29E39P

LHD型ヘリカル核融合炉FFHRの立ち上げシナリオ最適化
Optimization of Startup Scenario of LHD-type Helical Fusion Reactor FFHR

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Conceptual design study of the LHD (Large Helical Device)-type helical DEMO fusion reactor FFHR-d1 [1] is now being studied intensively under the Fusion Engineering Research Project in National Institute for Fusion Science. The main design parameters of FFHR-d1 were selected by design window analysis using the system design code HELIOSCOPE [2]. Detailed analysis of core plasma performance at its steady-state operation point is now underway on the basis of the plasma profiles directly extrapolated from the LHD experiment [3]. Helical system inherently has steady-state nature and no significant external power injection is needed to sustain a burning plasma. Therefore, it is important especially for helical system to optimize its start-up scenario from the viewpoint of minimizing a heating power requirement. In the past study by O. Mitarai *et al.*, a method of start-up and steady-state sustainment of a burning plasma of helical system by a PID control of a heating power and a fuelling amount was proposed using a 0-D power balance model [4]. The possibility of reduction of the heating power requirement by lengthening start-up time has been proposed with this 0-D model. However, it is important to consider the effect of plasma profile on the heating power deposition profile, pellet penetration depth, confinement property, and so on. Therefore, a quasi-1D power and particle balance model was developed and the requirements on pellet fuelling for an LHD-type helical fusion reactor was discussed [5]. In this model, time evolution of density profile is calculated by solving a 1-D diffusion equation with the pellet deposition profile estimated using the NGS model. On the other hand, time evolution of temperature profile is estimated by assuming the relationship between local density and temperature based on gyro-Bohm-type parameter dependence. This simplification enables a fast calculation and a relatively long-time simulation.

Using this model, plasma startup scenario of an LHD-type helical reactor with a pellet fuelling has been studied and possibility of the plasma startup with a PID control of fuelling rate by a fusion power was demonstrated as shown in Fig. 1. The detailed result of optimization of parameters (e.g., pellet size, heating power amount) will be discussed in the presentation.

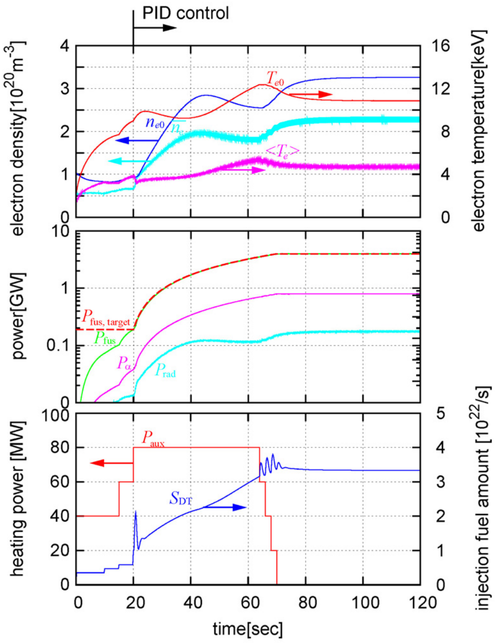

Fig. 1: Time evolution of plasma parameters.

Reference

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