Future Space Solar Power

An Introduction to the Vision

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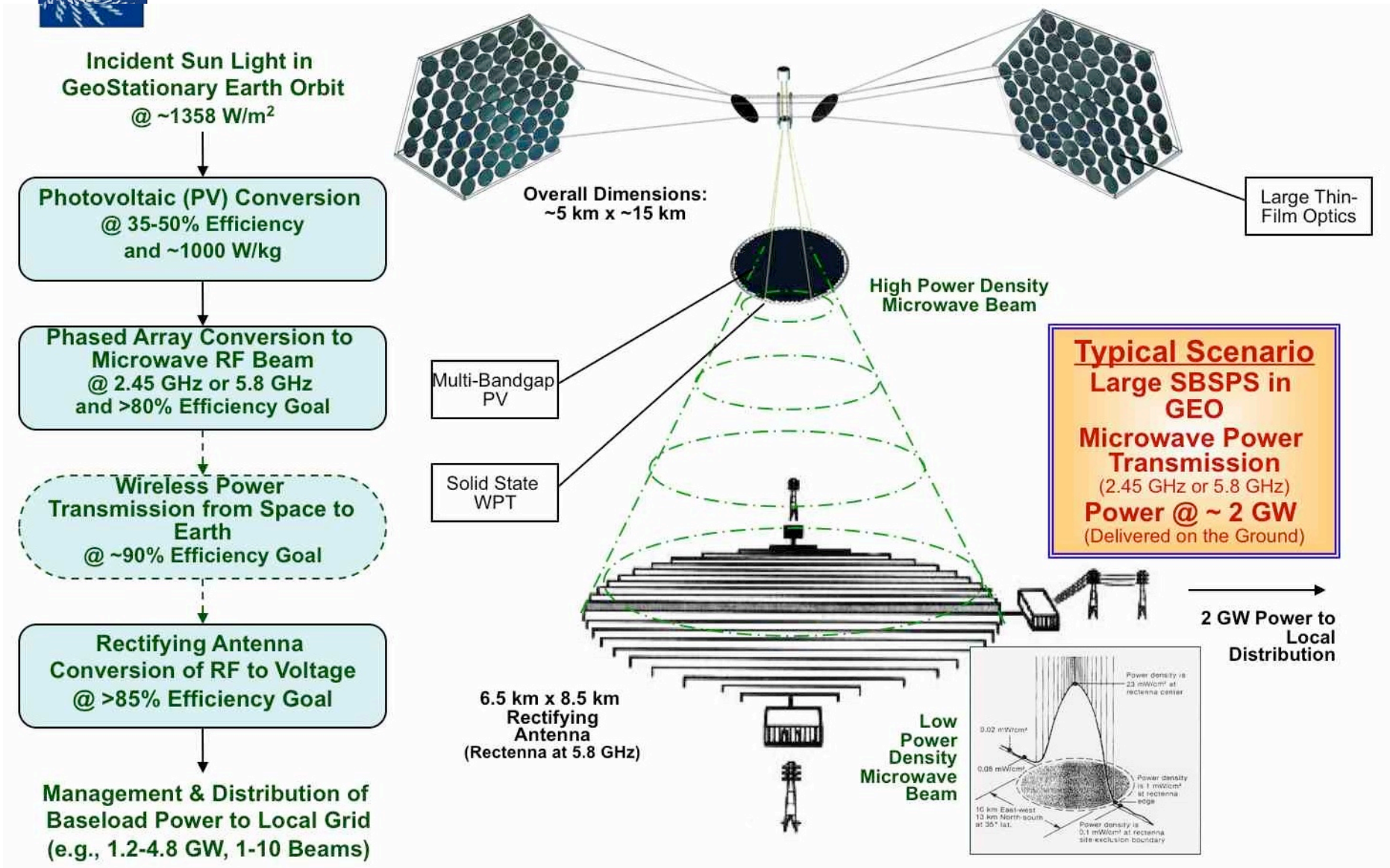
Space Solar Power: from the 1970's to Today
What Has Changed?

1979	**2009**
• Solar Power Generation – Efficiency @ ~ 10%	• Solar Power Generation – Efficiency @ ~ 40%, going to 50%
• Wireless Power Transmission – Solid State Amplifiers, with Efficiency @ ~ 20% – Mechanical Pointing, 200 meter gimbal carrying 7 GW to 1 km array	• Wireless Power Transmission – Solid State Amplifiers, with Efficiency @ ~ 80 - 90% – Electronic Beam Steering, with no mechanical gimbal
• SSPS Power Management Req'ts – Voltages @ ~ 50,000 Volts	• SSPS Power Management Req'ts – Voltages @ < 1,000 Volts
• SSPS Space Launch Req'ts – Unique Reusable Heavy Lift, with payloads @ 250 tons	• SSPS Space Launch Req'ts – Any Commercial Launcher, with payloads @ ~ 25 tons
• Space Robotics – Degrees of Freedom @ ~ 3 – Control ~ Programmed/ Teleoperated	• Space Robotics – Degrees of Freedom @ ~ 30++ – Control ~ Autonomous/ Telesupervised
• Space Assembly – 100's of Astronauts – Large Space Factory Required in GEO	• Space Assembly – No Astronauts – No Space Factory Required

End-to-End Solar Power Satellite Scenario



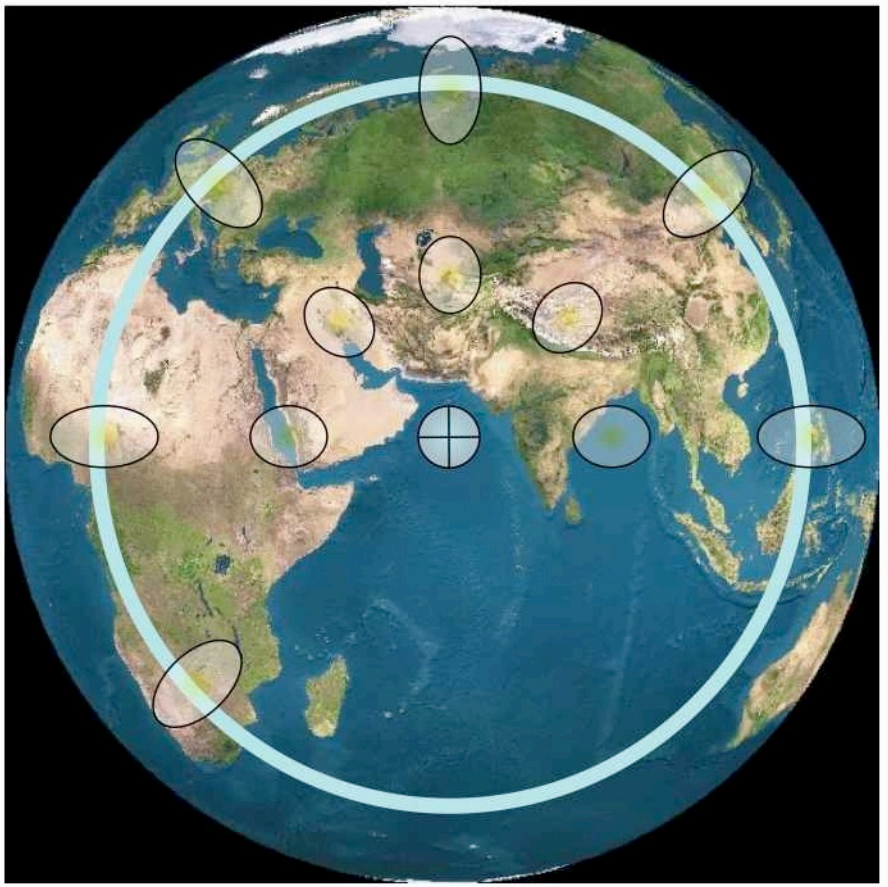
"Dispatchable" SPS Power

Global Context: Multiple Locations Possible

From GEO, a single SPS (with electronic beam Steering), could dispatch energy to a wide variety of locations – including multiple countries and continents…

Limitations include…

- Scanning angle losses at the transmitter
- Cosine limits at the receiver
- Increasing Atmospheric attenuation / Air Traffic issues



At Center of Addressable Earth

Circle / D = 10 km (2.45 GHz)

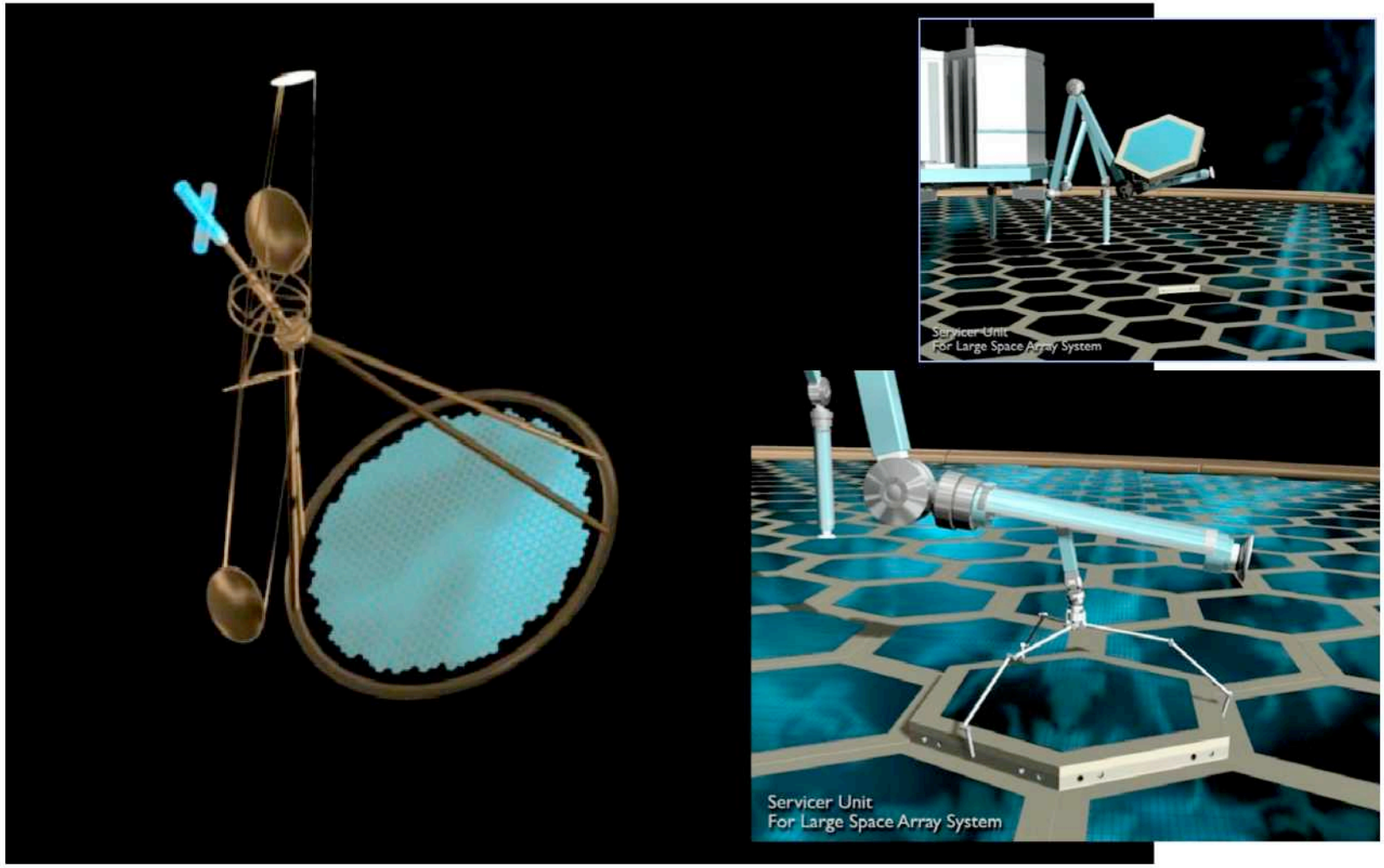
Circle / D = 4.2 km (5.8 GHz)

At Edge of Addressable Earth

Ellipse / 10 km x 20 km (2.45 GHz)

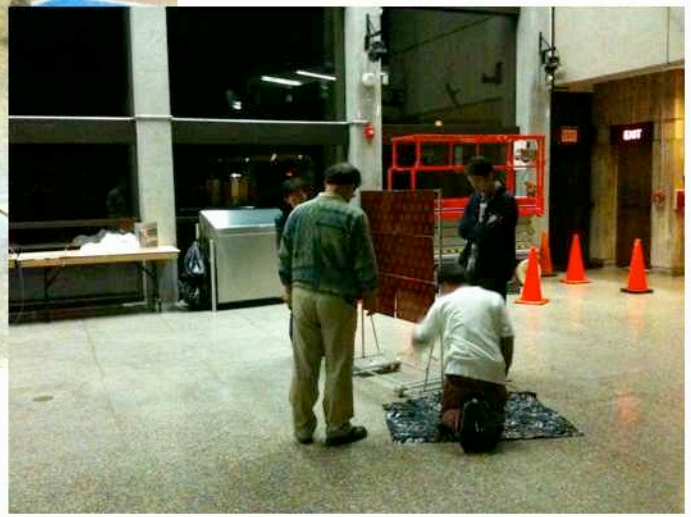
Ellipse / 4.2 km x 8.4 km (5.8 GHz)

Integrated Symmetrical/Modular SPS



Recent SSP Progress: 2008
Wireless Power Transmission System Tests

Recent SSP Progress: 2009
"Next Generation" Wireless Power Transmission System



Summary Observations

- SPS have the potential to deliver power for commercial and/or government operations within wide regions on Earth; for example…
  - A 100 MW-class prototype SPS could deliver power in the 1-10 MW range to several locations
  - A 2,000 MW-class full-scale SPS could deliver commercial baseload power
- SPS physics is well-established: no breakthroughs are required to achieve technical feasibility…
  - However, new technologies must be developed and demonstrated in to establish the economic viability of SPS
- Now, end-to-end systems studies are needed (coupled with focused technology research and development projects)
  - Goals: Determine SPS figures of merit; conduct technology readiness and risk assessments; define technology roadmaps; and define in detail systems demonstrations that must be implemented….

Back-Up Charts

SSP Historical Background
1970s SPS Studies & "Reference System"

- In the mid 1970s, a major ERDA (pre-DOE) and NASA Study effort had been initiated
- A primary result was the colossal "1979 SPS Reference System" and an aggressive plan for SSPS development and deployment
- The results received very negative reviews from the NRC and the Congressional OTA…