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Record Stability via Improved Laser Coherence in Strontium-87 Optical Clocks SARA CAMPBELL, TRAVIS NICHOLSON, MICHAEL MARTIN, BENJAMIN BLOOM, JASON WILLIAMS, MICHAEL BISHOF, XIBO ZHANG, JILA/University of Colorado at Boulder, MATTHEW SWALLOWS, AOSense, JUN YE, JILA/University of Colorado at Boulder — Many-particle clocks are promising candidates for next-generation frequency standards because quantum projection noise scales down with the square root of atom number. Previously, these clocks had been unable to demonstrate stability better than that of single-particle clocks, due to laser noise-induced instability via the Dick effect. We show that a better optical local oscillator with a 10^{-16} thermal noise floor directly results in a tenfold improvement in clock stability, now reaching 1×10^{-17} in 1000 s [1]. Leveraging the superior precision of a many-particle clock, we are working toward a full systematic evaluation of our clock accuracy with a goal of 1×10^{-17} fractional uncertainty. One of the important systematics inherent in many-particle clocks is the density-dependent frequency shift. In a new system that traps thousands of atoms at low density, we now measure the density shift with a fractional uncertainty of 8.2×10^{-19} [1]. Additionally, to further improve our clock stability, we have developed a novel technique to evaluate the noise spectrum of our ultra-stable laser using ^{87}Sr atoms as a quantum reference [2].

[1] T.L. Nicholson, et al., PRL 109, 23081 (2012).
[2] M. Bishof et al., in preparation (2013).

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