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Pellet Injection Technology and Application to Mitigate Transient Events on ITER

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The formation and acceleration of cryogenically solidified pellets of hydrogen isotopes has long been under development for fueling fusion plasmas. Injectors are being designed to provide this capability for fueling ITER with DT pellets injected from the inner wall. In addition to the fueling application, smaller pellets of D2 are to be injected from the outer or inner wall to purposely trigger rapid small edge localized modes (ELMs) to limit transient heat flux damage from otherwise large naturally occurring ELMs. A further application of pellet injection technology that is planned for ITER is that of mitigating disruptions where large pellets of neon, argon, and deuterium mixtures are produced and shattered upon injection into disrupting plasmas to radiate the plasma energy in order to mitigate possible damage to in-vessel components [1].

The pellets for fueling and ELM triggering are both to be formed by a twin-screw continuous extruder feeding that can produce either 5mm fueling size pellets or 3mm ELM triggering pellets with a newly developed adjustable extrusion size control providing up to 50% variation in the pellet length. Acceleration of the pellets is accomplished with pressurized deuterium gas that will be captured and recirculated. The large shattered pellets for disruption mitigation are formed in-situ in a pipe gun device that is cooled with supercritical helium and held intact ready to fire until needed during a disruption. Pressurized gas is also used to accelerate these pellets, but the gas enters the vessel and is not captured. The pellets are shattered when they impinge on a bent guide tube in the port plug shield block that is optimized to produce a spray of solid fragments mixed with gas and liquid at speeds approaching the sound speed of the propellant gas. A prototype 3-barrel injector has been fabricated and tested with deuterium-neon mixture pellets of 25mm size for thermal mitigation and for runaway electron suppression and dissipation [2]. The technology design and installation details and planned use on ITER will be presented.
[1] N. Commaux, et al., Nucl. Fusion 50 (2010) 112001.
[2] L. R. Baylor, et al., Fus. Sci. Tech. 68 (2015) 211.

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