

Preparation status of inelastic neutron scattering in HANARO

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Abstract

HANARO (High-flux Advanced Neutron Application Reactor) has been operated since its first criticality in February 1995, and a number of neutron scattering experimental facilities have been installed around its horizontal beam ports since 1997. There are 7 tangential beam ports of different types available for neutron beam research and among the 7 beam ports, five beam ports of ST1 to ST4 and CN are for neutron scattering experiments.

When the long term perspectives for 15 years in 1992 was made, the first 10 years was assumed as a capability build-up period from the ground in terms of research, instrumentation and methods, and manpower. Based on that direction and policy with the national demand and perspectives at the time, HANARO started to develop instruments with the strong intention of dual purposes of industrial application and basic sciences. The first instrument was, therefore, the neutron radiography facility installed in late 1996 and the second one was the high resolution powder diffractometer in 1998, followed by the four circle diffractometer in 1999, the residual stress instrument in 2000, the small angle neutron spectrometer in 2001, and the polarized neutron spectrometer with a function of test station in 2004, respectively. Instrument under development are the reflectometer with vertical sample geometry, the high intensity powder diffractometer, the reflectometer with horizontal sample geometry.

All of those instruments and research activities are of elastic scattering character, not inelastic one. Around 2001 to 2002 we could see an increasing demand and clear desire to have the inelastic scattering from the Korean scientific community. More and more voices were expressed and a survey in 2002, which was related with cold neutron research facility, obviously resulted in big reality in the demand. HANARO, therefore, decided to develop inelastic scattering instruments and started its preparation. In 2003, with the launch of the cold neutron research facility project, 3 projects of inelastic instruments were approved, which are a thermal neutron triple axis spectrometer (TAS) at the beam port ST4, a cold neutron triple axis spectrometer (Cold-TAS), and a disc-chopper time-of flight spectrometer (DC-TOF) in the cold neutron laboratory.

TAS will be a classical general purpose triple axis spectrometer but with the new development in ideas, methods and techniques for last 10 years, its design must accommodate new ideas and components for continuing future improvements. It will be used both as a diffractometer for crystallographic investigations and as a triple-axis spectrometer with polarized neutron capability for measurements of magnetic and nuclear inelastic scattering. The instrument features exchangeable monochromators (PG(002) and Cu(220), BPC-Si(111)), which enable focusing of the in-pile beam both horizontally and vertically down to a smallest spot at the sample position. High monochromatic neutron flux at the sample position is from the pyrolytic graphite and high energies

transfer would be achieved with copper monochromator. Polarized neutron capability will be considered with a Heusler crystal option or ^3He gas filters both as polarizer and analyzer. The spectrometer is equipped with a single detector or position-sensitive detector of 2-dimension.

Cold-TAS will occupy a full single guide line and be located at its terminal position to utilize its full beam and moving capability. It will be a compact but very powerful cold neutron triple axis spectrometer with polarized neutron capability, too, for measurements of magnetic and nuclear inelastic scattering. The instrument will have two exchangeable monochromators (PG(002) and Heusler(111)), which enable focusing of the guide beam vertically. High monochromatic neutron flux at the sample position is from the pyrolytic graphite and polarized neutron beam from the Heusler crystal monochromators with neutron filters of PG, Be and BeO. The spectrometer will be equipped with a single He-3 detector or a 2-dimensional position-sensitive detector for multiplexing detection.

A Disk Chopper Time of Flight spectrometer (DC-TOF) is initiated by prof. Park Je-Geun group under a collaboration with HANARO and it produces monochromatic neutron pulses using an array of disk choppers, and measures energy and momentum transfer with high accuracy. Although both DC-TOF and TAS have more or less the same energy and momentum space coverage and are used for dynamic study of condensed matter sciences, the latter is better suited for the study of excitations in single crystal samples. On the other hand, DC-TOF has an advantage of measuring a large energy-momentum area simultaneously because a wide solid angle could be covered by the numerous detectors of the DC-TOF. The neutron flux at the sample position is expected to be a 2×10^4 n/cm²/sec at 5Å and wavelength range is 3~10Å, which means their energy range will be 0.8~10 meV. In order to have those neutron tailoring, it will have 7 disc choppers of 3~20 krpm. Its distance from the detector to the sample position is 2.5m and angle coverage would be -30 to 140 degree, which means total area of detector array must be 18.75 m².

At present the TAS is expected to be completed by 2008 fiscal year and Cold-TAS and DC-TOF by 2009 and 2011, respectively. Those periods for users in Korea looks to be too late and so HANARO and its collaborators will do their best to meet the scientific demand in Korea and foreign users with their strong support.