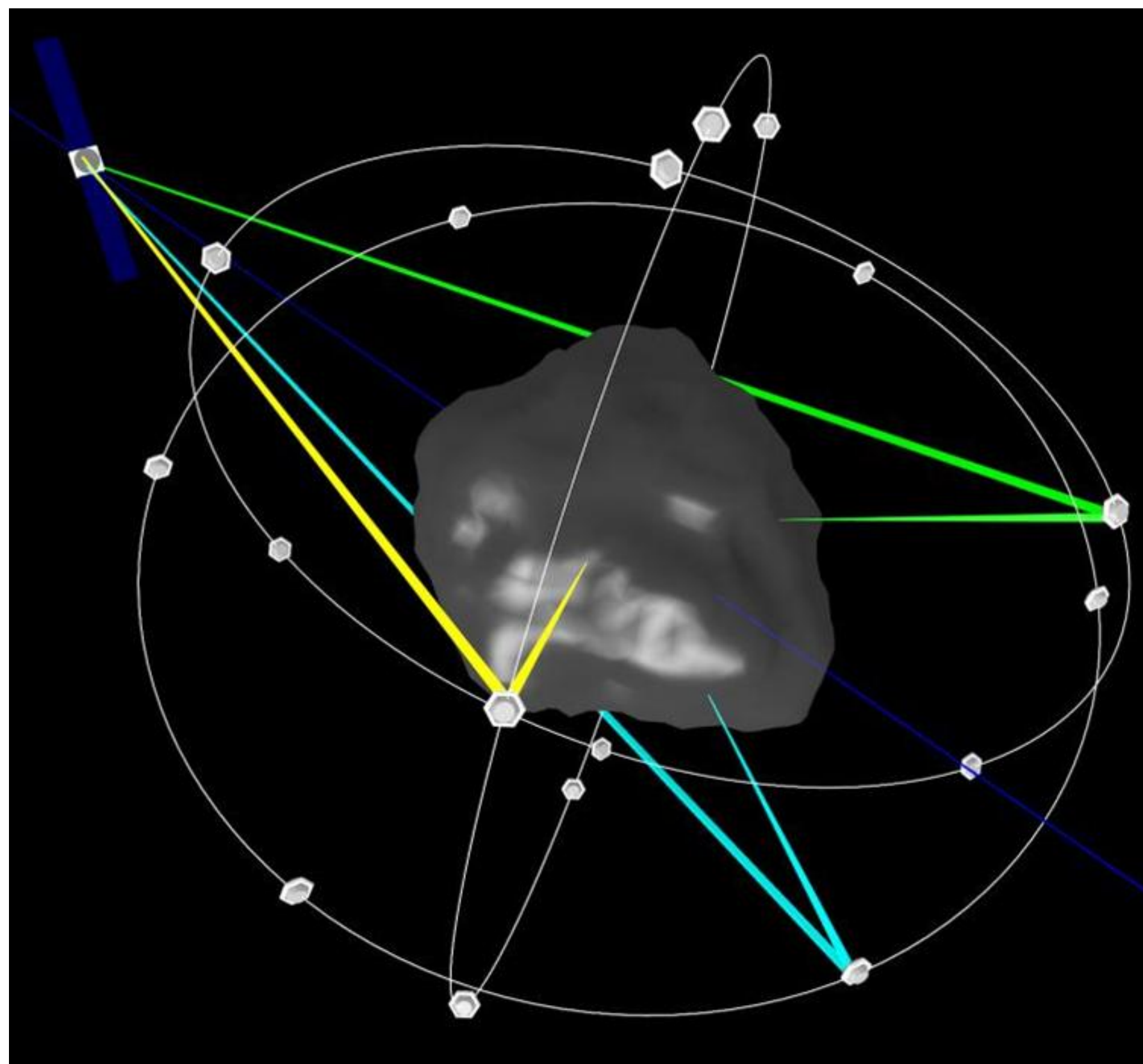


# Ultrashort Pulse Mode-Locked Lasers for Near-Earth Object Deflection

*Grant Bergstue, Luke Burgess, Spencer Cole  
 Electrical and Computer Engineering Department*

## Overview

Ultrashort optical pulses can be applied to the surface of a near-Earth object (NEO) to create thrust in a desired direction by ablation. Because the ejected material exits approximately normal to the surface of the NEO, the force applied to the NEO can be precisely delivered if its surface is well characterized. A system of orbiting micro-satellites can both map the surface and focus optical pulses to certain areas on the NEO. Free space multiplexing of ultrashort pulse mode-locked laser systems allows for multiple areas of the NEO to be illuminated simultaneously. For example, having three ablation areas on the NEO can provide stabilized thrust as well as prevent unwanted rotation of the NEO. This free space ultrashort pulse multiplexing also allows for scalable power applicable to NEO deflection.



## Impact

The precise application of ablative thrust to a NEO can provide an effective and efficient means of deflecting Earth-threatening objects of various masses.

## Acknowledgements

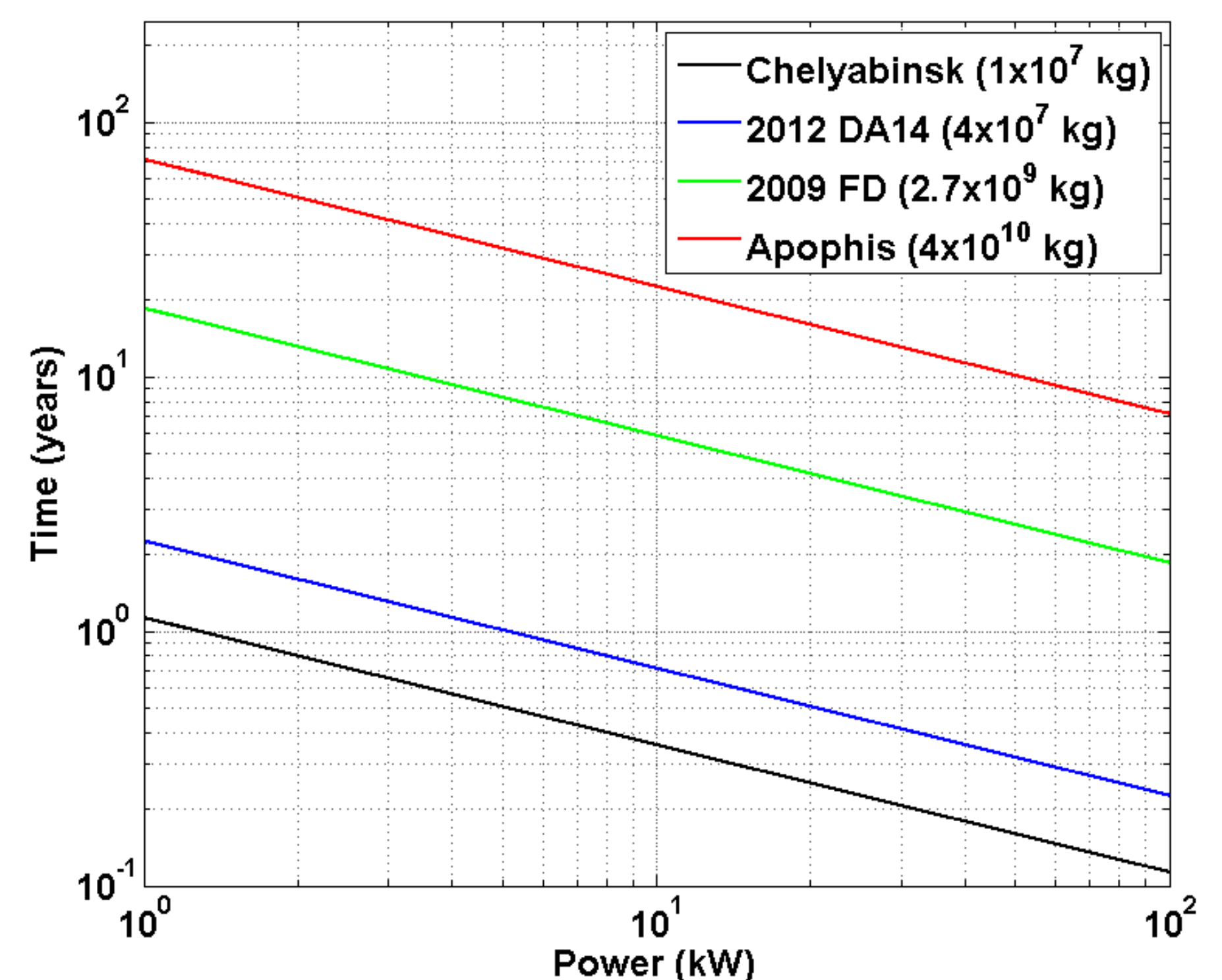
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## Key Findings

We calculate the time and average power required to deflect various NEO by at least the diameter of Earth using

$$\Delta t = \sqrt{\frac{D_E \cdot M \cdot v_{ej}}{P}}$$

where  $D_E$  is the diameter of Earth,  $M$  is the mass of the NEO,  $v_{ej}$  is the velocity of the ejected material ( $\sim 10^4$  m/s), and  $P$  is the applied average power.



Smaller NEO can be deflected in reasonable time. Free space multiplexing of mode-locked lasers seems necessary to reach higher average powers for deflection of larger NEO.

## Explanation

This research relates to the American Astronautical Society as it proposes new strategies and technological advancements for important future missions in space.