

**IHI**  
Realize your dreams

IHI AeroSpace

**MEISEI**

# Space Development Activities of IHI Group

*May 22<sup>nd</sup> 2014*

IHI Corporation  
IHI AEROSPACE Co., Ltd.  
MEISEI ELECTRIC Co., Ltd.

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**ILA** Berlin Air Show

The focal point of aerospace

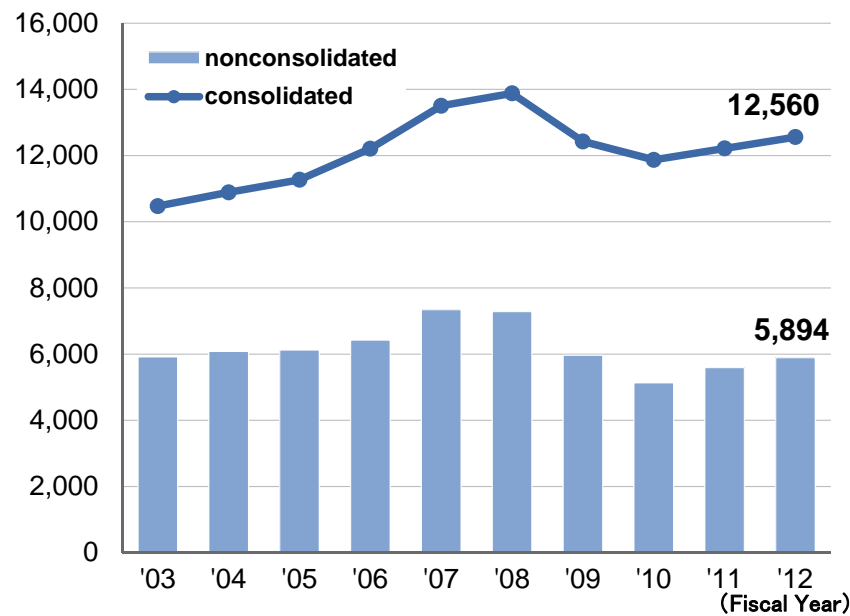
May 20 – 25, 2014  
Berlin ExpoCenter Airport

# Outline of IHI

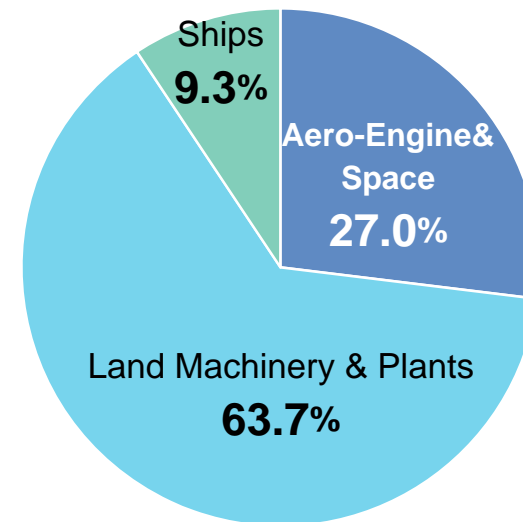
<b>Company Name</b>	IHI Corporation
<b>Head Office</b>	Toyosu IHI Building, 1-1, Toyosu 3-chome, Koto-ku, Tokyo 135-8710, Japan
<b>Year of establishment</b>	December 5, 1853
<b>Capital</b>	¥95,762 million (as of March 2013)
<b>President</b>	Tamotsu Saito, CEO

<b>Employees</b>	26,915 (nonconsolidated: 7,944 )
<b>Works</b>	10
<b>Branches and sales offices in Japan</b>	18
<b>Overseas offices</b>	14(as of March 2013)

**Annual Sales (Unit: 100 million yen)**



**Consolidated Sales Ratio (In fiscal 2012)**



# Products of IHI Group

**Energy and Resources**

**Shipbuilding, Social Infrastructure and Security**

**Industrial Machinery and Systems**

**Rotating Equipment and Mass Production Machinery**

**Aero Engine and Space**

**Energy and Resources**

**Reactor Pressure Vessel**

**Storage Plant Process Plant**

**Power Plant**

**Ships & Offshore Facilities**

**Traffic Systems Parking Systems**

**Real Estate**

**Rocket & Solid Booster**

**Jet engines**

**Bridge & Steel Structures**

**3D laser radar**

**Satellite Propulsion**

**Turbo Charger**

**Physical Distribution Systems**

**Construction Machinery**

**Centrifuge**

**Diesel Engine**

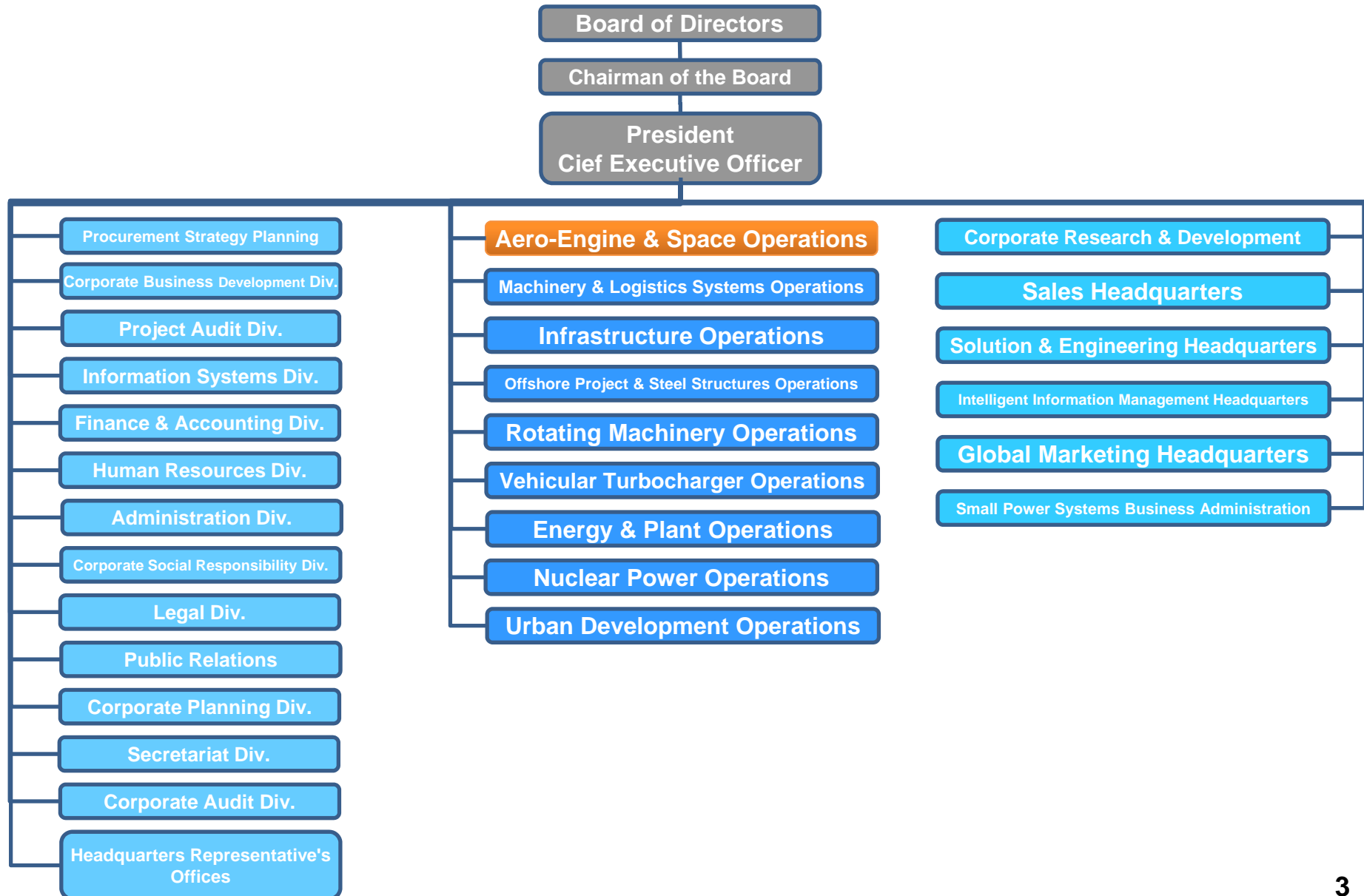
**Compressor**

**Container Cranes**

**Material Handling System**

**Blast Furnace Plant**

# IHI ORGANIZATION



# Products of IHI Group Companies

(As of April 2013)

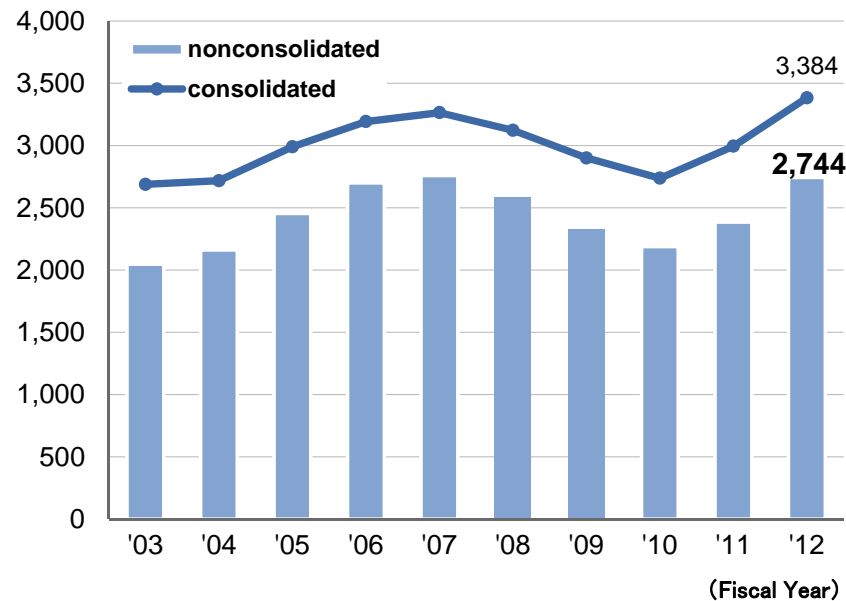
Operations	Main Products, Activities	Main Works
<b>Aero-Engine &amp; Space Operations</b>	Jet engines, marine gas turbines, space-related equipment, etc.	Mizuho Works, Kure Works, Soma No. 1 and No. 2 Works, IA Tomioka
<b>Machinery &amp; Logistics Systems Operations</b>	Materials handling equipment, steel structures, bridges, construction machinery, physical distribution systems, Industrial furnace, Rolling machine, Vacuum and new material furnace	
<b>Infrastructure Operations</b>	shield excavators, parking towers, etc.	Sunamachi Works
<b>Offshore Project &amp; Steel Structures Operations</b>	Offshore structure	Aichi Works
<b>Rotating Machinery Operations</b>	Compressor	Casting Workshop
<b>Vehicular Turbocharger Operations</b>	Vehicular Turbocharge	
<b>Energy &amp; Plant Operations</b>	thermal power plants, industrial boilers, Gas turbine, Gas engine, Environmental equipment, oil and gas processing plants, oil and gas storage systems, etc	Aioi Works
<b>Nuclear Power Operations</b>	Nuclear power plants & components	Yokohama Machinery Works
<b>Urban Development Operations</b>	Real estate business	

# Outline of Aero-Engine & Space Operations

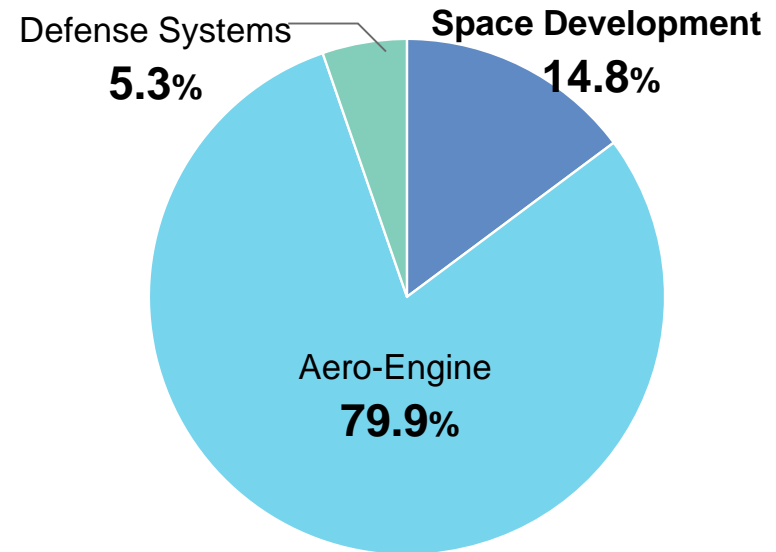
<b>President of Operations</b>	<b>Tsugio Mitsuoka</b>
<b>Managing Executive Officer</b>	
<b>Employees (nonconsolidated)</b>	3,075 (as of April 2013)
Office	1,181
Mizuho Works	763
Kure Works	377
Soma No.1 Works	233
Soma No.2 Works	521

- Operation divisions**
- Defense Systems Div.
  - Civil Aero-Engine Div.
  - Maintenance Div.
  - Space Development Dept.
  - Research & Engineering Div.
  - Manufacturing Div.

**Annual Sales (Unit: 100 million yen)**



**Consolidated Sales Ratio (In fiscal 2012)**

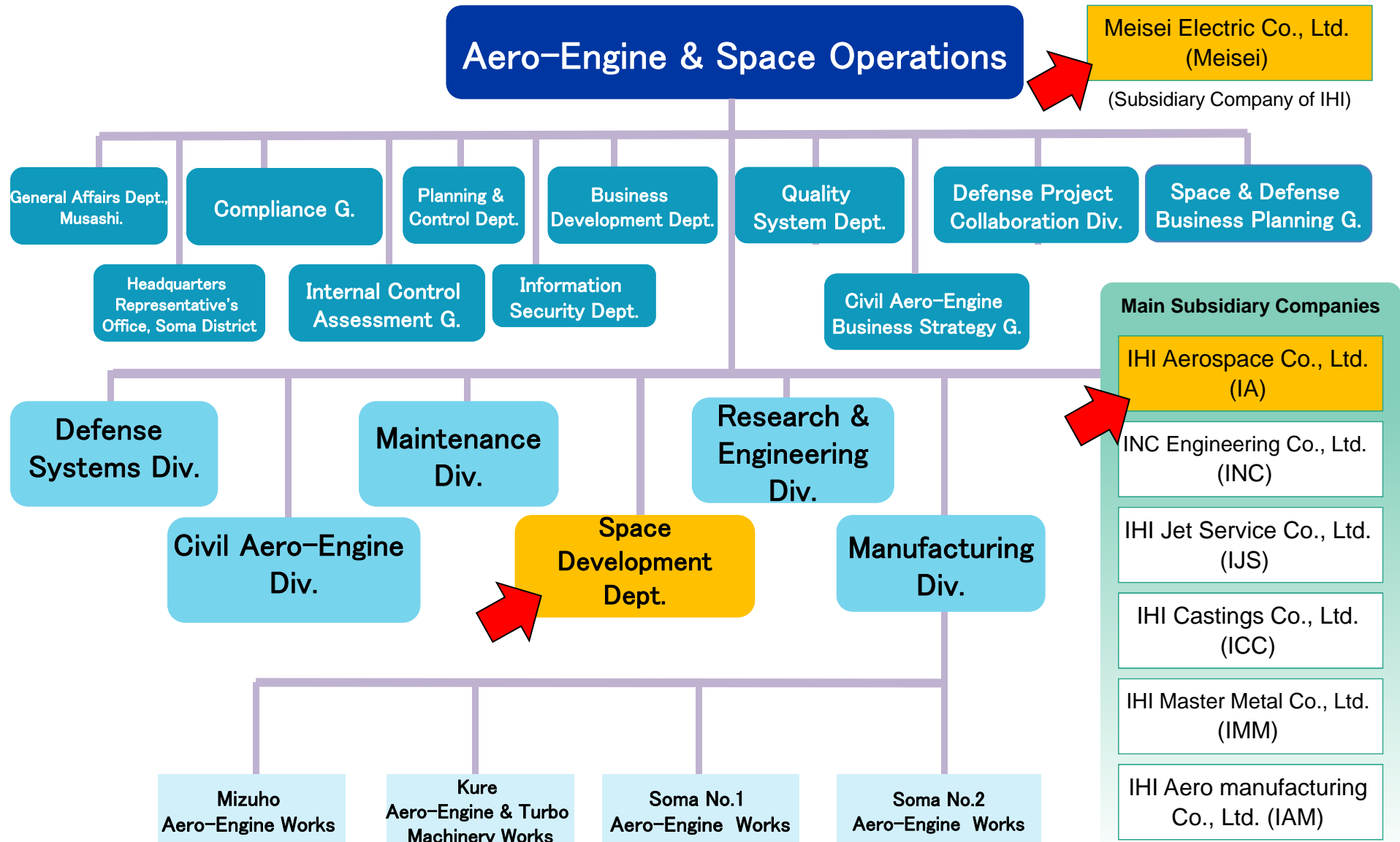


# Activities of Aero-Engine & Space Operations

Items	Contents
<b>Defense Systems and Aero-Engines for Japan Ministry of Defense</b>	<p><b>Production, Repair and R &amp; D of various engine and equipment</b></p> <ul style="list-style-type: none"> <li>• Production (T700, F7)</li> <li>• Overhaul &amp; Repair (F110, F100, F3, J79, JT8D, T64, T56, Makila, CF6, AE2100 etc.)</li> <li>• Research and Development (Engine for Advanced Technological Demonstrator-X, Next-generation engine for Future Fighter etc.)</li> <li>• Manufacture and Repair of Marine-use Gas Turbines (LM2500, LM500, 501K)</li> <li>• Defense Systems (CIWS<sup>※1</sup>, RAST<sup>※2</sup>, SPAT<sup>※3</sup>, MLRS<sup>※4</sup>, MCV<sup>※5</sup> etc.)</li> </ul>
<b>Civil Aero-Engines</b>	<p><b>International Co-development &amp; Co-production, Maintenance Repair and Overhaul of various engine</b></p> <ul style="list-style-type: none"> <li>• Co-development (PW1100G-JM, Passport20)</li> <li>• Co-production (V2500, GE90, RB211/Trent, CF34-8/10, GENx etc.)</li> <li>• Production of Engine Parts (Long-shaft etc.)</li> <li>• Maintenance Repair &amp; Overhaul for Engines and their Parts</li> </ul>
<b>Space Development</b>	<p><b>Production and R &amp; D of various Space equipment</b></p> <ul style="list-style-type: none"> <li>• Turbo Pump, Solid Rocket Boosters (SRB-A) for H-IIA Launch Vehicle, Epsilon Launch Vehicle etc.</li> <li>• LNG Engines, Liquid Apogee Engine, Hydrazine and Monopropellant Thruster etc.</li> <li>• ISS<sup>※6</sup> Exposed facility for KIBO, Propulsion System and Exposed Pallet of the HTV<sup>※7</sup>, “Hayabusa” reentry capsule etc.</li> </ul>

※1 CIWS: Close-in Weapon System   
 ※2 RAST: Recovery Assist, Secure & Traverse   
 ※3 SPAT: Self Propelled Acoustic Target   
 ※4 MLRS: Multiple Launch Rocket System  
 ※5 MCV: Mine Clearing Vehicle   
 ※6 ISS: International Space Station   
 ※7 HTV: H-II Transfer Vehicle

# Organization of Aero-Engine & Space Operations





# Works of Aero-Engine & Space Operations



## Mizuho Works

- Assembly & overhauling of jet engines, light type gas turbines
- Defense and space-related equipment

Site area	189,000㎡
Building spac	65,000㎡



## Kure No.2 Works

- Production and repair of jet engine / gas turbine parts
- Assembly and test of land / marine gas turbines

Site area	47,800㎡
Building spac	40,100㎡



## Soma NO.1 Works

- Production and repair of jet engine / gas turbine's blade parts

Site area	159,000㎡
Building spac	37,700㎡



## Tomioka Plant (IHI AEROSPACE)

- space-related equipment and Defense .
- Production of FRP parts

Site area	約490,490㎡
Building spac	約84,228㎡

## Soma No.2 Works

- Production and repair of jet engine's small, middle size parts
- Production of space-related equipment parts

Site area	167,300㎡
Building spac	54,200㎡

# Overview of IHI Group Space Activities

**H-IIA**

**M-V**

**Epsilon**

**Launch Vehicles**

©JAXA ©JAXA ©JAXA

This section highlights three types of launch vehicles. The top left shows the H-IIA rocket being mated to the Mobile Launcher Vehicle (MLV) on the launch pad. The top right shows the M-V rocket being mated to the MLV. The bottom image shows the Epsilon rocket being mated to the MLV. All images are credited to JAXA.

**Space Utilization**

©JAXA ©NASA

©JAXA

This section illustrates space utilization. The top left image shows a satellite in orbit over the moon's surface, credited to JAXA. The top right image shows the International Space Station (ISS) in orbit over Earth, credited to NASA. The bottom image shows a satellite in orbit over Earth, credited to JAXA.

**Satellite Propulsion System**

©JAXA

This section features a satellite in orbit with its solar panels deployed, credited to JAXA. Below it is a detailed view of the satellite's propulsion system, showing the main engine and various thrusters.

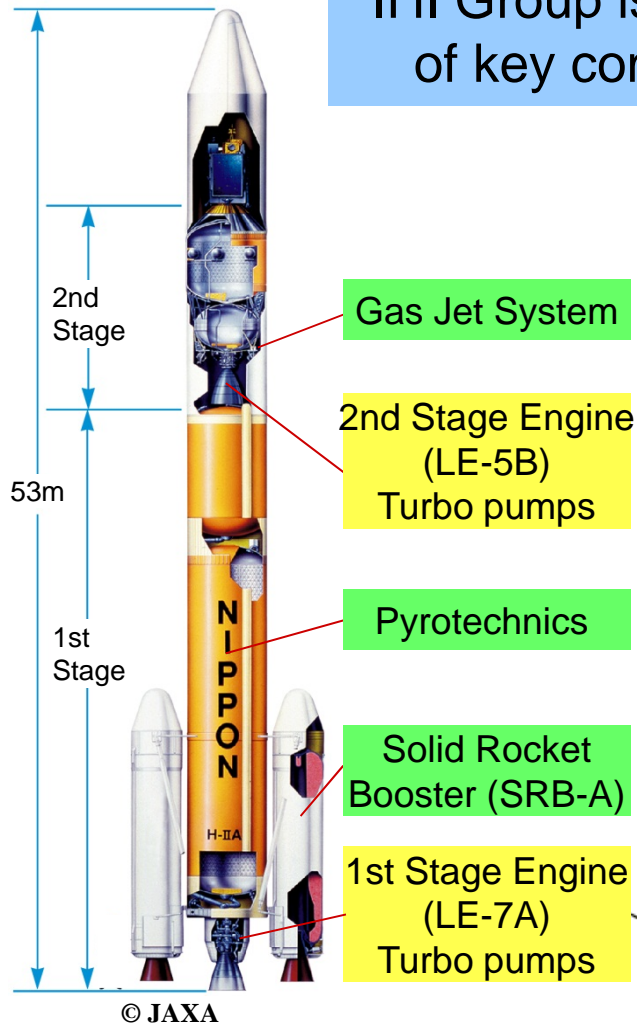
**Small Satellites**

©JAXA

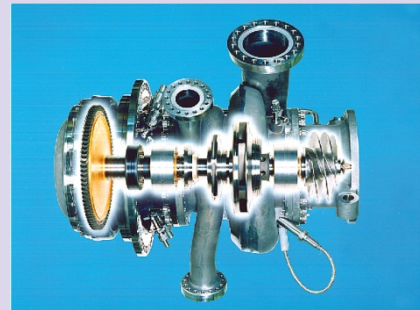
This section shows a satellite being launched from a rocket, credited to JAXA. Below it is a small satellite in orbit, also credited to JAXA.

# Turbo pumps

IHI Group is responsible for development and manufacturing of key components for H-IIA/B, Flagship Rocket of Japan



## 1st Stage Engine (LE-7A) Turbo pumps

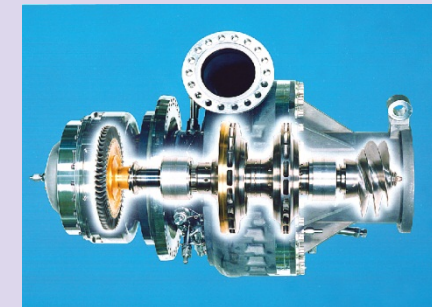


Liquid Oxygen Turbo pump

Mass	190 [kg]
Rotation Speed	18,000 [rpm]
Power Level	4.4 [MW]

## H-IIA Launch Vehicle Propellant

Fuel : Liquid Hydrogen  
(-253deg.C)  
Oxidizer : Liquid Oxygen  
(-183deg.C)



Liquid Hydrogen Turbo pump

Mass	220 [kg]
Rotation Speed	42,000 [rpm]
Power Level	21.3 [MW]

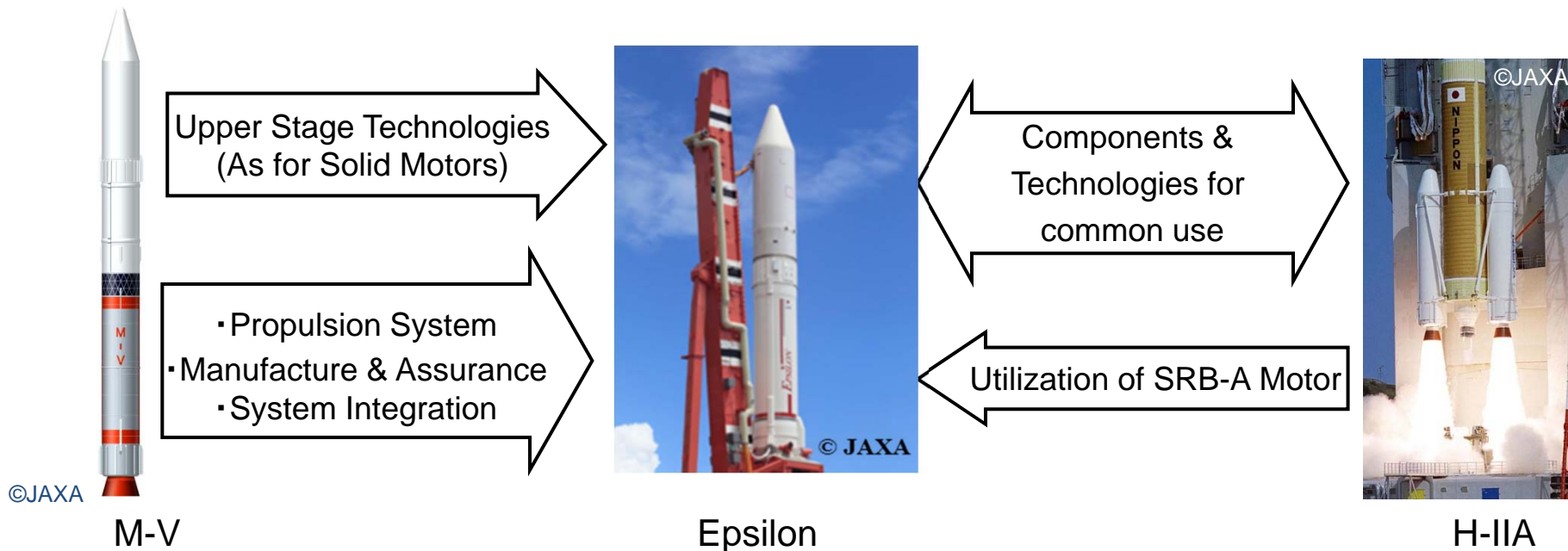
Remarks     : IHI responsible part     IA responsible part

# Solid Rockets

## Epsilon Rocket (First launch on 14/9/2013 )

Low cost, responsive, dedicated launch service

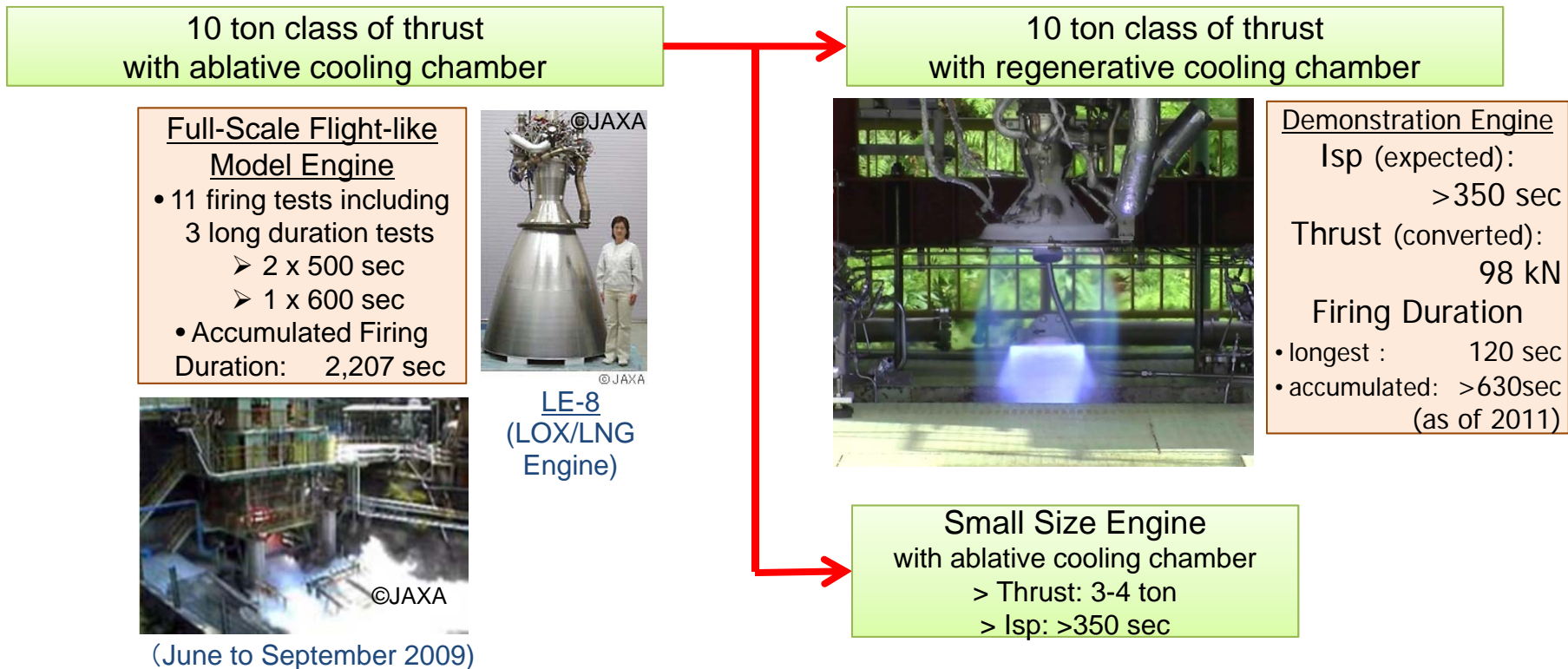
- 3 Staged Solid Rocket
- Launch Capability: LEO 1.2 ton, SSO 0.45 ton ~



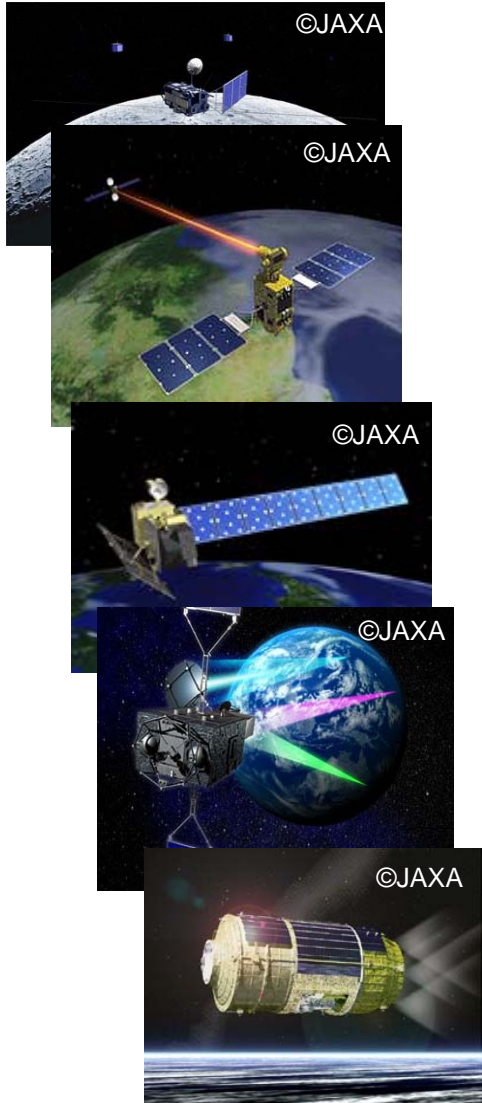
# LNG Propulsion system

IHI group is the world leading company for LNG (Liquefied Natural Gas: Methane) Rocket Engine.

- Design and manufacturing know-hows are accumulated through a lot of firing tests with variety of engine types.



# Space Propulsion System



- We have a lot of experience and results of space propulsion system through the number of JAXA's satellites development.
- We are exporting the components.



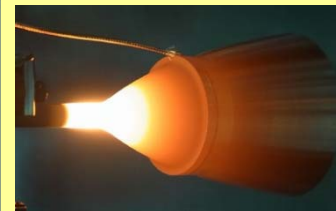
**N2H4 monopropellant thrusters**



**Tank**



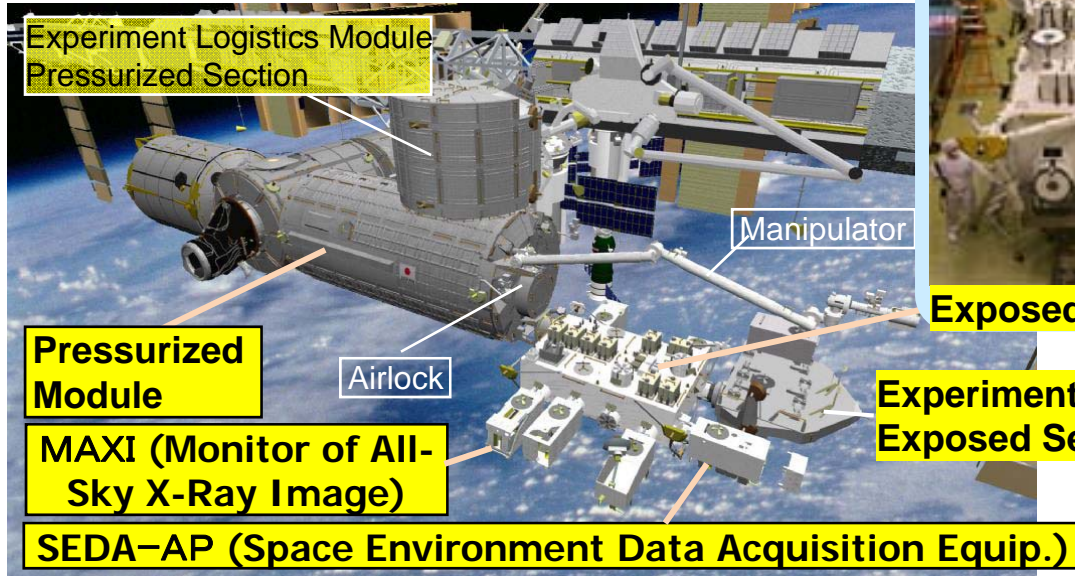
**MMH/NTO thruster for HTV**



**N2H4/NTO thrusters**

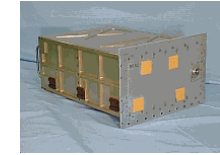
# Space Utilization

## Japanese Experiment Module「KIBO」

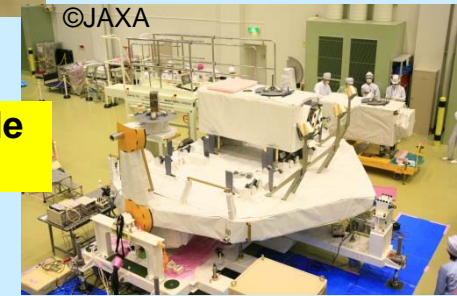


Experiment Logistics Module Exposed Section (ELM-ES)

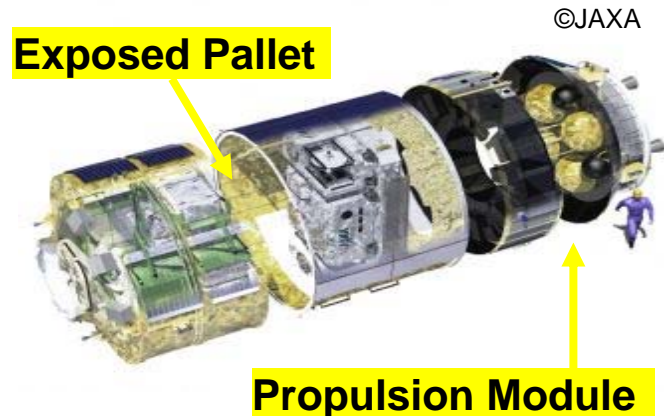
## Monitoring Equipment



BBND Detector unit



## H-II Transfer Vehicle (HTV)



Gradient Heating Furnace

## Experimental Equipments



Fluid Physics Experiment Facility

# Space Utilization (Cont.)

- We develop various kind of monitoring equipment.
- Our technologies are extended to small satellite.
- CubeSat, NanoSat and MicroSat are under development.

## JAXA Small Satellites

Mission Equipment and Bus Components



“WE WISH”

Cubesat on operating from 4<sup>th</sup> Oct. 2012



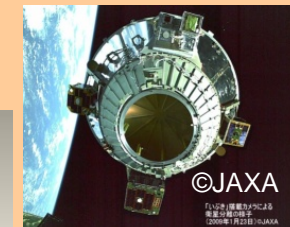
Fluorescent X-Ray Spectrometer onboard “HAYABUSA”



HDTV onboard “KAGUYA”



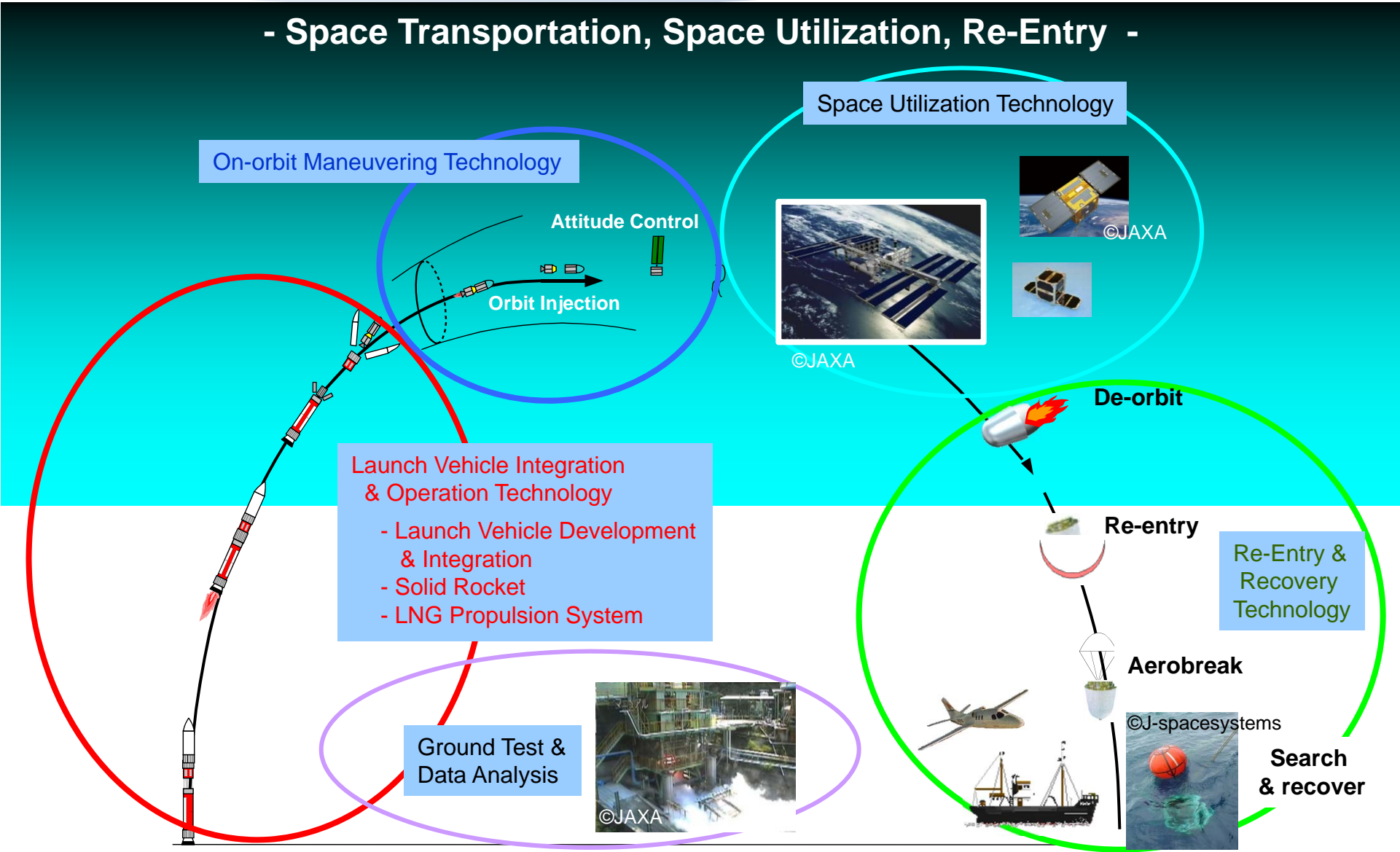
Monitor Camera onboard “IBUKI”





# Comprehensive Space Technology of IHI Group

## - Space Transportation, Space Utilization, Re-Entry -



# IHI

Realize your dreams

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IHI **Aero**Space

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