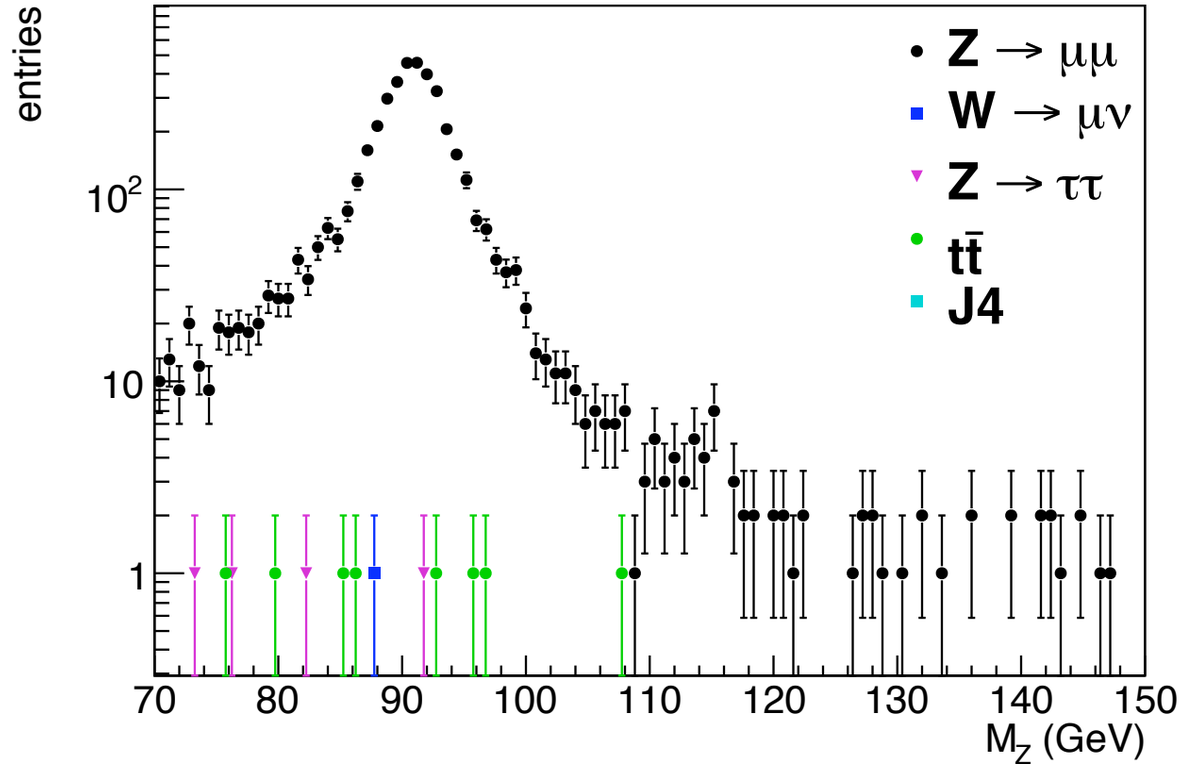
Measurement strategy

- Extract from data the number of selected Z events
  - ★ lineshape fit
  - ★ background subtraction



- Rescale this number for efficiencies and acceptance
  - ★ use MC cut flow estimation re-weighted with efficiencies extracted from data with Tag&Probe method + momentum scale corrections (not addressed here)

$$\begin{aligned}\epsilon_{event} = & \epsilon^{+}_{MS/ID} \cdot \epsilon^{+}_{CB/MS} \cdot \epsilon^{+}_{CBISO/CB} \\ \cdot & \epsilon^{-}_{MS/ID} \cdot \epsilon^{-}_{CB/MS} \cdot \epsilon^{-}_{CBISO/CB} \\ \cdot & (1-(1-\epsilon^{+}_{TRIG/CBISO})) \cdot (1-(1-\epsilon^{-}_{TRIG/CBISO}))\end{aligned}$$

Event efficiency formula

- Trigger "mu20"
- 2 combined tracks (MuonBoy-Staco) con p_T>20, $|\eta|$<2.5 and opposite charge
- Inner Detector track isolation with Σp_T^{cone}<6 GeV and ΣN^{cone}<5
- Invariant mass cut ±20 GeV around Z mass peak (non applied here)
- Event selection efficiency determined from single particle efficiencies

$$\epsilon_{event} = \epsilon^{+}_{MS/ID} \cdot \epsilon^{+}_{CB/MS} \cdot \epsilon^{+}_{CBISO/CB}$$
$$\cdot \quad \epsilon^{-}_{MS/ID} \cdot \epsilon^{-}_{CB/MS} \cdot \epsilon^{-}_{CBISO/CB}$$
$$\cdot \quad (1-(1-\epsilon^{+}_{TRIG/CBISO})) \cdot (1-(1-\epsilon^{-}_{TRIG/CBISO}))$$

Muon Spectrometer efficiency wrt Inner Detector

Combined Muon efficiency wrt Muon Spectrometer

Isolation efficiency wrt Combined Muon

20 GeV Muon Trigger efficiency wrt Isolated Combined Muon

Event re-weighting formula

MC signal ⟷ **resolution and scale corrections**

MC & DATA control samples → $\epsilon_{DATA} = \frac{\sum_{MC-selected} \epsilon_{cs-DATA}(p_T, \eta)/\epsilon_{cs-MC}(p_T, \eta)}{\sum_{MC-generated}}$

ϵ_{CS} derived from single particle efficiencies

Efficiencies from DATA and MC

MC *vs* pDATA

- MC = r635 MC08 AOD
- pDATA = r635 500 um misaligned AOD
- Stat = 200k (about 130 pb^{-1})

- Different event efficiencies to be compared, each is always the "fraction of events after each cut wrt previous"
  - ★ **CF** : cut flow from MC event counting
  - ★ **SPMCtruth** : event re-weighting based on **S**ingle **P**article efficiencies calculated with MC-truth method (MCT) on MC sample
  - ★ **SPMC** : from event re-weighting based on single particle efficiencies calculated with TagAndProbe on MC sample
  - ★ These 3 quantities can be calculated also on pData samples

- Comparing them vs p_T, eta, phi and integrated values to disentangle systematics

Benchmarks

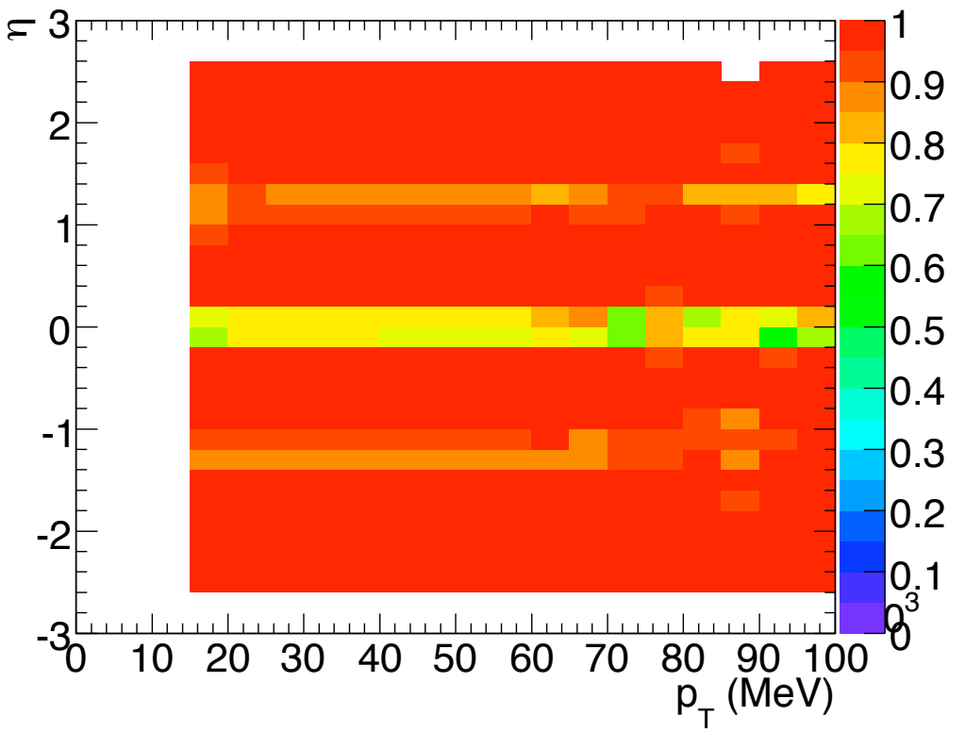
- **TP vs MCT** : how well Tag&Probe reproduces truth efficiencies
  - ★ best expected value = agreement
    >> **Tag&Probe validation**

- **SP-CF/CF** : how well event efficiency built from single particle efficiencies can to reproduce the cut flow
  - ★ Tag&Probe compared to MCT method
  - ★ best expected value = 0 %
    >> **Event efficiency validation**

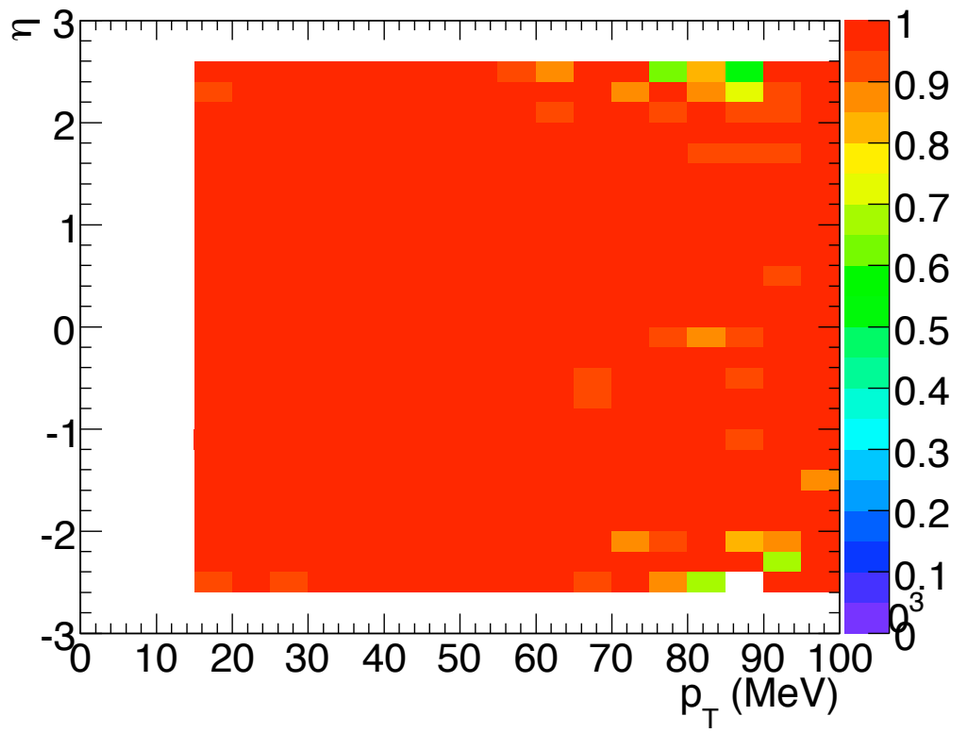
- **pData-MC/MC** : how different are the cut flow from MC and (pseudo)Data samples
  - ★ event re-weighting (SP) compared to cut flow
  - ★ best expected value = agreement
    >> **Event re-weighting validation**

Tag&Probe validation - 2D maps

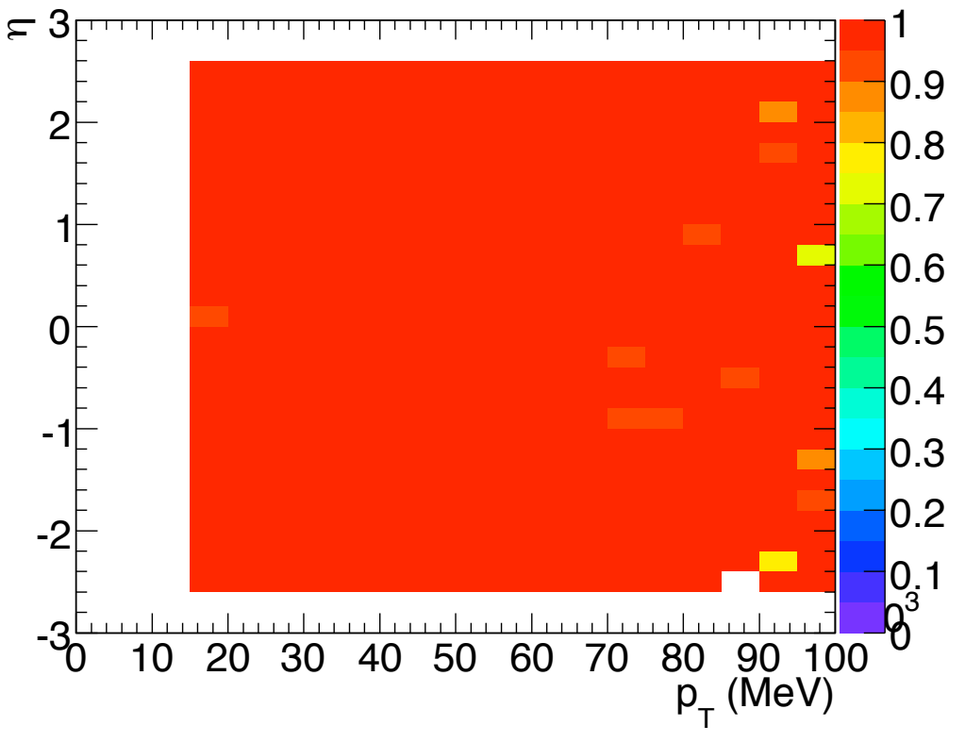
2D Efficiency for MSID



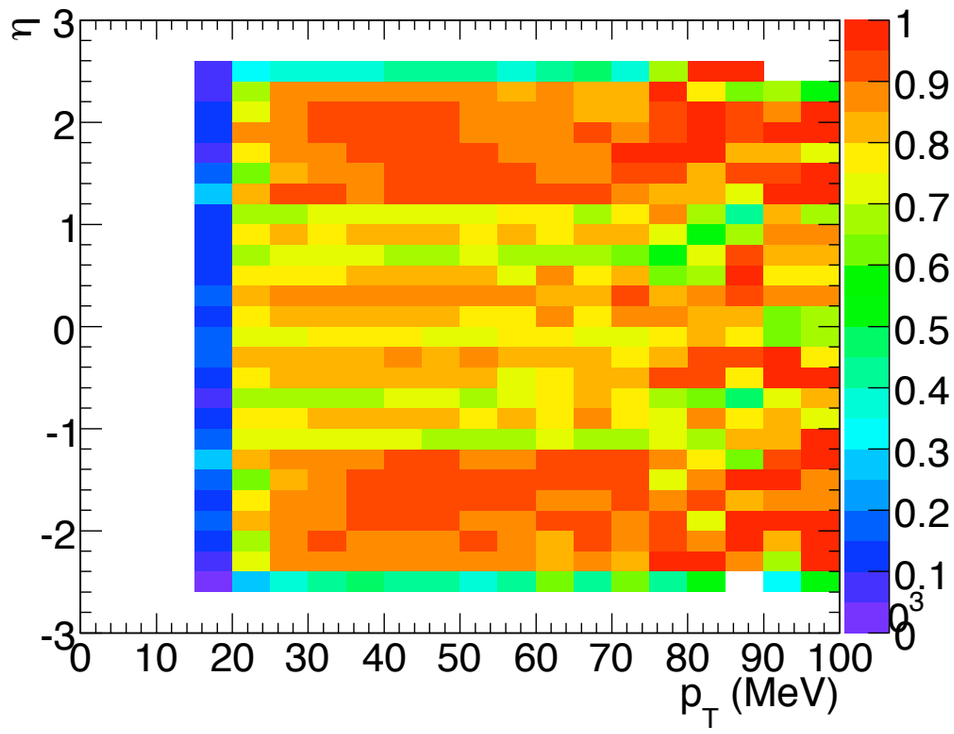
2D Efficiency for CBMS



2D Efficiency for CBISO

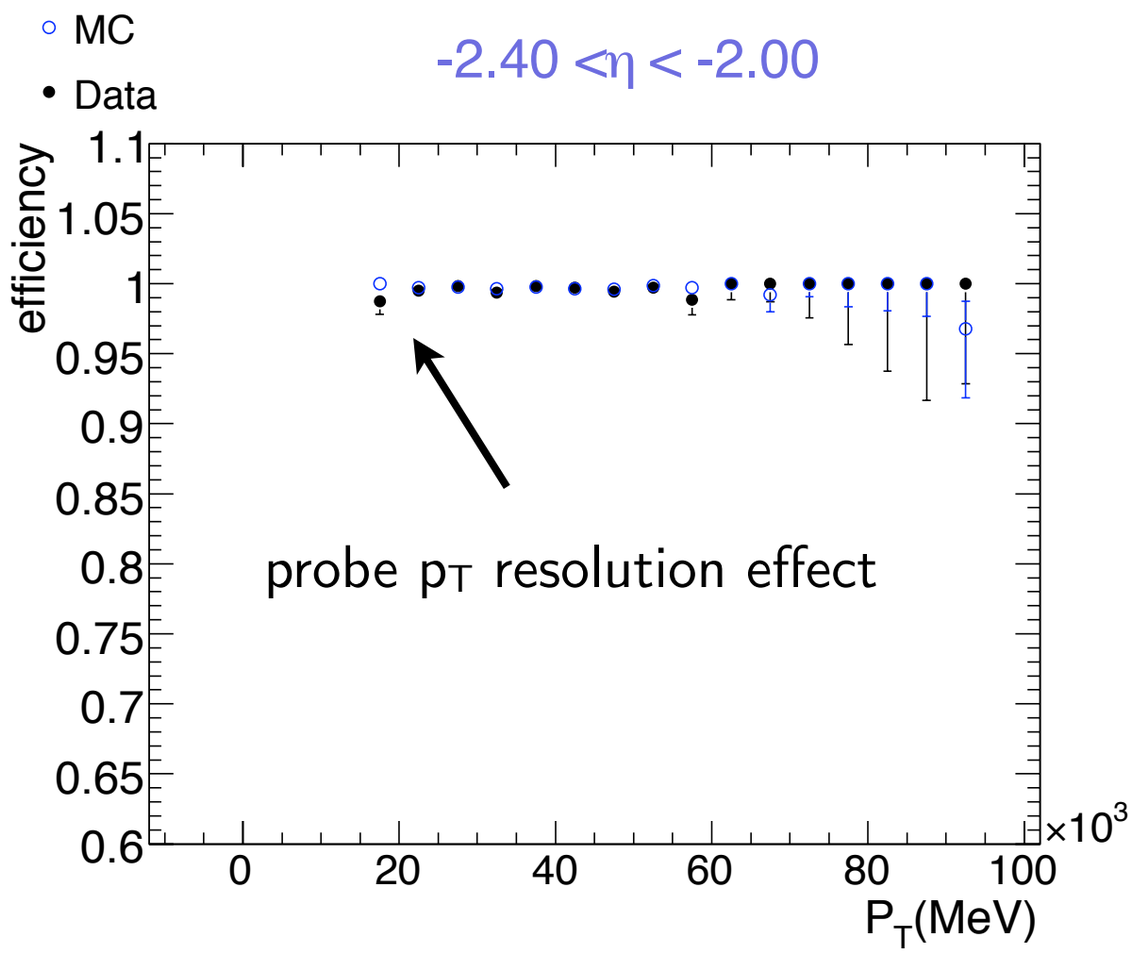


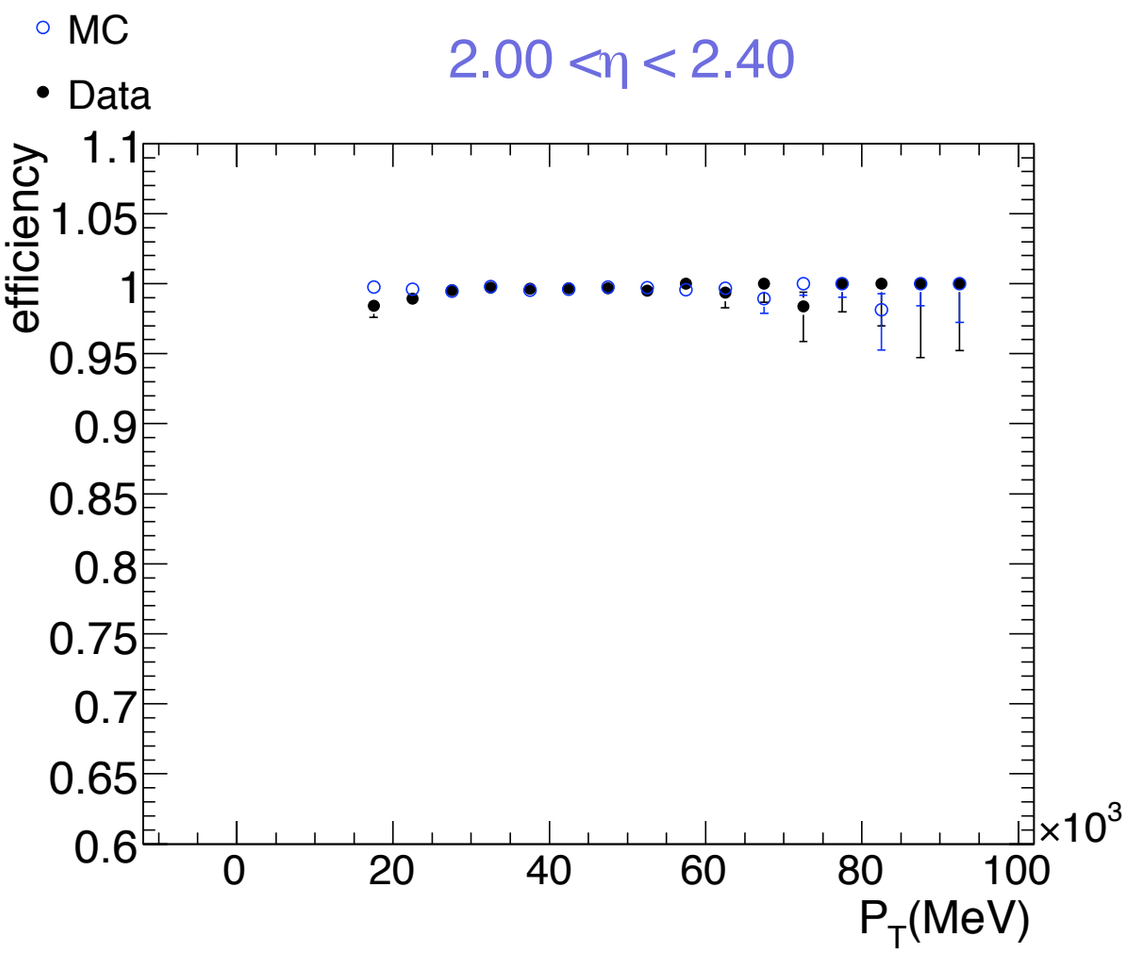
2D Efficiency for TRIGCBISO



Tag&Probe MSID term

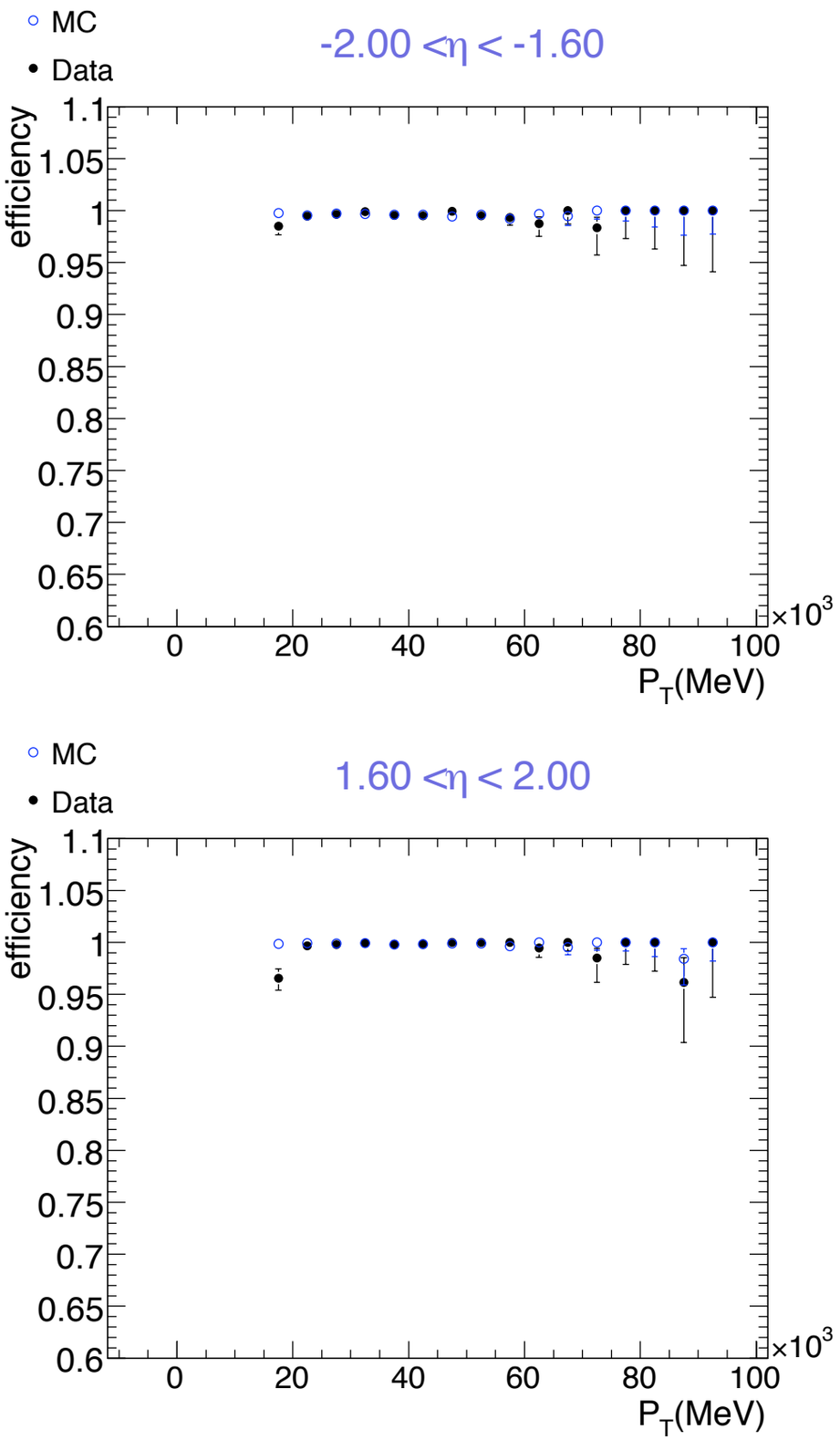
EC forward

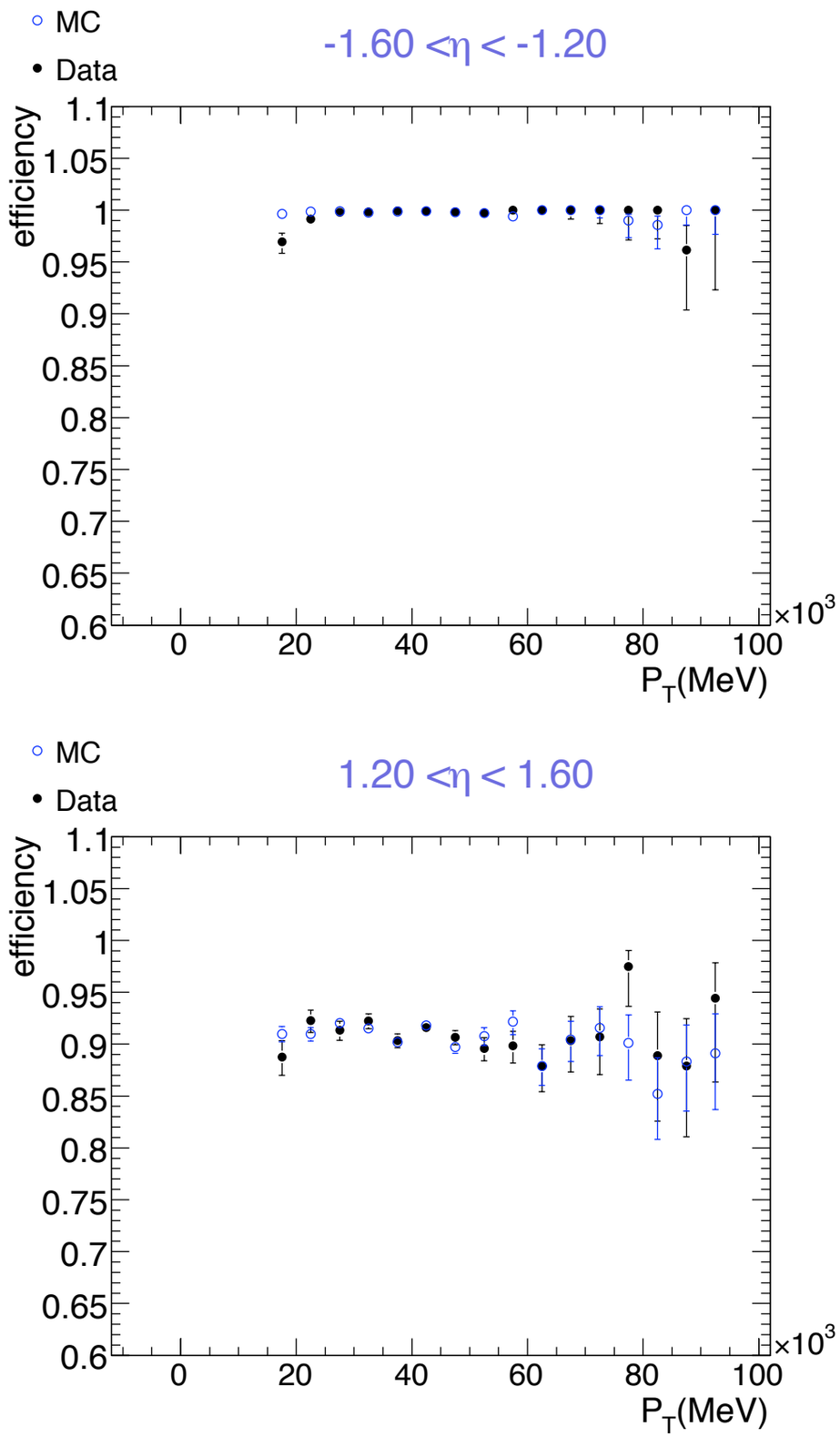




Tag&Probe MSID term

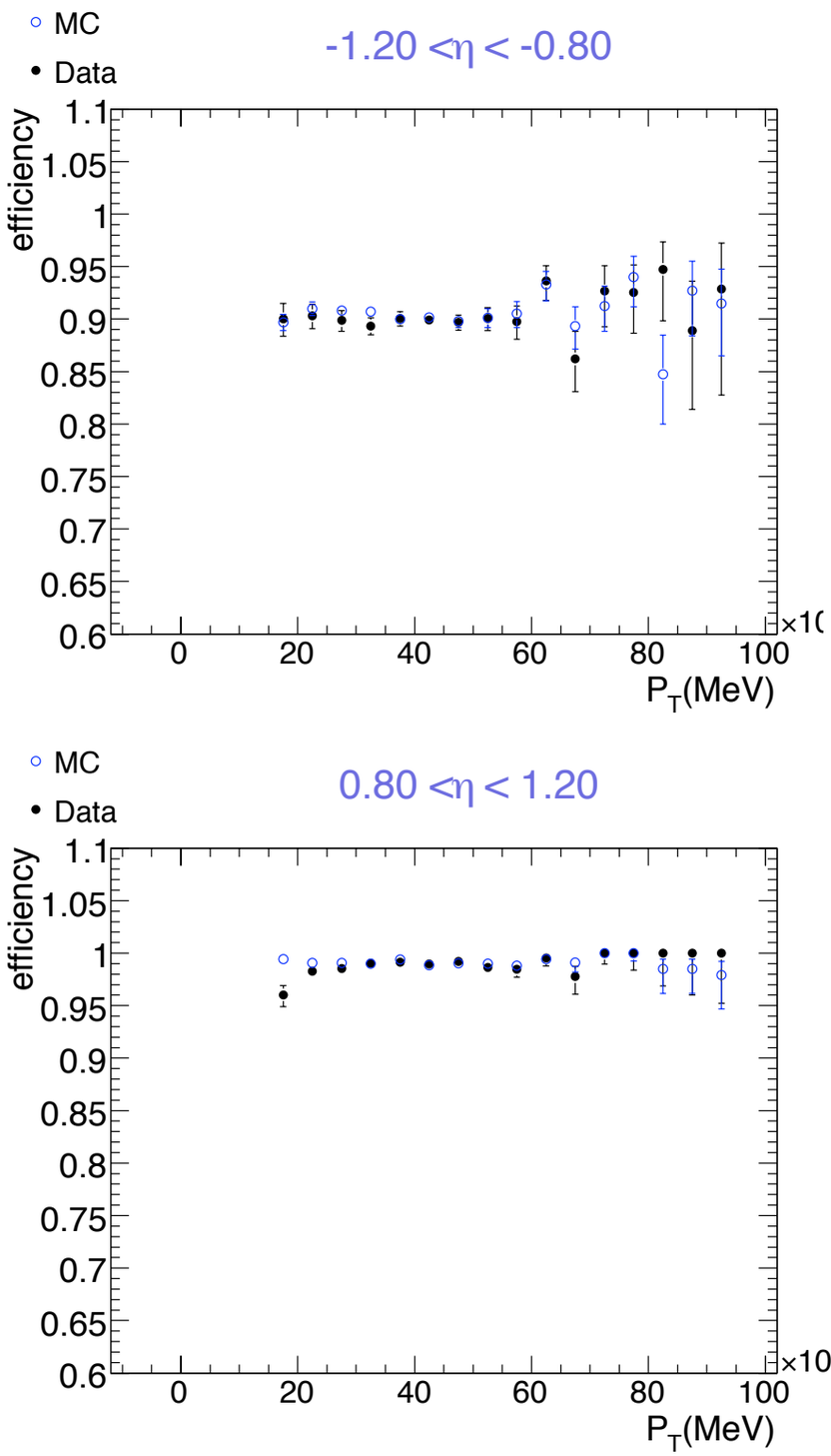
EC

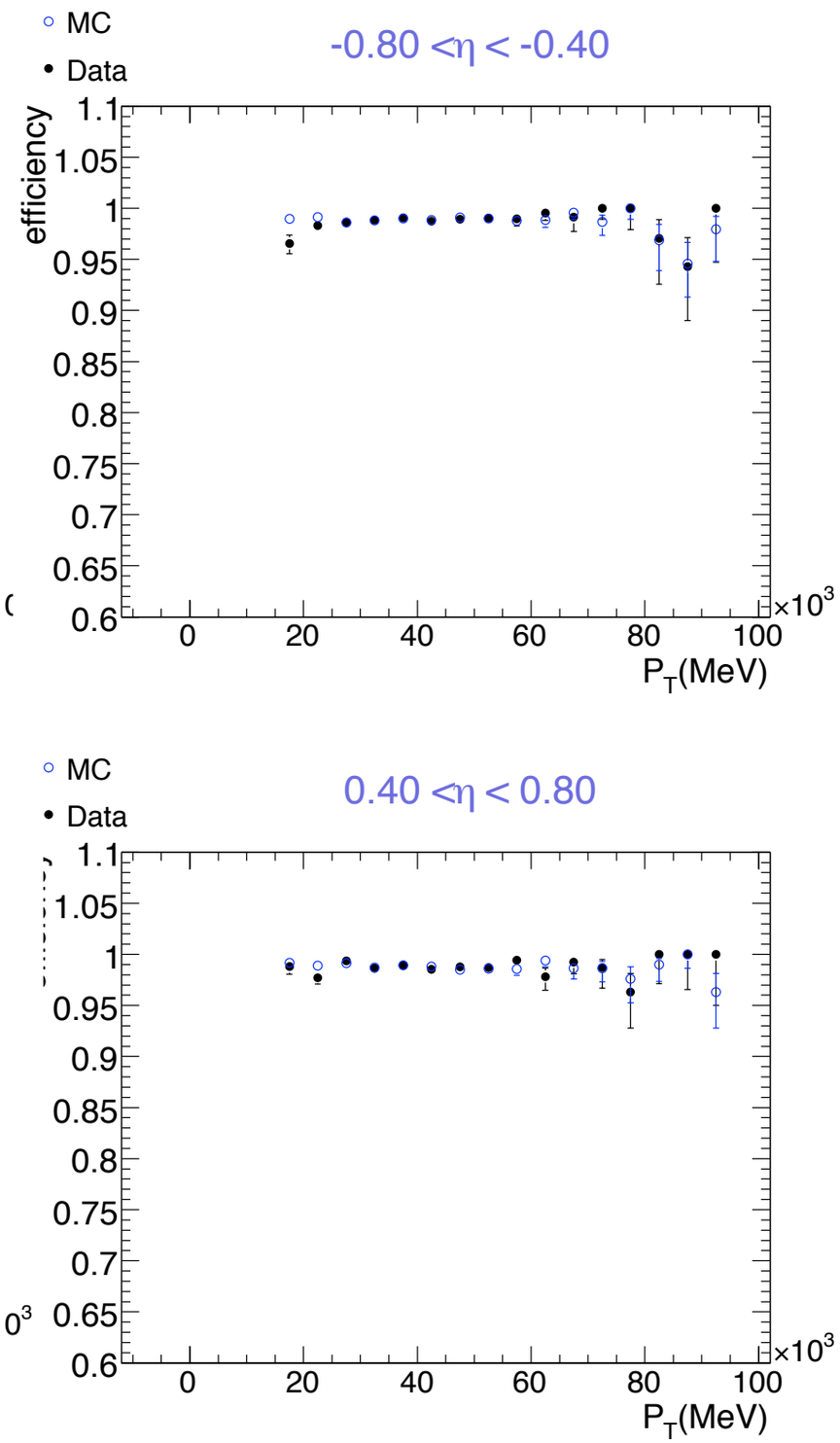


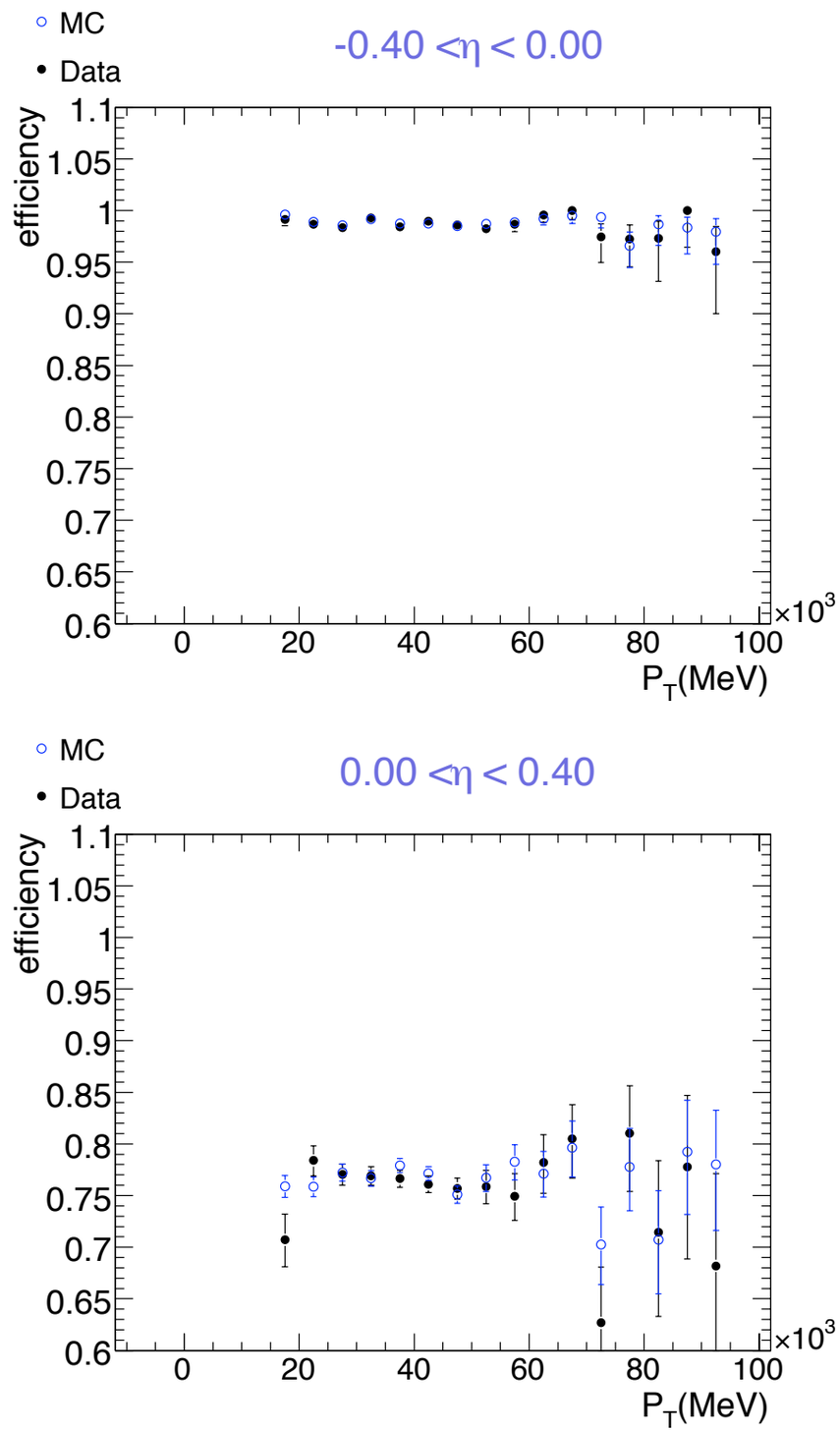


Tag&Probe MSID term

Barrel

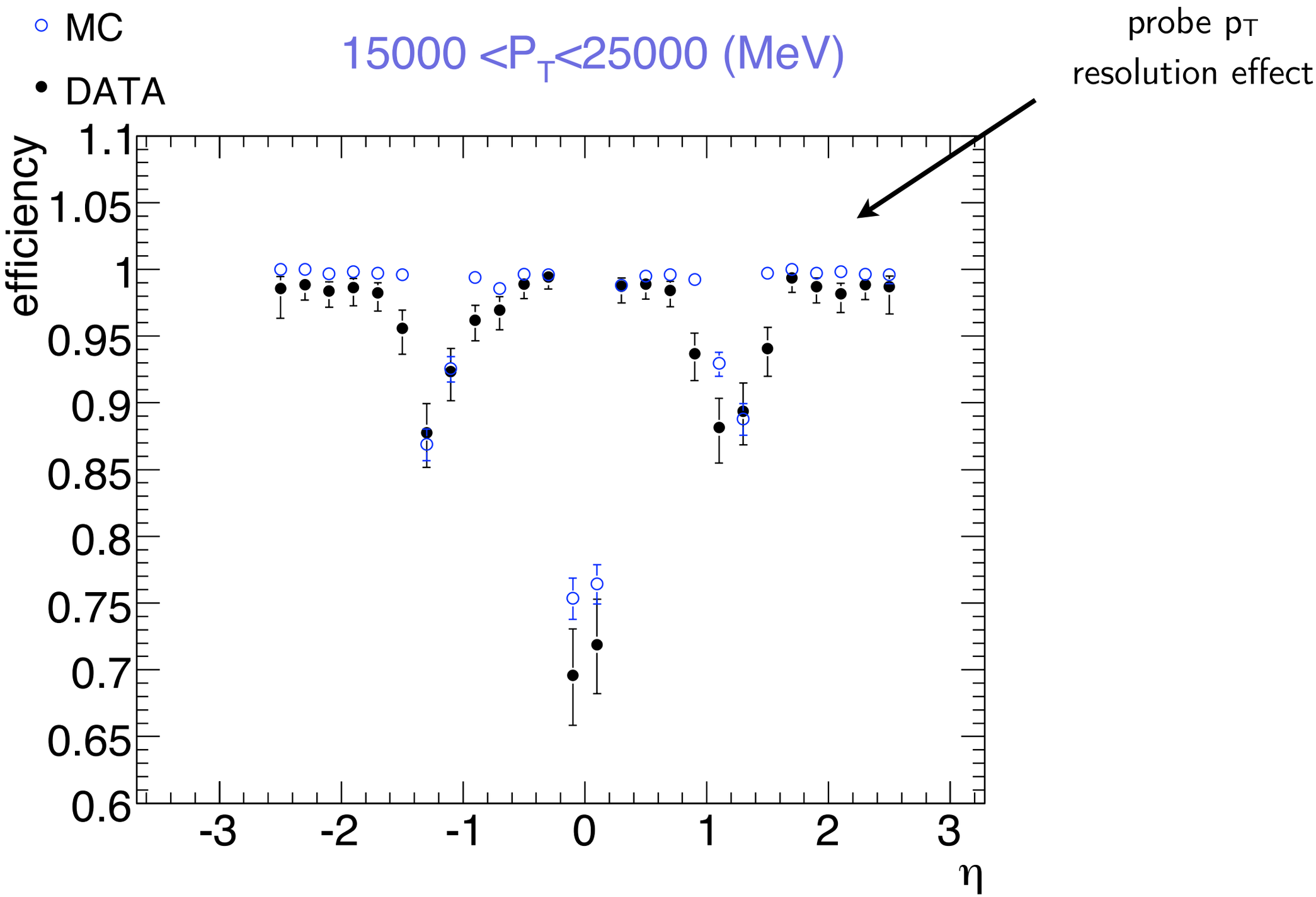






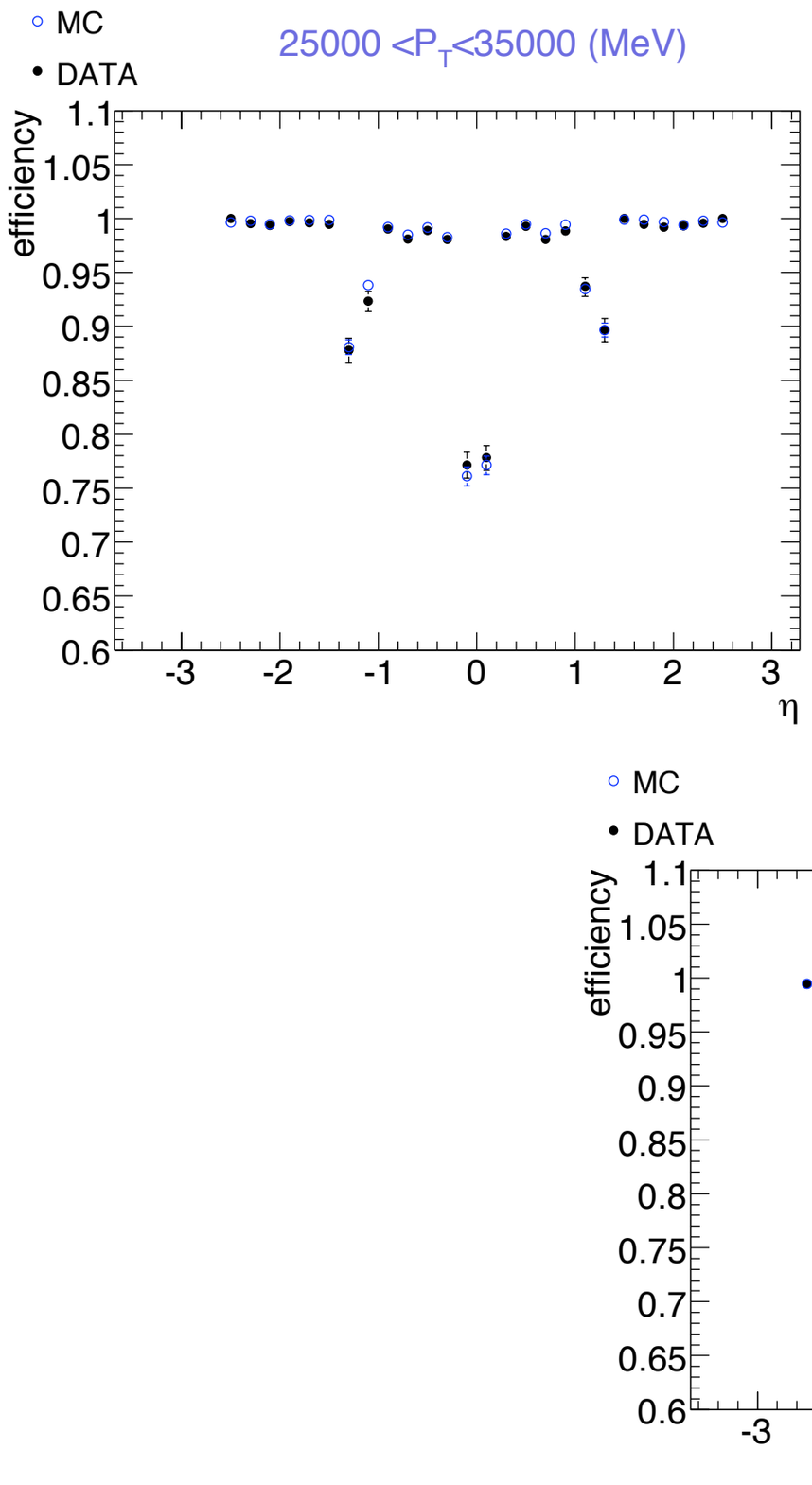
Tag&Probe MSID term

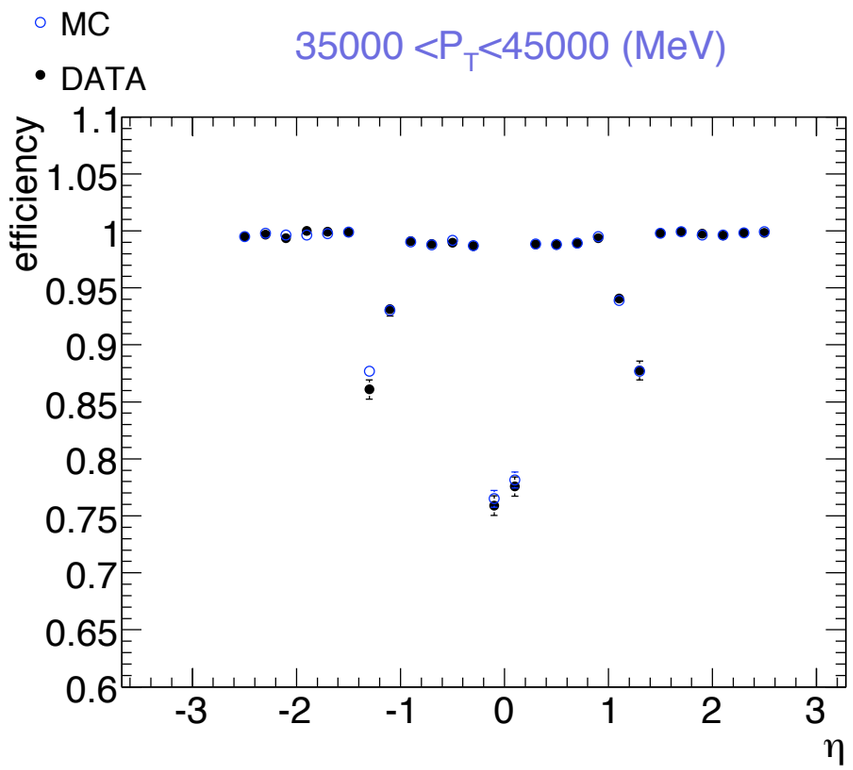
Low P_T

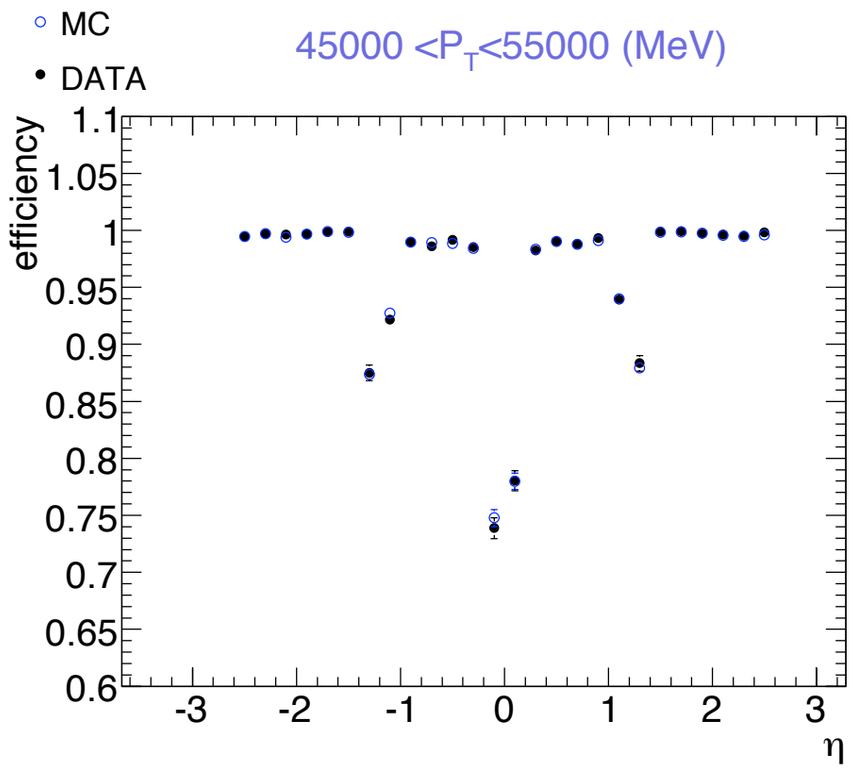


Tag&Probe MSID term

Jacobian region

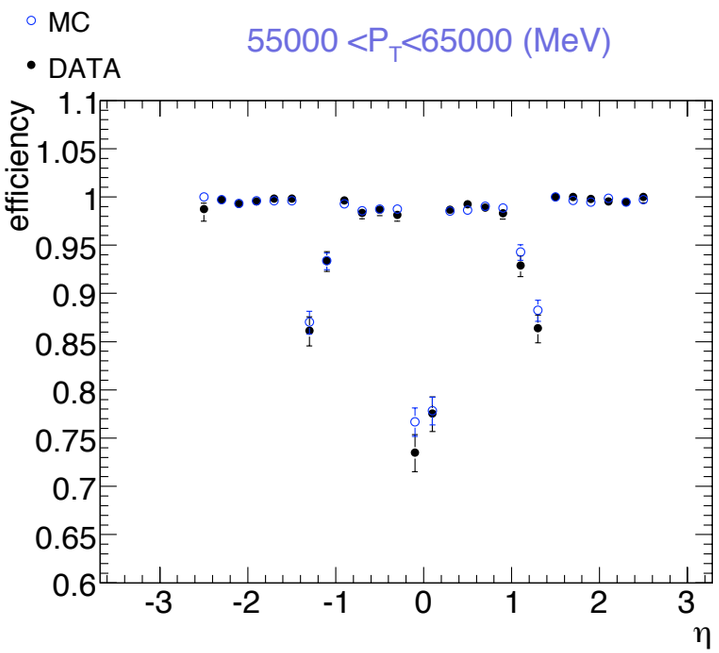


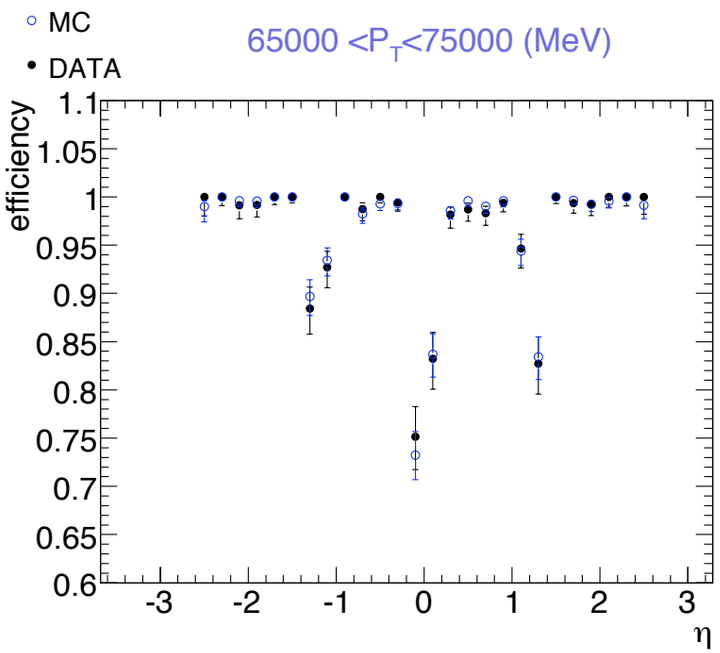


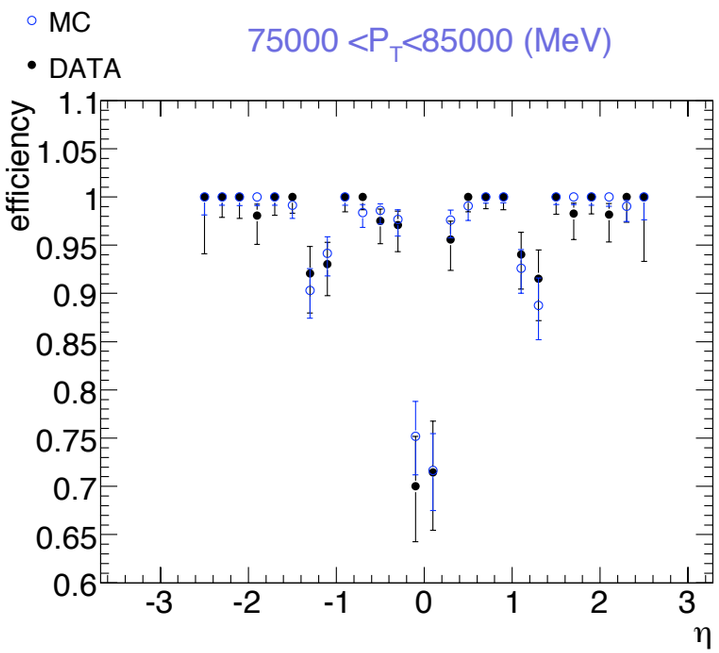


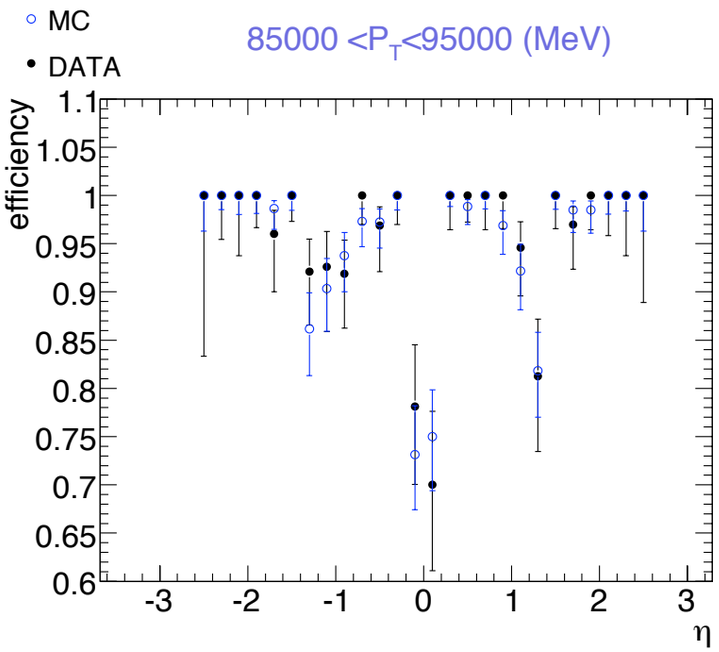
Tag&Probe MSID term

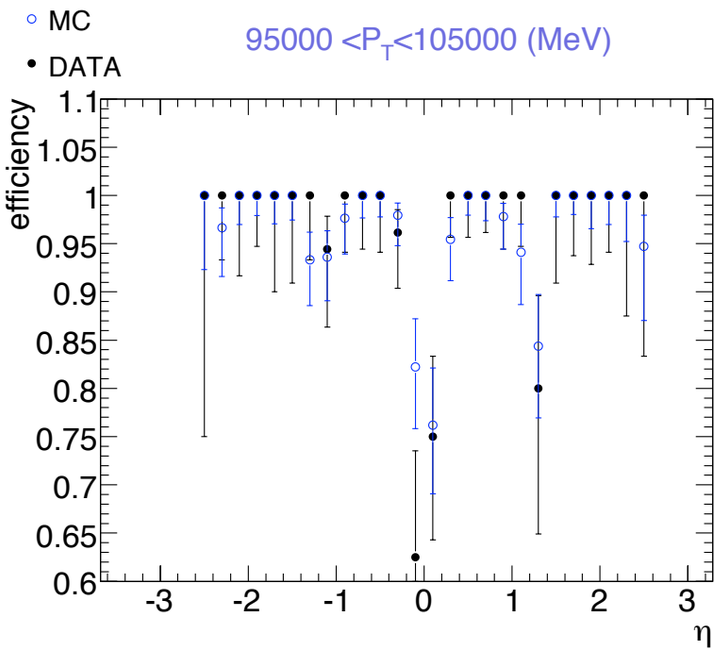
High P_T





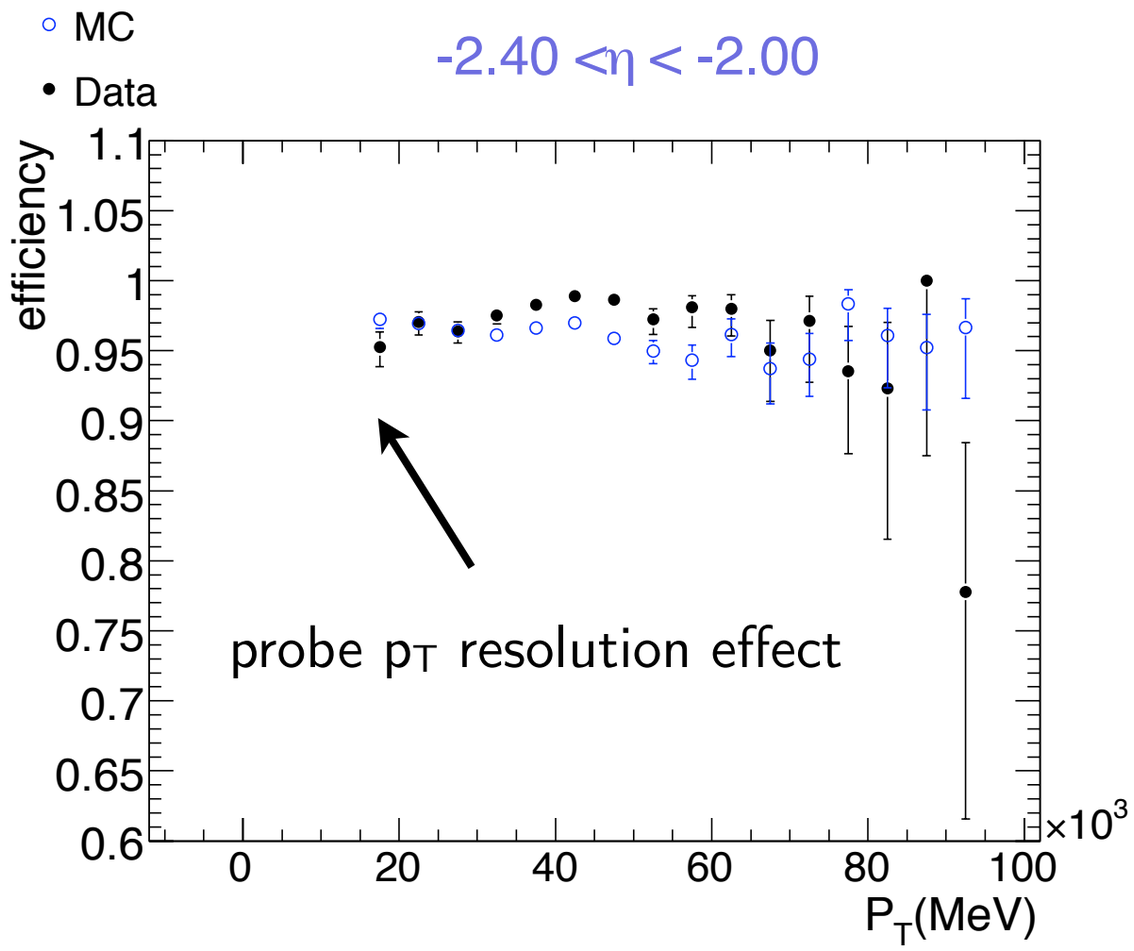


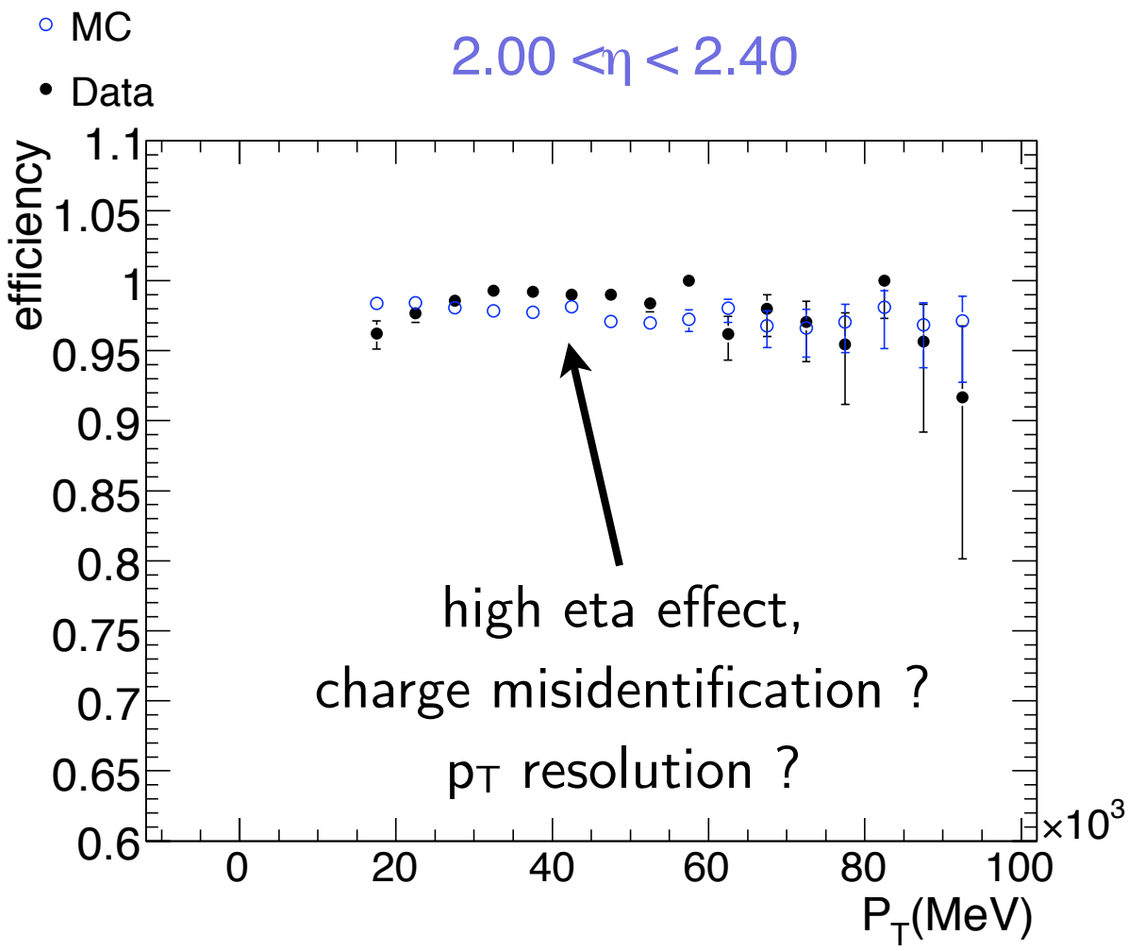




Tag&Probe CBMS term

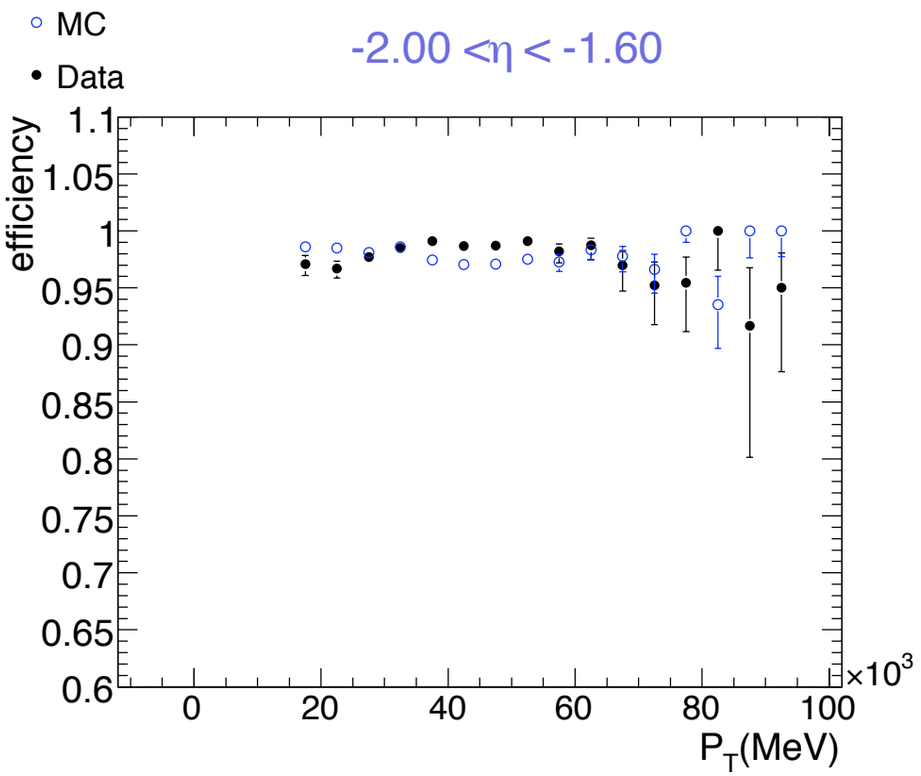
EC forward

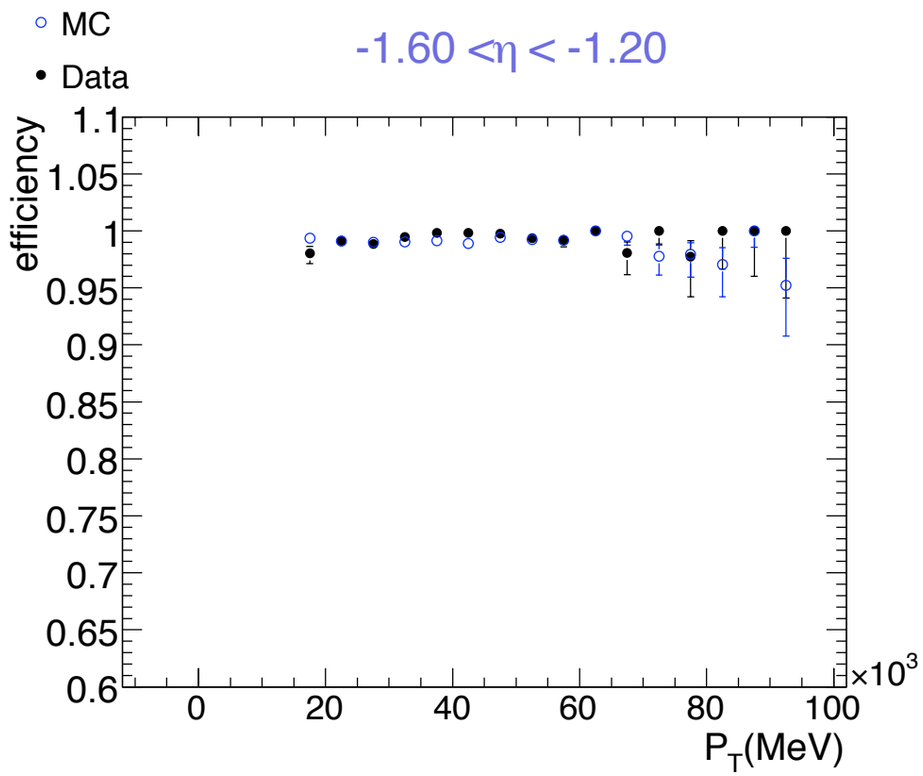


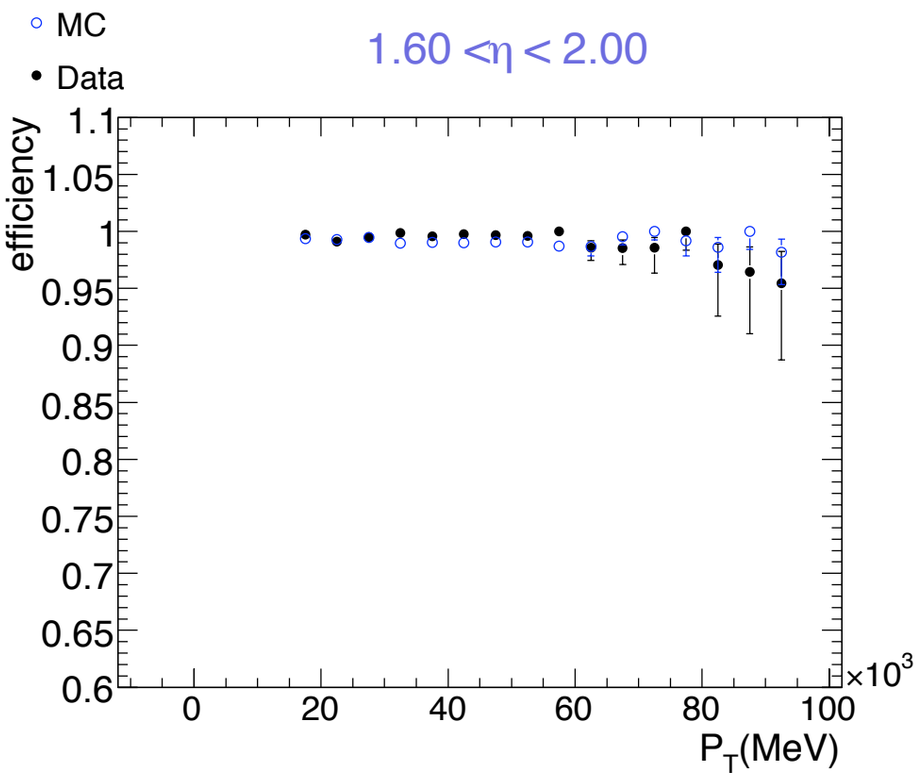


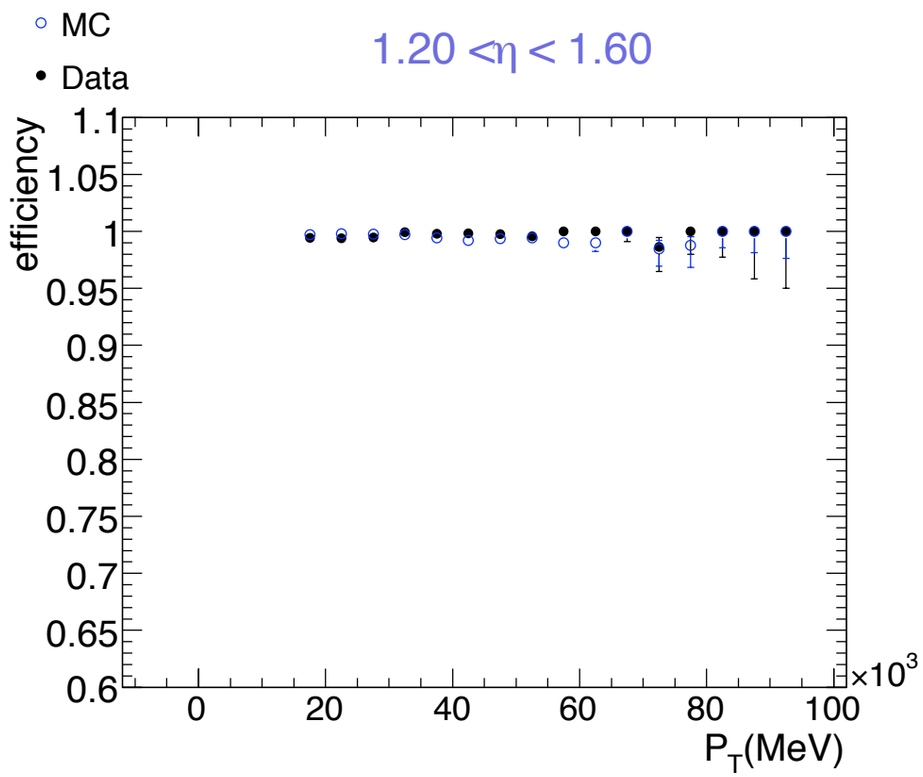
Tag&Probe CBMS term

EC



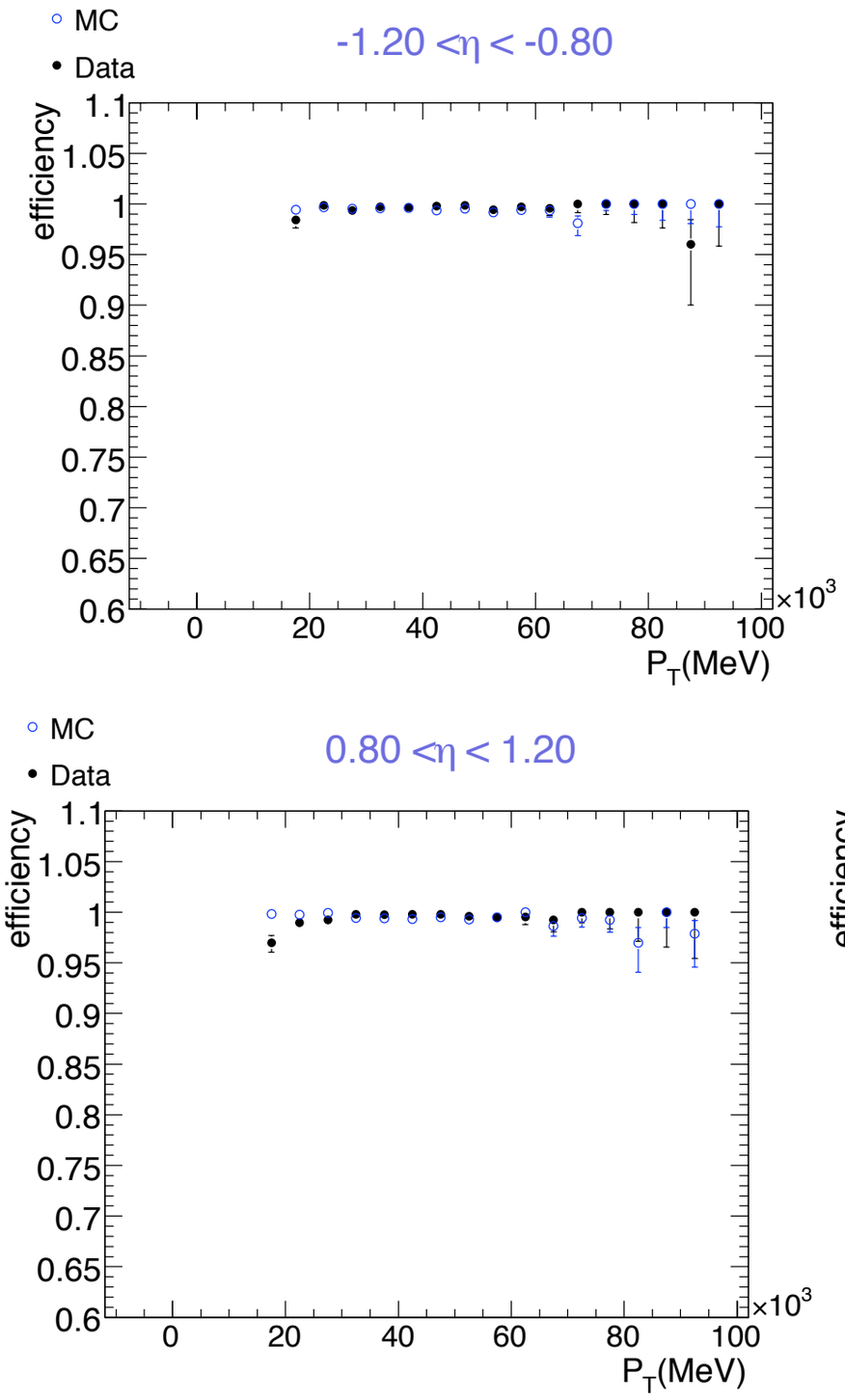


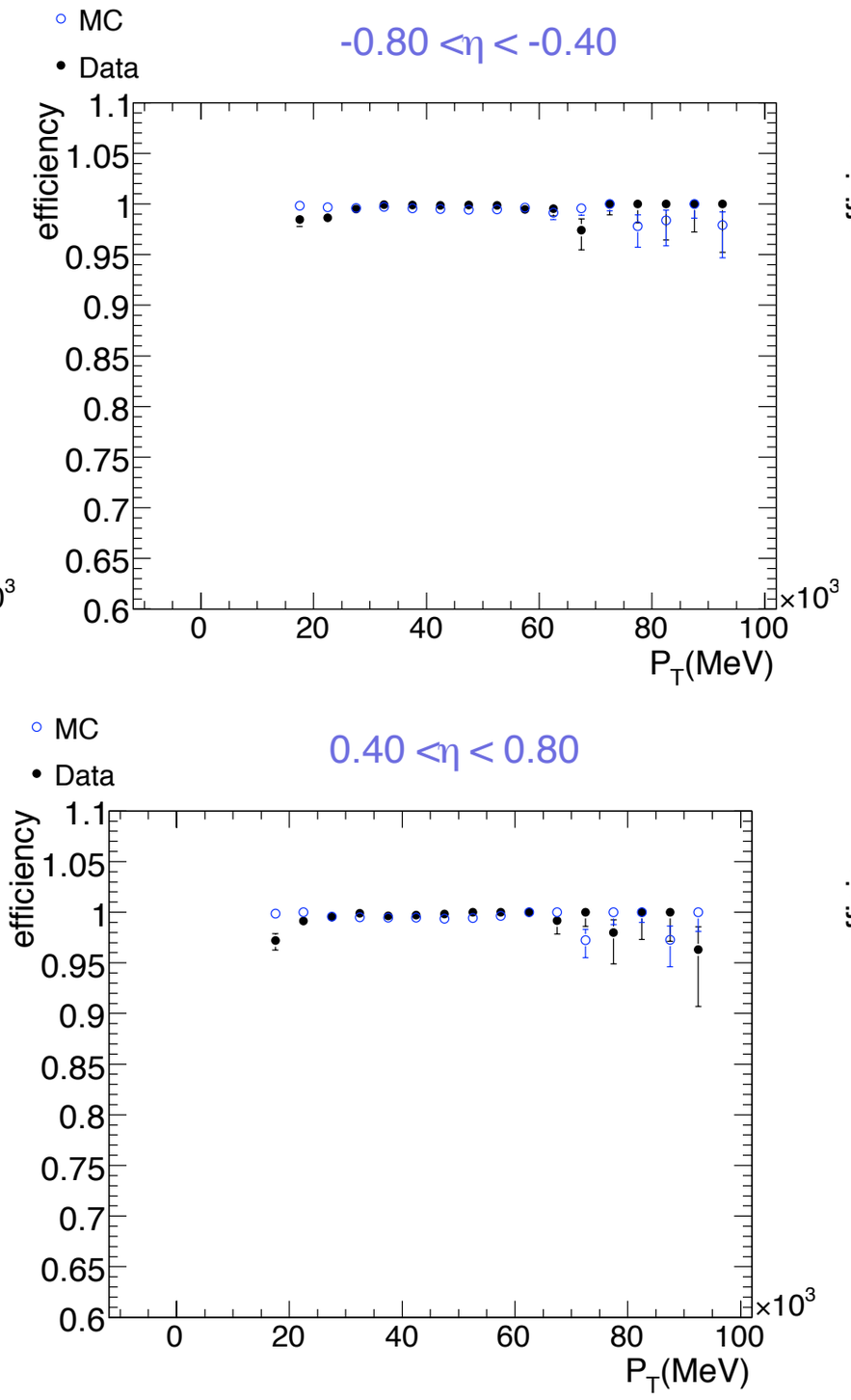


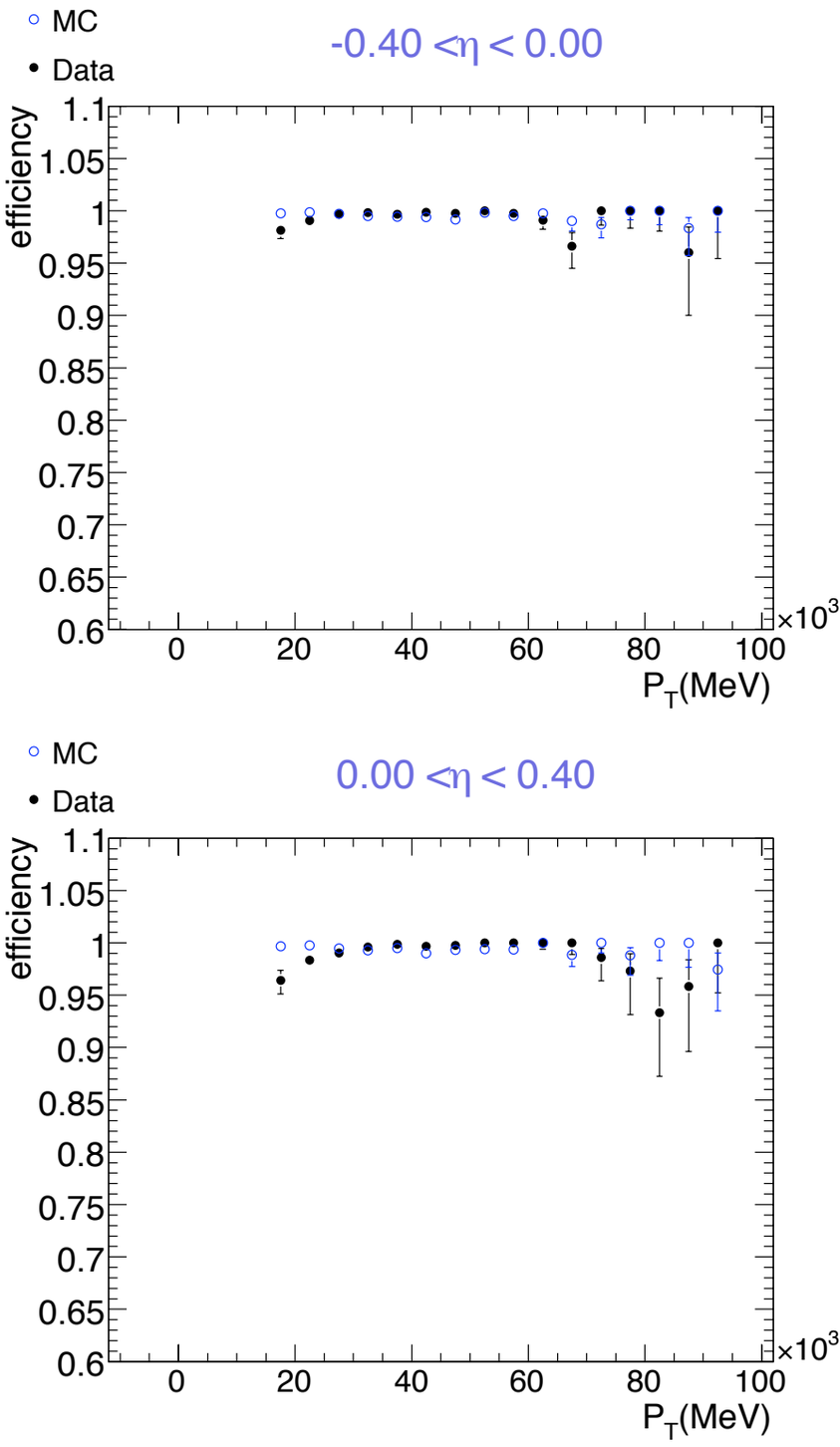


Tag&Probe CBMS term

Barrel

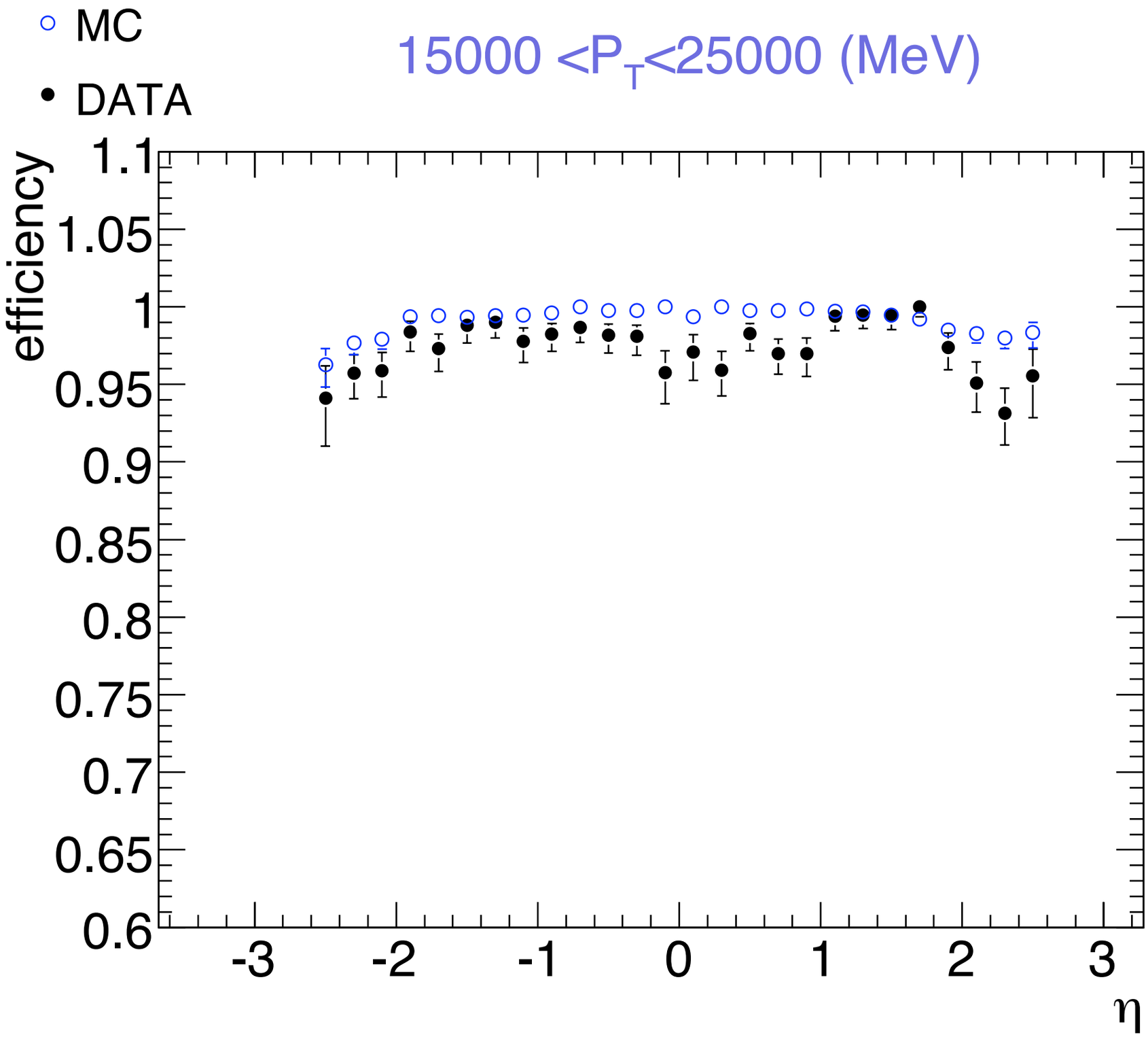






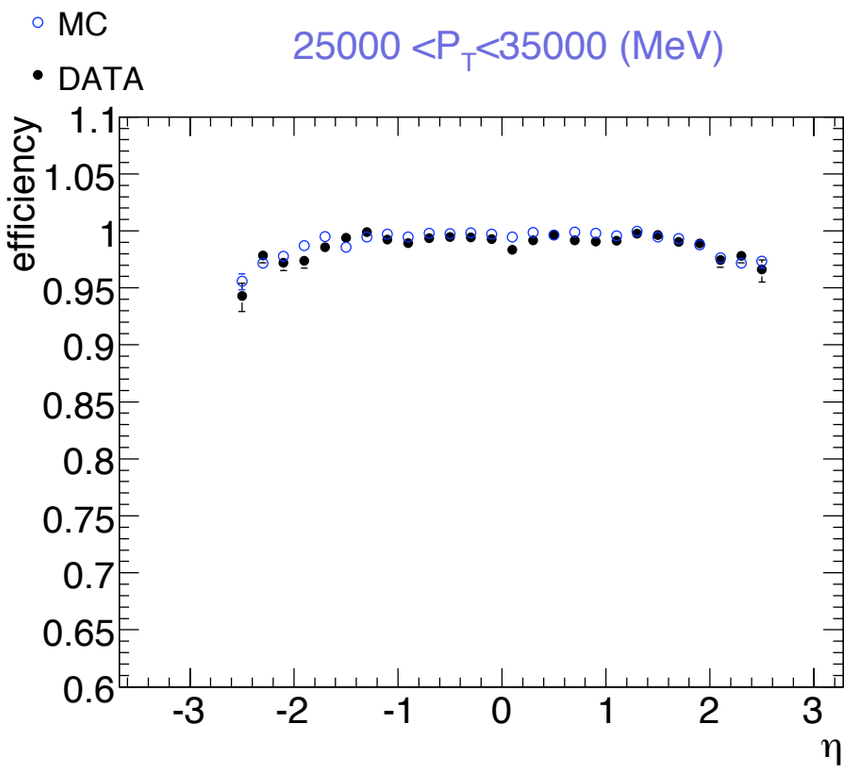
Tag&Probe CBMS term

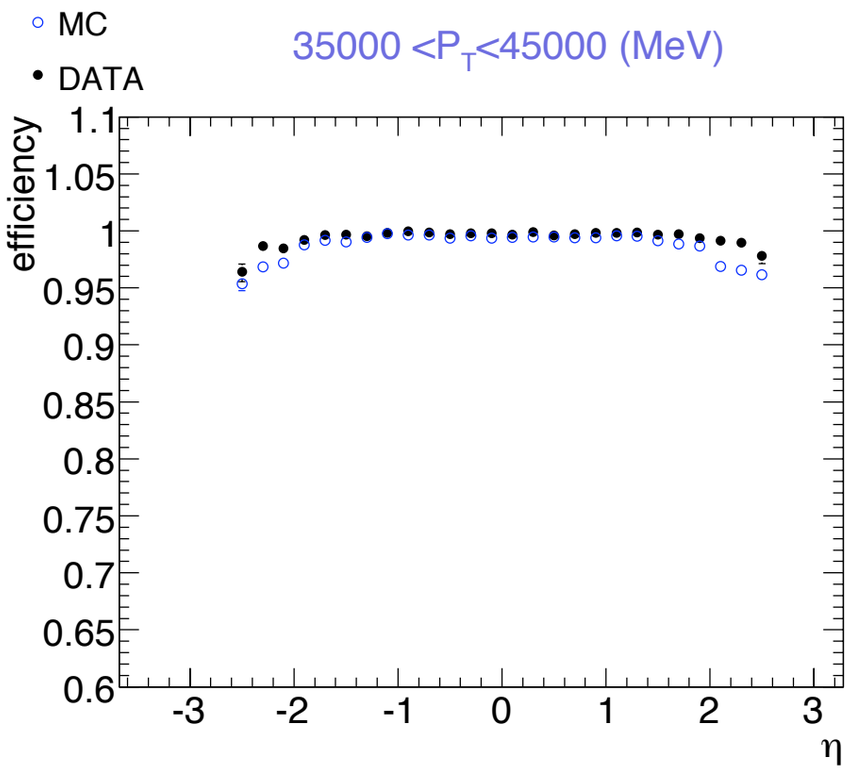
Low P_T

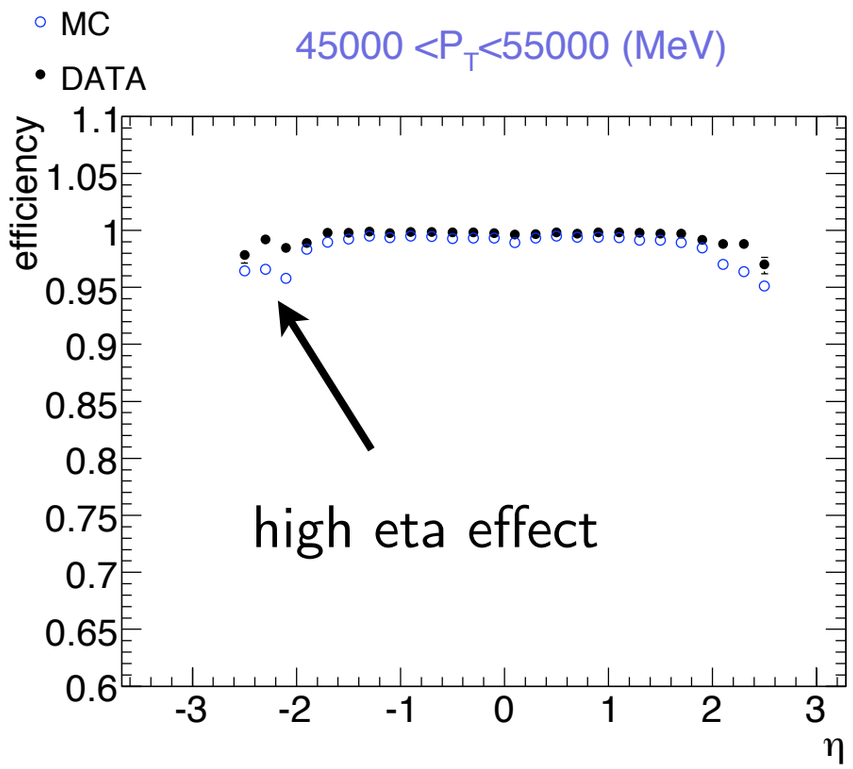


Tag&Probe CBMS term

Jacobian region

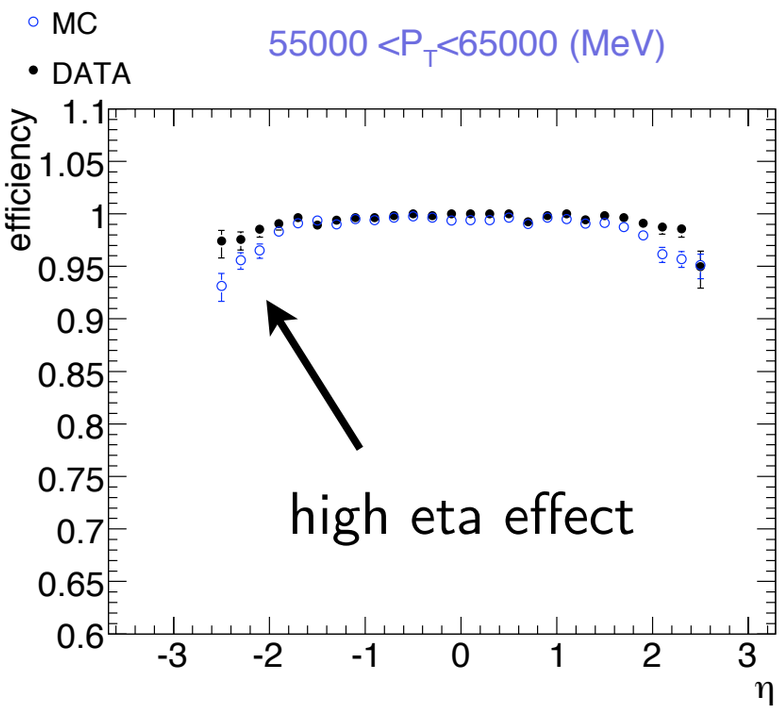


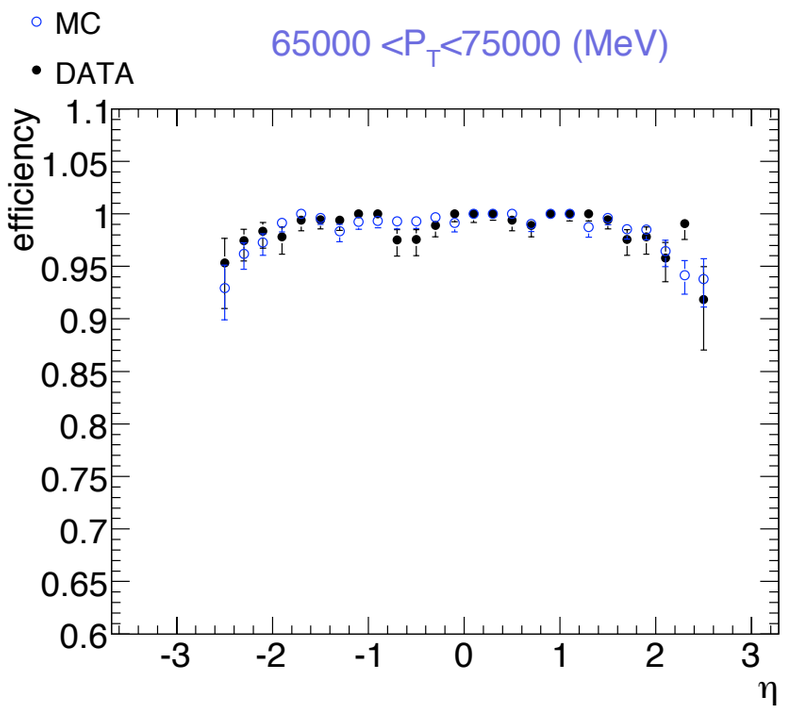


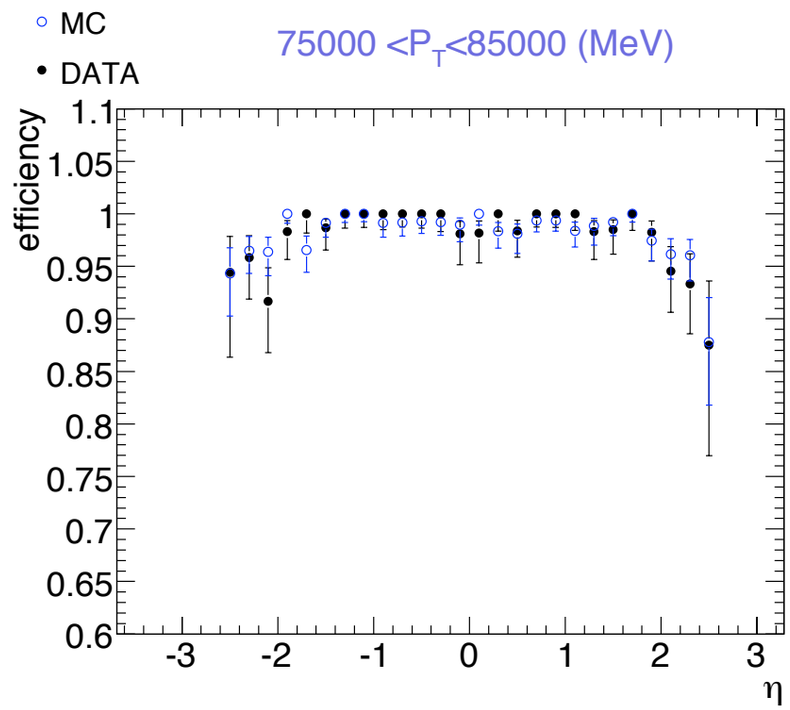


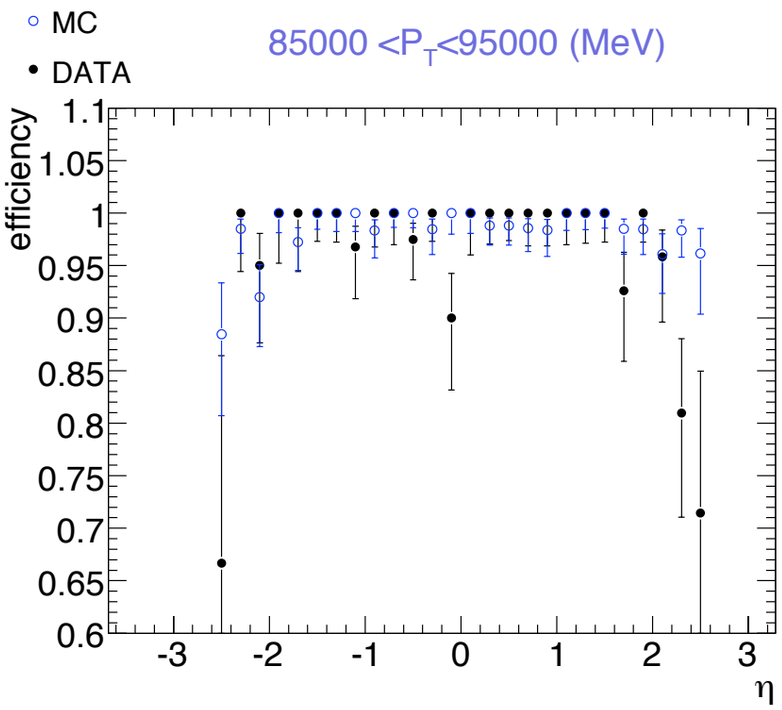
Tag&Probe CBMS term

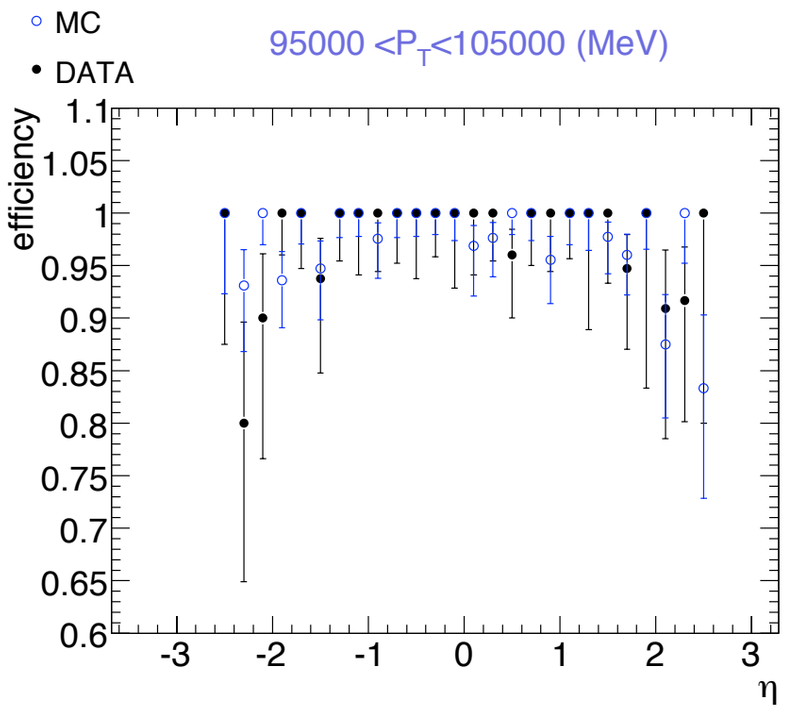
High P_T





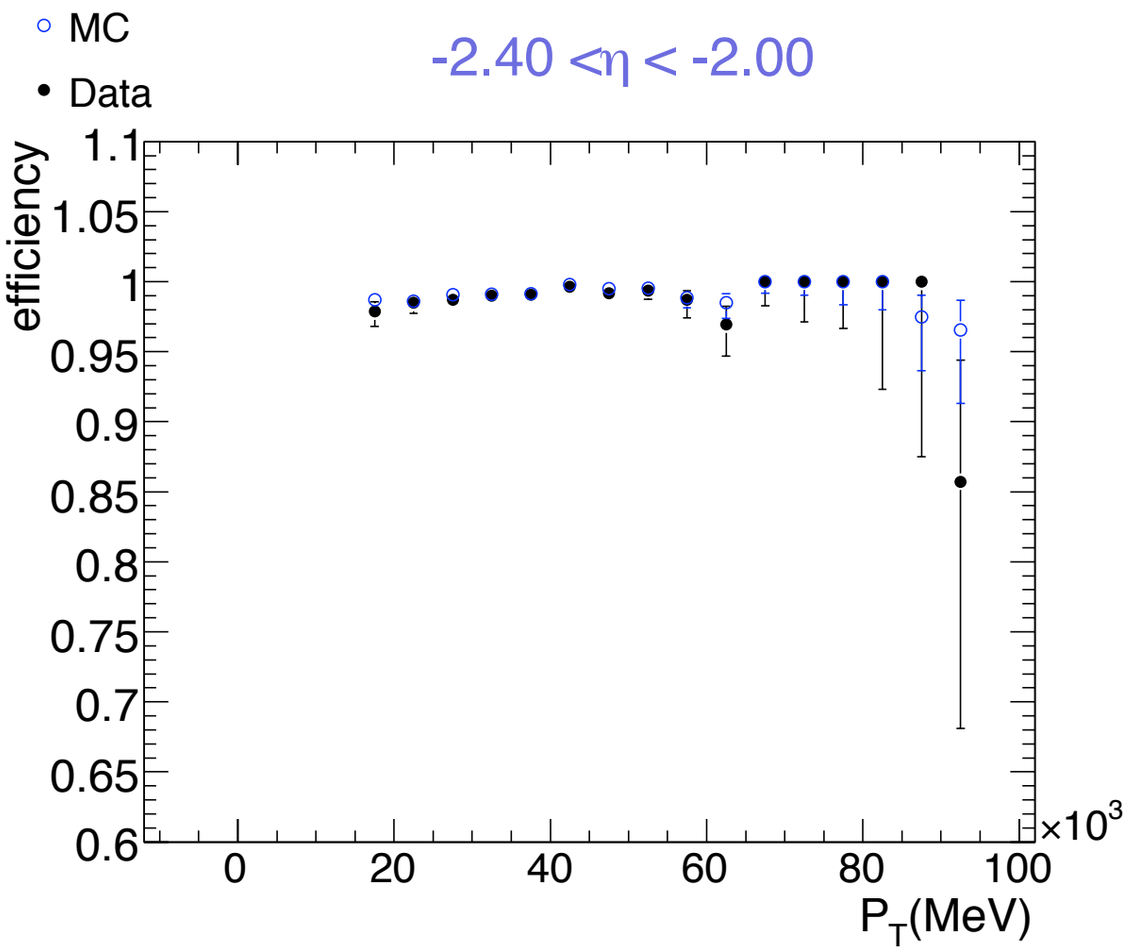


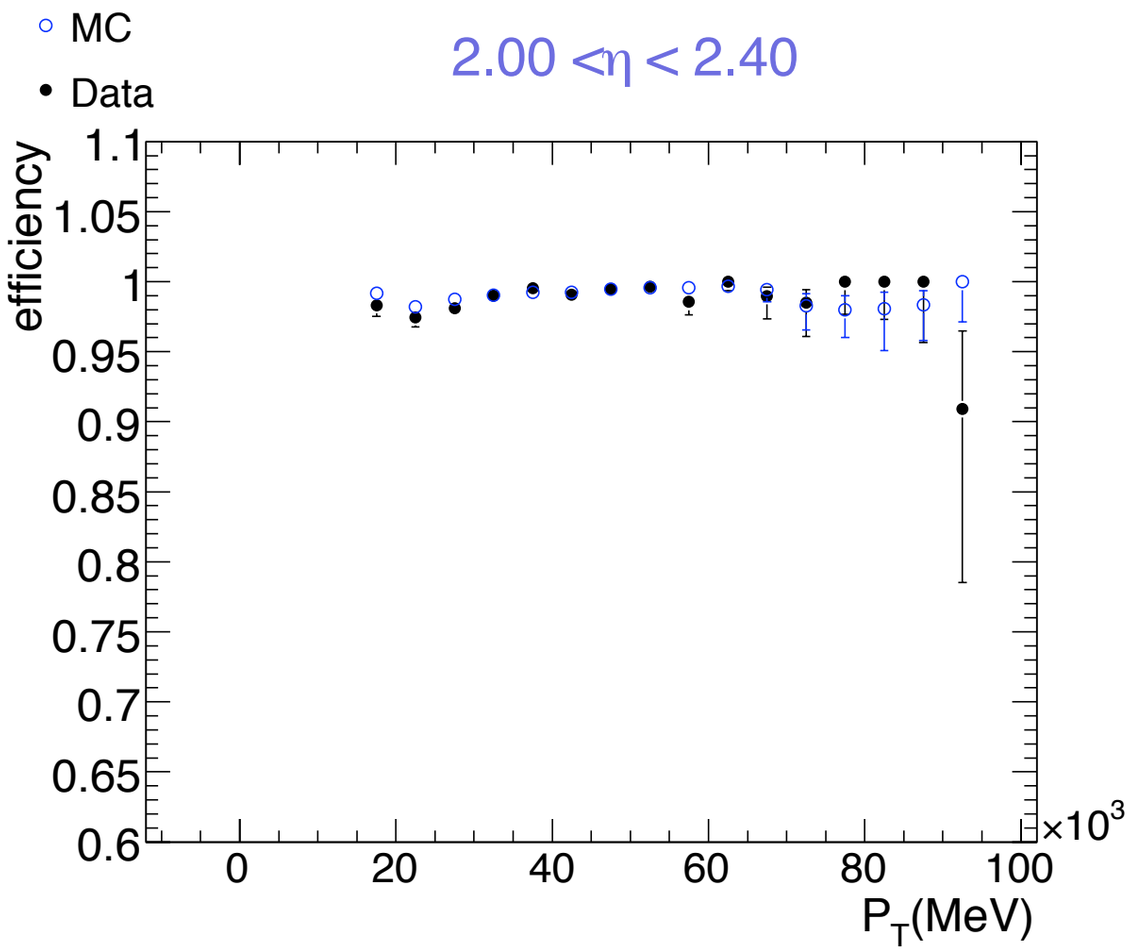




Tag&Probe CBISO term

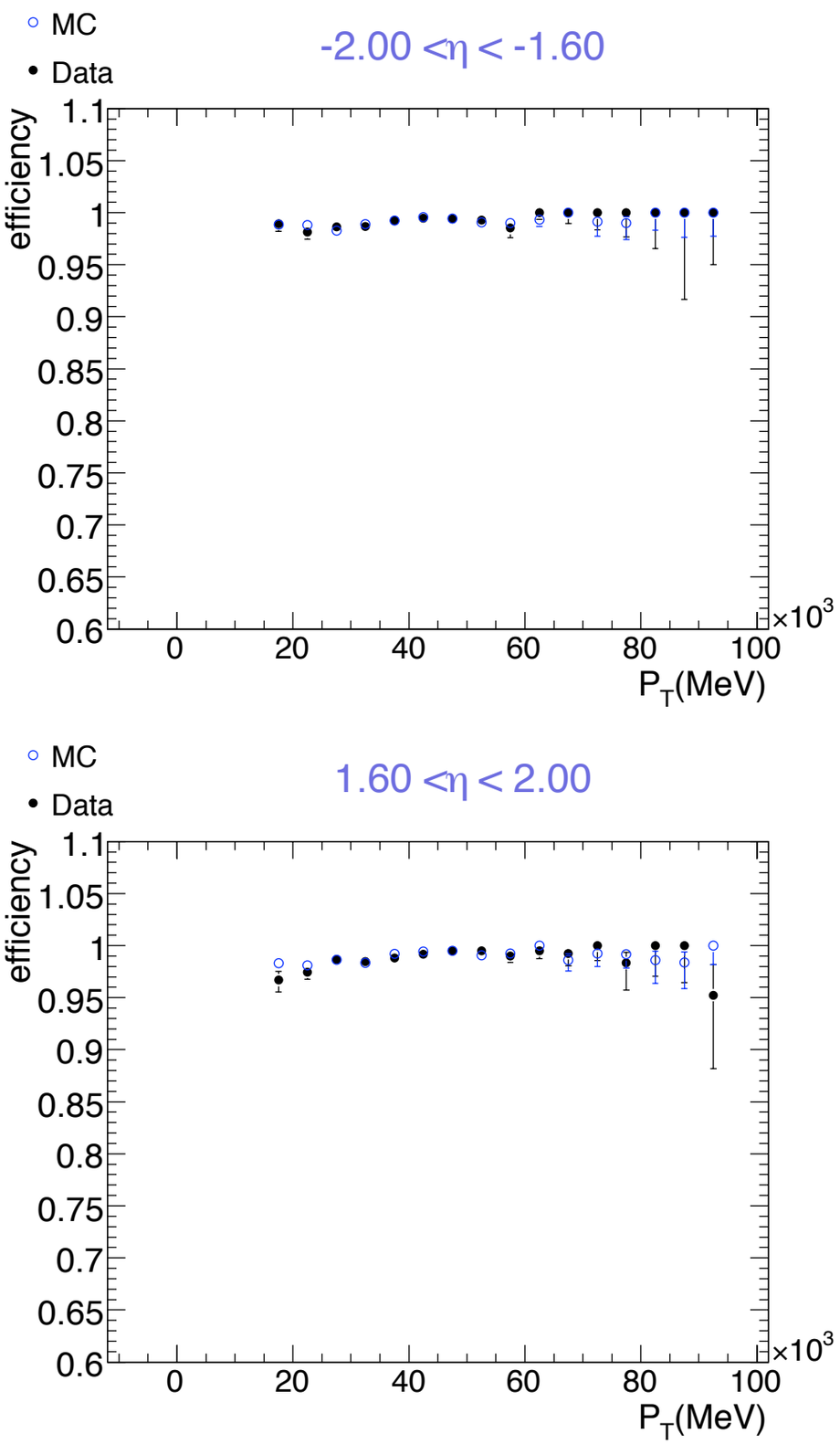
EC forward

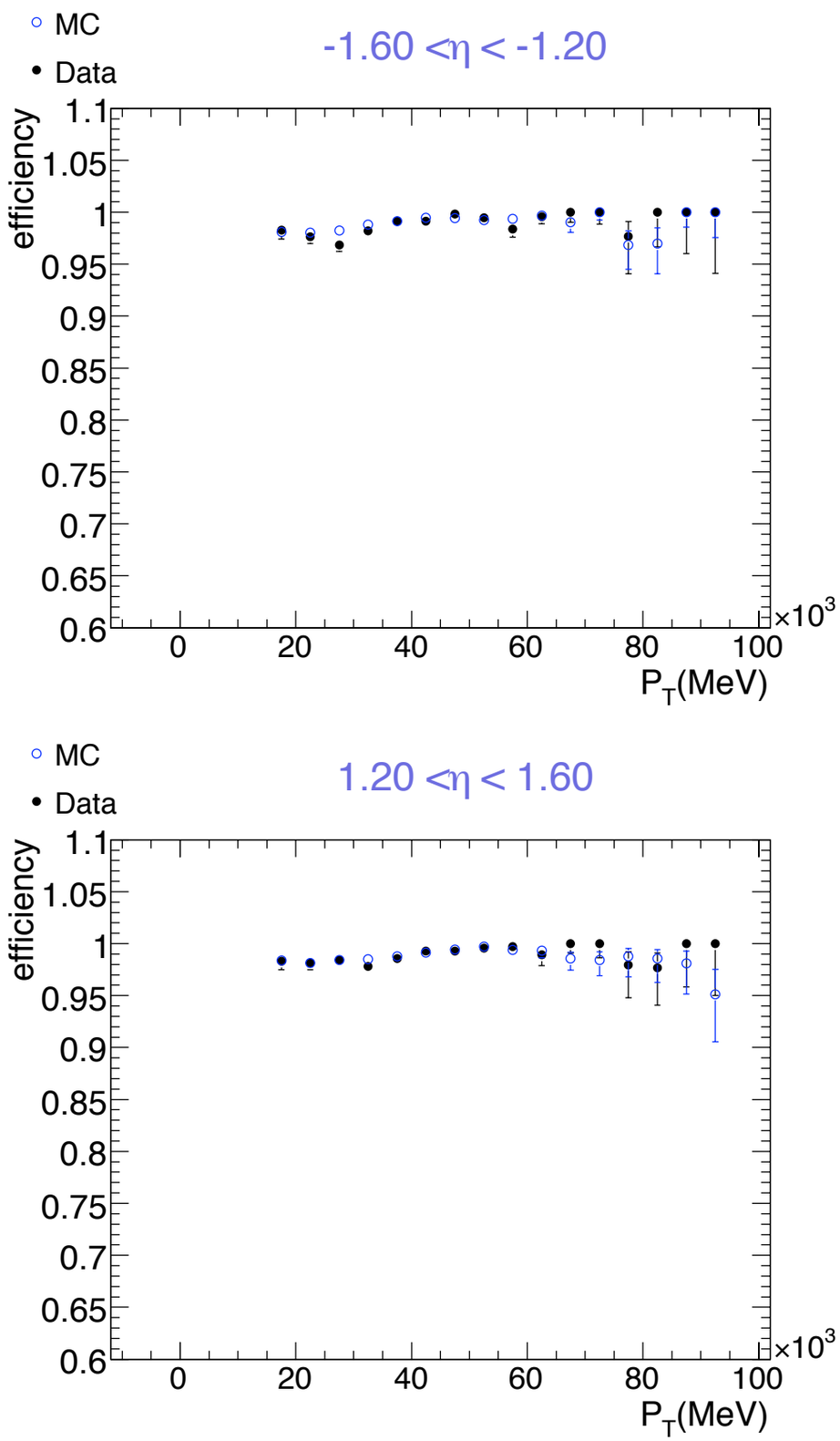




Tag&Probe CBISO term

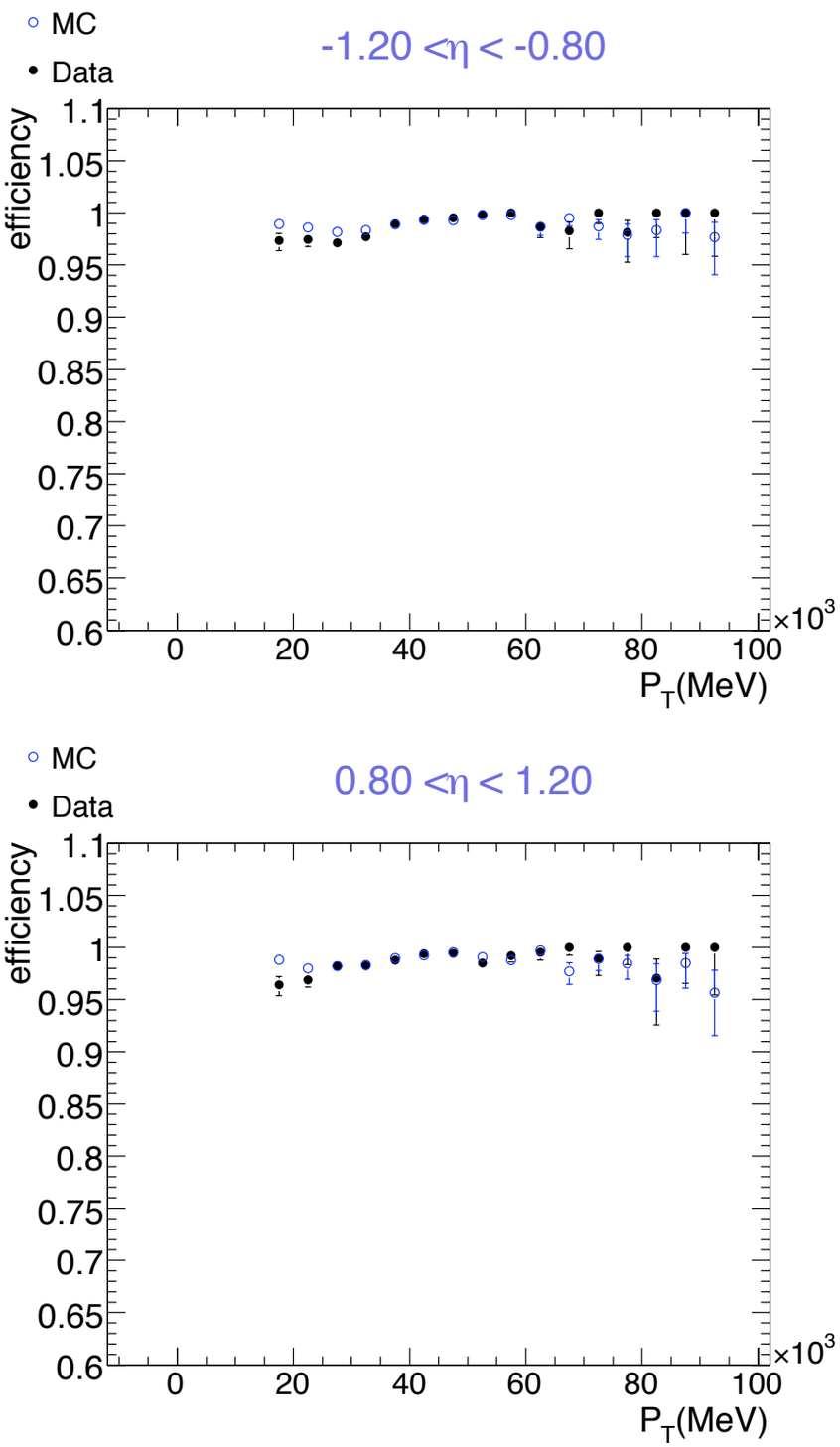
EC

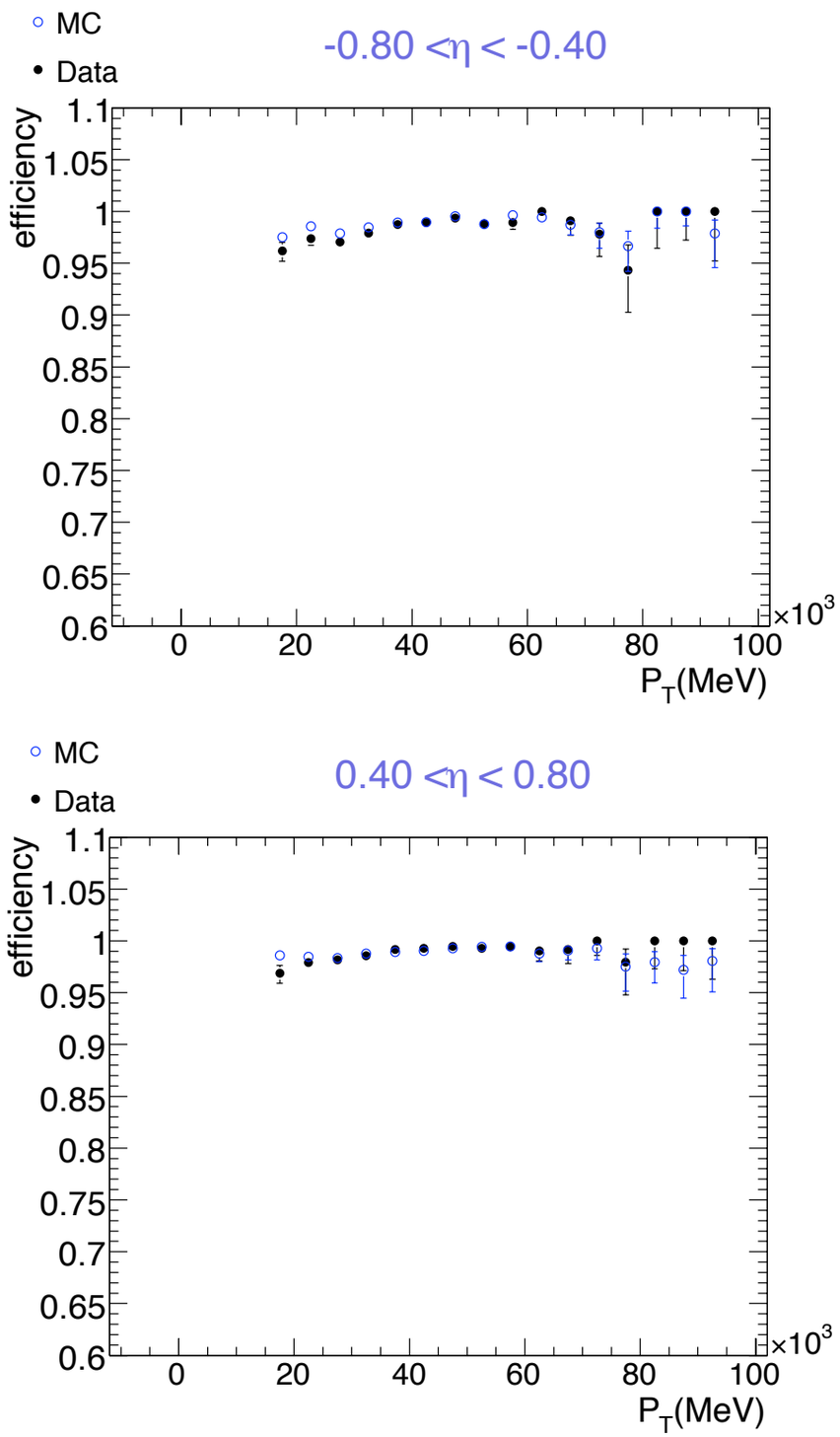


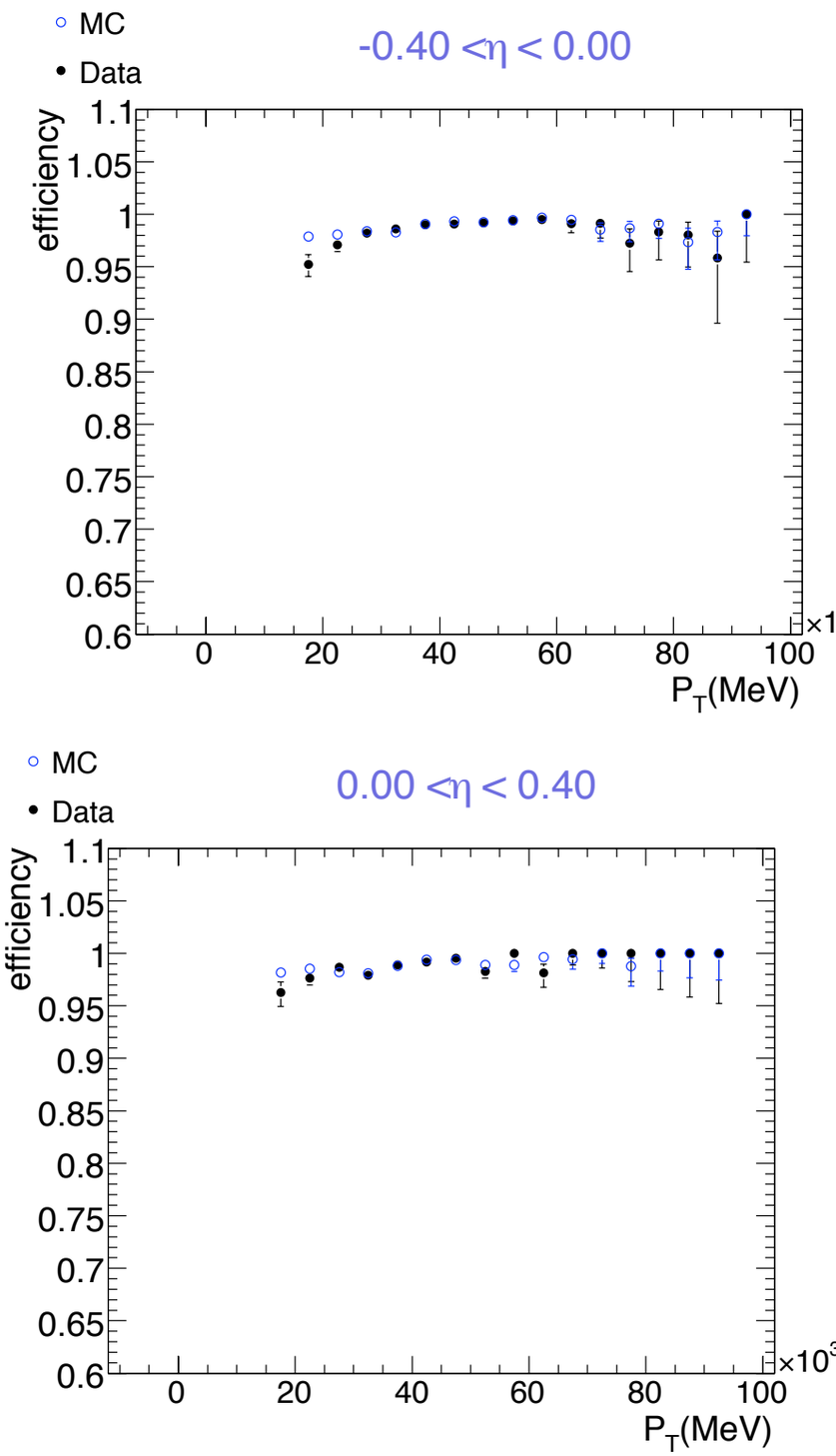


Tag&Probe CBISO term

Barrel

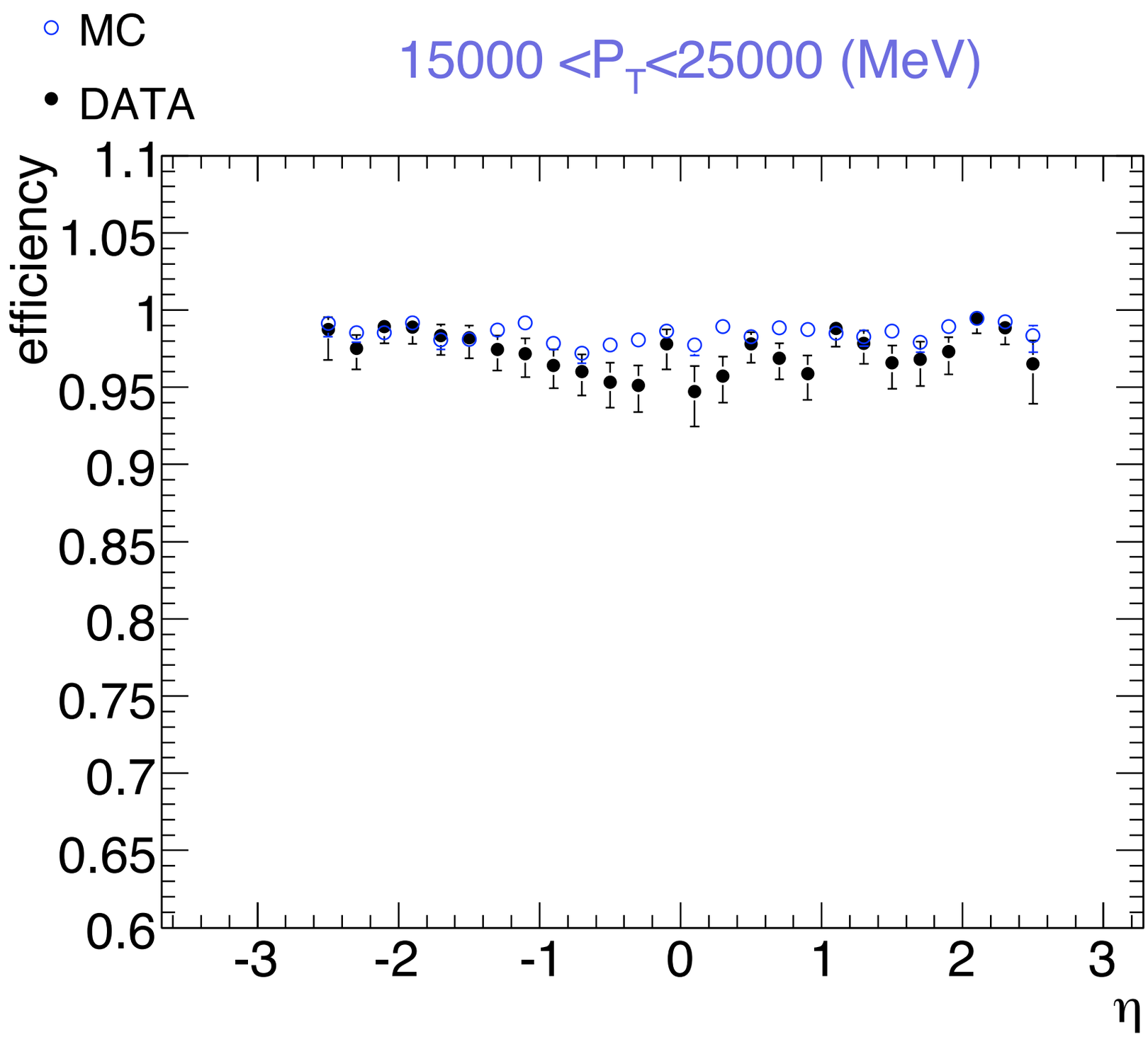






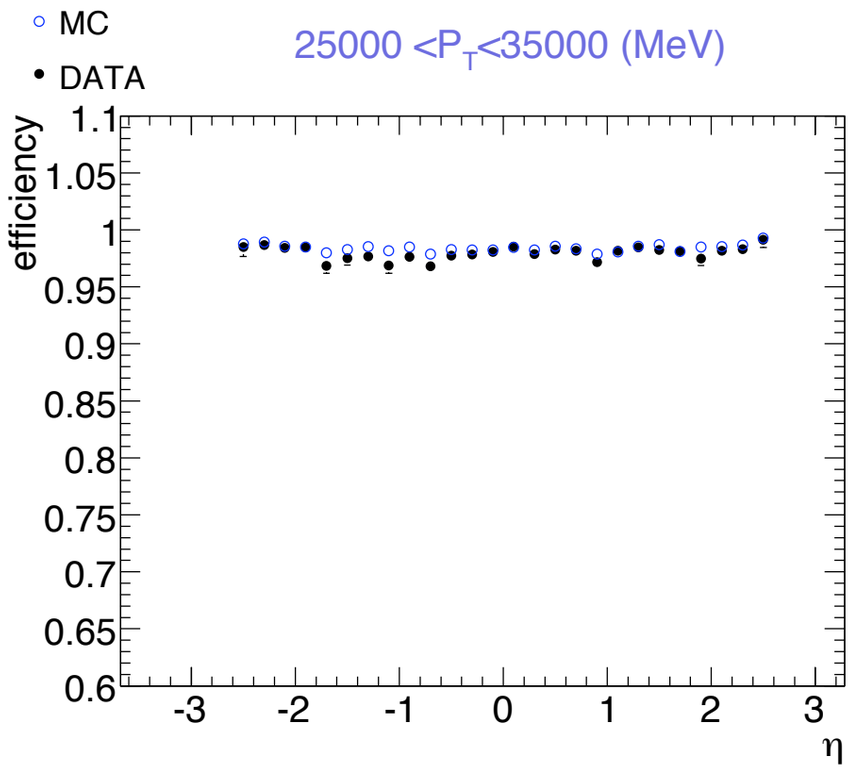
Tag&Probe CBISO term

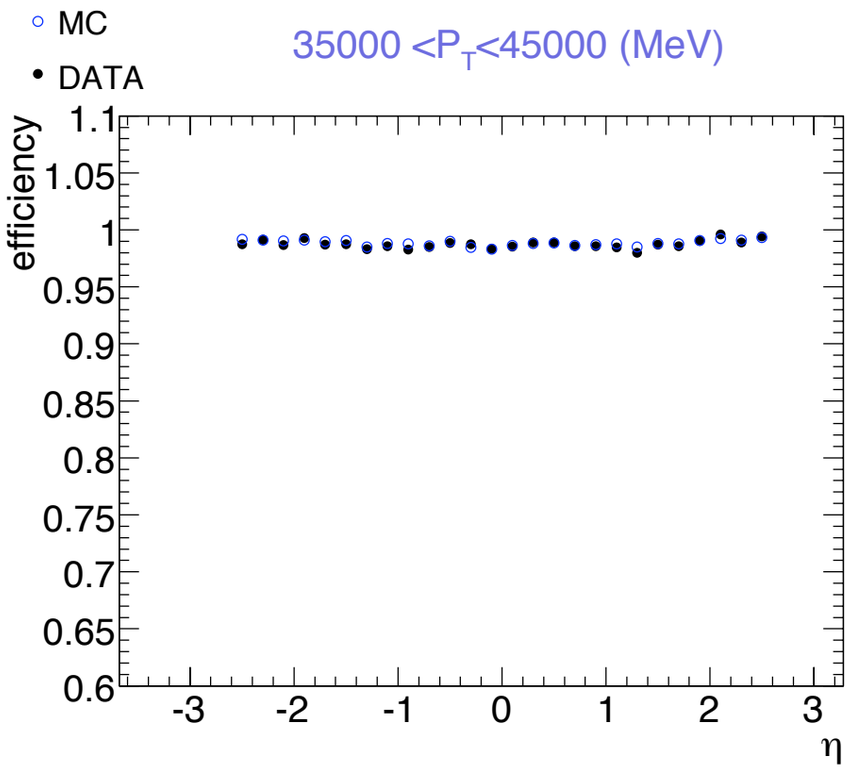
Low P_T

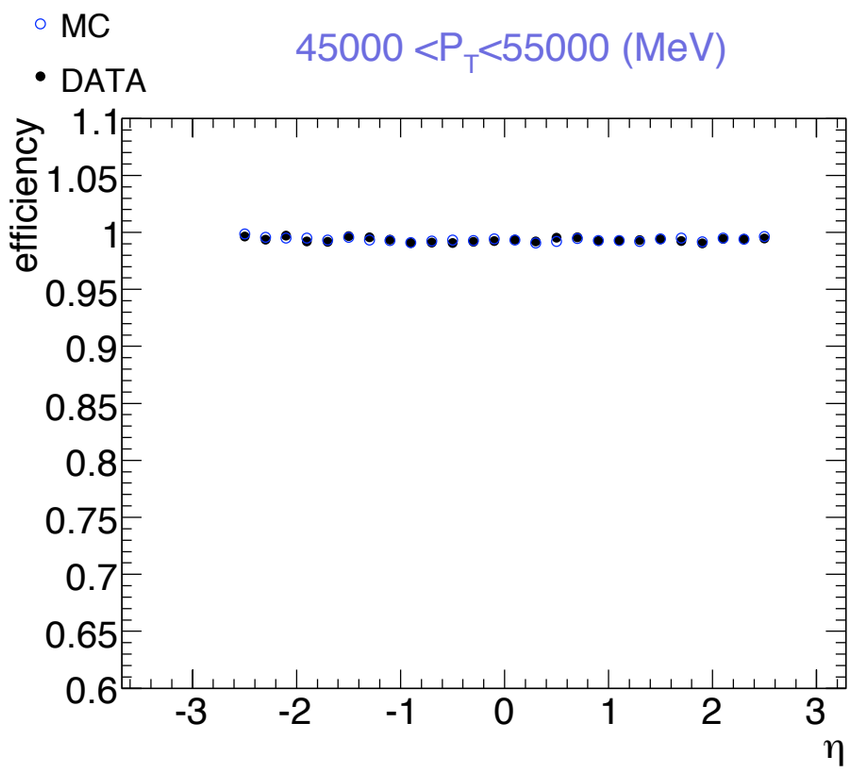


Tag&Probe CBISO term

Jacobian region

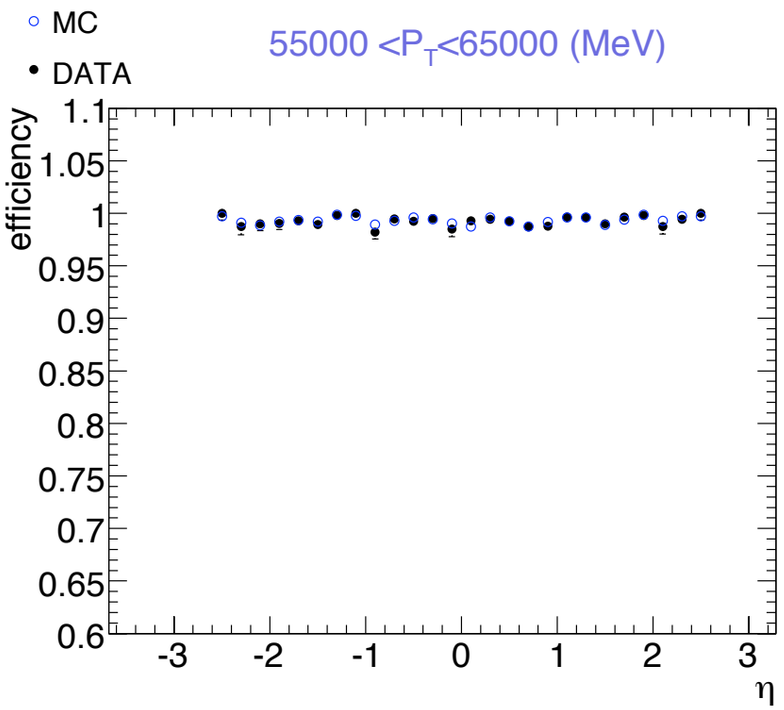


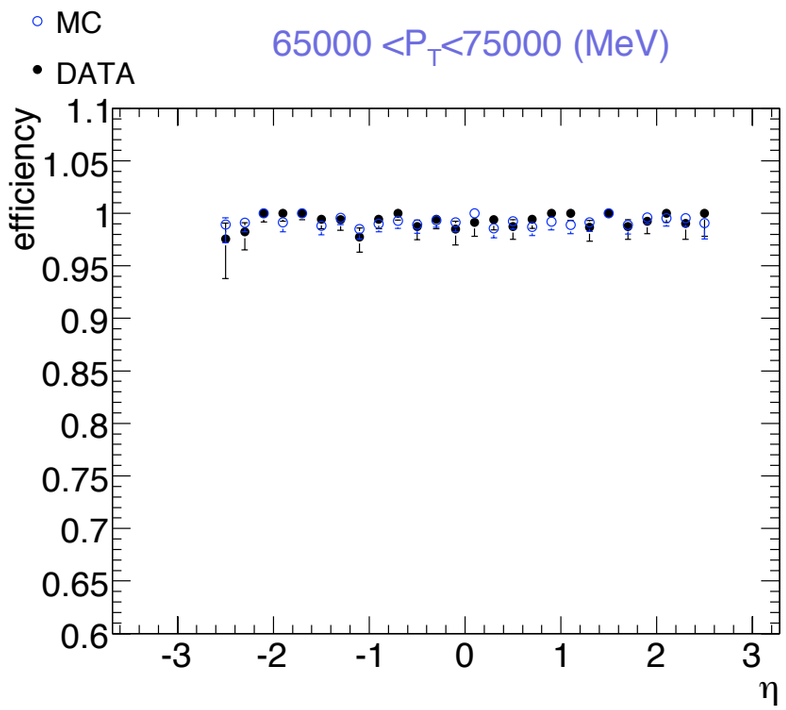


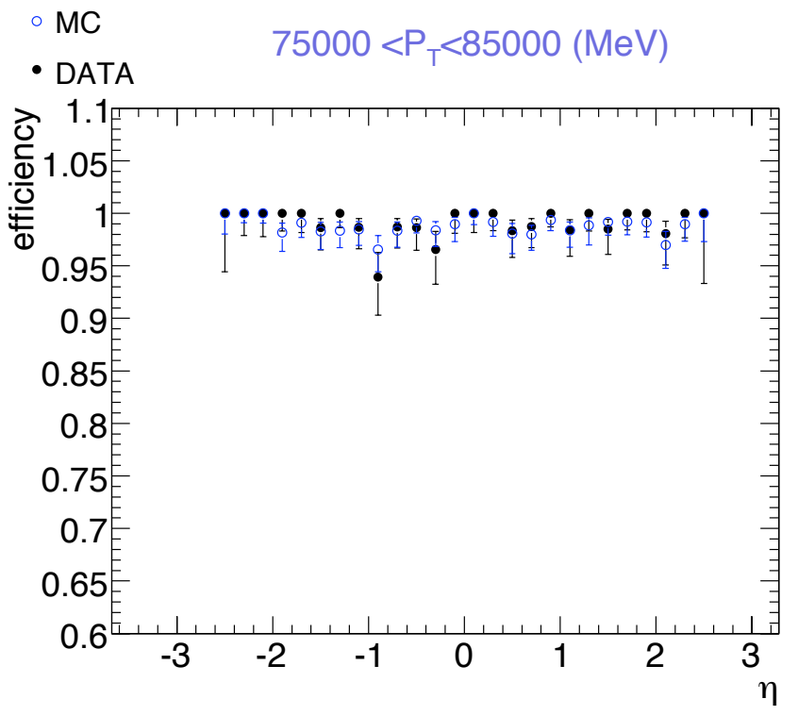


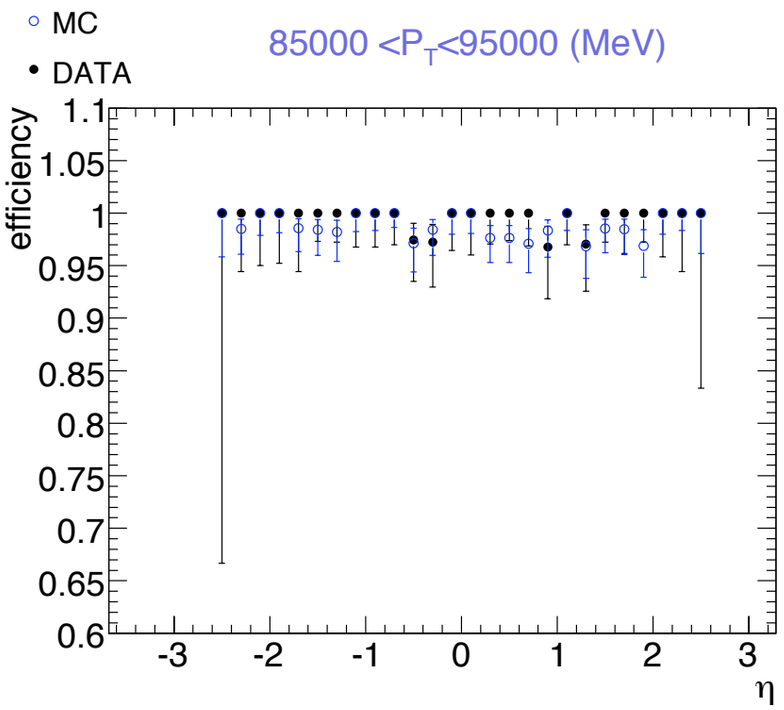
Tag&Probe CBISO term

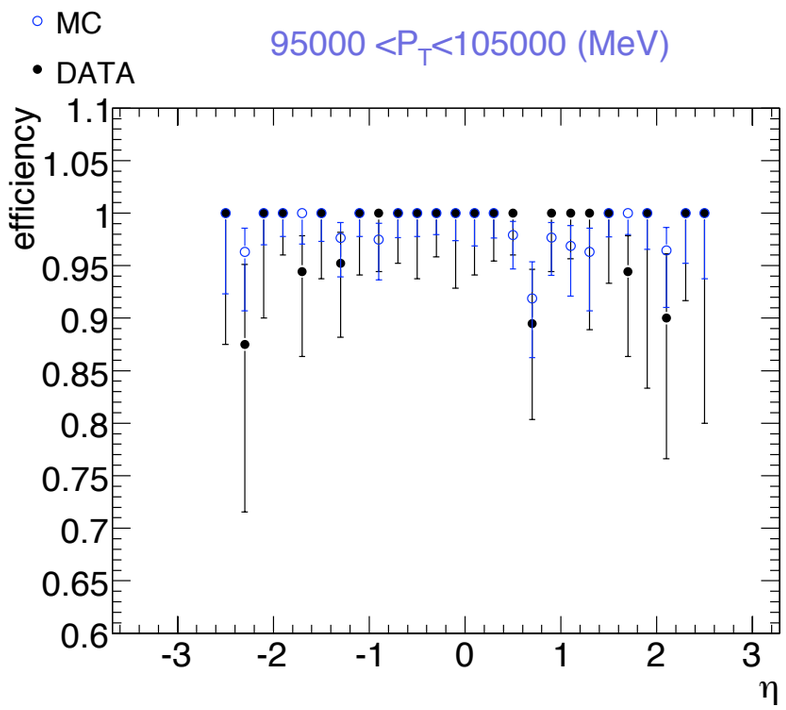
High P_T





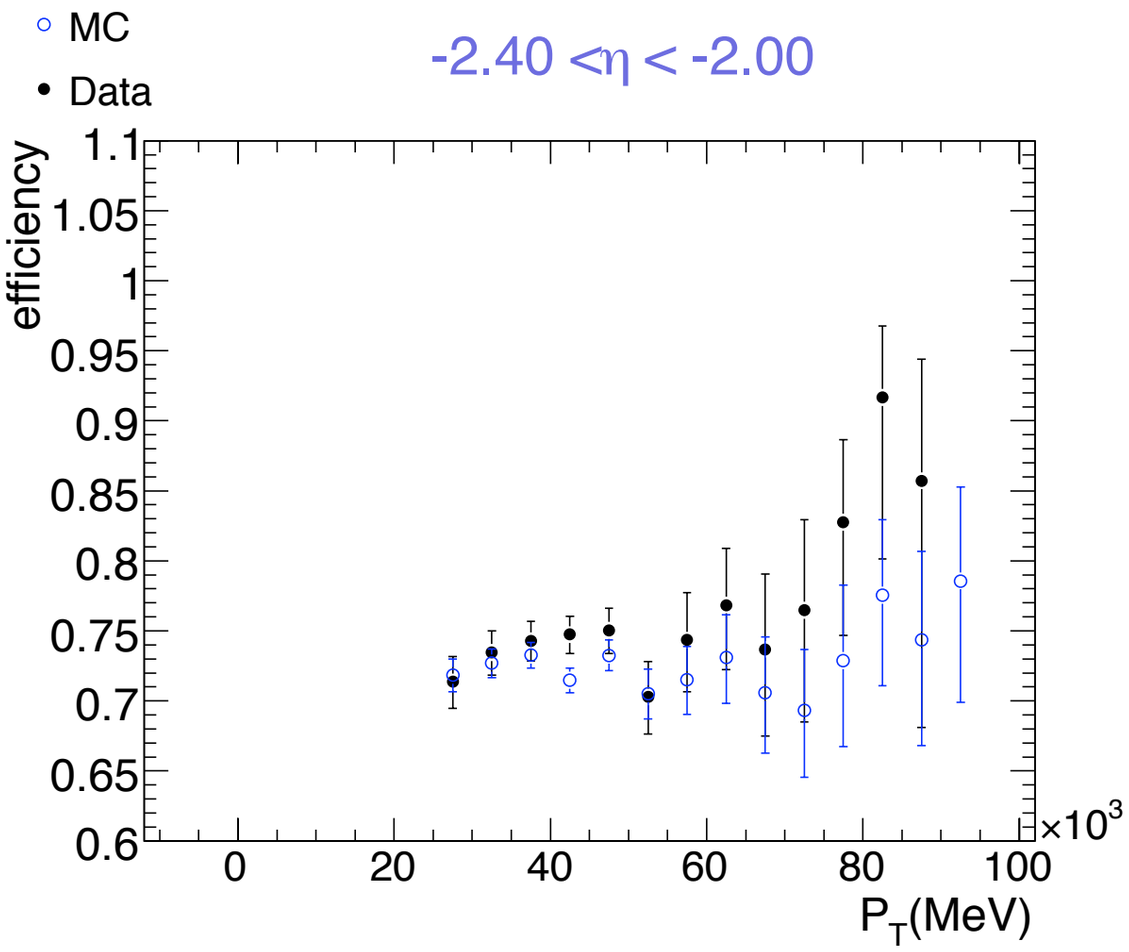


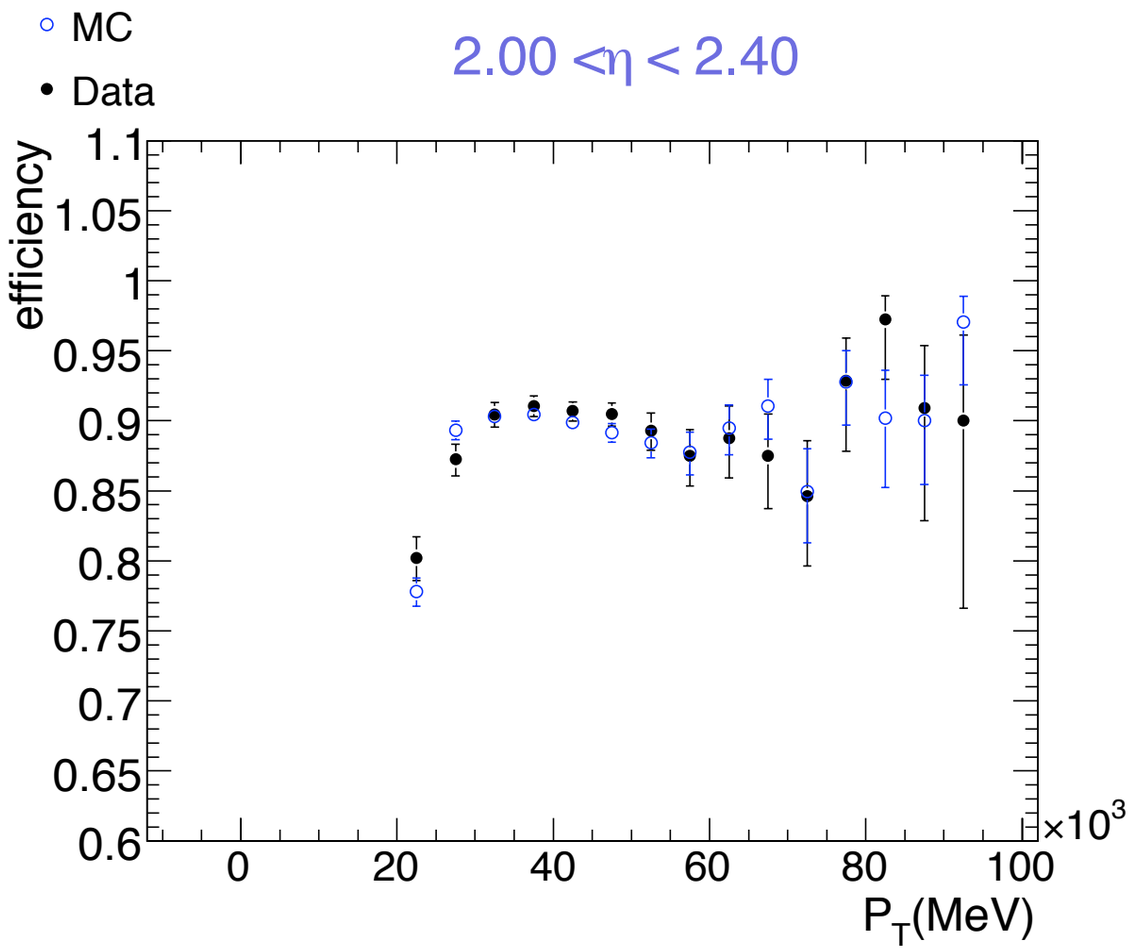




Tag&Probe TRIGCBISO term

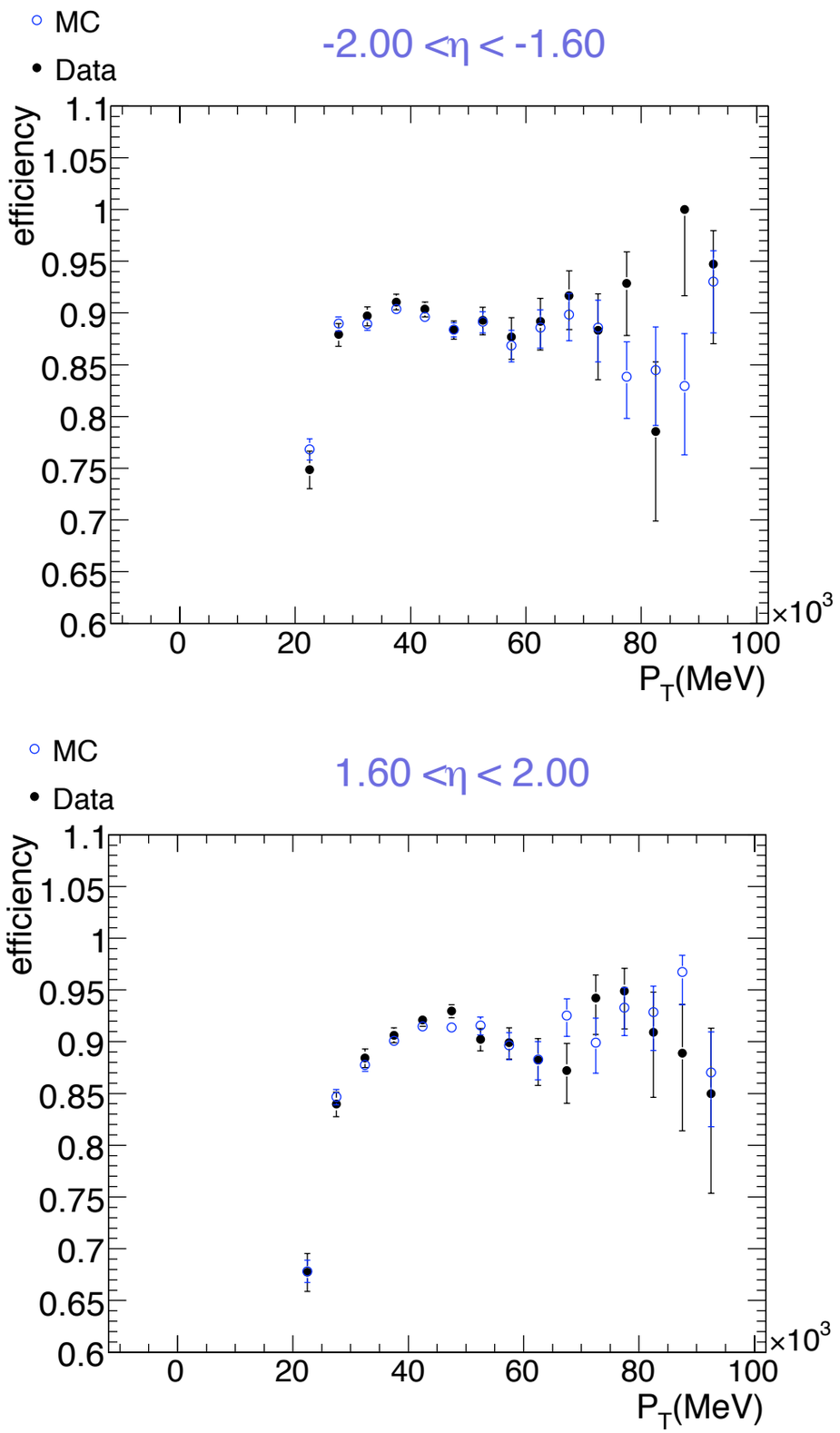
EC forward

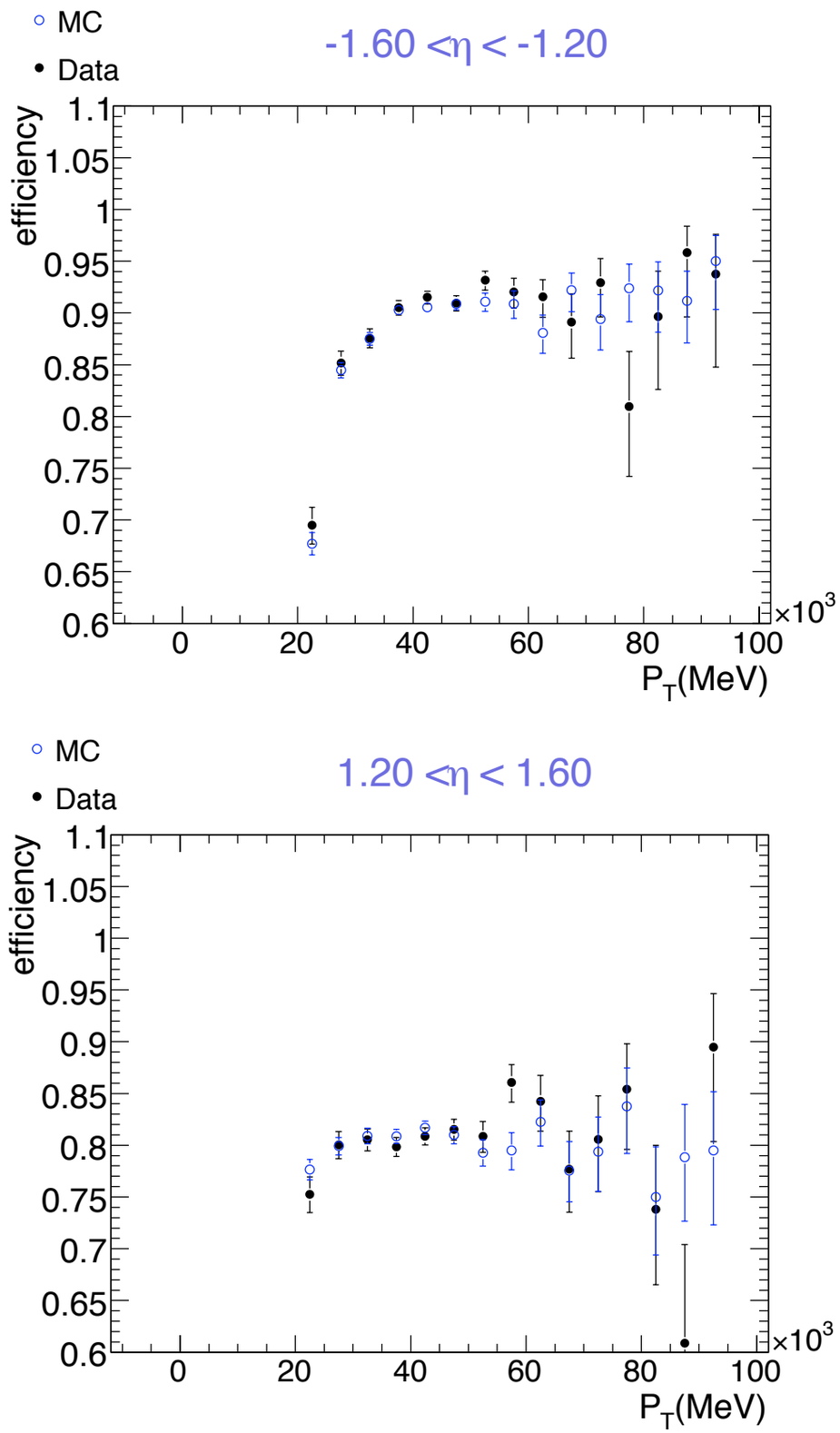




Tag&Probe TRIGCBISO term

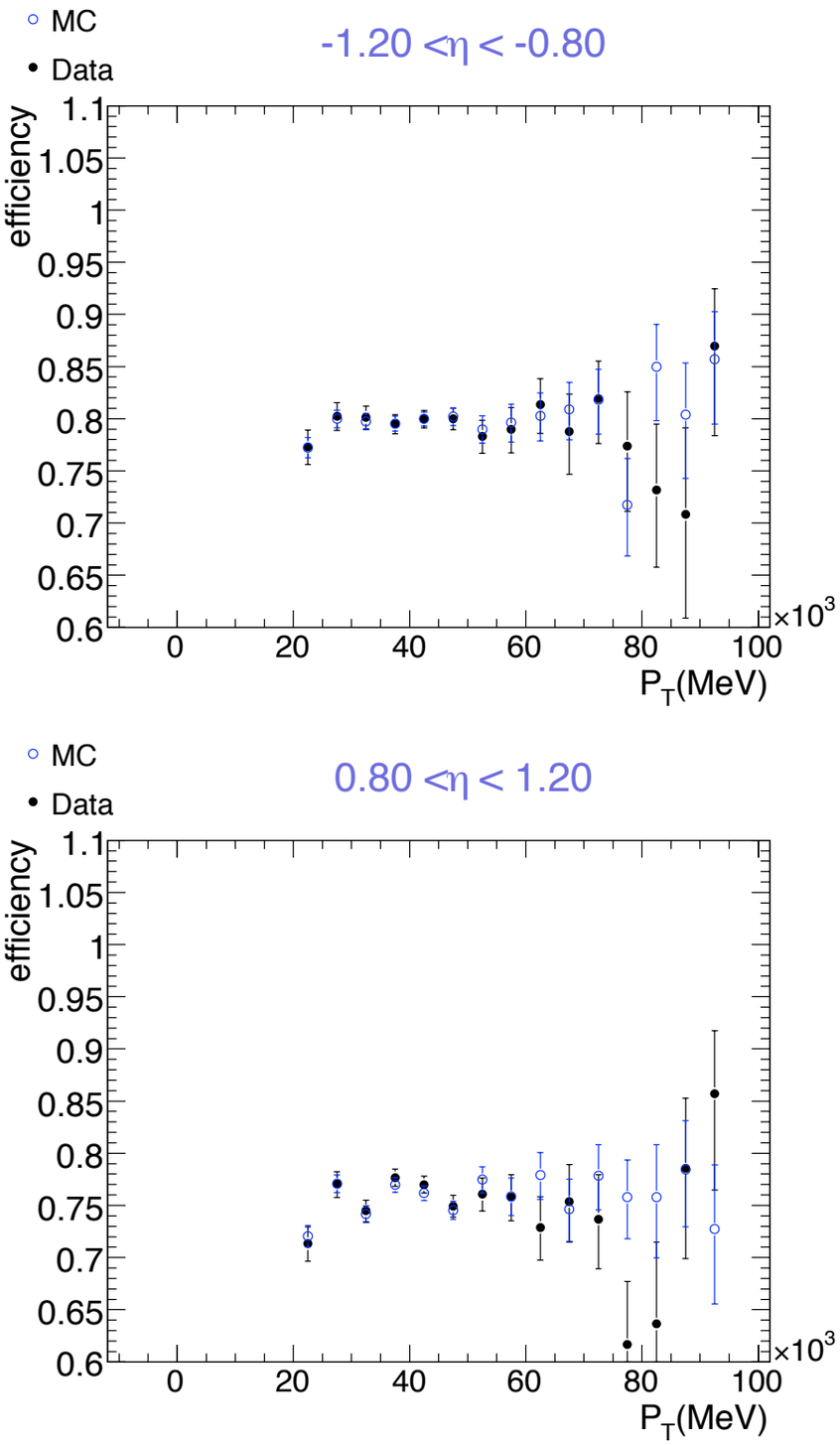
EC

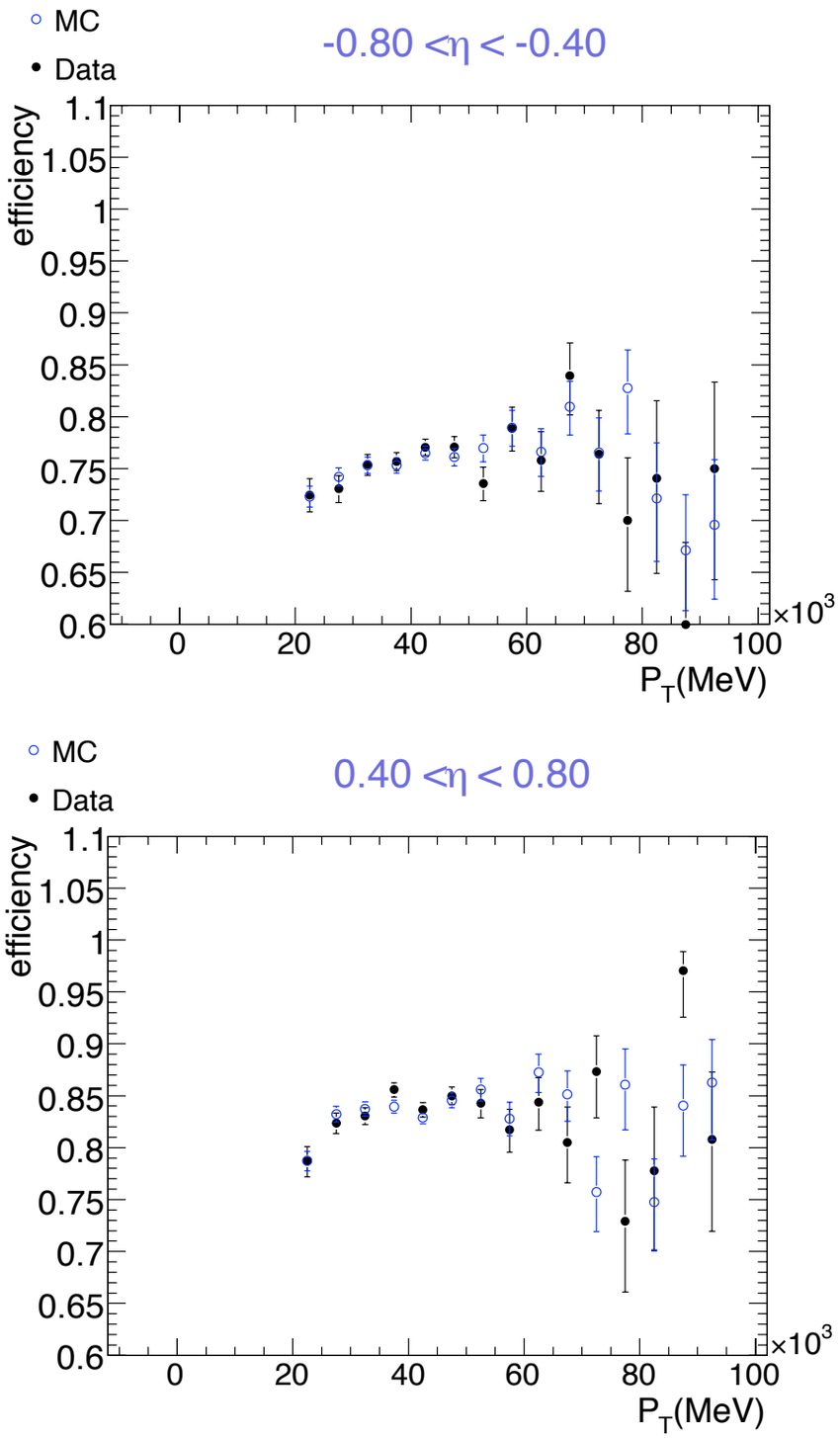


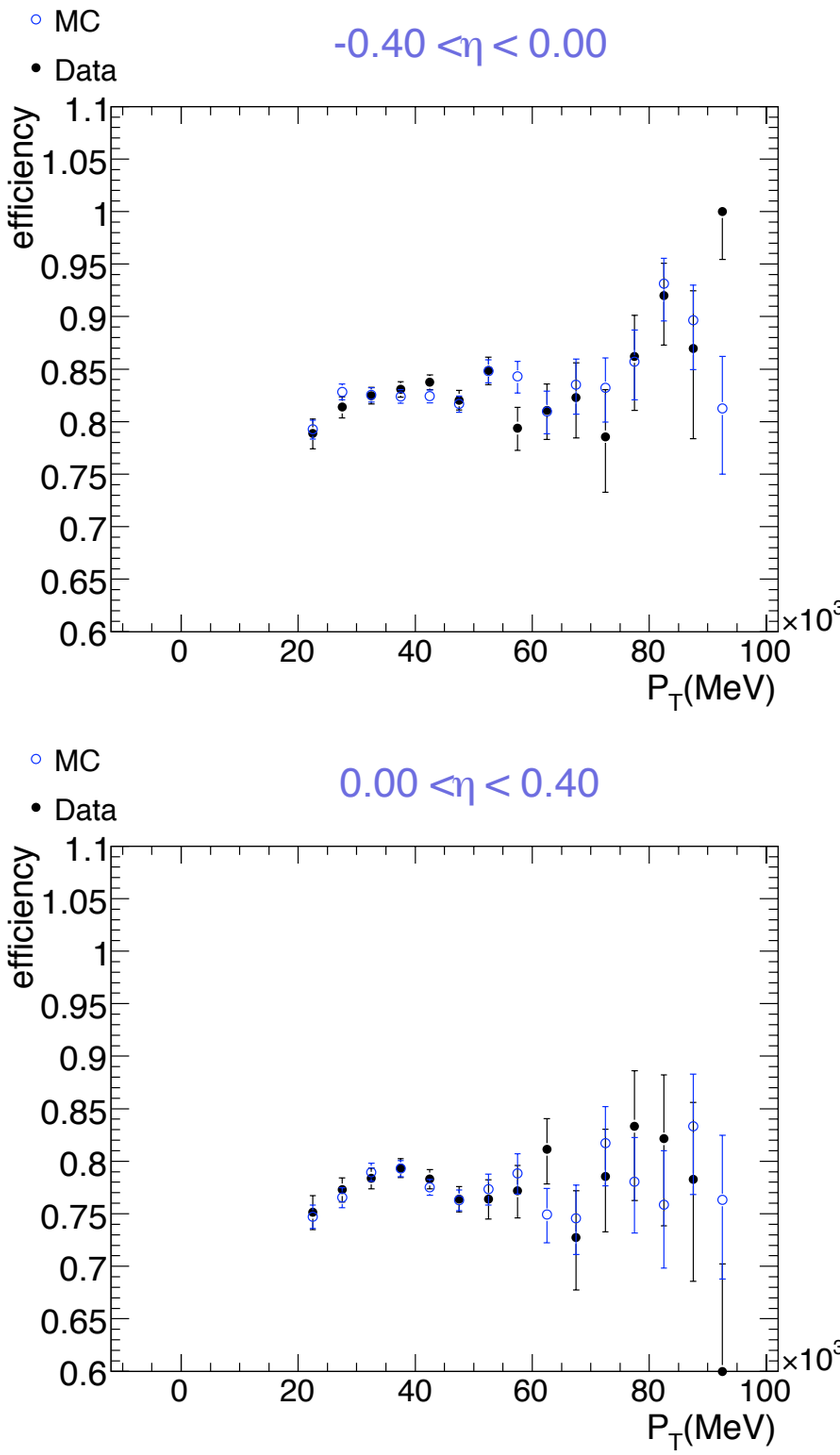


Tag&Probe TRIGCBISO term

Barrel

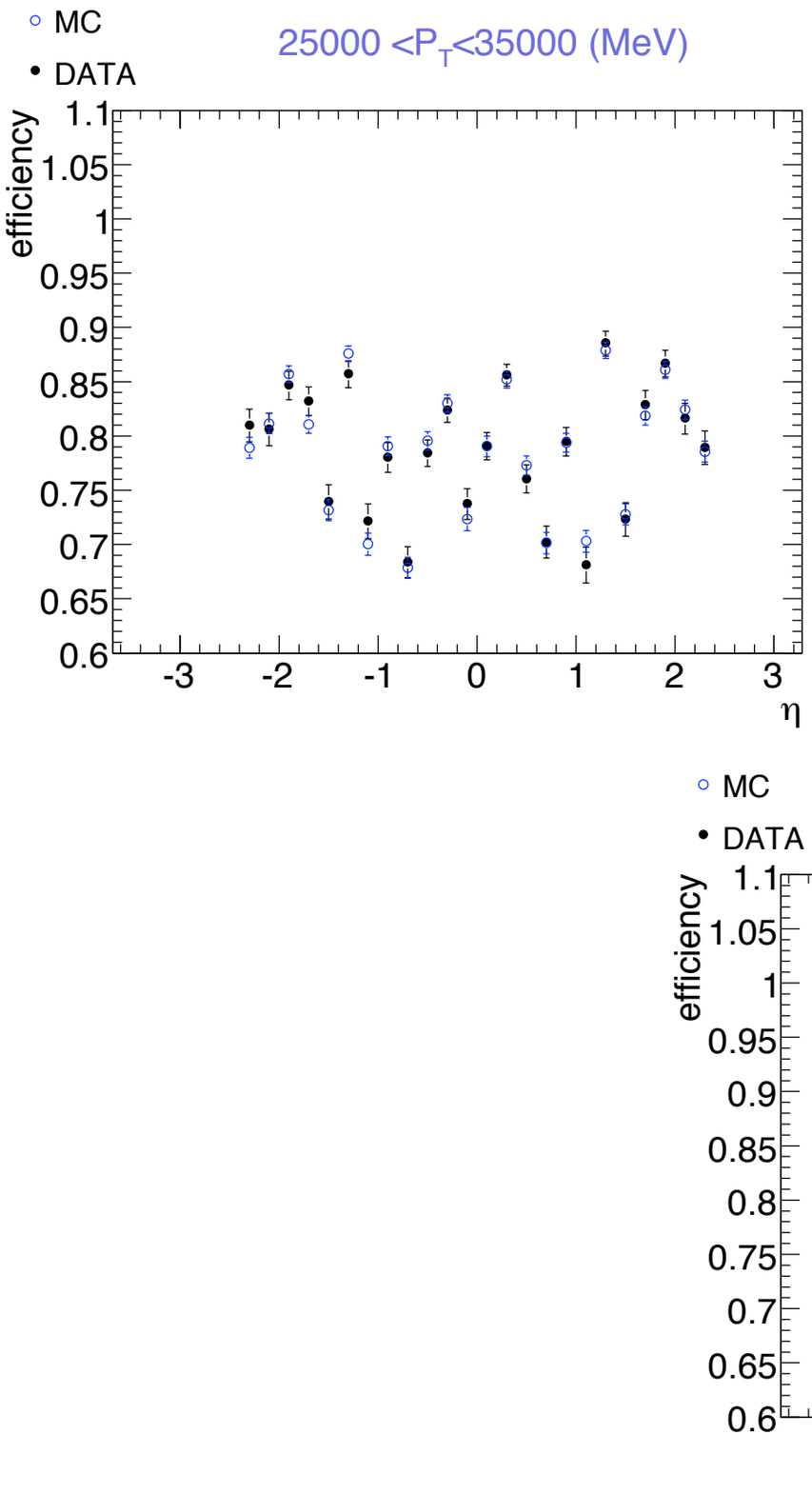


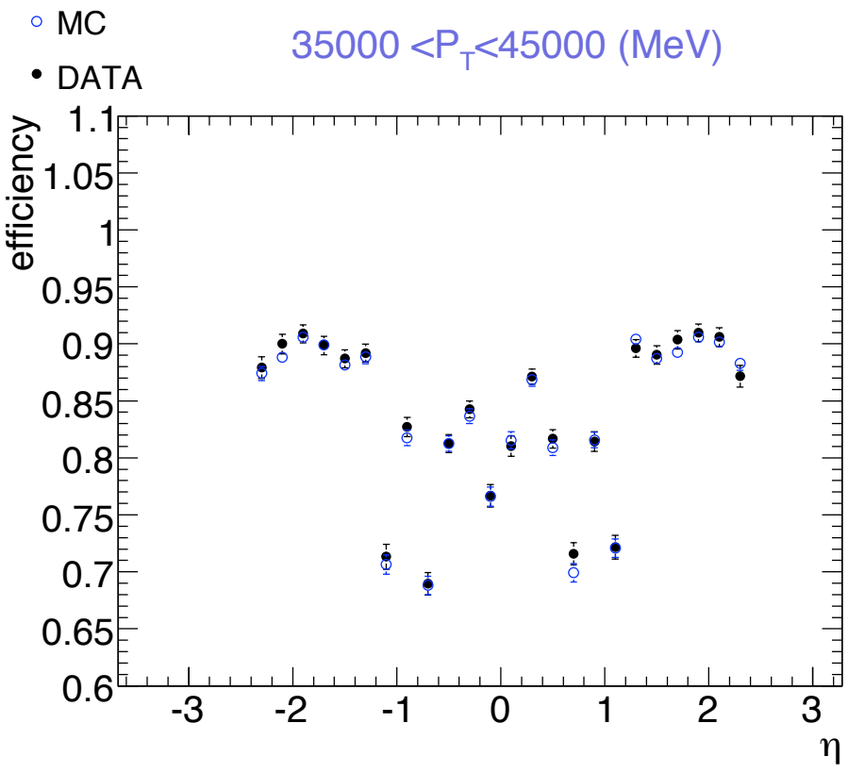


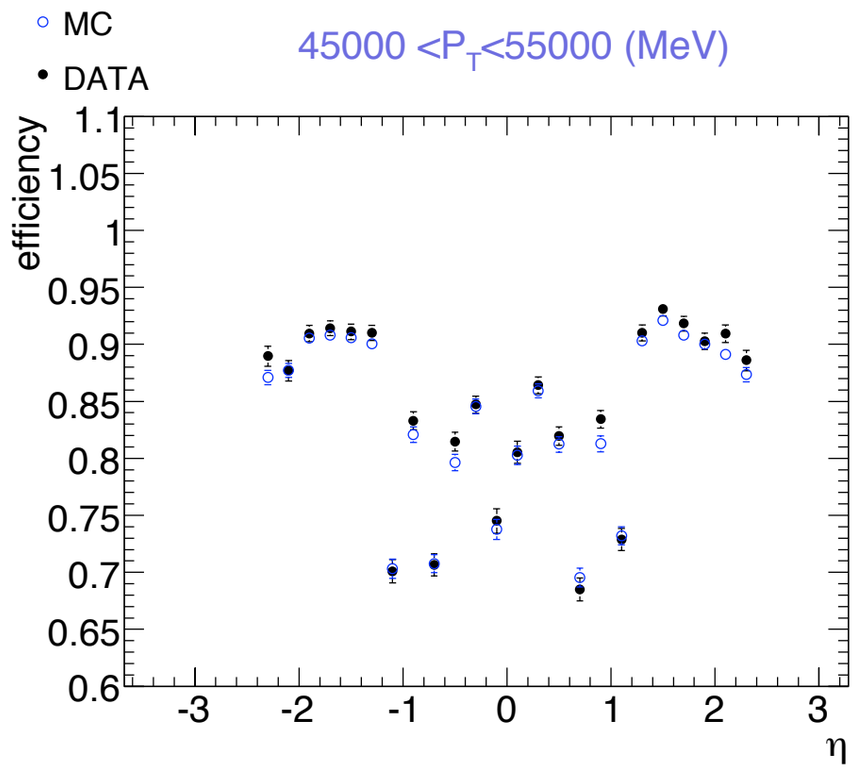


Tag&Probe CBISO term

Jacobian region

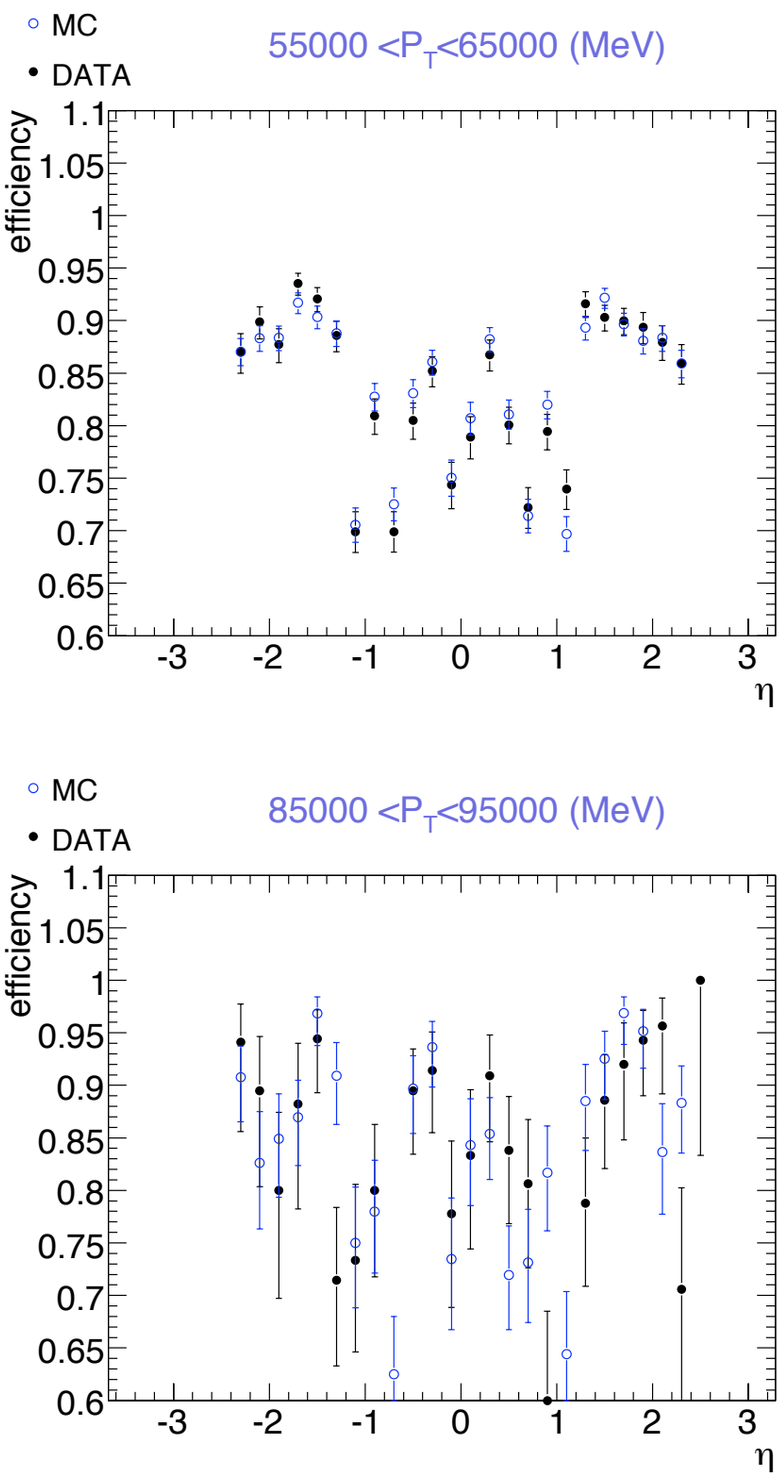


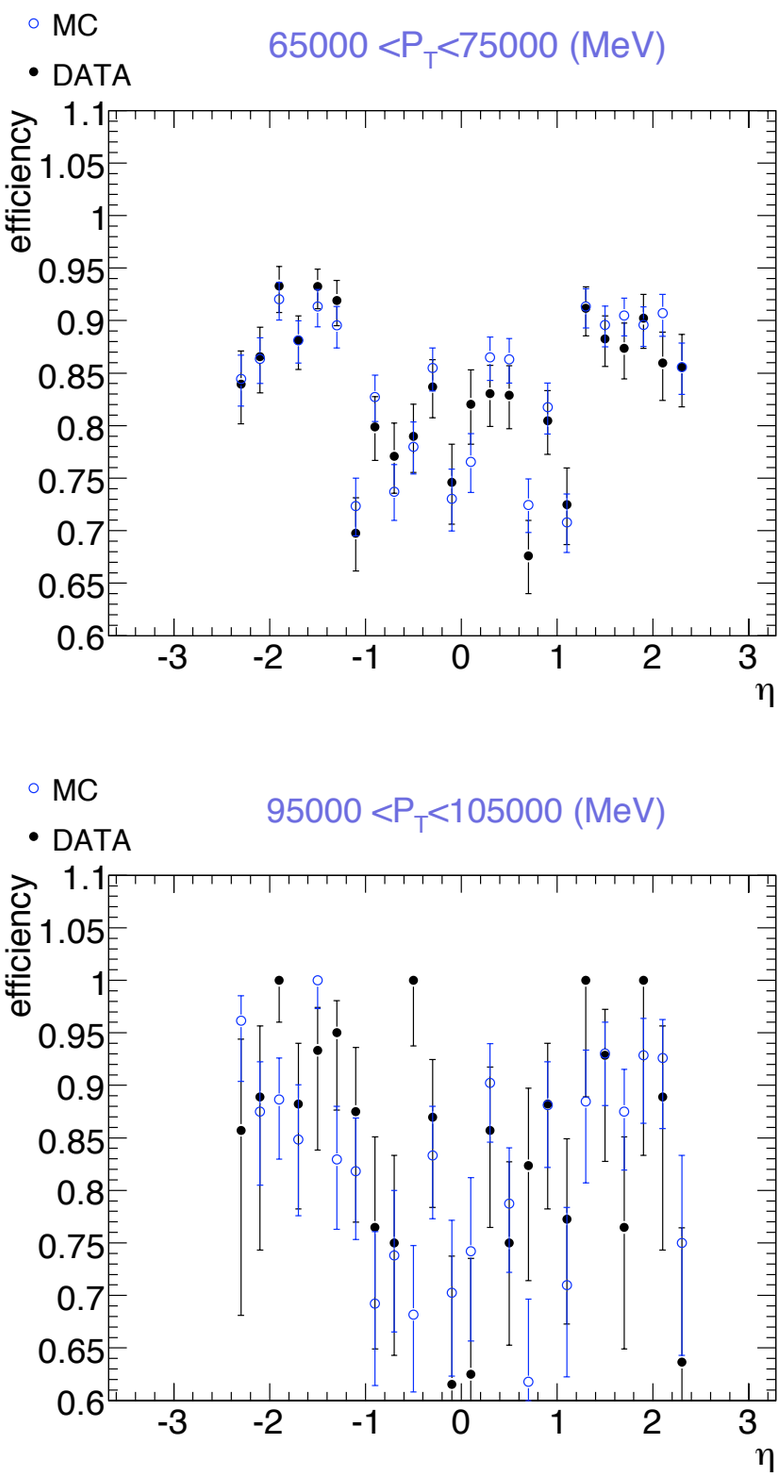


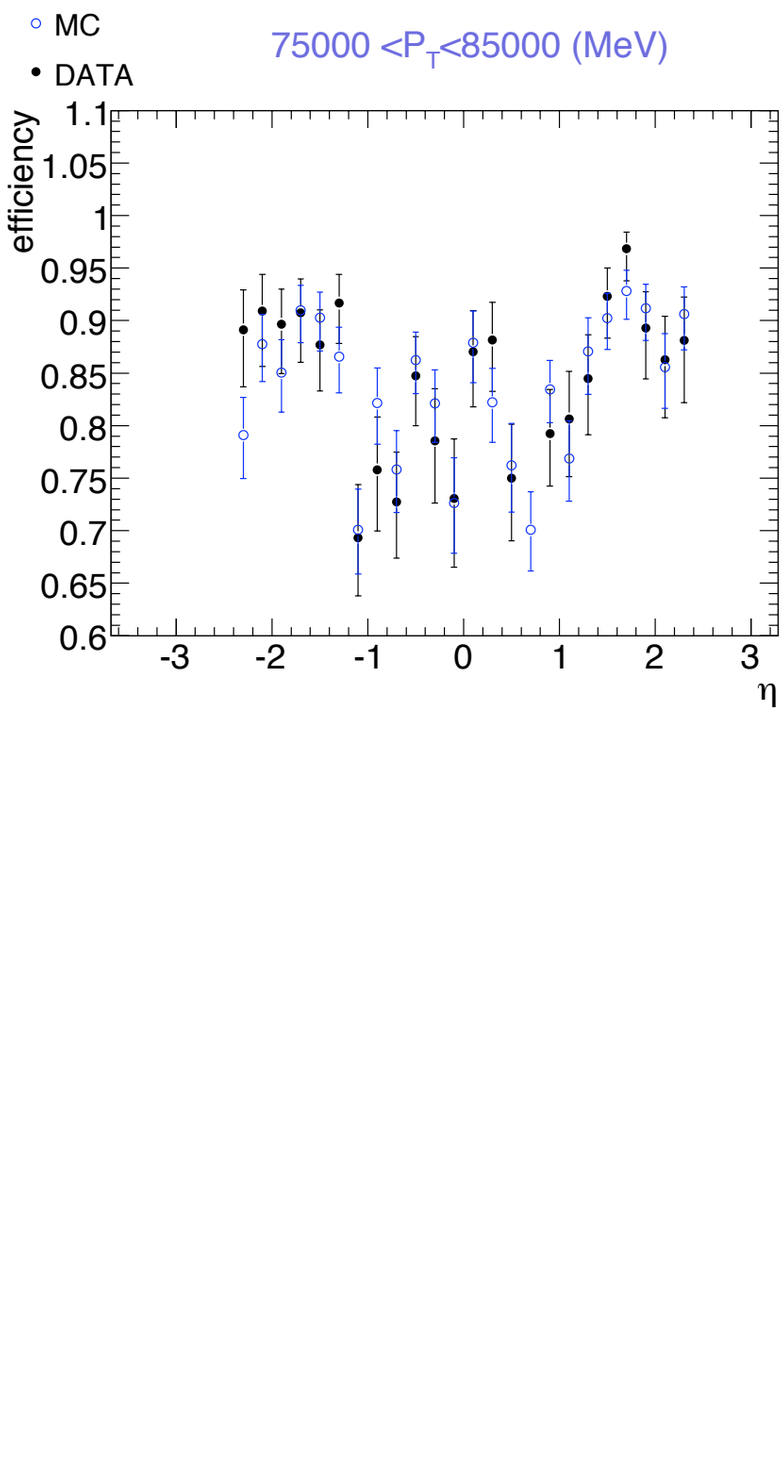


Tag&Probe TRIGCBISO term

High P_T







Benchmarks

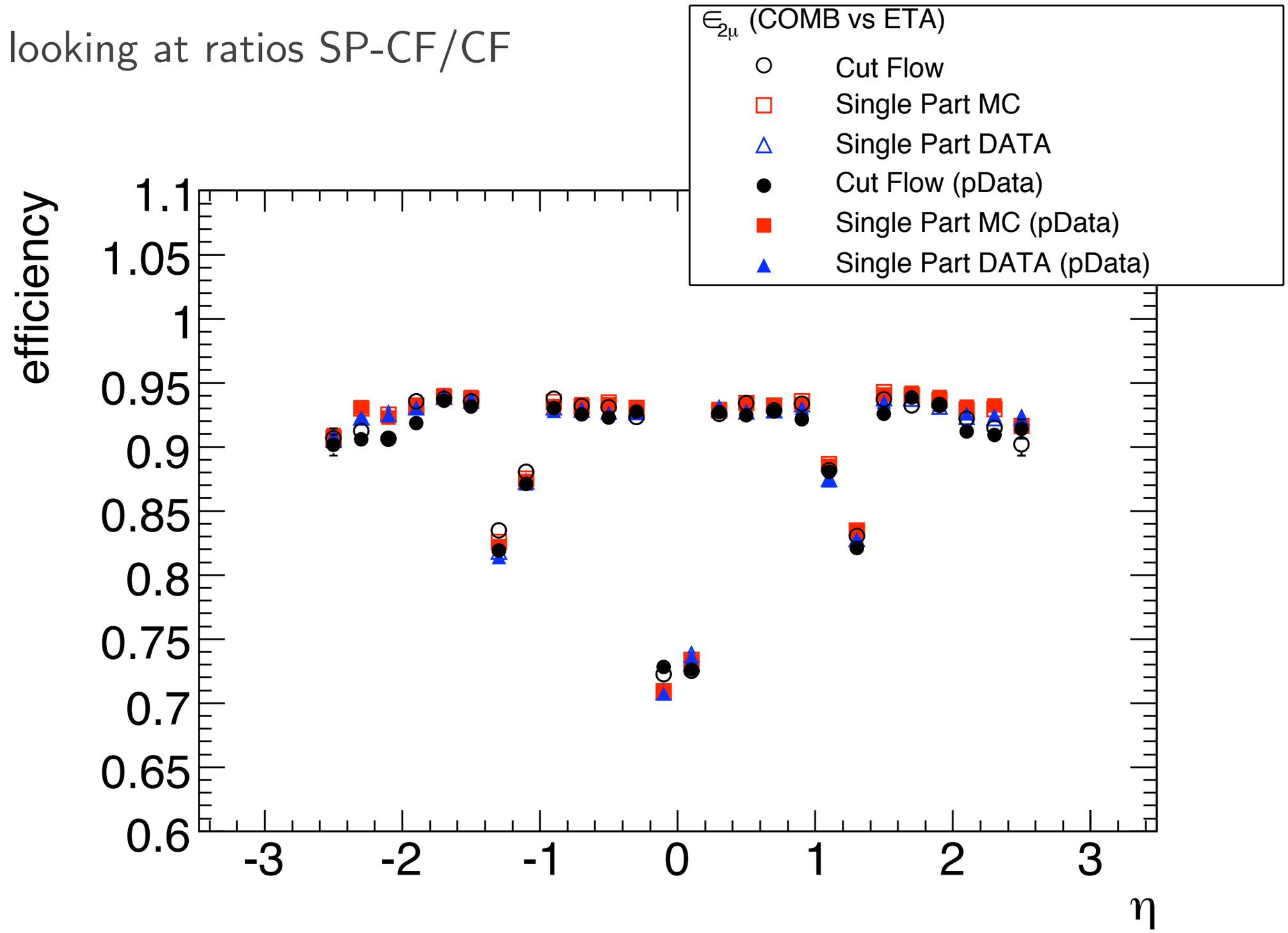
- **TP vs MCT** : how well Tag&Probe reproduces truth efficiencies
  - ★ best expected value = agreement
    >> **Tag&Probe validation**

- **SP-CF/CF** : how well event efficiency built from single particle efficiencies can to reproduce the cut flow
  - ★ Tag&Probe compared to MCT method
  - ★ best expected value = 0 %
    >> **Event efficiency validation**

- **pData-MC/MC** : how different are the cut flow from MC and (pseudo)Data samples
  - ★ event re-weighting (SP) compared to cut flow
  - ★ best expected value = agreement
    >> **Event re-weighting validation**

Event Efficiency validation

now looking at ratios SP-CF/CF



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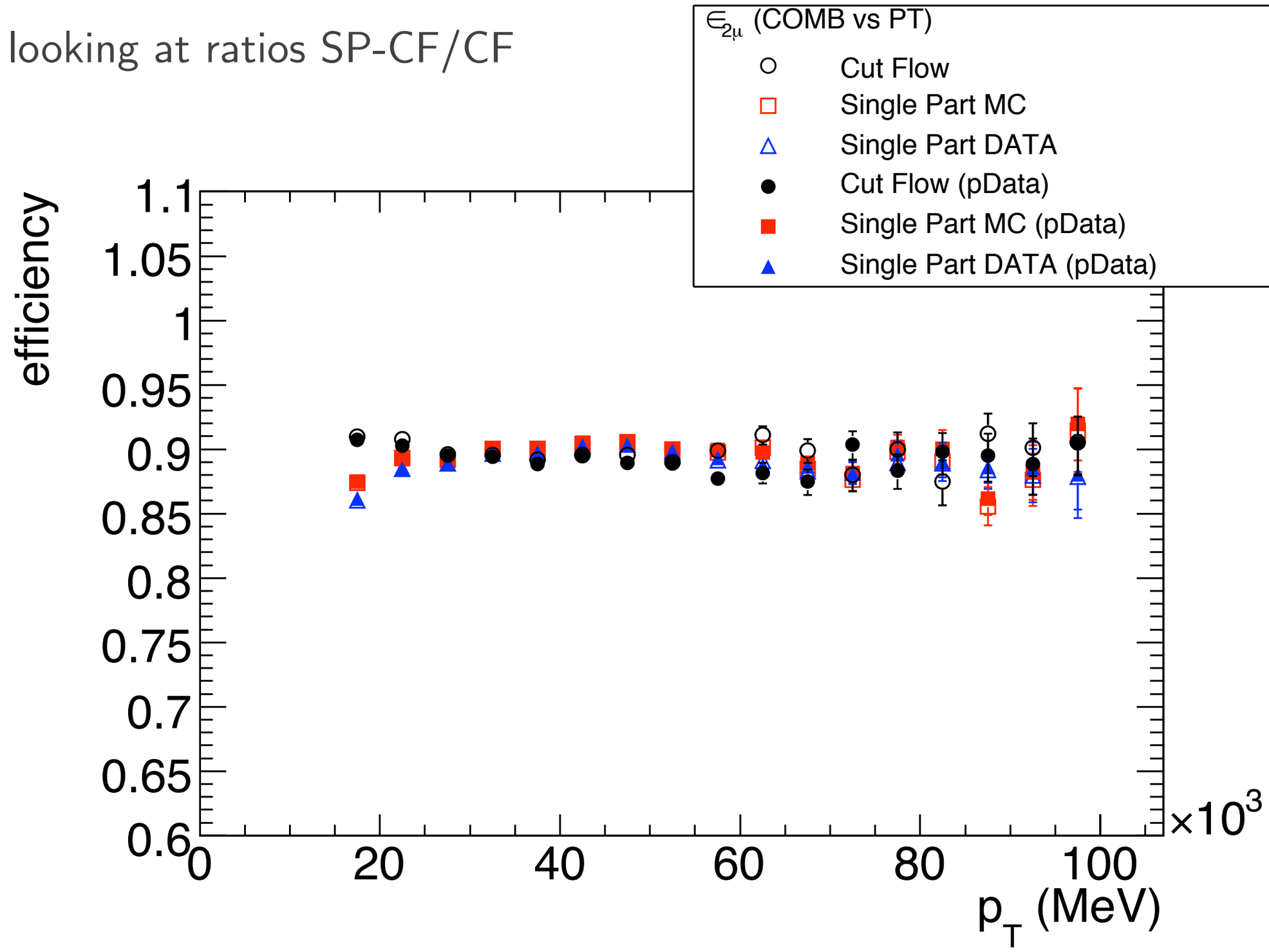
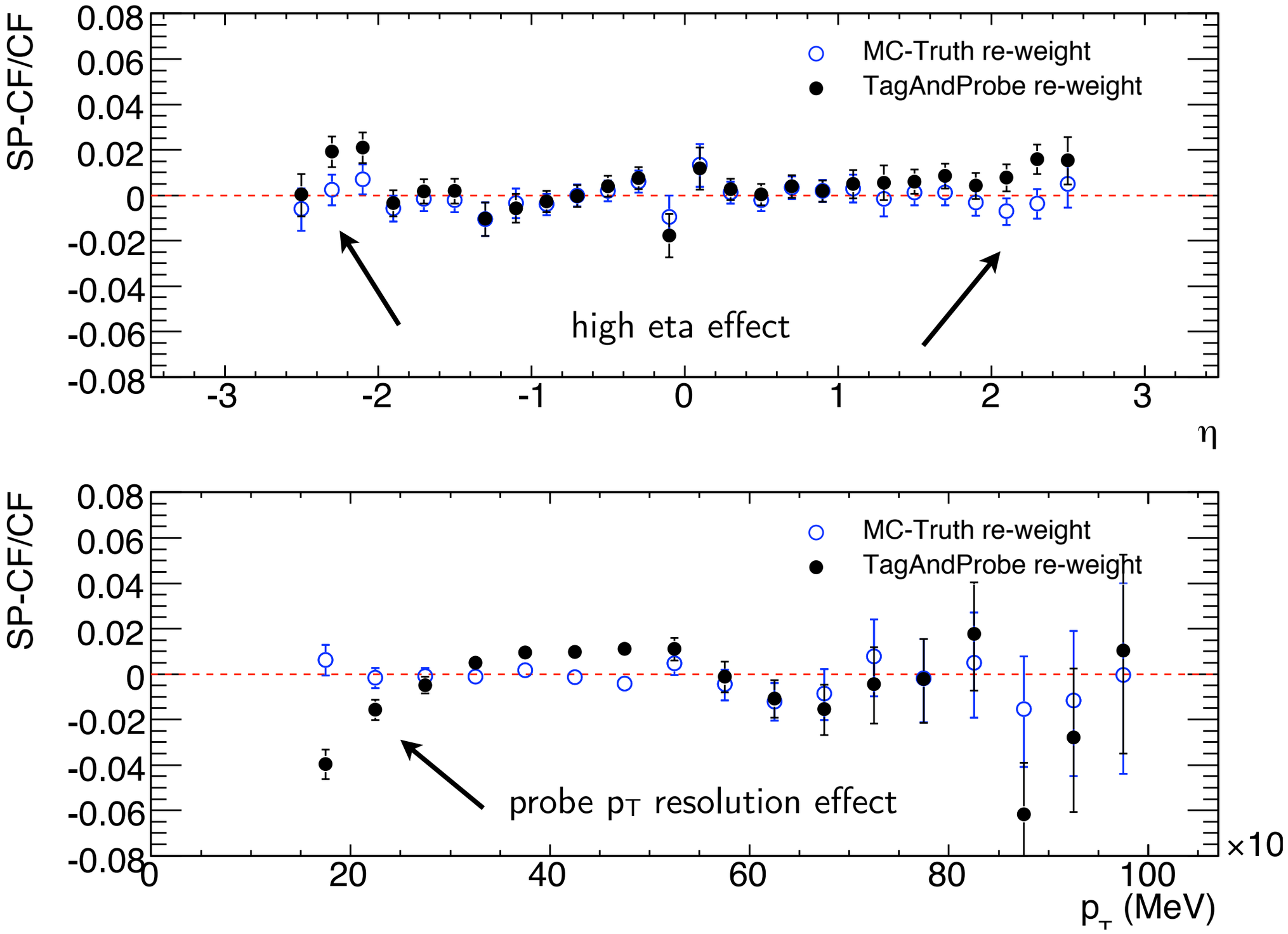


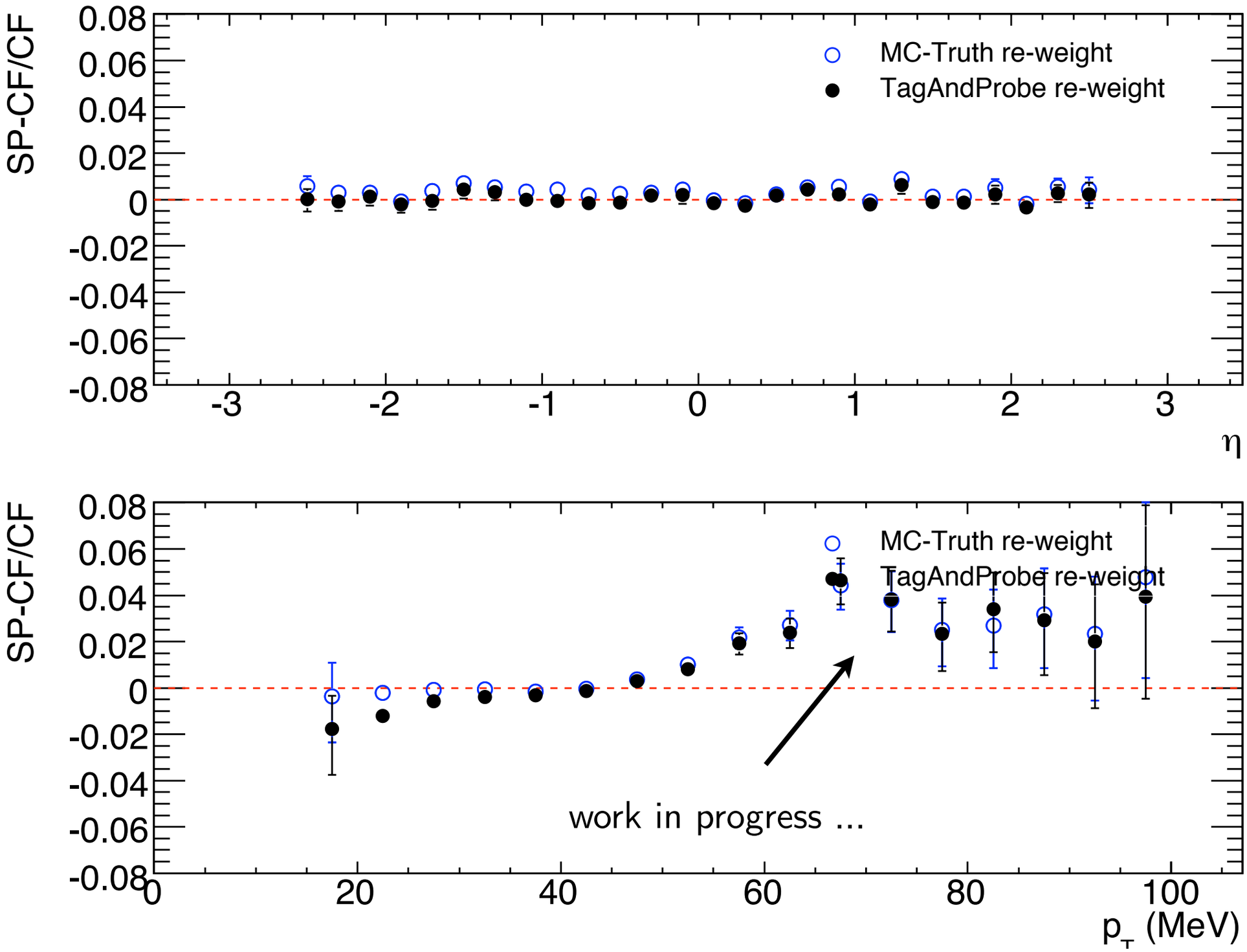
Event Efficiency validation

COMB term



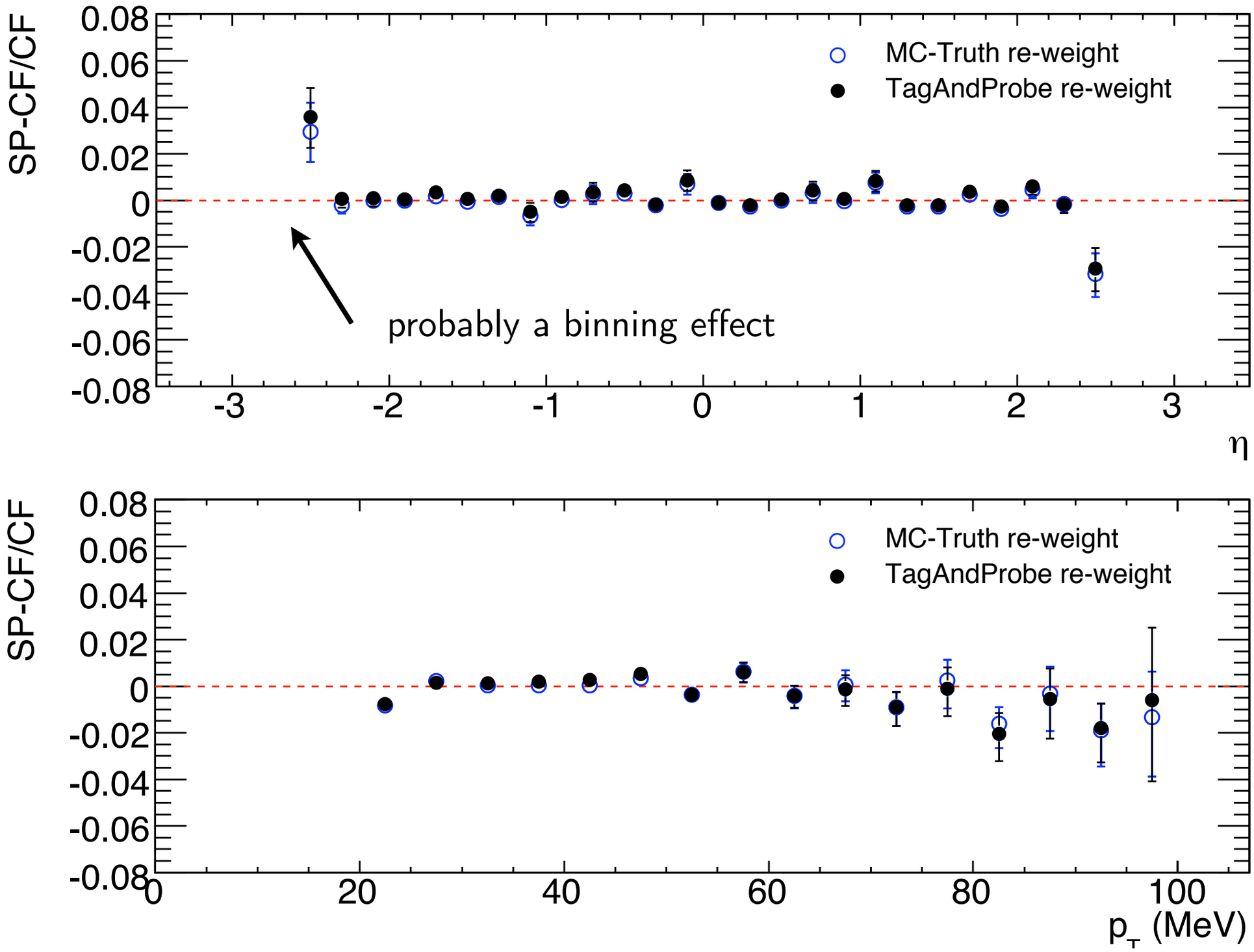
Event Efficiency validation

ISOL term



Event Efficiency validation

TRIG term



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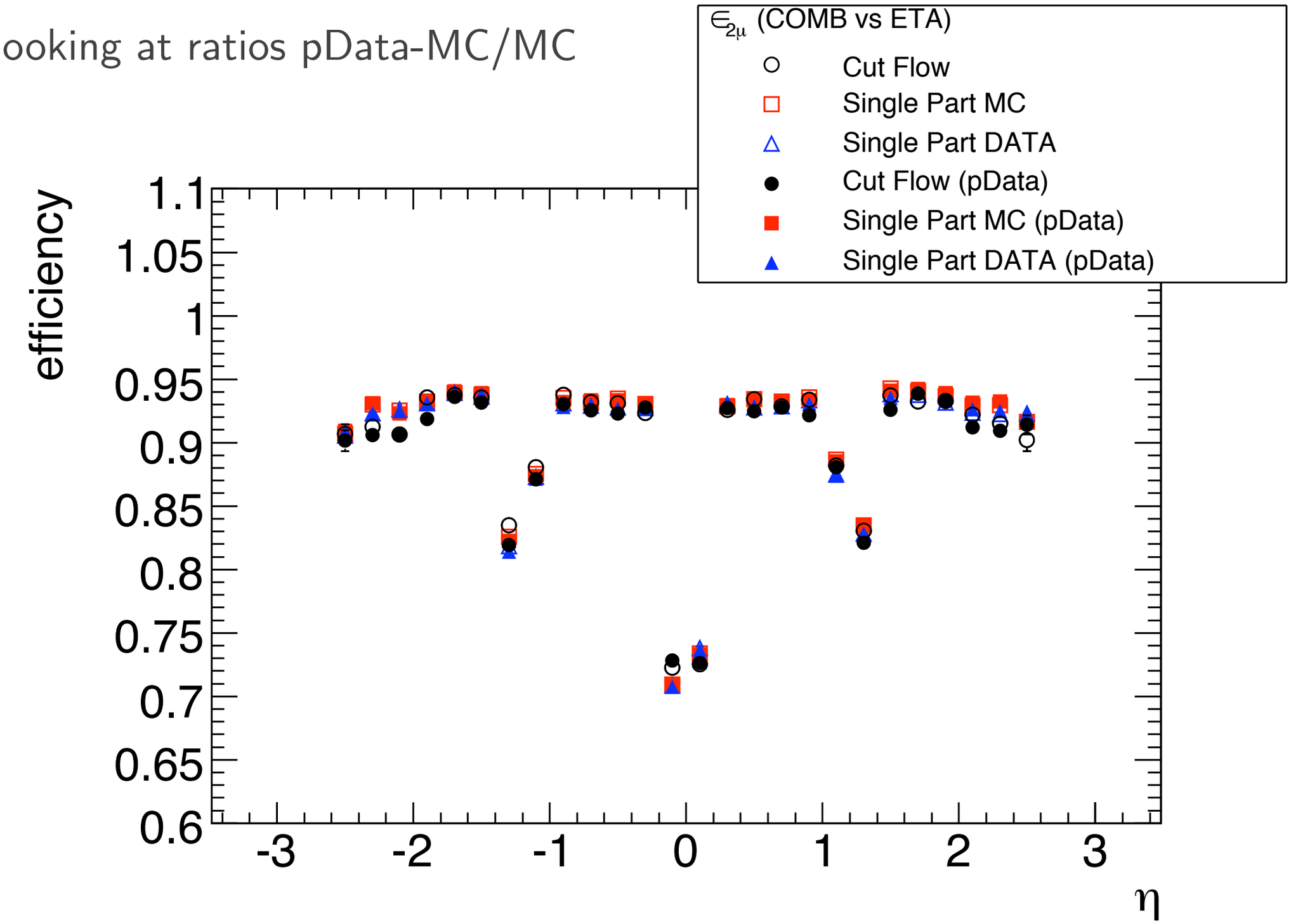
Event re-weighting validation

now looking at ratios pData-MC/MC



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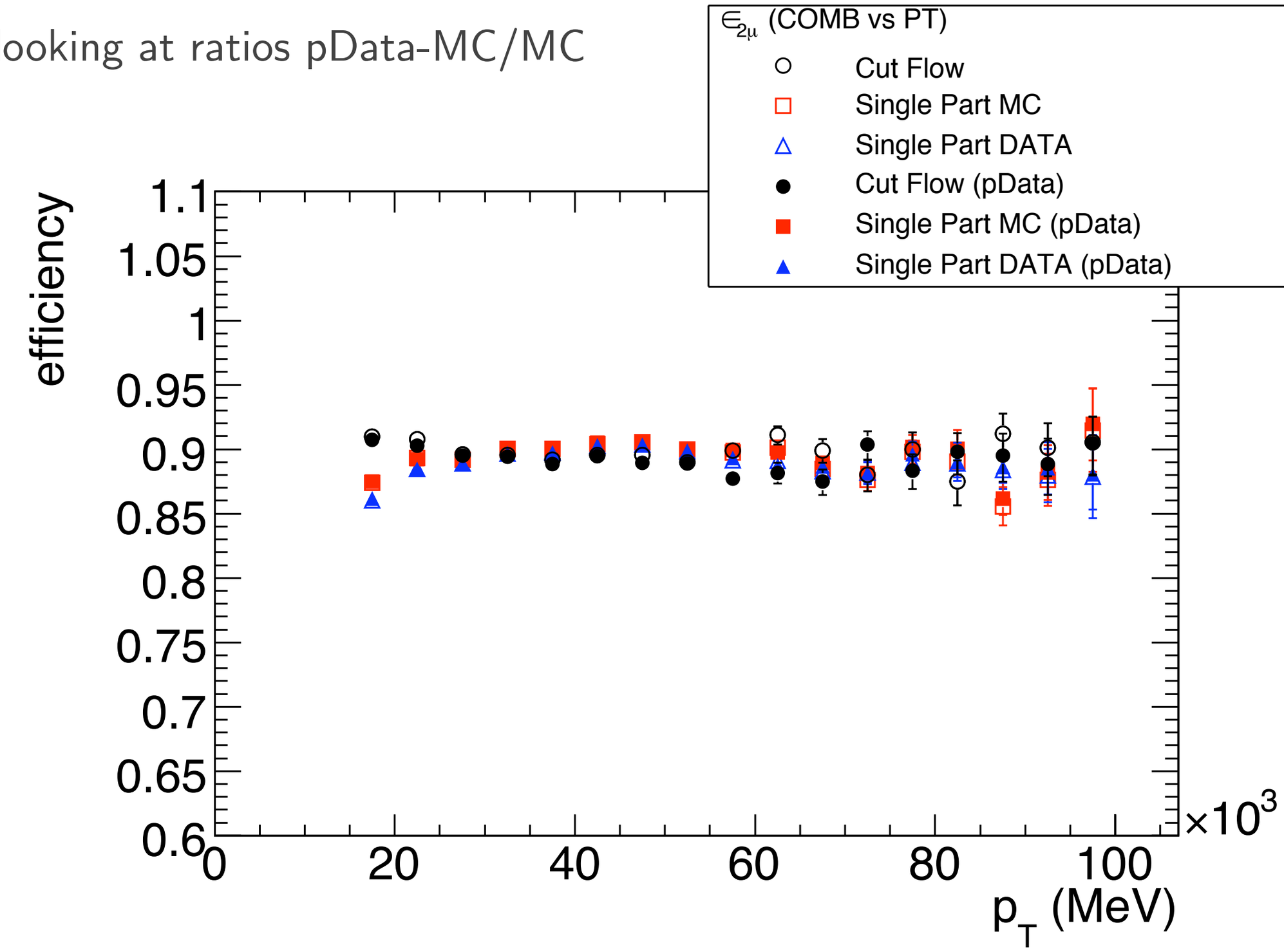
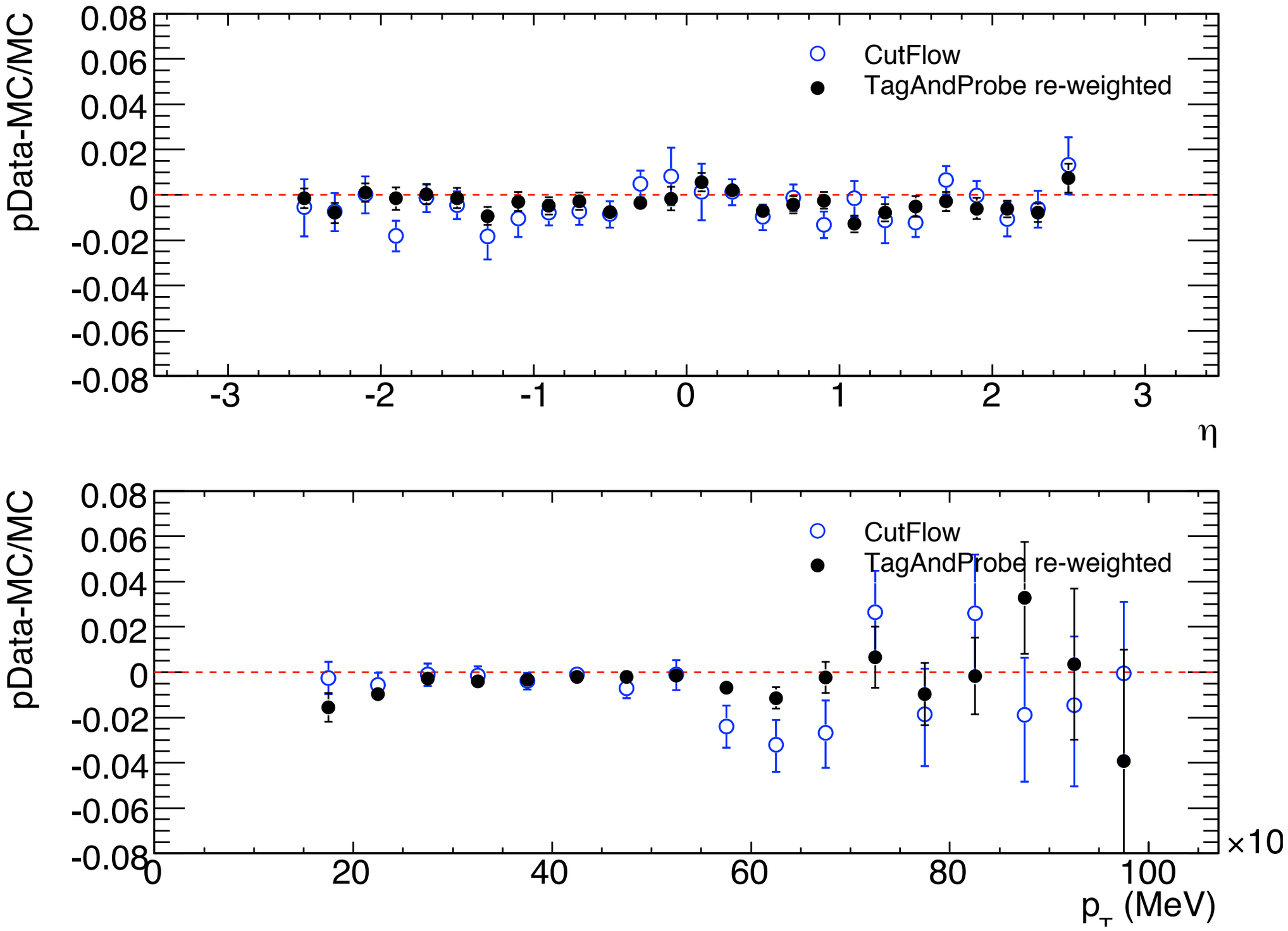


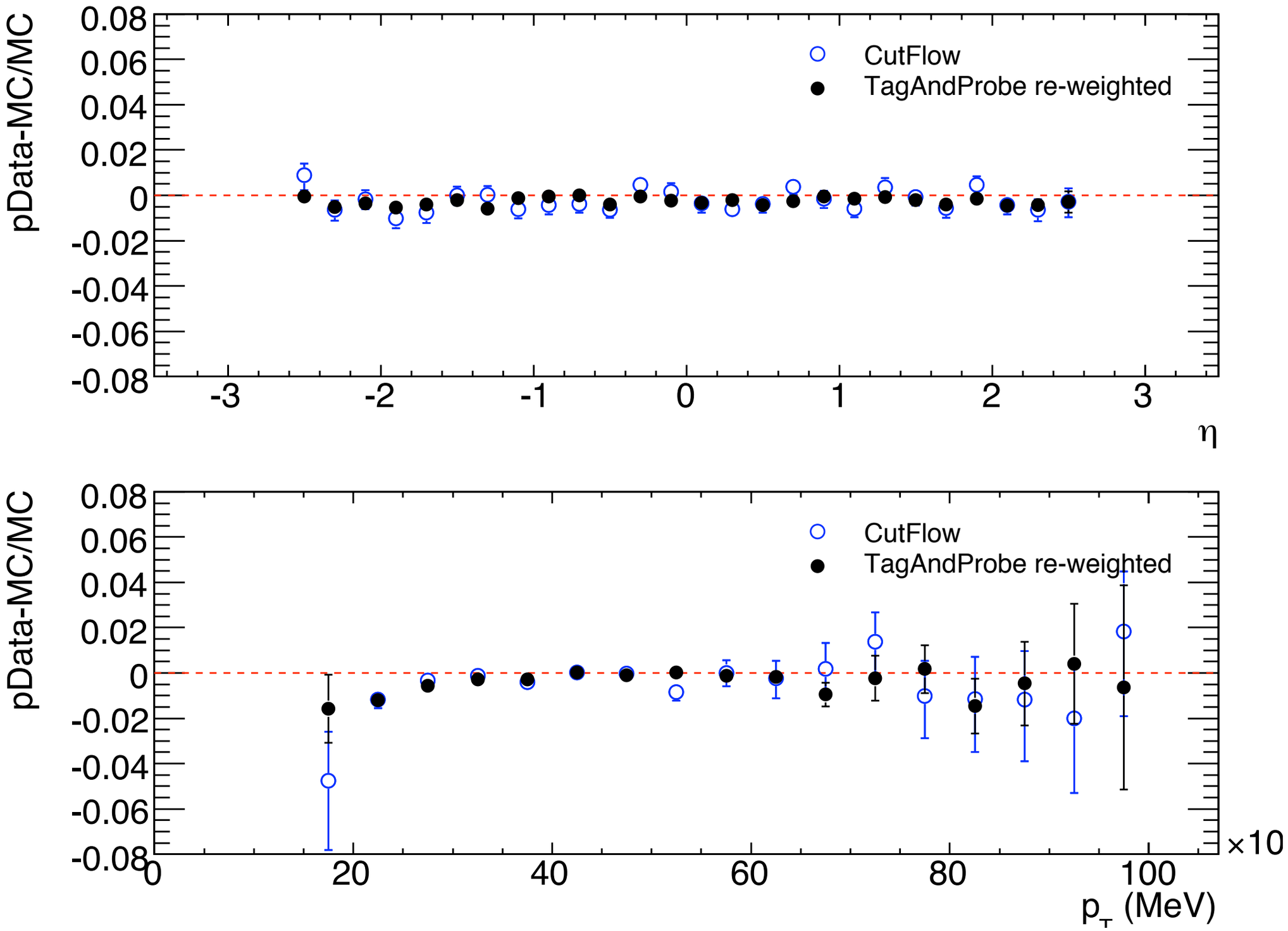
Event re-weighting validation

COMB term



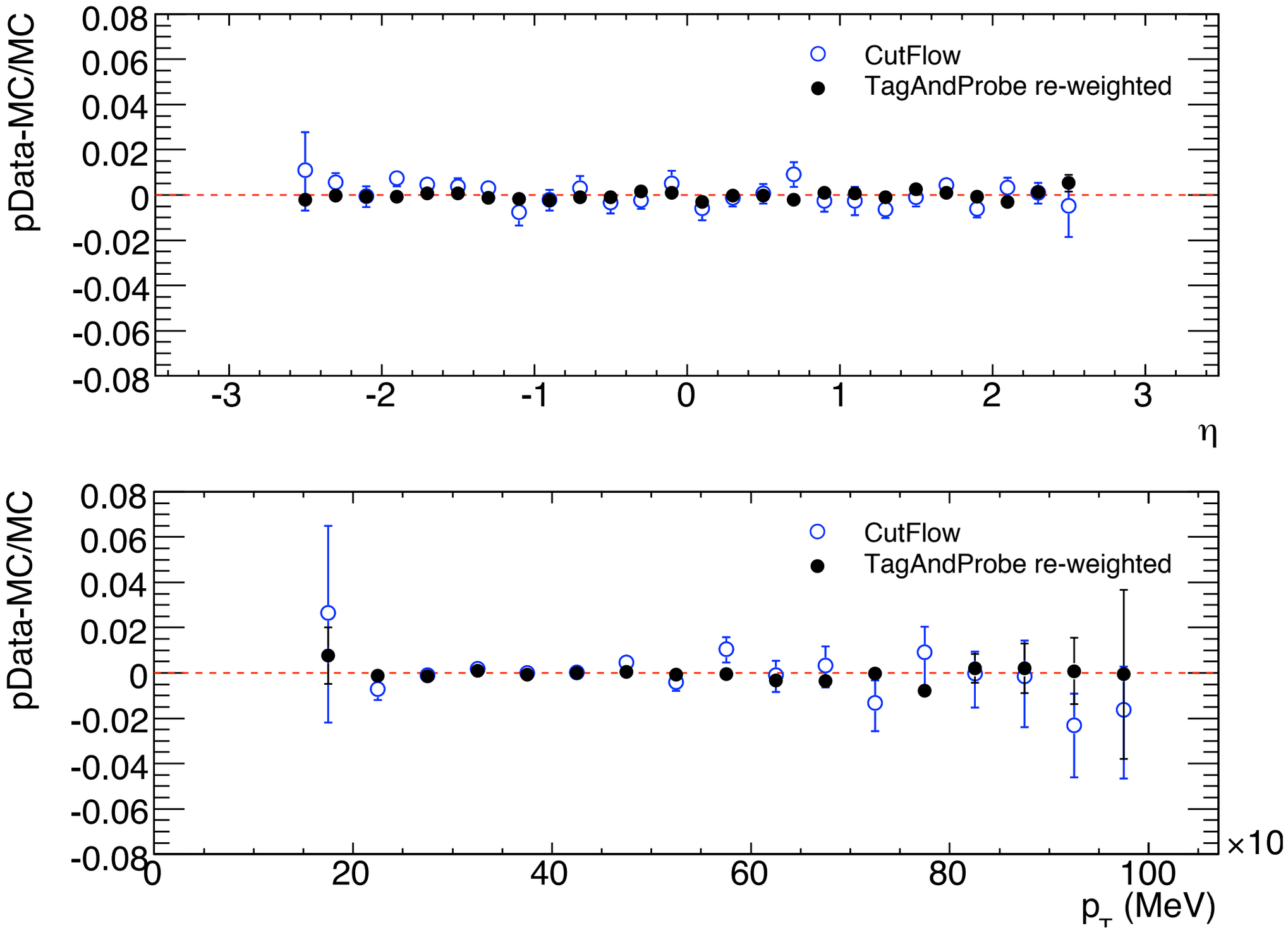
Event re-weighting validation

ISOL term



Event re-weighting validation

TRIG term



Final result

Efficiency on MC	38.595 ± 0.109
Weight	0.995 ± 0.002
Efficiency on MC weighted	$\mathbf{38.384 \pm 0.108\ (stat) \pm 0.089\ (weight)}$
Efficiency on pData	$\mathbf{38.322 \pm 0.109}$
Effi MC-pData w/o weight	0.273 ± 0.154
Effi MC-pData w/ weight	0.062 ± 0.177

Note skeleton

ATLAS NOTE

ATL-PHYS-PUB-2009-000

June 8, 2009

$Z \to \mu^+\mu^-$ and $W \to \mu\nu$ inclusive cross sections measurement in early data

The ATLAS Collaboration

Abstract

The upcoming start of the LHC will provide the unprecedented possibility to explore TeV scale physics. A good understanding and calibration of the detector will be mandatory for any physics measurement. In the analysis of first data, the so-called "standard candles" processes will therefore provide a fundamental tool to verify the detector response and perform first inclusive cross section measurements. In this note the measurements of $Z \to \mu^+\mu^-$ and $W \to \mu\nu$ inclusive cross sections in early data is presented, emphasizing the usage of data-driven techniques to estimate efficiencies and resolutions from data.