

**International Life Sciences Research  
Announcement: Research Opportunities  
for Flight  
Experiments in Space Life Sciences on  
the ISS (ILSRA-2009)**



**ROSE 2 – Mars Consortium  
Response of Organisms to Space Environment 2 – and to Mars  
PI Elke Rabbow - DLR**

CAREX Project Forum, Praha, 29 October 2009

Dr. Corinna Panitz  
RWTH Aachen, Germany

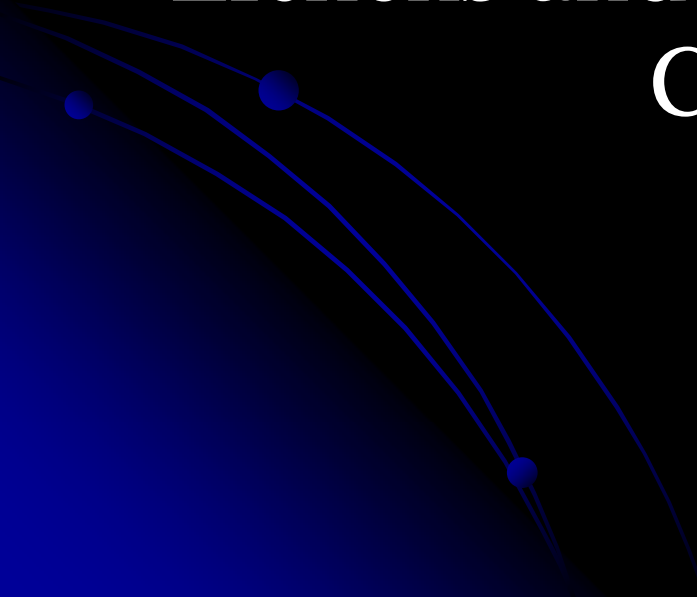
Dr. Rosa de la Torre-Noetzel  
INTA, Torrejón de Ardoz, Spain

Professor Attila Bérces  
Semmelweis University, Budapest, Hungary

Dr. Petra Rettberg  
DLR, Koeln, Germany

Dr. Jean de Vera  
DLR, Berlin, Germany

Professor Silvano Onofri  
Università degli Studi della Tuscia, Viterbo, Italy



**LIFE2**  
**Lichens and Fungi Experiment 2 and**  
**Cyanobacteria**

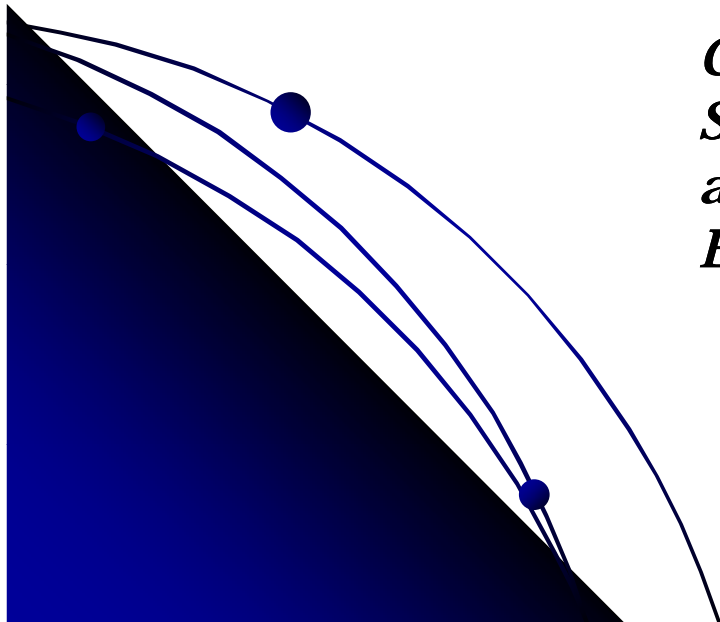


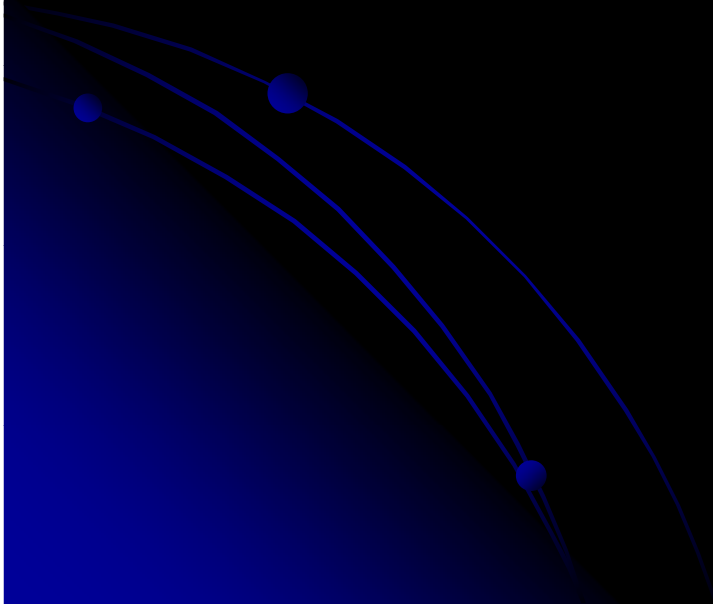
# LIFE-EXPOSE-E Experiment: survival of Antarctic fungi and lichens in space

*Silvano Onofri*

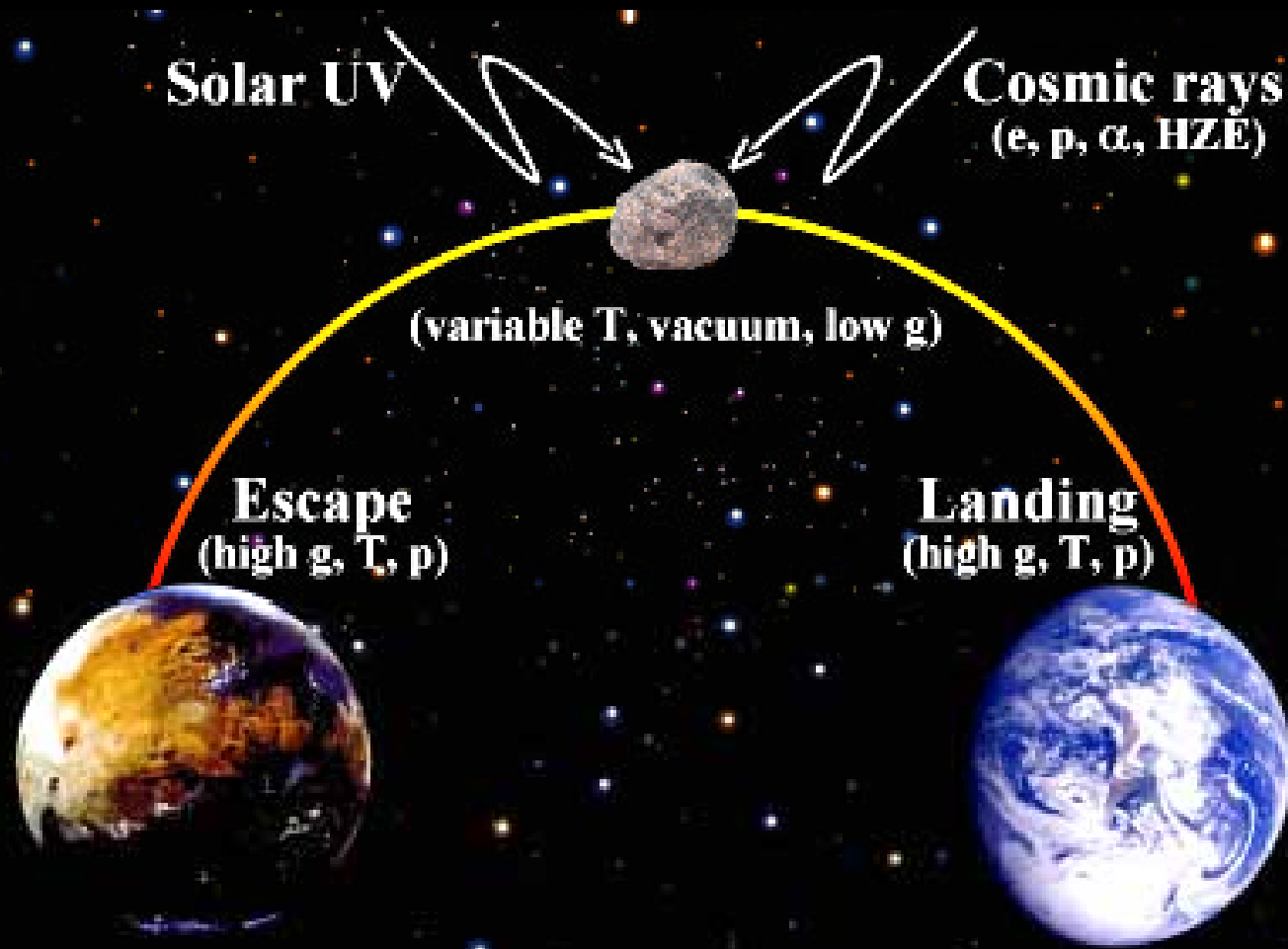
*Principal Investigator*

*Co-Investigators: L. Zucconi, L. Selbmann, (I), S. Ott, J.P. de Vera (D), and R. de la Torre (E) and D. Barreca (I), L.G. Sancho, C. Ascaso (E), E. Rabbow, G. Horneck (D)*

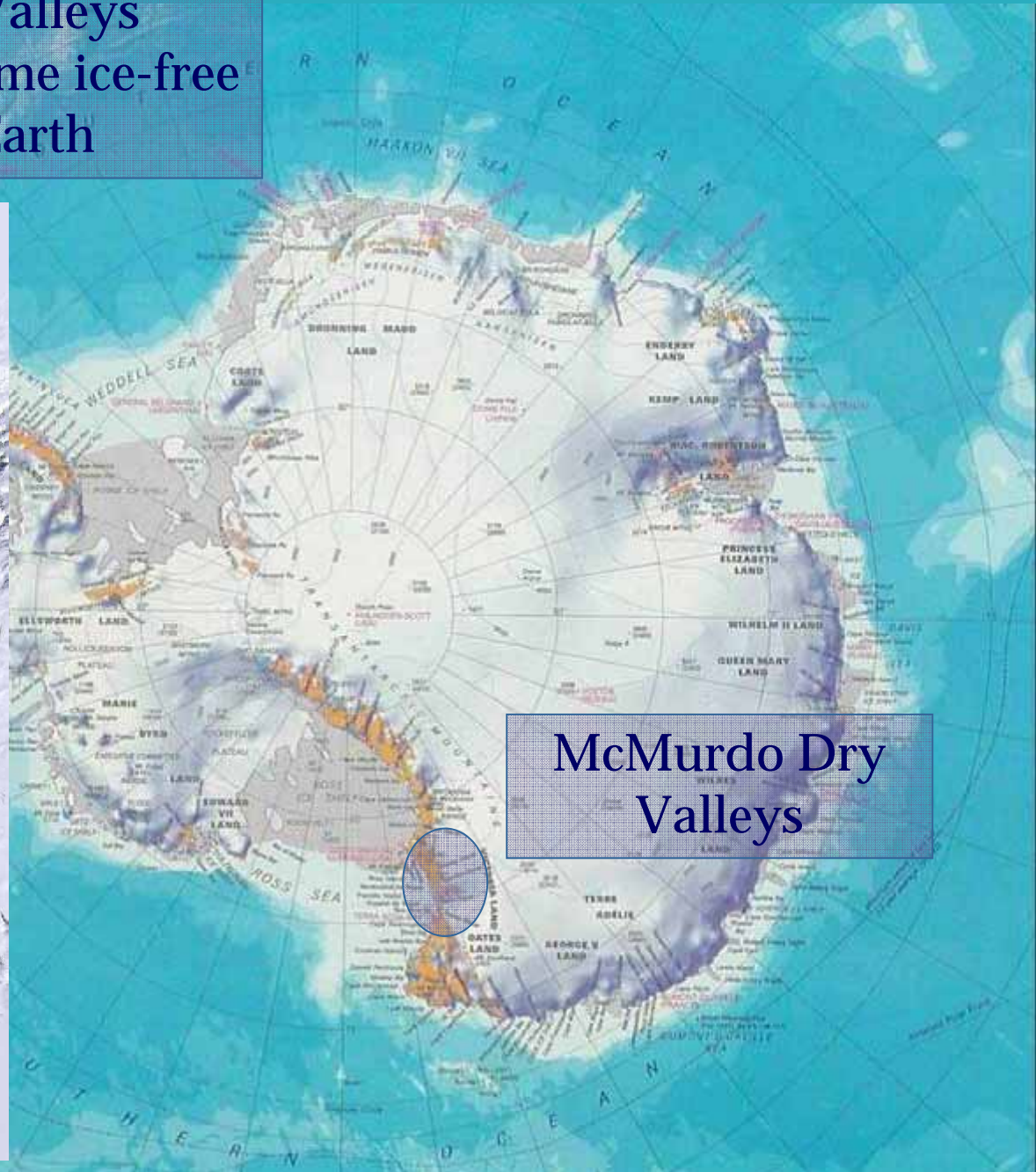




# *Lithopanspermia: likelihood of interplanetary transfer of life*



The McMurdo Dry Valleys  
(Antarctica) are the extreme ice-free  
environments on Earth



McMurdo Dry  
Valleys

The McMurdo Dry Valleys are the closest terrestrial analogue of Martian environment



Mars landscape



Dry Valleys landscape





Battleship Promontory



# Colonized Antarctic sandstone

Reddish-brown  
crust

Black zone: lichenized  
(symbiotic with algae)  
and non lichenized black  
fungi

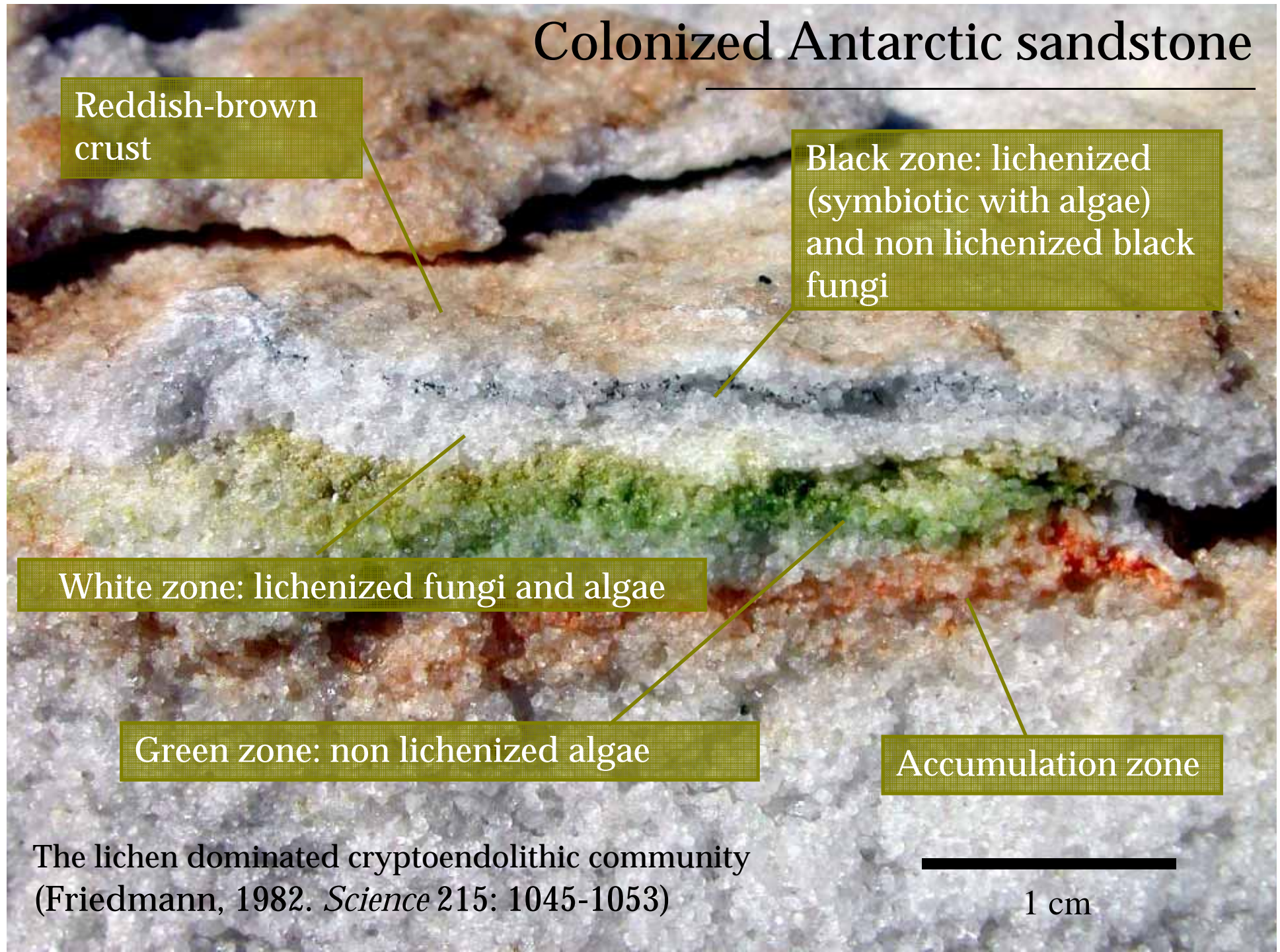
White zone: lichenized fungi and algae

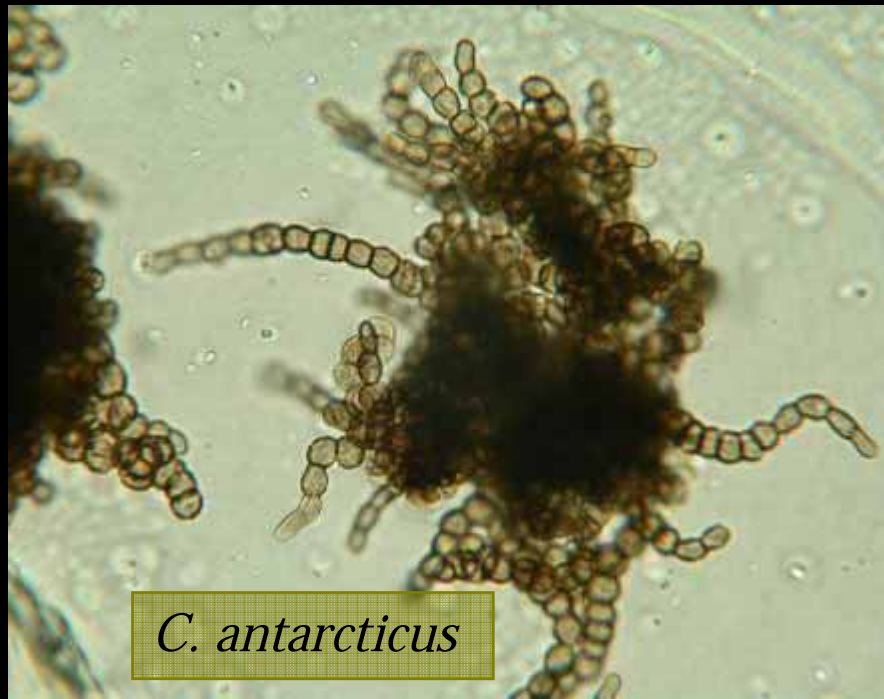
Green zone: non lichenized algae

Accumulation zone

The lichen dominated cryptoendolithic community  
(Friedmann, 1982. *Science* 215: 1045-1053)

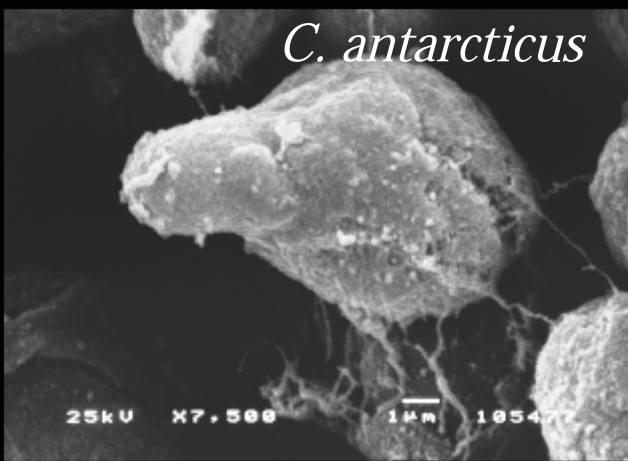
1 cm





*C. antarcticus*

Antarctic rock  
black fungi  
belonging to  
genera  
*Cryomyces*



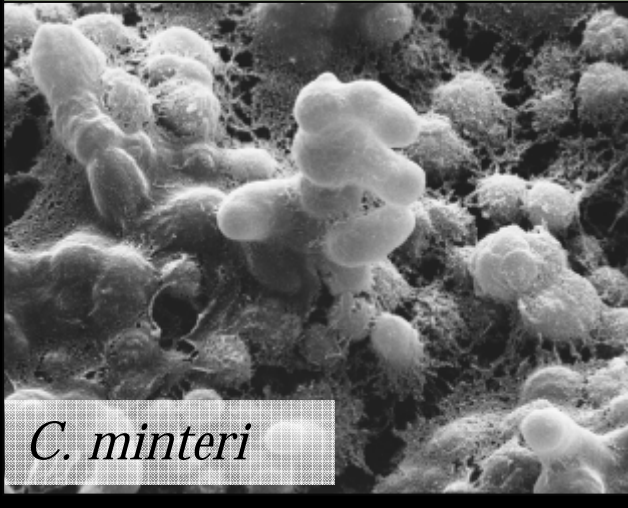
*C. antarcticus*



*C. minteri*



*C. minteri*



*C. minteri*

# Habitat area characterization of *Rhizocarpon geographicum* and *Xanthoria elegans* by an overview out of the helicopter

Rotenboden (2826 m)



Trockener Steg (2948 m)



Gornergrat (3147 m) + Hohtälli (3272 m)

Zmutt (2043 m)



Stellisee (2652 m)

Rothorn (3147 m)



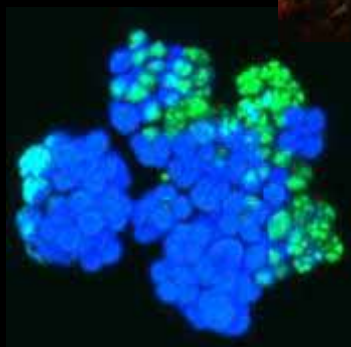
# Lichens and their symbionts



*Xanthoria  
elegans*



mycobiont



photobiont



*Rhizocarpon  
geographicum*

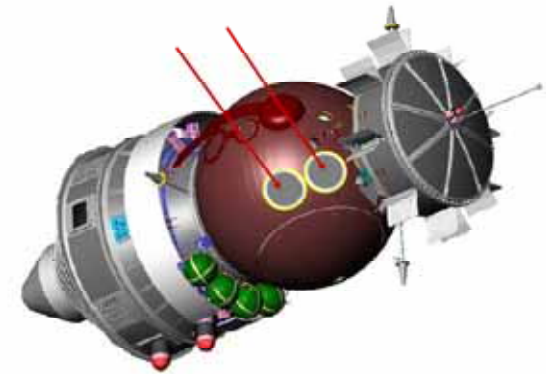
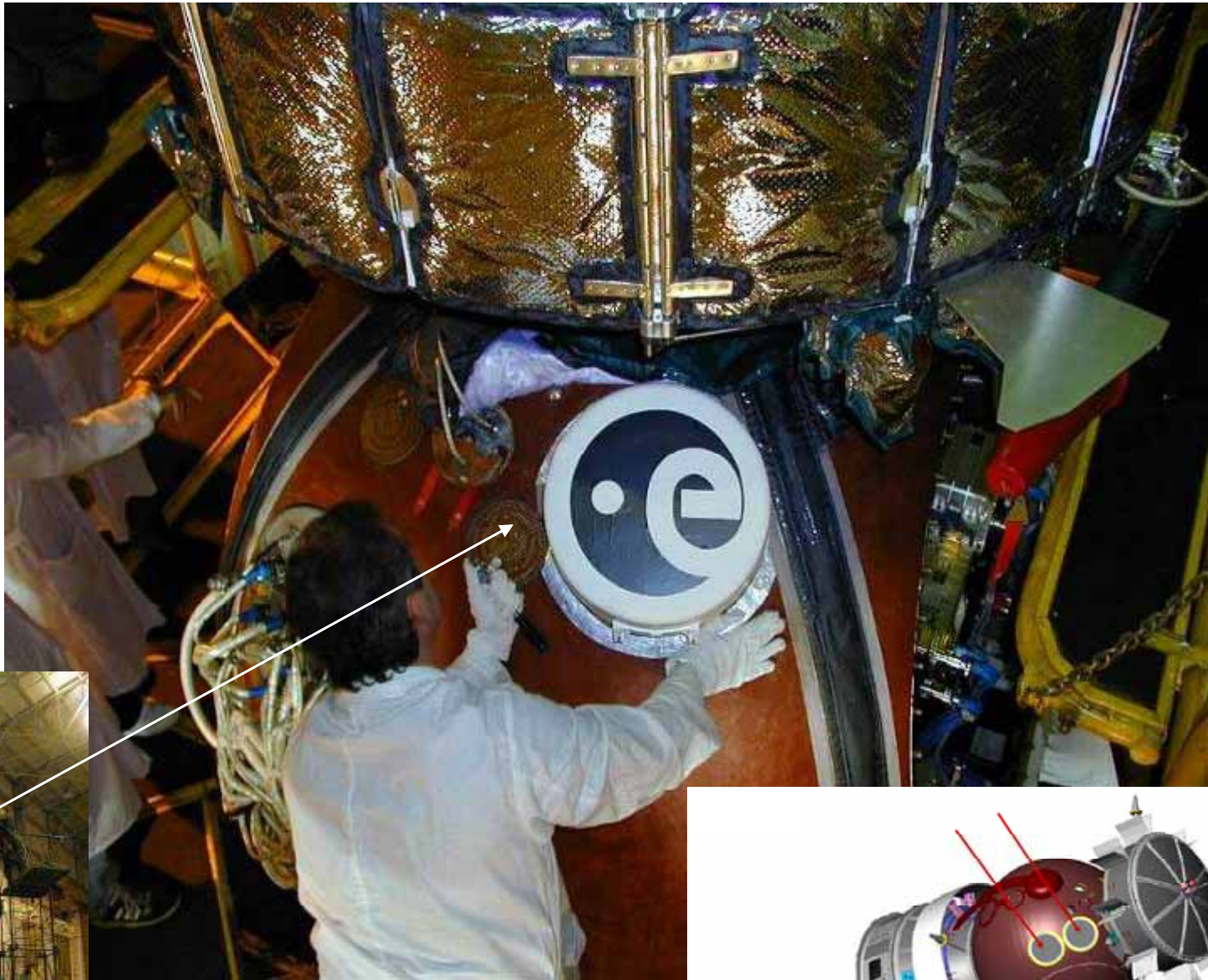


# LICHENS survived in space during the Biopan experiment on Foton M-2

*R. de la Torre, G. Horneck, and L.G. Sancho*

## Aims:

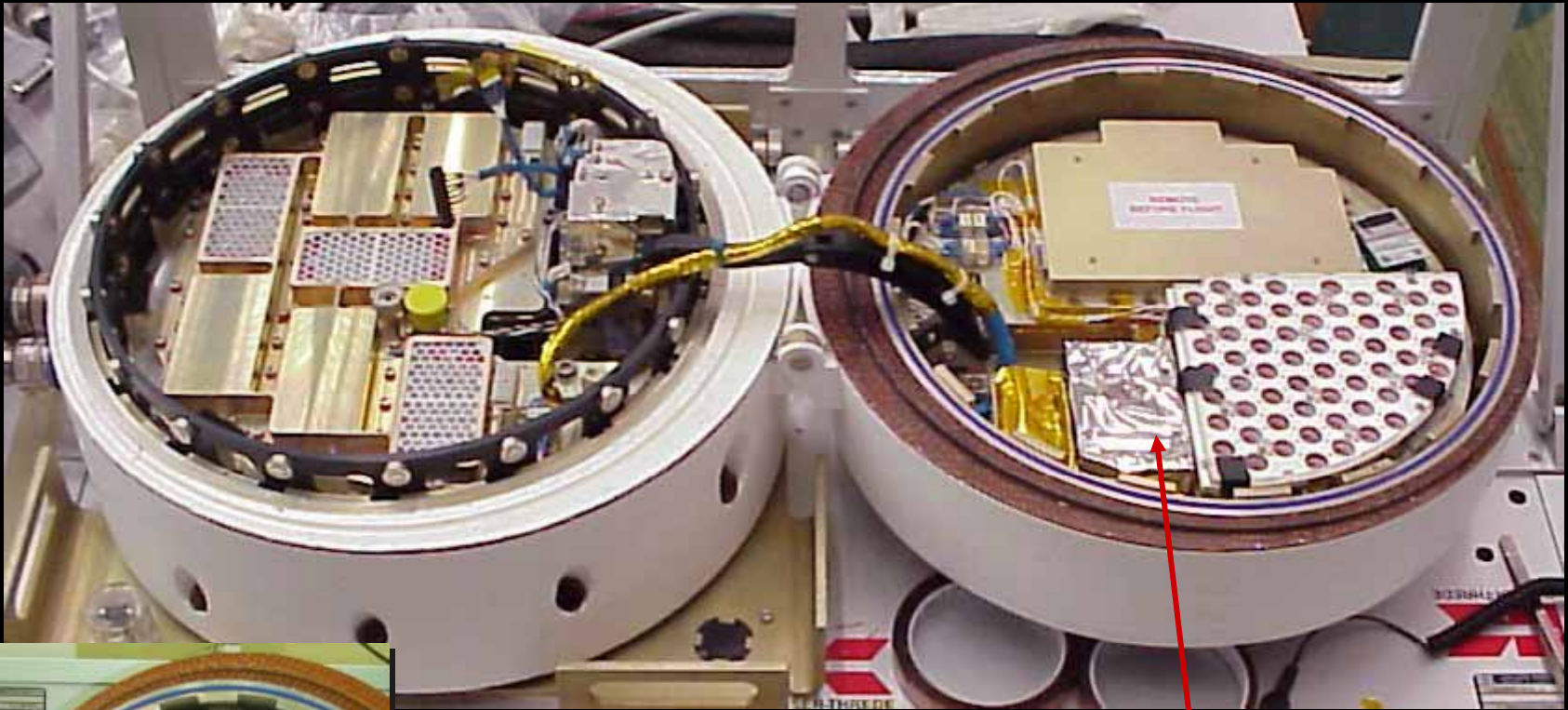
- studying survival of bipolar epilithic lichens on their natural rock substrate exposed to space
- contribution to the possible propagation of life through interplanetary space: *Lithopanspermia theory*



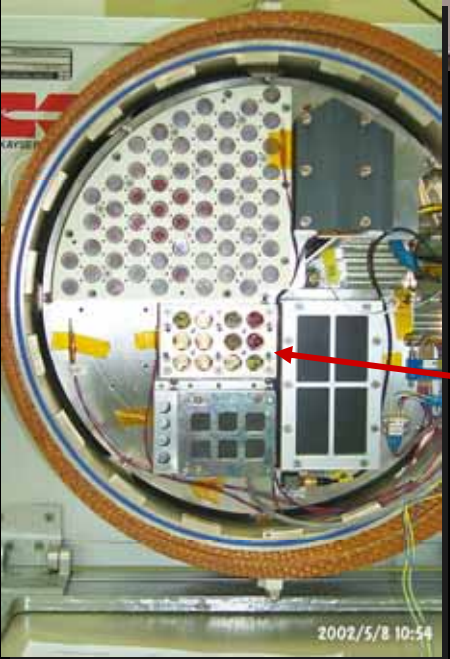
carrier: Foton-M  
automatic recoverable capsule



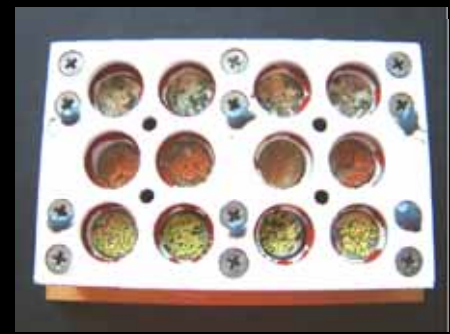




LICHENS-II  
Experiment



FOTON M-2  
BIOPAN-5



# *Xanthoria elegans*

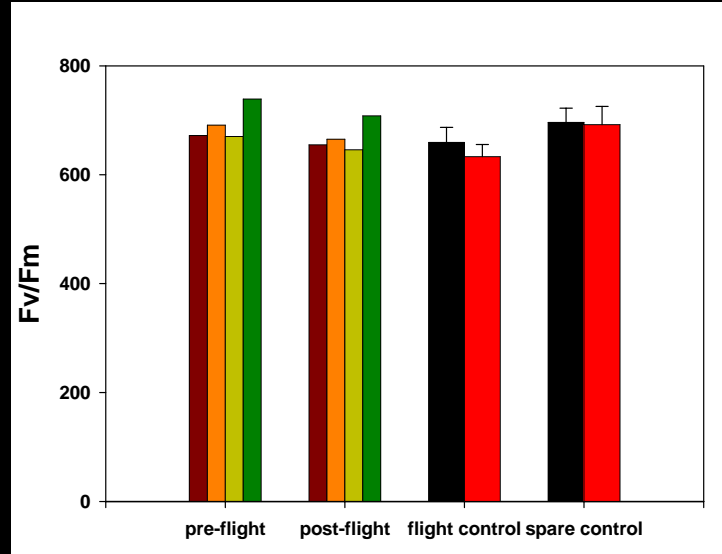
280 nm

320 nm

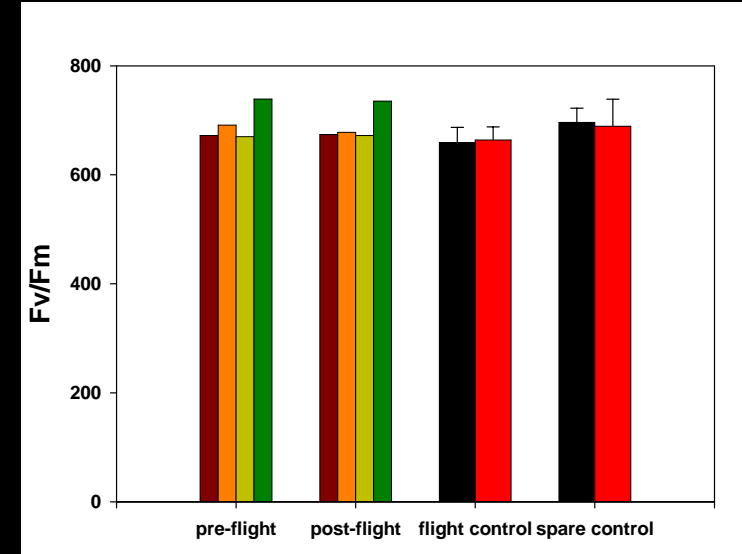
400 nm

neutral

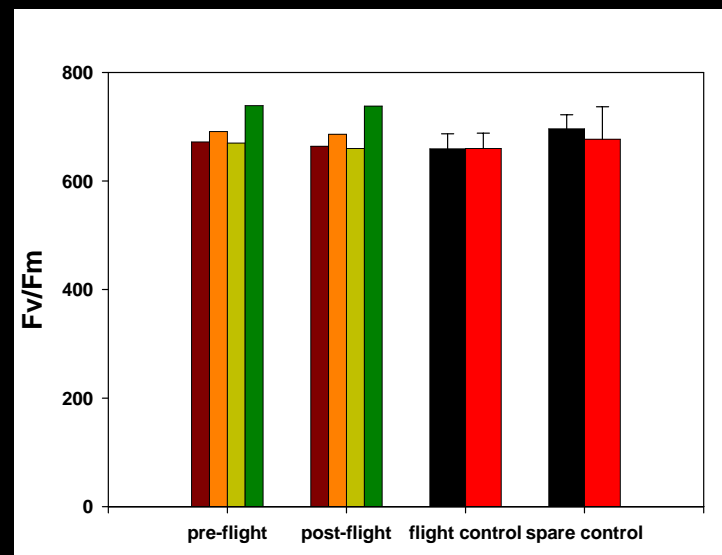
## 4 h



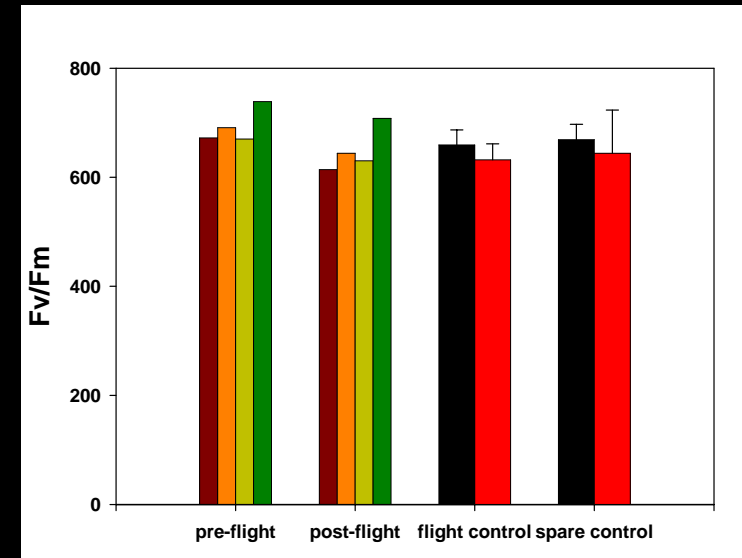
## 24 h



## 48 h



## 72 h

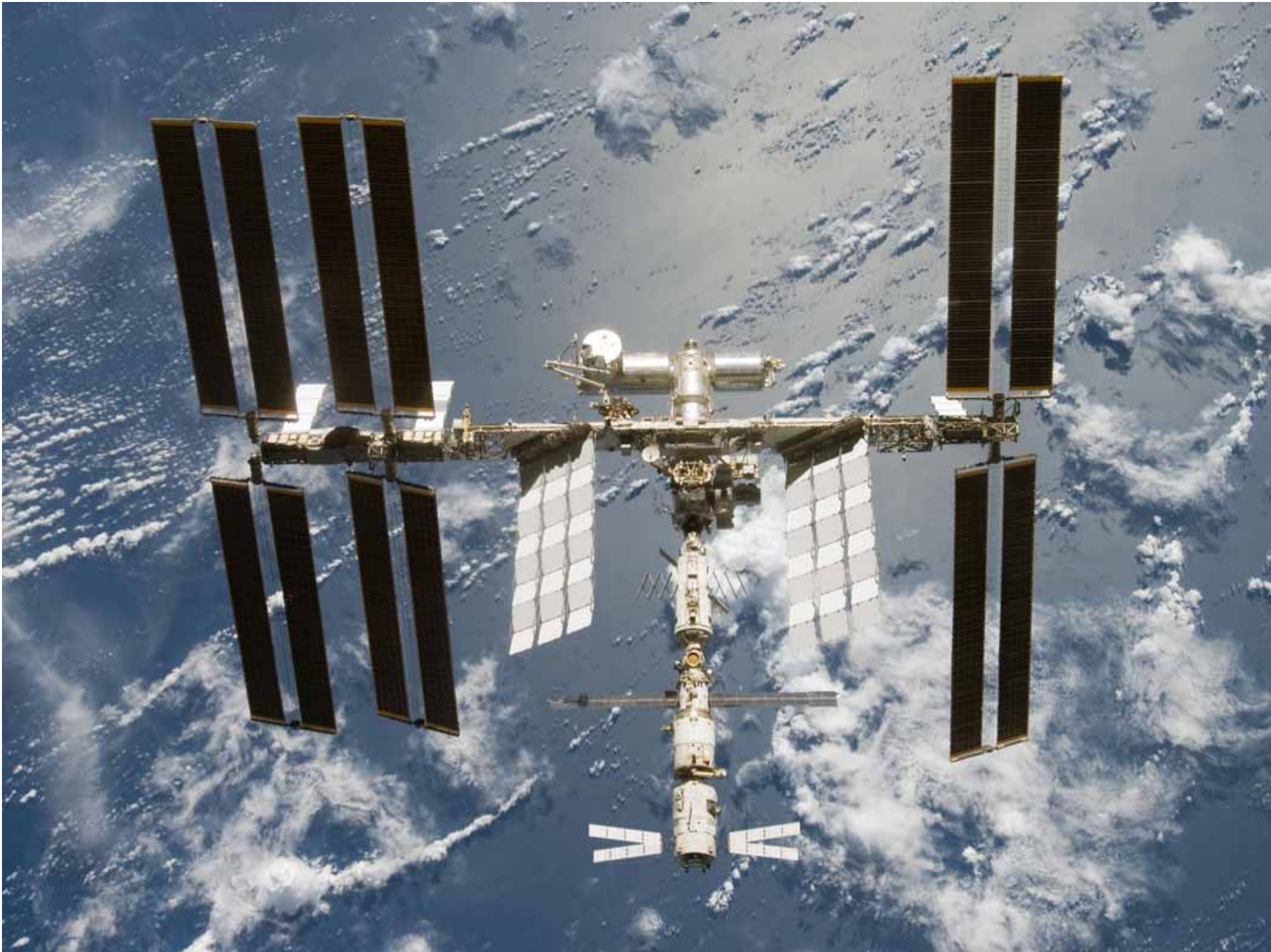


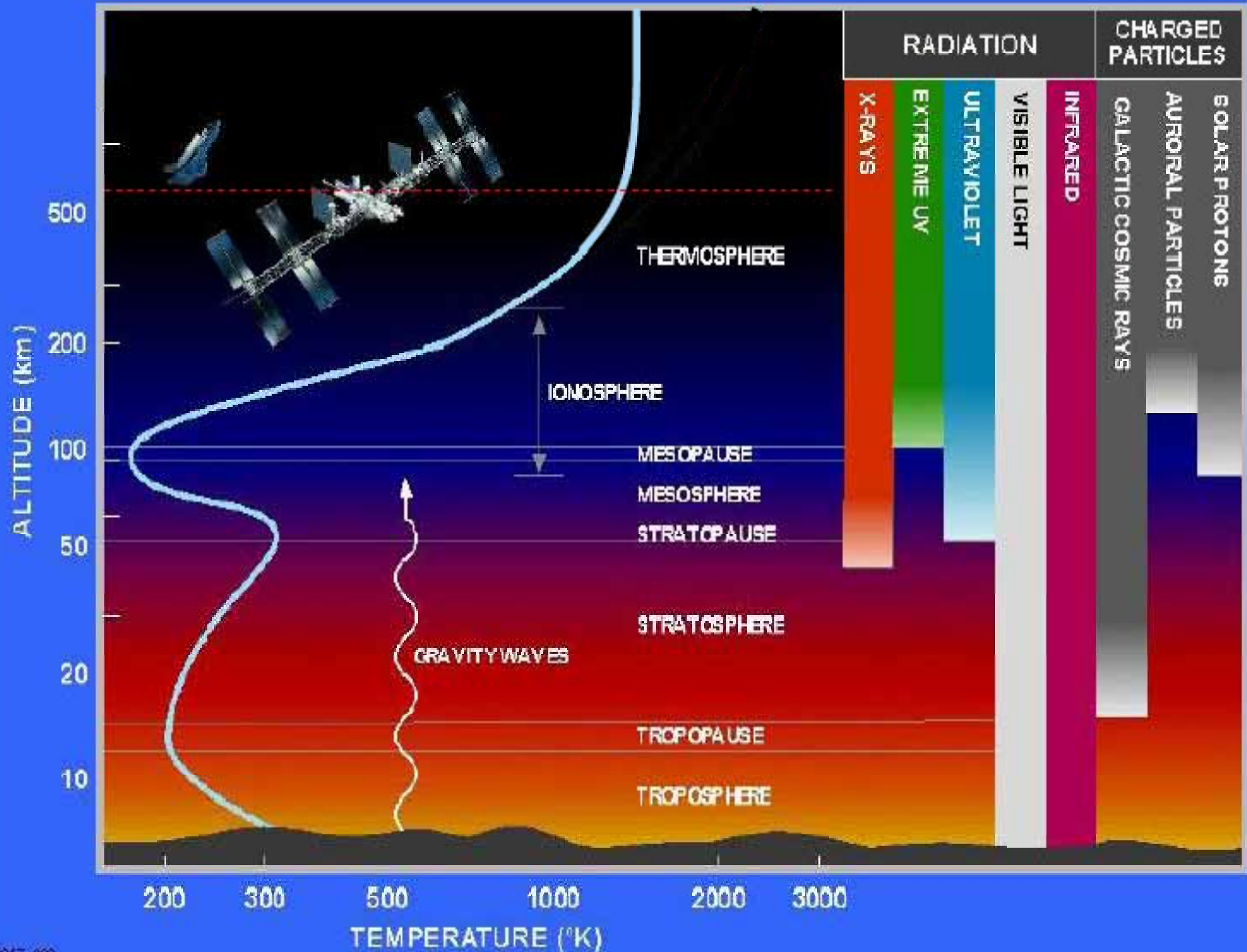
Maximum quantum yield of photosynthetic activity after UV irradiation for 4, 24, 48 and 72 h  
Sancho et al. 2007, Lichens survive in space. *Astrobiology*, 7, 443-454

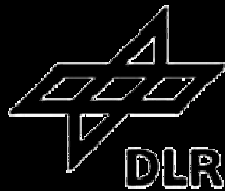
# Connection BIOPAN/EXPOSE

Long-duration re-flight necessary

A decorative graphic in the bottom-left corner of the slide. It features a blue gradient background that transitions from a darker blue at the bottom to a lighter blue at the top. Overlaid on this are several thin, curved blue lines that sweep upwards and to the right. Three small, solid blue circles are placed at various points along these lines. A single, thicker green line curves horizontally across the middle of the graphic, starting from the left and ending on the right.







# The EXPOSE-EuTEF Consortium

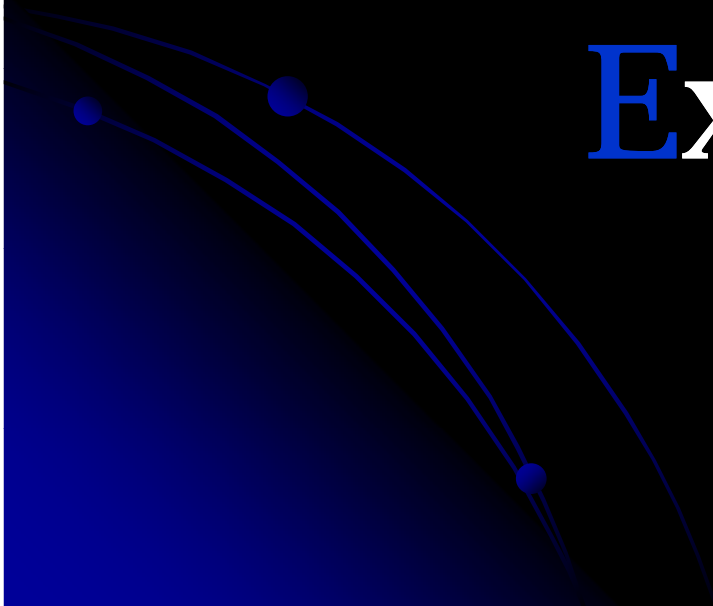
<b>EXPOSE-EuTEF Experiment</b>	<b>Principle Investigator</b>	<b>Affiliation</b>
ADAPT	Petra Rettberg	DLR, Cologne, Germany
DOBIES	Filip Vanhavere	SCK CEN Mol, Belgium
DOSIS	Günther Reitz	DLR, Cologne, Germany
<b>LIFE</b>	<b>Silvano Onofri</b>	<b>University Tuscia, Viterbo, Italy</b>
PROCESS	Hervé Cottin	LISA, Paris, France
PROTECT	Gerda Horneck	DLR, Cologne, Germany
R3D-E	Donat-Peter Häder	University Erlangen-Nürnberg, Erlangen, Germany
SEEDS	David A. Tepfer	INRA, Versailles, France

**LIFE**

**L**ichens and

**F**ungi

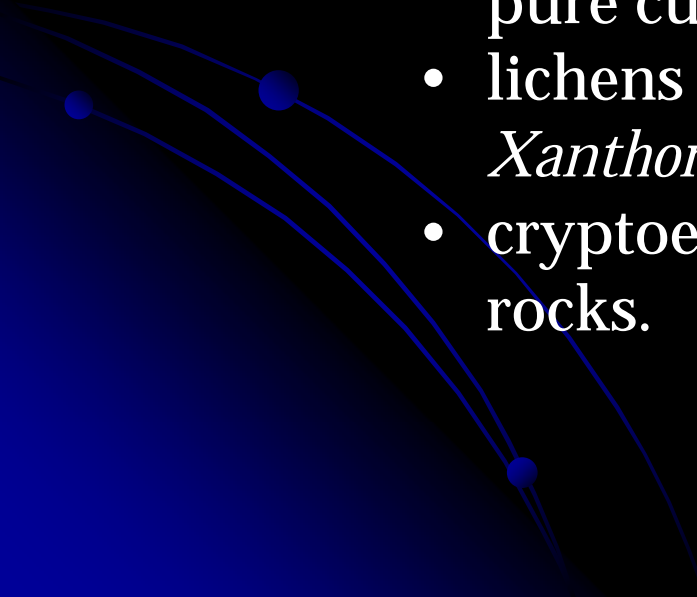
**E**xperiment





# LIFE: SPECIFIC GOALS

Resistance and survival of dried biological samples under real space and simulated environmental Mars conditions :

- cryptoendolithic meristematic black Antarctic fungi (*Cryomyces antarcticus* and *C. minteri*) in pure culture;
  - mycobiont of the lichen *Xanthoria elegans* in pure culture;
  - lichens (*Rhizocarpon geographicum* and *Xanthoria elegans*) on rocks;
  - cryptoendolithic Antarctic communities in rocks.
- 



# Resistance and survival of *fungus isolates*

	<i>C. antarcticus</i> CCFEE 515	<i>C. antarcticus</i> CCFEE 534	<i>C. minteri</i> CCFEE 5187
Control lab	+	+	+
UV-C (254 nm) 10 Jm <sup>-2</sup>	+	+	+
UV-C (254 nm) 100 Jm <sup>-2</sup>	+	+	+
UV-C (254 nm) 1000 Jm <sup>-2</sup>	+	+	+
UV (200-400 nm) 1.5 kJm <sup>-2</sup>	+	+	+
UV (200-400 nm) 1.5x10 <sup>3</sup> kJm <sup>-2</sup>	-	-	+
UV (200-400 nm) 1.5x10 <sup>5</sup> kJm <sup>-2</sup>	-	-	+
Vacuum 10 <sup>-5</sup> Pa 1h	+	+	+
Vacuum 10 <sup>-5</sup> Pa 1 week	+	-	+
50 cycles -20/+20°C 2 weeks	+	+	+
(Dark) Mars CO <sub>2</sub> 20 dd	-	-	+
UV (200-400 nm) Mars CO <sub>2</sub> 1.5x10 <sup>5</sup> kJm <sup>-2</sup>	+	-	+
Dark Vacuum 20 dd	+	-	+
Vacuum+UV (200-400 nm) 1.5x10 <sup>5</sup> kJm <sup>-2</sup>	-	-	+
	9/13	7/13	13/13

**EVTs  
RESULTS OF  
*C. minteri*  
CCFEE 5187**

Control lab

dark (2 months)



Temperature

50 cycles -20/+20°C (2 weeks)



Vacuum

10<sup>-5</sup>Pa (1h)



10<sup>-5</sup>Pa (1 week)



UV-C (254 nm)

10 Jm<sup>-2</sup>

100 Jm<sup>-2</sup>

1000 Jm<sup>-2</sup>



UV 200-400 nm (SOL2000)

1.5 kJm<sup>-2</sup>

1.5 x 10<sup>3</sup> kJm<sup>-2</sup>

1.5 x 10<sup>5</sup> kJm<sup>-2</sup>



Vacuum

dark (20dd)



SOL2000 1.5 x 10<sup>5</sup> kJm<sup>-2</sup>



Mars CO<sub>2</sub>

dark (20dd)

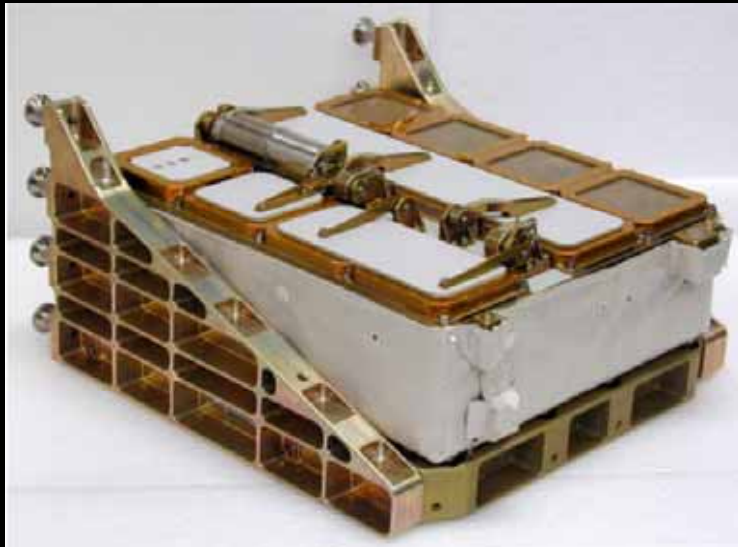


SOL2000 1.5 x 10<sup>5</sup> kJm<sup>-2</sup>

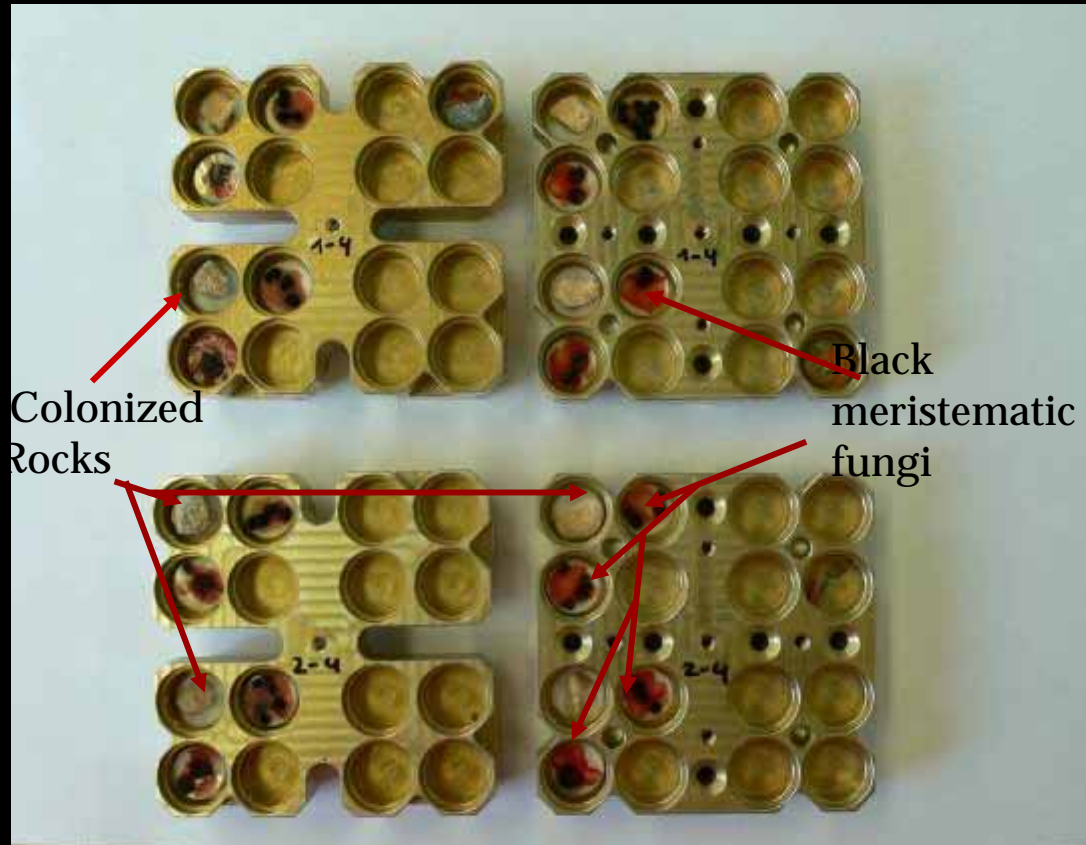


# *EXPOSE*

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*LIFE*



*Rhizocarpon geographicum*



*Xanthoria elegans*

**EXPOSE-EuTEF  
sample accommodation**

**ADAPT:**

- 1: newly isolated *B. subtilis* strain
- 2: *B. subtilis* strain 168
- 3: *Anabaena cylindrica* rock sample
- 4: *H. dombrowskii* pigmented
- 5: *H. dombrowskii* unpigmented

**PROTECT:**

- 1: *B. pumilus* SAFR-032
- 2: *B. subtilis* HA101
- 3: *B. subtilis* atrophaeus
- 4: *Bacillus* ssp.

**LIFE**

- CR: Colonized antarctic rock
- CA: *Cryomyces antarcticus*
- CM: *Cryomyces minteri*
- MB: Mycobiont
- RG: *Rhizocarpon geographicum*
- XA: *Xanthoria elegans*

⊠ TLDs (Dosis)

„Space“: □

Vacuum

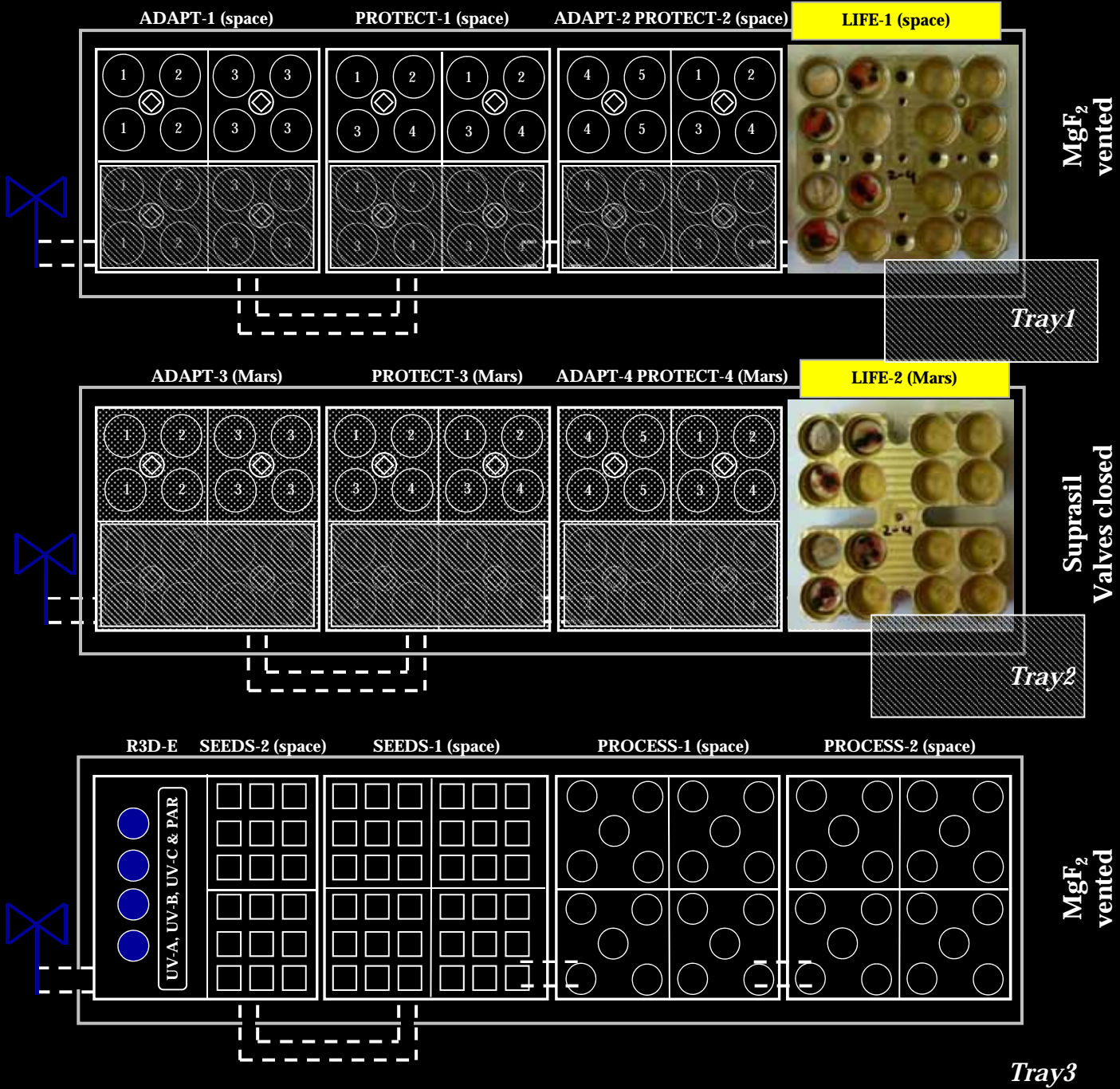
Irradiation: full spectrum MgF<sub>2</sub>

„Mars“: ▒

6 mbar CO<sub>2</sub> Mars atmosphere

Irradiation: >200 nm

Neutral density filter



Tray3

*Tray  
assembly*

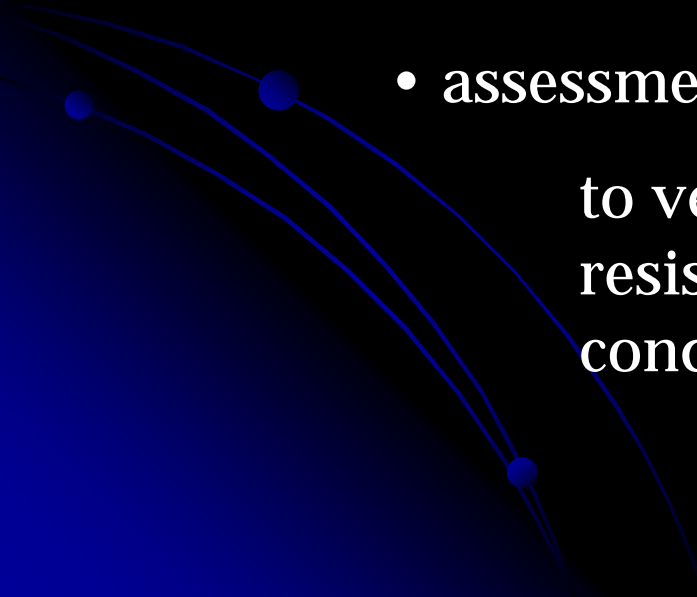


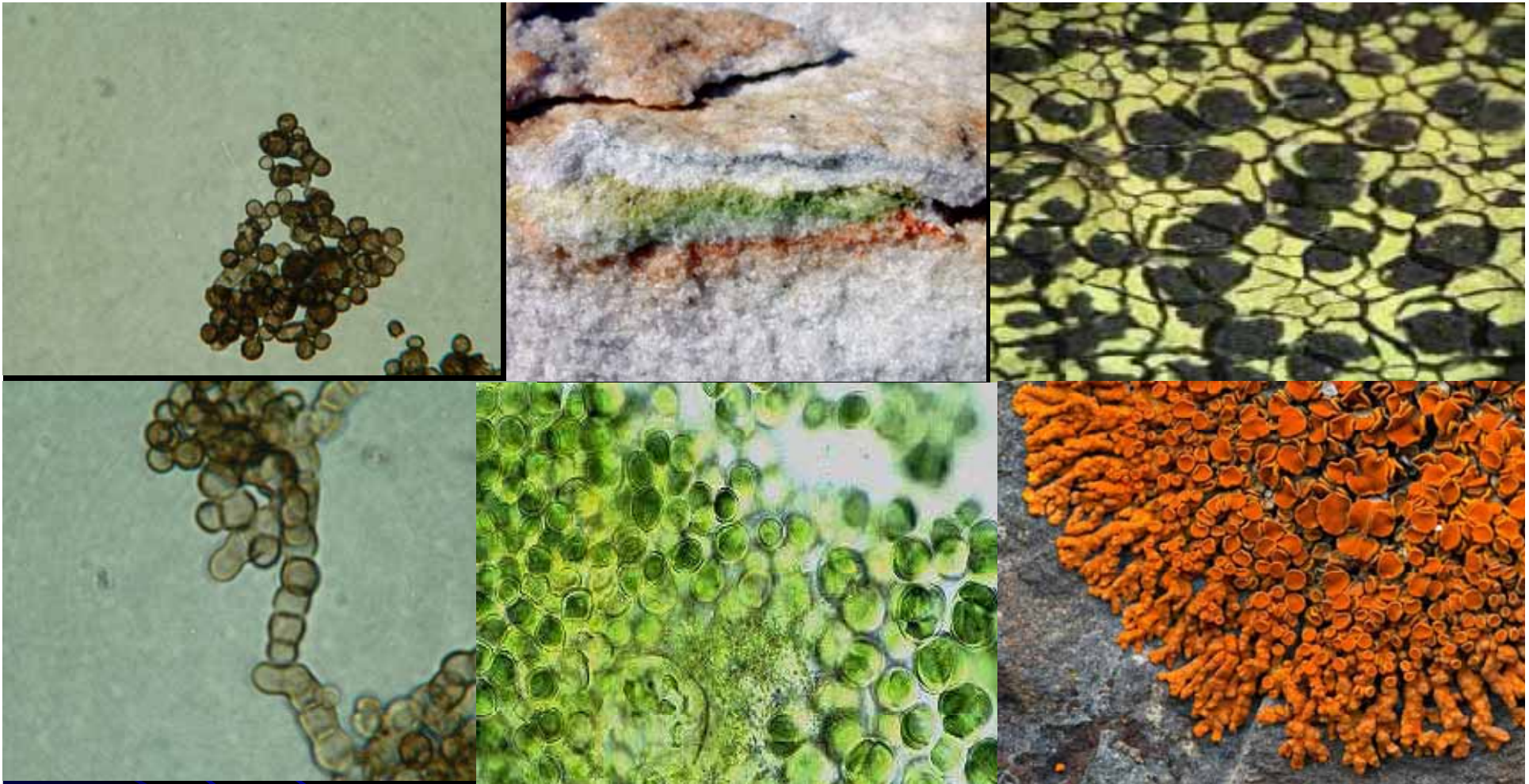


Exposed samples will be tested after flight in 2009 by:

- cultural tests;
- staining assays by Confocal Scanning Laser microscopy (CSLM);
- Transmission and Scanning Electron microscopy (TEM; SEM);
- assessment of DNA damage;

to verify survival, genetic damages and resistance of samples to space and Mars conditions.





## Lichens and Fungi Experiment 2 and Cyanobacteria “LIFE2”

Response to ILSRA-2009-LoI-0406

Science Team Coordinator

Prof. Silvano Onofri

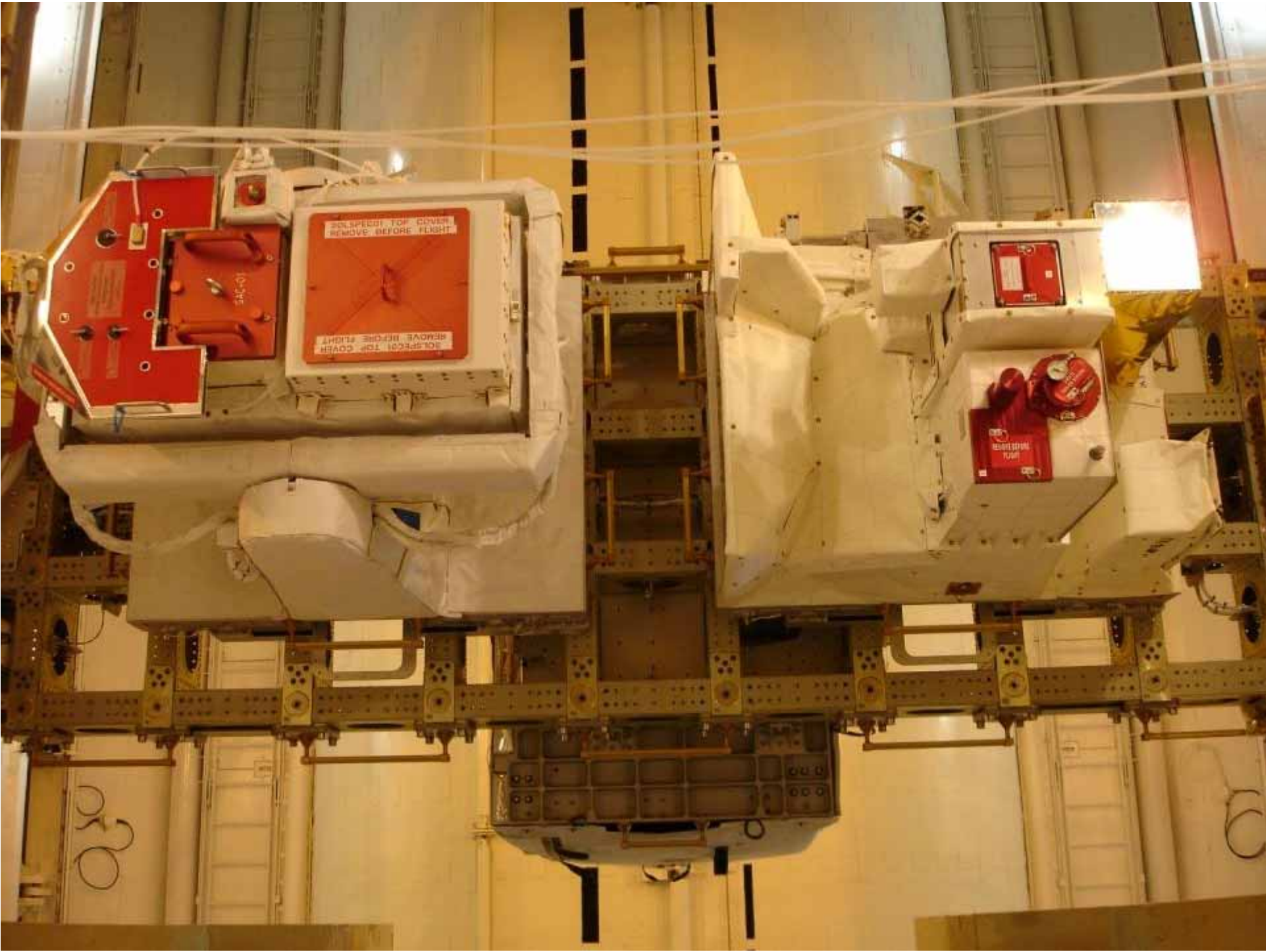
Department of Ecology and Sustainable Economic  
Development  
Università degli Studi della Tuscia  
Viterbo, Italy

Dipartimento di Biologia Università di Roma Tor  
Vergata  
Rome, Italy

Deutsches Zentrum für Luft- und Raumfahrt (DLR)  
Berlin, Germany

Instituto Nacional de Técnica Aeroespacial (INTA)  
CEPSAR, OPEN University  
United Kingdom







*COLUMBUS*

*EXPOSE-EuTEF*



**EUTEF**

*International Space Station (ISS)*

### Experiments

EuTEF can accommodate six 'standard' experiments. Unlike the later additions, the experiments remaining from the original configuration do not conform to these values. In total, the payloads mass is less than 350 kg, requiring less than 450W at its peak. The first round of experiments consists of:

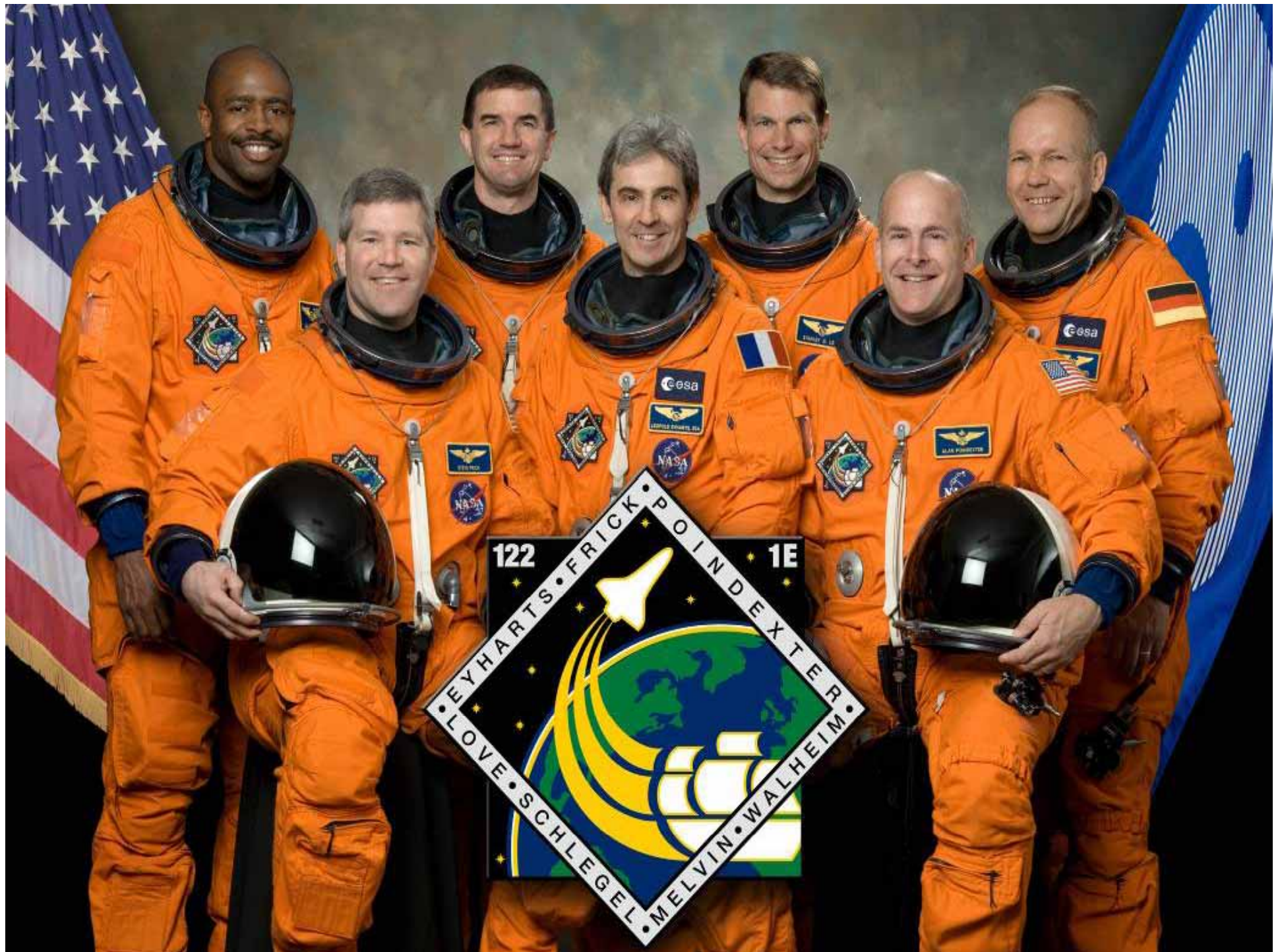
- MEDET, material degradation in space
- DOSTEL, radiation measurements
- TRIBOLAB, tribology properties of materials in space
- EXPOSE, photobiology and exobiology
- DEBIE-2, micrometeoroid and orbital debris detection contract
- FIPEX, atomic oxygen detector



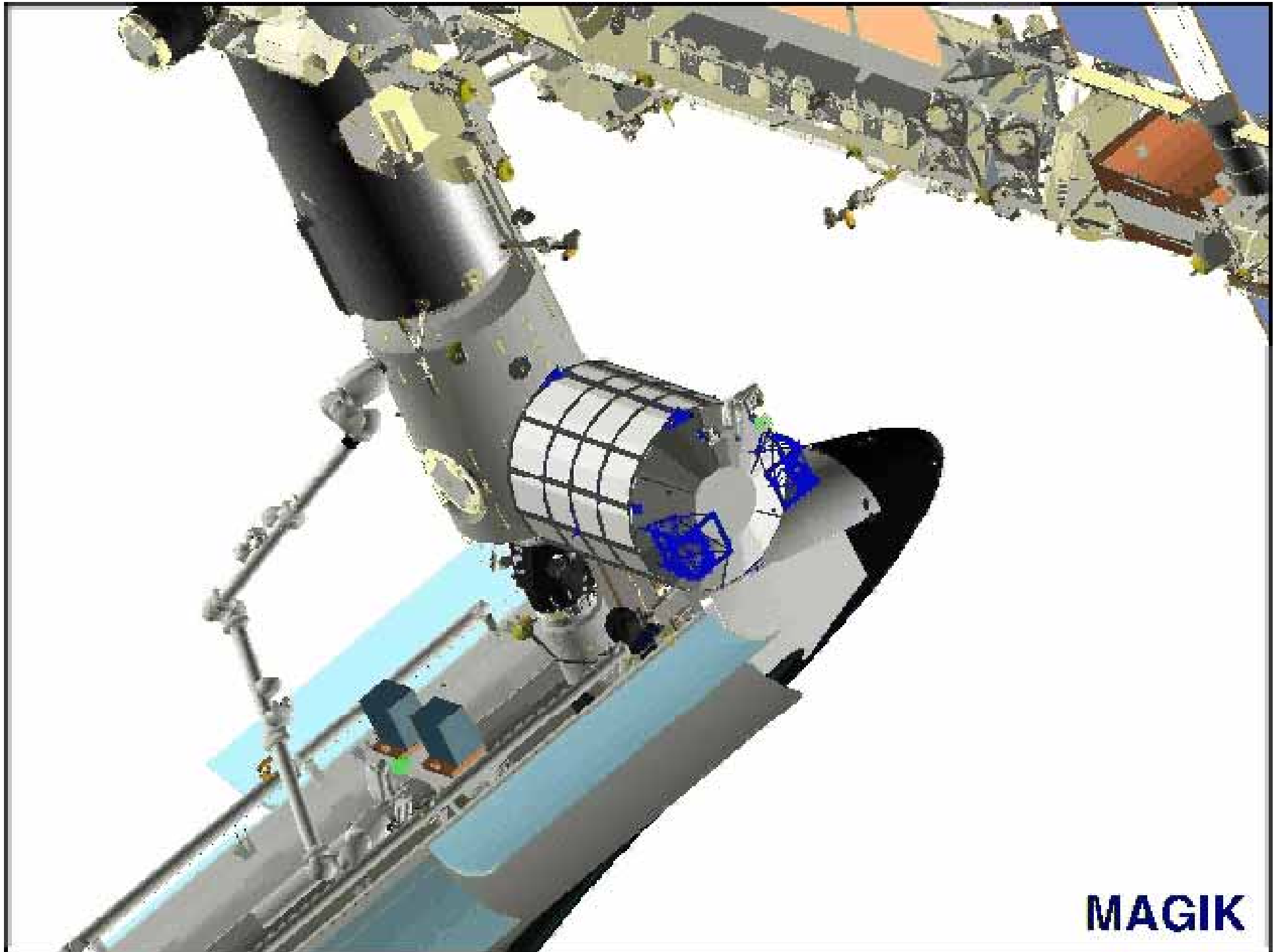
**EUTEF**











**MAGIK**



S122E009992

**Thank you for the attention...**



