Observation of Abrupt- and Fast-Rising SOL Current During Trigger Phase of ELMs in DIII-D Tokamak*

H. Takahashi[1], E.D. Fredrickson[1], M.J. Schaffer[2], M.E. Austin[3], N.H. Brooks[2], T.E. Evans[2], G.L. Jackson[2], L.L. Lao[2], and J.G. Watkins[4]

[1]*Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA*
[2]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA*
[3]*University of Texas at Austin, Austin, Texas, USA*
[4]*Sandia National Laboratories, Albuquerque, New Mexico, USA*

Recent high-speed measurements in NBI-heated "ELMing" H-mode discharges showed that the scrape-off-layer current (SOLC) density[1] begins to rise sharply (in 5-20 μs), well before (~100 μs) the electron temperature indicated the onset of a thermal collapse at the top of the pedestal. The SOLC could thus potentially play a role in the triggering of the ELM process through the non-axisymmetric and resonant magnetic field that it generates. The SOLC and pedestal electron temperature were measured using the tile current array (TCA) diagnostic and electron cyclotron emission (ECE) diagnostic, respectively, both at 100 kHz bandwidth. In the quiescent period between ELMs the density of SOLC, driven from the hot to cold divertor by the thermo-electric potential, is comparable to the ion saturation current (ISAT) density in the cold divertor. A model is being considered in which a momentary and localized sheath breakdown caused by high ion-sheath potential would allow rapid growth of the SOLC in the face of the ISAT limit. The sheath breakdown leads to formation of long, thin, helical, current-carrying filaments or flux tubes in the SOL. The flux tubes, having an increasing SOLC within, may become Kruskal-Shafranov unstable (screw-pinch instability), and cause the electron density and temperature within to rise, and hence the ISAT limit, through reconnection and engulfing of higher density and temperature regions. This bootstrapping process could allow a rapid increase of the local SOLC to well beyond its quiescent value, and contribute to the triggering of ELMs. Inferences from this model will be tested against measurements of conditions in the SOL and divertors prior to ELM events.

[1] H. Takahashi, *et al.,* Nucl. Fusion **44**, 1075 (2004).

*Work supported by the U.S. Department of Energy under DE-AC02-76CH03073, DE-FC02-04ER54698, DE-FG03-97ER54415 and DE-AC04-94AL85000.