Mitigation of ELM peak heat loads on NSTX-U through impurity granule injection

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Controlling the peak heat load associated with an Edge Localized Mode (ELM) is especially crucial in Spherical Tokomaks where the small major radius provides minimal opportunity for radial relaxation of the heat profiles prior to connection with the divertor. Thus it is critical to develop a method for mitigation of these events to ensure stable operation of next generation ST devices. As it has been shown that there is an inverse relationship between ELM frequency and the peak heat flux delivered during the mode, a system has been developed for NSTX-U whereby ELMs will be paced at a rate 10+ times higher than the natural ELM frequency by injection of impurity microgranules into the edge plasma. Granules of low Z impurity species (Li, B, C) are radially driven into the midplane edge of the discharge through impact acceleration with a rapidly rotating impeller. The rotation speed of the impeller determines the granule injection velocity within a range of 50 – 150 m/sec. In addition, the impeller frequency, coupled with the input rate of the granules, sets the overall particle injection frequency at up to 200 Hz. The granules, upon impact with the edge plasma, ablate and generate an overdense flux tube within the H-mode pedestal. This leads to a ballooning instability, resulting in the production of an ELM. These paced ELMs are then able to regulate the pedestal in a controlled manner, moderating the peak heat flux to a level tolerable to the plasma facing components. The mass deposition and ablation model benchmarked through lithium granule injection on DIII-D and its application to the plasma edge parameters found on NSTX-U will be discussed along with an outline of the upcoming NSTX-U experiments.

This work is supported by the US Department of Energy under DE-AC02-09CH11466.