The HERMES Recoil Detector

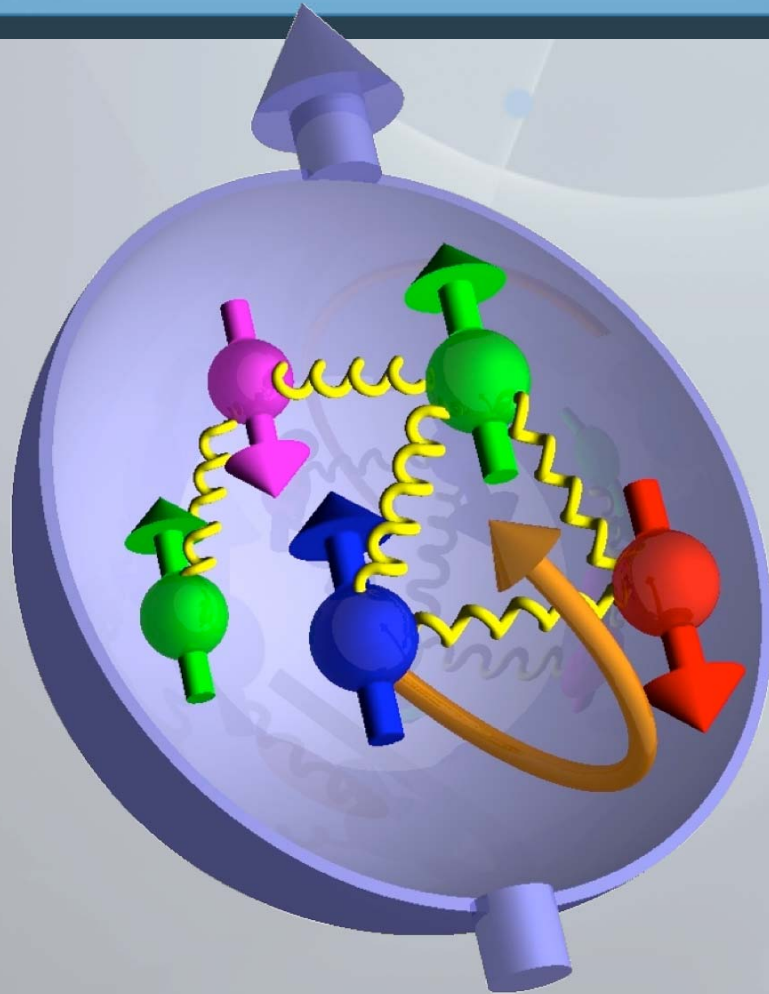**Inti Lehmann**

University of Glasgow

for the HERMES Collaboration

EuNPC Bochum, 17 March 2009

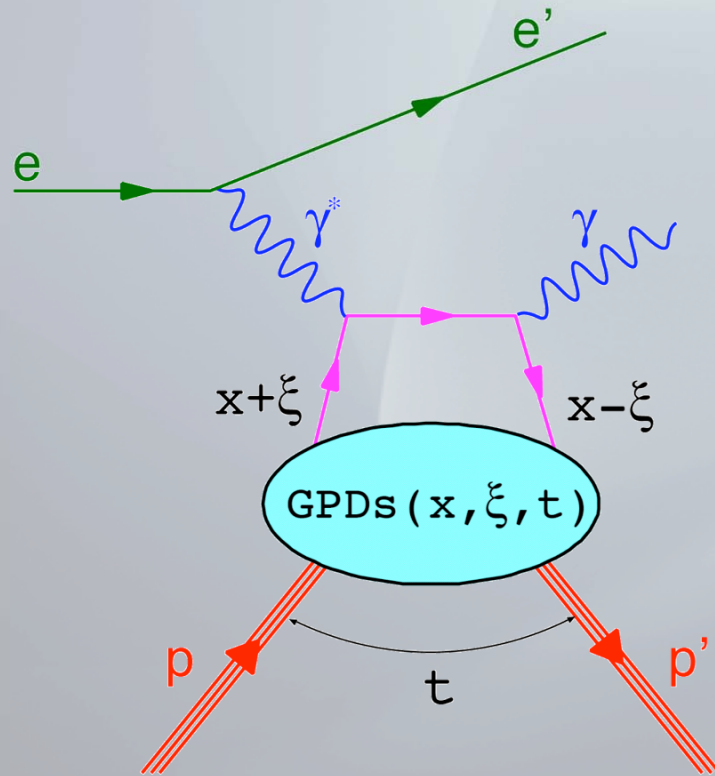# Nucleon Structure

- **Proton spin**

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + L_q + J_g$$

- $\Delta\Sigma$: **quark spin**
    - **about 1/3 (HERMES,…)**
- **L_q : quark angular momentum**
    - **unknown**
- **J_g : gluon total angular momentum**
    - **unknown**

- **How is the spin distributed?**

Access Nucleon Structure

Deeply Virtual Compton Scattering (DVCS)

Final state: e, γ, p
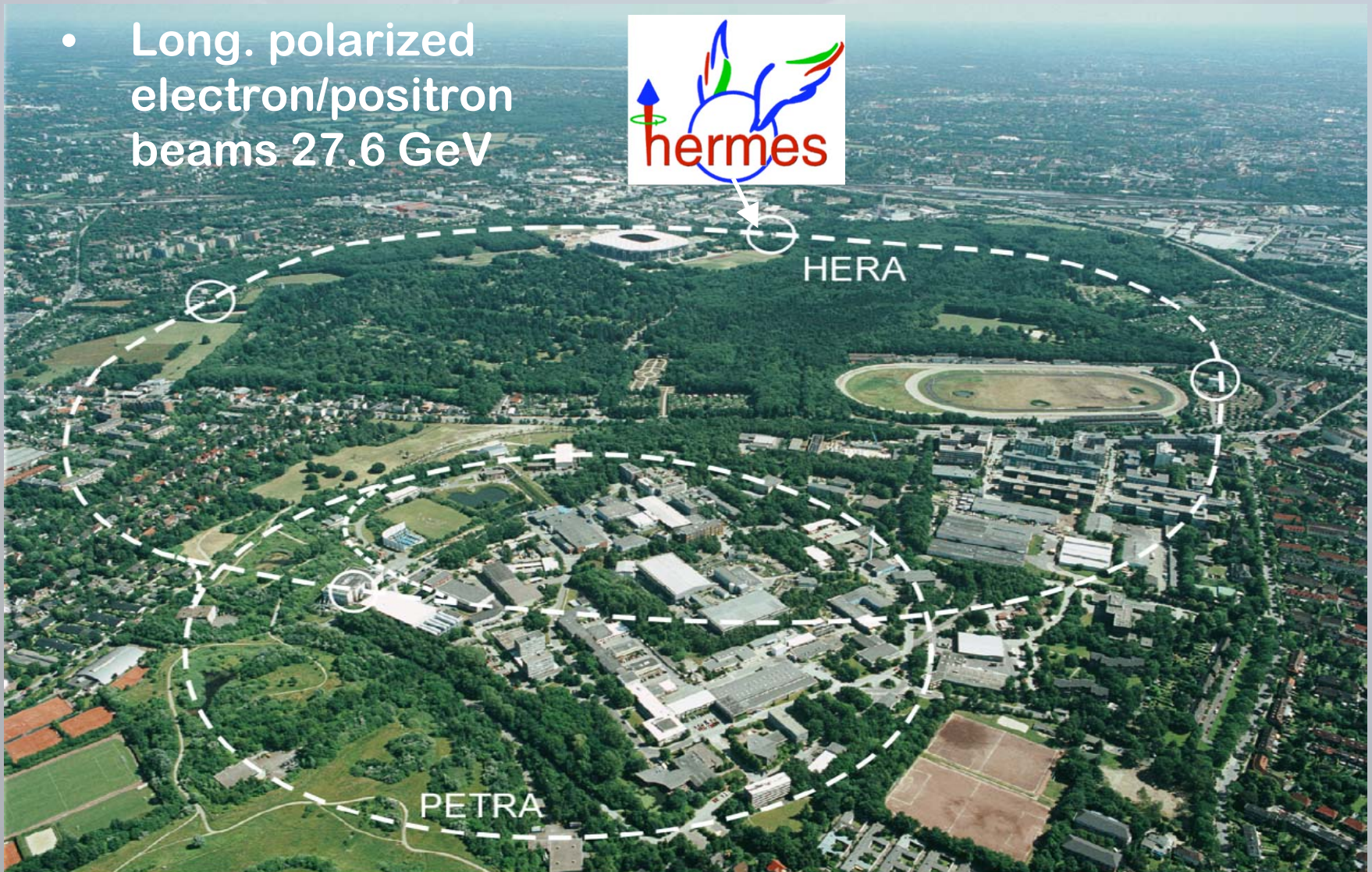
- **Ji Sum Rule**

$$J_q = \frac{1}{2} \int_{-1}^{1} x\, dx [H_q + E_q]$$

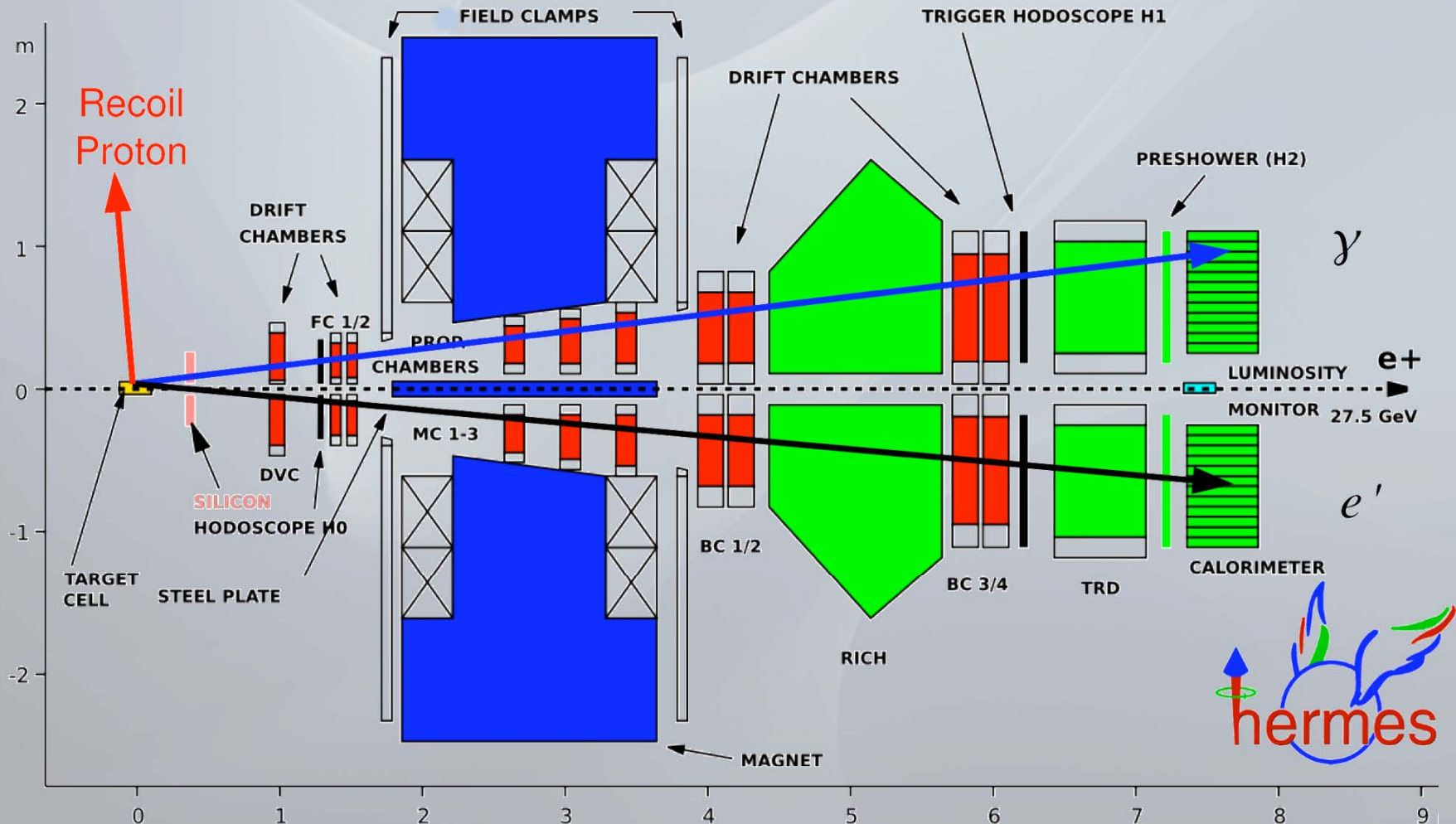**Generalised Parton Distributions (GPDs)**

- **Functions of 3 variables**
  - **parton momentum fraction x**
  - **skewedness ξ**
  - **p momentum transfer t**

- **Long. polarized electron/positron beams 27.6 GeV**

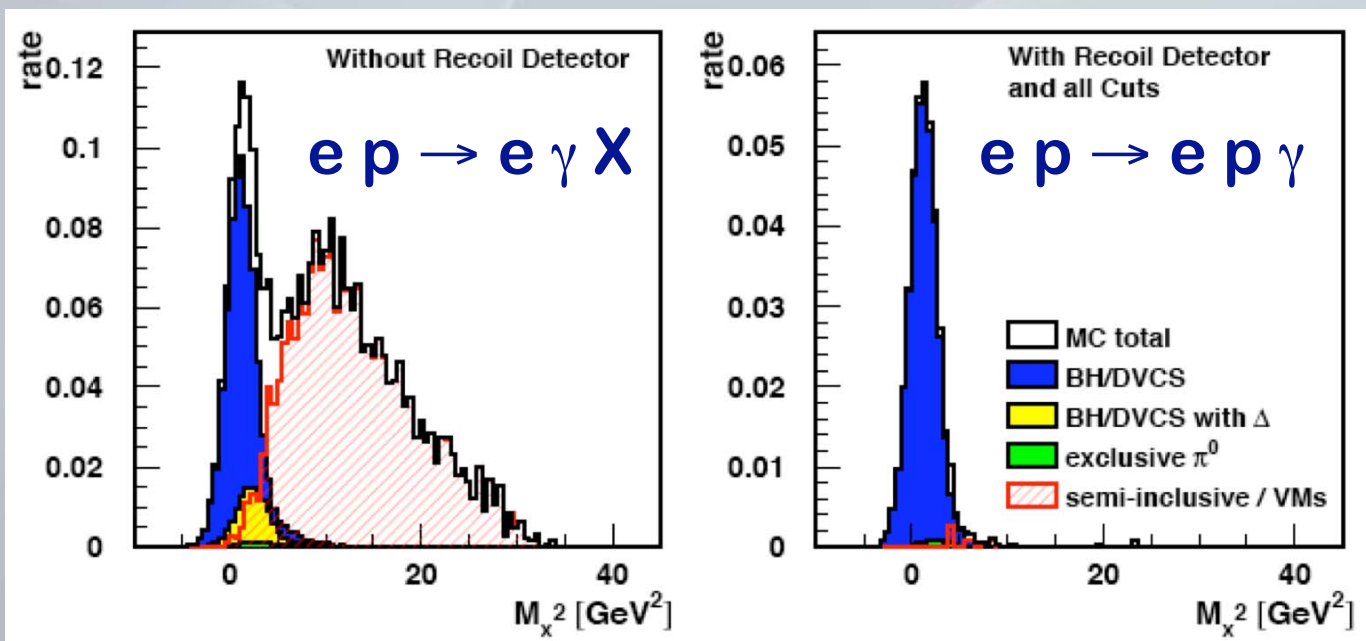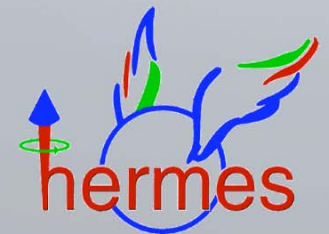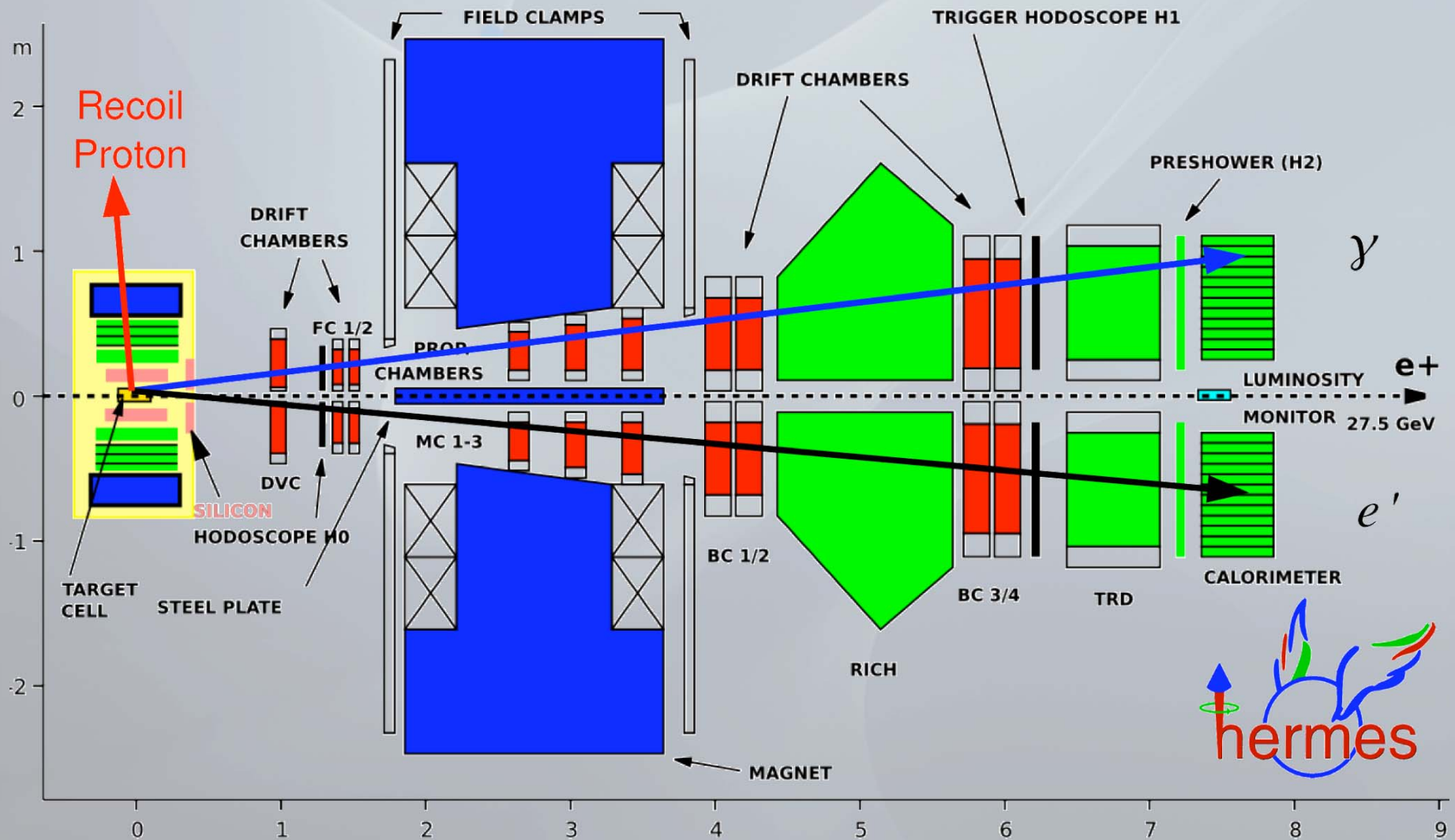**Magnetic spectrometer with transv. and long. polarized targets**
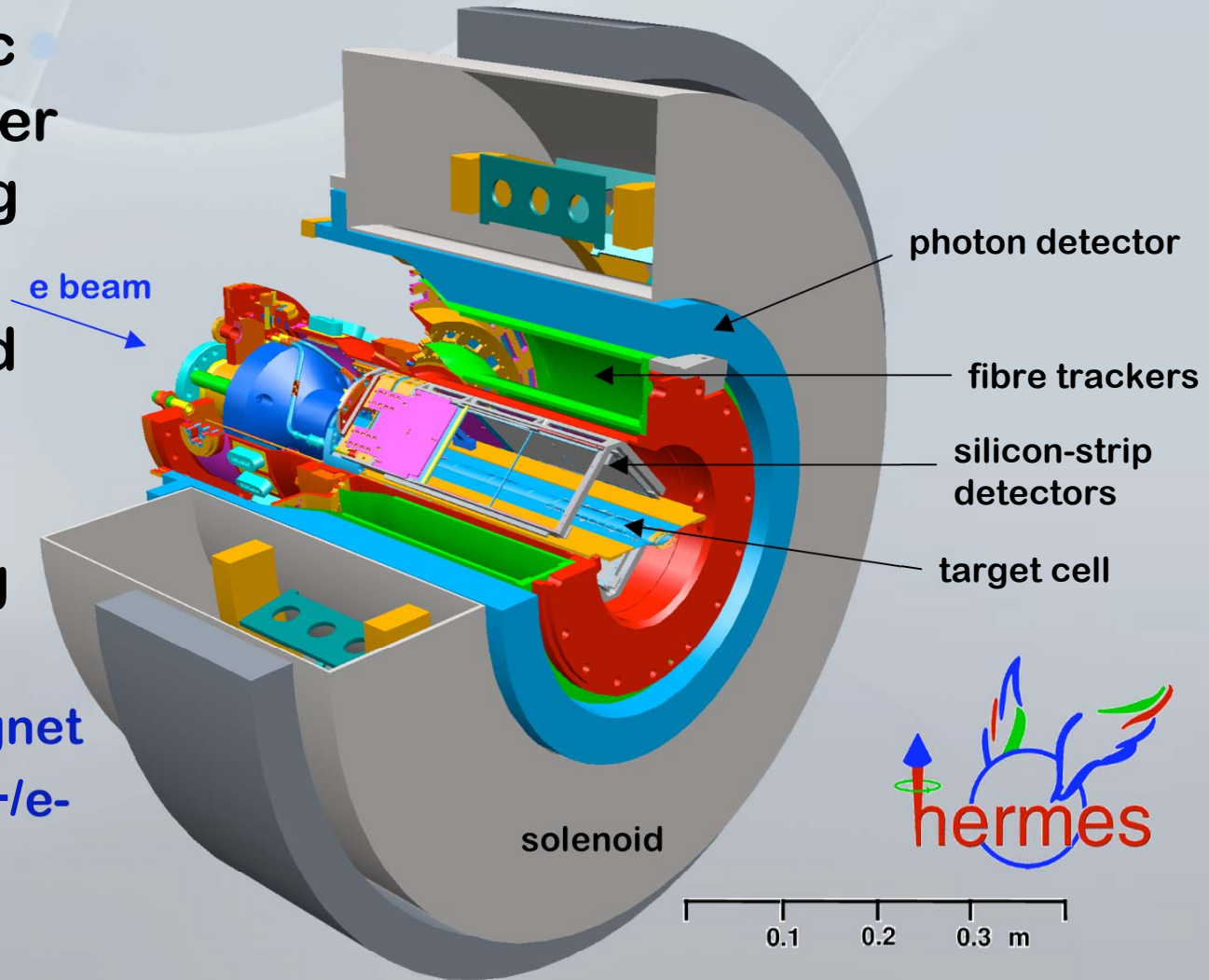
Measurement of Recoiling Proton

- **Remove background from associated BH/DVCS with intermediate Δ-production and from semi-inclusive processes**
  - **Reduction from 17% to about 1%**
- **Improve t-resolution at small t (with Si-detector)**
- **High luminosity with unpolarised targets**
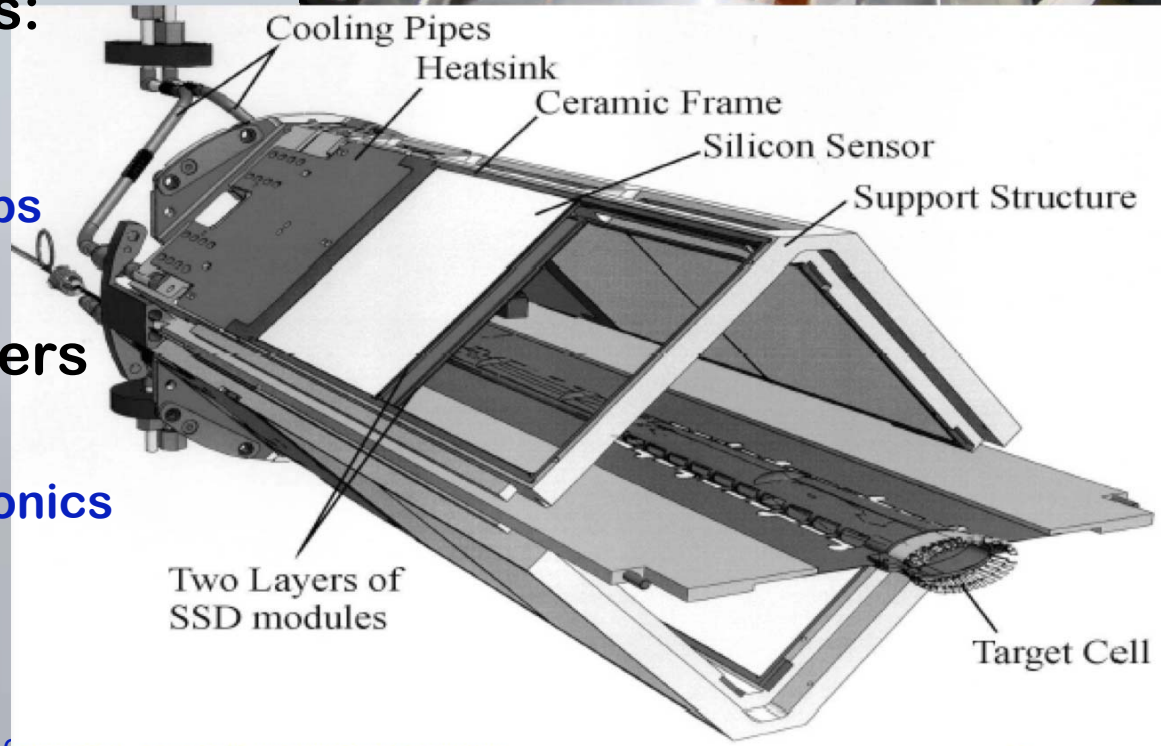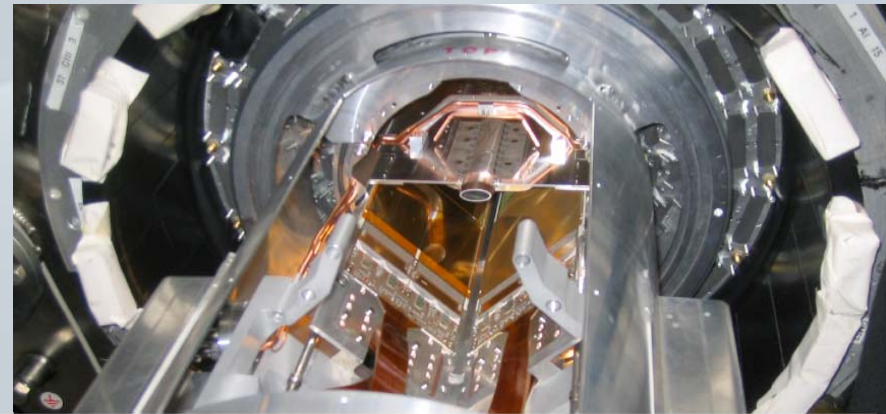
HERMES with Recoil

HERMES Recoil Detector

- **2π magnetic spectrometer surrounding target**

- **Unpolarised gas targets**
  - **H, D**

- **Challenging conditions**
 - **Inside magnet**
  - **Close to e+/e- beam**

e beam

photon detector

fibre trackers

silicon-strip detectors

target cell

solenoid

hermes

0.1   0.2   0.3   m

Silicon Strip Detector

- **Purpose**
  - **detect** 125-500 MeV/c **protons**
  - **Momentum and track reconstruction**
  - **Particle Identification**

- **16 silicon sensors:**
  - **10 x 10 cm^2 area**
  - **300um thickness**
  - **double-sided strips**

- **Arranged in 2 layers**

- **Challenge**
  - **Detector + electronics close to e beam**
  - **Inside vacuum**

Cooling Pipes
Heatsink
Ceramic Frame
Silicon Sensor
Support Structure
Two Layers of SSD modules
Target Cell

Scintillating Fibre Detector

- **Purpose**
  - **Momentum and track reconstruction**
  - **Particle Identification**
  - **Range:** p_p = 250-1200 MeV/c

- **2 barrels with each:**
  - **2 layers parallel with respect to the beam**
  - **2 layers 10° stereo angle**
  - **6910 fibres**

- **Readout:**
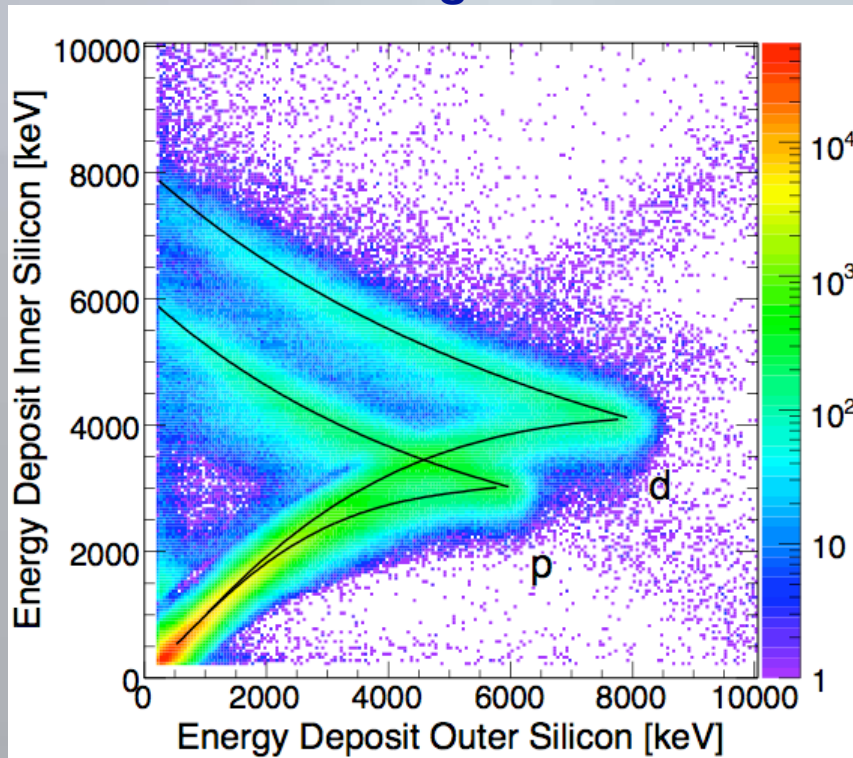 - **64 channels PMT (Hamamatsu)**
  - **totally 5120 channels**
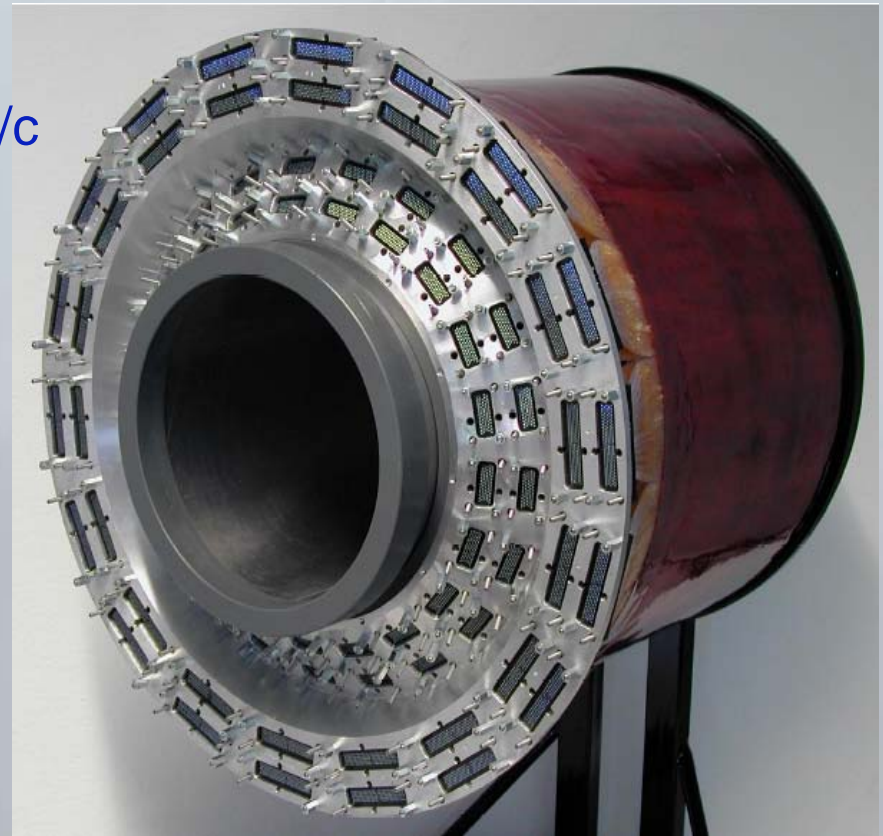
Photon Detector

- **Purposes**
  - **Photon detection from $\pi°$ decays ($\Delta^+ \rightarrow p\,\pi° \rightarrow p\,\gamma\gamma$)**
  - **Particle Identification**
  - **Background reduction**
- **3 layers of tungsten and scintillator**
  - **1st layer parallel to beam**
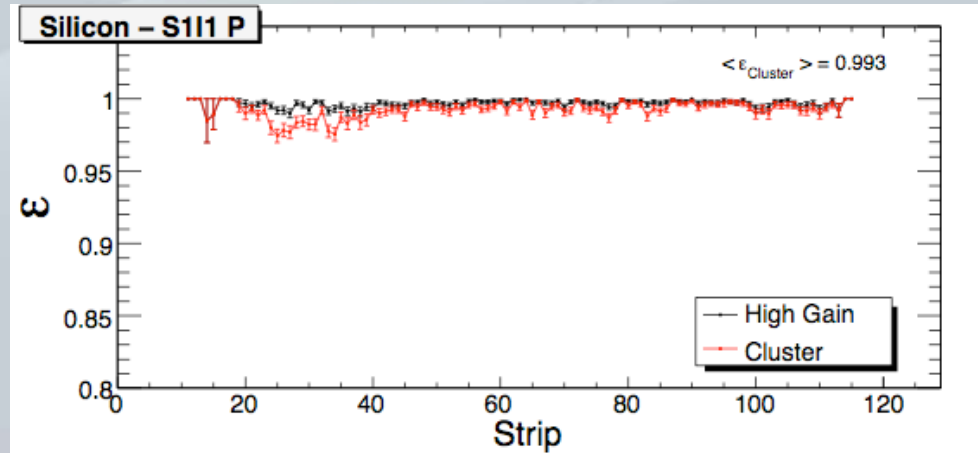 - **2nd layer +45° resp. to beam**
  - **3rd layer -45° resp. to beam**
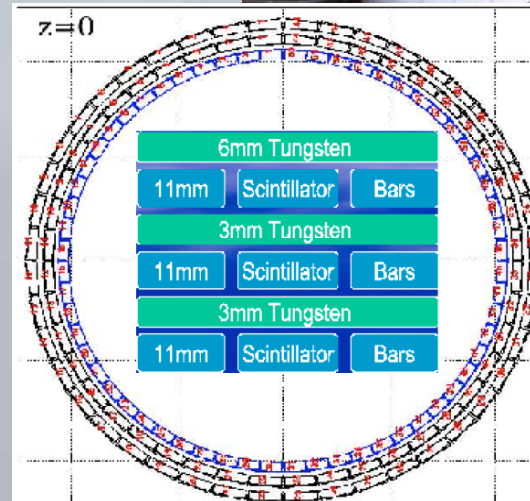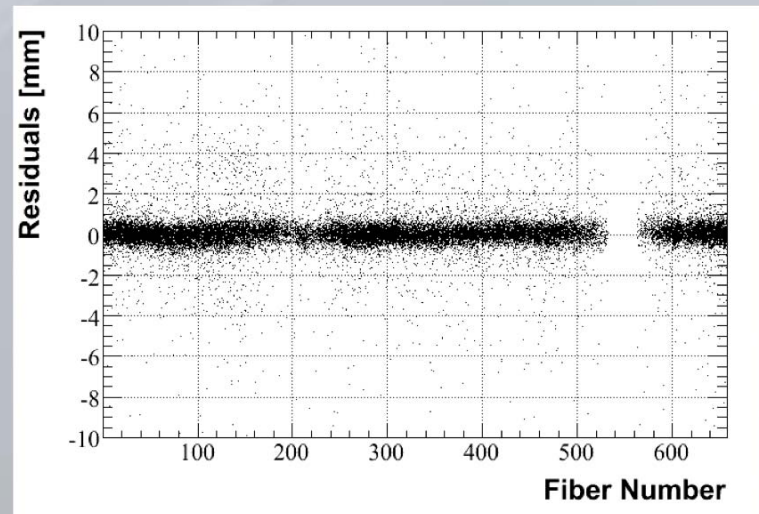
Performance

- ## Examples

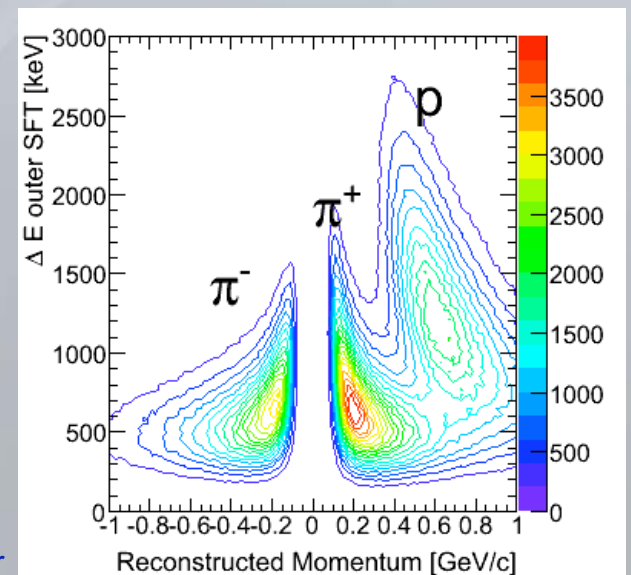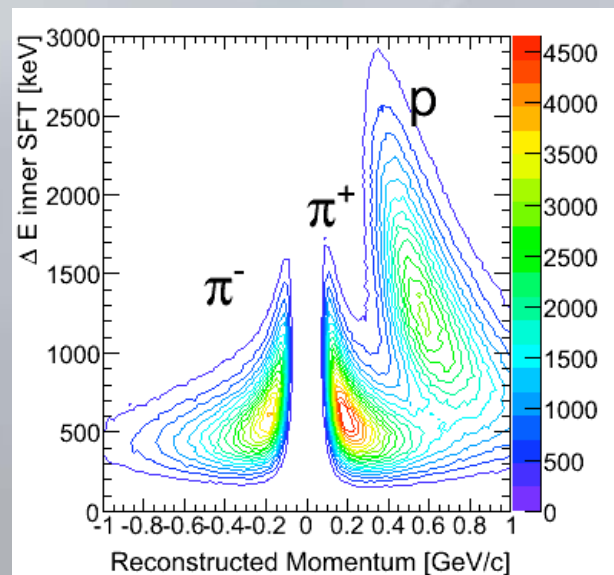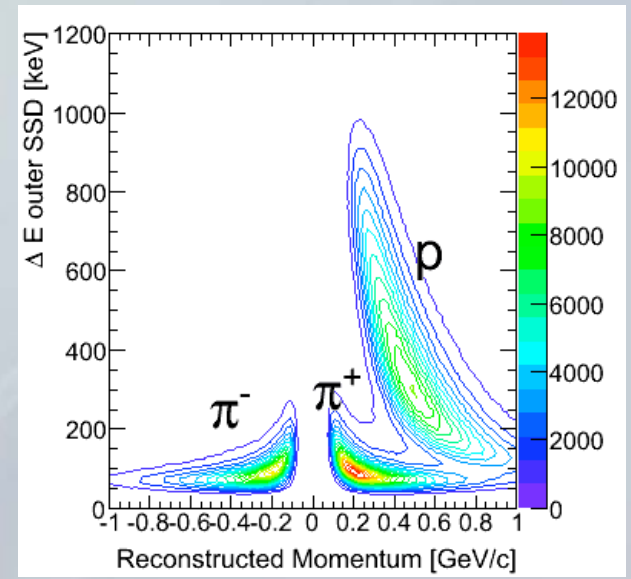### Energy deposit in silicon detectors on a deuterium target
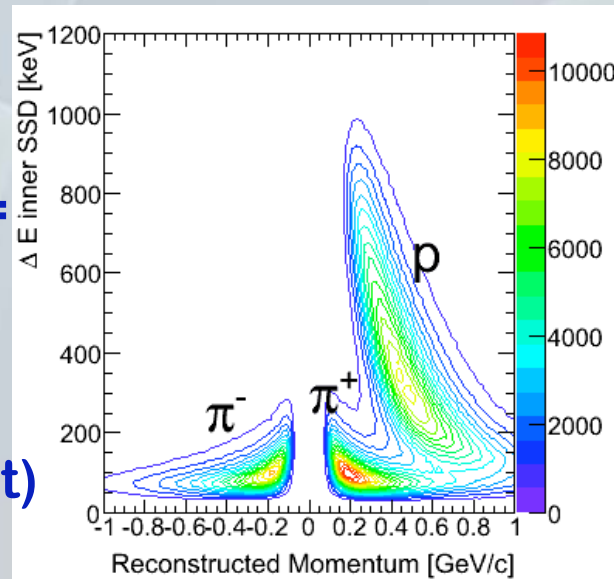

Efficiency for protons (e.g. 1 side, sensor)

Residuals show precise alignment
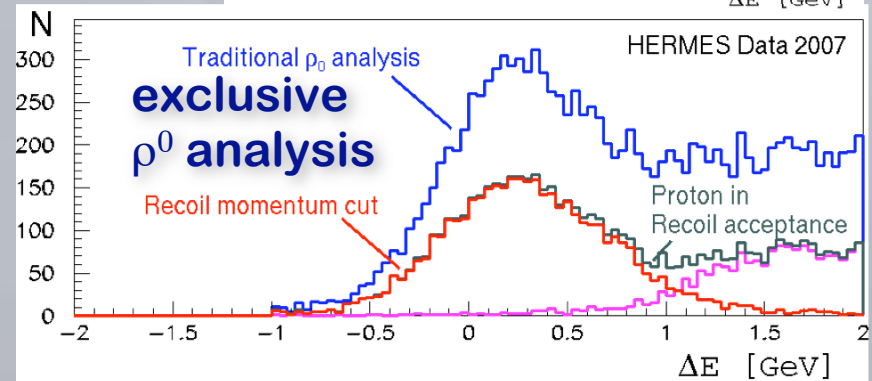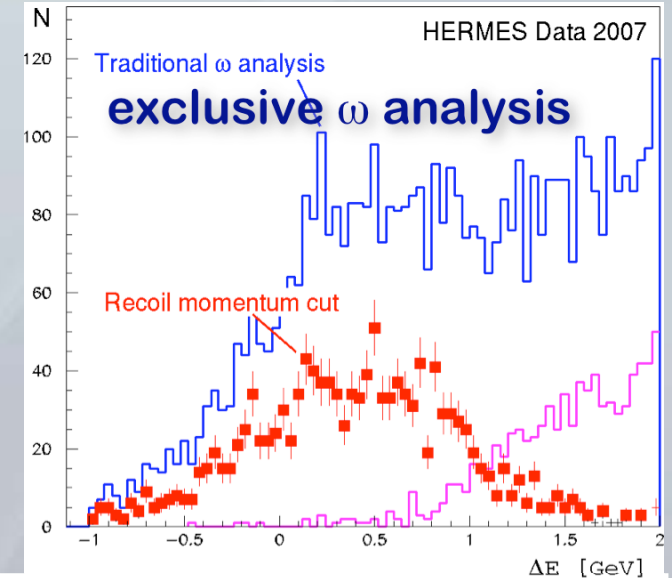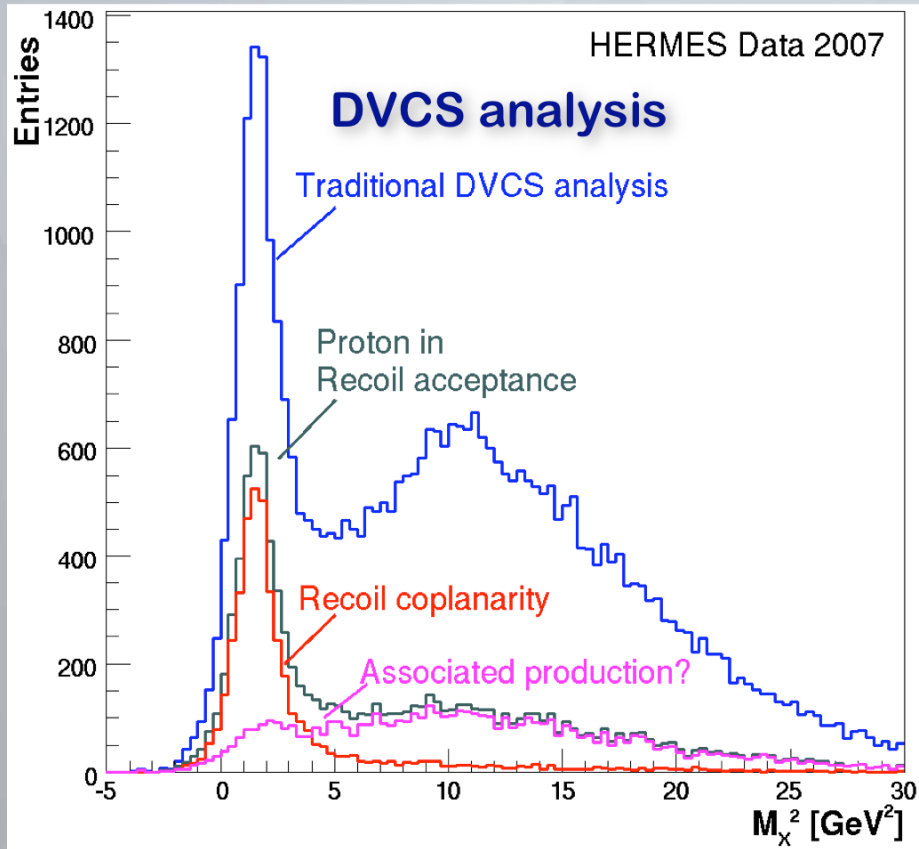
Performance

- **Particle identification**
  - **momentum = curvature**
  - **ΔE in each layer (independent)**

Event Selection

- **First comparison**
  - **Traditional criteria adding Recoil information**

Summary

- **About 40M DIS events on hydrogen collected in 2006/2007**
    - **More than in 10 years before (without Recoil)**
- **Detector status**
    - **Alignment and calibration finished**
    - **Detailed response studies ongoing**
    - **First physics analysis starting**
        - **Preliminary results promising**
        - **See HERMES talks on Thursday: HK 70**
- **Results expected soon**