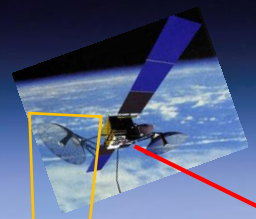
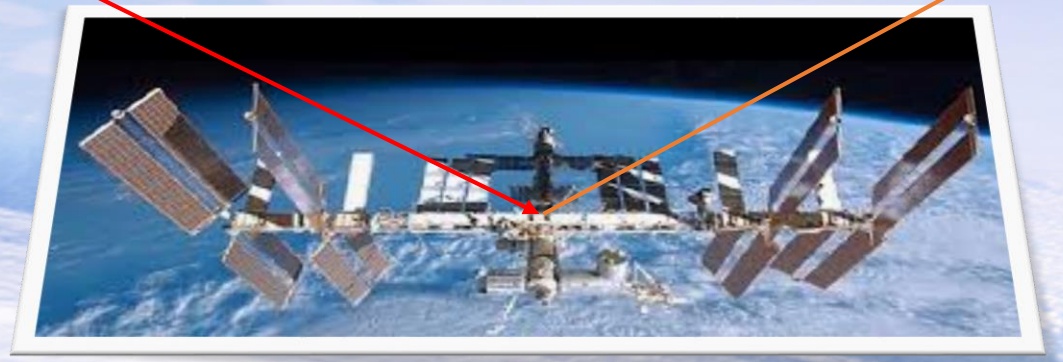
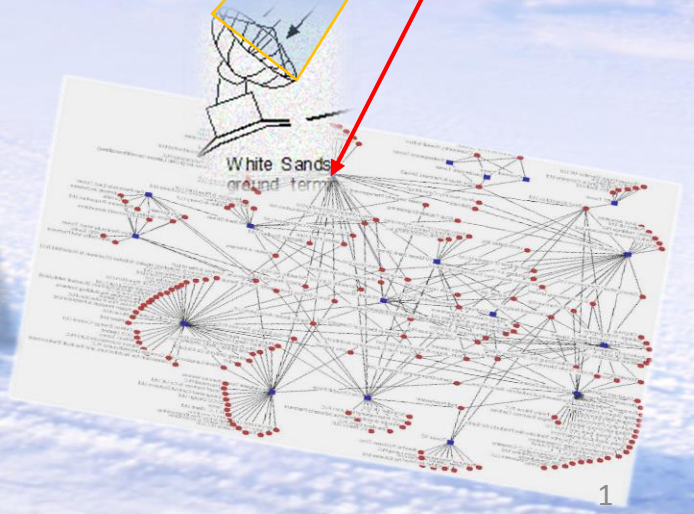
ISS As A Laser Pointing Development Testbed





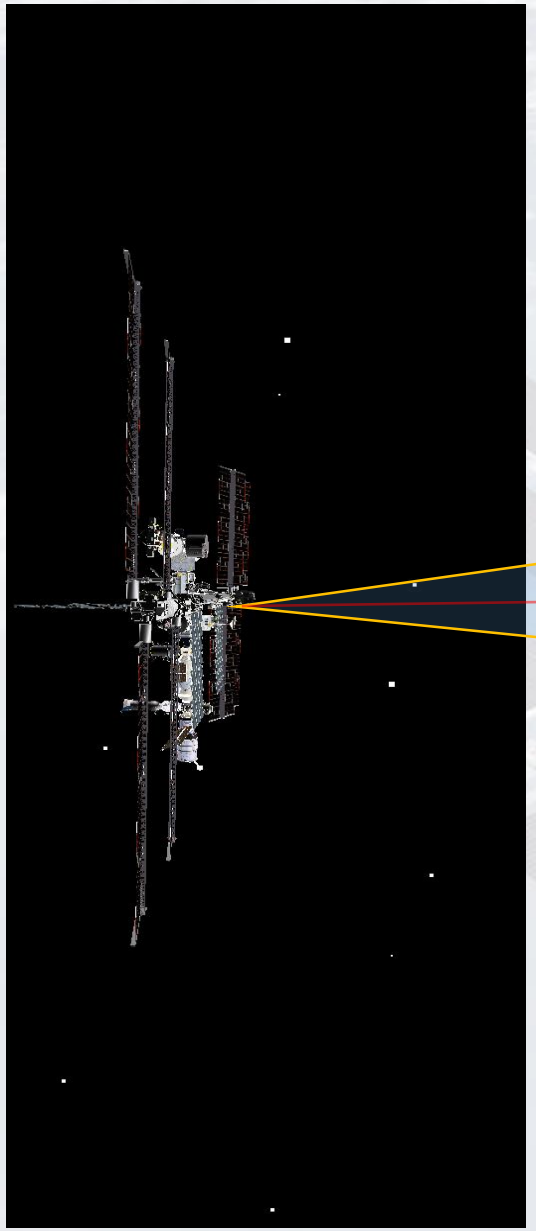


NASA/JSC/CI2/Dan Jackson
July, 2017

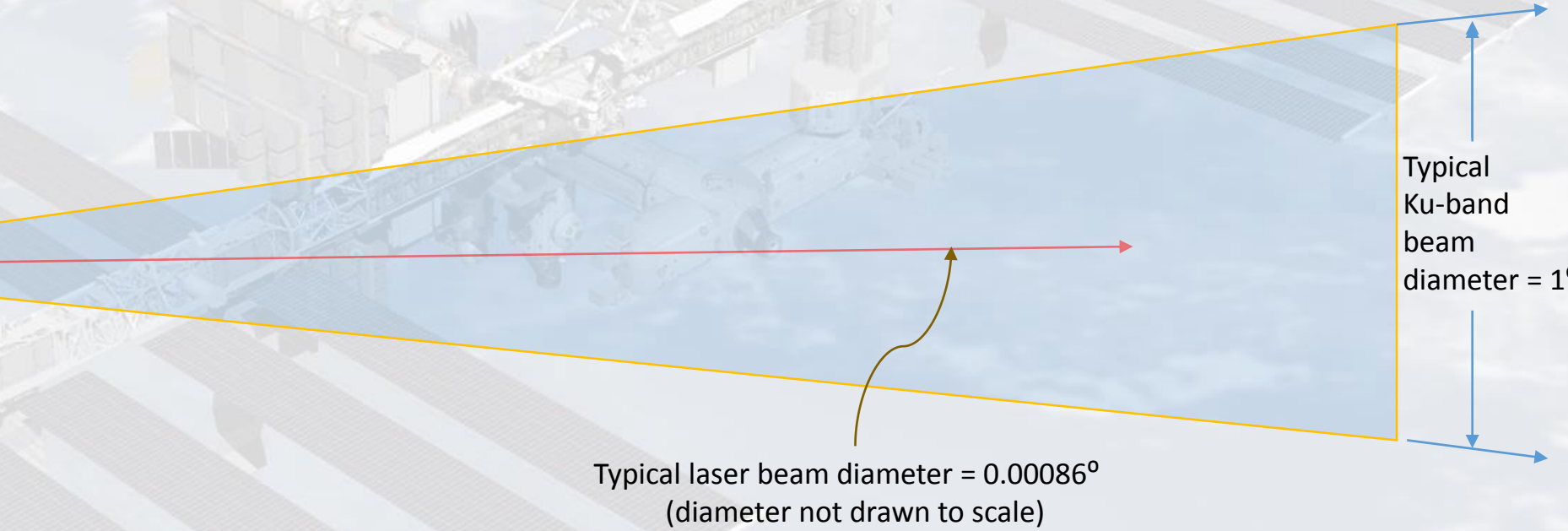
The ISS is the Only Real-World Analog for Future Human Deep-Space Exploration Programs

- Large multi-national crew capable of applying lessons-learned during laser comm system prototyping.
- Two operational basebands that are multiplexed to drive a laser communications system. (Could soon double.)
- Large articulating spacecraft components for generating power and thermal control.
- Structural vibrations representative of the kind that could be expected during a planetary exploration mission.
- Highly dynamic attitude timeline placing great demand on guidance and navigation's state knowledge.

Laser Communications Systems Impose a Great Demand on Pointing Accuracy



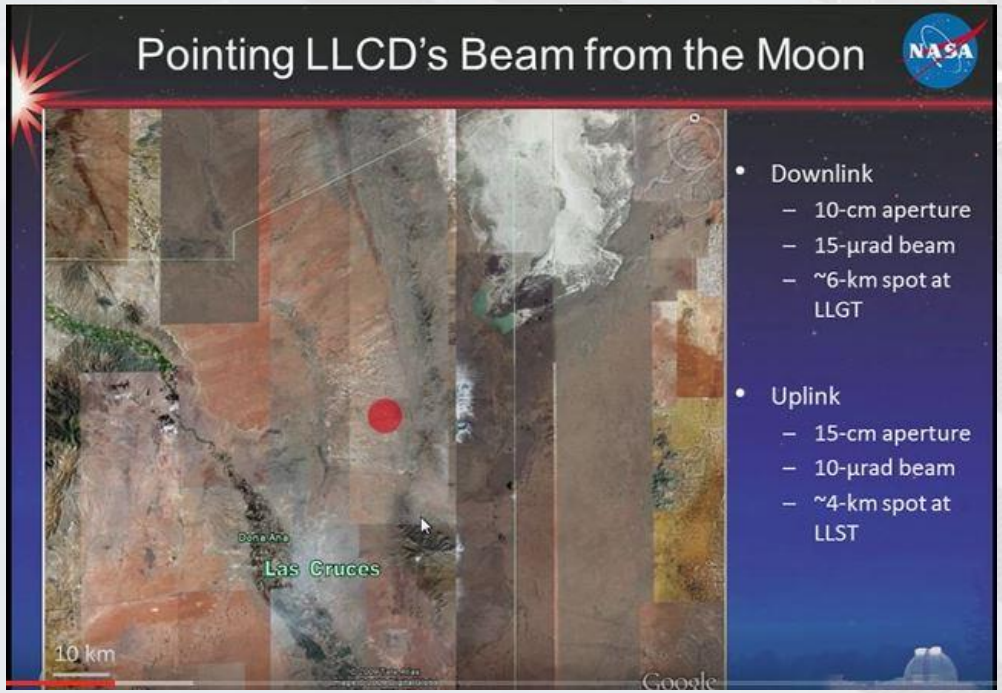
Current ISS attitude/state knowledge would have to improve by more than 1000 times to support laser communications requirements.



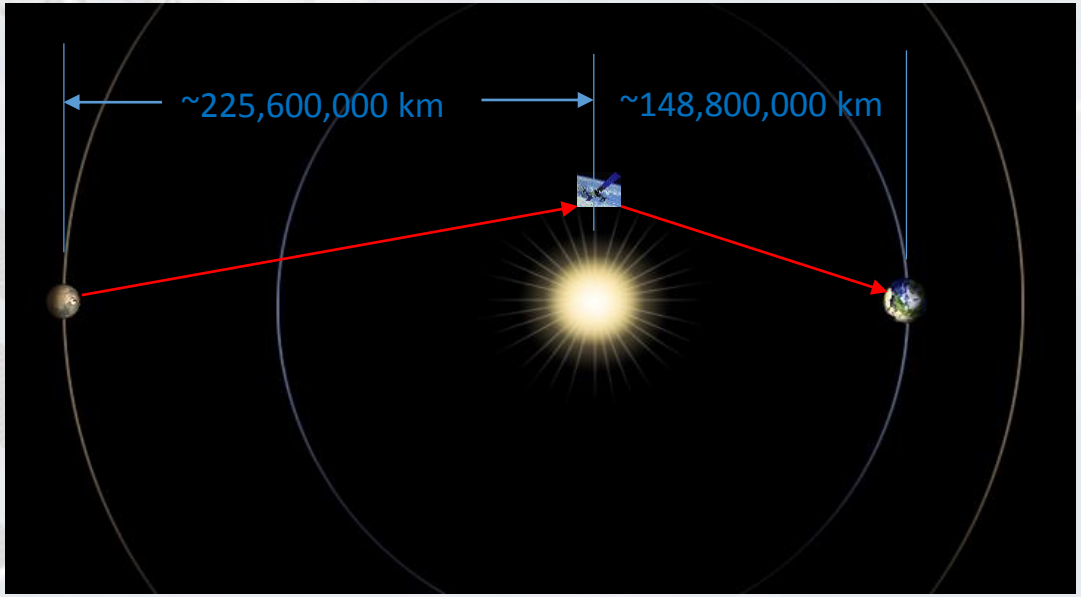
Laser Communications Systems Impose a Great Demand on Pointing Accuracy (continued)

Illustration from the Lunar Laser Communications Demonstration (LLCD) aboard the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission.

Moon to White Sands, roughly 382,400 Km results in a 6 Km “spot” at the laser ground terminal.



Mars in solar conjunction represents an even greater challenge to pointing systems.



The ISS Ku-band, an RF system, is the premier radio frequency link for returning payload science and crew video to MCC-H

- The ISS team undertook a serious Ku-band, guidance and navigation pointing performance analysis and were able to make changes to our pointing system to achieve more effective comm link operations.
- Illustrates ISS utility for upgrading future on-board pointing systems.

Decreased wait time between satellite searches by 1000%.

From: 30 sec

To: 3 sec

Decreased search time for satellites by 75%.

From: 40 sec

To: 10 sec

Decreased wait time for start of satellite service by 23%

From:

SLEW to Start

FINISH Comm Event

START Comm Event

To:

SLEW to Start

FINISH Comm Event

START Comm Event

Benefits Of Using ISS As a Laser Comm Testbed

- NASA plans to launch laser communications operations with the Laser Communications Relay Demonstration (LCRD) in 2019 and the Deep Space Optical Comm (DSOC) terminal in 2022.
    - ISS is strategically positioned for trials of those systems.
- ISS can quickly respond to laser comm lessons-learned:
    - Regular commercial re-supply cargo missions for upgraded components.
    - Experienced crew for in-flight maintenance/upgrades.
- Ideal for studies in laser relay technology and disruption-tolerant networking protocols.
- Previous ISS successes with related technologies indicate the utility of ISS: SCAN Testbed, OPALS, Vektor-T, ISTAR and LONESTAR.

Conclusion

- The ISS mission profile represents the most extreme environment for operational laser communications.
- Problems solved to ensure successful laser communications on the ISS represent highly-valued systems upgrades for planetary exploration programs.