Active control of kink modes using a non-magnetic, extreme ultraviolet sensor array

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Instability control in tokamaks often utilizes nonaxisymmetric magnetic sensors and actuators near the plasma edge and behind plasma facing components. Placing magnetic coils behind thick shielding walls would improve their longevity in a reactor at the expense of reducing frequency response, while a light-based detector could still respond quickly and with enhanced spatial sensitivity. We present the first demonstration of active feedback control of the kink mode using non-magnetic sensors consisting of extreme ultraviolet (EUV) detector arrays as input to drive a set of magnetic control coils in real time. Kink mode dynamics are measured via EUV emission along 64 poloidal viewing chords at one toroidal angle. Singular Value Decomposition (SVD) of EUV measurements from natural mode activity is used to establish a basis function set for calculating amplitude and phase of rotating perturbations during feedback. Both internal and external modes can be tracked by the feedback system, depending on the selected chords and bases. The poloidal spectrum of applied fields can change in response to geometry of the emissivity fluctuations. Feedback is completed using a graphics processing unit (GPU)-based control system with a low latency between measured input and delivered output [1]. We observe m/n=3/1 kink mode suppression and amplification as a function of the applied feedback phase angle relative to the measured emissivity fluctuations. This novel mode-tracking technique could be directly applied to higher-energy x-ray diagnostic systems that provide real-time information using appropriate diodes and energy-response filtering, such as the tomography system planned for use in the pre-nuclear phases of ITER operation.

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