Discussion on acceptance v Q^2

ePIC Inclusive Group
30 January 2023

Paul Newman and Stephen Maple (Birmingham)

Request from Thomas and the GD/I group:

"Following discussions we had at the collaboration meeting, there are increasing worries that ePIC is developing a "hole" in its Q2 coverage.

The GD/I group is planning a meeting on February 6th that is dedicated to the issue of ePIC's low-Q2 coverage. This meeting is mostly for information gathering and to understand our actual coverage.

Besides the key detector working groups we of course want to hear especially from the Inclusive Physics WG where we currently stand in terms of Q2 coverage from our simulations.

We would like to ask your WG to contribute with a brief 10 min presentation (+5 discussion) on the Q2 coverage."

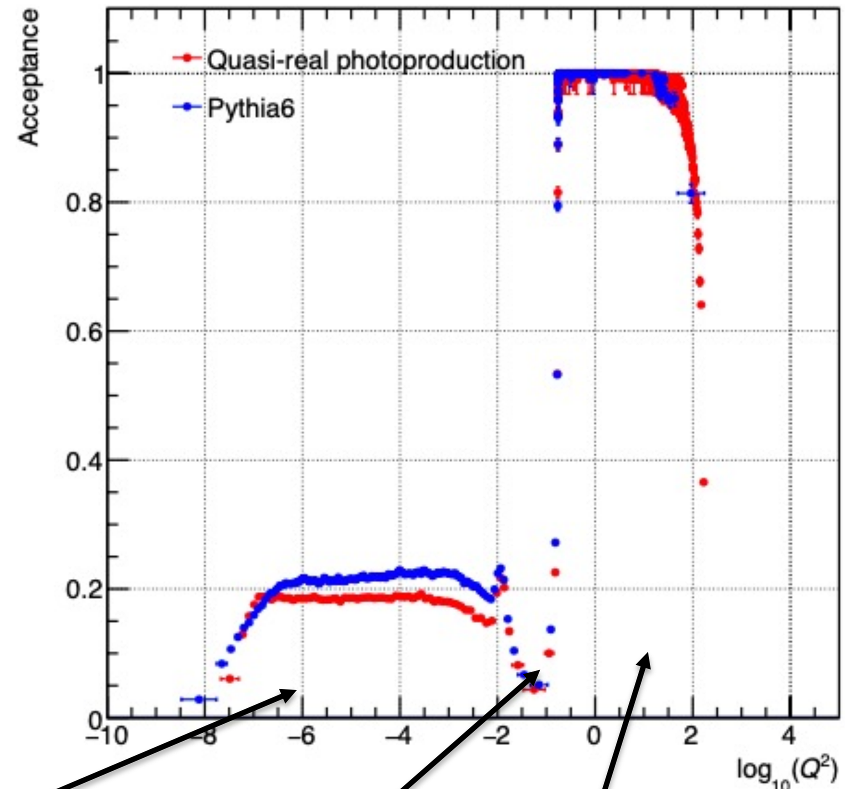
This is not a new question
(e.g. from `Complementarity' studies for Yellow Report)

Complementarity by Mitigating Acceptance Gaps

All detectors have gaps and cracks

… e.g. place gap in scattered electron acceptance between main detector and dipole/tagger in different places?

Can be mitigated by having 2 detectors with different high |η| layouts



Low Q^2 tagger

Beamipe

Main calorimeters

Electron Kinematics

$$Q_e^2 = 2E_e E'_e(1+\cos\theta) \qquad y_e = 1 - \frac{E'_e}{E_e}\sin^2\frac{\theta}{2}$$

As $Q^2 \rightarrow 0$, $\vartheta \rightarrow 180^o$, in kinematic peak ($y \rightarrow 0$) region,

$$Q^2 \rightarrow 2E_e^2(1+\cos\theta)$$

Strong correlation between Q^2 and θ

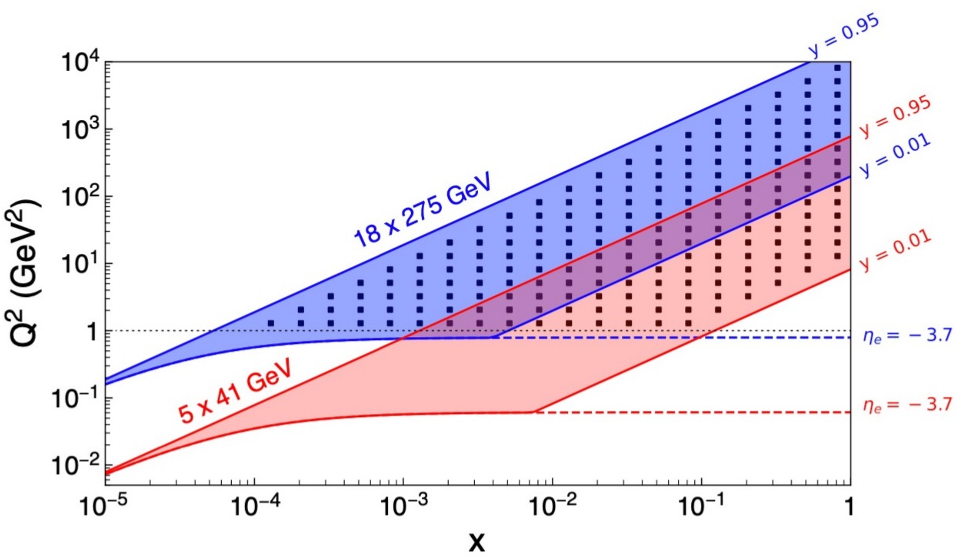
Weaker correlation between y (or x) and θ

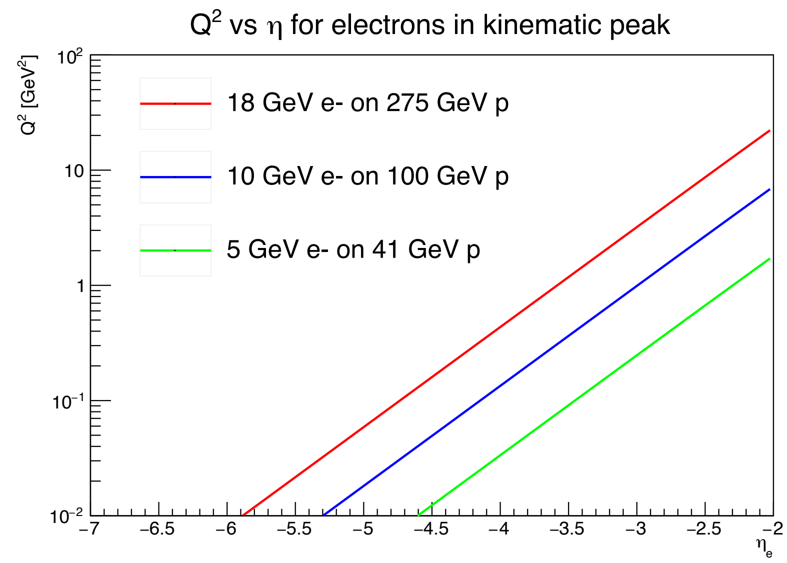
Note that these correlations only depend on the electron beam energy (proton energy is irrelevant)

Possible workarounds

1) Build more instrumentation in between main detector and Beamline instrumentation

2) Vary the electron beam energy

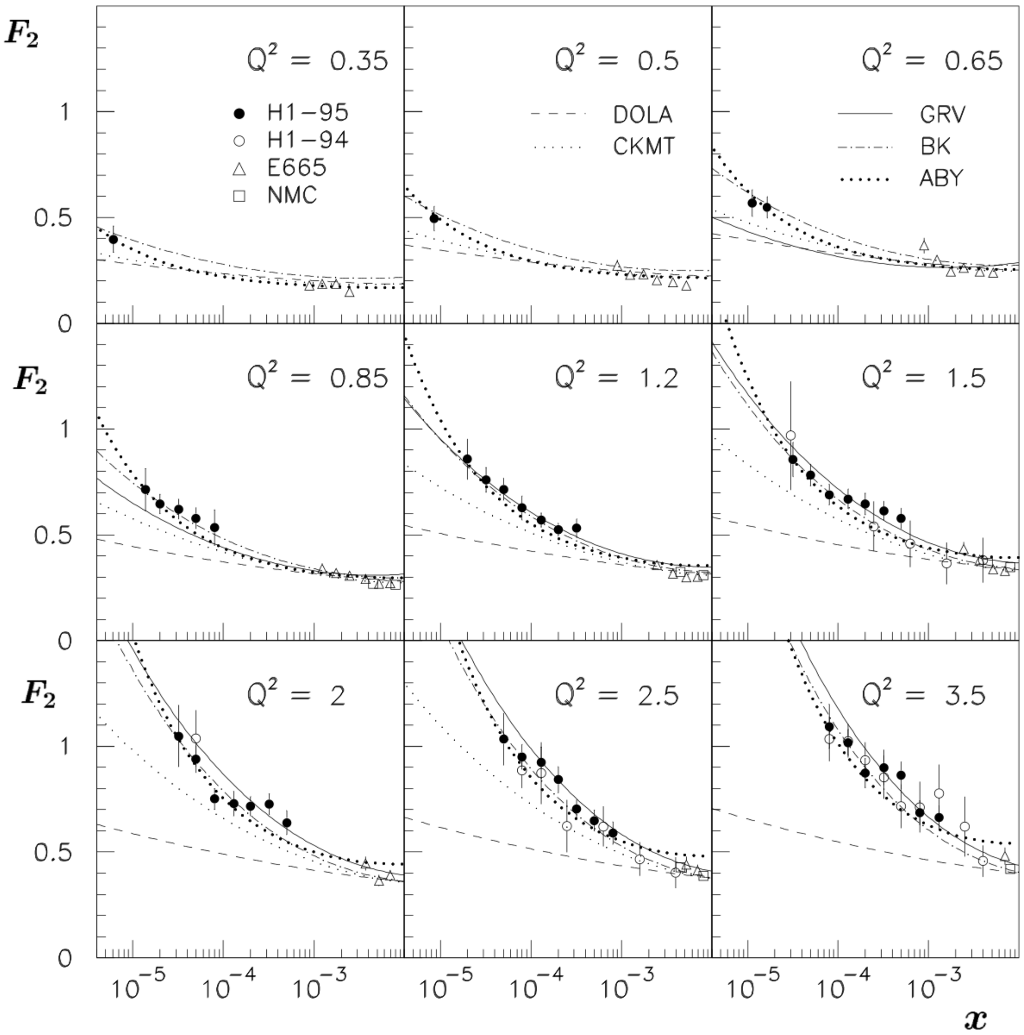




3) Shift the vertex

… by moving vertex in the outgoing hadron direction, extend acceptance to higher $|\eta|$

Shifted vertex example (H1)

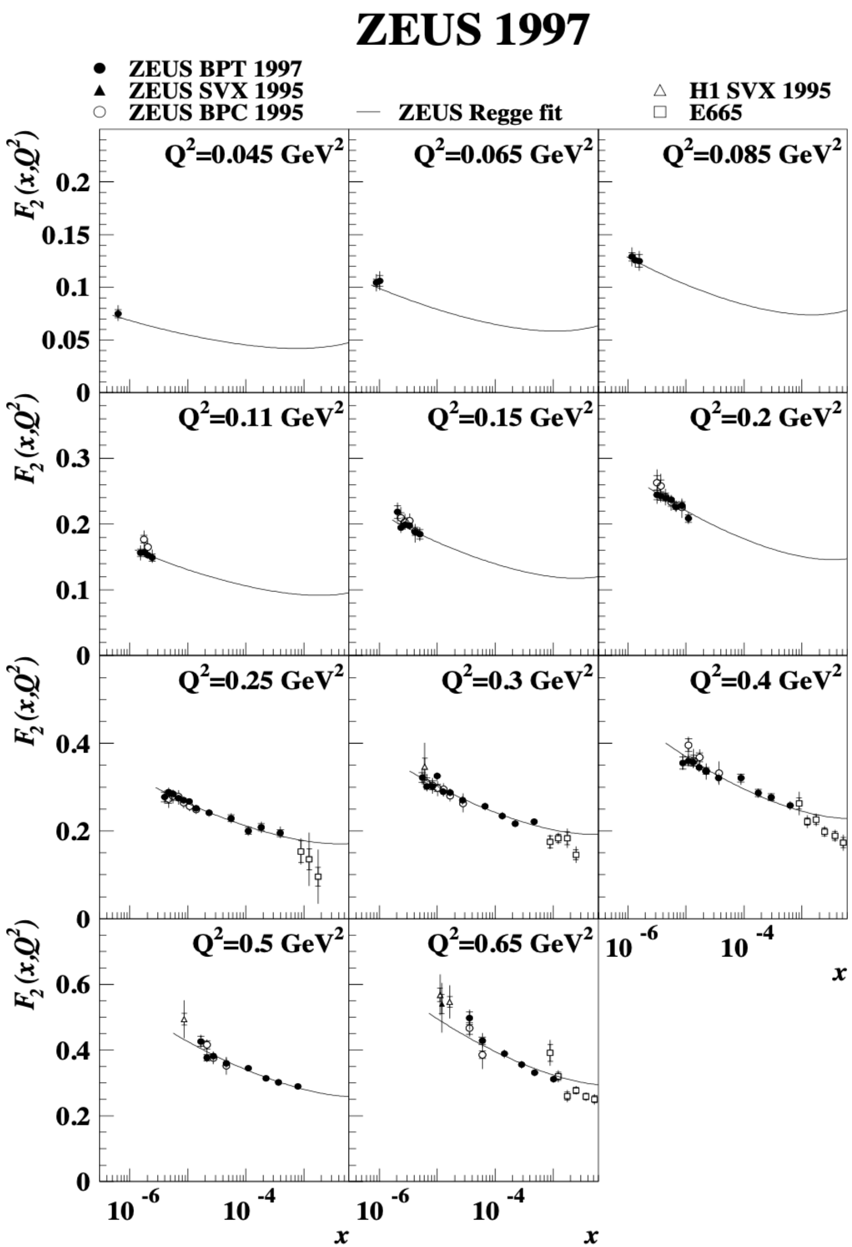


`H1-94' are nominal vertex (Q^2 >~ 1.5 GeV^2)

`H1-94 are with vertex shifted by 70cm (Q^2 >~ 0.35 GeV^2)

[similar technique applied at RHIC?]

‘Beam-pipe’ calo/tracker at ZEUS



- Measurement with ZEUS beampipe calo / tracker

- Electrons exited beampipe through exit window to reach the detectors

… really does fill in the gap!

- Experimentally tough (H1 version never resulted in published data.

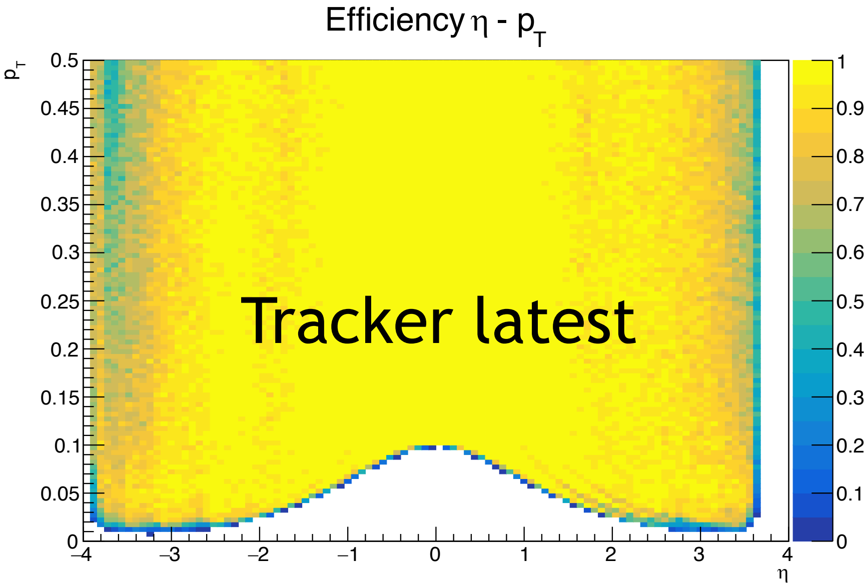
Simulations Studies?

- To study this properly, need MC sample extending to $Q^2 \to 0$ kinematic limit.

- … and ideally samples with a shifted vertex too

- Central detector acceptances and efficiencies are well Studied / included in simulation

- Not so sure about beamline instrumentation?



Truth level studies may be enough if we have a rough idea of beamline instrumentation η, p_T acceptance?