Optimization Study of ICRF heating in the LHD by TASK/WM+GNET

S. Murakami, T. Yamamoto, A. Fukuyama,
K. Saito[a], T. Seki[a], T. Mutoh[a], R. Kumazawa[a], M. Isobe[a], M. Nishiura[a], T. Ozaki[a],
M. Osakabe[a] and LHD Experimental Group

Department of Nuclear Engineering, Kyoto University, Kyoto 606-8501, Japan
[a]National Institute for Fusion Science, NINS, 322-6 Oroshi-cho, Toki 509-5292, Japan

e-mail: murakami@nucleng.kyoto-u.ac.jp

ICRF heating experiments has been successfully done in helical systems and have demonstrated the effectiveness of this heating method in three-dimensional (3D) magnetic configurations. In LHD, significant performances of this method have also been demonstrated and up to 2.5MeV of energetic tail ions have been observed by fast neutral particle analysis (NPA). These measured results indicate a good property of energetic ion confinement in helical systems. However, the measured information by NPA is obtained as an integrated value along a line of sight and we need a reliable theoretical model for reproducing the energetic ion distribution to discuss the confinement of energetic ions accurately.

To solve this problem we have studied ICRF heating in the LHD combining two simulation codes: a full wave solver TASK/WM[1] and a 5-D drift kinetic equation solver GNET[2]. Characteristics of energetic ion distributions in the phase space are investigated changing the resonance heating position; i.e. the on-axis and off-axis heating cases. The simulation results are also compared with experimental results in the two heating cases evaluating the count number of the neutral particle analyzer and a relatively good agreement is obtained.

On the other hand, recent numerical studies of energetic ion confinements in the LHD configurations indicate that an optimized configuration of the energetic ion confinement is different from that of the neoclassical transport (R_{ax}=3.53m)[3] due to the finite orbit effect of the energetic ions. Additionally the previous simulation study of ICRF heating in LHD[2] shows that the stable trapped particles near the resonance surface play an important role in generating energetic tail ions. Thus there is a possibility to find a better configuration and heating scenario than the present ones, and it is interest to investigate an optimization of ICRF heating in point of views of the energetic tail ion generation and their confinements in a helical plasma.

In this paper optimizations of the configurations and the heating scenario of ICRF heating are investigated in the LHD applying two global simulation codes; a full wave solver TASK/WM and a 5-D drift kinetic equation solver GNET. The difference between the ICRF heating optimization and the neoclassical transport one is discussed.

[1] A. Fukuyama, *et al.*, Proc. 18th IAEA Conf. on Fusion Energy (Sorrento, Italy, 2000) **THP2-26.**
[2] S. Murakami, *et al.*, Nucl. Fusion **46** (2006) S425.
[3] S. Murakami, *et al.*, Nucl. Fusion **42** (2002) L19.