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GoSolAr: Large-scale Deployable Photovoltaics for Planetary Defence and Small Solar System Body Applications using Gossamer Deployment Technologies

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ABSTRACT

Recently, high electrical power concepts have been proposed for planetary defence applications, mainly for deflection but also for payload transfer to asteroids. These include solar-electric propulsion gravity tractors, ion beam shepherds, laser ablation, and solar power sails. They have an electric power demand in the 10's of kW up to several MW in common; the lowest level is comparable to the largest currently built geostationary communication satellites.

The German Aerospace Center, DLR, developed gossamer deployment systems in the Gossamer-1 project for solar sails to qualification status, on which we report separately. Sailcraft were enisaged to use small on-sail thin-film photovoltaic arrays for their post-deployment power supply.

In the follow-on project GOSOLAR, the focus is now on gossamer deployment systems for huge thin-film photovoltaic arrays. Based on the previous achievements in deployment technology and qualification strategies, new technology for the integration of thin-film photovoltaics will be developed and qualified with the goal of a first in-orbit technology demonstration within about five years. The two major objectives of the project are the further development of deployment technology for a 25 m² gossamer solar power generator and the development of a flexible photovoltaic membrane. GOSOLAR enables a wider range of deployment concepts but can use the GOSSAMER-1 deployment approach, to minimize final mass. The technology demonstration is supposed to employ the S²TEP bus system which is developed on-site in parallel.

There are special challenges in the development of huge solar arrays. The currents required to carry power off the thin-film structure at commonly used bus voltages result in a substantial harness cross-section. At the same time, there is a desire for higher voltages, e.g. to power electrical propulsion directly. The development of high power systems will be studied in parallel to demonstrator development for implementation in future projects.

Using an established test strategy, a characterization of the deployment performance and deployment forces will be made based on a test-as-you-fly approach. It includes vibration testing, fast decompression, partial deployment under thermal-vacuum and full-scale ambient deployment on a test rig previously developed for GOSSAMER-1. The data gained can be used for further development and as input for mechanism and structure sizing. Examples for the application of those testing strategies are the previous DLR GOSSAMER-1 project, the ESA drag sail projects ‘Deployable Membrane’ and ‘Architectural Design and Testing of a De-Orbiting Subsystem’ (ADEO) as well as the tether deployment of the HP³ experiment on the NASA/JPL Mars mission INSIGHT.

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