The HERMES Recoil Detector

A recoil detector will be installed in 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).

- Silicon Strip Detector (SSD) Module and Assembly
  - Gas Insertion (H₂ Gas Target)
  - Vacuum of 10⁻³ mbar
  - Deposited energy is a steep function of momentum.
  - For recoil detectors, high momentum resolution is paramount.

- Electrical Feedthroughs
- Readout Electronics
- Readout Circuitry and Power Supply

- Phantom Detector: Two-layer aluminum nitride ceramic Shapal M
  - Size: 9.9 x 9.9 cm²
  - Thermal expansion coeff. very close to that of silicon
  - Aluminium nitride ceramic Shapal M

- Silicon Sensors:
  - Laser trimming to exact number after assembly
  - 4 torr of He allows high transparency and good injection efficiency

- Flexleads: Polyimide
  - Size: 9.9 x 9.9 cm²
  - Large holes (laser cut) for bonding

- Target Cell:
  - Aluminium nitride ceramic Shapal M
  - Thickness: 400 µm

- Pitch Adapter
- Temperature Monitor
- Analog Line Driver
- LVDS IC

The interconnection to the silicon sensors is realised by polyimide flexleads.

- 128 strips for 22 pF in the ratio 4:1
- 10 pF in the ratio 7.4:1
- 2200 mW (8.6 mW/channel)

- The pitch of 758 µm allows for 128 analog channels, followed by:
- Sequential readout of 128 analog channels, followed by:
- Analog line driver and LVDS receiver
- The injected signal charge of 22 fC divides up between:
- For High-gain HELIX (1.5 MeV): 10 pF
- For Low-gain HELIX (1.5 MeV): 22 pF
- The signal-to-noise ratio is 3.8 for 3.94 IC input charge.

- Measured output spectrum of the hybrid (10 bit).
- ENC (root-mean-square value of the spectrum) results in 1710 electrons (average value).

- The noise (ENC) of only the HELIX with Cₐ: detector capacitance (%): number of electrons.
- HELIX on hybrid:
  - Noise of the low-gain HELIX is independent of the connected capacitance value.
  - Reason: Charge division capacitor in series to the load.
  - The noise of the high-gain HELIX increases linearly with 50 electrons per pF (good agreement to the theoretical value of 47 electrons/pF).

- The ENC limit is determined by the charge division setup.

Conclusion
- The development and assembly procedure (sensors) is feasible.
- The hybrid fulfills all electrical requirements concerning dynamic input range and noise.
- The production of the complete HERMES silicon recoil detector starts now.