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Effects of High Charge Densities in Multi-GEM Detectors

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Gaseous Electron Multipliers (GEM) are well known for stable operation at high particle fluxes. For the first time we present a study of the intrinsic limits of GEM detectors when exposed to very high particle fluxes of the order of MHz/mm^2.
We give an interpretation to the variations of the effective gain, which, as a function of the particle flux, first increases and then decreases. We also discuss the reduction of the ion back-flow with increasing flux, which was first observed during studies for the ALICE Time Projection Chamber upgrade.
We present measurements with a triple GEM detector, describing its behaviour in terms of accumulation of positive ions that results in changes of the transfer fields and the amplification fields.
The behaviour is expected to be common to all multi-stage amplification devices where the efficiency of transferring the electrons from one stage to the next one is not 100%. Simulations, and measurements on double-stage and single-stage devices complete the discussion.

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