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[P06] Effect of thermal donors induced in bulk and variation in p-stop dose on the no-gain distance measurements of LGADs

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The Phase-2 upgrade of LHC to HL-LHC by 2027, would increase the number of interactions per bunch crossings (pileup) up to a value of 140-200. To cope with high pileup rates, a precision minimum ionizing particles timing detector(MTD) with a time resolution of~30-40 ps is proposed by the CMS experiment. An endcap part (1.6<|η|<3) of MIP timing detector (ETL) will be based on low-gain avalanche detector (LGAD) technology.
The UFSD3.1 production LGADs from Fondazione Bruno Kessler (FBK) include 2x2 pad sensors from three wafers, with different p-stop dose, but identical gain layer with boron doping - equivalent to FBK scale factor of 1.02 (without any carbon co-doping). Two of the wafers with low p-stop dose have thermal donors induced in the bulk. The purpose behind the variation in p-stop doping was to solve the issue of 'pop-corn noise'that was observed in the previous FBK UFSD3 production batch. Within the individual wafers, the sensors vary with their nominal interpad-gap values. The idea behind these variations within the no-gain region of the sensors is to estimate the optimum nominal interpad-gap value such that the sensors have a high fill-factor (defined as the ratio of the area within the gain region to the area of the total scanning region) and at the same time not undergo an early breakdown.
The IV and CV measurement of the detectors help us in understanding how a variation in the p-stop dose and thermal donors induced in the bulk of the detector affects the properties of the sensor.
We have also carried out a comparison study by using IR-laser in Scanning-Transient Current Technique (Scanning-TCT) for the sensors with different interpad designs from the wafers that differ in thermal donors induced within the bulk. Since, the gain is dependent on temperature, we will show how the fill-factor as well as the charge collected in voltage scans varies with temperature (from 25◦C to -25◦C). As a result of these studies, we can get a clear understanding on how the p-stop dose, thermal donor induced in the bulk and the structural design of the no-gain region cumulatively affect the fill-factor of the sensors with temperature.

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