PDC2019
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A VEIL OF POWER FOR PLANETARY DEFENSE – THE DLR GOSOLAR FLEXIBLE THINFILM PHOTOVOLATICS GOSSAMER SOLAR ARRAY CONCEPT IN PAYLOAD TRANSFER AND ASTEROID MITIGATION MISSIONS

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Keywords: *GoSolAr, space photovoltaic power, deployable membrane structures, solar-electric propulsion, asteroid mitigation*

ABSTRACT

The power demand will continue to rise not only for future satellite applications. Asteroid exploration missions such as the HAYABUSAS or DAWN and planetary defense experiments such as DART use kW-range solar-electric propulsion. During propelled cruise phases they continuously operate at a power level which exceeds the combined needs of all other consumers aboard a typical exploration spacecraft by about an order of magnitude.
Since the first Planetary Defense Conference, mission concepts were presented which require very high electrical power levels to operate solar-electric propulsion to arrive at the target asteroid or to pull it by gravity tractor. Also, laser-based concepts

require very high power levels. We provide a survey of these concepts, translate their power demand into possible solutions, and compare them to the trends of space power demand at Earth.
Geostationary telecommunication satellites currently approach a power level of up to 20 kW, and future spacecraft will have to power yet more services. Electric propulsion is increasingly used there for station keeping, attitude control and GEO circularization. Space Tugs are being studied for several fields, resulting in an engine power demand of 100 kW or more to fulfil mission requirements. These developments lead to a renewed interest in large, deployable and ultra-lightweight power generators in space. Within the GOSOLAR (GOSSAMER Solar Array) activity, DLR develops a new photovoltaic array technology. It is based on the DLR GOSSAMER approach using lightweight, deployable carbon fibre reinforced plastic (CFRP) booms and a polymer membrane covered with thin-film copper-indium-gallium-arsenide (CIGS) photovoltaics. The booms are arranged in a crossed configuration with a central deployment unit. The photovoltaic area is composed of one large square membrane with double folding using two-dimensional deployment. Even though the efficiency of thin-film photovoltaics is currently only about ⅓ of that of conventional space-grade photovoltaics, a membrane based array can already achieve better mass/power ratios. A 50 kW array requires an area of approximately 20 m by 20 m. In a first step, DLR develops a fully functional 5 m by 5 m demonstrator partially covered with thin-film photovoltaics integrated on standardized generator modules. Controlled deployment of structure and membrane, and a sufficiently stiff support structure for operation are key features of the conceptual design of the GoSolAr demonstrator.
We provide an overview of the selection and the maturity of the key technologies and subsystems, the first manufactured breadboard models, their testing, and the continuing development.

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