

ASSESSMENT OF GNC IMPACTS OF CHEMICAL PLUME IMPINGENT IN THE CASE OF PRISMA “IRIDES” EXPERIMENT

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ABSTRACT

The COBRa concept was studied under ESA contract and then internally by ESA, as part of ESA’s SysNova technology assessment scheme which uses “technology challenges” and competitions to survey a comparatively large number of alternative solutions. The concept was proposed by an industrial consortium made up by GMV from Spain and Politecnico di Milano and Thales Alenia Space from Italy. The concept came first in the first edition of the SysNova competition, completion in January 2013.

COBRa is an active debris removal concept studied ESA’s Concurrent Design Facility (CDF) and which relies on contactless technology to modify the orbit of a space debris object. Momentum is imparted on the debris object using the exhaust plume of a monopropellant hydrazine propulsion system. An interaction of such kind (intentional or unintentional) has never been studied before in any detail beyond chemical contamination effects. As proposed in COBRa and modelled by ESA aerothermodynamics experts, the effect might be taken as further advantage during a rendez-vous and docking phase with an uncooperative object (to complement direct systems e.g. a robotic arm) in e.g. Active Debris Removal operations.

Recently, relevant concepts for in orbit demonstration using satellites at their end-of-life have been considered. In particular the possibility to perform close proximity operations combined with orbit and attitude modification between two co-flying satellites has been assessed. In particular, the aim of the study will be performed in early 2014 to assess and model the required performances that would be needed to test such effects with two satellites entering their decommissioning phase, the Swedish PRISMA/Mango spacecraft and the French Picard mission. The PRISMA mission (originally made up by two spacecraft, “Mango” and “Tango”) has successfully demonstrated since its launch in 2010 formation flying with cm-accuracy and autonomous rendezvous from 30 km down to 2 m using GPS, Vision Based and Radio Frequency sensors. Following the nominal mission phase supported by SNSB, the mission –now only with the Mango spacecraft still in operation- is currently entering its final phase where an experiment named “IRIDES” (Iterative Reduction of Inspection Distance with Embedded Safety) is under evaluation.

The primary goal of IRIDES would be to perform a rendezvous with, and inspection of, a decommissioned satellite, namely the CNES-owned Picard satellite. The Mango spacecraft is manoeuvring towards the selected space object. This phase is planned to be completed by August 2014, when the chaser and target orbits will be aligned. The IRIDES experiment, and Mango’s

transfer to the final disposal orbit, shall then be completed before mid-November 2014 when an eclipse phase starts for a duration of approximately three months.

The IRIDES in-orbit experiment is expected to achieve a relative navigation precision better than 10 m along-track and 1 m in cross-track and radial. This performance, together with the presence of a perfectly functioning propulsion subsystem on-board the Mango spacecraft, and the capability of Picard to determine and control its attitude in presence of an external torque, might be a credible concrete scenario to enable the simulation of the "COBRa" dynamical concept as studied by ESA.

The ESA analysis reported in this paper could enable an insight into this dynamical interaction of relevance to the IRIDES experiment and to future formation flying missions.