DESIGN STUDIES OF INNOVATIVELY SMALL FUSION REACTOR BASED ON BIOMASS-FUSION HYBRID CONCEPT: GNOME

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Conceptual design of an innovatively small tokamak reactor "GNOME" based on non-fission biomass-fusion hybrid concept is proposed. The auhtors proposed the fusion plant concept that intends to use high-temperature heat from the blanket to generate hydrogen or synthetic fuels out of waste biomass. Since energy multiplication is expected through burning processes of biomass, the requirement for plasma will be reduced to $Q > 5$. In this study, reactor parameters for this concept were calculated by a system code TOPPER [1] which solves the 0-D plasma power balance. As a result, the GNOME tokamak reactor is designed to produce 320 MW fusion power with 5.2 m major radius, 3.1 normalized beta, 11 T maximum field. This relatively small maximum field of 11 T would be achieved by using Nb_3Sn super conducing magnets. The total magnetic energy by TF coils is estimated at 28.8 GJ. Besides, this reactor allows 1.5 m diameter space for the center solenoid and requires only 60 MW of the input power. These features require minimal technical extension from ITER. A comparison of plasma parameters of the GNOME reactor and the ITER reversed shear mode is shown in Figure 1.

It is also found that the small size plasma of GNOME greatly relieves the heat and particle loads to the first walls and the divertor. In particular, the small neutron loads for the first wall extends the predicted lifetime of the insulator of superconducting coils. Moreover, heat loads to the divertor tiles are estimated for attached and detached plasma. Based on these calculations, capabilities of plasma facing components (PFCs) are examined. In particular, a design of PFCs using liquid LiPb coolant in a SiC tube with a W monoblock will be introduced and compared with other PFC designs.

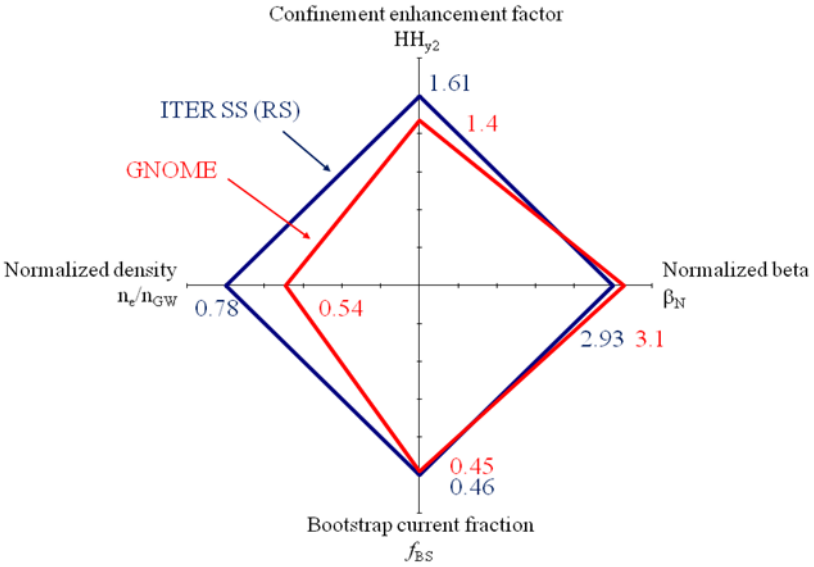

Figure 1: A comparison of plasma parameters of the GNOME reactor and ITER RS

[1] K. Tobita and et al., "System code of JAEA", 5th BA DEMO Design Work Shop, (2009) Garching