Contribution ID: **35** Type: **Oral presentation**

Low-Frequency control noise - Modelling ASC loops with Finesse

The Einstein Telescope (ET) is a third-generation gravitational-wave detector, which is expected to be 1000 times more sensitive than current instruments at low frequencies. In this frequency range, detectors have been limited by technical noises. Alignment control is at the frontline of the limiting noises.

The amount of angular control noise chained to the sensitivity depends upon the bandwidth of the alignment control systems. By using low-bandwith control loops ET can keep the control noise below ET fundamental noises. We are building a model of such an alignment control scheme, using Finesse, a python-based interferometer simulation program.

We started with modelling Advanced Virgo's alignent control system, which incorporates high-finesse optical cavities and the last two stages of the super-attenuator. Control filters in the global basis have been implemented as used during O3 run and the resulting closed-loop MIMO matrix accounts for cross-coupled degrees of freedom, both in sensing and actuation. We will use this model to evaluate the alignment controllability of the Virgo opto-mechanical plant for O5 run, design the control strategy and test its noise performance. We will use the experience on validation from Virgo to design the alignment scheme for ET.

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Session Classification: Technical noise for LF

Track Classification: Technical noises for low frequencies