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Physics and Operational Space of the Small ELM regime in NSTX[1]

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The search for high performance regimes with small or no periodic heat pulses, due e.g. to edge-localized modes (ELMs), has been a focus of international research, owing to possible erosion damage to plasma facing components during large, Type I ELMs as projected...[2] for ITER. A high-performance, small ELM regime is now routinely observed in the National Spherical Torus Experiment (NSTX). The ELMS (called [3] "type V") are consistent with high bootstrap current operation with line average density approaching Greenwald scaling. Each individual ELM has no measurable impact on stored energy. The ELM perturbation is observed via ultra-soft X-rays to typically originate near the lower divertor region and propagate with a poloidal component toward the outer midplane. A pre-cursor with n=1 is observed on an outboard near-midplane toroidal Mirnov array. The filament-like structure propagates in the counter plasma current direction and persists for $\leq$ 1-2 toroidal transit times. After crossing the separatrix to the open field lines, the ELM flux is observed to reach the outer strike point up to 400 μsec before the inboard side, consistent with leakage of ions from the pedestal top $\sim$ 200 eV across the separatrix on the low field side near the lower X-point, and sound speed propagation on the open field lines. In contrast, a large Type I ELM is observed to reach the outer strike point only up to 200 μsec before the inboard side, consistent with a ballooning-type perturbation near the outboard midplane. To date, the Type V ELM regime without intervening Type I ELMs has been obtained with $\beta_N \leq 5$, $\nu^*_{e,ped} > 1$, $\beta_{pol} \geq 0.5$ and $\beta_{ped} \leq 5\%$. The differences between these Type V ELMs and conventional Types I and III ELMs, which also observed in NSTX, will be presented.

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[2]A. Loarte, et. al., 2003 *J. Nucl. Materials* **313-316** 962.

[3]R. Maingi, et. al., 2005 *Nuclear Fusion* **45** 264.