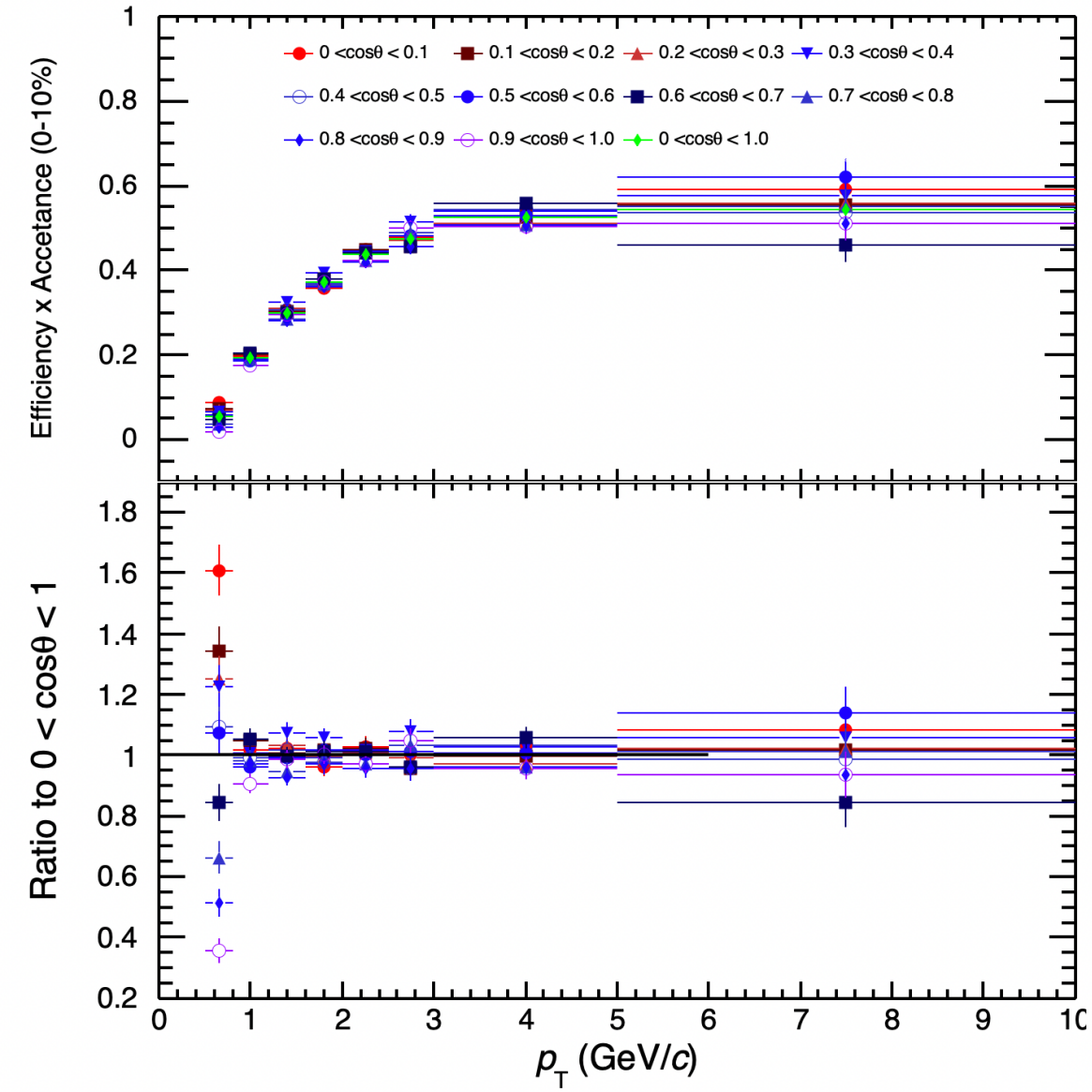
Invariant mass (0-10%)

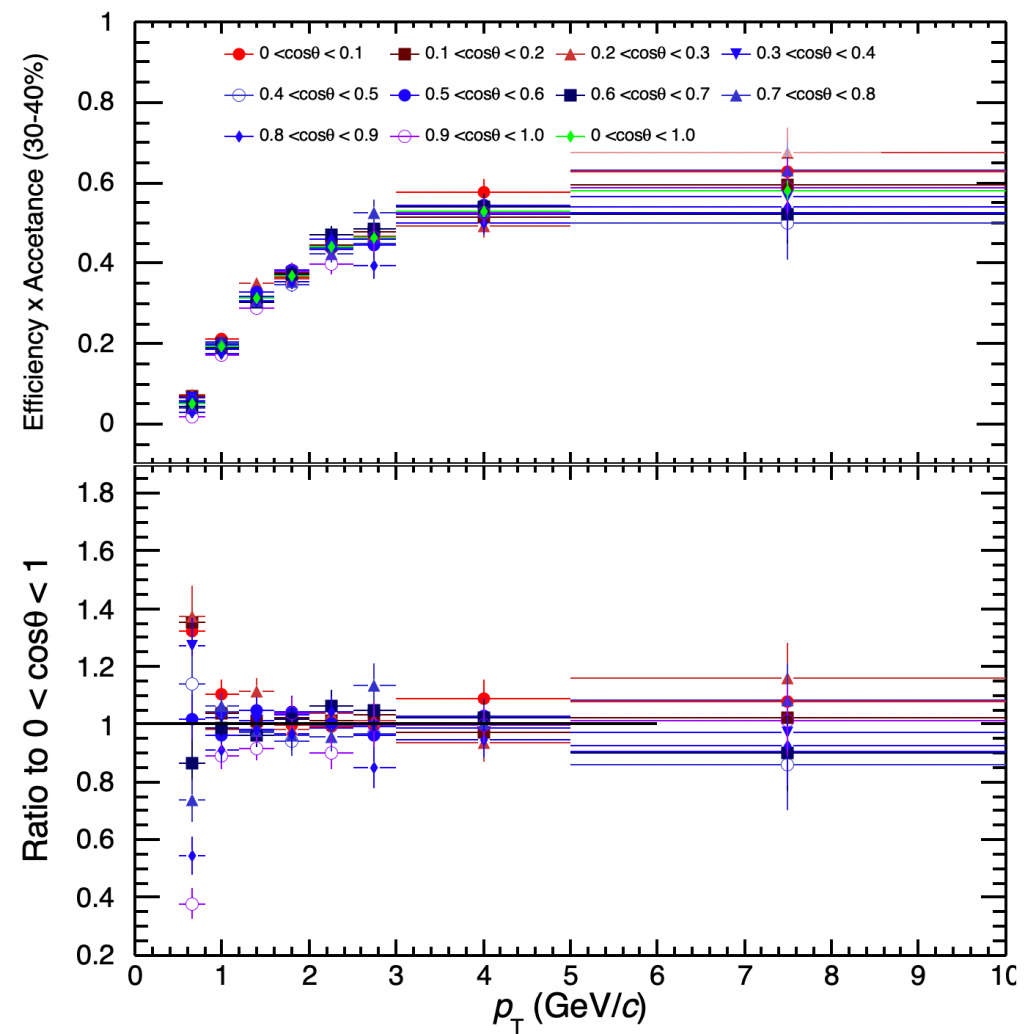
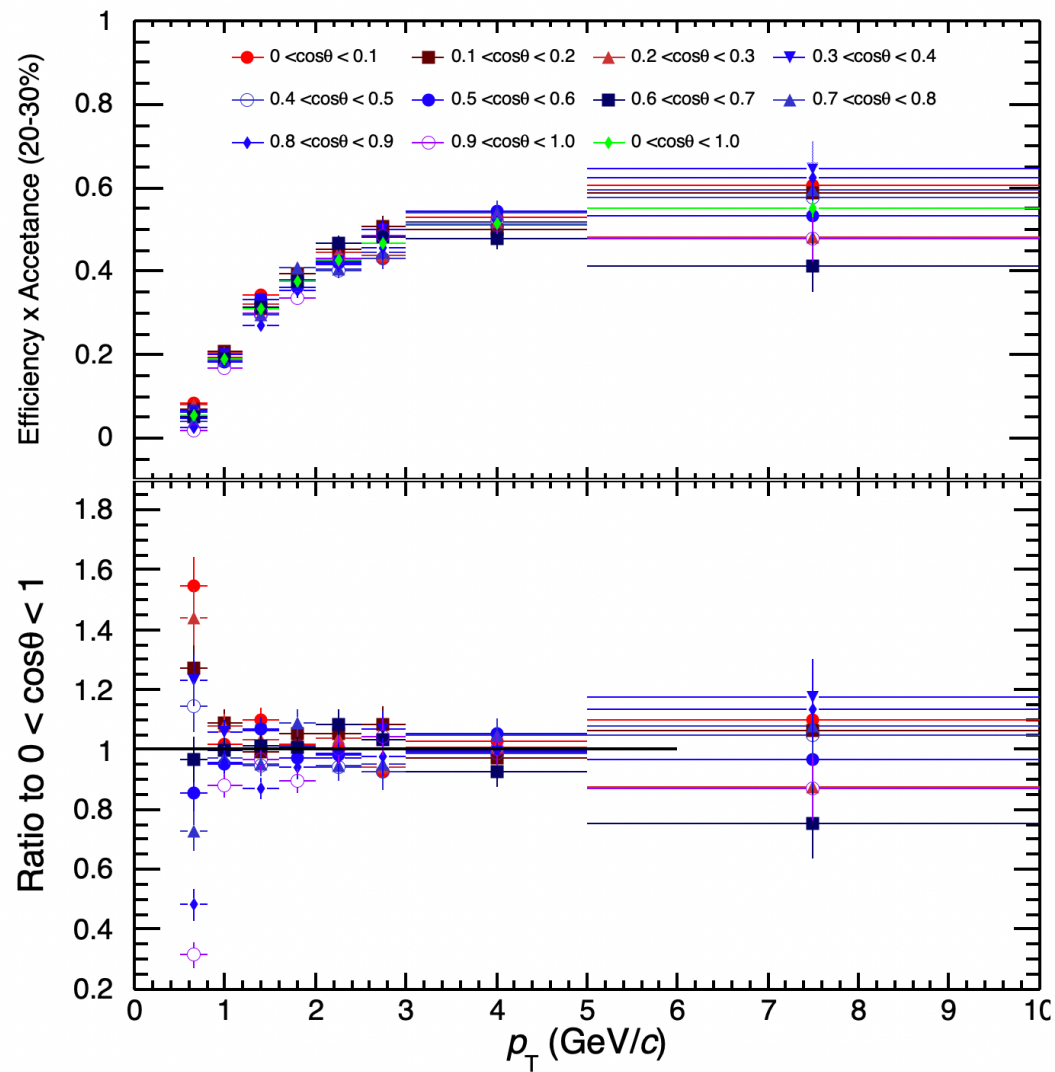


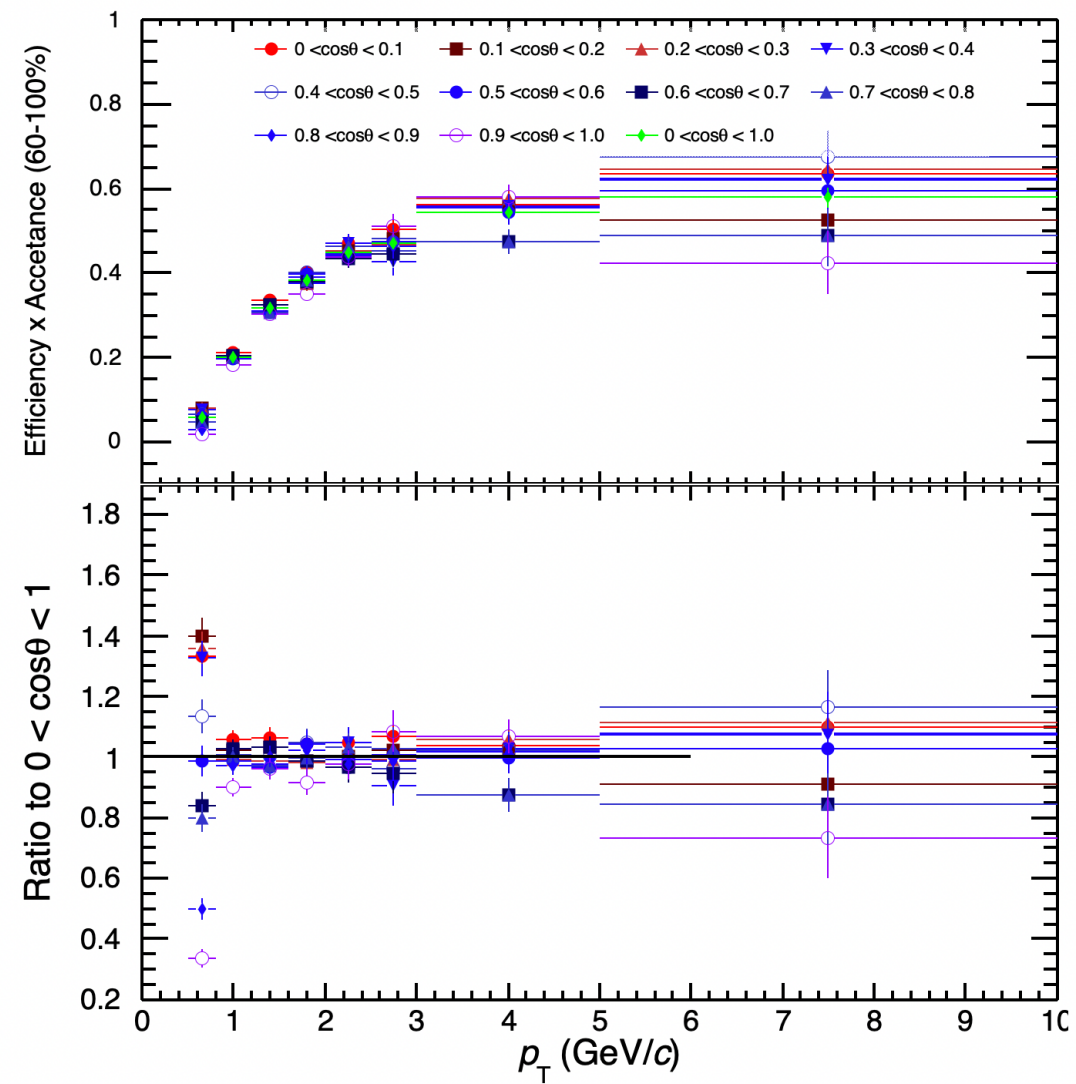
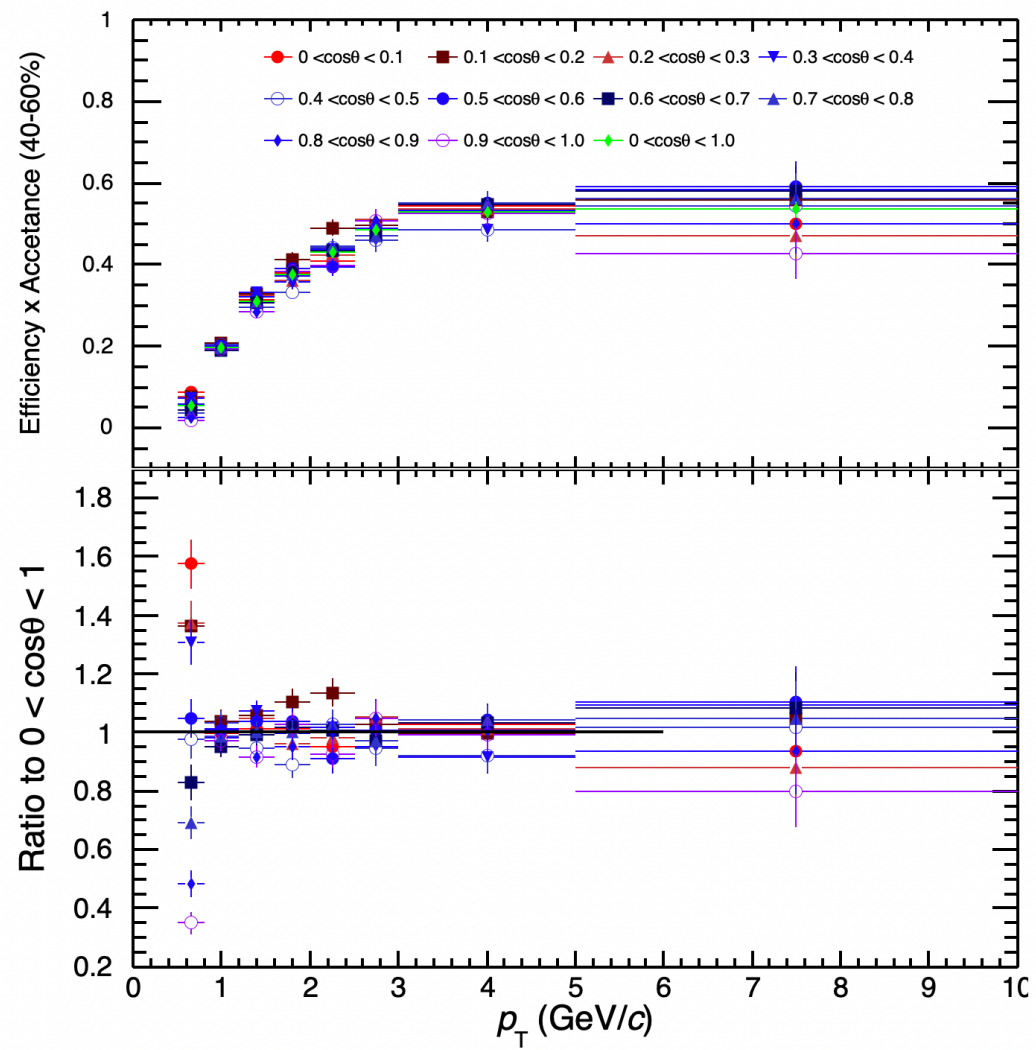
$$p_T = 5.0 - 10.0 \text{ GeV}/c$$

Efficiency x Acceptance

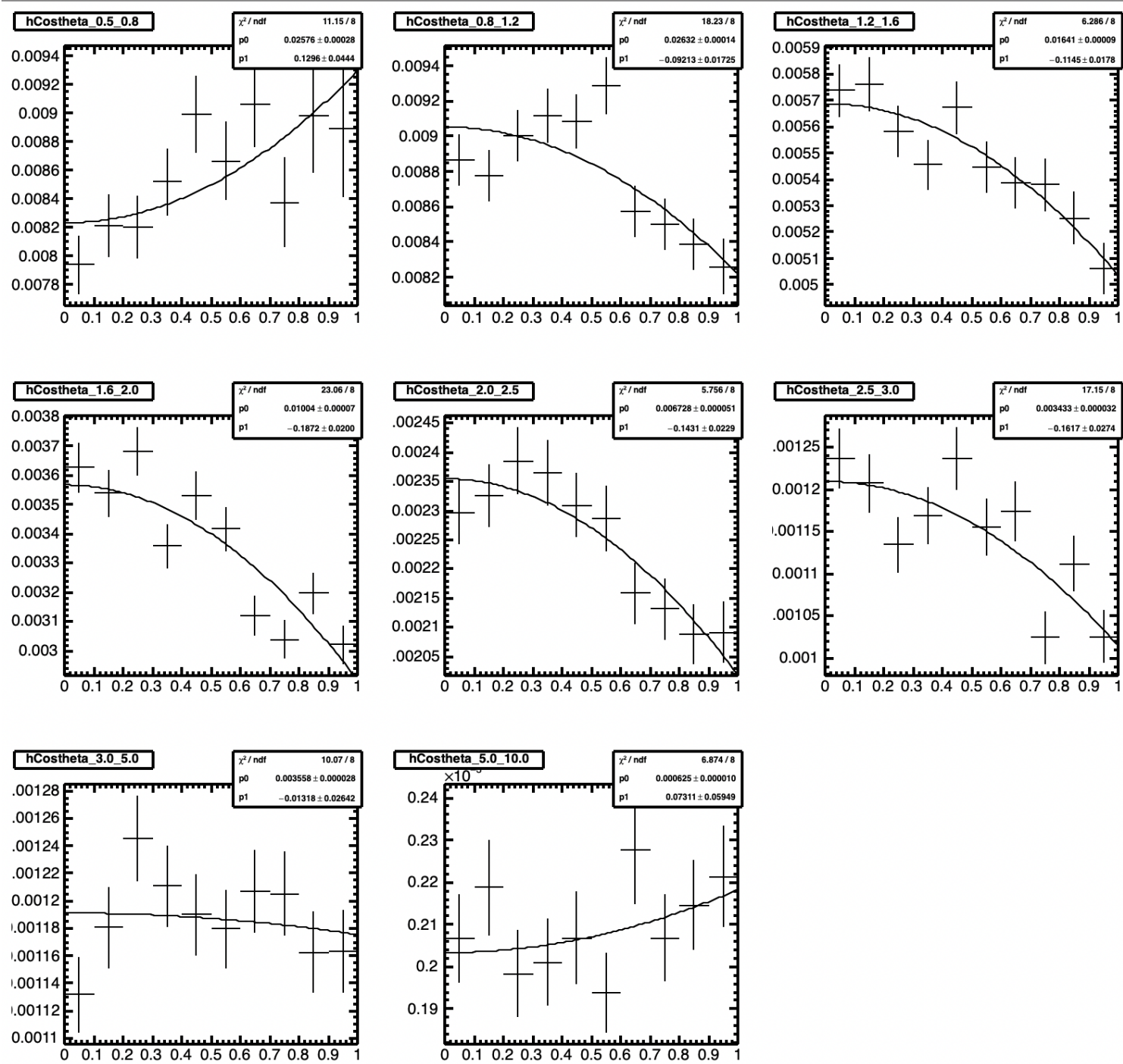




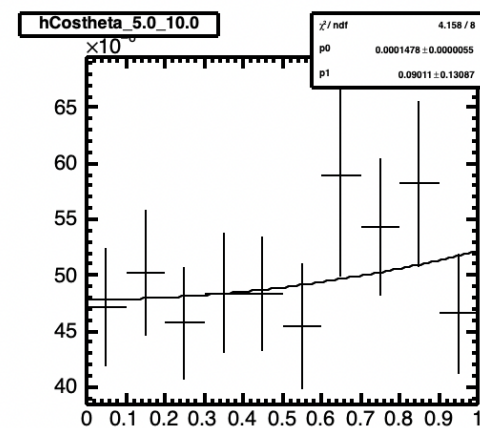
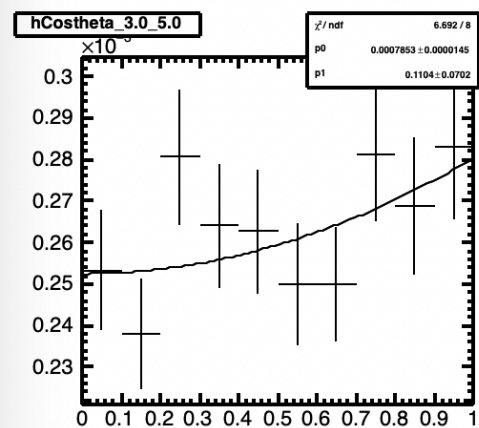
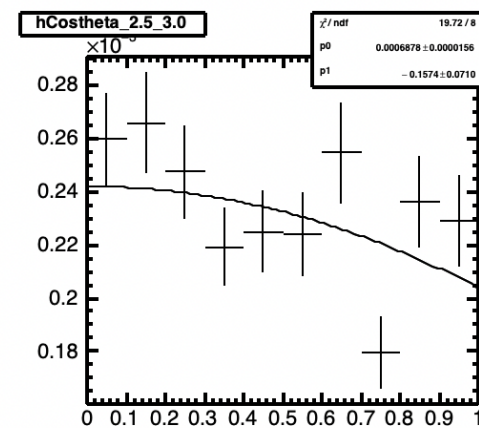
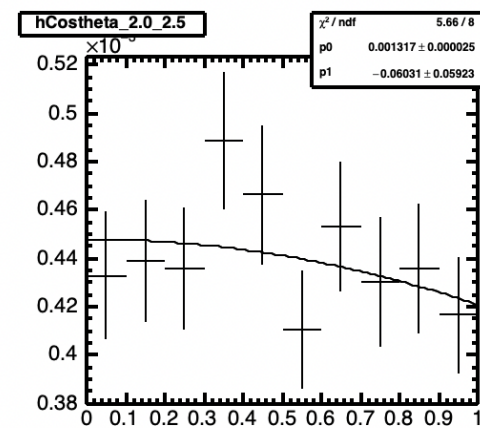
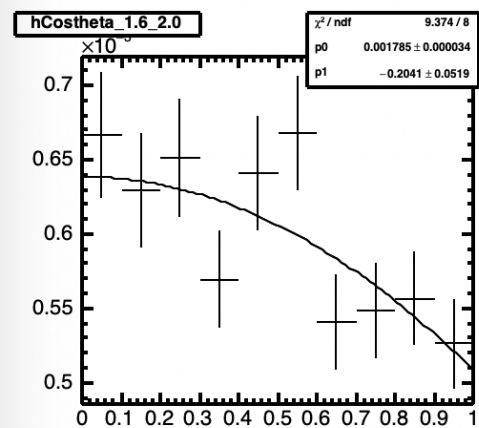
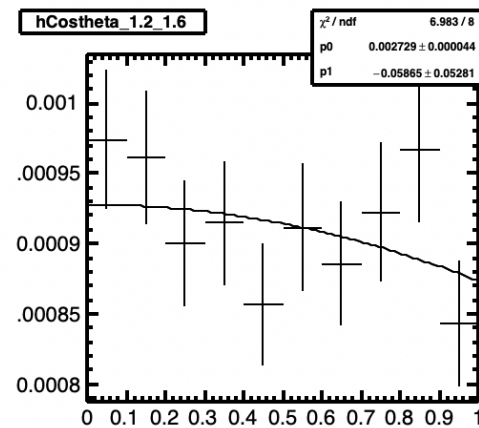
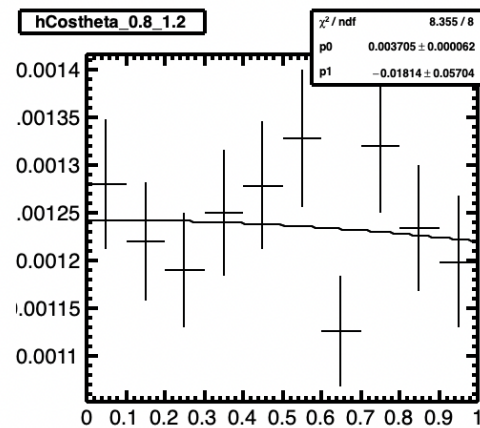
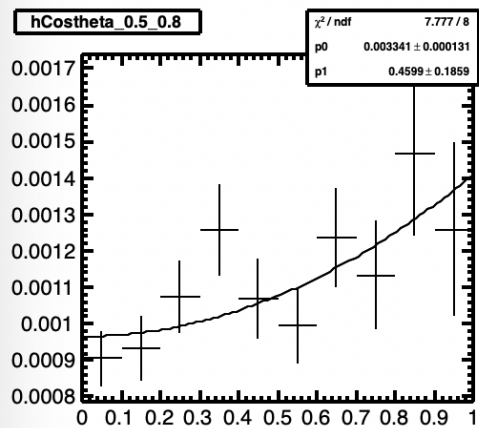




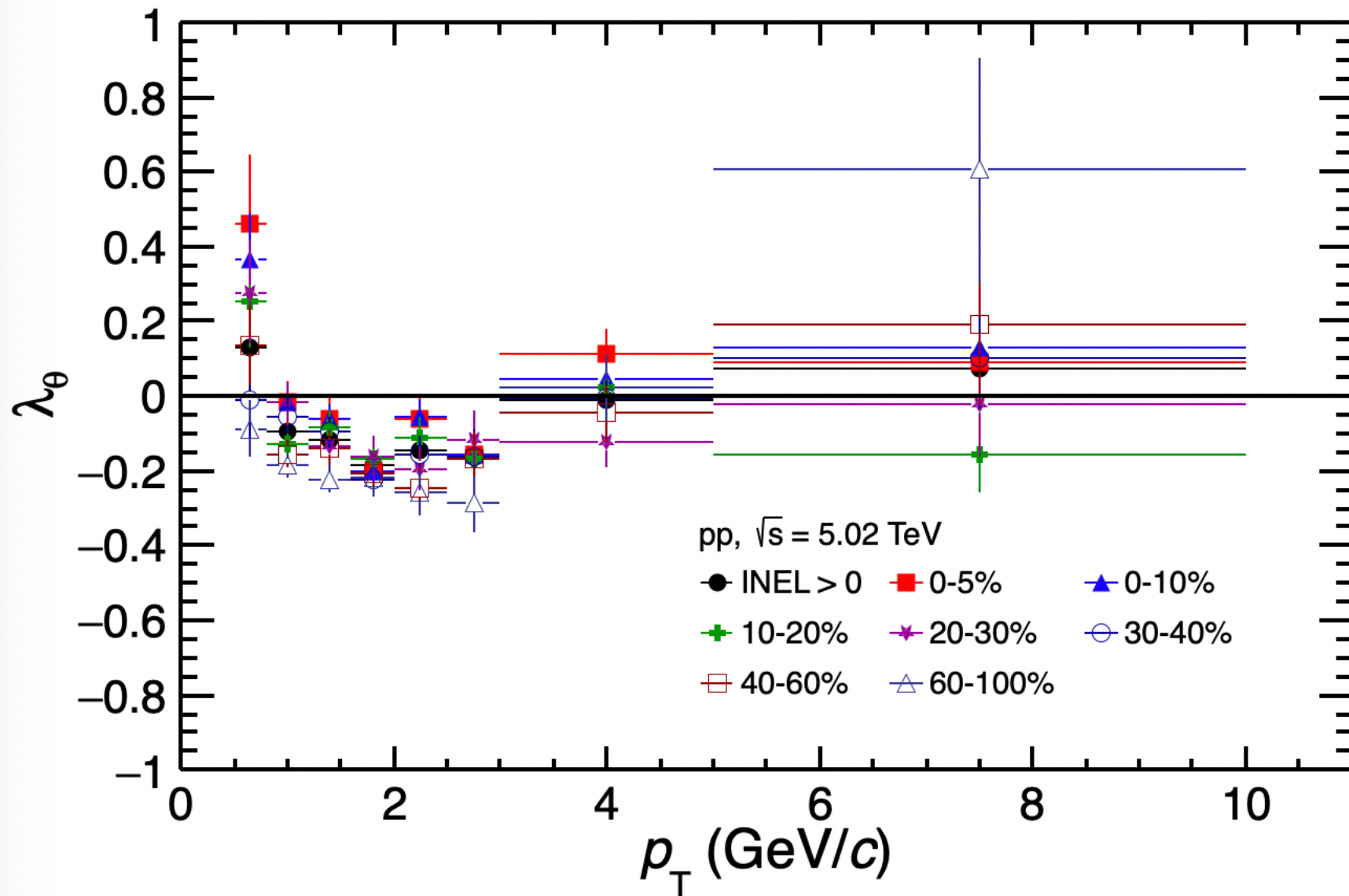
Corrected $\text{Cos}\theta$ distribution



INEL > 0



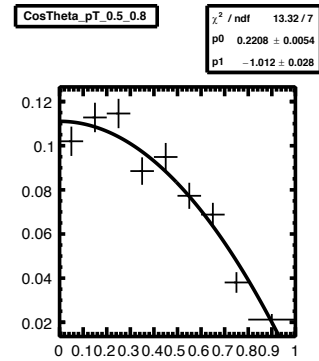
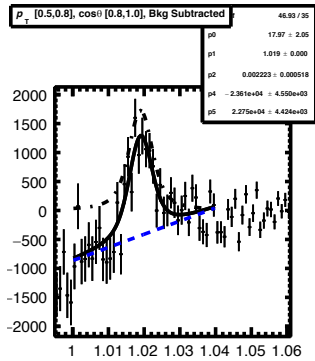
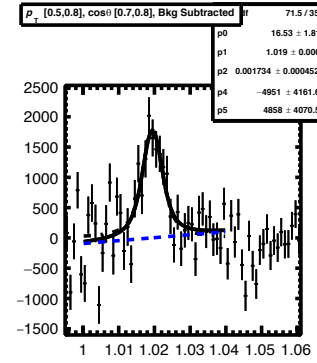
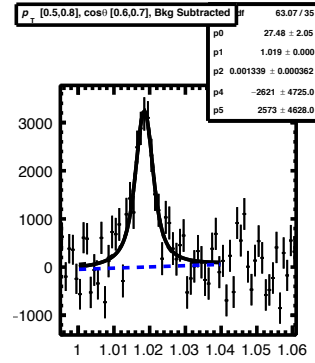
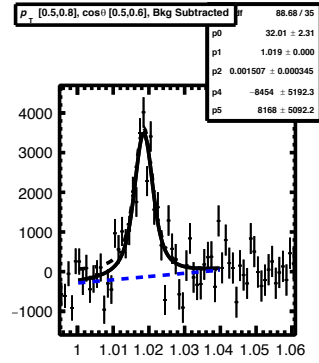
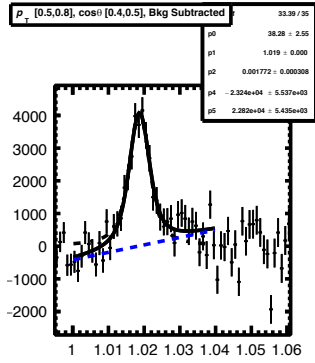
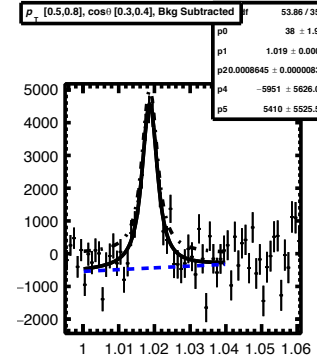
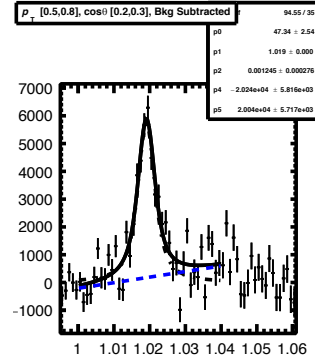
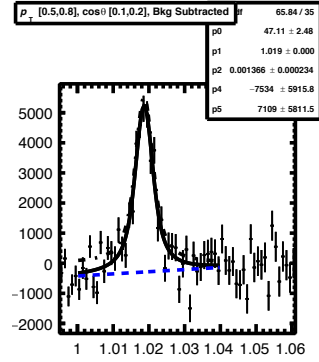
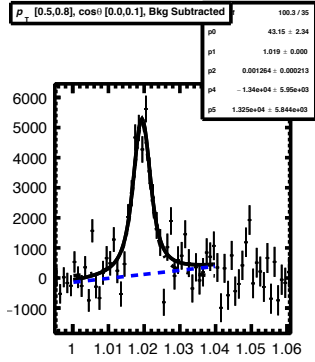
0-5%



Not much dependance on
multiplicity classes

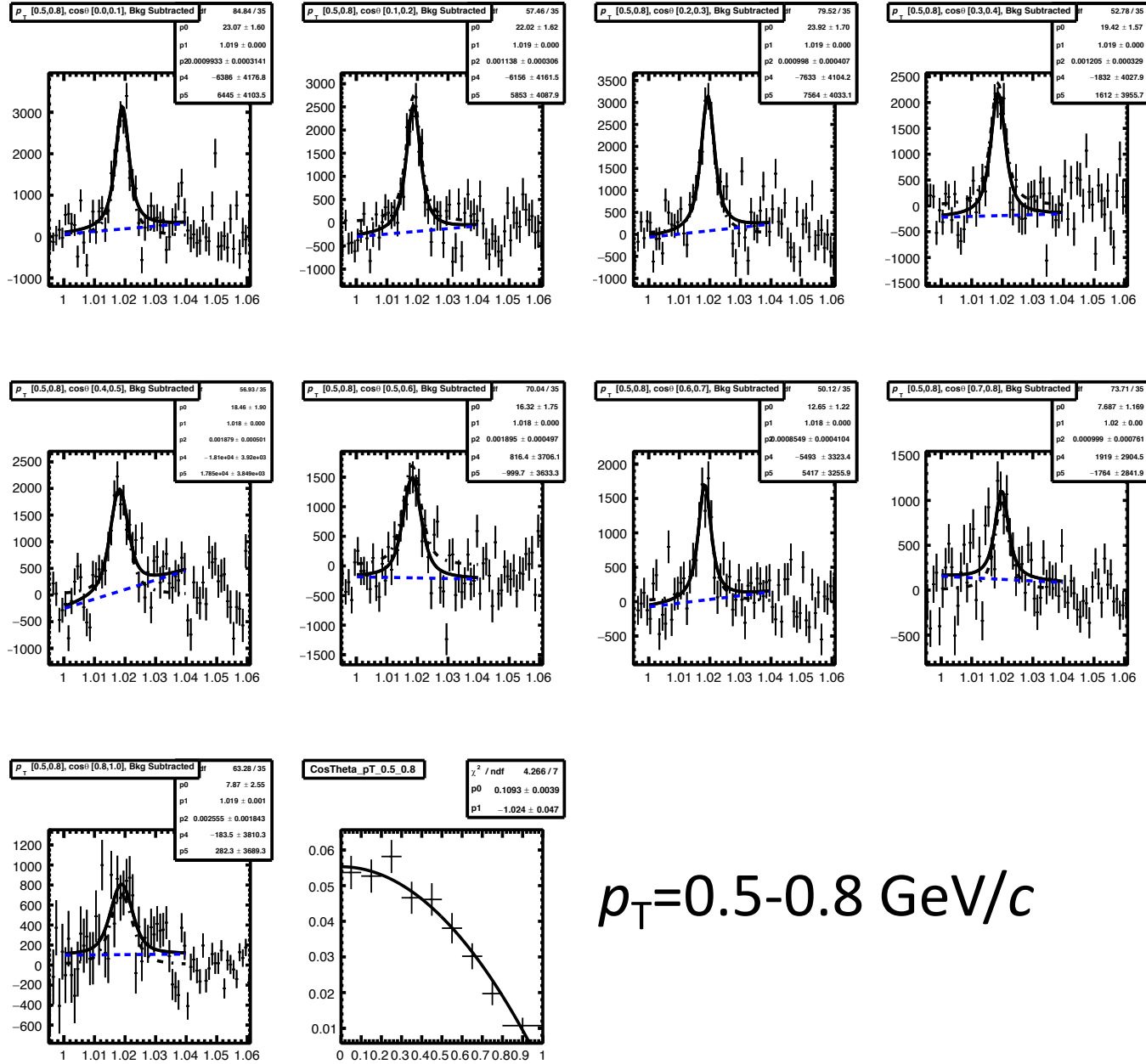
Back-up

Invariant mass (0-10%) $[-0.5 < \eta < 0.5]$



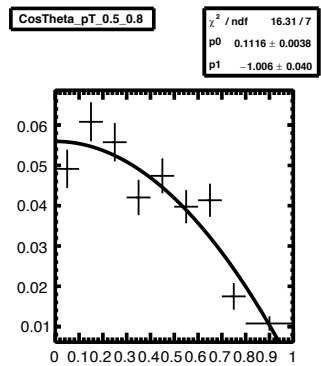
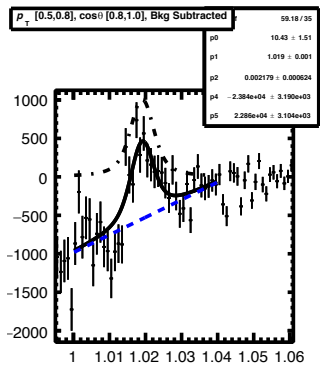
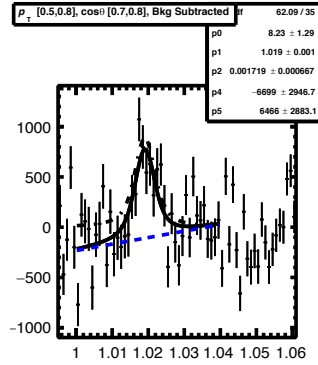
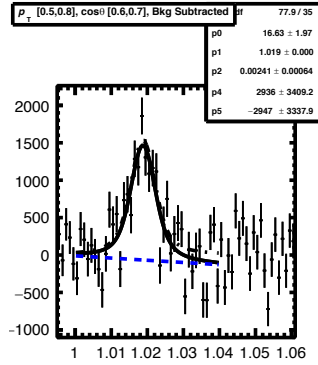
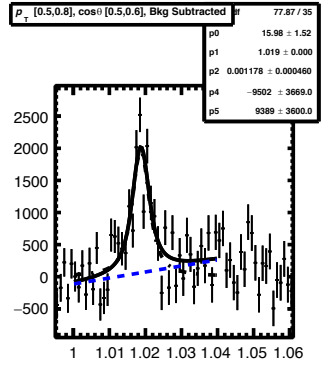
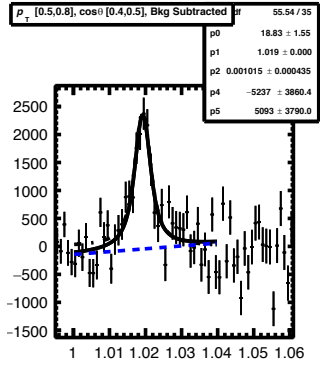
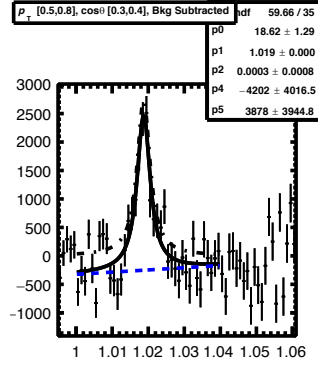
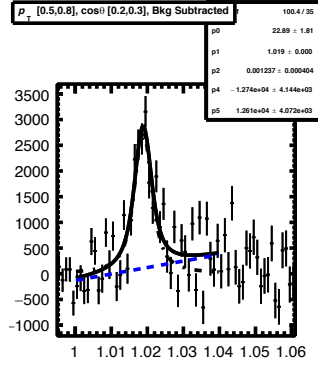
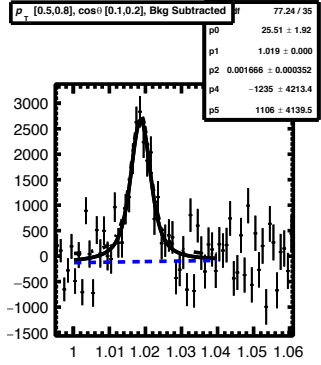
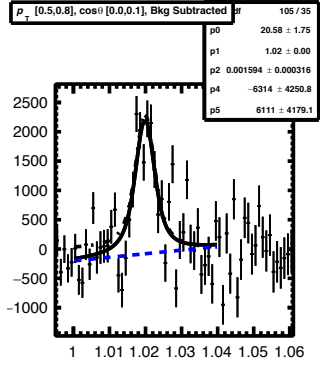
$p_T=0.5-0.8 \text{ GeV}/c$

Invariant mass (0-10%) $[-0.5 < \eta < 0]$



$p_T = 0.5-0.8 \text{ GeV}/c$

Invariant mass (0-10%) [$0 < \eta < 0.5$]

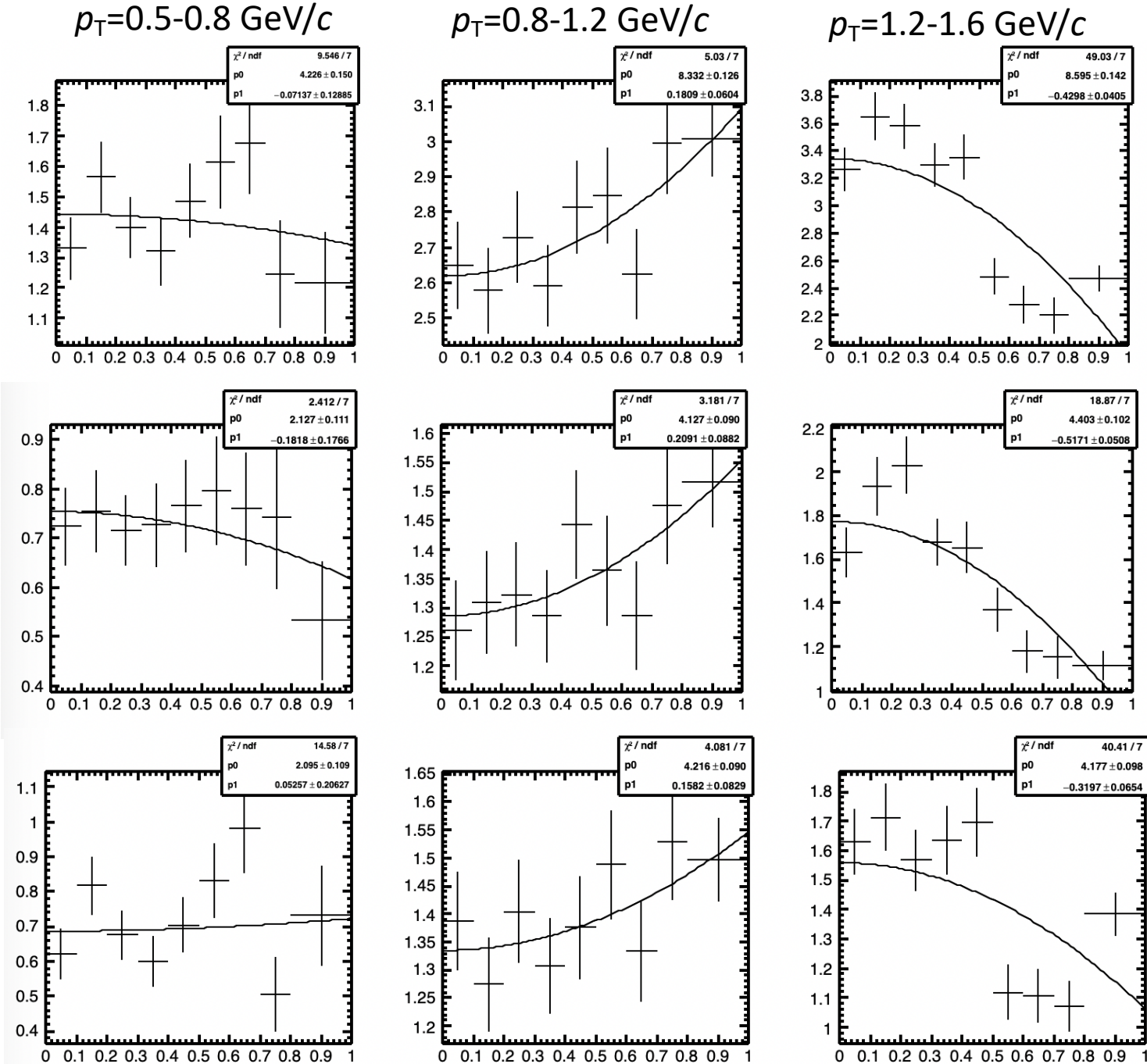


$p_T=0.5-0.8$ GeV/c

(0-10%) $[-0.5 < \eta < 0.5]$

(0-10%) $[-0.5 < \eta < 0]$

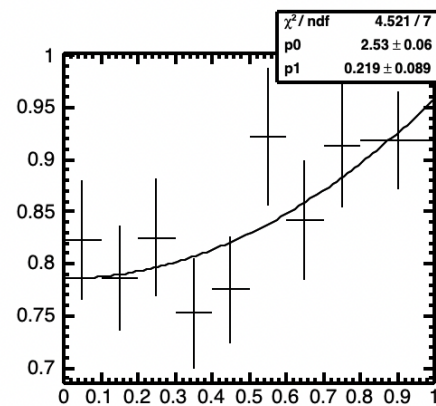
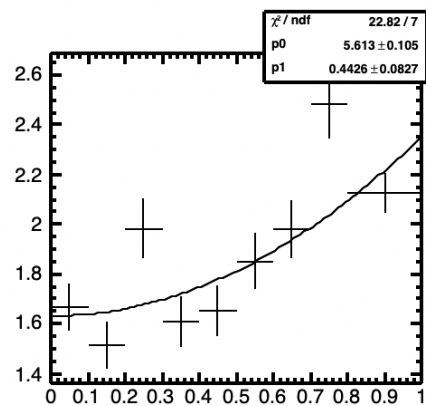
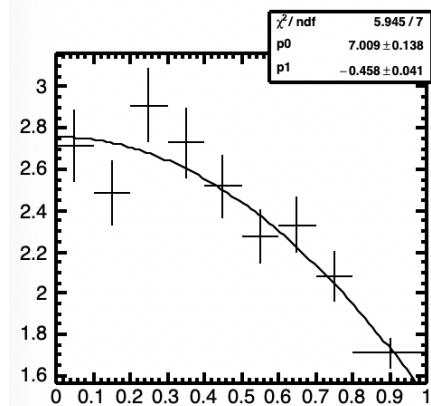
(0-10%) $[0 < \eta < 0.5]$



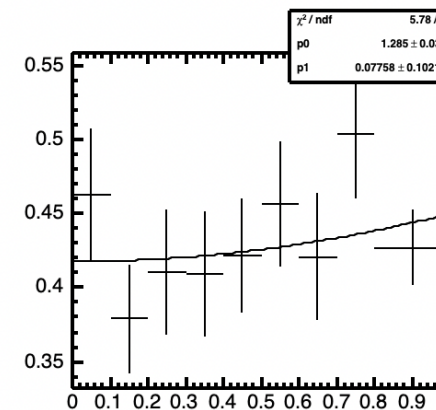
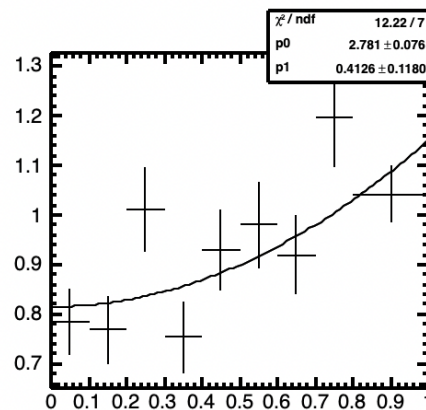
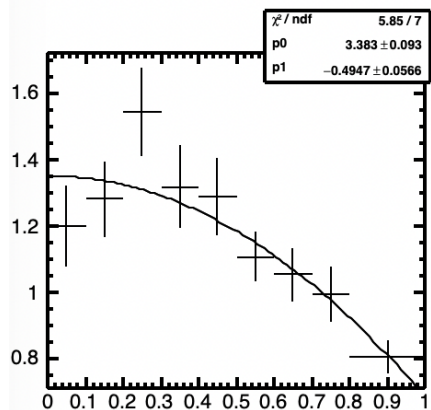
$p_{\text{T}}=1.6\text{-}2.0$ GeV/c

$p_{\text{T}}=2.0\text{-}2.5$ GeV/c

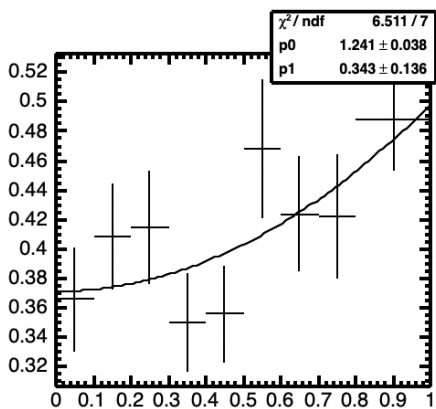
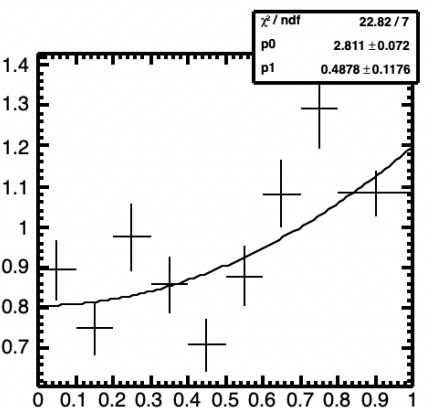
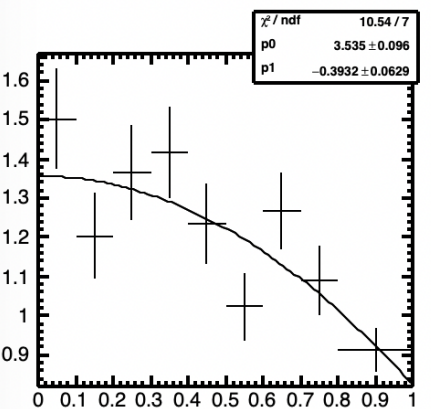
$p_{\text{T}}=2.5\text{-}3.0$ GeV/c



(0-10%) $[-0.5 < \text{eta} < 0.5]$

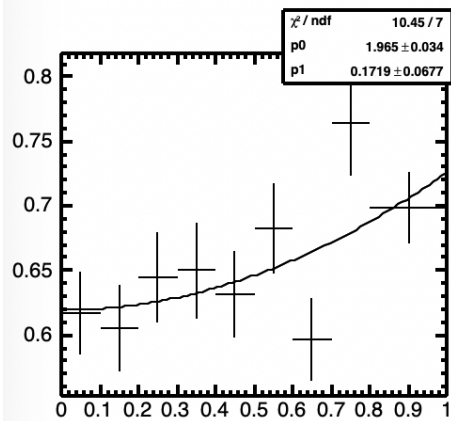


(0-10%) $[-0.5 < \text{eta} < 0]$

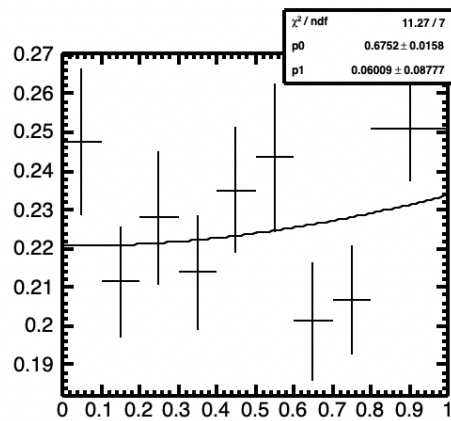


(0-10%) $[0 < \text{eta} < 0.5]$

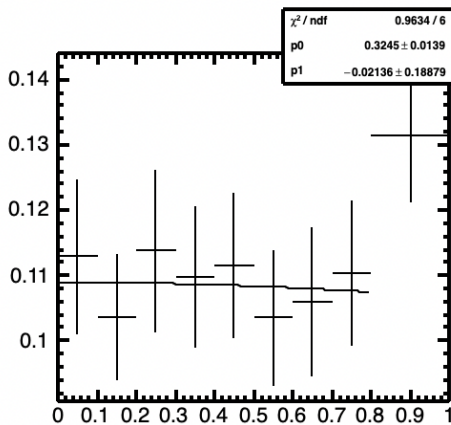
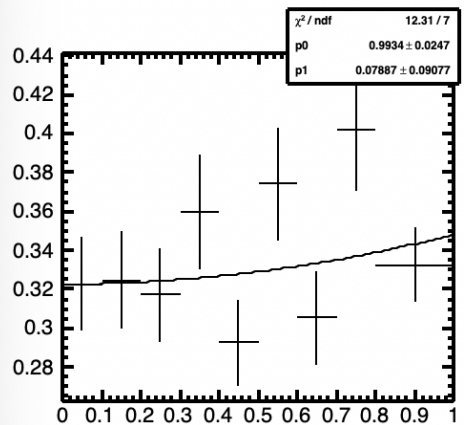
$p_{\text{T}}=3.0-5.0 \text{ GeV}/c$



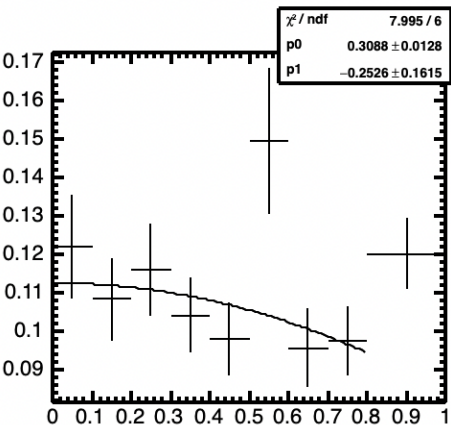
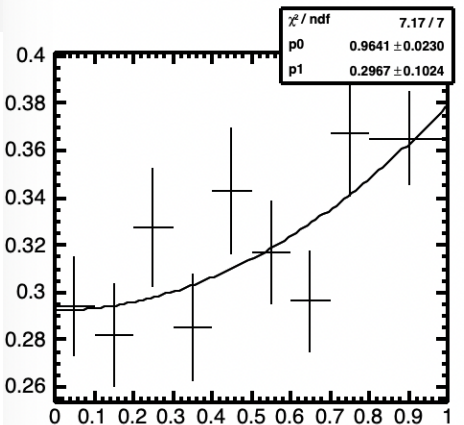
$p_{\text{T}}=5.0-10.0 \text{ GeV}/c$



(0-10%) $[-0.5 < \text{eta} < 0.5]$

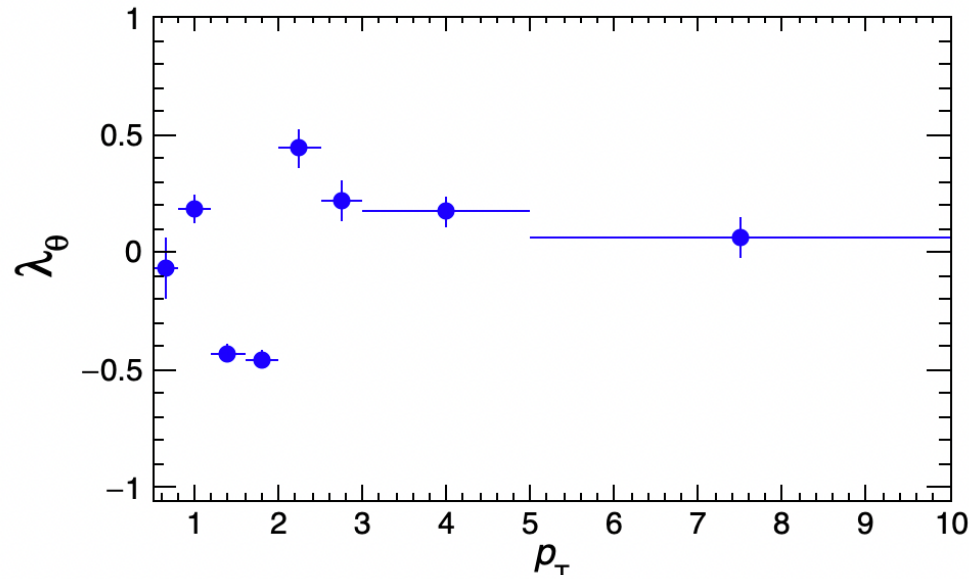


(0-10%) $[-0.5 < \text{eta} < 0]$



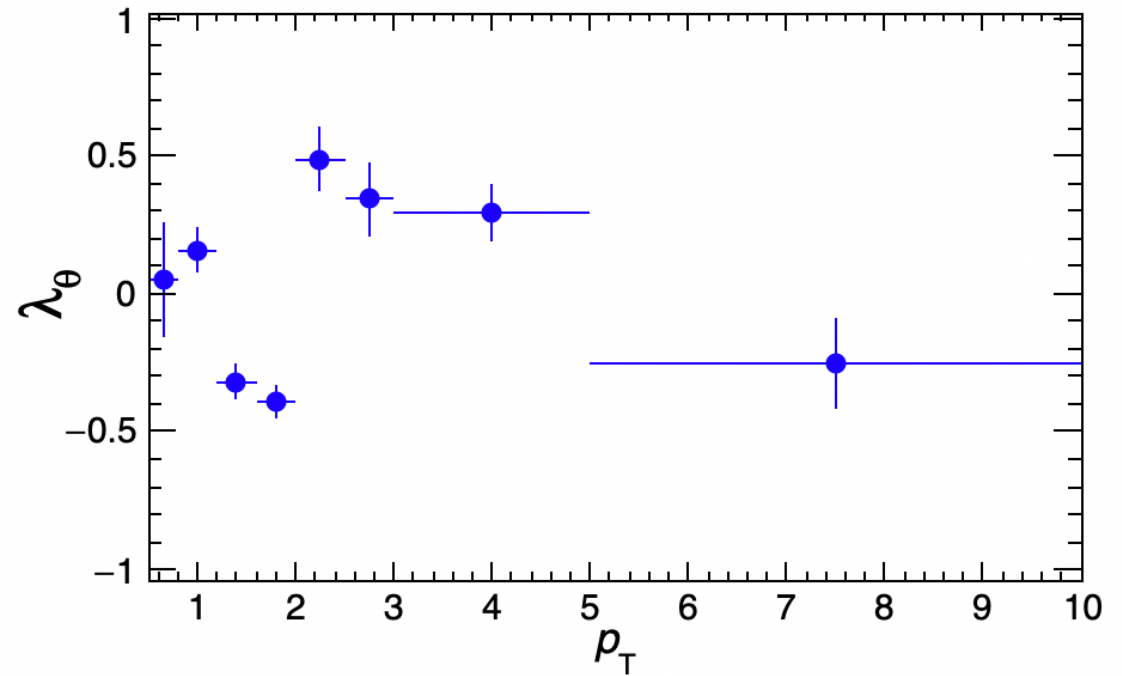
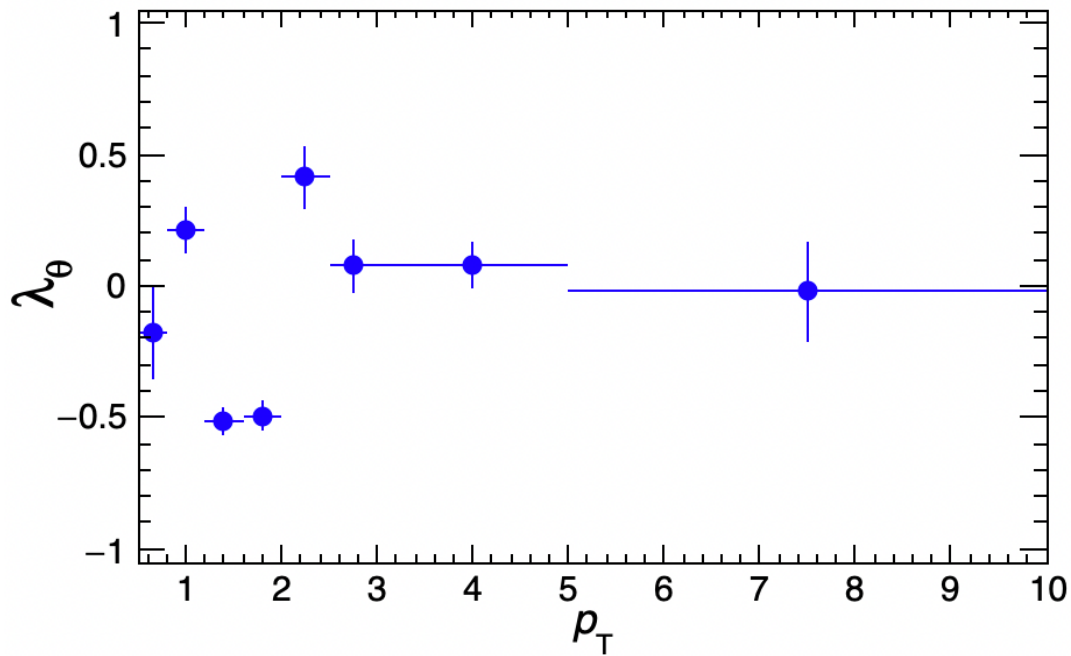
(0-10%) $[0 < \text{eta} < 0.5]$

λ_θ as a function of p_T

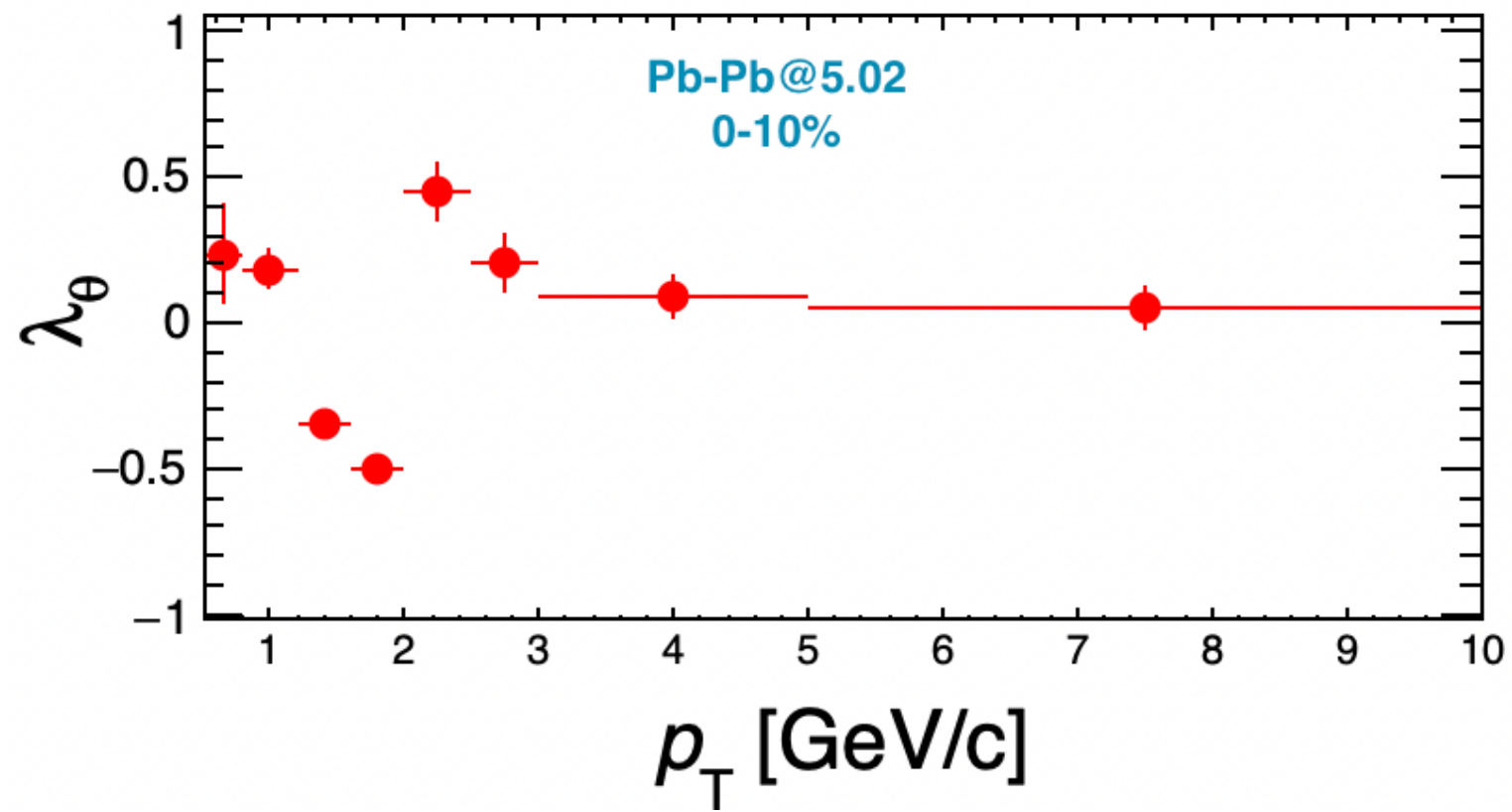


(0-10%) $[-0.5 < \eta < 0.5]$

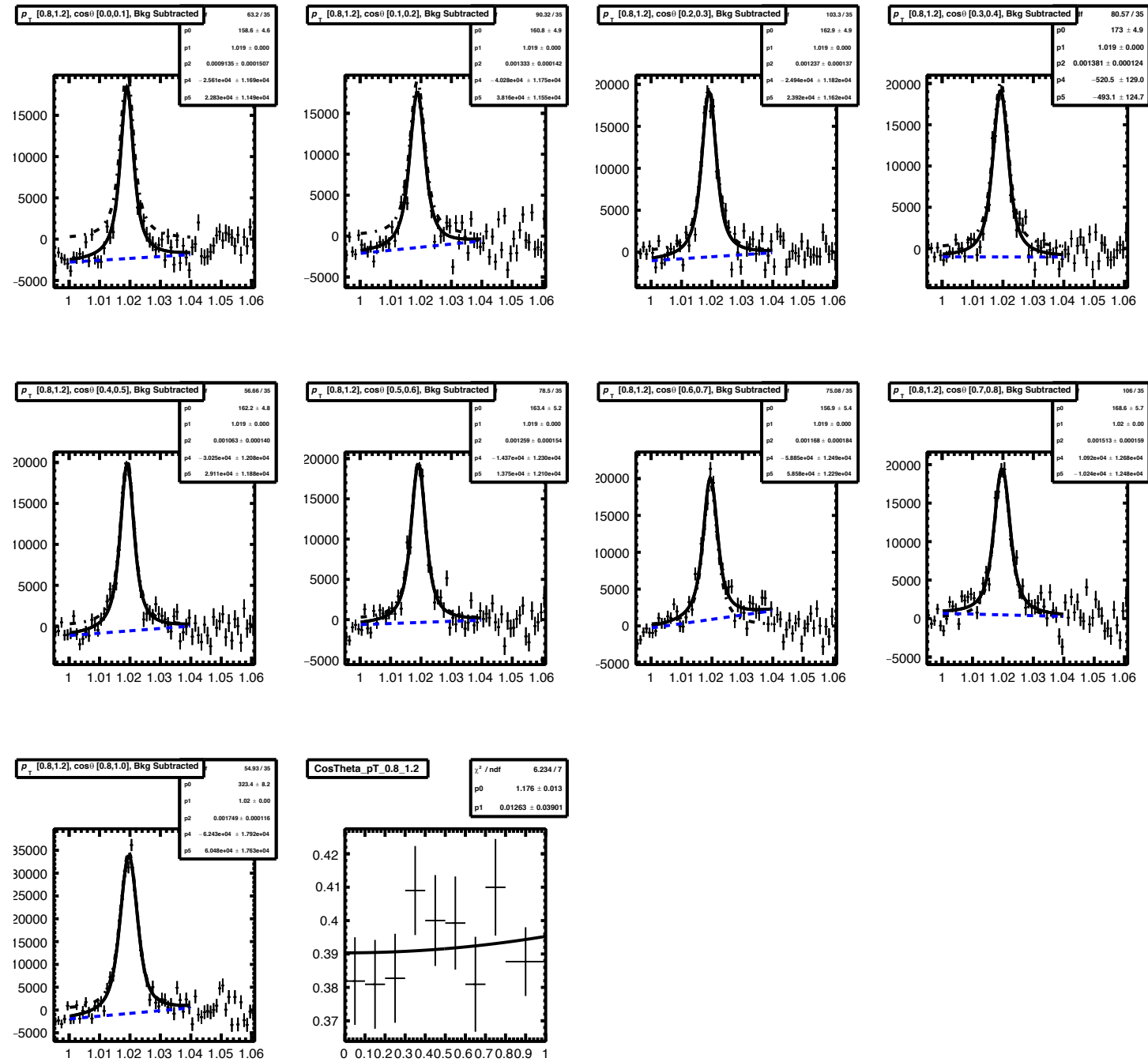
(0-10%) $[-0.5 < \eta < 0]$



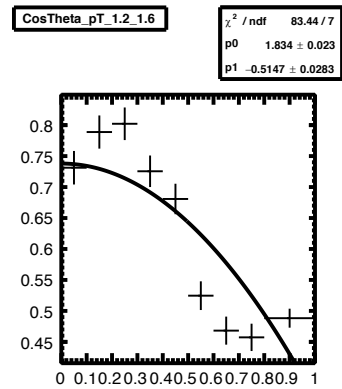
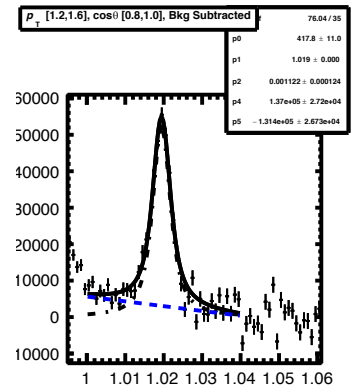
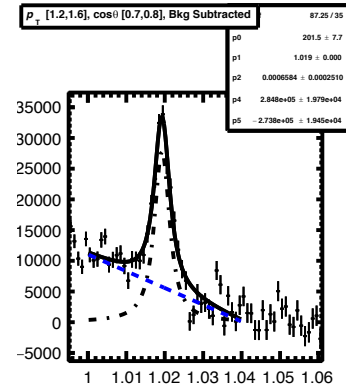
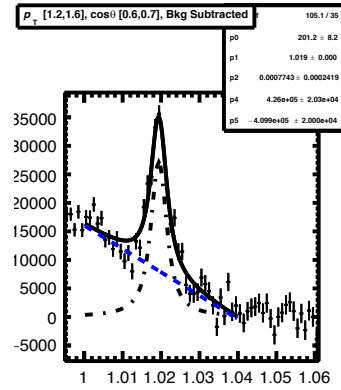
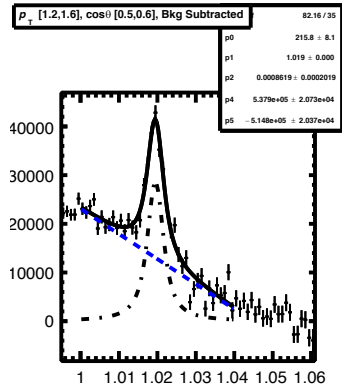
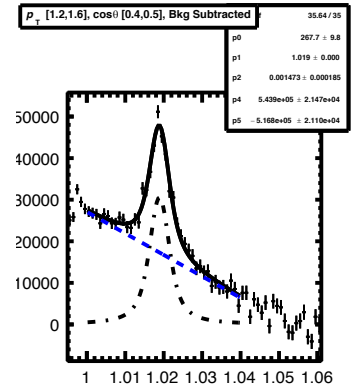
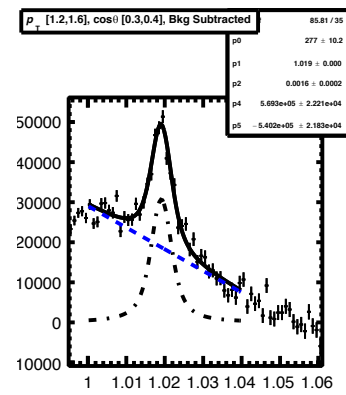
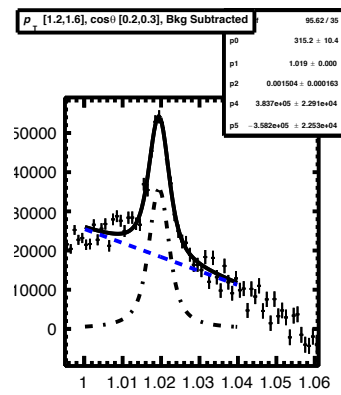
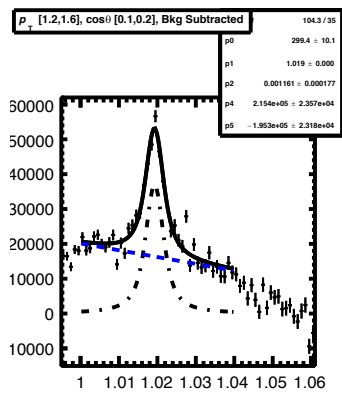
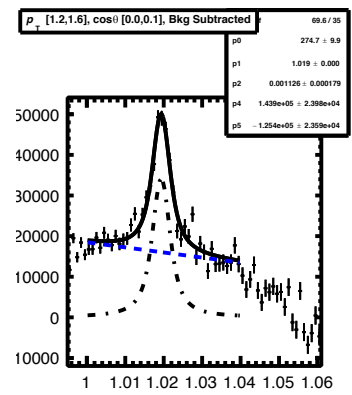
(0-10%) $[0 < \eta < 0.5]$



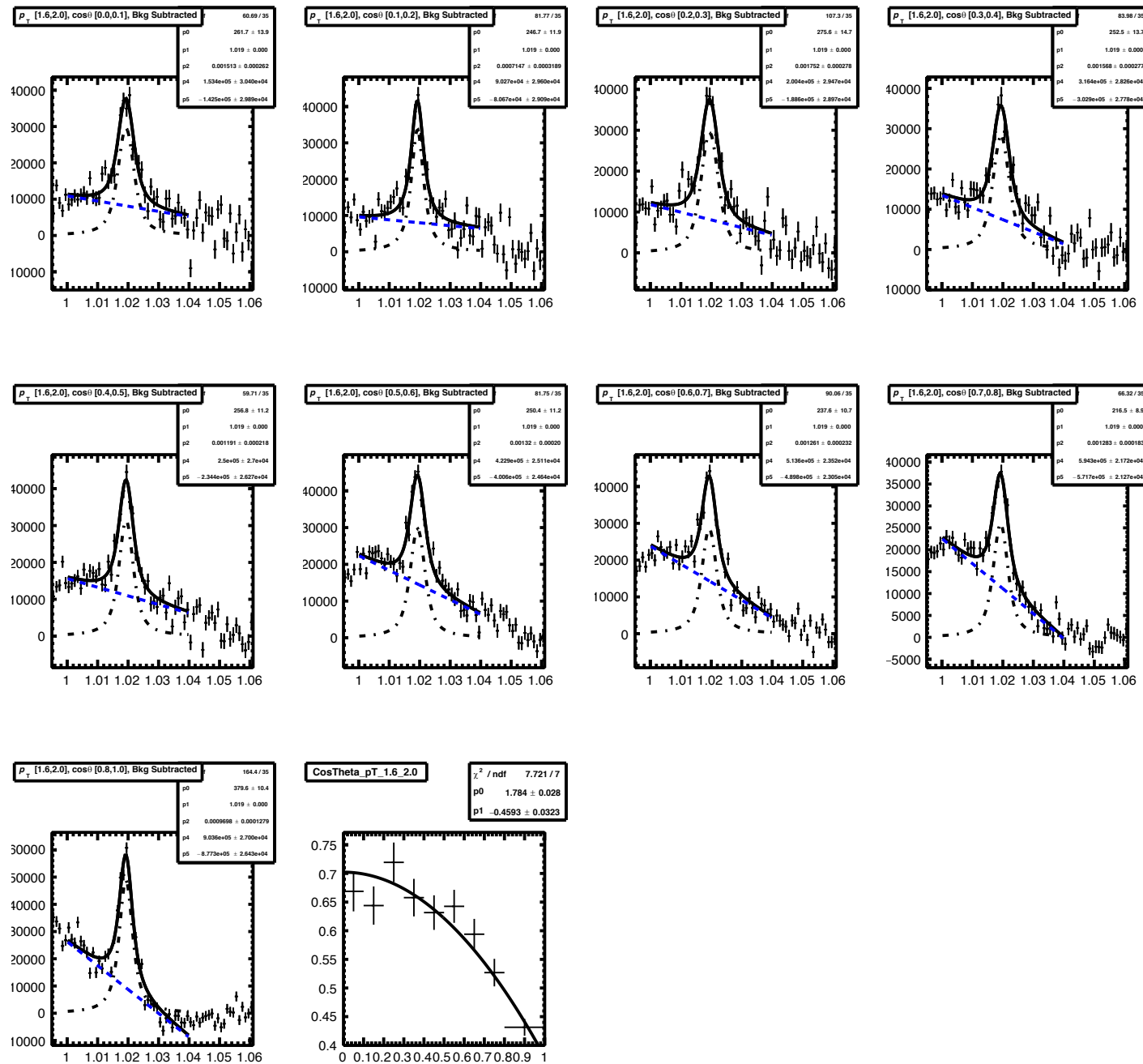
$p_T=0.8-1.2 \text{ GeV}/c$



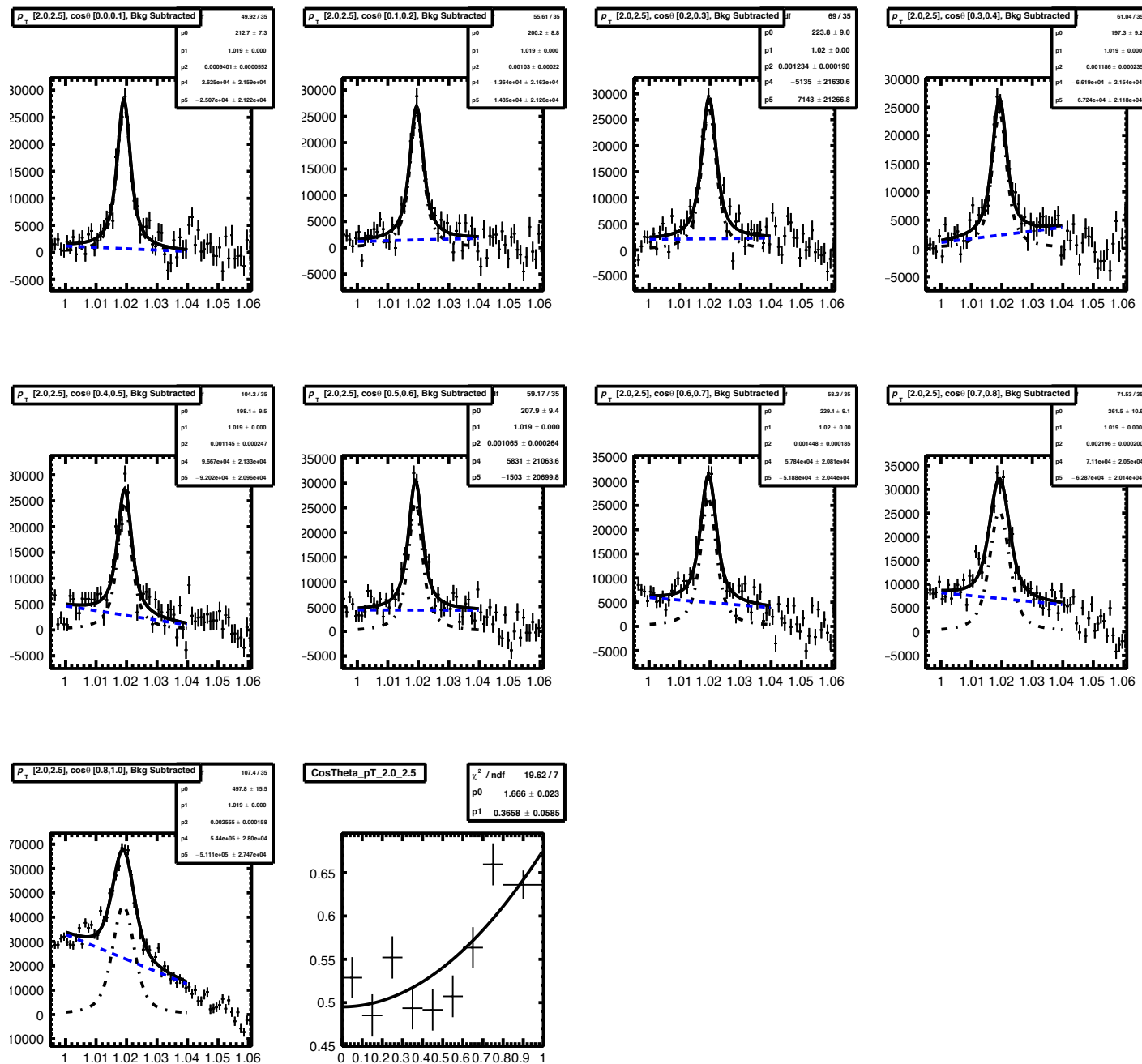
$p_T=1.2-1.6 \text{ GeV}/c$



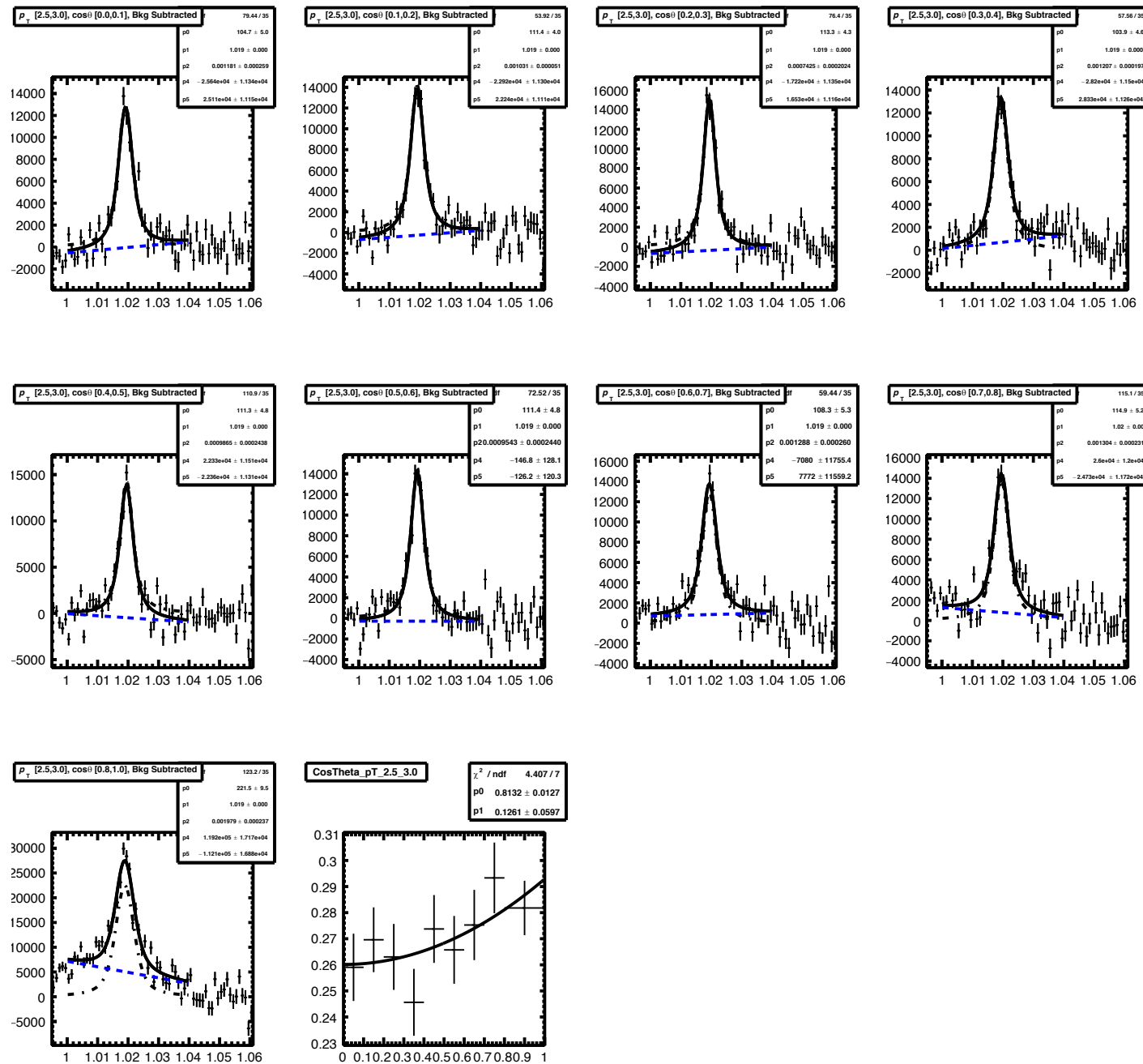
$p_T=1.6-2.0 \text{ GeV}/c$



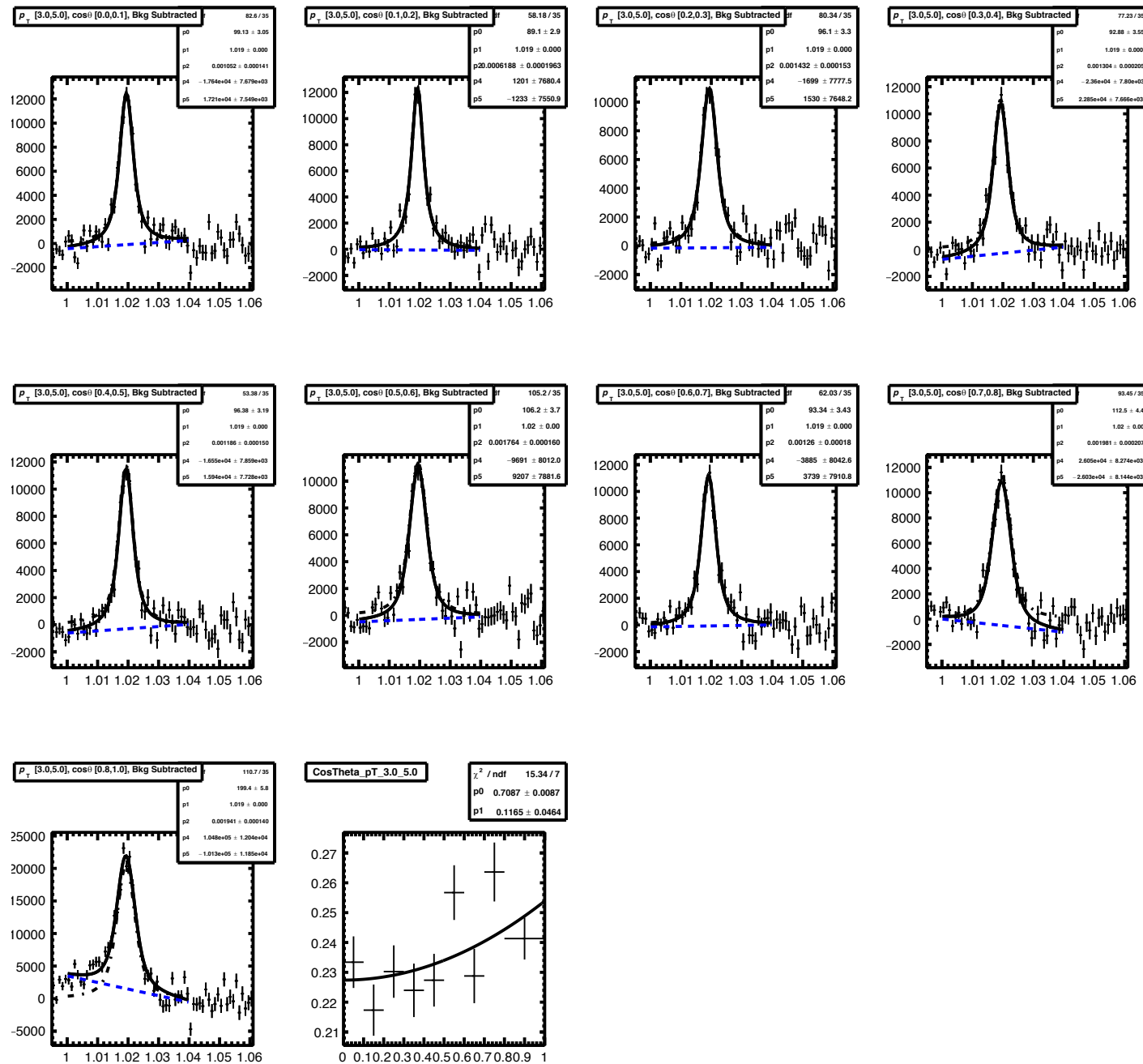
$p_T=2.0-2.5 \text{ GeV}/c$



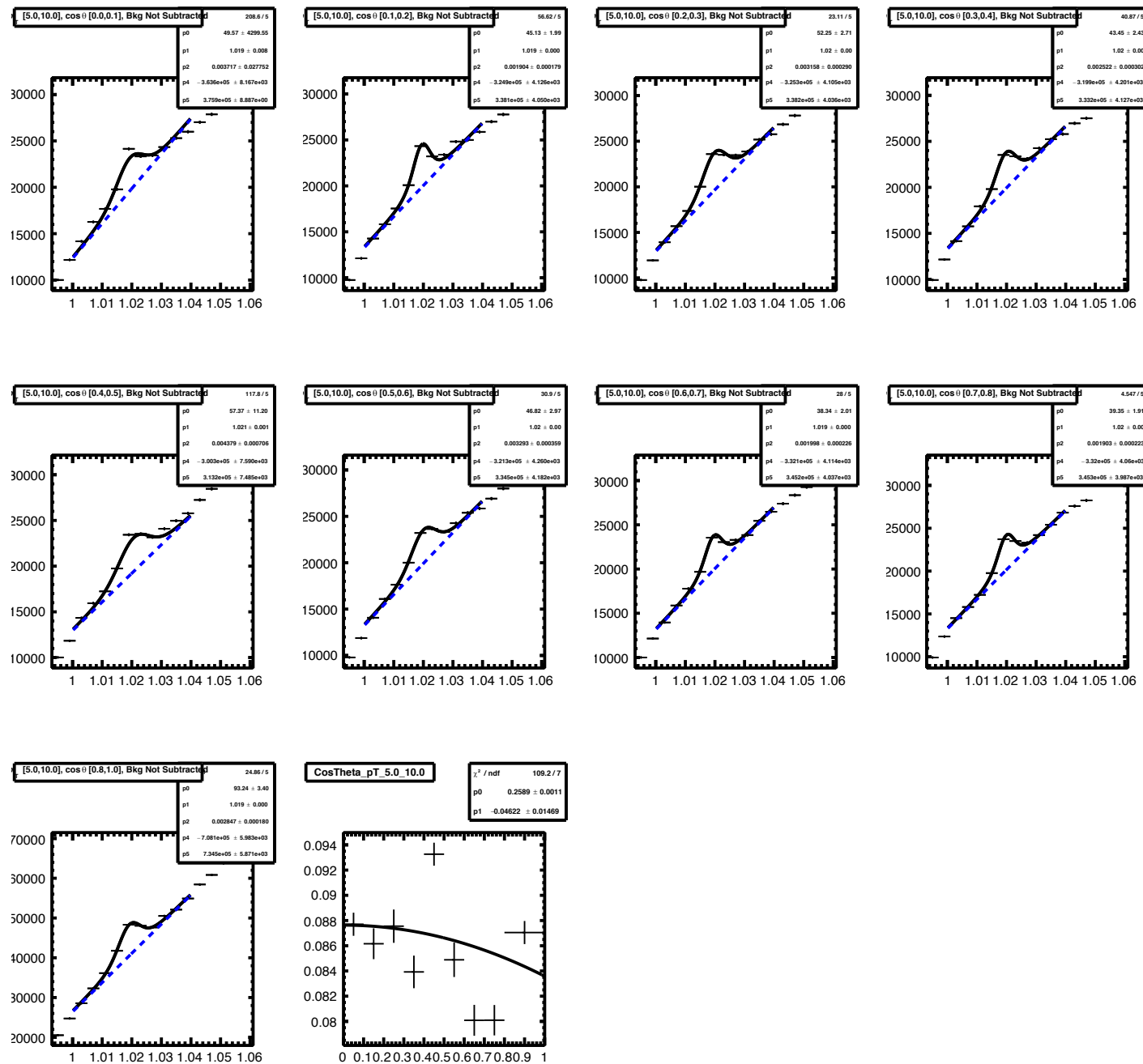
$p_T=2.5-3.0 \text{ GeV}/c$



$p_T=3.0-5.0 \text{ GeV}/c$



$p_T=5.0-15 \text{ GeV}/c$



Track selection: (StandardITSTPCTrackCuts2011)

1. MinNCrossedRowsTPC (70)
2. MinRatioCrossedRowsOverFindableClustersTPC (0.8)
3. MaxChi2PerClusterTPC (4)
4. AcceptKinkDaughters (kFALSE)
5. RequireTPCRefit (kTRUE)
6. RequireITSRefit (kTRUE)
7. ClusterRequirementITS (AliESDtrackCuts::kSPD, AliESDtrackCuts::kAny)
8. MaxDCAToVertexXYPtDep ("0.0105+0.0350/pt^1.1")
9. MaxDCAToVertexZ (2.0)
10. DCAToVertex2D (kFALSE)
11. RequireSigmaToVertex (kFALSE)
12. MaxChi2PerClusterITS (36)