DIJET (and inclusive-jet) CROSS SECTIONS IN DIS AT HERA

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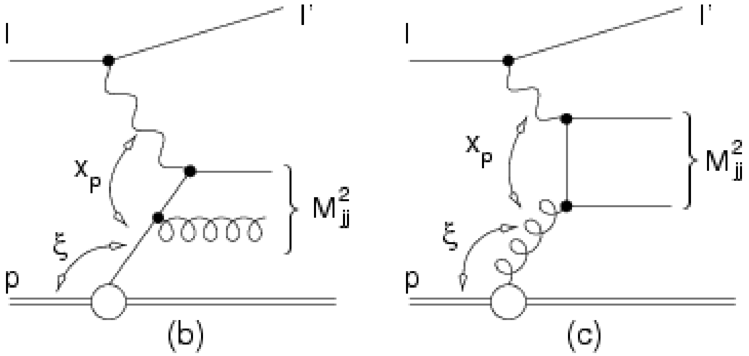
- Motivation
- Event and jet selection
- Data treatment, NLO theory, uncertainties
- Results
- Summary

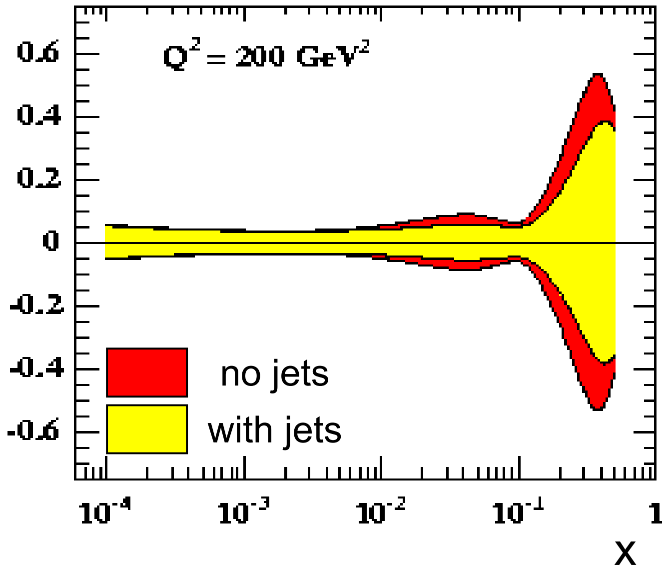
INTRODUCTION, MOTIVATION

¶ Jets at high values of Q^2 in the Breit frame
– provide clean tests of pQCD (parton universality, factorisation),
– allow access to the strong coupling and to the PDFs.



¶ Especially double-differential cross sections in Q^2 and E_T (inclusive jets) or Q^2 and ξ may help to further pin down the PDFs (gluon at high ξ!).

¶ The use of inclusive jets from high-Q^2 DIS was successful in recent ZEUS QCD fits!



¶ Compared to previous dijet analysis
– almost three times the statistics ($82 pb^{-2}$),
– new kinematic regime (E_p = 920 GeV).
– better analysis technique (Breit frame)
– data constrained to theoretically safer regime (high Q^2, higher E_T → reduced uncertainties)

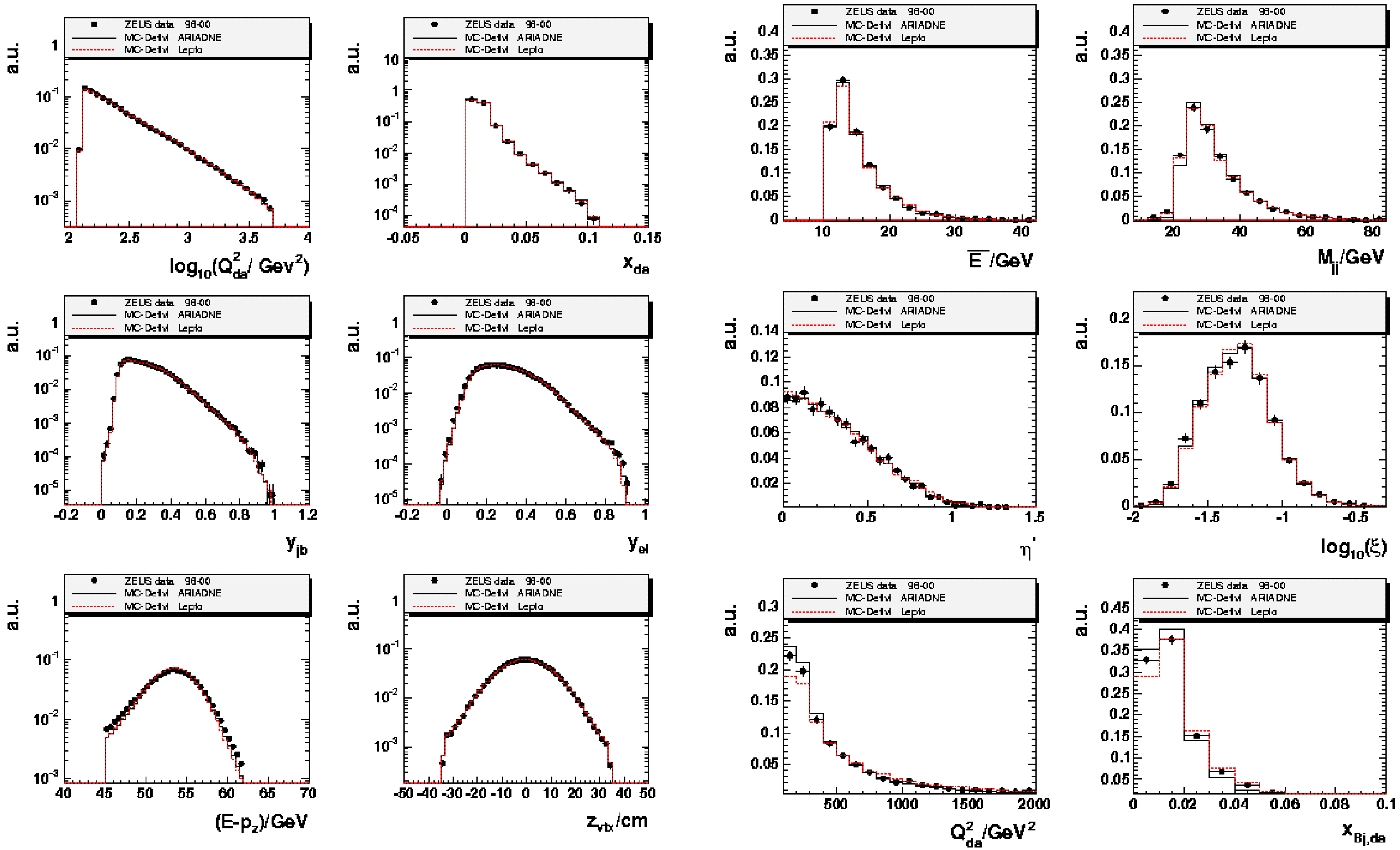
EVENT AND JET SELECTION

- Data: ZEUS 98-00, 81.73pb^{-1},
- MC: ARIADNE and LEPTO, each about 5× data luminosity
- Trigger: well-reconstructed electron with $Q^2 > 80$ GeV^2, 100% efficient for phase-space considered.
- Phase-space selection:
  - $125 < Q^2_{DA}$ (< 5000 GeV^2)
  - $|\cos\gamma_{had}| < 0.65$
- Cleaning cuts:
  - $E'_{el} > 10$ GeV, electron isolation
  - 45 GeV $< E-p_z <$ 62 GeV
  - $|Z_{vtx}| < 34$ cm
  - $p_T/\sqrt{E_T} < 2.5$
  - $r_{el} > 36$ cm
  - $y_{el} < 0.95$
  - no second e- candidate
- Jet reconstruction:
  - longitudinally invariant k_T cluster algo in Breit frame.
  - linear jet energy corrections
- Jet phase-space:
  - $-2 < \eta_{Breit} < 1.5$
  - $E_{T,1(2)} > 12$ (8) GeV / 8 GeV
- Jet Cleaning cuts

Final sample: 3868 events with at least two jets, 19640 inclusive-jet events

CONTROL-PLOTS

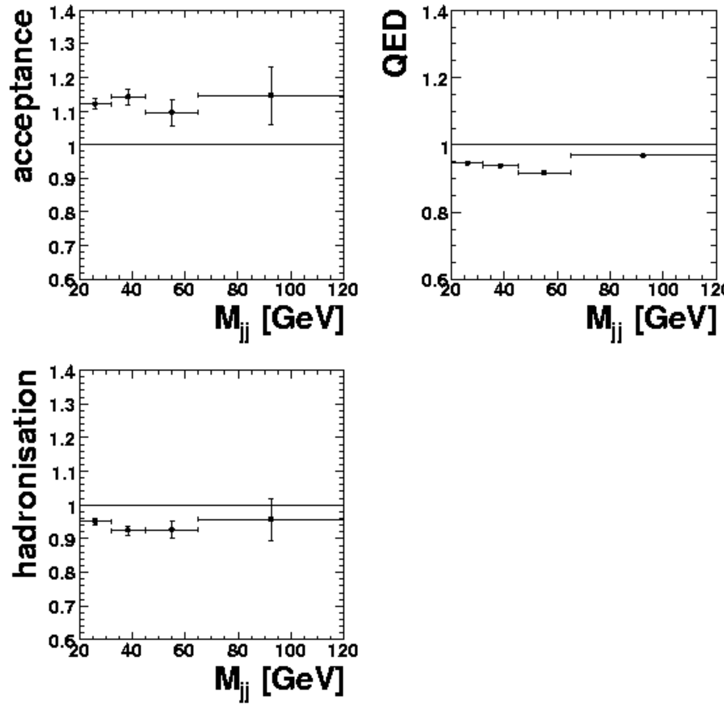
dijet analysis: inclusive event sample and dijet sample



Inclusive and dijet sample well described by both MC models

DATA TREATMENT
and systematic uncertainties

¶ Data corrections:
- for acceptance and efficiency with ARIADNE MC model.
- for QED effects.
- for dijets Z^0 effect negligible (Q^2<5000GeV^2)
- for inclusive jets Z0 small (<5%) (corrections for e^+, e^- partly cancel)



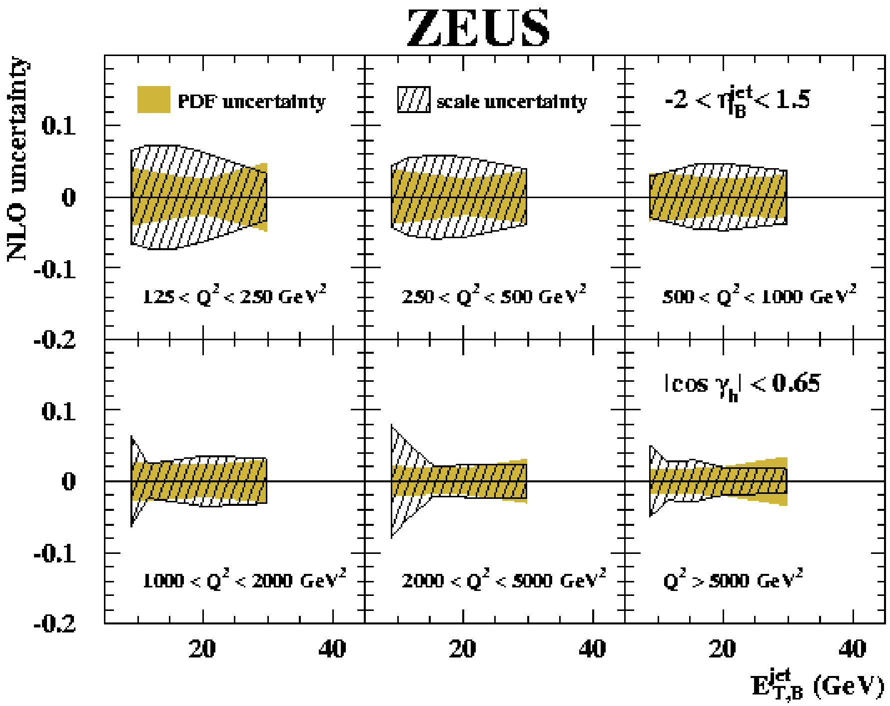
¶ Systematic checks:
- alternative electron finder → ≤1(3)%
- alternative acceptance correction (LEPTO) → ±7(8)%
- jet energy scale ±1(3)% → ±5-10%
- electron energy scale ±1% → ≤1%
- variation of selection criteria → ≤2%

¶ NLO: DISENT with CTEQ6

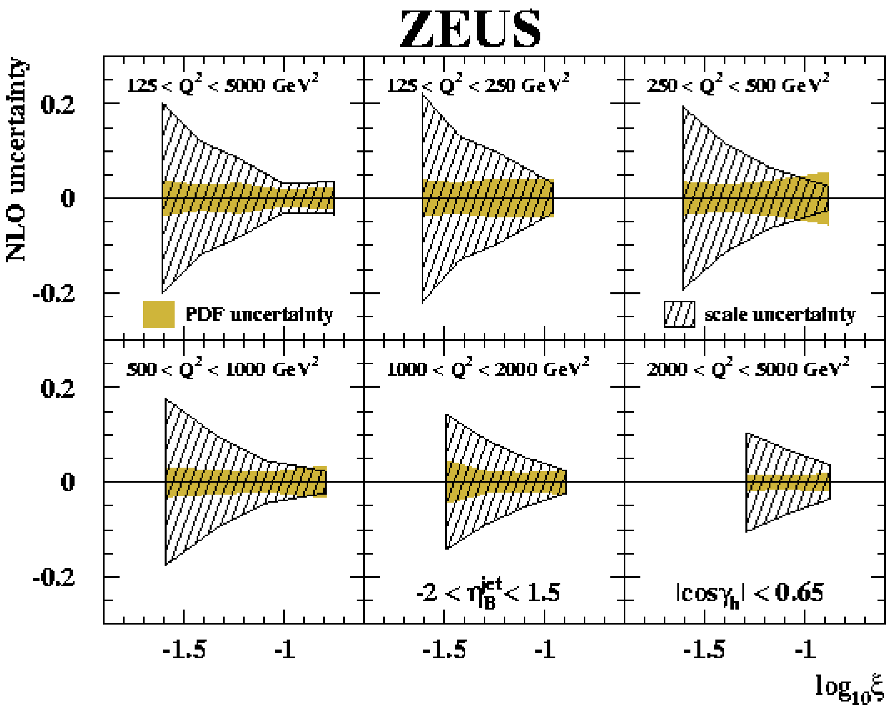
¶ Hadronisation: ARIADNE

¶ Theoretical uncertainties:
- scale: 0.5,2μ_R → ±5-10(20)%
- PDF: 40 CTEQ6 sets → ±2-5%
- α_S: CTEQ6AB → less than ±4%

THEORETICAL UNCERTAINTIES

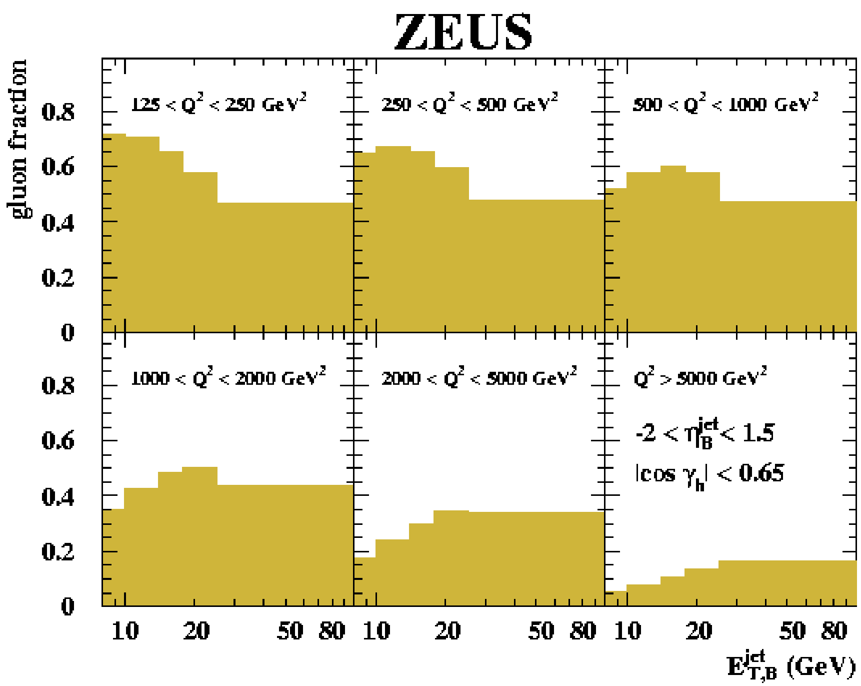


Double-diff. inclusive-jet analysis:
E_T distributions in Q2 bins
– scale uncertainty ≤8%, decreasing with increasing Q^2.
– PDF uncertainty ≤4%, significant at high E_T.

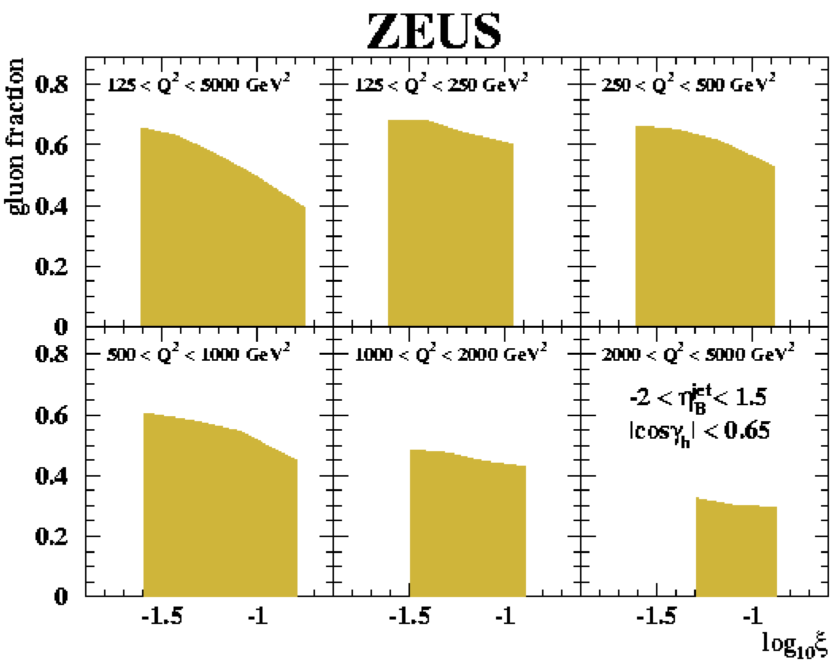


Double-diff. dijet analysis:
ξ distributions in Q^2 bins
– scale uncertainty 5-20%, large at small ξ.
– PDF uncertainty ≤4%, significant at high ξ.

GLUON-INDUCED EVENT FRACTION



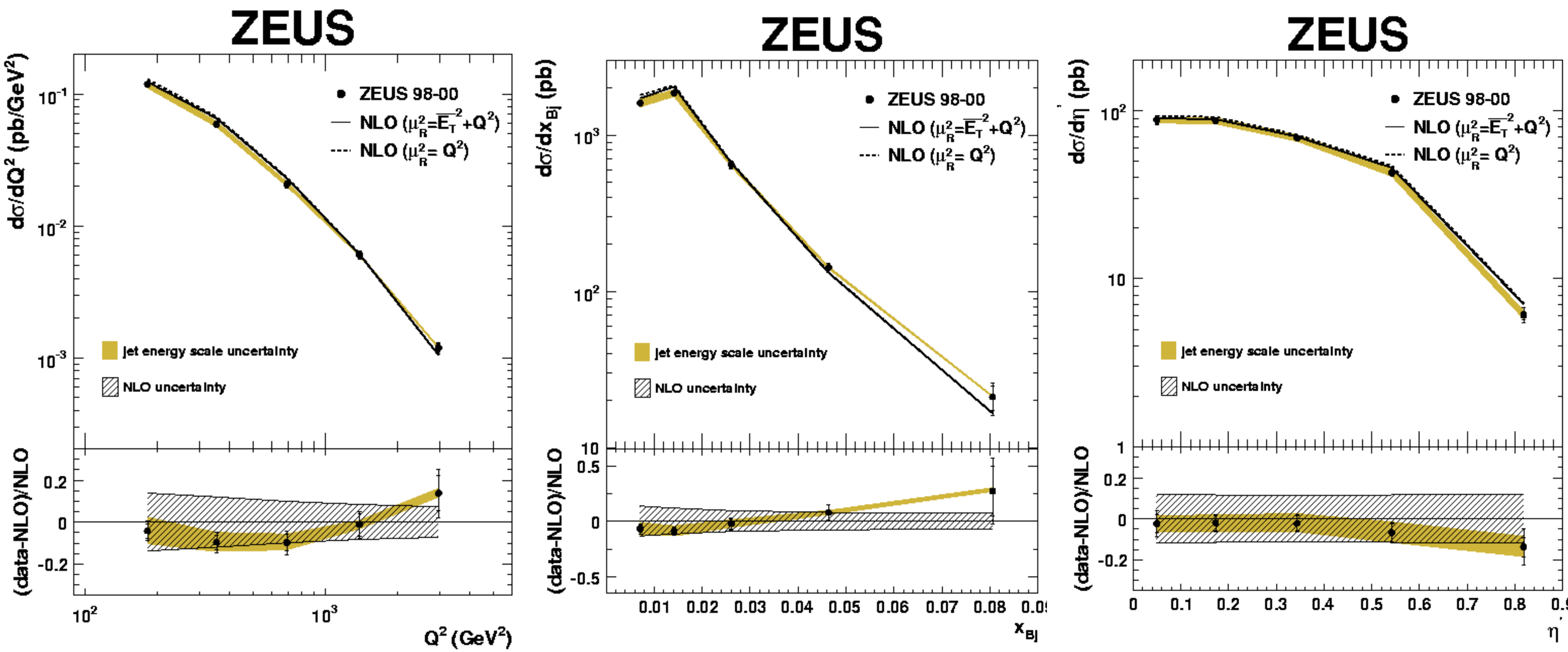
Double-diff. inclusive-jet analysis:
E_T distributions in Q2 bins
- gluon fraction decreases with increasing E_T and with increasing Q^2.



Double-diff. dijet analysis:
ξ distributions in Q^2 bins
- gluon fraction decreases with increasing ξ and Q^2.

FINAL RESULTS

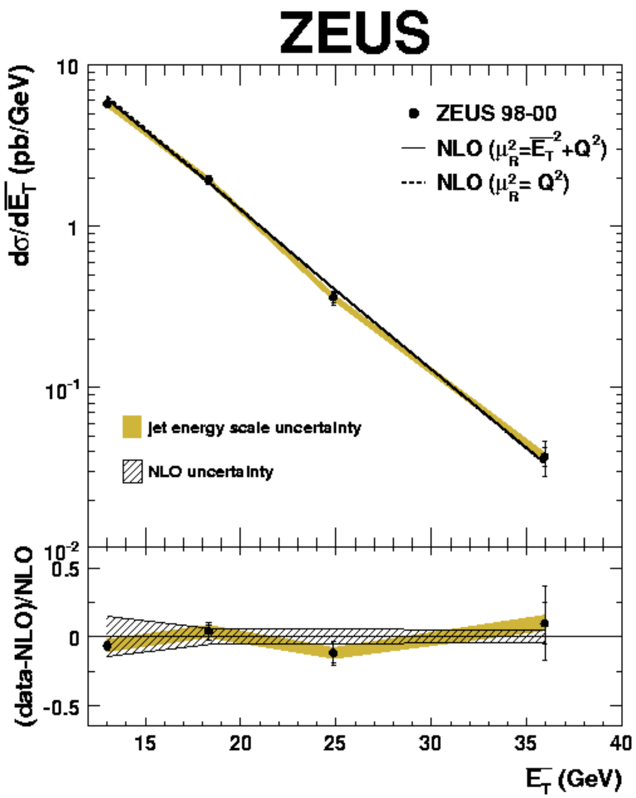
first set of single-diff. dijet variables

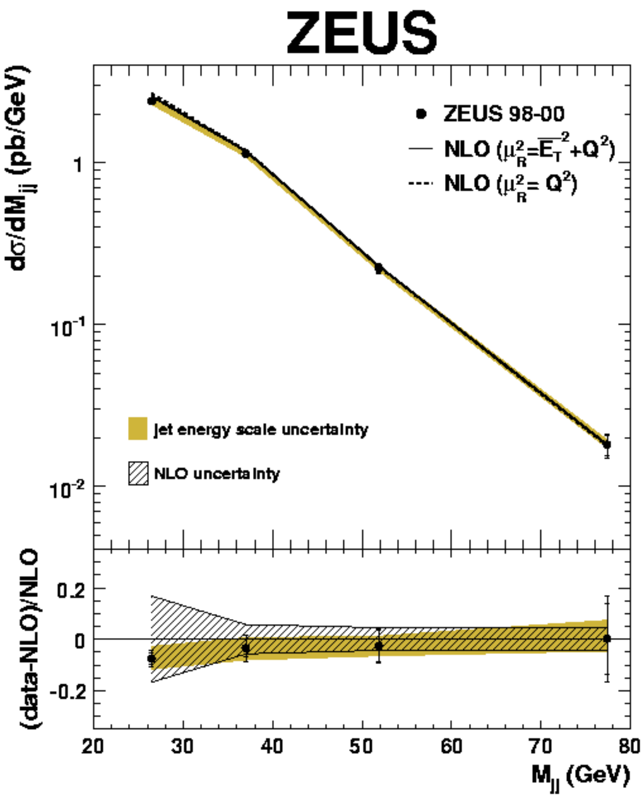


Data nicely described by the NLO theory. Errors dominated by theory (scale) and sometimes jet energy scale.

FINAL RESULTS

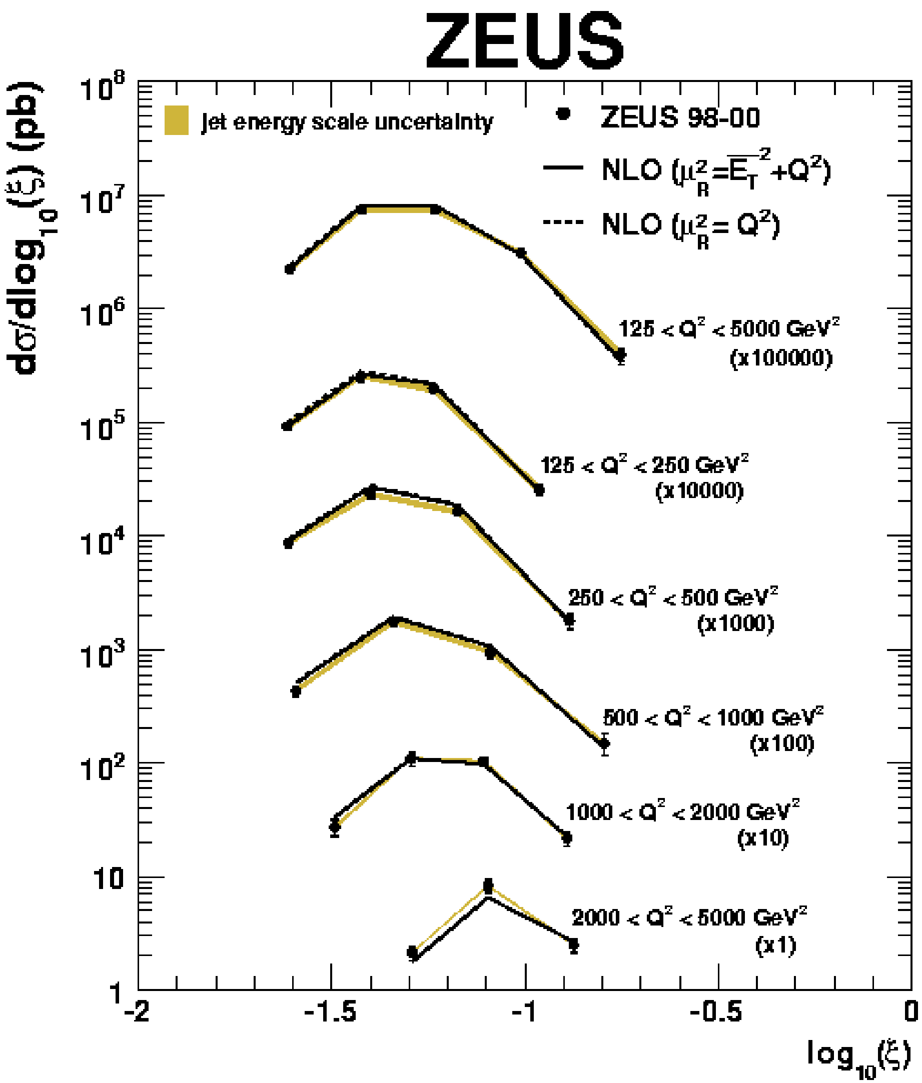
second set of single-diff. dijet variables

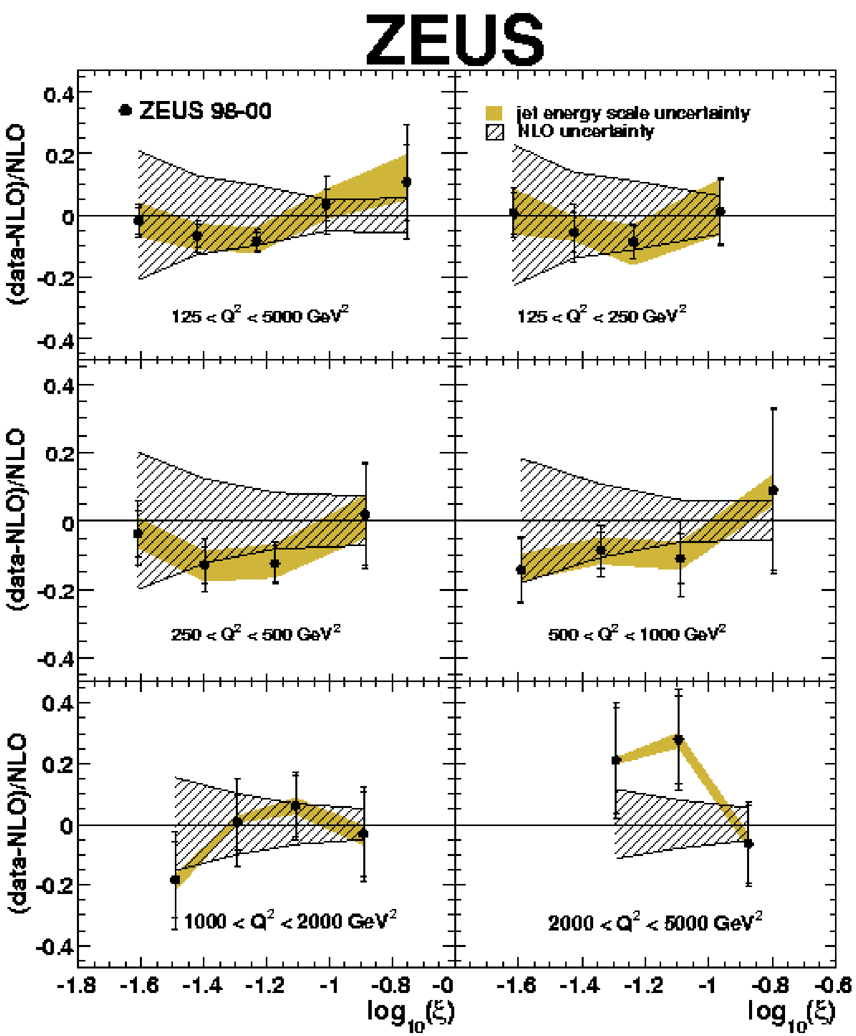




Data nicely described by the NLO theory. Errors dominated by theory (scale) and sometimes jet energy scale.

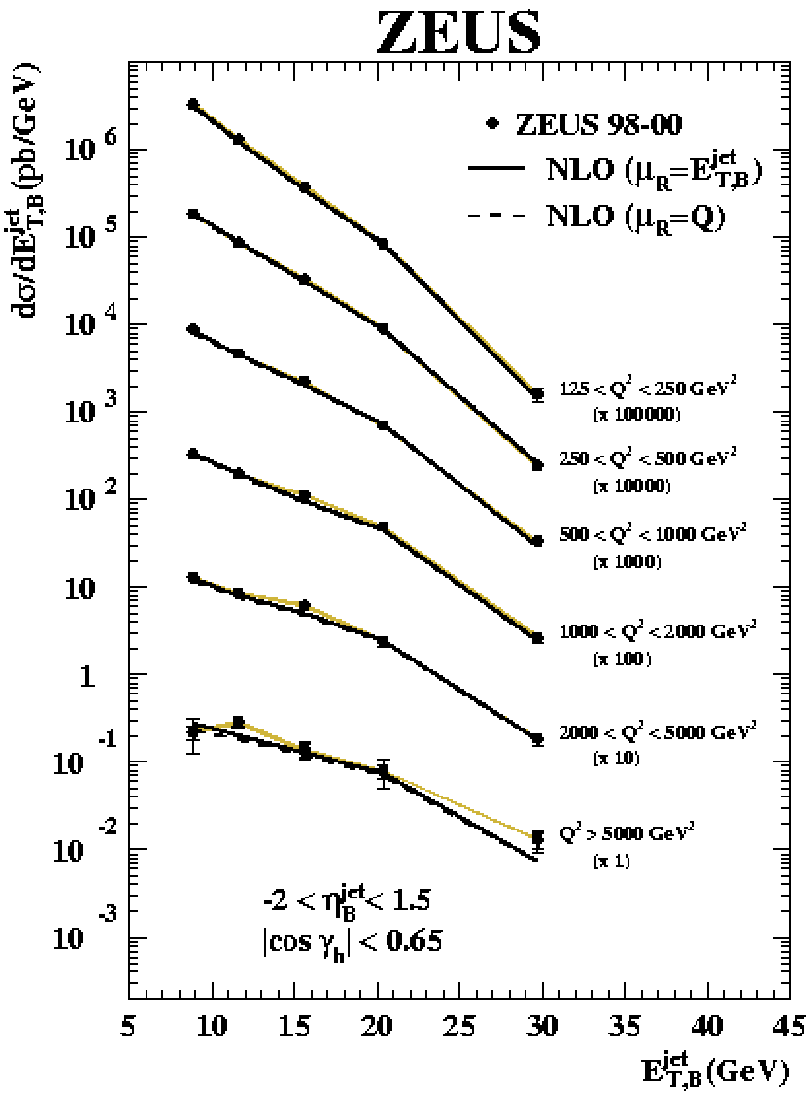
FINAL RESULTS
double-differential dijet analysis

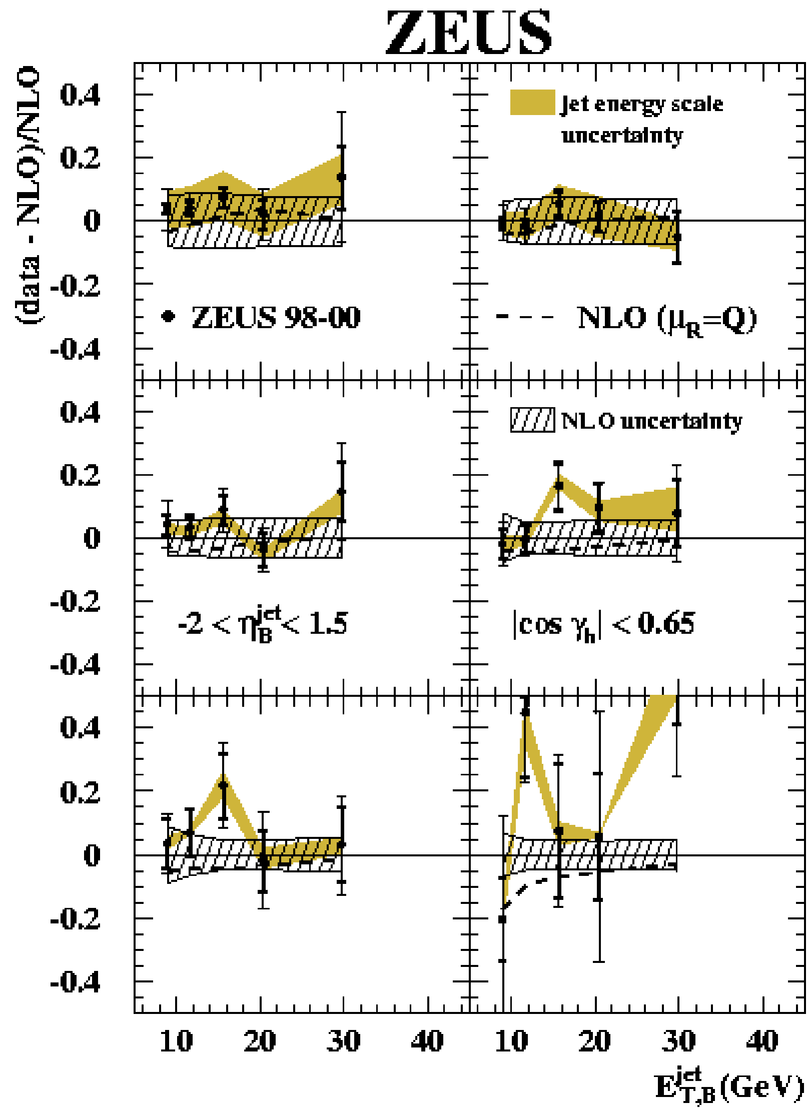




FINAL RESULTS

double-differential inclusive-jet analysis





SUMMARY

¶ Single- and double-differential dijet (and inclusive-jet) cross sections have been measured in high-Q^2 DIS in 98-00 data from the ZEUS experiment ($82pb^{-1}$).

¶ The dijet data improve previous analyses:
- larger statistics (almost factor 3 wrt. 96-97 data)
- higher center-of-mass energy (920 versus 820 GeV)
- improved selection (Breit frame) and tighter cuts (smaller uncertainties).

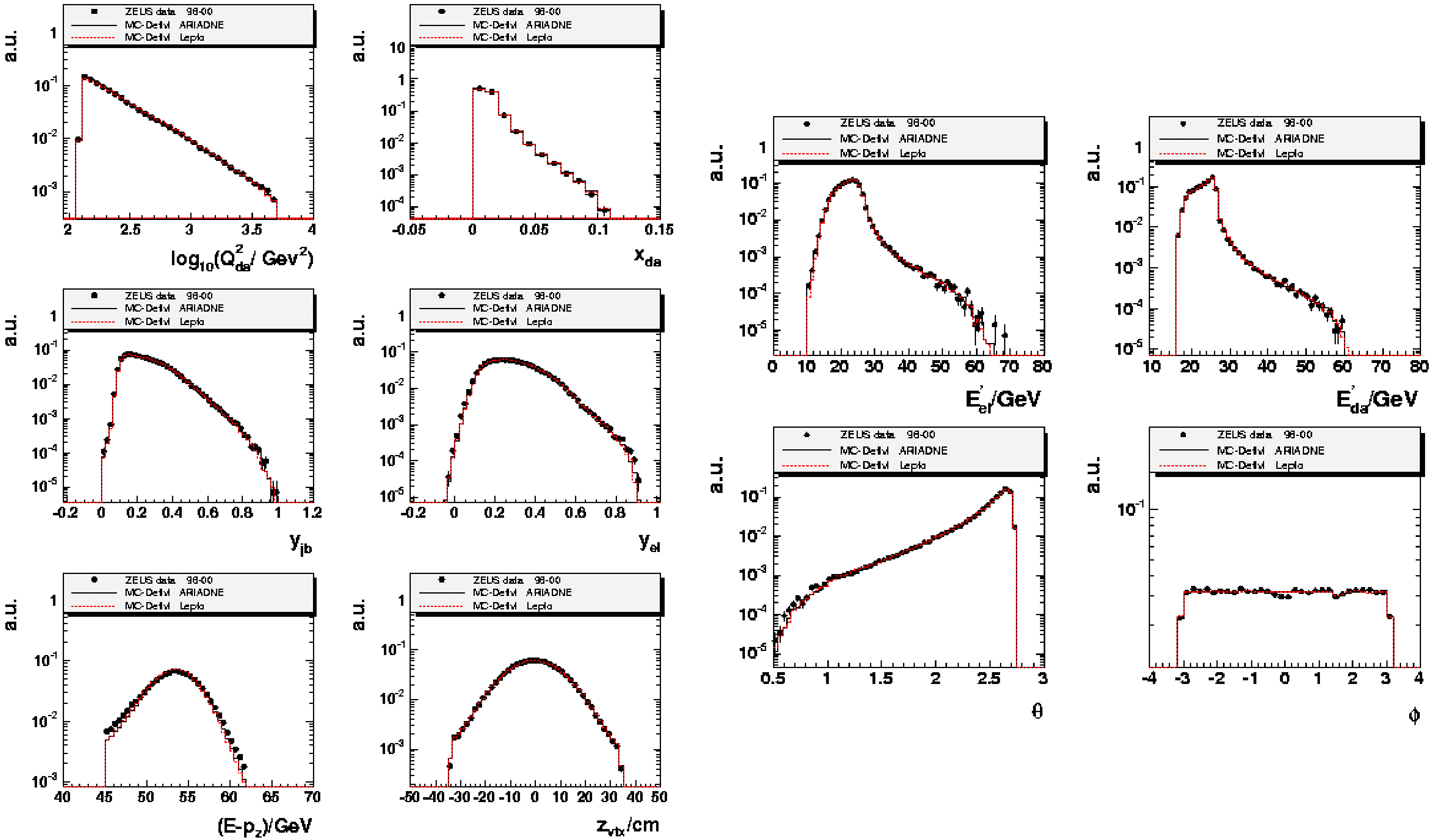
¶ The inclusive-jet data complement a measurement of single-differentiell inclusive-jet cross sections presented earlier.

¶ The data are well described by NLO QCD calculations.

¶ The double-differential distributions are sensitive to the gluon density in the proton and should thus serve as input to global QCD fits of the PDFs.

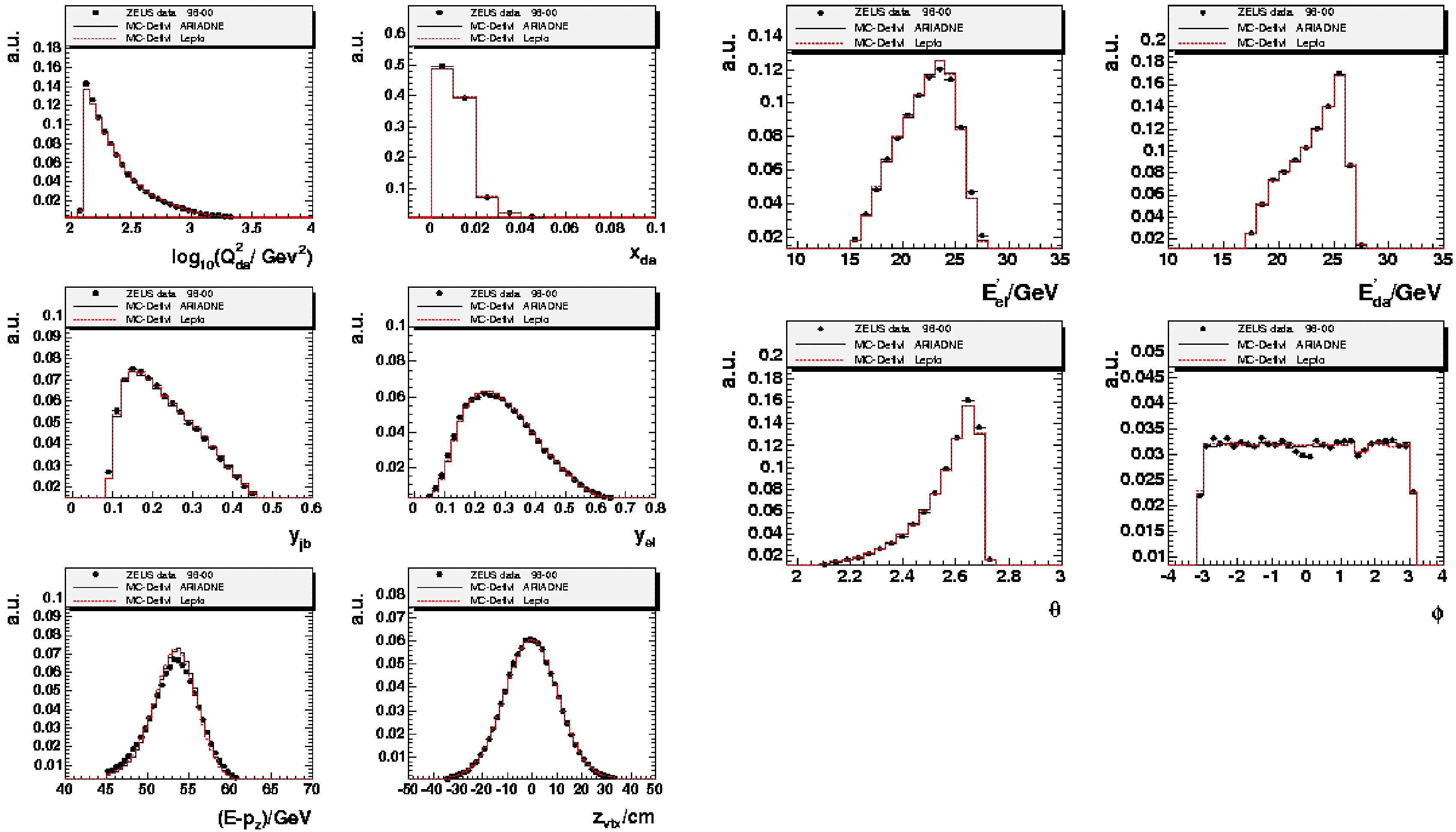
BACKUP

CONTROL-PLOTS: INCLUSIVE SAMPLE



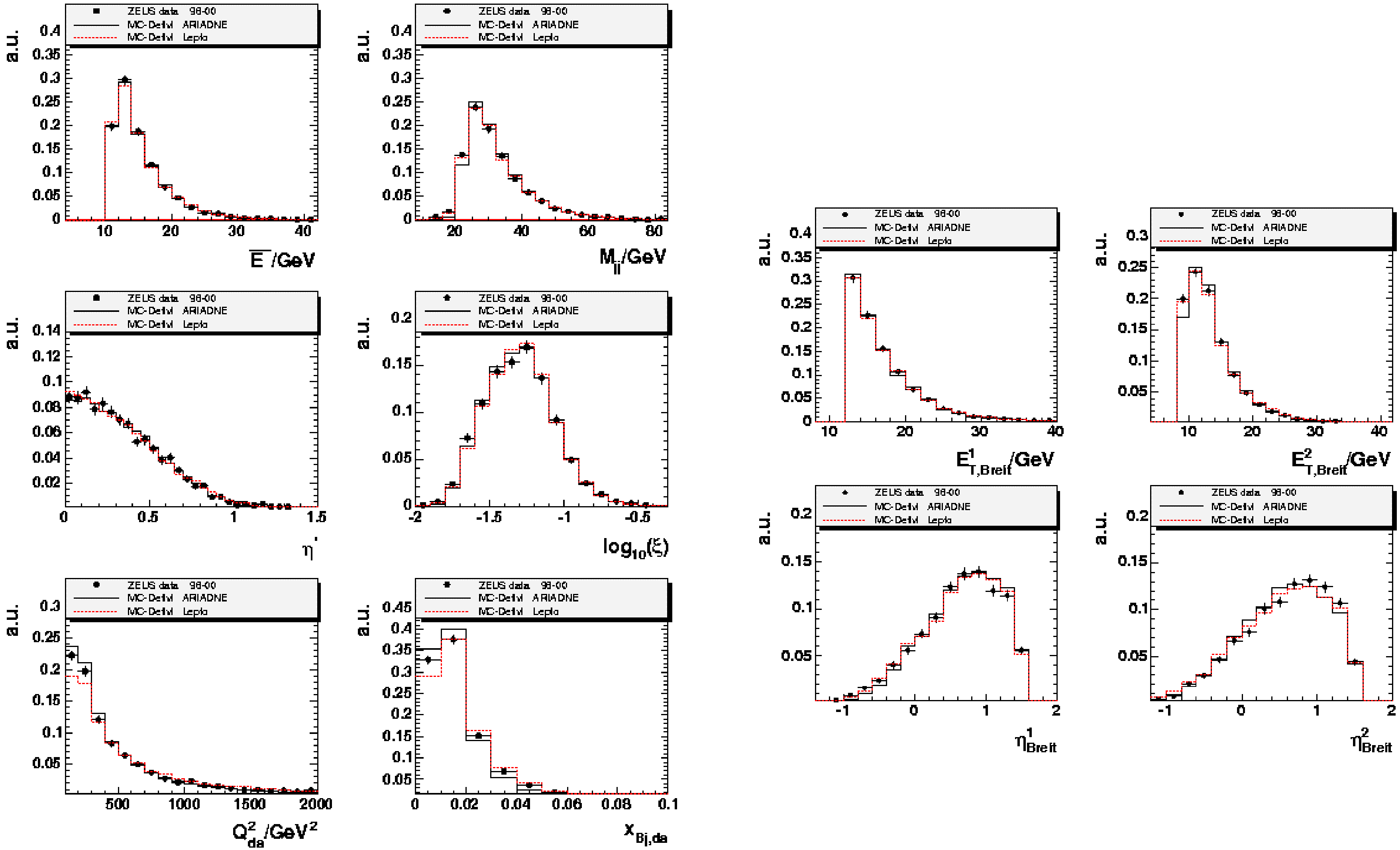
Inclusive sample well described by both MC models

CONTROL-PLOTS: DIJET, INCL. SAMPLE



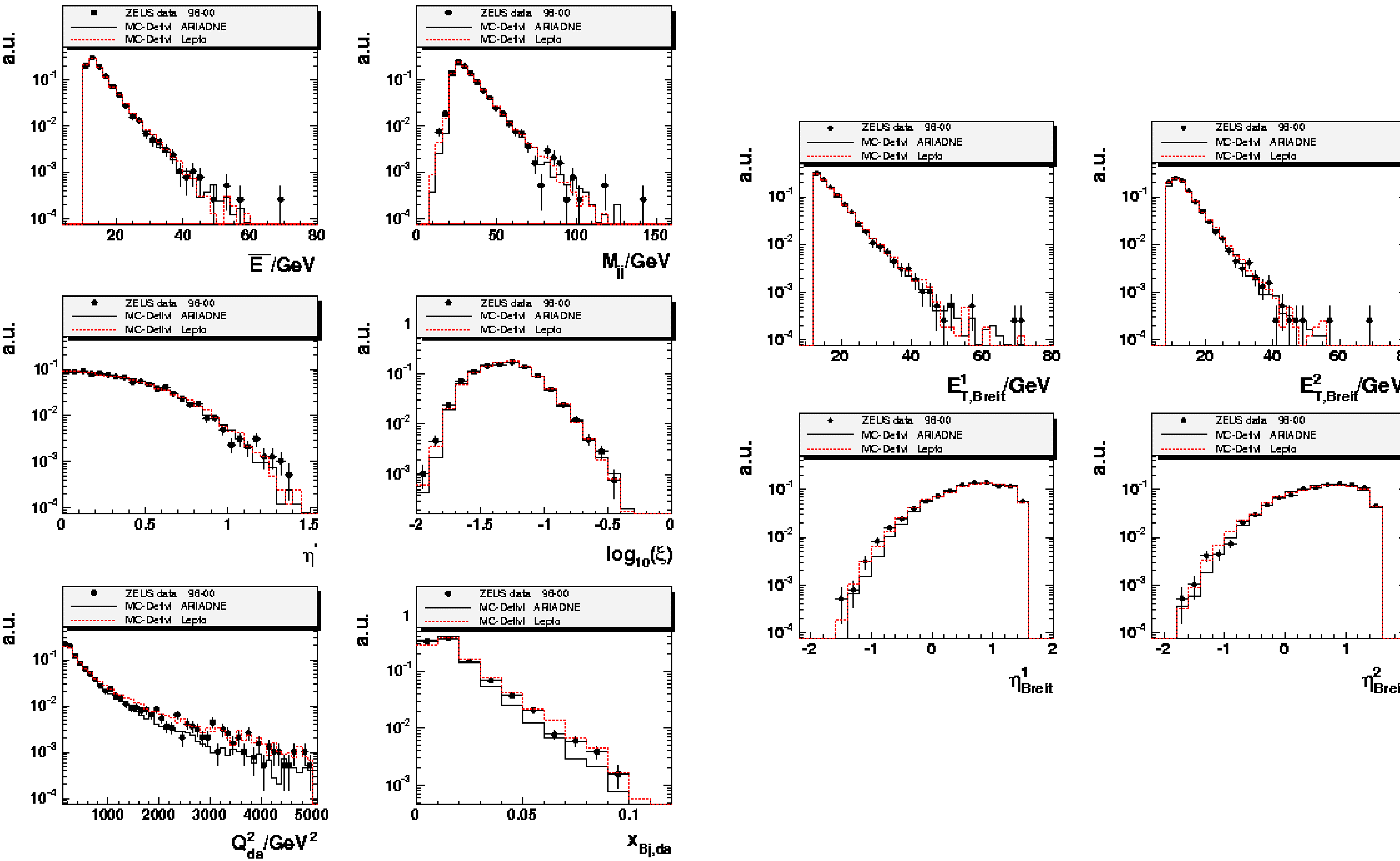
Inclusive sample well described by both MC models

CONTROL-PLOTS: DIJET SAMPLE



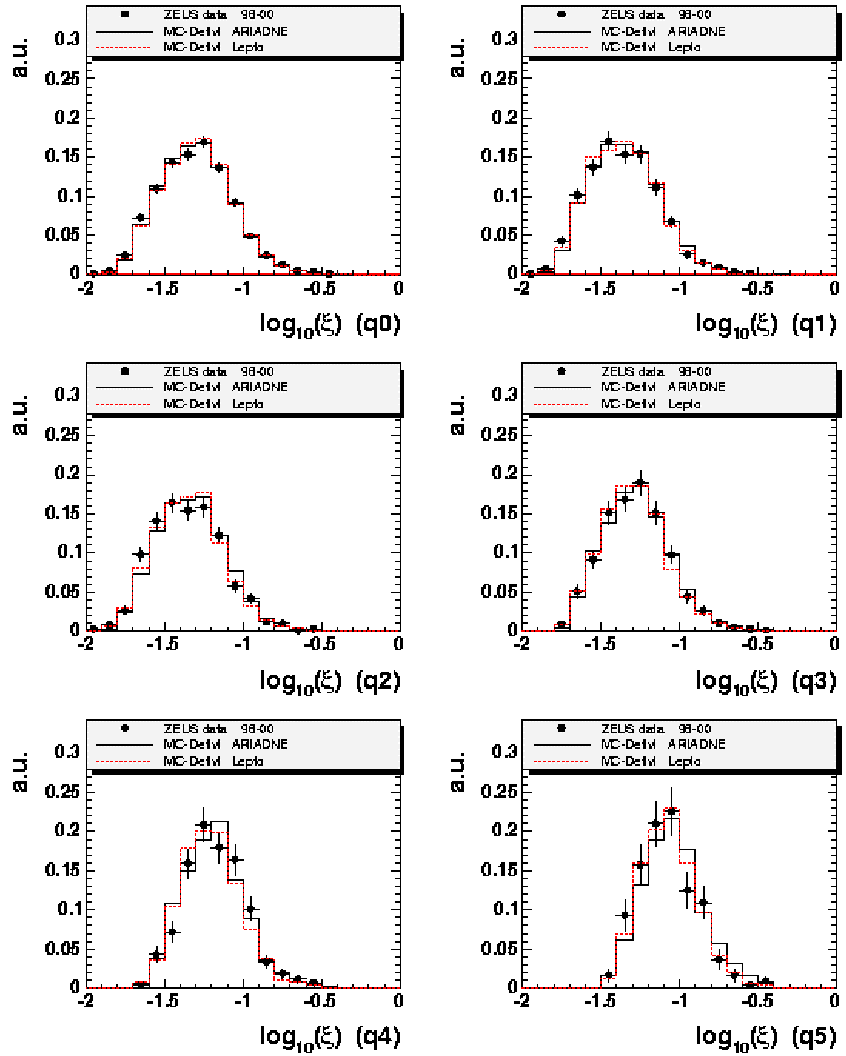
Dijet sample well described by both MC models

CONTROL-PLOTS: DIJET SAMPLE 1



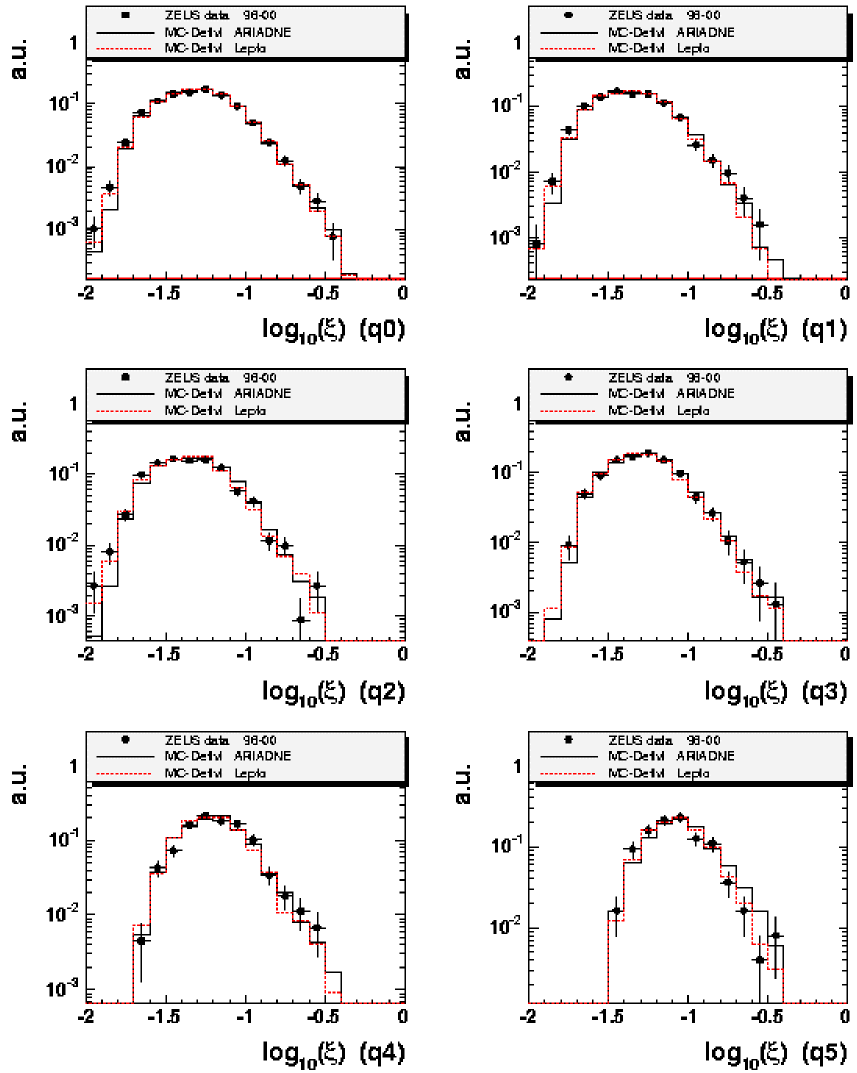
Dijet sample well described by both MC models

CONTROL-PLOTS: DIJET SAMPLE (2)



Dijet sample well described by both MC models

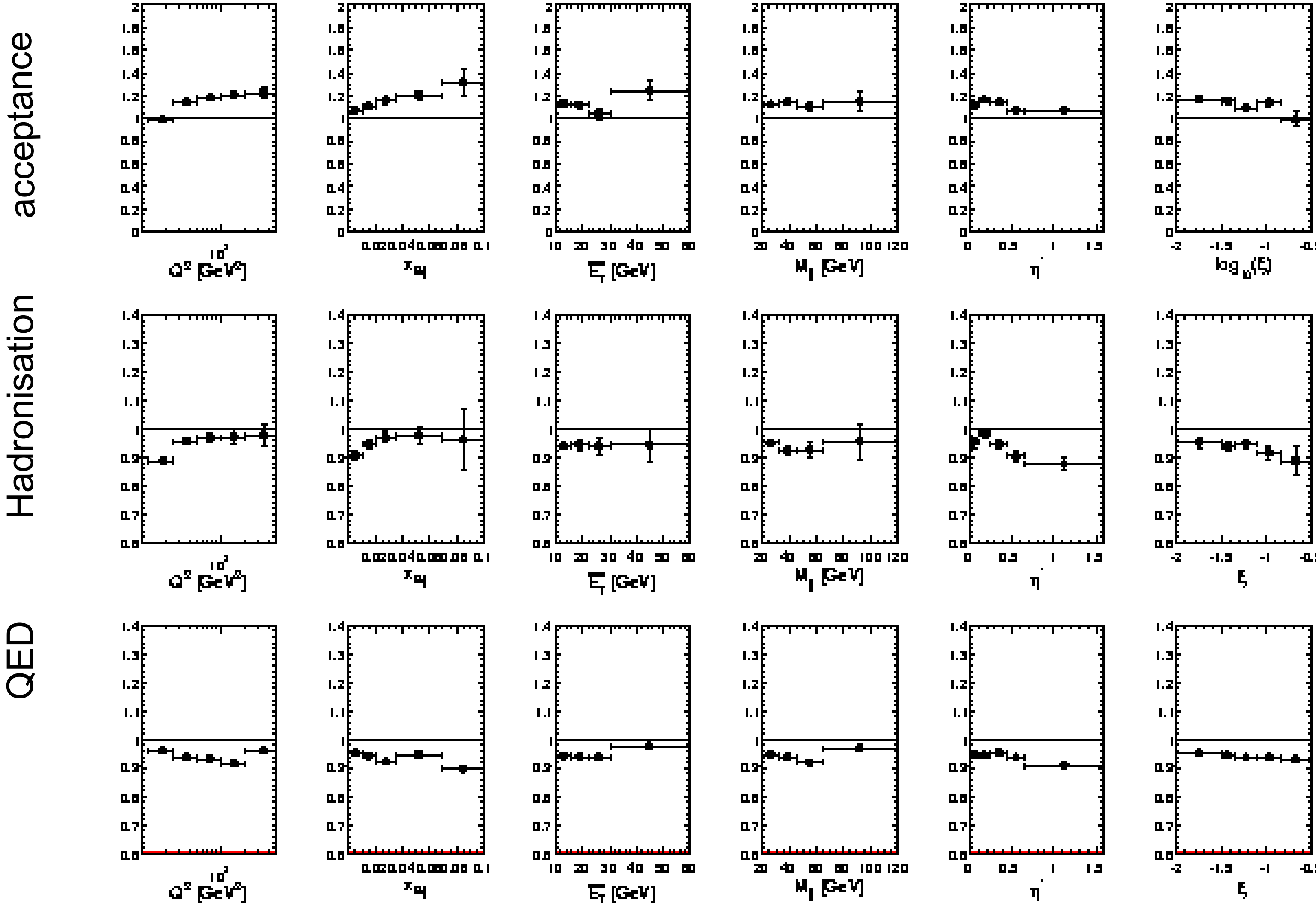
CONTROL-PLOTS: DIJET SAMPLE (2)



Dijet sample well described by both MC models

CORRECTIONS

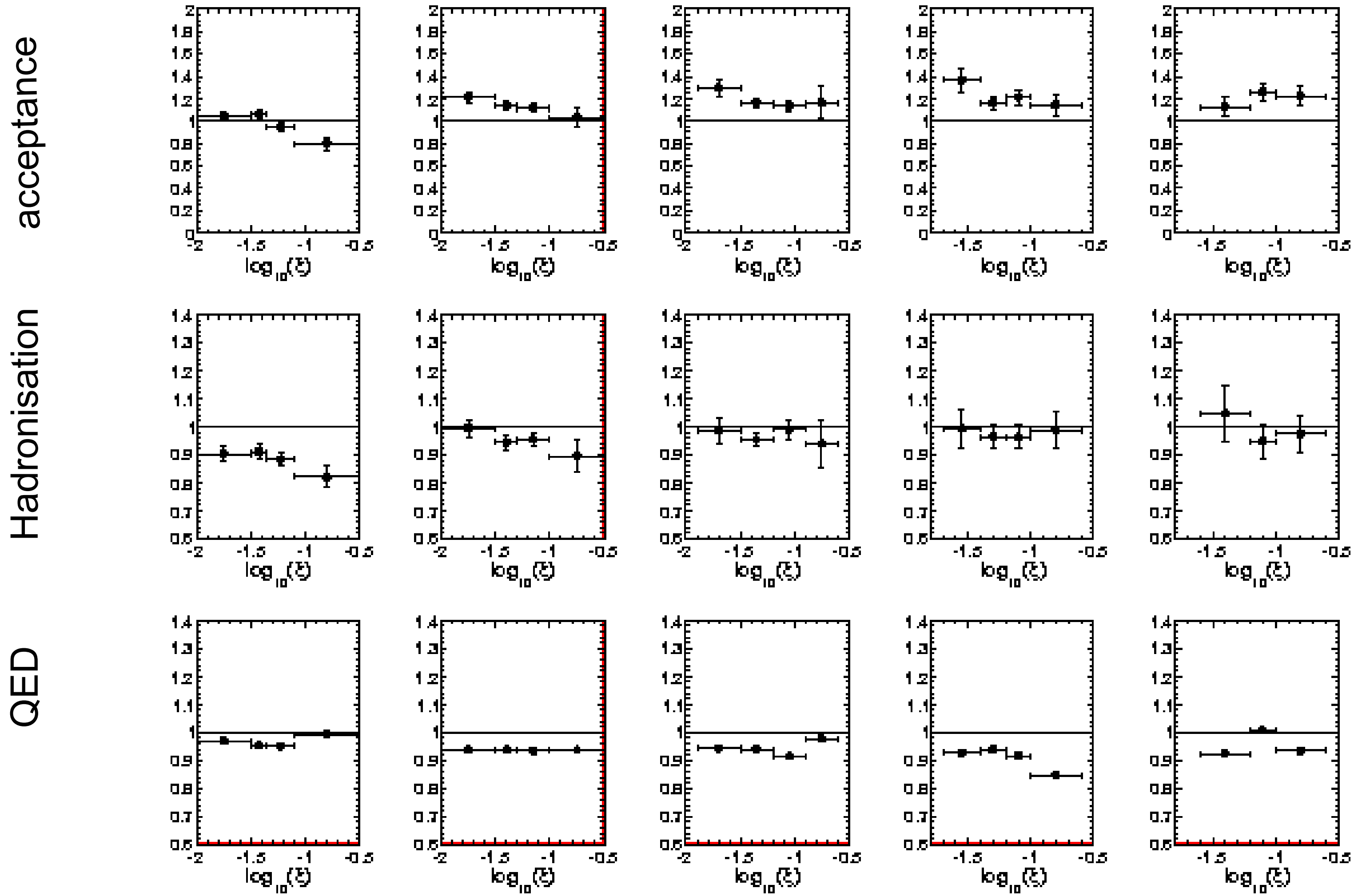
single-differential dijet analysis



Well under control, somewhat larger than for inclusive-jet analysis.

CORRECTIONS

double-differential dijet analysis



Corrections in general well under control.

A WORD ON THE QCD FITS

preparing the machinery for the use of the dijet data

Problem

- Evaluation of NLO jet cross-sections: 8 hours for 50M events.
- PDF fit requires O(100) evaluations → PROBLEM!

$$\sigma = \sum_{m=1}^{2} \alpha_s^m(\mu_r) \sum_{a=-5}^{5} \int d\eta \cdot f_a(\eta, \mu_f) \cdot \hat{\sigma}(x_{Bj}/\eta, \mu_r, \mu_f)$$

Assumption

- PDFs are approx. flat in small bins of x and μ_f.

- Divide phase-space in small x-μ_f bins.
- Remove `constant' PDF bit from integration in each bin,
- integrate the $\hat{\sigma}$ in each bin for once and for good and
- store the integrated values in ASCII table.

$$\sigma \cong \sum_{m=1}^{2} \alpha_s^m(\mu_r) \sum_{a=-5}^{5} \sum_{\eta_i, \mu_{f,j}} f_a(\eta_i, \mu_{f,j}) \cdot \int d\eta_i \hat{\sigma}(x_{Bj}/\eta_i, \mu_r, \mu_{f,j})$$

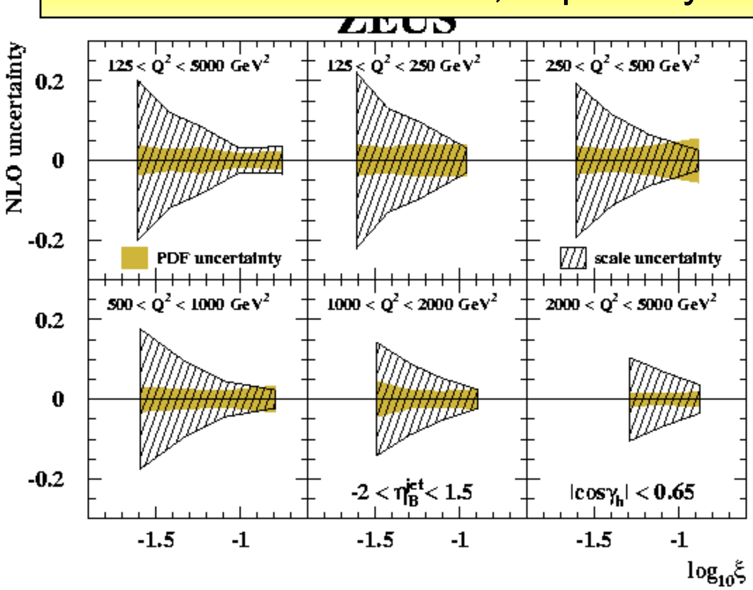
Simplification

– from integration of PDF and hard scattering matrix element
– to multiplication of constant PDF and tabulated $\int d\eta \hat{\sigma}$ and summation over all bins of x and μ_f. → 0.01s for NLO !!!!!

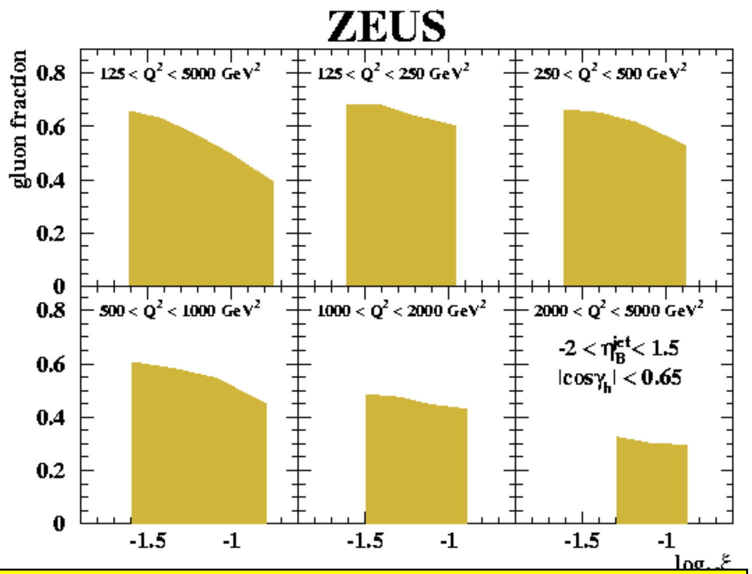
NLO THEORY
uncertainties, gluon fraction

- NLO: DISENT
  - PDFs: CTEQ6
  - renormalisation scale:
    $\mu_R = \mathrm{sqrt}(Q^2+E_T{}^2)$
  - factorisation scale:
    $\mu_F = Q$
  - hadronisation effects:
    ARIADNE MC

Scale effects dominate, especially at low ξ.



- Theoretical uncertainties:
  - scale variation: $0.5,2\mu_R$
    → ±5-10(20)%
  - PDF uncertainty: 40 sets from CTEQ6 → ±2-5%
  - α_S variation with CTEQ6AB
    → less than ±4%



Gluon fraction decreases with increasing ξ, Q^2.