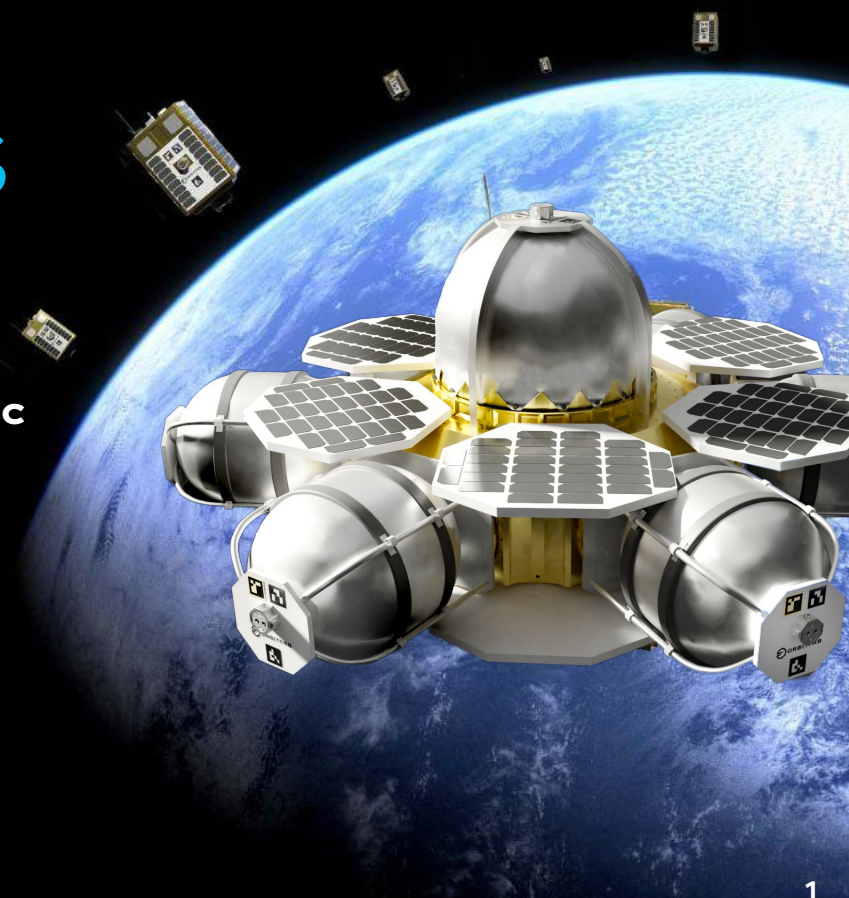
ORBITFAB

GAS STATIONS IN SPACE™



Creating Environmental and Economic Sustainability In Space Through Commercial Satellite Refueling

Connor Geiman, Manny Shar, Camille Calibeo, Aiden O'Leary, Daniel Faber

Clean Space Industry Days
October, 2022

SATELLITE “SINGLE USE” PARADIGM

AIRPLANES		**40,000** Refills
AUTOMOBILES		**750** Refills
LAUNCH VEHICLES		**10** Refills
SATELLITES		**0** Refills

"Once a satellite is launched, there is only a single tank of fuel and no opportunity for maintenance. Because of this, $100Bn worth of satellite were abandoned in the last 10 years."

CATALYST ACCELERATOR, US SPACE FORCE

Spring 2021 Promotional Materials, “On-orbit Servicing, Assembly, and Manufacturing”

Recent Incidents

Insurance claim for failed Measat-3 satellite in dispute

by **Jason Rainbow** — August 4, 2022

Measat's teleport and broadcast center. Credit: Measat

TAMPA, Fla. — An insurance claim for a Malaysian satellite that ran out of fuel prematurely remains unsettled more than a year after the incident.

Aging Telesat satellite running out of fuel as projected LEO costs soar

by **Jason Rainbow** — August 5, 2022

Phase 1, Telesat's first LEO satellite that launched in 2018, was supplied by SSTL. Credit: Telesat

TAMPA, Fla. — Canada's Telesat is bracing for a revenue hit in 2023 after being forced to retire its Anik F2 satellite from full service three years earlier than planned.

Source: SpaceNews

Throwing away satellites is not only *economically unsustainable*, it is **environmentally wasteful.**

THE ORBIT FAB MISSION

To Build the In-Space Propellant Supply Chain

THE ORBIT FAB VISION

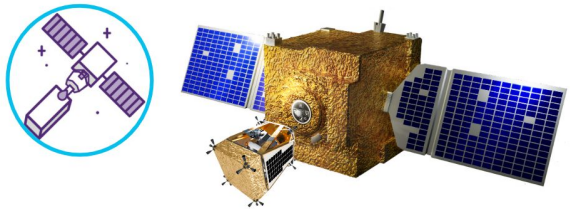
A Bustling In-Space Economy Supporting Permanent Jobs in Space

Company Overview

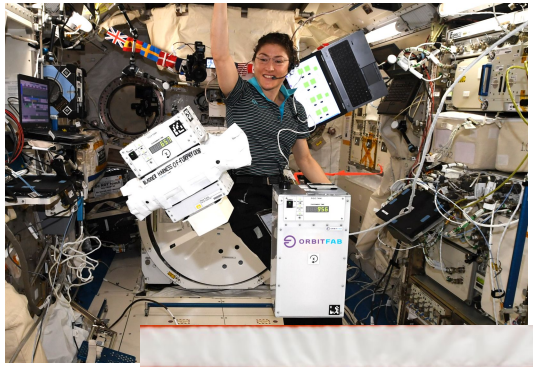
Orbit Fab was founded in 2018 to build the in-space propellant supply chain

- Headquartered in Lafayette, CO, USA and with a UK office
- 50+ employees & growing globally
- Received investment from Lockheed Martin & Northrop Grumman
- Two successful space flight missions
- First private commercial company to resupply the ISS with water
- End-to-end refueling demonstration in LEO SSO scheduled for 2023
- RAFTI baselined on 4 DoD & 100+ commercial satellites
- First in-space commercial fuel sale deal signed with Astroscale early 2022

Sell RAFTI Service Valves



Sell Fuel In Space

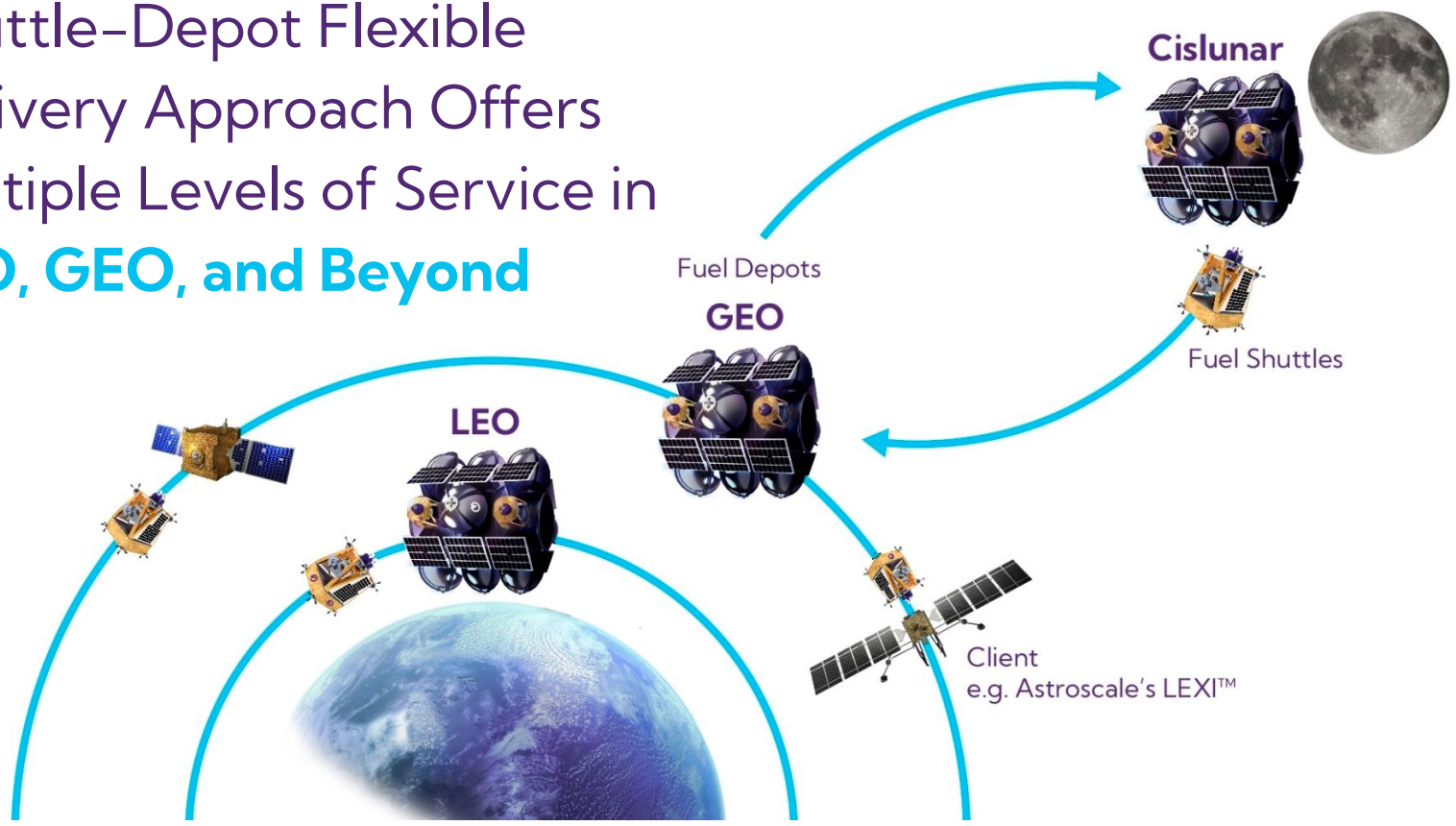


Top: ISS water resupply mission, Furphy (2019)
Bottom: First commercial fuel depot, Tenzing (2021)
Left: Orbit Fab's refueling products and services

Refueling Architecture

ORBITFAB Gas Stations in Space™

Shuttle-Depot Flexible Delivery Approach Offers Multiple Levels of Service in **LEO, GEO, and Beyond**

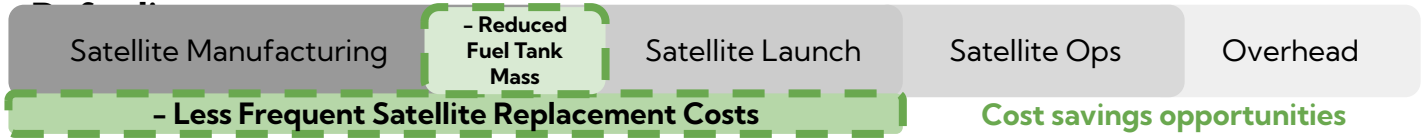


Economic Advantage with Refueling

ORBITFAB Gas Stations in Space™

Traditional Cost Structure

Cost Structure with



Traditional Revenue

Revenue Structure with Refueling

Environmental Advantage with Refueling

The *economic advantages* of refueling enable the **expansion of space capabilities** – including those which have an **impact on Earth's environment, such as**:

Tracking Wildfires

Mapping Deforestation

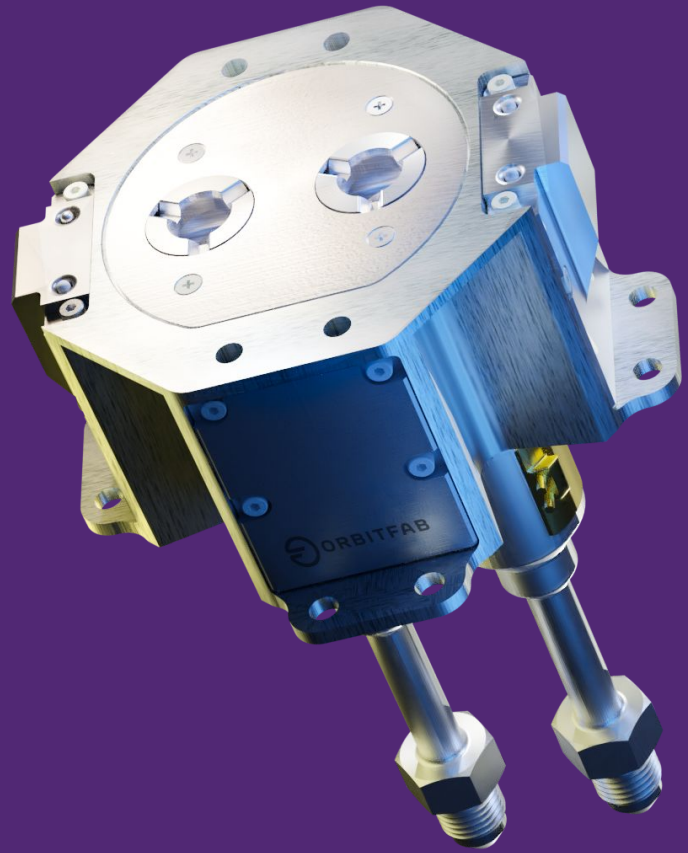
Monitoring Coral Reefs

...and many more

Images: NASA

RAFTI

Rapidly Attachable Fluid Transfer Interface



Commercially Available Interface

ORBITFAB Gas Stations in Space™

Rapidly Attachable Fluid Transfer Interface (RAFTI™)

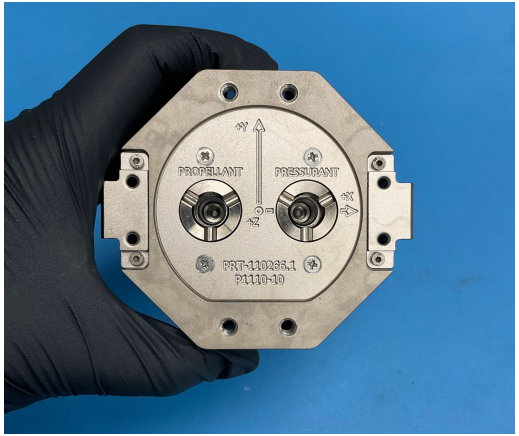
RAFTI is an open license TRL 8 refueling and docking interface that replaces a fill & drain valve to enable on-orbit and ground fueling.

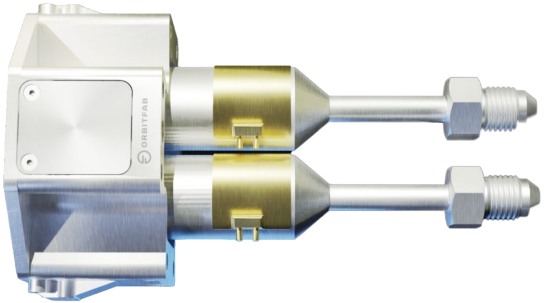
Size & Weight:

- Size: 85mm x 75mm x 45mm (external to spacecraft)
- Mass: ~500g

Features:

- Common geometry for all fluids, with material changes as needed for compatibility (N2H4, Xenon, ASCENT, HTP, H2O, Krypton, etc.)
- Energized seals for fluid and radiation compatibility
- Passively actuated covers to mitigate radiation exposure
- Make-before-break geometry to minimize drip
- Three inhibits to overboard leakage
- Grasp features to allow direct-docking
- Can integrate with 3rd party docking interfaces for a larger docking capture box (e.g. ASPIN & PRM)





Client Requirements

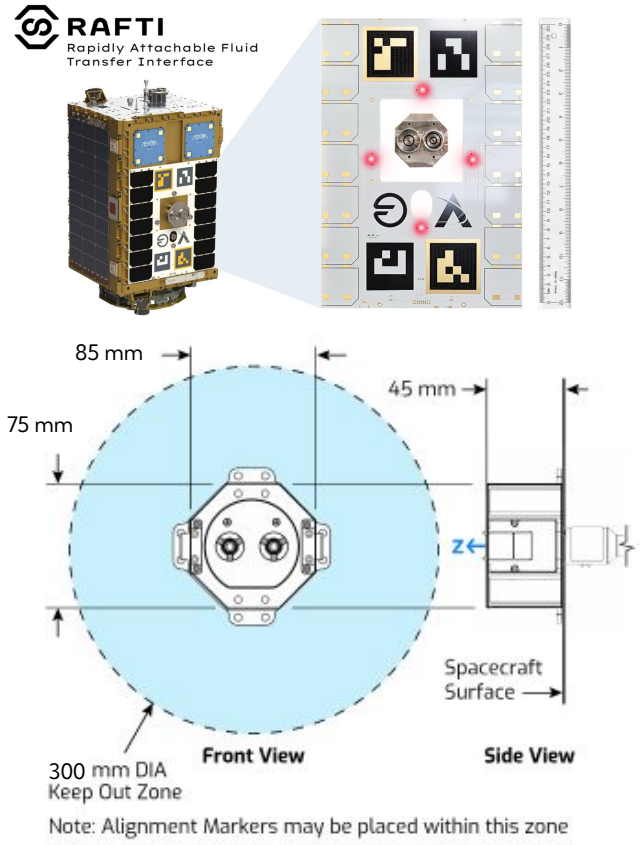
Client Spacecraft Requirements

- RAFTI Service Valve (RSV) – Client SHALL mount the RAFTI Service Valve according to interface specifications in the Mechanical Interface Control Document and provide for a 300 mm keepout zone.

- Pointing Accuracy – The client spacecraft SHALL maintain pointing with the RSV with the client spacecraft's velocity vector with an accuracy of 4 degrees or better.

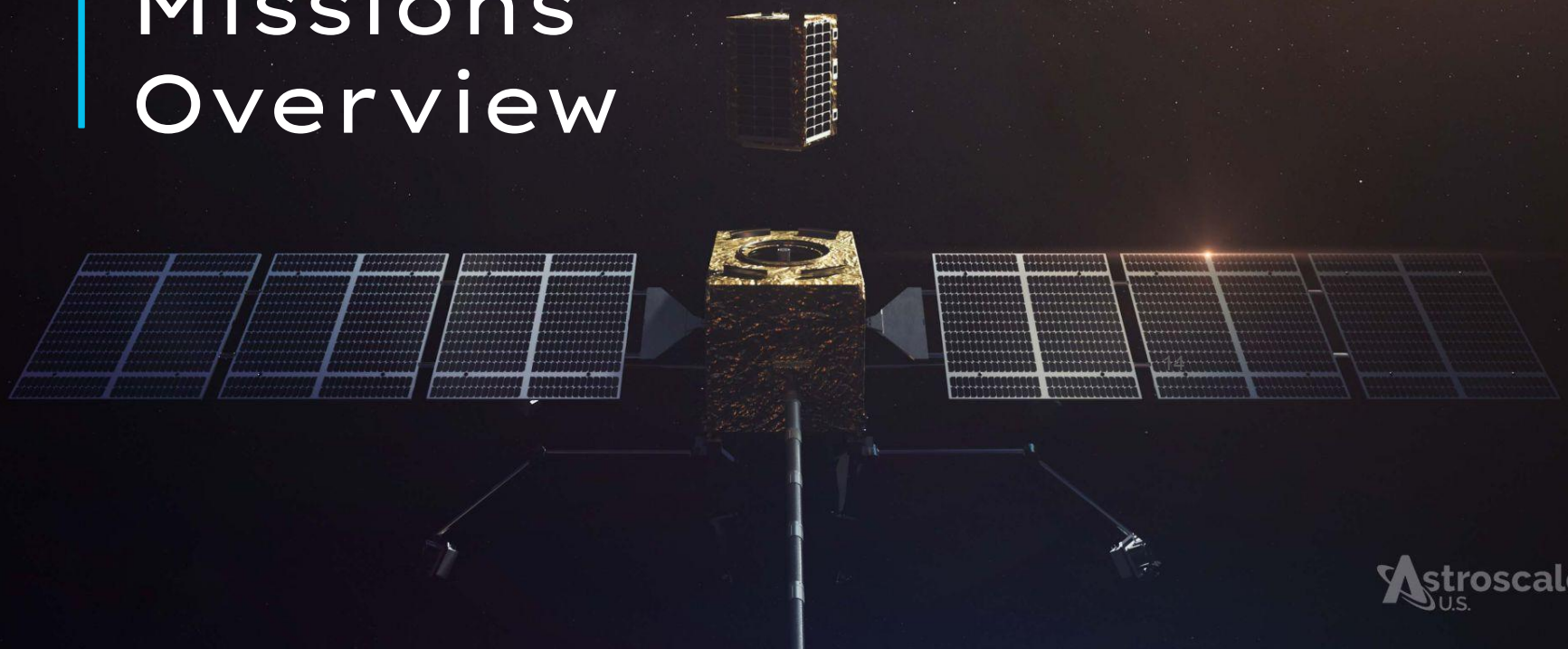
- Pointing Accuracy Drift – The client system SHALL maintain attitude drift rates less than 0.1 degrees per second during proximity operations.

- Fiducials – The client spacecraft SHALL incorporate CONFERS standard compliant fiducial markers on the same face of the spacecraft as the RAFTI docking port with side lengths of 10+ cm.



ORBITFAB
Gas Stations in Space™

Missions Overview

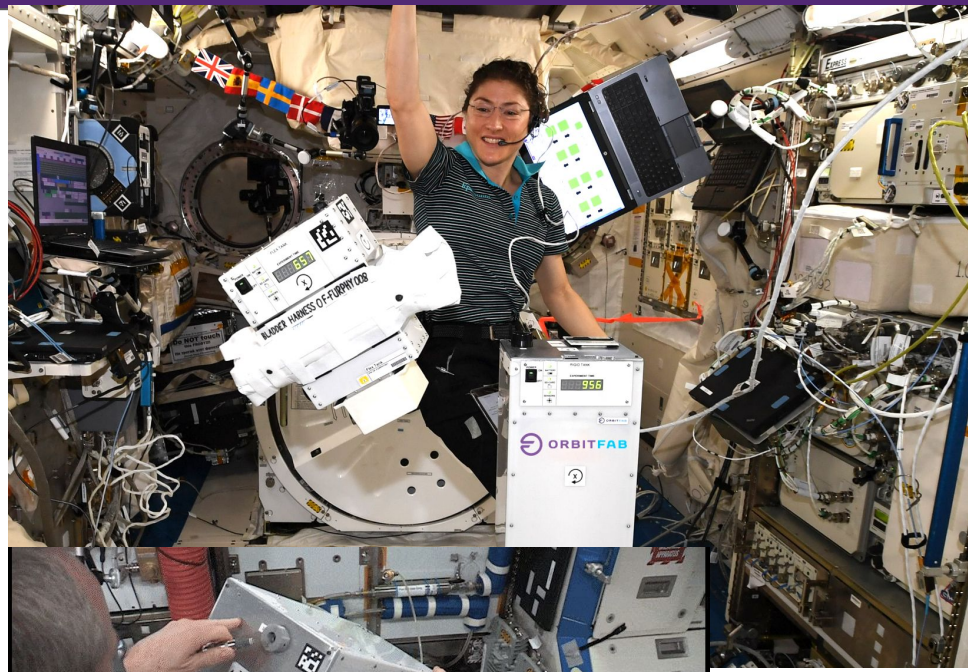


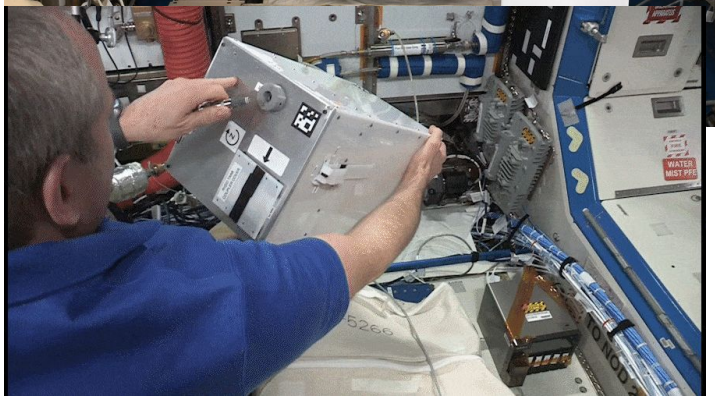
FURPHY - Mission Overview

First Private Company to Resupply Water to the ISS

Logistics

- 4.5 month program
- 2 tanker test beds testing fluid transfer in orbit
- First private company to supply water to the ISS



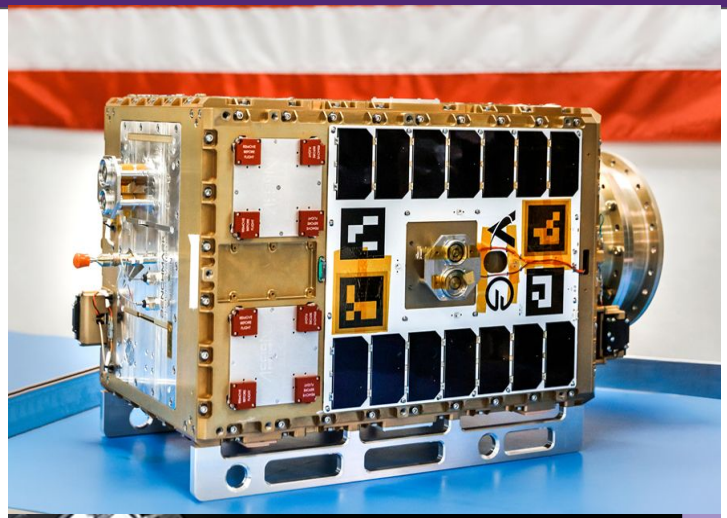


Tanker-001 Tenzing - Mission Overview

Demonstrated Ground Ops, Tanker Deployment, and Fuel Storage On Orbit

Logistics

- Launched and Deployed Q3 2021
- Operating at 550 km SSO
- 35 kg spacecraft carrying HTP
- Cameras to support RPO risk reduction
- Tank, valves, pressure transducers, RAFTI Block 1 all developed/assembled in house
- 9 months from ATP to launch



$12M STRATFI Program

ORBITFAB Gas Stations in Space

SPACE-RCO & AFRL SUPPORT

AFWERX STRATFI

UNITED STATES SPACE FORCE

SPACEWERX

SPACENEWS

Orbit Fab gets $12 million to integrate refueling port with military satellites

by Sandra Erwin — March 17, 2022

Orbit Fab developed a refueling port for satellites called RAFTI, short for Rapidly Attachable Fluid Transfer Interface. Credit: Orbit Fab

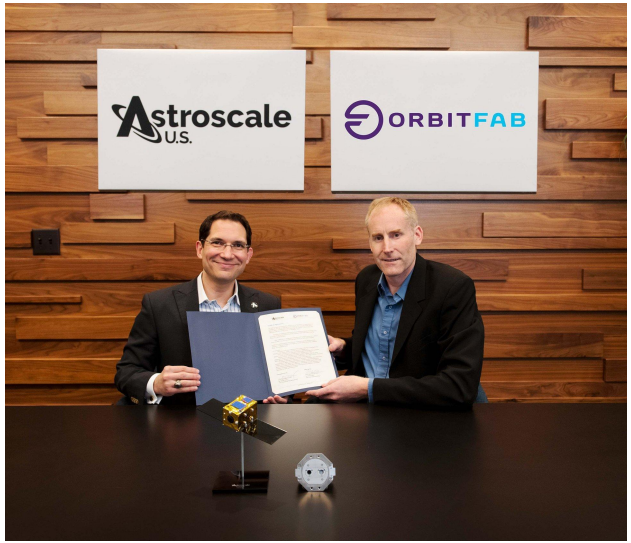
The funding includes $6 million from the U.S. Air Force and Space Force, and $6 million from private investors

WASHINGTON — Orbit Fab, a venture-funded startup offering a refueling service in space, announced it has won a $12 million deal to ensure its fueling interface works with U.S. military satellites.

The funding includes $6 million from the U.S. Air Force and U.S. Space Force, and $6 million from Orbit Fab's private investors. The contract is for the integration of Orbit Fab's fueling port, called RAFTI — short for rapidly attachable fluid transfer interface

$75M Commercial Fuel Sale

Refuel Astroscale LEXI GEO Fleet



SPACENEWS

Orbit Fab secures deal to refuel Astroscale's satellite-servicing robots

by **Sandra Erwin** — January 11, 2022

Visualization of Astroscale's geostationary satellite servicing spacecraft known as LEXI, short for Life Extension In-Orbit. Credit: Astroscale

WASHINGTON — Astroscale U.S., a provider of on-orbit services to extend the life of satellites, has signed an agreement to use Orbit Fab's in-space refueling tankers, the companies announced Jan. 11.

Orbit Fab, a startup offering "gas stations in space," will refuel Astroscale's geostationary satellite servicing spacecraft known as LEXI, short for Life Extension In-Orbit.

The agreement commits Orbit Fab to supply up to 1,000 kilograms of Xenon propellant to refuel Astroscale's LEXI vehicles,

Orbit Fab in Europe

- Orbit Fab office in the United Kingdom opened in 2022 in Harwell
- Orbit Fab is part of UK Active Debris Removal (ADR) programme to provide a refueling element
- Continuing to hire in the UK for both technical and nontechnical roles

Managing Director

Manny Shar

Special thank you to the UK SPACE AGENCY

ORBITFAB

Q&A Discussion

Connor Geiman connor@orbitfab.com
Manny Shar manny@orbitfab.com