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Anode charge-up in resistive Micromegas and its quenching effect on spark development

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Fast evacuation of avalanche ions in Micromegas makes these detectors capable of withstanding very high rates with no loss of gain. But this intrinsic high-rate capability is often compromised by sporadic sparking which introduces dead time and is potentially harmful for the readout. Resistive electrode designs, by limiting spark current and keeping voltage drop locally, provide an effective remedy. They are thus quite popular, but there is actually more to them than simply spark attenuation. We propose that the spark probability is also drastically reduced because of charge-up of the resistive electrode surface. The underlying mechanism is a progressive reduction of field (in the region where spark-initiating avalanches develop) by the charges successively incoming onto the surface. We predict that the time constant with which the surface potential is relaxed is crucial to the success of this quenching mechanism. Small prototypes with a time constant varying over 5 orders of magnitude were built to verify this model. During tests in a high intensity hadron beam, spark quenching was observed for time constants larger than roughly 1-10 ns, corresponding to the avalanche timescale in Micromegas. These findings shed light on the basic mechanism of spark quenching in resistive detectors. Of general interest to the gaseous detector community, they also open the way to an optimisation of the resistivity value for best rate capability and full spark suppression.

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