# Demonstration of ELM pacing by pellet injection on DIII-D and extrapolation to ITER*

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Deuterium pellet injection has been used in experiments on the DIII-D tokamak to investigate the possibility of triggering small rapid edge localized modes (ELMs) in reactor relevant plasma regimes. ELMs have been observed to be triggered from small 1.8 mm $D_2$ pellets injected from all available locations and under all H-mode operating scenarios in DIII-D. Experimental details have shown that the ELMs are triggered before the pellets reach the top of the H-mode pedestal, implying that very small shallow penetrating pellets are sufficient to trigger ELMs. Fast camera images of the pellet entering the plasma from the low field side show a single plasma filament becoming visible near the pellet cloud and striking the outer vessel wall within 200 μs. Additional ejected filaments are then observed to subsequently reach the wall. The plasma stored energy loss from the pellet triggered ELMs is a function of the elapsed time after a previous ELM.

Pellet ELM pacing has been proposed as a method to prevent large ELMs that can damage the ITER plasma facing components [1]. A demonstration of pacing of ELMs on DIII-D was made by injecting slow 14 Hz $D_2$ pellets on the low field side in an ITER shape plasma with low natural ELM frequency and a normalized β of 1.8. The non-pellet discharge natural ELM frequency was ~5 Hz with ELM energy losses up to 85 kJ (>10% of total stored energy) while the case with pellets was able to demonstrate >20 Hz ELMs with an average ELM energy loss less than 22 kJ (<3% of the total). The resulting ELM frequency was larger than the pellet frequency indicating both a direct ELM trigger by each pellet and an indirect effect on the overall pedestal stability to ELMs from the multiple pellets. No increase in density or significant decrease in energy confinement with the pellets was observed. The implications of these results for possible pellet ELM pacing on ITER will be discussed.

[1] P.T. Lang et al., Nucl. Fusion **44** (2004) 665.

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