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Integrated plasma control extending the Advance Tokamak regime in JT-60U

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In order to realize the economical fusion reactor, high confinement (H_{98} factor), high normalized beta (β_N), high bootstrap current fraction (f_{BS}), i.e. the Advanced Tokamak (AT) plasma must be sustained. In the recent experimental campaigns from November in 2007 to August in 2008, the operational regime and pulse lengths of AT plasmas has been significantly extended and the various control techniques toward steady state both in the core plasmas and in the boundary plasmas were steadily improved in JT-60U. The optimization of the beam heating profile for sustaining ITB and the enhanced wall conditioning successfully extended the high $\beta_N \sim$ 2.6 for 28 seconds (25 seconds for $H_{98} \geqq 1$) in the positive shear (PS) plasma without increase in particle recycling level in the divertor. Because of high G-factor (β_N H_{98}/ q_{95}^2) of 0.25, this plasma is relevant for ITER hybrid operation scenario. While the reversed shear (RS) plasma with high f_{BS} and high H_{98} factor accompanied with the strong ITB is attracting for the ITER advanced operation scenario and DEMO, the safety factor $q_{95} < 8$ has not been accessible for $f_{BS} \geqq 0.7$ due to low beta limit in the previous campaigns. In this experimental campaign, the b_N limit is significantly improved and $\beta_N \sim 2.7$ and $f_{BS} \sim 0.9$ was achieved at $q_{95} \sim 5.3$, by utilizing large volume configuration close to the conductive wall for stabilization of RWM. The real-time control for the power exhaust to the divertor was intensely investigated. Total radiation fraction of P_{rad} / P_{heat} = 0.8-0.9, was maintained continuously up to 13 seconds with H_{98} = 0.77-0.84 by utilizing radiation feedback for Ar gas seeding.