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# MICROSCOPE OPERATIONS: HOW TO IMPLEMENT COLLISION AVOIDANCE ON A NON-MANEUVERING SATELLITE

**Abstract**

MICROSCOPE (MICRO-Satellite à traînée Compensée pour l'Observation du Principe d'Equivalence, or Drag-Free micro-satellite for the observation of the Equivalence Principle) is a CNES-ESA-ONERA-CNRS-OCA mission, implemented on a microsatellite of the CNES Myriade series. The main scientific objective of MICROSCOPE is to challenge Einstein's Equivalence Principle with an accuracy one hundred times better than the best performance reached with experiments performed on Earth. MICROSCOPE was launched on the 25th of April 2016; its orbit is sun-synchronous circular at a 709km altitude.

The satellite design is based on the Myriade generic platform, though it integrates major differences, using new equipment and special functions. The payload, installed at the center of the satellite, is the T-SAGE (Twin-Space Accelerometer for Gravity Experiment) instrument, made up of two independent differential accelerometers. In routine operations, the payload measurements are used by the AACS (Attitude and Acceleration Control System) to estimate the attitude, coupling the acceleration measurements with the star tracker attitude data in order to nullify all non-gravitational forces on the accelerometers.

As collision risk mitigation was not a driver in MICROSCOPE's design, and because the mission does not require orbit control capability, there is no standard chemical propulsion subsystem onboard. Nevertheless, it is replaced by a set of cold gas micro-thrusters (nitrogen) located on the eight corners of the cubic structure. This CGPS (Cold Gas Propulsion System) provides thrust within the range of 1 to 300 $\mu$N, in order to compensate for any non-inertial force (drag for instance) on the payload.

These thrust performances are way below those of classic propulsive systems; in fact at first, MICROSCOPE was to be considered a non-maneuvering satellite. But this appeared to be hardly satisfying for a CNES mission, given the orbital environment. With respect to the collision risk and beyond the compliance to the legal French Space Act, CNES has a "best efforts" code of conduct to avoid debris proliferation. As a consequence, an innovative risk detection and avoidance strategy was tailored for MICROSCOPE.

This article will describe the concept of drag-free and an operational overview of its behavior since the launch. It will also present the adapted operational scenarios defined for MICROSCOPE collision avoidance.