Abstract Submitted
for the 4CF17 Meeting of
The American Physical Society

Ultrastable silicon cavity at 4 K using a continuously-operating closed-cycle cryostat[1] LINDSAY SONDERHOUSE, WEI ZHANG, JOHN ROBINSON, ERIC OELKER, CRAIG BENKO, JOHN HALL, JILA, NIST, and University of Colorado Boulder, THOMAS LEGERO, DAN MATEI, FRITZ RIEHLE, UWE STERR, Physikalisch-Technische Bundesanstalt, JUN YE, JILA, NIST, and University of Colorado Boulder — Ongoing advances in ultrastable lasers drive further development of the optical atomic clock. Currently, the most stable lasers are based on silicon cavities that are cooled to 124 K. The stability of these lasers is limited by the composite thermal noise of the coatings, substrates, and spacer. To further improve the stability of these lasers to a level comparable to the natural linewidth of state-of-the-art clock transitions, silicon cavities will need to be cooled to lower temperatures. Two major obstacles to operating at low temperatures are the vibration noise and temperature fluctuations of the closed-cycle cryostat, which can produce noise substantially above the thermal noise floor. We overcome these limitations with a custom-designed cryostat that cools the cavity to 4 K while simultaneously suppressing temperature fluctuations and vibration noise below the thermal noise floor of 6×10^{-17}. The closed-cycle cryostat also offers continuous cooling, removing the need for cryogen refilling. We demonstrate a 1×10^{-16} stability from .06 to 100 s and a linewidth of 17 mHz at 1542 nm. This represents a tenfold improvement in short-term stability and a 10^4 improvement in linewidth over past low-temperature results.

[1]The presenter is funded by the DoD through the NDSEG Fellowship Program.

Lindsay Sonderhouse
JILA, NIST, and University of Colorado Boulder

Date submitted: 20 Sep 2017 Electronic form version 1.4