EM ID Efficiencies

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- definition of "data method efficiency"
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  - by considering different p_T distribution
- completing the data method efficiency
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definition of EM−ID

- PURE Monte Carlo study
- p13.05 Monte Carlo processed with top_analyze v00−02−20 in p13.09.00
- two samples:
  - 21,000 top −> e + jets events (will also call them W−> e + ν)
  - 101,000 Z −> e + e events

- loose electron:
  - $p_T > 15$ GeV
  - EM fraction > 90%
  - isolation < 0.15
  - χ^2(H−matrix) < 20
- tight electron:
  - loose criteria
  - trackmatch with χ^2 probability > 0.01

MC method efficiency

goal: find EM ID efficiency for W −> e + ν in data.

$$\frac{\text{MC Eff } (W \to e + \nu)}{\text{Data Eff } (W \to e + \nu)} = \frac{\text{MC Eff } (Z \to e + e)}{\text{Data Eff } (Z \to e + e)}$$

efficiencies depend on p_T, η and ϕ.

Monte Carlo method (for W −> e + ν and Z −> e + e):

$$\varepsilon_{MC} = \frac{\text{number of tight electrons}}{\text{number of generated electrons}}$$

data method efficiency

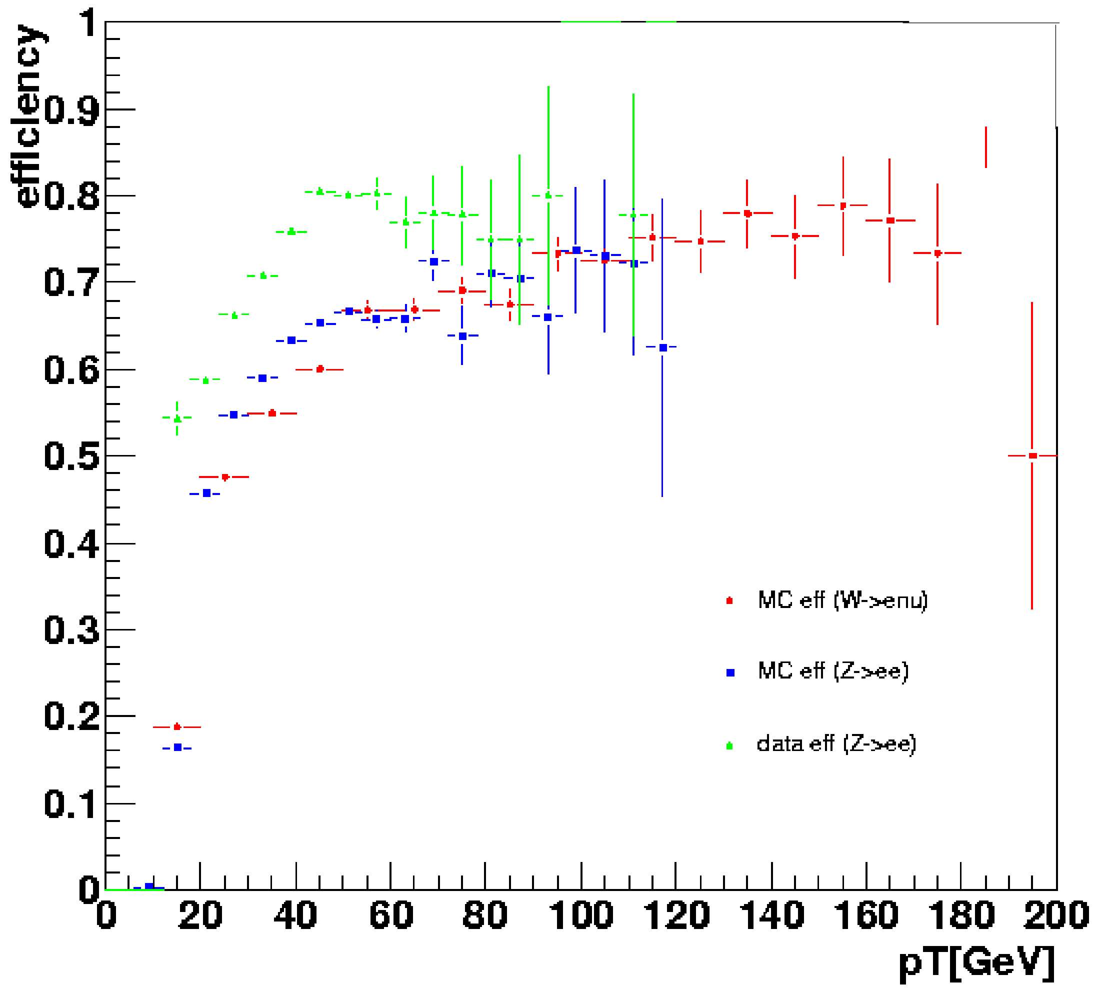
1) look for one tight electron (electron candidate 1)
2) look for a second loose electron in the same event (electron candidate 2)
3) calculate their invariant mass:

Is the result the Z−mass?
If so, electron candidate 2 was most likely an electron as well and we check if it was found as tight electron.

data method (for Z −> e + e only):

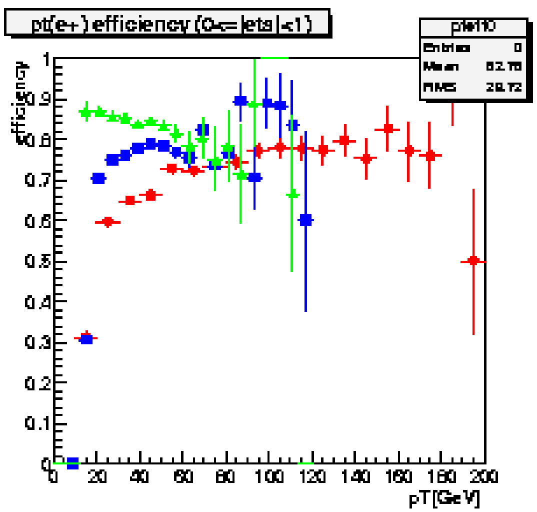
$$\varepsilon_{data} = \frac{\text{number of events with electron 2 tight}}{\text{number of events with electron 2 loose}}$$

naïve efficiency(p_T)

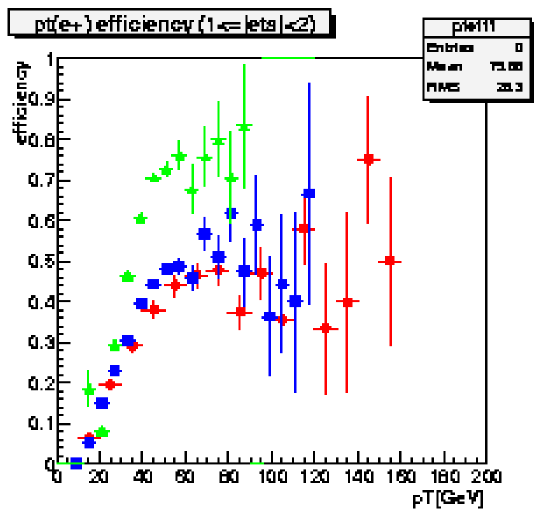


naïve efficiency(p_T)

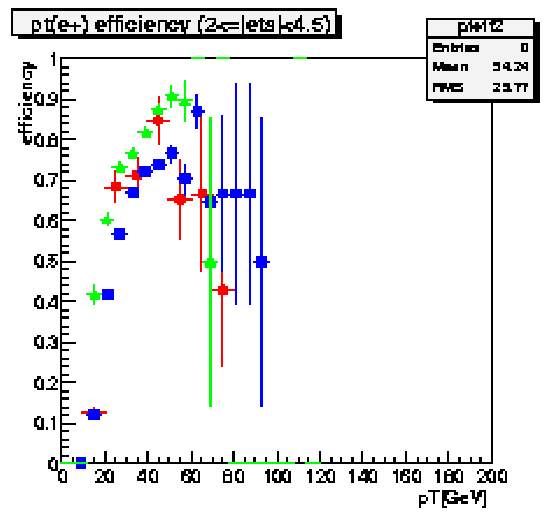
$0 \leq |\eta| < 1$



$1 \leq |\eta| < 2$



$2 \leq |\eta| < 4.5$



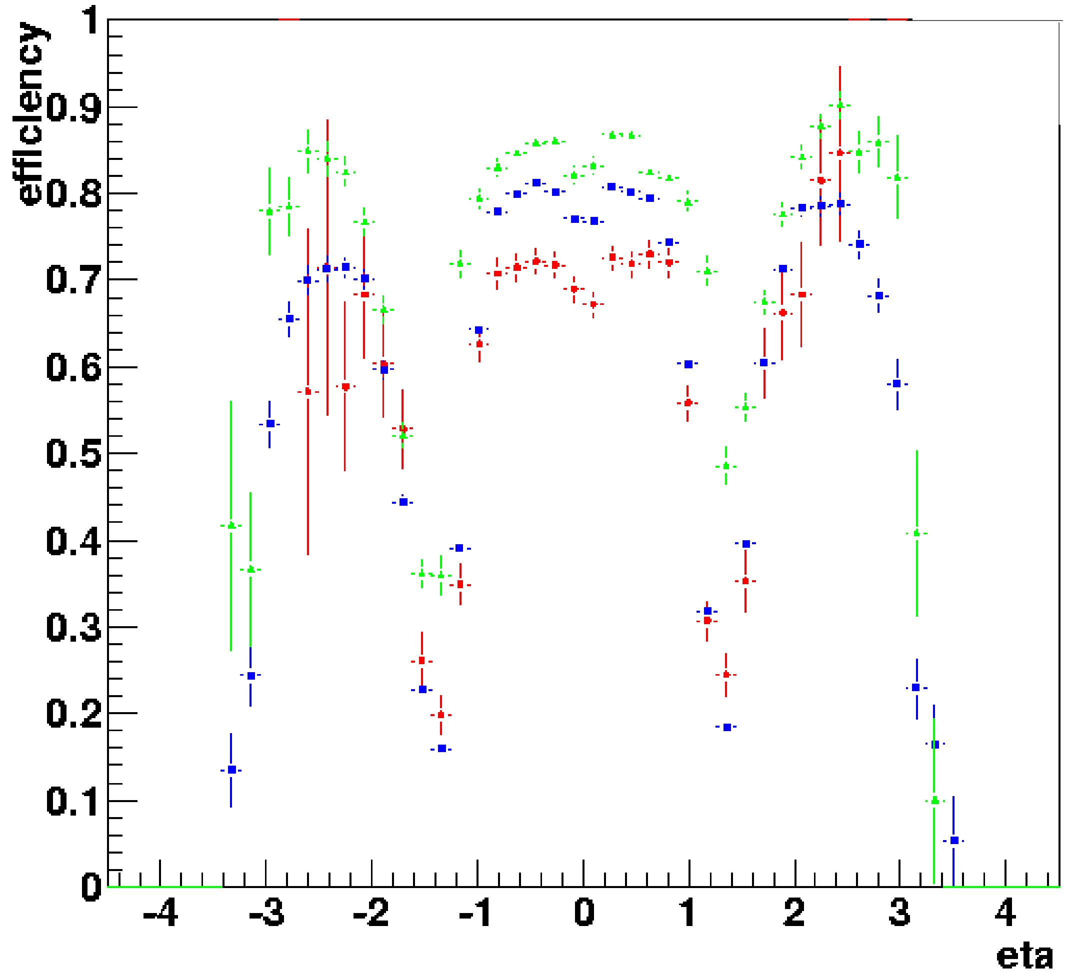
MC eff (W −> e + ν)

MC eff (Z −> e + e)

Daten eff (Z −> e + e)

naïve efficiency(η)

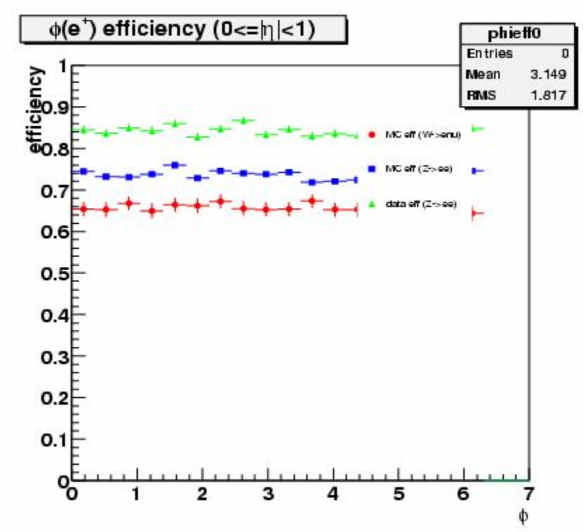
für $p_T > 30$ GeV:

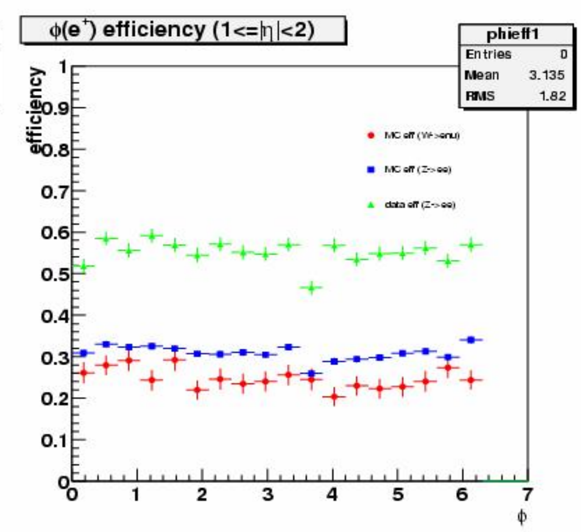


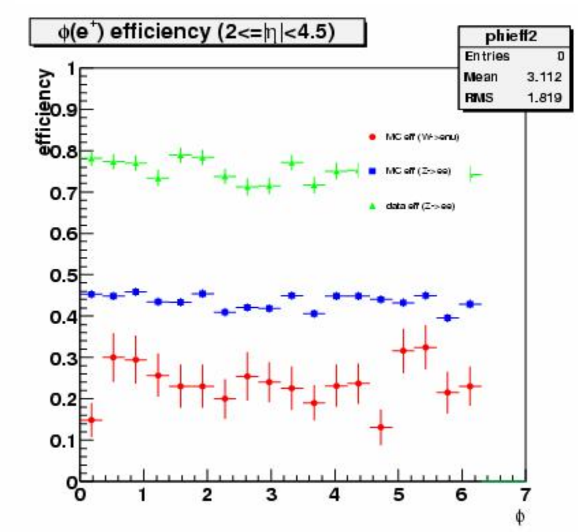
MC eff (W −> e + ν)
MC eff (Z −> e + e)
Daten eff (Z −> e + e)

naïve efficiency(ϕ)

$0 \leq |\eta| < 1$ | $1 \leq |\eta| < 2$ | $2 \leq |\eta| < 4.5$





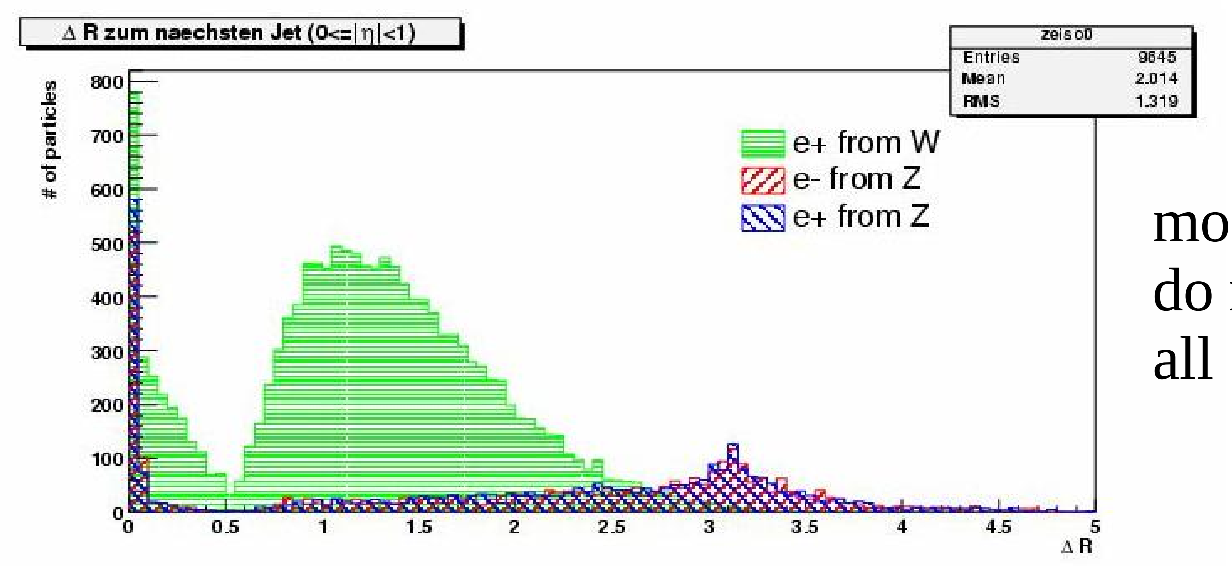


MC eff (W −> e + ν)
MC eff (Z −> e + e)
Daten eff (Z −> e + e)

MC efficiencies

- efficiencies should be the same, at least the two MC efficiencies
- where do the differences in the two samples come from?
  1) different topology −> isolation
  2) different p_T, η, ϕ distributions

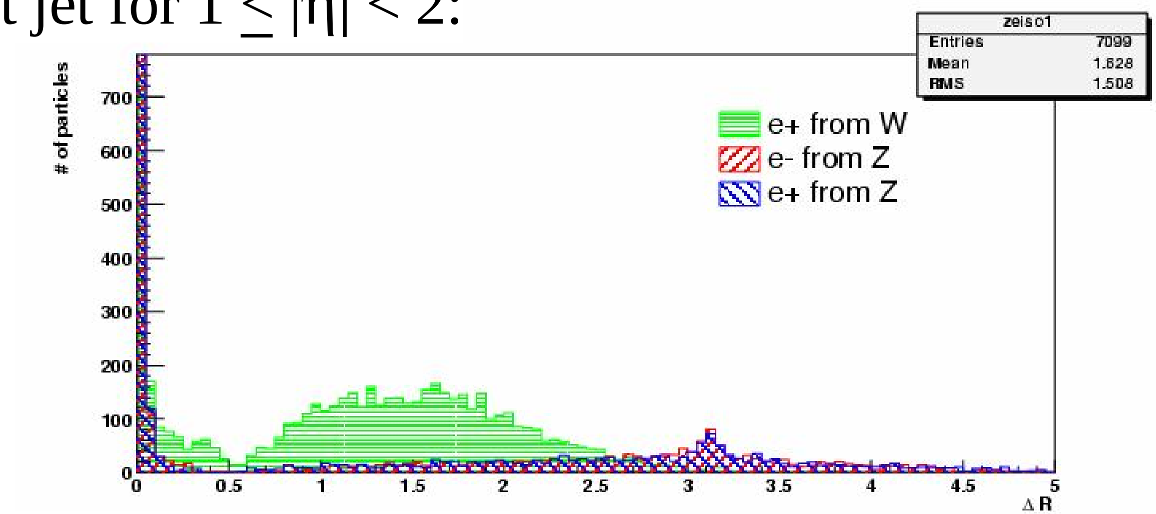
1) Isolation: ΔR to next jet for $0 \leq |\eta| < 1$:



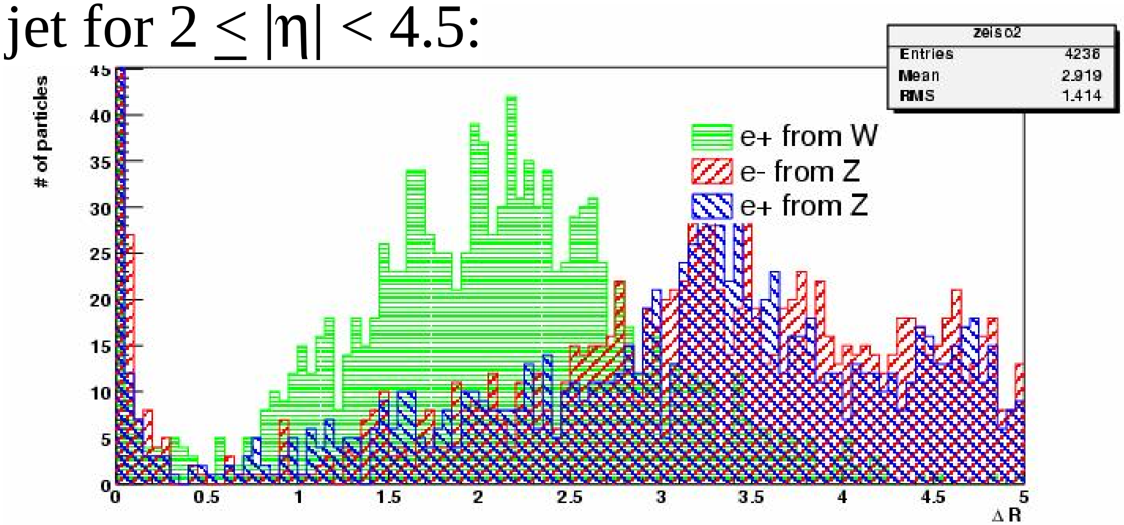
most Z −> e + e events do not have any jets at all

MC efficiencies

ΔR to next jet for $1 \leq |\eta| < 2$:

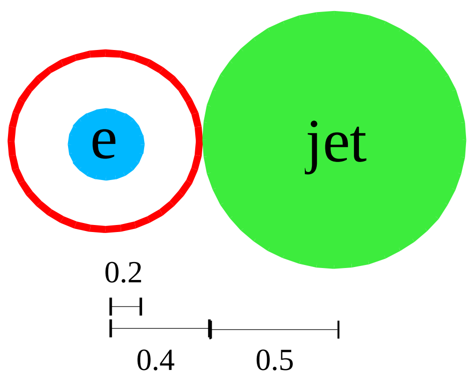


ΔR to next jet for $2 \leq |\eta| < 4.5$:



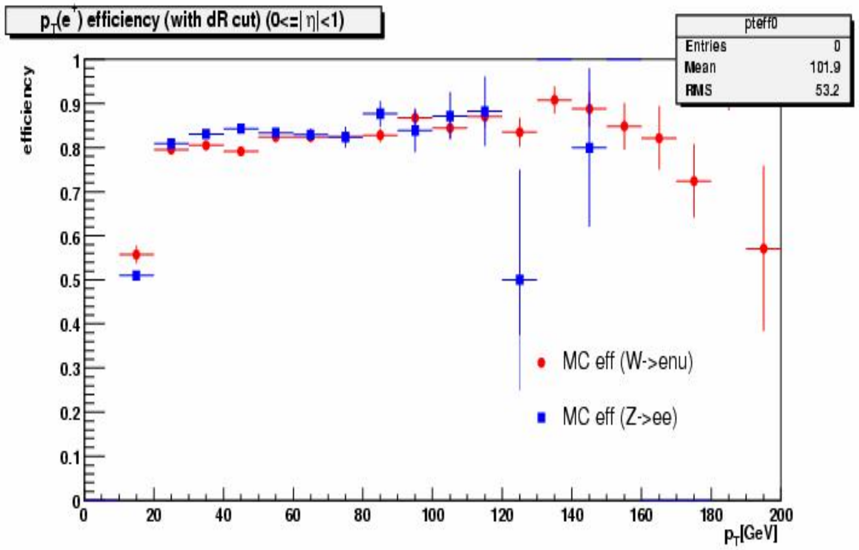
isolation correction

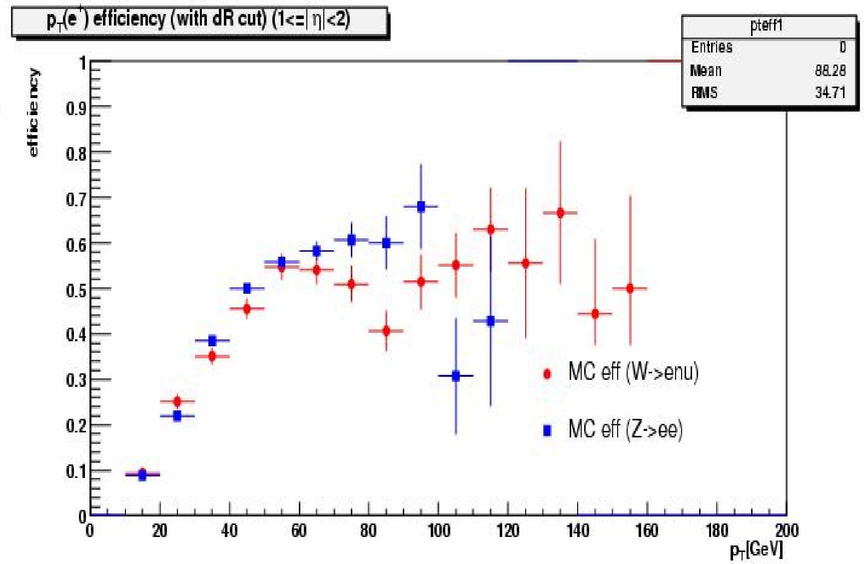
- neglect all electrons that have a jet closer than $\Delta R = 0.9$
- why 0.9?

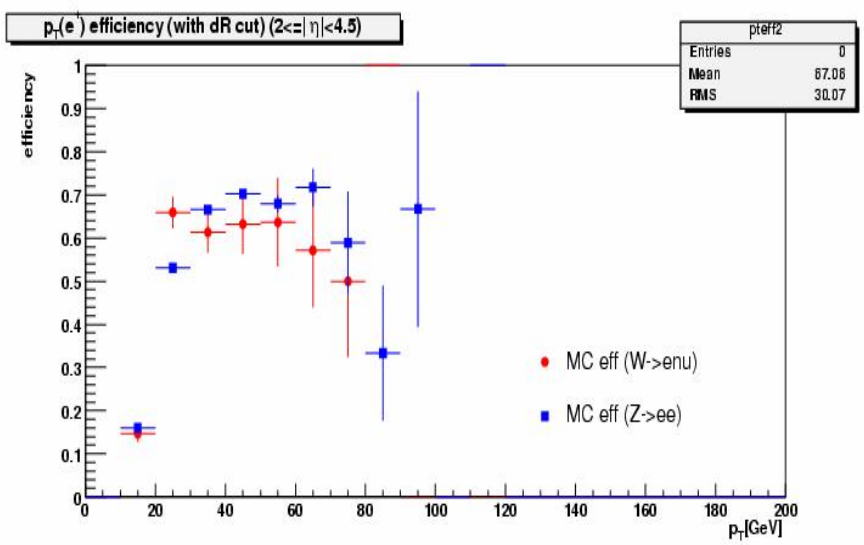


- I do not lose too much statistics by doing that

MC efficiency(p_T)





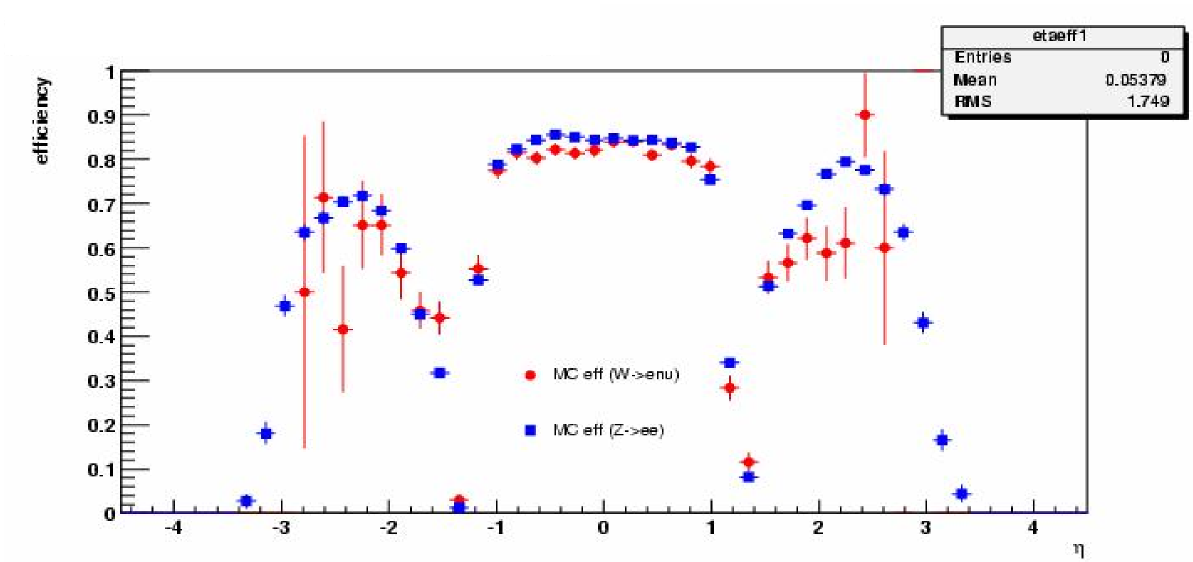


MC eff (W −> e + ν) w/ isolation cut

MC eff (Z −> e + e) w/ isolation cut

MC efficiency(η)

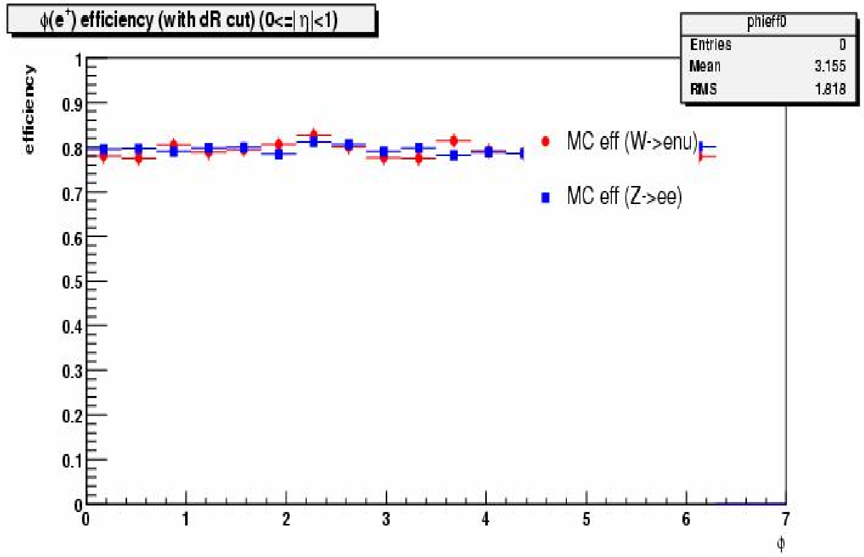
für $p_T > 30$ GeV:

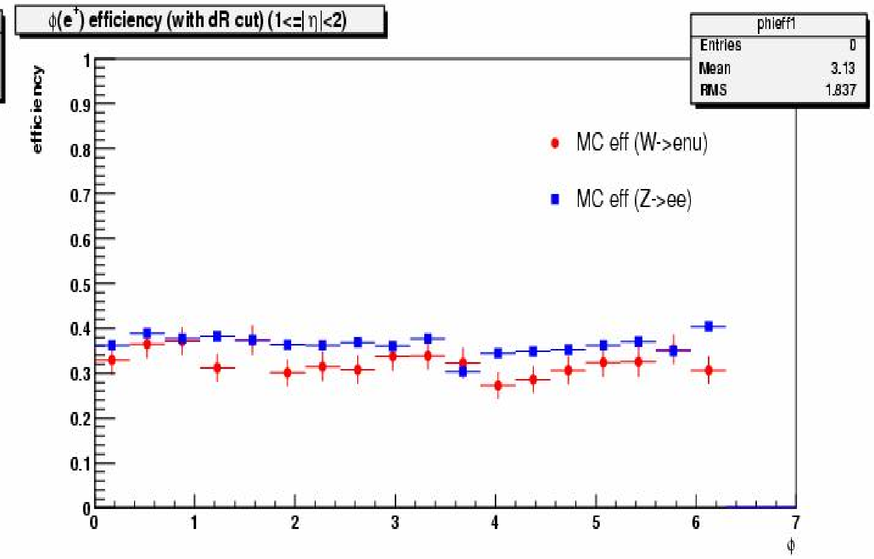


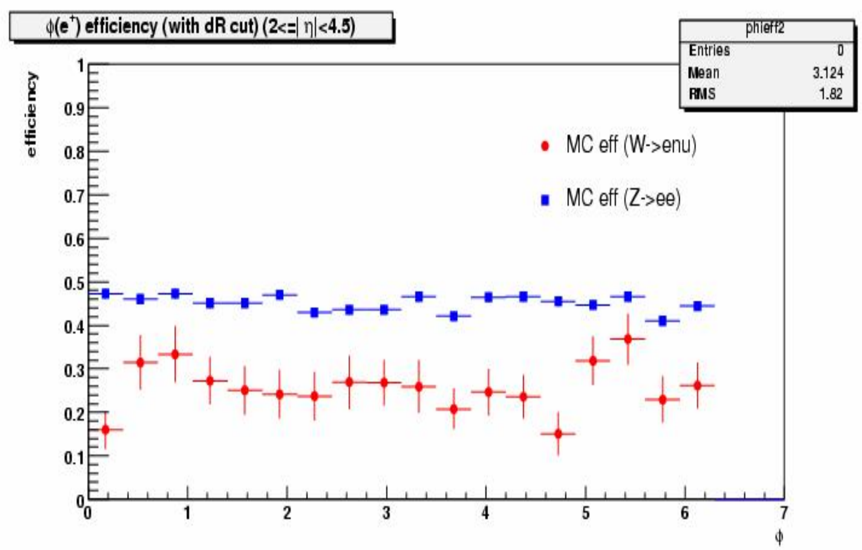
MC eff ($W \rightarrow e + \nu$) w/ isolation cut

MC eff ($Z \rightarrow e + e$) w/ isolation cut

MC efficiency(ϕ)





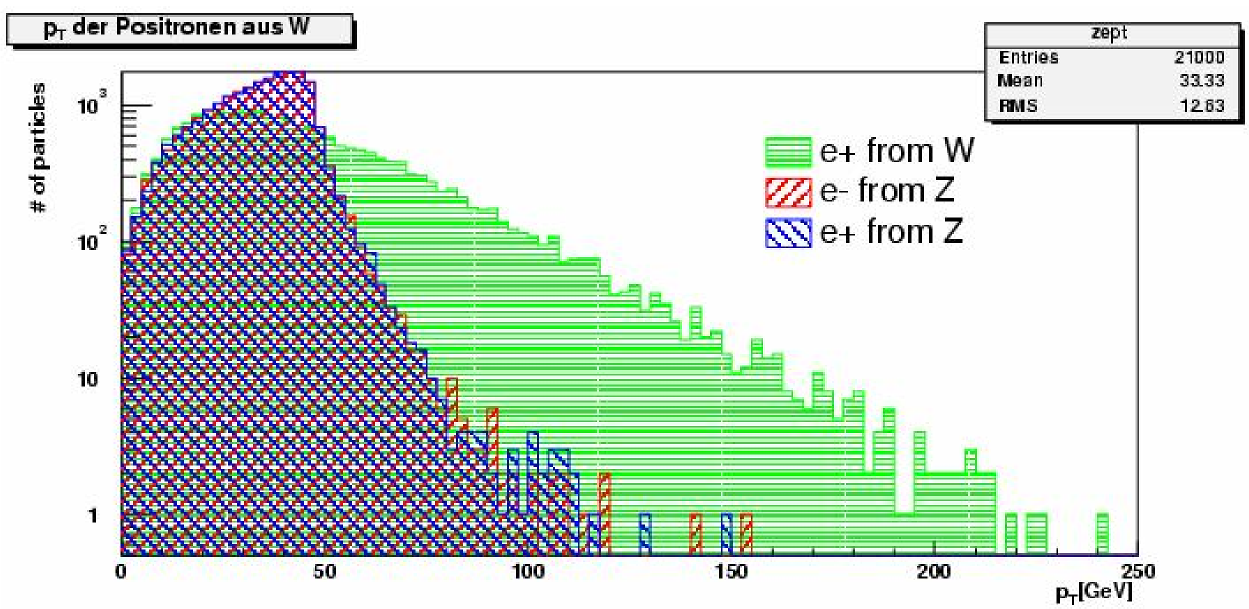


MC eff (W −> e + ν) w/ isolation cut

MC eff (Z −> e + e) w/ isolation cut

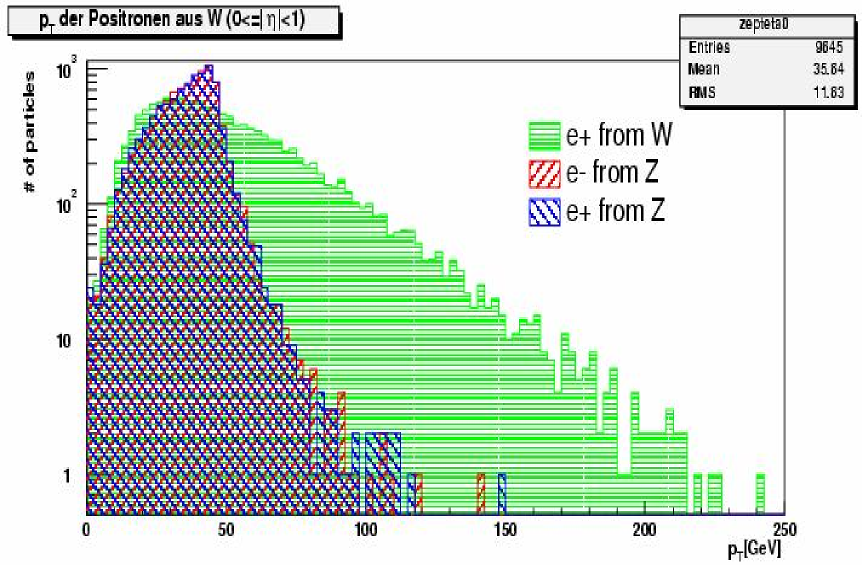
distributions

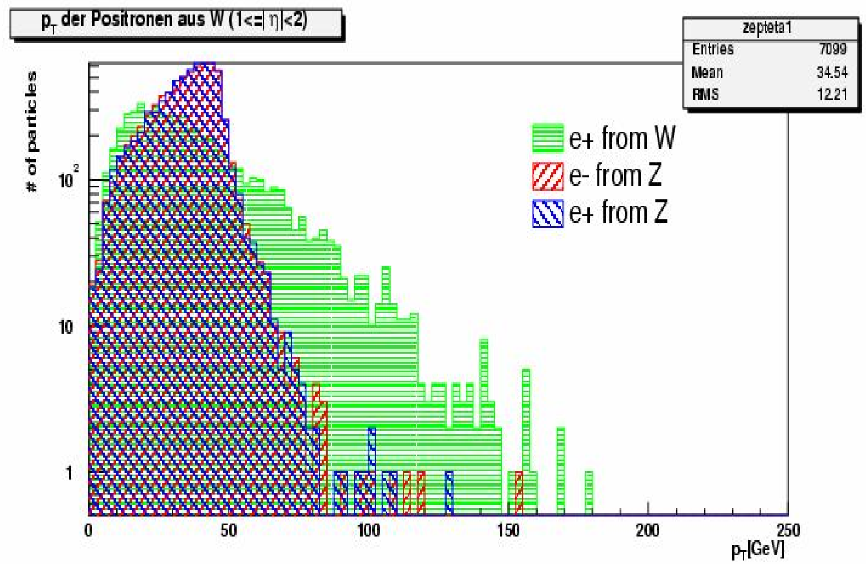
2) distributions:

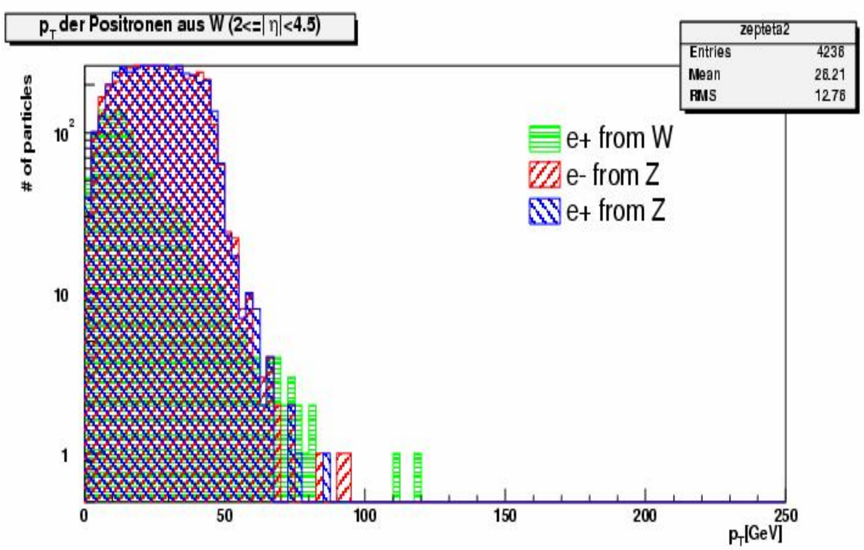


very different in sensitive area from 20 GeV to 60 GeV
−> weight p_T distribution

distributions

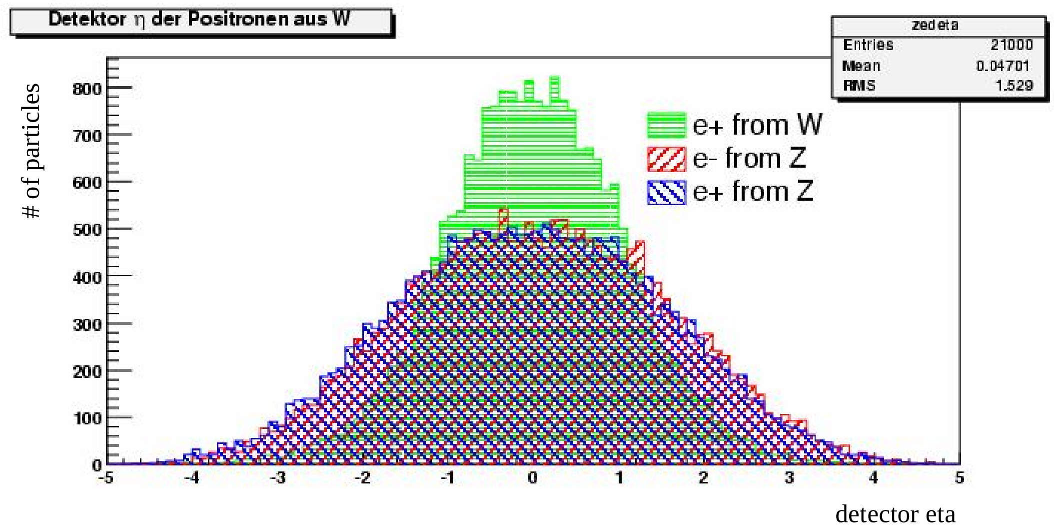




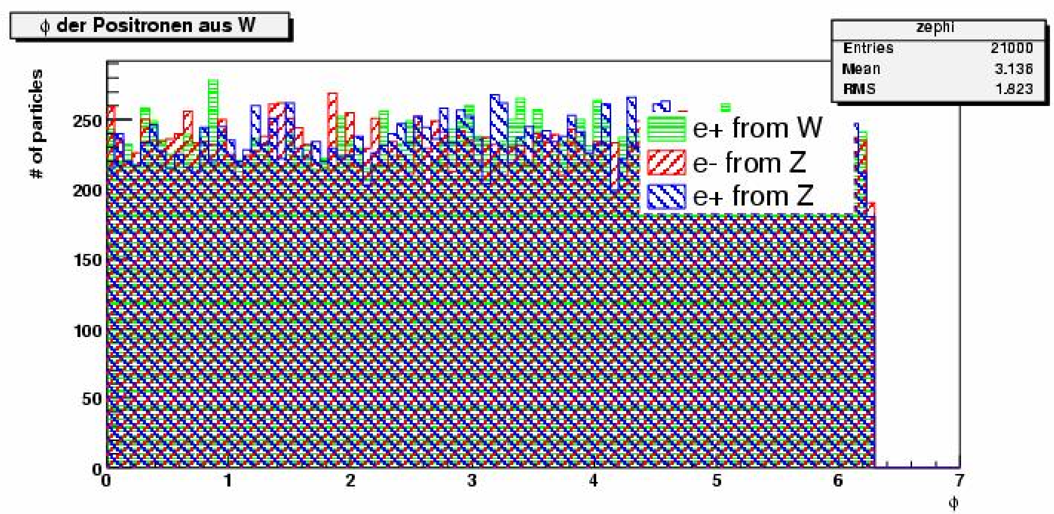


differs from η−region to η−region
−> weight p_T distribution according to η−region

distributions

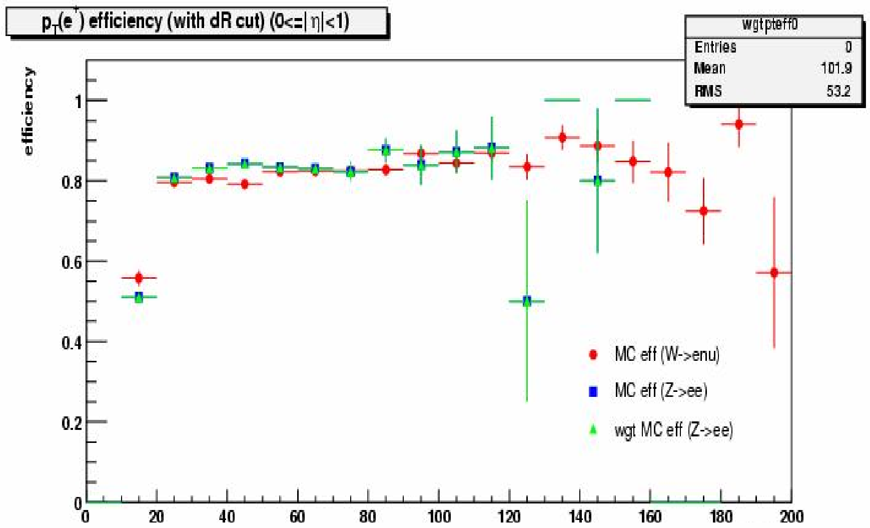


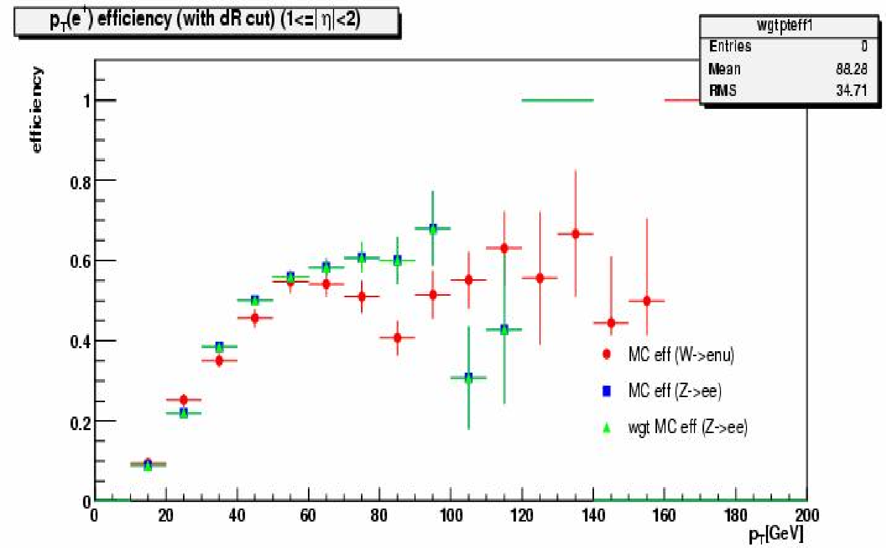
electrons from W from top only up to eta = 3

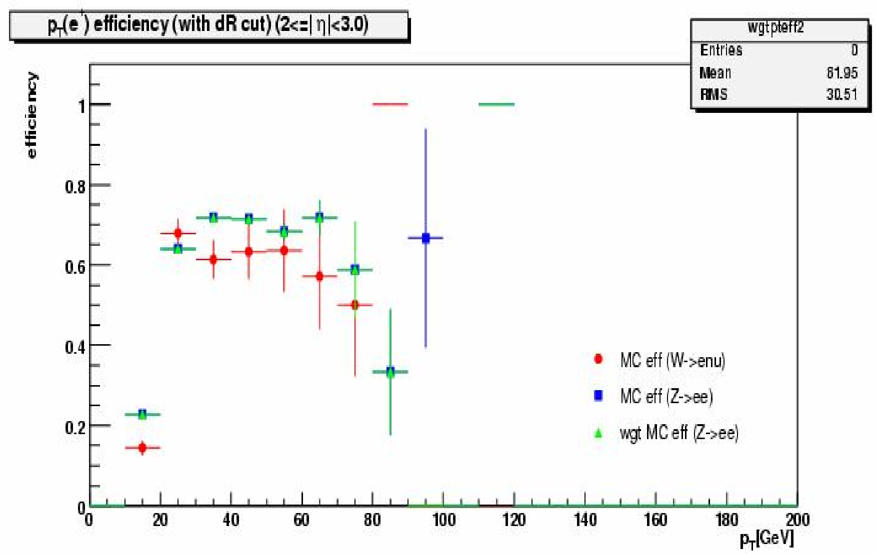


no difference, all flat

improved MC efficiency(p_T)





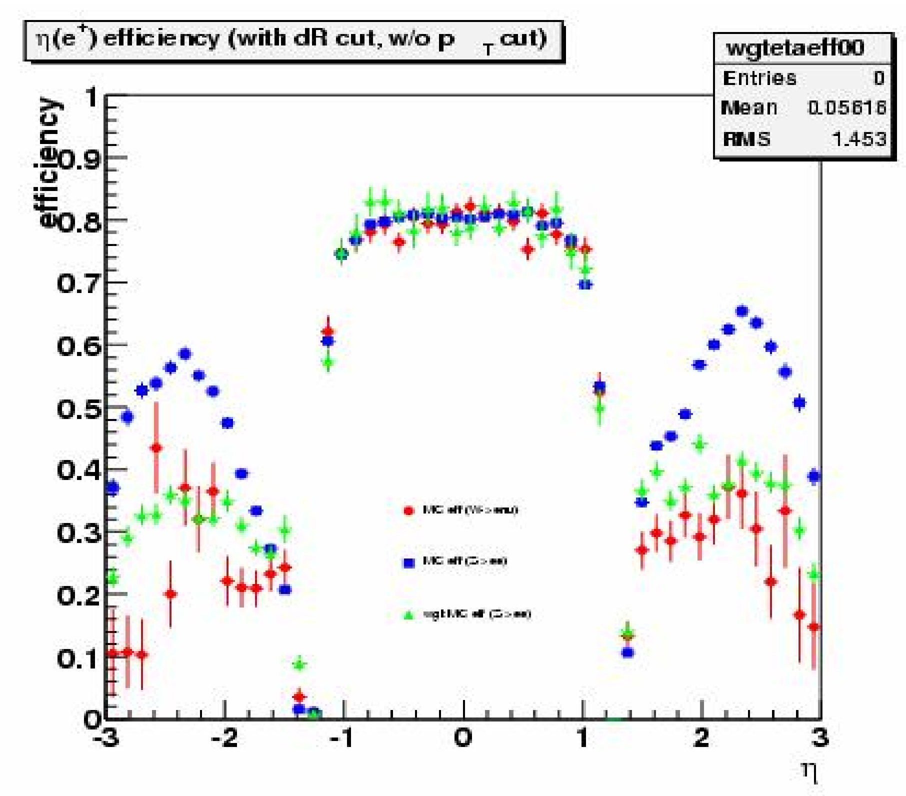


MC eff (W −> e + ν) w/ isolation cut

MC eff (Z −> e + e) w/ isolation cut

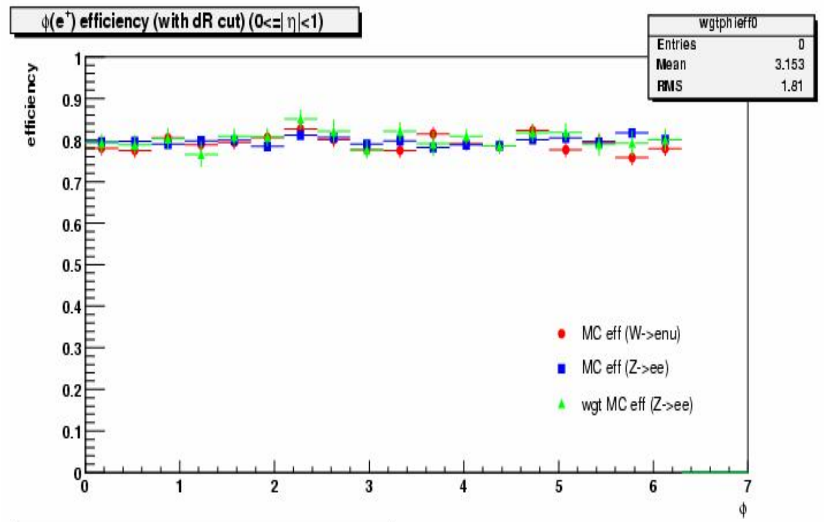
MC eff (Z −> e + e) w/ isolation cut and weighted distribution

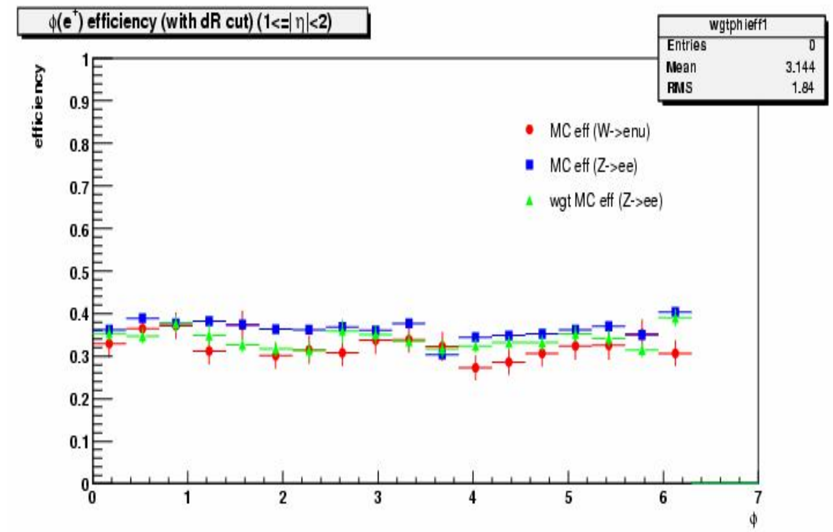
improved MC efficiency(η)

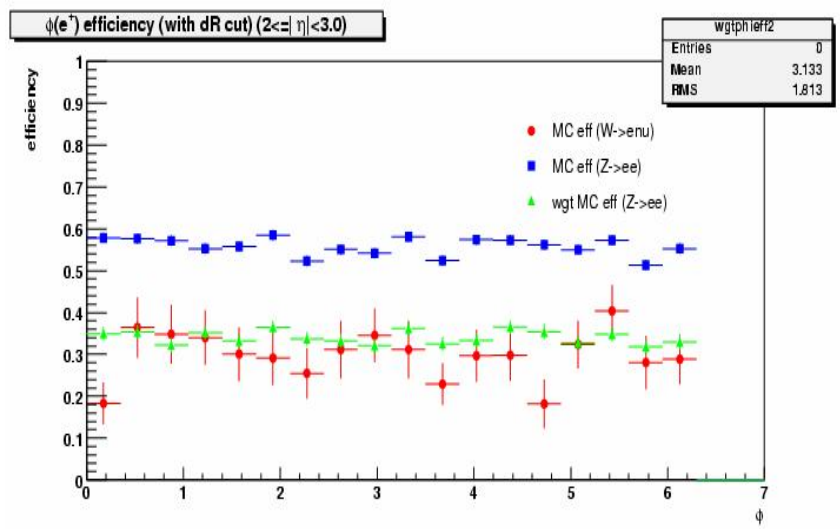


MC eff (W −> e + ν)
w/ isolation cut
MC eff (Z −> e + e)
w/ isolation cut
MC eff (Z −> e + e)
w/ isolation cut and
weighted distribution

improved MC efficiency(ϕ)







MC eff ($W \rightarrow e + \nu$)
w/ isolation cut

MC eff ($Z \rightarrow e + e$)
w/ isolation cut

MC eff ($Z \rightarrow e + e$)
w/ isolation cut and
weighted distribution

−> very good agreement in both samples using MC method now.

data method

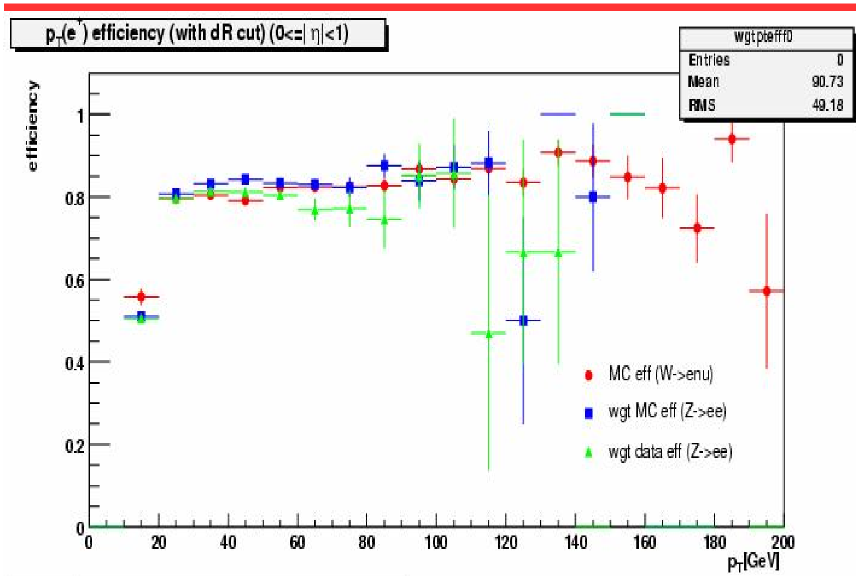
what about the data method?

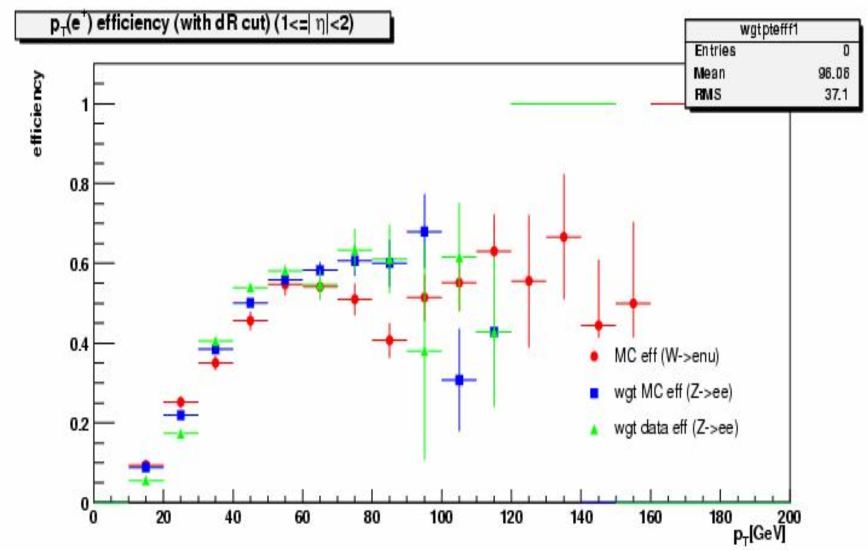
- cannot compare it directly to MC method like I did in my naïve first try, because

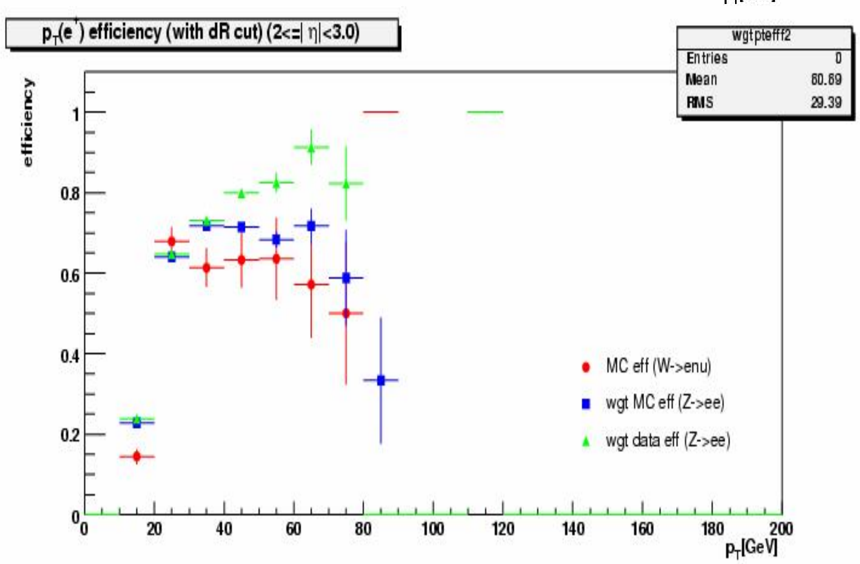
$$\varepsilon_{MC} = \frac{\#\,\text{tight}}{\#\,\text{all}} \quad \text{whereas} \quad \varepsilon_{data} = \frac{\#\,\text{tight + triggered}}{\#\,\text{loose + triggered}}$$

- need something like $\varepsilon_{trig} = \frac{\#\,\text{loose + triggered}}{\#\,\text{all}}$
- I was told that "loose" is a stricter criterium than the EM_HI trigger used for Z −> e + e triggering
- so I use $\varepsilon_{trig} = \frac{\#\,\text{loose}}{\#\,\text{all}}$ and multiply it to ε_{data}.

efficiency(p_T)





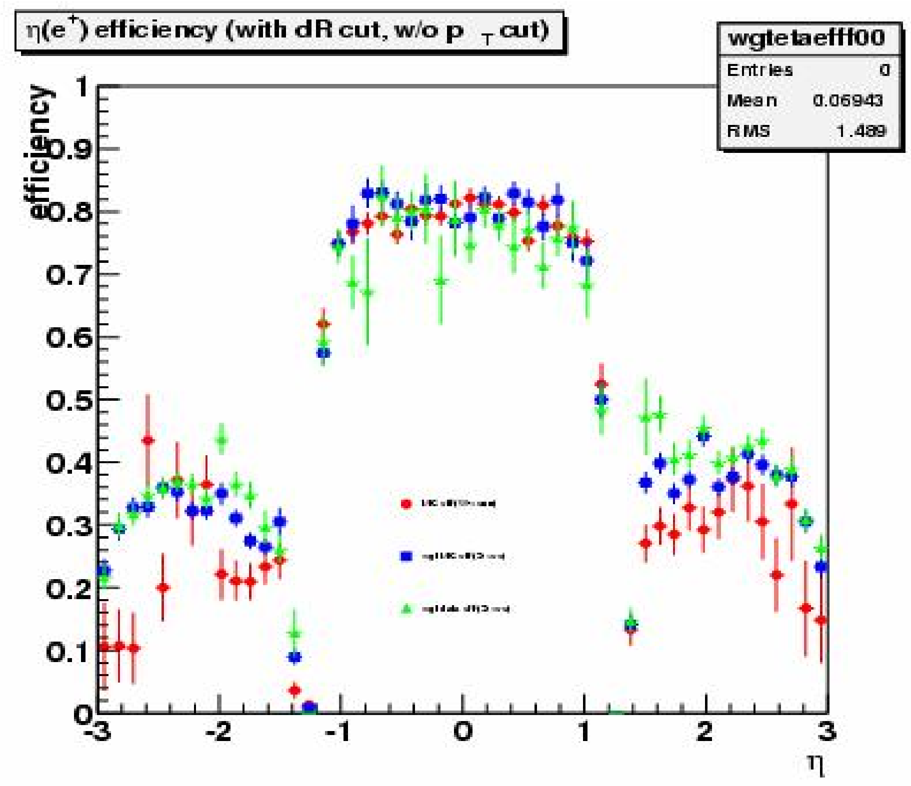


MC eff (W −> e + ν) w/ isolation cut

MC eff (Z −> e + e) w/ isolation cut and weighted distribution

data eff (Z −> e + e) w/ isolation cut and weighted distribution

efficiency(η)

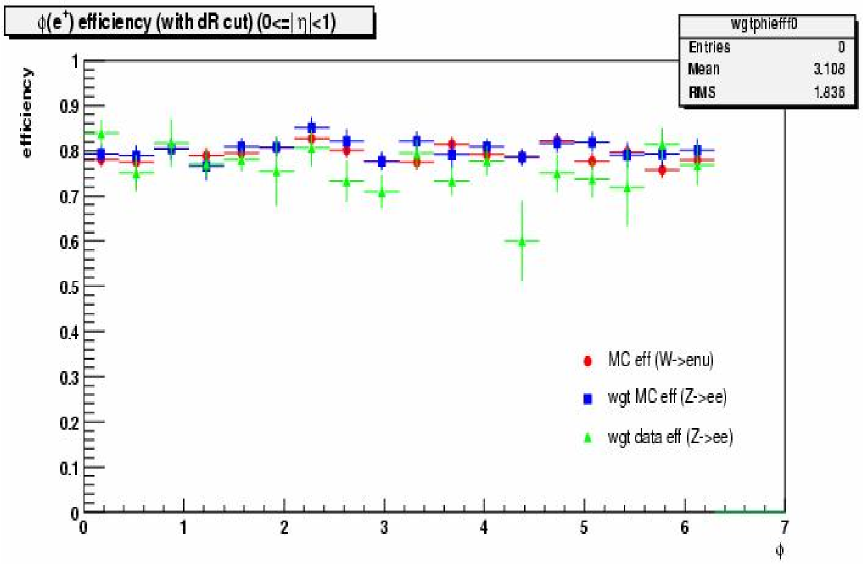


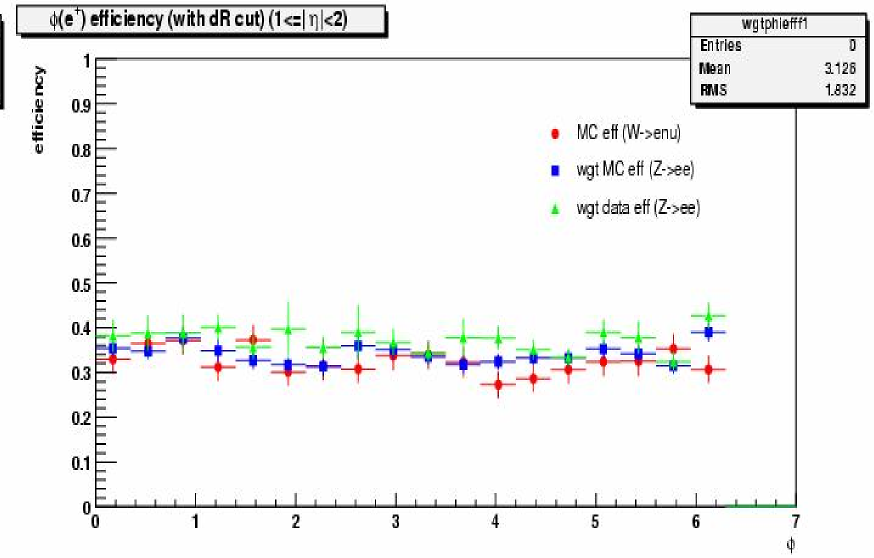
MC eff (W −> e + ν) w/ isolation cut

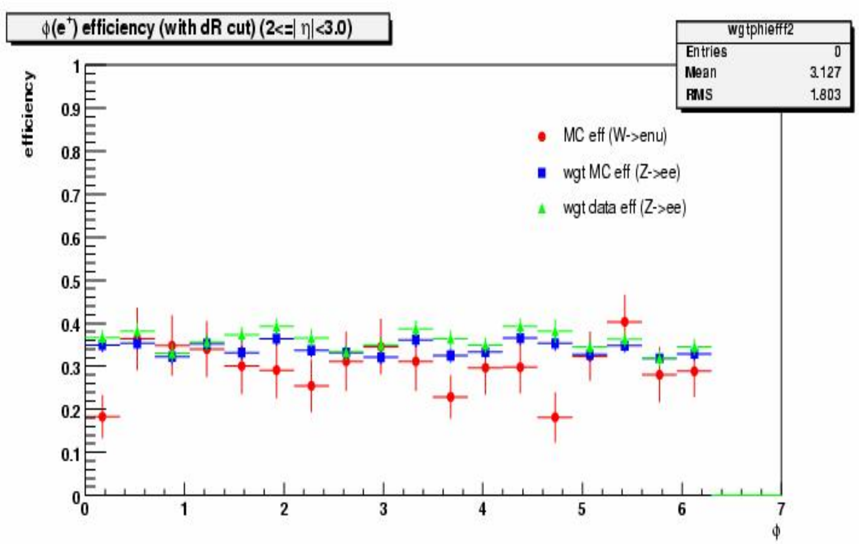
MC eff (Z −> e + e) w/ isolation cut and weighted distribution

data eff (Z −> e + e) w/ isolation cut and weighted distribution

efficiency(ϕ)







MC eff (W –> e + ν) w/ isolation cut

MC eff (Z –> e + e) w/ isolation cut and weighted distribution

data eff (Z –> e + e) w/ isolation cut and weighted distribution

Conclusion and Outlook

- very good agreement now
- looking at fake electrons in QCD
- could also look at efficiencies using likelihood