30TH SYMPOSIUM ON FUSION TECHNOLOGY
30th SOFT 2018
SEPTEMBER 16-21, 2018
Giardini Naxos, Sicily - Italy

Contribution ID: 997

TRANSP-based optimization for tokamak scenario development

William Wehner[1], Eugenio Schuster[1], Mark Boyer[2], Francesca Poli[2]
[1]Mechanical Engineering, Lehigh University, Bethlehem, United States
[2]Princeton Plasma Physics Laboratory, Princeton, United States

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.

This work has been supported by the US Department of Energy under DE-SC0010661 and the DOE Office of Science Graduate Student Research (SCGSR) program award (http://science.energy.gov/wdts/scgsr/).

Topic

A. Experimental Fusion Devices and Supporting Facilities

Preferred presentation

Oral

Keywords

Scenario development, tokamaks, NSTX-U, non-inductive scenarios, current ramp-up, optimization, controls

I grant permission to publish on behalf of all authors of the contribution.

yes