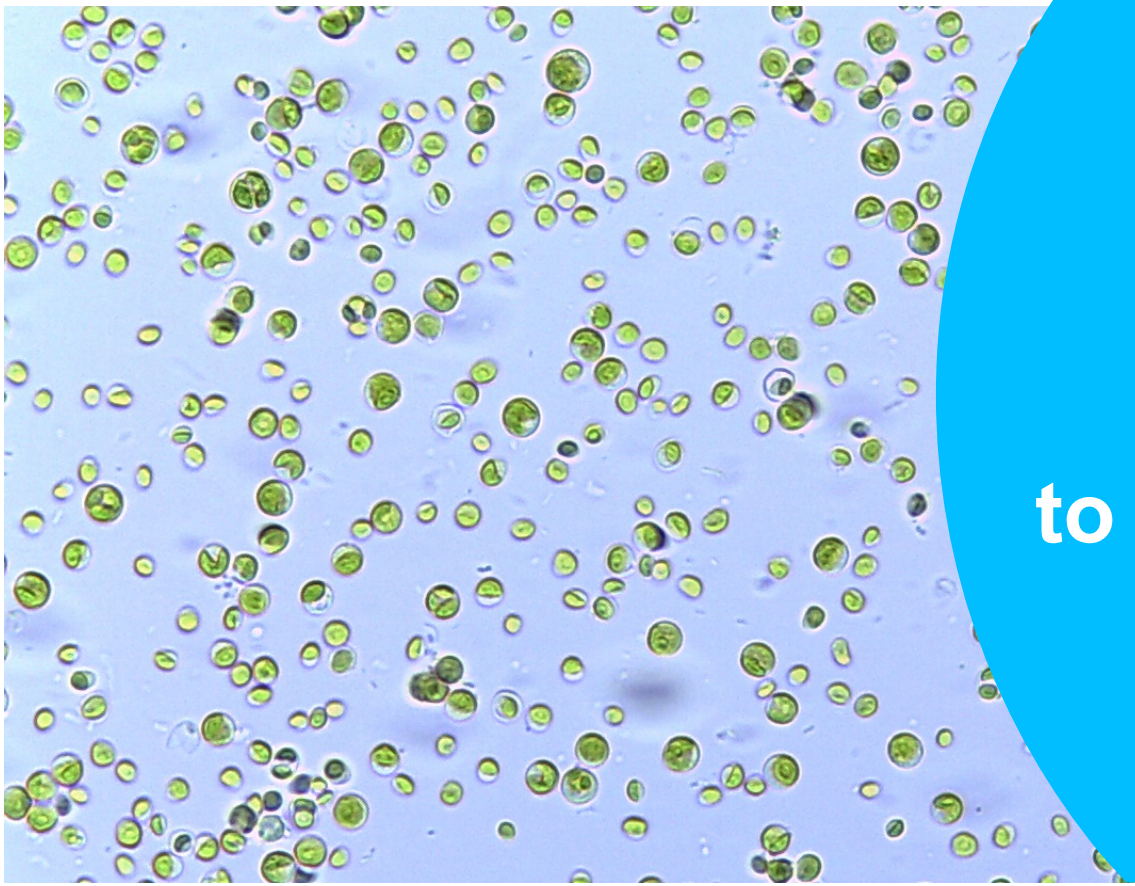
University of Stuttgart
Institute of Space Systems



Microalgae

from oxygen and food production in Space

to groundwater processing on Earth

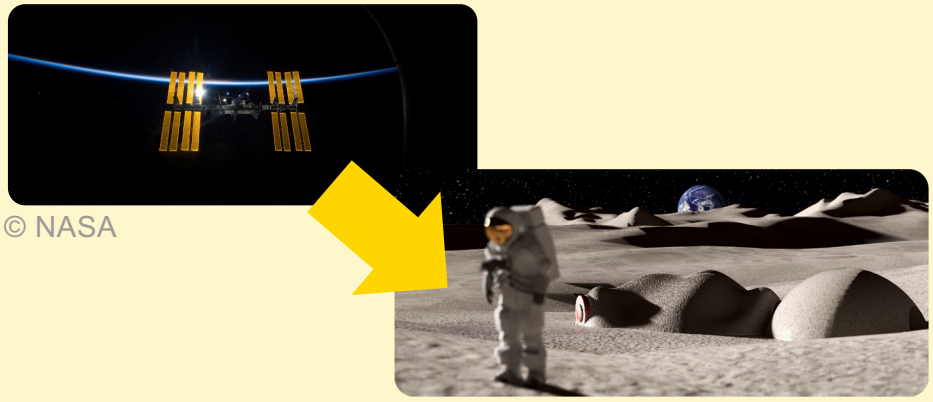
G. Detrell, H. Helisch, J. Keppler,
J. Martin, A. Dannenberg

MELiSSA Conference 2020

Institute of Space Systems

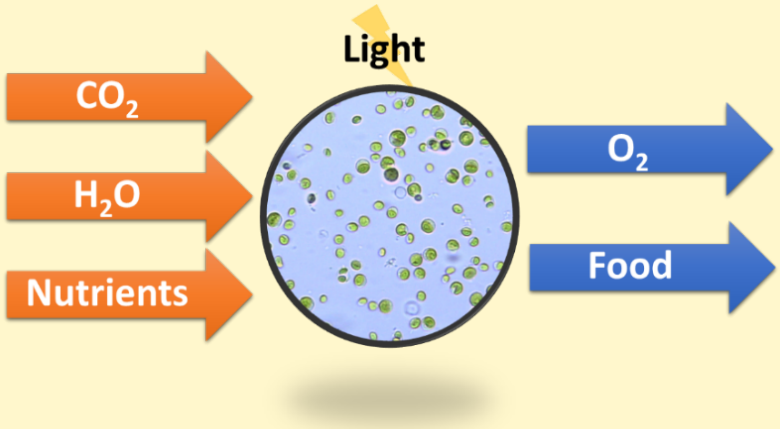
Microalgae: from Space to Earth Applications

1. Introduction



© NASA

© SSDW



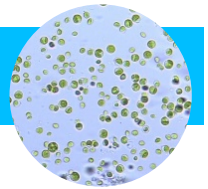
Oxygen & Food supplement

1

High throughput

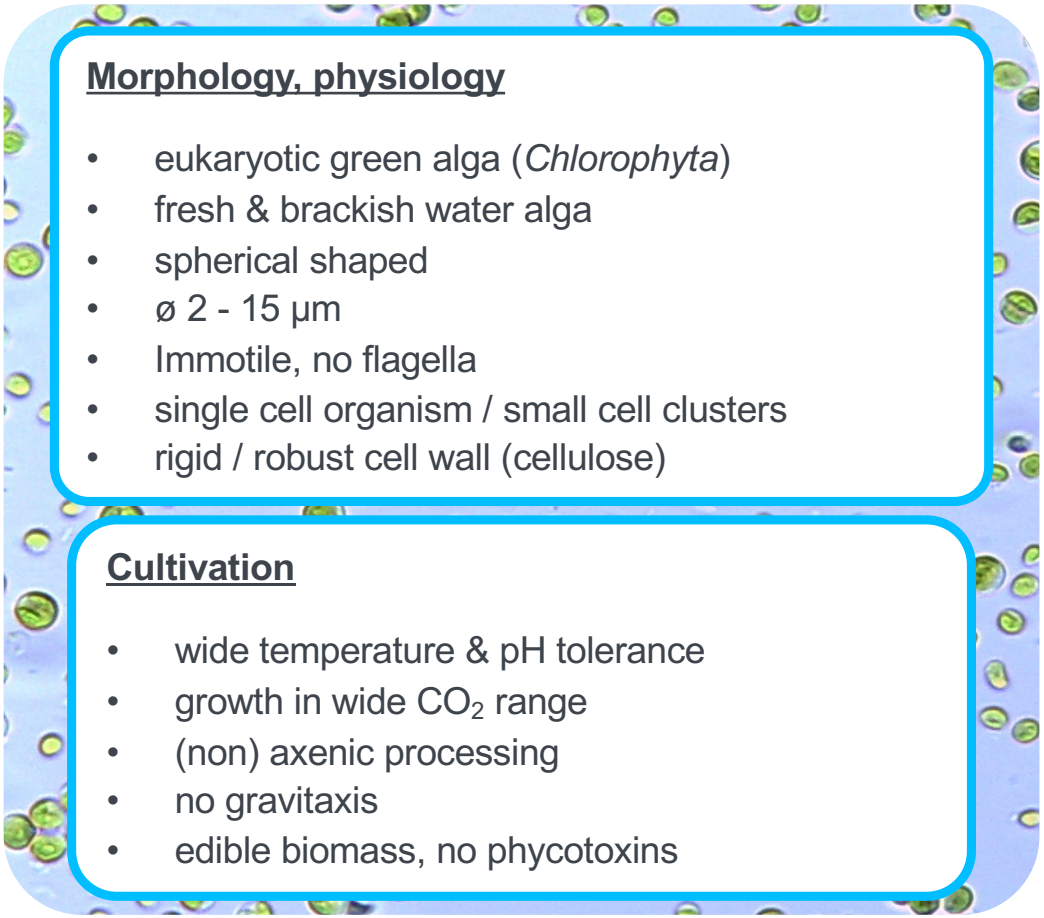
Cultivation

Robustness



1. Introduction

Chlorella vulgaris



Morphology, physiology

- eukaryotic green alga (*Chlorophyta*)
- fresh & brackish water alga
- spherical shaped
- ø 2 - 15 µm
- Immotile, no flagella
- single cell organism / small cell clusters
- rigid / robust cell wall (cellulose)

Cultivation

- wide temperature & pH tolerance
- growth in wide CO_2 range
- (non) axenic processing
- no gravitaxis
- edible biomass, no phycotoxins

Oxygen & Food supplement

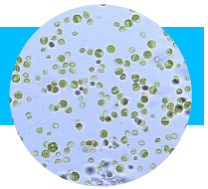
1 High throughput

Cultivation Robustness

2 Long-term stability

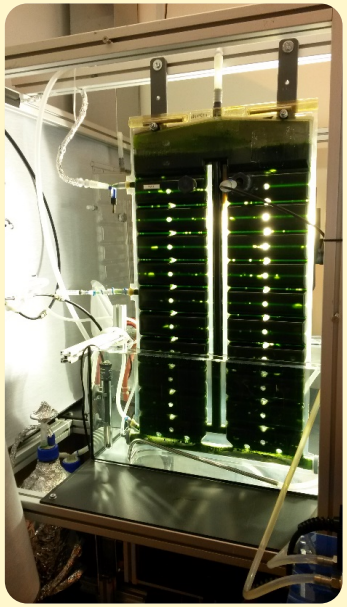
3 PBR for Space Systems

4 PBR for Terrestrial applications



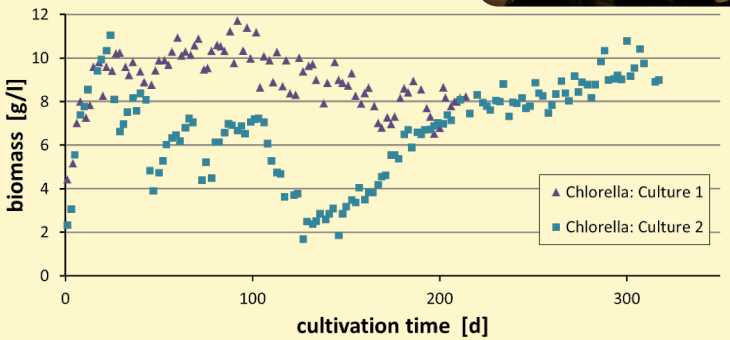
2. Long-term stability – Experiments at IRS lab

- > 6 years
- gravity dependant systems



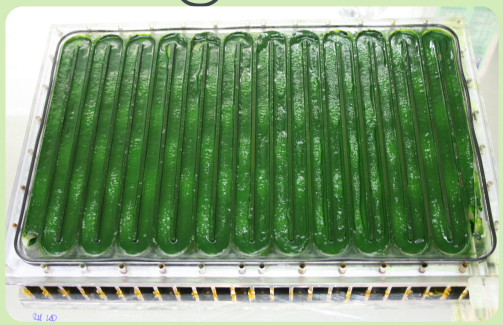
Flat Panel Airlift PBR

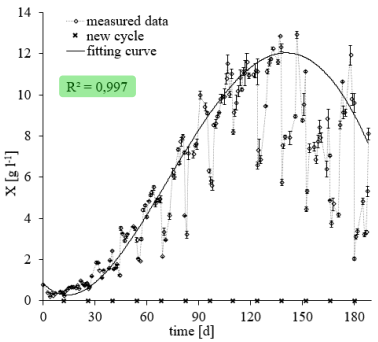
subitec

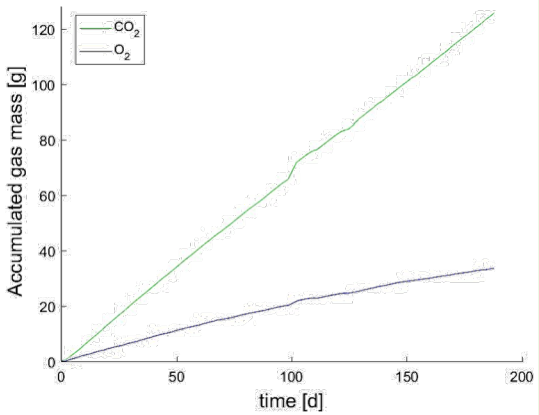


- > 6 Months
- microgravity designed system

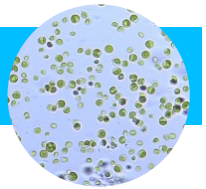
PBR@LSR BB







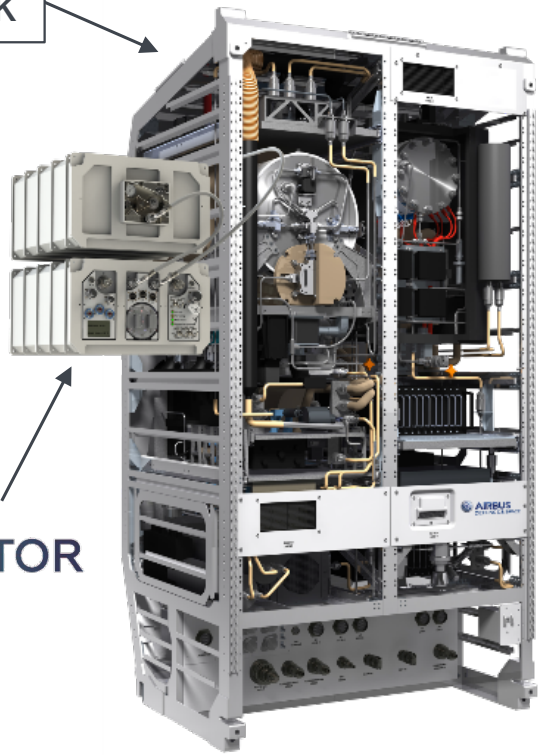
Microalgae: from Space to Earth Applications



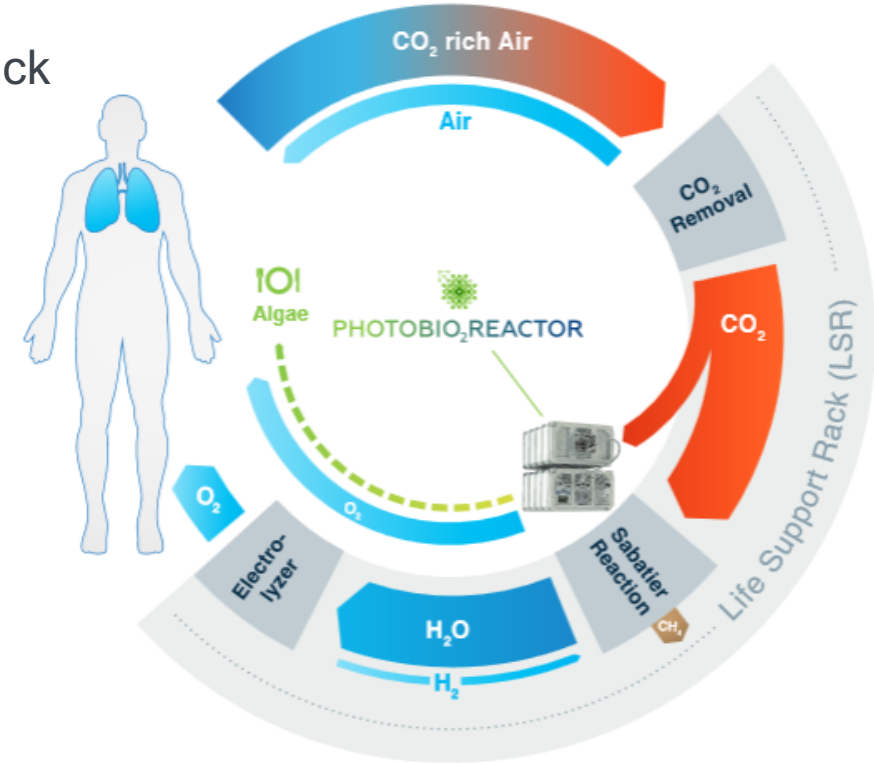
3. PBR for Space Systems

PBR@LSR = Photobioreactor @ the Life Support Rack

Life Support Rack

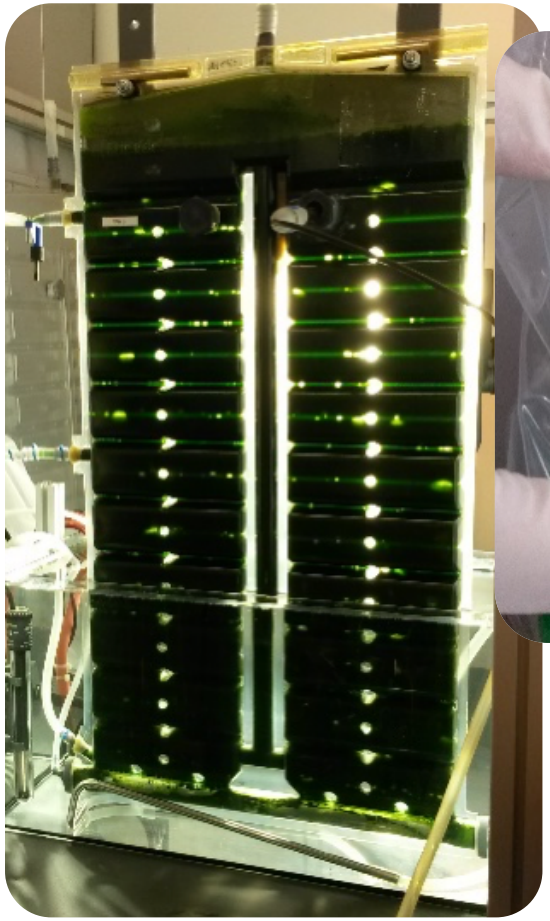


O_2 PHOTOBIOREACTOR



IRS DLR AIRBUS DEFENCE & SPACE

3. PBR for Space Systems – PBR@LSR

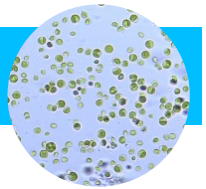


May 4th 2019

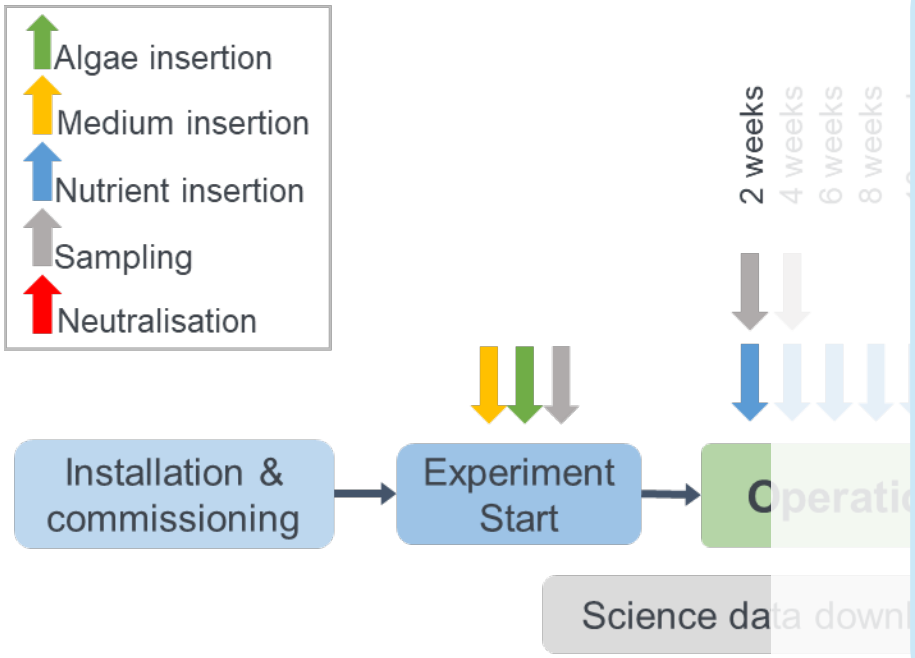
3. Space Research – PBR@LSR

GMT133

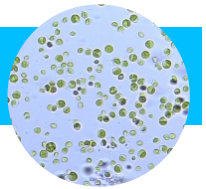
GMT157



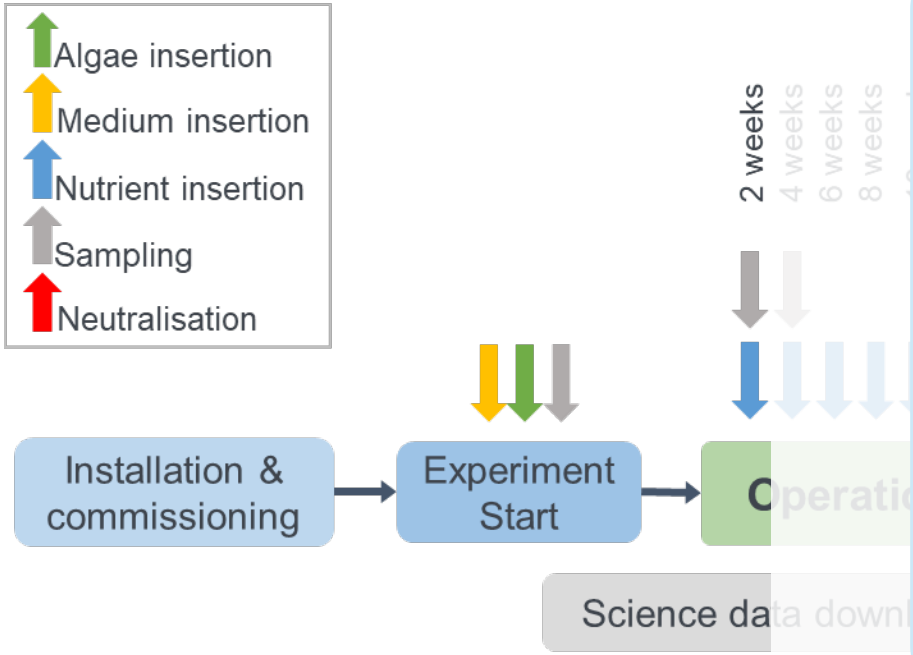
3. PBR for Space Systems – PBR@LSR



Sample after 2 weeks

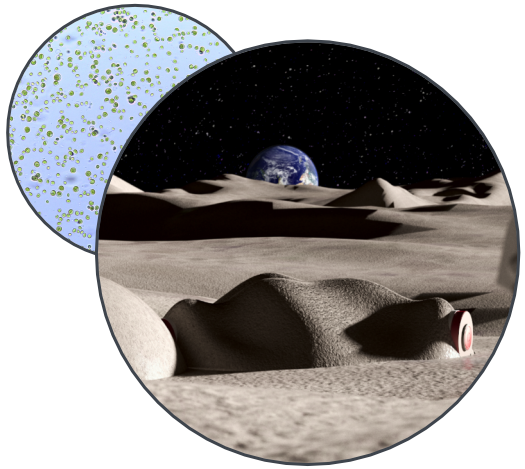


3. PBR for Space Systems – PBR@LSR



Samples Back to IRS

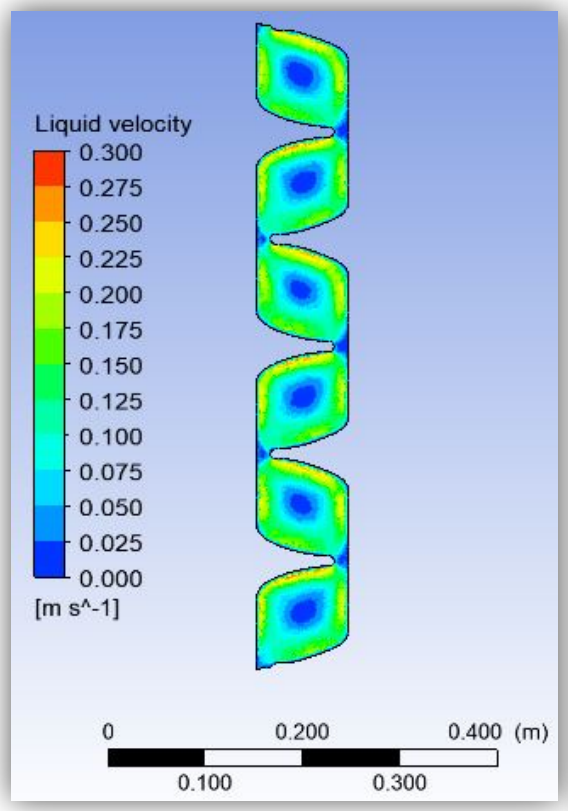
3. PBR for Space Systems – PBR@Moon/Mars



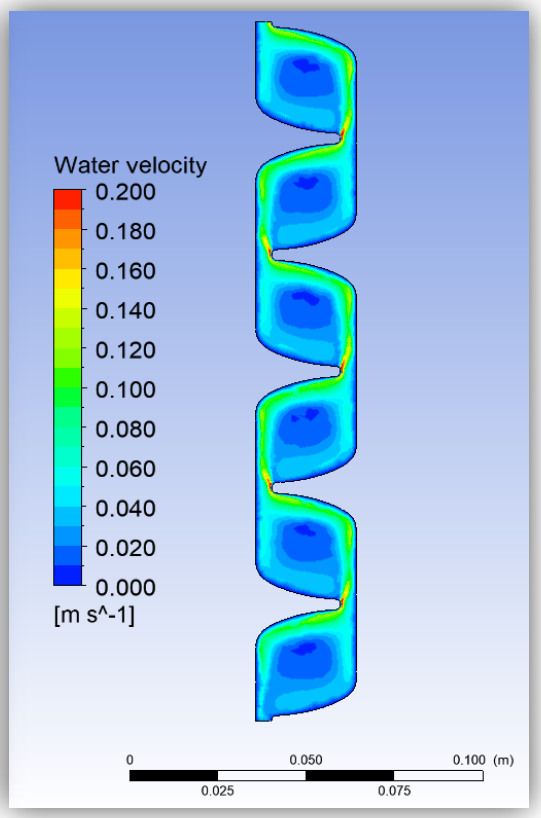
guaana

مؤسسة دبي للمستقبل
DUBAI FUTURE FOUNDATION

- PBR geometry
- In Situ Ressources Utilization

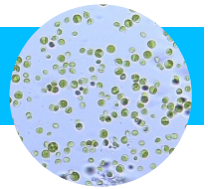


Earth Gravity



Moon Gravity

Microalgae: from Space to Earth Applications



4. PBR for Terrestrial Applications – PBR@Earth

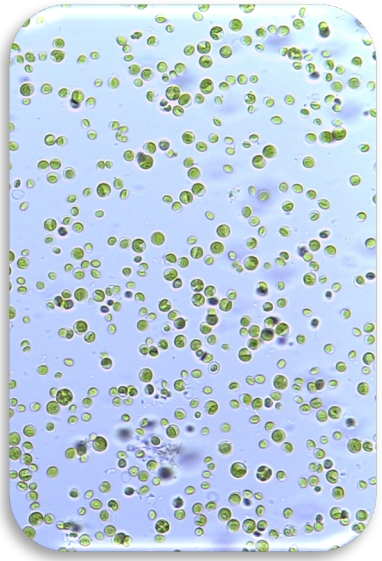
DLR

Friedrich und Elisabeth BOYSEN Stiftung für Forschung und Innovation

Ground water NO_3^- PO_4^-

CO_2

Energy

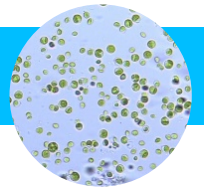


Clean water

O_2

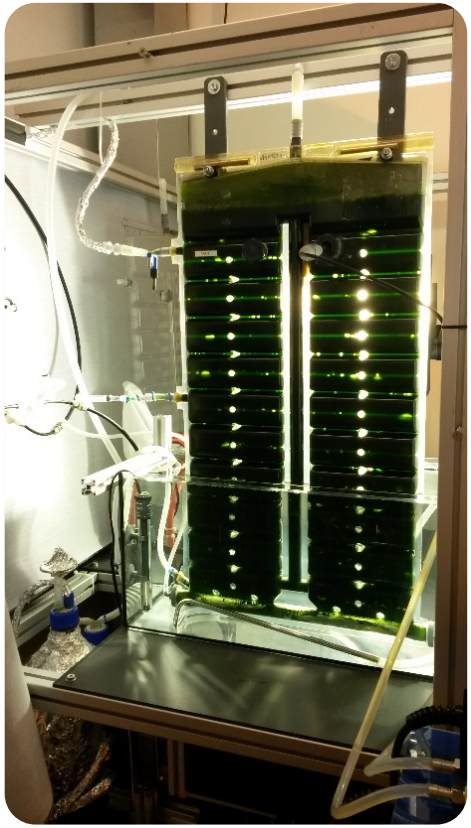
Biomass

- **Low energy consumption**
- **High uptake rates**
- **Scalability**
- **Reliability**
- **Longterm stability**
- **Low maintainance**

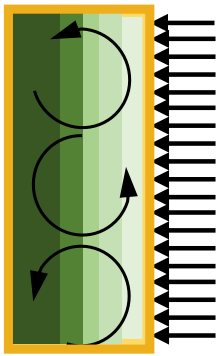


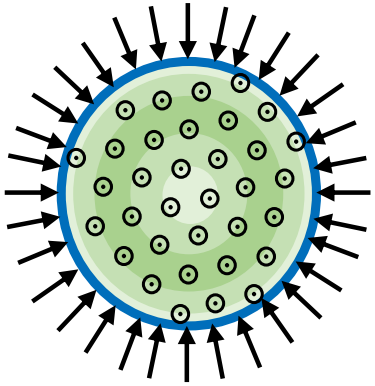
4. PBR for Terrestrial Applications – PBR@Earth

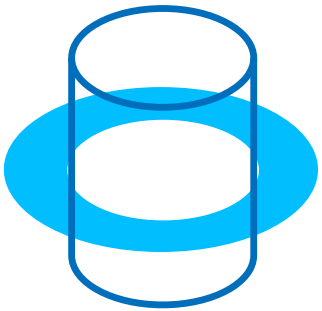
Reactor geometry and illumination

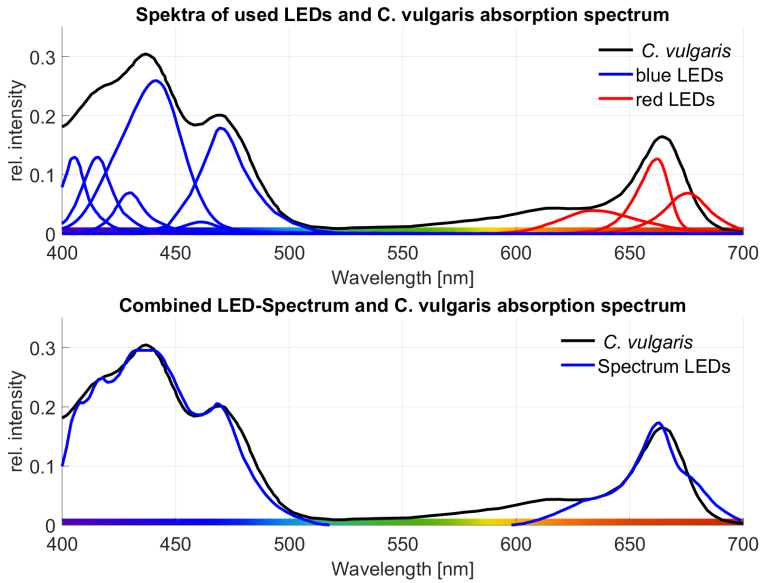


Flat Panel Airlift PBR

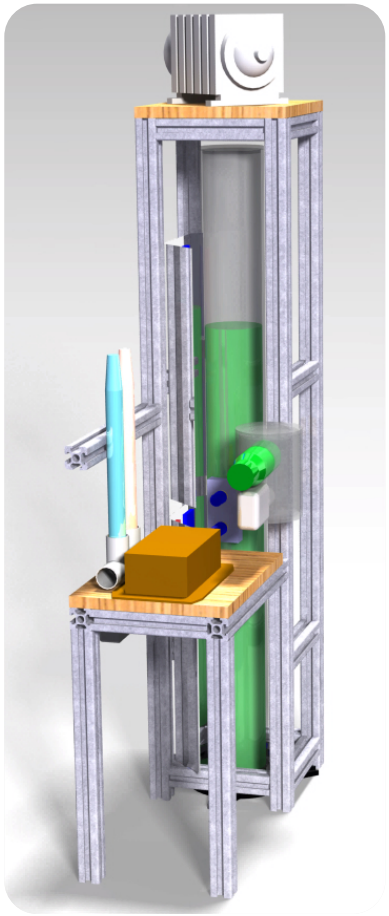






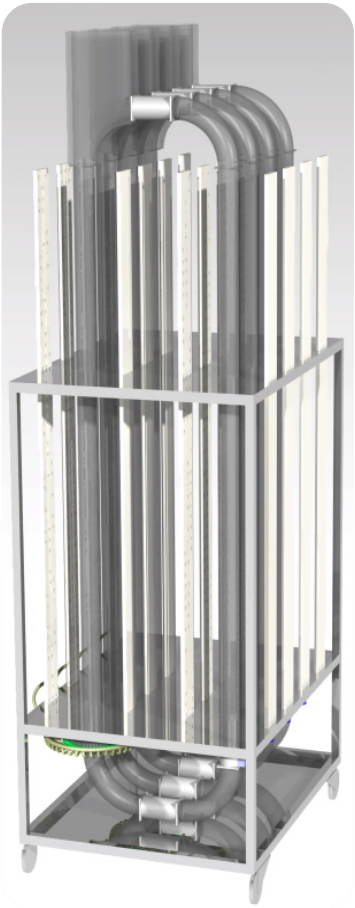


4. PBR for Terrestrial Applications – PBR@Earth



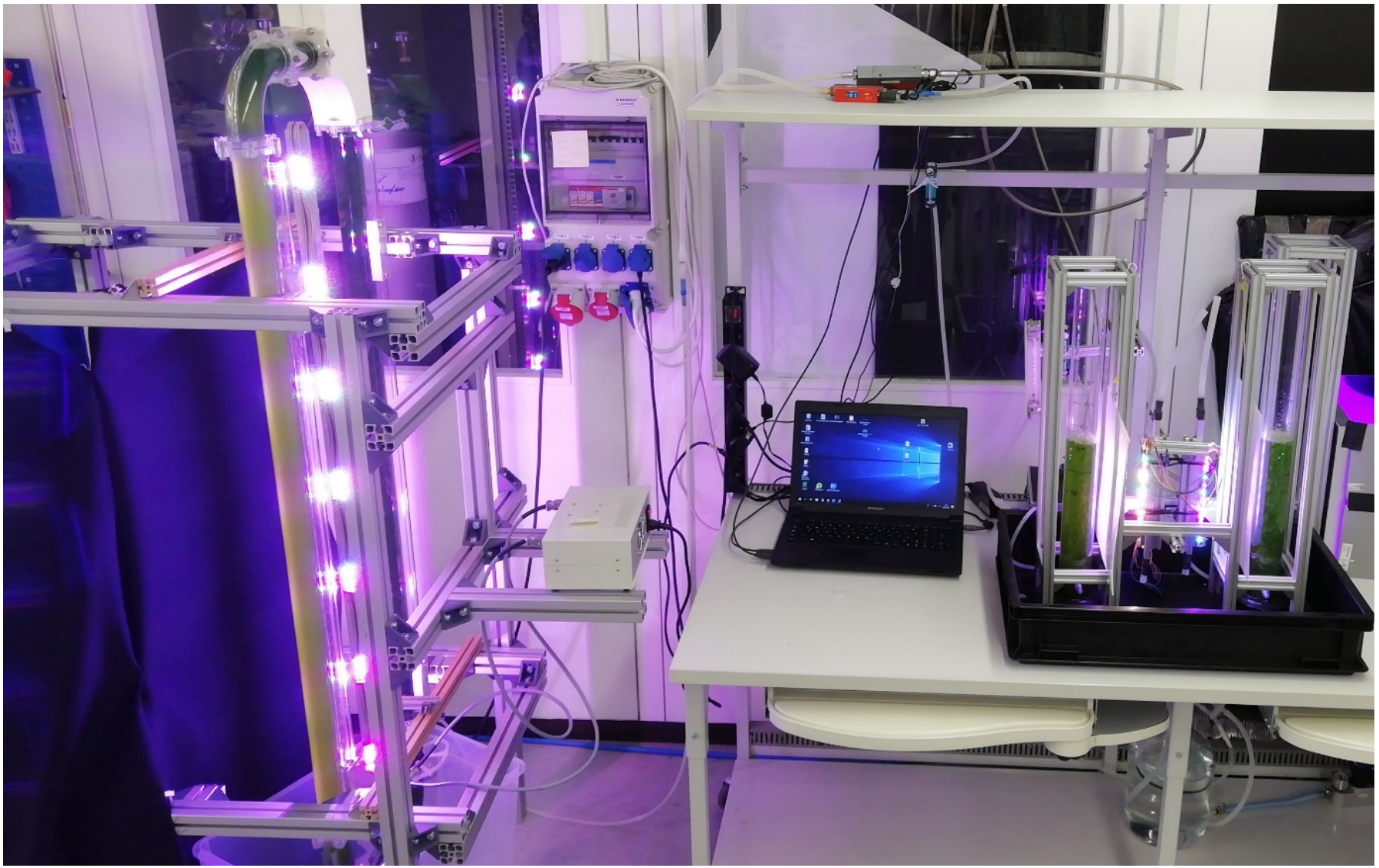
1 Liter

8 Liters

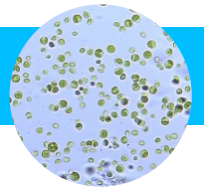


32 - 40 Liters

Microalgae: from Space to Earth Applications



Microalgae: from Space to Earth Applications



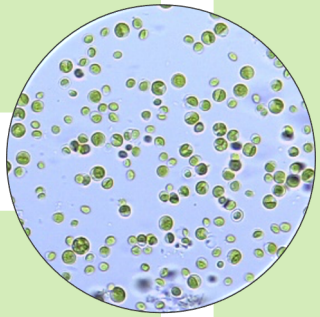
5. Conclusions

Long-term stability

- > 6 years
- Potential changes being evaluated

PBR for Terrestrial applications

- Improve systems for Earth applications
- Lessons learned back to space applications



PBR for Space Systems

- Microgravity PBR:
  - PBR@LSR run for 2 weeks
  - Technical problems (Power)
- Reduced gravity PBR:
  - Efficient Earth-like systems to be adapted to different gravity conditions

University of Stuttgart
Institute of Space Systems

MELiSSA
MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

MELiSSA Conference 2020

Dr. Gisela Detrell

e-mail detrell@irs.uni-stuttgart.de
phone +49 (0) 711 685-69611
www. irs.uni-stuttgart.de

Deutsches Zentrum für Luft- und Raumfahrt (DLR)
AIRBUS DEFENCE & SPACE
Friedrich und Elisabeth BOYSEN Stiftung für Forschung und Innovation
مؤسسة دبي للمستقبل DUBAI FUTURE FOUNDATION
guaana

University of Stuttgart
Institute of Space Systems
Pfaffenwaldring 29 – 70569 Stuttgart (Germany)