ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (9)

Author: Dr. Jonathan Grzymisch
European Space Agency (ESA-ESTEC), The Netherlands, jonathan.grzymisch@esa.int

Dr. Francesco Castellini
European Space Agency (ESA-ESOC), Germany, francesco.castellini@esa.int
Dr. Federico Zuiani
European Space Agency (ESA-ESOC), Germany, federico.zuiani@esa.int
Mr. Federico Cordero
European Space Agency (ESA-ESOC), Germany, Federico.Cordero@esa.int
Mr. Angelo Povoleri
Airbus Defence & Space, United Kingdom, angelo.povoleri@airbus.com
Mr. Vasco Pereira
Airbus Defence and Space Ltd, United Kingdom, vasco.pereira@airbus.com
Mr. Mark Watt
Airbus Defence and Space Ltd, United Kingdom, mark.watt@airbus.com
Mr. James Harkins
Airbus Defence and Space Ltd, United Kingdom, james.harkins@airbus.com
Mr. Ole Mikkelsen
Terma A/S, Denmark, om@terma.com
Mr. Peter Davidsen
Terma A/S, Denmark, pd@terma.com

STAR TRACKER PERFORMANCE DURING THE EARLY PHASES OF THE LISA PATHFINDER MISSION

Abstract

The Lisa Pathfinder (LPF) mission is a technology demonstrator for a gravity-wave observatory carrying the most critical technologies needed to measure gravity waves in space. These include an optical interferometer to measure very precisely the distance between two free-floating test masses, one in drag-free motion and one electrostatically controlled. In order to demonstrate that the noise levels that can be achieved are sufficiently low to measure gravity waves, the spacecraft had to be placed far from Earth's gravity at the Earth-Sun Lagrangian point L1. Due to launcher injection characteristics, the spacecraft was placed in an elliptical Low Earth Orbit (LEO) and had to make its way to L1 through a complex series of maneuvers using its propulsion module during its early orbit phase. Throughout these maneuvers, the spacecraft raised its orbit progressively, passing several times through the inner proton radiation belts. This caused several issues with various spacecraft systems including the main attitude sensor used during this phase of the mission, a CCD imager based Autonomous Star Tracker (AST) manufactured by Terma A/S, which had never been operated in orbits above LEO. This paper presents the technical details regarding the operational experience and performance of this Star Tracker during the early phases of the LPF mission. In particular, the pointing strategy of LPF required AST attitude acquisition and tracking for some time prior to the orbital perigee, where the apogee raising maneuvers were performed. Mainly due to radiation issues in the CCD imager, attitude was only acquired very late and only for a few minutes during some of the lower orbits. Nevertheless, attitude tracking was maintained well into the radiation belts once acquired above the belts in higher, more elliptical orbits. A detailed analysis of the acquisition and tracking performance of this star tracker is presented, along with an assessment of the radiation damage in terms of pointing errors and measurement noise performance. An assessment of the sensor alignment and performance improvements after in-orbit calibration of the camera optical parameters is also presented. Finally, a set of curious images of the Earth are shown, which were taken during efforts to diagnose the attitude acquisition issues faced.