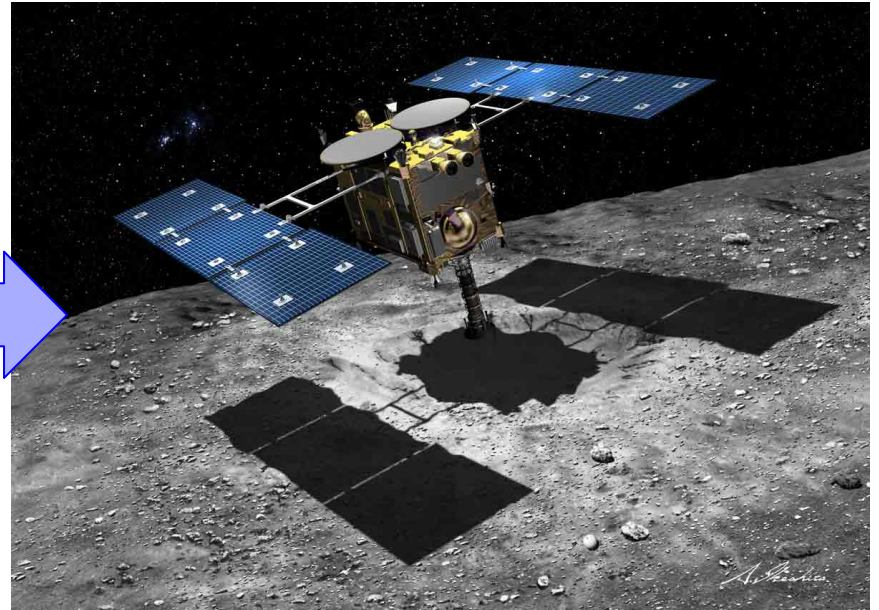
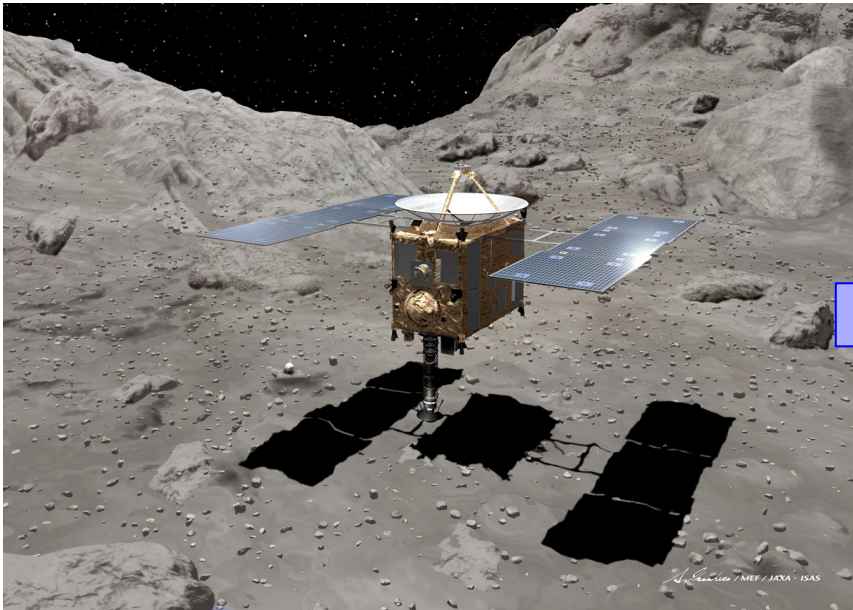


Japan's Asteroid Missions Hayabusa and Hayabusa2



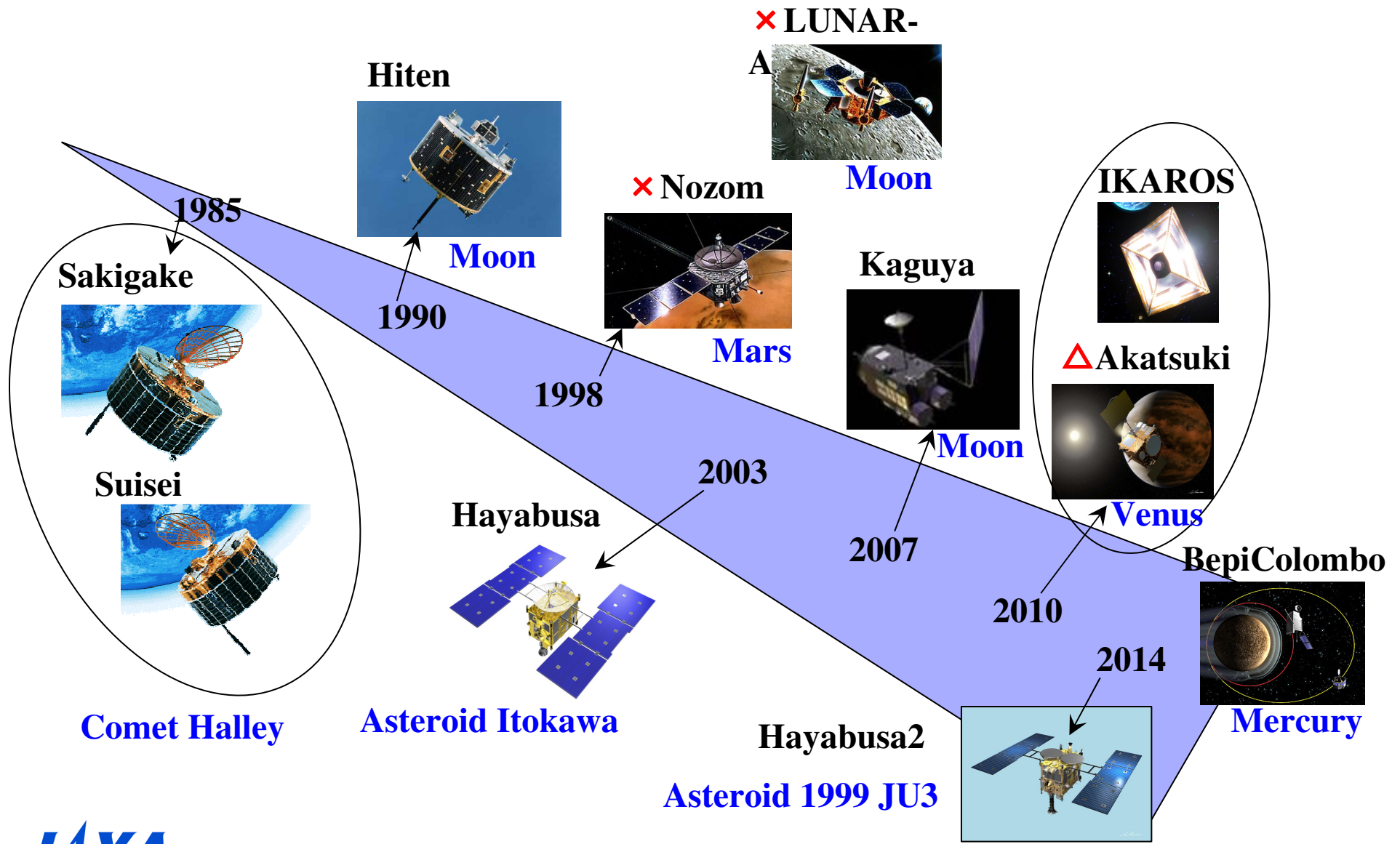
COPUOS 2013

February 15, 2013, Vienna, Austria

Makoto Yoshikawa

Hayabusa & Hayabusa2 Project Team, JAXA

Lunar and Planetary Missions of Japan

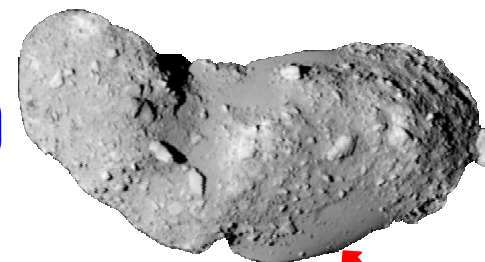


Challenges of Hayabusa and Hayabusa2

Development of the technology for asteroid sample return

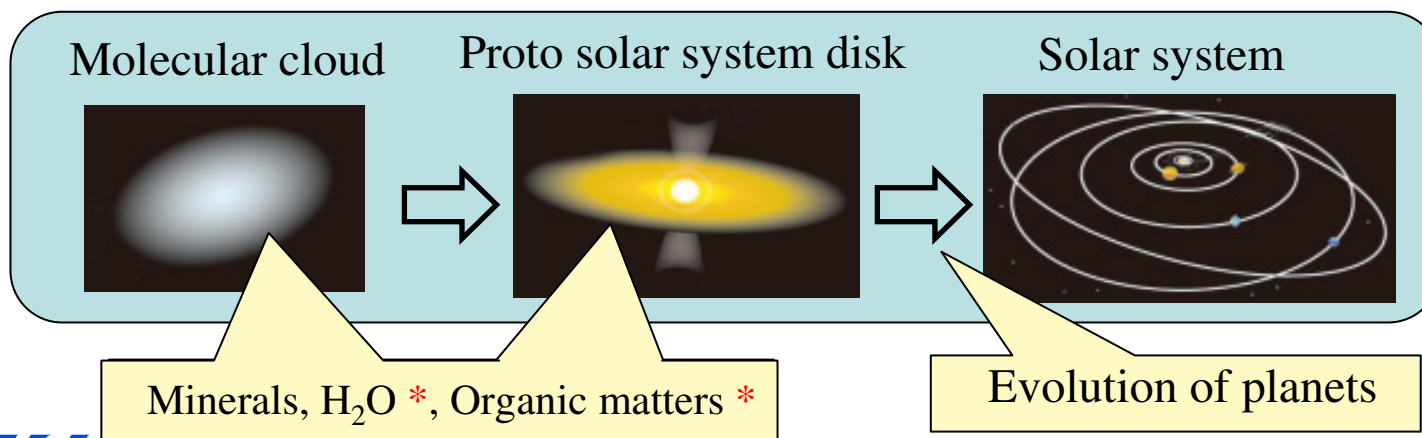


- Ion engine
- Autonomous navigation
- Sample collection system
- Reentry capsule

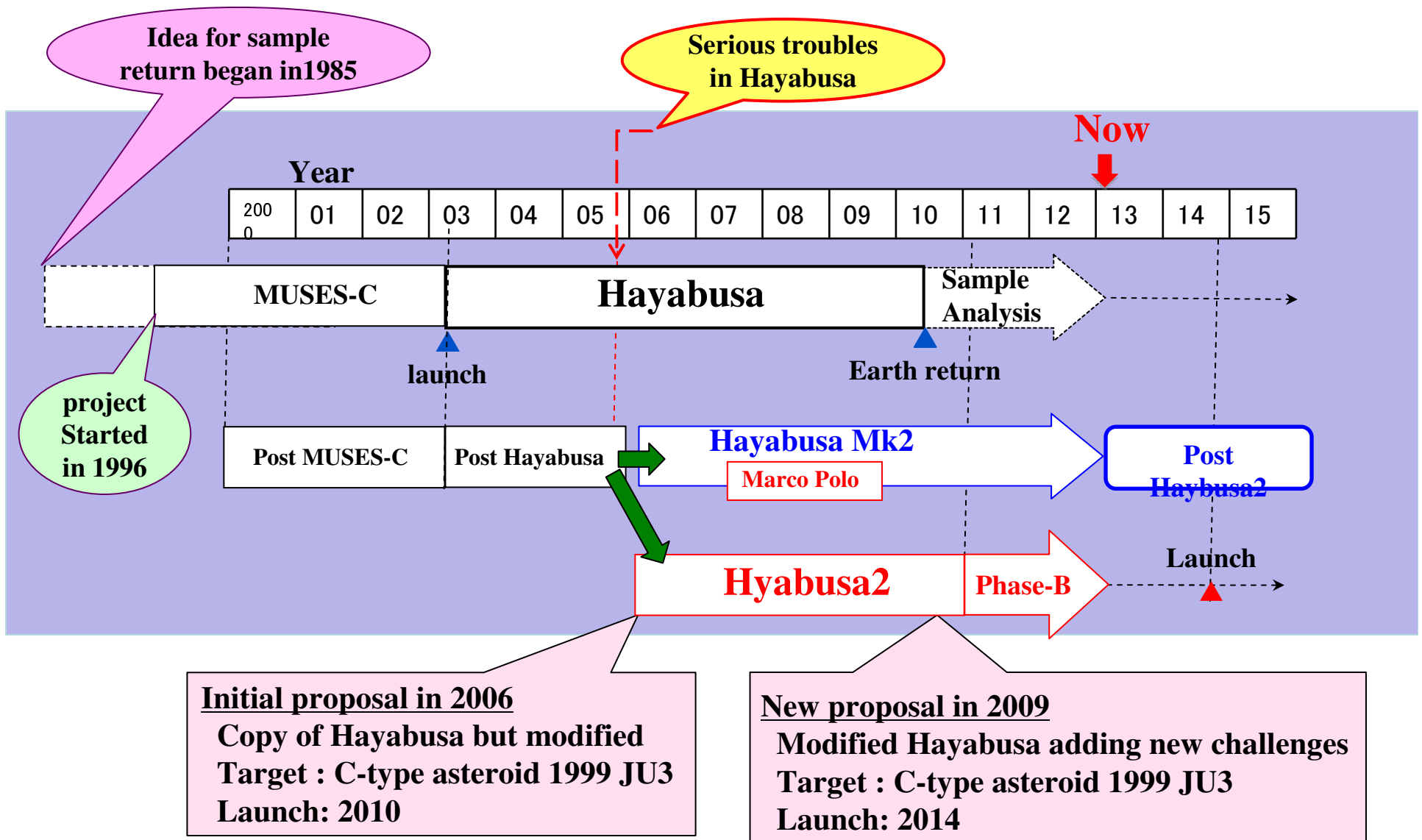


Impactor system *

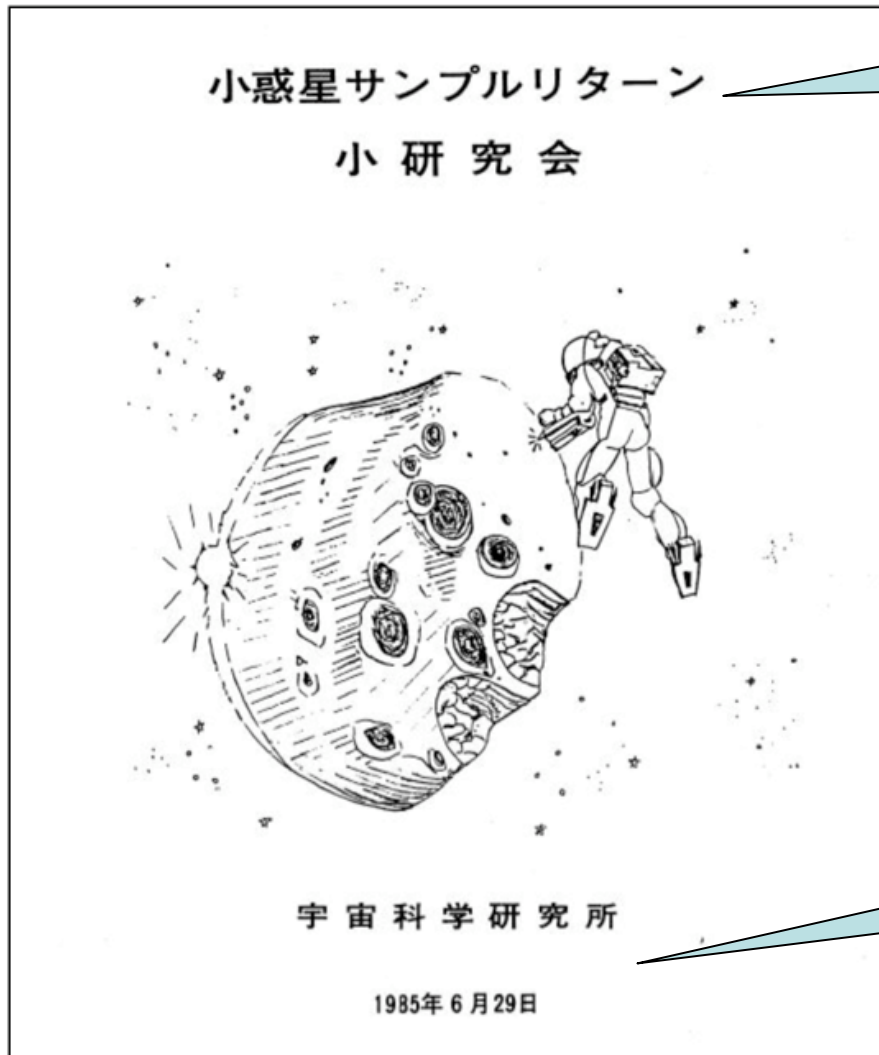
Study of the origin and evolution of the solar system



History of Hayabusa and Hayabusa2



Starting point of Hayabusa



Small Meeting for
Asteroid Sample Return
Mission

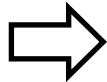
ISAS
June 29, 1985

Cover of meeting

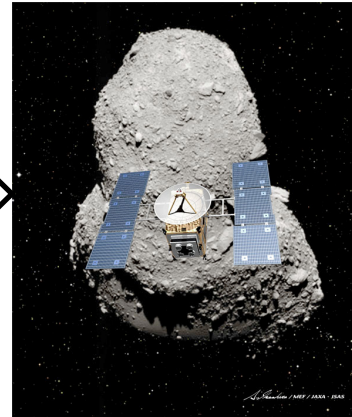
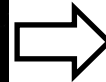
Mission Scenario of Hayabusa



Launch
9 May 2003



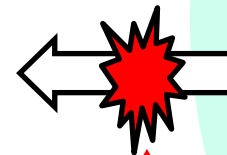
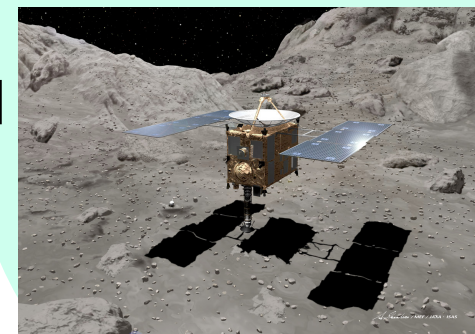
Earth Swingby
19 May 2004



Asteroid Arrival
12 Sept. 2005



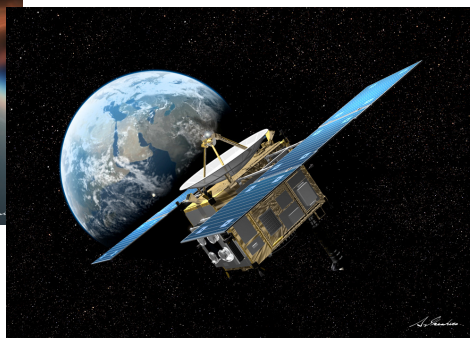
Observations, sampling



Serious troubles



Earth Return
13 June 2010



February 15, 2013

COPUOS 2013



Fireball of the reentry capsule and spacecraft of HAYABUSA 2010/06/13/22:22 LST

Hayabusa Reentry Observation Team, National Astronomical Observatory of Japan

Photo by Dr. Kouji Ohnishi, @ Coober Pedy, South Australia

Photo / Koji Ohnishi

June 13, 2010

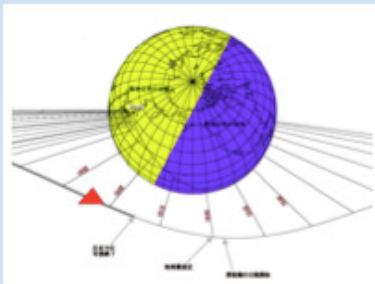
Engineering of Hayabusa

2003.05.09

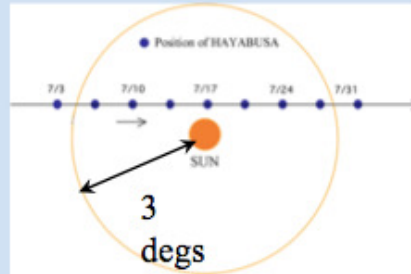


Launch

2004.05.19



Earth swingby



Solar conjunction

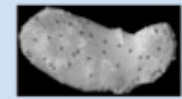


Optical navigation

2005.09.12



Operation near Itokawa



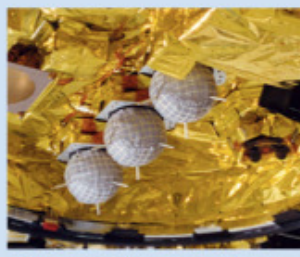
Terrain-based Navigation and Guidance



Touchdown



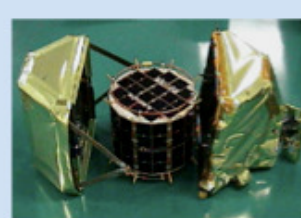
Ion engine



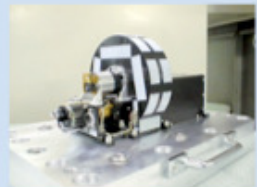
Target marker



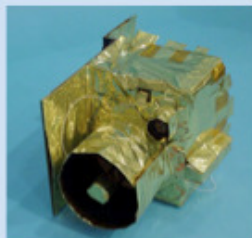
Sampler



MINERVA



AMICA



LIDAR



NIRS



XRS

Capsule and reentry

2010.06.13



Images of Itokawa

Eastern Side



Release 051101-1 ISAS/JAXA

Release 051101-3 ISAS/JAXA

Head



Western Side



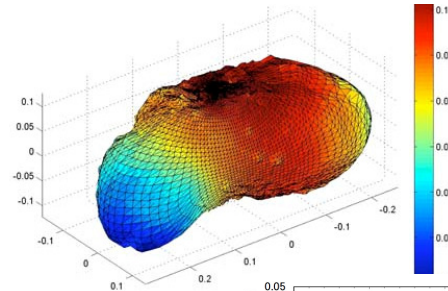
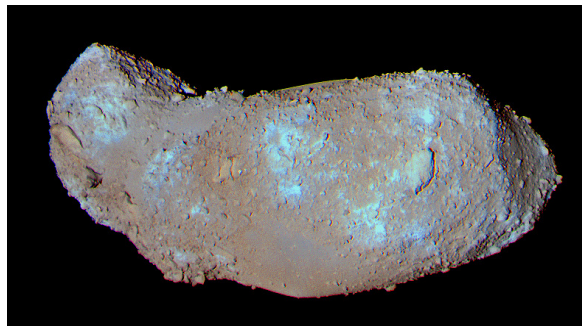
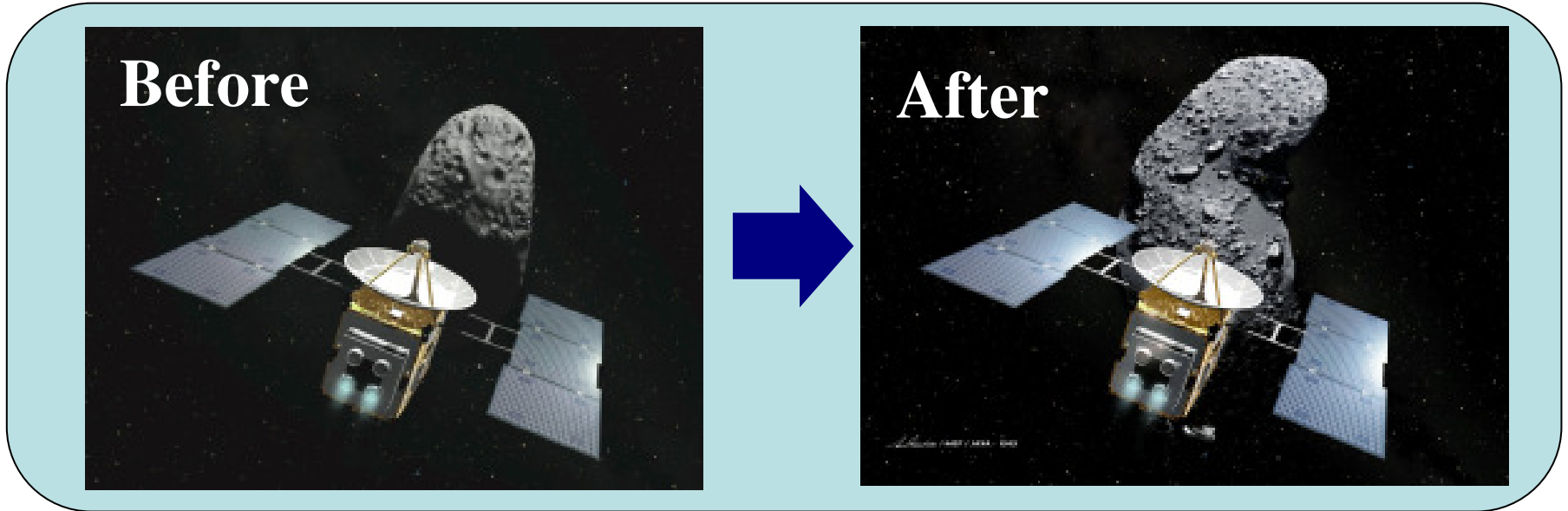
Release 051101-2 ISAS/JAXA

Bottom

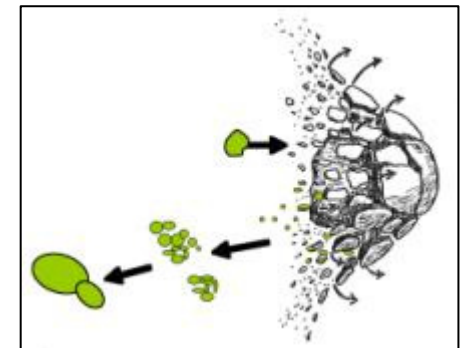
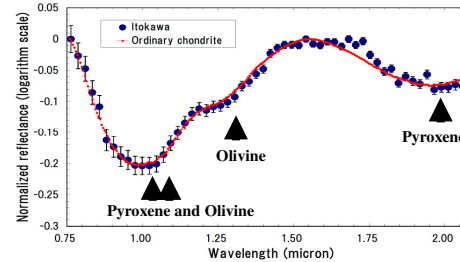
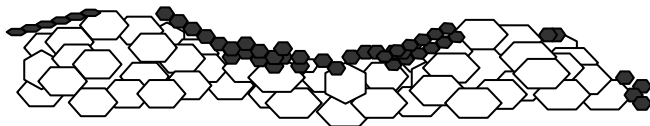


Release 051101-4 ISAS/JAXA

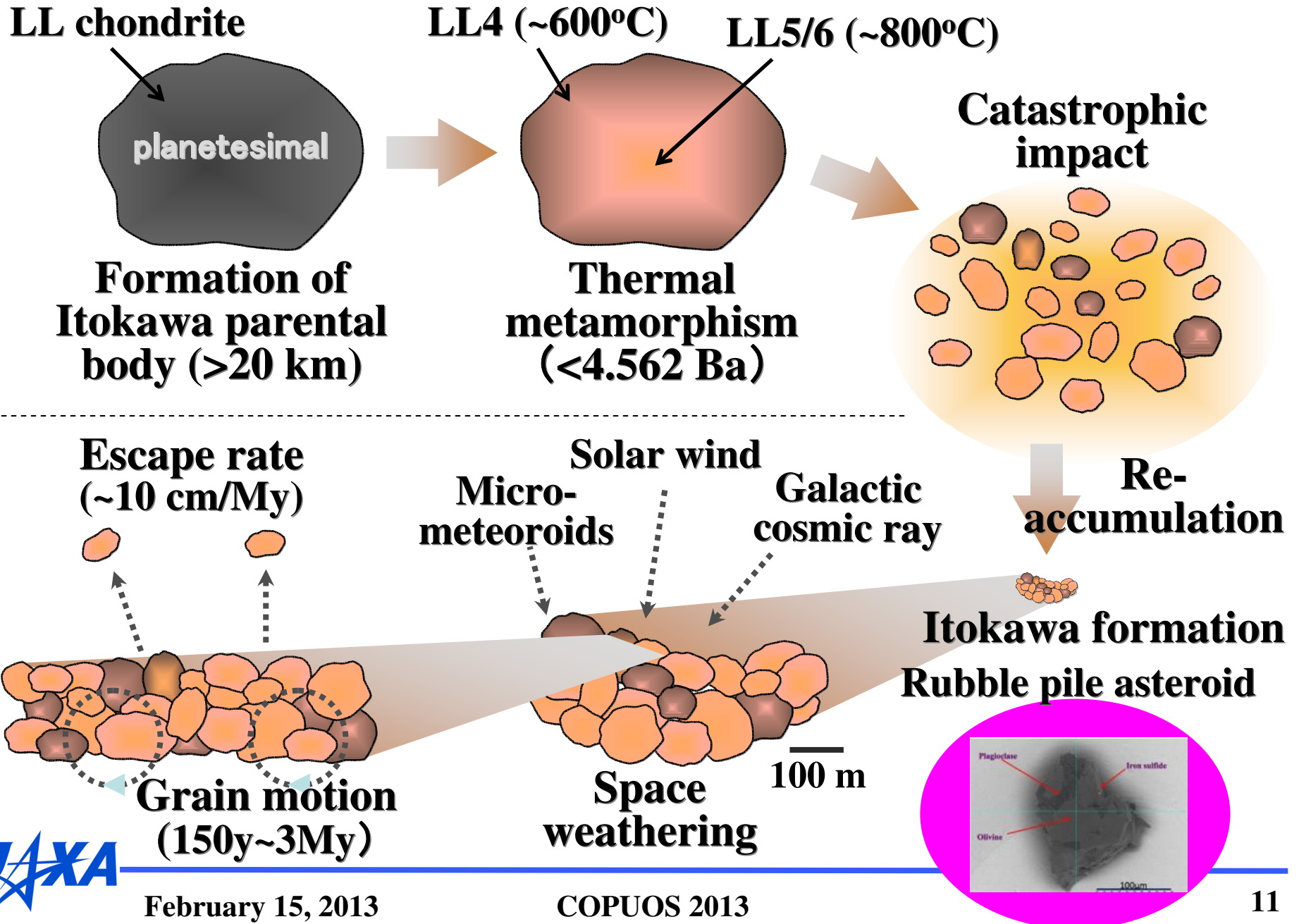
Scientific Results from Remote Sensing



- Mass
- Shape => volume
- Density



Scientific Results from Sample Initial Analysis



Science Publications



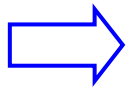
2 June 2006



26 August 2011

Hayabusa2 Mission Outline

Launch
2014



June 2018 : Arrival at 1999 JU3

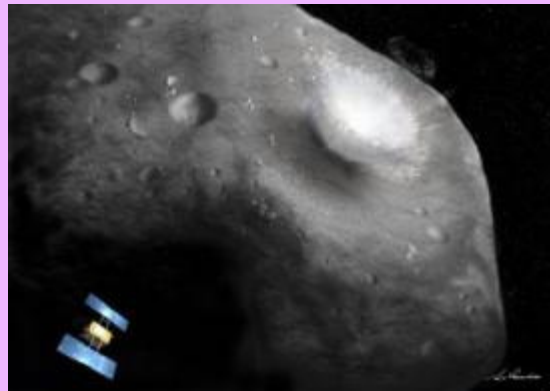
The spacecraft observes the asteroid, releases the small rovers and the lander, and executes multiple samplings.

The spacecraft carries an impactor.



2019

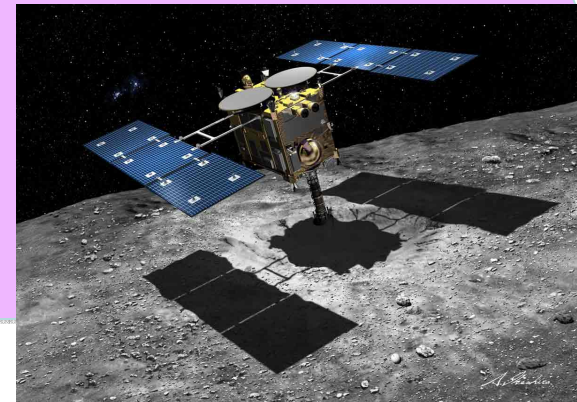
New Experiment



The impactor collides with the surface of the asteroid.



Samples will be obtained from the newly created crater.



Sample analysis



Earth Return

Dec. 2020

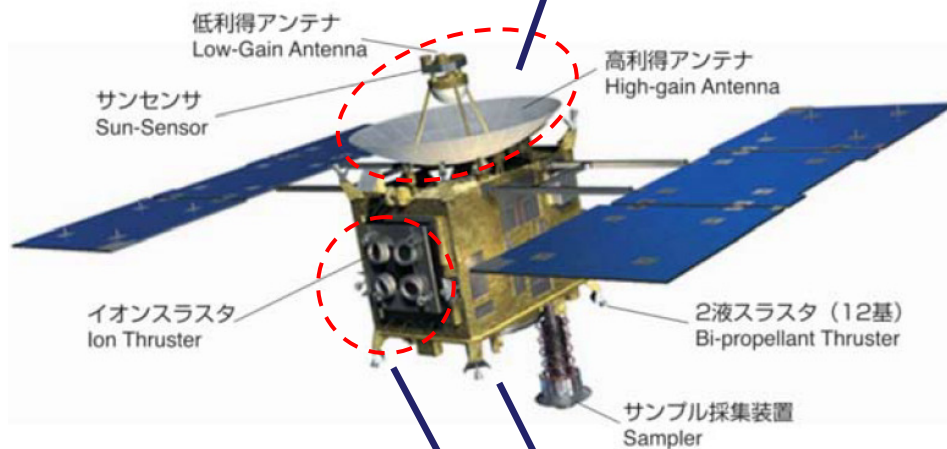


Dec. 2019 : Departure

Hayabusa vs. Hayabusa2

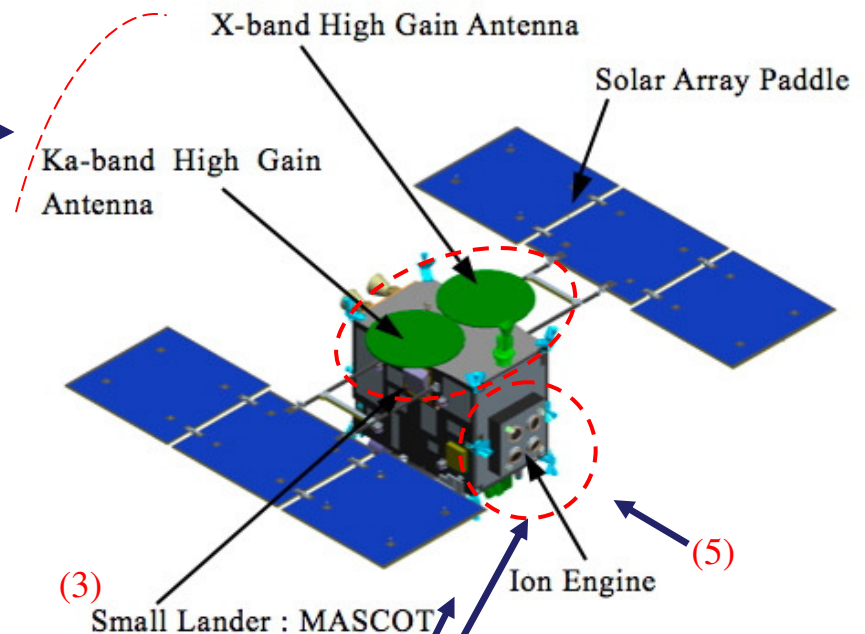
Hayabusa

Size : 1m × 1.6m × 1.1m
(body)
Mass : 510kg (Wet)



Hayabusa2

Size : 1m × 1.6m × 1.25m (body)
Mass : 600kg (Wet)



- (1) Communication : X-band + Ka-band
- (2) Ion engine : modified
- (3) Small lander : MASCOT (Mobile Asteroid Surface Scout) from DLR
- (4) AOCs : 4 reaction wheels
- (5) Impactor

Target Asteroid : 1999 JU3

Current estimate:

Rotation period: 7.625 ± 0.003 h *1

Shape : almost spherical *1

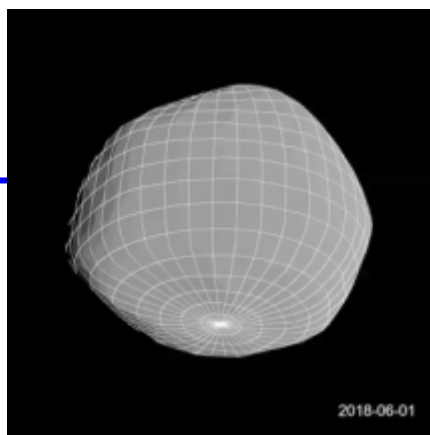
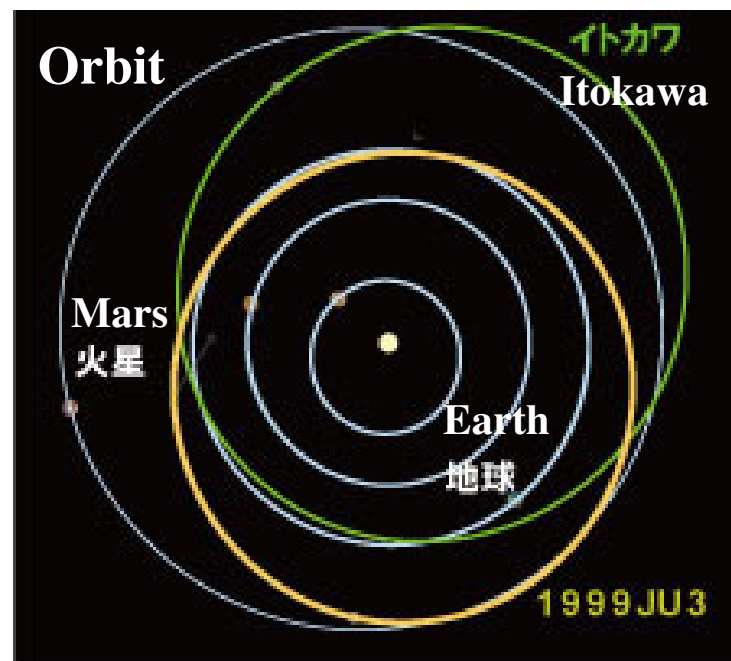
Size : 0.87 ± 0.03 km *2

Albedo : 0.070 ± 0.006 *2

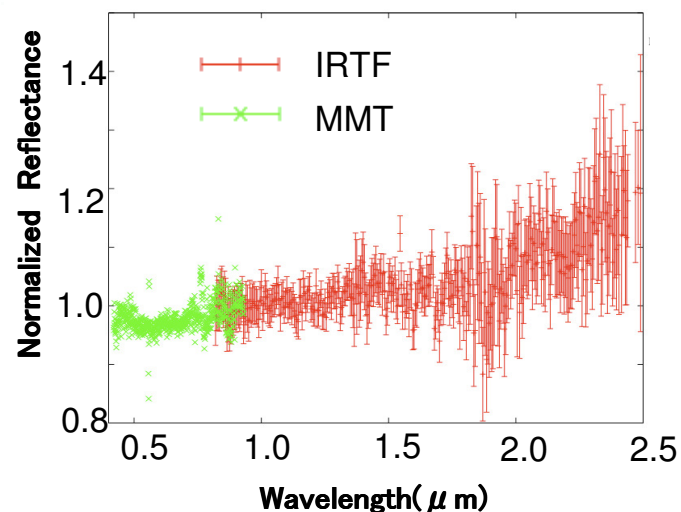
$H=18.69 \pm 0.07$, $G=-0.09 \pm 0.03$ *1

Type : Cg

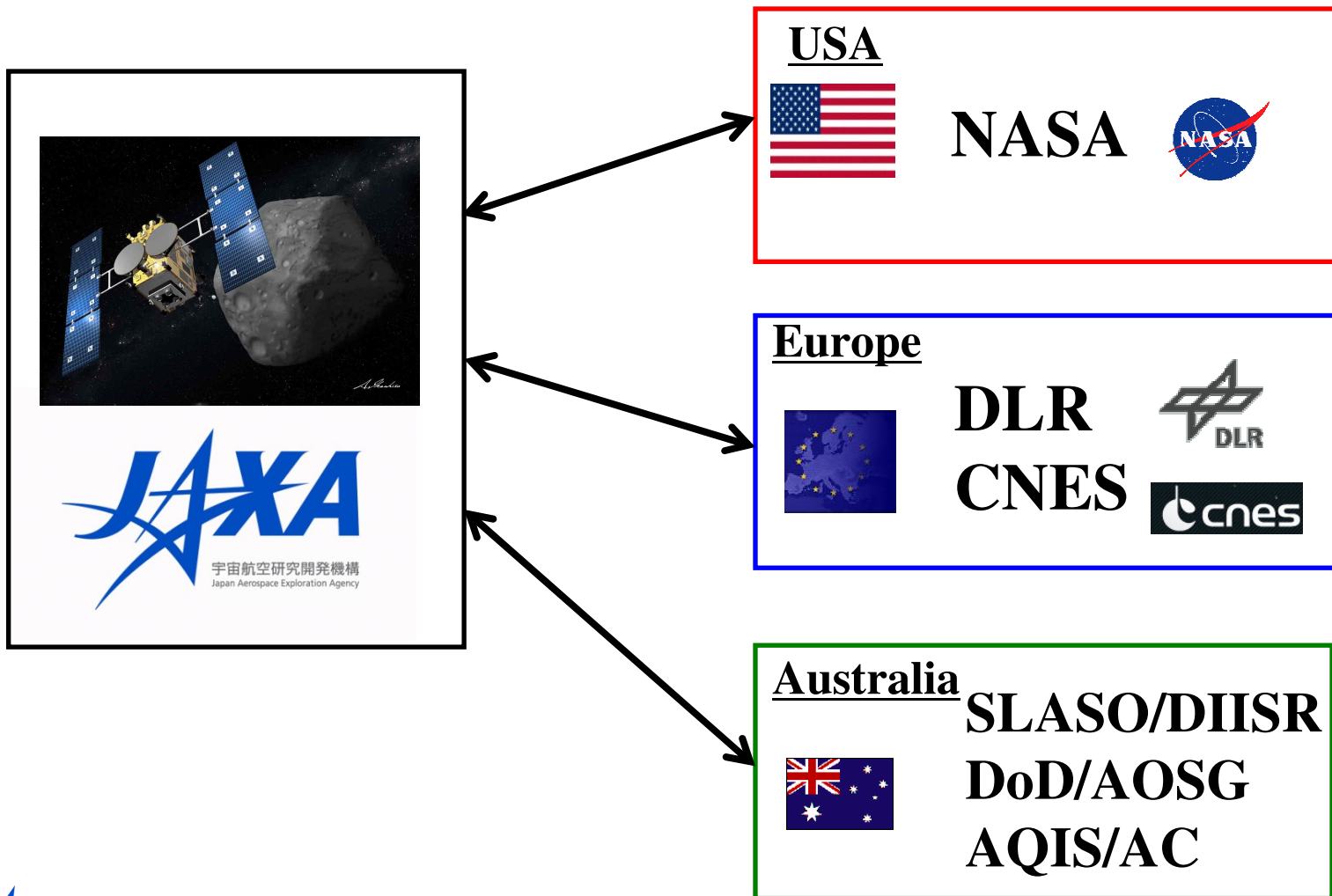
*1:Kim et al. *2:Mueller et al



(by Mueller et al.)



International Cooperation on Hayabusa2



Importance of Small Solar System Bodies

