EBW HEATING EXPERIMENTS ON MAST

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Conventional ECE diagnostics and ECRH methods typically cannot be used in spherical tokamaks (STs) because of the specific plasma parameters. Usually the plasma is well overdense in STs, i.e. $\omega_{pe} >> \omega_{ce}$, where ω_{pe} and ω_{ce} are the electron plasma and electron cyclotron frequencies, respectively. In such plasmas the core appears to be inaccessible for conventional electromagnetic modes in the range of frequencies corresponding to the first few EC harmonics. This is primarily because EC resonances in the core plasma are completely obscured by the O and X mode cutoffs.

Electron Bernstein waves (EBWs) are considered as a promising means for plasma heating and current drive (CD) in STs. Extensive ray tracing modelling and thermal EBW emission measurements suggest the preferable operating frequency for efficient EBW heating and CD must be in the range of the fundamental EC resonance or its lower harmonics [1, 2]. This requires a high power RF source in the range of 16 – 28 GHz. The 60 GHz (~1 MW) gyrotron complex is available on MAST. It is equipped with a steerable launching system. Despite the fact the operating frequency is far from optimum a number of physical processes can be studied in the present experimental set-up.

The experiments were conducted at 60 GHz with RF power injected up to 0.8 MW. Three different plasma scenarios have been developed for EBWH experiments. The first scenario is based on the high density ELM-free H-mode. It offers a relatively broad ($\pm 5^o$) ordinary-extraordinary-Bernstein (O-X-B) mode conversion window but EBW absorption, as predicted by modeling, is expected to be very peripheral (r/a~0.9). As the O-X-B mode conversion occurs in relatively cold plasma close to the separatrix the parametric decay phenomena was observed in this scenario [3]. The second scenario is based on ITB-like plasma, in which a high density gradient zone allowing the O-X-B conversion appears deeper into the plasma. The mode conversion window is narrower ($\pm 3^o$) in this case but the EBW power deposition can reach r/a ~ 0.6 hence plasma heating effects were observed [1]. In the third scenario the high density ohmic H-mode is achieved by the plasma compression in the major radius. Because plasma is compressed into a higher magnetic field r/a ~ 0.4 becomes accessible transiently at $3\omega_{ce}$ during the compression process. The mode conversion window ($\pm 1.5^o$) is very restrictive in this case hence the thermal EBW plasma emission was used for the launch optimization. A 10% increase in electron temperature has been measured in the last scenario.

The work was funded jointly by the United Kingdom Engineering and Physical Sciences Research Council and by EURATOM

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