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GPU based, real-time tracking of perturbed, 3D plasma equilibria N. RATH, J. BIALEK, P.J. BYRNE, B. DEBONO, J.P. LEVESQUE, B. LI, M.E. MAUEL, D.A. MAURER, G.A. NAVRATIL, D. SHIRAKI, Columbia University — The new high-resolution magnetic diagnostics and actuators of the HBT-EP tokamak [1] are used to evaluate a novel approach to long-wavelength MHD mode control: instead of controlling the amplitude of specific preselected perturbations from axisymmetry, the control system will attempt to control the 3D shape of the plasma. This approach frees the experimenter from having to know the approximate shape of the expected instabilities ahead of time, and lifts the restriction of the control reference having to be the perfectly axisymmetric state. Instead, the plasma can be maintained in an arbitrary perturbed equilibrium [2], which may be selected for beneficial plasma properties. The increased computational demands on the control system are handled by a graphical computing unit (GPU) with 448 computing cores that interfaces directly to digitizers and analog output boards. The control system is designed to handle 96 inputs and 64 outputs with cycle times below 5 and I/O latencies below 10 microseconds. We report on the technical and theoretical design of the control system and give experimental results from testing the system's observer module which tracks the perturbed plasma equilibrium in real-time. This work was supported by US-DOE grant DE-FG02-86ER53222.
[1] D.A. Maurer et al., *PPCF* 53(2011)
[2] A.H. Boozer, *PoP* 6(1999)

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