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From Sail to Soil – Getting Sailcraft Out of the Harbour on a Visit to One of Earth's Nearest Neighbours

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ABSTRACT

The DLR-ESTEC GOSSAMER roadmap envisages the development of solar sailing by successive low-cost technology demonstrators towards first science missions. In this framework, the GOSSAMER-1 deployment demonstrator for a (5 m)² sail structure in low Earth orbit is followed by a (20 m)² sail effect demonstrator GOSSAMER-2 for higher Earth orbits, and the (50 m)² GOSSAMER-3 sailcraft to prove the principle within the Earth-Moon system. Missions requiring the unique capabilities of solar sail propulsion were studied by science working groups, including multiple NEO rendezvous and fly-by.
The GOSSAMER sail technology has been developed by DLR since the 1990s, with a successful (20 m)² deployment test in 1999 at DLR Cologne. The requirements for GOSSAMER-3 demand the demonstration of sufficient trajectory and attitude control for science missions. Advances in boom, sail, and deployment mechanisms have already now increased the payload margin of baseline GOSSAMER-3 designs from a few to several kg. A camera to demonstrate attitude control and a magnetometer to study the space environment around a sail were first considered as payloads for GOSSAMER-3.
In addition to these, the shoebox-sized 10 kg asteroid lander MASCOT recently launched with HAYABUSA-2 also carries a hyperspectral infrared soil microscope and

a surface thermal infrared radiometer. The camera‘s and radiometer‘s fields of view coincide on the asteroid surface.
Although designed for a mission on (162173) 1999 JU_3, with the necessary margins for the unknown the instruments are versatile enough to adapt. Thus, a minimal modification of MASCOT may be integrated as separable instrument module with GOSSAMER-3, first to observe the sail during the deployment and demonstration flight phases. In an extended mission and with experience previously gained, the mission could be concluded by the rendezvous with and the challenging drop of a ballistic lander onto a small asteroid near Earth.
For the exercise scenario on the mitigation of fictional Earth impactor 2015 PDC, it is assumed that the GOSSAMER roadmap keeps its 2 year mission interval after the last expected launch date for GOSSAMER-1; the HAYABUSA-2 mission proceeds successfully; the MASCOT Flight Spare become Ground Reference Model is preserved flightworthy and released from duty ½ year after the landing of MASCOT on 1999 JU_3 to be mated to a likely GOSSAMER-3 design prepared for but not depending on this opportunity. The combined spacecraft may: fly a technology demonstration mission extended to end at a nearby NEA; proceed directly to 2015 PDC for a fast flyby, a rendezvous and lander drop, or both; or abort the already begun tech-demo mission and midways change course towards the newly recognized threat.

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