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Imaging with fast neutrons - improvements in spatial resolution and quantification

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Fast neutron imaging is a technique to investigate large objects where X-rays or thermal neutrons face limitations due to their comparatively low penetration capabilities. Compared to thermal neutrons, where thin scintillators (< 100µm) generally provide good detection efficiencies (» 1%) at high spatial resolutions in the 10th of microns range, fast neutrons currently require mm-thick scintillator materials with low detection efficiencies (~ 1%) at spatial resolutions in the mm-range, often blurring important details in radiographs, such as cracks or small inclusions.

Additionally, the predominant interaction mechanism for fast neutrons is via nuclear scattering in mostly forward direction. This furthermore implicates the traditional imaging approach by placing objects very close to the detector surface to reduce geometrical blurring. In collaboration between the Paul Scherrer Institut (PSI), Forschungs-Neutronenquelle (FRMII) Heinz Maier-Leibnitz, Los Alamos National Laboratory and the company RC Tritec, measurements were performed at the FRMII and LANL to characterize the impact of the mentioned challenges and to find a pathway for quantification and standardization of imaging setups at different facilities, as well as for improving resolution and efficiency of the technique in a collaborative effort. Here we present the results of these measurements, including a break-through in improved spatial resolution by use of a new scintillator concept for fast neutrons.

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