§1. Integrated Design Studies on Blanket Replacement in LHD-type Rector FFHR2m

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The long-life STB (spectral-shifter and tritium breeding) blanket concept has been proposed for a relatively large size helical reactor FFHR (R > 10 m) with a reduced neutron-wall loading around 1.5 MW/m^2 [1]. This concept needs to be evaluated in 3D calculations on key aspects of the peaking factor of the wall loading, the total TBR, and compatibility of the blanket shape with the magnetic configurations.

Figure 1 shows the 3D view of the LHD-type reactor FFHR2m1. The coil pitch parameter γ, which is defined by (m/l)(a_c/R_c), is 1.15 in FFHR2m1 to expand the blanket space and to reduce electromagnetic force. Due to this force reduction with simplified coils support structure as seen in Fig.1, fairly large maintenance holes can be arranged at upper and down ports. Based on those ports, the long-life STB blanket has been proposed. The 3D evaluations revealed that the peaking factor of the wall loading is 1.20 to 1.33, not so large, over the average 1.5 MW/m^2 as shown in Fig.2, depending on the neutron source profile. The total TBR over 1.05 is possible by optimizing the first wall design and the shielding design for the helical diverter pumping area to reduce neutron absorption and loss rates.

The 3D evaluation of the blanket shape revealed that, in FFHR2m1, there are sever interferences of the blanket with the ergodized magnetic layer as shown in Fig.3. To ensure the blanket space over 1 m, as shown in Fig.4, developments of larger sized designs as FFHR2m2 or advanced coile designs such as sprit helical coils [2] are new targets.

Reference:

1) Sagara, A., et al., Fusion Eng. Des. 81 (2006) 2703.
2) Yanagai, N., et al., in this report.

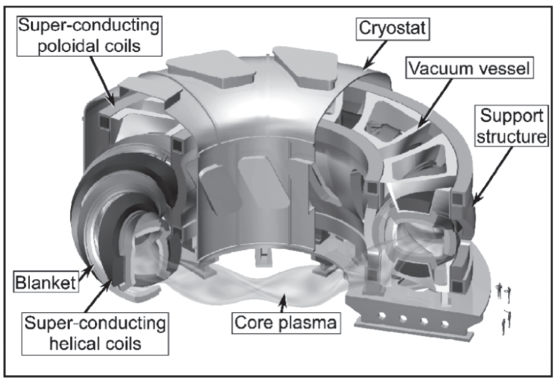

Fig.1. The 3D illustration of the FFHR2m1.

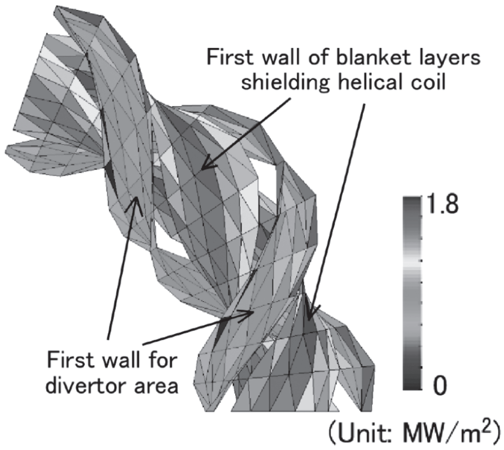

Fig.2 The 3D distribution of neutron wall loading on the first wall of FFHR2m1, where the averaged loading is 1.5 MW/m^2 and the helical shaped neutron source is assumed.

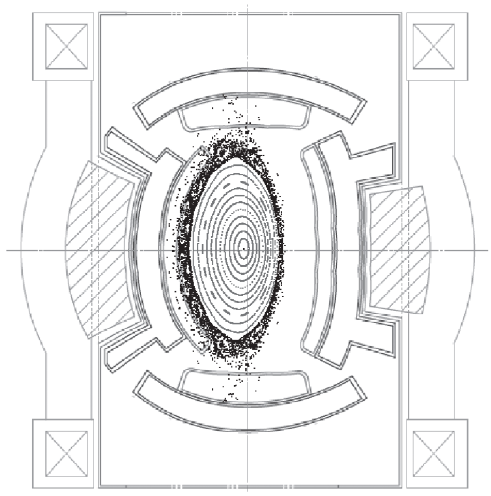

Fig.3 The vertical cross section of the FFHR2m1, where the ergodized magnetic layer clearly interferes with the inboard-side blanket.

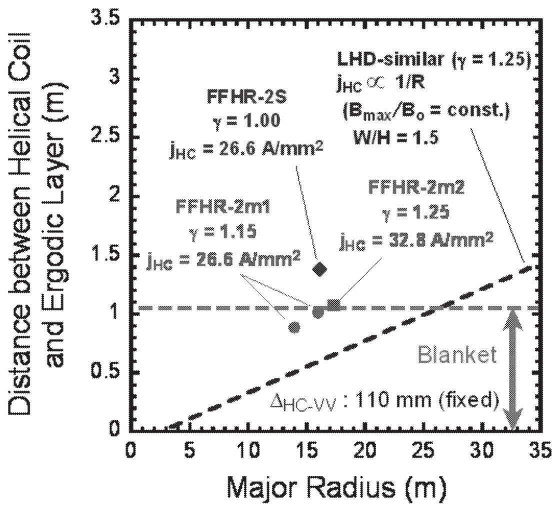

Fig.4 Distance between helical coil and ergodic layer, depending on magnet designs for FFHR, where the space for thermal insulation is kept constant to 110 mm as same as in LHD.