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Aging studies of the triple-GEM detectors for future upgrades of the CMS muon high rate region at the HL-LHC

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The high-luminosity LHC (HL-LHC) upgrade is setting a new challenge for particle detection technologies. In the CMS muon system based on gas detectors, the increased luminosity will yield a ten times higher particle background compared to the present LHC conditions. To cope with the high-rate environment and to maintain the actual performance, new Gas Electron Multiplier (GEM) detectors will be installed in the innermost region of the forward CMS muon spectrometer, $2 < \eta < 2.8$ (ME0 project). The detailed knowledge of the detector performance in the presence of such a high background is crucial for an optimized design and efficient operation at the HL-LHC. A precise understanding of possible aging effects of detector materials and gases is of extreme importance. For this reason, aging tests of full sized triple-GEM detector operated with an Ar/CO_2 (70/30) gas mixture at an effective gas gain of 2×10^4, are in course at GIF++, the CERN Gamma Irradiation Facility. One detector is irradiated with 662 keV gamma - rays from a 14 TBq ^{137}Cs source and, in parallel, a second similar detector with 22 keV X-rays at the quality control lab. This contribution describes the performance of triple-GEM detectors during the irradiation test and reports on their state-of-the art.

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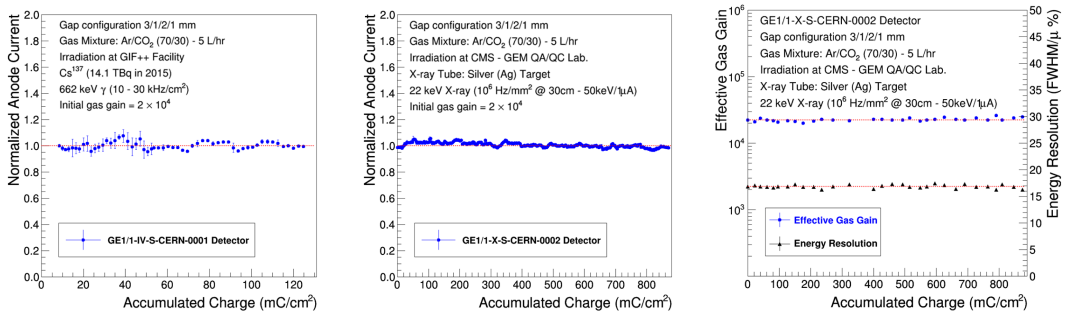
1. Introduction

The goal of the CMS GEM aging test campaign at the CERN Gamma Irradiation Facility (GIF++) [1] and in the CMS-GEM Production Lab. [2] is to qualify ten years of CMS-GEM operation at HL-LHC, with a minimum safety factor of three.

2. Aging studies of CMS triple-GEM detectors

The result for the anode current shown in Figure 1(a) indicates that the CMS triple-GEM detector does not suffer from any kind of aging effects or long-term degradation on GIF++[3].

An aging test with high rate 22 keV $X-$rays source was also set up in summer 2017 on CMS-GEM Production Lab. Not only monitor the anode current, also measure effective gain and energy resolution every week, i.e. every 30 mC/cm^2 of accumulated charge (Figure 1(c)).



(a) (b) (c)

Figure 1: Figure 1(a): Result of the GEM aging test at GIF++ showing the normalized and corrected anode current as a function of the accumulated charge. Figure 1(b): Result of the GEM aging test with $X-$ray showing the normalized and corrected anode current as a function of the accumulated charge. Figure 1(c): Result of the GEM aging test with $X-$ray showing the normalized corrected gain and energy resolution as a function of the accumulated charge.

3. Conclusion

The preliminary results presented in this paper indicate that the CMS triple-GEM detector can sustain the continuous operation in the CMS endcap environment for over 10 years at HL-LHC without suffering from any performance degradation.[2].

References

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