ZAF Meeting

Inclusive jet production in DIS using ZEUS data and NNLO QCD analysis in precision determination of $\alpha_s(M_Z)$

Progress towards reproduction of NC DIS analysis

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Motivation

Goal: reproduce parts of previous analyses

- Establish analysis precedure
- Do not need to justify physics decisions (cuts, corrections, methods, . . .)
- Easy verification via readily available control distributions
- Large overlap with new analysis

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Choosen analysis: PhD thesis of F. Januschek[1]

- Precision analysis of NC DIS at high Q^2
- Distinction of different polarizations (not relevant for new analysis)
- Precise calibration of electron energy scale
- No jet requirement

[1] F. Januschek, "Measurements of e^+p neutral current deep inelastic scattering with a longitudinally polarised positron beam and x-ray radiation damage for silicon sensors", PhD thesis, University of Hamburg (2011), DESY-THESIS-2012-012

Event selection
Overview

Datasets

- Data: `06p`, `07p`
- DIS MC: `ariadne_high_Q2_NC_0607p`
- Background MC: `PHP_HER_dir_4D_0607p`, `PHP_HER_res_4D_0607p`

Quality flags

- `EVTAKE_iwant` $\in$ `{1, 2}`
- `MVDTAKE == 1`
- `STTAKE == 1`
- `LPOLTAKE == 1` or `TPOLTAKE == 1`, depending on luminosities of each polarization for each run

Kinematic region

- $Q^2_{\text{da}} > 185\,\text{GeV}^2$
- $y_{\text{el}} < 0.9$

Trigger

- FLT: 28, 30, 36, 39, 40, 41, 43, 44, 46, 47
- SLT: EXO1, EXO2, EXO3, DIS7
- TLT: DIS3

Electron candidate

- At least one EM electron candidate
- Probability at least 0.001

Event selection
Cuts

DIS selection

- $E_{\text{electron}} > 10\,\text{GeV}$
- $38\,\text{GeV} < E - p_z < 65\,\text{GeV}$
- Other energy in $\Delta R = 0.8$ cone around electron $< 5\,\text{GeV}$

Tracking

- If electron in range $0.3 < \theta < 2.5$
  - Require track matched to electron
  - Track momentum $> 3\,\text{GeV}$
  - Distance of track to electron $< 10\,\text{cm}$
  - Distance of track to CAL module edge $> 1.5\,\text{cm}$
- At least one good vertex track

Detector effects

- Super crack
- RCAL chimney
- RCAL radius
- Projection of hadronic angle on FCAL

Background removal

- $|z_{\text{Vertex}}| < 30\,\text{cm}$
- $\frac{p_T}{\sqrt{E_T}} < 4\sqrt{\text{GeV}}$
- $p_T / E_T < 0.7$

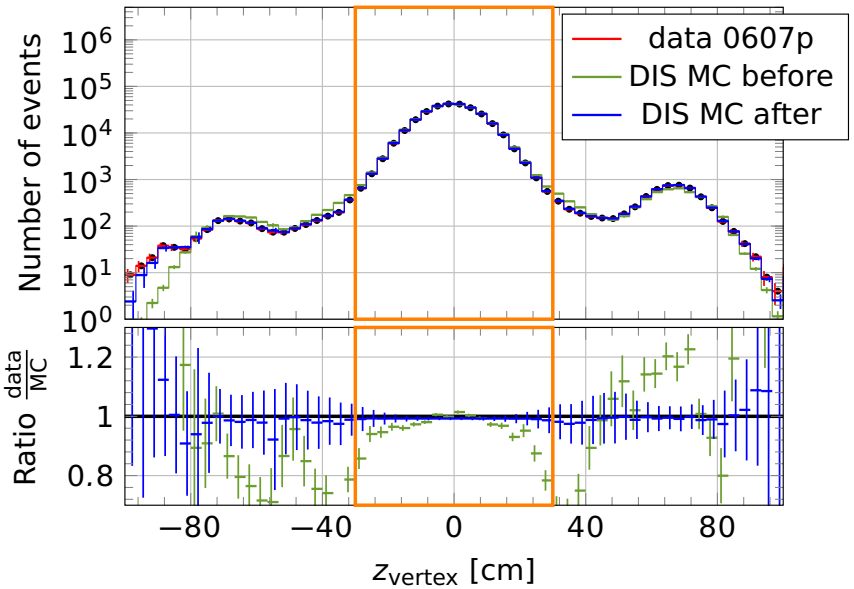
Deficiencies of MC

- $y_{\text{jb}}(1 - x_{\text{da}})^2 > 0.004$
- Reject QED Compton scattering

Longitudinal vertex position

- Satellite peaks not well described in MC
- Efficiency of z_{Vertex} cut would be incorrect
- Reweight MC events to match distribution in data

$$w(z_{\text{Vertex,true}}) = \frac{\mathcal{N}_{\text{data}}(z_{\text{Vertex,reconstructed}})}{\mathcal{N}_{\text{MC}}(z_{\text{Vertex,reconstructed}})}$$



Effect of correction

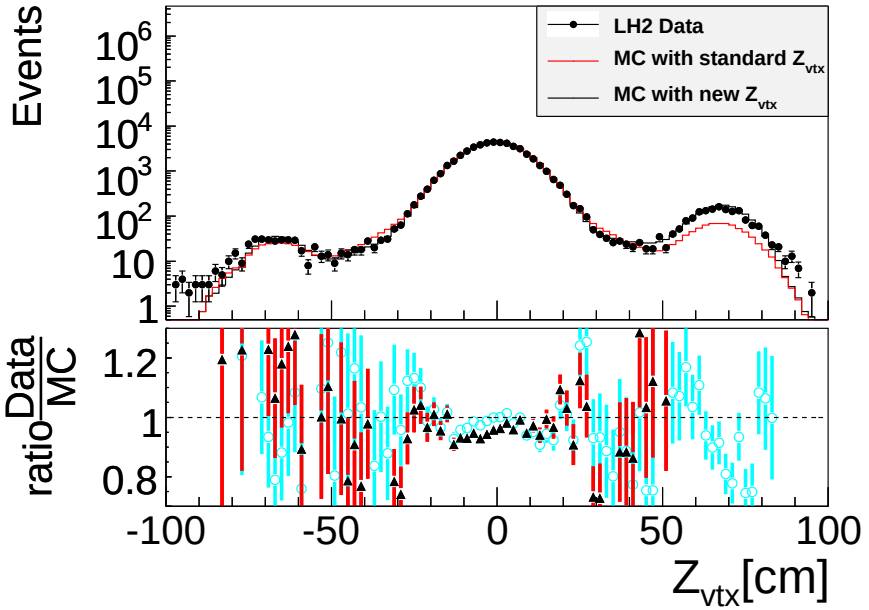


Figure 5.22 from reference

Longitudinal structure function

- MC generated with $F_L = 0$
- Reweight events using

$$w(x_{\text{true}}, Q^2_{\text{true}}) = \frac{\sigma(x, Q^2, F_L)}{\sigma(x, Q^2, 0)}$$

- Use prediction for $\sigma(x, Q^2, F_L)$ from `CTEQ5D`
- Currently, correction factors still missing

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Polarization

- MC generated with $P = 0$
- Reweight events using

$$w(Q^2_{\text{true}}) = \frac{\sigma(Q^2, P)}{\sigma(Q^2, 0)}$$

- Use prediction for $\sigma(x, P)$ from `HECTOR`
- Use average polarization of each run period
- Very small overall effect ($\approx 0.03\%$), due to small overall polarization

- Tracking not well described in MC $\rightarrow$ efficiencies of tracking related cuts do not match
- Reweight reconstructed events

Track matching efficiency

- Correction to combined efficiency of tracking cuts (see slide 3)
- Overall effect $\sim -1.3\%$

Track veto efficiency

- Correction to efficiency of FLT track classes
- Implementation in progress

Dead material/non-uniformity correction

- Electron loses energy as it passes through inactive material in detector
- Detector response different in different regions
- Correction factors for electron energy in data and MC calculated using test beam
- Corrections already included in latest Ntuples

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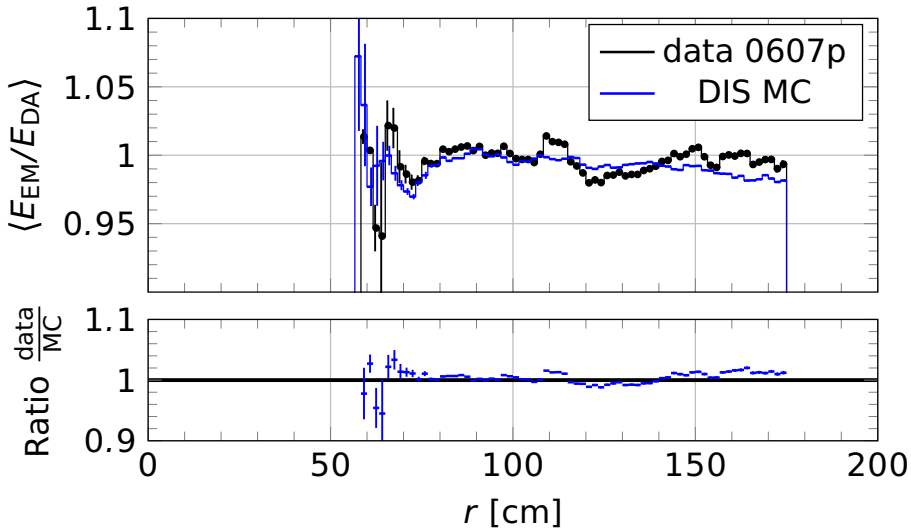

$\langle E_{\mathrm{EM}}/E_{\mathrm{DA}}\rangle\,(r)$ for RCAL electrons,
Correction not specifically applied

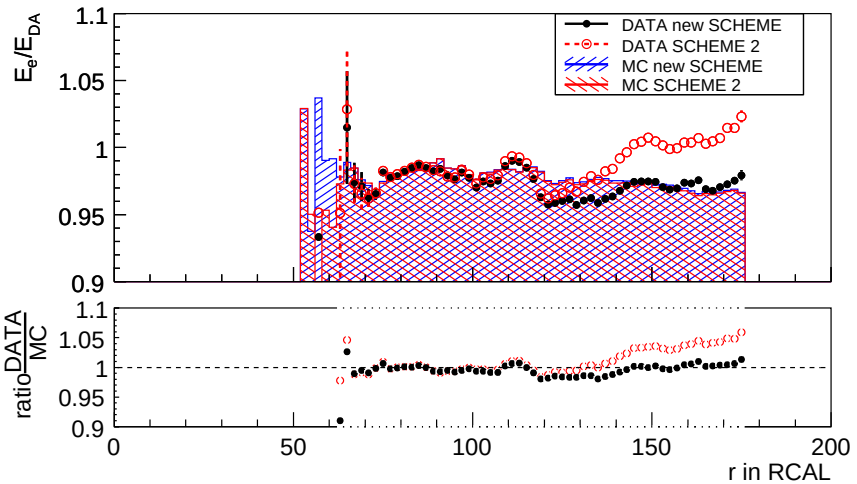

Figure 5.23 from reference

Energy resolution correction

- Energy resolution in MC better than in data
- Spread/shift electron energy in MC to match data
- Exact procedure taken from reference

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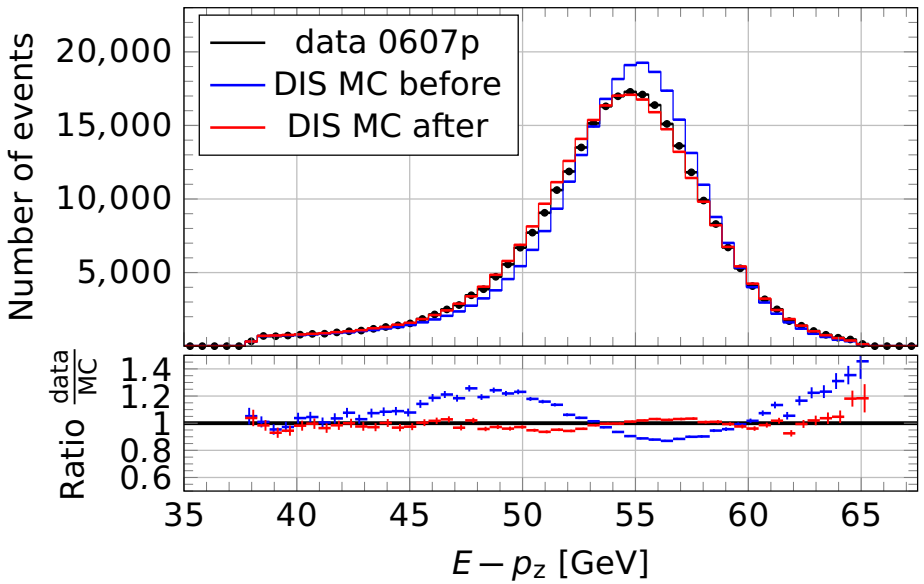

Effect of correction

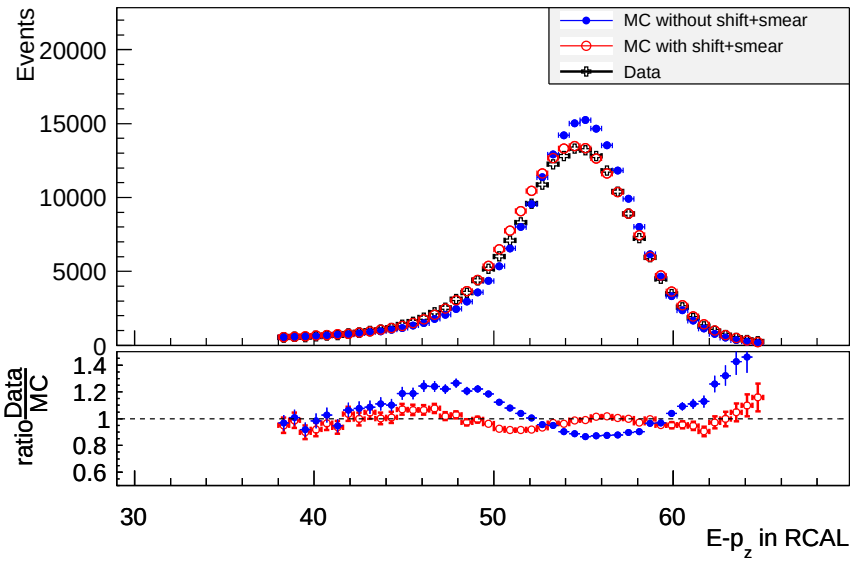

Figure 5.26 from reference

RISOE correction

- During 06p some data event were erroneously rejected due to incorrect trigger configuration
- Increase weight of similar events in data to compensate
- Exact procedure taken from reference
- Small overall effect ($\approx 0.15\%$)
- No notable changes to shape of common distributions
- Possibly better method: discard corresponding MC events

Outlook

NC DIS analysis

- Implement and verify missing corrections
- Extract electron energy calibration

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Jet analysis

- Repeat procedure for jet analysis
- Most likely reference: PhD thesis of J. Behr[1]

[1] J. Behr, "Jets at high Q^2 at HERA and test beam measurement with the EUDET pixel telescope", PhD thesis, University of Hamburg (2010), DESY-THESIS-2010-038