The HERMES Recoil Detector

Inti Lehmann
University of Glasgow
for the HERMES Collaboration

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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)

**Ji Sum Rule**

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

**Generalised Parton Distributions (GPDs)**

- Functions of 3 variables
  - parton momentum fraction \( x \)
  - skewedness \( \xi \)
  - \( p \) momentum transfer \( t \)

Final state: \( e, \gamma, p \)
HERMES at HERA, DESY

- Long. polarized electron/positron beams 27.6 GeV
HERMES at HERA, DESY

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

- Remove background from associated BH/DVCS with intermediate $\Delta$-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 Detector

Recoil Proton

17/03/2009 EuNPC I. Lehmann, HERMES Recoil Detector
HERMES Recoil Detector

- $2\pi$ magnetic spectrometer surrounding target
- Unpolarised gas targets
  - H, D
- Challenging conditions
  - Inside magnet
  - Close to e+/e-beam
Silicon Strip Detector

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

- **16 silicon sensors**:
  - 10 x 10 cm² area
  - 300um thickness
  - double-sided strips

- **Arranged in 2 layers**

- **Challenge**
  - Detector + electronics close to e beam
  - Inside vacuum
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 $\pi^0$ decays ($\Delta^+ \rightarrow p \pi^0 \rightarrow p \gamma \gamma$)
  - Particle Identification
  - Background reduction

• 3 layers of tungsten and scintillator
  - 1\textsuperscript{st} layer parallel to beam
  - 2\textsuperscript{nd} layer +45\degree resp. to beam
  - 3\textsuperscript{rd} layer -45\degree 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
  - $\Delta E$ 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