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# DTT: a facility to investigate heat exhaust solutions for fusion power plants

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The Divertor Tokamak Test facility (DTT) [1] is a research infrastructure proposed first in the EFDA Roadmap [2] to investigate innovative solutions for the heat exhaust in the DEMOnstration fusion power plant. The heat generated by fusion reactions is transported via conduction and convection towards the plasma edge and after crossing the plasma boundary (the so-called magnetic separatrix) flows in a narrow layer towards a niche in the reaction chamber (the divertor) where it is deposited on actively cooled components and extracted. The challenge arises because the layer is so narrow and the fusion power is so large that the heat flux on the divertor can reach values of a few tens of $MW/m^2$ – of the same order of the heat flux on the Sun surface!

The solution envisaged on ITER and tested on present devices relies on a combination of tungsten plasma facing components and detached plasma conditions and requires a significant fraction of the fusion power be converted in radiation. These conditions can be achieve using the conventional magnetic configuration with a single null point located above the divertor. However, for DEMO such a solution could be not sufficient to exhaust all the heat. DTT will investigate innovative solutions based on advanced magnetic configurations that allows distributing the heat on a larger area of the divertor (thus decreasing the heat flux) and advanced materials for plasma facing components such as composite materials, functionally graded materials and liquid metals. Some of these solutions have been already tested in proof-of-principle experiments and require a test at plasma parameters as close as possible to those of ITER and DEMO to ensure that their implementation is compatible with the core plasma conditions required for a burning plasma.

DTT (Fig. 1) is a compact experiment (major radius R=2.2m, minor radius 0.7m) that mimic the heat generated by fusion reactions using a large amount of external heating power (up to 45MW at the plasma). The DTT plasma current of 5.5MA allows to achieve breakeven-class plasma conditions. The DTT magnet system (toroidal filed B=5.7T) will be made of superconducting components to allow long pulse operation (pulse length of the order of 100s). This, in turn requires all the in-vessel components be actively cooled.

The initial DTT divertor will be made of the ITER tungsten monoblock solution with low-temperature water cooling. Four sectors of the machine will be devoted to the test of innovative plasma facing components. The first wall will be similarly made of actively cooled tungsten components. Therefore, DTT will have from the start of operation (expected at the beginning of the next decade) a configuration very similar to that of ITER making DTT an ideal device to prepare the initial operation of ITER. A research plan has been prepared with a large participation of scientists from various European laboratories to describe how to address at best the ITER needs. DTT and JT-60SA will be complementary devices for the ITER preparation.

DTT is presently under construction at the ENEA Frascati laboratory by a consortium (DTT s.c.ar.l.) that involves all the Italian public institutions working in fusion and the largest Italian energy company. One third of the budget is already committed in ongoing industrial contracts. The presentation will give a description of the scientific program and of the status of the construction.

References

[1] F. Romanelli,et al., Nucl. Fusion **64**, 112015(2024)
[2] F. Romanelli, et al., Fusion electricity. A roadmap to the realization of fusion energy. European Fusion Development Agreement, EFDA, ISBN 978-3-00-040720-8 (2012)

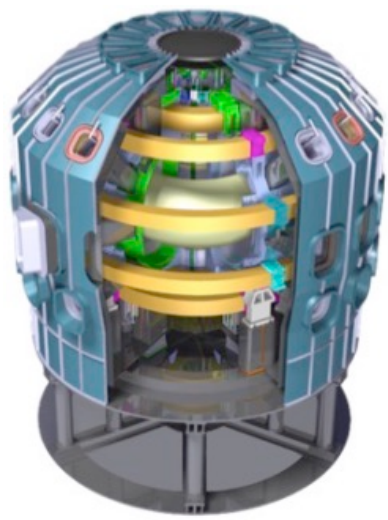

Figure 1. Divertor Tokamak Test facility layout