Measuremet of azimuthal decorrelation angle between the leading jet and the scattered lepton in deep inelastic scattering at HERA

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We present measurements of the azimuthal decorrelation angle between the leading jet and scattered lepton in deep inelastic scattering. Azimuthal angular decorrelation has been proposed to study the Q^2 dependence of the evolution of the transverse momentum distributions (TMDs) and understand the small x region, providing unique insight to nucleon structure with an electron-ion collider. Previous decorrelation measurements of two jets have been performed in proton-proton collisions at very high transverse momentum; these measurements are well described by perturbative QCD at next-to-leading order. The kinematic region covered by the HERA ep DIS data is revisited with the emphasis on the physics leading to azimuthal decorrelation. These measurements were obtained by the ZEUS experiment during the HERA II data-taking period, corresponding to integrated luminosities of 330 pb^{-1}, respectively. The measurements showing good agreement with predictions from QCD calculations.

From the previous presentation

- Check why we see a cut on η_{max}
- Try P_T reweighting to fix η^{jet}-discrepancy (for $\eta^{jet} > 1$)
- Choose unfolding-scheme to stick with

Event selection

Data

- 040506e $\sim 189\text{pb}^{-1}$
- 0607p $\sim 143\text{pb}^{-1}$

MC

- ari_incl_nc_DIS_lowQ2_040506e
- ari_incl_nc_DIS_lowQ2_0607p

Phase space

- $10 < Q^2 < 350\text{GeV}^2$
- $y_{el} < 0.7$ && $y_{jb} > 0.04$

Cleaning cuts

- $-40 <$ Zvtx/cm < 40
- $45\text{GeV} < E - p_z < 65\text{GeV}$
- Cal_pt/$\sqrt{\text{Cal\_et}} < 2.5$

Electron cuts

- 10 GeV $<$ Energy (Siecorr)
- $140^o < \theta < 180^o$
- Electron position $\sqrt{x^2 + y^2} > 20$
- Sienin[0] > 0.1*(Siein[0]+Sienin[0])
- Chimney cut
- Siprob[0], the lepton with hightest prob (> 0.9)

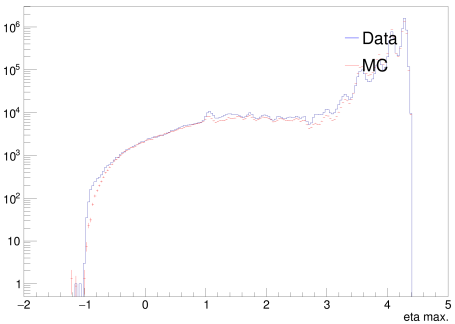
Triggers

- SPP02 (Tltw[2] & $(1 \ll 1)$) for 0405e
- SPP09 (Tltw[2] & $(1 \ll 8)$) for 06e and 0607p

Jet selection

- $E_T > 2.5$ GeV && $P_T < 30$ GeV
- $|\eta^{jet}| < 1.0$ / $-1.5 < \eta^{jet} < 1.8$
- Using jet with highest E_T

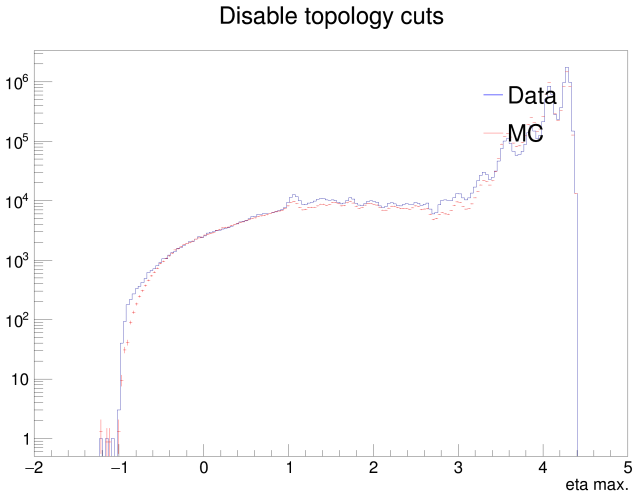
Eta max.



Etamax_ce

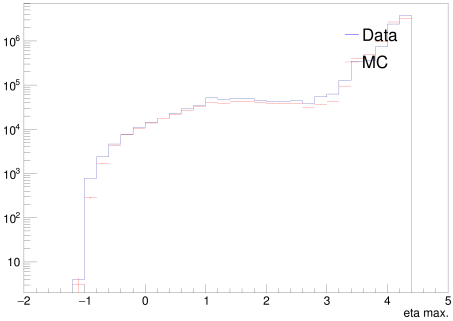
- Reduce bin width (plot on the left)
- Disable following cuts:
  - Cal_pt/$\sqrt{\text{Cal\_et}} < 2.5$
  - 10 GeV $<$ Energy (Siecorr)
  - $140^o < \theta < 180^o$
  - Energy in cone
  - Chimney cut
- Check eta max. from ZUFOs

Eta max., disable cuts

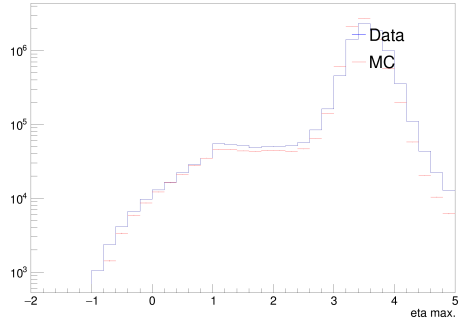


Disable some lepton cuts ⇒ *no changes*

Eta max. from ZUFOs



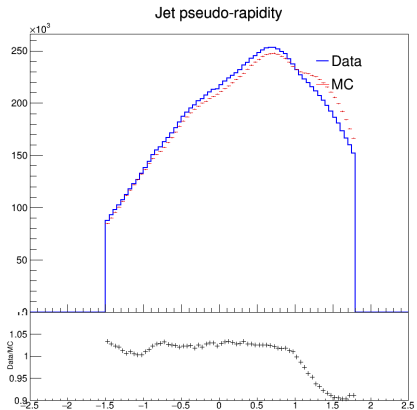
Etamax_ce



Etamax_zu

Check eta max. from ZUFOs ⇒ *Why so different?* *Which is the representative one?*

Jet pseudo-rapidity

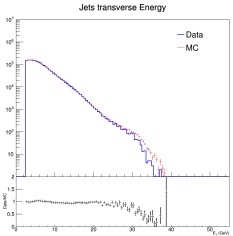


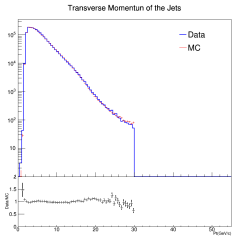
- Discrepancy in $\eta^{jet} > 1$ of $\approx 10\%$

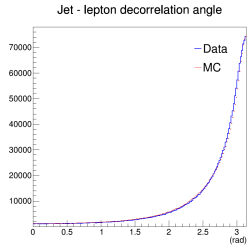
$\Rightarrow$ Try P_T^{jet}-reweighting (pol3)

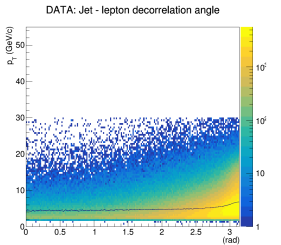
$\Rightarrow$ Try E_T^{jet}-reweighting (pol3)

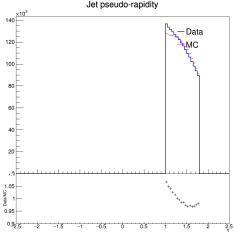
Jet η, P_T^{jet}-reweighting

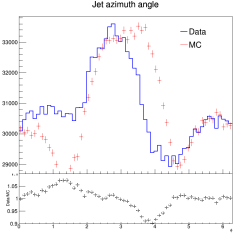


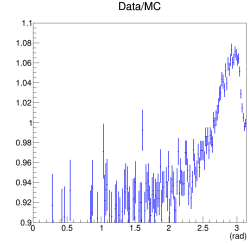


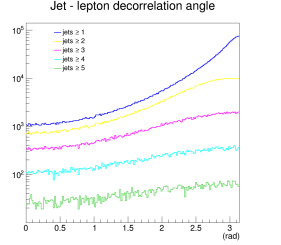




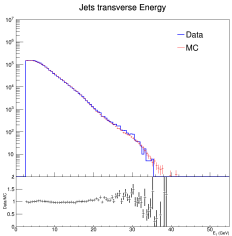


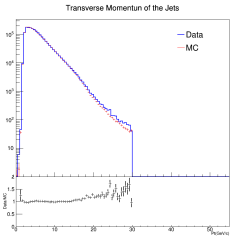


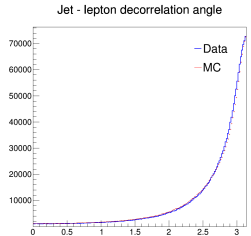


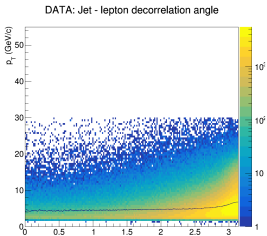


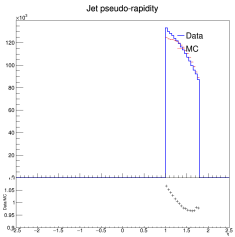
Jet η, E_T^{jet}-reweighting

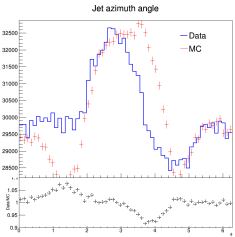


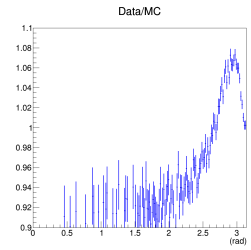


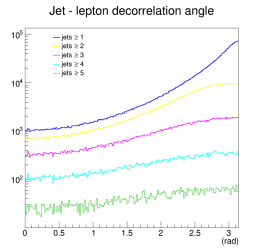




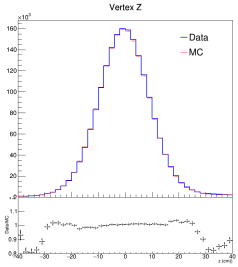


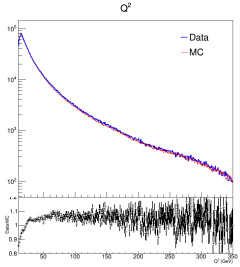


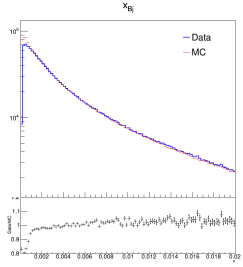


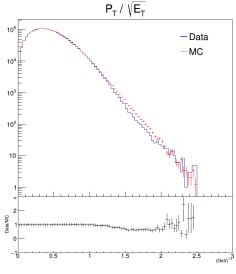


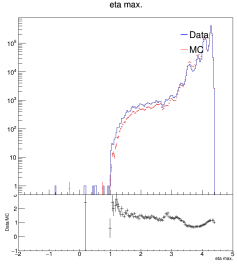
Jet η, Control plots for $\eta^{jet} > 1$

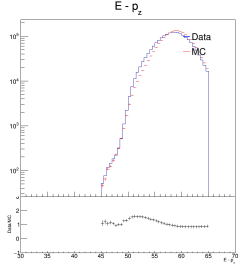




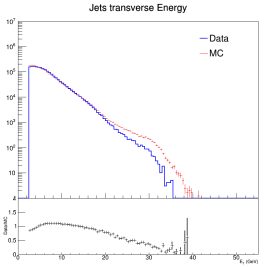


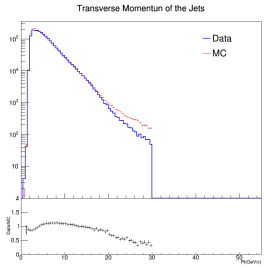


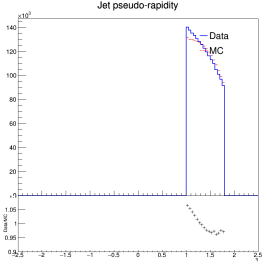


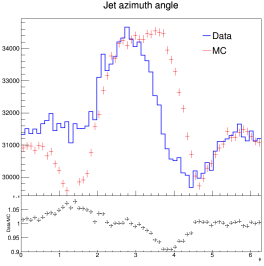


Jet η, Control plots for $\eta^{jet} > 1$

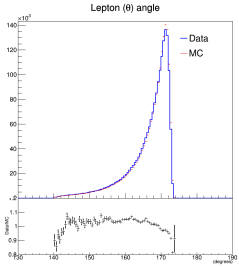


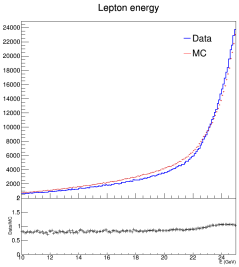


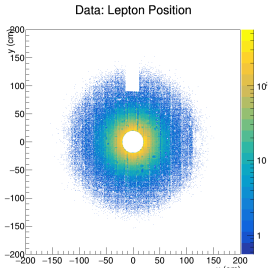


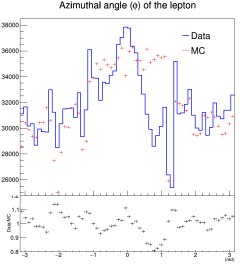


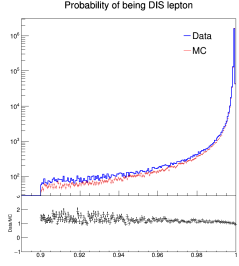
Jet η, Control plots for $n^{jet} > 1$

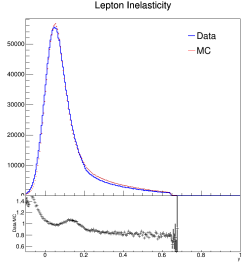




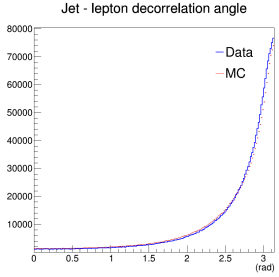


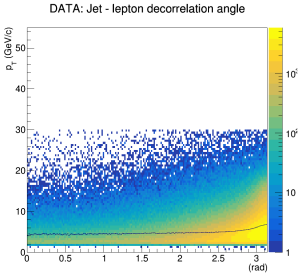


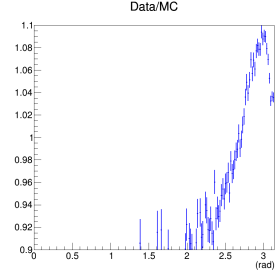


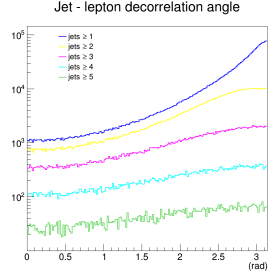


Jet η, Control plots for $\eta^{jet} > 1$









Note:
our measurement starts at $\underline{\Delta\varphi > 1.5}$

Jet η

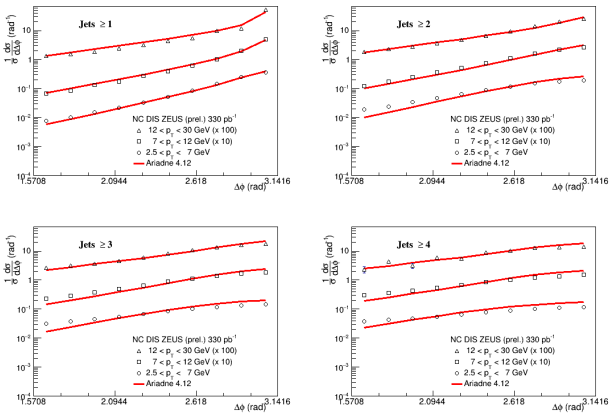
Summary

- Nor P_T nor E_T reweighting sovs issue with η.
- Reweightings give no significant improvements to decorrelation angle too, so won't be used onwards.
- It was said that "the straw tubes trackers was missing in 0405e", but separating this period doesn't fix the discrepancy.
- Discrepancy of $\approx 10\%$ is not fatal, so we are going to proceed it anyway. It will be propagated into systematics.
- Also, probably will do both eta^{jet}-ranges simultaneously.

Unfolding

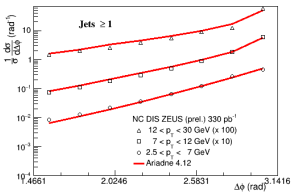
- Don't play with constrains on the regularization parameter,
- just reduce the binning for $N_{jet} \geq 4$ -plot

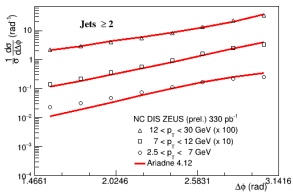
Unfolding (10 bins)

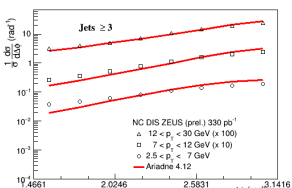


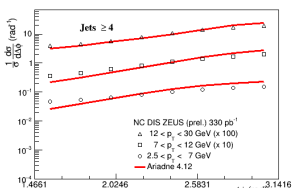
- good for Jets $\geq$ 1, 2, 3
- negative correlations for Jets $\geq$ 4

Unfolding (8 bins)









- works for Jets ≥ 4

$\Rightarrow$ use 10-bins-case for the former plots, and 8-bins for the last one

Systematics

- Variation of the energy measured for the lepton $\pm 2\%$ (Prompt photons)
- Jet energy scale, vary jet energy 4% for $E^{jet} < 10$ and 2.5% for $E^{jet} > 10$. (Prompt photons)
- Selection cuts, vary them within resolution of each variable. (Jets in DIS)
- Differences of using another MC generator to unfold the data. (Jets in DIS)

Summary

- Eta max. distribution is fine(?)
- Failed to fix discrepancy η.
- Reduce binning for high multiplicity (Jets ≥ 4)
- Primary list of systematics to be evaluated is presented.
- Will proceed with both η^{Jet} ranges ($|\eta| < 1$ and $-1.5 < \eta 1.8$).

Next steps

Calculate systematics

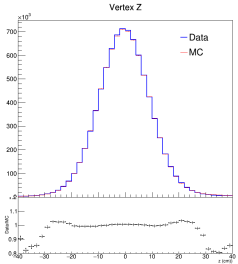
Backup

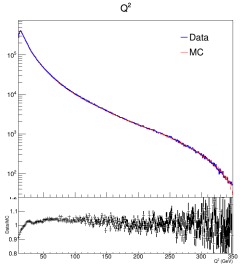
Control plots

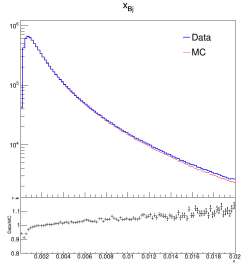
data: 8428266 events

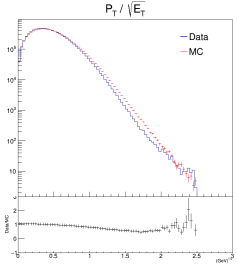
MC: 18976059 events

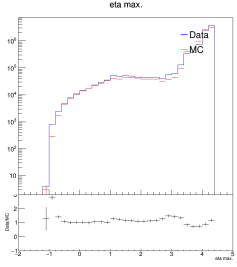
Control plots

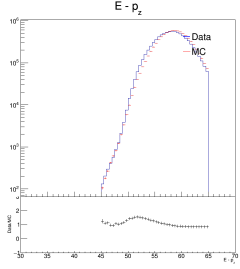




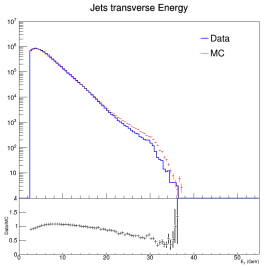


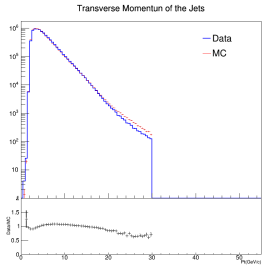


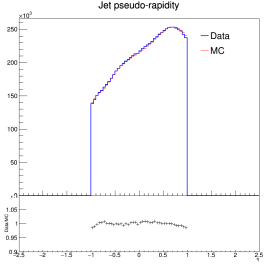


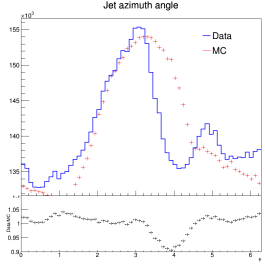


Control plots

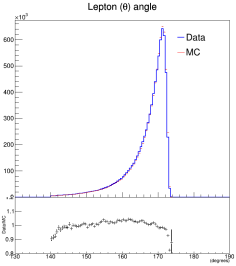


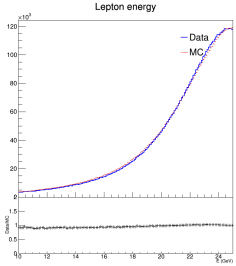


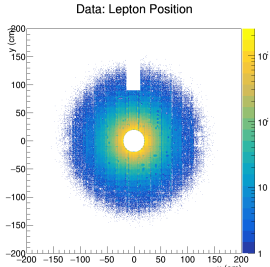


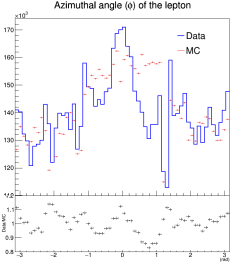


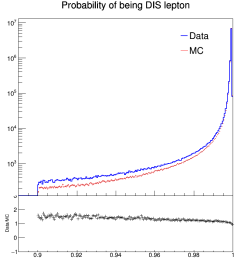
Control plots

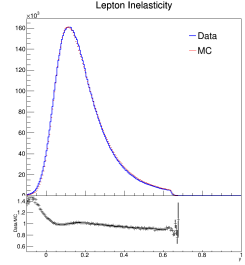




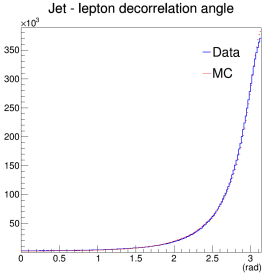


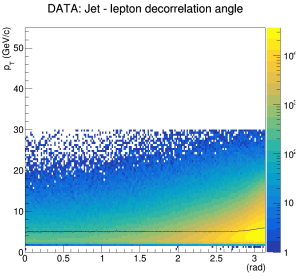


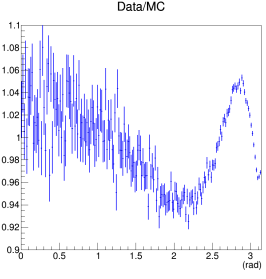


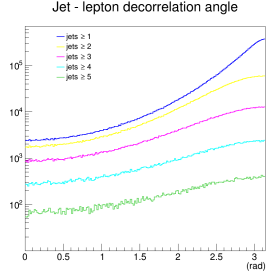


Control plots









Note:
our measurement starts at $\underline{\Delta\varphi > 1.5}$

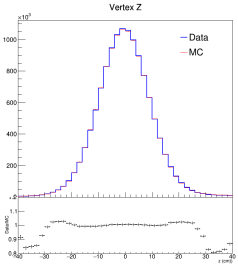
Wider η_{Jet} range

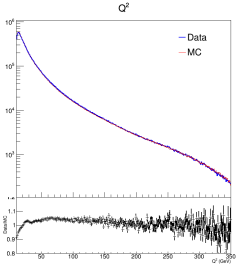
data: 12675772 events

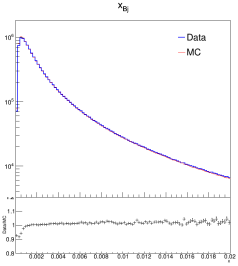
MC: 29241421 events

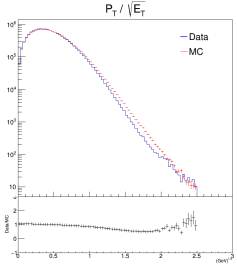
- $-1.5 < \eta_{Jet} < 1.8$

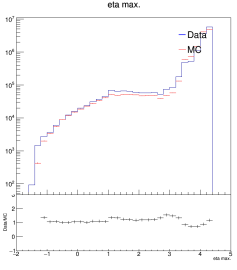
Control plots (wider η_{Jet})

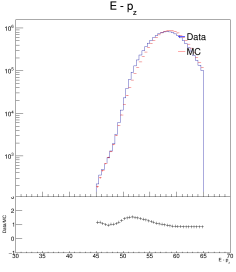




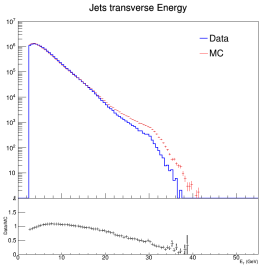


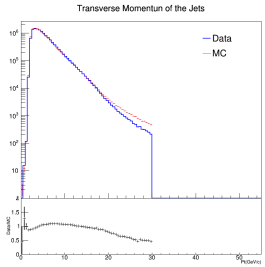


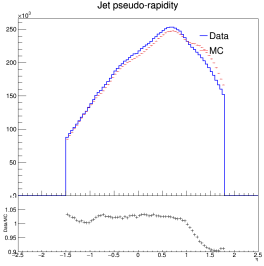


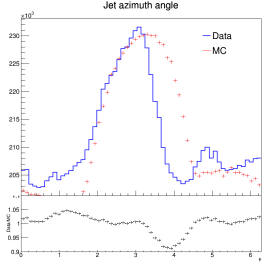


Control plots (wider η_{Jet})

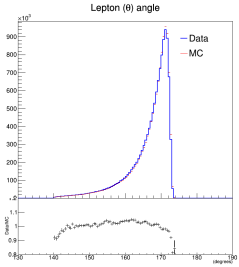


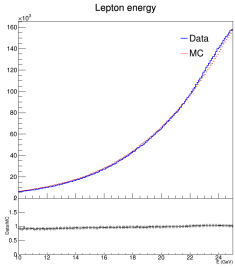


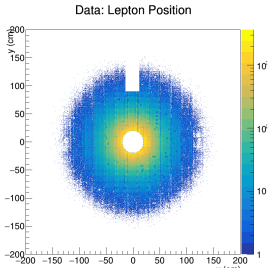


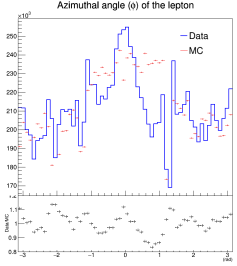


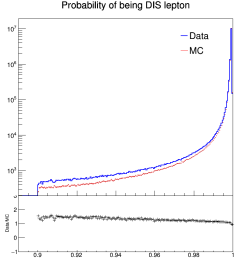
Control plots (wider η_{Jet})

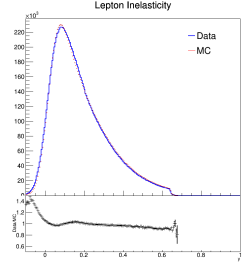




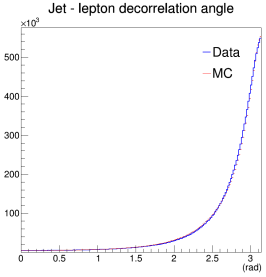


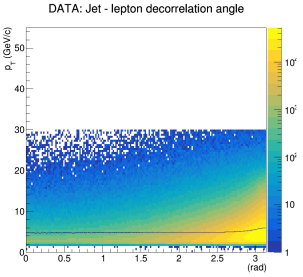


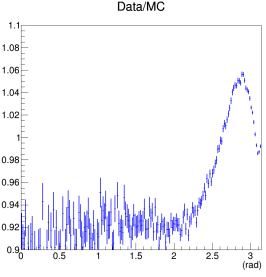


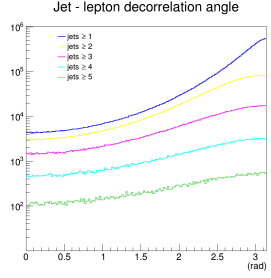


Control plots (wider η_{Jet})









Note:
our measurement starts at $\underline{\Delta\varphi > 1.5}$