



**Grappling and Refuelling Active
Solution for Propellants (GRASP) -
Concept and Development Summary**

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Clean Space Industry Days
October, 2023

OUR MISSION

To Build the In-Space
Propellant Supply Chain

OUR VISION

A Bustling In-Space
Economy Supporting
Permanent Jobs In Space



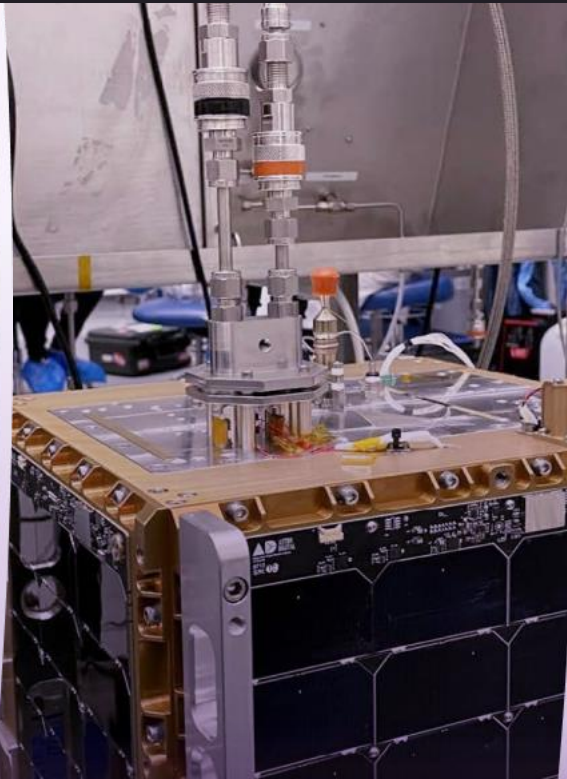
Key Milestones



2018-19

Furphy

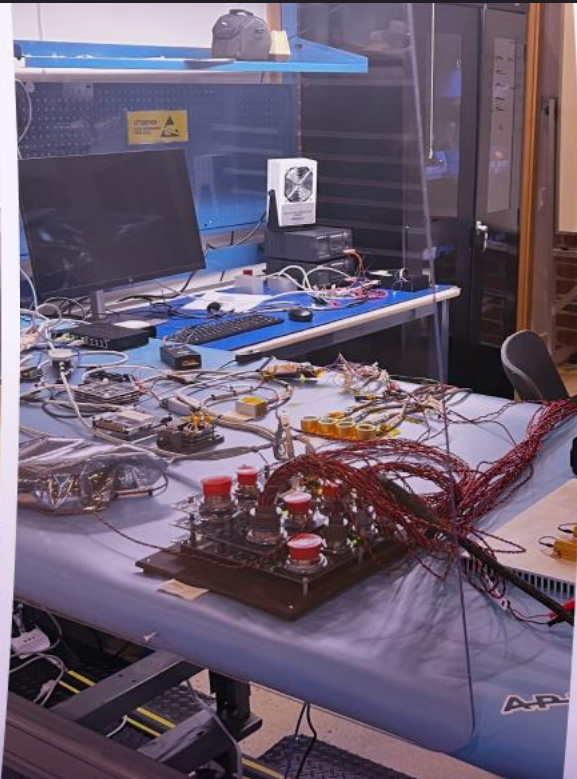
First privately-owned mission to resupply water to the ISS



2020-21

Tenzing

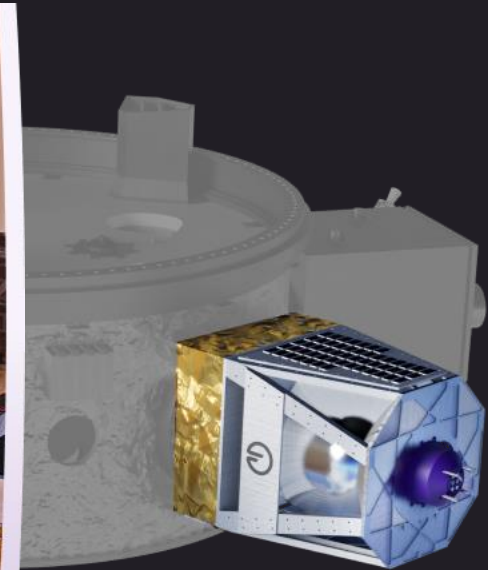
First commercial fuel depot in space



2023-24

Podracer

On-orbit rendezvous and proximity ops testbed



2025-26

First Refuelling

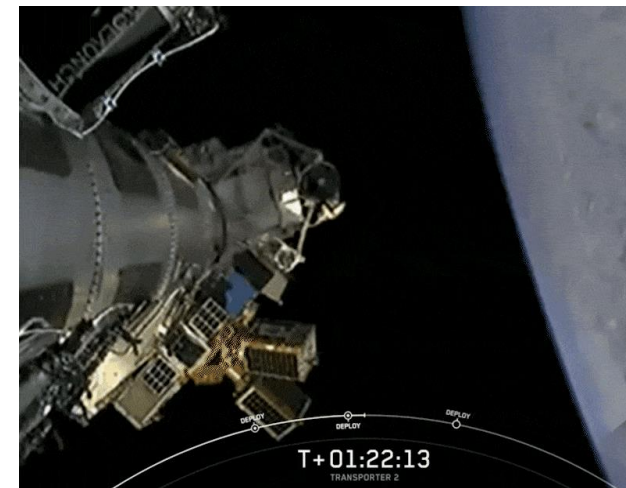
First commercial fuel depot offering self-service refuelling

ORBITFAB

- 60+ FTE & growing globally; Colorado, USA HQ + UK office (Harwell)
- VC-backed, raised \$30m+, inc. LM, NG, Munich Re, 8090 Industries, others
- Two successful space flight missions conducted
- First private commercial company to resupply the ISS with water
- RAFTI baselined on 100+ gov't & commercial satellites
- Signed commercial and government fuel sale agreements
- UK office operating since H2 2022



Company Highlights



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



UK Technology Development

- Development of Refuelling Vehicles (Shuttles and Depots)
- Development of new green and electric propellant active transfer systems
- Development of RPOD systems (with partners)
- Development of interface products (RAFTI and GRASP)

UK Business Development

Existing Contracts

- UKSA Active Debris Removal programme
- UKSA International Bilateral Fund
- UKSA Enabling Technology Programme

Future

- OFL ambition is to be refuelling mission leader for European institutional and commercial missions

Shuttle-Depot Architecture

Orbit Fab Interfaces:



RAFTI



GRIP/GRASP

Manual Ground Fueling with RAFTI Ground Coupling



Automated Ground Fueling



☾ Shuttle Refuels Customer

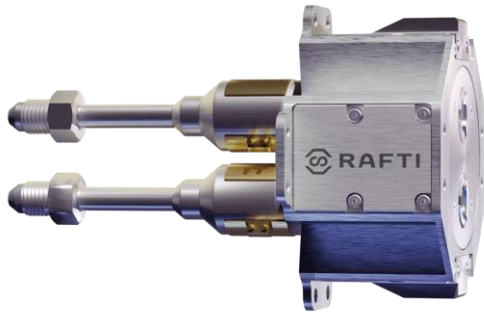
Full Service Customer

Self-Service Customer

RPOD-capable customer refuels directly from ☾ Docking Depot

☾ Shuttle Refuels at ☾ Depot





RAFTI

- Passive RAFTI Valve Cores
- Passive Grapple Fixture
- Not ITAR Controlled (EAR only)
- Used on Clients and OF Vehicles
- Low, Medium, High pressure designs
- TRL7 in Q4 2023
- Suitable for ground and space fuelling



GRIP

- Active RAFTI Valve Cores
- Active Grappling Mechanism
- ITAR Controlled
- Used on US OF Vehicles
- Low Pressure
- TRL7 in 2024
- Flight use only



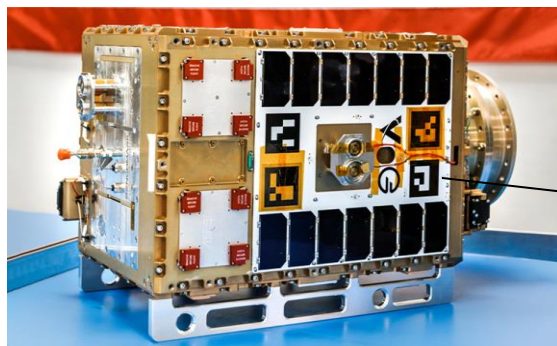
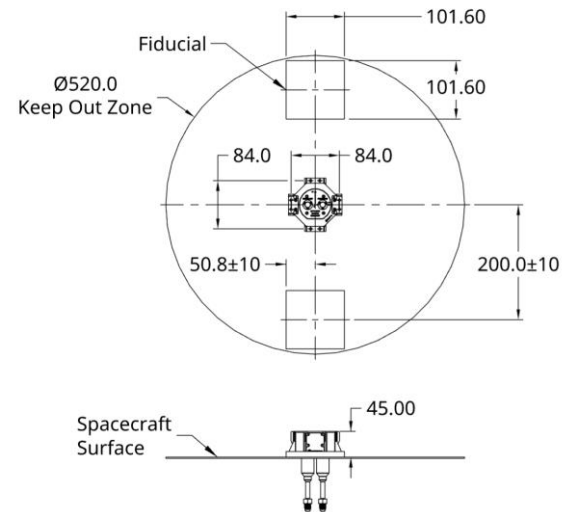
(Tentative design)

GRASP

- Active RAFTI Valve Cores
- Active Grappling Mechanism
- Non-ITAR
- For use on any OF vehicles
- Pressure Agnostic
- TRL 3 (TRL 5 in 2024)
- Shared building blocks for automated ground and space fuelling

Mount RAFTI & Fiducials

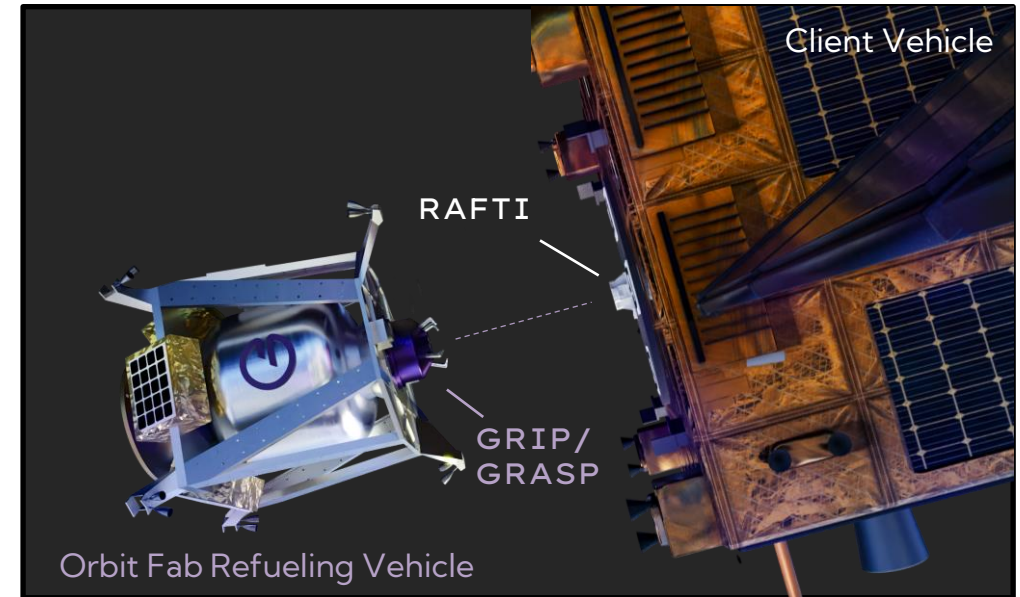
- **RAFTI** – Mount RAFTI on Client spacecraft according to specifications in the MICD and provide for a 520 mm keep out zone.
- **Fiducials** – Incorporate LWIR compatible fiducial ArUco markers on the same face of the spacecraft as RAFTI (offered by Orbit Fab).



Fiducials

Example fiducial mounting on Orbit Fab's Tenzing spacecraft

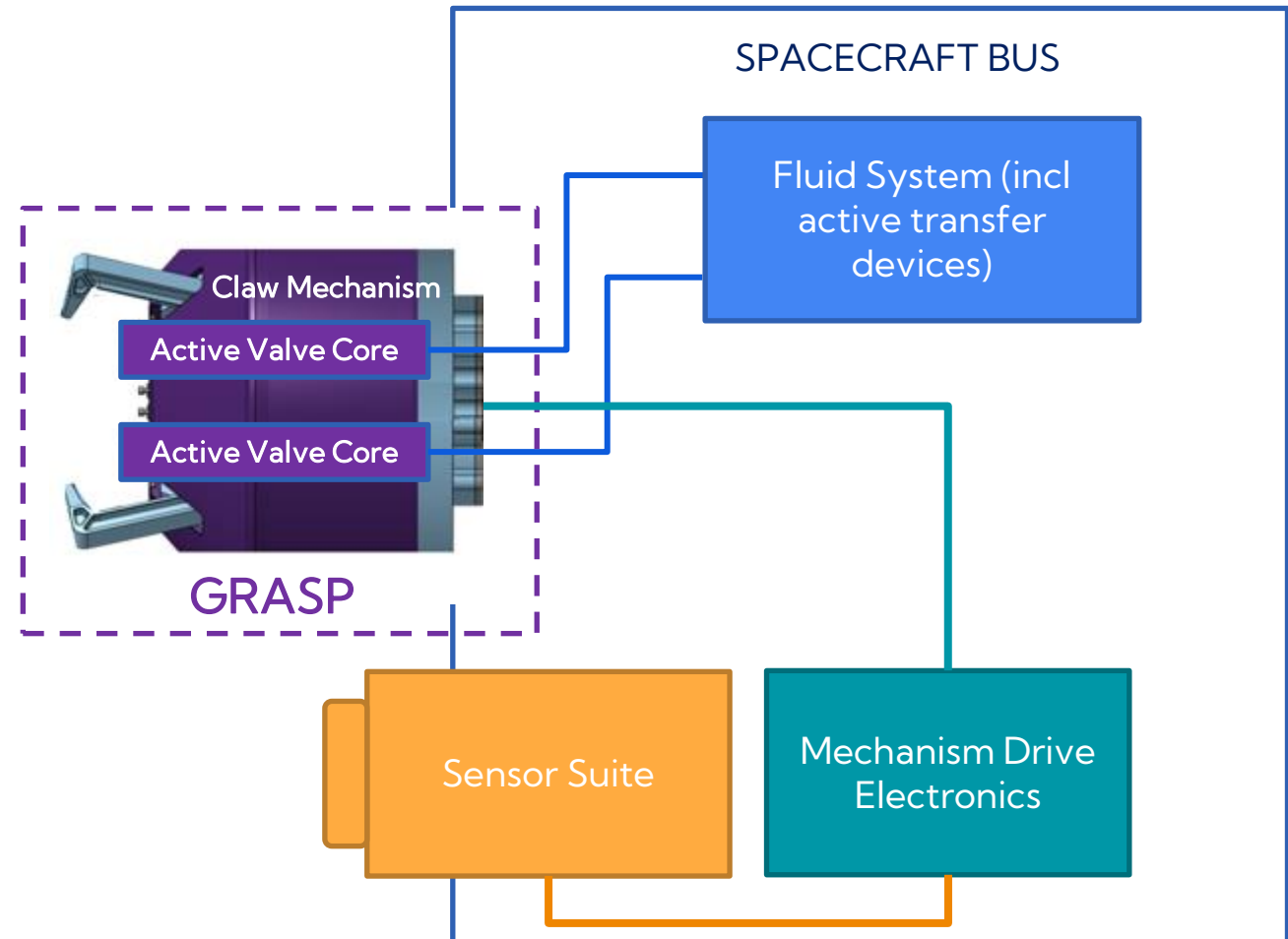
Maintain Stable Attitude



- **Pointing Accuracy** – Maintain pointing with RAFTI along Client spacecraft's velocity vector with an accuracy of 4 degrees or better.
- **Control Stability** – <0.1 degrees over 1 second, 1σ .

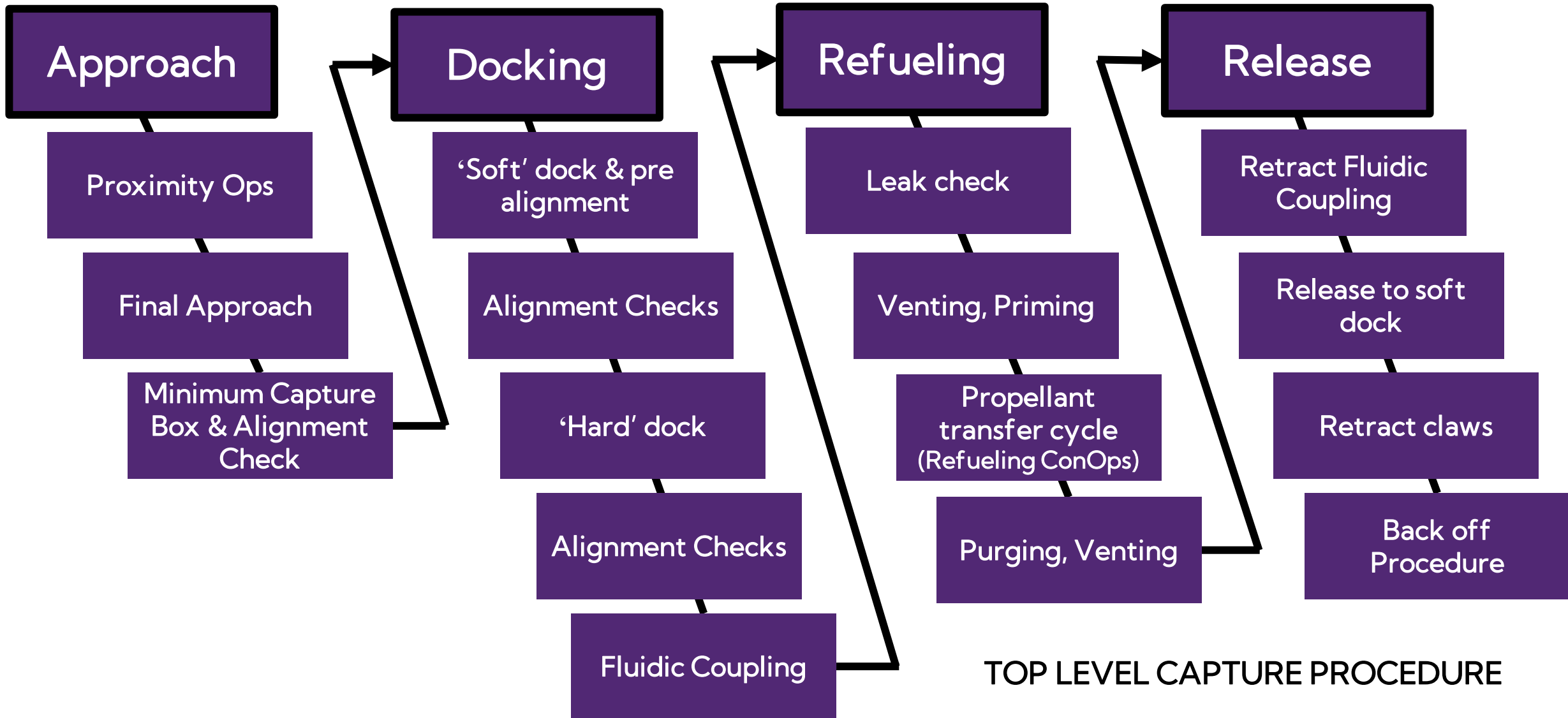
What is GRASP?

- GRASP is an active refuelling interface product, designed for the RAFTI service valve
- GRASP is the overall mechanism including the primary modules, linked together via primary structure
- Primary modules are the Claw mechanism and active RAFTI valve cores (1 or 2), independently actuated

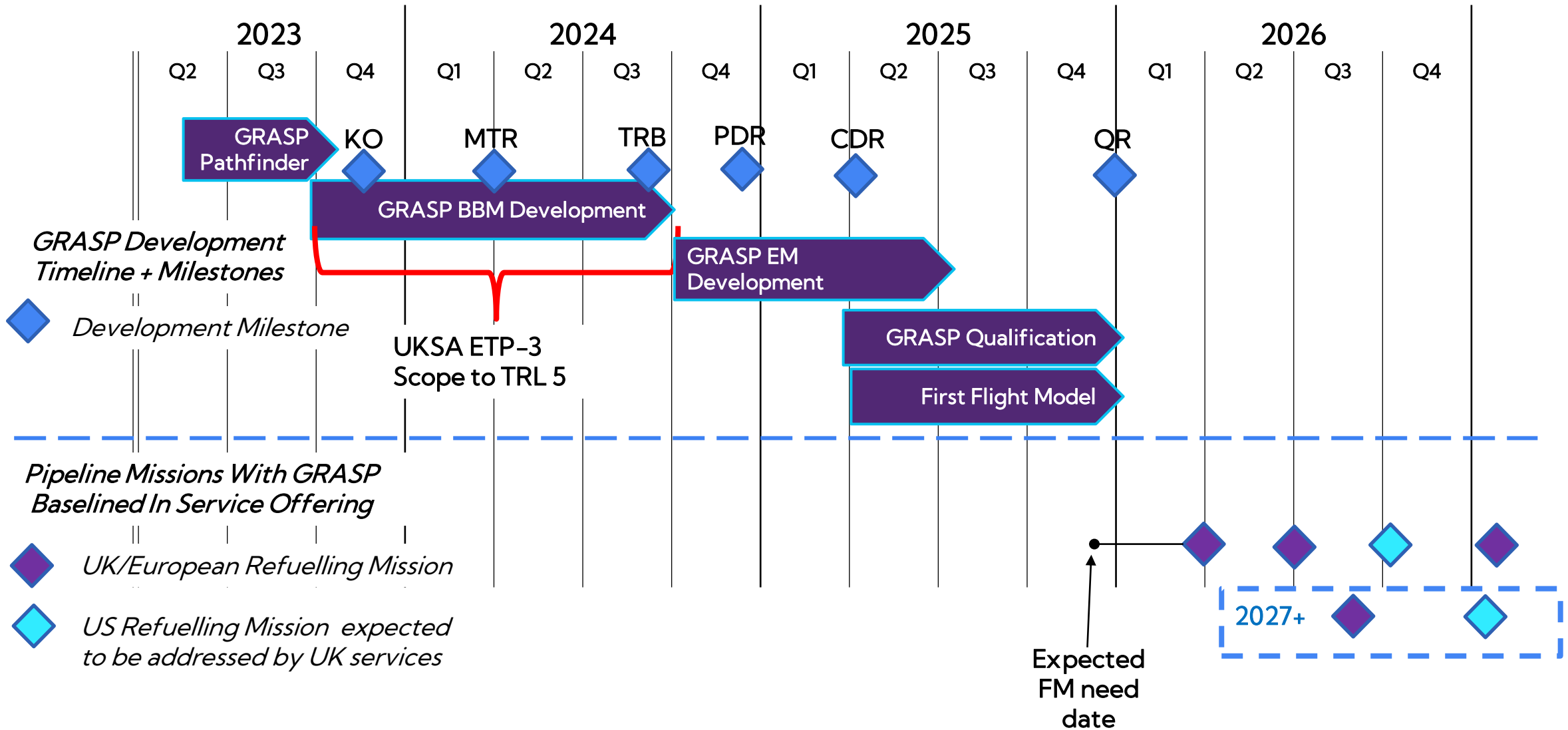


- Provide soft and hard capture capability to a RAFTI grapple fixture
- Usable in compliant and non compliant spacecraft structural contexts
- Enable the engagement of RAFTI valve cores (any type developed by OF)
- Enable bidirectional fluid flow
- Provide 0 inhibits unmated
- Provide 2 inhibits to overboard when mated with RAFTI
- Perform soft capture when within "capture box" (misalignment and displacement envelope, relative velocity envelope)
- Perform hard capture and alignment of RAFTI and active valve cores
- MEOP = 300 Bar
- Capture box values: 20-100 mm xyz, 10 degrees xyz, 0.01 m/s xyz
- Clamping force = 1kN
- Maximum interface load after dock = TBC N
- Flow = 0.5 Bar dP for 10g/s water max

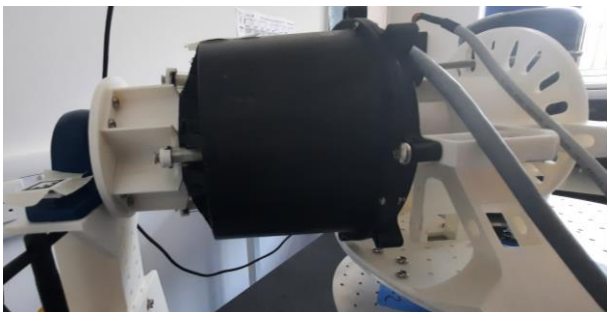
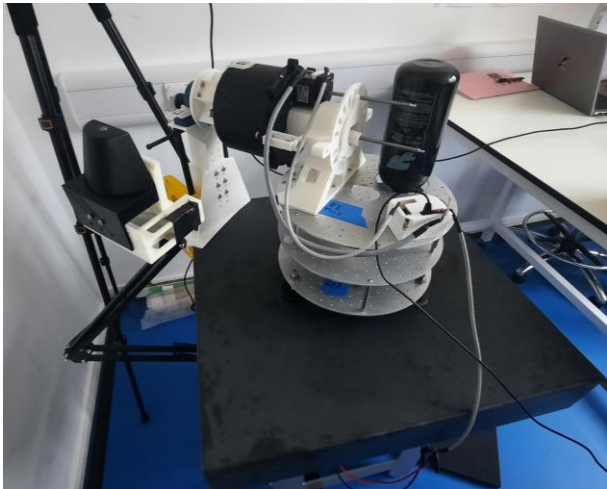
GRASP Operations



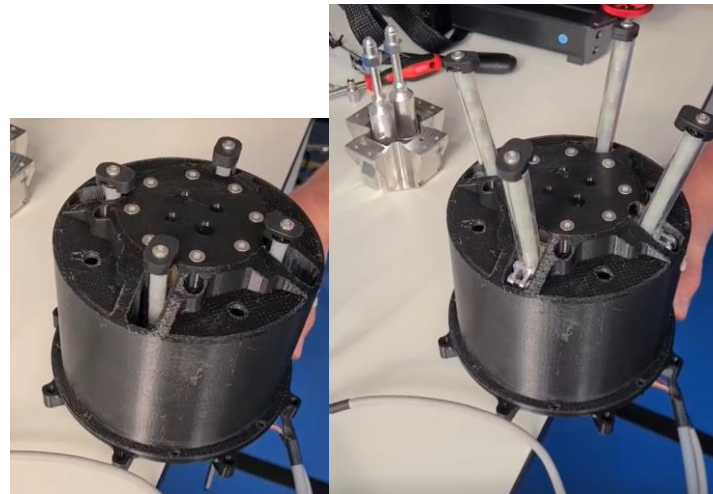
GRASP Roadmap



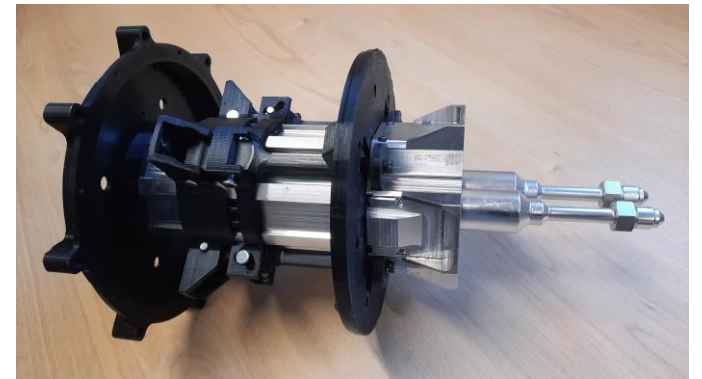
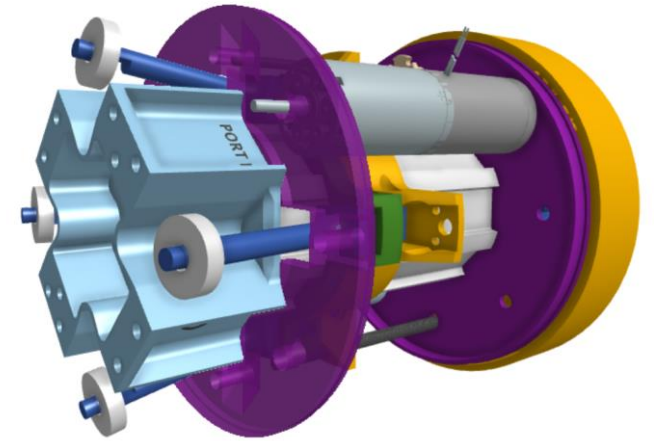
Test Capability



Kinematic Model / BBM 1



GRASP Working Concept





Q&A Discussion

- Want to talk about refuelling?
- Want to work on technology developments together?
- Get in contact!

UK Team

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