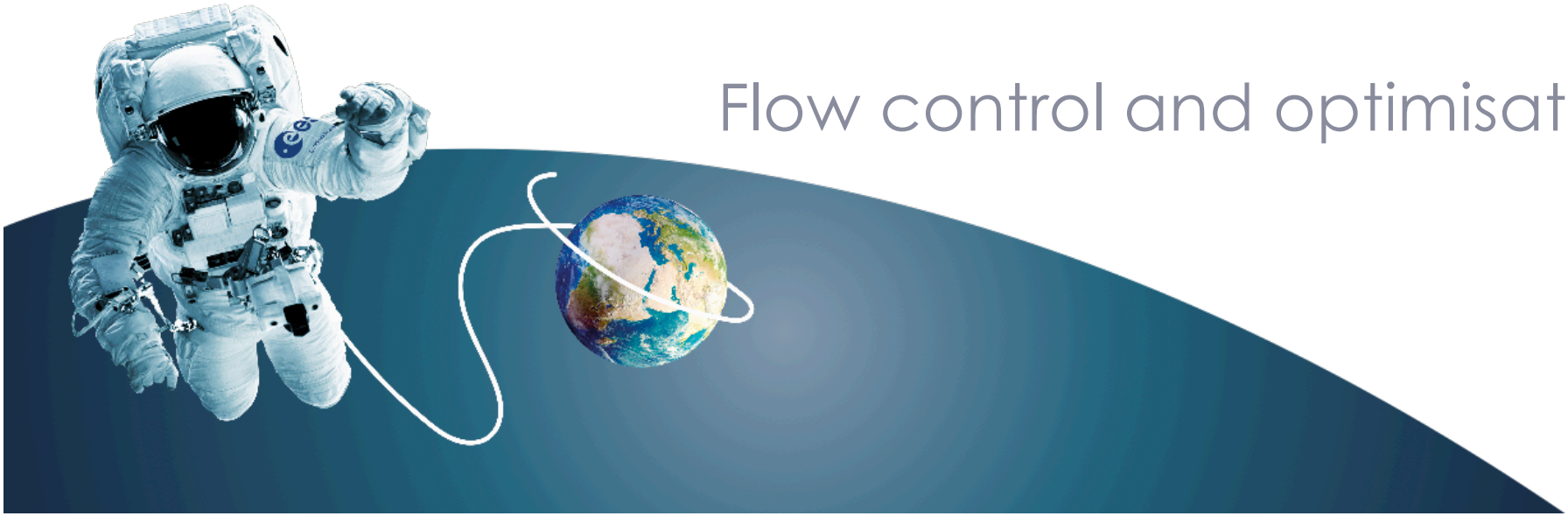
MELISSA
MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

SHERPA ENGINEERING

CREATING A CIRCULAR FUTURE

Global Control of the MELISSA Life Support System

Flow control and optimisation



Loop Control Problematic

- Ensure the crew survival
  - Management of the needs…

Element	Food	Oxygen	Water
Need (kg/astr/d)	0,58	0,89	1,5

  - …and waste

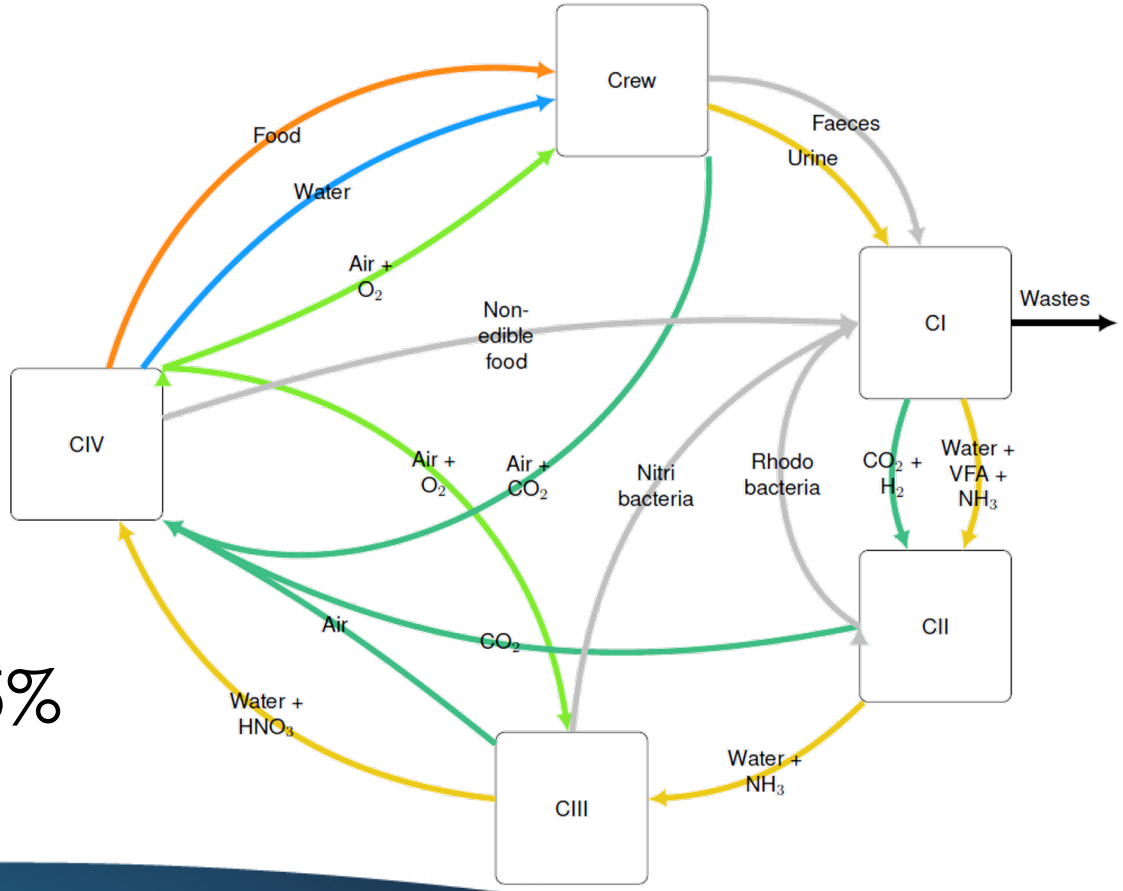
Element	Faeces	Urea	CO_2	Water
Need (kg/astr/d)	0,01	0,05	1,03	1,88

Loop Control Problematic

- Objectives:

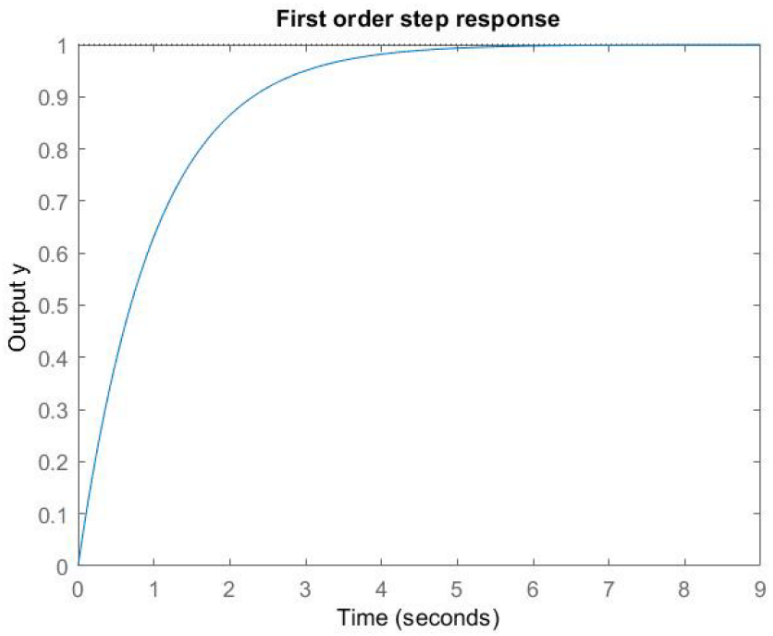
Element	Food	O_2	Water
Coverage	40%	100%	90%

- Air composition:
  - 18% < O_2 < 25%
  - CO_2 < 5000ppm = 0.5%



Loop Model

- Three Levels:
  - Static study based on stoichiometric equations
  - Dynamic model
  - System optimization



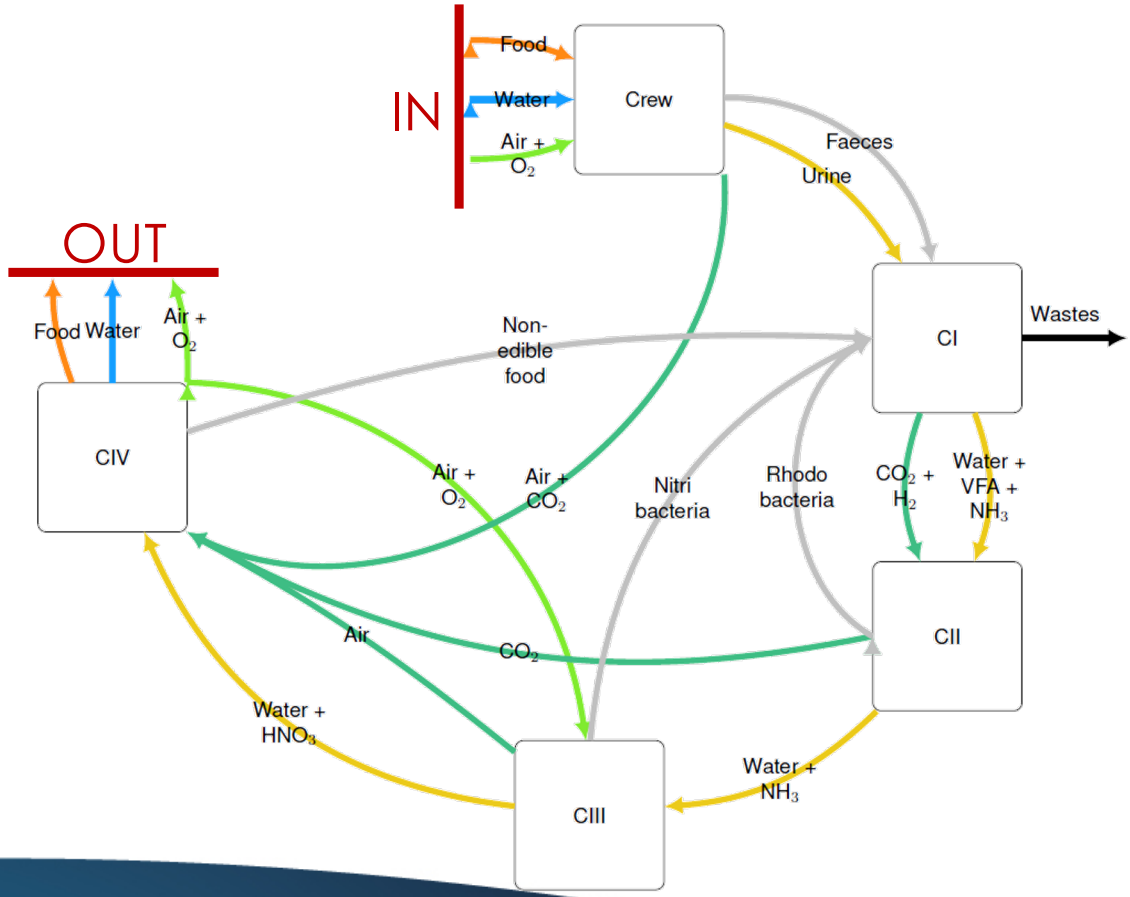
Loop Static Model

- Natural coverage:

Food	O_2	Water
24,2%	53%	117,6%

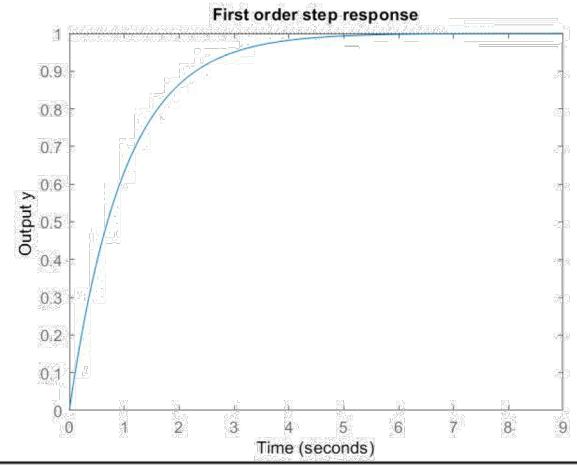
- Boosted loop:

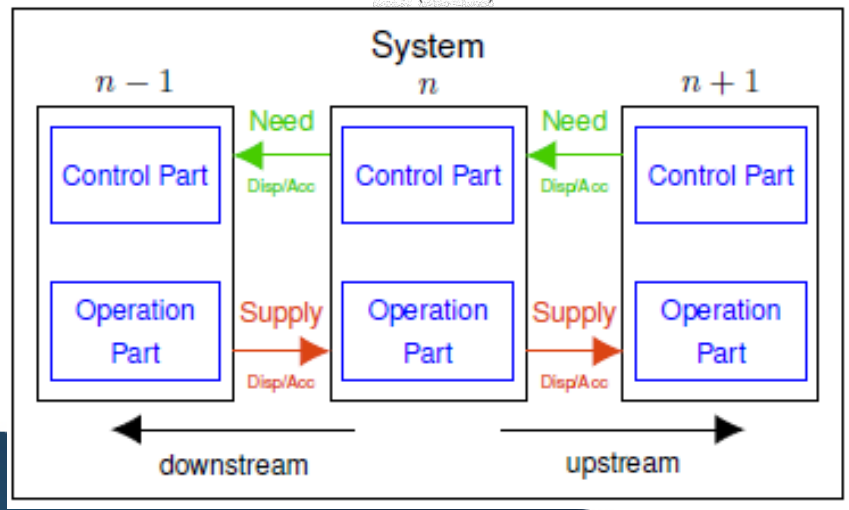
Food	O_2	Water
46%	100%	112%



Loop Dynamic Model

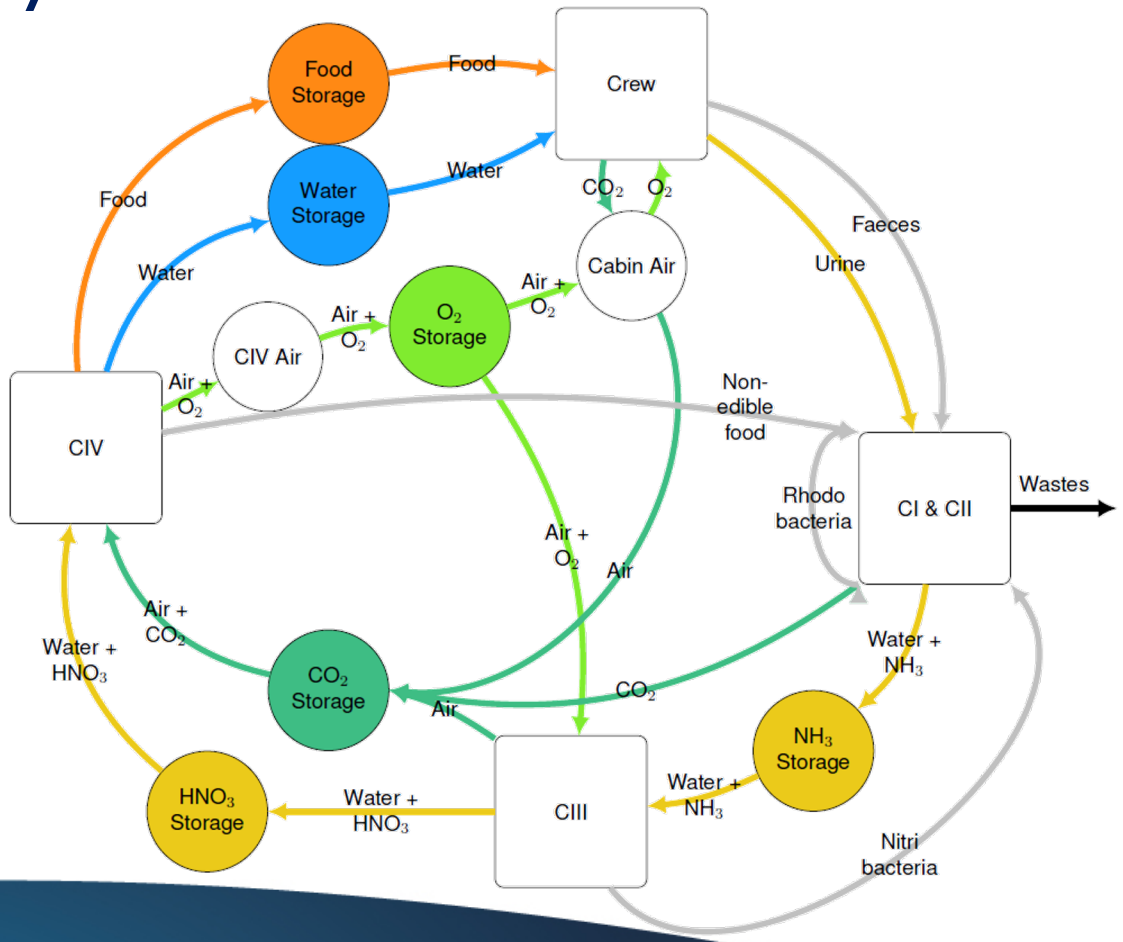
- Functional Energy-based Modelling
  - Each element has a specific function
  - EMI flow links (Energy, Matter or Information)





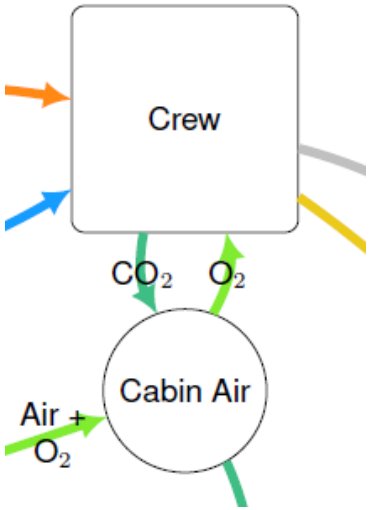
Loop Dynamic Model

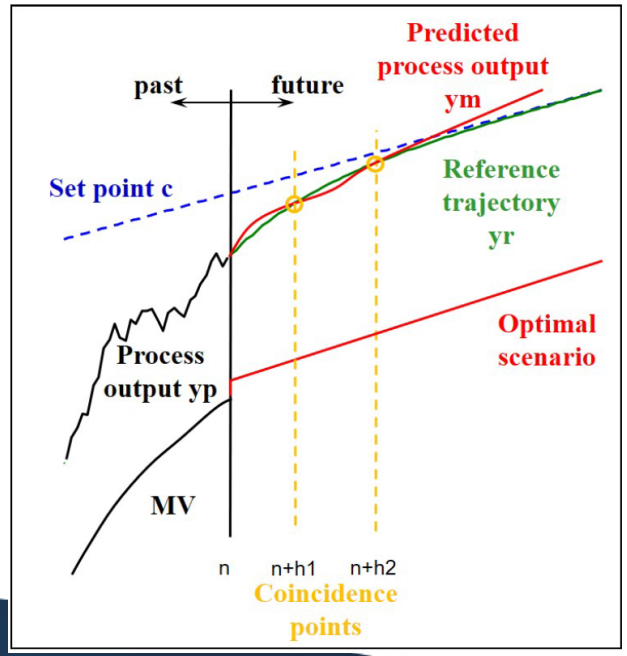
- Complete Model
  - Storages addition:
    - 6 elements storages
    - 2 air storages



Loop Dynamic Model

- Air storages issue
  - Varying composition
  - 2 different needs:
    - Specific element
    - Flow
- Predictive control





Loop Dynamic Model

- 7 scenarios

Scenario n°	Astronauts	External Resources	Specificities
1	1	O_2, HNO_3	
2	1	O_2, NH_3	
3	1	CO_2, NH_3	
4	1	CO_2, HNO_3, NH_3	
5	1,6	O_2, NH_3	
6	1	O_2, NH_3	ISS scenario
7	1	O_2, NH_3	Astronaut activity variation

Results

- Coverage

Scenario	Food Coverage in %	Water coverage in %	O_2 coverage in %
1	44.92	108.23	100.00
2	48.34	108.12	100.00
3	48.40	108.12	100.00
4	44.93	108.24	100.00
5	46.49	107.68	100.00
6	48.35	108.12	100.00
7	35.39	112.28	about 73

Results

- Cabin O_2 level

Scenario	Maximum in %	Minimum in %
1	20.926	20.548
2	20.926	20.548
3	20.9	20.788
4	20.903	20.788
5	20.926	20.548
6	20.967	20.788
7	21.039	20.603

Results

- Cabin CO_2 level

Scenario	Maximum in ppm	Number of days above 5 000 ppm
1	5000	0
2	5000	0
3	5561	40
4	5561	40
5	6461	30
6	5000	0
7	5118	0.5

System Optimization

- System mass minimization

Scenario	Length (days)	Crew	Total (kg)	kg/d/astr
1 (O2 - No loop)	80	1	219,35	2,741875
2 (O2)	80	1	66,510	0,831
3 (O2 - HNO3)	80	1	31,393	0,392
4 (O2 - CO2)	80	1	66,610	0,833
5 (O2 - NH3)	80	1	26,178	0,327
6 (HNO3)	80	1	31,073	0,388
7 (HNO3 - CO2)	80	1	30,996	0,387
8 (NH3 - CO2)	80	1	27,118	0,339
9 (O2 - HNO3 - CO2)	80	1	31,371	0,392
10 (O2 - NH3 - CO2)	80	1	26,262	0,328
		MIN	26,18	0,33

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THANK YOU.

Baptiste Boyer
Sherpa Engineering
b.boyer@sherpa-eng.com

www.**melissafoundation**.org

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