

## Study and mitigation of discharges in CMS triple-GEM detectors

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The GEM project of CMS encompasses the development, construction, and operation of three new triple-GEM detector systems, GE1/1, GE2/1 and ME0, for the upgrade of the forward muon spectrometer. The development of these systems and the operation of multiple advance-design demonstrators installed in the experiment, allowed for thorough studies of the gas breakdown effect that typically leads to discharge of energy stored in the GEM foils. This so-called discharge process has been investigated in different detector configurations, from single GEM hole to full size triple-GEM modules, and the consequences of discharge events were measured.

We studied the internal processes that could lead to the formation of discharges and their propagation inside the detector volume. We established the probability for such events to happen depending on the electric field strength, the internal detector capacitance, and the type of coupling to the high voltage power system. We measured the impact of discharges on the detector performance and longevity, looking at both the microscopic damage of the GEM foil itself, and the probability to damage peripheral systems such as the front-end electronics.

In this report, we summarize the studies of discharges in CMS GEM detectors and the strategies developed to mitigate the short-term and long-term degradation of detector performance.

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