Bioreactor Express Partnership

Committee #3
Meeting with ESA

November 15th 2023

Kayser Space Ltd
Harwell Campus, Building R104, Fermi Avenue
Didcot, Oxfordshire OX11 0QX
www.kayserspace.co.uk
info@kayserspace.co.uk

Contents

- Status of Commercial Utilisation
- Marketing and promotional activities
- BSGN Accelerators
- KUBIK availability and flight opportunities
- Customer satisfaction and impact survey
- Partnership agreement extension and evolution

Status of Commercial Utilization

- BioAsteroid
- Nano2Space (Immune Cell Activation)
- Greenbone
- Other activities

Status of Commercial Utilization

- BioAsteroids
  - The investigators have prepared a manuscript on BioAsteroid unique results, reporting on bioleaching and metabolomics data and are preparing for submittal
  - 18 authors and 7 collaborating centres

[1] UK Centre for Astrobiology, School of Physics and Astronomy, University of Edinburgh, Edinburgh, EH9 3JZ, UK
[2] Cancer Research UK Edinburgh Centre, Institute of Genetics and Cancer, University of Edinburgh, Edinburgh, UK
[3] Department of Physics & Astronomy, Rice University, Houston, TX, USA
[4] School of Biological Sciences, University of Edinburgh, Edinburgh, UK
[5] School of Geosciences, University of Edinburgh, Edinburgh, UK
[6] Kayser Italia S.r.l., Via di Popogna, 501, 57128 Livorno, Italy
[7] School of Chemistry, University of Edinburgh, Edinburgh, UK

Status of commercial activity development

- Nano2Space (Immune Cell Activation)
  - Payload, staff, support equipment and operational products ready to support the mission
  - The launch is planned for end of January 2024 with NG-20 from the NASA Kennedy Space Center Flight Facility

Status of commercial activity development

- Greenbone
  - Contract for Phase 1 (between ESA-ECSAT and GreenBone Ortho SpA) awarded
  - A new sample holder able to host the scaffold designed and manufactured
  - A medical biocompatible photopolymer resin was used to 3D print the sample holders
  - Desing baselined for Phase 2
  - Phase 1 demonstrated the adequacy of the SPHINX HW with the science protocol
  - Activities completed; final meeting held on March 1st 2023

Status of commercial activity development

- Greenbone
  - No feedback from ESA from the end of Phase 1
  - Any progress on Phase 2 preparations?
  - Proceca submitted in November 2022; no feedback received
  - Follow up phase 2
    - HW request to the Agency (same procedure already used for Phase 1)
    - HW refurbishment
    - Consolidation of the science protocol
    - Safety
    - SVT
    - Mission preparations
    - Integration at launch site
    - Launch and mission accomplishment
    - Estimated from KO Phase 2 until Flight Readiness: 9-12 months

Status of commercial activity development

- Other activities
  - Initial assessment and quotation prepared for Axiom Space for an experiment on Ax-3 mission
    - Axiom realised the experiment requirements could not be implemented in KUBIK (requiring a much larger centrifuge)
  - Further talks going on with Axiom Space facilitated by the UK Department of Business and Trade in view of a showcase in Houston (February 2024) where Axiom Space will meet with potential partners or supplies of technologies and services

Status of commercial activity development

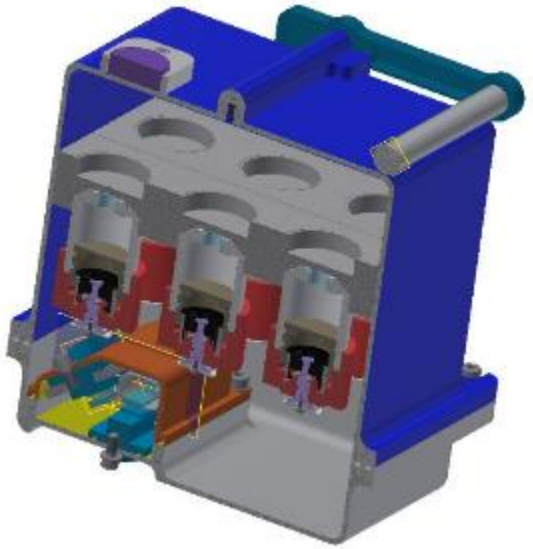
- Other activities
  - Studies and PoC previously accomplished
    - CelAgr (Campden BRI and Cellular Agriculture Ltd): investigation on Nutrition (future spaceflight, cultured meat scale up)
    - KICCAM (University of Nottingham): multi-well bioreactor fitted with a range of cameras able to take high resolution images of samples growing in individual culture cells
    - Both PoC were focused on the integration of the bioreactor within a 10x10x10 EC as reference of the CubeSat typical payload volume
    - The assembly would be compatible with tech demo in KUBIK (using the KIC Magnum)
  - Our partners are applying to a call of the UK Space Agency for emerging technologies and TRL increase
  - The proposals include a tech demo in KUBIK
  - Timeframe if successful: February 2024 – May 2025 (15-month work) with HW ready for demonstration
  - Flight opportunity could be sought from June 2025
  - CellAgr could require cold stowage / early access to KUBIK

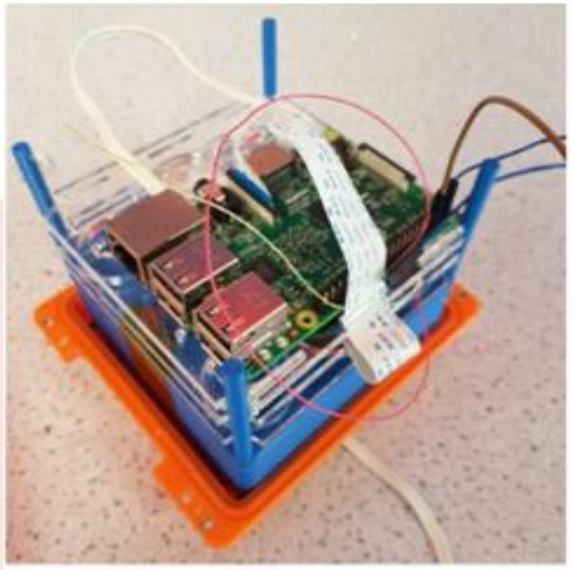
Status of commercial activity development

- KICCAM background

Kayser Space and the University of Nottingham have developed a breadboard for a multiple-well bioreactor fitted with a range of cameras able to take high resolution images of samples growing in individual culture cells. The entire payload can be enclosed within a standard 1U container that can provide several levels of biological and chemical containment

With the advent of commercial exploitation of the space environment, this technology opens up the possibility of carrying out in-situ monitoring and hence represents a step-change in life science experiments performed in microgravity that currently rely on sample return for analysis. It will also enable scientists to interact with experiments on the ISS and other future platforms in near real time, as well as the exploitation of other space platforms such as cubesats, and the deployment of experiments in extreme environments on Earth or the surface of the Moon, where sample return may not be feasible.



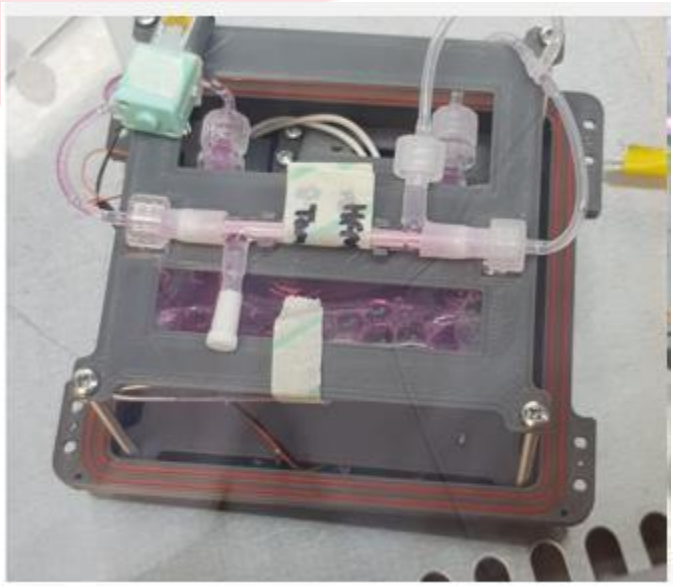


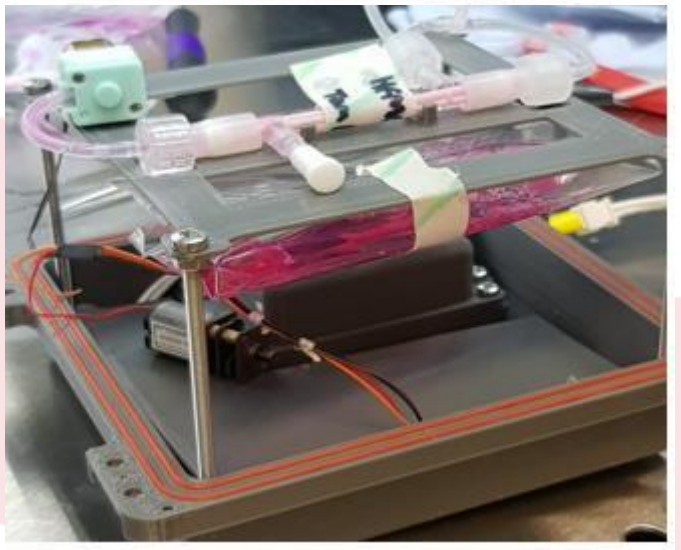
Status of commercial activity development

- CelAgr background

A proof of concept has been performed in 2022/2023 to study the implementation of a technological demonstration in KUBIK for a bioreactor aimed to fabrication of cultured meat in microgravity. The work was carried out by Cellular Agriculture Ltd (a company founded in 2016 as the first UK startup in the cultured protein R&D) in partnership with Kayser Space and Campden BRI.

Following a feasibility study funded by ESA on Cellular Agriculture for Future Human Space Missions, this PoC activity set out to implement a laboratory breadboard model for a system to grow artificial meat in space based on Hollow Fibre Bioreactor (HFB) technology. The breadboard combines the HFB with space qualified components (pumps, medium reservoirs, active enclosures) suitable for deployment on the ISS KUBIK incubator. The system is used in the laboratory to optimise the experimental parameters and protocol for a space demonstrator mission.





Marketing and promotional activities

- Website and social media
  - Website updates (2000+ visits); newsletter
  - Twitter (145 followers) and LinkedIn (2000+ followers) accounts active

- Events and dissemination
  - ESA BSGN Industry Accelerator (various events)
  - Italian Society of Astrobiology annual conference
  - UK Space Conference (next week)

- Investments
  - Optimisation / reallocation of biological laboratories at Kayser Italia
  - Procurement of new 3D bioprinter

BSGN Accelerators

- Kayser was involved in phase 2 applications with BRE
- Letters of support with initial offer provided to 8 bidding groups (mostly in the agriculture accelerator)
- Some proposals were not selected
- All Italian teams selected for phase 2 cannot proceed for lack of National funding
- Was securing National funding a requisite to go on in the accelerator?
- Only one collaboration active on the implementation of a fermentation and protein purification process in space, but with unclear scope and programme

- KUBIK availability and flight opportunities
- Customer satisfaction and impact survey
- Partnership agreement extension and evolution