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Numerical simulation of thin 3D detectors with built-in charge multiplication

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One of the required features of tracking devices for the futures upgrades of LHC experiments will be a reduced thickness, in order to decrease the material budget and to achieve lower multiple scattering.
The main drawback related to a reduced sensor thickness is a decrease in the total sensing volume, which translates in a large reduction of the signal available for particle detection. To counteract this effect, charge multiplication can be exploited to increase the sensor signal without significantly affecting the noise figure of the system.

We present a numerical simulation study aimed at defining an innovative thin 3D sensor topology with built-in charge multiplication, able to obtain moderate gains at relatively low voltages.
After proving that the simulator accurately reproduces charge multiplication effects recently observed in 3D detectors, the new sensor concept is presented. The effects of the sensor geometry on the electrical characteristics and the charge multiplication properties are studied both before and after heavy irradiation. The excess noise factor of the proposed sensors is also estimated by using an analytical model, and a preliminary layout and process sketch are proposed.

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