Abstract Submitted
for the DAMOP16 Meeting of
The American Physical Society

Scale Factor Measurements for a Gyroscope Based on an Expanding Cloud of Atoms GREGORY HOTH, BRUNO PELLE, STEFAN RIEDL, JOHN KITCHING, ELIZABETH DONLEY, NIST — We present an atom interferometer that can simultaneously measure two-axis rotations and one-axis accelerations with a single cloud of atoms in an active evacuated volume of about 1 cm^3. This is accomplished by extending the point-source interferometry technique (Dickerson et al. PRL, 111, 083001, 2013) to a compact regime. In this technique, the cloud of atoms is imaged after the interferometer sequence. Rotations cause spatial fringes to appear across the cloud. To realize a gyroscope with this method, it is necessary to know how the wave-vector of the spatial fringes, k, is related to the rotation rate, Ω. If the cloud is initially infinitesimally small, it can be shown that $k = F\Omega$ with a scale factor F determined by the time between interferometer pulses, the total free expansion time, and the wavelength of the interrogating laser. However, the point-source approximation is not appropriate in our case because the final size of the cloud in our experiment is between 1.4 and 5 times its initial size. We show experimentally that in this finite expansion regime the phase gradient is still well described by $k = F\Omega$, but the scale factor F depends on the initial distribution of the atoms. We also present modeling that explains this dependence.

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Date submitted: 26 Jan 2016 Electronic form version 1.4