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Parametric Instability challenges next-Generation detectors would need to consider

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In the run-up to LIGO's O4 commencement, some new Parametric Instability (PI) challenges have cropped up. Whilst LIGO has infrastructure to deal with PI, the best method still proves to be thermally tuning these instabilities out, with active damping being a risky endeavor. Despite the chances of facing compounding PI problems on the path to O5 being high at LIGO, the issue is still expected to be manageable. Proposals for many future detectors and upgrades hope to leverage larger test masses, test masses with materials with higher mechanical Q factors, larger beam spots, longer arm lengths, and of course higher laser power. These changes are fantastic for the prospect of increasing interferometer sensitivity but are simultaneously increasing the magnitude of PI gain as well as the probability of encountering PI. Design of upgrades would benefit from appreciating that PI could lead to inoperability of the detector at the desired specifications.

Primary author: BOSSILKOV, Vladimir (LIGO Livingston)

Presenter: BOSSILKOV, Vladimir (LIGO Livingston)

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