Optical Damage to Irradiated Scintillators and Induced Optical Recovery Techniques

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As particle accelerators enter the high-luminosity era and begin operating at unprecedented beam energies, the resulting increase in radiation dosage is causing critical damage to these accelerators' constituent particle detectors and high-energy calorimeters. Scintillators compose the majority of the aforementioned components and are at an especially high risk of radiation-induced optical damage necessitating their near-constant maintenance. Such servicing consumes significant time, capital, and energy, severely limiting the number of experiments possible in given time frame. As such, there is not only a demand, but a need for radiation-hard alternatives to the materials currently used as scintillators. In this study, I investigate the optical properties of fourteen different cerium-doped glasses and plastics before and after exposure to 10 MRads of gamma radiation meant to simulate the environment inside a particle accelerator. All of the investigated materials had shown promising radiation-resistance at lower dosages, but I find that this trend does not continue to more realistic environments and thus expostulate the viability of these materials for usage in particle detectors. I also demonstrate a novel method of pulsing UV light through irradiated scintillators to both dramatically shorten the optical recovery period and induce recovery far beyond the range offered by traditional methods. This latter discovery can be utilized to greatly increase the operational efficiency of radiation-absorbing optical systems in not only high energy physics, but also astrophysics, medical imaging, and even general industry through the development of new optical-healing technologies.