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Perspectives for Materials Investigations at the Structured Pulse Engineering Diffractometer (SPEED)

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Abstract

One important goal of modern engineering investigations is to improve our understanding of materials behaviour and failure on a microstructural basis. Various experimental investigations are performed to achieve this goal comprising measurements of stresses and textures. Those characterizations need neutron measurements if well defined gauge volumes located deep in the bulk of materials are to be analyzed. Complementary investigations are performed with X-rays to characterize surface structures or to investigate lightweight structures with hard X-rays. Neutron investigations should allow for three-dimensional maps of stresses and textures within engineering components or in-situ studies of fatigue behaviour or stresses in rotating machinery. Those measurements are, however, extremely time consuming and can thus not be performed to the required extent at modern instruments such as SALSA at ILL or STRESS-SPEC at FRM II. New perspectives for engineering applications will be offered by new instruments at MW spallation sources such as VULCAN at SNS.

Against this background the Helmholtz-Zentrum Geesthacht proposes to build a novel structured pulse engineering diffractometer (SPEED) at the European Spallation Source (ESS) in Lund/Sweden. The instrument will be based on a novel ToF-design distinguished by a modulation chopper positioned at a distance of ~ 25 m from the source. This chopper will be located ~ 50 m from the sample and allows setting the wavelength resolution almost independently of the wavelength in a broad range from about 0.15% to 2%. Despite the high resolution the chopper system in total has a transmission of about 30% of the 2 ms long source pulses for a broad and selectable wavelength range. SPEED thus will make full use of the high flux of the long pulse spallation source for high resolution diffractometry. The design of SPEED is introduced and its performance based on numerical simulations for texture and stress measurements is outlined. The development of SPEED is performed as an in-kind contribution to the ESS instrumentation, it is part of the German support to the ESS Pre-Construction Phase and Design Update.