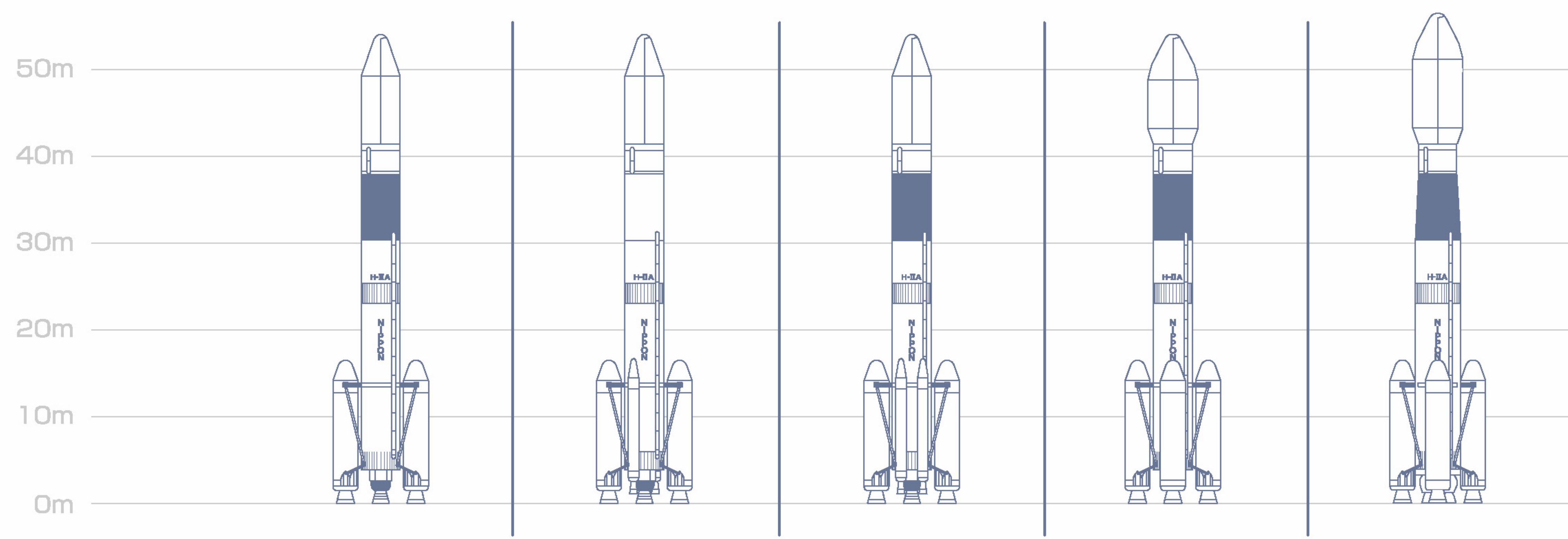
Overview of the H-IIA Launch Vehicle No.8 (H-IIA F8)

Japan Aerospace Exploration Agency (JAXA)
Independent Administrative Agency

H-IIA Launch Vehicle

- Liquid oxygen and hydrogen are used as propellant for both the first and second stages.
- Based on technology acquired by the development of the H-II, high reliability is maintained while cost reduction was achieved and the H-IIA family was formed with variations by attaching solid rocket boosters and solid strap-on boosters onto the standard H-IIA.
- Various launch needs can be met by choosing an appropriate type of payload fairing and payload attach fitting (PAF) according to the number and size of (a) satellite(s).
- Since its maiden flight in Aug. 2001, JAXA has successfully launched five H-IIA launch vehicles. However, in Nov. 2003, the sixth fight failed. In Feb. 2005, the H-IIA F7, the return-to-flight mission, was successfully launched.

H-IIA Launch Vehicle Family



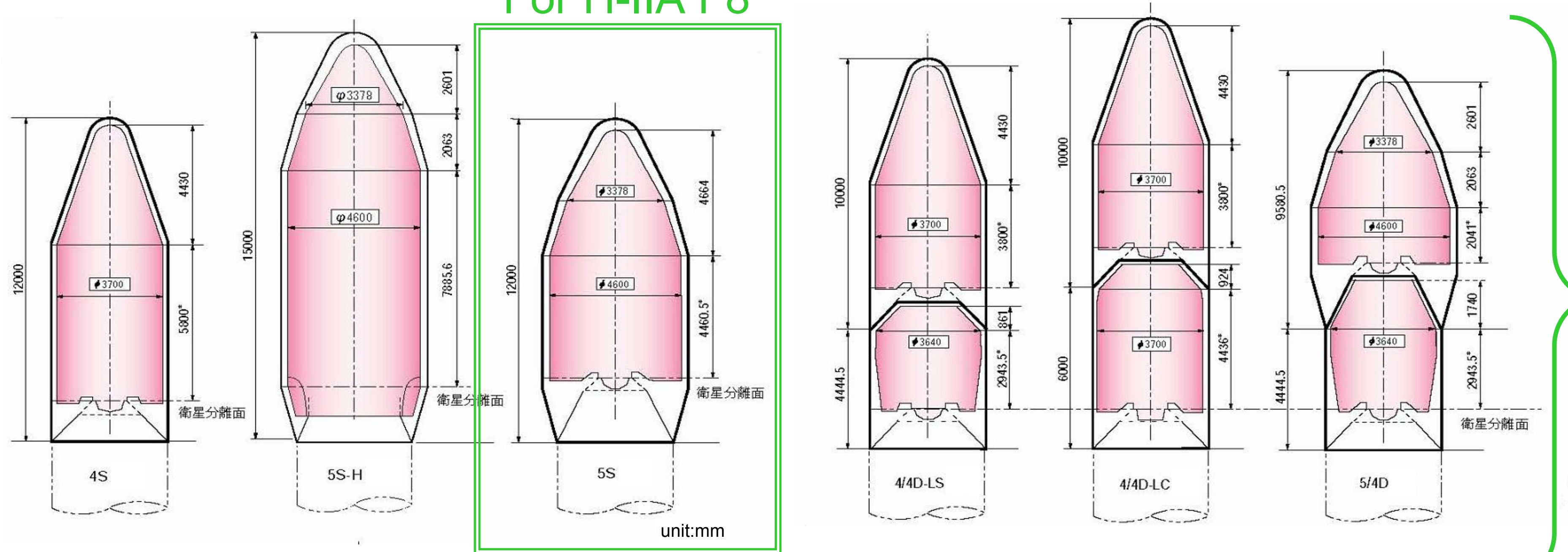
諸元 Item	H2A202 [標準型 Standard]	H2A2022	H2A2024	H2A204 [計画中 Planned]	H2B (Heavy Lift) [計画中 Planned]
全長[m] Length[m]	53	53	53	53	56
質量[ton]* Mass[ton]*	289	321	351	445	551
第2段 2nd Stage	1	1	1	1	1
第1段 1st Stage	1	1	1	1	1
SRB-A	2	2	2	4	4
SSB	–	2	4	–	–

H-ⅡAの機体名称　H2A a b c d(a:1段式/2段式、b:LRBの数、c:SRB-Aの数、d:SSBの数)
Figures following H2A indicate the number of the first plus second stages, number of LRB, number of SRB-A, and number of SSB.

＊：人工衛星は含まない。(Not including payload mass)

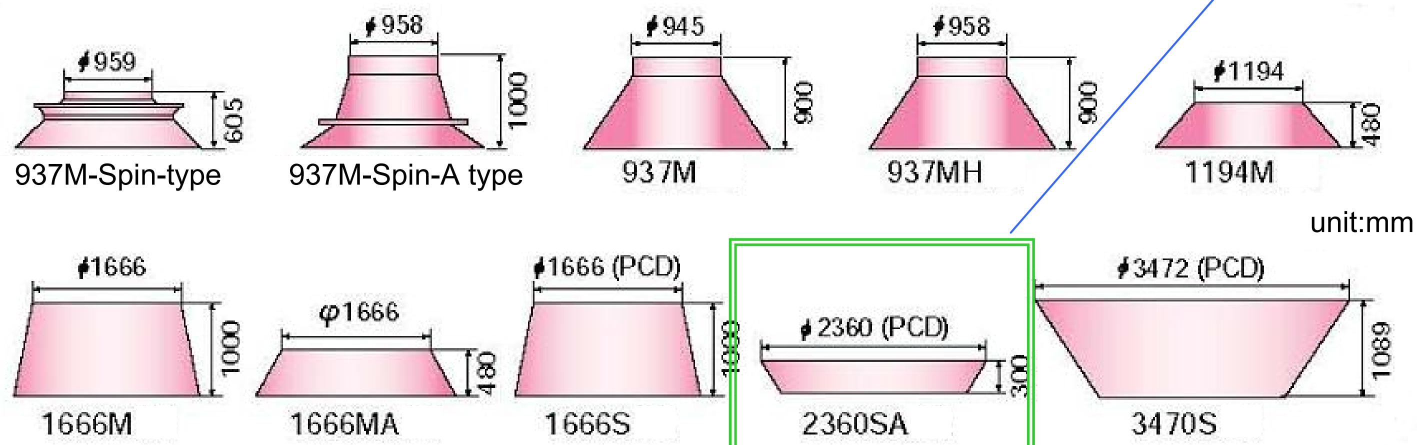
Types of Payload Fairing and Payload Attach Fitting (PAF)

For H-IIA F8



Payload Fairing

Payload Attach Fitting



For H-IIA

H-IIA F8 Configuration

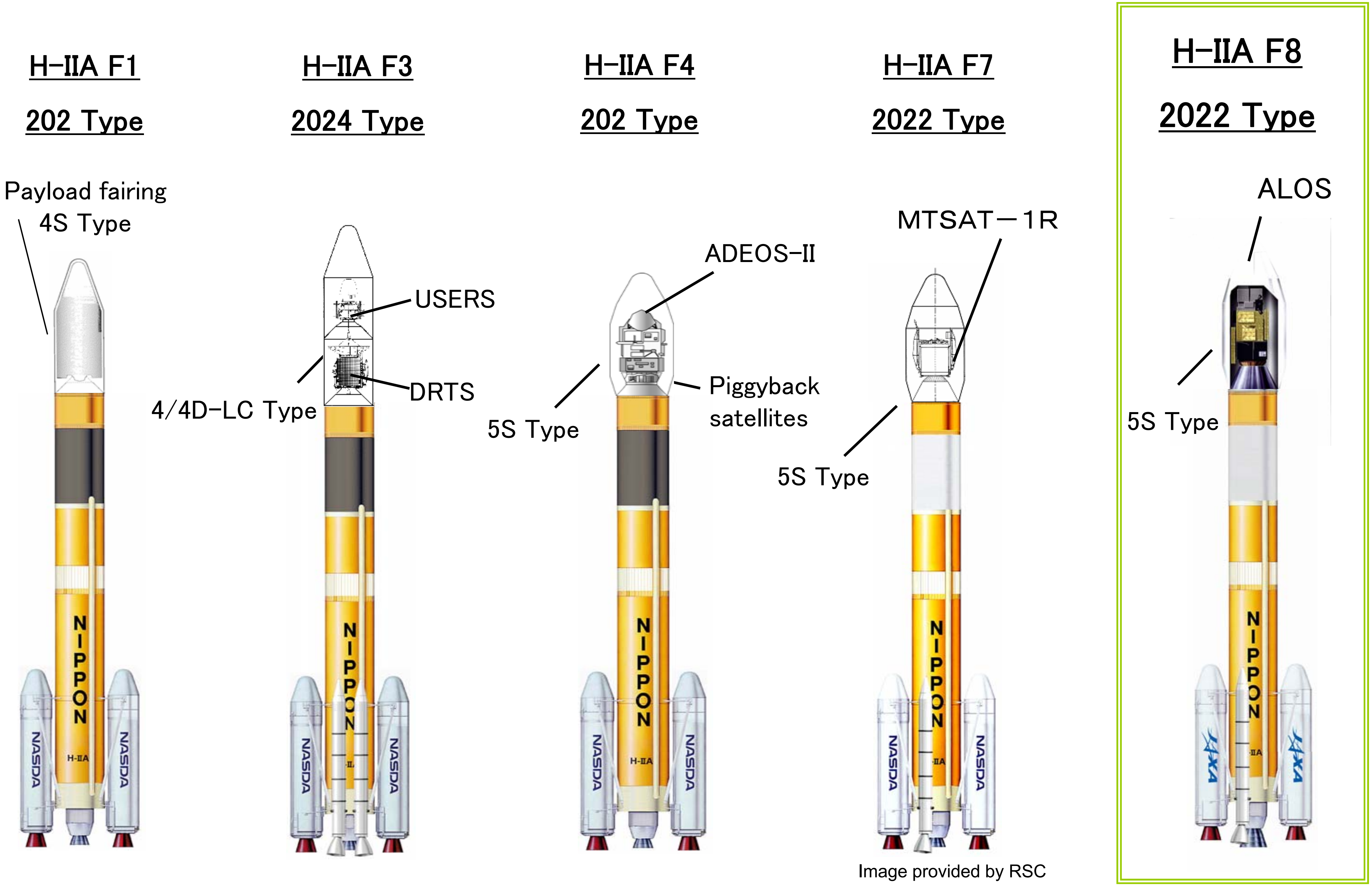
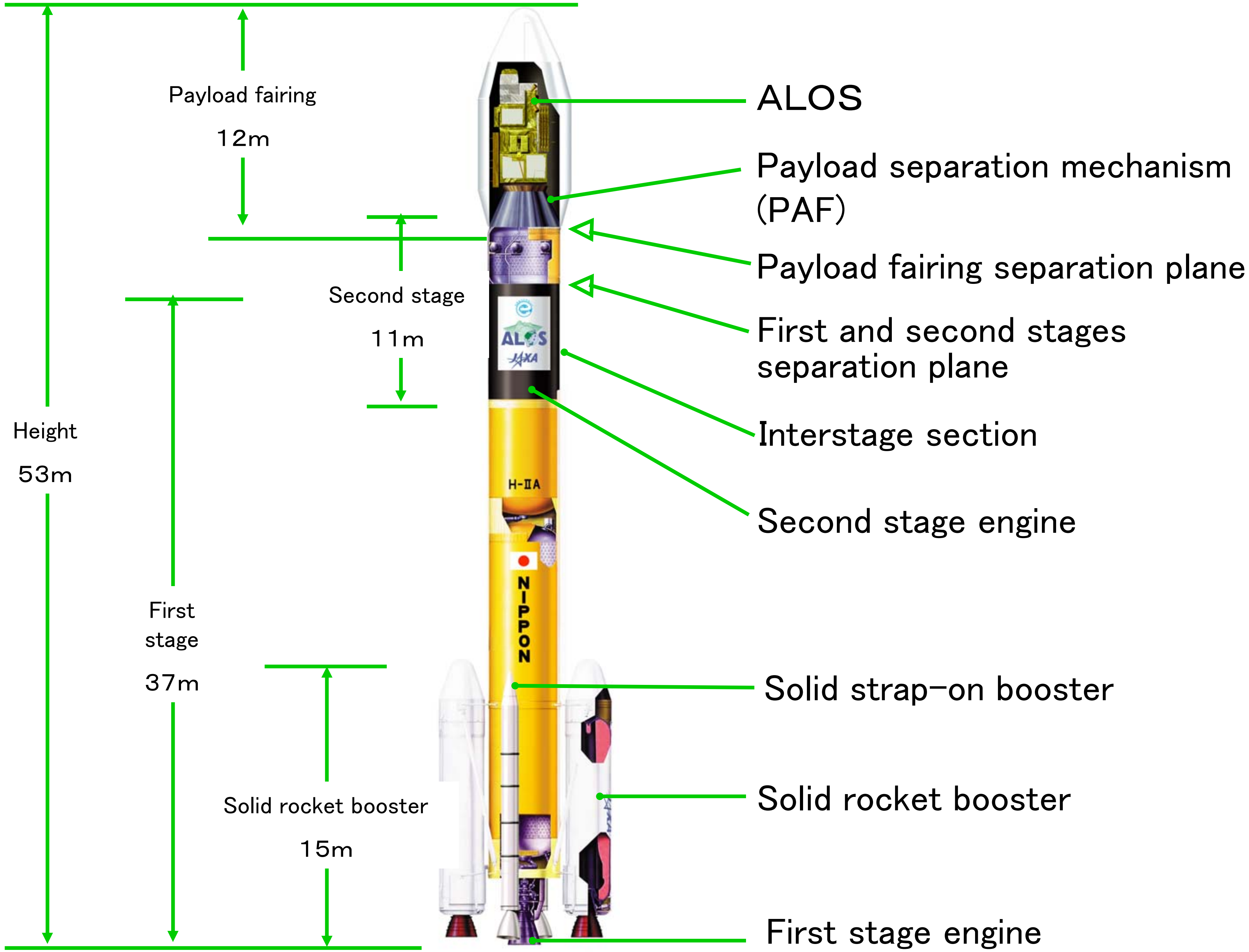


Image provided by RSC

H-IIA F8 Configuration



Objective of the H-IIA F8 Launch

- **Mission**
  To inject the Advanced Land Observing Satellite (ALOS) into a sun-synchronous subrecurrent orbit

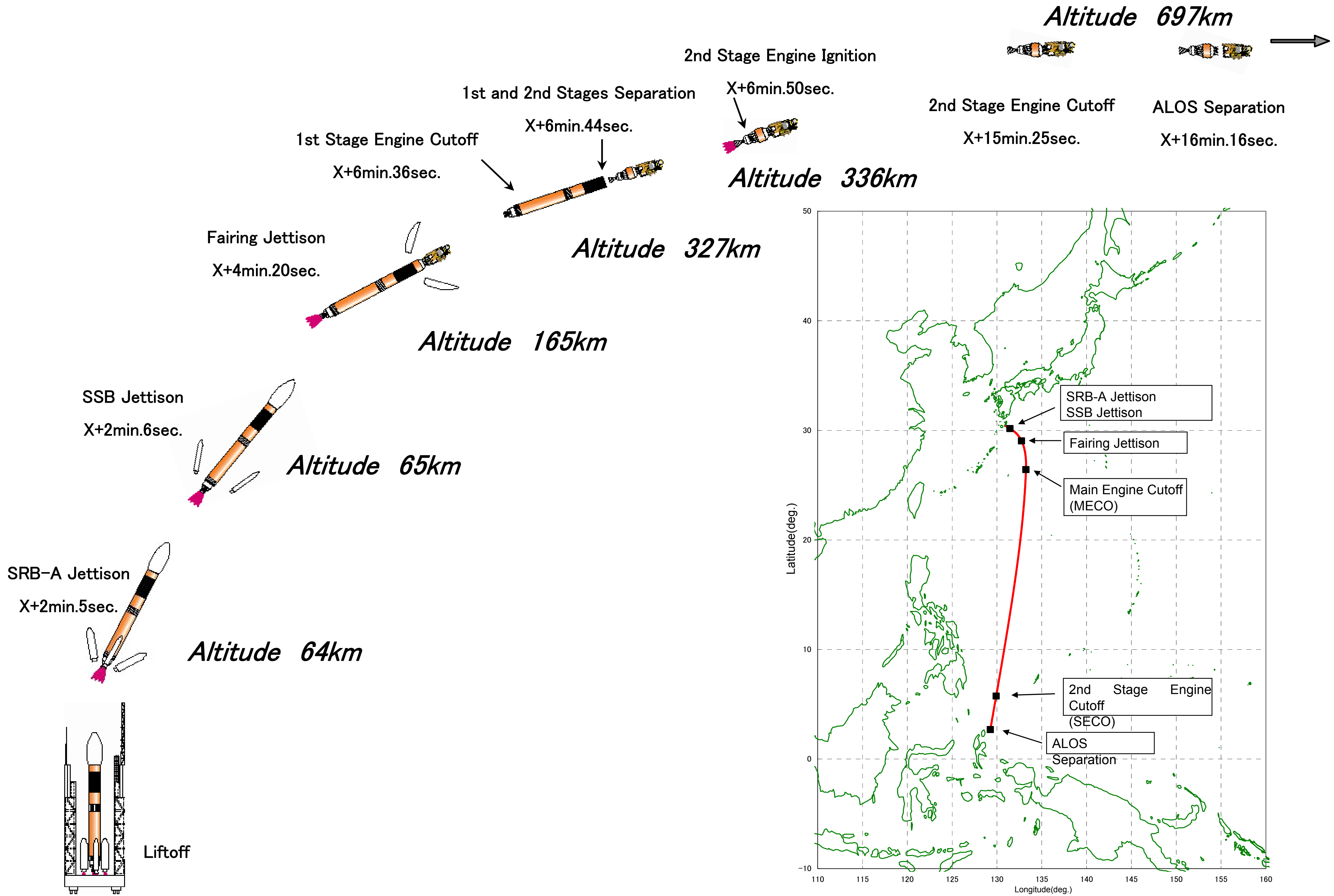
- **Scheduled Launch Day and Time**
  January 19 (Thursday), 2006
  Between 10:33 a.m. and 10:43 a.m.

- **Injection Orbit**
  Altitude: approx. 700 km
  Inclination: approx. 98 degrees
  Period: 99 minutes

- **Basic Specifications of the H-IIA F8**
  H2A2022 type
    5-m diameter fairing
    Two solid strap-on boosters

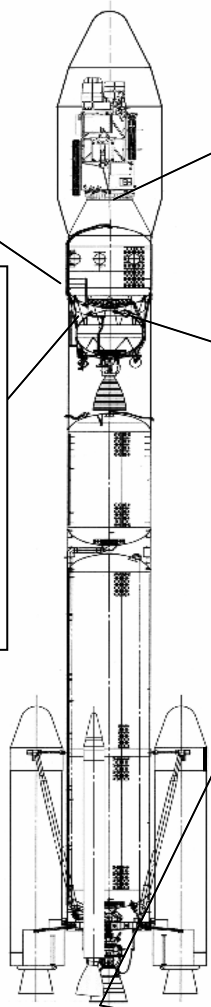
- **Special characteristics**
  The basic specifications are the same as the H-IIA F7 for the MTSAT-1R

H-IIA F8 Launch Sequence



Newly Introduced Items to the H-IIA F8

The following items have been introduced for the first time after their development was completed.



Gas Jet Equipment

A catalyst was changed to a European made one

Avionics Equipment

- First stage guidance control computer
- First stage data collecting device
- UHF telemetry transmitter
- Second stage batteries for measurement

Minimum modifications were made on the conventional avionics equipment whose performance had already been proved by past flights because some spare parts are not manufactured anymore and also because some parts were changed in the process of having the common specifications with the H-IIA 204 type.

Payload separation mechanism (PAF) (2360SA type)

Specially developed for the ALOS

Second stage supporting rod

Changed to a domestically made one

LE-7A nozzle insulation

Measures against heating by plume from the SRB-A to the long nozzle. The insulation is equipped this time to verify its effect for the H2A204.

LE-7A Engine (Regenerative cooling long nozzle)

For improving launch capability

LE-7A Engine (Regenerative cooling long nozzle)

[Development objective]

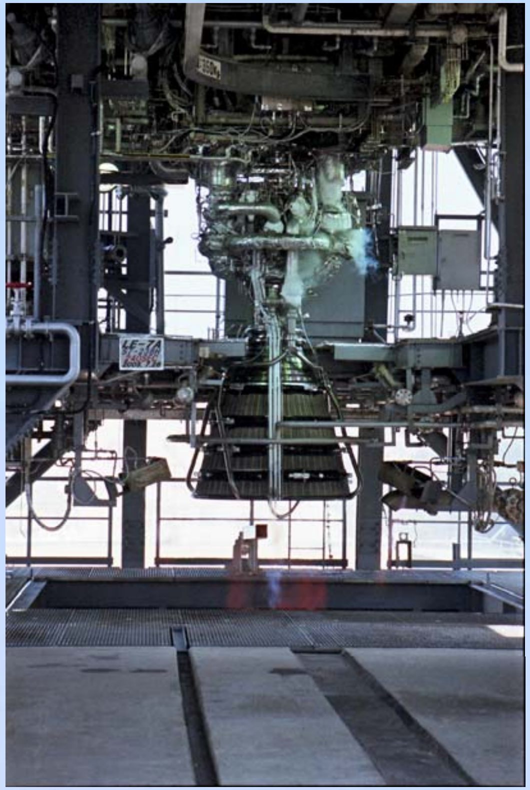
Increasing the reliability of the first stage engine, and improving the launch capability through higher performance

[Development history]

- June 1999:
  Excessive lateral thrust was generated during the Ground Test Vehicle (GTV) test. As short-term countermeasures for this non-conformity, JAXA decided to carry out rocket launches without a lower nozzle skirt (shorter nozzle configuration).

- December 2000:
  JAXA started development of the regenerative cooling long nozzle as countermeasures for excessive lateral thrust and for further improving reliability.

- Between 2002 and 2005:
  JAXA confirmed the durability of more than 4 MDCs (mission duty cycles) by two units of LE-7A.

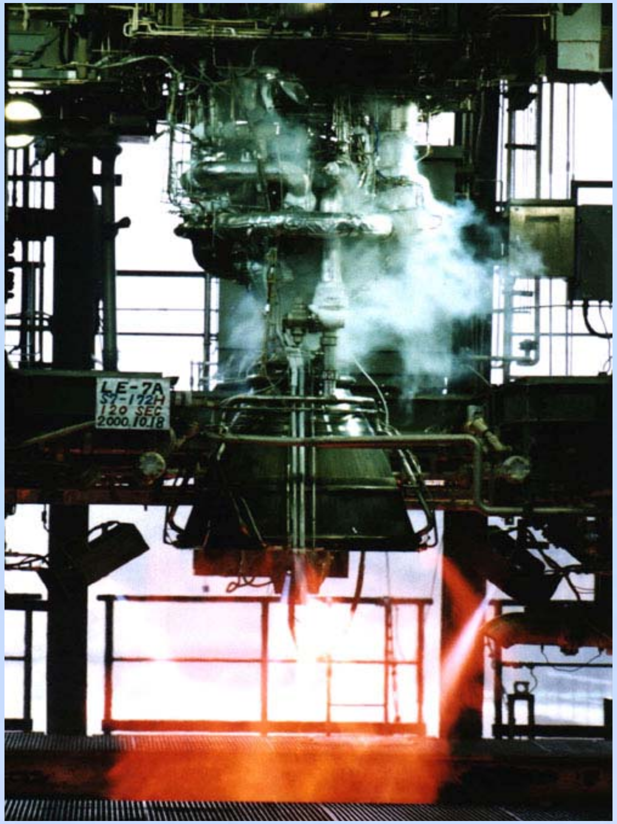


* Static firing test record

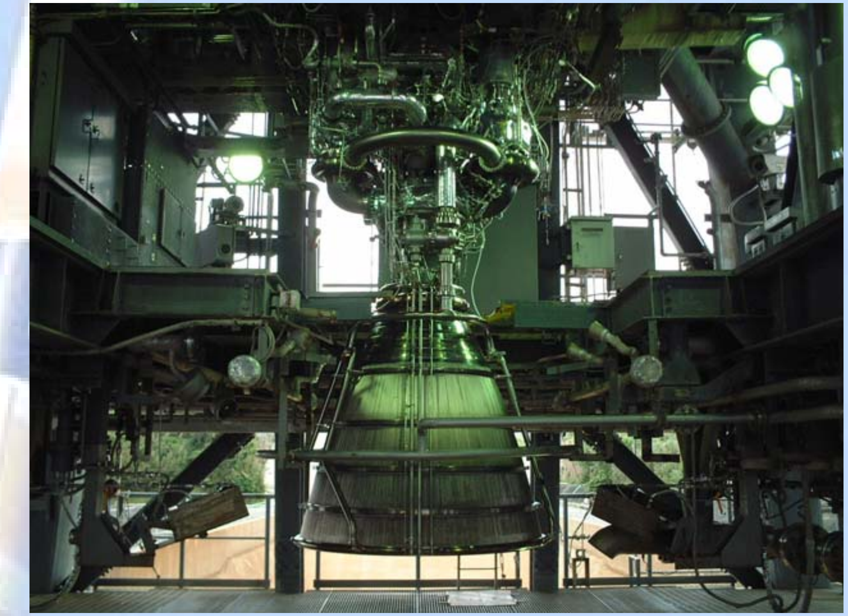
Acceptance test of the H-IIA F7 engine	12 times	2,241 seconds
Engine for technical data acquisition	8 times	1,989 seconds

(1MDC = 400 seconds)

Short Nozzle vs. Long Nozzle



Short nozzle configuration



Long nozzle configuration

3. 2m	Total engine length	3. 7m
1074kN(109. 5tonf)	Vacuum thrust	1098kN(112tonf)
429seconds	Vacuum specific impulse	440seconds

LE-7A Nozzle Insulation

[Development objective]

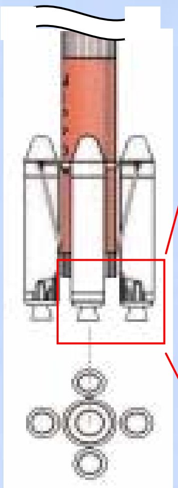
Countermeasures for heating of the LE-7A nozzle area by jet in the H2A204 configuration

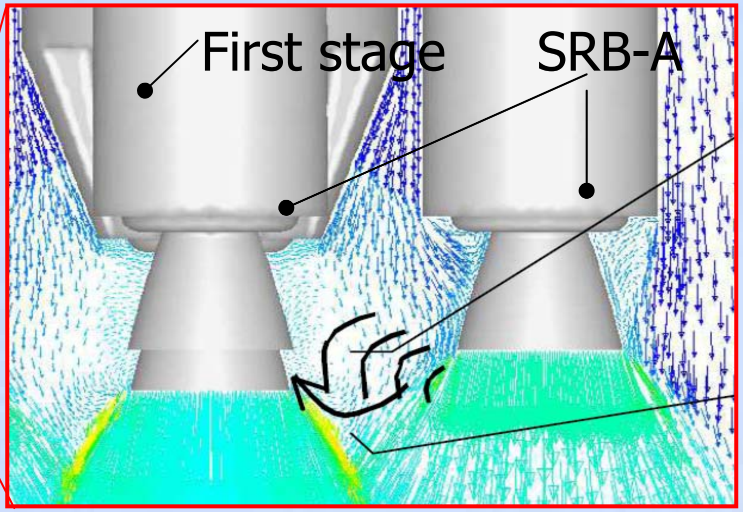
[Development history]

- Development was carried out between Nov. 2002 and May 2005.
- JAXA measured a heating rate at the tip of the nozzle during H-IIA F4, F5, and F7 flights, even though their engines were equipped with the short nozzle engine. JAXA was able to confirm the appropriateness of the design conditions.
- The insulation was attached to the engine for the static firing test, and it was verified that no damage was done to the nozzle and insulation.

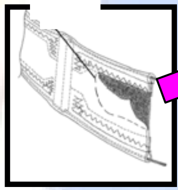
[Purpose of the insulation installation into the H-IIA F8]

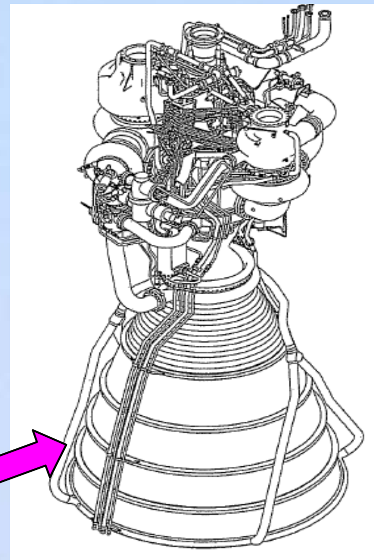
This is the first flight with the long-nozzle LE-7A engine, and JAXA will acquire heating rate data during the flight.





In the H2A204 configuration, the first stage engine (LE-7A) is surrounded by the SRB-As, thus the heating rate at the nozzle is high.





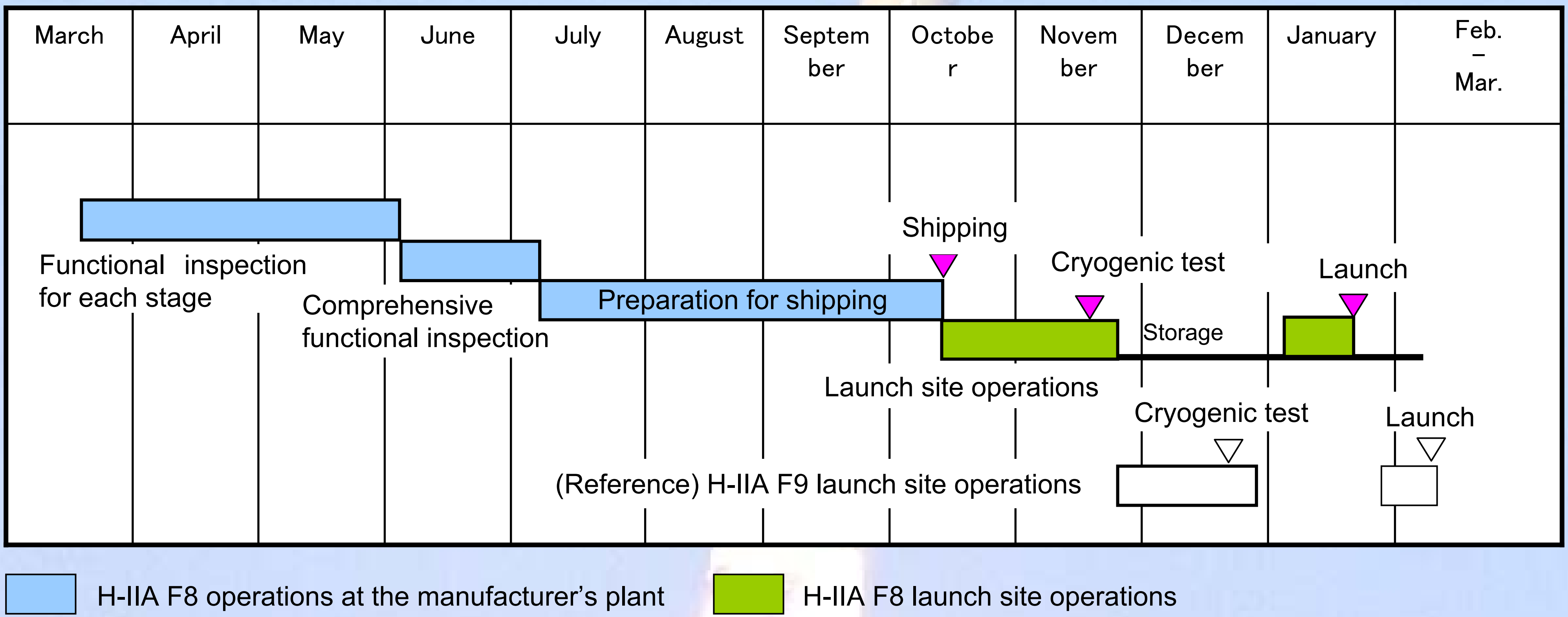
Put the insulation around the nozzle

The part wrapped by the insulation

Regenerative cooling long nozzle

H-IIA F8 Preparation Schedule

- The launch site operations were originally scheduled to start in the end of July 2005; however, it was delayed due to the ALOS launch schedule change.
- The launch site operations started in mid Oct. 2005, and the cryogenic test was held on Nov. 17.



Flow of the H-IIA F8 Launch Site Operations (till the Cryogenic Test)

Oct. 15-16, 2005
The launch vehicle arrived at Shimama Port, Tanegashima, and was transported to the Tanegashima Space Center (TNSC).

Oct. 16, 2005
After arriving at the TNSC, the "vehicle on stand" operations (VOS operations, or erecting the launch vehicle) were carried out. On the same day, the second stage was assembled.

Hoisting the first stage / hoisting the second stage and assembling the first and second stages

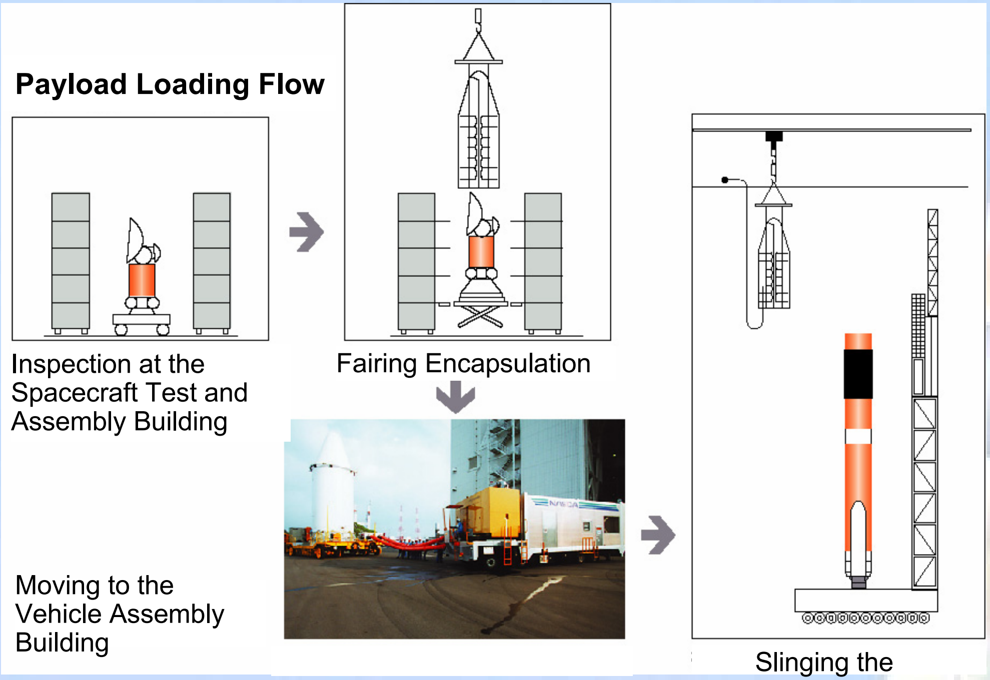
Cryogenic Test (F-0)

The test is for checking the function of the launch vehicle and ground facilities by actually loading propellants and following exactly the same process as that for the launch day.

Oct. 17-18, 2005
Installing the SRB-As onto the first stage, the right one first then the left

Nov. 17, 2005
The Cryogenic Test was held for the launch vehicle whose first and second stages, SRB-As and SSBs were assembled (without an encapsulated payload.)

Flow of the H-IIA F8 Launch Site Operations (from the Cryogenic Test to the Launch)



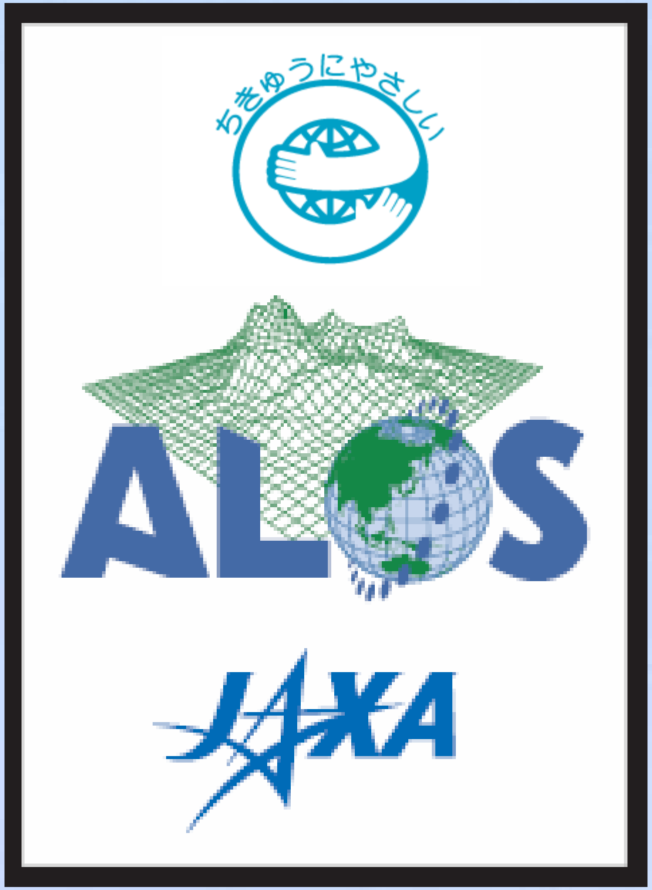
Slinging the encapsulated satellite

The Satellite to be loaded on top of the launch vehicle (scheduled on Jan. 10, 2006.)

Moving to the launch pad on the mobile launcher for launch

Launch
(scheduled on Jan. 19, 2006)

Billboard on the H-IIA F8 Vehicle Body



JAXA/ALOS Campaign is supported by the Eco mark of the Japan Environment Association.

■ The ALOS will observe the earth's topography and vegetation and contribute to cartography with high precision all over the world. With such geographic data, the ALOS is expected to play an important role in our community life and topographic research. The ALOS will also be useful for protecting our precious natural environment, society, and life by monitoring the environment from space, telling us the earth's features which we cannot see, and investigating damaged areas as soon as a disaster occurs.

■ JAXA would like the general public to know and be interested in more about the ALOS, whose missions are closely related to our life such as environment protection. For that purpose, aside from conventional PR activities, JAXA decided to carry out the "ALOS Mission Campaign" for the first time in collaboration with the industry sector. In the campaign, we have been asking private companies who are actively promoting environmentally friendly management, and/or who support Japanese space development such as rocket launches and satellite development, to become "campaign supporters."

■ This campaign was approved and supported by the Japan Environment Association (JEA) as a promotional and enlightening activity for environment protection that is promoted by the JEA. Consequently, the "Eco mark" sign was provided to be attached to the H-IIA F8 body as a symbolic mark.

■ The Eco mark is usually granted to environmentally friendly products after review and approval processes. It is also granted to a specific project or activity, like our case, if it is recommendable, and, accordingly, the use of the Eco mark is also approved. This is the third such case in Japan, and the first time that not only the Eco mark but also a satellite logo are put on the launch vehicle body.

■ JAXA plans various activities in corporation with the industry sector in the framework of the ALOS Mission Campaign for a limited period before the launch, on the launch day, and after the launch. Campaign supporters will play a central role, and the participants and their business contents will be introduced after they are named on the following ALOS Mission Campaign Official site. Please have a look.

http://jaxa.eco.goo.ne.jp
(ALOS Campaign Official Site)

goo www.goo.ne.jp

Outline of the ALOS (1/2)

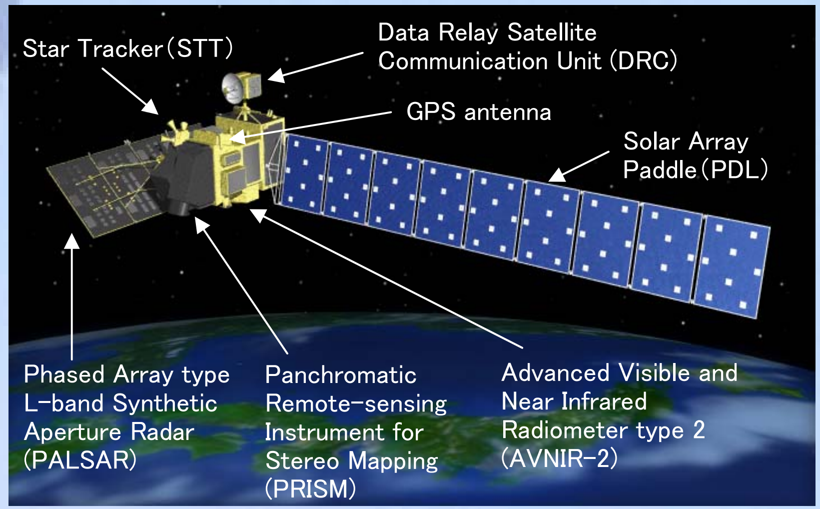
(1) Objectives

The Advanced Land Observing Satellite (ALOS) aims at contributing to cartography, regional observations, disaster monitoring, and resource surveying by inheriting and upgrading the land observation technology of the Japan Earth Resources Satellite-1 (JERS-1, or Fuyo) and the Advanced Earth Observing Satellite (ADEOS, or Midori).

(2) Major Characteristics

- Satellite Mass　Approx. 4,000 kg
- Power Generation　Approx. 7kW (End of Life)
- Designed Life　3 years or more, 5 years (target)
- Orbit　Sun Synchronous Sub-recurrent Orbit
  Altitude: approx. 691.65 km
  Inclination: 98.16 degrees
  Period: 98.7 minutes
  Recurrent period: 46 days (Sub cycle: 2 days)
  Local time at descending node: 10:30 a.m. +/- 15 minutes
- Developed by JAXA
  (PALSAR was developed in corporation with the JAROS of the Ministry of Economy, Trade, and Industry (METI).)

<On-Orbit Satellite Over View>



<ALOS Proto-flight Model>

Outline of the ALOS (2/2)

(3) ALOS Missions

Item	Mission Contents
Cartography	Acquiring necessary data for mapping on a scale of 25,000 to 1 or maintaining/updating existing maps in Japan as well as other countries in the Asia-Pacific region.
Regional Observation	Carrying out continuous global scale observations on distribution of forests and vegetation, cultivated land, actually planted acreage, and floating ice.
Disaster Monitoring	Monitoring a damaged area within two days when a large scale disaster occurs, and quickly providing data as soon as it is received. Japan joined the Charter on international disasters* designating the ALOS as a usable satellite.
Resource Surveying	Acquiring necessary data for surveying resources.
(METI takes responsibility.)	Verifying land observation technology with high resolution, broader observation range, and high precision.

* The Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters: The international framework to promote contribution of space-related organizations to help cope with natural disasters by providing earth observation satellite data. Members include The Centre National D'Etudes Spatial (CNES, French Space Agency), the European Space Agency (ESA) and the National Oceanic and Atmospheric Administration (NOAA, USA).
Japan joined the Charter in Feb. 2005 naming the Cabinet Office as a user organization.

H-IIA Launch History and Schedule

▲ Geostationary Transfer Orbit ■ Sun Synchronous Orbit

JFY 2001	JFY 2002	JFY 2003	JFY 2004	JFY 2005
▲ H-IIA F1 (Test flight) Successfully launched on Aug. 29 ▲ H-IIA F2 MDS-1 (Tsubasa) Successfully launched on Feb. 4	▲ H-IIA F3 DRTS/USERS Successfully launched on Sep. 10 ■ H-IIA F4 ADEOS-II (Midori 2) Successfully launched on Dec. 14 ■ H-IIA F5 IGS Successfully launched on March 28	■ H-IIA F6 IGS Launch failed on Nov. 29	▲ H-IIA F7 MTSAT-1R (Himawari6) Successfully launched on Feb. 26	■ H-IIA F8 ALOS ▲ H-IIA F9 MTSAT-2

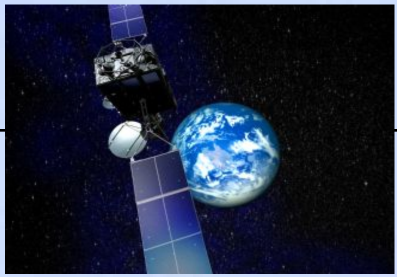
(JFY: Japan Fiscal Year. All dates are Japan Standard Time.)

H-IIA Launch Schedule in the Next Japan Fiscal Year and Later

ETS-Ⅷ

Japan Fiscal Year (JFY)	Satellite to be onboard	
JFY 2006	Information Gathering Satellite Optical 2*	
	Information Gathering Satellite Radar 2*	
	ETS-VIII (Engineering Test Satellite VIII)	An engineering satellite to carry out cutting-edge communication tests with the world's largest deployable antenna
JFY 2007	SELENE (Lunar orbiting satellite)	The first Japanese large lunar orbiting probe
	WINDS (Super high-speed internet satellite)	To carry out research and development necessary for establishing a future satellite communication network

SELENE



WINDS

* JAXA is commissioned to conduct a launch.

Reference / Additional Information

- Launch Related Facilities at the Tanegashima Space Center
- H-IIA F6 Launch Failure Cause and Investigation
- Issues Addressed for the H-IIA F7 (Design change of the SRB-A / Thorough review of the launch vehicle)
- H-IIA Launch Vehicle vs. Rockets around the World

Tanegashima Space Center (TNSC)

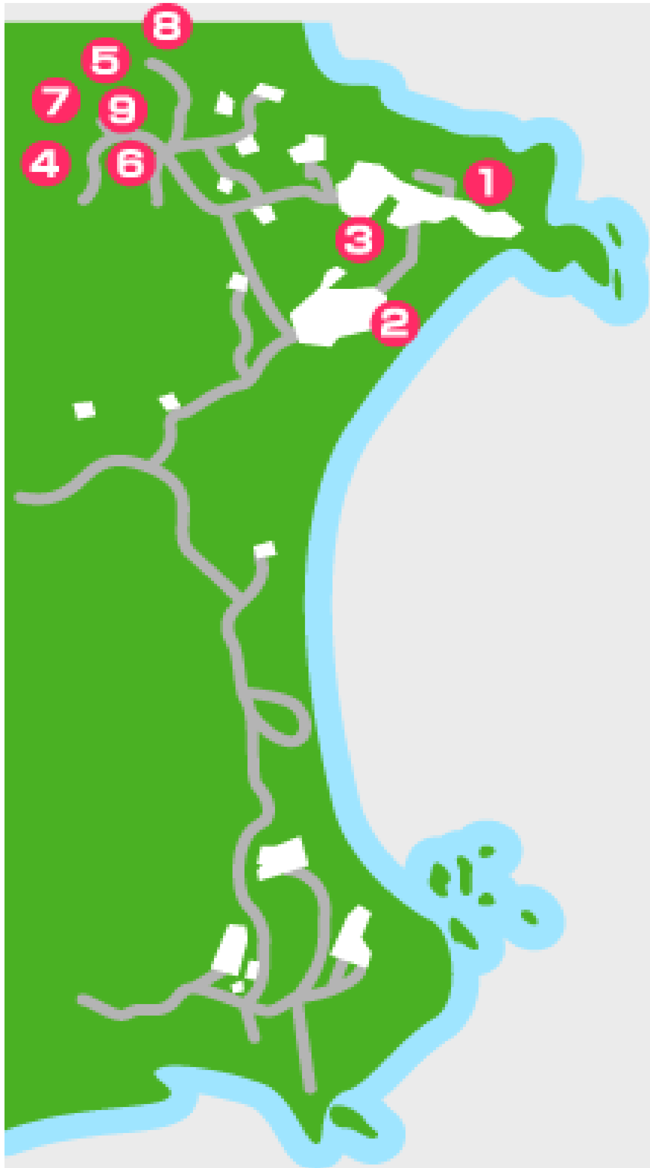
The center was constructed in 1969 when the former National Space Development Agency of Japan (current JAXA) was established. It is the largest space development facility in Japan with a total area of about 860 square meters.

3. Yoshinobu Firing Test Stand

This firing test stand for liquid engines used to be for carrying out the static firing test of the first stage engine (LE-7), which was the heart of the H-II Launch Vehicle, a 100 % domestically manufactured rocket. The stand is currently used for firing tests of the first stage engine (LE-7A) of the H-IIA.

4. Spacecraft and Fairing Assembly Building

This building is for operations for a large-size satellite that is to be launched by a large-size launch vehicle. The operations include assembly, launch preparation, and various tests.



1. Yoshinobu Launch Complex

At the TNSC, there are two launch pads for large-size rockets, Launch Pad 1 (for launching up to two tons of a geostationary satellite) and Launch Pad 2 (for two to four tons). H-IIA launches are conducted there.

1. Yoshinobu Launch Complex
2. Osaki Launch Complex
3. Yoshinobu Firing Test Stand
4. Spacecraft and Fairing Assembly Building
5. Non-Destructive Test Facility
6. First Spacecraft Test and Assembly Building
7. Spacecraft Test and Assembly Building #2
8. Hirota Optical Tracking Station
9. Osaki Power Supply Facilities

H-IIA F6 Launch Failure Cause

Left side

As the images show, no significant difference is observed between the H−IIA F5 and F6.

	F5 image data	F6 image data
106 seconds after liftoff SRB-A jettison	 	 

Right side

In the image data of the F6, the SRB−A, which was supposed to be separated before the SSB#1, was still attached to the first stage of the launch vehicle.

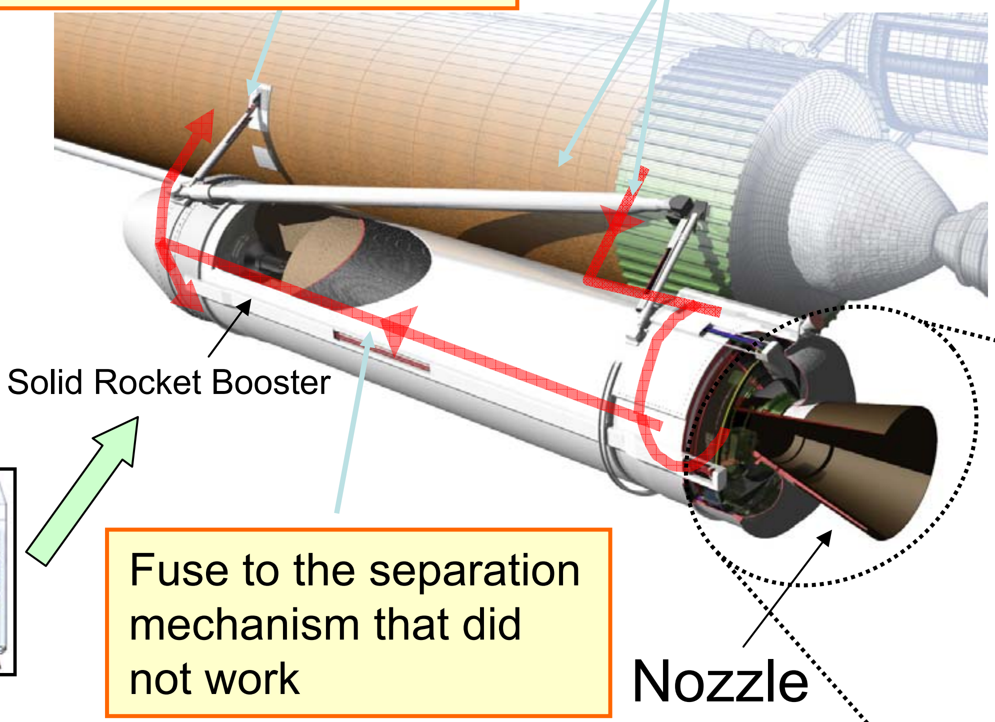
	F5 image data	F6 image data
106 seconds after liftoff SRB-A jettison	 	 
108 seconds after liftoff SSB#1 jettison		

H-IIA F6 Launch Failure Cause Investigation

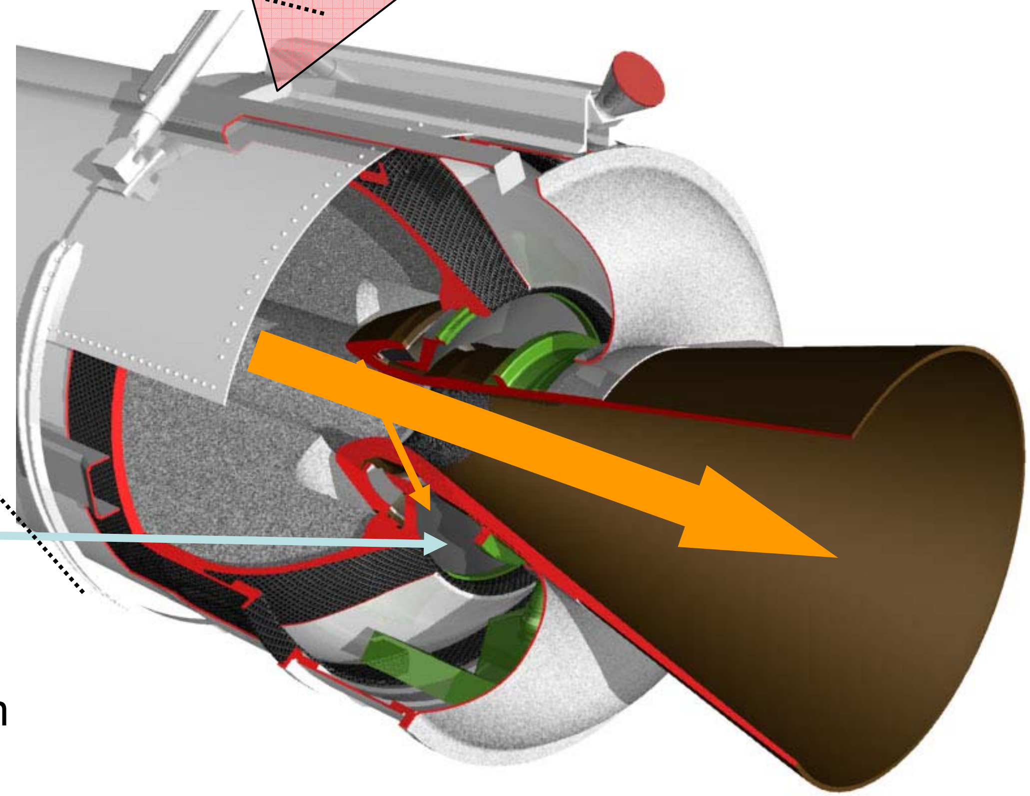
The separation mechanism that did not work

Normally separated

Note: The root part (joint part) of the nozzle is made of heat-resisting substances such as carbon material to avoid impact of very high heat combustion gas of 2,000 to 3,000 degrees Celsius. Carbon material burns and destroys itself when it contacts with combustion gas to protect the structural part from heat.



Fuse to the separation mechanism that did not work



Leakage of combustion gas

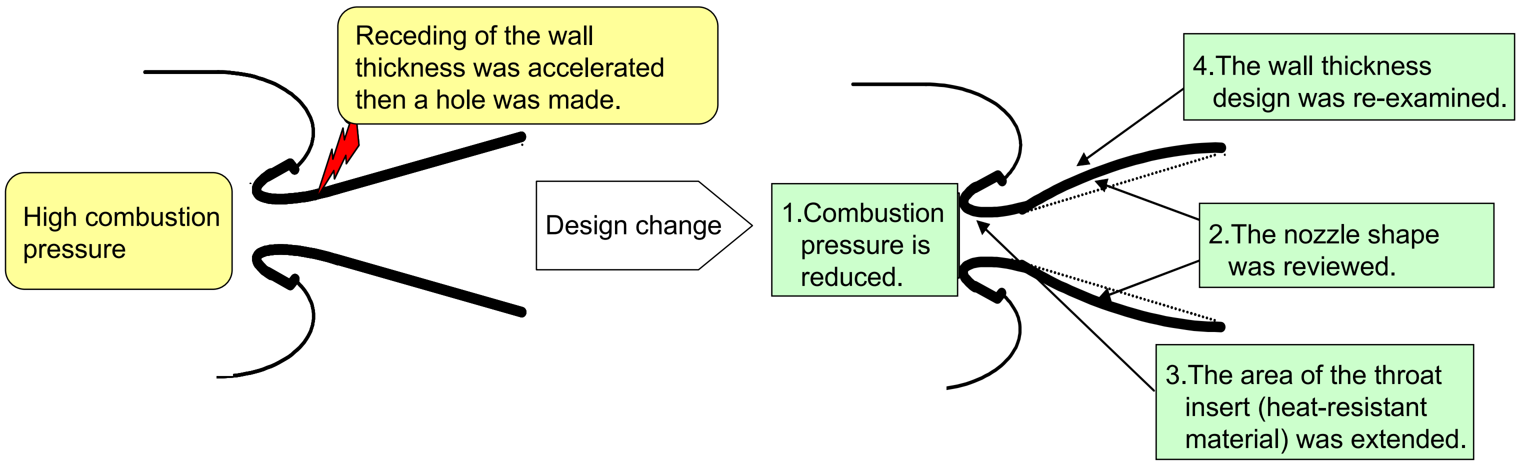
A hole was made in the root part (joint part) of the nozzle, and high temperature combustion gas leaked from the hole. The fuse for the separation mechanism that was routed near the hole was damaged by the gas, and that caused the failure of the separation.

Issues Addressed for the H-IIA F7

- Countermeasures for the Solid Rocket Booster (SRB-A)
  - As a result of the H-IIA F6 launch failure cause investigation, JAXA decided to take a basic policy of changing the SRB-A design to improve reliability. Consequently, the design of the nozzle and motor has been changed to improve the SRB-A.
  - JAXA verified the appropriateness of the design change by carrying out static firing tests three times using a life-size motor.

Conventional configuration

Improved configuration



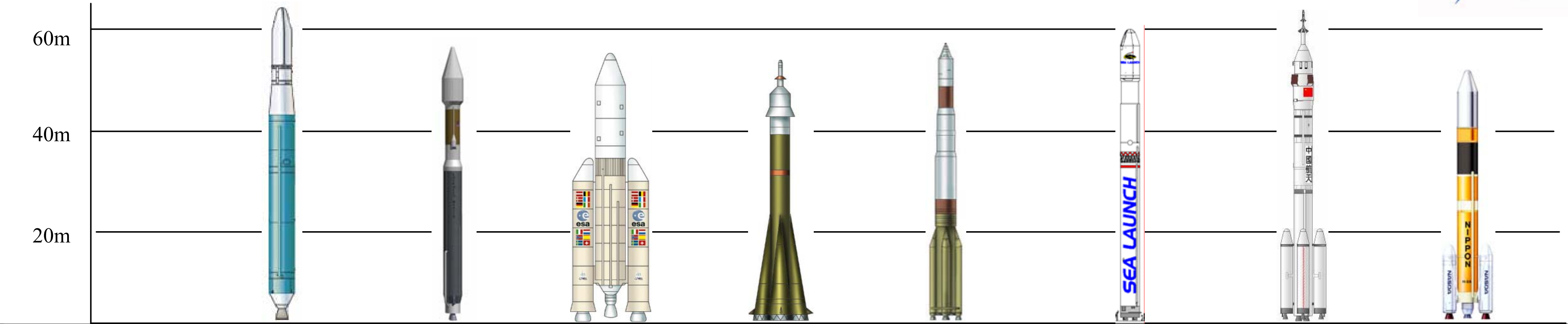
Conical-shaped nozzle

Bell-shaped nozzle

Static firing test of the improved SRB-A

- Thorough review of the H-IIA launch vehicle and the result of the H-IIA F7 launch
  - The entire launch vehicle was thoroughly checked even from the design basics.
  - The H-IIA F7, in which the measures were incorporated, was launched on Feb. 2005, and the MTSAT-1R was successfully injected into its scheduled orbit 40 minutes and 2 seconds after liftoff.

<Reference Chart> Launch Capability of the Launch Vehicle in the World



		Delta 4M	Atlas 5	Ariane 5	Soyuz U	Proton K	Zenit-3SL	Long March 2F	H-IIA
Name		Delta 4M (Delta 4M)	Atlas 5 (Atlas5 401)	Ariane 5	Soyuz U	Proton K	Zenit-3SL (Sea Launch)	Long March 2F (CZ-2F)	H-IIA (H2A202)
Country		USA		Europe	Russia		Ukraine	China	Japan
Number of stages		2	2	2	2	4	3	2	2
Height (m)		63	58	54	55	57	60	62	53
Diameter (m)		4	3.8	5.4	3.0	7.4	3.9	3.4	4.0
Total mass (t)		250	333	746	310	692	471	464	289
Launch capability to low orbit (t)		8.1	12.5	18.0	6.9	19.8	—	8.4	10
launch capability to GTO (t)		4.2	5.0	6.0	1.4	4.9	6.0	3.5	3.7 *
Propellant	Sub booster	Solid	Solid	Solid	Liquid oxygen /Kerosine	—	—	Nitrogen tetroxide, NTO/Hydrazine	Solid
	First stage	Liquid oxygen /Liquid hydrogen	Liquid oxygen /Kerosine	Liquid oxygen /Liquid hydrogen	Liquid oxygen /Kerosine	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Kerosine	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Liquid hydrogen
	Second stage	Liquid oxygen /Liquid hydrogen	Liquid oxygen /Liquid hydrogen	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Kerosine	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Kerosine	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Liquid hydrogen
	Third stage	—	—	—	—	Nitrogen tetroxide, NTO/Hydrazine	Liquid oxygen /Kerosine	—	—
	Fourth stage	—	—	—	—	Liquid oxygen /Liquid hydrogen	—	—	—

This value is provisional with the improved SRB-A. JAXA plans to further develop a renovated SRB-A to greater improve reliability.