

Mitigation of non-axisymmetric optical defects for the future gravitational wave detectors

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The experience gained during the commissioning of Advanced Virgo (AdV) has clearly highlighted the necessity of monitoring and controlling optical aberrations in a gravitational wave interferometric detector. The Thermal Compensation system (TCS), designed to detect and compensate aberrations caused by limits in the optics production process or laser power absorption in coatings, has made possible the operation of AdV in O3. TCS exploits thermo-optic effect to correct for wavefront deformations by illuminating on-path optics with a shaped CO₂ laser beam. With the foreseen high-power operation of ET-HF, the likely need of an adaptive control of residual aberrations in optical cavities has triggered a phase of conceptualization and prototyping of new actuators. This class of actuators must be versatile and ideally introduce no frequency-dependent noise in the detector band. We are presently exploring the application of deformable mirrors (DMs) as a versatile solution to project non-axisymmetric intensity patterns. DMs feature an intrinsic capacity for adaptive corrections and immunity to frequency-dependent noise due to their static nature. We developed a Modified Gerchberg-Saxton (MoG-S) algorithm to retrieve the phase correction needed to a particular intensity pattern on the image plane. The MoG-S simulations of an on-bench DM-based system and the results of the experimental tests will be presented.

Primary author: TARANTO, Claudia

Co-authors: ROCCHI, Alessio (INFN Roma Tor Vergata); LUMACA, Diana (INFN Sezione di Roma Tor Vergata); Dr CESARINI, Elisabetta (INFN Roma Tor Vergata); NARDECCHIA, Ilaria; AIELLO, Lorenzo; CIFALDI, Maria (Tor Vergata-INFN); IANNI, Matteo (INFN, Section of Rome Tor Vergata, Rome, Italy. University of Rome Tor Vergata, Department of Physics, Rome, Italy); LORENZINI, Matteo (Università di Roma Tor Vergata, Dipartimento di Fisica); PALMA, Pier Paolo; SCACCO, Valerio (Università degli Studi di Roma Tor Vergata; INFN sez. Roma Tor Vergata); FAFONE, Viviana; MINENKOV, Yury

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