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Adaptive optics methods in GW interferometric detectors, a perspective

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The performance of present and future gravitational wave detectors is limited by fundamental factors, such as thermal noise, seismic or newtonian noise and quantum nature of light. Besides, technological factors impact the reach of advanced detectors through status of art limits in the implementation of upgrade strategies. In the realm of optics, the quantum limit to sensitivity will be addressed by injecting higher laser power and by exploiting the capabilities of squeezed light. In turn, technological efforts in the preparation of suitable optics able to meet more and more demandig requirements are ongoing. Moreover, solutions to mitigate the effect of known showstoppers such as parametric instablities are being studied.
The present day strategy to correct for residual cold defects in the core optics and to counteract the thermal effects due to power absorption is embedded in a set of sensors and actuators integrated in the Advanced Virgo design, the so called Thermal Compensation System (TCS). This system is designed to be focussed on the needs of high power operation of the detector, nonetheless it is highly versatile and can deal with a bunch of foreseen and unexpected issues. We discuss the features of the TCS with emphasis on its versatility and portability to upgraded detectors; we also present the status of the R&D activity in the Tor Vergata labs, highlighting new applications where the methods of TCS can have a relevant impact, such as adaptive mode matching for squeezing and damping of parametric instabilities.

Primary author: LORENZINI, Matteo (GSGC)

Co-authors: ROCCHI, Alessio (ROMA2); Ms LUMACA, Diana (Università degli Studi di Roma Tor Vergata); Dr CESARINI, Elisabetta (Centro Studi e Ricerche Enrico Fermi); NARDECCHIA, Ilaria (Università degli Studi di Roma Tor Vergata); AIELLO, Lorenzo (GSSI); SEQUINO, Valeria (ROMA2); FAFONE, Viviana (Università degli Studi di Roma Tor Vergata); MINENKOV, Yury (ROMA2)

Presenter: LORENZINI, Matteo (GSGC)

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