



MELISSA WORKSHOP

Science and Technologies on Regenerative Life-Support

8 – 9 June 2016
Lausanne
Switzerland

European Space Agency
Agence spatiale européenne



Organizers

Dr Christophe Lasseur (ESA), Dr Stephanie Raffestin (ESA), Prof. Suren Erkman (UNIL), Theodore Besson (UNIL/Earth Space Technical Ecosystem Enterprises SA)

Scientific committee

Lorenzo Bucchieri (Enginsoft)

Dr Christophe Lasseur (ESA)

LLM Rob Sutera (IpStar B.V.)

Prof. Max Mergeay (MELISSA Foundation)

Dr Natalie Leys (SCK. CEN)

Jean Brunet (SHERPA ENGINEERING S.A.)

Prof. Francesc Godia (Universitat Autònoma de Barcelona, UAB)

Prof. Gilles Dussap (University Blaise Pascal, UBP)

Prof. Benedickt Sas (Ghent University, U Gent)

Prof. Ruddy Wattiez (University of Mons, U MONS)

Prof. Suren Erkman (University of Lausanne, UNIL)

Prof. Stefania De Pascale (University of Naples)

Prof. Mike Dixon (University of Guelph, UoG)

Dr Heleen de Wever (VITO)

Sessions Chairs

Session 1: Prof. Francesc Godia (UAB)

Session 2: Dr Heleen De Wever (VITO)

Session 3 : Dr Baptiste Leroy (U MONS)

Session 4 : Brigitte Lamaze (ESA)

Session 5 : Dr Natalie Leys (SCK.CEN)

Session 6 : Prof. Suren Erkman (UNIL)

Sponsors

European Space Agency



MELISSA Foundation



UNIL



Earth Space Technical Ecosystem Enterprises SA



Swiss Space Center



Introduction

MELISSA (Micro-Ecological Life Support System Alternative) is the European Project of closed life support system. It aims to produce food, water and oxygen for manned space missions.

The project targets to ease human exploration of the Solar System, but can also serve current global challenges as air quality, waste recycling, water provision, food production in harsh environment...

1. Develop the technology for a safe and reliable closed loop regenerative Life Support System (LSS) for sustained human presence in space: orbital station, Moon (e.g. a manned lunar outpost) or Mars
2. Generate knowledge on bio-processes & coupled systems
3. Use the developed know-how via technology implementation, knowledge transfer and education

The driving element of MELISSA is the recovering of food, water and oxygen from organic waste, carbon dioxide and minerals, using light as source of energy to promote biological photosynthesis. It is an assembly of processes (mechanical grinding, bioreactors, filtration, wet oxidation, greenhouses, etc.) aiming at a total conversion of the organic wastes and CO₂ to oxygen, water and food.

It is based on the principle of an "aquatic" lake ecosystem where waste products are processed using the metabolism of plants and algae which in return provide food, air revitalization and water purification.

The MELISSA loop has been structured as an assembly of unit-processes. These are the compartments, created to simplify the behaviour of an artificial ecosystem and allow a deterministic engineering approach. These compartments have specific functions assigned, demonstrating the concept of functional ecology.

Format of the MELISSA Workshop

The MELISSA workshop is organized to be an open platform for presenting MELISSA challenges, results, to prepare future research and to enlarge collaboration. The meeting is organized into 6 themes run in successive sessions:

- Session 1: Waste processing
- Session 2: Water recycling
- Session 3: Air recycling
- Session 4: Food production & preparation
- Session 5: Chemical & microbial safety
- Session 6: System tools

Six introduction lectures will present MELISSA state of the art, followed by six key speakers, who will present the state of the art world wide.

The session will be then open to external contribution, via the call for abstracts. Poster sessions will be organized and the best poster will be selected by the scientific committee.

Please register to the workshop via www.melissafoundation.org (Workshop registration in the menu)

Please ensure you provide the details of the presenting author and indicate whether you are submitting an abstract for oral or poster presentation.

Authors will be notified of the outcome of the review process within about 2 weeks of the submission deadline.

Key dates

Abstract deadline	01 April 2016
Abstract confirmation	15 April 2016
Registration deadline	01 May 2016

Conference Venue:**University of Lausanne**

Building : Amphimax 410

Quartier UNIL-Sorge
CH-1015 Lausanne
Switzerland

Travel Information:

- How to get to UNIL: <http://www.unil.ch/acces/en/home/menuinst/trois-sites.html>

- **by clicking on Dorigny site you can reach UNIL main site:** How to get to UNIL main site: <http://www.unil.ch/acces/en/home/menuinst/unil.html>

- Amphimax building:

plan: <http://planete.unil.ch/plan?t=b&i=MAX>

on GoogleMaps: <https://www.google.ch/maps/place/UNIL+-+Amphimax/@46.5209396,6.5748684,17z/data=!4m2!3m1!1s0x0000000000000000:0x23ed5b34994f8c87?hl=en>

- Amphipole building:

plan: <http://planete.unil.ch/plan?t=b&i=POL>

on GoogleMaps: <https://www.google.ch/maps/place/UNIL+-+Amphip%C3%B4le/@46.5209396,6.5748684,17z/data=!4m2!3m1!1s0x0000000000000000:0x6bee748b4a51a045?hl=en>

MELISSA Workshop Agenda

Wednesday, June 8, 2016

8:00 Registration / Amphimax 410

8:30 Introduction & goals of the workshop

**-Franco Ongaro (ESTEC director, ESA/TEC directorate director)_
Amphimax 414**

**-Prof. Philippe Moreillon (UNIL's vice rector "Research and
international relations")**

-Dr Oliver Botta (Swiss Space Office)

Session 1: Waste Processing

Chair: Prof. Francesc Godia (UAB)

**9:00 MELISSA State of art: Waste recovery as a prerequisite for long term
Space missions. Dr Peter Clauwaert (UGENT), Prof. Ruddy Wattiez (UMONS)**

**09:30 *How to discover and apply "impossible" anaerobic micro-organisms
to recycle carbon and nitrogen in a sustainable way.* Prof. Mike Jetten
(Soehngen Institute of Anaerobic Microbiology, Radboud University, Nijmegen,
Netherlands)**

**10:00 *Integrated omics provides unprecedented insights into microbial community
structure and function.* Shaman Narayanasamy, University of Luxembourg**

**10:15 *Engineering microbial communities for understanding and applications.* Prof. Dr
Orkun Soyer, University of Warwick (UK)**

**10:30 *Combination of a bioanode and a biocathode in a bioelectrochemical system
allows biowaste oxidation and microbial electrosynthesis of carboxylic acids with a
more than two-fold increase in energetic efficiency.* Dr Theodore Bouchez, IRSTEA-
HBAN (France)**

**10:45 *Pyrolytic conversion of human waste: an element of a closed-loop system?*
Andreas Schoenborn, Zurich University of Applied Science ZHAW**

11:00-11:30 coffee break/Poster Session

11:30 From living cells to stable isotopes: an interdisciplinary approach for unravelling microbial interactions in ammonia-overloaded anaerobic digesters. Dr Francesc Prenafeta, GIRO Joint research Unit IRTA-UPC (Spain)

11:45 Short and long term road map for the development of a robust mechanistic and dynamic model of the MELISSA C1 compartment based on microbial community characterization. Dr V. Nolla-Ardèvol, KUL (Belgium)

Session 2: Water Recycling

Chair: Dr Heleen De Wever (VITO)

12:00 Water cycling for manned Space missions: State-of-the-art within the MELISSA concept. Prof. Siegfried Vlaemick (UGENT)

12:30 How to cope with so much food: challenges for nitrifying bacteria in urine. Dr Kai M. Udert (EAWAG, Swiss Federal Institute of Aquatic Science and Technology, Switzerland)

13:00-14:00 Lunch

14:00 Electrochemical systems as core engines of the MELISSA loop. Prof. Korneel Rabaey, Ghent University (Belgium)

14:15 Closed loop hydroponics for a novel crop cultivation system on the EMCS rotor. Silje Wolff (CIRIS, Norway), Sander van Delden, Wageningen University (The Netherlands)

14:30 A certainty of bacterial growth on pipe materials in contact with potable water. Frederik Hammes, EAWAG (Switzerland)

Session 3: Air Recycling

Chair: Dr Baptiste Leroy (U MONS)

14:45 **Photobioreactor in space habitat: status and challenges.** **Christel Paille** (ESA), **Steven Hens** (QinetiQ Space), **Samuel Gass** (RUAG SPACE)

15:15 **Some insights on photobioreaction engineering.** **Prof. Jack LEGRAND** (GEPEA, -UMR CNRS 6144, University of Nantes – St Nazaire, France)

15:45 *Cultivation of microalgae for advanced closed life support systems as a technical and biological challenge.* Dr Stefan Belz, University of Stuttgart, Institute of Space Systems (Germany)

16:00 *ModuLES-PBR – lessons learned through parabolic flight tests.* Dr Klaus Slenzka, OHB system (Germany)

16:15 *Heat Ventilation and Air Conditioning of a Greenhouse in Antarctica.* Lorenzo Bucchieri, EnginSoft (Italy)

16:30-17:00 Coffee Break/Poster Session

Session 4: Food production & Preparation

Chair: Brigitte Lamaze (ESA)

17:00 **MELISSA State of art.** **Dr Roberta Paradiso** and **Prof. Stefania de Pascale** (University of Naples)

17:30 **Climate factors and crop growth: physiology and mechanistic modelling.** **Prof. Ep Heuvelink** (Wageningen University, the Netherlands)

18:00 *Emerging bioprocessing concepts for healthy and sustainable foods.* Prof. Dr.-Ing. Alexander Mathys, ETH Zurich (Switzerland)

18:15 *PFPU-Main Scientific criticalities of the Precursor of Food Production Unit in the MELISSA framework.* Giorgio Boscheri, Thales Alenia Space (Italy)

18:30 *NEMO'S garden: growing plants underwater.* Dr Elisabetta Princi, OCEAN REEF GROUP

18:45 *Lessons learned from commercial scale urban Spirulina production.* Saumil Shah, EnerGaia Co Ltd

19:00 End

Dinner (20:00)

Thursday, June, 9, 2016 (UNIL, Amphimax 410)

Session 5: Chemical & Microbial safety

Chair: Dr Natalie Leys (SCK.CEN)

08:00 *Closed loop system: a safety challenge for the crew as well as for the life support processes.* Dr Christophe Lasseur (ESA)

08:15 *About Microbial hazard and risk for Humans in spatial habitats.* Prof. Jean-Pierre Flandrois (University of Lyon 1, LBBE-UMR 5558, France)

08:45 *Application of ultraviolet-LED systems for microbial control in air and water loops.* Richard Simons, AquiSense technologies (Europe) Ltd/BIOWYSE

09:00 *Automated high-frequency flow cytometry enables in-situ process monitoring, control, and optimization of engineered water systems.* Michael Besmer, EAWAG/ETH Zurich (Switzerland)

09:15 *The Characterization of Humidity Condensation and Associated effects using Image Processing Techniques.* Dr Akhilesh Tiwari, IIT Allahabad (India)

09:30 *Understanding and Modelling of Airborne Bio-Contamination Process in Manned Spacecraft.* Aku Karvinen, VTT Technical Research Centre of Finland

09:45 *The peak of harvest- a non-destructive identification method. Streamlining the crop production for planetary missions by nutritional value indexes.* R.M. Giurgiu, University of Agricultural Sciences and Veterinary Medicine (Romania)

10:00-10:30 Coffee Break/Poster session

Session 6: System tools

Chair: Prof. Suren Erkman (UNIL)

10:30 *Comprehensive modelling and simulation, reliable sensors and multilayer control strategy: the essential system tools for a sustainable bioregenerative LSS.* Prof. Gilles Dussap (UBP)

11:00 *Model Predictive Control: State of the Art and Possible Opportunities for Life-Support Systems.* Prof. Alberto Bemporad (IMT School for Advanced Studies, Lucca-Italy)

11:30 A thermodynamic theory of microbial growth and its perspectives for modelling environmental biotechnology processes. Dr Theodore Bouchez, IRSTEA-HBAN (France)

11:45 EnRUM-Space and Energy Resources utilization Mapping. Gino Perna, Enginsoft (Italy)

12:00 Marine fish aquaculture in closed system : the couple Fish/algae. Dr Cyrille Przybyla, IFREMER (France)

12:15 European Platforms for Life-Support System development and validation. Dr Peter WEISS, COMEX (France)

12:30 Oikosmos research agenda: relevance of manned interplanetary missions to terrestrial sustainability. Théodore Besson, UNIL (Switzerland)

12:45 How Space technology empowers the Transition towards a circular economy. Rob Suters, IPSTAR (the Netherlands)

13:00 *Workshop Conclusions, Dr Marc Heppener (Head of Science Department, Directorate of Human Spaceflight and Robotic Exploration, ESA)*

13:30 End of the MELISSA Workshop