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DECAF Code Cross-device Investigation of Disruption Categorization and Timing Indicated by Variations in the Plasma Current and Vertical Position

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Timely detection and prevention of plasma disruptions is essential for next-step tokamaks. Plasma disruption is a multi-step process in which the loss of plasma vertical position control and the quenching of the plasma current are typically among the last events that precede complete plasma deconfinement. Given the major role of abnormal behavior of the plasma current and vertical position in the occurrence of disruptions, real-time control of these two plasma parameters has become routine in tokamak operations. Furthermore, deviation from a normal waveform of either parameter has served in various forms as an indicator of the disruption onset n a number of disruption-related studies [1,2]. The definition of the disruption time sets both the time scales and success rates of algorithms that aim to predict disruptions. The present non-uniformity of disruption time definitions across the tokamak community brings ambiguity in cross-comparisons of various predictor performances. Here, we present a systematic study of abnormal plasma current and vertical position waveforms and evaluate their capacity to serve as disruption onset indicators. The study is conducted on a multi-year, multi-device database with a focus on NSTX, KSTAR and MAST/-U tokamak data. The analysis is conducted with the Disruption Event Characterization and Forecasting (DECAF) code [3]. The frequency of occurrence of different types of abnormal waveforms and the disruption categories that they define will be presented in the context of the operational spaces of each device. Interconnection of the abnormal waveforms will be discussed as well. Results obtained hereby might serve to define a reliable indicator of the disruption onset time. *This research was supported by the U.S. Department of Energy under contracts DE-SC0018623 and DE-SC0016614.

[1] V. Klevarova et al., Fusion Engineering and Design 160 (2020) 111945
[2] A. Pau et al., Fusion Engineering and Design 125 (2017) 139-153
[3] S.A. Sabbagh et al., Proc. 27th IAEA Fusion Energy Conference, Ahmedabad, India (2018)

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