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Evaluation of fast neutron imaging scintillators

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As neutron imaging emerges as a complement to current nondestructive testing techniques such as X-Ray imaging, more research is focusing on fast neutron imaging. Fast neutrons offer excellent penetration through heavily shielded materials due to their low probability of collision interactions, however this also makes their detection difficult. This work applies lens-coupled imaging to measure several different scintillator screens' aptitude for fast neutron imaging. The experimental apparatus consists of an electron-multiplying charged coupled device (EMCCD) camera and a lithium doped front-surface mirror. We evaluate fast neutron imagers constructed at Lawrence Livermore National Laboratory (LLNL) that consist of Polyvinyltoluene (PVT) scintillators loaded with different dopants and given different backing materials. The PVT scintillators were irradiated both at The Ohio State University's Research Reactor (OSURR), which has a fast neutron flux of approximately 104n/(cm^2 s) and at Idaho National Laboratory's (INL) Neutron Radiography Reactor (NRAD), with a fast neutron flux of 107n/(cm^2 s). Grayscale values of the fast neutron images are utilized to determine the relative light output, while the Modulation Transfer Function (MTF), derived from the images is used to calculate the spatial resolution. These two properties are used to determine the optimum fast neutron imaging configuration. Additional scintillator materials were also subjected to NRAD's fast neutron beam and their imaging properties compared with PVT. Various phantoms are also imaged to demonstrate fast neutron imaging's practical advantages in real-world scenarios.

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