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Upgrade of the Wide-Angle Neutron Diffractometer at the High Flux Isotope Reactor

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The Wide-Angle Neutron Diffractometer (WAND) is a flat-cone geometry diffractometer located at the High Flux Isotope Reactor (HFIR). This instrument is currently being upgraded. The central part of this upgrade is the development of a new curved one-dimensional position sensitive detector which covers a 125 degree angular range with an effective radius of 71 cm. This detector will be a multi-anode (624 anodes on a 0.2 degree pitch) ³He gas-filled proportional counter. This totally new system will give high resolution, good uniformity and high counting rate - a maximum capability of 10⁵ cps/pixel and a 10⁷ cps overall. A prototype of this detector has shown that these design targets can be met. The new WAND will greatly broaden its capabilities for single-crystal diffraction experiments and for time-resolved measurements.

Keywords: Diffractometer WAND

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Since the Wide-Angle Neutron Diffractometer (WAND) was built at the High Flux Isotope Reactor (HFIR) as a part of the US-Japan Cooperative Program on Neutron Scattering, many unique experiments have been performed by this instrument [1]. The WAND shown in Fig. 1 is a flat-cone geometry diffractometer with a curved one-dimensional ^3He position sensitive detector covering 125 degree of the scattering angle. These features enabled us to measure single-crystal diffraction patterns in a short time over a wide range of the reciprocal space, and also to perform time-resolved experiments for structural transformations having a short time-constant. The examples are studies of magnetic structures and correlations in low-dimensional magnetic materials (YFe_2O_4 , LuFeMnO_4 , etc.) and other magnetic materials (CsNiBr_3 , $\beta\text{-Mn}$, etc.), precursor structures in martensitic phase transitions (Cu-Al-Ni alloy, etc.) and structural fluctuations of superionic conductors (Li_2O), and are investigations of the time-evolutions in the order-disorder transition (Ni_3Mn), phase separation (Mn-Cu alloy), crystallization of amorphous alloys (Fe-B-Si and Fe-P-Si) and phase transformations (CsCl , ZrO_2 , etc.).

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The WAND is now being upgraded and the central part of this upgrade is the development of a new detector of unprecedented capabilities. The present detector is a ^3He proportional counter using one LC delay line cathode, and the position decoding is made by the time difference between the zero-crossing of pulses at both ends of the cathode line. This method has some limitations of resolution, uniformity and counting rate. After a long term use and with recent technical developments, this detector will be renewed. The new detector will be a multi-anode type (624 anodes on a 0.2 degree pitch) ^3He gas-filled counter. The detector will cover 124.8 degree of arc with the focal distance of 71cm. The new position decoder consists of one preamplifier, shaping amplifier and discriminator circuit connected to each of the 624 anode outputs, and every detected neutron is stored in its corresponding memory bin. The discriminators are interconnected and their levels are set so that multiple counting of single neutron is avoided. This new system will give high resolution, good uniformity and very high counting rate - a maximum capability of 10^5 cps/pixel and a 10^7 cps overall. The data acquisition will be done by a microprocessor controlled system. Each of its 624 memory bins is pulled and cleared through the system communication bus. The data processor is networked to a host computer for remote control of the detector system, data transfer and analysis. This new detector system will be manufactured by ORDELA Inc.

A prototype of this detector (see Fig. 2) was also designed and built by ORDELA Inc. The test of this prototype showed that the design targets mentioned above were met. The angular resolution was checked by a perfect crystal of Si, and the resolution was estimated to be about 0.23 degree. This roughly corresponds with the spacing of the anodes. The uniformity was tested by a standard vanadium rod,

Reference

- [1] Progress report on JAERI-ORNL cooperative neutron scattering research I-IV, 1985, 1987, 1993, and 1996.

Figure captions

- Fig. 1. The WAND in the flat-cone geometry. On the top the curved one-dimensional ^3He position sensitive detector and the oscillating radial collimator are shown.
- Fig. 2. Prototype of the new detector (built by ORDELA Inc.).
- Fig. 3. Counts (cps/pixel) vs. thickness of the attenuator placed in the direct beam.

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