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Geometry control of large frame square cavity ring laser Gyroscopes

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In the last years the role of very large ring laser gyroscopes has gained a great importance in Geodesy and Geophysics survey. The stability of the laser cavity optical length is of outmost importance to improve the long term performance of these devices. We tested a geometry stabilization technique working on a medium size (GP2, 1.6 m side) ring laser by exploiting the Fabry Perot resonances of the diagonals of the ring square cavity. It has been demonstrated that by locking the diagonal lengths to an equal common value D, the deviation of the ring laser perimeter from the exact nominal value $2\sqrt{2}D$ can be expressed as a sum of quadratic terms ε_i^2 , being ε_i the deviations of the mirrors coordinates from the perfect shape [1]. To attain this goal, we locked the diagonal cavity lengths to an iodine stabilized HeNe laser, and we succeed in measuring with high precision these lengths by locking a VCO to a harmonic of the free spectral range.
At the moment, the diagonals of our prototype GP2 were locked at a relative value of 10^{-6}, limited by the acoustic noise in our laboratory.
This result is an important step towards the GINGER project, which foresees the construction of a tridimensional large frame laser gyroscope in an underground laboratory. The aim is to build a very broad band rotational observatory to detect subtle geophysical and geodetic signals like microseism, polar motion, and length of the day.

[1] J Belfi, et al., Interferometric length metrology for the dimensional control of ultra-stable Ring Laser Gyroscopes, Class. Quantum Grav. 31 225003 (2014).