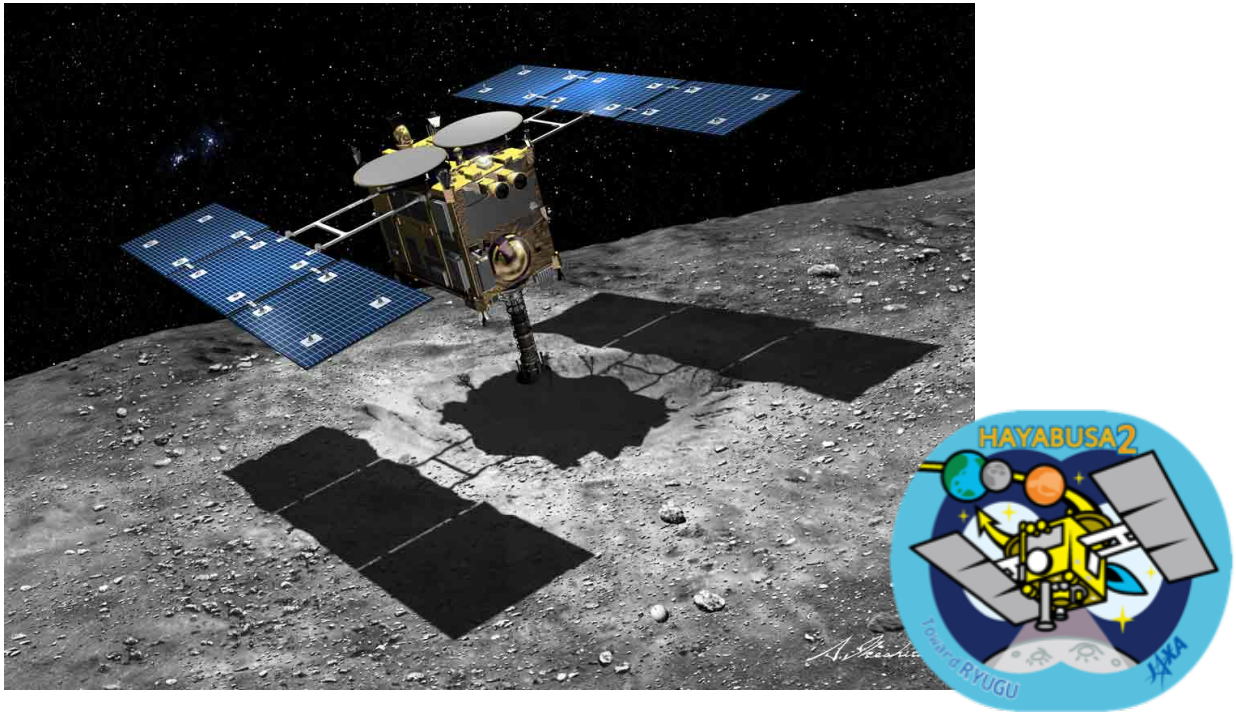
Hayabusa2 Status



SMPAG

Space Mission Planning Advisory Group 10th Meeting

STSC, UN-COPUOS, Vienna

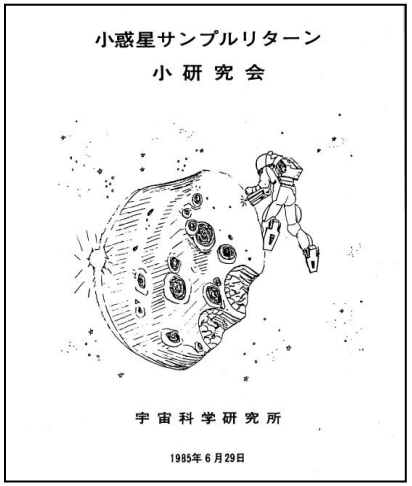
January 31, 2018

Makoto Yoshikawa (JAXA)

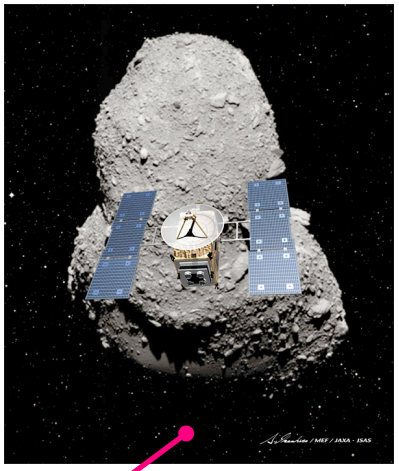
Japan's Asteroid Explorations

Past, Present, and Future

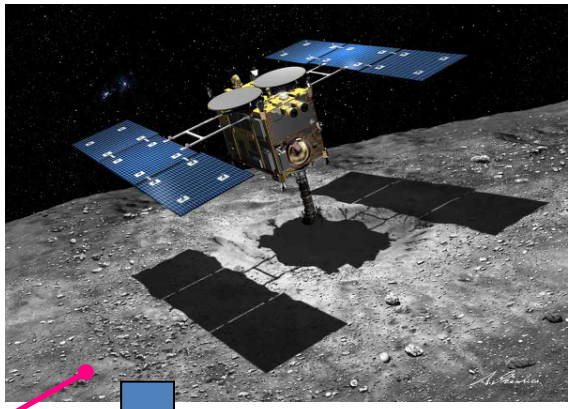
Starting Point
1985



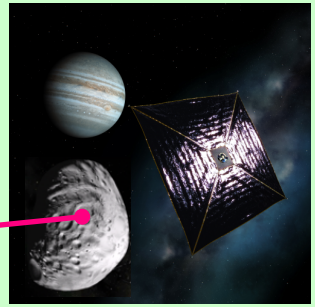
Hayabusa
2003-2010



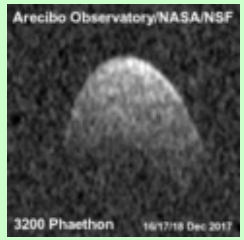
Hayabusa2
2014-2020



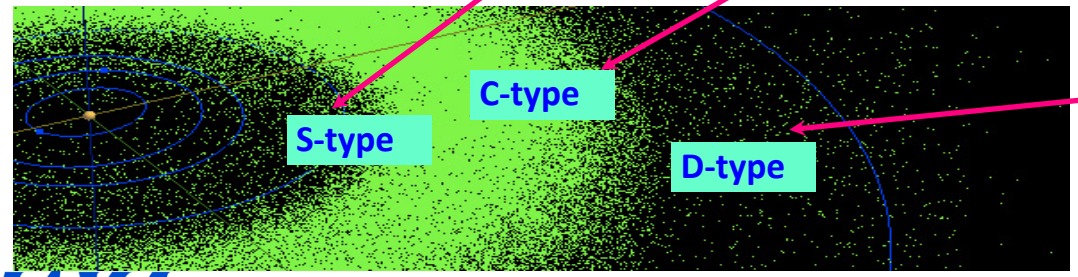
Future missions
(under discussion)



OKEANOS
Jupiter Trojans



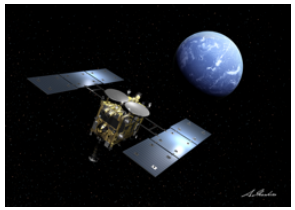
DESTINY+
Phaethon



Mission Scenario of Hayabusa2

Launch

03 Dec. 2014

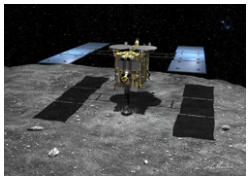


03 Dec. 2015

Earth swing-by

Arrival at Ryugu

June-July 2018



The spacecraft observes the asteroid, releases the small rovers and the lander, and executes multiple samplings.

Sample analysis

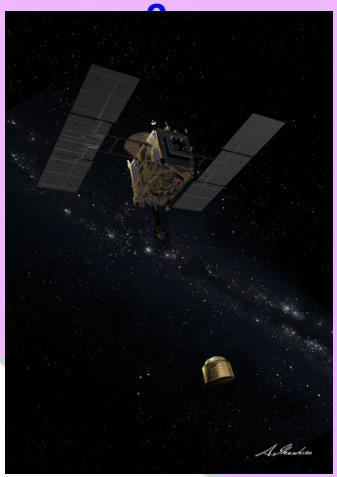
Earth Return

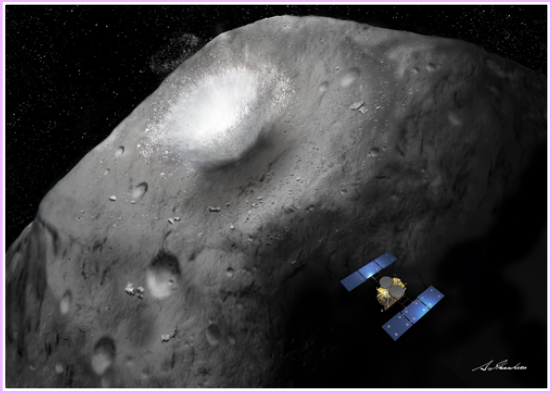
Nov.-Dec. 2020

Nov.-Dec. 2019 : Departure

New Experiment

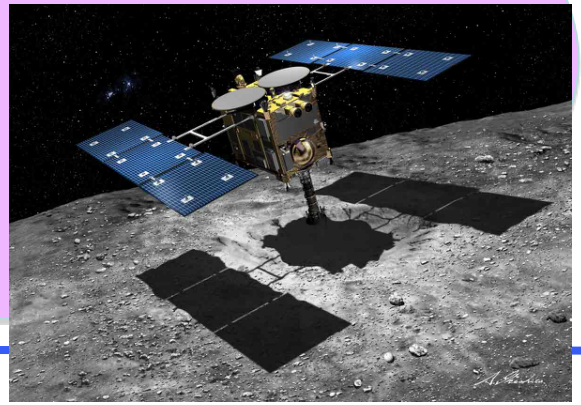
201



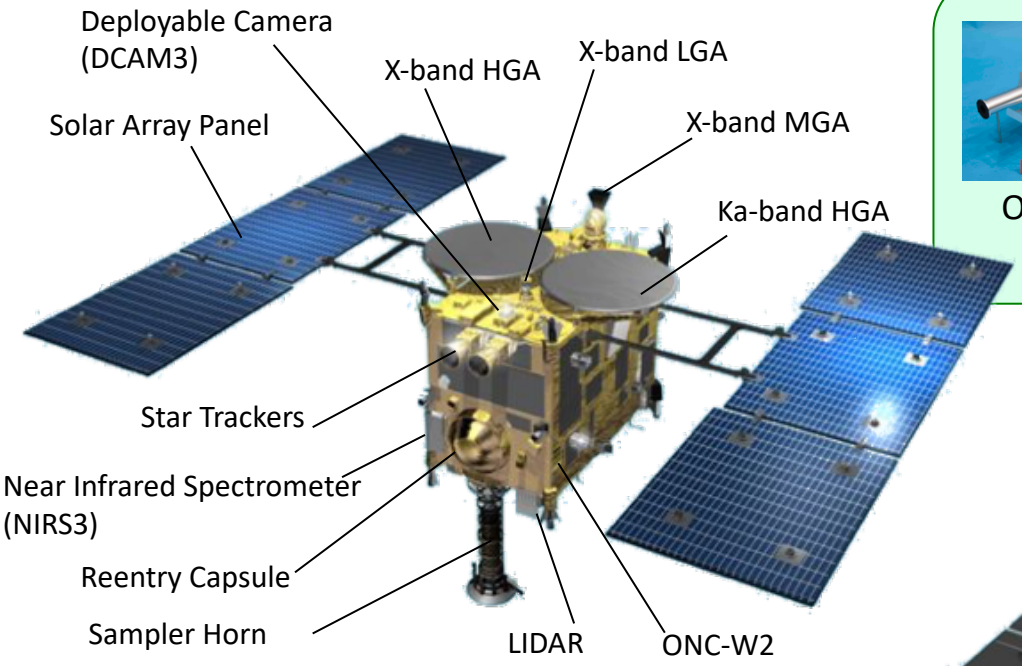


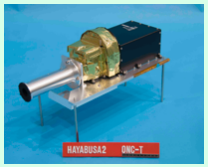
The impactor collides to the surface of the asteroid.

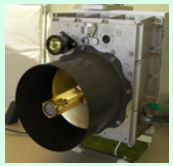
The sample will be obtained from the newly created crater.

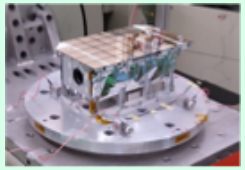


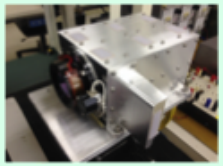
Hayabusa2 Spacecraft



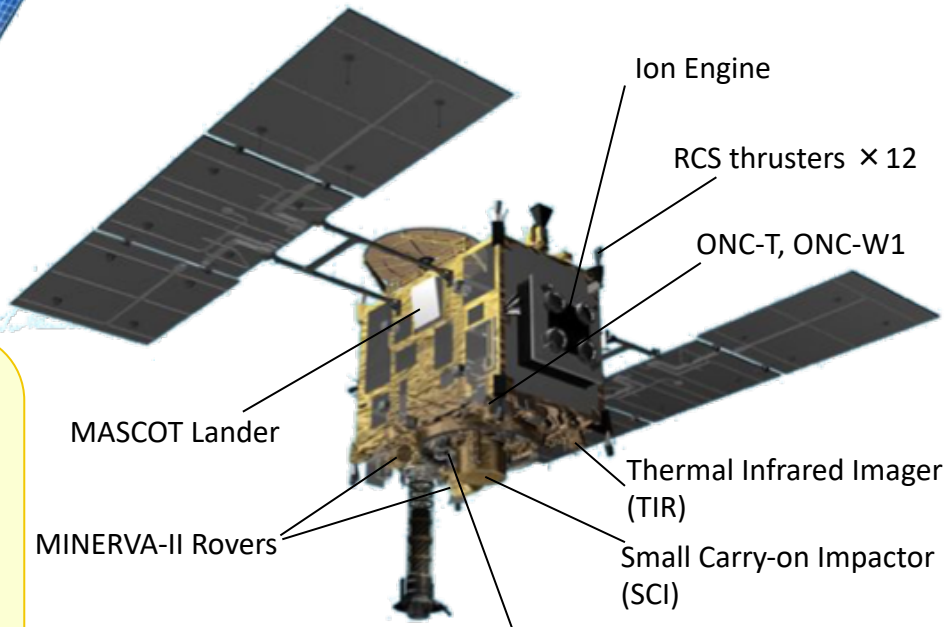

ONC-T


LIDAR


NIRS3

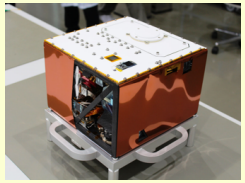

TIR

Science Instruments

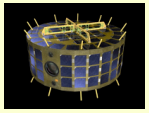


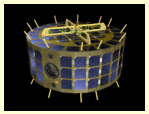
Small Lander and Rovers

MASCOT


by DLR and CNES

MINERVA-II


II-1A


II-1B

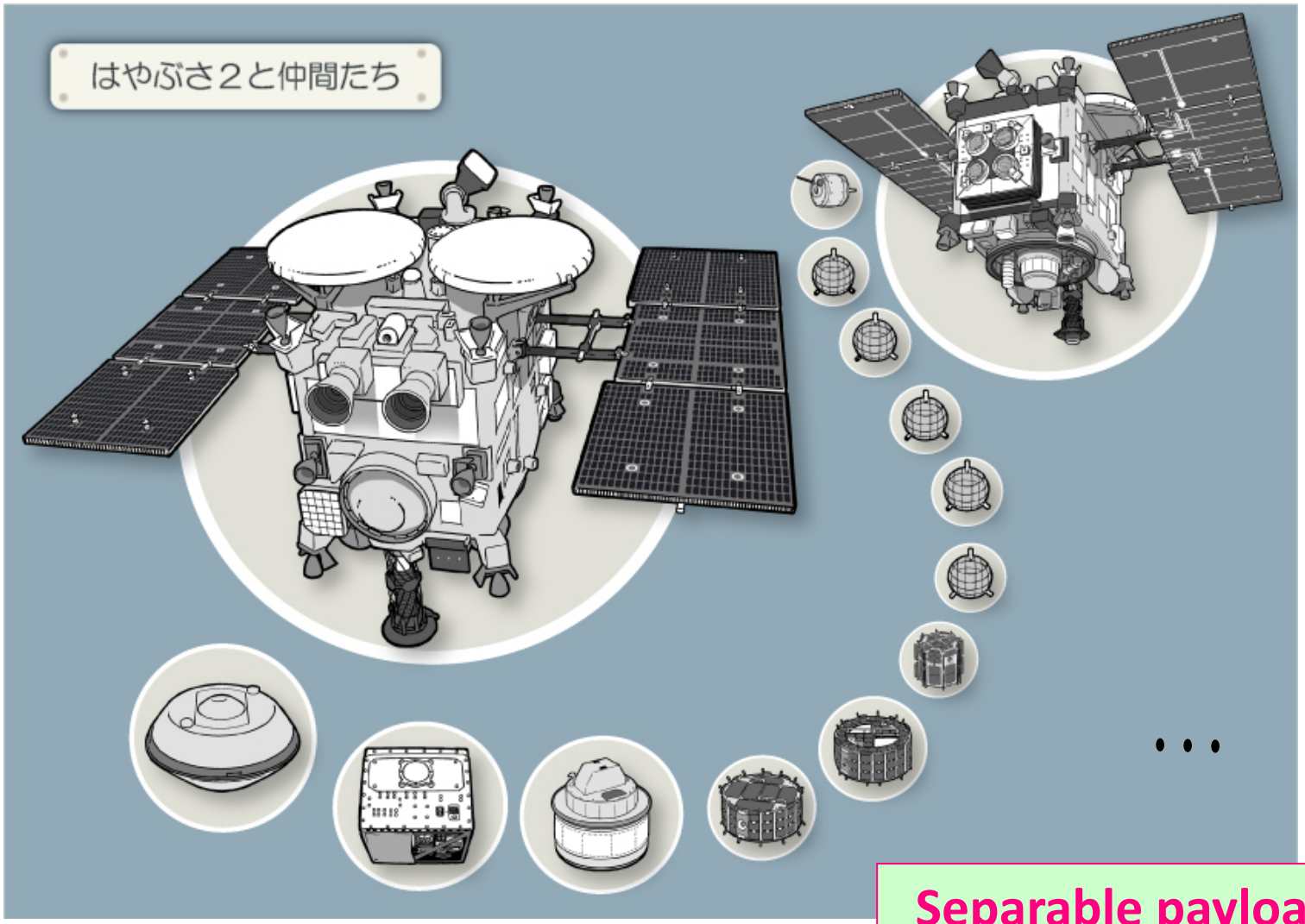

II-2

II-1 : by JAXA MINERVA-II Team

II-2 : by Tohoku Univ. & MINERVA-II consortium

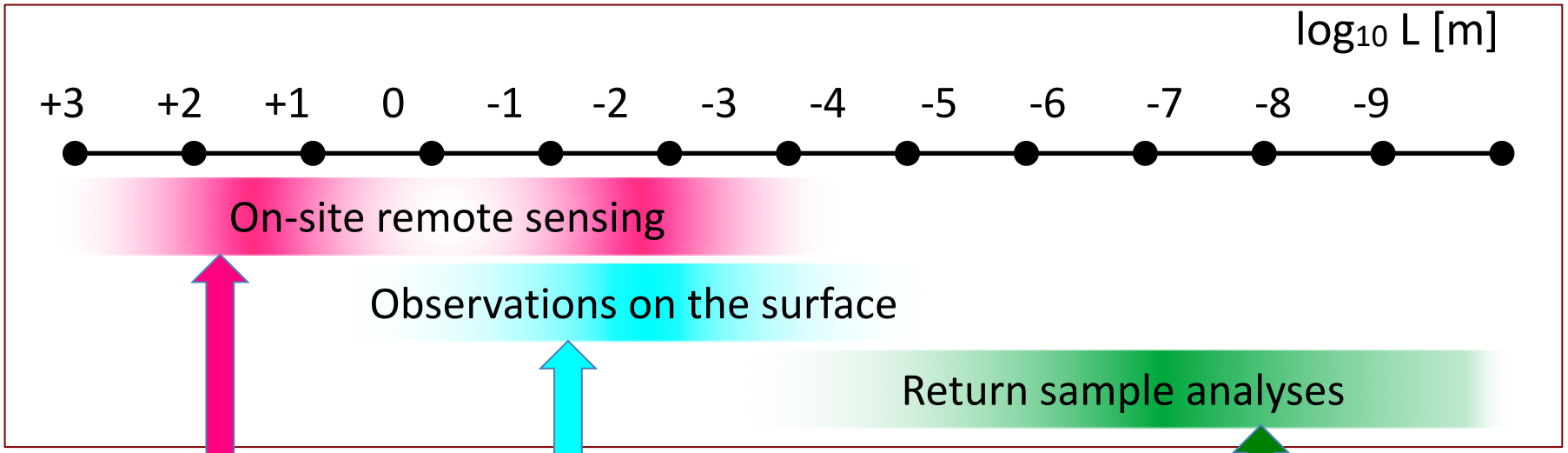
Size : 1m × 1.6m × 1.25m (body)
Mass: 609kg (Wet)

Hayabusa2 and its Family



Separable payloads

Science for Wide Scale Range



ONC (T, W1, W2)
LIDAR
NIRS3
TIR

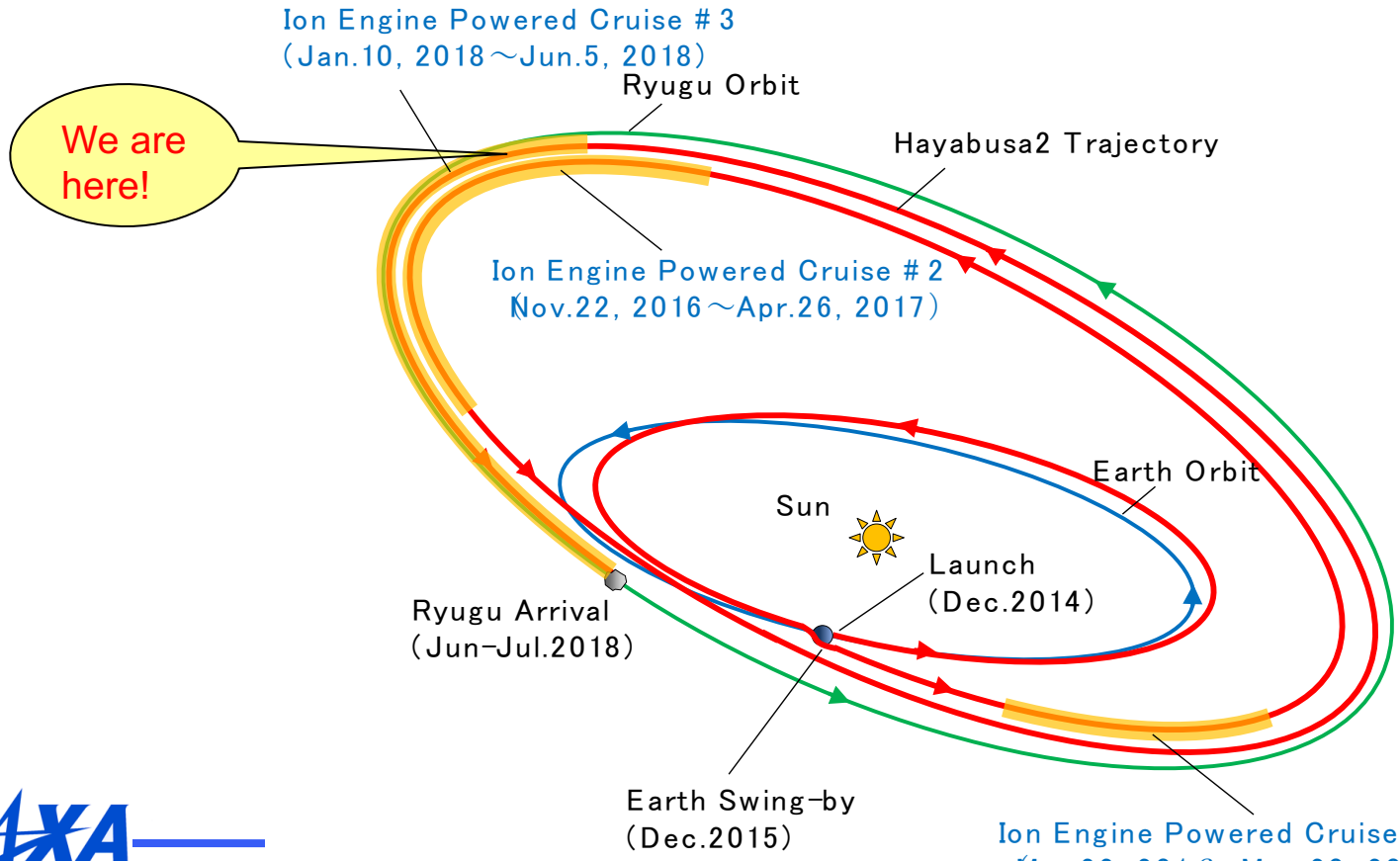
SCI
DCAM3
Sampler

MASCOT
MINERVA-II (1A, 1B, 2)

Ground based facilities

Present Status of Hayabusa2 (as of Jan. 31, 2018)

- Traveled 2.82 billion km (w.r.t heliocentric inertial frame)
- Solar distance 1.22au.
- Earth distance 2.08au (RTLT=35min.)
- Distance to Ryugu 2.36 million km (0.024au)



Recent / Near Future Cruise Operation

＜Recent Ops.＞

2017

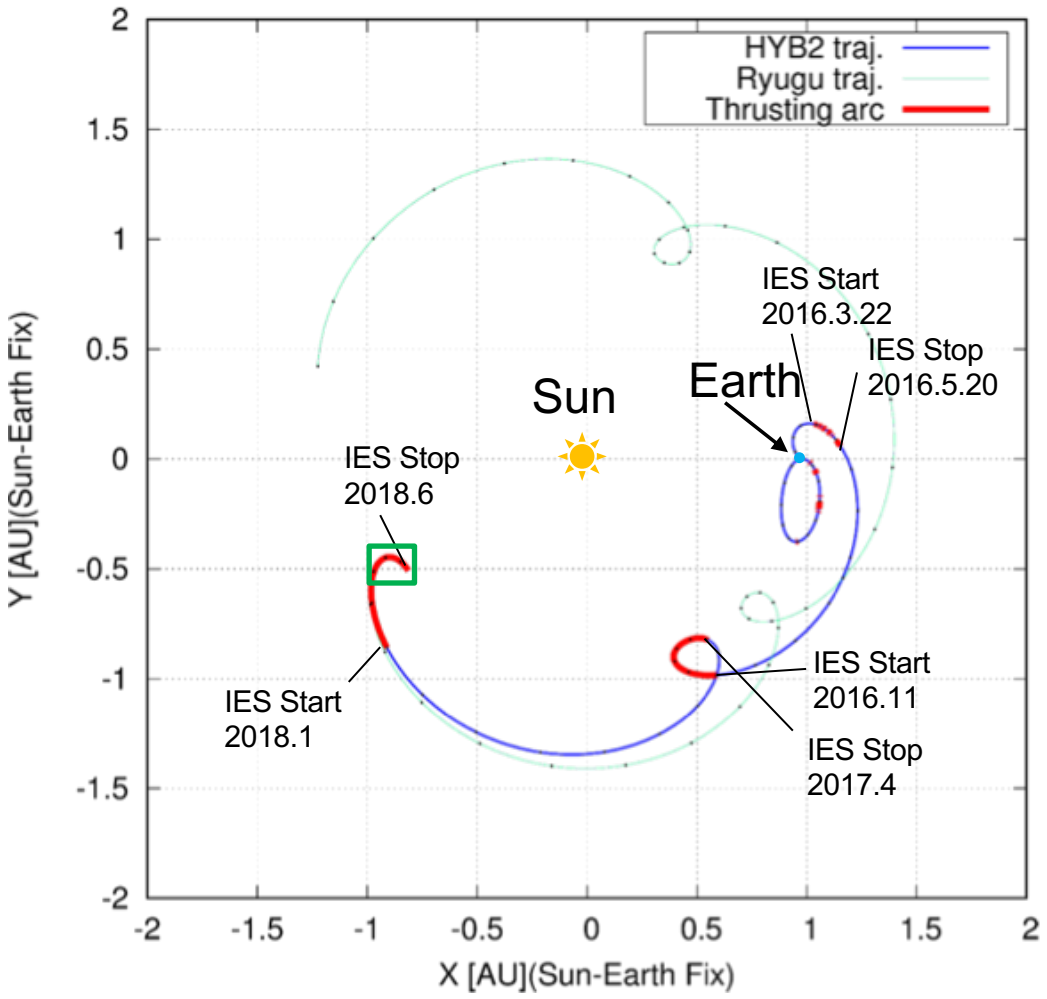
Apr.15	2nd IES Burn completed
Apr.25-26	IES trim burn
May16-28	Jupiter/star calibration
May.30-Jun.1	RCS test burn
Sep.5	Spacecraft clock reset
Jul.18-Nov.14	Science instruments program update
Nov.18,28	DSN-SSOC realtime Doppler transfer test
Dec.2	DSN-UDSC uplink transfer test
Dec.26-27	IES test burn

2018

Jan.10	3rd term IES Burn Start

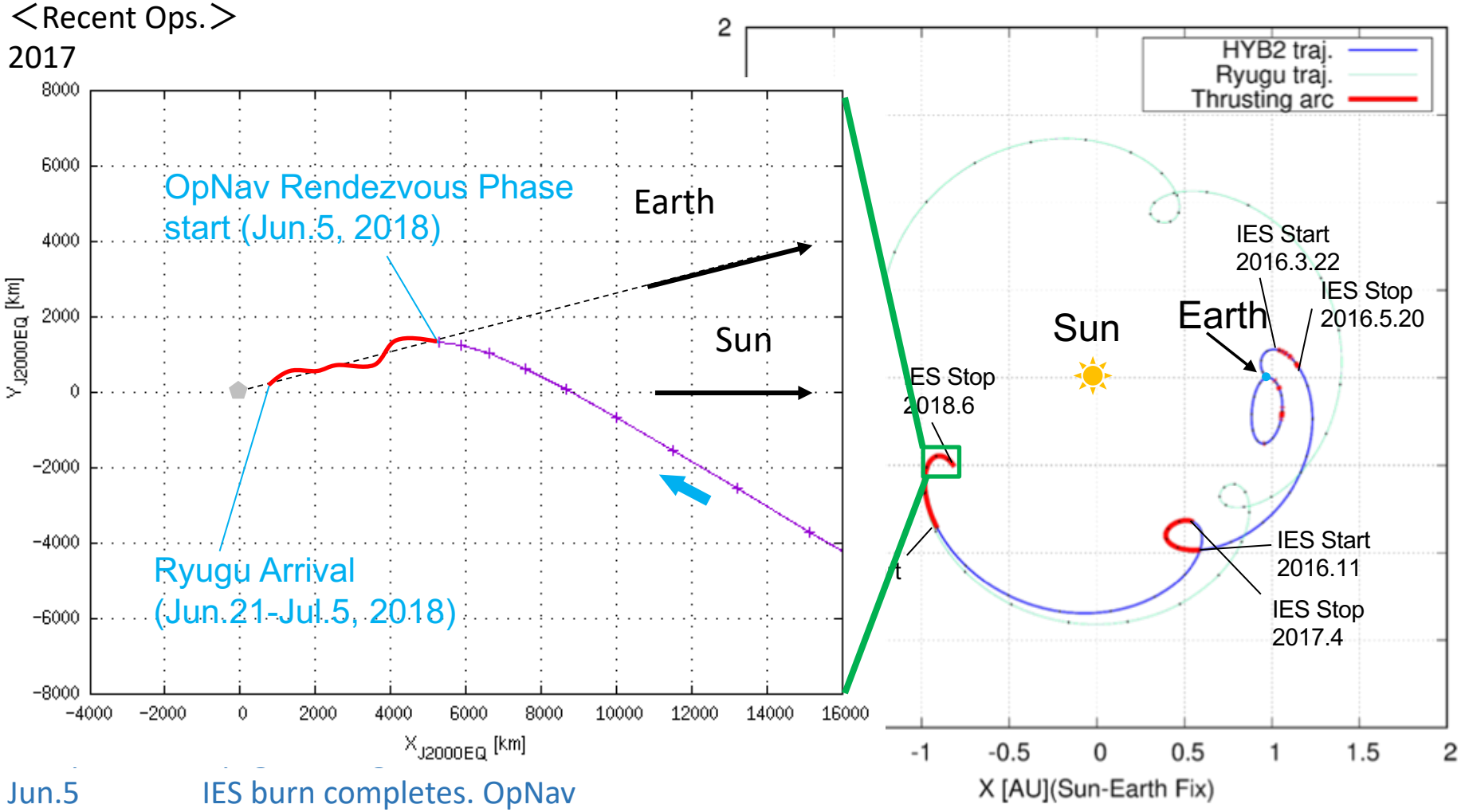
＜Near Future Ops.＞

~May	Ryugu first light
Jun.5	IES burn completes. OpNav begins.



Recent / Near Future Cruise Operation

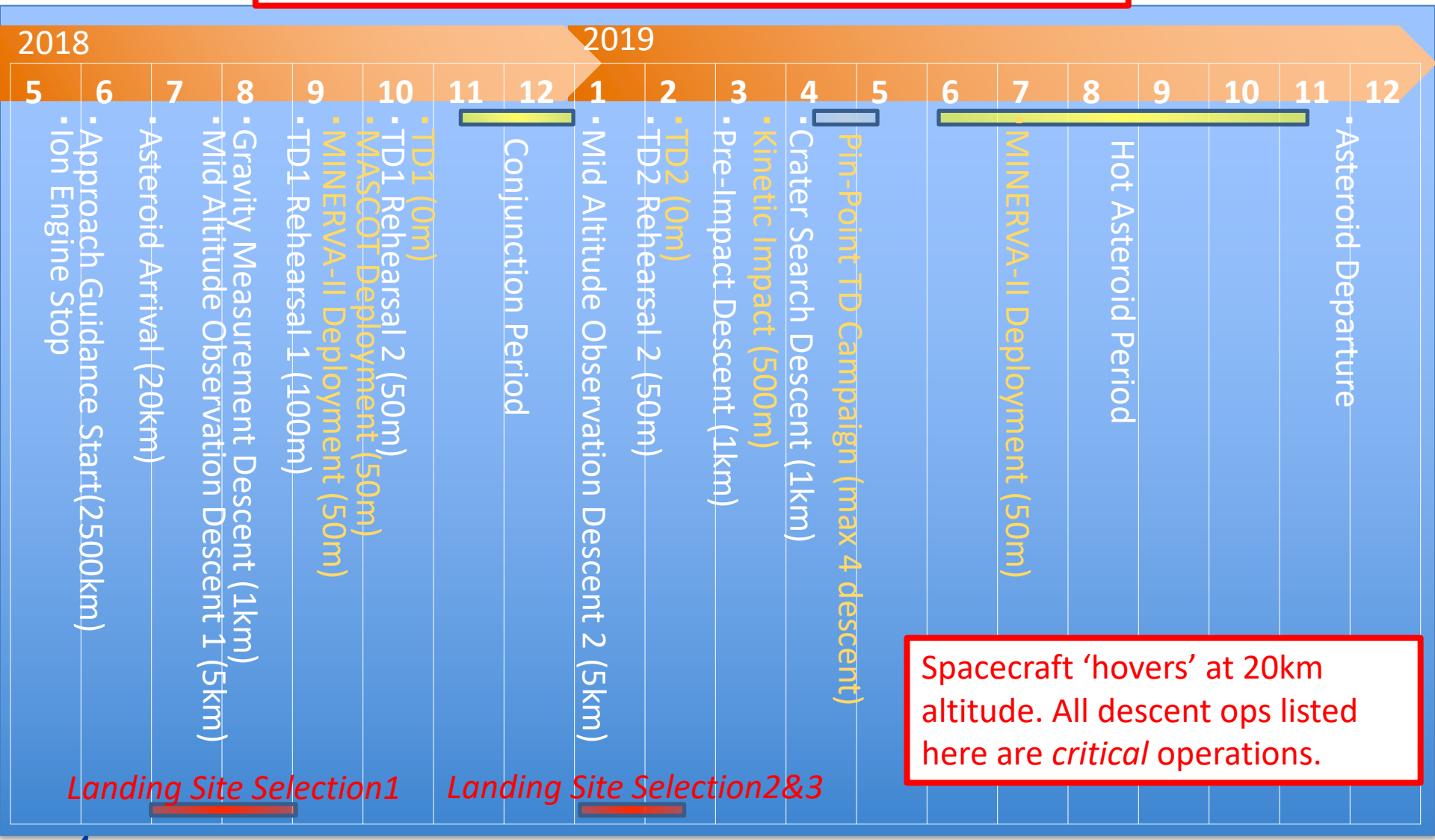
＜Recent Ops.＞
2017



Jun.5 IES burn completes. OpNav begins.

Proximity Operation Plan

Typical plan, Actual schedule fixed after arrival



Spacecraft 'hovers' at 20km altitude. All descent ops listed here are *critical* operations.

Proximity Operation Training

Landing Site Selection (LSS) Training

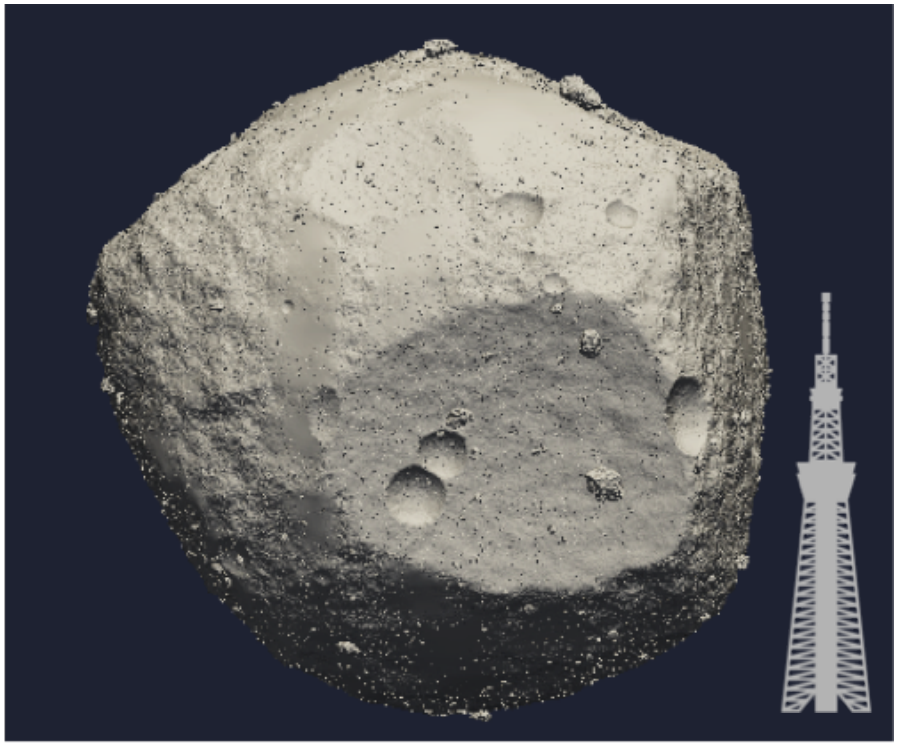
- Purpose: Verification of LSS process
  - Decision making framework/criteria, Tools and interface, ...
- Trainee
  - 100+ participants, JAXA engineering, Science (International), MASCOT team
- Training data
  - Asteroid images (CG) based on actual observation operation plan
  - Science data (Thermal, near infra-red, LIDAR data, gravity, …)
  - Navigation data (position & velocity of S/C), Attitude data.

Real-Time Integrated Operation (RIO) Training

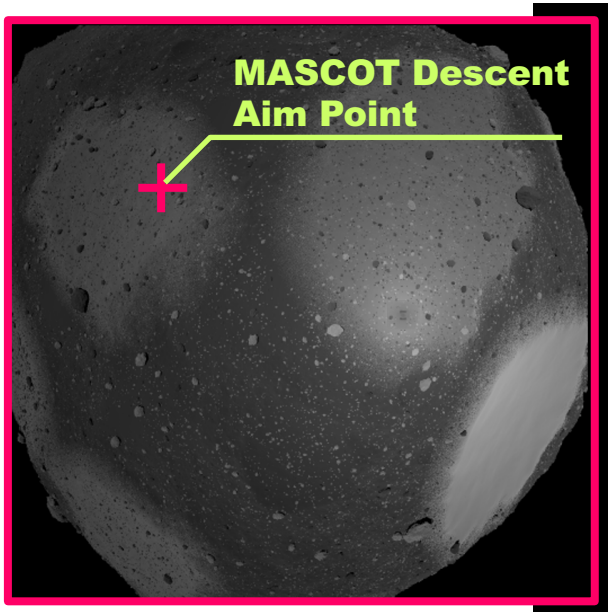
- Purpose: Real-time operation training, Verification of ground support tools
  - Touchdown operation, Impact operation, rover landing…
- Trainee: all the operation staffs
- Training data
  - Asteroid images (CG, real-time)
  - Telemetry data (with communication delay)

Fictitious Ryugu = Ryugoid

- Virtual asteroid ‘Ryugoid’ in place of mysterious Ryugu.
- Assume from the formation history of Ryugoid. The shape and all the other properties were derived from the history.
- Each property was Intendedly deviated from known Ryugu property.
- The rotation state is randomly selected from public via Twitter.
- Shape model: 25cm resolution, 370 million polygon.
- Observation data generated based on actual operation plan & actual instruments performance.
  - Generates attitude/trajectory simulation data based on operation plan
  - Observation data and their ancillary data generated based on the simulation data.
  - Goes through all the ground pipe line process as it really is.

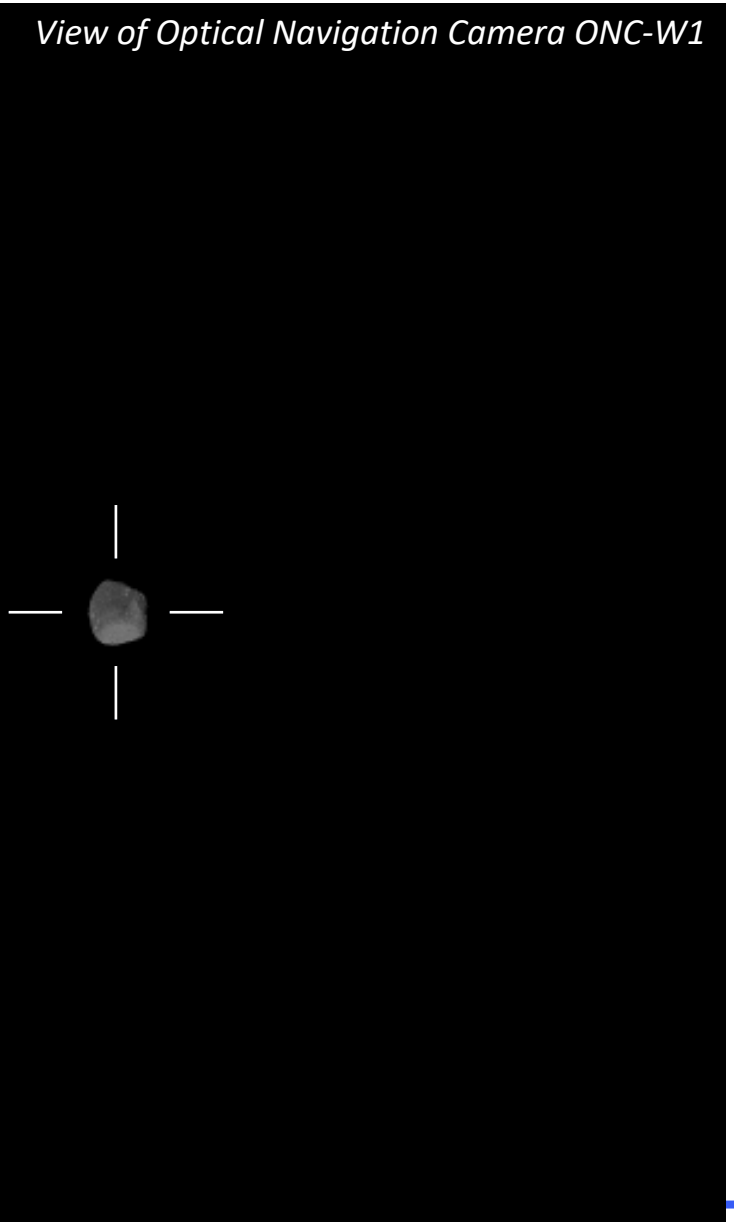


RIO Example: MASCOT Release Operation Practice



Descent start (-1m/s)
↓
Slow Down (-0.1m/s)
↓
60m arrival/release
↓
Ascent to 3km
↓
Hovering

View of Optical Navigation Camera ONC-W1



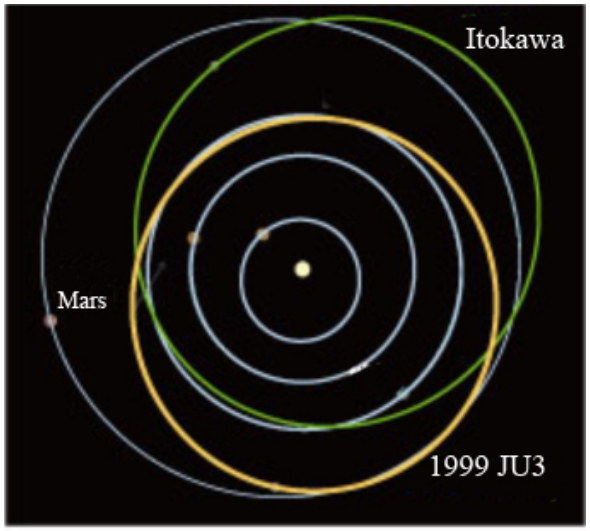
Target Asteroid : 1999 JU3 = Ryugu

Asteroid (162173) 1999 JU3

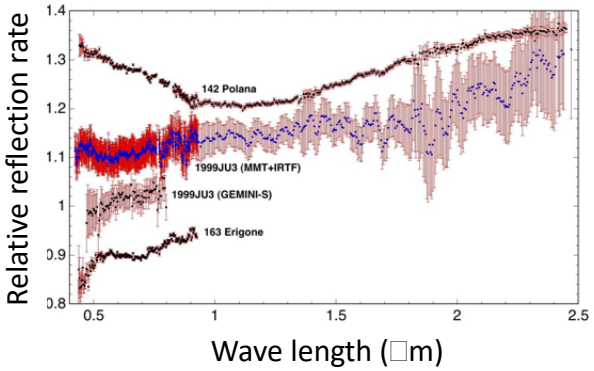
Discovered in May 1999 by LINEAR Team

Shape : almost spherical
Size : 900 m
Rotation period: 7.6 h
Pole orientation (320°, -40°) :current estimate
Albedo : 0.05
Type : Cg

Orbit

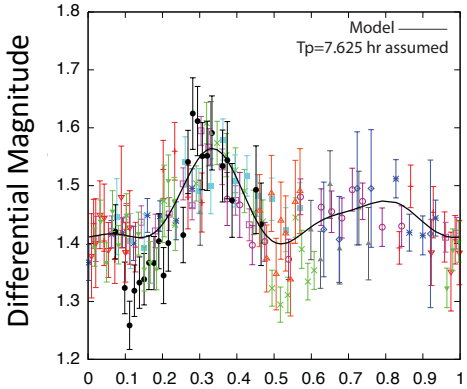


Spectrum



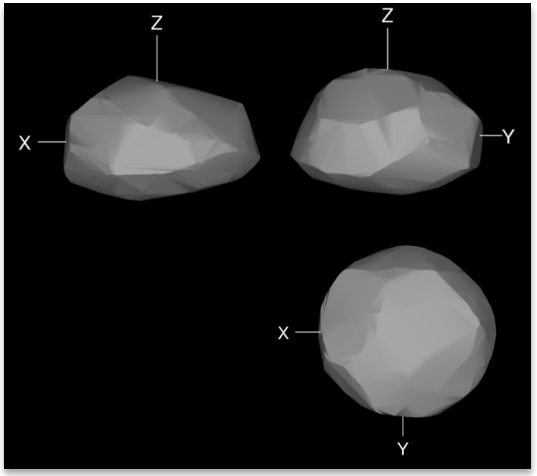
(Data by Viras 2008, Sugita+ 2012, Abe+ 2008)

Light curve



(by Kim, Choi, Moon et al. A&A 550, L11, 2013)

Shape



(by T. Müller)

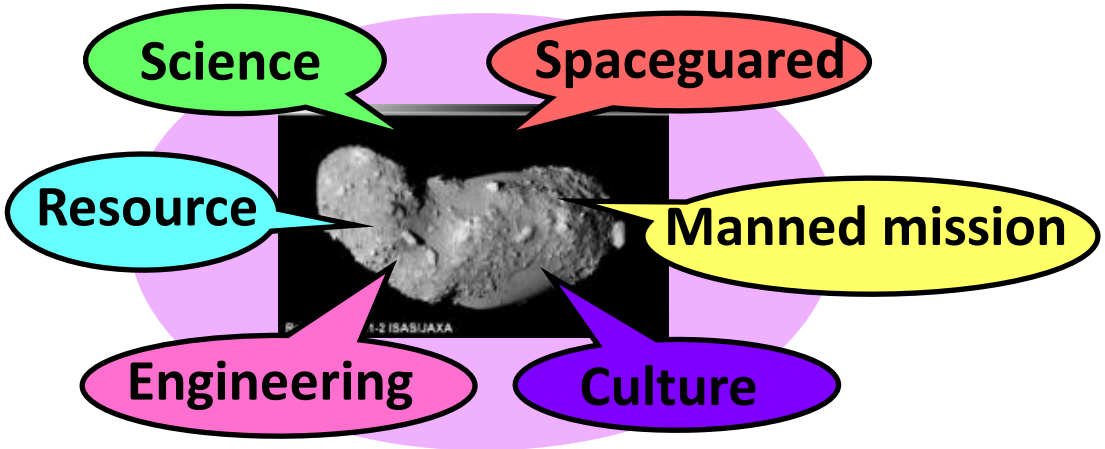
“Imagining Ryugu” Space Art Contest

http://www.hayabusa2.jaxa.jp/topics/20171227_e/

Can you predict Ryugu appearance better than scientists?

Summary

- Hayabusa2 is operated as scheduled, and it will arrive at its target asteroid Ryugu in June or July of 2018.
- We have been carrying out many training for the proximity operations.



Asteroids are important!