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A new modified Jamin interferometer for the IMGC-02 transportable rise-and-fall absolute gravimeter

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The value of the acceleration due to gravity is of interest in a wide field of physical sciences, such as metrology, geophysics and geodesy. In particular, geophysics and geodesy are mainly interested in the variations of gravity with location and time. Factors that account for the gravity changes are the earth's rotation, departures of its surface from an equipotential spheroid, density variations that occur within the earth, geodynamical and tectonic processes. The measurements of acceleration due to gravity are performed by relative or absolute gravimeters. However, relative measurements shall be referred to the absolute ones. Absolute measurements of the acceleration due to gravity are performed by absolute gravimeters, traceable to the units of length and time through their primary standards. For this purpose, INRiM developed a transportable ballistic rise-and-fall absolute gravimeter, the IMGC-02. It uses laser interferometry to measure the symmetrical free rising and falling motion of a test mass in the gravity field. In this work the improvement of the interferometric system is described. The current interferometer is a modified Mach-Zehnder interferometer, which is equipped with a movable mirror placed above the optical prism, in order to allow the recombination of the first reference beam, which represents the fixed arm of the interferometer, with the second beam which, being reflected by the fixed upper reference corner-cube retroreflector and by the flying lower retroreflector, represents the shifting arm of the interferometer. Since the recombining beams have to be coaxial in order to avoid distortions on the laser interference fringes, the angular position of the mirror has to be adjusted every time before the measurement and has to be monitored during the measurement. The alignment is achieved by rotating the mirror around its two axis through a 2 axis piezoelectric PZT-driven tilter actuator. Unfortunately, this operation entails practical problems, is highly time-consuming and it has to be performed before and, sometimes, during the measurement session. For this reason a new modified Jamin interferometer has been devised. Such system is similar to the modified Mach-Zehnder interferometer except that the two beams directly recombine on the optical prism, thus the movable mirror is removed. The alignment of the recombined beams is possible just shifting the reference corner-cube retroreflector along the horizontal plane. The main advantages are a simpler alignment of the two beams and a better stability in time, unless negligible Abbe errors due to the misalignment of the two upper and lower corner-cube retroreflectors, and the divergence of the retroreflectors, which is simply overcome by using corner-cubes with angular accuracy within 1". In such way, the new interferometric system guarantees more robust measurements and a faster preliminary installation of the gravimeter before the measurement. The scheme of the new interferometer is presented.