

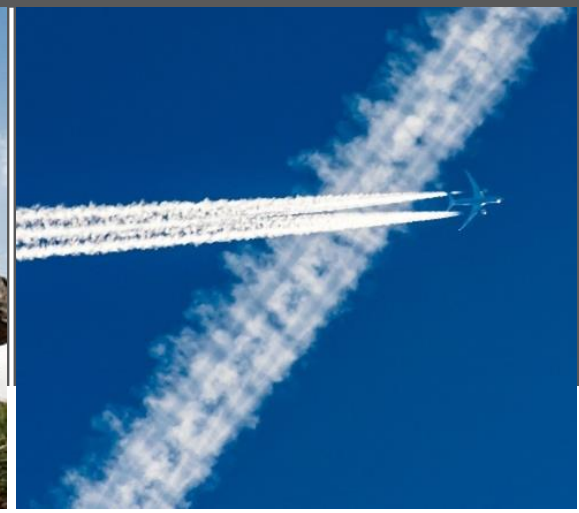

CubeSat Developers Workshop 2020 Path to the First Launch of the SL-OMV from the UK

Christopher Loghry – Moog Space – Business Development

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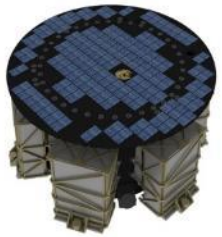
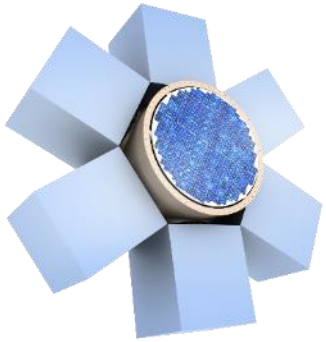
Moog OMV Family – Solutions For Every Mission

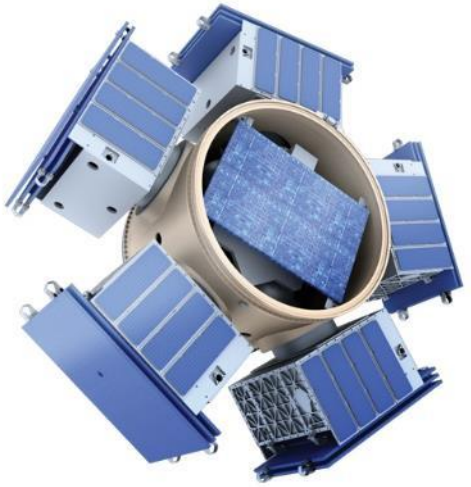
SL-OMV



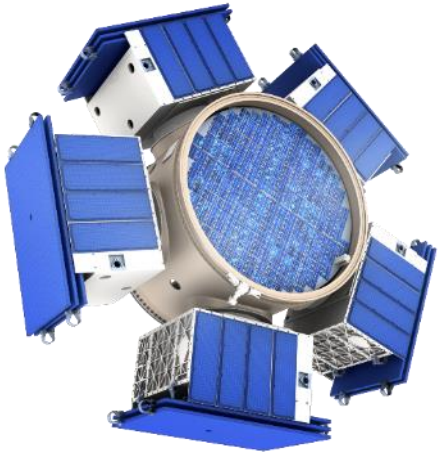
M-OMV



COMET



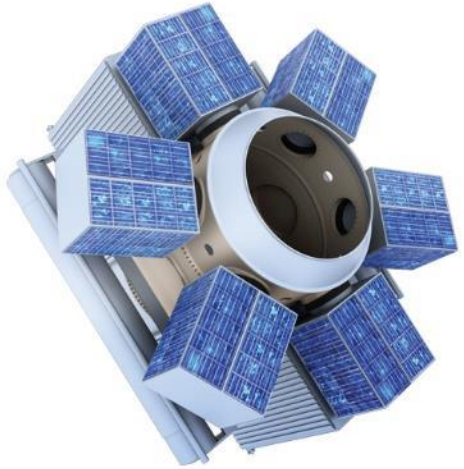
COMET-HPP



METEOR and METEOR Plus

ASTRO and ASTRO Plus

JUPITER



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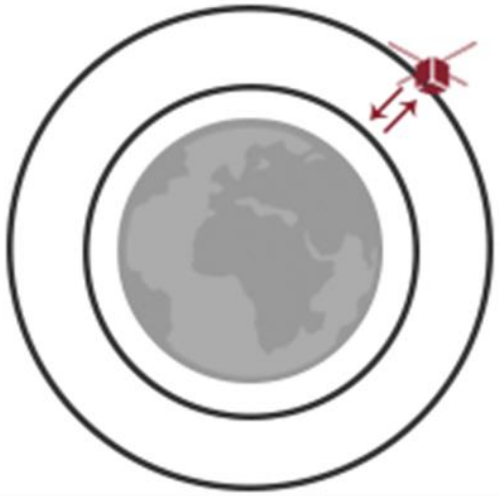
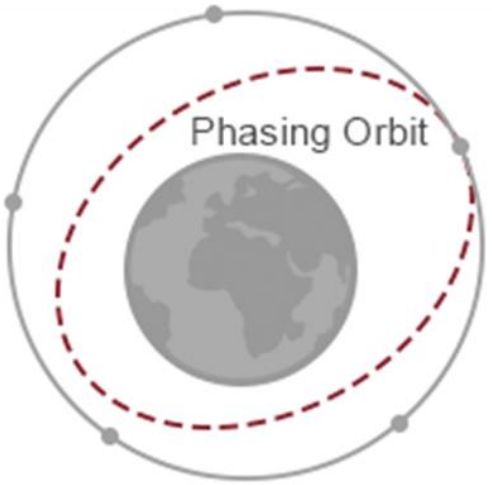
OMV Family Use Cases



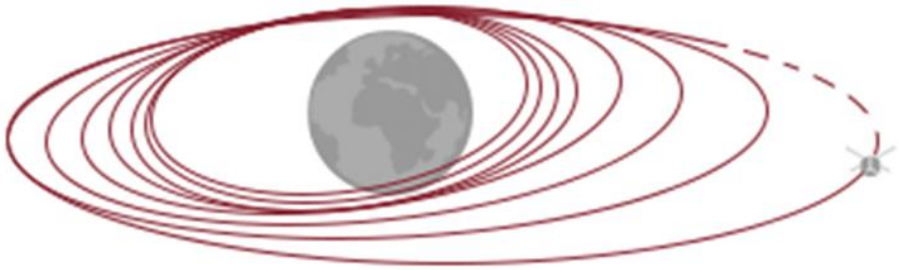
Change Altitude

Change Inclination

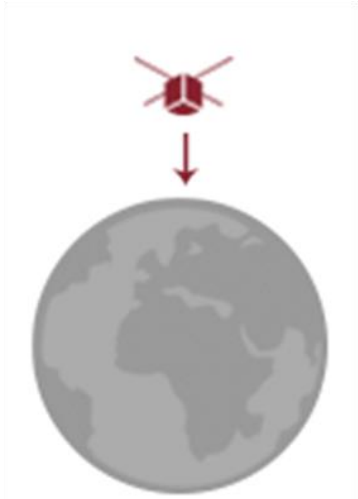


In-Plane Phasing

Multi-Plane Deployment



Liquid Insertion Stage



Hosted Payload

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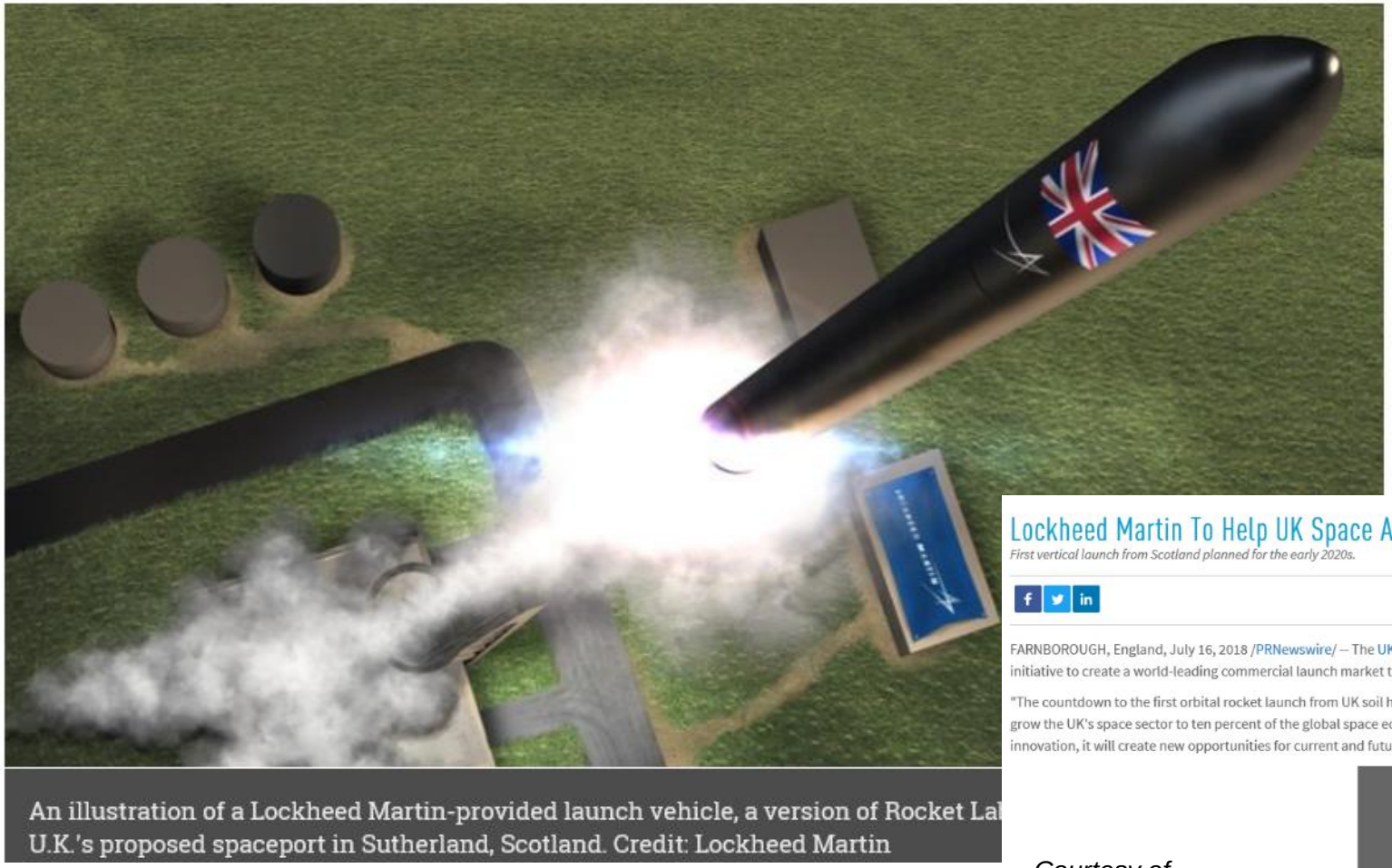
July 16, 2018 – A Big Day for the SL-OMV

Lockheed Martin, Orbex to launch from new British spaceport

by **Jeff Foust** — July 16, 2018



An illustration of a Lockheed Martin-provided launch vehicle, a version of Rocket Lab U.K.'s proposed spaceport in Sutherland, Scotland. Credit: Lockheed Martin

Courtesy of SpaceNews

Courtesy of NASA

Lockheed Martin To Help UK Space Agency Build First Commercial Spaceport; Launch First Orbital Rocket

First vertical launch from Scotland planned for the early 2020s.

FARNBOROUGH, England, July 16, 2018 /PRNewswire/ -- The UK Space Agency has selected Lockheed Martin (NYSE: LMT) to help implement its vision for the UK Spaceflight Programme, an innovative initiative to create a world-leading commercial launch market that grows the UK economy through regular, reliable and responsible access to space.

"The countdown to the first orbital rocket launch from UK soil has officially begun," said Patrick Wood, Lockheed Martin's UK Country Executive for Space. "The UK Government has stated its desire to grow the UK's space sector to ten percent of the global space economy by 2030. We are proud to be selected to help them achieve this goal. This initiative will not only spark advancements in science and innovation, it will create new opportunities for current and future UK-based suppliers to become part of the next space age."

Courtesy of Lockheed Martin

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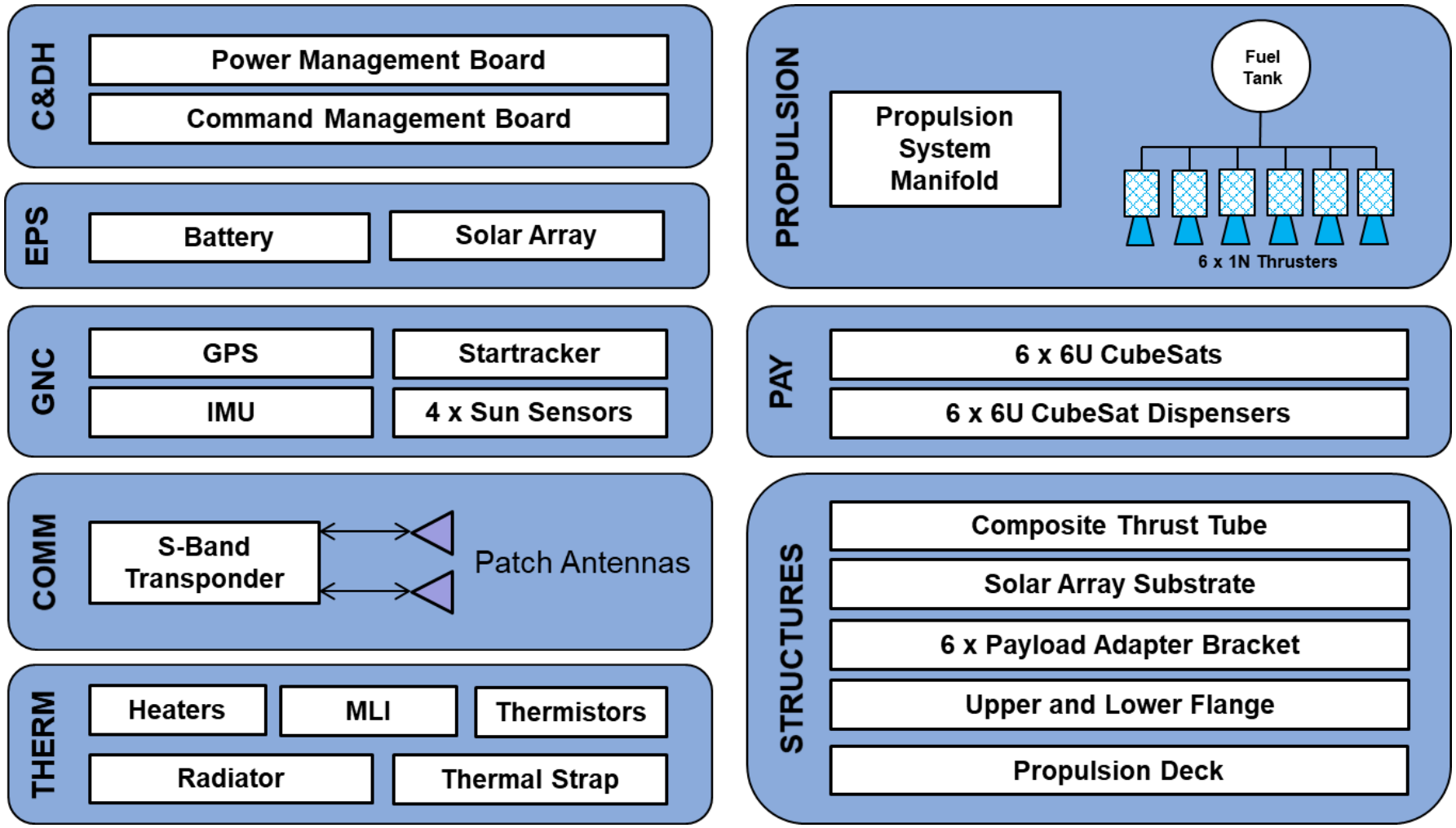
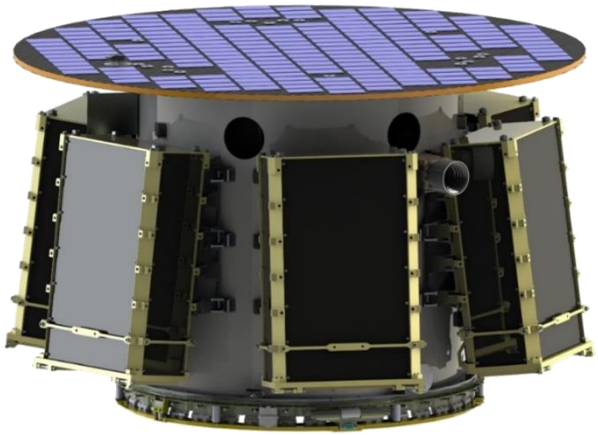
SL-OMV Summary





Subsystem	Mass + Cont (kg) + System Margin
ADCS	0.7
Avionics	3.9
Comms/TT&C	1.5
Power	8.1
Propulsion	10.7
Separation System	4.1
Structure	22.5
Thermal	2.1
Harness	2.5
Vehicle Dry Mass	56.0
System Margin (10%)	5.6
Propellant	13.0
Vehicle Wet Mass	74.6
Payload	87.4
TOTAL	162.0

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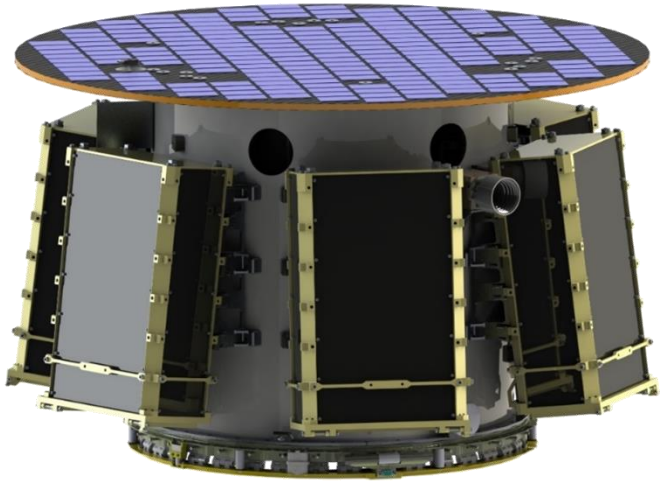
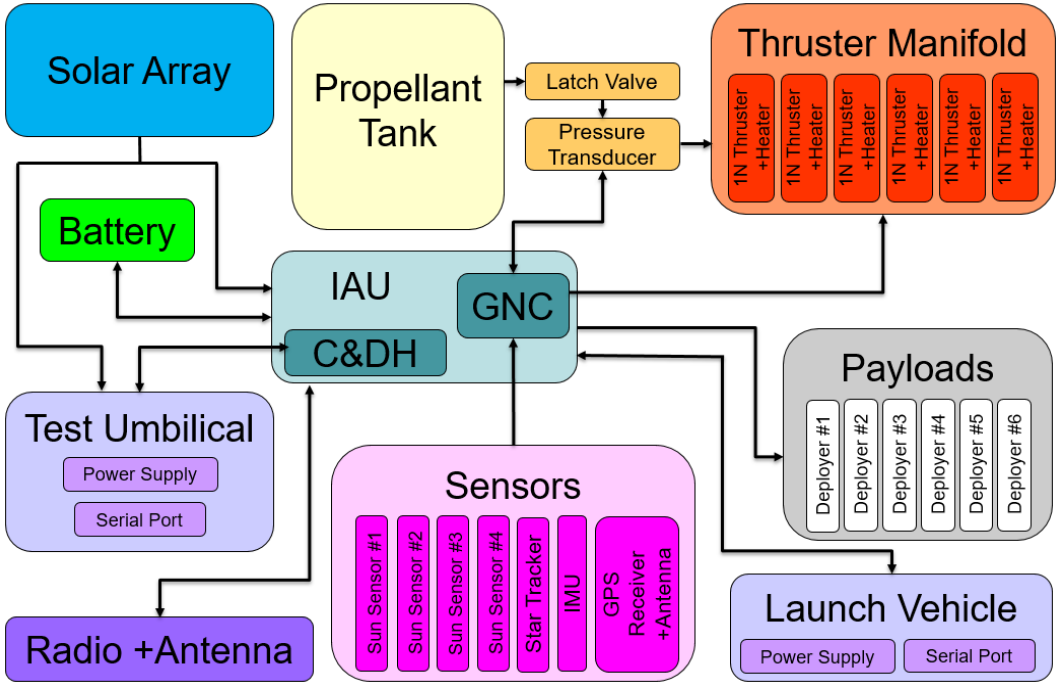
Key SL-OMV Subsystems

Unique Solar Array configuration developed specifically for SL-OMV



Custom Carbon Fibre structure

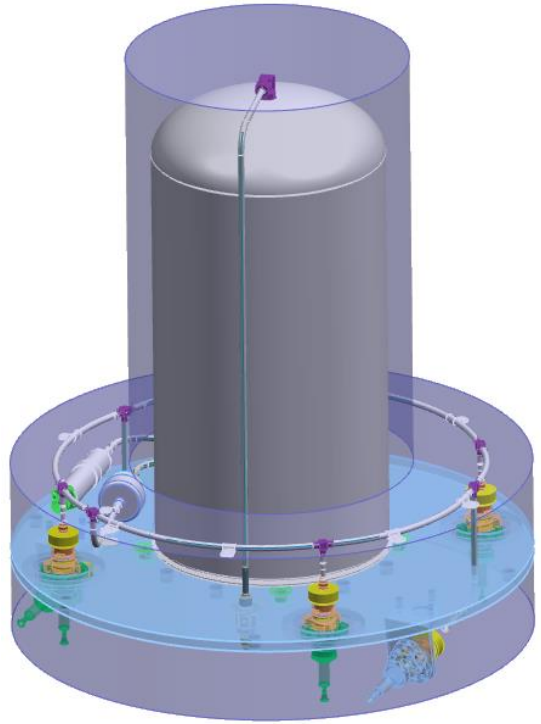
Low Mass Dispensers being qualified for the SL-OMV



Moog Main Avionics Computer (MAC) I/O Block Diagram

Leverages existing TRL 9 and Modified Designs

Currently Being Qualified for the SL-OMV application leveraging TRL 9 designs



Moog Green Propulsion System

Components developed and qualified for the SL-OMV application leveraging TRL 9 propulsion technology

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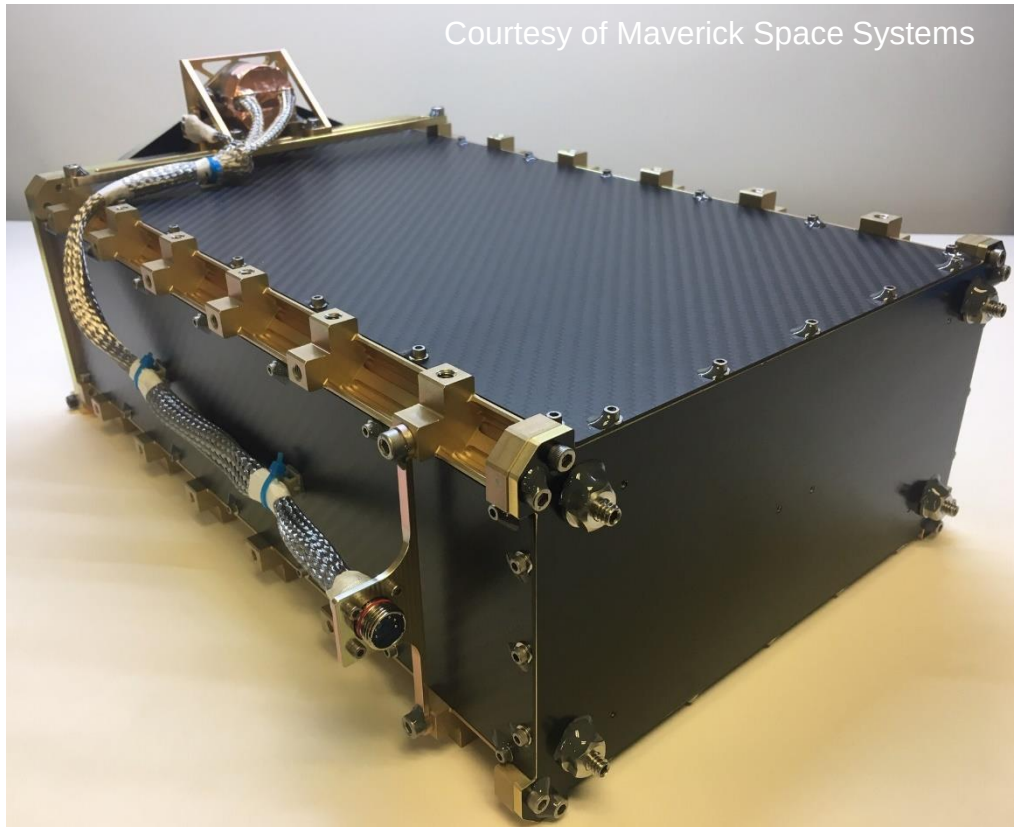
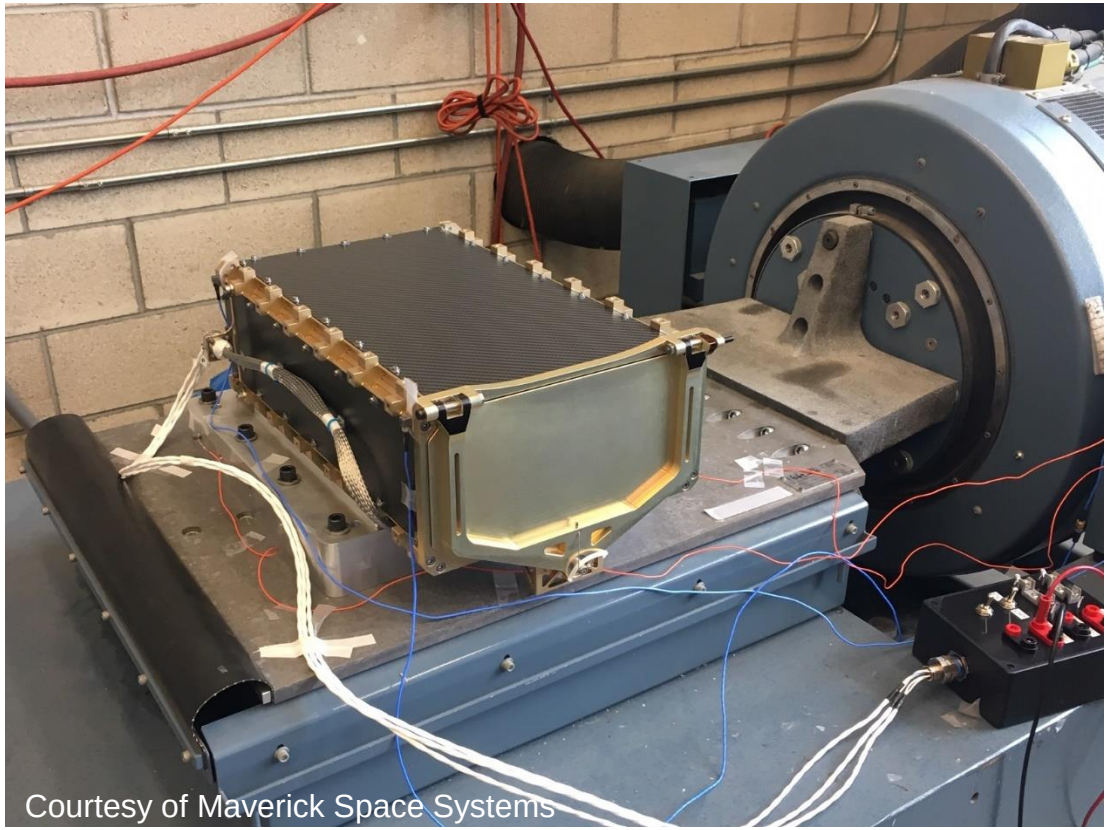
Low-Mass CubeSat Dispensers





- Maverick Space Systems, of San Luis Obispo, developing and qualifying the Mercury 6 CubeSat dispenser that will fly on the SL-OMV
- Lower Mass than current 6U Dispensers key for reduced launch mass
- Leverages existing TRL 9 components and technologies
- Recently completed Vibration Qualification Testing leveraging CalPoly SLO's test facilities

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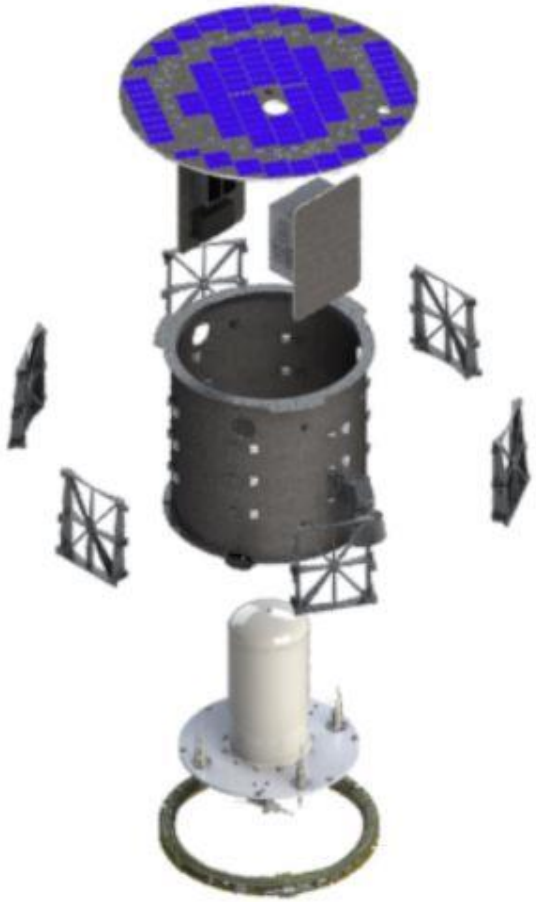
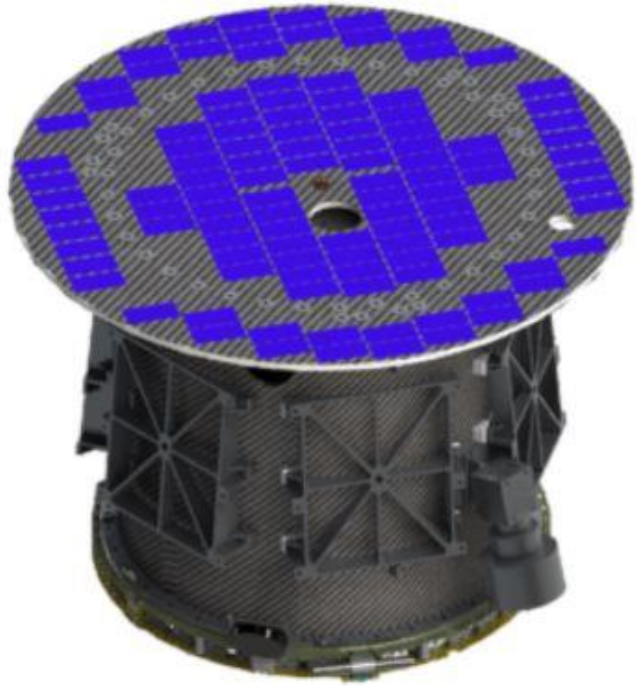
Integration and Test

KISPE supporting all UK Integration and Test planning and activities

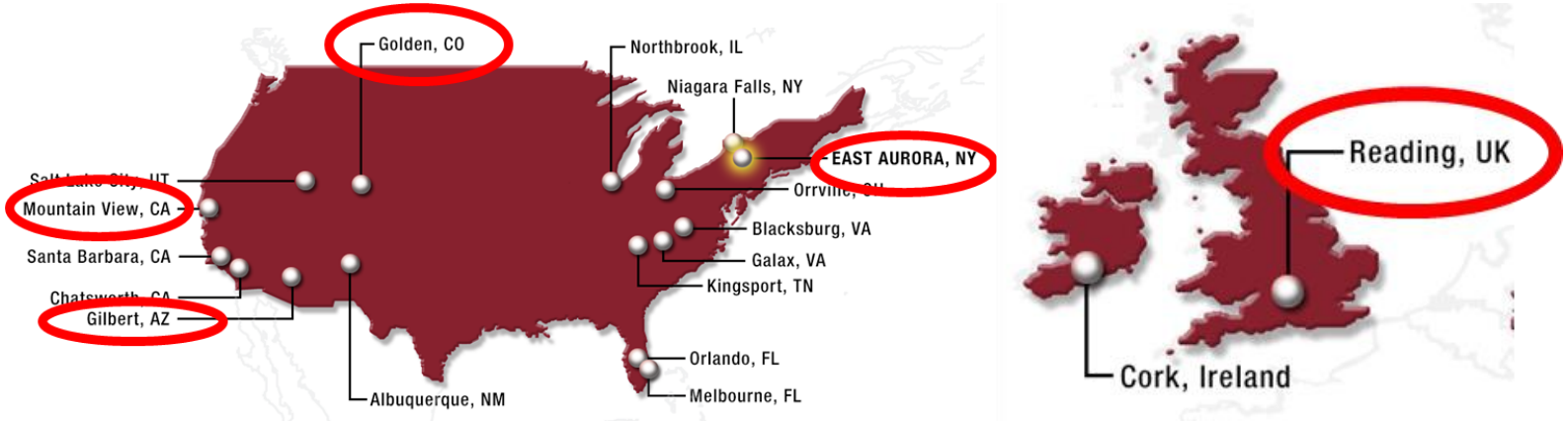


Propulsion System I&T at Nammo Westcott



SL-OMV I&T at Moog Reading and Harwell

Joint UK/US Effort

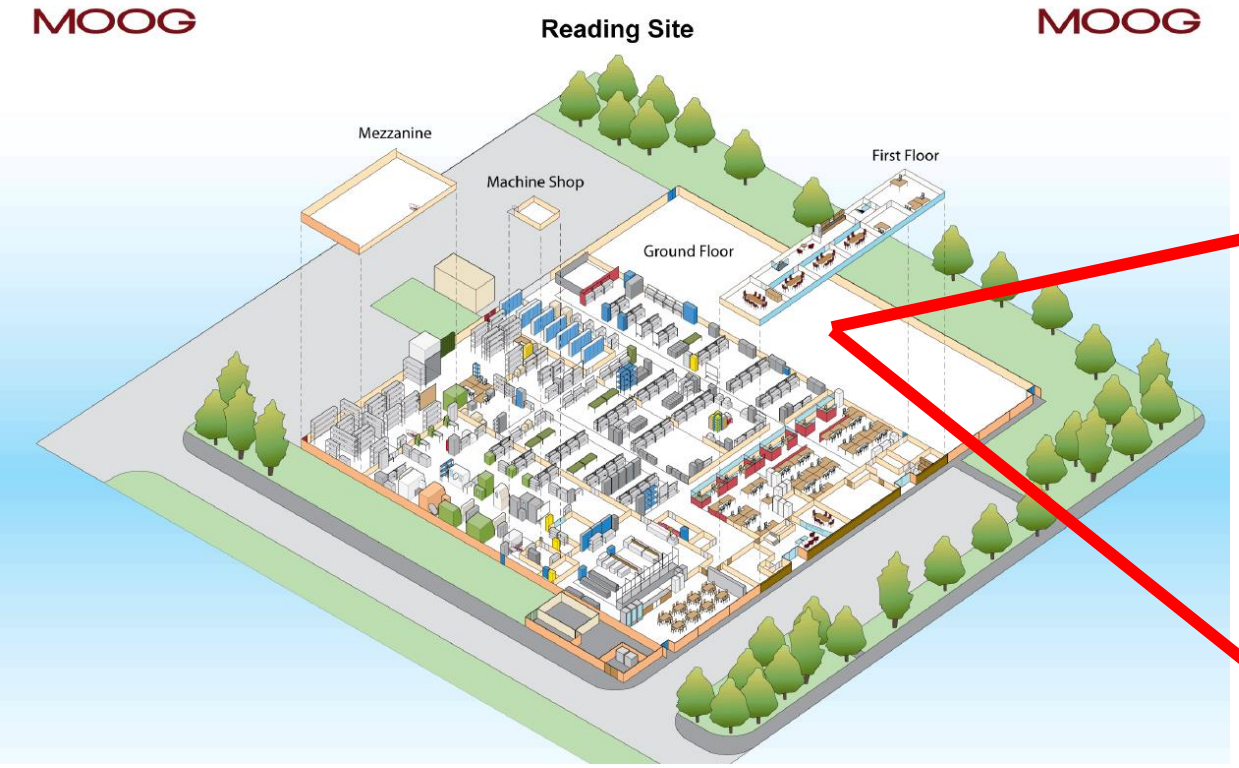


Moog Sites supporting SL-OMV

UK Supply Chain and UK Integration and Test Faciliites

- Propulsion integration and test at Nammo's Westcott propulsion facility
- Solar Panel production from AAC Clyde Space in Glasgow
- Battery production from ABSL in Abingdon
- Composite Structures from Tods Aerospace in Crewkerne
- GNC components from NewSpace Systems
- Final integrated system level testing in facilities at Harwell
- Systems Engineering and integration/test support from KISPE in Farnborough

Moog Reading



- Moog expanding it's Reading facility for SL-OMV integration and test
- Building a modular clean room to support current and future programs
- First Space program from Reading
- ISO 8 Clean Room commissioned in February 2020
- Thermal Chamber installation April 2020

SL-OMV Milestone Status

- ✓ Contract Announcement - July 2018
- ✓ Systems Requirements Review (SRR) - October 2018
- ✓ Preliminary Design Review (PDR) – December 2018
- ✓ Critical Design Review (PDR) – June/July 2019
- ✓ Mission Integration Review (MIR) – December 2019
- ✓ Production Readiness Review (PRR) – February 2020
- ✓ All components in procurement

System Integration and Test activities in Summer/Fall 2020

Launch details in public approval process with announcement soon so watch the space industry news outlets (or Moog social media channels)

SL-OMV Platform Tech Road Map

	LEO		High LEO/MEO	GEO/Lunar
Parameter	Mk I	Mk II	Mk III	Mk IV
Mission Type	Small Sat Constellation Deployment	Enhanced Mk I for longer life, hosted payloads, on-orbit 'sentinel'	High Energy Upper Stage for high LEO and MEO missions	High Delta-V Upper Stage for GEO and Lunar missions
Status	In Production	In Funded Study Phase	In Funded Study Phase	Concept Phase
Life	1 year	1-3 years	< 1 year	1 year
Launch Mass	~150 kg	150-300 kg	~300 kg	Varies; ~150-300 kg
Payload	6x6U or 12x3U	6 locations on perimeter or one large payload on top	75-100 kg payload on top	Varies: 100-200 kg payload on top
Propulsion	Green Monoprop	Green Monoprop	Green Bipropellant	Electric Propulsion
Power	Fixed Array	Larger Fixed or Deployable Array	Larger Fixed or Deployable Array	High Density Deployable Arrays
Avionics	Same Design (Rad-Hard BRE440 processor for all applications)			

What's Next for the SL-OMV Platform

Summary

- Moog's line of Orbital Maneuvering Vehicles can support a wide variety of new and exciting mission applications
  - Support the boom in Small Satellites and Rideshare
- Small Launch OMV (SL-OMV) currently under contract and in production for launch from the UK for the UKSA with mission partner Lockheed Martin
- SL-OMV is a straightforward design leveraging existing and new technologies that have applications elsewhere in the industry
- Joint UK/US team and supply chain including bringing new capabilities to the UK
- Moog is expanding its capabilities in Reading specifically to support the SL-OMV program
- SL-OMV has moved from the design to the production and test phase
- SL-OMV is the first step in a Technology Road Map that can be used for even more exciting missions beyond LEO
  - Potential for new technology infusion

Contact

Please contact us with any questions, potential applications, or applicable technologies you would like to discuss

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