Optimast-SCI: Structurally Connected Interferometry Enabled by In-Space Robotic Manufacturing and Assembly

Gerard T. van Belle[1], Simon Patané[2], Daniel Riley[2], Max Fagin[2], Noah Paul-Gin[2], Jack Schomer[2], Mike Snyder[2]

[1]Lowell Observatory, Flagstaff AZ; [2]Made in Space, Moffett Field CA

***Optimast-SCI* is currently a NASA SBIR-funded Phase 1 study of a space-based optical interferometer enabled by in-space manufacturing**

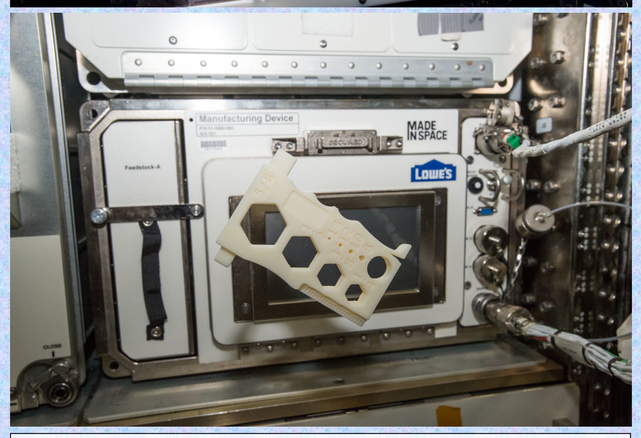
Basic *Optimast-SCI* Parameters

Two-element interferometer
- 2x10m booms from 2 ESAMM units
  - Baselines selectable from 1 to 20m by running booms in & out
- Resolution: 4.1 ms
- Spacecraft coherence time: 10sec
- Sensitivity: $m_V \leq 12$
  - Out-performs all ground facilities
- Two 2″ collecting apertures
- Bandpass: 0.4 – 1.0μm

Orbit: non-LEO, nominally Earth-Sun L2
- Thermally quiet

Spacecraft
- Weight: 100 kg

Cutaway view of the *Optimast-SCI* design. The bottom level is the additive manufacturing ESAMM units. The lower middle level is the optics bay; the upper middle top level is the avionics bay, under the feedstock container on top.



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

Flown Units

Technology Demonstrator 3D Printer
- Launched 2014 to ISS, demonstrated fused deposition modeling process in a microgravity environment

Additive Manufacturing Facility
- Launched 2016, permanent manufacturing facility now aboard ISS
- Commercially available ISS print service
- Current materials: ABS, Green PE, PEI/PC

MIS Fiber Optics
- Launched 2017 to ISS
- Successfully pulled ZBLAN in microgravity

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)

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

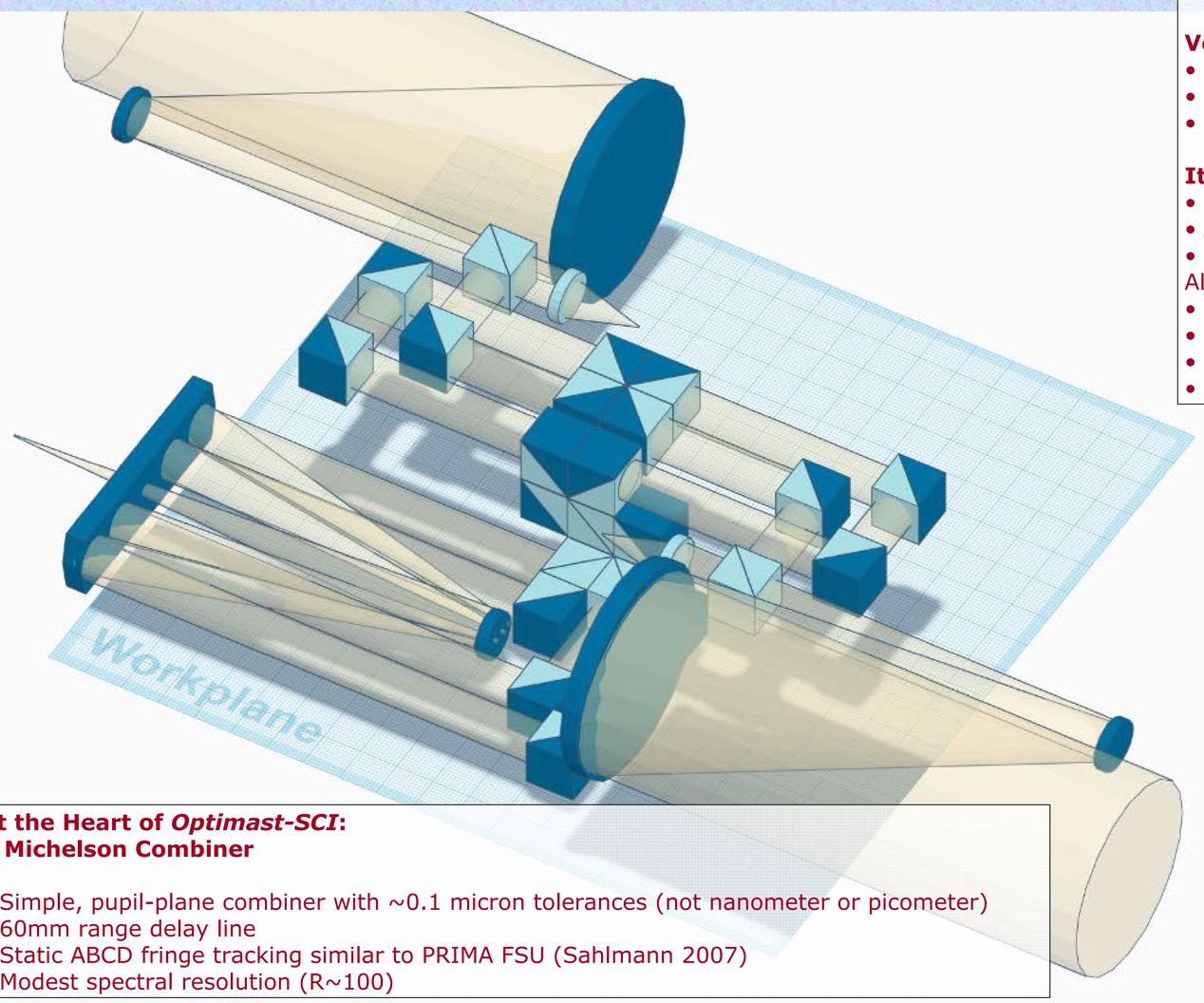
Why Additive Manufacturing in Space?

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
- Increased packing efficiency

It is the logical progression of:
- *Delivery* of telescopes to space (HST)
- *Assembly* of telescopes in space (JWST)
- *Manufacturing* of telescopes in space

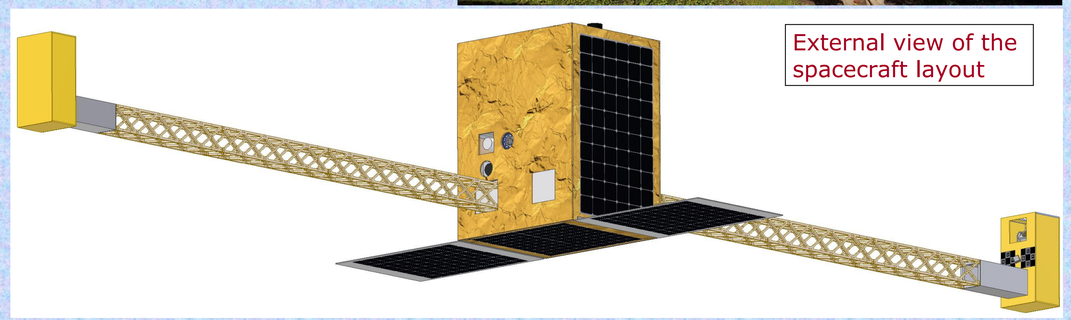
Allowing to achieve the:
- largest
- most sensitive
- highest resolution telescopes
- at the lowest cost



At the Heart of *Optimast-SCI*: A Michelson Combiner
- Simple, pupil-plane combiner with ~0.1 micron tolerances (not nanometer or picometer)
- 60mm range delay line
- Static ABCD fringe tracking similar to PRIMA FSU (Sahlmann 2007)
- Modest spectral resolution (R~100)

ESAMM Print Samples

Indefinite length, 100mm x 100m structures



External view of the spacecraft layout

Acknowledgements: This work has been supported by the NASA SBIR program, the Lowell Observatory, and Made In Space.

ONLINE RESOURCES

Like this poster? Get it!

SCAN ME

Contact:
Gerard T. van Belle,
gerard@lowell.edu