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Simultaneous injection of lower hybrid power at two frequencies on EAST

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EAST operates a number of electron heating sources, including two lower hybrid (LH) systems at 2.45 GHz and 4.6 GHz [1], and a 140 GHz electron cyclotron (EC) source [2]. This offers a flexible platform to study the synergy between the two different frequencies of LH, as well as between the LH and the EC. Here, the expected synergy is when the absorption of one radiofrequency (rf) wave increases the fast electron population, which allows a second, simultaneously injected rf wave to drive current at a higher efficiency. To date, this theoretically predicted synergy [3] has not be observed experimentally on EAST.

The various possible combinations of the three waves have been tested in experiment, which includes the 2.45 GHz and 4.6 GHz injected separately or simultaneously, and with or without background EC injection. When compared to 1 MW of 2.45 GHz LH alone or 1 MW of 4.6 GHz LH alone, the case of simultaneous injection of the two LH waves with total power of 1 MW had a slight decrease in measured loop voltage. This may be suggestive of stronger non-inductive current drive and possible synergy between the rf waves, but require further study to confirm.

Simulation is in progress to reproduce the experiment and better study the synergy between the waves. Because the DC electric field affects the fast electron distribution function, it is important that the magnetic equilibrium and the LH current drive are evolved self-consistently [4]. For this reason, time-dependent modeling is a necessary tool to guide experiments on EAST dedicated to access and sustainment of steady-state discharges.

The codes TRANSP [5], GENRAY [6], and CQL3D [7] are used in combination to simulate the LH wave propagation and absorption in the plasma, and its effect on the local and global plasma parameters. In order to conclude synergy, the radial location and magnitude of the driven current profiles need to be compared for cases when the two LH waves are injected independently or simultaneously, with or without EC. The total current profile can also be compared against the values measured by the polarimeter-interferometer (POINT) diagnostic, when available. Once the model is validated, scans of parameters such as electron density and temperature, z_{eff}, and different power combinations of the rf waves can be performed in order to find the optimal scenario for synergistic current drive.

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