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A Novel Technique for the Measurement of the Avalanche Fluctuation of Gaseous Detectors

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Gas amplification of the electrons created by X-rays, UV photons, or charged particles plays an essential role in their detection with gaseous detectors. It acts as a "preamplifier"with a sufficient gain. However, its gain fluctuates because of avalanche statistics, thereby degrading the energy resolution for monochromatic X-rays. For large Time Projection Chambers (TPCs) the azimuthal spatial resolution at long drift distances is limited by the relative variance of the gas gain for single drift electrons. Conventionally, avalanche fluctuations are estimated from the gas-amplified charge spectrum for single electrons created by a UV lamp or a laser. We have developed a novel technique for the measurement of the relative variance of avalanche fluctuation (f) using laser-induced tracks, exploiting the fixed cluster size of one for each ionization act along the tracks. The primary electrons are multiplied by a gas amplification device, and then collected by several readout pad rows arranged along the laser beam. The signal charges on adjacent pad rows are compared for each laser shot. The value of f is estimated from the width of the distribution of their differences using a straightforward relation. The technique is relatively simple and requires a short data-taking time of several tens of minutes. We present the experimental setup as well as the measurement principle, and the results obtained with a stack of Gas Electron Multipliers (GEMs) for several gas mixtures.

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