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空間分解3mVUV分光器を用いた LHDのエルゴディック層における不純物分布計測の開発

Development of impurity profile diagnostics in the ergodic layer of LHD using space-resolved 3 m VUV spectrometer

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Control of the impurity transport in the edge region of magnetically-confined plasmas has attracted an attention in the fusion research to sustain high-performance plasma and mitigation of the divertor heat flux. For the purpose the edge impurity transport and its effect on the plasma performance have been investigated in tokamak and helical devices. In particular, the impurity study in the edge stochastic magnetic field layer has recently attracted. For example, reduction of the cross-field impurity transport, so called “impurity screening”, has been observed in the large helical device (LHD). It is due to the presence of a thick stochastic magnetic field layer located outside of core plasma called “ergodic layer”. It is known that the impurity screening depends on the thickness of the ergodic layer [1]. A precise measurement on the spatial profile of impurity line emissions in the ergodic layer is necessarily required to investigate such effects of the ergodic layer in detailed.

Thickness of the ergodic layer surrounding the last closed flux surface (LCFS) ranges from several to several tens of centimeters, and has poloidal and toroidal variations, while it depends on the position of magnetic axis. The vacuum ultraviolet (VUV) lines from impurity ions are significantly emitted in the ergodic layer because the electron temperature around LCFS is about 500eV in maximum. A space-resolved VUV spectroscopy using a 3m normal incidence spectrometer has been also developed to study the plasma transport in the ergodic layer by measuring the spatial profile of VUV lines from impurities emitted in wavelength range of 300-3000 Å [2]. Figure 1 shows a schematic drawing of the diagnostics system. The wavelength resolution is 0.05 Å when an entrance slit is set to 20 μm in width and a 1200 g/mm grating is used. The optical axis of the spectrometer is arranged perpendicular to the toroidal magnetic field in the bottom edge at holizontally-elongated plasma cross section. Observable region is roughly 20cm in the vertical direction which can sufficiently cover the whole range of the ergodic layer. A vertical image of VUV line emissions can be thus obtained by optimizing a space-resolved slit located between the entrance slit and the grating. In this conference, details of the diagnostic system for impurity profile measurement in the ergodic layer of LHD are presented with preliminary experimental results.

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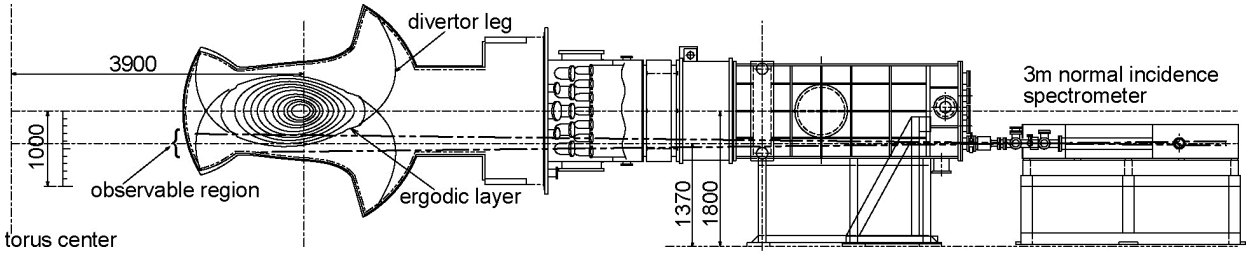

Fig. 1. Poloidal cross section of LHD and impurity diagnostics system for study of ergodic layer using space-resolved 3 m VUV spectrometer.