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Thin LGADs as radiation-resilient sensors for 4D tracking

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Precise tracking in space and time is becoming a more and more pivotal ingredient in designing high-energy physics experiments. Low-Gain Avalanche Diodes (LGADs) with an active thickness of ~ 50 µm have proved the ability of silicon sensors to provide precise timing down to about 30 ps. At present, this timing performance is maintained almost unchanged up to a fluence of $2.5 \cdot 10^{15}$ 1 MeV equivalent n/cm^2. Thinner substrates can further improve the timing resolution and the radiation tolerance of the LGAD sensors.

At the end of 2022, FBK released a batch of thin LGAD sensors with an active thickness between 15 and 45 μm to investigate the effect of the thickness in improving sensor performances.

A new design of the sensor layout and periphery has been studied and realised, optimised for the sensor thickness and the requirement to withstand high electric fields up to very high fluences.

The state-of-the-art design of the LGAD gain implant from FBK has been used on thin substrates, exploiting the concurrent implantation of boron and carbon atoms in the multiplication region typical of LGAD sensors. This resulted in the most radiation-tolerant LGADs ever produced by FBK.

The electrical characterisation of sensors before and after irradiation, together with the analysis of the signals from laser stimulus and charged particles, will be presented. The impact of the sensor thickness on the collected charge and the timing resolution will be explored and discussed.

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