AEROSPACE

/// TECHNOLOGY HIGHLIGHT

MONOCLE

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SPECS:

SWAP: < 50 kg, 35 W
APERTURE SIZE: 0.125
TRL: 3 4

Patent accepted 2021 August
Design scales to 1 m aperture with COTS parts

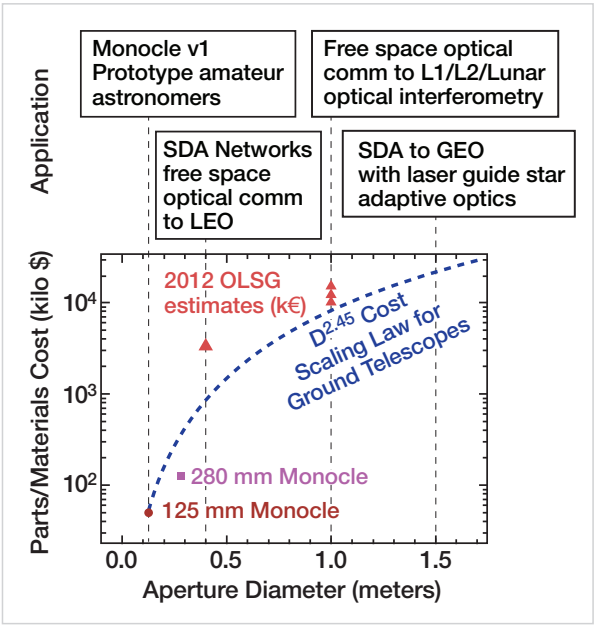
The number of resident space objects is growing exponentially, while the number of ground stations available to access them is growing linearly. The implications of this scaling law mismatch are a lack of observational capacity for space domain awareness and a communication bandwidth bottleneck for free space optical communication to resident space objects (RSO).

The Monocle prototype pictured here can shepherd in a new era of ground-based telescopy to keep up with the rapidly increasing number of space assets.

Monocle is an automated, environmentally shielded, electro-optical ground telescope that enables a network sensor approach. Its novel design features transcend existing limitations of ground-based telescopy, and its wireless communication permit it to be operated remotely. Development of a network of Monocles will provide unfettered access to space and ensure observational capacity of RSOs keeps pace with the ever-growing number of vehicles on-orbit.

Monocle was designed from COTS parts to control costs and ensure manufacturability at scale. The parts/materials cost of Monocle scales favorably with aperture diameter, falling below the historical cost scaling law of $D^{2.45}$. The prototype unit above weighs 45 kg and draws 35W during operation. This prototype provides a 3.6:1 dome-to-aperture ratio, yielding a smaller volume form factor than existing ground terminals.

Monocle addresses emerging applications that demand proliferated ground telescope networks. Examples include active and passive tracking of resident space objects and free space optical communication. Monocle's low-SWaP, low-cost form factor is ideally suited for manufacture, transport, and installation at scale.



Requirement	Monocle Design
1. Protection of telescope and instrumentation from weather, contaminants, wildlife	Telescope and instrumentation emplaced within sealed dome
2. Thermal control of telescope and optics for operation in diverse thermal environments	Sealed dome design permits temperature control via external HVAC system
3. Stray light suppression to reduce light pollution and mitigate laser jamming	Baffle mounting location on the optical tube assembly
4. Laser broadcast safety	Hardware limit precludes laser broadcast below limiting elevation
5. Minimization of wind loading on primary	Wind load transferred through the dome and into the base
6. Minimization of SWaP for transportability and fielding at remote sites	125 mm aperture prototype weighs 45 kg, 450 mm diameter dome, draws 35 W during operation
7. Components chosen to minimize cost and schedule risk	Ring bearings, rotary encoders, optical tube assembly, single board computers, GPS/IMU, laser, fast steering mirror, slip rings and camera are commodity-off-the-shelf. Enclosure is custom
8. Minimization of motion-control assemblies	Two-axis gimbal uses two rotating assemblies of the same design
9. Design scalable in aperture diameter	Design scalable in aperture diameter & design scales to aperture diameter of 1 m
10. Tracks RSOs in all orbital regimes	Low-SWaP two axis gimbal design minimizes moment of inertia and mass under motion-control, enabling tracking rates for LEO and all higher altitudes