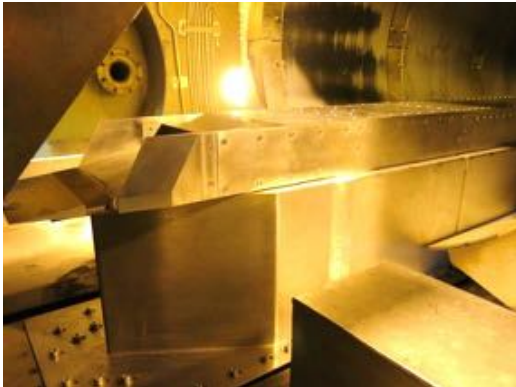


Research on Hypersonic Transport Aircraft and Hypersonic Pre-Cooled Turbojet Engine



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JAXA Hypersonic Transport Aircraft

- Maximum Speed: **Mach 5** , High Speed Intercontinental Transport
- Take-off and landing using normal airports. **Tokyo-Roma: 3 hours**
- Business model can be established assuming existing first class passengers will shift to HST.
- Potential use as the **1st stage of Two-Stages To Orbit Space Plane.**





Objectives of Hypersonic Flight

1. Realize sub-orbital plane using hypersonic technologies and **support the space tourism activities** by private companies.
2. Realize hypersonic transport aircraft, which can reach Roma in 3 hours in order **to enhance international trade and cultural exchange**.



Sub Orbital Space Plane



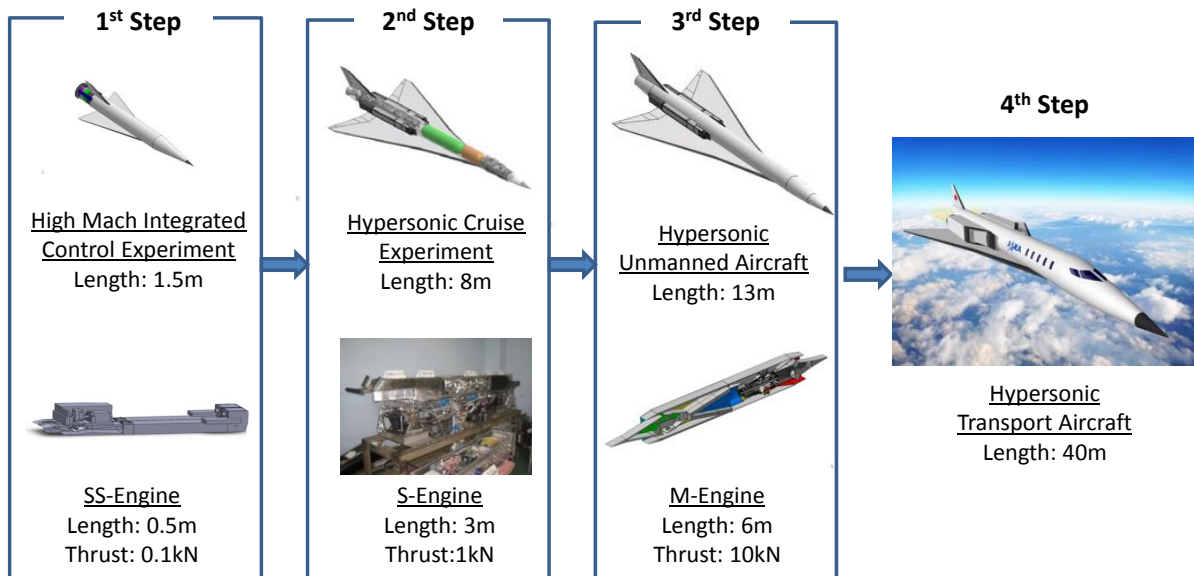
Hypersonic Transport Aircraft

3



R&D Plan of Hypersonic Flight Technologies

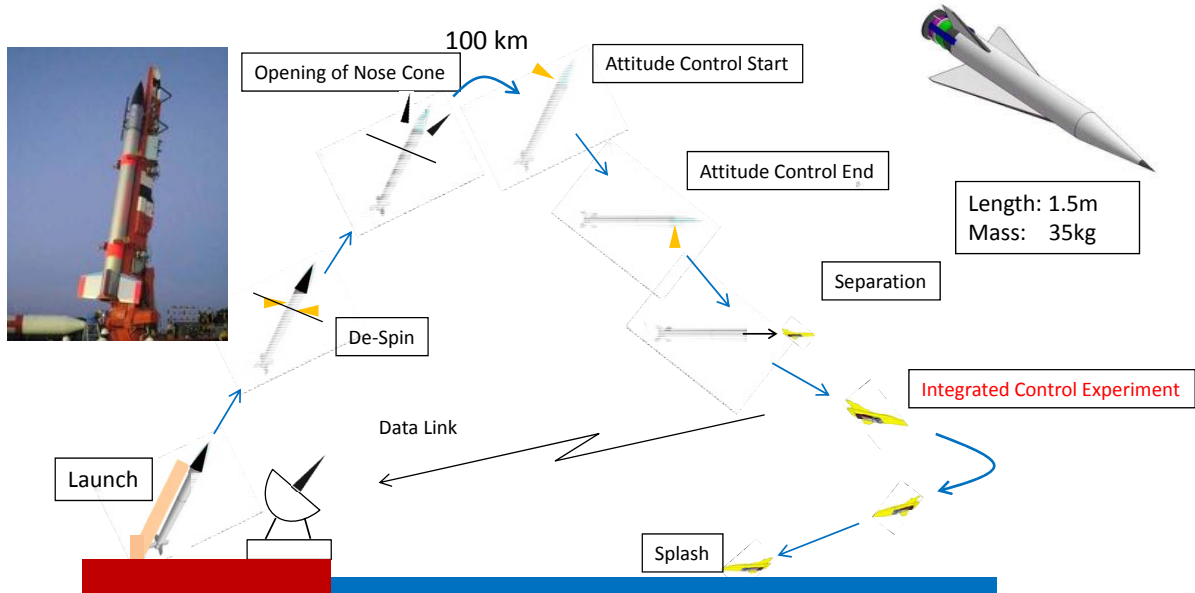
- 1st Step: High Mach Integrated Control Experiment -> **Airframe / Propulsion Integrated Control Method**
 2nd Step: Hypersonic Cruise Experiment -> **Cruise flight with Pre-Cooled Turbojet**
 3rd Step: Hypersonic Unmanned Aircraft -> **Autonomous Flight Demonstration/ Earth Observation**
 4th Step: Hypersonic Transport Aircraft -> **Intercontinental High Speed Transport**



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1st Step: High Mach Integrated Control Experiment

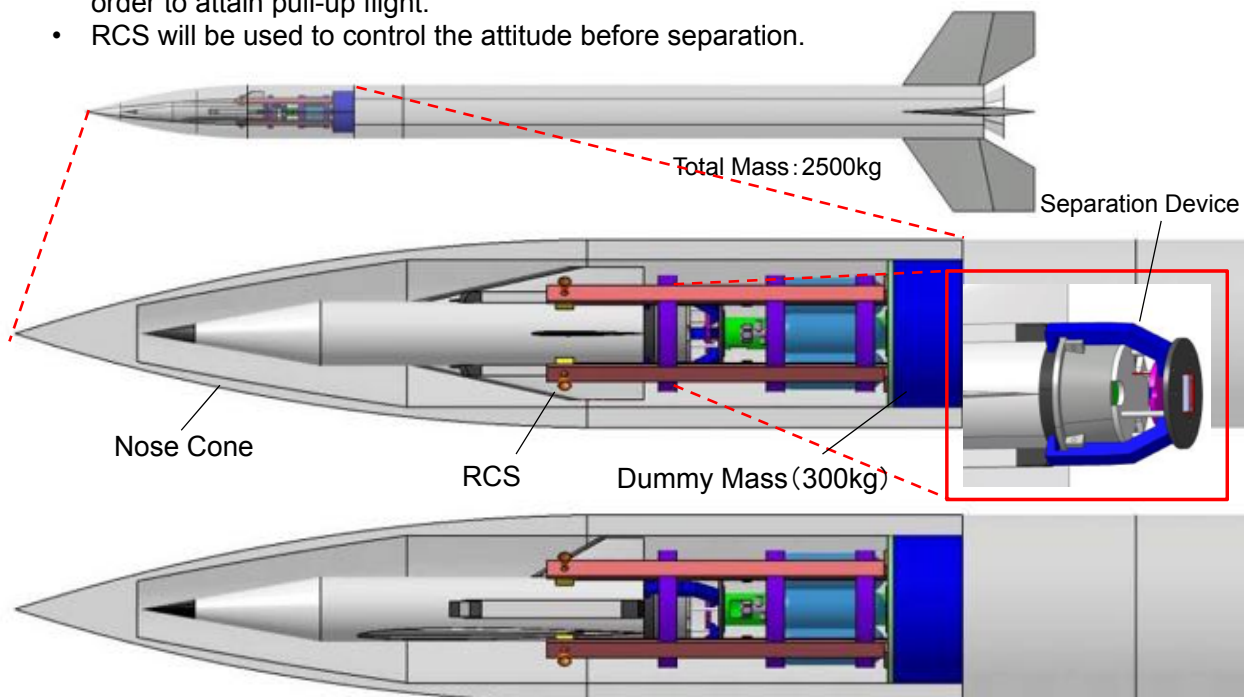
- Flight experiment to demonstrate the **airframe / propulsion integrated control method**.
- Flight test vehicle will be installed **inside of nose cone of existing sounding rocket**.
- Flight test vehicle will be separated at high altitude after attitude control.



5

Connection of HiMICO and S520 Sounding Rocket

- Wing span is determined by the inner diameter of S520 sounding rocket.
- Dummy mass will be mounted to decrease the maximum height of the trajectory in order to attain pull-up flight.
- RCS will be used to control the attitude before separation.

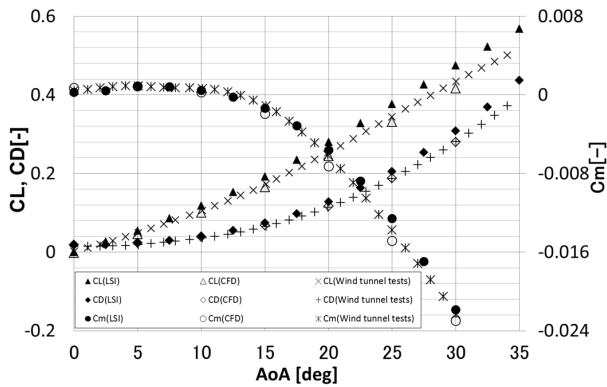
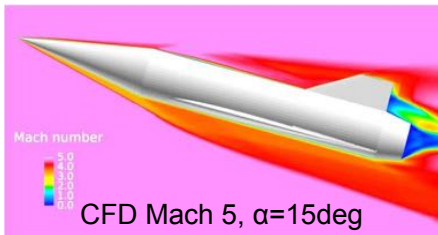
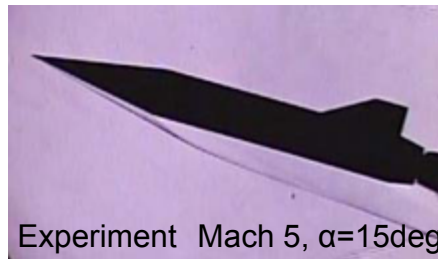


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Aerodynamic Performance of HiMICO

Experiment: JAXA 0.5m Hypersonic Wind Tunnel
 Analysis: Local Surface Inclination Method
 CFD (FaSTAR)

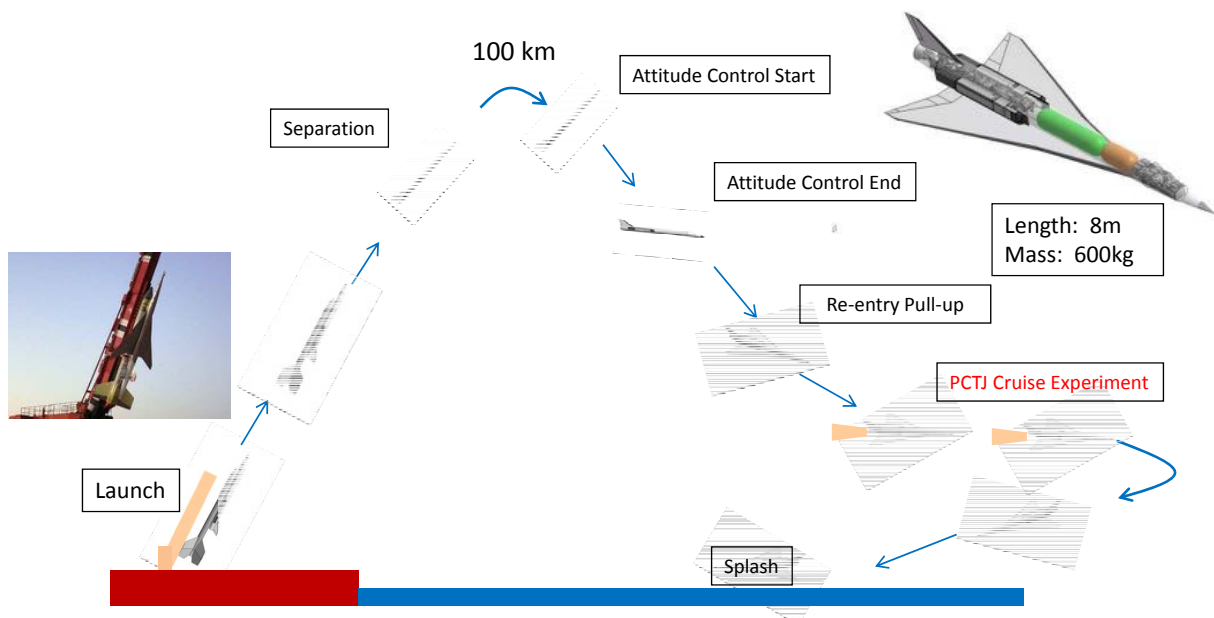
-Aerodynamic data has been obtained at
 AoA = 0 to 30deg considering reentry
 flight.



Aerodynamic Coefficients (Mach 5)

2nd Step: Hypersonic Cruise Experiment

- Flight demonstration of **hypersonic pre-cooled turbojet engine**.
- Flight test vehicle will be attached at the **side of existing sounding rocket** (NAL-735).
- Flight test vehicle will be separated at high altitude after the initial acceleration.

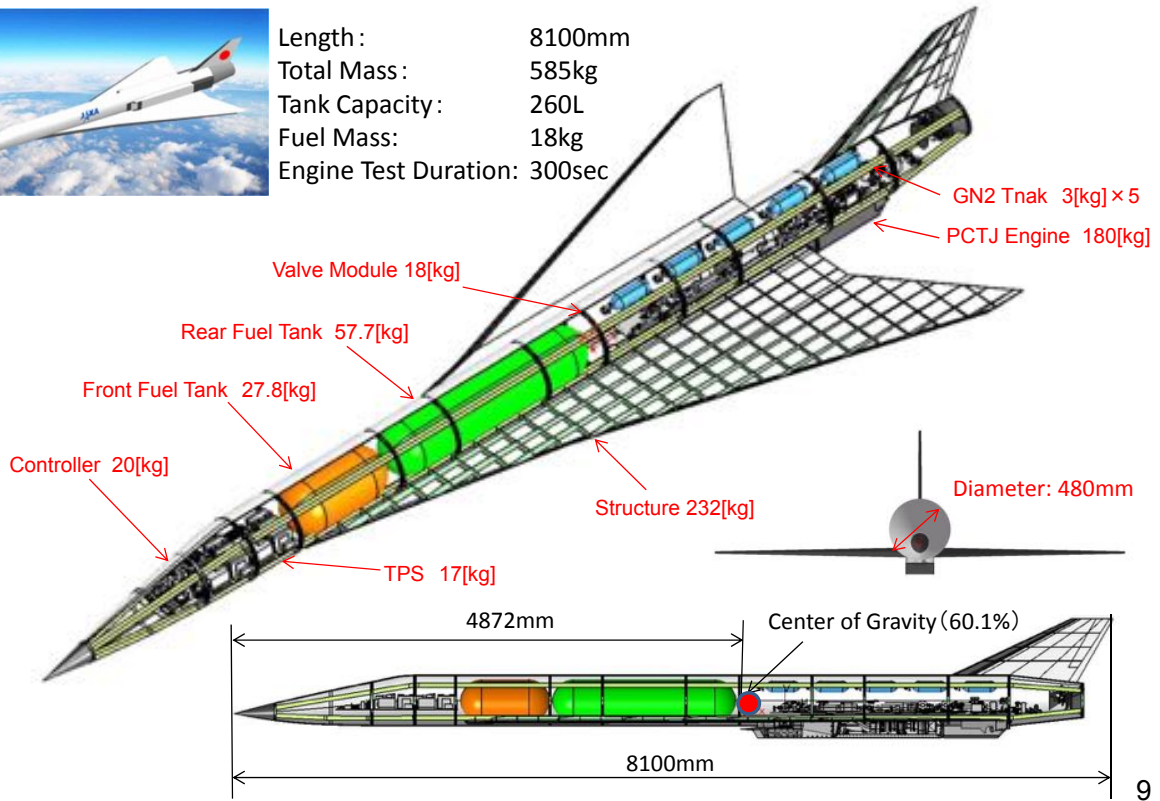












Hypersonic Cruise Experiment (HyCruise)

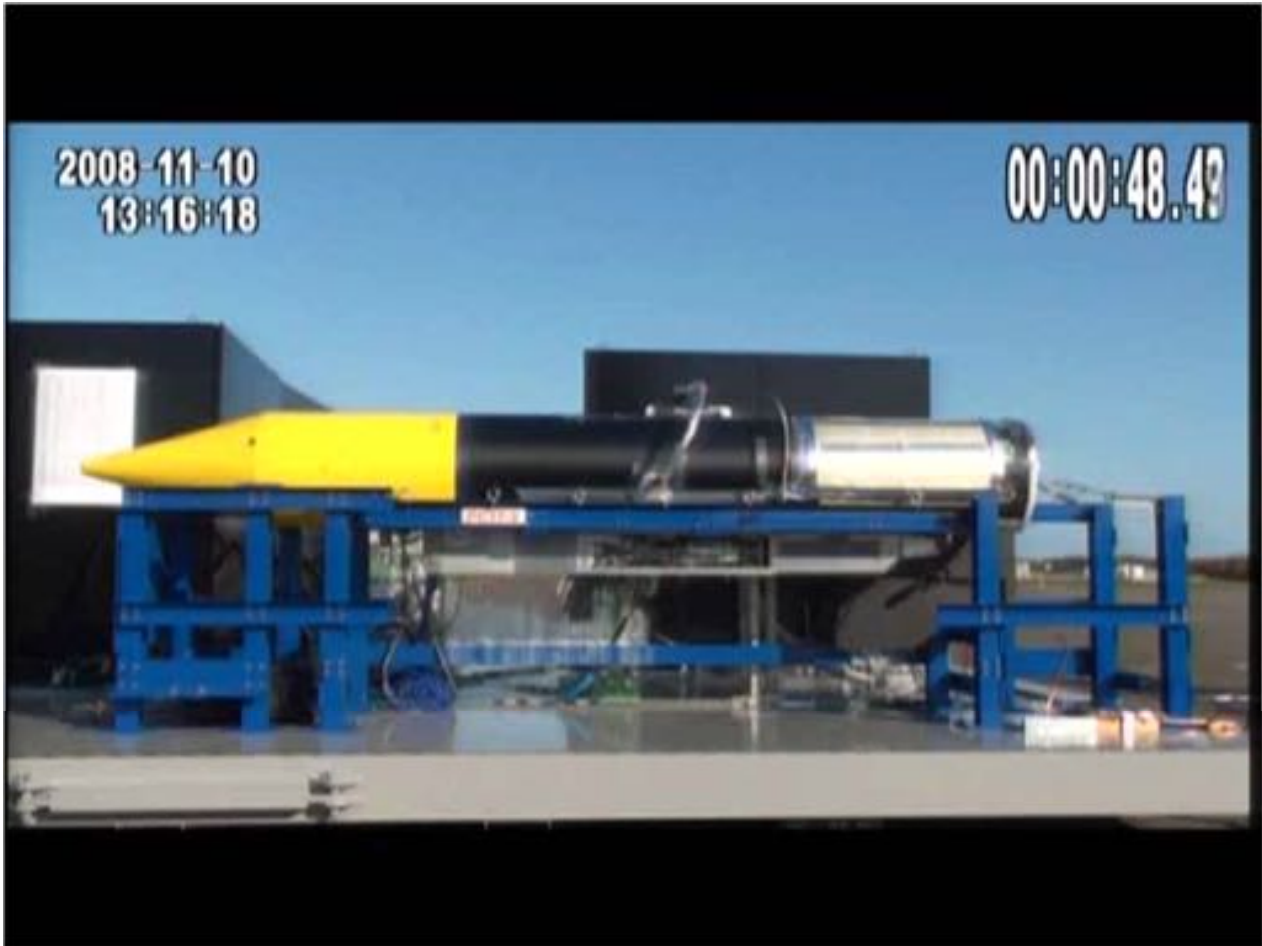


Length : 8100mm
 Total Mass : 585kg
 Tank Capacity : 260L
 Fuel Mass : 18kg
 Engine Test Duration : 300sec



R&D History of Hypersonic Turbojet Engine

FY2006	FY2007	FY2008	FY2009
 <p>1st Firing Test</p> <ul style="list-style-type: none"> - Core Engine Operation - Control and Measurement System 	 <p>2nd Firing Test</p> <ul style="list-style-type: none"> - Engine Starting Sequence - After-Burner Operation 	 <p>3rd Firing Test</p> <ul style="list-style-type: none"> - Flight Experimental Setup - 20 sec After Burner Operation 	 <p>4th Firing Test</p> <ul style="list-style-type: none"> - Evaluation of Gravity Effect and Electro-Magnetic Interference
FY2010	FY2011	FY2012	FY2013
 <p>Mach 2 Flight Experiment</p> <ul style="list-style-type: none"> - High Altitude Ignition - Mach 2 Operation 	 <p>High Temperature Pre-Cooler Test</p> <ul style="list-style-type: none"> - High Temp. Structure - Heat Exchange Rate 	 <p>5th Firing Test</p> <ul style="list-style-type: none"> - High Temp. Structure - Mach 4 Operation 	 <p>6th Firing Test</p> <ul style="list-style-type: none"> - Starting Sequence - Heat Structure of Variable Mechanism

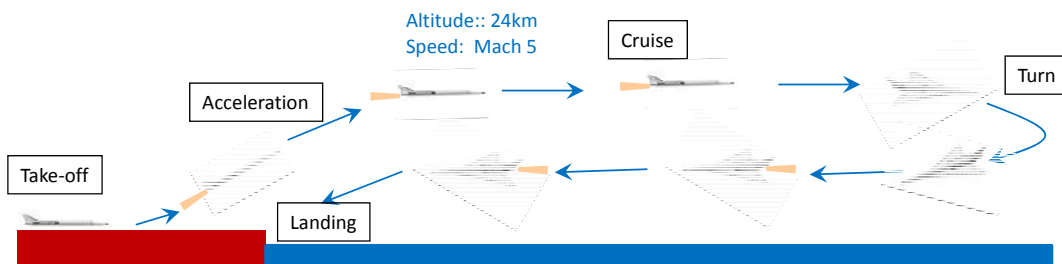


Mach 4 test of Hypersonic Turbojet Engine



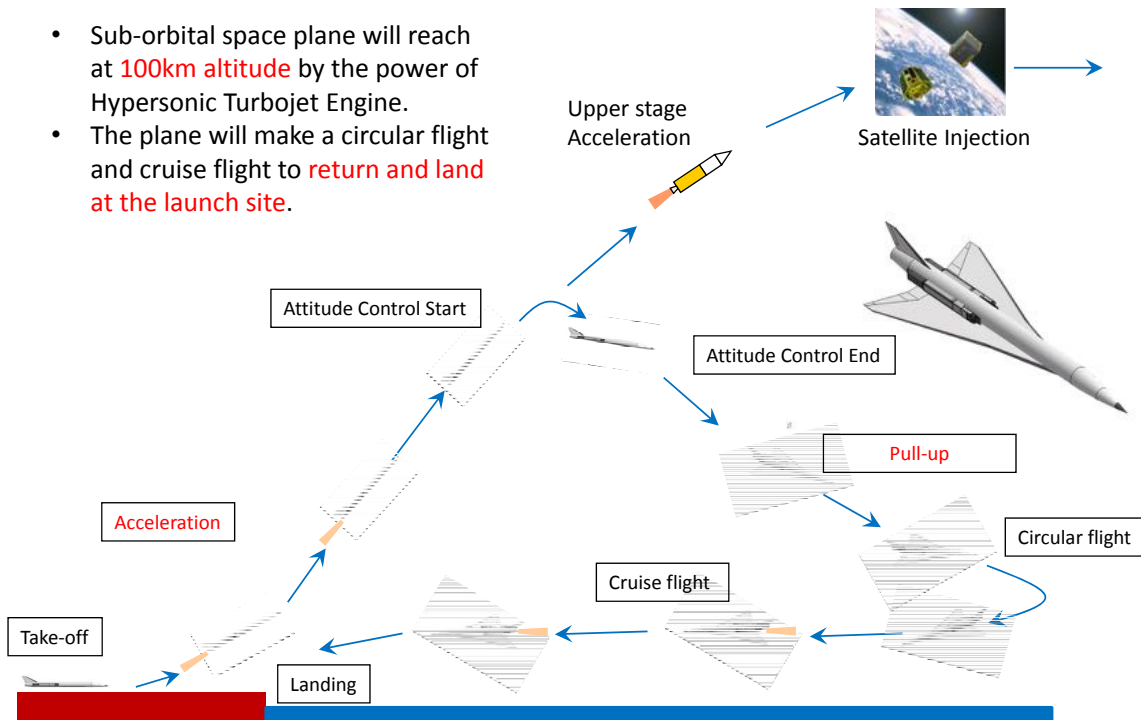
3rd Step: Hypersonic Unmanned Aircraft

- Autonomous acceleration flight from **take-off to Mach 5** by the power of pre-cooled turbojet engine.
- Mach 5 cruising demonstration at the altitude of 24km.
- Utilization of the airplane to earth observation mission.



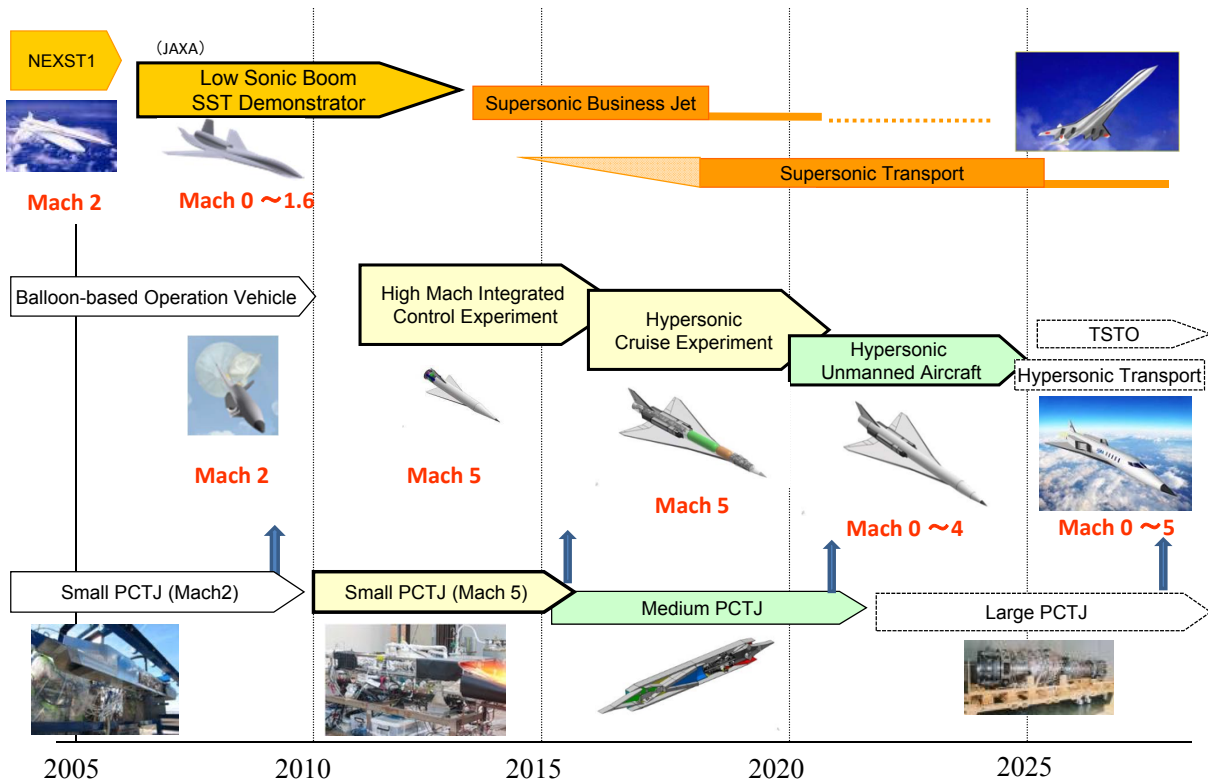
3rd Step: Sub-Orbital Space Plane

- Sub-orbital space plane will reach at **100km altitude** by the power of Hypersonic Turbojet Engine.
- The plane will make a circular flight and cruise flight to **return and land at the launch site**.





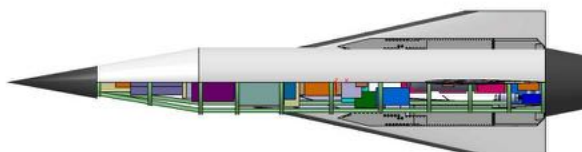
R&D Roadmap on Sub-Orbital Space Plane and HST



Conclusion

Flight experimental plan for hypersonic flight technologies are proposed.

1. High Mach Integrated Control Experiment Aircraft (HiMICO) is planned in order to demonstrate the airframe / propulsion integrated control technology.
2. Flight trajectory of HiMICO is analyzed assuming existing sounding rocket as an accelerator.
3. Aerodynamic performance and propulsion performance of HiMICO are obtained by experiments and analyses.
4. Hypersonic Cruise Experimental Aircraft (HyCruise) is planned in order to demonstrate the cruising capability of pre-cooled turbojet engine (PCTJ).
5. Aerodynamic performance and structure mass of HyCruise was obtained by analyses.



HiMICO



HyCruise