8 Particle Physics at DESY/HERA (HERA-B)

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in collaboration with:
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(**Hera-B** collaboration)

In last years annual report [1] we have reported in detail on the status of the Hera-B experiment, its goals, and on the motivation for our modest participation in this experiment. Since the experiment is still in the debugging phase, and our contributions to its development only minor - all of us have predominantly been occupied with other projects - we will keep the report on these aspects short, and concentrate on the only part of the Hera-B experiment, to which we have made contributions, the inner tracker (ITR).

With the completion of the thesis of T. Walter [2] our own research and development project concerning the development of microstrip gas chambers (MSGC) with gas electron multiplier (GEM) foils, has come to an end. We will, however, continue to contribute the maintenance, repair and replacement of defect MSGC's within the ITR, and are for this purpose supervising, as in the past, the production at the laboratories of IMT (Masken und Teilungen), Greifensee.

The present status of the inner tracking system is as follows: During the run period 2000 the stations in front of the ring imaging Čerenkov (RICH) (see Fig. 8.1) have been installed,

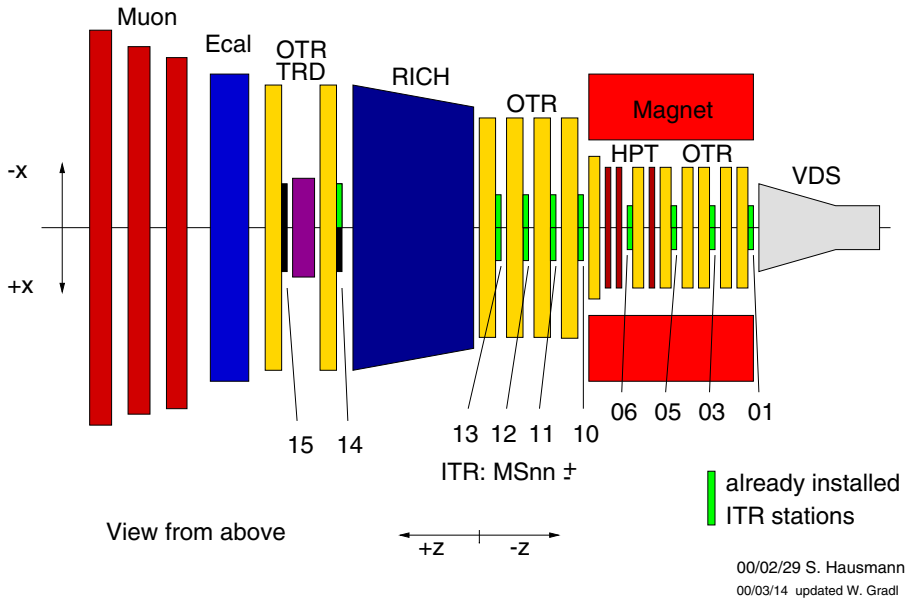

Figure 8.1: *Hera-B - tracking components. OTR: Outer tracker; ITR: inner tracker, VDS: silicon tracker. The inner tracker stations, which already have been installed are labeled MSnn, with* $nn = 01 \ldots 15$.

commissioned and finally routinely operated for a period of 6 - 8 weeks stably at target rates of 5 to 20 MHz with efficiencies between 90% and 96% (see Figure 8.2). These levels were reached after careful training during target operation. The drift and then the GEM voltages were slowly raised over a period of typically one week. This led to a continuous reduction of

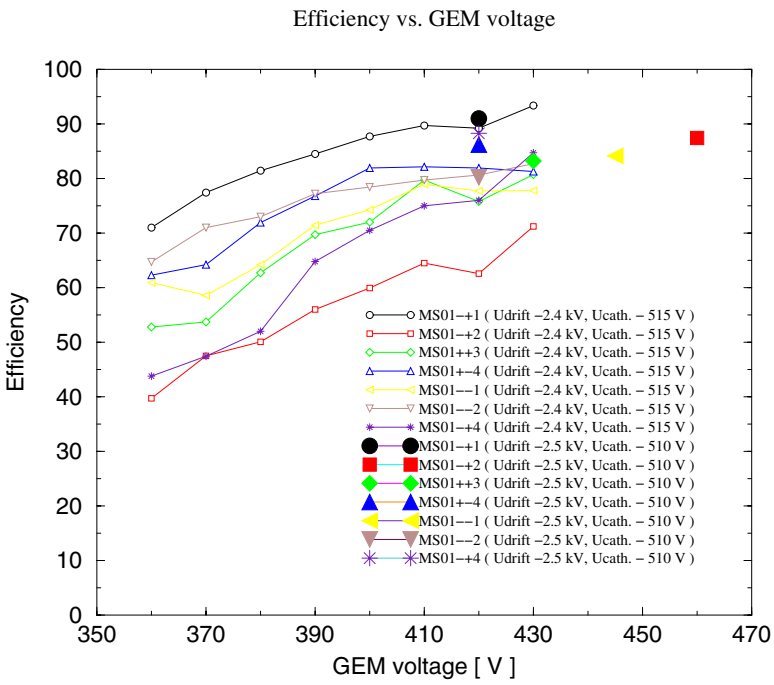

Figure 8.2: *Efficiency curves of MSGC MS01 versus GEM-foil voltage for fixed cathode voltage of 510 V. The filled symbols show the efficiencies for the current voltage settings after individual gain adjustments.*

the number of GEM sparks and subsequent trips. With a gas mixture of Ar/CO_2 (70%/30%) all detectors are first operated with a cathode voltage of 510 V and a GEM voltage of 420 V. With these settings the detector pulse height and gas gain varies up to a factor of 2.5 between different detectors, due to variations of the GEM gain of unknown origin. Invidual GEM voltage adjustment is therefore necessary to equalize response.

The ITR was not yet used in the first level trigger because the threshold could not be lowered enough to get acceptable efficiency. In August 2000 a new trigger setup was tested in Hera-B with three detectors using improved grounding and reduced voltage swing of the trigger outputs. This allowed efficient triggering under realistic beam conditions. Part of the improvements are based on the results of tests performed at PSI, which are described in the thesis of T. Walter [2].

During the shutdown 2000/1 the ITR undergoes major revisions, part of which are already completed, namely: All detectors are equipped with improved grounding to minimize baseline fluctuations and noise levels. Detectors with major defects were replaced, weak points of detectors were eliminated like some high voltage cable connections and protection diodes which were damaged. All anodes which produced shorts (about one in 2 detectors) were cut at the fan-in.

All detectors in the trigger stations will be equipped with new HELIX frontend boards using HELIX 1.3a chips. These have full pipeline length, an improved current source which is not oscillating and they can be reliably read out with a readout clock frequency up to 30 MHz. This way the readout can be done with minimal deadtime up to first level trigger rates of 90 kHz.

The calibration and alignment have been carried out for the 2000 data. The procedures are established to do it fast in the coming running period again. The construction program is an integral part of the overall Hera-B reconstruction. The code is also implemented in the second level trigger filter. Major problems were observed in 2000 with the stability of the readout system and online sparsification. The biggest problem were frequent failures of the low voltage power supplies. All of them have been modified in the meantime to

improve protection and reliability. Online sparsification is still under investigation and will be gradually improved.

A complete account of the status of the Hera-B experiment at the end of the run (autumn 2000) is contained in reference [3]. This is the status, which was reported to the DESY program review committee. This report was critically reviewed by the committee, which arrived at the following conclusion:

The original aim of the Hera-B experiment, which has been approved in 1995, has been the study of the question, why the universe consists mainly of matter although in the big bang matter and anti-matter had been produced equally. Experimentally the CP violation of B mesons is measured. It has been clear from the beginning, that the experiment would be very difficult and that detectors with unprecedented radiation hardness would have to be developed. Unexpected difficulties during this development resulted in delays. In parallel with Hera-B special electron-positron storage rings, each with one detector, have been developed in Japan and in the USA. They have already presented first results towards the CP violation of B mesons. Therefore the DESY PRC (Physics Research Committee) concluded in October 2000, that Hera-B would not be competitive with these experiments. On this basis and considering the critical manpower situation at DESY, the DESY EWR (Extended Scientific Council) recommended an orderly termination of Hera-B in the near future.

Further evaluations within the collaboration and presentations made to the DESY directorate, including an alternative physics program for the next two years, resulted in January of this year in the approval by the DESY directorate of the revised physics program. The relevant statement reads as follows:

The Hera-B collaboration has presented a revised physics program for the next two years and detailed plans for detector improvements, the running of the experiment and organisation of data and physics analysis. The collaboration has in this way taken into account the recommendations of the PRC and the EWR. The data and first results will be available by the end of 2002. The continuation beyond 2002 requires a detailed re-evaluation of the scientific potential of the Hera-B experiment.

The planned physics program covers open questions of strong interaction physics and rare decays of charmed quarks. Central themes are: the measurement of the B cross section in proton-nucleus interactions, the study of the production of charmonium states and the Drell-Yan production of lepton pairs, as well as the search for rare charm decays like $D^0 \to \mu^+\mu^-$. This physics program can be performed essentially with the detector in its present state and the manpower available in the collaboration.

The collaboration wants to demonstrate with this physics program, that Hera-B is a powerful precision spectrometer for the study of rare decays of charm and beauty.

References

[1] Physik-Institut, Universität Zürich, Annual Report 2000/1, available at *http://www.physik.unizh.ch/jb/2000.*

[2] *Contributions to the Development of Microstrip Gas Chambers (MSGC) for the Hera-B experiment*, Thesis T. Walter (February 2001).

[3] *Hera-B, Report on Status and Prospects*, 330 p; Executive Summary, 31 p; available at *http://www-hera-b.desy.de/general/publications/hb2k/.*

[4] Talk given by the spokesman at PRC, DESY, October 2000, available at *http://www-hera-b.desy.de/general/talks/prctalk/prc_Oct00.ps.gz.*