Optimast-SCI Technology: Precision In-Space Manufacturing for Structurally-Connected Interferometry

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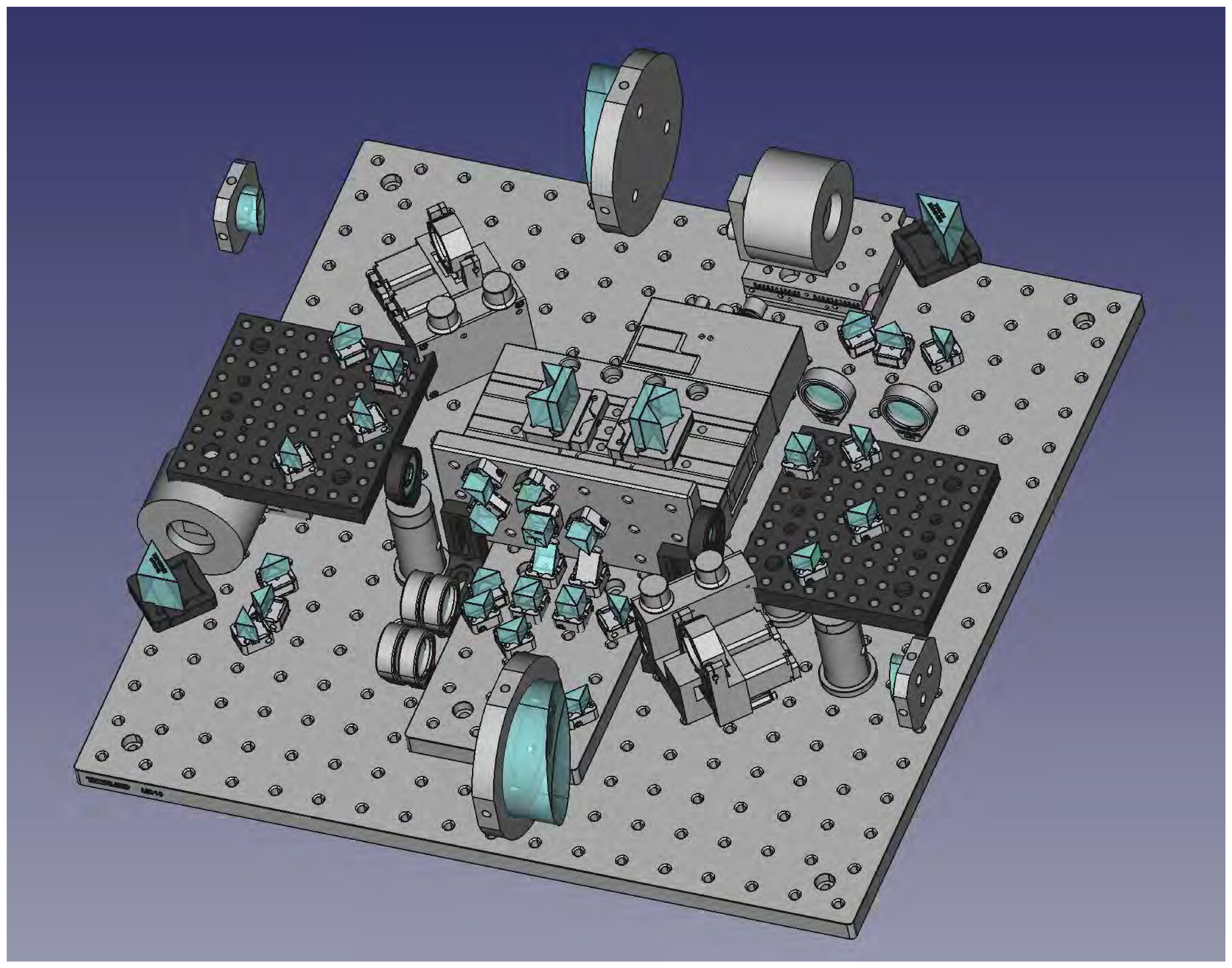


Basic *Optimast-SCI* Parameters

Two-element interferometer

- 2 booms, 6-25m from 2 ESAMM units
  - Baselines selectable from 1 to 50m by running booms in & out
- Resolution: 2 to 6 ms (Rayleigh limit, better with superresolution modes)
- Spacecraft coherence time: 10sec (minimum)
- Sensitivity: $m_V \leq 12 - 16$
  - Out-performs all ground facilities by 2 – 6 magnitudes
- Two collecting apertures, each 2” – 6” (depending on mission)
- Bandpass: 0.4 – 1.0μm

Precision tracking of outboard mirrors

- Enables optical interferometry without massive structures

Orbit: non-LEO, nominally Earth-Sun L2

- Thermally quiet

Spacecraft

- Mass: 300-400 kg

At the Heart of *Optimast-SCI*: A Simple Michelson Combiner

- Simple, pupil-plane combiner with ~0.1 micron tolerances (not nanometer or picometer)
- 75mm range delay line
- Static ABCD fringe tracking similar to PRIMA FSU (Sahlmann 2007)
- Modest spectral resolution (R~100)

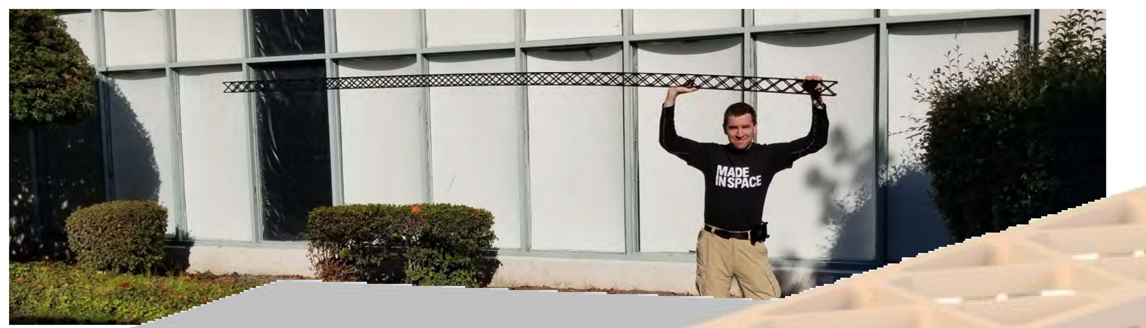
***Optimast-SCI* is currently a NASA SBIR-funded Phase 2 study of a space-based optical interferometer enabled by in-space manufacturing**

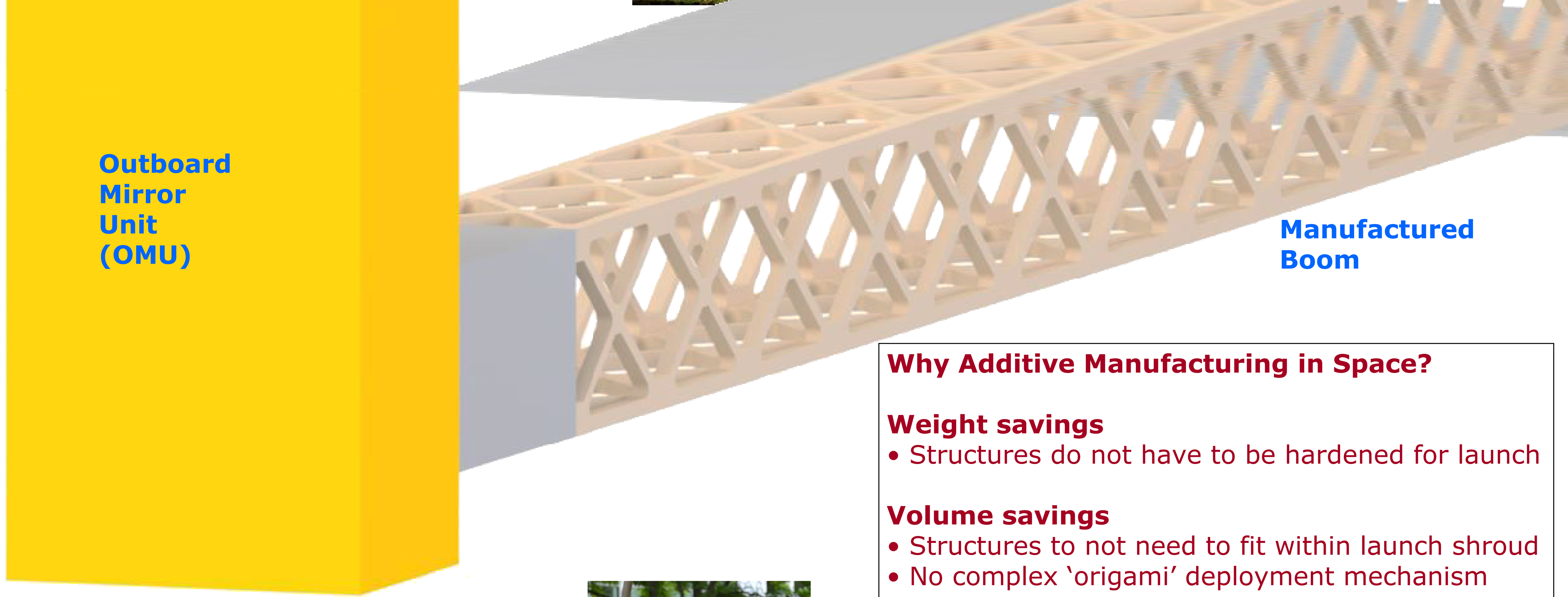
SBIR Phase 2 Engineering demonstration units will be built this year for boom manufacturing, optics subsystems

Manufactured Booms versus Free-Fliers

Booms are superior to free fliers

- One spacecraft versus three
- No consumables for pointing
- Outboard units are significantly simpler than free-fliers
- Short booms: single structure from a mechanical perspective
- Long booms (>100m): akin to tethers; outboard unit control is 2 DOF, not 6 DOF (as for free-flier)
  - Long boom case could be treated as simplified free-flier demo
- Failure modes are more failsafe / recoverable





Why Additive Manufacturing in Space?

Weight savings

- Structures do not have to be hardened for launch

Volume savings

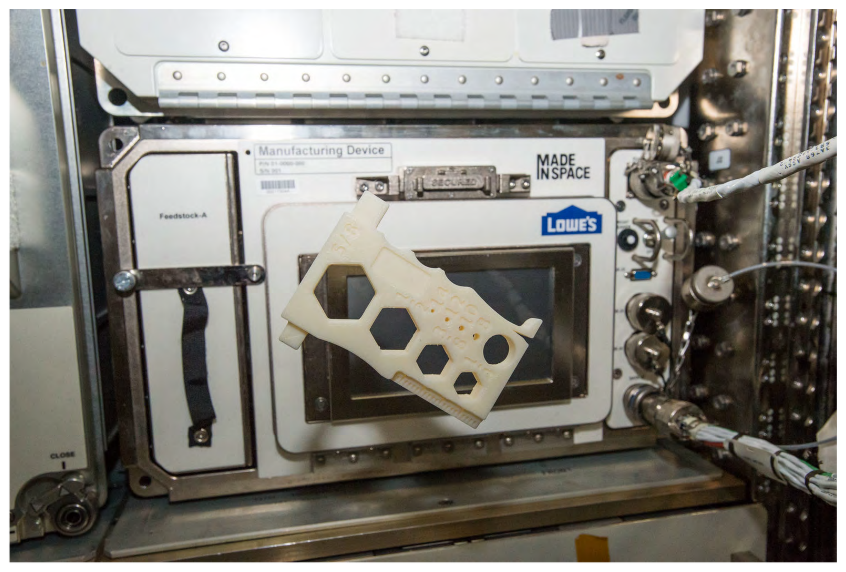
- Structures to not need to fit within launch shroud
- No complex ‘origami’ deployment mechanism

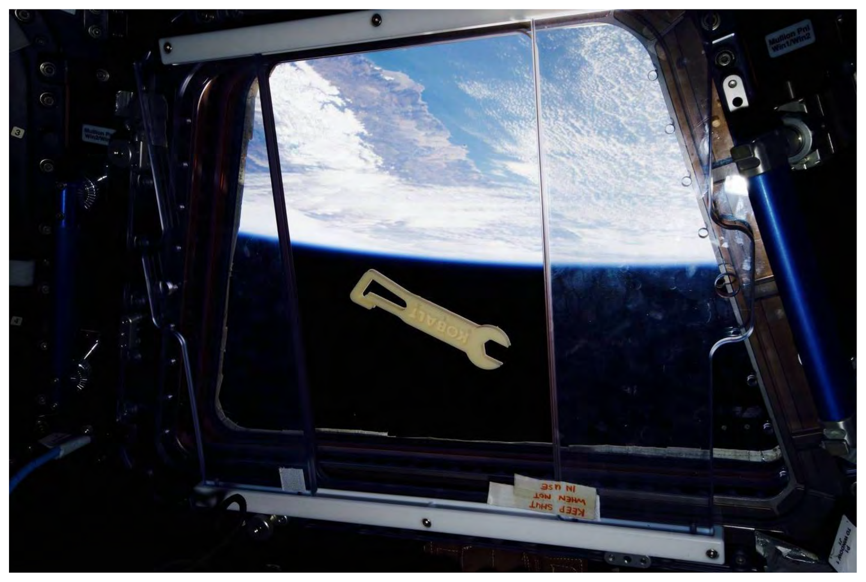
It is the logical progression of:

- *Delivery* of telescopes to space (HST)
- *Assembly* of telescopes in space (JWST)
- *Manufacturing* of telescopes in space

Allowing to achieve the:

- largest
- most sensitive
- highest resolution telescopes
- at the lowest cost





Made In Space Flight Units for Zero-G 3D Printing

Flown Units aboard ISS

Technology Demonstrator 3D Printer (2014)

- Demonstrated fused deposition modeling process in a microgravity environment

Additive Manufacturing Facility (2016)

- Permanent commercial manufacturing facility
- Current materials: ABS, Green PE, PEI/PC

MIS Fiber Optics (2017)

- Successfully pulled ZBLAN in microgravity

MIS Braskem Recycler (2019)

- Reuse of 3D objects into feedstock

***Flight-Qualified*: ESAMM**

- Thermal-vac tested for flight: TRL 6
- Guinness World Record for longest single 3D printed piece: 37 meter boom (print terminated when shop space limit reached)

***Selected*: Archinaut One (2022)**

- $74M flight mission, printing solar array structures

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