9 Summary of first operation at HERA

The successful operation of the H1 detector during the first years of HERA is evidenced by the many publications [83] which resulted from it.

The measurement of the total photoproduction cross-section [29] relied mainly on the luminosity monitor and electron tagger. It showed that the novel technique of monitoring luminosity via the $ep \rightarrow ep\gamma$ bremsstrahlung process combined with on-line background subtraction using electron pilot bunches can be used meaningfully. The electron tagger signal alone provides a fairly clean trigger for all photoproduction physics. Supplemented with tracker and calorimeter information at the trigger and reconstruction level the prominent beam gas background can be removed completely, as demonstrated in the analysis for hard photon scattering [30]. Figure 29 shows an event typical of this type of processes.

The total cross-section measurement with the electron tagger was cross-checked with data triggered only by the $z-$vertex trigger (see Section 5.3.1.2), which required a minimum number of tracks from a common vertex in the interaction region. Though photoproduction events from a different range of Q^2 and y are accepted by this trigger, a detailed understanding of this trigger and its dependence on chamber efficiency, noise, crosstalk, track transverse momentum p_t and energy loss is need, as is also a subtraction of proton pilot bunch data. The results are found to nicely confirm the electron tagger analysis.

The above examples were cited to emphasize again one of the stronger points of the H1 detector, which has been explained in more detail in the trigger section above, namely the ability to trigger on the soft physics while not loosing the deep inelastic events or vice versa. The use of topological information rather than thresholds on individual detectors, is a major step forward and will ease data taking at higher luminosities.

The first measurement of deep inelastic scattering in the new kinematic domain accessible to HERA required an understanding of the energy response of the backward electromagnetic calorimeter (BEMC) and the backward and central parts of the LAr calorimeter. Figure 30 shows the spectrum of energy clusters in the BEMC. Without additional constraints the trigger rate amounts to a few Hz/GeV even at the low beam intensities achieved so far. The observed rate is dominated by proton induced background hitting the rear part of the calorimeter. The rate can be reduced by almost two orders of magnitude by a simple timing requirement in the time-of-flight detector. In the analysis simple event topology and track matching cuts produce an almost background free electron spectrum for energies exceeding 15 GeV. Below that value fake electron signatures from photoproduction hadronic final states become dominant. These can be rejected by active electron identification tools (like shower shape analysis). The so-called kinematic peak, a feature discussed in our first publication on deep inelastic scattering at low x [84], and also in Section 3.2 of reference [9] in the context of the BEMC calibration, is clearly seen in this spectrum.

Events with a hadronic final state [85] are of the type shown in Figure 31. The check of the balance in transverse momentum (see Figs. 32 and 39 of reference [9]) entails the understanding of both the hadronic as well as the electromagnetic part of the liquid argon calorimeter, and the link between tracker and calorimeter information.

On the technical side, the high stability, reliability and small number of dead channels in the liquid argon calorimeter deserve to be singled out. The noise level was found to be low enough to extend its use down to quite low energies.

The digital muon system and the muon trigger behave as expected. Fig. 32 shows the invariant $\mu^+\mu^-$ mass spectrum for elastic and inelastic photoproduction of J/Ψ mesons, with a prominent peak at the mass of the J/Ψ meson. These events were mostly triggered and identified by the muon system.

Figure 33 shows the resolution of the K_s^0 peak in the $\pi^+\pi^-$ mass spectrum and of the $\Lambda(\bar{\Lambda})$ signal. This may serve as evidence, that the isolation of J/Ψ, D^*-tagging etc. is feasible, once sufficient statistics is available. The $J/\Psi \rightarrow \mu^+\mu^-$ candidates found prove that the tracker muon link can be made.

On the software side the online filtering and reconstruction concepts have permitted a fast access to the data, and also their quick reduction and dissemination to the various analysis centres.