The HERA III Project

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Future eN Scattering Measurements at HERA

➢ The potential of HERA is by far not explored with ep
➢ Next steps considered here constitute a 10 years programme

Two Letters of Intent

HERA is the largest microscope ever built and THE QCD machine par excellence with 1000 authors on H1,ZEUS and HERMES

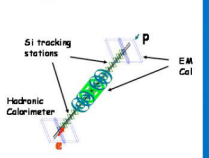
Electron-Deuteron Scattering at HERA

Low x ep in the „Transition Region"

Heavy Nuclei eA and High Density QCD

Collider Spin Physics

A New Detector to Study Strong Interaction Physics



- 23 institutes and 62 physicists
- Focus on low Q^2 ($0.1..100\ GeV^2$) and on small x
- Backward : F_L
- Forward : QCD parton radiation
- ep, eD, eA, option for spin at low x
- a new, dedicated apparatus

Compact : fits in dipole magnet with inner radius of 80 cm
Long : |z|≤9 m

A letter of intent for Experimentation with H1

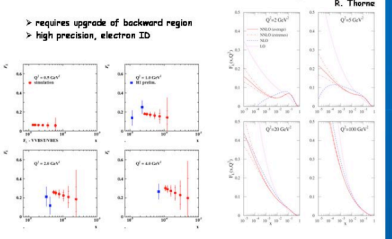
- 42 institutes and 167 physicists
- 23 institutes are H1 members
- tagged ed scattering including diffraction

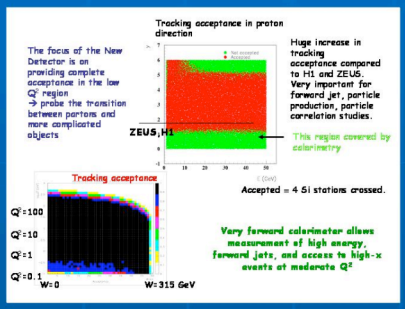
options considered are
- low x, Q^2 ~1 GeV^2: F_L
- heavy nuclei : eO, eCa, eHg
- polarised ep,ed

Measurement of F_L

R. Thorne

➢ requires upgrade of backward region
➢ high precision, electron ID





The focus of the New Detector is on providing complete acceptance in the low Q^2 region
→ probe the transition between partons and more complicated objects

Huge increase in tracking acceptance compared to H1 and ZEUS. Very important for forward jet, particle production, particle correlation studies.

This region covered by calorimetry

Accepted = 4 Si stations crossed.

Very forward calorimeter allows measurement of high energy, forward jets, and access to high-x events at moderate Q^2

Electron-Deuteron Scattering at HERA

➢ describe baryonic matter

➢ determine neutron structure at high Q2 and high x, and at low x

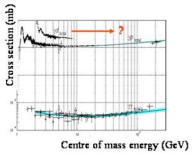
➢ unfolding of PDF's (low x → superhigh energy neutrino physics, LHC)

ed at HERA much richer than at fixed target experiments due to

➢ tagging of spectators (measuring $p(p_{spectator})$ and reconstruct en → eX)

➢ diffraction which is related to shadowing

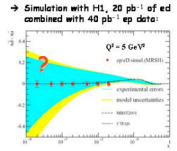
➢ charged currents at high Q2



Surprisingly little is known about the deuteron, and hence the neutron, at high energies !

Parton Distributions at Low x $\bar{d} - \bar{u}$?

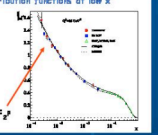
→ Simulation with H1, 20 pb^{-1} of ed combined with 40 pb^{-1} ep data:



$$\frac{1}{2}\left(F_2^p + F_2^n\right) - F_2^p = x\left(\frac{1}{2}\bar{d}_v - \frac{1}{2}\bar{u}_v + \frac{1}{2}\bar{d} - \frac{1}{2}\bar{u}\right) \approx \frac{1}{2}x\left(\bar{d} - \bar{u}\right) \text{ at low } x.$$

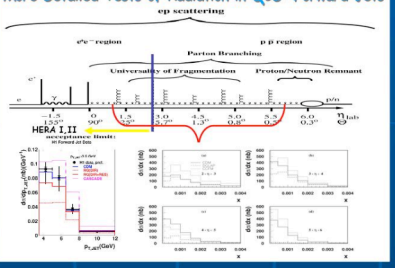
- Shadowing corrections can be applied with required precision.
- Important for LHC, e.g. luminosity determination via

→ Requires knowledge of sea quark distribution functions at low x

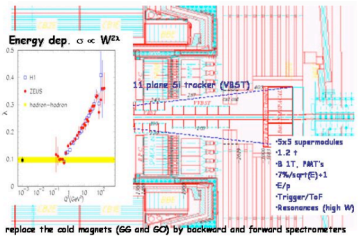


Determine quark flavour responsible for rise of F_2

More Detailed Tests of Radiation in QCD: Forward Jets



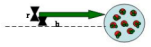
Low x and the transition from DIS to the nonperturbative regime

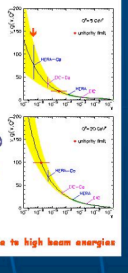


replace the cold magnets (GG and GO) by backward and forward spectrometers

Precision eA Measurements

- Enhancement of possible nonlinear effects (saturation)





At small x, the scattering is coherent over nucleus, so the diquark sees much larger # of partons:

$xg(x_{eff},Q^2) = A^{1/3}\, xg(x,Q^2)$, at small-x, $xg \propto x^{-\lambda}$, so

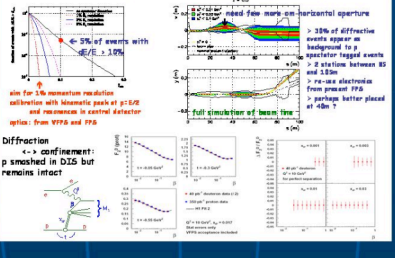
$x_{eff}^{-\lambda} = A^{1/3} x^{-\lambda}$ so $x_{eff} \approx xA^{-1/3\lambda} \approx xA^{-\frac{1}{3}}$ ($Q^2 < 1\ GeV^2$)
$\approx xA^{-1}$ ($Q^2 \approx 100\ GeV^2$)

- low x - field strength high, large Q2 - color coupling weak
  → unitarisation effects
  → new state of matter → Color Glass Condensate
- deconfinement
- nuclear parton distributions (RHIC, ALICE)

exploratory at lowest x - unique due to high beam energies

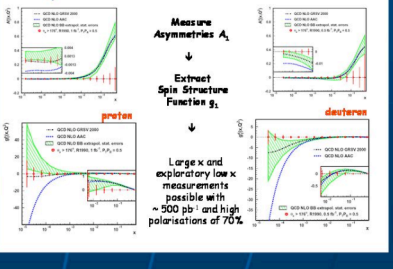
Diffractive Phenomena using Tagging of p, n or d

reconstruct en kinematics (reduce Fermi motion) by measuring spectator proton



Diffraction <-> confinement: p smashed in DIS but remains intact

Spin Structure of Protons and Deuterons



Let's take advantage of the full potential of HERA to answer some fundamental questions !

Compiled by Uta Stoesslein