Further Advances in Aging Studies for RPC's

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Aging phenomena in RPC's have been studied in the framework of the ATLAS experiment since 1997 on small size prototypes, irradiated with a ^{60}Co source. The early results evidenced a decrease of the detector's rate capability at fixed electric field due to an increase of the total resistance of the electrodes. This behavior was recently confirmed by an extensive aging test performed on the ATLAS RPC 8220 (module-08221) at the GIF-X5 facility of CERN, that showed a residual rate capability of 300 Hz/cm^2 after the equivalent of 12 years of the ATLAS experiment, the initial value being 2 kHz/cm^2. The primary cause of this effect was clearly attributed, with the help of systematic laboratory tests, to a degradation of the anodic graphite coating, which distributes the electric field on the Bakelite electrode. We present here a systematic test of an improved graphite coating, carried out on single Bakelite electrodes as well as on fully assembled RPC's irradiated at the GIF. The test results indicate an improvement of at least a factor of 2 in the detector aging.

Summary of Talk: Aging phenomena in RPC's have been studied in the framework of the ATLAS experiment since 1997 on small size prototypes, irradiated with a ^{60}Co source. The early results evidenced a decrease of the detector's rate capability at fixed applied electric field due to an increase of the total resistance of the electrodes. Due to the detector working current, the resistance increase produces an increase of voltage drop on the resistive electrodes, thus reducing the effective electric field applied to the gas. This behavior was recently confirmed by an extensive aging test performed on the ATLAS RPC 8220 (module-08221) at the GIF-X5 facility of CERN. The test consisted in irradiating the detector at working point conditions in order to integrate 10 years of working at the LHC under the conditions expected for the ATLAS experiment, including a safety factor of 10 (10^{10} counts/cm^2). This can be expressed in terms of total integrated charge, knowing the average charge per count (30 pC) delivered in the gas at full efficiency. This number depends of course on the front-end electronics threshold. Both the total counts and the current were monitored during the test, to estimate the aging progress. Periodically, both the detector performances with the X5 muon beam and the electrodes' total resistance were measured. The latter was obtained by measuring the average charge per count vs. the applied electric field for different source intensities. Representing the previous quantities vs. the effective field (i.e. the applied field decreased by the unknown ohmic drop) it is possible to fix the electrodes' resistance left as a free parameter. These measurements showed a residual rate capability of 300 Hz/cm^2 after 12 ATLAS years equivalent, the initial value being 2 kHz/cm^2, while the electrodes' total resistance increased by a factor of 12. The primary causes of this effect were clearly attributed, with the help of systematic laboratory tests, to some initial evolution of the Bakelite resistivity, but mostly to a degradation of the anodic graphite coating, which distributes the electric field on the Bakelite electrode. We present here the results of these tests by comparing the behavior of the previous graphite coating with an improved one. The test is carried out on single Bakelite electrodes, small detectors operating in pure Argon as well as fully assembled RPC's irradiated at the GIF and equipped with the standard front end of ATLAS. The laboratory tests were carried out on Bakelite samples of different resistivities to study the aging process which is of purely electro-chemical nature, and to compare the different performances. This was done by applying 400 V on 2 mm thick Bakelite slabs coated with graphite on both sides, in order to integrate the desired amount of charge. The test on the fully assembled detector was performed at GIF-X5, similarly to the test cited above, to check under realistic conditions the effective gain, in terms of aging, of the new setup. The test results indicate an improvement of at least a factor of 2 in the detector aging.