DEVELOPMENT OF A CLOSED LOOP SIMULATOR FOR POLOIDAL FIELD CONTROL IN DIII–D*

J.A. Leuer, M.L. Walker, D.A. Humphreys, J.R. Ferron, A. Nerem, and B.G. Penaflor

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

The DIII-D tokamak[1] is one of the most flexible fusion experiments in the world. It is easily configurable to study a wide variety of plasma cross sectional shapes and can be controlled using a wide range of control algorithms. The tokamak discharge is controlled using the plasma control system (PCS), which is a multi-CPU, real time digital control system.[2] The system contains a testing capability which allows for validation of newly developed control algorithms. To better utilize the testing capability, a comprehensive model has been developed to simulate the major electromagnetic components that produce poloidal fields in the DIII–D plant. The model contains the following components: 1) DC power supplies, 2) fast switched power supplies, 3) configurational switches, 4) axisymmetric shaping and Ohmic coils, 5) passive vacuum vessel elements, 6) linear plasma model, 7) data filters, and 8) magnetic diagnostics.

The DIII–D plant model has been developed in the Simulink/Matlab environment. Sub-models of all major poloidal electromagnetic components have been developed and validated. A linearized model of the plasma response is included which allows for stable or unstable motion. The model framework is sufficiently flexible to simulate the many electrical configurations used in the DIII–D device. For a particular simulation, all model parameters are established based on the actual discharge hardware configuration. The model can be operated in two modes: data input (Simulink) mode, or, "hardware-in-the-loop" (simserver) mode. The Simulink mode represents an open loop simulation of the plant. In this mode, data from the DIII–D data archival system is input to the Simulink model and diagnostic output is compared with actual discharge data. Validation of the model for a particular machine configuration is achieved using this mode. The simserver mode represents a closed loop simulation of the DIII–D plant. For a particular plant configuration, the model is reproduced in C-code using Simulink's Real Time Workshop capabilities and compiled into an executable code (called a simserver). The actual PCS, operating in a test mode, is linked externally to the simserver plant model and provides a method for simulating the closed loop response of the system. This allows testing of new control algorithms in the PCS without the need for actual machine operating time. The simulator is being used to validate multivariable controllers presently being implemented on the DIII–D device. Model architecture, model validation results and experimental applications are presented.

---

*Work supported by U.S. Department of Energy Contract DE-AC03-99ER54463.

[1] V.S. Chan, *et al*. "DIII–D Tokamak Concept Improvement", Proc. of the 16th Int. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, October 7–11, 1996, Montreal, Canada, Vol. 1, p. 95 (International Atomic Energy Agency, Vienna, 1997); General Atomics Report GA-A22471 (1996).

[2] J.R. Ferron, *et al.*, "Flexible Software Architecture for Tokamak Discharge Control Systems," Proc. 16th IEEE/NPSS Symp. on Fusion Engineering, September 30–October 5, 1995, Champaign, Illinois, Vol. 2, p. 870 (Institute of Electrical and Electronics Engineers, Inc., Piscataway, New Jersey, 1996).

J.A. Leuer
General Atomics
P.O. Box 85608
San Diego, CA 92186-5608
(619) 455-2673
FAX (619) 455-4190
e-mail: leuer@gav.gat.com

Prefer:
- Oral
- ✔ Poster

Session: Plasma Control Systems