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The impact of the hydrogen species on the HHFW performance with possible new NSTX-U scenarios

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The main goal of the NSTX-U is to operate at B=1T. With this magnetic field, the 1st and 2nd harmonics of hydrogen (H) are located at the high-field side and in the core plasma, respectively. As a consequence, part of the high-harmonic fast-wave (HHFW) injected power can be absorbed by the H population. This condition might open up new HHFW scenarios, which in turn can be relevant for the initial ITER ICRH experiments. Therefore, it is important to investigate the impact of the H species on HHFW performance in NSTX-U plasmas. First of all, the injected power absorbed by the H species can affect the electron and/or the fast-ion heating with respect to the "standard"HHFW performance in NSTX. Second, the presence of the H species might have some positive effects: the presence of the 2nd cyclotron harmonic of hydrogen in the core plasma can cause a localized H power absorption, which in turn might modify the ion temperature. On the other side, due to the high-energy (non-Maxwellian) tail of the H distribution function (caused by the acceleration of H species by HHFW), part of the H absorbed power could transfer to electron heating via collisions, providing an additional core electron heating to the "standard"HHFW performance. In this work, we analyze in detail all these possible scenarios by the use of the full wave code AORSA combined with the Fokker-Planck code CQL3D. Initial AORSA simulations have been performed for NSTX-U B=1T plasma with different H concentrations (from 2% to 10%) with and without NBI. For f=30MHz and B=1T, unlike an on-axis power deposition for electrons and fast ions, a localized H absorption around the 2nd cyclotron H harmonic is observed by AORSA. For larger n_phi the electron damping is dominant. However, for n_phi=5 and 10% H concentration, up to 30% and 60% of the total power can be absorbed by H with and without NBI, respectively. A more comprehensive numerical analysis will be presented including also the non-Maxwellian effects in the H and fast ions species by making use of the Fokker-Planck code CQL3D. Furthermore, a magnetic field scan will be performed in order to cover all possible scenarios. H majority plasma will be also considered and compared with D plasma. Finally, the case of 15MHz wave frequency will also be explored because it would open up the possibility to try ICRH minority heating in NSTX-U with B=1T.

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