ETA/CHARGE EFFECT ON MUON TRIGGER EFFICIENCY

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Trigger efficiency and cross sections

$$\ln \mathcal{L} = \sum_{i=1}^{N} w_i \cdot \ln\left[f_{signal}(m^i_{\mu\mu}) + f_{bkg}(m^i_{\mu\mu})\right]$$

Example from Jpsi note

$$w^{-1} = \mathcal{A}(p_T, y, \lambda_i) \times \epsilon_\mu(\vec{p}_1) \times \epsilon_\mu(\vec{p}_2) \times \epsilon_{trig}(\vec{p}_1, \vec{p}_2)$$

detector acceptance

spin-alignment scenario

reconstruction efficiency

trigger efficiency

But usually trigger efficiency is computed as: $\varepsilon_{trig} = \varepsilon_{trig}\left(\vec{p}_{T1}, \vec{p}_{T2}, \eta_1, \eta_2\right)$

Any charge-eta effect on trigger effciency?

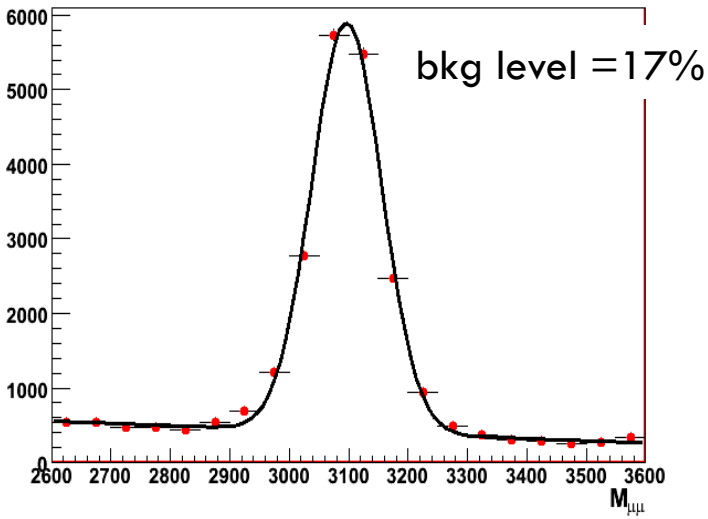
Is the q* η dependence good enough?

$$\varepsilon_{trig} = \varepsilon_{trig}\left(\vec{p}_{T1}, \vec{p}_{T2}, \eta_1, \eta_2, q_1, q_2\right)$$

Low-p_T selection: $J/\psi \rightarrow \mu\mu$

Selection:

- 2 OS muons in the [2-4] GeV mass range
  - at least 1 combined muon
  - the other one can be a combined or segment-tagged (low pt)
- nPixels>0, nSCT>5, nTRT>10 (if $|\eta|<2$)
- $0.3 < \Delta R(\mu 1, \mu 2) < 2.5$



Tag & Probe Method

"Tag" muon matched with the trigger object:

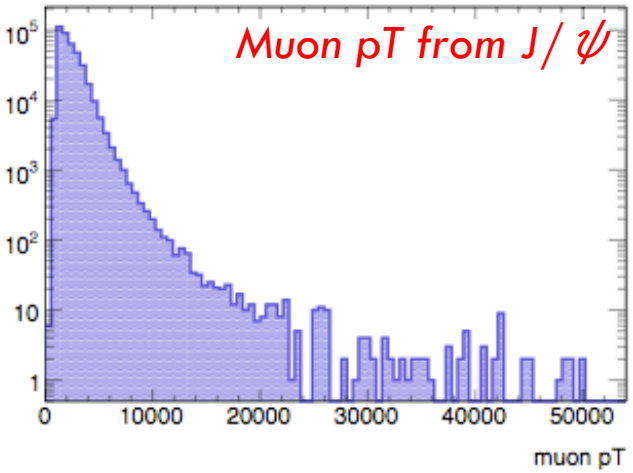
- period B+C+D1: L1_MU0
- period E : EF_mu4
- period F: EF_mu4

"Probe" muon used to test both L1 and HLT

trigger match:

DR(L1)<0.4, accepted RoIs in -2, -1, 0 BCs

DR(EF)<0.05

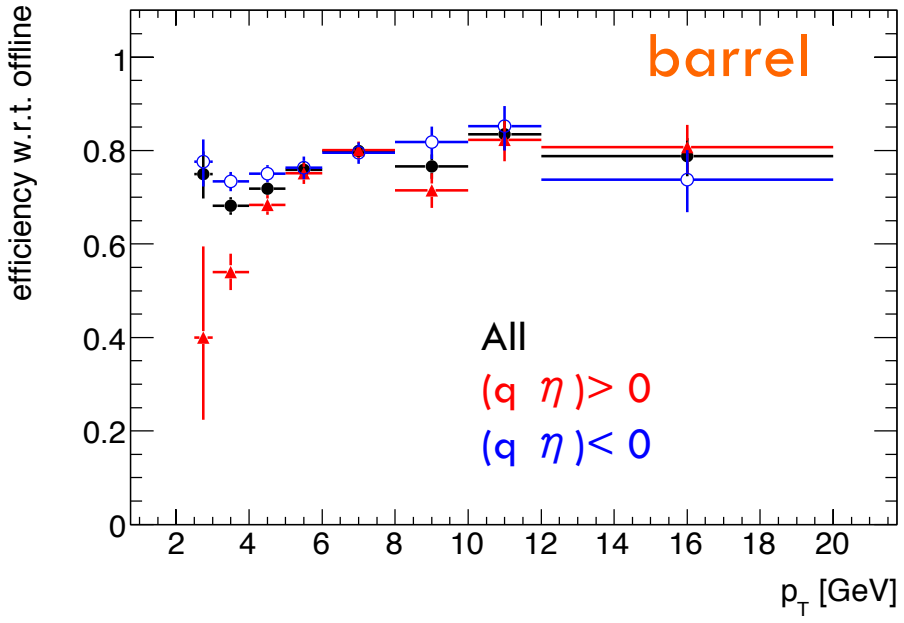


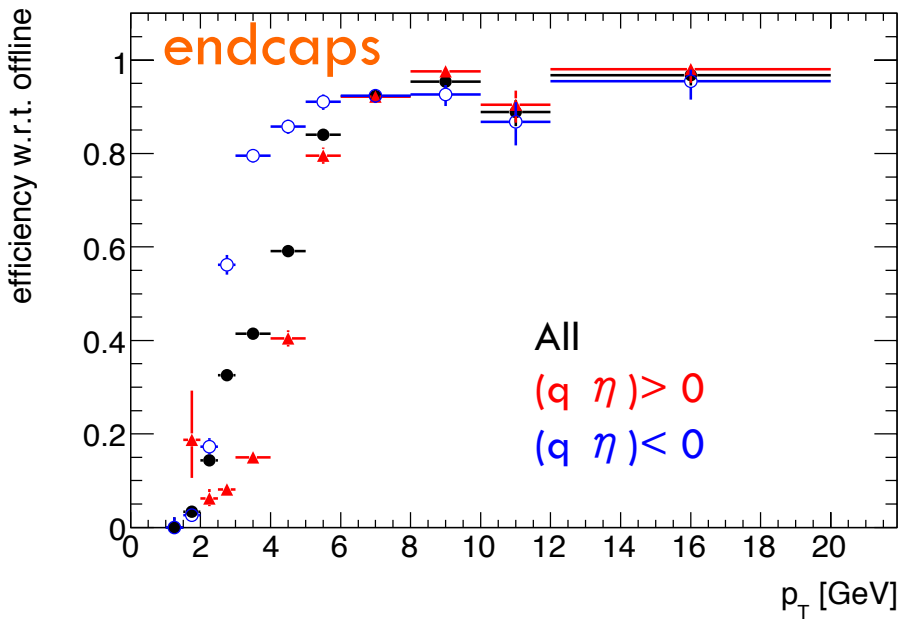
TurnOn curves: L1_MU0

period B+C+D1
period E
period F

STACO

Two combined Muons





All

(q η)> 0

(q η)< 0

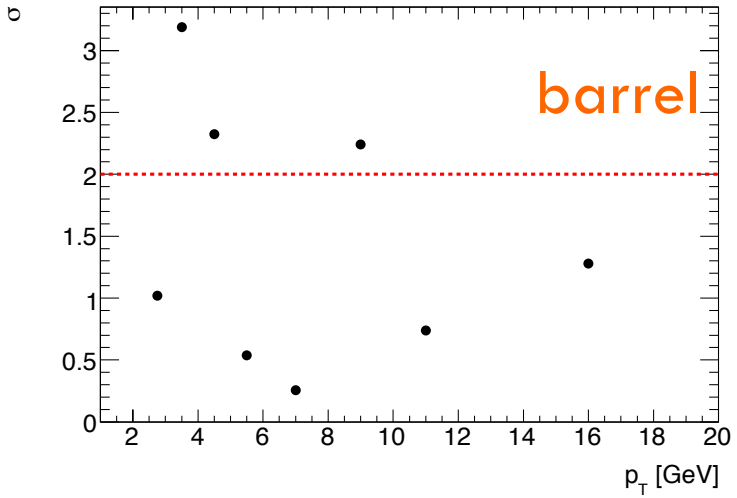
Simple statistical test on paired data

$$\sigma = \frac{|\varepsilon_1 - \varepsilon_2|}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

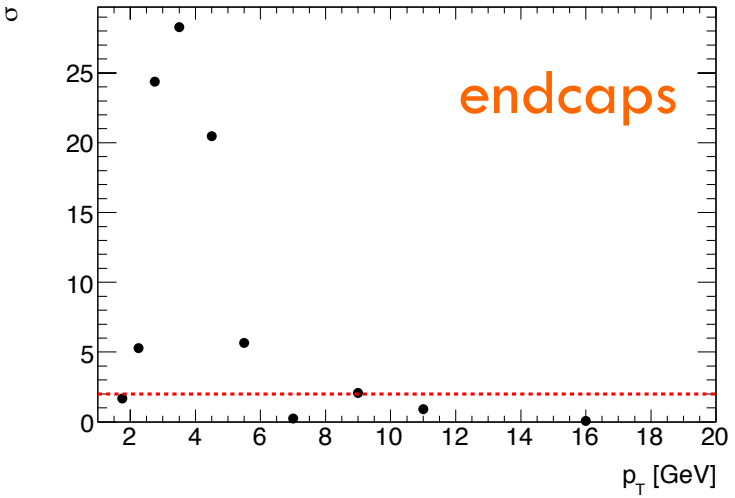
ε_1 is the efficiency selecting muons with $(q\ \eta) > 0$ and σ_1 is its error

ε_2 is the efficiency selecting muons with $(q\ \eta) < 0$ and σ_2 is its error

2 curves are compatible if we choose 2 sigma as CL



L1MU0



The two efficiency curve selecting muons with $(q\ \eta) > 0$ and $(q\ \eta) < 0$ are compatible for a $p_T > 5$GeV.

The two efficiency curve selecting muons with $(q\ \eta) > 0$ and $(q\ \eta) < 0$ are compatible for a $p_T > 6$GeV.

STACO

TurnOn curves: L1_MU0

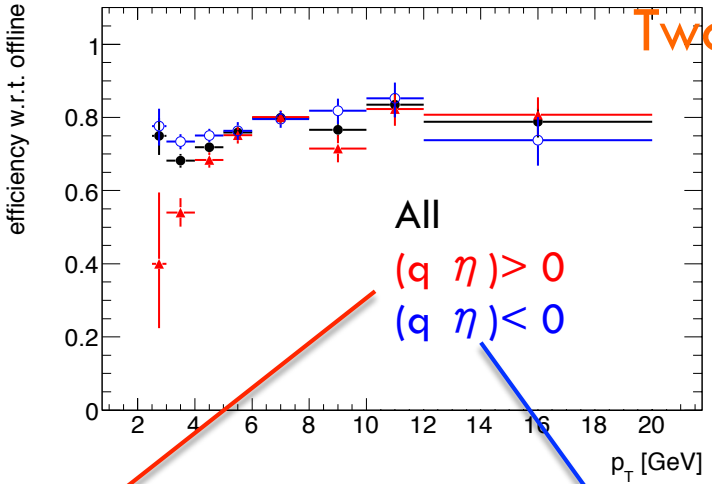
period B+C+D1
period E
period F

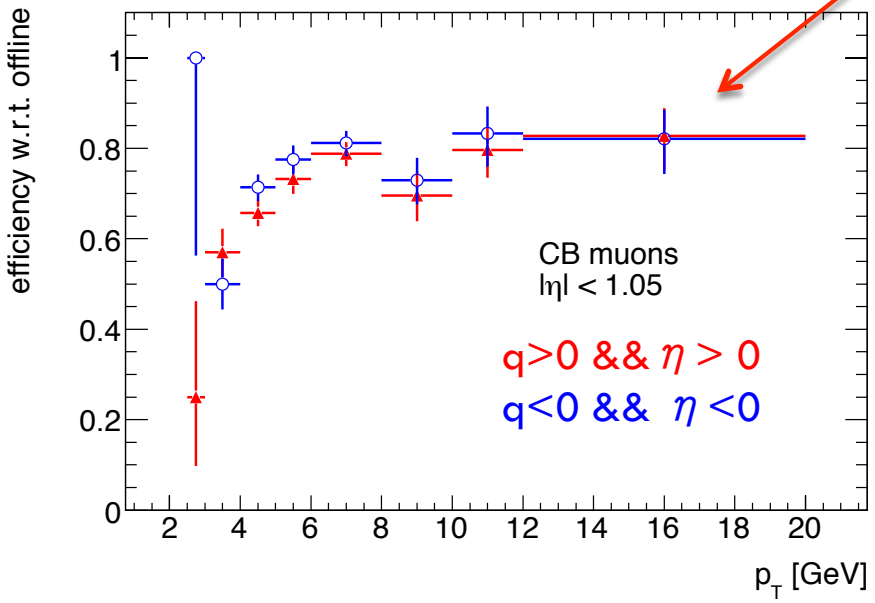
The two curves are still splitted in two:

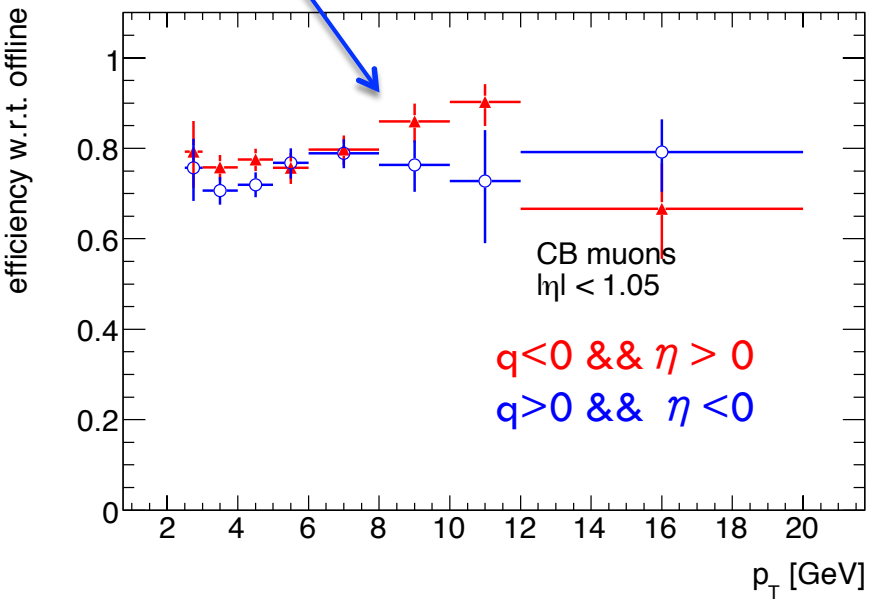
- $(q\ \eta) < 0$ is splitted in:
  - $q<0$ && $\eta > 0$
  - $q>0$ && $\eta <0$
- $(q\ \eta) > 0$ is splitted in:
  - $q>0$ && $\eta > 0$
  - $q<0$ && $\eta <0$

Two combined Muons

barrel







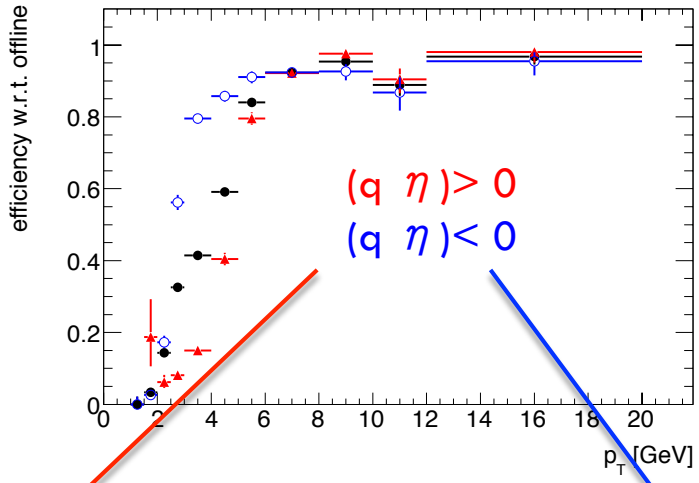
STACO

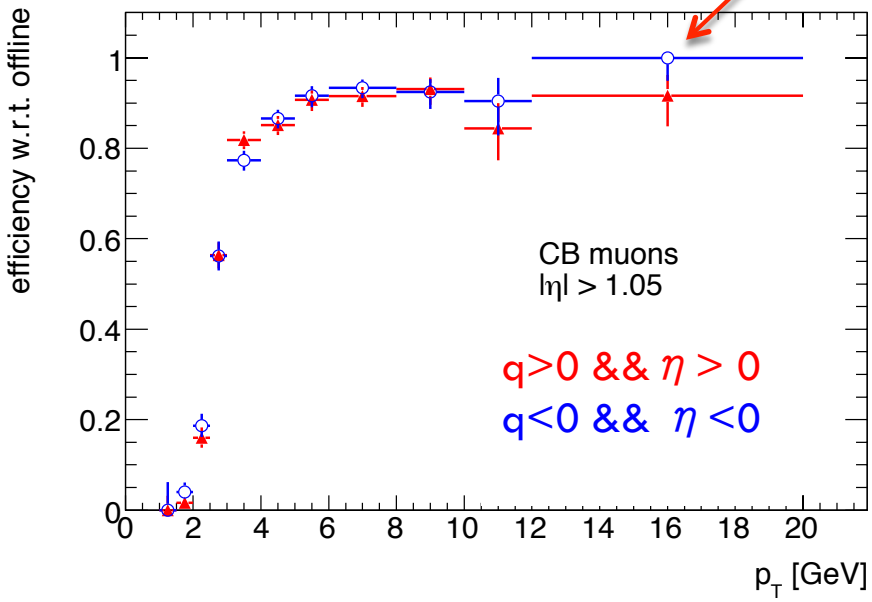
TurnOn curves: L1_MU0

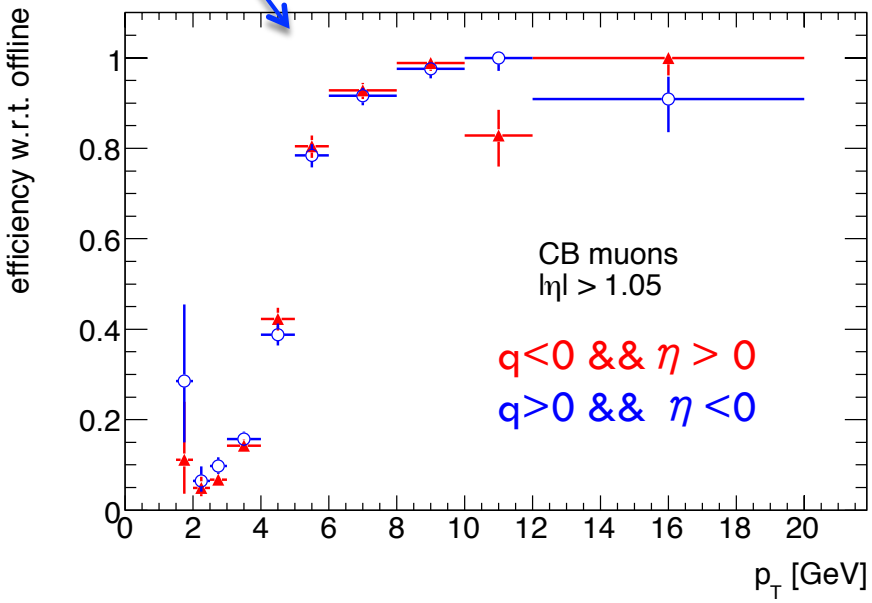
period B+C+D1
period E
period F

Two combined Muons

Endcap







Statistical test Results for L1MU0

barrel

Case 1: the efficiency curves obtained selecting muons with (q η)>0 and (q η)<0 are compatible for a p_T>5GeV.

Case 2 selection of muons with (q η)>0: the efficiency curves obtained selecting muons with (q>0 && η>0) and (q<0 && η<0) are compatible.

Case 3 selection of muons with (q η)<0: the efficiency curves obtained selecting muons with (q<0 && η>0) and (q>0 && η<0) are compatible.

endcaps

Case 1: the efficiency curves obtained selecting muons with (q η)>0 and (q η)<0 are compatible for a p_T>6GeV.

Case 2 selection of muons with (q η)>0: the efficiency curves obtained selecting muons with (q>0 && η>0) and (q<0 && η<0) are compatible.

Case 3 selection of muons with (q η)<0: the efficiency curves obtained selecting muons with (q<0 && η>0) and (q>0 && η<0) are compatible.

STACO

TurnOn curves: L1_MU6

period E
period F

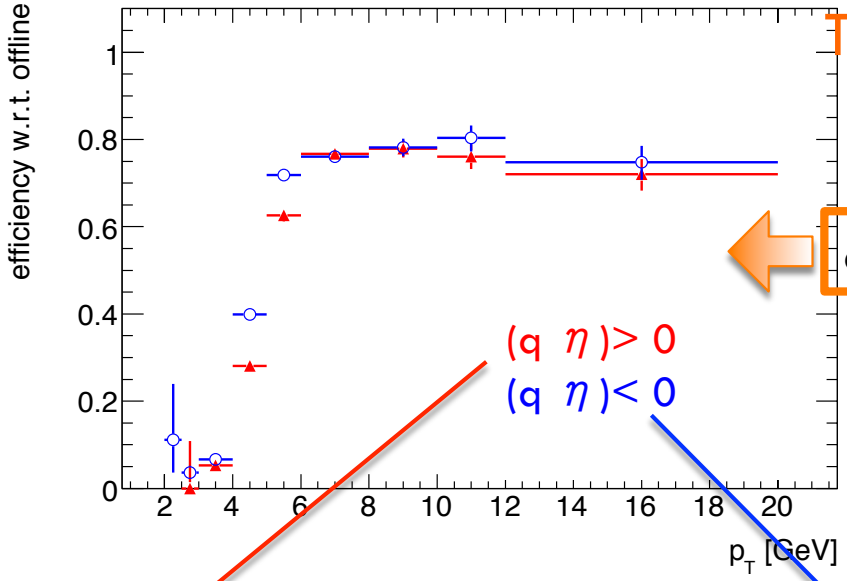
The two curves are still splitted in two:

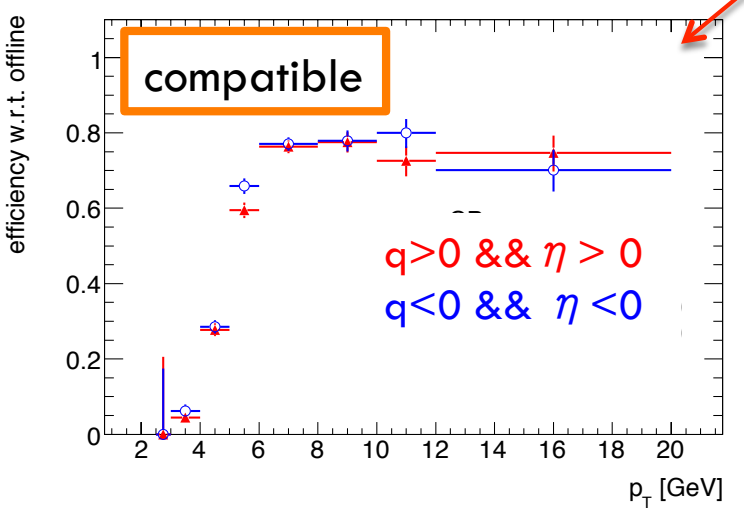
- $(q\ \eta) < 0$ is splitted in:
  - $q<0$ && $\eta > 0$
  - $q>0$ && $\eta <0$
- $(q\ \eta) > 0$ is splitted in:
  - $q>0$ && $\eta > 0$
  - $q<0$ && $\eta <0$

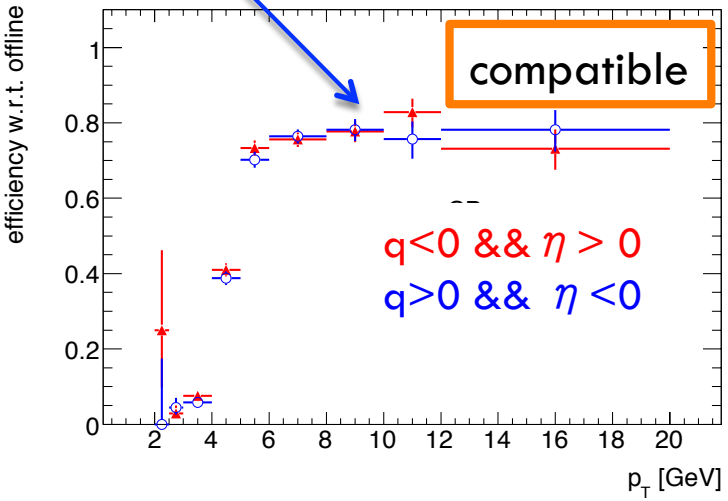
Two combined Muons

barrel

compatible for a p_T>6GeV







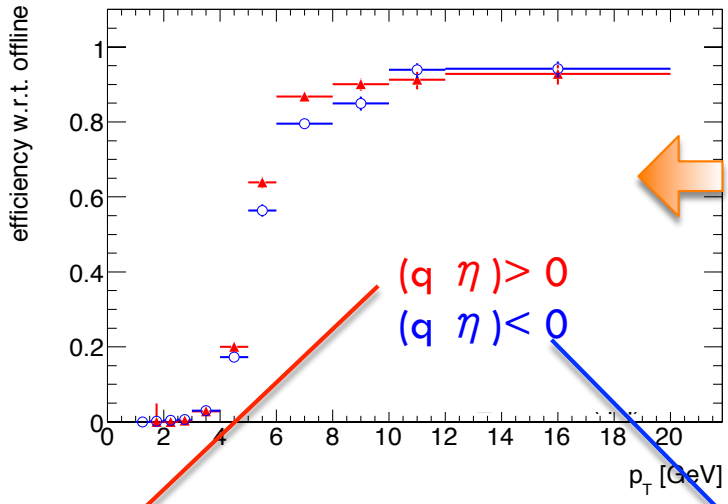
STACO

TurnOn curves: **L1_MU6**

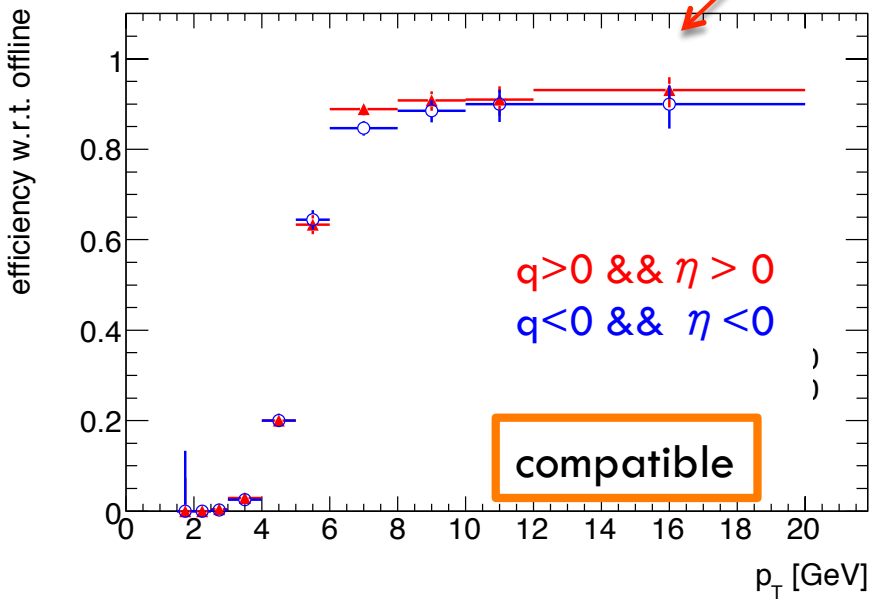
period E
period F

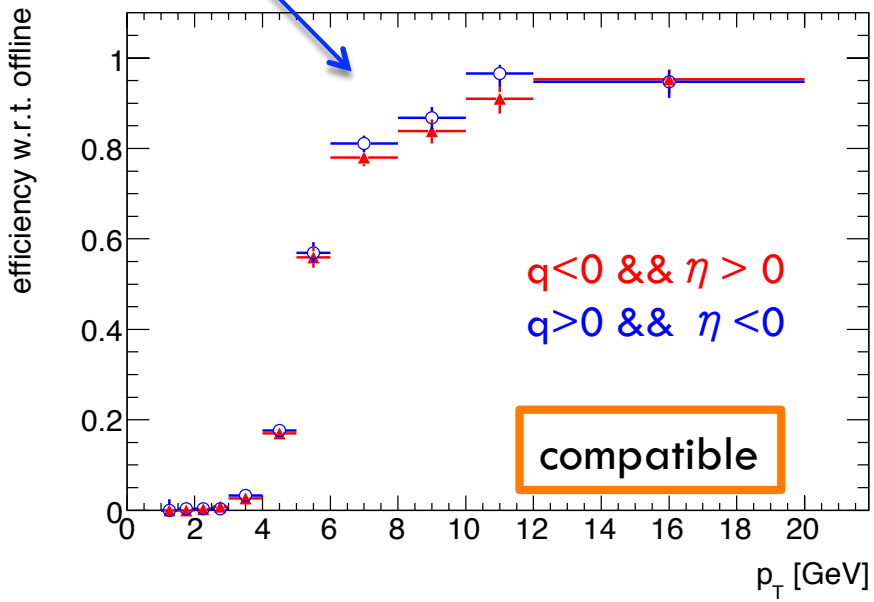
Two combined Muons

Endcap



The curves are not compatible





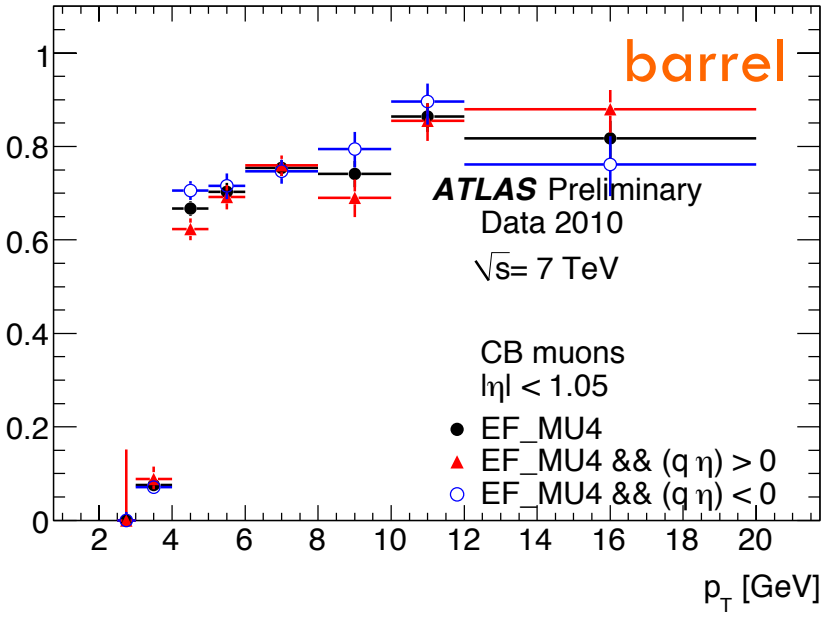
TurnOn curves: EF_MU4

period E
period F

STACO

Two combined Muons

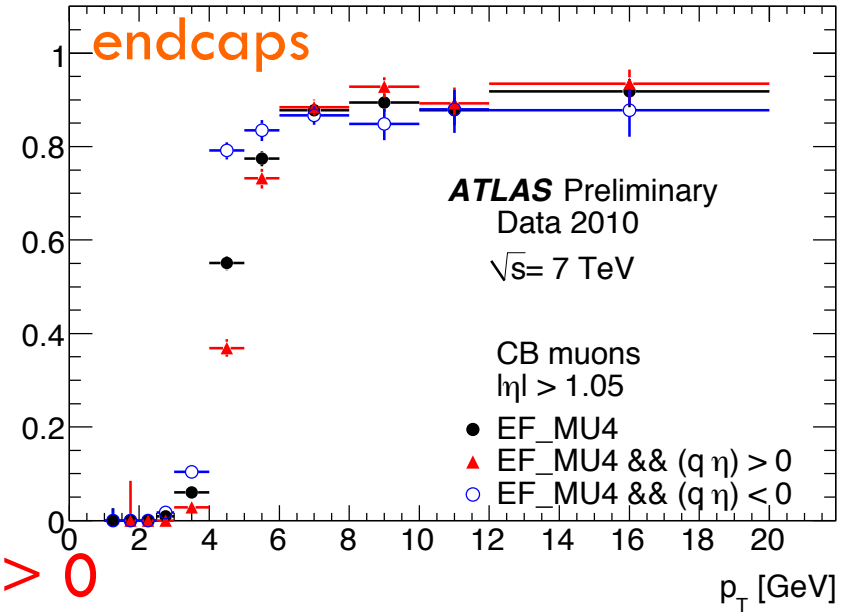
wrt the OFFLINE RECO



All

(q η)> 0

(q η)< 0



BARREL: *the two efficiency curve selecting muons with (q η)>0 and (q η)<0 are fully compatible*

ENDCAPS: *the two efficiency curve selecting muons with (q η)>0 and (q η)<0 are not compatible in the turn-on region*

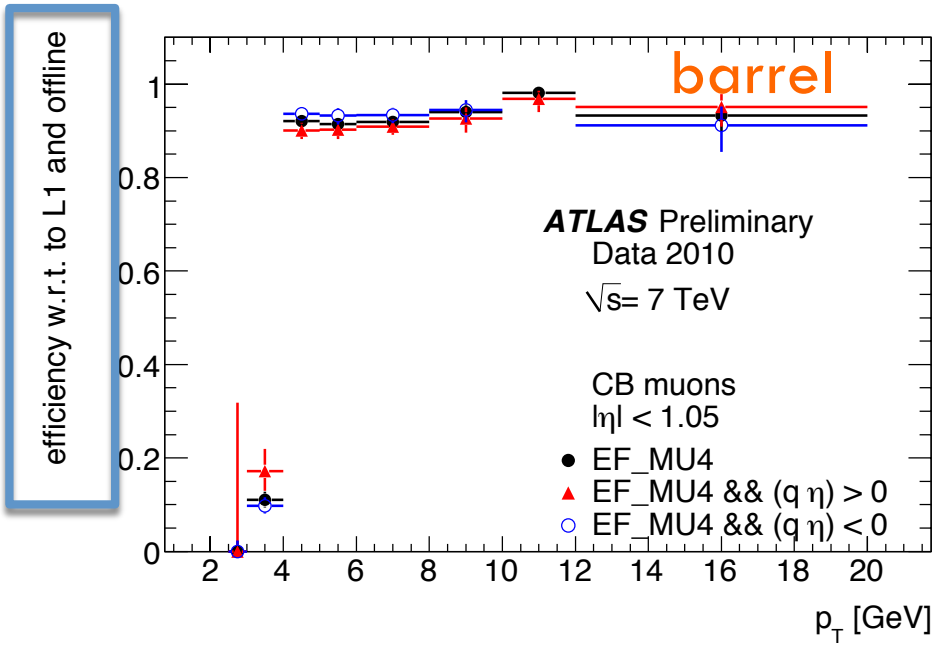
TurnOn curves: EF_MU4

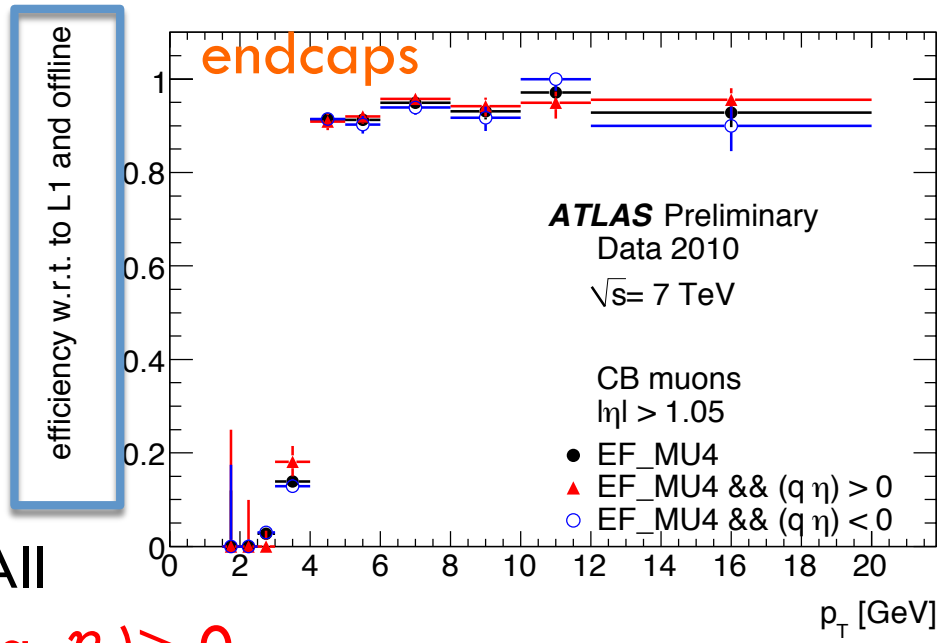
period E
period F

STACO

wrt the LVL1

Two combined Muons





All

$(q\ \eta) > 0$

$(q\ \eta) < 0$

The two efficiency curve selecting muons with $(q\ \eta)>0$ and $(q\ \eta)<0$ are fully compatible.

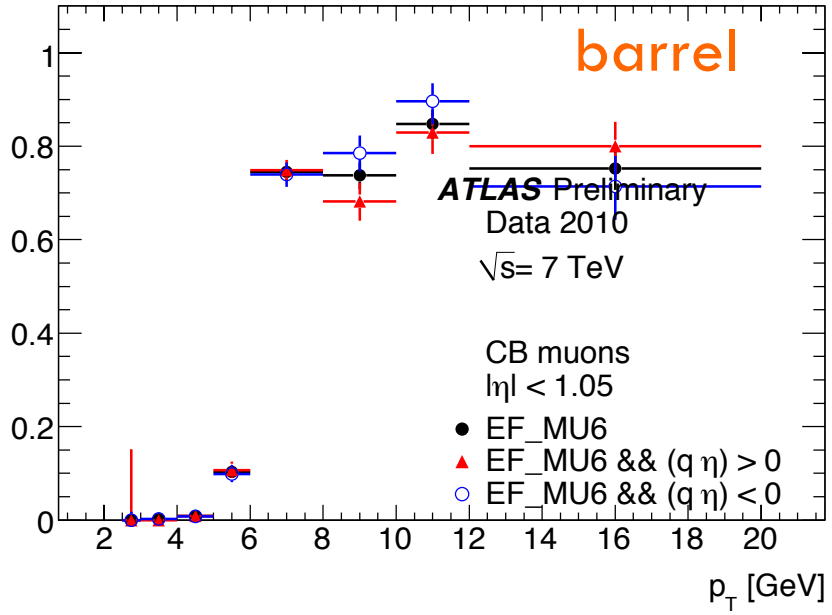
TurnOn curves: EF_MU6

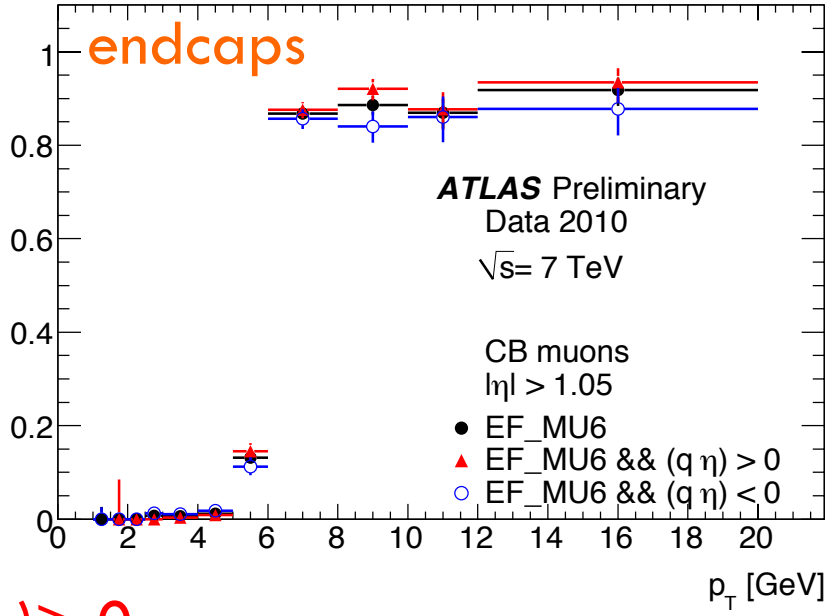
period E
period F

STACO

wrt the OFFLINE RECO

2 combined Muons





All

(q η)> 0

(q η)< 0

BARREL: *the two efficiency curve selecting muons with (q η)>0 and (q η)<0 are fully compatible*

ENDCAPS: *the two efficiency curve selecting muons with (q η)>0 and (q η)<0 are fully compatible*

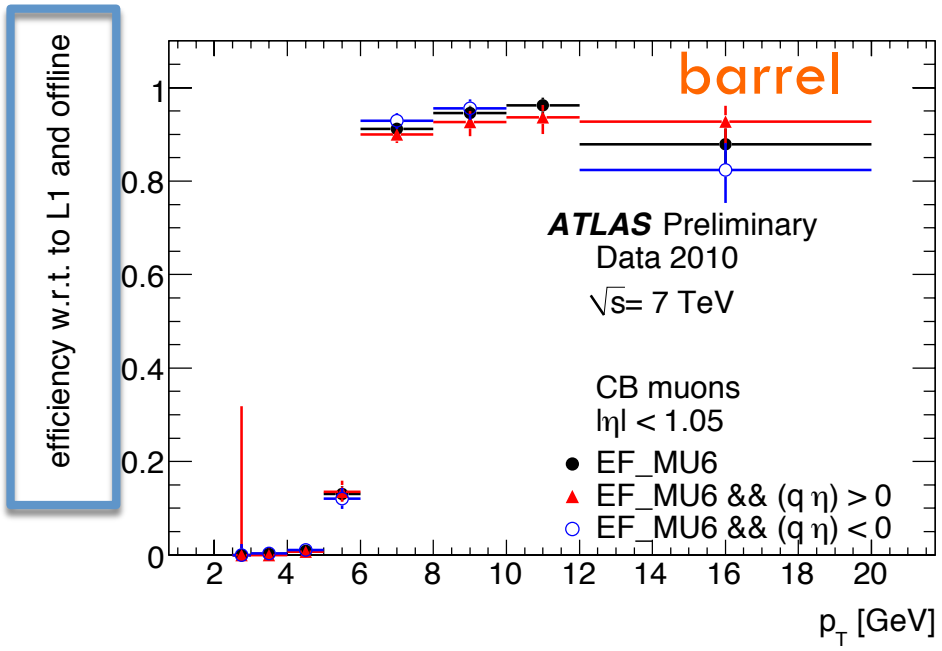
TurnOn curves: EF_MU6

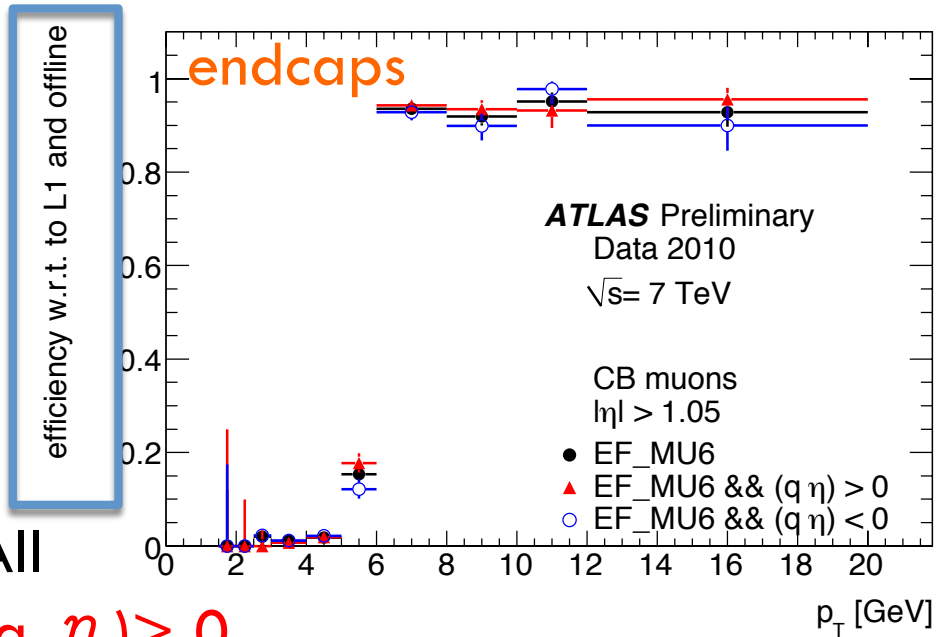
period E
period F

STACO

wrt the LVL1

2 combined Muons





All

(q η)> 0

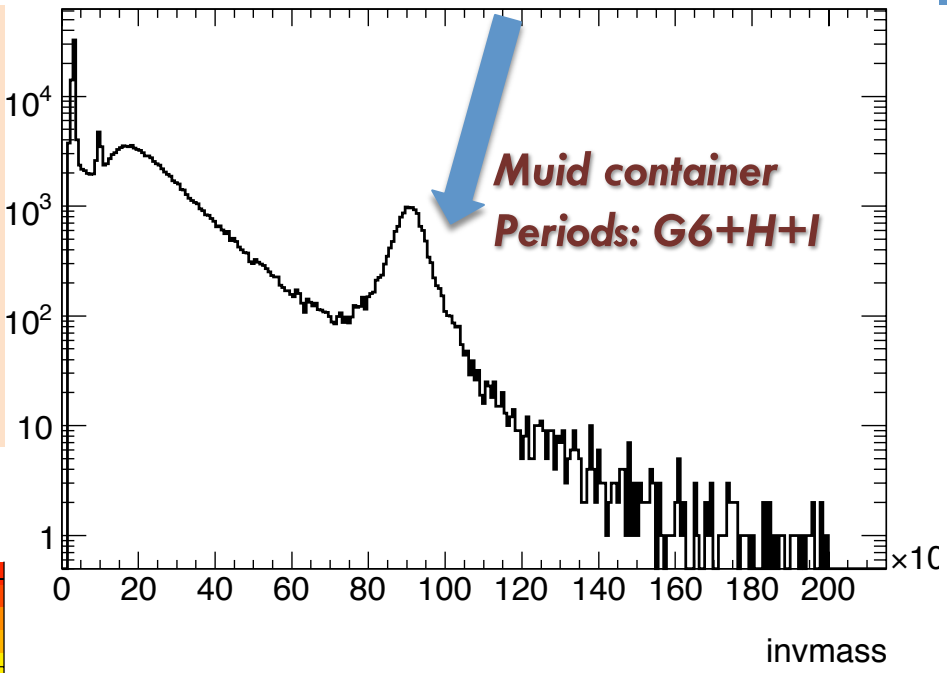
(q η)< 0

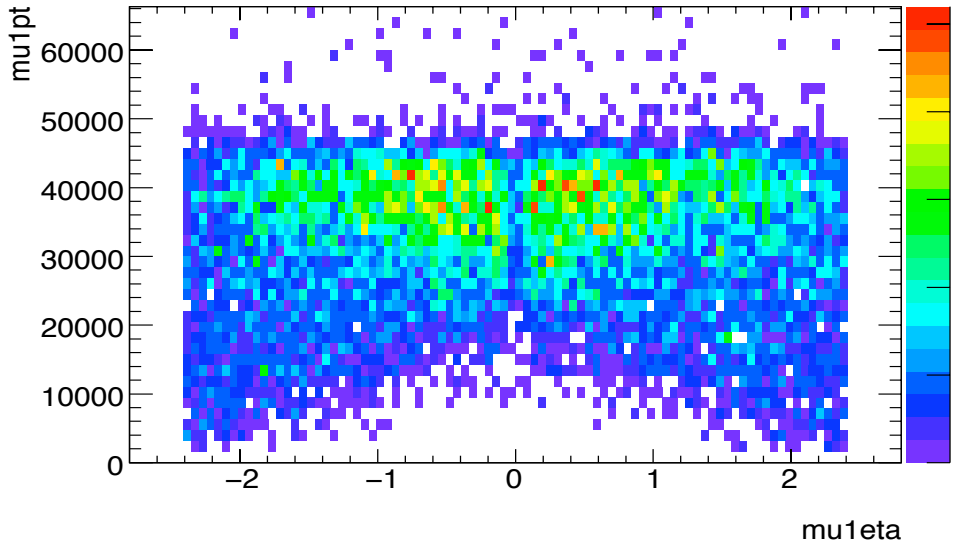
The two efficiency curve selecting muons with (q η)>0 and (q η)<0 are fully compatible.

High-p_T selection: $Z \rightarrow \mu\mu$

Selection:

- 2 OS combined muons in the [80-100] GeV mass range
- *dimuons vertexing*
- p>10GeV
- nPixels>0, nSCT>5, nTRT>10
- Isolation cut : pTcone40/pT < 0.2





Muon pT vs Muon η in the Z peak mass range

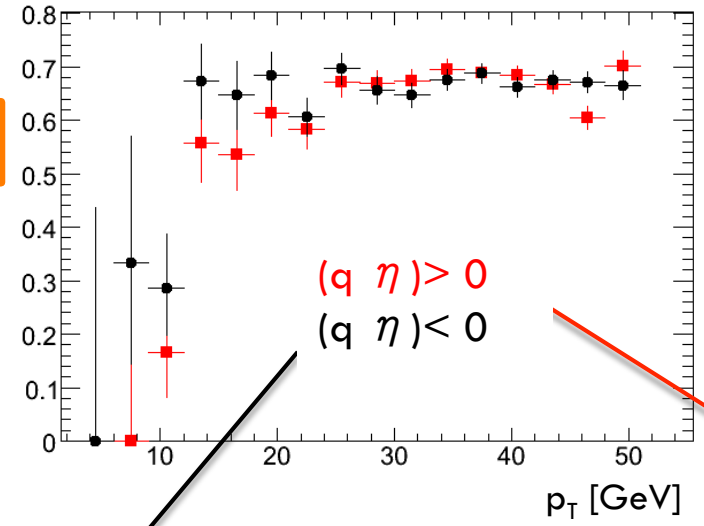
Tag & Probe Method:
"tag" muon matched with the trigger object EFMU13 TIGHT

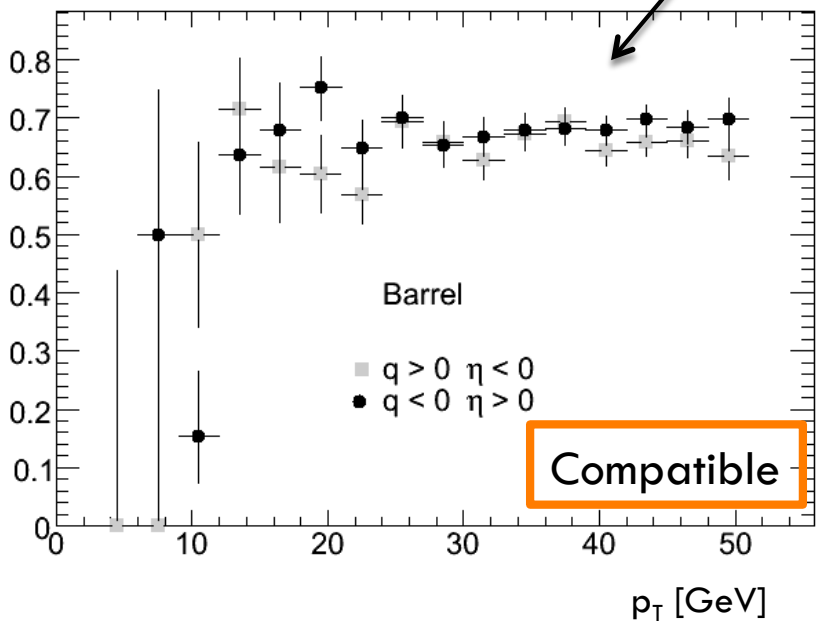
period G6
period H
period I

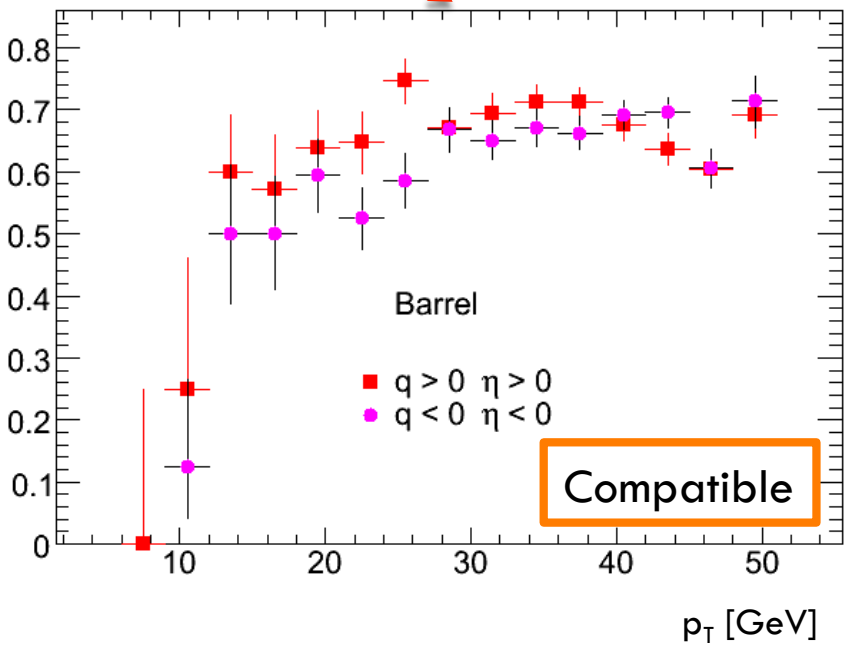
TurnOn curves: L1_MU15

compatible for a p_T>15GeV

barrel





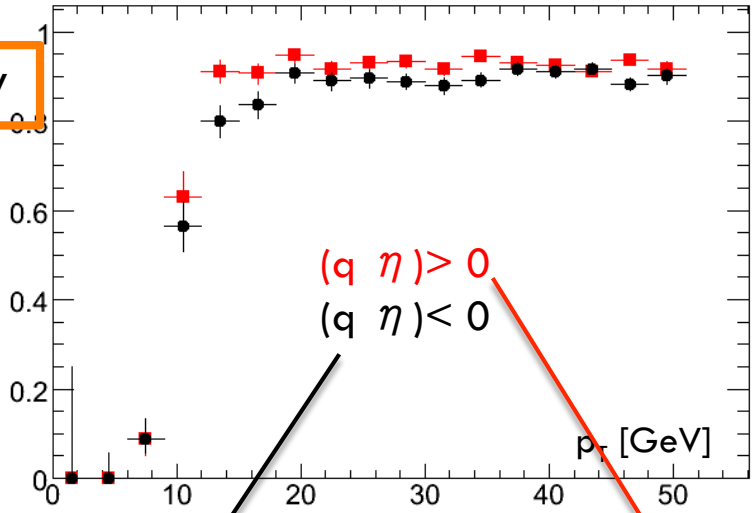


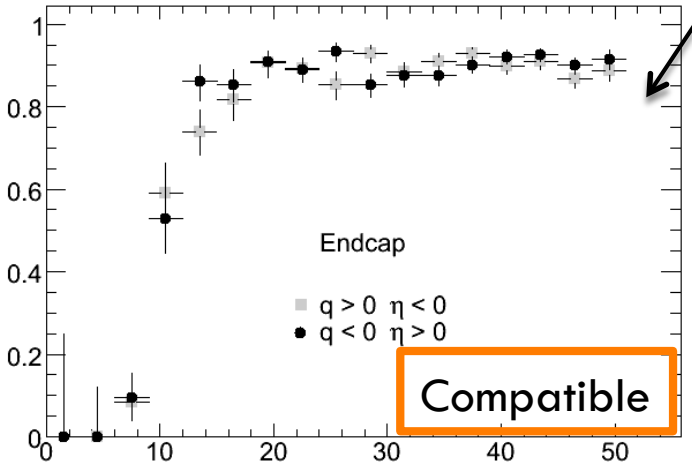
TurnOn curves: L1_MU15

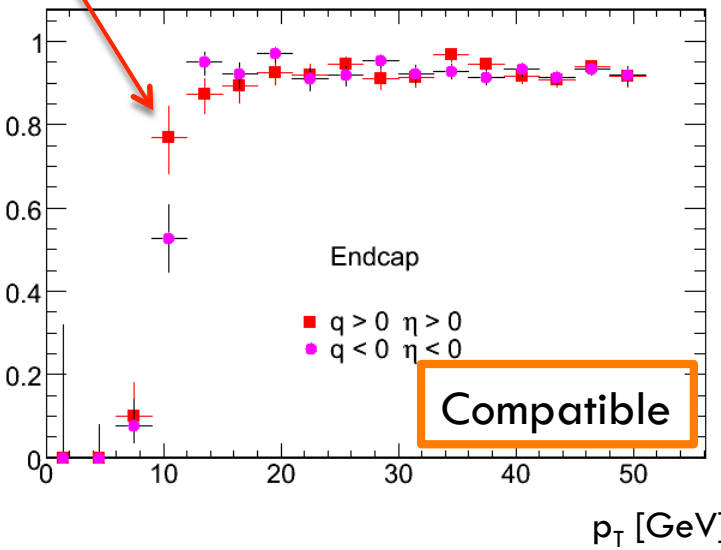
period G6
period H
period I

compatible for a p_T>15GeV

endcap







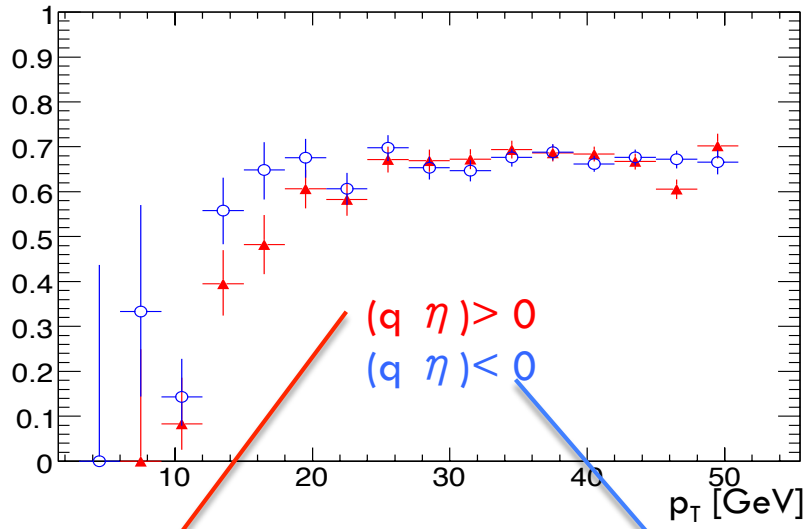
TurnOn curves: L1_MU20

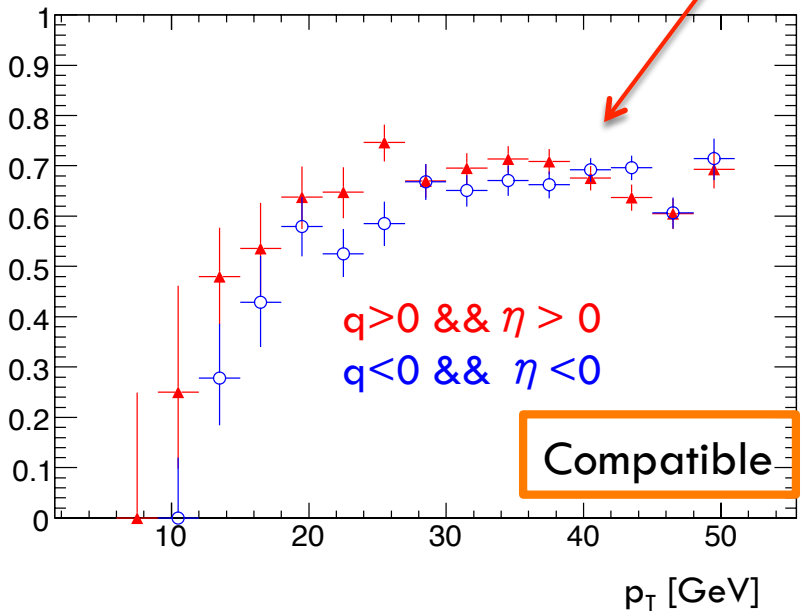
period G6
period H
period I

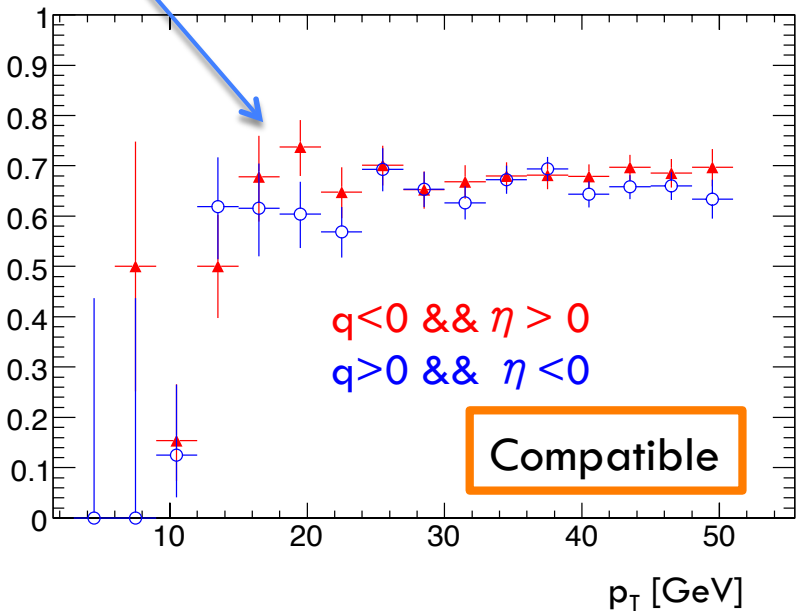
Staco

barrel

compatible for a p_T>20GeV







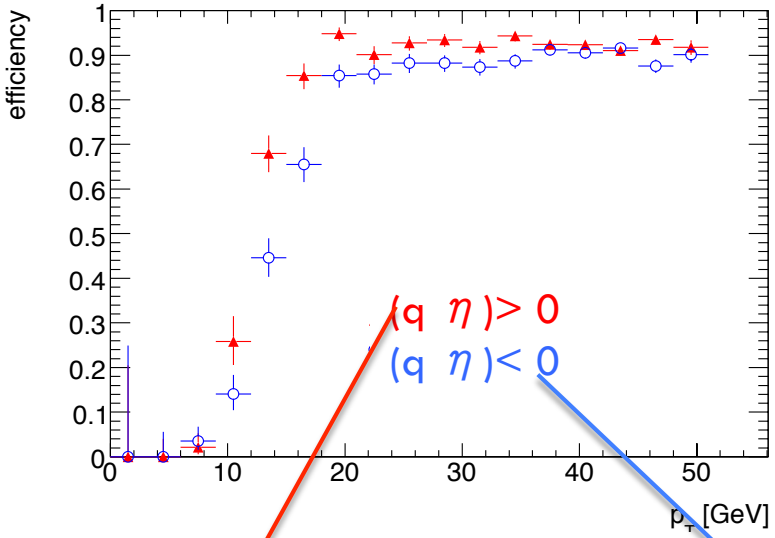
TurnOn curves: L1_MU20

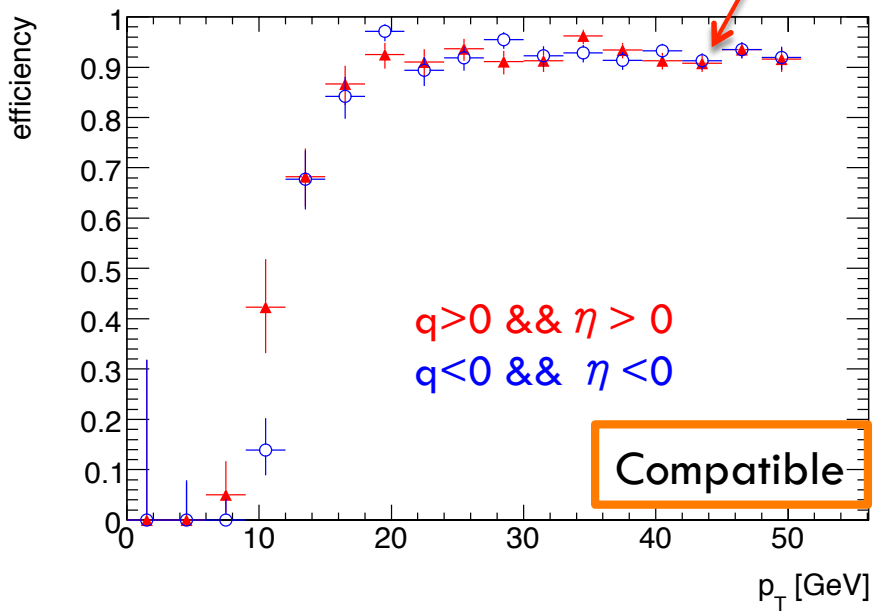
period G6
period H
period I

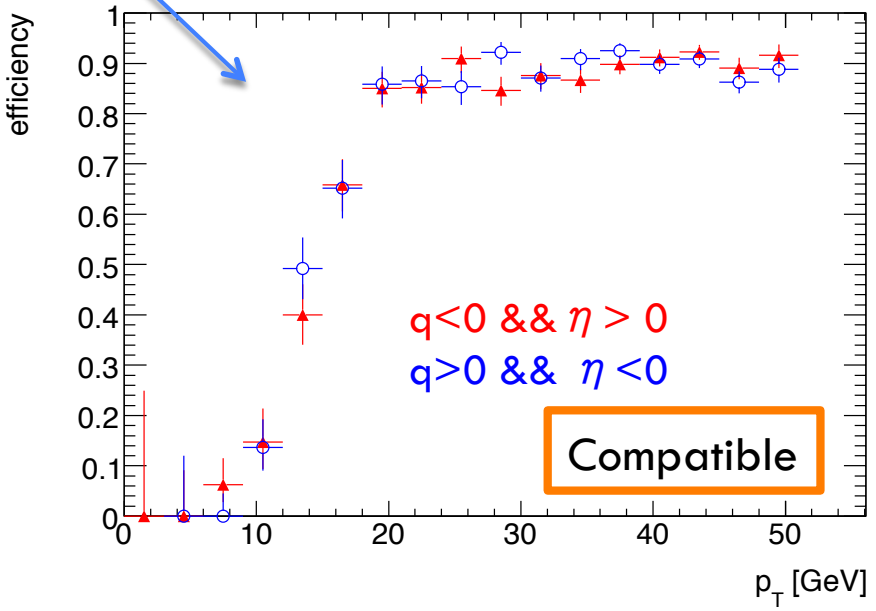
Staco

endcaps

Not compatible





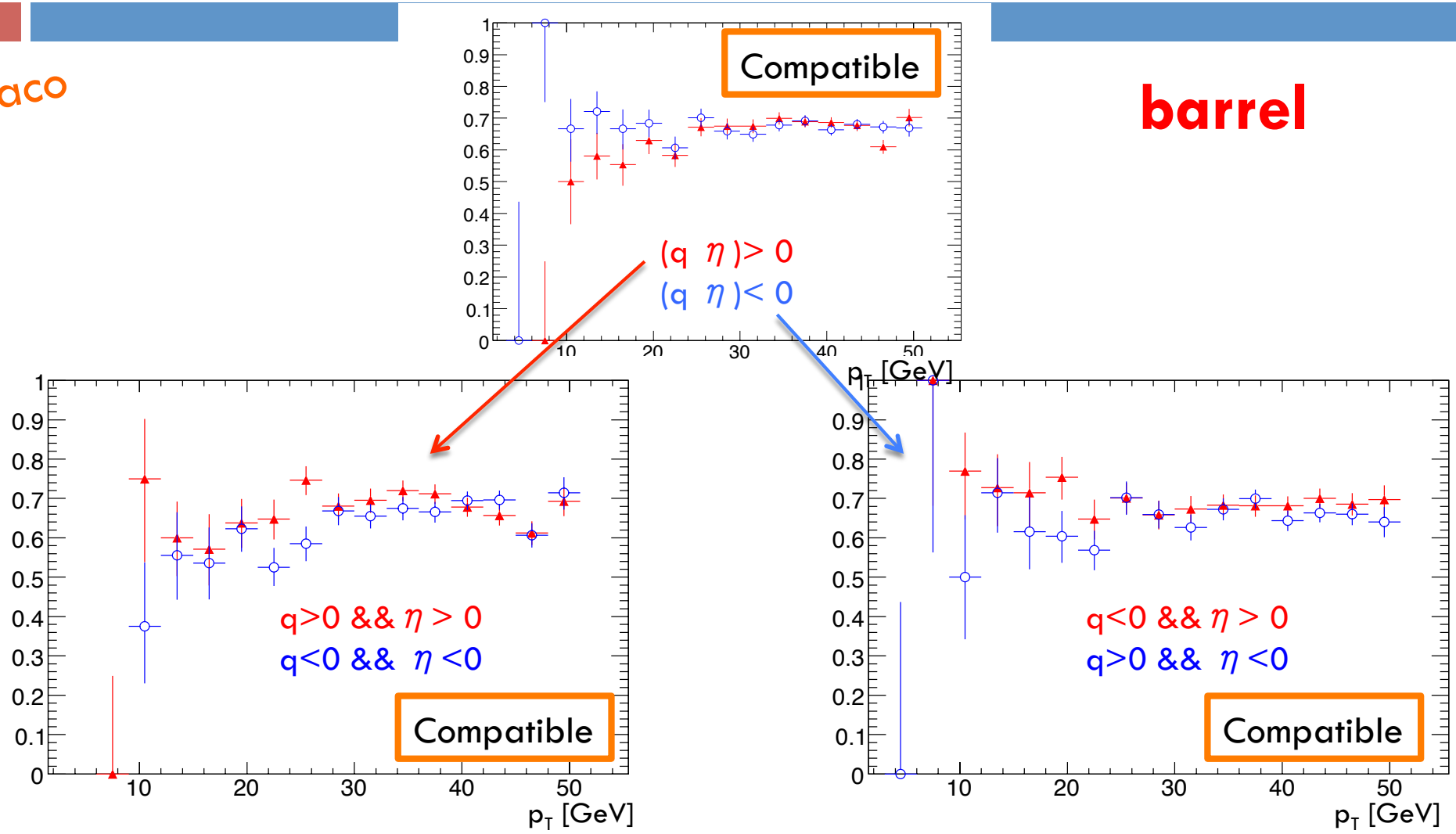


TurnOn curves: L1_MU0COMM

period G6
period H
period I

Staco

barrel



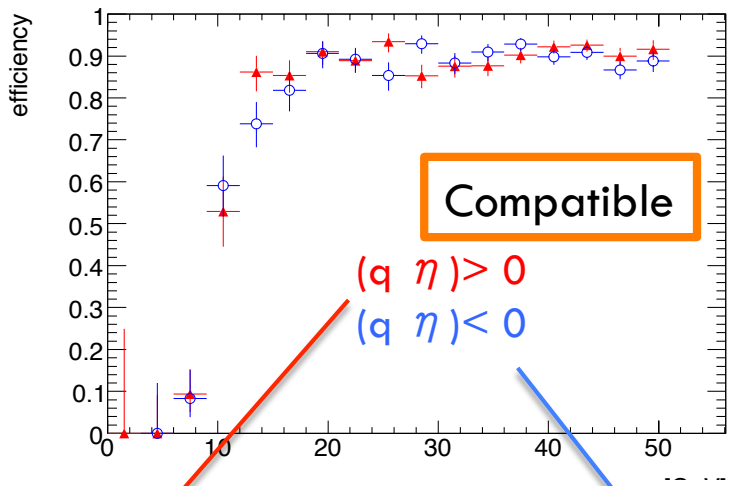
The curves are fully compatible in all the cases.

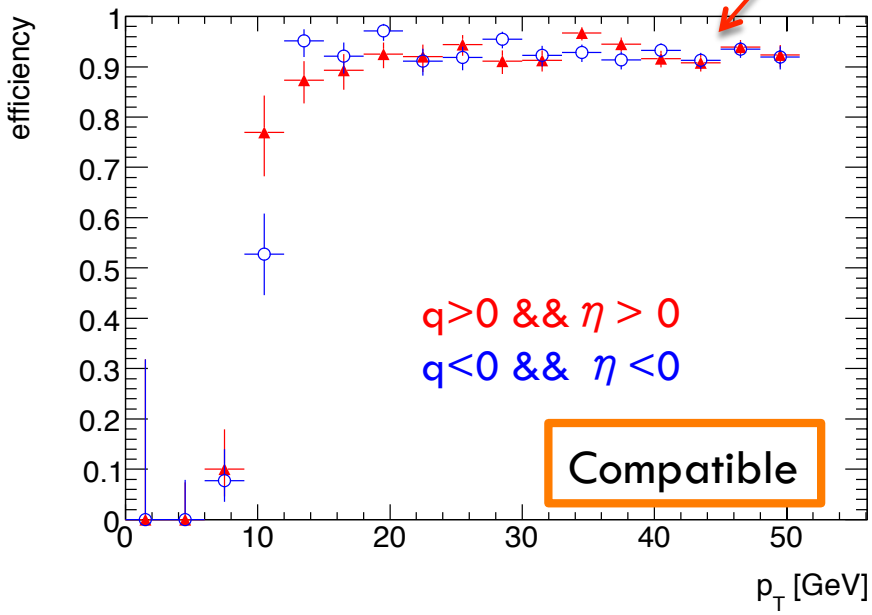
TurnOn curves: L1_MU0COMM

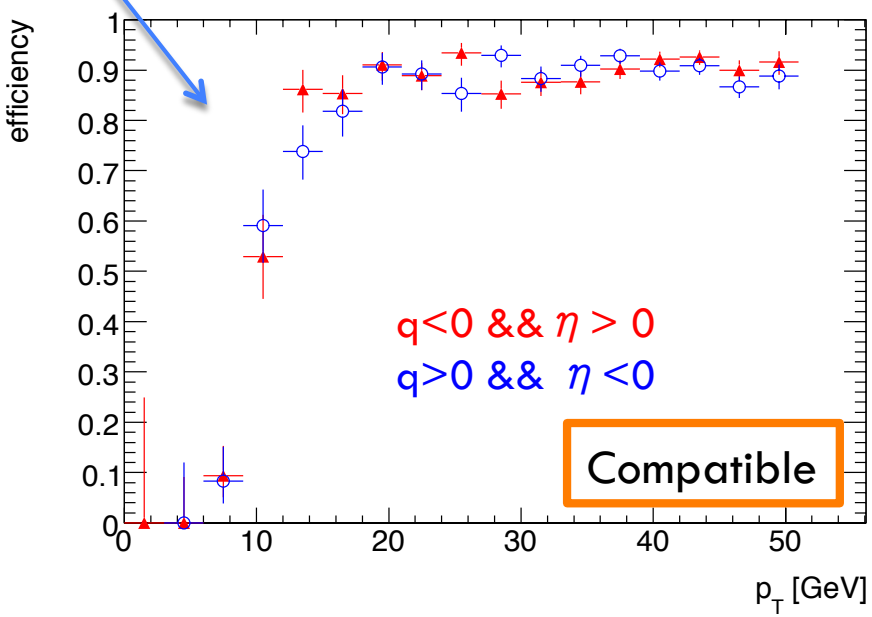
period G6
period H
period I

Staco

endcaps







The curves are fully compatible in all the cases.

Conclusions and Future plans…

There is a charge-eta effect on trigger effciency curves and it could be better to take it into account for cross section measurements.

Next step: the study of the efficiency of the dimuon triggers thresholds.