Demonstration of rapid shutdown using large shattered deuterium pellet injection in DIII-D

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Abstract

A severe consequence of a disruption on large tokamaks such as ITER could be the generation of multi-MeV electron beams that could damage the vacuum vessel and the structures of the machine if they hit the wall unmitigated. The mitigation of runaway electron beams is thus a key requirement for reliable operation of ITER. In order to achieve reliable disruption mitigation, a new fast shutdown technique has been developed: the injection of a large shattered cryogenic pellet in the plasma, which is expected to increase the electron density up to levels where the beam generation processes are mitigated by collisional losses. This technique has been implemented and tested for the first time ever on DIII-D. The first tests show evidence of an almost instantaneous deposition of more than 260 $Pa.m^3$ of deuterium deep in the core. Record local densities during the thermal quench were observed for each injection with a very high reliability. Pellet mass and plasma energy content scans show an improvement of the assimilation of the particles for higher plasma energy and larger pellet mass.

PACS Numbers: 52.55.Fa, 28.52.Nh, 28.52.Lf