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Shattered Pellet Technology and related developments at the ITER DMS support laboratory

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The ITER disruption mitigation support laboratory is part of the ITER Disruption Mitigation System (DMS) Task Force programme to establish the physics and technology basis for the ITER DMS. The laboratory is located at the HUN-REN Centre for Energy Research (CER), Budapest Hungary. The aims include production, launching and shattering of 28.5x57 mm (d x L) H, D, Ne and mixture pellets, testing various propellant suppressor setups, testing the ITER Optical Pellet Diagnostic (OPD) concept, and diagnosing the fragment plumes resulting from shattering. The OPD prototype, a fast shutter, propellant valve and additional technologies are being developed in the framework of additional contracts.

The pellet production process was studied in detail experimentally and via modelling. Pellet production recipes were developed where a loose (cryogenic snow) layer is formed at the pellet-barrel interface, enabling intact launch of H, D and Ne pellets. The conditions for snow formation are qualitatively understood. After launch the pellets fly thorugh a propellant suppressor volume similar to the ITER design. Various inner structures are studied and gas flow modelled to select the most suitable solution for ITER. After the suppressor and OPD pellets fly the same distance to the shattering head as they would do on ITER. Large diameter flight tubes are installed so as the pellet free flight directions and rotation can be diagnosed by fast cameras before shattering. The shattering head reproduces the ITER geometry, but enables camera view into it, therefore details of the shattering process can be observed. The fragments resulting from shattering are diagnosed by a laser curtain diagnostic. Spatial, temporal, velocity, size distributions are measured. Altogether about 800 pellets have been launched in the past two year of operation, therefore extensive experimental database has been accumulated.

Additional components and technologies are being developed at CER for SPI, and more broadly for cryogenic pellet injection: fast shutter, propellant valve, 3D printed cryogenic components, parahydrogen pellet technology. These are partly funded by ITER, partly by other sources. A general purpose cryogenic test infrastructure has been set up recently to enable testing of these technologies with both cryocooler and liquid Helium cooling.

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