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The new physical model to study the performance of avalanche photodiodes with single photoelectron detection.

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A new physical model of avalanche process with single photon detection capabilities is presented in this work. The new model describes development of avalanche process in time, taking into account the space charge resistance as well as the change of electric field in the avalanche region caused by internal discharge and external recharge currents. Results of simulations are compared with experimental data received with Geiger mode photodiodes from different suppliers. It was found that at fixed over-voltage the signal gain is reduced significantly depending on the space charge resistance and it reaches its maximum value ($2 \times C_p \times \Delta U_p$) when resistance of space charge is zero. The relative value of the reduction in signal gain depends on the pixel capacitance and over-voltage. The timing performance of avalanche photodiodes dependence on over-voltage, capacitance of pixel, parasitic capacitance and the space charge resistance are discussed widely in this work

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