Orbital Re-focusing of High Energy Laser Beams from Ground for Laser-ablative Post-Mission Disposal and Debris Removal

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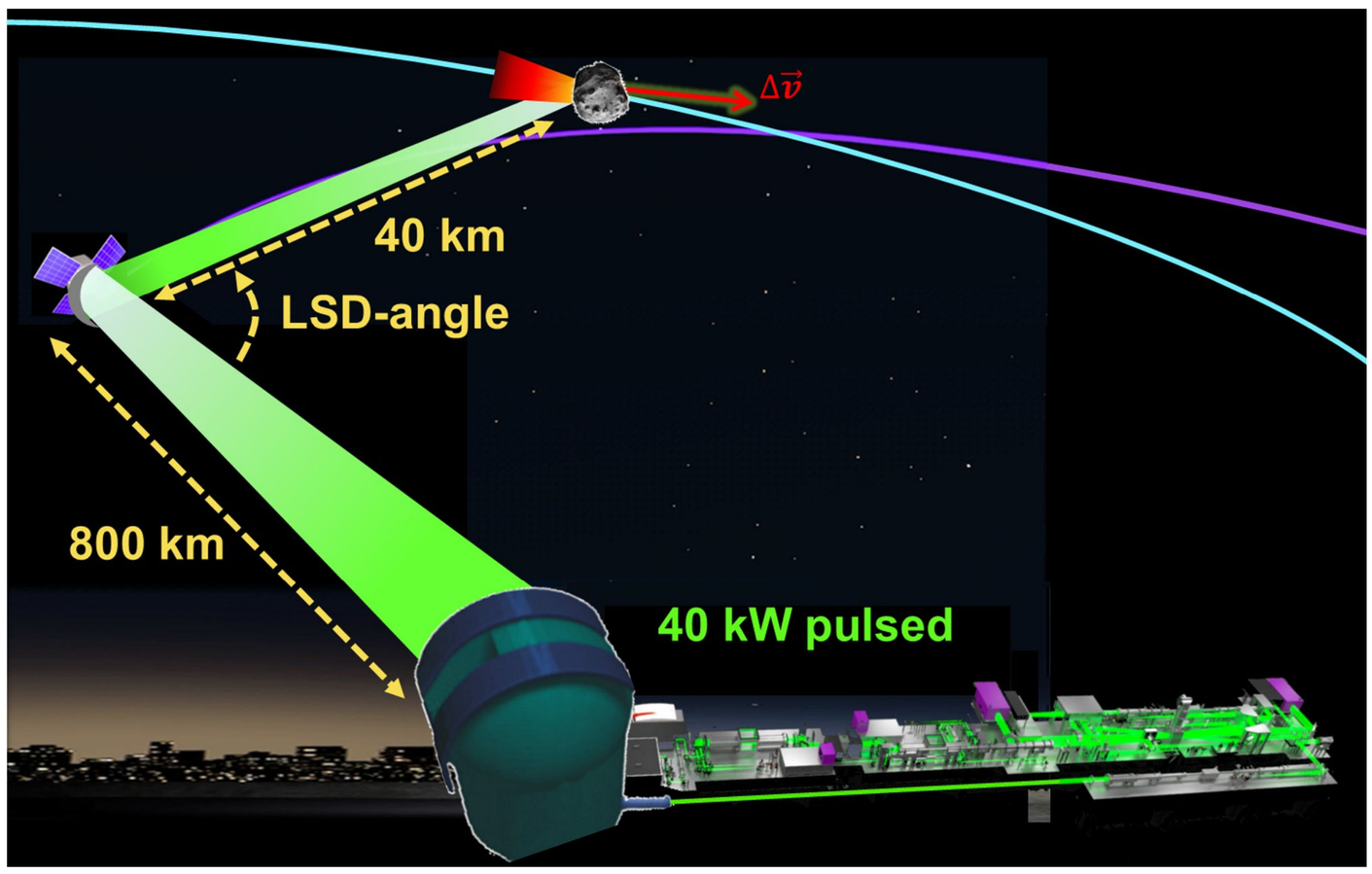
Debris Removal

Technological concept

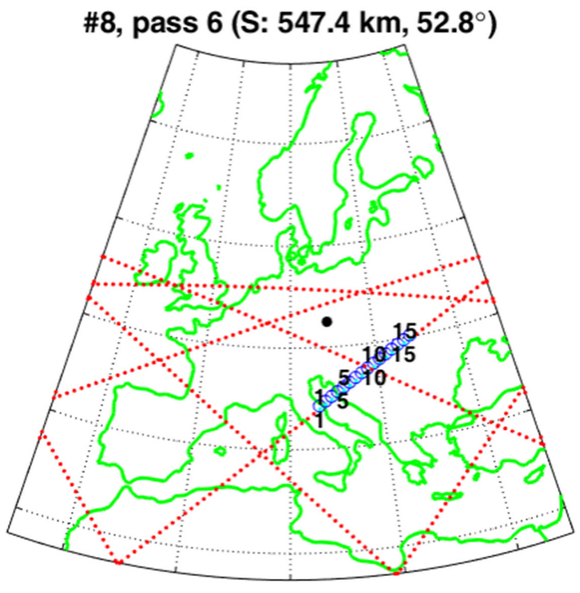
- In-orbit re-focusing of a high-power laser beam from ground
- Short in-space focusing distance (40 km)
- High fluence (10 J/cm²) for ablative momentum transfer

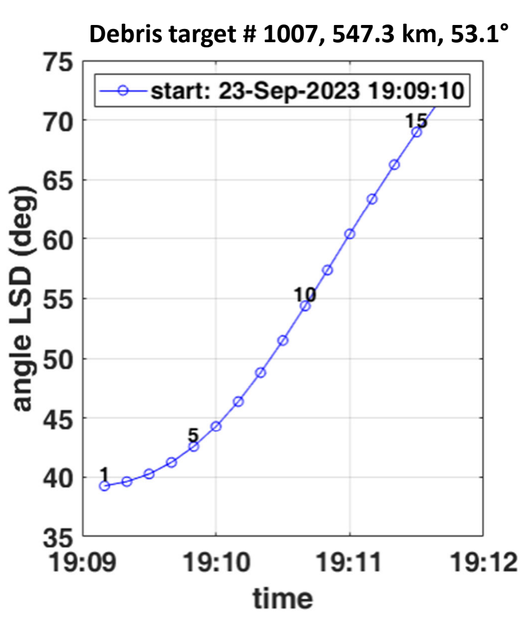


Ground-based laser irradiation of space debris for de-orbit using a focusing mirror on a relay satellite.

Comparison with direct irradiation of space debris from ground

- Minimized outshining losses
- 100× less pulse energy (200-400 J) → enhanced technology readiness
- Higher repetition rates possible (100-200 Hz)
- Active satellite beacon for turbulence compensation
- Large angular ranges for tracking → high agility required
- Triple conjunctions required: ground station + relay satellite + debris object



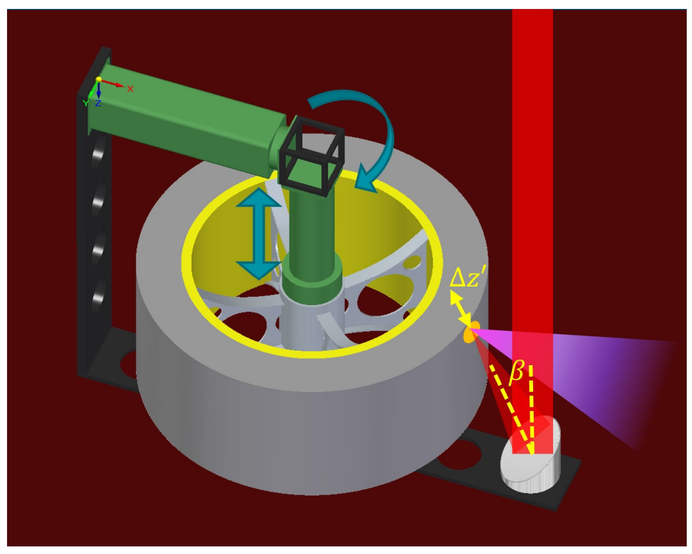


Laser conjunction example:
(left) Site location and relay satellite ground trajectory. (right) Laser relay interaction angle

Post-Mission Disposal

Thruster principle

- 0.4 m receiver for laser power input
- Small focus spot (1-2 cm diameter)
- Metal ablation: high specific impulse



Laser propulsion unit for post-mission disposal with a concave focusing mirror and aluminium as propellant.

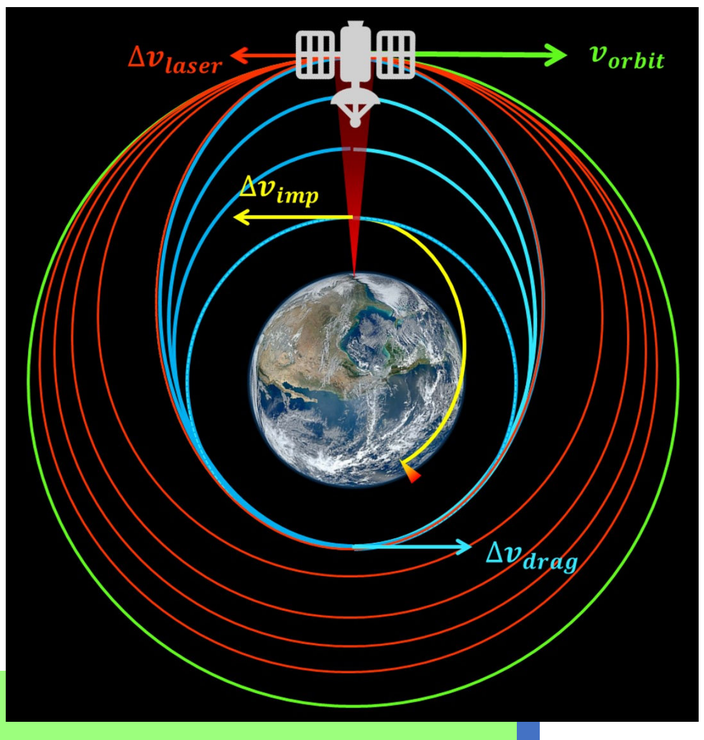
Laser power requirements

I: Perigee lowering (within 2 years):
- Micro satellite (150 kg): < 35 kW
- Medium satellite (1.5 t): > 170 kW

II: Drag-based descent: none (passive)

III: Re-entry:
- Laser-based: 3-30 MW or
- Uncontrolled / designed for demise

Phases of laser-powered post-mission disposal of a satellite with receiver unit and laser propulsion module.



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