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Propagation-based phase contrast neutron imaging in McStas

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Propagation-based phase contrast imaging is an established method in X-ray imaging. Recent results show that this approach with a Paganin type filter [1],[2] increases neutron image contrast significantly. We demonstrate that we can use this to distinguish materials with low neutron absorption. The neutron experiments were performed at BOA (SINQ@PSI [3]) using the neutron microscope [4]. These data were used to benchmark an implementation of wave propagation in McStas [5].
As proof-of-concept we applied the method to a sample of micrometre thin Al and Zr alternating layers, each of low neutron absorption. We showed that the individual layers can be distinguished using propagation-based phase contrast, despite the divergent and polychromatic beam.
In order to accurately simulate the formation of the phase contrast via sample interaction and wave propagation, a wave description of the neutron was implemented in McStas. This enabled us to simulate the phase difference of the wave gained when passing through the sample and the wave propagation between sample and detector and to replicate the experimental data.
[1] D. M. Paganin et al., arXiv, 1909.11186 (2019)
[2] M. Østergaard et al., arXiv, 2210.01403 (2022)
[3] M. Morgano et al., Nucl Instrum Methods Phys Res A 754, 46-56 (2014)
[4] P. Trtik et al., Physics Procedia 69, 169-176 (2015)
[5] P. K. Willendrup, and K. Lefmann, J Neutron Res 22, 1-16 (2020)

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