Progress in JT-60SA Construction, Research Plan and Research Activities

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The JT-60SA project has been developed under the Broader Approach agreement and Japanese domestic program. Mission of the JT-60SA project is to contribute to early realization of fusion energy by addressing key issues for ITER and DEMO. Examinations on JT-60SA will enable us to carry out ITER experiments efficiently to reach the goal in the ITER project. Results in JT-60SA will give a practically acceptable DEMO plasma design and a reliable idea of plasma control schemes for a power plant.

The JT-60SA device is capable of confining break-even-equivalent class high-temperature deuterium plasmas with high plasma current (5.5 MA), lasting for a duration (typically 100 s) longer than the time scales characterizing key plasma processes, such as energy / particle confinement time and current diffusion time, using superconducting toroidal and poloidal field coils. For the fist plasma in March 2019, the manufacture of the main components has been going well on schedule both in the EU and Japan, and the JT-60SA project is now entering a new phase as it moves from manufacture of components to assembly. Three equilibrium field coils were installed on the cryostat base in January 2014, then, assembly of the vacuum vessel started in May.

Parallel to the JT-60SA construction, the research plan for JT-60SA has been discussed in the fusion communities in Japan and Europe (more than 330 researchers from 40 institutes) to deepen and sharpen the research strategy for JT-60SA [1]. The JT-60SA Research Plan summarizes research objectives and strategy in JT-60SA experiments covering all the major research fields contributing to ITER and DEMO. Note that discussing the JT-60SA Research Plan is not only for future experiments but also for the present studies related to JT-60SA, ITER and DEMO.

Experiments in JT-60SA will be conducted over a wide range of operational regimes including ITER and DEMO relevant regimes. Simultaneous achievement of such high plasma performances (normalized β_N~4, confinement enhancement factor HH_{y2}~1.3, bootstrap current fraction f_{BS}~0.7, normalized density f_{GW}~1, radiation power ratio f_{rad}~0.9, non-inductive current drive fraction f_{CD}~1) will be tried by capitalizing on high power and current drive (10 MW N-NB, 7 MW ECRF, 24 MW P-NB), various torque input (co-, counter- and perpendicular-NBI), highly shaped configuration, flexible impurity seeding, pellet injection, etc. Plasma transport of bulk and energetic particles and micro and macro stabilities will be investigated in ITER and DEMO relevant regimes (high beta, highly self-regulating, dominant electron heating, low collisionality, small gyro radius, etc.). Theoretical models and simulation codes will be developed and validated using the observations in JT-60SA. The models and codes will be used for plasma prediction and development of an operation scenario in ITER and DEMO. Control schemes of plasma profiles, impurities, radiation, MHD instabilities, disruption, ELMs, etc. will be examined in JT-60SA high performance plasmas to propose a useful control scheme in ITER and DEMO. Both physics understanding of high performance plasmas (leading to plasma modeling) and developing plasma control systems are critical issues for ITER and DEMO that should be undertaken in JT-60SA.

[1] JT-60SA Research Plan version 3.1, http://www.jt60sa.org/b/index_nav_3.htm?n3/operation.htm