SPACE OPERATIONS SYMPOSIUM (B6)
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ESA'S BILLION STAR SURVEYOR – FLIGHT OPERATIONS EXPERIENCE FROM GAIA'S FIRST 1.5 YEARS.

Abstract

This paper details the in flight mission operations experience from ESA's ultra-precise Gaia spacecraft. Tasked with mapping 1 billion stars to unprecedented precision (to the micro-arc-second level, comparable to the width of a smart phone on the Moon as viewed from Earth), ESA's Science cornerstone mission is expected to also discover and chart 100,000's of new objects including near Earth asteroids, exoplanets, brown dwarfs and Quasars.

After a near flawless launch 19 Dec 2013 and early operations phase, Gaia was brought the circa 1.5 million kms into L2 via a sequence of technically demanding orbit transfer manoeuvres using onboard thrusters in thrust vectoring mode. Starting in parallel to this, and lasting 6 months, the full spacecraft was commissioned and brought gradually up to full performance.

The Gaia spacecraft contains a relatively large fraction of bespoke units, due largely to the incredible precision requirements. Gaia's digital camera is the largest ever flown in space, containing 106 CCDs, which are around 90 percent light efficient (c.f. 20 percent typical terrestrial camera efficiency). The telescope is linked to the on-board attitude control system, providing precise rate measurements and allowing an overall control rate error equivalent to one rotation every 410 years. There are no moving parts on board, so the data is downlinked through a novel electromagnetically steerable phased array antenna and attitude control is provided by a micro propulsion system that has its first flight use with Gaia. An atomic clock is used for precise time-stamping.

A number of problems were detected and tackled during commissioning operations. An apparent dimming of the on-board laser and imaged stars, was tracked down to ice building up inside the telescope enclosure. Also apparent was more Straylight than expected. Elsewhere, a micro-propulsion thruster developed unexpected performance levels and a back-up chemical thruster suffered a failed latch valve. These issues, like several others, were dealt with and solved in a series of review meetings, in-orbit special operations and newly developed procedures and on-board software changes.

After commissioning, Gaia was working so well that it was producing approximately 45 percent more science data than originally foreseen, since it was able to see stars fainter than required. The mission operations concept was quickly adapted to partially automate ground operations and increase ground station time to allow the full scientific potential of Gaia to be realised.