Large Observatory For X-ray Timing (LOFT-P): A Probe Class Mission Concept Study


Overview

LOFT-P is a mission concept for a NASA Astrophysics Probe-Class (~$1B) X-ray timing mission. It is based on the LOFT M-class concept 1,2,3, originally proposed to ESA's M3 and M4 calls. LOFT-P requires very large collecting area, high time resolution, good spectral resolution, broadband spectral coverage (2-30 keV), highly flexible scheduling, and an ability to detect and respond promptly to time-critical targets of opportunity. Many of LOFT-P's targets are bright, rapidly varying sources, so these measurements are synergistic to imaging and high-resolution spectroscopy instruments, addressing much smaller distance scales than are possible with very long baseline X-ray interferometry, and using complementary techniques to address the geometry and dynamics of emission regions. LOFT-P was presented as an example mission to the head of NASA's Astrophysics Division, to demonstrate the strong community support for creation of a probe-class, for missions costing between $500M and $1B. We submitted a white paper 4 in response to NASA PhysPAG's call for white papers: Probe-class Mission Concepts, describing LOFT-P science and a simple extrapolation from the ESA study costs. The next step for probe-class missions will be input into the NASA Astrophysics Decadal Survey. We report on a 2016 mission concept, which has been under study in the LOFT M3 Yellowbook. The goal of this 1-month study was to take a preliminary look at whether or not a US-led LOFT-P mission would fit within the $500M-$1B Probe class (excluding launch vehicle). The study addressed the following:

• Launch Vehicle and Orbit: An equatorial orbit with a minimum initial altitude of 650 km was recommended to avoid SAA and minimize station keeping. A Falcon 9 Heavy launch vehicle will easily place LOFT-P into this orbit.

• Spacecraft Structure: A monolithic design was selected to minimize complexity. The spacecraft structure will be manufactured using Quasi-isotropic IM-7 8552 composite laminates.

• Communication System: An X-band system with a fixed omnidirectional antenna is used for the downlink system. Two ground stations are required to meet the science data down load requirements, and 3-4 are needed to meet the science data goals. A secondary VHF burst alert system is included to provide rapid notice of transient events.

• Power System: The overall power requirement is 2066W. To meet this requirement, the power system uses two conventional, folding, rigid panel solar arrays, 7.2 m² each, and six ABSL 24AH-ABS-DW1001 batteries for energy storage.

• Avionics & GN&C: Two redundant flight computer interfaces to a redundant pair of star trackers and IMUs to provide attitude knowledge to 4°. Control momentum gyros and torque rods provide attitude control for inertially pointed observations with better than 1° pointing accuracy.

• Thermal Control System: Thermal control can be maintained using passive components. A system level model was level and run produced results consistent with LOFT M3 designs.

• Propulsion System: A high-TRL propulsion system is included to deorbit the spacecraft at the end of the mission and permit orbit maintenance maneuvers. Secondary purposes include orbit insertion corrections, tip-off damping, collision avoidance, and momentum unloading.

• Preliminary Cost Estimate: Two cost estimates were performed, based on the LOFT M3 Yellowbook and based on the results of this study. Both estimates included 35% cost reserve. These preliminary estimates allow an additional 15-25% margin with respect to the expected $1B cap for probe-class missions.

• Preliminary estimates show that LOFT-P is feasible as a <$1B Probe-class mission!

References


Mission Design

The LOFT-P spacecraft was designed to meet the requirements in Table 2. The goal of this 1-month study was to take a preliminary look at whether or not a US-led LOFT-P mission would fit within the $500M-$1B Probe class (excluding launch vehicle). The study addressed the following:

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