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EU DEMO Heating and Current Drive: Physics and Technology

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In the frame of the European Fusion Roadmap and under the Power Plant Physics and Technology program, the EUROfusion Consortium is conducting detailed studies on a tokamak DEMOnstration power plant. Scoping studies (e.g. scanning the aspect ratios and the toroidal magnetic field) are being performed. The EU DEMO1-2015 baseline is a 5. 7 T reactor delivering electricity in long pulse (> 2 hours). Its operation relies on the use of external heating during plasma initiation, current ramp-up to H mode, burn and instabilities control, and plasma ramp down phases. Extensive simulations of the power requirements during all plasma phases were conducted. It was found that about 150-170 MW are required during the different phases to fulfill the requirements described above. Since the DEMO1 is mainly an inductive tokamak, auxiliary current drive will contribute only weakly to the pulse duration (about 10%). System design based on the use of electron cyclotron (EC), ion cyclotron (IC) waves and neutral beam injection (NBI) and technical development in the fields of EC gyrotron sources and NB injector are performed. The HCD system must be fully integrated in the machine design and satisfy stringent criteria on safety, remote handling and impact on the Tritium Breeding Ratio. The presentation will cover the physics requirements from scenarios modeling. It will highlight the requirements during the current ramp-up phase and the transition to H mode. The technical part will be devoted to the design and R&D consideration for the three HCD systems and their integration in DEMO. For EC various options for the system from the gyrotrons to the launchers will be discussed. The integration of the launchers and the impact on the blanket design and TBR in the port plug will be outlined. Since the DEMO1 program is still in a pre-conceptual phase, advanced high frequency (240 GHz) high power (up to 2 MW) gyrotrons are under development to avoid de-scoping of potentially interesting options. For IC, the focus is on a distributed antenna, which offers many advantages, such as low RF power density and minimum reduction in TBR. In the field of NBI, the main issues under consideration are Cs management or avoidance in the negative ion source and neutralization methods (photoneutralization), which would significantly increase both the neutral power and the wall plug efficiency (η>60%).

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