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Updates on the Axion Longitudinal Plasma Haloscope (ALPHA) Phase I Construction

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The axion remains a compelling dark matter candidate, yet a substantial portion of its potential mass range remains unexplored. Post-inflation QCD axion string models suggest that axions could possess higher masses than what current haloscopes can detect. Traditional tunable cavity-based haloscopes have shown exceptional sensitivity at lower frequencies, but their effectiveness diminishes at higher frequencies due to reduced cavity volume. The Axion Longitudinal Plasma HAloscope (ALPHA) addresses these challenges by utilizing metamaterial resonators, which can operate between 10-100 GHz without volume constraints. This presentation will cover the progress of the initial phase of the ALPHA haloscope located at Yale, with a focus on the evolution of plasma resonator designs and the commissioning of the cryogenic receiver. The Yale installation features a cavity designed for the 10-20 GHz range, operated in a 9 Tesla magnetic field at millikelvin temperatures, with quantum-limited parametric amplifier readout. This phase of the ALPHA haloscope aims to both demonstrate enhanced sensitivity of metamaterial resonators within a high-field, large-bore magnet setting and establish KSVZ-limited constraints on the axion coupling for masses in the 40-80 μeV range.

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