Elastic vs. inelastic scattering

elastic scattering (LI form) for spin=1/2 particles - Rosenbluth formular

$$\frac{d\sigma}{dQ^2} = \frac{4\pi\alpha^2}{Q^4}\left[\frac{G_E^2(Q^2)+\tau G_M^2(Q^2)}{1+\tau}\left(1-y-\frac{m_p^2 y^2}{Q^2}\right)+\frac{1}{2}y^2 G_M^2(Q^2)\right]$$

$$= \frac{4\pi\alpha^2}{Q^4}\left[f_2(Q^2)\left(1-y-\frac{m_p^2 y^2}{Q^2}\right)+\frac{1}{2}y^2 f_1(Q^2)\right]$$

$Q = -q$: 4-momentum transfer

$y = \frac{p_2\, q}{p_2\, p_1}$ (fractional energy loss, depend on Q^2 alone for el. scattering)

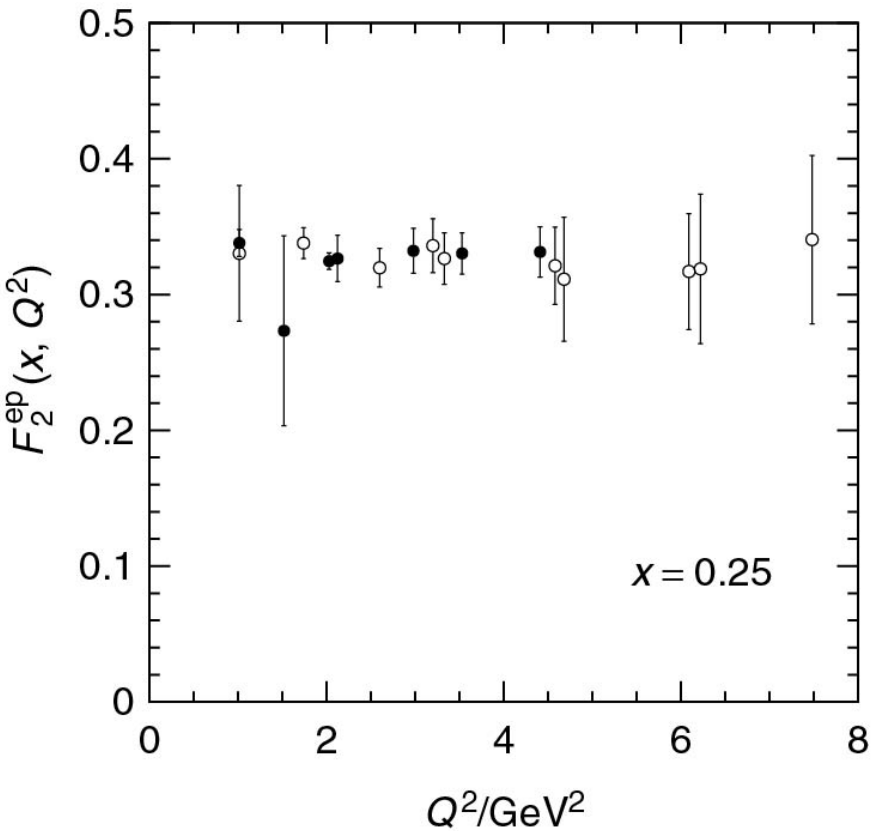
for point-like particles (Dirac particles) $f_1(Q^2) = f_2(Q^2) = 1$

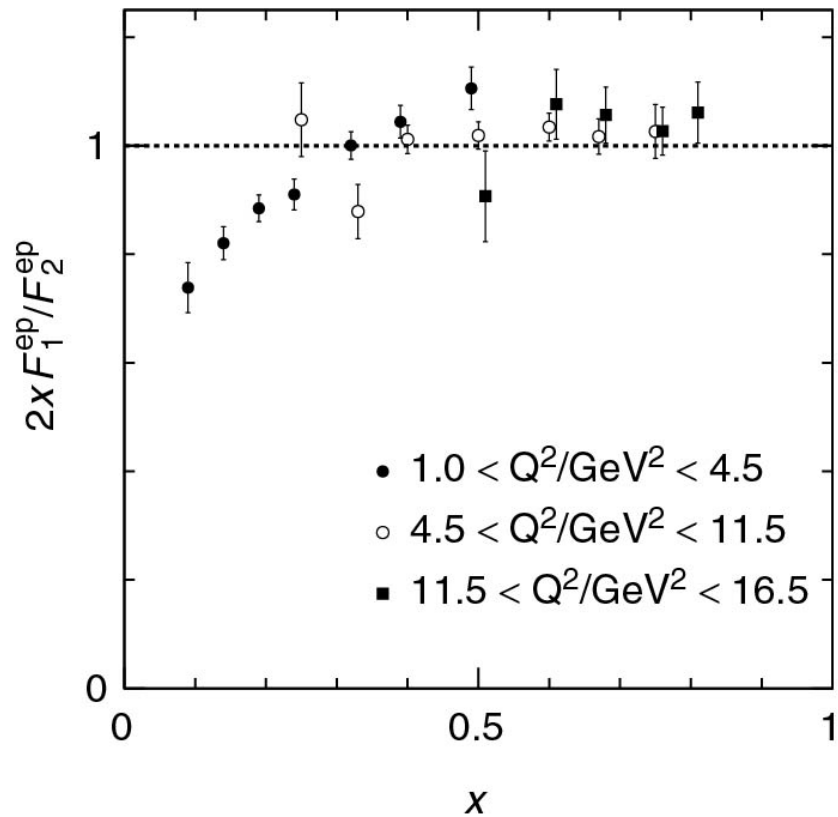
Inelastic scattering (LI form)

$$\frac{d^2\sigma}{dx\, dQ^2} = \frac{4\pi\alpha^2}{Q^4}\left[\frac{F_2(x,Q^2)}{x}\left(1-y-\frac{m_p^2 y^2}{Q^2}\right)+y^2 F_1(x,Q^2)\right]$$

$F_1(X,Q^2)$, $F_2(x,Q^2)$ are called structure functions

Inelastic scattering

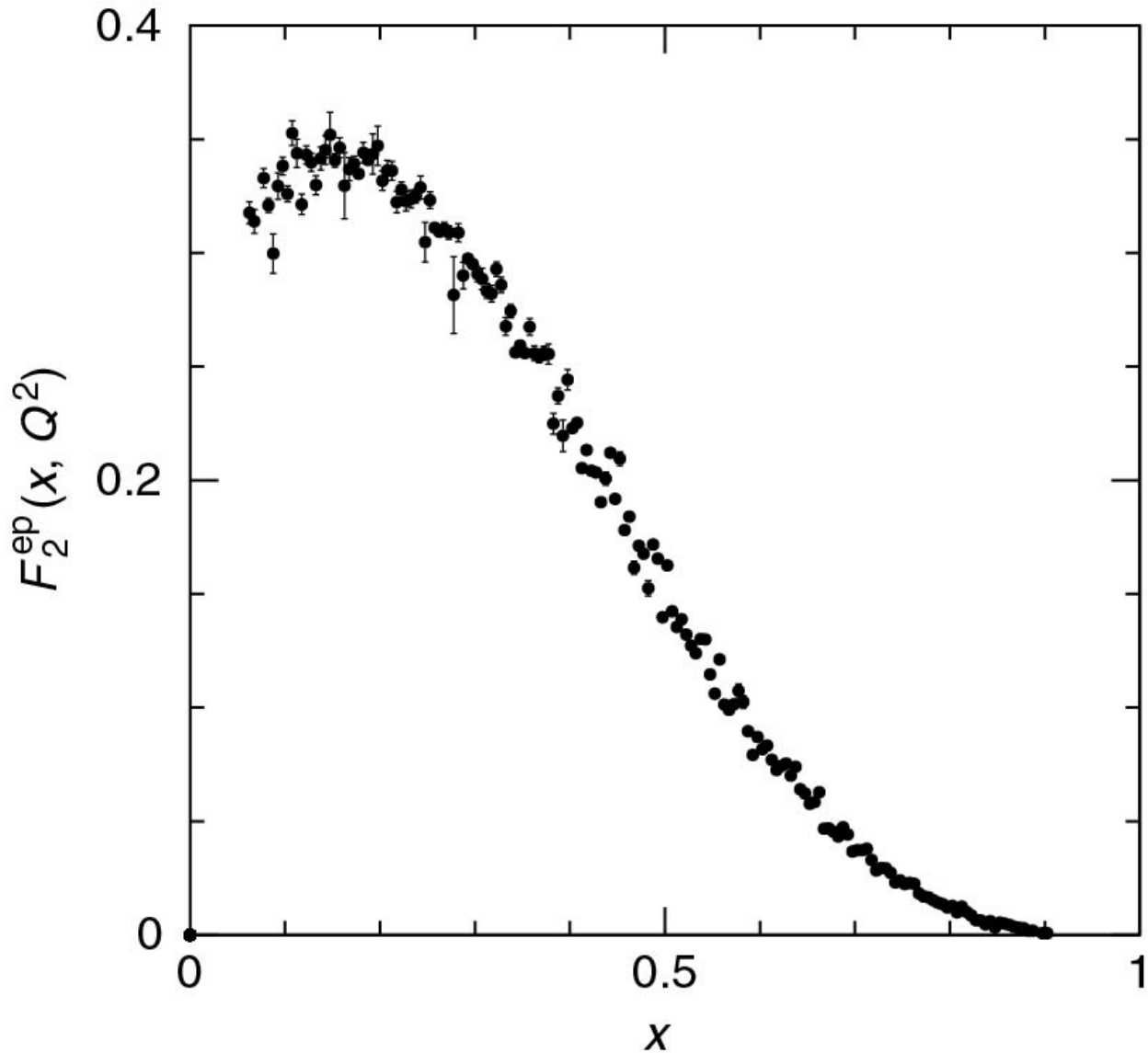




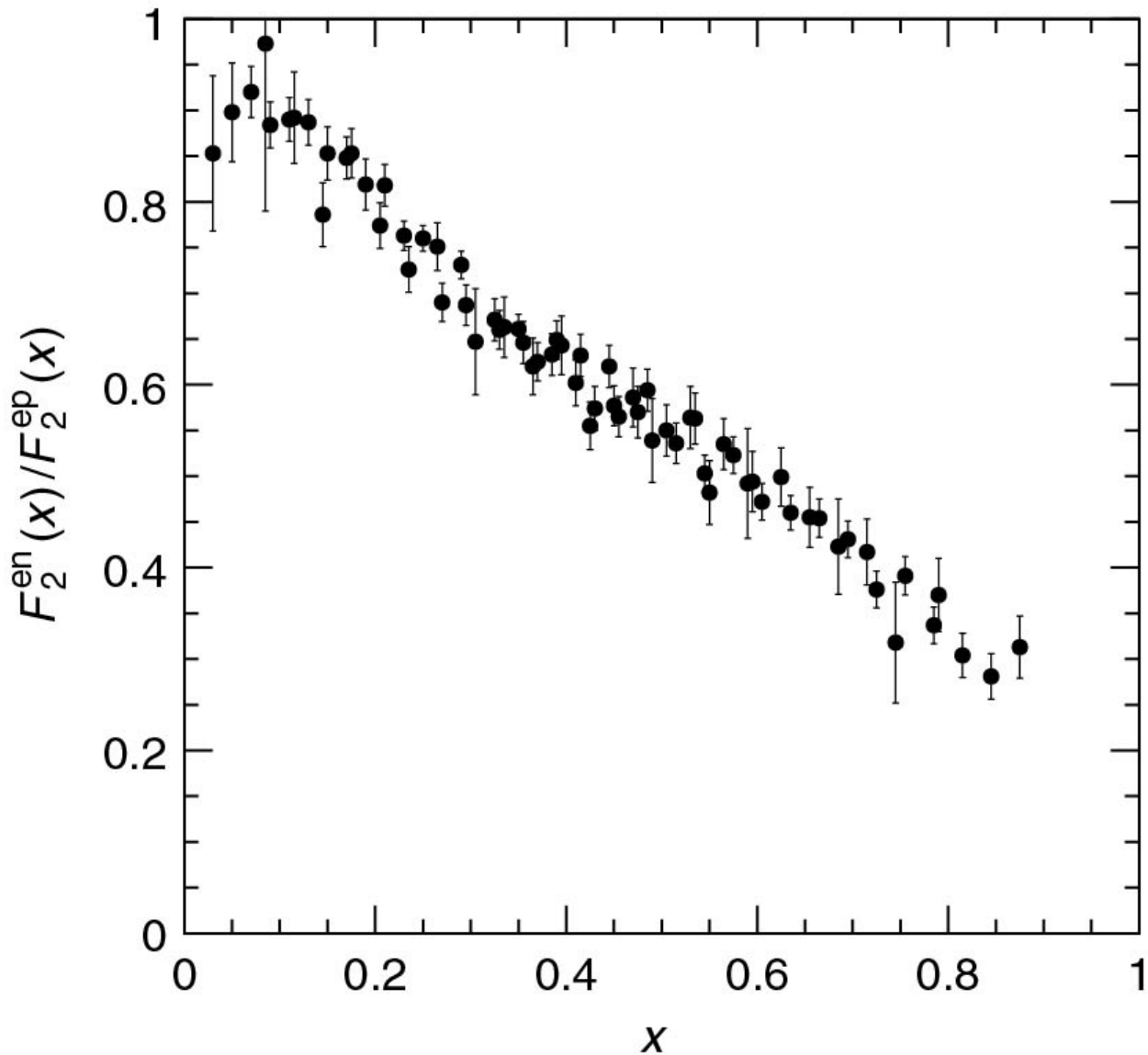
The proton consists of Dirac (point-like Spin 1/2) particles!

Callan-Cross relation $F_2(x, Q^2) = 2xF_1(x, Q^2)$

Measurement of structure function

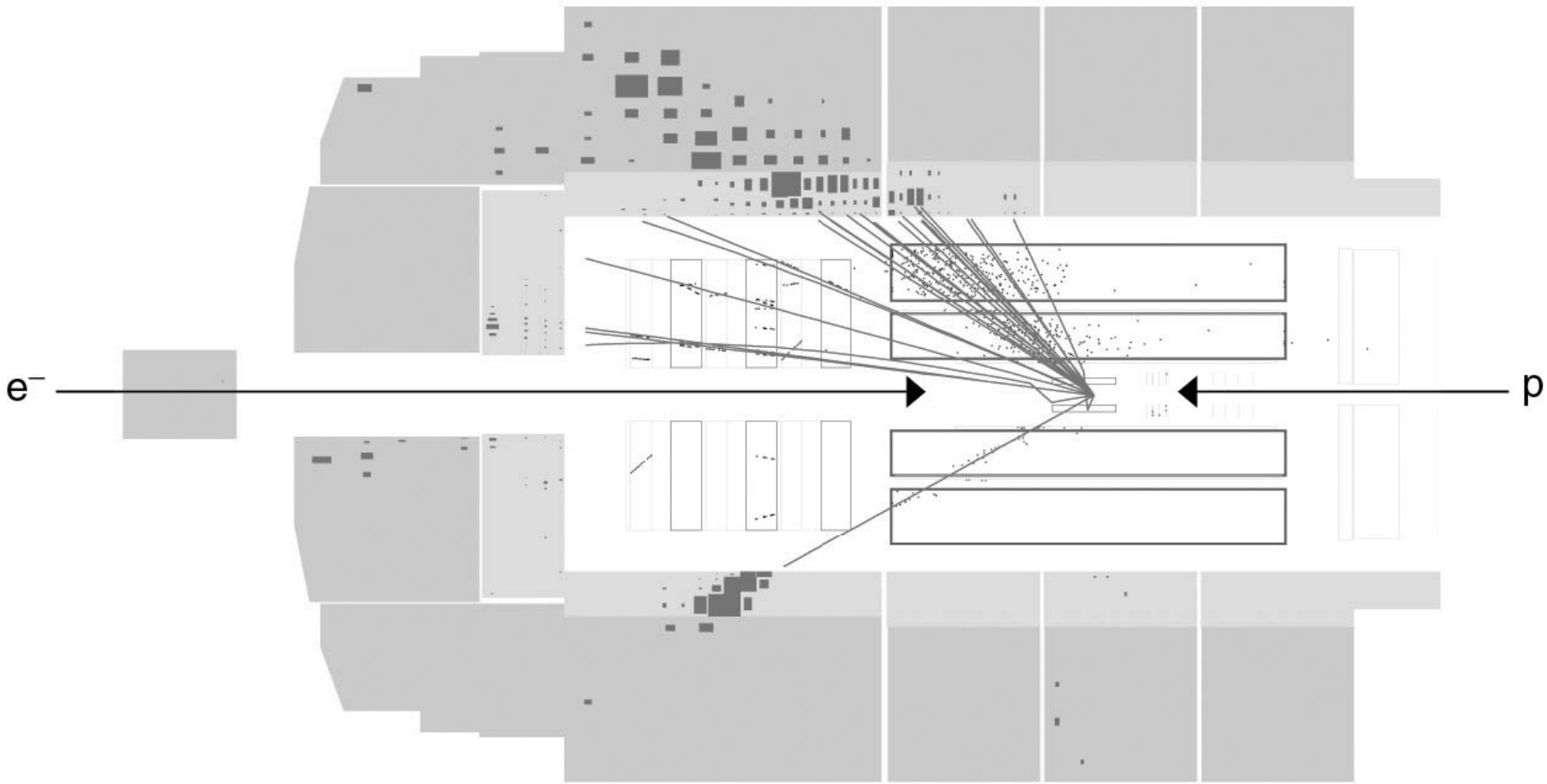


Ratio of Form Factors



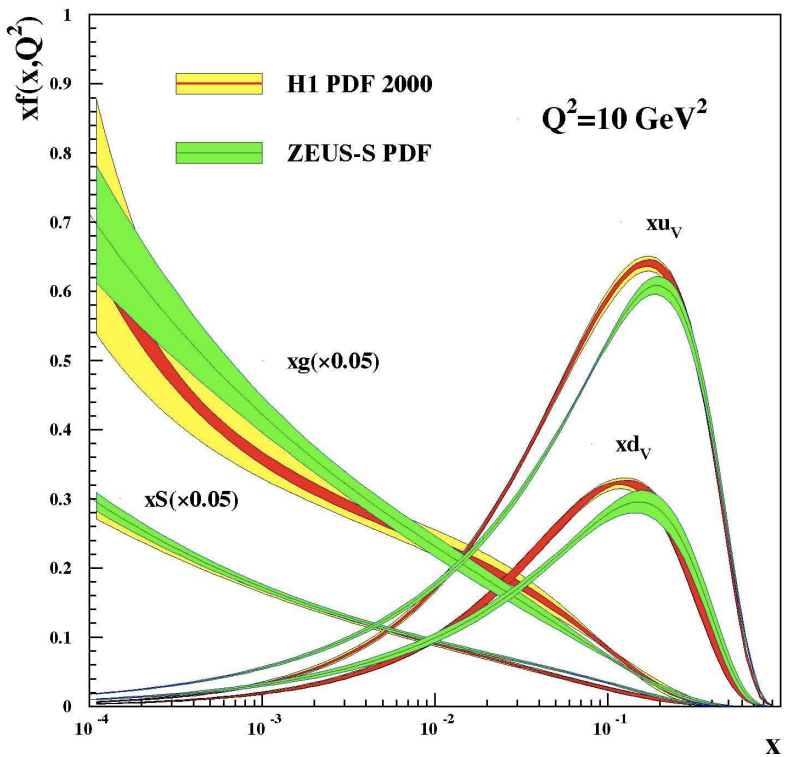
H1 at HERA

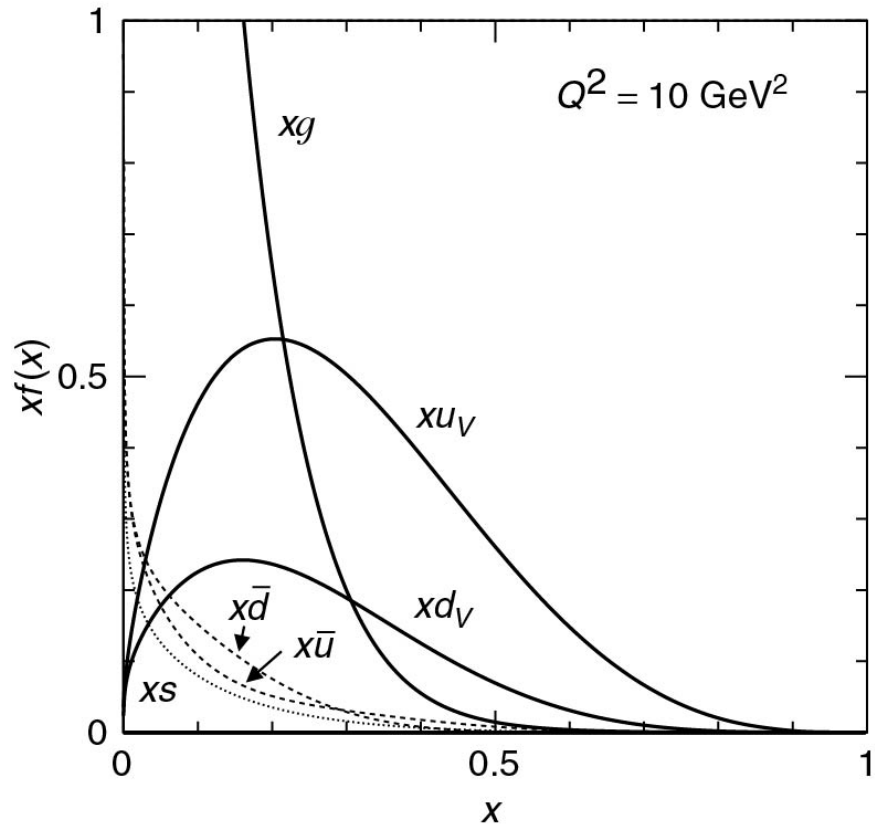
Two detectors measureing structure functions located at HERA/DESY (1991-2007): ZEUS & H1



$E_e = 27.5GeV$, $E_p = 820$ or $920GeV$

H1 at HERA


xf(x,Q²)
H1 PDF 2000
ZEUS-S PDF
Q²=10 GeV²
xu_V
xg(×0.05)
xd_V
xS(×0.05)
x


Q² = 10 GeV²
xg
xu_V
xd_V
xd̄
xū
xs
xf(x)
x

Structure functions