SSPACE Astrobiology Payload - 2 (SAP-2)

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Introduction

- The SSPACE Astrobiology Payload (SAP) series is a pioneering initiative to study the effects of space conditions on biological systems.
- It addresses critical challenges posed by microgravity and space radiation.
- Designed for autonomous experiments in Low Earth Orbit (LEO).
- Aims to provide valuable insights into microbial behavior and metabolic processes.
- Contributes to astrobiology research and the advancement of space exploration.

Payload Structure & Design

- The payload includes four hermetically sealed, cassette-like structures containing bacterial specimens in a semi-solid substrate.
- Each cassette is transparent and primarily made of acrylic.
- Features built-in carbon dioxide sensors to monitor gaseous concentration.

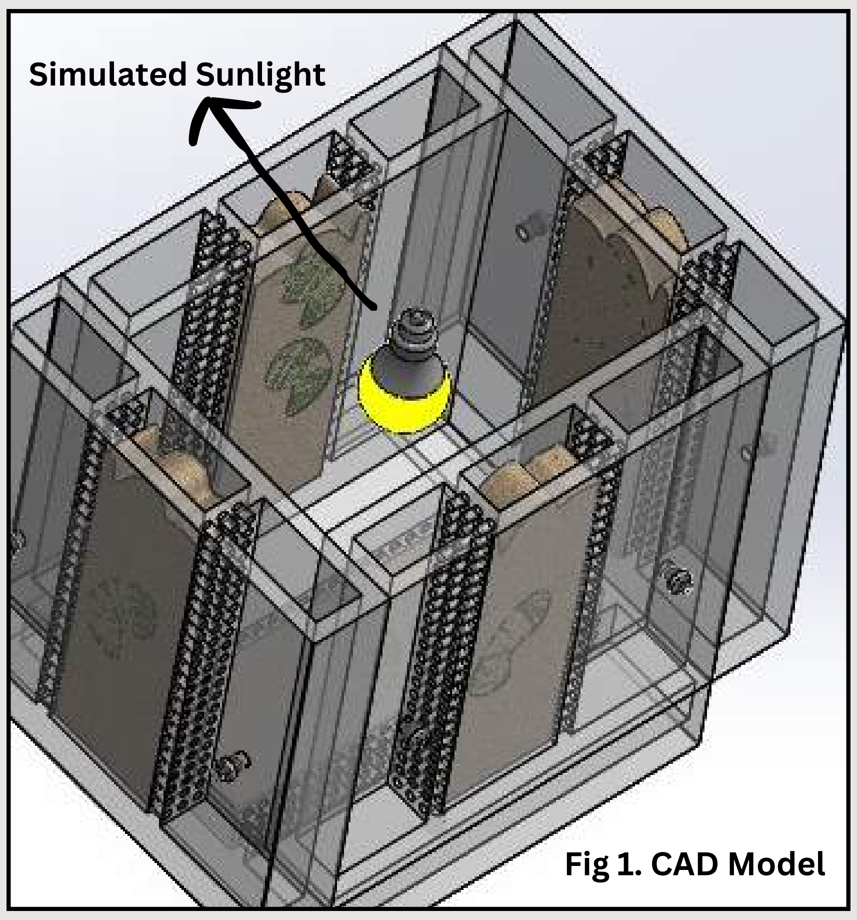


Fig 1. CAD Model

- The cassettes are housed within a 6U structure.
- 4U is dedicated to the biological setup.
- 2U is allocated for electronics and interfacing.
- The overall system weight is nearly 6 kg.

Fig 2. PSLV Launch Vehicle Proposed Vehicle for carrying SAP-2 to LEO

Fig 3. POEM payload platform carrying PILOT-G2, a payload developed indigenously at SSPACE IIST, which is now in orbit.

Microbe Used

Cyanobacteria, a class of blue green algae, are chosen as specimens of interest from a diverse range of microorganisms, for the fact that these can generate oxygen from carbon dioxide via photosynthesis. Thus, they are highly beneficial for human space missions and are less studied in adverse space conditions.

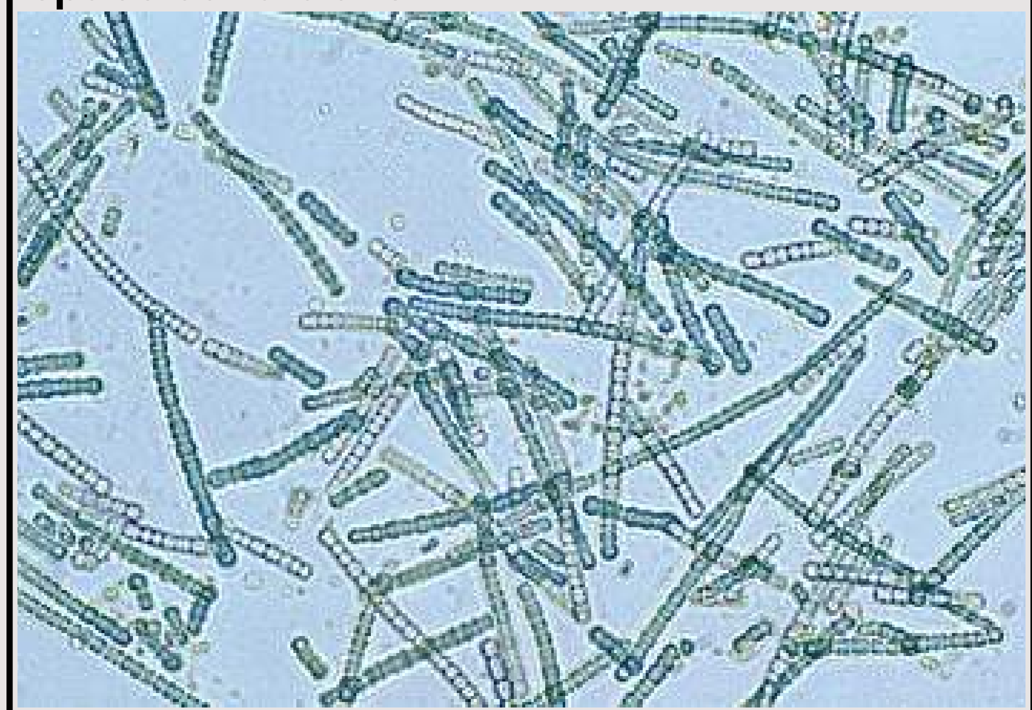


Fig 4. Cylindrospermum cyanobacteria under the microscope. Credit: Willem van Aken.

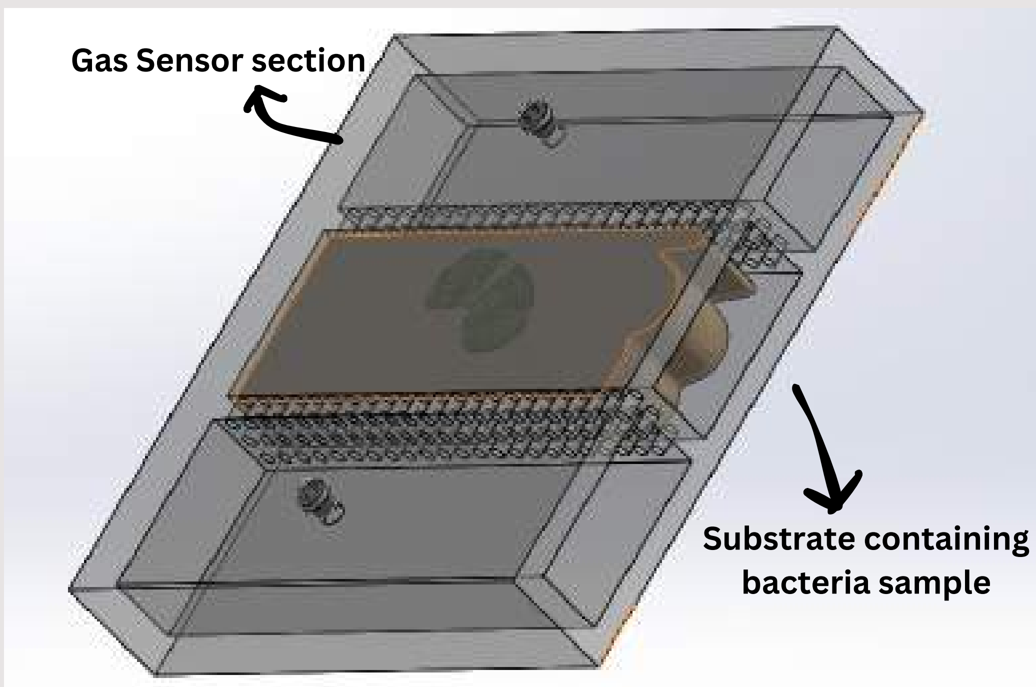
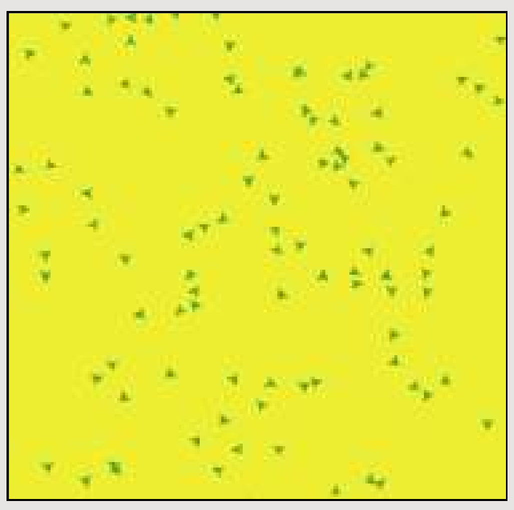


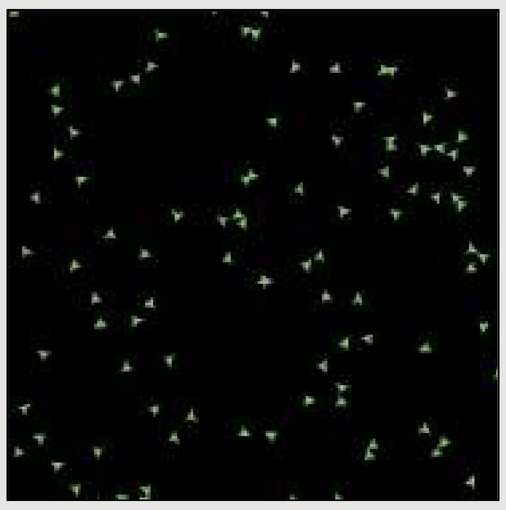
Fig 5. An individual Cassette of the payload

Simulations

- The agent-based model simulates bacteria that photosynthesize by day and respire at night, regulating CO_2, O_2, and glucose levels.
- Bacteria move, grow, reproduce, and die based on energy availability and lifespan.
- The environment alternates between day and night cycles, influencing population dynamics.



Sunlight On - Photosynthesis phase

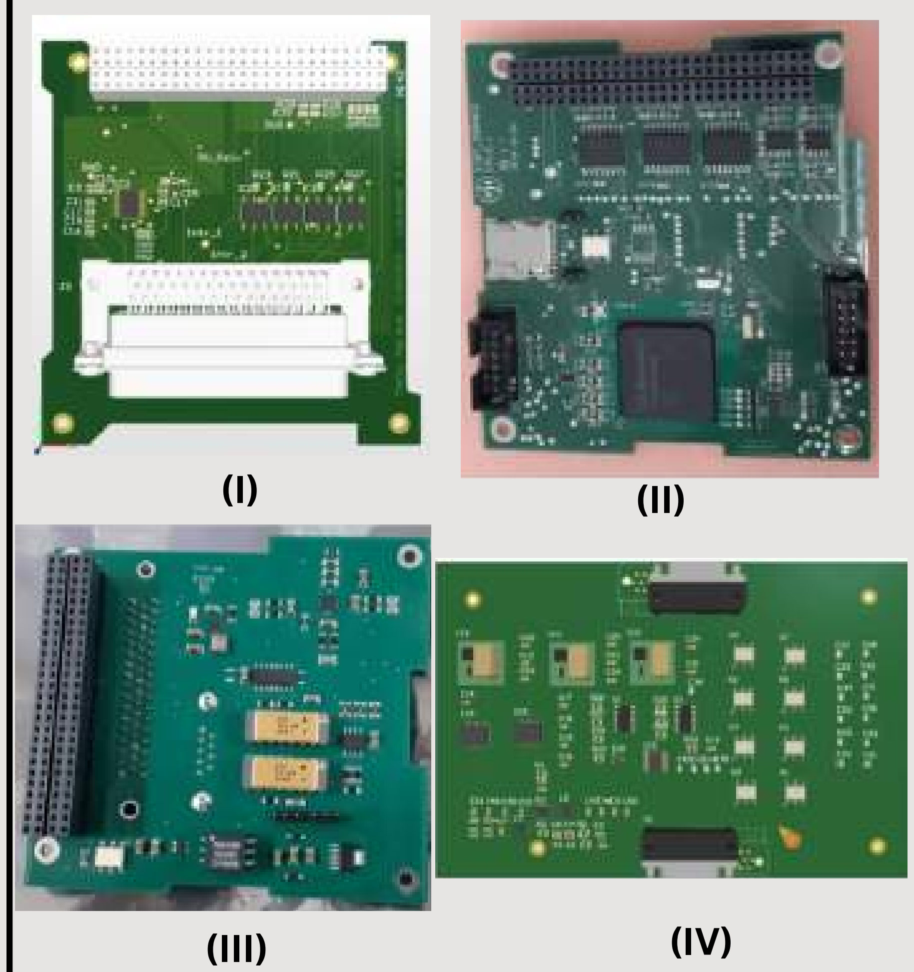


Sunlight Off- Respiration phase

- Microgravity and space radiation effects can also be incorporated into the model.
- The model was developed using NetLogo, a software tailored for agent-based modeling.

Payload Electronics

(I) Payload Interface Board
(II) On-Board Computer
(III) PSLV Interface Board
(IV) Chamber Electronics Board



- The Command and Data Handling (CDH) subsystem controls operations and data. It interfaces with the chamber electronics board to connect sensors, actuators, and light sources.
- A PSLV interface board enables communication with the POEM platform and manages data exchange.
- The payload interface board handles power, keeping total consumption below 5W in orbit.
- Data can be received by the in-house ground station at IIST.

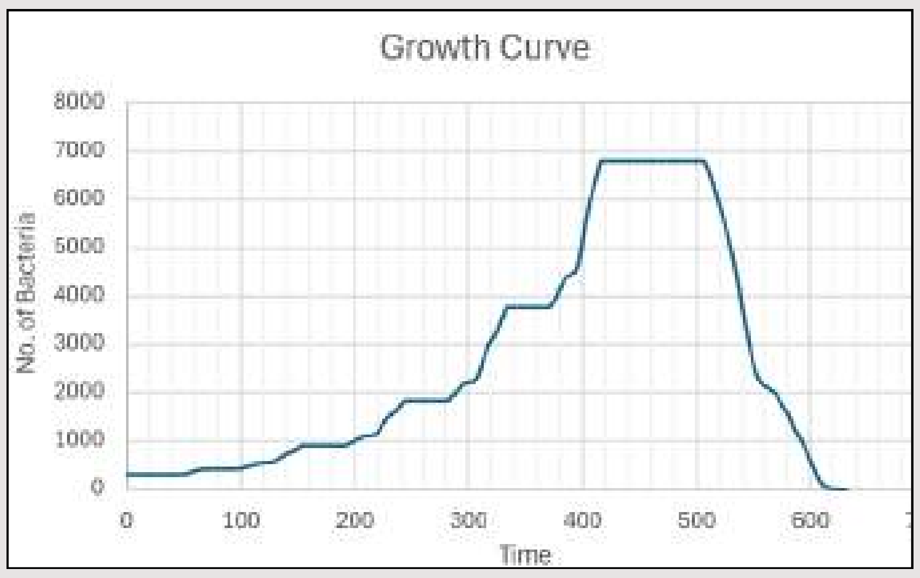


Fig 6. Simulated Bacterial Growth Curve using dummy values

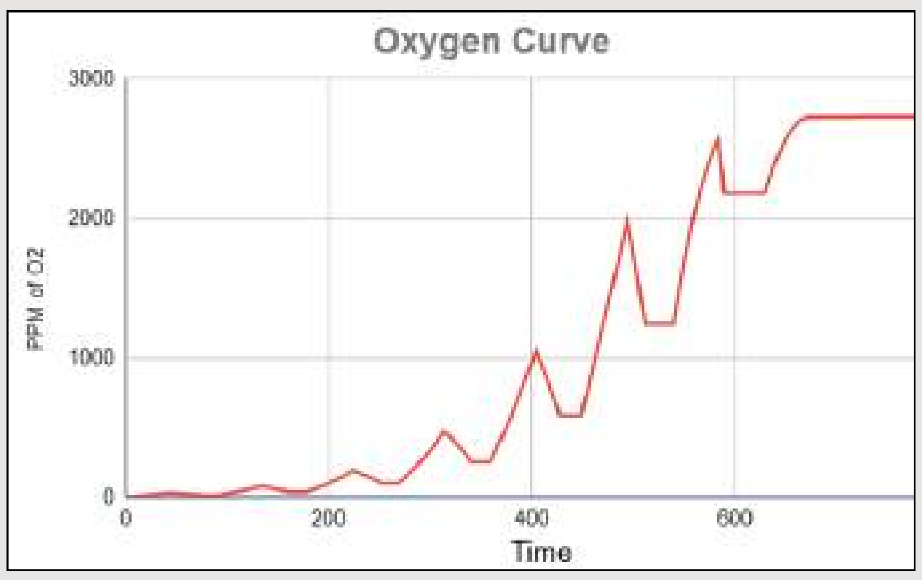


Fig 7. Simulated Oxygen Curve using dummy values

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