Study of Single Muon Reconstruction Efficiency

Xiaorong Wang
New Mexico State University

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Outline

Motivation:

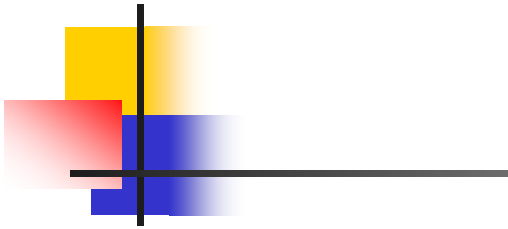
- R_{dA}, R_{AA} and open charm type physics need absolute yield measurement -> "d^2N/dP_Tdy", so we need to understand the detector efficiency accurately as a function of y, p_T(or p) and centrality.

Part I: Single muon reconstruction efficiency

- Ereco (p, θ, centrality);
- Momentum Resolution(p, θ, centrality)

Part II: BBC efficiency study: PYTHIA decay muon simulation

Summary and to do list



Part I:
Single Muon reconstruction efficiency

Single Muon Measurement

- Single Muon Sources:
  - Light meson decay: (K, π)
    dominates single muons!
  - Prompt muon: (heavy flavor decay)
  - Punch through background

- Experimental Measurement:

$$\Delta N_{meas} = \Delta N \cdot \varepsilon_{reco} \cdot \varepsilon_{BBC} \cdot (\varepsilon_{BLT})$$

Single Muon Simulation

- Samples: μ^-
  - 3 θ bins from 15-30 for each arm
  - 4 p_{tot} samples:
    p = 3, 6, 9, 12(GeV)
  - 2 embedded with dAu samples:
    0-20%, 60-88%
- Offline Library: pro50
- Old framework simulation

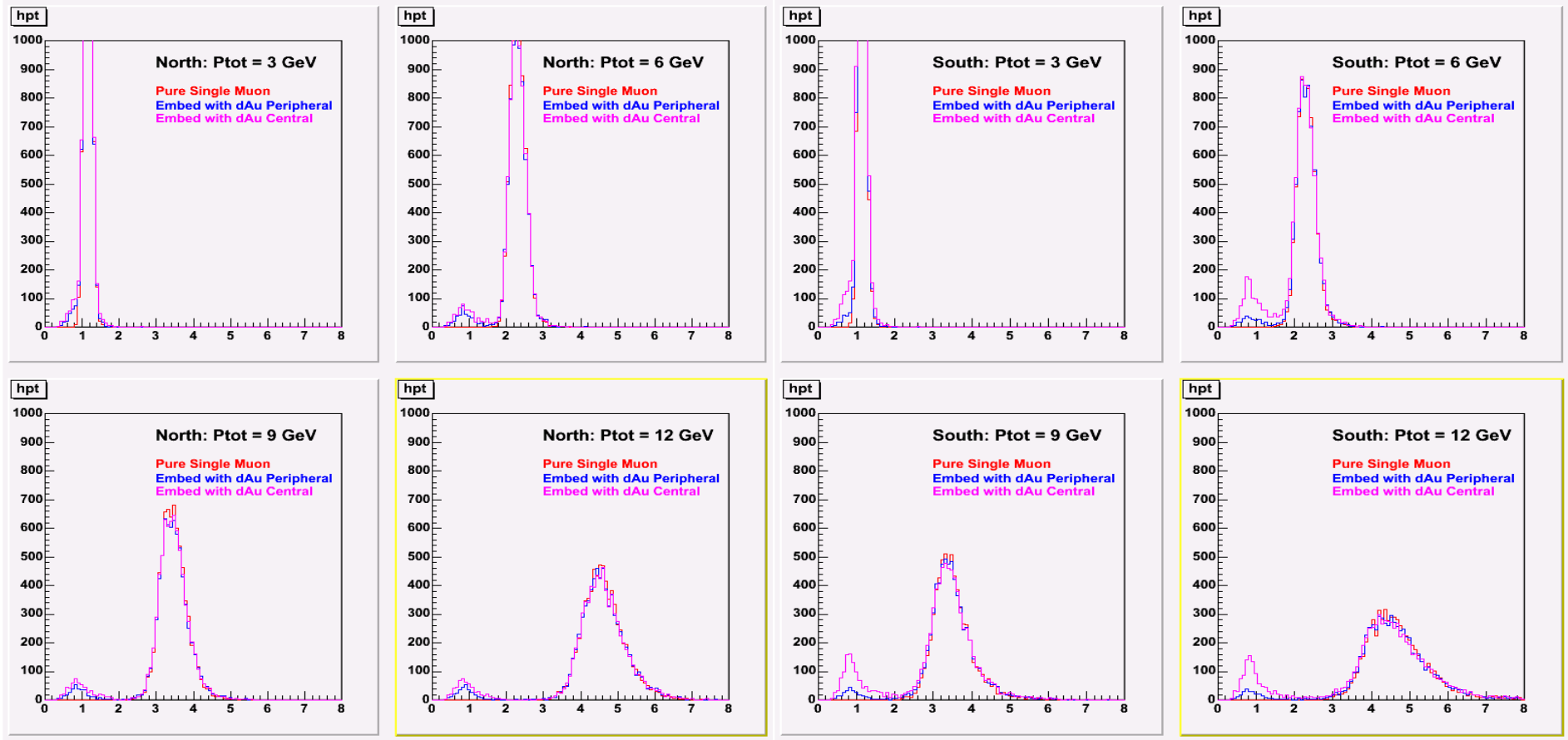
Muon Reconstruction Efficiency & $\Delta p/p$

- Muon track quality cut:
  - single muon reached at least gap 4;
  - chisq < 20;
  - $|p - p_{mc}| < 3\sigma$;
  - ghost track subtracted: ($N_{reco} = N^{-}_{reco} - N^{+}_{reco}$)
- Single Muon Reconstruction Efficiency

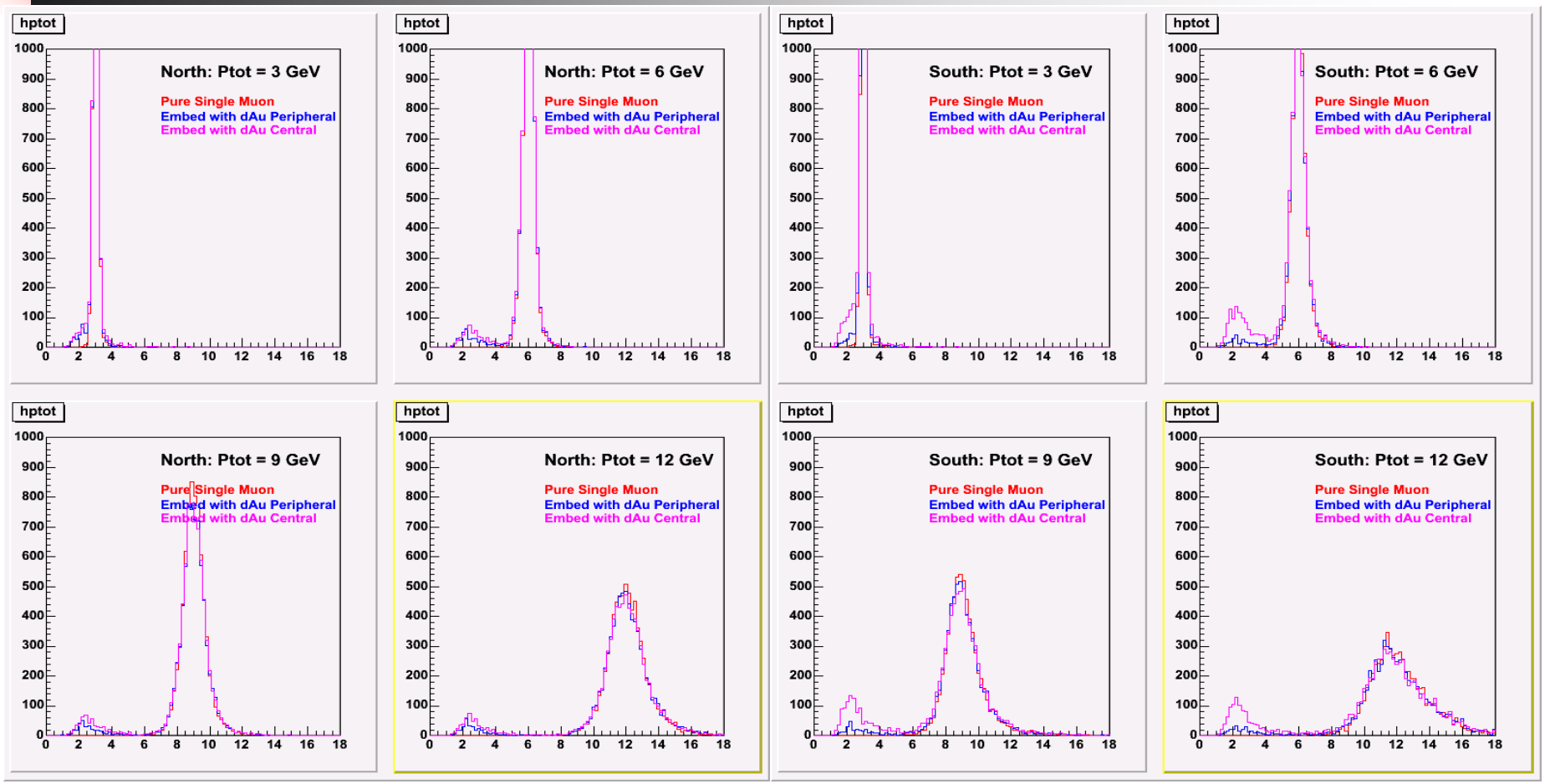
$$\varepsilon_{reco}(p,\theta,cent) = \frac{N^{reco}}{N^{genMC}}$$

- Momentum Resolution:
  - Fit reconstructed muon momentum distribution
  - $\Delta p/p$ (p, θ, centrality)

Reconstructed muon p_t distribution

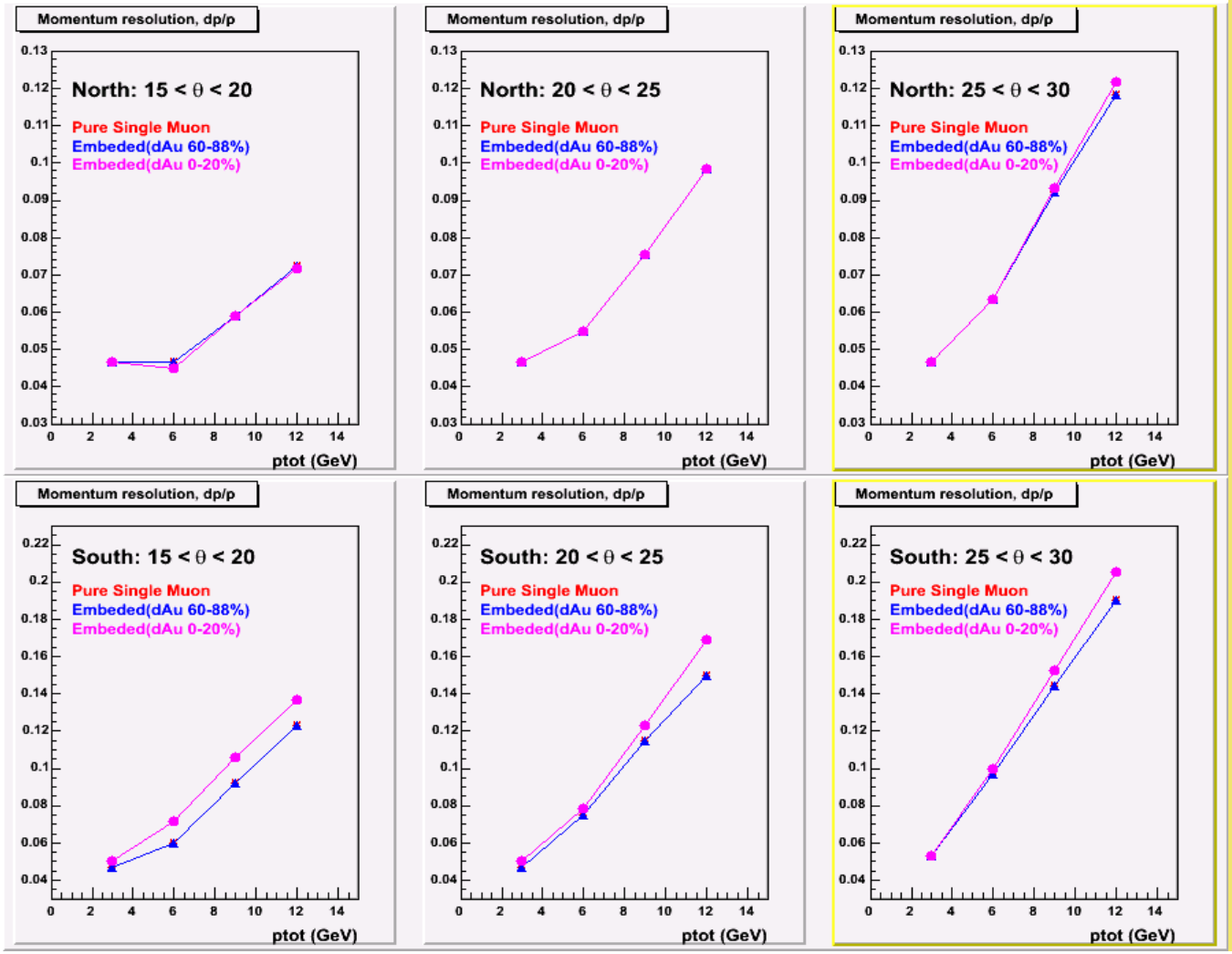


Reconstructed muon p_{tot} distribution



p_{tot} and p_T distribution: Embed events contains more background in south
p_{tot} width: strongly p_{tot} dependent.

Momentum Resolution



$\Delta p/p$:

->Strongly

p_{tot} dependent

θ dependent

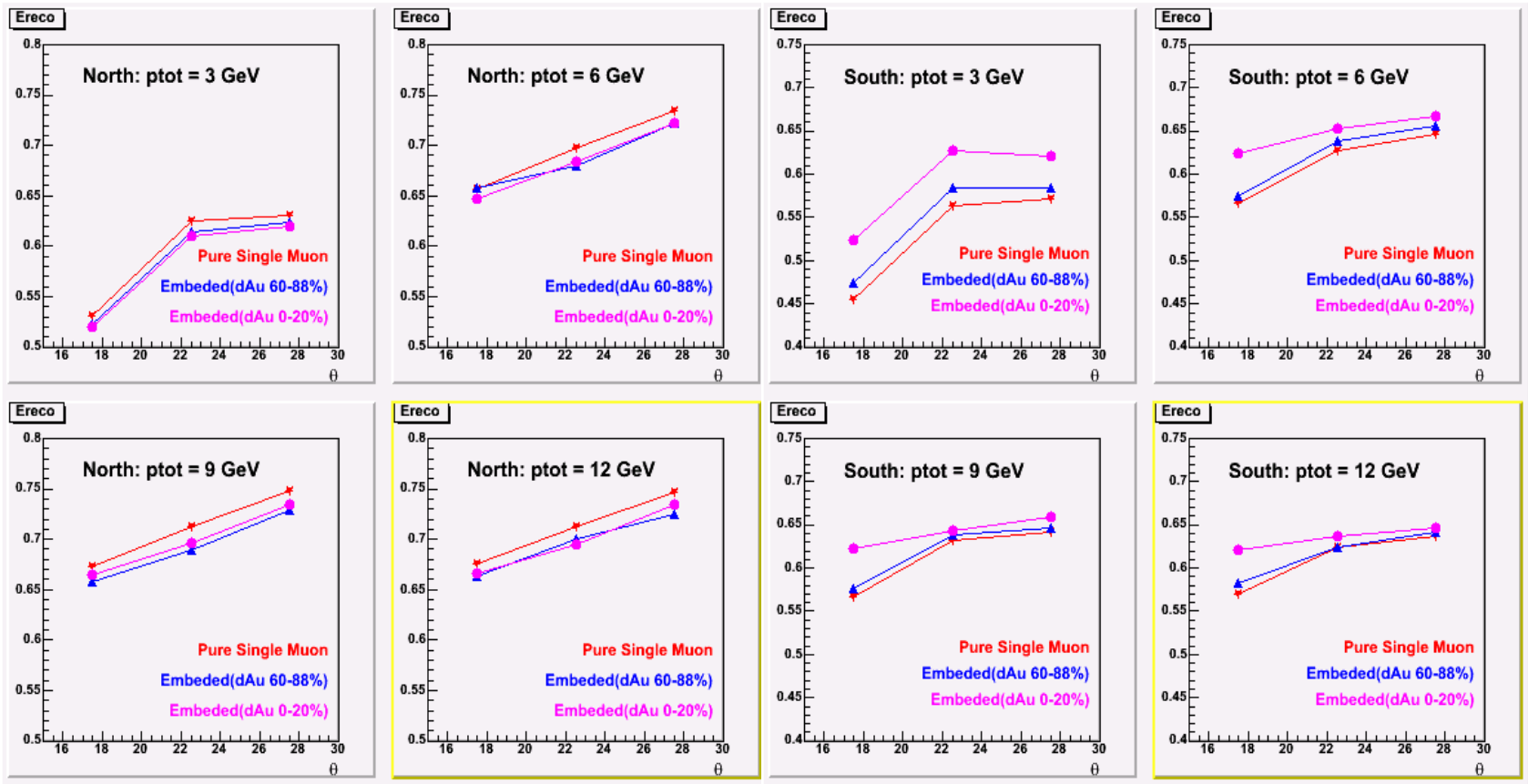
4% to 12% (North)

4% to 20% (South)

->no centrality dependent in North

Slight centrality dependent in South

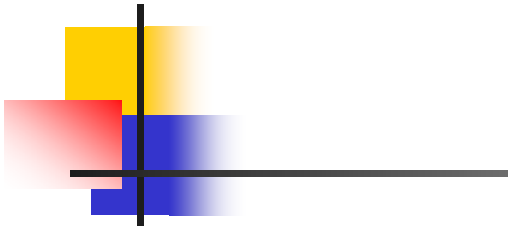
Single Muon Reconstruction Efficiency



Ereco is around 10% higher in North Arm;

10% centrality dependence was observed for South, but not for North;

Ereco increased around 10% as θ goes up from 15 to 30, Effect is stronger for low momentum;



Part II:
BBC Trigger Efficiency Study

BBC Efficiency (From PYTHIA)

- Independent of whether muon is reconstructed or not
- Estimated with Beam-clock triggered data, also can be checked with PYTHIA pp MB decay muons events
- BBC efficiency:

$$\varepsilon_{BBC}^{(1)} = \frac{N(BBC\_vtx)}{N(genMC_{\mu})}$$

- BBC Efficiency for reconstructed muon events

$$\varepsilon_{BBC}^{(2)} = \frac{N(BBC\_vtx, good\_reco\_muons)}{N(good\_reco\_muons)}$$

- Need to check:

$$\varepsilon_{BBC}^{(1)} \overset{?}{\approx} \varepsilon_{BBC}^{(2)}$$

PYTHIA pp events sample

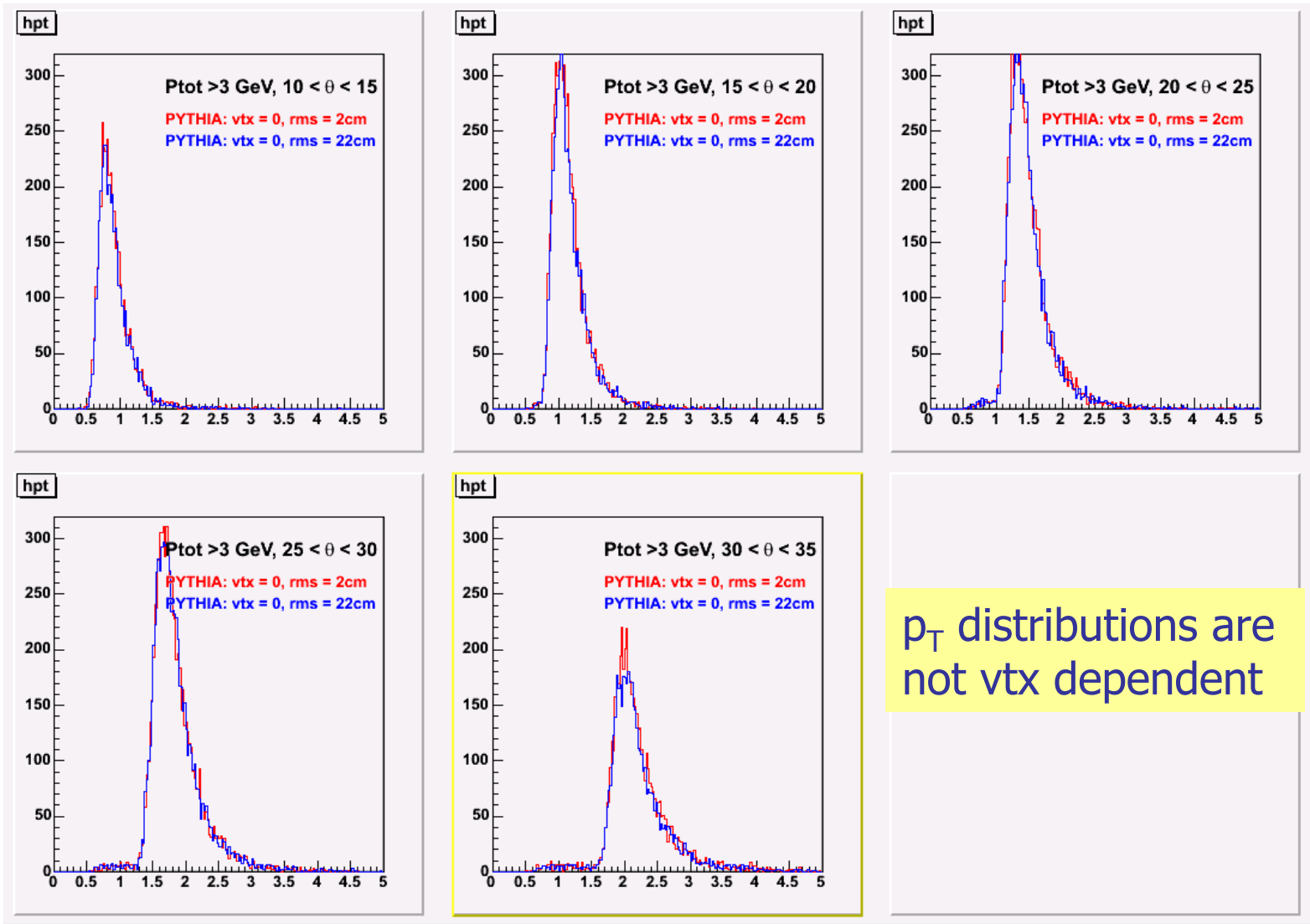
- PYTHIA pp events w/ decay muons

$$\pi^{\pm} \rightarrow \mu^{\pm} + \nu_{\mu}$$

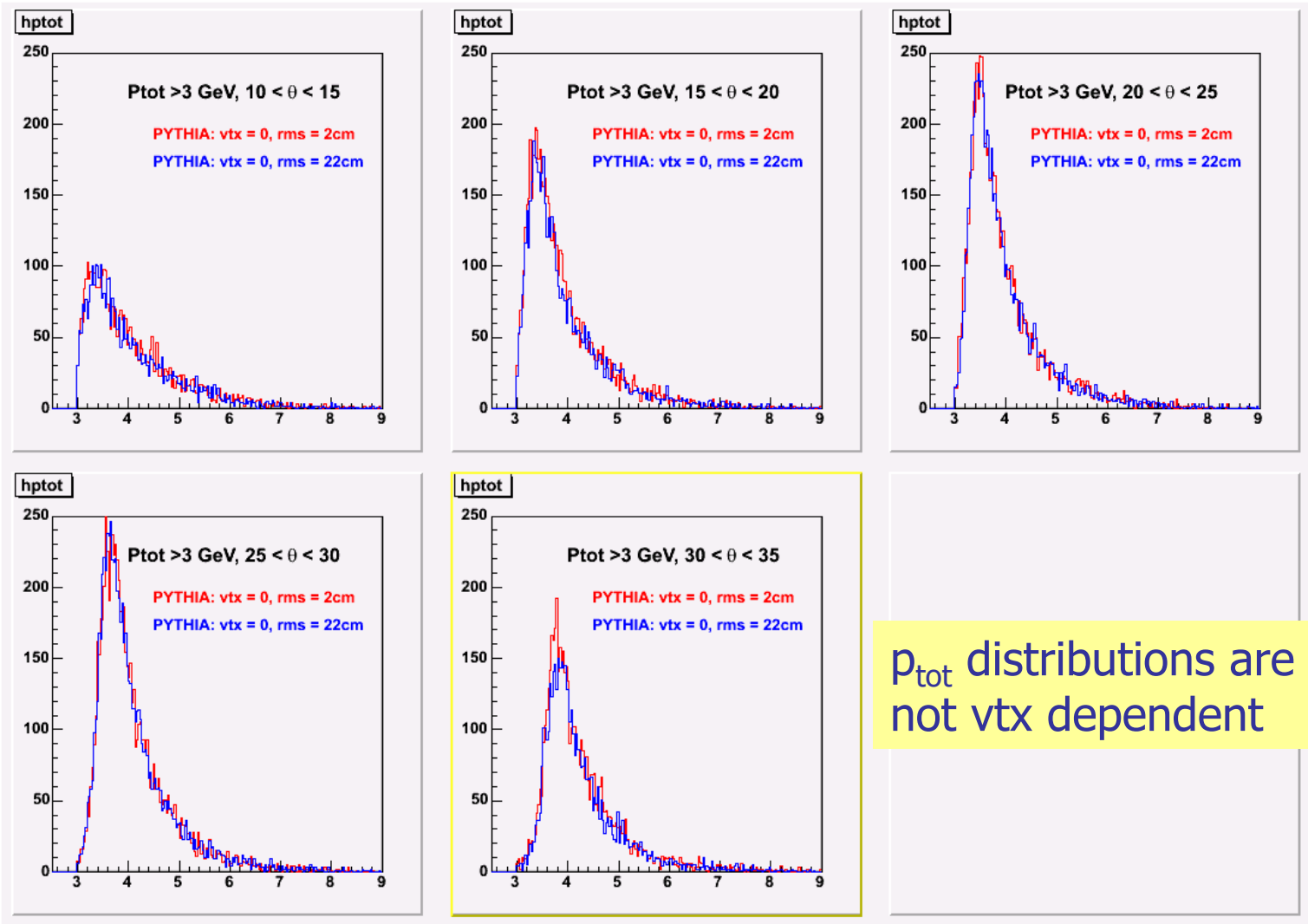
$$K^{\pm} \rightarrow \mu^{\pm} + \nu_{\mu}$$

- 5 θ bins from 10-37 for north arm only
- 2 Vertex samples
  - vtx =0, rms =2cm
  - vtx =0, rms=22cm

Reconstructed muon p_T distributions

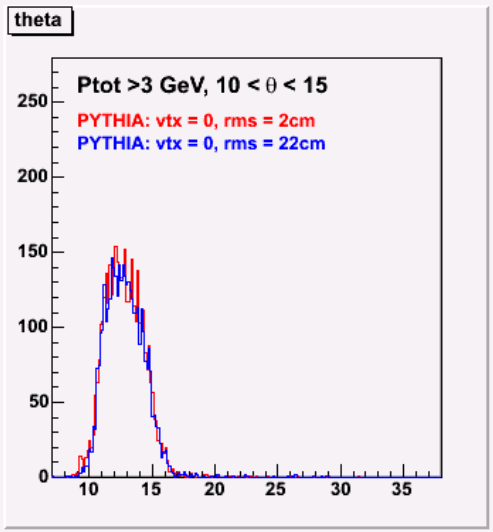


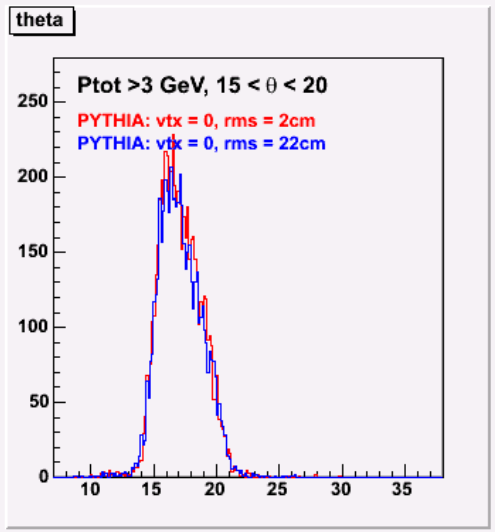
Reconstructed muons p_{tot} distributions

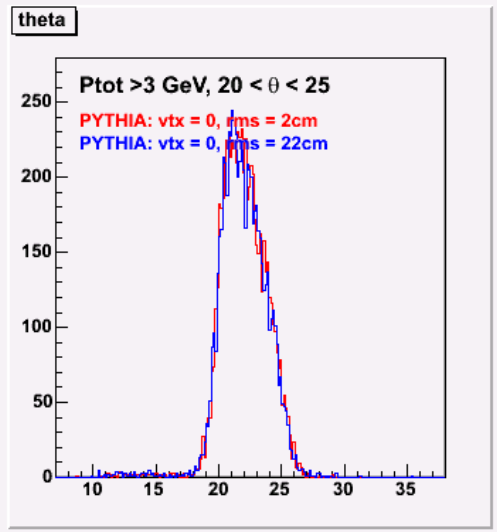


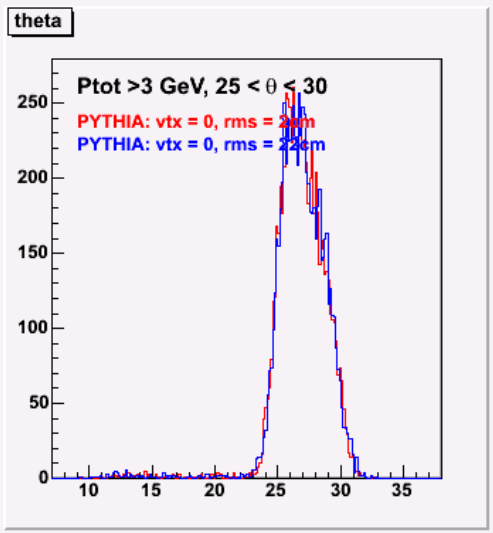
p_{tot} distributions are not vtx dependent

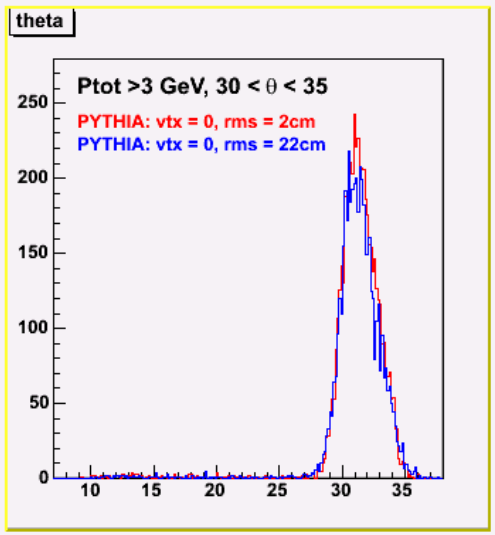
Reconstructed muon θ distribution





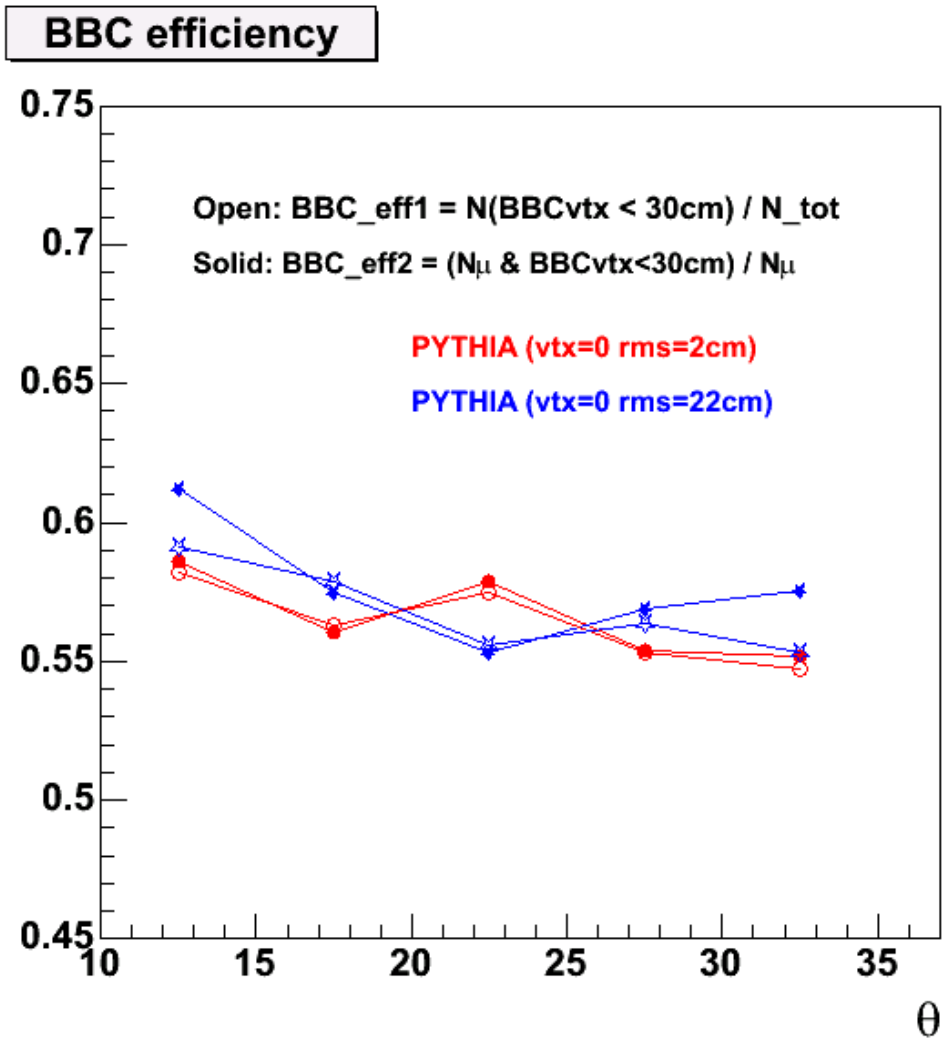






Θ distributions are not vtx dependent

BBC Efficiency from Decay Muon



BBC trigger efficiency:

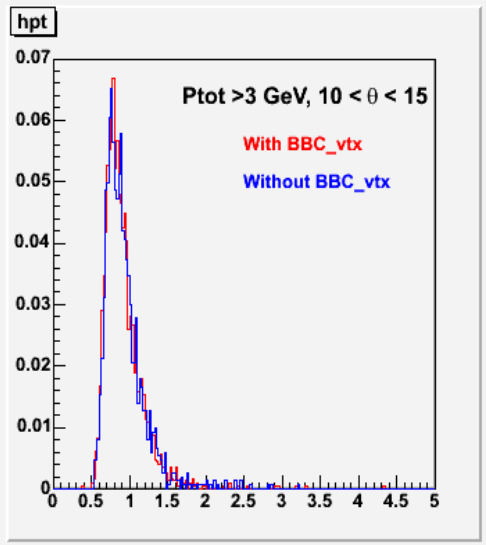
> No vertex dependence

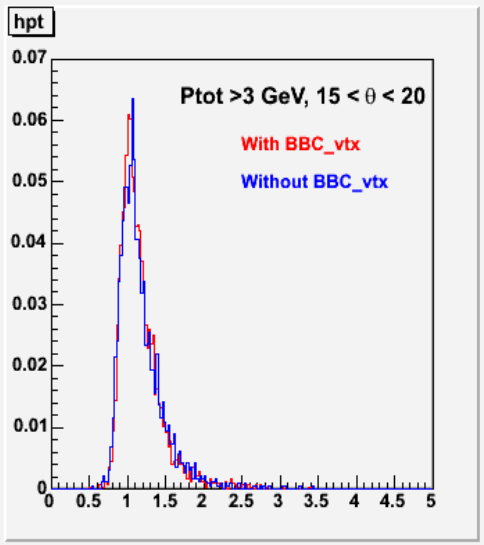
> Slightly depends on θ

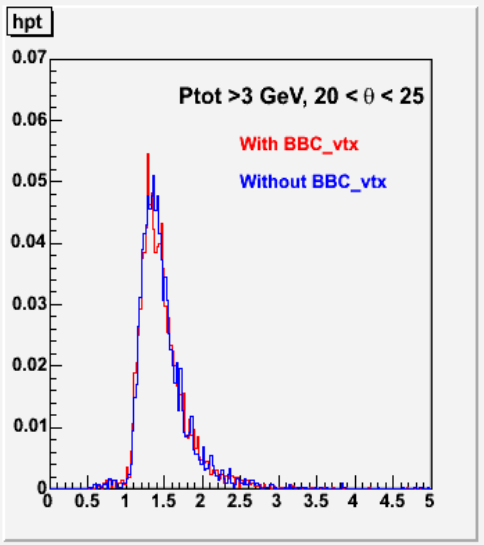
> $BBC_{eff}^{(1)} \approx BBC_{eff}^{(2)}$

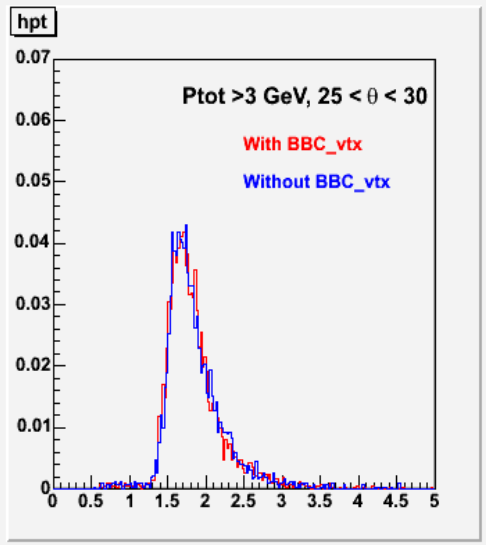
> ~55-60%

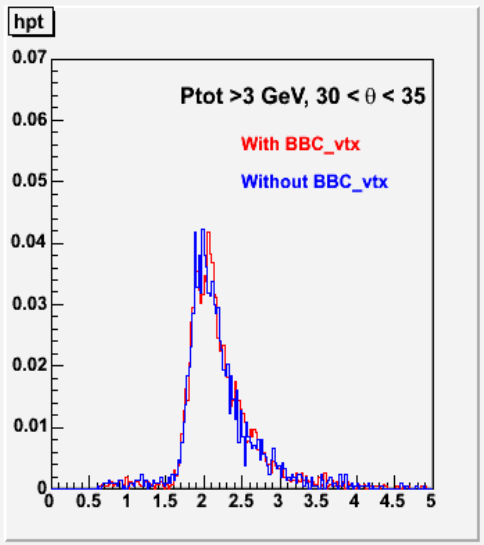
p_T dist. w & w/o good BBC_vtx





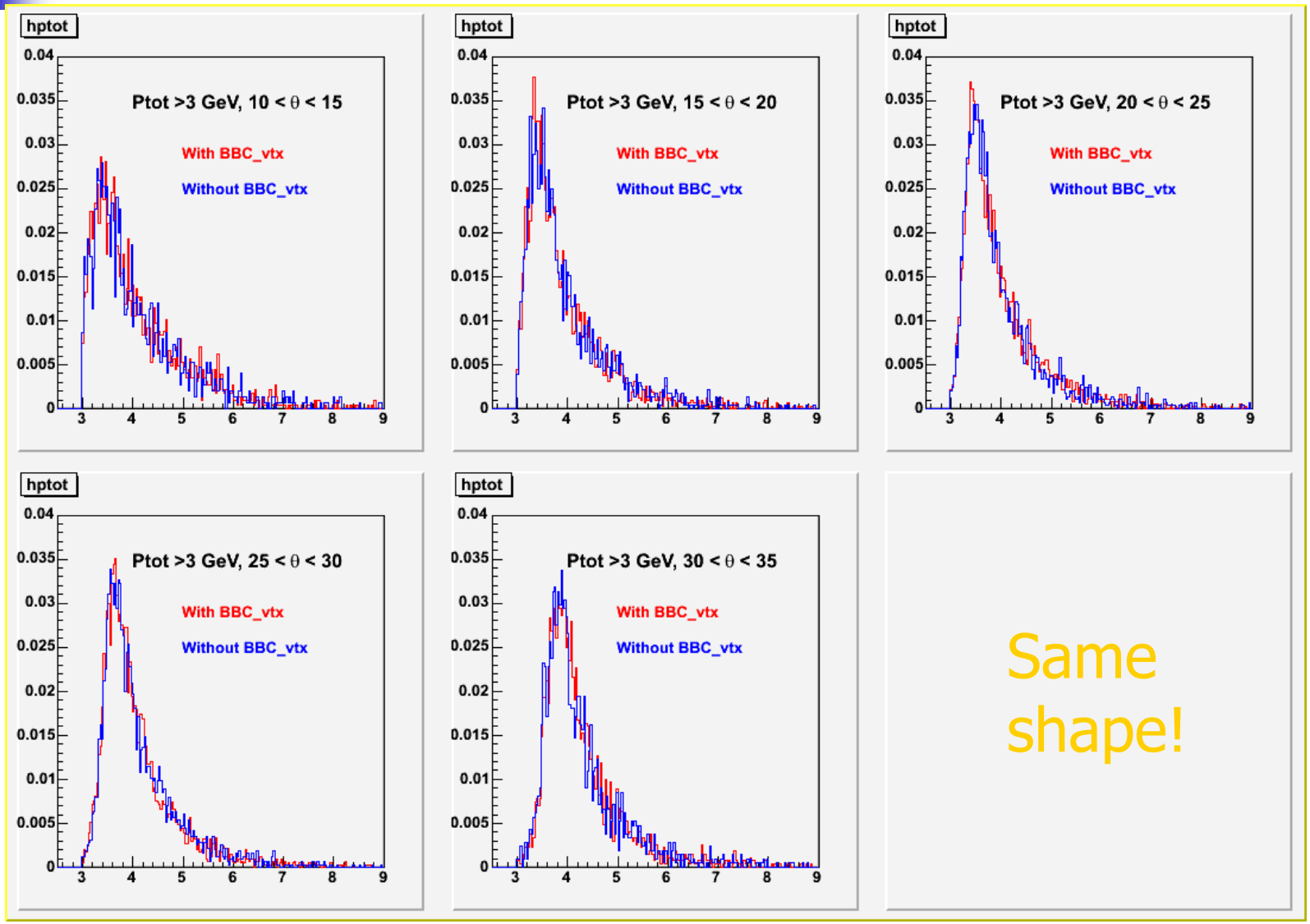




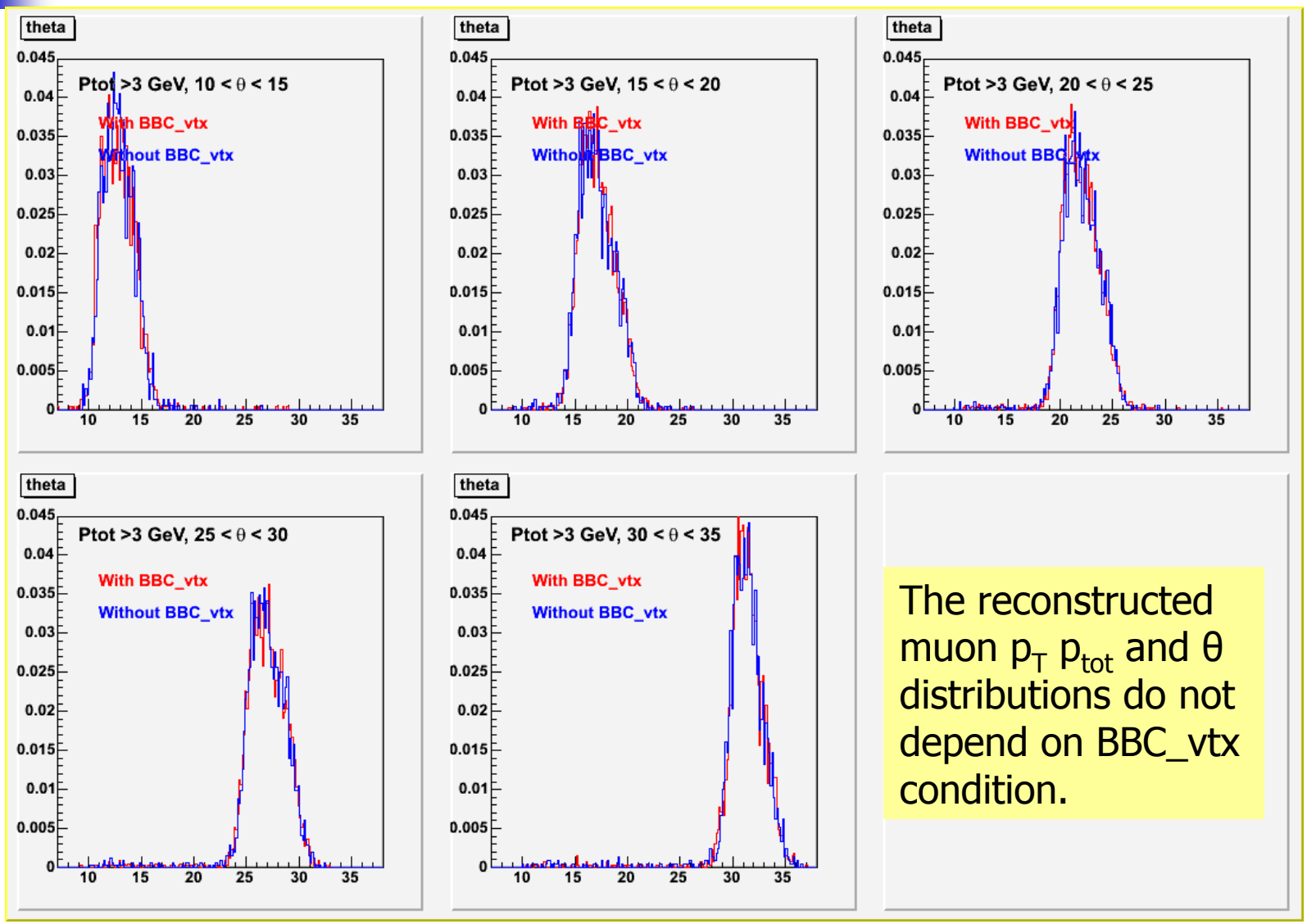


Same shape!

p_{tot} dist. w & w/o good BBC_vtx



θ dist. w & w/o good BBC_vtx

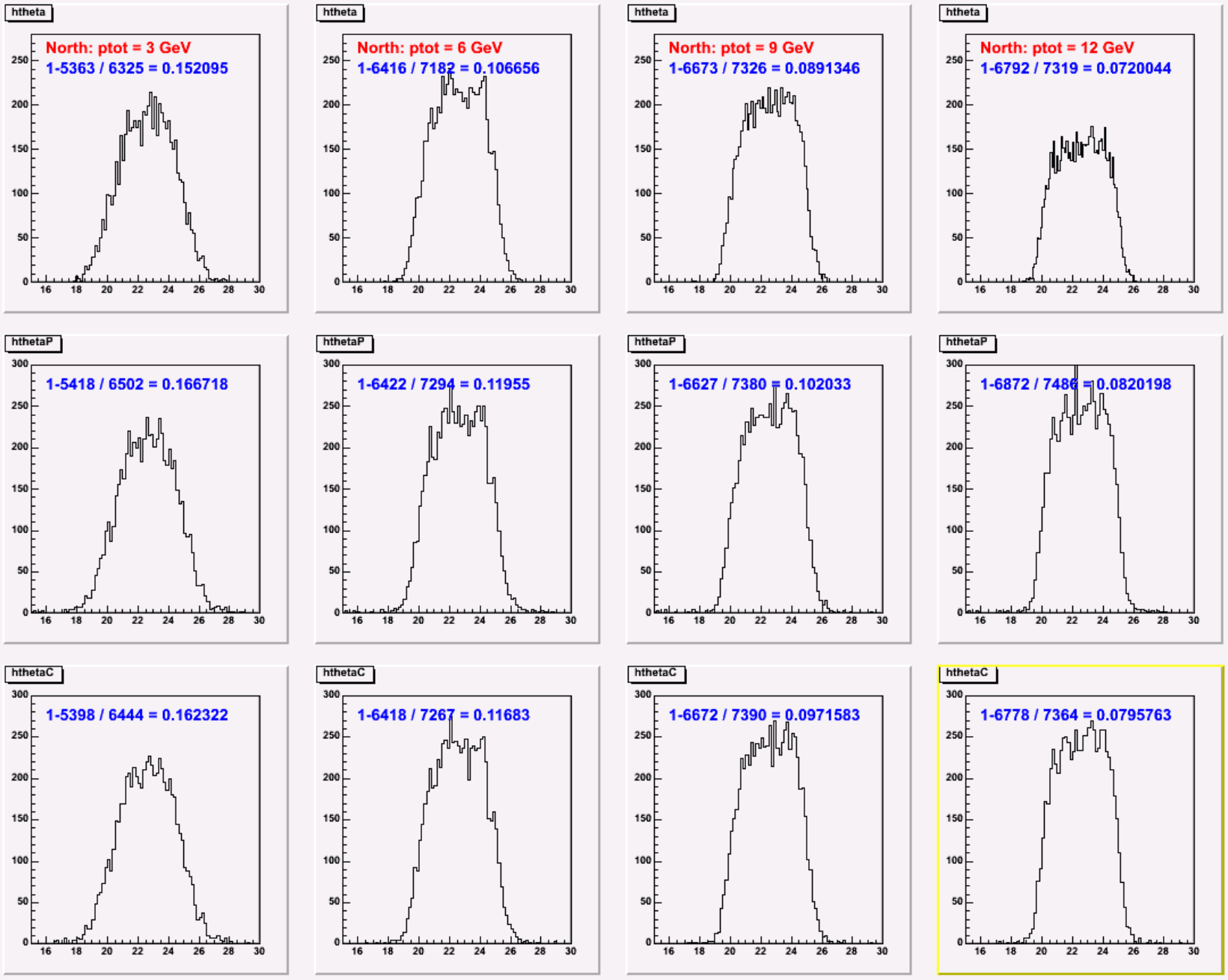


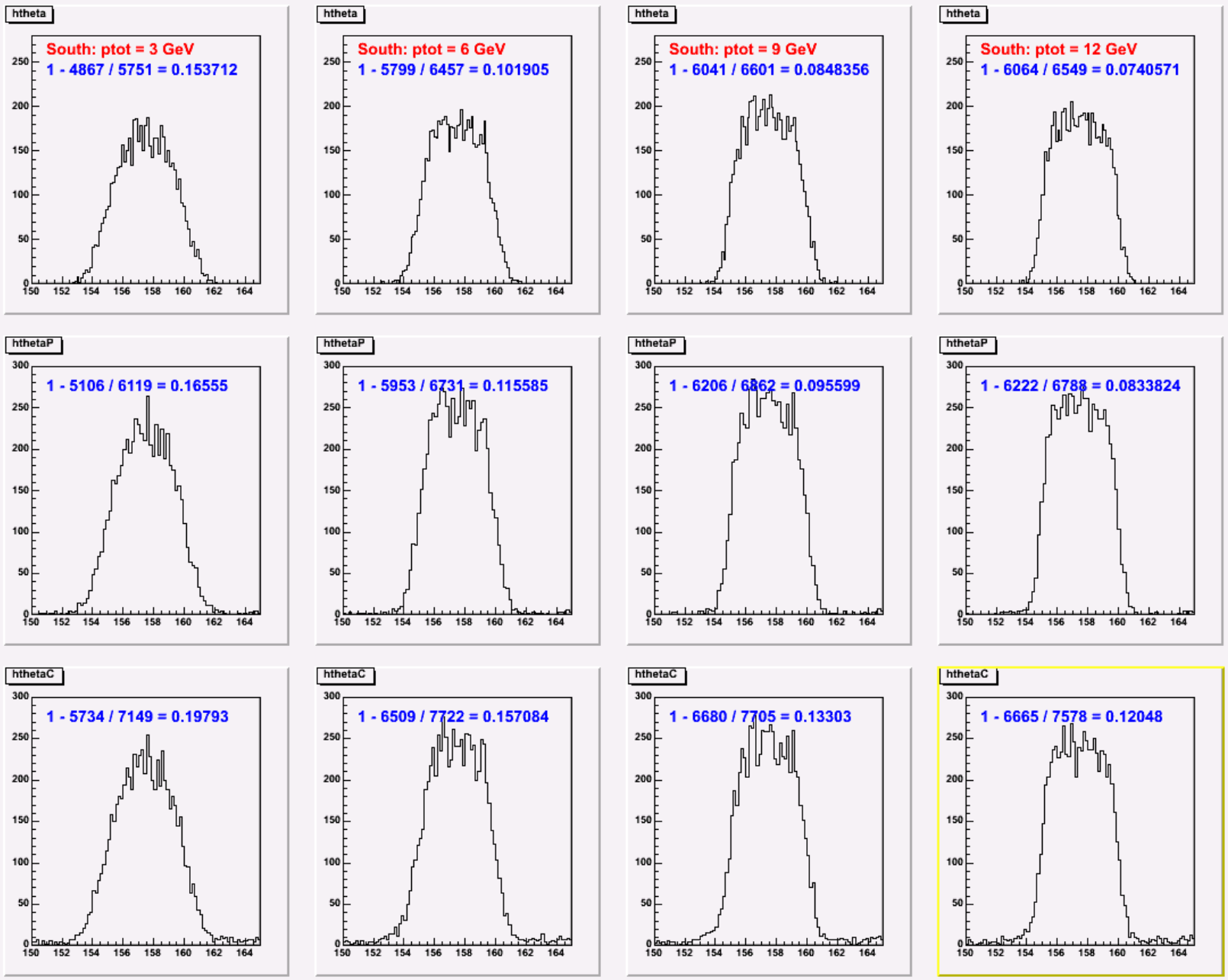
The reconstructed muon p_T p_{tot} and θ distributions do not depend on BBC_vtx condition.

Summary & to do

- d^2N/dP_Tdy - need efficiency corrections for different p_{tot} (or p_T), θ(y) and centrality:
  - Ereco 10% centrality dependence was observed for South, but not for North;
  - Ereco increased around 10% as θ goes up from 15 to 30;
  - Ereco is p_{tot} dependend, this effect is stronger at low $p_{tot.}$
- BBC_eff:
  - For pp MB event: BBC_eff ~55%-60%
  - no vertex dependence with |vtx|<30cm;
  - Slightly depends on θ
- Scan beam-clock triggered p-p data to cross check "BBC trigger efficiency";
- Embed with pp data - to get the correct pp reference (for R_{dA}, open charm measurents).

Backup plots


htheta
North: ptot = 3 GeV
1-5363 / 6325 = 0.152095
htheta
North: ptot = 6 GeV
1-6416 / 7182 = 0.106656
htheta
North: ptot = 9 GeV
1-6673 / 7326 = 0.0891346
htheta
North: ptot = 12 GeV
1-6792 / 7319 = 0.0720044
thetaP
1-5418 / 6502 = 0.166718
thetaP
1-6422 / 7294 = 0.11955
thetaP
1-6627 / 7380 = 0.102033
thetaP
1-6872 / 7486 = 0.0820198
thetaC
1-5398 / 6444 = 0.162322
thetaC
1-6418 / 7267 = 0.11683
thetaC
1-6672 / 7390 = 0.0971583
thetaC
1-6778 / 7364 = 0.0795763


htheta
South: ptot = 3 GeV
1 - 4867 / 5751 = 0.153712
htheta
South: ptot = 6 GeV
1 - 5799 / 6457 = 0.101905
htheta
South: ptot = 9 GeV
1 - 6041 / 6601 = 0.0848356
htheta
South: ptot = 12 GeV
1 - 6064 / 6549 = 0.0740571
hthetaP
1 - 5106 / 6119 = 0.16555
hthetaP
1 - 5953 / 6731 = 0.115585
hthetaP
1 - 6206 / 6862 = 0.095599
hthetaP
1 - 6222 / 6788 = 0.0833824
hthetaC
1 - 5734 / 7149 = 0.19793
hthetaC
1 - 6509 / 7722 = 0.157084
hthetaC
1 - 6680 / 7705 = 0.13303
hthetaC
1 - 6665 / 7578 = 0.12048