MELiSSA workshop
Some Recommendations

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The Workshop

- 140 Participants, 35 students, 21 Countries,
- Academic as well as space industry,
- A large number of publications (>200)
- 2 spin-off, 1 Foundation including PhD program,
- 7 Flight Experiments in 15 years,
- MELiSSA is not a club anymore but a real European initiative,

Proposed E3P Content

E3P MAIN ACTIVITY AREAS

ISS:

- Agreed enhancements
- Operations
- MPCV-ESMs
- Astronauts missions

ExoMars:

- 2016 missions ops
- 2020 mission

Lunar Resource Lander:

PILOT, PROSPECT and SPECTRUM (Ground ops)

SciSpace: Science in Space activities (replacing ELIPS) :

- Science Support and Applications
- ISS Payload Development
- Complementary non-ISS experiment platforms

ExPeRT: Exploration Preparation, Research and Technology

- Mission Studies
- Pre-development new technologies
- International Collaborations
- Spaceship EAC

Human Space Exploration: Deep Space Habitat

Robotic missions:

- Phobos Sample Return: Phase B1 – mission decision
- Lunar Polar Sample Return: Phase A – mission decision
- Lunar Volatile Prospector: Phase A – mission decision
- Mars Sample Return – Carrier and Fetch rover: Phase A – mission decision

Commercial Exploration Partnership

2016 C-M Decisions Later C-M Decisions

Roadmaps

Human Research

The Human body under space conditions: adaptations and countermeasures

- *Understanding human physiological processes.*
- *Exploration –related health risks and their prevention.*
- *Health and ageing issues on Earth.*

Psychological and neurosensory adaptations to reduced gravity, isolation and confinement

- *Impact of spaceflight on psychological, sensorimotor and neuro-behavioural performance.*
- *Selection, training and support methodologies for crew on long-duration missions.*

Biology

Astrobiology

- *Chemical and biological effects of exposure to space radiation and vacuum.*
- *Origins, limits and signs of life in the Universe.*

Biology under non-Earth gravity conditions

- *Understanding gravity-dependent processes in cells and organisms.*
- *Biochemistry and health-related phenomena.*

Supporting life in hostile environments

- *Understanding the effects of space factors on microorganisms and plants.*
- *Integrated closed-loop life support systems for exploration.*

Physical Sciences

Ultra-precise cold atom sensors, quantum information and high energy particles

- *Boundaries of relativity and quantum physics.*
- *Advanced navigation and communication.*

Soft or Complex matter

- *Interactions and self-organisation in foams, emulsions, granular matter, atmospheric dust and colloids.*
- *Food and (petro)chemical industry, physics of biological processes.*

Boiling, evaporation and heat transfer

- *Multi-scale modelling of fluid physics including phase change.*
- *Efficient cooling of micro-electronics, industrial boilers and power plants.*

Advanced material processing

- *Microstructure formation and materials properties.*
- *Casting, automotive and aerospace industry.*

Cosmic radiation risks for Human Exploration of the Solar System

Excellent curiosity-driven research

Energy storage, fire safety, cardiovascular fluid physics, hibernation and torpor

ROADMAP	EXPLORATION RELEVANCE												SOCIO-ECONOMIC BENEFITS/ GLOBAL GOALS							
	Origin and distribution of life	Fundamental Physics on the moon	Musculoskeletal	Sensorimotor	Ocular syndrome	Nutrition	Behaviour health and performance	Radiation	Hypogravity	Emergency response	Closed loop ecosystems	Deep space/lunar habitat	Inspiration	Fundamental knowledge	Zero hunger	Good health and wellbeing	Clean water and sanitation	Affordable and clean energy	Industry, innovation and infrastructure	Quality education
Physiological adaptations	E		E	E	E	I			E	R			R	I		E				I
Psychological/ neurosensory adaptations				E	E		E		R	E			I	I		I				I
Astrobiology	E												E	I						I
Life support						I	R		R	I	E	I	R	I	R	R	I		R	R
Gravity-related biology	I		I			I			R		I		R	I	R	R	R			I
Cosmic radiation risks								E		R			I	I					R	I
Quantum and relativistic physics		E											I	I					E	I
Soft or Complex matter		I											R	I					E	I
Two-phase heat transfer										I		I	R	I				I	E	I
Material properties		R								I		R	R	I				I		I
Curiosity-driven research:																				
Energy storage										I		I	R	I				I	I	R
Fire safety										E			R	I				I	I	R
Cardiovascular fluid physics			I						R				R	I		I				R
Hibernation and torpor	R		I	I	R	I	I	I	R				E	I		I				R

	Essential contribution
	Important contribution
	Relevant contribution

Current Framework

- Utilisation of ISS until 2024
- Payload ready for flight by 2020
- Priority to precursors of technology useful for future space exploration scenario (e.g. CIS-lunar mission, Mars mission,..)

Workshop Recommendations

10 Recommendations will be issued and place on MEliSSA internet site, as for Example:

- Focus on understanding waste processing from a fundamental approach
- To face the complexity of this critical part of MELISSA loop, both for the substrate and the microbial communities
- To capitalize on the continuous advances in the technologies and genetic and molecular leves (“-omics),
- Explore how to align space and terrestrial approaches to study food production and preparation, in order to join forces and progress faster. Explore how the statement “production and preparation of healthy food” could become a common starting point, in order to focus on the end-users nutritional needs in all cases.
- Re-assess technologies scale-up and scale down and associated tools.

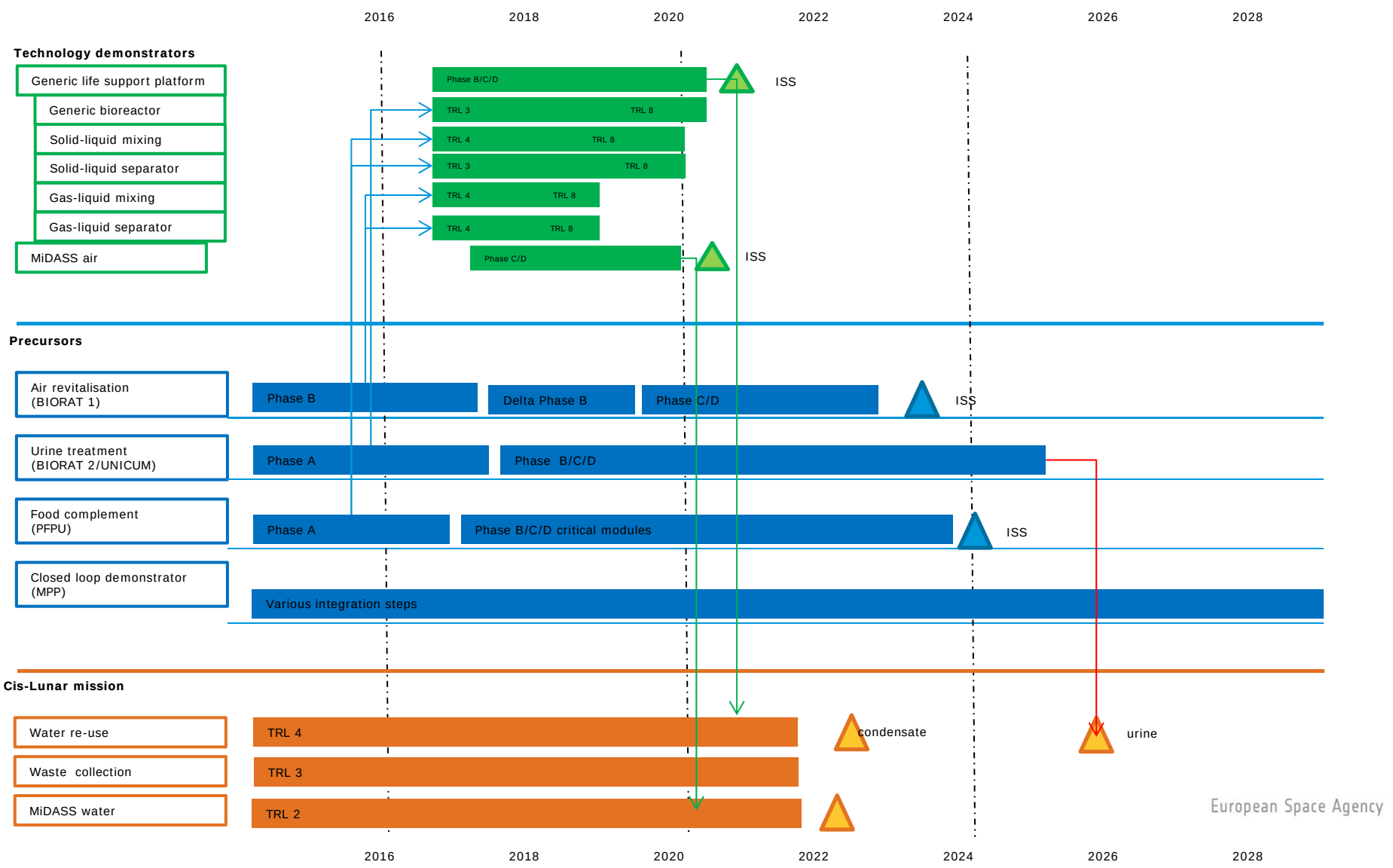
Generic Approach

- Life Support development will be multiphasic,
- ISS is the appropriate platform
- CIS Lunar will be in Micro gravity

- Approach in 3 phases :

  a. Terrestrial Research (Blue),
  b. ISS investigations on Multi-phasic processes, (Green)
  c. Development of CIS Lunar Life support system (Orange)

Generic Approach



Generic life support platform

- Main Objectives: Demonstration of key enabling technologies of life support processes
  - solid-liquid mixing without bubble generation
  - gas-liquid mixing: transfer gas phase (e.g. O2, ammonia, CO2)without bubble generation in several types of liquid
  - membrane wettability in low liquid flow rate
  - gas liquid separation in low liquid flow rate
  - Solid-liquid separation: concentrate solid generated/accumulated in liquid (e.g. micro-organisms, biomass) with minimum power usage and reuse of liquid
  - Generic bioreactor: control the bio-process (e.g. sustain and monitor the growth of considered micro-organism, control inputs/outputs)
- Concept could be modular and eventually incremental

One Example :PHOTOBIOREACTOR

ARTEMISS Flight Experiment,

1. Started in 1998 with a Trainee, YGT, and a few PhDs,
2. First photobioreactor in microgravity, in continuous mode,
3. European Consortium (B, F, CH)
4. Final Set of Flight Hardware tests in culture are positive: we are ready !
5. Large numbers of publication already approved,
6. Know-how already transfer to Earth : Algolsolis industrial platform,

7. Logic follow-on:
    a. URINIS approved at ELIPS 4 call – Sciences Development
    b. BIORAT at PDR level: Technology Development

Key enabling technologies

1. Photo-bioreactor
    a. Technology demonstration: produce oxygen and consume carbon dioxide for man-equivalent size
    b. Starting point: TRL 6 for scientific payload, need design adaptation for precursor (scale change)
    c. Objective: TRL 9 by 2018 for scientific version, TRL 9 by 2023 for precursor

2. Generic Instrumented Bioreactor (urine treatment, ammonia treatment, root zone of plant,)
    a. Technology demonstration: preferably on synthetic urine biological treatment or chemical oxidation of ammonia
    b. Starting point: TRL 3,
    c. Objective: TRL 9 by 2021

Conclusion

1. MELiSSA is a structured (long term…) development based on serious sciences :
    a. Publications,
    b. Project audit,

2. The 27 years of research are now giving fruits (and vegetables…) to :
    a. Manned Space Exploration,
    b. Terrestrial challenges,
    c. Education

3. Your Next challenges:
    a. be more visible,
    b. Closer to space utilisation,

The POSTER winner

And the winner are:

1. Mr Quentin De Meur, University of Mons, Belgium,
2. Mrs Xue Jiang, University of Warwick, UK

Congratulations !