Unbundling Space Power Systems to foster applications of Space-to-Space Power Beaming

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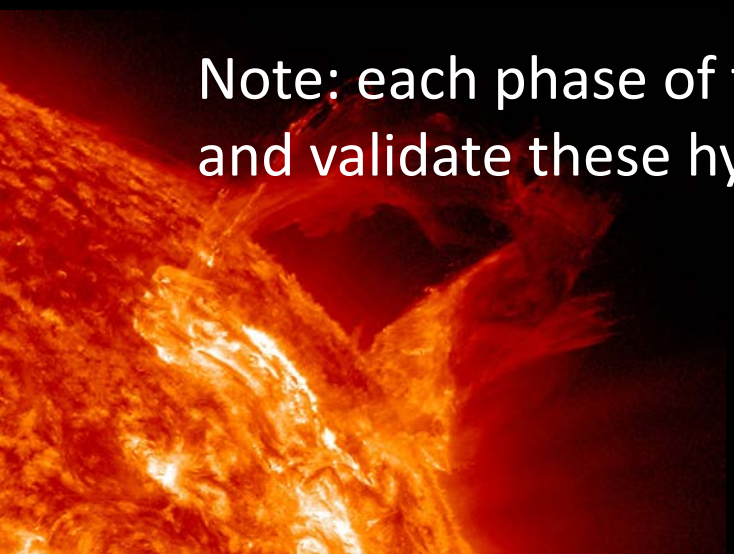
Outline

- The Problem Addressed . . .
- The Solution Proposed . . .
- Possible Applications
- Conclusions . . .

The Problem Addressed . . .

It is hypothesized that unbundling power systems (i.e., the separation of power generation, transmission, control, and loads) can:
(1) reduce spacecraft complexity,
(2) reduce/reallocate mass and/or volume,
(3) impart delta-V along velocity vectors of choice, and
(4) foster the development of loosely coupled modular structures / distributed infrastructure.

Note: each phase of the proposed work will reexamine and validate these hypotheses.



The Solution Proposed - 1

Space-to-space power beaming is an application of Space Solar Power technology which could:

1. be tested/implemented now to immediate benefit, and
2. serve as a means of incrementally maturing the technology base.

The Solution Proposed - 2

This presentation describes a technology development mission proposed for the International Space Station (ISS) which:

1. leverages available resources to serve as a testbed,
2. simultaneously supports payload experiments, and
3. serves to help mitigate perceived cost, schedule, and technical risk associated with the use of Space Solar Power.

The work described has been proposed as part of a draft Space Act Umbrella Agreement Annex under negotiation between NASA and XISP-Inc.

The Solution Proposed - 3

This experiment is an opportunity to craft viable technology demonstrations that will establish the basis for a confluence of interest between real mission users and the space-to-space power beaming technology development effort.

This can lead to a range of technology development missions on ISS and subsequent flight opportunities that can make efficient and effective use of beamed energy to support:

- sustained operations,
- directly and/or indirectly augmented propulsion, and
- loosely coupled modular structures.

The Solution Proposed – 4

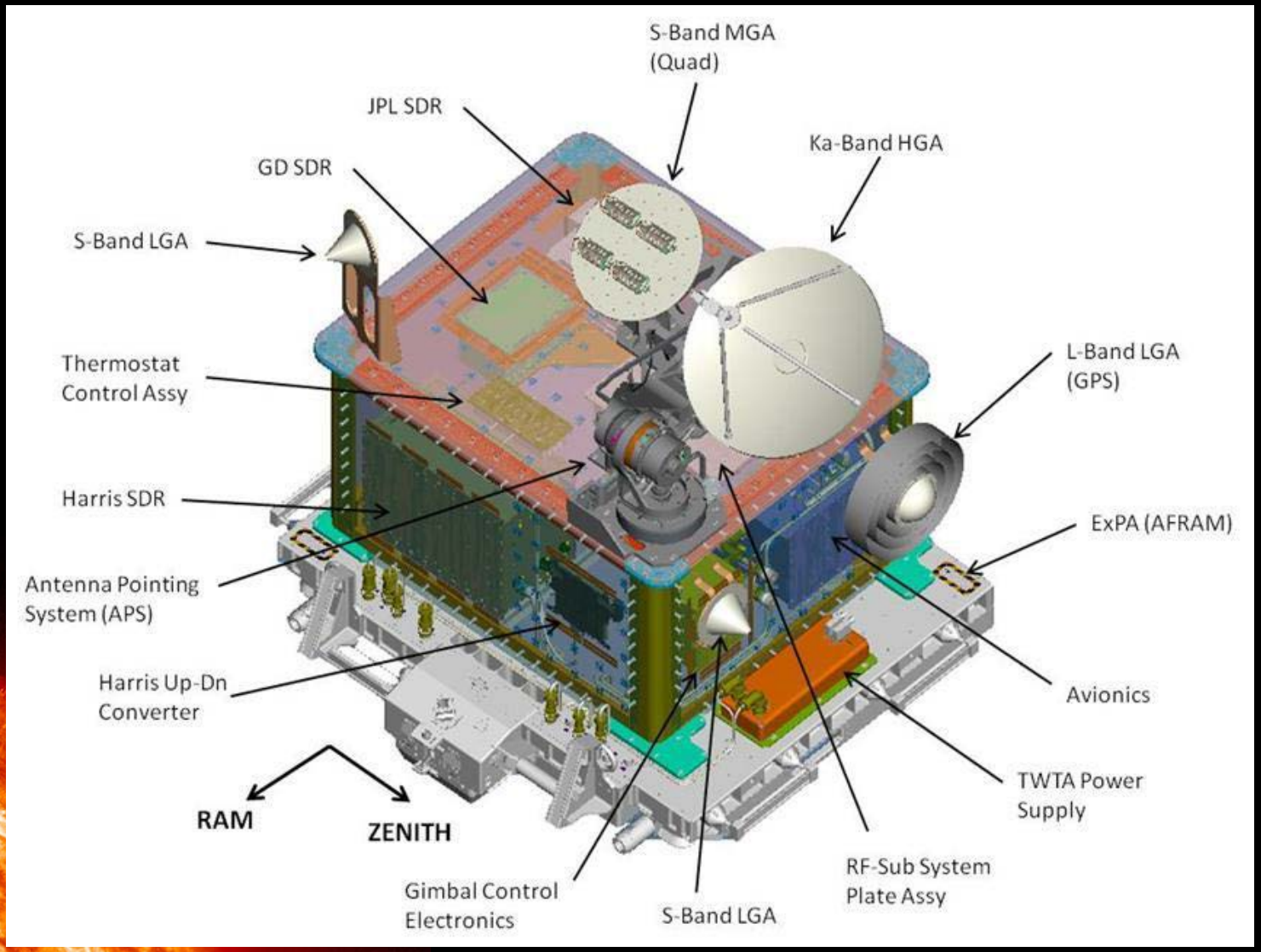
Experiment Objectives

(1) demonstrate space-to-space power beaming by powering multiple co-orbiting (~200 m) cubesat sized (3 to 6 U) spacecraft using an International Space Station (ISS) based Ka-band transmitter on the Space Communications and Navigation (SCaN) Testbed.

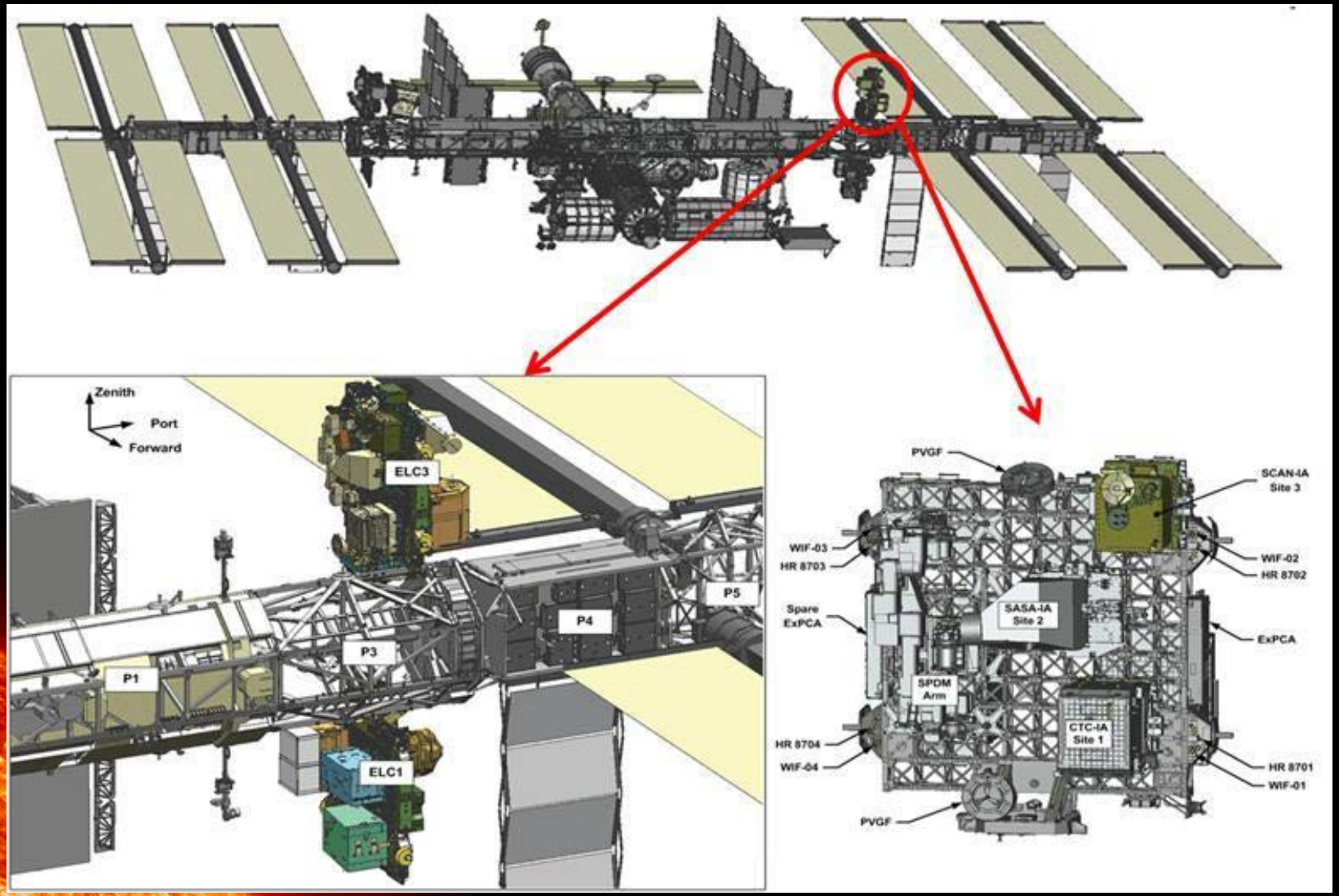
(2) demonstrate the successful characterization as well as the scaleable direct and indirect use of radiant energy “beam” components.

(3) reduce the cost, schedule, and technical risk associated with the use of the space solar power technology to better address the mission challenges for a new spacecraft and/or infrastructure.

ISS SCaN Testbed Components



ISS SCaN Testbed Location

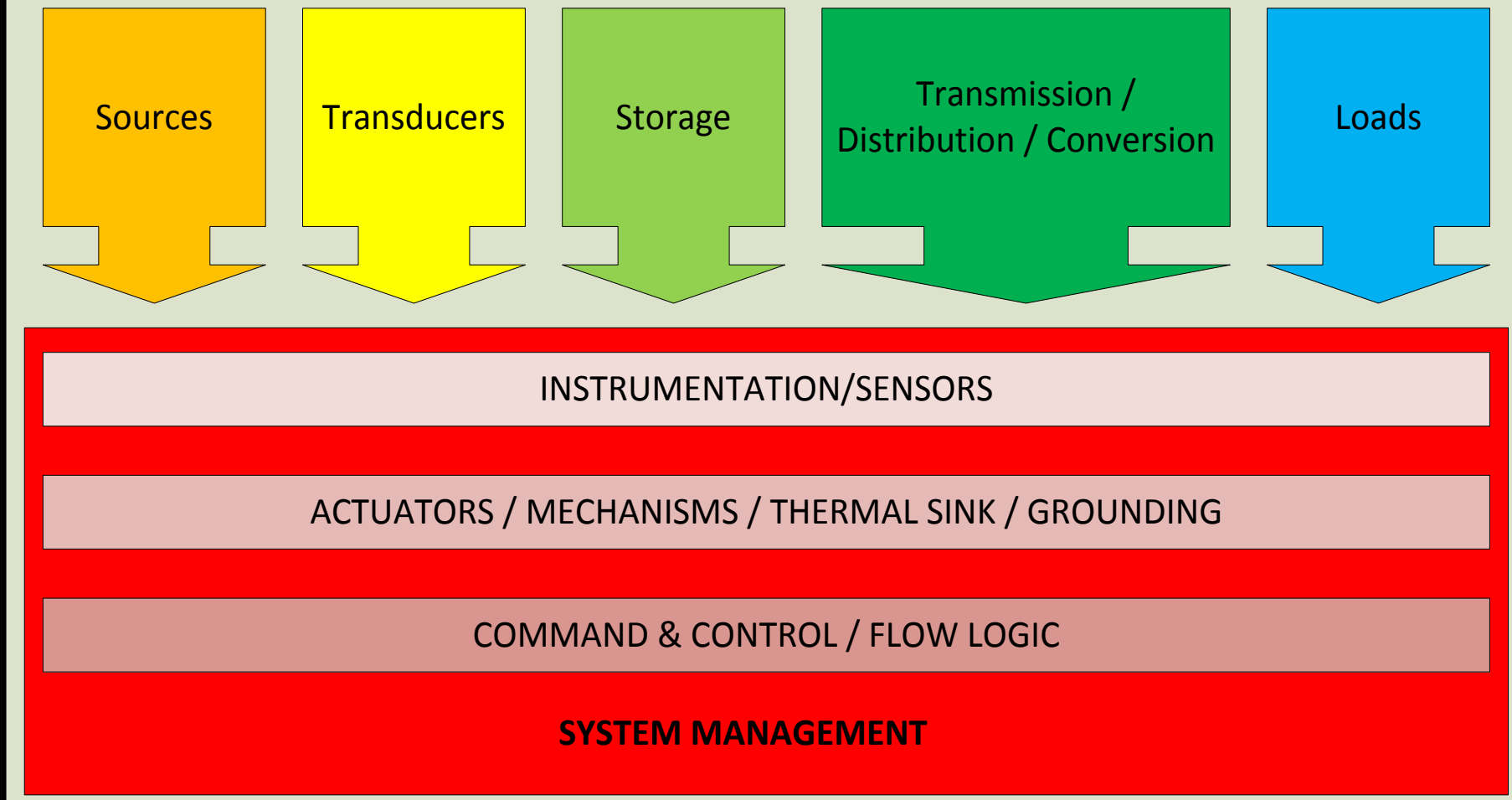


Experiment Procedure -1

The proposed experiment has three phases:

- Phase I is ground testbed work,
- Phase II is on-orbit SCaN Test Bed (STB) work with minimal augmentation and ISS / interoperating equipment interface requirements, and
- Phase III is on-orbit STB work with augmentation/optimization as needed to accommodate more extensive ISS / interoperating equipment interface requirements.

Power System Block Diagram



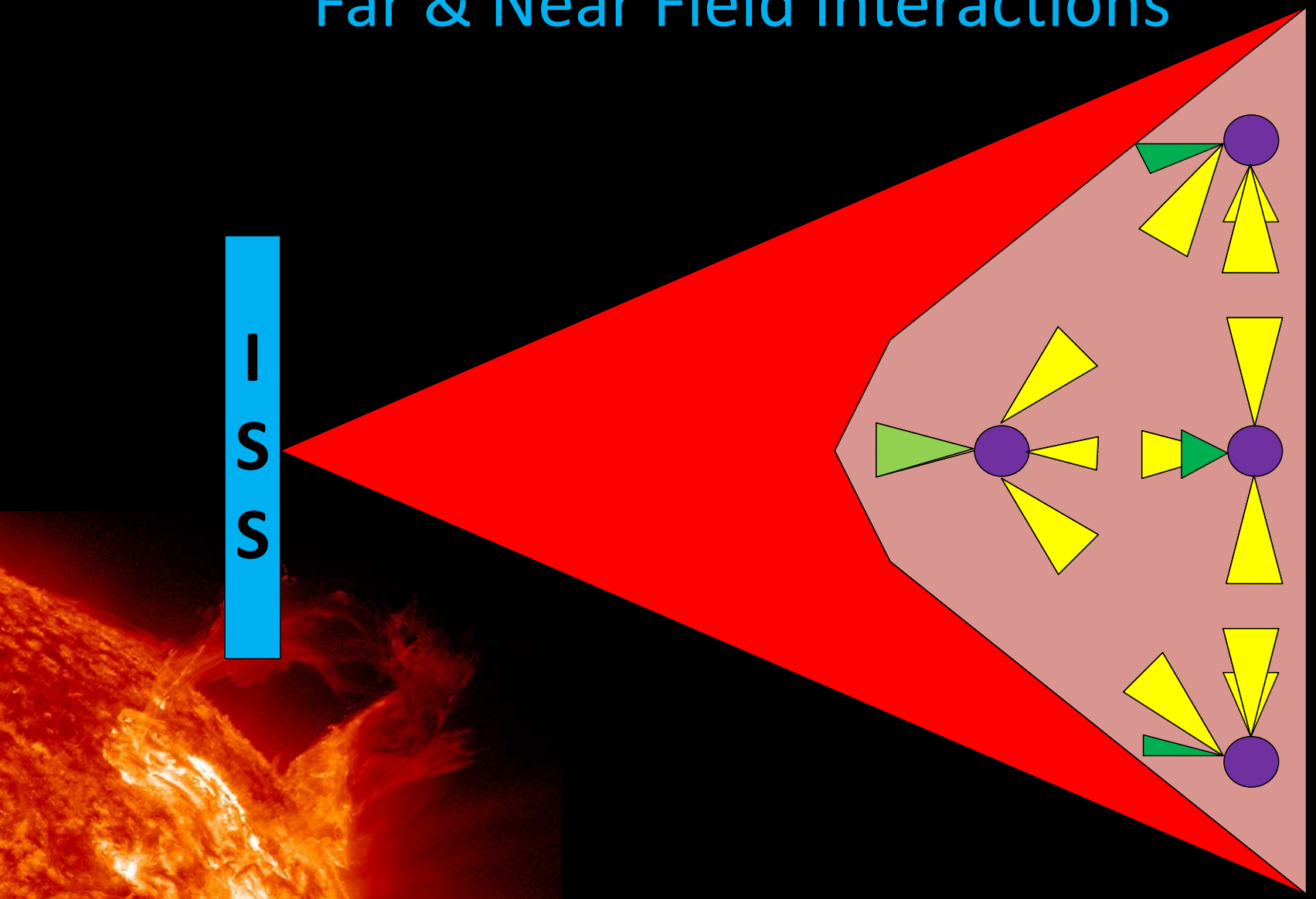
Mathematics of Power Beaming* - Efficiency

DC to Microwave Conversion	Beam Forming Antenna	Free Space Transmission	Reception Conversion to DC
Circa 1992 70 – 90 %	Circa 1992 70 – 97 %	Circa 1992 5 – 95 %	Circa 1992 85 – 92 %

Maximum Possible DC to DC Efficiency --- 76 %
Experimental DC to DC Efficiency --- 54 %
Circa 1992

*William C. Brown, Life Fellow, IEEE, and E. Eugene Eves, Beamed Microwave Power Transmission and its Application to Space, IEEE Transactions On Microwave Theory and Techniques, Vol. 40, No. 6. June 1992

Beam to Tetrahedral Formation
Far & Near Field Interactions



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Conclusion

Successful demonstration of space solar power beaming helps pave the way for it's use in a range of space-to-space, and space-to-lunar/infrastructure surface applications by reducing the perceived cost, schedule, and technical risk of the technology.

Commercial space applications include mission enhancing and/or mission enabling expansion of operational mission time/capabilities, enhanced spacecraft/infrastructure design flexibility as well as out-bound orbital trajectory insertion propulsion.