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Significant performance recovery of SiPMs' irradiation damage with in-situ current annealing

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We have developed a technique that utilizes the forward current to heat and anneal SiPMs to mitigate the effects of radiation damage in high-radiation environments. We conducted an experimental study on the radiation damage and recovery of SiPMs. SiPMs from three different manufacturers (SengL, Hamamatsu, and Beijing Normal University) were examined. Unlike the conventional method of using low current for prolonged periods, our approach yields a substantial annealing effect in a shorter duration of tens to hundreds of seconds using higher current (about 0.8 A). A magnitude reduction of 1-2 orders in the dark current of all SiPMs was observed post-annealing. When the irradiated SiPMs were subjected to temperature sensitivity testing from -30℃ to 20℃, it was noticed that in-situ current annealing corrected the decreased sensitivity of SiPMs to temperature and enhanced the energy resolution of SiPMs, which restored the peak position of SiPMs to nearly 80% of their pre-irradiation levels. In conclusion, our outcomes demonstrate considerable enhancement of SiPM properties following in-situ current annealing. Therefore, our short-duration but higher-ampere in-situ annealing provides a practical and effective method to improve the radiation resistance of SiPMs in space and collider experiments.

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