Contribution ID: **78** Type: **not specified**

Conceptual design of a Neutral Beam Heating system for DTT

Monday, 17 September 2018 11:00 (2 hours)

The main purpose of the Divertor Tokamak Test (DTT) is to study solutions to mitigate the issue of power exhaust in conditions relevant for ITER and DEMO. The key feature of such a study is to equip the machine with a significant amount of auxiliary heating power (45 MW) in order to test different divertor solutions. According to the Italian project, the experiment is foreseen to operate with the following main parameters: BT = 6 T, IP = 5.5 MA, R0 = 2.08 m, a = 0.65 m and a pulse duration of 90-100 s. It shall be able to study different divertor magnetic configurations and reach a reactor relevant power flow to the divertor. The proposed mix of heating power foreseen to achieve the target value of 45 MW delivered to the plasma will be provided by Electron Cyclotron Resonant Heating (ECRH), Ion Cyclotron Resonant Heating (ICRH) and Negative-ion-based Neutral Beam Heating (NNBH).

In this framework, the conceptual design of a NNBH system for DTT is here presented, with a particular focus on the technical solutions adopted to fulfil the requirements and maximize the performances. The proposed system features two beamlines providing deuterium negative ions (D-) with an energy not smaller than 300 keV and an injected power of 5-8 MW each.

The design of the main components of the injectors is described in detail, explaining the motivations behind the main design choices. A comprehensive set of simulations was carried out using several physics and engineering codes to drive the development of the design. These simulations mainly regard the efficiency of the main processes, the optics of the beam, the physics reactions along the beamline (stripping, charge-exchange and ionization), the thermo-mechanical behaviour of the acceleration grids and the coupling between the beam and the plasma in the tokamak chamber.

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Session Classification: P1

Track Classification: Plasma Heating and Current Drive