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Charge transfer inefficiency degradations of the CCD detector induced by proton and neutron radiation

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Charge coupled devices (CCDs) have been widely used as detectors for particle detection and space applications for their merits of low cost, small size and high sensitivity. Charge transfer inefficiency (CTI) degradations of the CCD detector used in harsh radiation environments are one of the main concerns of the detector performance. The CTI degradations are very sensitive to the displacement damage induced by proton or neutron radiation and usually not sensitive to the ionization damage induced by gamma ray or X-ray radiation.
The proton radiation experiments were carried out at the cyclotron accelerator (at China institute of atomic energy, Beijing, China) with energies of 60 and 90 MeV. The neutron radiation experiments were carried out at the back-streaming white neutrons at China Spallation Neutron Source (CSNS) (at institute of high energy physics, Dongguan, China) and at Xi'an pulse reactor (XAPR) (at Northwest Institute of Nuclear Technology, Xian, China). The CTI degradations were measured at the saturation and half saturation illumination.
The research reported herein examines the CTI degradations of the CCD detectors induced by proton and neutron radiation. The CTI degradations versus the proton or neutron fluences are presented. The annealing tests after radiation are also performed to observe the CTI recovery. The degradation mechanisms of the CTI induced by proton and neutron radiation damage are demonstrated in details. The research will provide the basis of the theories and experiment techniques to evaluate the CTI degradations of the CCD detectors induced by proton or neutron displacement damage.

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