

# Report on HERMES running with the new Recoil Detector

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on behalf of the HERMES collaboration



DIS08, London

# Deeply Virtual Compton Scattering (DVCS) to probe the nucleon's spin

$$\frac{1}{2} = \frac{1}{2} \Delta\Sigma + \mathbf{L}^Q + J^G$$

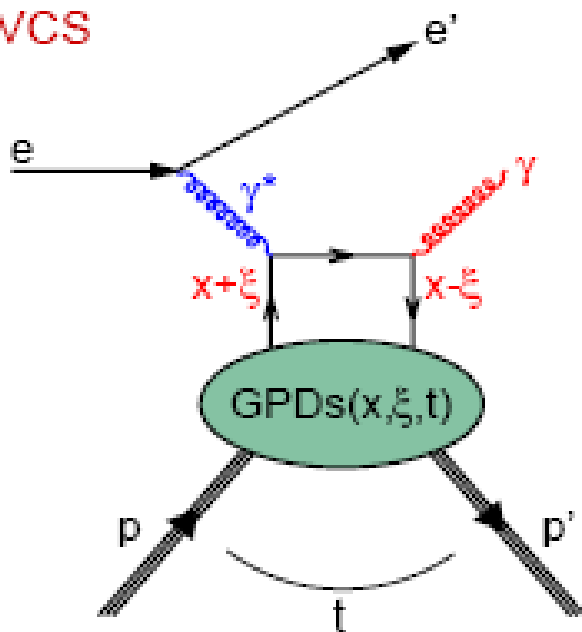
Measured in DIS ~1/3

Ji's relation -Ji, PRL 78 (1997) 610

$$J^q = \lim_{r \rightarrow 0} \int_{-1}^1 dx x \underbrace{[H^q(x, \xi, t) + E^q(x, \xi, t)]}_{\text{GPDs}(x, \xi, t)}$$

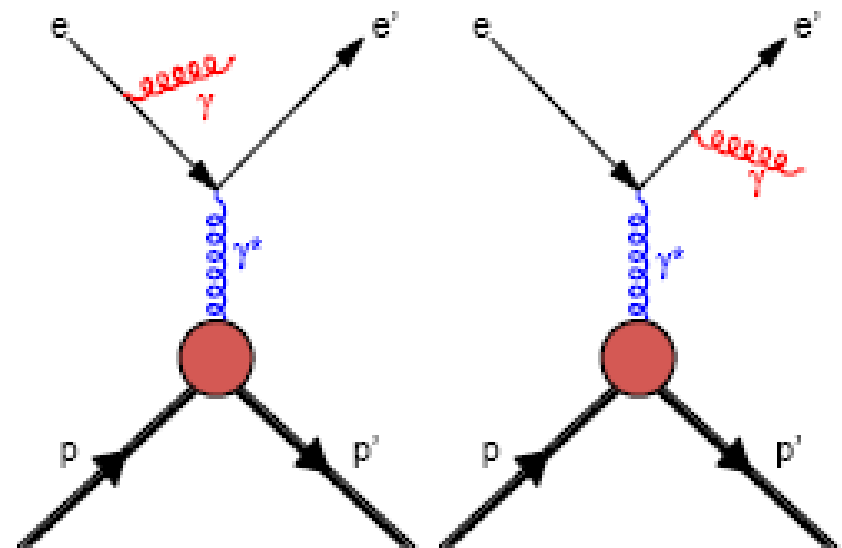
Cleanest way to access GPDs:

DVCS

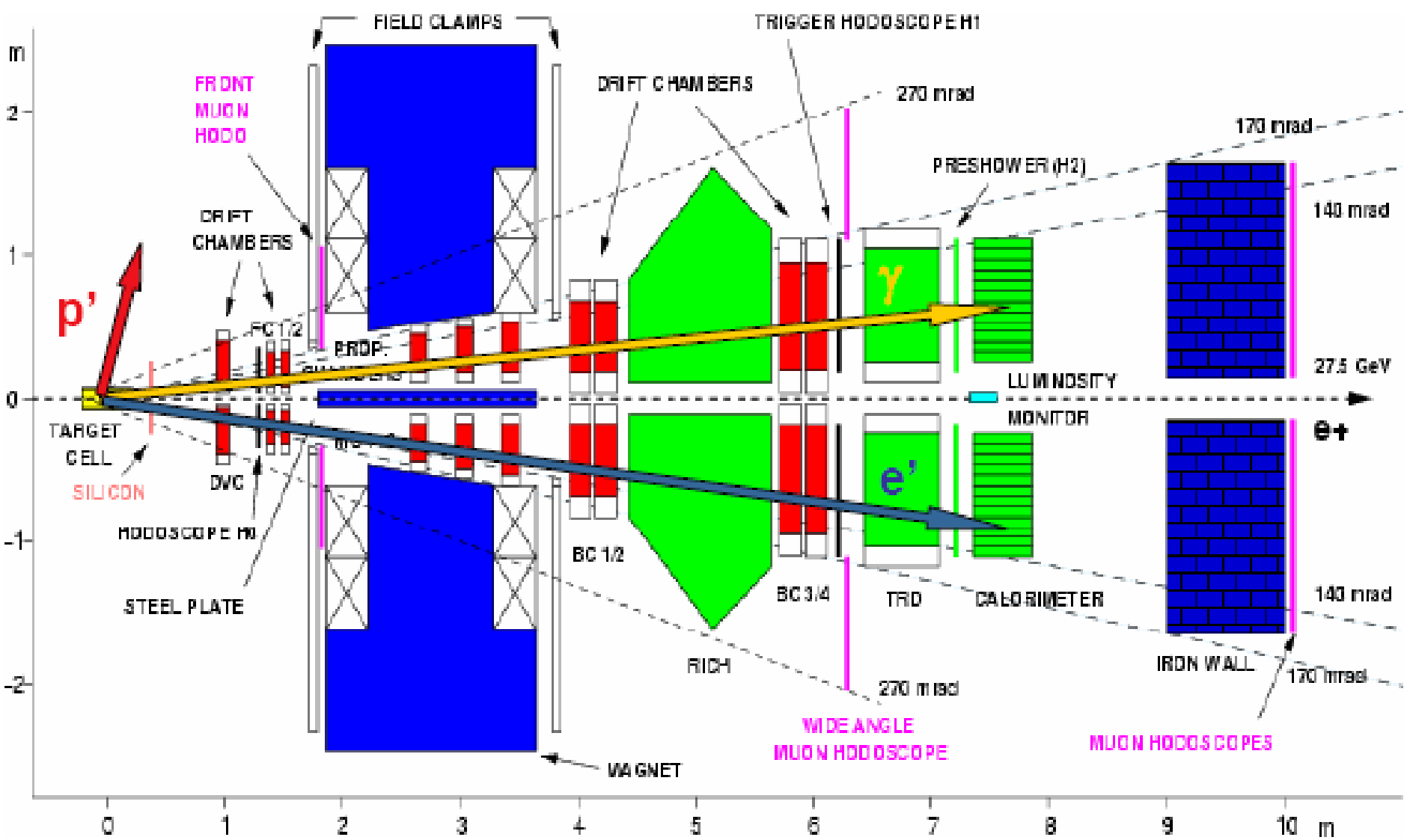


interferes with

Bethe-Heitler



# DVCS kinematics at HERMES



# DVCS reconstruction at HERMES

Reconstruction of **proton** via **missing mass**

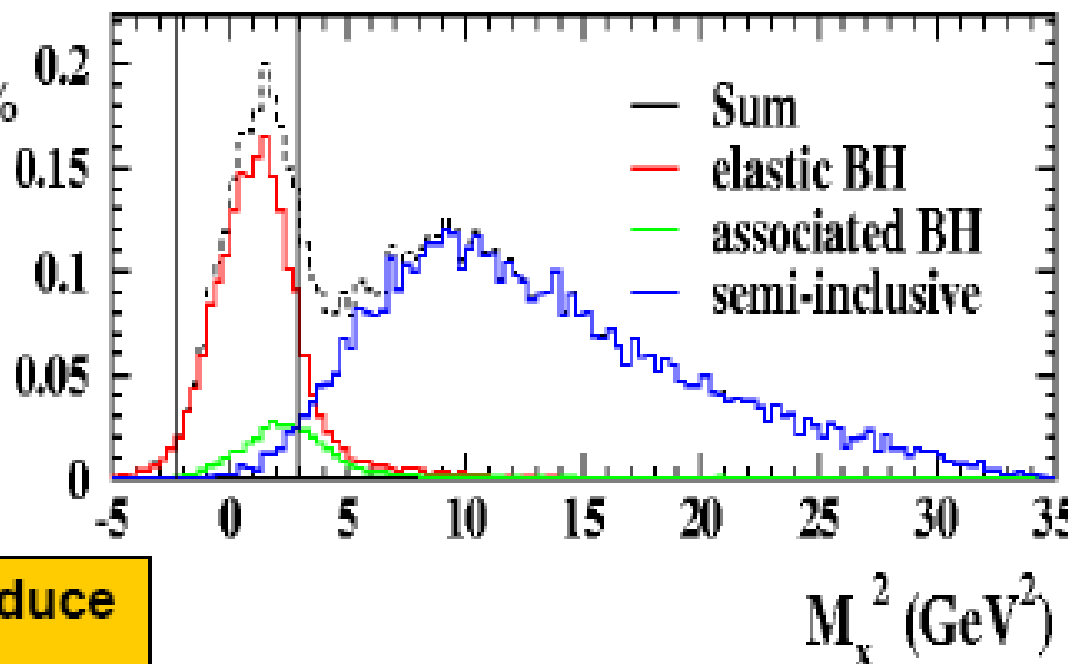
but

## Background contributions

- Associated Bethe-Heitler  $\sim 11\%$

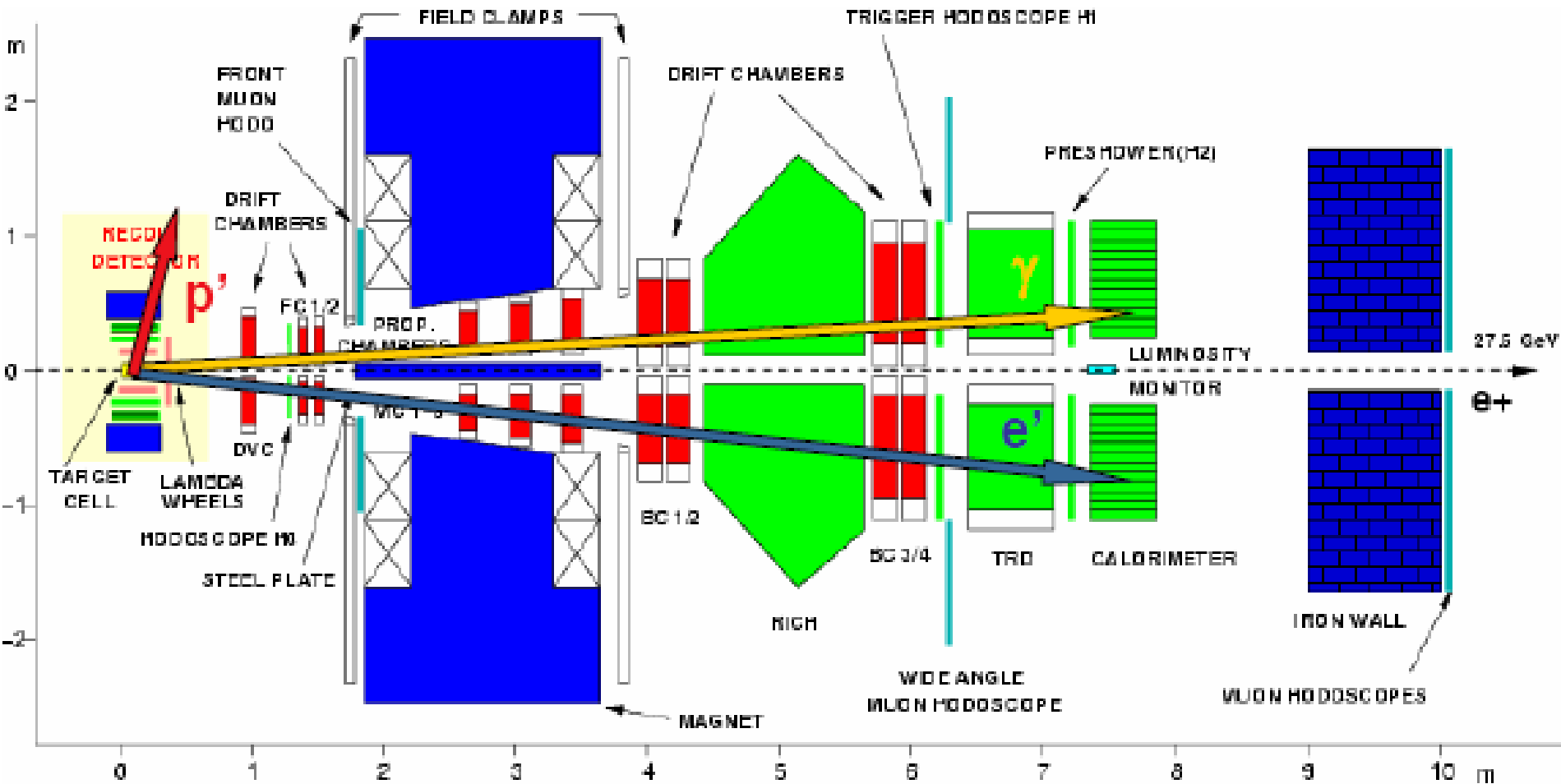


- Semi-inclusive  $\sim 5\%$

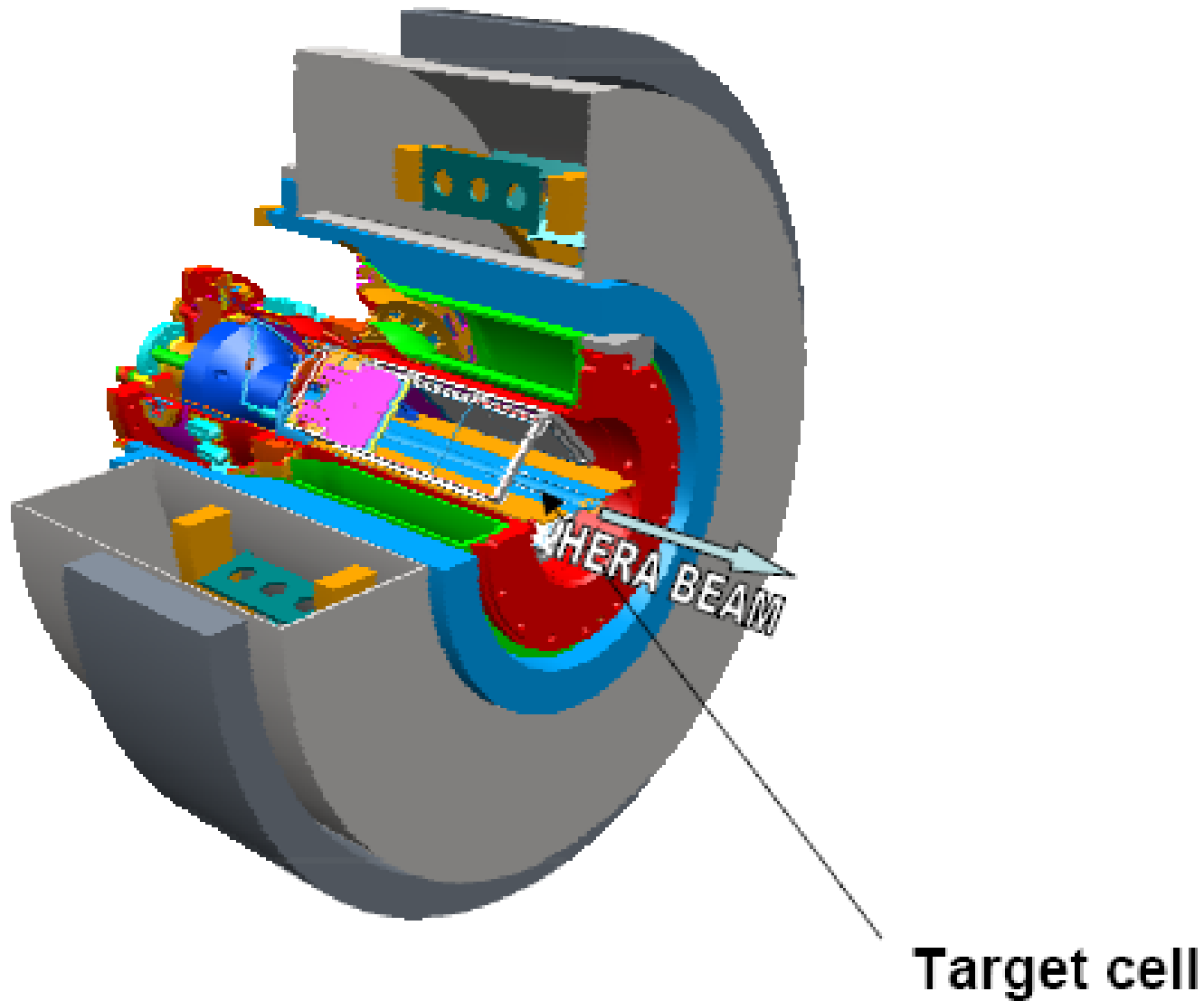


Improve exclusivity and reduce background by detecting  
recoil proton  
photons and pions

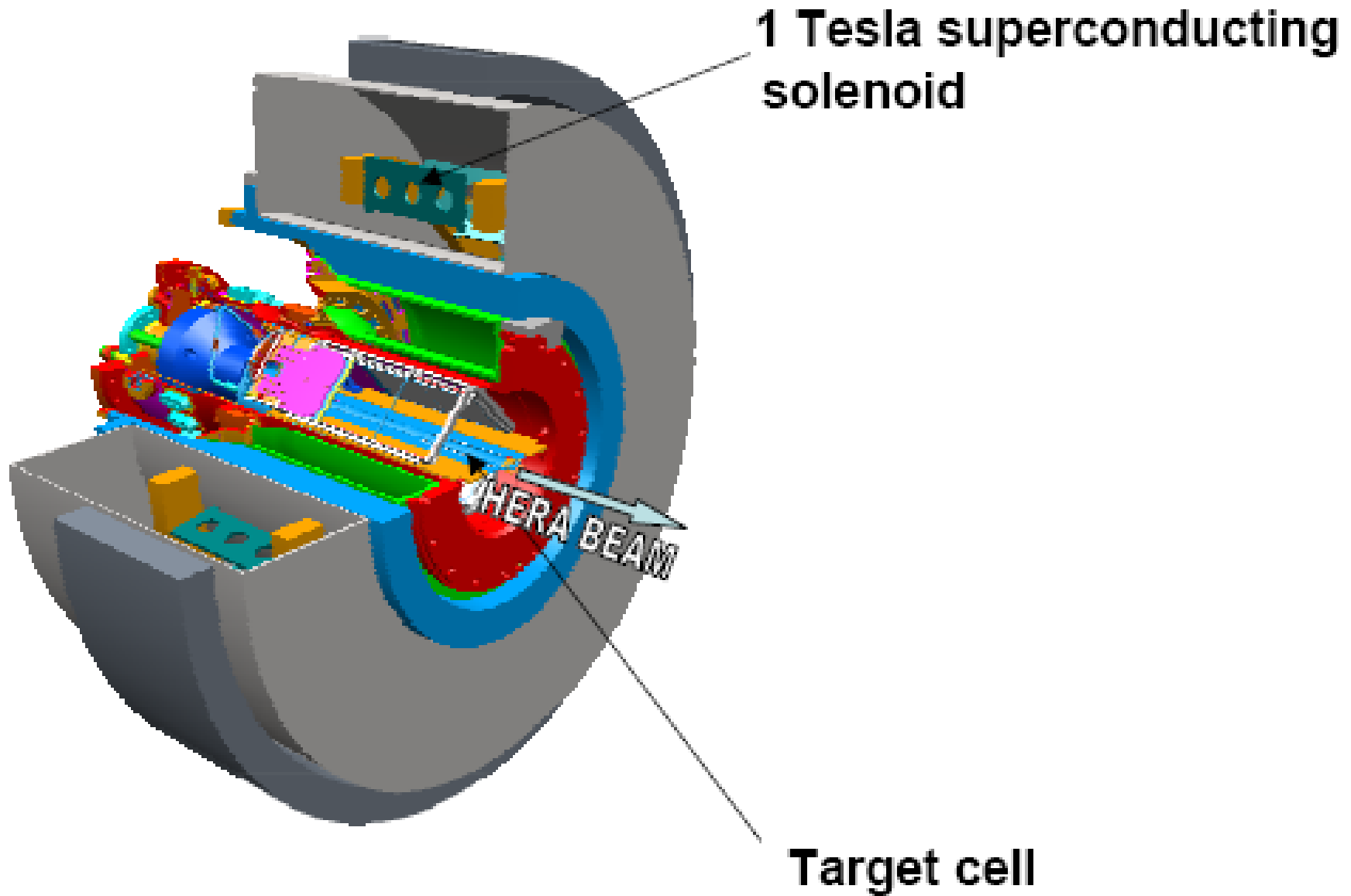
# Installation of the Recoil Detector 2005-2006



# Recoil Detector



# Recoil Detector

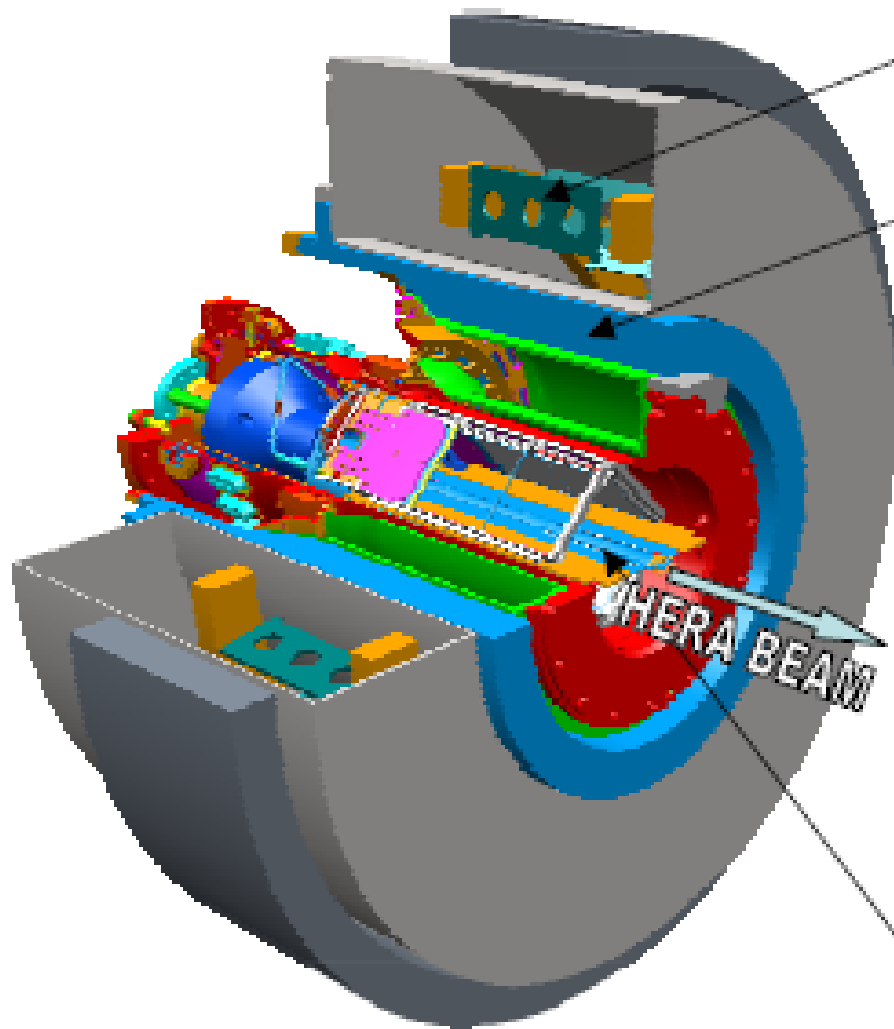


# Recoil Detector

1 Tesla superconducting solenoid

Photon Detector

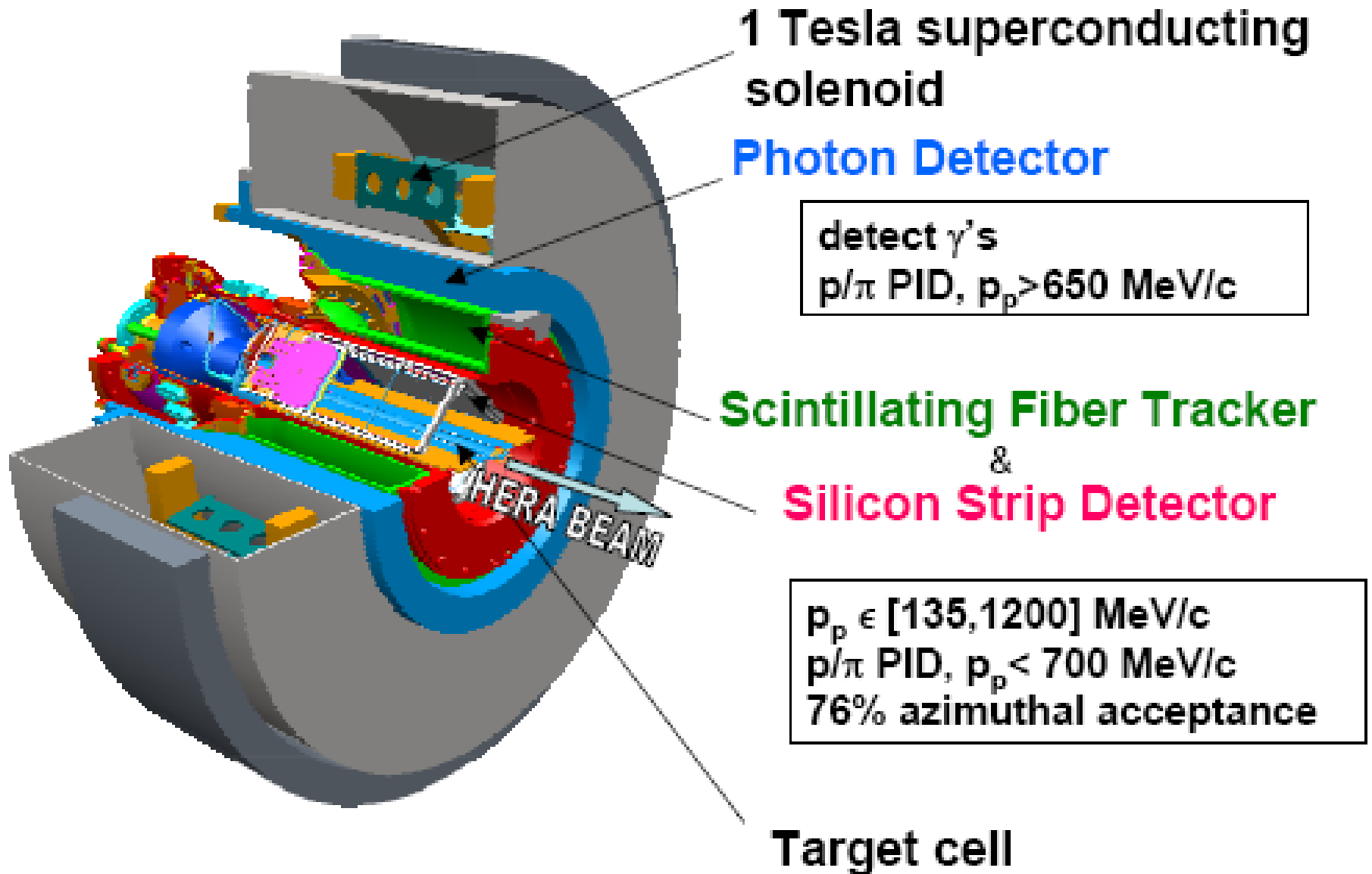
detect  $\gamma$ 's  
p/ $\pi$  PID,  $p_p > 650$  MeV/c



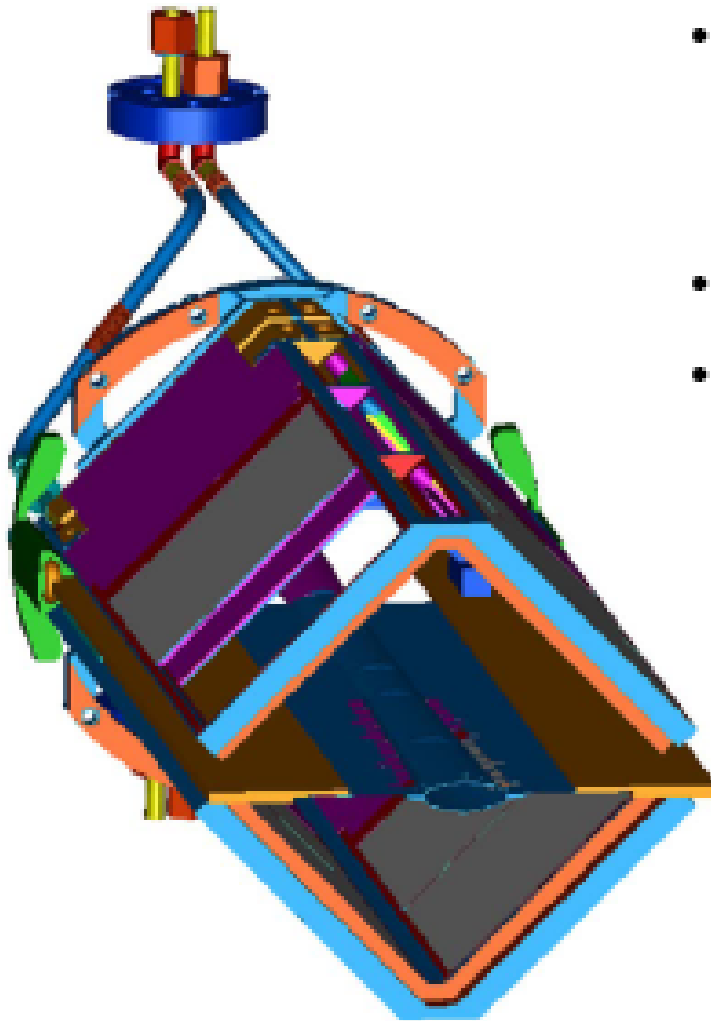
Target cell



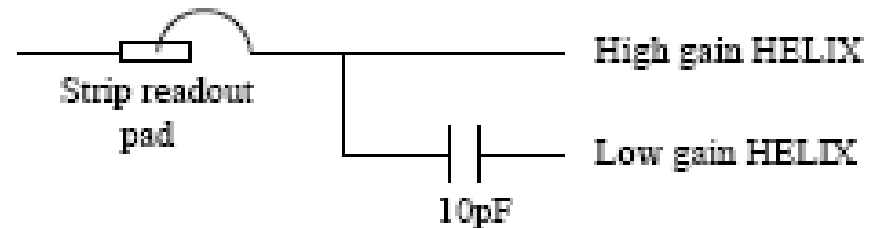
# Recoil Detector



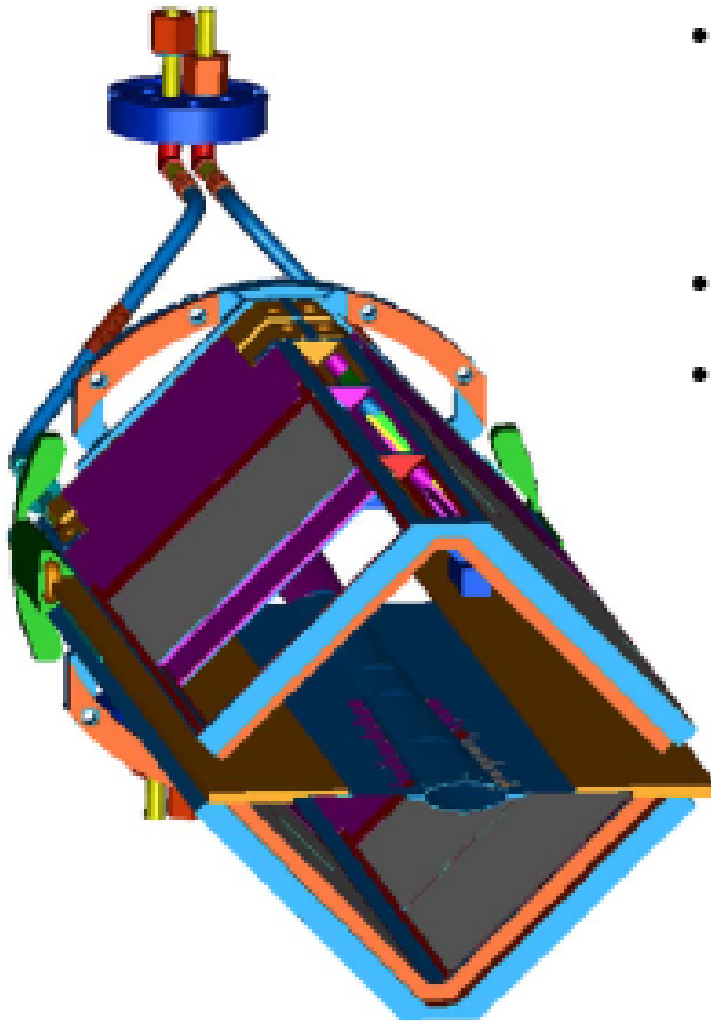
# Silicon Strip Detector (SSD)



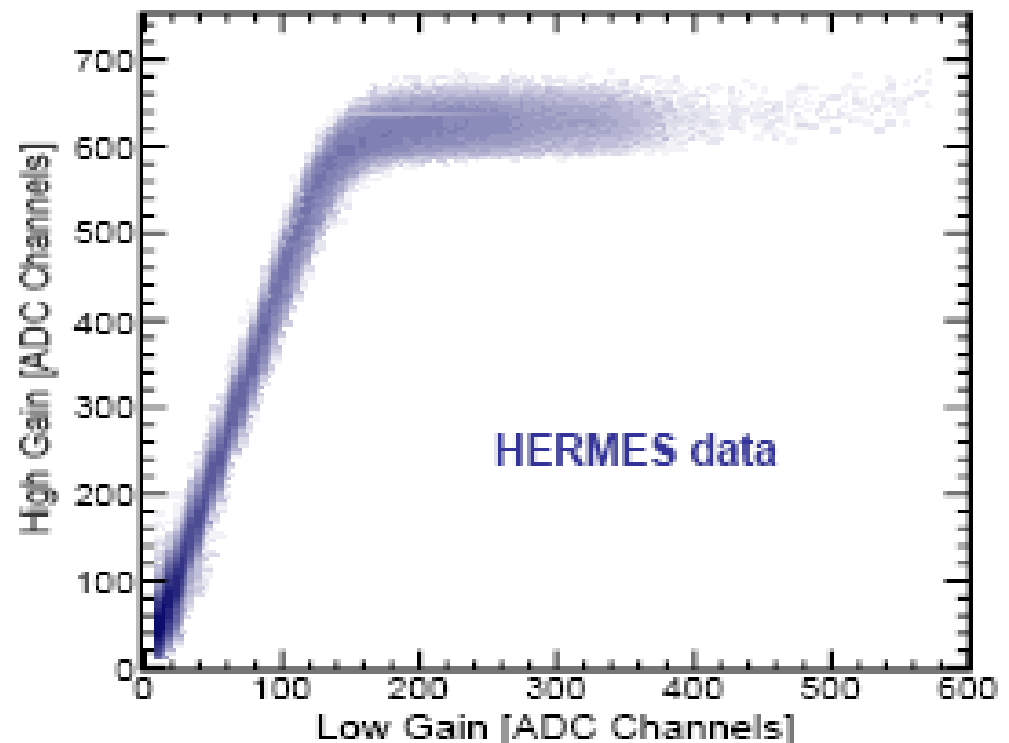
- 2 layers of double sided silicon micro-strip sensors in beam vacuum
- strips:  $\perp$ , pitch=758  $\mu\text{m}$ , 300 $\mu\text{m}$  thick
- read out by HELIX chips:  
high and low gain  $\rightarrow$  70 MIPs



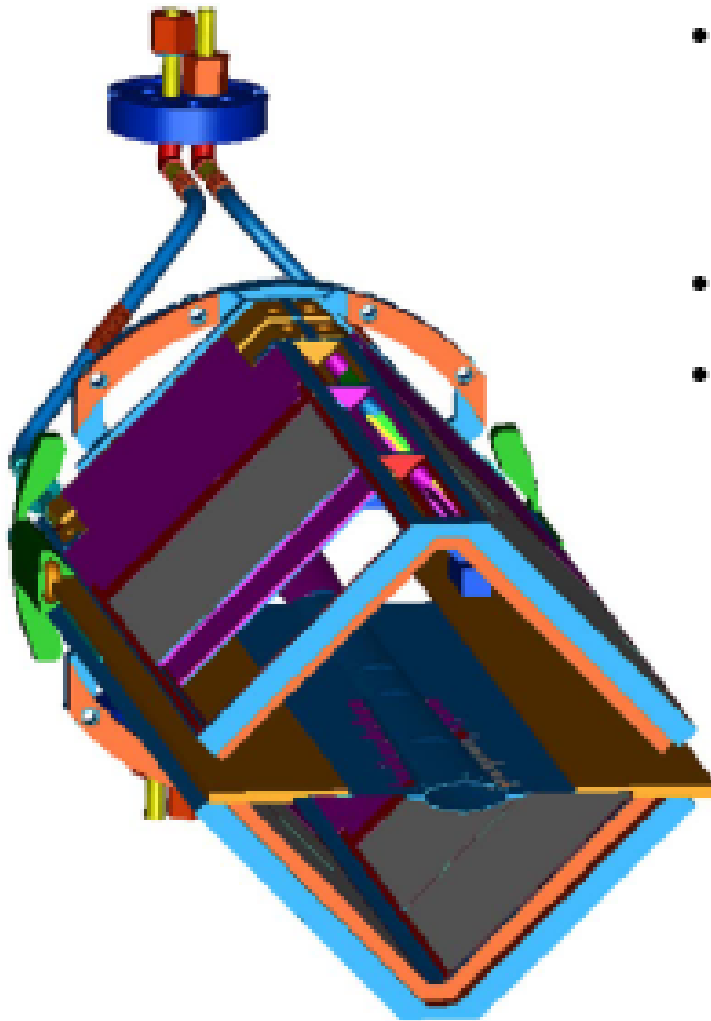
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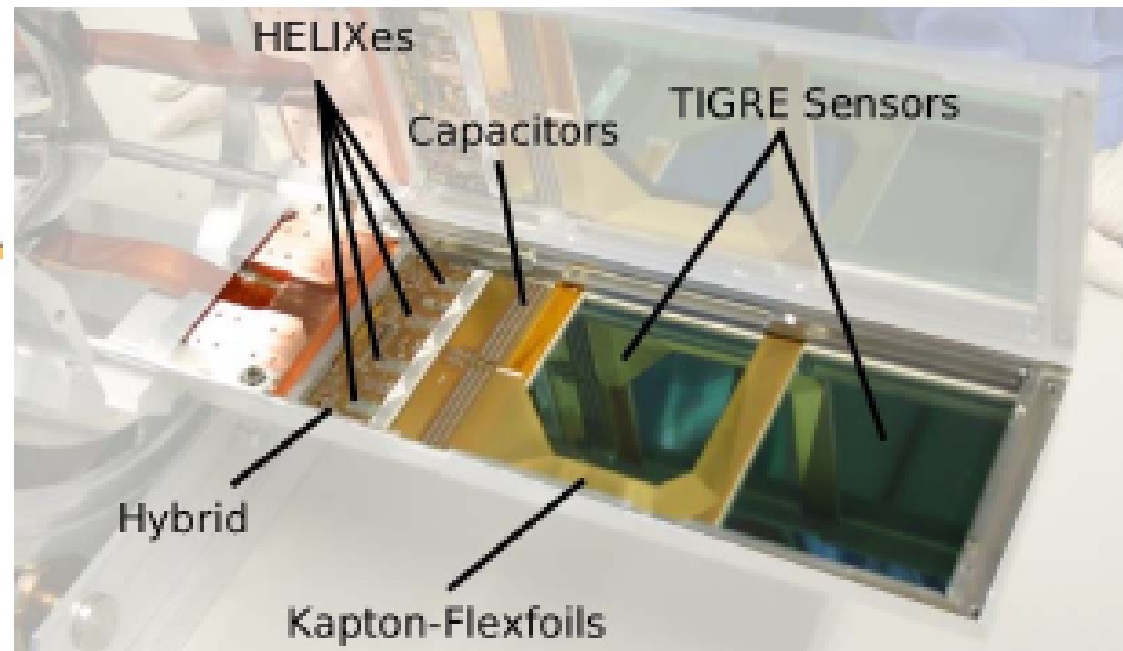
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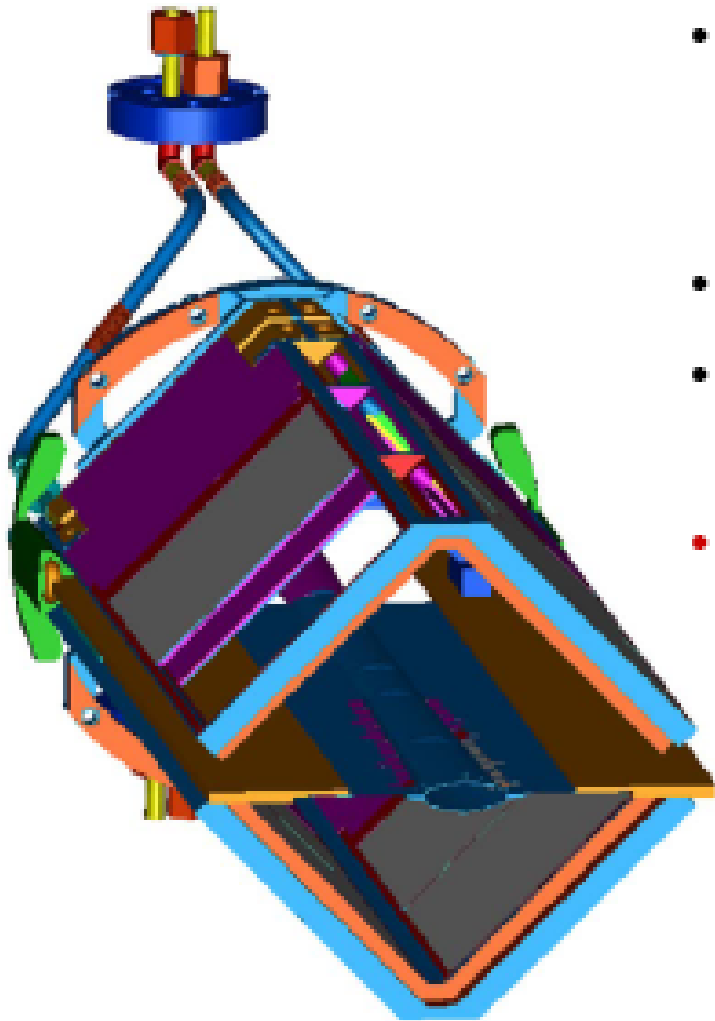
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# Silicon Strip Detector (SSD)

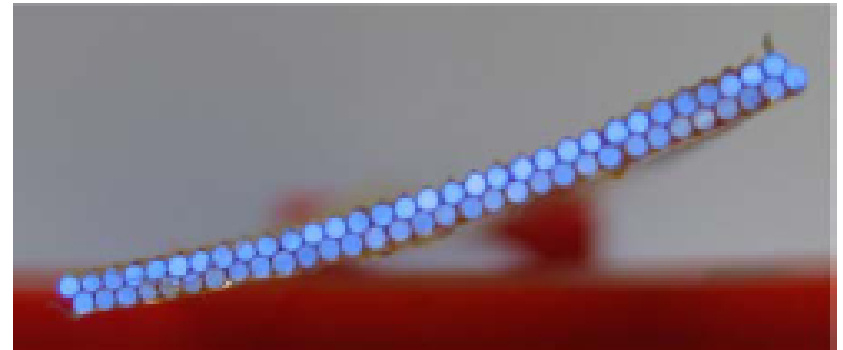


- 2 layers of double sided silicon micro-strip sensors in beam vacuum
- strips:  $\perp$ , pitch=758  $\mu\text{m}$ , 300 $\mu\text{m}$  thick
- read out by HELIX chips: high and low gain  $\rightarrow$  70 MIPs
- $p_p$ : 135-450 MeV/c

# Scintillating Fiber Tracker (SFT)



- 2 cylinders:
  - 2 parallel layers
  - 2 10° stereo layers
- fibers: 1mm diameter



- read out by multi-anode PMTs
- $p_p$ : 250 – 1200 MeV/c from bending in magnetic field

# Photon Detector (PD)



- 3 layers of tungsten-scintillator:
  - A-layer || beam axis
  - B/C: under  $+45^\circ / -45^\circ$  angle

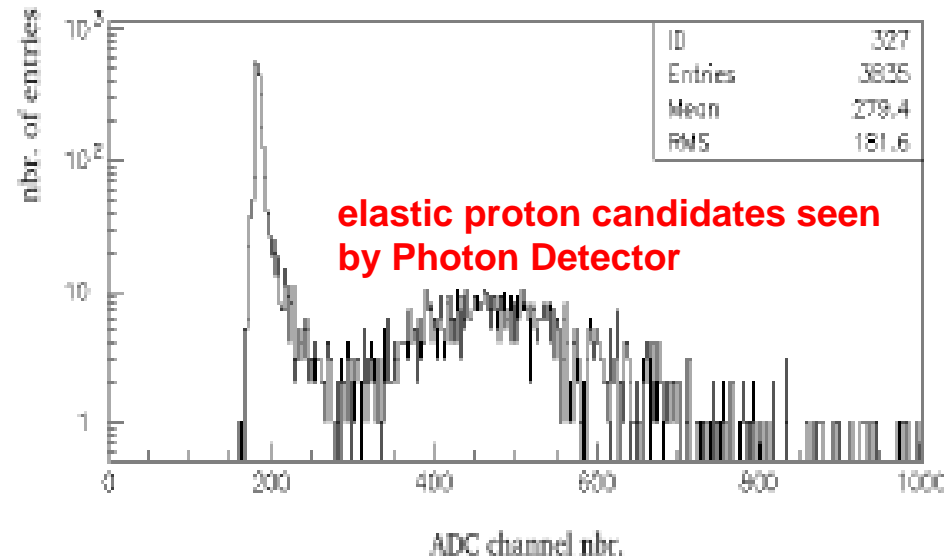
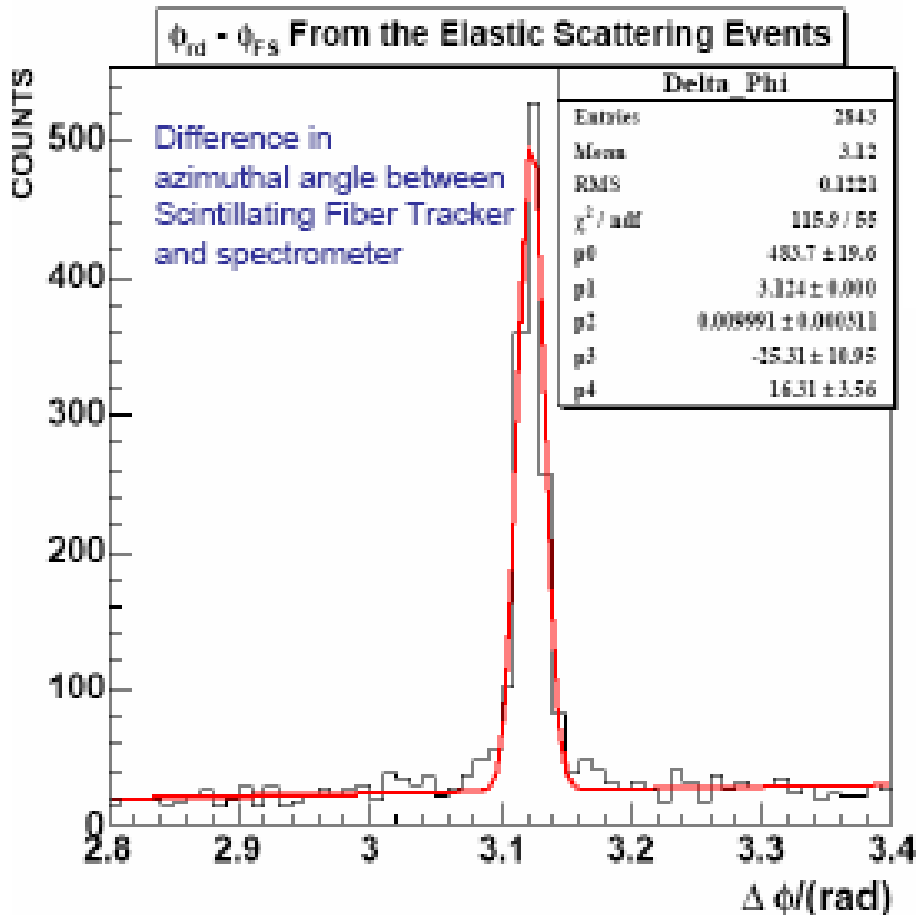


1 r.l. = 3.5 cm

- strips:  $2 \times 1 \times 28 \text{ cm}^3$
- read out by multi-anode PMTs
- detect 1  $\gamma$  from  $\pi^0$  decay
- if 2  $\gamma$ 's detected, reconstruct  $\pi^0$

# First Results

First reconstructed physics channel seen by Recoil Detector: protons from elastic scattering

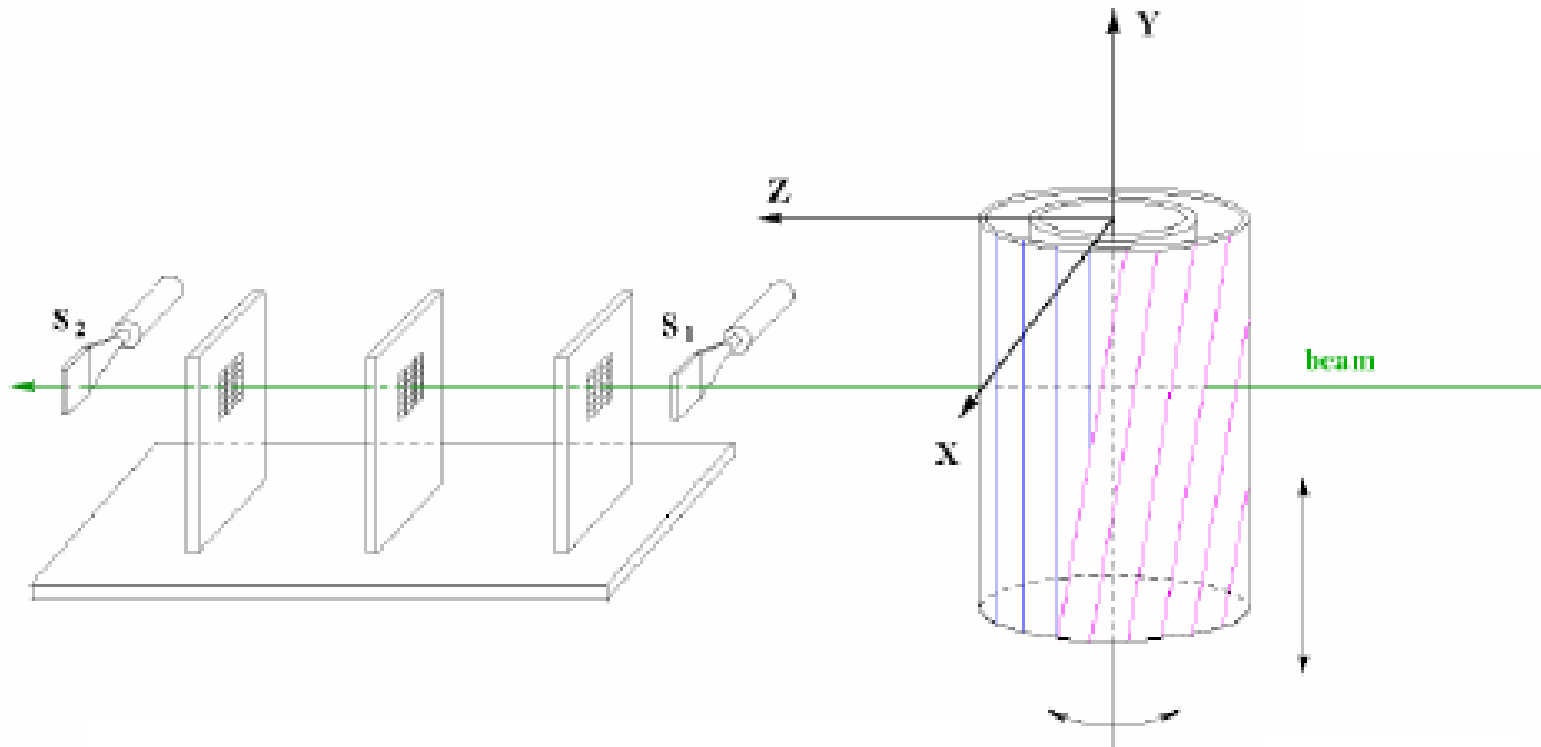


The elastic protons will be used to align the Recoil Detector with the spectrometer



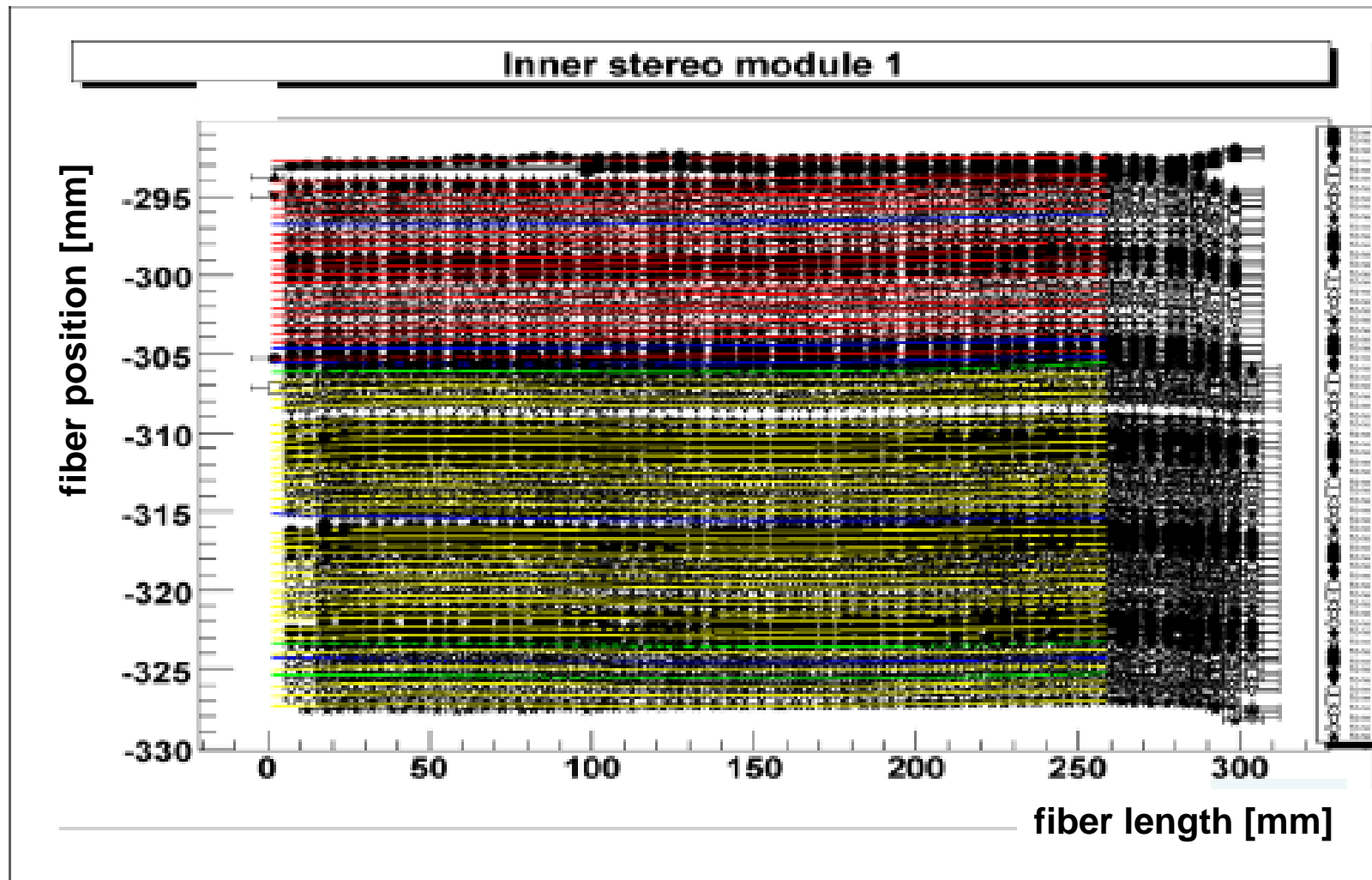
# Internal alignment of Recoil Detector

- Internal alignment of the SFT in DESY 22 test beam



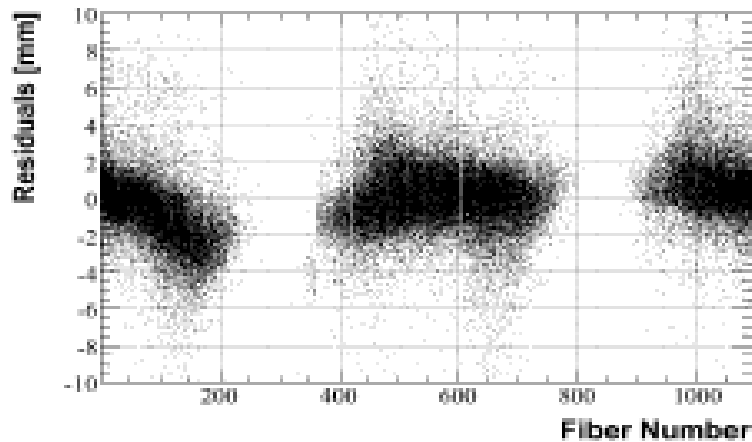
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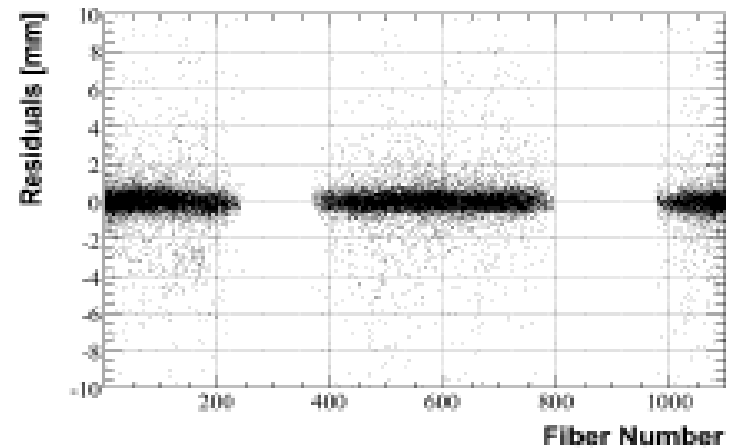


# Internal alignment of Recoil Detector

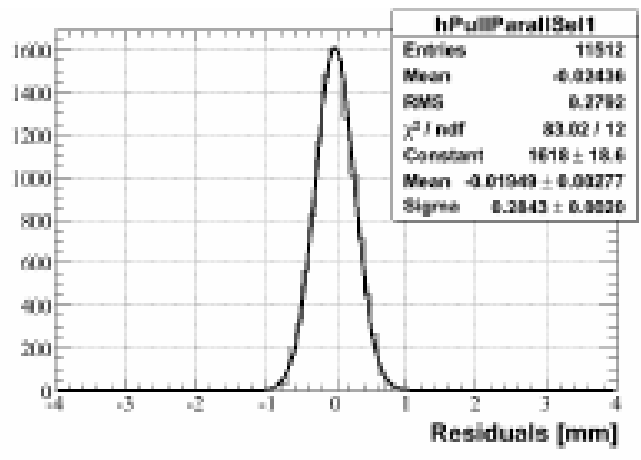
- Test of internal alignment of the SFT using cosmic signals



Without internal alignment



With internal alignment

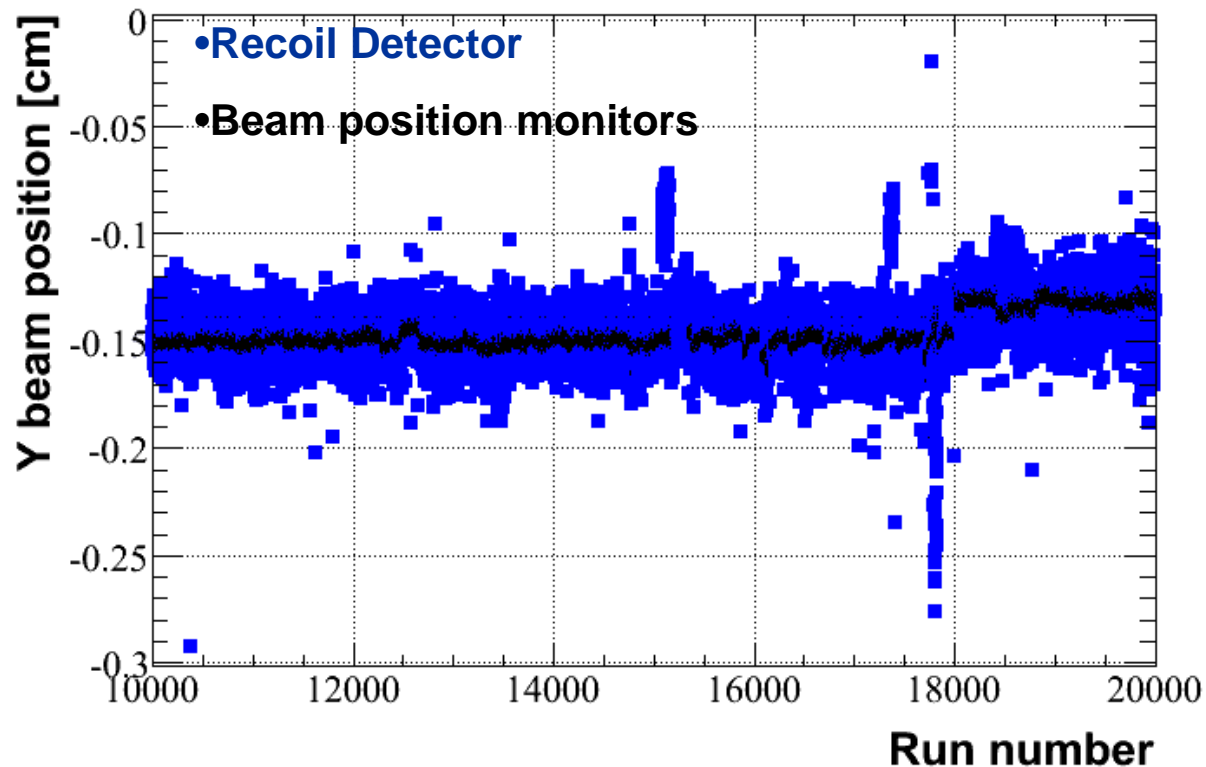


Residuals from data : 280  $\mu\text{m}$

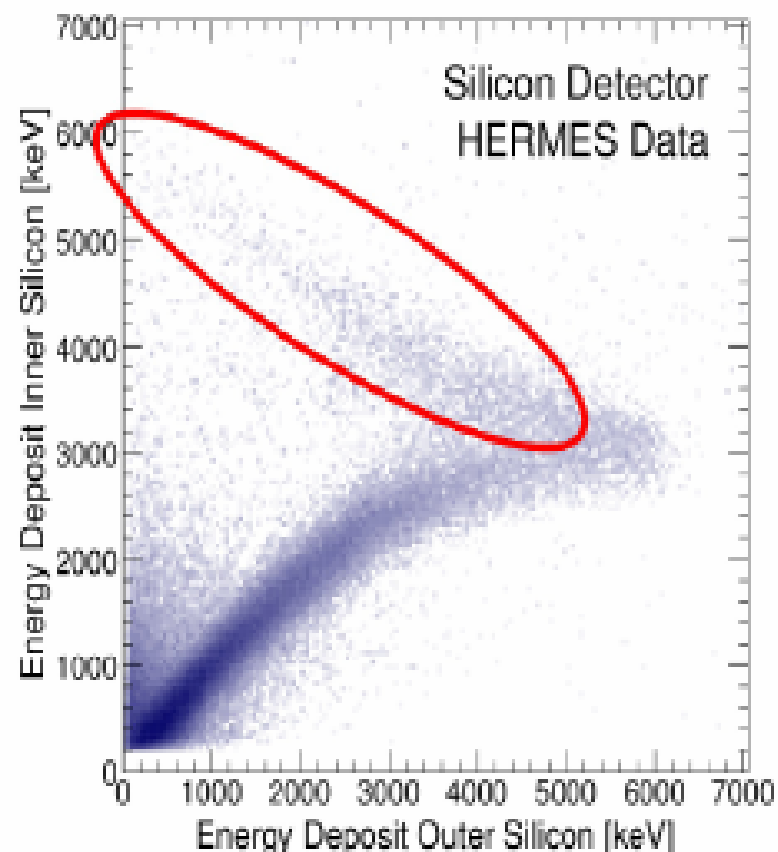
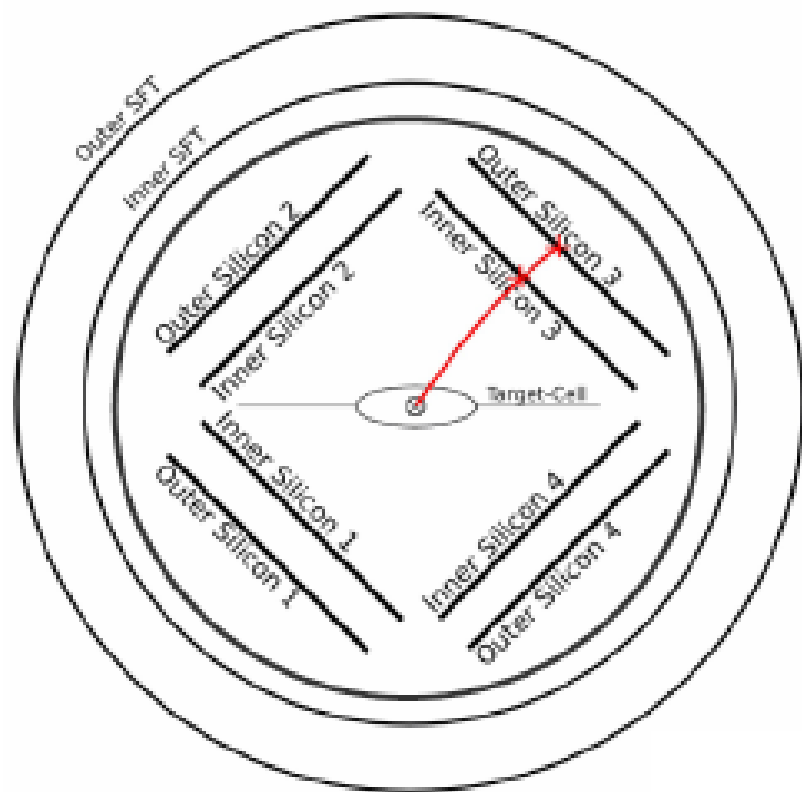
Residuals from perfectly aligned MC : 220  $\mu\text{m}$

# Internal alignment of Recoil Detector

- PD and SSD aligned with respect to SFT with straight tracks
- SSD residuals 0.26 strip
- Beam position from Beam Position Monitors installed at HERMES and as **reconstructed by Recoil Detector**



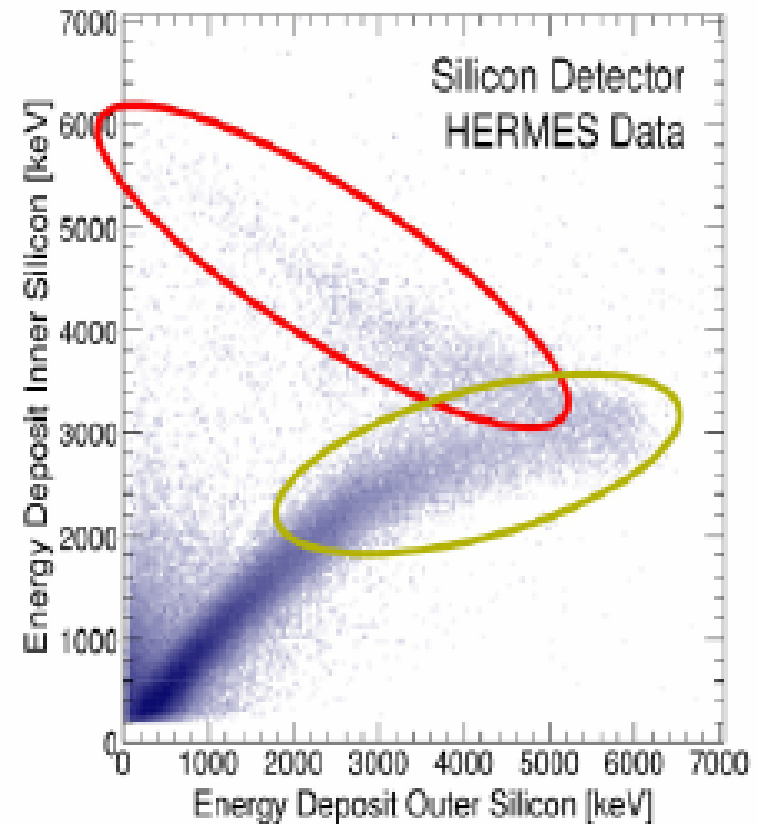
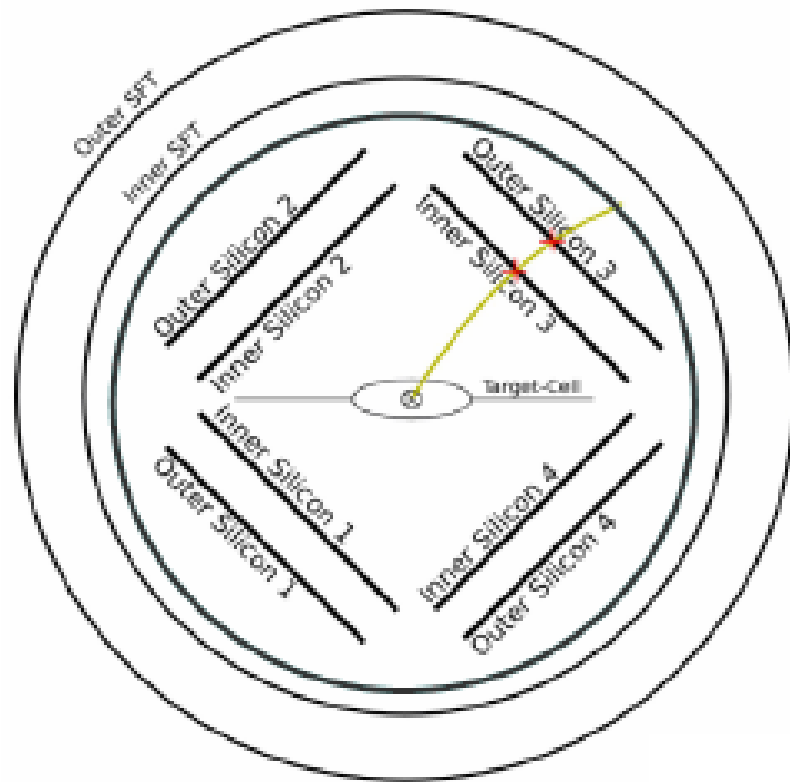
# Momentum reconstruction



low momentum protons

Momentum reconstruction via sum of total E deposition

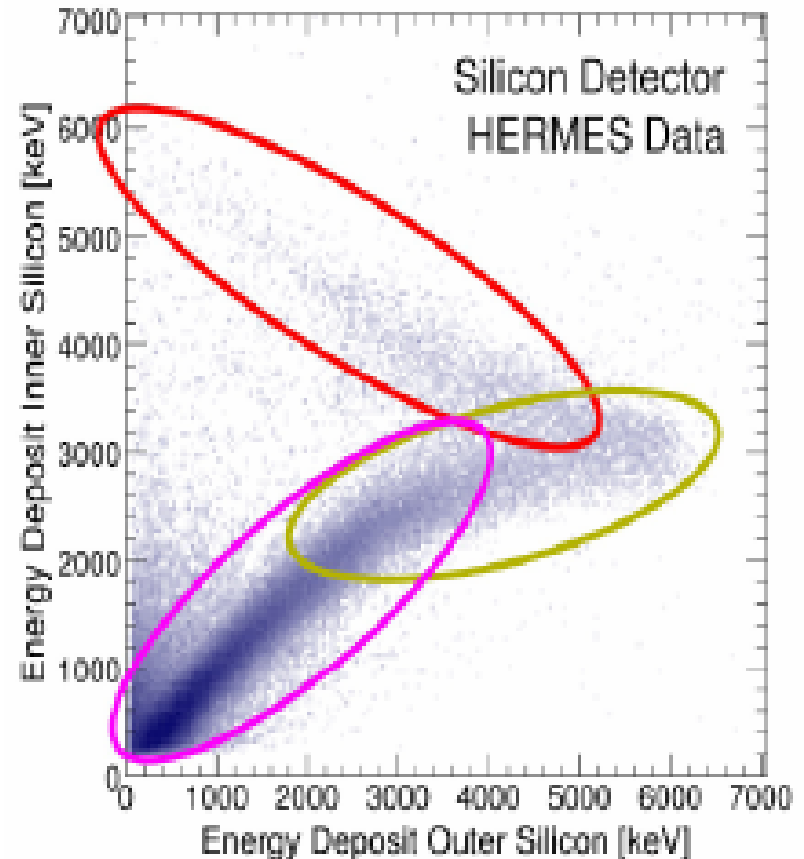
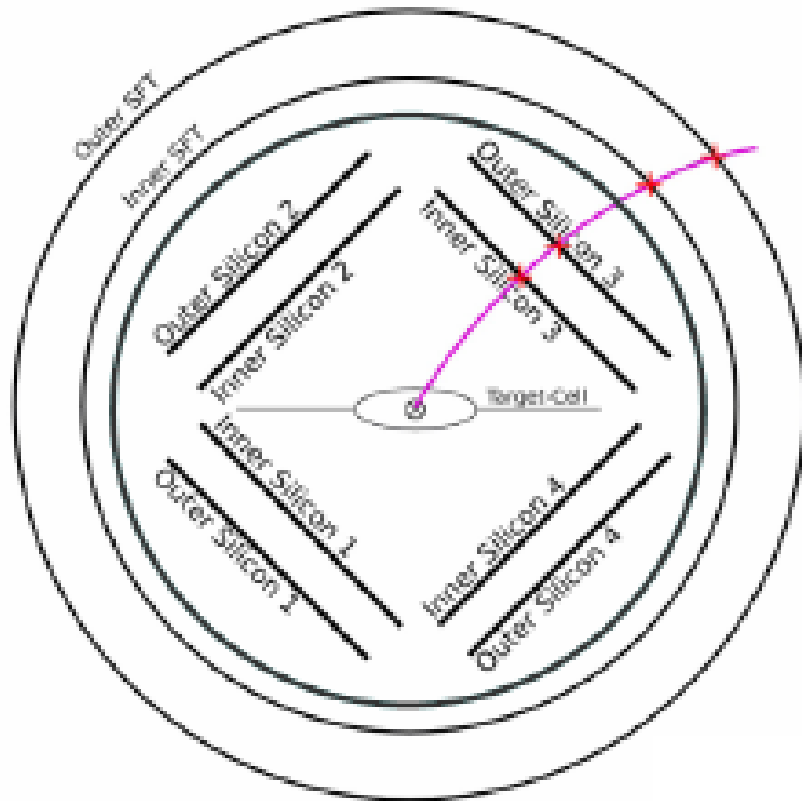
# Momentum reconstruction



higher momentum protons

Momentum reconstruction via  $dE/dx$  Bethe-Bloch

# Momentum reconstruction

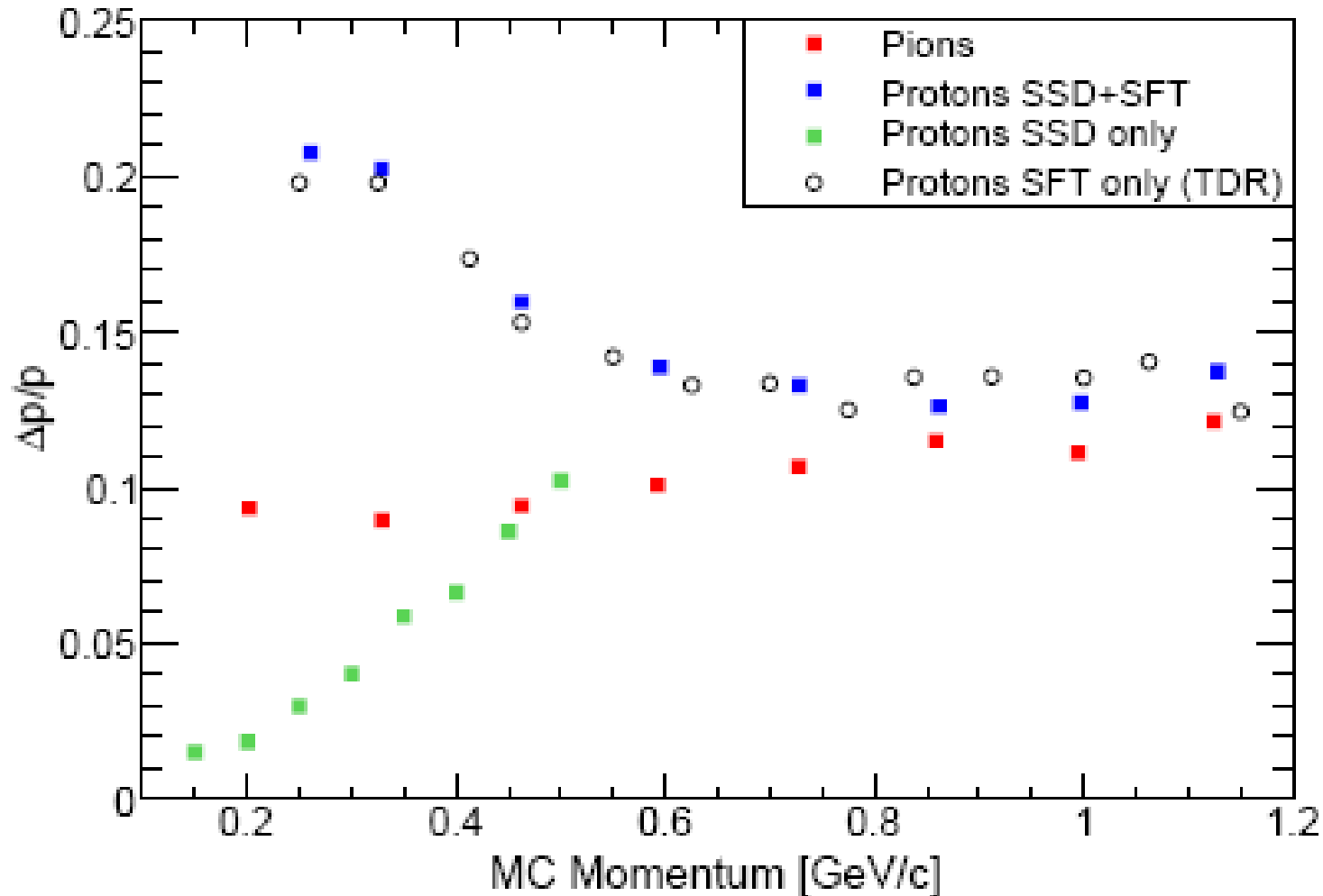


"High" momentum particles

Momentum reconstruction via bending in magnetic field

# Momentum reconstruction

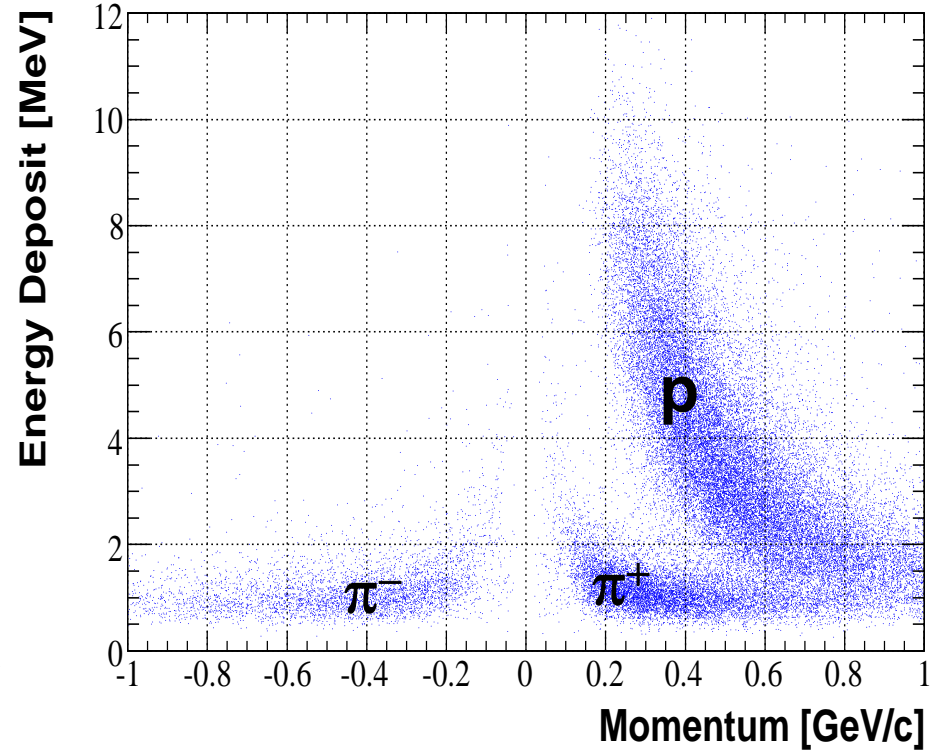
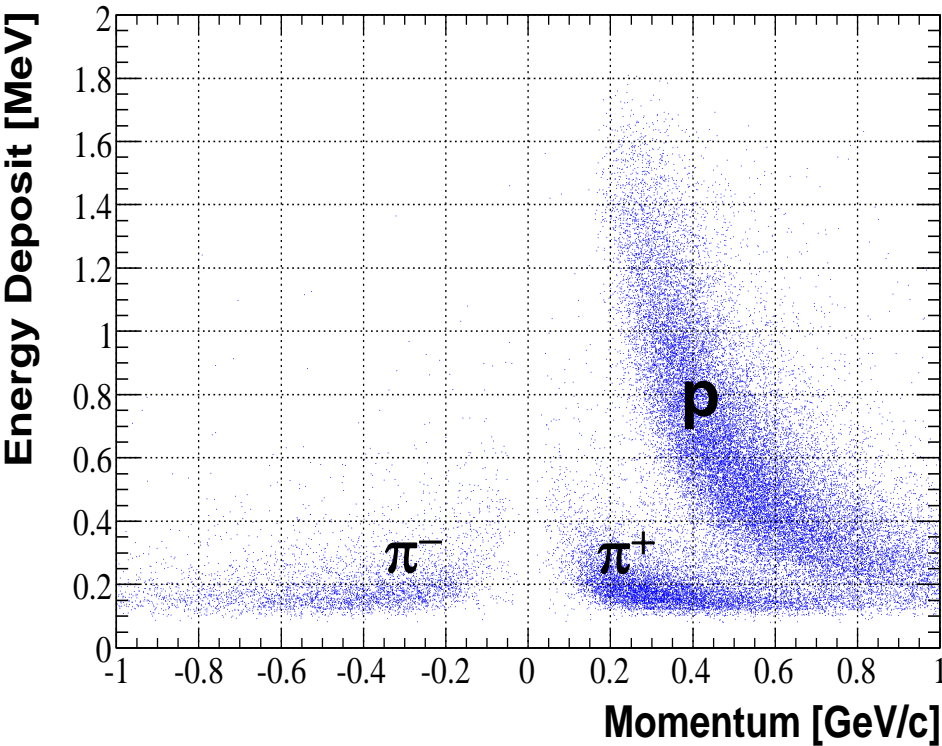
## Resolution of the momentum reconstruction





# Particle identification

After internal alignment & preliminary calibration,  
the energy deposition versus momentum allows for proton/pion separation



# Performance of the Recoil Detector

- First data taking February 2006 with  $e^-$  beam  
Scintillating Fiber Tracker fully operational
- Switch to  $e^+$  beam in July 2006  
September: all detectors fully operational
- Last data taking 30th June 2007 HERMES
- Amount of collected data

## $e^-$ beam (SFT only)

Hydrogen: 3 M DIS

Deuterium: 0.8 M DIS

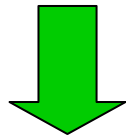
## $e^+$ beam (all detectors)

Hydrogen: 28 M DIS

Deuterium: 7 M DIS

# Summary and outlook

- Collected large amount of data with Recoil Detector
- alignment
- improved tracking
- preliminary calibration
- noise studies



- DVCS background suppression:
- Associated Bethe-Heitler 11%  $\rightarrow$  ~1%
- Semi-inclusive: 5  $\rightarrow$   $\ll$  1%
- Refine previous DVCS analysis with knowledge of background contributions