e-p physics opportunities at eRHIC

Key measurements & capabilities

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DIS 2011

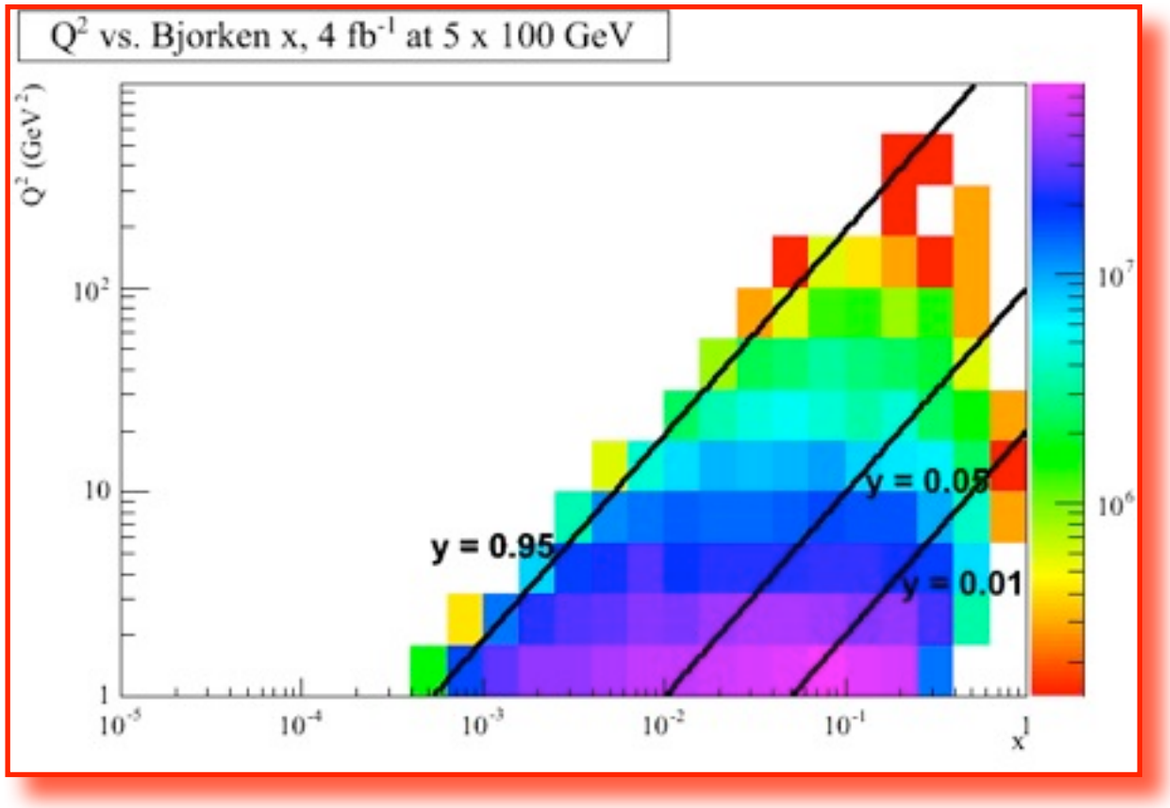
Thursday 14th April

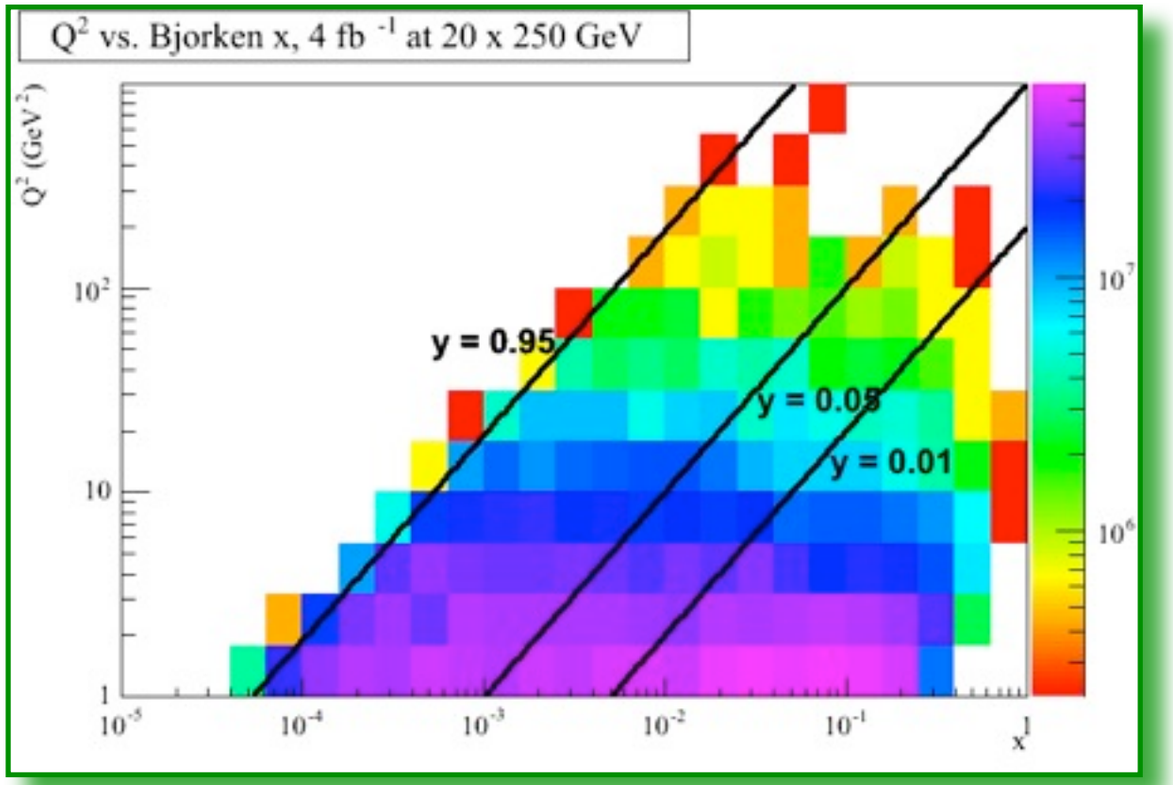
Overview

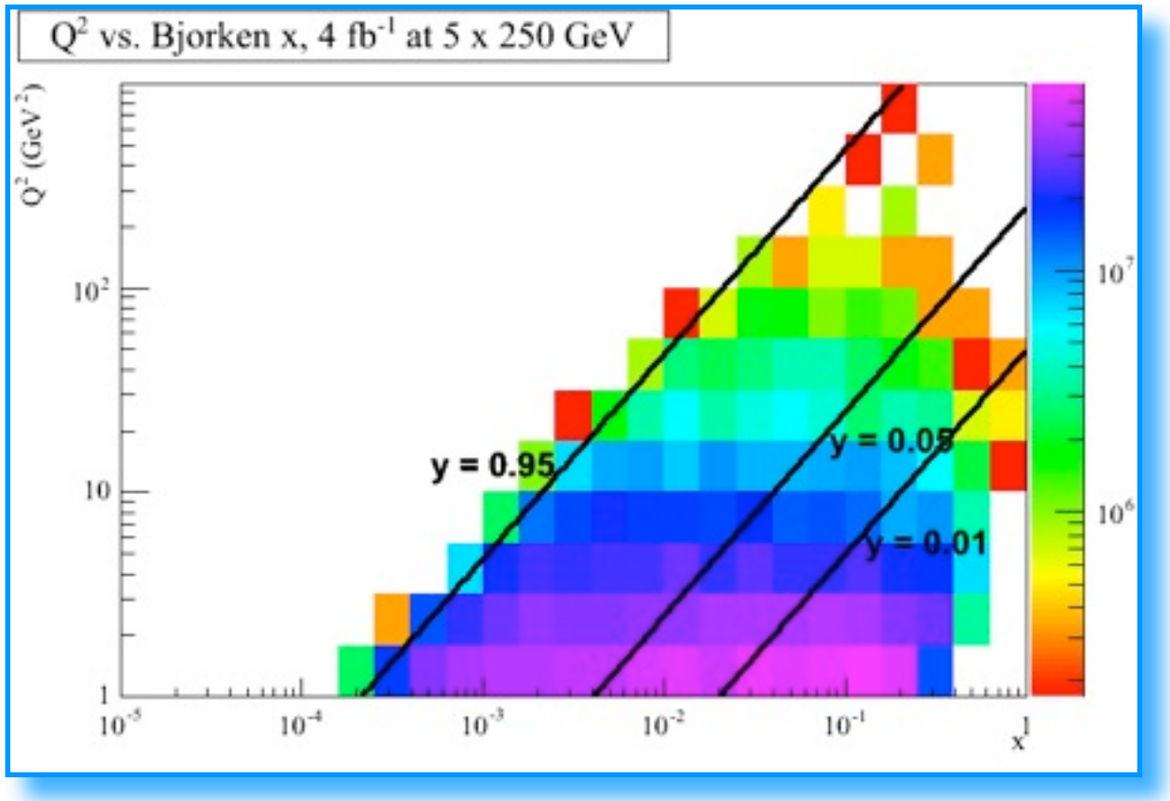
- Kinematic coverage
- F_L
- ΔG
- Sea quarks
- Imaging: GPDs and TMDs

eRHIC Kinematics

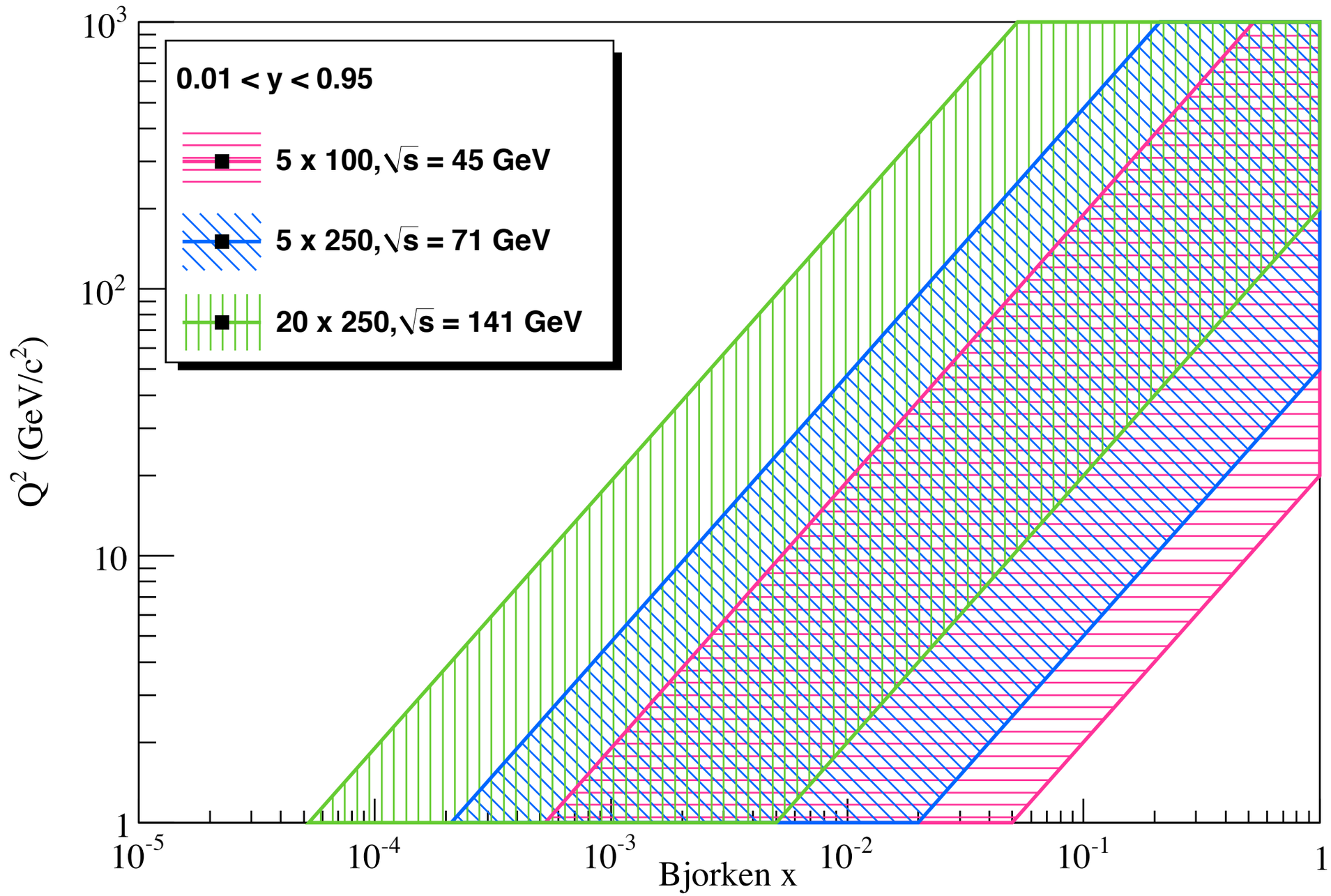
E_e	E_p	$\sqrt{s}$ (GeV)	L (10^{33} cm^{-2} s^{-1})	Days for 4 fb^{-1}
5	100	45	0.62	150
5	250	71	9.7	10
20	250	141	9.7	10







Kinematics



QED radiative corrections need to be controlled

➡ Investigating with Monte Carlo

Longitudinal structure function: F_L

$$\sigma_r = F_2\left(x, Q^2\right) - \frac{y^2}{Y_+} F_L\left(x, Q^2\right)$$

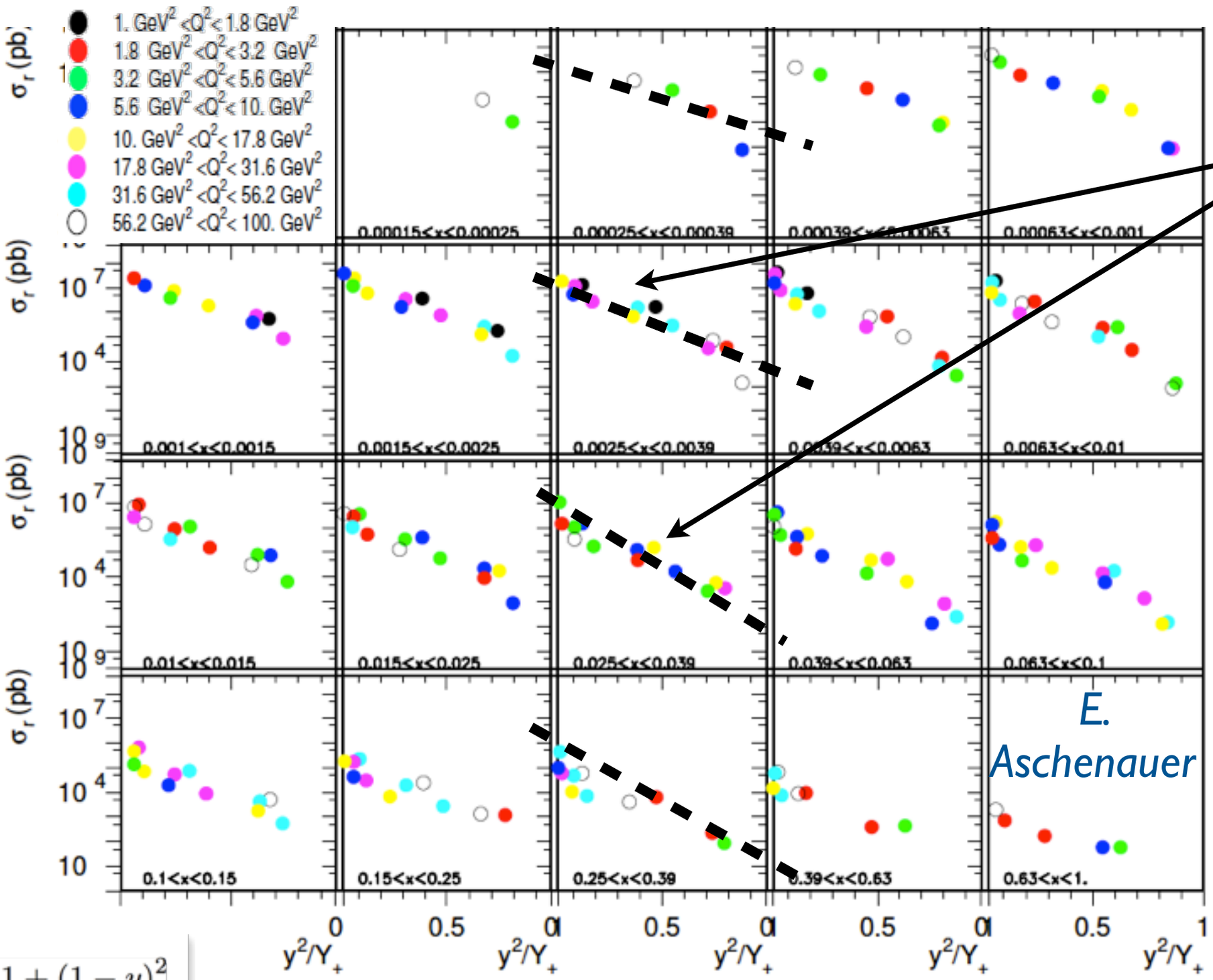
$$Y_+ = 1 + (1 - y)^2$$

- Contributes significantly only at large *y*
- Use variable s at fixed x, Q^2
  - Measure σ_r slope vs. y^2/Y_+

$$Q^2 = sxy$$

- EIC strength
  - eRHIC $\sqrt{s}$ = 30-200 GeV

Feasibility study



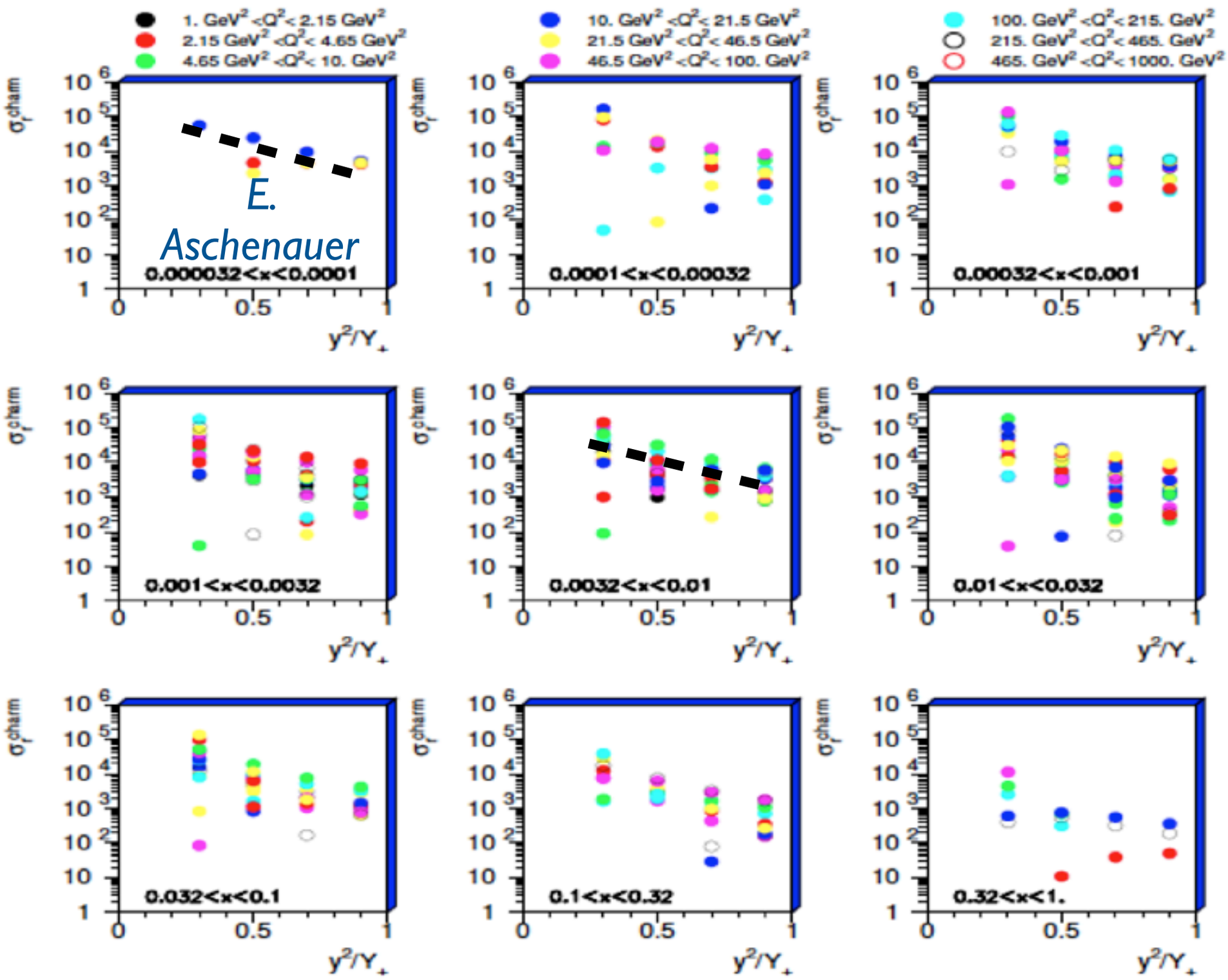
Measure slopes

Under refinement - how well can we do?

E. Aschenauer

$$Y_+ = 1 + (1-y)^2$$

With charm (D mesons)

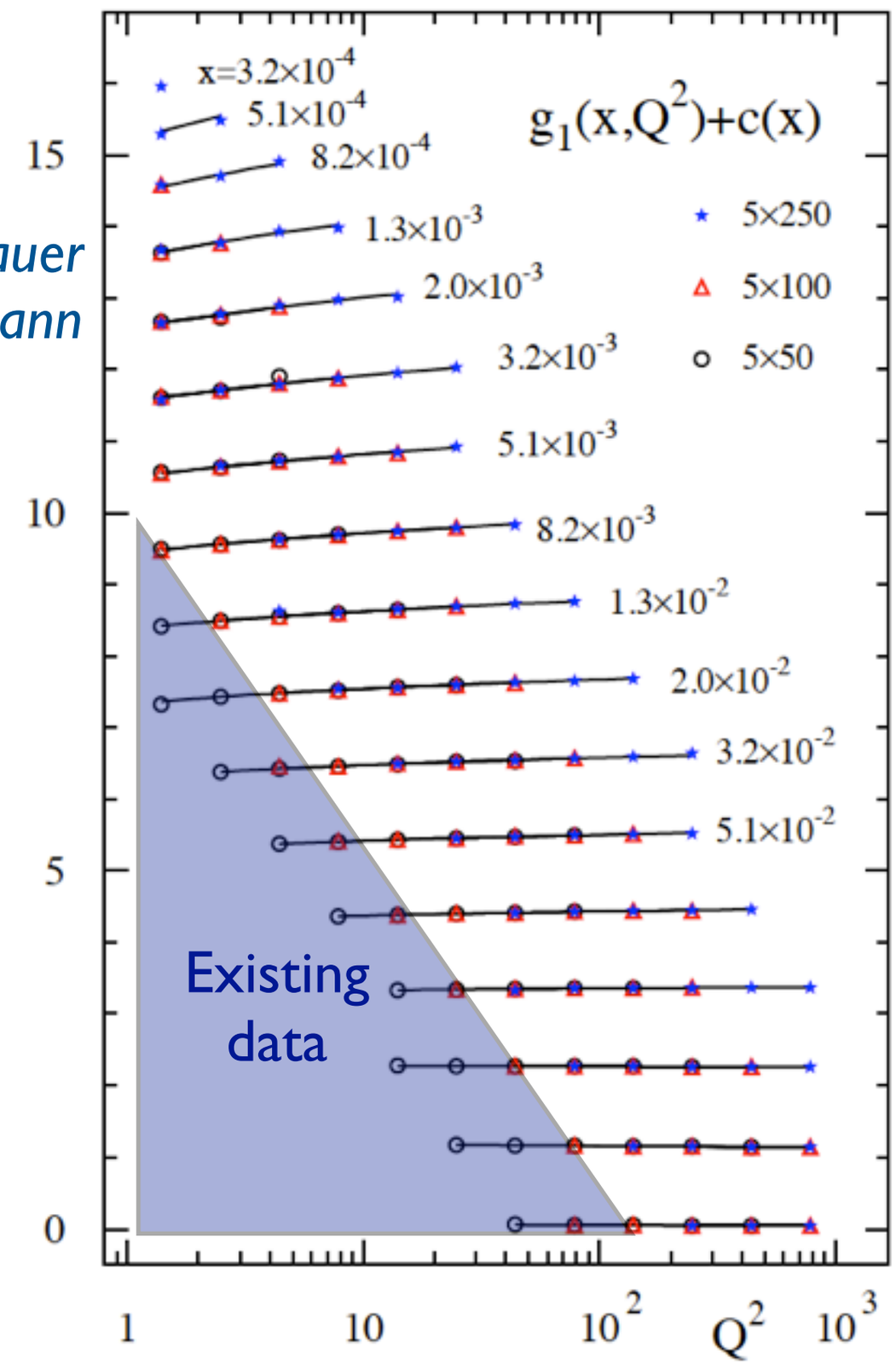


Measuring ΔG

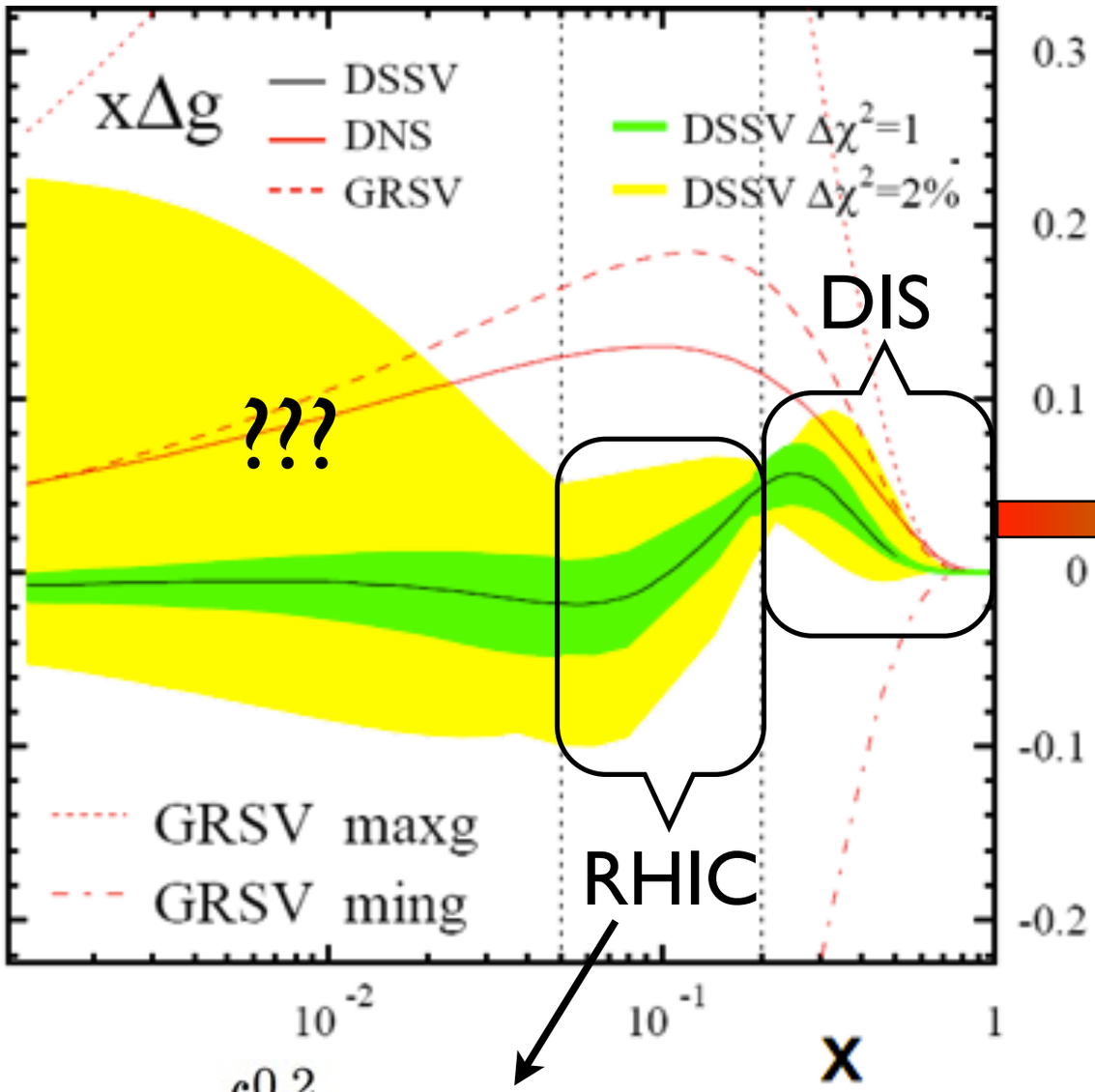
- Scaling violations
  - $\Delta G \propto dg_1/d\log(Q^2)$
- Estimate impact using pseudodata
- Tiny statistical errors
  - rapidly systematics-dominated

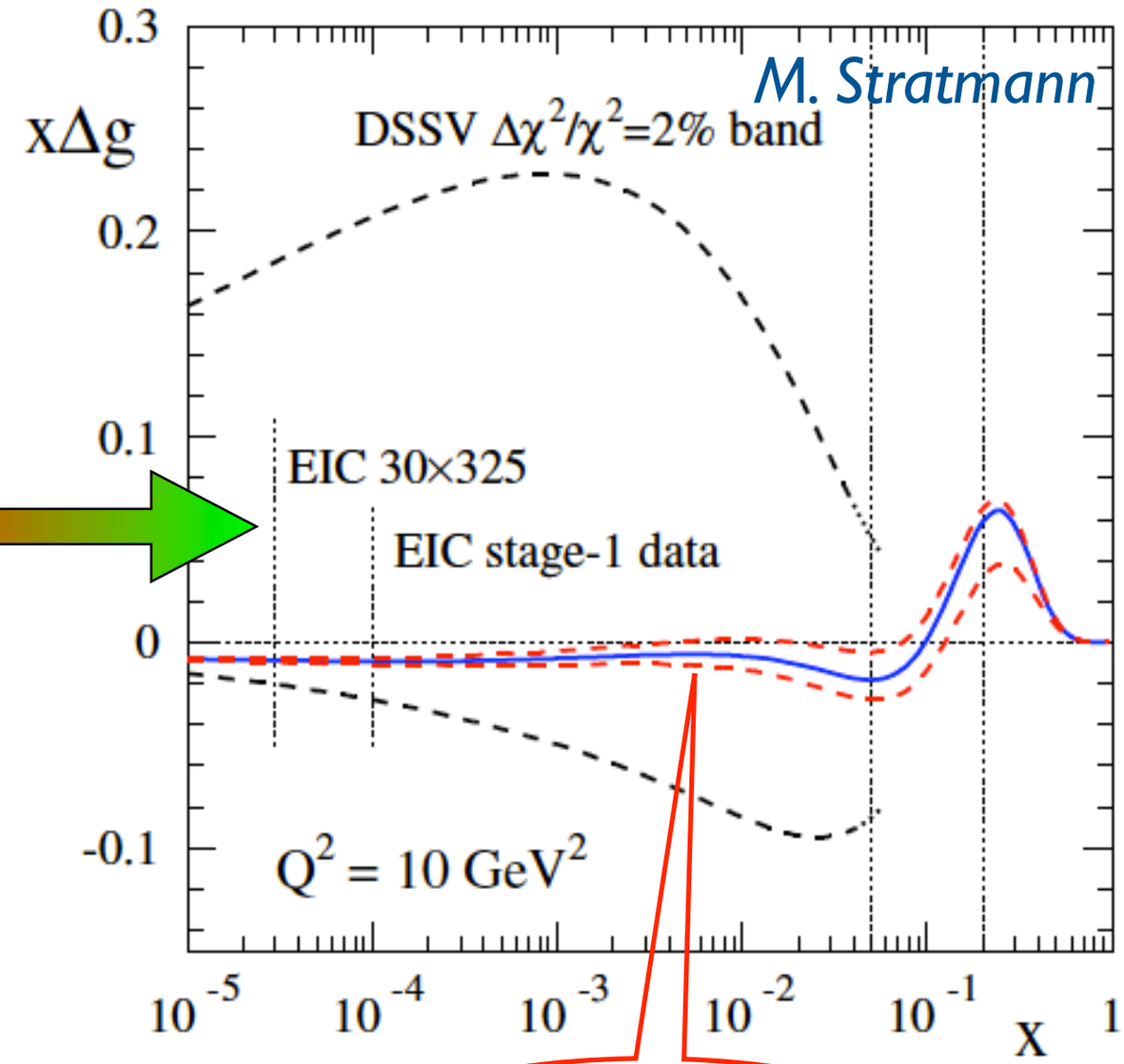
~ 1 month

E. Aschenauer
M. Stratmann



Measuring ΔG



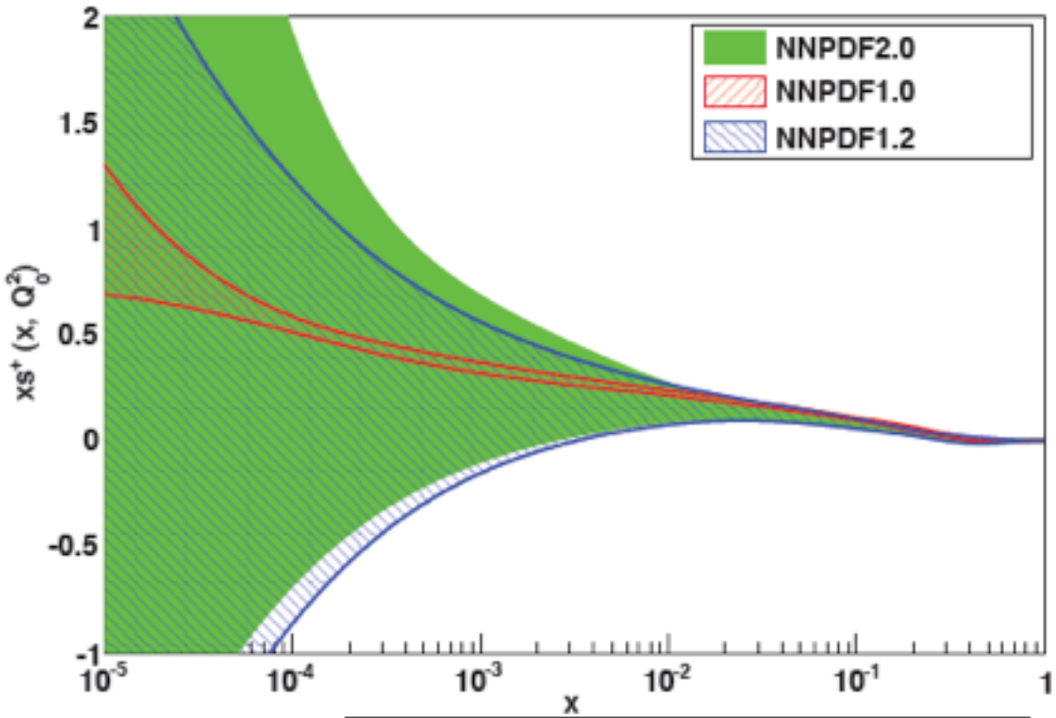


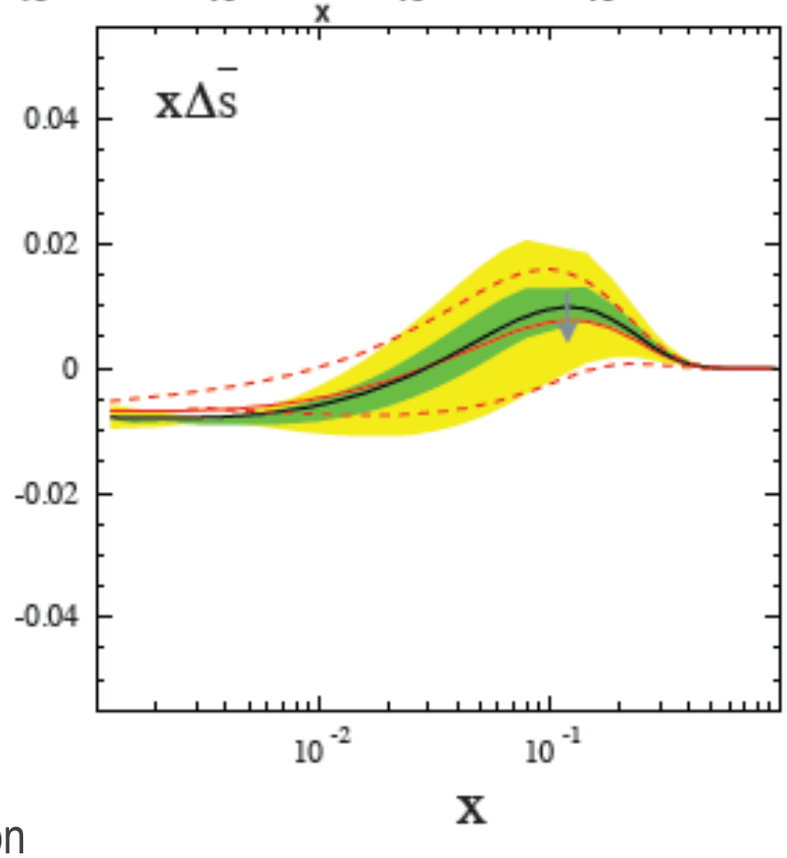
$$\int_{0.05}^{0.2} \Delta g(x, Q^2) dx \approx 0$$

$$\int_{0}^{1} \Delta g(x, Q^2) dx = \ldots ?$$

Measure ΔG to within ~10%

Sea quarks

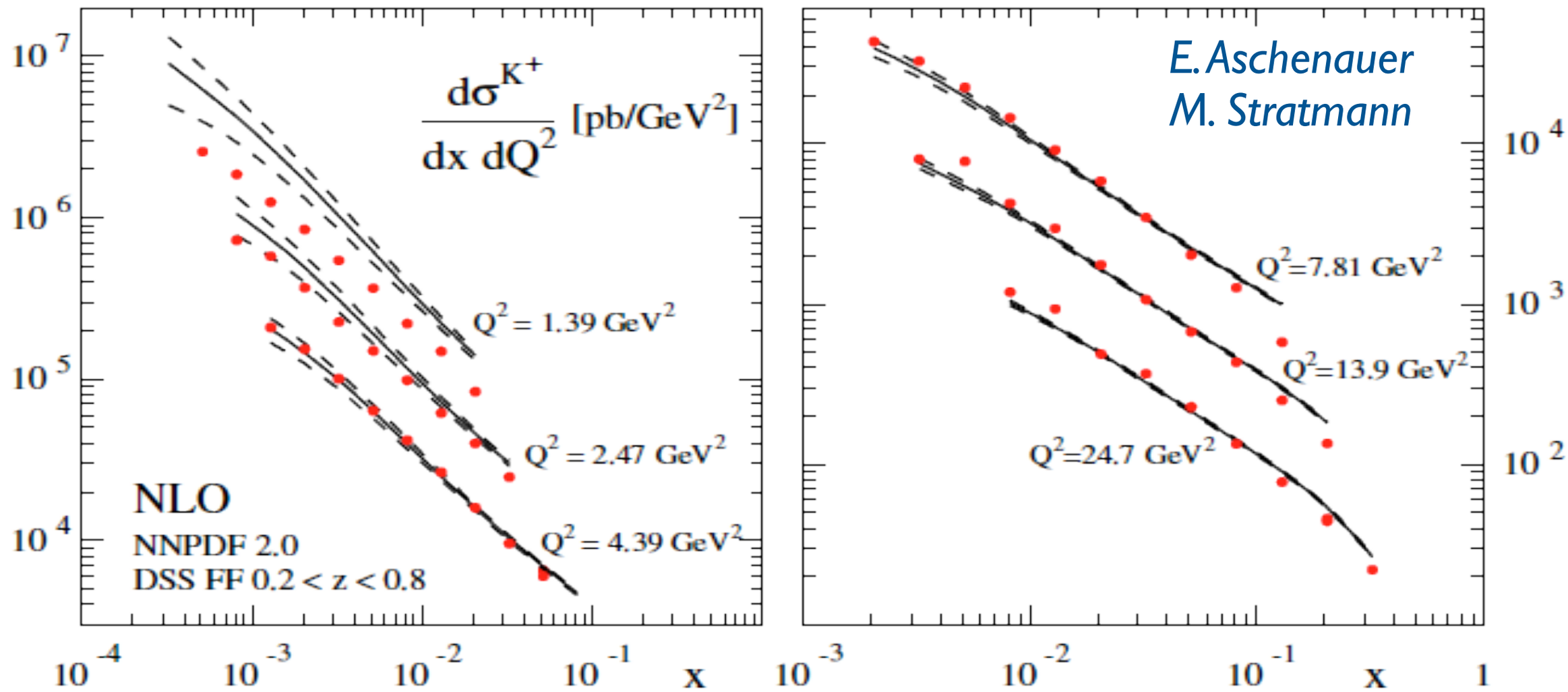




- Distributions uncertain
- esp. strange sea unpolarised & polarised.
- Flavour separation
  - SIDIS
  - Variety of hadrons π^+, π^-, K^+, K^-...

First study

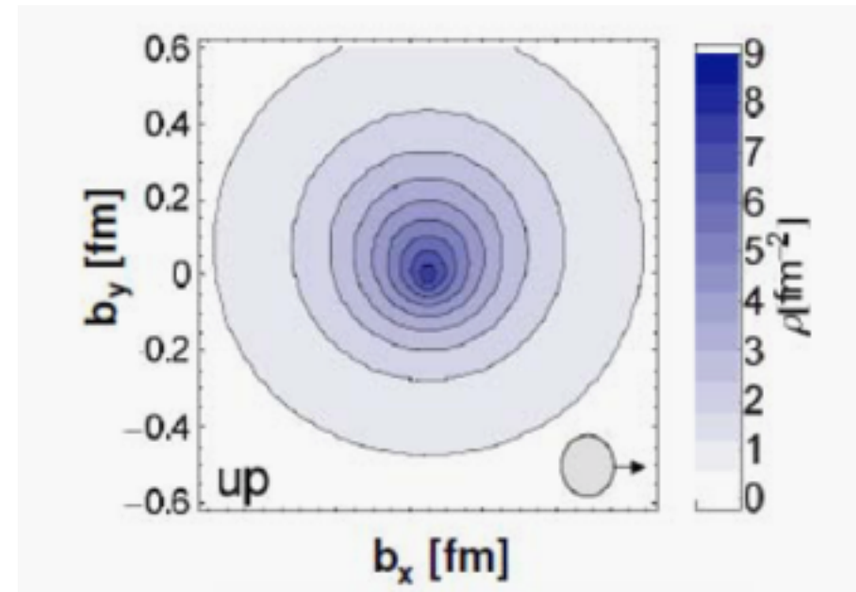
- Can we use MC to simulate psuedodata?
- PYTHIA vs. NLO calculation

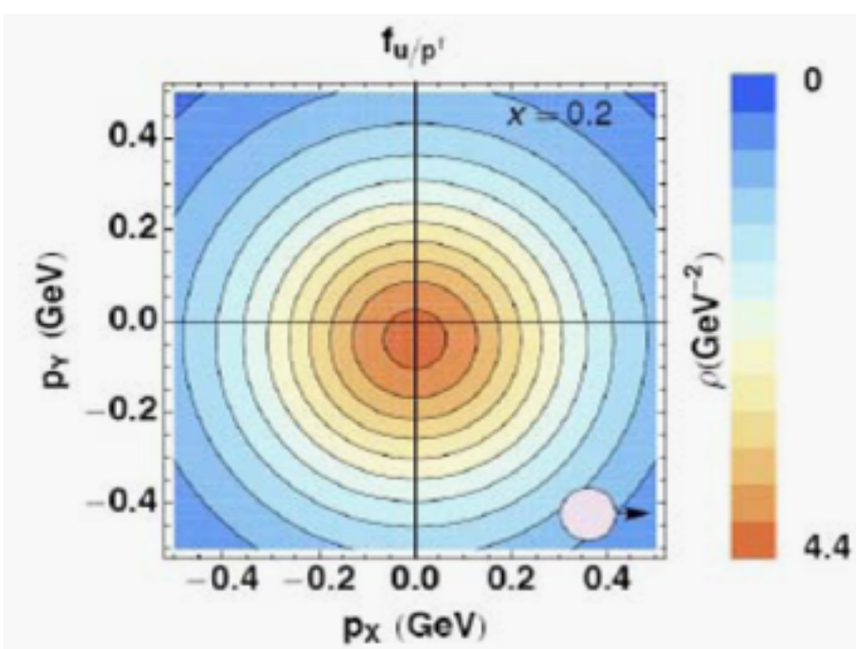


➡ Good agreement

Imaging

- Generalised parton distributions (GPDs)
  - transverse spatial distribution

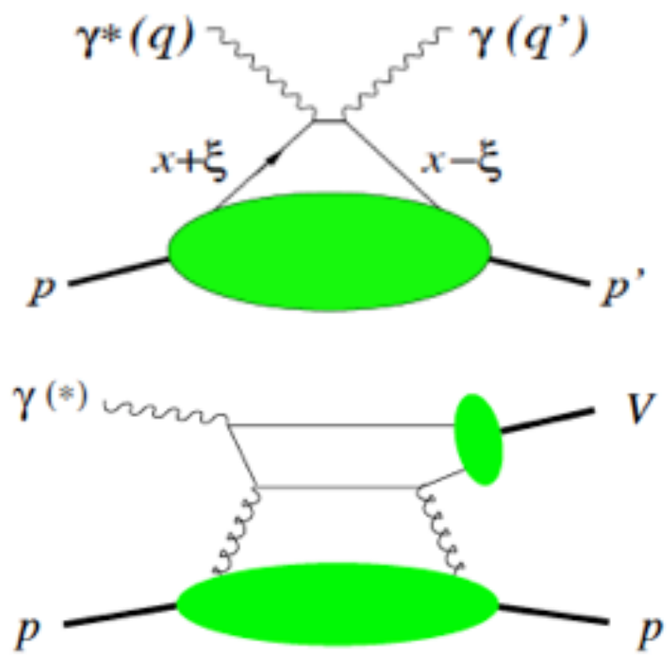




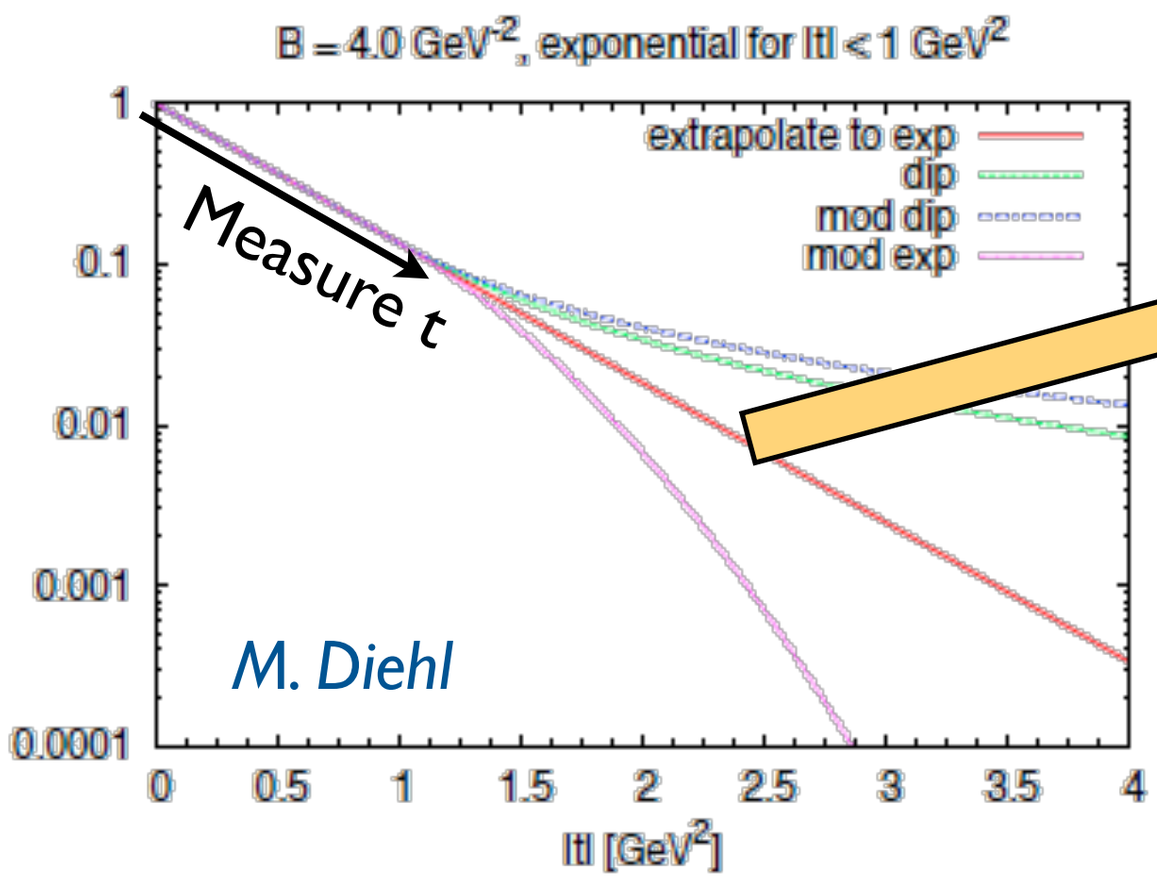
- Transverse-momentum-dependent distribution functions (TMDs)
  - transverse momentum distribution

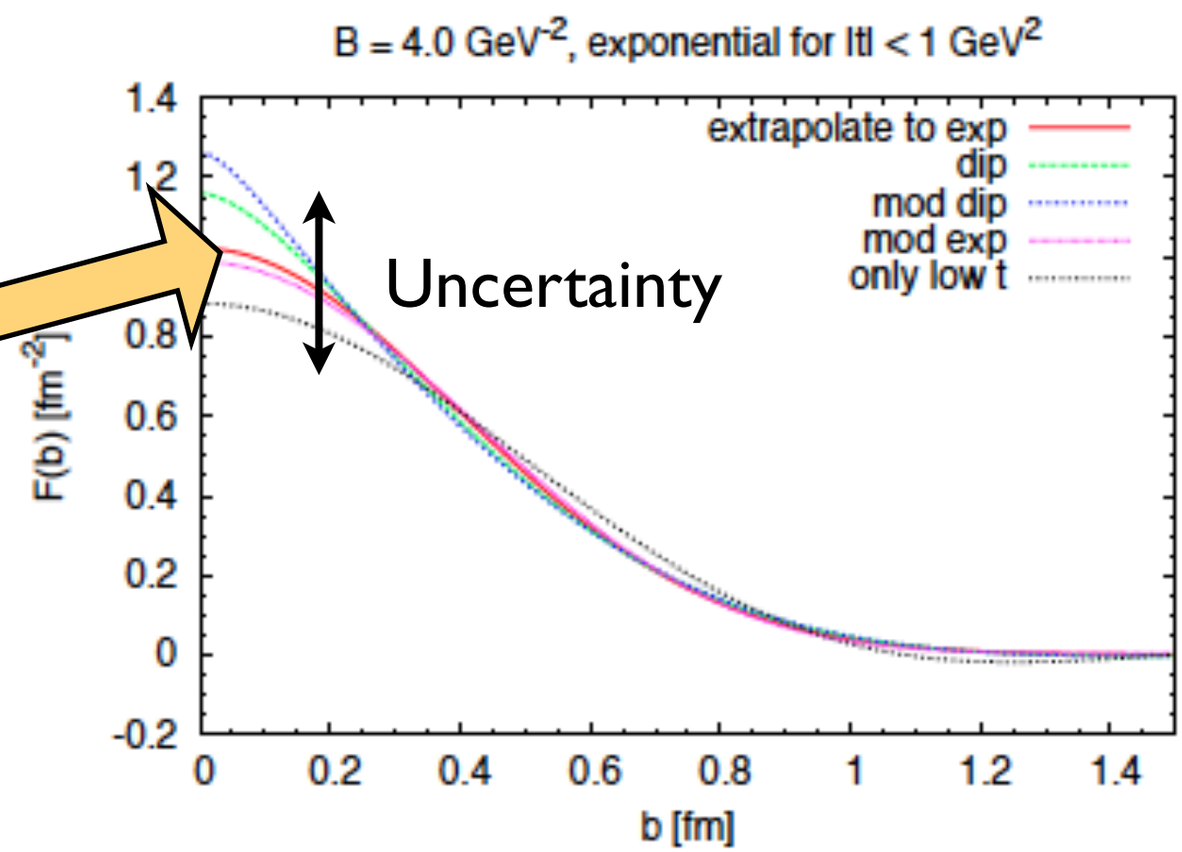
GPDs

Access via exclusive reactions:

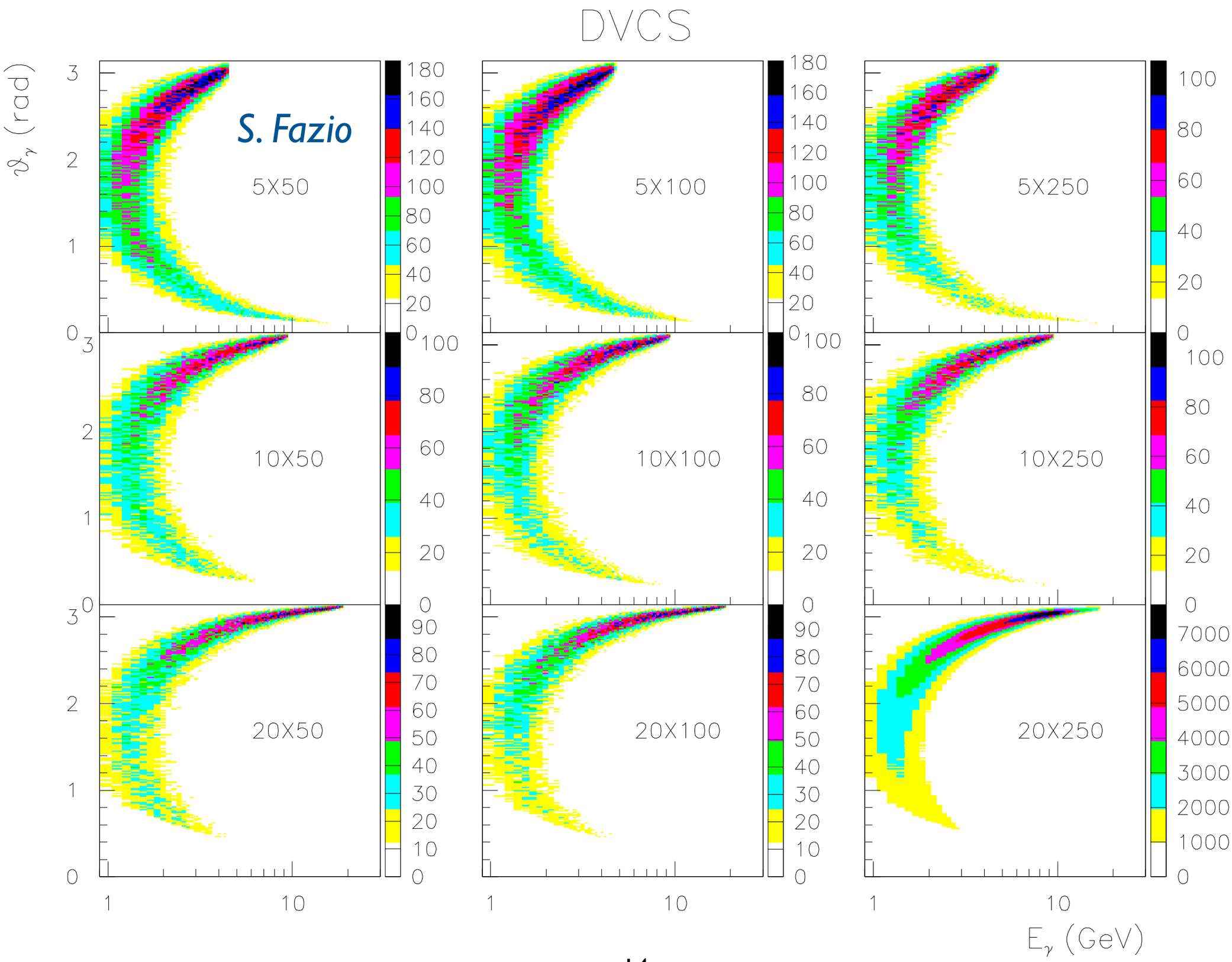


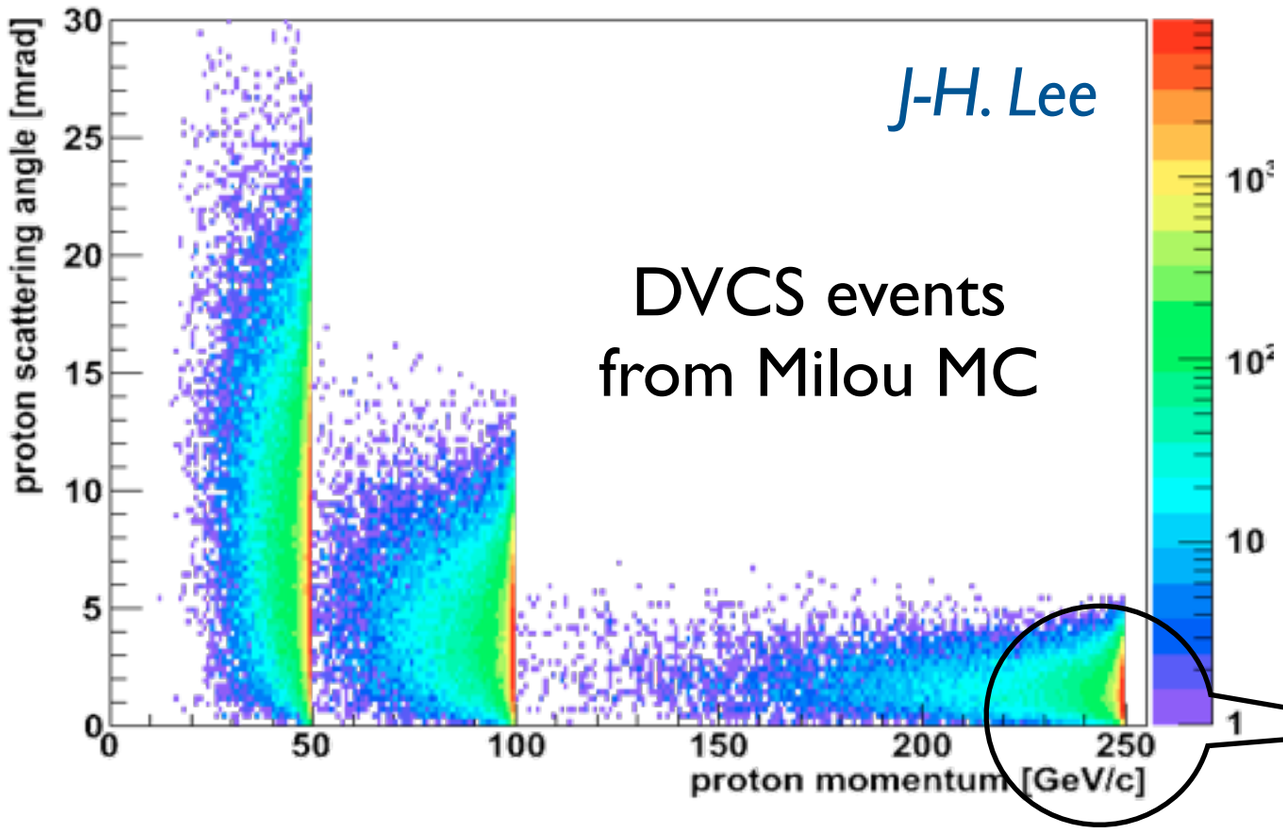
- 2+1D imaging
  - Momentum (x) & impact parameter (b)
- b range depends on measured t range

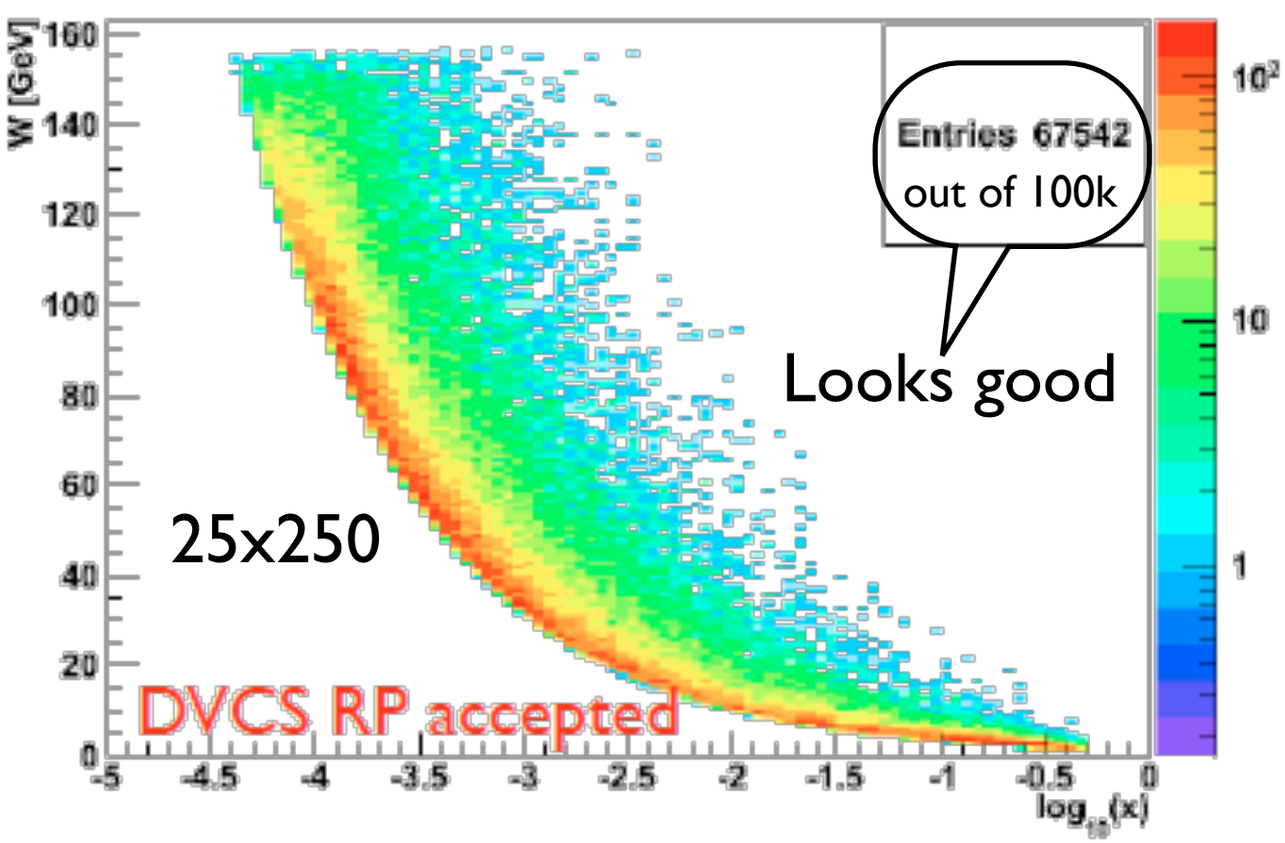




Milou Monte Carlo generator



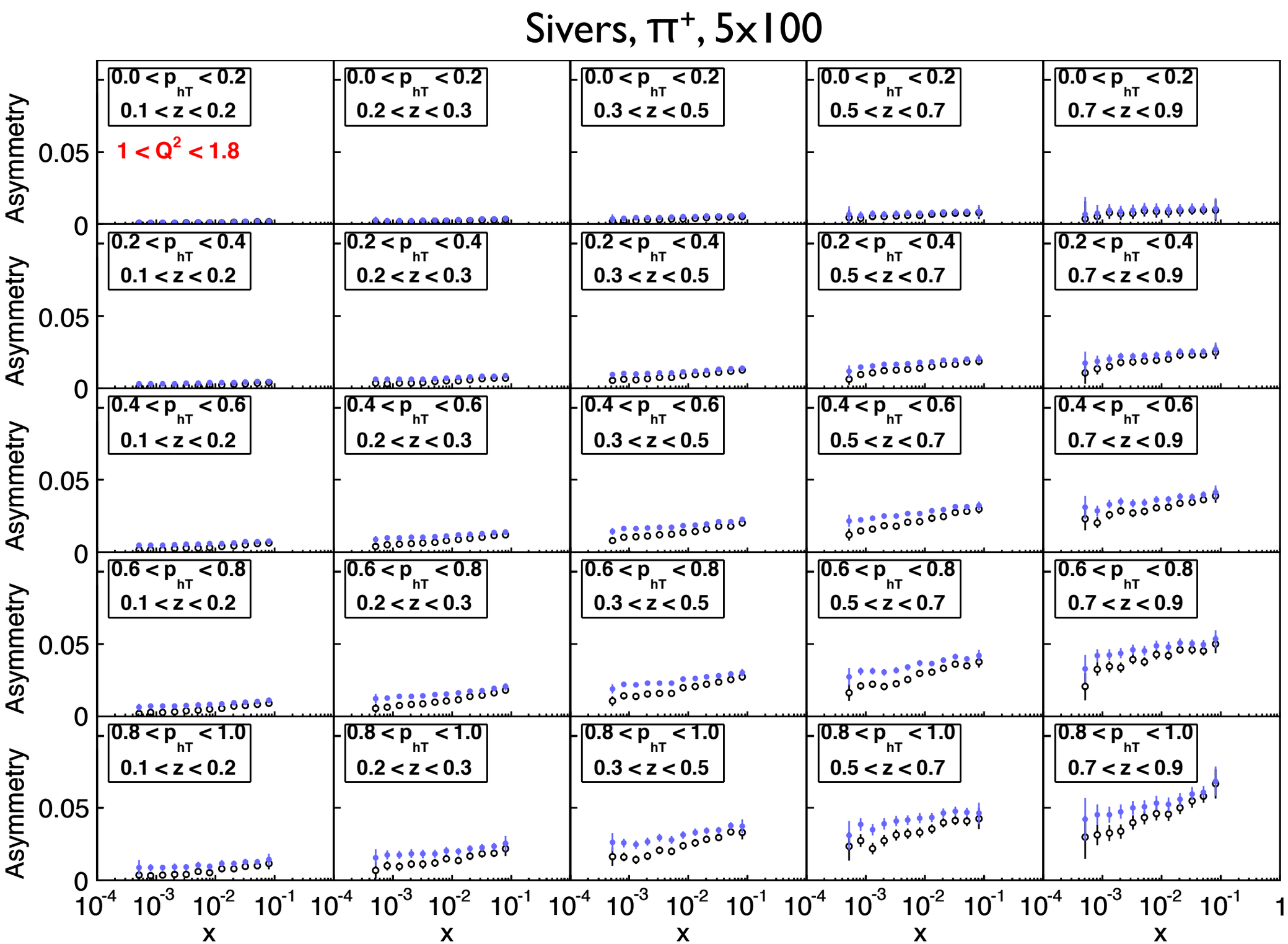




- Detect *e*, *p* & γ
  - Demands on detector & IR
- Roman pot detector needed for proton
- t acceptance:
  - beam envelope
  - magnet apertures

TMDs

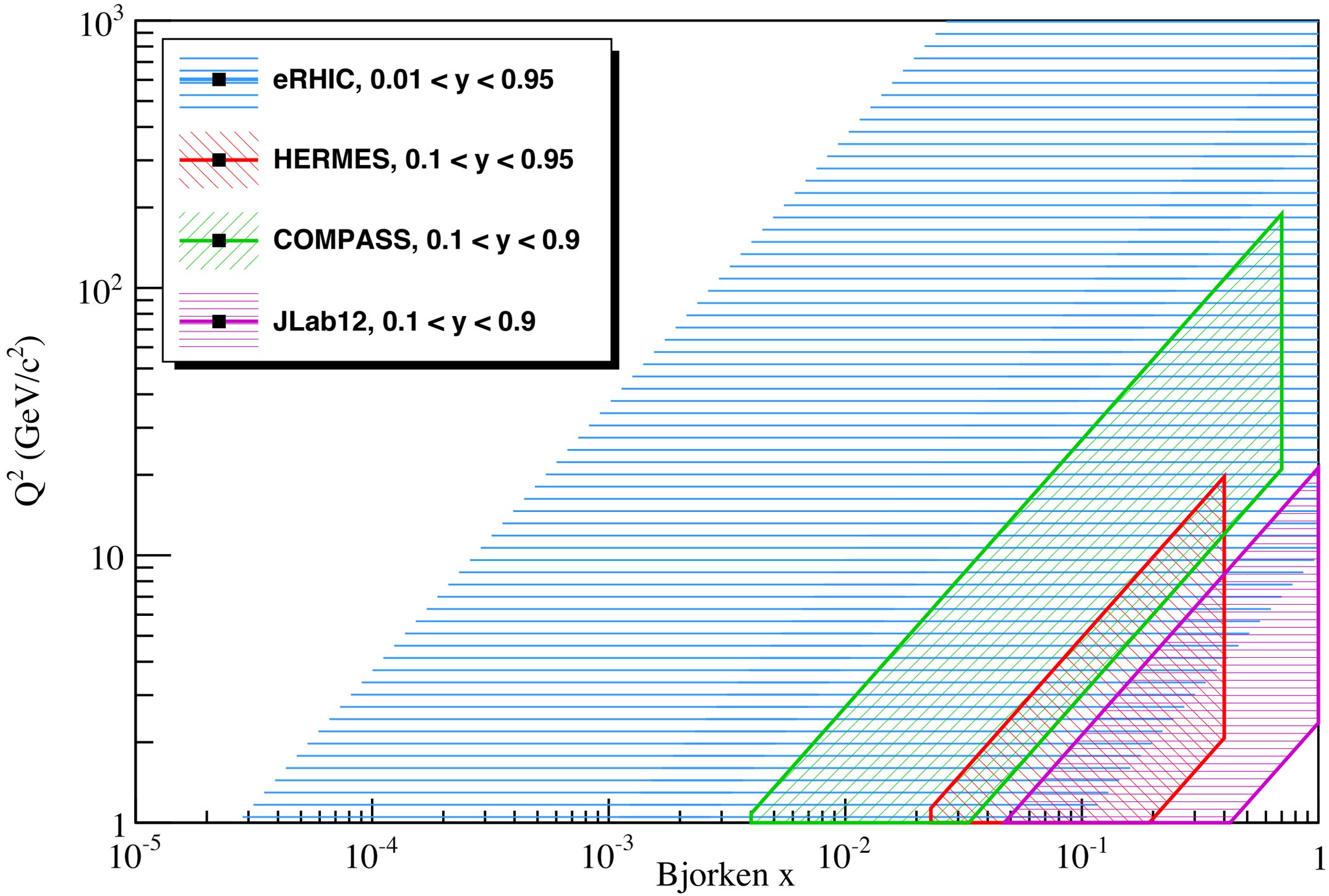
- See talks by Haiyan Gao, Min Huang



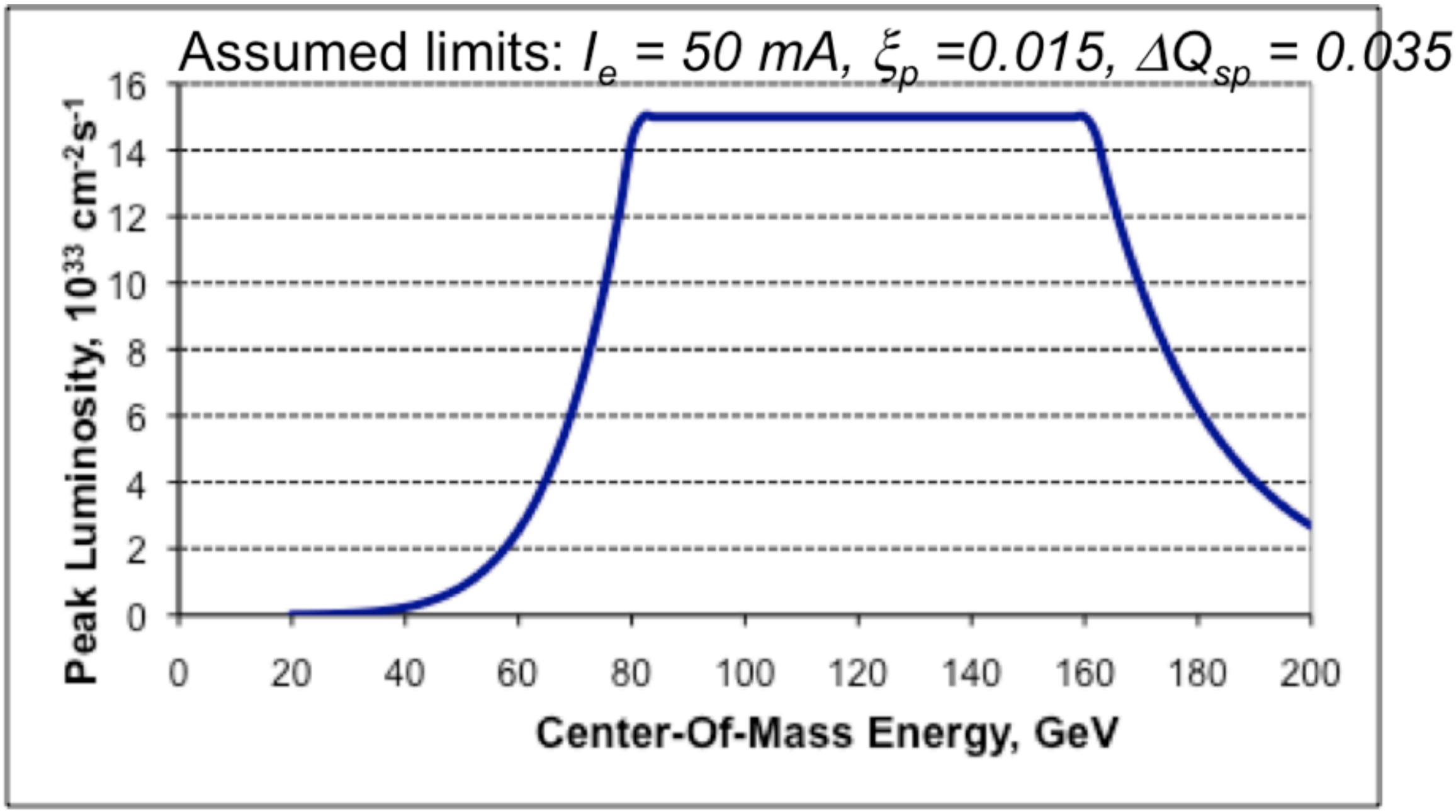
In summary

- EIC delivers very broad e+p programme
  - Inclusive, semi-inclusive, exclusive
- Only a few key measurement presented
  - electroweak, F_2^c, intrinsic charm, orbital angular momentum, photoproduction...
- Please see talks in this session, plus
  - Yingchaun Li, Abhay Deshpande & spin joint session

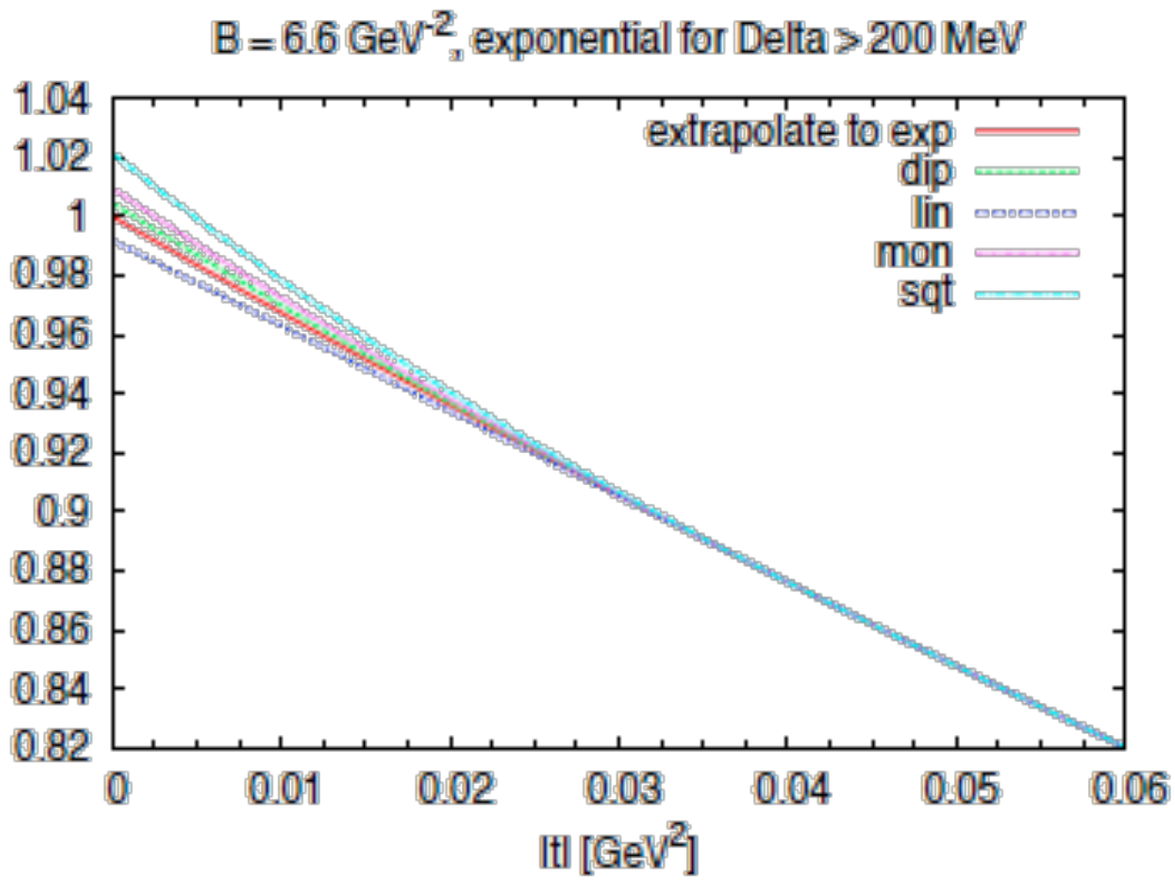
Past, present & future

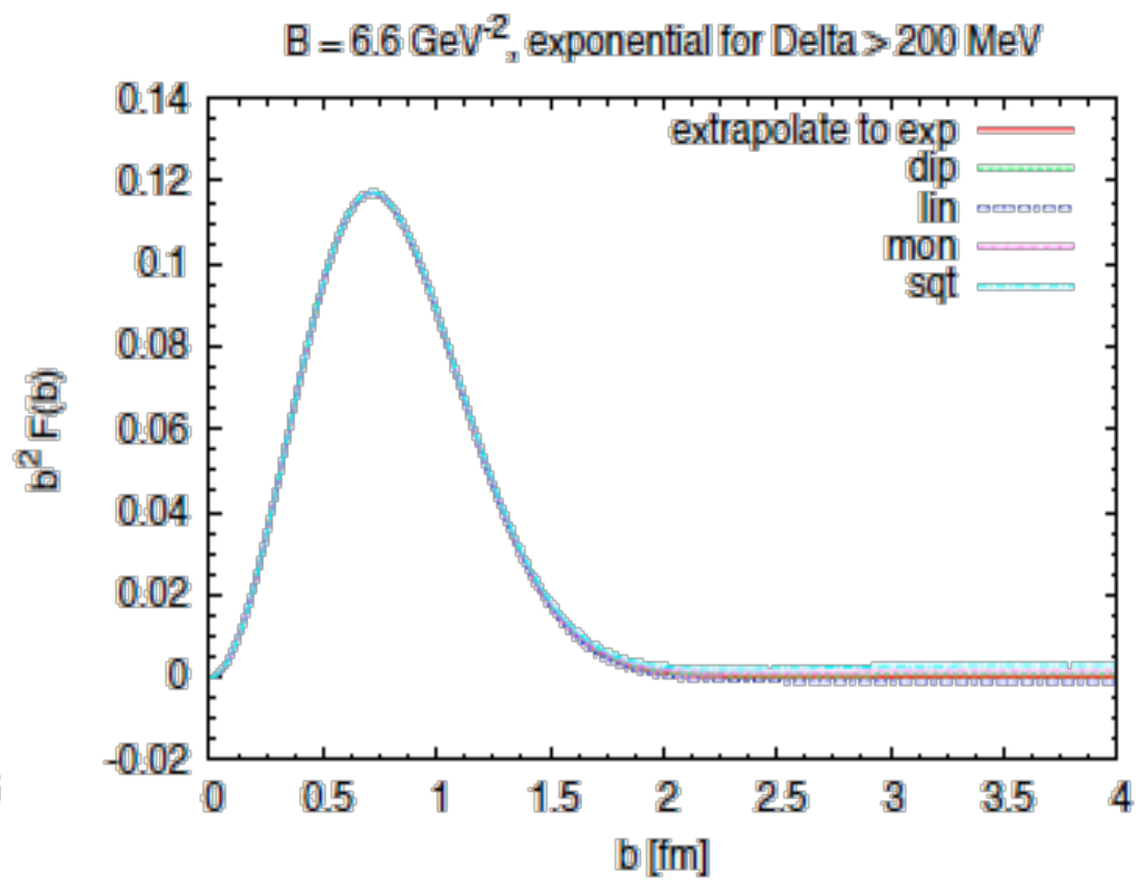


eRHIC luminosity

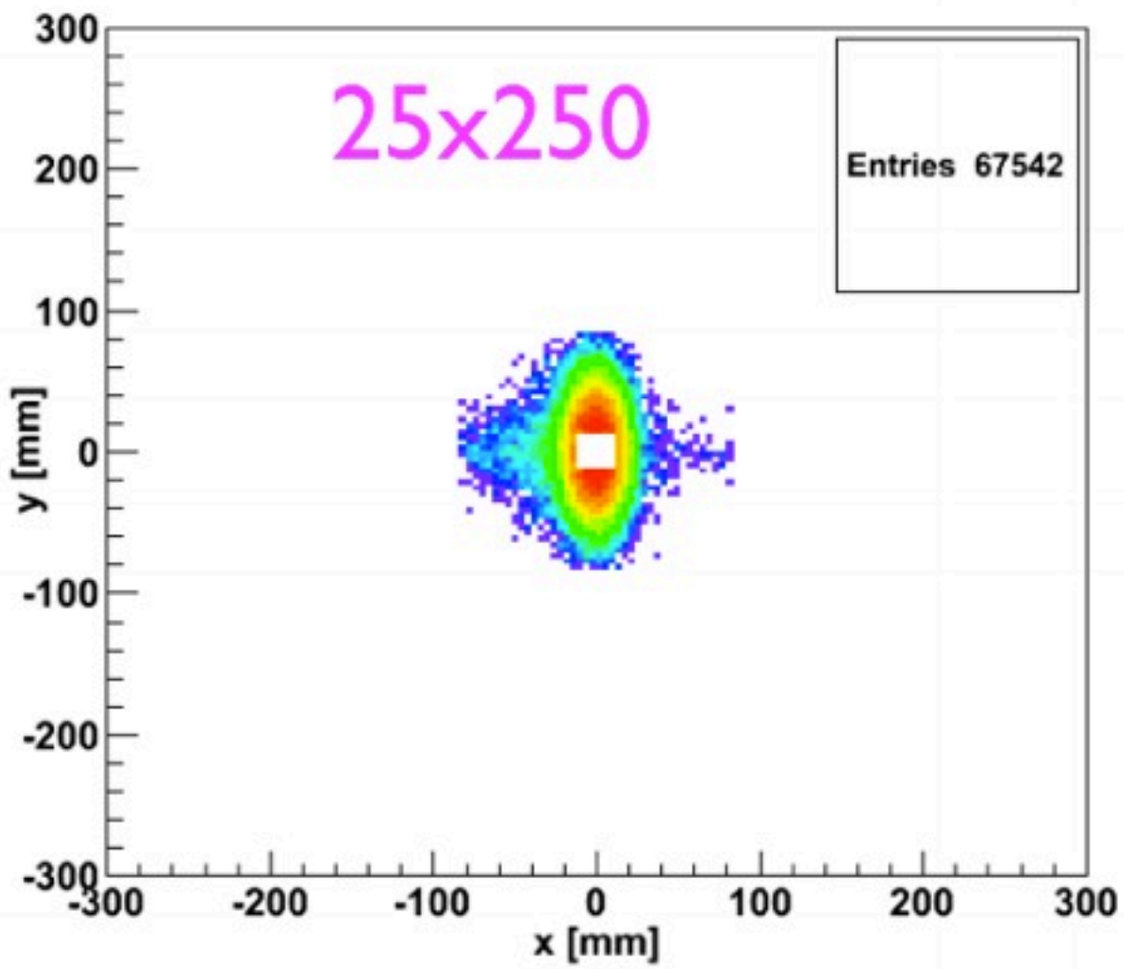


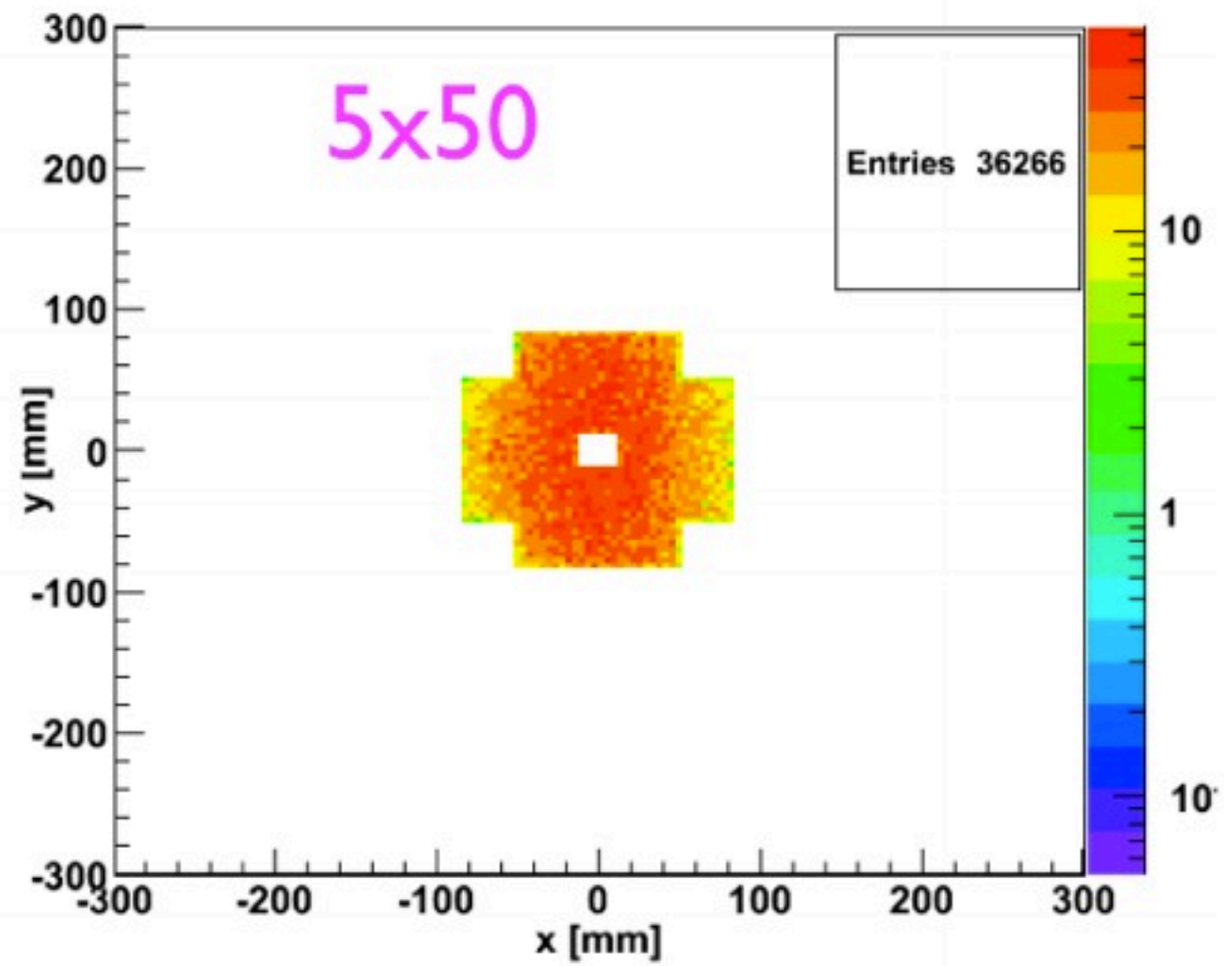
Small t - large b



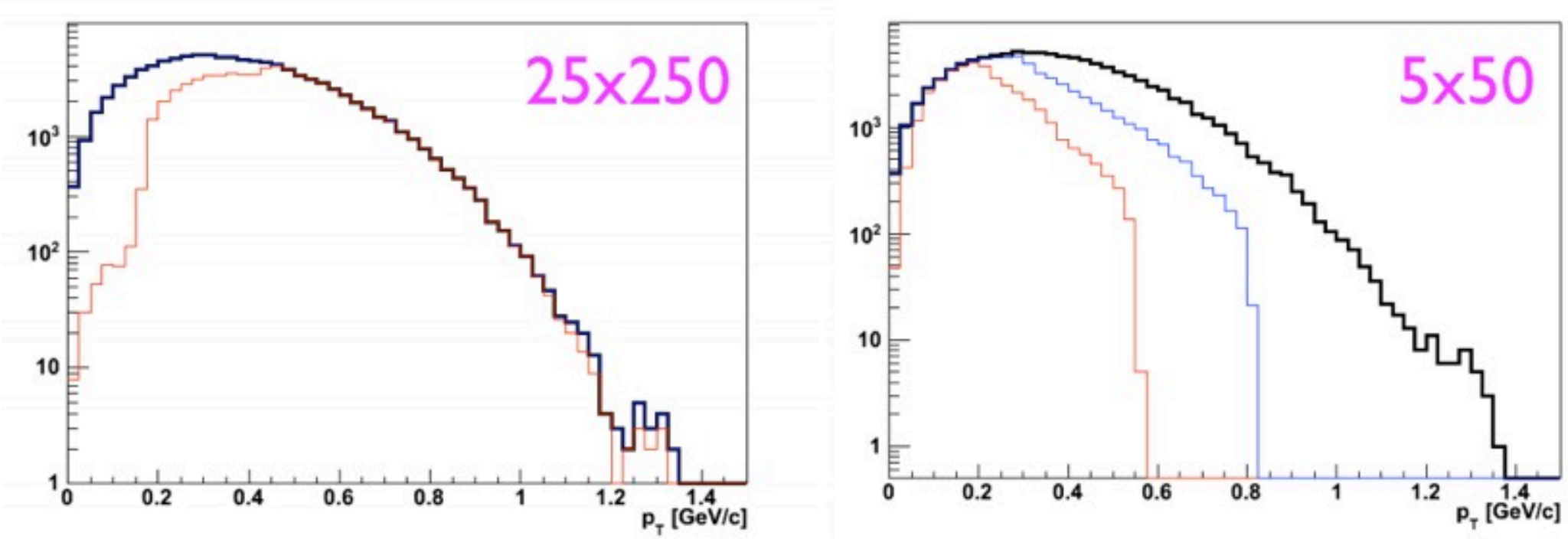


Roman pot acceptance





Roman pot p_T acceptance



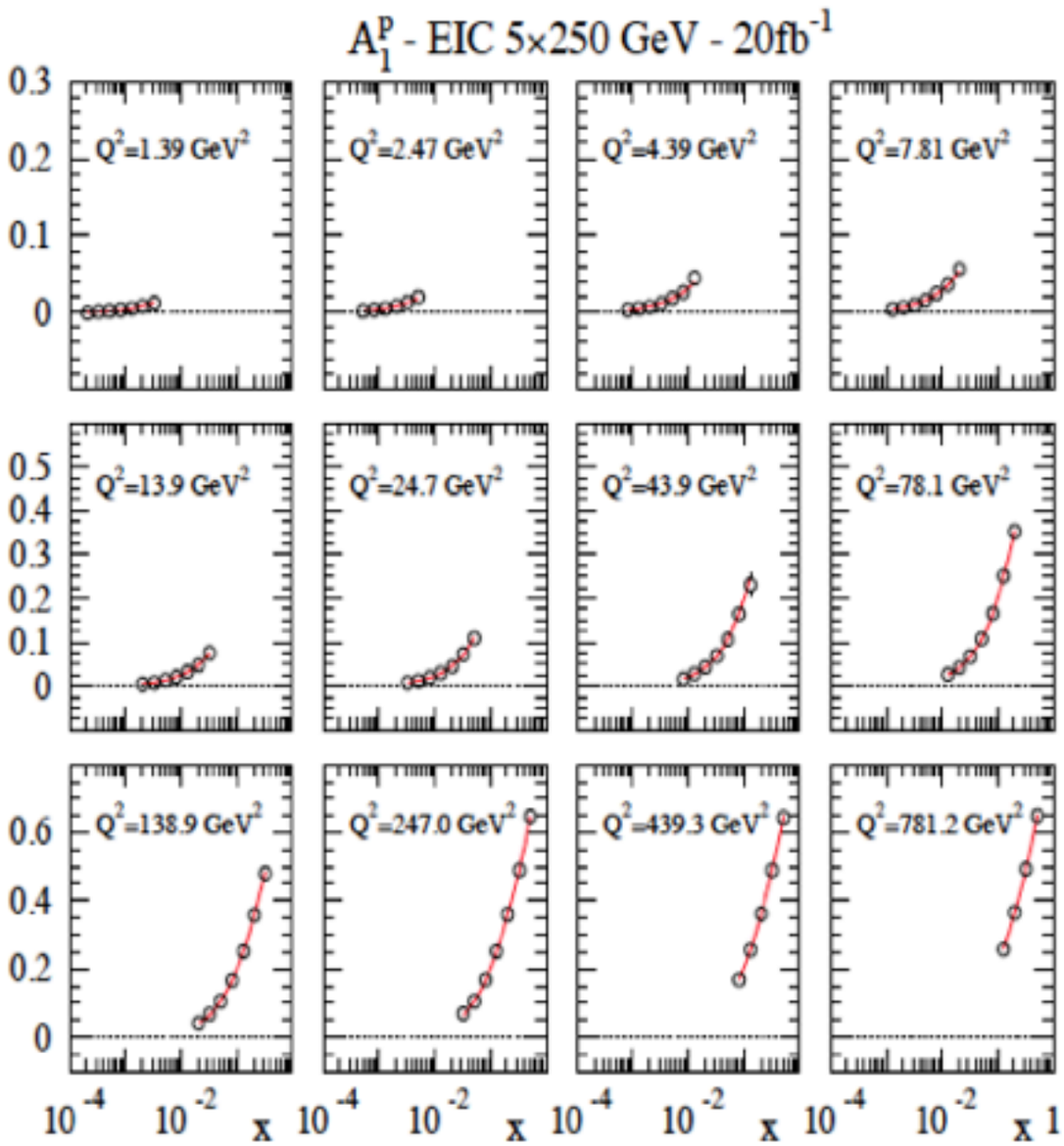
— Generated

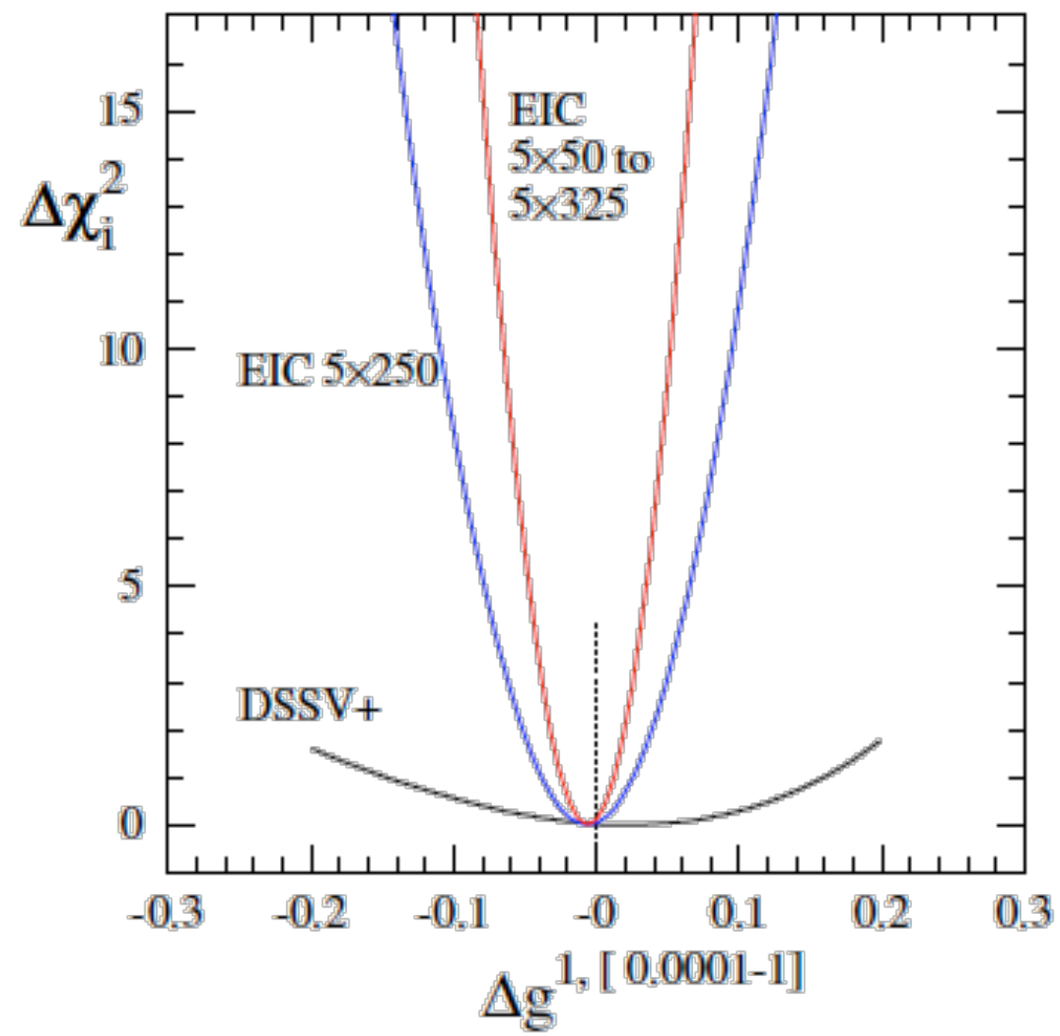
— Quad aperture limited

— RP (at 20m) accepted

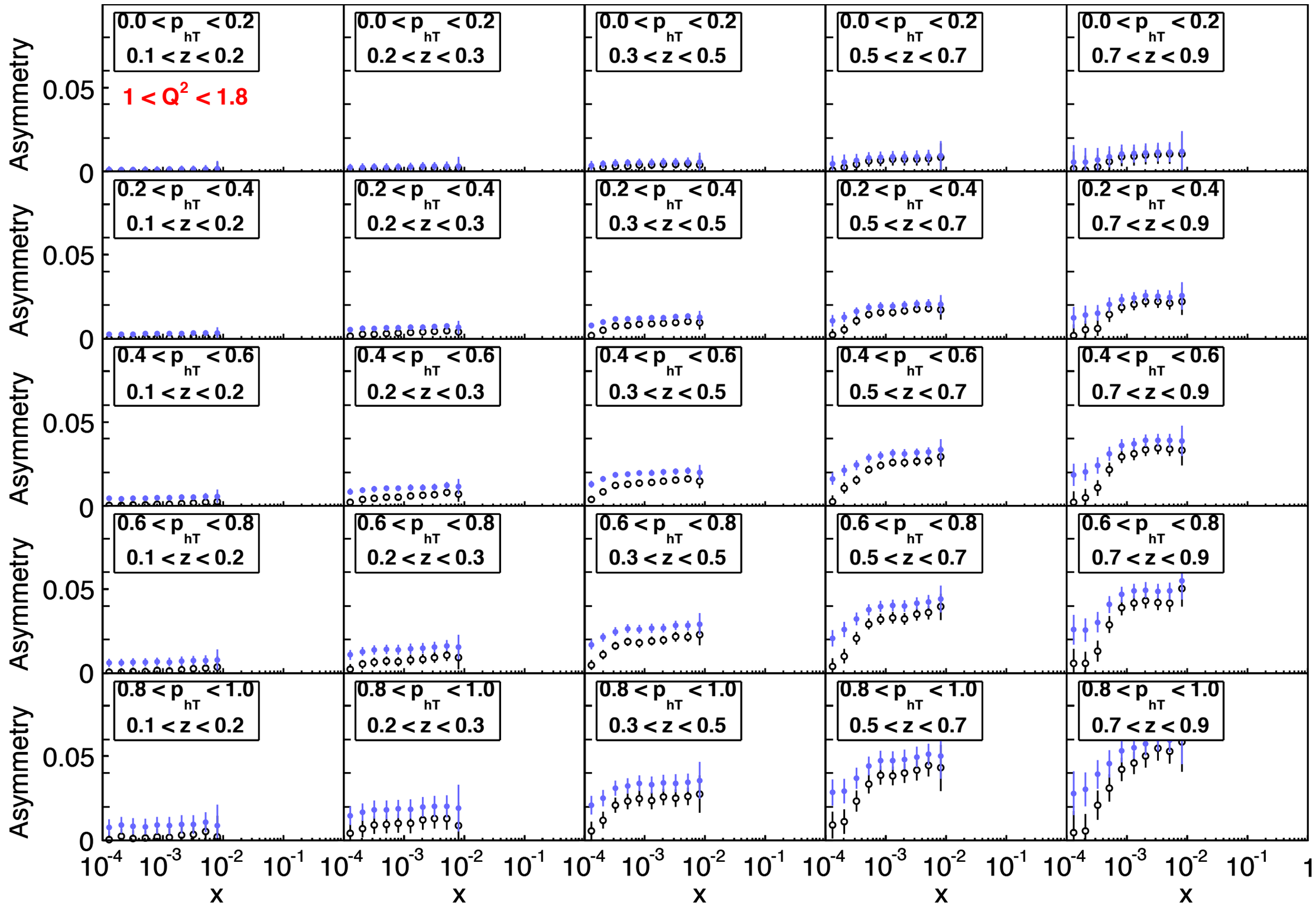
J-H. Lee

M. Stratmann

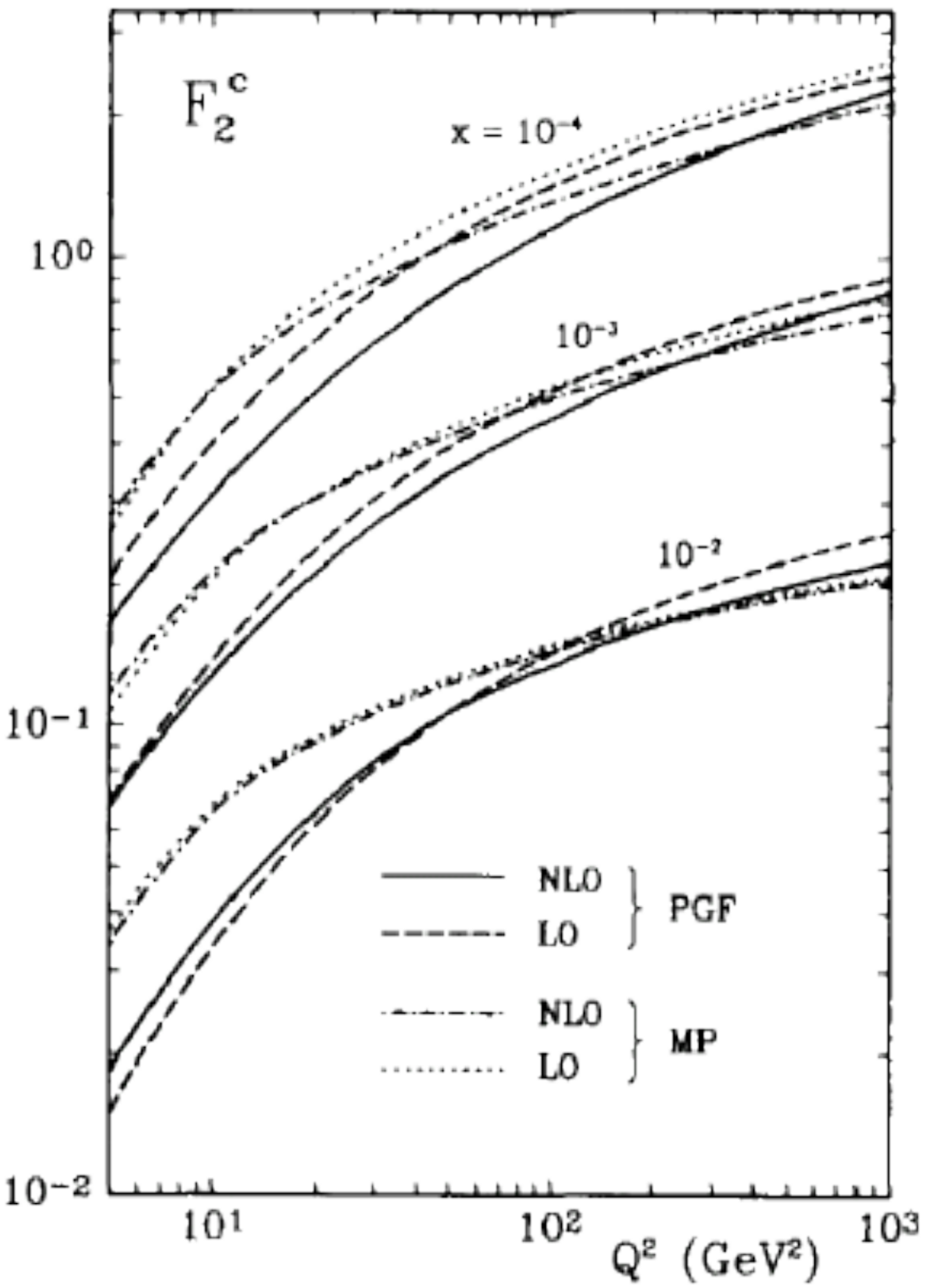

A_1^p - EIC 5×250 GeV - 20fb^{-1}
Q^2=1.39 GeV^2
Q^2=2.47 GeV^2
Q^2=4.39 GeV^2
Q^2=7.81 GeV^2
Q^2=13.9 GeV^2
Q^2=24.7 GeV^2
Q^2=43.9 GeV^2
Q^2=78.1 GeV^2
Q^2=138.9 GeV^2
Q^2=247.0 GeV^2
Q^2=439.3 GeV^2
Q^2=781.2 GeV^2
x

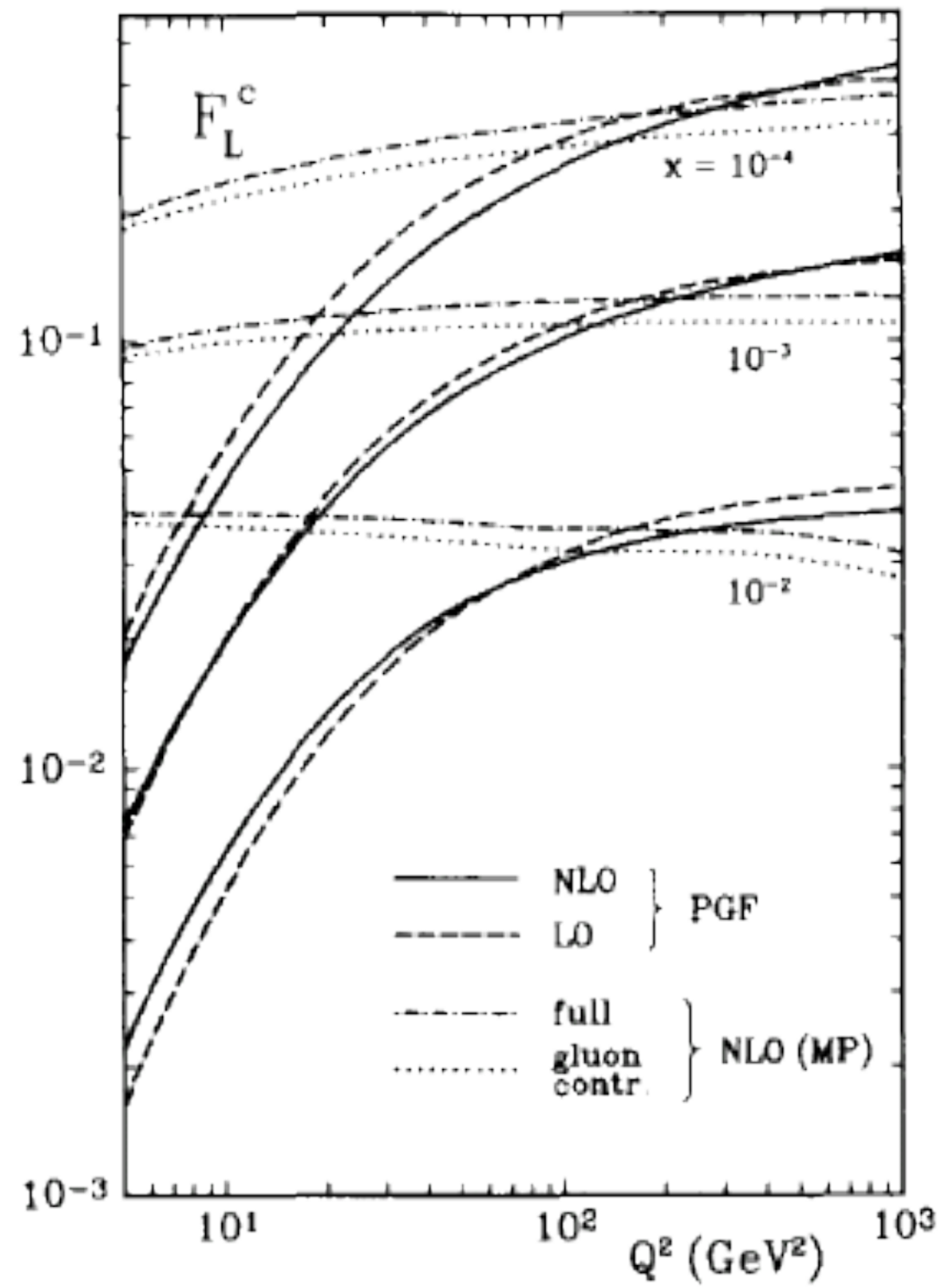

$\Delta\chi_i^2$
EIC
5×50 to
5×325
EIC 5×250
DSSV+
$\Delta g^{1,[0.0001-1]}$

K^+, 20x250


0.0 < p_hT < 0.2
0.1 < z < 0.2
1 < Q^2 < 1.8
0.0 < p_hT < 0.2
0.2 < z < 0.3
0.0 < p_hT < 0.2
0.3 < z < 0.5
0.0 < p_hT < 0.2
0.5 < z < 0.7
0.0 < p_hT < 0.2
0.7 < z < 0.9
0.2 < p_hT < 0.4
0.1 < z < 0.2
0.2 < p_hT < 0.4
0.2 < z < 0.3
0.2 < p_hT < 0.4
0.3 < z < 0.5
0.2 < p_hT < 0.4
0.5 < z < 0.7
0.2 < p_hT < 0.4
0.7 < z < 0.9
0.4 < p_hT < 0.6
0.1 < z < 0.2
0.4 < p_hT < 0.6
0.2 < z < 0.3
0.4 < p_hT < 0.6
0.3 < z < 0.5
0.4 < p_hT < 0.6
0.5 < z < 0.7
0.4 < p_hT < 0.6
0.7 < z < 0.9
0.6 < p_hT < 0.8
0.1 < z < 0.2
0.6 < p_hT < 0.8
0.2 < z < 0.3
0.6 < p_hT < 0.8
0.3 < z < 0.5
0.6 < p_hT < 0.8
0.5 < z < 0.7
0.6 < p_hT < 0.8
0.7 < z < 0.9
0.8 < p_hT < 1.0
0.1 < z < 0.2
0.8 < p_hT < 1.0
0.2 < z < 0.3
0.8 < p_hT < 1.0
0.3 < z < 0.5
0.8 < p_hT < 1.0
0.5 < z < 0.7
0.8 < p_hT < 1.0
0.7 < z < 0.9
Asymmetry
0.05
0
10^-4 10^-3 10^-2 10^-1 1
x

F_2^c, F_L^c


F_2^c
x = 10^{-4}
10^{-3}
10^{-2}
10^0
10^{-1}
10^{-2}
NLO
LO
PGF
NLO
LO
MP
10^1
10^2
10^3
Q^2 (GeV^2)


F_L^c
x = 10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{-2}
10^{-3}
NLO
LO
PGF
full
gluon contr.
NLO (MP)
10^1
10^2
10^3
Q^2 (GeV^2)