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Apparatus for generating highly squeezed collective atomic spin states NILS JOHAN ENGELSEN, RAJIV KRISHNAKUMAR, ONUR HOSTEN, MARK KASEVICH, Stanford University — Production of spin-squeezed atomic ensembles could greatly enhance the performance of existing atom-based sensors by overcoming the atomic shot-noise inherent in sensors with uncorrelated atoms. We pursue a measurement based method for spin squeezing inside of a high-finesse cavity, potentially enabling spin-squeezing at 20 dB in variance, compatible with releasing the generated states into free space. We use a dual-wavelength cavity, resonant at both 780 nm and 1560 nm, with a finesse of 10^5. Up to 10^5 Rubidium atoms can be trapped at the anti-nodes of the 1560 nm mode, and probed by the 780 nm mode. The commensurate wavelength relationship allows identical coupling of the probe light to all atoms, minimizing decoherence issues associated with inhomogeneous coupling Thus far we have engineered a homodyne detection system that has an empty cavity technical read-out noise level of 10Hz in 200μs measurement intervals, corresponding to the resonance shift induced by an individual atom at a probe detuning of $\sim$ 1GHz. This technical noise level is so low that it has no significant effect in the preparation of the anticipated squeezed states. At the time of writing, we have demonstrated back-to-back measurements with 20x10^3 atoms, with 0.02 photons scattered per atom in a measurement interval of 200μs, that exhibit read-out noise levels compatible with 10-17dB of squeezing.

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