Comparison of ELM Pulse Propagation in the DIII-D SOL and Divertors with an Ion Convection Model*

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A model that describes energy and particle transport for both electrons and ions over a range of Edge Localized Mode (ELM) characteristics is needed to predict the effect of ELMs on plasma material interactions in future tokamak reactors. Results from dedicated experi-ments measuring the effect of particle and energy pulses from Type-I ELMs in the DIII-D SOL and divertor are compared with a simple model in which ELM pulse propagation is dominated by ion parallel convection along SOL field lines and the recovery from the ELM is determined set by recycling physics. Simultaneous fast measurements of target ion current (probes and tile current monitors) and heat flux (IRTV), divertor and midplane neutral flux (D_α detectors) density (interferometry and reflectometry) and line emission (filtered cameras), SOL radiated power (bolometers), and pedestal n_e density and temperature T_e (Thomson scattering) are used to test the model. Experimental variation in the ion convection regime is achieved by varying the plasma density.

The timing of the response to the outer midplane ELM instability on several diagnostics, at various points in the SOL/divertor, is consistent with ion sound speed convection along field lines. At moderate to high density, $n_e/n_{Gr} = 0.5\text{-}0.8$, the delays in the response of the boundary plasma to the midplane ELM pulses, the density dependence of those delays and other observations are consistent with the model. However, at the lowest densities, $n_e/n_{Gr} \sim 0.35$, small delays between the responses in the two divertors, and changes in the response of the pedestal thermal energy to ELM events, indicate that additional factors may be playing a role. Possible factors include electron conduction in the SOL, the pre-ELM condition of the divertor plasma, and the ratio of ELM instability duration to SOL transit time. Variation, as a function of density, of the ELM inner/outer target heat flux ratio, the 2D line emission profiles, and the toroidal asymmetry of target currents will also be presented. Initial fluid code modeling of ELMs in the SOL and divertor will be compared with the observations.

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*Work supported by the U.S. Department of Energy under Contract Nos. DE-AC03-99ER54463, W-7405-ENG-48, DE-FG03-95ER54294, DE-AC05-00OR22725, DE-AC02-76CH03073, DE-AC04-94AL85000, DE-FG03-01ER54615.