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The interaction of the near-field plasma with antennas used in magnetic fusion research[1]

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Plasma heating and current drive using antennas in the Ion Cyclotron Range of Frequencies (ICRF) are important elements for the success of magnetic fusion. The antennas must operate in a harsh environment, where local plasma densities can be $> 10^{18}/\mathrm{m}^3$, magnetic fields can range from 0.2-5 Tesla, and antenna operating voltages can be > 40 kV. This environment creates operational issues due to the interaction of the near-field of the antenna with the local plasma. In addition to parasitic losses in this plasma region, voltage and current distributions on the antenna structure lead to the formation of high electric fields and RF plasma sheaths, which can lead to enhanced particle and energy fluxes on the antenna and on surfaces intersected by magnetic field lines connected to or passing near the antenna. These issues are being studied using a simple electrode structure and a single-strap antenna on the Prototype Materials Plasma EXperiment (Proto-MPEX) at ORNL, which is a linear plasma device that uses an electron Bernstein wave heated helicon plasma source to create a high-density plasma suitable for use in a plasma-material interaction test stand. Several diagnostics are being used to characterize the near-field interactions, including double-Langmuir probes, a retarding field energy analyzer, and optical emission spectroscopy. The RF electric field is being studied utilizing Dynamic Stark Effect spectroscopy and Doppler-Free Saturation Spectroscopy. Recent experimental results and future plans will be presented.

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