Aging Studies for the Inner Tracker of HERA–B

(title assigned)

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The Inner Tracker of the HERA–B experiment at the Deutsches Elektronensynchrotron (DESY) is a position-sensitive detector which was designed to be exposed to a particle flux density up to $2 \cdot 10^4$ MIPs/mm^{2}s and to a radiation dose up to 1 Mrad/year (10 kGy/year). The system consists of Microstrip-Gas-Chambers (MSGC) using a Gas Electron Multiplier (GEM) as preamplifier structure in the gas volume. During the R&D phase, long term aging measurements with X-rays were performed to study which materials and glues do not lead to aging of the detector over long running periods.

Summary of Talk: Aim of measurements: The aim of the high rate and long term aging measurements with X-rays described here was to study which materials and glues do not lead to aging of the GEM-MSGC detector with Ar/DME 50:50 as counting gas over long running periods. The typical running time at HERA–B is 10^7 s/year. For a GEM–MSGC which is operated at a gas gain of 4000 and which is exposed to an average particle flux of $1 \cdot 10^4$ MIPs/mm^{2}s the total accumulated charge amounts to 5 mC/cm per year. The aging measurements were performed within the scope of the development of the detectors for the Inner Tracker at HERA–B and took place at the high rate test setup at the Physikalisches Institut of the University Heidelberg.
Test setup: The detectors were irradiated with a particle flux up to $20 \cdot 10^3$ γ/mm^{2}s (Cu-K$_\alpha$). A very clean gas system was used for the gas supply, with components made of stainless steel and sealing rings made of Kalrez. Several bypass devices furthermore allowed to add α-particles as well as 0.3 % water to the counting gas and to direct the gas over additional samples of materials or glues.
Results: Aluminum and gold as electrode material for the MSGC structure were tested. For aluminum a significant decrease in the pulse height was observed for a total accumulated charge of much less than what is expected after one year of running at HERA–B. The aging was observed both for Ar/CO_2 70:30 and Ar/DME 50:50 as counting gas. The cathode strips showed large and small bubbles after running with Ar/CO_2, whereas after the operation with Ar/DME the cathode strips were covered with small craters. No aging effects and no damages of the cathode were observed for MSGC's with an electrode structure made of gold. Adding 0.3 % water to the counting gas led to a more stable detector operation but also to massive aging of the anode strips and in consequence to a strong decrease of the pulse height and energy resolution. A thick coating on the anode stripes was visible with the microscope. In addition some anode strips showed 'worm-like' growths in the plane of the MSGC substrate.