Event Shapes in DIS measured with the ZEUS Detector and Study of Power Corrections

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Overview

- ZEUS preliminary results

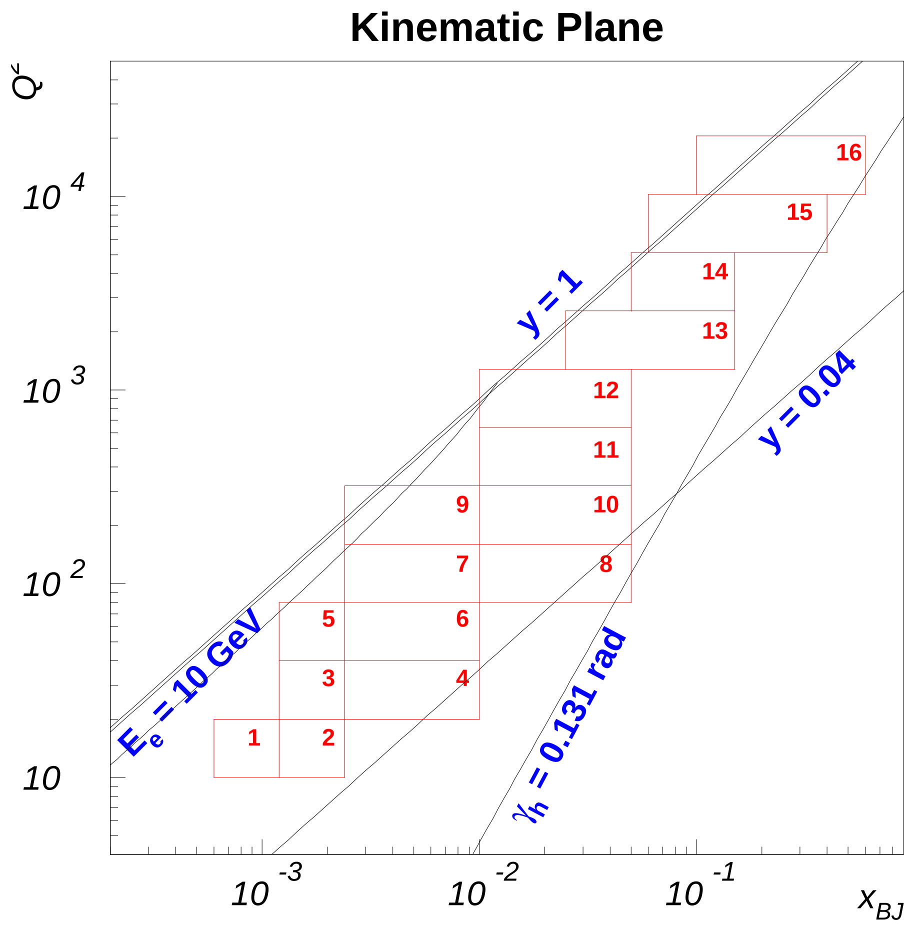
  Mean Event Shape Values

  e^+p Data of 95-97 periods (45 pb^{-1})
- Fit Results

  (DISENT+ Power Corrections)
- x_{Bj} - Dependence
- Comparison with H1-results
- Conclusions

Analysis Bins in the Kinematic Region

Double Angle method for kinematic reconstruction



➡ Explicit x_{Bj} -dependence at smaller Q^2

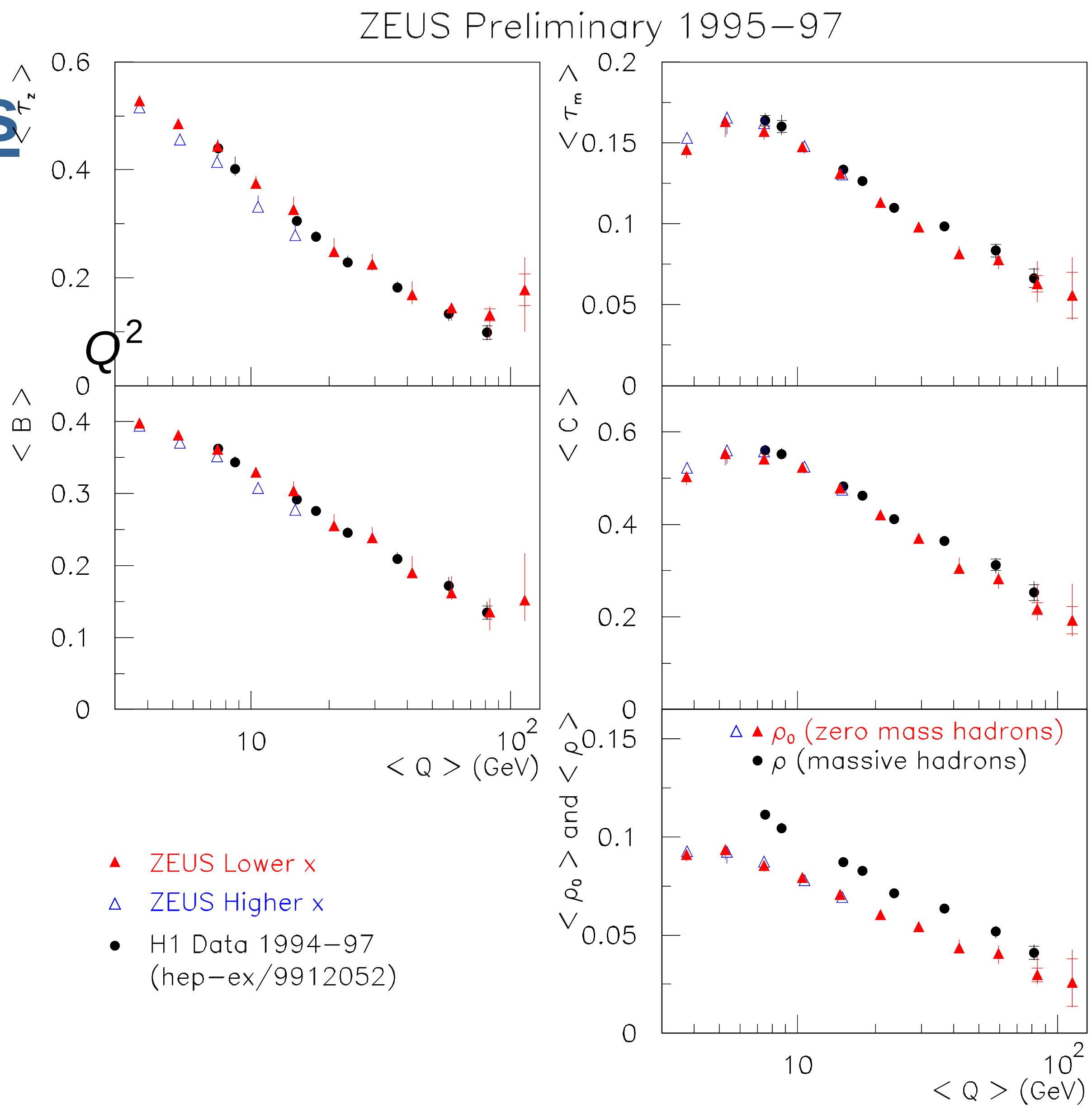
Definitions

- Sums of Particles in Current Region of Breit Frame
- Hadron Level: Zero-Mass Assumption (G.Salam)

w.r.t. photon axis	e^+e^- - type variables
Thrust $$\tau_z = 1 - \frac{\sum \lvert\vec{p}\cdot\vec{n}\rvert}{\sum \lvert\vec{p}\rvert}$$	**Thrust** $$\tau_{max} = 1 - \frac{\sum \lvert\vec{p}\cdot\vec{n}_T\rvert}{\sum \lvert\vec{p}\rvert}$$
Jet-Broadening $$B = \frac{\sum \lvert\vec{p}\times\vec{n}\rvert}{\sum \lvert\vec{p}\rvert}$$	**C-Parameter** $$C_p = \frac{3}{2}\frac{1}{(\sum_i E_i)^2}\sum_{a,b\in CR} \lvert\vec{p}_a\rvert\lvert\vec{p}_b\rvert \sin^2\theta_{ab}$$
	Jet Mass $$J_m = \frac{M^2}{(2\sum_i E_i)^2} = \frac{(\sum_i E_i)^2 - \lvert\sum_i \vec{p}_i\rvert^2}{(\sum_i E_i)^2}$$

Mean Event Shapes

- Events become more collimated with increasing Q^2
- Fair agreement between the experiments
- Jet Mass definition different between H1 and ZEUS



Power Correction Ansatz

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$\boxed{F = F_{pert} + F_{pow}}$ $\quad F_{pert}$ from DISENT $(O(\alpha_s^2))$

$$F_{pow} = a_F \cdot M \cdot \frac{C_F \mu_I}{2\pi^2 Q} \cdot \left[\overline{\alpha}_0(\mu_I) - \alpha_s(Q) - \alpha_s^2(Q)\, 2b \left(\frac{k}{2b} + 1 + \ln\left(\frac{Q}{\mu_I}\right)\right)\right]$$

$M = 1{,}43 \quad (Milan\ Faktor)$

$b = \frac{11C_A - 2N_f}{12\pi}$

$k = \frac{(67-3\pi^2)C_A - N_f}{36\pi}$

$C_F = 4/3,\ C_A = 3, \quad N_f = 3$

$$a_F = \begin{cases} 4 & \text{für}\quad Thrust \\ 6\pi & \text{für}\quad C-Parameter \\ 2 & \text{für}\quad Jet\ Masse \\ 2 & \text{für}\quad Jet\ Breite \end{cases}$$

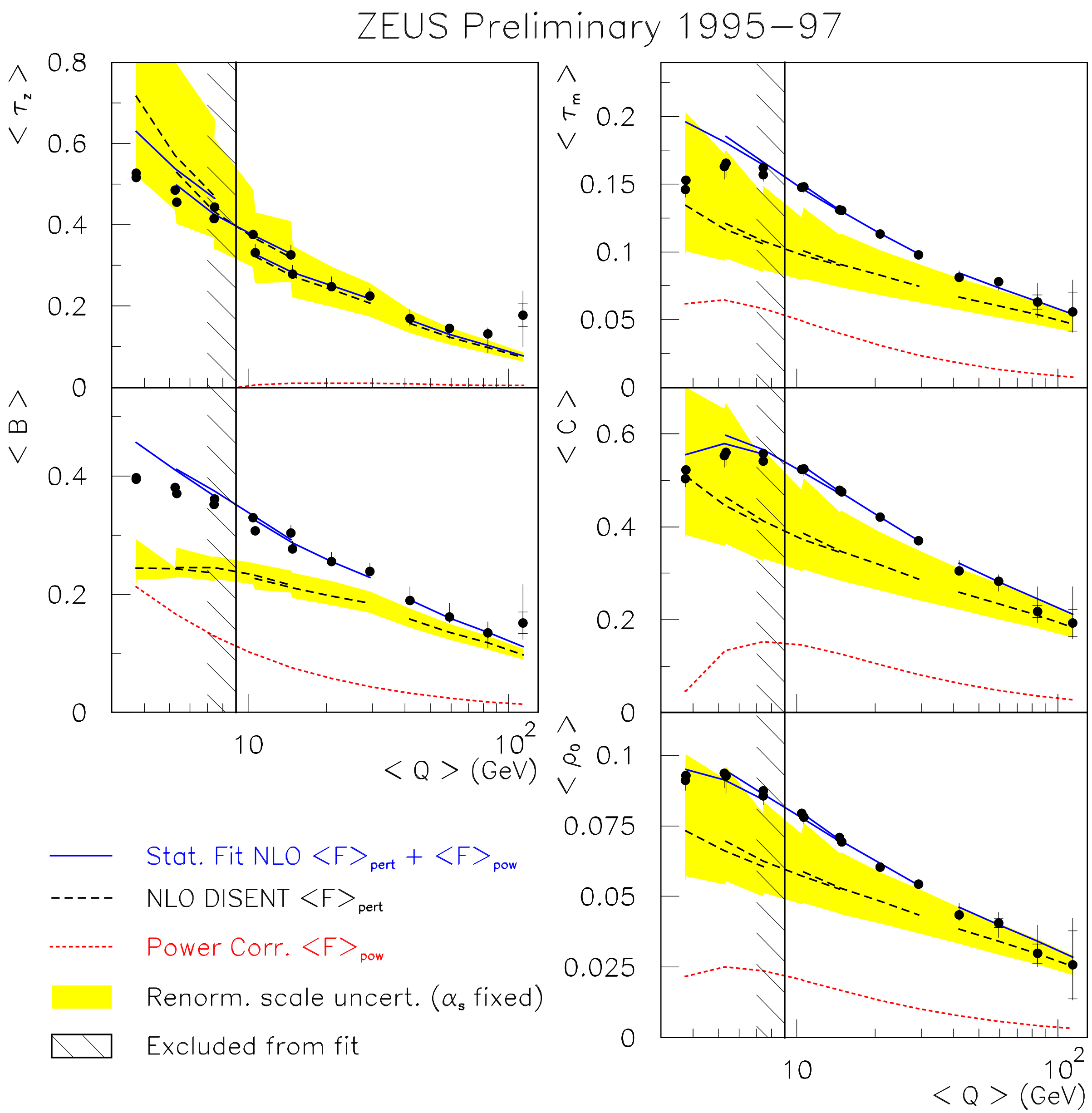
Special treatment of Jet Broadening:

$$a_F \to a_F \cdot \Delta B, \quad \Delta B = \left(\frac{\pi}{2\sqrt{2 C_F \alpha_{CMW}(\overline{Q}^2)}} + \frac{3}{4} - \frac{\pi b}{3 C_F} + \eta_0 + O(1) \right)$$

$$\alpha_{CMW} = \alpha_{\overline{MS}} \cdot 1 + \frac{k}{2\pi} \cdot \frac{\alpha_{MS}}{2\pi}, \quad \eta_0 = -0.6137057, \qquad \overline{Q} = Q e^{-3/4}$$

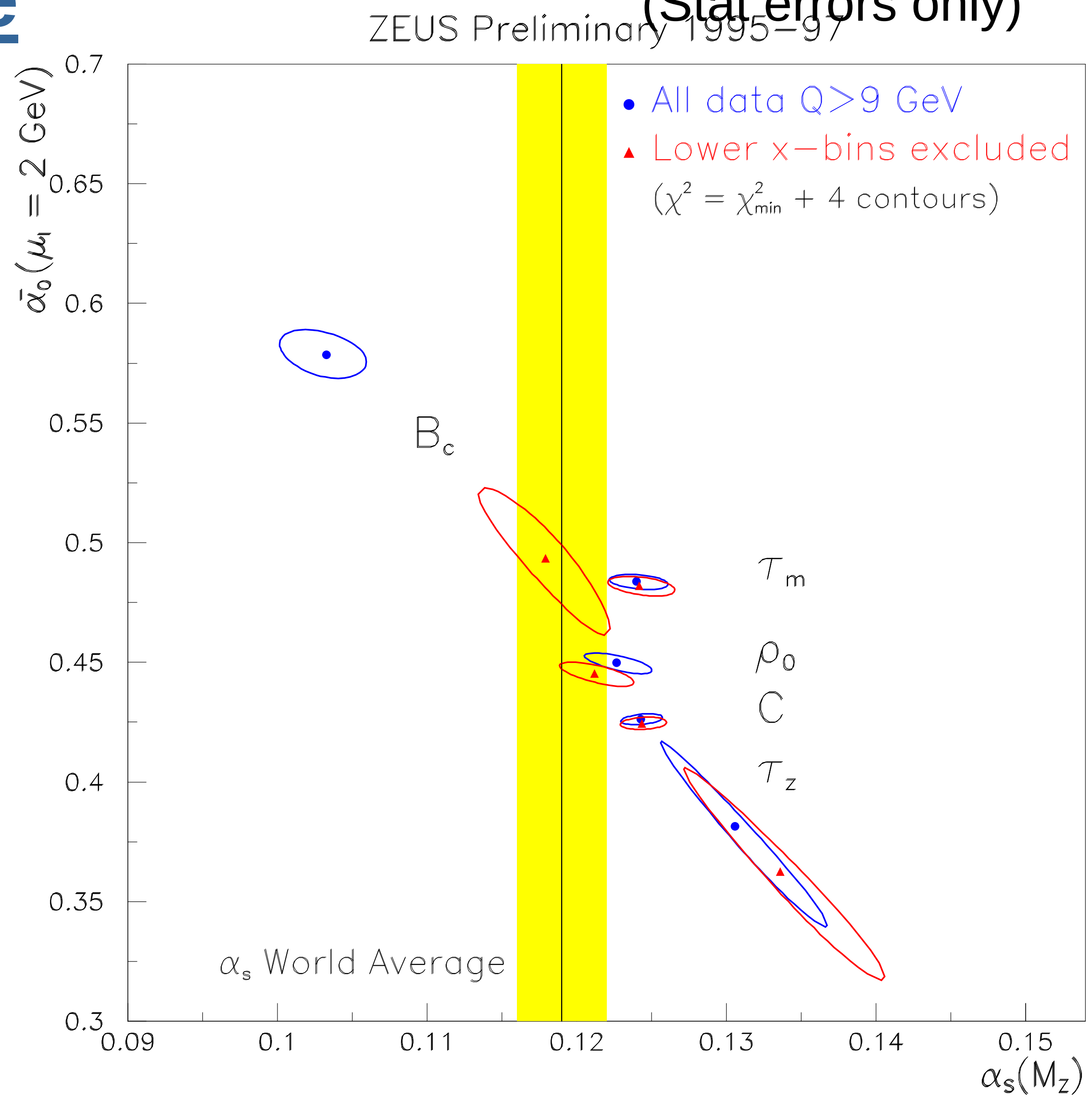
Fit Results

- large scale uncertainties
  ⇨ lower Q-bins excluded
- e^+e^- type variables fit well
- problems with DIS specific variables B, τ_z
  x-dependence not reproduced



x - Dependence

(Stat errors only)



TEST:

Repeat fit with lower *x*-bins excluded from fit

➡ fit-results unstable for JetBroadening

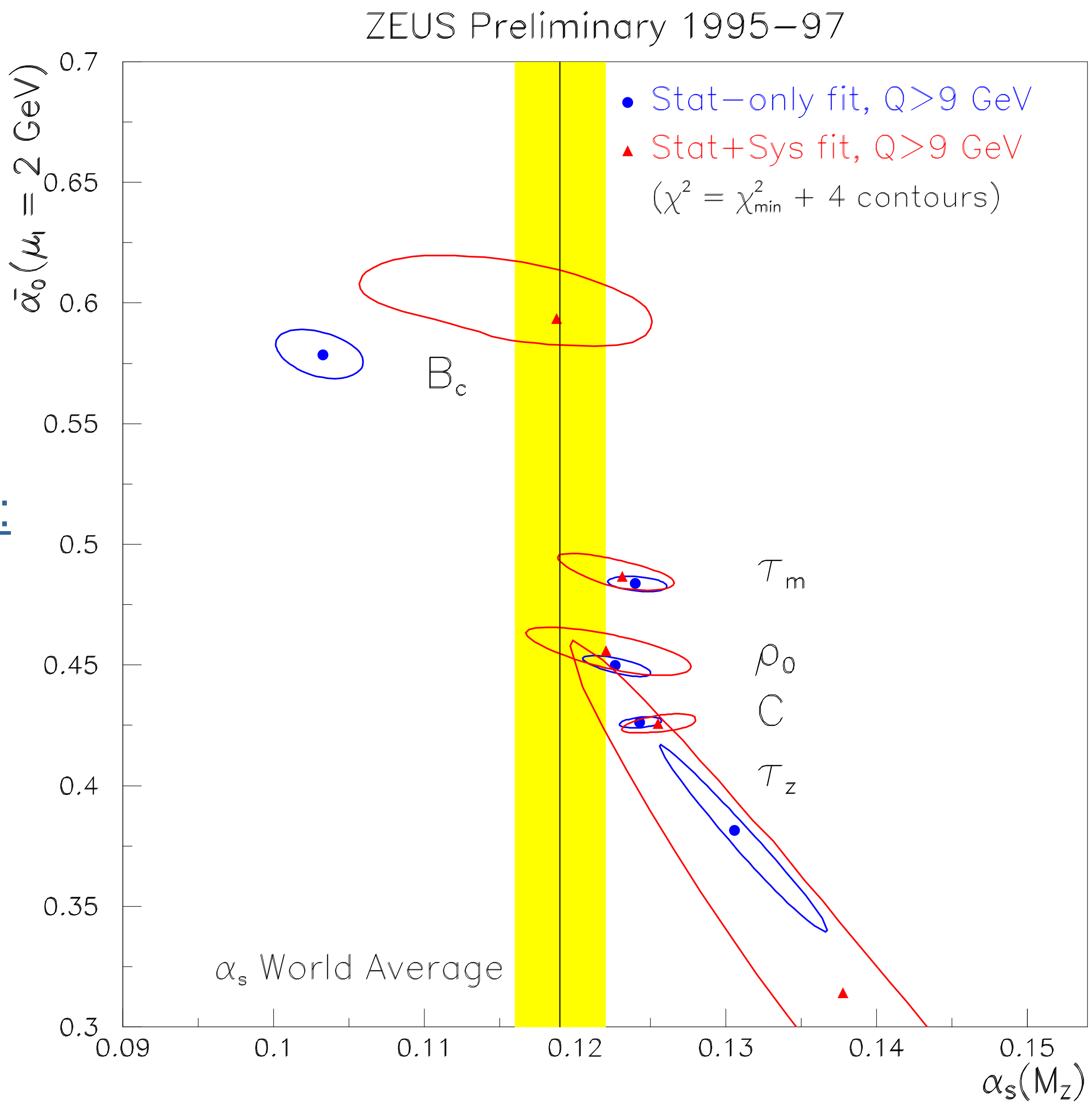
Error Treatment?

e^+e^- type variables:
small spread in $\overline{\alpha}_0$, fitted value of α_s compatible with world average

DIS specific variables:
large spread in $\overline{\alpha}_0$ and α_s

Missing higher order QCD - corrections ?

Fit results for B and τ_z depend on error taken in the fit



Comparison with H1 results

Data points agree fairly, but not the fit results

Observations

- Different results for Jet Mass
- H1 sees larger values for α_s, sees larger spread in $\overline{\alpha}_0$
- Different behaviour of τ_z ZEUS sees negligible contribution of power corrections in the fit
- Different results for B might be correlated with x-dependance of fit result

Explanations?

- Different definition of ρ (different mass treatment)
- Different binning: ZEUS bins explicitely in x, H1 integrates
- Different Renormalisation scale uncertainty:
  - ZEUS : $\mu_R^2 = 4Q^2, {}^1\!/_4 Q^2$
  - H1 : $\mu_R^2 = 2Q^2, {}^1\!/_2 Q^2$

Conclusions

ZEUS preliminary results for mean values of 5 event shape variables and power correction fits to them → Data is precise and consistent with H1

ZEUS data is explicitely binned in x → Conceptual Problems with fits to DIS specific variables B and τ_z

consistent values of $\overline{\alpha}_0$ and α_s for e^+e^- type variables → Supports basic concept of approximately universal power corrections