§8. Detailed Physics Analyses of FFHR-d1 Core Plasma in Collaboration with the Numerical Simulation Research Project

Miyazawa, J., Yokoyama, M., Suzuki, Y., Seki, R.,
Satake, S., Goto, T., Sagara, A.,
Masaoka, Y., Murakami, S. (Kyoto Univ.)

Detailed physics analyses of FFHR-d1 core plasma have been started in collaboration with the Numerical Simulation Research Project. The profile data are provided by the DPE method [1]. The MHD equilibrium is reconstructed by HINT2 (Fig. 1) and VMEC. The neoclassical transport is calculated by GSRAKE (Fig. 2) and FORTEC-3D. The alpha particle transport is solved by GNET (Fig. 3) and MORH (Fig. 4).

HINT2 predict a large Shafranov shift and destruction of the magnetic surfaces in the peripheral region (Fig. 1(b)). Therefore, we have applied the plasma position control by the vertical magnetic field identical to that used to form an inward shifted configuration of R_{ax}^{vac} = 14.0 m in vacuum. Then, the Shafranov shift is mitigated and the destructed magnetic surfaces are reformed (Fig. 1(c). The neoclassical transport and the alpha heat deposition are deteriorated due to the large Shafranov shift (Figs. 2 and 3). However, MORH predicts that the alpha particle confinement can be improved by the plasma position control (Fig. 4). Furthermore, if the "re-entering effect" of alpha particle is taken into account by setting the loss boundary on the vacuum vessel, then the alpha loss ratio will be improved to ~10 % (Fig. 4).

1) J. Miyazawa, et al., Fusion Eng. Des. **86** (2011) 2879.

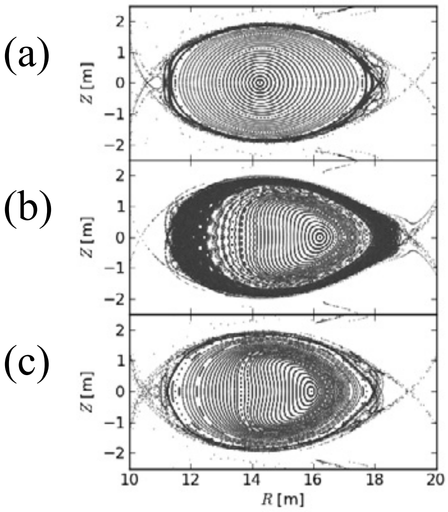

Fig. 1. Magnetic surfaces in FFHR-d1 calculated by HINT2, with the conditions of (a) (R_{ax}^{vac} = 14.4 m, vacuum), (b) (R_{ax}^{vac} = 14.4 m, β_0 = 8.5 %), and (c) (R_{ax}^{vac} = 14.0 m, β_0 = 10.0 %).

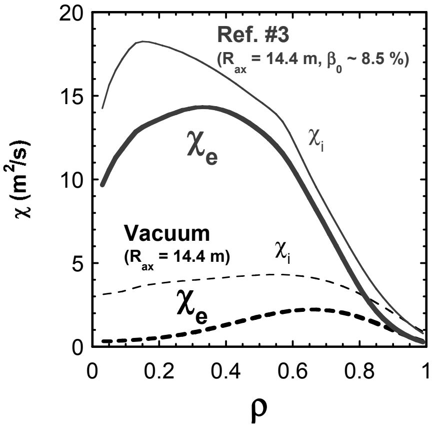

Fig. 2. Radial profiles of the neoclassical thermal conductivities in vacuum (broken curves) and finite beta (solid curves) conditions. The MHD equilibrium shown in Fig. 1(b) is used for the latter case.

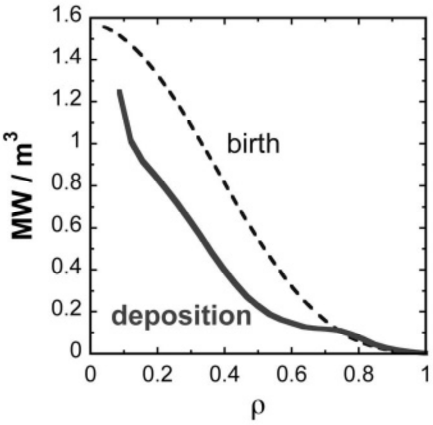

Fig. 3. The birth (broken curve) and heat deposition (solid curve) profiles of alpha particles in FFHR-d1 calculated by GNET, where the MHD equilibrium shown in Fig. 1(b) is used.

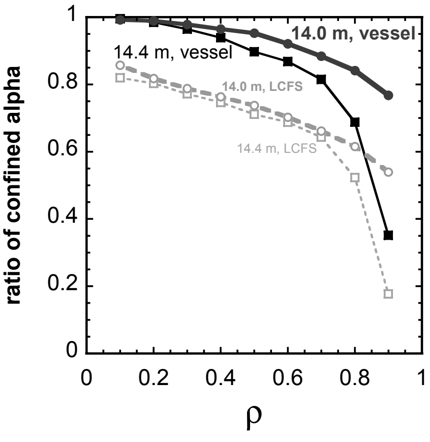

Fig. 4. Radial profiles of the ratio of confined alpha calculated by MORH, where thin and bold curves denote the MHD equilibrium with (see Fig. 1(b)) and without (Fig. 1(c)) plasma position control, while broken and solid curves denote the loss boundaries set on LCFS and the vacuum vessel, respectively.