Development of HERA-B high–p$_T$ trigger

Vitaly Eiges

DESY
HERA–B Collaboration

May 25, 1998

Abstract

The main goal of the HERA–B fixed target experiment at the HERA proton ring is to measure the CP asymmetry in the decay $B^0 \to J/\psi K_S^0$, which is sensitive to the $\sin 2\beta$ parameter of the unitarity triangle. The high–p$_T$ hadron trigger of HERA–B provides a capability to obtain results complementary to the main goal of the experiment.

The implementation of the high–p$_T$ trigger allows to make an effective selection of two–prong B–meson decays i.e. events with pairs of oppositely charged tracks having large invariant mass and high transverse momenta. Measurement of asymmetry in the decay $B^0 \to \pi^+\pi^-$ could be used to extract $\sin 2(\beta + \gamma)$ parameter. The total yield of reconstructed $B^0 \to \pi^+\pi^-$ events on HERA–B amounts to about 500/year. It was recently pointed out that a constraint or even a measurement of the angle γ of the unitarity triangle is also possible via the measurement of asymmetry between decay rates of $B^0 \to K^+\pi^-$ and $\bar{B}^0 \to K^-\pi^+$. There will be approximately 750 of such decays reconstructed per one year of HERA–B running. A high suppression of minimum bias background (up to 6 orders of magnitude) could be achieved by use of detached vertex requirement, topological cuts, additional secondary vertex requirement and others.

The high–p$_T$ trigger uses three layers of pad chambers located within the HERA–B magnet. Each layer has chambers with different pad sizes to assure a projective geometry of pads. This allows a fast selection of tracks with high transverse momenta.

The inner region of each layer is covered by the gas pixel chambers developed at ITEP (Moscow). The outer region is covered by straw tubes with cathode pad readout developed at Princeton University.

Full scale prototypes of gas pixel chambers were extensively tested. An efficiency of 99.87% has been obtained with a test chamber. The high efficiency is extremely important since the chamber efficiency enters the total one to the 6th power (for two–prong B–meson decays). A chamber prototype with $10.4 \times 10.4\ mm^2$ pad size filled with the fast CF_4 based gas mixture allows detection of more than 99% of all particles within 80 nsec. Stable operation was achieved with fluxes of up to 10^6 particles/cm^2/sec without any visible degradation of the performance. The full scale prototypes worked well for about one and half years in HERA–B experimental hall under real conditions.