HERMES status and future running

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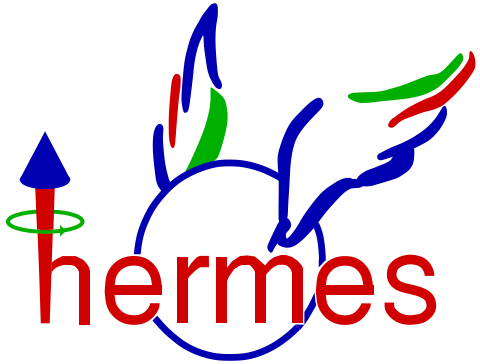
on behalf of the



collaboration

Access to Transversity

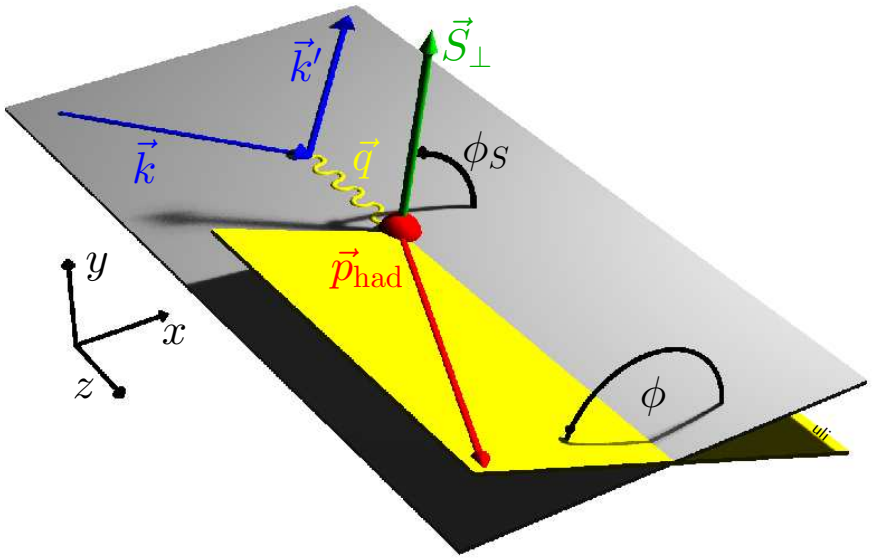
Single spin azimuthal asymmetries on a transverse polarized Target

$$ep^{\uparrow} \longrightarrow e'\pi X$$

$$\sigma^{ep\to e\pi X} = \sum_q f^{N\to q} \otimes \sigma^{eq\to eq} \otimes D^{q\to\pi}$$

Distribution-function $h_1^{\perp}$

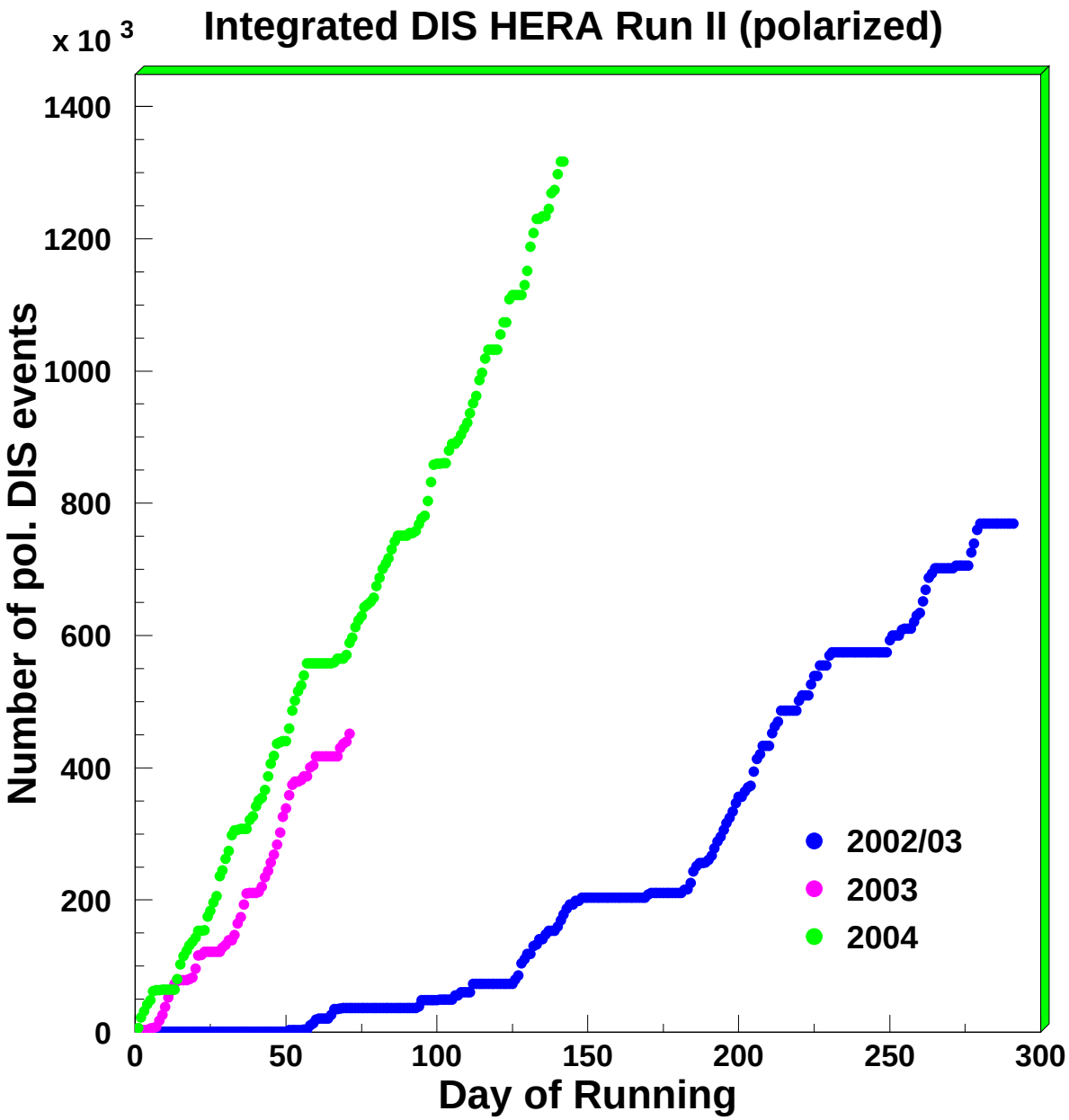
Fragmentat.-function $H_1^{\perp}$ (Collins)



$$\mathbf{A_{UT}^{h}}(\phi,\phi_{\mathbf{s}}) = \frac{\mathbf{1}}{|\mathbf{S_T}|}\frac{\mathbf{N_h^{\uparrow}}(\phi,\phi_{\mathbf{s}}) - \mathbf{N_h^{\downarrow}}(\phi,\phi_{\mathbf{s}})}{\mathbf{N_h^{\uparrow}}(\phi,\phi_{\mathbf{s}}) + \mathbf{N_h^{\downarrow}}(\phi,\phi_{\mathbf{s}})}$$

$$\mathbf{A_{UT}^{Collins}} \propto \frac{\sum_{\mathbf{q}} \mathbf{e_q^2}\, \delta\mathbf{q}(\mathbf{x})\, \mathbf{H_1^{\perp,q}}(\mathbf{z})}{\sum_{\mathbf{q}} \mathbf{e_q^2}\, \mathbf{q}(\mathbf{x})\, \mathbf{D_1^q}(\mathbf{z})}$$

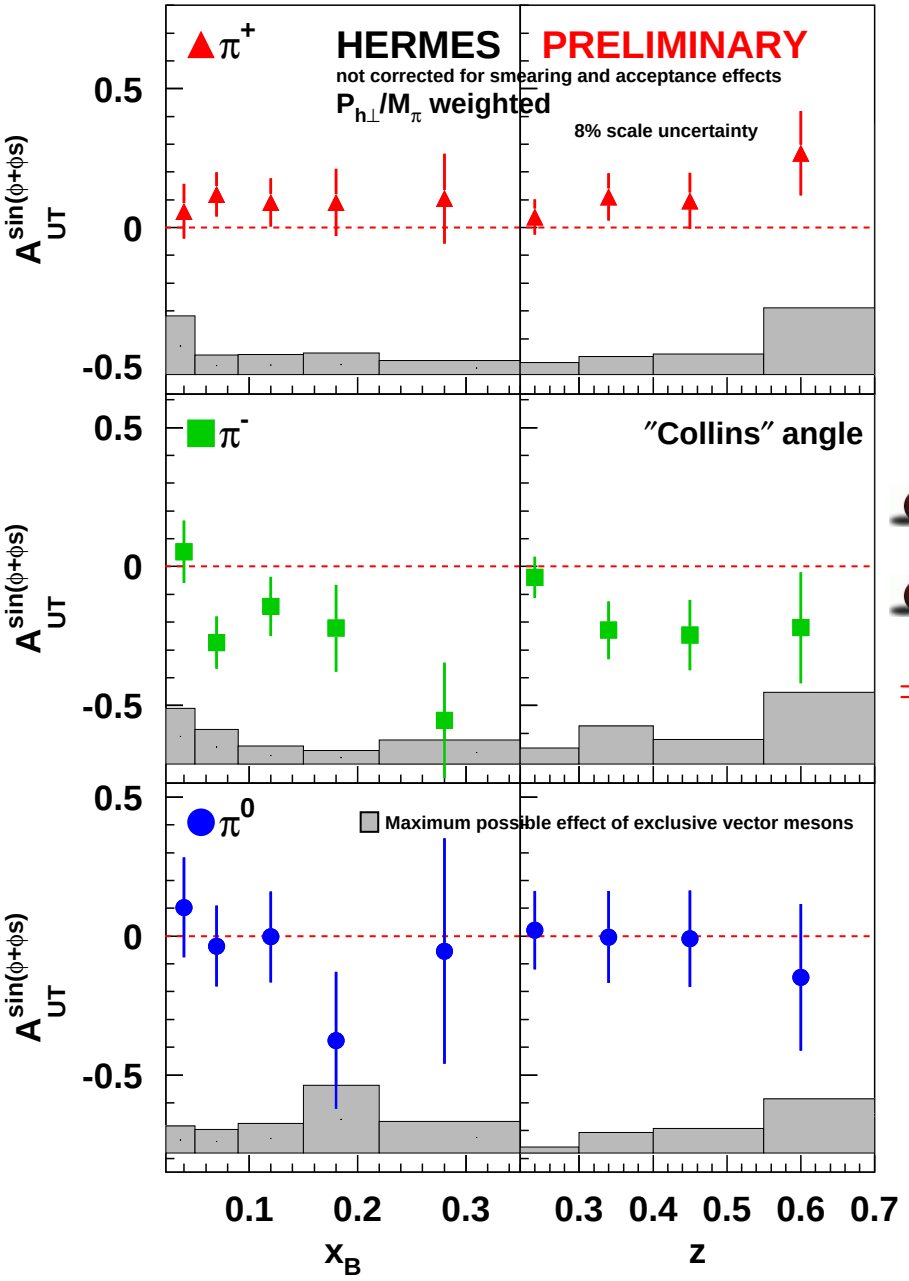
Data on Transversity



Statistics

- 02: 0.94 M DIS
- 03: 0.50 M DIS
- 04: 1.30 M DIS
- TOTAL 2.8 M DIS
- GOAL 6 M DIS

Very First Results on TRANSVERSITY



- x-dependence $\Rightarrow \delta q$
- z-dependence $\Rightarrow$ FF

$\Rightarrow$ more data for 2-dim. analysis

6 Million DIS

Access to Collins

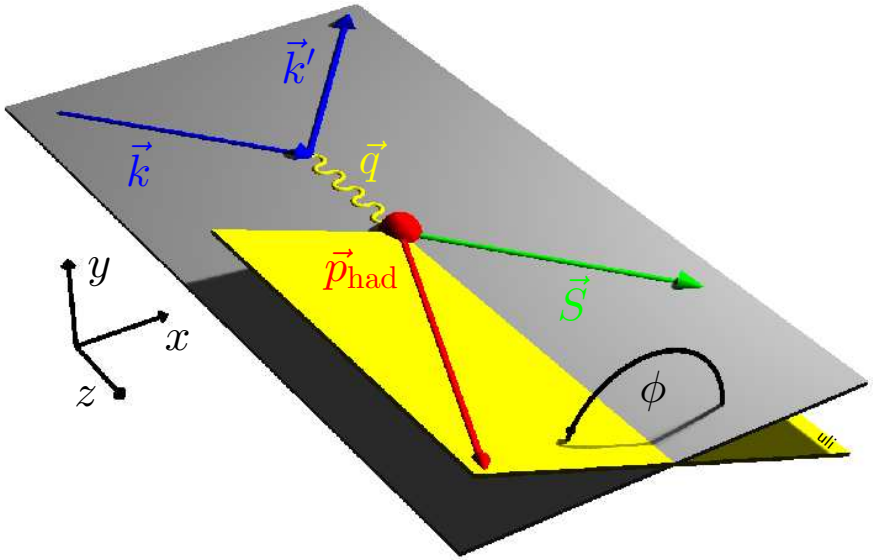
Beam spin azimuthal asymmetries

$$e^{\uparrow} p \longrightarrow e' \pi X$$

$$\sigma^{ep \to e\pi X} = \sum_q f^{N \to q} \otimes \sigma^{eq \to eq} \otimes D^{q \to \pi}$$

Distribution-function e

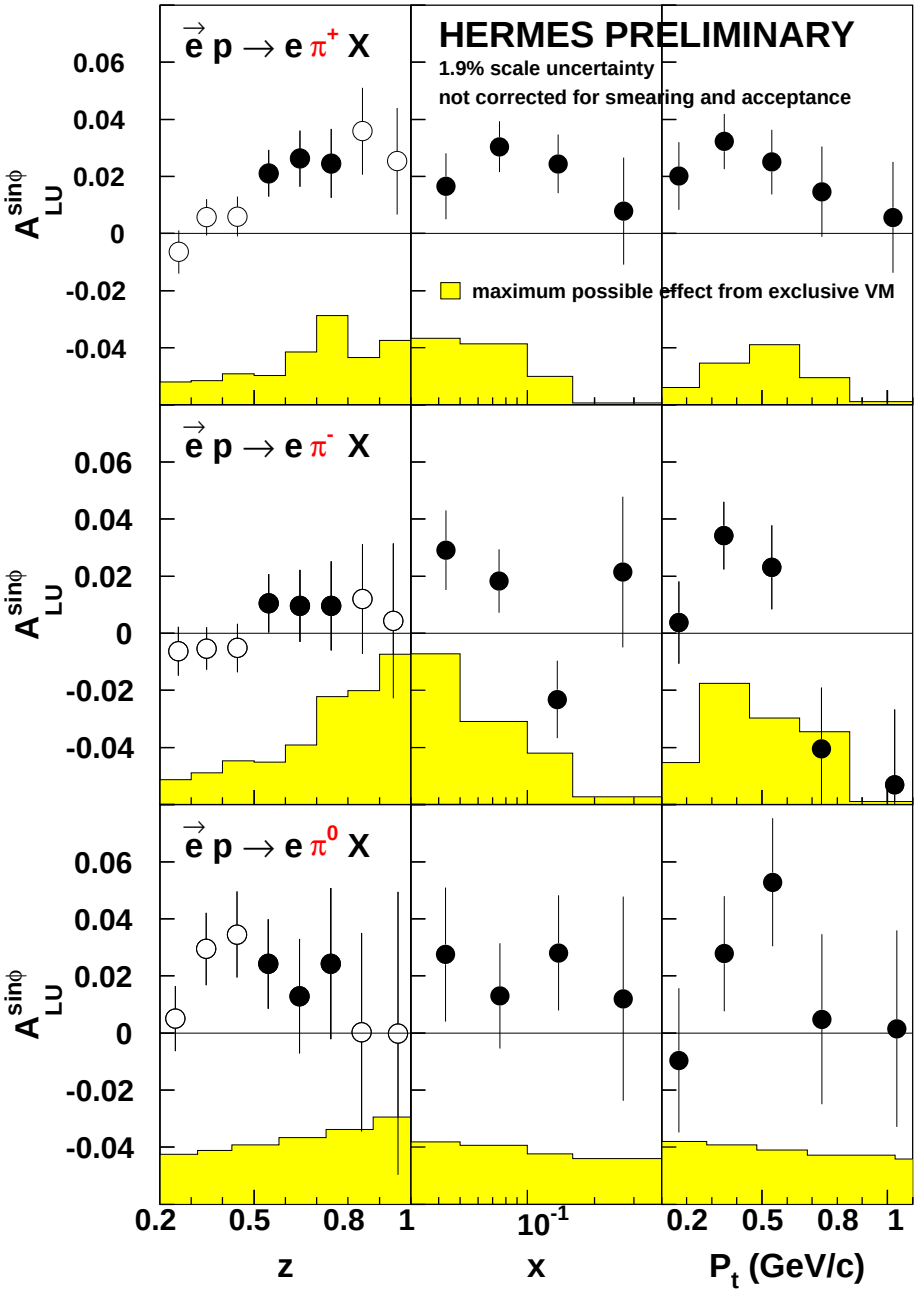
Fragmentat.-function $H_1^{\perp}$

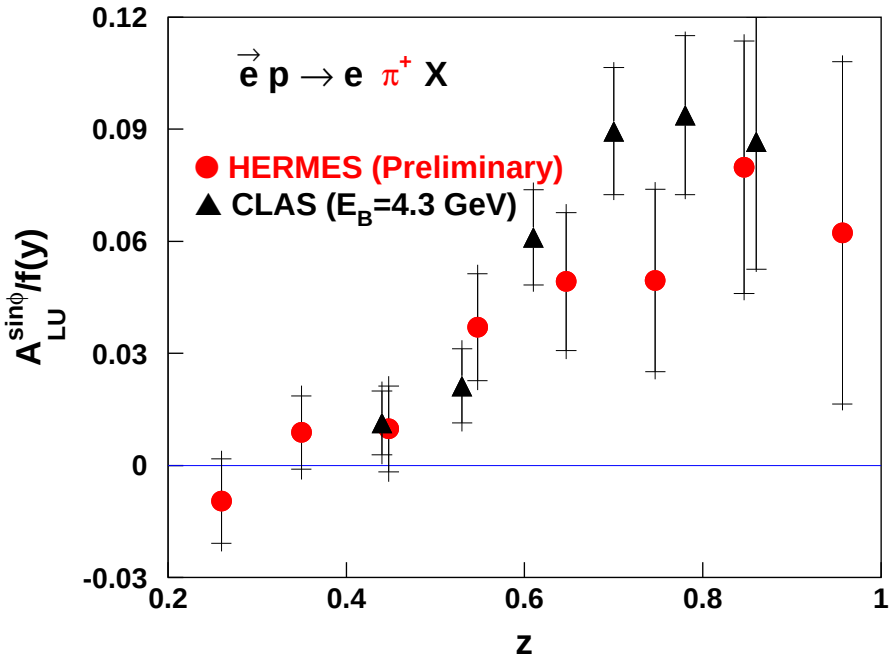


$$\mathbf{A_{LU}^{h}}(\phi) = \frac{\mathbf{1}}{|\mathbf{S_L}|} \frac{\vec{\mathbf{N}}_{\mathbf{h}}(\phi) - \overleftarrow{\mathbf{N}}_{\mathbf{h}}(\phi)}{\vec{\mathbf{N}}_{\mathbf{h}}(\phi) + \overleftarrow{\mathbf{N}}_{\mathbf{h}}(\phi)}$$

$$\mathbf{A_{LU}^{Collins}} \propto \frac{\sum_{\mathbf{q}} \mathbf{e_q^2}\, \mathbf{e(x)}\, \mathbf{H_1^{\perp,q}(z)}}{\sum_{\mathbf{q}} \mathbf{e_q^2}\, \mathbf{q(x)}\, \mathbf{D_1^q(z)}}$$

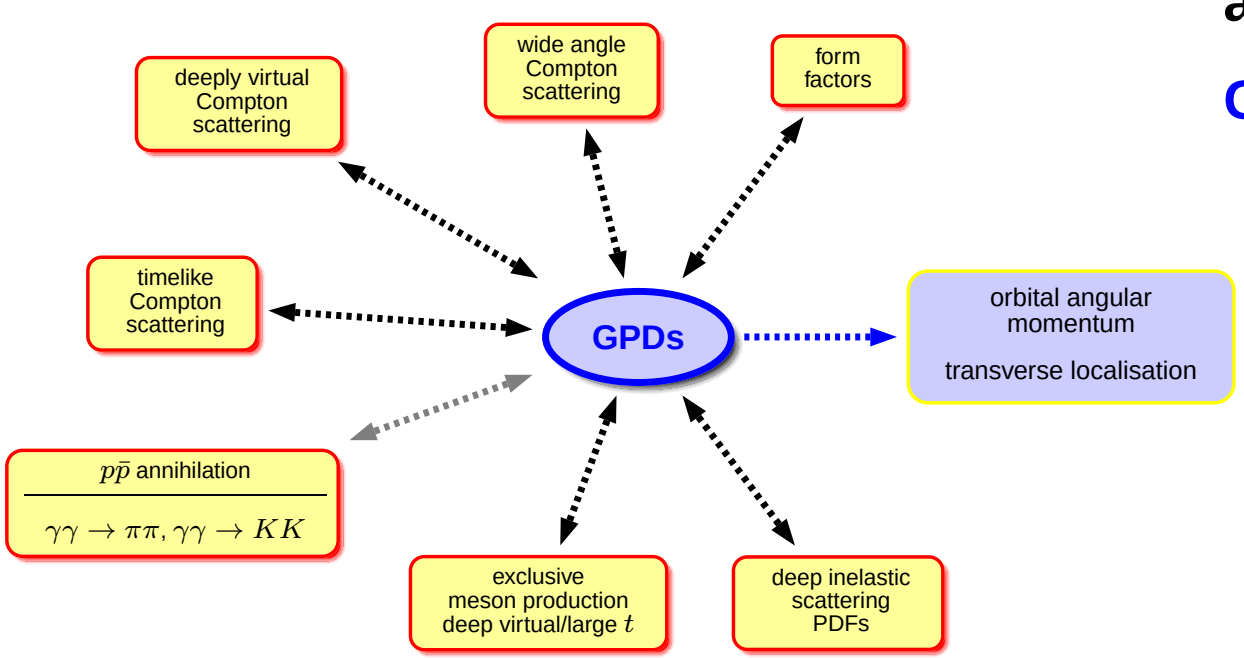
Beam Spin Asymmetry





- more results on Deuterium target to come

The Hermes Quest for L_q



Study of hard exclusive processes leads to a new class of PDFs

Generalised Parton Distributions

$$H^q, E^q, \tilde{H}^q, \tilde{E}^q$$

$\Rightarrow$ **possible access to orbital angular momentum**

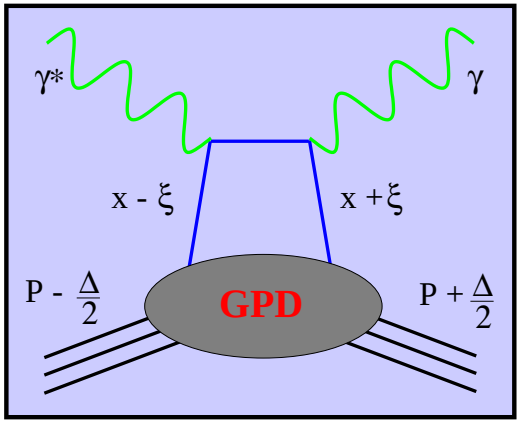
$$J_q = \frac{1}{2}\left(\int_{-1}^{1} x \mathrm{d}x (H^q + E^q)\right)_{t\to 0}$$
$$J_q = \frac{1}{2}\Delta\Sigma + L_q$$

exclusive: all products of a reaction are detected

$\Longrightarrow$ **missing energy (ΔE) and missing Mass (M_x) = 0**

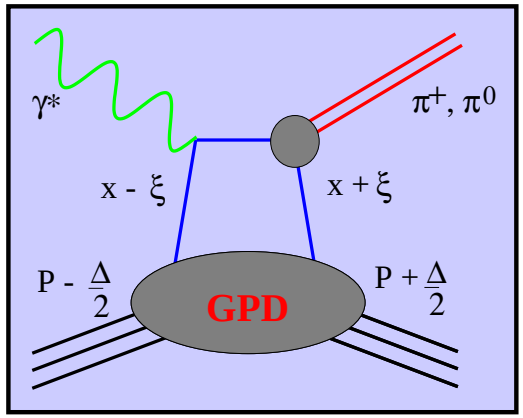
GPDs Introduction

quantum numbers of final state $\Rightarrow$ select different GPDs



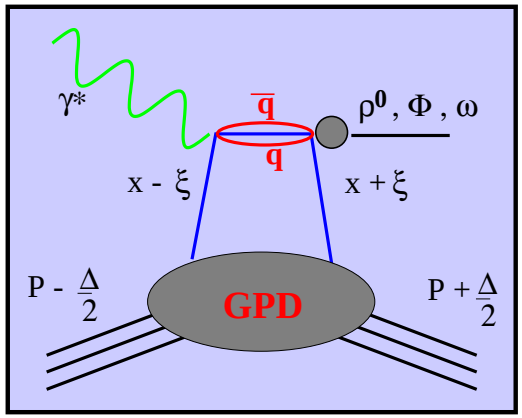
DVCS:

$H^q, E^q, \tilde{H}^q, \tilde{E}^q$



pseudo-scalar mesons

$\tilde{H}^q, \tilde{E}^q$



vector mesons

H^q, E^q

What does GPDs characterize?

unpolarized	polarized	
$H^q(x,\xi,t)$	$\tilde{H}^q(x,\xi,t)$	**conserve nucleon helicity**
		$H^q(x,0,0) = q$, $\tilde{H}^q(x,0,0) = \Delta q$
$E^q(x,\xi,t)$	$\tilde{E}^q(x,\xi,t)$	**flip nucleon helicity**
		not accessible in DIS

x, t, ξ defined on the light cone

x: longitudinal momentum fraction **t: momentum transfer ($t = \Delta^2$)**

ξ: exchanged longitudinal momentum fraction ($\xi = \frac{x_{Bj}/2}{1 - x_{Bj}/2}$)

How to Measure E, $\tilde{E}$?

meson production $\rightarrow \sigma_{\rm L}$

@ Hermes kinematics:

	vector mesons		pseudoscalar mesons	
	$\sigma_{\rm L}$	$A_{\rm UT}$ **(nominator)**	$\sigma_{\rm L}$	$A_{\rm UT}$ **(nominator)**
H	$(1-\xi^2)$	$\sqrt{1-\xi^2}$		
$\tilde{H}$			$(1-\xi^2)$	$\sqrt{1-\xi^2}\cdot\xi$
E	$(\xi^2+\frac{t}{4M^2})$	$\sqrt{1-\xi^2}$		
$\tilde{E}$			$\xi^2\frac{t}{4m^2}$	$\sqrt{1-\xi^2}\cdot\xi$

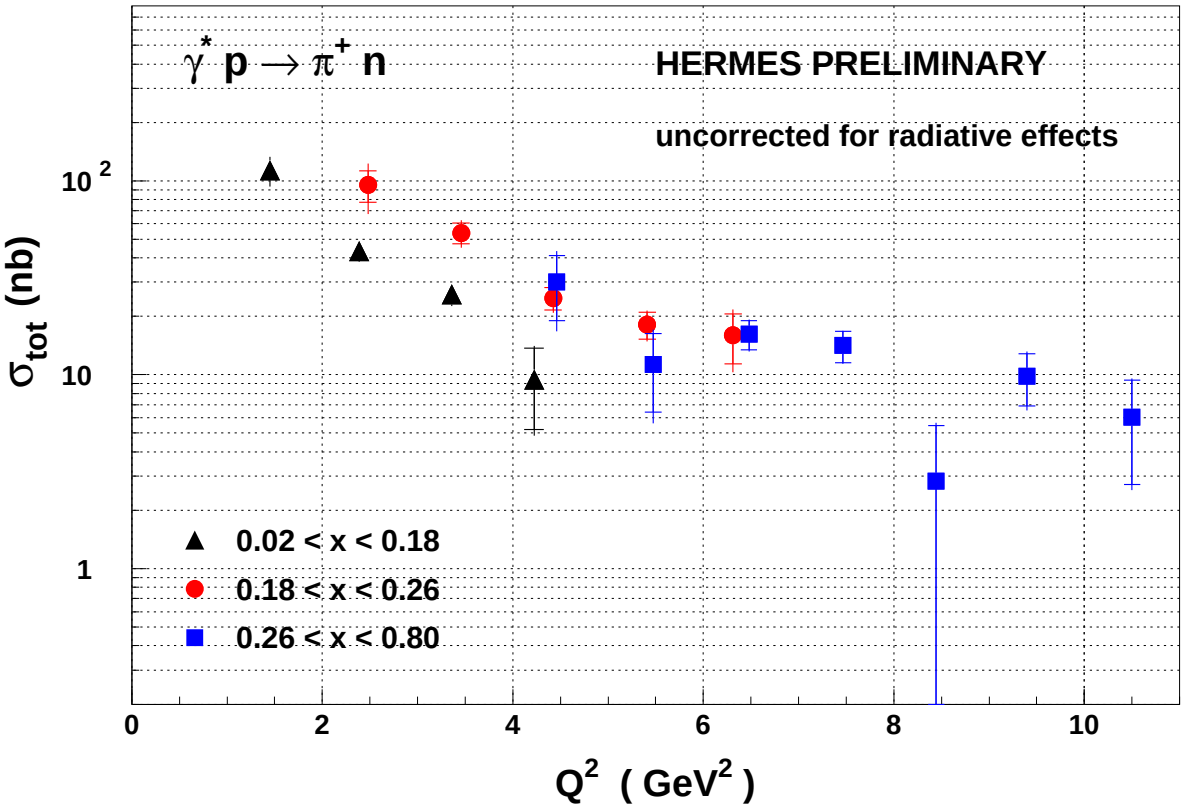
$$\xi \approx \frac{x_{\rm B}}{2-x_{\rm B}}$$

$$\xi \approx 0.01-0.3$$

$$\xi_{|x=0.1} \approx 0.05$$

$$\frac{t}{4M^2} \approx 0.02-0.1$$

Exclusive π^+ result



- cross section in 3 x-bins
- sensitivity to $\tilde{E}$ at higher x
- complete new data
- comparison with theory in progress

How to Measure E, $\tilde{E}$?

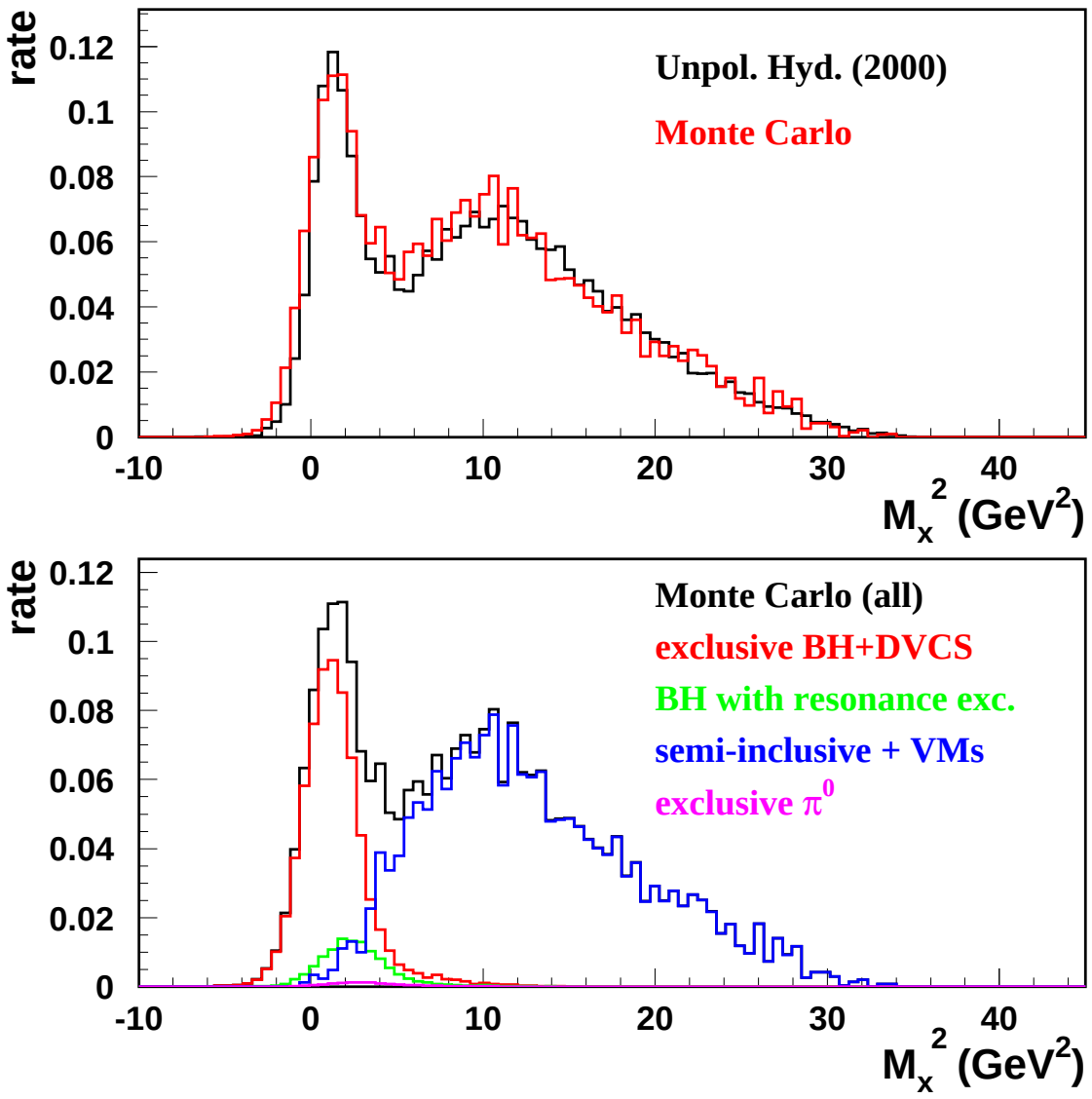
	DVCS $A_{\rm C}$, $A_{\rm LU}$	$A_{\rm UL}$	$A_{\rm UT}$ **(twist-2 amplitudes of the interference terms only)**
H	F_1	$\xi(F_1+F_2)$	$\xi^2 F_1 + \frac{t}{4M^2}(1-\xi^2)F_2$
$\tilde{H}$	$\xi(F_1+F_2)$	F_1	$\xi^2(F_1+F_2)$
E	$\frac{t}{4M^2}F_2$	$\frac{\xi^2}{1+\xi}(F_1+F_2)$	$\xi^2 F_1 + \frac{t}{4M^2}(F_1+\xi^2 F_2)$
$\tilde{E}$		$\frac{\xi^2}{1+\xi}F_1 + \xi\frac{t}{4M^2}F_2$	$\xi^2\frac{t}{4M^2}(F_1+F_2)$

F_1 **and** F_2 **...Dirac and Pauli form factor**

$\Rightarrow$ **to access** E **transverse target polarisation is essential**

Exclusive Scattering

Missing Mass to select exclusive events



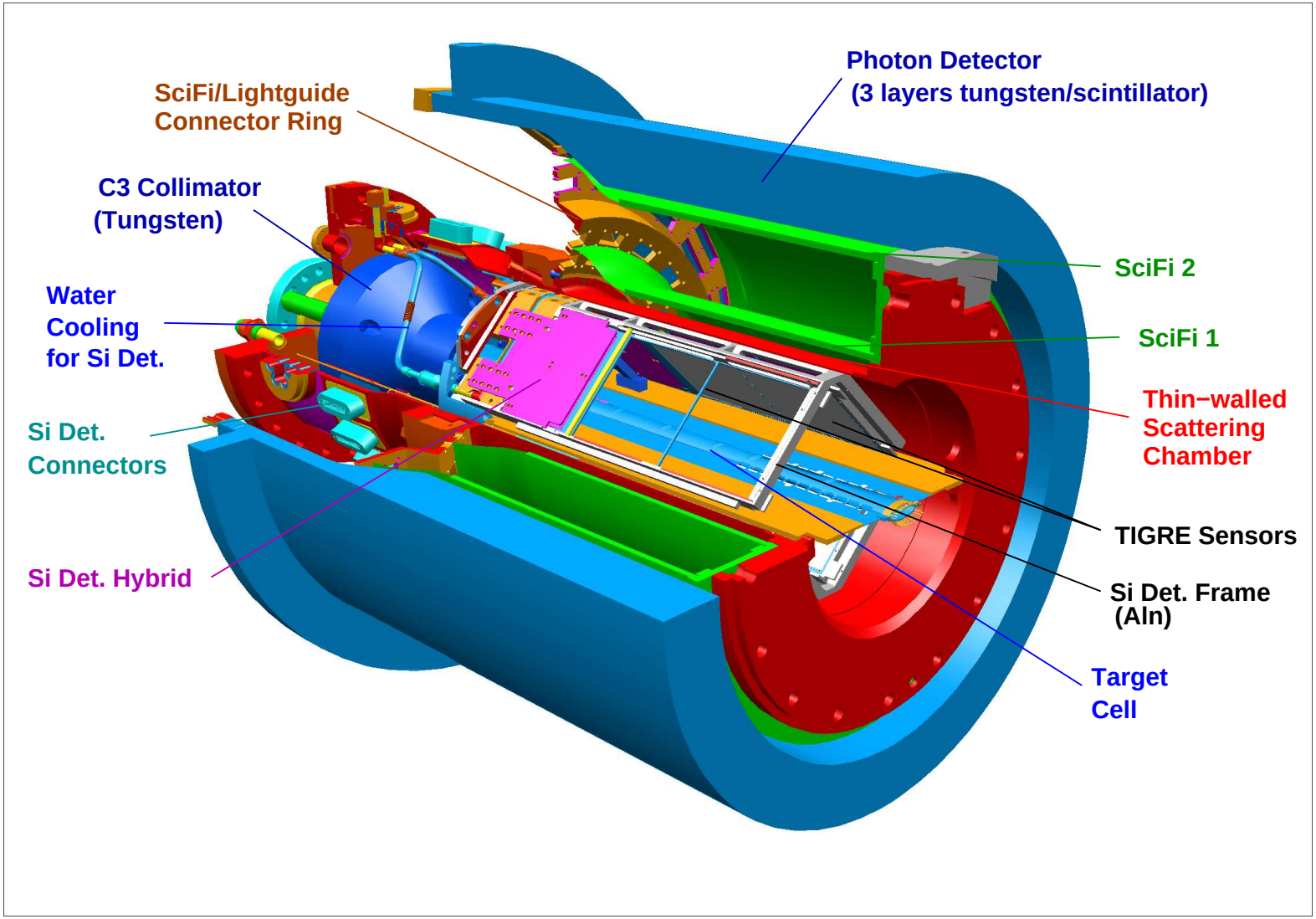
Background from

- **Resonances**
- **SIDIS**

$\Rightarrow$ **tag recoil Nucleon**

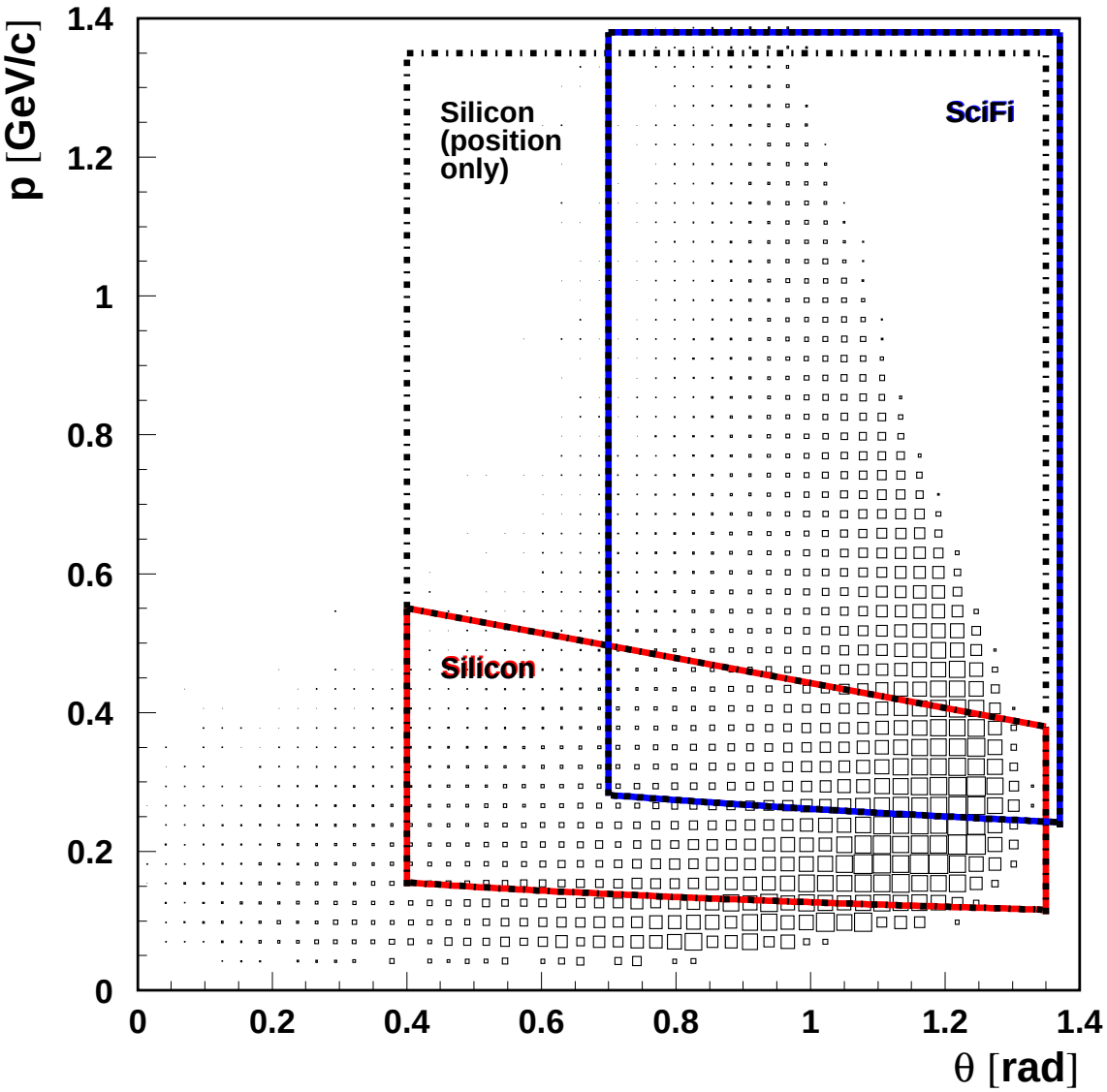
Recoil Detector

Measure the recoiling target nucleon



Recoil Detector

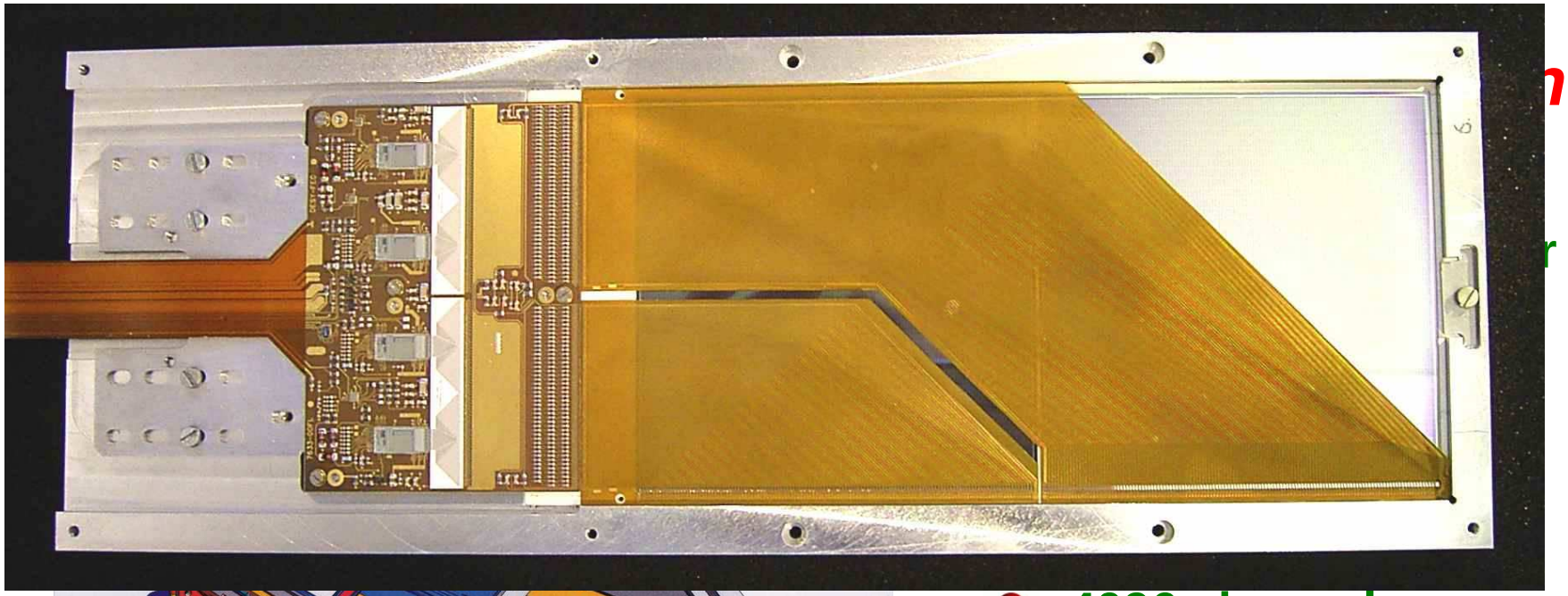
Measure the recoiling target nucleon

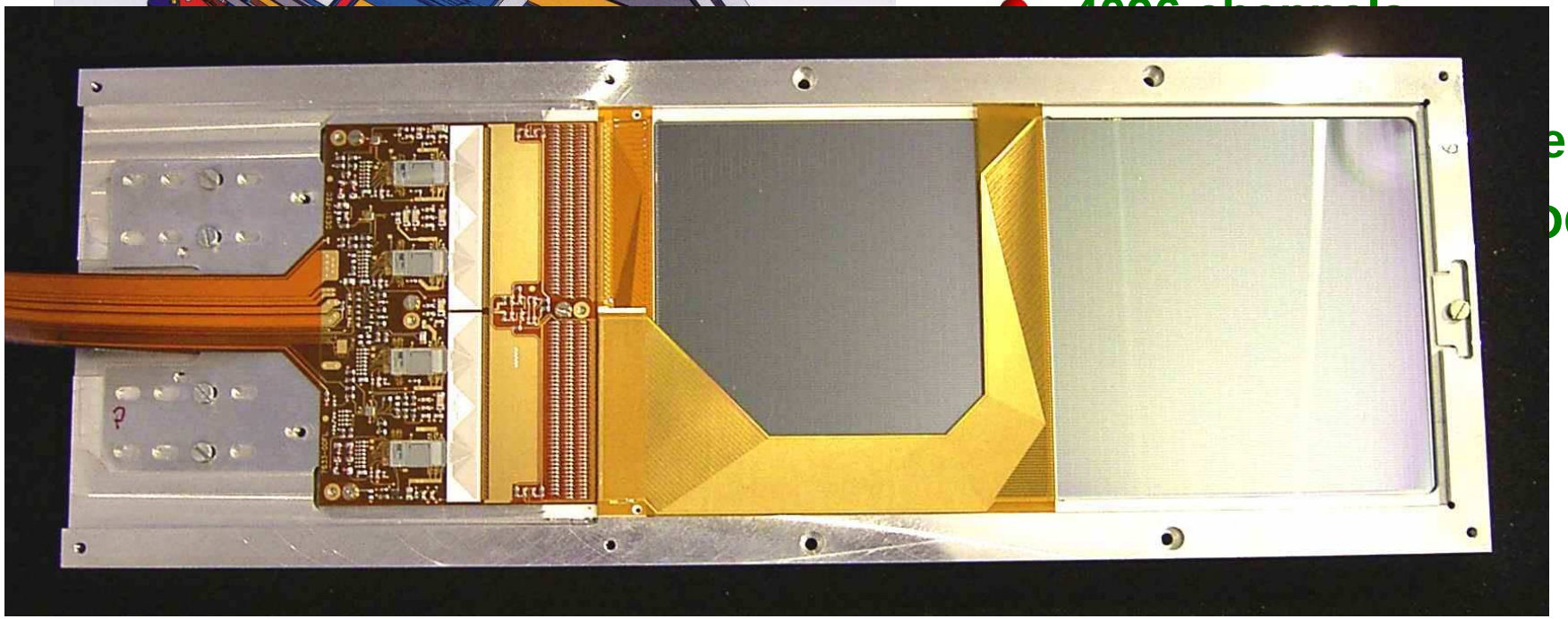


- 135 to 1400 MeV/c momentum coverage
- low p cut off due to E-loss in target cell
- 76% acceptance in ϕ
- π-p separation via dE/dx

Silicon Detector

- **Silicon strip detector**
- **in HERA machine vacuum**
- **2-sided readout**
- **two layers for dE/dx**
- **4096 channels**
- **135 to 400 MeV/c momentum coverage**
- **HELIX chip with HADC**
- **charge division (2 gain ranges)**

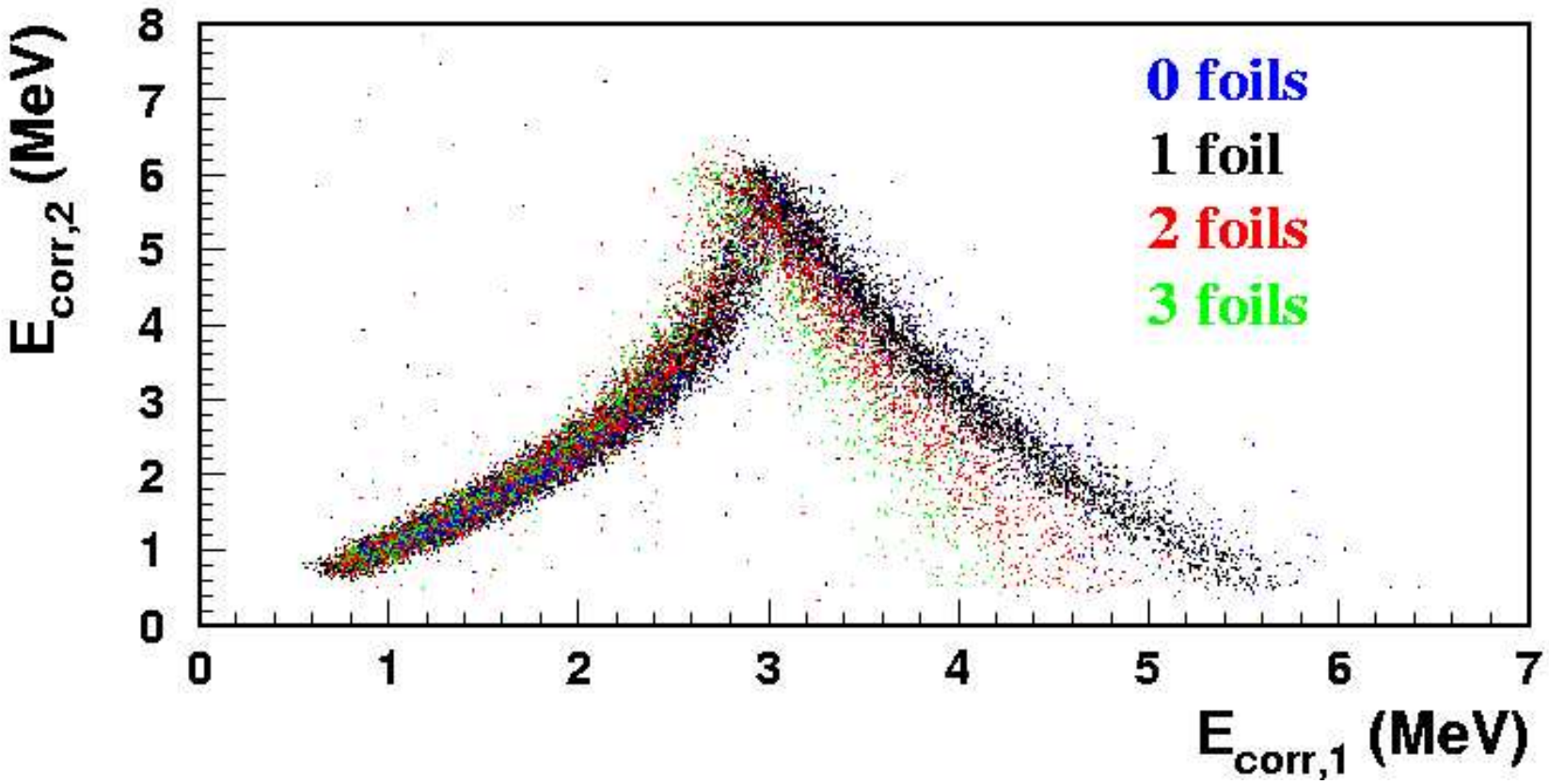




All modules necessary at hand.

Silicon Detector

- Silicon strip detector
- in HERA machine vacuum
- 2-sided readout



in

Silicon Detector

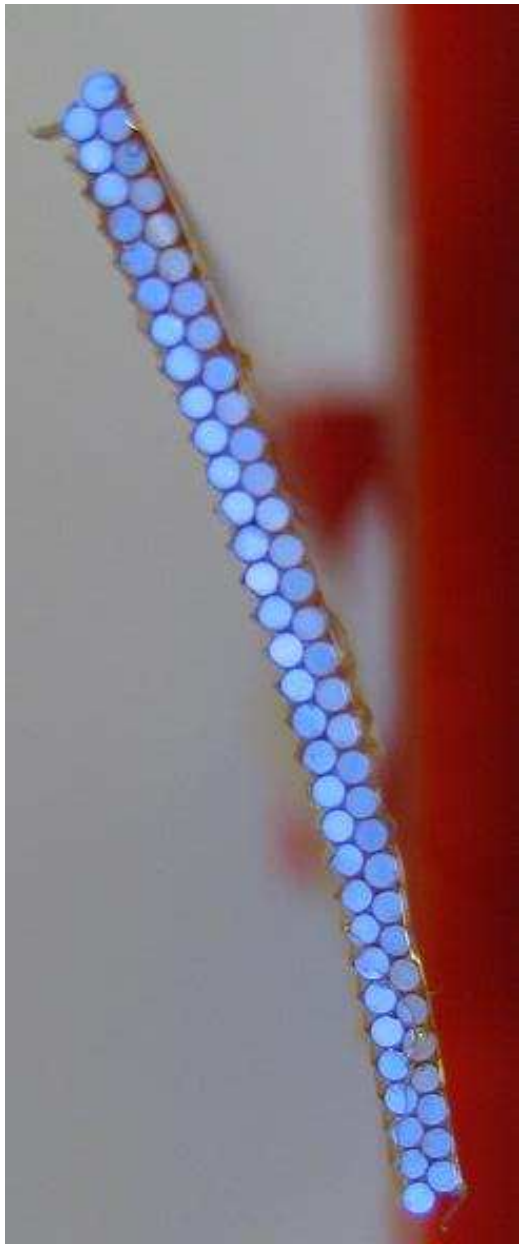
- Silicon strip detector
- in HERA machine vacuum
- 2-sided readout
- two layers for dE/dx
- 4096 channels
- 135 to 400 MeV/c momentum coverage
- HELIX chip with HADC
- charge division (2 gain ranges)

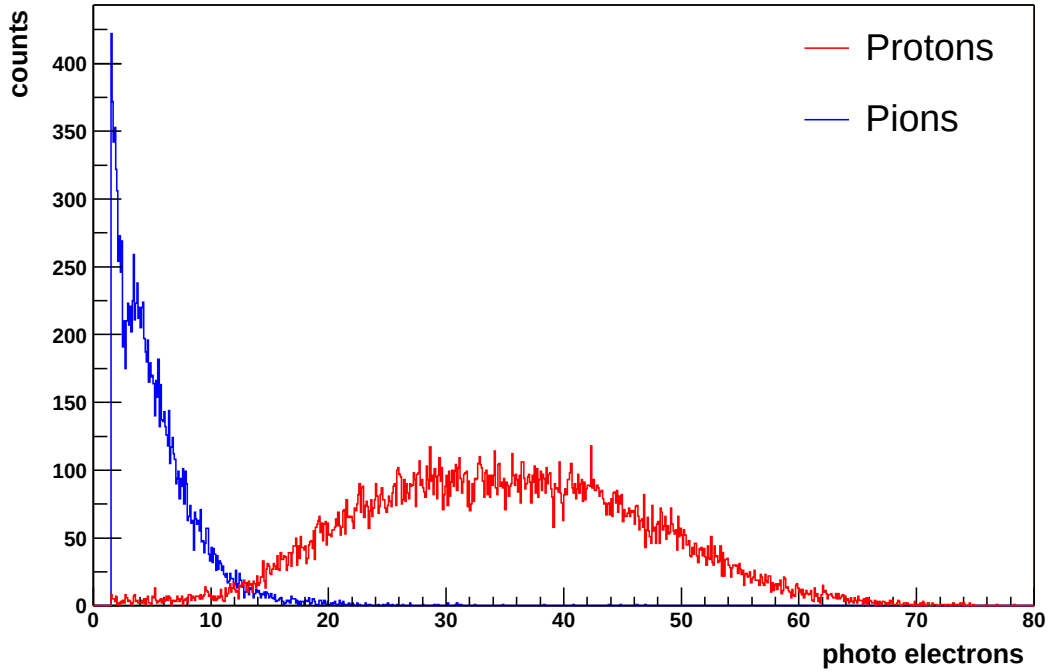
- DESY test beam (e+ beam) S/N = 6.2
- Erlangen test beam (< 11 MeV p)

Scintillating Fiber Detector

- 300 to 1400 MeV/c momentum range
- Two separate planes (barrel)
- each plane two cylinders of stacks two layers of scintillation fibers
- 4992 channels
- 64-pixel PMTs for light conversion

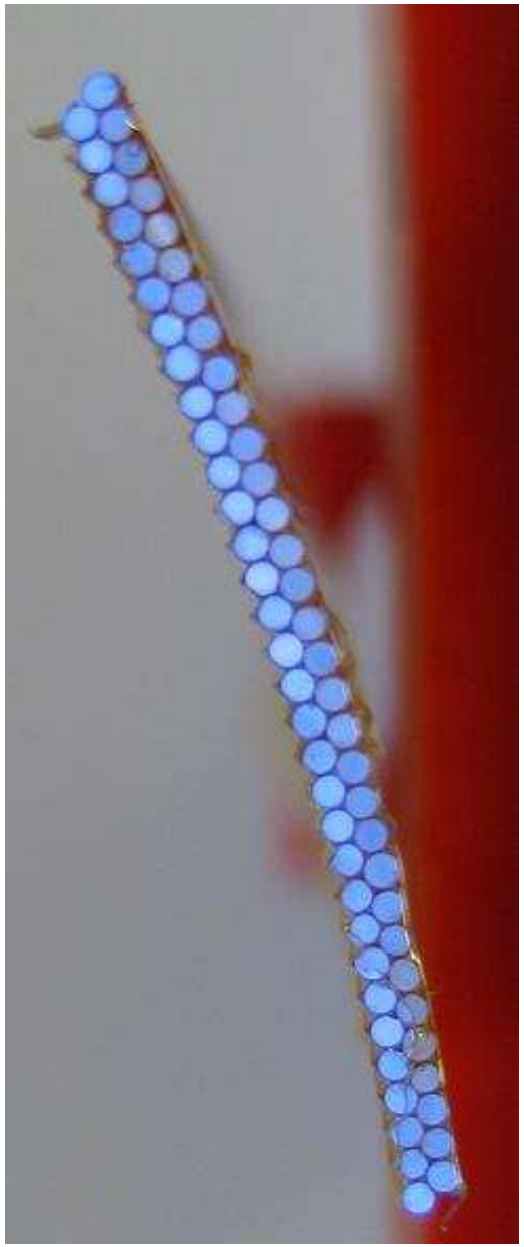
Scintillating Fiber Detector

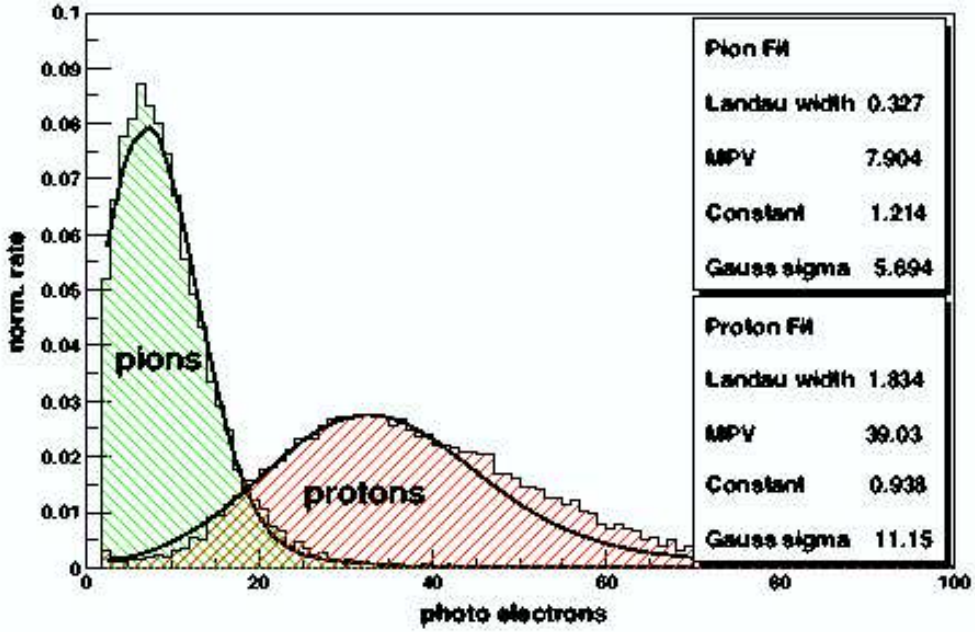


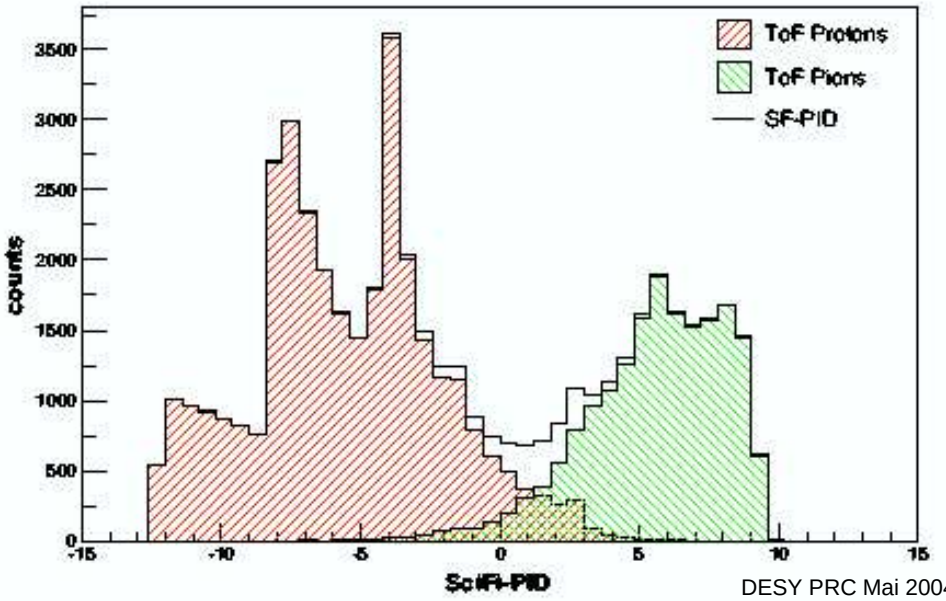


- momentum 300 MeV/c
- response of the sum of the two layers

Scintillating Fiber Detector



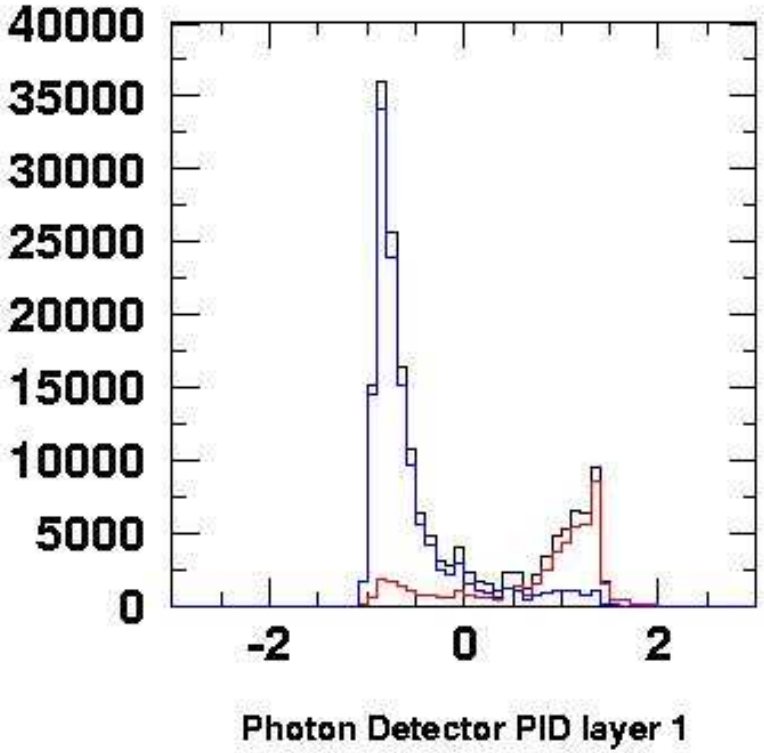




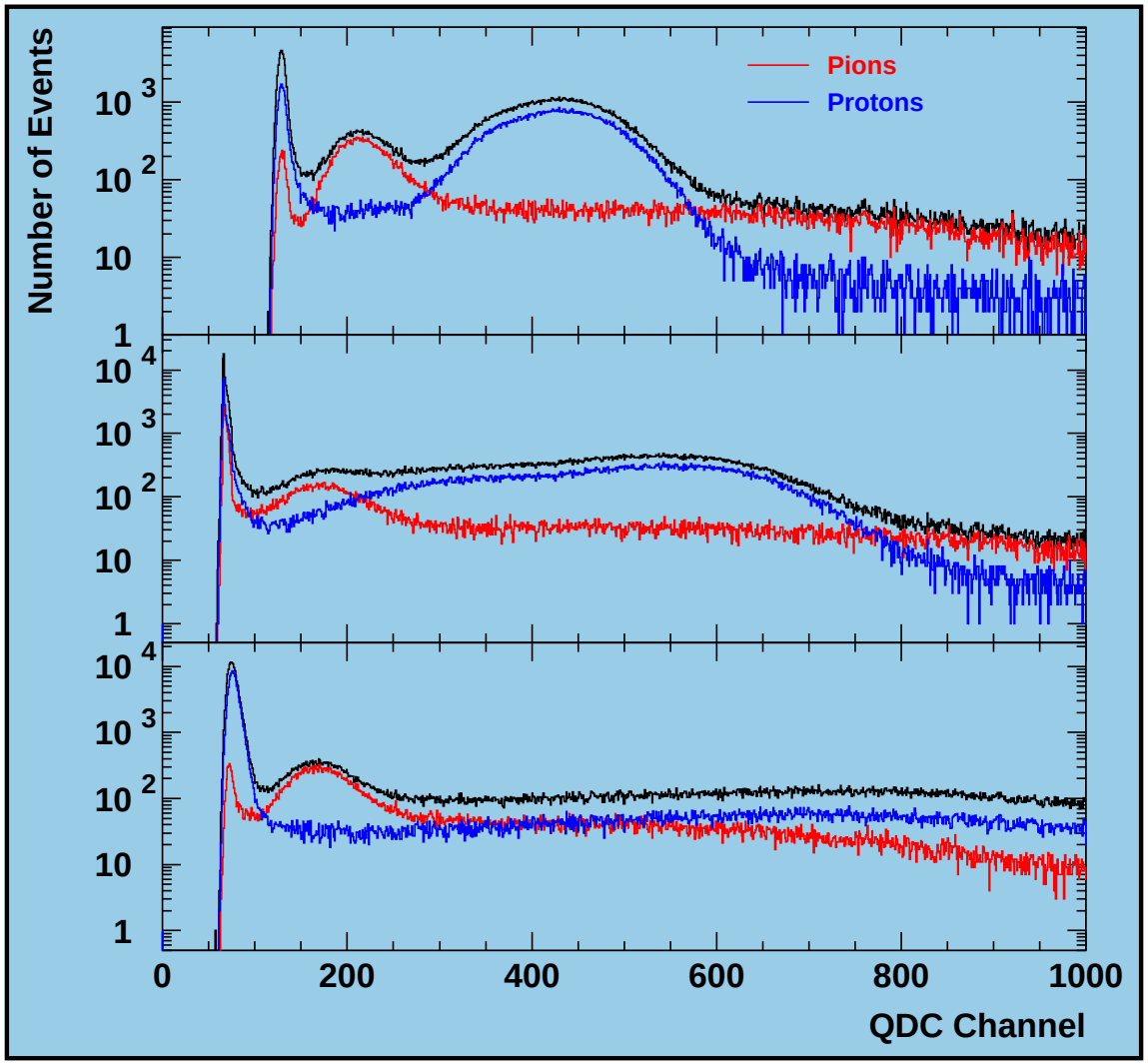
Photon Detector

- detect neutral particles
- photons from π^o decay
- 3 layers of scintillator strips
- fiber light guides
- tungsten as pre-shower
- gain monitoring system

Photon Detector



- momentum 600 MeV/c
- use detector response for PID



Coffee is approaching

- **Collins FF with transverse pol. target or BSA**
- **GPDs give access to orbital angular momentum of quarks**
- **transverse pol. target needed to access E**
- **exclusive π production access to $\tilde{H}, \tilde{E}$**
- **DVCS access to H**
- **install the Recoil Detector in sumer 2005**
- **focus on DVCS with e- and e+ beam**
- **other topics: Hyperon (strange quark), Penta-quark, exclusive VM, target fragmentation ...**