MULTIVARIABLE SHAPE CONTROL DEVELOPMENT ON THE DIII–D TOKAMAK*

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Extensive work has been done at DIII–D in an effort to convert to more modern methods of plasma shape and position control. A modern digital control system has been implemented and is routinely used in plasma operations. All coil/vessel systems and power systems have been modeled and validated with experimental test data. Linear, nonrigid, flux-conserving models of plasma dynamics are now being generated on a routine basis using the LLNL Corsica code [1]. The dominant modes of these models (corresponding to radial and vertical motion) have been validated against DIII–D experimental data. Systematic calibration procedures are being implemented to ensure the integrity of diagnostic and command circuits used in control. An algorithm for extremely accurate real-time estimation of flux everywhere inside the vessel (and consequently plasma shape) has been implemented and used in experimental operations. Shape control power supply voltage has been brought under feedback control in preparation for use as voltage sources for multivariable controllers. The most recent change of control methodology at DIII–D has been the switch from so-called “gap control” which controls plasma to vessel wall gaps to “isoflux” control which controls magnetic flux at specific locations within the tokamak vessel to enforce a desired plasma shape. This approach has been made possible by the recent development, implementation, and operation of a real time plasma equilibrium reconstruction capability based on the EFIT algorithm [2]. Current work which seeks to exploit this new capability and the “isoflux” control approach is the development of true multivariable controllers which can account for the many dependencies of controlled flux and driving flux at shaping coils on currents in those shaping coils. The process of developing, implementing, and evaluating these controllers will be described.

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[1]D.A. Humphreys, et al., “Toward a Design for the ITER Plasma Shape andStability Control System,” Fus. Tech. **26** (1994) 331.

[2]L.L. Lao, *et al.*, Nucl. Fusion **25**, 1611 (1985).

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