Development of Faraday-cup-based Fast Ion Loss Detector in Wendelstein 7-X

K. Ogawa[1, 2], M. Isobe[1, 2], M. Osakabe[1, 2], S. Bozhenkov[3], S. Äkäslompolo[3], C. Killer[3], R. C. Wolf[3], and the W7-X team

[1] *National Institute for Fusion Science, National Institutes of Natural Sciences, Toki, Japan*

[2] *SOKENDAI (The Graduate University for Advanced Studies), Toki, Japan*

[3] *Max-Planck-Institute for Plasma Physics, Greifswald, Germany*

A study on fast-ion losses due to magnetic field ripples and fast-ion-driven magnetohydrodynamic (MHD) modes is important in terms of view of research on fusion-born alpha losses in fusion devices. To understand fast-ion loss in Wendelstein 7-X (W7-X) plasmas, installation of fast-ion loss diagnostics for W7-X has been planned. For the Op1.2b campaign, the prototype Faraday-cup-based fast-ion loss detector (FILD) has been designed as joint cooperative project between National Institute for Fusion Science and Max Planck Institute for Plasma Physics. The Faraday-cup-based FILD is relatively cost-effective in construction compared with a scintillator-type FILD. The FILD is capable of providing the flux, pitch angle, and Larmor radius of escaping fast ions simultaneously, providing the clear understanding on fast-ion losses induced by MHD mode as well as non-axisymmetric magnetic field ripples.

A Lorentz orbit code (LORBIT code and ASCOT code) has been used to find a position suitable for detection of escaping beam ions. It is found that the sufficient beam-ion flux on the head position of the multi-purpose manipulator (MPM) is expected. Therefore, we decided to install the prototype FILD head using the MPM. The detector is mainly composed of a molybdenum head having a set of two apertures restrict the orbits of fast ions that can enter the probe and eight Faraday films as a charge collector. The size and the position of those apertures are decided using the grid calculation program. Faraday film is a thin film of aluminum vapor deposited onto one side of the quartz substrate. The thickness of the films is approximately 0.2 μm. Electric current from each Faraday film will be carried to the low input impedance current amplifier (I-76, NF Corporation) and an isolation amplifier. The signal level of the FILD predicted by the ASCOT code is up to 0.5 μA, which is comparable with that of a FILD in the Compact Helical System (CHS).