



## **Overview of the Project**

Ch.Lasseur, ESA, 25-26<sup>th</sup> May 2006

Sperlonga Italy.

# Main Contents



- Boundaries Conditions,
- Introduction to MELISSA Project,
- Main Activities on Plant and Nutritional,
- Our Proposal to progress together.



## Plants Interests

- Well known and accepted food source,
- Water Recycling,
- Air Recycling,
- Probably a psychological impact (to be confirmed),



## Plants Weaknesses

- Slow rates of production,
- High waste production (~ **50% of produced biomass**),
- Needs the “proper” nutrients,
- Limited volumetric used of light,
- Difficult modelling,
- Sensitive to pathogens.



# Nutrition Issues

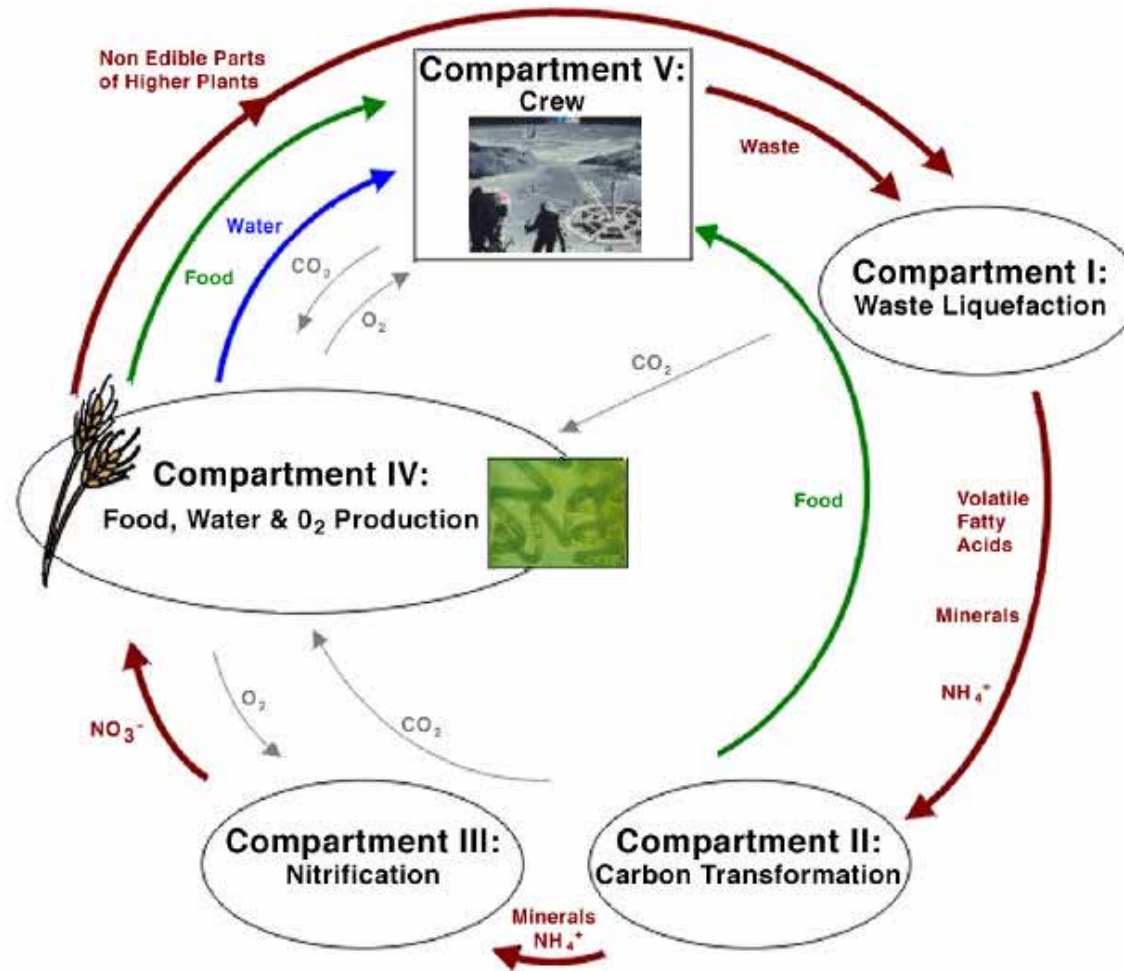
- Water and Air Quality shall reach well defined ESA standards, but Today no detailed Food Standards exists.
- Because:
  - Human physiology in Space is not known enough,
  - Psychology and acceptance issues are not well understood.

# Boundaries Conditions



- A Greenhouse Alone has not interest for Life Support,
- Plant Characterisation cannot be decoupled from:
  - Waste Recycling,
  - Food Preparation and associated Instrumentation
  - Nutrition,
  - Food Acceptance,
  - Overall modelling

# MELiSSA Concept



## Background



- Project initiated in 1989,
- Covers almost all aspects of Biological Life support from scientific research to Engineering and to Bench experiment up to flight hardware,
- Regroups a large scientific and technical community,
- Internationally recognised (> 200 events since 2004),

# Who is ?

- Countries : B, F, E, NL, IRL, CND, ( CH ask to join in 2006),
- More than 30 organisations over Europe & Canada, including :
  - Academic Research Centers,
  - SME,
  - Space companies,
  - Terrestrial companies.
  - **9 Of them have signed a MOU.**



## Budget Sources

- ESA Budgets (TRP, GSTP, Prodex, AURORA, ELIPS, EMIR,..)
- Direct National (Space & Non space),
- Direct Local & Regional (Catalogna, Auvergne, Flandres, Ontario,..),
- Private Investment.

# Organisation



- Phase 1: Basic R&D,
- Phase 2: Preliminary Flight Experiments,
- Phase 3 : Ground & Space Demonstration WITH a consumer,
- Phase 4: Terrestrial transfer,
- Phase 5 : Education and Communication

## The Approach



1. Study of the requirements (sometimes definition)
2. Gain high understanding of the processes (ALISSE criteria),
3. Study the associated technology (i.e food instrumentation),
4. Trade-off + detailed Design,
5. Demonstrate the feasibility and operability of Pilot Units on Earth,
6. Conduct Space experiment of critical issues (e.g. gas/liquid),
7. Test life support Unit as payload (Low Earth Orbit)
8. Use the Unit for life support.

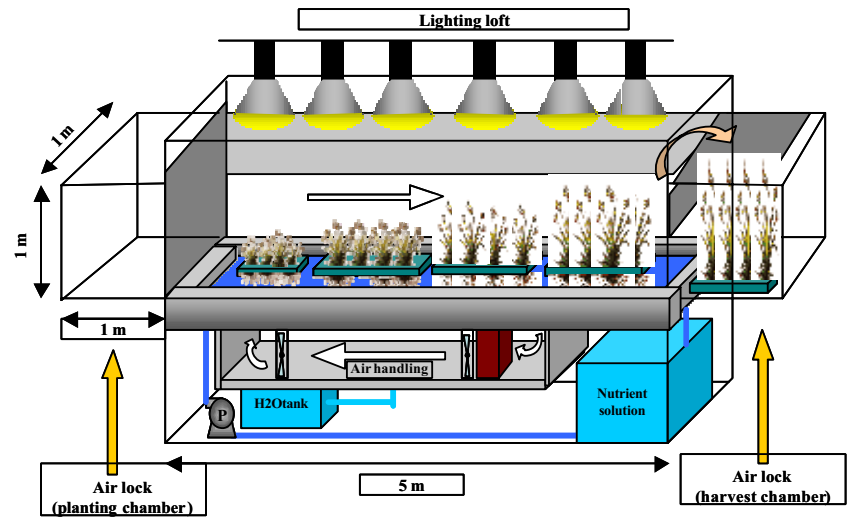
# The Process Characterisation

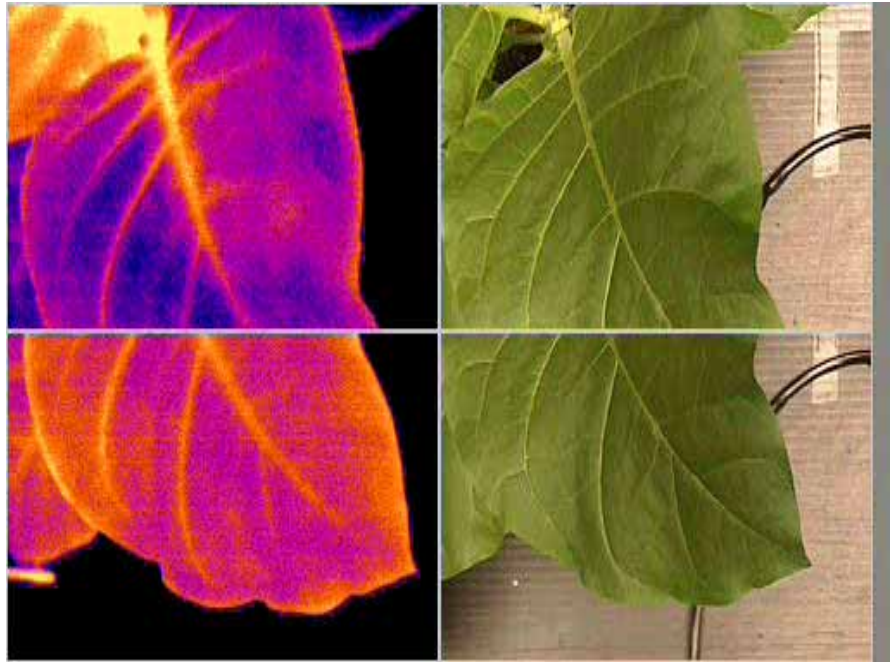
- Characterisation in different modes (nominal, limitation, inhibition,..)
- Stoichiometry studies,
- Hydrodynamic Characterisation,
- Static Modeling,
- Dynamic Modeling,
- Control Model,
- Safety issues (chemical and microbiological)
- Maintenance and Dependability

## Phase 1 (related to plants)

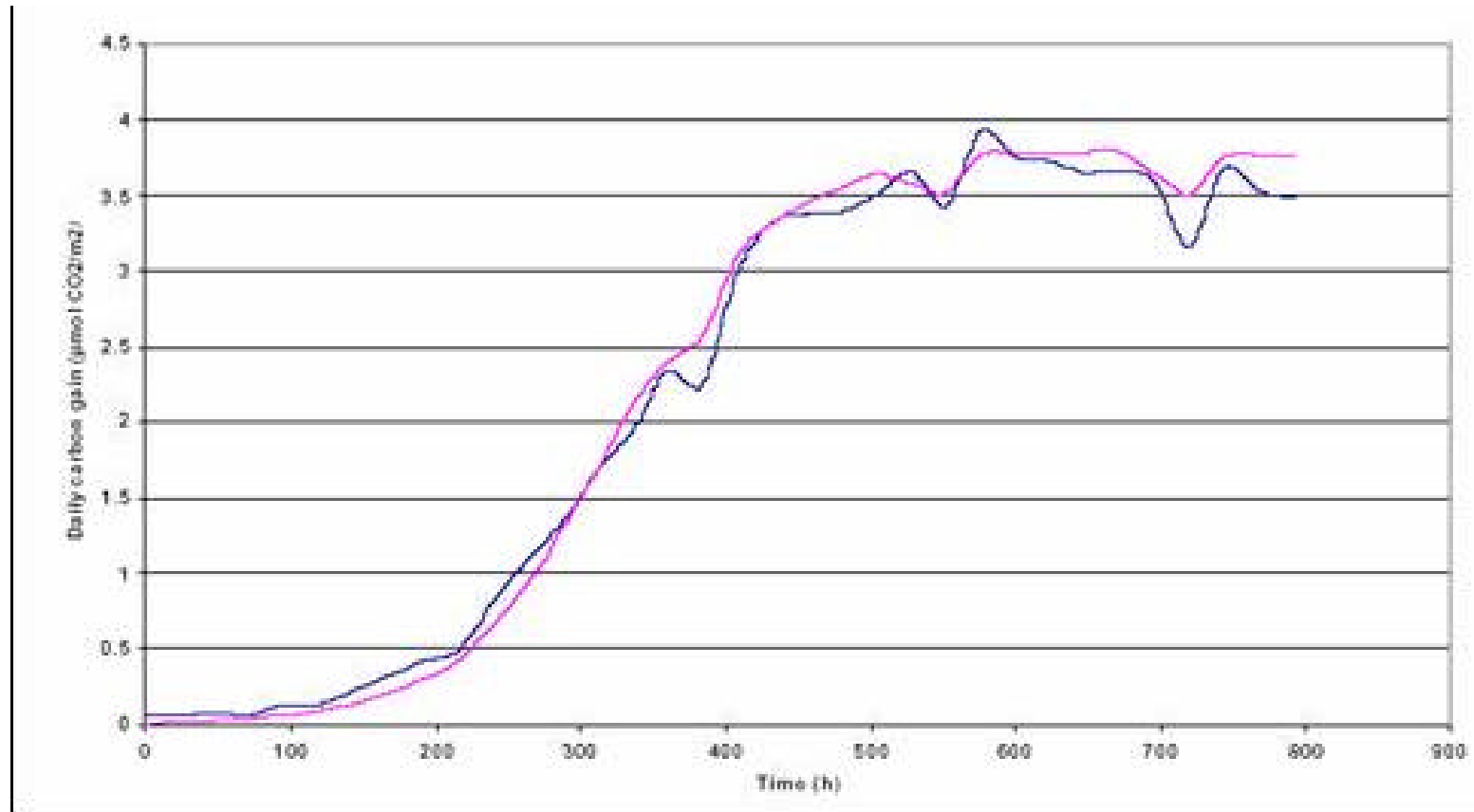


- Plant Characterisation (C, H, N, O, S, P,...),
- Plant Modelling,
- GreenHouse Design (metabolic),
- Associated Instrumentation,
- Recieps Elaboration and Acceptance,
- Biomass valorisation,
- Non Edible part recycling.





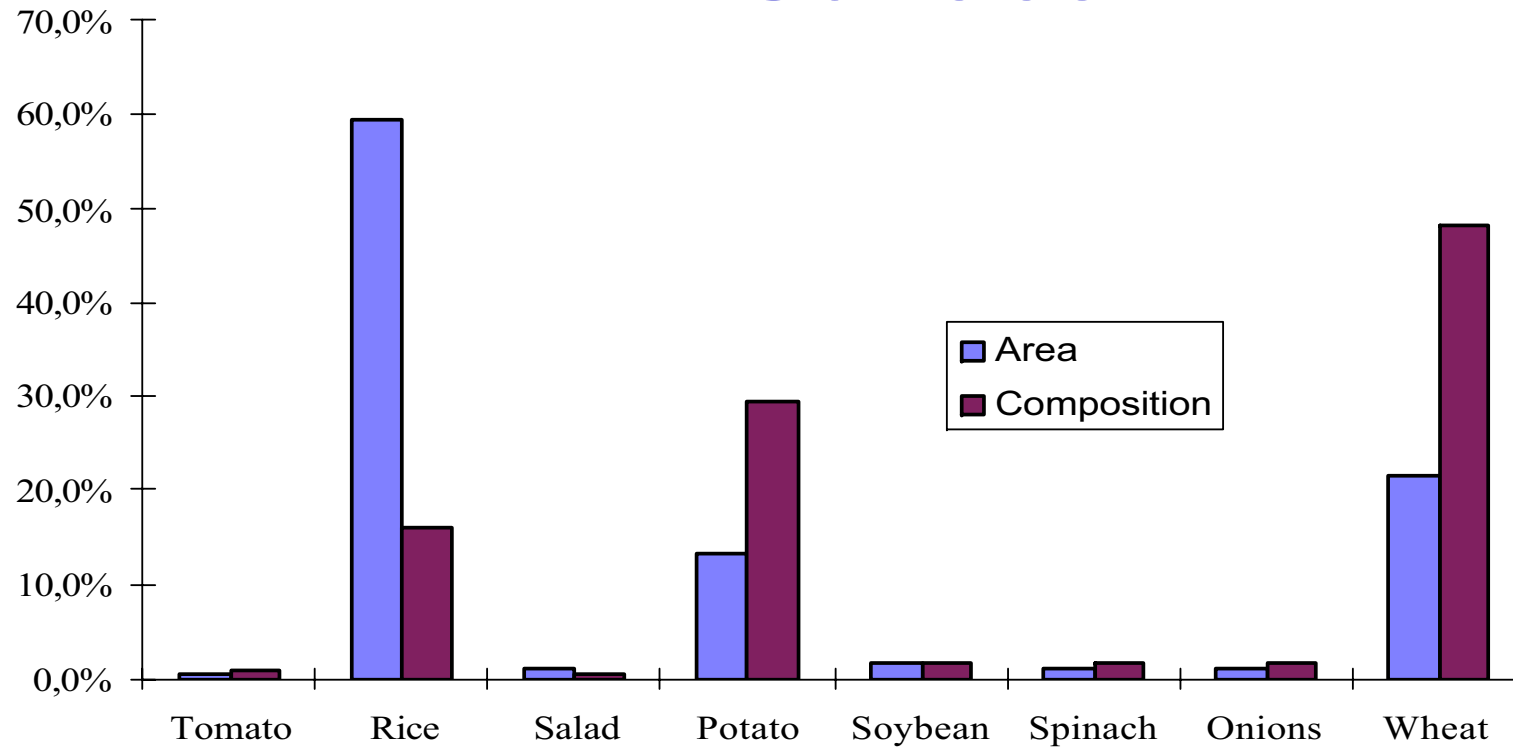
# Modelling



Comparison of Beet NCER/DCG to Thornley model Predictions



## Influence of plant Choice on Surface



# A few Recipes...



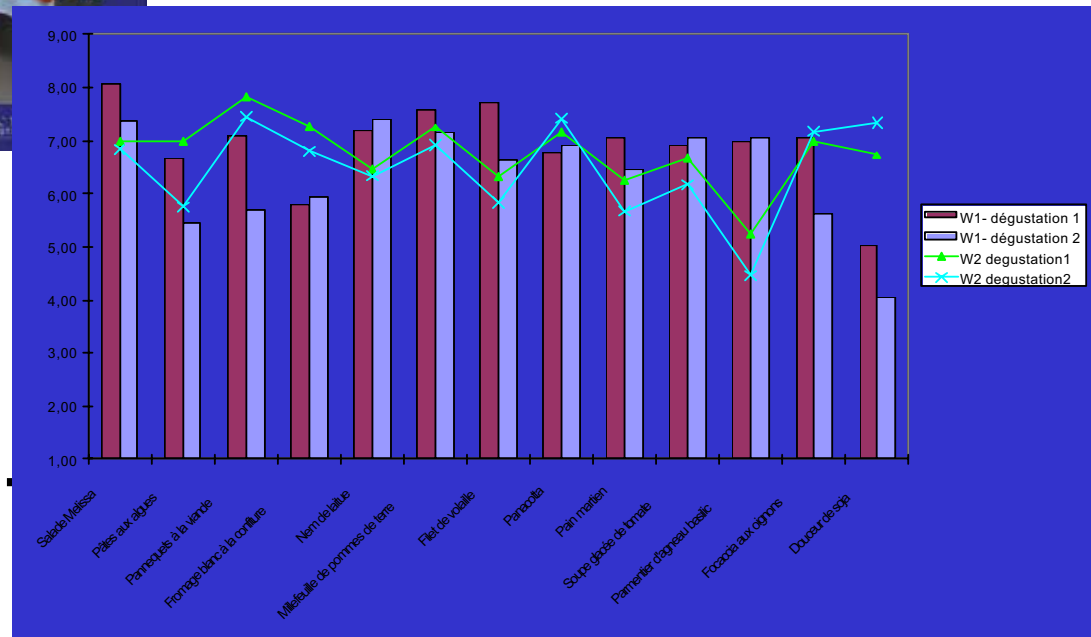
- ✓ Gnocchis de pommes de terre
- ✓ Tomates et oignons farcis
- ✓ Nems de laitue
- ✓ Millefeuille de pommes de terre à la tomat
- ✓ Soupe glacée à la tomate fraîche
- ✓ Galettes de pommes de terre
- ✓ Légumes en Tempura
- ✓ Pâtes aux algues et fondue de tomates
- ✓ Risotto aux algues
- ✓ Riz au lait de soja
- ✓ Salade « Melissa »
- ✓ Tomates à la Provençale
- ✓ Panacotta au lait de soja
- ✓ Confiture de tomates vertes
- ✓ Potage Parmentier
- ✓ Barbajuans
- ✓ Pain « Martien »



# Bed Rest Test



**90 days jours**  
**at -6°**  
**60 scientists**  
**including USA, Japon,...**



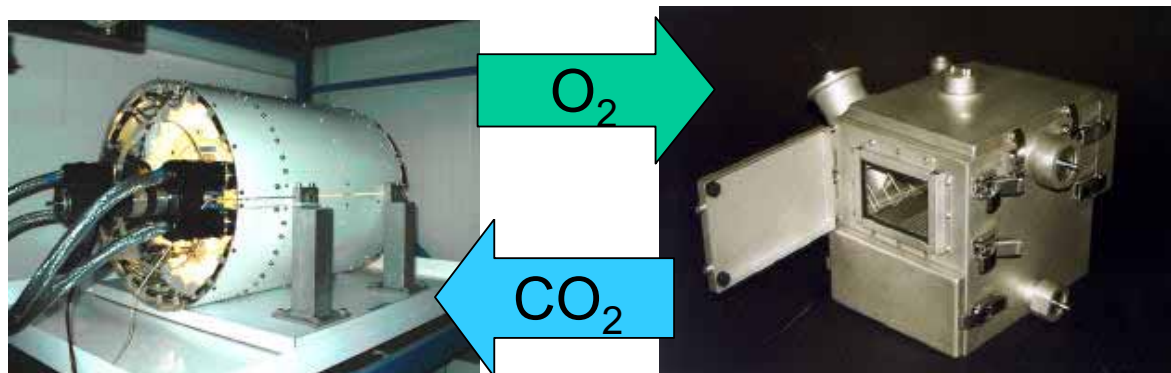
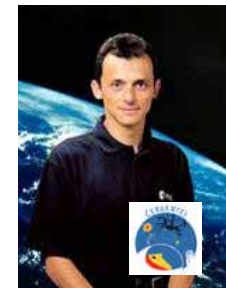
# What can we predict ?



| Détail des écarts entre analyses et calculs théoriques |             |                  |         |       |
|--------------------------------------------------------|-------------|------------------|---------|-------|
| Produit                                                | Composition | Calcul théorique | Analyse | Ecart |
| Pannacotta                                             | Eau         | 54,2             | 55,82   | -3%   |
|                                                        | Energie     | 300,4            | 251,7   | 19%   |
|                                                        | Lipides     | 24               | 22,81   | 5%    |
|                                                        | Glucides    | 18,7             | 8,51    | 120%  |
|                                                        | Protides    | 2,8              | 3,09    | -9%   |
|                                                        | Sodium      | 23,2             | 42      | -45%  |
|                                                        | Potassium   | 87,8             | 90      | -2%   |
|                                                        | Fer         | 0,2              | 0,34    | -41%  |
|                                                        | Calcium     | 37,1             | 57,3    | -35%  |
|                                                        | Magnésium   | 5,3              | 9       | -41%  |
| Riz au lait                                            | Eau         | 83,7             | 66,54   | 26%   |
|                                                        | Energie     | 77,1             | 137,9   | -44%  |
|                                                        | Lipides     | 2,6              | 3,53    | -26%  |
|                                                        | Glucides    | 9,6              | 21,1    | -55%  |
|                                                        | Protides    | 3,8              | 5,44    | -30%  |
|                                                        | Sodium      | 69,7             | 248     | -72%  |
|                                                        | Potassium   | 118,3            | 132     | -10%  |
|                                                        | Fer         | 0,5              | 0,57    | -12%  |
|                                                        | Calcium     | 33,3             | 56,9    | -41%  |
|                                                        | Magnésium   | 15               | 19,6    | -23%  |
| Soupe aux tomates                                      | Eau         | 86,2             | 90,23   | -4%   |
|                                                        | Energie     | 75,3             | 40,6    | 85%   |
|                                                        | Lipides     | 5,3              | 3,27    | 62%   |
|                                                        | Glucides    | 5,2              | 1,92    | 171%  |
|                                                        | Protides    | 1,6              | 0,86    | 86%   |
|                                                        | Sodium      | 35,1             | 423     | -92%  |
|                                                        | Potassium   | 196,9            | 257     | -23%  |
|                                                        | Fer         | 0,4              | 0,52    | -23%  |
|                                                        | Calcium     | 39,3             | 18,5    | 112%  |
|                                                        | Magnésium   | 10,7             | 11,2    | -4%   |

# P2: Preliminary Experiment

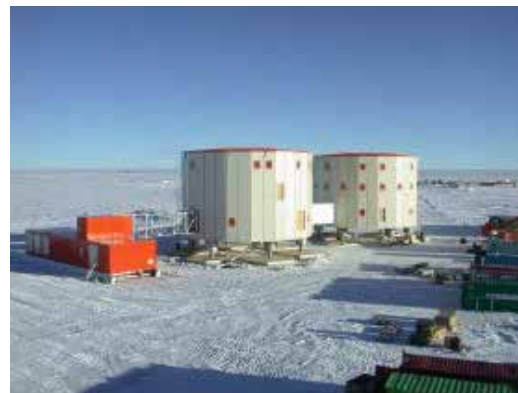
- **Already : 2 Flights Experiments on ISS:**
  - MESSAGE 1 & 2 with F. DeWinne and P.Duque,
- **In development :**
  - BASE (september 2006),
  - BIORAT (O<sub>2</sub>/CO<sub>2</sub> recycling demonstration with mice)

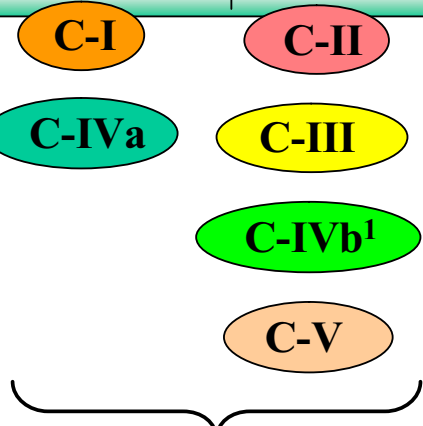
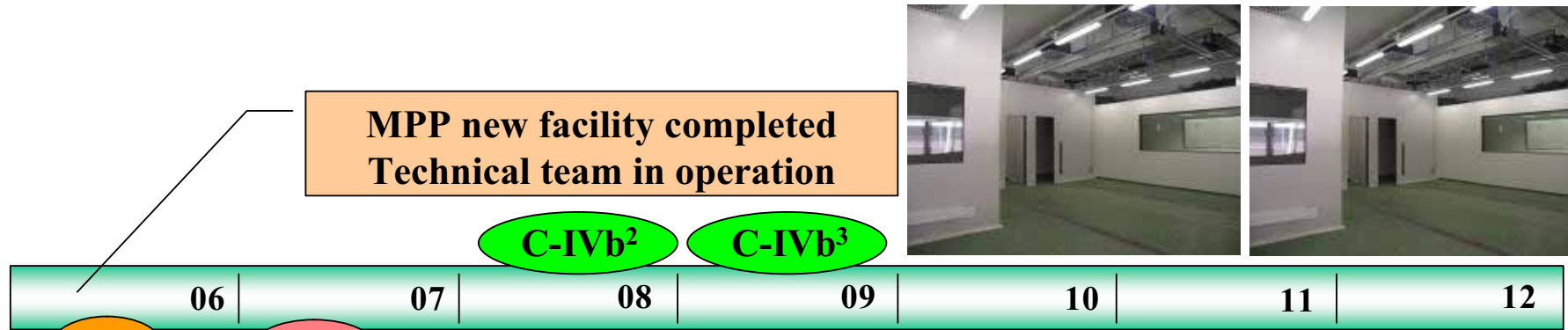


## Phase 3



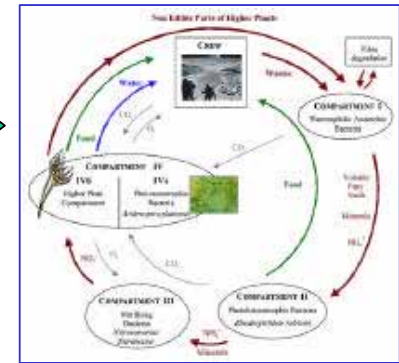
- MELISSA Pilot Plant (new Building),
- CONCORDIA (Waste and Nitrification),
- BIOS (collaboration with IBP)





**Delivery and installation of all compartments in the MPP**

**Further characterization of Compartments operation and implementation of control laws**



# P4: Technology transfer



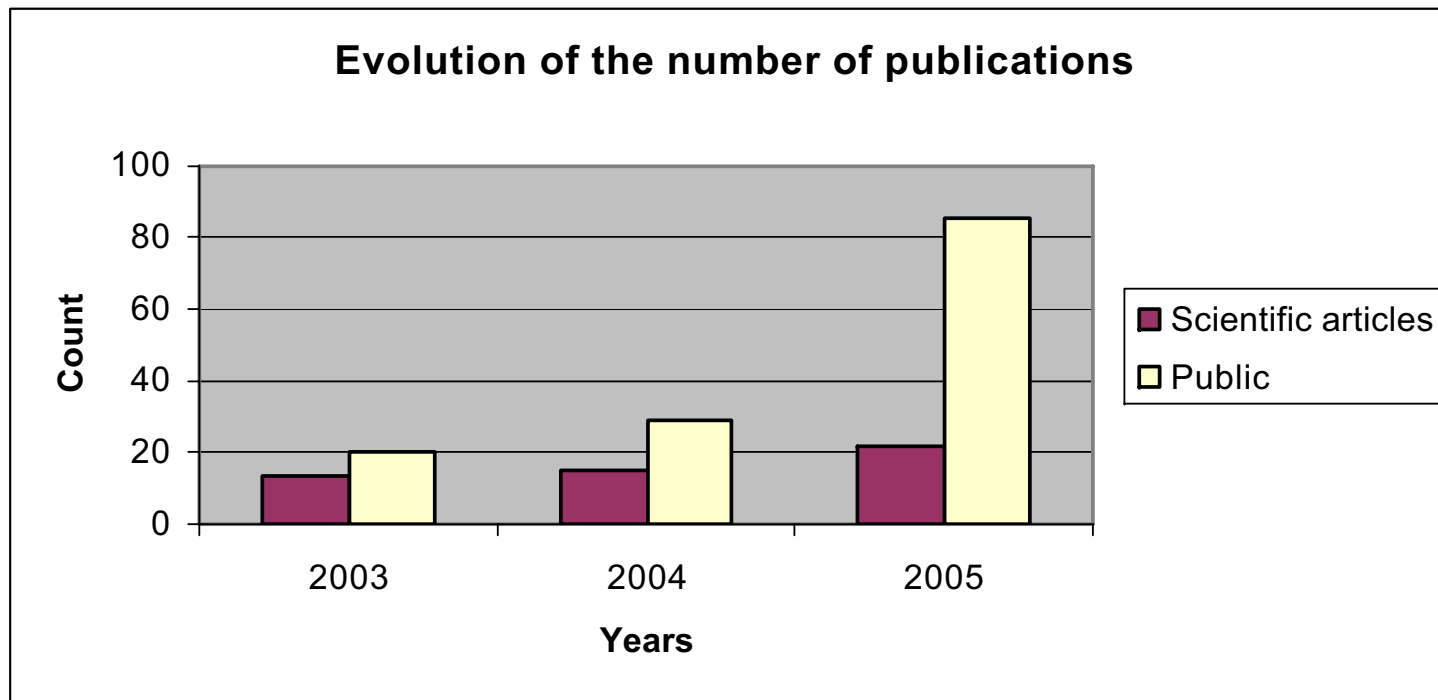
**Creation of a Spin-off Company  
In March 2005.**



Food production  
Water recycling  
Waste management  
Air revitalization  
Contaminant removal  
Safety, quality control  
Energy efficiency and simulations

- Nano technology (needs specification)
- Food additive technology (needs specification)
- Greenhouse technology
- Renewable energy
- Microwind turbine technology
- Very large wind turbine technology
- Solar panel technology
- Biomass and fermentation
- Ozone treatment for food conservation and disinfection

# P5: Education & Communication



In 2005, 87% of the media-related communication concern food!

# Conclusion



- ESA is active in Closed Life support system since 1989,
- The Closed Life support research is a very long term effort which requires a large number of expert and harmonisation,
- Today, several European countries are already very active in this field,
- ESA is very much open of collaboration and harmonisation, and propose to do it via the existing MELISSA project.



Web Page

<http://ecls.esa.int/ecls>