Model-based current profile control at DIII-D

Y. Ou,[a] C. Xu,[a] E. Schuster,[a] T. Luce,[b] J. Ferron,[b] M.L. Walker,[b] D.A. Humphreys,[b]

[a]Lehigh University, Bethlehem, Pennsylvania, USA
[b]General Atomics, San Diego, California, USA

There is consensus in the fusion community that control of the radial profiles of various plasma quantities (current, pressure, rotation, etc.) will be key to the optimization of burning plasma scenarios. It has been suggested, for instance, that global current profile control, eventually combined with pressure profile control, can be an effective mechanism for neoclassical tearing mode (NTM) control and avoidance. It has been also suggested that simultaneous real-time control of the current and pressure profiles could lead to the steady state sustainment of an internal transport barrier (ITB) and so to a stationary optimized plasma regime.

A key goal in control of an advanced tokamak (AT) discharge is to maintain safety factor (q) and pressure profiles that are compatible with both MHD stability at high toroidal beta and a high fraction of the self-generated bootstrap current. This will enable high fusion gain and noninductive sustainment of 100% of the plasma current for steady-state operation. Active feedback control of the q profile evolution at DIII-D has been already demonstrated [1]. In this work we report progress towards enabling model-based active control of the current profile during both plasma current ramp-up and flattop phases.

Initial results on modeling and simulation of the dynamic evolution of the poloidal flux profile are presented. Dynamic models will allow the exploitation of recent developments in the field of (nonlinear) control of distributed-parameter systems to solve present profile control problems in magnetic fusion energy.

[1] J.R. Ferron, et al., "Control of DIII-D Advanced Tokamak Discharges," 32nd EPS Conference on Plasma Physics, Tarragona, 27 June – 1 July 2005, ECA vol. 29C, p. 1,069 (2005).