Contribution ID: **103** Type: **not specified**

Prospects for neutron imaging at the ESS long pulse source

Monday, 16 April 2012 08:50 (20 minutes)

Beside the powerful tool of conventional attenuation contrast imaging with a broad thermal or cold energy spectrum a number of novel imaging methods exploiting a monochromatic beam or energy resolved approaches have become available within the last decade [1]. These developments have the potential and do extend the range of applications of neutron imaging significantly. Modern short pulse spallation neutron sources are advantageous as compared to continuous sources especially for methods requiring relatively high wavelength resolution, which are those utilizing Bragg scattering for imaging contrast and providing spatially resolved information about crystalline structures present in a sample. The planned long pulse target station of the ESS on the other hand provides the potential to serve most to date available neutron imaging contrast methods with an outstanding efficiency [2,3] including (i) conventional attenuation contrast [1], (ii) energy resolved attenuation contrast imaging exploiting Bragg scattering [3,4], (iii) phase contrast imaging addressing the refractive index distribution of the sample, (iv) polarized neutron imaging with the aim to investigate magnetic structures, fields and phenomena [5,6] as well as (v) dark-field contrast imaging with the potential to investigate (magnetic) microstructures beyond real space resolution [7,8]. The potential of wavelength resolved application of the latter methods, i.e. polarized neutron imaging, phase and dark-field contrast imaging but also Bragg edge imaging has been outlined [2,3]. However, the development of such techniques as well as their specific requirements and information output are still a task for intense engagement and further exploration. The state-of-the-art as well as directions of progress will be presented and discussed.
Additionally, the design of an efficient future instrument with such a range of flexibility, in particular concerning wavelength resolution, at the long pulse target station constitutes a significant challenge. This conveys (i) especially an appropriate chopper system, a novel task for imaging instruments [2,3], required to achieve such wavelength resolution as well as to define the utilized wavelength band, (ii) an appropriate transport of a useful divergence, flux and spectrum via neutron guides and optics, but also (iii) novel technological solutions especially for time resolved high spatial resolution image detection [9]. First approaches and ideas for such an instrument as well as its potentials for future science cases will be presented and discussed.

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Session Classification: Introduction