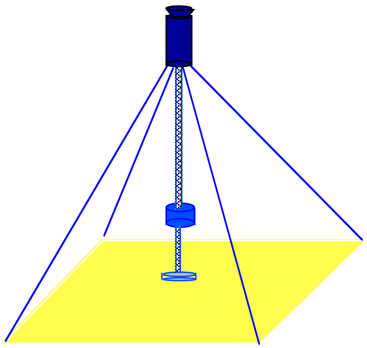
Conceptual Study of SSPS Demonstration Experiment

- Objectives of the study
- System configuration
- Flight operation
- Associated technologies



July 2003

Strategy and Policy

Strategy

First Step: Concept Development for Practical SSPS → Second Step: Design of Demonstration SSPS

Policy 0

- A large number of electrical parts (solar cells, microwave elements) required: 0

  ⇨ COTS(commercial off-the-shelf), high-technology, mass production, low-cost 0

- Structure and mechanism be simple and robust: 0

  ⇨ no active attitude control and no movable mechanism in operation 0

- Distributed power system : 0

  ⇨ power generation/transmission module(sandwitch power module), no power bus 0

- Concentration of information: 0

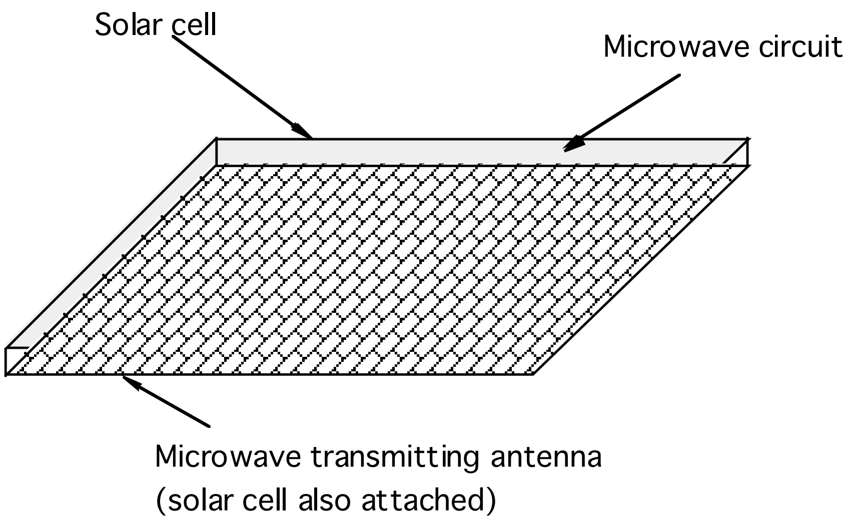
  ⇨ wireless LAN 0

Concept of Power Generation and Transmission Module (Sandwich Panel) 0

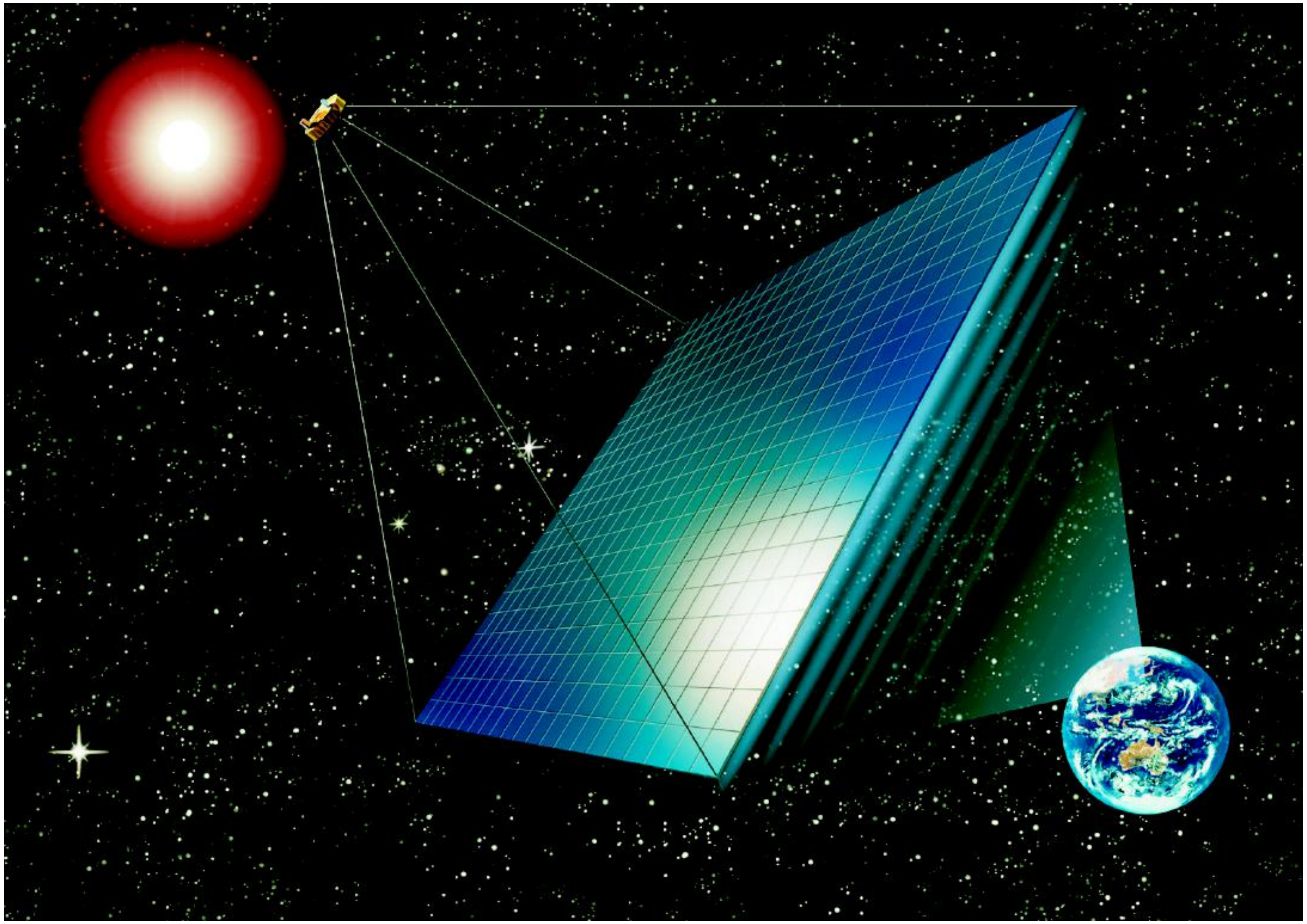
- Module including power generation and transmission 0
- Wireless interface between modules 0

0

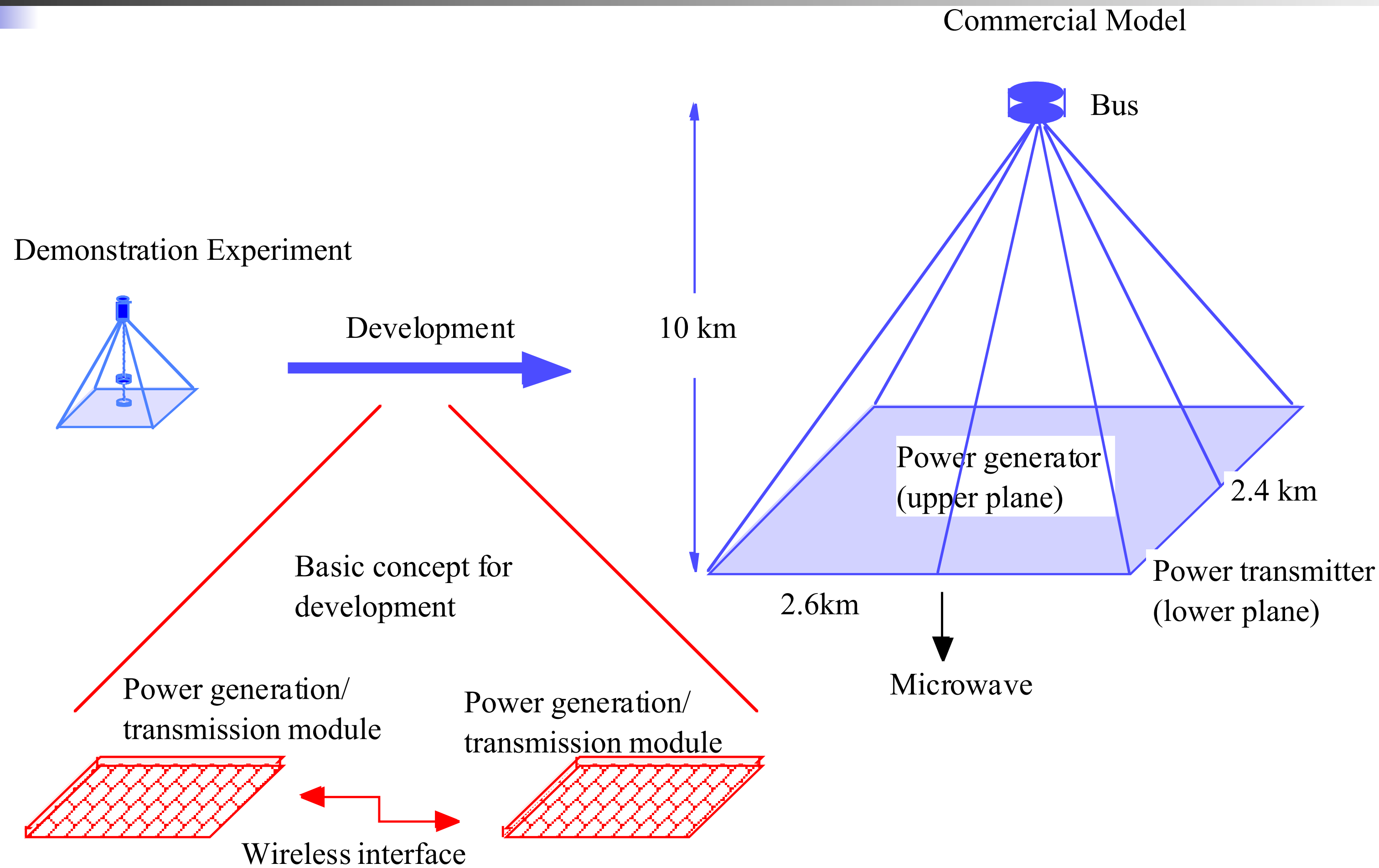
- easy attachment and detachment as a module 0
- robust as a power system 0
- easy fabrication, test, integration, and maintenance



Practical or Commercial SSPS 0



Evolution of Demonstration Experiment to Practical SSPS 0



Concept of Demonstration Experiment 0

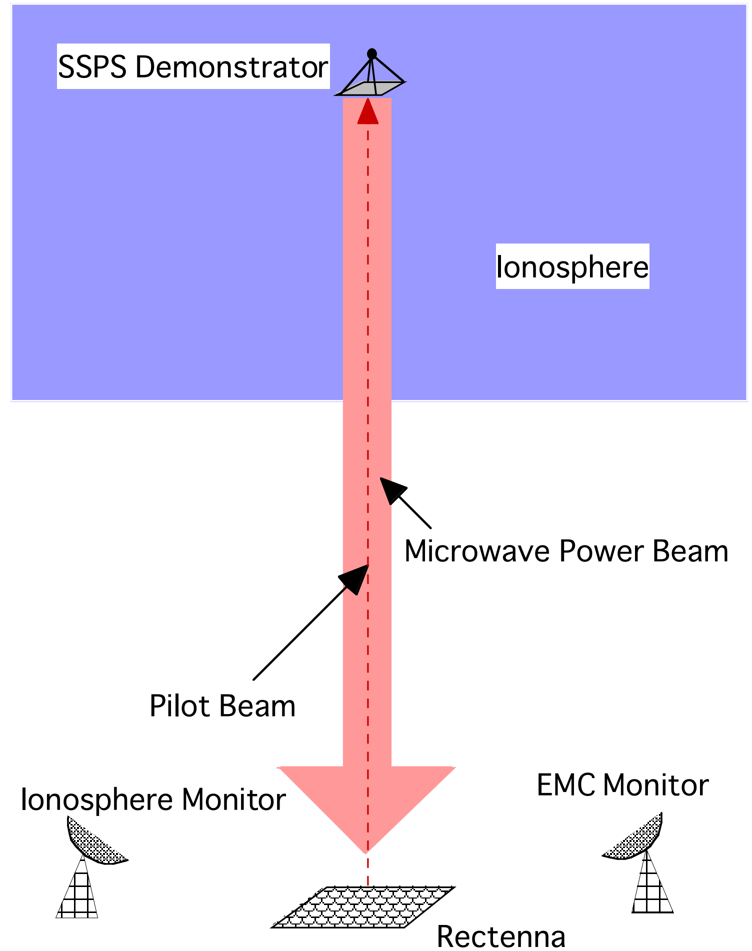
Most important subject at this stage towards the practical SSPS is a verification of power transmission from space to ground. 0

(1) Demonstration of microwave beam control, pointing precisely to a rectenna on ground from a large antenna dynamically-moving in orbit. 0

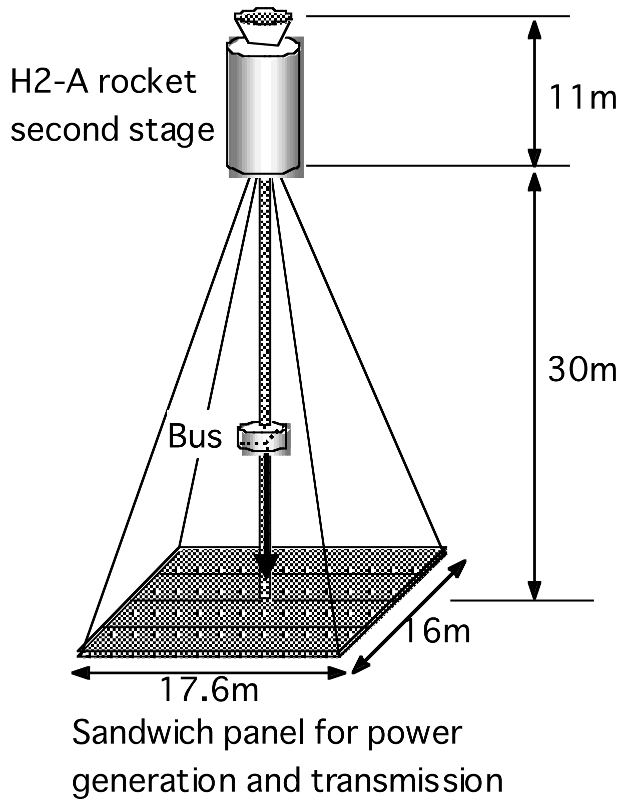
(2) Evaluation of over-all power efficiency as an energy system.

(3) Demonstration of electromagnetic compatibility with existing communication infrastructure.

(4) Study of operation procedure as an solar power satellite. 0



Configuration of Demonstration Experiment

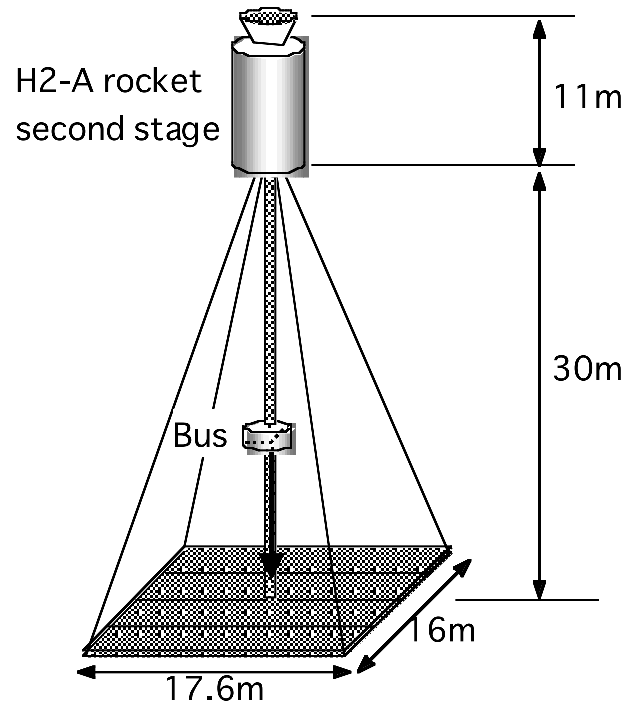


Selected Technologies for the Demonstration Experiment 0

- Modular panel(sandwitch panel) combined with power generation and microwave transmission. 0
- Small panels folded in rocket and deployment in orbit to a large single panel. 0
- Attitude stabilization by gravity gradient force using a tether system and truss system. 0
- Thin film-type solar cells commercially available. 0
- Microwave transmission elements commercially available. 0
- f = 5.8GHz. 0
- Hybrid system combined with magnetron and semiconductors. 0
- Wireless synchronization of frequency and phase of oscillators for all panels. 0
- Retrodirective beam control using pilot signal from ground.

System of Demonstration Experiment 0

Size	40.8m x 17.6m x 16.0m
Total Weight	18,100 kg
Power Generation	36 kW max
Power Transmission	420 kW～140 kW
Beam Control	retrodirective control
Microwave Frequency	5.8 GHz
Operation	full power for 16 sec 10% power for 4 min
System Configuration	panel, truss, tether, weight mass
Panel Configuration	80 foldable panels 400 power modules 250,000 antennas
Attitude Control	gravity gradient force
Altitude	370 km
Rectenna type	parabola collector
Rectenna output	30 kW～10 kW(500 m diameter)



Sandwich panel for power generation and transmission

Mission Operation 0

M E T 0 — Launch
Orbit（370km altitude）
despin

M E T 1 — bus system checkout
earth pointing

truss deploment

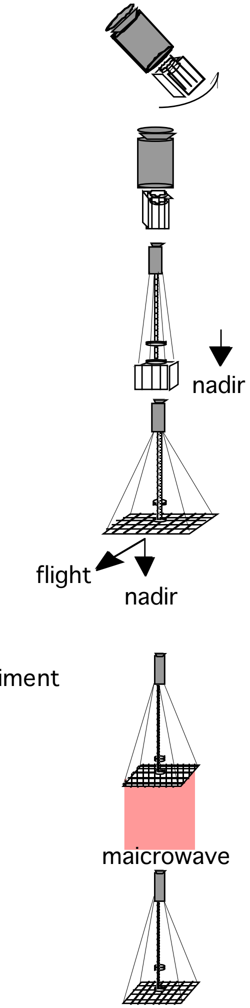
M E T 2 — panel deployment

M E T 3～ — orbit adjustment

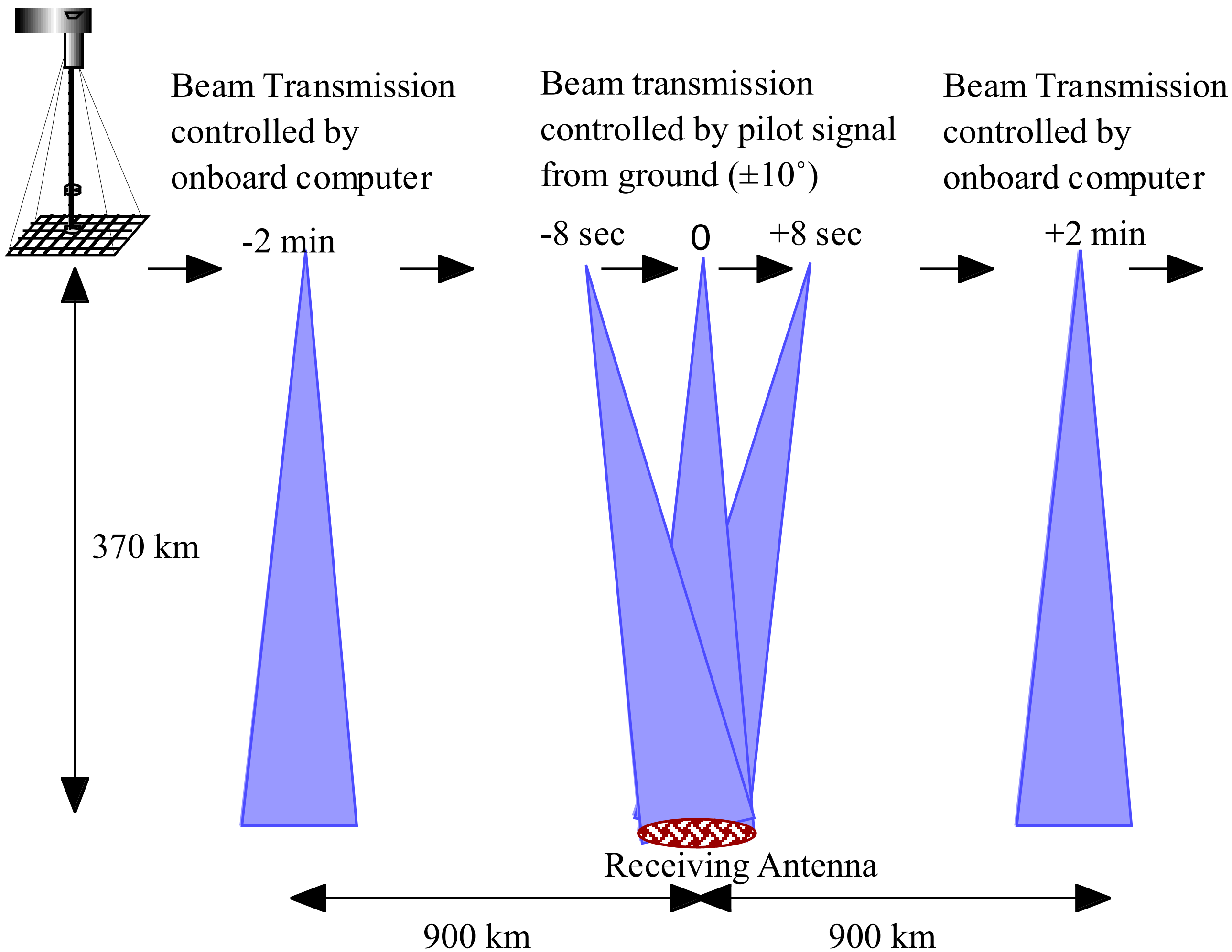
M E T 3 0 — experiment checkout

M E T 3 1～ — power transmission experiment

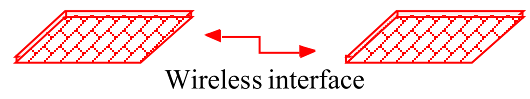
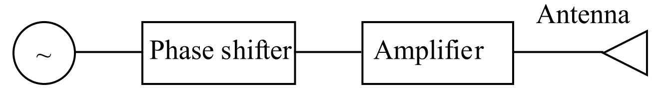
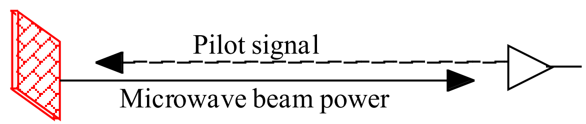
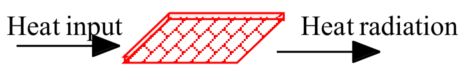
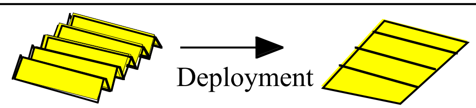
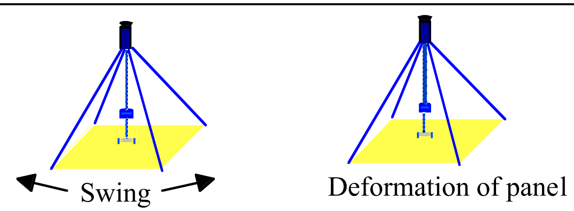
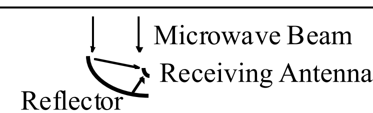
standby



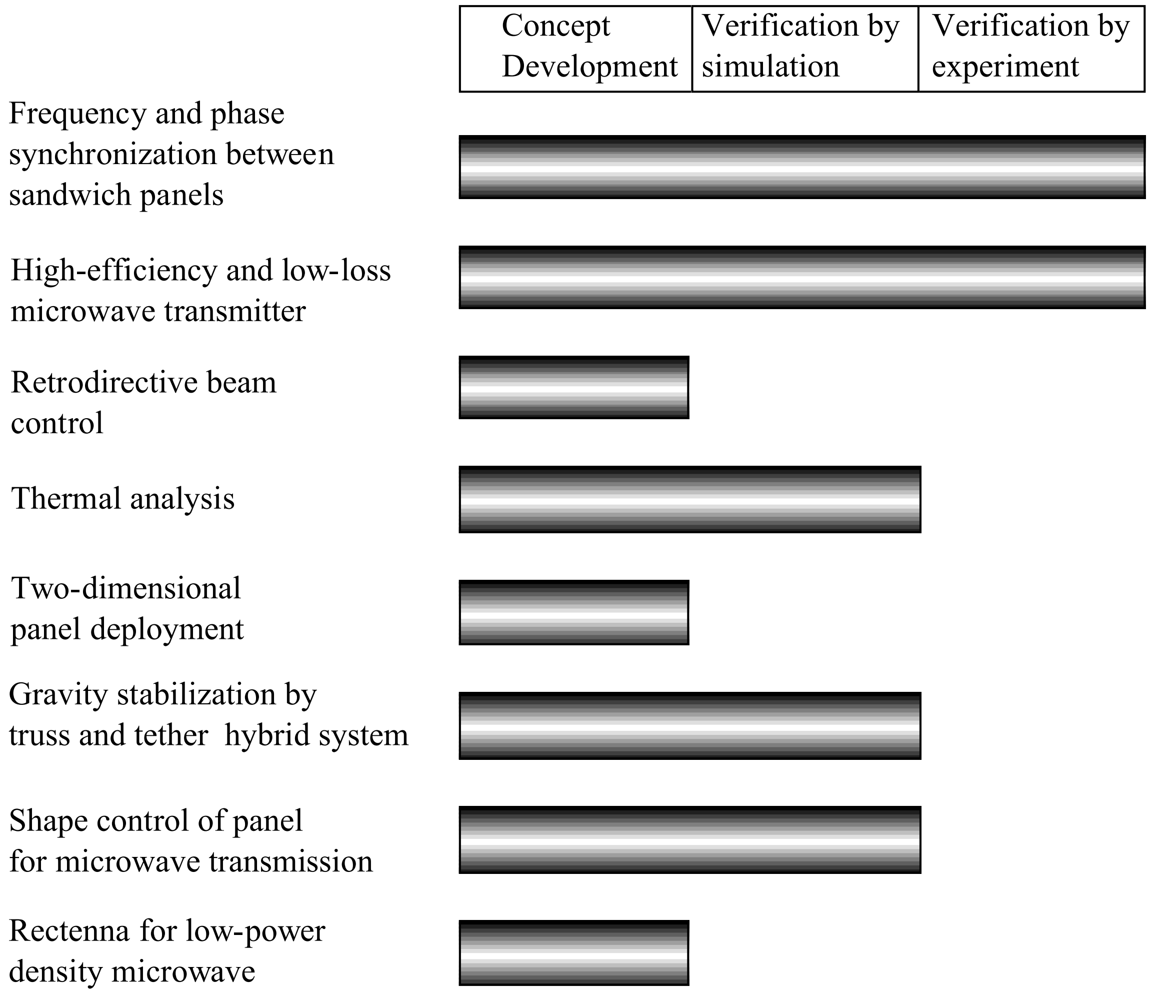
Experiment Sequence of Microwave Power Transmission 0



Critical Technologies for Demonstration Experiment 0

Critical issues	Problem Area
Frequency and phase synchronization between sandwich panels	
High-efficiency and low-loss microwave transmitter	
Retrodirective beam control	
Thermal analysis	
Two-dimensional panel deployment	
Gravity stabilization by truss and tether hybrid system Shape control of panel for microwave transmission	
Rectenna for low-power density microwave	

Current Status of Research 0



Conclusion 0

- Demonstration experiment towards the practical SSPS has been studied.
- Sandwich panel module, wireless interface between modules, stabilization by gravity gradient force using tether and truss, are major characteristic features.
- Study indicates power transmission from space to ground more than 100kW or more is feasible.
- Further study is required for retro-directive beam control, two-dimensional panel deployment, and rectenna for low-power intensity microwave.