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Dual SPI experiments with Identical pellets on DIII-D

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Shattered Pellet Injection (SPI) has been chosen as the baseline disruption mitigation system for ITER. However, many questions remain regarding its operation, particularly under the presently envisaged operating scenario where several simultaneous and staggered SPIs are needed to inject high-Z radiating impurities prior to the thermal quench. Experiments on DIII-D used two SPIs with pellets of equal composition (˜200 torr-L of pure Ne each) simultaneously or with a slight time delay between injections. Simultaneous injection exhibits a reduction in the pre-thermal quench time (time from when SPI fragments reach the plasma edge until the start of the thermal quench), relative to similar single SPI mitigated shutdowns. Despite the decreased time to assimilate the injected impurities, radial density measurements have similar increases in electron density while a vertical array shows a much faster electron density increase in the plasma core for simultaneous SPIs. Total radiated energy during the thermal quench, determined through summing radiated energy at three toroidal locations, and the current quench (CQ) duration are approximately the same for single or simultaneous injection. Additionally, fast visible camera images and analysis of impurity radiation from fast bolometer fan arrays show the injected impurities spread primarily in the parallel direction, away from the injection location in two distinct regions, corresponding to each of the SPIs. This separation of radiative zones suggests a lower radiation peaking factor, which is a promising result towards the success of the massively parallel ITER SPI system.

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