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P1.1041 Progress on disruption event characterization and forecasting in tokamaks and supporting physics analysis

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See the full abstract here:
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Disruption prediction and avoidance is critical in ITER and reactor-scale tokamaks to maintain steady plasma operation and to avoid damage to device components. The present status and results from the physics-based disruption event characterization and forecasting (DECAF) research effort are shown for multiple tokamak devices. Present analysis of KSTAR, MAST, and NSTX databases shows low disruptivity paths to high beta operation. The DECAF code applied to a database of ~104 plasmas with only 5 DECAF events predicts disruptions with 91.2% true positives and 8.7% false negatives. Increasing the number of events will improve the latter value. Automated analysis of rotating magnetohydrodynamic (MHD) modes now allows the identification of disruption event chains for several devices including coupling, bifurcation, locking, and potential triggering by other MHD activity. DECAF can now provide an early disruption forecast (on transport timescales) allowing the potential for disruption avoidance through profile control. Hardware to allow real-time evaluation of this activity on KSTAR is now being configured for installation in 2019. New analysis of the MAST database has uncovered global MHD events at high normalized beta, N, with characteristics identifying them as resistive wall modes (RWMs). The MAST RWM eigenfunction shape and growth rate appear significantly altered by the location of conducting structure compared to results from NSTX. The conducting wall stabilizing effect on the kink mode is computed to be relatively small in MAST and primarily due to the vacuum vessel, but will be increased for MAST-U by changes to the divertor plates. Analysis of high performance KSTAR experiments using TRANSP shows that the non-inductive current fraction has reached 75%. Regions of weak safety factor q shear can form in different parts of these plasmas dependent upon the broadness of the bootstrap current profile. Resistive stability including ‘ calculation by the Resistive DCON code is evaluated for these plasmas using kinetic equilibrium reconstructions with magnetic field pitch angle data to determine capability for instability forecasting. TRANSP code predictive capability is used to examine the impact of the second (off-axis) KSTAR neutral beam injection (NBI) system determining plasma parameters important for stability. Predictive analyses are used to design experiments using as few as 4 (of 6) NBI sources yielding solutions with N~4.5 and 100% non-inductive current drive, adding a novel regime for disruption prediction studies.

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