§9. He Gas Exhaust Experiments in LHD Closed Divertor with Pumping Function and Resonance Magnetic Perturbation Coils

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i) Introduction

The ratio of the alpha ash confinement time to the energy confinement time (τ_α^*/τ_E) is one of important parameters in designing the FFHR helical reactor. If the thermalized alpha particles accumulate in the plasma interior, ignition cannot be maintained. To exhaust the He ash the powerful pumping is necessary. However, if some method to enhance the He ash exhaust exists in addition to the powerful pumping capability, it is quite helpful. For this purpose, we have started to make experiments to use the resonant magnetic perturbation (RMP) whether it can enhance the He exhaust or not. In the last fiscal year, it is found that the m/n=1/1 mode slightly helps the He exhaust in the normalized minor radius of ρ=0.9 in LHD. At the observation point of R= 3.879 m, He CX signal is slightly decreasing compared to no m/n=1/1 RMP case.

In this annual report, we describe the new challenge to examine the possibility of the He exhaust using the RMP with m/n=2/1 mode in LHD, which exists more interior of the plasma.

ii) RMP application experiments

Figure 1 shows the experimental results on the resonant magnetic field perturbation with m/n=2/1, and the electron temperature profile with the shoulders at the resonant region of ρ=0.3, which was observed in LHD past experiments [1].

This situation should be established at first in this He exhaust experiment. In this year we have tried to make the m/n=2/1 mode for He exhaust experiments. However, as shown in Fig. 2, the temperature profile does not show the temperature shoulder at the m/n=2/1 mode position. This might be due to too much outboard of the plasma position.

On the other hand, the different group have gotten essentially same results with our last fiscal year experiments, such that the m/n=1/1 mode clearly show the He gas exhaust showing the decay waveform than the last year's experiments.

In Fig.3 is shown the alpha particle birth profile for the high-density and low temperature operation for the density profile of α_n=3 and temperature profile of α_T=1. The alpha particle birth profile exists inner than ρ=0.5. Therefore, the magnetic island of m/n=2/1 may enhance the alpha particle loss and diffuse it out. After giving up the their energy to the plasma, alpha particles could diffuse away to the outside by the m/n=2/1 mode and then the m/n=1/1 mode at the outside may enhance alpha particle loss, leading to effective pumping out.

The high-energy particles produced in DD experiments may contribute this type of experiments.

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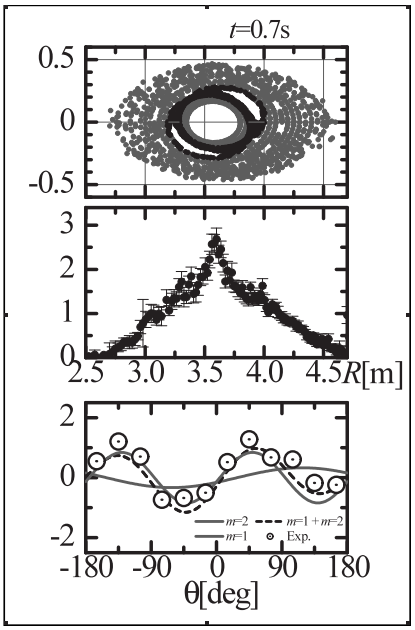

Fig.1. (Top) The magnetic island with m/n=2/1 mode, (Middle) the electron temperature profile, and (Bottom) the plasma response magnetic field, which were obtained in the past experiments [1].

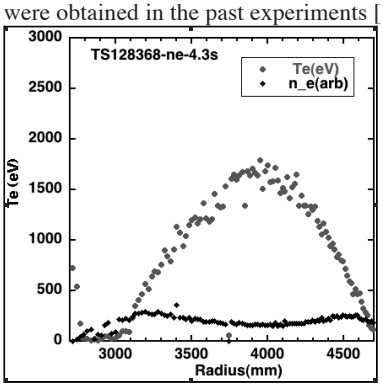

Fig.2. The electron temperature profile for m/n=2/1 mode at t=4.3s. (#128368) The m/n=2/1mode is not produced.

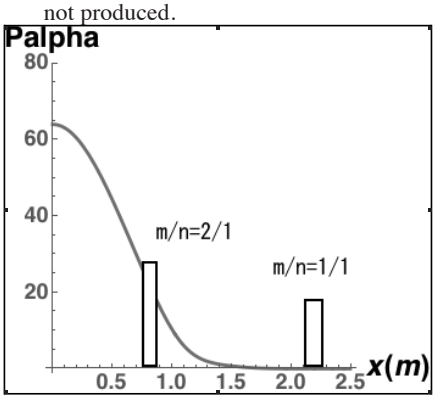

Fig.3. Alpha particle birth profile and resonant position of the magnetic perturbation in FFHR when the same type of the perturbation coils in LHD are used.

1) Y. Narushima in 27th Plasma Fusion Conference (2010.11.30–12.3) 02P13