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APPROACH TO MARS SAMPLE RETURN CAPTURE PHASE IN-FLIGHT VALIDATION USING OPPORTUNITY

Abstract

Sample return missions are very complex andrequire advanced technologies. Each phase could be considered a mission itself in terms of complexity and dedicated resources. The capture phase of the Mars Sample Return (MSR) mission starts when the Sample Canister containing Martial soil samples is delivered in orbit around Mars by the Mars Ascent Vehicle, and ends when the MSR Orbiter has captured it and accommodated for the return flight to Earth. Three main enabling technologies can be identified for the MSR capture phase: Guidance, Navigation Control (GNC) for all mission phases (far, intermediate and short range rendezvous and capture including collision safety), the autonomous vision-based navigation system (including Image Processing –IP- and avionics solution, very challenging, as the Canister search and tracking is performed at hundreds of kilometres of range), and the capture mechanism. Some of the above referred technologies developed at ESA have been usually tested on ground test benches. Despite the improved space representativeness tests conditions there will always be uncertainties about the behaviour of the full system during the mission, unless an ultimate in-flight validation is performed. Nevertheless, in-flight validation opportunities are scarce and costly (particularly when considering ad-hoc IOD missions). GMV intended to identify an approach for in-flight validation of the MSR capture phase enabling technologies making use of opportunistic missions. The main target will be to achieve the same validation level as considering an ad-hoc IOD mission but with a much affordable cost. The idea is to split the validation targets in sub-phases or sub-applications and test them within different opportunity missions. A distributed but good coordinated approach is mandatory and is preliminary summarized as below:

1. Capture mechanism could be validated by using the VEGA AVUM module with minimum or no modifications but just adding a capture mechanism device and a canister mock-up carried by the own AVUM. Launch cost would be zero and AVUM platform use cost would be low.
2. MSR IP/Avionics solution for far range (Canister is seen as single-pixel object) can be hosted and flight validated by any opportunity mission with an optical camera and using a far asteroid, a GEO satellite or a small solar body as "virtual" canister (through appropriate results scaling as per used camera)
3. For short range visual navigation, data from past missions (e.g. Swedish PRISMA) or opportunity hosting in currently on-development missions (e.g. PROBA3) can be considered. Similarly for the GNC.