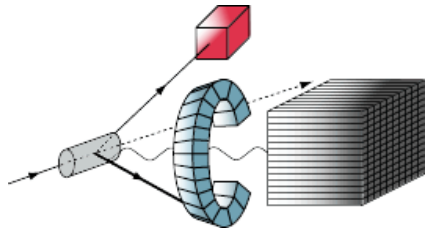
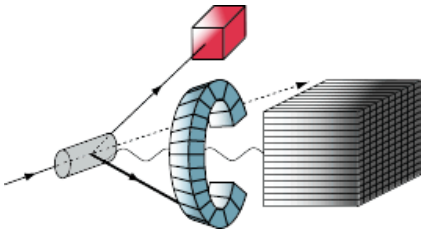


Deeply Virtual Compton Scattering in Hall A

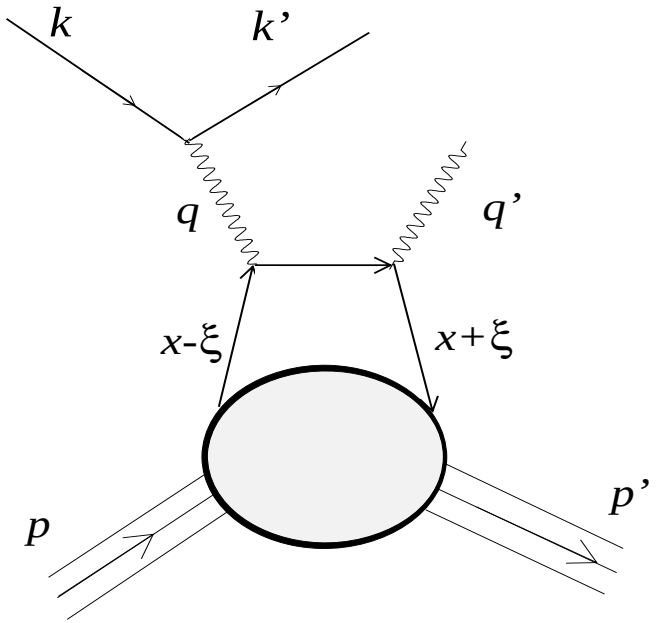
A. Camsonne

User Group meeting

June 13th 2006



Deeply Virtual Compton Scattering

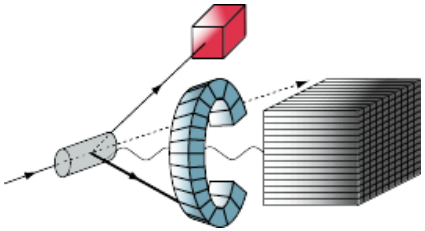


$$Q^2 = -q^2 = -(k-k')^2 \qquad \nu = E - E'$$

$$x_{Bj} = \frac{Q^2}{2p\cdot q} = \frac{Q^2}{2M\nu}$$

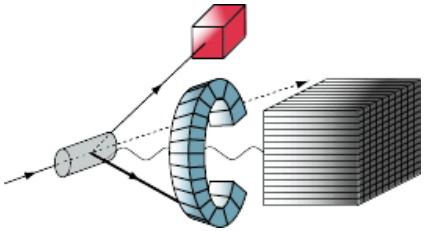
$$\Delta = (p'-p) \qquad P = p'+p$$

$$t = \Delta^2 \qquad \xi = \frac{\Delta\cdot q}{P\cdot q}$$

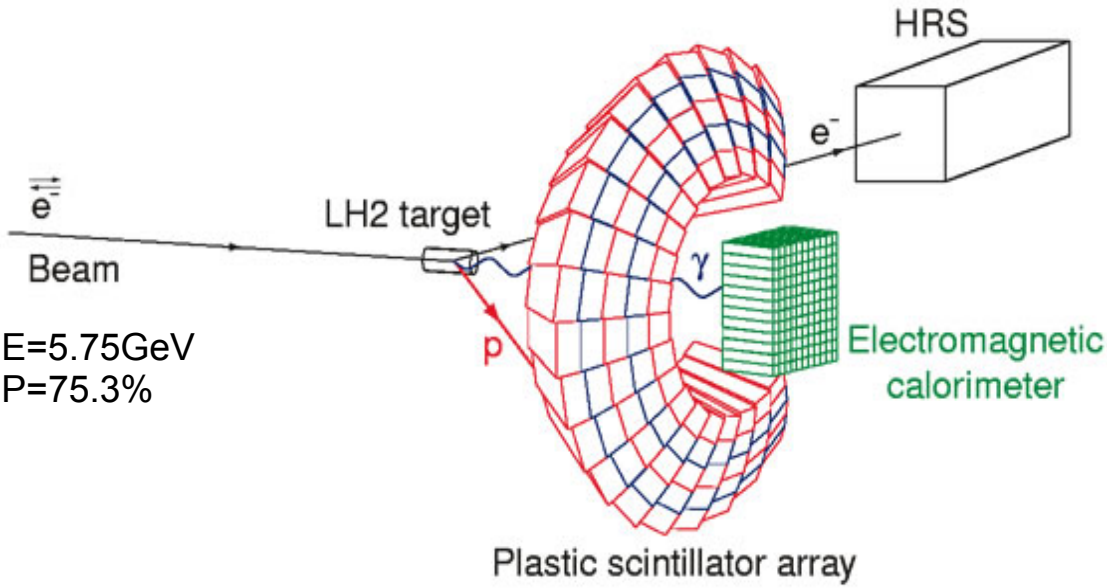


Hall A DVCS experiment

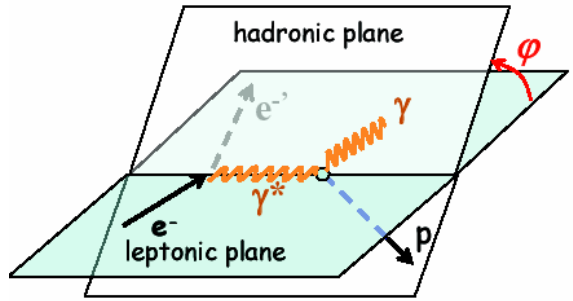
- First dedicated experiment
  - High resolution on electron
    - Q^2 dependence
    - Better background rejection
  - High statistical accuracy
    - Cross-section measurement (high luminosity $10^{37} cm^{-2}.s^{-1}$)
  - Exclusivity
    - Proton or neutron detector

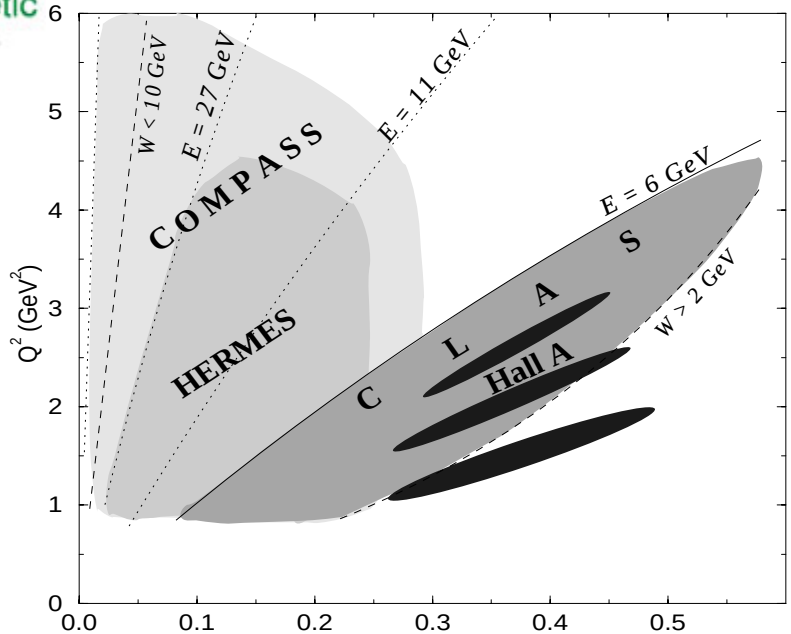


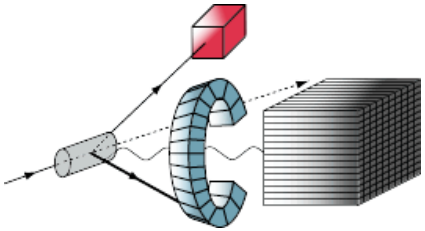
Experimental setup



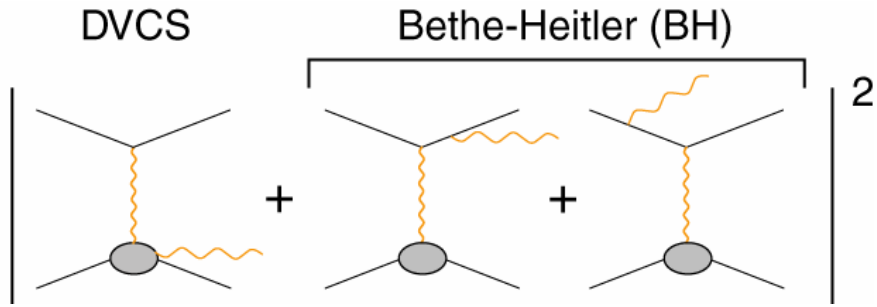
E=5.75GeV
P=75.3%

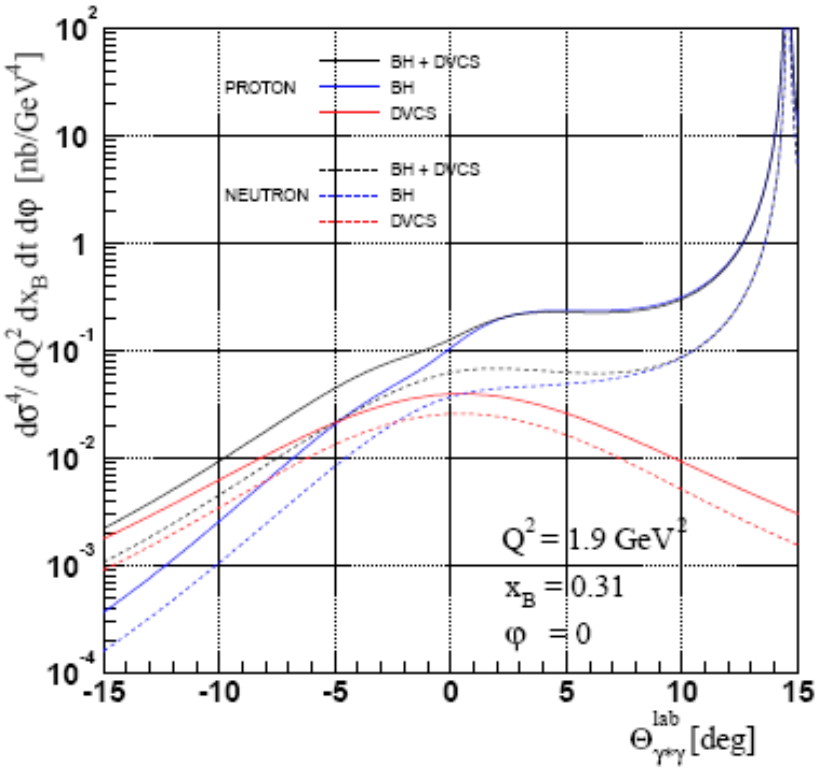






Deeply Virtual Compton Scattering

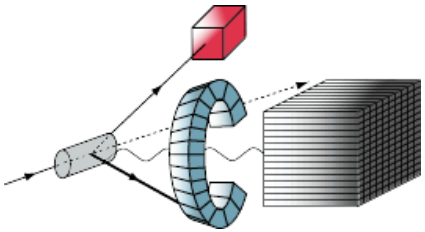




Cross section measurements

$$d^5\vec{\sigma} - d^5\overleftarrow{\sigma} \propto BH \cdot \mathrm{Im}(DVCS) + (\overrightarrow{DVCS}^2 - \overleftarrow{DVCS}^2)$$

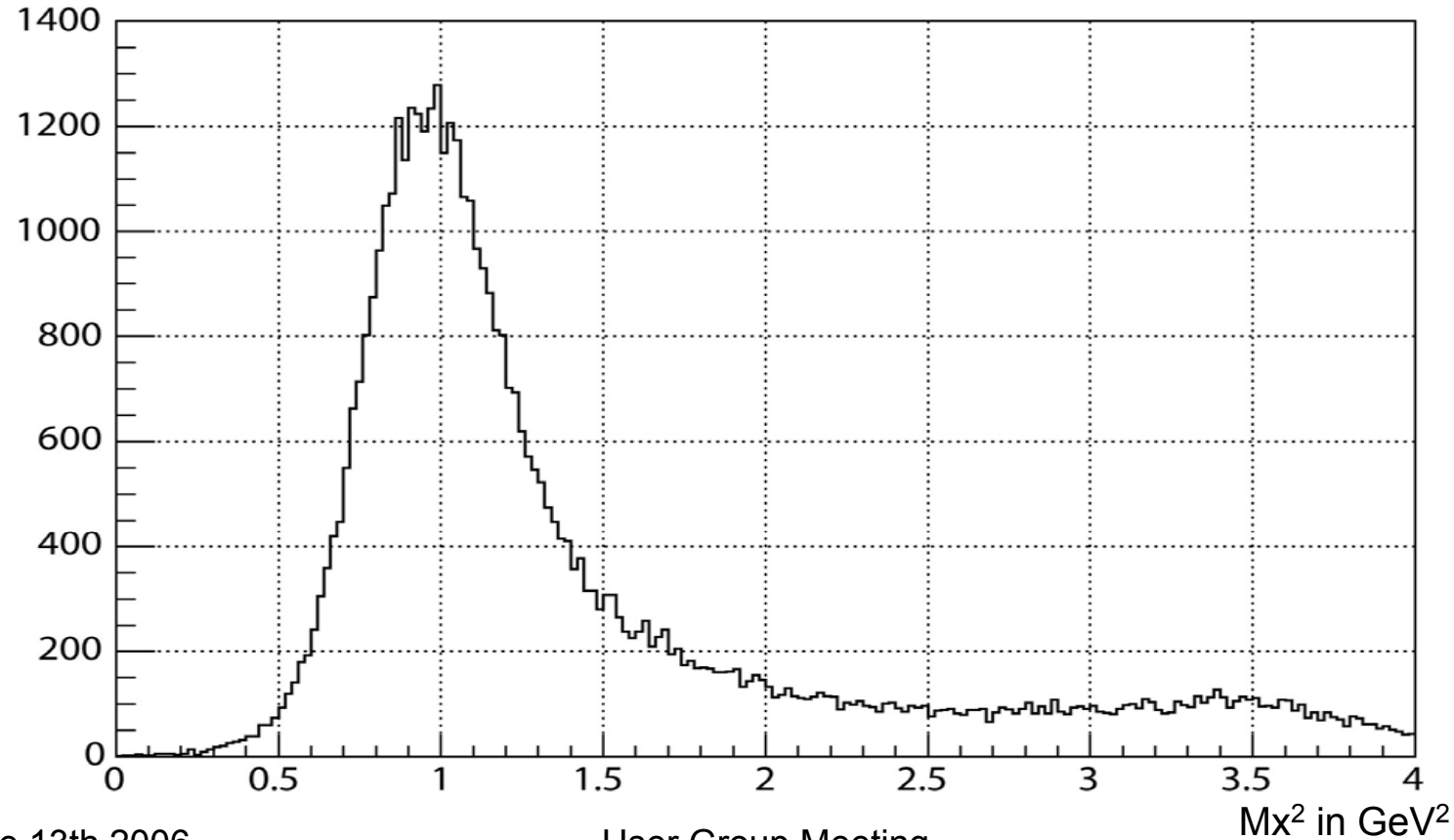
$$d^5\vec{\sigma} + d^5\overleftarrow{\sigma} \propto BH^2 + \mathrm{Re}(BH \cdot DVCS) + DVCS^2$$

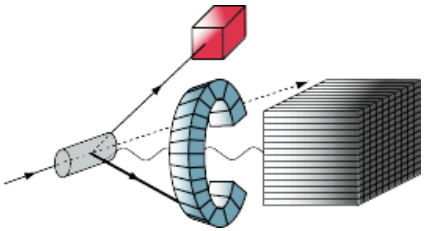


Exclusive DVCS events

Missing mass with the proton array in triple coincidence

$ep \longrightarrow e\gamma X$

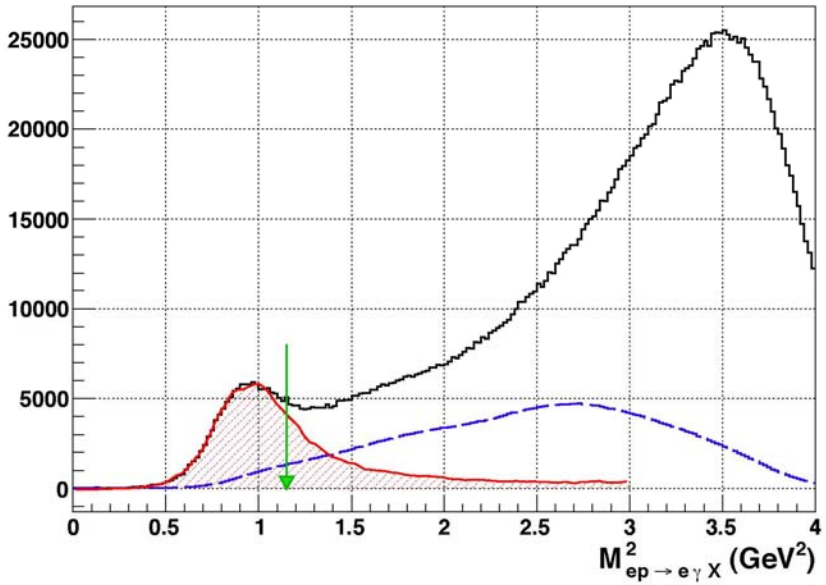


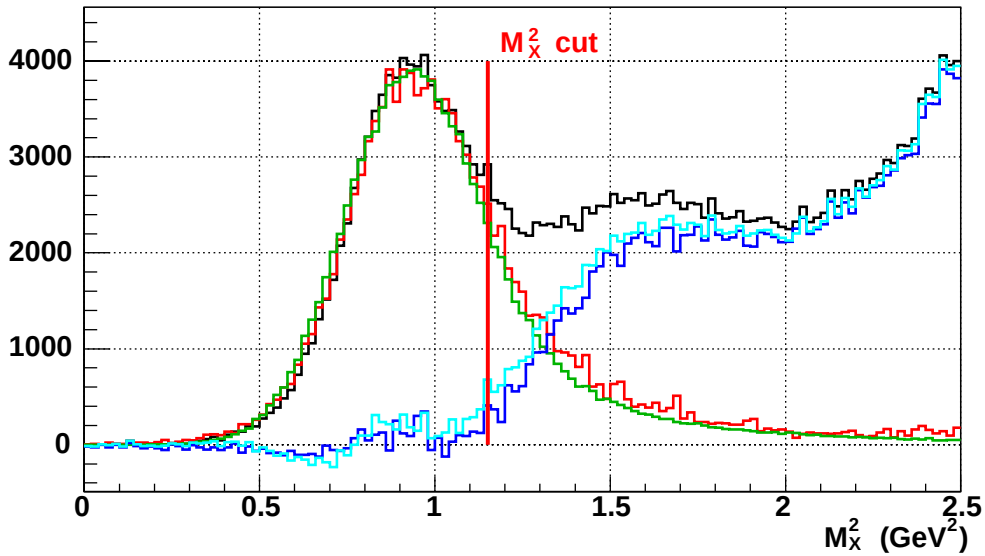


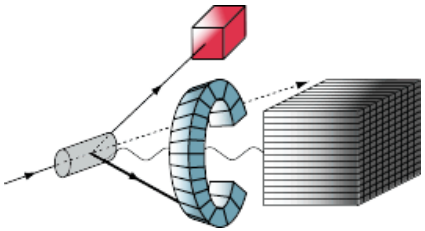
Two arm data electron photon

π^0 subtraction done using the 2 clusters π^0 sample recorded in the calorimeter to regenerate the isotropic π^0 distribution

Extraction of the exclusive events by using the shape of the exclusive events.







Extraction

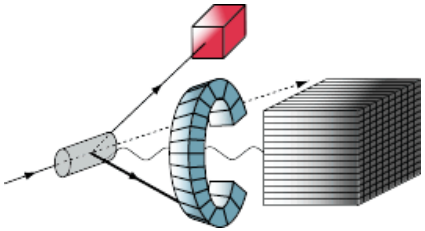
$$\frac{d^5\vec{\sigma}}{dQ^2 dt d\varphi_e d\varphi_{\gamma\gamma} dx} - \frac{d^5\overleftarrow{\sigma}}{dQ^2 dt d\varphi_e d\varphi_{\gamma\gamma} dx} = \Gamma_{T2}(x,\varphi_e,t,\varphi_{\gamma\gamma})\cdot C^I \sin(\varphi) + \Gamma_{T3}(x,\varphi_e,t,\varphi_{\gamma\gamma})\cdot C^I_{eff} \sin(2\varphi)$$

$$\Delta N_{i_e} = N^+_{i_e} - N^-_{i_e}$$

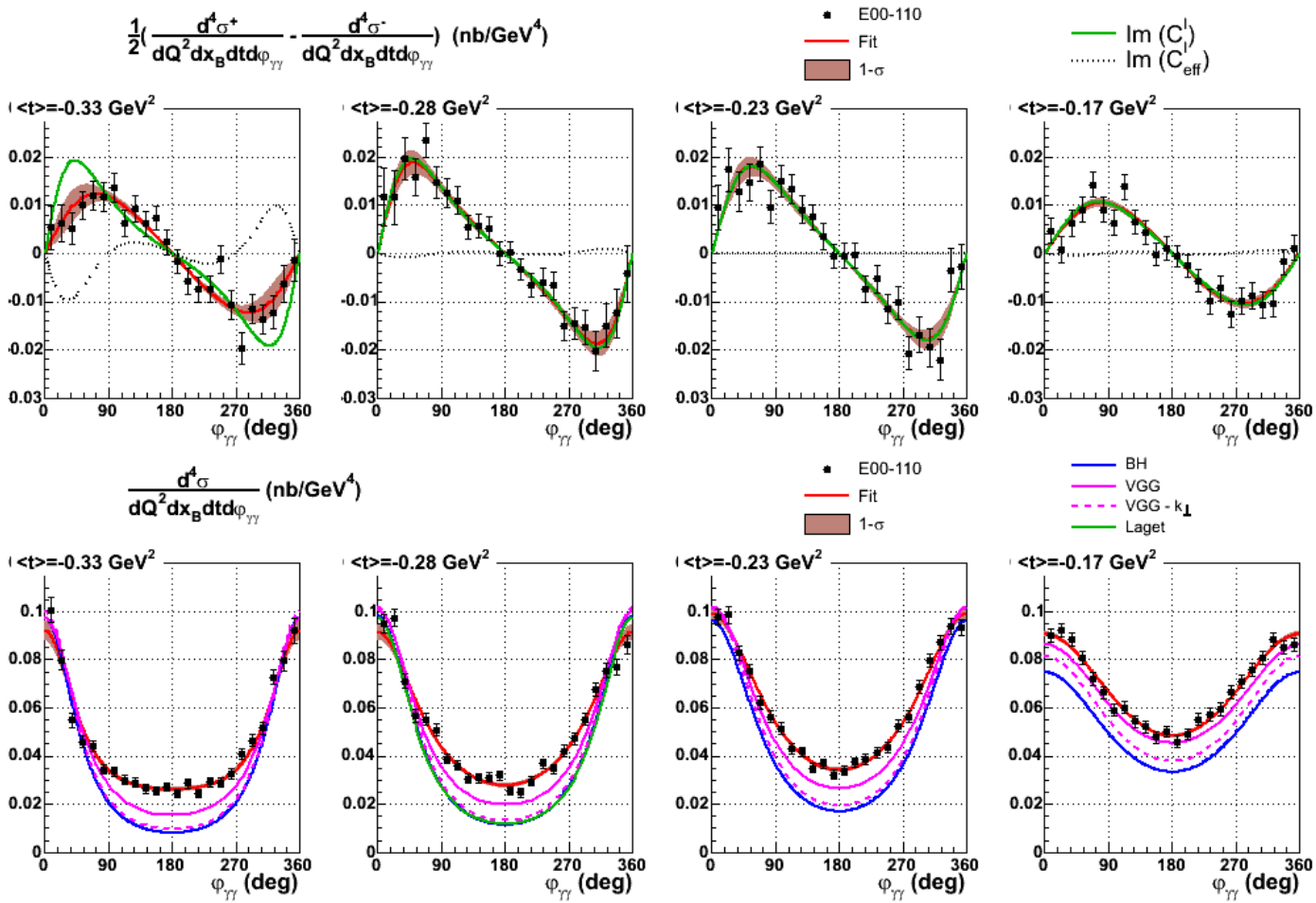
$$\Delta N^{MC}(i_e) = L\left[C^I \underbrace{\int_{x\in i_e} \Gamma_{T2}\cdot\sin\varphi \otimes Acc}_{MC\ sampling} + C^I_{eff} \underbrace{\int_{x\in i_e} \Gamma_{T3}\cdot\sin 2\varphi \otimes Acc}_{MC\ sampling} \right]$$

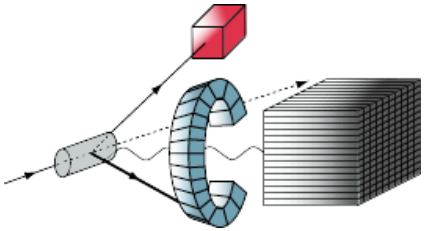
MC includes real radiative corrections (external+internal)

$$\chi^2 = \sum_{i_e} \frac{\left[\Delta N^{Exp}(i_e) - \Delta N^{MC}(i_e)\right]^2}{\left[\sigma^{Exp}(i_e)\right]^2} \Rightarrow \begin{cases} C^I \\ C^I_{eff} \end{cases}$$



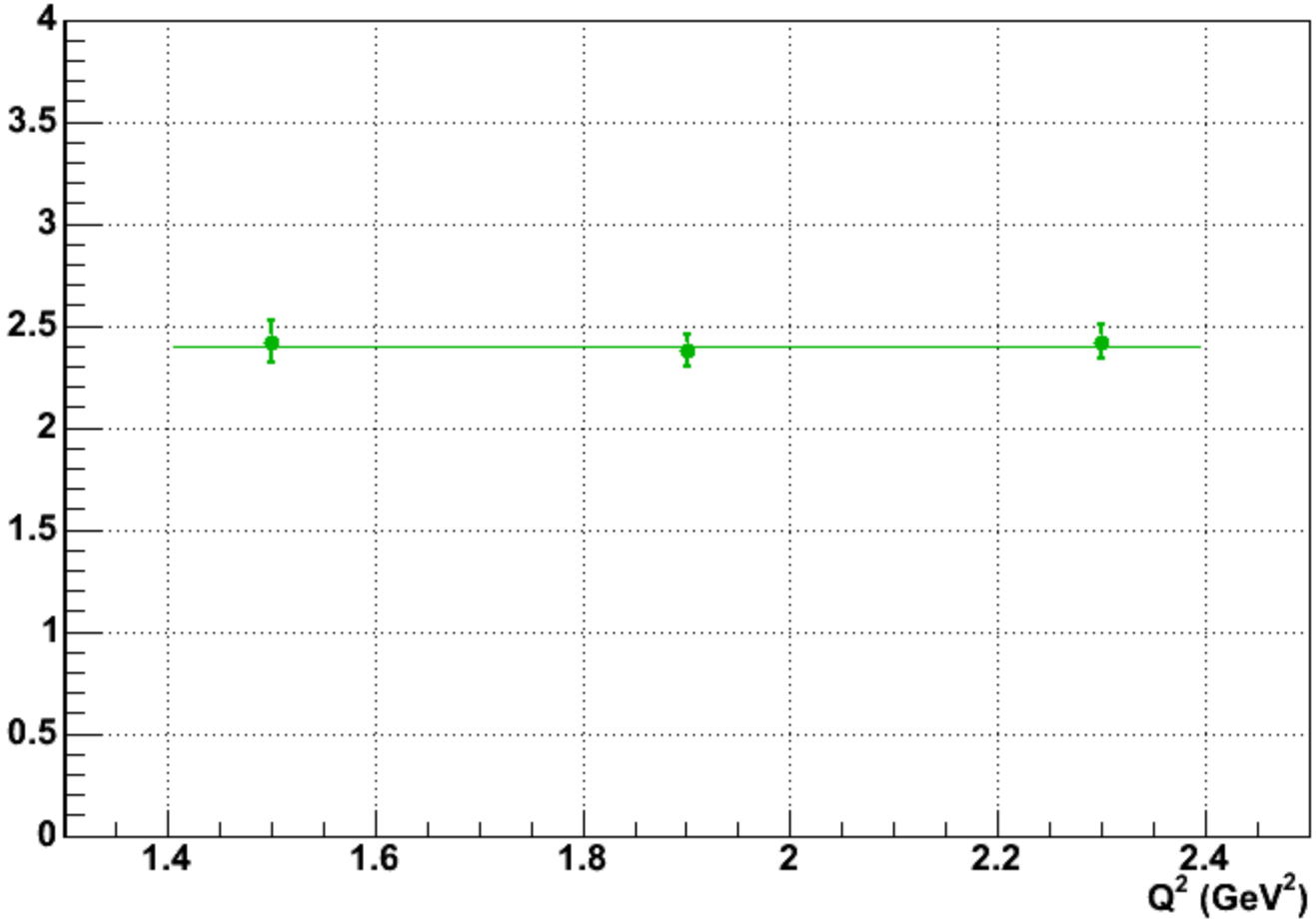
Cross sections

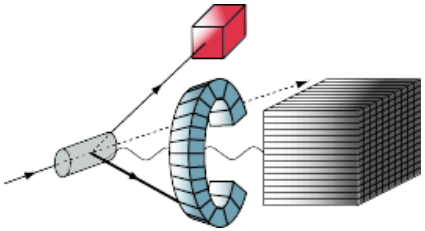




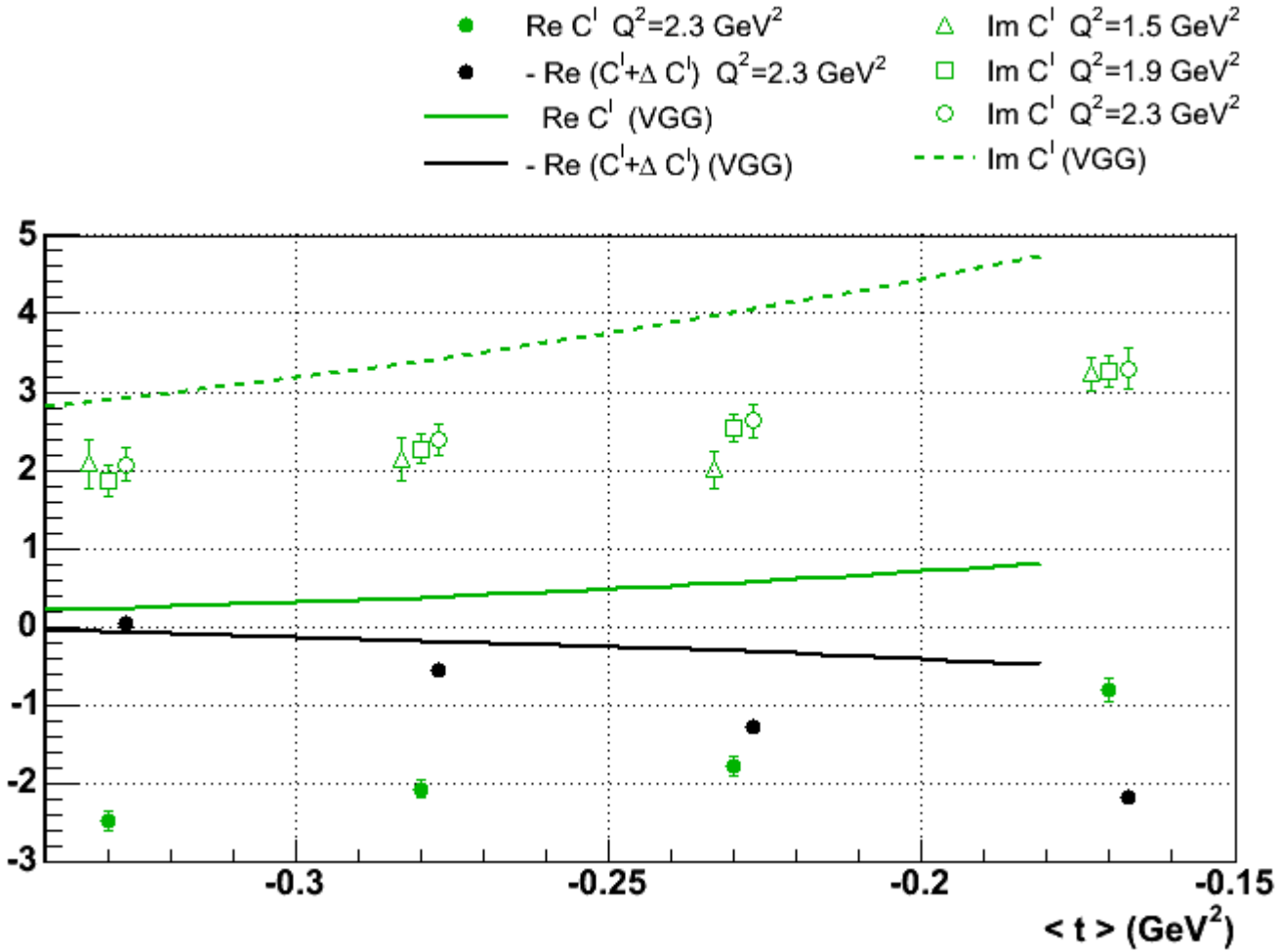
Q^2 dependence proton results

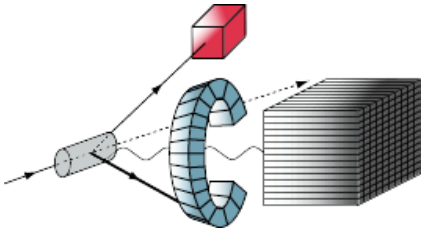
$Im(C^I)$





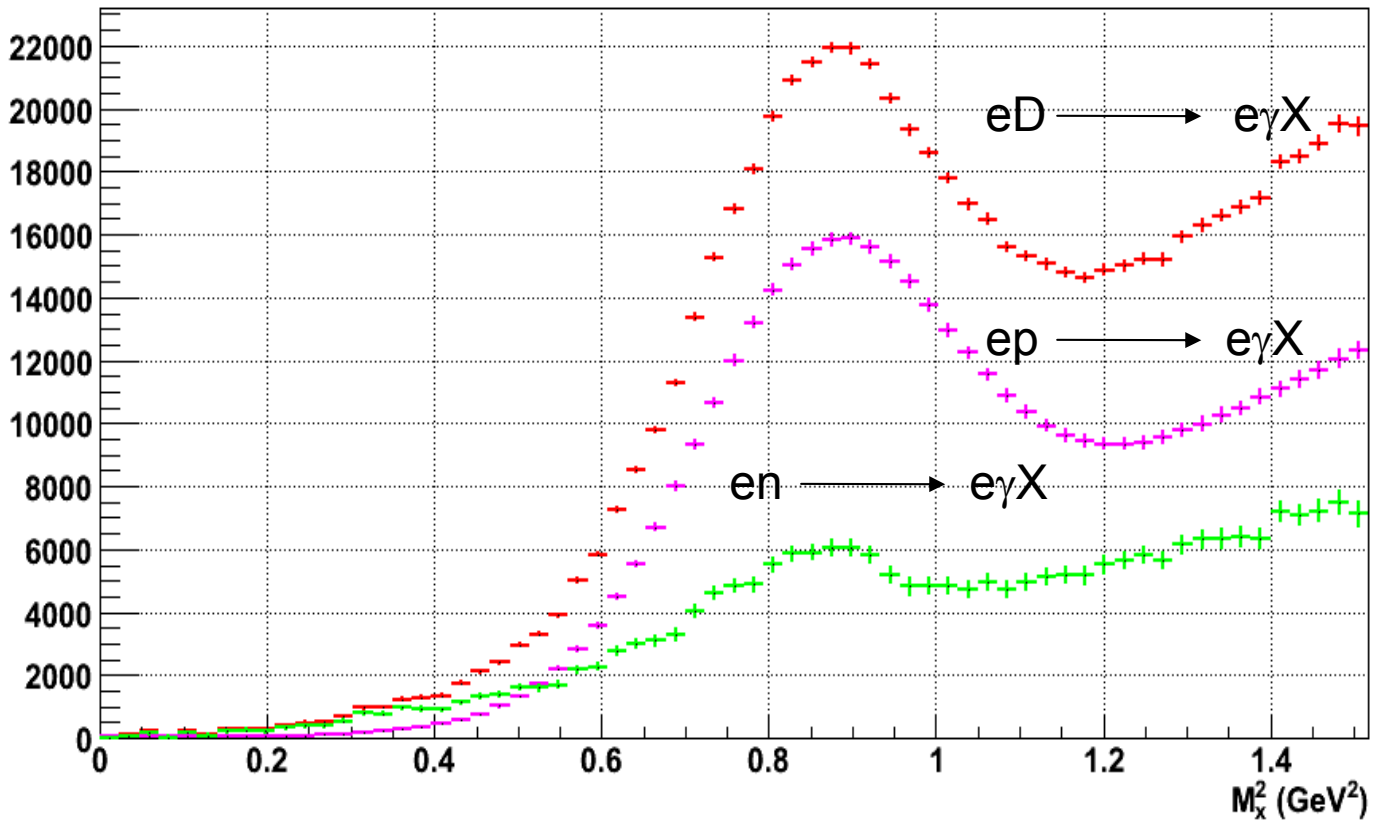
t dependence proton results





Neutron DVCS

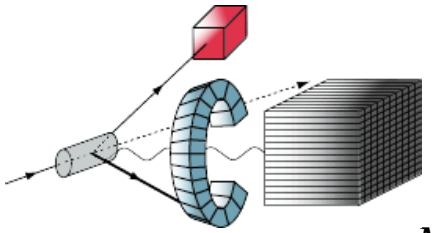
Subtraction Deuterium data minus Proton data



Deuterium

Proton

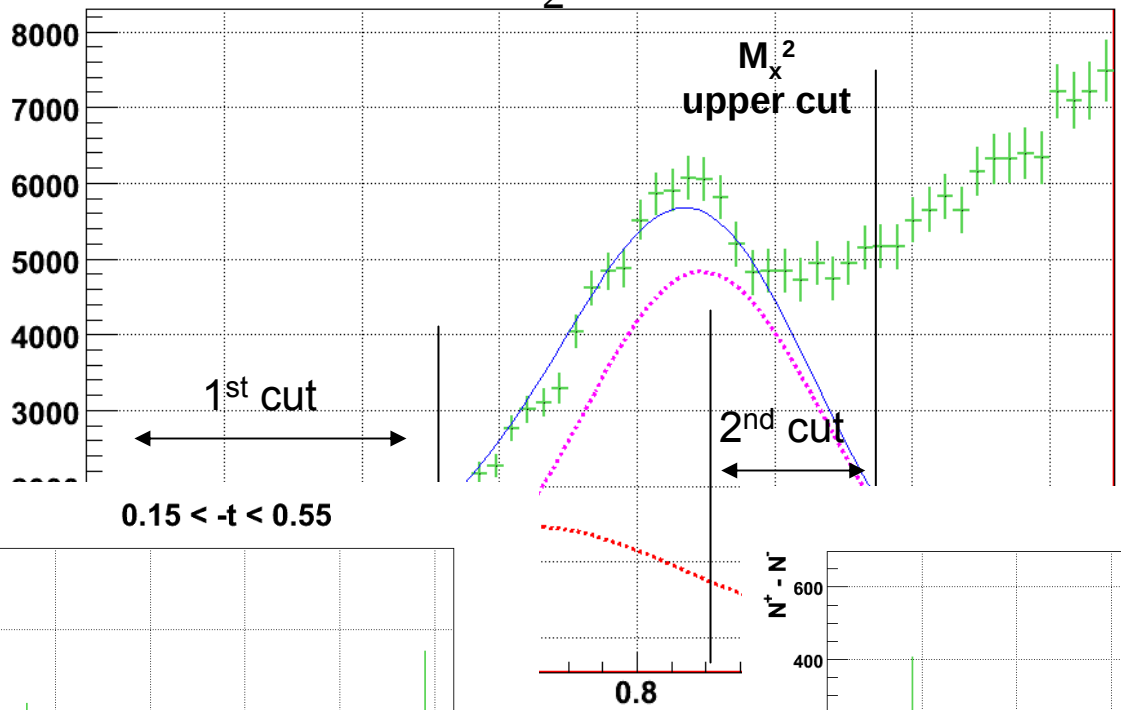
Deuterium - Proton

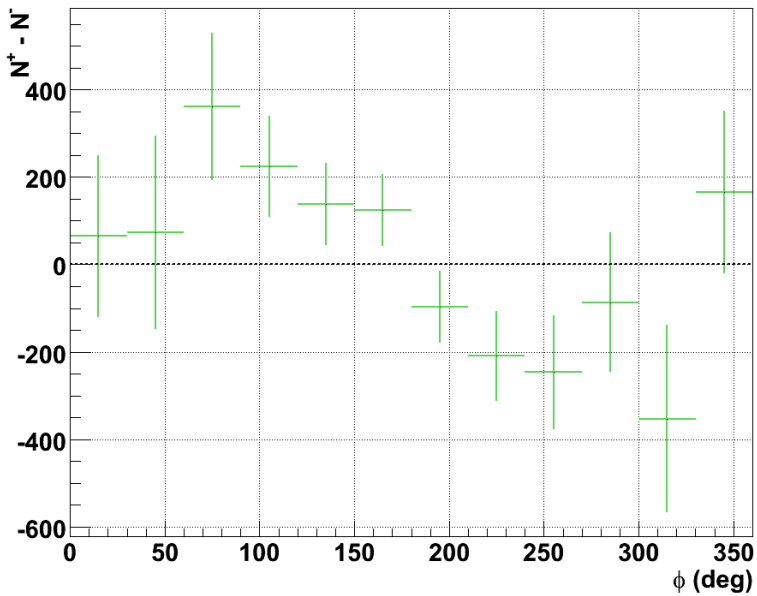


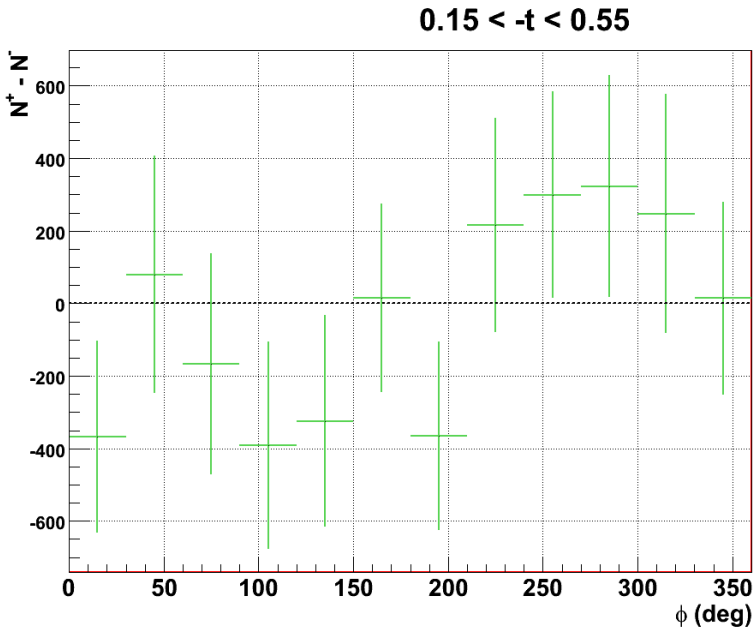
Neutron DVCS

$$M_X^2(coherent) \approx M_p^2 + \frac{t}{2} + \text{ resolution effects}$$

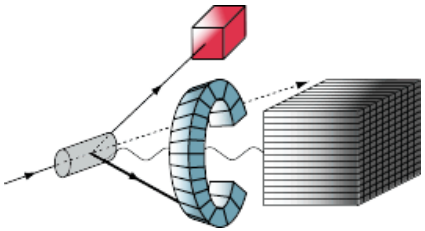
Q^2= 1.9 GeV^2
<t>= -0.3 GeV^2







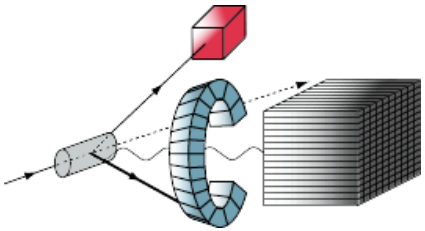
· Group Meet



Conclusions

- Results for the proton DVCS cross sections
  - small contribution of the higher twist terms at Jefferson Laboratory kinematics
  - extraction of $\mathrm{Im}(C^i)$ linear combination of GPDs
  - access to real part of the DVCS amplitude
- On-going work on the neutron DVCS
  - extraction of the contributions of the coherent and incoherent deuterium

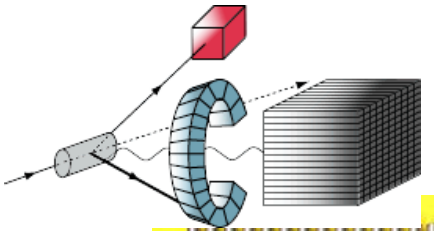
The End

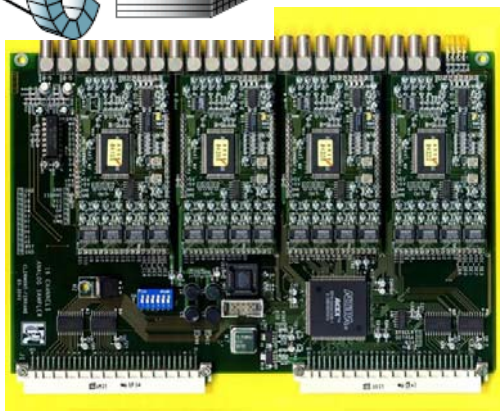


Systematic errors

Contribution	Value
Luminosity,acceptance spectro, acceptance calorimeter	3%
π^0 subtraction	3%
Inelastic background	3%
Beam polarization	2%
Radiative corrections	2%

Sampling system

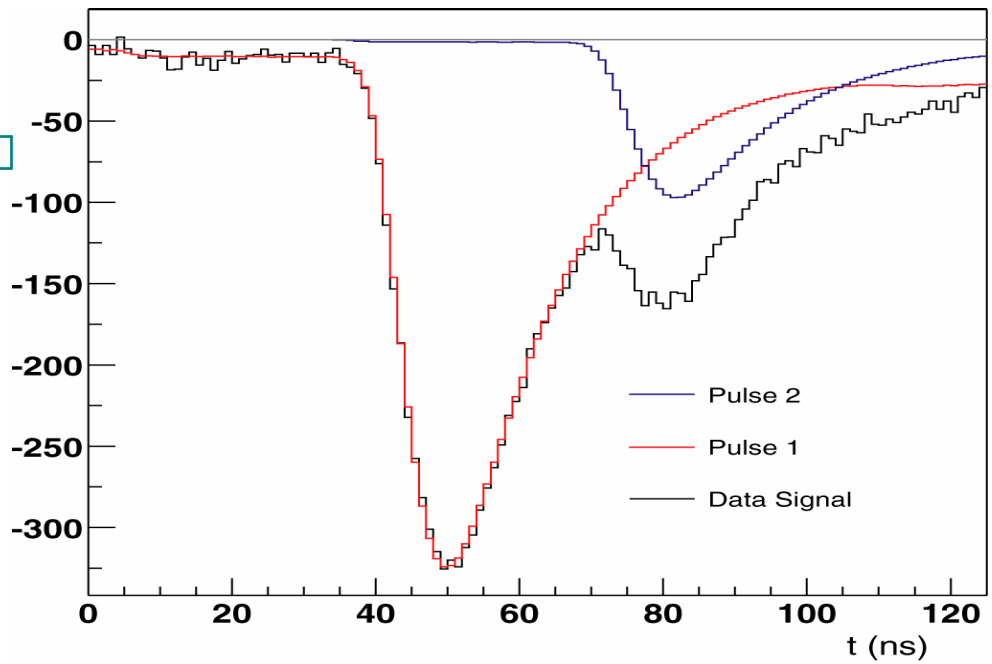




1 GHz Analog Ring Sampler (ARS)

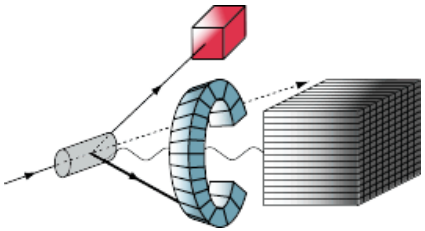
x 128 samples x 289 detector channels

Sample each PMT signal in 128 values (1 value/ns)



Extract signal properties (charge, time) with a wave form Analysis.

Allows to deal with pile-up events.



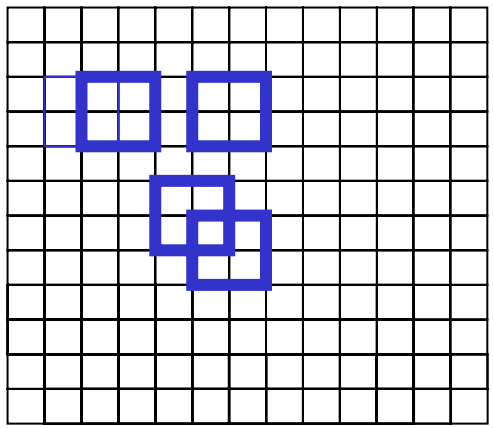
Calorimeter trigger

Calorimeter trigger

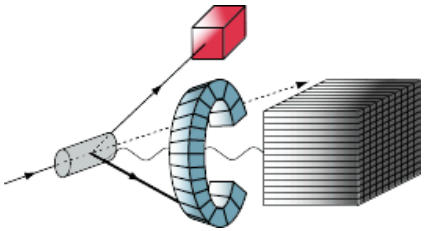
Following HRS trigger, stop ARS.

30MHz trigger FADC digitizes all calorimeter signals in 85ns window.

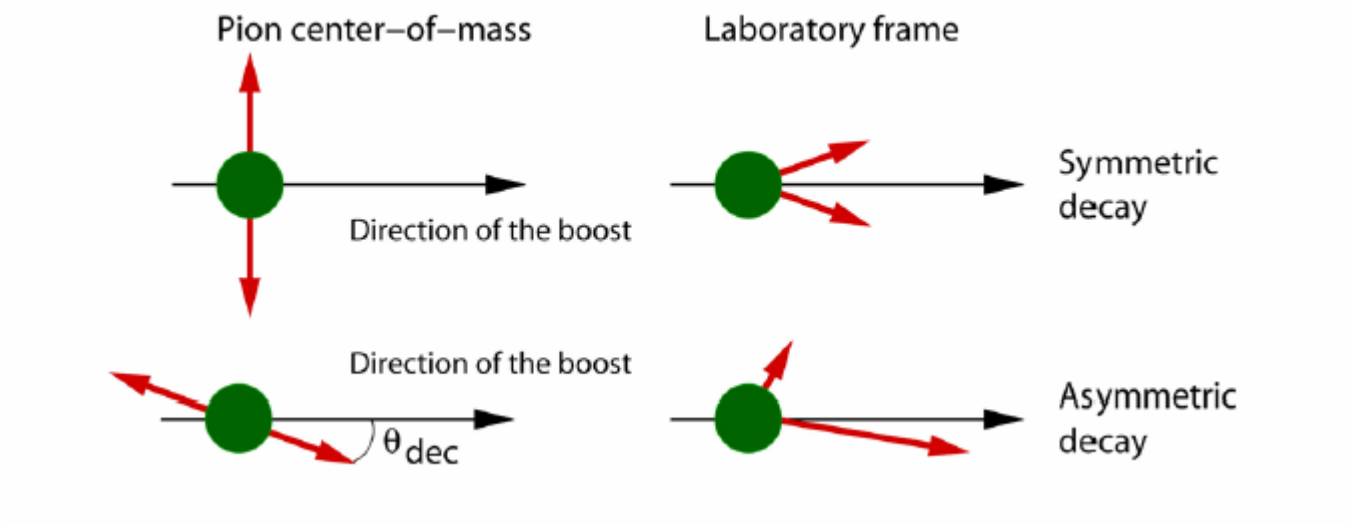
- Compute all sums of 4 adjacent blocks.
- Look for at least 1 sum over threshold
- Validate or reject HRS trigger within 340 ns



Not all the Proton Array channels are read for each event

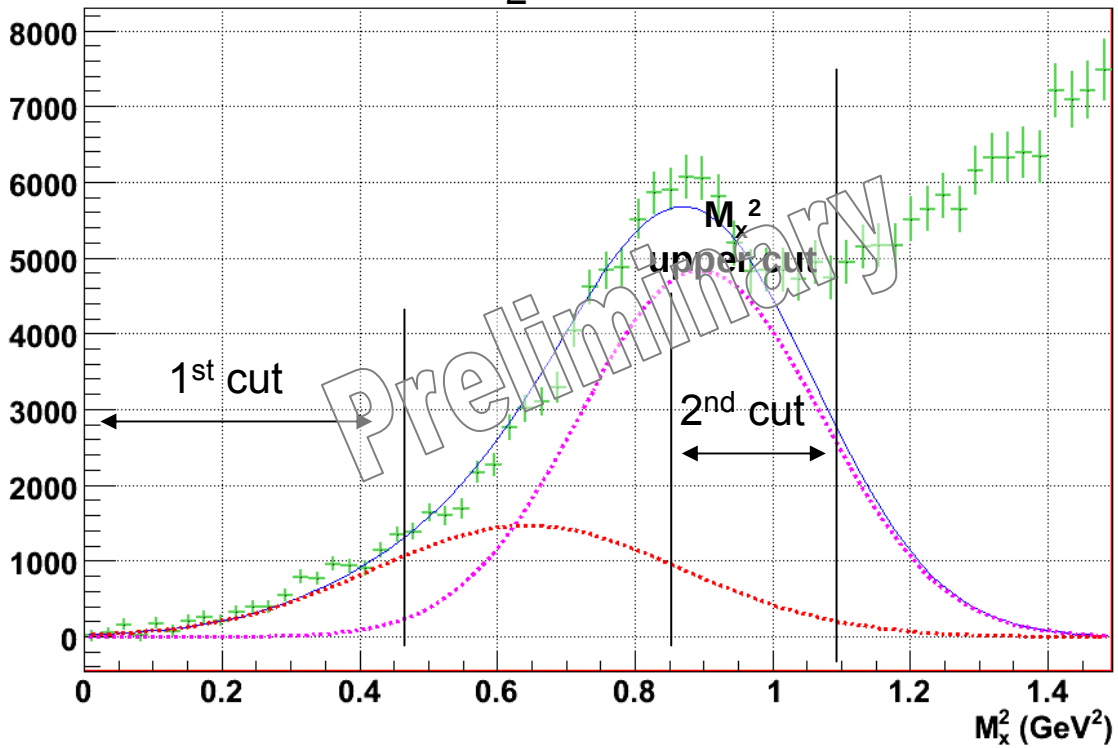


π^0 subtraction

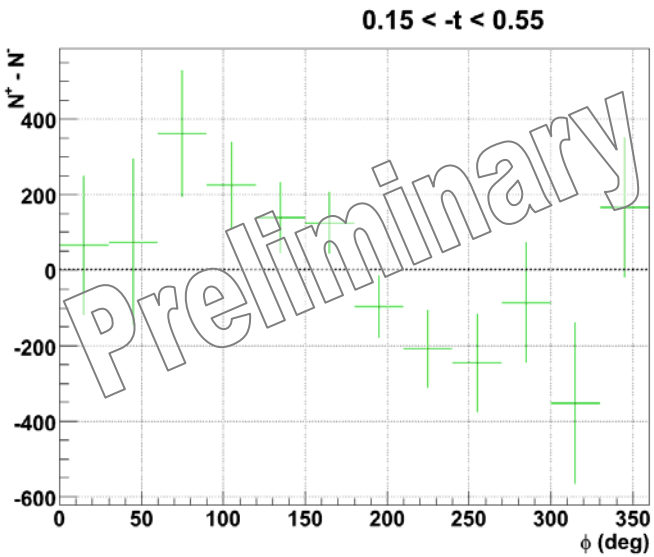


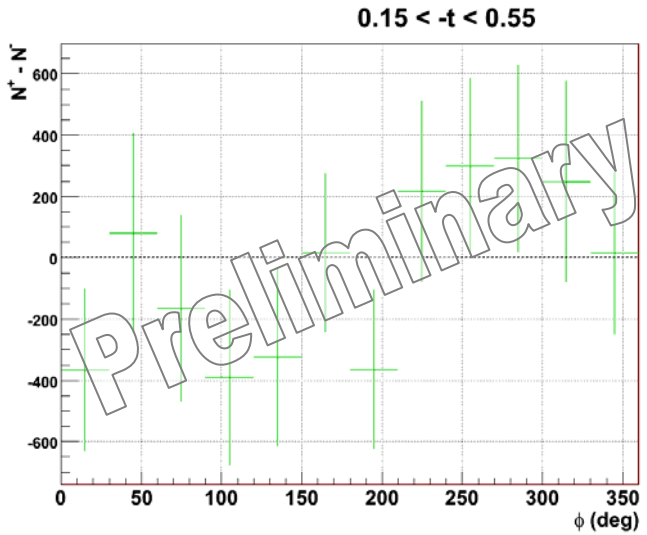
- Symmetric decay: two distinct photons are detected in the calorimeter → No contamination
- Asymmetric decay: 1 photon carries most of the π0 energy → contamination because DVCS-like event.

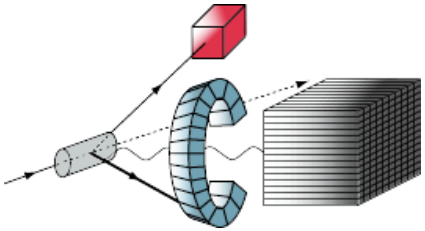
$$M_X^2(coherent) \approx M_p^2 + \frac{t}{2} + \text{ resolution effects}$$



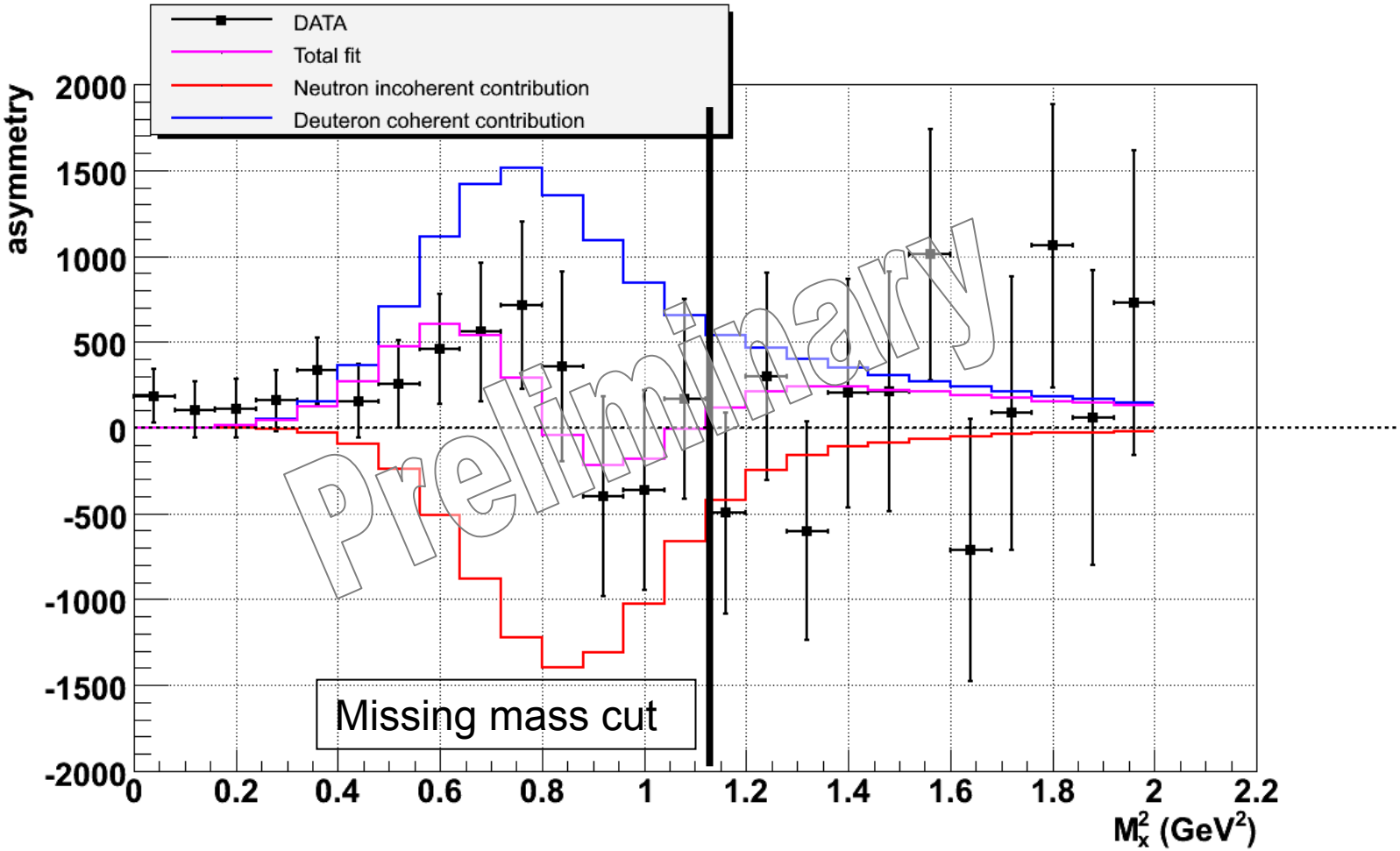
Q^2= 1.9 GeV^2
<t>= -0.3 GeV^2

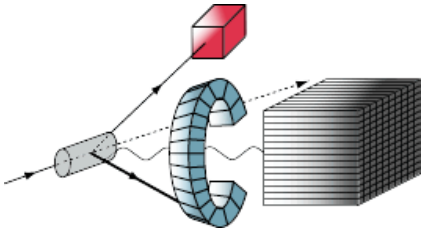




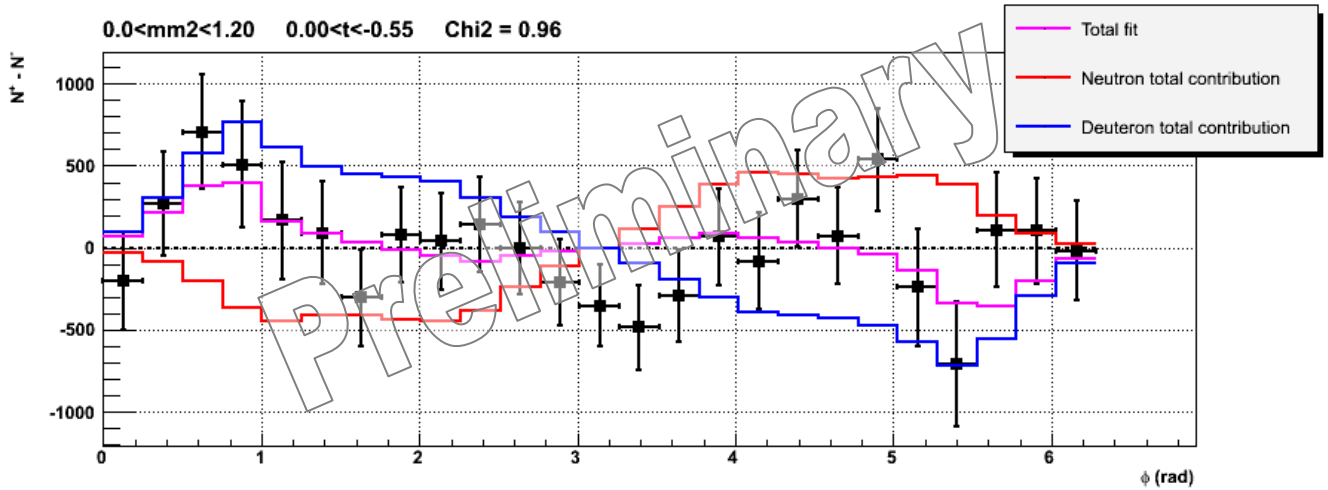


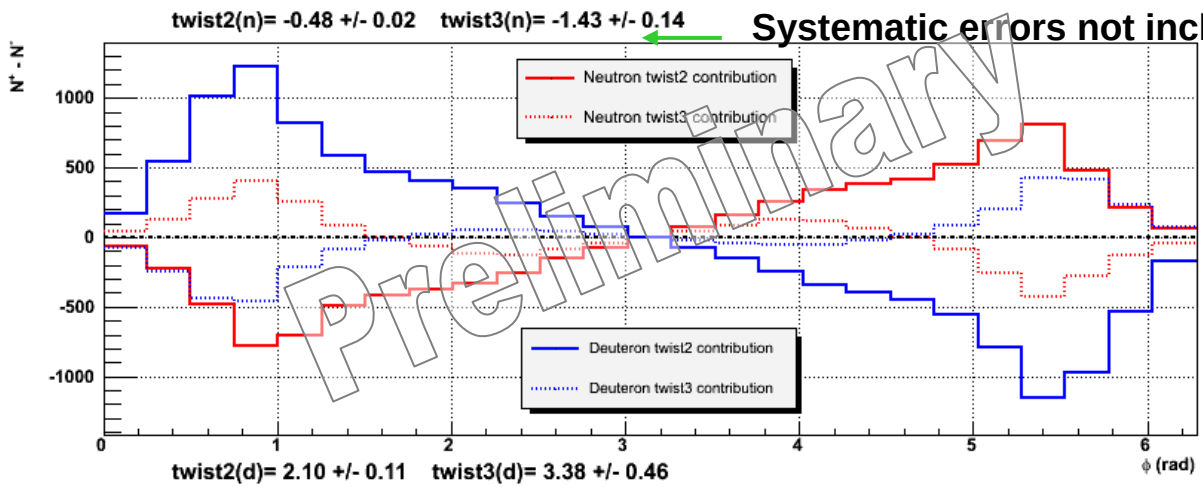
Neutron DVCS



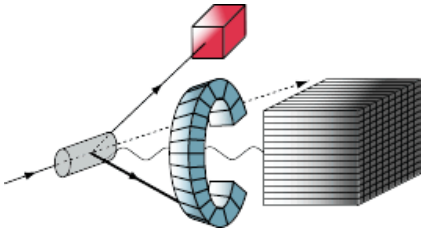


Neutron DVCS





Systematic errors not included yet



Neutron DVCS

$$\frac{d\vec{\sigma}}{dQ^2 dx_B d\Delta^2 d\varphi_e d\varphi_{\gamma\gamma}} - \frac{d\overleftarrow{\sigma}}{dQ^2 dx_B d\Delta^2 d\varphi_e d\varphi_{\gamma\gamma}} = \Gamma^n{}_A(x_B,\varphi_e,\Delta^2,\varphi)\cdot A\sin\varphi + \Gamma^n{}_B(x_B,\varphi_e,\Delta^2,\varphi)B\sin 2\varphi$$

$$+\Gamma^d{}_C(x_B,\varphi_e,\Delta^2,\varphi)\cdot C\sin\varphi + \Gamma^d{}_D(x_B,\varphi_e,\Delta^2,\varphi)D\sin 2\varphi$$

$$\Delta N^{Exp}(i_e) = N^+_{i_e} - N^-_{i_e}$$

$$\Delta N^{MC}(i_e) = L\left[\begin{array}{l} A\int_{x\in i_e}\Gamma_A.\sin\varphi\otimes Acc + B\int_{x\in i_e}\Gamma_B.\sin 2\varphi\otimes Acc + \\ C\int_{x\in i_e}\Gamma_C.\sin\varphi\otimes Acc + D\int_{x\in i_e}\Gamma_D.\sin 2\varphi\otimes Acc \end{array}\right]$$

Binning on the M_x^2

MC includes real radiative corrections (external+internal)

$$\chi^2 = \sum_{i_e}\frac{\left[N^{Exp}(i_e) - N^{MC}(i_e)\right]^2}{\left[\sigma^{Exp}(i_e)\right]^2}$$

→ **A**, **B**, **C**, **D**