

Layout and Performance of HPK Prototype LGAD sensors for the High-Granularity Timing Detector HGTD

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We report on the layout and performance of Low-Gain Avalanche Detectors (LGAD) produced by HPK as prototypes for the HGTD in ATLAS. The HGTD is a multi-layer upgrade of the ATLAS detector of total area of 6.4m² covering the pseudo-rapidity region between 2.4 and 4.0 with timing sensors with time resolution of 50 ps, representing the first large scale application of the LGAD.

With a common mask, sensors with an active thickness of 50 μm (2 splits) and 35 μm (3 splits) were produced. The different splits refer to different combinations of doping profile of the gain layer and resistivity of the bulk, which were measured using C-V. The layout of the sensors is based on a pitch of 1.3 x 1.3 mm² pads. Single pads with varying distance to the edge and 2x2 arrays with different inter-pad gap were used to determine safe outside and inside dimensions. Large arrays with 5x5 and 15x15 pads were used to investigate the yield by measuring the breakdown voltage. The dynamic properties of the LGAD were determined with charge collection measurements with laser and charged particles yielding the bias dependence of the gain and of the time resolution.

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