Contribution ID: **99** Type: **Poster**

Detuning the signal recycling cavity in AdV+

Tuesday, 23 May 2023 18:36 (1 minute)

The current GW detectors (LIGO, Virgo and KAGRA) are Dual Recycled Fabry Perot Michelson Interferometers which are all controlled to operate in a broadband, Resonant Sideband Extraction (RSE) configuration. By changing the microscopic length of the Signal Recycling mirror, one obtains a Detuned RSE (DRSE) setup. It has been previously shown that a lossless DRSE configuration presents unique physical phenomena such as the presence of an opto-mechanical spring and a reduction of quantum noise below the standard quantum limit without injecting squeezed light.

In this contribution, we study the advantages and difficulties for operating AdV+ in a DRSE configuration. We show that DRSE can reduce some of the problems related to the degeneracy of the signal recycling cavity in Virgo. Furthermore, with the current noise budget of AdV+, DRSE can improve the sensitivity for BNS and BBH detection compared to the current RSE counterpart. We predict the technical challenges and main noise contributions associated with controlling DRSE using the optical simulation tool Finesse3 and propose a commissioning strategy to switch between the RSE and DRSE configurations. We estimate the optimal quantum noise reduction granted by injection of frequency-independent or frequency-dependent squeezed vacuum from the squeezing source currently used in AdV+.

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Session Classification: Tuesday Poster session

Track Classification: Current detectors and prototypes: O4 Commissioning