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Trapped atom number in millimeter-scale magneto-optical traps GREGORY W. HOTH, ELIZABETH A. DONLEY, JOHN KITCHING, National Institute of Standards and Technology — For compact cold-atom instruments, it is desirable to trap a large number of atoms in a small volume to maximize the signalto-noise ratio. In MOTs with beam diameters of a centimeter or larger, the slowing force is roughly constant versus velocity and the trapped atom number scales as d^4 . For millimeter-scale MOTs formed from pyramidal reflectors, a d^6 dependence has been observed [Pollack et al., Opt. Express 17, 14109 (2009)]. A d⁶ scaling is expected for small MOTs, where the slowing force is proportional to the atom velocity. For a 1 mm diameter MOT, a d^6 scaling results in 10 atoms, and the difference between a d^4 and a d^6 dependence corresponds to a factor of 1000 in atom number and a factor of 30 in the signal-to-noise ratio. We have observed $> 10^4$ atoms in 1 mm diameter MOTs, consistent with a d^4 dependence. We are currently performing measurements for sub-mm MOTs to determine where the d^4 to d^6 crossover occurs in our system. We are also exploring MOTs based on linear polarization, which can potentially produce stronger slowing forces due to stimulated emission [Emile et al., Europhys. Lett. 20, 687 (1992)]. It may be possible to trap more atoms in small volumes with this method, since high intensities can be easily achieved.

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