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Towards a complete L0-to-L2 pipeline –Progress in simulation, processing and analysis (part 1)

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LISA will allow the simultaneous observation and characterization of thousands of gravitational-wave sources, which presents unique data analysis challenges. Preparing for these challenges requires realistic simulations of the data streams entering the final astrophysical data analysis (L1 data).

First steps towards such demonstrations have been made as part of the LISA Data challenges (LDC), which showed that a number of data analysis techniques are able to perform good parameter estimations for individual or a small number of superimposed sources. Future challenges are expected to tackle more realistic datasets.

In parallel, significant progress is being made in the description and demonstration of the data processing steps required to produce the L1 data from the raw measurements provided by the spacecraft (L0 data). The most well-known of these processing steps is laser noise suppression by time-delay interferometry (TDI), which is already included in the LDC data generation. However, there are a number of additional processing steps required to reduce the impact of other noise sources and synchronize the final data streams to a common time frame.

We will present the current state-of-the-art in instrument simulations for LISA, which includes several effects currently not included in typical data analyses, such as realistic numerically optimized orbits, different time frames for L0 data, and a multitude of additional noise sources. In addition, we will discuss a possible implementation of the L0-L1 pipeline, which is able to reduce the most critical of the additional noise sources and provide synchronized data streams. We then inject this more realistic L1 data in a simple analysis pipeline (adapted from the LDC) to assess the impact of added complexity in the instrumental model and the additional processing steps on the scientific performance of LISA. This is achieved by combining multiple simulation (orbits, response to gravitational waves, instrument), processing (reduction of various noises), and analysis (parameter estimation) tools in a flexible pipeline structure.

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