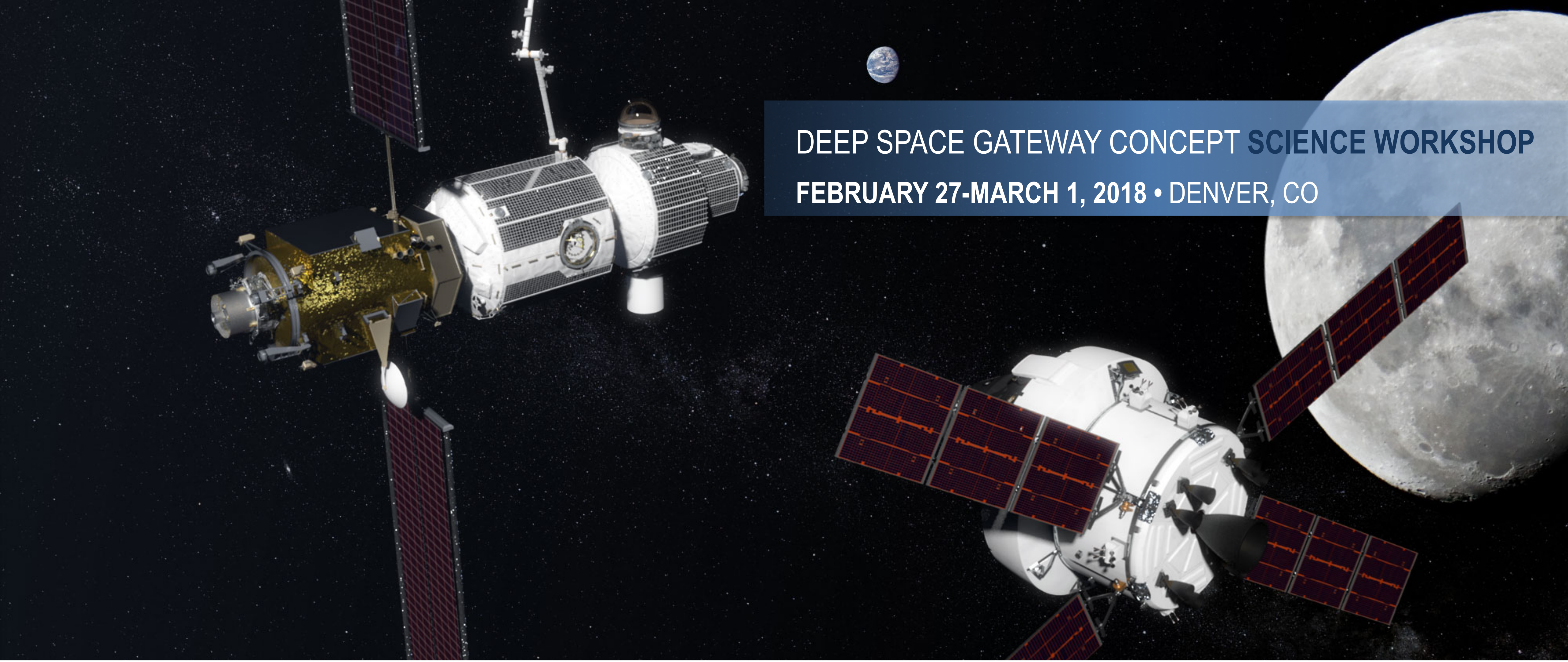

DEEP SPACE GATEWAY CONCEPT **SCIENCE WORKSHOP**

FEBRUARY 27-MARCH 1, 2018 • DENVER, CO

Enabling Servicing of Large Space Telescopes with the DSG

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Instrument Function Statement and Gateway Usage

STATEMENT	INSTRUMENT/CONCEPT DETAILS
The DSG enables servicing (and in the future, assembly) of large space telescopes to extend their lifetimes.	We will use the Large Ultraviolet Optical Infrared Surveyor (LUVOIR) as a case study.
Future large telescopes (including JWST, WFIRST, and LUVOIR) will operate at Sun-Earth L2. Servicing robotically or with humans at S-E L2 is dangerous and expensive. The modest ΔV (~10’s m/s) to return to Earth-Moon L1 or L2 suggests DSG is a good place to service telescopes that can then return to S-E L2.	LUVOIR is being designed to be in-space serviceable.

Why Put Telescopes at Sun-Earth L2?

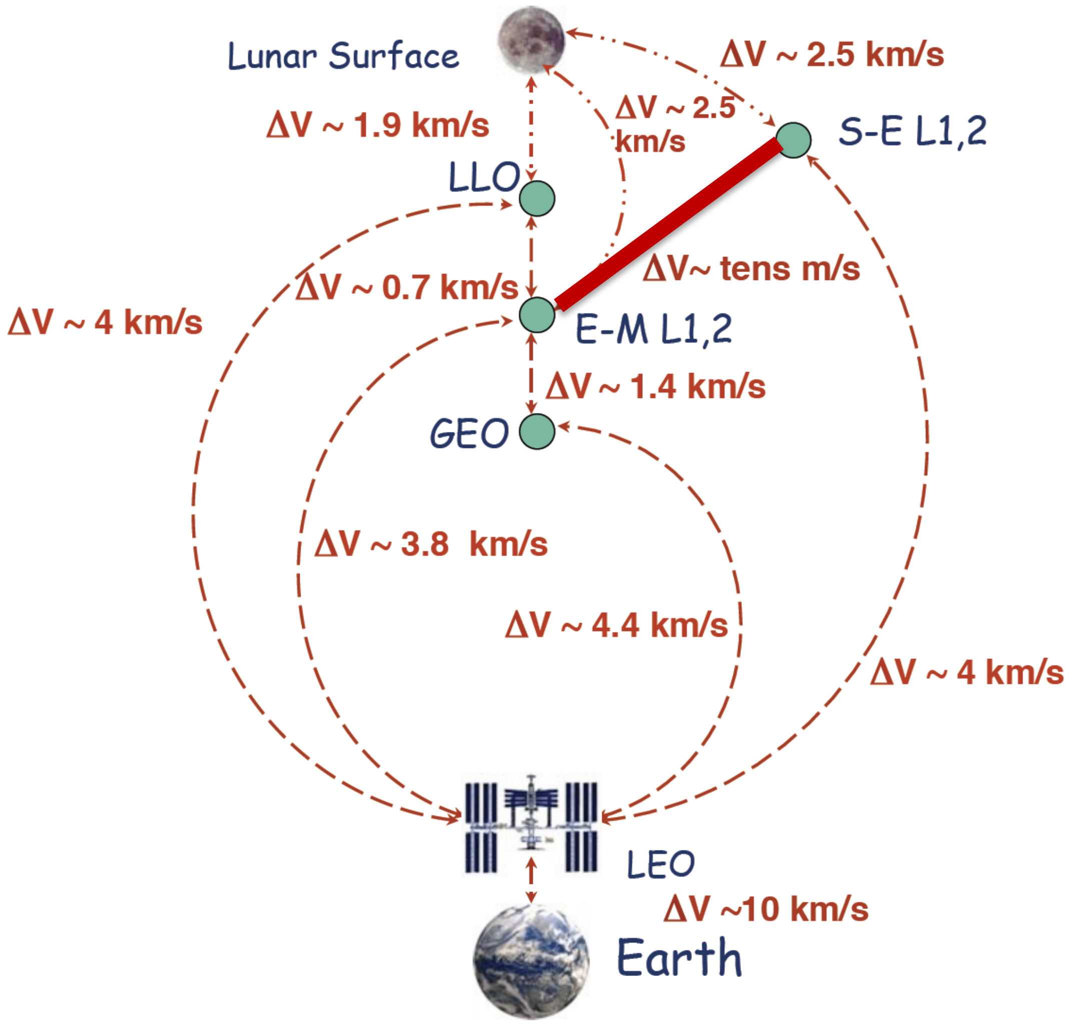
- **Various reasons make S-E L2 a highly desirable location for telescopes**
- **Relative importance depends on mission science, wavelength range, etc.**
- **For LUVOIR:**
  - Most important: Nearly constant solar illumination allows the temperature stability required for long coronagraphic observations of exoplanets in the habitable zone around nearby stars (LUVOIR operating temperature 270K)
  - Always power-positive, no Earth/Moon avoidance required
  - High observing efficiency (no day/night cycles as in other orbits)
  - Telescope is quasi-stationary in Sun-Earth rotating reference frame
  - Contamination issues of LEO avoided
  - Zodical background decreased in near-IR
  - No (or minimal) communications blackouts

Why the Deep Space Gateway?

- **Cis-lunar orbit is ideally accessible to Sun-Earth L2**
  - ➢ ΔV ~ 10's of m/s
  - ➢ Low propulsion needs to go back and forth (EML1 <---> SEL2) for servicing

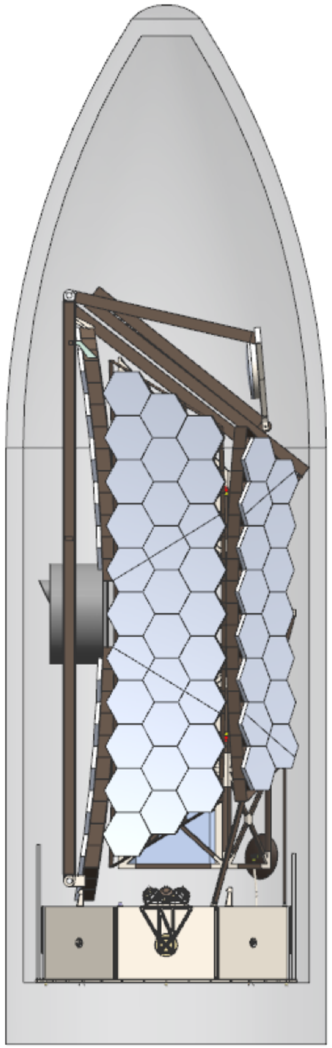
- **Expected to offer both astronaut and tele-robotics capabilities**

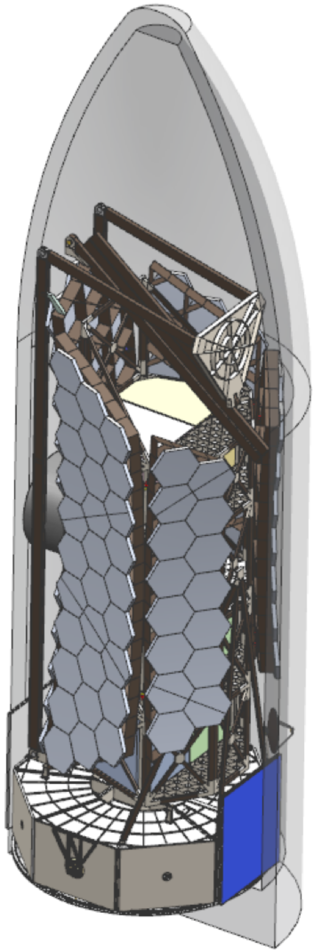
- **Expected to be equipped with important infrastructure**
  - ➢ High-data rate communication, versatile imaging systems, robotic arms



NASA's Decade Planning Team (2000)

(notional SLS Fairing)





Basic Instrument Parameters

PARAMETER	INSTRUMENT ESTIMATE & ANY COMMENTS
MASS (KG)	44.3 mT
VOLUME (M)	79 x 79 x 17 m deployed, including sun shield
POWER (W)	10 kW Nominal during servicing (mostly power to heaters)
THERMAL REQUIREMENTS	Telescope side remains in shade, but heated to 270 K
DAILY DATA VOLUME	13 Tbits (although no data collection during servicing)
CURRENT TRL	Various
WAG COST & BASIS	TBD / Astrophysics Flagship Class
DURATION OF EXPERIMENT	~1-2 month at DSG per decade
OTHER PARAMETERS	

Instrument Gateway Usage

USAGE	INSTRUMENT REQUIREMENTS & COMMENTS
ORBIT CONSIDERATIONS	Preferred Earth-Moon L1 or L2 halo for DSG
FIELD OF VIEW REQUIREMENTS	N/A
REQUIRES USE OF AIRLOCK	If human serviced
CREW INTERACTION REQUIRED?	Optional
WILL ASTRONAUT PRESENCE BE DISRUPTIVE?	Will need to follow contamination protocols as used on Hubble servicing missions.
DOES THE INSTRUMENT PRESENT A RISK TO THE CREW	Nominal. Payload has a 120v bus, so high voltage may be a concern.
OTHER CONSUMABLES REQUIRED	Maneuvering fuel, possibly cryogen replacement
SPECIAL SAMPLE HANDLING REQUIREMENTS	Contamination concerns, as noted above. Key issue will be thruster plumes, which will need to be managed away from optics.
NEED FOR TELEROBOTICS?	Optional
OTHER REQUIREMNTS OF THE GATEWAY?	Shuttle-like robotic arm, attach points

Selected References and Assessment of DSG-based Servicing

Archived documents and presentations of the Future Assembly/Servicing Study Team (FASST): https://exoplanets.nasa.gov/exep/technology/in-space-assembly/

Future In-Space Operations (FISO) colloquia: http://fiso.spiritastro.net/archivelist.htm

Archived documents from the Decade Planning Team (DPT): http://history.nasa.gov/DPT/DPT.htm

Notably: Decade Planning Team JSC 2001 "Gateway" architecture (EX15-001-01)

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A Gateway for Human Exploration of Space? The Weak Stability Boundary Space Policy, 17, 13 (2001)

Site Selection and Deployment Scenarios for Servicing of Deep-Space Observatories, IEEE 0-7803-7231-X (2001)

Conceptual Design of a Lunar L1 Gateway Outpost, IAC-02-IAA.13.2.04 (2002)

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Leveraging Exploration Capabilities for Space-Based Astronomical Observatories, SPIE vol 5899 (2005)

Strategies for Servicing the Single Aperture Far IR (SAFIR) Telescope, SPIE 5899-21 (2005)

Destinations for Exploration: More than Just Rocks?, Space Review, July 16, 2007

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Accelerating the Future: Human Achievements Beyond LEO Within a Decade, The Space Review, http://www.thespacereview.com/article/1756/1 (2011)

Autonomous In-Space Assembly "déjà vu," FISO Seminar, September 27, 2017

LUVOIR