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Radiation Hardness of Thallium Doped Cesium Iodide Scintillation Crystals

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To prepare for the large backgrounds expected to be present in the Belle II detector from the SuperKEKB e+ecollider, the radiation hardness of several $(5 \times 5 \times 30 \text{ cm}^3)$ thallium doped cesium iodide scintillation crystals are studied to accumulated ~ 1 MeV photon doses of up to 1000 Gray. The sample set of crystals studied consists of 2 spare crystals from the Belle experiment and 8 crystals from the BaBar experiment. The two Belle crystals and two of the BaBar crystals are readout using pin diodes glued to the crystal face while the remaining 6 BaBar crystals are readout using a PMT. The crystals are dosed in 6 stages. At each stage all crystals are given uniform dose profiles except for one BaBar crystal which was dosed face on giving a longitudinally non-uniform dose profile. Using Cesium-137 and Bismuth-207 sources and cosmic rays, the longitudinal uniformity of the crystals light yield, scintillation decay times, time resolution and energy resolution are measured at each stage and compared to non-dosed reference crystals. In addition to experimental work, Monte Carlo simulations using Geant4 are used to further understand the baseline experiments and to study the expected effects of radiation damage at SuperKEKB.

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