New neutron monochromators for hot and thermal neutrons - design and development

Proposer: NPI

Partners: NPI Rez, ILL Grenoble, Institut für Physik, Universität Augsburg, Germany , Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), Technische Universität München, Garching, Germany, European Spallation Source ESS, Lund, Sweden
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Estimated budget (in person months, other direct cost) and tentative distribution per partner:

Abstract of your innovative activity:

At present, neutron monochromators used in scattering experiments with hot neutrons have rather low efficiency which results in correspondingly longer, time consuming, measurements. Recently, first attempts have been carried out when testing diamond single crystals as monochromators for hot neutrons. However, the obtained results with newly prepared diamond monochromators are far beyond theoretical expectations. The first diamond prototype devices did not provide any gain over conventional mosaic ones in terms of both neutron flux at the sample position and resolution [1]. The activity can be connected with the growth of the crystals with required quality.

Then, in thermal neutron scattering, the project also covers the design and development of high resolution neutron monochromators. The tendency in neutron scattering experiments is the use of smaller and smaller samples and there are requirements for higher angular and/or wavelength resolution, simultaneously. Preliminary investigations show that these requirements can be fulfilled by so called dispersive monochromators based on double reflection process carried out either in one elastically bent perfect crystal [2] or by two independent elastically bent perfect crystals [3,4]. As the elastically bent perfect crystals have high peak reflectivity in thermal neutron region, double diffraction process has little impact on resulting monochromatic neutron current. Advantage of using bent perfect crystals consists also in an easy possibility to manipulate with real space focusing as well as with focusing in scattering.

When carrying out related specific experiments, in both cases user community can benefit from excellent properties of newly designed monochromators: higher resolution and/or a shorter measurement time .

[1] P. Courtois, M. T. Fernandez-Diaz, G. Nenert, K. H. Andersen, A K Freund, S. Gsell, M. Fischer, M. Schreck, P. Link and M. Meven, ***The first prototype diamond monochromator at the Institut Laue-Langevin***
In Proc. of the International Workshop on Neutron Optics and Detectors (NOP&D 2013), 2-5 July 2013, Munich (Ismaning), Germany, IOP, Conference Series, 2014, In print.

[2] P. Mikula, M. Vrána, J. Šaroun, V. Davydov, V. Em and B.S. Seong, ***Experimental studies of dispersive double reflections excited in cylindrically bent perfect-crystal slabs at a constant neutron wavelength***, J. Appl. Cryst. 45, (2012) 98-105. ISSN 0021-8898, [doi:10.1107/S0021889811054124]

[3] P. Mikula, M. Vrána, J. Šaroun, V. Em, B.S. Seong, W. Woo, ***Double bent crystal dispersive arrangement for high resolution diffractometry,*** In Proc. of the ECNS 2011 Conf. 18-23, July, Journal of Physics: Conference Series **340** (2012) 012014 doi:10.1088/1742-6596/340/1/012014.

[4] P. Mikula, M. Vrána, J. Šaroun, B.S. Seong, C. Woo a V. Em, ***Neutron diffraction studies of dispersive double-crystal setting containing a fully asymmetric diffraction (FAD) geometry of a bent perfect crystal (BPC) with the output beam expansion (OBE),*** In Proc. of the International Workshop on Neutron Optics and Detectors (NOP&D 2013), 2-5 July 2013, Munich (Ismaning), Germany; IOP: Conference series 2014, In print.