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Delayed crosstalk and afterpulsing evaluation in silicon photomultipliers

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Crosstalk and afterpulsing in silicon photomultipliers can strongly limit the photon-counting resolution and dynamic range of the sensors. In this work we present a method and measurements to separate the afterpulse and delayed crosstalk components of the delayed correlated pulses in the silicon photomultiplier signal. On one hand, the motivation was to understand the relative contributions of the delayed crosstalk and afterpulses, on the other hand, to investigate the dependency of these components on the substrate doping level. It has been found that the contribution of delayed crosstalk pulses to the silicon photomultiplier signal can be significant (11, 5 and 3%) respect to the contribution of the afterpulses (4.2, 1.2 and 0.8%). As well, even if one suppresses the afterpulses by applying a longer recharge time, the delayed crosstalk component remains unaffected. A decreasing tendency of the delayed crosstalk and afterpulsing contribution was measured with the increase of the substrate doping. The higher the doping level, the shorter diffusion length, that is, the carriers generated in deeper region of the substrate have a decreasing probability to reach the active region. However, the affect of doping on the afterpulses suggests that the phenomenon of afterpulsing is not strictly located in the microcell, but also related to the deeper region of the device.

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