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Impact of high deposited energy on Single Event Burnout in LGAD sensors

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Silicon sensors with gain such as LGADs (Low Gain Avalanche Diodes) are prime candidates for high resolution timing applications in High Energy Physics, Nuclear science, and other fields. Over the course of their lifetime, these sensors are required to withstand enormous amounts of radiation (>$10^{15} n_{eq}/cm^2$) while maintaining acceptable performances at hadron colliders. Particles interacting with highly biased sensors can produce irreversible damages known as Single Event Burnouts (SEBs).

Recent studies conducted using high energy protons or pions, i.e. minimum ionizing particles (MIPs), have shown that the probability of mortality caused by SEB for these sensors is proportional to the strength of the electric field generated locally by the particle interaction. Thus, the current expectation is that SEB events are more likely when a particle deposits a high amount of energy in the interaction with silicon. Protons and ions in the O(10 - 100) MeV energy range deposit a high amount of energy in silicon in their interaction, increasing the probability of SEBs with respect to a MIP produced at higher energy accelerators.

We exposed a variety of LGADs, pre-irradiated at the Rhode Island Nuclear Science Center up to $1.5 \times 10^{15} n_{eq}/cm^2$, to a high intensity beam of both non-MIP protons and ions produced at the BNL Tandem Van de Graaff accelerator. Results from this study allow us to strengthen our understanding of SEB and permanent radiation damages and parametrize SEB probability in interactions with high deposited energy.

Primary authors: TISHELMAN-CHARNY, Abraham (Brookhaven National Laboratory); TRICOLI, Alessandro (Brookhaven National Laboratory); BUZZI, Alexander (Brown University); PONMAN, Dylan (Brown University); ROSSI, Enrico (Brookhaven National Laboratory); D'AMEN, Gabriele (Brookhaven National Laboratory); GIACOMINI, Gabriele (Brookhaven National Laboratory); ROLOFF, Jennifer (Brown University); KURTH, Matthew (Brookhaven National Laboratory); STUCCI, Stefania (Brookhaven National Laboratory)

Presenter: D'AMEN, Gabriele (Brookhaven National Laboratory)

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