DPP17-2017-000523

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

Integrated tokamak modeling: when physics informs engineering and research planning[1]

FRANCESCA POLI, Princeton Plasma Physics Laboratory

Simulations that integrate virtually all the relevant engineering and physics aspects of a real tokamak experiment are a power tool for experimental interpretation, model validation and planning for both present and future devices. This tutorial will guide through the building blocks of an integrated tokamak simulation, such as magnetic flux diffusion, thermal, momentum and particle transport, external heating and current drive sources, wall particle sources and sinks. Emphasis is given to the connection and interplay between external actuators and plasma response, between the slow time scales of the current diffusion and the fast time scales of transport, and how reduced and high-fidelity models can contribute to simulate a *whole device* [2].

To illustrate the potential and limitations of integrated tokamak modeling for discharge prediction, a helium plasma scenario for the ITER pre-nuclear phase is taken as an example. This scenario presents challenges because it requires core-edge integration and advanced models for interaction between waves and fast-ions, which are subject to a limited experimental database for validation and guidance. Starting from a scenario obtained by re-scaling parameters from the demonstration inductive ITER baseline, it is shown how self-consistent simulations that encompass both core and edge plasma regions, as well as high-fidelity heating and current drive source models are needed to set constraints on the density, magnetic field and heating scheme. This tutorial aims at demonstrating how integrated modeling, when used with adequate level of criticism, can not only support design of operational scenarios, but also help to asses the limitations and gaps in the available models, thus indicating where improved modeling tools are required and how present experiments can help their validation and inform research planning.

[1]Work supported by DOE under DE-AC02-09CH1146

[2]Report of the Workshop on Integrated Simulations for Magnetic Fusion Energy Science, 2015