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Measurement of spatial structures of fluctuations during the startup of tokamak plasmas in the PLATO tokamak by HIBP

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The PLATO tokamak [1] was newly constructed at Kyushu University with the aim of elucidating transport phenomena in plasma turbulence. A Heavy Ion Beam Probe (HIBP) has been installed to measure the transport phenomena [2]. HIBP is a powerful diagnostic device in transport research that can simultaneously measure the electric potential, its fluctuation, and electron density fluctuation, and has the potential to measure magnetic field fluctuations as well [3].

In the PLATO tokamak, a tokamak plasma with the plasma current of 20 kA was generated under the toroidal magnetic field B_t of 0.25 T for about 16 ms (Figure 1). The HIBP beam was bent by electric field created by electrostatic deflectors. Electrostatic deflectors are used for poloidal and toroidal deflectors, and 0 V and -480 V are applied to the poloidal (PS1) and toroidal (TS1) deflectors, respectively. The probe beam is injected with the incident angle at 30 degree, and the measurement position is near the center of the plasma which is estimated by the equilibrium code. The detected beam intensity is shown in Figure 1. (d). The ion species of the probe beam is potassium(K) and the beam energy is 27 keV. The injected primary beam(K^+) is ionized to K^{2+} by collisions with electrons in the plasma, and K^{2+} beam (secondary beam) is detected. The intensity of the secondary beam is related to the electron density and temperature of the plasma. In other words, the fluctuation component of the obtained signal intensity includes fluctuations in electron density and temperature.

Figure 2. shows the results of the Fast Fourier Transfer (FFT) analysis of the secondary beam intensity (Figure 1. (d)) in the period 1.008-1.016 s. According to the result, sudden and steady fluctuations appear Figure 2. These fluctuations are expected to be caused by MHD instability. We will present an evaluation of the spatial structures of the instabilities in the minor radius direction using HIBP to identify the instabilities.

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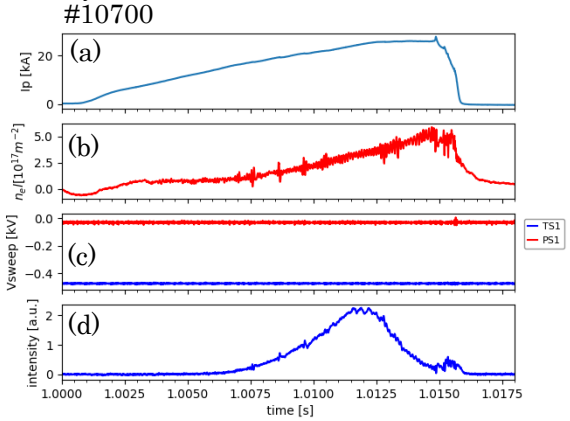

Figure 1. Discharge waveform and HIBP measurement data. (a) Plasma current, (b) Interferometric line integrated density, (c) Voltage of electrostatic deflectors of HIBP. The red line is poloidal sweeper voltage. The blue line is toroidal sweeper voltage. (d) Signal intensity of HIBP.

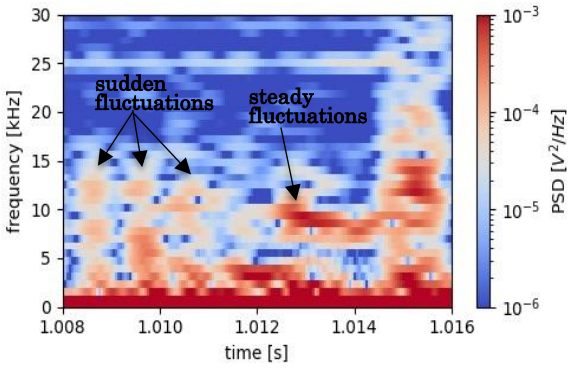

Figure 2. Power spectrum density of the intensity of HIBP, which includes the electron density fluctuation and temperature fluctuation.

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