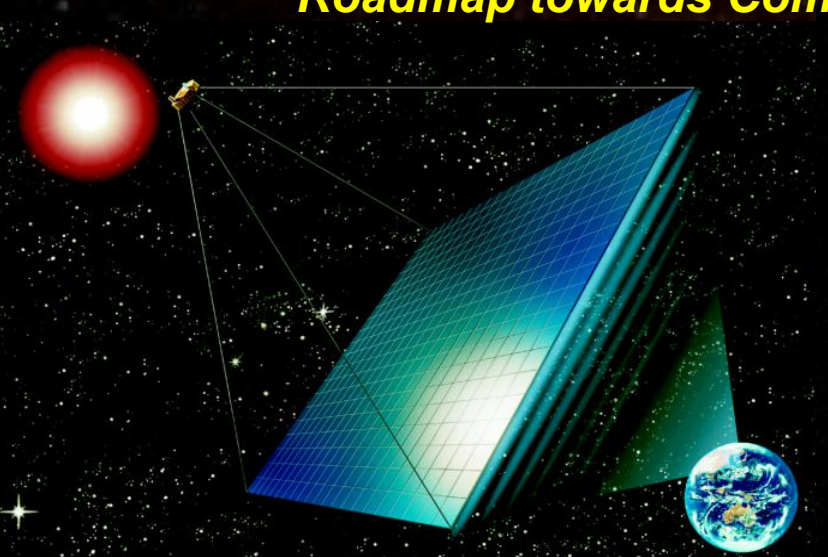
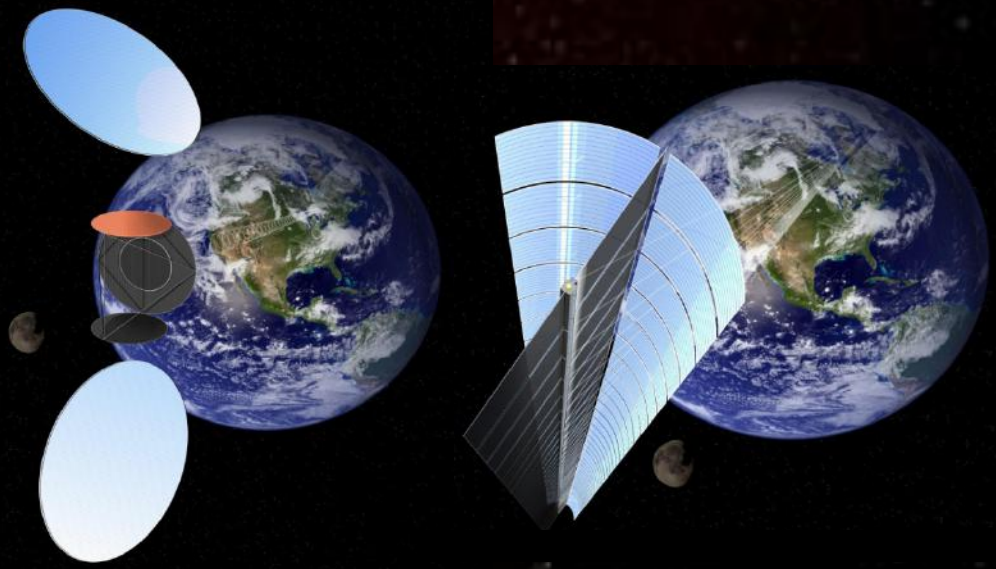
JAXA Activities for SSPS Research

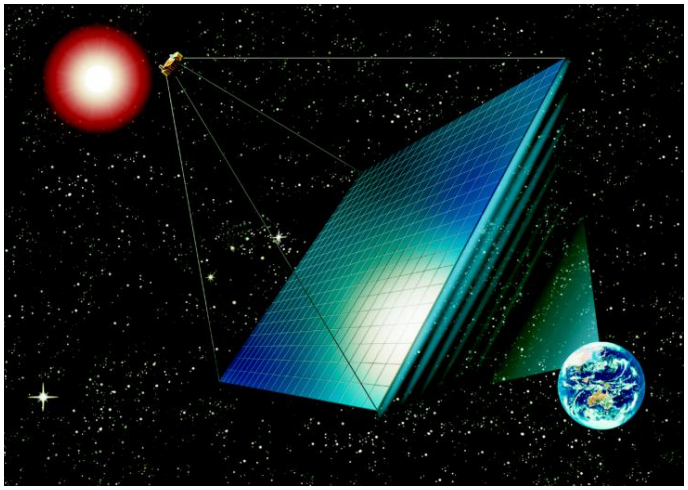
- Commercial Models of Space Solar Power Systems (SSPS)
- Ground Demonstration Experiments
  - Wireless Power Transmission(Microwave and Laser)
  - Large Space Structure
- Space Demonstration Experiments
- Roadmap towards Commercial SSPS



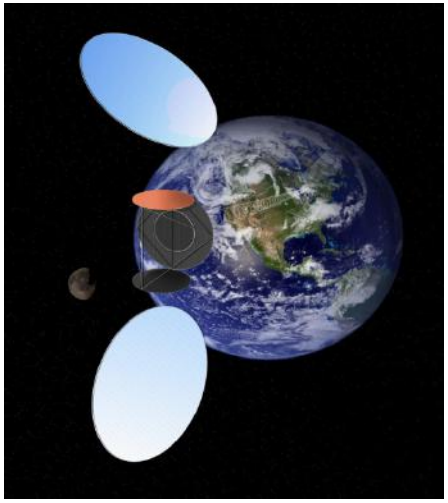


June 2011

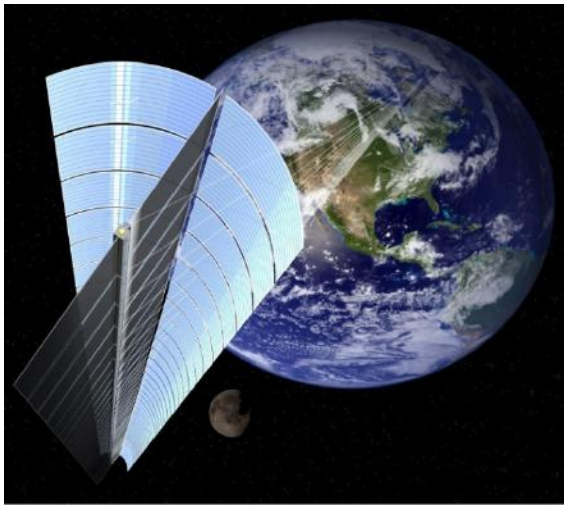
Commercial SSPS Concepts Currently Studied in Japan



Basic Microwave-type Model (USEF/METI)



Advanced Microwave-type Model (JAXA/MEXT)

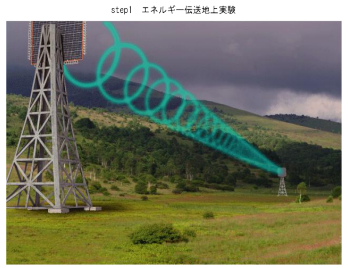


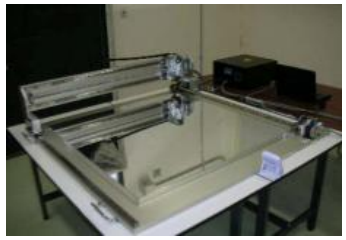
Laser Model (JAXA/MEXT)

USEF/METI:Unmanned Space Experiment Free Flyer/ Ministry of Economy, Trade and Industry
JAXA/MEXT:Japan Aerospace Exploration Agency/ Ministry of Education, Culture, Sports, Science and Technology

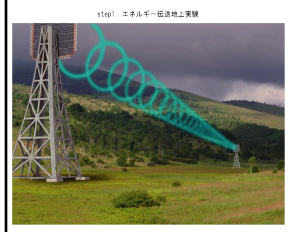
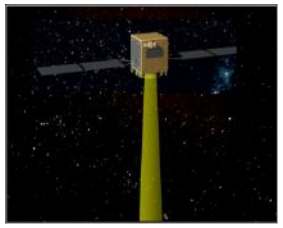
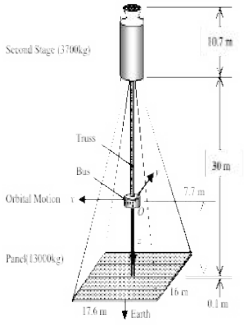
SSPS Key Tasks Required for Near-term Research

Technology field	Specific Technology/Research
Microwave power transmission	Precise microwave beam pointing
	High efficiency power conversion between dc and rf
	Interaction between high-power beam and ionosphere
Laser power transmission	Direct laser generation from sunlight in a high efficiency
	Precise laser beam pointing
	High efficiency power conversion between laser and dc
	Transmission efficiency through atmosphere
Large space structure	Deployment of panel structure typically 0.1 m thick
	Deployment of light-weight structure typically 300 g/m^2
Solar power collecting mirror	High magnification sun light collector
	Filter coatings for uv and ir light

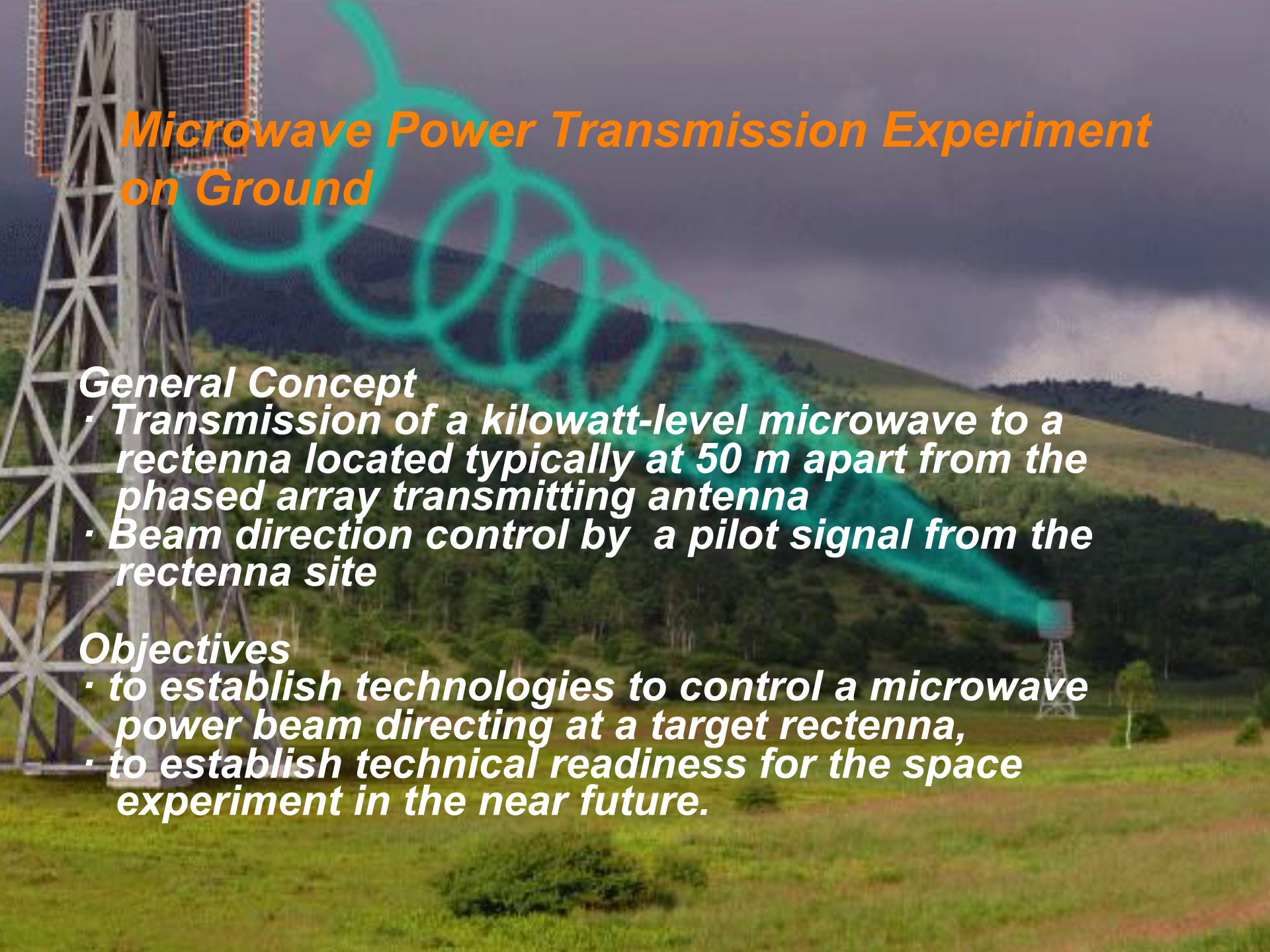




Development Steps towards Commercial SSPS

Phase	Ground Demonstration	Small Scale Demonstration in Space	Large Scale Demonstration in Space	Small Plant in Space	Large Plant in Space
Transmission	Ground	LEO to Ground	LEO to Ground	1000 km to Ground	GSO to Ground
Range	50-500 m	400 km	400 km	1000 km	36000 km
Power Level	kW level	kW level	100 kW level	2 MW level	200 MW level
Structure Scale	several m	several m	20 m	100 m	500 m
Power at Receiver	several hundreds Watt	—	10kW	1.8MW	160MW
System(in case of Basic Model)					


Ground Demonstration Experiment

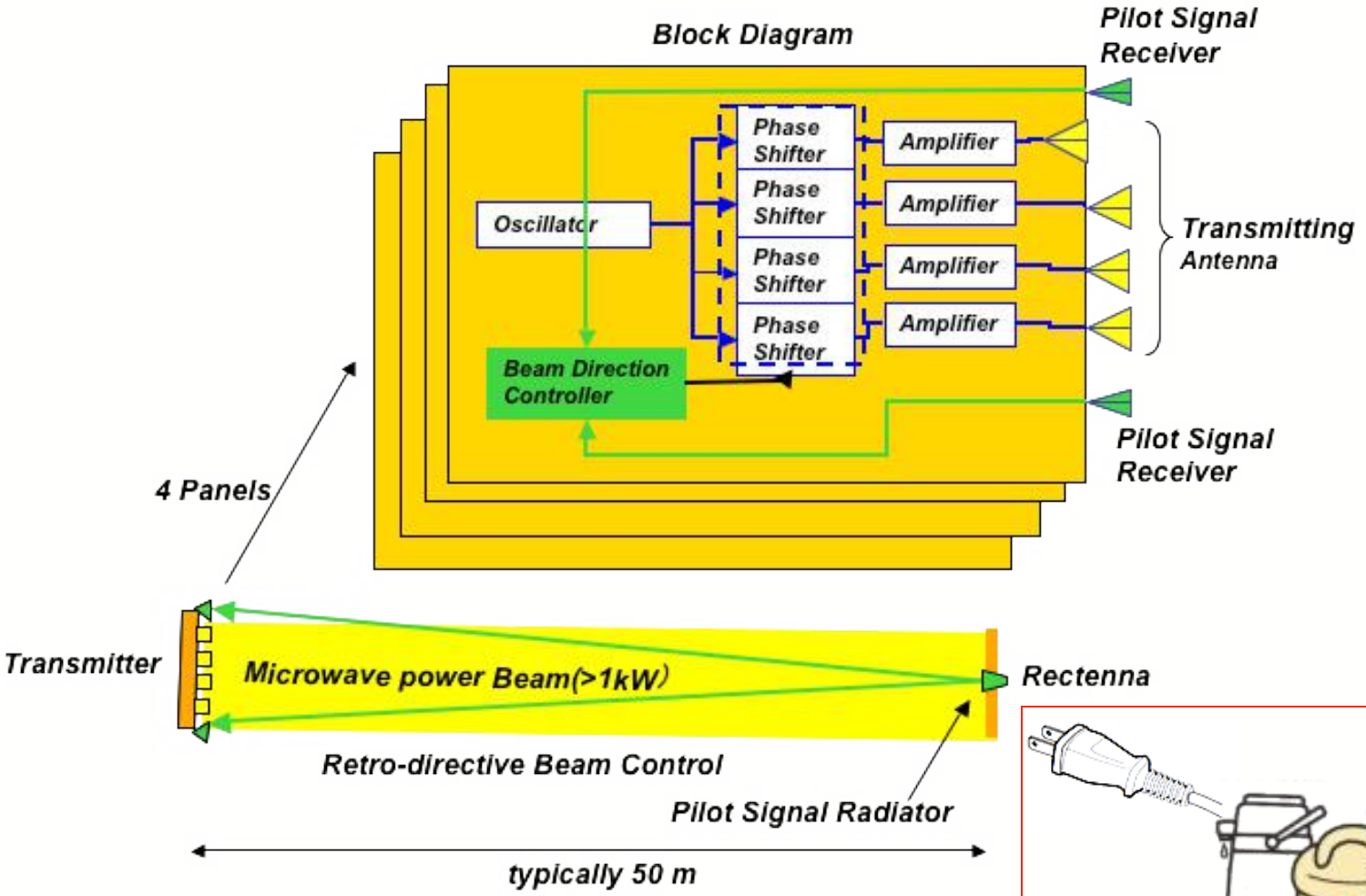


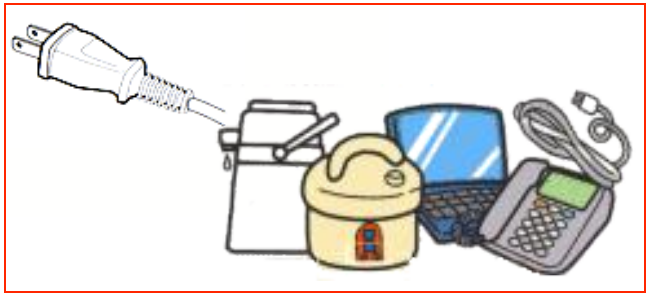
Microwave Power Transmission Experiment on Ground

General Concept
- Transmission of a kilowatt-level microwave to a rectenna located typically at 50 m apart from the phased array transmitting antenna
- Beam direction control by a pilot signal from the rectenna site

Objectives
- to establish technologies to control a microwave power beam directing at a target rectenna,
- to establish technical readiness for the space experiment in the near future.

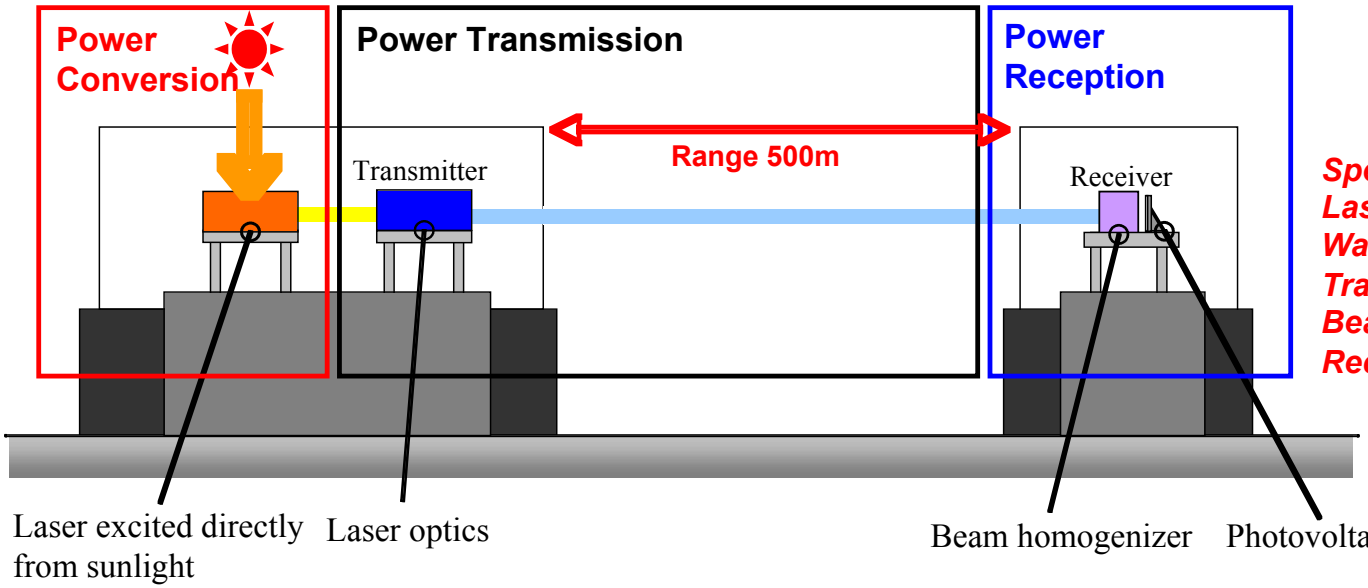
Microwave Power Transmission Demonstration





Rectenna output power will be used to operate household electric appliances for public demonstration.

Laser Power Transmission Experiment on Ground

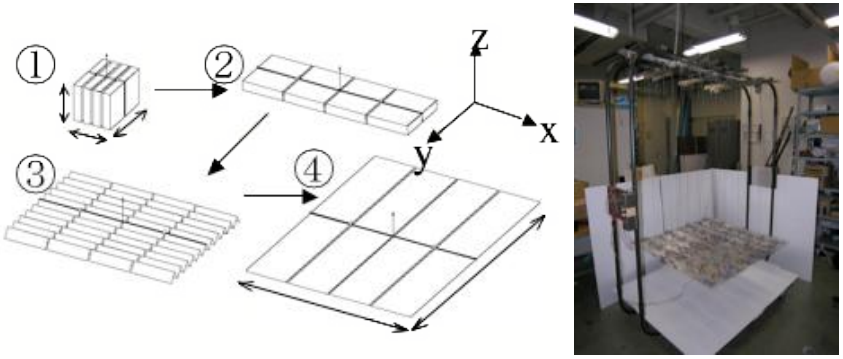


Specification
Laser output 1kW
Wave length 1.06μm
Transmission 500m
Beam control several μrad
Receiver output 0.2kW

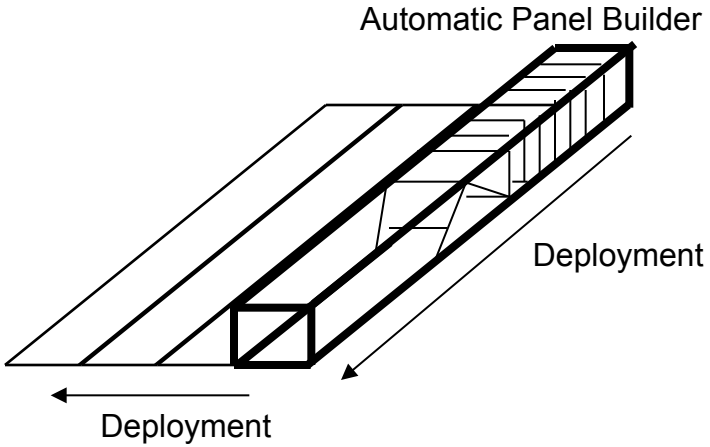
Laser Power Transmission experiment(200W class) at Kakuta/JAXA

Laser power generation experiment(100W class)

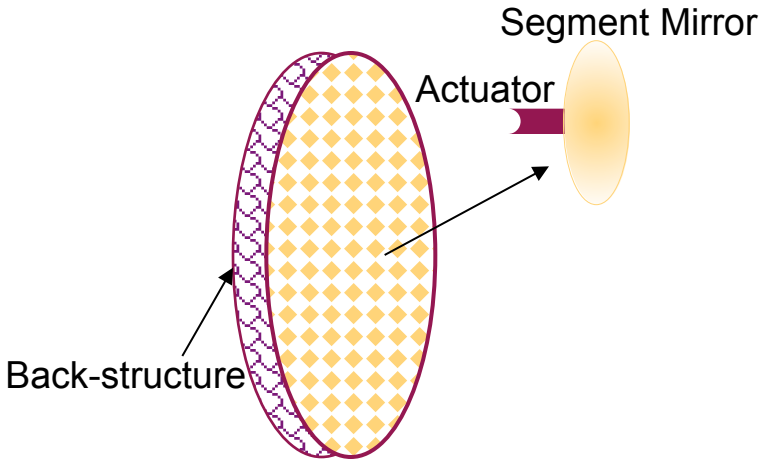
Large Space Structure (Thick Panel and Thin Mirror)



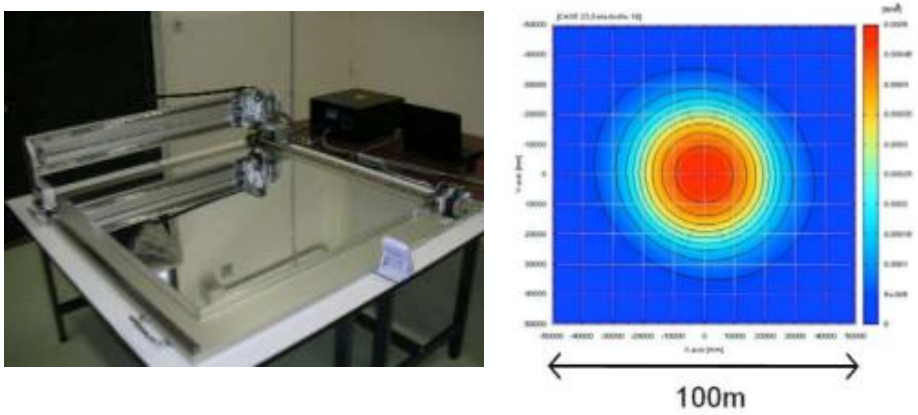
Demonstration of Automatic Deployment



Configuration of automatic panel builder.



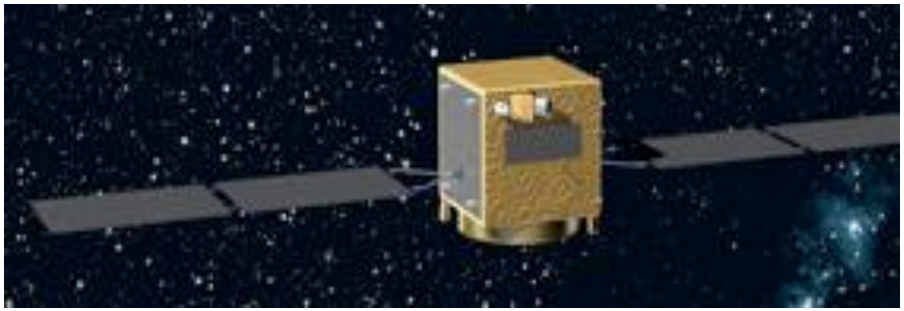
Large mirror consisting of a large number of segment mirrors (non-monolithic mirror)



Measurement of mirror surface roughness and evaluation of reflectance performance in a km range


Flight Demonstration Experiment
JAXA
NIPPON
JAXA

Two Possible Platforms for SSPS Wireless Power Transmission Experiment in the Near Future

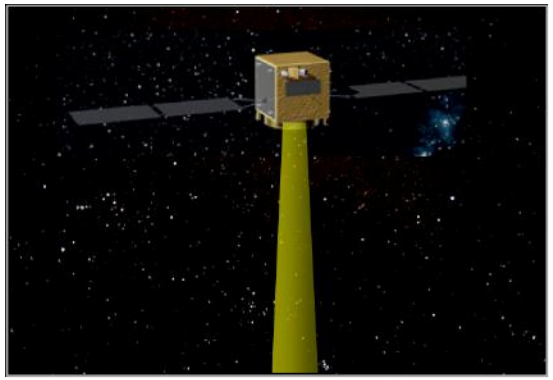


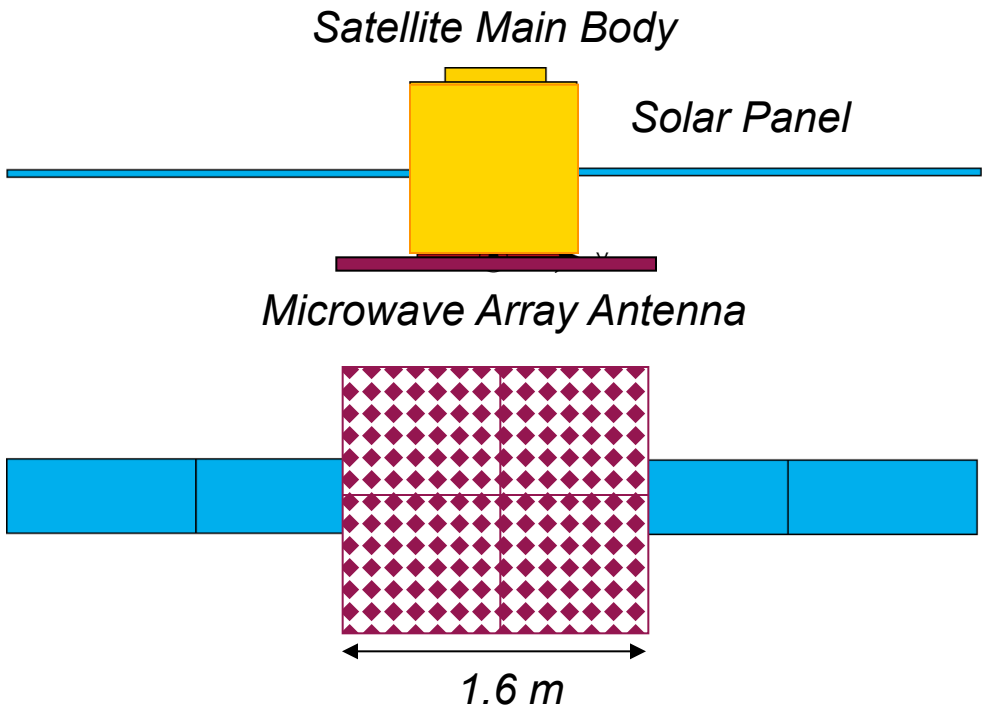
JAXA small scientific satellite to be launched by next-generation solid propellant rocket, Epsilon launch vehicle. 500 kg class satellite. Payload weight 200 kg typical. First flight will be in 2013.

Japanese Experiment Module Kibo on the International Space Station (ISS), for science and technology research. Payload weight 500 kg typical.

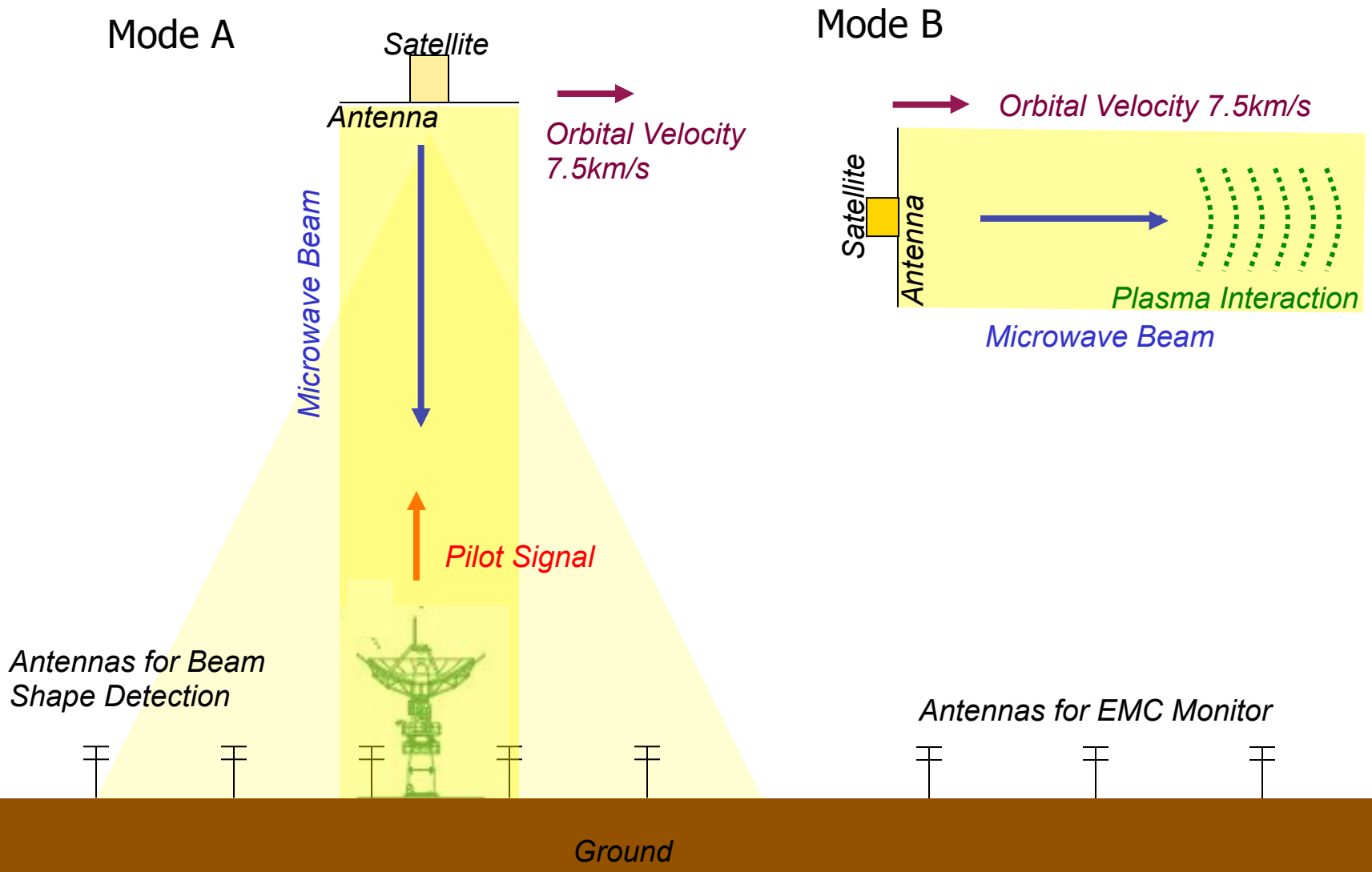
Experiment on Small Satellite

Orbit: Low Earth Orbit (370 km)
Satellite Weight: 500 kg
Mission Weight: 200 kg
Attitude Control: 3-axis Stabilization
Transmission Power: 3.8 kW





Experiment Configuration



Laser Power Transmission Experiment from JEM (an example)

International Space Station JEM

Transmitter
1 kW, 1.06 μm
20 cmΦ Optics

Laser Beam

Divergence 15 μrad
Pointing 1 μrad

Pilot Beam

Receiver
10 mΦ Area
200 W Output

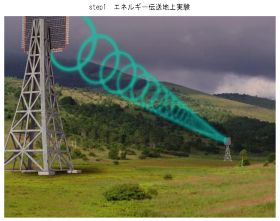
Photovoltaic Cell Array

Roadmap

Research Phase

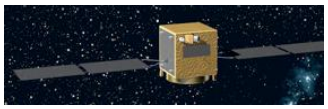
09 10 11 12 13 14 15 16 17 18 19

Ground demonstration



Small-scale on orbit demonstration

WPT Selection (microwave or laser)



100kW class on orbit demonstration

Configuration selection

Development Phase

20 21 22 23 24 25 26 27 28 29

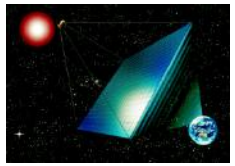
2MW class demonstration

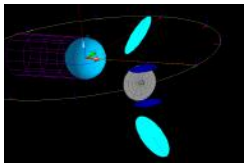
200MW class plant

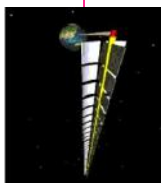
Commercial Phase

30 31 32 33 34 35 36 37 38 39

1GW class first commercial model







Commercial SPSS（1SSPS/year）

Summary and Conclusion

- *Three commercial SPS models currently studied in Japan; basic microwave-type, advanced microwave-type, and laser type, are introduced.*
- *As the first demonstration on the ground towards the commercial models, kW-class wireless power transmission experiments with 50-500 m range and deployment experiment for large space structure are now under way and will be completed within 2-3 years.*
- *Immediately after the ground demonstration experiment, we will conduct a small-scale experiment in orbit to transmit a 1 kW class wireless power to the ground.*
- *This approach is in accordance with the basic plan on space development by the government's space development strategy headquarter in Japan.*