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The ITER Disruption Mitigation System design progress and validation

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The Disruption Mitigation System (DMS) is an essential plant system of ITER to reduce the deleterious effects of a disruption on in-vessel components. The design of the ITER DMS is based on shattered pellet injection (SPI) technology. This technique works by forming large cryogenic pellets of up to 28mm in diameter and firing them at high speeds towards a shattering section, where they fracture into showers of small fragments and sprayed into the plasma to provide high mass assimilation in the plasma as needed for the mitigation process.

The ITER DMS consists of 27 toroidally and poloidally distributed barrel type single shot pellet injectors. The majority of these injectors are located in three port cells on the equatorial level, while three injectors are installed in three port cells on the upper level. The integration of the injectors, which are located in the port cells inside the bio-shield where they are exposed to excessive neutron flux and radiation, had to overcome major challenges not only in terms of functionality but also for accessibility and maintainability. The port cells will be equipped with a large number of highly integrated components which provide the conditions and the monitoring needed to form and maintain pellets in the injectors.

In addition to these technical and integration solutions, the remaining technological challenges to make this first of a kind system highly effective and reliable are addressed by the ITER DMS task force through a number of dedicated technology studies. For example, the ideal de-sublimation process for protium which requires careful design and operating conditions, such as the thermal environment, the mass flow and the barrel pressure, is studied to form pellets with high integrity. Pellet launching methods are tested to dislodge and accelerate pellets intact, reliably and with minimum jitter. Novel propellant gas suppressors with internal structures are investigated to prevent the gas entering the torus ahead of the pellet fragments. An optical pellet diagnostic capable of withstanding the harsh tokamak environment is being developed to measure pellet parameters such as velocity and integrity. Flight line components are optimised to control the pellet flight path. In order to determine the ideal shattering geometry to achieve the desired fragment size distribution and velocities, laboratory experiments are carried out and the complicated fragmentation process is simulated using codes based on discrete element methods.

This presentation will describe the ITER DMS design and summarise the DMS task force technology activities to support and validate the design.

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