The 7th
Mission Idea Contest
For Deep Space Science and Exploration

Mission

ACE

- Apophis Close Encounter -

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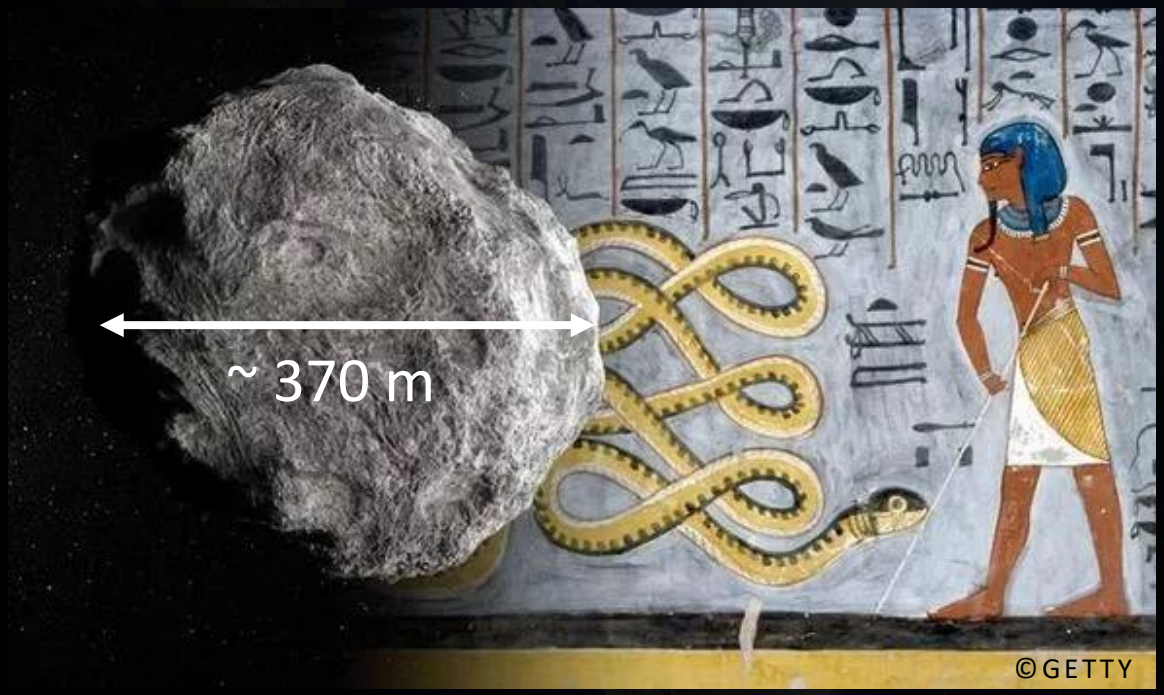
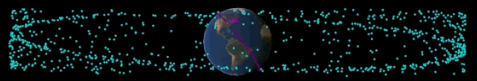
Nov. 2021

Target

99942 Apophis (the god of chaos)



- Close Encounter (CE) on **2029.04.13** (Friday)
- How close?
  ~ 36700 ± 9000 km above Earth surface (almost GEO orbit)



A once-per-thousand-year event!!!

Rationale

Potentially Hazardous Asteroid (PHA):

- Min. orbital intersection distance < 0.05 AU (~19.5 lunar distance)
- Diameter ≥ 140 m
- Potential city killer (cf. Tunguska: 200-m obj. destroyed 2000-km^2 forest)
- Rich in resources (e.g., Fe, Ni, Co, Ge, …)
- Key to the planetary formation

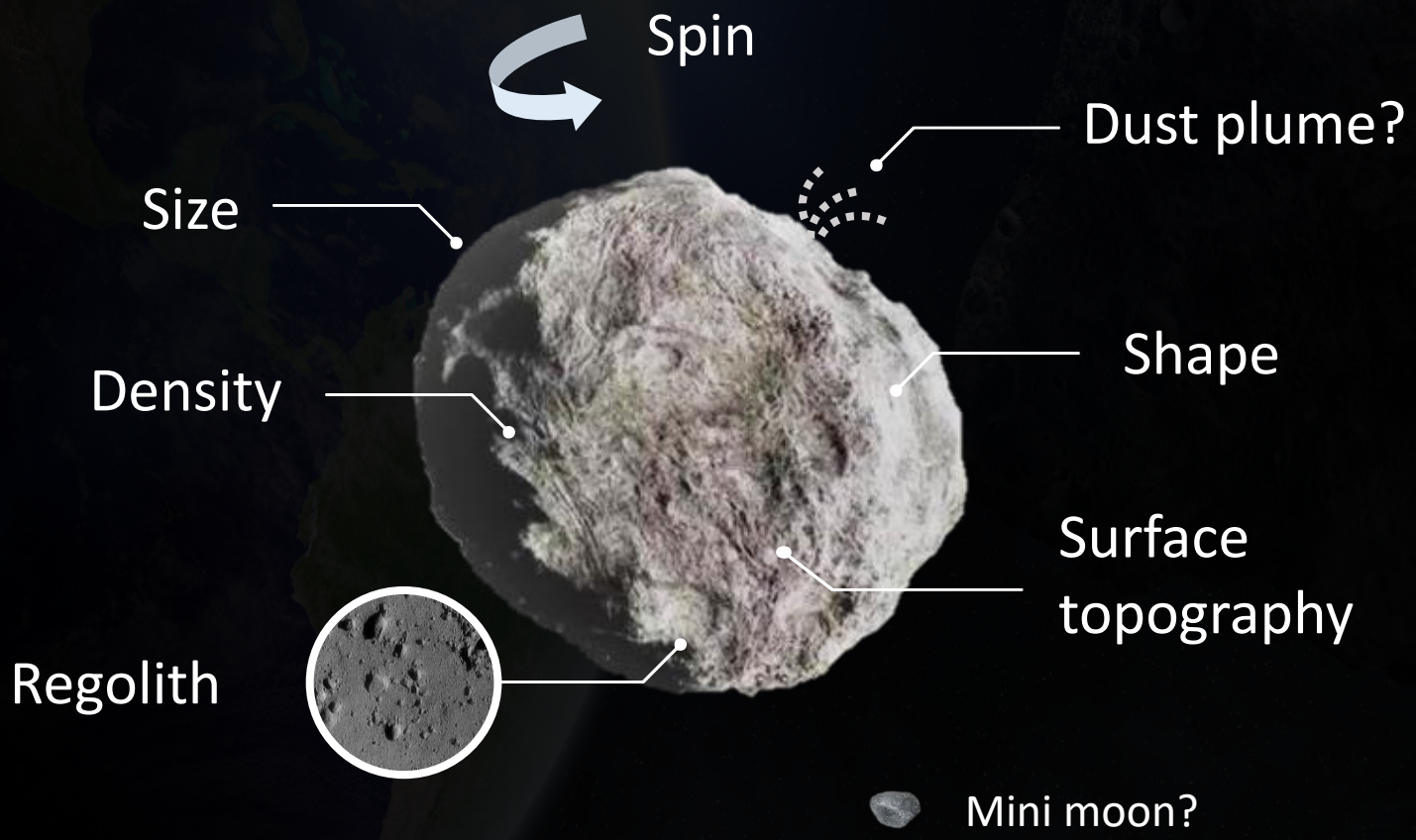
An extraordinary chance to inform planetary science & defense

The solar elongation of Apophis will restrain ground-based obs. immediately from the day of CE until Sep. 2029

In-situ observation is needed!!!

Objectives

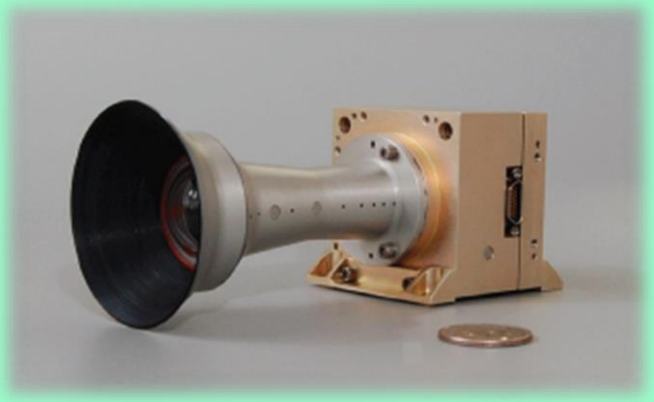
- A physical check of Apophis in situ **before/after** the CE:



Picture credit: getty

Payload

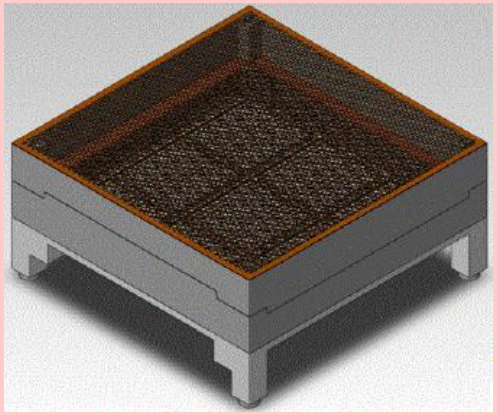
Imager



MSSS/ECAM-C50

- 400 – 750 nm
- 25° x 19° FOV
- 256 g, 78 x 58 x 44 mm
- size, shape, rotation, albedo, terrain, regolith, …

Dust Detector



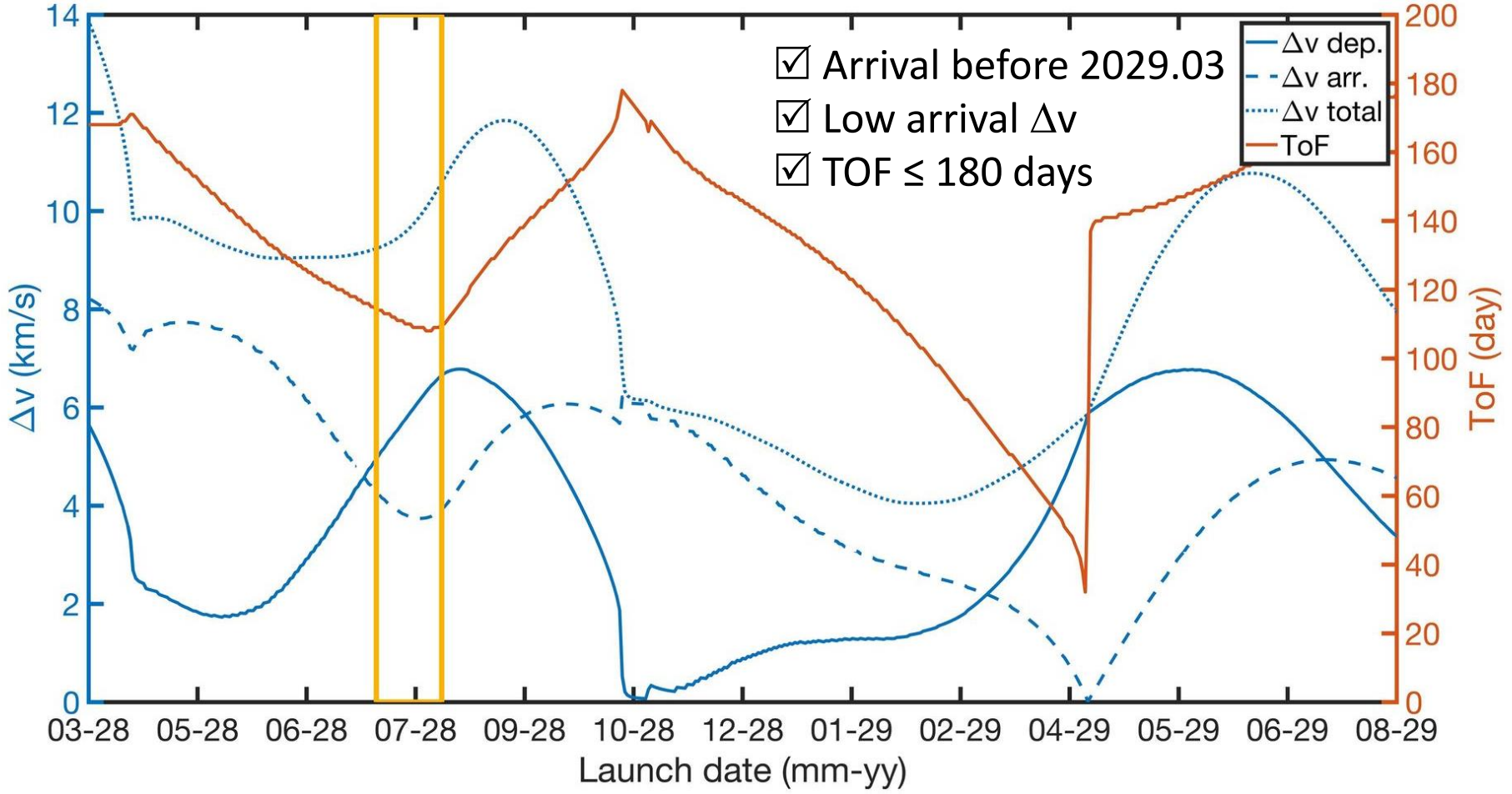
Piezo Dust Detector

- $A_{detector}$ ~ 2600 mm^2
- 1 µm – 1 mm, V_{max} = 10 km/s
- 500 g, 80 x 80 x 40 mm
- dust & debris monitoring [Wolf et al., 2012]

Picture credit: MSSS/Wolf et al. (2012)

Launch Window

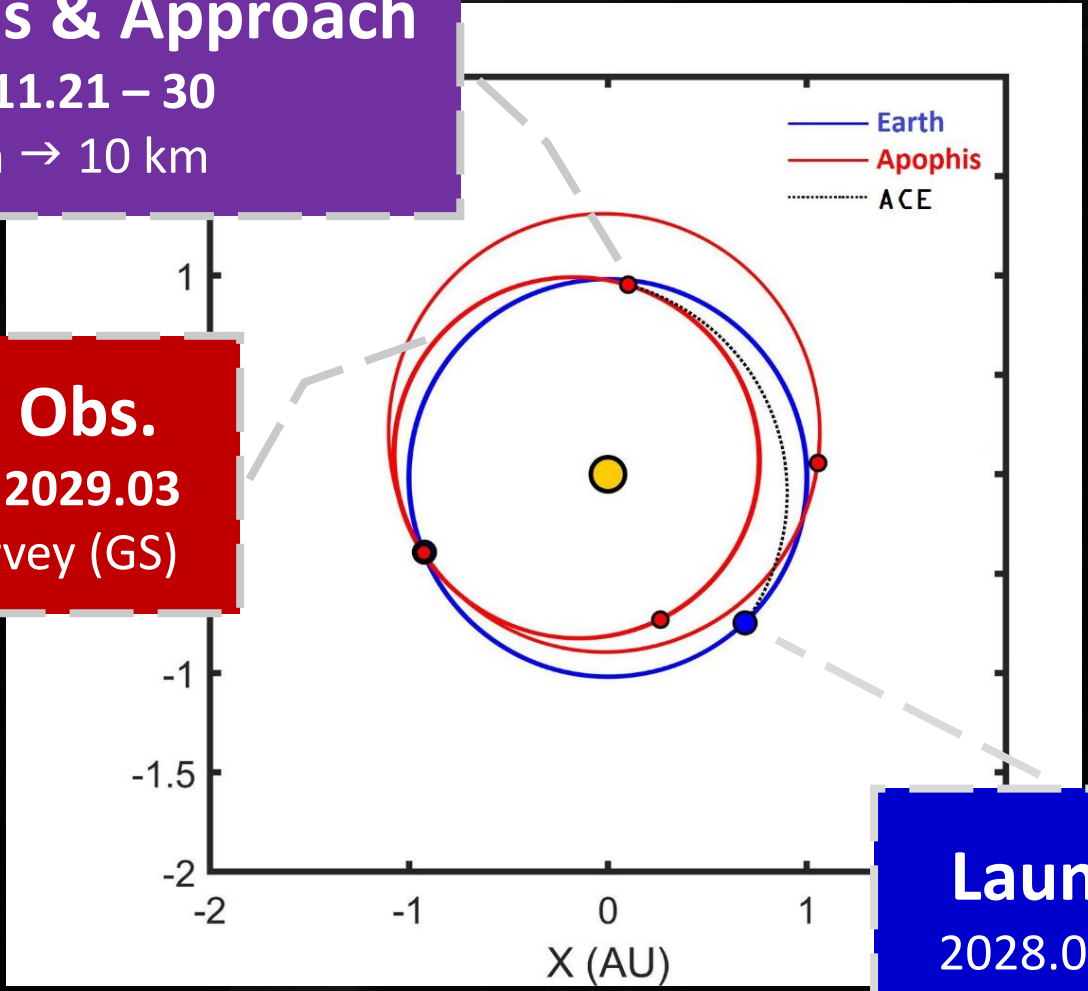
- Best between July 16th – August 10th, 2028



Concept of Operations

Rendezvous & Approach
2028.11.21 – 30
50 km → 10 km

Pre-CE Obs.
2028.12 – 2029.03
Global Survey (GS)



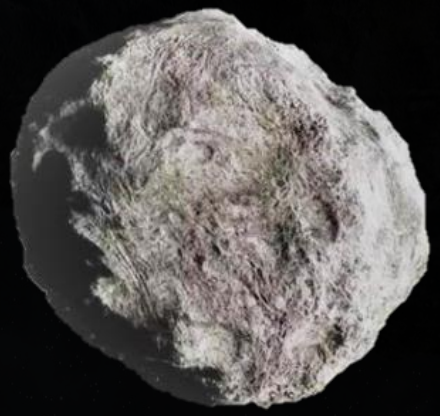
Launch
2028.08.05

Concept of Operations

- In Pre-CE Observation (and Post-CE Obs.):

GS1: co-orbit
10 km, 55 days
Bulk properties

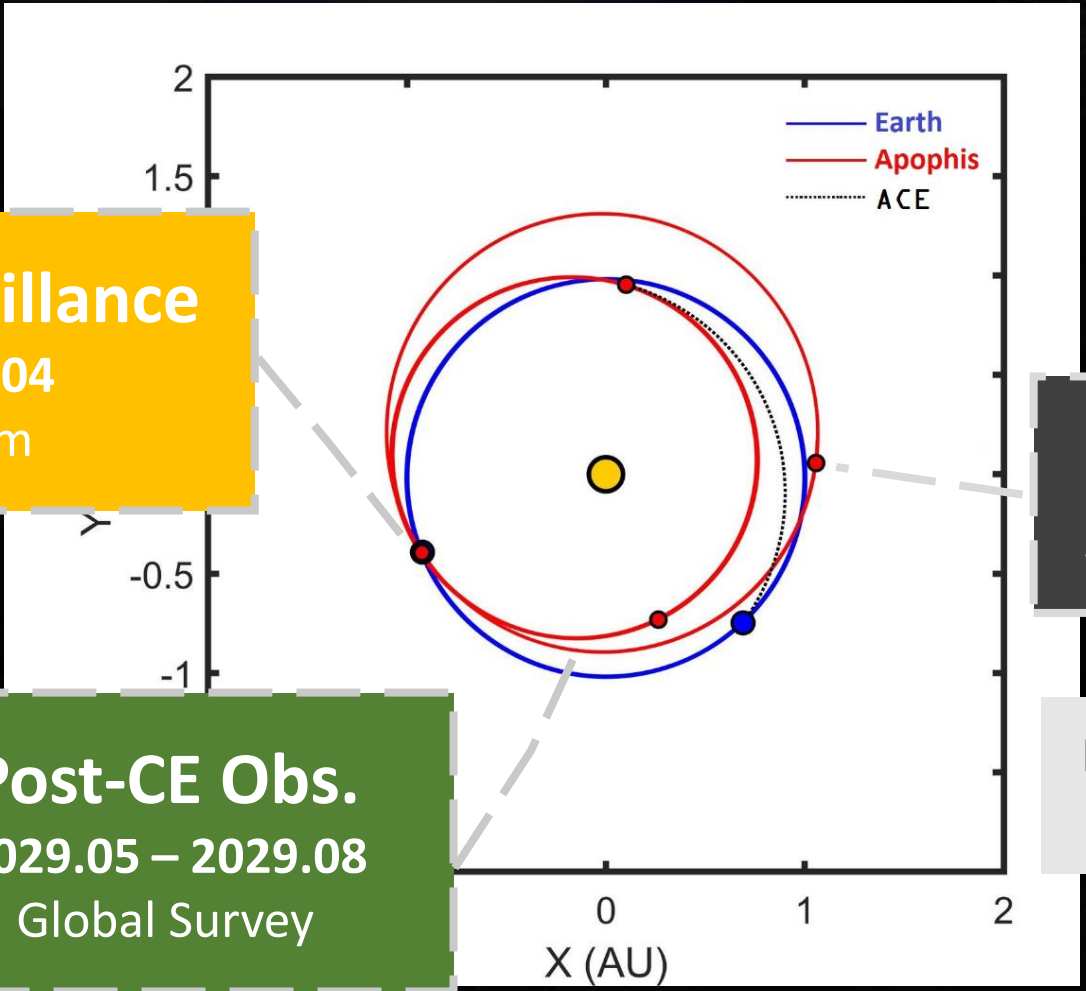
GS2: orbit
2.5 km, 55 – 56 days
Surface features



Note: The distance and the size of spacecraft are not to scale.

Concept of Operations

CE Surveillance
2029.04
10 km



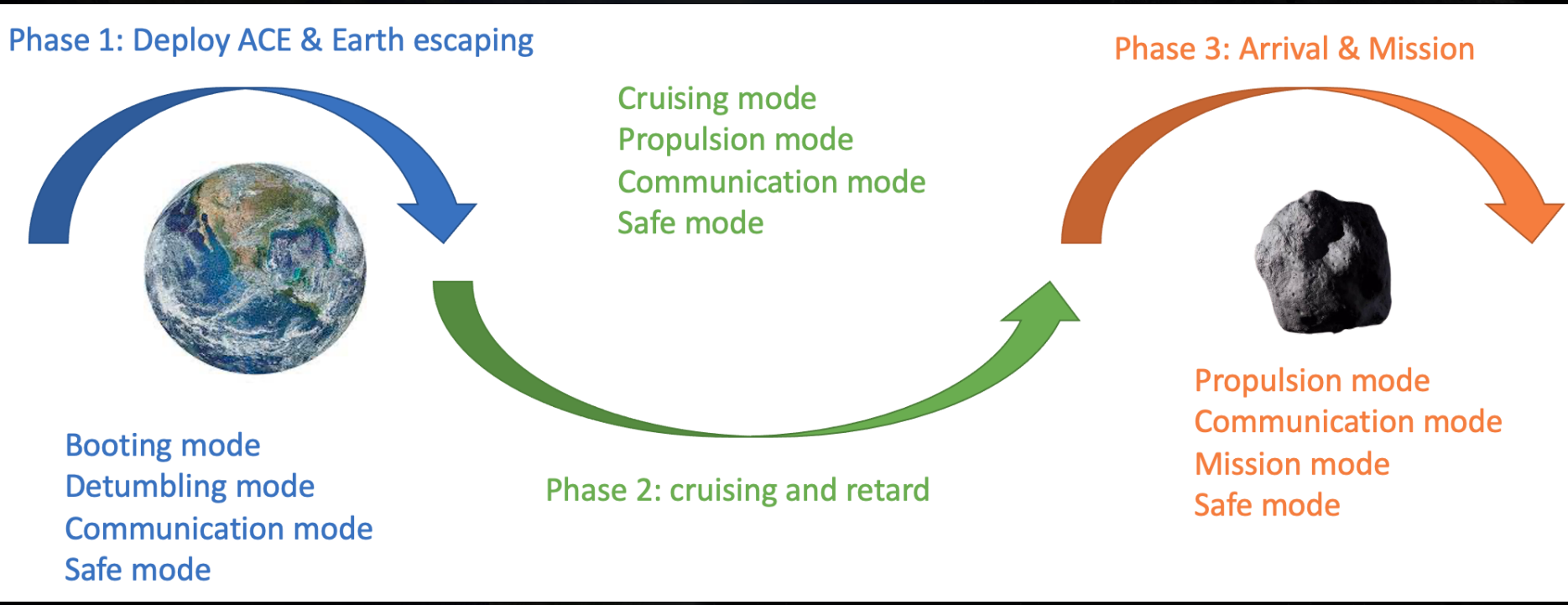
Finale
2029.08 / 09

Post-CE Obs.
2029.05 – 2029.08
Global Survey

Mission span
~ 280 days

Concept of Operations

- Operation modes:

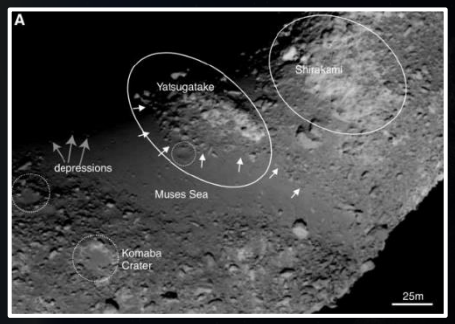


Key Performance Parameters

- Image resolution

1.7 m/px

40 cm/px



→ Surface features of Itokawa with image resolution ~70 cm/px. (Saito et al., 2006)

GS1 | GS2

Pre-CE Obs. | **CES** | **Post-CE Obs.**

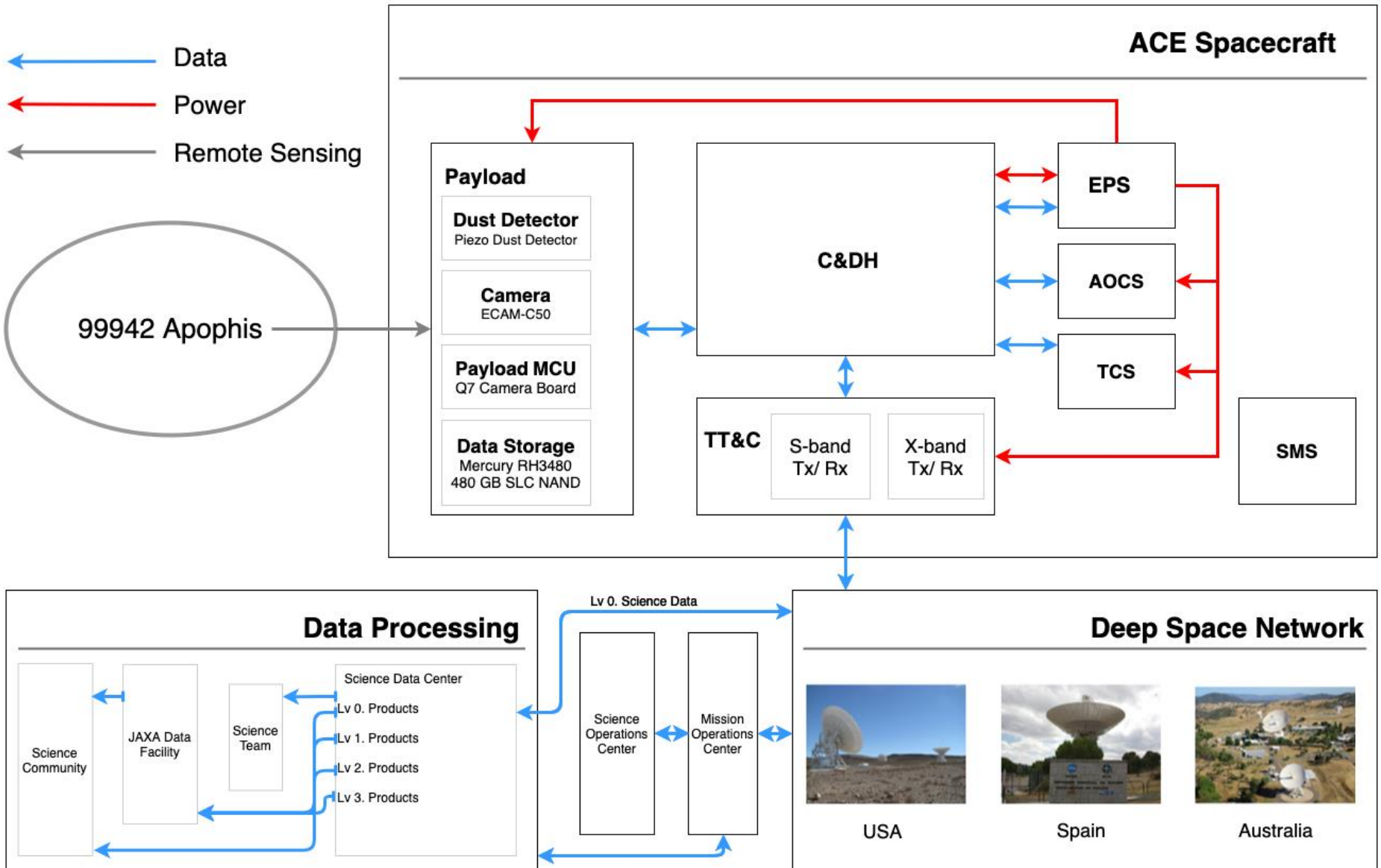
- Image S/N: ~100
- Accuracy of attitude determination: ±0.001°

80 kbps
~ 4 d

3 kbps
~ 70 d

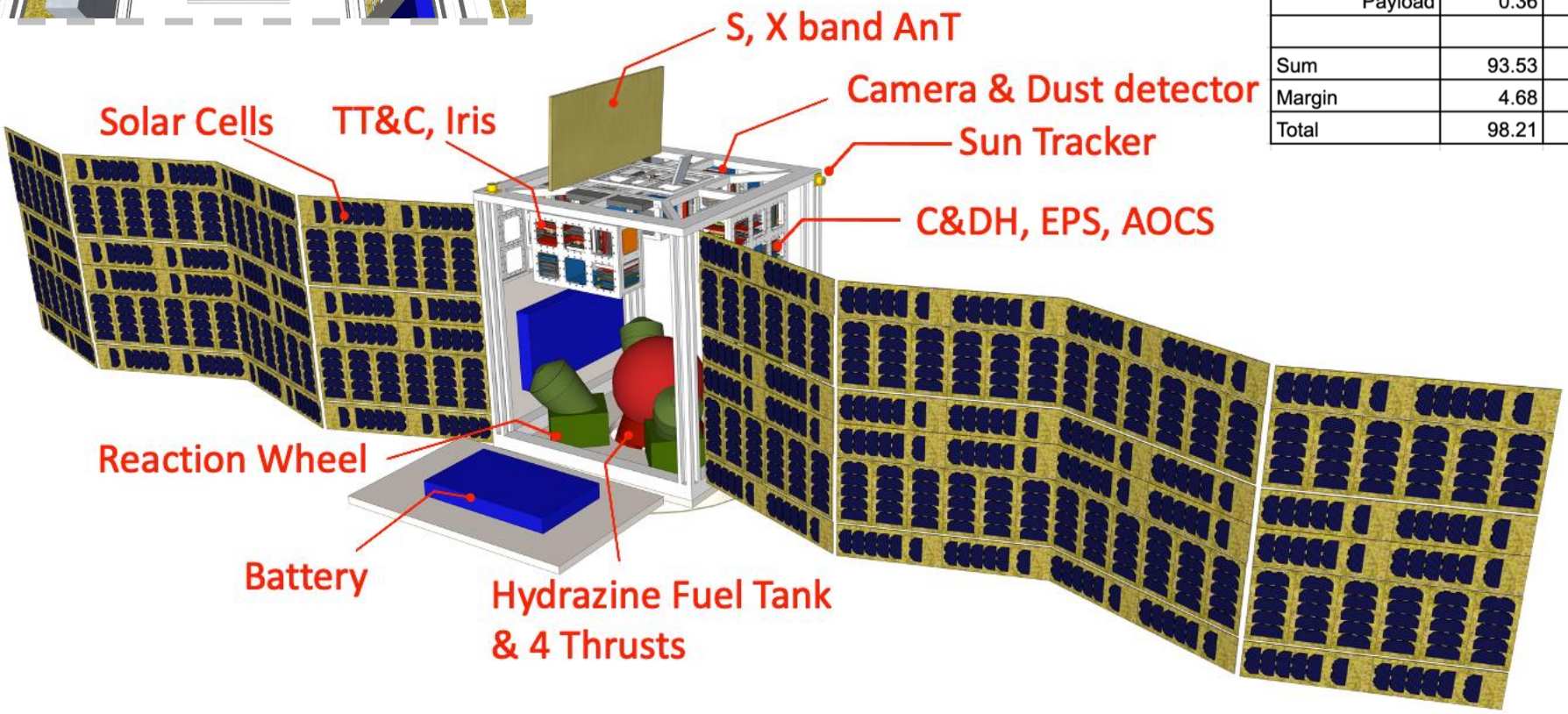
- Communication rate

Space Segment



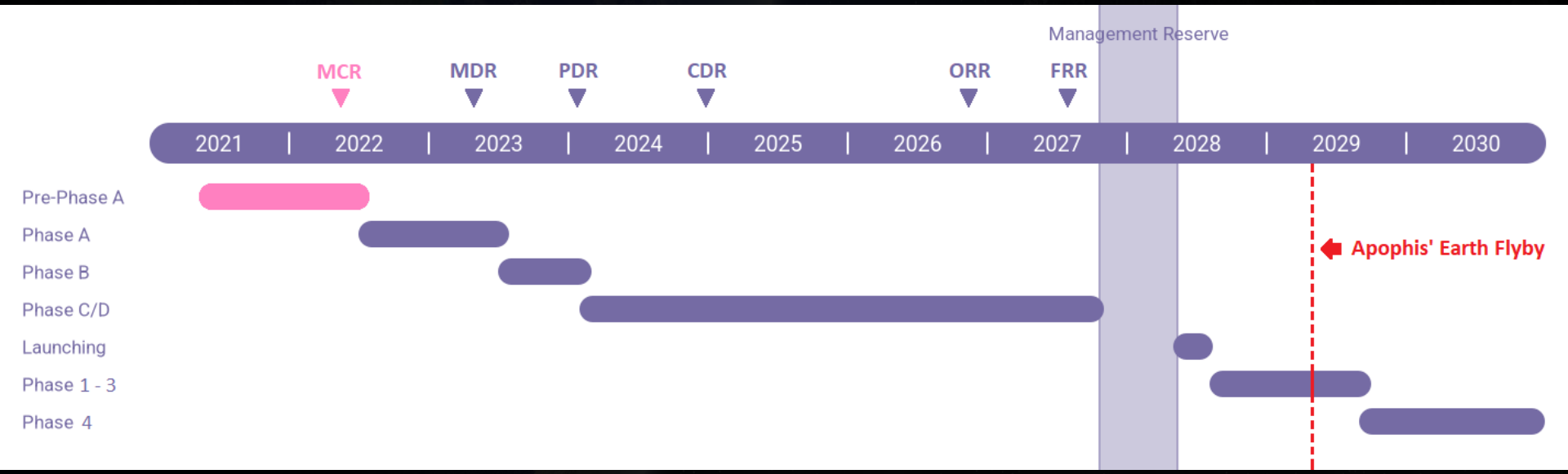
Space Segment

ACE Subsystem	Mass (kg)	Power (W)
SMS	39.65	0
TCS	3.82	10
AOCS	19.2	26.75
EPS	24.8	10
C&DH	0.9	2
TT&C	4.8	50
Payload	0.36	3.5
Sum	93.53	102.25
Margin	4.68	20.45
Total	98.21	122.7



Implementation Plan

- Leading organization: TIPSSE
- Potential partners: NCU, NCKU, TSU, NSPO
- Estimated cost: 2,082,500 USD (s/c only)
- Timeline:



Summary

ACE has the potential to:

- Characterize the PHA Apophis with an imager and a dust detector to address key constraints to planetary defense and asteroid science
- Demonstrate a relatively low-cost and short-duration investigation capability for a small spacecraft
- Stimulate the scientific research and technological capabilities of industrial sectors in Taiwan

Thank you

ありがとうございました