The HERMES Recoil Detector

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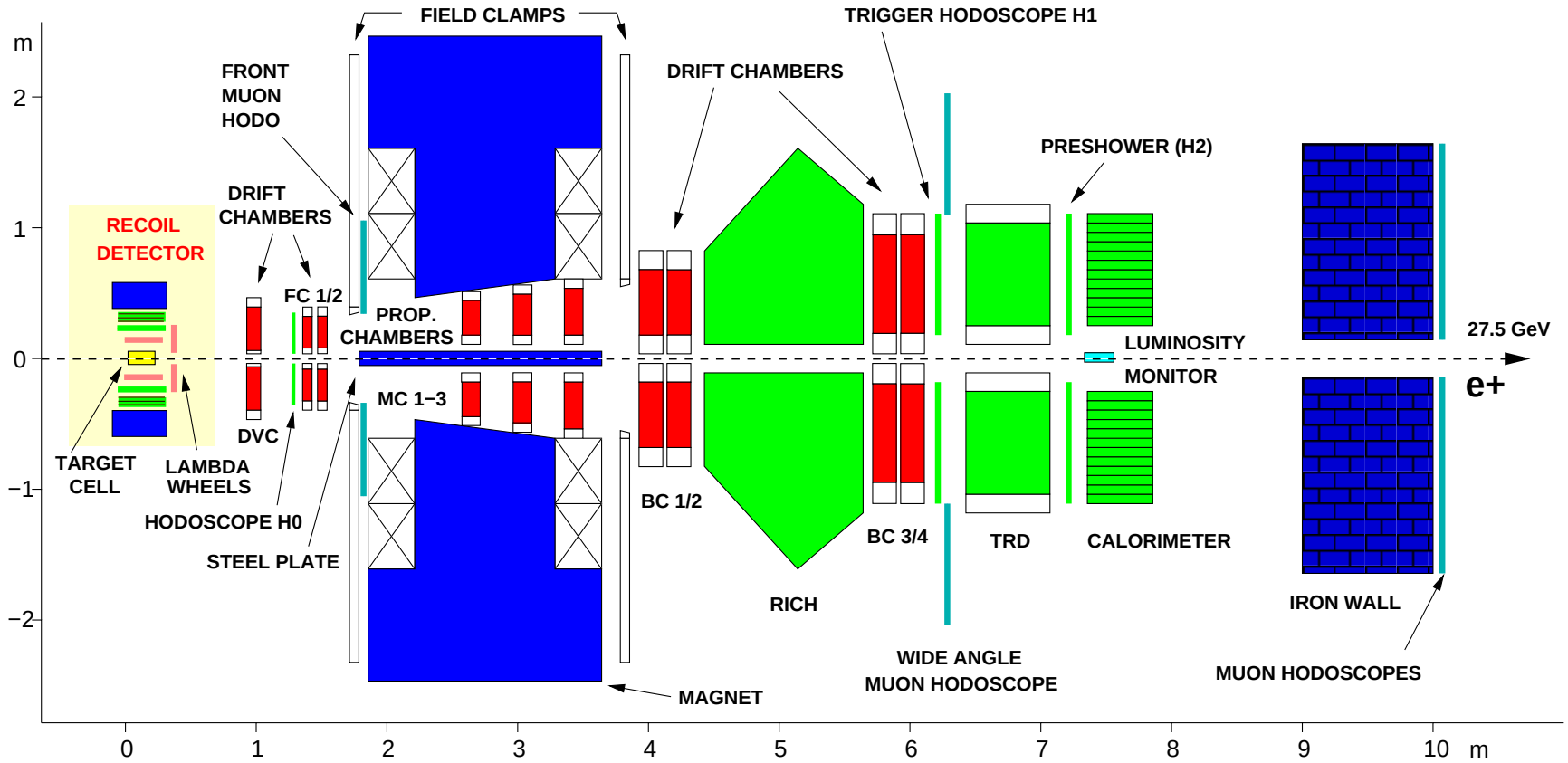
on behalf of the HERMES Collaboration

- Motivation and Requirements
- Recoil Detector Design
- Expected Detector Performance
- Cosmics Test Experiment
- Physics Projections

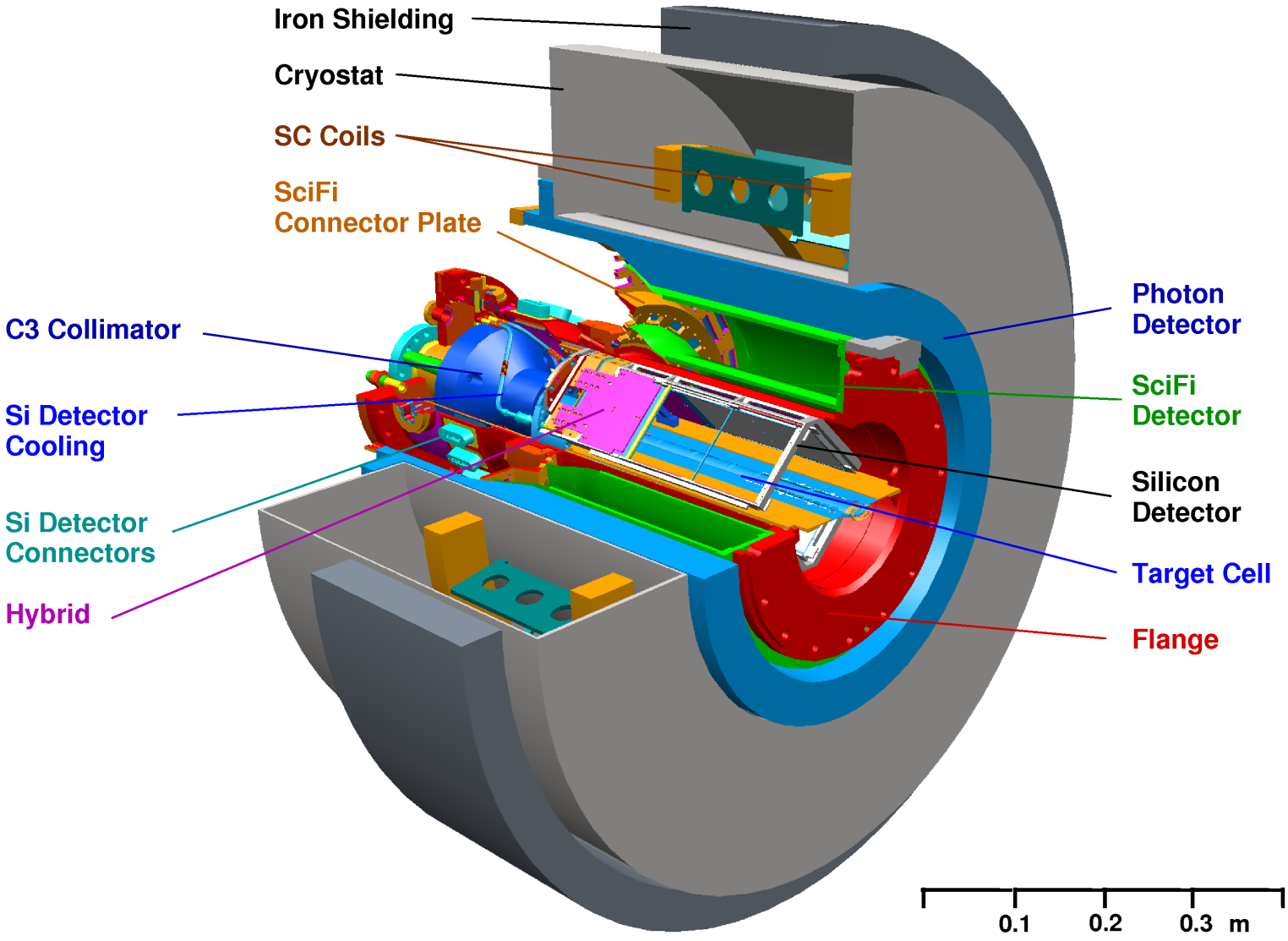
The HERMES Spectrometer



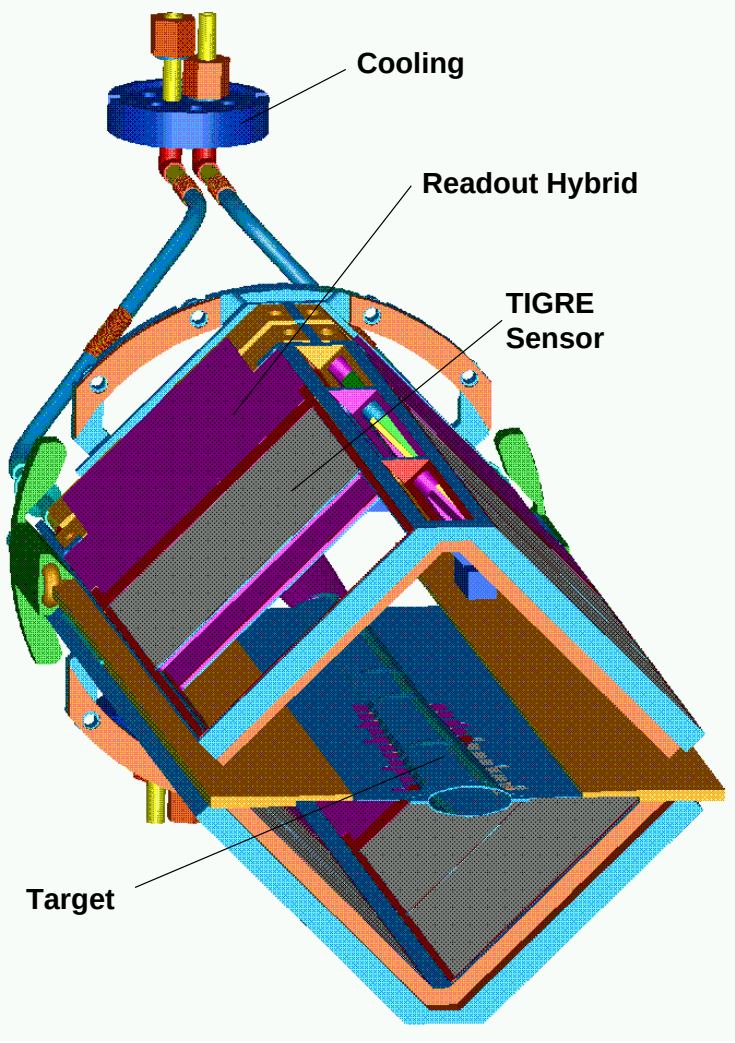
Requirements for DVCS Measurements

- High density unpolarised target to maximise statistics.
- Detection of all reaction products over entire momentum range to ensure exclusivity at the event level.
  - recoil protons
  - pions and protons from background processes, e.g. intermediate Δ^+ production
  - photons from $\pi^0 \rightarrow \gamma\gamma$
- Sufficient t-resolution to allow binning in t; important for extrapolation $t \rightarrow 0$.

HERMES Recoil Detector - 3D CAD

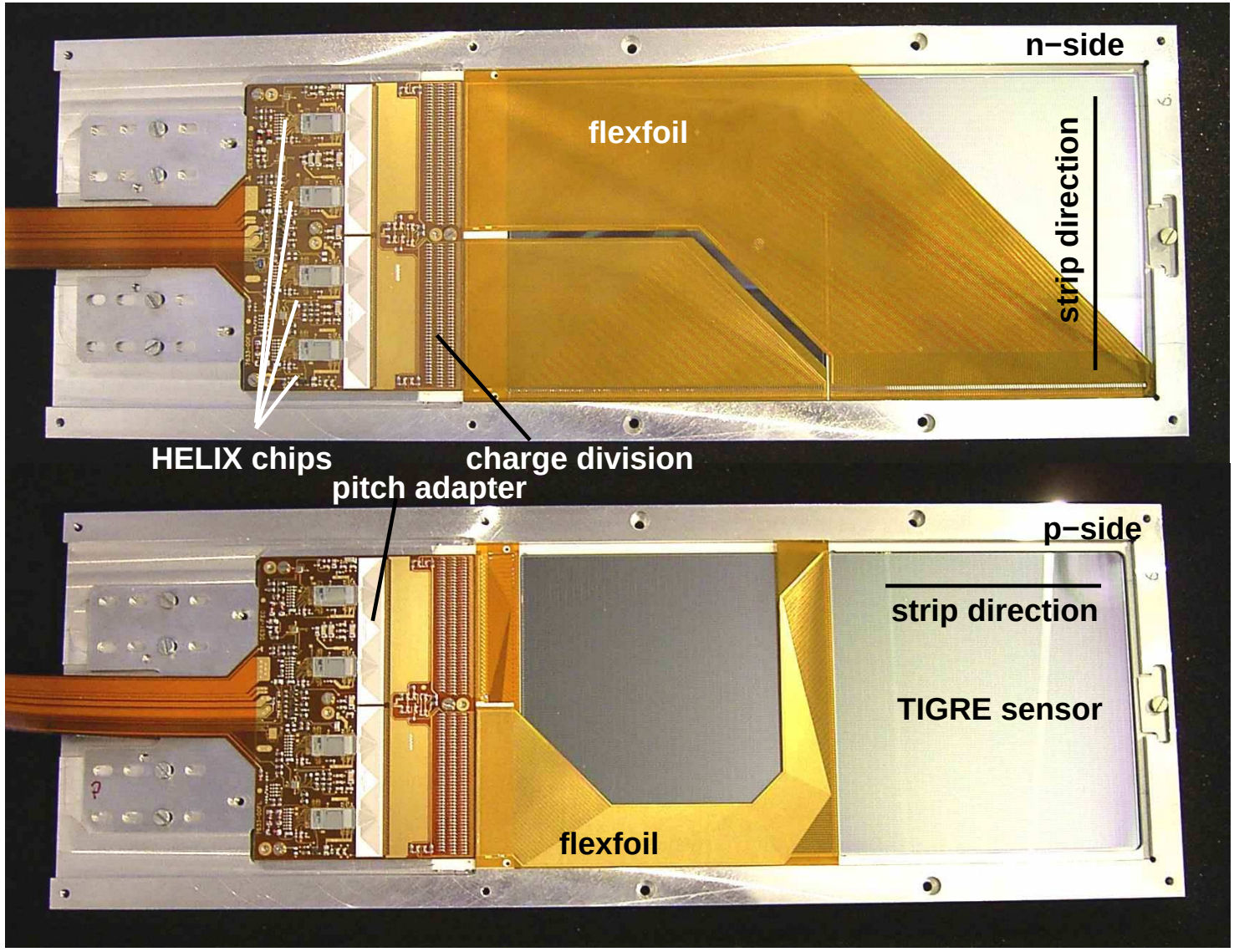


Silicon Detector



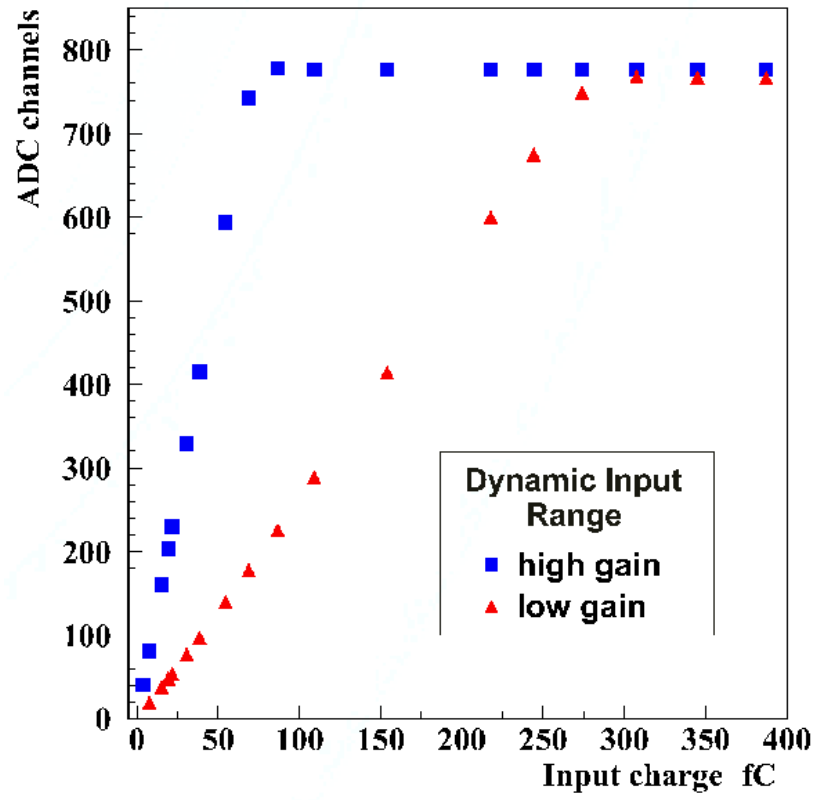
- 16 TIGRE sensors inside beam vacuum; few cm from beam
- 300 μm double sided, 8192 channels total
- 76 % ϕ-acceptance
- p-measurement from $\mathbf{dE/dx}$ 135-500 MeV/c
- tracking space points $\mathbf{p > 135}$ MeV/c
- $\pi/\mathbf{p}$ PID from $\mathbf{dE/dx}$ $\mathbf{p < 250}$ MeV/c

Silicon Detector Module



Silicon Detector Readout

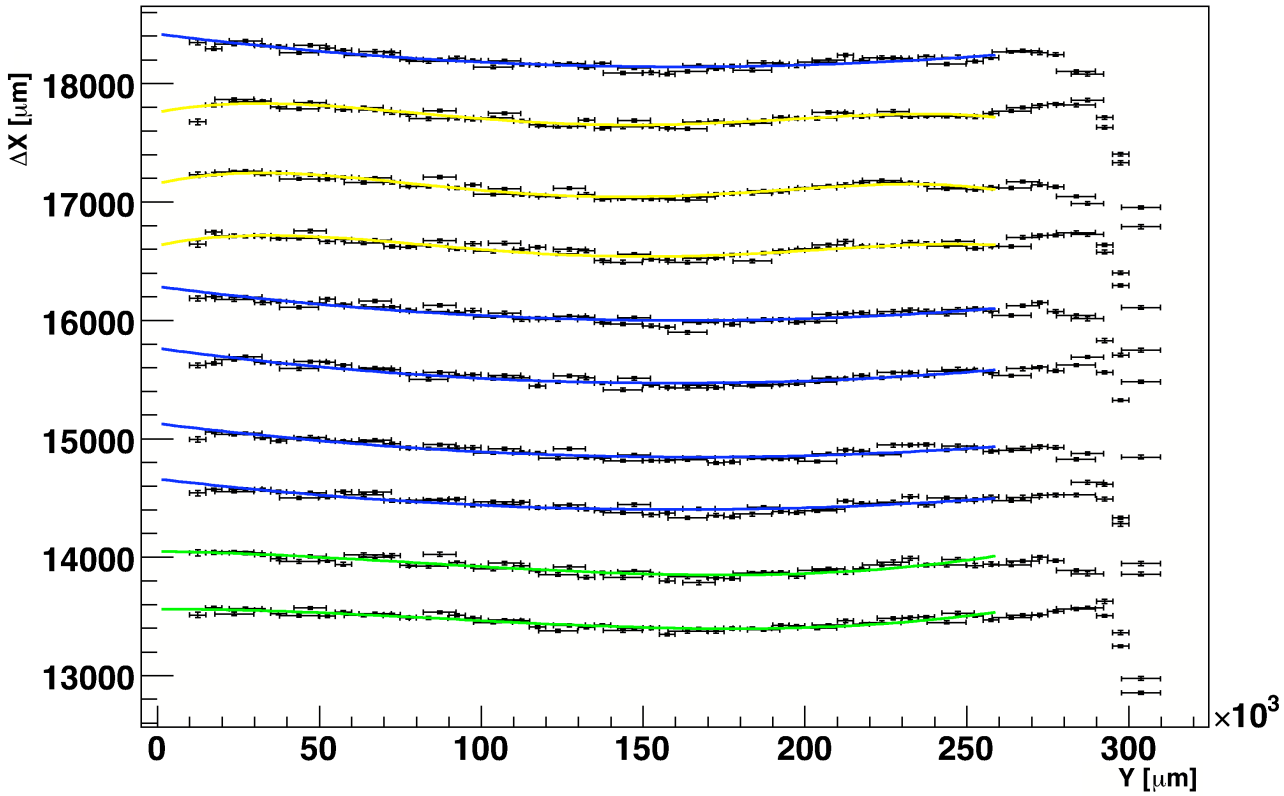
- Challenge:
  detect MIPs as well as recoil protons
- split signal into high and low gain channel
- 2 Helix 3.0 chips per silicon strip
- adjust dynamic range through capacitor to ± 70 MIPs
- S/N (MIP) 6.5 (e^--testbeam)



Scintillating Fibre Tracker

- 2 cylinders of 2×2 layers, 10° stereo angle
- 1 mm Kuraray fibres, mirrored ends
- 4992 channels total
- Kuraray lightguides, 64 channel Hamamatsu PMTs
- p-measurement 300-1200 MeV/c
- $\pi/\mathbf{p}$ PID from $\mathbf{dE/dx}$ $\mathbf{250 < p < 450}$ MeV/c

SFT Testbeam Results - Alignment

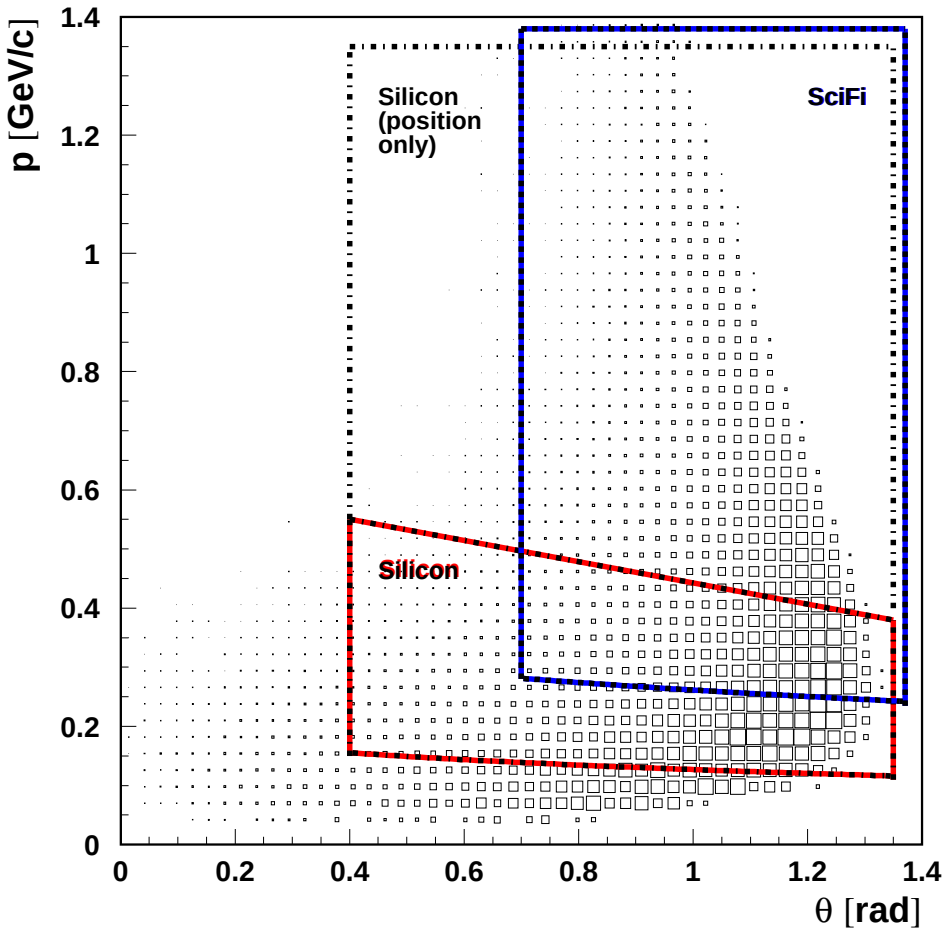


- SFT fibre alignment measured in e-testbeam at DESY.
- About 30 % of all fibres are not ideally straight; fitted with higher order polynomial
- Results will be used in data base to optimise detector resolution.

Photon Detector

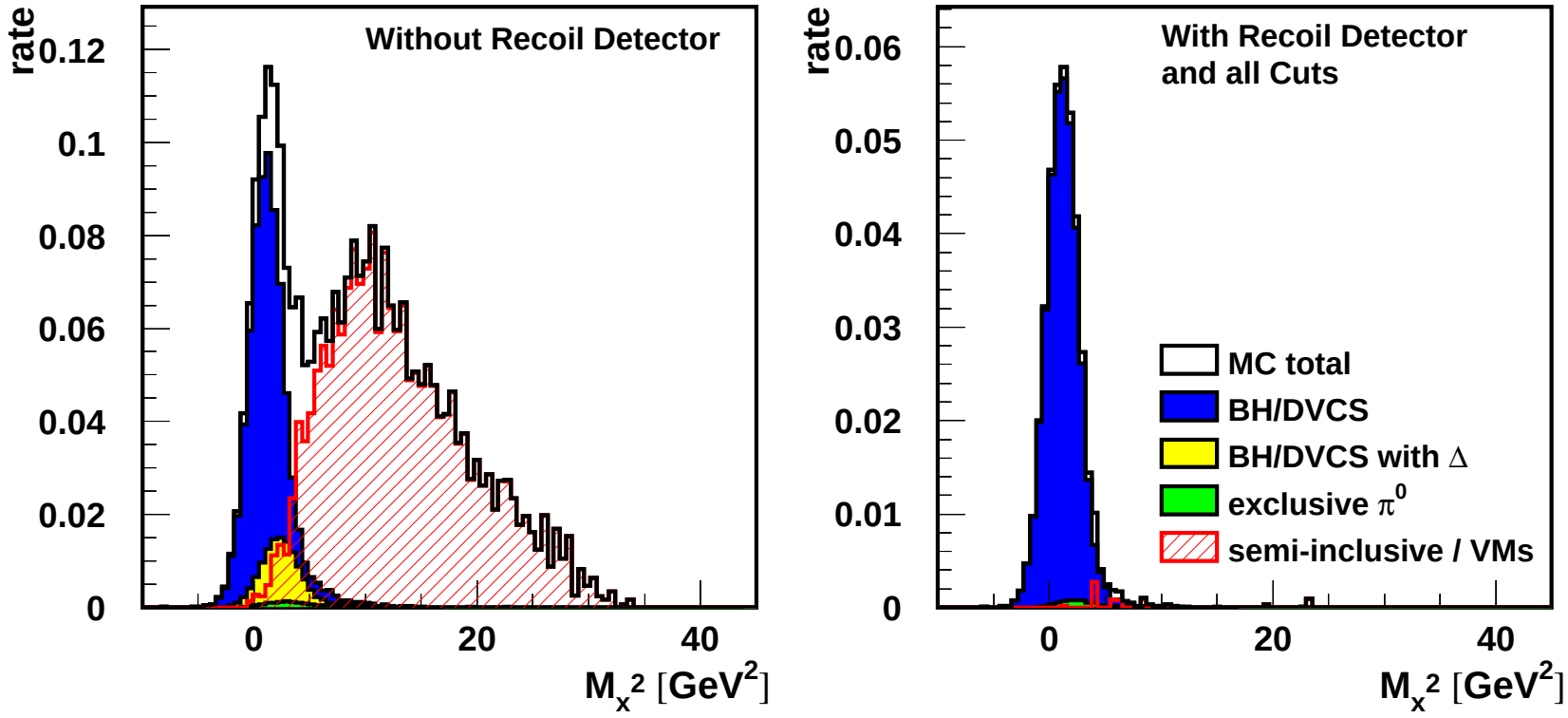
- detect photons from intermediate Δ-resonances $\Delta^+ \rightarrow p\pi^0 \rightarrow p\gamma\gamma$
- reconstruct π^0 if both photons are detected
- contribute to pion/proton separation (together with SciFi)
- provide Cosmics Trigger

Recoil Detector Kinematic Coverage



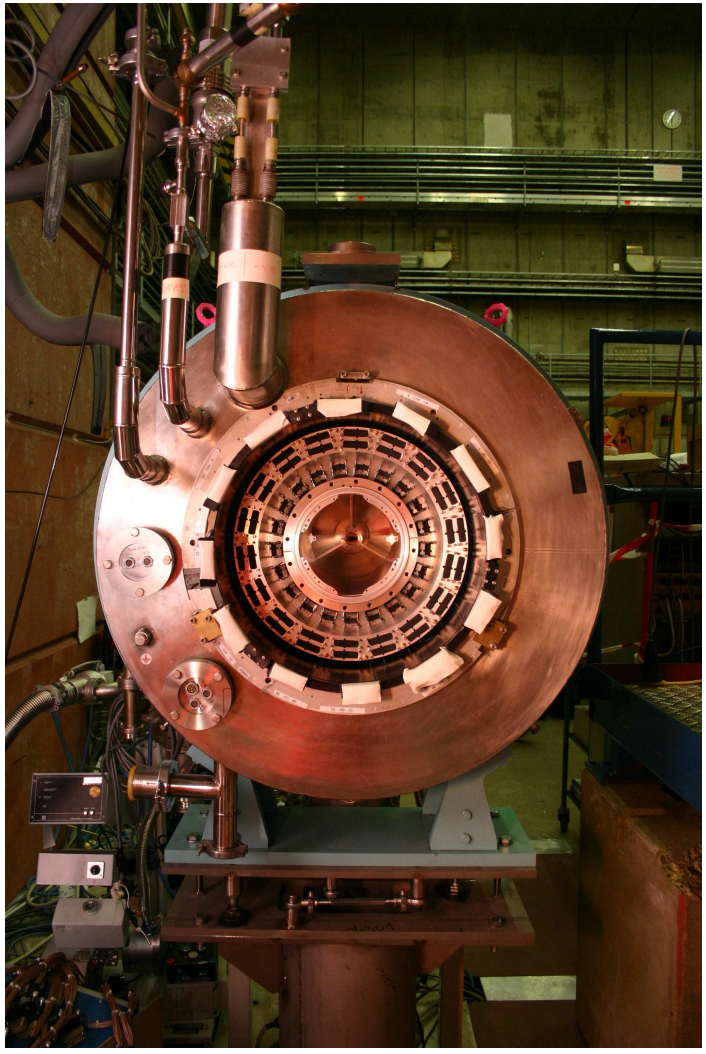
- Si low momentum cut-off 135 MeV/c (10 MeV), require signal in both layers
- Scifi low momentum cut-off 250 MeV/c
- Si $\mathrm{dE/dx}$ measurement up to 500 MeV/c (3 MIPs)

Exclusivity



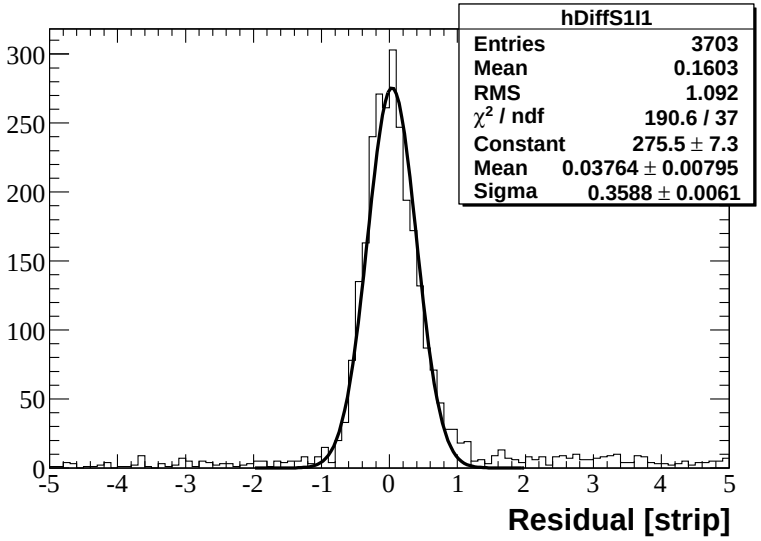
- Combination of coplanarity cuts, single proton requirement, pion rejection, photon cluster from π^0 (MC simulation)

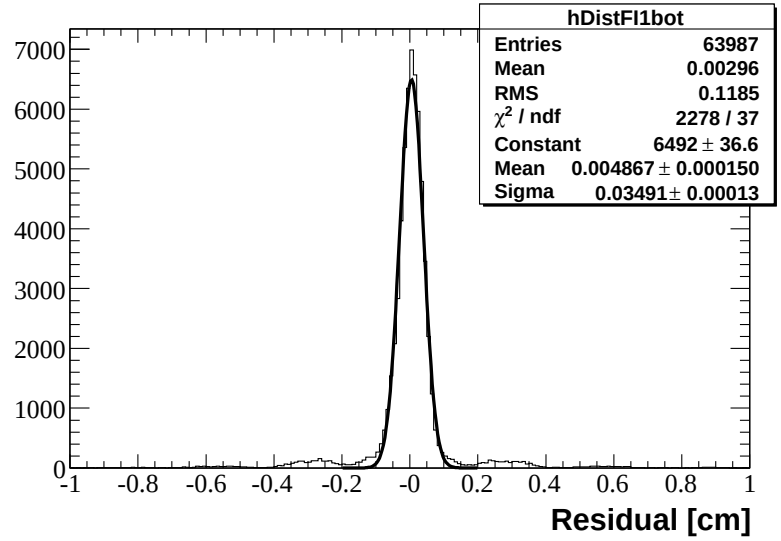
Cosmics Test Experiment



- full systems test using photon detector for cosmics trigger
- 2 TByte data collected (April-Sept. 05)
- successful integration into HERMES DAQ
- resulted in crucial hardware improvements
- residuals, efficiencies, time stability

Residuals from Cosmics



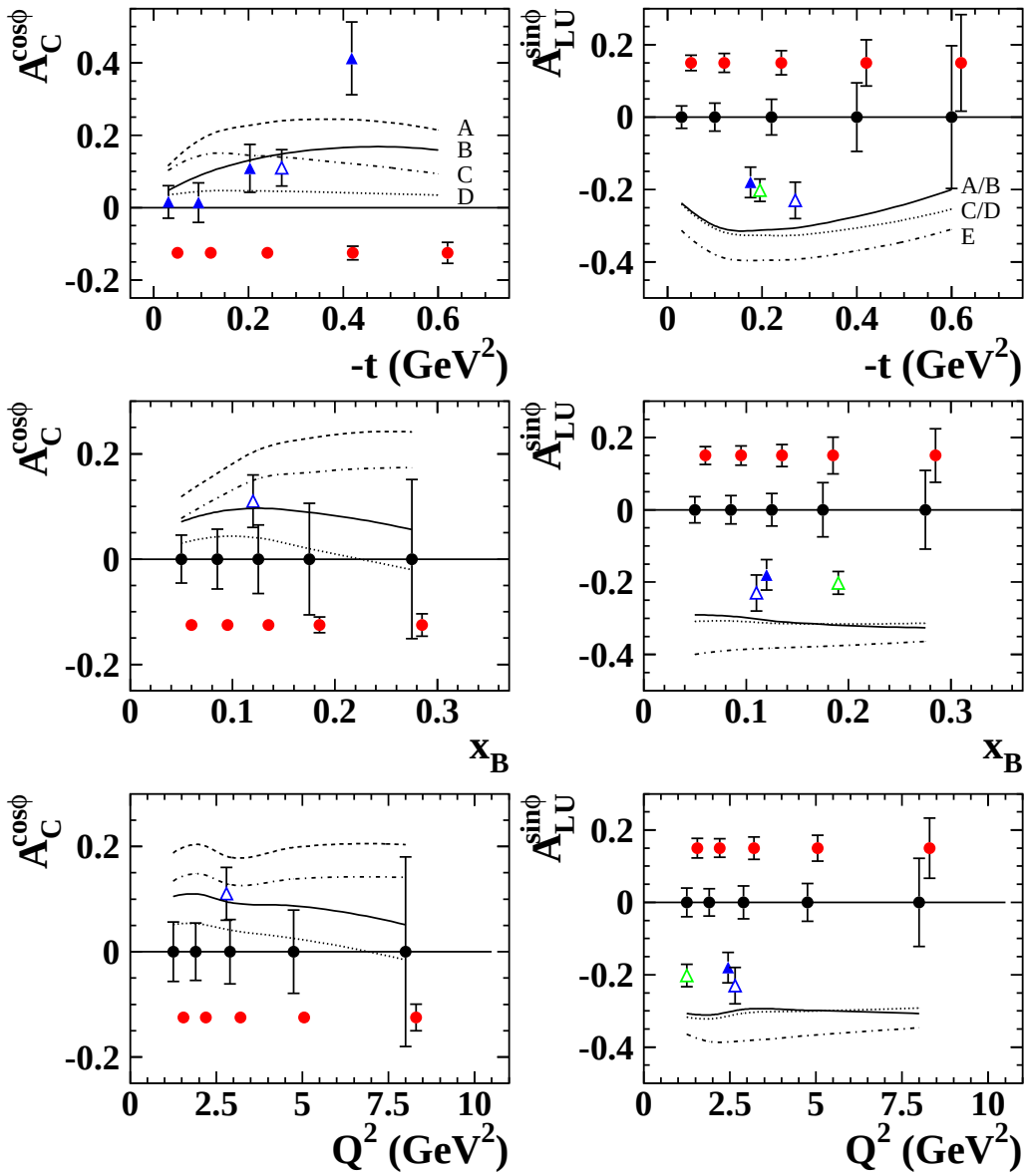


Silicon Detector
σ=0.359 strips

Scintillating Fibre Tracker
σ=0.349 mm

- only rough internal alignment, e.g. no SFT fibre alignment
- for comparison $1/\sqrt{12}$=0.289

HERMES DVCS Projections Overview



- blue triangles: HERMES published
- green triangles: CLAS published
- **black** dots: HERMES 1996-2000
- red dots: HERMES 2005-2007 Recoil Detector 1 fb^{-1}
- curves: different VGG models (PhD thesis F.Ellinghaus)

⇒ DVCS talk by E.Aschenauer

Summary

- The HERMES Recoil Detector will ensure exclusivity at the event-level by allowing the detection of all reaction products.
- Si-detector inside beam vacuum, SciFi tracker in solenoidal magnetic field of 1 T and photon detector.
- Successful full systems test with cosmics April-Sept. 2005
- Installation about to begin: Nov.2005 - Jan.2006
- 16 months of data taking until summer 2007.
- Exciting new results on DVCS beam spin and beam charge asymmetry with significantly improved statistics and systematics expected.