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Adaptive Multi-Mode Feedback Control of Magnetic Perturbations on the HBT-EP Tokamak[1] N. RATH, P.J. BYRNE, B.A. DEBONO, J.P. LEVESQUE, M.E. MAUEL, G.A. NAVRATIL, Q. PENG, D. SHIRAKI, Columbia University — We report the first multi-mode feedback studies of rotating wall-stabilized kink modes in the HBT-EP tokamak performed with its new, GPU based control system. The system processes up to 96 inputs from an array of magnetic pickup coils and calculates control currents for 40 magnetic saddle coils within a cycle time of 6 μs. A recursive high-pass filter based on continuous polynomial fitting is used to separate the structure and time evolution of multiple three-dimensional magnetic perturbations from the slowly-evolving equilibrium signals. Perturbations are well described by quadrature mode pairs, and their amplitude and phase is tracked and fitted recursively to a time-evolving mode rotation frequency, which is used to adjust the control output matrix to dynamically compensate for latency and amplifier response. Simultaneous control of $m/n = 3/1$ and $6/2$ helical perturbations is studied as a function of edge safety factor and plasma rotation as well as other plasma equilibrium parameters. High-resolution detection using 216 poloidal and radial magnetic sensors is used to independently monitor the plasma's 3D magnetic structure during feedback control. Results are compared with previous demonstrations of single-mode feedback control and predictions from theoretical models.

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