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Riddle of Puzzling Ghosts in Double Trench Isolated LGAD

In our presentation, we delve into the investigation of the intrepad (IP) region within double trench isolated LGADs (2Tr TI-LGADs), focusing on double-trenched PINs from both the RD50 and Aida Innova production runs. Our previous research revealed that exceptionally large signals, with prolonged duration, manifest in the IP region alongside the standard IP signals recorded in conventional LGADs with 2JET and 2 p-stops. We have identified a correlation between strong signals and ghost signals persisting in the IP region even when the laser is deactivated. Recently, we replicated a study using double-trenched PINs (without gain layer in pads) and observed no ghost signals. However, under specific laser power and bias threshold conditions, we recorded remarkably high signals in IP region between trenches, with prolonged duration, akin to observations in double-trenched LGADs where ghost signals were present. A new puzzle came after we found ghosts also in irradiated 2Tr LGAD (0.8x1015 neq/cm2) although we could stimulate a strong signal in the IP region with a laser. Observed ghosts in irradiated samples have some important differences in comparison to previously observed ghosts for non-irradiated 2TR LGAD. Those ghosts (seen in the irradiated sample) are much stronger than previous ghosts (amplitude of 3-4 V vs 0.2-0.3 V in non-irradiated W11 LGAD). The frequency of occurrence is much lower (about 30 Hz vs tens of kHz previously). They appear at a very high bias which is close to the damage threshold (previous ghosts appear at quite a low bias, ˜50V, quite far from the damage limit). As emphasized above, this signal does not appear as laser synchronized "strong"signal. It could be that this type of ghost signal, contrary to previous cases from non-irradiated 2 Tr LGADs, does not come from the IP region but from the pad. Not being able to stimulate a strong signal we could not locate the region with the highest occurrence of ghosts in the irradiated sample. An additional charge, opposite to what is seen in PINs may be killing the ghost in the pad region due to the presence of the gain region. It is also possible that due to high hole excess current in the irradiated sample and bulk inversion, depletion starts from the back side and the laser wavelength (800 nm) is too short to interact with the bubble of charge; charge defuses from the non-depleted region between trenches not reaching the critical density needed for ghosts to be formed in IP. In future campaigns at ELI, to decipher the ghost riddle we will explore the ghosts with the fs-laser of different wavelengths and with the lower laser repetition rates.

Type of presentation (in-person/online)

online presentation (zoom)

Type of presentation (scientific results or project proposal)

Presentation on scientific results

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