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TCV divertor and heating upgrades for contributing to DEMO physics basis

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Major upgrades to the TCV infrastructure are implemented to increase the DEMO relevance of its research. A major component is the creation of an in-vessel divertor chamber of variable closure to contribute to the qualification of alternative divertor concepts, including the demonstration of advantageous plasma exhaust performance, combining detachment with particle control, He compression and impurity retention in the divertor, and ELM control. Options to implement mechanically extendible or replaceable baffles are studied. The present design consists of one set of 32 solid graphite tiles on the high field side and several sets of 64 tiles on the low field side. The latter vary in tile protrusion to change the divertor closure. Enhancements of existing diagnostics together with new systems are envisaged to characterise the divertor performance. A new high capacity pump and an extended set of gas valves will enhance the particle control. Finally, one to three additional poloidal field coils close to the divertor may be needed to increase the range of accessible divertor configurations and improve the relevant control capabilities. We intend to use high temperature superconductors, which permit over an order of magnitude larger current densities compared to water cooled copper coils, reducing space requirements and facilitating in-situ construction. The divertor upgrade completes a set of major improvements to the plasma heating systems, which are conducted in two steps, one presently under way and another foreseen in 2017-2020. The installation of a 1MW 15-30keV NBI has recently been completed. Ion temperatures of 2keV and rotation velocities of 160km/s have already been measured. The first step also includes the acquisition of two 0.75MW gyrotrons for ECH/ECCD at the 2nd harmonic (X2, 87GHz). The second step consists of the installation of a 1MW, 50 keV beam, directed opposite to the first beam, for plasma rotation and fast ion physics studies, and two 1MW dual frequency gyrotrons, (83GHz, X2 and 126GHz, X3). EMC3-Eirene simulations indicate that realistic baffles together with the heating upgrade (designed to reach Ti/Te>1 and ☒N˜3) allow for significantly higher neutral pressure, impurity compression and power dissipation in the divertor (Psep/R˜6MW/m).
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