LISA Mission Architecture

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Abstract. The Laser Interferometer Space Antenna (LISA) mission is a unique mission design in that three spacecraft and their associated operations form one distributed science instrument, unlike more conventional missions where one or more science instruments are components of an individual spacecraft. The interferometer measurements between spacecraft that form the basis for the science measurements, i.e., strain, rely on all three of the spacecraft interacting as designed. The performance of one spacecraft in the LISA constellation is directly coupled to the performance of the two remaining spacecraft in order for the instrument to collect meaningful science data. This dependency on all three spacecraft to function as one instrument is the primary driver for unique design requirements that span all spacecraft subsystems and the overall mission design. A detailed discussion will be presented that describes the spacecraft and current mission architecture needed to meet the LISA science requirements.

3 Sciencecraft  Instrument

The LISA “instrument” that detects gravitational waves is the three cooperating spacecraft and not the “payload” on each LISA spacecraft.

Mission Design. Through the selection of orbits and operational strategies, allows the instrument to meet science performance requirements for 5 year data acquisition lifetime:
- Orbits provide a thermally benign payload environment;
- Small data volume allows use of standard Deep Space Network (DSN) services;
- Small aperture interferometer allows for non-gravitational perturbations to be measured by the instrument; and
- Small footprint allows operations to be performed at nearly any time relative to solar geometry and the Earth-Moon System.

Sciencecraft

Payload

The LISA Payload implements the primary measurement of changing proof mass separation.

The constellation of three spacecraft form an equilateral triangle with 5 million km sides. Each spacecraft contains a pair of “free-falling” proof mass that define the ends of the measured arms.

Mission Segments

The LISA Mission is comprised of the launch segment, flight segment, ground segment and science data processing segment.

Mission

Launch Segment (LS)

Flight Segment (FS)

Ground Segment (GS)

Science Data Processing Segment (SDPS)

Spacecraft

Propulsion Module

Scientific Complement Payload (PL)

Bus

The LISA Payload utilizes a bi-propellant propulsion system to provide the delta-v required to transfer the S/C from its separation from the launch vehicle upper stage to its operational heliocentric orbit.

Stack

The LISA Mission Architecture

The LISA Mission is comprised of the launch segment, flight segment, ground segment and science data processing segment.

The Launch Segment (LS) includes the Launch Vehicle and the related infrastructure at the launch site:
- The Flight Segment (FS) consists of three sciencecraft (each comprising a Bus and Scientific Complement-Payload (PL)), and three Propulsion Modules (PM). The combination of the sciencecraft and PM is referred to as the Spacecraft (SC); the combination of 3 SCs constitutes the Stack: the three sciencecraft operating together on-orbit defines the Constellation.
- The Ground Segment (GS) comprises the infrastructure required for ground command, control, communications, operations and data archiving and distribution, including GSE necessary for development and maintenance; it also includes the DSN services.
- The Science Data Processing Segment (SDSP) comprises the ESA and NASA facilities needed for analysis of science data.

The two primary components of the payload are the –
- Laser Interferometer System –
- Sciencecraft –

- The Laser Interferometer System provides the instruments to measure gravitational waves;
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Propulsion Module

The Propulsion Module utilizes a bi-propellant propulsion system to provide the delta-v required to transfer the S/C from its separation from the launch vehicle upper stage to its operational heliocentric orbit.

The PM also provides:
- support to the sciencecraft during ground operations and the primary load path for the S/C during launch
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- Power for the sciencecraft during ground operations and the primary load path for the S/C during launch
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The LISA Payload is a three spacecraft interferometer on a 5 million km scale, with a path length of 5 million km. The sciencecraft contains a pair of “free-falling” proof masses that define the ends of the measured arms. The constellation of three sciencecraft form an equilateral triangle with 5 million km sides. Each spacecraft contains a pair of “free-falling” proof mass that define the ends of the measured arms. LISA will observe all the sources simultaneously all the time, with scheduled interruptions only for short periods of time needed for communications and maintenance tasks.

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