

Key Technologies (7)
Key Technologies (2) (2)

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EXPERIENCE AND PERSPECTIVE OF CNES FLIGHT DYNAMICS IN EXPLORATION MISSIONS

Abstract

Taking advantage of a significant heritage in astrodynamics advanced techniques, the CNES Flight Dynamics department has been constantly strengthening and developing its skills and ambitions on exploration missions. In the last years, the major contribution to the development and operational phases of the Philae mission allowed to propose our Flight Dynamics skills to scientists for the choice of the landing site and for Flight Dynamics calculations for the mission instruments. The participation to MASCOT mission reinforced and supplemented these skills by adapting them to a very ambitious mission timeline in the environment of an asteroid. Today CNES is cooperating with JAXA on the MMX mission by actively contributing in the three elds of this cooperation: supporting the design of the MMX probe complex trajectories in the vicinity of Phobos, including geodesy and navigation error analyses, taking in charge calculations and assessment of Flight Dynamics for the Franco-German rover and contributing to the design of the French instrument MacroMega with coverage analyses and support to operational mission programming. Meanwhile, CNES Flight Dynamics department teams participate in several phase-0 project studies: dimensioning of landing mass on the Moon with Ariane 6 launcher, swarm missions around the Moon, orbital rendezvous, all of them using CNES knowledge, methods and heritage. For three years now, the department has set up a horizontal working group where each Flight Dynamics domain is represented (orbitography, attitude control, manoeuvre, feasibility analysis, mission programming, space management). This working group objectives are to capitalize on the achievements, federate the different domains of expertise in Flight Dynamics, build and maintain the roadmap in terms of exploration

missions in close collaboration with FOCSE center (French Operations Center for Science and Exploration). The CNES Flight Dynamics roadmap for exploration missions is dened and ambitious, we intend to provide support to French research laboratories, to support our French industry and to participate in future international collaborations. Relying on the experience described above and driven by the strong willingness to develop its knowhow in space exploration, the CNES Flight Dynamics experts integrate the HERA mission led by ESA to bring the Flight Dynamics activities (mission analysis, Flight Dynamics engineering and Flight Dynamics operations from Toulouse Space Center) for the two cubesats of this mission. This paper will present a retrospective of our various contributions in past and current missions and will explain our strategy for the future and the plan for its implementation.