space transportation

esa

The Space Rider System key-role as European reusable IOS platform

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Speaker: Raul Cafini (ESA)

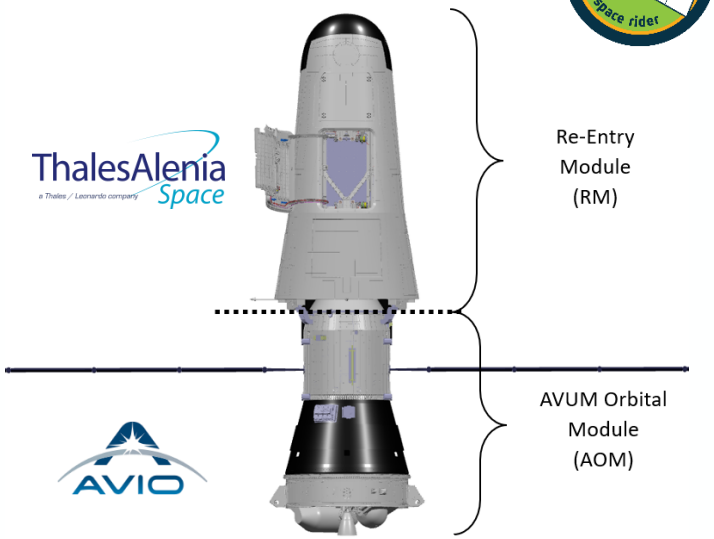
Authors: Fabio Caramelli (ESA), Antonio Rinalducci (ESA)
Gianni Truscelli (ESA), Raul Cafini (ESA)

The Space Rider System (SRS)

- The first European **affordable**, **independent**, **re-usable**, **uncrewed**, **end-to-end commercial transportation system** for **routine access** to (and from) **LEO**.

- **Space Rider (SR) vehicle**: uncrewed robotic laboratory composed by a **Re-entry Module** (**RM**) [TAS-I] and an **Orbital Module** (**AOM**) [AVIO].
  - ✓ Capability to hosts **P/Ls** for an array of **applications**, **orbit altitudes** and **inclinations** (launcher dependant), and **mission durations**;
  - ✓ **2+ Months in-orbit operations**, performing experiments inside its cargo bay such as **technology demonstration** and **research activities** in different fields (e.g., pharmaceutics, biology, physical science, ...)

- **Space Rider Ground Segment** for **orbital vehicle control** (Telespazio) and **P/Ls data & landing management** (ALTEC).

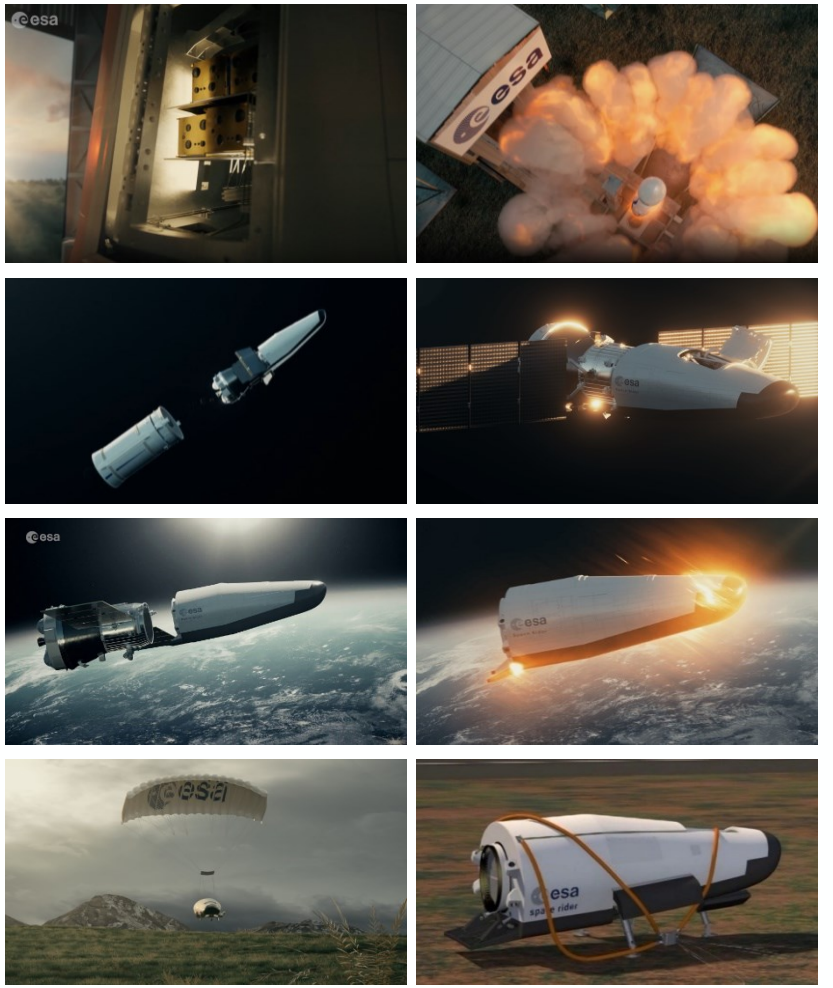


TELESPAZIO a LEONARDO and THALES company

ALTEC

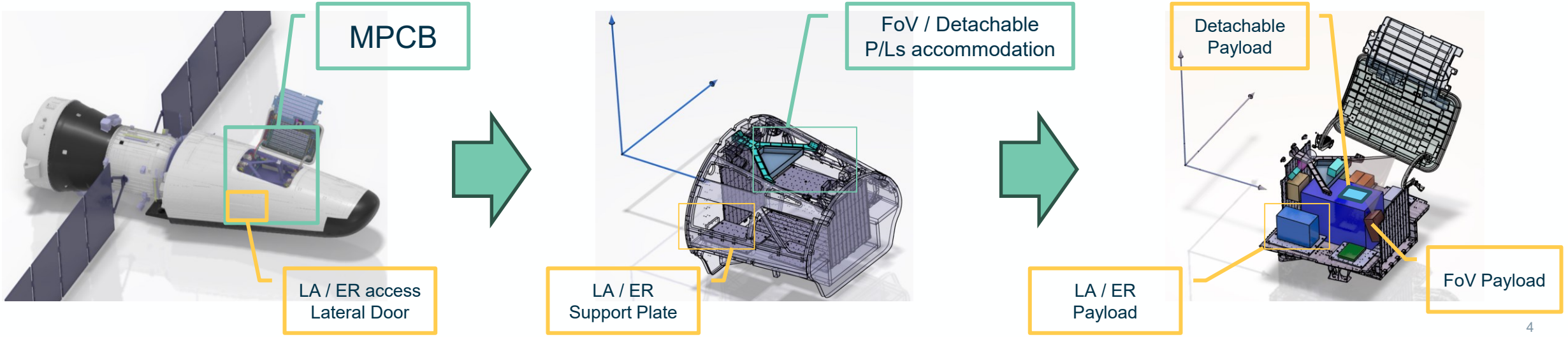
Space Rider – Mission ConOps

- **Pre-launch**: pre-integration and tests, transport to launch site final integration and tests, installation on launcher and transport to launch pad;
- **Launch and ascent**: launch vehicle mission, into near-circular orbit on equatorial/mid inclinations, extendable up to SSO;
- **Orbital flight:** payloads operations for a period of two months and more, each orbit lasting approximately 90 minutes;
- **De-orbiting**: reconfiguration of the Space Rider vehicle for deorbit, execution of the deorbit manoeuvre, separation of AOM and RM;
- **Re-entry and Landing**: AOM destruction and RM re-entry going from hypersonic to transonic flights till the deployment of a subsonic parachute, followed by the triggering of a guided parafoil for a controlled descent till the landing site.
- **Post-Landing**: P/Ls retrieval, RM moved to refurbishment facilities;
- **Post-Flight**: RM inspection, analysis and refurbishment for next flight. The turn-over time is six-month. The RM is designed to perform 6 flights.



Space Rider – Multi Purpose Cargo Bay (MPCB)

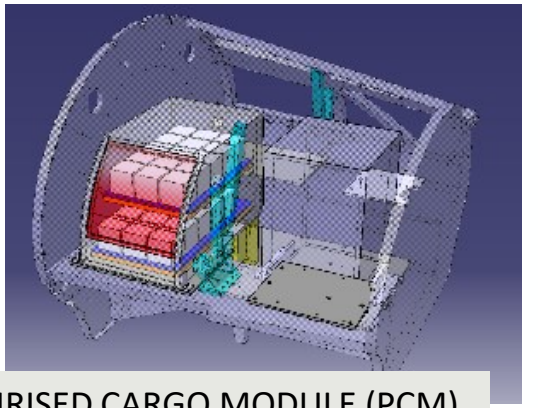
- Accommodation of **multiple P/L configurations**, **sealed** or **vented** P/Ls **directly** or **partially exposed** to space environment (e.g., direct illumination, FoV, …) **movable** or **detachable** (released from cargo-bay).
- Geometrical volume up to **1.2 m^3**, up to **600 Kg** of P/Ls instruments mass.
- Equipped with **power** and **data lines** on **7 payload Support Plates** (**SP**) which purposes are to be:
  - Mechanical standardized fixing interface between the P/L and the RM cold structure.
  - Thermal conductive path between the P/L and the RM Thermal Control System.
- **Late-Access** (**LA**) and **Early-Retrieval** (**ER**) for environmental sensitive P/Ls, integration and retrieval through RM lateral doors dedicated access to the outer face of P/Ls mounted on LA/ER MPCB support plates.



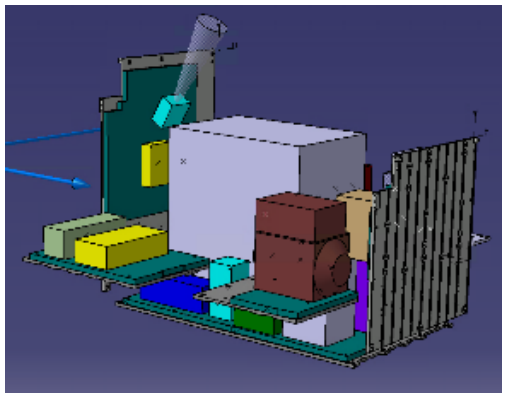
Maiden Flight – Payloads Aggregate Status

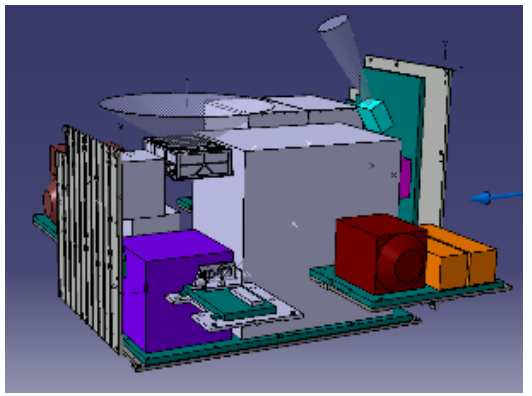
Space Rider **Payloads Aggregate** design for the **Maiden Flight** is currently on going:

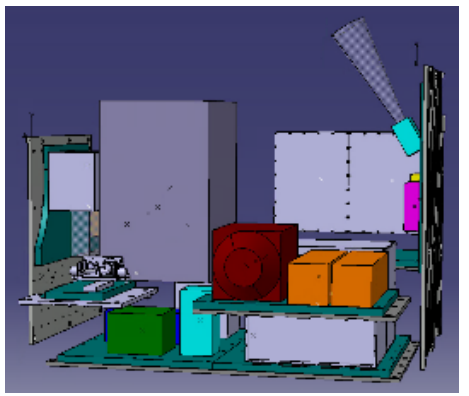
- **20 Payloads** from both **commercial** and **institutional customers** are at the moment on board, representing **various typologies of experiments**:
  - ✓ Pharma/biotech micro-g R&D
  - ✓ Technology IOV/IOD
  - ✓ Physical science, remote sensing
  - ✓ In-orbit operation technologies and processes
- Additional studies ongoing for a **Pressurised Cargo Module** and **Robotic Arm** concepts;

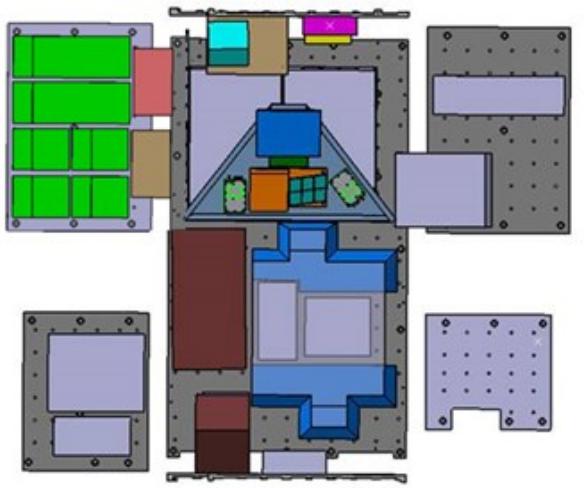


PRESSURISED CARGO MODULE (PCM)









Commercial exploitation (and beyond)

- ESA is committed to **support** and **provide access to space** to European **research**, **development** & **commercial entities** and to enhance the capabilities of **unmanned platforms** with a **mixed institutional & private partnership**;
- **Commercial exploitation** is a SR **primary objective**. Market and use-case applications analyses **identified commercial segments** for PL experiments and highlighted a **strong interest and demand for In-Orbit Services platforms** in the following years;

SR Transportation System

- Transportation Vehicle to support Commercial Service Provider Facilities and Capability

SR Qualification System

- Pre-eminent IOV and IOD qualification platform

Identified SR Commercial Segments

In-Orbit Servicing

- Pioneering the interoperability in LEO platforms

SR ISS Alternative

- Options for oversubscribed and soon to be de-commissioned ISS

Microgravity as a Service

- Platform that supports a wide range of life and physical science applications

ESA STS and Space Rider Business 2 Business portal

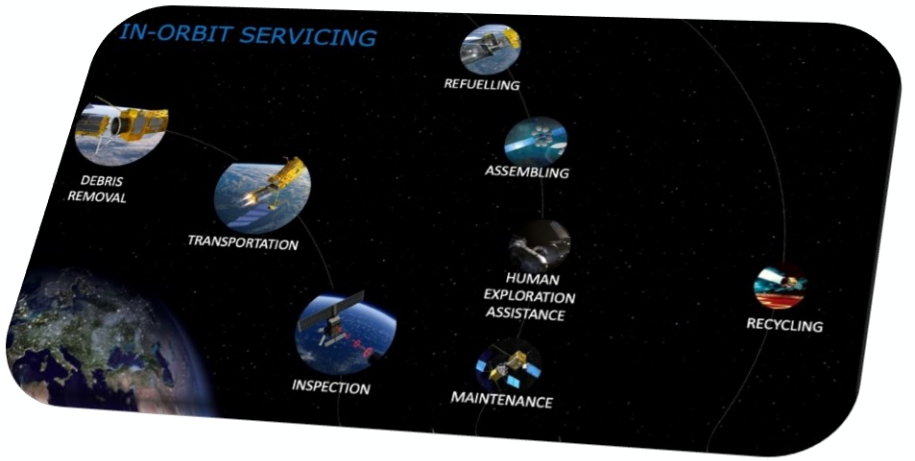
A (unique) platform for clean space applications

- Automated platform capable to (fully) support clean-space applications with its unique features;
- **Baseline architecture** offers
  - **Service provisioning**, **orbital maneuver**, **attitude control**, **cooperative target** capabilities;
  - Capability to **host and release** in orbit the other **PLs/vehicles** to perform joint operations (reducing rendez-vous distances and complexity);
  - Possibility to release PLs/vehicles **shortly before re-entry** to study/explore the re-entry phases and the dominion of the upper atmosphere;
  - **IOD/IOV and TRL raising applications** with capability to **recover flight proven valuable assets** for inspection, further analyses and re-use;
- **Future Capabilities** targeting full support to IOS/CPO operations (more details on next slides);
- Space Rider can also be considered a **first Circular-Economy demonstrator**:
  - Implement, by design, a first example of circular economy in space. The **AOM** is (a modified) **part of the VEGA-C rocket used as a service module**. At the end of the mission, it will be **demised** (via controlled de-orbit burn) if not **potentially reused** for other purposes;
  - The **re-entry module** will be **recovered**, **refurbished** and **re-flight** up-to six times;

Space Rider – Current and Future capabilities

Baseline concept can be **extended** to serve as an **IOS / CPO platform** in addition to a **unique commercial exploitation medium**. SR can be eventually **equipped** to be and configured as:

- A **cooperative** & **prepared target** to be optionally **captured** by another S/C(s)
- A **chaser** able to **manoeuvre**, **reach** and **inspect / capture** a target S/C(s)



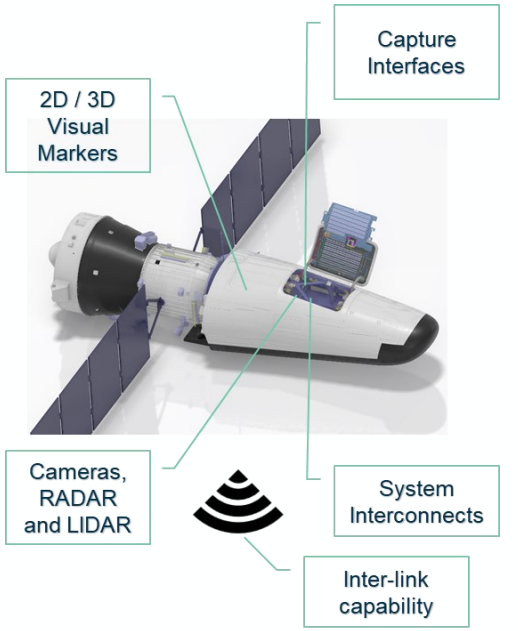
Space Rider IOS / CPO Present and Future Use Cases

- **IOD/IOV of Enabling Technologies & Deploy (and Retrieval) of P/Ls**: P/Ls for IOD/IOV of re-entry and debris mitigation technologies and PLs able to be deployed (optionally retrieved) from cargo-bay. Deployable P/Ls with manoeuvrable capabilities can also perform retrieval and/or re-visitation tasks (e.g., **SROC**)
- **Rendez-vous, Docking / Berthing and Joint Operations**: acting as a cooperative & prepared target for rendez-vous, docking or berthing operations with dedicated robotic arm to perform tasks with other S/Cs (e.g., exchange of P/Ls, mission life extension, available services improvement, de-orbiting capability …).
- **Inspection, Refurbishment, Assembly and Manufacturing**: acting as a chaser performing inspection tasks using its manuverable capability and dedicated robotic arm equipped with cameras or other effectors eventually used for refurbishment, assembly and or in-orbit manufacturing.

Future Capabilities – IOS / CPO Interfaces & Robotics

Ongoing activity for **identification** of the best solutions to equip SR with **physical interfaces** to support **future IOS / CPO use-cases**, exploring the following aspects:

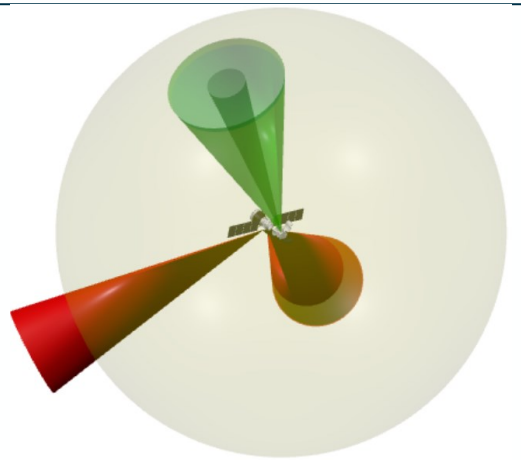
- **Visual Markers**: 2D/3D visual markers to support relative and close navigation during rendezvous up-to docking / berthing operations.
- **Cameras, RADAR, LIDAR**: high-resolution, low latency camera and/or RADAR/LIDAR sub-systems to provide Space Situation Awareness.
- **Mechanical Capture / Grappling Interfaces**: mechanical fixture to enable the SR capture by another S/C, sustained loads, required detailed multi-body analyses.
- **System Interconnects**: exchanging power, data, and other services (e.g., fuels)
- **Standard-based Data and T&C Inter-link**: chaser / target inter-link for communication of vital T&C for CPO in a cooperative scenario (and related security aspects in additional cases) and GNC co-ordination.
- **Robotics**: **robotic arm(s) demonstrators** to manipulate P/Ls from / to or within the cargo-bay, perform inspection duties or other **handling** operations;

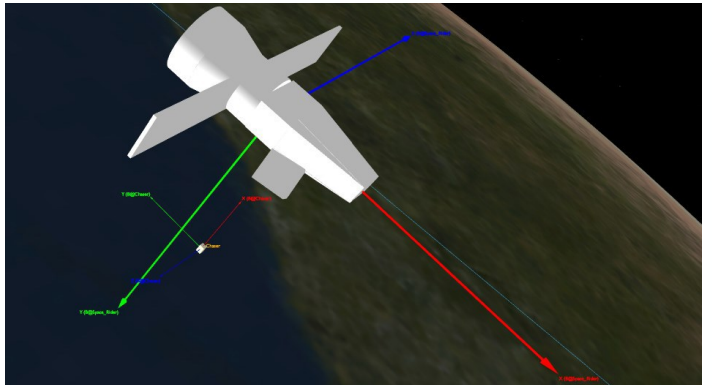


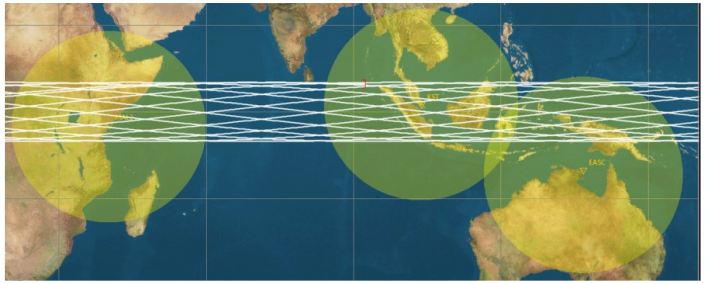
Future Capabilities – Operational Interfaces

Based on "ESA Guidelines on Safe Close Proximity Operations" we have defined the **design principles** and **best practices** to ensure **safe and sustainable** CPO activities with SR defining the **operational requirements** and **procedures** for **current** and **future use-cases**:

- Definition of SR vehicle **parameters** for a **reference CPO configuration** (i.e., passive cooperative and prepared target to ensure safe operation capability)
    - *Empty weight, balance sheet, variable weights, C.G. position and tensor of inertia, propulsion location, plume type and geometry potential proximity sensors and markers positions, mapping of potential sensitive areas or equipment (e.g., physical or other nature shading risk areas), …*
- In accordance with **safety requirements**, the **definition** of suitable system requirements for CPO activities with SR
    - *Preliminary definition of **Approach Zone** and **Keep-out Zone** around the vehicle, a proper **Approach Corridor(s)** to its cargo-bay, **forbidden areas** needed for vehicle attitude control (e.g., star-trackers FoV, …) etc.*

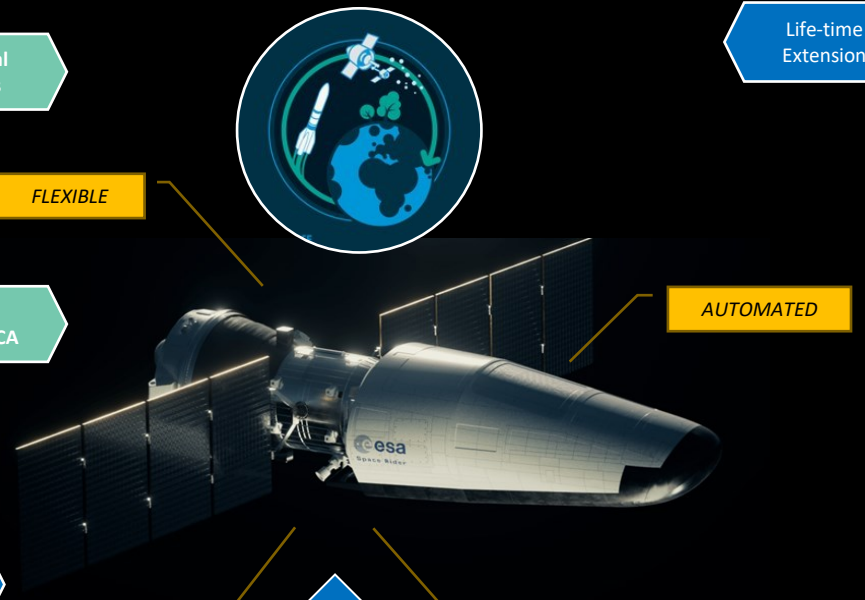






Space Rider Clean Space Applications

- Technology IOD / IOV
  - GNC & Navigation
  - Robotics
  - Atmospheric re-entry studies
  - Mechanical Interfaces
  - Debris Tracking & CA
- Transportation System
  - P/Ls In-Orbit Deployment
  - P/Ls Retrieval
- Microgravity as a Service
  - life and physical science
  - In-space compounds manufacturing



- ISS Complement
  - Life-time Extension
  - P/Ls Exchange
  - Earth / Deep Space Observation
- In-Orbit Services
  - Maintenance / Refuelling
  - Inspection
  - De-orbiting Kit Placement
  - Recycling & valuable assets recovery
  - Space Traffic Management

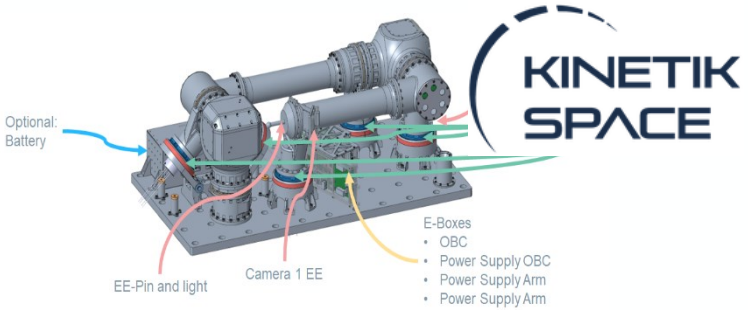
Standard PLs Integration

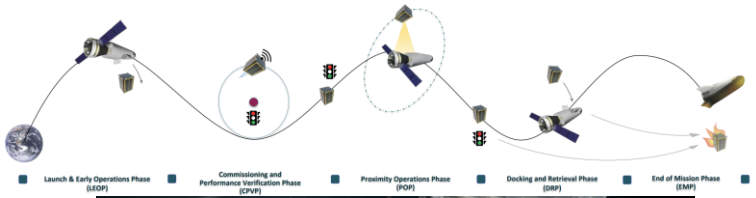
Refurbishment

Standard PLs Retrieval

Ongoing system studies and collaborations

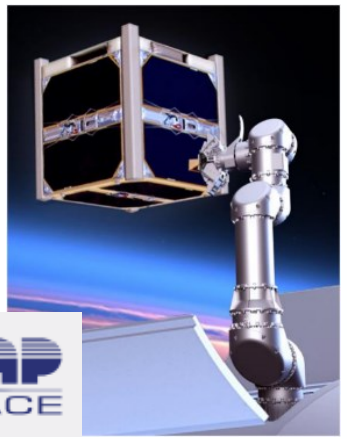
- ✓ Currently ongoing system studies and technology development roadmap in preparation;
- ✓ Following partner collaborations on different fields: deploy and retrieval, joint operations, robotics, …





SAB Aerospace

Tyvak
A Terran Orbital Corporation



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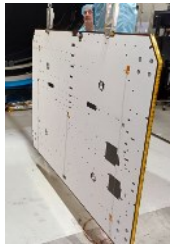
Program Status

- ✓ Scaled-down tests for GNC algorithms validation on-going in Spain
- ✓ First Full-scale Open Loop test sequence concluded end of May in Sardinia.

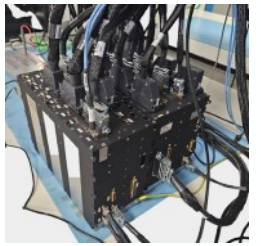


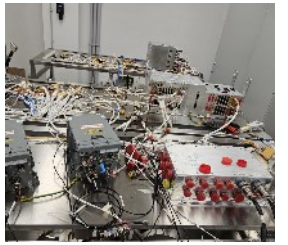

- ✓ Phase D activities on-going. Qualification and flight models hardware under manufacturing/delivering.
- ✓ Avionic benches for system level tests on-going.


ALEK Cone

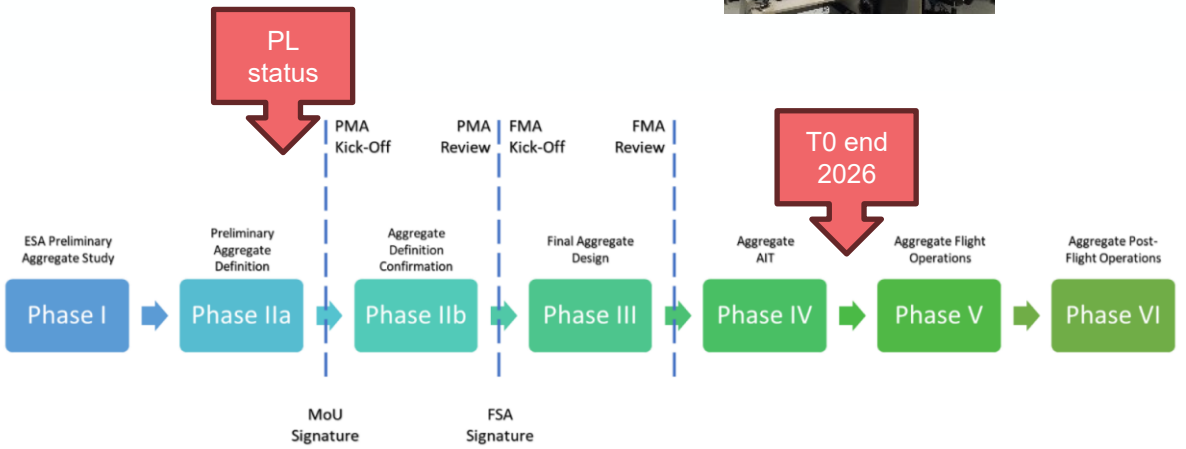

Solar Array Wing


Star-Tracker


On-Board Computer


HWIL Test Set-up

- ✓ Ground Segment activities on-going. Ground Segment Implementation Review (GSIR) successfully completed in July



Conclusions

- Do you plan to provide a **service in space** (e.g. **in-space laboratory**, **in-orbit manufacturing**, **refuelling**, …) and are you looking for a **suitable platform to enable it**?
- Do you plan to **test**, **validate** and/or **operate innovative technologies** (i.e. related to **debris mitigation**, **GNC**, **proximity/formation flight**, …) in space?
- Are you looking for an **affordable**, **service-capable** (power/thermal/data provisioning) and **re-usable vehicle** to **fly** [**deploy/recovery**] and support **your application** in space?
- Are you **designing a mission** for **clean space applications** and want to exploit Space Rider as a **transportation** and **co-operation** means for your **objectives**?

esa space rider

What are you waiting for?
Join the Space Rider journey!

spacerider.commercialisation@esa.int