Contribution ID: **41** Type: **Contributed Oral**

Development of a Novel Magnet for the HAICU Hydrogen Fountain

Friday, 14 February 2025 10:30 (15 minutes)

The fundamental symmetries between matter and anti-matter can be precisely probed via the most basic (anti)atom (anti)Hydrogen. Anti-atoms are commonly studied by trapping them with confining magnetic fields, these fields induce Zeeman shifting of the atomic levels, which introduce uncertainties. To navigate this problem, and to enable quantum sensing techniques such as anti-atom interferometers, the HAICU experiment is currently developing an atomic fountain, with Hydrogen as a proxy for anti-matter. A challenge with Hydrogen is cooling the atom to low enough temperatures, typically O~(μK). Doppler and recoil limits, O~(mK), will be overcome by a technique we coin as Magneto-Optical Compression Cooling (MOCC).

Magnets are a vital tool for manipulating atoms, particles, and molecules in various applications. One of these categories of magnets is the Bitter coil design, which aims to bridge the magnetic capabilities of conventional electromagnets and superconducting coils. HAICU's magnetic minimum trap design consists of two Bitter coil systems, the quadrupole and mirror coils, which provide ample access to the trapping volume. To create high fluxes high current densities are required, which produce significant heat requiring sufficient cooling. The design, construction, and testing of the quadrupole have required me to develop unique techniques, enabling the creation of a uniform and homogeneous radial background field.

Here I will present the findings that enabled us to create a watertight magnet at high water pressures, and additionally the methods developed to monitor the system during testing prior implementation.

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Session Classification: Morning 2 - Particle Physics

Track Classification: Particle Physics