Scilight

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DECAF perks up plasma forecasting

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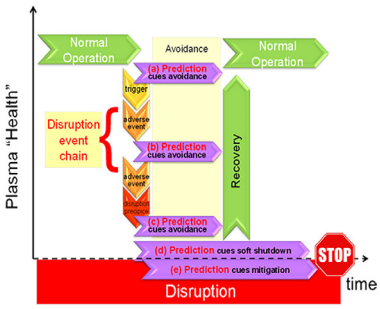
Physics-based approach accurately predicts plasma disruption events in tokamaks producing fusion energy



Tokamaks use a donut-shaped magnetic field to confine plasma and produce fusion energy. However, instabilities in the plasma, such as a kinking, can disrupt the plasma and damage the surrounding walls of the tokamak. Large, next-generation machines and future fusion power systems must be able to accurately predict disruption events before they happen.

Sabbagh et al. developed an analysis approach called Disruption Event Characterization and Forecasting, or DECAF. Compiling years of tokamak data and research, DECAF's models automatically detect triggers to forecast disruption events before they happen and issue warnings cueing either avoidance, shutdown, or mitigation maneuvers.

Whereas most disruption forecasting approaches today are built using data analysis without including physical models, the authors incorporated physical models and experimental results into their approach. This, combined with the fact that the approach is deterministic instead of statistical, allowed very high accuracy characterization and forecasting disruptions exceeding 91%, with more recent models exceeding 99%.

"DECAF produces an underlying understanding of what's going on so that these happenings can be avoided," said author Steven Sabbagh. "Because we can understand what's going on, it's not like turning a key to an algorithm where we don't understand what's underneath it. We know why these things are happening, which is required for avoidance."

The authors' ultimate goal is to reach 98% accuracy, the level required for future tokamak devices, and to incorporate all tokamak plasma data. They are expanding the number of physical processes included in DECAF and testing its models against existing tokamak databases to reach this goal.

DECAF also needs to forecast in real-time. Recently, the researchers found the approach demonstrated 100% accuracy predicting disruption events in over 50 plasmas in the KSTAR tokamak.

Source: "Disruption event characterization and forecasting in tokamaks," by S. A. Sabbagh, J. W. Berkery, Y. S. Park, J. Butt, J. D. Riquezes, J. G. Bak, R. E. Bell, L. Delgado-Aparicio, C .J. Ham, J. Hollocombe, J. W. Lee, J. Kim, A. Kirk, J. Ko, W. H. Ko, L. Kogan, B. P. LeBlanc, J. H. Lee, A. Thornton, and S. W. Yoon, *Physics of Plasmas* (2023). The article can be accessed at https://doi.org/10.1063/5.0133825.