Development of the UV and Visible Impurity Influx Monitor (Divertor) for ITER

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A Spectroscopic diagnostics system in the wavelength range of from 200 to 1000 nm has been designed and developed [1,2] for monitoring the influx of impurities in the divertor region of ITER. Optical components placed close to the plasma are expected to be exposed to high neutron radiation as well as gamma-rays and high energy particles. The impurity influx monitor observes the divertor plasma with fan arrays of multiple lines of sight from the upper port, the equatorial port and the divertor port. The configuration of optical components and the selection of their material composition are optimized in order to avoid the deterioration to the optical characteristics. The detailed mechanical design of the front-end optics and relay optics in the port includes a mechanism of shutters and mirror steering with a brake. Those mechanisms are operable in the harsh environment of vacuum vessel.

Light emission from plasma is designed to be observed through a narrow aperture equipped with a mechanical shutter. The shutter prevents the mirror facing the plasma from the deteriorating due to particle bombardment and the deposit of impurities during glow discharge cleaning. An in-situ calibration system is installed to measure the degradation of the optical components. A micro retro-reflector array (MRA) is mounted on the backside of the shutter plate. The MRA serves to reflect light from a standard light source back to the observation system. Light from the plasma is relayed to spectrometers by a telescope, and a micro lens array coupled to optical fibers. We have constructed prototypes of the optical components: metal mirrors, a Cassegrain reflector, a micro-lens array coupled to an optical fiber bundle, optical-fiber light distributors and a micro retro-reflector array. The characteristics of these prototype optical components have been experimentally examined. The micro lens array consists of fifty biconvex lenses. Each of them has a square aperture of 0.250 mm × 3.50 mm with surface curvatures of r=3.3 mm, are jointed to a silica optical fiber of 200 μm core. The collection efficiency of the Cassegrain equipped with a micro lens array and optical fibers was compared to that of the Cassegrain connected to the optical fiber only. The efficiency increased by a factor of 1.7 with the introduction of the micro lens array. Estimation using the prototype of signal intensity detection from impurity emissions in the divertor plasma is discussed.

For various diagnostics purposes, such as detection of an ionization front, localization of a plasma detachment and impurity influx evaluation, multiple chords observation should provide the ability to localize these phenomena approximately. Computerized tomography of virtual intensity distribution at the divertor is examined with two fan-like views to observe the divertor plasma through a gap between the divertor cassettes in the divertor port. A reconstruction code based on the maximum entropy method (MEM) is used for solving the reconstruction problem. The method and viewing chords are tested on numerically simulated phantoms with shapes that are characteristic of divertor impurity tomography.

[1] T. Sugie, et al., in *Burning Plasma Diagnostics* (AIP, New York 2008) 218.
[2] H.Ogawa, et al., *Plasma and Fusion Res*. **2** (2007) S1054.