Aging Studies for the Cathode Strip Chambers of the CMS Muon Endcap Detector

(title assigned)

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The CMS Endcap Muon system will consist of 540 six-plane cathode strip chambers with an overall area of a thousand meters square and about 2.5 million wires. Given the scale of the detector the primary concern is obviously the reliability and chamber aging is one of the critical points of the system operation. Two CMS ME1/2 production Cathode Strip Chambers were tested to study chamber performance and aging effects in the high-radiation environment at the Gamma Irradiation Facility (GIF) at CERN. At an accumulated dose of 0.3 C/cm, equivalent to about 40 years of LHC operation at full luminosity, no evidence of dramatic chamber deterioration was observed. There was no significant change in gas gain and chamber efficiency, and the dark counting noise rate remained within the acceptable range. Only one sign of aging phenomena was found in the decrease of the strip-to-strip resistance, which indicates accumulation of deposits on the cathode planes but it did not affect the chamber performance.

Summary of Talk: Two sets of aging test with EMU Cathode Strip Chamber were performed at GIF. The 6-plane ME1/2 production chambers of 0.8 m $\times$ 1.8 m were irradiated over 0.4 m^2 at a rate of 18 kHZ/cm^2 for 4–5 months. Chambers were tested with an $Ar/CO_2/CF_4$ 40:50:10 gas mixture using a prototype of the closed-loop circulation system where oxygen and water were being removed by purifiers. The prototype contained the same materials (including all piping) and components that will be used in the final CMS gas system. The flow rate was about 1 chamber volume per day in purging mode and 4 volumes/day with the closed-loop circulation system. The impurity levels in the gas system were monitored with oxygen and water sensors and a gas chromatograph. In both experiment – with and without circulation system – we did not find any indication of aging which could cause a deterioration of chamber performance under realistic LHC conditions. Chamber parameters like gas gain and chamber efficiency did not change up to 0.3 C/cm. The dark current and wire noise rate remained at the same level as at the beginning of the test, about 1-10 nA per plane and 8-10 Hz per anode wire group ($\sim$120 cm^2). Only one evidence of an aging effect was discovered in form of a drop of strip-to-strip resistance by two orders of magnitude (from 1000 GOhm to 10 GOhm) but it stayed at a level about two orders above the safety limits. After the chamber was disassembled some deposits were observed on the cathode planes. From the previous aging test with a CSC prototype the deposit was mostly connected to a silicone coating which came from the machined FR-4 material existing in the chamber gas volume and silicone RTV used for chamber sealing. The gas-chromatographic analysis showed that within errors ($\pm$ 200 ppm) we do not see any difference between premixed gas and working gas mixture in the circulation system. The oxygen in the system was found to be at the level of 140 ppm and the water at about 10 ppm. All tests showed that EMU chambers operated with a $Ar/CO_2/CF_4$ gas mixture can be run in the LHC environment without appreciable aging effects.