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Keeping my beams in shape for next generation gravitational-wave detectors

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Employing km-scale cavity-enhanced interferometry, gravitational-wave detectors have detected tens of compact binary coalescences to date. Next generation detectors like the Einstein Telescope and Cosmic Explorer aim to improve current detector sensitivity by one order of magnitude. Not only a huge increase in detection statistics is expected but also an unprecedented reach to very high cosmological redshift will be possible.
In order to achieve the target sensitivity, some of the upgrades needed with respect to current detectors are to increase the optical power in the main optical cavities by up to 8 times and improve the quantum noise reduction from 6 to 10dB.
Higher circulating power can cause thermal effects that lead to aberrations of the circulating beams resulting in higher optical losses. These losses are a big limitation to the amount of achievable quantum noise reduction. A necessary 10-fold decrease in optical losses is estimated in order to reach the 10dB goal.
Currently, efforts are being made into improving the ways we monitor the wavefront of circulating beams. In particular, phase cameras are wavefront sensors capable of imaging the 2D amplitude and phase of a beam. I will present a table-top study employing the phase camera images to measure the spatial mismatch of a beam coupling into an optical cavity. I will show how different error signals can be extracted from the phase camera information and how they can be used with different actuation schemes. The goal is to showcase how the phase camera can be used in future detectors to minimise optical losses and reach our sensitivity goals.

Collaboration

Role of Submitter

I am the presenter

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