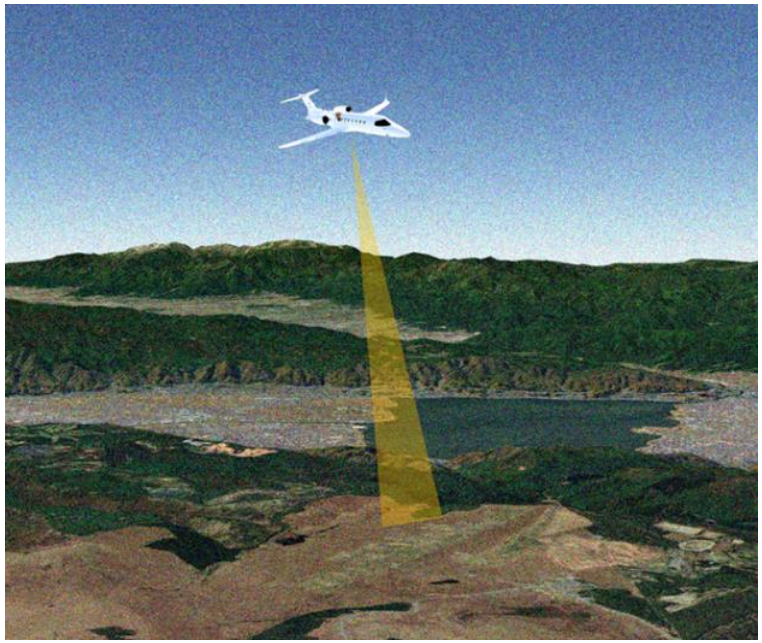
Long Range WPT Flight Demonstration (Dec. 2024)
- First Report -



December 12, 2024

HIROKI YANAGAWA, Japan Space Systems

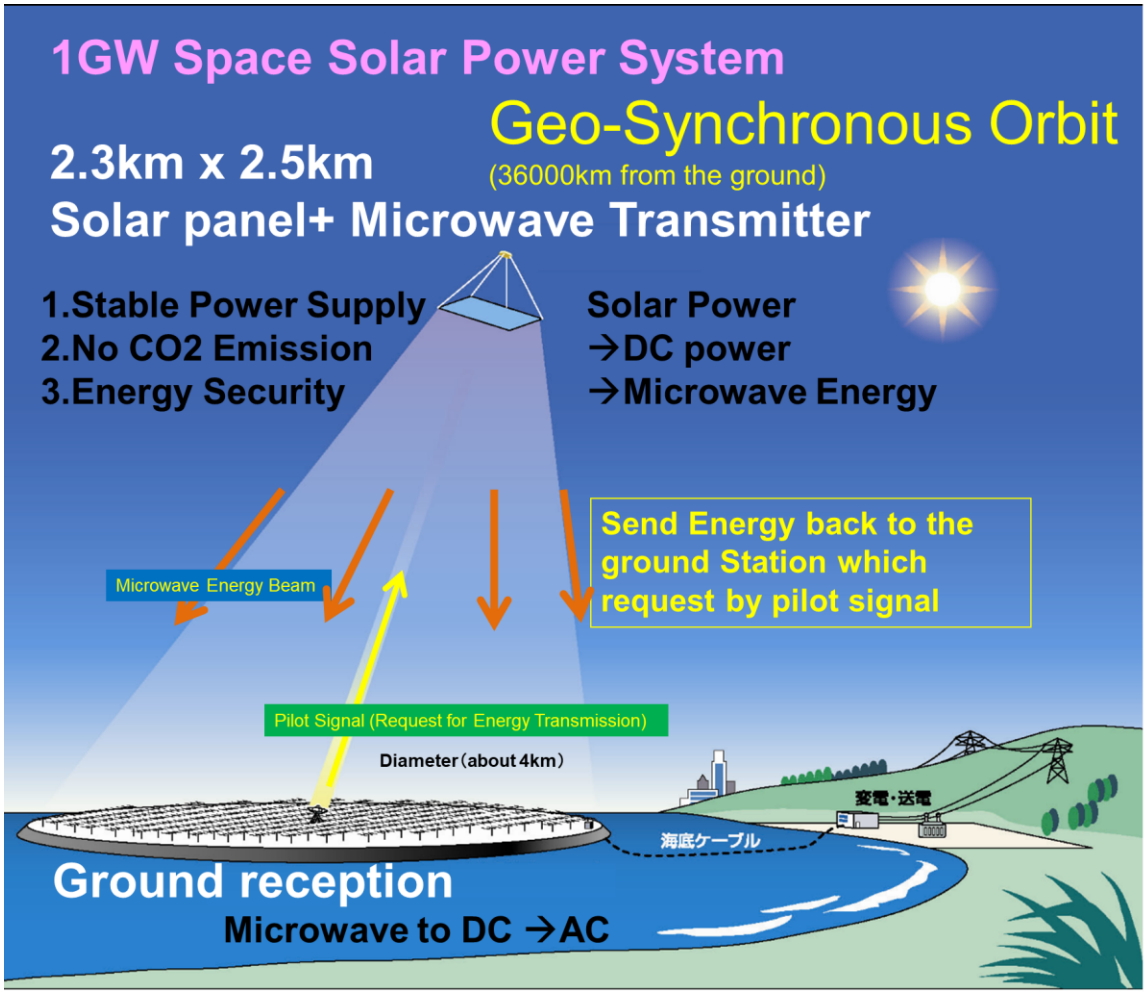
Contents

SSPS: Space Solar Power System

1. Japan Space Systems' Efforts to Realize SSPS

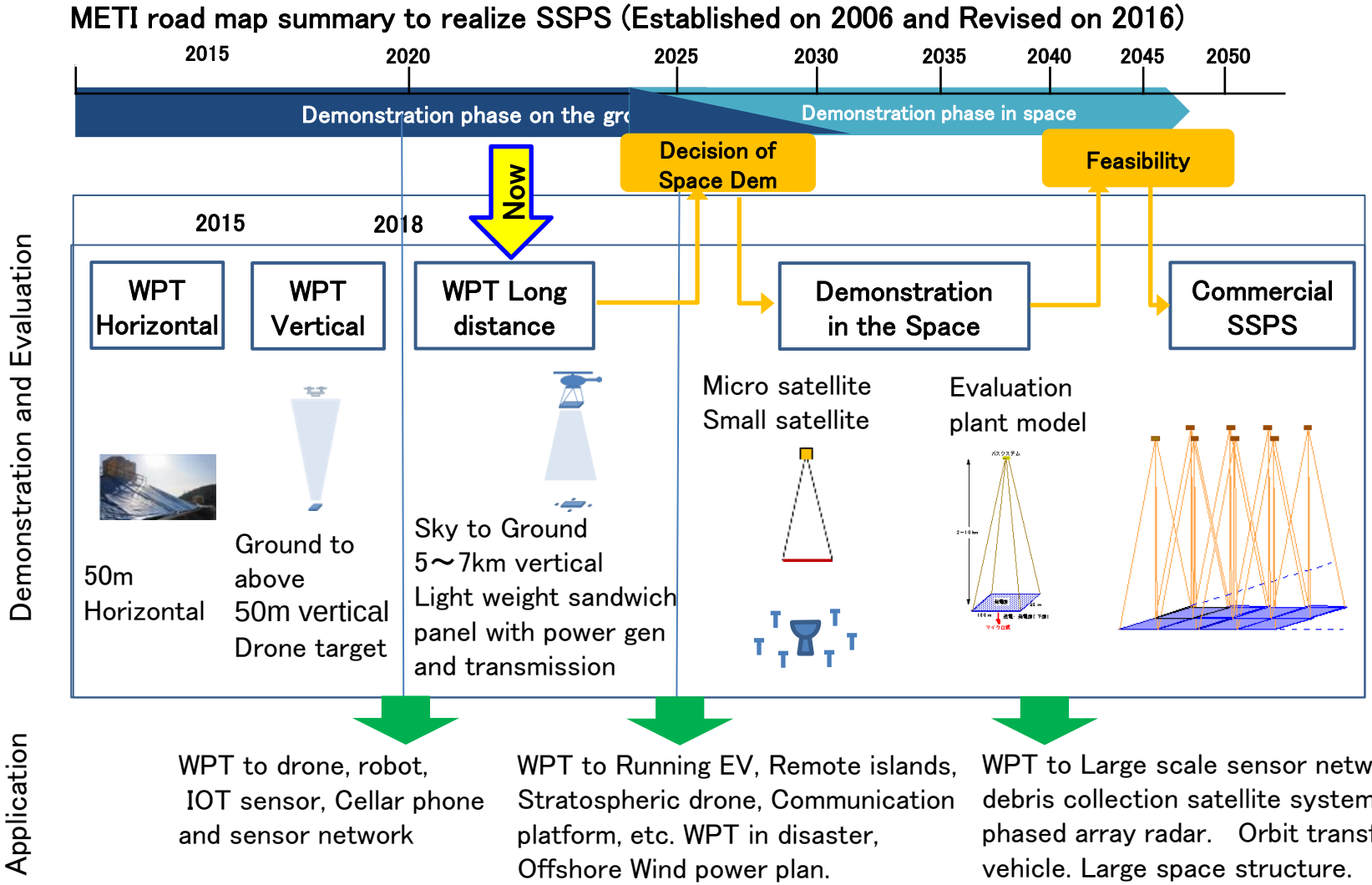
◆ SSPS Concept

- Geostationary Orbit
- Modular Design
- Using the Power Generation and the Transmission Panel (PGTP) concept
- Long range WPT by using Phased Array Control Technology



1. Japan Space Systems' Efforts to Realize SSPS

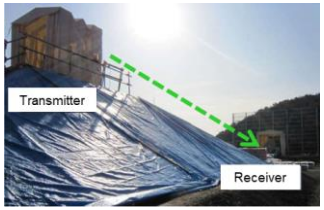
◆ SSPS Technology Development



Step-Up of Microwave WPT Experiment by JSS

◆ SSPS Technology Development

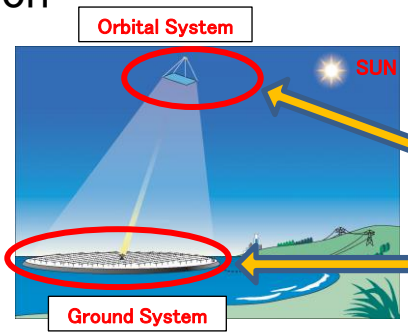
2015 •Horizontal WPT demonstration: distance 50m

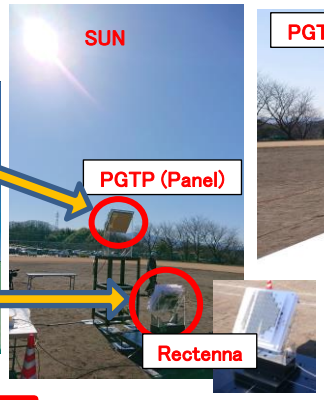


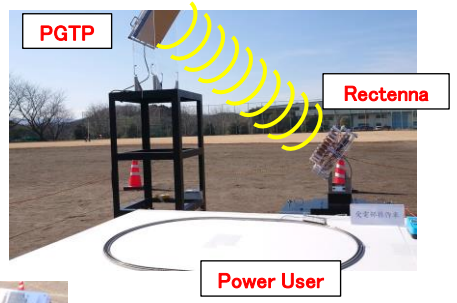
2019 •Vertical WPT demonstration: distance 30 – 100m

2024 •SSPS Concept demonstration by use WPT technology

Demo Video



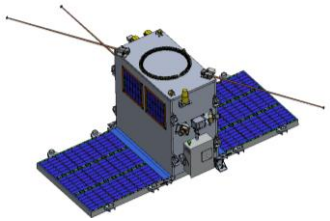




Next Step

•WPT Flight demonstration (2024Winter)
Power Transport from Aircraft to the Ground,

•Demonstrate WPT demonstration from the LEO (2025TBD)



2. Demonstration Experiment held in 2024

【PURPOSE of flight experiments】

The GOAL of SSPS transmission distance … 36,000km

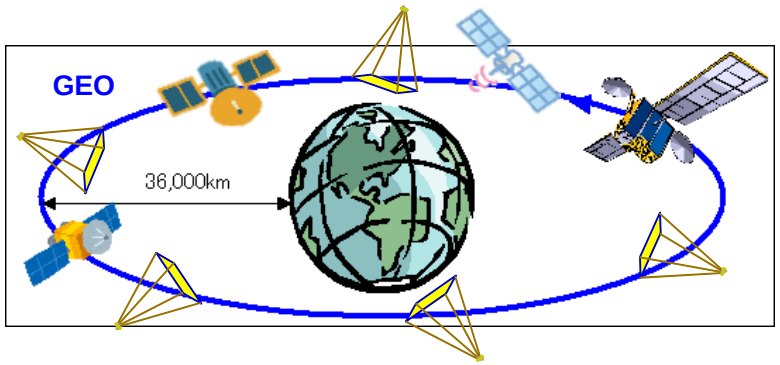
Transmission distance so far by Japan Space Systems … 30 – 100m (vertical)

0.0003% of the GOAL.

In this experiment, we will conduct the world's first demonstration experiment of wireless power transmission from an aircraft to the ground using the same technology as the SSPS we are aiming for.

The transmission distance … about 5km (vertical)

⇒ The purpose of this experiment is
- to confirm various technologies in this experiment and
- to prepare and rehearse for the on-orbit demonstration.



2. Demonstration Experiment held in 2024

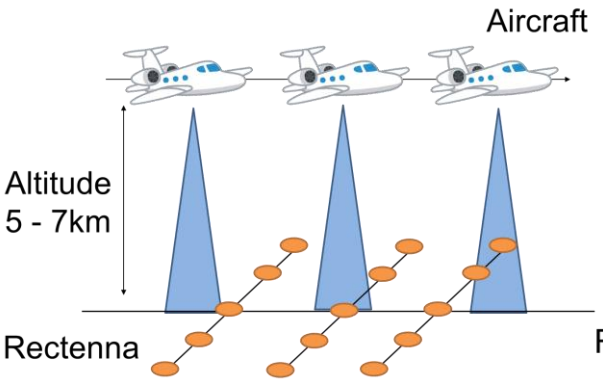
【OUTLINE of the demonstration】

Japan Space Systems will conduct a demonstration experiment of wireless power transmission from the aircraft flying at an altitude of 7 km to the ground by installing a phased array power transmission panel on the aircraft.

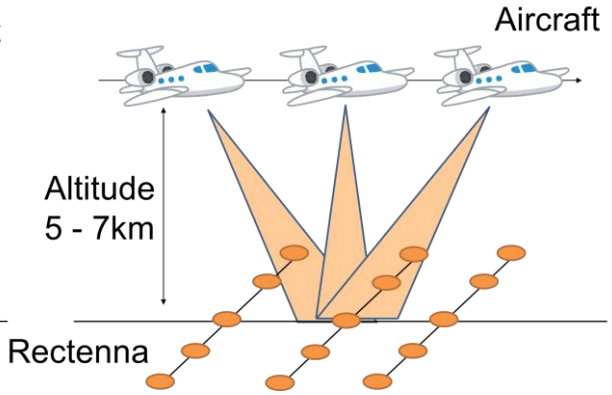
We aim to acquire the following technologies through this experiment;

(1) Microwave Beamforming technology

(2) Directional Beam Control technology



Beamforming Test



Direction Control Test

Logo of the flight demo 2024

2. Demonstration Experiment held in 2024

Duration of the Demonstration Test:

December 3-6, 2024

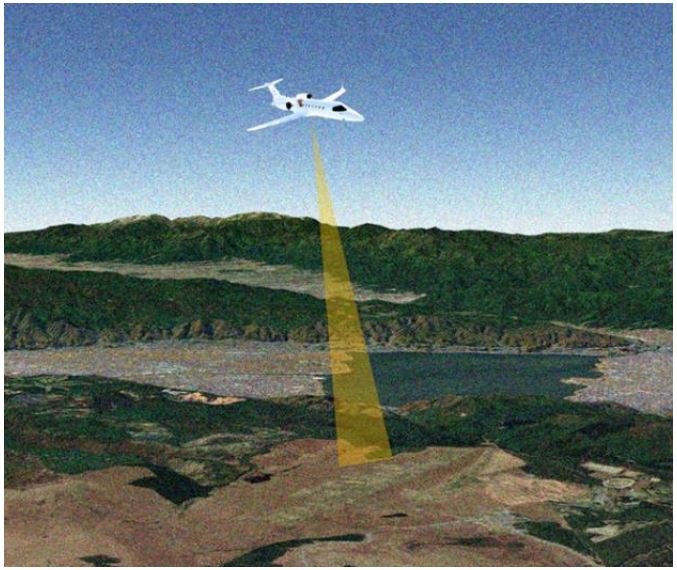
Open to the press: Dec. 4, 2024

Test Location:

Suwa Area, Nagano Prefecture, JAPAN

Kirigamine glider gliding range

(Altitude about 1,700m)



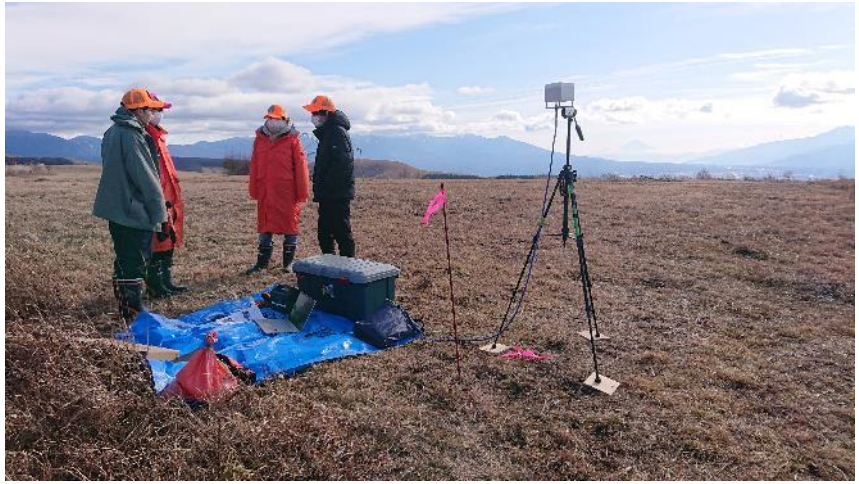
Demo Image

View from Mt. Kurumayama

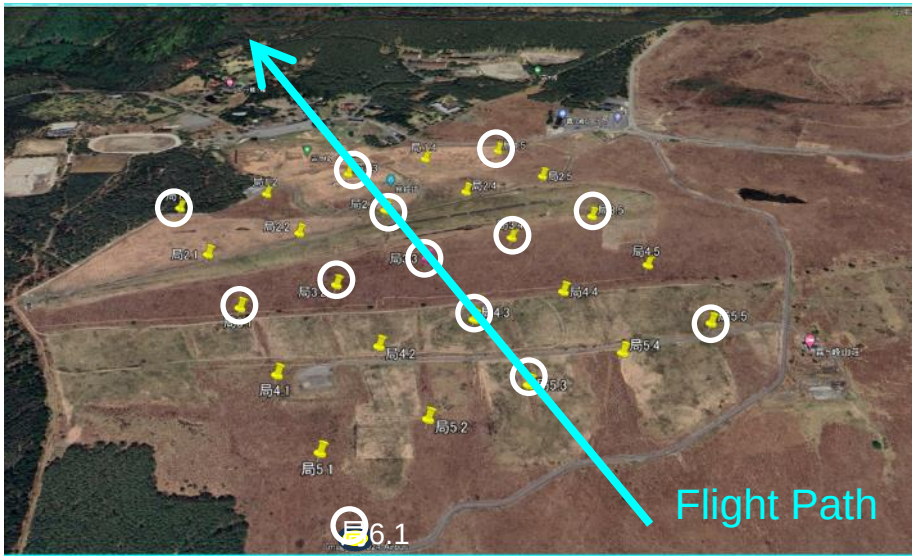
2. Demonstration Experiment held in 2024

Ground Measurement System:

Thirteen measuring devices were placed in a 600m square area of the test site, and the ground test team will conduct measure the microwave beam configuration capability and the beam pattern measurement from the aircraft.



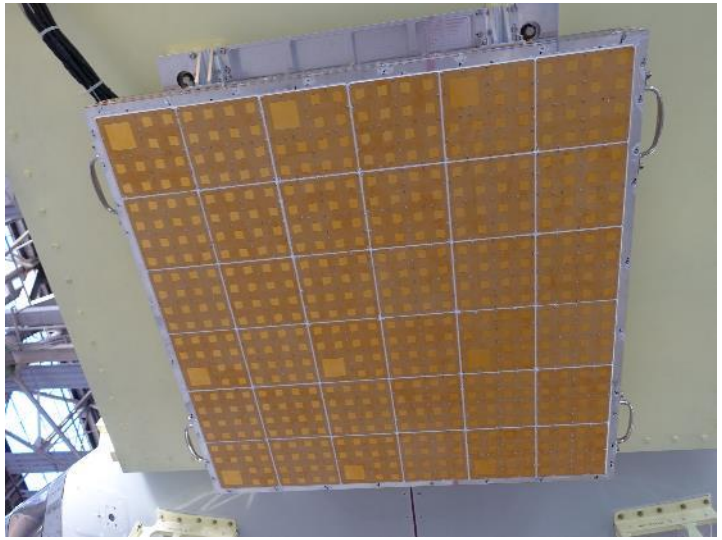
Rectenna and Ground Measurement System



Layout Diagram of the Rectenna

2. Demonstration Experiment held in 2024

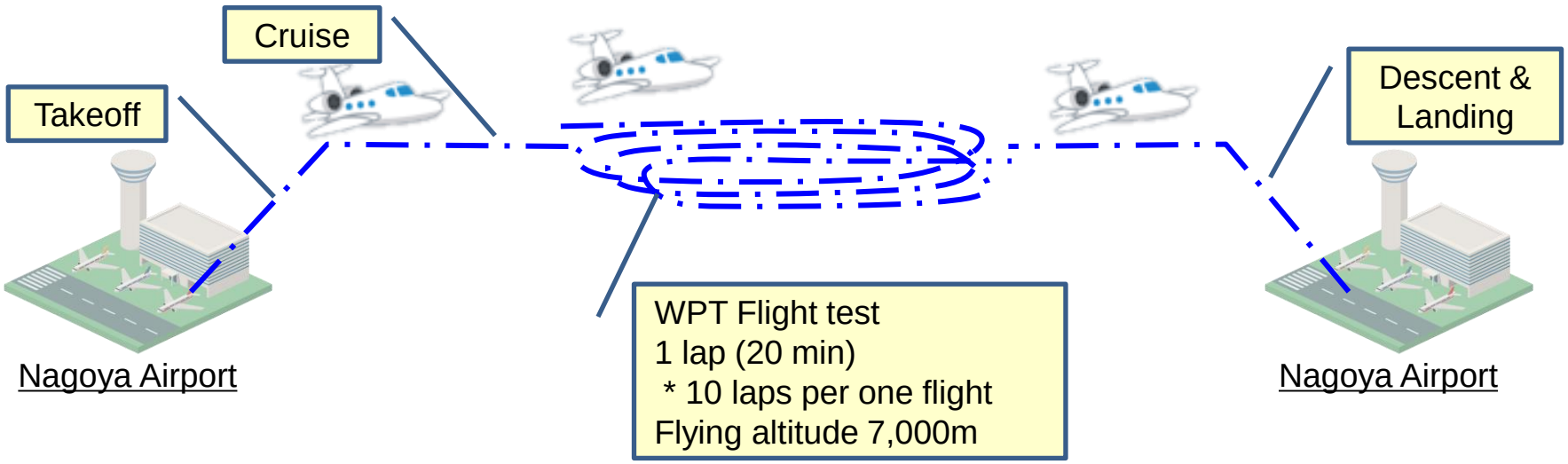
Test Aircraft: Diamond Air Services' Gulfstream-IV type Business jet. The microwave transmitter panel will be mounted in the fairing of this aircraft.



Test Equipment (WPT panel) attached in the fairing.

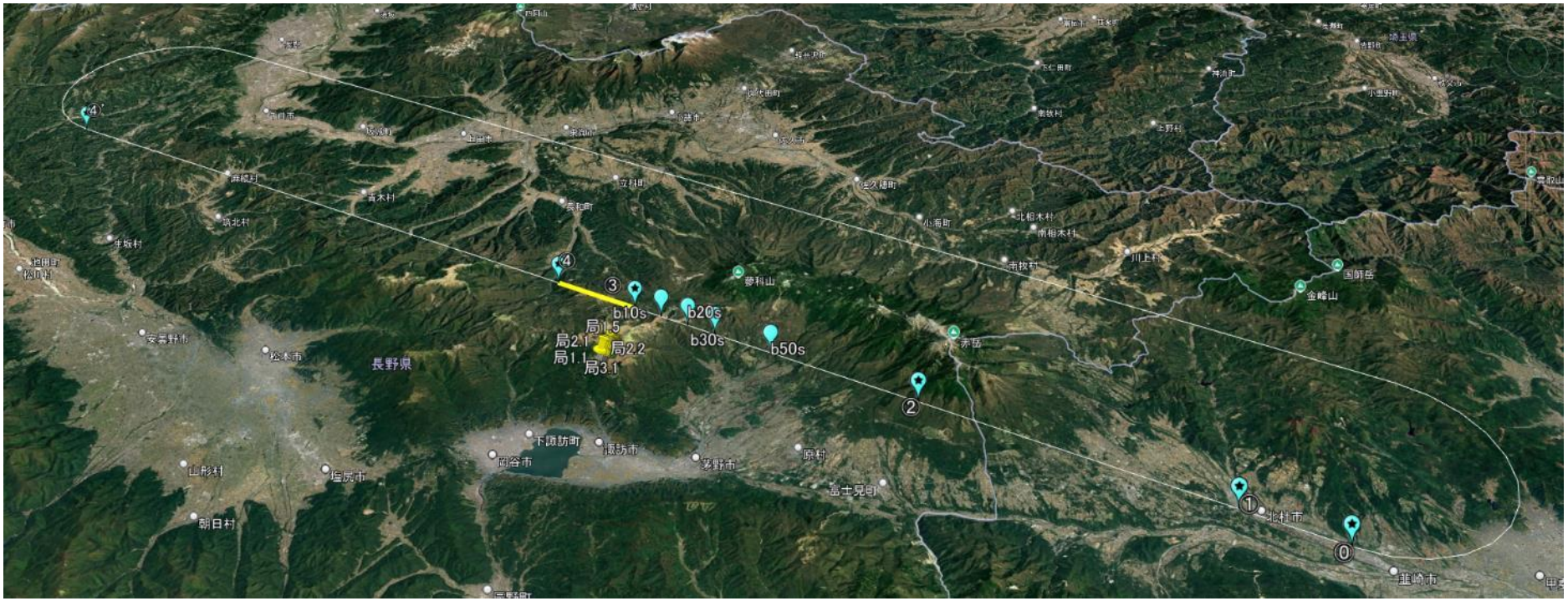
2. Demonstration Experiment held in 2024

Flight Plan : The Test Aircraft plan to
- Takeoff at Nagoya Airport,
- Fly to the flight test field at altitude 7,000 m,
- Conduct 10 laps of WPT flight test,
- Return to the Nagoya Airport/ Base of Diamond Air Service Inc.



2. Demonstration Experiment held in 2024

Flight Path： The test aircraft plan to fly at 700 km/h on the demonstration, so it will take about 20 minutes to complete one lap.



2. Demonstration Experiment held in 2024

【Experimental Results Bulletin】

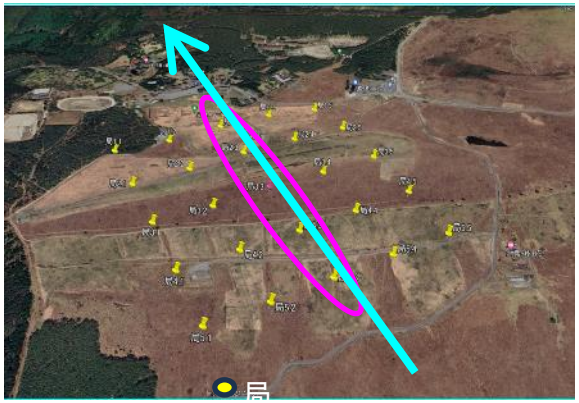
Japan Space Systems successfully conducted 40 power transmission experiments in 4 flight, achieving the objectives of this demonstration test.

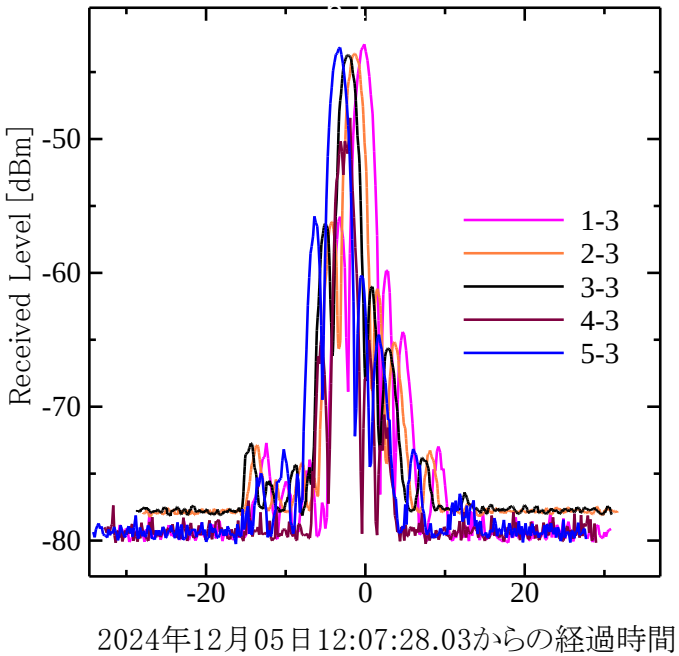
This experiment was **the first in the world** in that

- ✓ Beam formation and direction control using a phased array antenna,
- ✓ Long distance WPT that more than 5 km,
- ✓ Vertical WPT from the sky to the ground,
- ✓ WPT from high-speed aircraft to the ground.

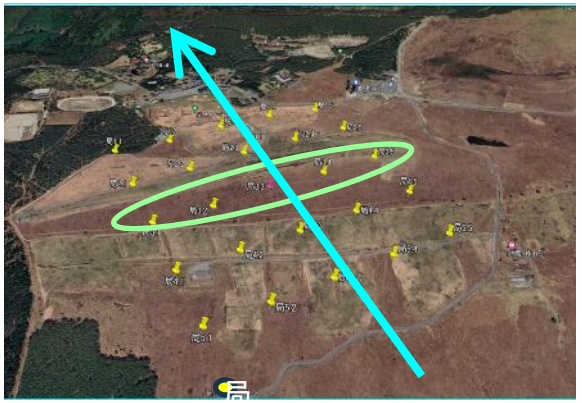
With the success of this experiment, we were able to take an important step towards on-orbit demonstration.

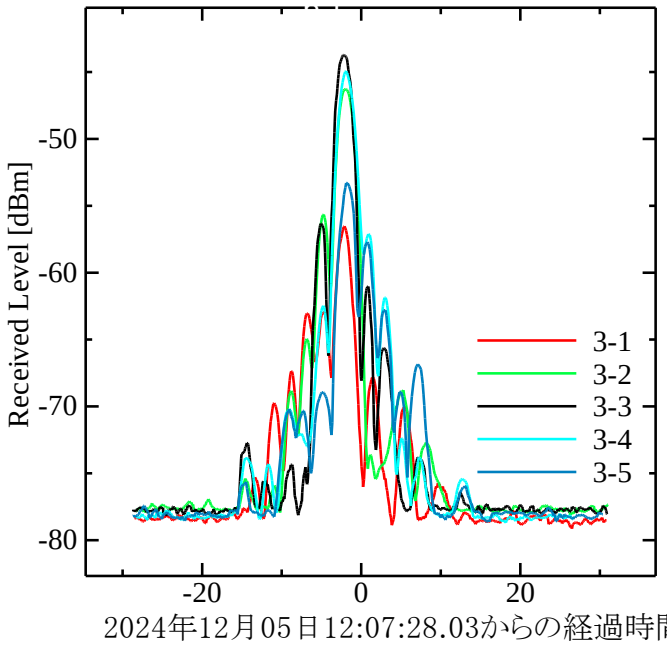
Preliminary Results: Antenna Pattern Measurement Test





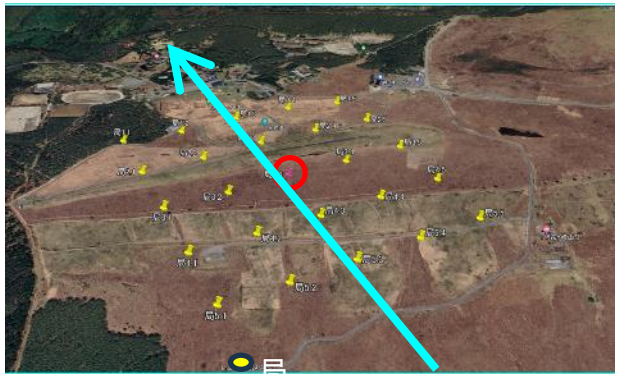
Receiving station measurements result
(longitudinal)

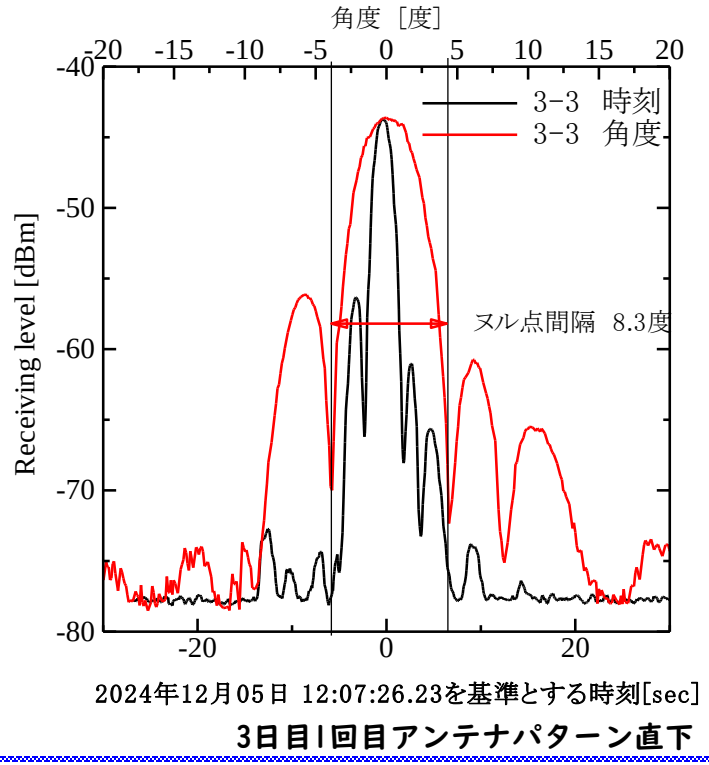




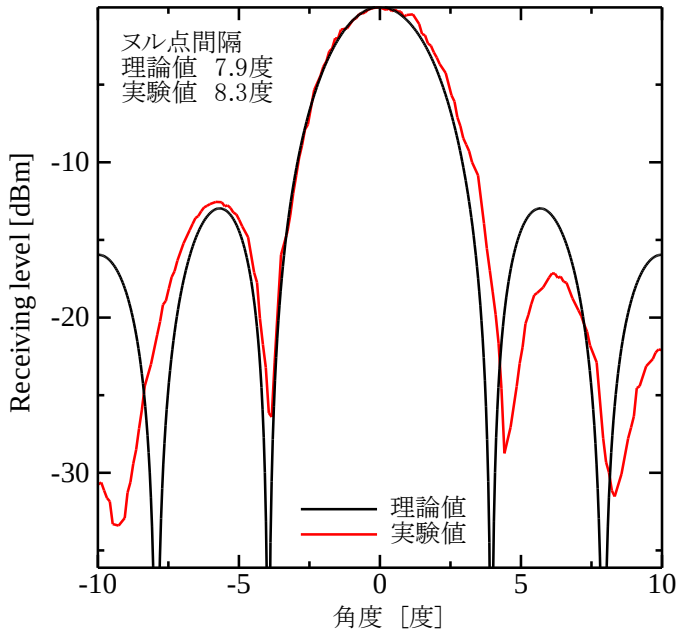
Receiving station measurements result
(lateral direction)

Preliminary Results: Antenna Pattern Measurement Test





3日目1回目アンテナパターン直下



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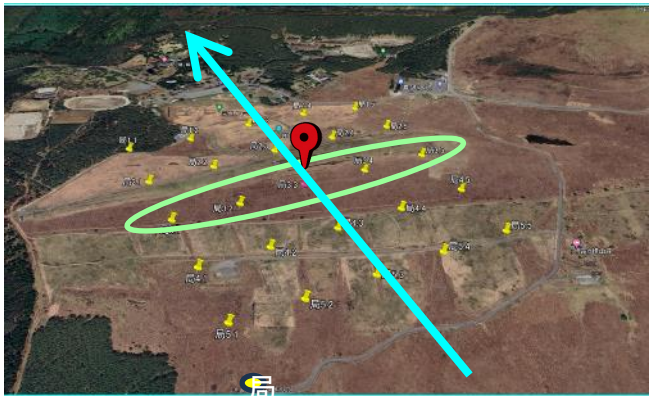
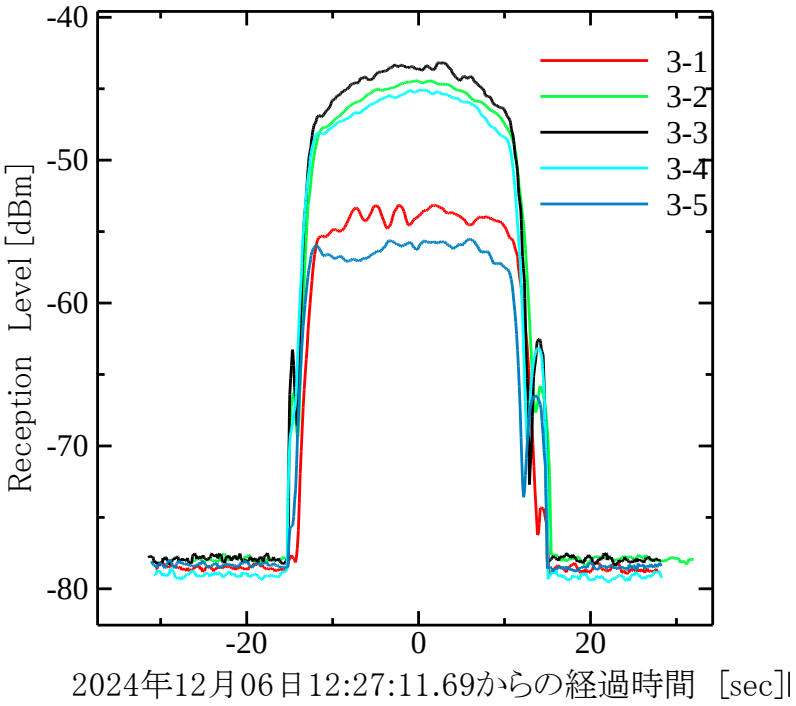
Preliminary Results: Tracking Characteristic Measurement Test





It was confirmed that the following were good:

- ✓ Antenna Pattern
- ✓ Antenna characteristics
- ✓ Tracking characteristics
- ✓ Received field intensity

3. Conclusion and Acknowledgments

- SSPS is no longer a product of fantasy or science fiction, but could become a reality in the near future than is commonly thought.

- The flight test is an important step towards the realization of SSPS and **the last** long-range wireless power transmission experiment before moving on to on-orbit demonstration.

- We would like to express our sincere gratitude for the great efforts, support, and cooperation of the various organizations that participated in the demonstration test team and various parties related to Nagano Prefecture in this flight test.

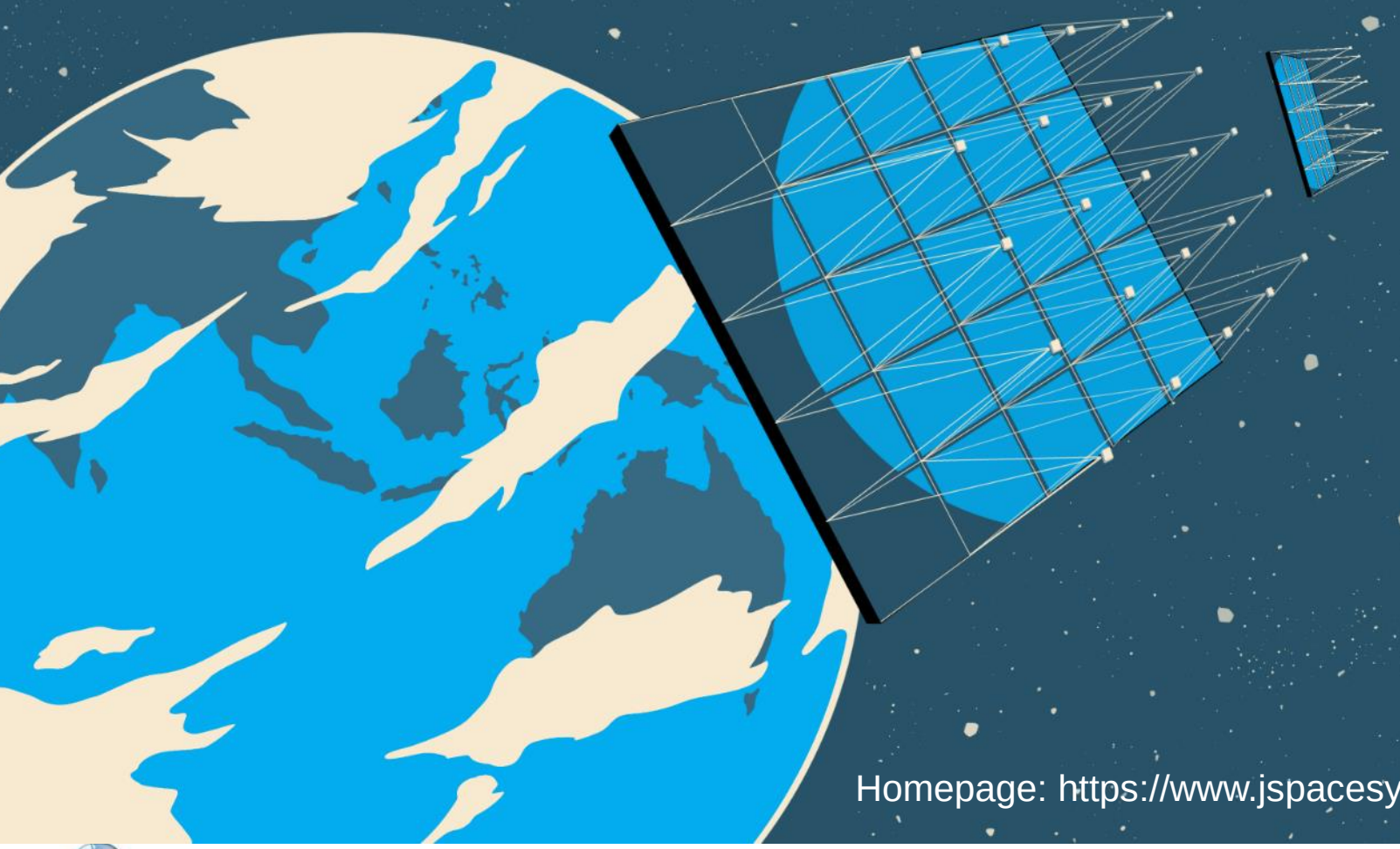
Demonstration Team Members (Aircraft side)

Members: Institute of Space and Astronautical Science (ISAS) of JAXA, Kyoto University, Diamond Air Service, Inc., Orient Microwave Corp., Technosolver Corporation, KYOCERA Communication Systems Co., Ltd., Sounds of Memory, Inc., Japan Space Systems

Demonstration Team Members (Ground side)

Members: Toyo University, Institute of Space and Astronautical Science (ISAS) of JAXA, Kyoto University, Suwa University of Science, KYOCERA Communication Systems Co., Ltd., Diamond Air Service, Inc., Earth Create, Suwa Glider Association, ITINAI Co., Ltd., Sounds of Memory, Inc., Japan Space Systems

Contact:
HIROKI YANAGAWA, SSPS team,
Satellite System and Earth Observation Division, Japan Space Systems
Email: Yanagawa-Hiroki@jspacesystems.or.jp



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