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EX/P2-16: Progress toward Steady-state Regimes in Alcator C-Mod

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Over 1 MW of RF power in the lower hybrid (LH) frequency range (4.6 GHz) has been injected into C-Mod plasmas. Fully non-inductive discharges were sustained for 2-3 current relaxation time with $n_{e0} = 0.5 \times 10^{20} \text{ m}^{-3}$, $I_p = 0.5 \text{ MA}$ and $B_T = 5.4 \text{ T}$. Sawteeth are completely suppressed and modestly reversed shear plasmas, with $q_0 \sim 2$ and $q_{\min} \sim 1.5$, were obtained. CD efficiency is in the range of $2.0\text{-}2.5 \times 10^{19} \text{ A/Wm}^2$, consistent with what is assumed in ITER. Also, spontaneous formation of an ITB was observed during these discharges after the current profile relaxed. Accessing ITER-relevant steady-state regimes with $f_{BS} \sim 50\%$ in C-Mod requires increasing the density to $\sim 1.5 \times 10^{20} \text{ m}^{-3}$ with $T_{e0} \sim 5 \text{ keV}$ [1]. Target plasmas with these parameters have been produced in C-Mod both by mode-converted ICRF heating as well as in I-Mode [2]. However, in low temperature ($T_{e0} \sim 2 \text{ keV}$) Ohmically heated plasmas, LHCD efficiency drops precipitously as the density is increased above $\sim 5 \times 10^{19} \text{ m}^{-3}$ even though this density is well below conventional limits set by either accessibility or parametric decay [3,4]. This falloff with density has been explored with two newly developed and independent simulations, ray-tracing and fullwave codes coupled with 3D Fokker-planck codes [5,6]. Both simulations indicate that wave interactions in edge plasmas including SOL can lead to the observed loss in efficiency, either by direct collisional absorption and/or by causing an up-shift in the parallel refractive index. The simulations also indicate that the loss in efficiency can be recovered by increasing the first-pass absorption. Experiments aimed at verifying this result have been carried out in mode-converted ICRF-heated He discharges with high T_{e0} (up to 5.3 keV). Good agreement with the simulations is found, verifying that low parasitic absorption occurs with stronger absorption. Based on this result, additional launcher was designed to aim maximizing the velocity space synergy between two launchers. Implications for realizing steady-state regimes in C-Mod will be discussed.

[1] P. T. Bonoli et al, NF, 40 1251 (2000)

[2] D. G. Whyte et al, NF 50 105005 (2010)

[3] G. M. Wallace et al, PoP 17 082508 (2010)

[4] G. M. Wallace et al, NF 51 083032 (2011)

[5] O. Meneghini et al, PoP 16, 090701 (2009)

[6] S. Shiraiwa et al, PoP 18, 080705 (2011)

Country or International Organization of Primary Author

USA

Primary author: Mr SHIRAIWA, Syun'ichi (USA)

Co-authors: Dr SMIRNOV, A. P. (M.V. Lomonosov Moscow State University); Dr HUBBARD, Amanda (Massachusetts Institute of Technology, Plasma Science and Fusion Center); Dr WALLACE, G. M. (PSFC, MIT); Mr FAUST, I. C. (PSFC, MIT); Dr WILSON, J. R. (PPPL); Dr MENEGHINI, Orso (General Atomics); Dr BONOLI, Paul (Massachusetts Institute of Technology); Prof. PARKER, R. R. (PSFC, MIT); Dr HARVEY, R. W. (CompX); Mr BAEK, S. G. (PSFC, MIT)

Presenter: Mr SHIRAIWA, Syun'ichi (USA)

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