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LHD型ヘリカル核融合炉FFHRのプラズマ運転制御シナリオ
Plasma operation control of LHD-type helical reactor FFHR

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Since helical system does not need current ramp-up and steady-state current drive, flexible options of steady-state operation point and the path toward them can be adopted. On the other hand, plasma operation scenario should be optimized by considering the condition of the control equipment (heating system, fuelling system and diagnostics). In particular, the required capacity of the heating system depends on the ignition-access scenario. The time for the ignition access, which corresponds to the rate of the change in the thermal output, is also an important factor in the design of the plant equipment. In past study, plasma start-up scenario of LHD-type helical system was studied using a 0-D model, and PID control method of the fusion power by manipulating the fuelling rate and the heating power amount was proposed [1].

To confirm the results of the 0-D analysis and to optimize the plasma operation scenario, we developed a quasi-1D calculation code, which can provide a fast calculation of the time evolution of the radial profile of the plasma density and temperature with a pellet fuelling by utilizing the gyro-Bohm type parameter dependence observed in the LHD experiment [2, 3]. Ignition access scenario of the LHD-type helical reactor FFHR-d1 [4] was examined by using the code. It was found that feedback control of the fusion power by the fuelling rate is difficult due to the delay in the response of the fusion power caused by a shallow deposition of the pellet. Thus we selected the line-average electron density as a controlled parameter because it promptly responses after the pellet injection and there are a couple of diagnostics which can measure it with a high accuracy. As shown in Fig. 1 and 2, smooth ignition access and steady-state sustainment can be achieved with adequate heating power control.

In the presentation, the effect of the accuracy of the diagnostics and control method of the heating power will be discussed.

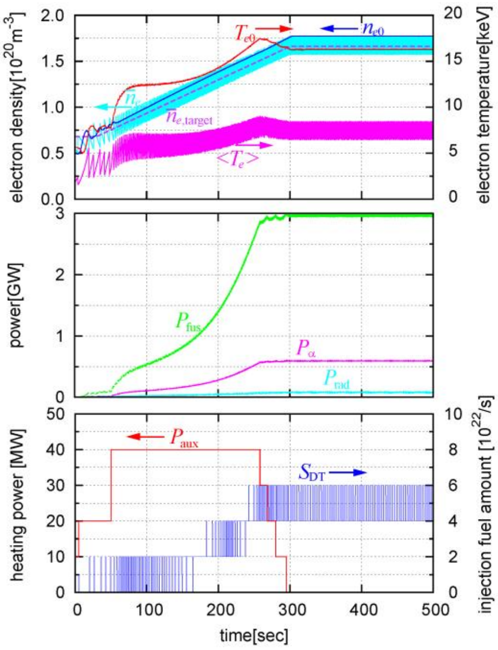

Fig. 1 Time evolution of the plasma and controlled parameters.

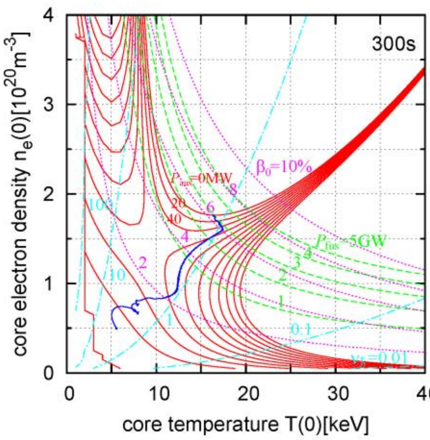

Fig. 2 POPCON plot corresponds to the final (steady-state) condition.

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[2] J. Miyazawa *et al.*, Fusion Eng. Des. **86** 2879 (2011).
[3] R. Sakamoto *et al.*, Nucl. Fusion **52** 083006 (2012).
[4] A. Sagara *et al.*, Fusion Eng. Des. **87** 594 (2012).