

Second harmonic electron cyclotron pre-ionization in the DIII-D tokamak

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Abstract. Second harmonic 60 GHz electron cyclotron (EC) pre-ionization using low field side (LFS) X-mode launchers has been effective in producing target plasmas for startup of the DIII-D tokamak with electron densities comparable to fundamental LFS pre-ionization plasmas using the same EC system. A visible Bremsstrahlung array showed that breakdown occurred at the 2nd harmonic resonance location and after a few milliseconds the EC driven plasma filled the entire vessel, independent of the resonant location, which was varied from near the inner wall to the center of the torus. The power threshold for ionization of ~ 0.4 MW was observed in DIII-D for these 2nd harmonic pre-ionization experiments. An orbit following code calculated that cold (0.03 eV) electrons could be heated to energies above 20 eV where ionization of the neutral deuterium gas can occur. Scaling from DIII-D to ITER indicates that ECH 2nd harmonic pre-ionization and initial plasma formation is possible if ITER operation at reduced toroidal field is desired, but additional experiments are required to extrapolate the entire ECH start-up scenario from DIII-D to ITER.

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