PLANS FOR THE HERMES EXPERIMENT AT HERA II

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Abstract

The HERMES experiment [1] has been operational at the HERA accelerator of DESY since 1995.

In HERMES Run-1 the focus was on a first accurate determination of the flavour separated quark helicity distributions [2]. This was done on the basis of a large data set on both a longitudinally polarized hydrogen and a longitudinally polarized deuteron target. For the deuteron data HERMES could substantially improve the accuracy because of a RICH detector [3], which was installed in 1998. This enabled the identification of pions and kaons over most of the momentum range. For the earlier hydrogen data only pion identification was possible using the previously installed threshold Cherenkov detector. The valence polarizations are well determined, but the much smaller sea polarizations are essentially compatible with 0. The accuracy of these results could substantially be improved by taking an additional 4 Mio DIS events with a longitudinally polarized hydrogen target and the RICH detector. This improvement in statistical accuracy would be particularly important for the sea polarizations. With the present statistics no such asymmetry is evident. Various theoretical calculations exist (again largely prompted by the data taking of HERMES) that predict a non-zero asymmetry. The additional 4 Mio DIS events would improve the statistics enough to allow verification of several models.

In semi-inclusive reactions, when not only the scattered positron but also some of the produced hadrons are detected, a lot of interest has been generated by the appearance of single-spin asymmetries. These offer the best road towards a measurement of the unknown transversity distribution of quarks. HERMES has started Run-2, where a first determination of the transversity through the Collins mechanism is the prime objective for the

next years. It was partly driven by the fact that for this the beam does not need to be polarized. Up to February 2003 about 900'000 events have been recorded with a transversely polarized hydrogen target. From estimates reported in e.g. the HERMES Long Range Plan it is known that about 7 Mio DIS events are needed for a statistically satisfactory measurement. This is necessary to discriminate between different theoretical models for the transversity distribution. In fact, the results published by HERMES on Run-1 [4] with a *longitudinally* polarized H and D targets, and the fact that HERMES now runs with a transversely polarized target have led to a spate of new calculations by several theory groups around the globe.

As is well known a measurement of exclusive reactions gives access to the newly introduced Generalized Parton Distributions (GPD), which contain more detailed information on the internal quark structure of the nucleon than the standard Parton Distribution Functions. The cleanest way to arrive at the GPDs is through the Deeply Virtual Compton Scattering (DVCS) process, which was already measured and published in HERMES Run-1 [5]. However, it is obvious that HERMES in its present configuration has insufficient energy resolution to allow an event-by-event separation of exclusive reactions from non-ground state transitions. The easiest way to improve on this situation is by the installation of a recoil detector around the target to detect the recoiling target proton. Such a recoil detector is presently under construction for HERMES and will be ready for installation for the last two years of HERA operation.

Another essential improvement brought by the recoil detector is the much better resolution in momentum transfer $-t$. A full programme of DVCS measurements with the recoil detector needs about 2 years of beam time. Since the installation of the recoil detector necessitates the removal of the present polarized target system, the most efficient planning requires these 2 years to be the last 2 years of data taking with HERMES. An additional condition is that these 2 years of data should consist of roughly equal data sets with opposite beam charge. HERA is the only facility worldwide where beam-charge asymmetries in the interference of DVCS and Bethe-Heitler can be exploited to get to the DVCS amplitudes (rather than cross sections). 1 year of data with electrons and 1 year of data with positrons (both polarized!) will yield unprecedented accuracy for this asymmetry.

The physics case for the next phases in the HERMES running will be presented and an overview of the challenges ahead for the experiment will be given.

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