6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

The role of the modeling in the optimization of the DTT divertor

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The handling of excessive thermal load onto the plates of the divertor and the necessity to limit the erosion of the divertor material are of crucial importance to guarantee the lifetime of the Plasma facing component (PFC) in future fusion reactor. The standard Single Null Divertor (SND) configuration is largely adopted in present tokamak machine and represent the base scenario for ITER [1]. However, there is the possibility that it could not provide a safe solution in reactor relevant conditions. The fusion community is devoting a strong effort to investigate alternative solutions able to alleviate the exhaust problem. Among them, the use of alternative divertor magnetic configuration (ADCs) and the adoption of liquid metal targets are currently under study, both from experimental [2] and numerical predictive [3] point of views.

The new Divertor Tokamak Test facility (DTT) [4] is currently under construction in Italy. Its main mission is to act as a testbed for possible exhaust solutions in reactor relevant conditions. The possibility to accommodate a wide range of ADCs is a leading feature of this device. During the design phase, a particular attention was given to the definition of divertor geometry. A synergy between the engineering and the physics aspects is adopted by gathering the main findings of the physical predictive studies with the feasibility of the different proposed solutions. The major engineering constrain is the tungsten monoblock implementation of the divertor targets plates and dome, which on one side is the only technological solution able to withstand up to $\approx$20 MW/m^2 of stationary heat flux and for this reason is presently foreseen for DEMO but on the other side it sets strong geometrical constrains on the divertor shape and pumping slot apertures. In the design previous engineering constrains have been coupled to the DTT physical goal being able to test different power exhaust solutions which calls for a high divertor flexibility. This means that the divertor shape must be able to accommodate at least the SND and some of the ADCs, e.g. the X-Divertor (XD) and the hybrid Super-X/long leg SN. In this framework, a crucial role is played by the edge modeling of the Scrape Off Layer (SOL) plasma by means of edge code suites as SOLPS-ITER and SOLEDGE2D-EIRENE. The divertor performance in different geometries have been assessed in terms of main plasma contamination, divertor plasma conditions and pumping capability, . The code predictions were essential to define the size of the divertor by showing the better divertor plasma performance obtained in the so-called "wide" divertor with respect to the "narrow" one: we get a lower impurity concentration and lower plasma temperature at the target in the former case. These aspects are crucial to guarantee an integrated scenario where both the main plasma performance and the technological limit imposed by the PFC have to be satisfied. Furthermore, This divertor shape also well matches the request in terms of flexibility, since with the multiple functionality of the "dome" the long leg and Snowflake Divertor (SFC) can be tested. Finally, the possibility to change the shape and the size of the dome has been also evaluated. Previous study in ITER-like geometry[5] have considered the impact of the dome in the subdivertor conditions and pumping. The modeling of DTT has shown the possibility to adopt a dome geometry different from the one foreseen in ITER with no major impact on the pumping performance. All these ingredients have represented a powerful support to the design and optimization of the divertor geometry.

References

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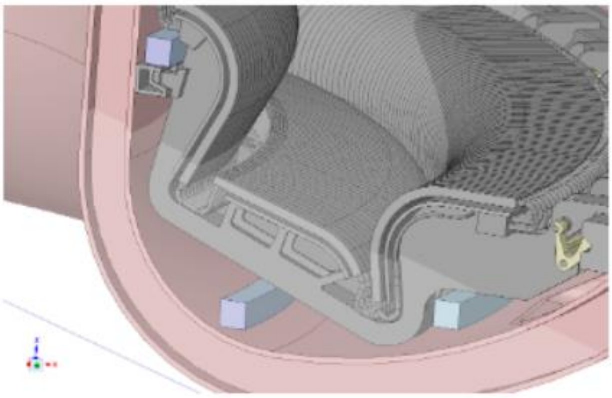

Figure 1: Proposed divertor for the DTT machine as a results of the optimization procedure.