Heavy Flavours : news from HERA and e+e- colliders

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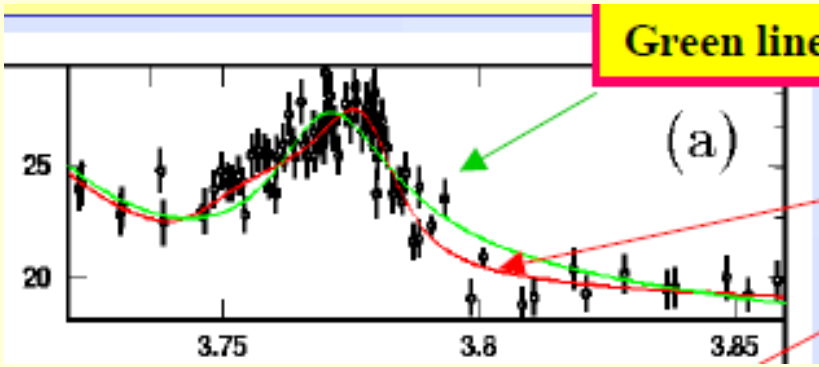
Jiangchuan Chen (BES II, CLEO-c)	Psi(3770) and D decays
Thomas Kuhr (BaBar, Belle)	X(3872) decays and new Z+ states
Veronique Ziegler (Babar)	eta_b observation and search for light Higgs
Roberto Spighi (HERA-B)	J/psi nuclear effects and angular distributions
Alessandro Bertolin (ZEUS)	J/psi helicity distributions
Leonid Gladilin (ZEUS)	Charm fragmentation and excited D mesons
Silvia Miglioranzi (ZEUS)	Beauty photoproduction
Benno List (H1)	Beauty photoproduction
Andreas Jung (H1)	F2c(x,Q2) for Q2<100 GeV2
Philipp Roloff (ZEUS)	F2c(x,Q2)
Martin Brinkmann (H1)	F2c(x,Q2) for Q2>100 GeV2
Paul Thompson (H1)	Combined F2c(x,Q2) and F2b(x,Q2)
Marcello Bindi (ZEUS)	F2b(x,Q2)

BES II : Is Psi(3770) one state ?

$BF\ (\psi\ (3770\ ) \rightarrow non\ -D\overline{D}) = (15.1 \pm 5.6 \pm 1.8)\%$

And expected ~2%

- **Anomalous line-shape of σ_{had} near 3.770 GeV**



Green line is the fit with one ψ(3770) hypothesis

Two Amplitudes structure hypothesis improved fitting obviously

M_1=(3762.6±11.5±0.5) MeV, $\Gamma_1^{tot=}$ (49.9±32.1±0.5) MeV,
M_2=(3781.0± 1.3±0.5) MeV, $\Gamma_2^{tot=}$ (19.3±3.1±0.1) MeV,

If no other effects to distort the pure D-wave Breit-Weigner shape of the cross sections, result indicates that there is a new structure additional to ψ(3770) resonance at **7σ statistical significance**.

D^0, D^+, and D_s^+ Decays at CLEO-c

$D^+ \to \mu^+\nu$

$B(D^+ \to \mu^+\nu) = (3.82 \pm 0.32 \pm 0.09) \times 10^{-4}$,
$f_{D+} = (205.8 \pm 8.5 \pm 2.5)$ MeV,

$D_s^+ \to \{\mu^+, \tau^+\}\nu$

$B(D_s^+ \to \tau^+\nu)$ from $\tau^+ \to e^+\nu\bar{\nu}$ =
$(5.30 \pm 0.47 \pm 0.22)\%$

$B(D_s^+ \to \tau^+\nu)$ from $\tau^+ \to \pi^+\bar{\nu}$ =
$(6.42 \pm 0.81 \pm 0.18)\%$

$B(D_s^+ \to \mu^+\nu)$ =
$(5.65 \pm 0.45 \pm 0.17) \times 10^{-3}$

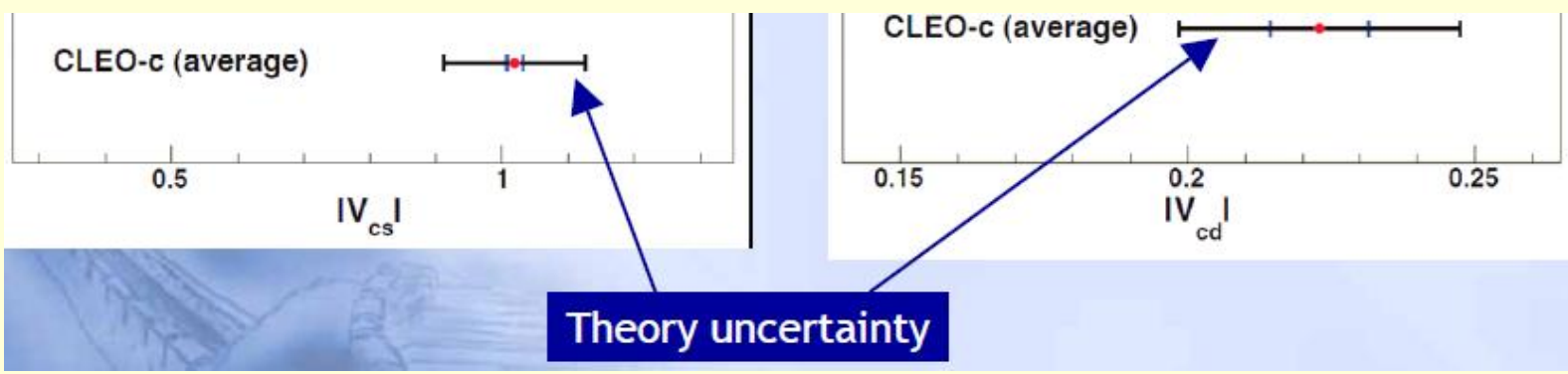
Average decay constant:

- $f_{Ds+} = (259.5 \pm 6.6 \pm 3.1)$ MeV

2.3σ higher than LQCD
[PRL 100, 062002 (2008)]:

- $f_{Ds+} = (241 \pm 3)$ MeV

D^0/D^+ SL: V_{cs} and V_{cd}



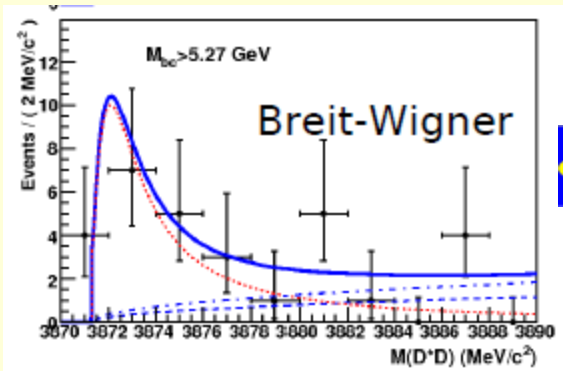
BaBar and Belle

What is the X(3872)?

$X(3872) \to D^0\bar{D}^{*0}$

$M = 3875.1\ ^{+0.7}_{-0.5} \pm 0.5$ MeV

$\Gamma = 3.0\ ^{+1.9}_{-1.4} \pm 0.9$ MeV



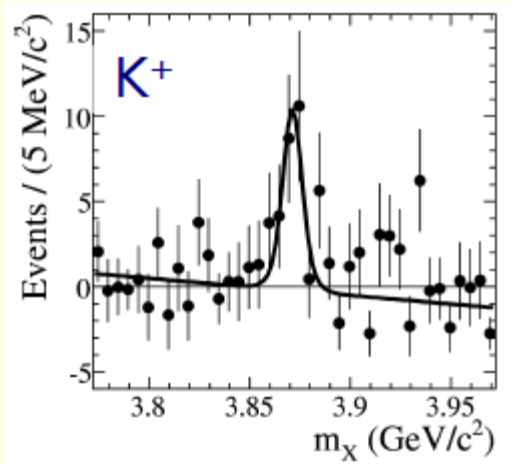
$M = 3872.6\ ^{+0.5}_{-0.4} \pm 0.4$ MeV, $M(X \to J/\psi\pi\pi) = 3871.46 \pm 0.19$ MeV

$\Gamma = 3.9\ ^{+2.5}_{-1.3}\ ^{+0.8}_{-0.3}$ MeV, $BR(B \to X(D^0D^{*0})K) = (0.73 \pm 0.17 \pm 0.08) \times 10^{-4}$

$X(3872) \to \psi(2S)\gamma$

$BR(X \to \psi(2S)\gamma)$ / $BR(X \to J/\psi\gamma)$ = 3.4 ± 1.4

Molecule model expects < 0.01

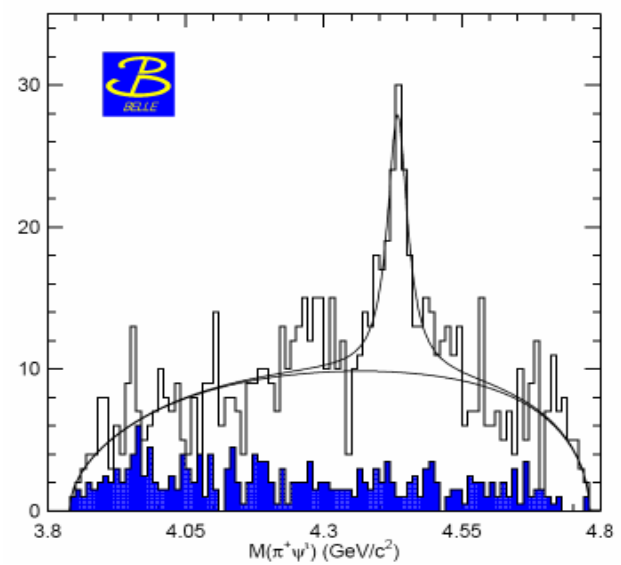


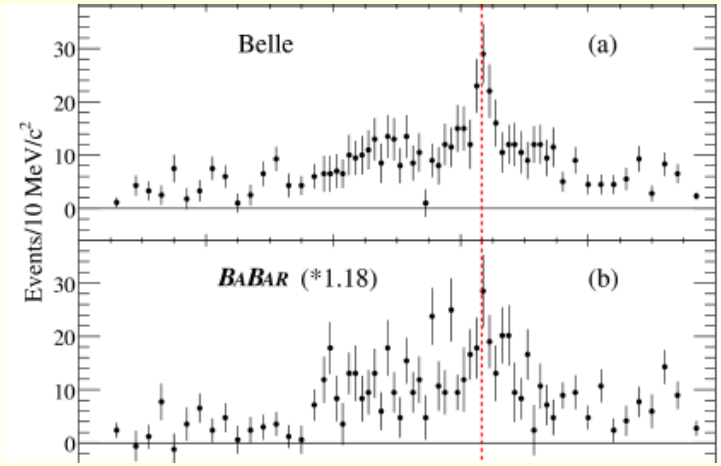
$B^{+/0} \to \psi(2S)\gamma K$

BaBar and Belle

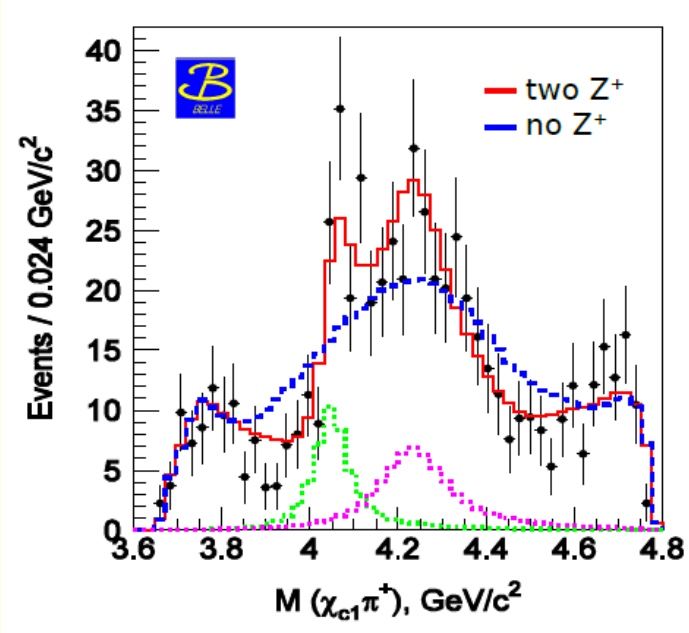
Z^+

$M = 4433 \pm 4 \pm 2$ MeV





No confirmation by BaBar, no signal in $J/\psi\pi^+$



Two further charged states observed by Belle

Mass [MeV]

Z_1: $4051 \pm 14 \,^{+20}_{-41}$

Z_2: $4248 \,^{+44}_{-29} \,^{+180}_{-35}$

Γ [MeV]

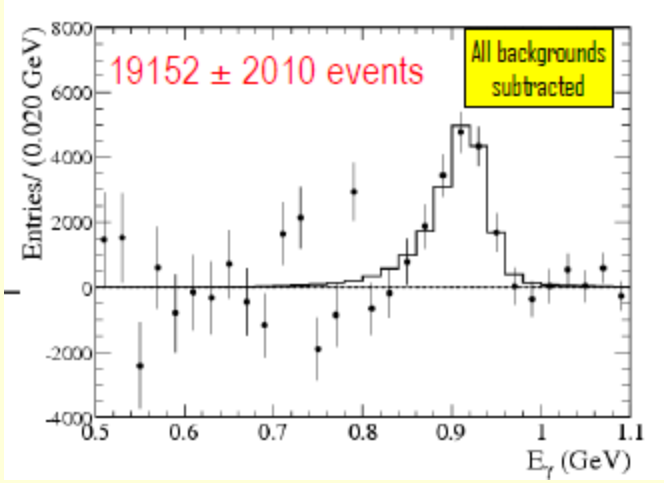
Z_1: $82 \,^{+21}_{-18} \,^{+47}_{-22}$

Z_2: $177 \,^{+54}_{-39} \,^{+316}_{-61}$

Search for the η_b at BaBar

$\Upsilon(3S) \to \gamma \eta_b(1S)$

$\Upsilon(2S) \to \gamma \eta_b$



$Y(3S)$ analysis: $m(\eta_b) = 9388.9^{+3.1}_{-2.3} \pm 2.7$ MeV/c^2

Phys.Rev.Lett.100;06200(2008)

$Y(2S)$ analysis: $m(\eta_b) = 9392.9^{+4.6}_{-4.8} \pm 1.8$ MeV/c^2

arXiv : 0903.1124 (submitted to PRL)

$m(\eta_b(1S)) = 9390.4 \pm 3.1$ MeV/c^2

Searches for light *Higgs-like* particle

light CP-odd Higgs state

A^0, $m(A0) < 2\, m_b$

NMSSM parameter search

⇨ $BF(\Upsilon(3S) \to \gamma A^0) \sim 10^{-4}$

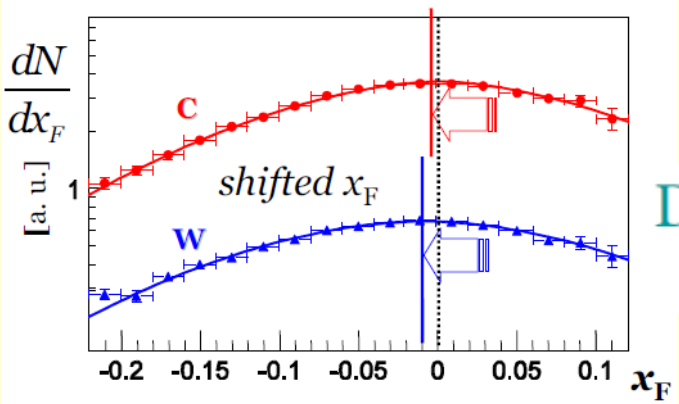
$\Upsilon(3S) \to \gamma A^0$, $A^0 \to$ *invisible*

$\Upsilon(2S, 3S) \to \gamma A^0$, $A^0 \to \mu^+\mu^-$

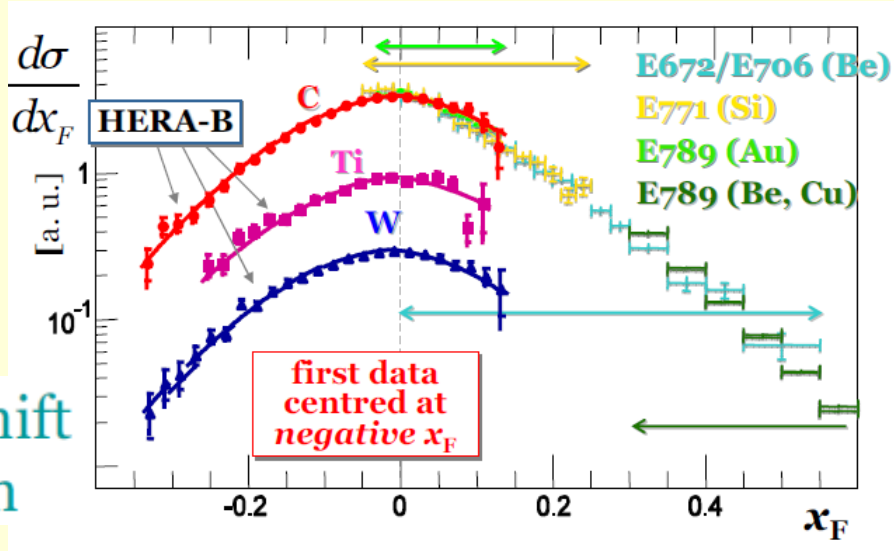
No significant signal found

Upper limits rule out much of the parameter space allowed by the light Higgs models

Recent results on charmonium production at HERA-B



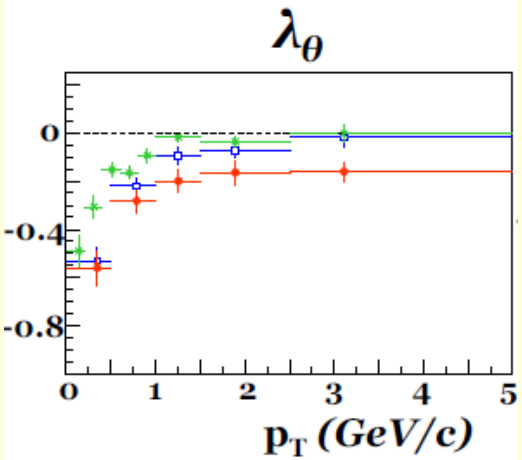
Different shift and width



nuclear suppression vs x_F

Two leptons decay angular distribution

$$\frac{dN}{d(\cos\theta)d\varphi} \propto 1 + \lambda_\theta \cos^2\theta + \lambda_{\theta\varphi} \sin 2\theta \sin\varphi + \lambda_\varphi \sin^2\theta \cos 2\varphi$$



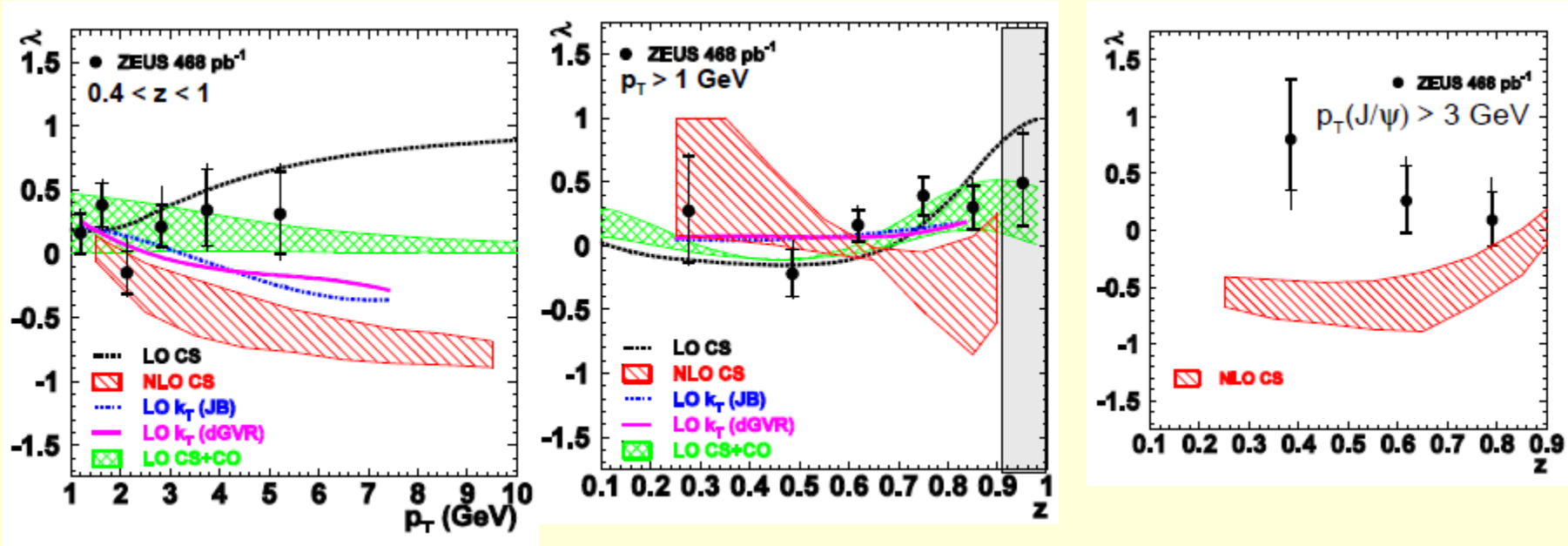
X_c production

$$R(\chi_c) = 18.8 \pm 1.3_{stat}\ {}^{+0.024}_{-0.022}\,sys$$

$$R\chi_{c1} / R\chi_{c2} = 1.02 \pm 0.40$$

HCM BEAM CS

Measurement of J/ψ helicity distributions in inelastic photoproduction at ZEUS

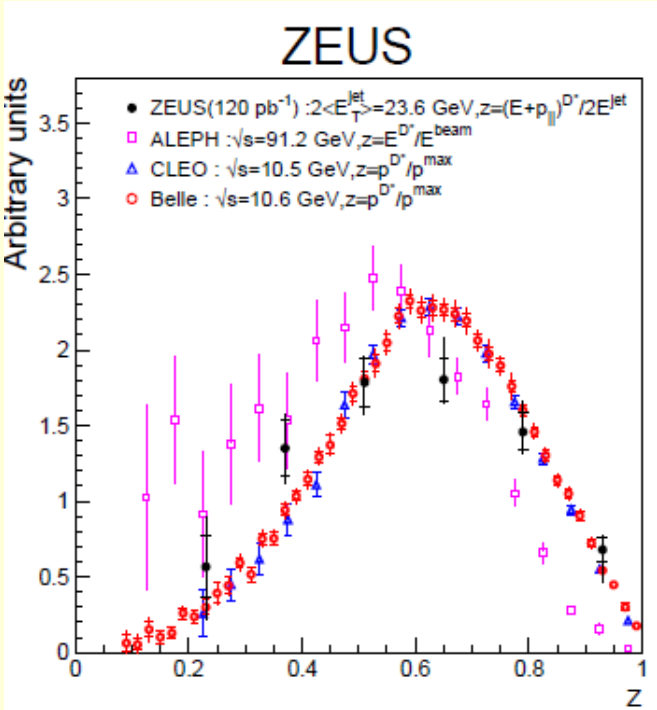


p-rest frame: $z = E(\psi)/E(\gamma^*)$

none of these predictions is able to describe all aspects of the data

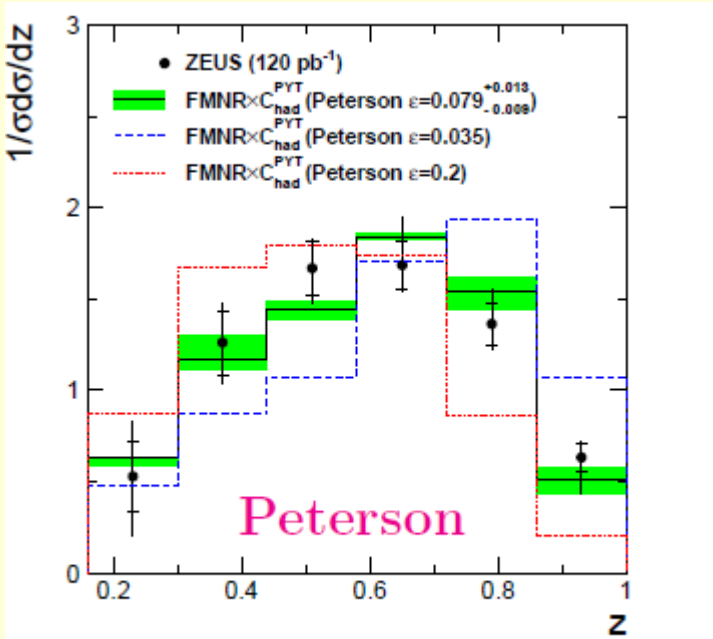
… something not yet understood or m(J/ψ) is too small ?

charm fragmentation function ($D^{*\pm}$)



$$z = (E+p_{||})^{D^*}/(E+p_{||})^{\text{jet}} \equiv (E+p_{||})^{D^*}/2\,E^{\text{jet}}$$

expected QCD scaling violation



$\epsilon = 0.079 \pm 0.008^{+0.010}_{-0.005}$ (ZEUS)

$\epsilon = 0.035$ (NLO fit to ARGUS data) $\Longleftarrow$ Nason, Oleari

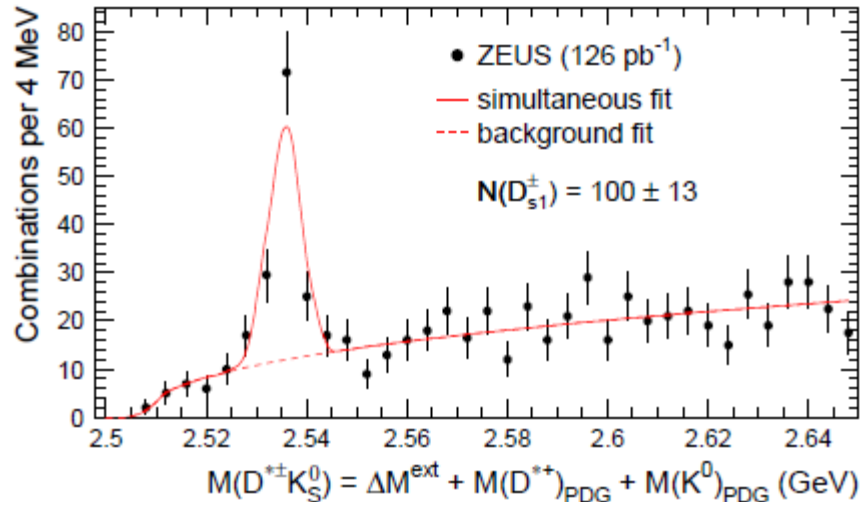
Excited D mesons

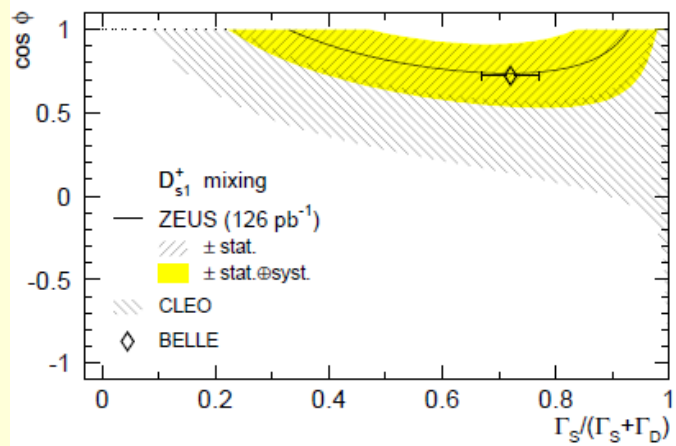
$$\Gamma(D_1^0) = 53.2 \pm 7.1(\text{stat.})^{+3.3}_{-4.9}(\text{syst.})$$

$$\frac{\mathcal{B}_{D_2^{*0} \to D^+\pi^-}}{\mathcal{B}_{D_2^{*0} \to D^{*+}\pi^-}} = 2.8 \pm 0.8(\text{stat.})^{+0.5}_{-0.6}(\text{syst.})$$

$$\frac{\mathcal{B}_{D_{s1}^+ \to D^{*0}K^+}}{\mathcal{B}_{D_{s1}^+ \to D^{*+}K^0}} = 2.3 \pm 0.6(\text{stat.}) \pm 0.3(\text{syst.})$$

	$f(c \to D_1^0)$ [%]	$f(c \to D_2^{*0})$ [%]	$f(c \to D_{s1}^+)$ [%]
ZEUS	$3.5 \pm 0.4^{+0.4}_{-0.6}$	$3.8 \pm 0.7^{+0.5}_{-0.6}$	$1.11 \pm 0.16^{+0.08}_{-0.10}$
OPAL	2.1 ± 0.8	5.2 ± 2.6	$1.6 \pm 0.4 \pm 0.3$
ALEPH			$0.94 \pm 0.22 \pm 0.07$



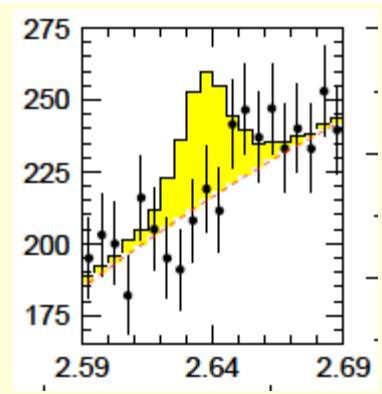


Search for radially excited $D^{*\prime\pm} \to D^{*\pm}\pi^+\pi^-$

$$f(c \to D^{*\prime+}) \cdot \mathcal{B}_{D^{*\prime+} \to D^{*+}\pi^+\pi^-} < 0.4\%$$

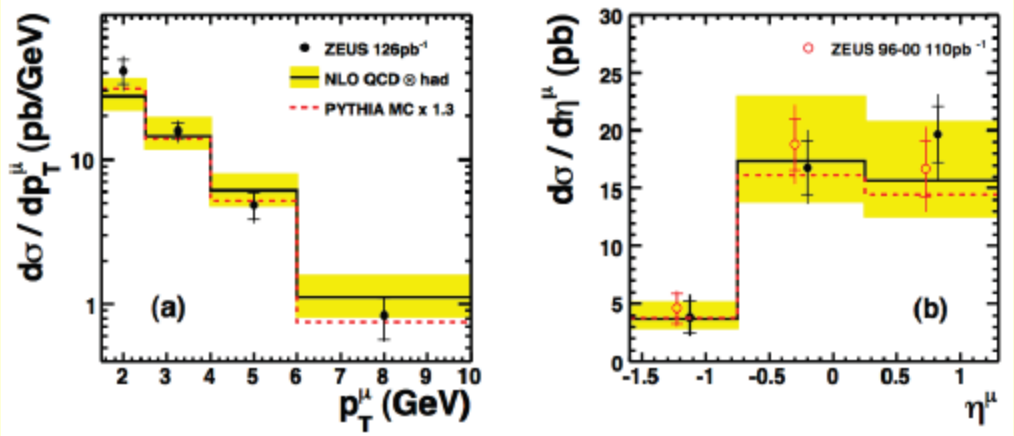
(95% C.L.)

stronger than the 0.9% OPAL limit

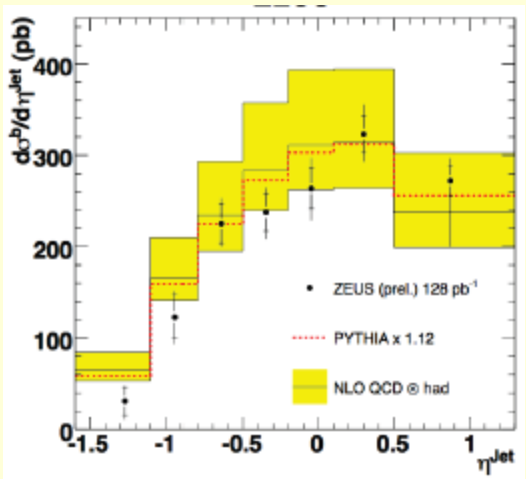


Beauty photoproduction at ZEUS

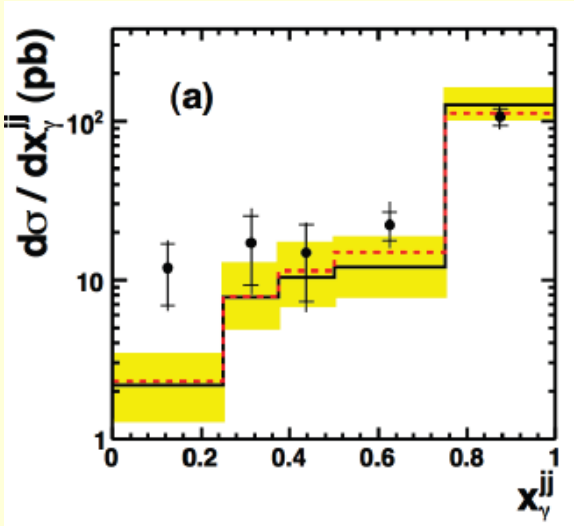
events with 2 jets + 1μ

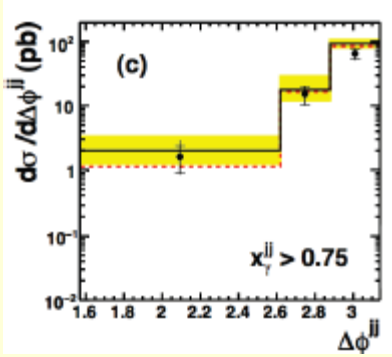


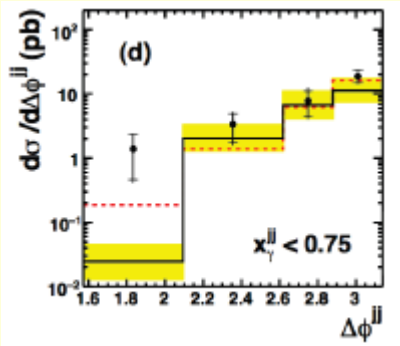
events with 2 jets + vertex



Good agreement with NLO QCD





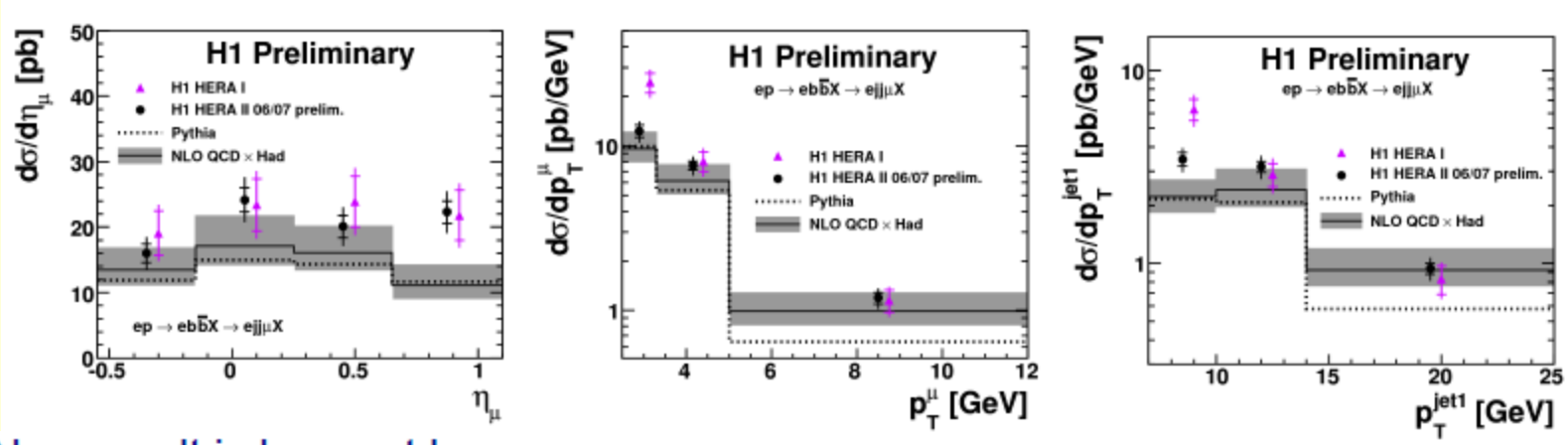


for beauty NLO QCD agrees well

$x_{\gamma}^{jet} = \Sigma_{j1,j2}(E - P_Z)/\Sigma_h(E - P_Z)$

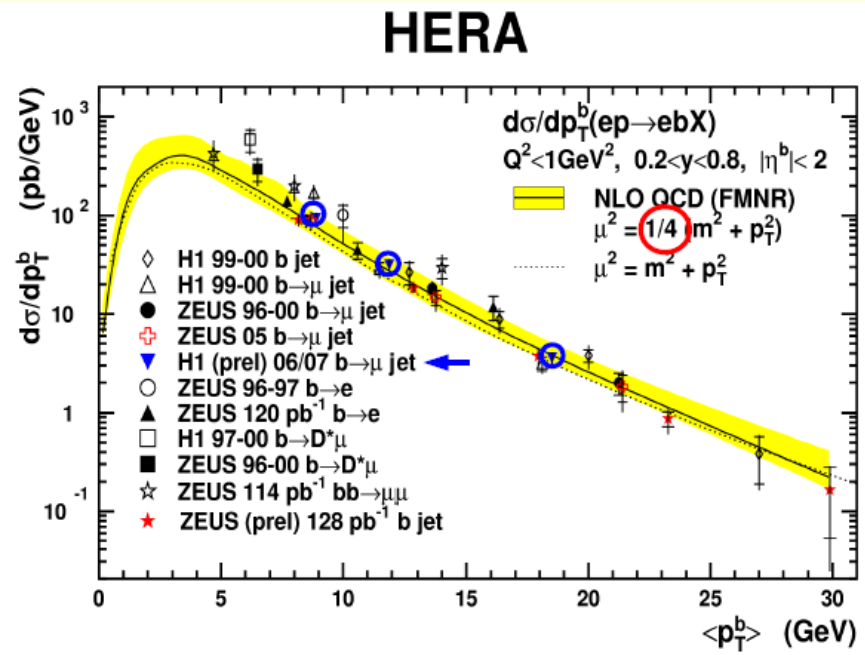
Beauty Photoproduction

events with 2 jets + 1μ



New result is lower at low p_T

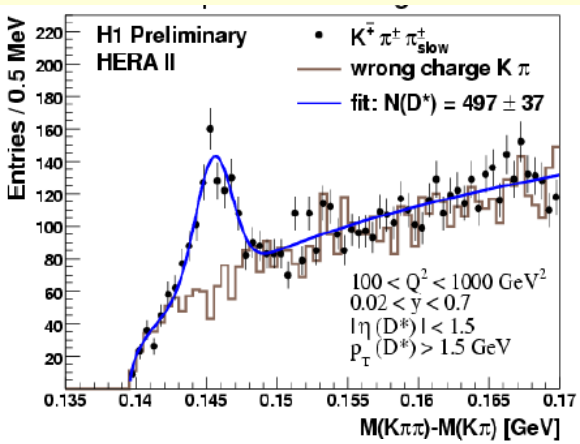
NLO QCD describes p_T spectra reasonably well

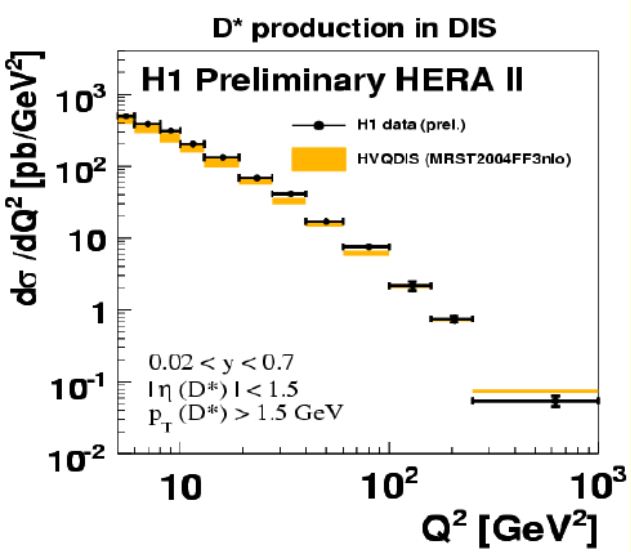


Nicely described by NLO QCD

central scale set to ½ the naïve value

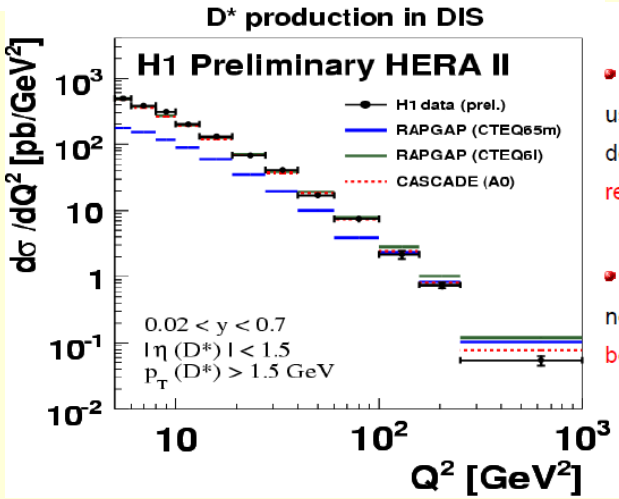
Extraction of $F_2^c(x,Q^2)$ from D* cross sections



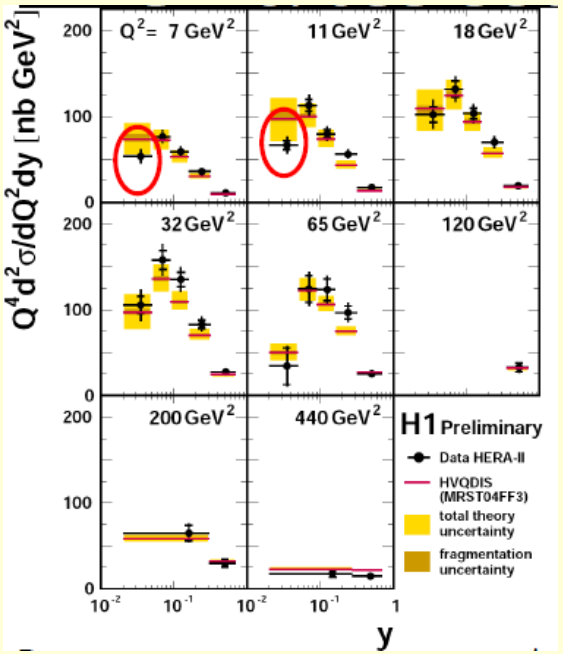


Fragmentation uncertainty from FF values used for extrapolation:

	HVQDIS:	CASCADE:
at-threshold:	$\alpha = 6.0^{+1.0}_{-0.8}$	$\alpha = 8.2 \pm 1.1$
above-threshold:	$\alpha = 3.3 \pm 0.4$	$\alpha = 4.6 \pm 0.6$

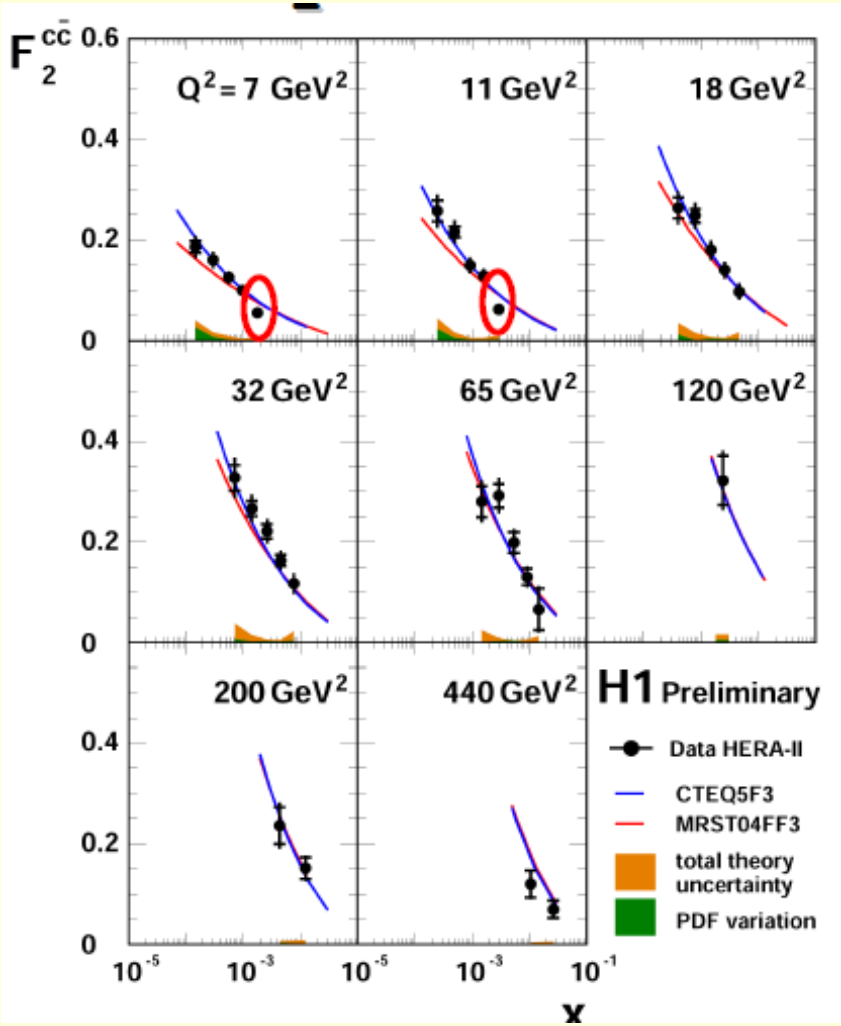


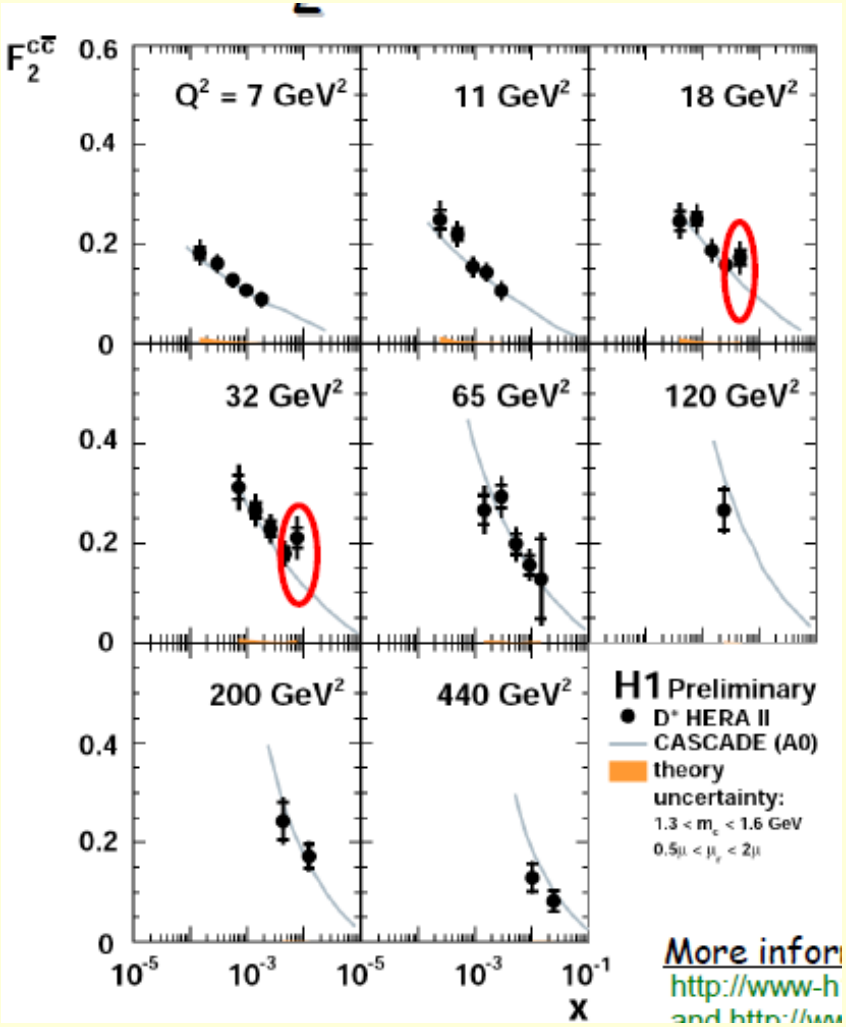
- CASCADE (LO+PS CCFM): uses consistently determined PDF (set A0) reasonable description of the data
- RAPGAP (LO+PS DGLAP): no consistent PDF set available both PDFs don't describe data well



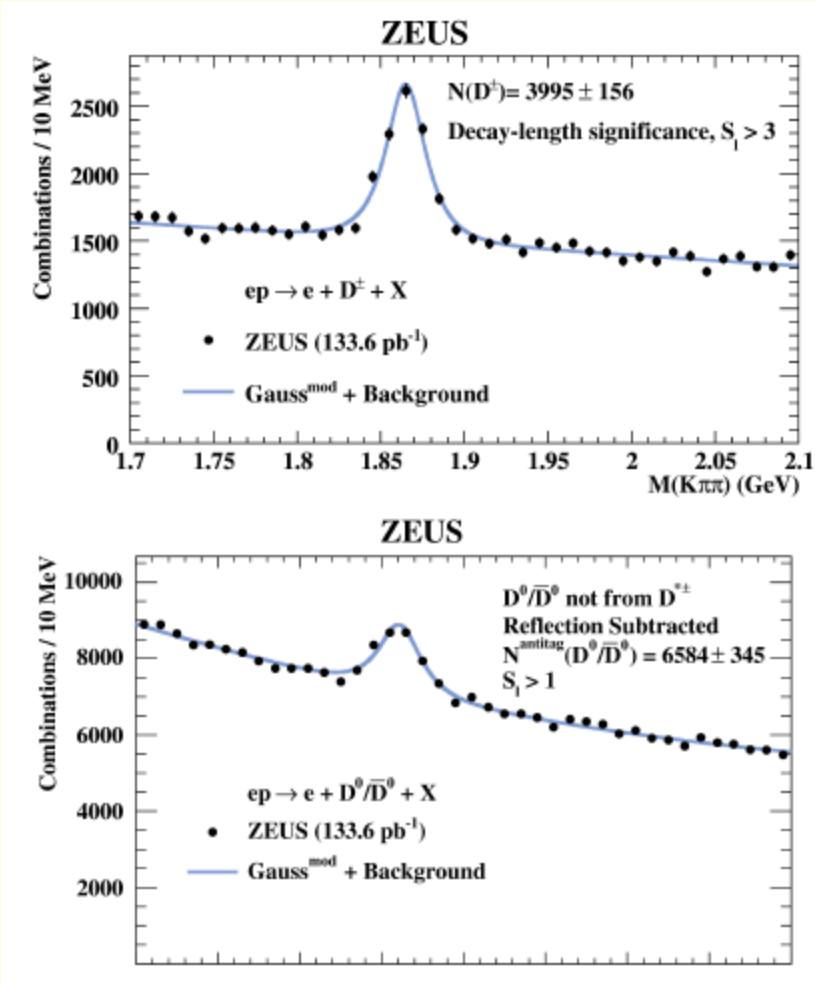
F_2^c in NLO DGLAP

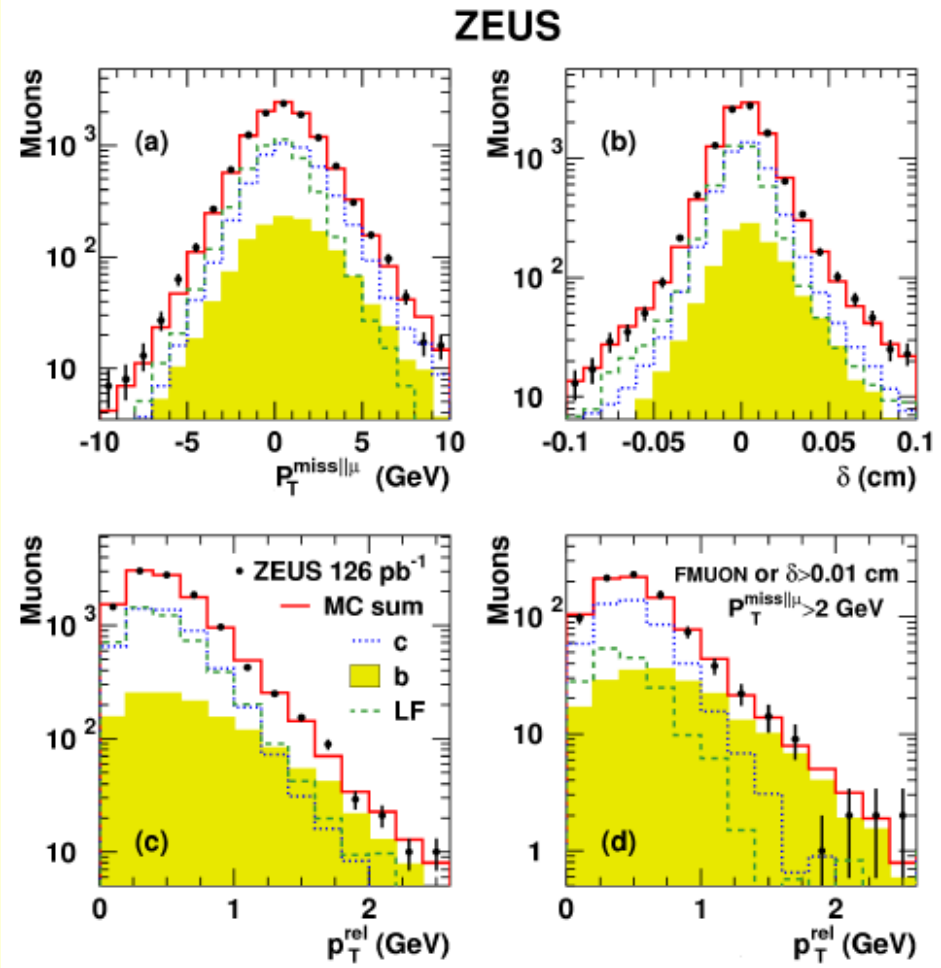
F_2^c in CCFM





Charm production in DIS and the measurement of F_2^{cc} at ZEUS

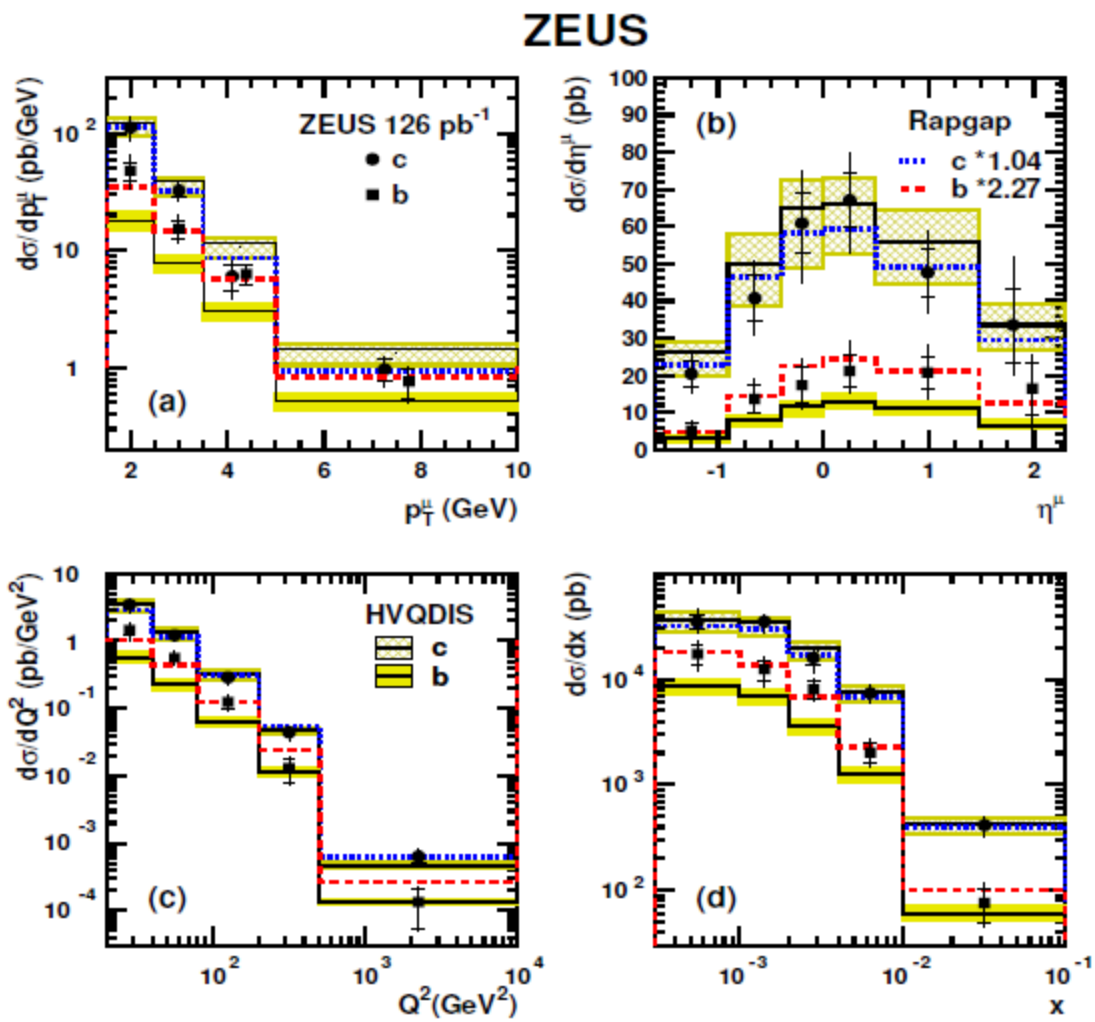




$D^{\pm}$ and D^0

decays into muons

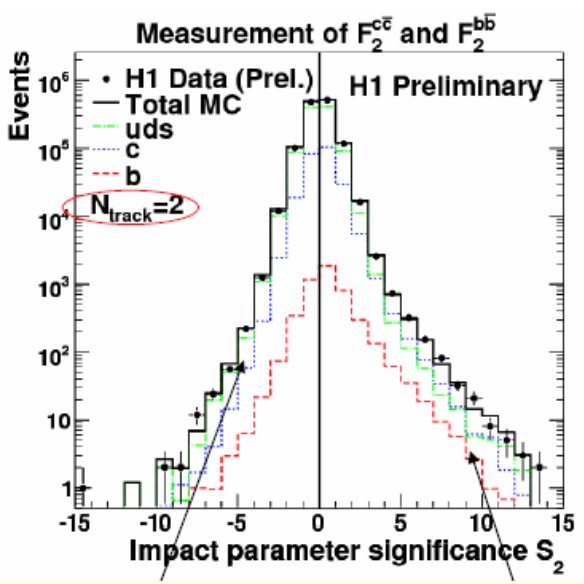
Muon cross sections

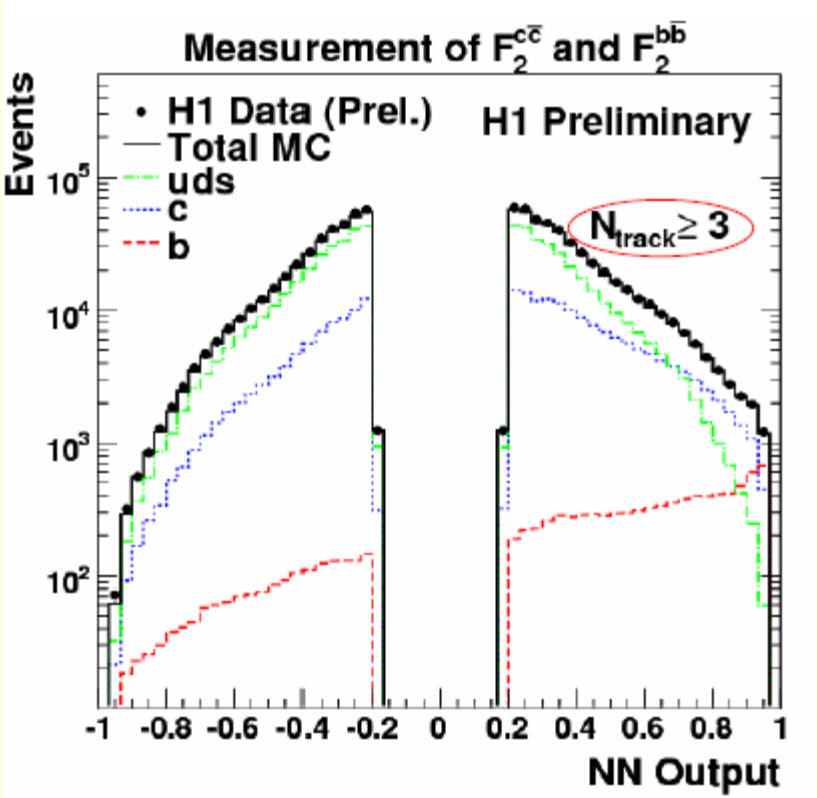


Differential cross sections

- **charm**: good agreement with HVQDIS and RAPGAP.
- **beauty**: excess at low Q^2 (within ~2σ the significance).

Measurement of F_2^{cc} and F_2^{bb} using the H1 Vertex Detector and combination of F_2^{cc} with D* method





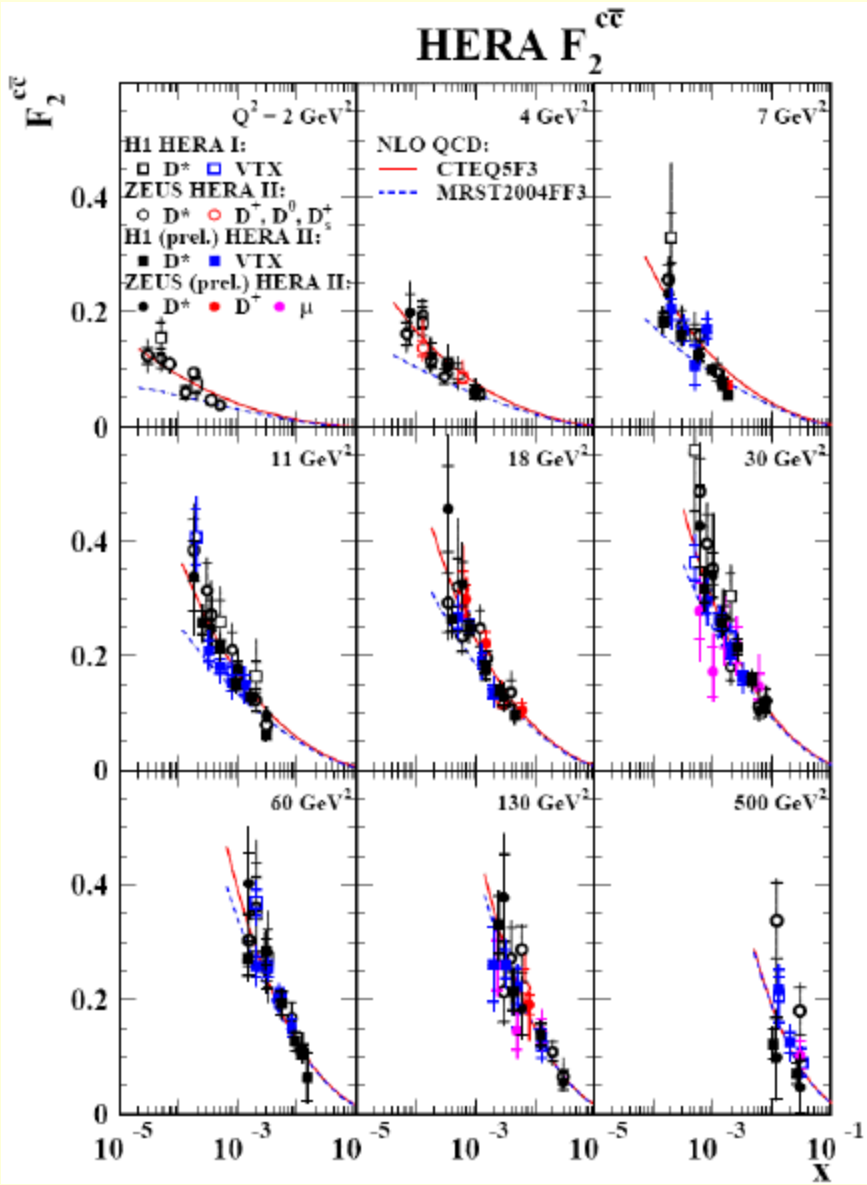
S_1 highest |S| for N_{track}=1

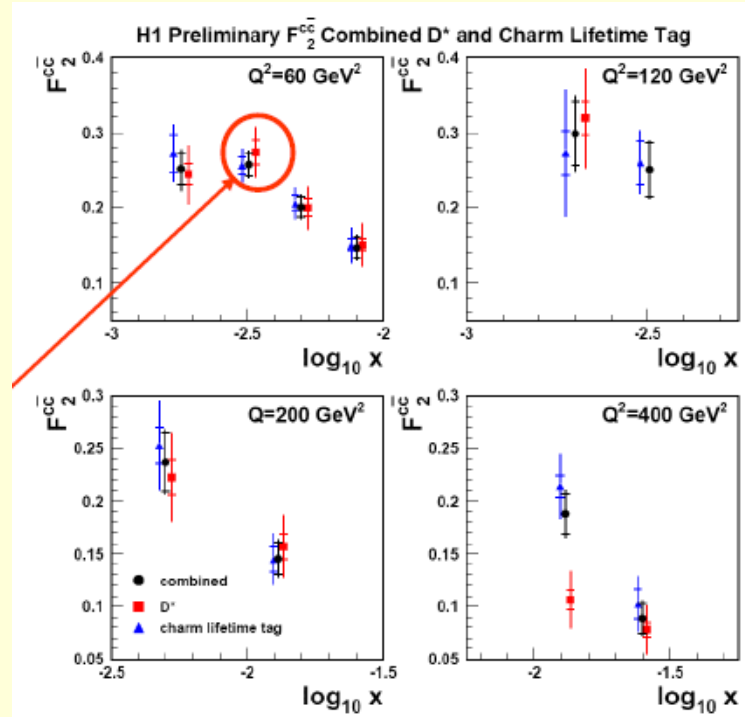
S_2 2nd highest |S| for N_{track}=2

Improve *c*,*b* separation: use neural network for >= 3 tracks

Inputs: S_1, S_2, S_3, sec. vertex decay length significance S_L, 1st(2nd) highest track p_T, number of CST (sec. vertex) tracks

Averaging procedure



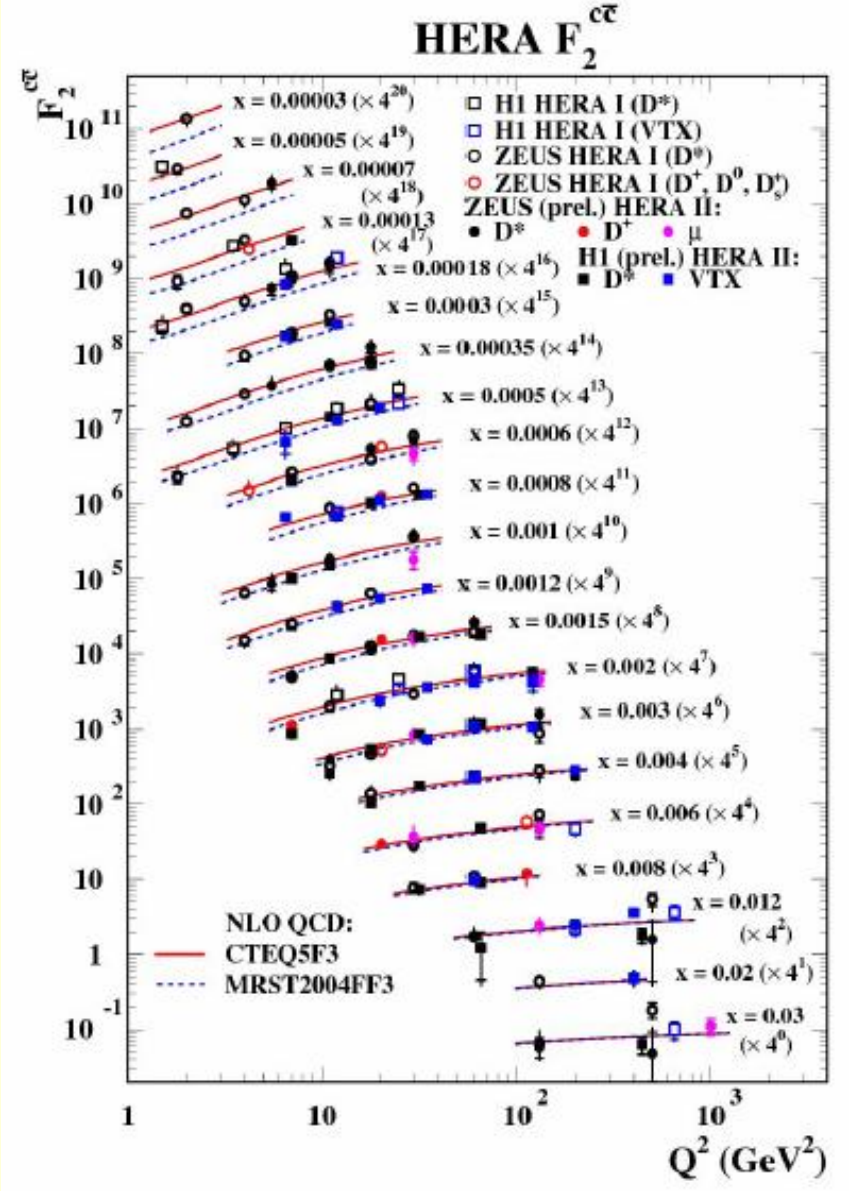


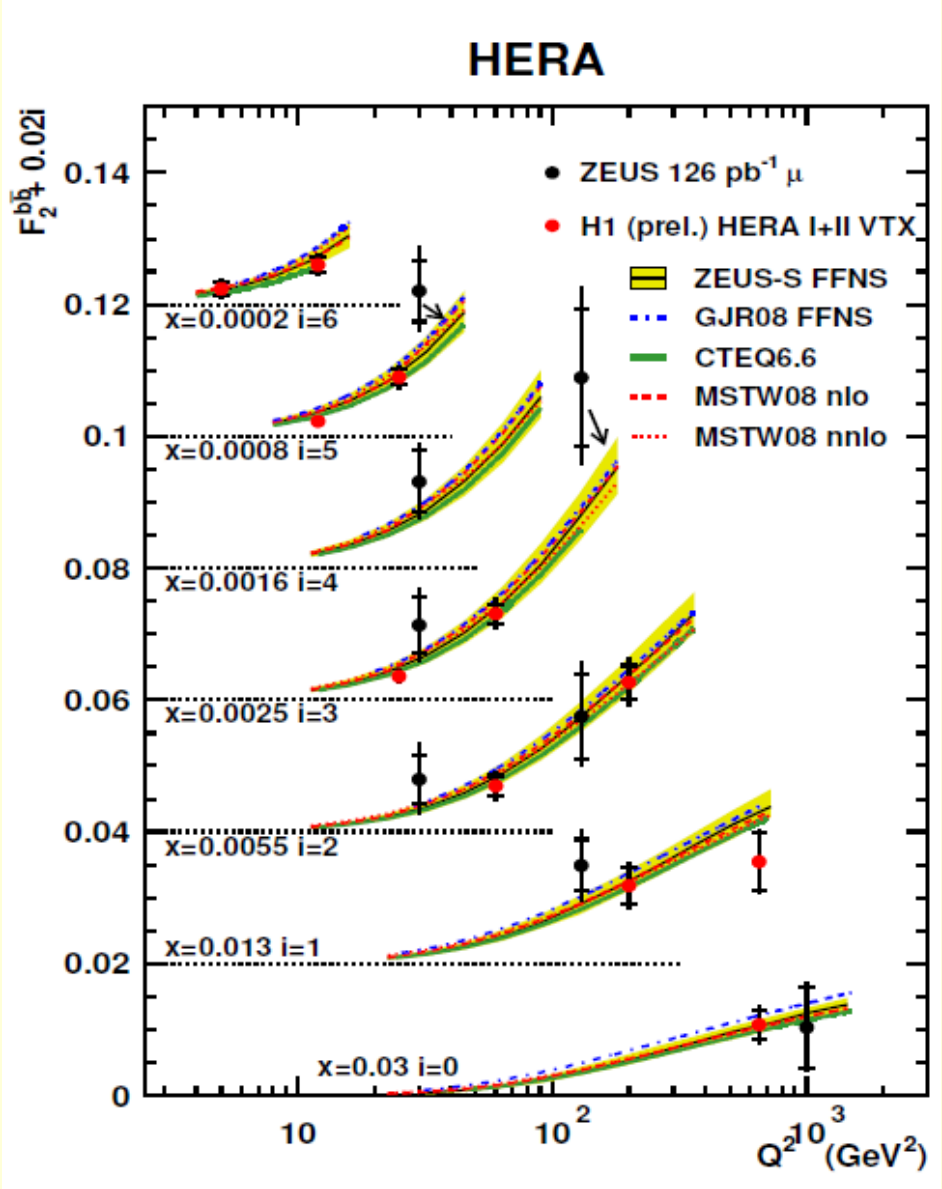
$$\chi^2(M^{i,true}, \Delta\alpha_j) = \sum \frac{\left[M^{i,true} - \left(M^i + \sum_j \frac{\partial M^i}{\partial \alpha_j} \frac{M^{i,true}}{M_i} \Delta\alpha_j \right) \right]^2}{\left(\sigma_i \frac{M^{i,true}}{M_i} \right)^2} + \sum_j \frac{(\Delta\alpha_j)^2}{\sigma_{\alpha_j}^2}$$

M^i measured central values

Detailed in H1 paper
arXiv:0904.0929

Charm and beauty contributions to proton structure function





Many thanks to all speakers

and to organizers !

We enjoined the session.

Ahmed Ali

Diego Tonelli

Leonid Gladilin

谢 谢！