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P4.033 Closed-loop simulation with Grad-Shafranov equilibrium evolution for plasma control system development

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Plasma control design increasingly depends on fast simulations able to connect to operational plasma control system (PCS) software for iterative development. GSevolve is a nonlinear free-boundary simulation that evolves the Grad-Shafranov equilibrium including current and pressure profiles, and can connect to all versions of the DIII-D PCS operational on devices around the world. Its ability to simulate the evolution of current continuously from open to closed field lines enables GSevolve to simulate full-discharge control from breakdown through plasma termination. GSevolve is compliant with the Plasma Control System Simulation Platform (PCSSP), a Matlab/Simulink-based environment that serves as the primary framework for development of the ITER Plasma Control System (PCS). The code employs a novel response function-updating scheme to achieve faster than real-time simulations of ITER. The plasma evolves linearly until a significant shape change triggers a nonlinear update of the response while enforcing a prescribed accuracy. Old responses are recalled if the plasma changes back to an old shape. The equilibrium is a function of a state vector containing axisymmetric conductor currents and parameters related to parallel and perpendicular currents, which evolves according to an efficient state space circuit formulation. Control design and validation results are presented for simulations of DIII-D and EAST, connected to their corresponding versions of the DIII-D PCS.
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