Fast Pedestal, SOL and Divertor Measurements from DIII-D to Validate BOUT++ Nonlinear ELM Simulations*

M.E. Fenstermacher[1], X.Q. Xu[1], I. Joseph[1], C.J. Lasnier[1], A.W. Leonard[2], W.H. Meyer[1], and T.H. Osborne[2]

[1]*Lawrence Livermore National Laboratory, Livermore, California, USA*

[2]*General Atomics, San Diego, California 92186-5608, USA*

Initial simulations using a hyper-resistivity model in the BOUT++ nonlinear MHD code [1] show Edge Localized Mode (ELM) energy losses comparable to fast magnetics measurements at pedestal collisionality typical of DIII-D H-mode plasmas. BOUT++ has been upgraded recently to allow full nonlinear simulations of large Type-I ELMs at experimental values of edge plasma resistivity in x-point divertor geometry [2]. Work to validate these state-of-the-art simulations against fast DIII-D measurements of ELM pedestal energy loss, as well as scrape-off layer (SOL) and target heat and particle fluxes is underway. To avoid the unphysically large and vanishingly thin current layers typical of nonlinear MHD ELM simulations at low experimental collisionality, the upgraded BOUT++ uses a hyper-resistivity model [3] which postulates that the electron viscosity is set by micro-turbulence and therefore comparable to turbulent electron thermal diffusivity. This allows the current sheets to diffuse at small scales, relaxes the ideal MHD constraint on magnetic field evolution and facilitates the nonlinear ELM crash at low collisionality. Previous simulations without this model were done for anomalously high plasma resistivity and showed ELM pedestal energy losses that exceeded typical experimental measurements from fast magnetics by up to a factor of 4.

This paper will focus on validation of specific BOUT++ simulations of DIII-D ELMing H-mode discharges against fast pedestal energy loss, as well as SOL and target heat and particle flux data. Measurements of ELM pedestal energy loss will be obtained from fast magnetics measurements and EFIT reconstructions. High time resolution SOL and target particle flux measurements will be obtained from midplane and divertor filterscope arrays and gated-intensified, tangentially viewing divertor cameras. ELM target heat flux data will be obtained from vertically viewing, high framing rate IR cameras. Results will be compared with synthetic diagnostic data generated from a recently installed parallel heat flux model in BOUT++. In addition a periscope, giving new simultaneous, high frame rate views of both visible and IR emission from the main chamber and the upper plus lower divertors in DIII-D, is under construction [4]. Information on the periscope design and capabilities will be presented, and if available, data will be compared with BOUT++ simulations

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