Some Aspects of HERA II Physics Programme

Highlights of HERA I

- Structure of proton;
  rise of F_2
  role of gluon
- Structure of (virtual) photon;
  partonic content of the γ
- Electroweak unification
- Search for effects
  Beyond the Standard Model
- Colour singlet exchange process;
  Diffraction interpreted in terms of QCD

Experimental. Prospects for HERA II

- 1000 pb^{-1}
- e^+ and e^- beams of 27.6 GeV
- proton beams of ≥920 GeV
- polarized electron beam (P≈0.6)

Focus of this Talk

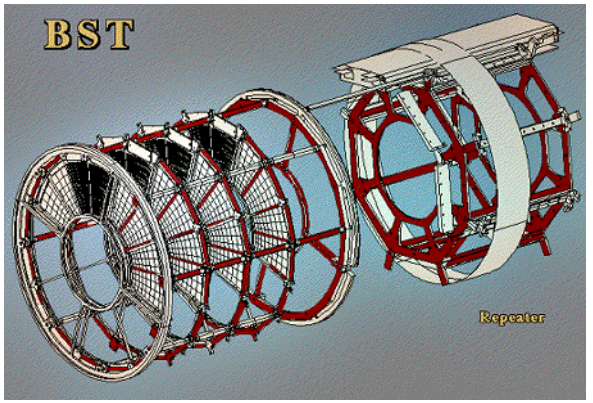
- Aspects of QCD
- Diffraction
- High Q^2 physics
- Searches

An Upgrade Precursor

In 1995 H1 upgraded the backward direction

- Calorimeter SpaCal
- Backward Drift BDC
- Backward Silicon BST (staged introduction)

Early version BST



which provided

- precise electron energy/angle measurement
- charged particle measurements (γp-background)
- access to high y-region

Si Tracking was hence systematically extended.

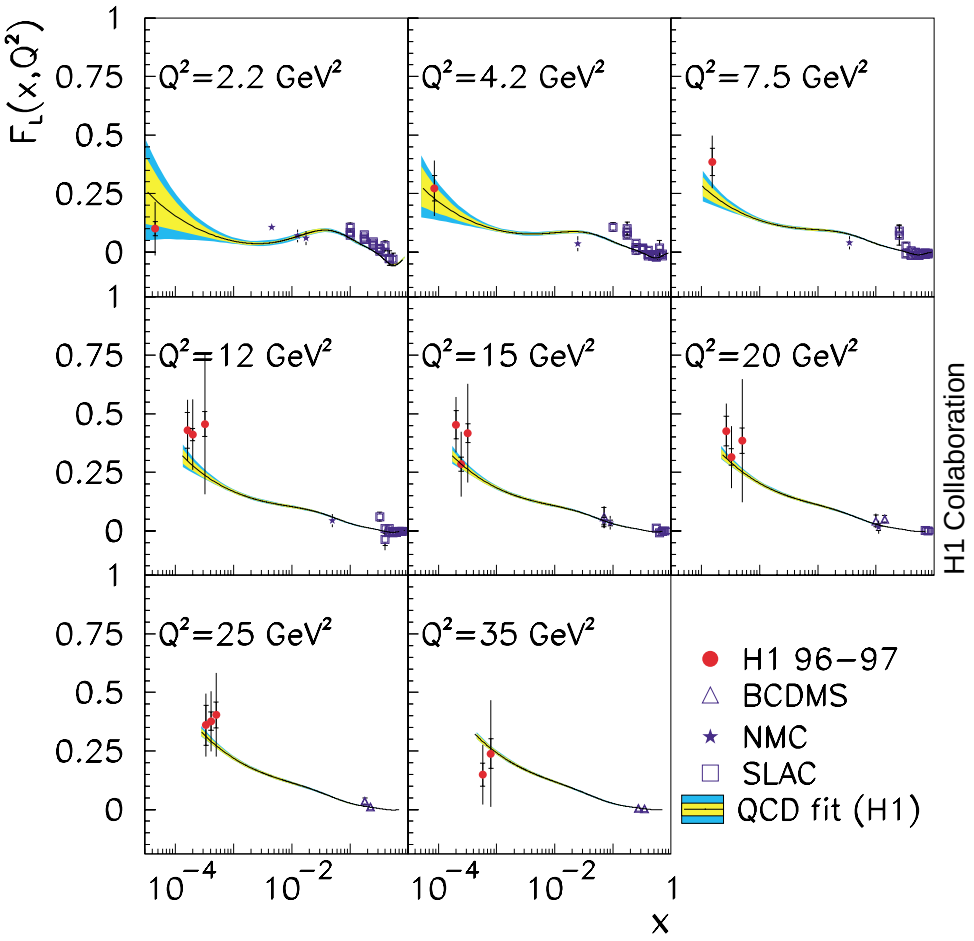
- H1 will have nearly 4π Si tracking for HERA II

F_L Measurement

F_L as a test of QCD.

- present extractions of F_L are based on extrapolations of perturbative QCD into the region of high y.
- $\sigma_r(x, Q^2) = F_2(x, Q^2) - \frac{y^2}{1 + (1-y)^2} F_L(x, Q^2)$
- a measurement of F_L free of additional assumptions requires data at various √s.
- It is most advantageous to lower proton energy to ~400 GeV.

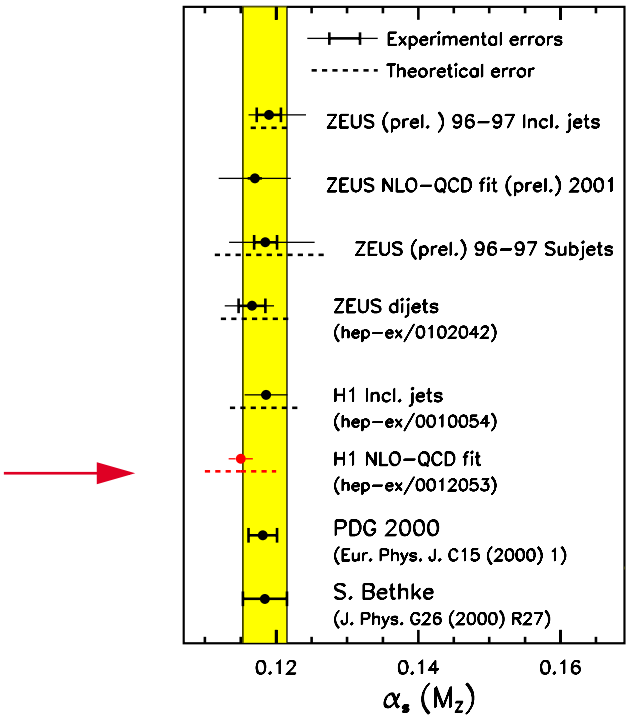
From QCD Extrapolations

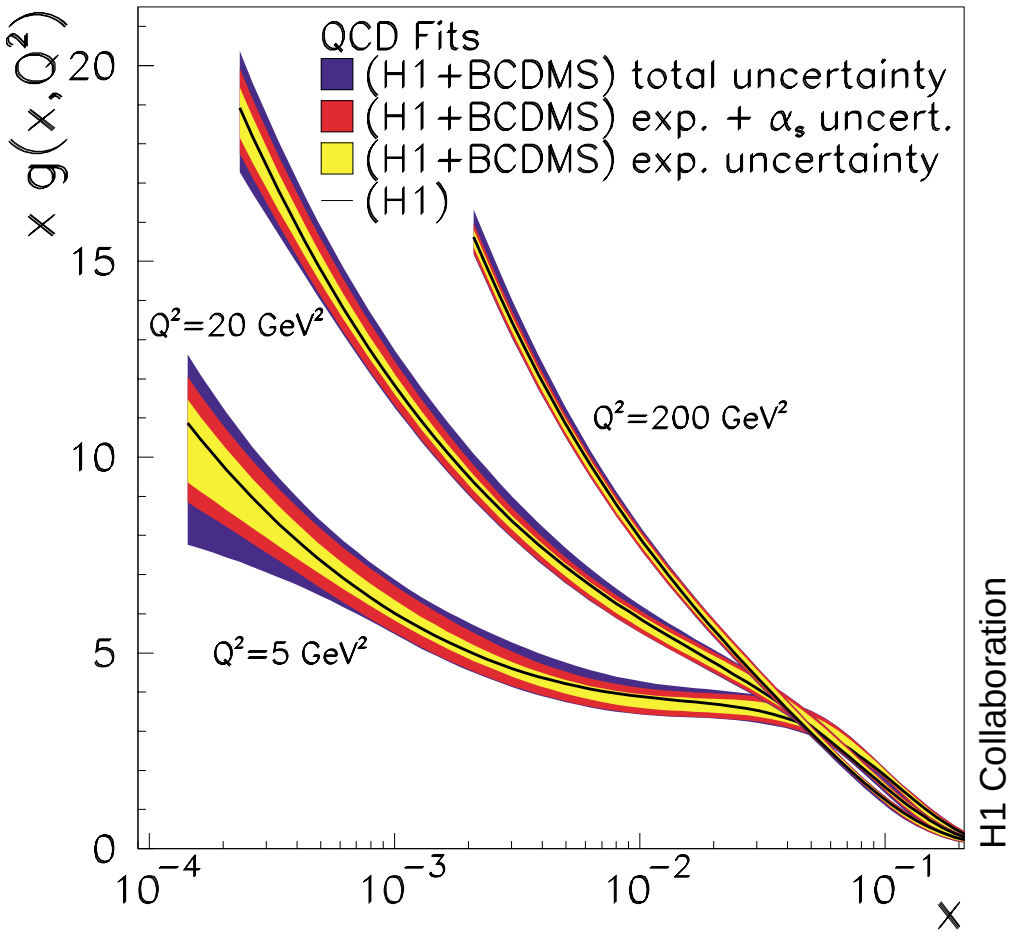


α_s and the Gluon Density

From the inclusive cross section

- determination of $xg(x)$
- together with BCDMS α_s and gluon

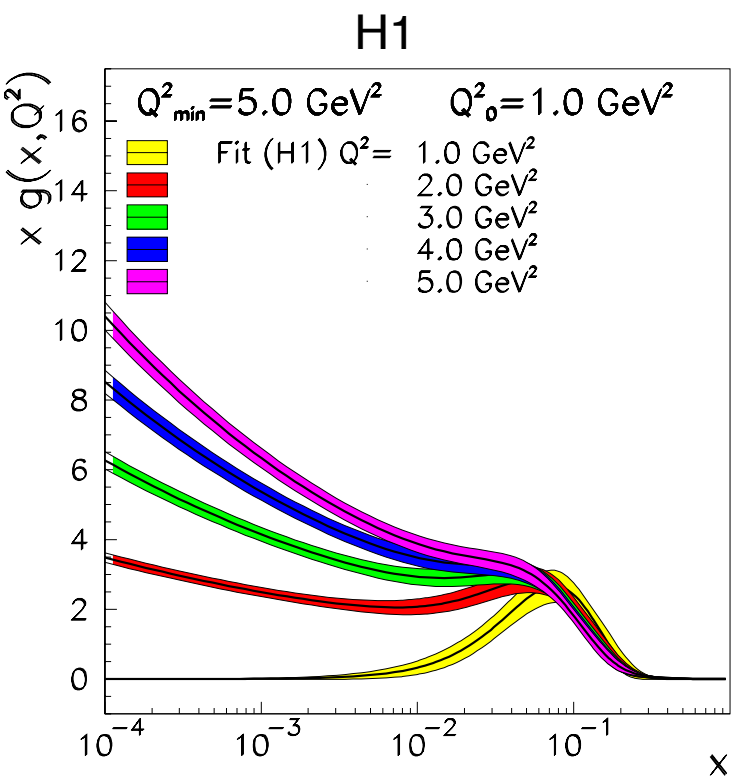


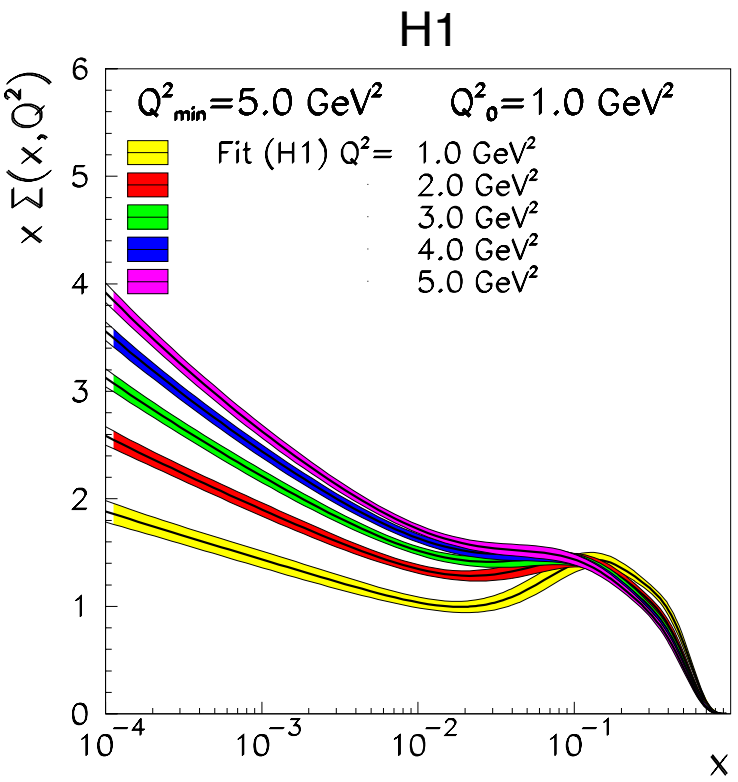


Parton Densities at low Q^2

Dramatic changes of the parton description as we approach the low Q^2 limit.

- gluon becomes valence like
- Singlet distribution takes over





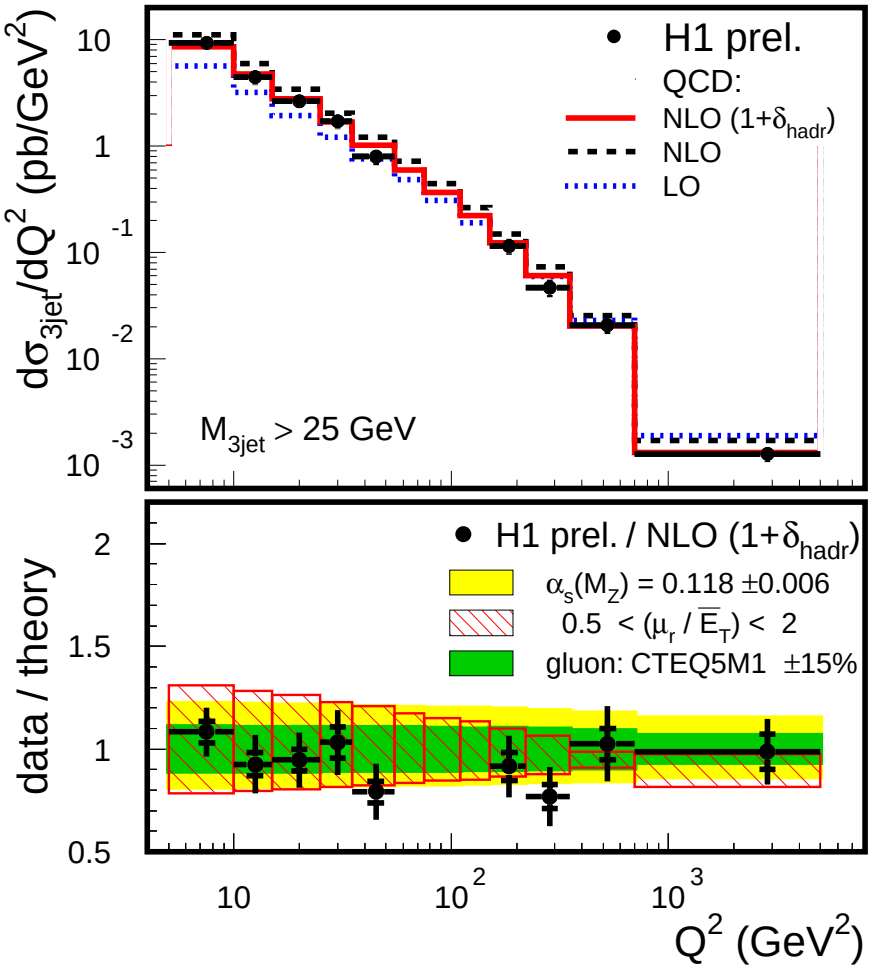
QCD and Jets

Exclusive QCD Processes

- 2-Jets
- 3 Jets
  recent progress

Request for higher Order Calculations

- large differences between LO and NLO calculations at low Q^2

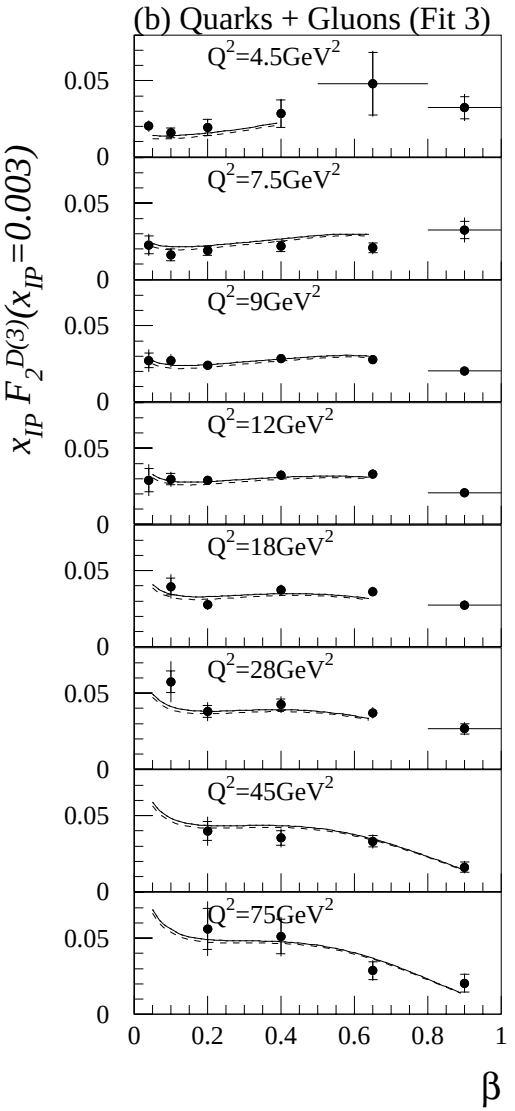


Diffraction

Even in hard scattering processes ($Q^2 \gg 0$) the proton often remains intact.

- early observation at HERA
- analysis of diffractive exchange in terms of its partonic content
- factorization has meanwhile been proven theoretically
- diffractive exchange is gluon dominated

more differential measurements required to disentangle (QCD-) mechanisms



Diffractive Dijets

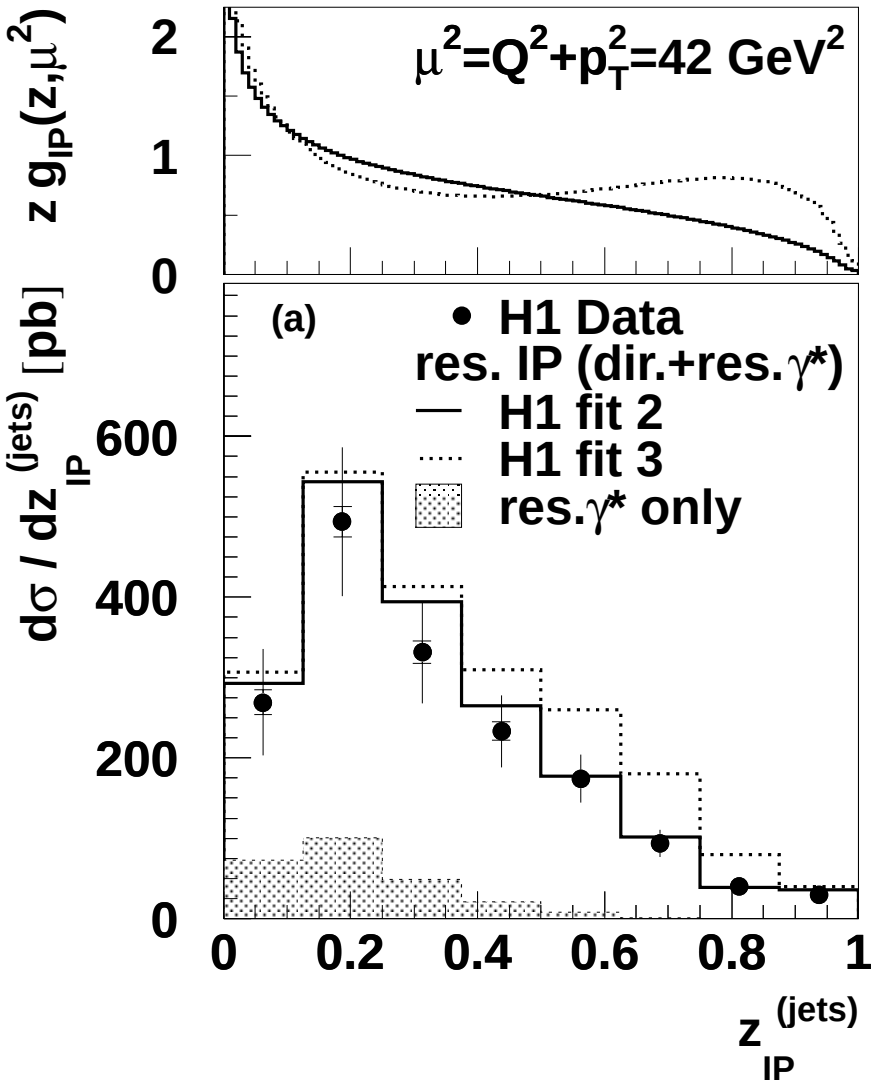
Dijets production in diffractive events

- sensitive to partonic content of diffractive exchange

Necessity of more exclusive diffractive data

- vector mesons
- charm
- jets

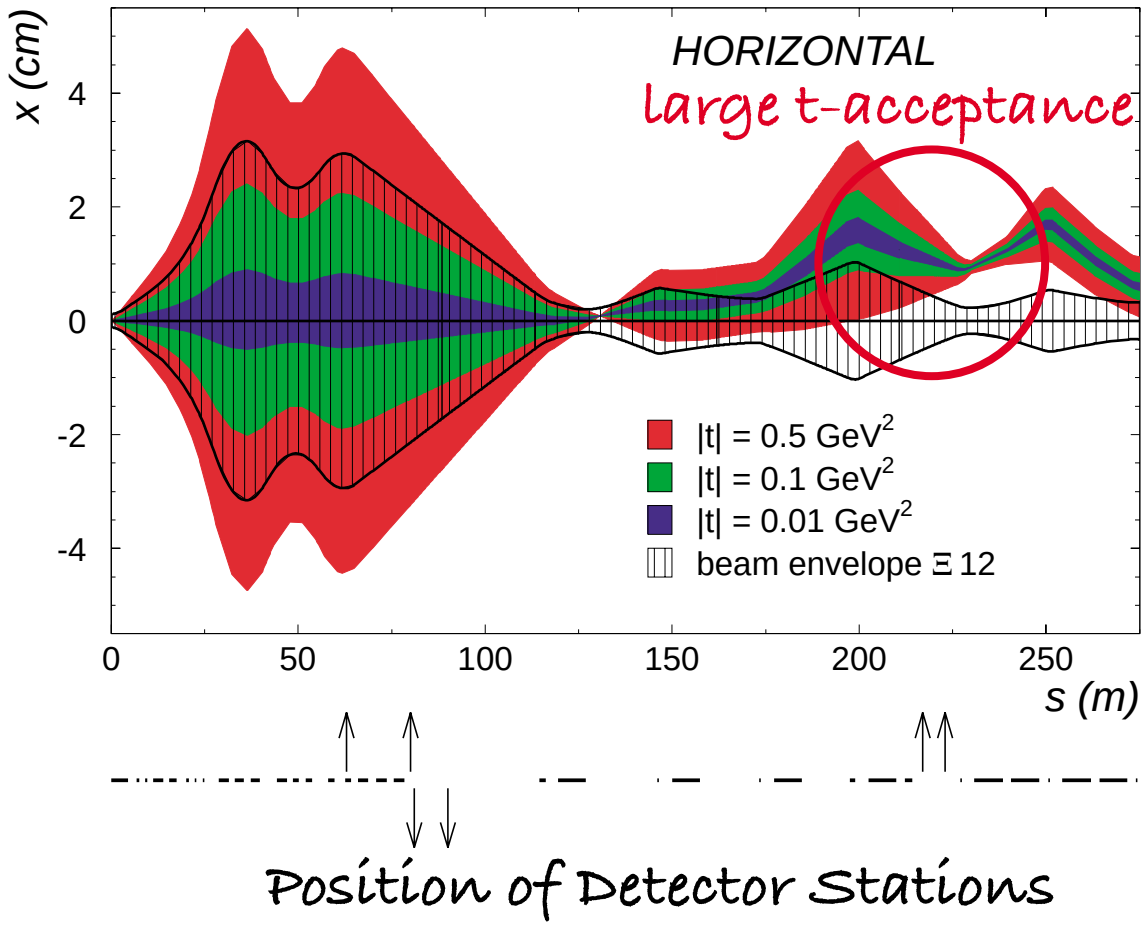
and the $|t|$-dependence



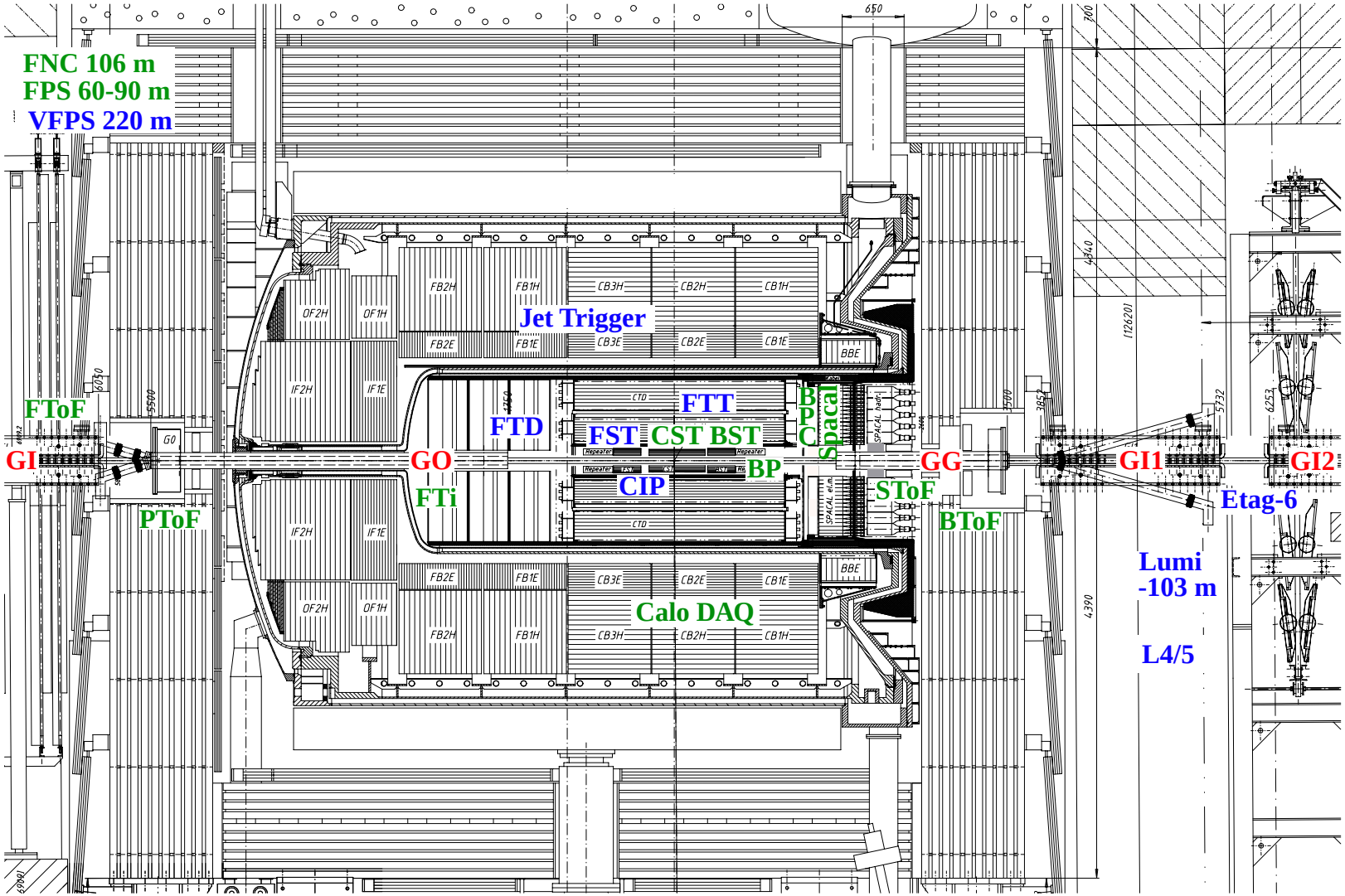
Very Forward Proton Spectrometer

- increase proton acceptance in forward direction for $|t| \leq 0.5$ GeV^2
- at 200 m proton beam is well separated from scattered p (detector has to be installed in cold section of ring)
- detector to be installed in first major shutdown after 2002 running

Benefits for inclusive measurements, VM, jets, charm



Overview of Upgrades



Necessary Modifications of the Forward Direction

Challenges

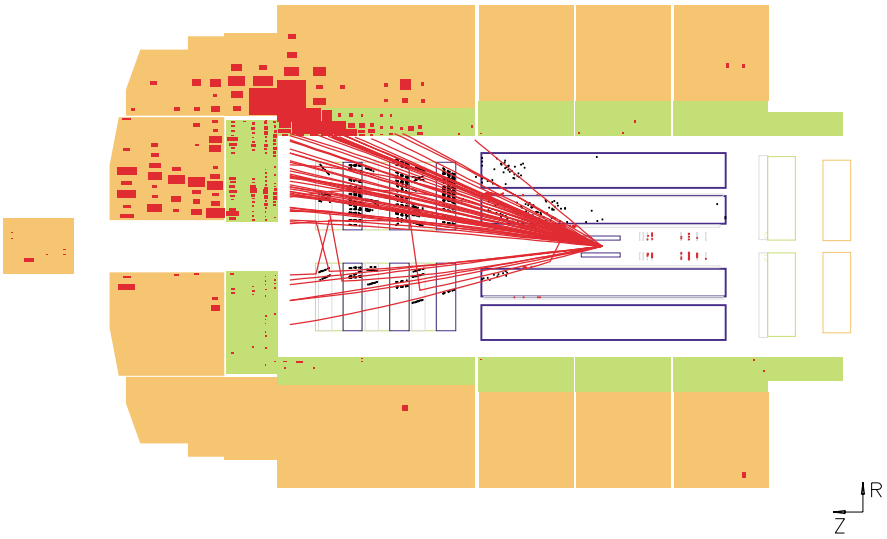
- track density
- separation of electrons/photons and hadrons

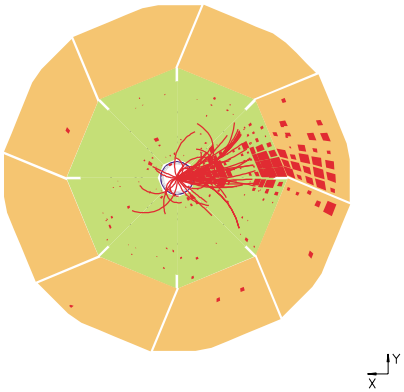
Solution

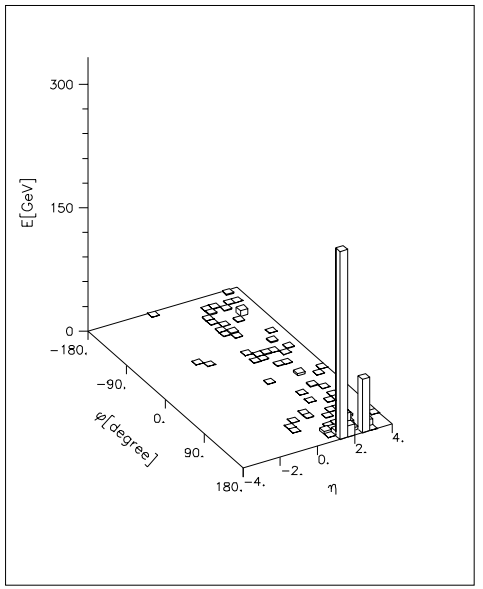
- Forward Tracker (FTD) with more redundancy
- Silicon detector (FST) close to interaction point

CC event

$p_t = 140$ GeV







Detectors take Shape

FTD

- 3 modules
- 8 wire planar chambers replace radial modules and TRD
- more redundancy
- pattern recognition/ambiguities

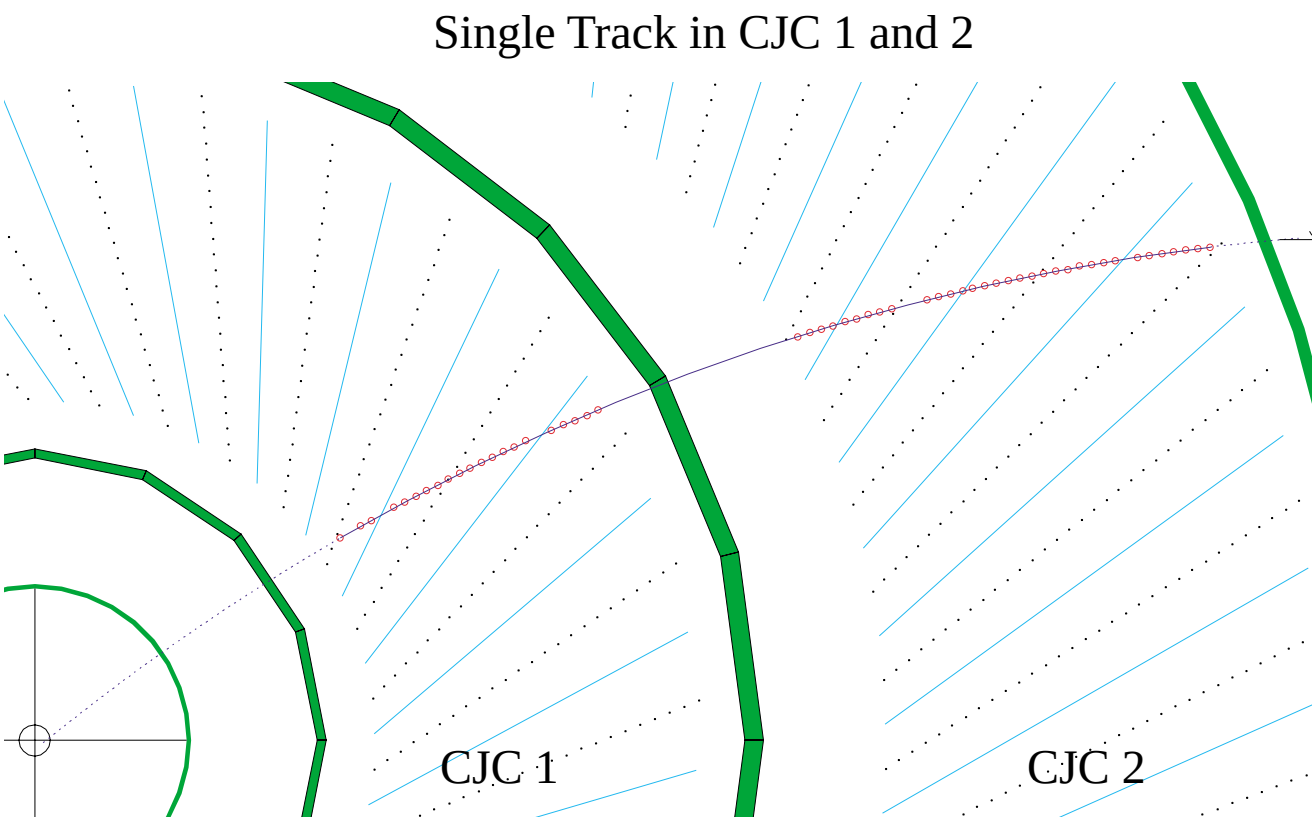
FST

- 5 planes of Si detector to cover small angle acceptance
- design taken from BST
- sophisticated detector insertion mechanism required

Online Heavy Quark Selection

Online Charm and Bottom Selection

- Fast Track Trigger
- Inclusive rates are large and prohibitive at low scales (Q^2 or p_t)
- calorimetric measurement not distinctive at low energy scales
- require track based reconstruction of $\Delta m = m_{K\pi\pi} - m_{K\pi}$

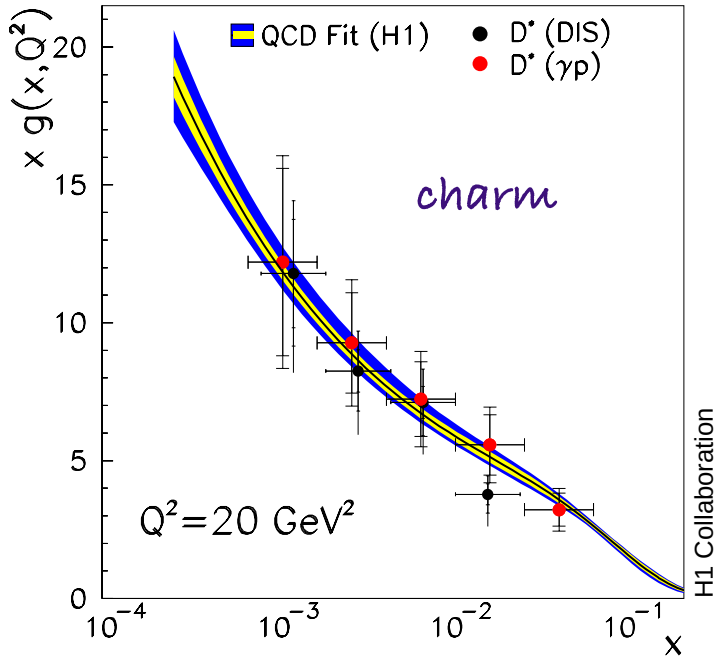


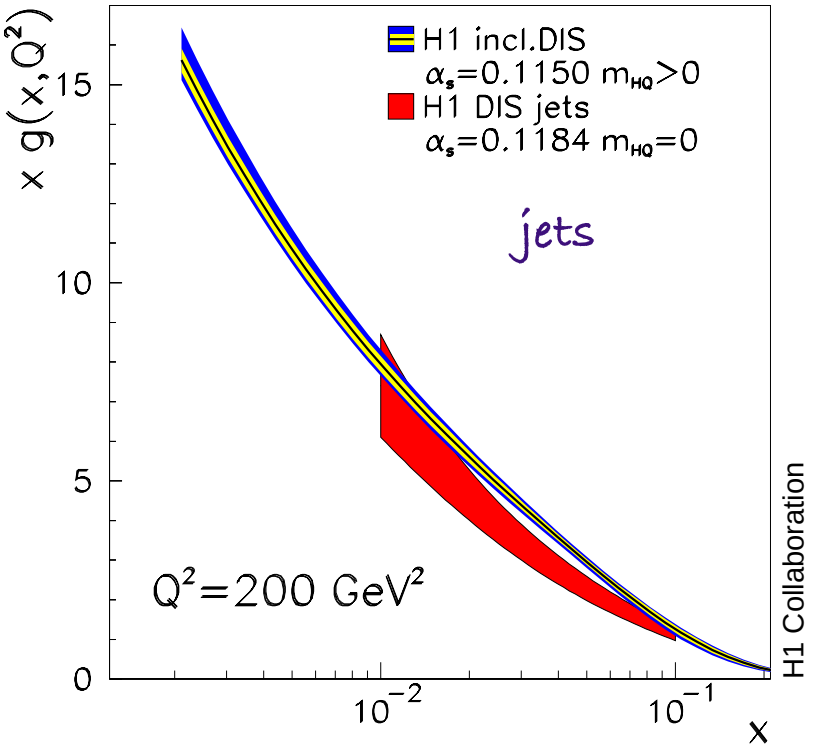
Consistency of the Gluon Extraction

Inclusive F_2

Jet and Charm data

- mass treatment in theoretical description

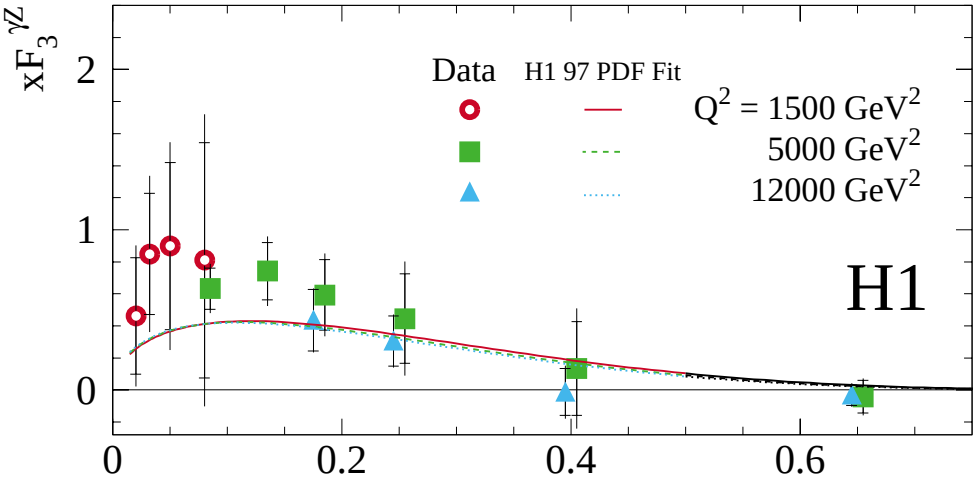


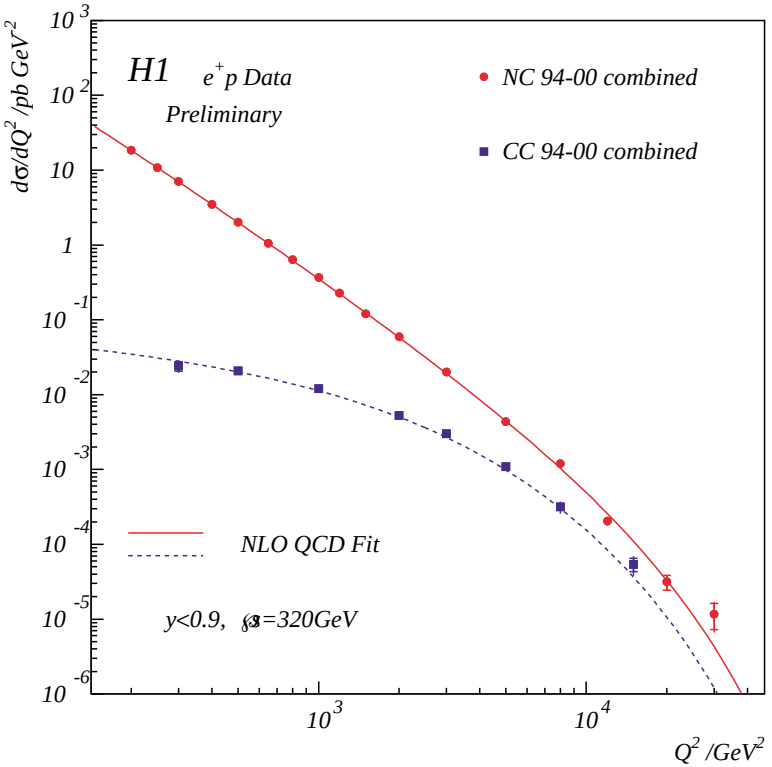


Electroweak Physics

Analysis of Charged and Neutral Current

- at large Q^2 the electromagnetic and weak current assume equal strength
- limited statistics at high Q^2!
- more data, in particular for e^- beams required to explore high Q^2 region

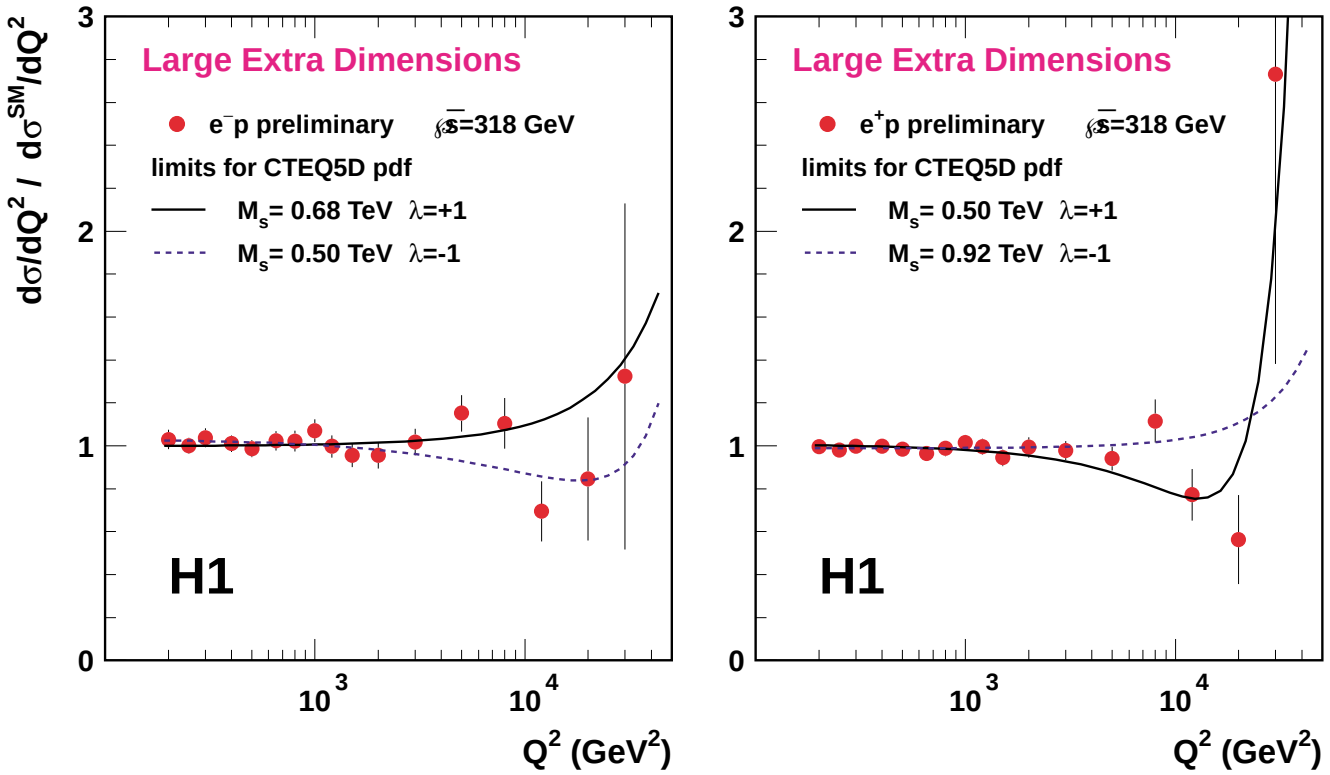




Exploration of the kinematic limit

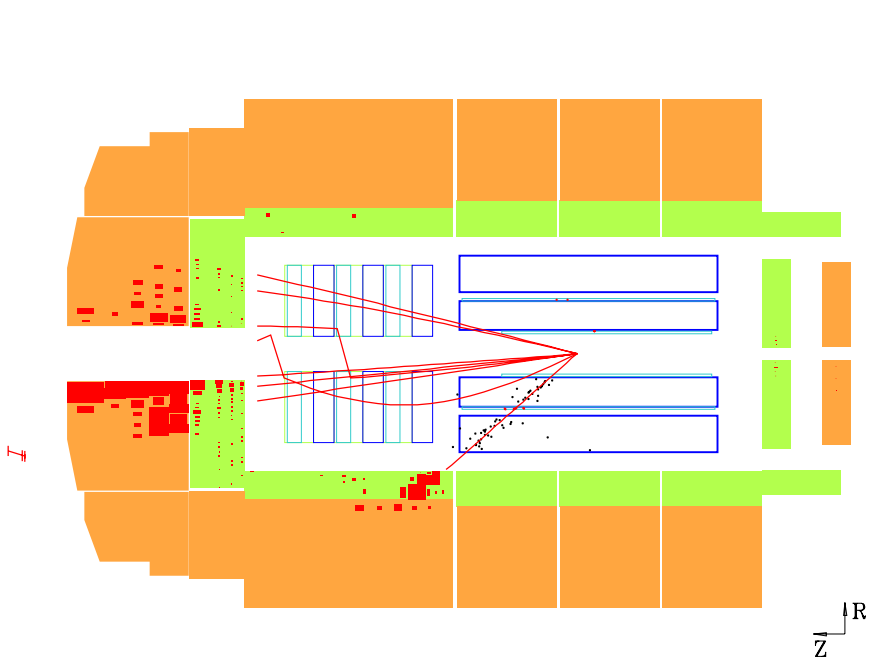
High Q^2 data

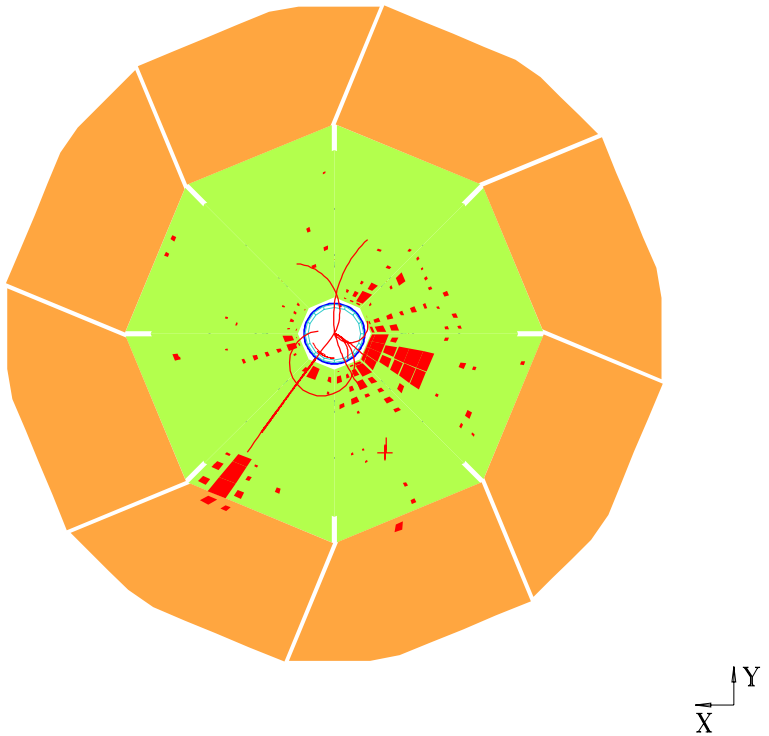
- Search for indirect effects at the kinematic limit
- Example: Extra Dimen-sions
- More data at the highest possible Q^2 (Can we still increase E_p?)



High p_t Leptons with missing Transverse Momentum

...another event with p_t^X>25 GeV

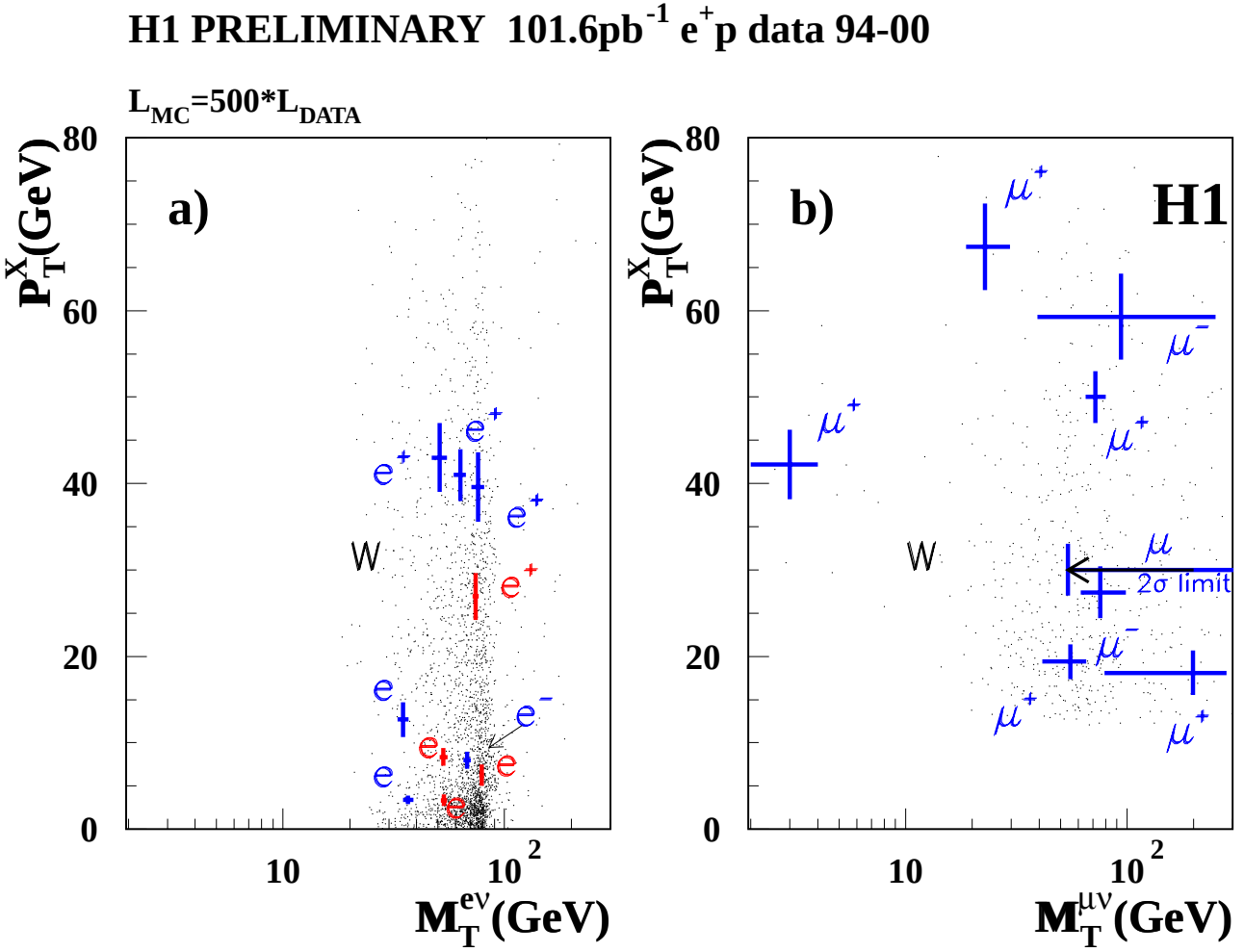




High p_t Leptons with missing Transverse Momentum

High pt μ and e

- H1:
  18 events seen
  ~10 expected
  for p_t^X>25 GeV:
  10 seen for ~3 expected.
- ZEUS:
  good agreement with expectation
- Statistical fluctuation of background or new signal.



Conclusions

At the dawn of HERA II...

H1 well prepared for more inclusive and exclusive measurements

- new components to measure with better precision are in place
- upgrades in trigger provide selectivity for rare processes
- HERA will deliver the rate

...theory has to follow suite

- theory of QCD suffers from lack of higher order calculations
- diffractive exchange only partially understood

Detector has moved back into beam position on 29.3.2001