H1 Status Report

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On behalf of the H1 collaboration

69th PRC Meeting

Outline:

- New Physics Results
- Progress in Analysis Support
- Data Preservation

New H1 Physics Results since the 68th PRC Meeting

3 New Publications:

DESY-09-185 Measurement of Leading Neutron Production in Deep-Inelastic Scattering at HERA

DESY-09-225 Inelastic Production of J/psi Mesons in Photoproduction and Deep Inelastic Scattering at HERA

DESY-10-043* Diffractive Dijet photoproduction and Deep Inelastic Scattering at HERA

15 New Preliminaries: 33 presentations at DIS2010

H1prelim-10-061 Search for Lepton Flavour Violation at HERA

H1prelim-10-063 Search for Squark Production in R-Parity Violating Supersymmetry at HERA

H1prelim-09-043 High Q^2 Charged Current in polarised ep collisions at HERA II

H1prelim-10-042 Combined Electroweak and QCD Fit of Inclusive NC and CC Data with Polarized Lepton Beams at HERA

H1prelim-10-045 PDF fits including F2c data

H1prelim-10-043 Combined measurement of the Inclusive e+p Scattering Cross Sections at HERA for Reduced Proton Beam Energy Runs and Determination of F_L

H1prelim-10-035 Transverse Momentum of Charged Particles at low Q^2 at HERA

H1prelim-10-031 K^0s production at high Q^2 at HERA II

H1prelim-10-073 Measurement of Charm and Beauty Jets in Deep Inelastic Scattering at HERA

H1prelim-10-072 D* with jets in photoproduction

H1prelim-10-011 $F_2^{D(3)}$ with rapidity gap

H1prelim-10-017 Measurement of the longitudinal diffractive structure function F_L^D at low Q^2 at HERA

H1prelim-10-012 $F_2^{D(4)}$ with FPS

H1prelim-10-013 Diffractive Jet Production in Deep-Inelastic Scattering with a Leading proton at HERA II

H1prelim-10-014 $F_2^{D(3)}$ with VFPS

H1 Physics Program

Search for Lepton Flavour Violation

Search for Squarks in R_P Violating SUSY

$F_2^{D(3)}$ with rapidity gap

F_L^D at low Q^2

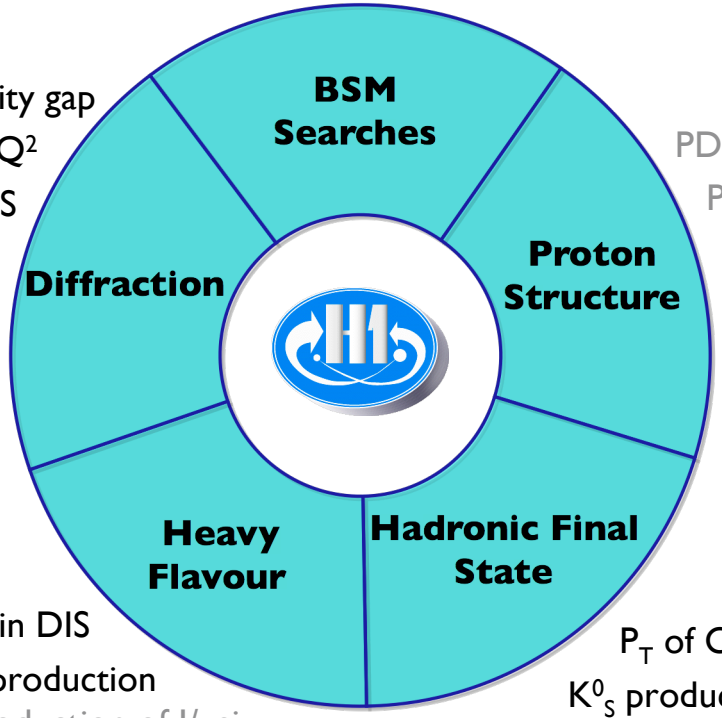
$F_2^{D(4)}$ with FPS

$F_2^{D(3)}$ with VFPS

Diffractive Jets with proton in FPS

Diffractive dijet photoproduction

Leading neutron in DIS



PDF fits +F_2^c (H1+ZEUS)

PDF fits +F_L (H1+ZEUS)

High Q^2 CC HERA II polarised ep

PDF+EW fits of NC, CC

Charm and beauty jets in DIS

D* with jets in photoproduction

Inelastic Production of J/psi

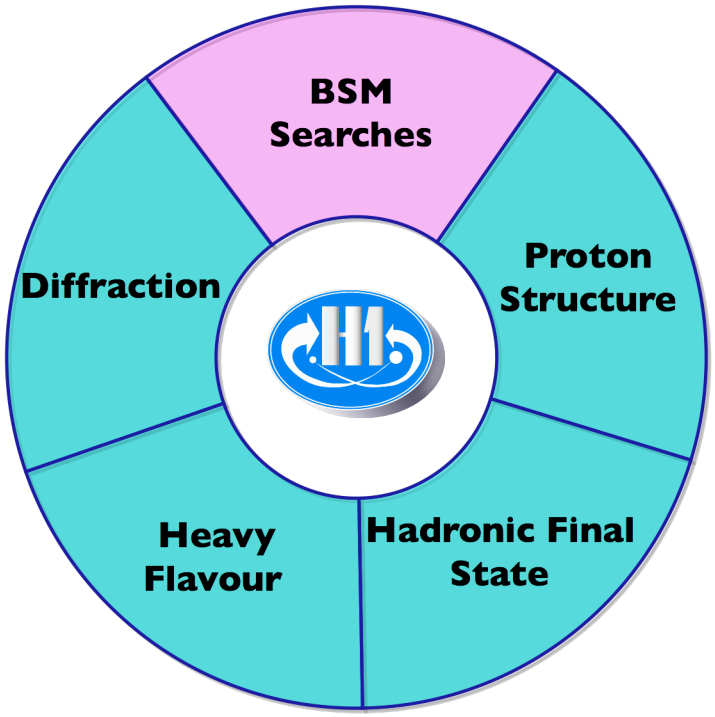
P_T of Charged Particles at low Q^2

K^0_S production at high Q^2 at HERA II

H1 Physics Program

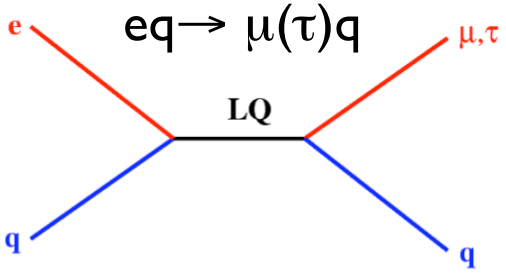
Search for Lepton Flavour Violation

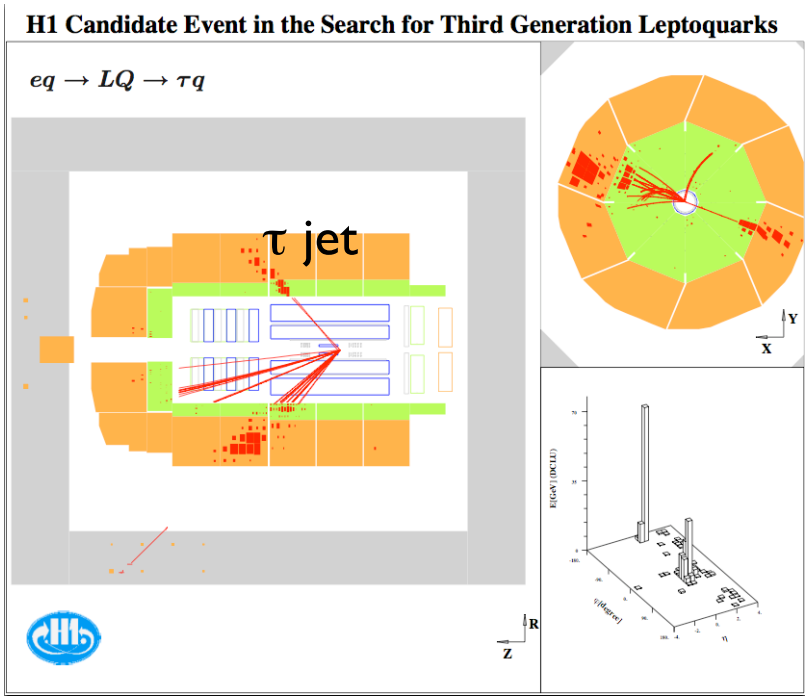
Search for Squarks in R_P Violating SUSY

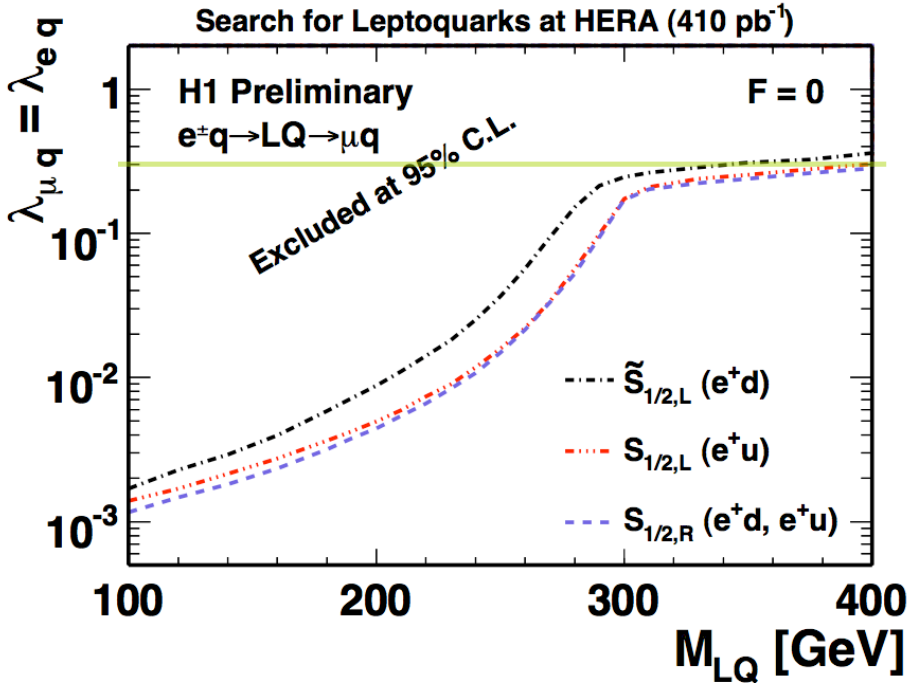


Searches for Lepton Flavour Violation

- Search for lepton flavour violating leptoquarks using complete HERA data







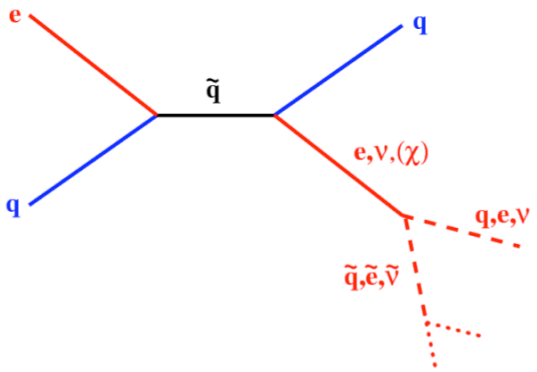
No signal observed→ derive LFV LQ limits:

- For coupling of electromagnetic strength $\lambda=\sqrt{4\pi\alpha_{em}}$ = 0.3 lower limits are set for all 14 LQs, depending on the LQ type, M_{LQ} > 272 up to 530 GeV

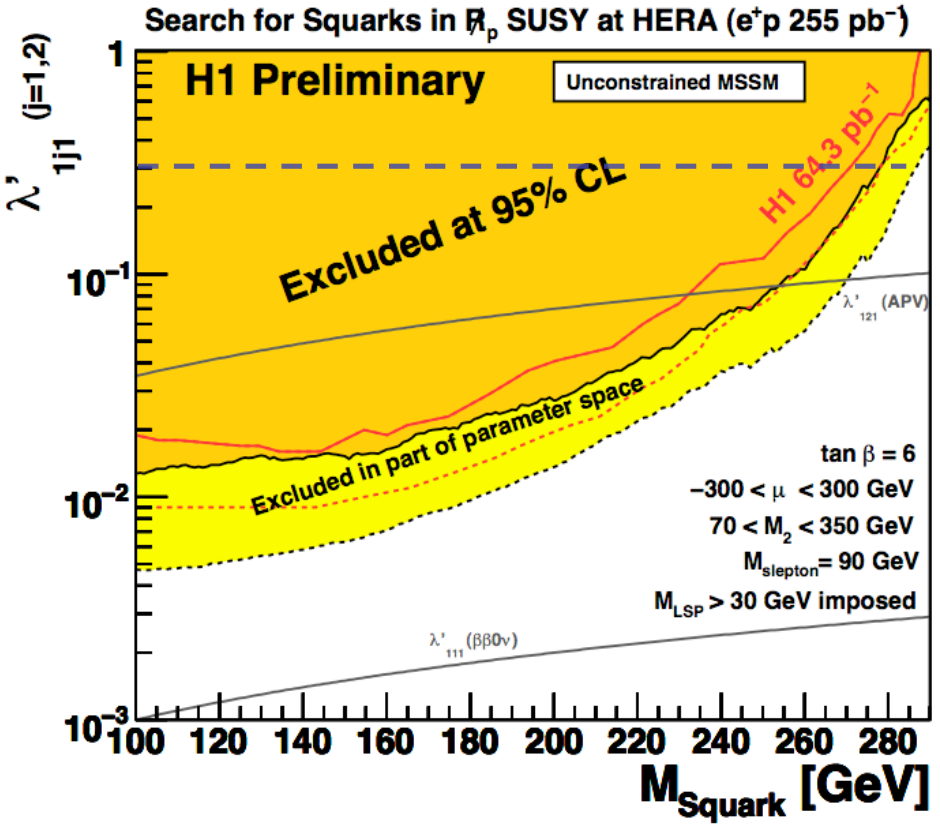
HERA limits complementary to LEP and Tevatron

R-parity violating SUSY

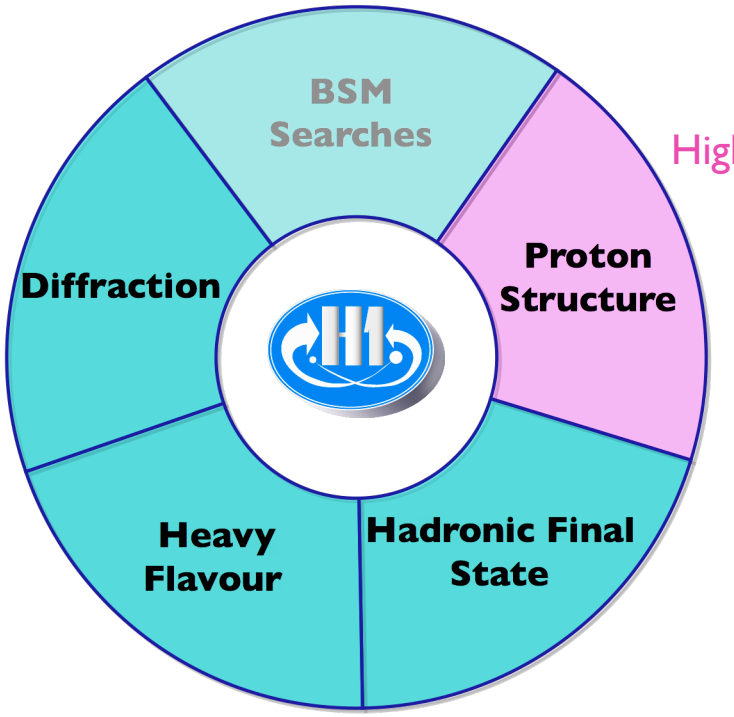
- Searches for squarks in R-parity violating SUSY using complete data set of the H1 experiment at HERA:
  - No signal observed → Full parameter scan using the MSSM and mSUGRA models



- Interpretation of search results within the MSSM and mSUGRA models for electromagnetic strength coupling λ=0.3:
  - Up-type squarks excluded <275 GeV
  - Down-type squarks excluded <290 GeV



H1 Physics Program



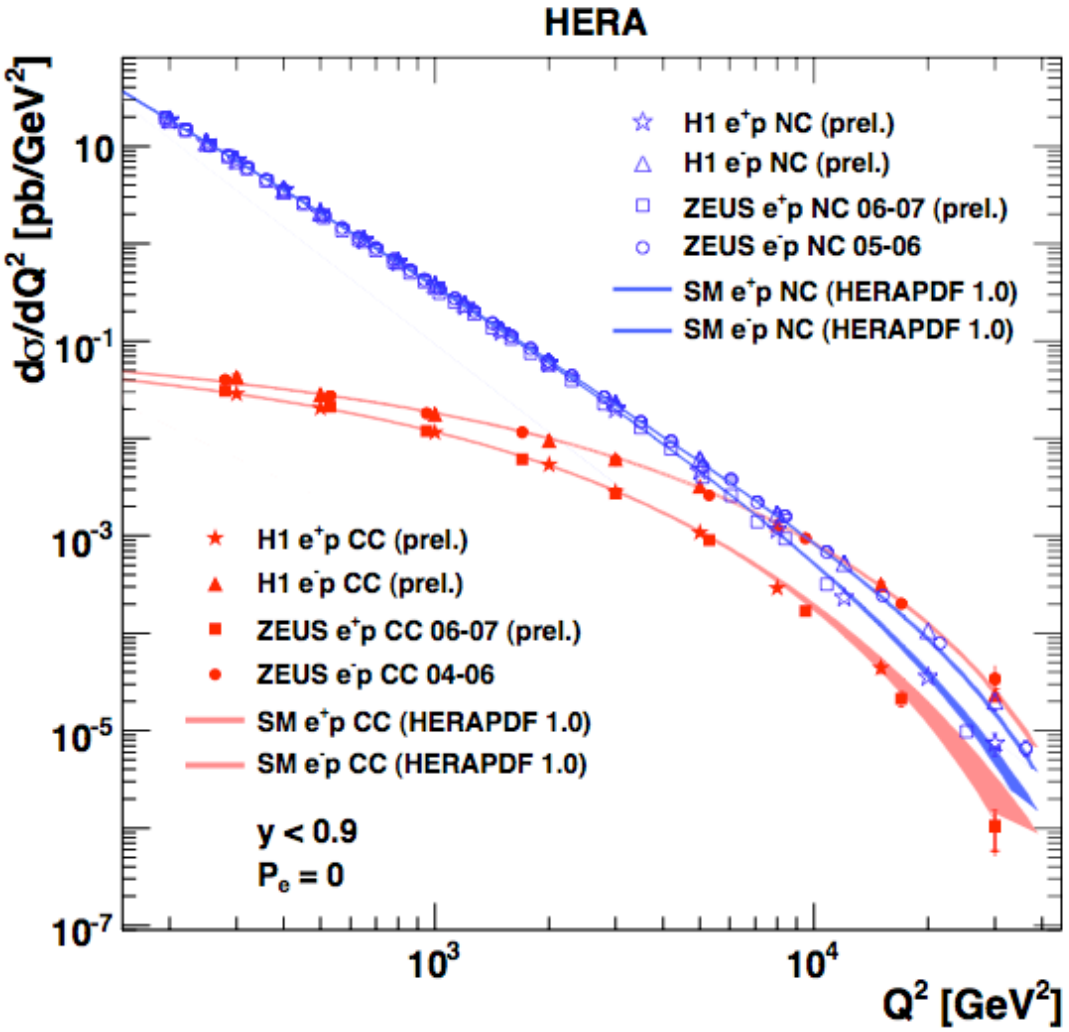
High Q^2 CC HERA II polarised ep

PDF+EW fits of NC, CC

High Q^2 NC and CC

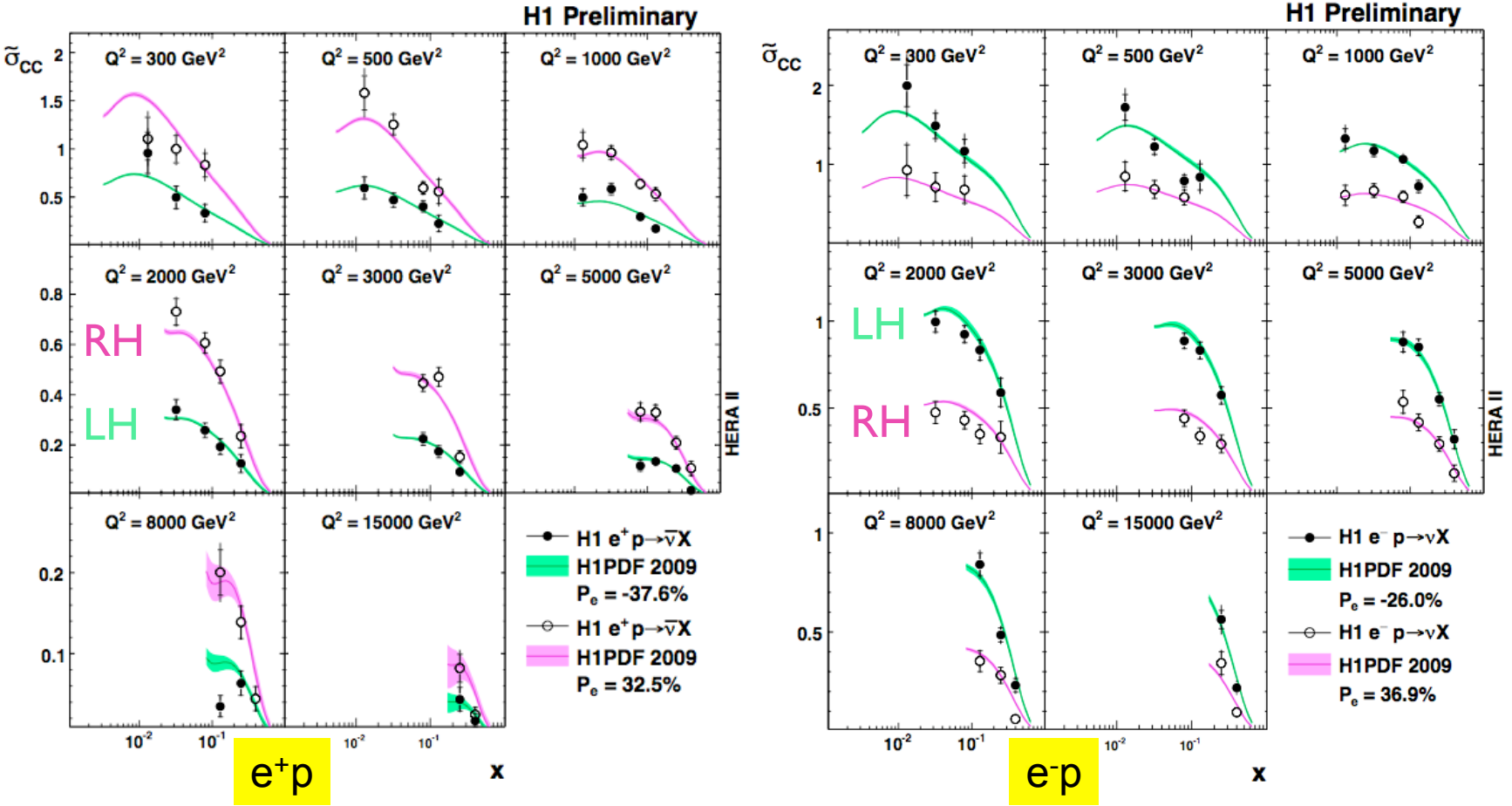
- Combined H1 NC and CC cross sections:
  - 165 pb^{-1} for e^-p
  - 280 pb^{-1} for e^+p

- New CC data available, completes the picture.



High Q^2 CC at HERA II

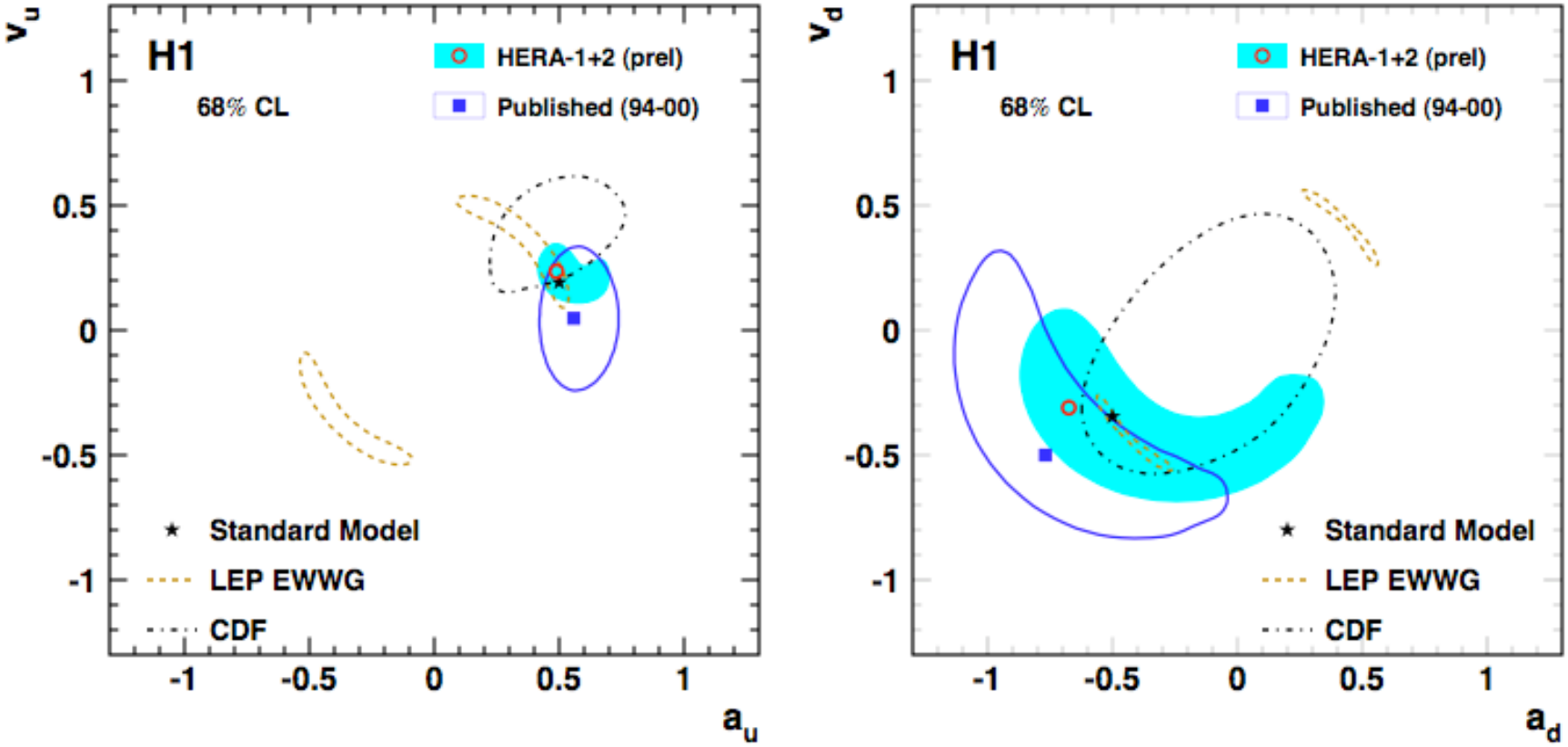
- Measurement of the double differential polarised $e^{\pm}p$ CC cross sections



- Opposite polarisation dependence for e^+ to e^-
- Different PDF sensitivities: CC e^-p sensitive to **u**, CC e^+p sensitive to **d**

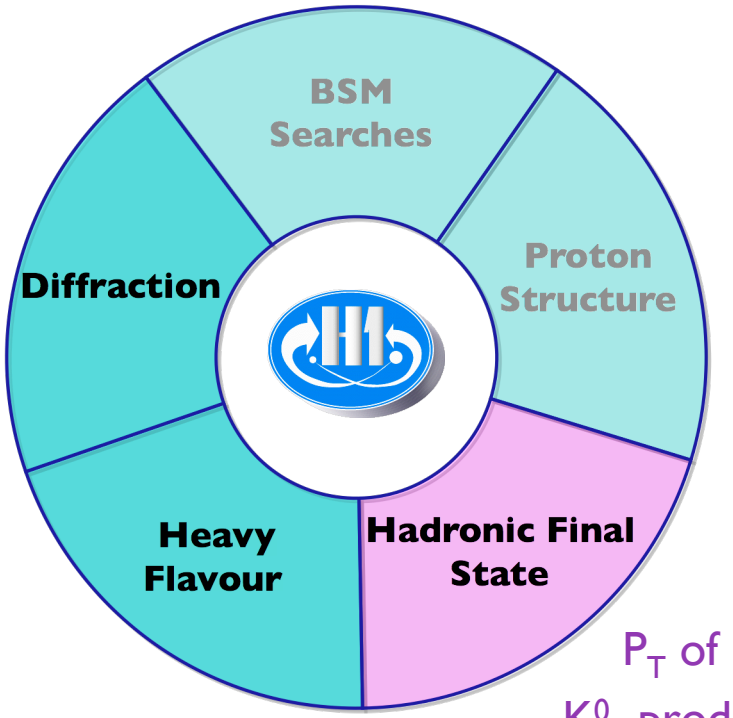
PDF+EW fits to NC and CC data

- Determination of the **u** and **d** quarks couplings to the Z simultaneously with PDF fits using full HERA I+II data, including data with polarised electron beam.



- Improved sensitivity to vector couplings due to polarisation of HERA II data

H1 Physics Program



P_T of Charged Particles at low Q^2

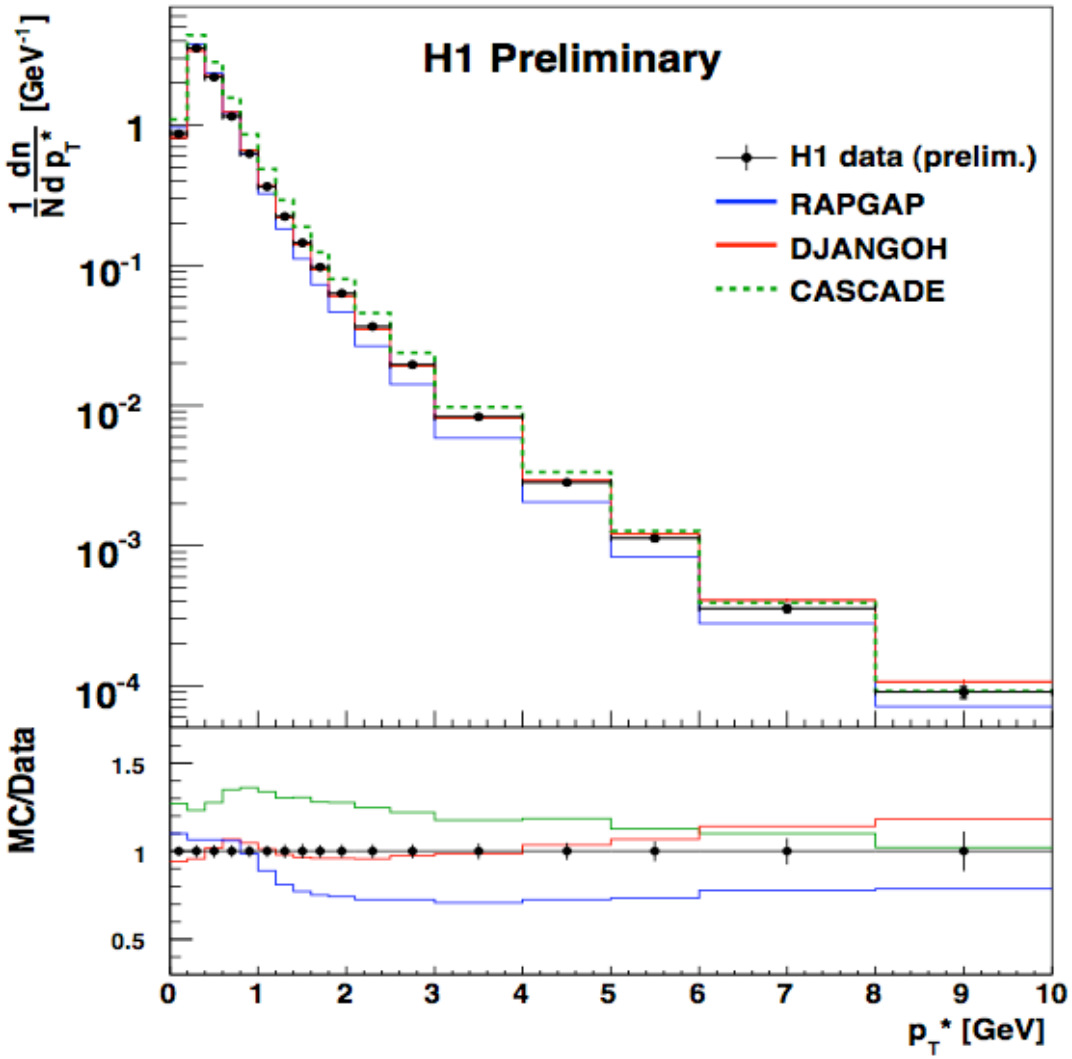
K^0_S production at high Q^2 at HERA II

Charged Particle Spectra

- Semi-inclusive measurements
  ep→e'hX could discriminate between different evolution models:
  - Transverse momentum spectra
    - Low P^*_T < 1 GeV sensitive to hadronisation parameters
    - High P^*_T > 1GeV sensitive to different parton dynamics

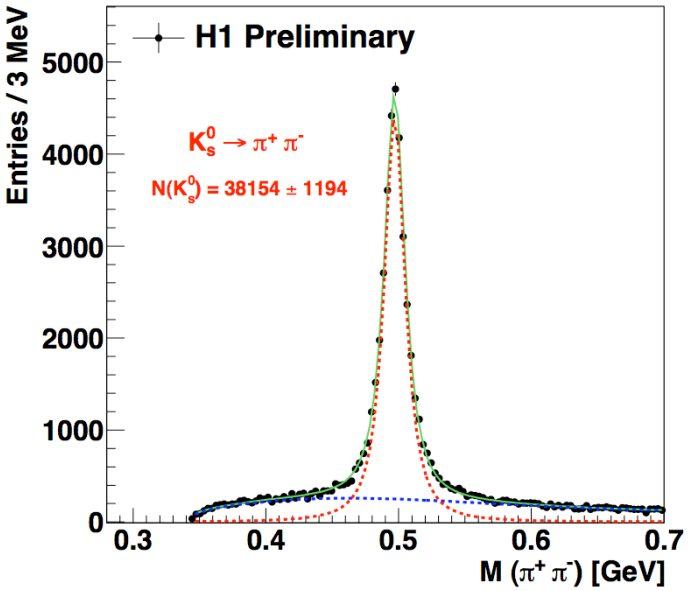
- Using 2006 e+p with L= 88.64 pb^{-1}, central tracks are analysed

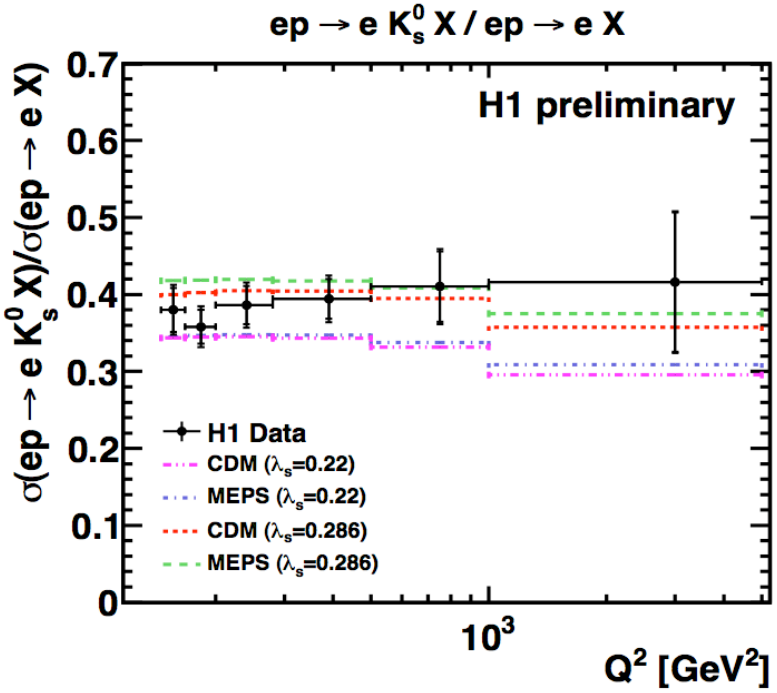
- DJANGOH(CDM) describes new data for whole P^*_T spectra
  RAPGAP(DGLAP) is below the data for P^*_T >1 GeV
  CASCADE(CCFM) is systematically above the data



K^0_S at high Q^2

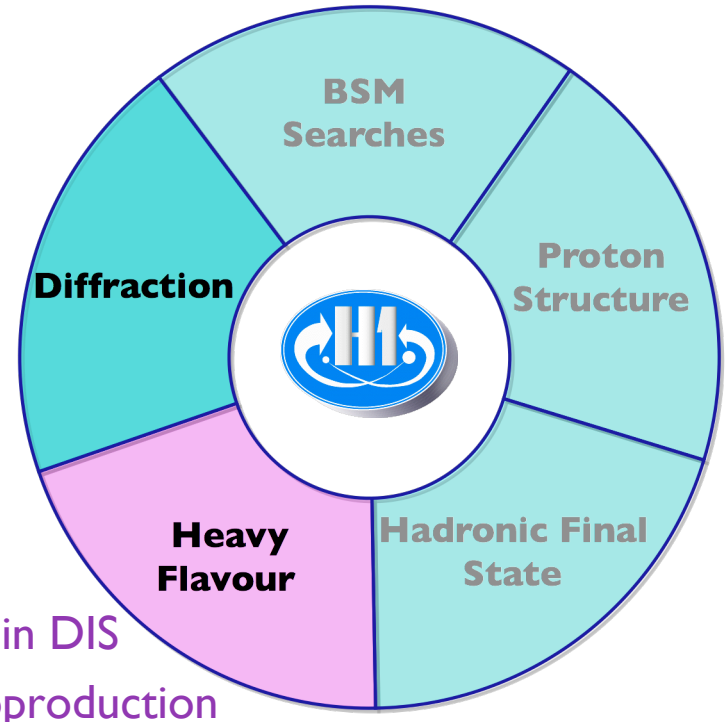
- Analysis based on the full HERA II statistics
- Test of fragmentation into **s** particles: λ_s=P(s)/P(q)
- Ratio of cross sections with tagged K^0_S to total cross sections compared to various fragmentation models with different λ_s





λ_s = 0.286 is preferred, consistent with ALEPH results which confirms fragmentation universality

H1 Physics Program

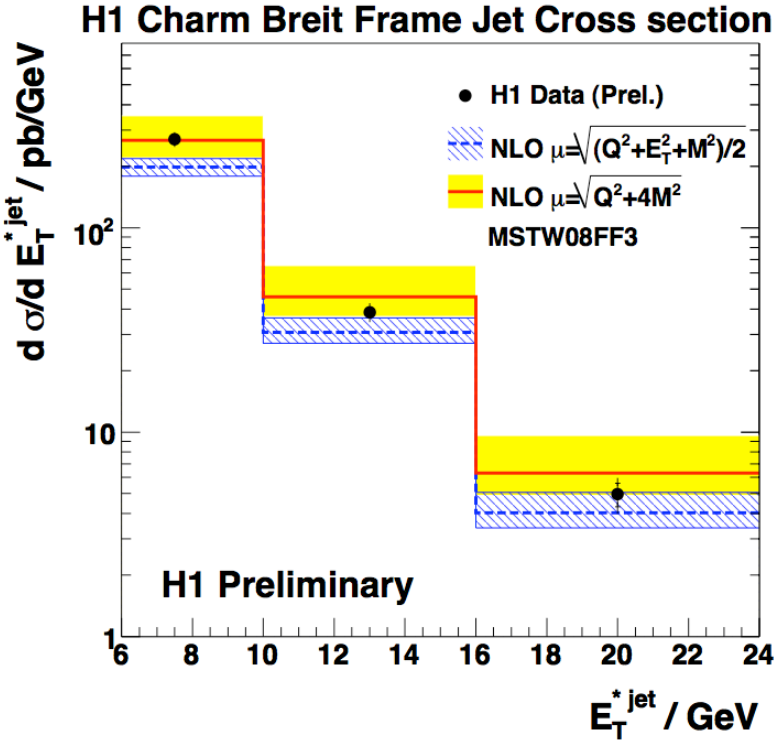


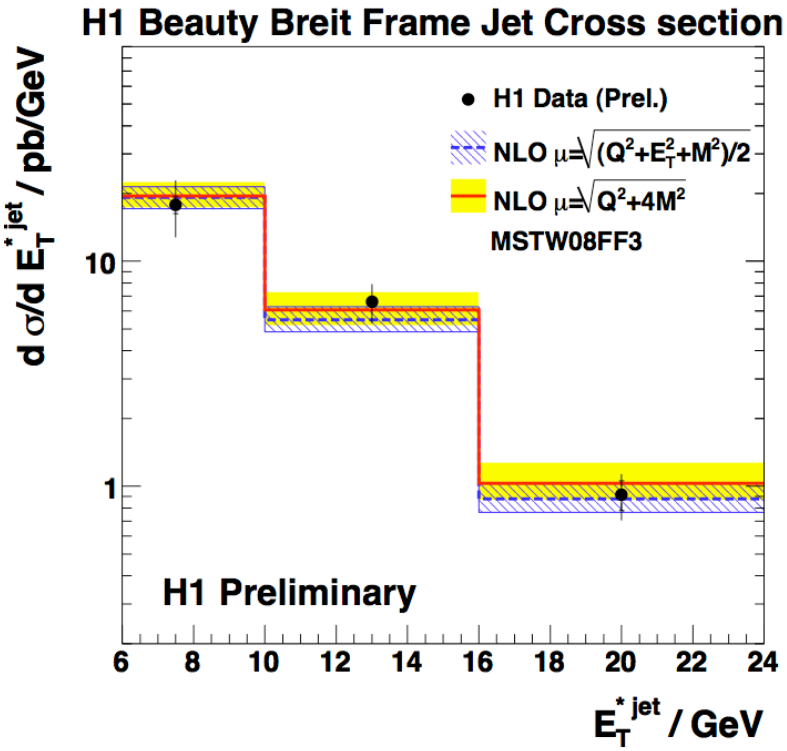
Charm and beauty jets in DIS

D* with jets in photoproduction

Charm and Beauty Jets

- New measurement of **c** and **b** final states with a high E_T jet to test the pQCD theory of heavy quarks
  - Use lifetime technique to tag events with **c** and **b** jets
  - Cross sections determined in lab and Breit frame
- Compare results to NLO predictions using different scales:

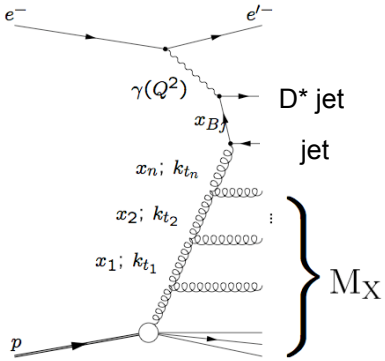


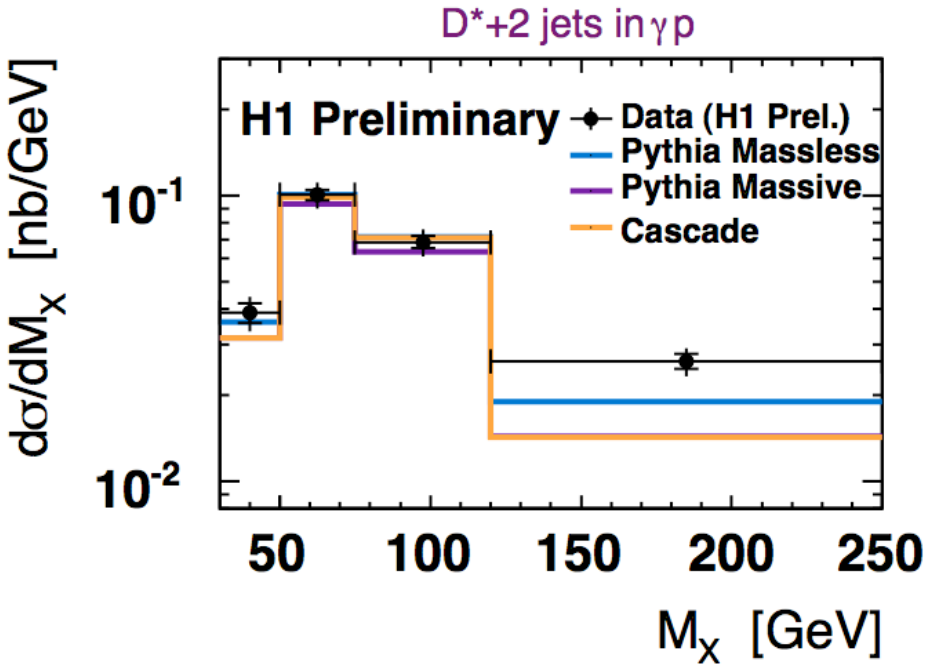


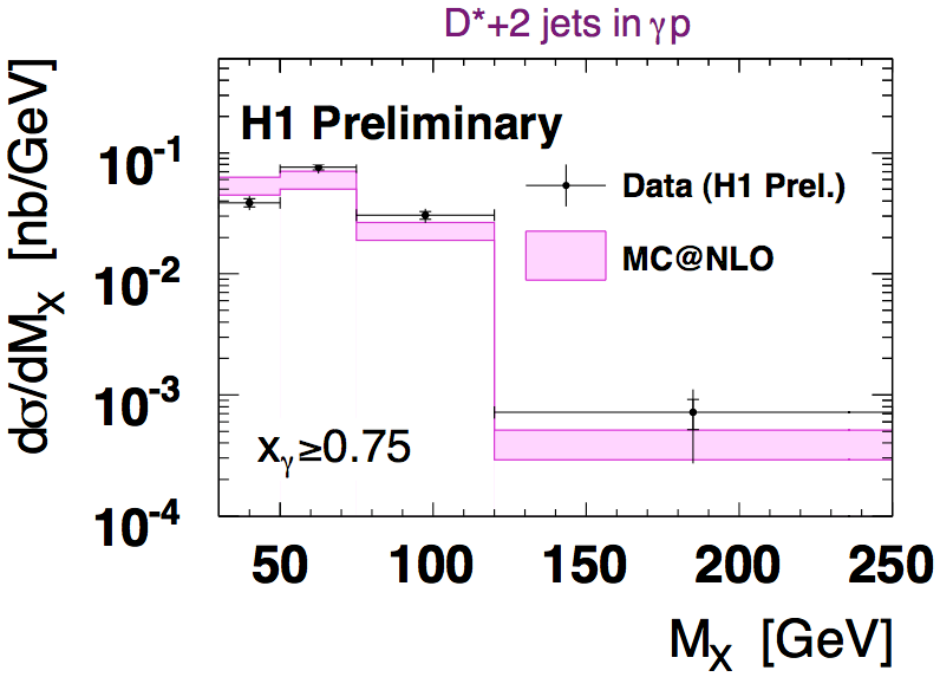
- Charm data is more sensitive to the scale used in NLO calculations than Beauty jet data → Stringent tests of QCD

D* and jets in Photoproduction

- In photoproduction $Q^2 \approx 0$ →suitable scale for pQCD is m_c
- Dominant process: boson gluon fusion
  - Signature: D* meson and 2 jets
- Study variables sensitive to parton dynamics in x_γ regions enriched by direct/resolved photon processes
- Comparison to LO ME+PS MCs and to MC@NLO

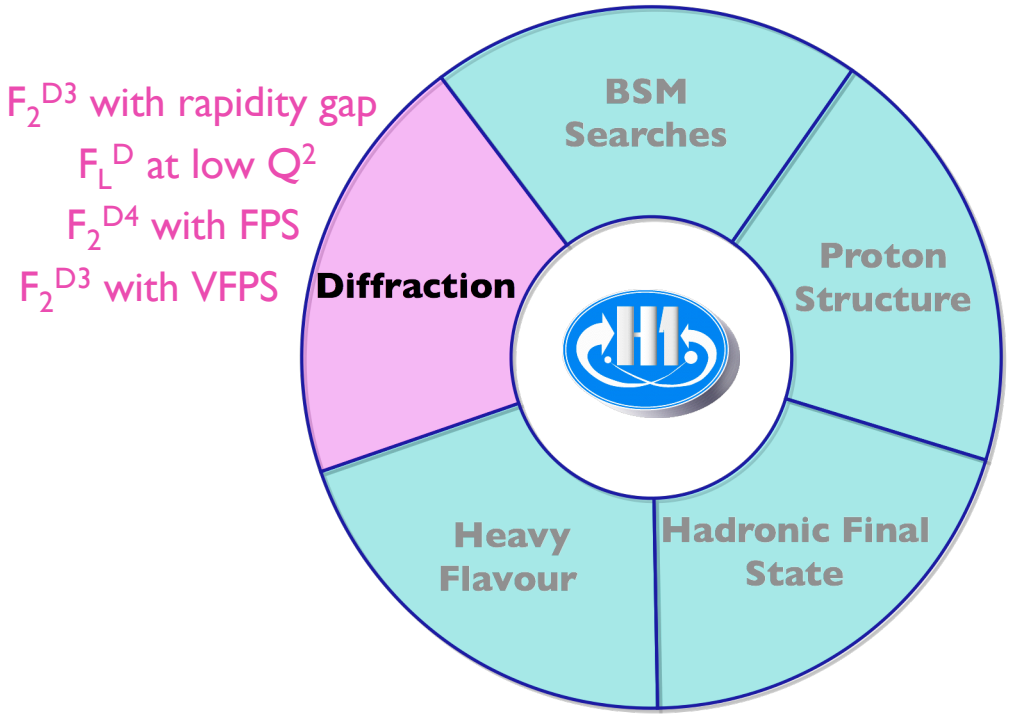






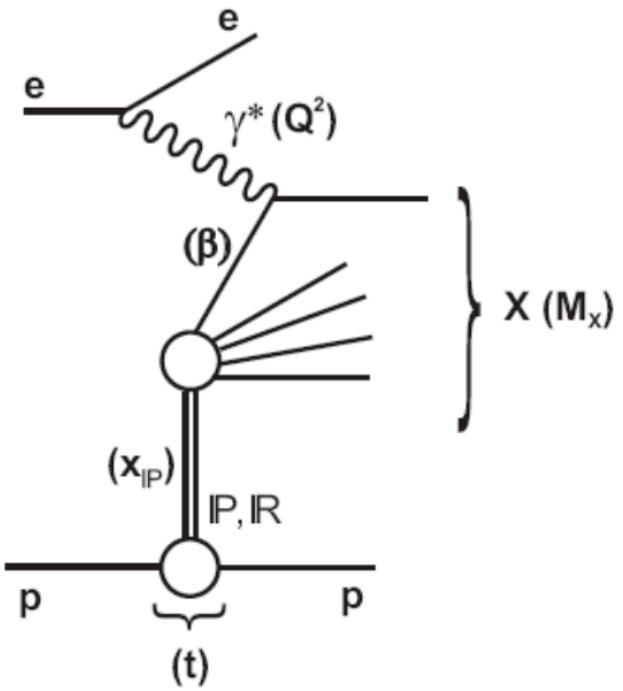
The precision of the measurement can distinguish between models

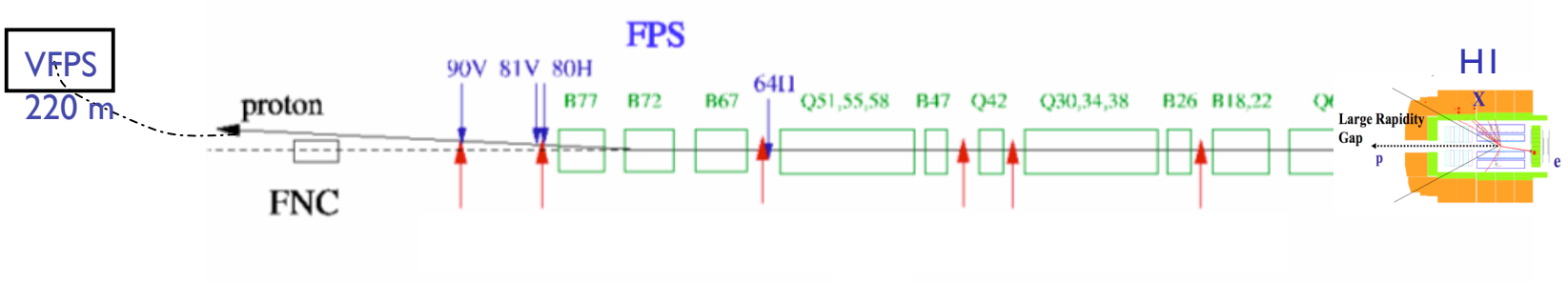
H1 Physics Program



Diffractive DIS at HERA

- At HERA, 10% of low-x DIS events are diffractive:
  - Additional kinematics defined wrt DIS
    - x_{IP}: momentum fraction of colour singlet
    - t: 4-momentum transfer squared at proton vertex
    - β: momentum fraction of struck quark
- Probe QCD structure of color singlet
- Experimental methods:
  - Large Rapidity Gap (LRG) selection
  - Leading proton measurement

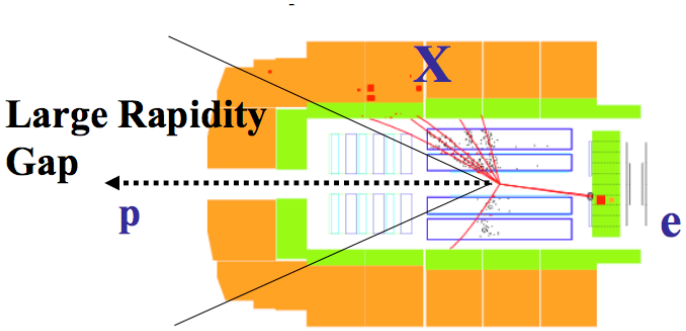




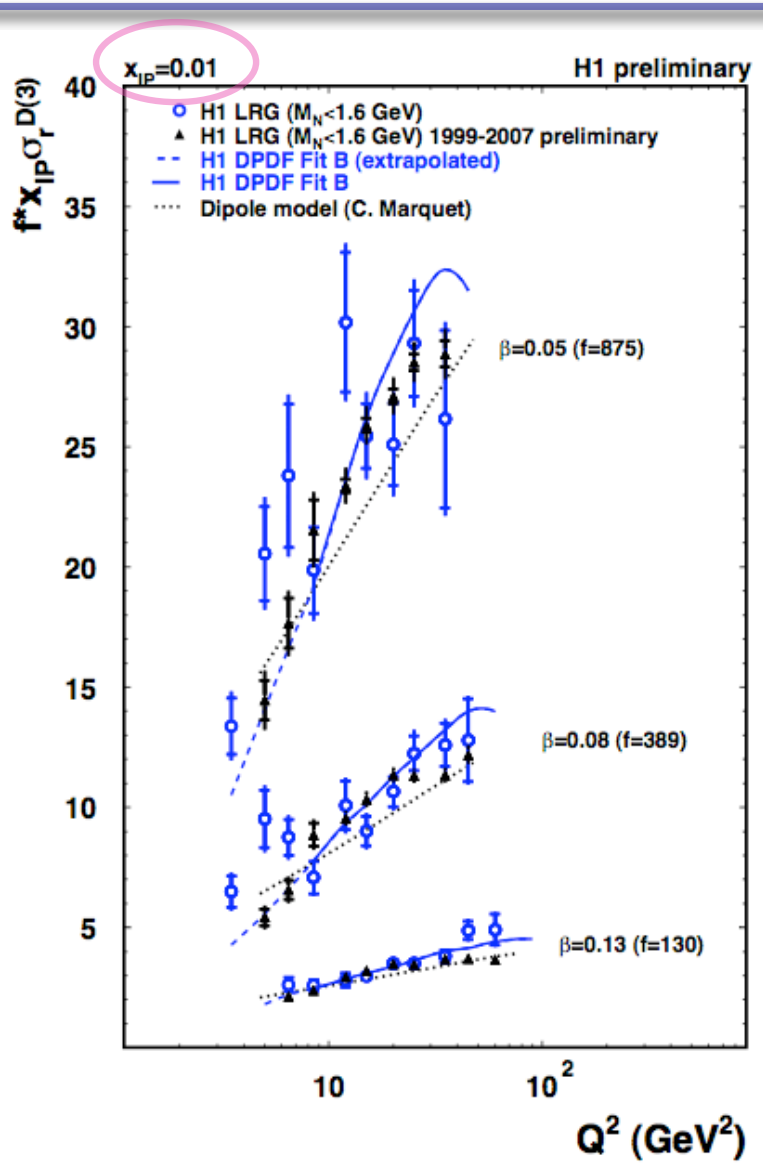
$F_2^{D(3)}$ with Rapidity Gap

- Using full HERA data, the cross section is measured for $3.5<Q^2<90$ GeV^2, triple differentially in x_{IP}, Q^2, and β.

- Select events based on the Large Rapidity Gap topology:



- New H1 LRG data (black) is compared to the previous published H1 data (blue)
  - Large improvement in precision.

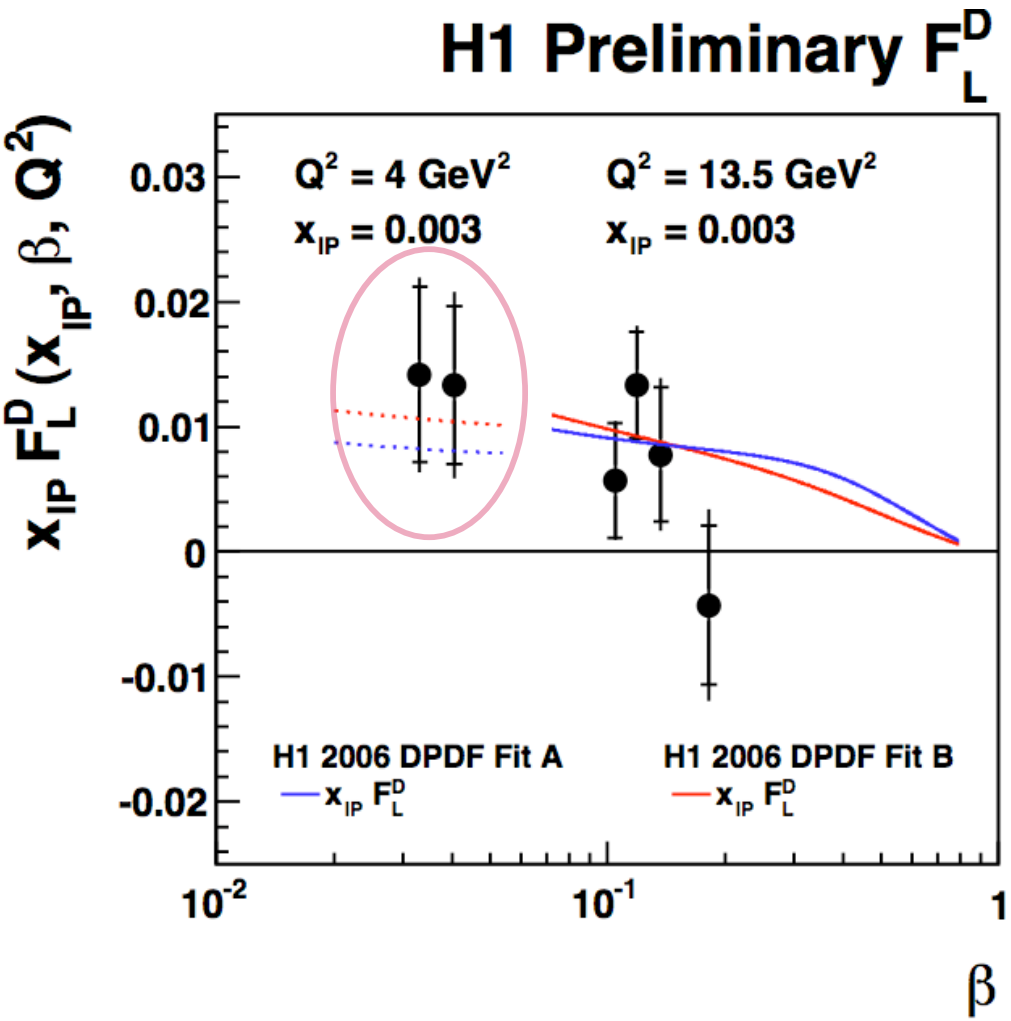


F_L^D in extended Q^2 range

- Unique measurement of F_L^D at low Q^2 using low energy data runs from HERA with $\sqrt{s}$ = 225, 252 GeV, are combined with published results at $\sqrt{s}$ = 300 GeV

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

- New data agree with DPDF fits in the low Q^2 region and is shown together with the previous measurement of F_L^D at medium Q^2



$F_2^{D(4)}$ with Proton in FPS

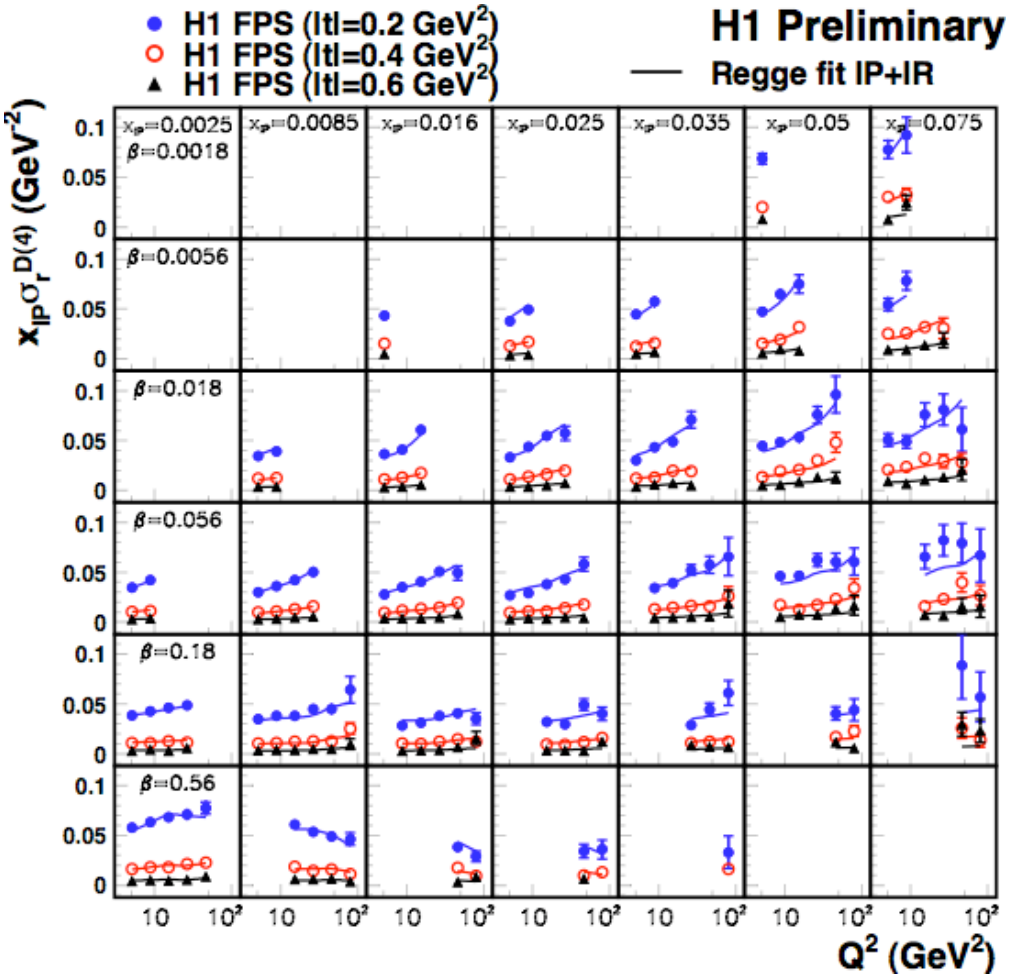
- New cross section measurement for the diffractive DIS process ep→eXp is performed differentially in 4 variables,

  with the leading final state proton detected in the H1 Forward Proton Spectrometer (FPS), using full HERA-II data

- The data cover the range:
  - $x_{IP} < 0.1$
  - $0.1 \le t \le 0.7$ GeV^2
  - $5 \le Q^2 \le 200$ GeV^2
  - $0.0018 \le \beta \le 0.56$

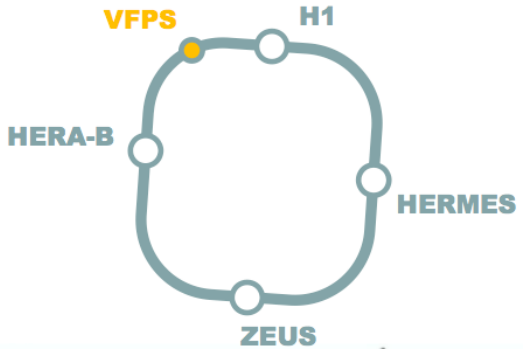
- t-dependence as for hard processes

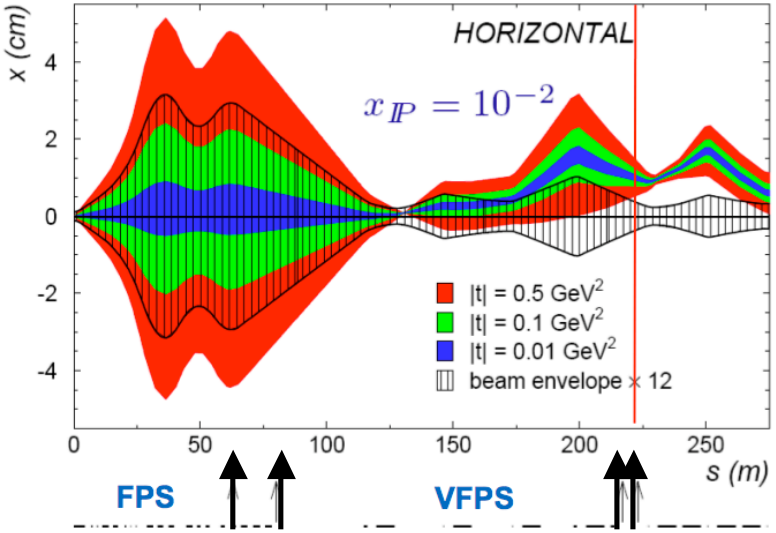
- Regge fit works on the 4 differential cross section: results are consistent with proton vertex factorization

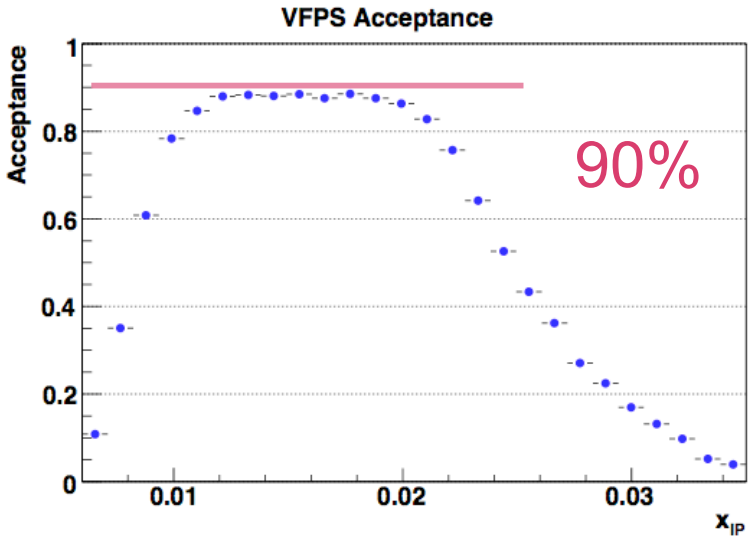


$F_2^{D(3)}$ with Proton in VFPS: Acceptance

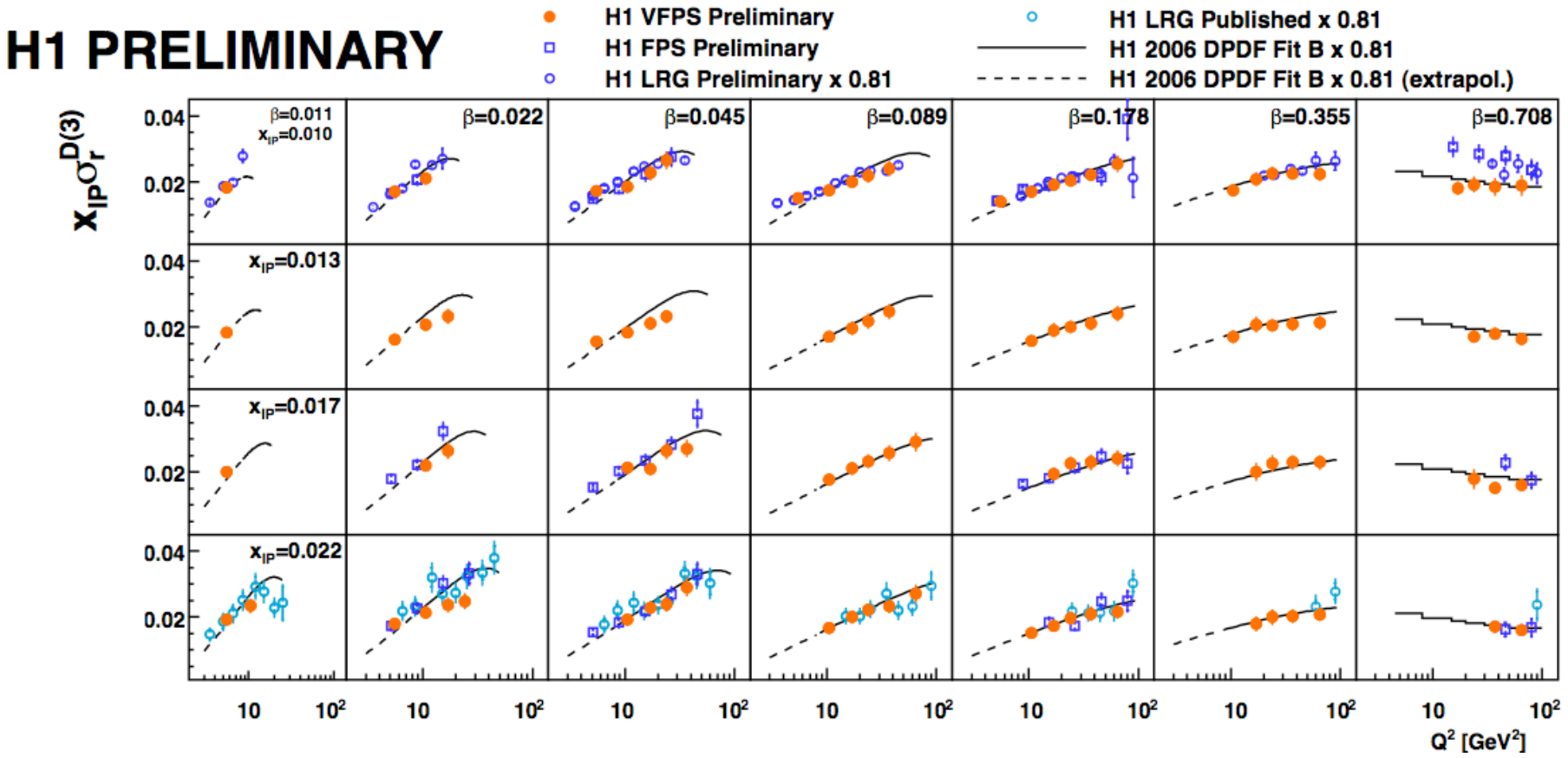
- New device in HERA II (since 2005): Very Forward Proton Spectrometer
  - VFPS location is optimised for acceptance: $|t| < 0.25\ \text{GeV}^2$, $0.009 < x_{IP} < 0.026$
    - 220m from the interaction point of the proton ring.
    - acceptance is highest between $0.006 < x_{IP} < 0.025$ and $|t| < 0.25\ \text{GeV}^2$ (down to lowest $|t|$) and depends on **VFPS position** during run (affects low x_{IP})







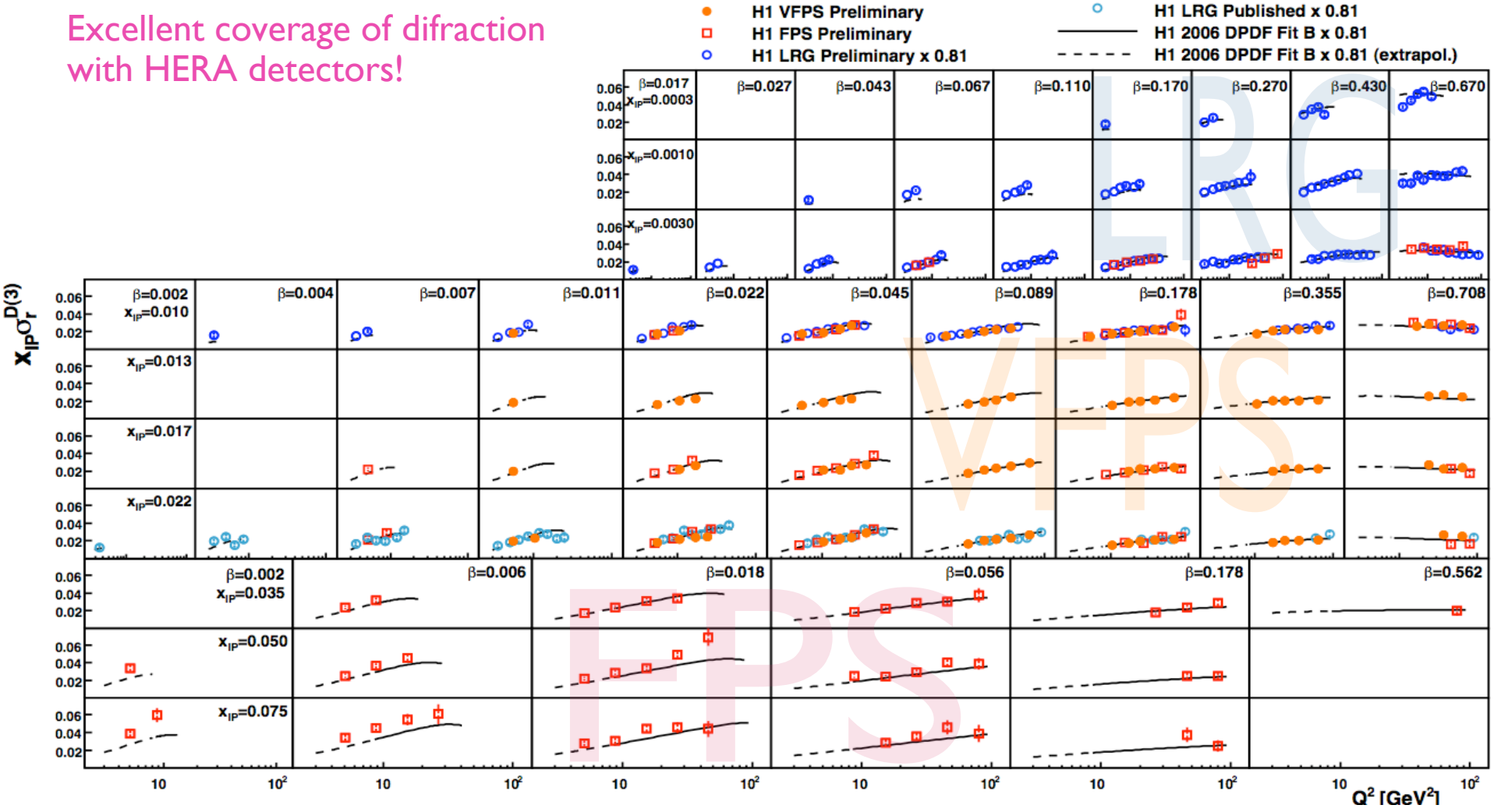
$F_2^{D(3)}$ with Proton in VFPS



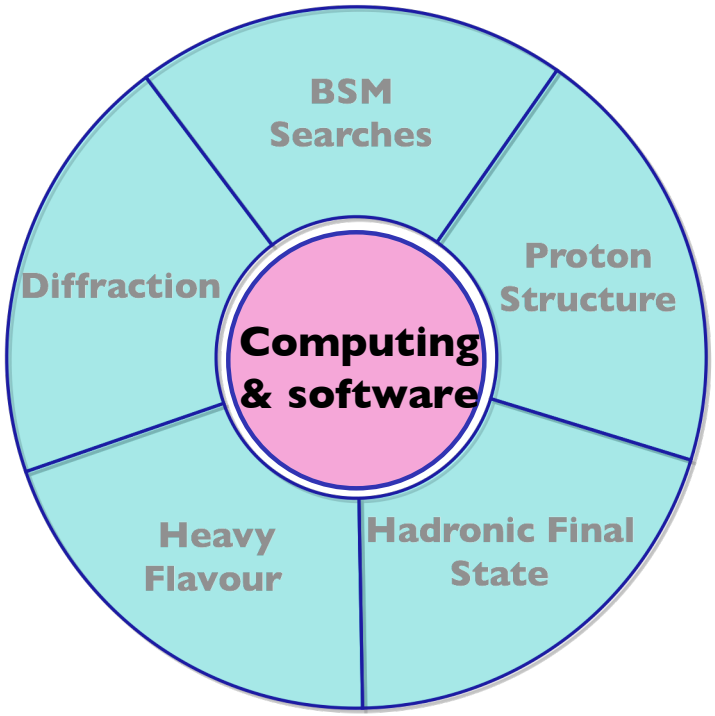
- scaling violations
- higher precision in x_{IP}
- Good agreement between rap. gap, FPS and VFPS measurements

$F_2^{D(3)}$ Summary

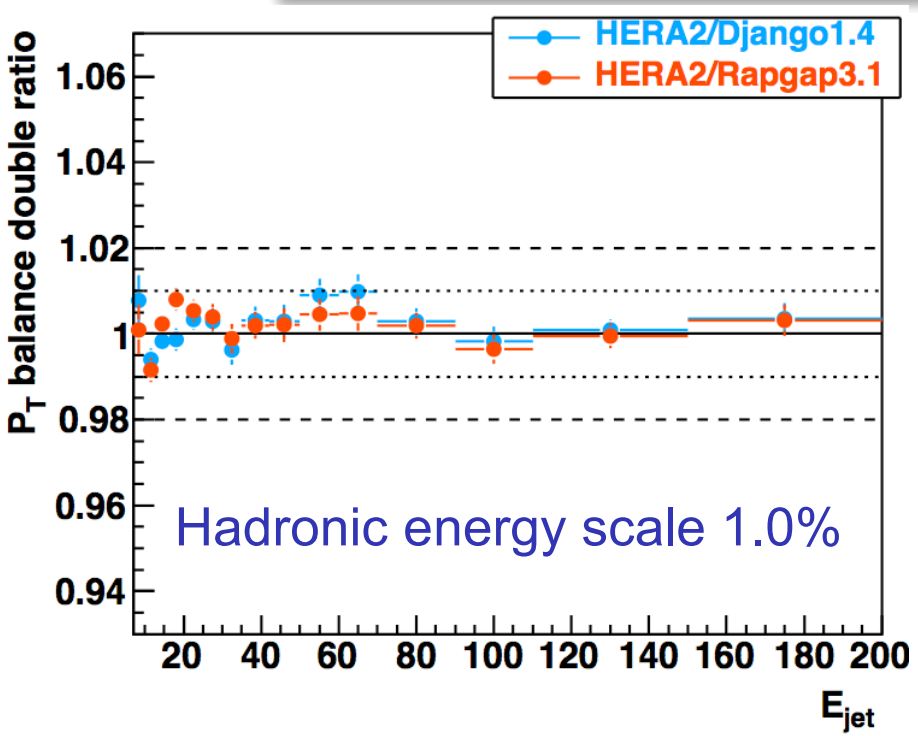
Excellent coverage of difraction with HERA detectors!

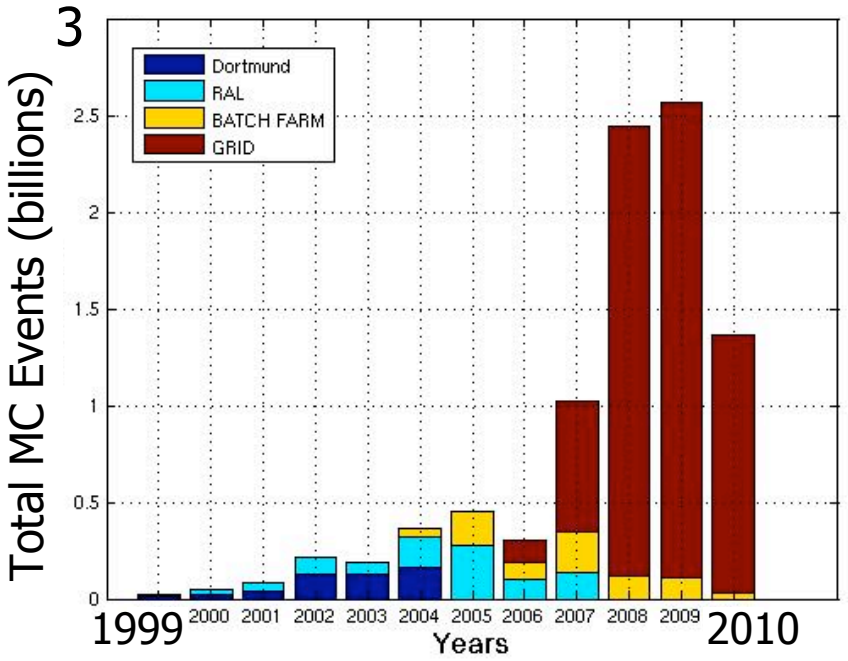


H1 Physics Program



Computing and Software: Improvements and Resources





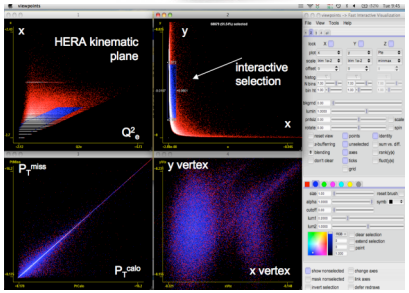
Final HERA II Calibrations Completed

- DST 7 (reconstruction level) in 2009
- H1OO 4.0 (analysis level) released
  - Target precision reached on EM (0.5%) and hadronic (1.0%) calibrations
  - Best knowledge contained in common framework with centralised production

H1 MC Production

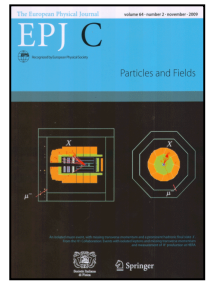
- Strong MC team, large scale
  - Over 2 .5 billion events in 2009
  - Record in March: > 500M events
  - Total H1 on GRID: 7 billion events
- Level to be maintained in 2011
  - Similar resources needed

Data Preservation Projects



- H1 computing activities are increasingly aimed towards consolidation for the longer term
  - Data, MC samples and analysis software for long term
  - Non-digital documentation: Cataloguing and organisation
  - Setting out the future governance of the collaboration
  - Define the resources needed for future analysis

- Also involved in several joint data preservation projects
  - Strong H1 role in DPHEP initiative
  - Future virtualisation / validation project with DESY-IT
  - Pilot projects with the Library / INSPIRE started
  - HEP Outreach project with BaBar
  - *Document submitted to PRC*



Summary and Outlook

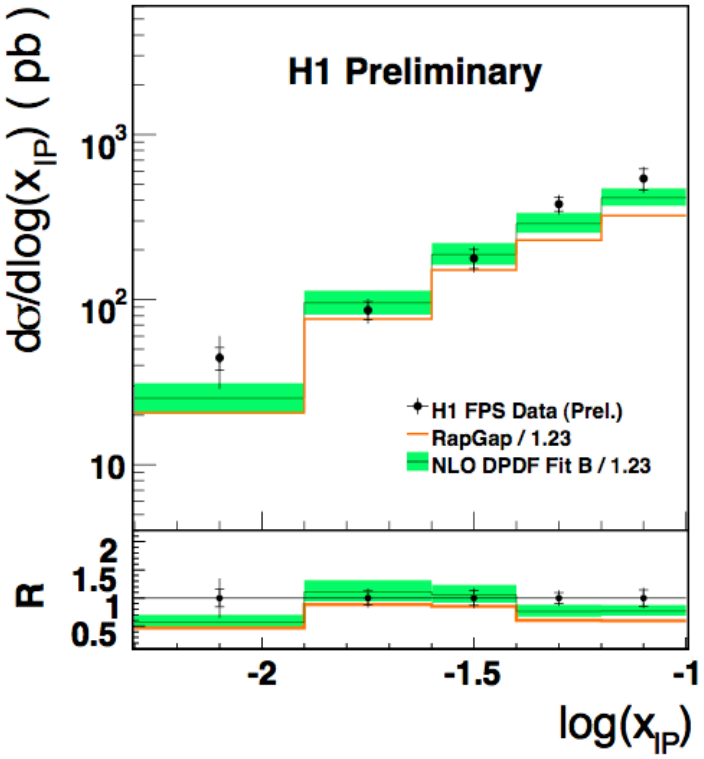
- Many new results in key areas of H1 physics program:
  - high Q2 NC and CC HERA II data
  - finalisation of searches
  - inclusive diffractive scattering
    - First VFPS measurement
    - Unique measurement of F_L^D at low Q^2

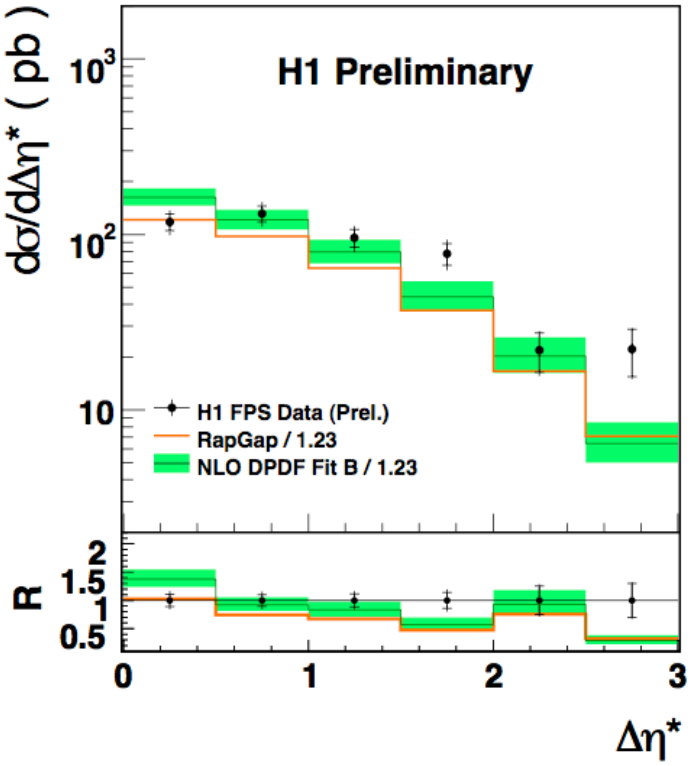
- In the process of harvesting the HERA II precision now

- Persistent analyses to complete the physics program
  - Expect ~35 new publications
- Beyond: keep capability for future analyses (data preservation)

Diffractive Jets with Proton in FPS

- HERA II data used for diffractive jet analysis with Leading Proton in FPS:
  - $x_{IP} < 0.1$, $0.1 \leq t \leq 0.7$ GeV^2, $4 \leq Q^2 \leq 110$ GeV^2
- The dijet topology is defined by 2 inclusive jets in the central region
- The data are compared to parton shower and to NLO predictions





- Within errors NLO describes the data
- DPDFs are tested in the new region up to $x_{IP}<0.1$