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Multi-Channel Turbulence Diagnostics for Stationary I-mode in EAST tokamak

C. Zhou[1], A. D. Liu[1] , X. L. Zou[2], X. Feng[1], G. Zhuang[1], J. L. Xie[1], X. M. Zhong[1], W. X. Ding[1], T. Lan[1], H. Li[1], W. Z. Mao[1], W. D. Liu[1], S. B. Zhang[3], Y. Liu[3], H. Q. Liu[3], L. Q. Hu[3], Y. T. Song[3] and EAST Team[3]

1) University of Science and Technology of China, Hefei, Anhui 230026, China

E-mail: zhouchu@ustc.edu.cn

2)Institute for Magnetic Fusion Research, CEA, F-13115 Saint-Paul-lez-Durance, France

3)Institute of Plasma Physics, Chinese Academy of Sciences, Anhui Hefei 230031, China

I-mode, characterized by a sharp edge temperature pedestal without edge density pedestal and ELMs, represents a potential solution alternative to H-mode in a future fusion reactor [1, 2]. Moreover, the advantages: preventing metallic impurity central accumulation and facilitating fusion product ash removal, are crucial for fusion reactors. However, although it is widely accepted that the I-mode edge should be ideal MHD stable and dominated by turbulence transport, the intrinsic microscopic mechanism to achieve such specific improved confinement is still unclear.

In EAST tokamak, stationary I-mode was recently identified and characterized [3, 4]. Several diagnostics are specially designed and upgraded for measuring the turbulence in the edge region, including the eight-channel Doppler reflectometer (DR8)[5], the five-channel tunable Doppler reflectometer (DR5)[6] and the Electron Cyclotron Emission Imaging (ECEI)[7]. The DR8 can provide turbulence evolutions with the wavenumber range 2–15/cm at eight different radial locations simultaneously by launching eight fixed frequencies into plasmas. The DR5 launches an array of finely spaced ($\Delta f = 400$ MHz) frequencies into plasmas for measurements of the flow shear, the turbulence's correlation length and radial structure. The center of the array bandwidth could be tunable within the range of 75-97.8 GHz. The ECEI is a 384 channels (24 vertical × 16 horizontal) system, which can provide two dimension measurement of the electron temperature fluctuations in the coverage of 600 mm (poloidal) ×180 mm (radial).

These multi-channel turbulence diagnostics could provide the fluctuation measurement of the density, the radial electric and the temperature at different radial locations simultaneously, and will play the key role to reveal the instinct mechanism for accessing, maintaining and controlling stationary I-mode in the future.

References

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