IMPLEMENTATION OF MODEL-BASED MULTIVARIABLE CONTROL ON DIII–D*

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This paper describes the implementation and first experimental tests of a model-based multi-input-multi-output (MIMO) controller on the DIII–D tokamak. It is anticipated that multivariable controllers can improve control of existing tokamaks and will in fact be necessary for control of future advanced tokamak configurations because of the requirement for integrated control of plasma shape with current and/or pressure profile control. Current work at DIII–D seeks to extend the successful operational use of real-time equilibrium reconstruction to estimate, and ultimately to control, these internal plasma parameters. This is the first attempt at implementing plasma shape control based on multivariable methods as part of routine tokamak operations. As part of this effort, a number of practical problems involving state-of-the-art control technology issues must also be addressed. These include avoidance of coil current saturation, mitigation of voltage saturation effects, and gain scheduling and smooth transfer of control laws based on varying operating regimes in plasma beta and current profile characteristics. A characteristic of multivariable controller development is the required construction of a dynamic model of the tokamak and plasma for use in controller design and implementation. This paper discusses the models which have been developed of the DIII–D tokamak and plasma, the methods used for validation, and the controller design approach, including the use of detailed simulations for closed loop performance verification. A description of the developed controller is given and test results from use of this controller in experimental operations are summarized.

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