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Progress of Impurity Influx Monitor (divertor) for ITER
ITERダイバータ不純物モニター開発の進展

Hiroaki Ogawa, Sin-iti Kitazawa, Tatsuo Sugie, Atsushi Katsunuma[1)], Daishuke Kitazawa[1)], Keishuke Ohmori[1)] and Kiyoshi Itami
小川宏明、北澤真一、杉江達夫、勝沼淳[1)]、北澤大輔[1)]、大森啓介[1)]、伊丹潔

Naka Fusion Institute, Japan Atomic Energy Agency,
801-1 Mukoyama, Naka, 311-0193 Japan
日本原子力研究機構那珂核融合研究所 〒311-0193 那珂市向山801-1
[1)]Nikon Corporation,
1-12-1 Yurakucho Chiyoda-ku, Tokyo 100-8331 Japan
[1)]株式会社ニコン 〒100-8331 東京都千代田区有楽町1-12-1

The optical design of Impurity influx monitor (divertor) for ITER has been carried out to fit the reserved space in upper, equatorial, lower port and divertor cassette. Obtained results indicate that the optical design will meet the ITER requirement for spatial resolution and the distortion is no effect on the optical properties. In order to use an in-situ calibration, a cat's eye mirror made of Mo was manufactured and reflectivity was measured by using 3 lasers. Obtained reflectivity was almost same as that of Mo.

1. Introduction

The main function of the Impurity Influx Monitor (divertor), hereafter referred to as "DIM", is to measure the parameters of impurities and isotopes of hydrogen (tritium, deuterium and hydrogen) in the divertor plasmas by using spectroscopic techniques in the wavelength range of 200 - 1000 nm. The detailed requirements are shown in references [1,2]. The expected impurities are tungsten, beryllium, copper and helium originating from the divertor target plate, from the surface of the first wall in the main chamber and from the fusion reaction. Neon, argon or other impurity gases injected into the plasma for radiation cooling in the divertor and the plasma edge will also be observed.

Japan Atomic Energy Agency (JAEA) and ITER organization (IO) signed the procurement arrangement for the design, manufacture and supply of the DIM in last July and the preliminary design work has been carried out until now. In this paper, we present recent results of optical of DIM and new in-situ calibration method using the cat's eye mirror.

2. Optical design

DIM observes divertor plasma with four optical systems; i) central optics with mirrors installed in the divertor cassette, ii) side optics through the gap between the divertor cassettes, iii) optics from the equatorial port, iv) optics from the upper port as shown in Fig. 1. The optical system from the equatorial port views near tangentially and other optical systems view near perpendicular. The light from the each viewing fan is reflected by mirrors in the front-end optics and guided to the window on the end of the port. After that, the light goes through the labyrinth in the biological shield, and then the light is focused on the optical fiber array by the collection optics. The optical design of each viewing port has been carried out by using the ray-tracing code (CODE-V) assuming that the entrance pupil is ϕ20 mm and the vacuum window is ϕ 120 mm and following results are obtained.

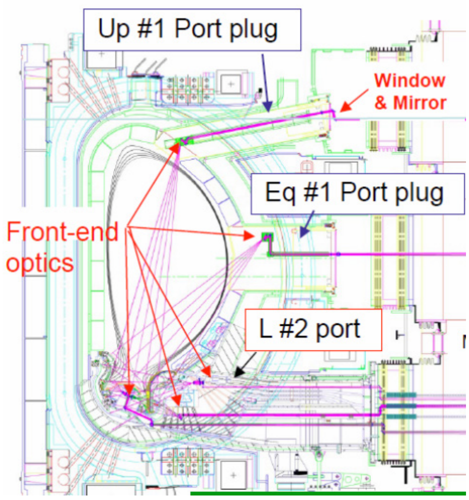

Fig. 1 Four optical system for DIM

In order to avoid the interaction with other diagnostic system, all the optical components of DIM are arranged inside CMM (Configuration Management Model), which is the reserved space of DIM in the port and/or the port plug. In order to increase the detected light, relay optics consisted of toroidal mirrors inside the vacuum vessel (VV) and of an achromatic lenses made of silica and CaF_2 outside VV is used and the numerical apparatus of about 0.1is obtained. This value is almost same as the previous design with no space restriction [3, 4].

The special resolution, which determined by the image size of the optical fiber on the imaginary space of the collection optics, is less than the required value (50 mm). This indicates that this optical design will meet the ITER requirement for spatial resolution.

The spot diagram analysis shows that the spot size of all the position at the imaginary plate is less than the image size of the optical fiber. This result shows that the distortion is no effect on the optical properties in the present optical design.

3. in-situ Calibration

It is necessary to know the sensitivity change for the measurement with the higher reliability. It was introduced one method for in-situ calibration using a micro retro-reflector array [5-7]. In this method, a standard light is set behind the bio-shield or in the diagnostic room and the light is applied to the micro retro-reflector array mounted on a shutter through the same optics for plasma measurement with the collection optics. The reflected light is measured with a spectrometer to evaluate the sensitivity change of the optics. A micro retro-reflector is made of Ni and manufactured by the electrical-forming method. Because the surface of each the micro retro-reflector array cannot be polished due to the size of the surface, the reflectivity of a micro retro-reflector array reduced in the UV range compared with the reflectivity of Ni. We introduce a cat's eye mirror instead of a micro retro-reflector array. The advantage of a cat's eye mirror is that the all of the reflected surface can be polished. The proto-type of cat's eye mirror was manufactured by Mo as shown in Fig. 2 and reflectivity was measured by 3 lasers (λ = 632.8, 543.5, 473.0 nm). The incident light to the cat's eye mirror reflects 7 times and then returns to the incident direction. Figure 3 shows that the reflectivity of Mo and measured values. This result indicates that the reflectivity of a cat's eye mirror is almost agreed with of the Mo.

4. Summary

The optical design of DIM has been carried out and the obtained design will meet the ITER requirement for spatial resolution and the distortion is no effect on the optical properties. The cat's eye mirror was manufactured and reflectivity was measured 3 lasers light. Measured reflectivity is almost same as that of Mo.

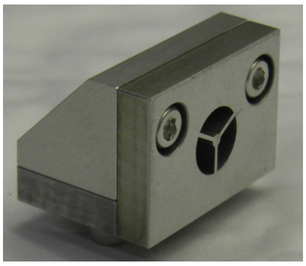

Fig.2 Photography of Cat's eye mirror

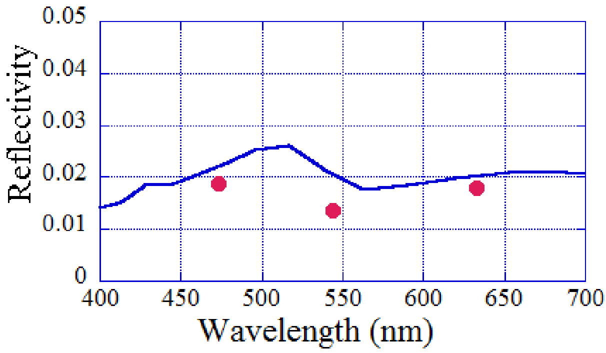

Fig.3 Reflectivity of Mo (solid line) and measured values (closed circles)

Acknowledgments

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The views and opinions expressed herein do not necessarily reflect those of the ITER organization.

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