

DVCS from HERA to CERN

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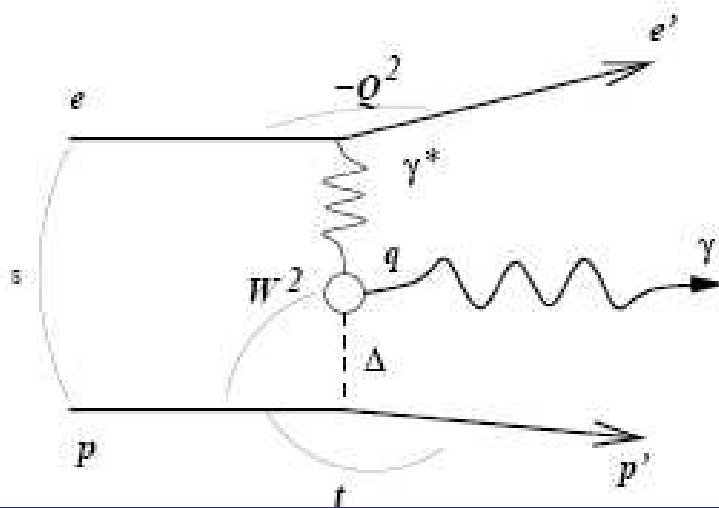
CEA Saclay

Photon 2009

Put in perspective HERA results and COMPASS
prospects for DVCS with
a few issues (related to GPDs/proton-spin)

DVCS kinematics

DVCS: QCD process



$$s = (e + p)^2$$

$$Q^2 = -q^2 = -(e - e')^2$$

$$W^2 = (q + p)^2$$

$$t = \Delta^2 = (p - p')^2 \approx -p_T'^2$$

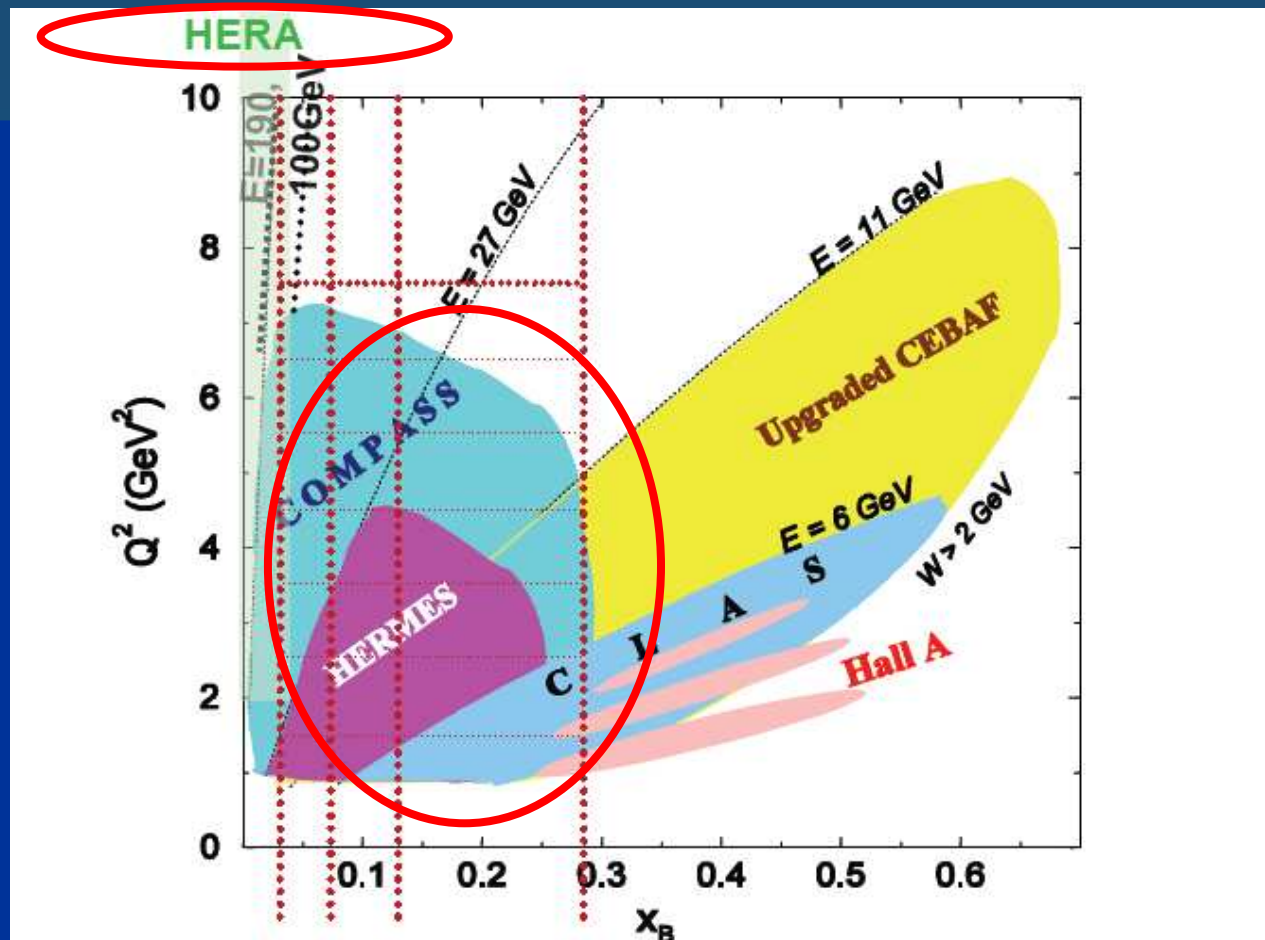
HERA : $e p \rightarrow e p \gamma$

COMPASS : $\mu p \rightarrow \mu p \gamma$

DVCS interferes with the purely EM process BH

DVCS in the word

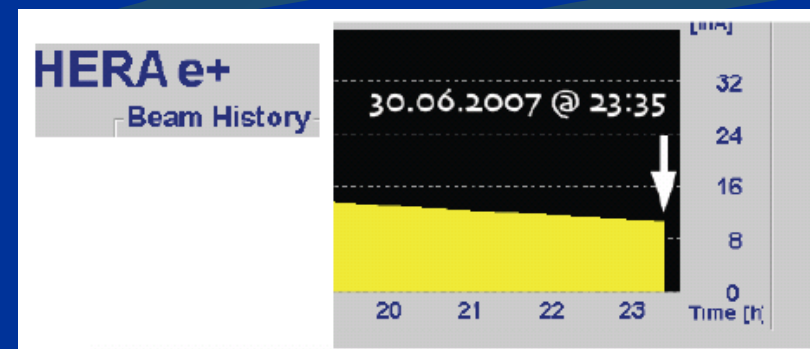
COMPASS/HERMES kin domain $x \subset [0.01, 0.1]$
H1/ZEUS kin domain $x < 0.01$ (large Q^2 range 2-100 GeV^2)
Jlab experiments: kin domain $x > 0.1$



Some basic characteristics

- **H1/ZEUS:** low x ($x < 0.01$) : large gluon density, saturation effects?!
DVCS cross section \sim BH cross section ($Q^2 \sim 10 \text{ GeV}^2$)
For $x < 0.01 \Rightarrow$ **Direct σ_{DVCS} can be measured...**
 Q^2 scale dependence can be analysed over 1 order of magnitude
- **HERMES and COMPASS:** similar kin domains
Continuity with HERA (low x) domain
At COMPASS: possibility to measure also directly σ_{DVCS}
and DVCS/BH interference
(// HERMES: *see dedicated talk @ this conf.*)
- Jlab: *see dedicated talk @ this conf.*

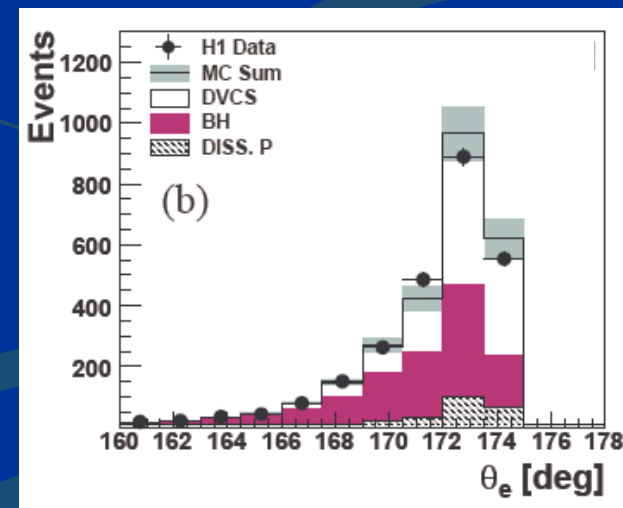
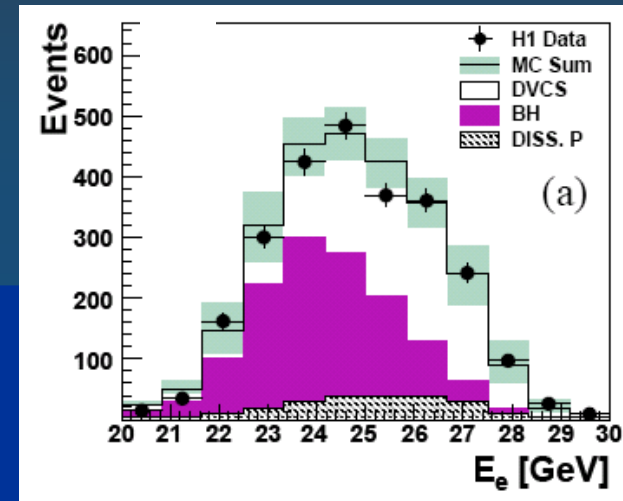
(I)
DVCS cross section
(at HERA $x \sim 10^{-3}$)
H1 & ZEUS results



DVCS at HERA

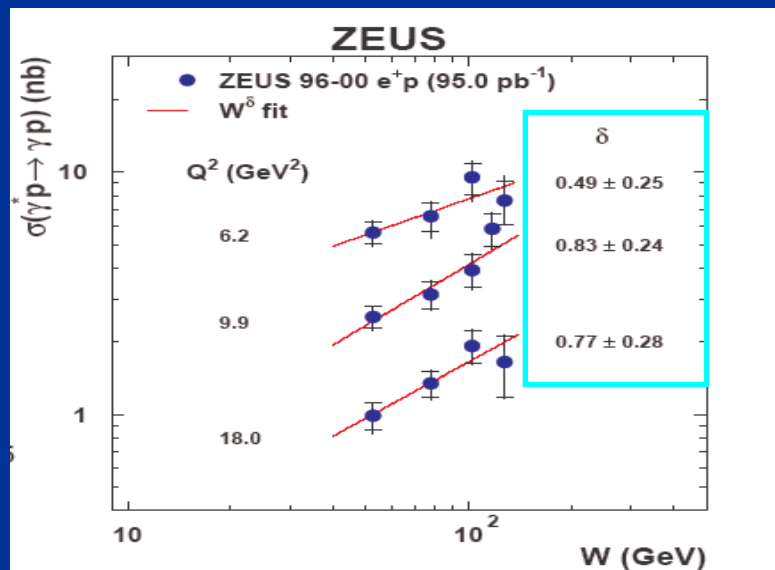
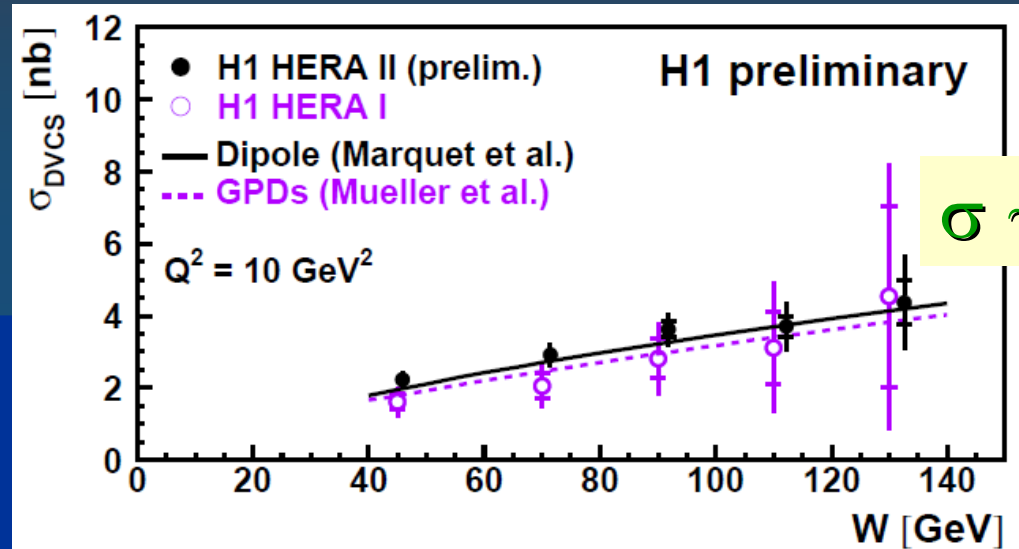
Results on control distributions

- Lepton variables
 - Good description by Monte-Carlo (MC) with 2 dominant contributions:
 - DVCS signal (ok)
 - BH background (irreducible)
- Note: interference contribution $<1\%$ as we integrate over ϕ (lepton-proton azimuthal angle)



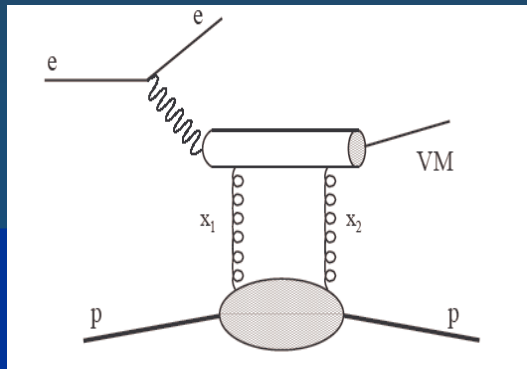
DVCS cross sections in W...

a first fundamental result (large W, low x)

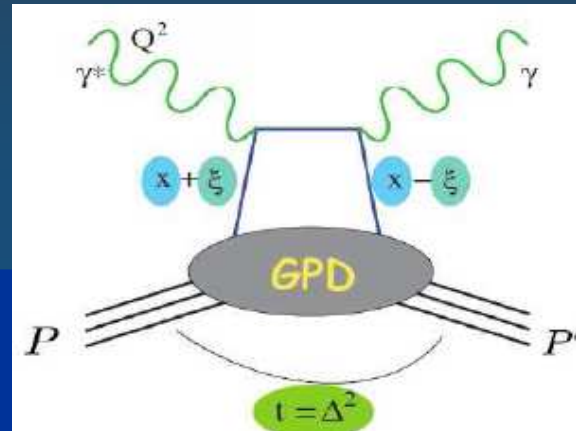


Hard W dependence
 \Rightarrow DVCS at HERA (low x)
 is a hard process...
 can be described
 by pQCD...

DVCS versus Skeewing: prospects



VM => photon



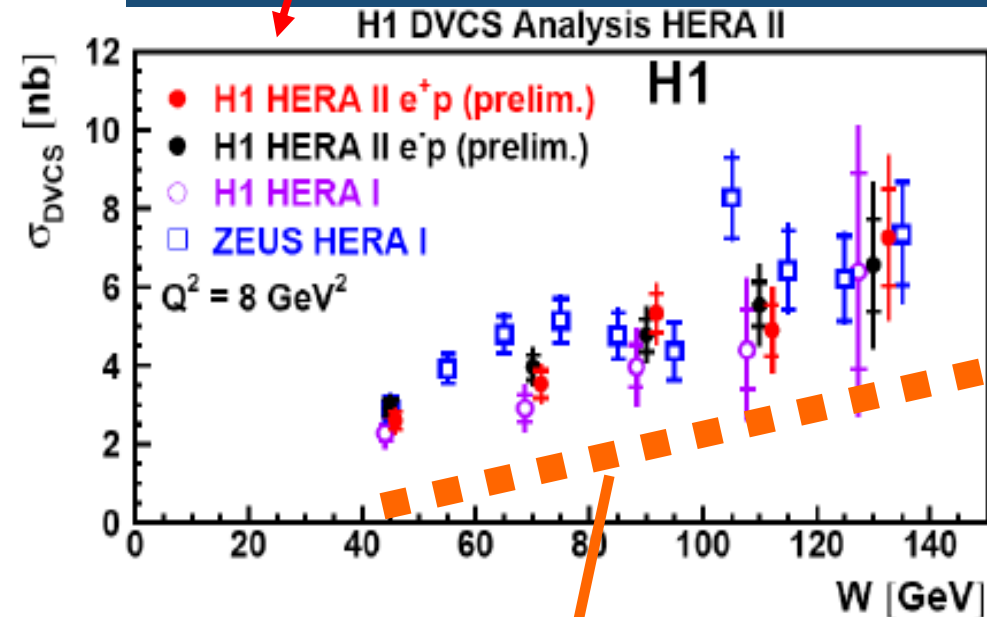
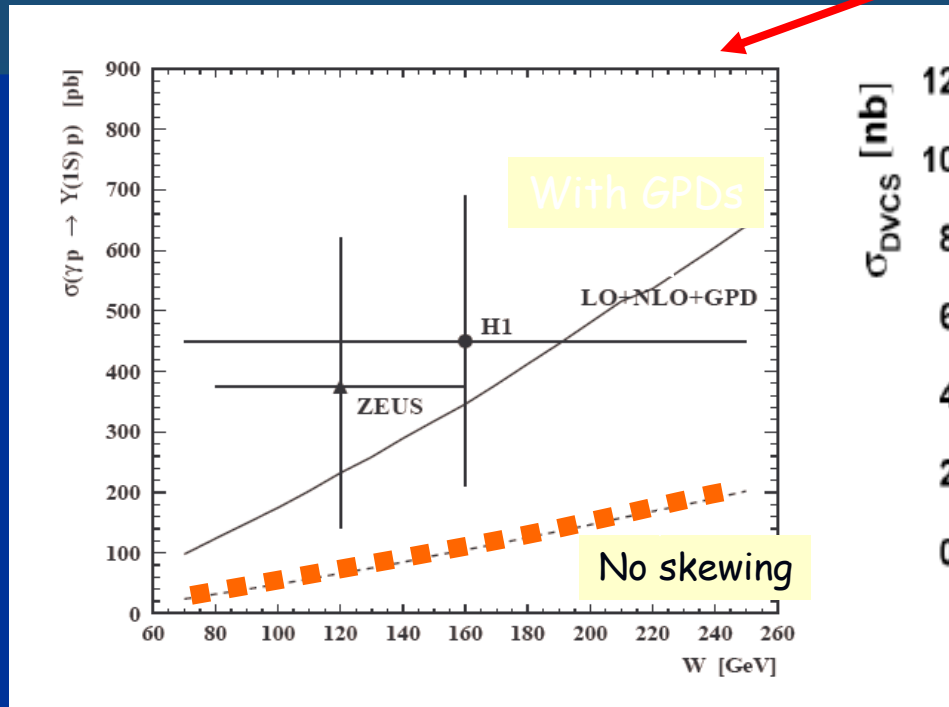
$$x_1 - x_2 \sim [Q^2 + M^2] / W^2 \Rightarrow \xi \sim x_{bj} / 2$$

We expect skewing effects to be important
In VM & DVCS @ HERA

=> Replacement of PDFs by GPDs ?!

Skeewing effects: PROOF

The DVCS xs calculations include terms in $|GPD(x_1, x_2)|^2$ (skeewing)
If we forget these effects, we replace GPD by PDF in calulations but it fails!

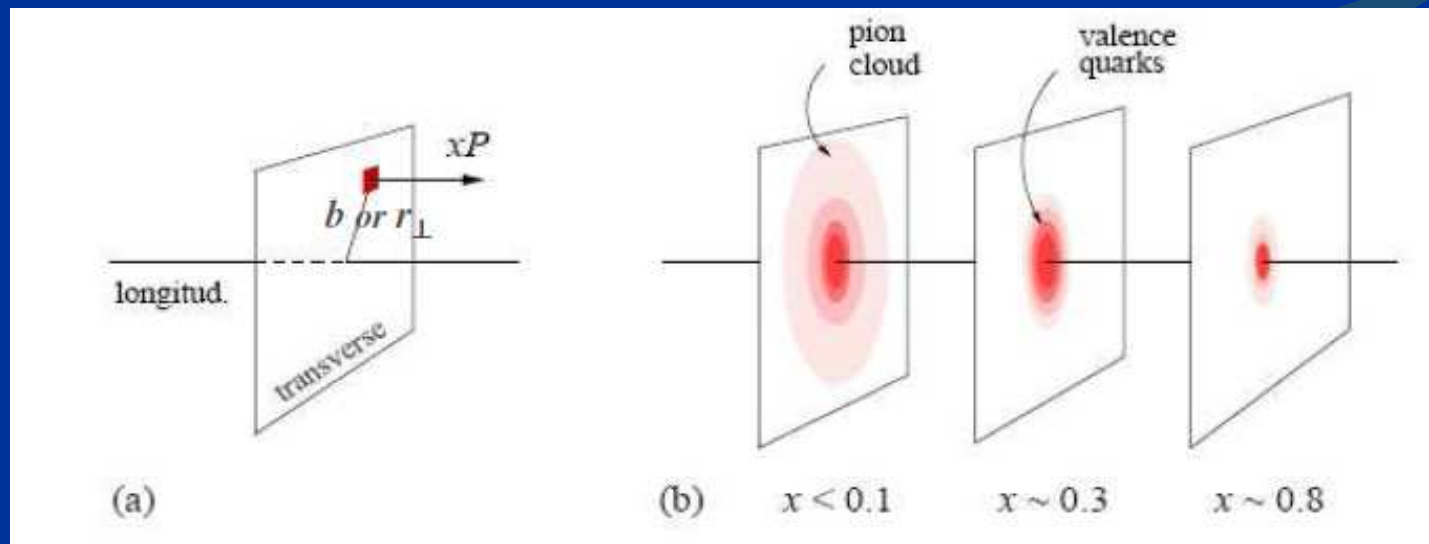


The first observation of
skeewing (GPDs) impact

Prediction without skewing
a factor ~4 below the data

(II)

Impact parameter dependence of the DVCS cross section (& BCA)



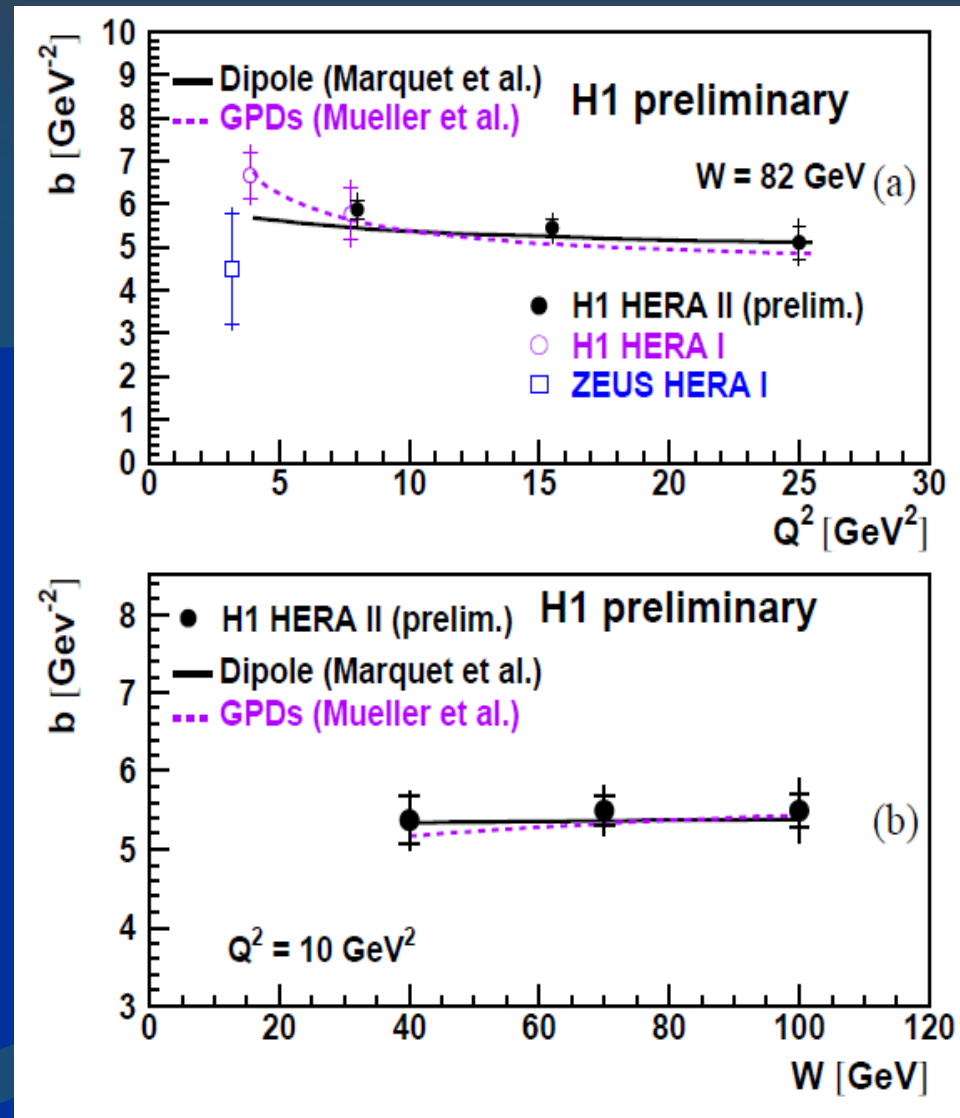
HERA DVCS ($x \sim 10^{-3}$): $d\sigma/dt \sim e^{bt}$

- @ low Q^2 : higher twists effects in $1/Q^2$: finite size of the qqbar pair probe
- @ large Q^2 : scaling in Q^2 ... we are really probing the proton structure with a « pointlike » qqbar pair configuration
- No dependence in W observed (α' small)

$$b = 5.45 \pm 0.19 \pm 0.34 \text{ GeV}^{-2}$$

$$\Rightarrow \sqrt{\langle r_T^2 \rangle} = 0.65 \text{ fm}$$

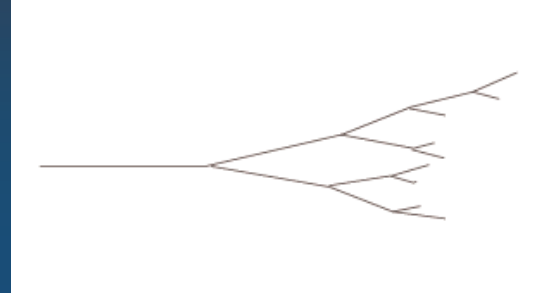
» valence quarks value



A brief status on α'

Gribov diffusion: parton branching as random walk in b space

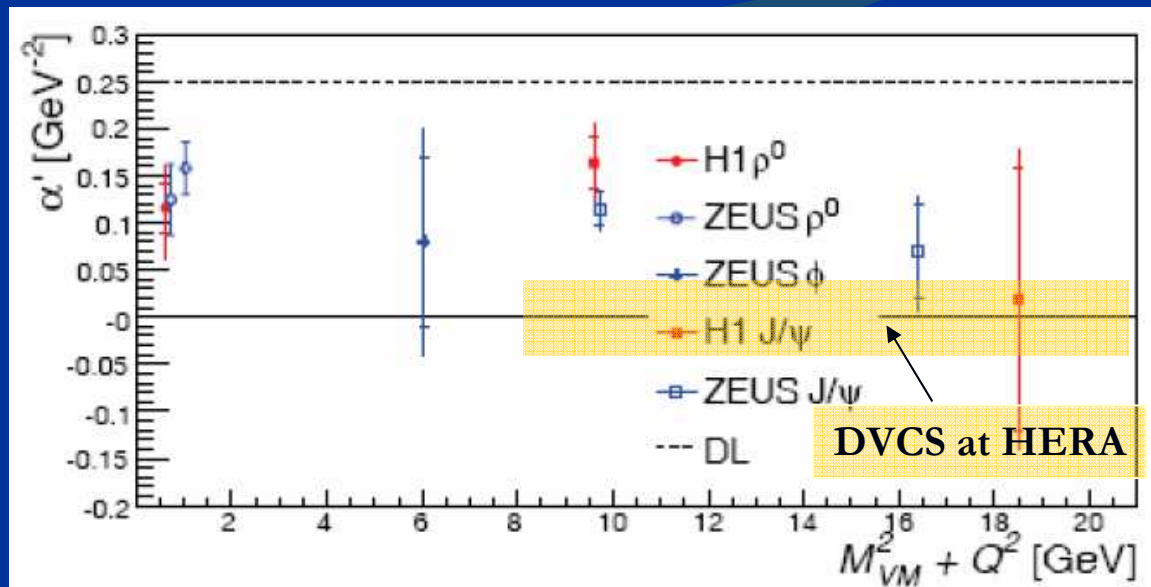
$$\rightarrow \langle b^2 \rangle \propto \alpha' \log(1/x)$$



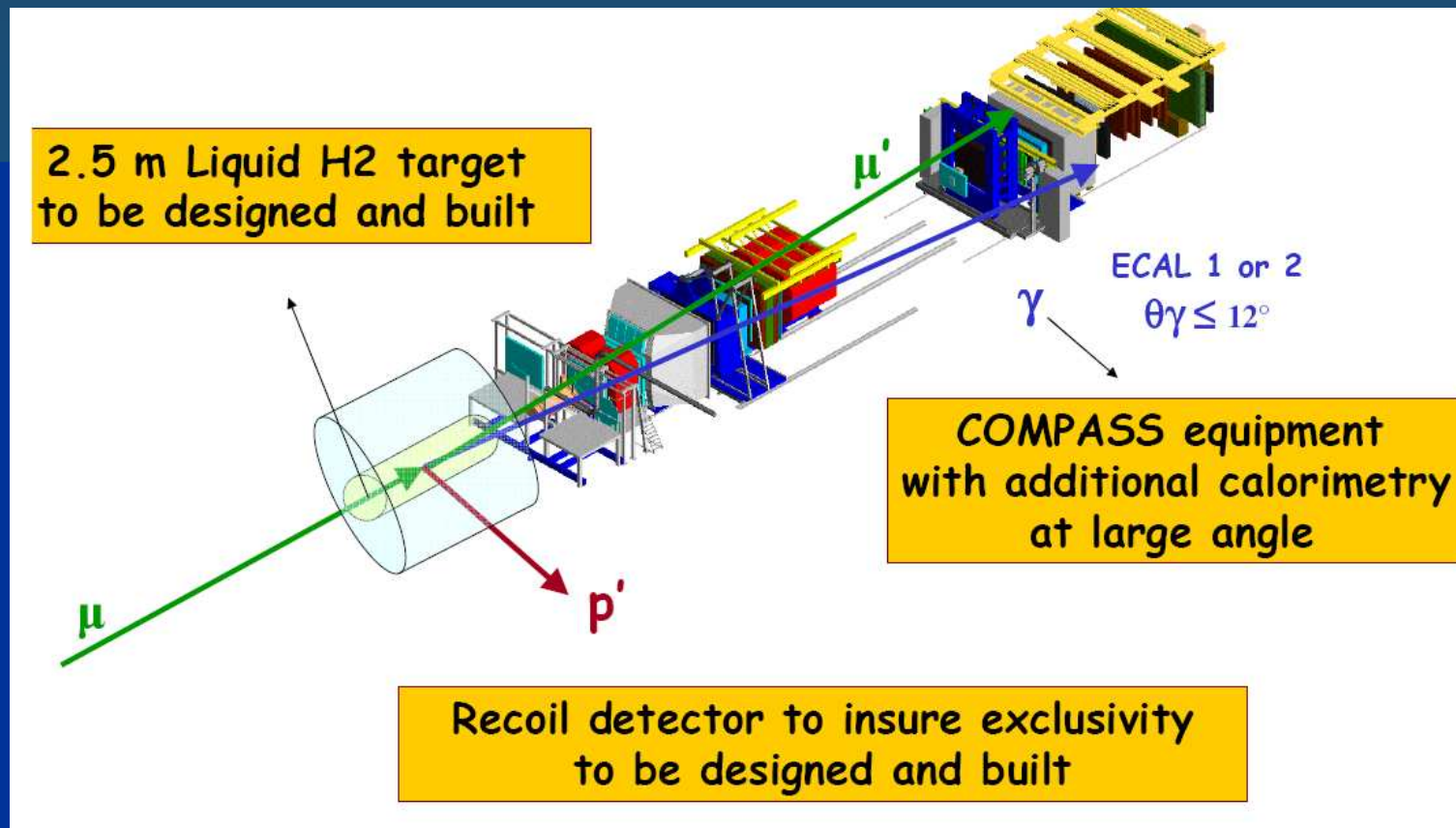
We expect a non zero value of α' due to « basic » (Gribov) diffusion: Emission of more & more partons... But @ large Q^2 , low x : results are different!

The 2D-size of a p-p system grows 2 times faster than the size of γ -p system with $\ln(W)$ & the size of a $\gamma^*(Q^2 \text{ large})$ -p system does not grow...

What does it give @ $x \sim 0.1$?

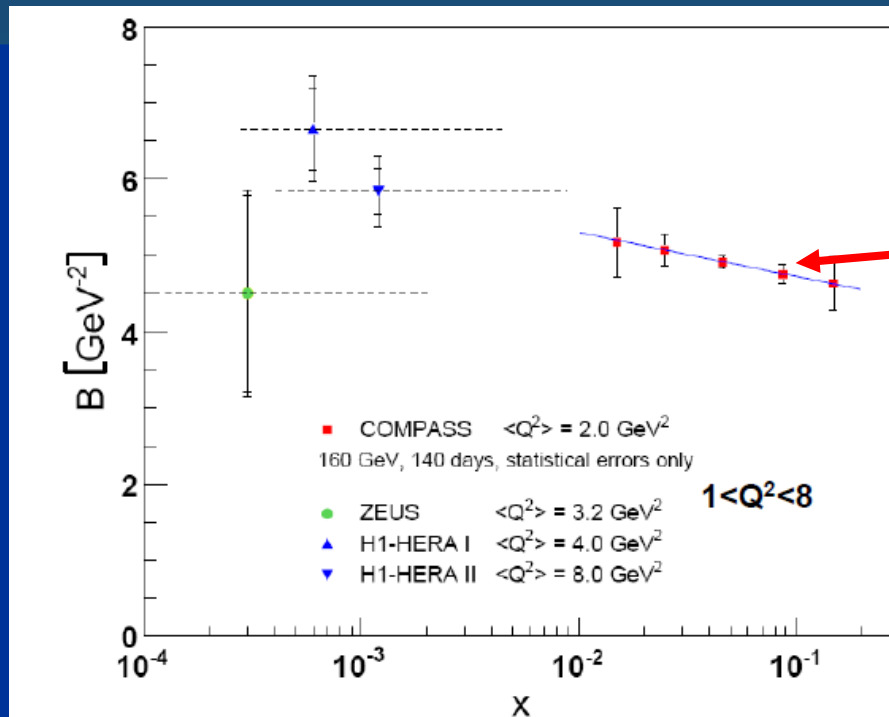


DVCS at CERN: COMPASS



Direct σ_{DVCS} measurements

Measure directly DVCS cross section \Rightarrow the t-slope dependence in x!
 \Rightarrow determine subsequently α' essentially unknown in this kin domain



Projected error bars

THEN, COMPASS can use this
first possible result on α' to
interpret data on BCA



Beam Charge Asymmetry BCA

$$BCA \equiv \frac{d\sigma_{e^+} - d\sigma_{e^-}}{d\sigma_{e^+} + d\sigma_{e^-}} = \frac{\mathcal{A}_{\text{Interference}}}{|\mathcal{A}_{\text{DVCS}}|^2 + |\mathcal{A}_{\text{BH}}|^2}$$

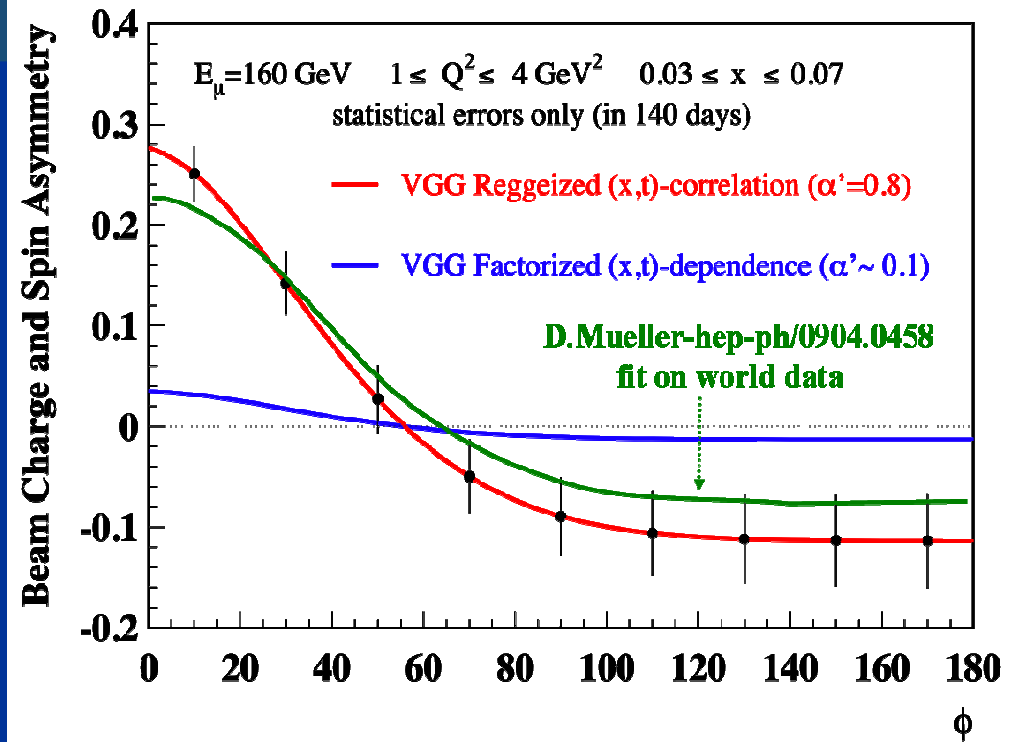
Non-factorised ansatz:

Mix t/x dependences =>

$$H(x,0,t) = f(x)/x^{\alpha't}$$

α' is then an important measurement
from cross sections [t]
(see previous slides)

$$BCSA = \mathcal{D}_{u,cs} / \mathcal{S}_{u,cs}$$



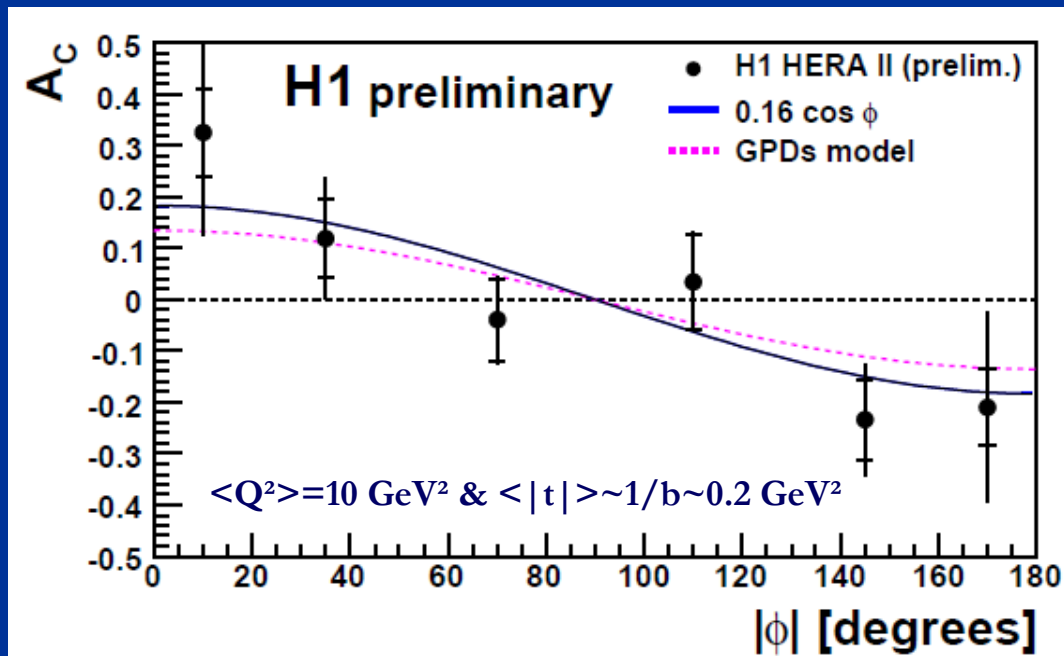
BCA as measured by H1

Main interest => provide information on $\text{Re}(\text{DVCS amplitude})\dots$

Direct sensitivity to GPDs models

(with small α' value, as measured directly)

Extract Re/Im and check of dispersion relations

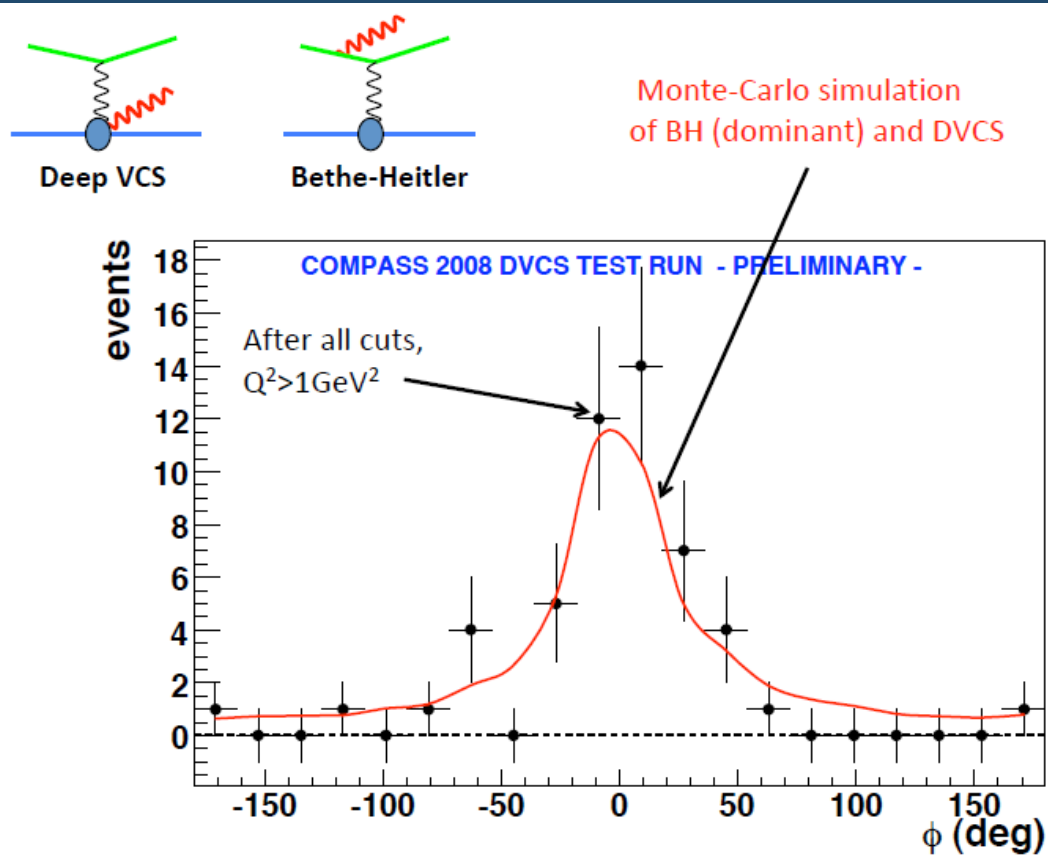


$$\text{Re}/\text{Im} = 0.20 \pm 0.05 \pm 0.08$$

From Dispersion relation
(W dependence of σ_{DVCS})

$$\text{Re}/\text{Im} = 0.25 \pm 0.03 \pm 0.05$$

A first 2 days running at COMPASS



Observation of
Exclusive photon (BH)

2009: 2 weeks planned
in autumn.

Outlook

- Direct continuity from **HERA** to **COMPASS** for **DVCS**
 - From the kin domain (trivial)
 - From observables: **direct DVCS cross sections** & BCA
 - Community of interests:
 - t-slopes measured @ HERA => COMPASS ?
 - also what is the α' value measured @ COMPASS?
 - versus HERA (low x) value which is small!
- More data on DVCS cross sections => more sensitivity to GPD (Hq/Hg)
- *More data means also a possibility to move to global fits of GPDs on all measured quantities*