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Quantum noise reduction for AdV+

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The detection of gravitational waves is limited by quantum noise from vacuum field fluctuations. To overcome this limitation, squeezed vacuum states can reshape the shot and radiation pressure noise contributions by manipulating the quadrature amplitude distribution. While injecting a frequency-independent squeezed (FIS) vacuum state allowed for sub-shot noise limited sensitivity in the last observation run, it enhanced the quantum radiation pressure noise and limited low-frequency sensitivity. To address this, a frequency-dependent squeezed (FDS) vacuum field can be injected into the detection port, minimizing total quantum noise at each frequency for maximum noise reduction across the full detector bandwidth. In this talk, we show the status of the commissioning of the AdV+ FDS source, which is generated by a phase rotation of a state through a 285 m long, high-finesse, near-detuned optical resonator. In particular, we present a detailed analysis of the correlations between detuning frequency drift and temperature, which were crucial for optimizing the performance of the FDS source. We will also discuss the long-term stability measurements and we will showcase the first injection of the FIS source inside the interferometer, which shows promising results for the reduction of quantum noise and for the injection of the FDS.

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