LUMOS

ESA

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Cis-lunar Domain : Raising awareness and real cases

Memorandum on US Space Policy Directive 7

Consistent with the National Space Traffic Management Policy, PNT services will also play an important role in space traffic management and future applications in the Cislunar Service Volume, …

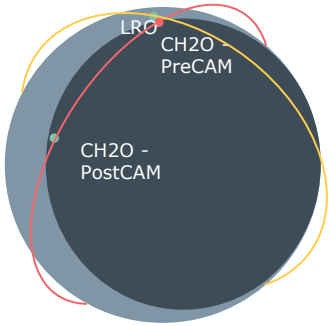
2021

US National Cislunar Science & Technology Strategy

… demonstrate cost-effective space-based and Lunar surface sensors

2022

Chandrayaan-2 Orbiter (CH2O) performs an evasive manoeuvre to mitigate a close approach with NASA LRO



2021

Space junk on collision course with the moon likely a Chinese rocket

"Mystery" object was not a SpaceX Falcon rocket upper stage … maybe the third stage of a Chinese rocket

2022

Challenges

Difficult observation conditions from ground-based and low-Earth observers:

- Moon occultations
- Straylight and atmospheric scattering
- Weather dependency
- Limited diversity in observation geometry

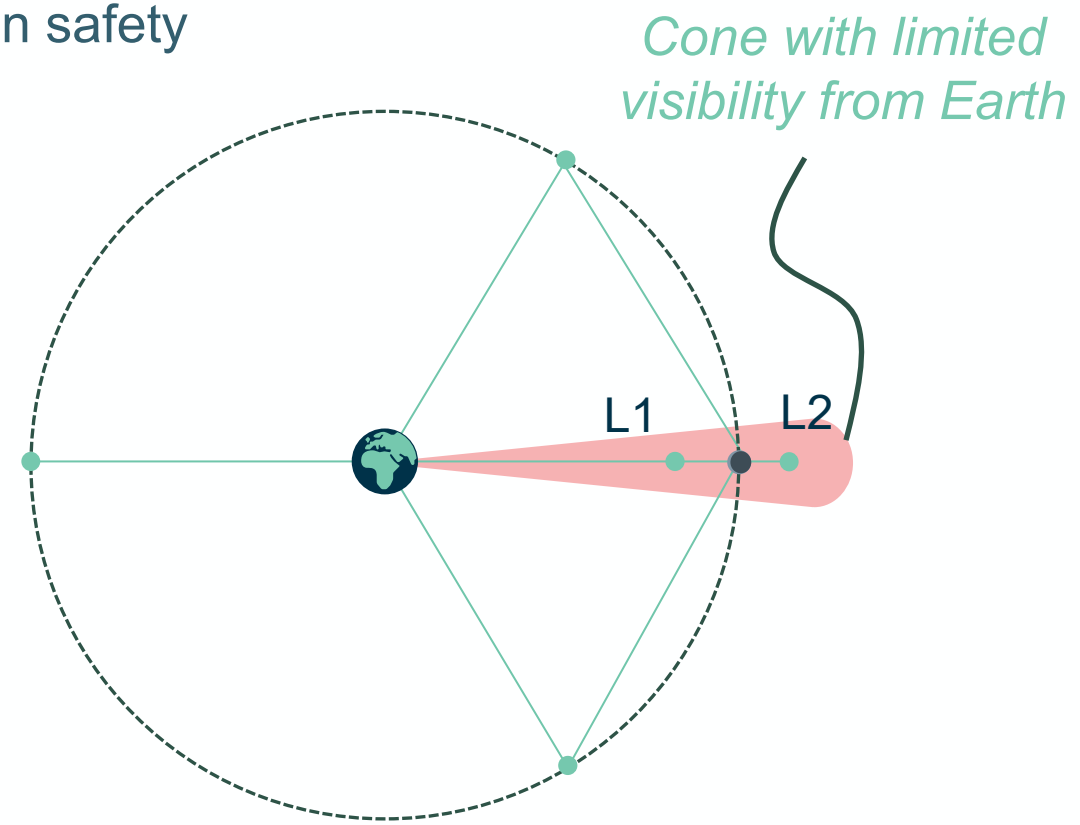
Improved geometries from optical payload in cis-lunar space

- Lunar missions require high Δv for launch and operations
- Trajectory should allow finding objects (high duty cycle and revisit period)

Mission Objectives

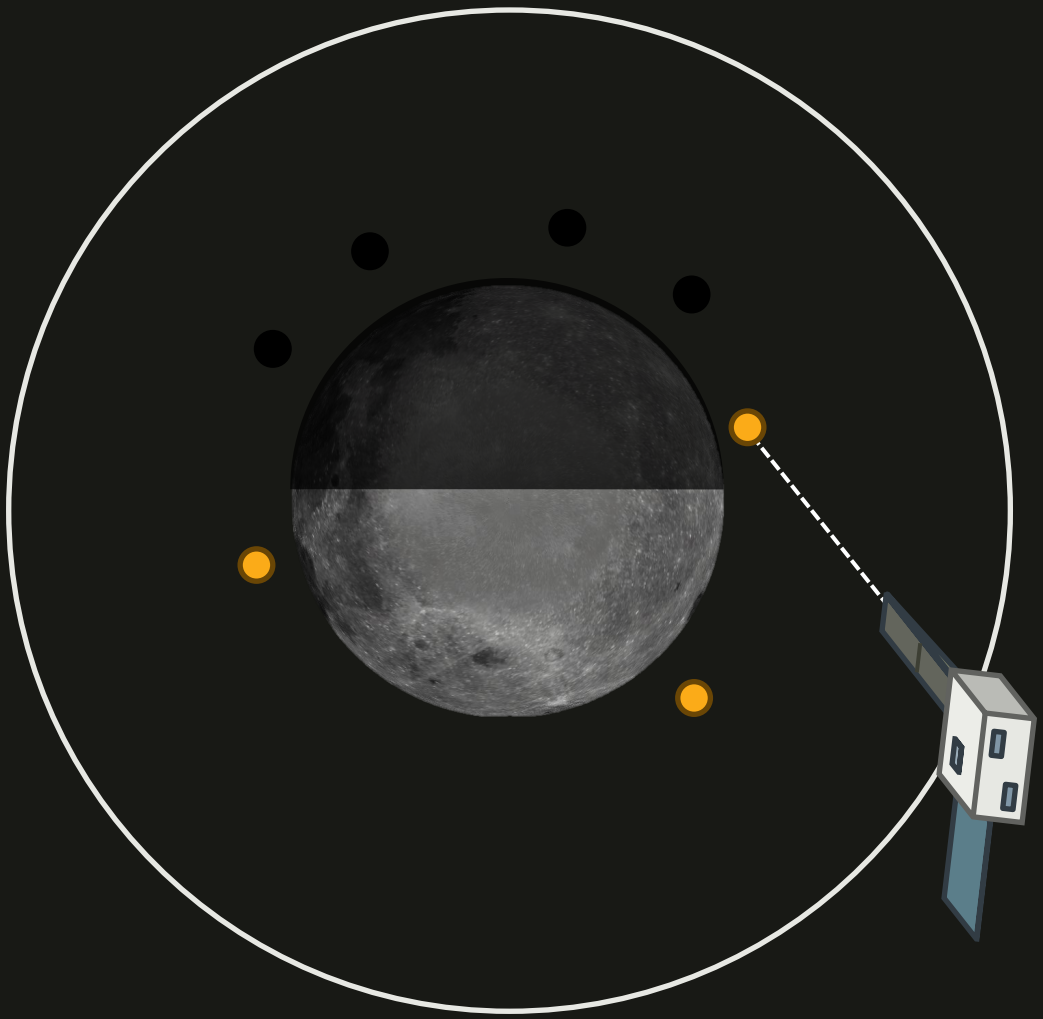
Objective: Demonstrate capability to detect, find, and track objects in cislunar orbits (Earth-Moon transfer, lunar, Lagrange point orbits)

- Objects: at least 1m (target 10 cm), in stable orbits or crossing operational orbits
- Enable collision avoidance operations and support mission safety
- Assess Earth/Moon/Heliocentric capture during disposal
- Predict Earth/Moon impacts
- Characterise objects (brightness)
- Backup navigation support for lunar missions
  e.g. in contingency situations



Idea

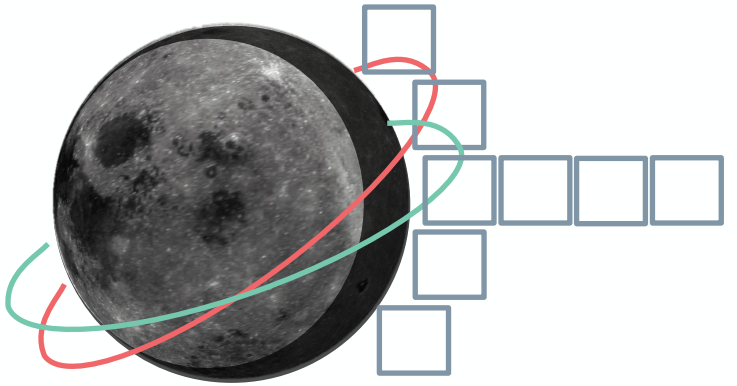
- Passive-optical payload in vis. range (based on heritage)
- Deployable “Moon-shield” for direct straylight reduction
- DRO 40.000 km (approx. circular 7 days period)
- Duty cycle: ~40% (SNR>threshold for higher lunar targets targets)
- Observation windows for low-lunar orbits (exclusion from terminator line)



CDF in March 2024 → Industry Phase A in mid 2024

Observation strategy

- Survey area of interest (all stable orbits - may be reduced further) in ~8 days
- Tracking and survey mode
- On-board processing for object detection (data reduction rate based on heritage software using differencing algorithm)



Support from ground-based telescope network:

- High-lunar altitude orbits may be observed from ground-based sensors

Launch

1. Launch into standard GTO
2. 7 days loitering (16 revolutions)
3. Apogee Raising Manoeuvre (ARM) to WSB
4. Up to three Deep Space Manoeuvres (DSM)
5. Lunar Gravity Assist (LGA)
6. DRO Insertion Manoeuvre (DIM)

Alternative: Direct insertion into WSB