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Fast Neutron Induced Radiation Damage in Fast Inorganic Scintillators

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One crucial issue for applications of scintillation crystals in HEP calorimeters is radiation damage in severe radiation environment, such as the HL-LHC. While radiation damage induced by ionization dose is well understood, investigations are still on going to understand radiation damage caused by hadrons, including both charged hadrons and neutrons. In this paper, we report investigations on radiation damage in fast inorganic scintillators, including BaF₂, LYSO:Ce and PWO crystals, by mixed particles, including neutrons, γ -rays and protons, at the East Port of the Weapons Neutron Research facility of Los Alamos Neutron Science Center (WNR of LANSCE). In 2015, three groups of LFS (a type of LYSO) plates (6/each) of $14 \times 14 \times 1.5$ mm³ were irradiated for 13.4, 54.5 and 118 days with fast neutron (>1 MeV) fluences of 0.22, 1.0 and 2.1×10^{15} n/cm² plus ionization dose of 0.45, 2.0 and 4.3 Mrad, respectively. To evaluate the contribution from accompanying γ -rays quantitatively, we applied 5 mm Pb shielding to half samples for a comparison in 2016. Three groups of BaF₂, LYSO and PWO plates of $10/15 \times 10/15 \times 5$ mm³ were irradiated for 21.2, 46 and 120 days with fast neutron (>1 MeV) fluences of 0.39, 0.86 and 1.9×10^{15} n/cm² plus ionization dose of 0.80, 1.7 and 3.9 Mrad, respectively. The results of this investigation show that LYSO and BaF₂ are radiation hard against fast neutrons up to 2×10^{15} n/cm² plus 4 Mrad ionization dose, and the ionization dose dominates the observed damages in these samples.

Secondary topics

radiation damage

Applications

Design concepts for future calorimeter at the energy frontier

Primary topic

Scintillators

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