Preview of new ZEUS results for ICHEP04

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45 Papers sent to ICHEP04:

- **15 published articles**
- **14 Prel. results released for other conferences (incl. DIS04)**
- **18 New results**
  3 of which from HERA-II data

Summary:

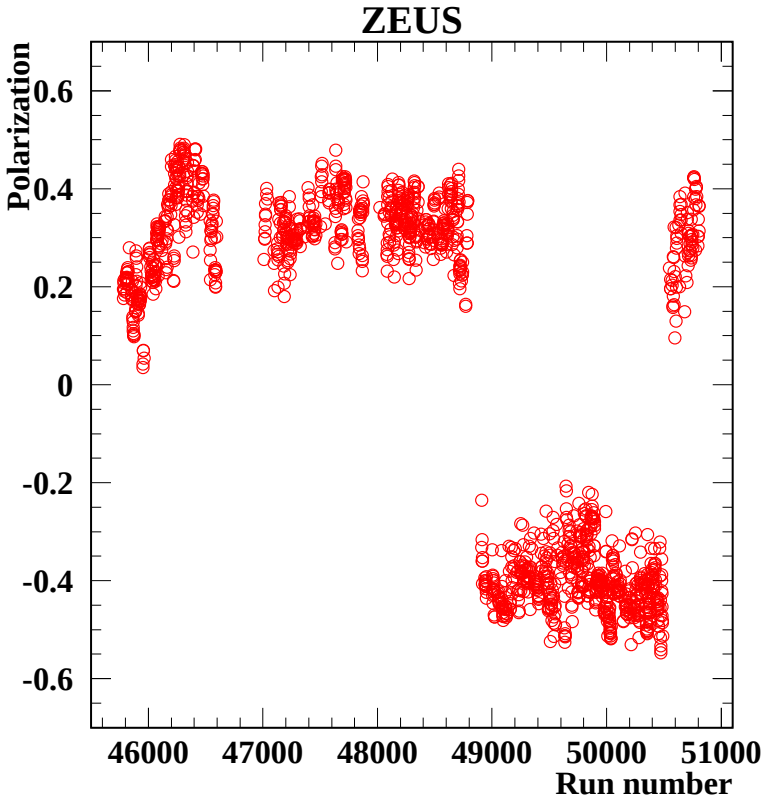
- **Polarized CC and NC**
- **PDFs and α_S**
- **Jets and Hadronic final states**
- **Diffraction**
- **Heavy Flavours**
- **Searches for new physics**
- **Pentaquarks**

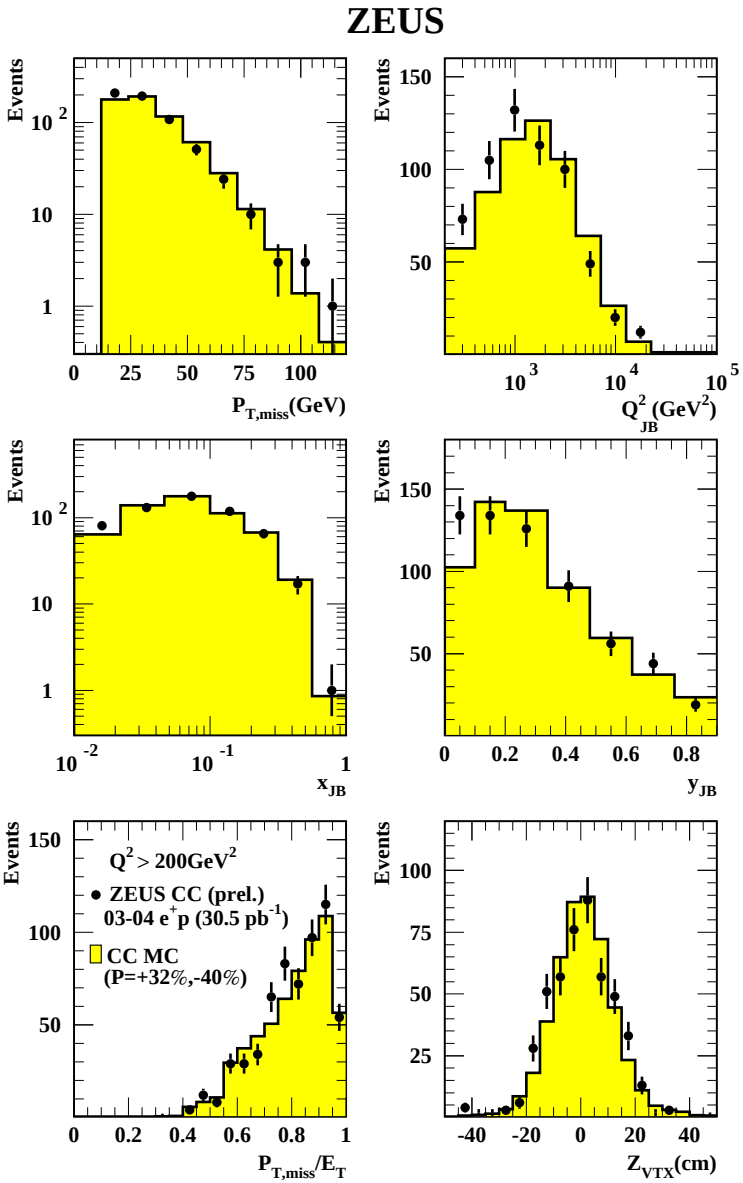
Polarized Charged Currents

03-04 data $P = \frac{N(e_R^+) - N(e_L^+)}{N(e_R^+) + N(e_L^+)}$

Right-handed: $\mathbf{L = 14.1\ pb^{-1}}$ $P = +31.8 \pm 0.9\%$

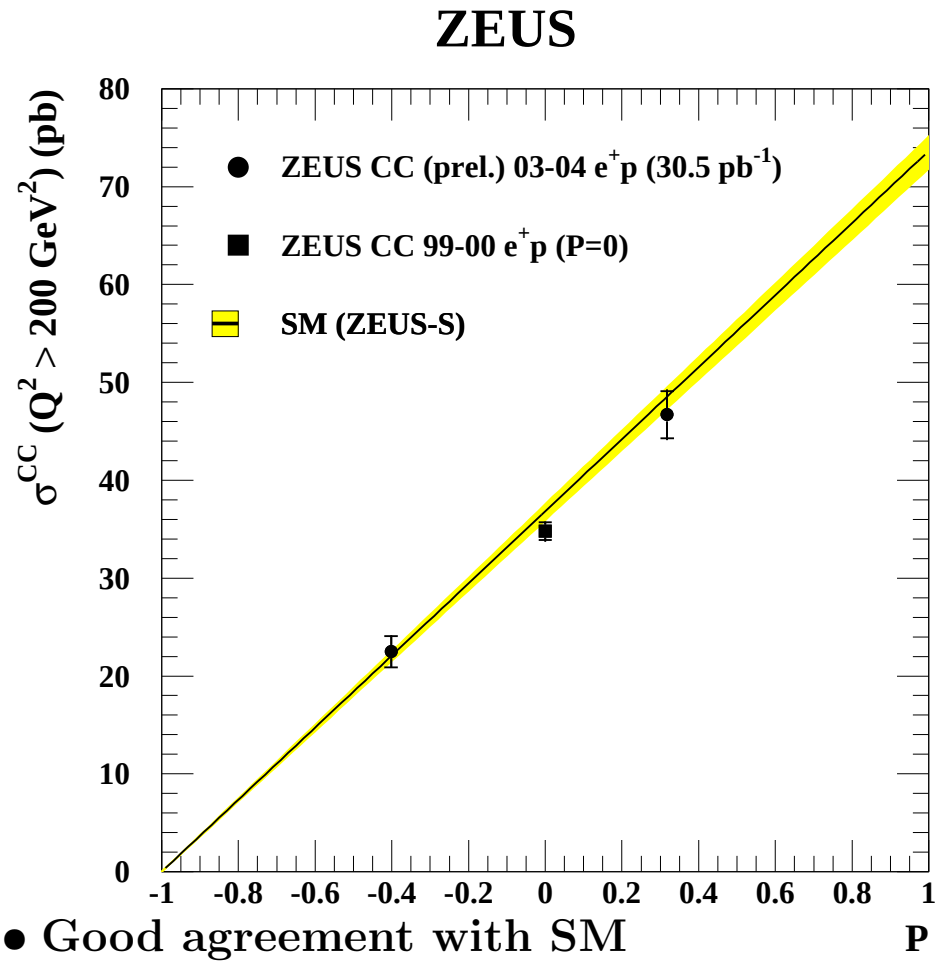
Left-handed: $\mathbf{L = 16.4\ pb^{-1}}$ $P = -40.2 \pm 1.1\%$

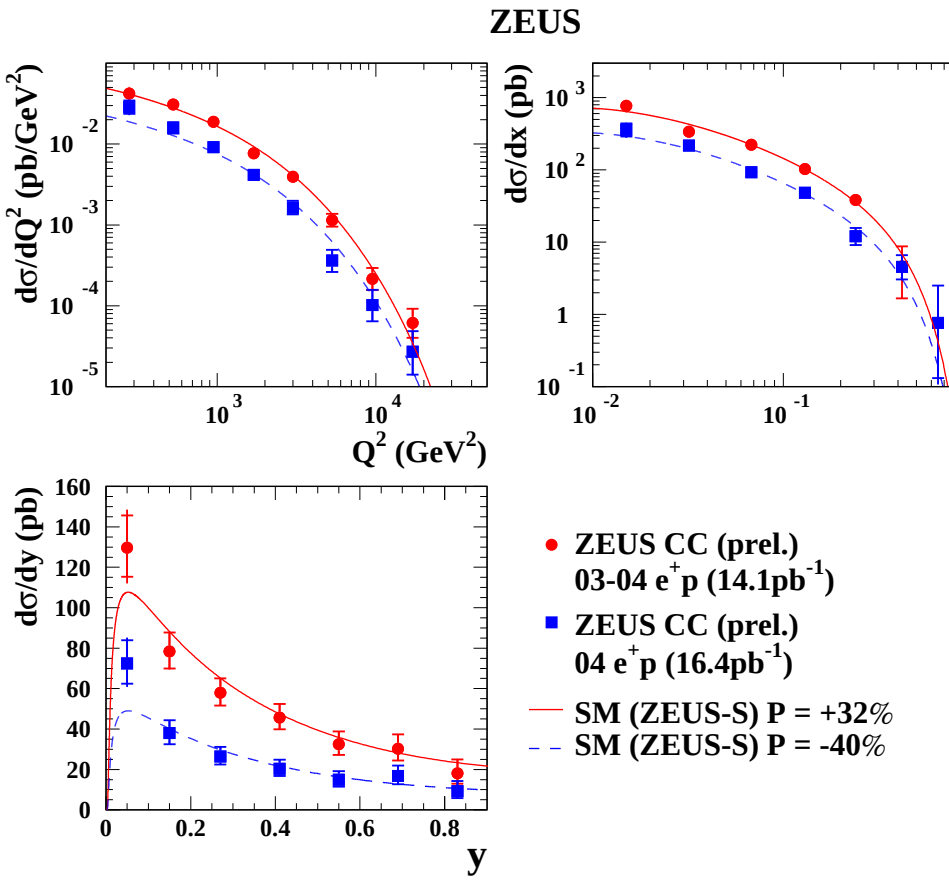




Polarized Charged Currents

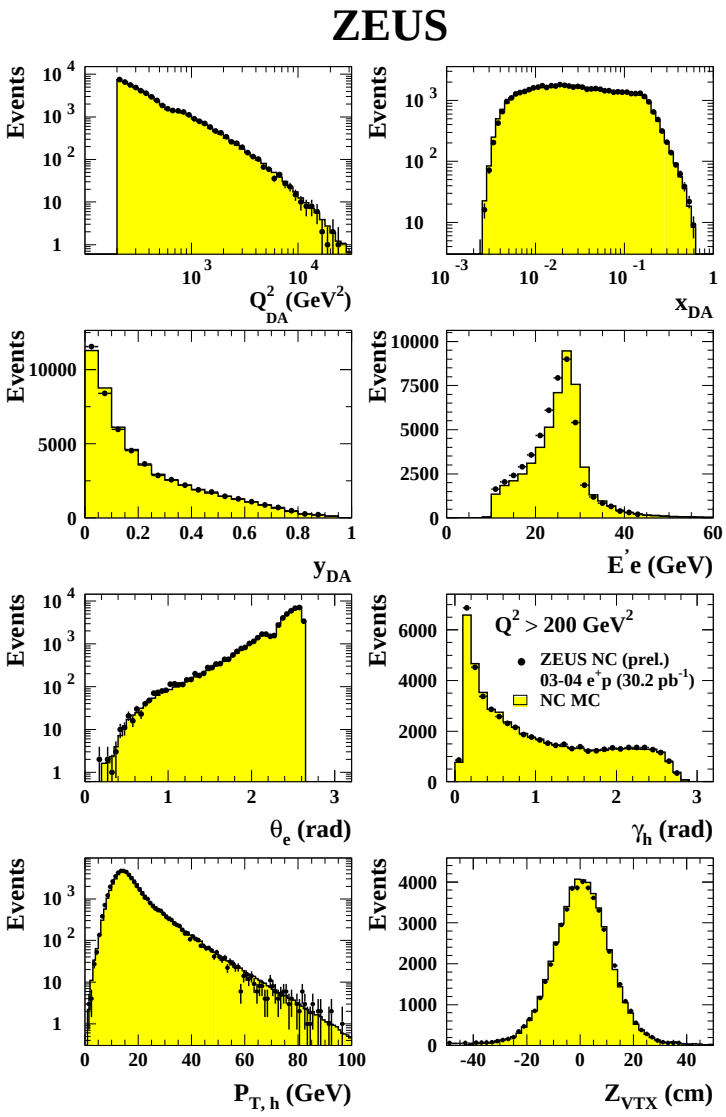
$$\sigma_{\mathrm{cc}}(e^+p) = (1+P)\sigma_{cc}(e^+_Rp)$$

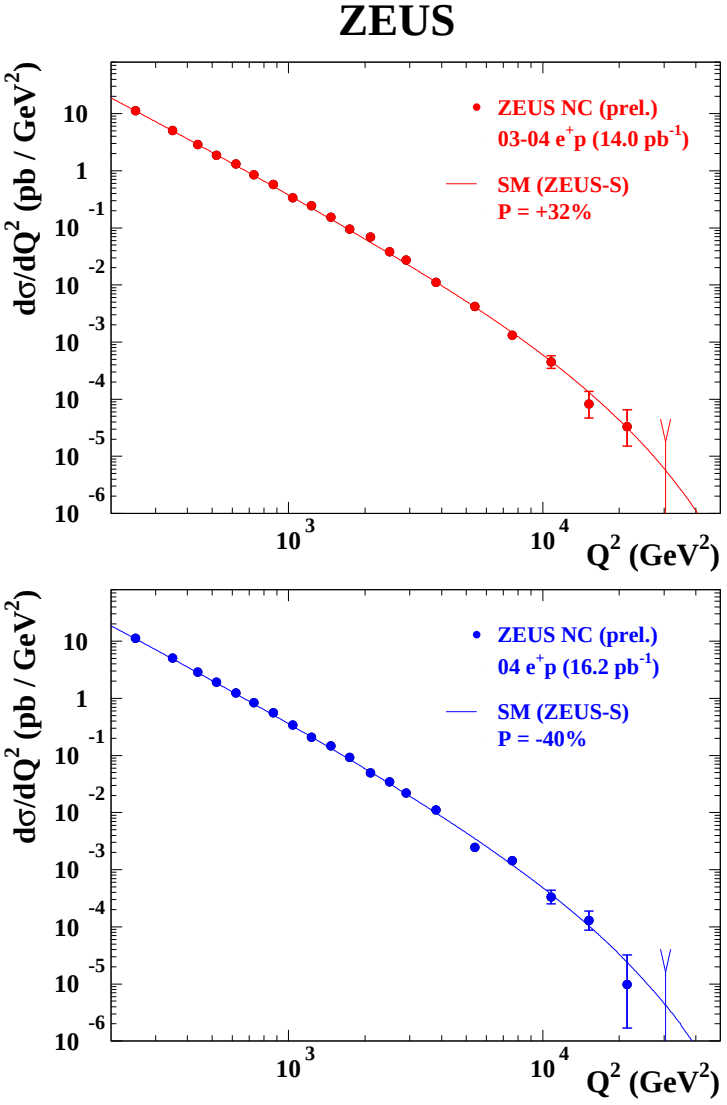




- Good agreement with SM
- No hint for right-handed charged currents

Polarized Neutral Currents





- same data set as for CC
- good agreement with SM

Polarized Neutral Currents

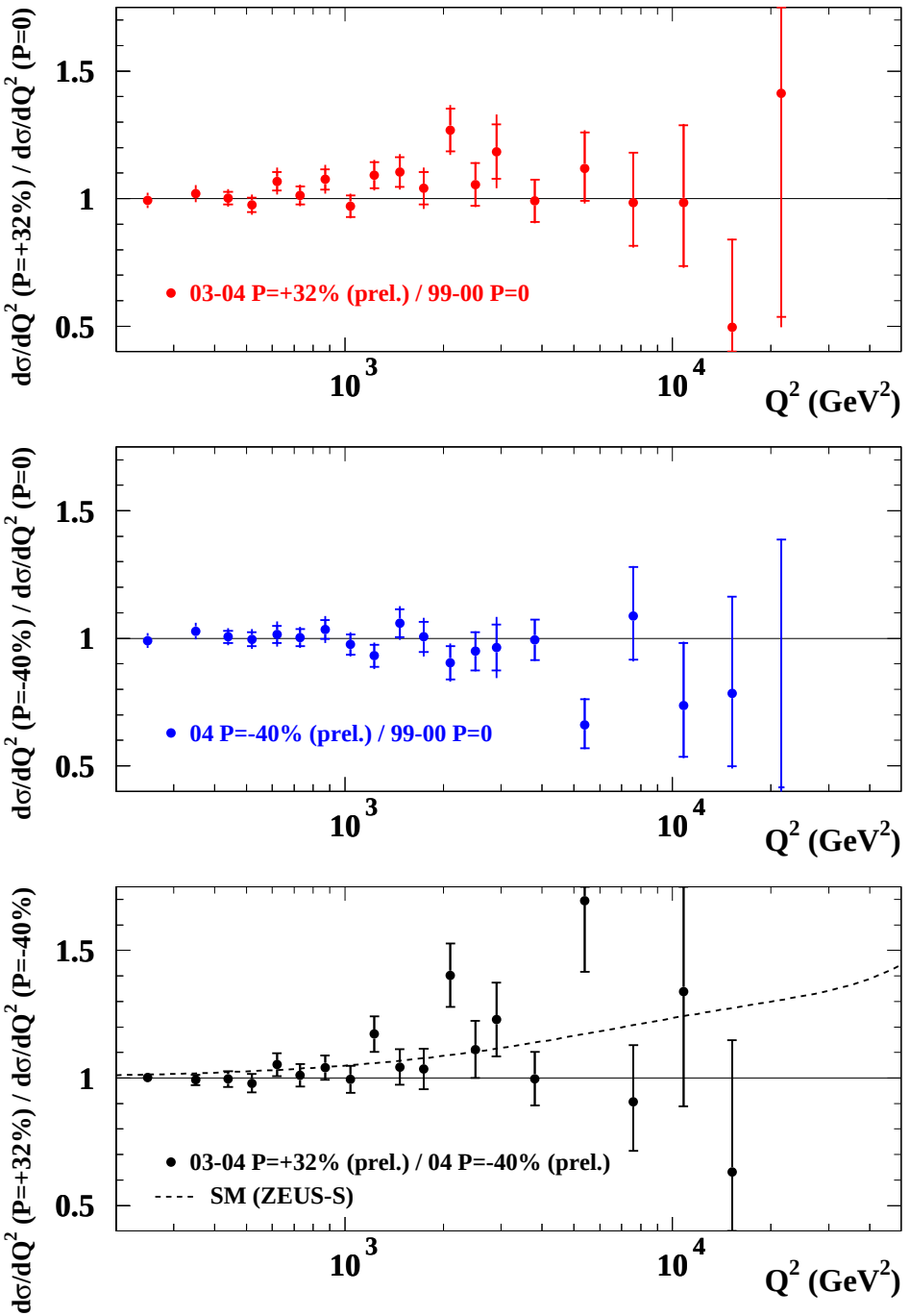
- $\frac{\sigma(P{=}+32\%)}{\sigma(P{=}0)}$ **vs** Q^2

- $\frac{\sigma(P{=}-40\%)}{\sigma(P{=}0)}$ **vs** Q^2

- $\frac{\sigma(P{=}+32\%)}{\sigma(P{=}-40\%)}$ **vs** Q^2

  - $\sigma(e^+_R) > \sigma(e^+_L)$ **at large** Q^2
  - **Parity violation in neutral currents**
  - **Agreement with SM**

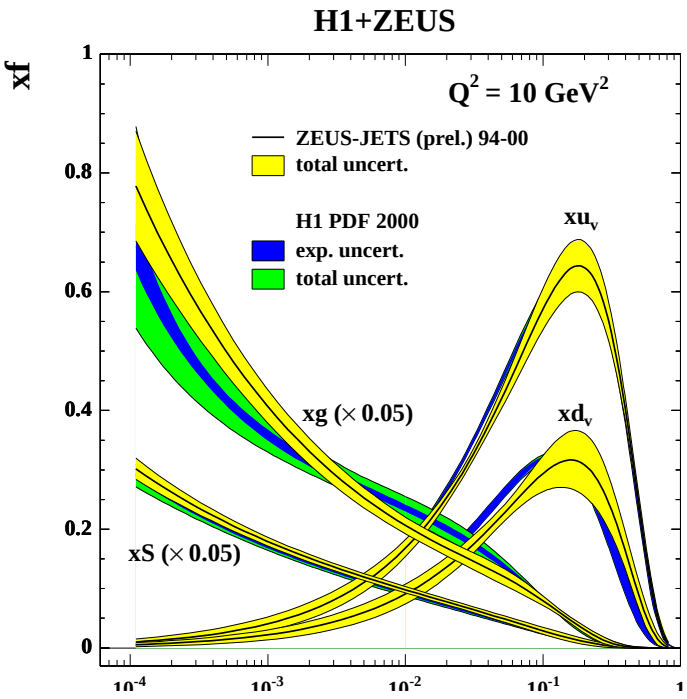
ZEUS

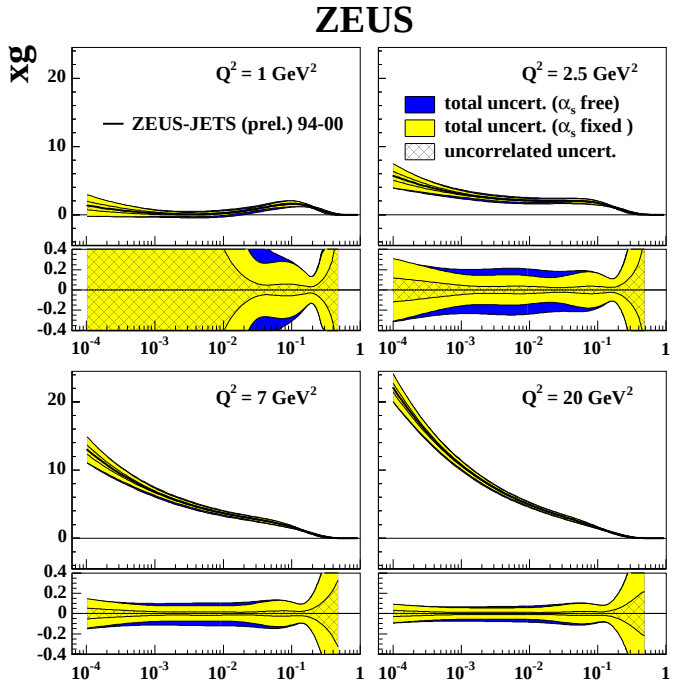


α_S and PDFs from QCD Fit

- **ZEUS-jets-α_S fit (prel.)**
- **Use ZEUS data only:**
  - **NC and CC DIS**
  - **inclusive jets (Breit frame) in DIS**
  - **dijets in PhP**
- **jet data help fixing $g(x)$ at mid-high x**
- **Simultaneous determination of α_S and PDFs in 1 experiment**

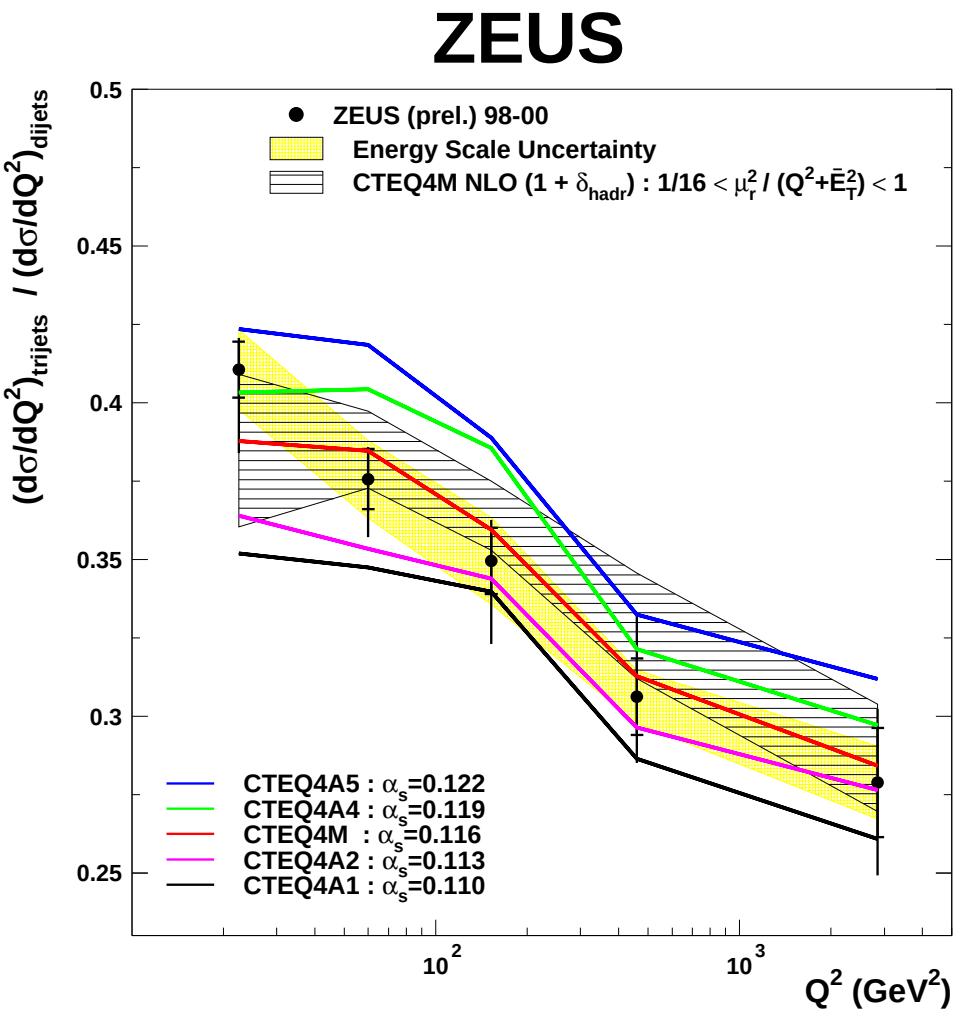
- $\alpha_S(M_Z) = 0.1183 \pm 0.0028(\text{exp.}) \pm 0.0008(\text{model})$
  Theoretical uncertainty ~ 0.005
- **Uncertainty on $g(x)$ larger than fit with constrained α_S**





α_S from 3/2 jets ratio in DIS

- **98-00 data (82 pb^{-1})**
- $10 < Q^2 < 5000\mathbf{GeV}^2$
- **Breit Frame 2,3-jet events with** $E_{T,B}^{jet} > 5\mathbf{GeV}$, $-1 < \eta_{LAB}^{jet} < 2.5$, $M_{2j,3j} > 25\mathbf{GeV}$
- α_S **from 3/2 jet ratio**
- α_S **measured down to** $Q^2 = 25\mathbf{GeV}^2$
- **using ratios reduces both syst. and theo. uncertainties**

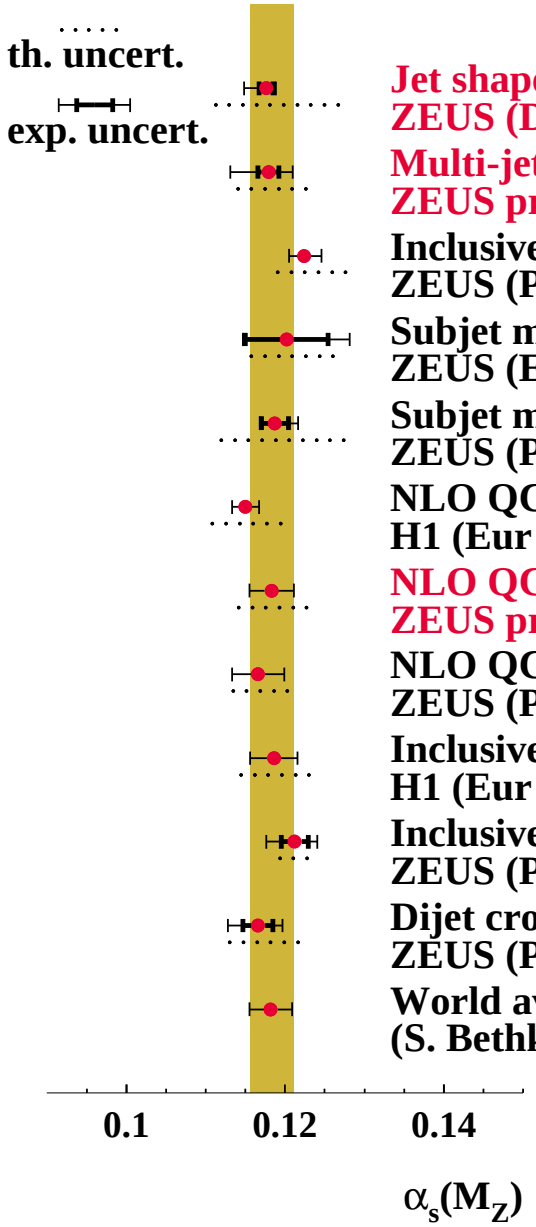


$$\alpha_S(M_Z) = 0.1179 \pm 0.0013(\text{stat.})^{+0.0028}_{-0.0046}(\text{exp.})^{+0.0061}_{-0.0040}(\text{theo.})$$

Summary of α_S from ZEUS

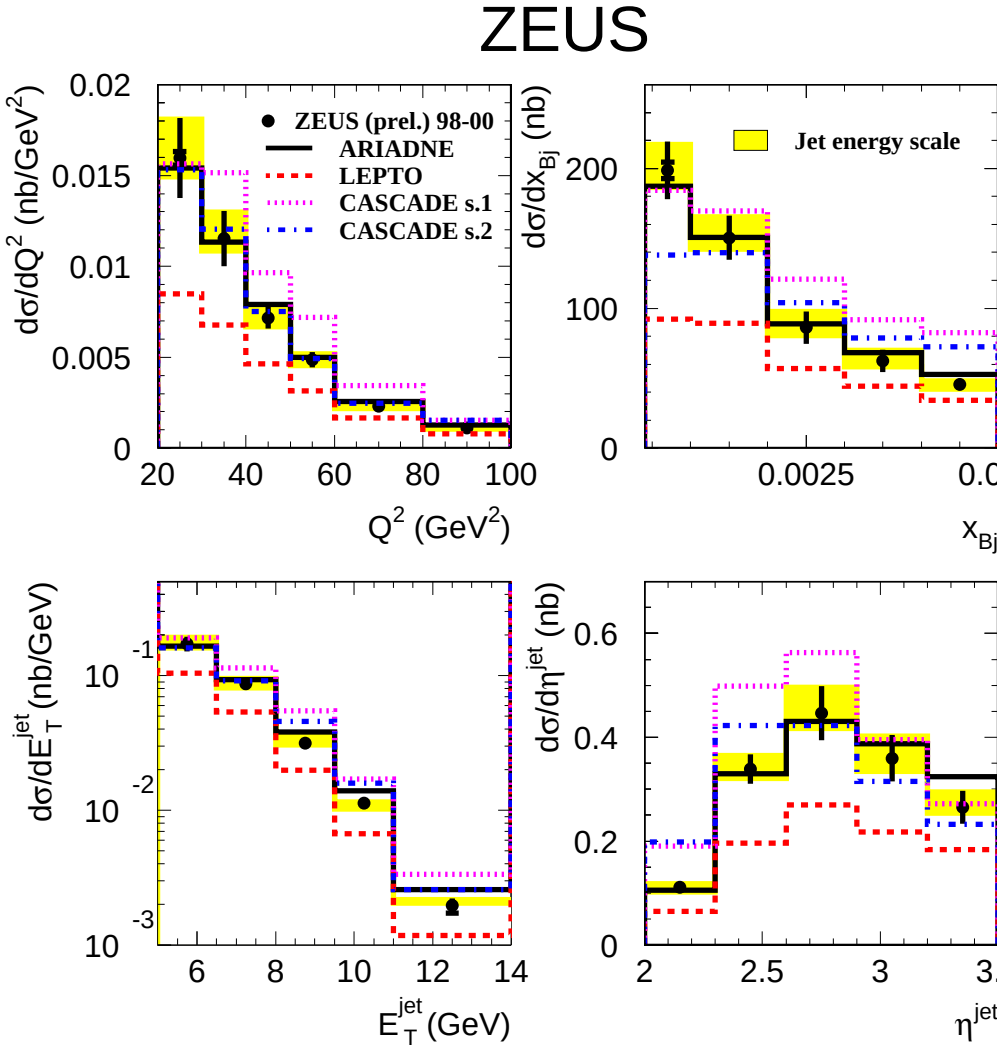
3/2 jet ratio $\Longrightarrow$

New QCD fit $\Longrightarrow$



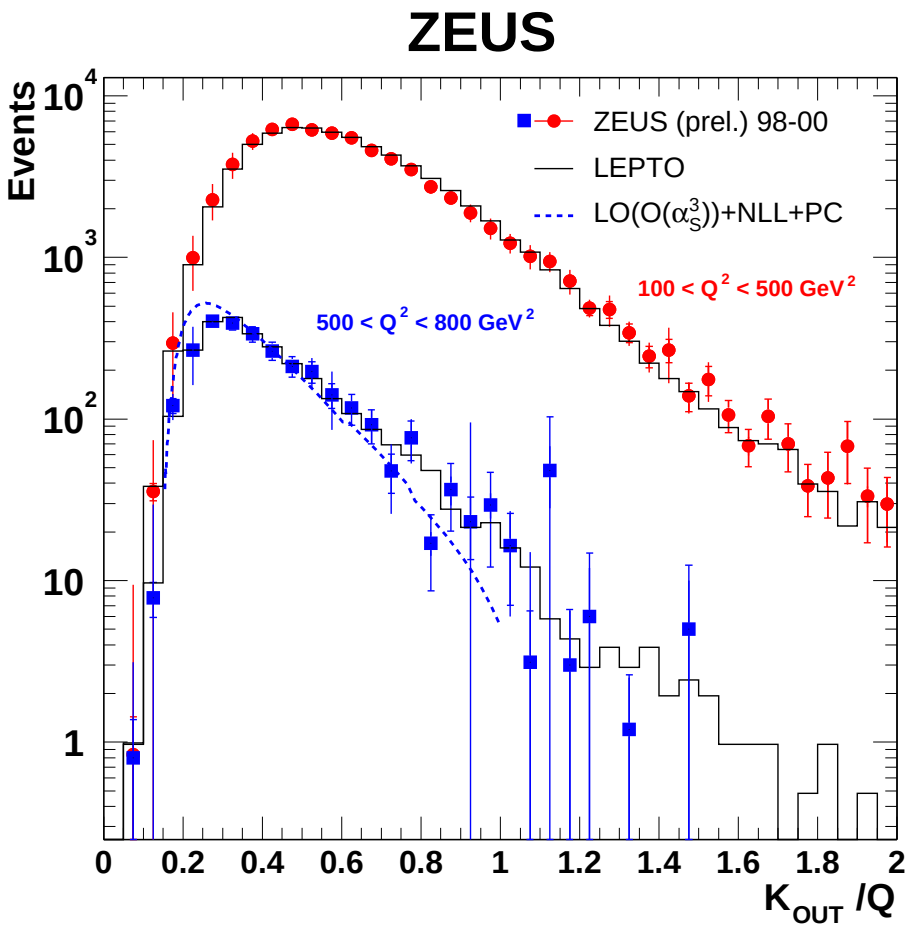
Very forward inclusive jets in DIS

- **Jets up to $\eta = 3.5$ using the FPC**
- **98-00 data (82 pb^{-1})**
- $20 < Q^2 < 100$**GeV**^{2}, $0.04 < y < 0.07$, $0.0004 < x < 0.005$
- **Breit frame jets boosted to lab** $E_T^{jet} > 5$ **GeV,** $2 < \eta^{jet} < 3.5$
- **to enhance low x effects:** $x_{jet} = p_z^{jet}/P_p > 0.036$, $0.5 < (E_T^{jet})^2/Q^2 < 2$
- **Comparison with MC models:**
  - LEPTO SCI **too low**
  - ARIADNE **describes the data well**
  - CASCADE **shape not OK**



Event Shapes in DIS

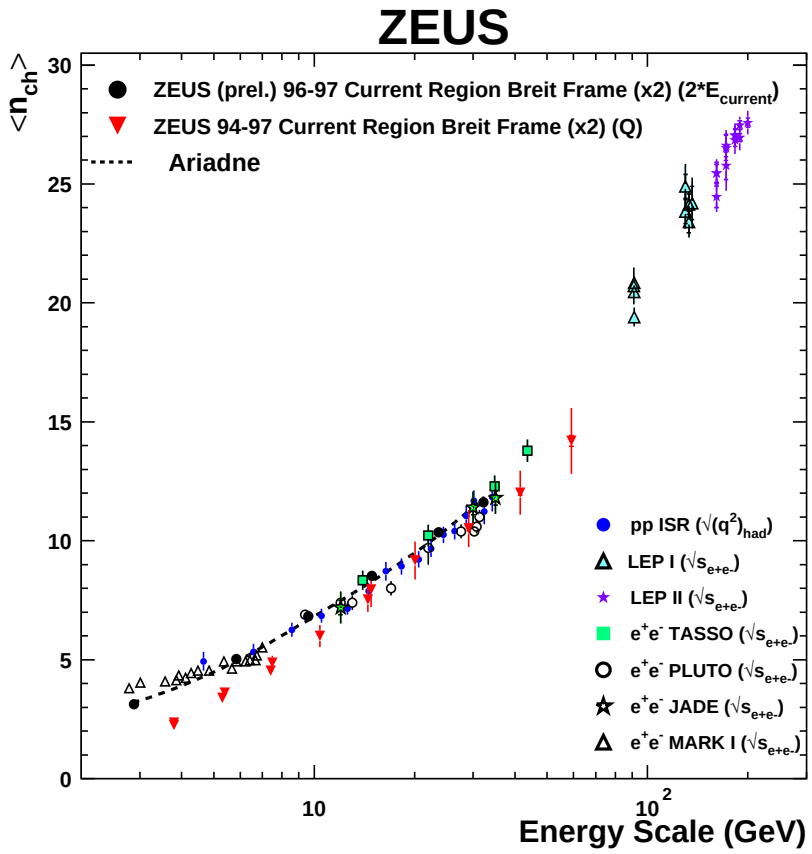
- **New event shape variable:** K_{OUT}
- **Events with 2 jets in Breit frame**
  $K_{OUT} = \sum_i p_i^{out}$
  p_i^{out} **is the hadron momentum outside the dijet plane**
- **98-00 data (82 pb^{-1})**
- $Q^2 > 100\mathbf{GeV}^2$, $0.0024 < x < 0.6$
- **LO ($O(\alpha_S^3)$) + NLL + PC theory does not describe** K_{OUT}/Q
  NLO needed to fit α_S, α_0



Charged particle multiplicities in DIS

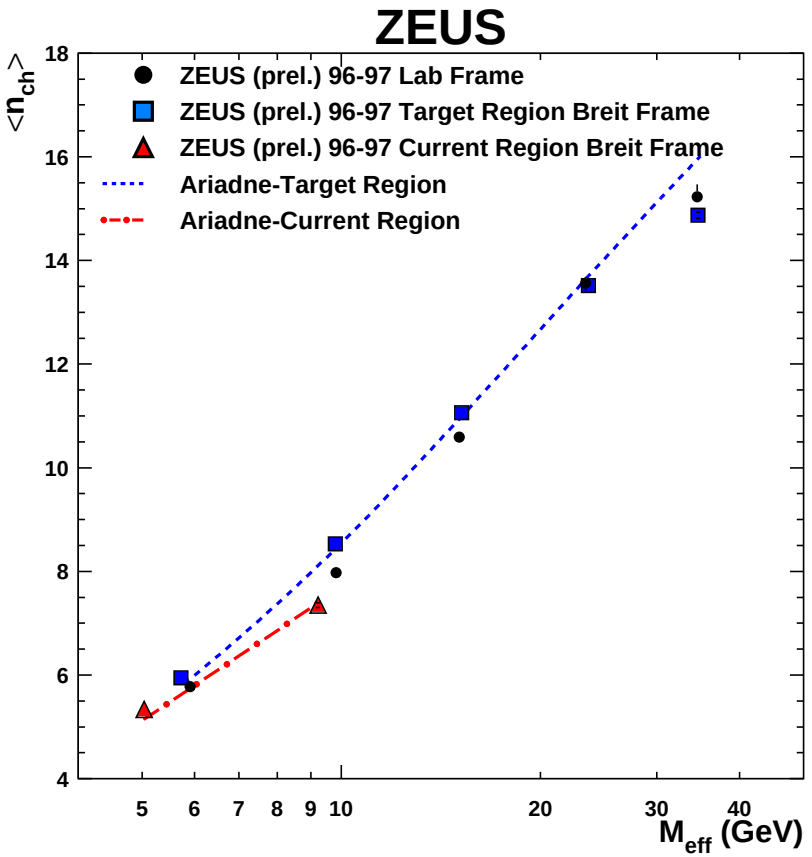
Current region
$2\langle n_{ch}\rangle$ **vs** $2E_{\text{current}}$

agrees with $\langle n_{ch}\rangle$**vs**$\sqrt{s}$ **in** e^+e^- **and Ariadne**



Target region
$\langle n_{ch}^{vis}\rangle$ **vs** M_{eff}^{vis}

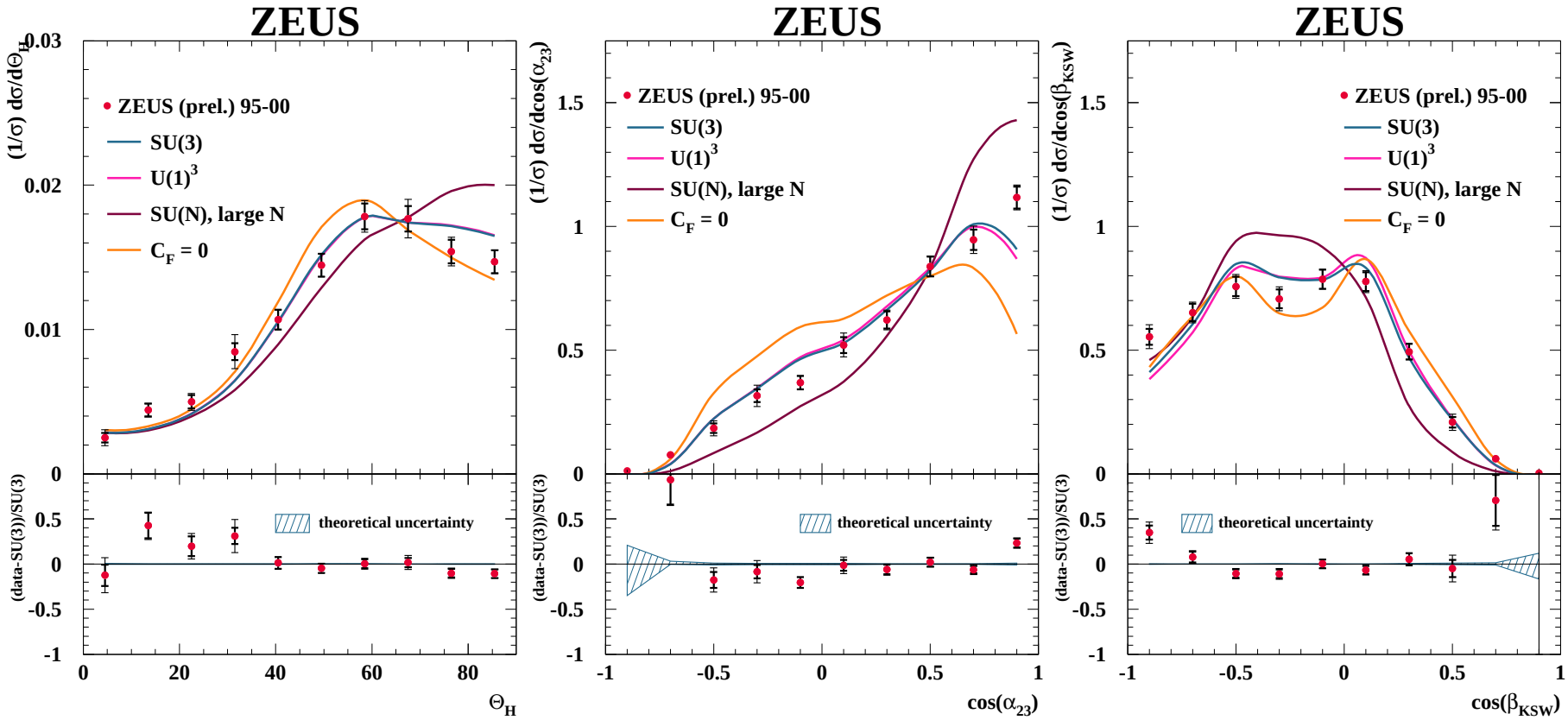
vis. mult. $>$ **than current region agreement with Ariadne**



Three-jet photoproduction and colour dynamics

- **Angular distribution sensitive to color factors:**
  $q \to qg \propto C_F$, $g \to gg \propto C_A$, $g \to q\bar{q} \propto T_F$
- **depend on gauge group of the theory:**
  - **SU(3):** $C_A/C_F = 9/4$, $T_F/C_F = 3/8$
  - **U(1)^3:** $C_A = 0$, $T_F/C_F = 3$
  - **SU(N$\gg$ 1):** $C_A/C_F = 2$, $T_F/C_F = 0$

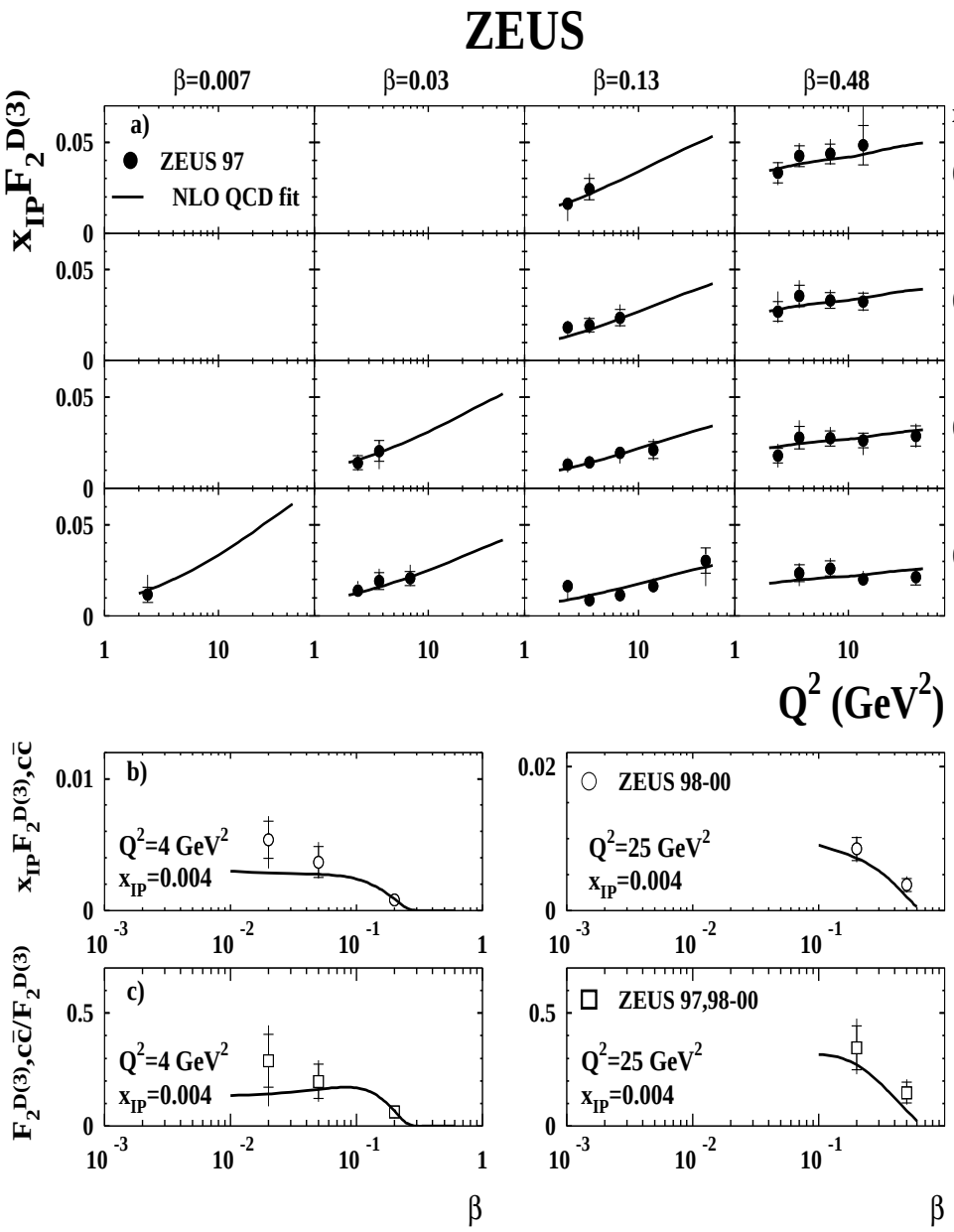
- **Analysis of 3-jet angular distributions in direct photoproduction**
- $L = 127\mathbf{pb}^{-1}$, $E_T > 14\mathbf{GeV}$, $x_\gamma^{obs} > 0.7$
- **Angular variables considered:**
  - $\theta_H = \angle((\mathbf{p_1} \times \mathbf{p_B}), (\mathbf{p_2} \times \mathbf{p_3}))$
  - $\alpha_{23} = \angle(\mathbf{p_2}, \mathbf{p_3})$
  - $\beta_{KSW} = 0.5\angle((\mathbf{p_1} \times \mathbf{p_3}), (\mathbf{p_2} \times \mathbf{p_B})) + \theta_H$



Agreement with Pythia and LO calculation for SU(3), U(1), disfavour SU(N$\gg$ 1), C_F=

DGLAP fit of Inclusive diffraction

- New paper with QCD analysis of $F_2^{D(3)}$ and $F_2^{D(3),c\bar{c}}$
- Assume Regge factorization
  $F_2^{D(3)}(\beta, Q^2, x_{I\!P}) = f_{I\!P}(x_{I\!P}) F_2^{I\!P}(\beta, Q^2)$
  $f_{I\!P}(x_{I\!P})$ from Donnachie-Landshoff
- DGLAP fit of $F_2^{I\!P}(\beta, Q^2)$
- Data:
  - $F_2^{D(3)}$ from LPS data
    $Q^2 > 2\mathrm{GeV}^2$, $x_{I\!P} < 0.01$
  - $F_2^{D(3),c\bar{c}}$ from diffractive D^*
- good fit
- not enough precision for PDF determination
- Momentum fraction carried by gluons:
  $\int dx\, x g_{I\!P}(x, Q^2) = \left(82 \pm 8(\mathrm{stat.})^{+15}_{-16}(\mathrm{syst.})\right)\%$
  (at $Q^2 = 2\mathrm{GeV}^2$)



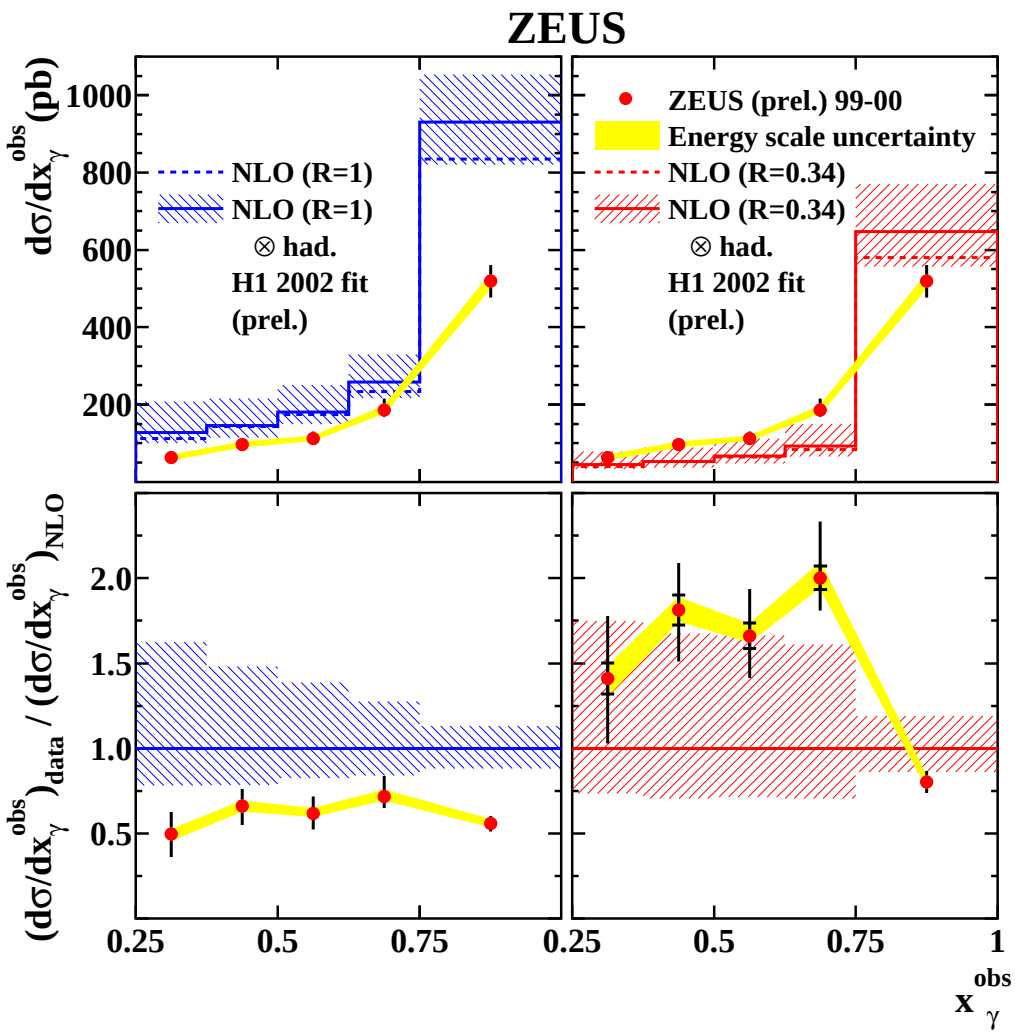
$\sim 1/3$ of $F_2^{D(3)}$ from charm at low β, high Q^2

Diffractive dijet photoproduction

- Sensitivity to gluon
- RG suppression in γp as in $p\bar{p}$?

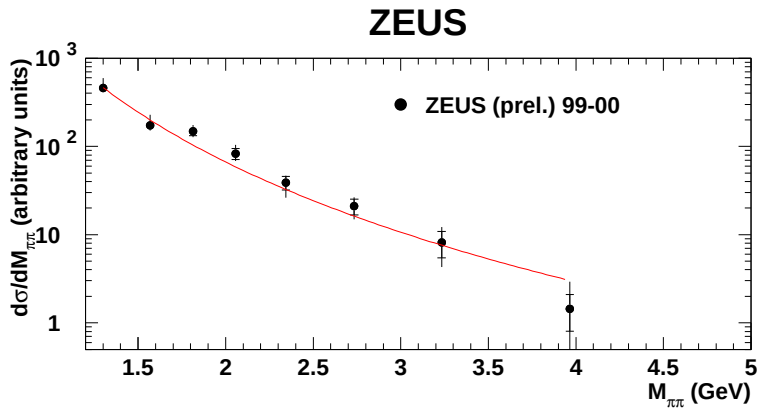
- 99-00 ZEUS data (77.6 pb^{-1})
- $E_T > 7.5, 6.5\mathbf{GeV}$, $-1.5 < \eta < 2$, $x_{I\!P} < 0.035$

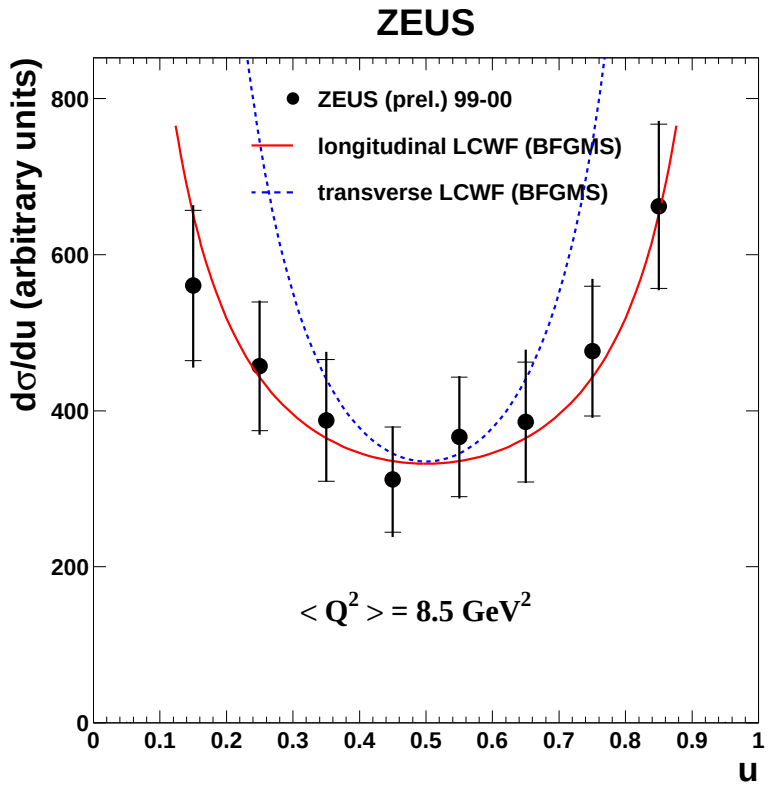
- Compare with NLO (PDF: H1 2002 fit prel.)
- NLO shape OK normalization $\sim 2\times$ too high
- Data do not support a suppression of the resolved part only ($R = 0.34$)



Exclusive dipion production $ep \to e\pi^+\pi^- p$

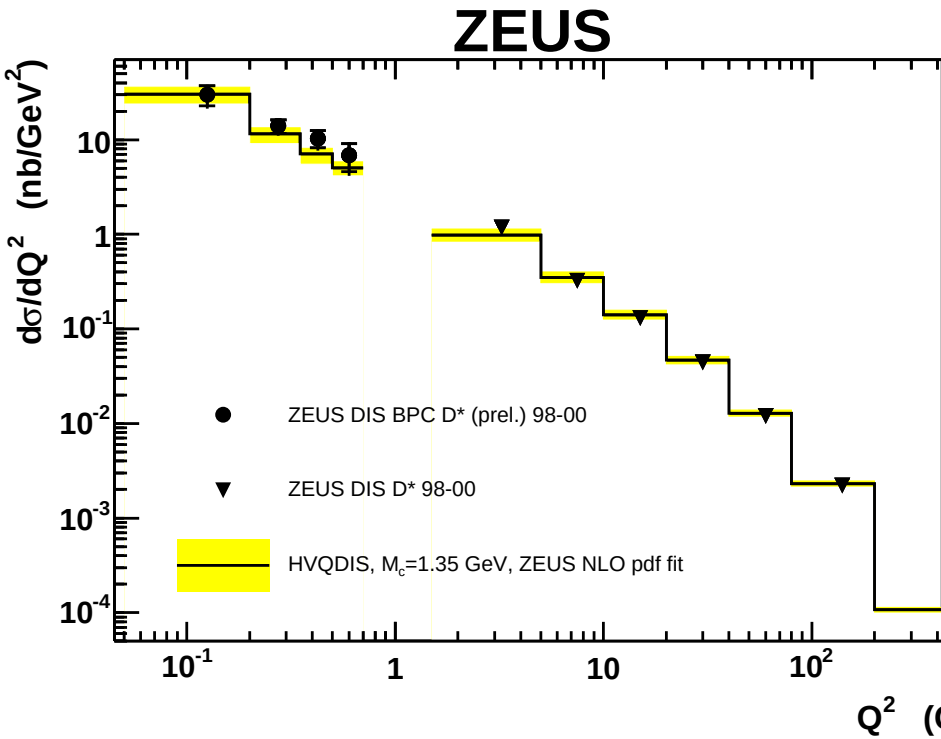
- $ep \to e'\pi^+\pi^- p$
- **1999-2000 data (66 pb^{-1})**
- $2 < Q^2 < 20\mathbf{GeV}^2$, $1.2 < M_{\pi\pi} < 5\mathbf{GeV}$, $40 < W < 120\mathbf{GeV}$
- **hadronic Light Cone Wave Function**
  $$|\gamma\rangle = a|\gamma_p\rangle + b|l^+l^-\rangle + d|q\bar{q}\rangle + \ldots$$
- $u = \frac{(E+p_{Z'})_{\pi^+}}{(E+p_{Z'})_{\pi^+}+(E+p_{Z'})_{\pi^-}}$
  (Z'=**direction of $\pi\pi$ system**)
  reflects the momentum share in $|q\bar{q}\rangle$
- $1/\sigma\, d\sigma/dM_{\pi\pi} \sim M_{\pi\pi}^{-4.5}$
- $d\sigma/du$ **compatible with LCWF**





Extension of charm measurements in DIS

- D^* **in DIS extended to low** Q^2
- **98-00 BPC data (L=80 pb**$^{-1}$**)**
- **down to** $Q^2 \sim 0.05\mathbf{GeV}^2$
- **Good agreement with NLO (HVQDIS)**



- **charm measurement extended to** D^0, $D^\pm$ **and** D_s
- **test fragmentation also in DIS**
- **compare to HVQDIS** $\times$ **fragmentation**
- $f(c \to D)$ **from** e^+e^-, **Peterson fragm. with** ϵ**=0.035**
- D_s **rate higher than expected ?**

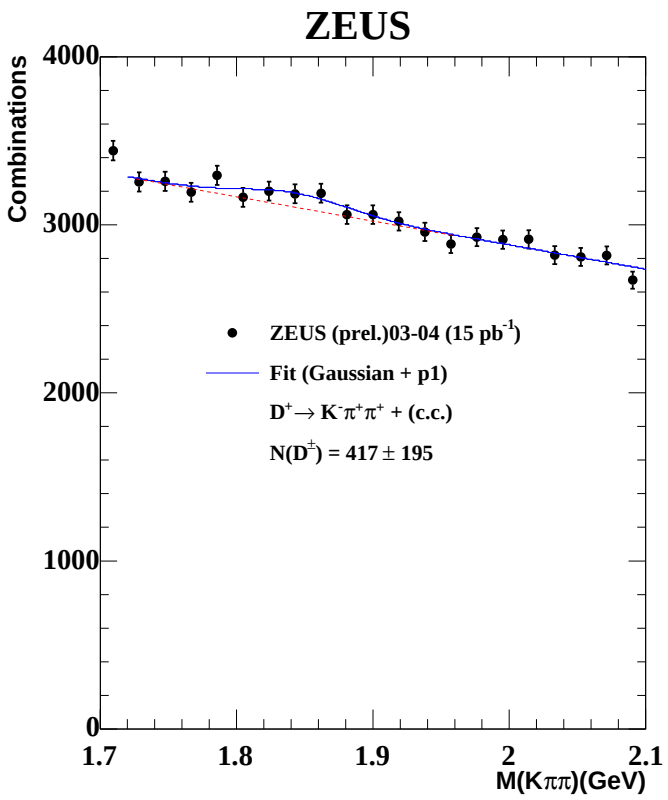
$\sigma(ep \to e'DX)$ **(nb)**

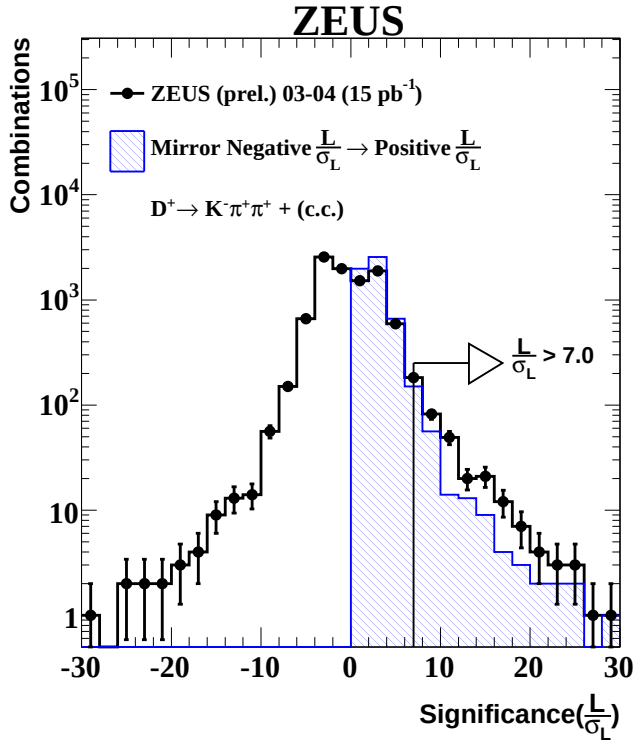
$Q^2 > 1.5\mathbf{GeV}^2$, $0.2 > y > 0.7$, $p_T(D) > 3\mathbf{GeV}$, $|\eta(D)| < 1.6$

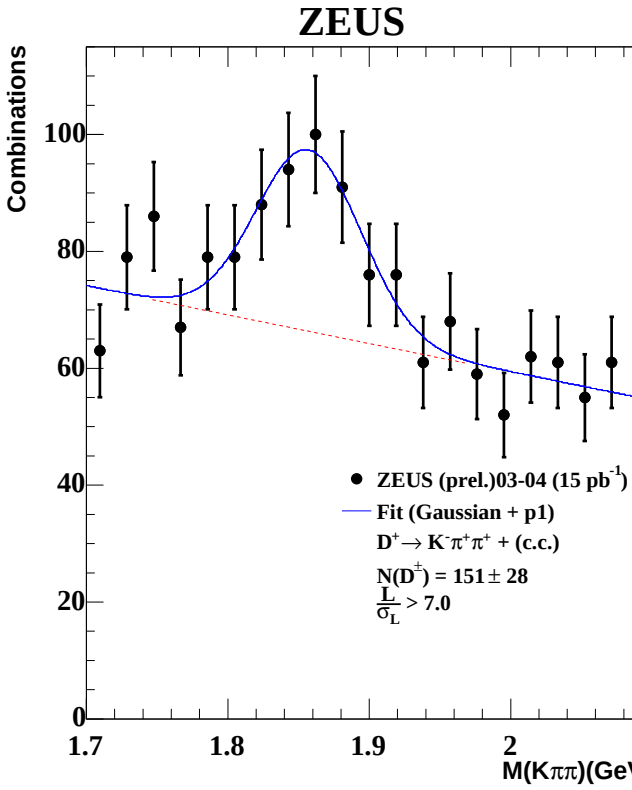
Meson	ZEUS 98-00 (prel.)	HVQD
D^0	$7.44 \pm 0.78^{+0.29}_{-0.49}$	7.14
D^+	$2.42 \pm 0.30^{+0.21}_{-0.06}$	3.02
D_S	$2.25 \pm 0.30^{+0.09}_{-0.33}$	1.32
D^*	$3.22 \pm 0.08^{+0.07}_{-0.05}$	3.06

Charm in HERA-II data

- **First look at the D^+ signal in 03-04 data (15 pb^{-1}) with the new MVD**
- **inclusive (PhP + DIS) sample, $D^{\pm} \to K^{\mp}\pi^{\pm}\pi^{\pm}$, $p_T(D^+) > 3.7$GeV**
- **Cutting on significance of $D^{\pm}$ secondary vertex improves dramatically the signal to background ratio**





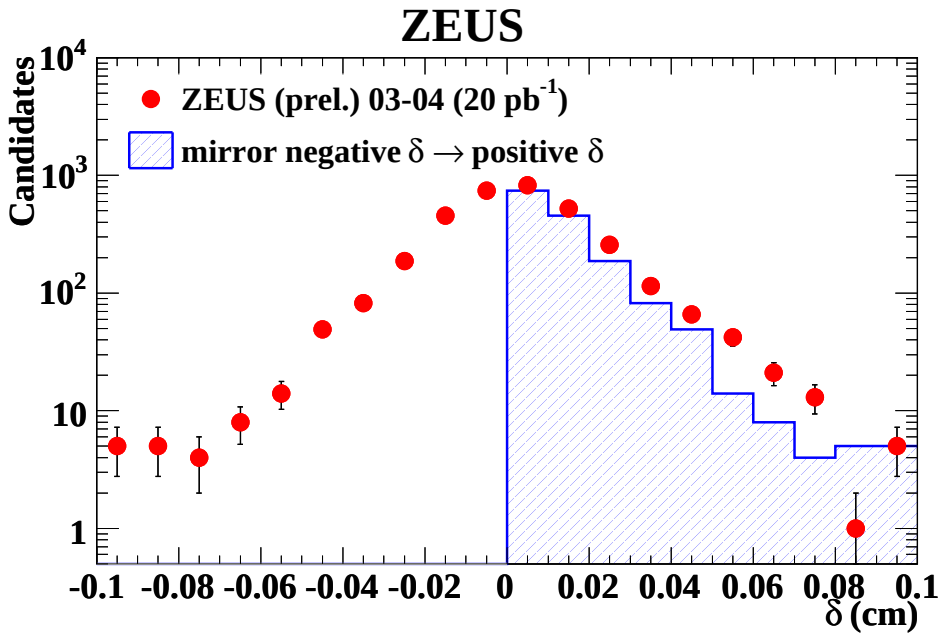


before: $N(D^+) = 417 \pm 195$

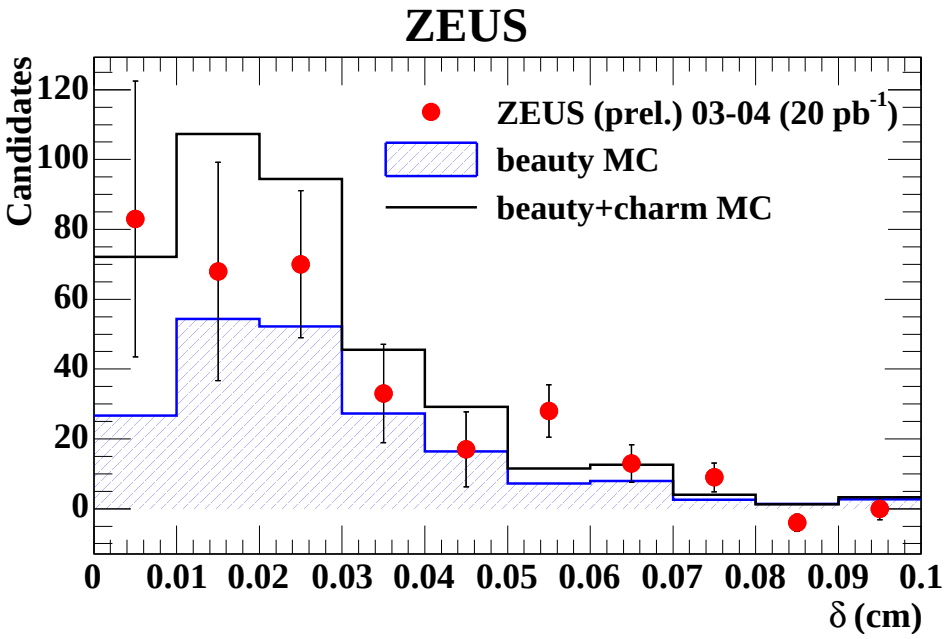
after: $N(D^+) = 151 \pm 28$

Beauty in HERA-II data

- First look at beauty with MVD
- 03-04 data (20 pb^{-1})
- Dijet+μ PhP sample, $p_T^{\mathrm{jet}} > 6,7\mathrm{GeV}$ $p_T^{\mu} > 0.75$ GeV (loose μ selection)
- $f_b = 16.1 \pm 2.7(\mathrm{stat.})\%$ from p_T^{rel} fit
- μ impact parameter wrt beam spot: excess at positive δ

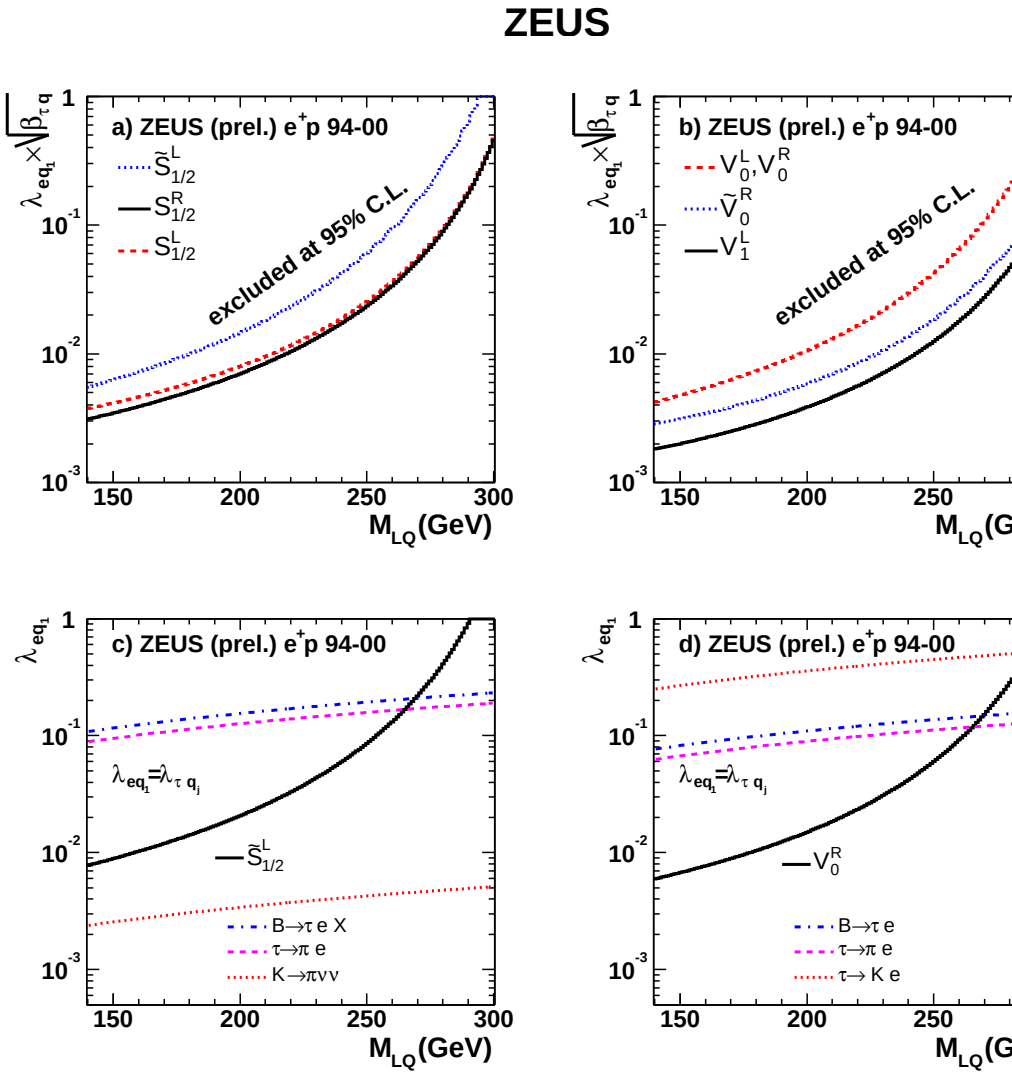


- Subtracted positive excess compatible with $b+c$ MC
  -b MC normalized to f_b from p_T^{rel}
  -c MC from MC prediction for $f_c/(f_{udsg})$



Lepton Flavour Violation

- Full HERA-I data sample (130 pb^{-1})
- search for
  $ep \to \mu X$
  $ep \to \tau X$
- no candidate found
- limits on LF-violating LQs
- independent from final quark flavour
- limits on $e \to \tau$
  stronger than from B and τ decays

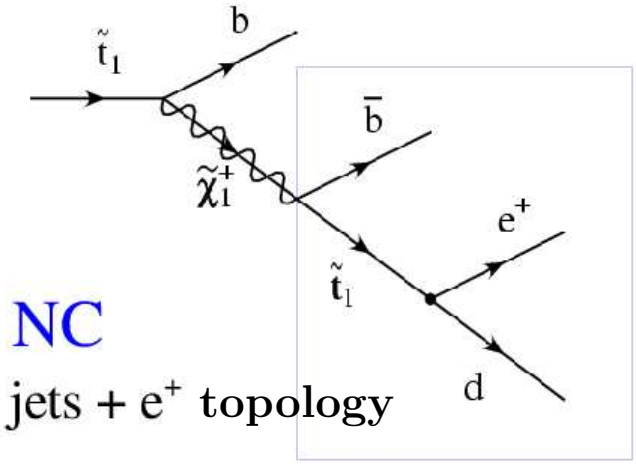


Stop

- Stop may be the lightest squark
- produced via R-parity violating coupling

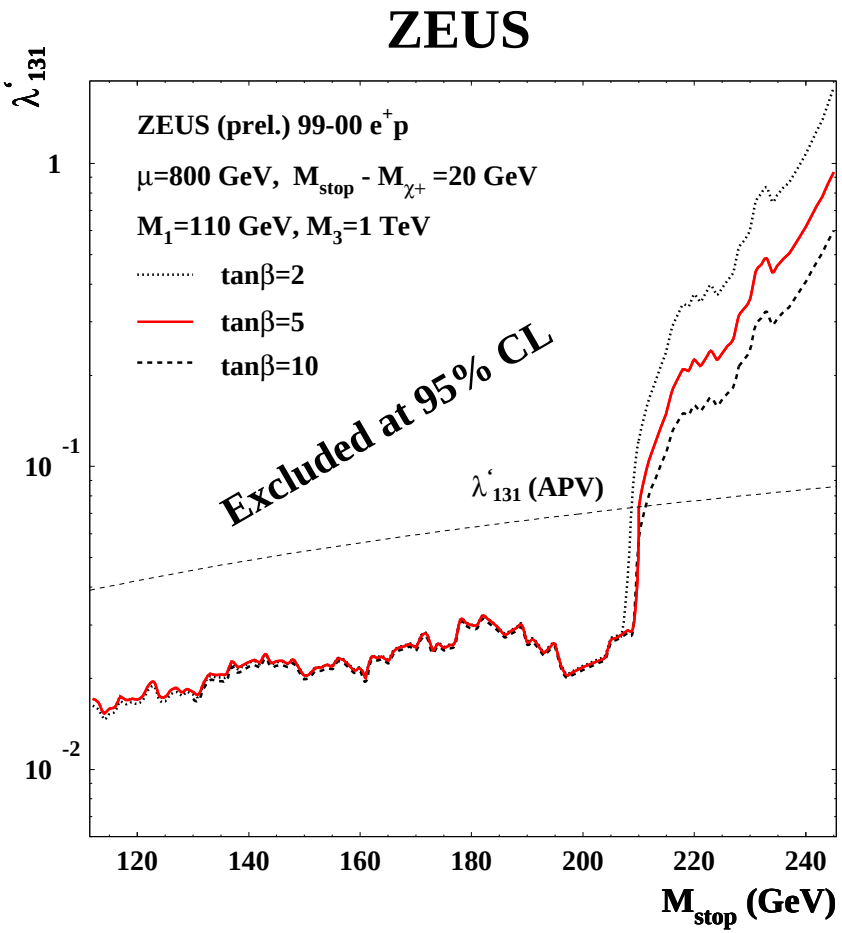
$$\lambda'_{131}: \qquad e^+ d \to \tilde{t}$$

- for small λ'_{131} decays mainly via chargino:

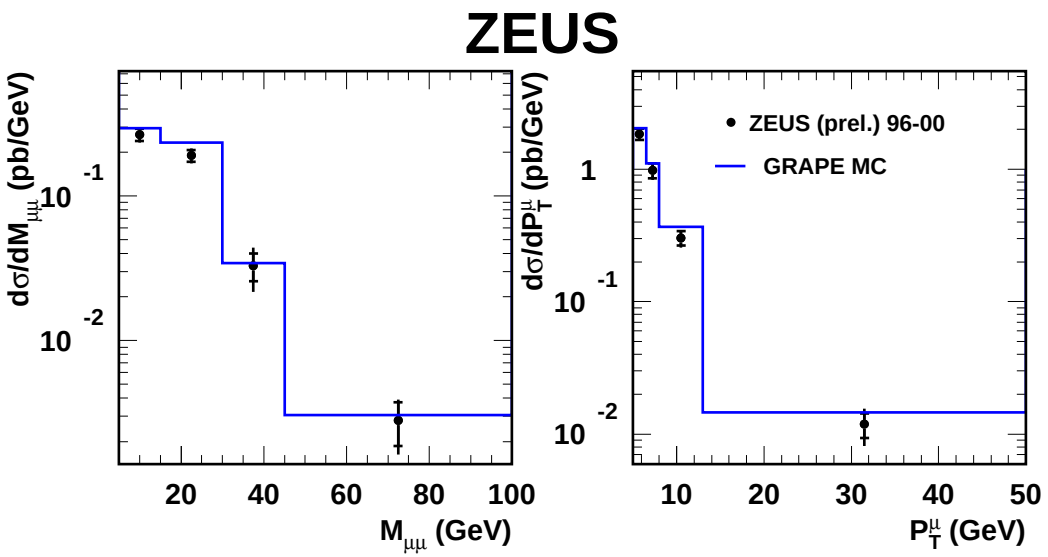


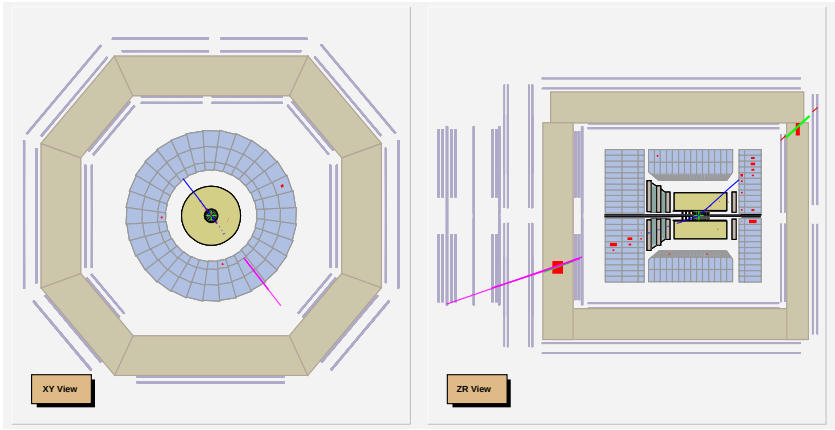
- 3 jets + e^+ topology

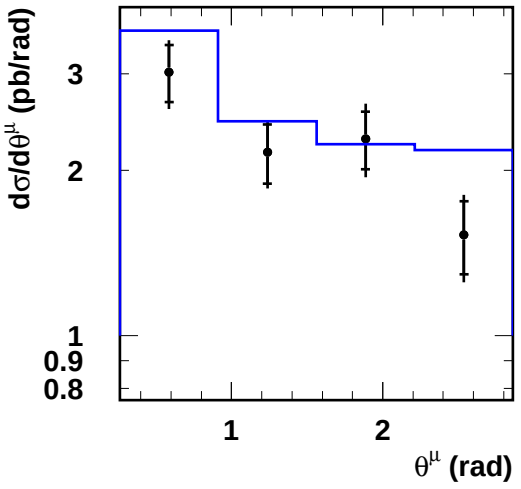
- $98-00$ data (**65.5 pb^{-1}**)
- NC DIS events with large circularity, large y and $Q^2 > 3000$**GeV**^{2}
- No peak found in hadron+e mass
- limits on λ'_{131} vs $M_{\tilde{t}}$
- low dependence on MSSM parameters



Dimuon production





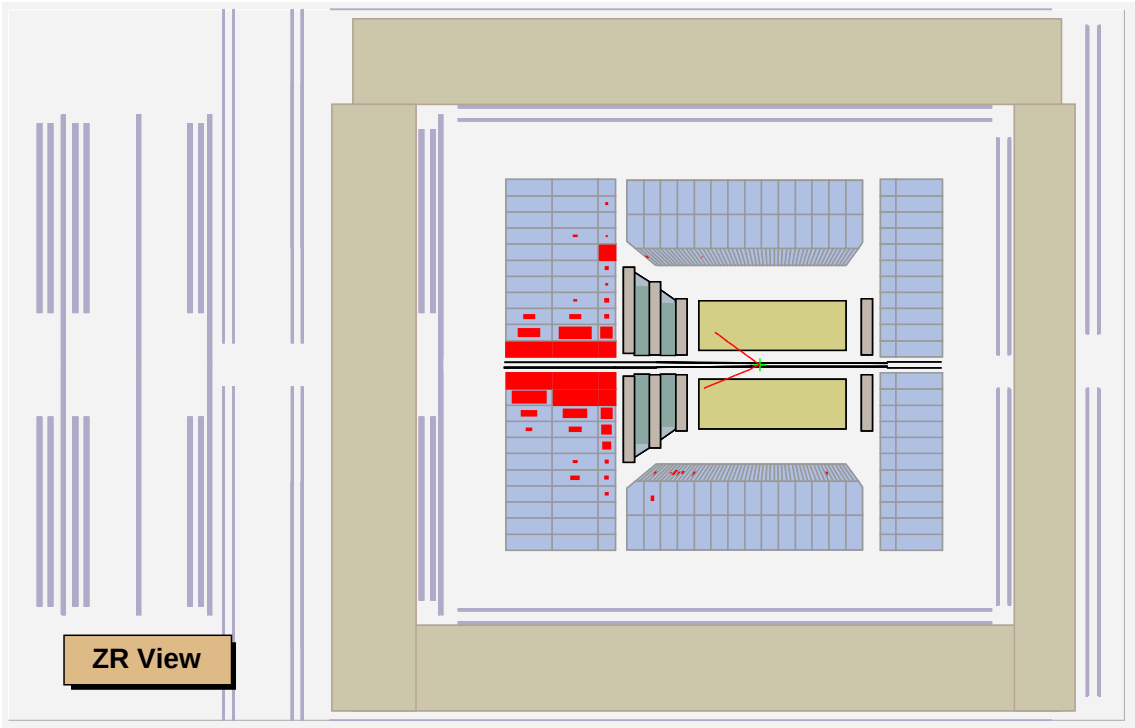


- **QED process, precise theory**
- **96-00 data (110 pb^{-1})**
- **hi-mass $\mu^+\mu^-$ pairs**
- **$p_T^{\mu} > 5$GeV, $12^o < \theta^{\mu} < 164^o$, $m_{\mu\mu} > 5$ GeV**
- **Events with $M_{\mu\mu}$ up to 80 GeV**
- **No deviation from SM (GRAPE)**

W production

- **W production: very low cross section** ($\sigma_{SM} \sim 1$**pb**)
- **search for** $W \to e\nu$**: electron and missing-**p_T
- **98-00 data: 63 pb**$^{-1}$ **(94-97 already published)**
- **good agreement with SM**
- **Upper limit:** $\sigma(ep \to eWX) < 2.8$ **pb (98% CL)**

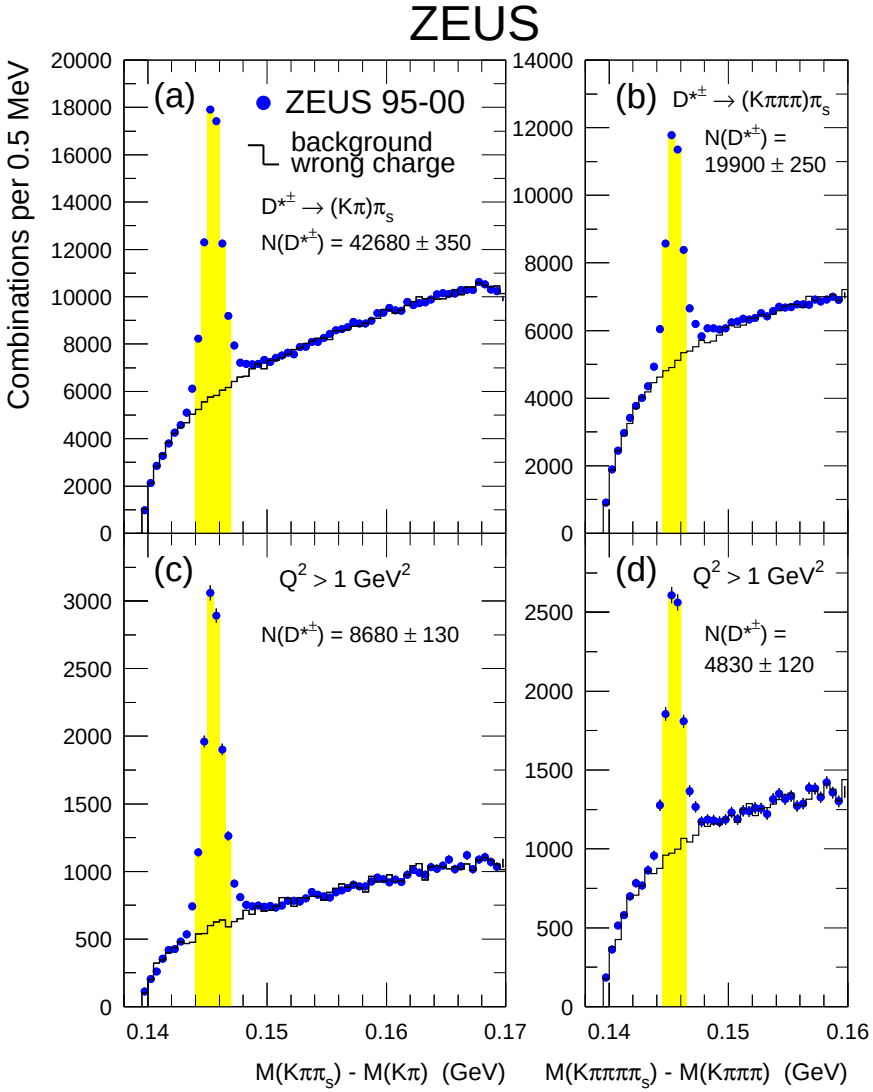
	Events
data	5
W (SM)	3.2 ± 1.1
bkg (SM)	3.5 ± 1.8



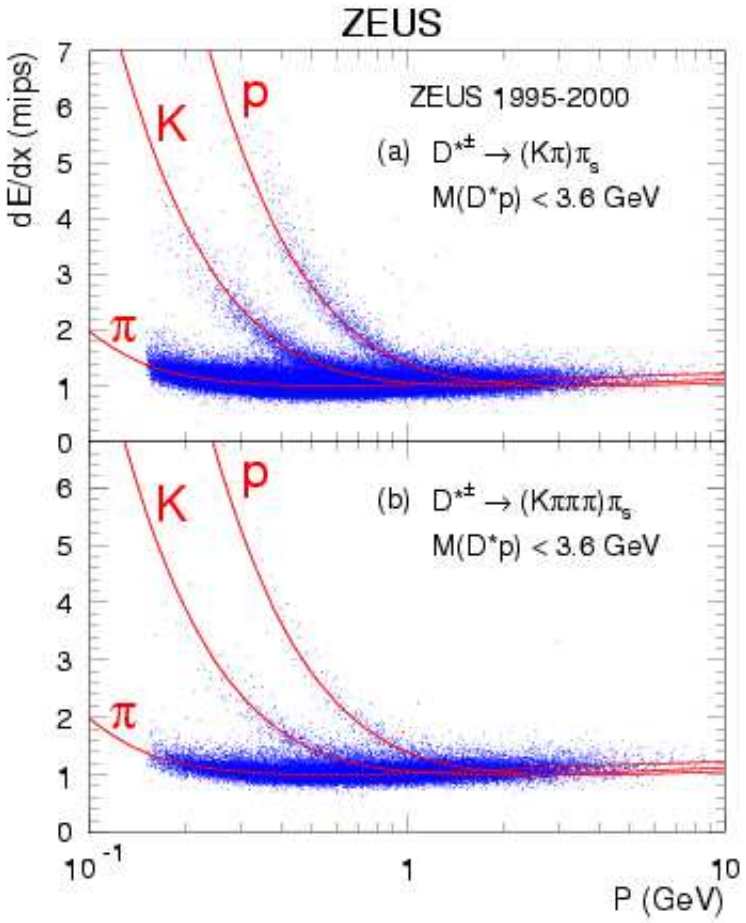
$p_T^e = 30\text{GeV}$
$\theta_e = 0.58\text{rad}$
$p_T^X = 29\text{GeV}$
$\not{p}_T = 48\text{GeV}$

Charmed Pentaquarks I

- **New paper, improved analysis**
- **search for** $\Theta_c^0 \to D^* p$
- **all HERA-I data (126 pb^{-1})**

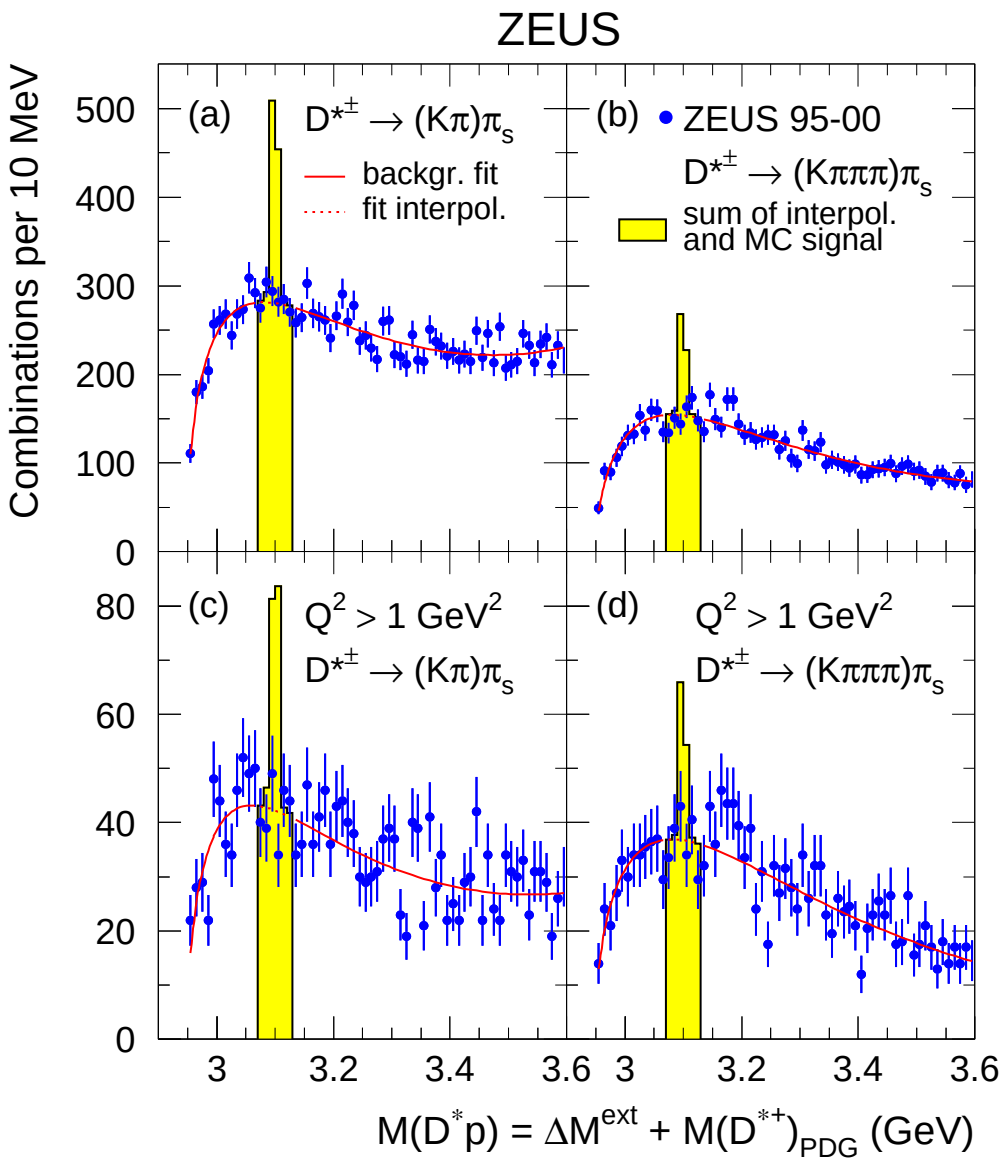


- 42680 ± 350 $D*$ **from** $(K\pi)\pi_S$
- 19900 ± 250 $D*$ **from** $(K\pi\pi\pi)\pi_S$
- **improved proton ID via** dE/dx



Charmed Pentaquarks II

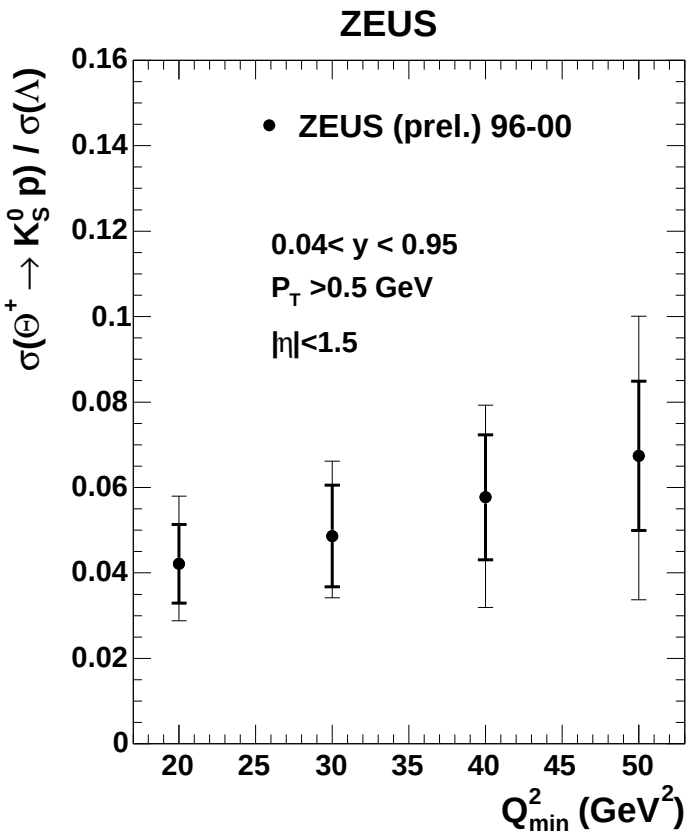
- **no signal in both channels**
- **no signal at** $Q^2 > 1\mathbf{GeV}^2$
- **upper limit on**
  $R = N(\Theta_c \to D^* p)/N(D^*)$
  for D^* **in** $P_T > 1.35\mathbf{GeV}$, $|\eta| < 1.6$
- $R < 0.29\%$ **at** $95\% CL$,
  $R < 0.41\%$ **for** $Q^2 > 1\mathbf{GeV}^2$
- $R \sim 1\%$ **excluded at** 9σ



Strange Pentaquark

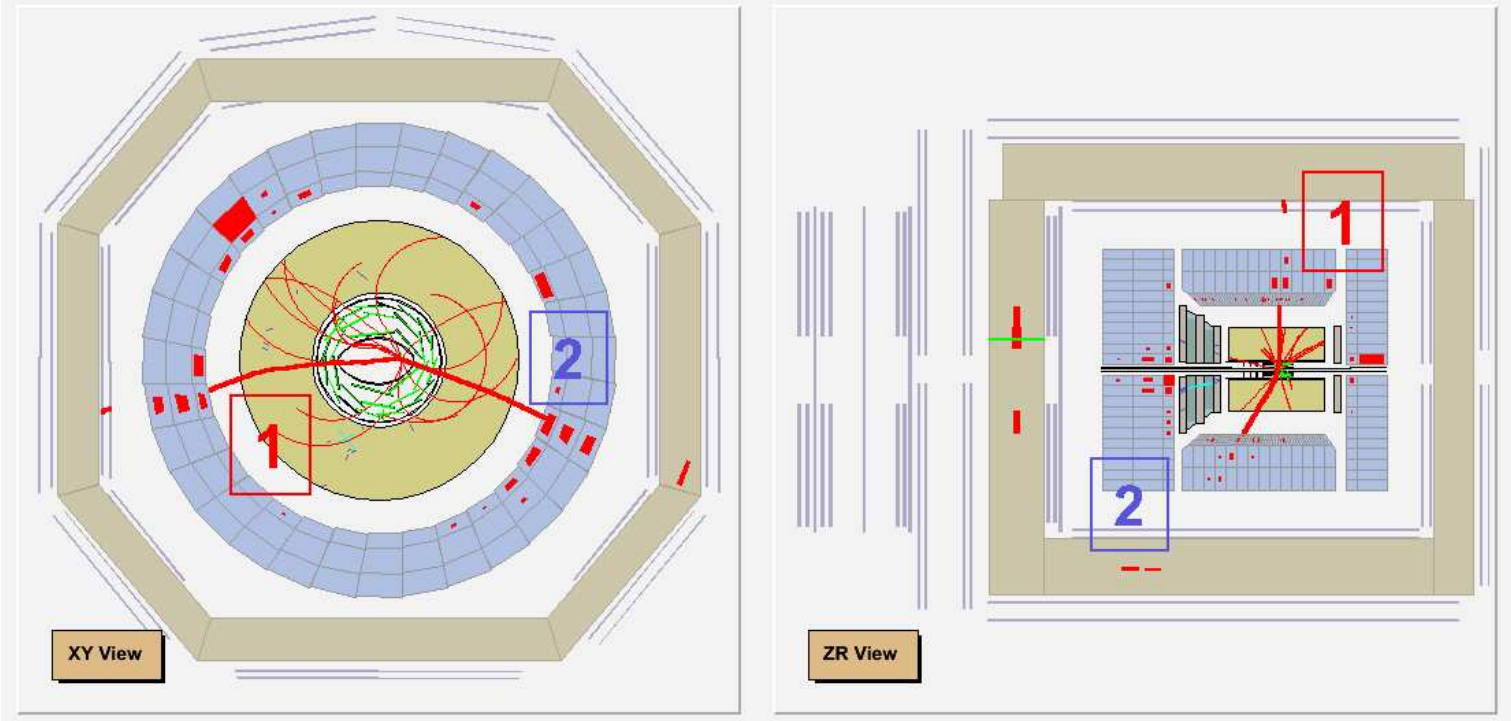
- **cross section and**
  $R = N(\Theta^+ \to K^0_S p)/N(\Lambda(1116))$
  for published $\Theta^+ \to K^0_S p$ **signal**
- $Q^2 > 20\mathbf{GeV}^2$, $p_T > 0.5\mathbf{GeV}$, $|\eta| < 1.6$
- $\sigma(ep \to e\Theta^+ X) = 125 \pm 27(\text{stat.})^{+36}_{-28}(\text{syst.})\mathbf{pb}$
- $R = \left(4.2 \pm 0.9(\text{stat.})^{+1.2}_{-0.9}(\text{syst.})\right)\,\%$

- **no dependence from the** Q^2 **cut observed**



Summary

- still many new results from HERA-I data
- first physics results from HERA-II



dijet+dimu event

$ep \to eb\bar{b}X \to e(j\mu^+)(j$

$p_T^{\rm rel}(\mu 1) = 1.24{\rm GeV}$

$p_T^{\rm rel}(\mu 2) = 2.05{\rm GeV}$

$\delta(\mu 1) = +250\mu{\rm m}$

$\delta(\mu 2) = +330\mu{\rm m}$

Charmed Pentaquark with H1 selection