The Heating & Current Drive System of Divertor Tokamak Test (DTT)

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Abstract:

Appropriate disposal of the non-neutronic energy and particle exhaust in a reactor is universally recognized as one of the high priority challenges for the exploitation of fusion as an energy source. The Divertor Tokamak Test (DTT) facility will be built to study a solution suitable for the power exhaust in conditions relevant for DEMO. The tokamak will reach the needed condition of 15 MW/m power flow to the divertor by coupling up to 45 MW of additional power to the plasma. The selected Heating Systems to achieve this goal are Electron Cyclotron Heating (ECH), Ion Cyclotron Heating (ICH) and Negative Neutron Beam Injector (NNBI). The power systems will be installed in two stages: at a first stage 16 MW of ECRH power, 3 MW of ICRH and one 7.5 MW NNBI injector will be installed, making the DTT plasma suitable for relevant experiment at 6T, 4MA configuration. The EC system relies on a 170 GHz, 1 MW gyrotron, similar to those developed for ITER, while for the power transmission a Quasi Optical approach has been chosen, where a multi-beam mirrors will be installed under vacuum to reduce the overall transmission losses below 10%. The power will be injected exploiting independent front-steering antennas capable to steer in real-time all the beams. The module of the ICRH system will be based on transmitters, capable of a wide frequency range (60-90 MHz), connected to two movable antennas inserted in the equatorial ports of DTT. The choice of the antenna type will be based on reliability (i.e. power density) rather than on its performance in terms of peak coupled power. Fast variations of the antenna loading, as the one expected in presence of ELM, will be compensated exploiting an external matching system. The NNBI will be based on two RF plasma sources capable to produce a negative ion current that will be accelerated by a grids system up to 400 keV. The designed injector will reflect the experience gained in SPIDER and MITICA, with modifications aiming to a simplified and well performing system. The paper describes the main characteristics of the design of DTT additional heating system, that will be one of the most powerful between the tokamaks of the next generation.