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Design of a movable material probe system for PWI study in JT-60SA
JT-60SAにおけるプラズマ・壁相互作用研究のための試料搬送装置設計検討

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A design of the movable material probe system for JT-60SA is proposed. The system provides the opportunity for inserting material specimens and diagnostics into the plasma vacuum vessel, and for specimens changing during experimental campaign. The system will consist of manipulator, gate-valves, working chamber and pumps. The system is under consideration to be installed in a bottom port. It will contribute to plasma-wall interaction studies in JT-60SA.

1. Introduction

Understanding of plasma-wall interaction (PWI) in fusion devices is a crucial issue for design of fusion reactor. Two ways of PWI studies have been conducted in present fusion devices. One is post-mortem analysis of plasma facing components and/or material specimens after opening vacuum vessel to the atmosphere [1], and the other is material specimens exposure to plasma using manipulator of material probe system. In the former case, all PWIs on the components and specimens during experimental campaign are integrated. On the other hand, in the latter case, PWIs in different plasma conditions can be distinguished, and various PWI experiments can be conducted if the material probe system has gate-valves and pumps. Such systems are utilized in several present fusion devices, such as LHD[2], DIII-D[3], ASDEX-Upgrade[4] and TEXTOR[5], and contribute to PWI studies. In JT-60SA, a movable material probe system is under consideration to be installed. Feasibility of this system has been studied.

In this presentation, a design of the material probe system for JT-60SA will be shown.

2. Movable material probe system

The movable material probe system is planned to be installed in JT-60SA from a bottom port in the toroidal section P-10 as shown in Fig. 1. Material specimens will be inserted into the plasma vacuum vessel from the “cover for pipe connection” which is located above the outer baffle. There is a rectangular slot for the material probe system on the cover, and the size is 60mm in the toroidal direction and 170mm in the radial direction. This slot’s size is the limit of the size of the head of the

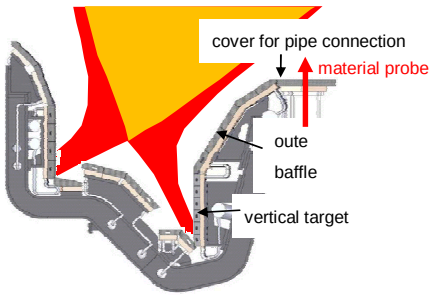

Fig. 1 The position of the port in a poloidal cross-section in JT-60SA in which the material probe system will be installed.

manipulator. Figure 2 shows the overall view of the movable material probe system. The system is equipped with gate-valves and pumps (cryo-pump and turbo-pump), and the material specimens can be changed more than once in the “chamber” during an experimental campaign without opening the plasma vacuum vessel. JT-60SA is a super-conducting device, and it has cryostat for sustaining liquid-He temperature of super-conducting equipment. Therefore, the distance between the vacuum-atmosphere interface ports and plasma is long. The moving line of the manipulator is shown by the red arrow in the figure. The top of the manipulator can reach to the scrape-off layer plasma, and its maximum moving length is about 5.9 m. In this design, welding bellows are joined in series to enable the long stroke. About 10 m long bellows is necessary for it. From the basement floor to the first floor level is almost same distance as the necessary bellows length. The pumps are put in the existing pit under the bottom port. Two air-motors drive the manipulator with gear sets and ball-screws. One motor drives fast moving part which moves from the chamber to the entrance of the vacuum vessel, and the moving length is 4.29 m. Another motor drives slow moving part which moves inside the vacuum vessel and is required position control, and the maximum moving length is 1.56 m.

The probe head will be replaceable unit. The design of the probe head depends on the purpose of experiment. Both water cooling and heater for specimen are necessary for various PWI experiments.

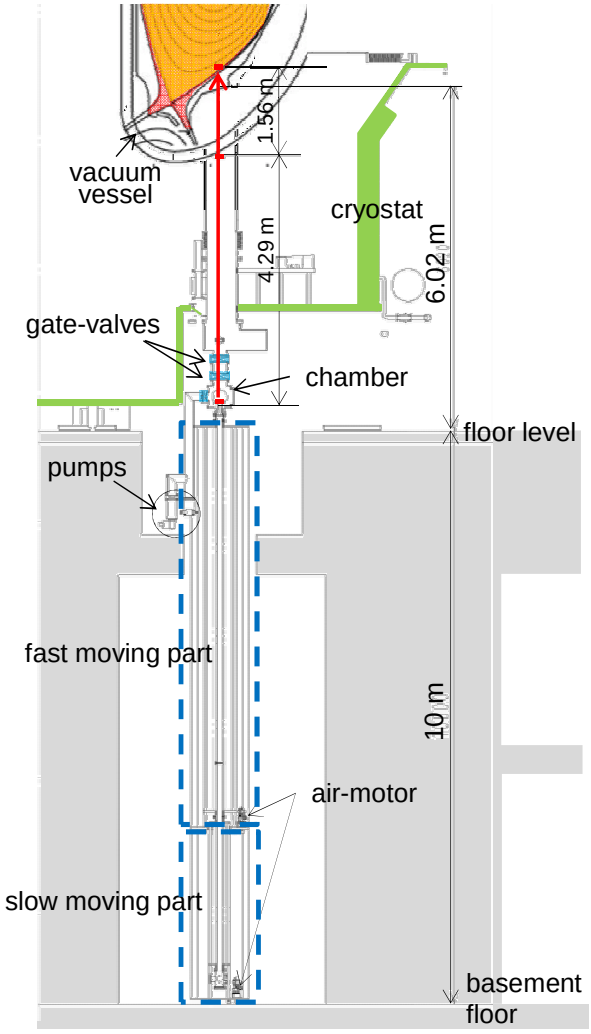

Fig. 2 Overall view of the movable material probe system.

3. Summary

A design of the movable material probe system for JT-60SA was proposed. It can insert various material specimens into the scrape-off layer plasma. The probe head is replaceable, and various design of the head should be done for various PWI experiment.

Acknowledgments

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