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Continuous Earth Rotation Monitoring with the large Ring Laser G

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Over the last decade, ring lasers have found their way back into the research laboratories. By scaling them up in size, they have gained several orders of magnitude over their commercial counterparts, both in sensitivity and stability. Unlike the established space geodetic techniques SLR/LLR and VLBI, ring lasers can be operated autonomous and continuously. While a single ring laser component already provides direct access to the instantaneous axis of rotation of the Earth, it is also susceptible to local perturbations both with respect to platform rotation and instrumental tilt caused by local wind load for example. These instrumental coupling issues are addressed in more detail in a separate paper (Gebauer et al.) in this conference. Currently the laser gyro G at the Geodetic Observatory Wettzell (Germany) can resolve rotation rates as small as 1 pico-rad/s requiring an integration time of less than 2 hours. This opens the door for the research of high frequency variations in Earth rotation.

Over the last year we have improved the ring laser technology by as much as a factor of 3 in sensitivity, which makes the domain of ΔOmega/Omega $\approx$ 10e-9 of Earth rotation accessible to a local rotation sensor. Currently it appears that the micro-seismic background activity of the Earth causes the major part from the observed deviation of the sensor performance with respect to the computed shot noise limit. Recent efforts concentrated on the improvement of the sensor stability against drift effects caused by the aging of the laser gas, scale factor instabilities induced by atmospheric pressure variations and the corresponding temperature changes from adiabatic expansion and compression of the local air around the instrument. Over the last year have introduced a pressure stabilizing vessel enclosing the entire ring laser structure. By monitoring the optical frequency in the ring laser cavity continuously and stabilizing the scale factor in a closed loop system, it became possible to extend the range of sensor stability from the short term (1-3 days) to at least well into the mid-term regime (>40 days) and possible even well beyond that. Once a sufficiently long time-series from ring laser data has become available, we will be able to define the range of temporal stability in more detail. The extension of the regime of stability gives access to geophysical signals at frequencies substantially lower than previously observable with ring lasers. This talk outlines this recent progress in Sagnac interferometry and presents the new data.