



# Summary of MSFC Space Solar Power Activities

September 10, 2002

**Joe T. Howell**

Marshall Space Flight Center

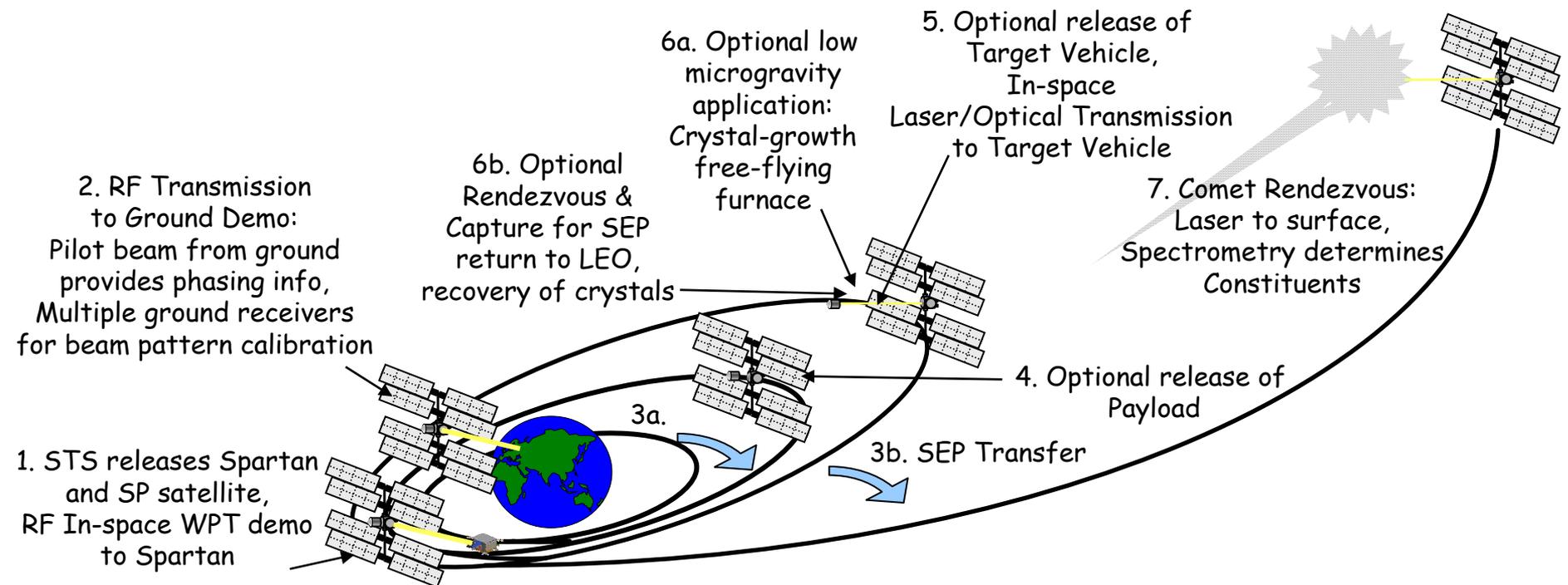
Flight Projects Directorate

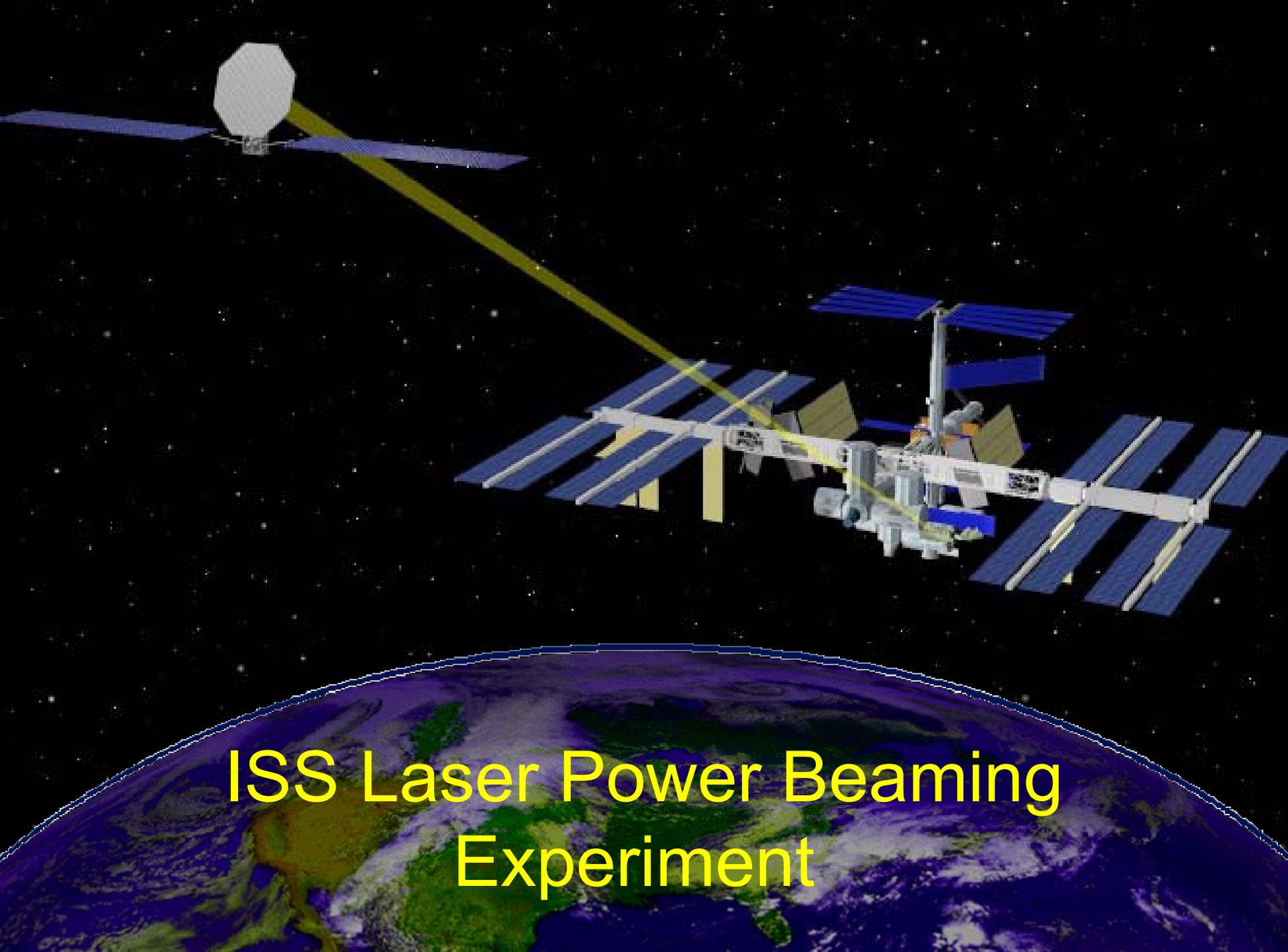
256-961-7566

[joe.howell@msfc.nasa.gov](mailto:joe.howell@msfc.nasa.gov)

# TFD Mission Scenario Options

- 100 kW Technology Demonstrator could perform a variety of mission scenarios
- TFD provides an energy-rich platform for a variety of technology experiments

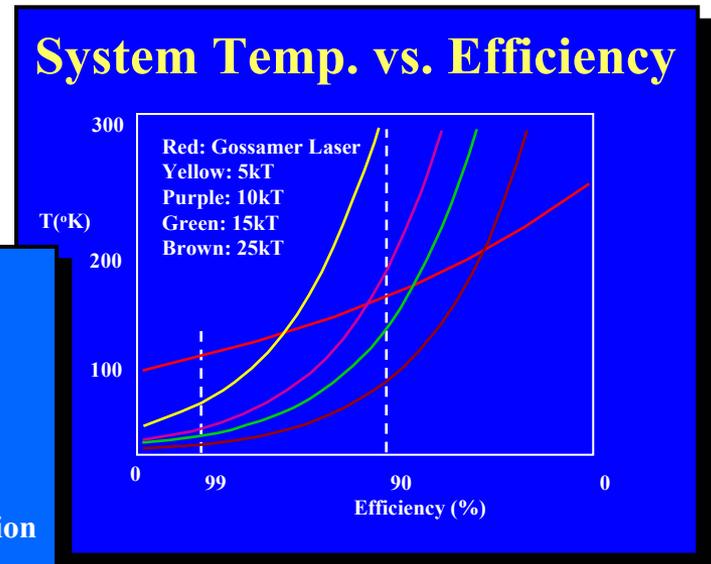
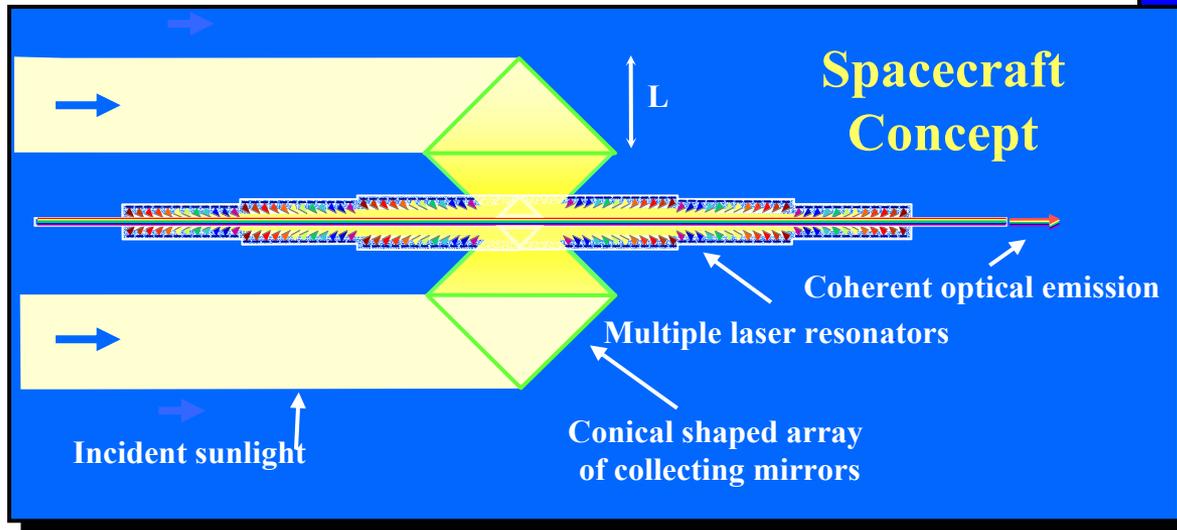




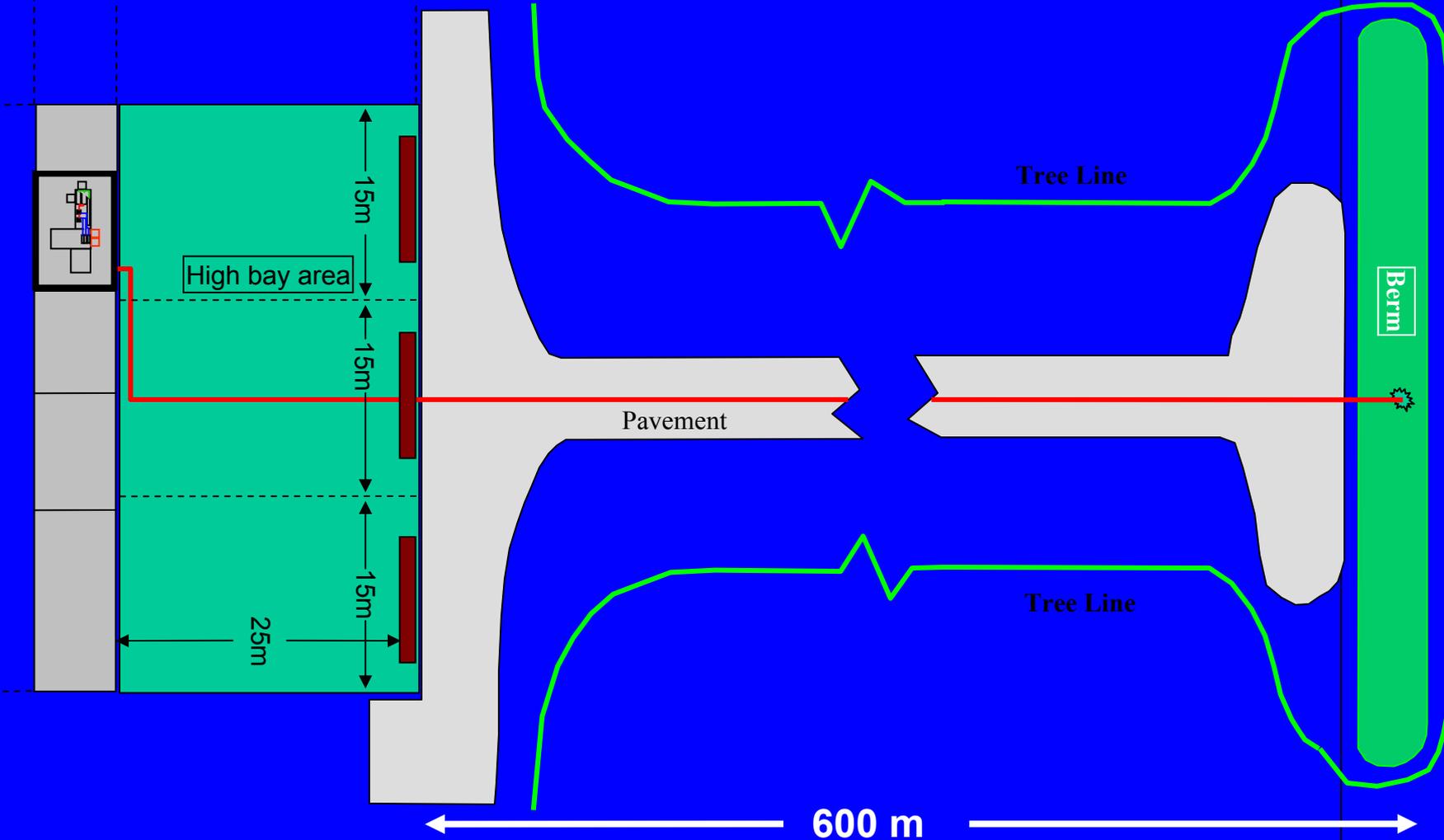
# ISS Laser Power Beaming Experiment

# Laser Power Transmission And High Energy Laser R&D

- UAH's Dr. Richard Fork is developing proof-of-concepts for high-efficiency laser power transmission directly from sunlight
- FD02 is collaborating with UAH and SMDC on the synergistic development of a surface high energy laser for DoD applications

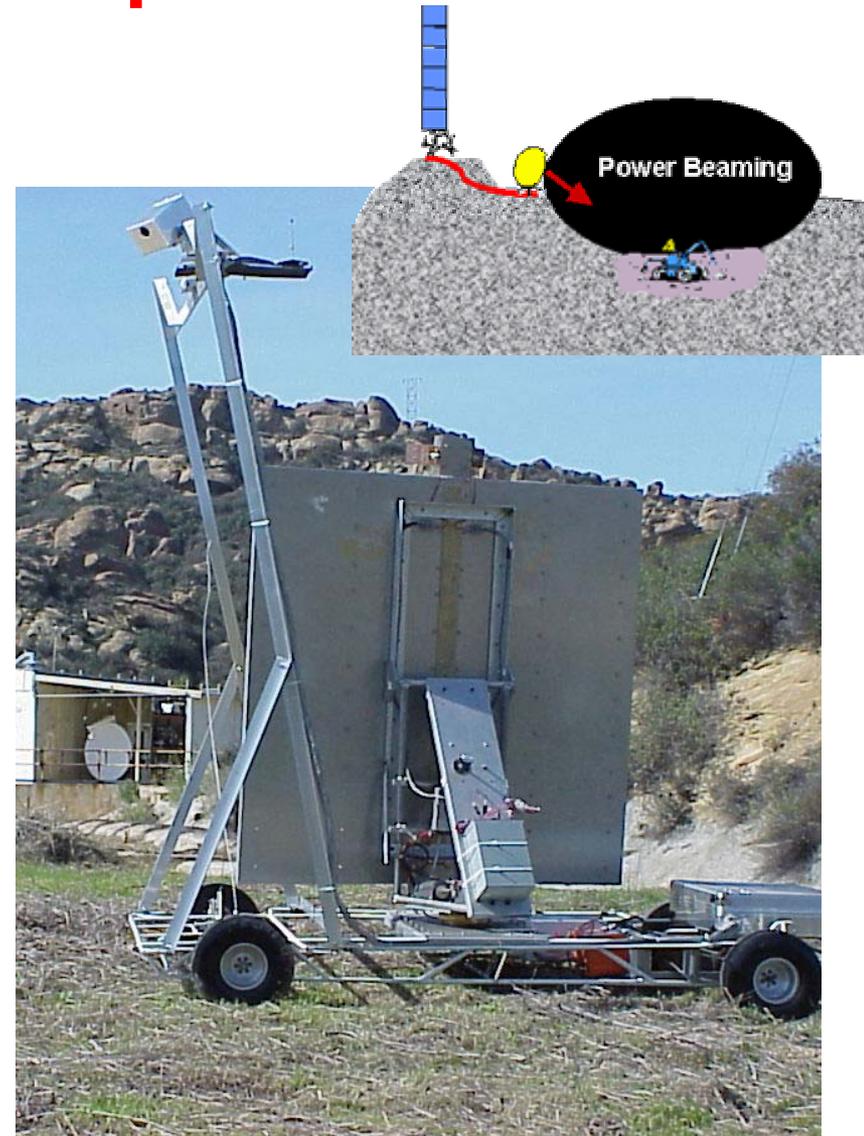


# Integrated Laser Laboratory and Outdoor Range



# Technology Demonstration for Lunar Polar Exploration

- Developed a mission scenario to explore a permanently shadowed crater on the moon in search of water for scientific and commercial development purposes
- Remotely operated the Lunar Rover Technology Demonstrator via the internet during MSFC Open House
- Performed Wireless Power Transmission (WPT) over a distance of 100 feet and heated water during the Lunar Rover Technology Demonstrator testing

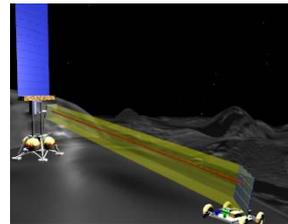


Beamed Power Lunar Rover Technology Demonstrator

# Lunar Polar SSP Technology Demonstration

## Objectives of Current Activities

- \*Advance the state of the art in laser-photovoltaic wireless power transmission by initial terrestrial demonstrations
- \*Obtain and test a laser power transmitter with a photovoltaic receiver
- \*Perform bench-top testing of an experimental system
- \*Measure overall system efficiency (power out / power in).
- \*Assess WPT efficiency variations in response to beam intensity and laser spot size
- \*Test laser power transmission over short and intermediate ranges
- \*Use a small PV-powered rover as a target
- \*Outline plans for future long-range system testing (10 to 100 km WPT distances)
- \*Perform education and public outreach

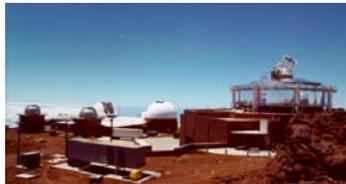


# Lunar Polar SSP Technology

## Ground and Flight Demonstration

### Laser-Photovoltaic Wireless Power Transmission Ground Demo :

- NASA-Boeing-AFRL cooperation considered for laser testing
- Japanese participation considered for rover targets
- Experimental Transmitter obtained from Harvey Mudd College
- Experimental Receiver obtained from Univ. Colorado-Boulder
- Bench-top tests performed up to 4 Watts at AFRL AMOS facilities
- WPT test planning has reviewed site safety, access, public outreach



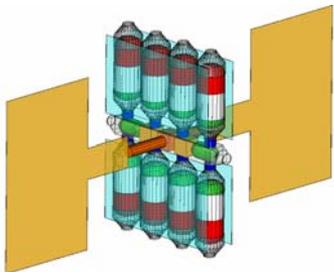
AFRL Directed Energy Research Facility  
Air Force Maui Optical & Supercomputing Site (AMOS)

# In-Space Cryogenic Propellant Depots

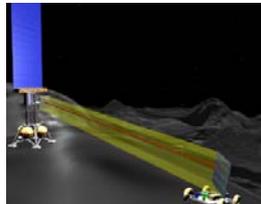
## Study Background and Objectives

### Study Background

- **NASA/MSFC and Boeing are assessing In-Space Cryogenic Propellant Production Depot options**
- **Current activity leverages previous MSFC/Boeing Propellant Depot activities and LaRC and JSC activities**
- **Large quantities of hydrogen discovered on lunar poles believed to be in the form of water (ice)**
- **Additional volatiles may be available at lunar poles**



In-Space Cryogenic  
Propellant Depot  
MSFC/Boeing Activity



Lunar Polar Applications  
MSFC/Boeing Activity



Earth-Moon L1 Gateway  
JSC Activity



Hybrid Propellant Module  
LaRC Activity

### Study Objectives

- **Define Propellant Production Depot system requirements**
- **Study Propellant Production Depot location options**
- **Define Propellant Production Depot design concept**
  - **Conceptualize supporting infrastructure elements**
- **Trade options for Lunar ice processing**
  - **Assess collecting different volatiles**
- **Identify technology requirements for ground and flight demonstration**

# The Virtual Research Center

- **A Web based Project Management Environment**

- Fifth Year of Operation
- Over 5,000 registered users
- Managing over 40,000 files
- Security measures include:
  - Passwords
  - Data Encryption
  - Firewalls
  - Virtual Private Network (VPN)

- **VRC Tools Include**

- Calendar
- Action Item Tracker
- File Management System
- Search Engine
- Topic Discussion Tool
- Team Directory
- Activity Reports



## Recent Accomplishments

- Incorporated new collaborative functions such as a bulletin board for posting articles, polls to enable teams to vote on approaches, and an instant messaging system
- Working with the MSFC Information Service Department (ISD) to implement a Virtual Private Network (VPN) for the user community

# Solar Power Satellites

Affordable clean energy was ranked as a No.2 global need in a recent Global Foresight workshop.

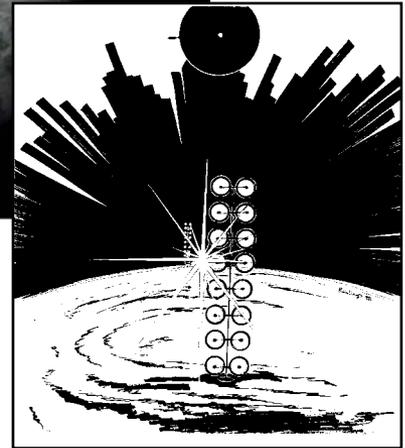
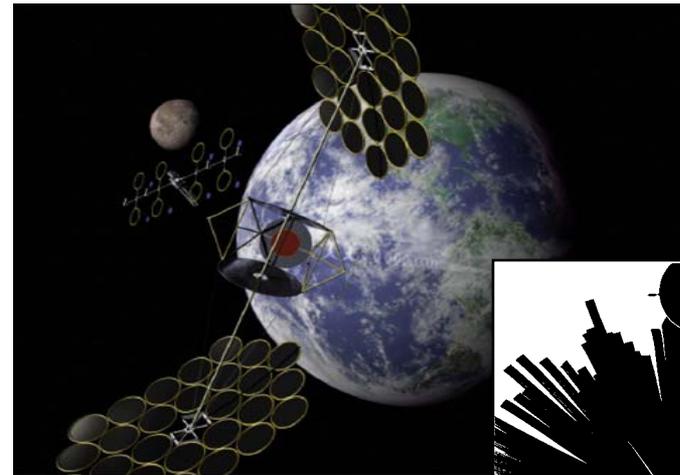
## ISS Heritage for Solar Power Satellite Demonstrations:

- Robotic Systems
- Structures
- Power Systems
- Control Systems

## Engineering Demonstrations at ISS

- Wireless power transfer
- Advanced solar arrays
- Advanced high power management systems
- Ground Operations

## Could lead to Advanced Solar Arrays for ISS



**Solar Power Satellite.** A large solar power satellite in geosynchronous orbit beams power to Earth for distribution through terrestrial power grids. (Concepts from 2000 SERT Studies)