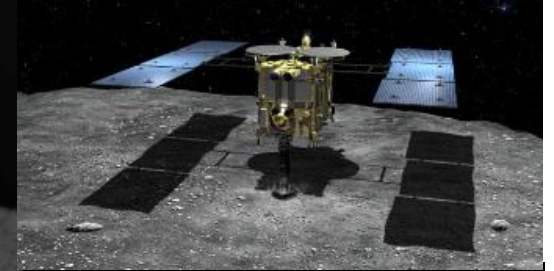
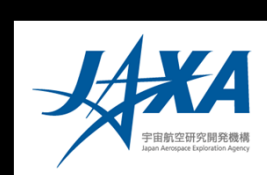


# Summary of Hayabusa2

**Yuichi Tsuda**  
Project Manager, Hayabusa2  
Institute of Space and Astronautical Science  
Japan Aerospace Exploration Agency





# Hayabusa2 Mission

- ✓ Sample return mission to a C-type asteroid "Ryugu"
- ✓ 52 billion km interplanetary journey.

**Launch**  
Dec.3, 2014



**Earth Gravity Assist**  
Dec.3, 2015



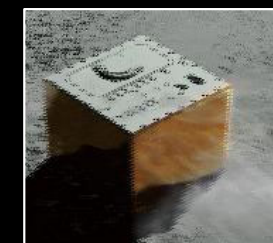
**Ryugu Arrival**  
Jun.27, 2018



**MINERVA-II-1 Deployment**  
Sep.21, 2018



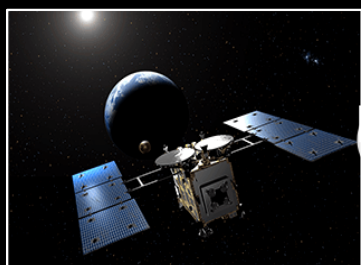
**MASCOT Deployment**  
Oct.3, 2018



**Ryugu Departure**  
Nov.13.2019



**Earth Return**  
Dec.6, 2020



**Target Markers Orbiting Touchdown**  
Sep.16, 2019



**Second Touchdown**  
Jul.11, 2019

**Kinetic Impact**  
Apr.5, 2019



**First Touchdown**  
Feb.22, 2019

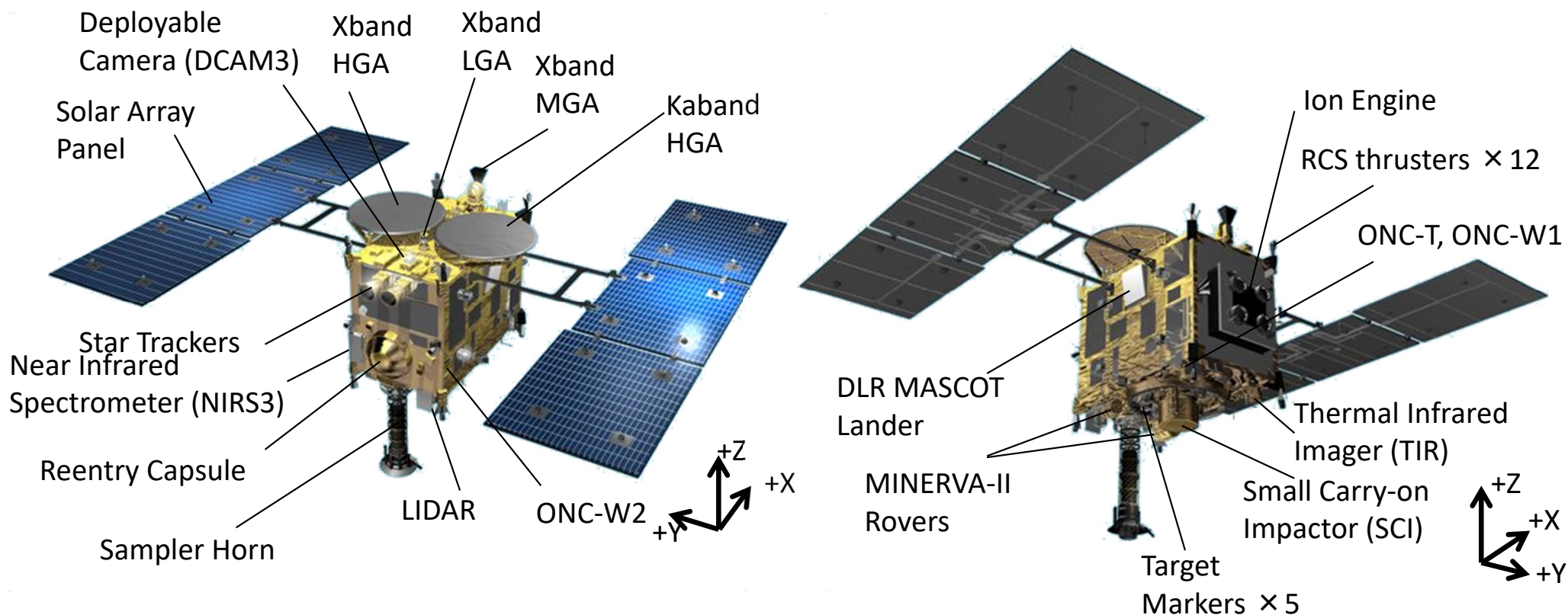


**MINERVA-II-2 Orbiting**  
Oct.2, 2019





# Hayabusa2 Spacecraft Overview



Launch Mass: 609kg

Ion Engine: Total  $\Delta V=3.2\text{km/s}$ , Thrust=5-28mN (variable), Specific Impulse=2800-3000sec. (4 thrusters, mounted on two-axis gimbal)

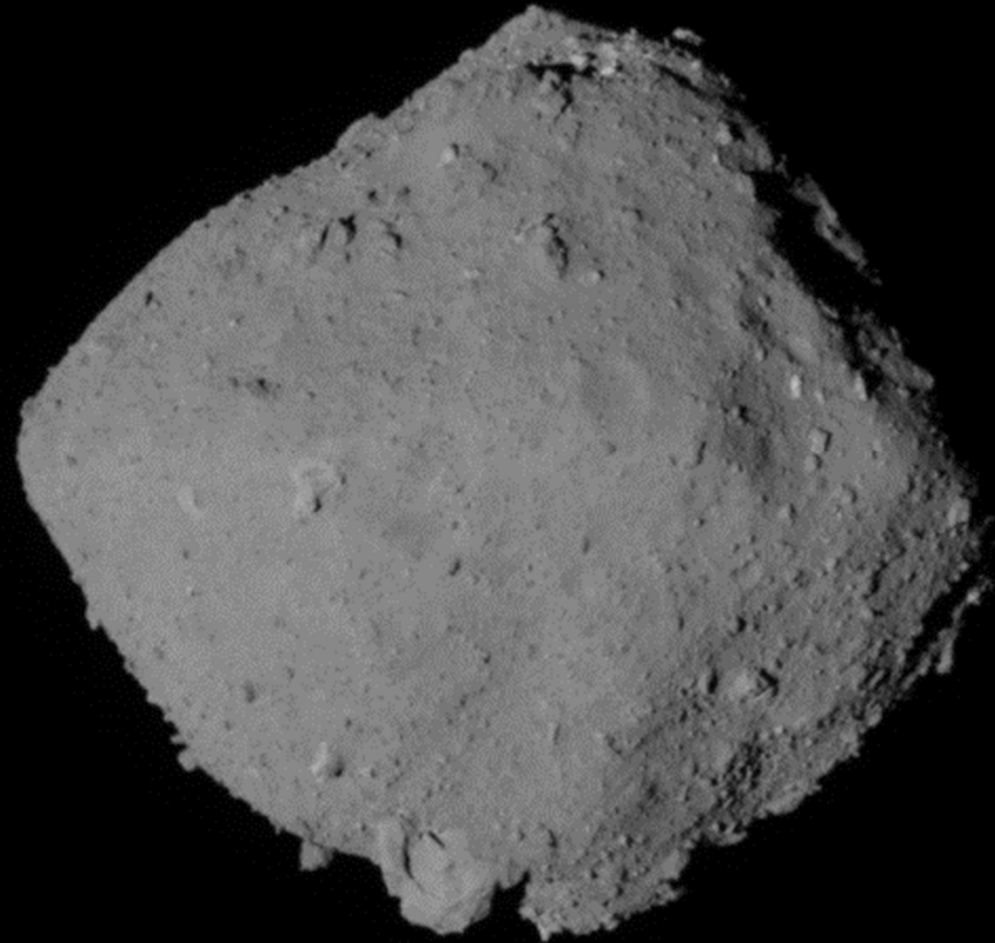
Chemical RCS: Bi-prop. 20N thrusters × 12 (6 DOF maneuverability)

Solar Array Paddle: 2.6kW @ 1 a.u.

TT&C: X-band Uplink, X/Ka-band Downlink, 8-32Kbps, X/Ka RARR&DDOR capability

# Arrival at Ryugu on June 27, 2018

- **Top shape** with a very circular equatorial bulge
- Spectrum type: Cb
- Diameter:  $\sim 900$  m
- Mass:  $\sim 450$  million ton
- Obliquity:  $\sim 8^\circ$
- Rotation period:  $P = 7.63$  hours
- Reflectance factor (v-band) : 0.02
- Terrain: **Very bumpy**



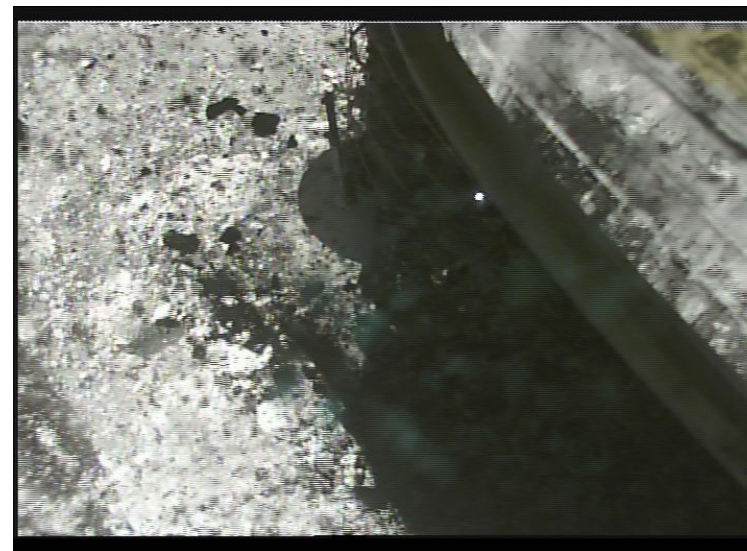




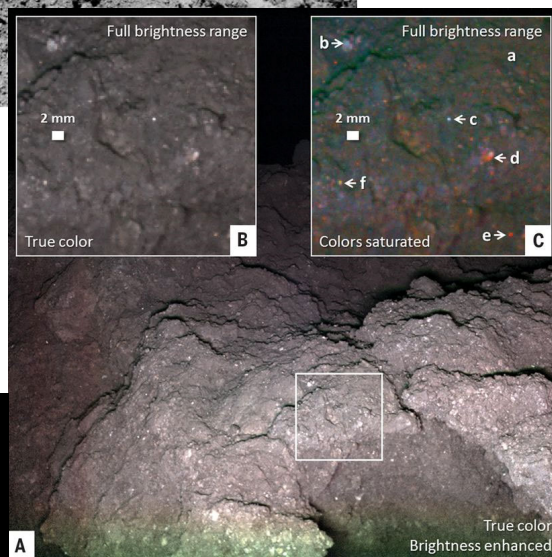
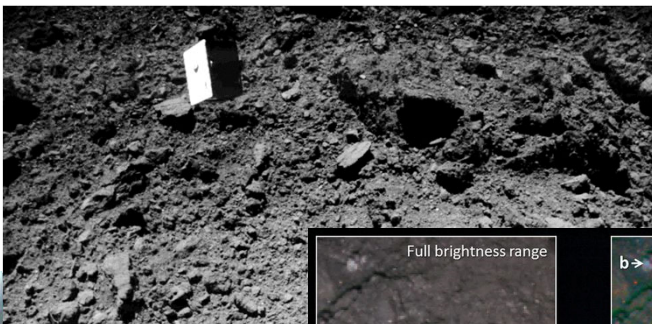
# Accomplishments of Hayabusa2 (1/2)

- 1. Mobile activity of exploration robots on small body
- 2. Multiple robots deployment on small body

CAM-H image at the 1st touchdown



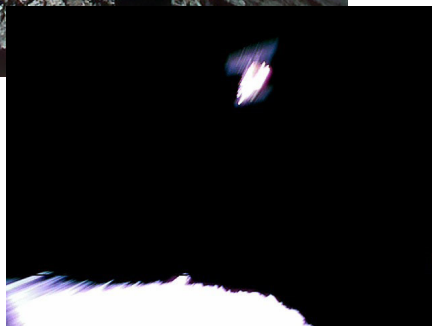
MASCOT taken by ONC-W2



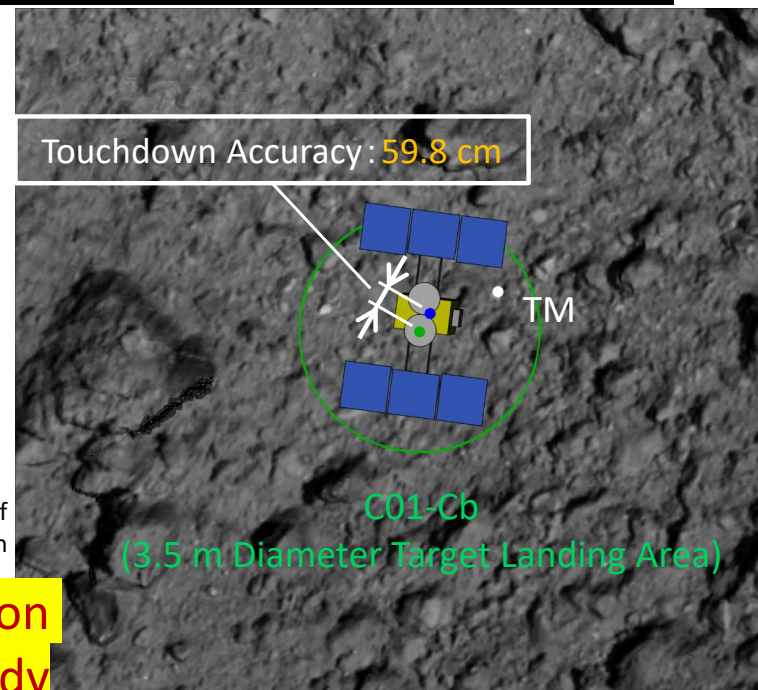
MASCOT images



MINERVA-II-1A image



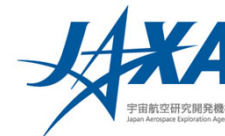
MINERVA-II-1A image



Landing accuracy of the 2nd touchdown

- 3. 60cm-accuracy landing and sampling on extra-terrestrial celestial body



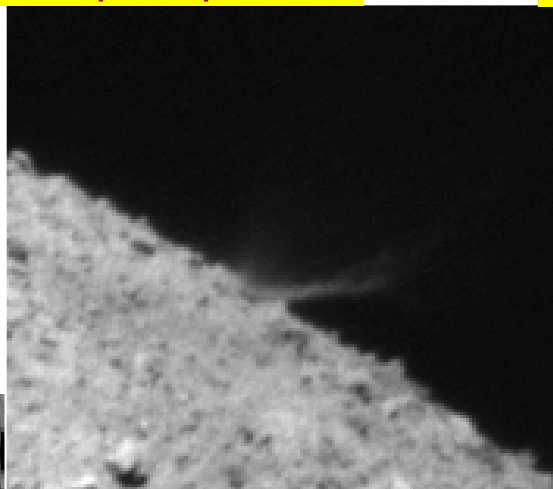


# Accomplishments of Hayabusa2 (2/2)

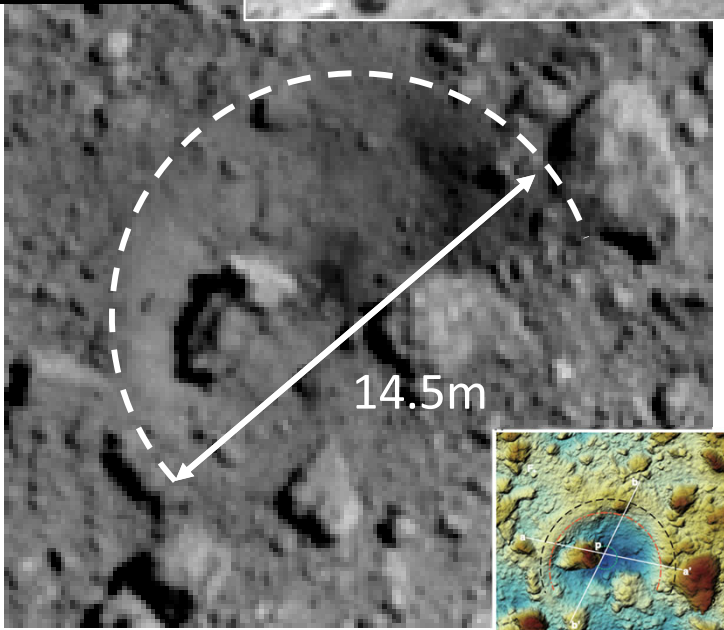
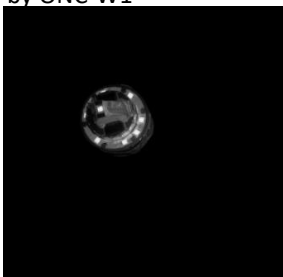
4. Artificial crater forming and detailed observation of impact process

5. Multiple landing on extra-terrestrial celestial body  
6. Access to subsurface material

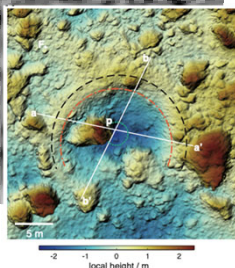
Impact ejecta observed by DCAM3



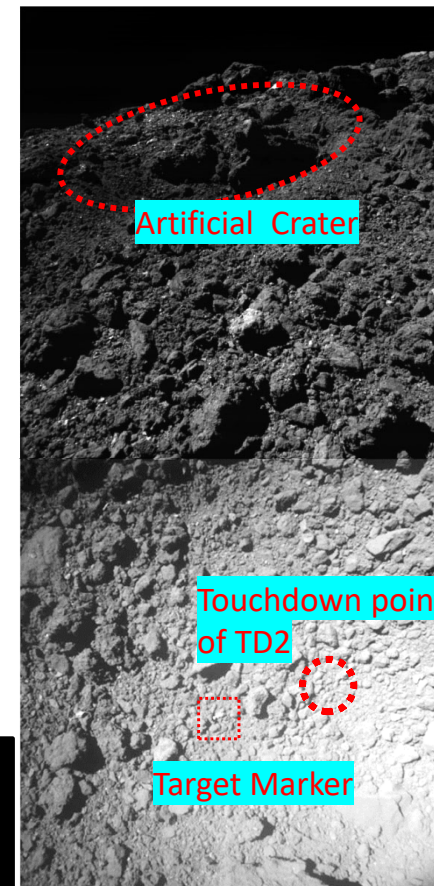
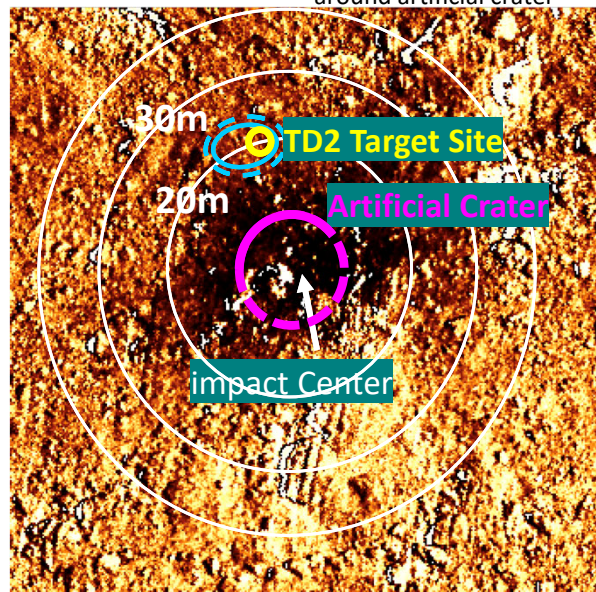
Deployed SCI taken by ONC-W1



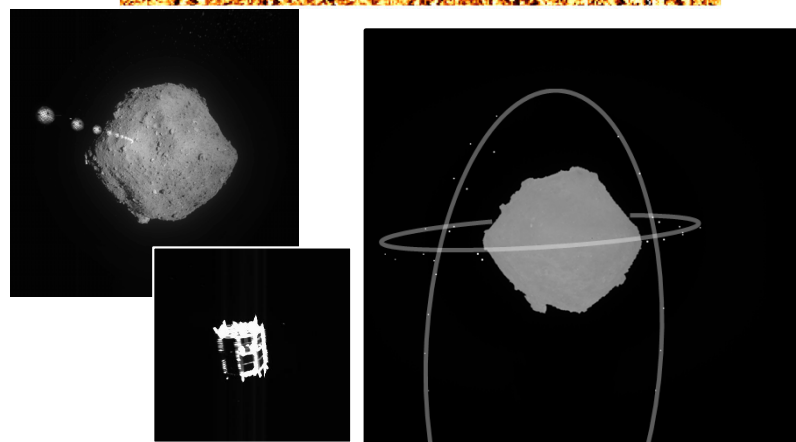
Artificial crater generated by SCI (above) and its digital elevation map (right)



Accumulation of Impact ejecta around artificial crater



Artificial crater and TD2 point in one view

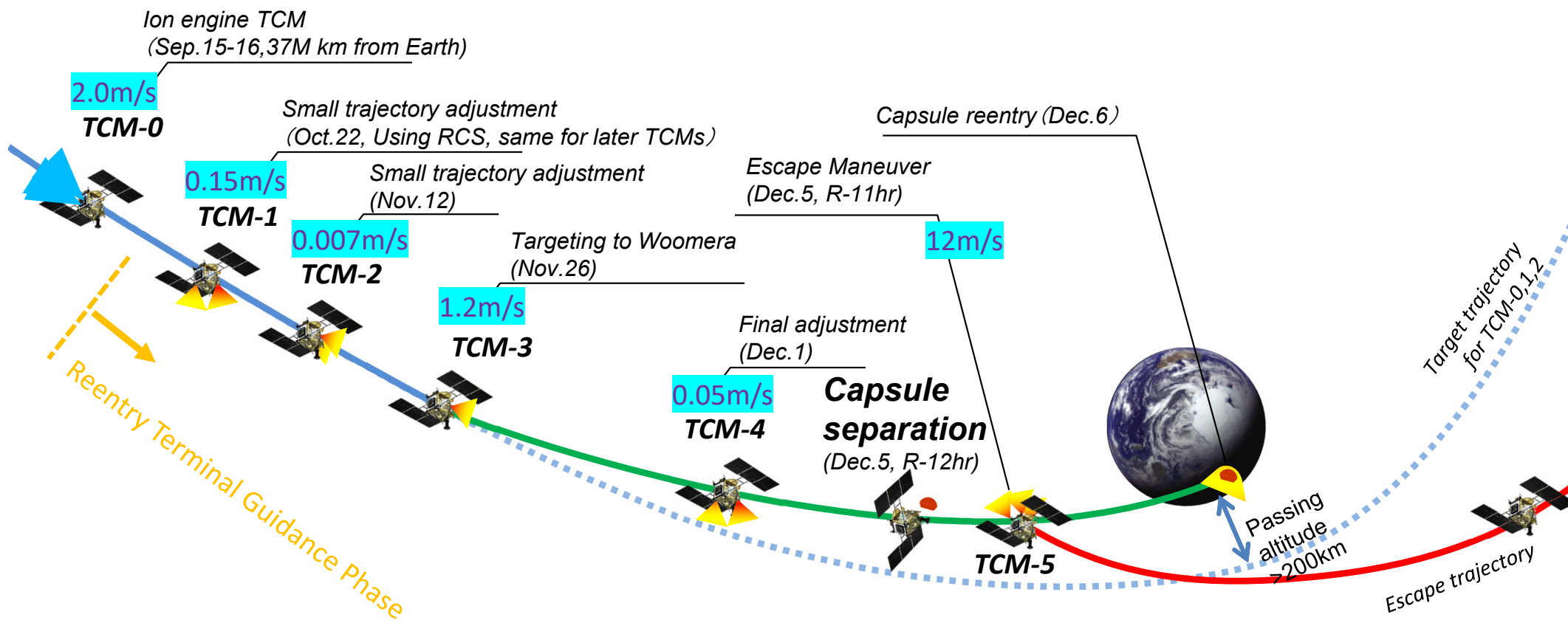


7. Smallest-object constellation around extra-terrestrial celestial body



# Reentry Terminal Guidance Phase

- 5 TCMs in the last 2 months before Earth return.
- The SRC was separated 12 hrs before reentry.
- The spacecraft diverted from the reentry trajectory 11 hrs before reentry.





# Fireball of Hayabusa2 Sample Return Capsule

Cooper Pedy, Australia, Dec.6, 2020, 2:28:48-2:29:11JST (Altitude 80~50km)





# Sample Return Capsule recovery



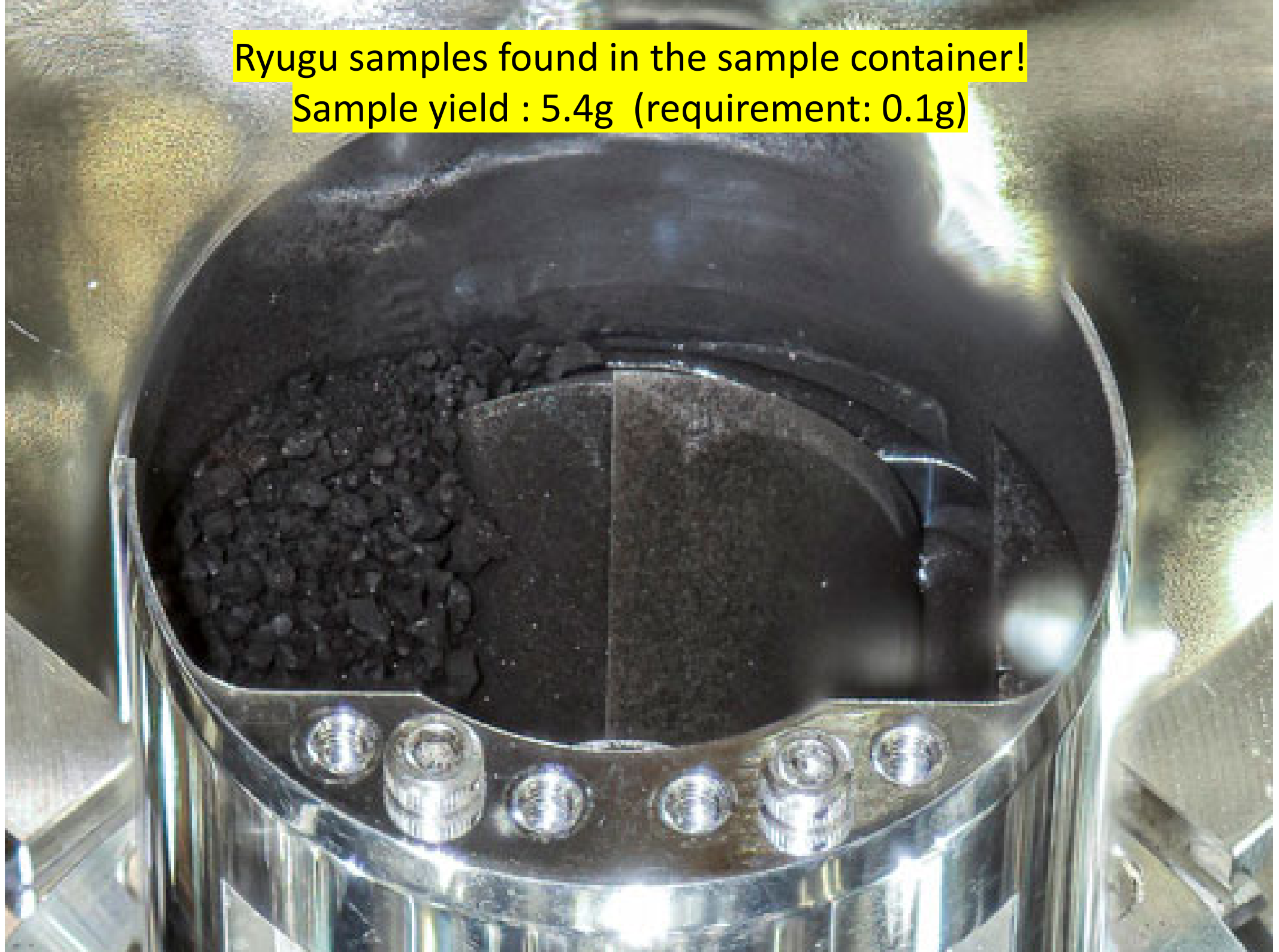
Dec.6 (JST)

- 02:28 SRC reentry
- 02:32 SRC beacon signal detected
- 02:54 SRC landed (loss of beacon signal)
- 04:47 SRC found
- 08:03 SRC arrived at Quick Look Facility
- 11:13 Fore-heat shield found
- 12:31 Aft-heat shield found
- Dec.7
- 22:30 SRC shipped to Japan
- Dec.8
- 11:27 SRC carried into curation facility

57hr!  
(requirement  
100hr)



Ryugu samples found in the sample container!  
Sample yield : 5.4g (requirement: 0.1g)







# Significance of Hayabusa2

Science

Space Exploration Engineering

Planetary Defense

Planetary Resource

Hayabusa2 is pushing forward the boundaries of small body surface activity

**ACCESS / ROVING / SAMPLING / IMPACTING**



December 6 @Sagamihara Space Operation Center

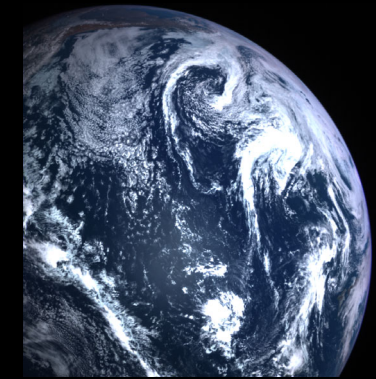


Image by leaving Hayabusa2 after divert maneuver, Dec.6, 2020, 6:30JST, 88,000km)

**Mission completed! ...and continuing to Extended Mission**



December 14@Landing Point, Woomera