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Radiation performance of new semiconductor power devices for the LHC experiment upgrades

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GaN and SiC power devices were extensively tested under different types of radiation, in the framework of the APOLLO R&D collaboration, aiming to use these new technologies for designing power supplies for the future LHC experiments upgrades.
SiC power MOSFETs were irradiated with gamma-rays, neutrons, protons and heavy ions (Iodine, Bromine) at different energies (20MeV - 550MeV). They showed very good performances in terms of Total Ionizing Dose (TID) sensitivity, but exhibited a quite poor Safe Operating Area (SOA) with respect to Single Event Effects (SEEs).
Enhancement-mode GaN transistors manufactured by EPC, with blocking voltage ranging from 40V to 200V, were irradiated with gamma-rays, heavy ions (Iodine, Bromine), high and low energy protons. They showed a very good SOA toward SEE. After the irradiation with 3-MeV protons at the highest fluence (4·10^14 p/cm^2), the devices exhibited an increase of up to one order of magnitude in gate leakage, almost 1 V of threshold voltage reduction, degradation of the subthreshold slope, and drop in transconductance. The reduction in threshold is in contrast with the increase normally observed in GaN devices irradiated with protons, and is likely due to radiation effects in the layers introduced to engineer the positive threshold voltage

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