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ECH and ECCD modelling studies for DTT

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The new Divertor Tokamak Test facility (DTT [1]), aimed to perform studies regarding power exhaust and divertor load and currently under construction, will be provided with a mix of additional heating systems. The Electron Cyclotron Resonance Heating (ECRH) system is foreseen to accomplish several tasks: plasma heating, MHD control and non-inductive current drive (CD) for transformer assistance and current profile tailoring. To this purpose, two types of launcher have been proposed, for different wave injection geometries, equipped by steering mirror systems which allow EC absorption over a broad range of plasma locations. Considering the reference DTT Single Null full power scenario (B=6 T) [2], central plasma heating requires 10-20 MW of EC power, with injection frequency of 170 GHz.
In order to investigate and to optimize launchers performances for the foreseen EC tasks, the beam- tracing code GRAY [3] has been used to perform a comprehensive study regarding the propagation, absorption and current drive of the EC beams on the main reference DTT scenario. A range of beam injection positions and angles around the values foreseen by the actual EC launchers design have been tested to reach ECH&ECCD optimization and to evaluate the launchers capability to fulfil its main tasks. Optimal poloidal and toroidal injection angles and relative steering ranges have been identified for the best localization and trade-off between maximum CD and narrow driven current profile width required for efficient MHD control.
In order to explore the EC launchers flexibility, the capability of properly working also in presence of edge density fluctuations induced by pellets injection has been investigated. Significant effects of beam refraction and deviation are seen for a density variation dne,max>6 1019 m-3. Large angle adjustments (5o-20o) can be required to maintain off-axis ECCD at a fixed location, while the plasma core is foreseen to be marginally reachable during large pellet injection. The requirements for real-time control of the injected beam polarization, due to changes either in the steering angles or in the magnetic configuration at the plasma boundary, were also assessed given the importance of optimal coupling to Ordinary mode when operating at the first harmonic resonance.
As future work, the analysis is going to be focused on the dynamical phases of the DTT scenarios.

References

[1] R. Martone et al., DTT Divertor Tokamak Test facility. Interim Design Report, ENEA (ISBN 978-88-8286-378-4), April 2019 ("Green Book")
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[3] D. Farina, et al., Fusion Sci. Tech. 52, 154 (2007)

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