**7th IAA PLANETARY DEFENSE CONFERENCE 2021**

**Vienna, Austria**

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**☐ NEO Characterization Results**

**☐ Deflection and Disruption Models & Testing**

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**☐ Public Education & Communication**

**LANCER: Reaching and Deflecting Apophis in 5 days using Nuclear Electric Power and Solar Wind Repulsion**

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 **ABSTRACT**

The LANCER (Large Asteroid Near Collision with Earth Redirect) mission uses nuclear electric propulsion to send a 20 metric ton impactor to 99942 Apophis (2004 MN4).  For a head-on collision, based on the latest mass estimate for that asteroid, the maximum change in velocity is 0.25 km/s.  The impactor detaches from the main spacecraft on approach to the target, so the impact can be observed from a safe distance.  The spacecraft uses a compact fission reactor core, as well as a combination of ion linear accelerator (Linac) electric thrusters and a solar wind drag device called a Wind Rider to achieve a maximum relative velocity of 436 km/s.  The spin-stabilized impactor payload consists of tungsten heavy alloy, high-fracture toughness steel cladding and a ceramic shock attenuator.

After monitoring the collision, the vehicle slows down before returning to Earth orbit for its next payload.  It is possible to re-use the vehicle for multiple impactor delivery runs, to redirect the orbit of Apophis far from Earth, over a series of collisions that accumulate delta-v over time.  A trajectory simulation leading to the first impact is provided, using commercially available software tools.  A discussion of the scaling analysis results for mission sizing follows, as well as an alternative approach with the same technology to move Apophis.

With the exception of the impactor payload, the hardware and techniques described in this paper are the product of the Practical Interplanetary Propulsion Study Group (PIPG), a technical sub-committee under the auspices of the Nuclear and Future Flight Propulsion Technical Committee of the American Institute of Aeronautics and Astronautics (AIAA).  The impactor itself is a generic design derived primarily from Mil-Handbook-5 and other standard references, for an asteroid target composed of semi-porous carbonaceous rock.  Methods and limits are described for legs of the journey from Earth geo-transfer orbit (GTO) to Apophis using the solar wind to accelerate using the wind rider stage.  That device and its performance optimization are detailed for this mission concept, given power limitations of the core and time remaining to arrive at Apophis.

***Comments:***

 *(Alternative session: Deflection & Disruption Modeling and Testing, Oral)*