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Statistical Modeling of SiPM Noise

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SiPM noises are very complicated in general due to a presence of correlated processes, namely, crosstalk and afterpulsing. From a statistical point of view, SiPM noises are stochastic processes contributing to a total SiPM response charge. The charge is a random variable which could be completely characterized by its probability distribution. Partial characterization of the SiPM response by its mean and variance is the most important practical case. However, discrimination and analysis of specific noise contributions in the total response and optimization of SiPM operations appear to be rather uncertain because of their correlations (the means and variances could not be summed up for dependent variables) and their different dependencies on a bias voltage (relative weights are changeable).
Excess noise factor (ENF) approach extends a well-known measure of an avalanche multiplication noisiness to any stochastic processes especially initiated by a non-random unit input quantity (single electron, single-fired cell). Therefore, all specific noise contributions are represented, distinguished, and analyzed by corresponding ENFs, and the total response ENF is approximately equal to a product of the specific ENFs.
The report presents an overview of statistics and models related to the specific ENFs of the gain, dark counts, crosstalk, and afterpulsing as well as some practical recommendations on their applicability for analysis, optimization, and energy resolution related applications of the SiPM.

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