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CLUSTER II: AN OPTIMIZED THERMAL STRATEGY TO AVOID SPACECRAFT EXCESS COOLING DURING THE LONG POWER DOWN ECLIPSES IN 2012 AND BEYOND

Abstract

Cluster II is an ESA multi-spacecraft mission launched in 2000. The mission was designed to study the Earth's magnetic field during a 3 years mission, but the four satellites are still flying and collecting valuable science data 14 years after launch. One of the challenges of Cluster is to perform routine operations with the decreasing power available from the solar arrays, degraded battery capacity, and the spacecraft becoming colder. Particularly critical are the eclipses, where the spacecraft undergoes a complete power down: no heater can be activated during eclipse as batteries are no longer operational. A thermal model was developed in 2006 to simulate the evolution of the spacecraft temperature before and during eclipse. A new pre-heating strategy was applied successfully during the following years, making use of the propellant and oxidiser tanks as thermal capacitors. In 2012 new thermal concerns arose: the eclipses duration increased to almost 3 hours, while the spacecraft temperature in routine was significantly cooler and the power available for pre-heating much reduced compared to 2006. Critical units such as the High Power Amplifier and the thrusters were expected to reach their acceptance temperature limits. The existing thermal strategy needed to be revised and the thermal model improved in order to give more reliable predictions. A series of empirical tests were performed to understand the discrepancies between the predictions and telemetry. The goal of this paper is to describe the tests and simulations which allowed to improve the thermal model and to optimize the strategy to face the long eclipses in 2012 and 2013. Simulation results will be compared with telemetry and the differences between the four spacecraft highlighted. The pre-heating strategy guaranteed platform integrity during the eclipses and will be a key to continue with the success of the mission in the future.