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Progress in preparing research plan and construction of JT-60SA

Naoyuki Oyama[1]

[1] National Institutes for Quantum and Radiological Science and Technology

e-mail: oyama.naoyuki@qst.go.jp

JT-60SA project [1,2] is a joint programme of the Satellite Tokamak Programme of the Broader Approach Agreement between EURATOM and Japan, and the Japanese national programme. The JT-60SA project has three major objectives, (1) Supportive research for the ITER project to realize a Q = 10 operation in ITER, (2) Complementary research to ITER in order to promote DEMO design activities and (3) foster scientists and technicians in the younger generation. To achieve these objectives, a fully superconducting tokamak JT-60SA has following capabilities; high plasma current up to 5.5MA, a large value of shape factor $S = q_{95}I_p/(aB_t)$ larger than 6 aiming at high β_N plasmas, high power (up to 41 MW) and long pulse (up to 100s) heating power (See, figure 1).

There are three research phases in the JT-60SA operation: (i) the initial research phase, (ii) the integrated research phase, and (iii) the extended research phase. In each phase, maximum heating power increases step by step up to 41 MW and therefore the divertor will also be upgraded to the full monoblock CFC target to withstand a heat load up to 15 MW m^{-2}. Considering these research phase, dedicated research plan of JT-60SA in each research area such as operation regime development, MHD stability/control, transport/confinement, high energy particle behavior, pedestal and edge physics, divertor/SOL/plasma-material interaction and so on have been discussed, and summarized in the "JT-60SA research plan (SARP)" [3].

Every year, research topics, objectives and approaches in SARP have been elaborated based on extensive discussion among the research unit, results of simulation studies and observations in the present devices. Reflecting latest schedule of JT-60SA and ITER research plan, prioritization of many research topics and a strategy of changeover from carbon wall to tungsten wall have been discussed in the research unit for preparing the new version of the SARP. In addition, predictive modeling of JT-60SA scenario has also progressed using the integrated modeling codes such as TOPICS and JINTRAC, indicating that JT-60SA has enough capability to explore the divertor heat load control by impurity seeding in high-beta steady-state plasmas. To prepare the changeover to tungsten wall, a sample of tungsten coating on CFC mono-block has been developed using a vacuum plasma spraying (VPS) method. As a result of high energy H ion beam irradiation tests using GLADIS, we confirmed that cyclic loadings at 15 MW/m^2 expected at the divertor target in JT-60SA produced no severe morphological change.

The construction of JT-60SA has also progressed. The winding and pre-installation of the three lower Equilibrium Field (EF) coils, the welding of a 340 degree of the Vacuum Vessel sectors, and the manufacturing of all the Toroidal Field (TF) Coils has been completed. Recently, the last two TF coils are transported to Japan by a huge airplane in Feb. 2018. Since the construction is progressing steadily, the achievement of a big milestone of the completion of assembly of all toroidal field coils and vacuum vessel of 360 degree is foreseen in near future (See, figure 2). The construction of JT-60SA will be finished in Mar. 2020 and first plasma is expected in Sep. 2020.

References

1 H. Shirai et al 2017 Nucl. Fusion 57 102002

2 V. Tomarchio et al 2017 Fusion Eng. Des. 123 3-10

3 JT-60SA Research Unit 2016 JT-60SA research plan -research objectives and strategy- version 3.3 (www.jt60sa.org/pdfs/JT-60SA_Res_Plan.pdf)

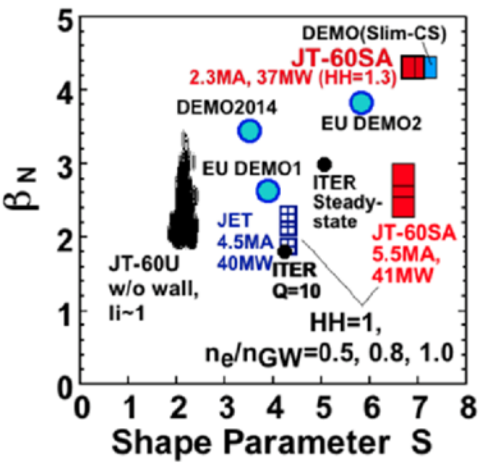

Figure 1 Non-dimensional plasma parameter regimes of JT-60SA: the normalized beta and the shape factor

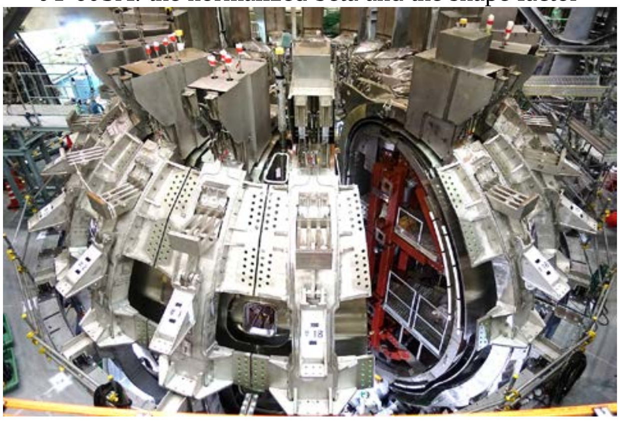

Figure 2 Progress of assembly of all toroidal field coils and vacuum vessel of 340 degree in April 2018