ADVANCES IN INTEGRATED PLASMA CONTROL ON DIII-D

M.L. Walker,[1] J.R. Ferron,[1] D.A. Humphreys,[1] Y. In,[2] R.D. Johnson,[1] J.S. Kim,[2] R.J. La Haye,[1] J.A. Leuer,[1] T.C. Luce,[1] B.G. Penaflor,[1] E. Schuster,[3] J.T. Scoville,[1] A.S. Welander[1]

[1]General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA
[2]FAR-TECH, Inc., San Diego, California, USA
[3]Lehigh University, Bethlehem, Pennsylvania, USA

The DIII-D experimental program in advanced tokamak (AT) physics requires extremely high performance from the DIII-D plasma control system (PCS) [1], including simultaneous and highly accurate regulation of plasma shape, stored energy, density, and divertor characteristics, as well as coordinated suppression of magnetohydrodynamic instabilities. To satisfy these demanding control requirements, we apply the integrated plasma control method, consisting of construction of physics-based plasma and system response models, validation of models against operating experiments, design of integrated controllers that operate in concert with one another as well as with supervisory modules, simulation of control action against off-line and actual machine control platforms, and optimization through iteration of the design-test loop. The present work describes progress in development of physics models and development and experimental application of several new model-based plasma controllers on DIII-D.

We discuss experimental use of advanced shape control algorithms containing nonlinear techniques for improving control of steady state plasmas, model-based controllers for optimal rejection of edge localized mode disturbances during resistive wall mode stabilization, model-based controllers for neoclassical tearing mode stabilization, including methods for maximizing stabilization effectiveness with substantial constraints on available power, model-based integrated control of plasma rotation and beta, and initial experience in development of model-based controllers for advanced tokamak current profile modification.

The experience gained from DIII-D has been applied to the development of control systems for the EAST and KSTAR tokamaks. We describe the development of the control software, hardware, and model-based control algorithms for these superconducting tokamaks, with emphasis on relevance of problems and solutions to the superconducting ITER tokamak. We also discuss issues of standardization of models, software, and model-based control technologies, which are being applied in support of control development at several experimental devices, and the implications of use of such standardized tools to predictive extrapolation and eventual application to devices such as ITER.

[1] B.G.Penaflor, et al., 4th IAEA Tech. Mtg on Control and Data Acq., San Diego, CA (2003).

Work supported by the US Department of Energy under DE-FC02-04ER54698, DE-FG02-ER83657, and De-FG02-92ER54141.