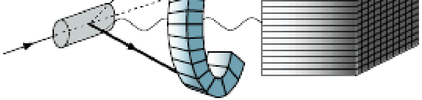


Deeply Virtual Compton Scattering in Hall A

Alexandre Camsonne

Hall A Jefferson Laboratory

FINN 2007

First dedicated experiment proposed for the study of the Deeply Vi
Compton Scattering

A unique approach

- High resolution and high precision on a limited kinematic range
  - Study of scaling with fixed x_{bj} =0.364
  - 3 Q^2 values □1.5 GeV^2,1.9 GeV^2,2.32 GeV^2 with H target
  - 1 Q^2 values □1.9 GeV^2 with D target
- High resolution calorimeter
- Focus on cross section measurement
- Ensure exclusivity
- High luminosity

x_{Bj}=.364 -t dependence $-t_{min}$ up to 0.4 GeV^2

$$p(e,e'\gamma)p$$

Q^2=**2.3,1.9,1.5** GeV^2 h=+/-1
Q^2=**2.3** GeV^2 h=0

Published

(C. Muñoz-Cam
et al., PRL 97 (2
262002)

$$n(e,e'\gamma)n$$

$$D(e,e'\gamma)D$$

Q^2=**1.9** GeV^2 h=+/-1

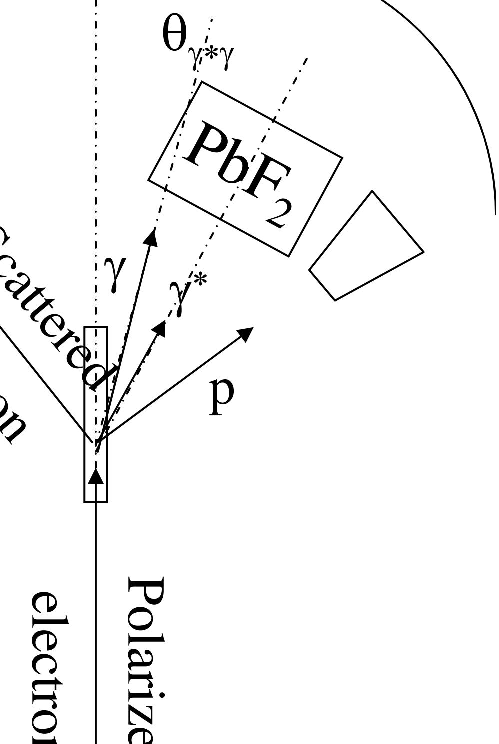
Malek Mazouz

Submitted to PRL

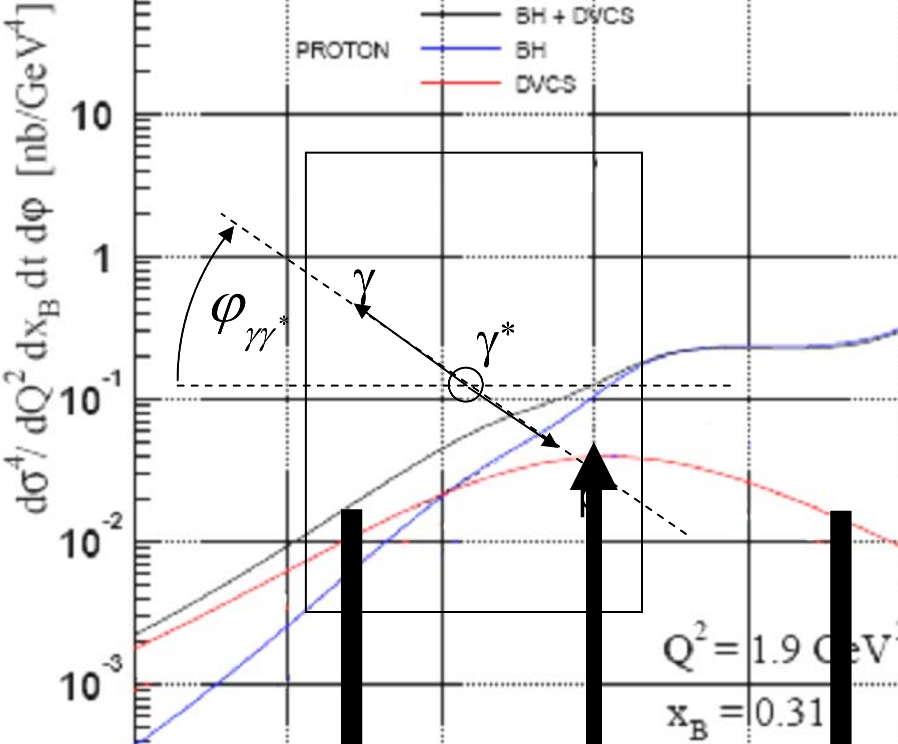
$$p(e,e'\pi^0)p$$

Q^2=**2.3**, **1.9** GeV^2 h=0, h=+/-1

High Q^2 complete



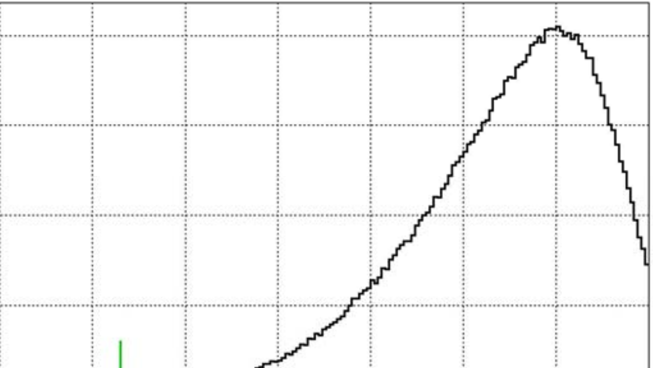
$\theta_{\gamma^*\gamma}$
PbF_2
γ
γ^*
p

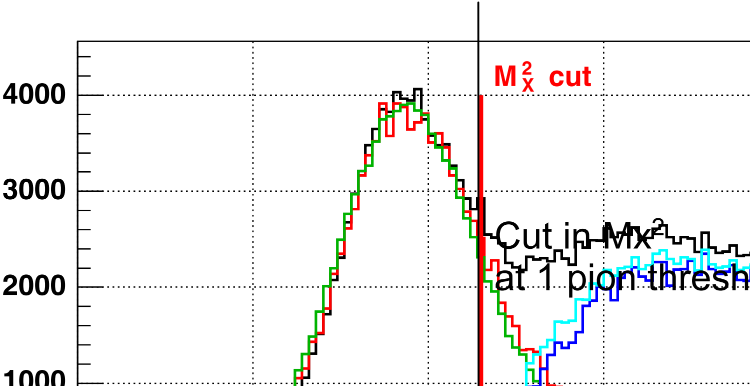


BH + DVCS
PROTON
BH
DVCS
$d\sigma^4/ dQ^2 dx_B dt d\phi$ [nb/GeV^4]
10
1
10^{-1}
10^{-2}
10^{-3}
$\varphi_{\gamma\gamma^*}$
γ
γ^*
$x_B = 0.31$

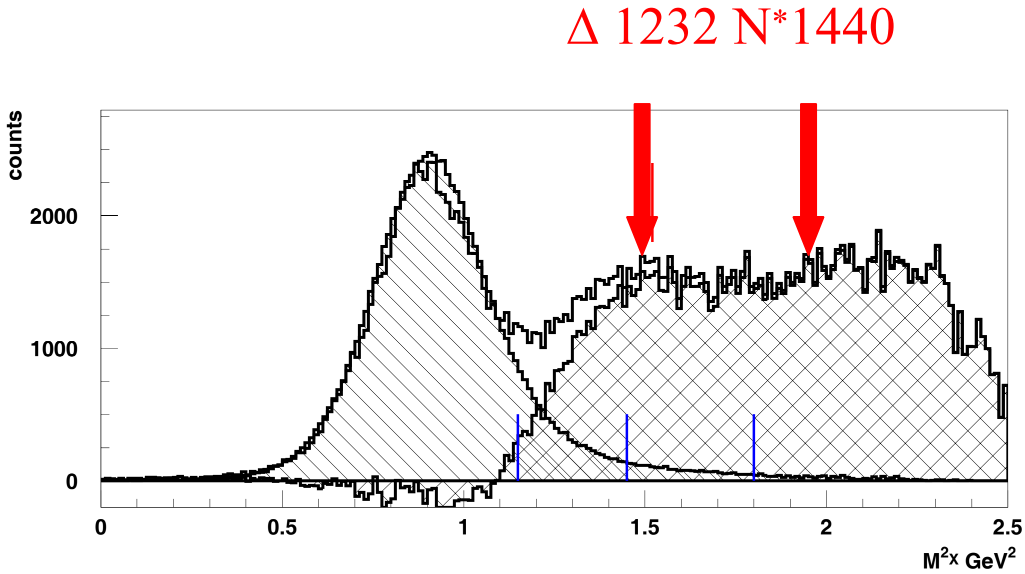
subtraction done using the π^0 sample recorded in the calorimeter

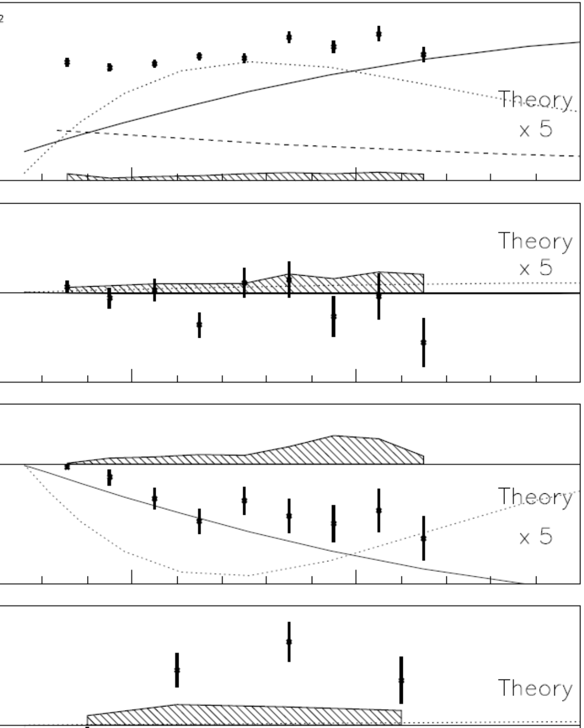
Subtracted data fits exact simulation and the shape exclusive events:
good understanding of the d
Exclusivity in two arm

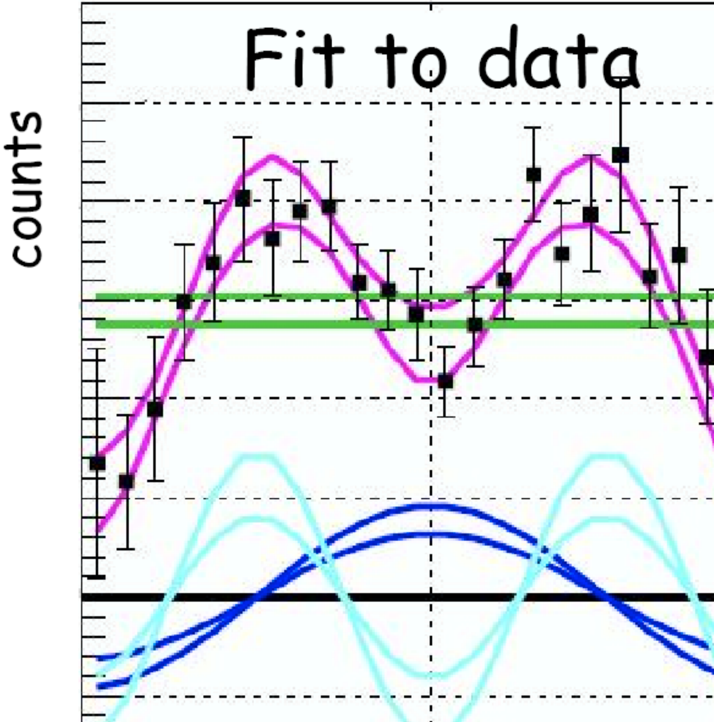


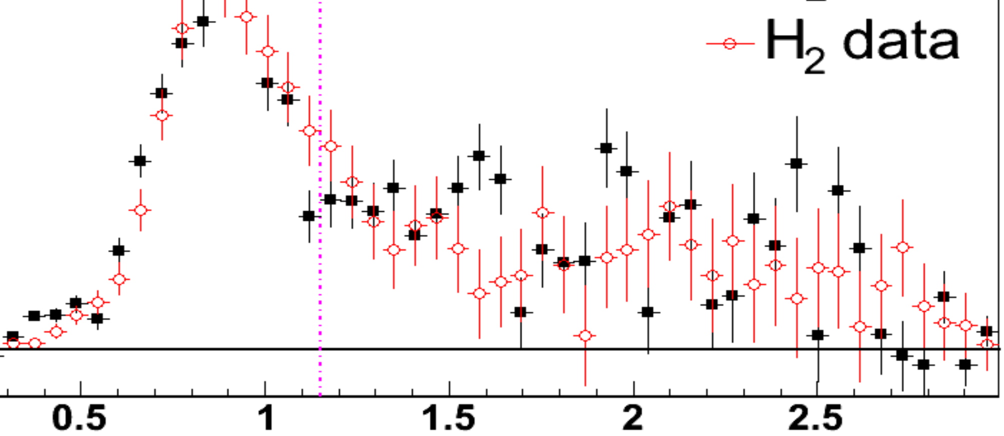


ut on missing mass $ep \rightarrow e\pi^0 X$




Theory
x 5
Theory
x 5
Theory
x 5
Theory


counts
Fit to data

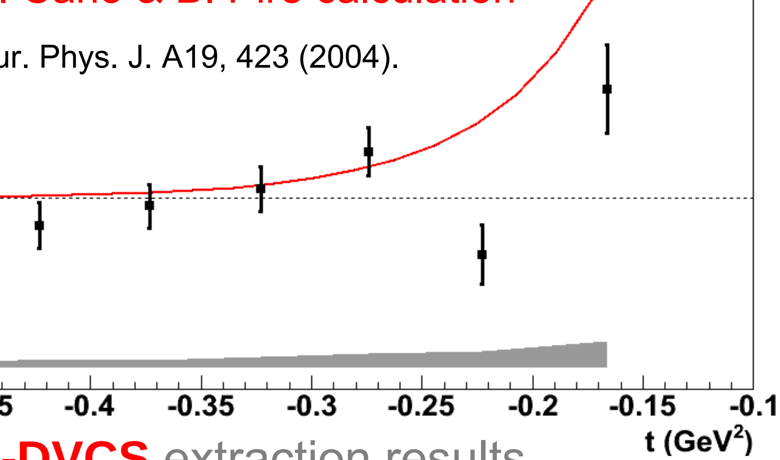


-Normalizing H_2 and
the same luminosity

-Adding Fermi mom
H2 data

2 principle sources o
systematic errors :

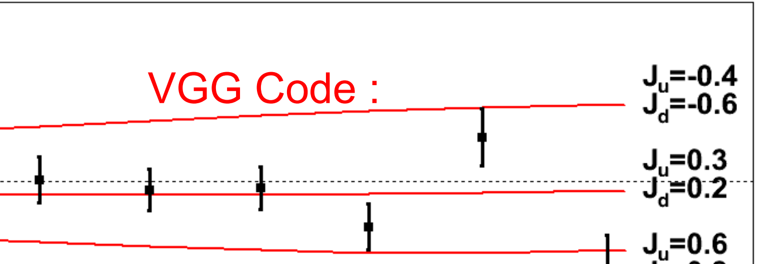
-The contamination o
electroproduction on



Deuteron moments co…

with zero at large -t

-DVCS extraction results



Neutron contribution is

small and compatible

w insights from the first Hall A DVCS experiment

Importance of the $DVCS^2$

$$d^5\overrightarrow{\sigma} + d^5\overleftarrow{\sigma} \propto BH^2 + \mathrm{Re}(BH \cdot DVCS) + \boxed{DVCS^2}$$

focus on π^0 measurement

- Cross section measurement
- Improved π^0 detection for better systematical error on proton from the π^0 subtraction

crease in luminosity

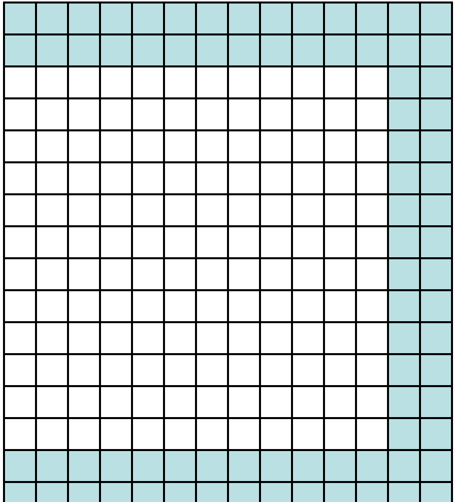
meter

creased size of the calorimeter from 132 to
8 blocks for larger acceptance for the π^0

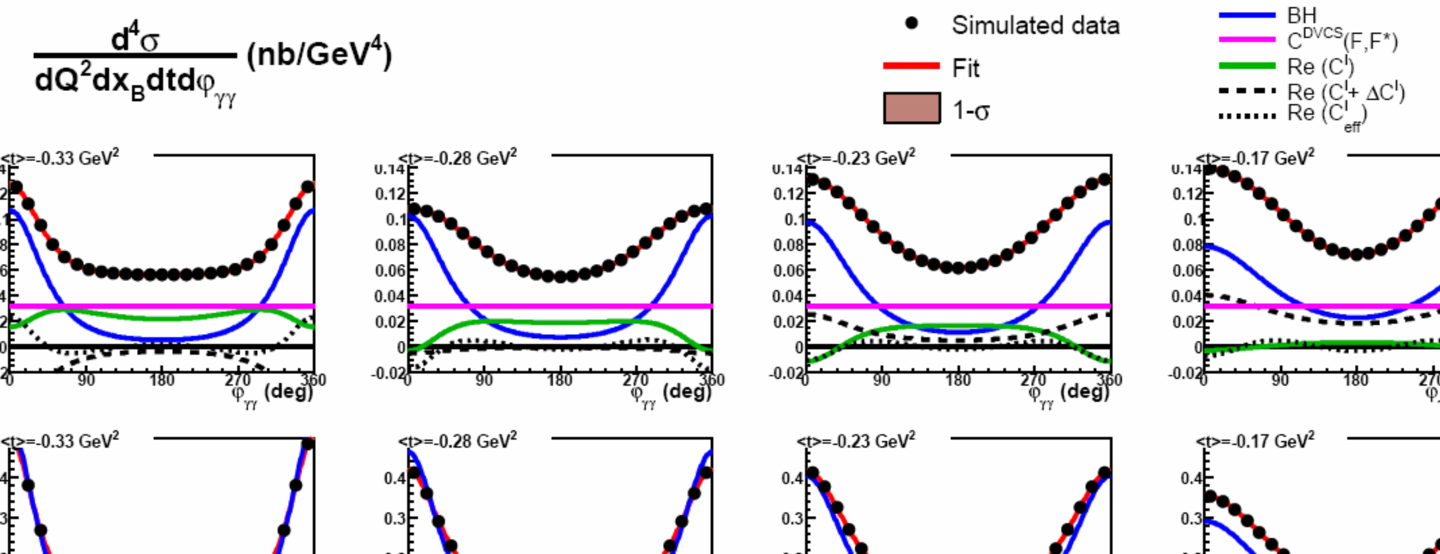
onics

proved trigger for optimal π^0 detection
many π^0 were cut by the high threshold for
VCS photons)

ta transfer improvement to accommodate



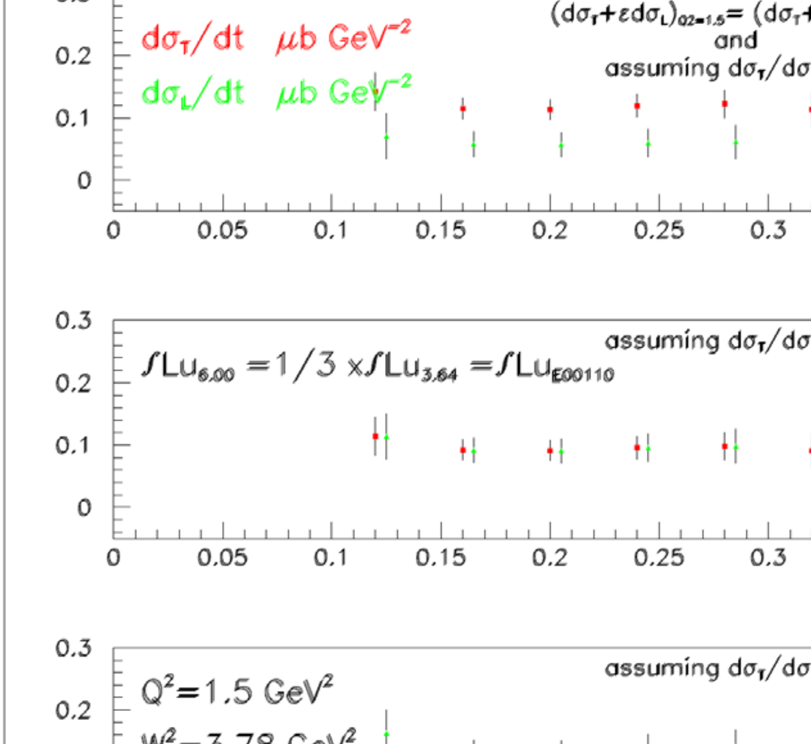
– Study of the importance of the DVCS^2 compared to th
interference term by varying the incident beam energ



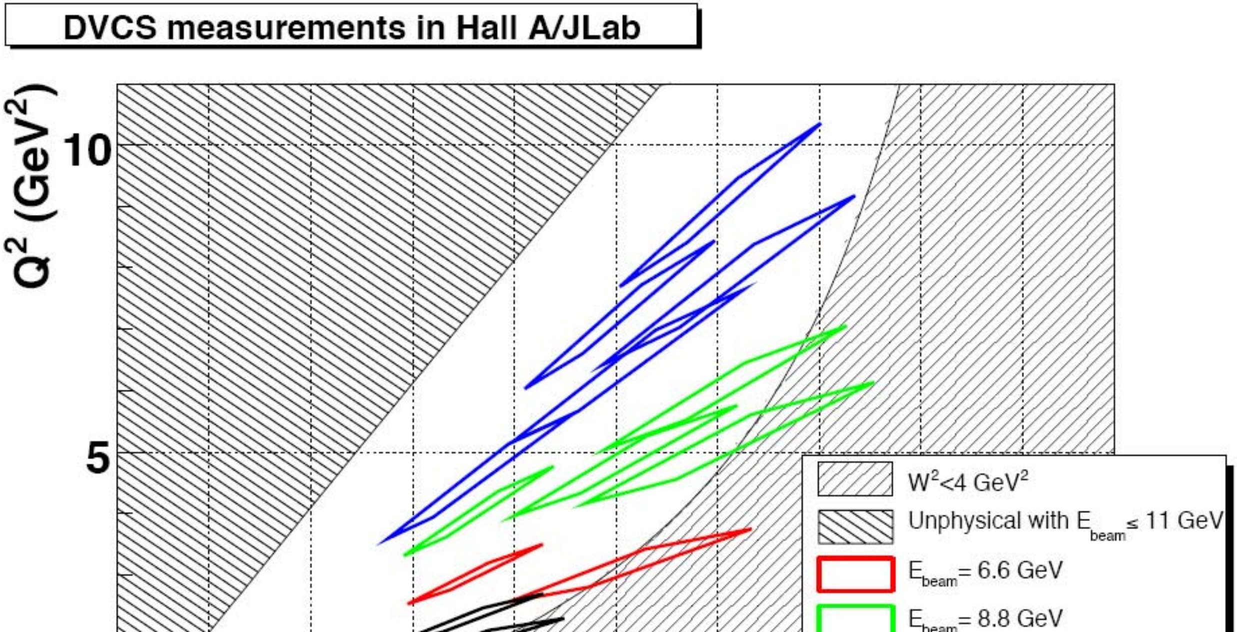
with a LT separation

$$d\Omega$$

$$= \frac{d\sigma_T}{d\Omega} + \varepsilon \frac{d\sigma_L}{d\Omega} + \sqrt{2\varepsilon(1+\varepsilon)}\frac{d\sigma_{LT}}{d\Omega}\cos\varphi + \varepsilon\frac{d\sigma_{TT}}{d\Omega}\cos 2\varphi + h\sqrt{2\varepsilon(1-\varepsilon)}\frac{d\sigma_{LT'}}{d\Omega}\sin\varphi$$



– Increased kinematical range Q^2 up to 9 GeV^2 at x_{bj}=0



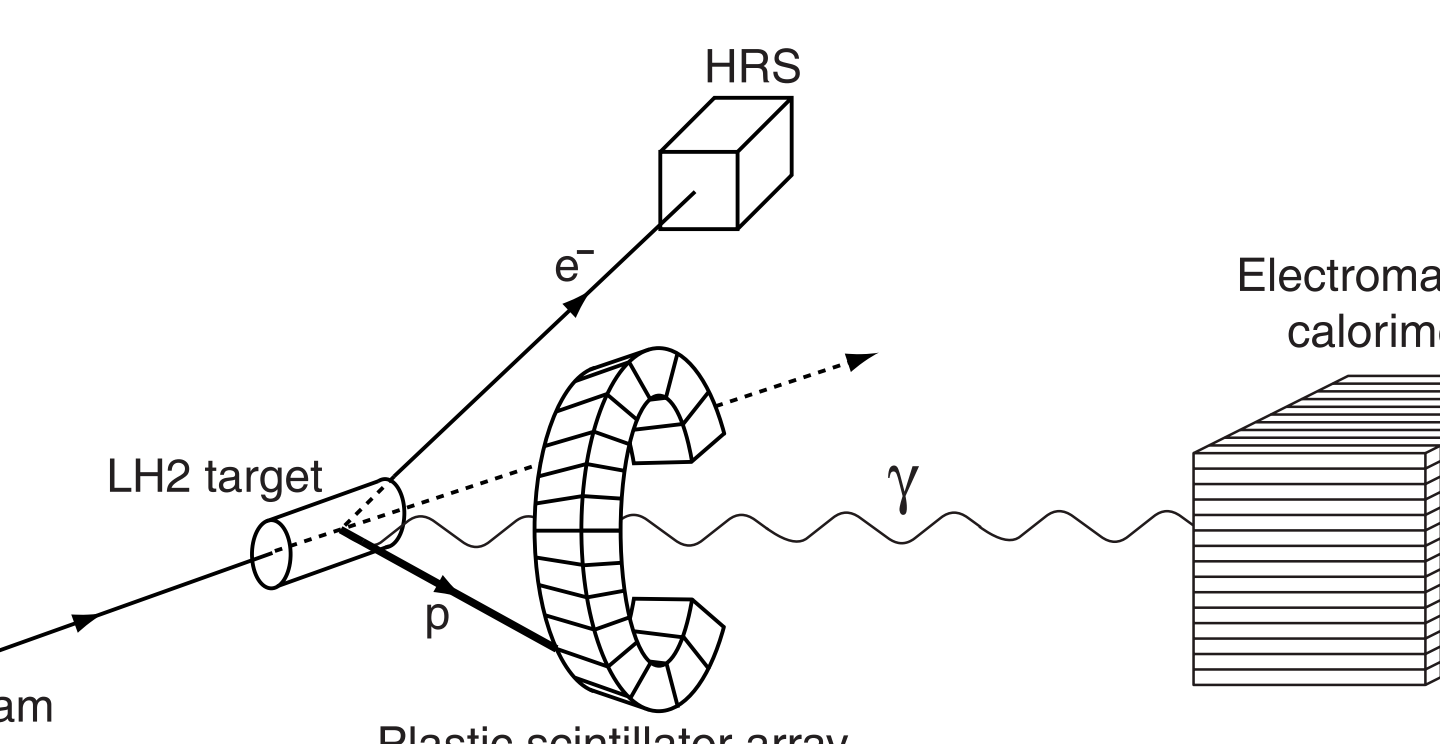
- Same setup : same improvements as for 6 GeV prot
  - Better π^0 subtraction
- Interleave proton and deuterium runs to reduce systematics linked to subtraction

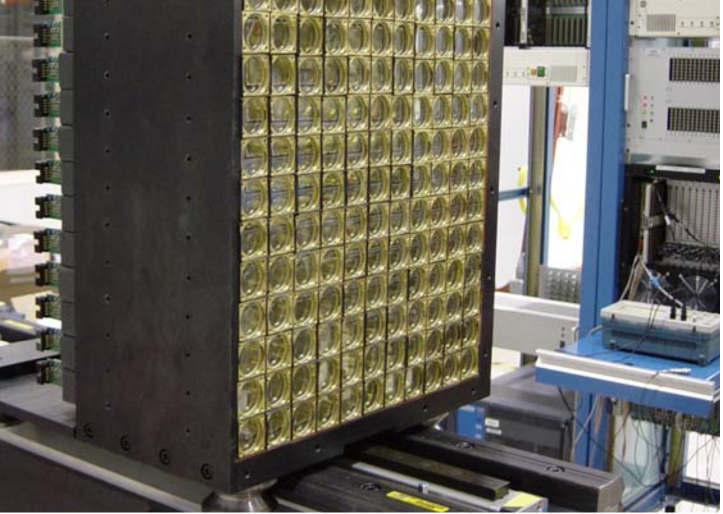
Two energies

- $DVCS^2$
- LT separation for π^0
- Real part of DVCS amplitude

- Resolution achieved is sufficient to work in double arm
- Many results
  - Proton DVCS
  - Neutron/Deuteron DVCS
  - π^0 electroproduction
- Approved experiments
  - LT separation for the π^0
  - Improvement of systematic from π^0 subtraction
  - Evaluation of the importance of the DVCS amplitude
  - 6 GeV experiment in 2010

END


HRS
e-
LH2 target
p
γ



110 cm from the target

1msr per block

•Lead fluoride

•Pure Cerenkov : not sensit
charged hadronic backgrou

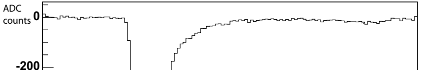
•density 7.77 g.cm^3

•X_0=0.93 cm length=20X_0
Molière radius = 2.2 cm

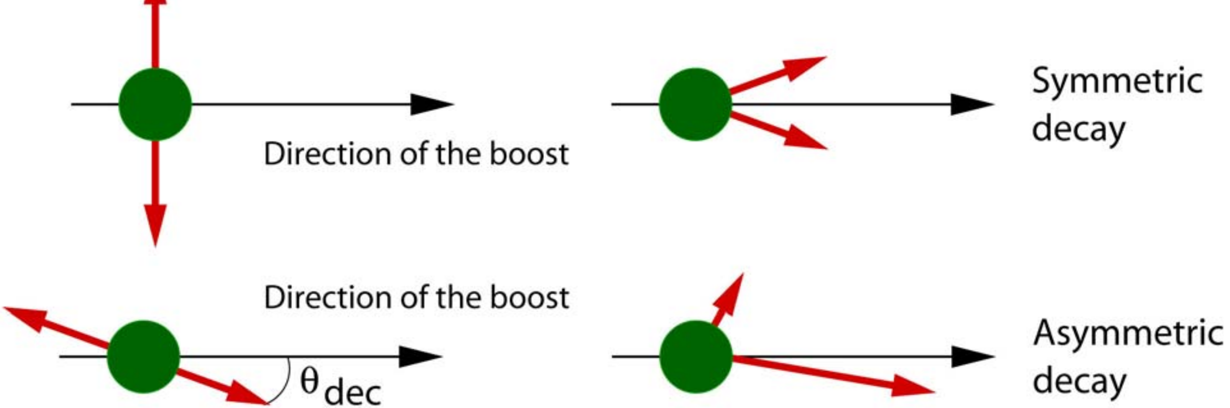
•Good radiation hardness

00 Hamamatsu

ges

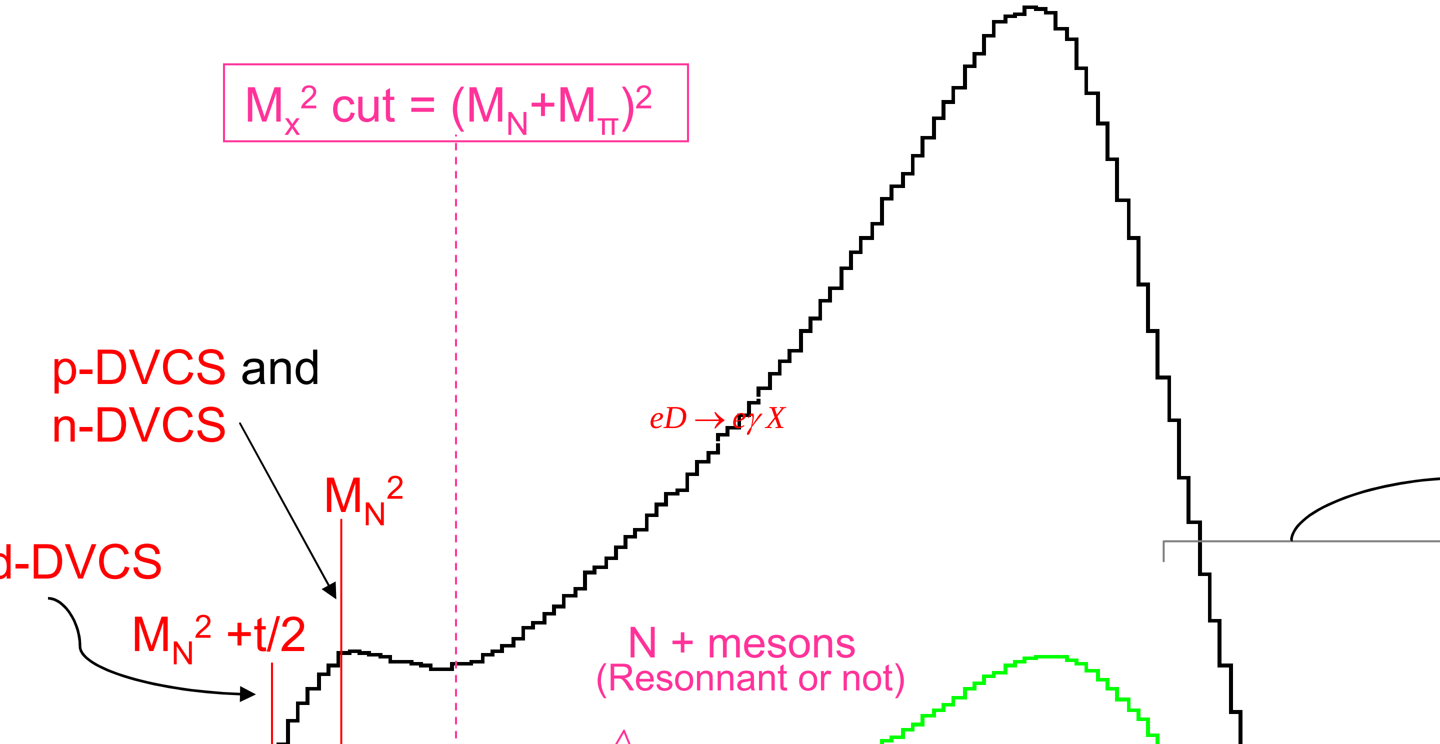


•1 Photoelectron per
•Energy resolution 4



mmetric decay: minimum angle in lab of 4.4° at max π^o energy

symmetric decay: sometimes one high energy cluster can be misindentified for a DVCS event



M_x^2 cut = $(M_N+M_\pi)^2$
p-DVCS and
n-DVCS
M_N^2
d-DVCS
M_N^2 +t/2
$eD \rightarrow e\gamma X$
N + mesons
(Resonnant or not)

$$dx_B d\Delta^2 d\varphi_e d\varphi_{\gamma\gamma} \quad dQ^2 dx_B d\Delta^2 d\varphi_e d\varphi_{\gamma\gamma} \Big]$$

$$\Gamma_n(x_B,\varphi_e,\Delta^2,\varphi)\cdot\Im\mathrm{m}\left(C_n^{I-\exp}\right)\sin\varphi+\Gamma_d(x_B,\varphi_e,\Delta^2,\varphi)\cdot\Im\mathrm{m}\left(C_d^{I-\exp}\right)\mathrm{s}$$

$$= N_{i_e}^{+} - N_{i_e}^{-}$$

$$= L\left[\Im\mathrm{m}\left(C_n^{I-\exp}\right)\underbrace{\int_{x\in i_e}\Gamma_n.\sin\varphi\otimes Acc}_{\text{MC sampling}}+\Im\mathrm{m}\left(C_d^{I-\exp}\right)\underbrace{\int_{x\in i_e}\Gamma_d.\sin}_{\text{MC sa}}\right.$$

ninosity

includes real radiative corrections (external+internal)

atic errors
els are not

s sensitive to Jd

s sensitive to Ju

lementarity