Device configuration for correction of neutron generation in Tokamak

H. S. Kim [a*], Y.S.Lee [a], K.R.Park [a]
[a]*Korea Institude of Fusion Energy.,169-148, Guahak-ro, Yuseong-gu, Daejeon*
[*]*Corresponding author: hskim21@kfe.re.kr*

1. Introduction

Tokamak is a device for nuclear fusion reactions and has a complex structure. One of the criteria for diagnosing a fusion reaction is the amount of neutron generation. It is impossible to directly measure the total amount of neutrons generated in the tokamak. Therefore, it is necessary to calibrate the neutron generation amount to grasp the relationship between the actual generation amount and the measured value using a standard source and a neutron meter. In this paper, we will describe the configuration of a device for calibration of neutron generation.

2. Methods and Results

The transmission device for neutron calibration must be able to transmit information to the measuring instrument by rotating the inside of the tokamak and irradiating the neutron at regular intervals, and it must be operated remotely for safety. The transfer device is largely divided into a control unit and a mechanism unit.

2.1 Mechanism

The mechanism part of the neutron measurement transfer device is to transfer the neutron generating device and the neutron detection device in the circumferential direction within the KSTAR device, and to fix the main body of the transfer device that fixes the neutron generation unit, the transfer rail supporting it, and the transfer rail. It consists of Rail Support.

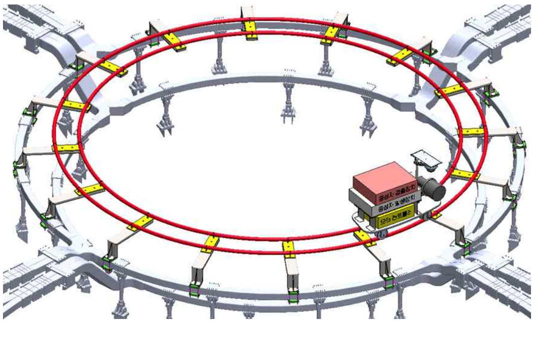

Fig. 1. Device configuration diagram

The rail support was fixed to an IVCC (In Vessel Control Coil) installed in a ring shape inside the tokamak. IVCC is a kind of magnet for fine-tuning plasma and has enough strength to support this device. The rail was installed by connecting 16 inside and outside each by processing two rods in a ring shape. Stepper Motor was used for accurate movement of the device. Although 16 position sensors are installed, the movement of the device can be specified in 0.1 mm increments by using a stepper motor. In addition, CCTV for internal monitoring was installed to prepare for errors that may occur during operation.

Table I: Transmission device Specification

Category	Item	Specification
Device Size	rail	Inner : tube-3805mm Outer tube : 4305mm
	transfer device	Turning radius 2207.5mm
Device weight	rail, transfer device	about 160kg
Driving	Rotation speed	One section (500mm) travel time takes about 6 seconds
Control	Motor controller	Using Limit S/W, Start work and check each section

2.2 Control unit

The transfer device is installed inside the tokamak in the form of a ling. The transfer device is operated in a separate control room outside the Tokamak Hall. The ports of the KSTAR device range from A-Port to P-port. The transfer device is connected by cables for power and communication, so it is important to determine the starting and ending points. In this experiment, the starting point was set to O-port and rotated clockwise or counterclockwise to proceed to the opposite port, G-port.

The transport device is operated remotely using the Ethernet method. Figure 2 is the operation screen. It is also possible to move to a designated position by using a position sensor, or to move only a fixed distance by using a step motor.

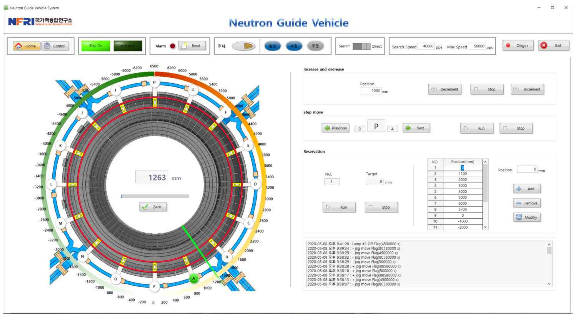

Fig. 2. Operation screen

3. Conclusions

When measuring the neutron weight of the KSTAR device, it was corrected using the data measured by the Neutron Activation System (NAS). However, the real-time data cannot be known because the NAS has to measure and calculate the radioactive samples. If the correction constant is determined through this experiment, the total amount of neutron generation can be known from the data measured in real time. This will be of great help in license management for devices regulated by the amount of neutron generation, and will also be used to check the shielding performance of the facility.

REFERENCES

[1]] Y.S. Lee, et al., “Assessment of mixed neutron and photon radiation ratios using a tissue equivalent proportional counter on KSTAR", Fusion Engineering and Design 153 (2020) 11452
[2] Y.S. Lee, et al., “Diamond fast-neutron detector applied to the KSTAR tokamak”, Fusion Engineering and Design 153 (2020) 11452.
[3] M. Zboril, et al., “Simulation of the neutron response functions of diamond detectors with the NRESP code”, ECPD Conf. Proc. Sci. (2015)..
[4] H. Sjostrand, et al., “Triton burn-up neutron emission in JET low current plasmas”, Journal of Physics D: Applied Physics 41 (2008) 115208
[5] M S Cheon. Diagnostic neutron activation system for KSTAR, Journal of Instrumentation, Volume 7, May 2012.