Recent H1 results

Stefan Schmitt, DESY Hamburg

H1 and HERA

- ep Collider HERA

  E_p=920 GeV, E_e=27.6 GeV

  $\sqrt{s}$=319 GeV
- Collider experiments

  H1 and ZEUS
- H1 Luminosity

  184 pb^{-1} in e^-p

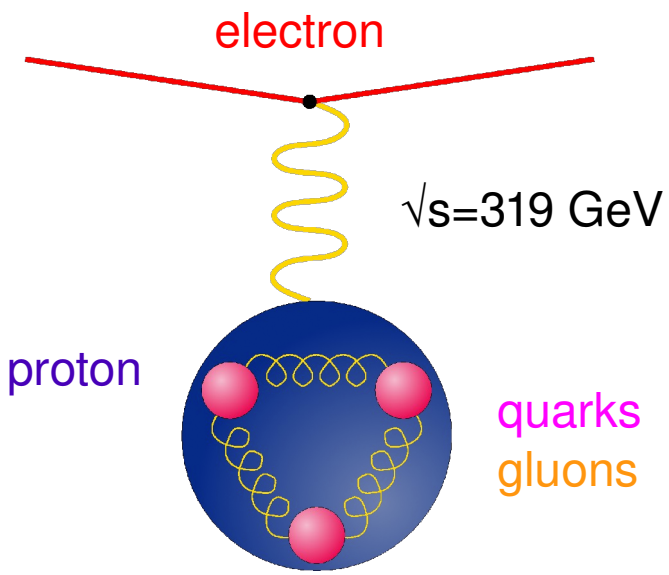
  294 pb^{-1} in e^+p
- Low energy run:

  12 pb^{-1} at E_p=460 GeV

  6 pb^{-1} at E_p=575 GeV

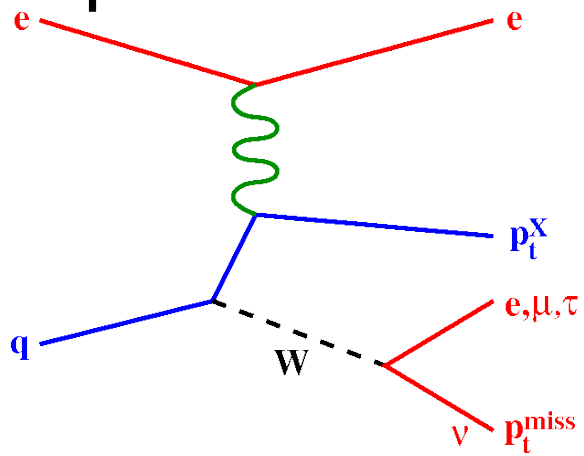
HERA program

- Searches
- Proton structure
- QCD tests
- Diffraction

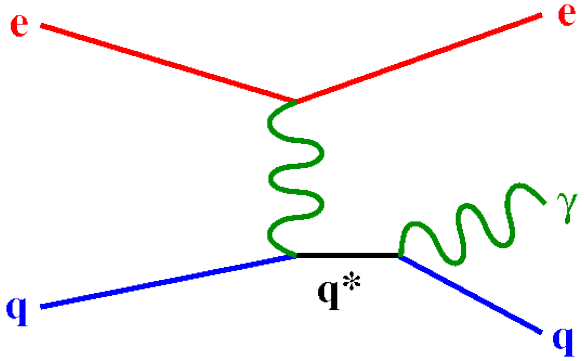


Rare processes/Searches

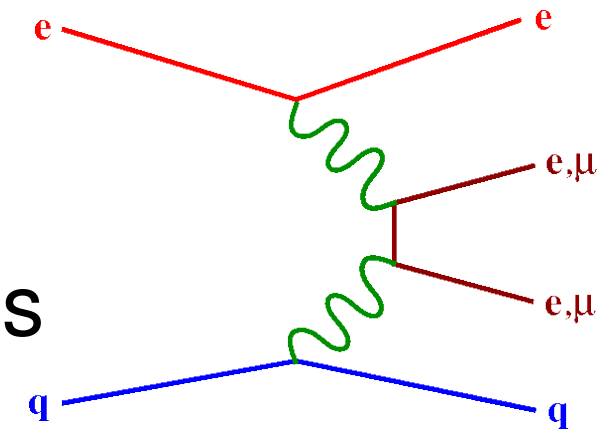
- W production



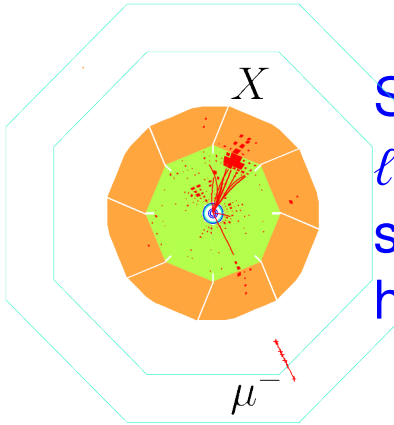
- Search for excited fermions



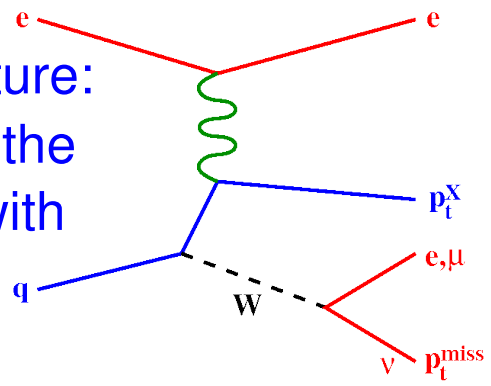
- Multi-lepton events

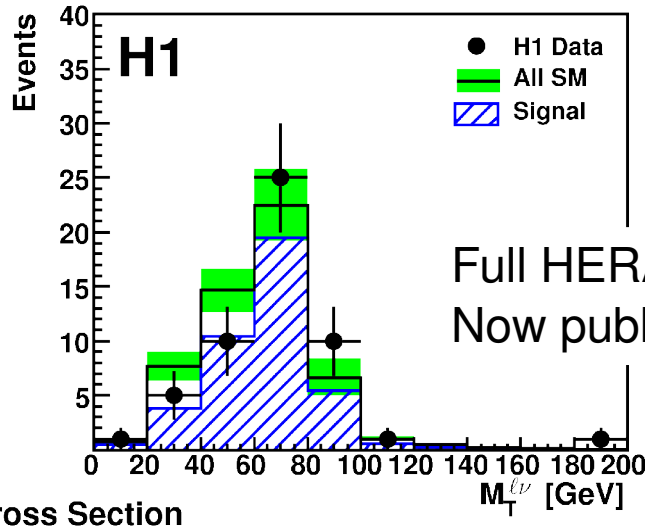


Single W production

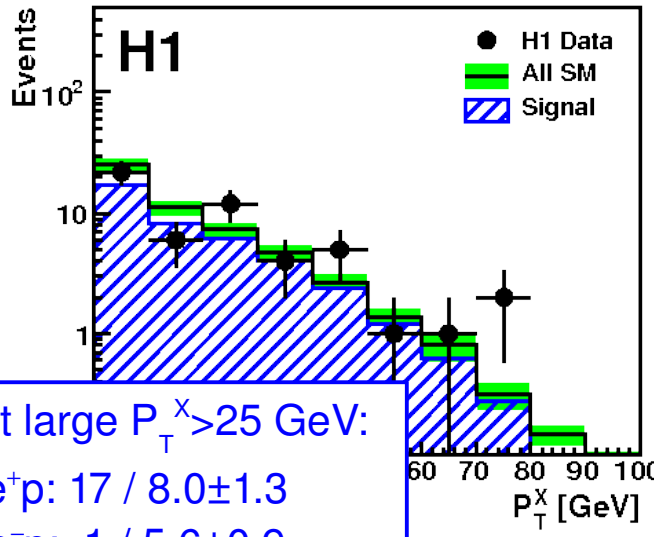


Striking signature:
ℓ=e,μ and ν in the same event, with high P_T

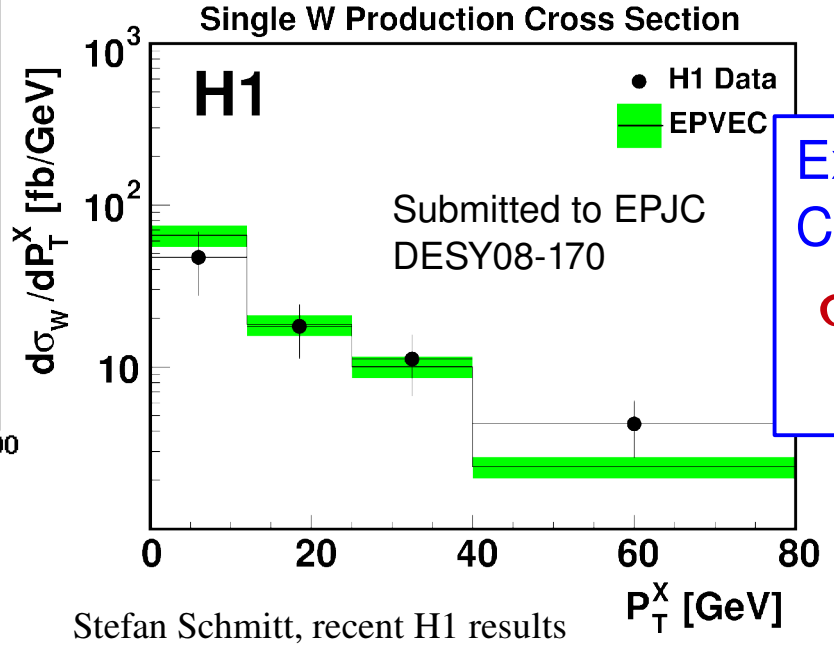




Full HERA data
Now published



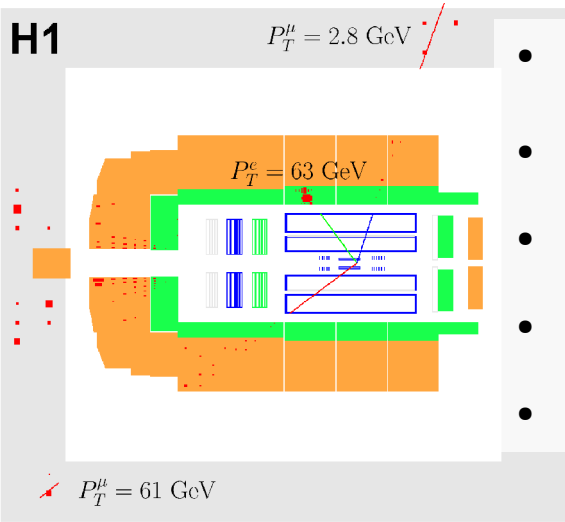
At large P_T^X>25 GeV:
e^+p: 17 / 8.0±1.3
e^-p: 1 / 5.6±0.9



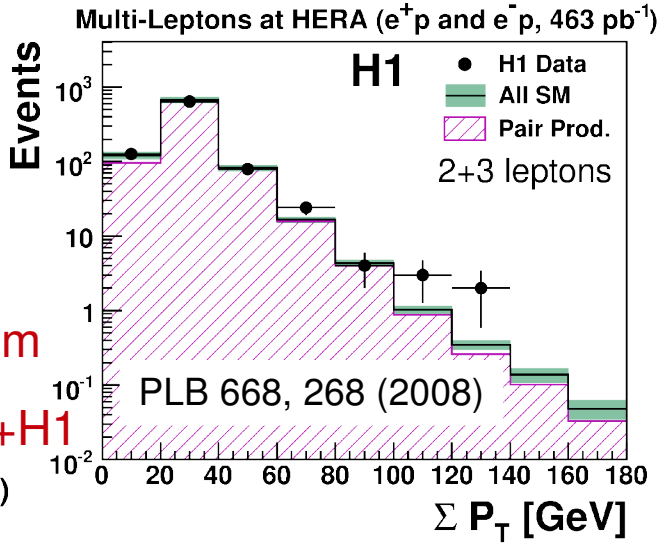
Extracted W
Cross section
σ=1.14±0.25
±0.14 pb

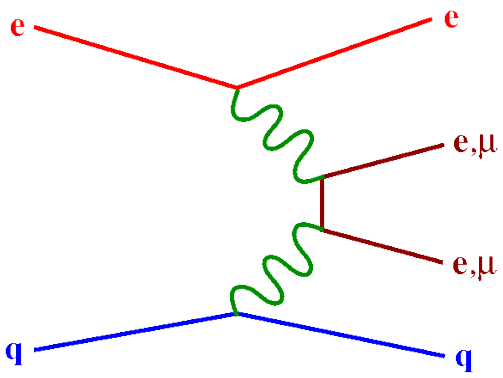
→ G. Brandt [33]

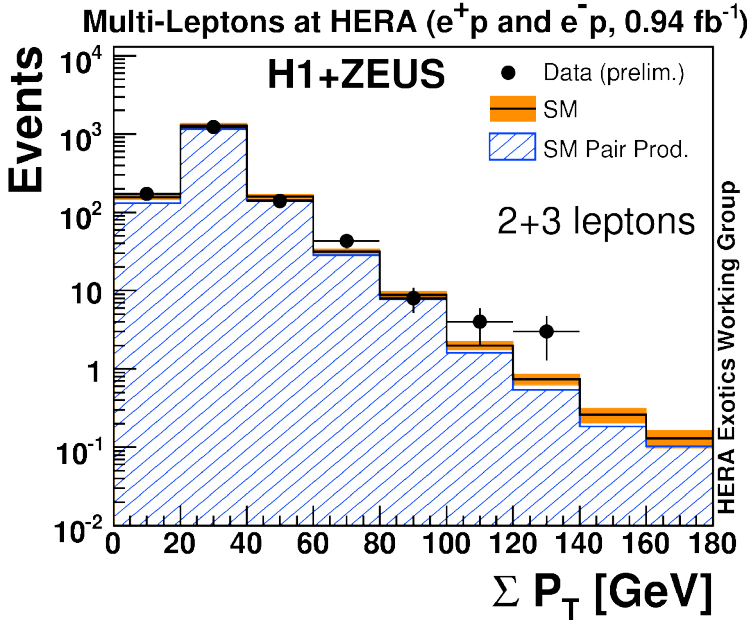
Multi-lepton events



- 2 or 3 high P_T leptons: ℓ=e,μ
- SM signal $\gamma\gamma \to \ell^+\ell^-$
- Full HERA data published
- Events at high transverse momentum
- Limited statistics → combine ZEUS+H1





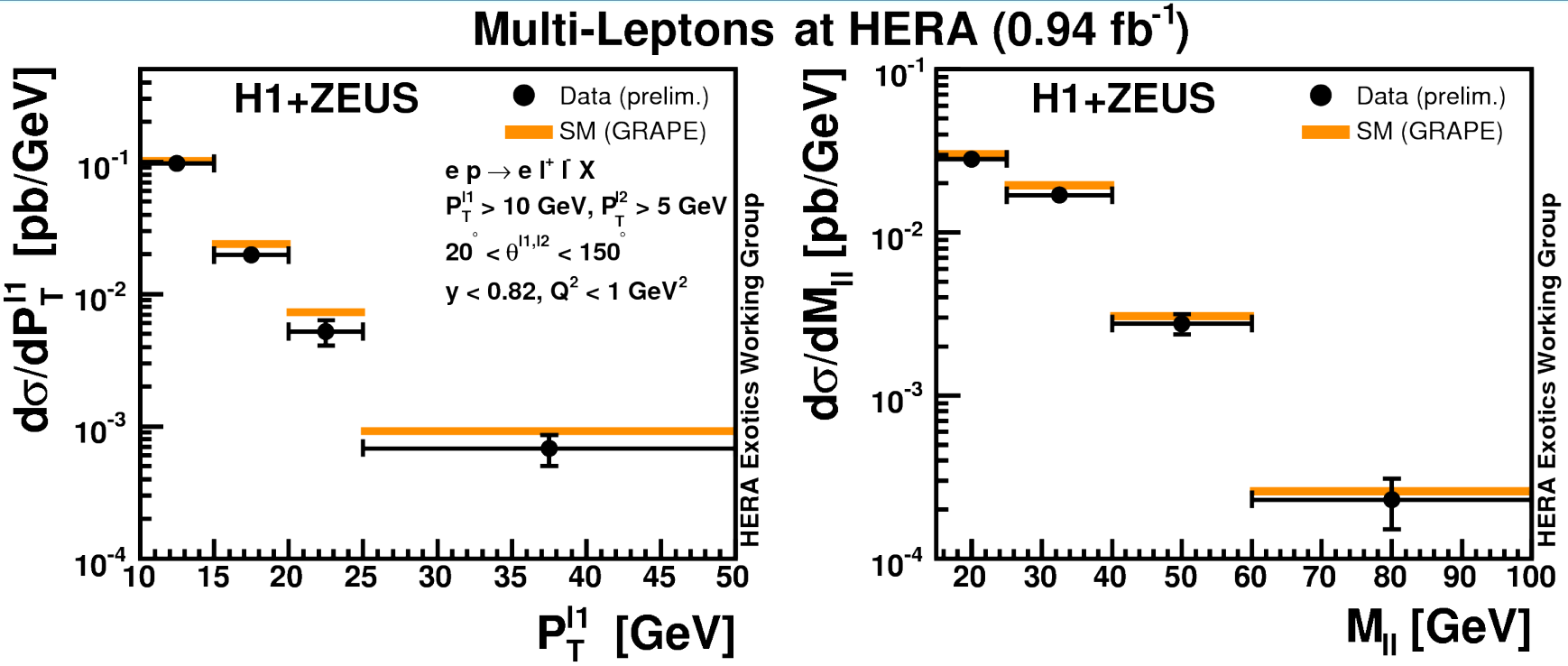


H1+ZEUS at ΣP_T>100 GeV

	DATA	SM prediction	
e^+p	7	1.94 ± 0.17	2.6σ
e^-p	0	1.19 ± 0.12	

→ M. Turcato [67]

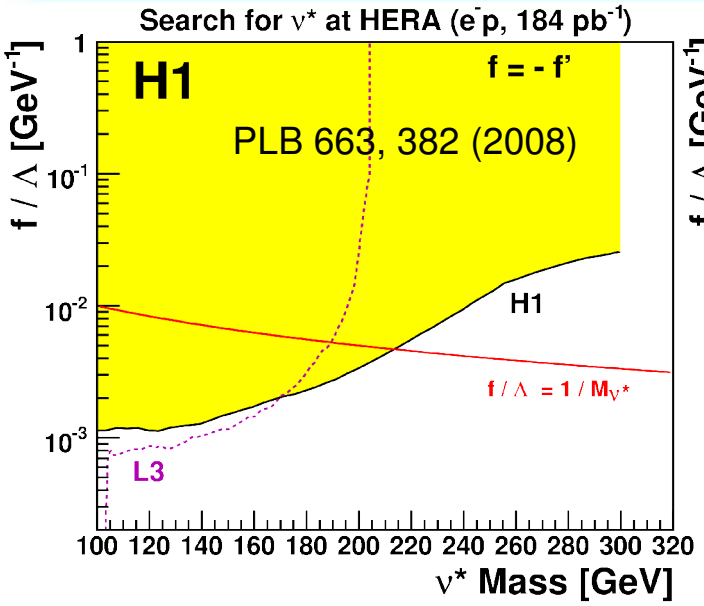
Cross-section $\gamma\gamma \to \ell^+\ell^-$

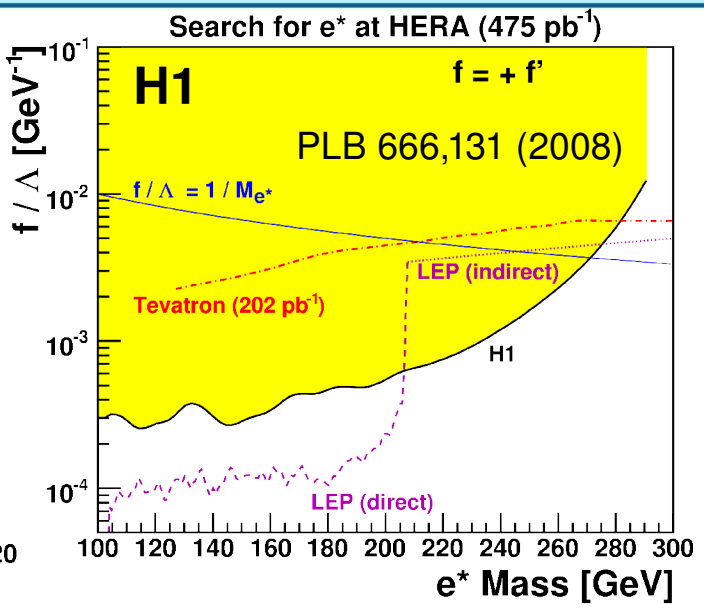


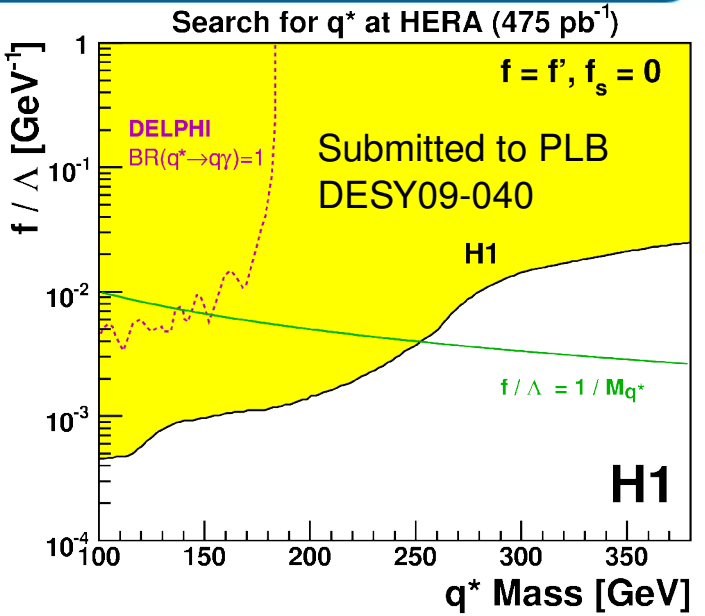
- H1+ZEUS combined cross-section of $\gamma\gamma \to \ell^+\ell^-$ at high P_T
- Good agreement with SM prediction

→ M. Turcato [67]

Excited Fermion limits

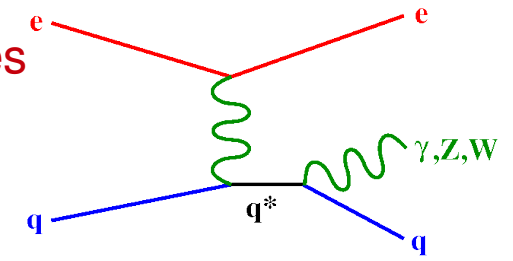


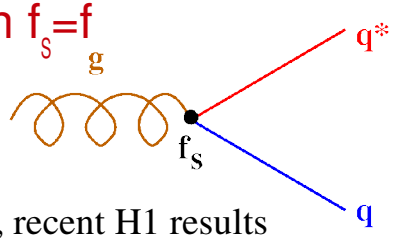




- Full HERA statistics analysed and published
- Best collider limits on compositeness scale f/Λ for high ν* masses
- Best excited quark limits for f_s=0

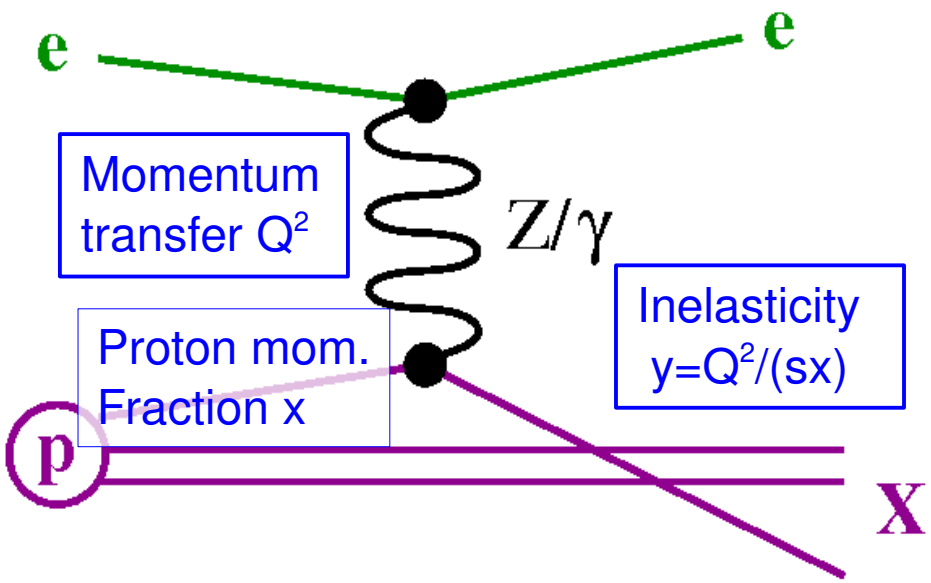
  complementary to Tevatron assumption f_s=f





→ G. Stoicea [43]

Structure functions



- $Q^2 \lesssim 5$ GeV^2: phenomenological models
- $Q^2 \gtrsim 2$ GeV^2: perturbative QCD, DGLAP evolution

Reduced cross-section:

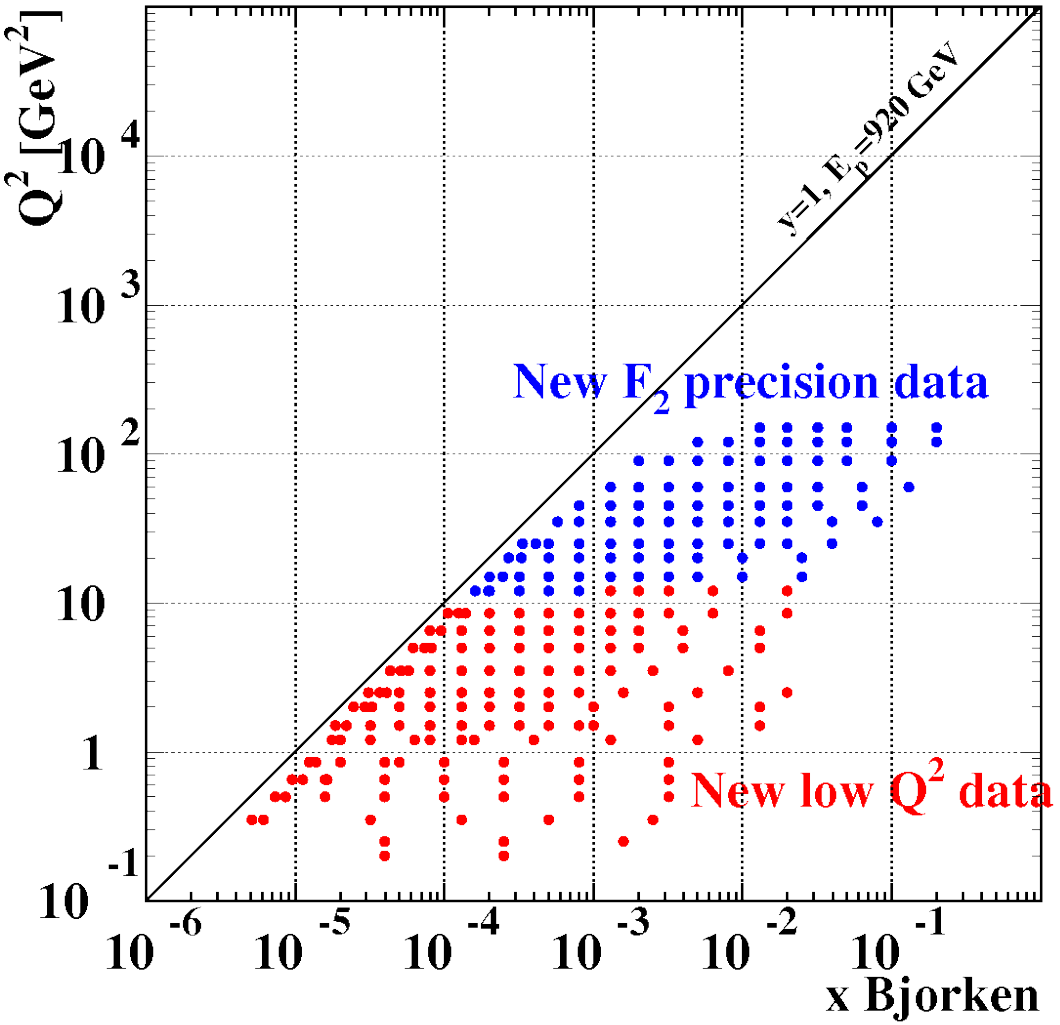
$$\sigma_r \propto F_2 - \frac{y^2}{1+(1-y)^2} F_L$$

Structure functions F_2 and F_L

F_2 : valence and sea quarks
gluon enters through scaling violations

F_L : direct sensitivity to the gluon density,
suppressed by helicity factor

New data on σ_r and F_2



- New data published by H1
  - Low Q^2

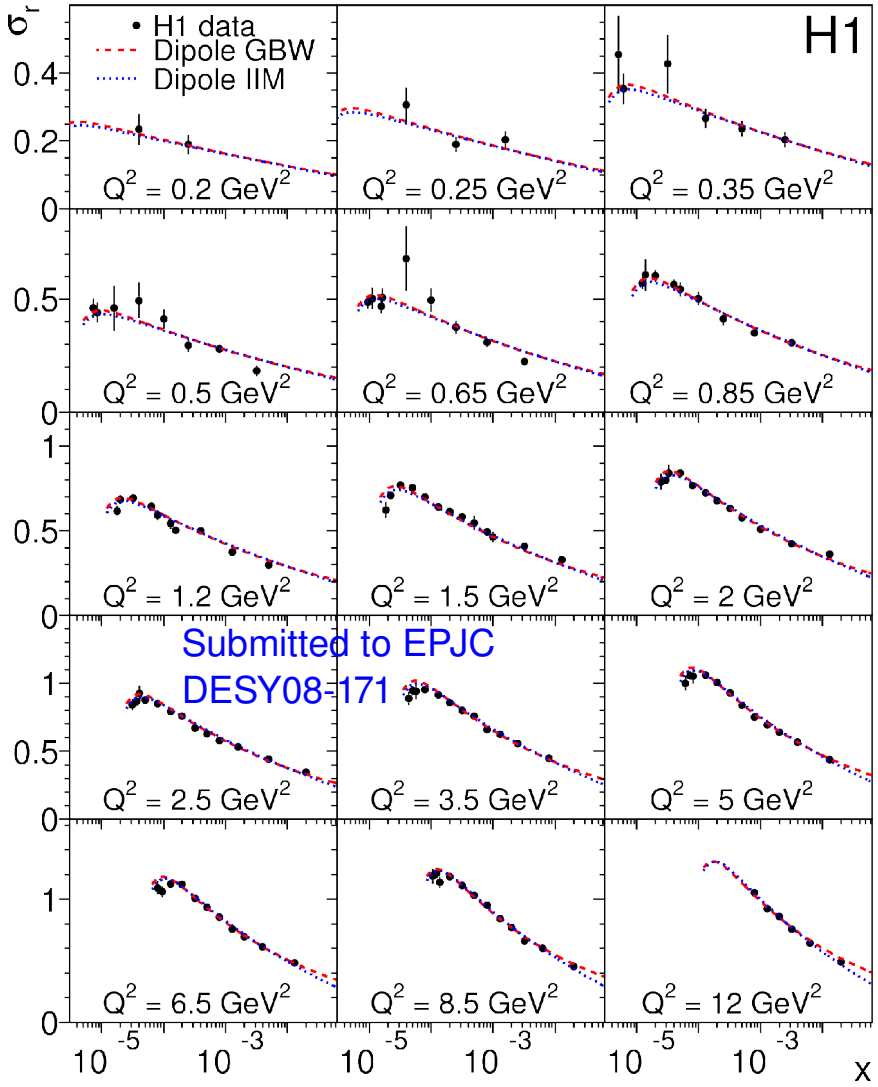
    $0.2 \leq Q^2 \leq 12$ GeV^2

    Precision 2–3%
  - Medium Q2

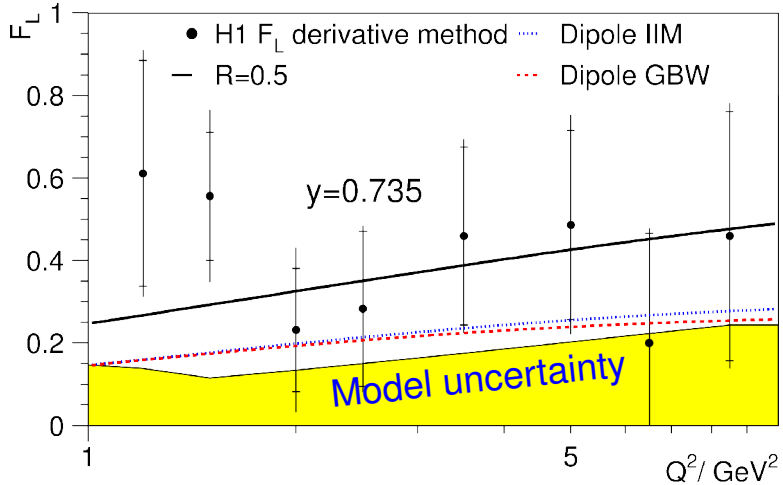
    $12 \leq Q^2 \leq 100$ GeV^2

    Precision 1.3-2%

DIS at low Q^2 and low x

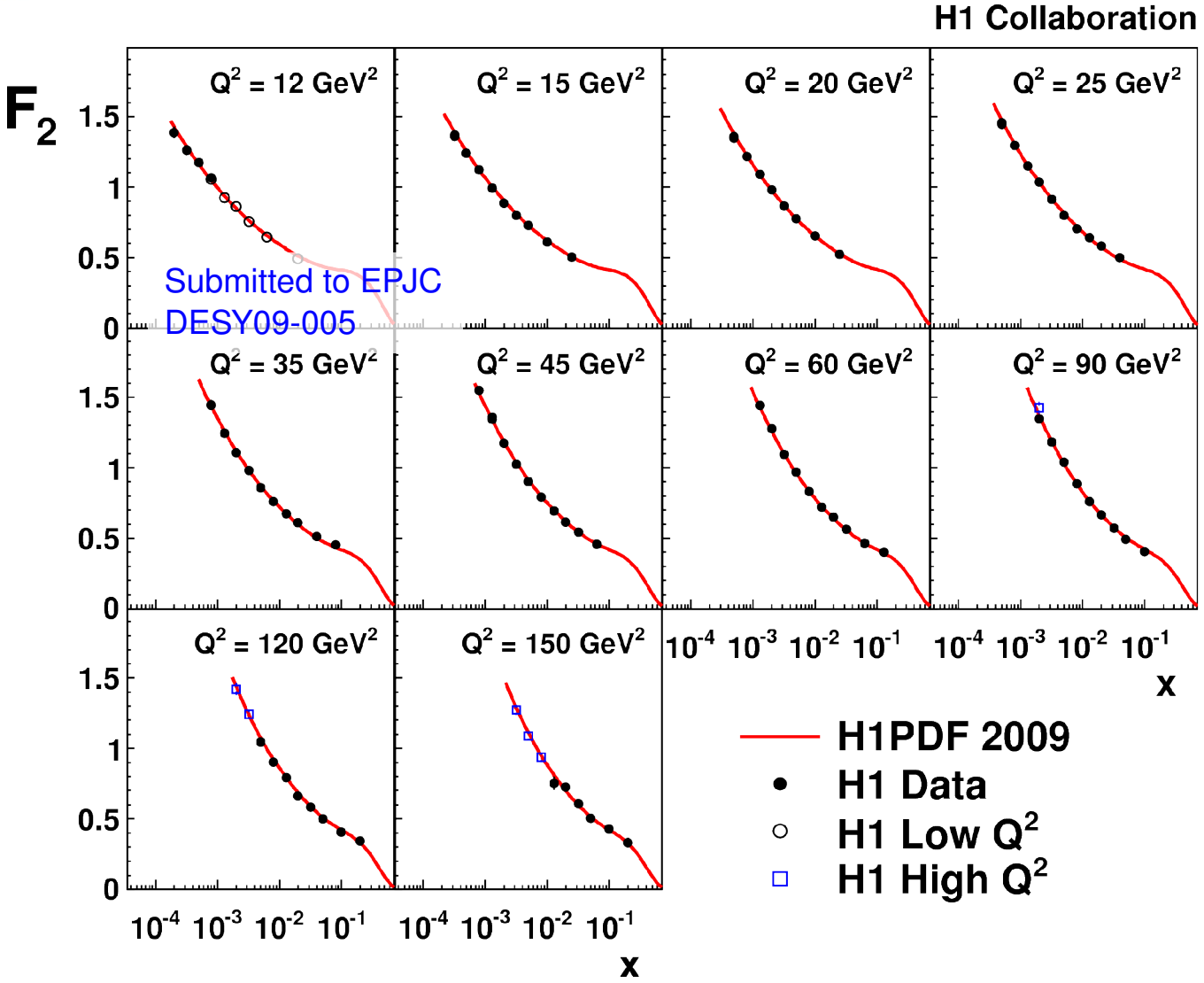


- Full H1 data for low Q^2 published
- Precision 2–3%
- Combination of several H1 datasets
- Fits to power-law, fractal and dipole models
- F_L extracted using indirect methods, consistent with models



→ A. Petrukhin [54]

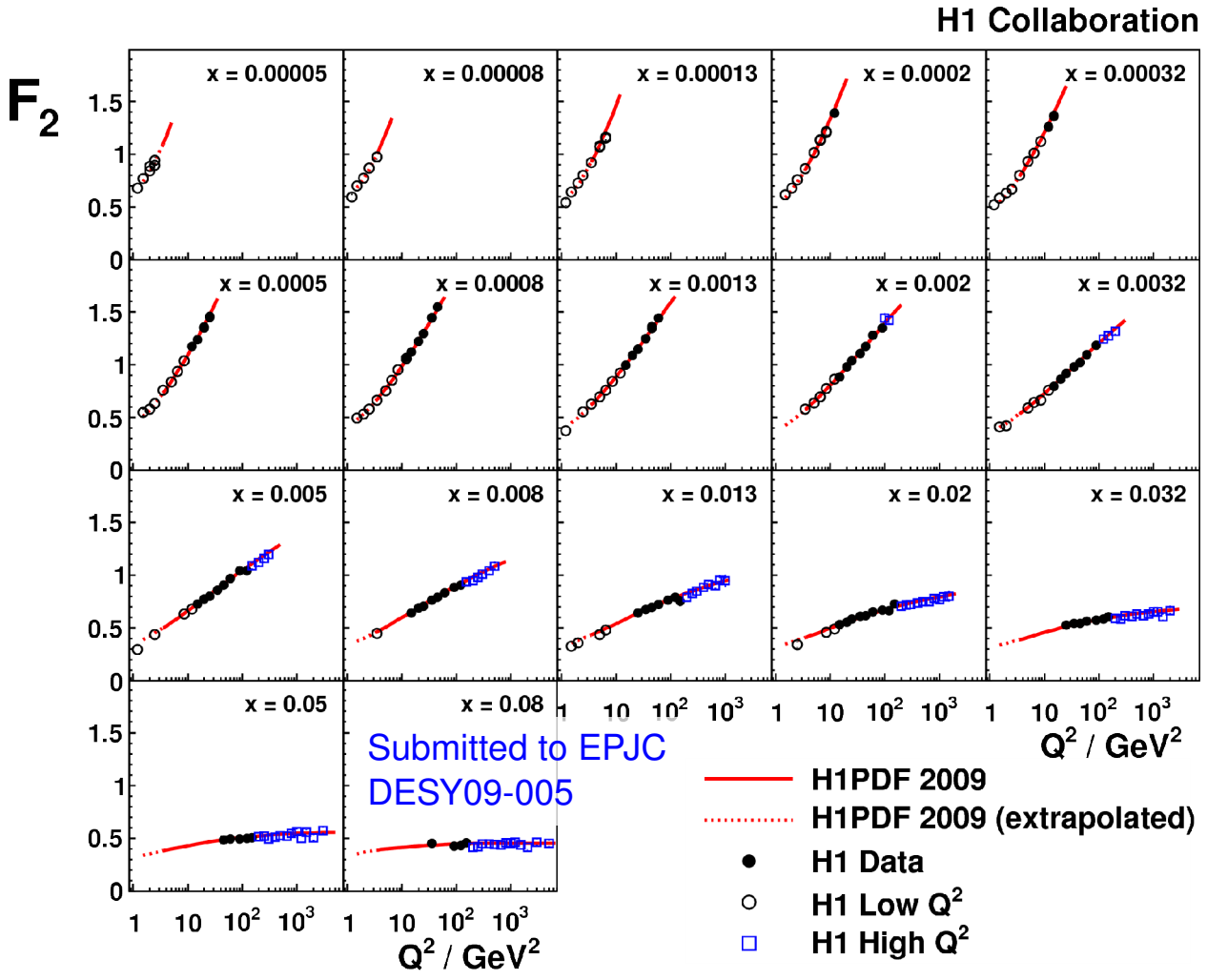
F_2 precision data



- Full HERA I data for $12<Q^2<150$ GeV^2
- Most precise F_2 data in this Q^2 range, uncertainty 1.3–2%
- Combination of two independent datasets
- New QCD fit, very good consistency with DGLAP prediction

→ J. Kretzschmar [56]
Combination with ZEUS:
→ E. Tassi [63]

H1PDF 2009 QCD fit

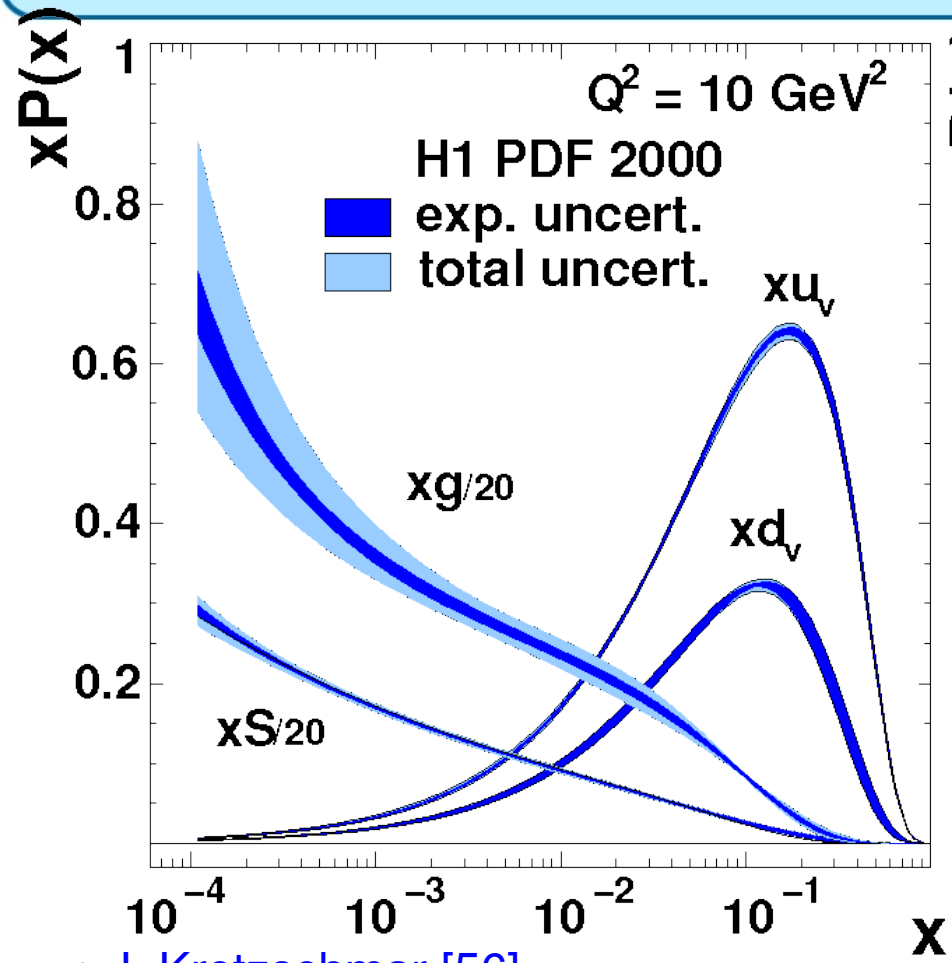


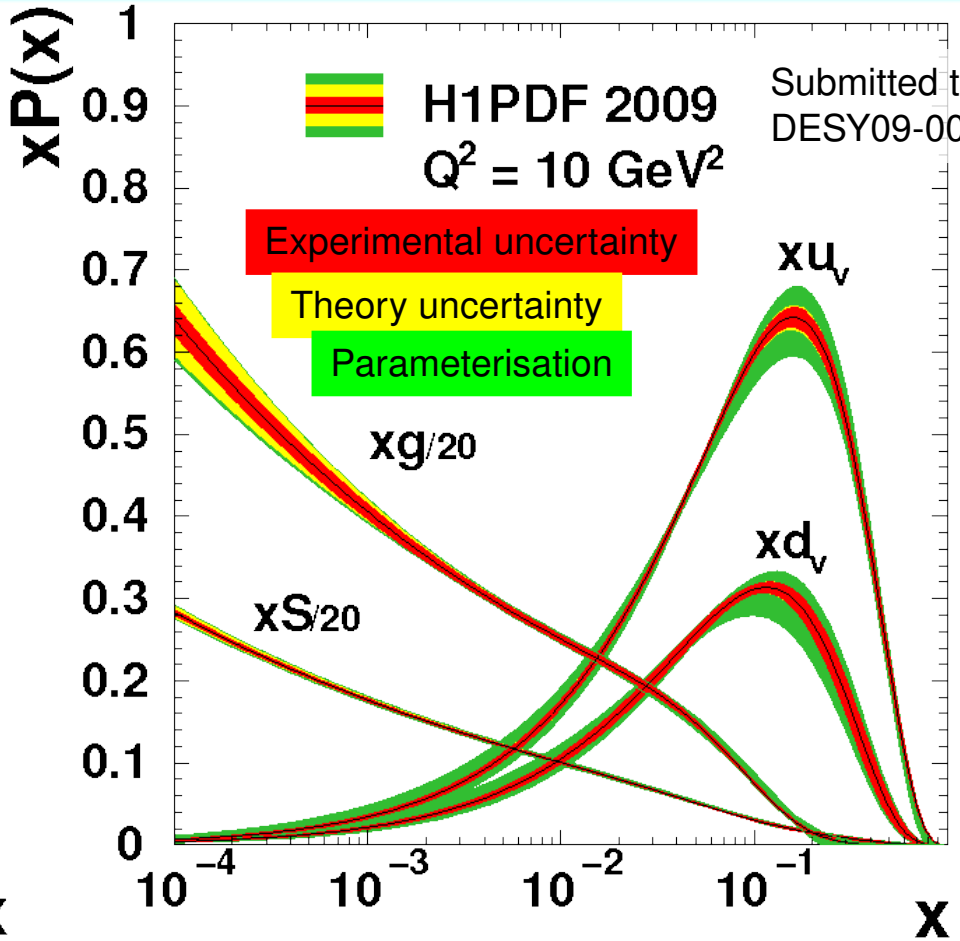
- QCD fit to all H1 HERA-I data, NC and CC
- VFNS heavy flavour treatment (Thorne/Roberts)

→ J. Kretzschmar [56]

HERAPDF0.2 Fit
→ V. Radescu [86]

H1 QCD fit





Submitted to EPJC
DESY09-005

→ J. Kretzschmar [56]
HERAPDF0.2 fit (H1+ZEUS)
→ V. Radescu [86]

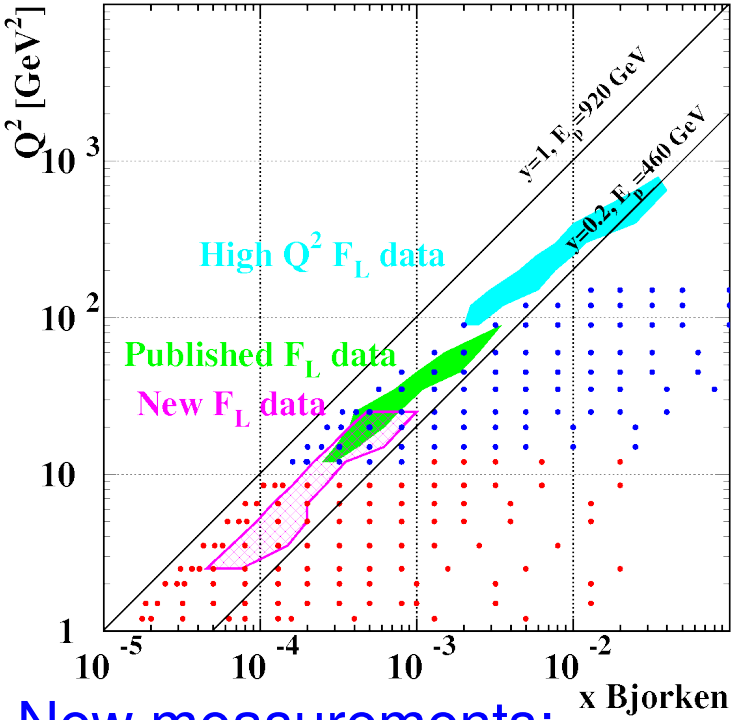
- H1PDF 2009 fit to all H1 HERA-I data
- Gain in precision compared to H1PDF2000

Measurement of F_L at low Q^2

First H1 F_L measurements shown at DIS08:

High Q^2 data: $100 \le Q^2 \le 800$ GeV^2

Medium Q^2 data: $12 \le Q^2 \le 100$ GeV^2



New measurements:

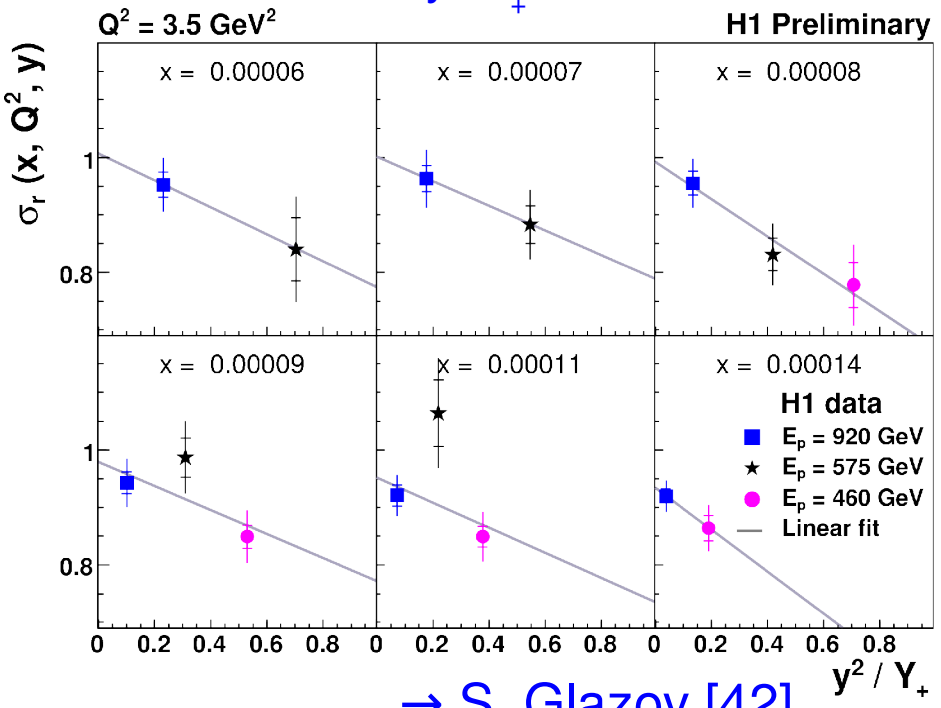
Low Q2 data: $2.5 \le Q^2 \le 25$ GeV^2

Direct Measurement of F_L:

$\sigma_r \propto F_2 - y^2/Y_+ \cdot F_L$ and $y=Q^2/(sx)$

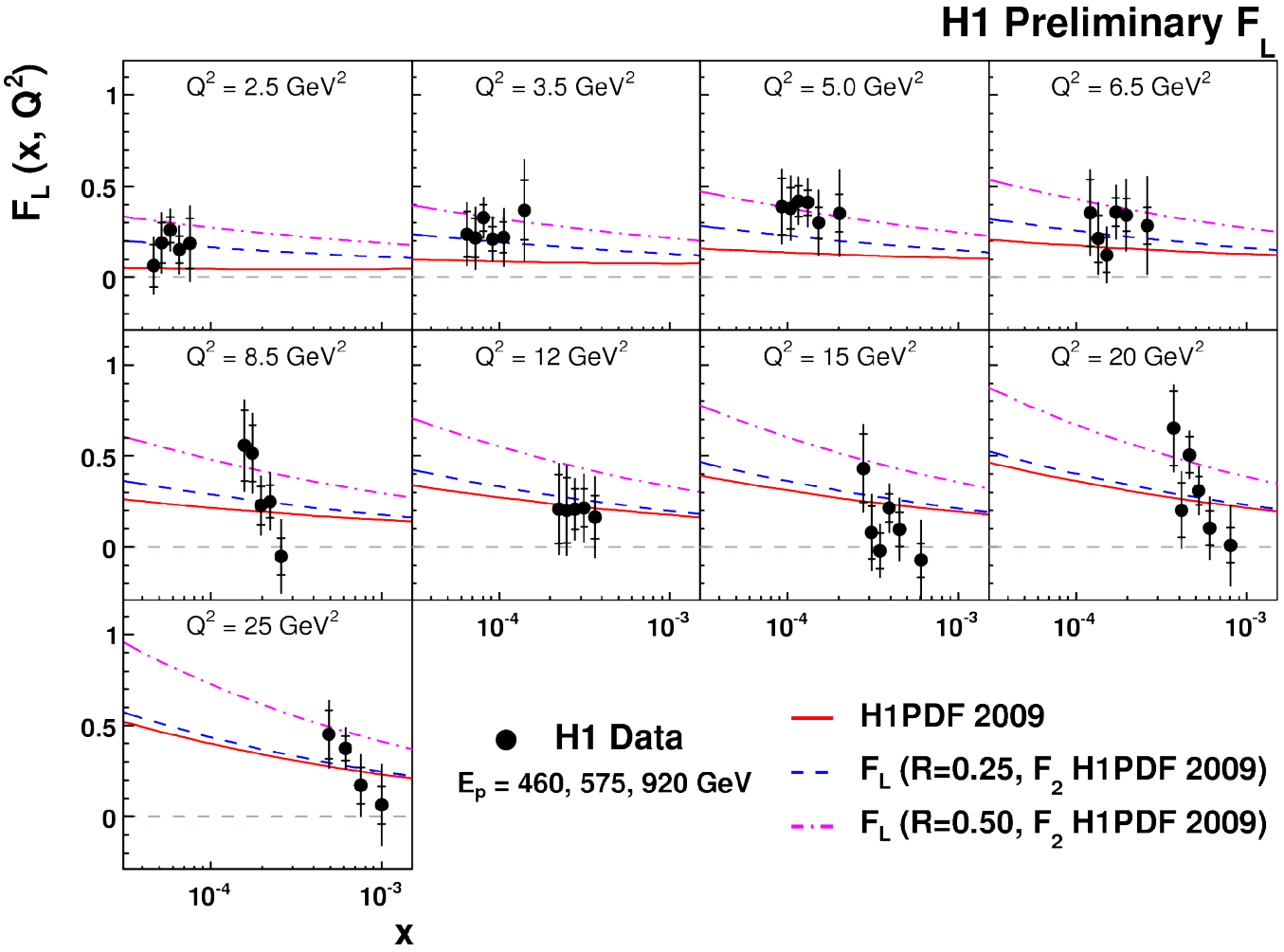
Change y for fixed Q^2,x by changing s

Rosenbluth plot: extract F_L from slope of σ_r as a function of y^2/Y_+



→ S. Glazov [42]

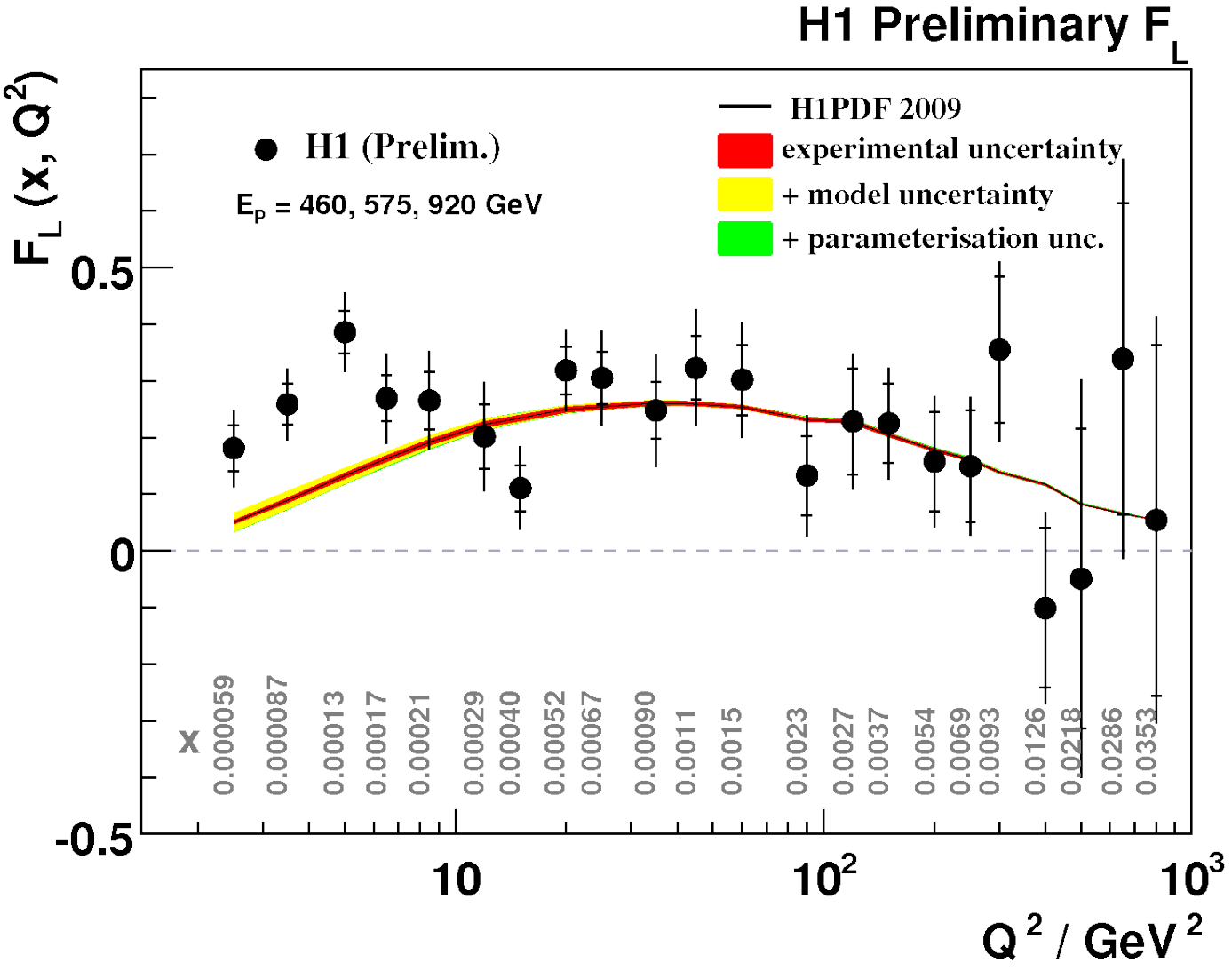
F_L data at low Q^2



- Kinematic range $2.5 \le Q^2 \le 25$ GeV^2
- Non-zero F_L is confirmed at low Q^2
- Consistent with QCD fits

→ S. Glazov [42]

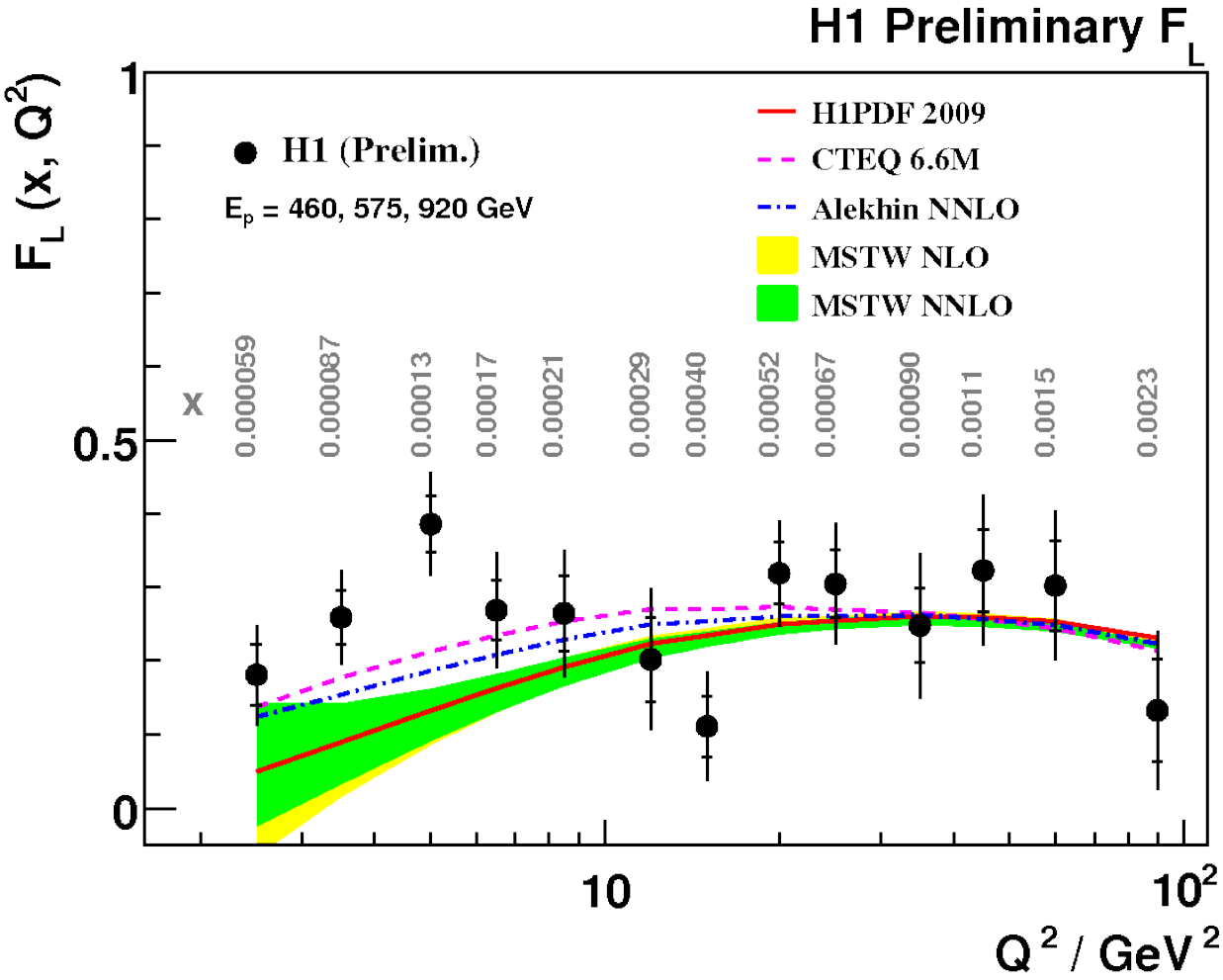
F_L dependence on Q^2



- F_L averaged over x in bins of Q^2
- H1 measurements cover the range $2.5 \leq Q^2 \leq 800$ GeV^2

→ S. Glazov [42]

F_L as a function of Q^2



- Low Q^2 regions: largest spread in theoretical predictions
- Sensitivity to PDFs

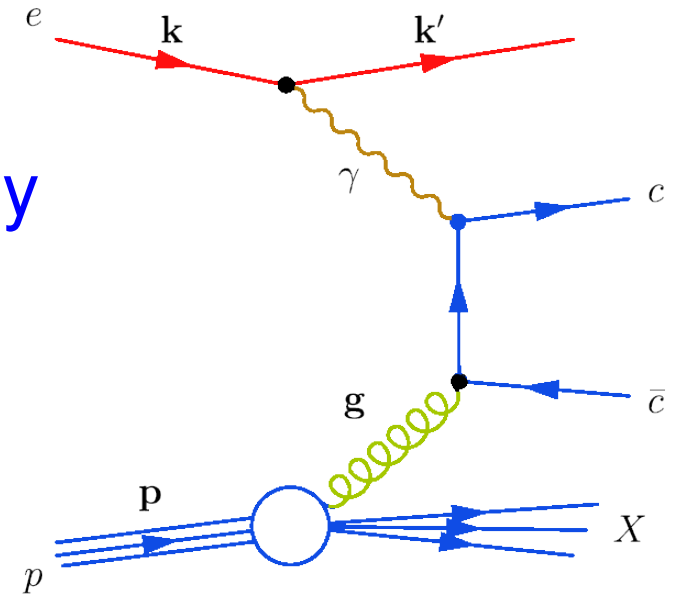
→ S. Glazov [42]

F_2^b and F_2^c structure functions

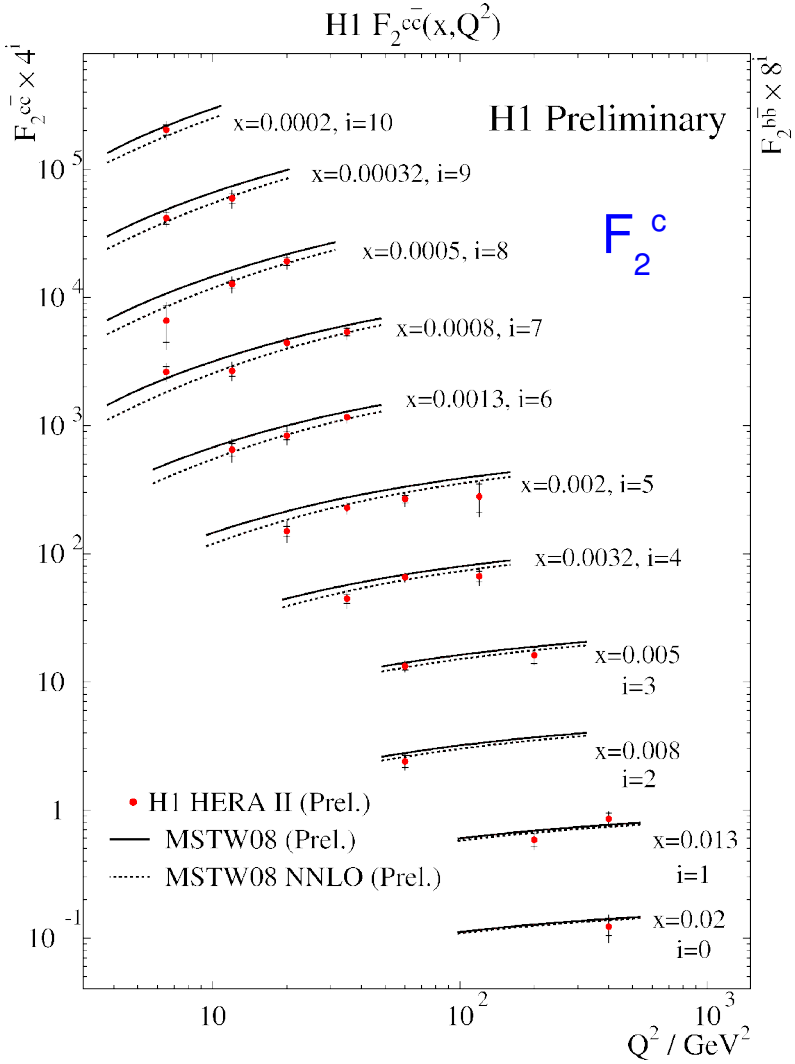
- Investigate F_2 contribution from beauty and charm
- b, c quarks: produced dominantly by boson-gluon fusion

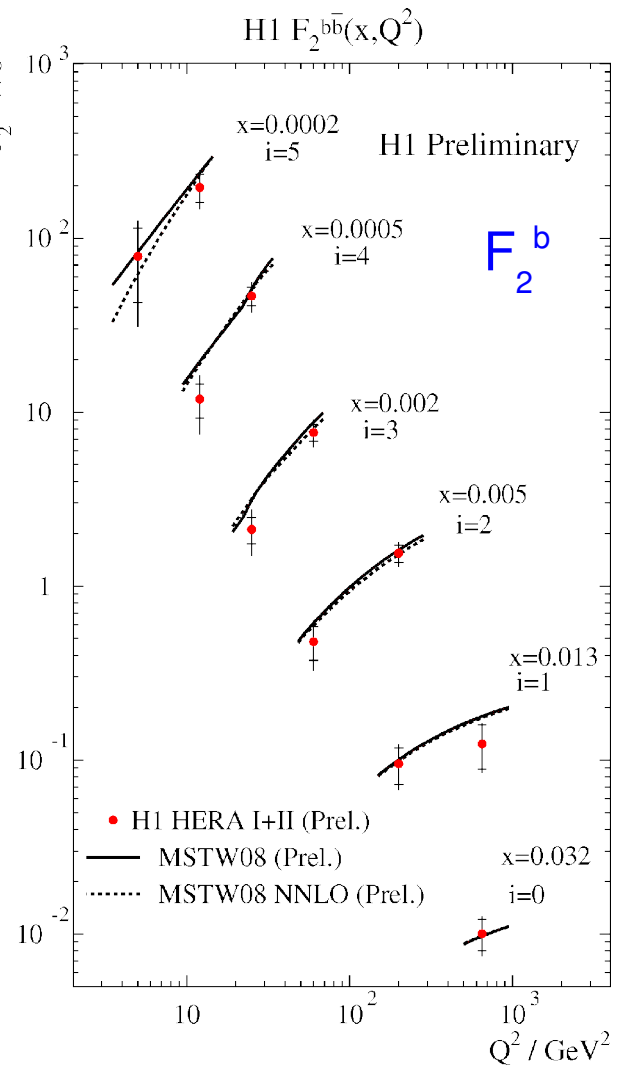
  → sensitivity to the gluon PDF
- Experimental methods:

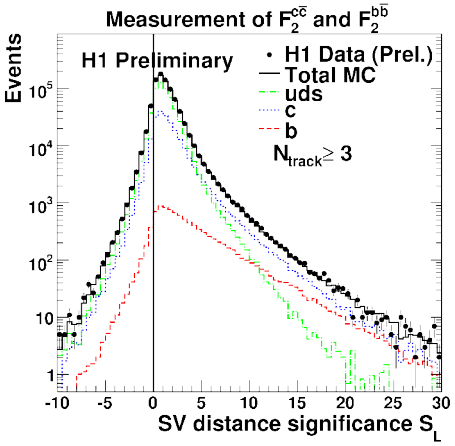
  b and c hadron lifetime, D*



Lifetime analysis





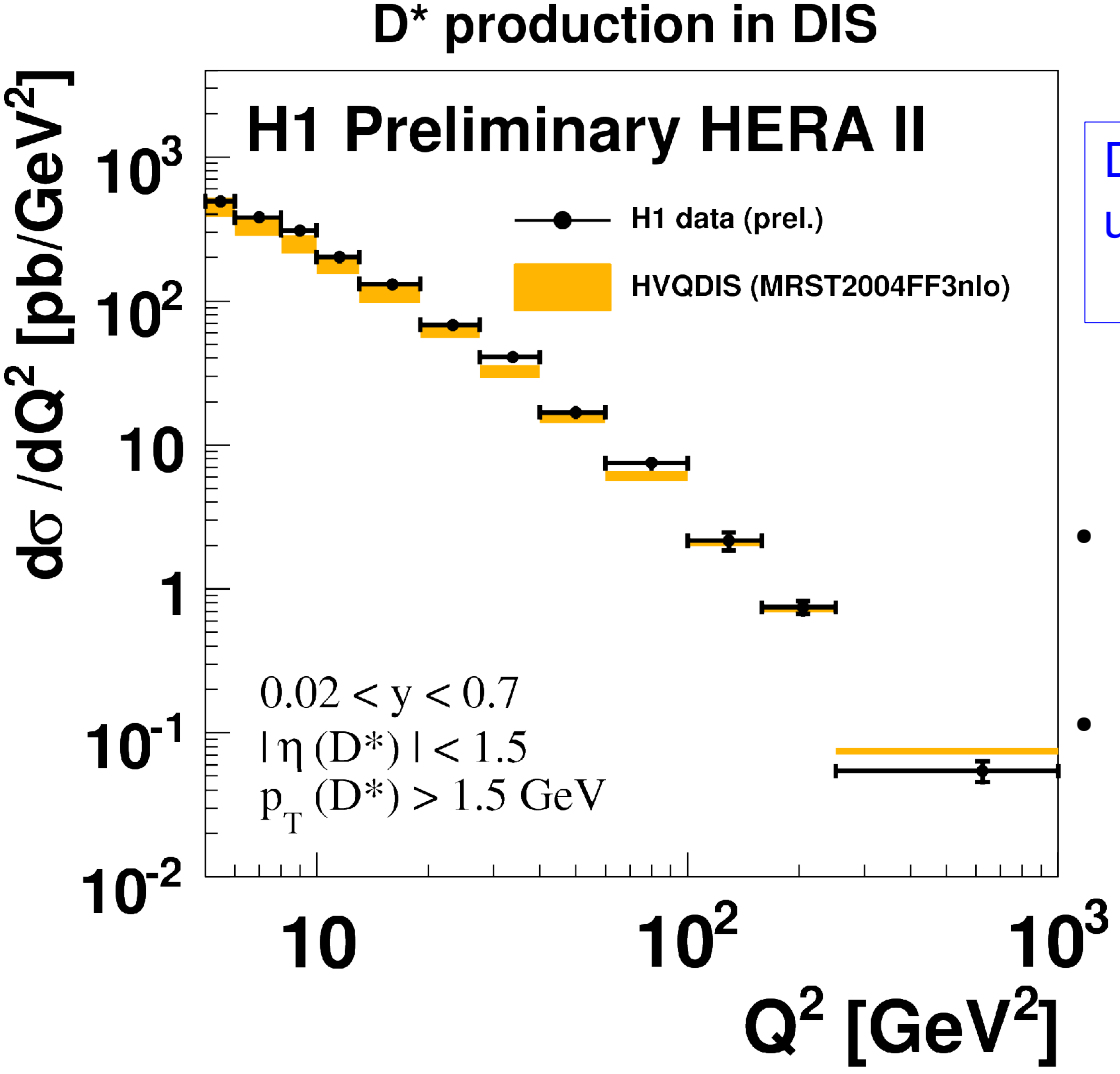


- Lifetime analysis of full HERA II data
- $5<Q^2<650$ GeV^2
- Uncertainty:

  8% for F_2^c, 20% for F_2^b
- Agreement with NLO QCD

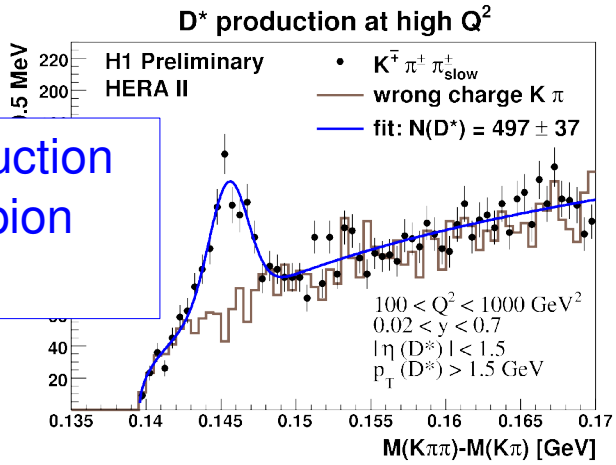
→ P. Thompson [177]

D* production in DIS



D* reconstruction using slow pion

$D^* \rightarrow D^0\pi$



- D* cross sections measured for

  $5 \le Q^2 \le 800\ \mathrm{GeV}^2$

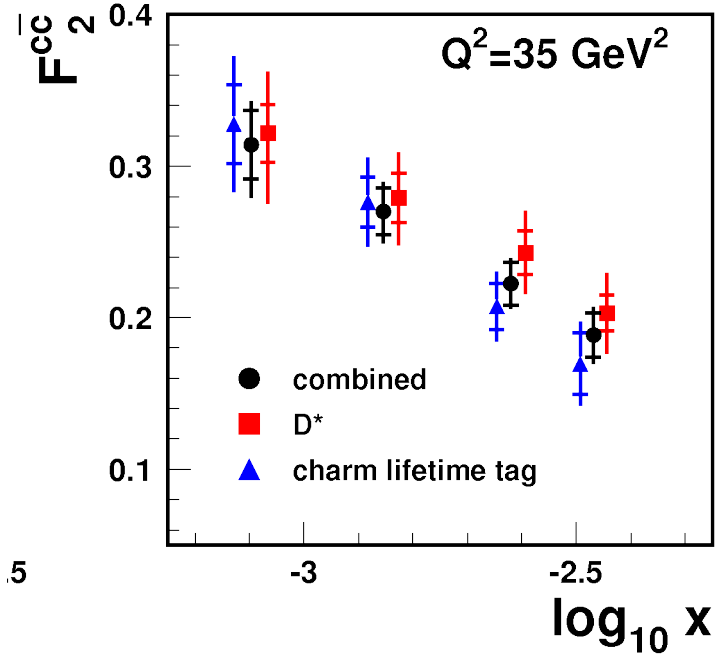
- Good description by NLO calculation

→ extrapolate to full phase-space, measure F_2^c

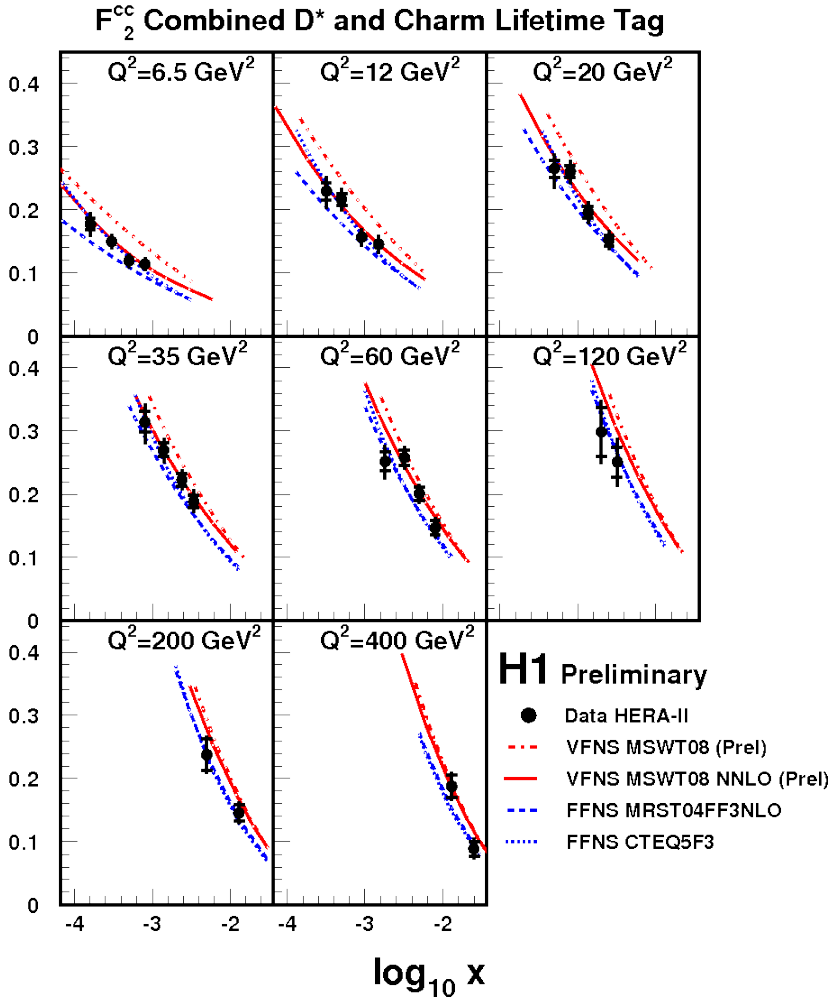
→ A. Jung [167]

→ M. Brinkmann [170]

Combined F_2^c



Extract F_2^c from D* cross sections and combine with lifetime-tag F_2^c

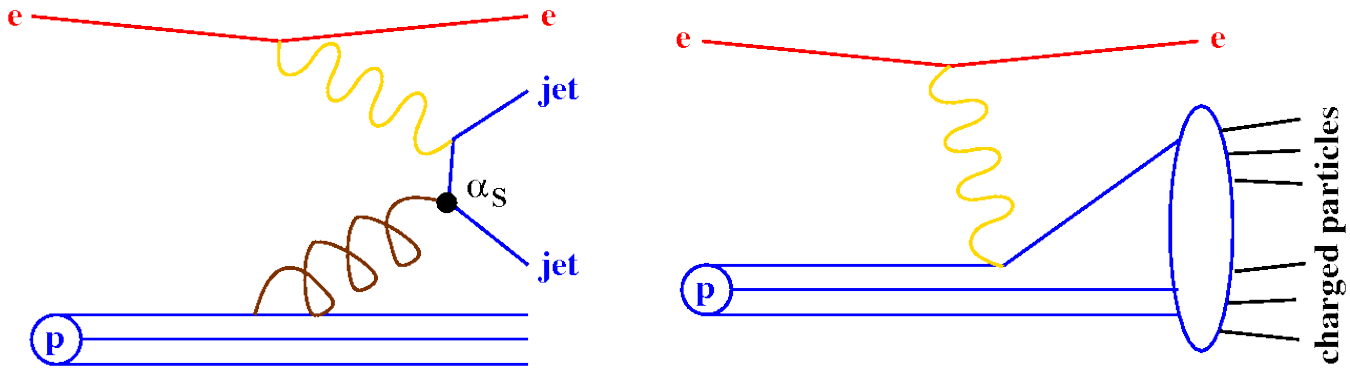


- Consistent results from lifetime and D* analyses
- Combine the two measurements
- Significant improvement in precision
- Data constrain PDFs and heavy quark treatment in QCD fits

→ P. Thompson [177]

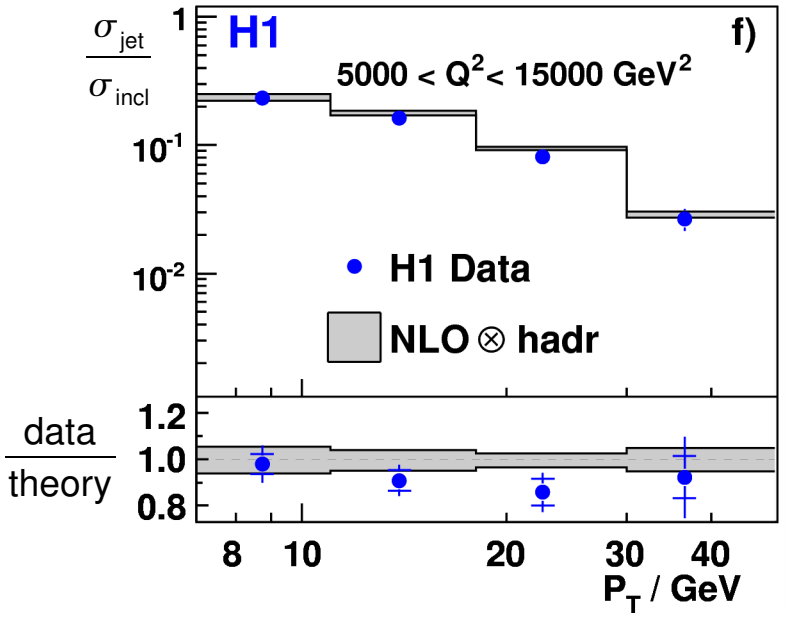
Hadronic final states

- Determination of α_S from jets at high Q^2
- Particle charge asymmetry at high Q^2



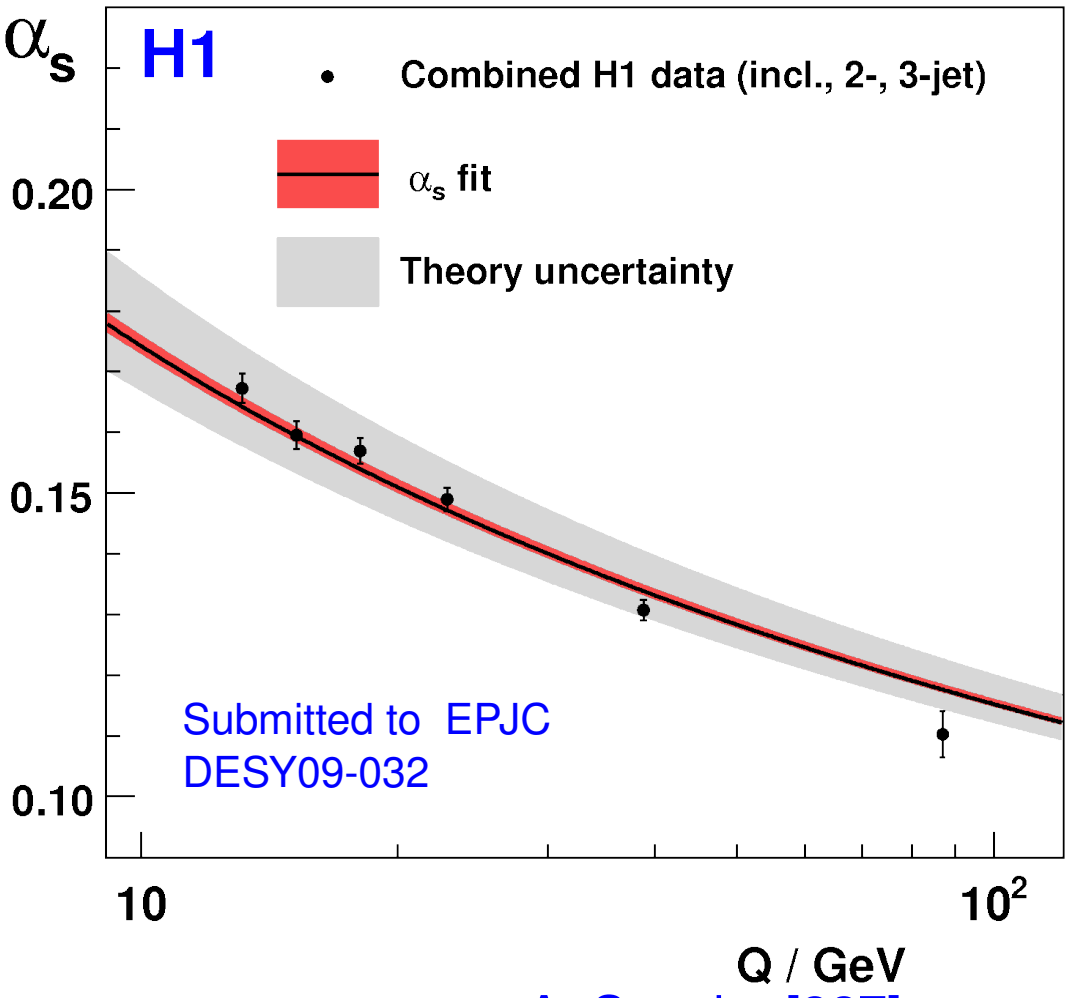
High Q^2 jets and α_s

Inclusive jet rate, highest Q^2 bin



- Analysis of inclusive, 2-jet, 3-jet rates
- Full HERA data now published
- α_s is extracted from a simultaneous fit to $\sigma^{jet}/\sigma^{incl}$, $\sigma^{2\text{-}jet}/\sigma^{incl}$, $\sigma^{3\text{-}jet}/\sigma^{incl}$

Normalised Jet Cross Sections

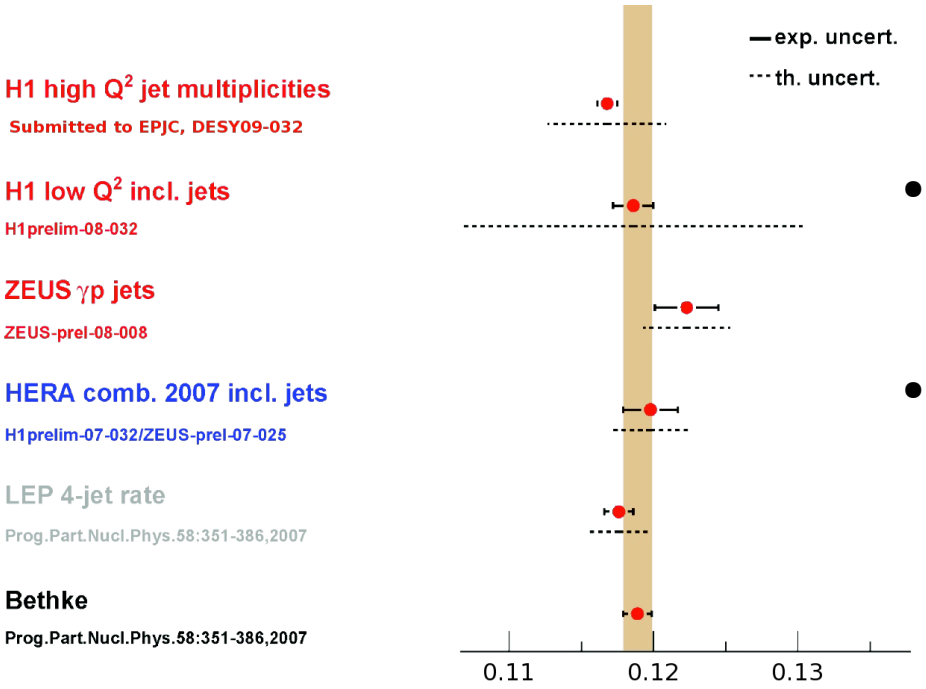


→ A. Specka [237]

Result on α_s

- Result: strong coupling extracted from H1 jet data

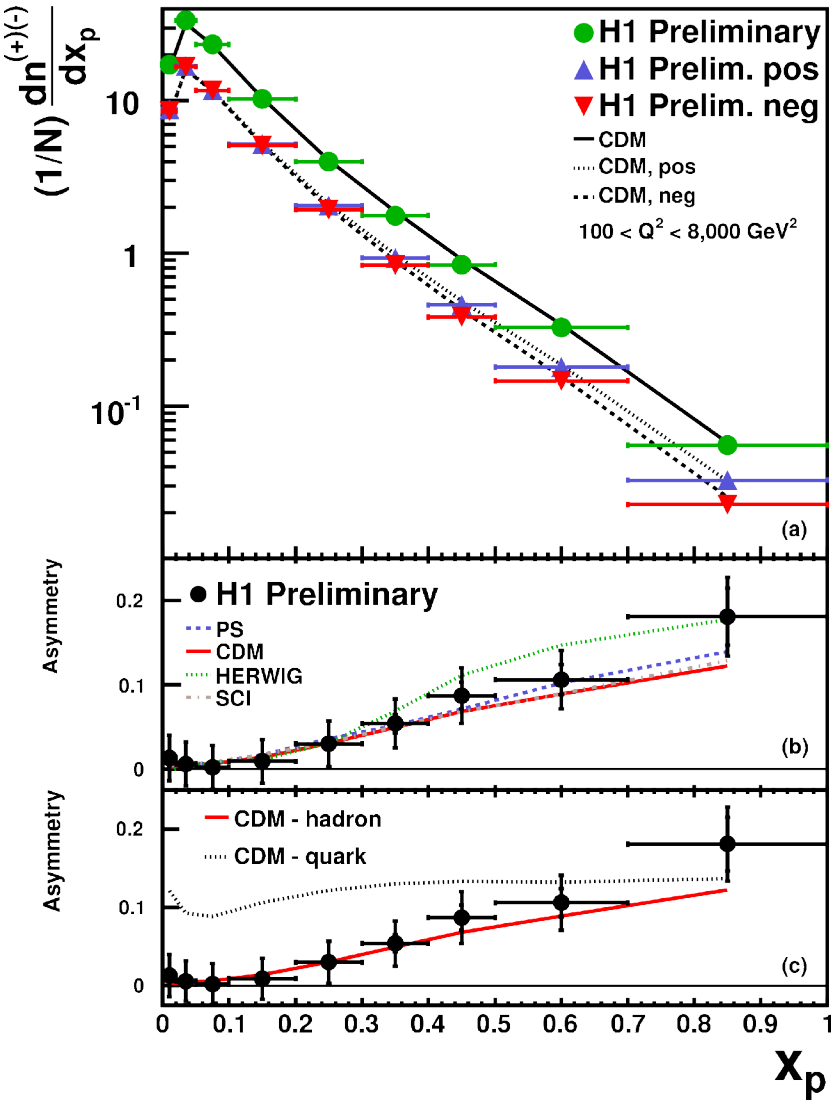
$$\alpha_S = 0.1168 \pm 0.0007\,(\text{exp}) \pm^{0.0046}_{0.0030}\,(\text{theo}) \pm 0.0016\,(\text{PDF})$$

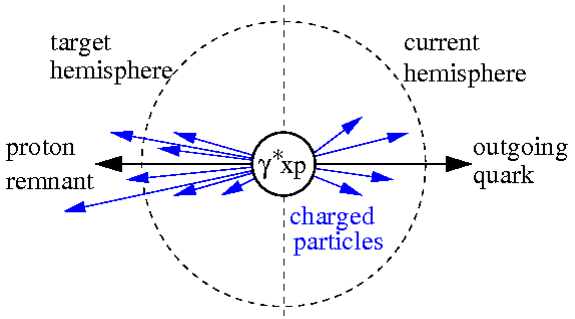


- Experimentally most precise single measurement of α_s (0.6%)
- Theory (NLO) error dominated by scale uncertainties (3-4%)

→ A. Specka [237]

Particle charge asymmetry





Momentum fraction in current hemisphere of the Breit frame

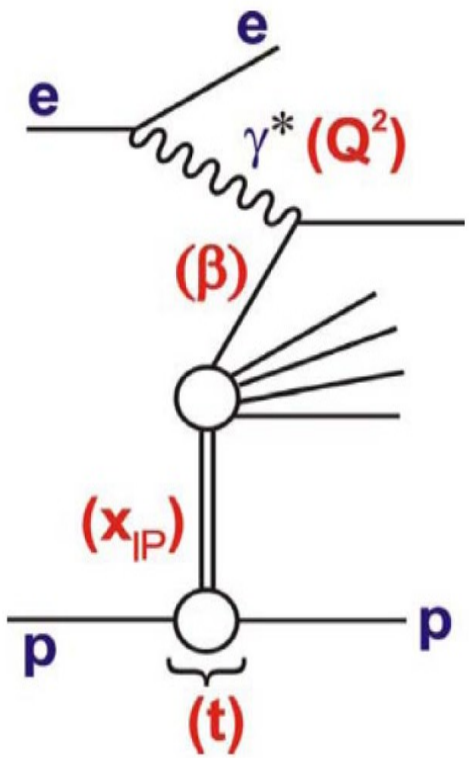
$x_p = 2p/Q$

- Measure rate of charged particles produced in the current hemisphere at high $Q^2 > 100$ GeV^2
- Asymmetry of positive wrt negative charged tracks, up to 0.2 at high x_p
- In agreement with fragmentation models

→ D. Traynor [289]

Diffraction

- First measurement of F_L^D
- Leading proton cross-sections
- Leading neutron cross-sections

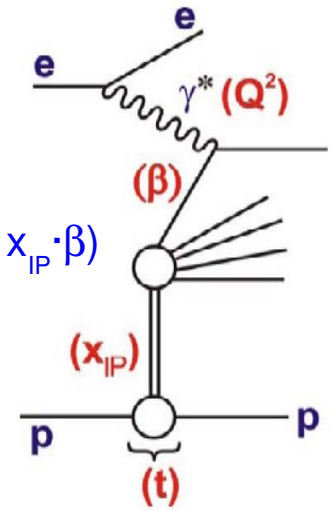


Direct measurement of F_L^D

- Diffractive cross-section can be decomposed into structure functions:

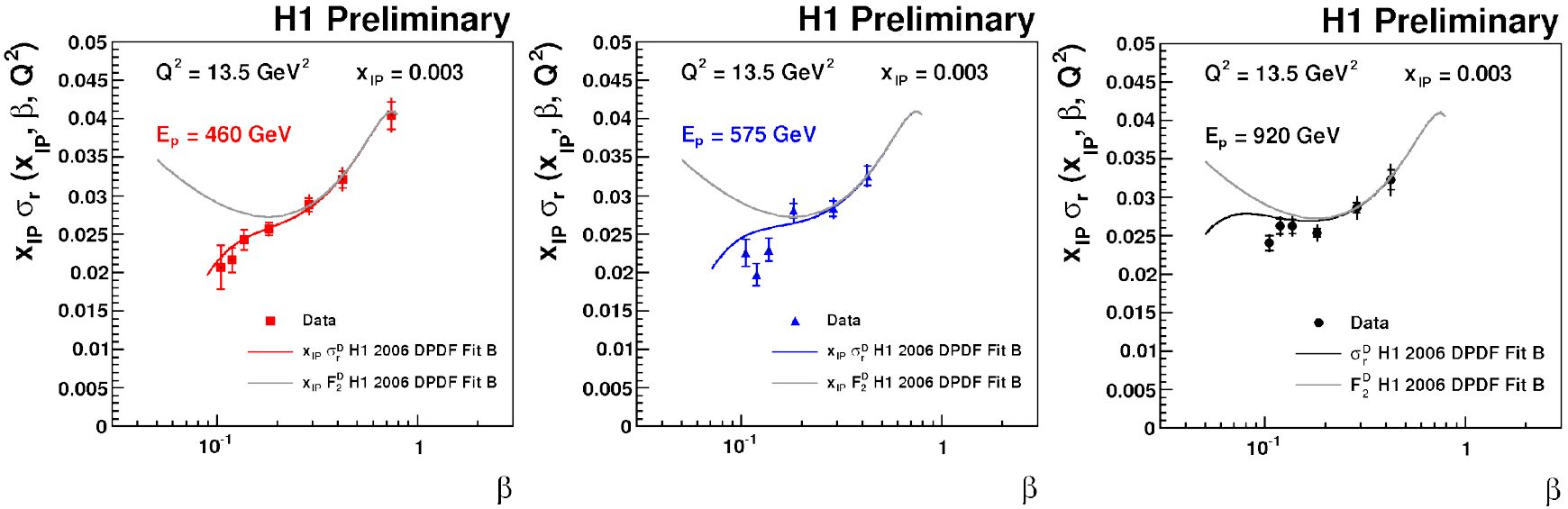
$$\sigma_r^D \propto F_2^D - \frac{y^2}{1+(1-y)^2} F_L^D$$

- Diffractive kinematic variables: t, x_{IP}, β
- Measure $\sigma_r(x_{IP}, \beta, Q^2)$ at fixed Q^2, x_{IP} as a function of β
- Extract F_L^D from σ_r data at different beam energies and low β

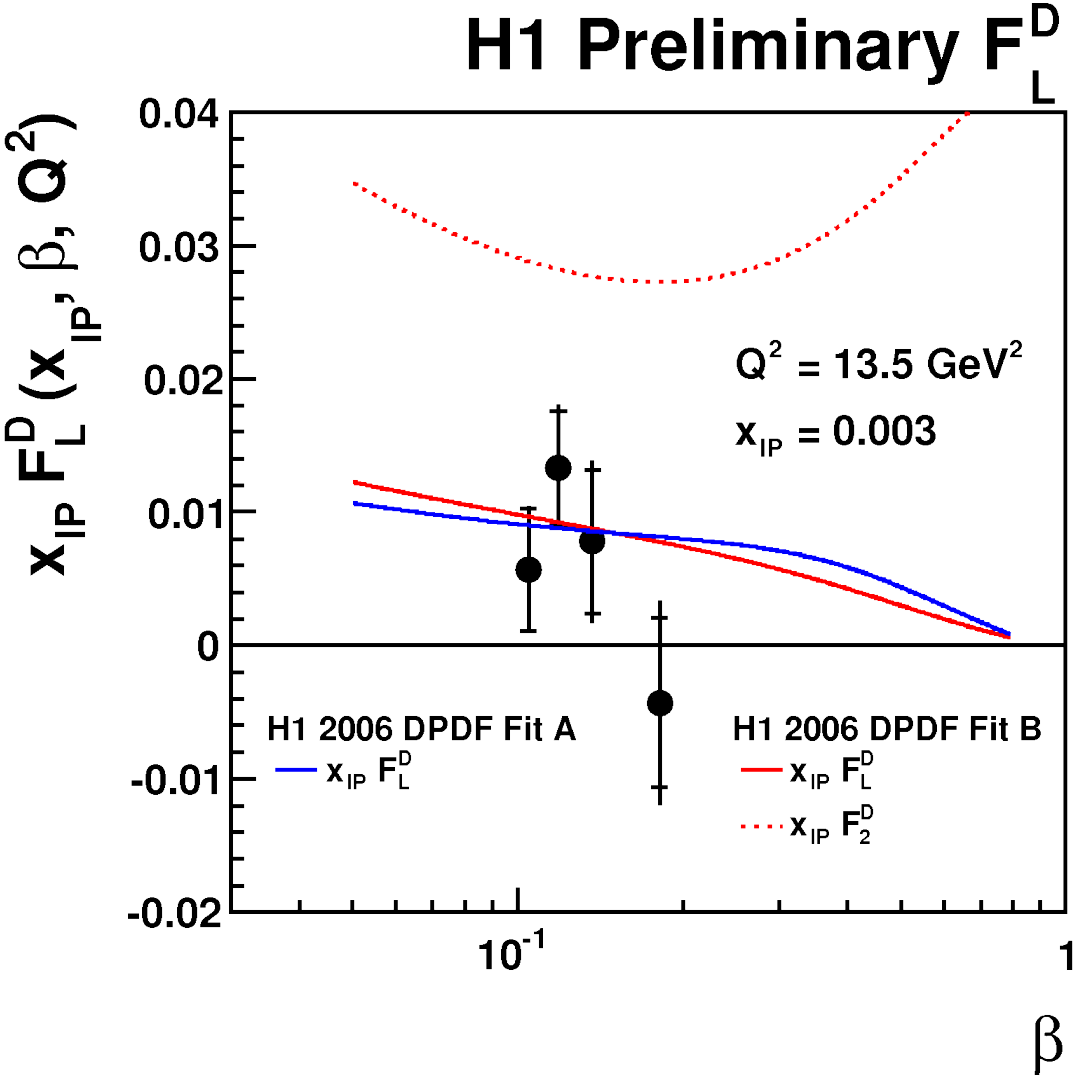


$x = x_{IP} \cdot \beta$

$y = Q^2/(s \cdot x_{IP} \cdot \beta)$



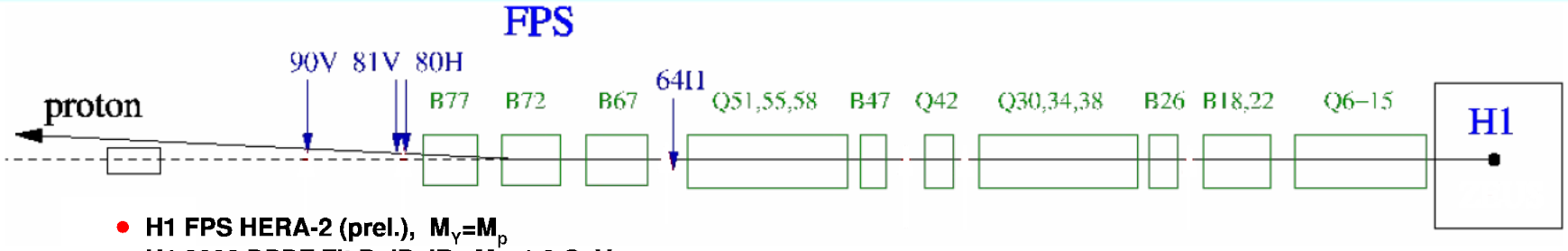
The H1 F_L^D data

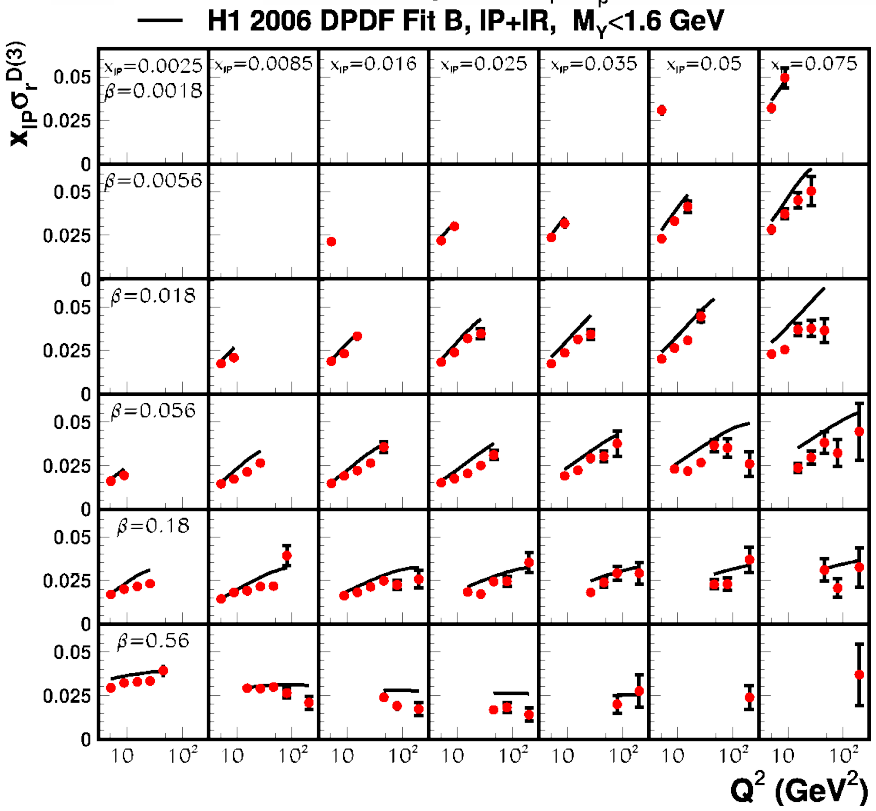


- First measurement of the longitudinal diffractive structure function F_L^D
- Non-zero F_L^D at 3σ
- Consistent with DPDF fit

D. Salek [111]

Leading protons at HERA II

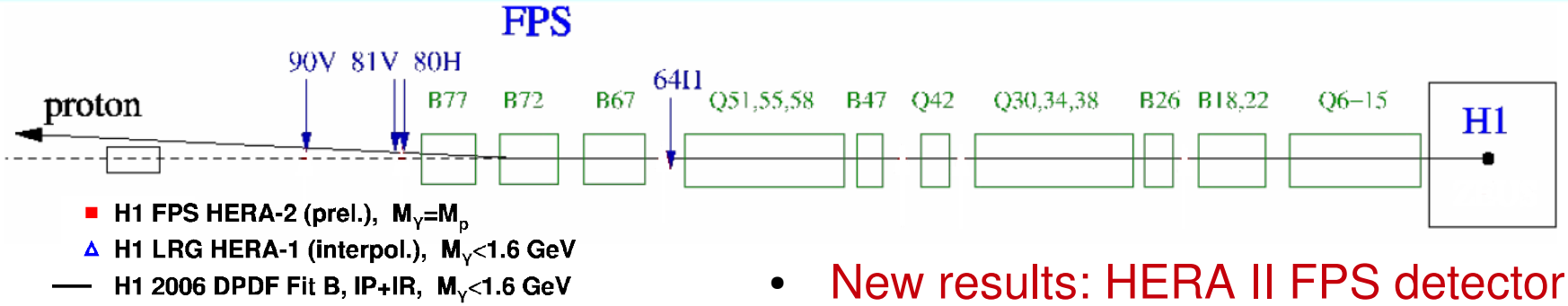


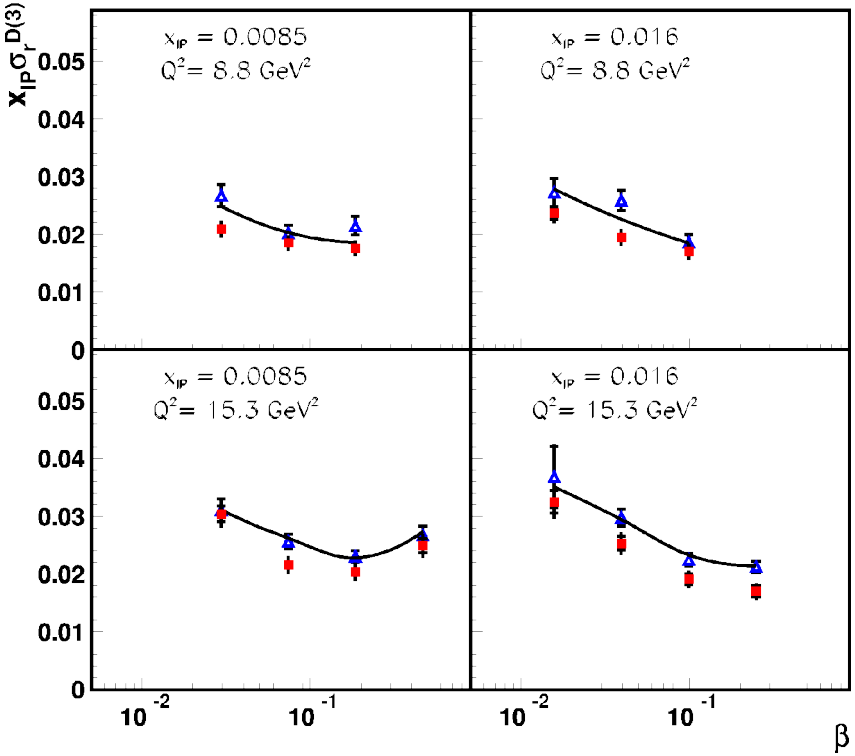


- New results: HERA II FPS detector (Roman pots)
- Measure $\sigma_r(x_{IP}, \beta, Q^2)$ for $4 \le Q^2 \le 700$ GeV^2
- Described by DPDF fit to rapidity-gap data
- Higher Q^2 reach compared to HERA I FPS (increased statistics)
- Precision ~8% at low Q^2 (systematically limited)

→ M. Kapishin [125]

Leading protons at HERA II





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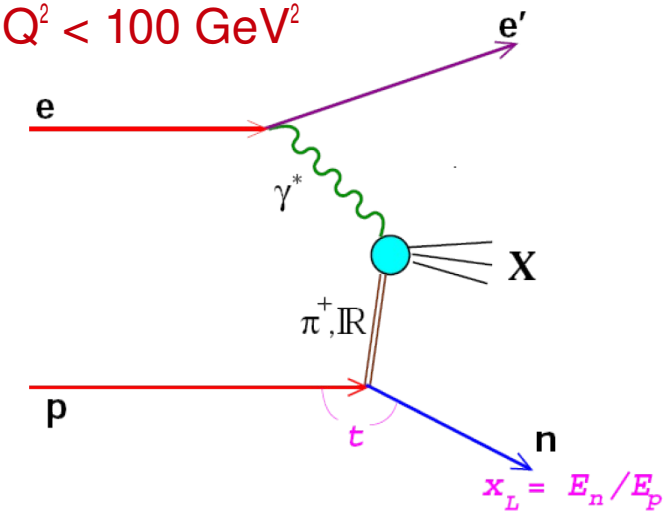
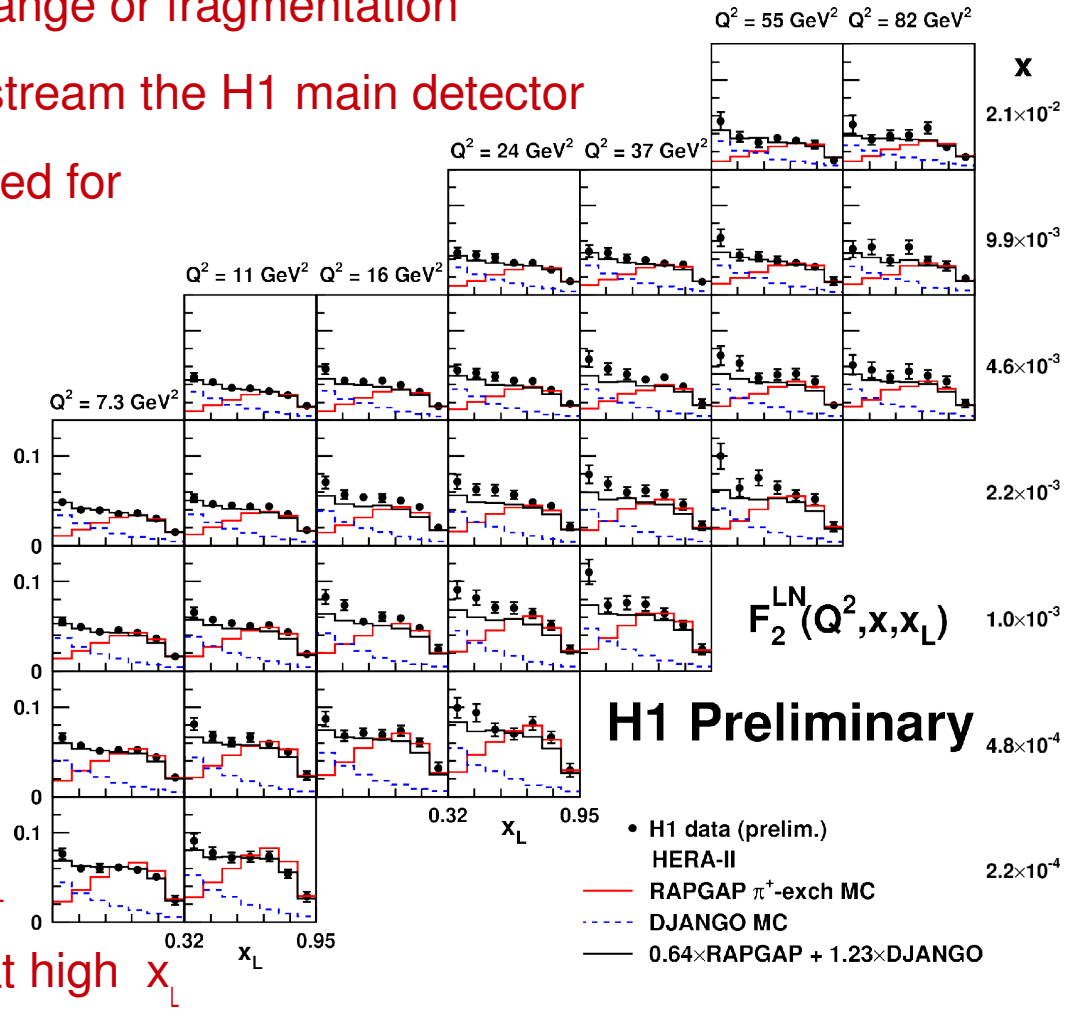
→ M. Kapishin [125]

Leading neutrons at HERA II

- Leading neutrons: produced by π^+ exchange or fragmentation
- Forward Neutron Counter, 106m downstream the H1 main detector
- Structure function $F_2^{LN}(Q^2,x,x_L)$ is measured for

  $6 < Q^2 < 100$ GeV^2





- Data described by π^+ exchange

  +neutrons from fragmentation at low x_L
- Extract π structure function from data at high x_L

→ V. Dodonov [146]

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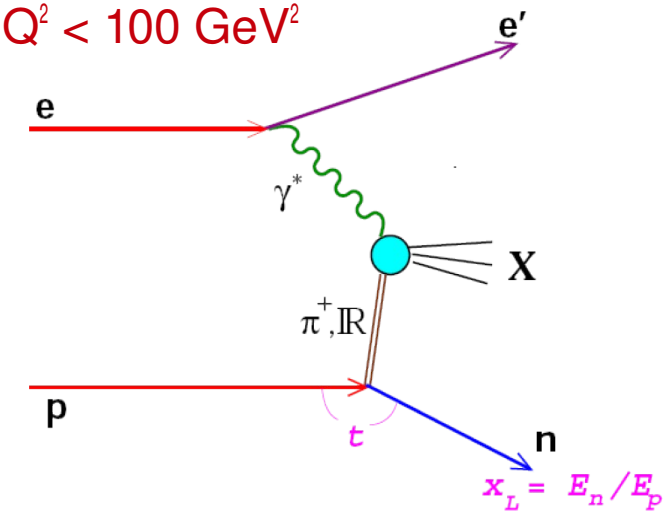

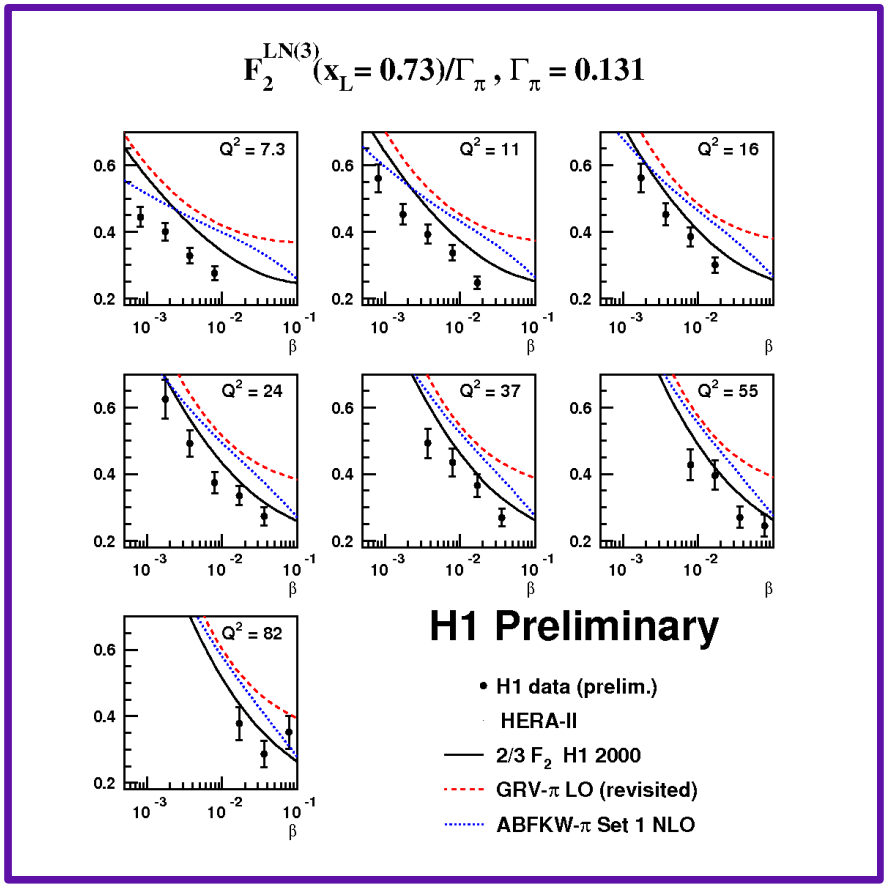

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→ V. Dodonov [146]

H1 results at DIS09

Searches and rare processes

- Search for single top: S. Antonelli [29]
- Isolated high p_T leptons: G. Brandt [33]
- Excited fermions: G. Stoicea [43]
- Multi-lepton production: M. Turcato [67]
- General search: G. Brandt [106]

Structure functions and PDF fits

- Measurements of F_L: S. Glazov [42]
- DIS at low Q^2, x: A. Petrukhin [54]
- F_2 and PDF fit: J. Kretzschmar [56]
- H1+ZEUS F_2 data: E. Tassi [63]
- HERAPDF fit: V. Radescu [86]

Heavy flavours

- Beauty with μ+jets: B. List [116]
- F_2^c from D*: A. Jung[167]
- D* at high Q^2: M. Brinkmann [170]
- F_2^c and F_2^b with second. vertex: P. Thompson [177]

Hadronic final states

- K* production in DIS: D. Sunar [245]
- Strangeness in DIS: G. Nowak [246]
- Light VM in γp: A. Kropvinitskaya [247]
- Jets and α_s: A. Specka [237]
- Prompt photons in γp: K. Nowak [283]
- The underlying event in γp: L. Marti [288]
- Particle charge asymmetries: D. Traynor [289]

Diffraction

- First meas. of F_L^D: D. Salek [111]
- Diffractive dijets in γp: K. Cerny [124]
- Leading protons: M. Kapishin [125]
- Leading neutrons: V. Dodonov [146]
- ρ pomeron trajectory: B. List [161]
- Diffractive photons at high t: T. Hreus [172]
- DVCS and VM: P. Marage [184]

RED covered in this talk
BLACK: parallel sessions

Summary

- Many new results from H1

  → Milestones of the physics program are achieved
- Some Highlights
  - Excited fermion searches completed
  - Precision data on inclusive cross-sections and F_2
  - Precision normalized jet cross-sections and α_S
  - New measurement of F_L at low Q^2
  - First measurement of F_L^D