

Flying... Green!

(C. Lobascio, M. A. Perino)

The central position AAS has gained in the ISS Development stems from a know how pursued and established across 30 years of cooperation in ASI and ESA projects



MPLM



ATV

Cupola



Nodes

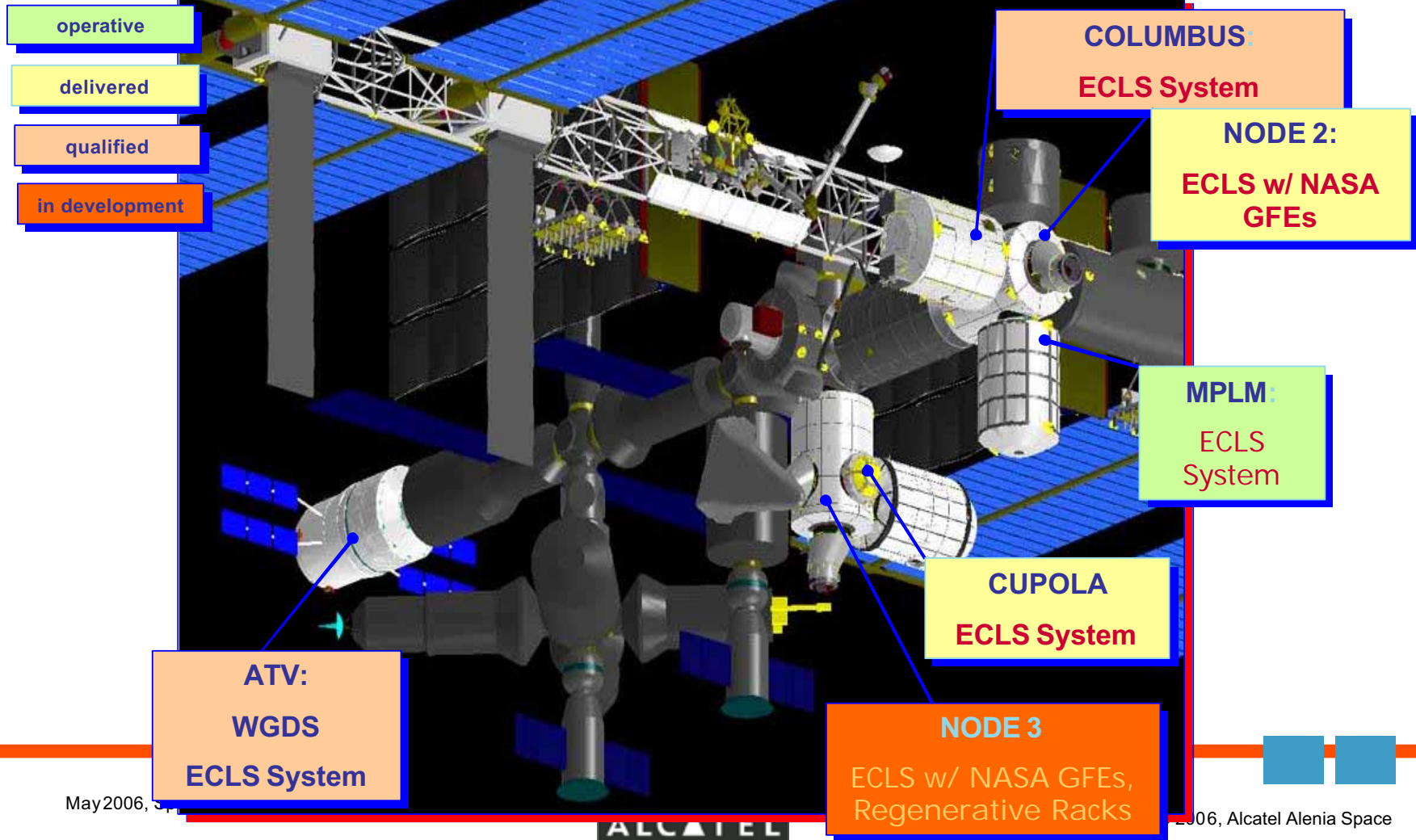


Columbus

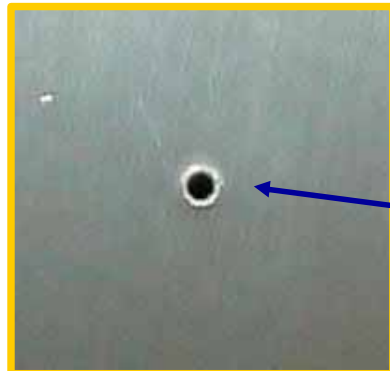
Spacelab



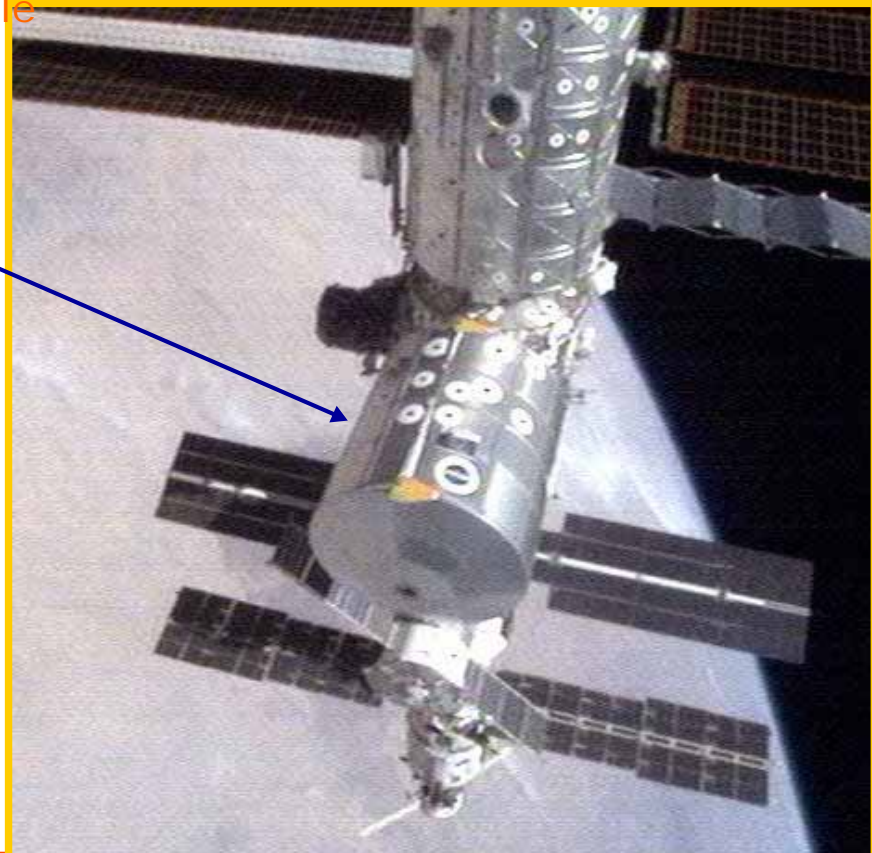
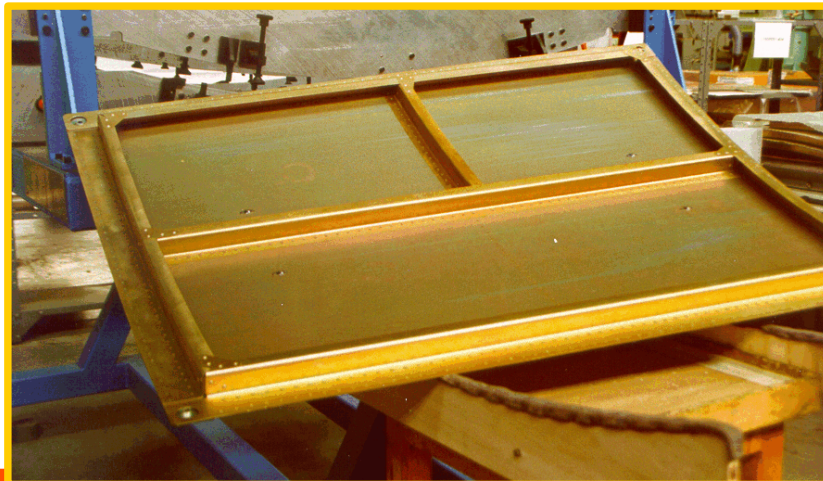
Spacehab



MPLM Leonardo mission STS-102/5A.1, 2001 - 3 MMOD impacts - 1.44 mm hole



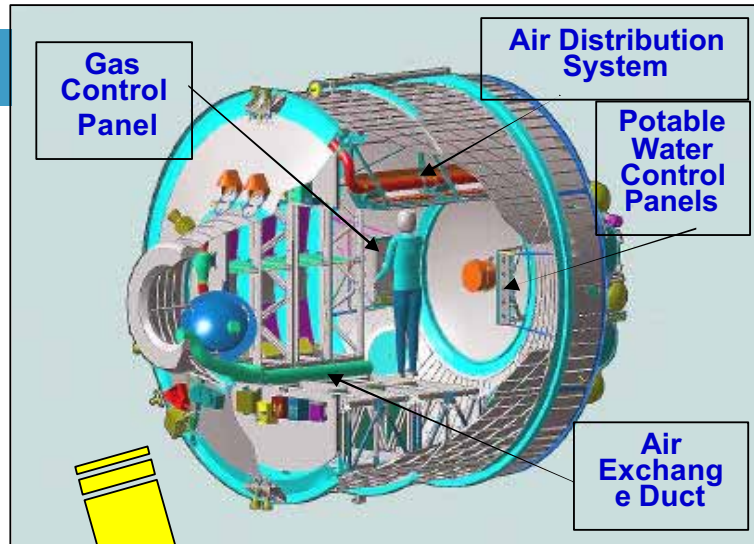
hole



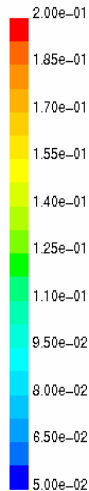
From a recent astronauts debriefing (MPLM 5A.1):

- ***“The air was not hazy. It did not irritate the eyes or upper respiratory tract. [...] Did not notice any ‘dead’ air pockets. Four crew members slept in the MPLM. [...] MPLM was a quiet module. [...] Loudest was Service Module. Quietest was MPLM.”***

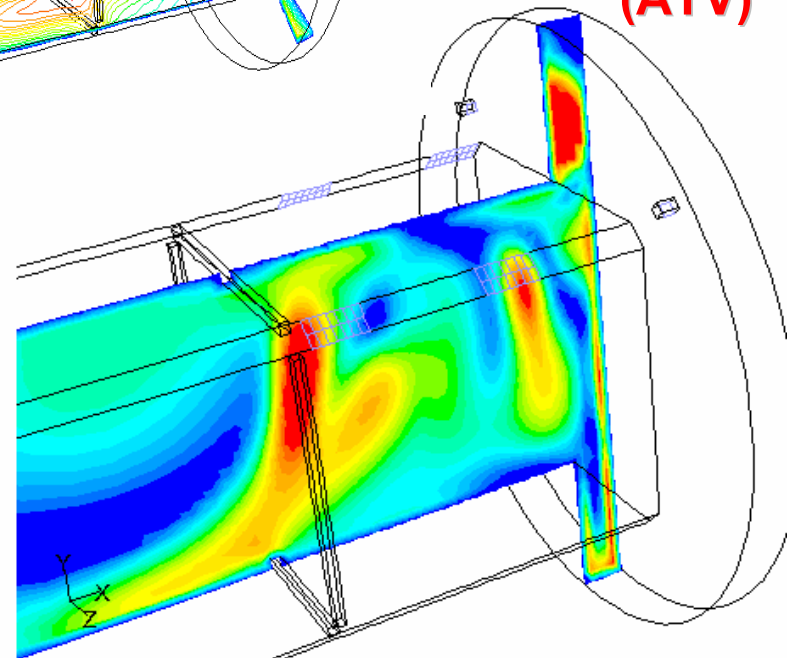
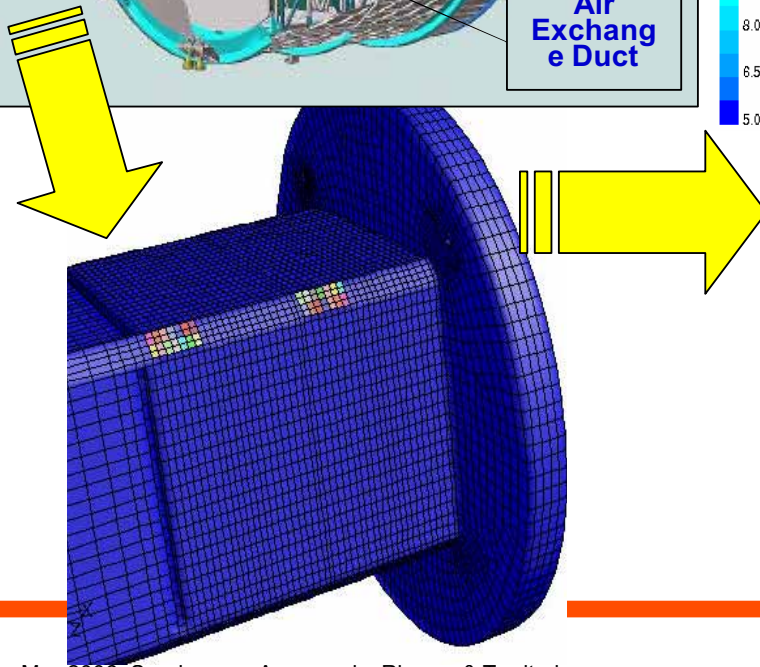
NASA Chief Toxicologist reported after the 2nd MPLM Offgassing test : *“This is a low offgassing rate (approximately 5-fold lower than the Lab module) and shows that the crew can enter the module without any protection from volatile offgas products.”*



Velocity range [m/s]



Cabin Ventilation - CFD Analysis Automated Transfer Vehicle (ATV)

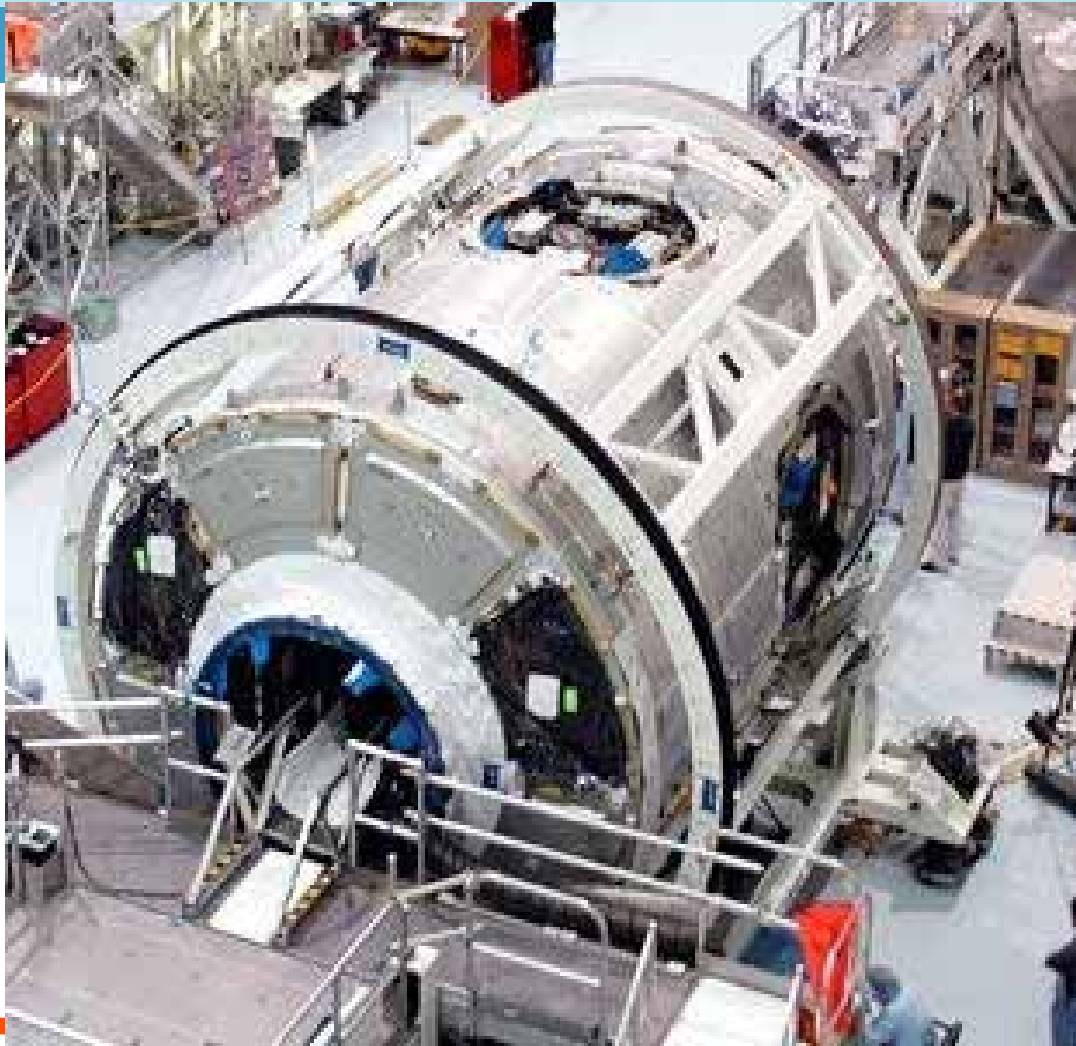


MPLM cabin ventilation test



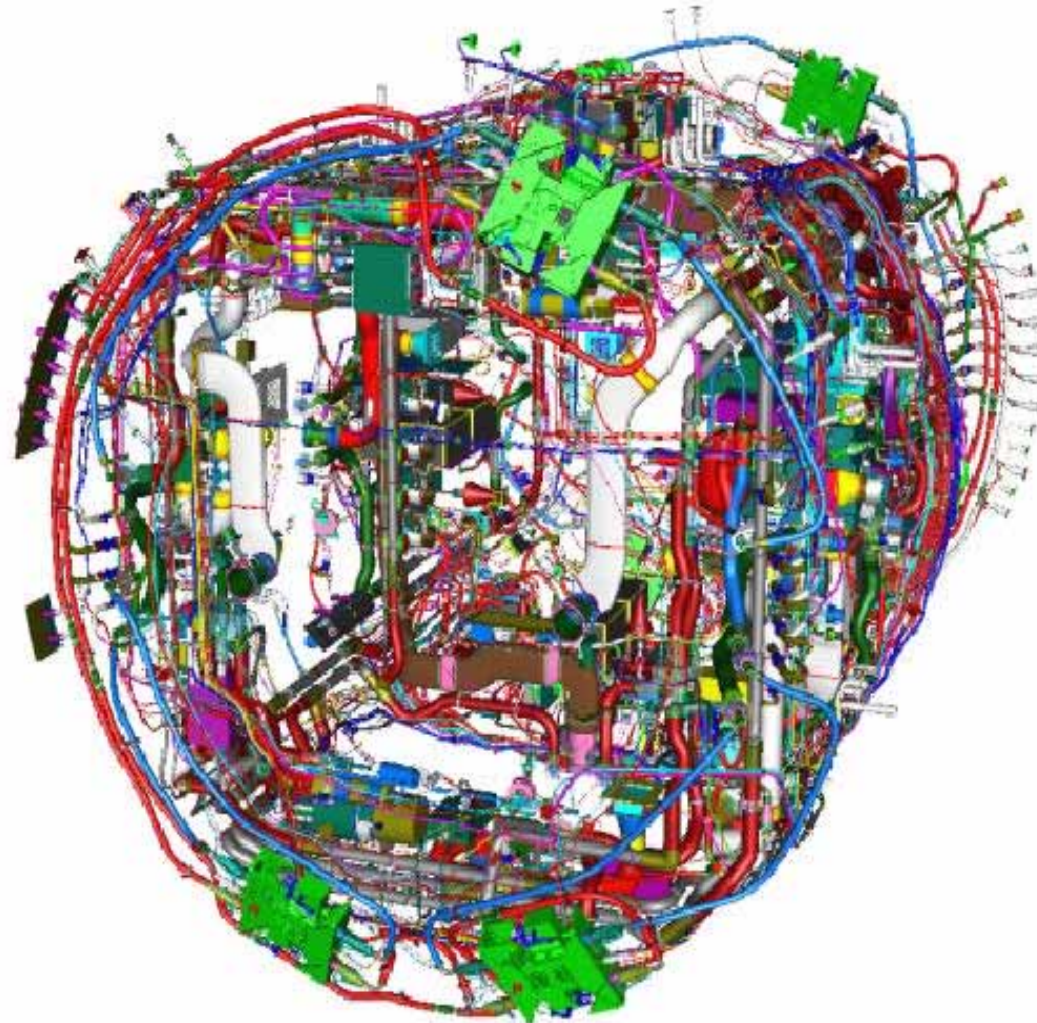
A CFD model correlated with ventilation test results allows
avoiding further testing, with great cost and schedule
benefits

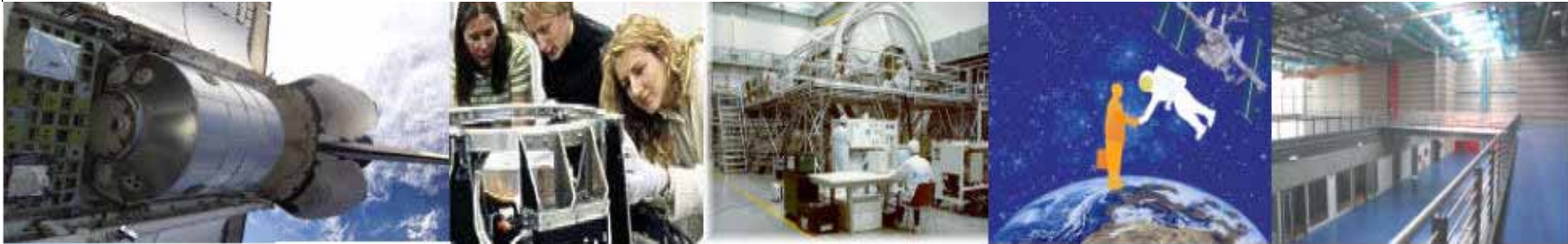
Example of
Pressurised
Module:
Node 2



Example of Pressurised Module: Node 2

Internal Lines Complexity





ALTEC is the Italian Centre of Excellence, operating in an international context, for the provision of a wide range of hi-tech engineering services relevant to the International Space Station and other Space Infrastructures, for Institutional, Industrial and Commercial Customers.



Result of team work, with agencies and industrial partners

We learned (and are still learning!) to be effective and “smart” integrators of complex systems, in the harsh environment of space, creating comfortable and safe environmental conditions in the habitats

We are learning to fly... “Light blue”

We need more colors to obtain the green



ISS modules

ISS exploitation (test bed)

Entry vehicles

Rovers & Landers

Low/Mid term planetary habitats (travelling, orbiting & base)

Logistic support

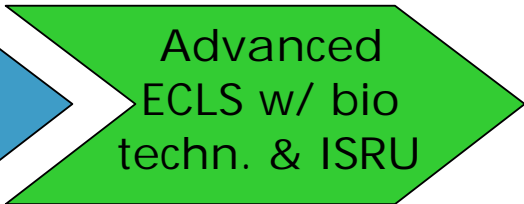
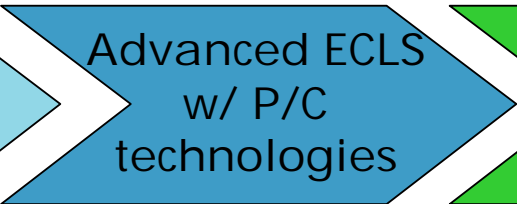
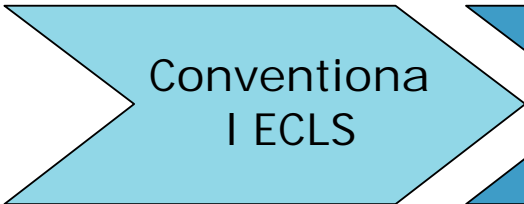
Severity of enviro

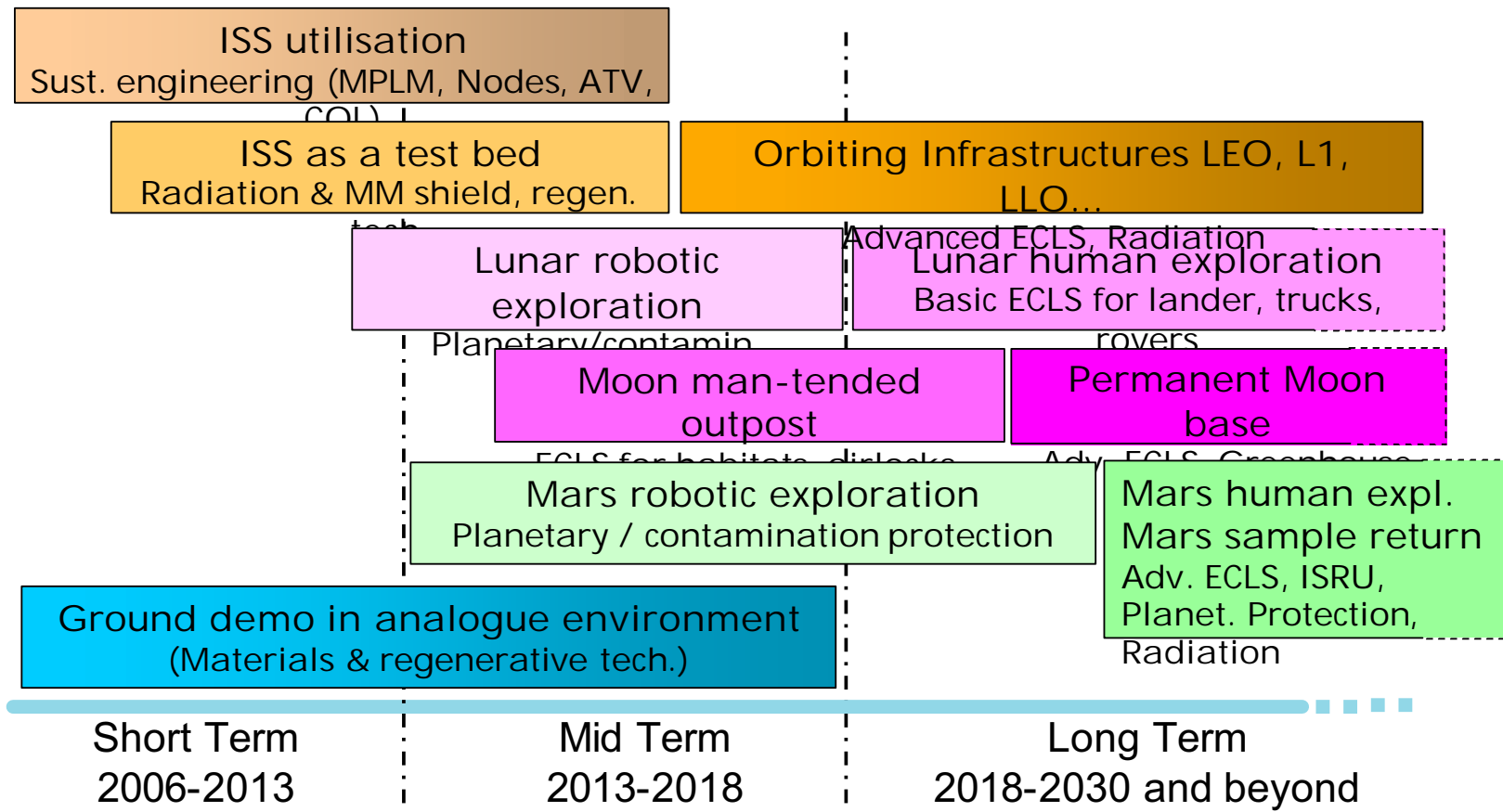
High



Long term planetary missions (base)

High





- Environmental Control Systems must evolve to meet the increasingly stringent requirements imposed by the future manned missions:
 - ◆ Autonomy to minimise the logistic support → FOOD
 - ◆ Long duration to allow planetary exploration
 - ◆ Severe environmental conditions
 - ◆ Increased number of crewmembers to support
 - ◆ Higher dependability (reliability, availability, maintainability and safety)
 - ◆ Extreme care of the psychological human comfort
 - ◆ Planetary protection

- Exploit & consolidate the acquired know-how and role in the “classical” Life Support Systems, for the ISS exploitation and next manned exploration programmes
- Prepare, innovate for the future steps: moon and Mars
 - Regenerative technologies, In Situ Resources Utilization (ISRU)
 - Technologies for environmental and planetary protection
- Exploit the opportunities and fall out in terrestrial applications: analogues in extreme environment, protection and emergency systems, decontamination, food production, sustainability

Lord Baden Powell of Gilwell, exploration expert

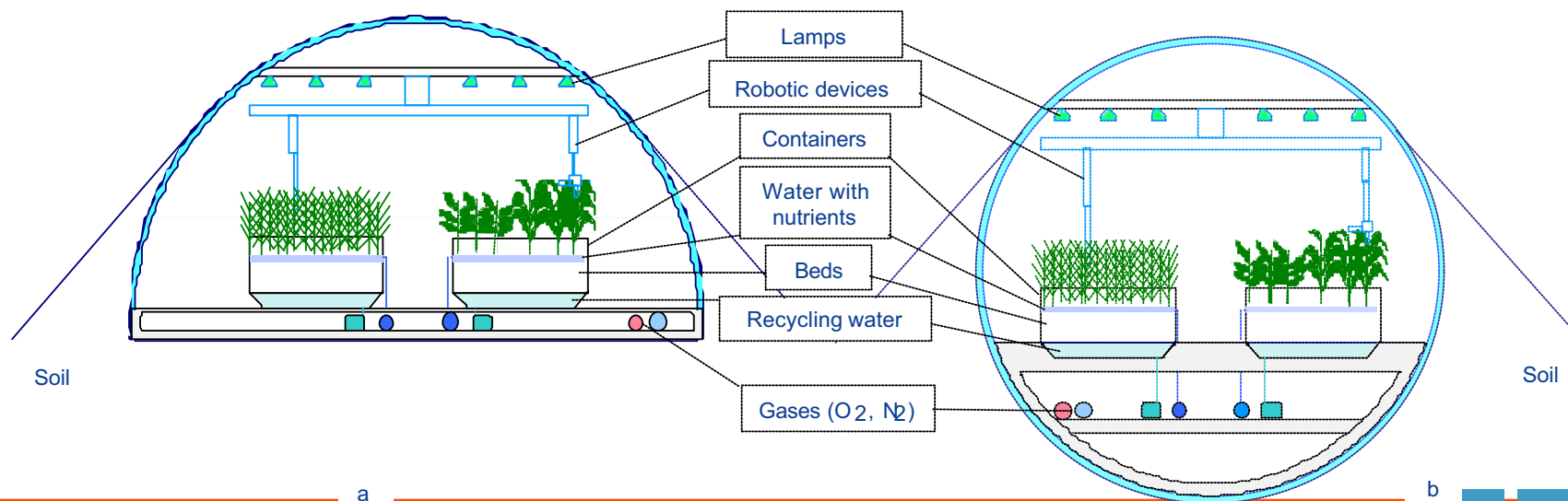


How?

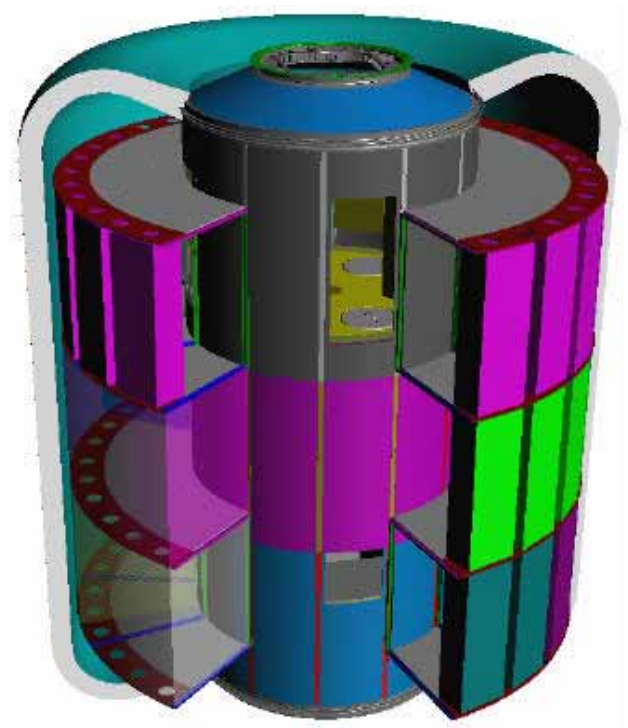
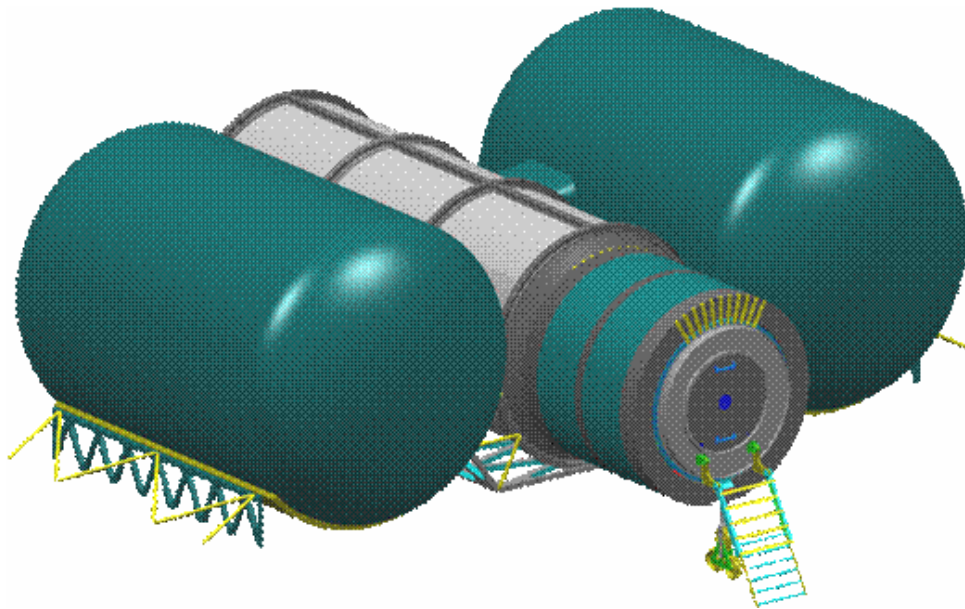
- System level studies
- Technolog. Develop.
- Visibility actions
- Collaborations
- Investments

Recent studies lead or involving AAS-I:

- “European Mission Architectures and Technologies in the Mars Exploration Scenario - S51”
- Lunar exploration architecture - greenhouse

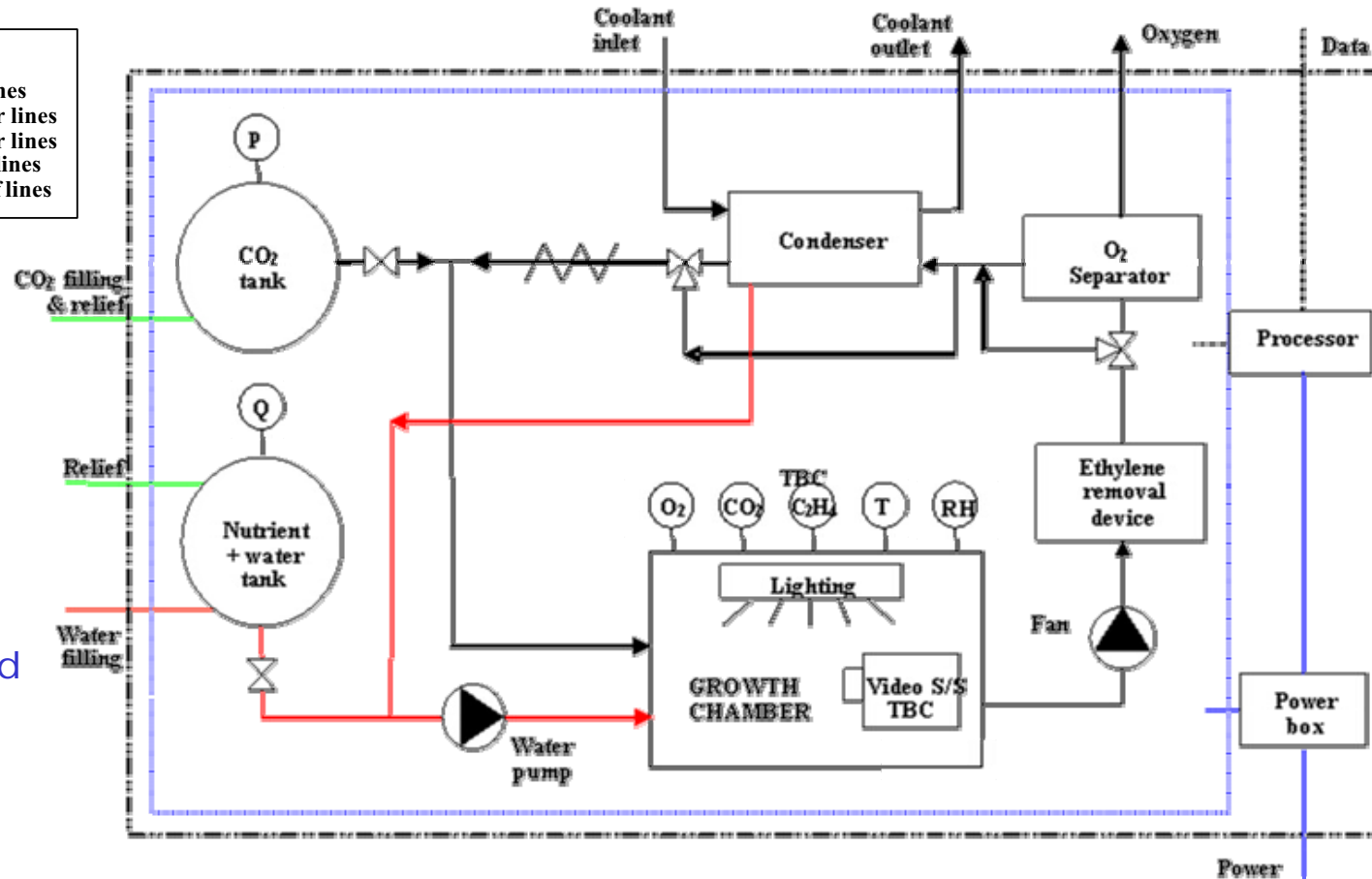


- Inflatable habitat study - Spacehaven - Definition of the advanced life support

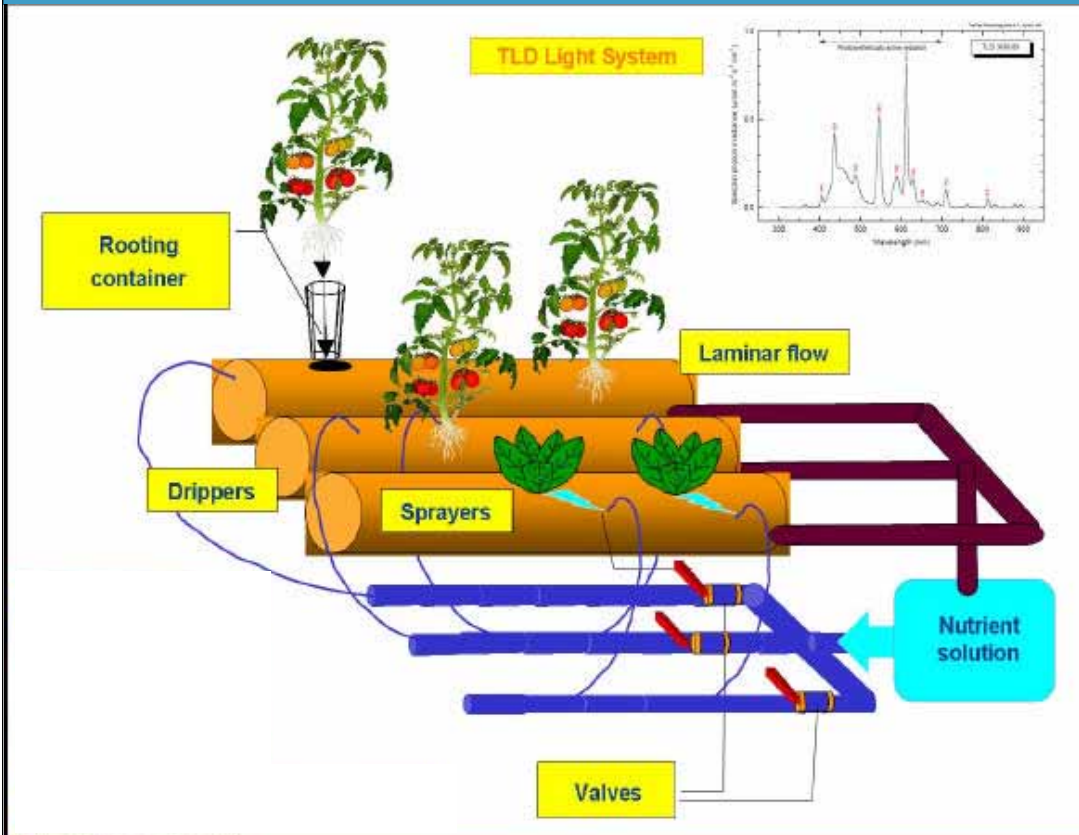


LEGENDA

- Air lines
- Water lines
- Power lines
- - - - Data lines
- Relief lines



Note: “Salad Machine” is a term from M. Kliss of NASA

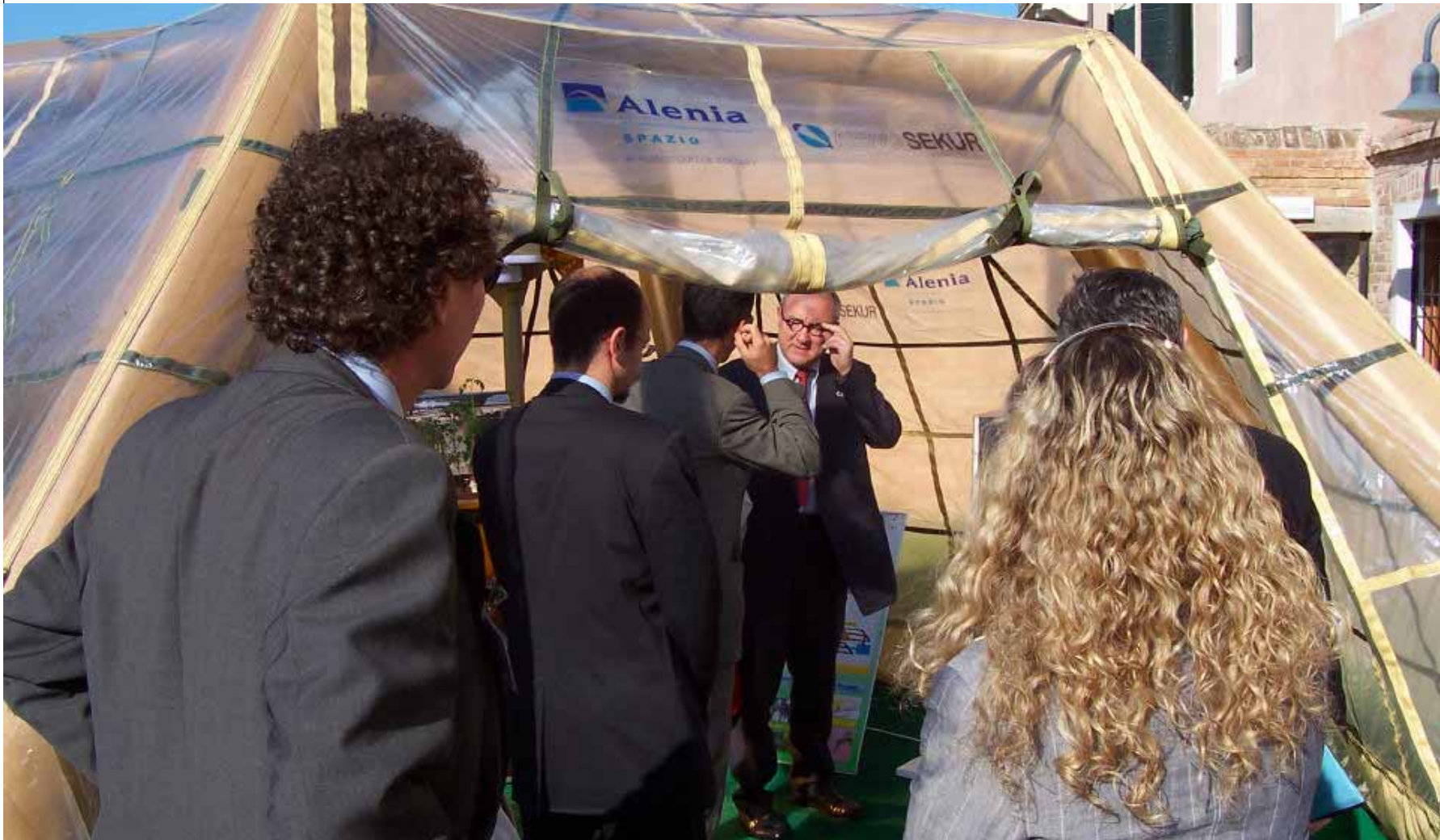


EDEN - EPISODE 1
(Experimental Plant Irrigation System On ground DEMonstrator 1)

Inflatable greenhouse - demo at Moonbase Italy



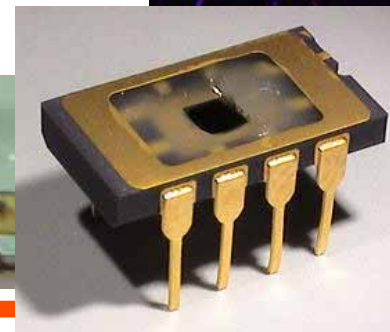
May 2006, Sperlonga – Agros spazio. Ricerca &



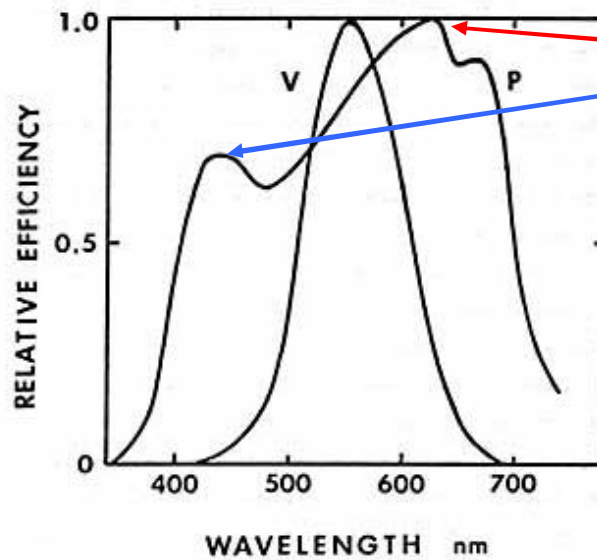
ESA/ASI **CHECS** (Closed Habitat Environmental Control Sensors) for the development of environmental micro-sensors for plant facilities.

Principal Investigator: L. Boarino,
Ist. Elettrotecnico Naz. Galileo Ferraris

Investigator Plant Physiology:
Center of Excellence Biosensors,
Prof. M. Maffei (Univ. Torino)



Purpose: allow and stimulate photosynthesis
We must consider the **PAR**
(Photosynthetically Active Radiation)

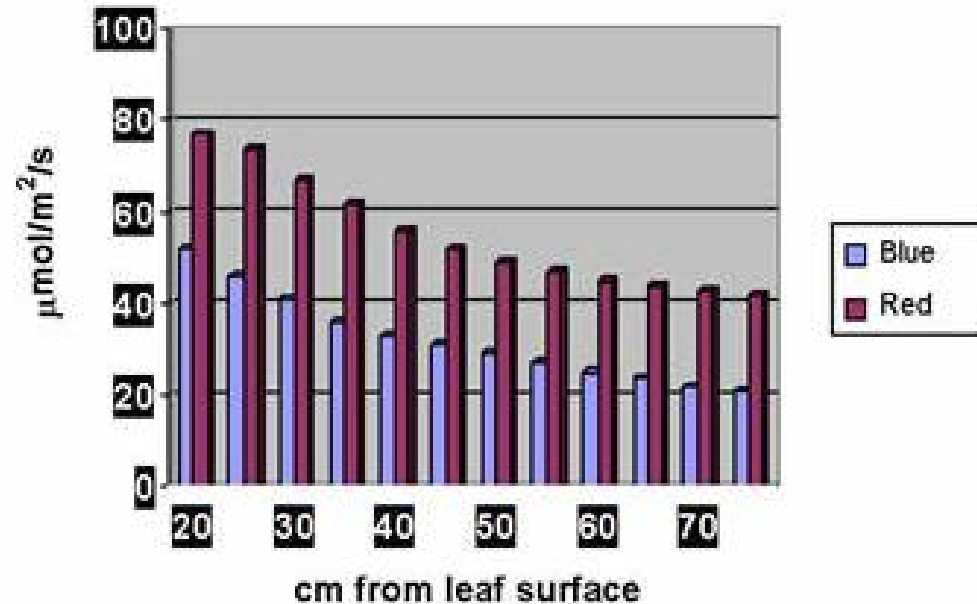


Line P (plants): maximum relative efficiency @ ca. 430 and ca. 630 nm

LED-panel sample: 49 red (644 nm) LED, 21 blue (470 nm) (ratio 7 : 3)
Emission spectrum tested at Ist. Elettrotecnico Nazionale Galileo Ferraris



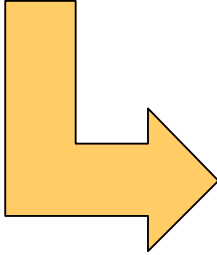
Our LED-panel in a small growth chamber, with lettuce

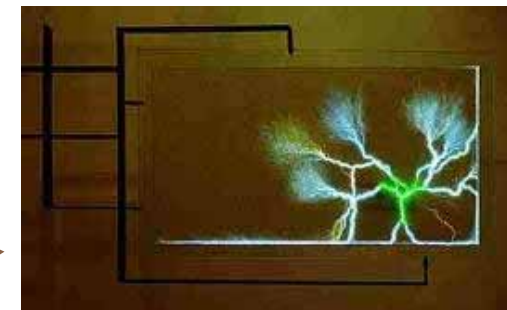


LEDs: PRO's and CON's

- ☺ Reliability (100,000 hrs life time)
- ☺ Selectable wavelength
- ☺ High efficiency (ca. 30 lumen/watt)
- ☺ Cold source (relative small need of cooling)
- ☹ Light intensity lower than e.g. HPS lamps

IMPROVEMENTS:

- 
- ✓ Intensification of LED number (but: heating issues and physical limitations)
 - ✓ Use of High Power LEDs (1 W vs 0.1 W of typical LEDs)
 - ✓ New light sources...



Examples of AAS-I activities crucial for exploration

- ATV water preparation, treatment, disinfection, storage
- Radiation experiments: ALTCRISS, Matroshka II



■ Regenerative ECLS

- Water treatment pilot plant to test RO, ion exchange, membranes
- Air treatment: photo-catalysis development unit
- Overall demonstrator RECYCLAB



■ Inflatable structure – environmental testing

- Hypervelocity impact test in laboratory (reduced scale)
- Offgassing and outgassing testing
- Radiation shielding testing in accelerators (heavy ions) at Chiba, Brookhaven, collaboration w/ Prof. Durante (Uni-Napoli)



■ ISRU

- Development of technologies for O₂ & H₂O production from local resources
- Study shielding capabilities of regolith for radiation protection

■ Planetary environment and protection

Development of strategies, technologies and know-how for:

- Protection of astronauts, manned and robotic spacecraft and surface habitats against planetary environment effects (radiation, micrometeoroids, dust contamination, modified gravity, etc.)
- Planetary protection (forward and backward contamination, sterilization)

- Water monitoring & regeneration (Regione Piemonte funding, P.I. Prof. C. Sarzanini, Uni-To)
 - Monitoring of silver disinfectant in water
- Commercial initiatives in the field of water treatment
 - Launching mineral water, properly treated, on the ATV
- Radiation shielding strategies and materials (ASI-MOMA)
- Bio-regenerative environmental control (ASI-CAB)

Objective: feasibility study of a controlled biological system, allowing the regeneration of resources and the production of food for life support

Constituents:

- higher plants as basic elements for food and oxygen production, CO₂ regeneration and water purification via the photosynthetic and leaf transpiration processes
- Biological & physico-chemical systems for environmental control, monitoring, power & data distribution, etc.

Sectors of concern:

- Food production
- Air purification
- Production of O₂
- Regeneration of CO₂
- Control environmental contaminants
- Water processing
- Solid waste processing
- Thermal-hygrometric control
- Regenerative technologies devp
- Storage of resources

Specific objectives:

- Development of analytical methods and tools for bioregenerative systems
- Resolution of space environment compatibility issues
- Technology transfer and spin-offs

Incremental technological development of closed loop demonstrators:

- Lab / educational facility
- Extreme environment (e.g. Concordia base)
- For critical, gravity-sensitive technologies: ISS

The preliminary project will last 8 months, with the objective to pose the basis for the next "Progetto Definitivo" of at least 3 years (our goal: 6)

AAS-I is Prime Contractor with, at the beginning, two partners (Uni-NA, Uni-TO)

First 4 months devoted to architectural study and definition of R&D needs

Call for ideas, selection of team members (University, Research Inst., SMEs)

Finalization of project definition, organization, cost and schedule

- We have gained some confidence in flying “light blue”, on ISS – however most modules still need to fly
- There are favourable conditions to “fly green” on planets
- The “agrospace” development process has already started
- It will be very complex, many issues are still unresolved
- A cooperative endeavour, at all levels
- Let’s continue to do our best...

Thanks for your attention!