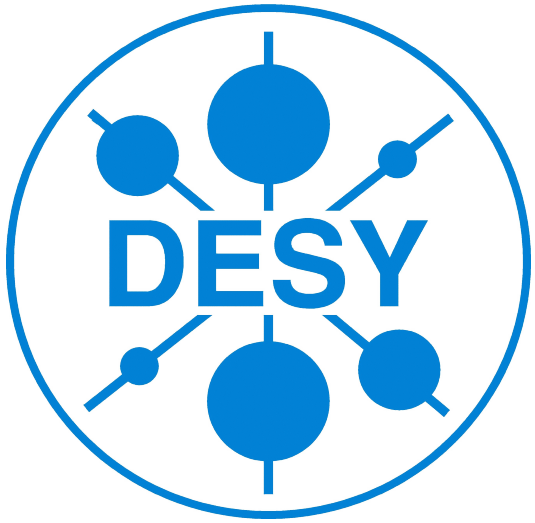




# Lepton Efficiencies with Run2 Data
## (in context of Z → ττ → e+μ analysis)

**A. Raspereza**

**CMS UHH-DESY Meeting, June 16th 2015**

# Introduction

- **LHC Running strategy in 2015**
  - **13 TeV, 50ns, L = $5 \times 10^{33}$ $cm^{-2}s^{-1}$ (PU ~ 30), ~ 1/fb**
  - **13 TeV, 25ns, L = $7 \times 10^{33}$ $cm^{-2}s^{-1}$ (PU ~ 20), ~ 5/fb**
  - **13 TeV, 25ns, L = $1.4 \times 10^{34}$ $cm^{-2}s^{-1}$ (PU ~ 40), ~ 10/fb**
- **Higgs → ττ. Final states : μ+τ , e+τ, τ+τ, e+μ**
- **DESY group plans to analyze e+μ final state**
- **Triggers for the e+μ analysis**
  - **HLT_Mu8_TrkIsoVVL_Ele23_CaloIdL_TrackIdL_IsoVL_v1**
  - **HLT_Mu23_TrkIsoVVL_Ele12_CaloIdL_TrackIdL_IsoVL_v1**
- **Kinematic cuts in Z → ττ → e+μ analysis (proposed baseline)**
  - **(pT(e) > 24 GeV && pT(μ) > 10 GeV) ||**
    **(pT(e) > 13 GeV && pT(μ) > 24 GeV)**
  - **eta(e) < 2.3**
  - **eta(μ) < 2.3**

# Monte Carlo Study

- **“toy” study with Phys14 MC sample**

  **/DYJetsToLL_M-50_13TeV-madgraph-pythia8/Phys14DR-PU20bx25_PHYS14_25_V1-v1/AODSIM**
- **Number of generated events ~ 3M**
- **Cross section ~ 6000 pb**
- **Corresponding luminosity ~ 500 1/pb**
- **Analysis is done with CMSSW_723**
- **Physics objects used**
  - **reco::Muon**
  - **reco::egmGsfElectron**

# Electron/Muon ID and Isolation

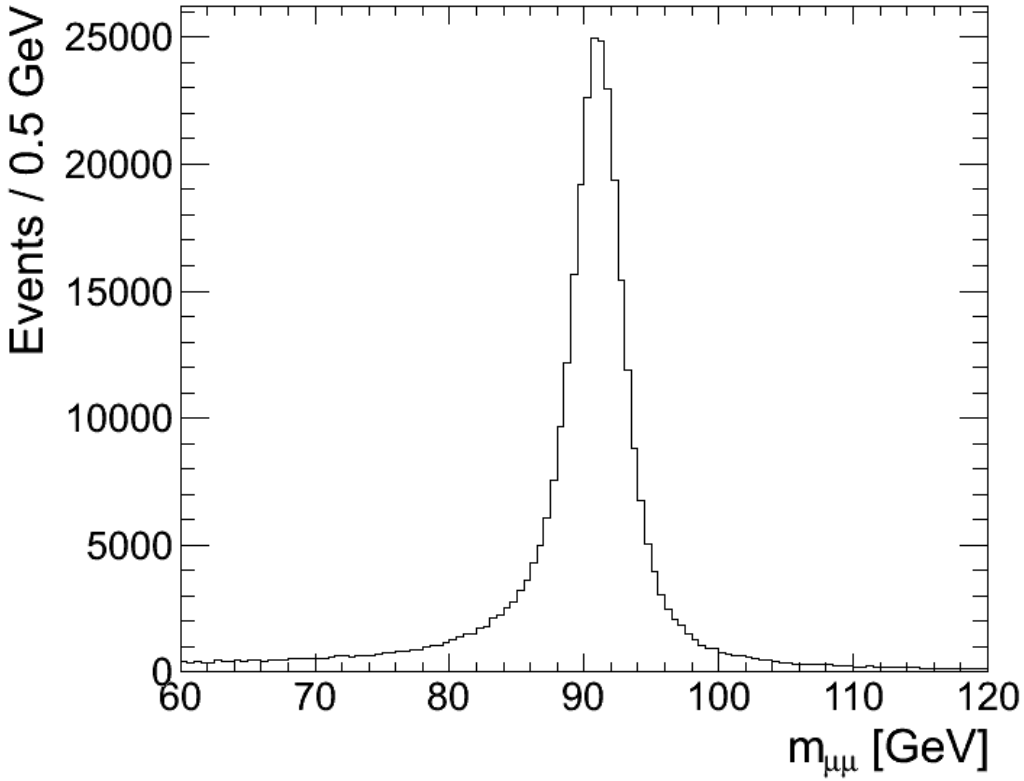
- **Electron Id**
  - **Conversion veto**
  - **new non triggering MVA Id (trained with Phys14 MC) (tight WP)**
- **Muon Id**
  - **Medium**
- **dxy < 0.045 cm, dz < 0.2 cm**
- **delta-beta corrected PFlow isolation**
  - **Relative Isolation < 0.15**

# Measurements of Lepton Id and Iso

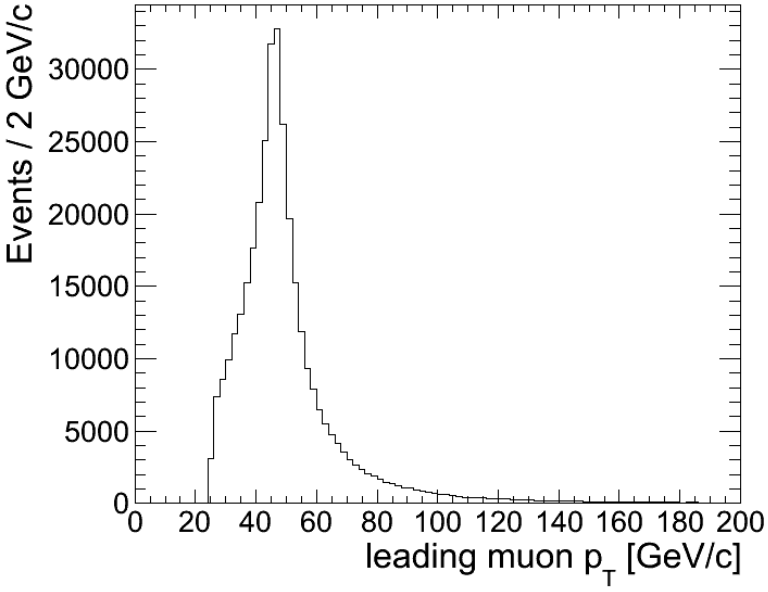
- **Tag-&-probe with Z → μμ**
- **Monitor trigger**
  - **HLT_IsoMu24_eta2p1_IterTrk02_v1**
- **Tag muon →**
  - **matches trigger object (dR<0.3)**
  - **Passes medium muon Id and isolation (relIso < 0.15)**
  - **pt > 25 GeV/c, eta < 2.1**
- **Tag-&-probe with Z → ee**
- **Monitor trigger**
  - **HLT_Ele27_eta2p1_WP85_Gsf_v1**
- **Tag electron →**
  - **matches trigger object (dR < 0.3)**
  - **passes tight MVA electron Id (relIso < 0.15)**
  - **pt > 30 GeV/c, eta < 2.1**

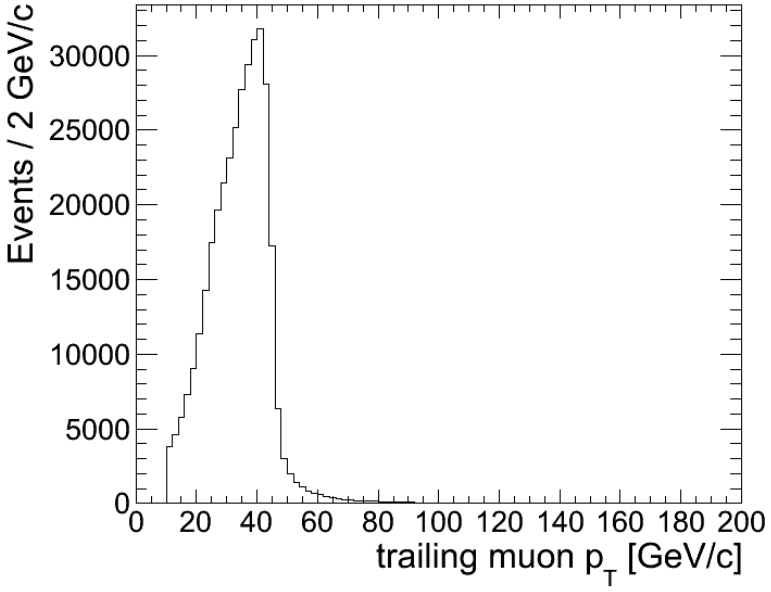
# Sanity checks (muons)

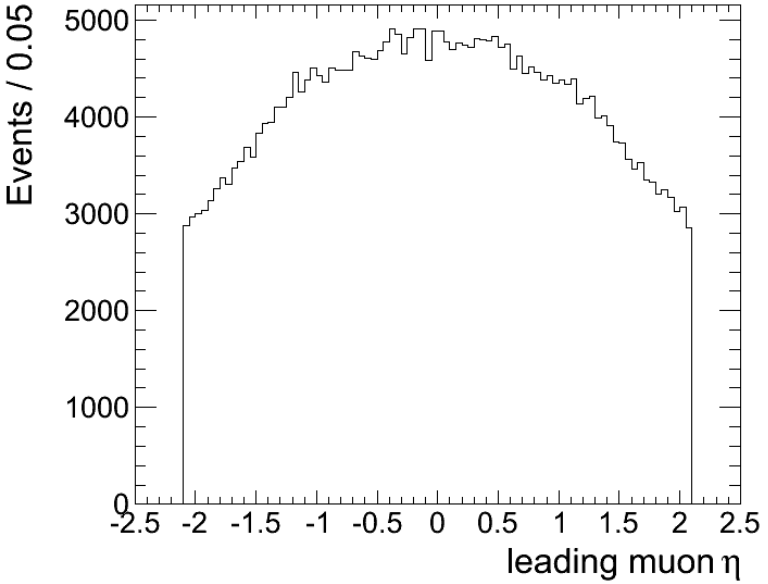
- **Leading muon pt > 25, eta < 2.1 matched trigger object, passes Medium Muon Id and Iso**
- **Trailing muon pt > 10, eta < 2.3, passes Medium Muon Id and Iso**

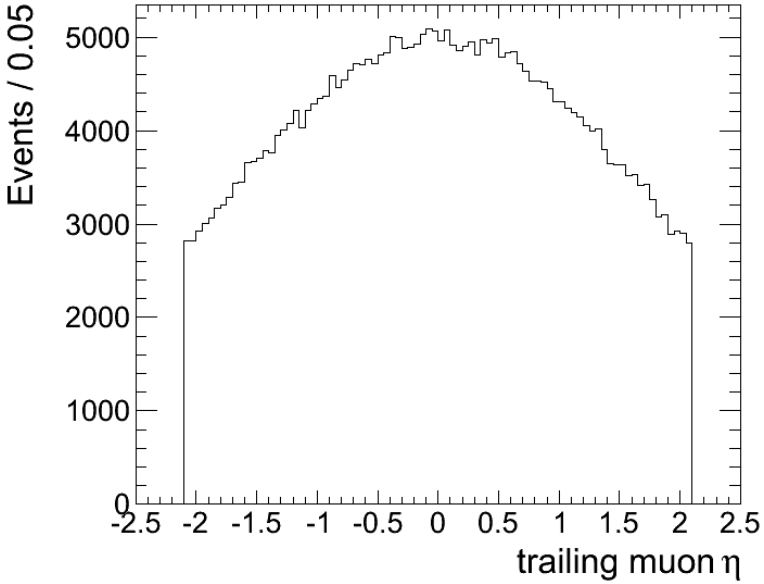


# Sanity checks (muons)



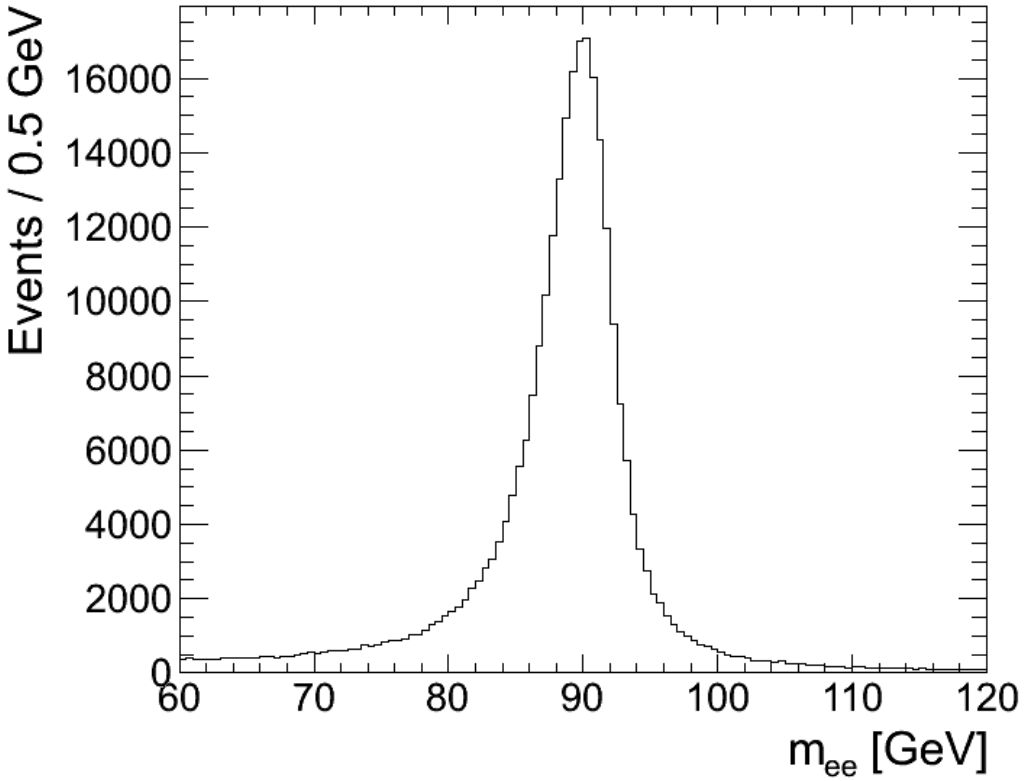



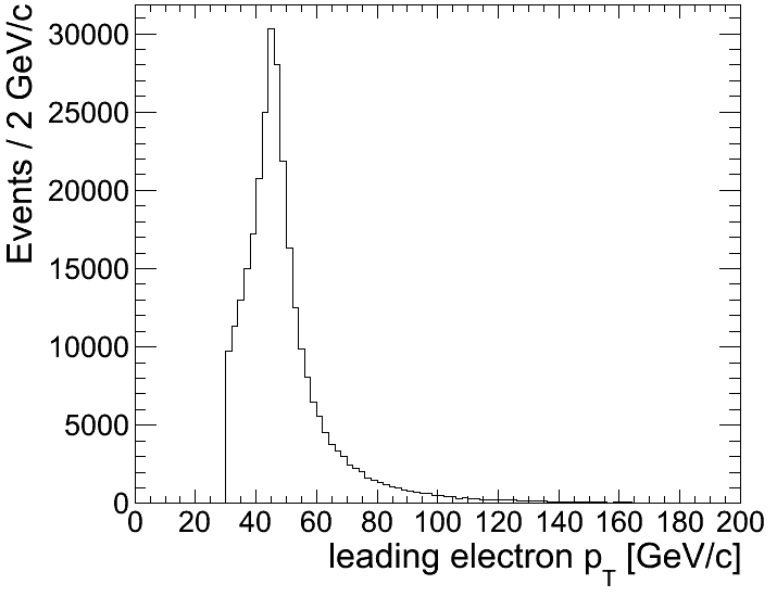



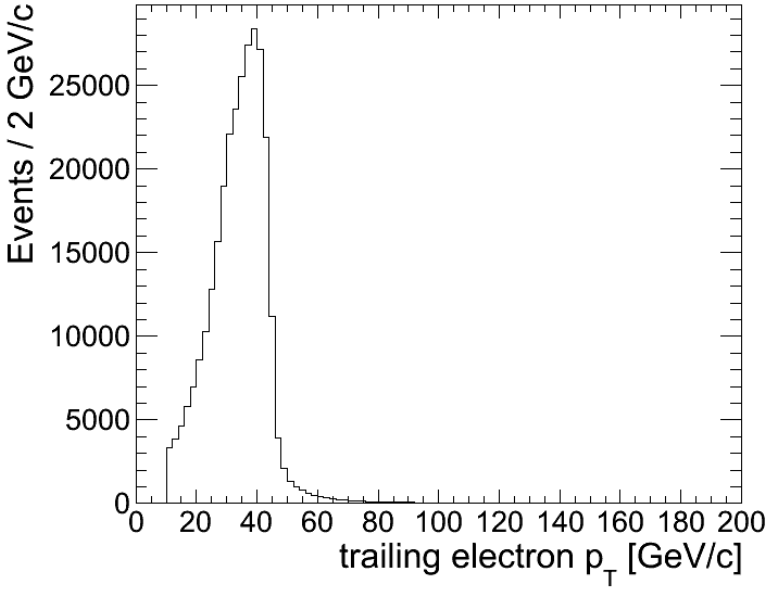
# Sanity checks (electrons)

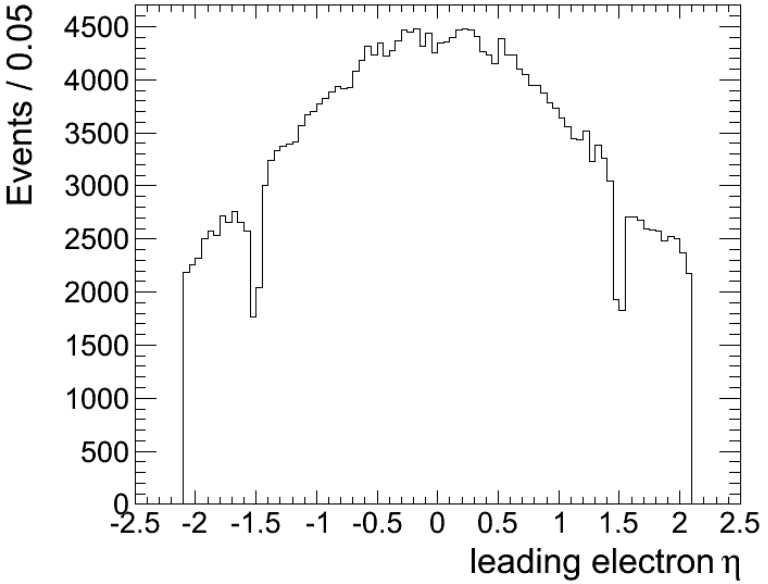
- **Leading electron pt > 30, eta < 2.1 matched trigger object, passes tight Electron MVA Id and Iso**
- **Trailing electron pt > 13, eta < 2.3, passes Tight electron MVA Id and Iso**

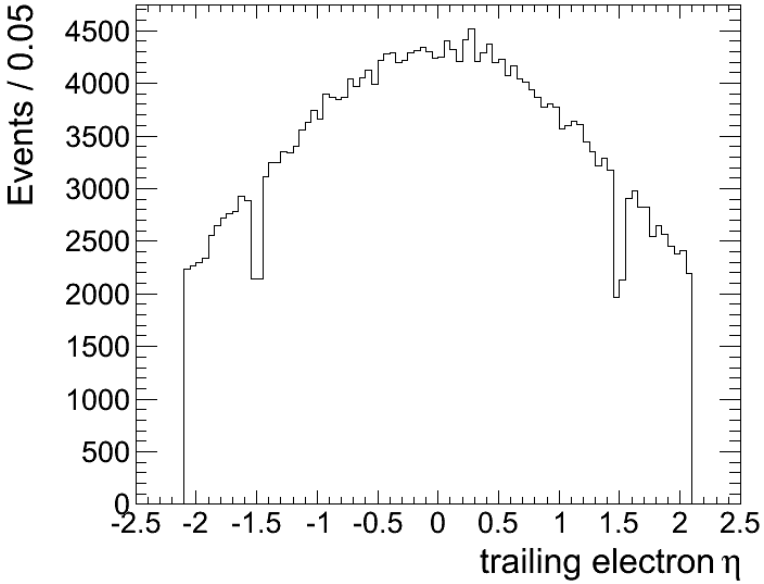


# Sanity checks (electrons)



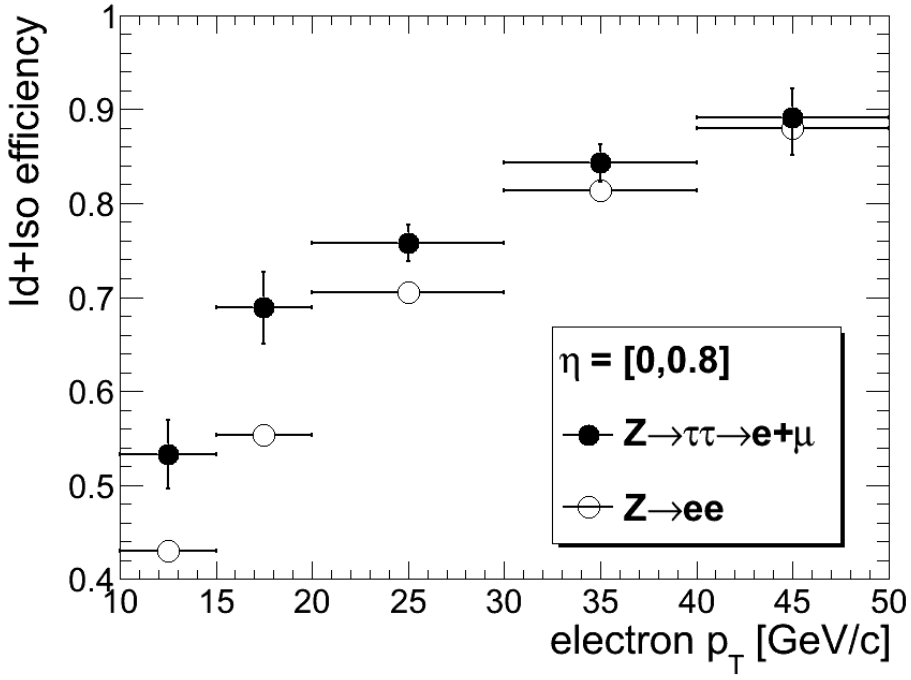



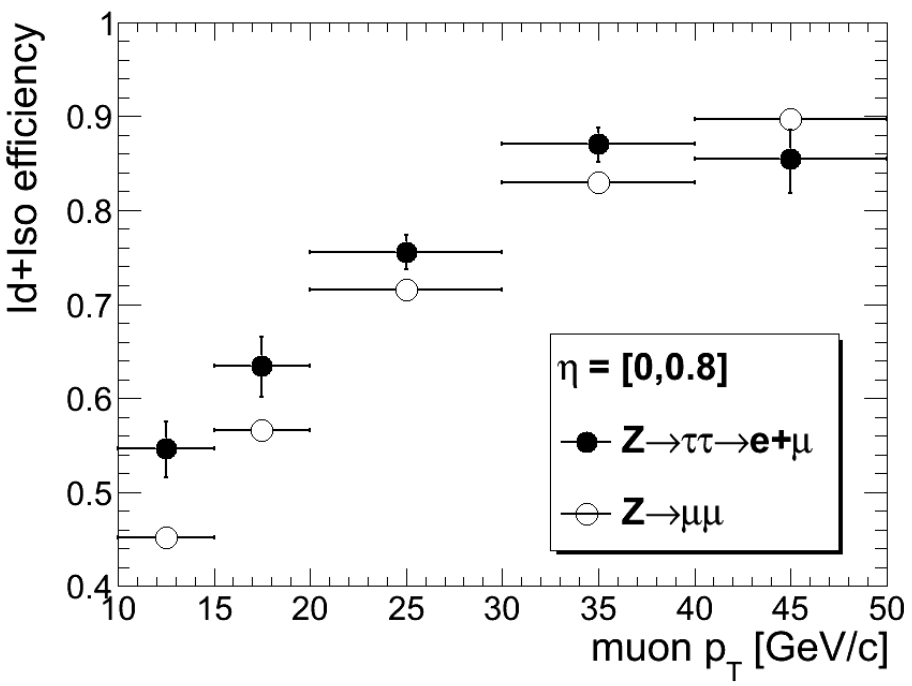



# Is efficiency the same for Z→ττ and Z→ee/μμ events

- **Compare measured efficiencies with Tag-&-Probe with actual efficiencies in the Z → ττ → e+μ events passing kinematic cuts**
  - **(pT(e) > 24 GeV AND pT(mu) > 10 GeV)**
    **OR (pT(e) > 13 GeV AND pT(mu) > 24 GeV)**
  - **eta(e) < 2.3, eta(mu) < 2.3**
  - **Match reconstructed lepton to generated lepton from Z → ττ decay**



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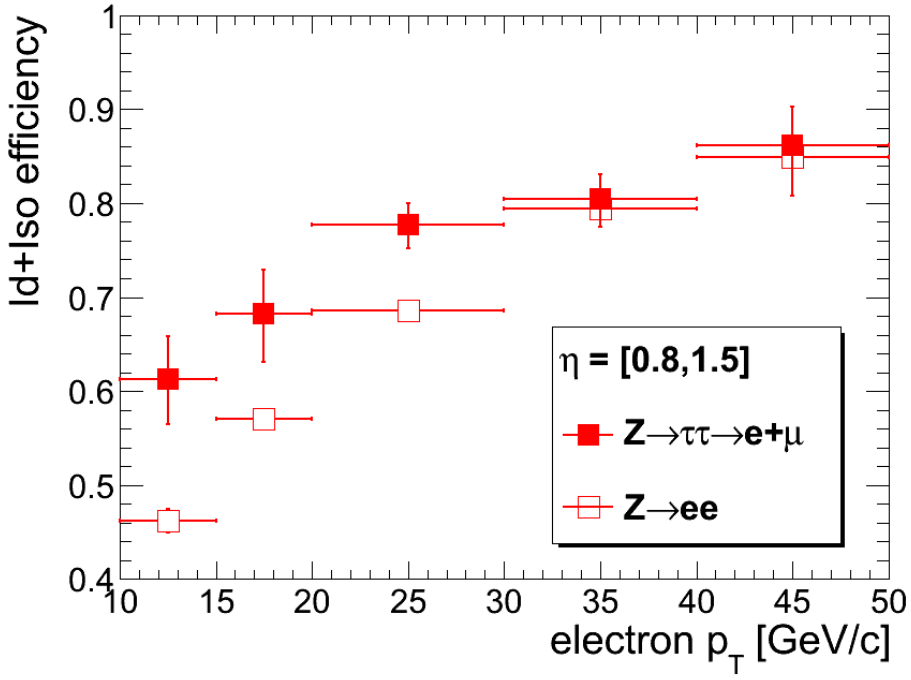


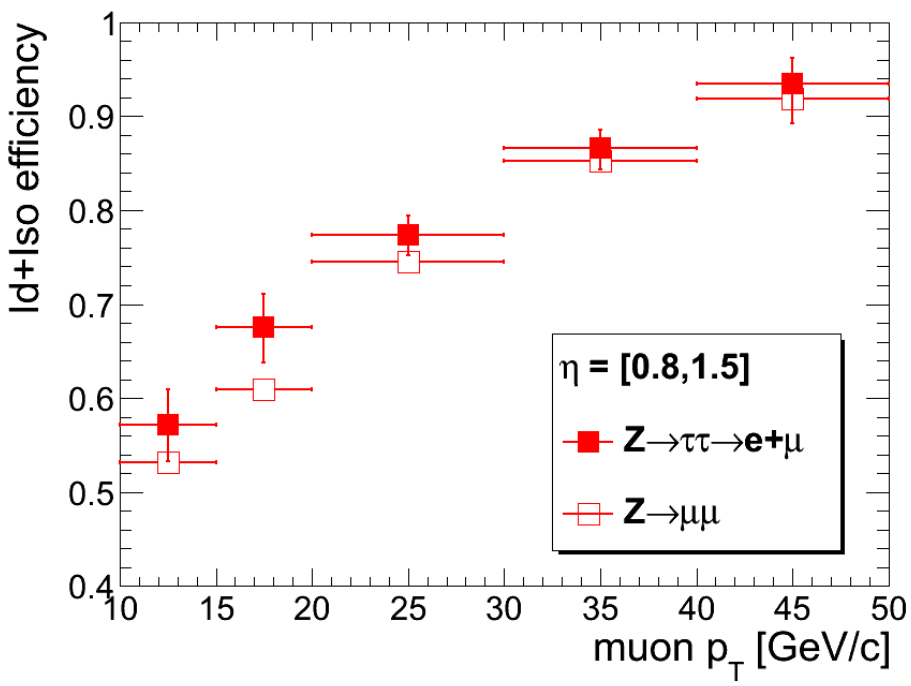

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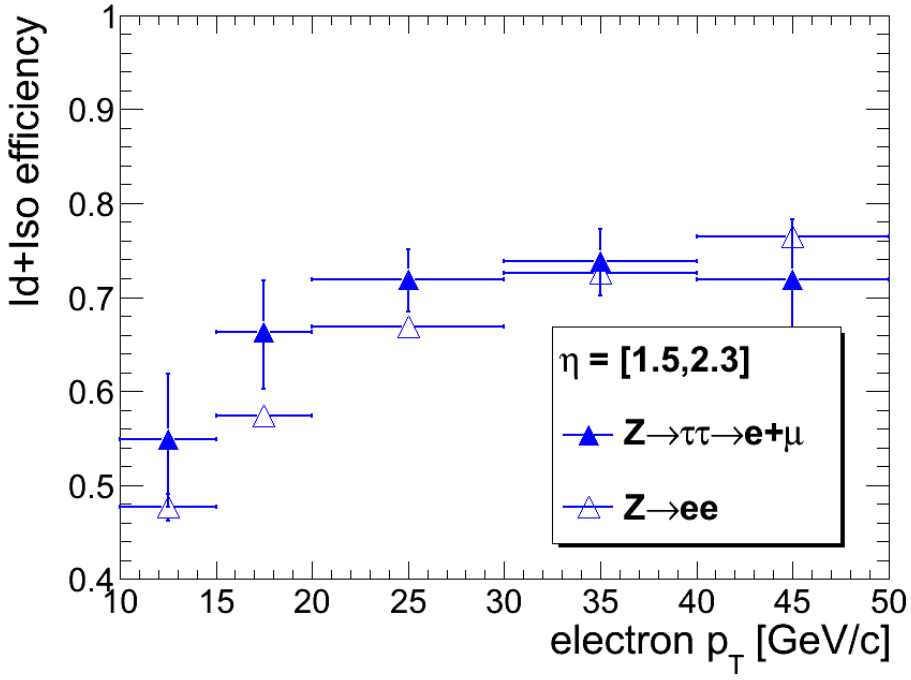
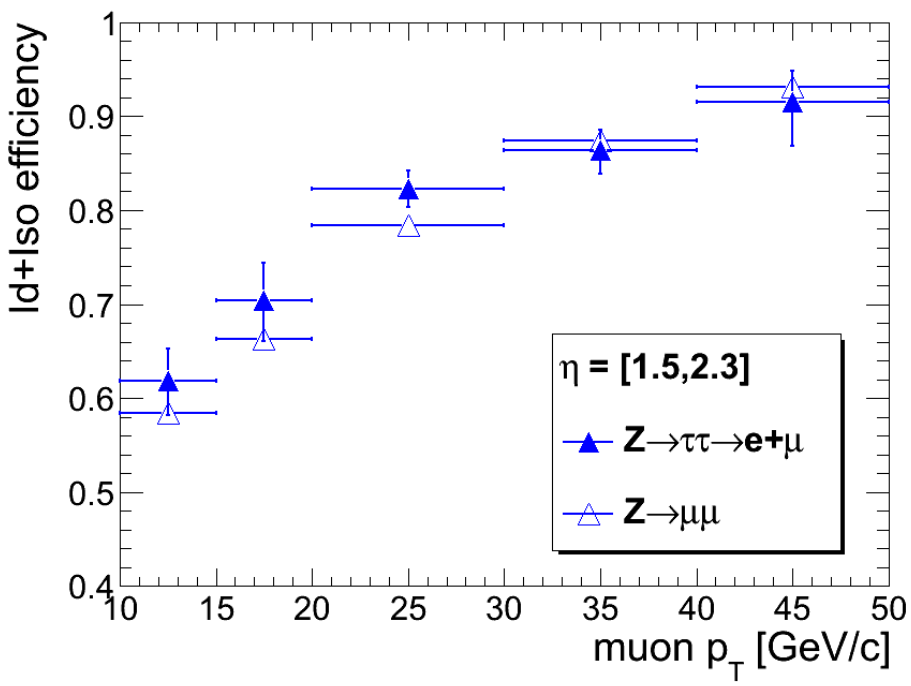
  - **eta(e) < 2.3, eta(mu) < 2.3**
  - **Match reconstructed lepton to the generated lepton from Z → ττ decay**

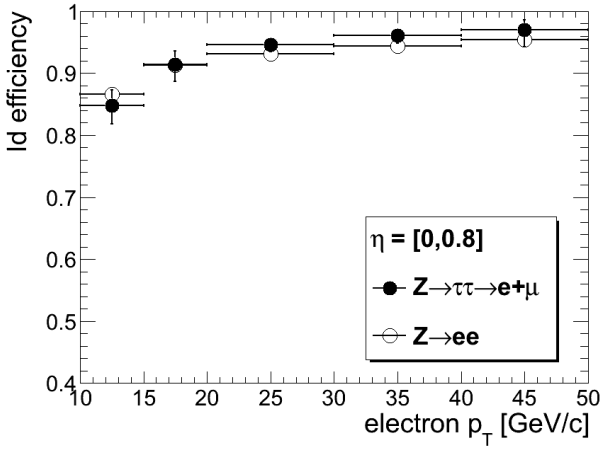


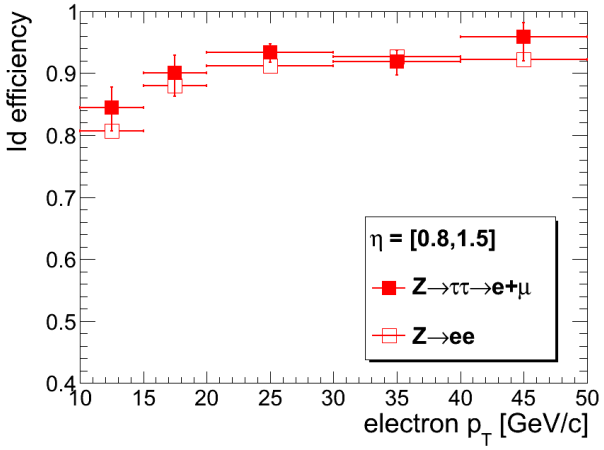



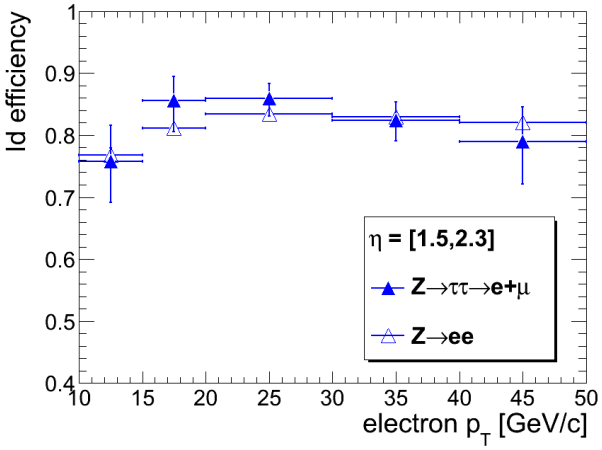
# Break down efficiency

- **Lepton ID (including impact parameter cuts)**

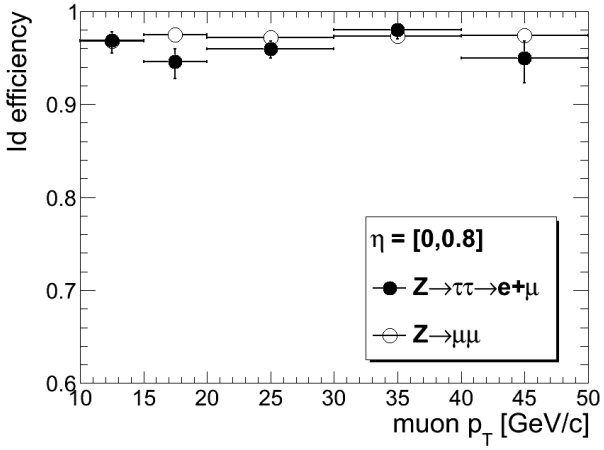
## Electrons

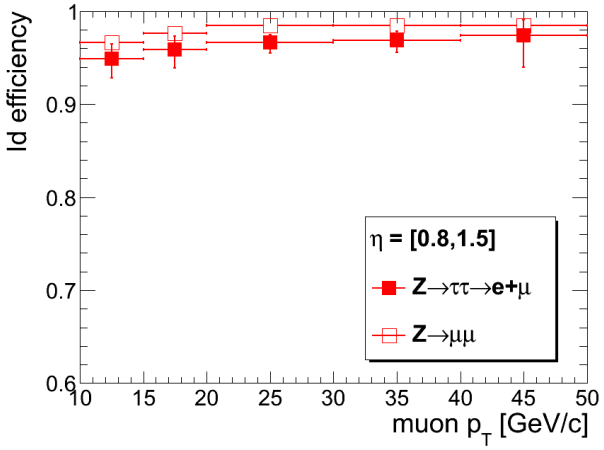


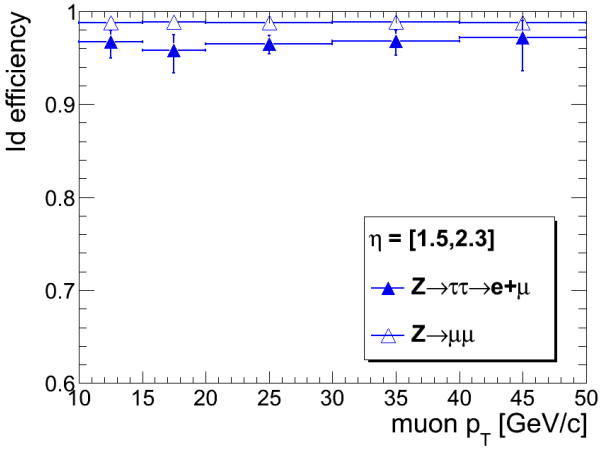




## Muons



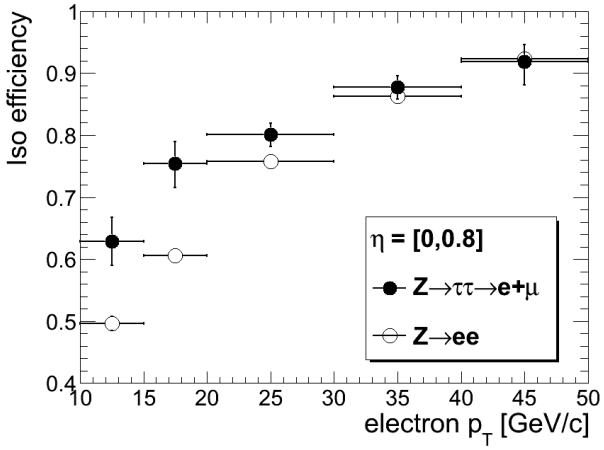



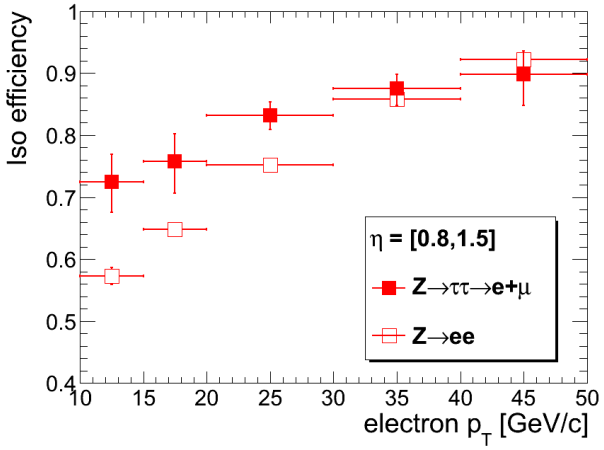



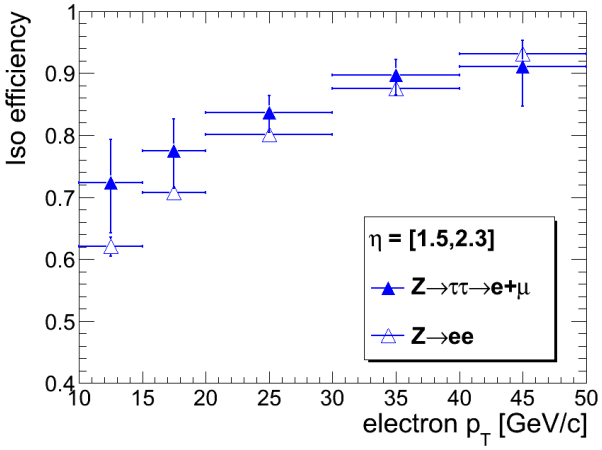
# Break down efficiency

- **Lepton Iso (relative to ID)**

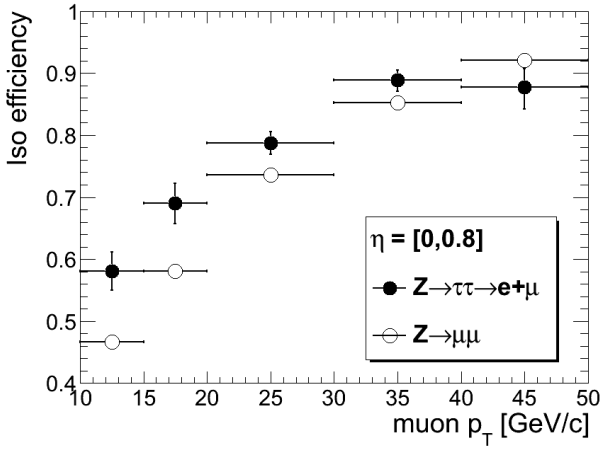
## Electrons

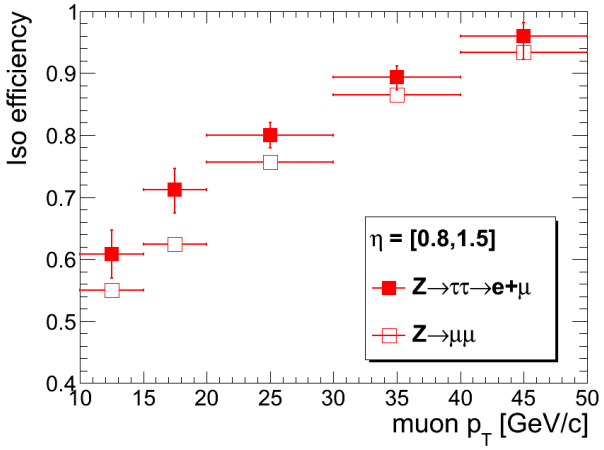


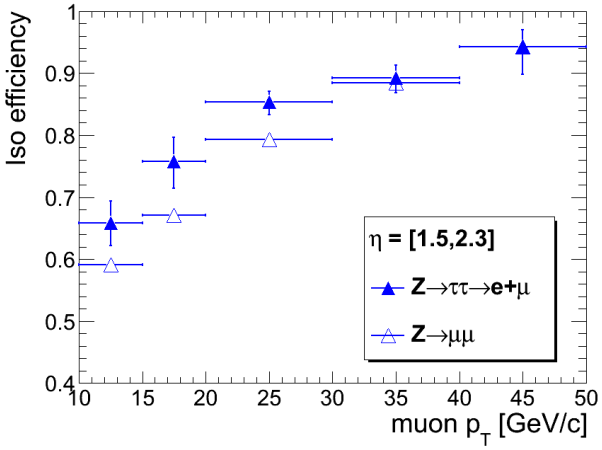




## Muons



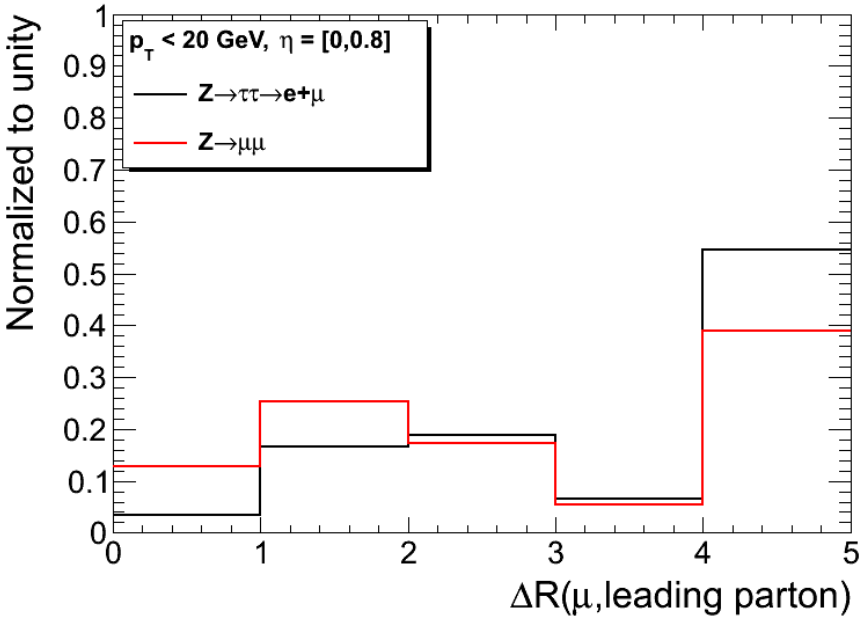
# Observations

- **The lepton isolation efficiency differs between T-&-P measurement and actual isolation efficiency in $Z \rightarrow \tau\tau \rightarrow e+\mu$ events**
  - **difference is more pronounced for low pT leptons in the central region**
- **Educative guess**
  - **Isolation is affected by additional jets in DY events**
  - **T-&-P selection of $Z \rightarrow ee/\mu\mu$ events and nominal selection of $Z \rightarrow \tau\tau \rightarrow e\mu$ events probe different phase space of Z boson and accompanying jets**
- **Generator test**
  - **Plot $\Delta R$ between generated lepton and leading accompanying parton (DY+Jets events) for different (pT,eta) bins of generated leptons**
  - **leading parton is requested to have pT > 10 GeV**
  - **second lepton is required to be within the acceptance cuts imposed**
    - **by T-&-P selection (tag lepton) in $Z \rightarrow ee/$**
    - **by nominal $Z \rightarrow \tau\tau \rightarrow e+\mu$ selection**

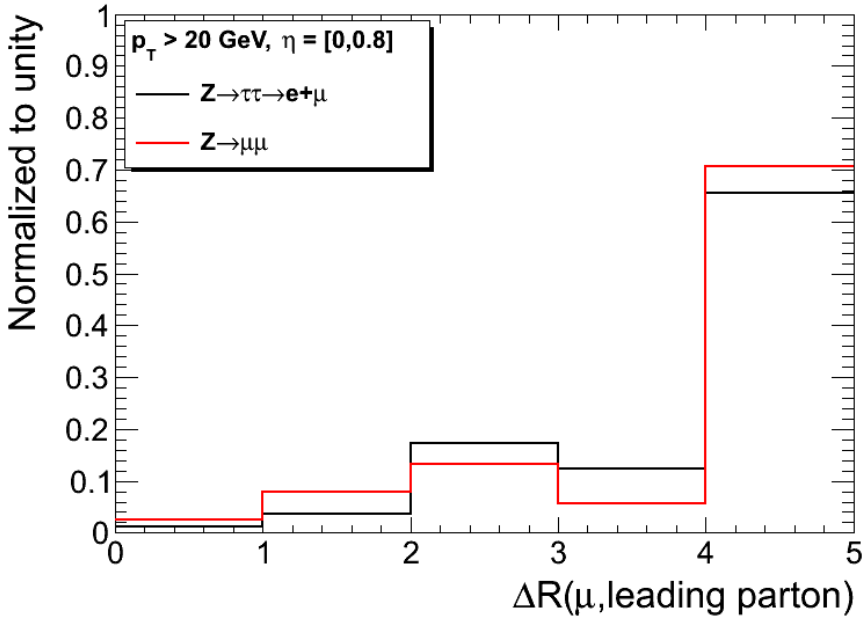
# Generator test

## Muons, |μ| < 0.8

### pT < 20 GeV



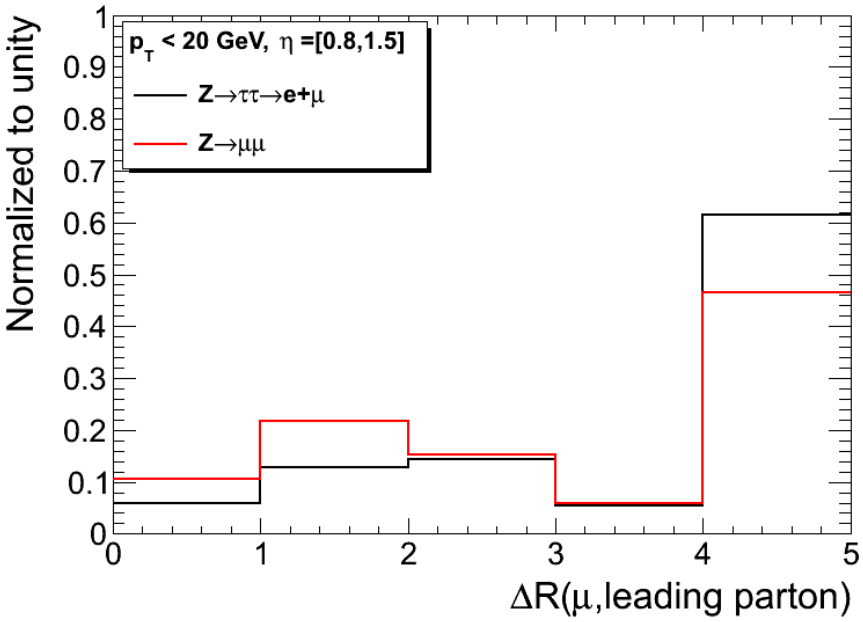

### pT > 20 GeV



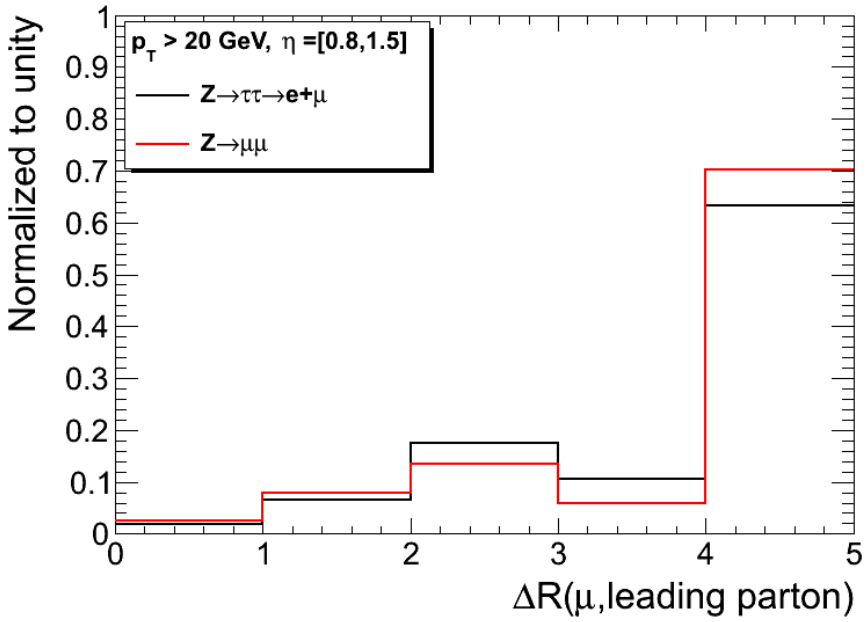
# Generator test

## Muons, 0.8 < |μ| < 1.5

### pT < 20 GeV



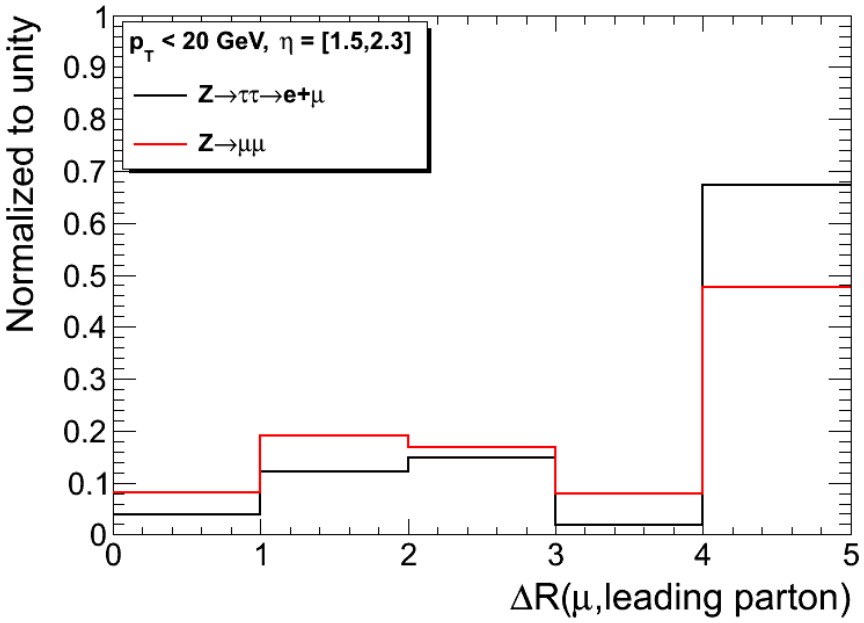

### pT > 20 GeV



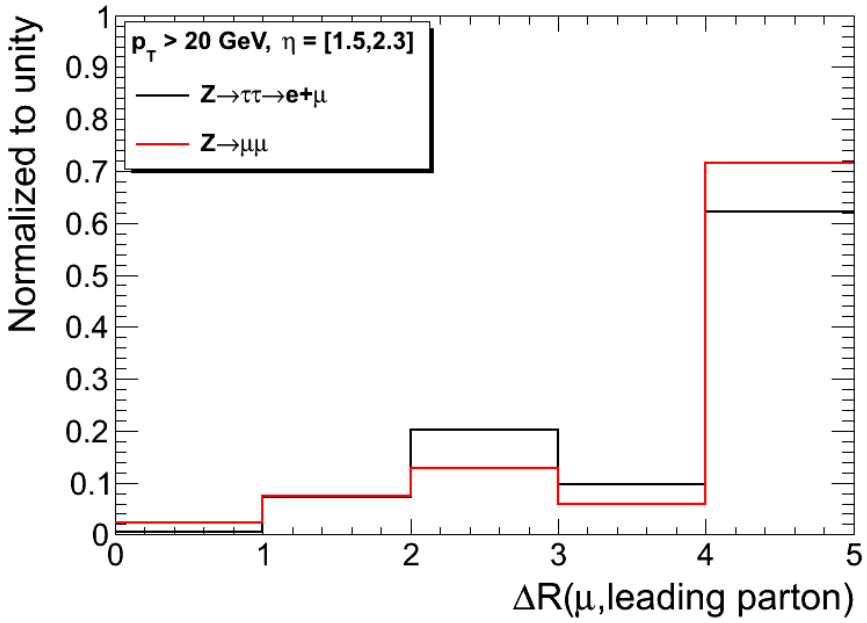
# Generator test

## Muons, 1.5 < |μ| < 2.3

### pT < 20 GeV




### pT > 20 GeV



# Summary

- **Systematic difference is observed between lepton Iso efficiency as measured with T-&-P technique and actual Iso efficiency in Z → e+μ events**
  - **effect is more pronounced for low pT leptons in the central region**
- **Effect is due to different phase space of Z boson and accompanying jets probed by T-&-P selection of Z → ee/μμ and nominal Z → ττ → e+μ selection**
- **Will this introduce significant bias in computation of lepton scale factors?**
  - **additional studies are needed**