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Neutron grating interferometry –an advanced neutron imaging method

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Neutron imaging is an established technique to non-destructively map the spatial distribution of the elemental composition and density of bulk materials in the sub-millimeter region.
This is achieved by measuring the spatial distribution of the neutron attenuation coefficient in a 2D radiography or 3D computed tomography.
By adding an intensity modulation to the beam additional contrast modalities can be accessed such as phase contrast in the differential phase contrast image (DPCI) or (ultra-) small-angle scattering contrast in the dark field image (DFI).
The most common way to introduce the aforementioned intensity modulation to a neutron imaging beam is a Talbot-Lau grating interferometer.
The DFI contrast contains information of scattering under small angles in form of the slit-smeared real-space correlation function and the total scattering probability.
The correlation function of the sample system is probed at a specific correlation length which can be adjusted depending on the neutron wavelength and position of the sample.
This enables to extract the average (ultra-) small-angle scattering contrast with the spatial resolution of typical neutron imaging instrumentation.
The materials used for plasma-facing components of fusion plasmas are typically dense and consist of heavy elements. This severely limits the applicability of many established techniques of non-destructive testing, especially X-Ray methods. However, neutron radiation is uniquely suited here due to it primarily interacting with the nuclei and thus showing high penetration and good contrast over a large range of elements.
Neutron grating interferometry (nGI) is exceptionally suited to combat the challenges of non-destructive testing and material characterization as it adds information about micro-meter sized porosities and other defects to the pure attenuation signal.
We will showcase the possibilities of this technique on composite tungsten-copper components intended as divertor material showing pores of varying size.
With this poster we want to give an overview over the technique of Talbot-Lau nGI and the methods applied to obtain quantitative results from small-angle scattering with DFI as well as highlight limitations.

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