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Measurements of time and spatial resolution of AC-LGADs with different designs

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AC-LGAD sensors are prime candidates for fast and precise measurement of charged particles in a variety of applications. In a fine-pitched pixel or strip AC-LGAD sensor, the signal generated by the passage of a particle is not localized in a limited volume in the sensor, but is shared among multiple electrodes. This signal sharing characteristic allows us to improve the spatial resolution of AC-LGAD sensors beyond the capabilities of common silicon trackers. Since the magnitude of the shared signal depends on the distance between the pixels or strips and the point of passage of the particle, signal sharing is strongly influenced by the geometry of the sensor. The electrode pitch and gap size as well as the shape can be fine tuned to maximize the space resolution, while keeping the detector granularity and the number of channels to be read out under control. Prototypes of AC-LGAD sensors produced at the Brookhaven National Laboratory covering a variety of possible geometries have been studied via Transient Current Technique using an Infrared laser, and the signal sharing, spatial resolution, and time resolution of the different topologies have been measured. These results have been compared with measurements performed in test-beams with 120 GeV protons at the Fermilab Test Beam Facility, or with beta particles generated in the decay of a ^{90}Sr source. A time resolution of $\sim$30 ps can be achieved using AC-LGAD sensors with a thickness of 50 μm, compatible to that of standard DC-coupled LGADs, while presenting a far superior spatial resolution. This combination of high precision, fast timing capabilities, and low material budget makes AC-LGADs an ideal choice for a truly 4D detector.

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