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Invited talk: Low Gain Avalanche Detectors (LGAD) for High Energy Physics experiments

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Low Gain Avalanche Detectors (LGAD) represent a remarkable advance in high energy particle detection, since they provide a moderate multiplication (gain ˜ 20) on the collected charge, thus leading to a notable improvement of the signal to noise ratio, which largely extends the possibilities of application of silicon detectors beyond their present working field.

LGAD detectors are based on the standard Avalanche Photo Diodes (APD), normally used for optical and X-ray detection applications. The main differences to them are the low gain requested to detect high energy charged particles, and the possibility to have fine segmentation pitches, thus allowing the fabrication of microstrip and pixel devices which do not suffer from crosstalk in their readouts, which is one of the most common limitations usually found in avalanche detectors. As the LGAD gain remains low, the signal amplitudes are prevented for exceeding the dynamic range of readout electronics. Besides, it also results in reductions of the detector noise, as well as in increased stability.

Signal multiplication in LGAD detectors allows obtaining very low mass sensors, with thickness reduced down to ˜50 µm, while retaining a large output signal. At the same time, they can exhibit good performance even when the Charge Collection Efficiency (CCE) is reduced, for instance as a consequence of their operation under high irradiation conditions. In this sense, LGAD detectors are foreseen as good candidates for their implementation in radiation-hard demanded systems, since the gain implemented in the non-irradiated devices is expected to retain some effect also after irradiation. In addition, the signal enhancement, together with the possibility of thinning the detectors, is expected to provide a remarkable improvement of the timing capabilities.

This work compiles the main aspects of the first LGAD prototype productions fabricated at the IMB-CNM. The most relevant features concerning the LGAD design and the fabrication technology will be disclosed throughout the work, highlighting some of the critical issues addressed during the sample processing. LGAD prototypes have been evaluated in several institutions connected within the framework of the CERN RD-50 collaboration. The main results of their characterizations are gathered here, as well, in order to show the LGAD performance under several operation conditions.

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