3.2 The ZEUS detector

ZEUS is a general purpose detector for the measurement of a wide variety of *ep* physics topics available at HERA. Construction of the ZEUS detector began in 1988. The detector was commissioned in 1992, the first year of HERA operation. The ZEUS collaboration presently consists of about 450 physicists from near 50 institutes located in 12 countries(Canada, Germany, Italy, Israel, Japan, Korea, the Netherlands, Poland, Russia, Spain, the U.K., and the USA).

The design of the ZEUS was optimized for study of DIS physics. Reconstruction of kinematics in deep inelastic scattering requires that electrons and jets of neutral and charged particles with energy up to several hundred GeV be precisely measured. Near 4π solid angle coverage is essential for detection of charged current(CC) events. A nearly hermetic, finely segmented and fully compensated high precision calorimeter hence forms the heart of the ZEUS. Precise momentum measurement for charged particles in the lower energy range is provided by conventional tracking chambers in the magnetic field of up to 1.4 Tesla produced by a thin superconducting solenoid. An iron yoke surrounding the calorimeter returns the magnetic flux of the solenoid. It is also instrumented as a backing calorimeter. Identification of muons is important in studying processes with decay of massive particles. Muon chambers are installed in the inner side and outer side of the magnetized iron yoke. In the forward direction, iron toroids and tracking chambers reinforce detection of very energetic muons. Further away from the interaction point, upstream of the proton beam and close to the beamline, the luminosity monitor measures the beam luminosity. These are the major components of the ZEUS detector. The layout of the ZEUS detector is shown in Figure 11. The ZEUS coordinate system is right-handed. The proton beam direction defines z-axis. y-axis points upward. The origin coincides with the nominal interaction point. Polar angles are measured with respect to z-axis. Abbreviations of the component detector names are listed in Table 3.

The detector design also includes some auxiliary components such as the rear hadron electron separator(RHES) which helps to identify electrons in hadronic

Figure 11: The ZEUS detector.

Table 3: Abbreviations of ZEUS component detector names

VXD	vertex detector	BMUI	inner barrel muon chamber
CTD	central tracking detector	BMUO	outer barrel muon chamber
FTD	forward tracking detector	RMUI	inner rear muon chamber
RTD	rear tracking detector	RMUO	outer rear muon chamber
TRD	transition radiation detector	FMU	forward muon chamber
FCAL	forward calorimeter	VETO	veto wall detector
BCAL	barrel calorimeter	C5	C5 counter
RCAL	rear calorimeter	LUMI	luminosity monitor
COIL	thin superconducting solenoid	EDET	LUMI electron detector
YOKE	iron yoke	GDET	LUMI photon detector
BAC	backing calorimeter	LPS	leading proton spectrometer
RHES	rear hadron electron separator	FNC	forward neutron detector

jets in the rear direction, the leading proton spectrometer(LPS) for tagging of protons in diffractive scatterings, and the transitional radiation detector(TRD) for electron identification. These auxiliary components were not fully instrumented for the 1993 runs.

Apart from the above mentioned components for reconstruction of physics events, there are also materials and devices which shield the detector from unwanted flux of background and take part in the first level trigger decision in rejecting background events. The Veto Wall detector and C5 detector will be described briefly in the next subsection.† Then the CAL, CTD and VXD, which are crucial for the analysis in this thesis, will be described in some detail.

3.2.1 Veto Wall and C5

At ZEUS, background to physics events come mostly from halo particles and particles produced in proton beam gas interactions upstream of the main detector. The VetoWall and C5 are positioned upstream of the main detector to discern these background events.

The Veto Wall detector[18,25] locates at $z = -7.5m$. It consists of an iron wall of thickness $87cm$ and area $8m \times 9m$ with two layers of scintillation hodoscopes installed on both sides. It recognizes whether particles have penetrated the iron wall and also checks whether the hits are in coincidence with arrival of the beam proton bunches. Information provided by the Veto Wall detector can be used by the first level trigger to reject proton beam background.

The C5 monitor is an assembly of scintillation counters partially surrounding the beampipe for the purpose of beam quality monitoring. It measures rates and arrival times of the halo particles accompanying electron and proton beams. The beam arrival time measurement, accurate to $1ns$, provided by this rather small device made a large contribution in the first two years of data taking and analysis.[26]

† Beam collimators and beam scrapers protect the ZEUS detector from most of the beam induced background.[18] Description of the ZEUS detector here is limited to the instrumented parts.