Active Control of the Resistive Wall Mode in HBT-EP*

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We report the first observation in a tokamak of the use of active feedback control to suppress the onset of the wall stabilized *n*=1 external kink mode destabilized by finite conductivity when the stabilizing wall is non-ideal, *i.e.* the resistive wall mode (RWM). In toroidal devices such as the reversed field pinch (RFP) or the advanced tokamak (AT) which rely on a nearby conducting wall to stabilize the current or pressure driven external low-*n* kink mode, the lifetime and/or beta limit of these devices is set by the onset of the RWM [1,2] which grows on the much slower time scale of the flux penetration through the conducting wall rather than the very rapid MHD Alfven time scale. These RWMs have been identified as limiting phenomena in the RFP [3,4] and in the AT [5,6] and similar phenomena are expected to be important in a wide range of toroidally confined plasmas including the Spherical Torus, Spheromak, and Field Reversed Configuration. One approach to the stabilization of these RWM instabilities is to use a network of active feedback coils configured so that the electrical response of the resistive wall simulates that of a perfect conductor. This so-called ‘intelligent shell’ or ‘smart shell’ was proposed by Bishop [7] and has been implemented in the HBT-EP tokamak with 30 independent sensor/driver feedback loops mounted behind a 2 mm stainless-steel resistive wall located near the plasma boundary. The time constant for flux soak through of this stainless-steel wall is about 300 microseconds which is consistent with the observed growth time of the RWM as expected from the theory. The performance of the HBT-EP smart shell feedback stabilization system has been modeled by a 3D finite element electromagnetic code, VALEN, and is in agreement with the observed stabilization of the RWM. The VALEN code has also been quantitatively benchmarked against the predictions of a large aspect ratio analytic MHD model.

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