Method of neutron guide alignment in the guide cassette using laser tracker

Jin-Won Shin and Yeong-Garp Cho
Korea Atomic Energy Research Institute, 1045 Daedeok-daero, Yuseong-gu, Daejeon 305-353, Korea
jwshin@kaeri.re.kr

1. Introduction

The research reactor HANARO in Korea will be equipped with a neutron guide system, in order to transport cold neutrons from the cold neutron source to the neutron scattering instruments in the neutron guide hall near the reactor building [1]. The neutron guide system of HANARO (Fig. 1) consists of the in-pile plug assembly, the primary shutter, and out-of-pile neutron guides with dedicated secondary shutters. The 5 neutron guides of different cross sections will be installed and aligned in the in-pile plug assembly and the primary shutter. After the primary shutter, the guides start to curve in the reactor confinement building to remove the gamma rays and fast neutrons, with each providing different curvatures. Two of the 5 guides will be separated into two guides each by using a splitter next to the primary shutter.

In order to align neutron guides with accurate dimensions and angles, a laser tracker was used. It is a portable, contact measurement system that uses laser technology to accurately measure parts and machinery across a wide range of industrial applications. In this paper, a method of neutron guide alignment using a laser tracker is described.

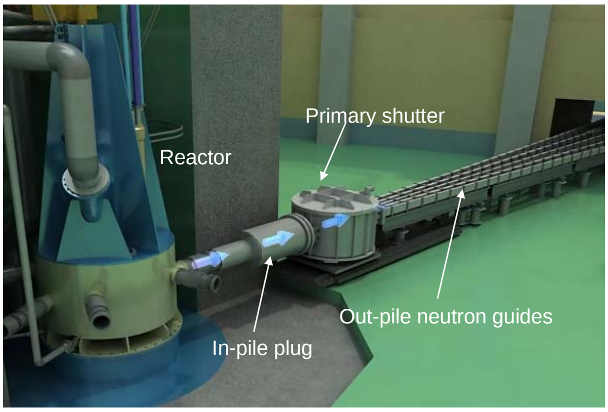

Fig. 1. The neutron guide system at HANARO

2. Cassettes for neutron guides

There is one guide cassette for the in-pile plug assembly and three guide cassettes for the primary shutter (Fig. 2). Each cassette has five neutron guides with adjustment parts which are used for the alignment and fixation of guides (Fig. 3). Each guide can be controlled by level adjustment bolts to satisfy a particular level. Side thrust pins are used for the alignment of guides to a lateral direction which is normal to beam direction. Stoppers are for fixing of guides to the beam direction which prevents guides from moving back and forth.

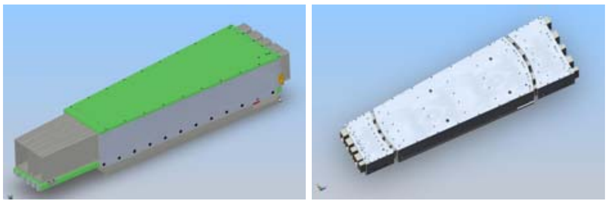
Fig. 2. Guide cassettes for the in-pile plug assembly and the primary shutter

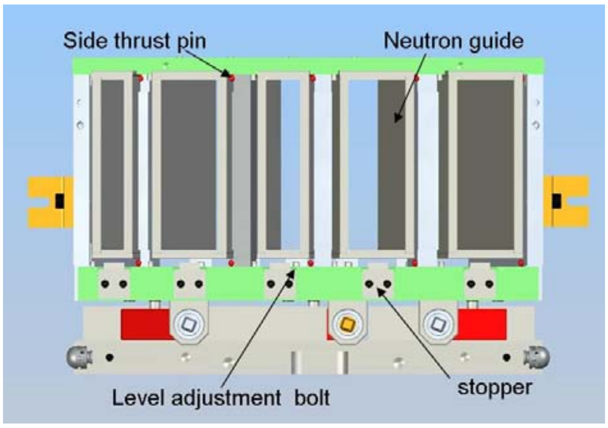

Fig. 3. The section view of a guide cassette which contains neutron guides and adjustment parts for the alignment

3. Procedure of neutron guide alignment

The basic concept of alignment method is based on the idea that every single position of the neutron guide system has a defined xyz-coordinate in the global coordinate system. The origin of this coordinate system is the theoretical center of the cold neutron source inside the reactor. The direction of the x-axis, which is the exact beam center line, is defined through an existing optical mark on the reactor hall wall. The z-axis is defined as perpendicular, which indicates the level (Fig. 4).

The alignment procedure consists of three main steps to reach the final installation. The first step is to align each guide in guide cassettes of the in-pile plug assembly and the primary shutter. It is the most important step to succeed in the alignment of the whole neutron guides. The next step is to make a coordinate system of the beam port in the reactor hall. It is needed to make many reference marks in the reactor hall to indicate the coordinate system because we have to move a laser tracker many times to measure every point of interested targets. We used so called “room-reference-nest” which can be read out by a laser tracker for reference marks as shown in Fig. 4. The final step is to align every cassette of the in-pile plug assembly and the primary shutter using the coordinate system and reference marks in the reactor hall.

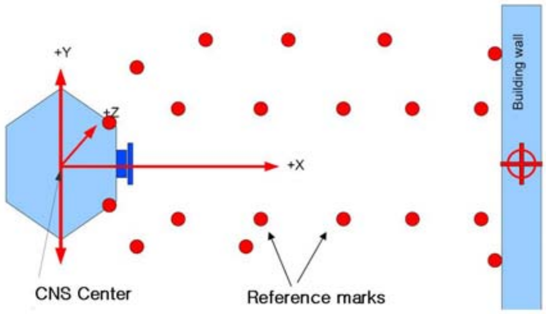

Fig. 4. The coordinate system for the neutron guides alignment in the reactor hall

4. Method of guide alignment in the cassette

The cassette assembly is put on a stable flat surface and the laser tracker is located on a position where it is able to see all significant measurement points (Fig. 5). At least 3 measurable and defined points of the cassette assembly is used for matching CAD data. Iterative-mode is executed to compare and match these points after measuring on the cassette. Several reference nests are installed on the outer surface of the cassette for movements of the laser tracker.

Three guide nests are attached on each guide after inserting 5 guides into the cassettes (Fig. 6). The coordinates of SMR positions of guides is entered into a program and defined as nominal points. Three SMR are put on each nest and coordinates of SMR centers can be measured by the laser tracker. The alignment of guides can be achieved by comparing nominal points with measured points.

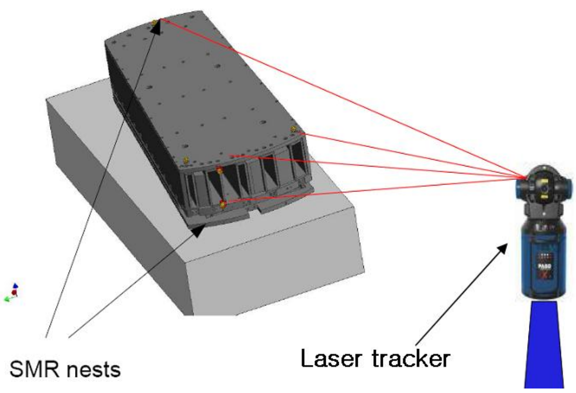

Fig. 5. The alignment of guides in the guide cassette using a laser tracker

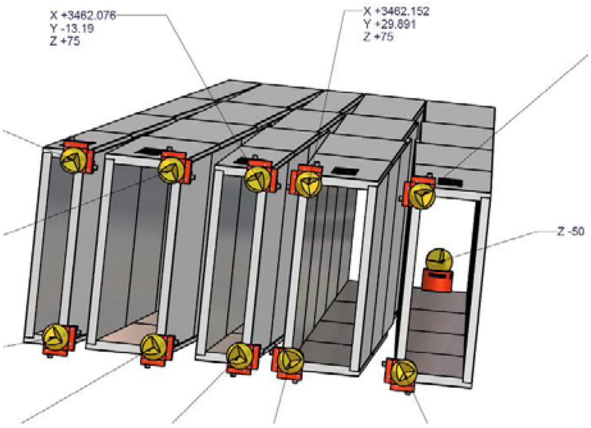

Fig. 6. The coordinate of guides in the guide cassette.

5. Conclusion

KAERI has installed neutron guides for the in-pile plug assembly and the primary shutter. A laser tracker has been used for the alignment of guides. The construction of the whole coordinate system and the accurate alignment of neutron guides were achieved successfully.

REFERENCE

[1] J. W. Shin, Y. G. Cho, B. S. Seong, S. J. Cho and J. S. Ryu , “Conceptual Design of the In-pile Plug Assembly and the Primary Shutter for the Cold Neutron Research Facility in HANARO,” Transaction of the Korean Nuclear Society Autumn Meeting, pp. 70-71, 2006