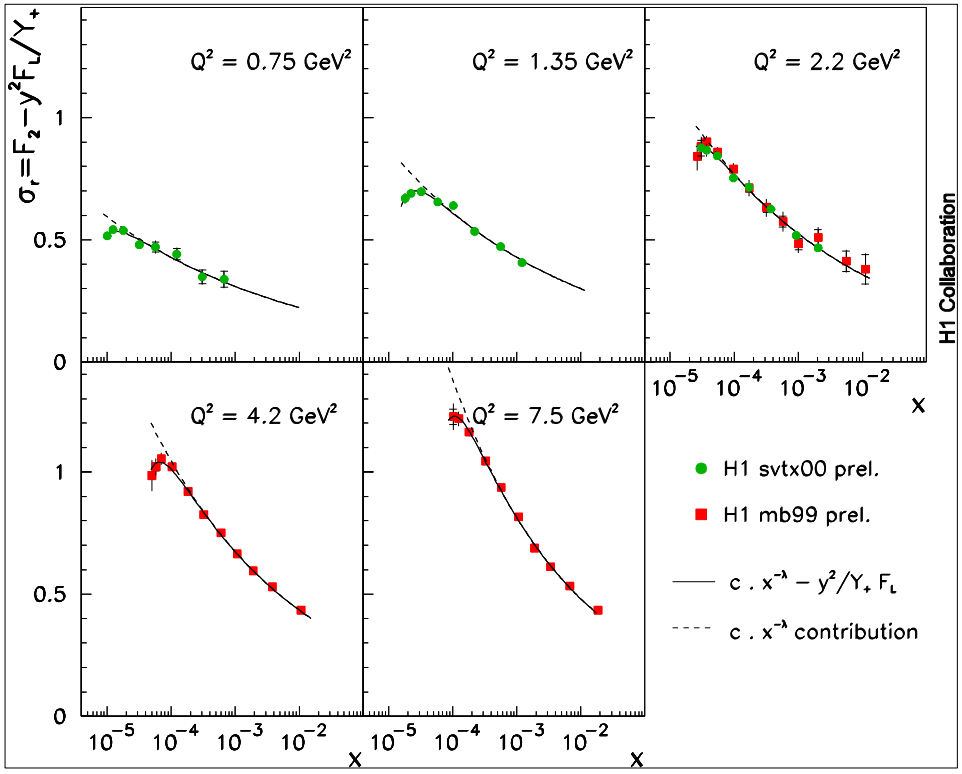
On the Future Measurement of the Longitudinal Structure Function

Max Klein
DESY Zeuthen

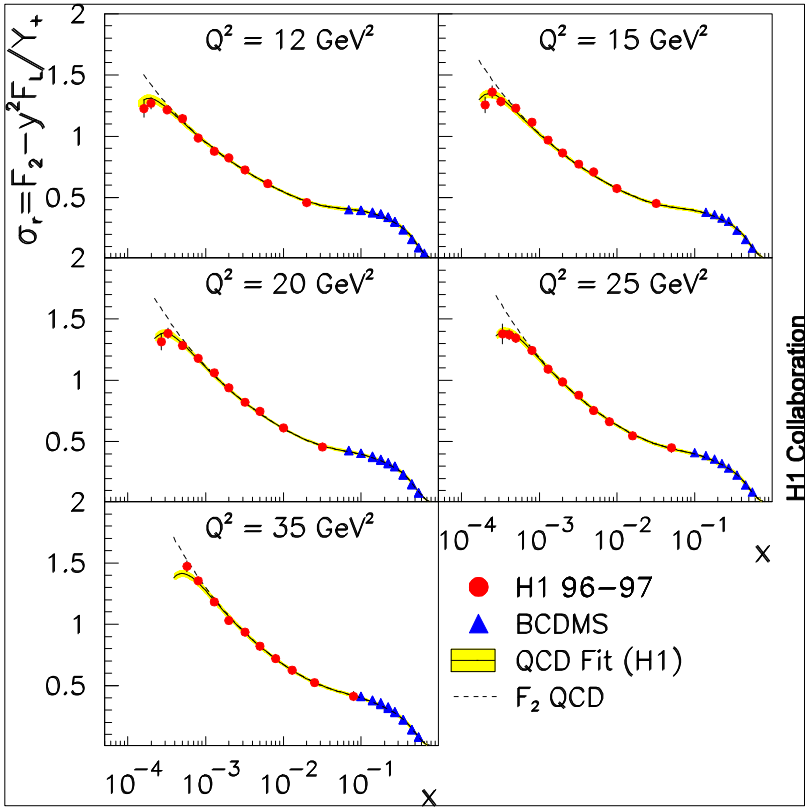
$$s_r = F_2 - y^2/[1+(1-y)^2]\cdot F_L = F_2(x,Q^2) - f(y)\cdot F_L(x,Q^2)$$

Needs accurate measurement at high y and a variation of y at fixed x,Q2

Present an update of L.Bauerdick, A.Glazov, MK (HERA WS 1996/97), hep-ph/97...

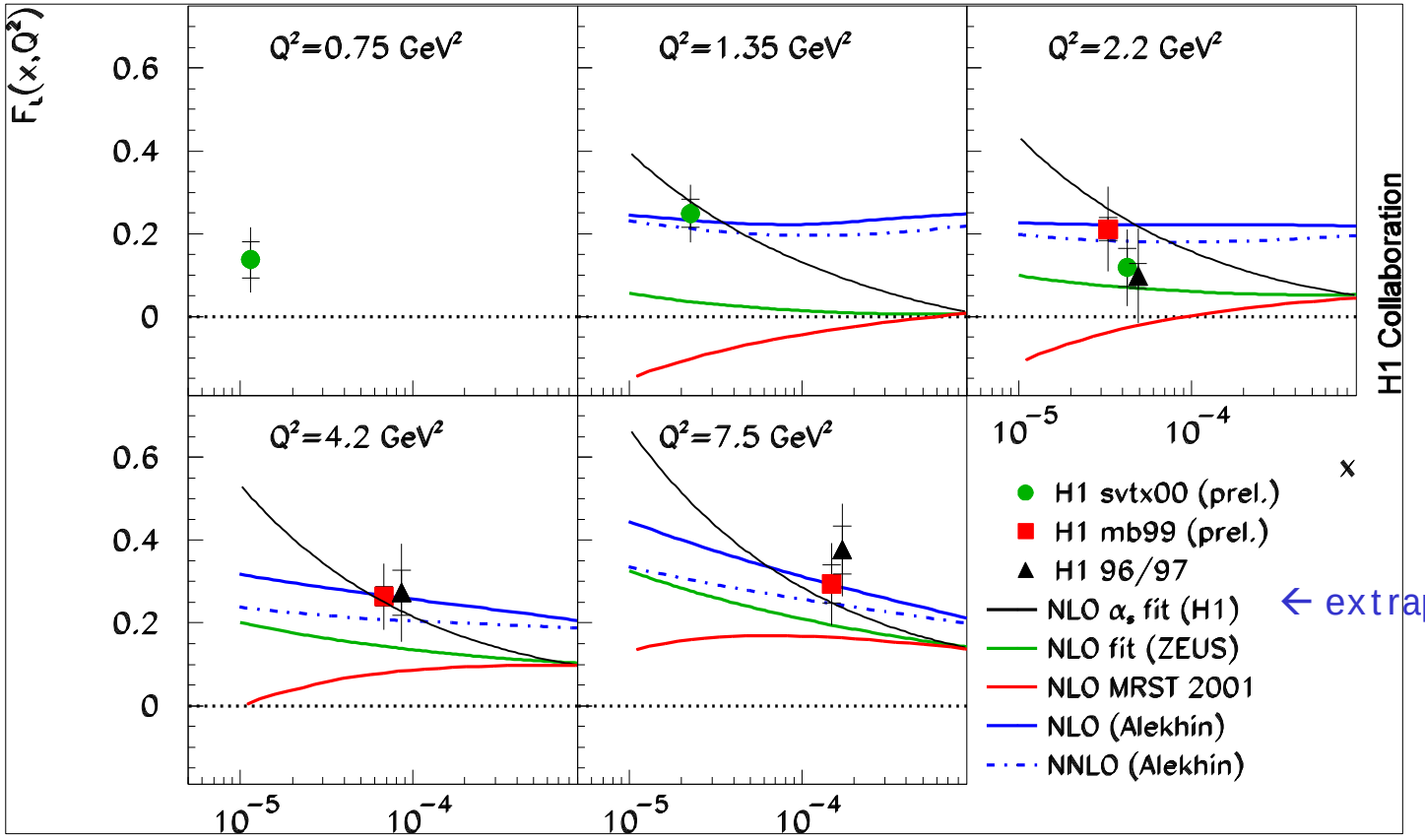


Major upgrades of H1 bwd apparatus: SpaCal + Chamber + Backward Silicon Tracker in 1995, 1997 and in 2001



Measured turnover of cross section at x=Q2/sy for y about 0.5 for all Q2 → FL

note: the turnover is a real constraint to QCD fits and could be given a high weight.



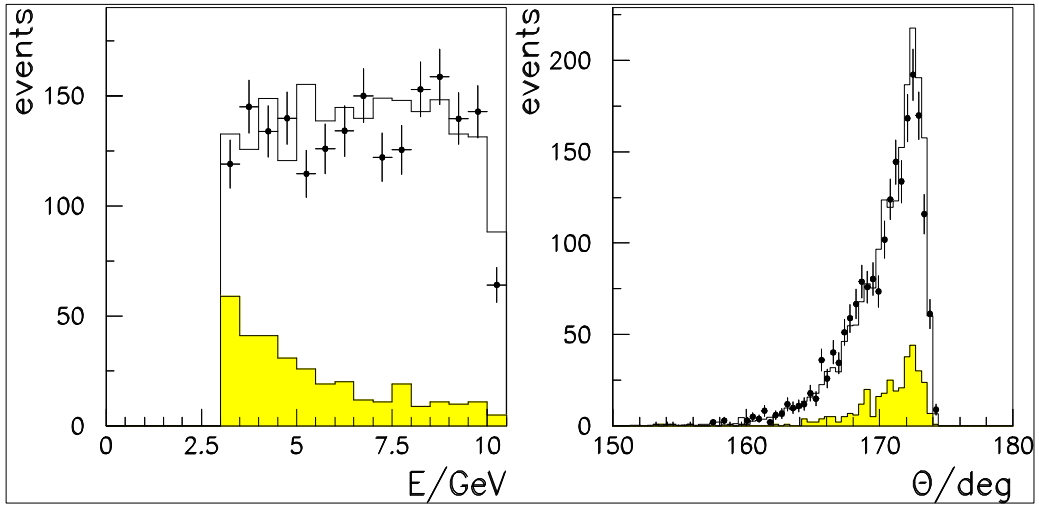
← extrapol < 3.5 GeV2

two limitations:

small x range & FL extraction needs F2, **cf. talk of E.Lobodzinska WGA and DIS03 sophisticated analysis and FL extraction**

•How to improve?

•Still improve accuracy: higher statistics, BST u/v wafers: p in 2pi



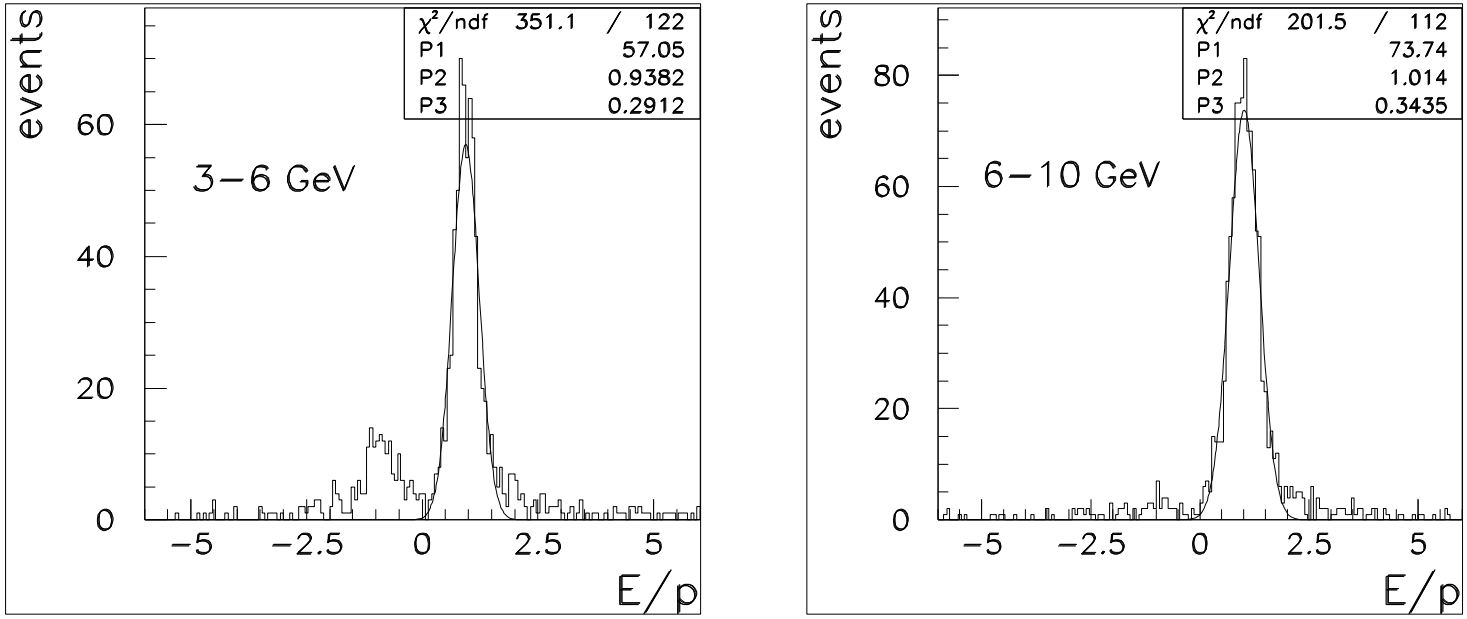
SpaCal E and BST theta from 99 low Q2 data

3 GeV is about y=0.9

y=1-Ee'/Ee →
keep Ee fixed, high
[don't disturb HERMES]

lower proton beam energy
acceptance less E dep.

•at low Ee': background from hadrons (mainly yp, also DIS) sizeable



SpaCal E/ BST p (pilot installation) for 99 low Q2 data

BST and CJC trackers reduce neutral background and moreover allow false charge distributions to be identified and statistically subtracted

low energy hadrons almost charge symmetric (antiprotons n.e. protons)

Simulation of FL measurement using 'Rosenbluth separation'

$$s_r = F_2(x,Q^2) - f(y)\cdot F_L(x,Q^2)$$

- measure at fixed x and Q2, varying y by changing Ep. fit xsection vs f(y)

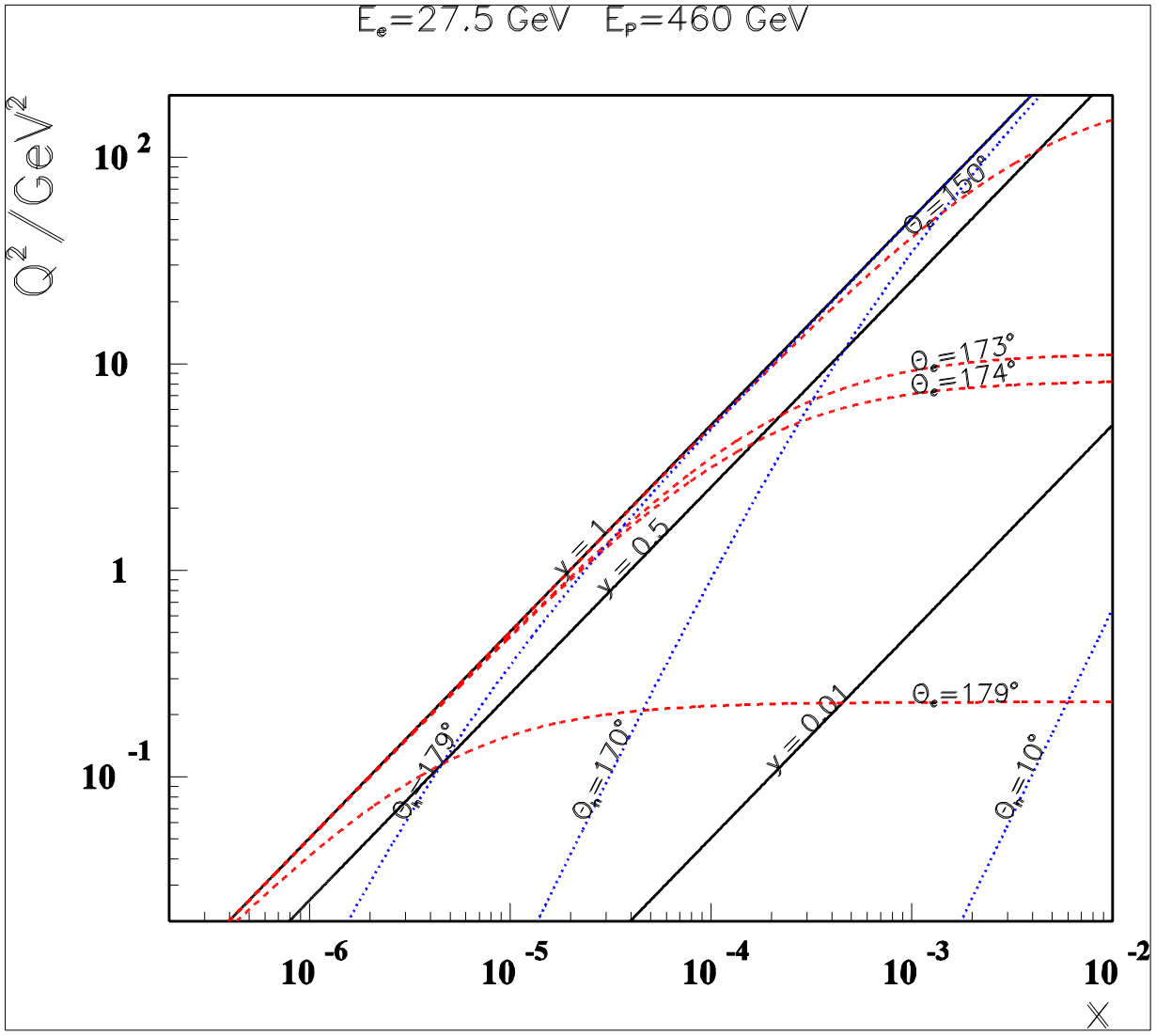
- choose set of proton beam energies such that f(y) is binned equidistantly
- include highest Ep (920 GeV) and lowest Ep (> 330 GeV – F.Willeke)

e.g. 400, 465, 575, 920 GeV
with e.g. 3 5 10 30 pb-1 case study!

[this leads to a luminosity equivalent of ~50 pb-1 from the low Ep sets.
expectations for lumi have been high: 230 pb-1 in half of 2007??
yet in 2004 obtained about 20pb-1 in recent months.
Need efficient HERA also for the low Ep programme.]

- systematic errors assumed are as reached in the present H1 analysis of BST – SpaCal data, leading to a few % cross section accuracy

- distinguish between correlated and uncorrelated errors in FL extraction

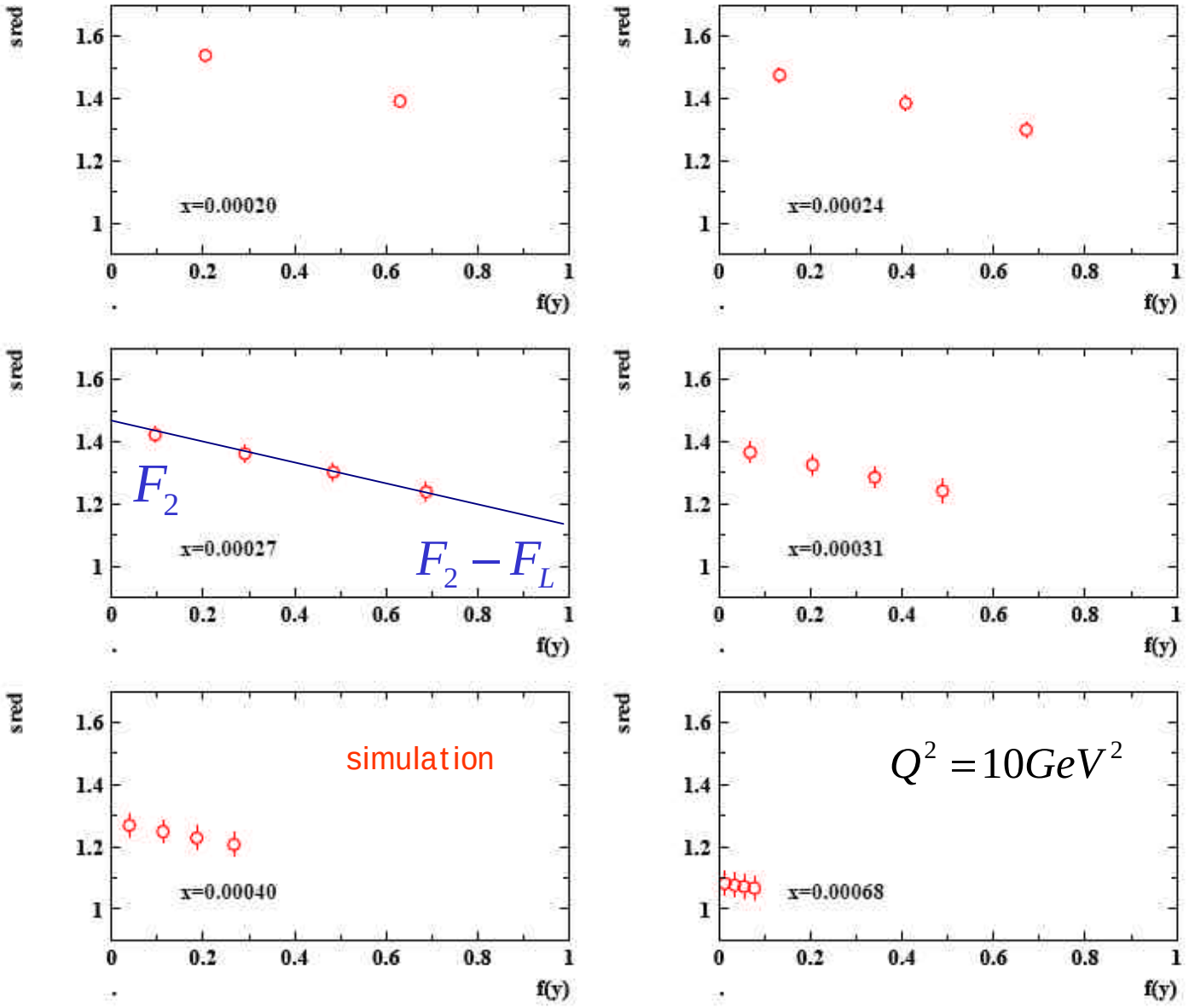


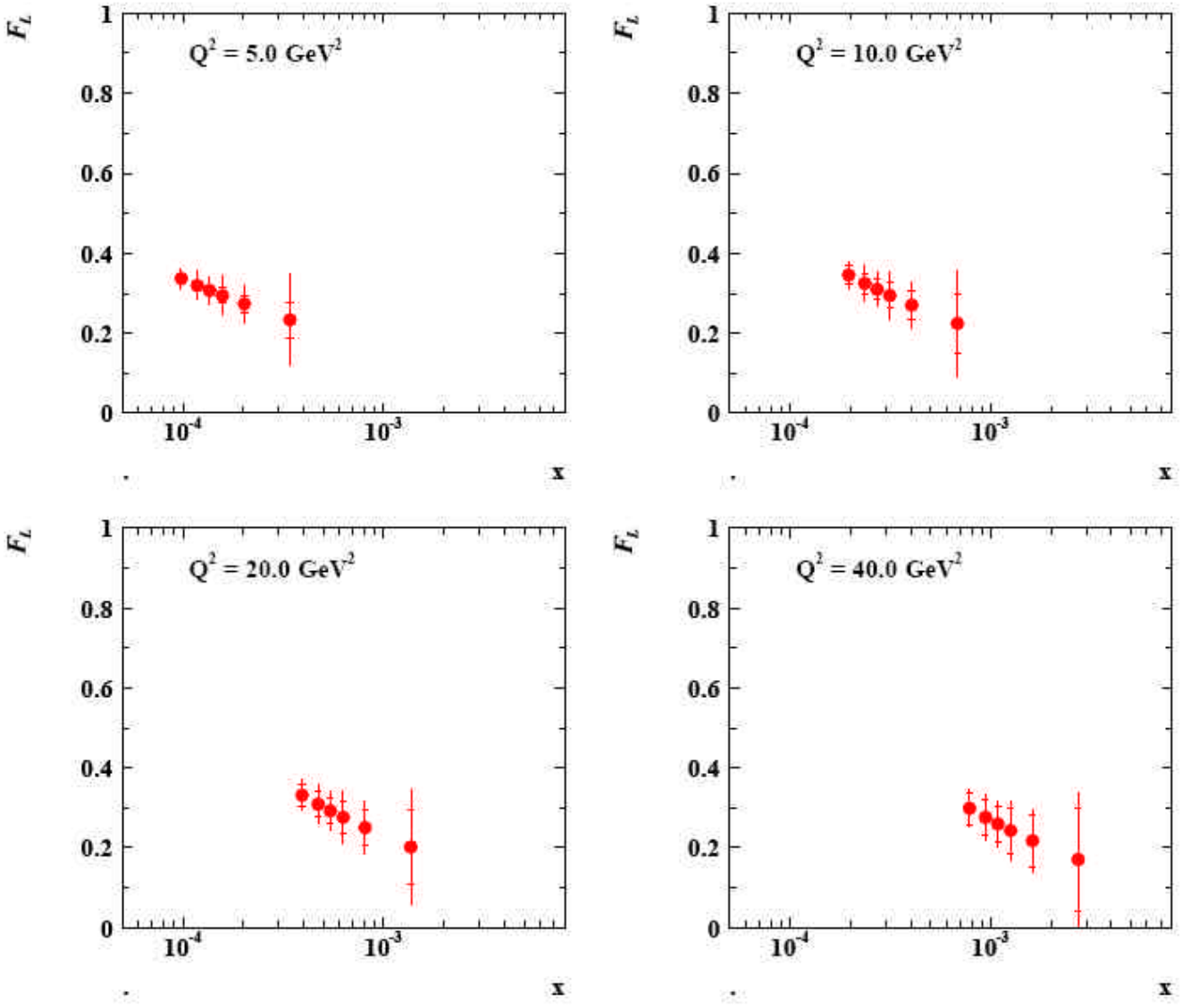
HERA II

HERA III

- **no FL data in transition region with current focussing magnets → cf HERA III LoI's**
  [MK at MPI workshop on H3, Dec 2002]

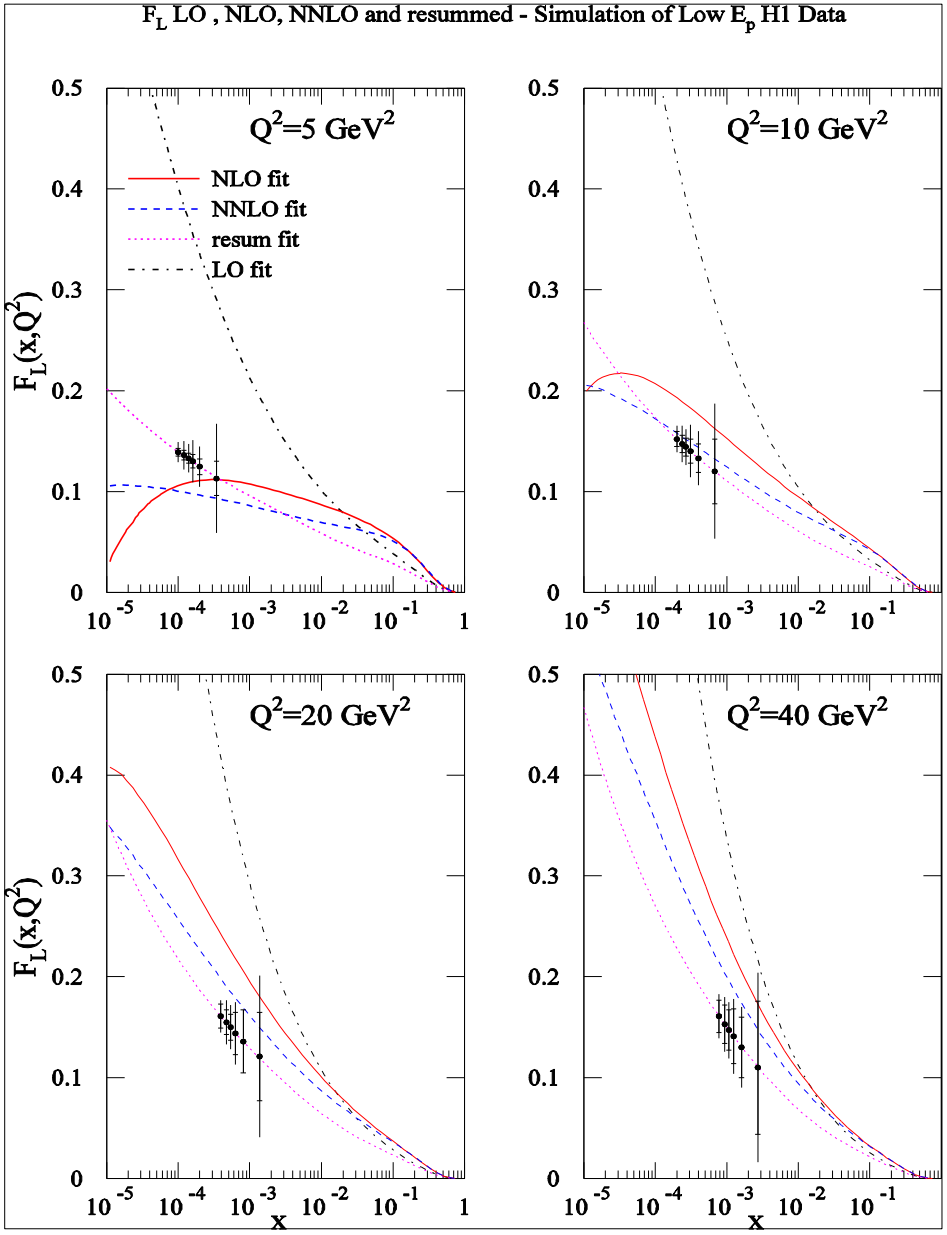
$$s_r = F_2(x,Q^2) - f(y)\cdot F_L(x,Q^2)$$





inner error bar: stat
full error: stat & syst

$dF_L \propto ds \,/\, y^2$ → measurement also meaningful for smaller y_min than 0.9



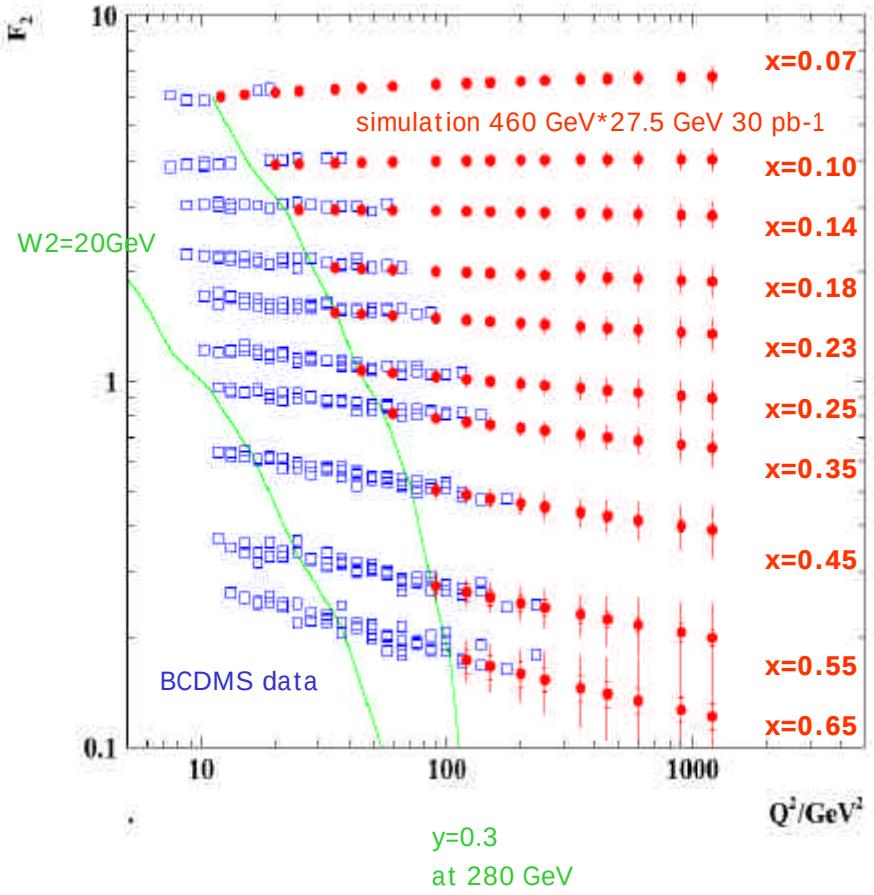
R.Thorne

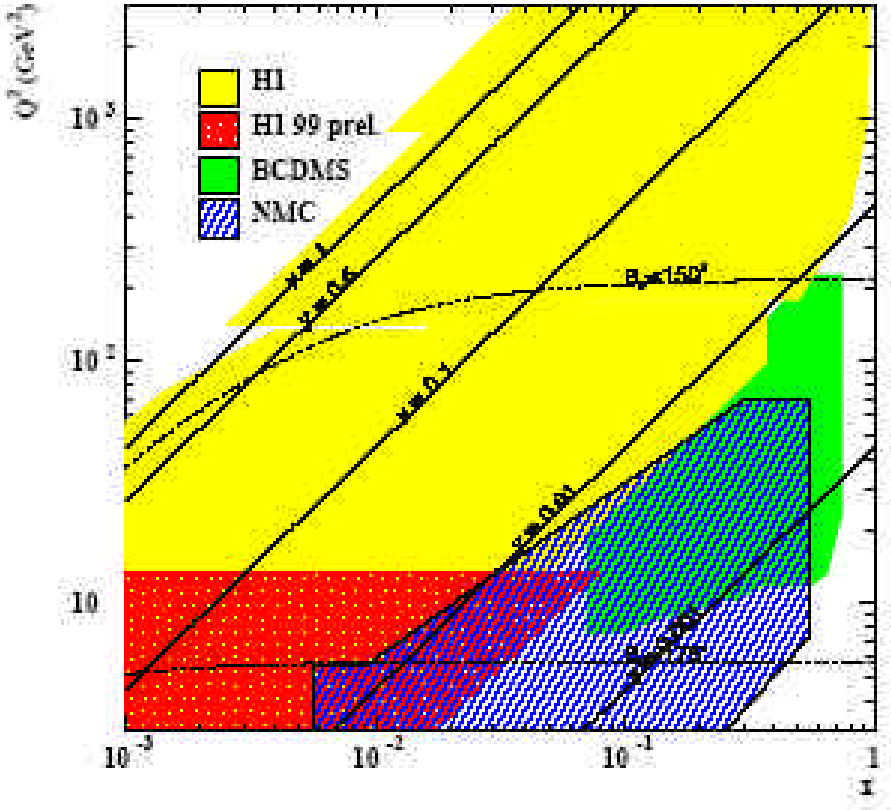
accurate FL data
at low x and Q2
are required to
test h.o.QCD and
pin down xg(x,Q2)
such a measurement
is challenging but
possible at HERA II
it delivers also data
at large x, medium Q2
besides measuring the
W,E dependence of
various xsections

lower Ep once in 15 years
of HERA operation (think
of fixed target DIS exps)

further studies needed
(HERA, MC, yp, resolutions, hix..)

also access large x at lower Q2

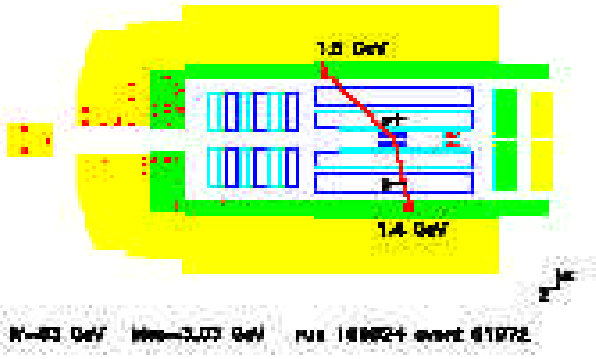




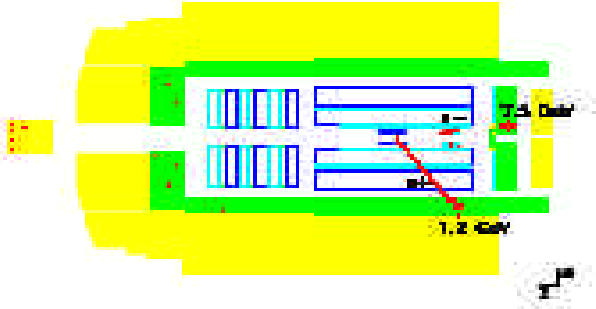
extend measurements to lowest y

- Simulation of resonance region (SOPHIA)
- Low noise calorimetry (upgraded electr.)
- Forward tracking (upgraded FST, FTD)

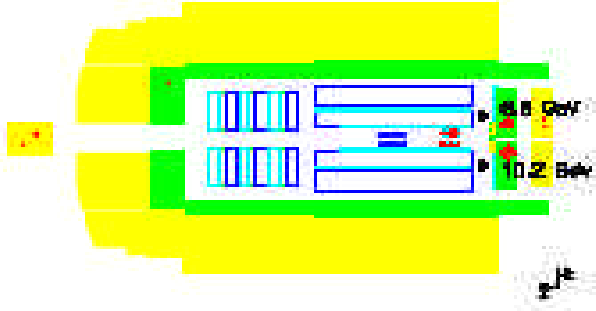
T–T



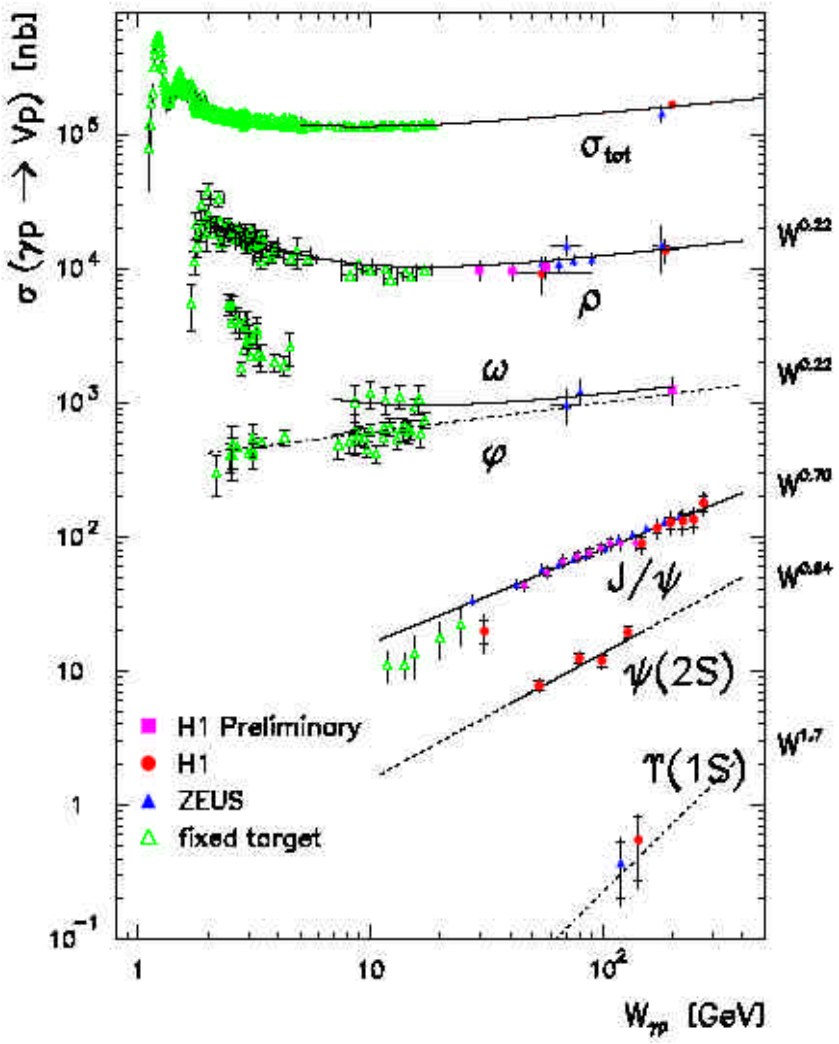
T–C



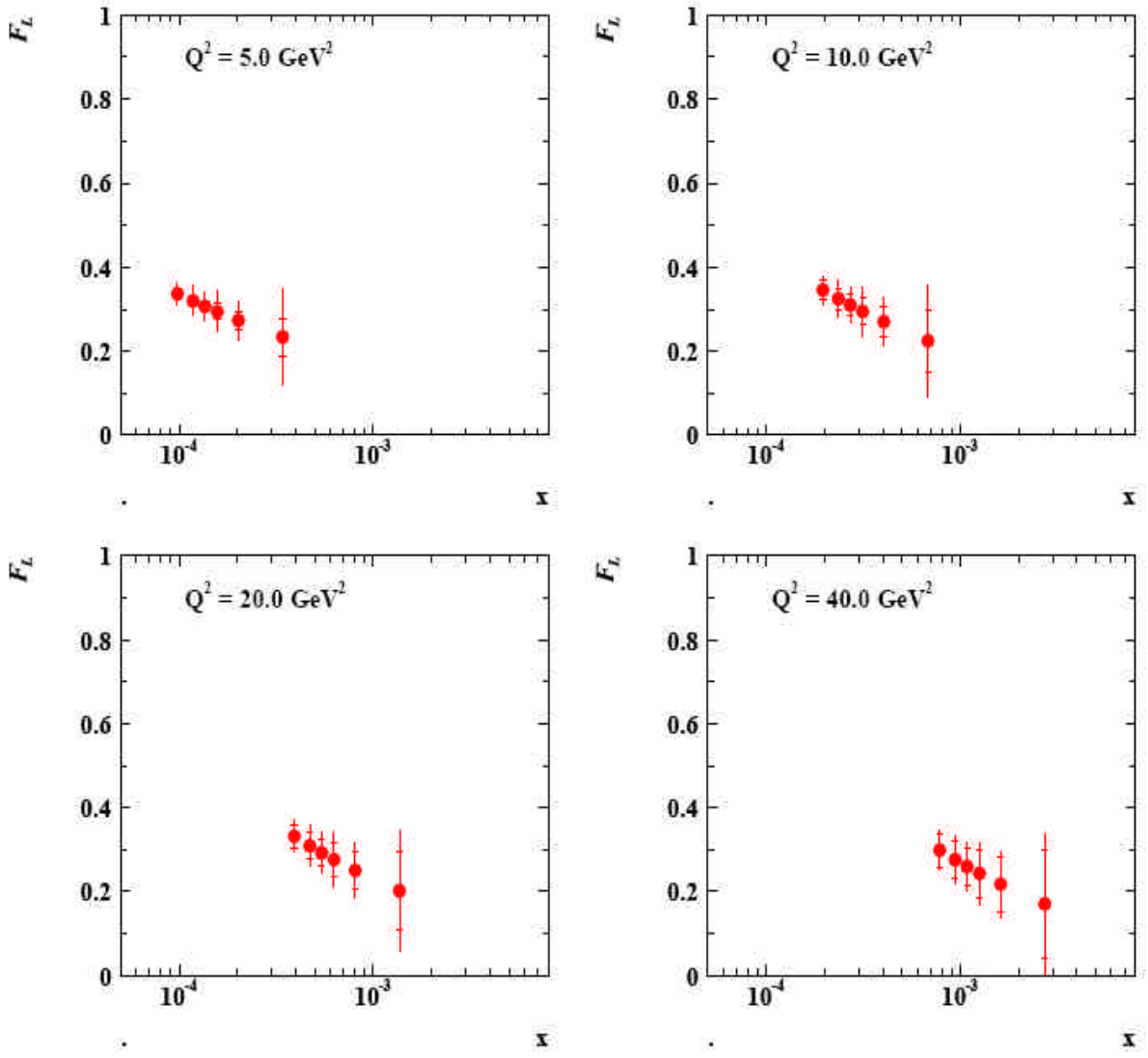
C–C



measure energy (W) dependence of cross sections, VM production …



Simulation of low x FL measurement at HERA based on low Ep Runs



$$s_r = F_2(x,Q^2) - f(y)\cdot F_L(x,Q^2)$$

$$y = Q^2/(4E_eE_p\cdot x) \cong 1 - E_e'/E_e$$

eID at low E' → high y
y=0.9 for E'=3GeV (H1)

keep Ee fixed, lower Ep
fix x,Q2 → vary E

Ep = 400, 465, 575, 920 GeV
Lum= 3 5 10 30 pb-1
case study

inner error bar: stat
full error: stat & syst

MK WGA 14.4.2004