§49. Formation of Divertor Configuration and Measurement of Divertor Plasmas on QUEST

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Radial profiles of ion saturation current, Is, and floating potential, Vf, were measured with a divertor probe arrays on a divertor configuration. The values of Vf just outside the outer divertor leg show significantly negative. Deposited heat load also measured with calorimetric technique and it is higher than an expected value estimated by the probe measurement. These indicate that some of trapped electrons gave an effect on plasma parameters on the divertor region. It may be caused by pitch angle scattering providing modification of orbit of the trapped electrons.

1. Introduction

Spherical tokamak (ST) is a candidate for cost-effective fusion power plant and the improvement of the plasma performance of ST has been tried in many institutes. ST has an advantage of compactness, however it means that a figure of merit, P/R, is naturally higher than that on conventional tokamaks, where P, and R show injected and productive power, and major radius, respectively. Therefore heat load to divertor region should be investigated. The QUEST (Q-shu University Experiment with Steady State Spherical Tokamak) project focuses on the steady state operation of ST and monitoring of heat load to divertor region has been done using a divertor probe array and calorimetric technique applied to divertor limiters.

2. Experimental Apparatus

A divertor probe system is installed on only the top side and comprises two Langmuir probe arrays arranged along the R direction. Thirty-one tungsten probe tips are arranged from R = 365mm to 815 mm every 15 mm for the measurement of I_s and another seventeen tungsten probe tips from R = 462mm to 702 mm every 15 mm for the measurement of V_f. The probe system can move vertically by 55mm from the plasma-side surface of divertor plates to the plasma-side surface of divertor limiters. 2-dimentional profile in R and Z of I_s and V_f can be obtained under the assumption of shot reproducibility. Power suppliers for probes are -54V DC batteries and resistances of 100Ω are used to detect I_s.

3. Experimental Results

The probe measurement has been done on a limiter, upper, and lower single null (USD, and LSD) configurations as shown in Fig. 1. The measured results are also shown in Fig. 1. Significant negative values of Vf was observed just outside of the outter divertor leg. The negative values cannot expected by space potential and bulk electron temperature. The negative values was strongly happen on the probes on which electrons produced on 2nd and 3rd ECRs can reach.

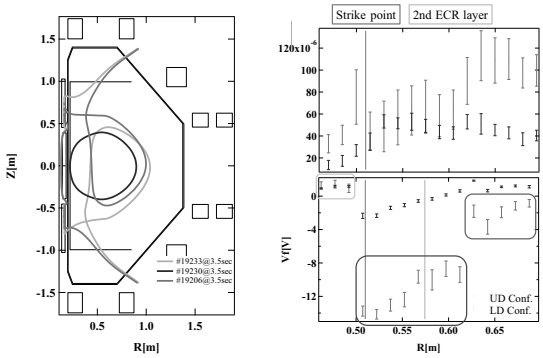

Fig. 1 Typical magnetic configurations on limiter (Blue), upper (Red), and lower (Orange) single null divertor are shown in the left figure. In the right figure, I_s (top) and V_f (bottom) profiles of the UD and LD configurations at the time of 3.5sec ±10msec, strike point (R = 0.51m; the blue vertical line) and 2nd ECR layer (R = 0.57m; the orange vertical line) of the UD configuration are shown. In the bottom figure, orange, green, and violet rectangles show the group which electrons are coming from only fundamental, 2nd and 3rd, and only 3rd ECR, respectively.

The results can be explained as the followings,
Trapped electrons with higher energy located outside of the last closed flux surface affect some pitch angle scattering and its orbit may be modified a little. The modification sometimes push the electrons to lost orbit, which directly connected to divertor region. Some of them are likely to reach on the probes indicated by the green rectangle in Fig. 1. This can be confirmed by electron orbit calculation using measured magnetic configuration.

A calorimetric measurement for divertor limiters was done and the delivered power was approximately 14kW in the case of USN shown in Fig. 1. While that in LSN is less than 1kW, although the values of Is measured with the probe array. Therefore almost of delivered power is provided by lost energetic electron as described above.

4. Summary

Heat load measurement and investigation on what is dominant process were executed. As the results, it find out that loss of trapped electron located outside of the closed flux surface is dominant.

[1] S.Takahashi, *et al.*,Proc.on ITC-22, Nov. 19-22, 2012.
[2] K.Hanada *et al.*, IEEJ, Vol. 132 / Sec. A, pp.490-498.