The HERMES Recoil Detector

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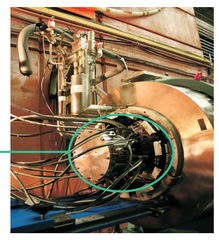
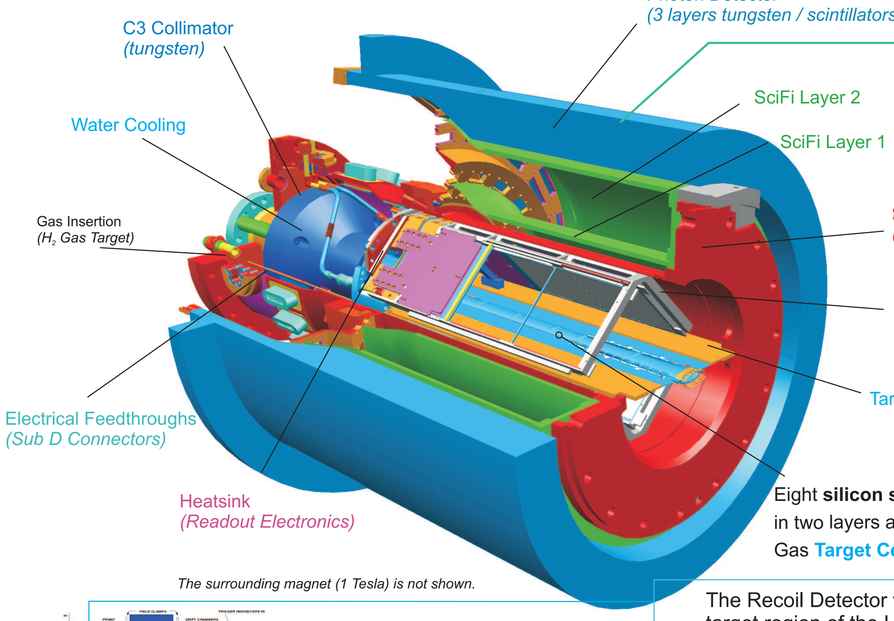
The HERMES Recoil Detector

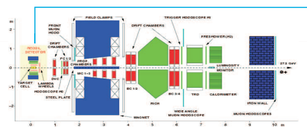
A **recoil detector** will be installed to the HERMES experiment at DESY .
- HERMES : a fixed target experiment with 27.5 GeV electrons/positrons.
- Detection of **protons** from Deeply Virtual Compton Scattering (DVCS).





Eight **silicon strip detector** (SSD) modules in two layers around the elliptical Gas **Target Cell.** Sensors are not shown.

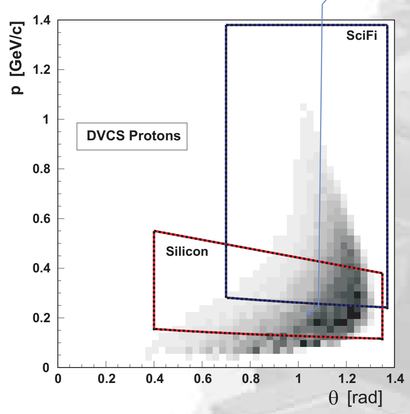
The surrounding magnet (1 Tesla) is not shown.



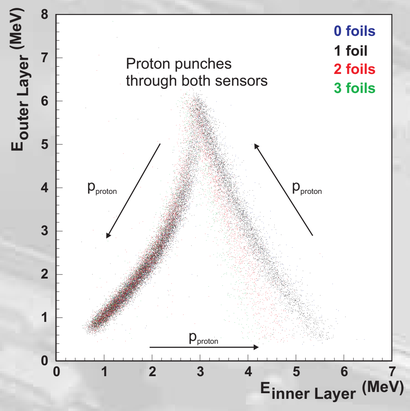
The Recoil Detector will be added in the target region of the HERMES spectrometer and its main job will be to detect the protons that are produced in DVCS.

The outer photon detector will measure photons produced by Bethe-Heitler scattering so as to provide a way for the DVCS events to be conveniently identified.

Azimuthal coverage of 76 % and an almost complete polar angular coverage.



Recoil proton momentum versus polar angle (with respect to the beam). The boxes indicate the acceptance of the silicon and SciFi detector.



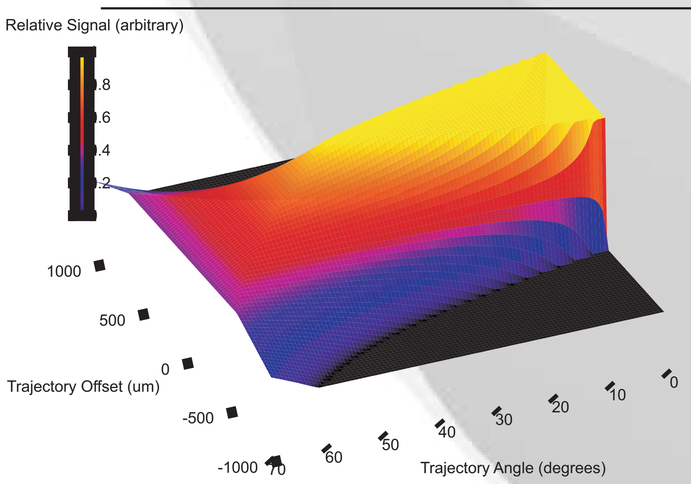
Energy deposition of protons within outer layer of silicon sensors versus the deposition in the inner layer.

Expected recoil proton momenta : from 135 MeV/c up to 1.4 GeV/c.

Deposited energy is a steep function of momentum (**$1/\beta^2$ area of Bethe Bloch)** ⟶ Momentum measurement !

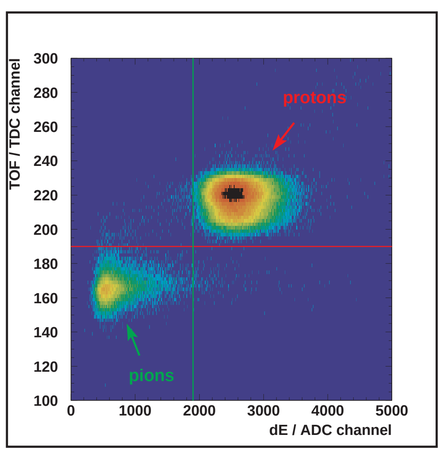
The placement of the silicon detector into the vacuum requires the compatibility of all detector components with a **vacuum of 10^{-9}** mbar.

Recoil Detector Test Beams



A display of the deposited energy in the silicon detector versus the incident angle of the incoming particle and the position of incidence on the strip. The data was taken at the GSI testbeam facility.

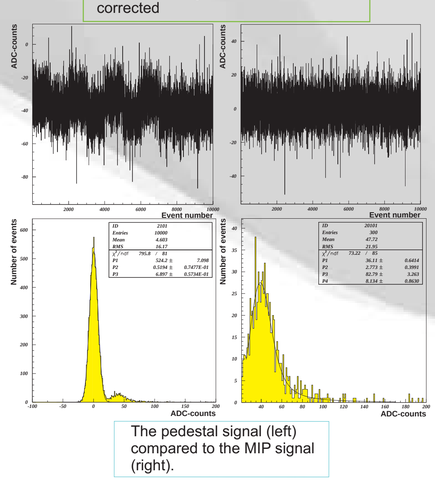
Also at the GSI testbeam, timing parameters were refined and a rudimentary tracking system was invented. This testbeam was the first to feature all three subdetectors.



Particle Identification(PID) in the Recoil Detector will be done mainly with the Scintillating Fibre Detector. The data above, from the GSI test beam, shows the detector's ability to separate protons from pions in terms of energy deposited in the detector.

The horizontal axis is the detector's response, the vertical axis is the ToF system at GSI and the warmer the colour, the more events in this bin.

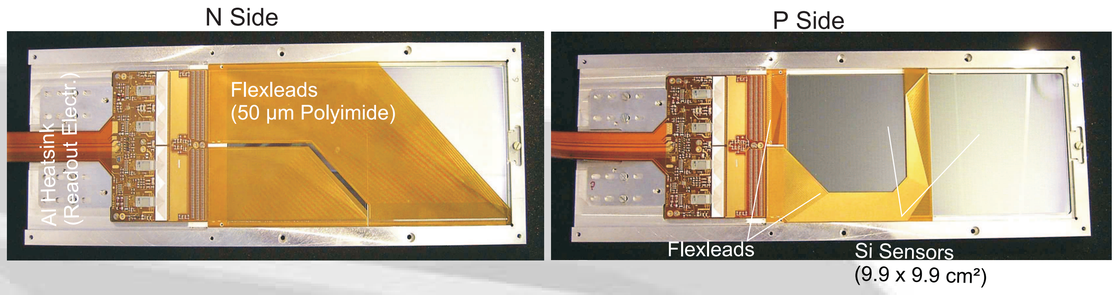
Every 1000 events the readout chips need to be reprogrammed. This causes a shift in the signal that can be corrected



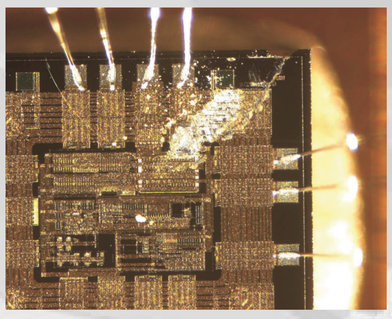
The pedestal signal (left) compared to the MIP signal (right).

Data from the test facility that I ran, T22 at DESY. This calibration of the silicon detector was useful in several ways - discovering the reaction of the silicon detector readout chips when they are frequently reprogrammed and the technique as to how to correct for it (top), and the first 1 MIP signal seen in the silicon detector (bottom) - a signal 3x smaller than the design specifications.

The HERMES Recoil Detector Test Installation

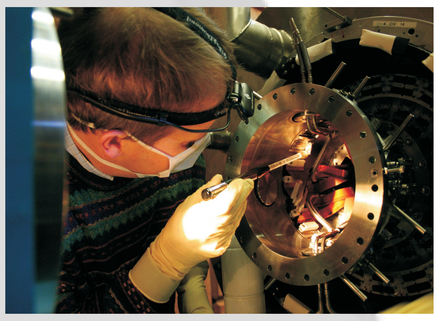


Two silicon strip sensors with the same strip orientation are mounted in an AlN ceramic frame. Sensors are shown in their Aluminium Transport Boxes. Each sensor has 128 strips and two readout channels which allow the sensor to respond over its large dynamic range



Left Top; Some slight damage done to one of the silicon detector's modules during installation. The problem was fixed easily and does not affect the final detector.

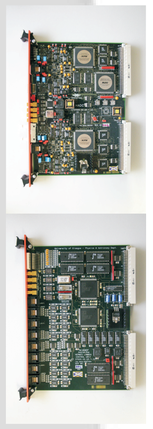
Right Top: The Silicon Detector as it is installed to the scattering chamber.



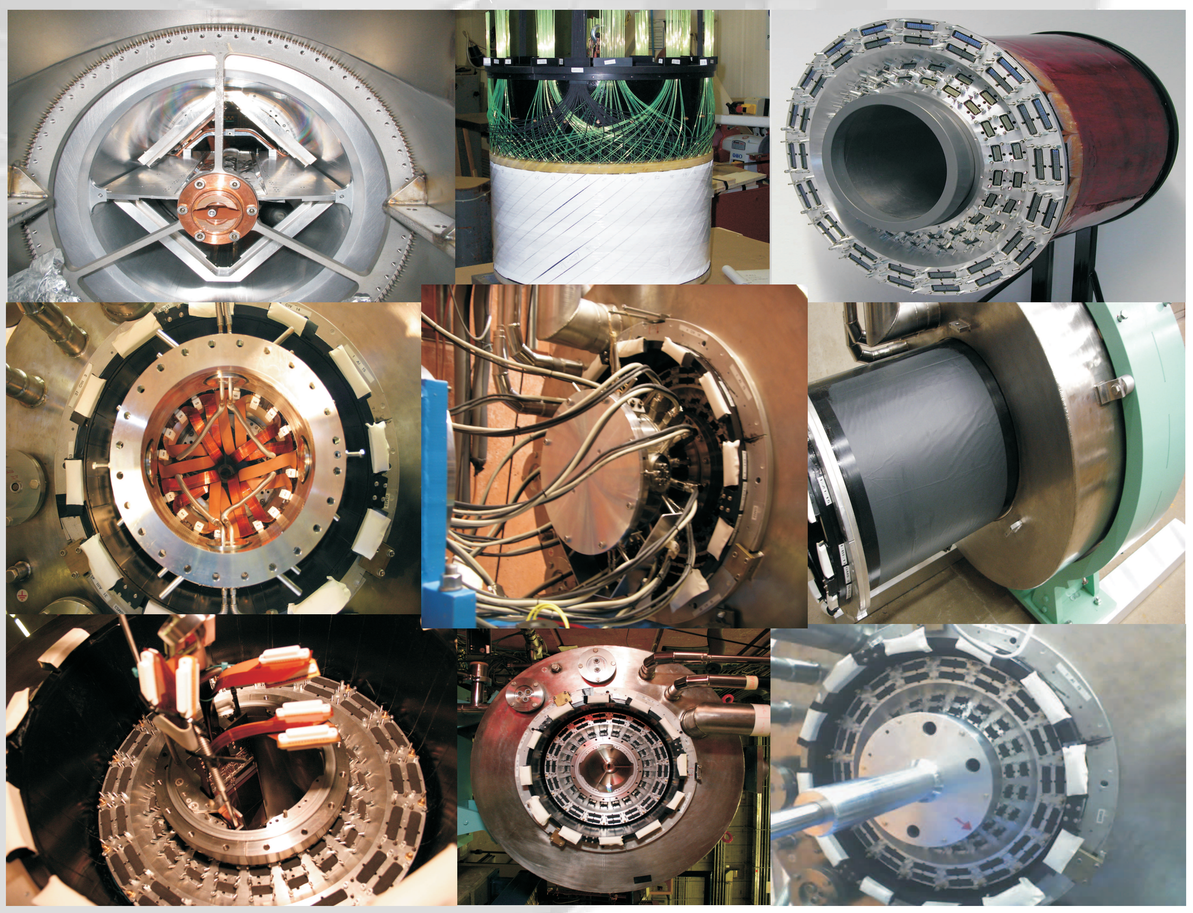
Left Bottom: The Silicon Detector's onboard electronics and coupling capacitors.

Right Bottom: The Silicon Detector gets installed into the holding frame.

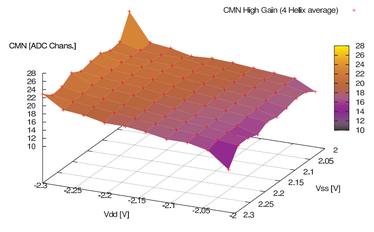
Far Right, Bottom: The readout cards for the Silicon Detector. Each custom ADC has more than 850 components!

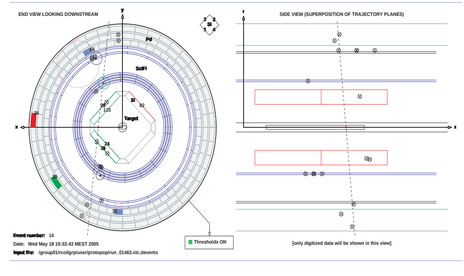


Starting at the top left and ending at the centre, the installation process of the Recoil Detector: The target chamber, the Photon Detector , the Scintillating Fibre Detector, the installation of the two to the Magnet and finally the Silicon Detector is installed and cabled.



Finally some results from the Test Installation: Left shows the variation of noise levels in the silicon detectors in the installation, Right shows a cosmic ray track through the detector.





The Recoil Detector is built and tested: its performance meets and in parts exceeds design specifications. It will be installed in HERMES starting Nov. 14th, 2005!