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**Advanced Tokamak Research in Long Time Scales on JT-60U**

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In order to realize a steady-state tokamak fusion reactor, sustainment of advanced tokamak plasmas with a large fraction of bootstrap current ($f_{BS}$) and high normalized beta ($\beta_N$) is required. Important characteristic time scales to be considered are the current diffusion time ($\tau_R$) and the wall saturation time ($\tau_{wall}$). Recent JT-60U experiments extended the duration of advanced tokamak plasmas longer than $\tau_R$ and approaching $\tau_{wall}$, which enabled us to study control issues in long time scales. In a reversed shear plasma, a very high $f_{BS}$ of 75% was maintained for 7.4 s ($2.7\tau_R$) together with very high confinement $HH_{y2} \sim 1.7$ at $\beta_N \sim 1.7$ and $q_{95} \sim 8.6$. Stationary conditions in the current and pressure profiles have been obtained for the first time in a bootstrap-current-dominant plasma relevant to the steady-state tokamak reactor. In a high $\beta_p$ H-mode plasma with N-NB injection, a weak shear $q$ profile with $q_{min} \sim 1.5$, $q_{95} \sim 4.5$, $f_{BS} \sim$ 43-50% and $\beta_N$ of 2.4 was successfully maintained for 5.8 s ($2.8\tau_R$) under nearly full non-inductive current drive condition, approaching to requirements for the ITER steady-state operation scenario. In a high $\beta_p$ H-mode plasma with $q(0)$ close to 1, $\beta_N$ of 2.5 and $f_{BS}$ of $\sim$ 30-35% have been successfully maintained for 15.5 s ($\sim 9.5\tau_R$) at $q_{95} \sim 3.4$ with extended pulse length of NB. The figure of merit of fusion performance $\beta_N H_{89}/q_{95}^2$ was kept 0.4-0.5. The current profile reached a stationary state with $q(0) \sim 1$ without appearance of sawteeth or neoclassical tearing modes. A slight decrease in energy confinement was observed in a later phase, which can be attributed to the increase in the particle recycling and the plasma density, suggesting importance of particle control in long pulse plasmas. The divertor pumping was effective for density control under the saturation of wall inventory in repeated long pulse ($\sim$ 30 s) ELMy H-mode discharges.