PFPU - main scientific criticalities of the Precursor of Food Production Unit in the MELiSSA framework

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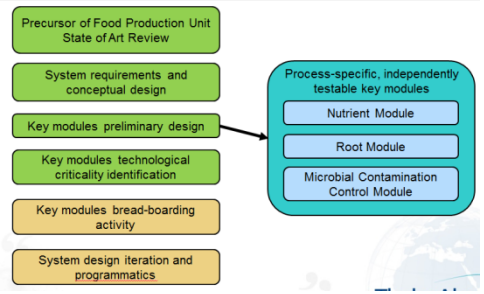
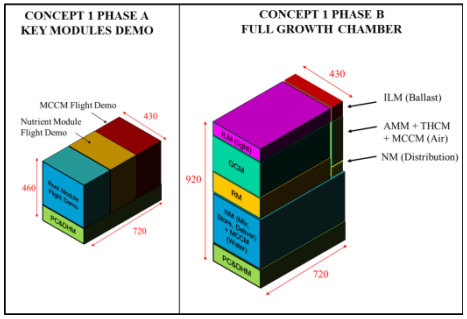
Presentation outline

Food production system for space - criticalities

A step-by step modular approach

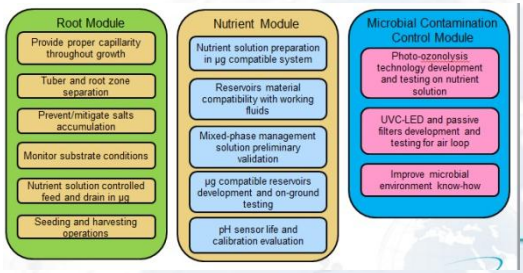
What is PFPU





PFPU concept

The 3 key process-specific modules identified criticalities and demonstration strategy



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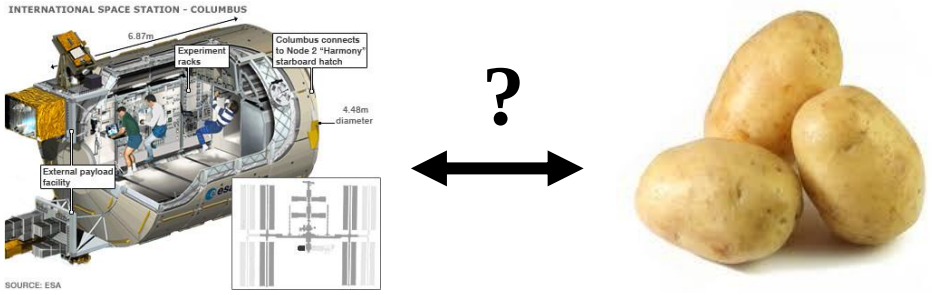
Food production system for space – criticalities

Microbial population management

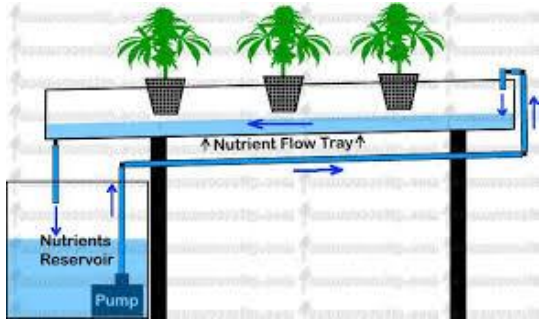
Food safety

Humidity management



Integration strategy

Food quality prediction



Nutrient delivery management

Step-by step modular approach

Laboratory environment testing

Key modules in relevant environment to Advance TRL

ISS/LEO: subsystems testing/plants experiments/use as Supplemental Food

Moon/asteroid, then Mars transit/surface: use as Supplemental Food, then Life Support

Precursor of Food Production Unit

Precursor of Food Production Unit State of Art Review

System requirements and conceptual design

Key modules preliminary design

Key modules technological criticality identification

Key modules bread-boarding activity

System design iteration and programmatics

Process-specific, independently testable key modules

- Nutrient Module
- Root Module
- Microbial Contamination Control Module

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Precursor of Food Production Unit

MELiSSA knowledge management

SHERPA ENGINEERING

PFPU System

ThalesAlenia Space

Microbial Contamination Control Module

ThalesAlenia Space

AEROSEKUR

Root Module

Telespazio

A Finmeccanica/Thales Company

Nutrient Module

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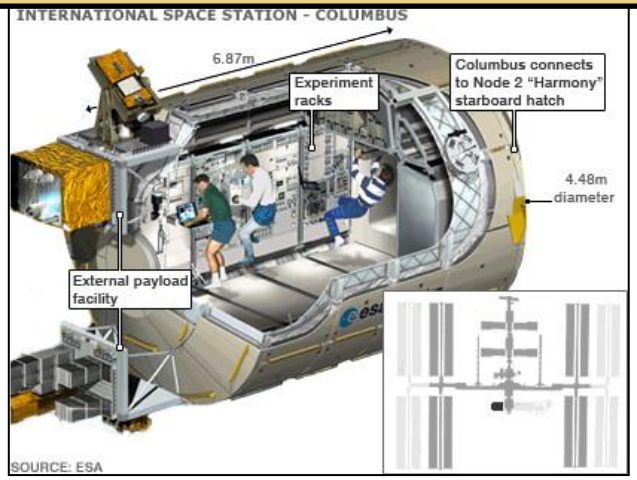
PFPU Preliminary Concept

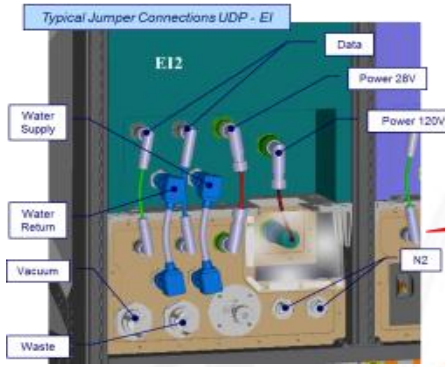
International Space Station

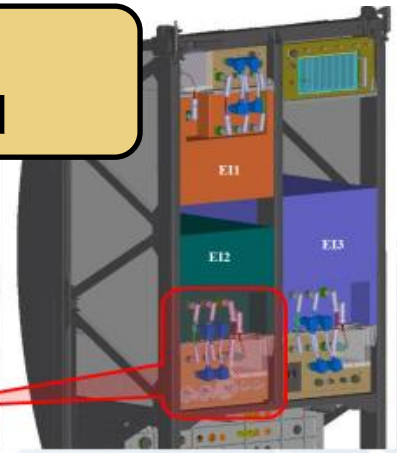
Columbus Module



European Drawer Rack II

PFPU shall fit as an incremental payload





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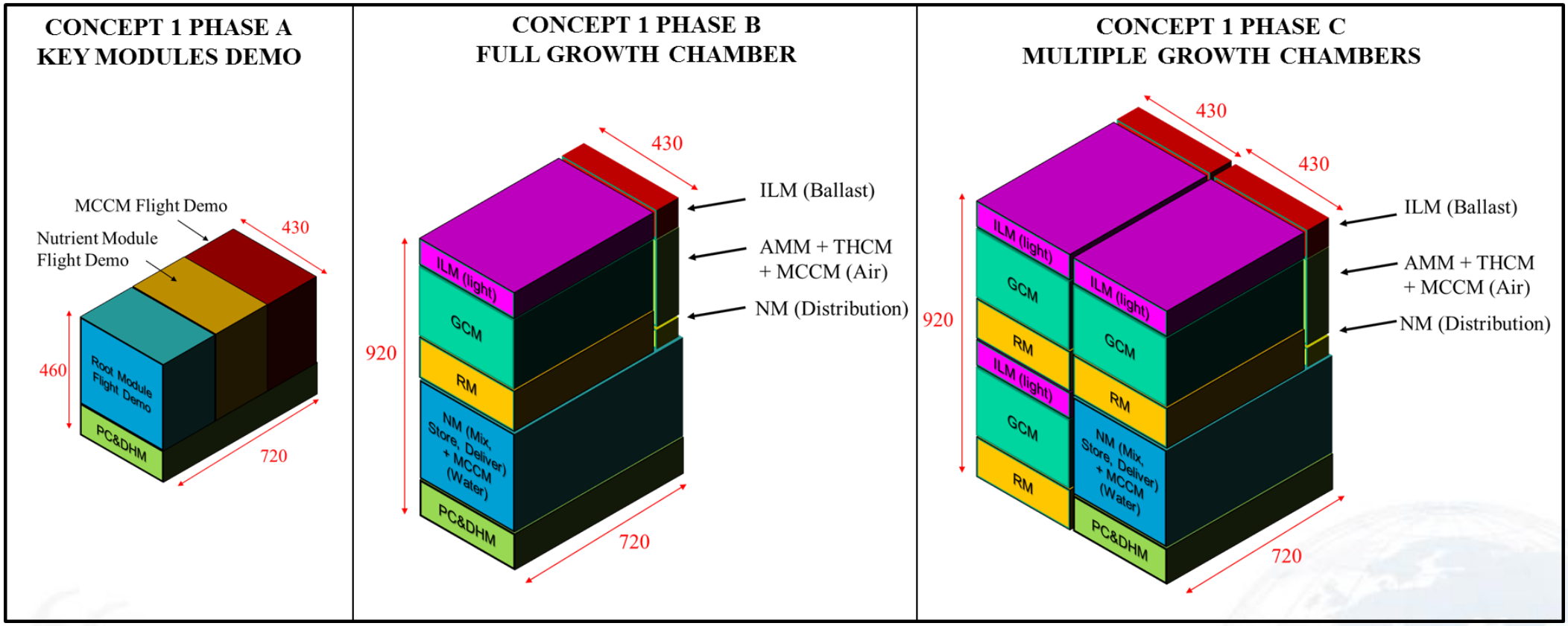
PFPU Preliminary Concept

Modular approach



Incremental approach

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PFPU Root Module Criticalities

Tuber zone separation

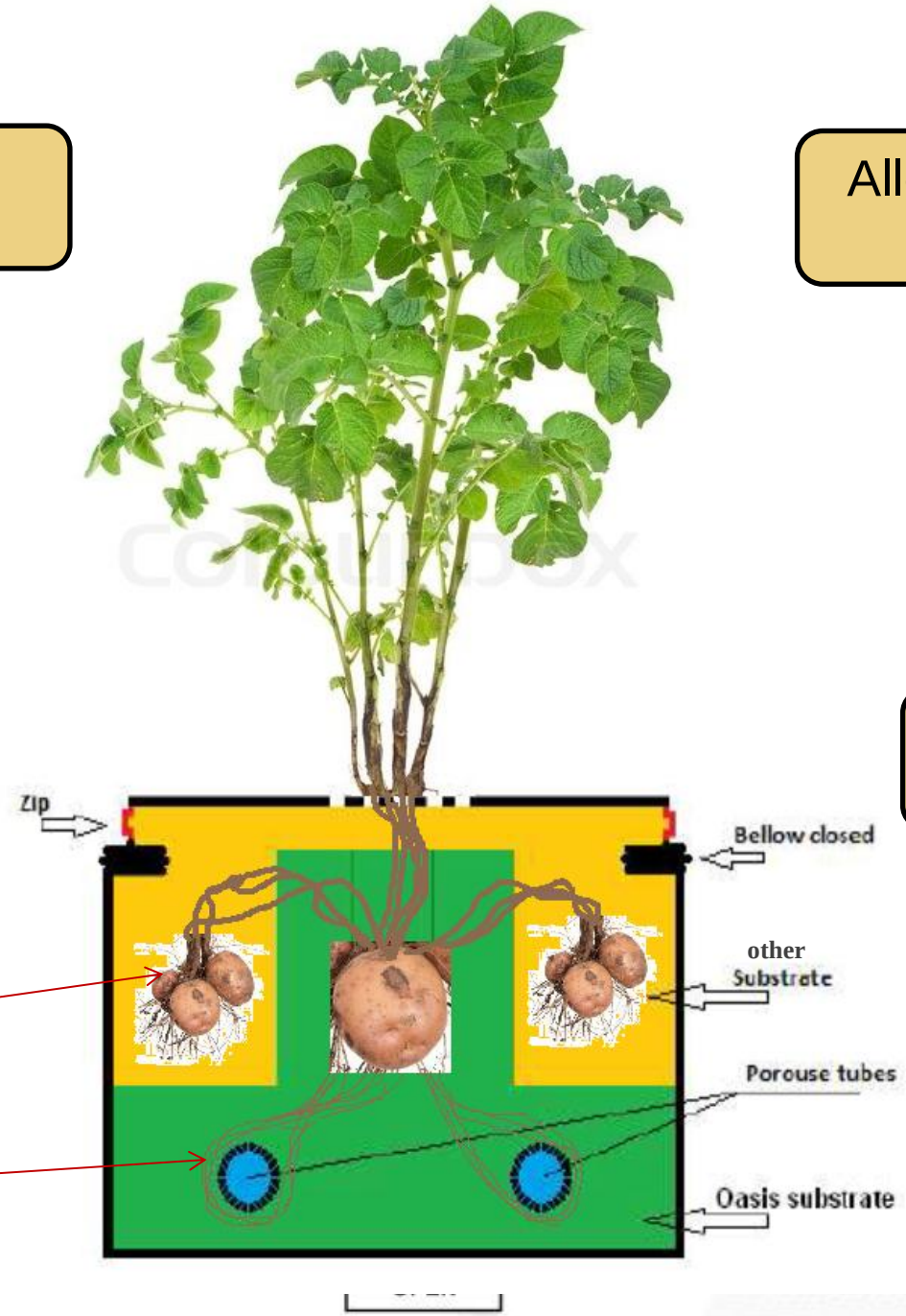
Allow accessibility to tubers

Tuberization mechanism in µg

Monitor substrate conditions

Provide proper capillarity through growth

Control microbial environment

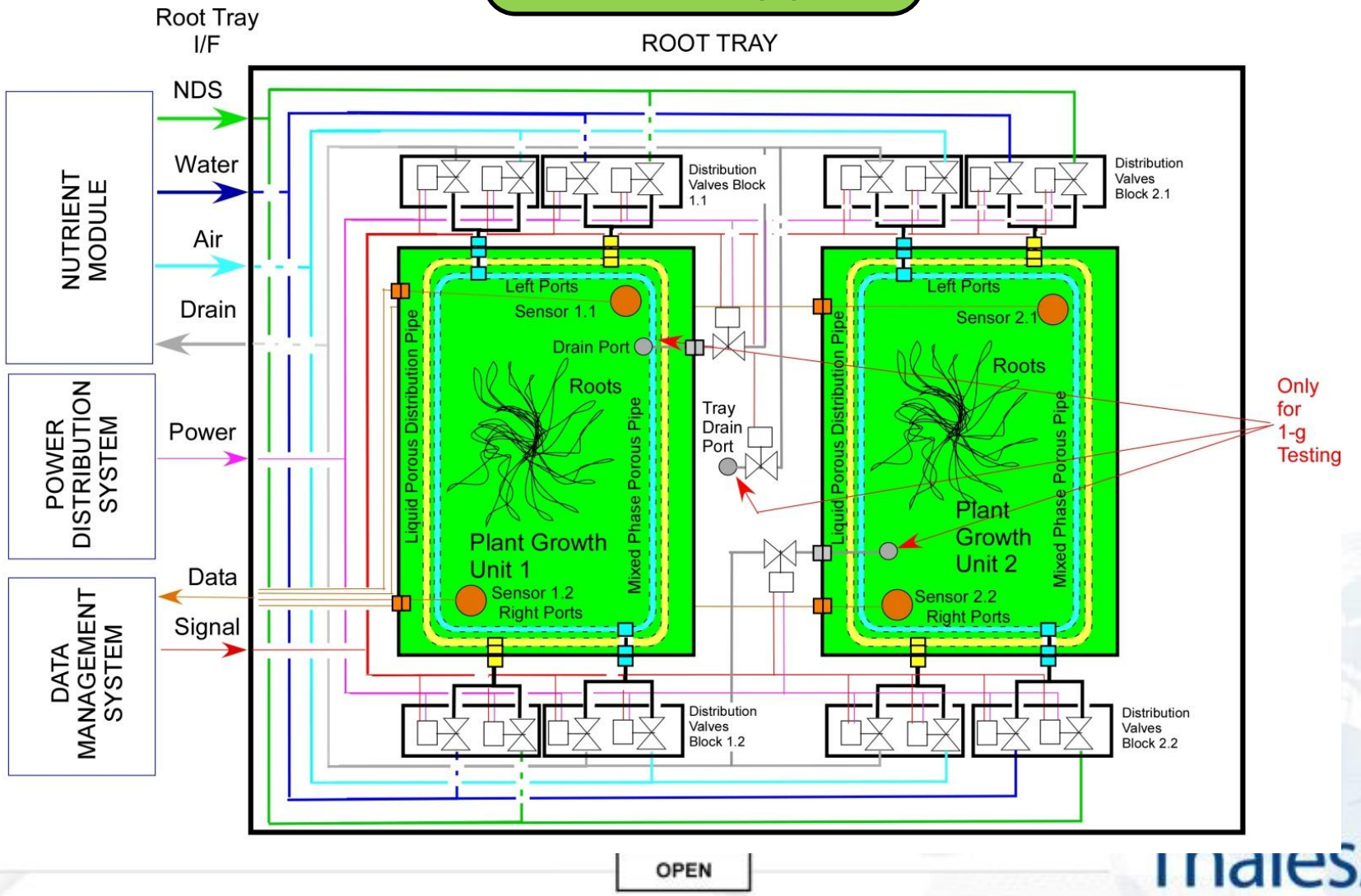


PFPU Root/Nutrient Module Criticalities

Provide uniform aeration

Nutrient solution controlled feed and drain in µg

Prevent/mitigate salts accumulation

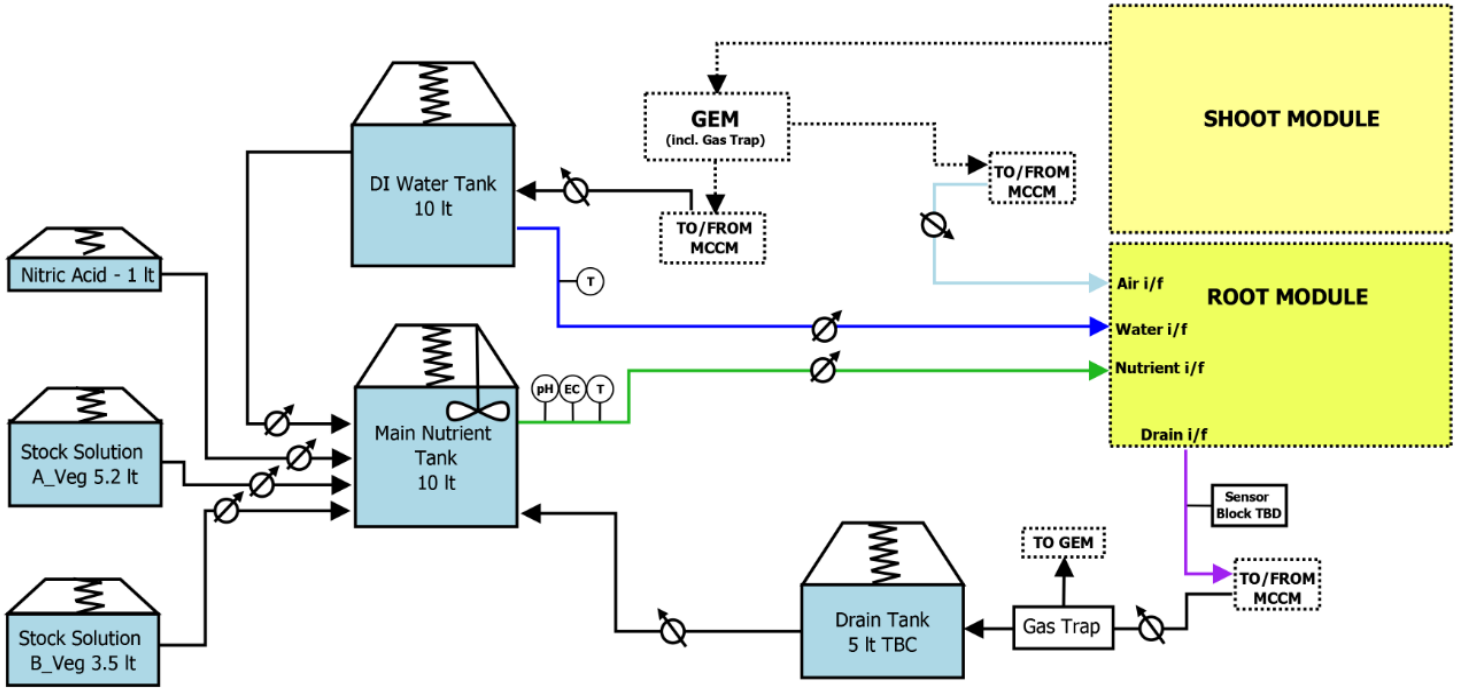


PFPU Nutrient Module Criticalities

Nutrient solution on-orbit preparation

Sensors calibration and life

µg sensitive equipment (e.g. reservoirs)



Mixed phase management

Materials compatibility with space and plants

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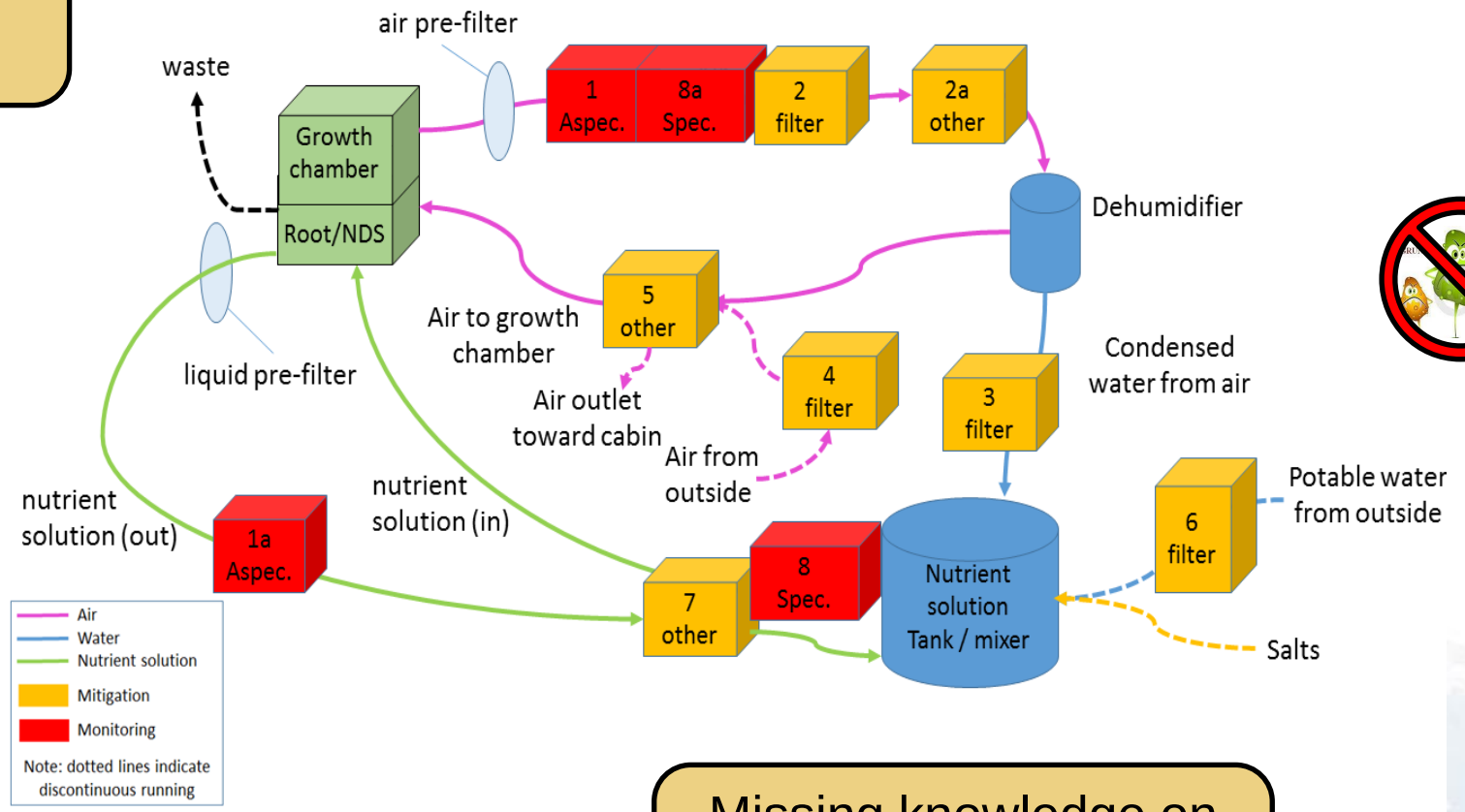
PFPU Microbial Contamination Control Module Criticalities

Develop specific and a-specific monitoring solutions

Build synergy between monitoring and mitigation



Consolidate components and plant material sterilization need

Missing knowledge on typical microbiological environment

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PFPU – current study demonstration

Root Module

- **Provide proper capillarity throughout growth**
- **Tuber zone separation**
- Prevent/mitigate salts accumulation
- Monitor substrate conditions
- Nutrient solution controlled feed and drain in µg
- Seeding and harvesting operations

Nutrient Module

- Nutrient solution preparation in µg compatible system
- **Reservoirs material compatibility with working fluids**
- **Mixed-phase management solution preliminary validation**
- µg compatible reservoirs development and on-ground testing
- pH sensor life and calibration evaluation

Microbial Contamination Control Module

- Photo-ozonolysis technology development and testing on nutrient solution
- UVC-LED and passive filters development and testing for air loop
- **Improve microbial environment know-how**

PFPU Demonstration strategy for current and future phases

Laboratory Environment

- Technologies development and functional validation
- Modules and system architecture validation
- Budgets consolidation (incl. consumables, spares, etc.)

Relevant environment (analogs, µg test facility)

- µG sensitive equipment (low resp. time) valid.
- Environment-specific aspects validation
- Logistics and remote support validation

ISS and future orbiting platforms

- µG sensitive equipment (long resp. time) valid.
- Modules architecture validation
- System architecture validation (possible in incremental manner)

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