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Qualification and development of fast neutron imaging scintillator screens

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We have performed extensive testing and qualification of different commercial fast neutron scintillator screens in camera-based imaging detectors. These include BC400 organic scintillator from St. Gobain and ZnS(Cu) inorganic scintillator from RC Tritec AG. Furthermore, we have developed simple and inexpensive ZnS-based fast neutron imaging screens and their performance have been tested and compared to the aforementioned commercial ones. ZnS(Ag) and ZnS(Cu) powders have been mixed with optical epoxy, deaerated and casted into sheet form using an aluminum frame. Furthermore ZnS(Ag) was mixed with high viscosity glycerol to create suspension type imaging screen. The ZnS concentration and the screen thickness have been optimized using sample screen pieces. To initially test the performance of the screens, the fast tail of the flux in the thermal NEUTRA beam line at the SINQ spallation source of the Paul Scherrer Institute Switzerland has been utilized. Furthermore, extensive testing has been carried out at the RAD beamline of the 10 MW research reactor of the Budapest Neutron Centre (BNC), Hungary. The latter beamline is routinely utilized for thermal neutron imaging, however it has been adapted to enable fast neutron studies using in-beam filters against gamma and thermal neutrons. Our results indicated that the ZnS(Cu) commercial screen from the company Tritec AG had the best performance which could still be slightly improved according to our results. On the other hand, the BC400 screen performed the worst mainly due to its low light output, which is detrimental in a camera-based imaging detector. The in-house ZnS-epoxy screens produced about 60% of light intensity of its commercial counterpart, which is mainly due to the lower hydrogen density of the optical epoxy compared to polypropylene. The glycerol suspension screen underperformed relative to expectations due mainly to an apparent separation of the scintillator powder and the glycerol. Some fast neutron radiographic images are shown to demonstrate the capabilities of the screens.

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