0.1 The HERA-B Internal Target

For the HERA-B experiment an internal target in the 820 GeV HERA proton ring, built out of 8 independent movable wires, is foreseen as the source of the B-mesons. A constant interaction rate of 40 MHz equally distributed on the different wires is required [1, 2].

Since 1992 test measurements with internal targets were carried out at the HERA proton ring in the west right straight section (WR118) to study their performance [1, 2, 3]. These test measurements were continued in 1995 with large effort.

A major improvement in 1995 was the completely new built target mechanics, which allowed the first time to move four forks simultanously from all four sides close to the proton beam (see Fig. 1). The forks have been equipped with $50{*}500\,\mu\mathrm{m}^2$ ribbons, two made out of aluminium, the other two out of copper.

Over several weeks of continuous running more than 30 successful measurements have been carried out parallel to HERA e-p luminosity operation. During this time regular shifts have been scheduled successfully the first time inside the HERA-B collaboration.

HERA was operated with 180 proton bunches. The integrated current was increased by nearly 50% compared to 1994, up to peak values above 70 mA, with typical lifetimes of several hundred hours. The high proton lifetime, already observed in 1994, results in a natural lossrate ($r_{\mathrm{loss}} = 37\ \mathrm{MHz} \cdot \frac{\mathrm{I}_p[100\ \mathrm{mA}]}{\tau_p[100\ \mathrm{h}]}$) too small to achieve the desired HERA-B interaction rate of 40 MHz. Therefore the wires have to be moved closer to the beam to scrape directly protons away from the tails of the proton distribution. Considerations to disturb and blow up the beam in a well defined way, e.g. by applying white noise to a magnet are under discussion [4]. This artificial increase of diffusion would in addition be helpful to stabilize the interaction rate, because it would smear out the sharp edge of the beam density distribution at the wire target and would make

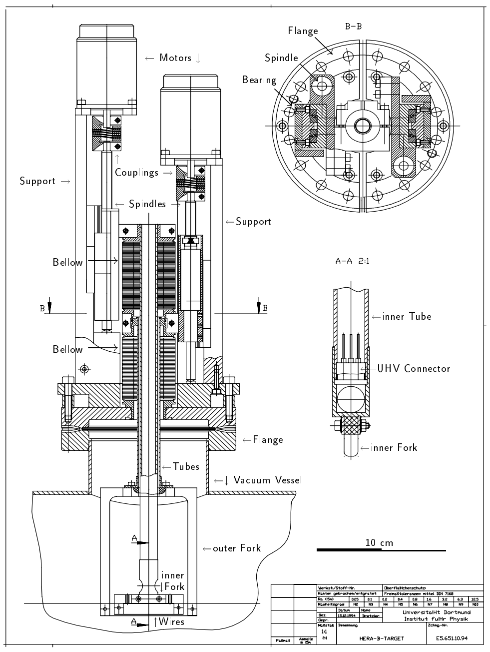

Figure 1: Technical drawing showing the 1995 target setup. Always a pair of forks is mounted on one vacuum flange.

the rate less sensitive to unavoidable fluctuations of the proton beam. The interaction rate was analysed with a frequency analyser yielding the spectrum shown in Fig. 2.

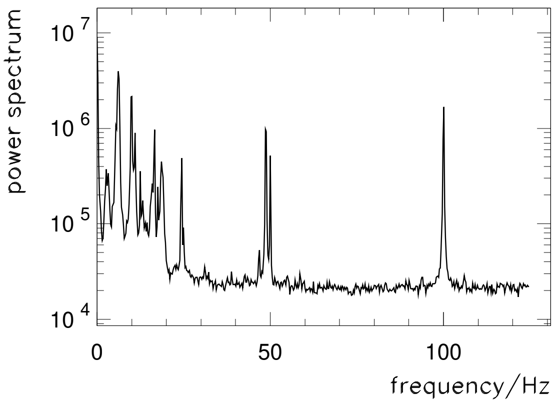

Figure 2: Power spectrum of the interaction rate showing typical lines from power supply ripple at 50 and 100 Hz but also lines from vibrations of machine elements.

A large progress was made in 1995 for the steering and the control of the target. The main control program runs now on a VME-CPU under LynxOs with an interface to the controller of the stepping motors and a direct scaler readout of several relevant rates. The complete target is then controlled from a graphical user interface based on TCL/TK, which runs on any workstation and communicates over a TCP/IP based protocol with the control program on the VME-CPU.

Several different steering algorithms have been developed and tested in order to stabilize the rate and to equalize the contribution on the different wires. Fig. 3 shows an example where all four wires contributes to a stable interaction rate. The different wire distances reflects mainly the difference in the horizontal and vertical beam dimension and to a minor amount the different target materials.

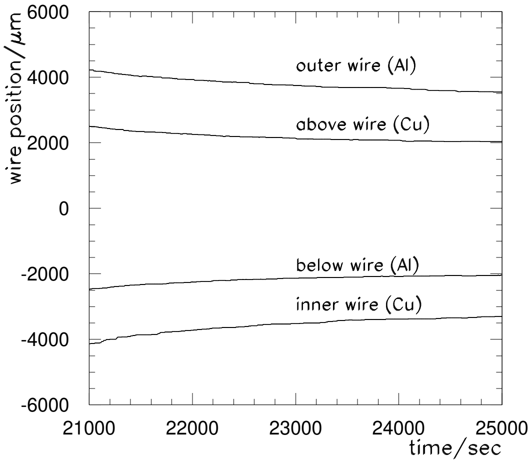

Figure 3: Automatic movement of all four target wires at a constant rate of 12 MHz.

Quite some effort was undertaken to determine the impact of the individual wires to the global rate, e.g. several different counters for the target monitoring system have been succesfully tested in 1995. One relative simple and effective way to investigate the contribution of individual wires is given by the rate asymmetry in counters at different geometrical locations, e.g. up-down asymmetry: $\mathrm{A}_{\mathrm{ud}} = \frac{\mathrm{rate}_\mathrm{u} - \mathrm{rate}_\mathrm{d}}{\mathrm{rate}_\mathrm{u} + \mathrm{rate}_\mathrm{d}}$. Fig. 4 shows for several measurements the two-dimensional asymmetry. Background gives usually an asymmetry point very distinct from that coming from wire interactions. Having in mind the inaccuracies in the calibration and geometrical alignment of the counters, the single wires give well separated asymmetry points at the expected locations. The intersection point between the horizontal and vertical wire pairs defines the beam center and the equilibrium, where all four wires contributes. This point didn't lie in the geometrical middle of the individual asymmetries, mainly caused by the different track multiplicity of the two different target materials. However the different relative changes of the single wire asymmetries ($\Delta A/\Delta x = 0.015...0.04/\mathrm{mm}$) lead with good precision to equal distances to the beam center and scales consistently for the horizontal and vertical wires ($\Delta A_{ud}(\mathrm{Cu})/\Delta A_{ud}(\mathrm{Al}) = \Delta A_{lr}(\mathrm{Cu})/\Delta A_{lr}(\mathrm{Al})$). The asymmetry points where all four wires contributes (run 5, 11 and 13) lies even for different proton fills reasonable centered between the individual asymmetry points.

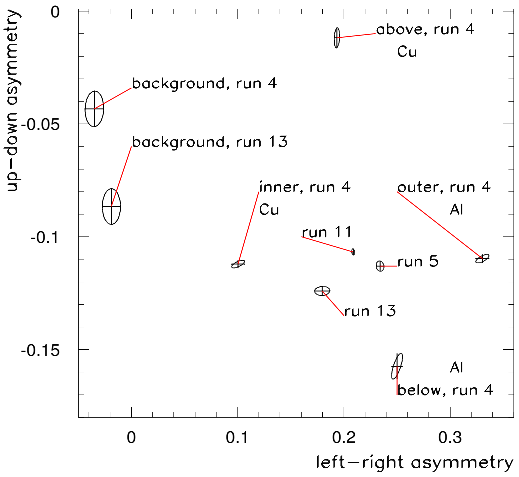

Figure 4: Several measured asymmetry points with $1\,\sigma$ error ellipses.

Another important topic in the 1995 target test run was the study of the background caused by the wire target [5]. While the central detectors of the other HERA experiments (ZEUS, H1 and HERMES) usually didn't suffer from any additional background, the new forward spectrometers showed a large sensitivity to the target rates. Especially the ZEUS LPS and FNC detectors had observed in the beginning of the 1995 run a very large increase of their background proportional to the HERA-*B* rates. The situation improved significantly by a more stable operation of the HERA machine and by the optimization of the proton collimators and the tune.

In 1996 the HERA-*B* target will be operated at it's final location inside the vertex vessel in the HERA West Hall with eight independently moveable wires, the new HERA-*B* optics and an improved proton collimator system [2].

References

[1] T. Lohse *et al.*, *HERA-B An Experiment to Study CP Violation in the B System Using an Internal Target at the HERA Proton Ring*, Proposal: DESY-PRC 94/02 (1994).

[2] Technical Design Report

[3] MPI-Kernphysik, Jahresbericht 94

[4] M. Seidel, *HERA-B Interaction Rate versus Luminosity at ZEUS and H1*, DESY HERA 95-10 (1995).

[5] E. Lohrmann and M. Seidel, *Study of Background Caused by Scattering at the HERA-B Wire Target*, DESY HERA 95-04 (1995).