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Transverse Variables for HPTPC

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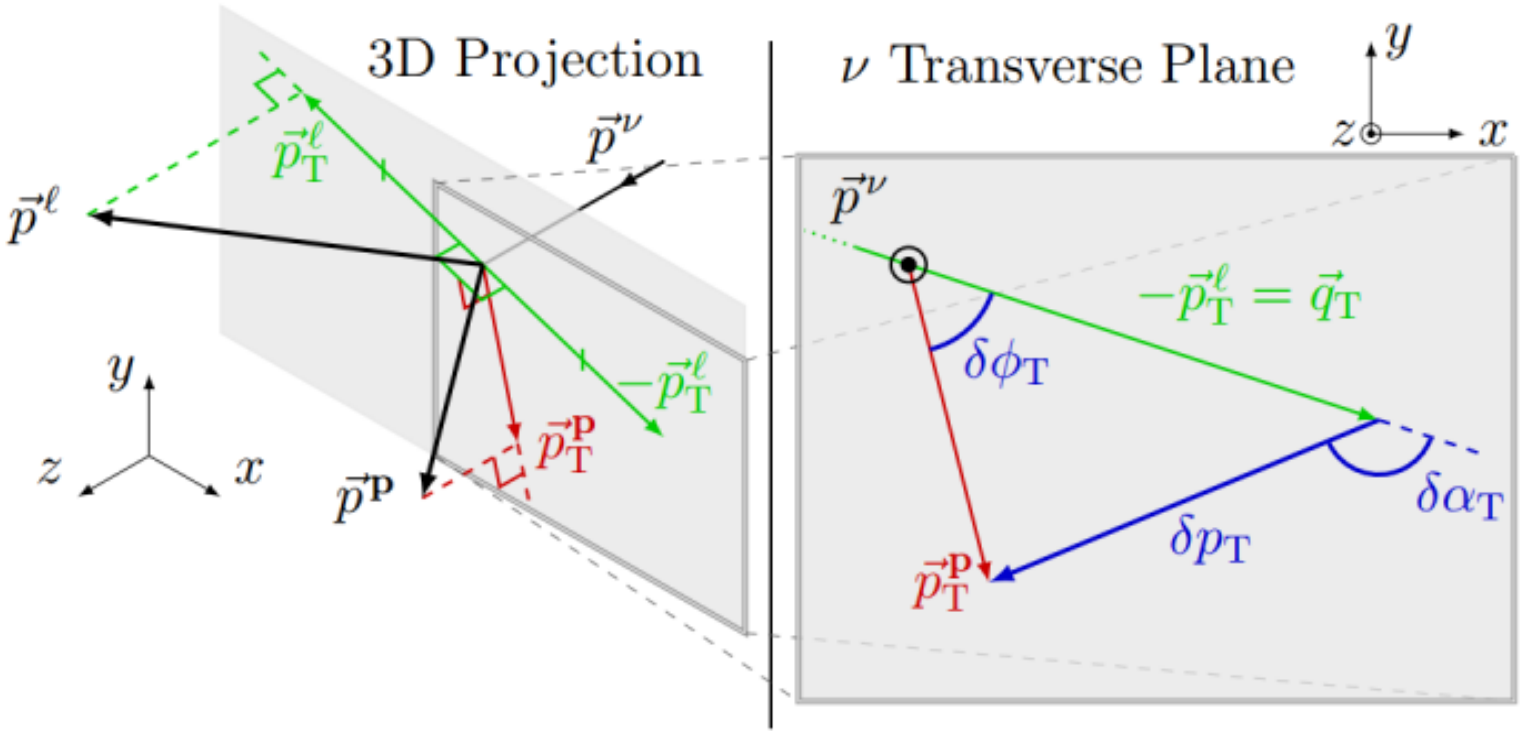
Overview

- Introduction to Single Transverse Variables (STV)
- Distributions of STV for ND280 and HPTPC-like selections

Single Transverse Variables

- Use hadronic information to estimate nuclear effects
- For simple CCQE without nuclear effects $\delta p_T = 0$, $\delta \alpha_T = \pi$, $\delta \phi_T = 0$



HPTPC Study

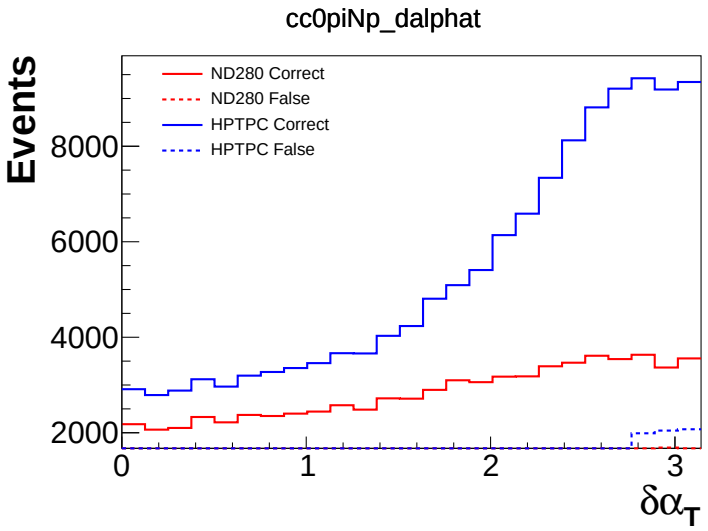
- HPTPC-like and ND280-like momentum thresholds (below) and efficiencies (see Mark's talk) were applied to ND280 MC truth
  - Same as shown by Mark Scott previously
- Then calculated transverse variables
  - Only make sense in samples with a proton or a pion
  - CC0πNp, CC1π0p, CC1πNp

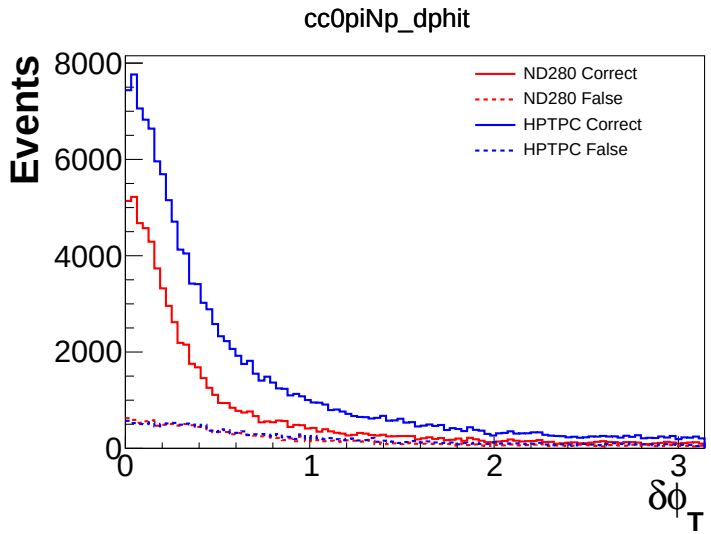
Particle	ND280 Threshold/MeV	HPTPC Threshold/MeV
μ	100	15
π	120	16
p	450	60
e	100	1

HPTPC Study

- Will show the $\delta\alpha_T$, $\delta\phi_T$ and δp_T for all four samples
  - apologies for large number of plots
- Will show both ND280 and HPTPC thresholds and efficiencies
- Truth information is used to determine which events truly belong in the sample ("correct"), and which are fakes ("false")
  - Distributions of transverse variables are shown for both

CC0πNP


cc0piNp_dalphat
Events
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
8000
6000
4000
2000
0
1
2
3
$\delta\alpha_T$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Events
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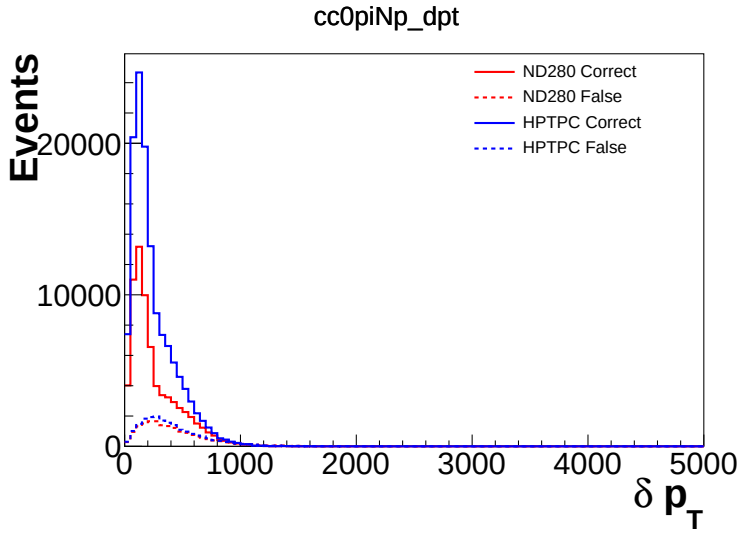
ND280 False
HPTPC Correct
HPTPC False
8000
6000
4000
2000
0
1
2
3
$\delta\phi_T$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Events
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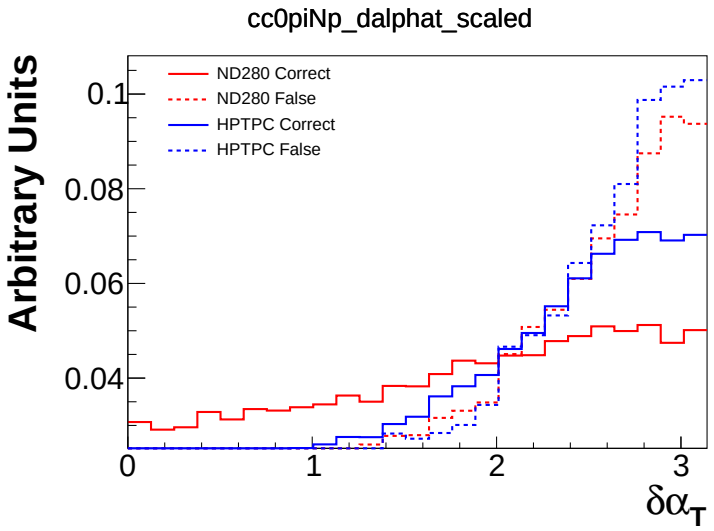
10000
0
1000
2000
3000
4000
5000
$\delta\ p_T$

CC0πNP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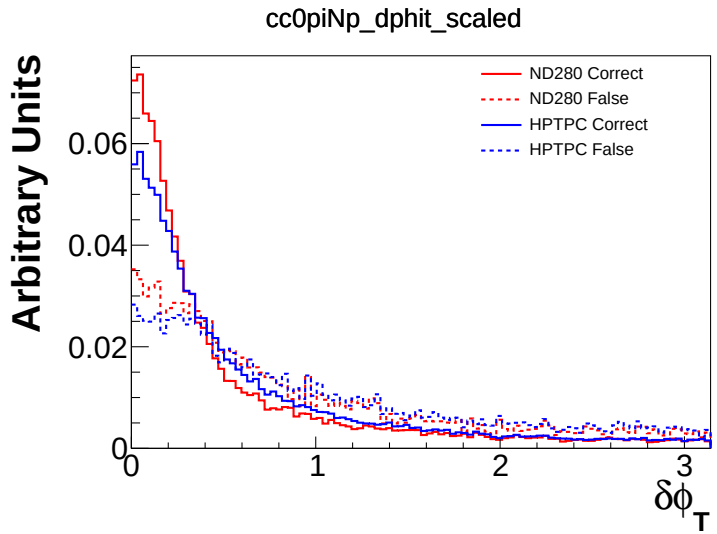
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0.1
0.08
0.06
0.04
0
1
2
3
$\delta\alpha_T$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Arbitrary Units
ND280 Correct
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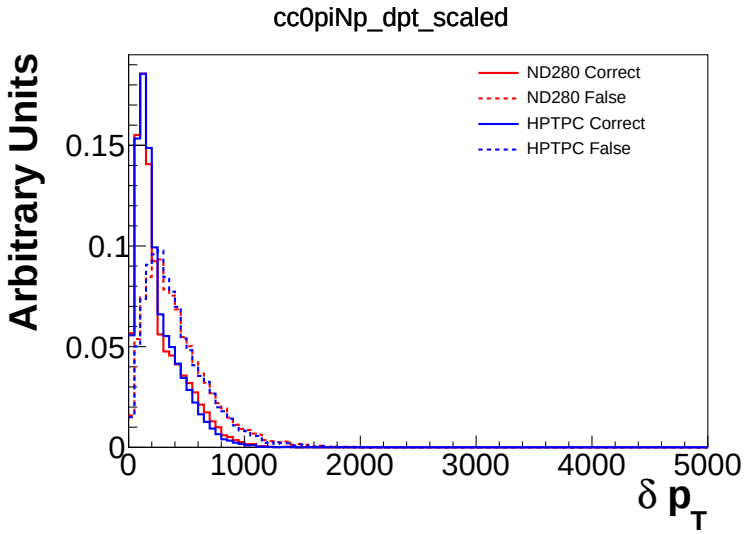
HPTPC Correct
HPTPC False
0.06
0.04
0.02
0
0
1
2
3
$\delta\phi_T$


cc0piNp_dpt_scaled
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
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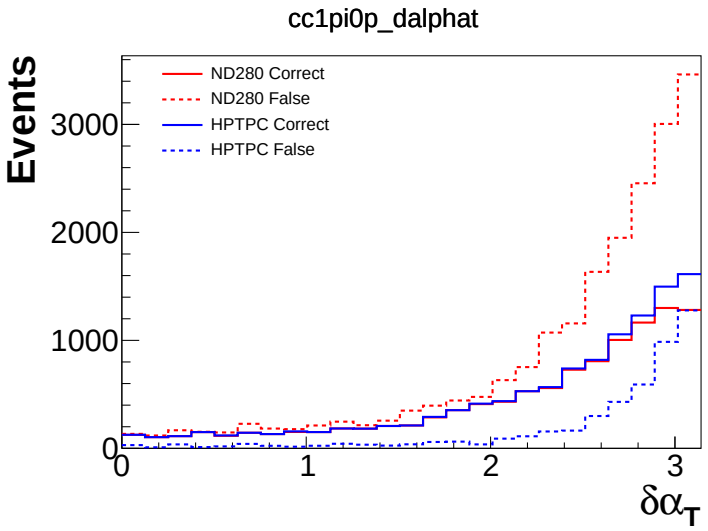
0.1
0.05
0
0
1000
2000
3000
4000
5000
$\delta\ p_T$

CC1π0P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Events
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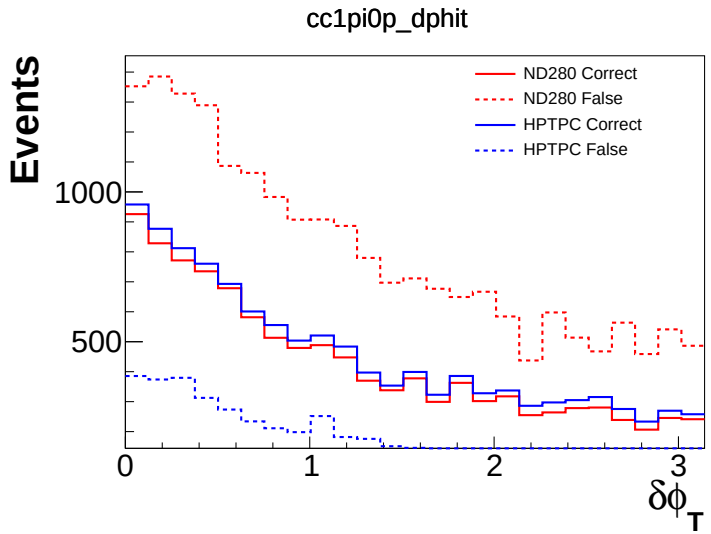
ND280 False
HPTPC Correct
HPTPC False
0
1000
2000
3000
0
1
2
3
$\delta\alpha_T$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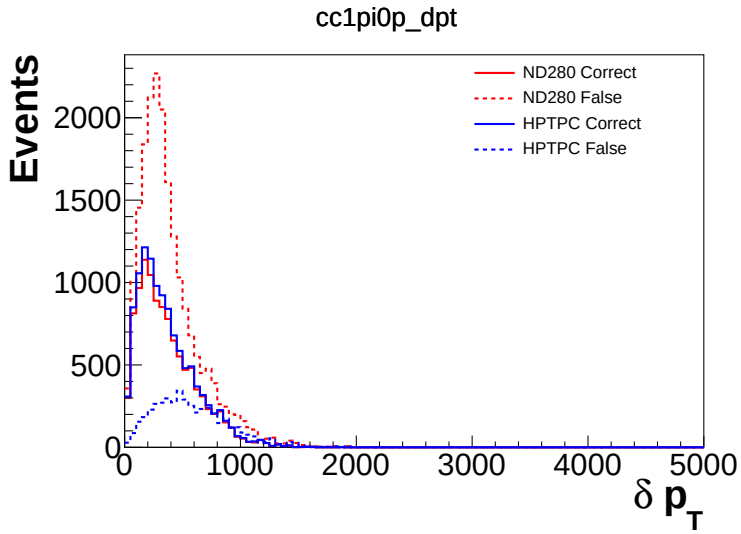
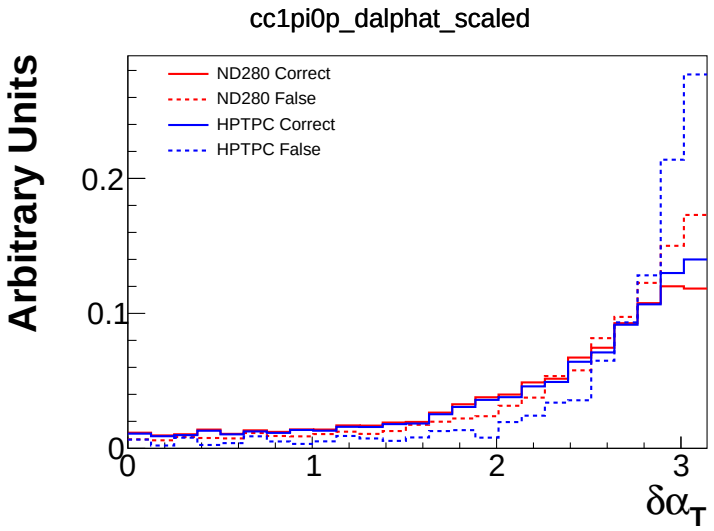
HPTPC Correct
HPTPC False
500
1000
0
1
2
3
$\delta\phi_T$


cc1pi0p_dpt
Events
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0
500
1000
1500
2000
0
1000
2000
3000
4000
5000
$\delta\ p_T$

CC1π0P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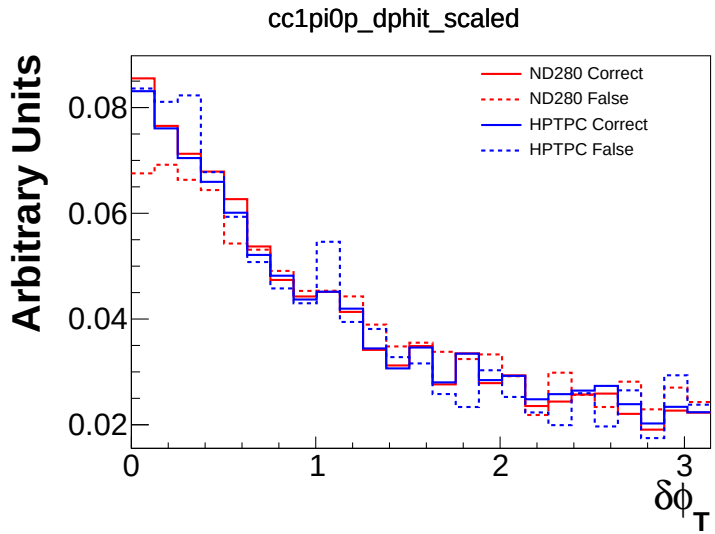
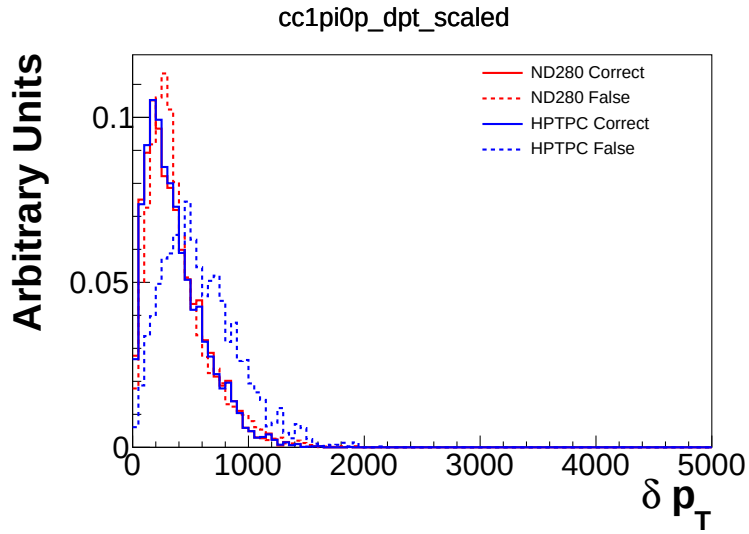
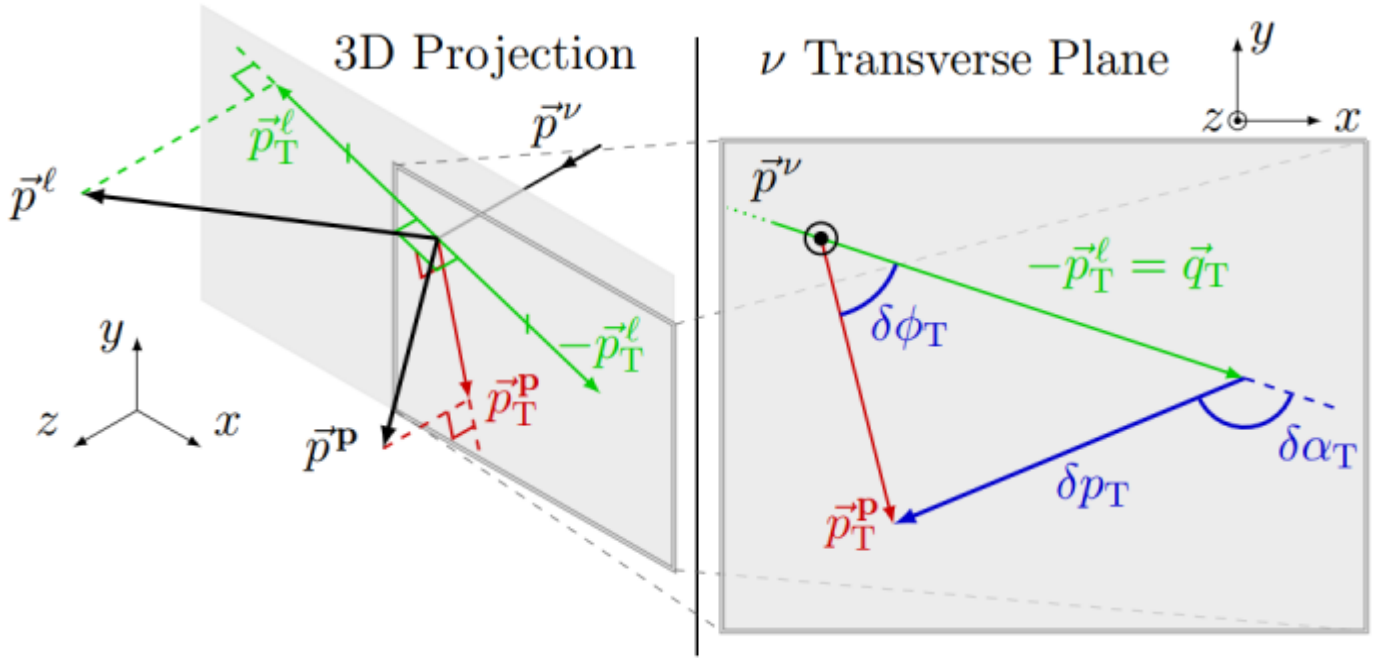
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0
0.1
0.2
0
1
2
3
$\delta\alpha_T$


cc1pi0p_dphit_scaled
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0.02
0.04
0.06
0.08
0
1
2
3
$\delta\phi_T$

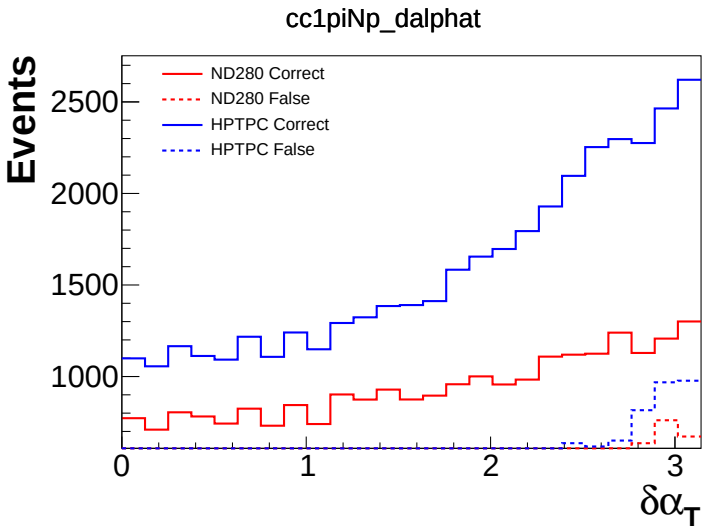

cc1pi0p_dpt_scaled
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0
0.05
0.1
0
1000
2000
3000
4000
5000
$\delta\ p_T$

CC1π0P - difference hypothesis

- Pion threshold is much lower in HPTPC (120 vs 16 MeV)
- Therefore HPTPC sample contains more $p+\pi$ events where the proton is missed and the pion is of low energy
- Increases the number of false events with high δp_T and $\delta \alpha_T$
- Will investigate 2D distributions of events



CC1πNP


cc1piNp_dalphat
Events
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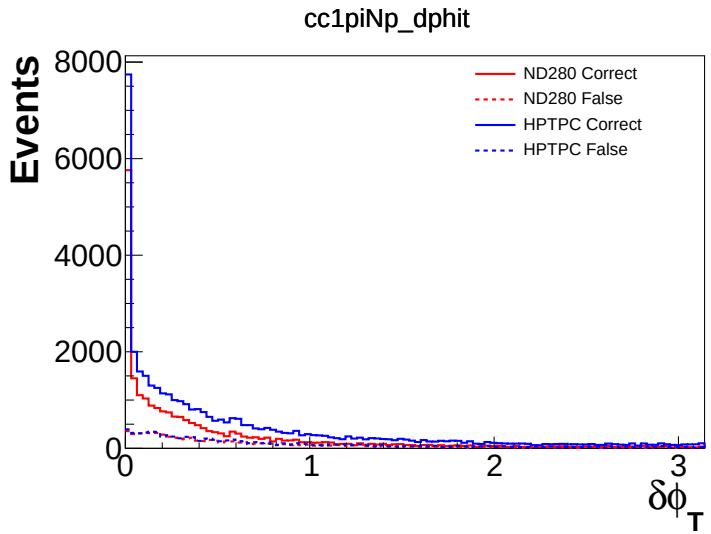
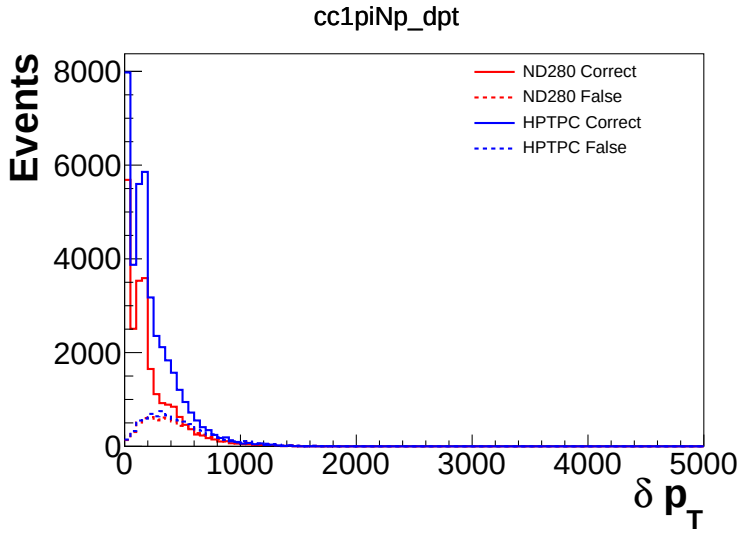
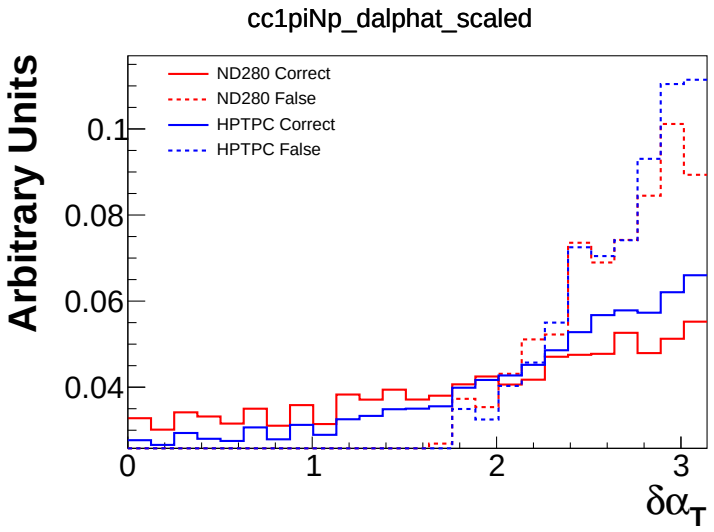
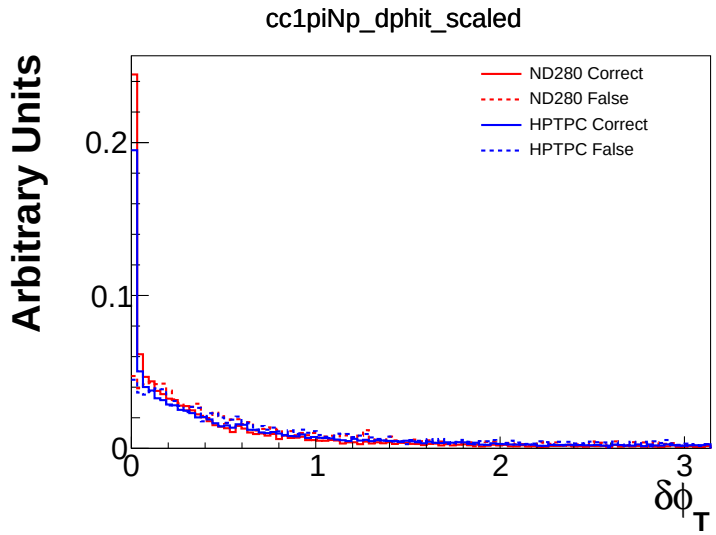
ND280 False
HPTPC Correct
HPTPC False
2500
2000
1500
1000
0
1
2
3
$\delta\alpha_T$


cc1piNp_dphit
Events
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
8000
6000
4000
2000
0
0
1
2
3
$\delta\phi_T$


cc1piNp_dpt
Events
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
8000
6000
4000
2000
0
0
1000
2000
3000
4000
5000
$\delta\ p_T$

CC1πNP


cc1piNp_dalphat_scaled
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0.1
0.08
0.06
0.04
0
1
2
3
$\delta\alpha_T$


cc1piNp_dphit_scaled
Arbitrary Units
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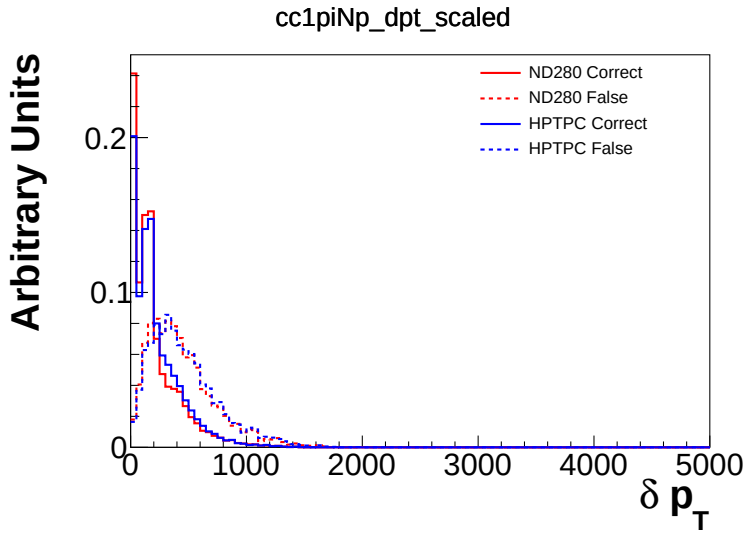
ND280 False
HPTPC Correct
HPTPC False
0.2
0.1
0
0
1
2
3
$\delta\phi_T$


cc1piNp_dpt_scaled
Arbitrary Units
ND280 Correct
ND280 False
HPTPC Correct
HPTPC False
0.2
0.1
0
0
1000
2000
3000
4000
5000
$\delta\ p_T$

- Transverse variables appear similarly distributed for ND280 and HPTPC thresholds
- Exception is CC1π0p where δp_T of false events is higher in HPTPC than ND280
  - Likely caused by there being more low energy pions identified giving a larger difference between lepton and pion momentum
  - Potentially could be used to separate signal and background
  - δp_T could also be used as a proxy for the missing proton