Experimental Summary of Structure Functions WG

Structure Function Measurements From JLAB to HERA

Parton Densities

Photon Structure

Future Prospects

Contributions were: 15 experimental talks
10 phenomenology talks
21 theoretical talks
2 joint sessions with BSM/EW and Diffractive WGs

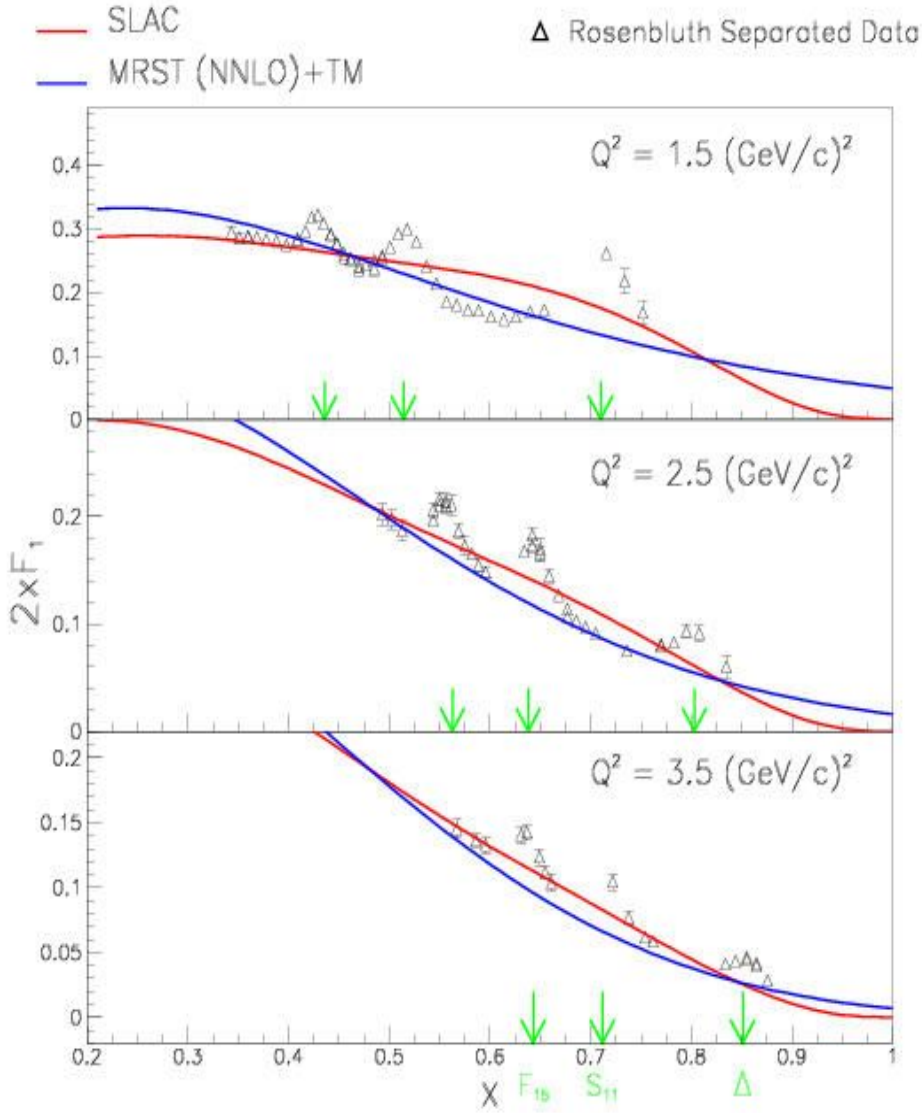
This talk will cover experiment & phenomenology

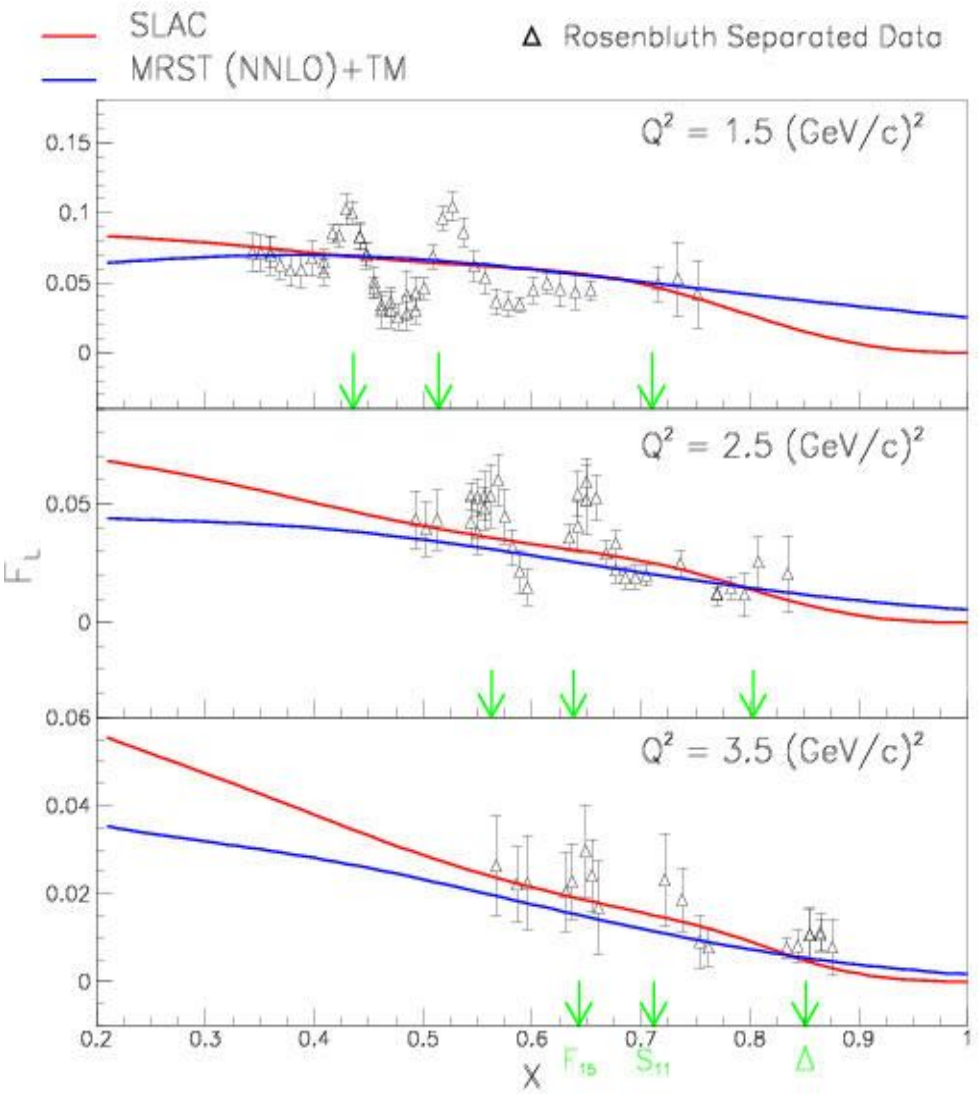
E. Lobodzinska: H1 Structure Functions
A. Petrukhin: H1 Structure Functions
A. Cocco: Chorus Neutrino DIS
V. Radescu: NuTeV Structure Functions
M. Przybycien: F2 Photon
A. Zembrzuski: F2 Photon Fits
X. Liu: Transition Region at eRHIC
O. Henshaw: H1 CC polarised cross section
M. Kataoka: ZEUS CC polarised cross section
A. Tapper: ZEUS Unpolarised NC Cross sections
D. Isenhower: NuSea Results
S. Kumano: NuTeV $\sin^2(\theta_W)$ Anomaly
K. Diener: EW Corrections to NuTeV
W. Tung: CTEQ PDFs
R. Thorne: MRST PDFs
B. Portheault: H1 PDFs
A. Cooper-Sarkar: ZEUS PDFs
R. Ent: Structure Functions at Low Q2
M. Boonekamp: Precision Cross sections at LHC
A. Holzer: Precision Cross sections at LHC
A. Ogawa: Forward Physics at RHIC
A. Caldwell: Muon Collider & Neutrino Factory R&D

Anna will cover theory & low-x

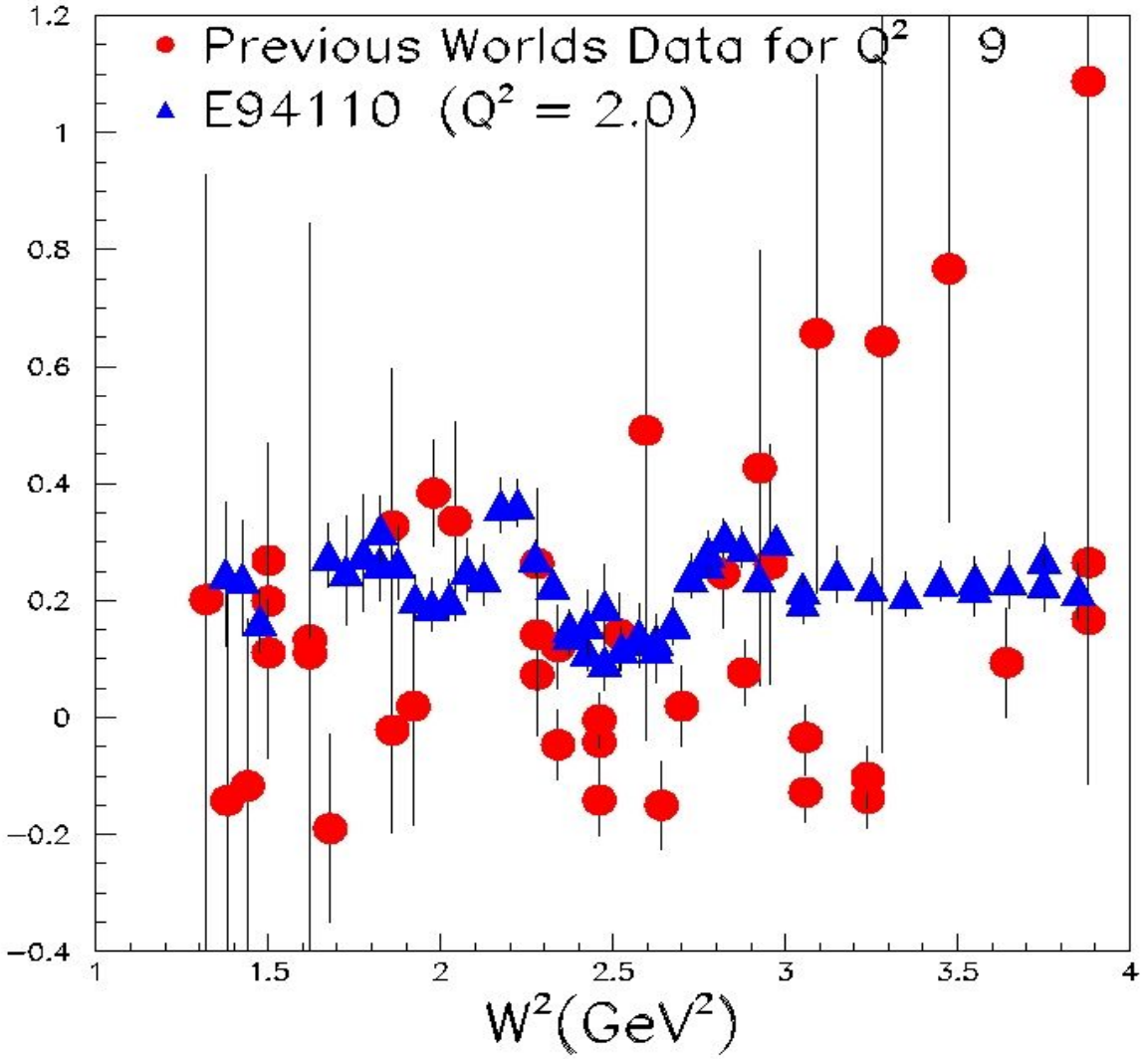
New precision measurements of F_2 and F_L at low Q^2 and very high x from JLAB

pQCD describes general behaviour (except for resonances)



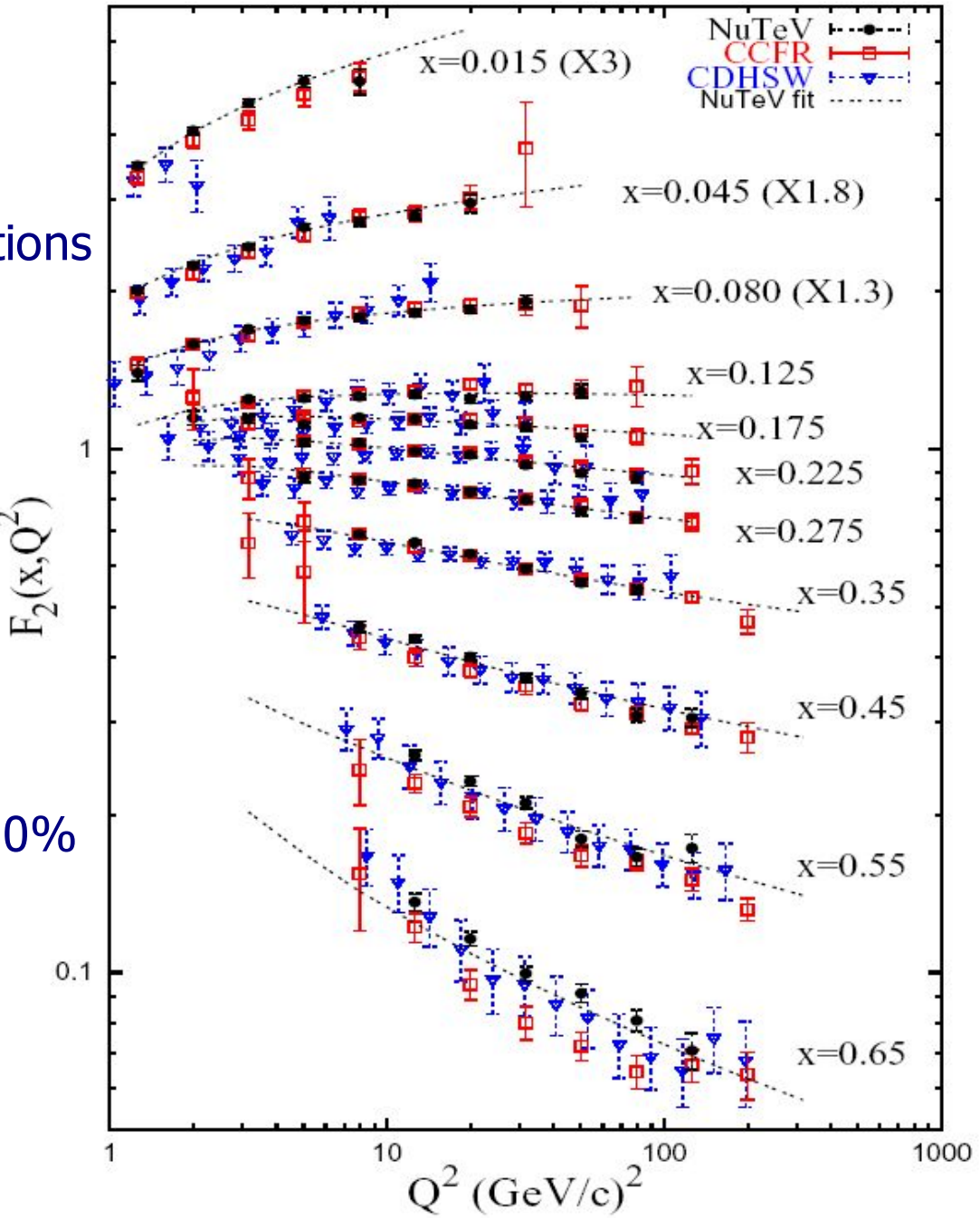


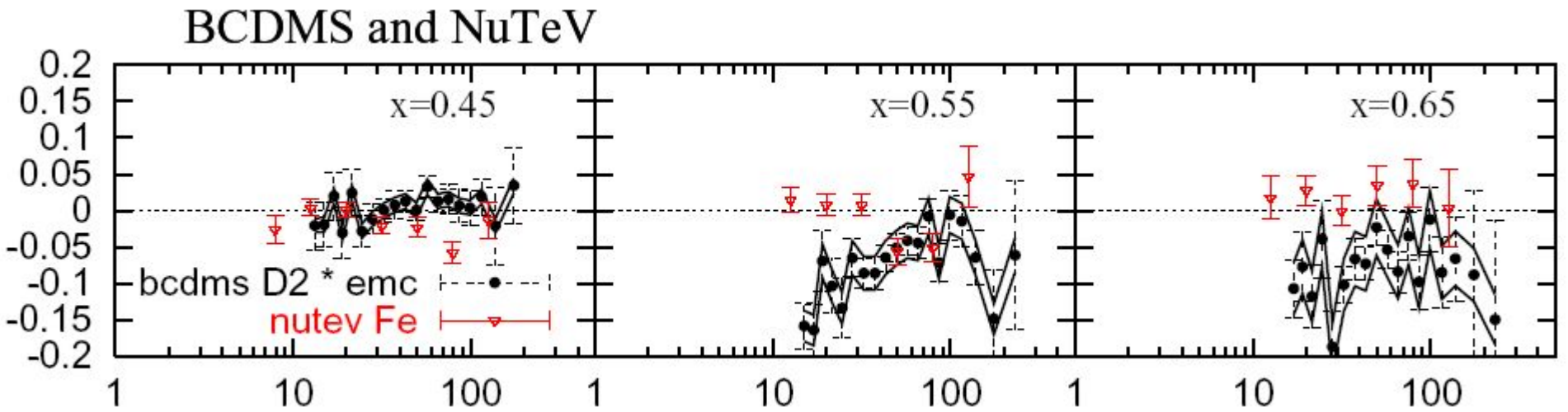
Comparison of previous measurements of $R = \sigma_L / \sigma_T$



Resonances also seen in R

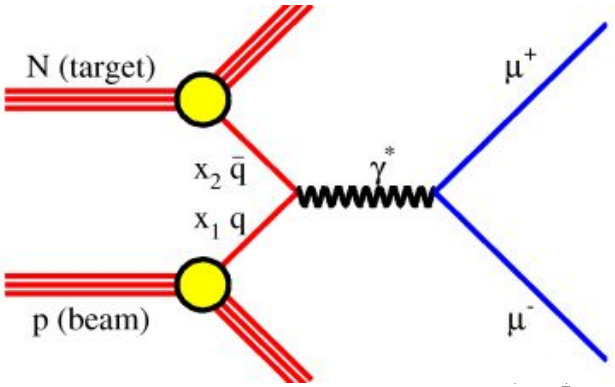
- NuTeV measure NC / CC ν-Fe cross sections
- Now extended to higher y (lower x)
- Largest systematics halved wrt CCFR
- For x >0.5 NuTeV higher than CCFR ~20%





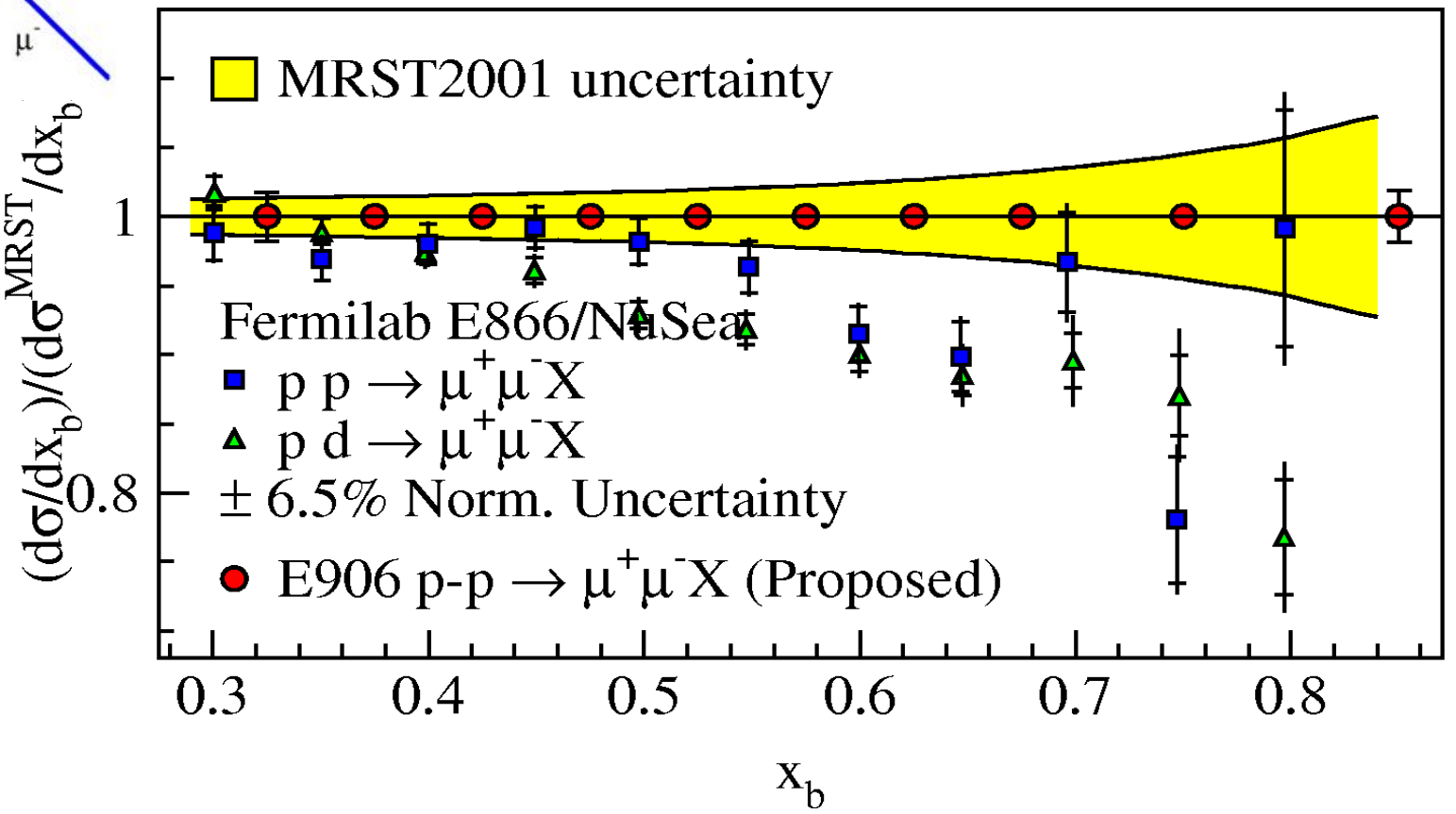
- NuTeV also high wrt BCDMS (after correction for Fe target)

- Data being finalised for publication



NuSea: Mesurements of high stats Drell-Yan data in pp or pd fixed target experiment

Proposed E906 will further constrain $\bar{d}$ / $\bar{u}$ at high x

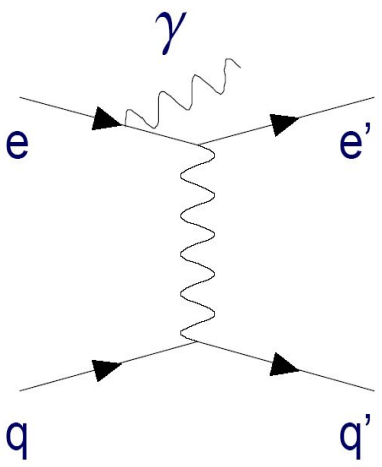


Indicate current PDFs overestimate valence quarks at high x

Needs clarification (CTEQ & MRST dont see this problem)

data will be included in global fits

New kinematic extension of F_2 at low Q^2 from H1



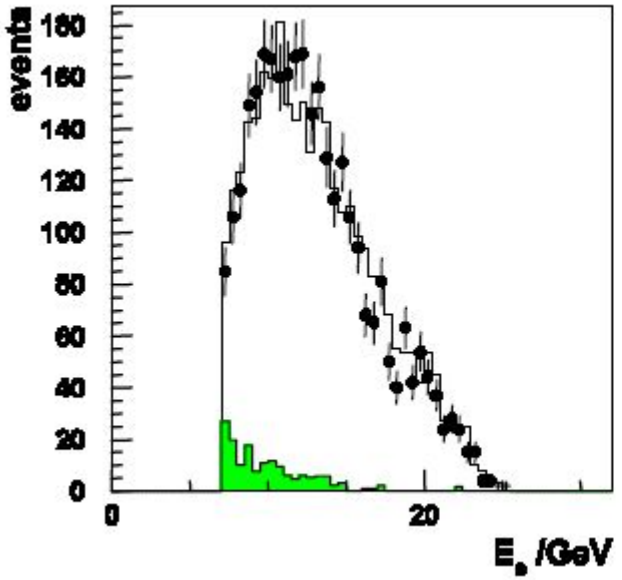
Reconstruct initial electron beam energy
Valid for radiative & non-radiative events:

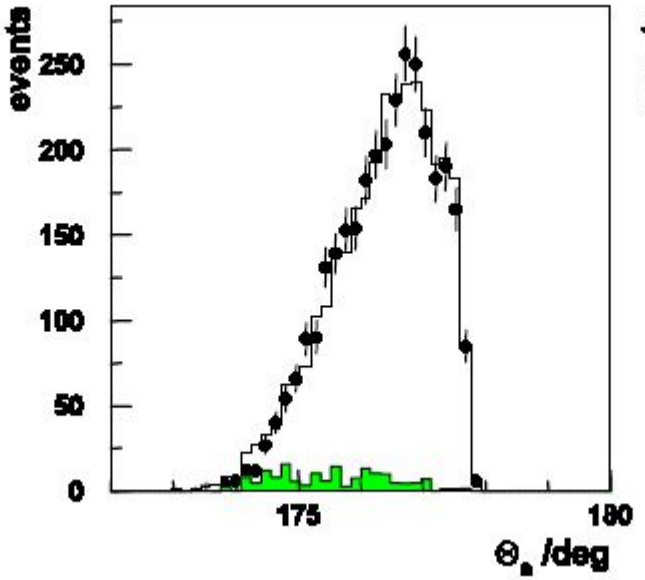
$$2E_e = \Sigma + (E - p_z)_{el}$$

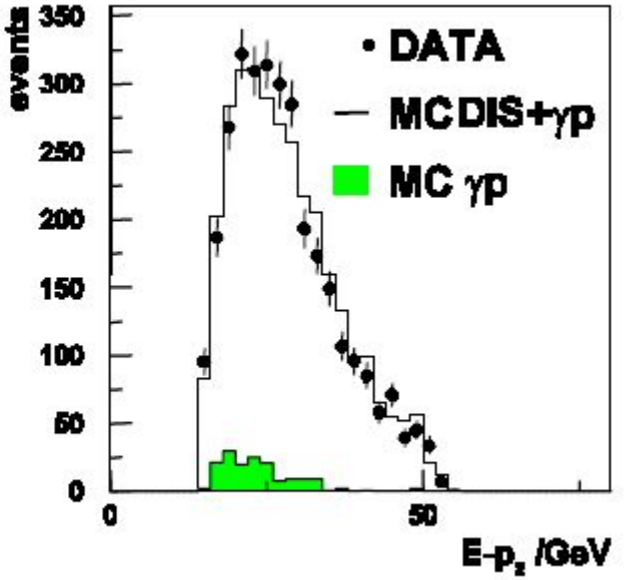
Radiative events have smaller √s $\Rightarrow$ access higher x

$$x_R = \frac{Q^2_\Sigma}{y_\Sigma . 4E_e E_p} = \frac{Q^2_\Sigma}{2\Sigma E_p}$$ x is indep of E_e

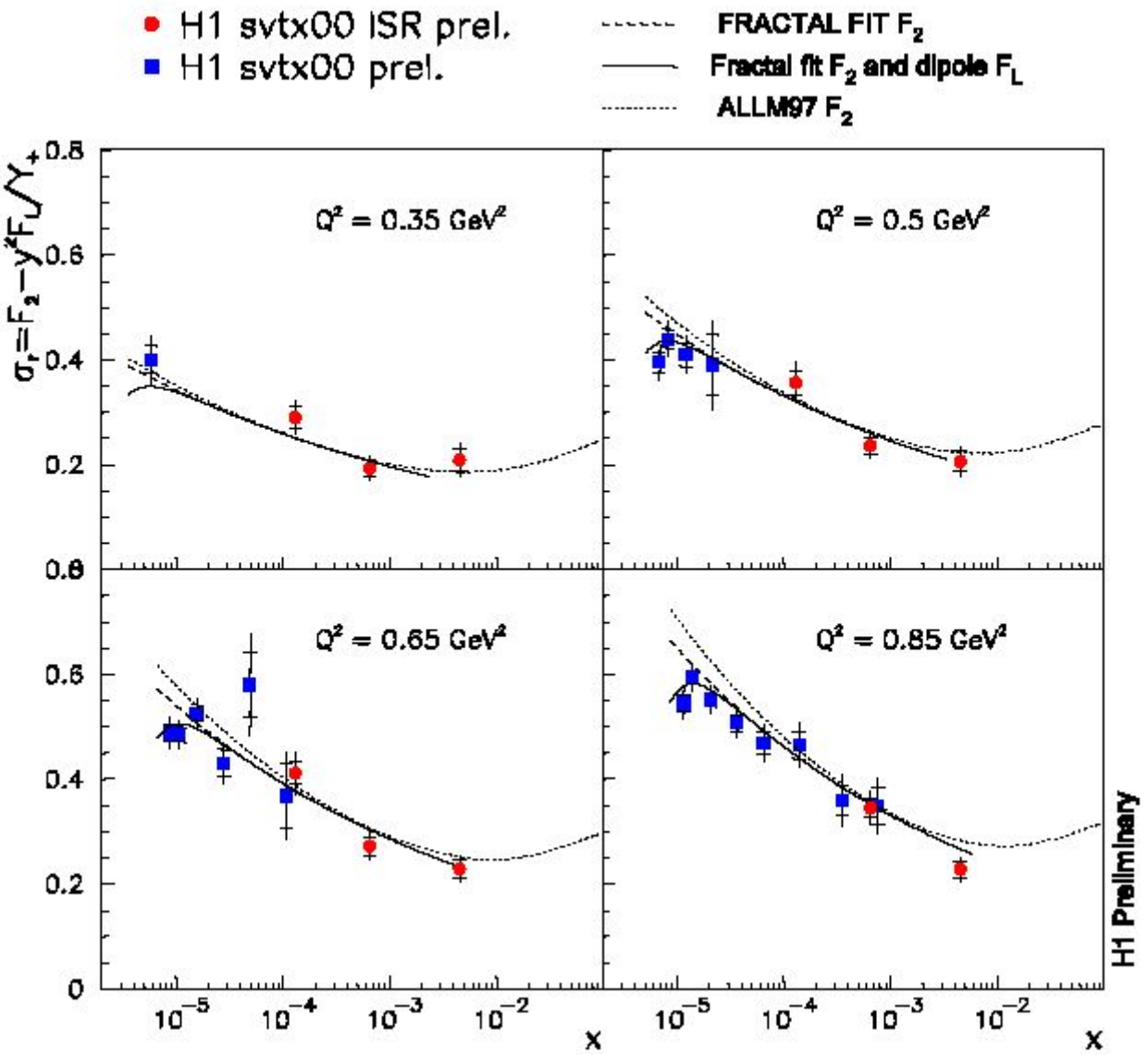
Do not require any useage of photon taggers







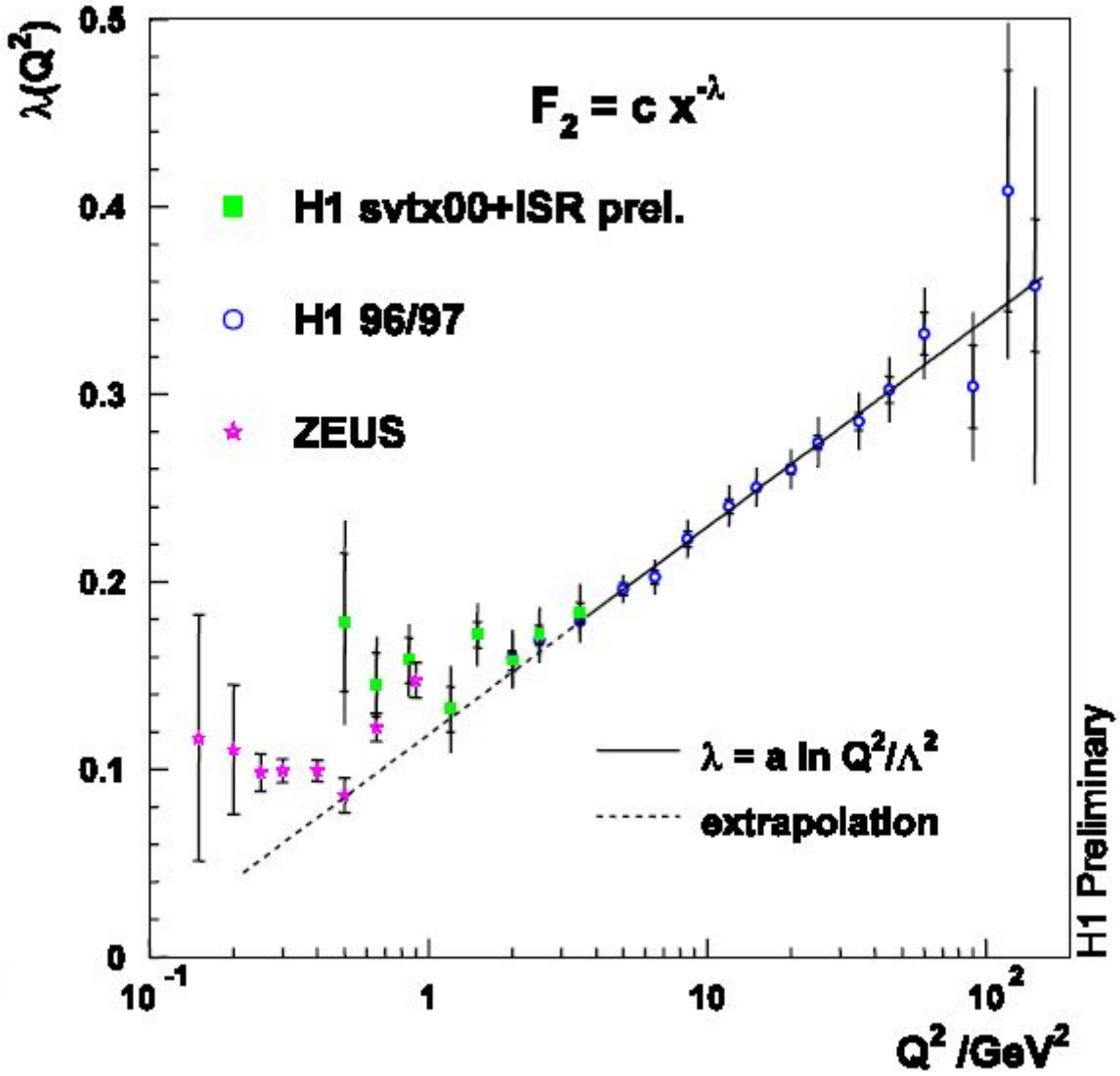
ISR data extend phase space to x: 10^{-4} – 10^{-2} for $Q^2 \sim 1$ GeV^2



Data are being finalised for publication

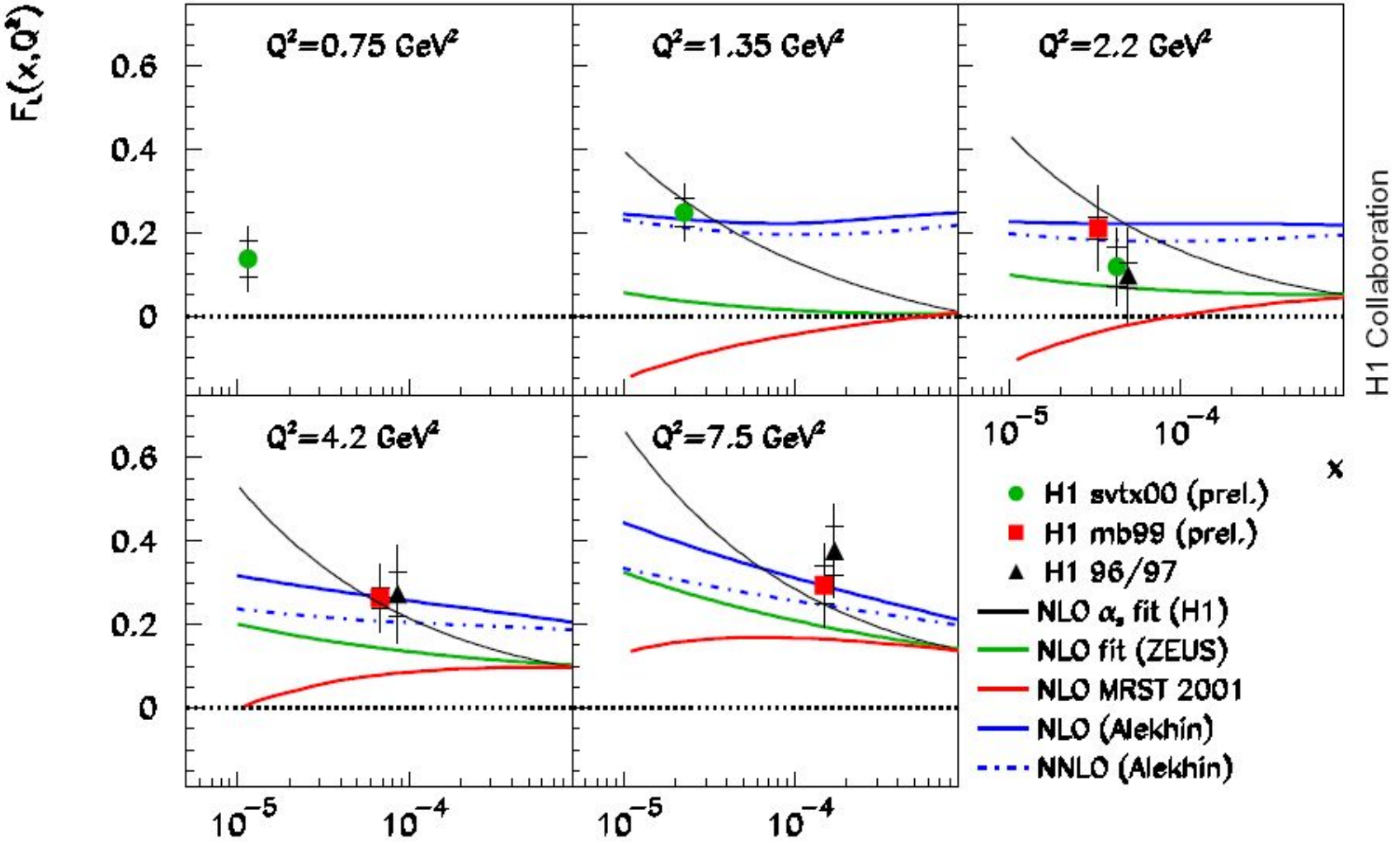
Update of the λ plot: fill in gap between ZEUS BPT data & nominal analysis

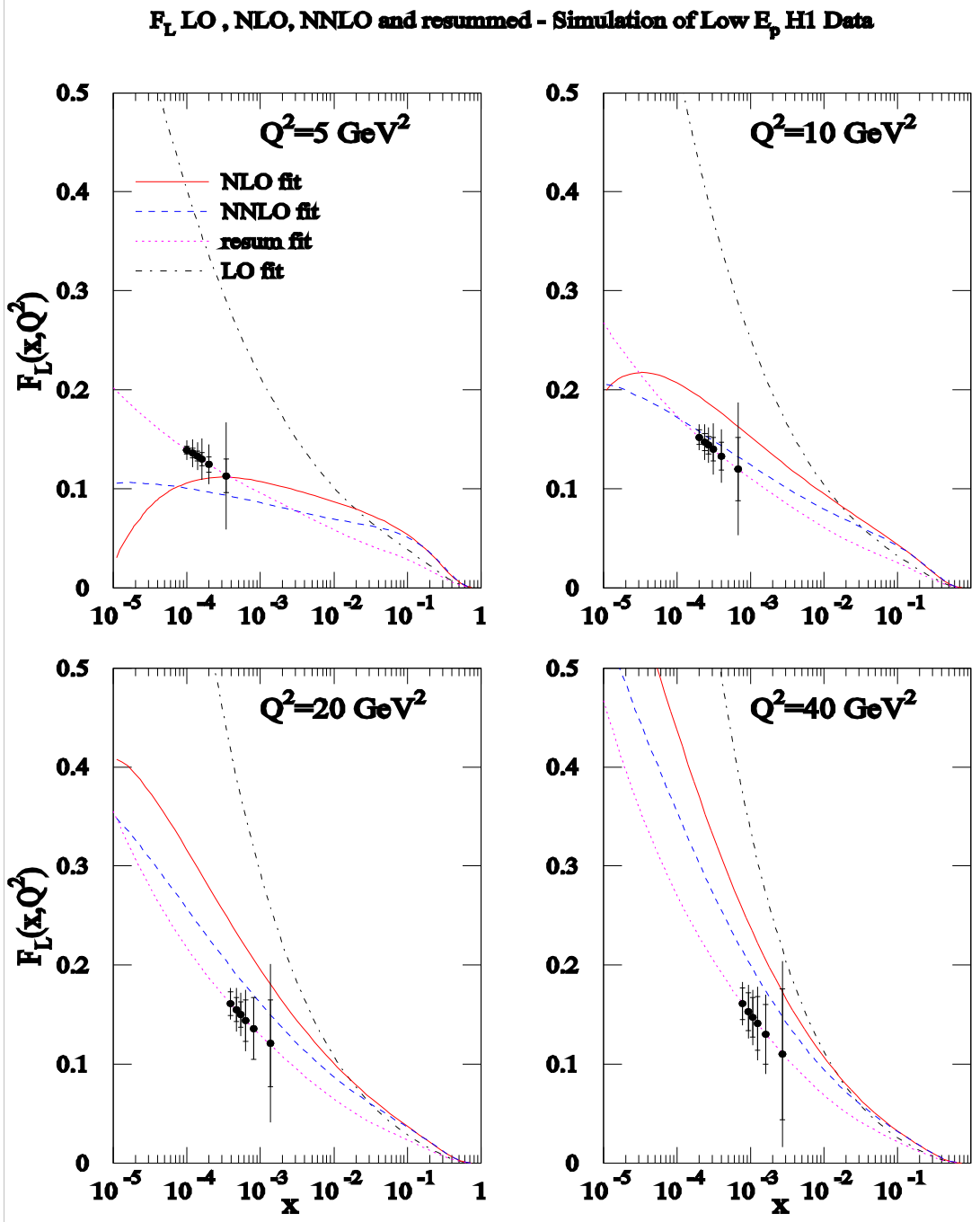
$$F_2 = c(Q^2) \cdot x^{-\lambda(Q^2)}$$



Extract F_L using new "shape method"

Rely on $F_2 \sim x^{\lambda(Q2)}$ - works well for $x < 0.01$



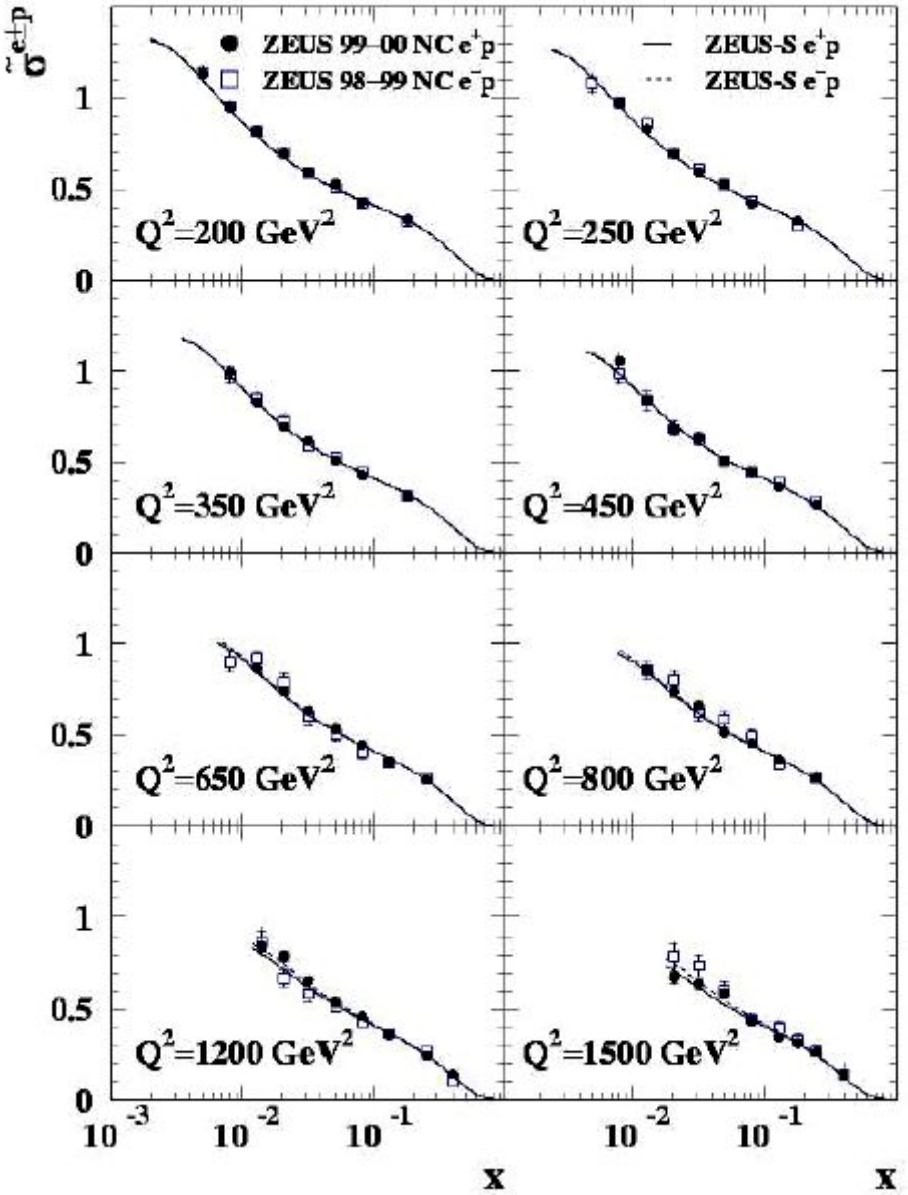


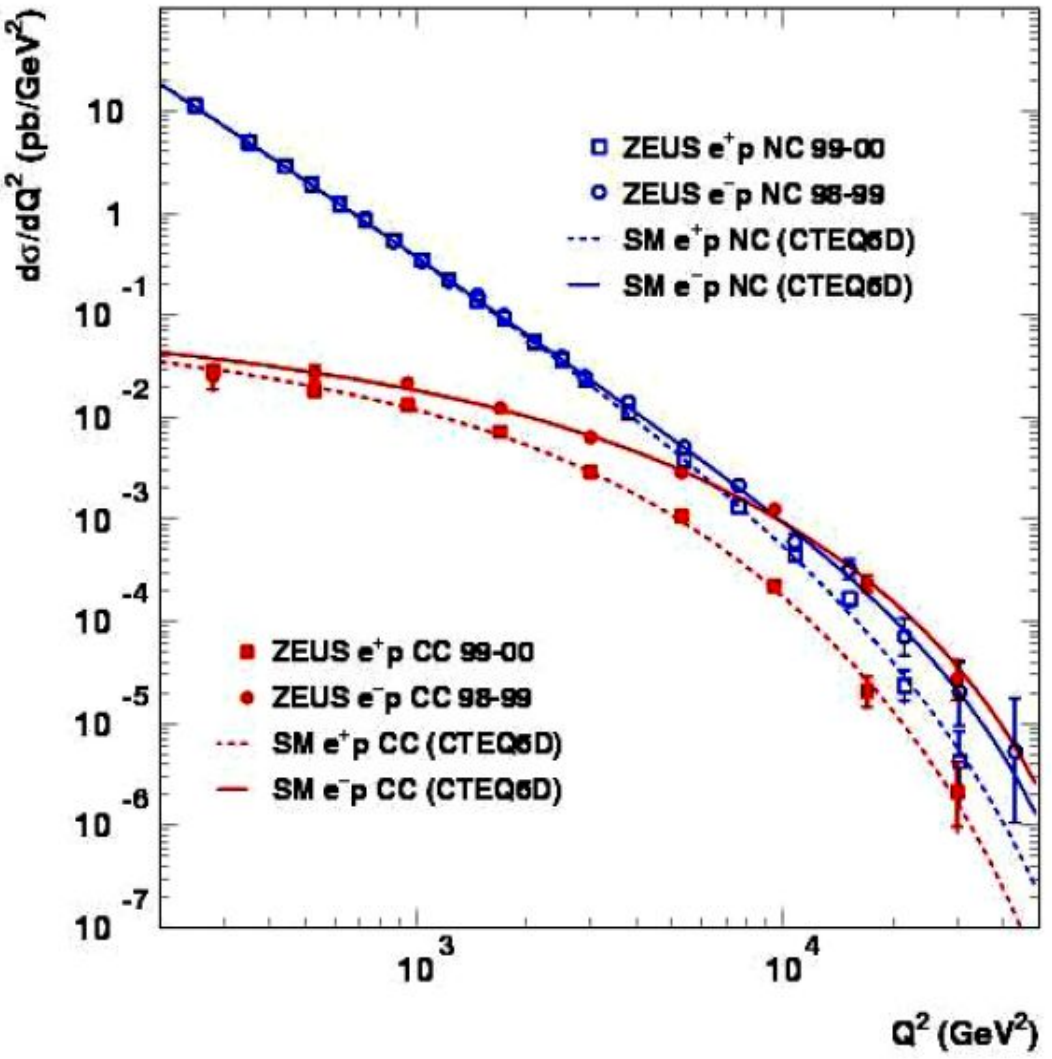
measure cross section at fixed x and Q^2, varying y by changing Ep

e.g.	400,	465,	575,	920	GeV
with e.g.	3	5	10	30	pb^{-1}

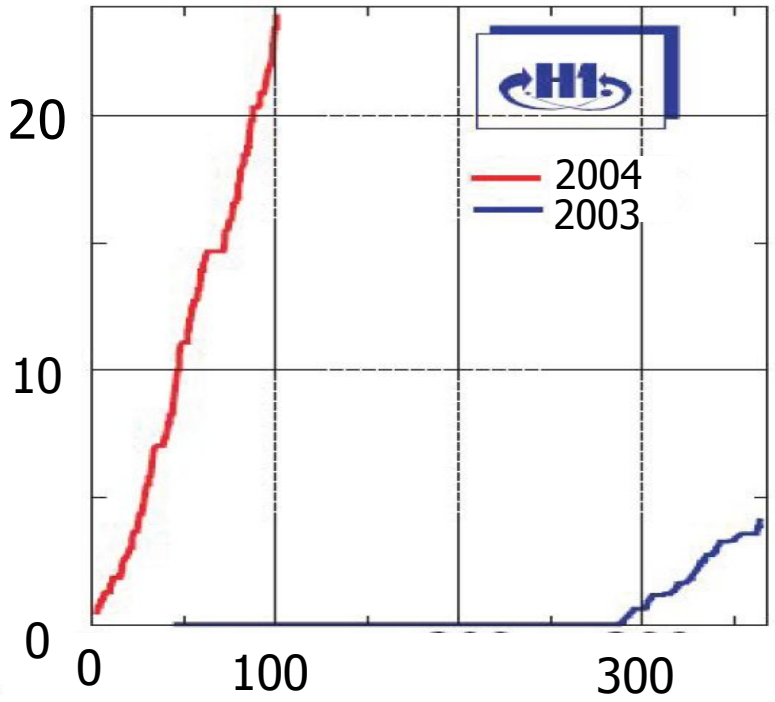
simulation includes systematics

- Complete HERA-I high Q^2 dataset now published from H1 & ZEUS
- NC cross sections with ~2-4% precision over much of phase space



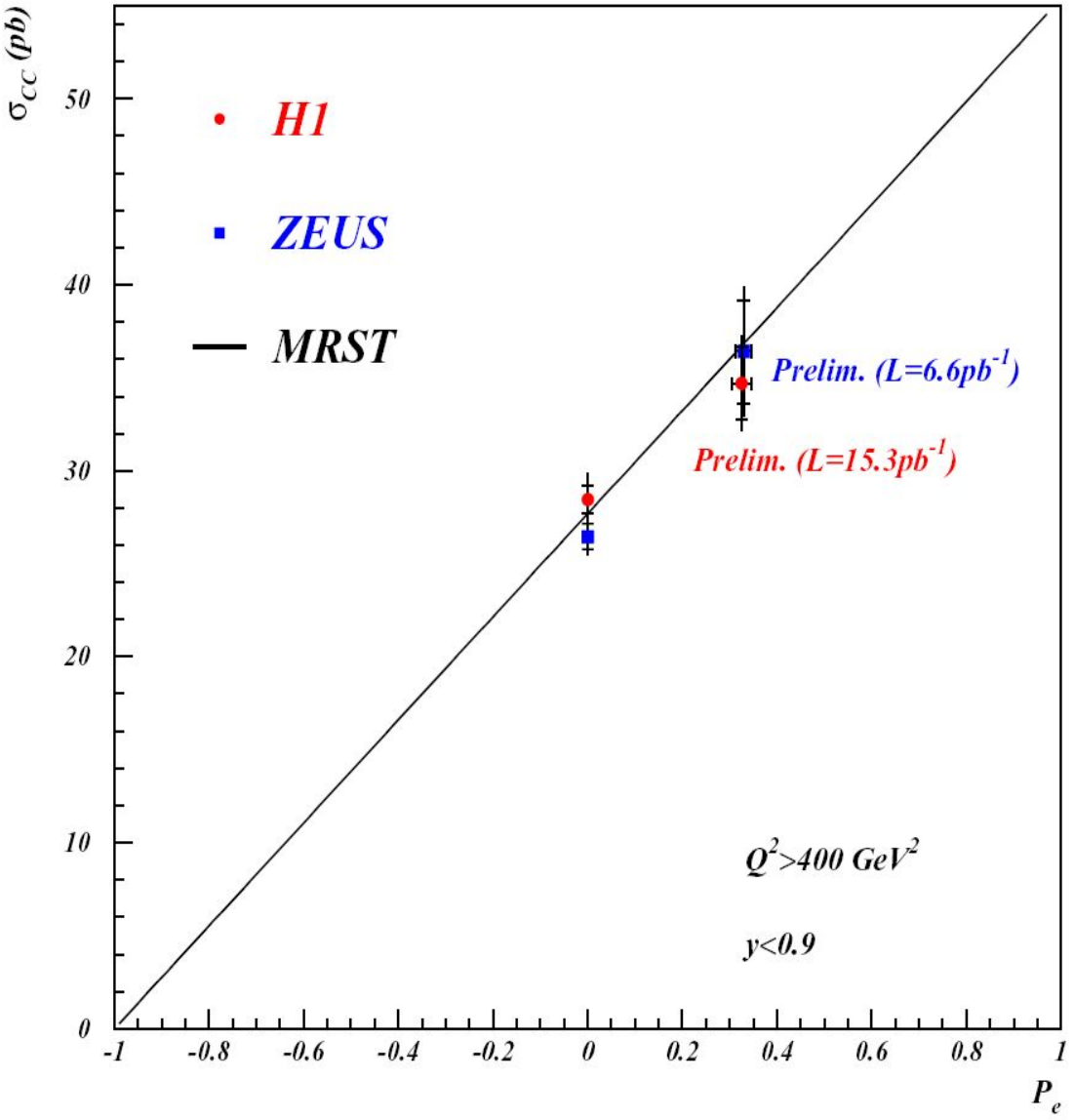


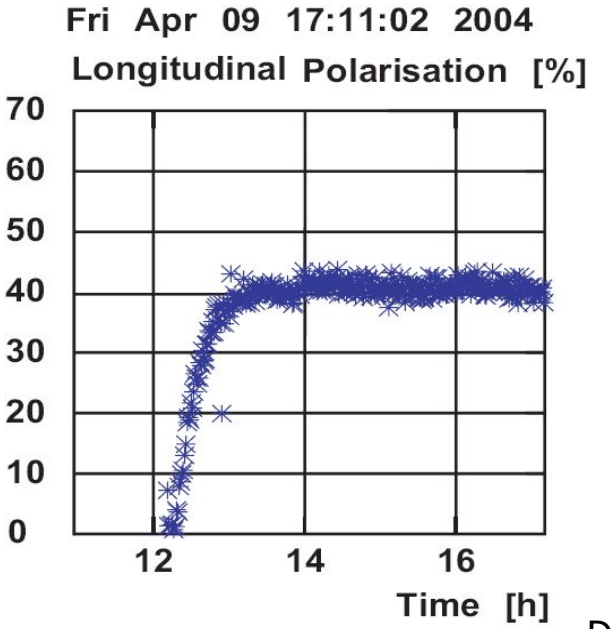
Integrated Lumi vs Day



HERA-II now running, collected ~25pb^{-1} RH e^{+}

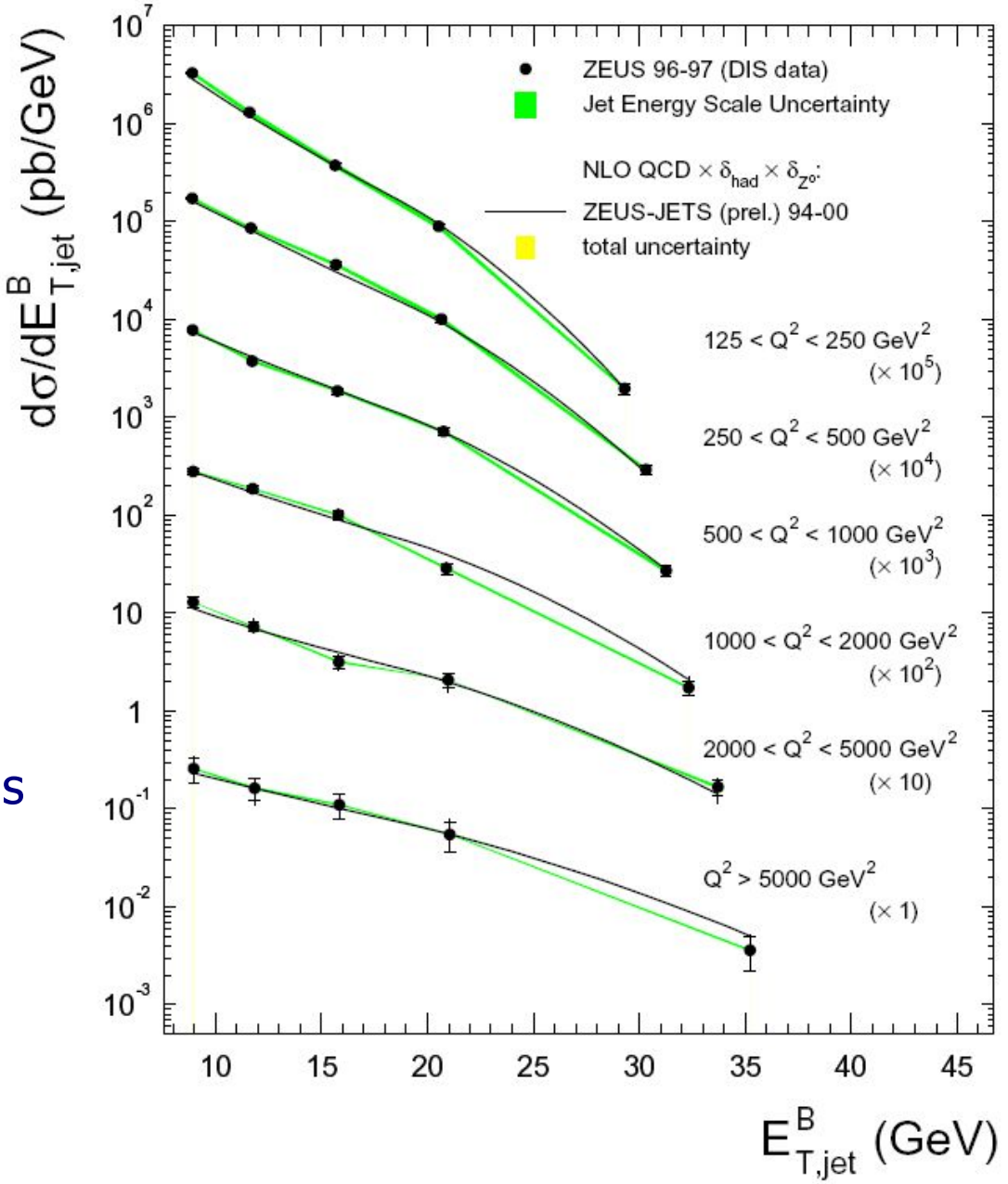
Switched to LH e^{+} last Friday

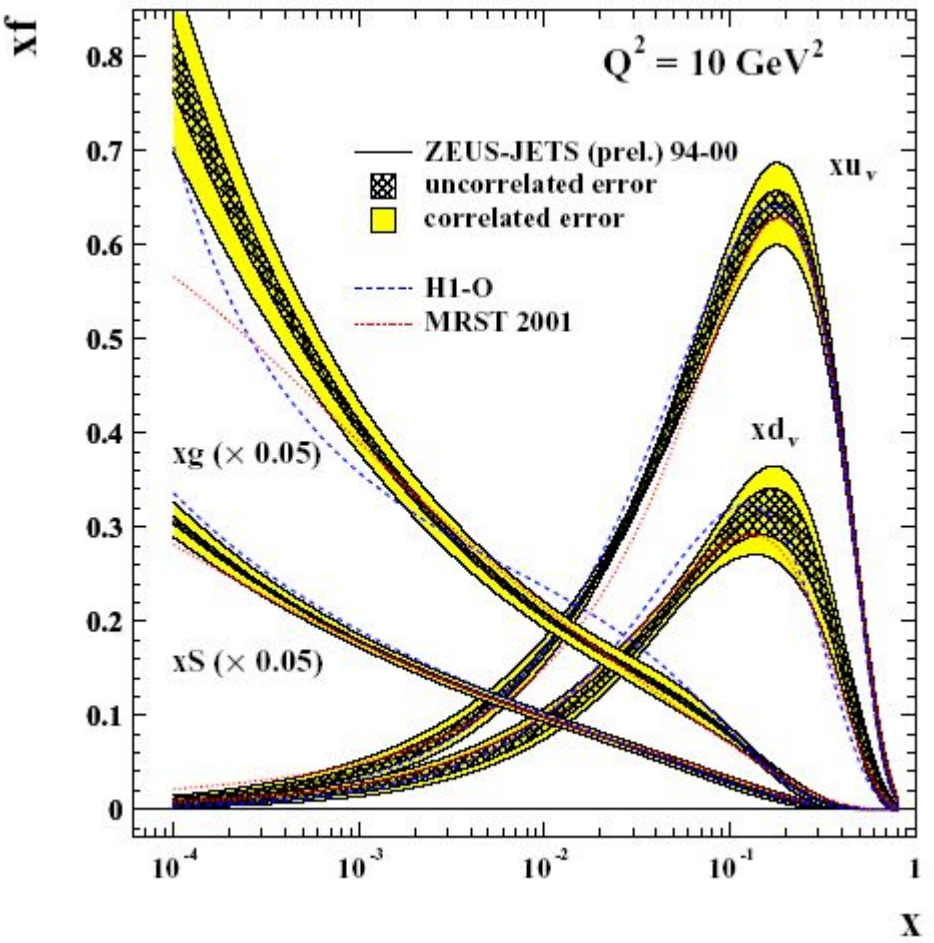




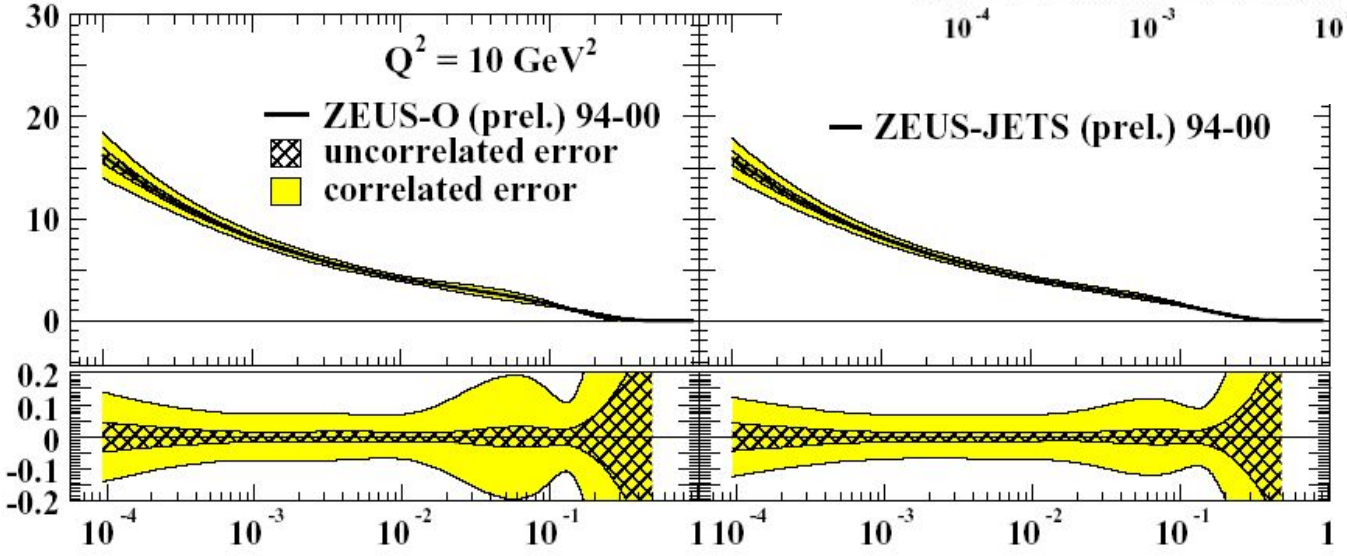
With final high Q^2 cross sections H1 & ZEUS fit PDFs using their data alone

- use $e^{\pm}$ NC & CC cross sections: partial flavour decomposition
- use only proton target DIS data
- control of experimental systematics
- high x constraints statistically limited
- NEW zeus include their own jet data complete framework for QCD analysis will include further exclusive data





Including jet data reduces gluon uncertainty by ~half at moderate x



CTEQ & MRST: estimation of PDF uncertainty is difficult

cannot rely on rigorous 1σ gaussian errors ($\Delta\chi^2=1$)

more realistically choose $\Delta\chi^2 \sim$ 50-100

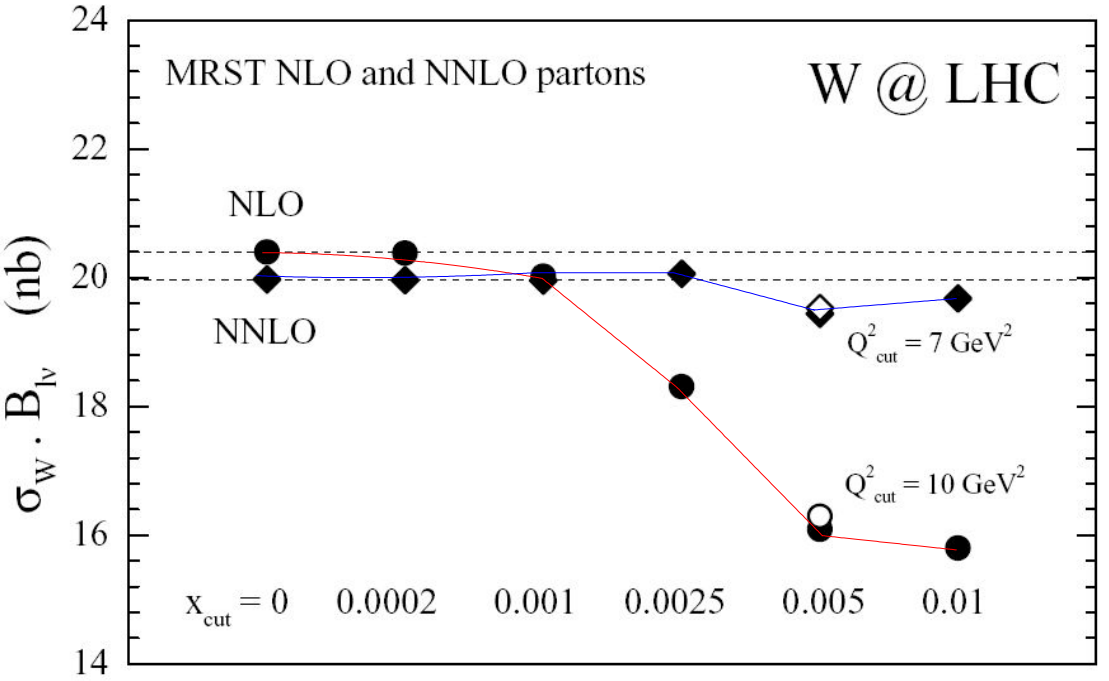
different fit approaches $\rightarrow$ similar error, different central value

must consider fit assumptions:

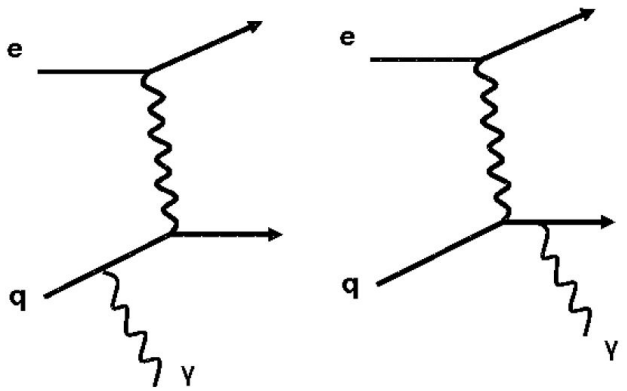
- data sets
- cuts on data
- experimental errors
- model parameters (α_s)
- model inadequacies (eg N^{n}LO)
- parameteristions chosen

Not seen in CTEQ analysis

MRST find upto ~20% change in σ_W due to fit cut variations



NNLO seems more stable



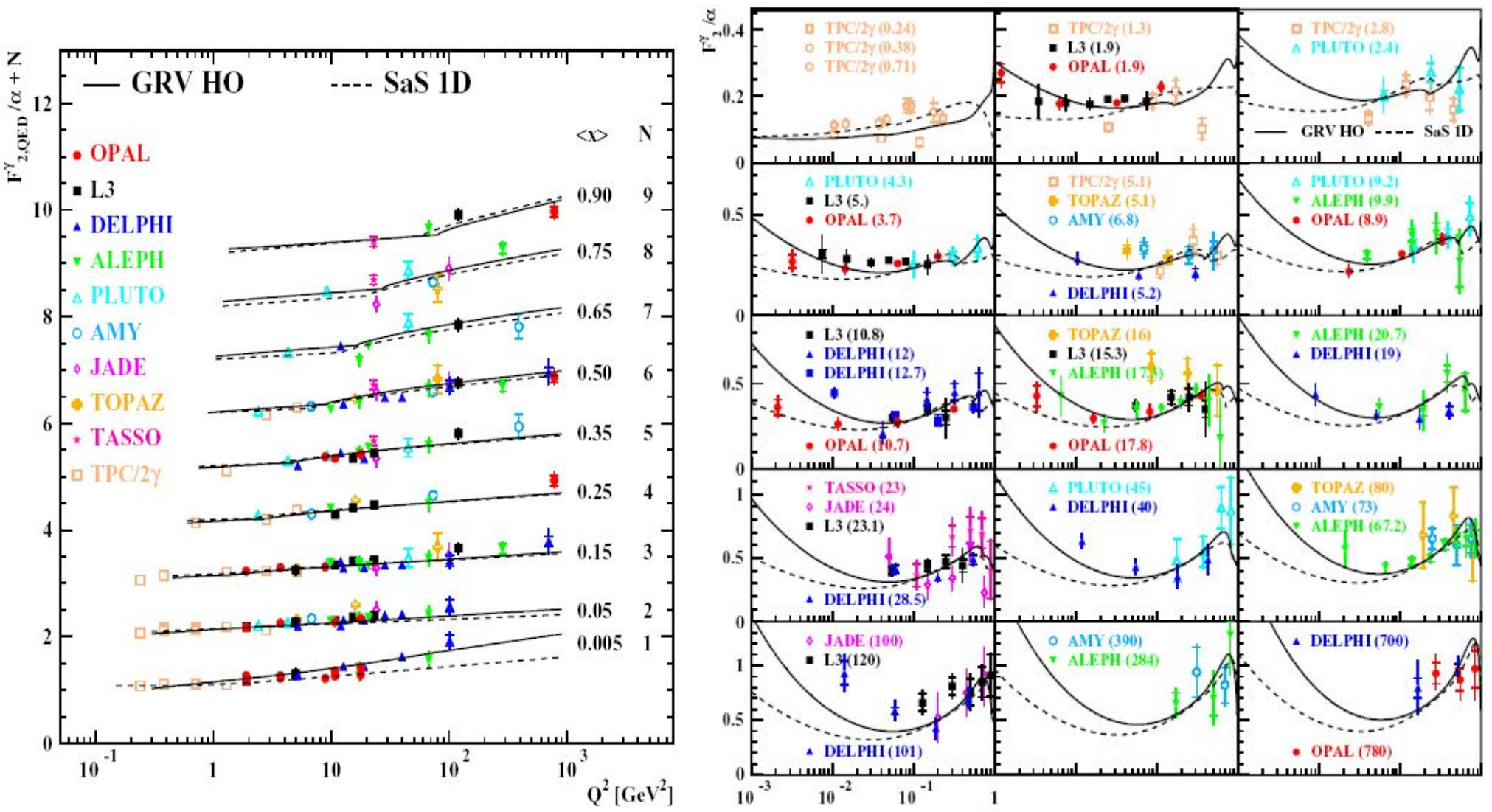
New MRST development:

- apply QED improved DGLAP evolution
- include photon in mometum sum rule
- effect diminishes u_v ~ 3% for $Q^2 \sim 10^4$
- for dv < 0.5% (since γ couples to e_q^2)

Implies small isospin asymmetry since d radiates less than u

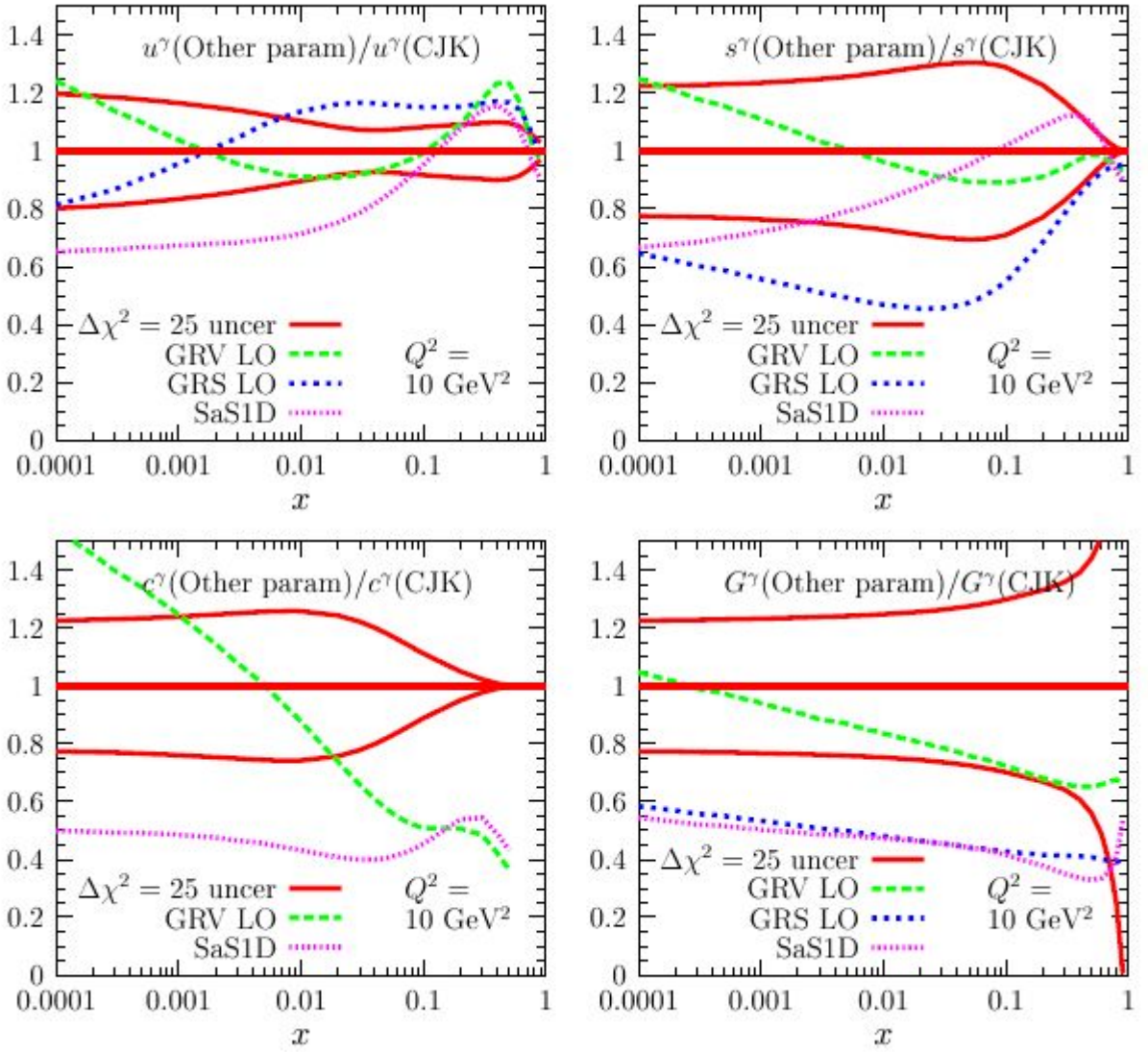
i.e. $d_v^p > u_v^n$

This seems to partially explain ~ ½ of NuTeV $\sin^2(\vartheta_W)$ anomaly (2.9σ)



- New measurements of F_2^{γ} from Opal/Delphi/Aleph based on LEP-II data 550 pb^{-1}
- x: $10^{-3} \rightarrow 0.9$ & Q^2: $0.24 \rightarrow 780$ GeV^2
- First measurement of F_2^{γ}-charm (Opal)
- Old photon PDFs work well but are ~10 years old & dataset has ~doubled!

- For first time a new fit uses general mass – VFNS treatment for heavy quarks
- Improved treatment of experimental systematics used for first time
- Complete error analysis available for LO fit (NLO errors in progress)
- Will include HERA data

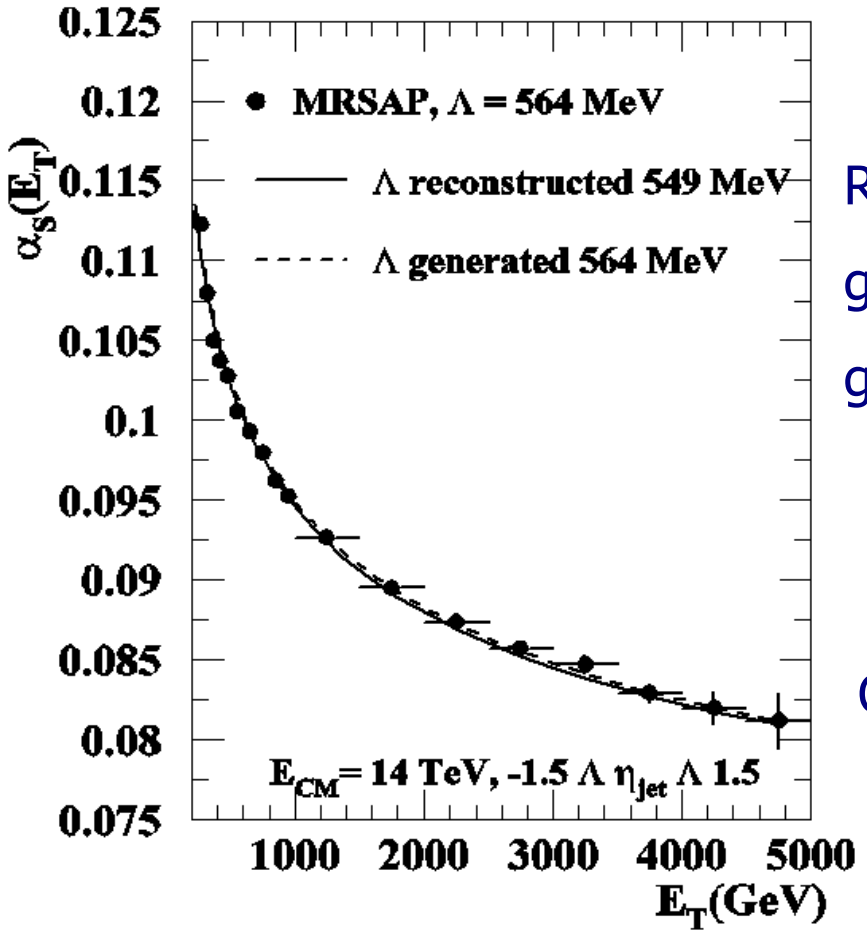


Last session devoted to future colliders – Precision QCD measurements at LHC

statistics on most channels will be copious (stat errors ~0.1%)

dominated by large systematics (lumi, jet scale etc...)

e.g. Measurement of α_s running from 100 GeV – 4 TeV



Requires careful systematic control

goal: jet energy scale known to 1%

goal: EM scale to 0.02%

Clearly LHC will be a challenging experiment

Apologies for to those who gave presentations but I was unable to include here

All talks available on web for further details

Thanks to organisers for a well organised and pleasant environment!