DTT: a Divertor Tokamak Test facility for the study of the power exhaust issues in view of DEMO

R. Albanese et al.

Consorzio CREATE - DIETI, Università degli Studi di Napoli Federico II – Italy

One of the main challenges in the European fusion roadmap is to design a heat and power exhaust system able to withstand the large loads expected in the divertor of a DEMO fusion power plant. Therefore, in parallel with the programme to optimise the operation with a conventional divertor based on detached conditions to be tested on the ITER device currently under construction in Cadarache, a specific project has been launched to investigate alternative power exhaust solutions for DEMO, aimed at the definition and the design of a Divertor Tokamak Test facility. This tokamak should be capable of hosting scaled experiments integrating most of the possible aspects of the DEMO power and particle exhaust. DTT should retain the possibility to test different divertor magnetic configurations, liquid metal divertor targets, and other possible solutions for the power exhaust problem. The DTT project proposal refers to a set of parameters selected so as to have edge conditions as close as possible to DEMO (in terms of the temperature and the normalized collisionality, pressure and ion gyro radius), while remaining compatible with DEMO bulk plasma performance in terms of dimensionless parameters and a given constraints. The talk will illustrate the DTT project proposal, referring to a 6 MA plasma with a major radius of 2.15 m, an aspect ratio of about 3, an elongation of 1.6-1.8, and a toroidal field of 6 T. This selection will guarantee to have a sufficient flexibility to test a wide set of divertor concepts and techniques to cope with large heat loads, including conventional tungsten divertors, liquid metal divertors, both conventional and advanced magnetic configurations (including single null, snow flake, quasi snow flake, X divertor, double null), internal coils for strike point sweeping and control of the width of the SOL (Scrape-Off Layer) in the divertor region, radiation control. The CS and PF coils are planned to provide a total flux swing of more than 35 Vs, compatible with a pulse length of more than 100 s. This pulse length, fully compatible with the mission of the study of the power exhaust problem is obtained using superconducting coils (NbTi for PF coils, Nb3Sn for the CS and the TF coils). Additional heating of 25 MW will be provided in the first phase of the operation using ICRH and ECRH. Afterwards, the ECRH heating power will be increased and NBI launchers will be added. The vacuum vessel is a single 35 mm shell of INCONEL 625, with five ports in each of the 18 sectors. The first wall is made of 5 mm of tungsten coating on a 60 mm stainless steel structure. The tungsten coating is thicker in selected zones of the first wall (where the plasma leans during the limiter phases of ramp-up and shut-down, where the plasma is expected to hit the wall in a disruption, at the upper strike points of double null configurations). Particular attention will be dedicated to the diagnostics and control issues, especially those relevant for plasma control in the divertor region, designed to be as compatible as possible with a DEMO-like environment. The construction is expected to last about seven years, and the selection of an Italian site would be compatible with a budget of 500 MEUR.