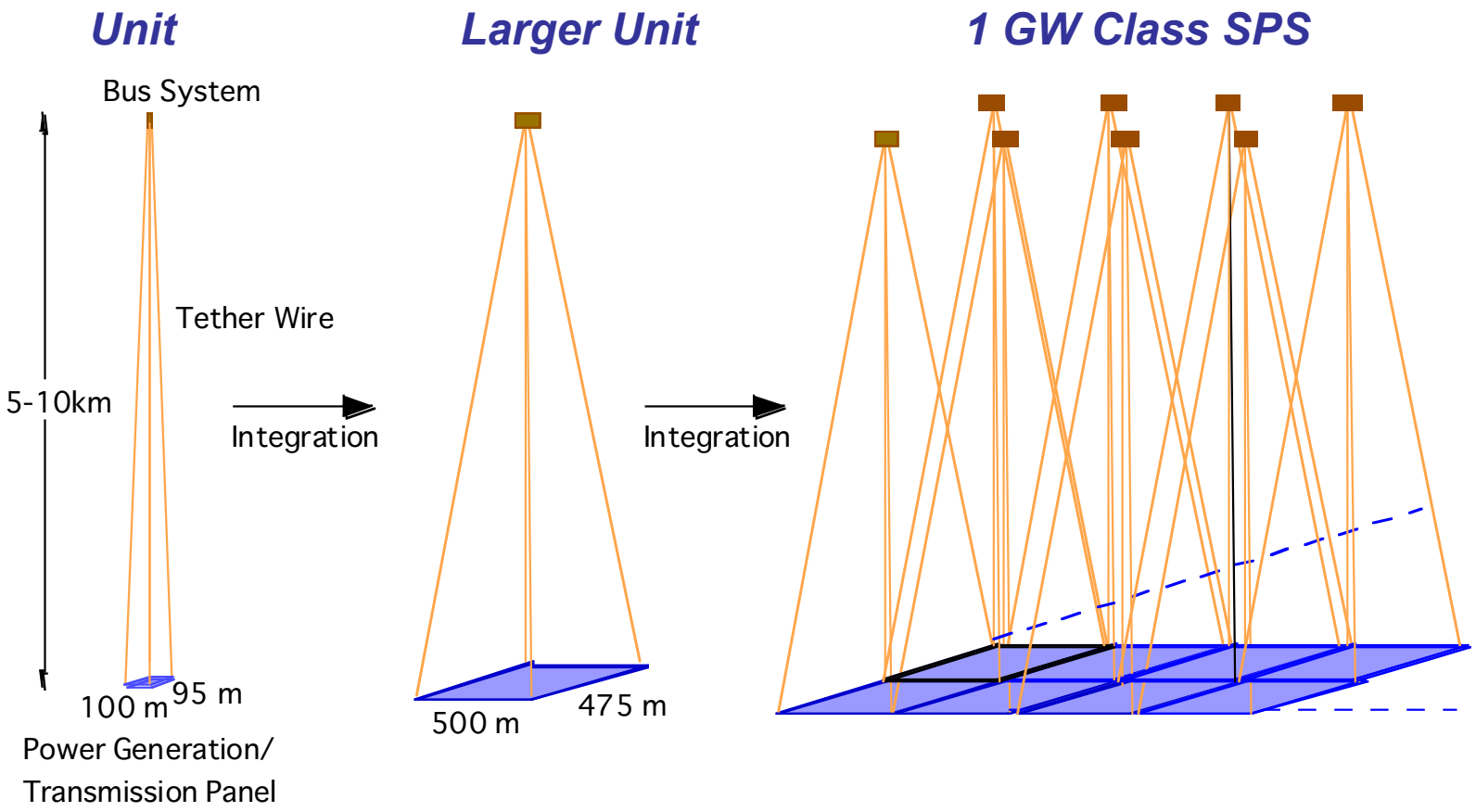
Feasibility Study of Multi-bus Tethered-SPS～

- Concept of Multi-bus Tethered-SPS
- Construction Scenario
- Engineering Studies
- Environmental Studies

September 2008

Concept of Multi-bus Tethered-SPS

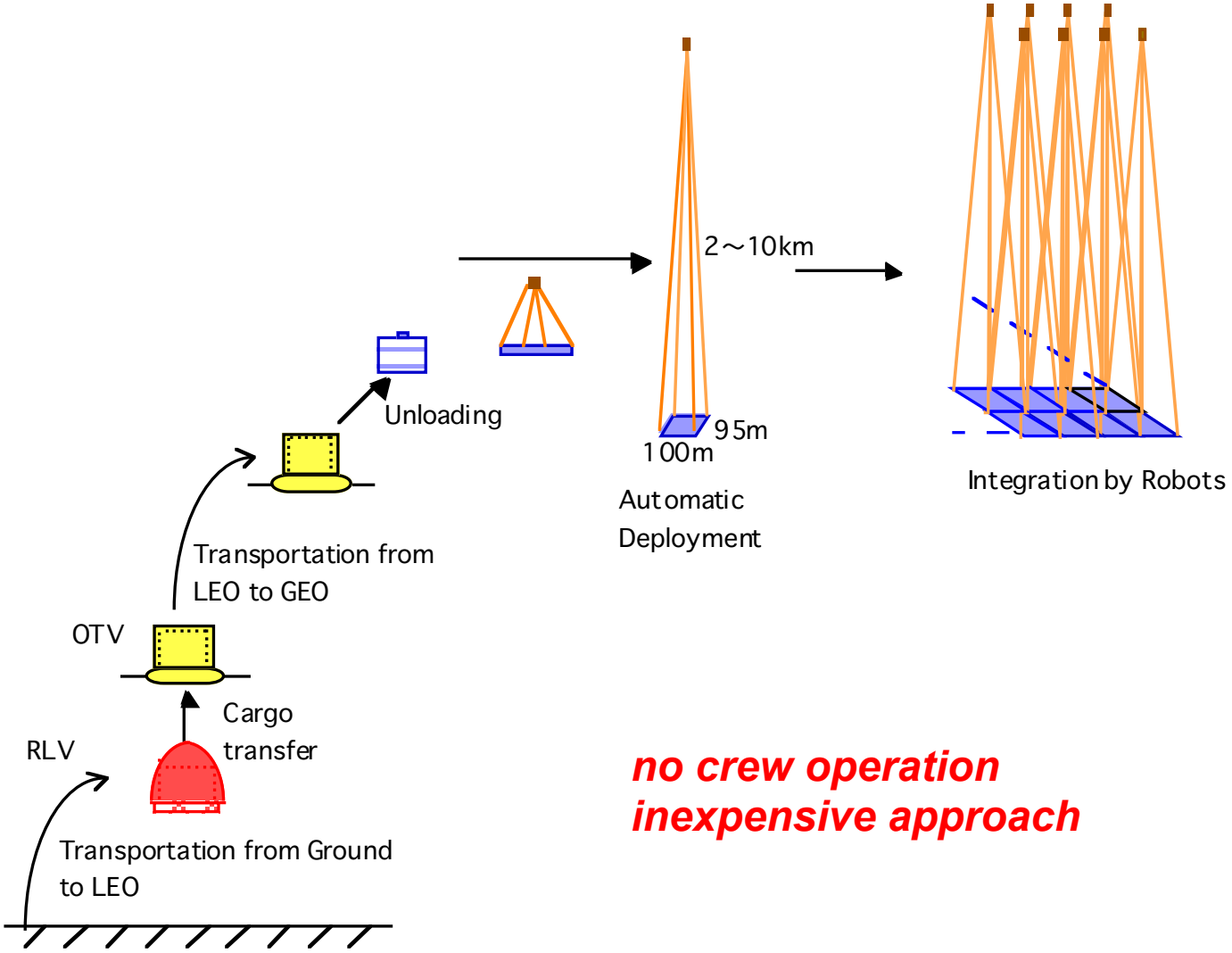


simple and flexible

System Characteristics of Tethered-SPS (1GW Class)

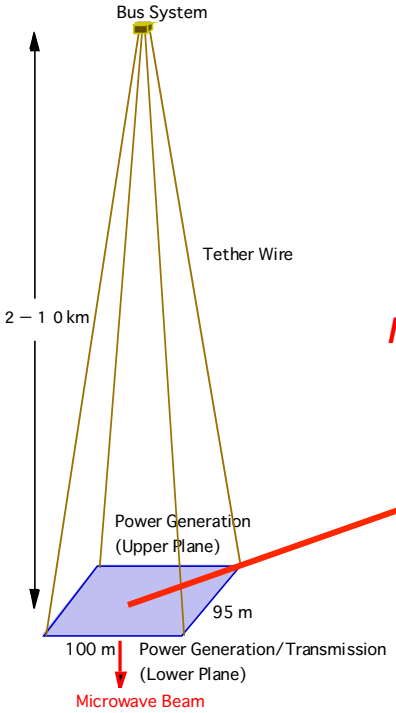
	Item	Performance	Note
Tethered SPS	Weight	26,562 MT	25,234MT（Panel）、1,328MT（Bus）
	Size	2.5 km x 2.375 km x (5-10) km	250 Tethered SPS modules
	Output Power	1.36 GW	Microwave frequency 5.8 GHz
Tethered SPS Module	Weight	42.5 MT	40,375 kg（Panel）、2,125 kg（Bus）
	Tether Length	2-10 km	Width 1cm, Para-aramid fiber （Kevlar/DuPont), UV protection coating
	Panel Size	100m x 95 m	100x 95 Power generation/ Transmission modules
	Output Power	2.2 MW	Microwave frequency 2.45 GHz
Power Generation/ Transmission Module	Weight	4.25 kg	Microwave circuit 2.3kg(10g/W) Solar cell 0.45kg(0.5g/W) Batteriies 1.0kg(2000Wh/kg) Structure 0.5kg(0.025g/cc)
	Size	1 m x 1m x 2 cm	
	Output Power	230 W	Microwave frequency 2.45 GHz

Construction Scenario

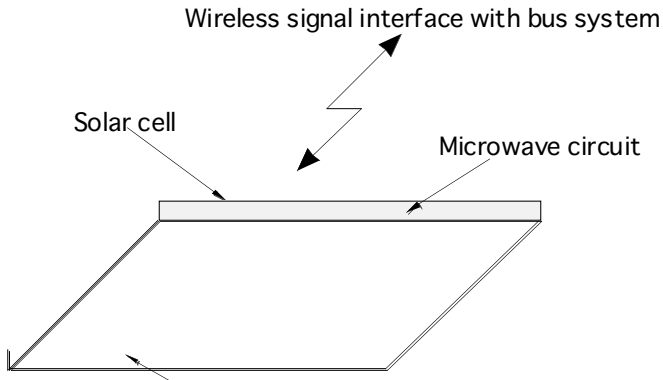


no crew operation
inexpensive approach

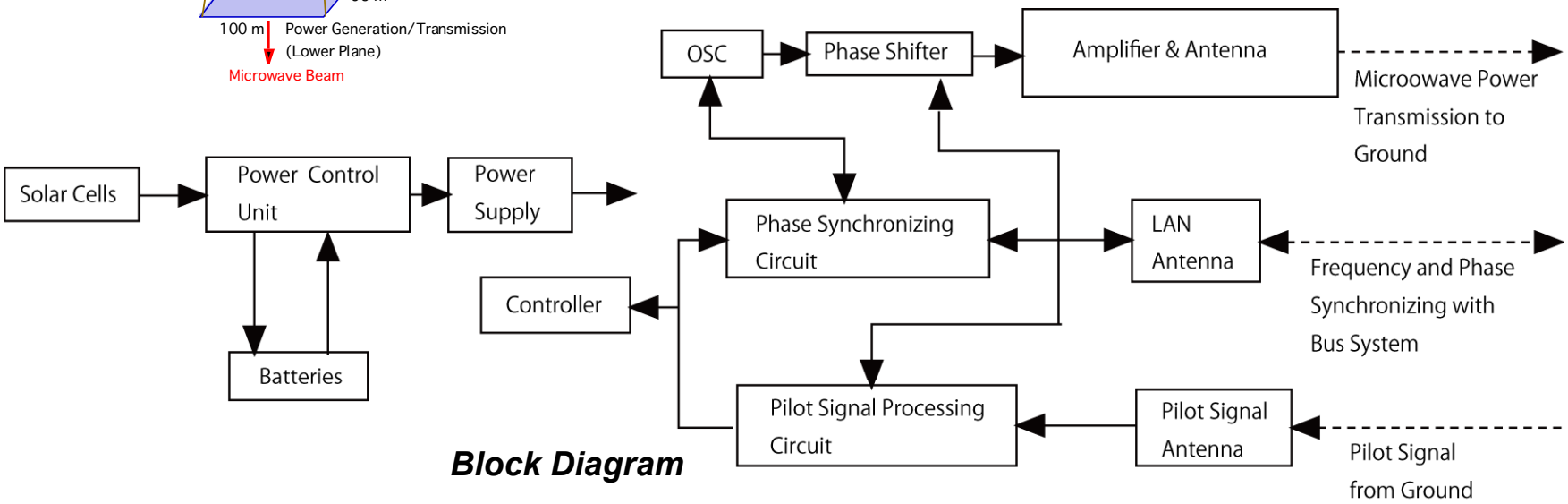
Design of Power Generation/Transmission Module



module structure

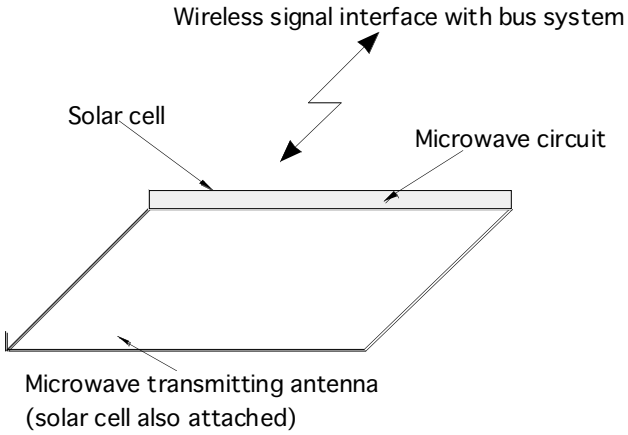


Power generation/transmission module

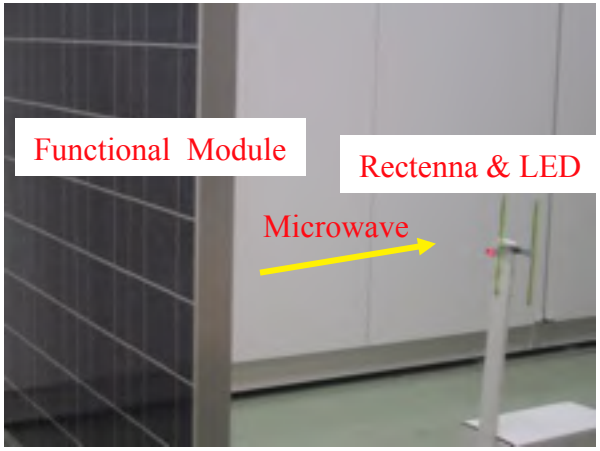


Block Diagram

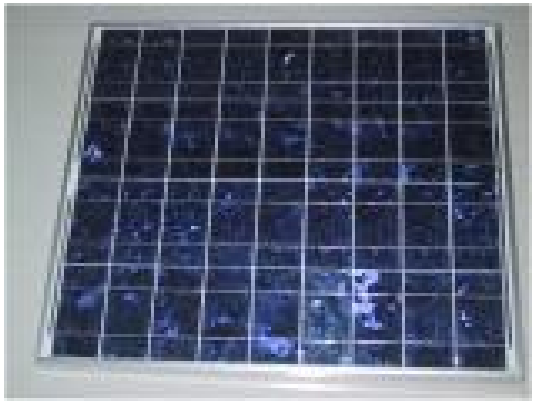
Fabrication and Test of Power Generation/ Transmission Module



Power generation/transmission module



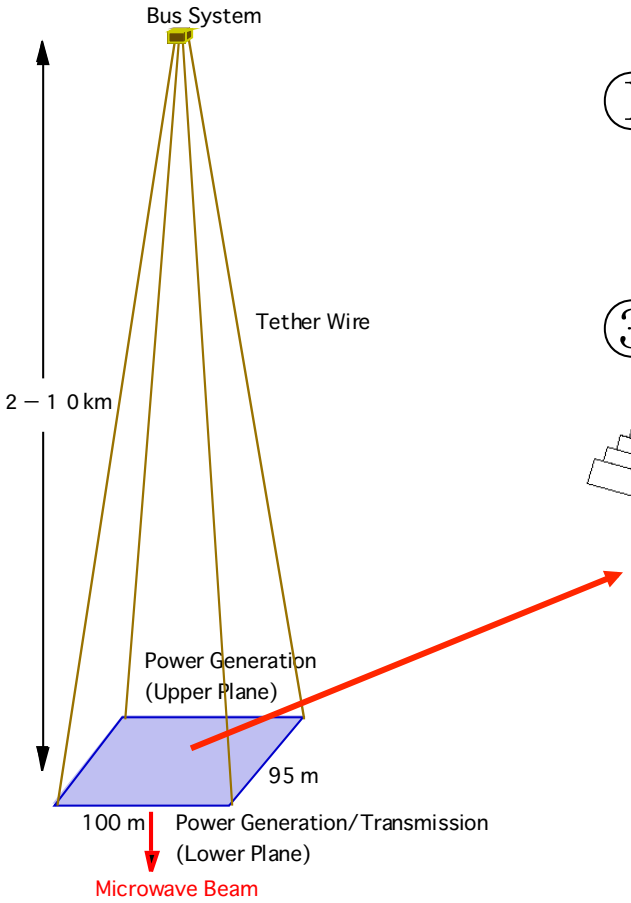
Power Transmission Demonstration

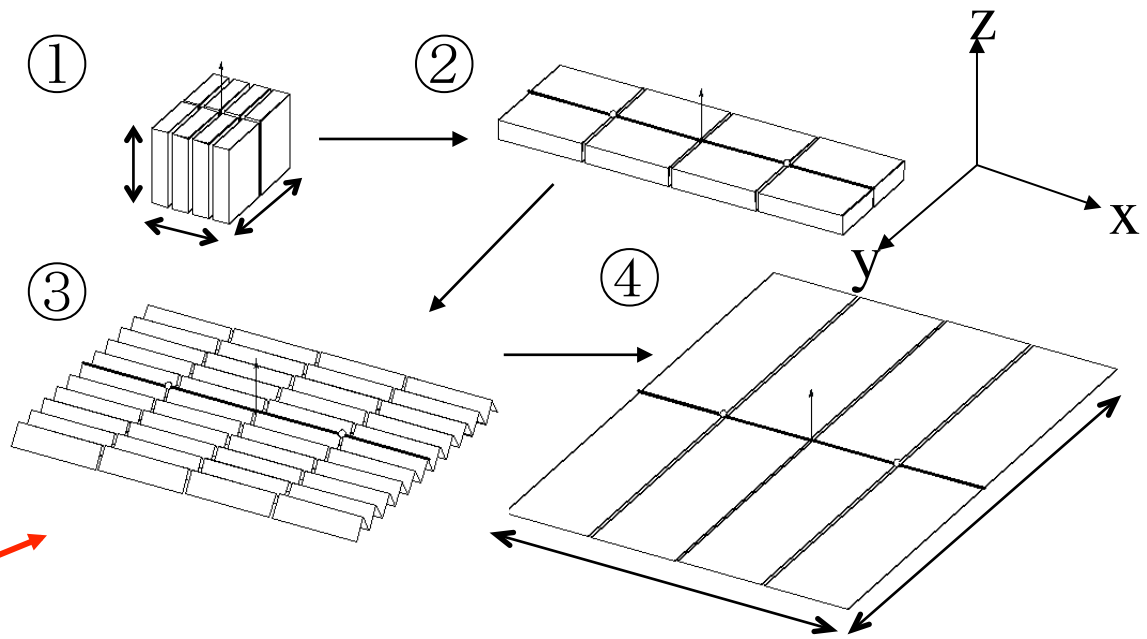


Functional model of module
(solar cell side)

Functional model of module
(microwave antenna side)

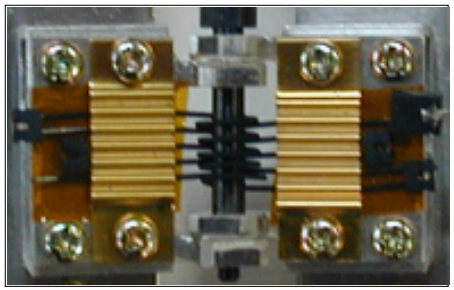
Deployment of Power Generation/ Transmission Panel



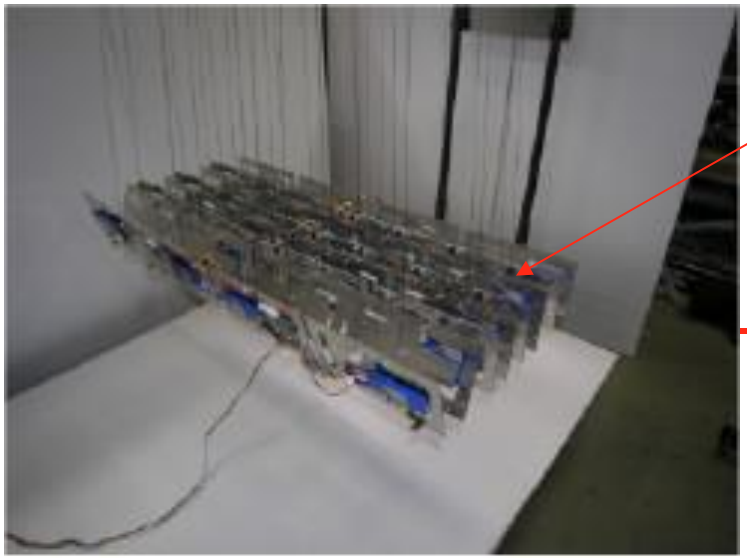


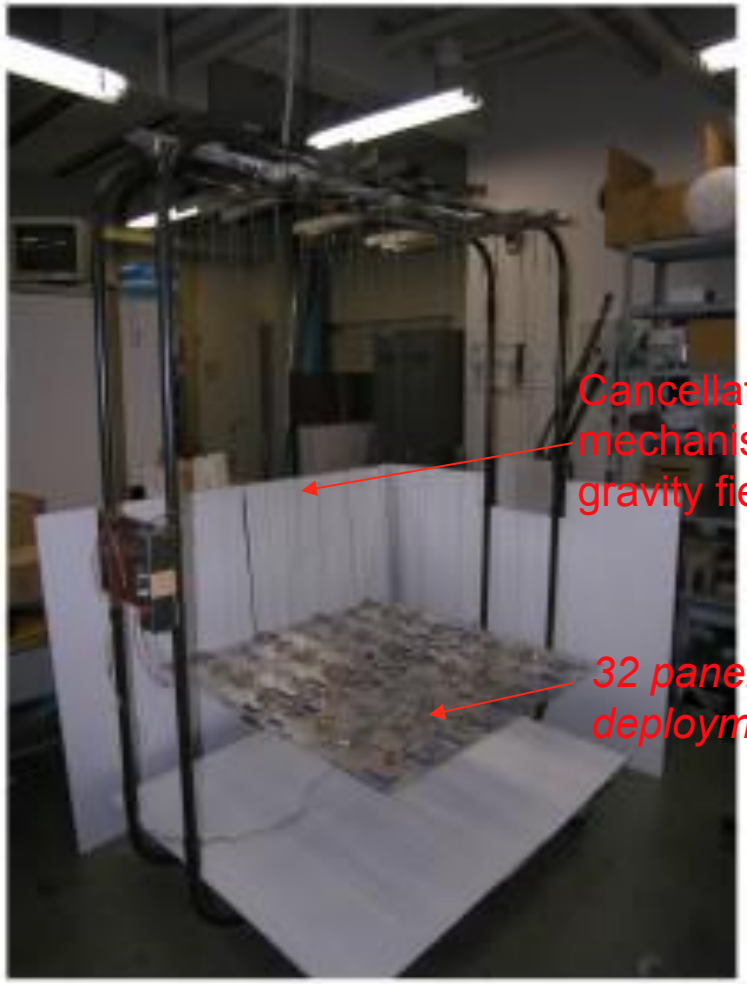
simple deployment scenario
a large number of actuators

Deployment Test using SMA (Shape Memory Alloy) Actuators



Actuator using shape memory alloy coils

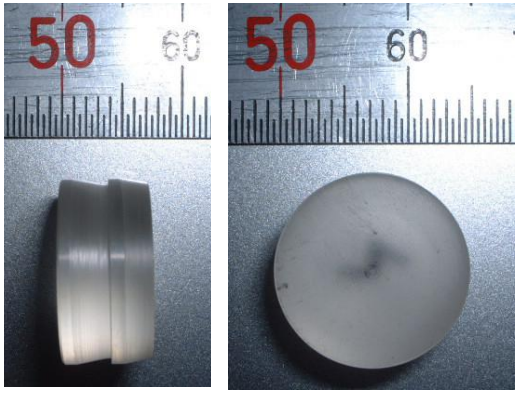




potential candidate for the actuators of the large panel

Rail-gun Facility to Study Debris Impact on Power Generation/Transmission Panel

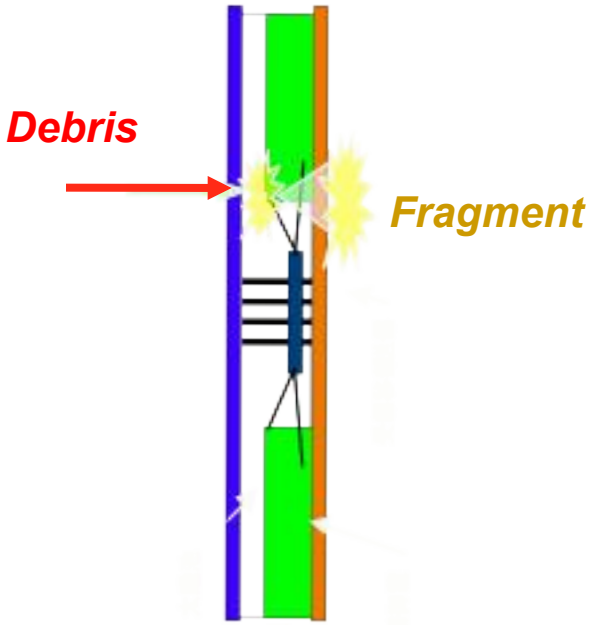
Rail-gun Facility at ISAS/JAXA



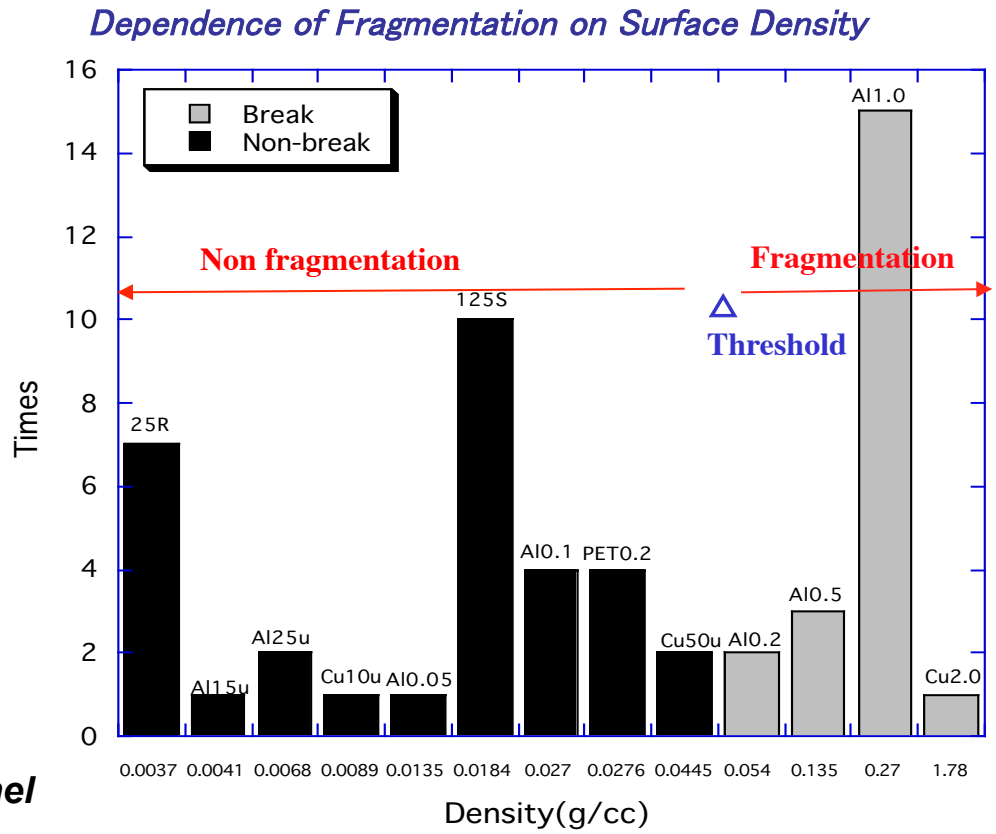
Projectile

Impact on Thin Plate Target

Fragmentation of Projectile



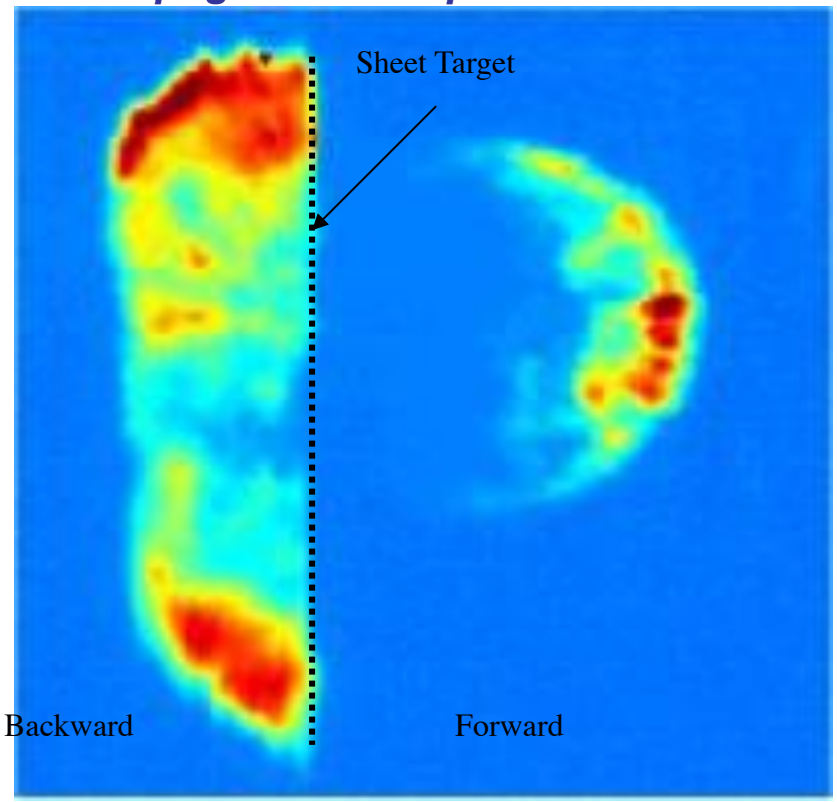
Power Generation/Transmission Panel



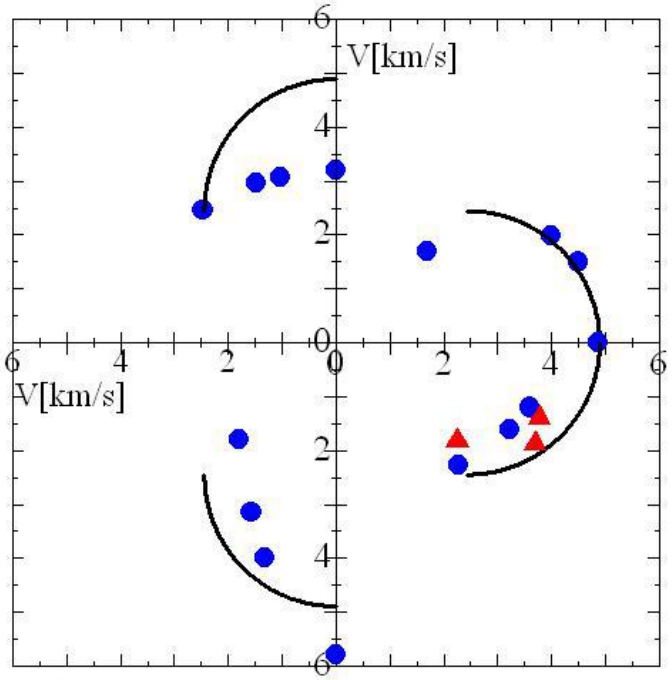
depending on debris size, velocity impact data to be used for design of panel structure

Propagation of Impact Plasma

Propagation of Impact Plasma

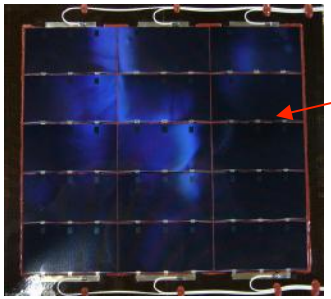


Velocity Vector

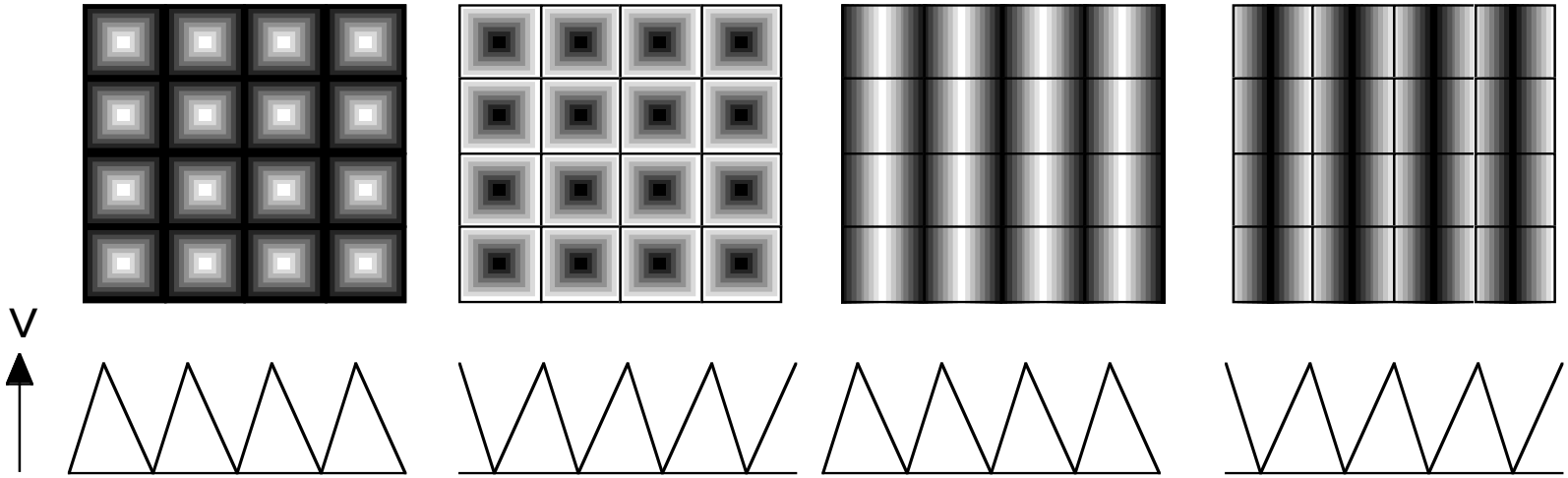


plasma propagation data to be used for design of solar array

Discharge Resistant Solar Array



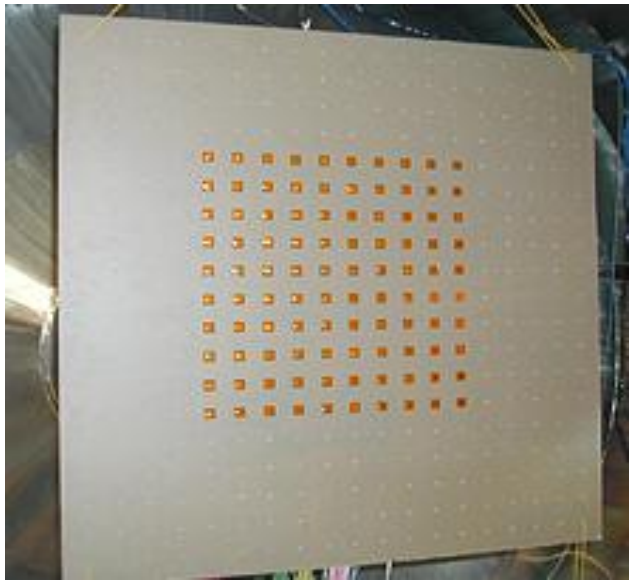
inter-connection
exposed to space environment



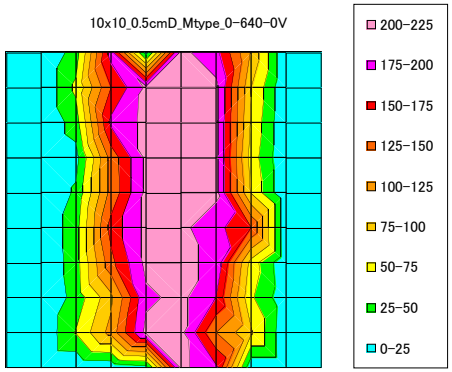
4 typical design option for array distribution (voltage distribution)

Simulation Experiment on Solar Array/Plasma Interaction

Diameter : 2.5m Length : 5m
Achievement degree of vacuum : 1×10^{-5}Pa
Plasma density : $10^{3}\sim10^{6}cm^{-3}$
Back-diffusion type discharge plasma source

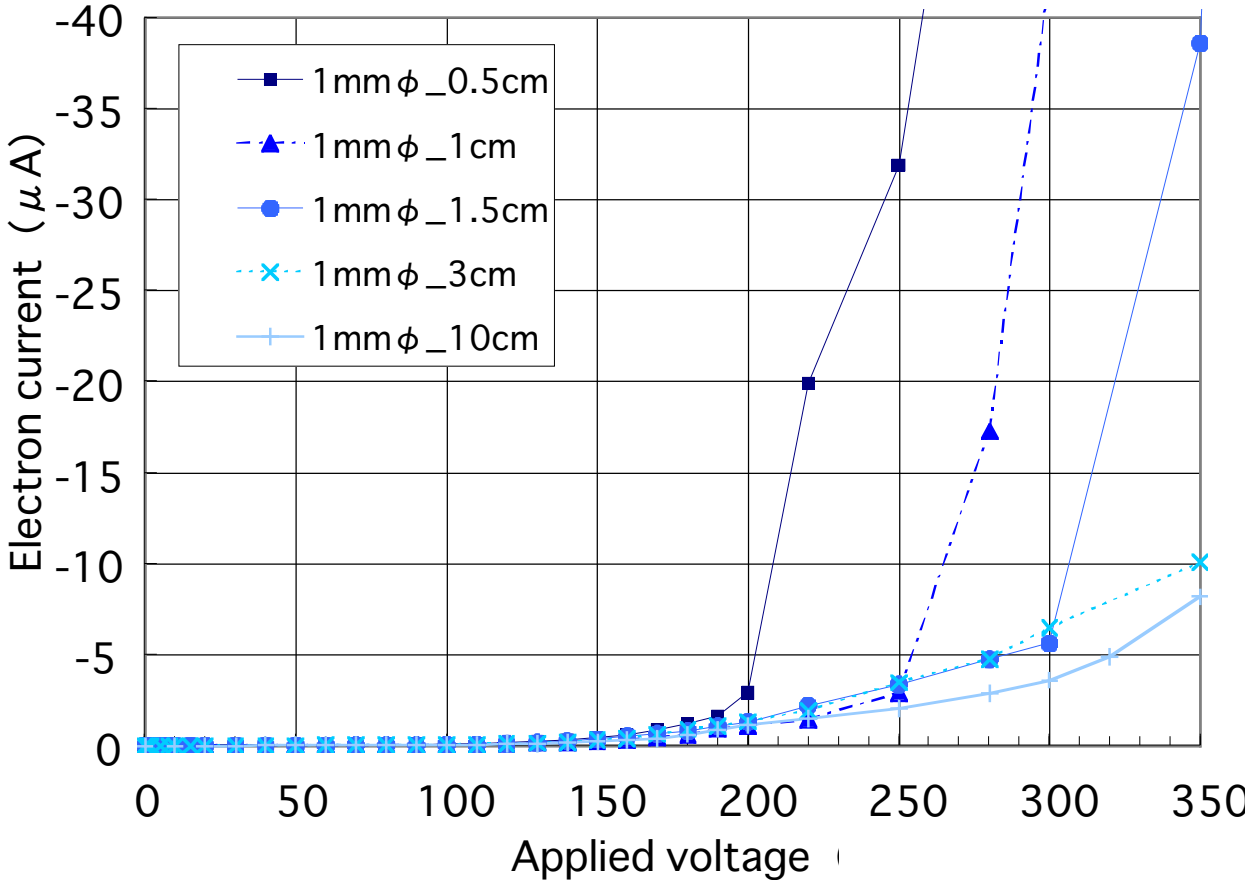


Solar Array Simulator (Multi-electrode panel)



Example of Current Collection

Dependence of Array Current on Electrode Configuration



array current data to be used for design of solar array

Summary and Conclusion

- The construction scenario has been generated based on the future but feasible technologies.
- The power generation/ transmission panel was designed and tested partly to demonstrate the electrical performance.
- The method to deploy the panel in two dimensions was tested using miniature panels with SMA actuators.
- The results obtained in the laboratory experiments on the hyper-velocity impact and solar array-plasma interaction are used to establish the design guidelines for the power generation/transmission panel.
- These engineering and environmental studies have increased the technical readiness for the Tethered-SPS.