Neon seeding effects on two JET high performance baseline plasmas

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On JET Neon injection seems to improve confinement [1] and in addition it is needed in high performance plasmas for mitigating heat fluxes to the divertor and to the first wall. Recent experiments at JET were able to combine low- to mid-Z impurity seeding with high performance baseline H-modes, obtaining an improvement in the confinement when Neon gas was injected with respect to the equivalent unseeded plasmas [1]. Impurity seeding has an impact on plasma dilution and on the radiative power profile, but can also modify the transport. In this paper the results of the modelling of two JET baseline pulses, one with Neon seeding and one without seeding, are presented, including a comparison of their turbulence spectra, in order to understand the effects of Neon seeding on transport and confinement. The baseline is one of the two plasma scenarios explored at JET for stationary high fusion performance, in which the confinement is achieved at high plasma current ($I_p \geq 3.0$ MA) and moderate beta normalized, with a relaxed current profile [2]. The shots modelled in this paper share similar plasma parameters (3.0 MA/2.8 T, $\beta_N \approx 2.2$, $q_{95} \approx 3$) and auxiliary heating powers ($P_{NBI} \approx 28.7$ MW, $P_{ICRH} \approx 3.7$ MW), with the only difference being the Neon seeding, which allows the modelling to investigate the effects of Neon on transport.
The simulations are performed in a fully predictive way in the JINTRAC [3] suite of codes, using JETTO as transport solver and QuaLiKiz [4, 5] as quasilinear gyrokinetic transport model from the magnetic axis up to the pedestal top. The modelling takes into account the pedestal improvement obtained with Neon seeding, also seen in other shots [1]. The pedestal is modelled by adjusting the heat transport in the Edge Transport Barrier (ETB) in order to match the experimental height of the temperature pedestal. The evolution of the plasma current density, electron density, electron and ion temperatures and plasma rotation are computed self-consistently, as well as the equilibrium. The transport of impurities is evolved, considering an impurity mix of Be, Ne, Ni and W. Boundary conditions on the electron and ion temperatures are imposed at the separatrix and equal to 100 eV; initial conditions on the profiles of the electron density and temperature are taken from High Resolution Thomson Scattering (HRTS) measurements, while ion temperature and toroidal rotation are taken from the beam Charge Exchange (CX) spectroscopy.
The results of the predictive simulations are in good agreement with the experimental measurements for both of the analysed shots. QuaLiKiz shows a reduction in the electron and ion thermal diffusivities in the Ne seeded shot for $0.4 < \Psi_N < 0.9$. In order to understand the cause of the transport reduction, QuaLiKiz turbulence spectra are compared. The microstability analysis suggests that Ne injection reduces the growth rates of both ETG and ITG modes, which leads to a decrease of the heat fluxes with respect to the unseeded pulse.

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[1] Giroud C. *et al* 2021 *28th IAEA Fusion Energy Conference (FEC 2020)* [2] L. Garzotti *et al* 2019 *Nucl. Fusion* **59** 076037 [3] Romanelli M. *et al* 2014 *Plasma and Fusion Research* **9** 3403023 [4] Bourdelle C. *et al* 2016 *Plasma Phys. Control. Fusion* **58** 014036 [5] Citrin J. *et al* 2017 *Plasma Phys. Control. Fusion* **59** 064010