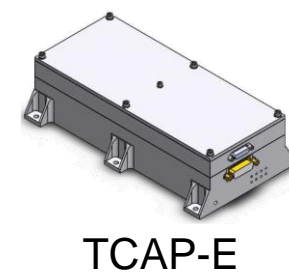
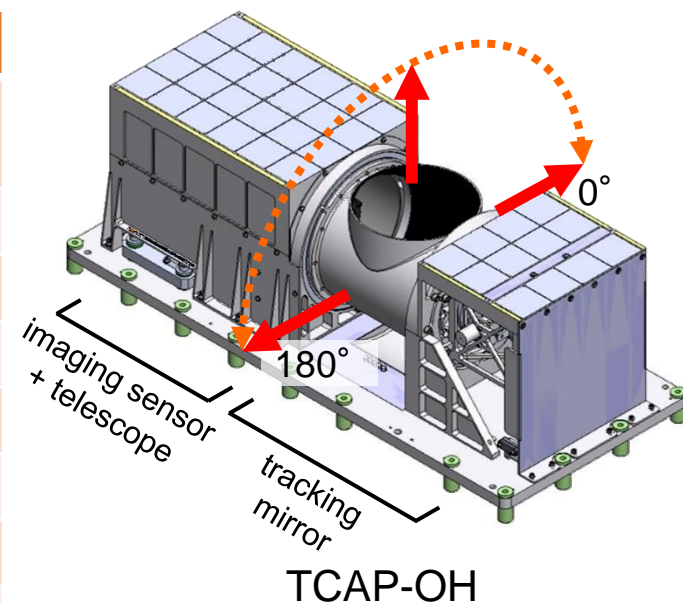


# Telescopic CAmera for Phaethon (TCAP)

- TCAP = telescope + tracking mirror
- 3.5 m/pixel @500 km (closest approach)

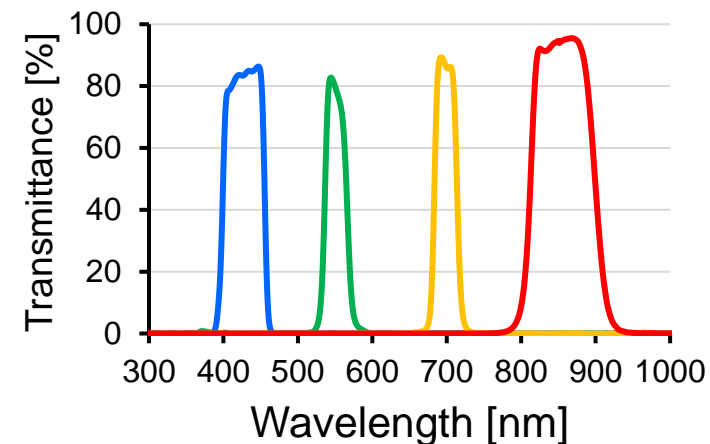
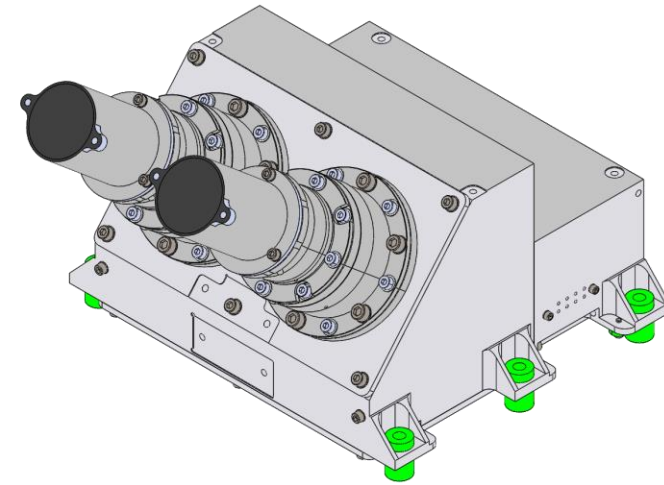
Property	Value
Aperture	114 mm (blocked by a $\phi 49.16$ -mm secondary mirror)
Focal length	787.7 mm
FOV	0.81 deg $\times$ 0.81 deg
Pixels per image	2048 $\times$ 2048 pixels
Pixel size	5.5 $\mu\text{m}$ $\times$ 5.5 $\mu\text{m}$
Pixel FOV	7 $\mu\text{rad}$ /pixel
Spatial resolution	Ensquared energy (2x2 pixels) $\geq 0.52$
Max. imaging rate	1 fps for full image
Asteroid tracking	Yes
Mass	11.17 kg (TCAP-OH 10.0 kg, TCAP-E 1.17 kg)
Volume	
TCAP-OH	D250 mm $\times$ W600 mm $\times$ H270 mm
TCAP-E	D120mm $\times$ W220 mm $\times$ H63.2 mm



# Multiband CAmera for Phaethon (MCAP)

- Having multiple optical systems and sensors to take images of all the bands simultaneously.
- 42 m/pixel @778 km (nominal distance of MCAP imaging)

Property	Value
Wavelength	425, 550, 700, 850 nm
Aperture	20.8 mm
Focal length	99 mm
FOV	6.54 deg × 6.54 deg
Pixels per image	2048 × 2048 pixels
Pixel size	5.5 μm × 5.5 μm
Pixel FOV	54 μrad/pixel
Spatial resolution	$\leq 0.11$ mrad for $\leq 1.0$ deg angle of view $\leq 0.13$ mrad for $\leq 1.9$ deg angle of view $\leq 0.16$ mrad for $\leq 2.5$ deg angle of view $\leq 0.55$ mrad for $> 2.5$ deg angle of view
Max. imaging rate	1 fps for full image
Asteroid tracking	No
Mass	2.7 kg
Volume	D247 mm × W204 mm × H166 mm

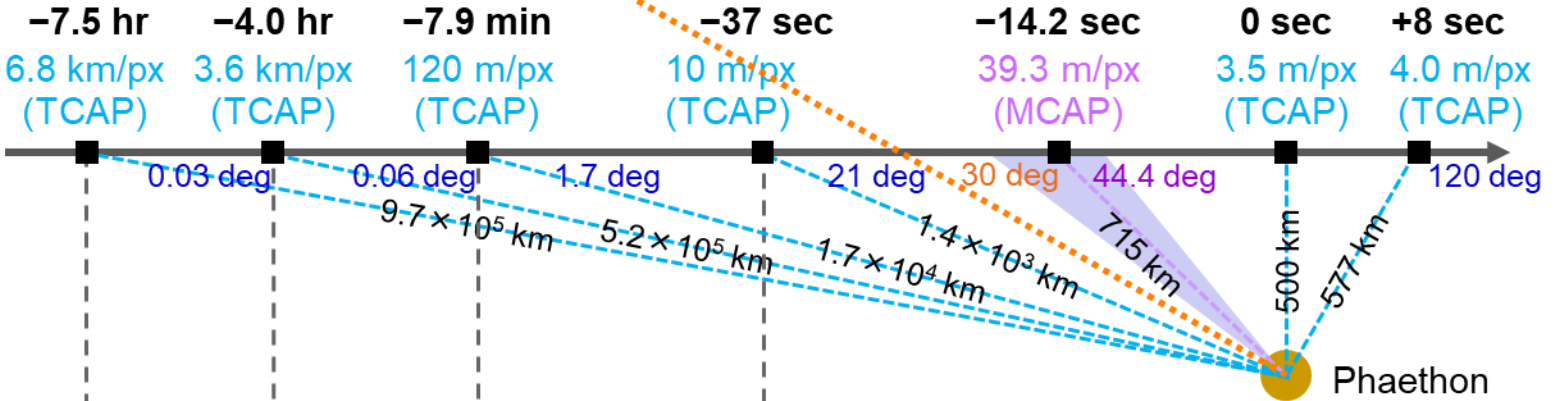


# Flyby imaging with TCAP and MCAP

36 km/s relative velocity



Time to closest approach  
Pixel scale



Material distributions

Local features

Semi-global features

Global shape

Multiband imaging

≥1 frame/sec

Imaging for surface geological feature obs.

1 frame/sec

Imaging for 3D topographic model

every 1 deg or less

Imaging for outline obs.

a few frames

Imaging for light curve obs.

1 frame/10 min

Phaethon  
(~φ 5-6km)

# Expected TCAP images

-40 sec  
phase angle = 9 deg

10 m/px

Southern  
hemisphere



Northern  
hemisphere

-30 sec  
phase angle = 4.5 deg

8.1 m/px



-25 sec  
phase angle = 0 deg

7.1 m/px



opposition

-20 sec  
phase angle = 5.5 deg

6 m/px



-10 sec  
phase angle = 25 deg

4.3 m/px



0 sec  
phase angle = 60 deg

3.5 m/px



closest approach

+10 sec  
phase angle = 95 deg

4.3 m/px

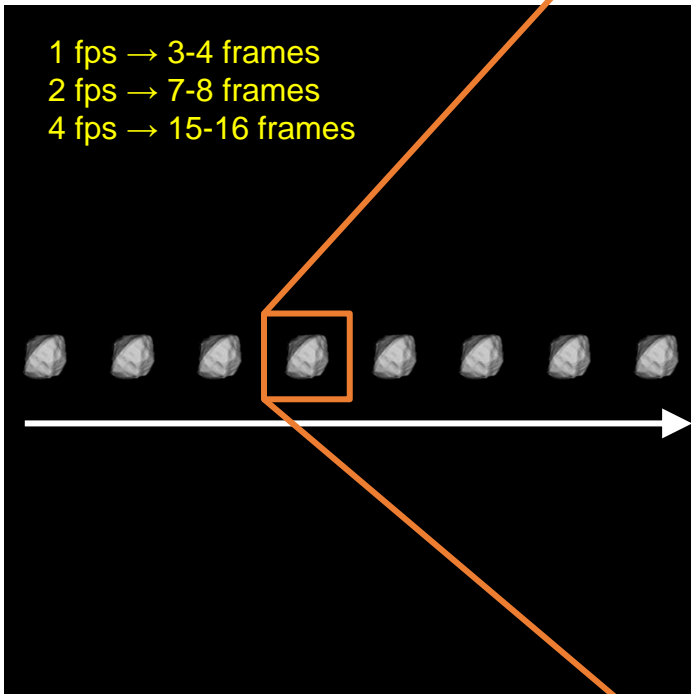


Phaethon shape model:  
Marshall+2022

# Expected MCAP images

## Appearance of Phaethon in the FOV of MCAP

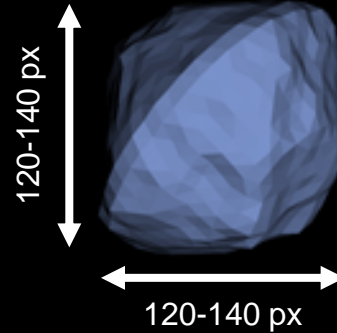
1 fps → 3-4 frames  
2 fps → 7-8 frames  
4 fps → 15-16 frames



Phaethon shape model:  
Marshall+2022

425 nm

43 m/px



550 nm



700 nm



850 nm

