Enhanced temperature measurement concept for LISA

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Temperature fluctuations will play an important role in LISA [1] since their contribution typically dominates the low frequency regime (below the milli-Hertz) [2]. Moreover, at such time scales they are ubiquitous to the satellite with a potential to impact different stages and subsystems of the measurement chain, from thermal induced forces applied directly to the test mass to temperature induced path-length variations in the interferometers.

Therefore, although the requirements are still being defined, it is expected that the mission will need a temperature acquisition system with noise levels below 10^{-4} K/$\sqrt{\text{Hz}}$ at 0.1 mHz and below 10^{-6} K/$\sqrt{\text{Hz}}$ for the 1 mHz down to the 100 mHz frequency band. This means an improvement of a factor of 10 with regards to LISA Pathfinder [3].

In this work, we make a brief summary of the technical challenges for such a temperature measurement system and propose some improvements to the LISA Pathfinder design to reach the new challenging noise level. These improvements are based on the same previous lock-in amplifier architecture. But, taking advantage of newer space qualified components available and moving most of the complexity to the digital domain, we show how we can reach this lower noise level. Furthermore, these changes will allow the acquisition system to be more in-flight and on-ground reconfigurable, allowing us to also be more capable to adapt and overcome future challenges that may appear during instrument integration and testing.

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[2] Nofrarias M. et al., Subtraction of temperature induced phase noise in the LISA frequency band, Phys. Rev. D, 87, 2007

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