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P4.005 TRANSP-based optimization for tokamak scenario development

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An optimization approach that incorporates the predictive transport code TRANSP is proposed for tokamak scenario development. Optimization methods are often employed to develop open-loop control strategies to aid access to high performance tokamak scenarios [Fusion Eng. Des. 123 (2017) 513–517]. In general, the optimization approaches use control-oriented models, i.e. models that are significantly reduced in complexity and prediction accuracy as compared to physics-oriented prediction codes such as TRANSP but have the advantage of enabling fast simulations. In the presented approach, control-oriented optimization is combined with TRANSP-based optimization. The fast control-oriented optimization accelerates the TRANSP-based optimization by providing an initial guess solution, and the TRANSP-based optimization improves the accuracy of the control-oriented optimization by providing updated model parameters on each iteration. As a test case, the injected neutral-beam power, high-frequency fast-wave power, and electron-cyclotron heating power are optimized to develop a control strategy that maximizes the non-inductive current fraction during the ramp-up phase for NSTX-U. Simulation studies towards the achievement of non-inductive ramp-up in NSTX-U have already been carried out with the TRANSP code [Nucl. Fusion 55 (2015) 123011 (12pp)]. The optimization-based approach proposed in this work is used to maximize the non-inductive current fraction during ramp-up in NSTX-U, demonstrating that the scenario development task can be automated. The proposed optimization technique has the potential of playing a critical role in achieving a robustly stable non-inductive ramp-up, which will ultimately be necessary to demonstrate applicability of the spherical torus concept to larger devices without sufficient room for a central coil.

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Presenter: Dr WEHNER, William (Mechanical Engineering Lehigh University)

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