6Da02

ヘリカル体積中性子源FFHR-b1の役割と課題
The Role and Issues of a Helical Volumetric Neutron Source FFHR-b1

宮澤順一[1,2], 田中照也[1,2], 後藤拓也[1,2], 田村仁[1], 柳長門[1,2], 相良明男[1,2], FFHR設計グループ
MIYAZAWA Junichi[1,2], TANAKA Teruya[1,2], GOTO Takuya[1,2], TAMURA Hitoshi[1], YANAGI Nagato[1,2], SAGARA Akio[1,2], and the FFHR Design Group

[1]核融合研, [2]総研大
[1]NIFS, [2]SOKENDAI

The FFHR-b1 has been proposed as the beam-plasma fusion based HElical Volumetric Neutron Source (HEVNS) for neutron irradiation tests of in-vessel systems including blanket, divertor, and high-temperature superconducting (HTS) magnets. The FFHR-b1 is one of the important steps toward realization of the helical fusion reactors FFHR-c1 and d1A, as shown in Fig. 1. The FFHR-001 for proof-of-principal of the HTS magnets and the FFHR-a1 for basic R&D in a non-nuclear environment are also involved in the step-by-step approach [1].

The device size of the FFHR-b1 is the same as the LHD (the plasma major radius is ~3.6 m), while the magnetic field strength is doubled to ~6 T. The D-T fusion output produced by 20 MW D-beam is expected to be ~7 MW, at the least. Then, the neutron flux of the order of 10^{16} n/(m^2 s) will be supplied to ~200 m^2 of the 1st wall of the blanket. In Fig. 2, the irradiation area and the neutron flux are compared with those of other neutron sources of A-FNS [2] and ST-VNS [3].

Due to the small device size and the narrow blanket space, the neutron attenuation ratio will be as low as ~0.1. This may result in a short device lifetime from the point of view of the degradation of the SC magnets. Nevertheless, the operation time of the FFHR-b1 is still long enough. A few years of D-D operation will be carried out before the D-T operation with a low fusion power of ~70 kW to test the blanket and divertor systems with ~10^{14} n/(m^2 s) of the neutron flux. One-year steady-state operation and the maintenance within five months to achieve 70 % availability will be demonstrated during the D-D operation phase. At the same time, the initial loading of tritium can be produced. Then, the DT operation will be carried out for several years to irradiate the SC magnets in a reactor-relevant situation until these become degraded. As a result, more than 10 years of operation in total is possible.

The FFHR-b1 as the HEVNS can help to test the blanket and divertor systems not only for the FFHR-c1 but also for the tokamak DEMO. It is also possible to test the SC magnets in the real reactor-relevant situation with high magnetic field, low temperature, high electric current, and high mechanical stress.

This work was supported by JSPS KAKENHI Grant Number 16K14530.

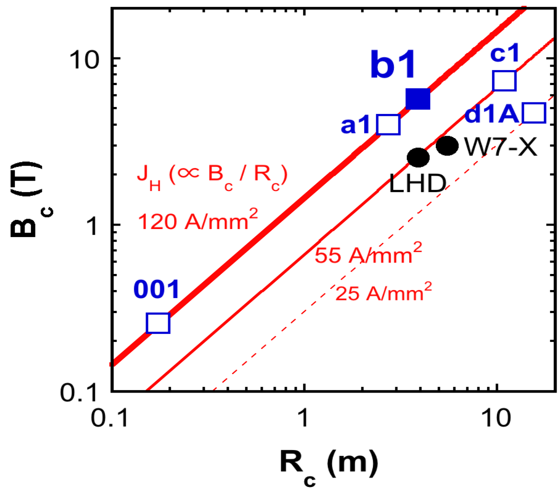

Fig. 1: Relations between the major radius of the helical coil center, R_c, and the magnetic field strength at the helical coil center, B_c, in FFHR-d1A, c1, b1, a1, 001, LHD, and W7-X. Lines denote the combinations of R_c and B_c, which give the identical helical coil current density, J_H, of 25, 50, and 120 A/mm^2, in similar devices to the FFHR-d1A.

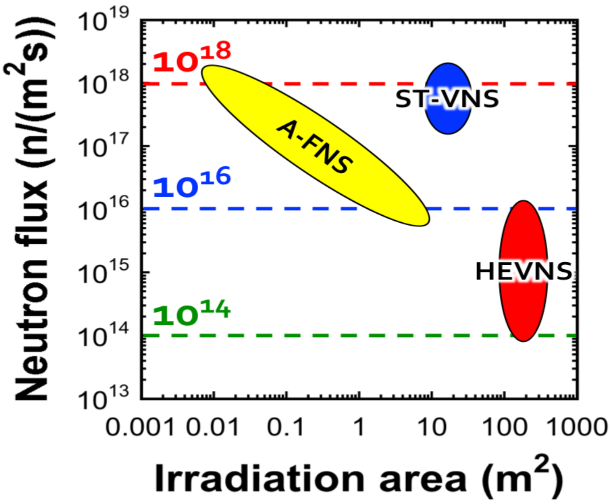

Fig. 2: Comparison of the irradiation area and the neutron flux in the A-FNS [2], the ST-VNS [3], and the FFHR-b1 as the HEVNS.

[1] J. Miyazawa, et al., 30th SOFT (2018, Sicily), P1.003.
[2] K. Ochiai, et al., JPFR **92** (2016) 274.
[3] E.T. Cheng, et al., FED **38** (1998) 219.