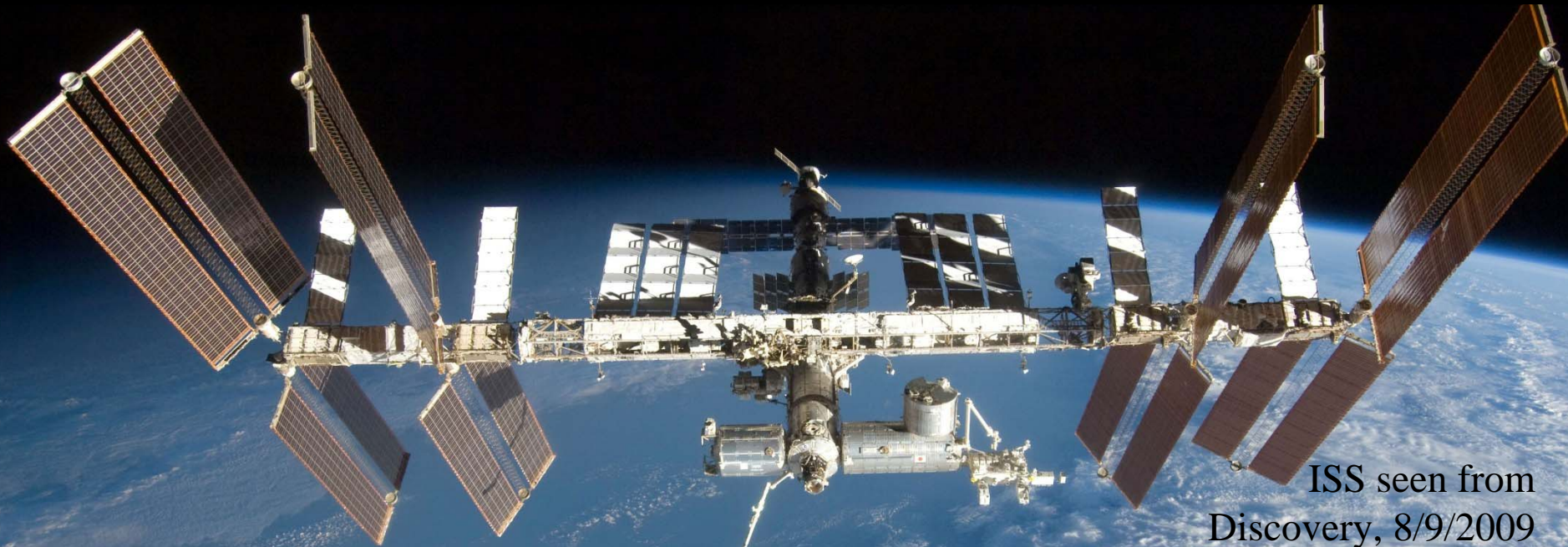


ESA's Research on ISS



ISS seen from
Discovery, 8/9/2009

Christer Fuglesang
Head of Science and Application Division, HSF, ESA

15th Workshop on Radiation Monitoring for the International Space Station
Frascati, 7/9 2010

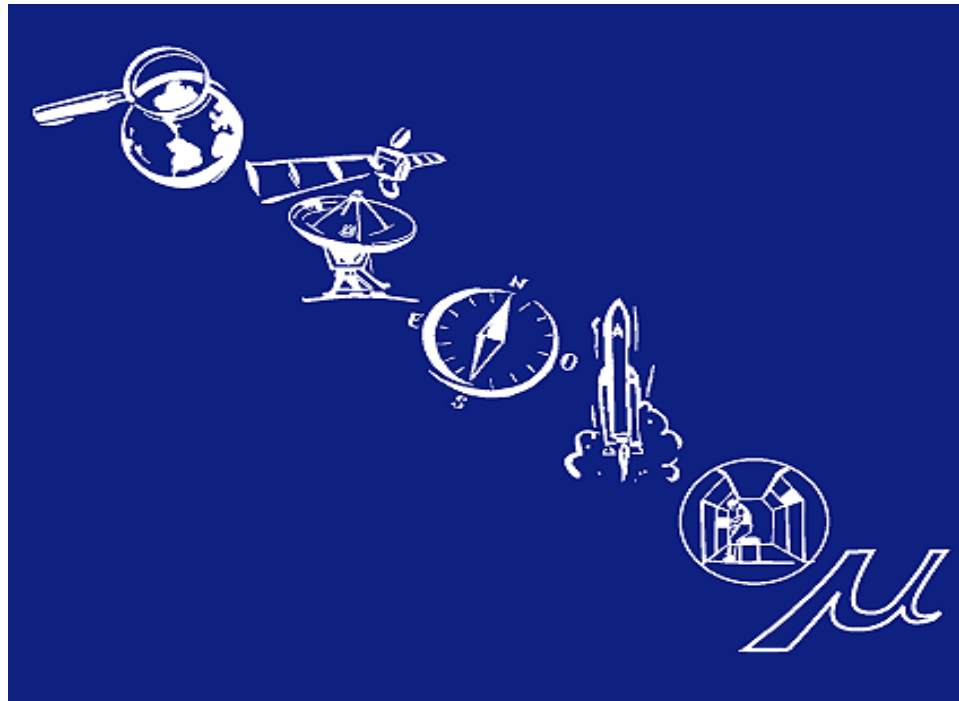
ESA Programmes



All member states participate in activities related to space science and in a common set of programmes: the MANDATORY PROGRAMMES.

In addition, member states chose the level of participation in OPTIONAL PROGRAMMES

- Earth observation
- Telecommunications
- Navigation
- Launcher development
- Manned space flight
- Microgravity research
- Exploration



human spaceflight



ELIPS

European Life and Physical Science Research Program

Since 2001

Now ELIPS-3

Funding determined at Ministerial Councils

18 ESA MEMBER STATES

10 in ISS, 15 in ELIPS



Austria, Belgium*, Czech Republic, Denmark*, Finland, France*, Germany*, Greece, Ireland, Italy*, Luxembourg, Norway*, the Netherlands*, Portugal, Spain*, Sweden*, Switzerland* and the United Kingdom.

Canada takes part in some programmes under a Cooperation Agreement.

Hungary, Romania, Poland, Slovenia, and Estonia are European Cooperating States.

Cyprus and Latvia have signed Cooperation Agreements with ESA.

* = ISS Program participants (10)

ELIPS Program participants (15)

Note: Many scientists from countries outside ESA participates in ELIP projects



Budget allocations



**ELIPS-3 achieved 285 MEuro subscription at last Ministerial Council 2008
(forseen for ca 3 yrs 2009-2011; 395 MEuro had been proposed)**

- Largest part is developments for instrument (by European industry)
- National research organizations expected to fund personnel and ground equipment

ESA's **Exploitation cost** for ISS is roughly 400 MEuro/yr

- This is to cover:
- Transport (ATV)
 - On-board resources
 - Maintenance
 - Operations (COL-CC, USOCs)
 - Industrial Operation Team (payload integration)

The ELIPS main Characteristics

■ The projects are categorized per Cornerstones / Sub-Cornerstones:

•Fundamental Physics

- Physics of Plasmas and solid/liquid dust particles
- Cold Atom Clocks, Matter Wave Interferometers and Bose-Einstein Condensates

•Fluid Physics

- Fluid and Interface Physics
- Combustion

•Material sciences

- Thermophysical properties of Fluids for Advanced Processes
- New Materials, Products and Processes

•Biology

- Molecular and Cell biology
- Plant Biology
- Developmental Biology

•Exobiology

- Origin, Evolution and Distribution of life

•Physiology

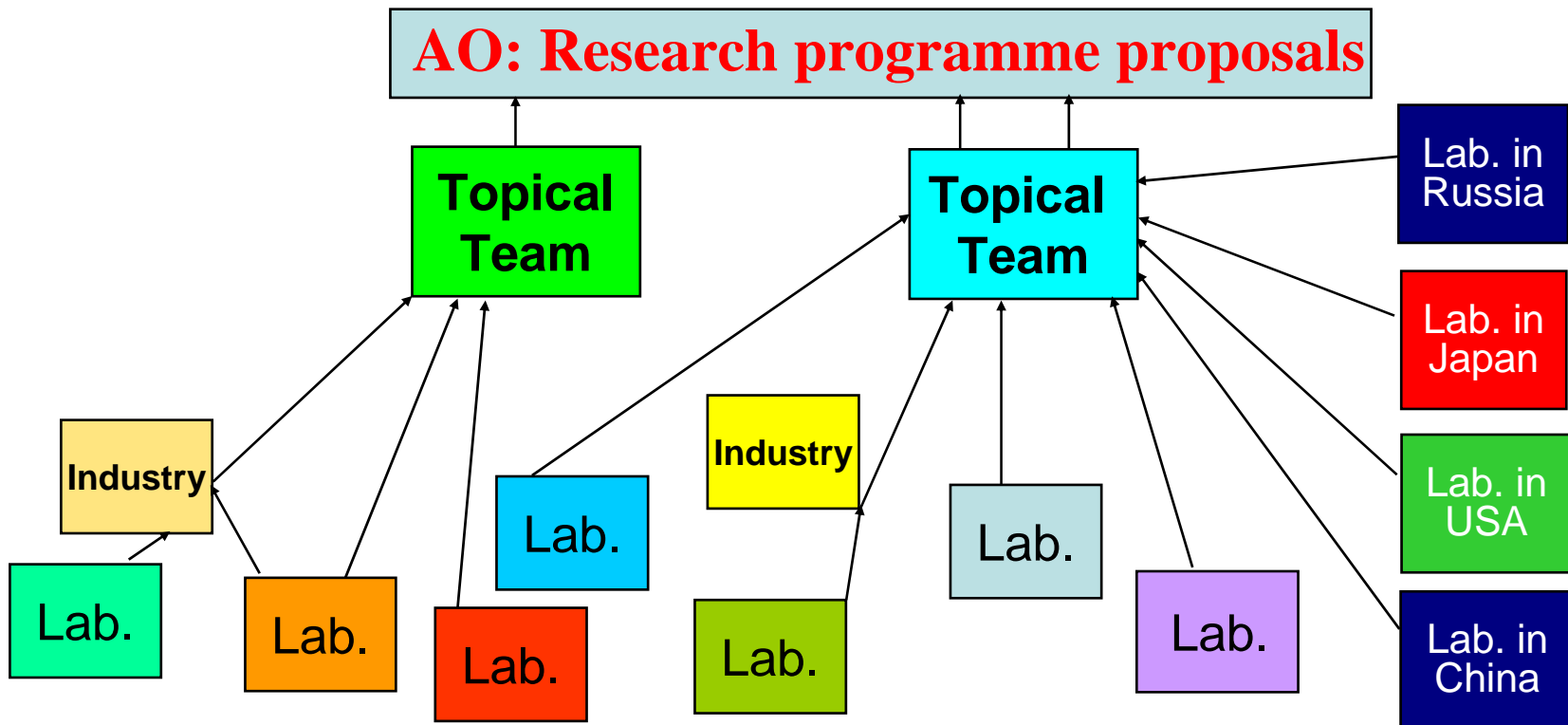
- Integrative gravitational physiology
- Non-gravitational physiology of spaceflight
- Countermeasures

•Planetary Exploration

- Preparation of Human Planetary Exploration

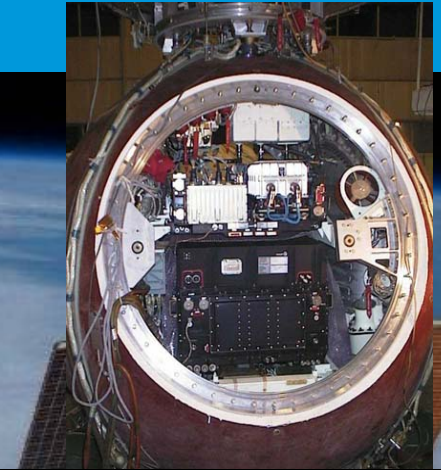
```
graph LR; RP([Research Plan]) --> ELP{{ELIPS PROGRAMME Proposal to Ministerial Council}}; PE[Peer evaluation] --> RP
```

The diagram illustrates the process of submitting a proposal to the ELIPS PROGRAMME. It features a green oval labeled "Research Plan" which points via a red arrow to a light blue hexagon labeled "ELIPS PROGRAMME Proposal to Ministerial Council". Below the "Research Plan" oval, a red rectangle labeled "Peer evaluation" has five black arrows pointing upwards towards the oval, indicating its influence on the research plan.



human spaceflight

ELIPS Mission Platforms



ion beams

ILSRA-09 (ESA/NASA/JAXA/CSA): Life Science on ISS (148 proposals)

AO-2009 (ESA): Phys. Sci on ISS (33 prop.) and PS/Biology on SR (10 prop)

	Science score >70		Feasible
ILSRA-09 (all ISS)	Total	ESA	
Biology	25	18	
Physiology	29	20	
Microbiology	5	3	
Exobiology	5	5	
Environment Science	1	1	
Dosimetry	1	1	
<i>Total</i>	<i>66</i>	<i>48</i>	<i>39</i>
AO-2009 (Physical Science on ISS)		<i>23</i>	<i>20</i>
Biology on SR		4	4

Bed Rest AO-09: 29 proposals, 20 selected

EXAMPLE:

International participation to the **22 projects** to the recent ESA AO-2009 in physical sciences that are selected for the ELIPS pool

AUS	1
B	15
CDN	19
CH	4
D	44
E	6
F	31
FIN	1
GR	1
H	5
I	17
IND	1
IRL	1

J	18
N	2
NL	3
PL	3
PRC	1
ROK	1
ROM	1
RUS	12
S	2
SK	2
UK	4
USA	8
	203

Es ISS Facilities

SOLAR



EuTEF
(returned Sep-09)



European
Drawe
Rack



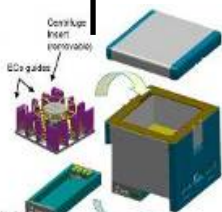
European
Physiology
Moddule



PCDF



KUBIK



MEEMM +
CardioLab



Fluid
Science
Lab



BIOLAB



European
Transport
Carrier
FLYWHEEL



HRF-1/-2 PFS
HRF - MARES



3MELFIs



MATERIAL
SCIENCE
LAB

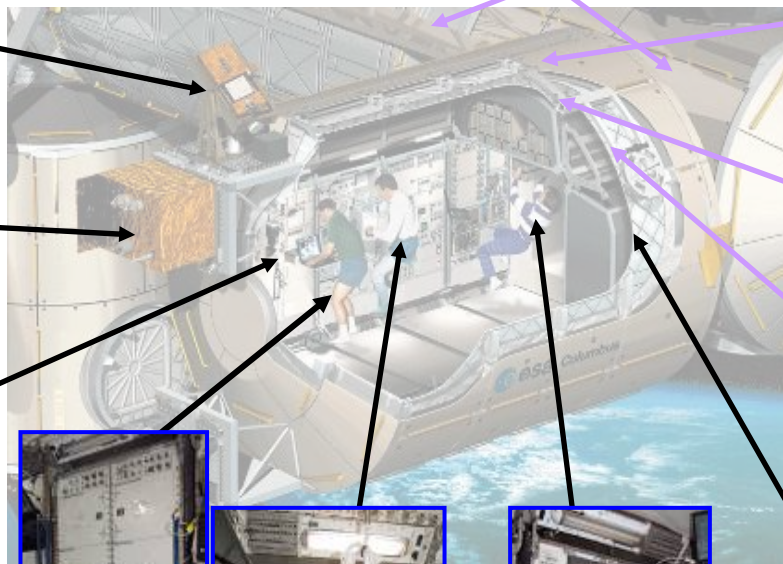


ER-3/
EMCS

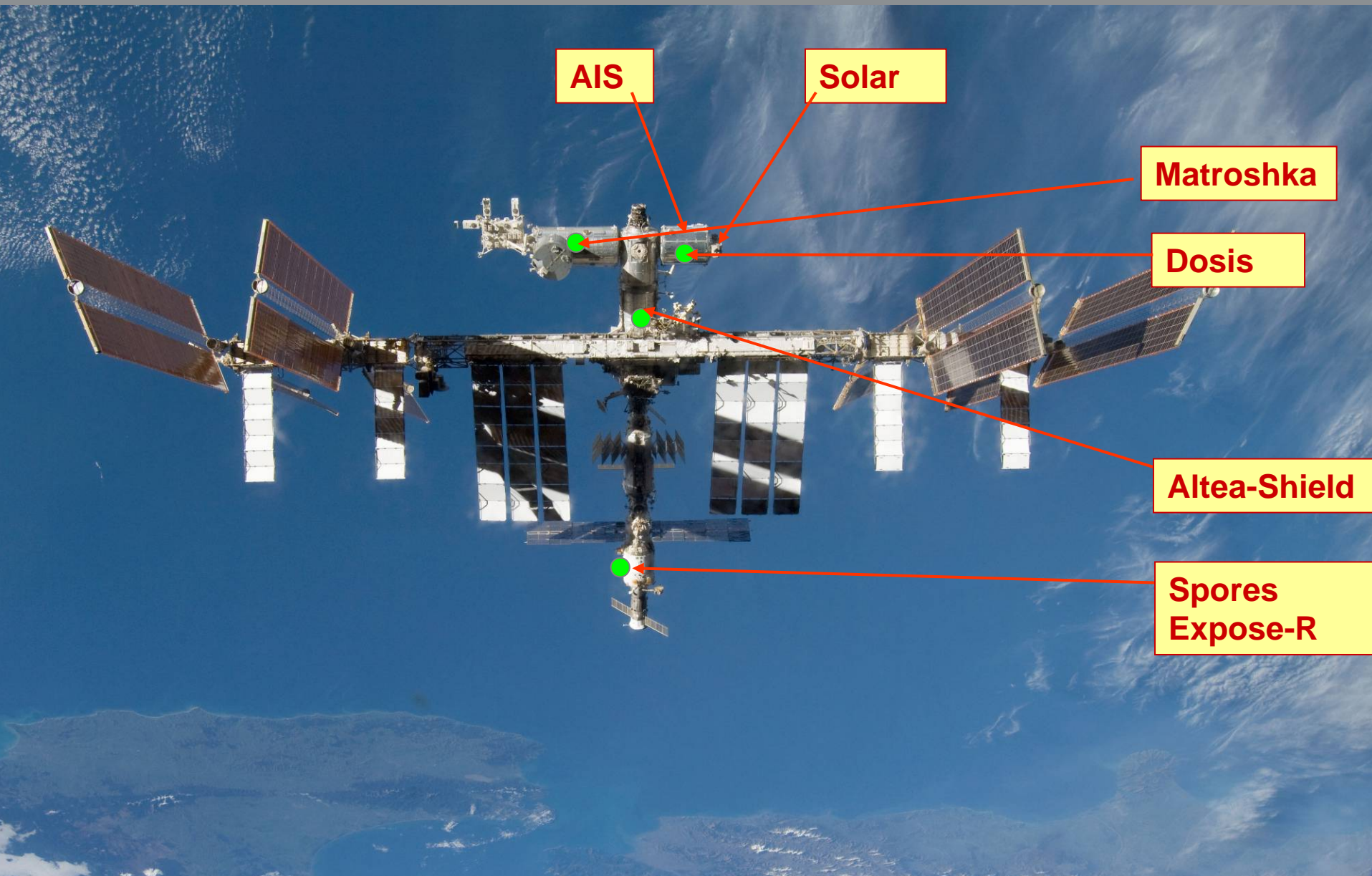


Relocation
from
Destiny

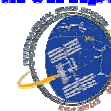
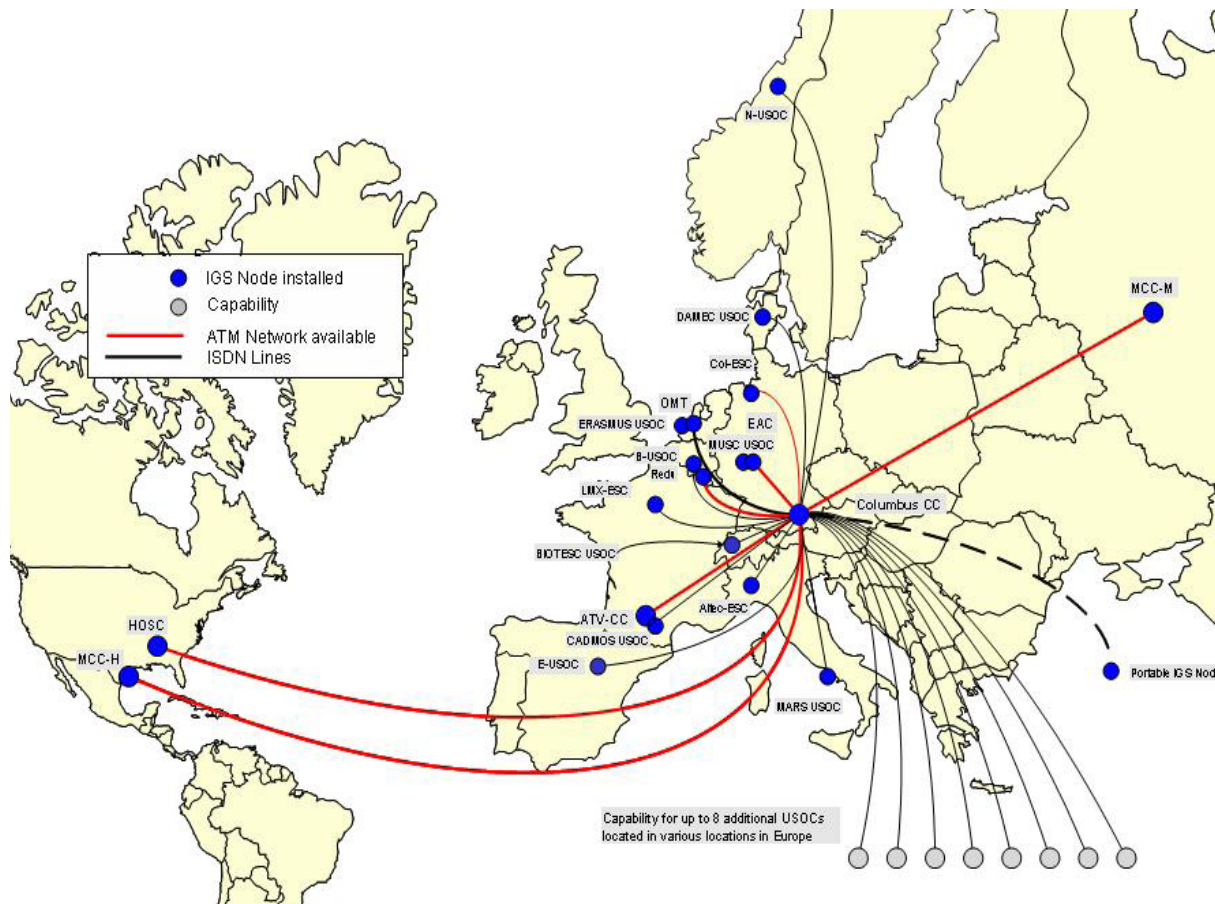
MSG



...and some more related to monitoring  esa



ESA Utilisation Operations: 9 European USOCs



COL-CC in Oberpfaffenhofen is
ESA's Control Center for Columbus

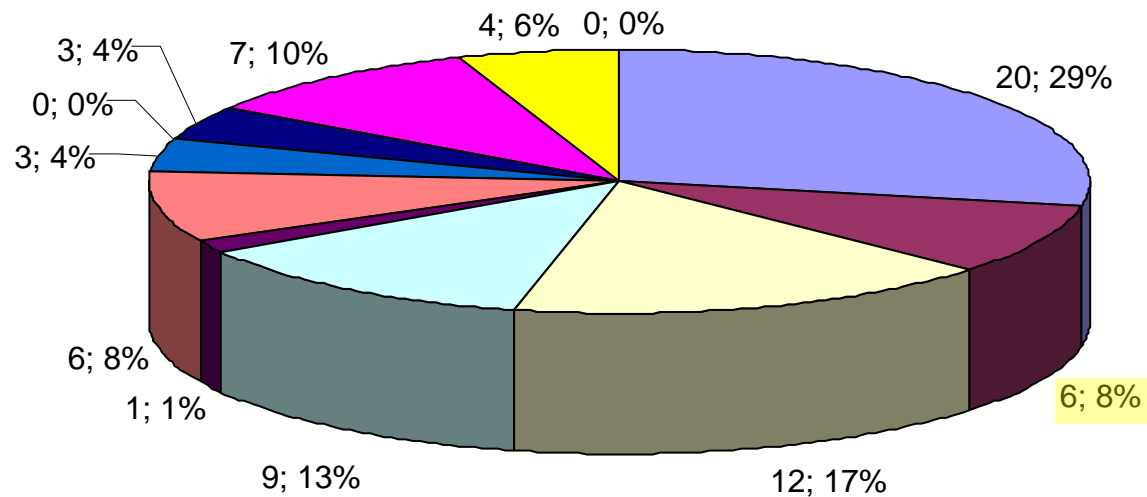
ESA Utilisation

human spaceflight



2/2008 – 5/2010: Total 71 experiments

- Through Incr. 22 (April 2010) **ESA has performed 163 investigations**
- The **European user community** has been very active with multi-national research teams comprising **233 Principal Investigators and 1146 Scientists.**



Human Physiology	Radiation	Biology	Exobiology
Countermeasures	Fluid Physics	Material Sciences	Plasma Physics
Solar Physics	Technology Demo	Education	Commercial

ISS Incr. 23-24 (Apr-Sept 2010)

• Physiology

- 3D-SPACE
- CARD
- EDOS (ground-based)
- EKE (ground-based)
- IMMUNO
- PASSAGES
- SOLO
- SPIN (ground-based)
- THERMOLAB
- **VESSEL IMAGING**
- ZAG & OTOLITH (STS / ground-based)

Life Sciences

• Biology

- Biolab / TRIPLELUX-B > Incr. 25
- Biolab / WAICO-2
- EMCS / GENARA-A
- PADIAC
- CFS-A > Incr. 25



Note:
New experiments
indicated in **bold**

Physical Sciences

- **FSL / FASES > Incr. 29**
- MSL – MICAST & CETSOL
- SODI – DSC
- **SODI – COLLOID**

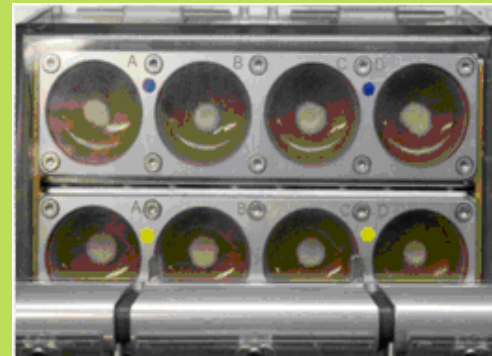
Radiation / Solar physics

- **ALTEA-SHIELD**
- DOSIS
- SOLAR
- EXPOSE-R
- **MATROSHKA-2**

Educational Activities & Tech Demo

- **TASTE in SPACE** • **ERB-2**
- **VESSEL ID SYSTEM (AIS/GATOR)**

- **YEAST-B**: “Yeast in No Gravity”, investigated for 2 different configuration: liquid cultures and solid substrate cultures;
- Samples uploaded with 20S. Hosted in BIOLAB, the YEAST Experiment Containers (ECs) were processed during 20S/18S exchange;
- Good visible growth of the yeast colonies + 2 photography session on FD04 / FD09;
- Automated Filtration and Fixation of the cultivation chamber successfully commanded from BIOLAB;
- Experiment containers were then stored at +4degC in the Thermal Control Unit (TCU) of BIOLAB, and returned with 18S.



FD04



FD09

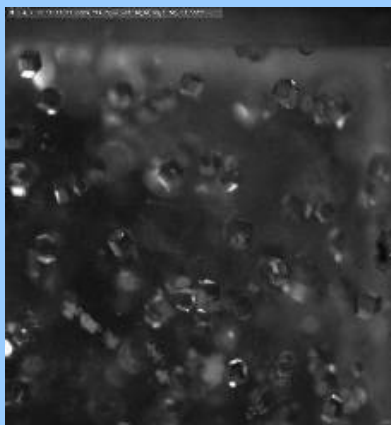
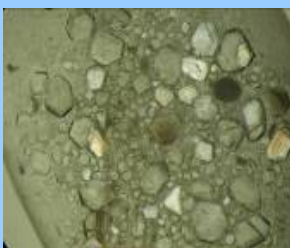


YEAST-B

Protein Crystallisation



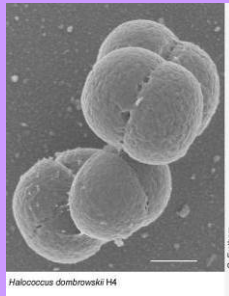
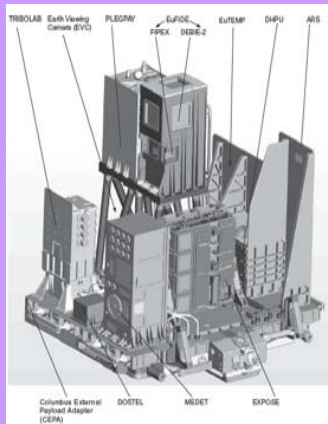
PCDF /
PROTEIN



PCDF-Protein

- Experiment launched on 15A (STS-119) and brought back with 2J/A (STS-127);
- 4 experimental reactors devoted to the study of solution crystallisation physics;
- First truly interactive payload in Columbus, with near real-time feedback from science team on ground – remote adaptation of experimental protocol as the science runs are being carried out;
- Detailed samples' analysis on-ground is in progress and the data looks promising.

Technology Exposure Facility (EuTEF)

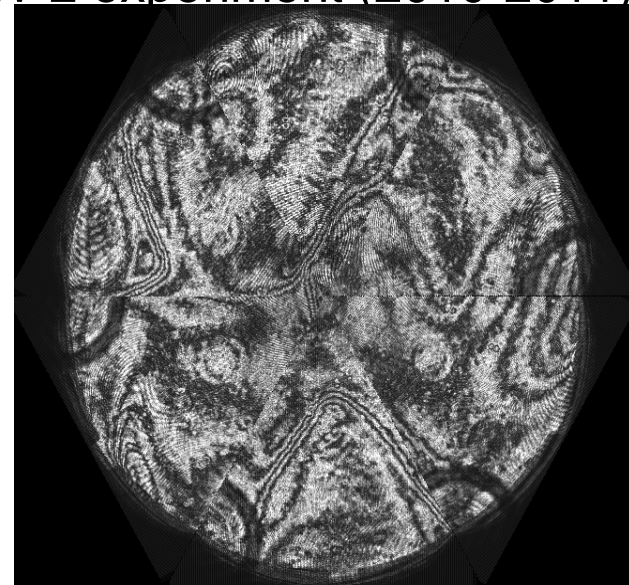
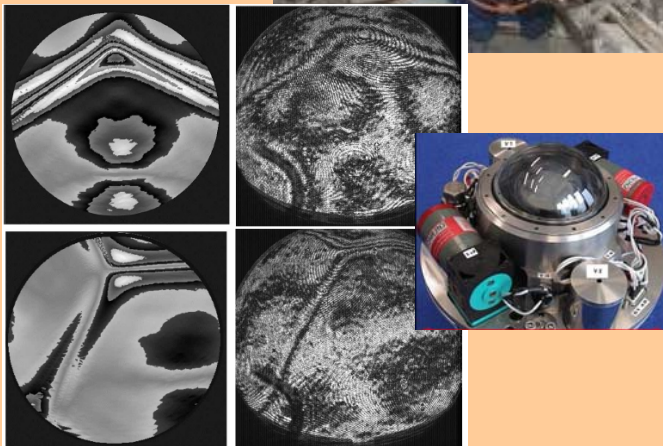
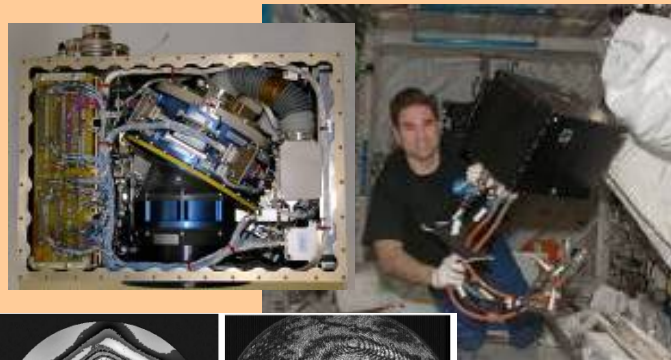
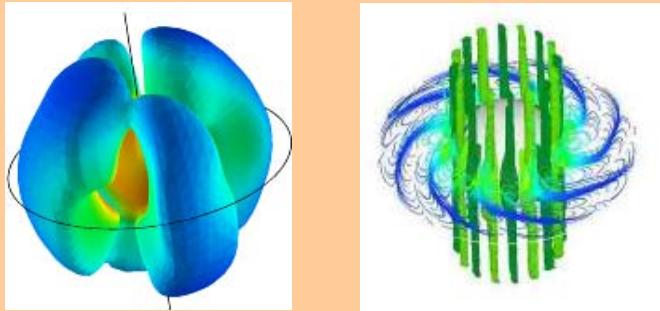


EuTEF
(13 experiments)

- Continuous science acquisition for 9 instruments for technology / physical / debris / radiation / exobiology research during 18 months;
- Large set of exobiology samples for 5 experiments in the trays of the EXPOSE-E instrument;
- Integrated EuTEF platform has been downloaded with Shuttle 17A (STS-128) mission and science teams have reported prelim. results in dedicated symposium 3/2010.
- Multi-purpose permanent EuTEF-2 platform planned for the future.

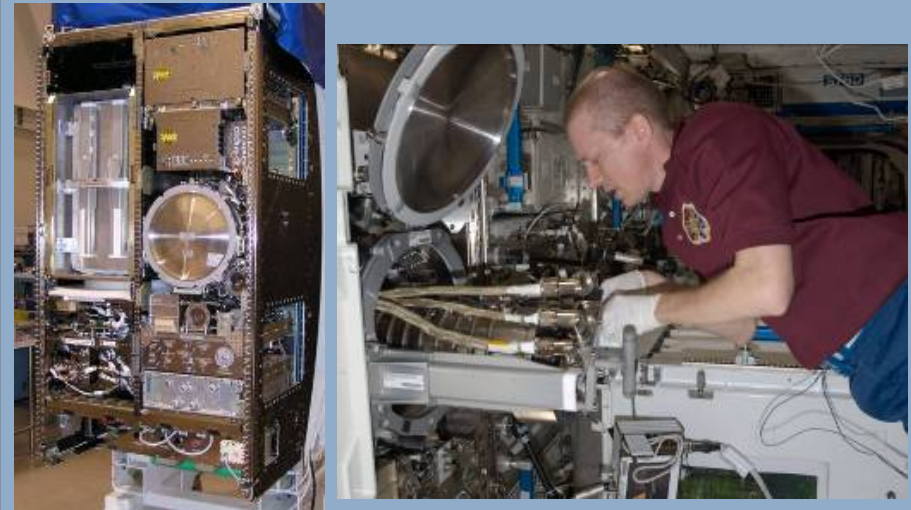
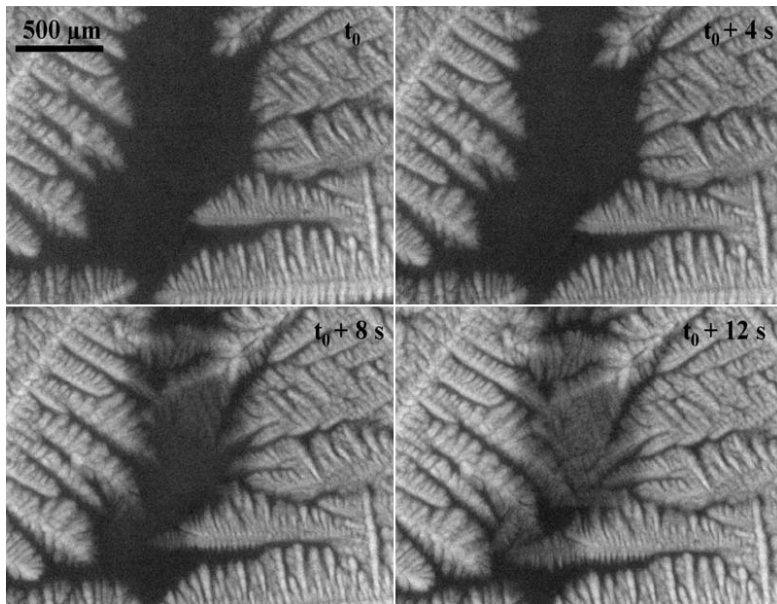
FSL - Geoflow

- Execution of GEOFLOW experiment runs with excellent interferometric image data.
- Failure of a thermal control loop pump in the Experiment Container has shortened the mission a bit but conclusive scientific data could be obtained
- ESA is preparing for the follow-on GEOFLOW-2 experiment (2010-2011)

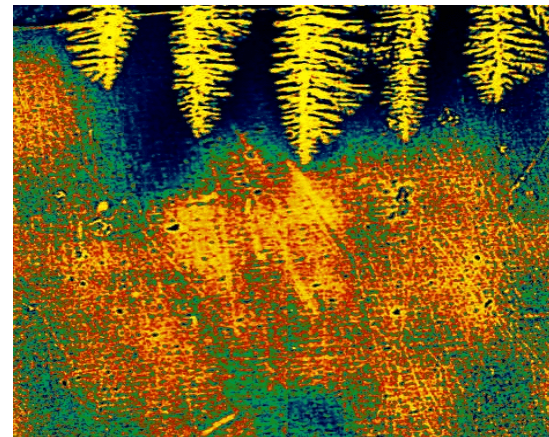


Material sciences

- Successful commissioning of MSL/MSRR with the first 12 cooperative ESA-NASA experiments
- In-situ visualisation by X-ray diagnostics (Maxus)



MSL / MICAST + CETSOL



ESA Radiation Dosimetry on the ISS

Status: August 2010 (provided by Rene Demets)

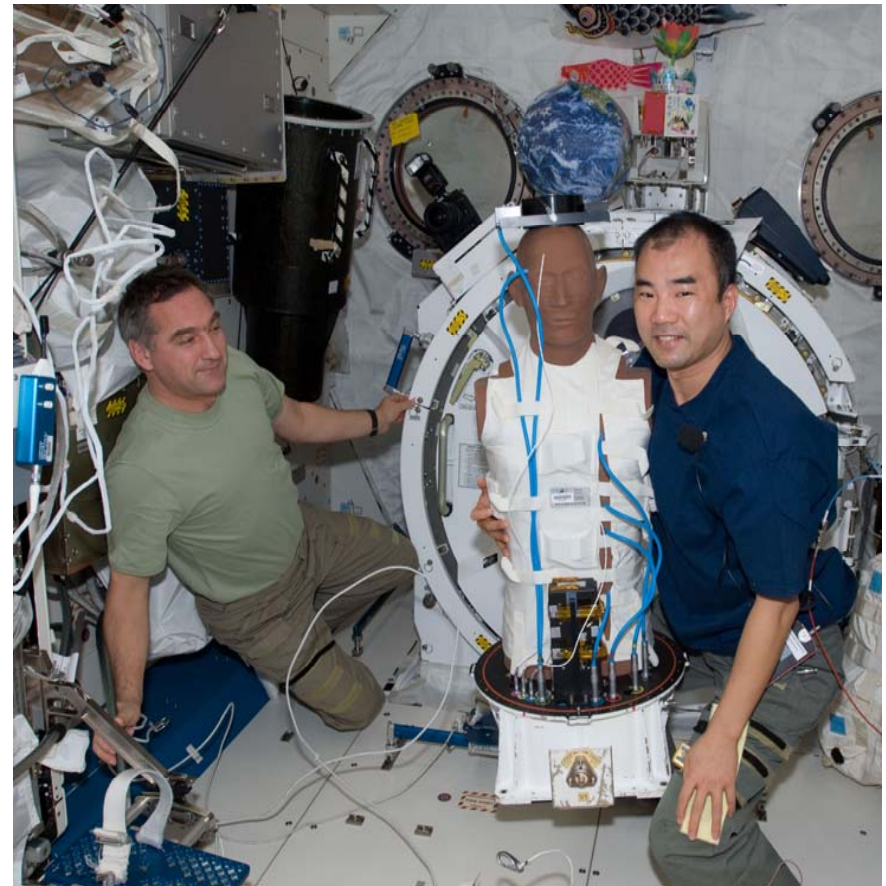


**Electronic box
of DOSIS**



R3D

EXPOSE-R



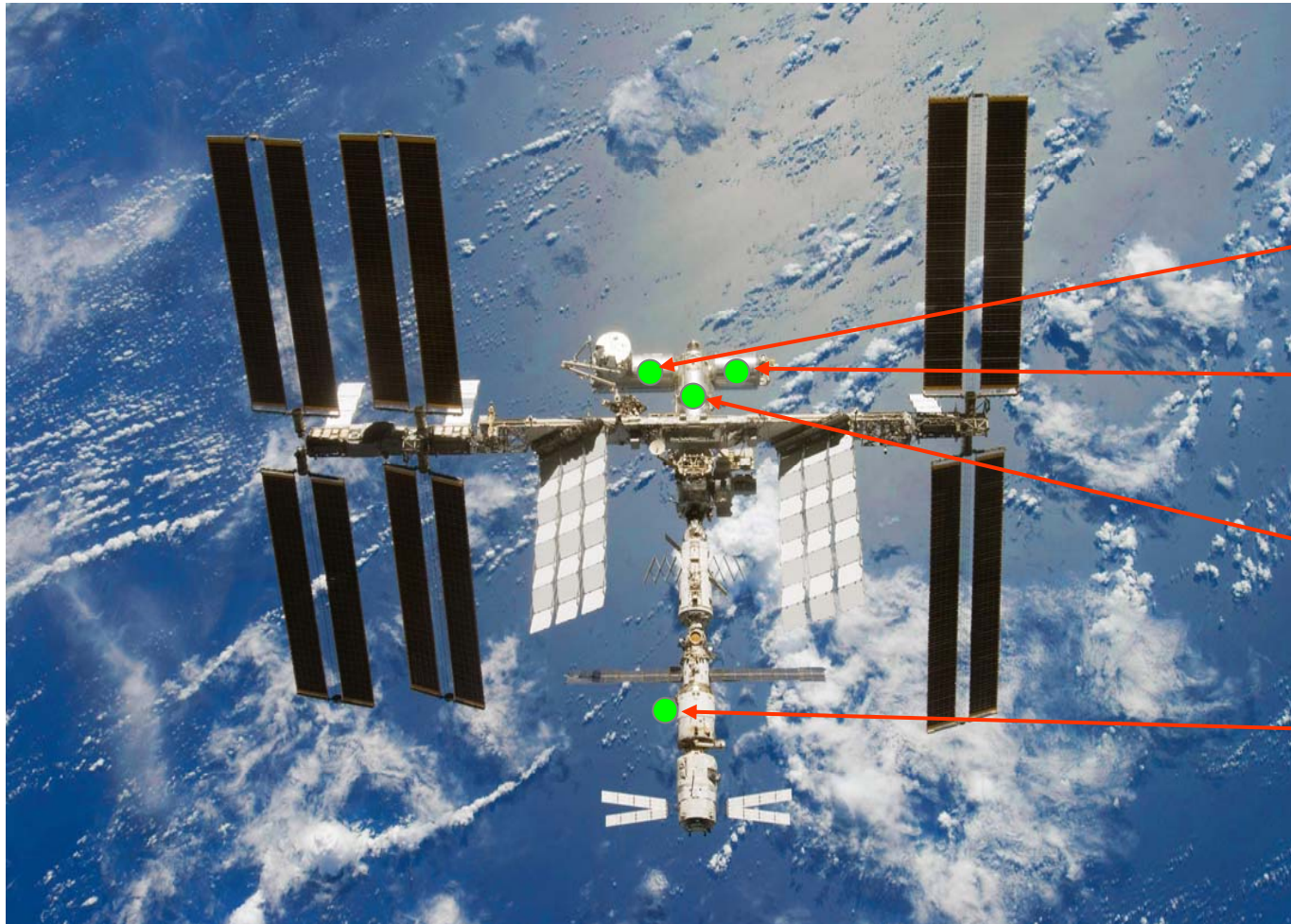
Matroshka in KIBO

ESA Dosimetry programme



- **SPORES / R3D** (021-D-LS) *lead scientists: G. Horneck, T. Dachev*
ongoing activity
upload 26 November 2008 on 31P; deployed 10 March 2009 (Expose-R)
expected download November 2010 on 23S
- **DOSIS** (ILSRA-2004-167) *lead scientist: T. Berger*
ongoing activity
upload 15 July 2009 on STS-127; deployed 20 July 2009
- **Matroshka-KIBO** (ILSRA-2004-247) *lead scientist: G. Reitz*
ongoing activity
upload new detectors 28 April 2010 on 37P; deployed 4 May 2010
expected download March 2011 on 24S
- **ALTEA-SHIELD** (ILSRA-2004-110) *lead scientist: L. Narici*
upload first part (SURVEY) 5 April 2010 on STS-131; deploy prel for 20 Sep 2010
- **TRITEL** (SURE-AO-2006-018) *lead scientist: A. Hirn*
in preparation; upload envisaged in 2011, Inc 27/28

Distributed over ISS



Matroshka

Dosis

Altea-Shield

Spores

Operational detectors

- occupy many spots; provide area dosimetry
- cannot deliver real-time information (ALTEA exception)
- cannot measure dose rates; only accumulated doses per increment
- provide information about spatial dose distribution variations in the ISS
- provide characterization of the cosmic particles

Research detectors

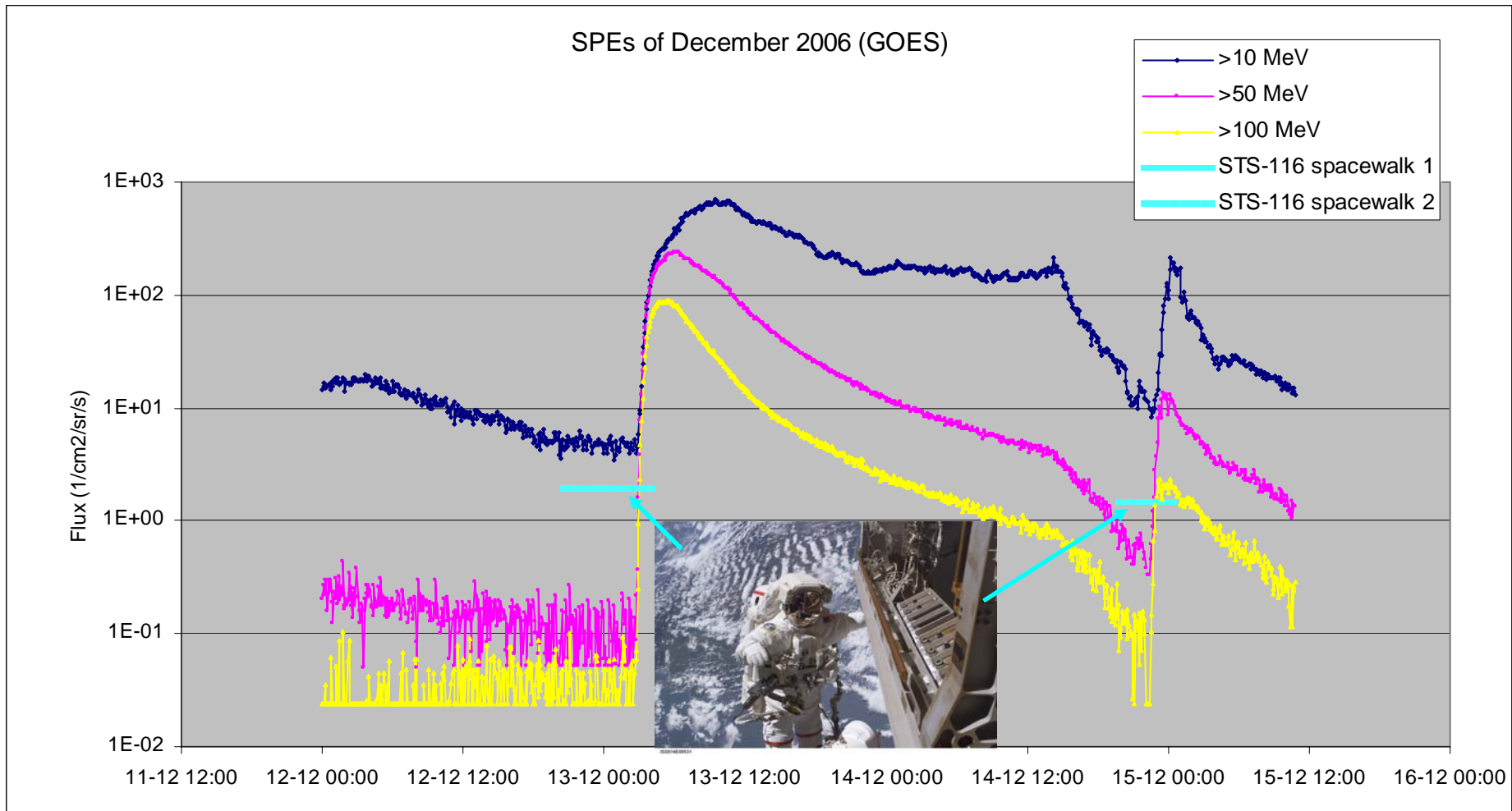
- are active in a single spot
- deliver real-time information
- provide information about dose rates & dose rate variations over time
- provide characterization of the cosmic particles
- provide partial or full (TriTel) information about directionality

Scientific objectives



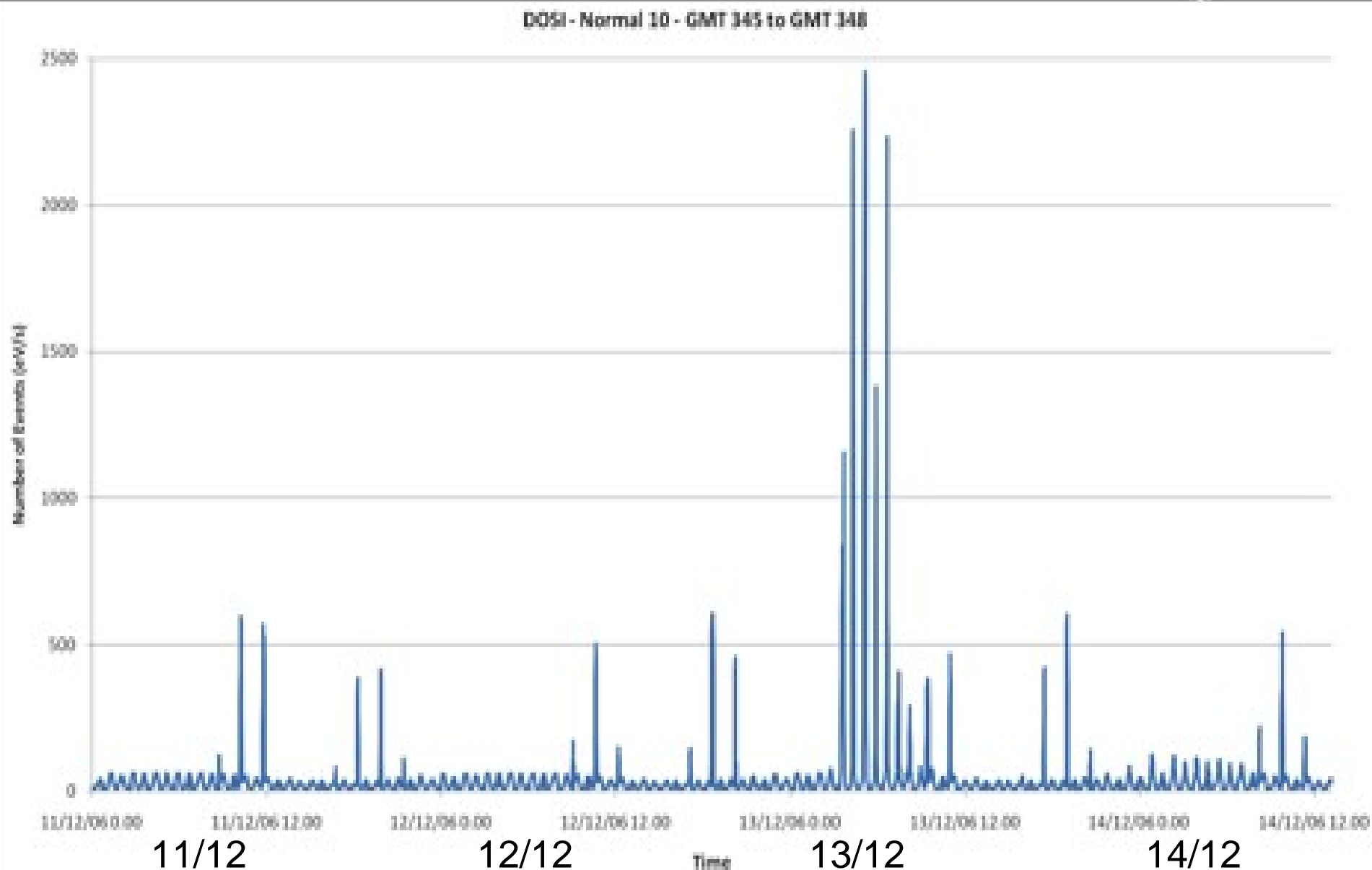
	outside ISS	inside ISS	operational dosimetry (passive)	research dosimetry (active)	detector types
SPORES / R3D Expose-R	x			x	1 silicon detector
DOSIS Columbus		x		x	2 silicon detector telescopes
Matroshka-KIBO KIBO		x	x		CR-39, TLD
ALTEA-SHIELD USLab		x		x	6 silicon detector telescopes
TriTel Columbus		x	x	x	3 silicon detector telescopes CR-39, TLD

Solar particle flux seen by the GOES satellite during spacewalks of STS-116



December: | 12 | 13 | 14 | 15 |


Solar Flare of 13/12/2006 seen by ALTEA particle rates



A photograph of an astronaut in a white spacesuit working on the exterior of the International Space Station. The astronaut is positioned on a large, flat, metallic surface, possibly a solar panel array, and is reaching towards a complex structure of white and gold equipment. The background shows the intricate framework of the station, including various beams, cables, and components. The lighting is bright, casting a distinct shadow of the astronaut onto the surface they are working on.

STS-116: special dose measurement during three EVAs (total 18h 14m).

Dose rate did not increase within accuracy (ca 10%)



**Space is ideal for
studying weather,
climate and human
influence**

Collaboration HSF – EOP
45 proposals received –
significant ratio of high level
ideas

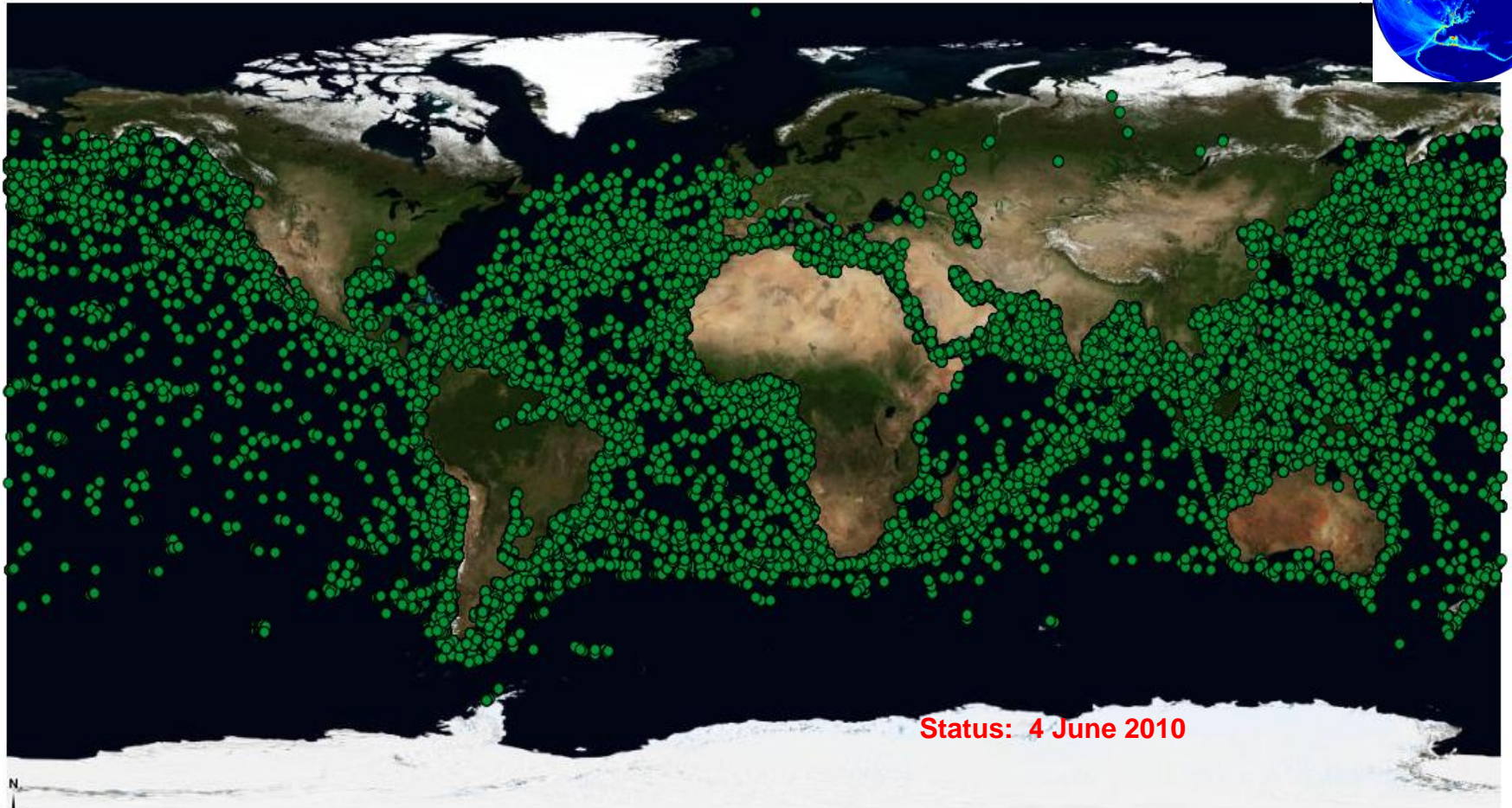
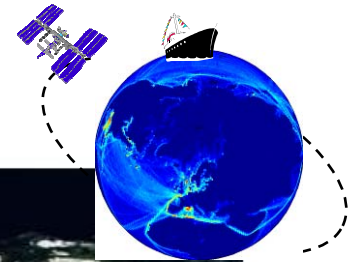
Next Steps:

- **Dedicated AO (Q4/2010)**
- **GSP studies**
- **(New) programme descision on**
Ministerial Council expected 2010

Summary Plot of Ship Tracking Data from NORAIS Receiver on ISS-Columbus



0 30
degrees



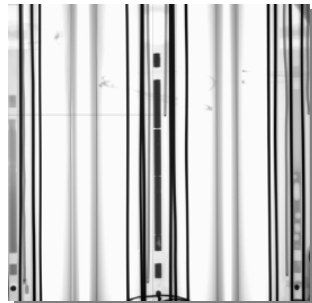
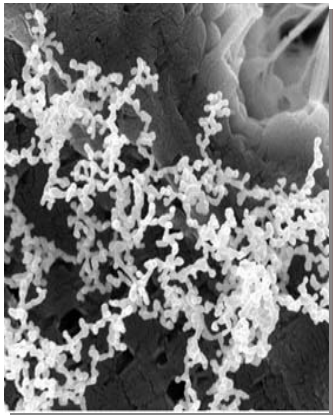
Status: 4 June 2010





Launch Date: 26 March 2010
Apogee: 701 km
 μ g-time: 12 min 15 sec

Metal nano-particles
produced in weightlessness
via an evaporation-
condensation process.
(Image: IFAM, Germany)



X-ray of the three
diffusion samples from
ground reference
experiments
(Image: SSC, Sweden)

A snapshot of the video feed,
showing the “statoliths”
displaced at the plasma
membrane of the rhizoid cell
(image: EADS-Astrium,
Germany)



4 Experiment Modules

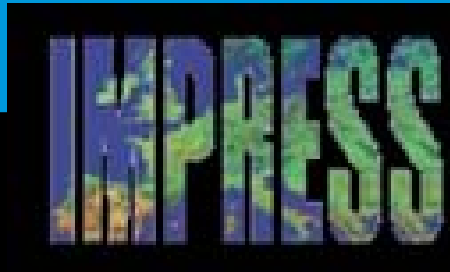
- Solidification of new titanium-aluminide alloys
Science Team: Y. Fautrelle, O. Budenkova, INPG (F); S. Rex (D); D.Browne, S.McFadden (IRL); L. Froyen (B); A.Kartavykh (Rus)
- Agglomeration of nickel nano-particles
Science Team: B. Günther, S. Lössch, Fraunhofer (D)
- X-ray monitoring of liquid diffusion in metallic alloys (XRMON)
Science Team: A. Griesche (D); R. Mathiesen (N)
- Cytoskeletal forces underlying gravity sensing mechanisms of Characin cell
Science Team: M. Braun, B. Buchen, N. Vagt (D)

Microstructure obtained in a ground
reference TiAlNb sample in preparation for
the final definition of the microgravity process
parameters (image: IMPRESS, Germany)



Applications

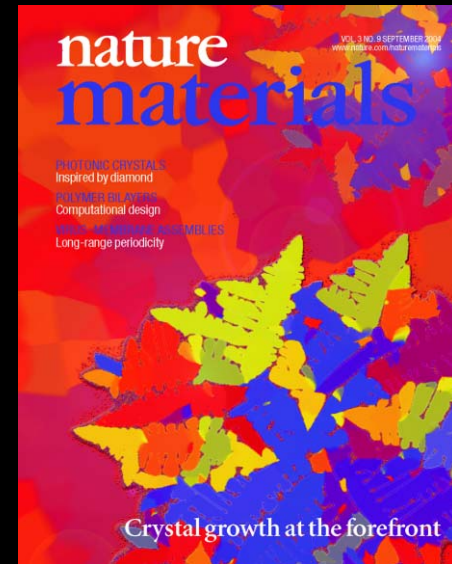
human spaceflight



41 M€ESA/EC IMPRESS Project on “Intermetallic Materials”



- New lightweight TiAl turbine blades for jet engines and gas turbines (50% lighter than conventional nickel superalloys)
- New NiAl catalytic powders for hydrogen fuel cells and other chemical processes (better than conventional platinum and many hundreds of times cheaper)
- The above research was enabled by microgravity experiments on sounding rockets and regular parabolic flights
- Supported by sophisticated modelling
- World-leading project in this field



The A300 has now also been certified for flying parabolas that provides, in addition to microgravity, reduced gravity levels of 0.16g for approximately 23 s and 0.38 g for approximately 30 s. These gravity levels correspond to Lunar and Martian gravity levels.



ESA parabolic flight campaigns for science and technology investigations are generally performed twice per year, with about 12-14 exp'ts (including educational)

First AO for partial-G closed 31 August 2010.

42 proposals received!

Tentatively joint ESA/CNES/DLR flight campaign mid-2011.



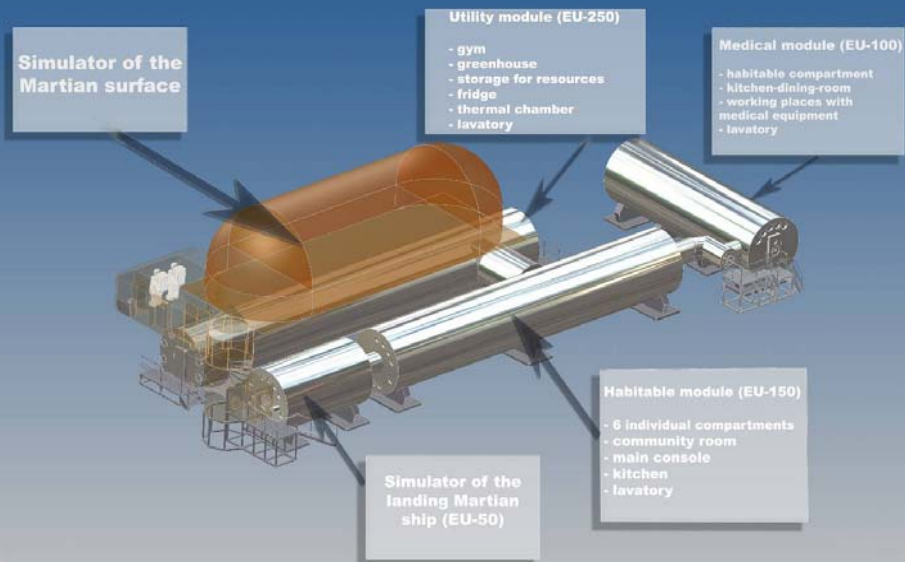
The 520-day crew launched on June 3rd.

Enormous media interest!

Over 100 experiments, 14 ESA's.

Sukhrob Kamolov, Romain Charles, Alexandr Smoleevskiy, Wang Yue, Alexey Sitev (CDR), Diego Urbina, IT

Isolation facility at IBMP



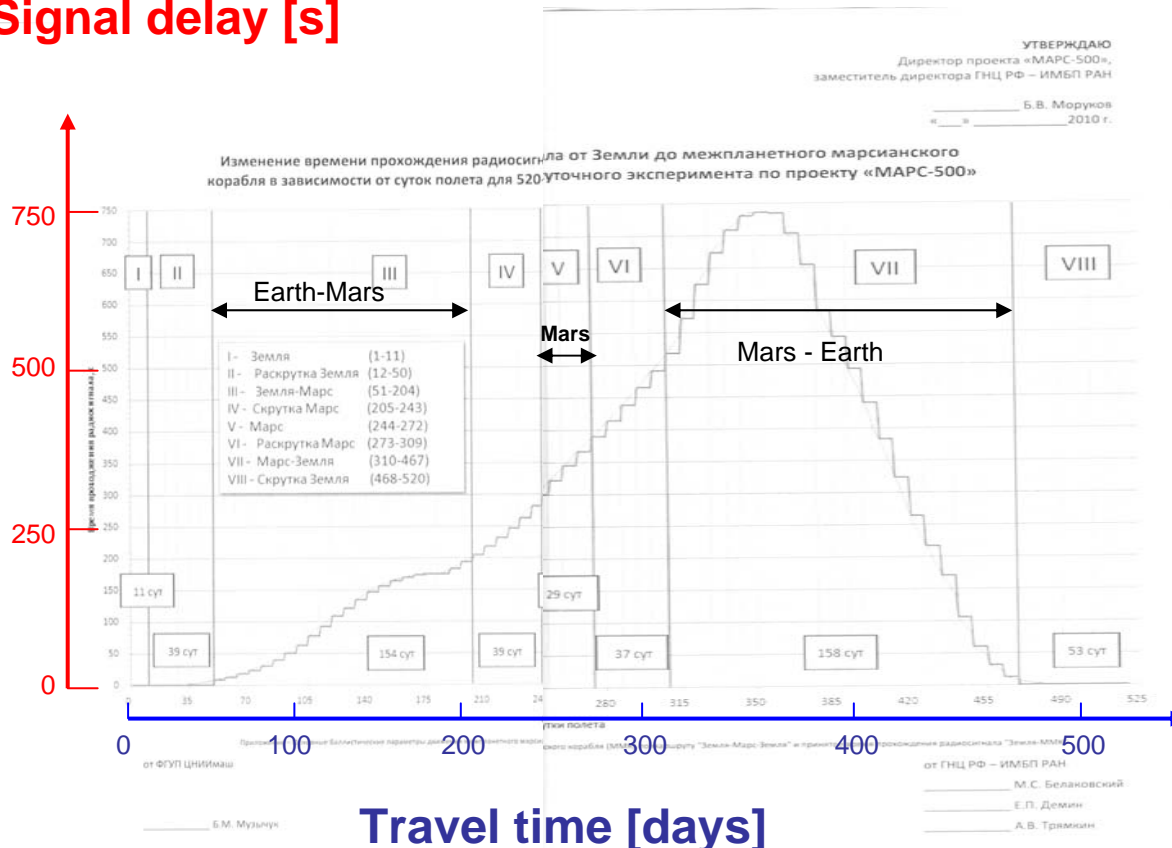
The 105-days crew

Major operational challenge:

Time delayed signals, up to 20 min one way

No voice comm, except first and last month (ca)

Signal delay [s]



Future of Human Exploration



- International collaborations
- Utilize ISS to 2020 (at least)
 - ESA is making significant advancements in its own technologies:
 - Advanced Re-entry Vehicle
 - Lunar Lander
 - Life Support Systems (ARES, MELiSSA)
- A return to the Moon where we will learn how to live and stay on another planet
- A visit to Lagrange points, Near Earth Objects
- Mars as the ultimate destination where one day humans may live and work



Paolo Nespoli

Exp. 26/27: 14 Dec'10 – 16 May'11



Roberto Vittori

STS-134 (AMS)

26 Feb 2011



ATV-2

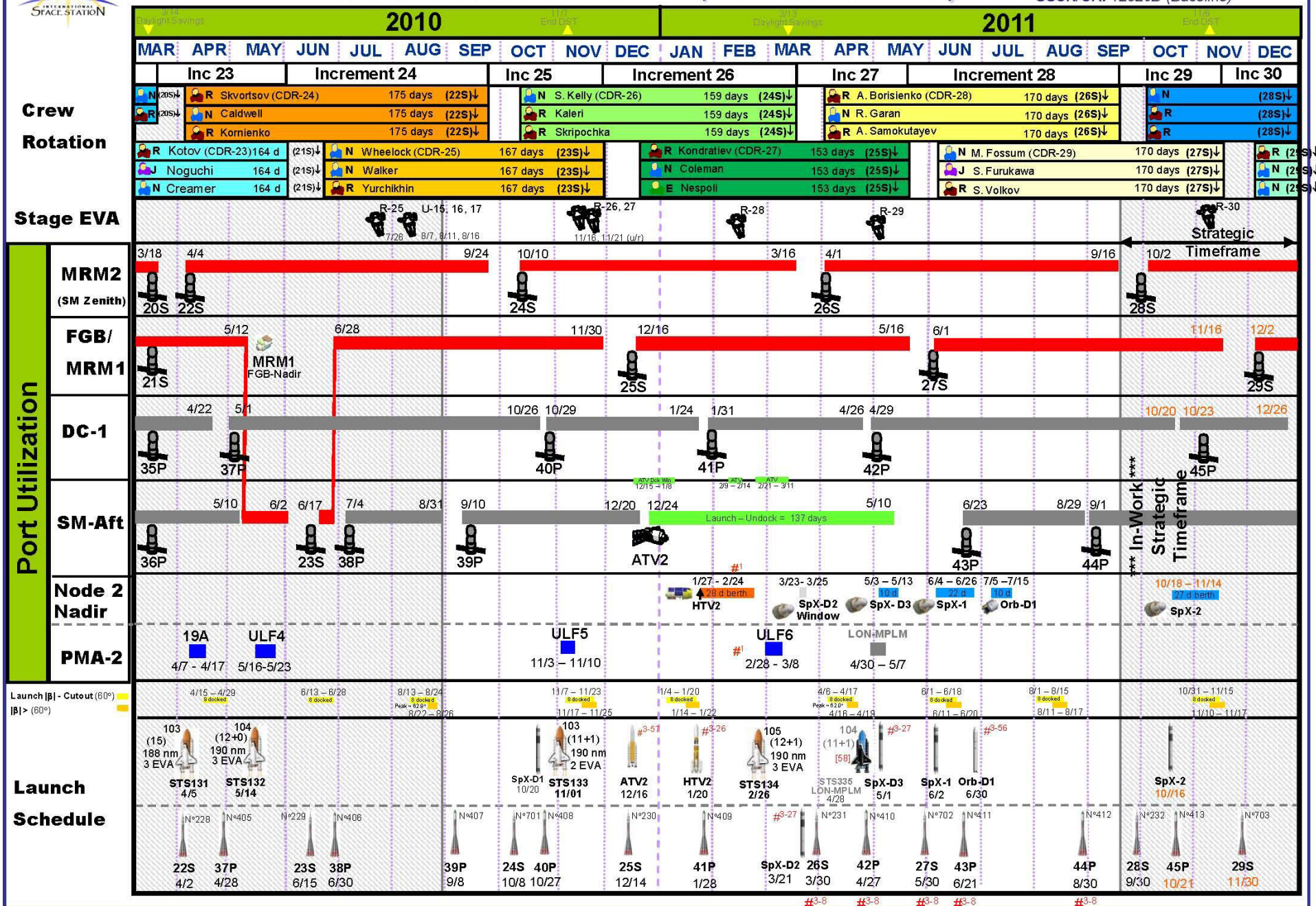
24 Dec 2010





Chart Updated: August 31st, 2010

SSCN/CR: 12326B (Baseline)





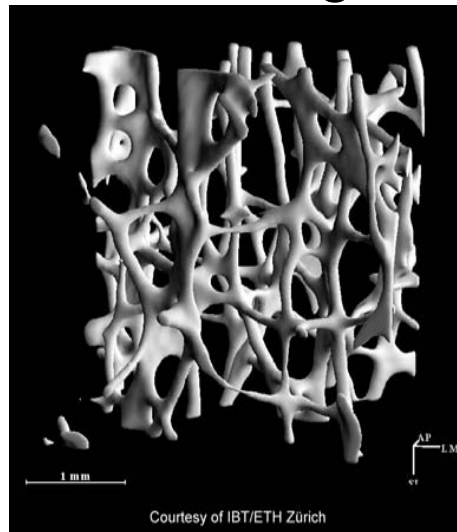
Inspire future generations!





BACKUP SLIDES

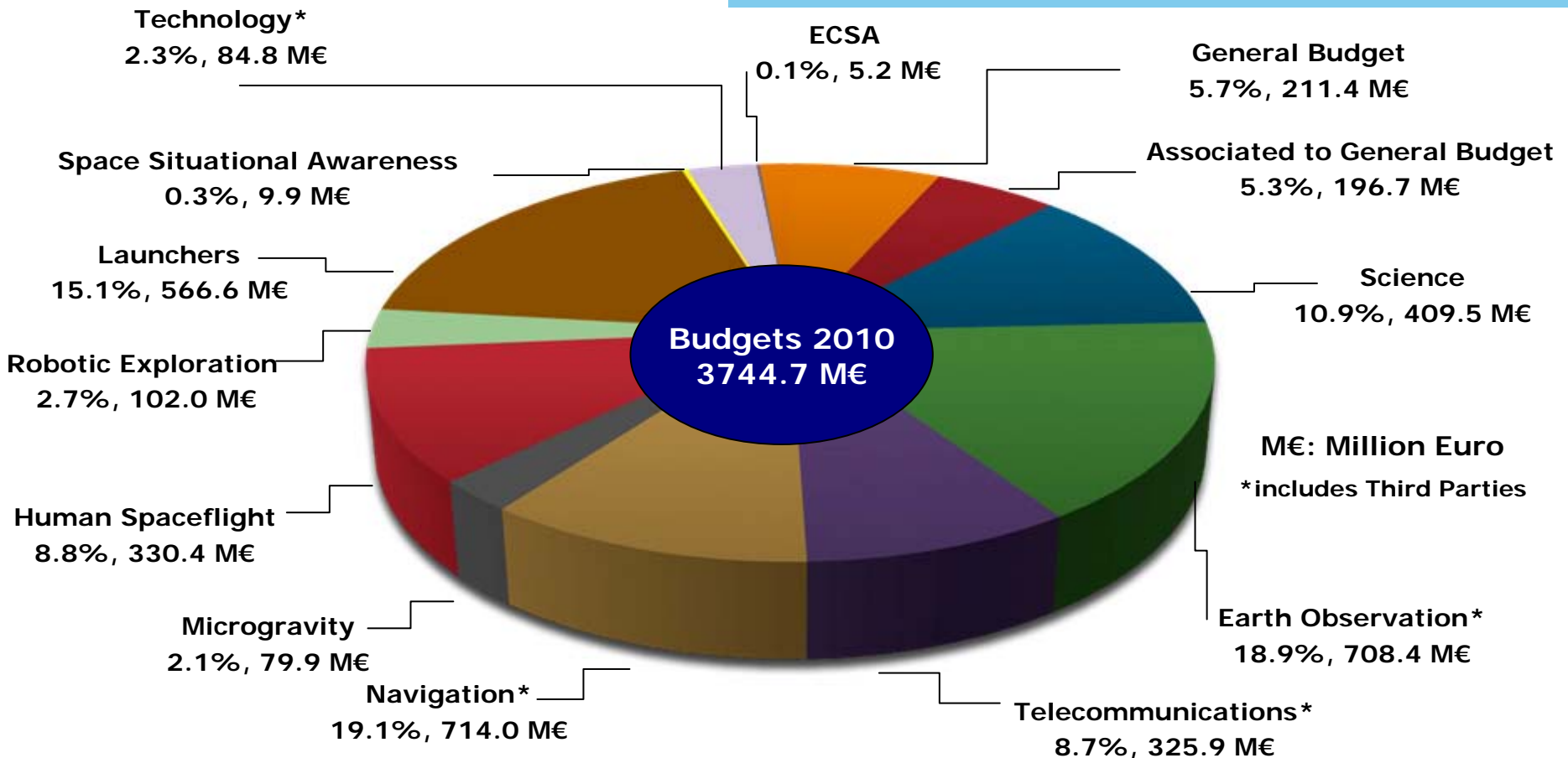
- Science: currently 78 selected experiments in implementation phase.
 - 27 for ISS
 - 26 for the Bed rest programme
 - 8 for Concordia
 - 14 for Mars500
 - 4 for Parabolic flights



ESA BUDGET BY PROGRAMME (2010)



Programmes and mandatory activities	3739.5 M€
European Cooperating States Agreement (ECSA)	5.2 M€
Total	3744.7 M€

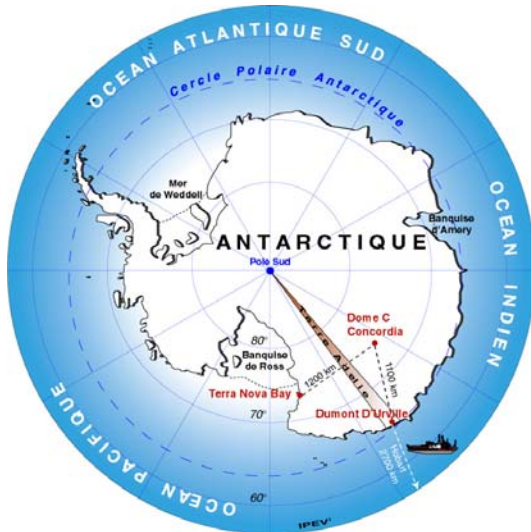


Station built and operated by French Polar Institute (IPEV) and the Italian Antarctic Programme (PNRA S.c.r.L.)

Station permanently manned since 2005

Relatively small crews for the winter-over (Mar-Oct, 12-14 persons)

ESA AO searching for a crew member for next season



- New upcoming (ACES; ASIM
- CF shower