Contribution ID: **88** Type: **Poster**

Mode matching sensing through RF Higher Order Modulation method

Tuesday, 23 May 2023 18:39 (1 minute)

In the upcoming Advanced Virgo+ upgrade, the goal is to reduce quantum noise across the detector's entire bandwidth by introducing a frequency-dependence using a 300m long cavity (Filter Cavity). However, there can be a mismatch between the fundamental mode of the squeezed vacuum field and the cavity-supported mode that can lead to optical losses. This mismatch is described in terms of the higher-order mode (HOM) content of the former in the latter's defined base. When the cavity locks onto the fundamental mode, reflected HOMs can reveal information on the origin of the mismatch, such as differences in the dimensions and positions of the waist that will generate the Laguerre-Gaussian mode LG10.
To detect this HOM mismatch, we are developing an innovative method based on RF Higher Order Mode Modulation. This approach involves generating sidebands on the LG10 mode using an electro-optical lens (EOL) which is made up of a lithium niobate crystal with electrodes on top. The shape of the electrodes determines the ability of the object to act as a lens. By sending a sine wave with a frequency twice of the HOM spacing frequency, we can have one of the sideband resonating inside the locked cavity while the other is reflected. In this way we break the sidebands symmetry being possible to sense the beat signal between the carrier LG10 mode and the LG10 sideband on a single-element photodiode.
The I/Q demodulation at the sideband frequency allows for extracting the real and imaginary parts of the LG10 mode, which are proportional to the waist size and waist position mismatch, respectively.
Active correction of mode-mismatch is essential to enhance the performance of the interferometer. The technique presented here allows to implement mode-mismatch sensing with minimal additional hardware (it can use the single-element photodiode usually present for PDH locking).

Primary authors: CHIARINI, Gabriella (Istituto Nazionale di Fisica Nucleare); CIANI, Giacomo (Istituto Nazionale di Fisica Nucleare)

Presenter: CHIARINI, Gabriella (Istituto Nazionale di Fisica Nucleare)

Session Classification: Tuesday Poster session

Track Classification: Thermal effects: Thermal effects in interferometry and squeezing