The External Calibrator for Hydrogen Observatories (ECHO)
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The Epoch of Reionization(EoR) is a time period in the chronology of the universe that marks a major phase transition believed to have been caused by the formation of the very first stars. One way to probe this period is to look for spatial and temporal fluctuations in the 21cm signal of neutral hydrogen, the most abundant element in the universe. Several low-frequency radio arrays including the LWA, MWA, LOFAR, and HERA have been developed to probe this epoch in addition to their other science cases. The biggest challenge in detecting the 21cm line is mitigating confusion with foregrounds which are 10,000 times brighter than the cosmological signal.

Removal of these foregrounds requires accurate electromagnetic models of the receiver system. Current radio array models assume ideal radiation patterns however, due to manufacturing defects and installment tolerances, no two dipoles are completely alike. These as-built variations limit the precision to which foreground sources can be subtracted from the measured sky spectra. Beam mapping methods like anechoic chambers or satellite constellations have been used to good effect but have fundamental limitations.

Drone-mounted calibrators have been found to be a promising alternative to traditional beam calibration methods. We report results from recent experiments in measuring beam patterns of an LWA dipole embedded in the array. The experiments were carried out in the 20 - 50 MHz frequency regime using the ECHO calibration procedure described in Jacobs et. al 2017. We describe design changes made to increase flight time, positional accuracy, the stability of the calibration source, and portability of the setup. We also note the challenges of drone-based calibration in this low-frequency regime.