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SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Concepts (7)

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ACTIVE REMOVAL OF SMALL ORBITAL DEBRIS USING LASER SYSTEMS IN SPACE

Abstract

We are exploring use, in space, of a laser system for active deorbiting of small orbital debris from near Earth space. We have identified procedures and technology which appear promising. Multiple areas where further progress is needed are: (1) Achievement of international consensus regarding procedures for using the laser systems of interest within near Earth space; (2) Development of better procedures for locating and characterizing small debris elements within space from a spacecraft also in the same general vicinity as the debris element. Properties of the debris element of interest are: dimensions, mass, trajectory, velocity, material, shape, center of gravity, rotational rate, optical absorption and any others relevant to the deorbiting process; (3) Identification of feasible laser systems that can exert the required deorbiting impulse at the anticipated multi-kilometer distance; and (4) Development of means for tracking a debris element not only prior to, but during and after exertion of the deorbiting impulse. A highly desirable goal will be determination of the resulting altered trajectory of the debris element after exertion of the deorbiting impulse. We will describe a method developed collaboratively with Larry Kos, others from the Advanced Projects Group at NASA MSFC, and Donald Kessler, well known for his work on orbital debris. That work indicated a favorable opportunity for deorbiting a small debris element is most likely to occur as the debris element propagates toward, and within about 10 km of, the deorbiting spacecraft. As an illustration we consider deorbiting a 5 gm object, about the mass of a US quarter. For a velocity of the debris element of about 7 km per sec a deorbiting impulse of at least 12.5 kW of average power will be required. A representative distance from which the deorbiting impulse needs to be exerted is about 10 km. The time window in which the impulse must be exerted is order of one second. A transient obscuration of the optical path to the debris element by material ejected in the ablative propulsion event is expected. We see this as recommending use of a sequence of subpicosecond optical pulses of the order of 100 millijoule energy each. We note that laser systems within an order of magnitude, as regards average power and achievable pulse energy, are currently being demonstrated by researchers in Jena and Aachen, Germany. We hope to explore opportunities for an effort that will develop procedures agreeable to the international community.