High Frequency ELM Pacing by Lithium Pellet Injection on DIII-D*

A. Bortolon¹, R. Maingi¹, D.K. Mansfield¹, A. Nagy¹, A.L. Roquemore¹, L.R. Baylor², N. Commaux², E. Gilson¹, G.L. Jackson³, and R. Lunsford¹

¹Princeton Plasma Physics Laboratory, PO Box 451, Princeton, NJ 08543-0451, USA
²Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, TN 37831, USA
³General Atomics, PO Box 85608, San Diego, CA 92186-5608, USA

Periodic, unmitigated edge localized modes (ELMs) are likely to cause unacceptable damage to plasma facing components in fusion devices like ITER, which might require a 20-50x reduction in peak ELM heat flux [1]. While this could be achieved by fast ELM pacing with deuterium pellets [2], use of non-fuel particles would reduce gas load to the pumping system. A simple device to inject non-fuel granules (lithium) was shown to trigger ELMs in EAST [3]. An upgraded version of the Lithium Granule Injector (LGI) was recently installed on DIII-D, to study pacing efficiency dependence on granule size and velocity, and characterize LGI induced ELMs. The LGI was tested in a number of different ELMy scenarios ($\beta_N=1.2-2.0$) injecting granules of nominal diameter 0.3, 0.5, 0.7 and 0.9 mm, with injection speed 50-120 m/s and injection rates up to 500 Hz. Robust ELM pacing was documented on long time windows (up to 3.5 s), with triggering efficiency close to 100% obtained with 0.9 mm diameter granules, lower with smaller sizes, and weakly depending on granule velocity. Paced ELM frequencies up to 100 Hz were achieved, with a 2-5 fold increase over the natural ELM frequency and a consequent reduction of divertor peak heat flux (Fig. 1). Li was found to penetrate the plasma core, but concurrent reduction of core metallic impurities consistently was observed. Overall, LGI high frequency pacing, appeared to be compatible with maintaining high plasma performance, in terms of global confinement and pedestal characteristics.


*Work supported by the U.S. Department of Energy under DE-AC02-09CH11466, DE-AC05-00OR22725, and DE-FC02-04ER54698.