ICRH physics for relevant schemes in T and D-T experiments at JET

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A tritium (T) campaign is planned in preparation for the deuterium-tritium (D-T) campaign (DTE2) at the Joint European Torus (JET). These experiments will be the first experiments involving T with the ITER-like plasma-wall facing component materials and they will give a unique opportunity to test several ion cyclotron resonance frequency heating (ICRH) schemes in T rich plasmas.

This contribution provides physical insight on different ICRH schemes envisaged for operation in T and D-T campaigns at JET [1,2]. The results highlight their impact on fusion performance and the expected similarities when used in T and D-T. In our modelling we use two selected record discharges during the steady-state H mode phase as reference, a hybrid discharge in D plasma and a DTE1 discharge in T rich plasma, i.e., using its experimental profiles. We consider three ICRF schemes, i.e. $\omega = \omega_{3He} = 2\omega_T$, $\omega = 2\omega_T$ (no ^{3}He) and $\omega = \omega_D$, with a central resonance and NBI heating. In this work we focus on the heating physics of these schemes and we have not taken into account the transport and isotope effects. The modelling has been carried out with the ICRF code PION [3] and the beam code PENCIL [4] which take into account the ICRF+NBI synergy.

As a T campaign will be performed in preparation of the D-T campaign, it is important to understand the heating physics of each particular ICRH scheme but also to assess the differences and similarities that they might show in different plasma compositions. The analysis of the T velocity distribution function shows a different behaviour depending on the T content in the plasma for the $\omega = 2\omega_T$ scheme. At higher T concentrations, the T velocity distribution is stronger around the critical energy as compared to those plasmas with a lower content in T. This fact leads the T plasma to show a higher and more peaked ion-ion collisional power density at the plasma centre as compared to the D-T plasma. This result suggests that higher ion temperatures might be achieved in T plasmas for this ICRH scheme. On the other hand, the use of ^{3}He as a minority $\omega = \omega_{3He} = 2\omega_T$ makes the fast ion T energy considerably lower due to strong ^{3}He absorption. As a result, the distribution functions of ^{3}He and T are similar in both scenarios, T and D-T. Therefore, there is a strong heating similarity between T and D-T plasmas for the ^{3}He minority scheme.

Regarding the D minority scheme ($\omega = \omega_D$), it achieved a record Q with ICRH only [5,6] during the first D-T experiments at JET (DTE1). Our modelling of this scheme delves in two particular aspects: (1) the predicted fusion performance in DTE2 that could be achieved if NBI is used together with ICRH and (2), the study of the ICRF power absorption dependency on D minority concentration. Our modelling predicts a substantial boost of the fusion power generation by adding NBI and sheds some light on the D absorption strength decrease at larger concentrations which is a question that has remained opened since DTE1 [6].

References

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