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Remote detector for high radiation fluences

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Certain applications of ionizing radiation detectors require extreme radiation hardness that is an especially sensitive issue for the electronic part of many of the detectors currently in use. Scintillator detectors have an advantage in the possibility of designing them in two remotely separated units, the all-optical detection unit and the electronic unit converting the optical signal to the electric signal convenient for further analysis. However, the scintillation light collection to the lightguide usually exploited to transfer the scintillation detector in such systems has substantial physical limitations.
We suggest a technique for the detection of high fluences of ionizing radiation with an on-spot all-optical detection unit optically connected with an optoelectronic unit converting the optical signal proportional to the irradiation fluence to an electrical signal. The detection of the ionizing radiation in the detector we propose is based on the change in the optical transmission of the detecting crystal due to the irradiation-generated nonequilibrium electron-hole pairs. To increase the spatial overlap of the volumes affected by the irradiation to be detected and the light beam used for probing of the change in absorption, various experimental configurations ensuring multiple transitions of the detecting crystal by the probing beam were tested and the optimal configuration was identified.
Ce-doped gadolinium aluminum gallium garnet was found to be a promising option as the crystal for the remote detection unit. Moreover, the gadolinium-containing detection crystal is efficient for neutron detection. The capabilities of the detector with the detection properties optimized under optical excitation were tested under X-ray excitation. A linear response of the detector to the intensity of the ionizing radiation is evidenced.

Collaboration

Role of Submitter

I am the presenter

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