Overview on the first-principle integrated modelling of the main scenarios of the new Divertor Tokamak Test facility

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The construction of the Divertor Tokamak Test facility (DTT)[1,2], a new D-shaped superconducting tokamak (R=2.19m, a=0.70m, BT≤ 6T, Ip ≤ 5.5MA, pulse length ≤ 100s, auxiliary heating ≤ 45MW, W first wall and divertor), is starting in Frascati, Italy. Its main mission is to study the controlled exhaust of energy and particle from a fusion reactor, which is a top priority research item in the European Roadmap[3] towards thermonuclear fusion power production. The characteristics of the machine will allow to address many ITER and DEMO relevant physics issues besides plasma wall interaction in a fusion relevant range of plasma parameters.

In order to support the device design, and particularly the heating mix definition, the design of the neutron shields, of diagnostic systems, and of pellet injectors, and the assessment of fast particle losses, as well as to help the elaboration of a DTT scientific work-programme, it is a key priority to achieve multi-channel integrated modelling of DTT scenarios based on state-of-art first principle quasi-linear transport models.

The integrated simulations of main DTT scenarios, carried out with the JINTRAC[4] suite or with the ASTRA[5] transport solver, cover the region inside the separatrix and predict steady-state profiles of ion and electron temperature, density, rotation, current density, impurity (Ar, W) density, with heating and current drive modelled self-consistently and with a calculated self-consistent equilibrium starting from a fixed boundary taken from [6]. Inside the top of the pedestal, the turbulent heat and particle transport is calculated by the Trapped-Gyro-Landau-Fluid (TGLF)[7] or QuaLiKiz (QLK)[8] quasi-linear transport models. First results of this modelling work are presented and for some cases these results are validated against GENE[9] gyrokinetic simulations with the specific DTT parameters, to corroborate the validity of the reduced models in the particular case of DTT.

As a result of this work, the heating mix was defined. Particularly, in the full power scenario, an extrìernal power of about 45MW will be provided from the 3 heating auxiliary systems to the plasma: ~30MW from the 170 GHz ECRH system, ~10MW from the NBI system composed by one injector at 510keV, and ~6MW from the 60-90MHz ICRH system to the plasma.

In the full power scenario, central temperatures of ~20 keV for electrons and ~10keV for ions with central densities ~2.5×10^{20}m^{-3} are predicted in fair agreement by the two models used.

Moreover, reference profiles for diagnostic design, estimates of neutron yields and fast particle losses have become available.

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