Development of a new helium imaging system to measure the edge two-dimensional turbulence and profiles simultaneously on EAST

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Abstract:

Since plasma turbulence is driven by free energy source for micro-instabilities, edge turbulence plays an essential role in the energy and particle transports due to the radial gradient of plasma temperature and density in the boundary region [1]. Understanding the interaction between edge turbulence and cross-field transport could be beneficial to controlling radial transport and divertor heat load, which is a key issue in magnetically controlled plasmas. Therefore, the measurements of edge turbulence and the corresponding plasma profiles could provide a means to identify the edge turbulence pattern and its contribution to transport.

A new helium imaging system is under development based on the gas puff imaging (GPI) system in EAST, aiming to measure the evolution of two-dimensional edge turbulence structure and plasma profiles simultaneously with high temporal and spatial resolution. Recently, the GPI system on EAST has been upgraded by applying a new relay optical system [2]. In contrast with the previous optical system of GPI in which a coherent glass fiber bundle is used to transmit the image from the end of a telescope inside the vacuum vessel to the outside, the new relay optical system has much lower light loss, i.e., the emission intensity on the image plane of the new GPI is at least 15 times higher than the previous one. The temporal resolution of the GPI system is 530 kHz, and the spatial resolution is 2 mm. Based on the GPI system, the new optical system of helium imaging system contains two optical branches through a light-splitting optical system, with one branch operated as the standard GPI system, and the other operated as a four-color optical system. In the latter branch, four wavelengths (587.6 nm, 667.8 nm, 706.5 nm and 728.1 nm) are extracted and focused on a thin image surface. The 2D electron temperature and density can be derived from the ratio of and as the standard helium beam diagnostic [3]. Consequently, the new helium imaging system can measure the edge turbulence evolution and 2D plasma profiles simultaneously, which is of great significance to identifying edge turbulence and its contribution to transport.

References

[1] Doyle E. J. *et al* Chapter 2: Plasma confinement and transport, Nucl. Fusion 47 (2007) S18

[2] Liu S. C. *et al* Upgrade and application of the gas puff imaging system in EAST, Fusion Eng. Des. 179 (2022) 113156

[3] Schmitz O. *et al* Status of electron temperature and density measurement with beam emission spectroscopy on thermal helium at TEXTOR, Plasma Phys. Control. Fusion. 50 (2008) 115004