Data-driven approaches for disruption prediction in Tokamaks

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ABSTRACT

Disruptions are fast and dangerous events in Tokamaks that take place when the plasma is close to a stability limit. During a disruption, the plasma column moves towards the wall of the Tokamak and it can provoke strong structural damage in the vacuum vessel due to, on the one hand, the impact of high energy run away electrons on it and, on the other hand, the presence of high electromagnetic forces in the vessel. Moreover, if the plasma column deposits excessive thermal energy onto the plasma facing components, their melting can result in serious damage in these elements. In the case of an inevitable disruption, methods to mitigate their harmful effects are needed. However, a pre-requisite to put into operation mitigation actions is the recognition in advance of a forthcoming disruption. Disruption prediction is usually carried out with data-driven models derived from machine learning methods. This contribution summarizes the evolution of real-time predictors based on data-driven models in the JET Tokamak during the last decade: from large datasets for training purposes to adaptive predictors from scratch, from bare predictions to probabilistic predictions and from simple recognition of disruptive behaviours to predict the time to the disruption.