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Experimental Validation of the Model Connecting Time, Contrast Wathlength and Spatial Resolution

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A model describing the connection between time, spatial, wavelength and contrast resolution was presented at ITMNR-8 in 2016 [1]. Resolution limits caused by the sample contrast were derived from the model. The resolution of neutron imaging measurements is limited by practically available illumination time. The time needed for radiography and tomography measurements depends on the fifth and sixth power of the spatial resolution for radiography and tomography measurements, respectively. A general limitation is reached if illumination times of several days per image or tomogram are reached.
Neutron radiographs and a neutron tomography were measured at the BOA and POLDI beamline at SINQ (Paul Scherrer Institut, Switzerland) as well as at the ANTARES beamline at FRM-2 (TU Munich, Germany) to validate the model. Test specimens consisting of an aluminium frame with gold (Σtotal = 6.28 cm-1) and hafnium (Σtotal = 5.12 cm-1) wires with a thicknesses of 75 and 125 µm, respectively, as well as copper (Σtotal = 1.00 cm-1) wires with thicknesses of 20, 50, 75 and 125 µm were illuminated at various times and collimations. The effective pixel size of the detectors applied was adapted by pixel rebining to fit the detector resolution to the wire thickness.
The results will be compared with the predictions of the model. Whereas the hafnium wire becomes visible after few seconds, The 20 µm thick copper wire was not visible even after 6 h illumination time at ANTARES with a collimation of 800 in terms of L/d. The gold, hafnium and the copper wires with 125 and 75 µm thicknesses are visible in the reconstruction of a tomography measured at Antares with 420 projections each 40 s illuminated.
The validity of the model premises are checked. The differences between visual and numerical analysis as well as the practically reachable resolution limits depending on the sample contrast will be discussed.

References

[1] M. Grosse, N. Kardjilov, Which Resolution can be Achieved in Practice in Neutron Imaging Experiments? - A General View and Application on the Zr - ZrH2 and ZrO2 - ZrN Systems, Physics Procedia 88 (2017) 266-274

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