Measurement of the *G* Double Polarisation Observable in Pion Photoproduction

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Background

The excitation spectrum of the nucleon remains poorly established, despite being a fundamental test of our knowledge of the structure and dynamics of the nucleon.

In meson photoproduction there are 16 experimental observables including the differential cross section, 3 single polarisation observables and 12 double polarisation observables. Measurement of 8 carefully chosen observables will largely eliminate model dependencies in the determination of the reaction amplitudes from the experimental data and the resulting extraction of the excitation spectrum.

The "G" observable was measured in this experiment in the single pion photoproduction reactions $p(\gamma,\pi^+)n$ and $p(\gamma,p)\pi^0$ for photon energies 0.6-2.0GeV.

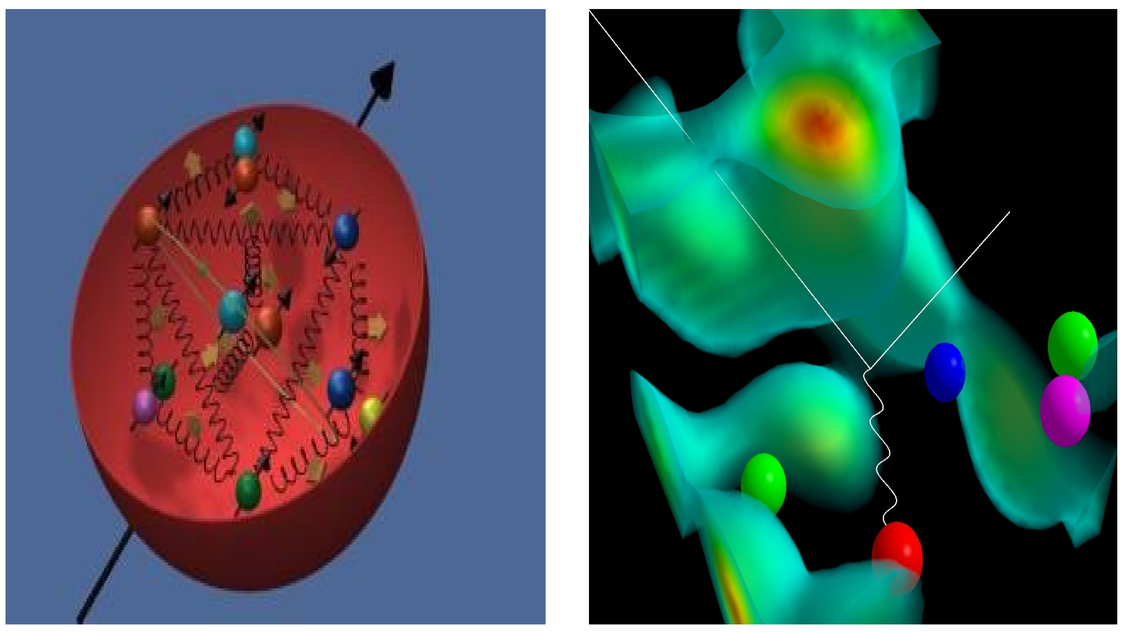

Fig. 1: Two ways to picture the nucleon [1],[2]

Facility

The experiment was carried out using the CEBAF Large Acceptance Spectrometer (CLAS) in Hall B of the Thomas Jefferson National Accelerator Facility.

CLAS has an onion-like structure with combinations of drift chambers, calorimeters and time-of-flight detectors arranged in layers. These are divided into 6 sectors separated by solenoids which create the magnetic field. This allows measurement of charged particles with good momentum resolution and close to complete angular coverage.

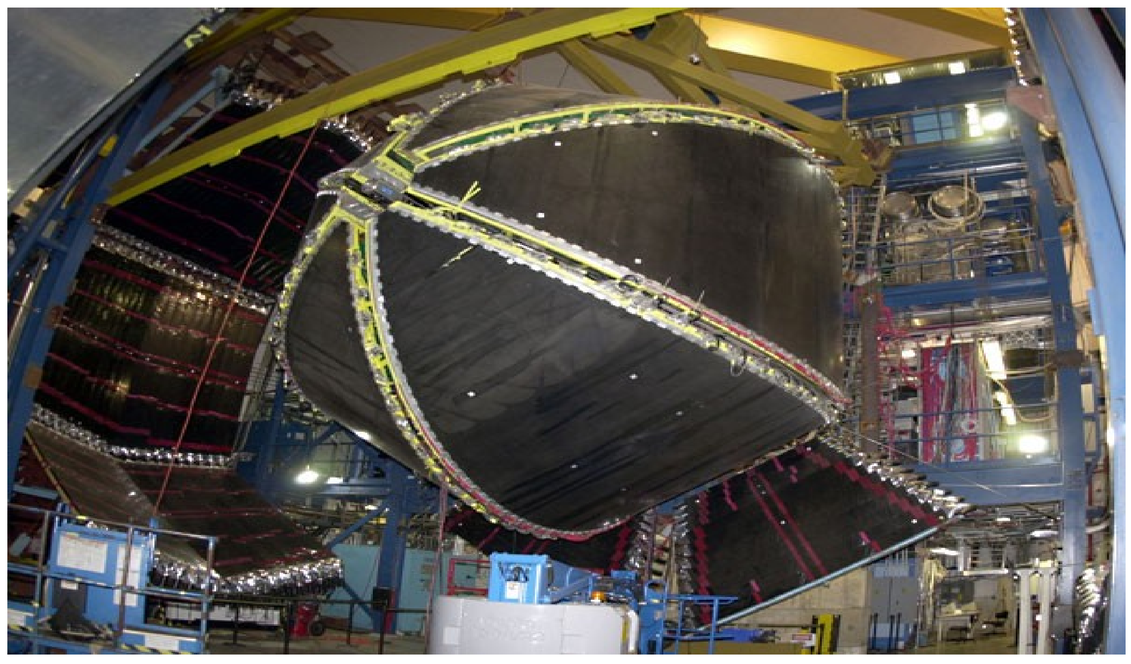

Figure 2: The CLAS detector, Hall B [3]

Measuring the *G* Double Polarisation Observable

This requires a linearly polarised photon beam, produced by bremsstrahlung of an incident photon beam on a thin diamond radiator. The polarisation can reach 80% to 90% depending on photon beam energy and degree of collimation.

In addition the target must be longitudinally polarised. This experiment was the first to use the Frozen Spin Target, FROST. The target contains 1.5mm beads of butanol which are highly polarised outside the detector using the Dynamic Nuclear Polarisation Technique at a temperature of 0.3K and a magnetic field of 5.0T. Once a maximum polarisation of ~80% has been achieved, the target is cooled to ~0.05K before being placed in a 0.56T holding field and inserted into CLAS.

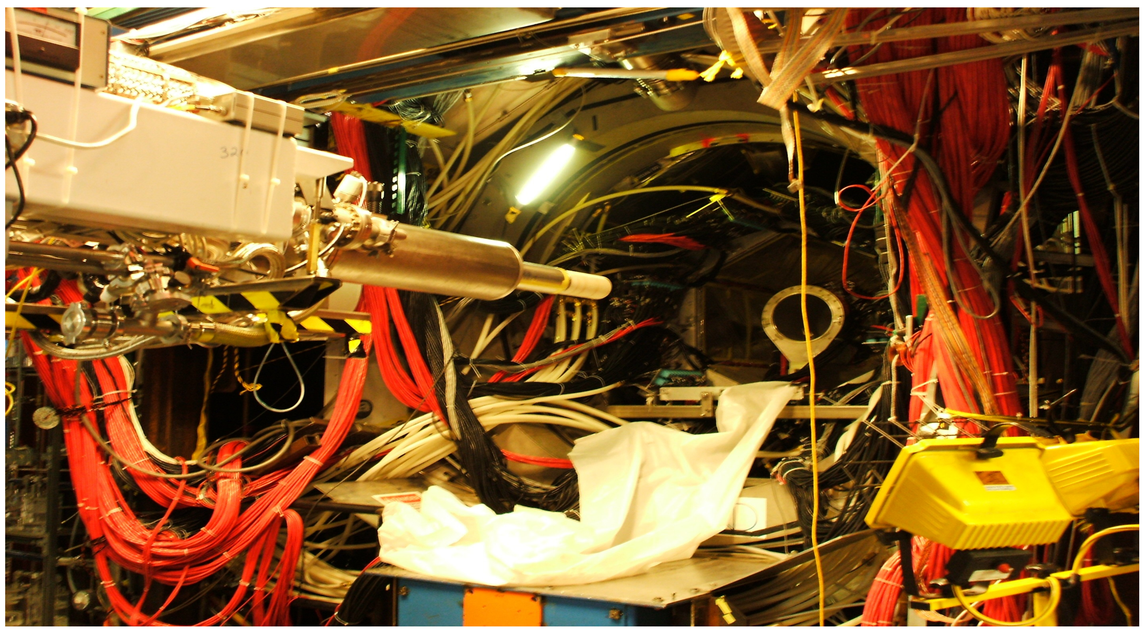

Fig 3: Photograph of the target

Results so far...

Data taking for this experiment finished in February 2008 with over 10 billion events recorded. The analysis of the *G* double-polarisation observable in pion photoproduction will be led by the Edinburgh group. The calibration of the experimental data is ongoing. A preliminary analysis of the data has been carried out and is presented in *Fig. 4* below. The figure shows beam asymmetries as a function of pion azimuthal angle for the $p(\gamma,n\pi^+)$ reaction, from which the Σ and *G* observables will be extracted.

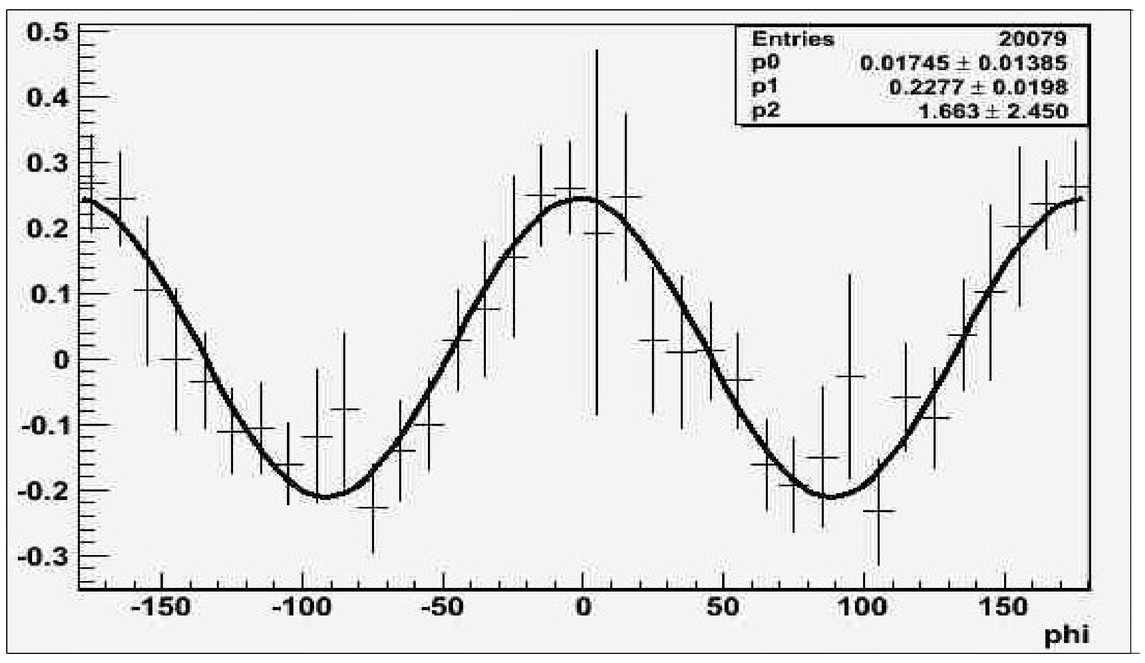

Fig. 4: Very preliminary asymmetry in the CMS Energy range 1.4GeV to 1.5GeV

References

1. www3.tsl.uu.se
2. www.scitech.ac.uk
3. www.jlab.org