Contribution ID: **163** Type: **POSTER**

Radiation damage evaluation of the CCD detector induced by high energy protons

Sunday, 10 December 2017 20:45 (1 minute)

Charge coupled devices (CCDs) have many merits such as low cost, low noise, low power consumption, and high sensitively. Because of these merits, they have been widely used as the detectors for particle detection and space applications. However, the CCD detectors used in the above applications will be operated in the high energy proton radiation environments and be susceptible to radiation damages such as ionizing damage and displacement damage. The radiation damage evaluation of the CCD detector induced by high energy protons will help the designers to improve the CCD detector design, reliability and applicability for applications in the high energy proton radiation environments. Though many papers have been published on the radiation damages in the CCDs, fewer papers have focused on the radiation damage evaluation of the CCD detector induced by high energy protons.

The research reported herein examines the high energy proton radiation effects on the CCD detectors. The radiation experiments are carried out at the cyclotron accelerator (at China institute of atomic energy, Beijing, CHN) with energies of 30, 60, 100 MeV. The degradations of the CCD parameters such as dark current, dark signal non-uniformity (DSNU), saturation output, dynamic range (DR), and signal to noise ratio (SNR) induced by proton radiation are analyzed. The degradations versus the proton fluences are presented. The degradations induced by different proton energies are compared. The degradation mechanisms of the CCD parameters induced by proton radiation damage are demonstrated in details. The research will provide the radiation damage evaluation of the CCD detector induced by high energy protons to instruct the detector design for applications in the high energy proton radiation environments.

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Session Classification: POSTER

Track Classification: Radiation damage and radiation tolerant materials