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Tearing Modes in neon seeding experiments in JET hybrid plasmas

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Neon seeding experiments have been performed on JET in order to investigate the potential for divertor heat-load mitigation in hybrid plasmas by increasing plasma radiation [1]. Pulses with same values for the toroidal magnetic field ($B_T = 1.9$ T), the plasma current ($I_P = 1.4$ MA), the injected neutral beam power ($P_{NB} = 16$ MW) and the same waveform for Neon injection (from 43.5 s to 45.0 s), but different neon flow-rate values, have been analyzed. To highlight the neon seeding effects, the behavior of some parameters has been studied as a function of the neon seeding rate: the radiated power and the effective charge increase; the electron density increases, the electron temperature decreases and the electron pressure is largely unaltered; β_N remains constant, but the neutron rate decreases. A very interesting property of such pulses is the increase of the density peaking, which suggests an effect of neon on the particle transport properties [2].

The main aim of this work is to study the stability of the Tearing Modes (TM), which can deteriorate the confinement leading to the decrease of the plasma energy content. It is worth noting that the core plasma radiation increases at high neon seeding rate, leading to a flattening of the electron temperature profile, and spectroscopic analysis suggests that high-Z impurity accumulation could be involved [3]. The TM activity is affected by the increasing neon seeding rate, showing a transition from ST-triggered to spontaneous modes. In particular, for a given neon flow-rate, the sequence of spontaneous TM onset (4/3 -> 3/2 -> 5/3) from inner to outer plasma region (Figure 1), suggests a destabilization mechanism associated to the progressive hollowing of the current density profile, as confirmed by the disappearing of the $q = 1$ activity in the spectrograms obtained from the magnetic pick-up coils. In addition, the onset time for each spontaneous mode progressively anticipates with increasing neon seeding rate (Figure 1), supporting the hypothesis that a progressive peaking of the effective charge profile is tacking place. The TM stability analysis was performed for some neon seeded pulses, to confirm the hypotheses done. The analysis procedure also includes a linear MHD stability calculation, via the resistive, global, full MHD code MARS [4], utilized starting from TRANSP simulations performed with the effective charge profiles obtained considering the neon concentration from charge exchange diagnostics and the high-Z impurity concentration from soft-X ray emission. The analysis addresses also the idea of a possible use of impurity seeding for tailoring the safety factor profile and improve performance and MHD stability.

References

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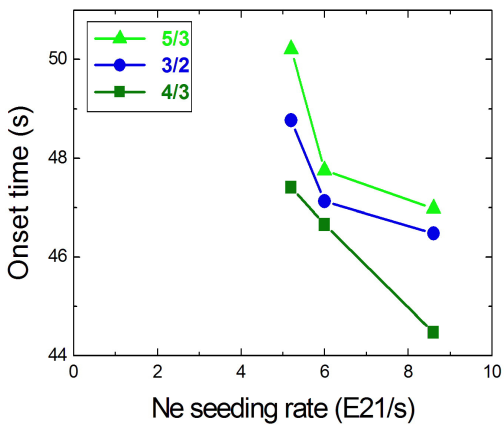

Figure 1. Onset time for the spontaneous Tearing Modes m/n = 4/3, 3/2, 5/3, where m and n are the poloidal and the toroidal mode number, respectively, as a function of the neon seeding rate. The analysis is performed by means of an array of magnetic pick-up coils.