

# Update on photon and neutral pion spectra and flow

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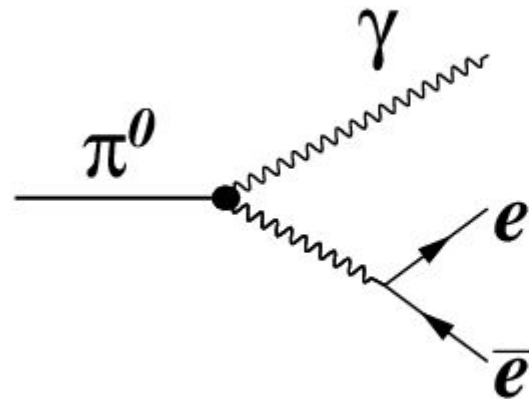
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MPD Cross-PWG meeting  
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# Reminder

- Two possibilities for photon reconstruction:
  - Signal in EMC
  - $e^+e^-$  pairs from TPC for converted photons
- Three methods for  $\pi^0$  reconstruction:
  - Calorimeter (both photons reconstructed with EMC)
  - Hybrid (EMC + converted photon)
  - Conversion (two converted photons)

**Conversion method gives significantly higher momentum resolution but much lower reconstruction efficiency.**



# Analysis details

- UrQMD, Bi+Bi @ 9.2 GeV (request 25)
- Analysis procedure implemented in MpdConvPi0 class
- Output from EP, PID and V0Maker wagons is used
- Results are shown for the analysis train request #3

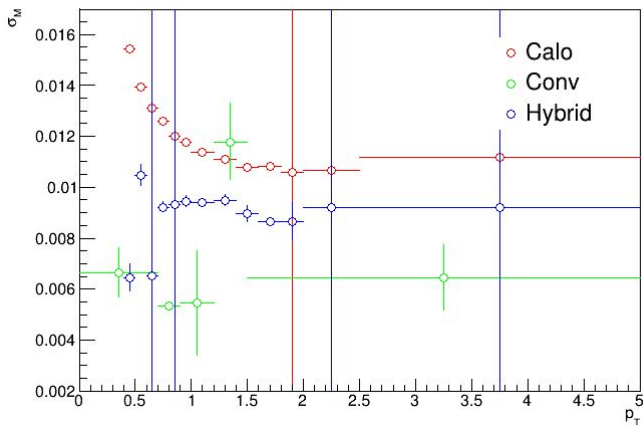
# Changes since the [previous report](#)

- Flow of inclusive photons
- Use of EMC cluster core energy to reduce effects of cluster overlap
- Prevented the use of one track in several V0s
- Updated cluster and V0 selection criteria using both conventional and MVA approaches aimed to improve photon and  $\pi^0$  reconstruction efficiency. Five configurations tested:
  - Loose
  - Default
  - Tight
  - BDT (Boosted Decision Tree) selection for V0
  - BDT + momentum correction for V0
- Other smaller changes

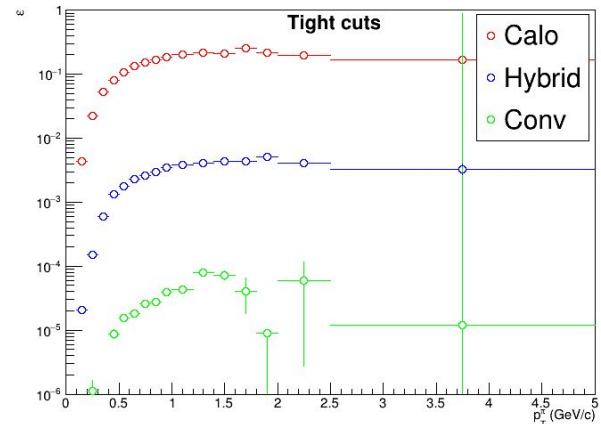
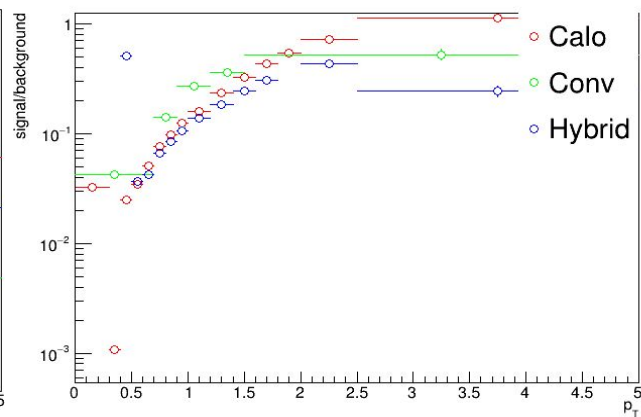
# Spectra of neutral pions

# Comparison of different selection criteria

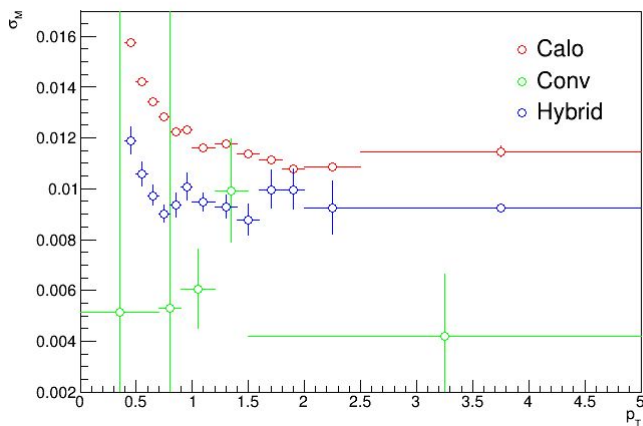
sigma vS pT, tight



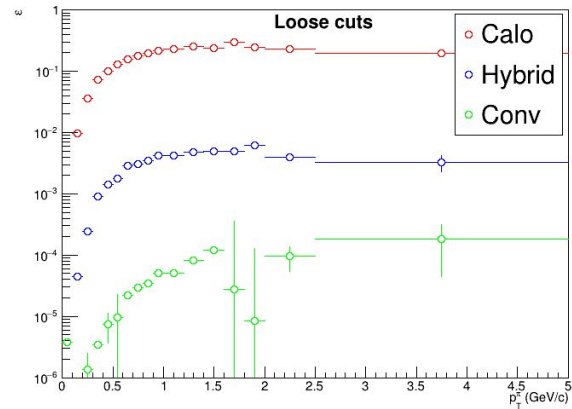
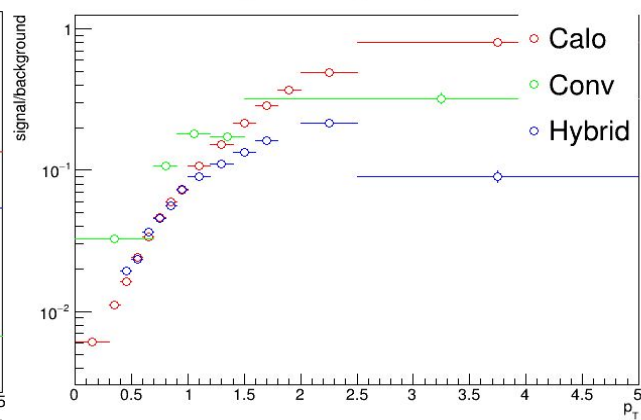
signal / background, tight



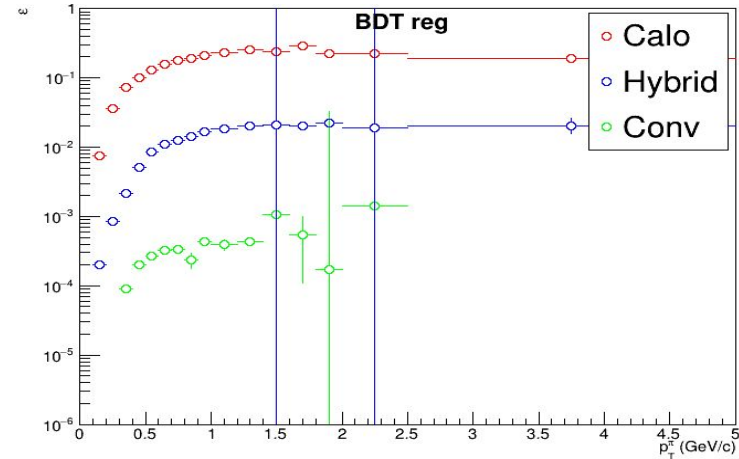
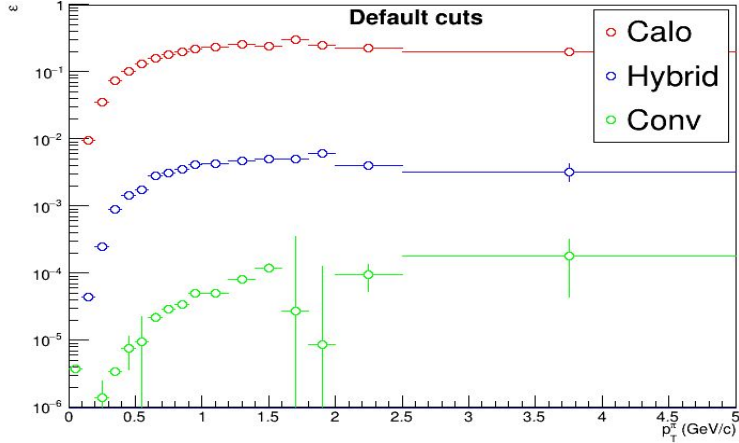
sigma vS pT, loose



signal / background, loose



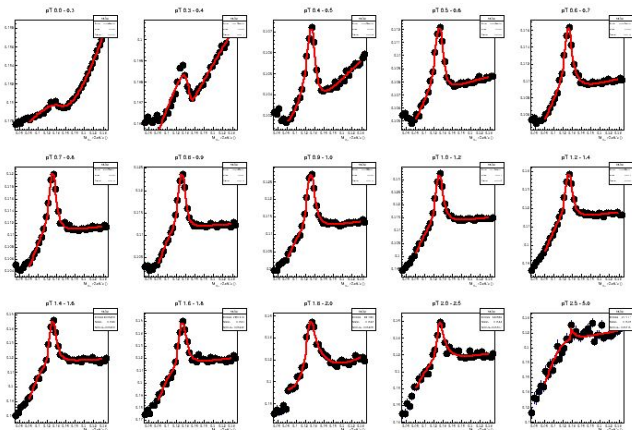
# Cut dependence summary



- Tight/loose cut does not change pion peak parameters.
- Tight cut strongly (factor 1.5-2) increases S/Bg ratio, as expected
- Loose cuts increase calo/hybrid/conv efficiency by 16%/21%/27% at 1 GeV respectively
- BDT cuts increases efficiency at low- $p_T$  by factor > 10, but introduce correlated background (see further)

# Problems found

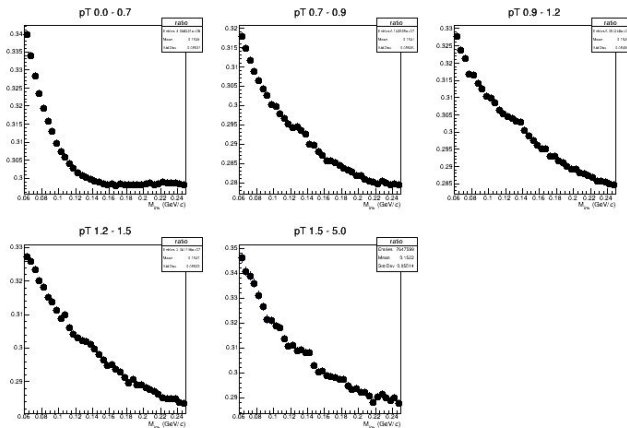
Hybrid, loose



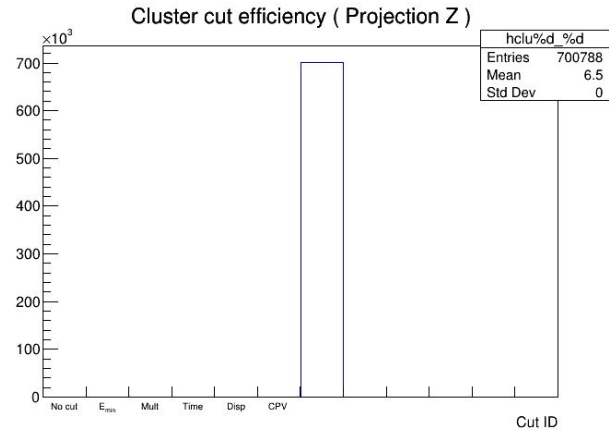
Strange kink in Real/Mixed ratio in pi0 mass region. Makes pi0 extraction hard, investigating the reason

Conversion, BDT

Strongly correlated background in Real at low m appears in BDT case. Requirement to not share tracks between V0 did not help. Investigating selection criteria



Gamma cuts



Histogram for cluster cut efficiency is has too many bins ant is not properly filled. The error could not be reproduced.

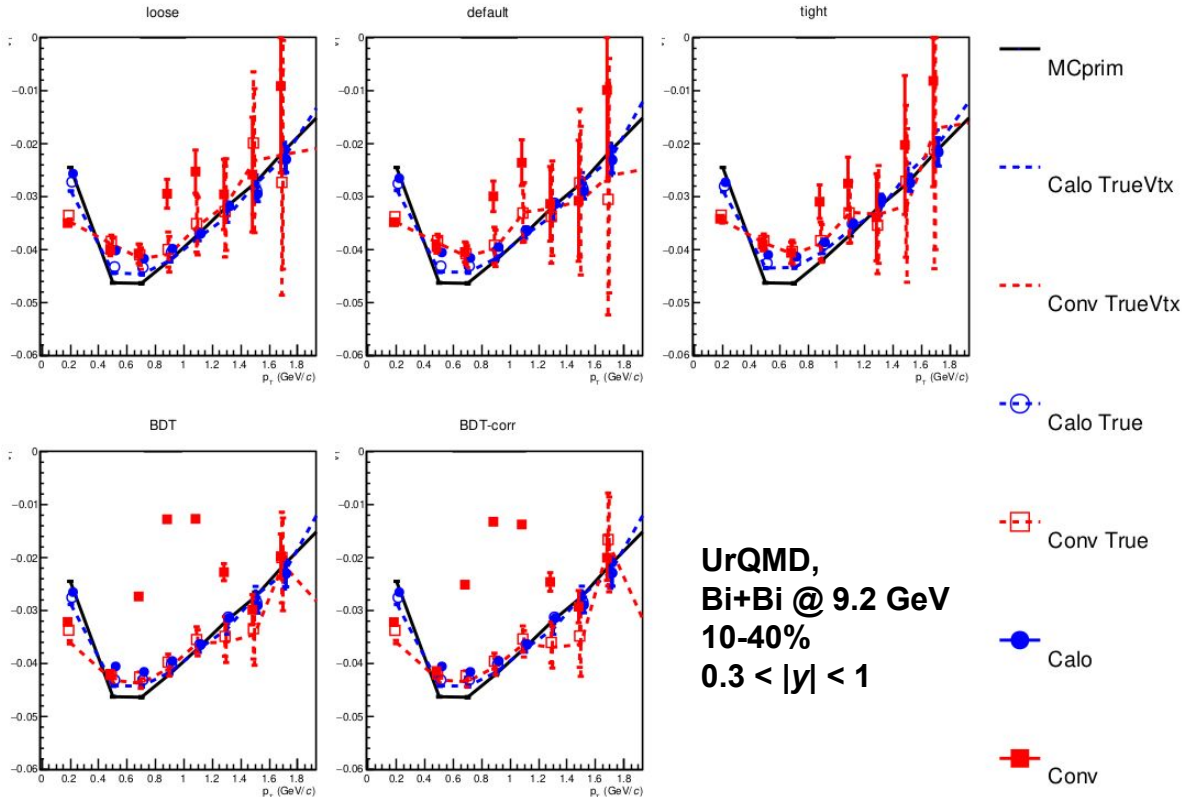


# Flow of inclusive photons and neutral pions

# Notations at flow plots

- Primary photon - photon produced in the vicinity of the primary vertex  
( $DCA_{\text{vtx}} < 1\text{cm}$ )
- **MCprim** - primary photons
- **Calo TrueVtx** - clusters with the main contribution from a primary photon
- **Conv TrueVtx** - track pairs descending from a primary photon
- **Calo True** - clusters with the main contribution from a photon
- **Conv True** - track pairs descending from a photon

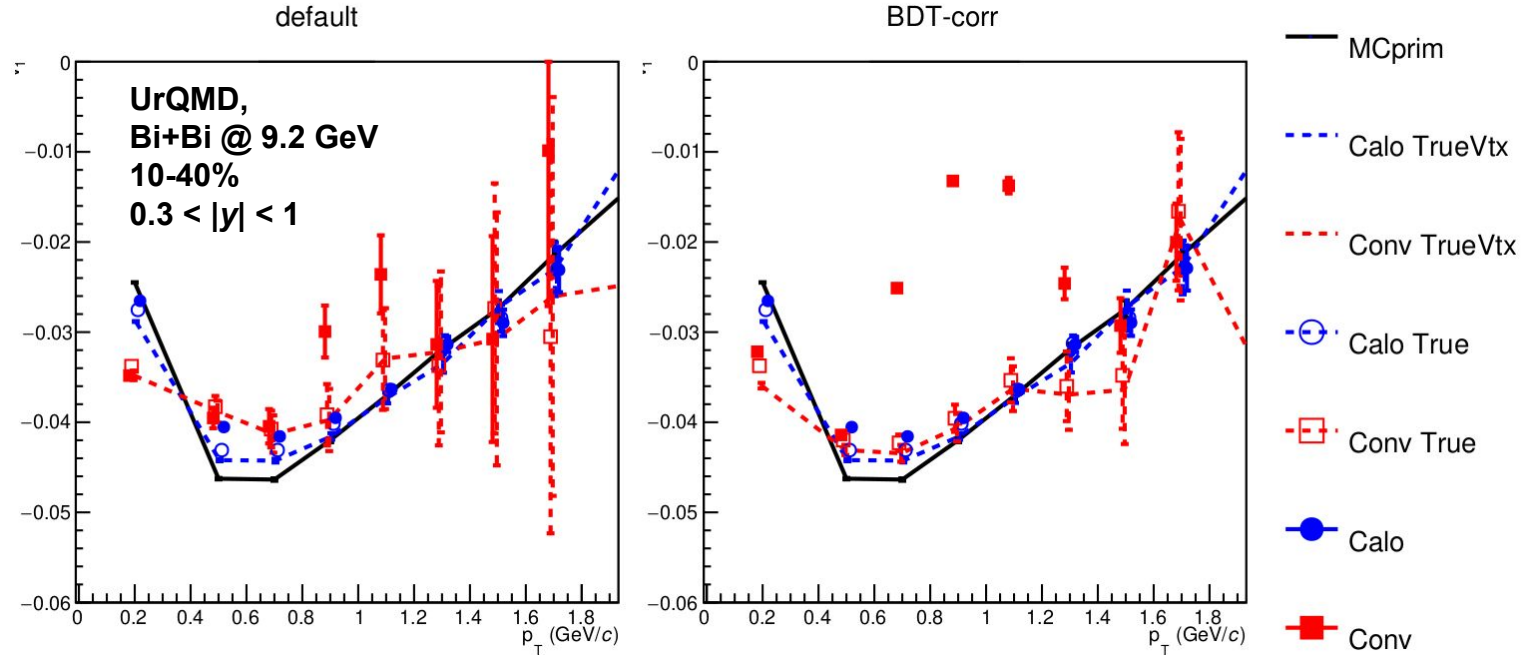
# Directed flow of photons



**MCprim** - primary photons  
**Calo TrueVtx** - clusters with the main contribution from a primary photon  
**Conv TrueVtx** - track pairs descending from a primary photon  
**Calo True** - clusters with the main contribution from a photon  
**Conv True** - track pairs descending from a photon

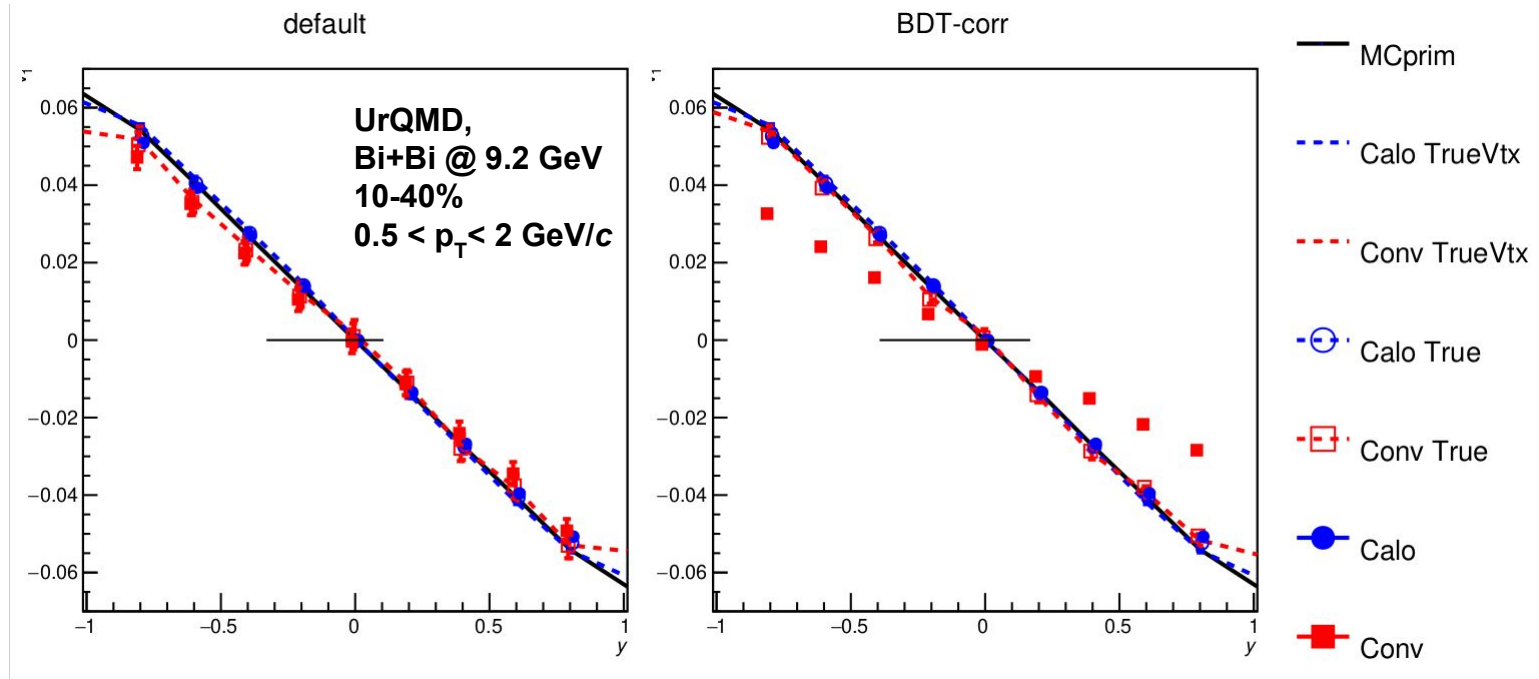
Results are similar for different sets of conventional (upper row) and MVA (lower row) selection

# Directed flow of photons



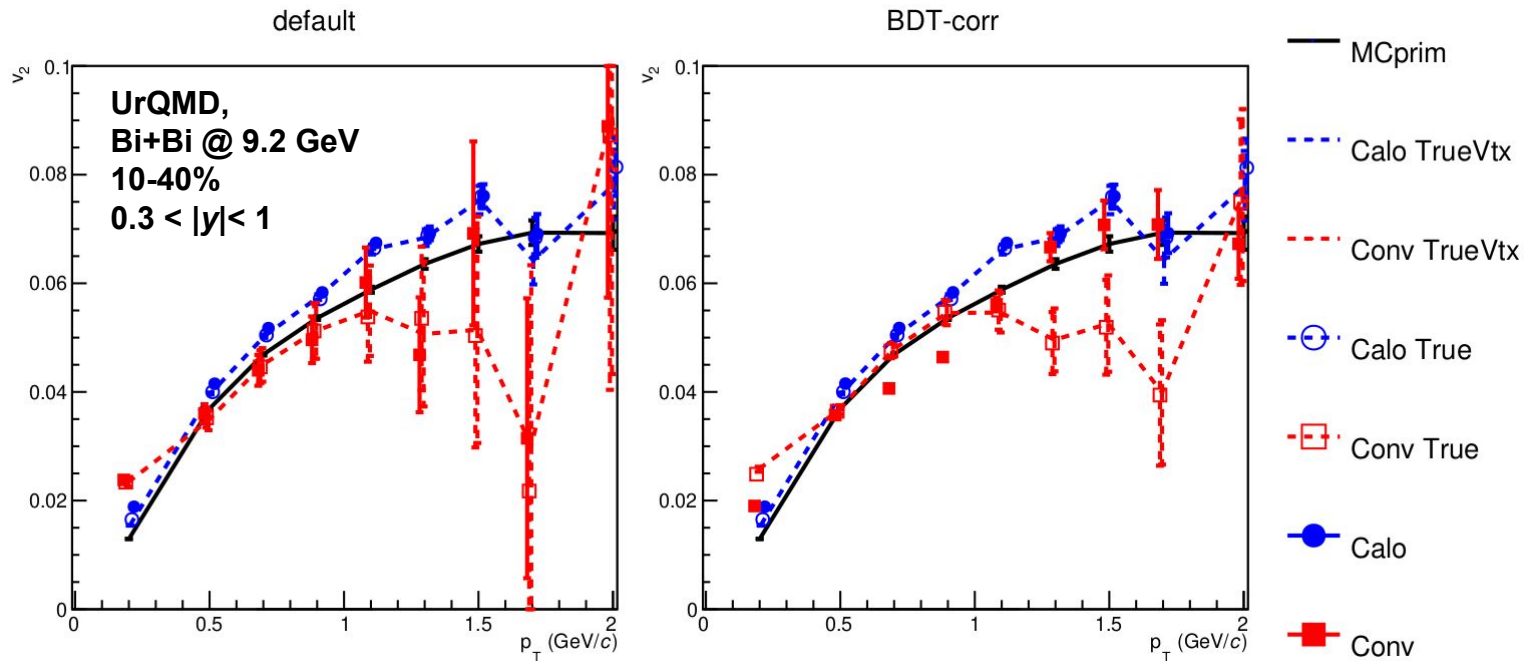
- Calorimeter method is consistent with generator values
- BDT selection of V0 produces a hump at the intermediate  $p_T$  with conversion method - irregular efficiency?

# Directed flow of photons



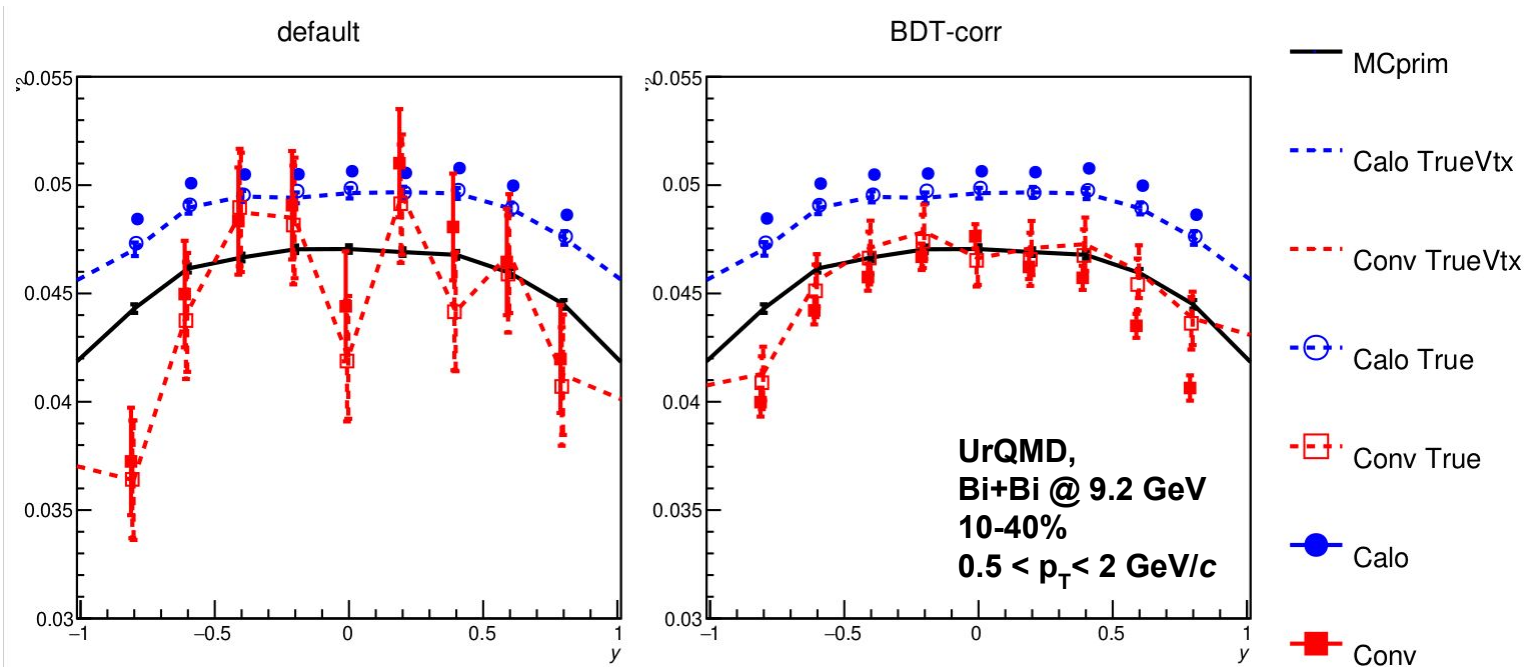
- Calorimeter method is consistent with generator values
- BDT selection of V0 gives lower  $v_1$  with conversion method

# Elliptic flow of photons



- Both calorimeter and conversion methods agree with the values for true photon detector signals (only at lower  $p_T$  for conversion)
- Hump at intermediate  $p_T$  with BDT selection (like for  $v_1$ )

# Elliptic flow of photons

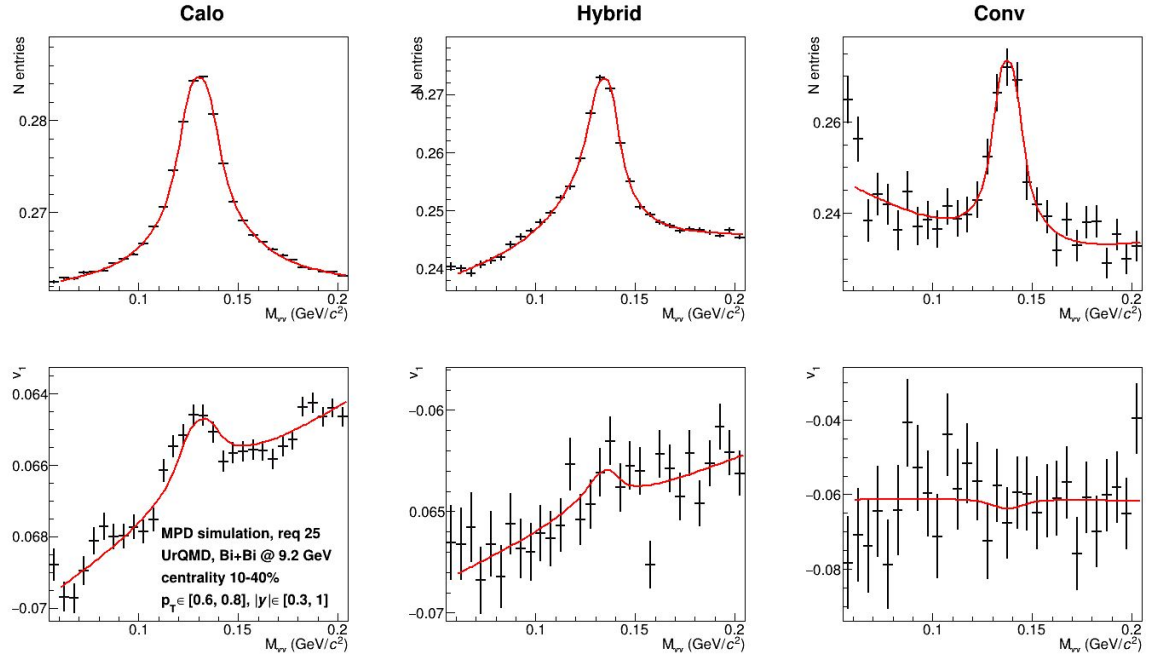


- Both calorimeter and conversion methods agree with the values for true photon detector signals (only at midrapidity for conversion)
- Flow of photons registered with ECAL differs from the flow of primary photons - efficiency corrections could probably help

# Reconstruction of $\pi^0$ flow

Fit  $v_n$  dependence on the invariant mass of photon pair with the following function below.

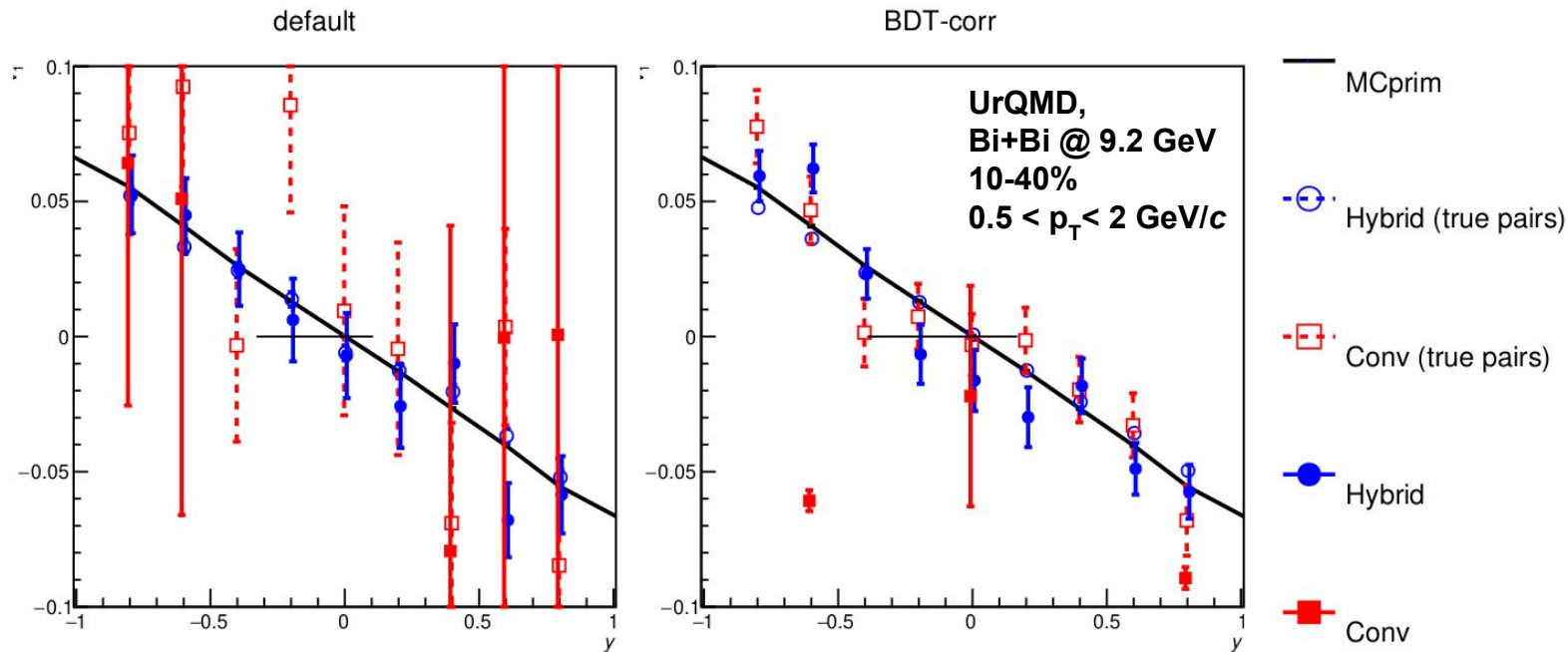
$v_{sig}$  and  $v_{bg}$  are free parameters,  $n_{sig}$  and  $n_{bg}$  are obtained from the fits of pair distributions.



$$v_{all}(M_{inv}) = \frac{n_{sig}(M_{inv})v_{sig} + n_{bg}(M_{inv})(v_{bg}^{const} + v_{bg}^{lin} * M_{inv})}{n_{sig}(M_{inv}) + n_{bg}(M_{inv})}$$

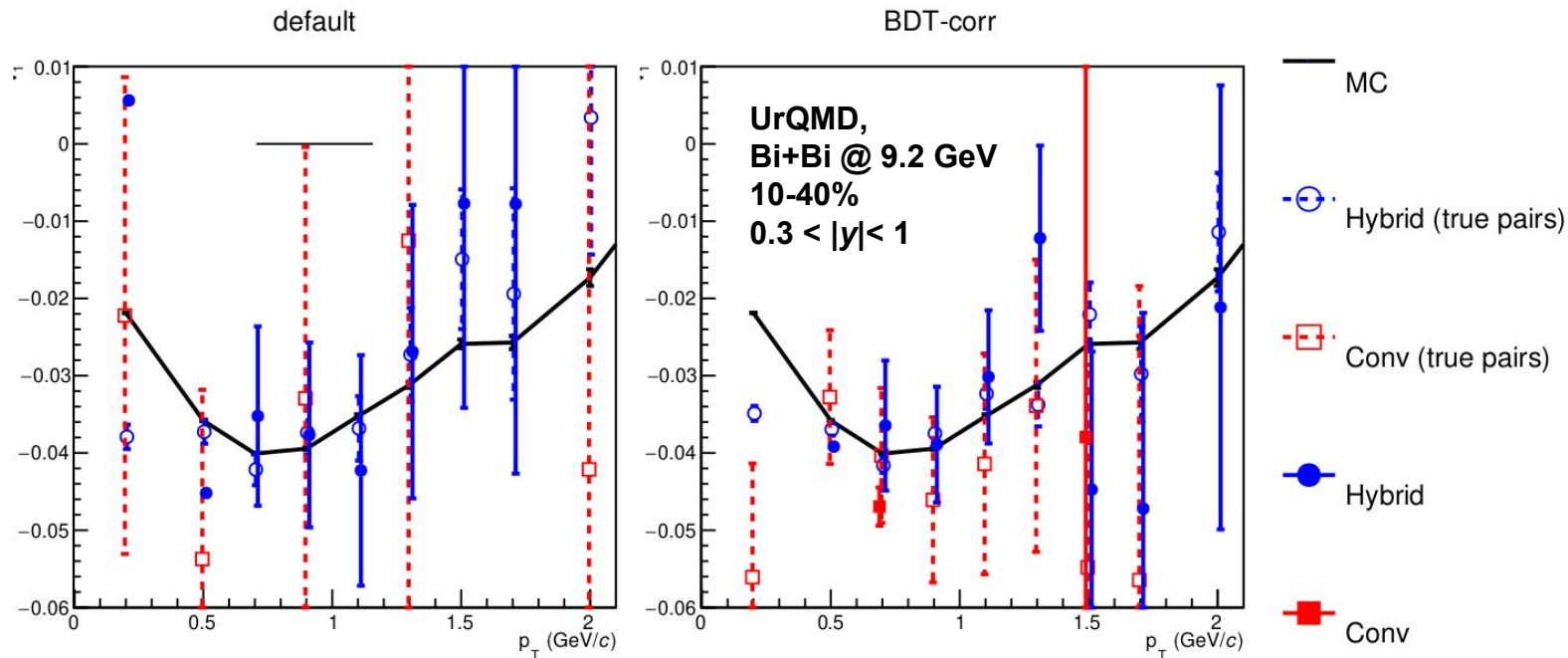


# Directed flow of $\pi^0$



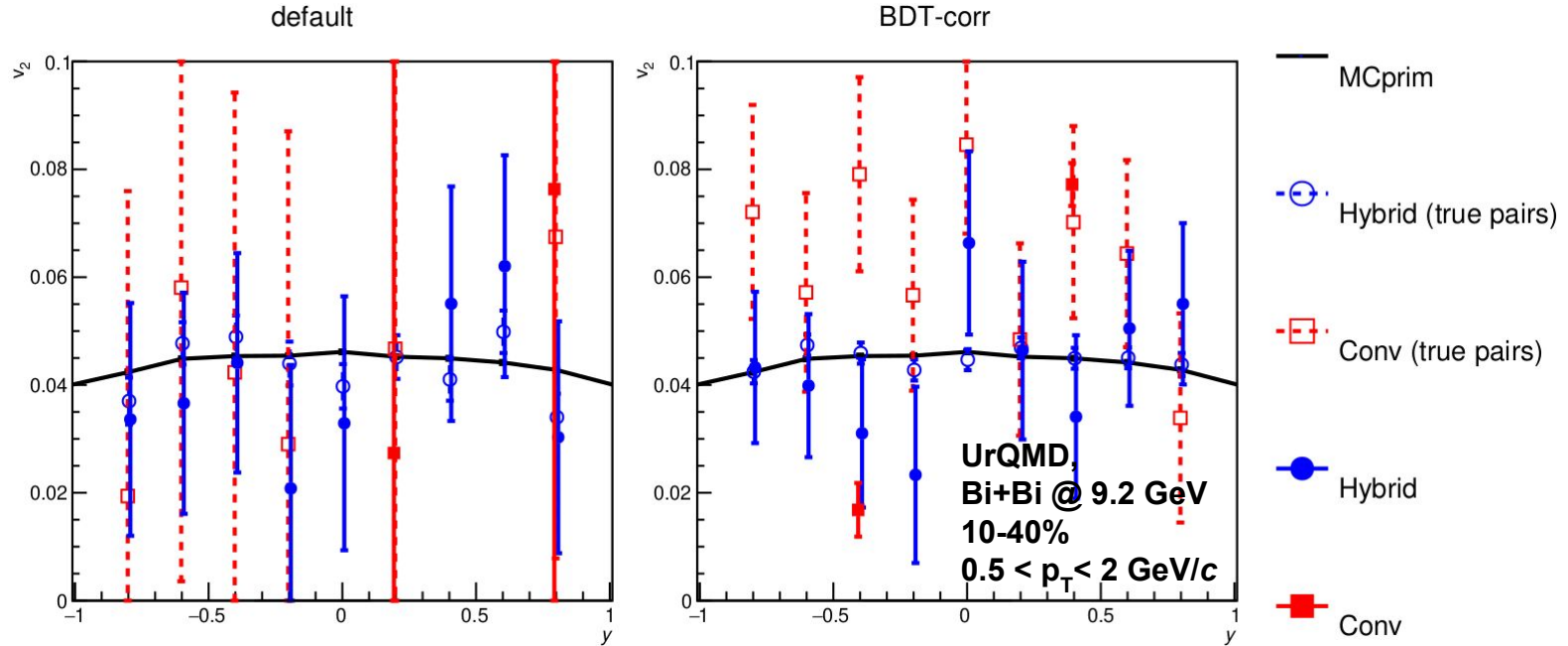
- Calorimeter method had a bug in train #3 and is not shown for  $\pi^0$
- Good agreement with MC for the hybrid method
- Not high enough statistics for both methods even with BDT selection

# Directed flow of $\pi^0$



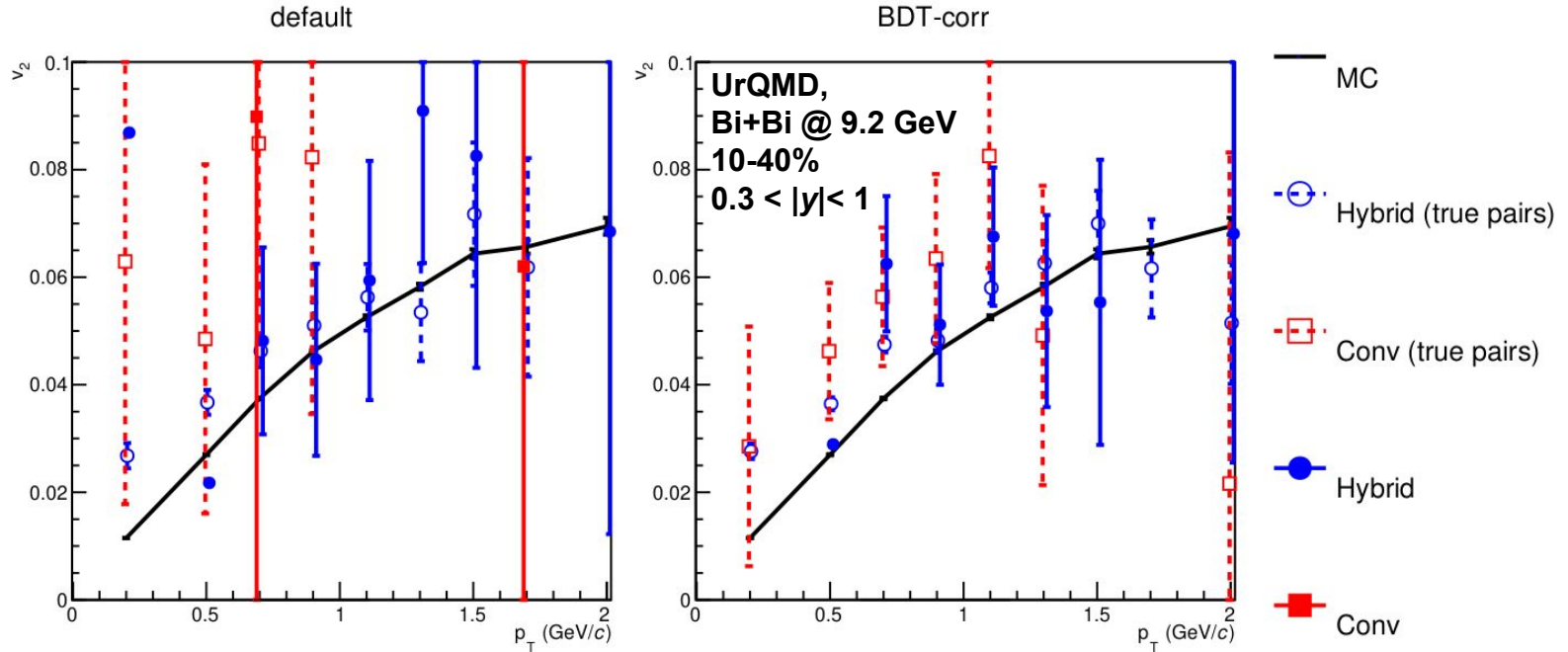
- Good agreement with MC for the hybrid method except for the low  $p_T$
- Not high enough statistics for both methods even with BDT selection

# Elliptic flow of $\pi^0$



- Good agreement with MC for the hybrid method (true pairs)
- Not high enough statistics for both methods even with BDT selection

# Elliptic flow of $\pi^0$



- Reasonable agreement with MC for the hybrid method (true pairs)
- Not high enough statistics for both methods even with BDT selection

# Summary

- EMC analysis is developing with the help of analysis trains
- For the calorimeter method  $\pi^0$  spectra and flow measurements seem to be viable with 20M selected collisions of Bi+Bi @9.2 GeV.
- Hybrid and conversion methods will likely require higher statistics.

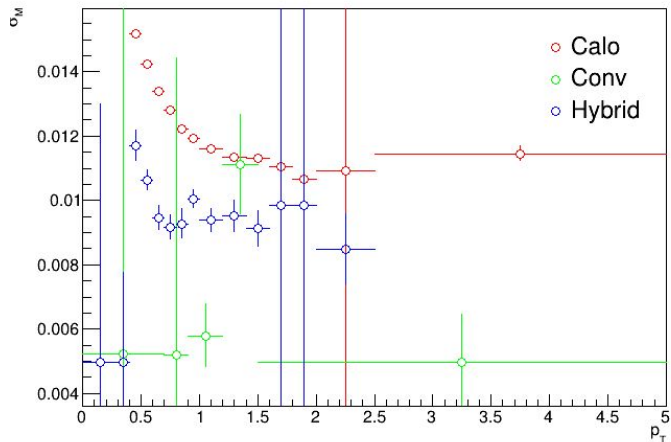
# Nearest plans

- Investigate the effect of cluster and V0 selection on photon and neutral meson reconstruction efficiency and improve the procedure
- Look for the sources inconsistencies with MC curves for the photon flow (limit the MC particles to EMC acceptance, introduce efficiency corrections)

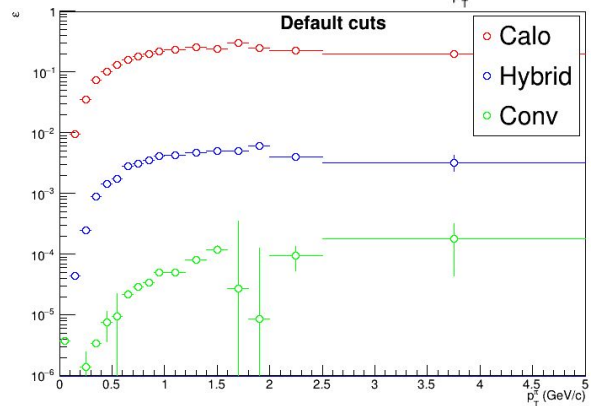
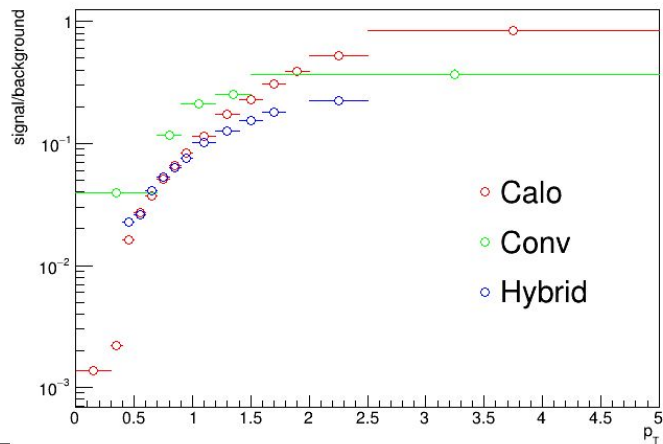
# Backup

# Peak width & signal/background (default cuts)

sigma vS pT, default

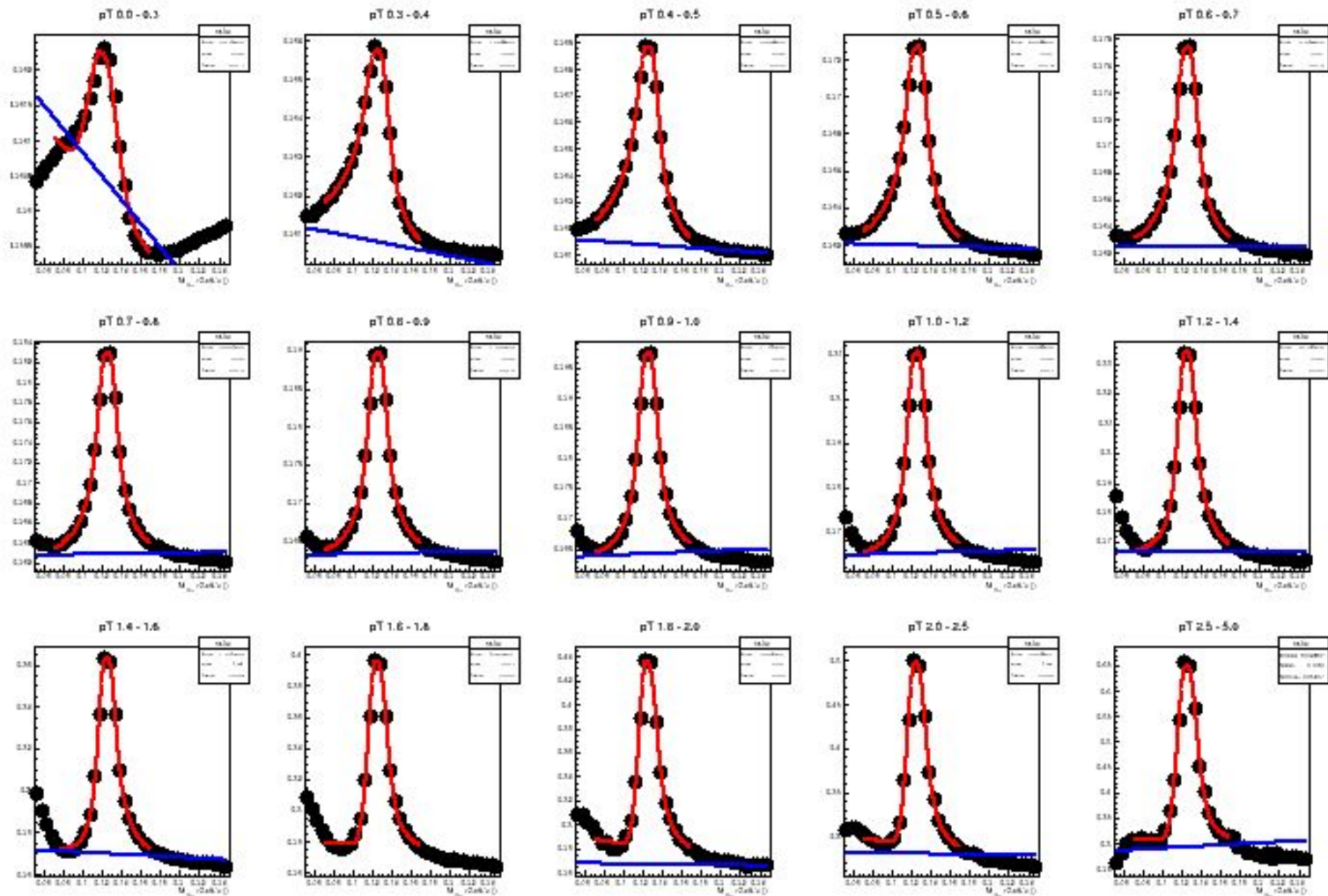


signal / background, default



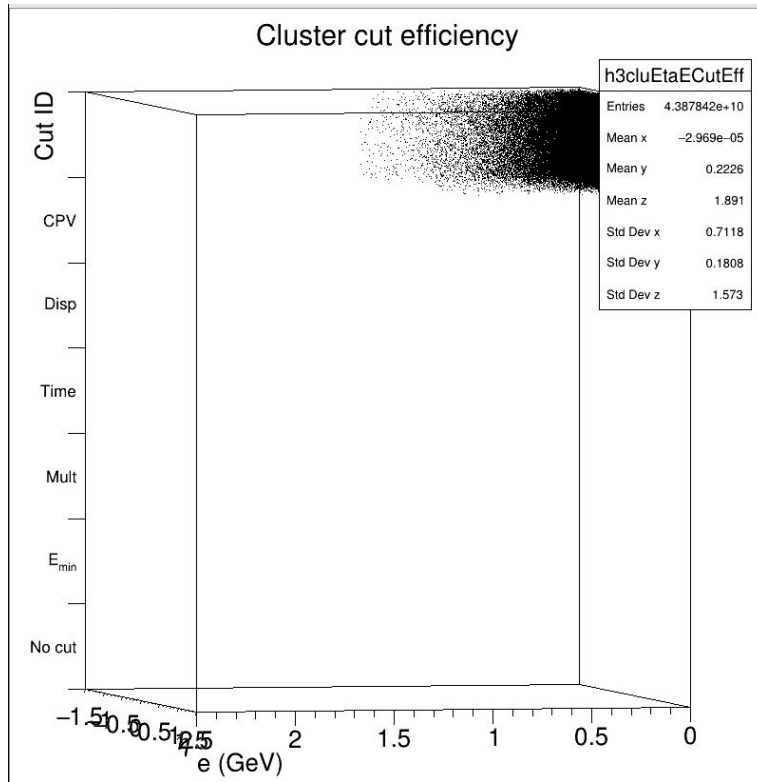


Calo, tight  
cut,  
Real to  
mixed  
ratio



# Cluster cut efficiency histogram magic

## Train #3



## Manual

