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P2.1053 Investigation of higher harmonics of electron cyclotron emission in the W7-X stellarator

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The W7-X stellarator with its large aspect ratio has spectrally well separated electron cyclotron harmonics compared to tokamaks. Because of this geometrical advantage, it is easier to address the electron cyclotron harmonics (70,140,210…GHz) at a magnetic field of 2.5 T. In a standard electron cyclotron emission (ECE) diagnostic1, the optically thick second harmonic extraordinary mode (X2 mode) of ECE is used to determine the electron temperature profiles. For confinement reasons, W7-X plans to work at high plasma densities aiming at detached steady state operation. For such overdense plasmas with plasma density 1.2×1019 m-3, the optically thick X2 mode (120-160 GHz) of ECE is in cutoff and hence there is no direct access to electron temperature profiles from the standard ECE. For overdense plasmas, higher harmonics2 provide the only access to the ECE. And for such cases, the diagnostic capabilities of higher harmonics are explored as high density access to electron temperatures profiles. For this purpose, a Michelson interferometer3 with a time resolution of 22ms and spectral resolution of approximately 5GHz was used during operational phase OP1.2b of W7-X for broadband ECE (50-500 GHz) scan. The experimental results will be compared to the modeling of ECE at different plasma parameters applying radiation transport calculations (TRAVIS). Preliminarily results indicate that X3 mode of ECE above a certain density is optically thick and can be used to measure the electron temperature profiles.

1 M.Hirsch et al., this conference
2 N.Chaudhary et al., Proceedings of 20th workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, May 14-17, 2018, Greifswald, Germany, EPJ Web of Conferences
3J.W. Oosterbeek et al., 'Michelson Interferometer design in ECW heated plasmas and initial results', accepted for publication, Fusion Engineering and Design, 2019

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