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Wavefront sensing and control in Gravitational Wave detectors

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In the past decades the sensitivities of gravitational wave detectors have been improved leading to the detection of more than 90 events. The detection rate should dramatically increase as the sensitivity of the interferometers improves. The LIGO/Virgo/Kagra Scientific Collaboration will increase the range and the sensitivity of gravitational wave interferometers by applying new techniques suitable for the current and the next generation of gravitational wave detectors. This achievement will be possible only when the device presents low losses. Specifically, the optical losses are worrisome for gravitational wave detectors, as, for example, they limit the benefit of future upgrades like squeezing. However, optical losses are responsible for signal to noise ratio degradation. For a gravitational wave interferometer the dominant optical losses are due to the mode matching into the output mode cleaner, as well as the mode matching between signal recycling cavity and interferometer arm. The current gravitational wave detectors design implemented thermal lens correction actuators in the recycling cavities to properly adjust the shape of the resonant light and additional actuators to improve the mode-matching with the external systems such as the Frequency Dependent squeezer and the output mode-cleaner. Here, an overview of the sensing and the control of the light wave-front, together with possible innovative techniques, will be presented.

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