The $F_L(x,Q^2)$ Structure Function.

R. Debbe

The neutral current inclusive e-nucleon cross section can be written as a combination of two terms:

$$\sigma_r(x, Q^2, y) = \frac{d^2\sigma}{dxdQ^2} \cdot \frac{Q^4 x}{2\pi\alpha^2 Y_+} = F_2(x, Q^2) - \frac{y^2}{Y_+} \cdot F_L(x, Q^2)\ ,$$

"reduced cross section"

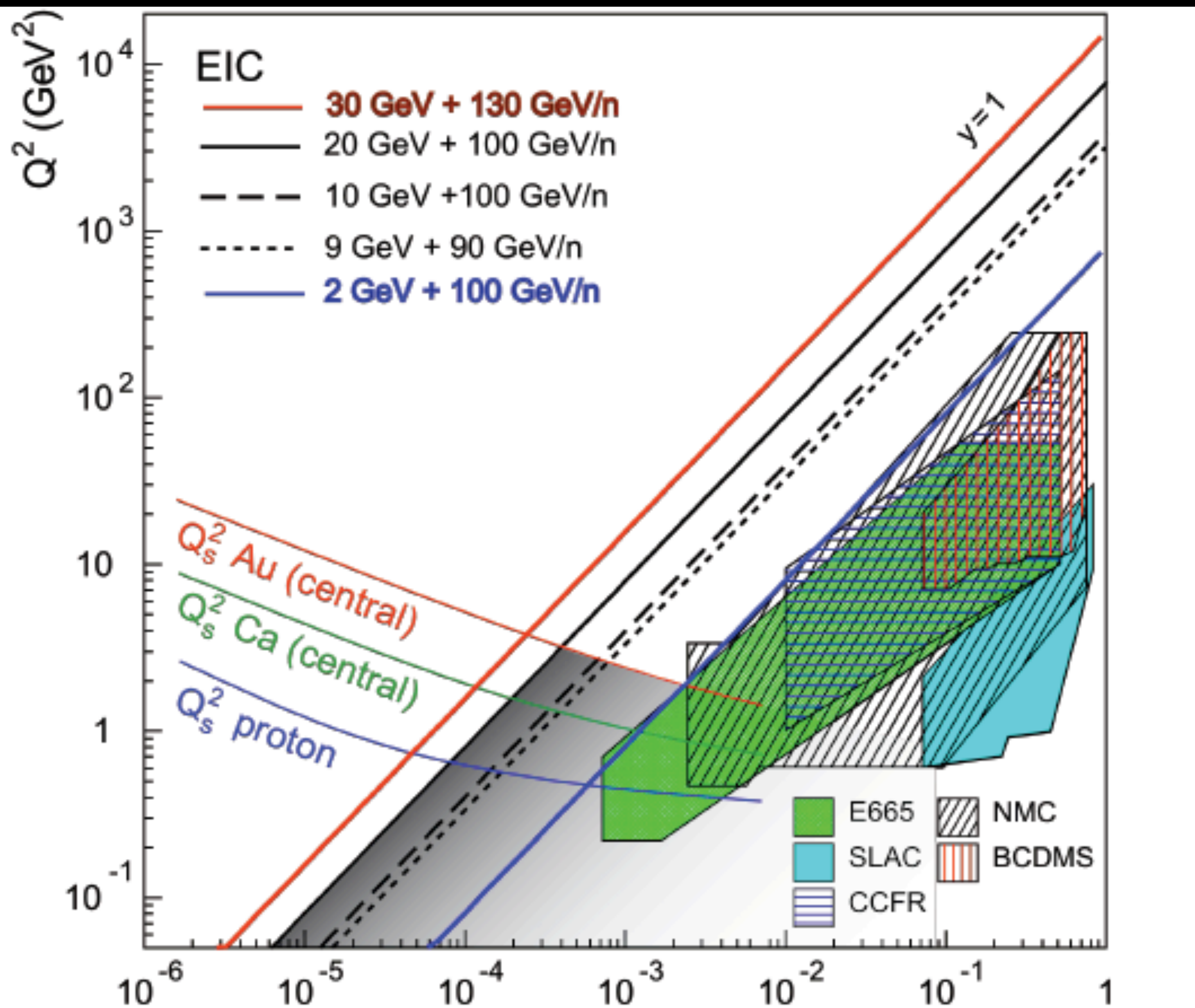
$F_2 \alpha (\sigma_T + \sigma_L)$ $F_L \sim \sigma_L$ where σ_T and σ_L are the γ^*P cross sections for transverse and longitudinally polarized virtual photons. The value of F_2 is determined by the sum of quark and anti-quark distributions, whereas F_L depends on quark + gluon distributions. Above some value of $Q^{2,}$ quark PDFs are much smaller than gluon PDFs hence F_L is mainly "driven" by gluon PDFs

The measurement has experimental difficulties: The highest sensitivity is obtained at high values of $y = Q^2/sx$, at low values of Q^2 high y corresponds to low energy of the scattered e that can be obscured by hadronic background. (One possible reason to have redundant electron PID).

The FL measurements is done at different values of y for fixed x and Q2. (at HERA they fix the e+ beam energy and change the energy of the proton beam.

Jamie does something similar with two calculators of e-p scattering GRB98 and MRST.
Both calculations produce cross sections in bins of x and Q^2 at six beam energy combinations:

data ela / 5., 10., 5., 10., 10., 5./
data epa / 50., 50., 250., 250., 100., 100. /



James Dunlop

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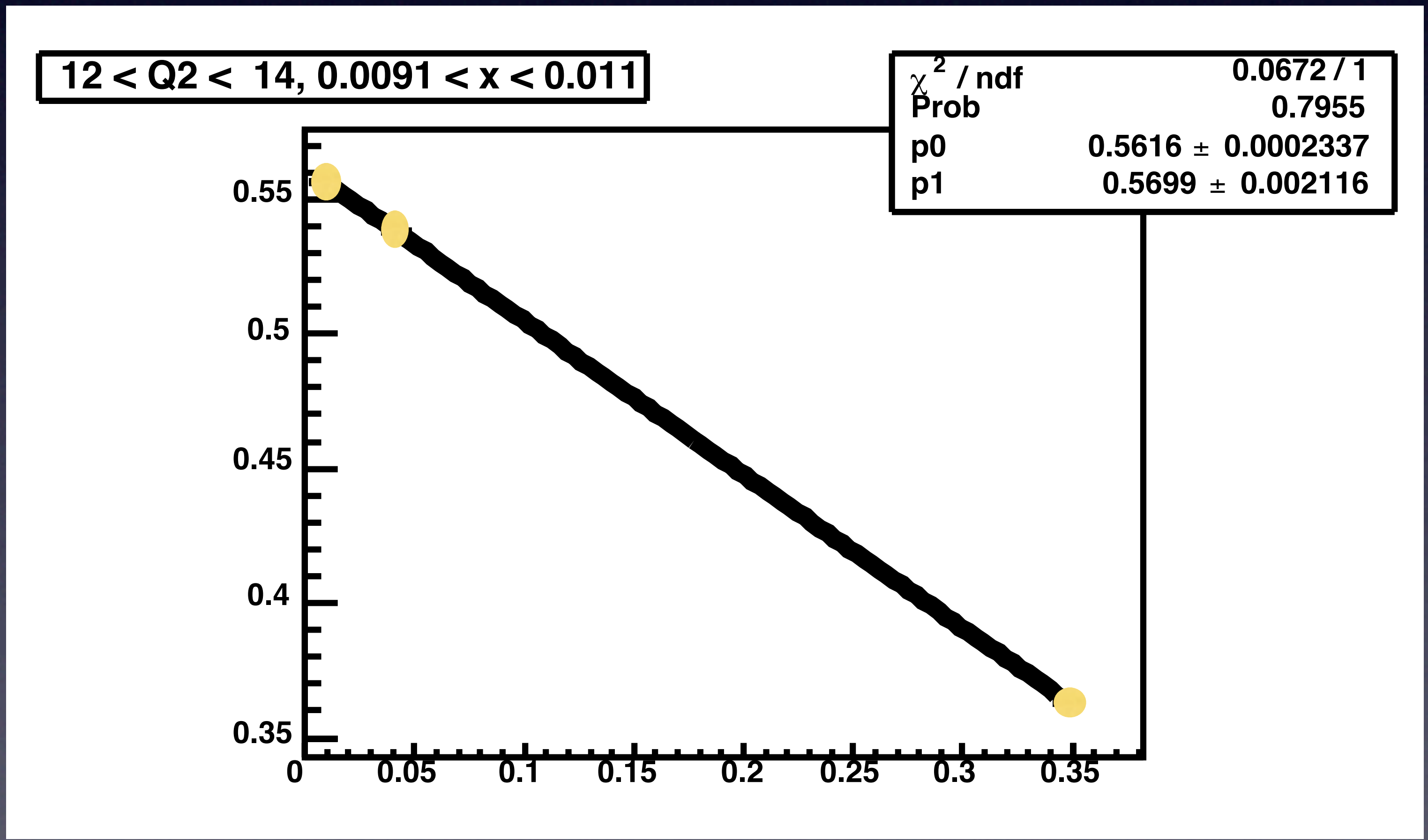
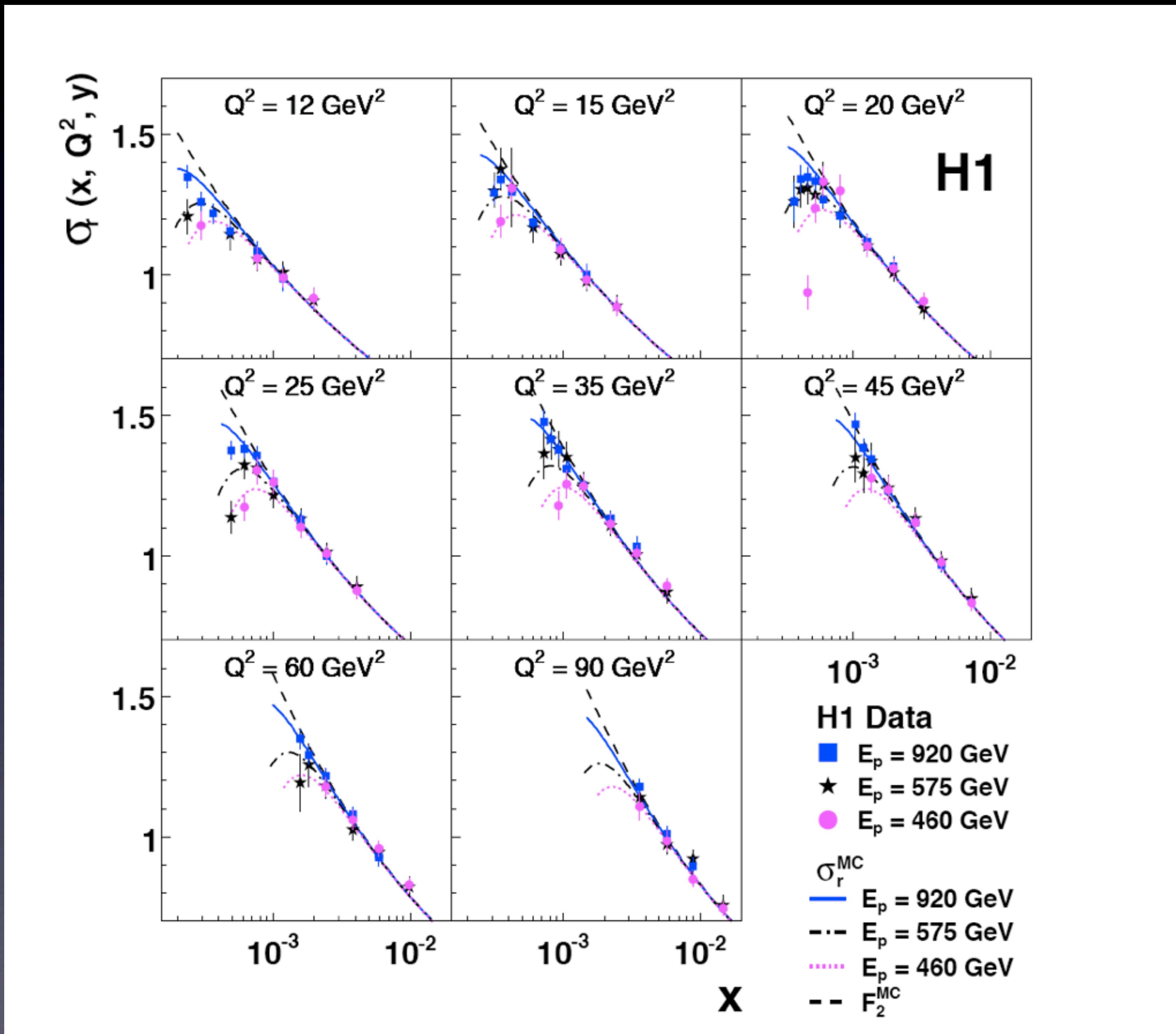
For Q^2 and x bins the data is plotted as counts versus y^2/Y_+ and each plot is fitted to a line: the intercept is equal to F_2 and the slope is F_L.

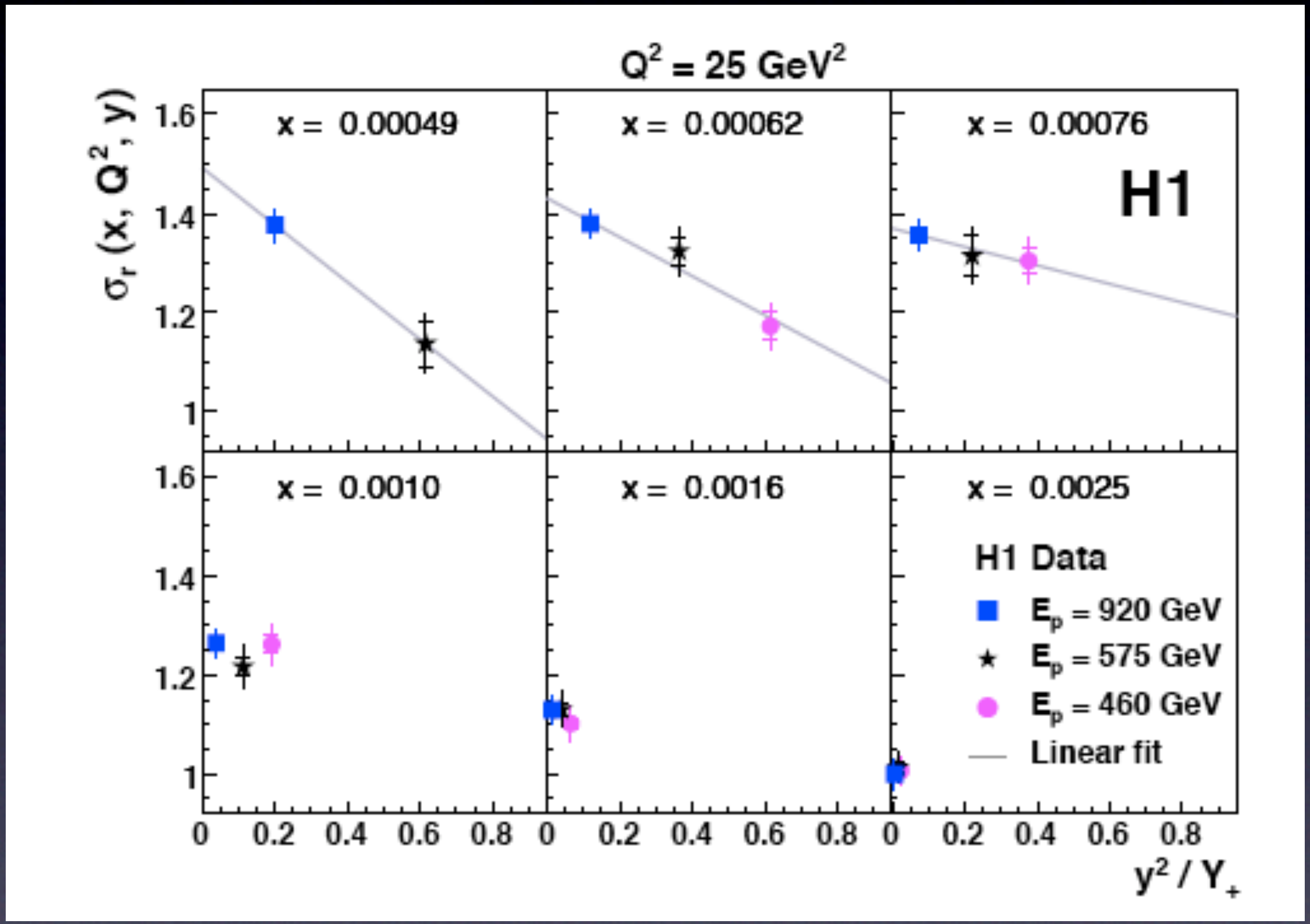




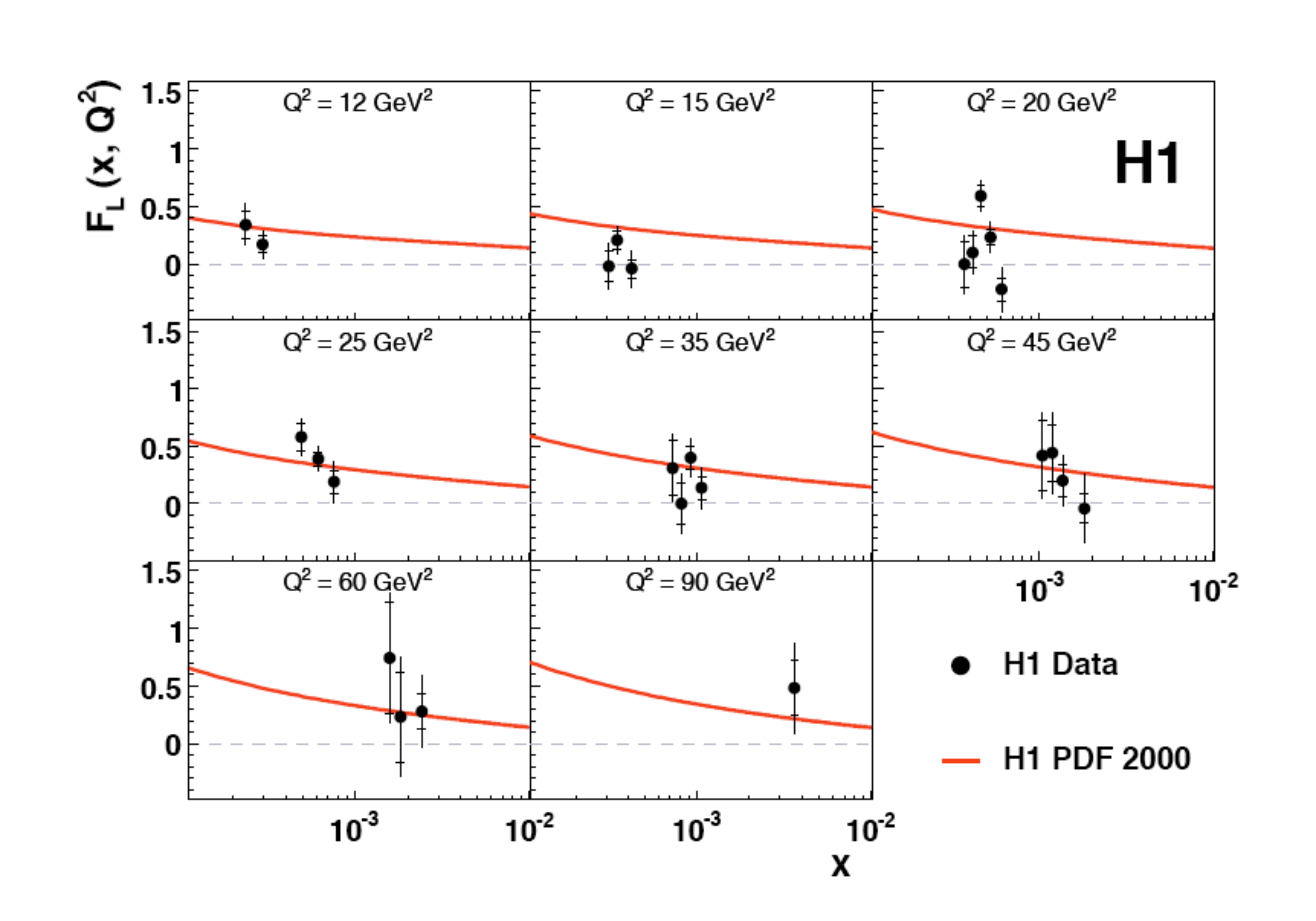
The first F_L measurement in a collider: H1 and Zeus.

H1 has a publication in the arXiv: hep-ex:0805.2809v2

Zeus results are still a collaboration document.

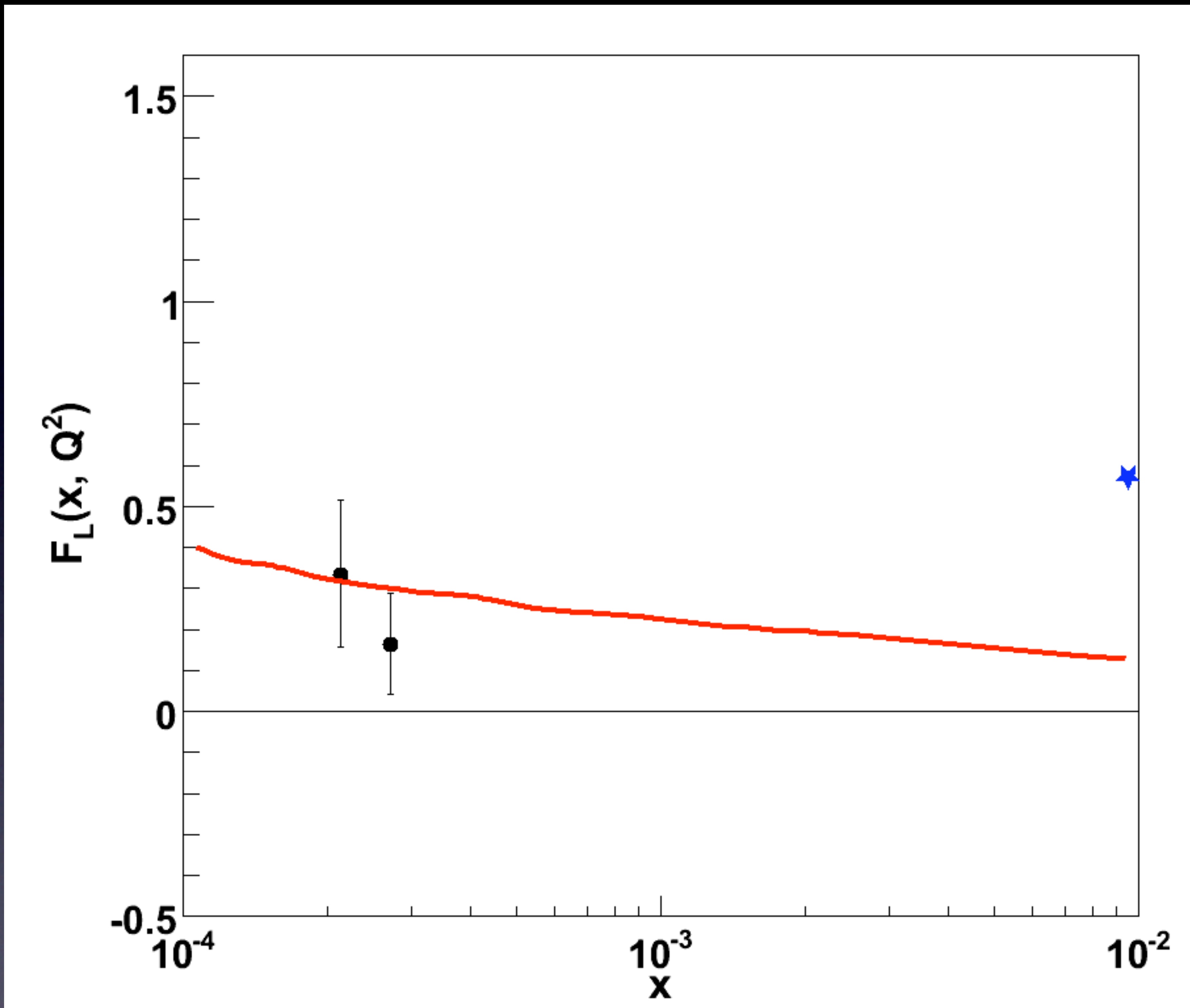


Linear fits to measurements at different y at fixed x and Q^2.



$F_L(x, Q^2)$
$Q^2 = 12$ GeV^2
$Q^2 = 15$ GeV^2
$Q^2 = 20$ GeV^2
$Q^2 = 25$ GeV^2
$Q^2 = 35$ GeV^2
$Q^2 = 45$ GeV^2
$Q^2 = 60$ GeV^2
$Q^2 = 90$ GeV^2
H1
H1 Data
H1 PDF 2000
x

H1 measurement at Q^2=12 GeV^2



The **blue star** is a value obtained by Jamie with the MRST calculation. (Statistical errors is smaller than the marker)

H1 at Q^2=12GeV^2

Things to do:

- Extend the range of y.
- Produce data in the H1 range to see how good are these calculations.
- Event generator with a simple detector geometry.
- Try other models.