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New Insight into Gain Suppression and Single Event Burnout Effects in LGAD

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Gain Suppression has been observed [1-5] and dramatic reduction in gain in LGAD is observed after ion beam has been injected, Fig 1. Also, the degradation of gain in LGAD is the highest at normal incidence. Significant reductions in the degradation rates are observed at beam tilting angles. This observation could be examined from different perspectives than it was given until now (charge space effects and screening of the electric field dependence on charge density). Here we examine the effect by studying the differences in the prompt thermal effects within the LGAD structure at different tilting angles.

The dissipated power density that governs the heating depends on the product of the electric field and the current density. Hence, at higher angles, the reduced collected charge density will result in reduced power densities, which can be assumed to cause the reduction in the
surface leakage current-induced degradation (noticed in the SEB effect).

Moreover, the lower energy dissipation at higher angles can be explained by the misalignment of the ion-induced charge eh pair - plasma-like/filament and the potential gradient within the depletion region, as reported by some authors. This reduces the current density within the LGAD structure, which leads to a reduced density of overall energy dissipation. An insight into the significance of degradation of leakage surface current by thermal runaway facilitating fatalities in SEB and the looping effect between bulk and surface leakage current in facilitating the thermal runaway effect is studied for the first time. For this purpose, a dedicated experiment to investigate responses of the peripheral units used for the optimization of LGAD is conducted. Both, experimental results, and concussions from modelling on observed behavior will be presented. Plasma formation mechanism coupled to thermal runaway is explored in SEB results as well, also through more advanced microscopic inspections of fatality SEB features, Fig 1(bottom image) [6], some of them not yet publicly presented. Also, for the first time we present results dedicated for gain suppression search during different SEB phases.

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