

HAYABUSA 2

Add-On for Orbiter 2010-P1 (v.100830)

REQUIREMENTS (LAUNCH SCENARIO ONLY)

Vinka's "multistage2.dll" available at Vinka's website

<http://users.swing.be/vinka/>

"StageDLL" for Orbiter2010 (fixes Vinka's stage.dll bug)

<http://www.orbithangar.com/searchid.php?ID=4661>

Alex's "H-IIA ELV beta 0.5"

<http://www.orbithangar.com/searchid.php?ID=2769>

Donamy's "H-IIB HTV"

<http://www.orbithangar.com/searchid.php?ID=4197>

SUGGESTED UTILITIES

Jarmonik's "InterplanetaryMFD (IMFD)" available at

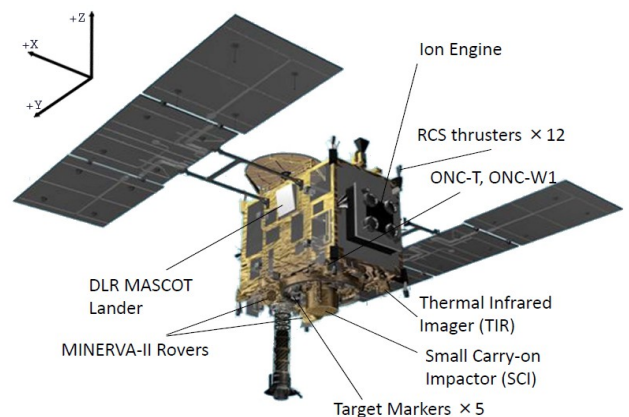
<http://koti.mbnet.fi/jarmonik/Orbiter.html>

"IEAT MFD" Ion Engine Attitude and Throttle MFD

<http://www.orbithangar.com/searchid.php?ID=3815>

Piper's "Low Thrust Trajectory Planner"

<http://www.orbiter-forum.com/showthread.php?t=15036>



INSTALLATION

Extract all files to the root of your Orbiter program directory, preserving the directory structure. This should NOT overwrite anything in the standard Orbiter package.

WHAT'S IN THIS ADD-ON?

The Hayabusa2 spacecraft with deployable Surface Markers, Mascot and Minerva rovers, Impactor and Sample Return Capsule. Secondary launch payloads Procyon, Shinen2, Artsat2.

Custom Solar System config including asteroids 1999JU3 and 1999JV6.

Multistage2.dll based H-IIA with optional ascent/parking orbit autopilot. Repackaged SRB and Fairing meshes by kind permission of Alex. Launch and post-launch scenarios.

MISSION OVERVIEW

Japan's Hayabusa2 mission to visit asteroid 1999JU3, collect samples and return them to Earth in it's Sample Return Capsule(SRC). Hayabusa2 uses high-efficiency low-thrust Ion engines to rendezvous with the asteroid and return to Earth.

Secondary payloads launched alongside Hayabusa2 include Shinen2 and Artsat2, passive satellites with no propulsion.

Also launched with Hayabusa2 was the small Procyon spacecraft, designed to fly by asteroid 1999JV6 and also using a small Ion engine.

MORE INFO HERE...

http://www.lpi.usra.edu/sbag/meetings/.../TUES_0900_Hayabusa-2.pdf

http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1500_Kuninaka_Haya2-SBAG.pdf

<http://www.lpi.usra.edu/meetings/lpsc2013/pdf/1904.pdf>

<http://science.nasa.gov/media/medialibrary/2014/06/04/NAC-PPS-Yano-140521c-11.pdf>

<http://www.planetary.org/blogs/emily-lakdawalla/2014/12020853-hayabusa-2-launch.html>

http://en.wikipedia.org/wiki/Hayabusa_2

ADD-ON NOTES

Both Hayabusa2 and Procyon have Reaction Wheels for attitude control, RCS should be reserved for course corrections(Procyon uses the same Xenon fuel for both RCS and Ion engines). The Main Engines (Ion engines) thrust in the +Y direction (like a "Hover" engine).

Deploy Hayabusa2 Impactor from ~500m alt. I recommend viewing the Impactor detonation and crater impact from the cockpit view of DCam3, so jettison DCam3 in the correct location and attitude for observation after deploying Impactor. Move Hayabusa2 to safe zone before detonation.

SRC is jettisoned 100,000km - 200,000km from Earth. If you are using the IMFD "Base Approach" function, set Woomera as target base, reference altitude = 80km ; ReA = 5.5deg ; Ant = 6deg

Available commands and dV info are displayed on spacecraft HUD.

The launch and post-launch scenarios use a custom Solar System config file "Sol_H2.cfg".

This is the standard Orbiter Sol.cfg with 1999JU3 and 1999JV6 added.

There are 5 surface bases on asteroid 1999JU3, named "SampleSite_1" to "SampleSite_5".

These correspond to "landable" sites where the asteroid surface "mesh" is at the same level as nominal "ground level". Recommended as targets for Hayabusa2's Surface Markers, rovers and Impactor.

Extra .txt files for adding asteroids 1999JU3 and 1999JV6 to Piper's "Low Thrust Trajectory Planner" are included alongside this document in the Doc/Hayabusa2/LTTPlanner/ folder.

Trajectory planning - I haven't completed this mission yet, so can't offer much advice.

I guess a combination of IMFD"Delta Velocity"+IMFD"Map/PlanView", TransX and LTTPlanner might crack it. Let us know on OrbiterForum if you find a solution!

SPACECRAFT SPECS

HAYABUSA2:	
Bus Empty Mass	454.9kg
SRC Mass	16.5kg
Mascot Mass	10kg
Impactor Mass	7kg
DCam3 Mass	0.1kg
Marker 1-5 Mass	0.1kg (each)
Minerva 1a,1b Mass	0.25kg (each)
Minerva 2 Mass	0.5kg
Ion Engine Xenon Fuel	73kg
RCS Hydrazine Fuel	37kg
Main Engine	1,2 or 3 x Ion Engines, Max. 0.01N(each), thrust +Y direction
Main Engine ISP	27500Ns/kg, total dV > 3500m/s
RCS Engines	12 x 20N, balanced 3-axis rotation, translation Z and Y axis only
RCS Engines ISP	2500Ns/kg, total dV > 159m/s

PROCYON:

Bus Empty Mass	64.5kg
Ion Eng./RCS Xenon Fuel	2.5kg
Main Engine	1 x Ion Engine, Max. 0.0003N, thrust +Y direction
Main Engine ISP	10000Ns/kg, total dV ~380m/s
RCS Engines	12 x 0.025N, balanced 3-axis rotation and translation
RCS Engines ISP	240Ns/kg, total dV ~9.1m/s

ARTSAT2:

Bus Mass	30kg
----------	------

SHINEN2:

Bus Mass	15kg
----------	------

LAUNCHER CONTROLS**H2A Launcher:**

[P] = Start ascent autopilot at T-10s (no re-start).

Autopilot inc.auto fairing separation, ends after 225km parking orbit insertion, ~ 4450m/s dV remaining in 2nd stage.

[F] = Manual Fairing jettison

[J] = Manual Stage / Payload jettison

SPACECRAFT CONTROLS**HAYABUSA2:**

Linear RCS in Z and Y axis only.

[J] = Toggle HUD Display: Control Options/Payload Options

[G] = Deploy Solar Panels

[P] = Deploy Sample Horn

[V] = Hold Prograde Attitude

[B] = Hold Retrograde Attitude

[N] = Select Reference Body for Prograde[V]/Retrograde[B] functions

[K] = Toggle Main Engine Configuration: 1,2 or 3 Ion Engines

[W] = LIDAR On/Off

[M] = Strobe On/Off

[E] = Set Cockpit View Forward/Back (+Z/-Z axis)

Hayabusa2 also has Reaction Wheels for attitude control

Use [Shift]+[NumPad] controls to use Reaction Wheels:

[Shift]+[NumPad 2/8] = Pitch

[Shift]+[NumPad 1/3] = Yaw

[Shift]+[NumPad 4/6] = Bank

[Shift]+[NumPad 5] = KillRot

Reaction Wheel "KillRot" function status on HUD.

Hayabusa2 payload deployment:

[Shift]+[G] = Deploy Marker 1-5

[Shift]+[K] = Deploy Minerva 1a,1b,2

[Shift]+[V] = Deploy Mascot

[Shift]+[B] = Deploy Impactor (0.1 m/s -Z axis, 6rpm spin)

[Shift]+[N] = Deploy DCam3 (Dcam3 cockpit view +Y axis)

[Shift]+[M] = Deploy Sample Return Capsule (0.3 m/s +Y axis, 2.5rpm spin)

Navigation Utility:

[Shift]+[W] = Create "hayabusa2ltt.txt" file in Doc/Hayabusa2/ folder. Contains "object" orbital data for use with Piper's Low Thrust Trajectory Planner. Copy into LTT Planner/Object/ folder.

MINERVA 1a,1b,2
[B] = Rotate Left (when landed)
[M] = Rotate Right (when landed)
[J] = Jump (+Z direction) (when landed)

MASCOT
[J] = Jump (+Z direction) (when landed)

IMPACTOR
[J] = Detonate Impactor Charge (adds 2000m/s velocity to Impactor +Z axis)

DCAM3
[J] = Remote Detonate Impactor Charge
Default cockpit view is +Y axis.

MARKER 1-5
No active controls

SAMPLE RETURN CAPSULE(SRC)
No active controls.
Auto heatshield, backshell and parachute deployment at 10km alt.

PROCYON
[G] = Deploy Solar Panels
[V] = Hold Prograde Attitude
[B] = Hold Retrograde Attitude
[N] = Select Reference Body for Prograde[V]/Retrograde[B] functions
[E] = Set Cockpit View Forward/Back (+Z/-Z axis)

Procyon also has Reaction Wheels for attitude control
Use [Shift]+[NumPad] controls to use Reaction Wheels:
[Shift]+[NumPad 2/8] = Pitch
[Shift]+[NumPad 1/3] = Yaw
[Shift]+[NumPad 4/6] = Bank
[Shift]+[NumPad 5] = KillRot
Reaction Wheel "KillRot" function status on HUD.

SHINEN2 / ARTSAT2
No active controls

HAYABUSA2 MISSION TIMELINE

Launch: Tanegashima	Dec 03 2014, 04:22:00 UTC
Earth Gravity Assist	Dec 02 2015, MJD 57358.6? (could be MJD 57360?)
Arrive at 1999JU3	June 2018, MJD 58284?
Depart from 1999JU3	Dec 2019, MJD 58832?
Return SRC to Earth	Dec 2020, MJD 59198?

PROCYON MISSION TIMELINE

Launch: Tanegashima	Dec 03 2014, 04:22:00 UTC
Earth Gravity Assist	Dec 05 2015, MJD 57361?
Flyby asteroid 1999JV6	Mar 04 2016, MJD 57451?

Thanks to...Alex, Donamy and all Orbiter devs and users :-)
BrianJ, Dec 2014