MF2-O7 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Progress in Validating MHD Modeling Results of Edge Harmonic Oscillation in DIII-D QH-mode Discharges

A. Y. Pankin, J. R. King, S. E. Kruger
Tech-X Corporation, 5621 Arapahoe Ave. Boulder, CO 80303, USA

Xi Chen, K. H. Burrell, A. M. Garofalo, R. J. Groebner
General Atomics, PO Box 85608, San Diego, CA 921865608, USA

S. Taheri
Department of Aeronautics and Astronautics, University of Washington Seattle, WA 98195, USA

G.R. McKee, Z. Yan
Department of Engineering Physics, University of Wisconsin-Madison, Madison, WI 53706-1687, USA

M. Porkolab, and J.C. Rost
Plasma Science and Fusion Center, Massachusetts Institute of Technology, Cambridge, MA 02139-4307, USA

The extended-MHD NIMROD code [C.R. Sovinec and J.R. King, J. Comput. Phys. **229**, 5803 (2010)] is used to simulate the dynamics of an Edge Harmonic Oscillation (EHO) in the DIII-D [J. L. Luxon, Nucl. Fusion **42**, 614 (2002)] quiescent H-mode (QH-mode) discharge 163518. EHOs observed in nonlinear MHD simulations have $n = 1$ and $n = 2$ as dominant modes akin the DIII-D experiment. Kinetic equilibrium reconstructions during the time of the fully-developed EHO include the effect of the MHD profile relaxation and are found to be below the stability boundary. In the experiment, EHO is triggered at much earlier time when both the rotation profiles and pressure profiles are different. The experimental equilibrium for the DIII-D discharge 163518 is modified to include two levels of instability drive by increasing the pressure gradients in the H-mode pedestal by factors of 1.4 and 2. These changes in the plasma pressure profiles are outside of experimental error bars, but they can introduce sufficient transport to relax the profiles below stability boundary after EHO triggering similar to the experiment. In simulations, EHOs with low-n dominant toroidal modes numbers are found for both equilbria. However, the levels of density perturbations are found to be very different in two cases. The level of density perturbations for the case with the weak instability drive remains below the experimental level and above the experimental level for the case with the strong instability drive. The saturated temperature and density profiles in the simulations are found above the experimental profiles for the case with the weak instability drive and below for the case with the strong instability drive. In order to do a more direct comparison of the simulation results with the experiment, a synthetic BES diagnostic is used to compute cross-correlation and cross-power spectral densities associated with the simulated density perturbations. The synthetic cross-power spectral density shows a transition from a double to a single peak in frequency when the BES analysis shifts from near the LCFS towards the steep gradient region of the pedestal. Difference between experimental and synthetic cross-power spectral densities are explained by limitations in how the numerical simulations were developed. In addition, we present the first results from a new synthetic PCI diagnostic developed for NIMROD. Validation of density perturbation profiles using BES and PCI enables cross-comparison between different synthetic diagnostic techniques and gives an opportunity to validate EHO model in NIMROD in different tokamak regions. The BES and PCI synthetic diagnostics are included in a new synthetic diagnostic package that called is called MaGnostics. The package provides a unified approach to several categories of synthetic diagnostics including the diagnostics that utilizes the point spread functions (PSFs) such as BES and CECE, line measurements such as soft X-ray and interferometer, and magnetics such as Rogowski and Mirnov coils. We demonstrate how synthetic diagnostics can be used to help form better numerical experiments.

* Work supported by US DOE under DE-SC0019070, DE-SC0020251, and DE-FC02-04ER54698 . Computational support from NERSC by US DOE under No. DE-AC02-05CH11231.