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Refraction contrast imaging and edge effects in neutron radiography

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Following the achievements in X-ray imaging several new imaging modalities have been demonstrated recently in thermal and cold neutron radiography. In addition to conventional radiography and tomography based on neutron absorption contrast both propagation and grating-based diffraction contrast as well as phase contrast imaging has been demonstrated with neutrons providing unique non-destructive testing techniques that are complimentary to the X-ray results. In addition, the interaction of neutron spin with magnetic fields enable a unique method of imaging magnetic fields. Existence of both absorption and refraction contrasts in neutron radiographic images has been observed with certain materials and geometries, e.g. aluminum and steel objects with flat and curved surfaces illuminated at grazing incidence.

In this paper we describe the edge enhancement and refraction/scattering effects in neutron radiography measured at thermal and cold neutron beams with a high resolution microchannel plate neutron counting detector. These effects in some cases can enhance the contrast of certain features in the neutron radiographic images. At the same time, the same effects introduce image distortions, as in case of tomographic reconstructions. We also demonstrate how novel microcapillary neutron collimators can enable refraction and scattering contrast imaging in some cases, where the refraction and scattering angles are relatively large. These collimators can also be used to reduce some refraction artifacts, namely remove bright edges in the transmission images.

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