# Installation of the in-pile plug assembly and the primary shutter for the neutron guide system at HANARO

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## 1. Introduction

The cold neutron guide systems, as a part of the cold neutron research facilities in HANARO, have been being developed since 2003. Until early 2008, the beam port assigned for the cold neutron (CN) has been used for an 8-m SANS instrument without a neutron guide. All the hardware for the CN beam line is being replaced with a completely new system composed of neutron guides, an in-pile plug, a primary shutter, shielding blocks, and vacuum system as shown in Fig 1 [1].

It is most important for the constructing of the neutron guide system to install a new in-pile plug assembly and primary shutter with neutron guides precisely at the beam port of the reactor in radiation environment. This paper presents the summary of the successful installation of the in-pile plug assembly and the primary shutter.

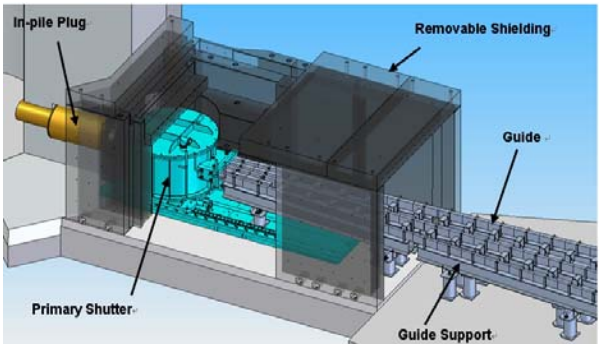


Fig. 1. The neutron guide system at HANARO

## 2. Removal of old plug

Fig. 2 and Fig 3 show the process for the old plug removal from the CN beam port using the plug cask and the installation tool. The old plug is extracted from the beam port and put into a plug cask by a long tool connected with the adapting plate inside the plug cask. The final step of the removal process is to transport the plug cask to a storage using overhead crane after covering the upper and the front side of the cask.

The radiation shielding was proper at the front of the beam port fully open, the first time forever since the criticality of the reactor operation. The old plug was safely moved and finally stored to the plug storage hole.

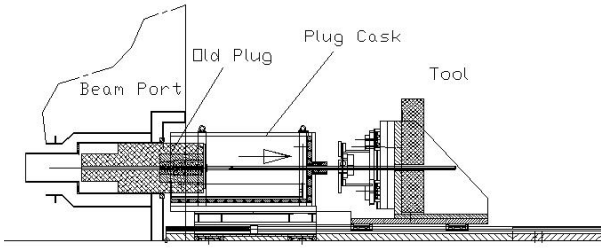


Fig. 2. The removal process of the old plug at CN beam port

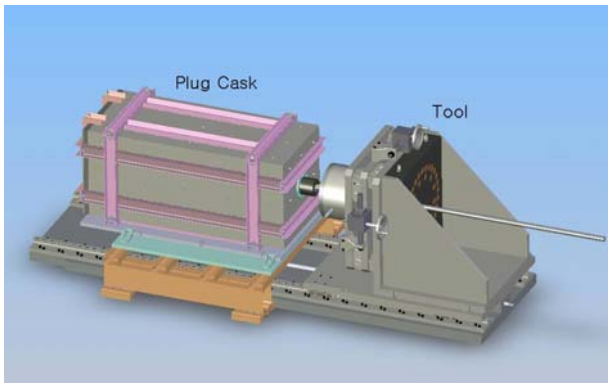


Fig. 3. The plug cask and tool for the removal of the old plug

## 3. Installation of the in-pile plug assembly

The in-pile plug assembly contains a neutron guide cassette in which five guides are aligned with each angle. It consists of a main plug with the front plug, a plug base table with a ring flange, a guide cassette, and a blind flange with a window. It has a two-stepped cylindrical shape with a 380mm (diameter) x 735mm (length) and a 700mm (diameter) x 1170mm (length).

The first step of the installation is to insert the plug base table with the ring flange into the beam port. The plug base table supports the plug during a mounting, and in its final position. The second step is to push the plug into the beam port after mounting it on the adapter of the installation tool as shown in Fig 4. It is possible to adjust the center coordinate and the horizontal angle of the plug using X-Y table and jacking screws [2]. The

plug is fixed to the plug base table by the axial link when it is successfully installed. The final step is to install the blind flange and window with a metal O-ring. The O-ring is used for preventing the leakage of helium inside the CN beam port.

The installation tool consists of a base rail, a carriage, a mounting adapter, an X-Y table, jacking screws, and a shielding block. Therefore the plug assembly can be aligned to the beam port in all directions with this tool.

The installation was successful with a proper shielding against the gamma radiation about 250 mSv/h.

The laser tracker system did an excellent role to align and install the plug assembly into the beam port with 1 mm clearance.

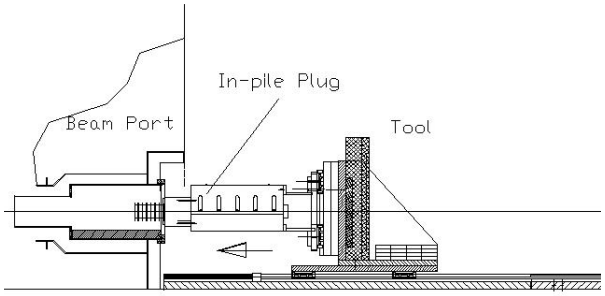


Fig. 4. The installation process of the in-pile plug assembly

## 4. Installation of the primary shutter assembly

The primary shutter assembly contains three guide cassettes, in a vacuum vessel; up-stream cassette, drum cassette and down stream cassette. The drum cassette rotates to 90 degrees to open or close the beam by the shielding drum. The driving mechanism is located outside of the shielding blocks and mechanically connected to the drum. There is no electronic part in the vessel and the shielding blocks for easy maintenance.

The primary shutter assembly was relatively easy for the installation but more delicate for the alignment and precise driving motion. The Fig.5 shows a general assembly of the primary shutter.

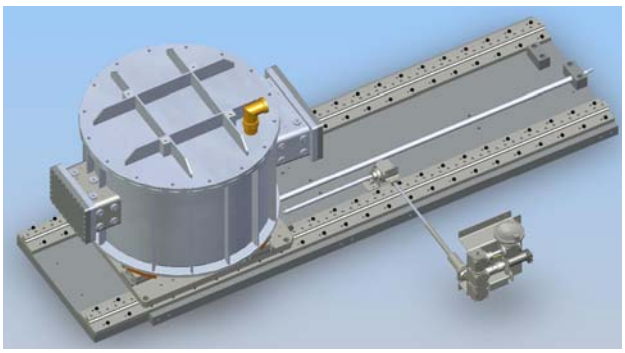

Fig. 5. The installation the primary shutter assembly

## 5. Conclusions

KAERI developed the in-pile plug, the primary shutter and many tools for the removal and installation. In September 2008, the in-pile plug and the primary shutter were successfully installed in the beam port with all neutron guides well aligned within 0.1mm/m. All the working procedure and tools were good at the real situation due to a lot of rehearsal. The out-pile guides will be installed and aligned from November 2008 during the reactor shutdown.

## REFERENCE

[1] Yeong Garp Cho *, Jin Won Shin, Sang-Jin Cho, Jong-Myeong Oh, Jeong Soo Ryu, Baek-Seok Seong, Hak-Sung Kim Jung-Hee Lee, Min-Jin Kim, Hyun-Jun Kim, "Development of Neutron Guides in HANARO" Spring Meeting, pp685-686, 2008

[2] Jin-Won Shin, Yeong-Garp Cho, and Jung-Hee Lee , "Installation technique of the in-pile plug assembly for the neutron guide system at HANARO Spring Meeting, pp 681-682, 2008