How predict-first will change our approach to experimental planning

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Time-dependent, transport simulations of experiments ahead of time can improve the efficiency of our experimental studies and might become a game changer. High-fidelity, validated models are critical for the success of the predict-first approach, which relies entirely on the fidelity of the models used to evolve transport and magnetic equilibrium.

We are going to show an example of successful application of the predict-first approach on DIII-D, for the optimization of access to steady-state operation with sustained high q_{min} at mid-radius. A feed-forward scheme has been proposed using free-boundary time-dependent simulations with TRANSP, combining EC and NBI injection in the ramp-up to delay the relaxation of the safety factor profile. Simulations indicate that a combination of Electron Cyclotron heating and current drive for pre-heating in L-mode and Neutral Beam injection sustain a broad and flat safety factor profile in the flattop phase, which has been *a posteriori* verified in the experiment, a successful demonstration of the predict-first approach towards experimental planning and optimization of runtime resources.

The limits of predictive modeling will be discussed and examples will be provided to show what assumptions are critical for the success of the predict-first approach. In particular, self-consistent particle transport, with realistic feedback control on the line-averaged density, like it is done in experiments, is critical for experimental projections.

These examples provide directions for improvement of modeling capabilities in time-dependent solvers.

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