Cold Neutron Research Facility and Its Utilization at HANARO

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HANARO (High-Flux Advance Neutron Application Reactor) is a multi-purpose research reactor with a thermal power of 30 MW. It has been operating already for 15 years since its initial criticality in February of 1995, and this research reactor has been utilized for in various fields in science and engineering areas such as material irradiation, nuclear fuel irradiation, neutron scattering, neutron imaging as well as neutron transmutation doping for silicon. From the outset in mid-1980s of the design phase of HANARO, the cold neutron use for neutron beam research had been in mind toward more or less next 20 years later. But at that time, neutron beam research had been so poor that only the provision for future installation of the cold source and neutron guide port had been made. Since its first criticality in 1995, roughly 5 years of hard times was needed to prepare necessary beam port utilities and to install first phase thermal neutron beam instruments, which are the neutron radiography facility, and the high resolution powder diffractometer. And then a series of activities on the installation and utilization had been done for ~10 years with outside 'users', who were potential users at the initial phase. Around 2001, many voices and recommendations from scientists and engineers inside the institutes and outside universities, many institutions, companies, too. And then after 2 years of project planning and a series of workshops, the HANARO CNRF (Cold Neutron Research Facility) project was approved by the ministry of science and technology (MOST, now MEST). This project was regarded to greatly enhance neutron science research capability for national infrastructure for basic science and utilization of HANARO as a research reactor.

HANARO CNRF project was composed of 4 sub-projects, which are the cold neutron source and licensing, the CNS system utility and its auxiliary building annex, and the neutron guide systems and the last one of which is the development of 6 cold neutron spectrometers to be installed in the cold neutron laboratory building next to the reactor building. Those 6 spectrometers were finally selected from the project planning committee in early 2003 after nation-wide cold neutron instruments demand survey in 2001-2002 for next 30 years national R&D demand. There are 3 newly developed spectrometers; 40m small angle neutron spectrometer (40M-SANS), the cold neutron triple-axis spectrometer (Cold-TAS) and the disc-chopper time-of-flight spectrometer (DC-TOF), and another 3 relocated spectrometers from the reactor hall with modification and upgrades to the cold neutron guide environment, which are 18m small angle neutron spectrometer (18M-SANS), reflectometer with vertical sample geometry (REF-H), and the bio-reflectometer with horizontal sample geometry (Bio-REF). During the project period, two more instruments were added, one of which is the general purpose test station (G-TS), especially for mirror and neutron optical components testing purposes, and the other is the ultra-small angle neutron spectrometer (KIST-USANS) by KIST (Korea Institute of Science and Technology). The cold neutron guide laboratory building (CNL) had been constructed in parallel with the CNRF project next to the reactor building site, which were reserved and prepared for that purpose 20 years ago. There are two important technology development activities for these large scale instruments developments under CNRF project scheme, and one of which is the development of neutron mirror and guide fabrication technology and the other is fast neutron counting electronics for large scale neutron detectors for TOF instruments with its firmware and acquisition software.

As for the guide systems, we had a strategy of combining commercially supplied parts (upstream part, half of total guide installation, ~180 m) and in-house parts (downstream part) in order to securely control the budget and project schedule under tight project budget and external conditions of guide supply. Before the guide installation, especially the in-pile section, the reactor had been operated more than 10 years and the port had been used for 8 meter SANS without a cold source using thermal neutron spectrum, and so most of the in-pile replacement parts were active and the working condition under high radiation environment must be managed safely even though we had no such kind of experience before. All of these installation tasks had been well managed under given tight schedule with well prepared technical documents and repeated group practice training. Full scope of guide installation had been also done within schedule, budget and manpower with the good help of the laser tracker.

When the first full power reactor beam commissioning of the CNS, September, 2009, was tried, the primary shutter for the full guide beam lines and guide neutron transportation performance were also evaluated by measuring neutron fluxes with Au-wire NAA on the 5 guide lines at the 2ndary shutter positions and monochromator positions, too, and the neutron spectrum with a neutron time-of flight measurement at one of the guide lines, especially for 40M-SANS line. The result was very much promising and complied with design parameters and goals.

In this contribution, we will present the strategy of instrument selection and development, progress, achievement under the project, activities of users' association and international collaboration during the project and present situation of the cold neutron laboratory.

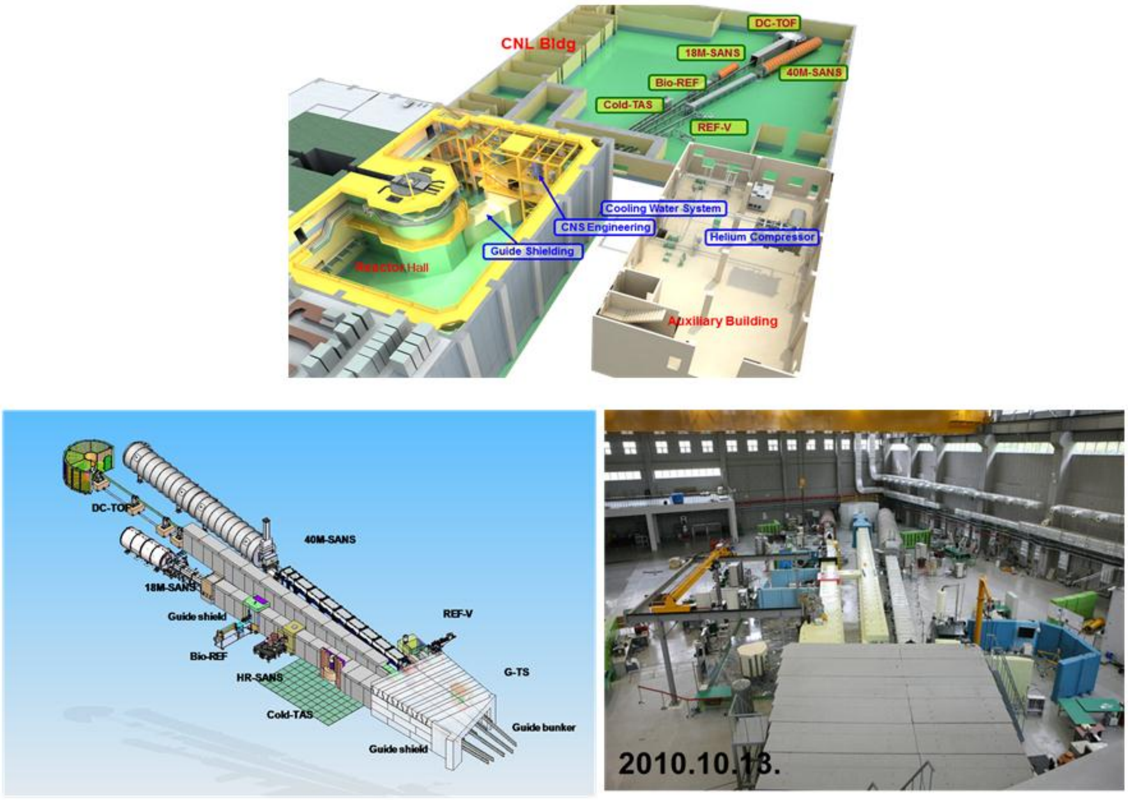

FIG. 1. Schematic view of the HANARO CNRF and instruments layout in the CNL.

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