§13. Observation of the *m*/*n* = 2/1 Mode Structure by Using the Upgraded Tangentially Viewing VUV Imaging System in LHD

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A high-speed tangentially viewing VUV imaging telescope system has been developed in LHD from 2008[1, 2]. However, the sampling rate was restrained due to the low signal/noise ratio in the experiment. In order to improve the signal/noise level, upgrade was made during the experiment campaign in 2013. In this upgrade, the modifications are: effective diameter of the first mirror is enlarged from 23.2mm to 34mm, the focal length is reduced from 7 m to 5.2 m and the image magnification factor is increased from 60 to 80. The distance from the detector to LHD is reduced about 0.9m. And the observable diameter in the plasma is enlarged from 0.6m to 1.0m. Hence, the maximum framing rate is improved from 2000 frame per second (fps) in the old system to 6000 fps with a similar spatial resolution. The picture and viewing field of the upgraded imaging system are shown in Fig. 1 (a) and (b), respectively. The long dashed lines indicate the viewing field of the upgraded system, while the short ones denote that of the old system.

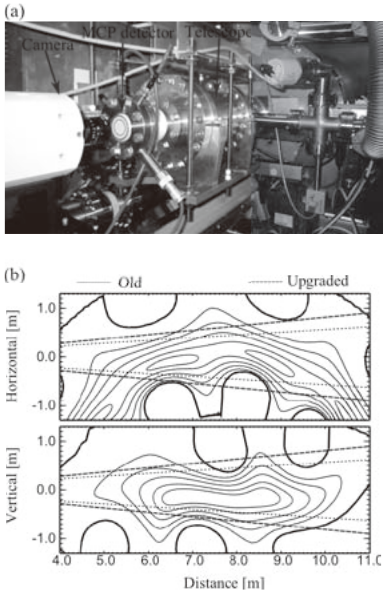

Fig. 1: (a)Picture of the installation, (b)horizontally and vertically viewing field of the upgraded (long dashed line) and old (short dashed) VUV imaging systems.

In the experiment campaign in 2013, the upgraded imaging system has been used to investigate the two-dimensional (2D) C VI emission structure in the experiment. As an example, Fig.2 shows Topos, Chronos and corresponding singular values of the first two key fluctuating components of the VUV imaging data. In this discharge, the magnetic configurations are: $Bt = 0.9T, R_{ax} = 3.75m$. The $m/n = 2/1$ MHD instability with a frequency about 0.6 kHz is excited. And this fluctuation is also detected by the upgraded VUV imaging system. The 2D mode structure is estimated by comparing the experimental images (U1 and U2) and synthetic images produced with plausible 2D emission profiles, as shown in Fig.3. This mode is localized at the $\rho = 0.45$ and mode width is about 0.15.

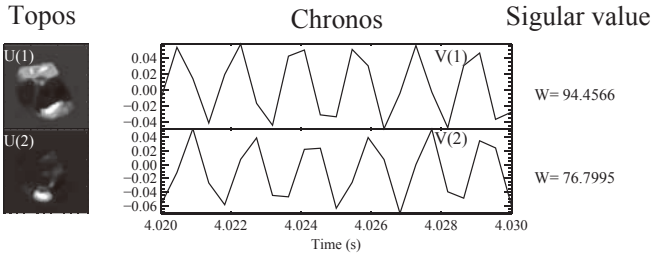

Fig. 2: Topos, Chronos and corresponding singular values of the first two key fluctuating components.

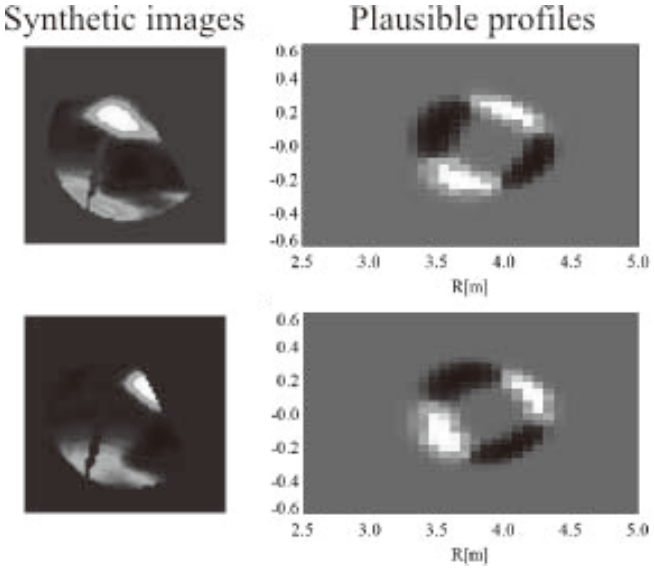

Fig. 3: Synthetic line-integrated images and corresponding plausible mode structures for U1(Top) and U2 (bottom), respectively

1) M. Takeuchi *et al*, "Development of a High-Speed VUV Camera System for 2-Dimensional Imaging of Edge Turbulent Structure in the LHD", Plasma Fusion Res. 5 (2010) S1037

2) T.F. Ming *et al*, "High speed vacuum ultraviolet telescope system for edge fluctuation measurement in the large helical device", Review of Scientific Instruments, Vol.83, Issue 10 (2012) 10E513.