Contribution ID: **32** Type: **not specified**

# Advance Virgo+ Quantum Noise Reduction system for O4

*Tuesday, September 5, 2023 10:30 AM (1 hour)*

One of the fundamental noise in gravitational waves detectors is the so called Quantum Noise, that is related to the intrinsic quantum nature of the laser used to interrogate the GW interferometers, i.e. to the uncertainty on amplitude and phase of the coherent state of light that couples with the vacuum fluctuations. Due to the frequency dependent opto-mechanical response of the GW detectors, the amplitude and phase fluctuations is weighted in different way in the detectors frequency band, leading to the so called Radiation Pression Noise (RPN) at low frequency and to the so called Shot Noise (SN) at high frequency, respectively. By injecting frequency independent squeezed (FIS) vacuum light into the dark port of the GW interferometer a significant reduction of the SN can be and has been observed during the last observations runs, both for Advance Virgo and the two LIGO detectors. Nevertheless the big effort done to reduce in parallel one of the most sensitivity limiting noise in the low frequency region, the technical noise, has revealed the main draw back of the FIS injection: the increasing of the RPN at low frequency.
Moreover, even without FIS injection, the improvement of the low frequency sensitivity for the new upgraded detectors, in any case leads to the needed of the quantum noise mitigation in the whole detectors band. For this reason FIS injection has been replaced with frequency dependent squeezed vacuum (FDS). For the current observation run, both Virgo and LIGO collaboration prepared FDS injection. The technique to produce it is based on the phase sensitive response of a filter cavity that allows the squeezing ellipse rotation in the detectors frequency band.
Here, after a general introduction to the QN and the FDS technique, we will present the status of the Quantum Noise Reduction system for the FDS injection into AdV+.

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