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Development and characterization of large area LGADs for space applications

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Low Gain Avalanche Diodes (LGADs) are silicon detectors that use the impact ionization process to achieve gain values of about O(10) and timing resolution of 30 ps for Minimum Ionizing Particles. In High Energy Physics, the state of the art LGADs used for timing layers have an active thickness of 50 µm and a channel size in the order of O(1 mm2). Space based experiments could benefit from a Time of Flight system composed by these sensors to distinguish between primary and secondary particles interacting in the tracker. Scaling up the technology to match the typical channel area of the micro-strip sensors used in space-borne experiments deteriorates the timing capabilities of the LGADs due, in first approximation, to the increased capacitance. The devices used in this study consist of pad sensors with thickness 50 µm, 100 µm or 150 µm and presents different gain layer profiles to cope with the capacitance variation. Also various layouts are compared to see their effect on the time resolution. The performances of these devices are evaluated Current and Capacitance against Bias Voltage characterization along with Transient Current Technique, to simulate the passage of a Minimum Ionizing Particle , and radioactive sources. By evaluating gain, noise, and jitter, this work demonstrates it is possible to obtain 1 cm2 LGADs with a jitter as low as 40 ps. At the same time, the signal propagation and uniformity are studied since it was observed the channel size makes these features relevant for the timing capabilities.

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