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Affordable Access to Experiments Aboard the ISS

Astrium Space Transportation

Dr. Peter Kern // November 2011

All the space you need

UNOOSA



United Nations
Office for Outer Space Affairs



ASTRIUM
AN EADS COMPANY

Presentation Outline

- Astrium: Who we are and what we do
- What is NanoRacks?
- Astrium & NanoRacks Partnership
- The Astrium Advantage
- The New User Advantage



- Development of a Life Science Experiment –

A class room lecture with hardware demonstration

HD-2: Wednesday during break time

Astrium – A 100 % Subsidiary of EADS

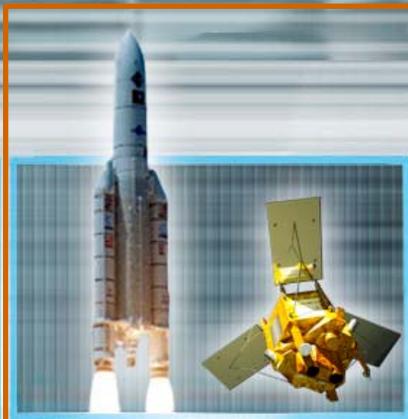
EADS



**Airbus,
Airbus Military**



Eurocopter



Astrium



Cassidian

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Astrium – Space Transportation

Astrium Space Transportation

The European prime contractor for civil and military space transportation and manned space activities



Astrium Satellites

A world leader in the design and manufacture of satellite systems



Astrium Services

At the forefront of satellite services in the secure communications, geo-information and navigation fields



WE DELIVER FOR SCIENCE

Astrium Space Transportation
>30 years of μ g-experiences



Astrium supports European role in ISS and its utilization:

- Industrial Prime Contractor for the Core European ISS Elements
 - Columbus Research Laboratory
 - Automated Transfer Vehicle (ATV)
- Responsible for Major Subsystems
 - Data management systems (DMS-R)
 - ECLS (Environmental Control Life Support)
- Industrial Operator Function for the European Utilization Scenario
 - Sustaining engineering
 - Astronaut training
 - Control centers Col-CC and ATV-CC
 - ATVs
 - Payloads & Experiments operations
- Experiment Facilities & Experiments Development for Scientific Research & Utilization



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Astrium & the Columbus Laboratory

- European contribution to the ISS: Columbus
 - Pressurized laboratory
 - Designed for microgravity research
 - Physical Science
 - Chemistry
 - Biology
 - Medicine
 - Human Physiology
 - Space Science and Geosciences
 - Atomic Clocks



Length:	8 m
Diameter:	4.5 m
Payload:	10 active payload racks
Launch mass:	12,770 tons
Crew:	designed for three crew members

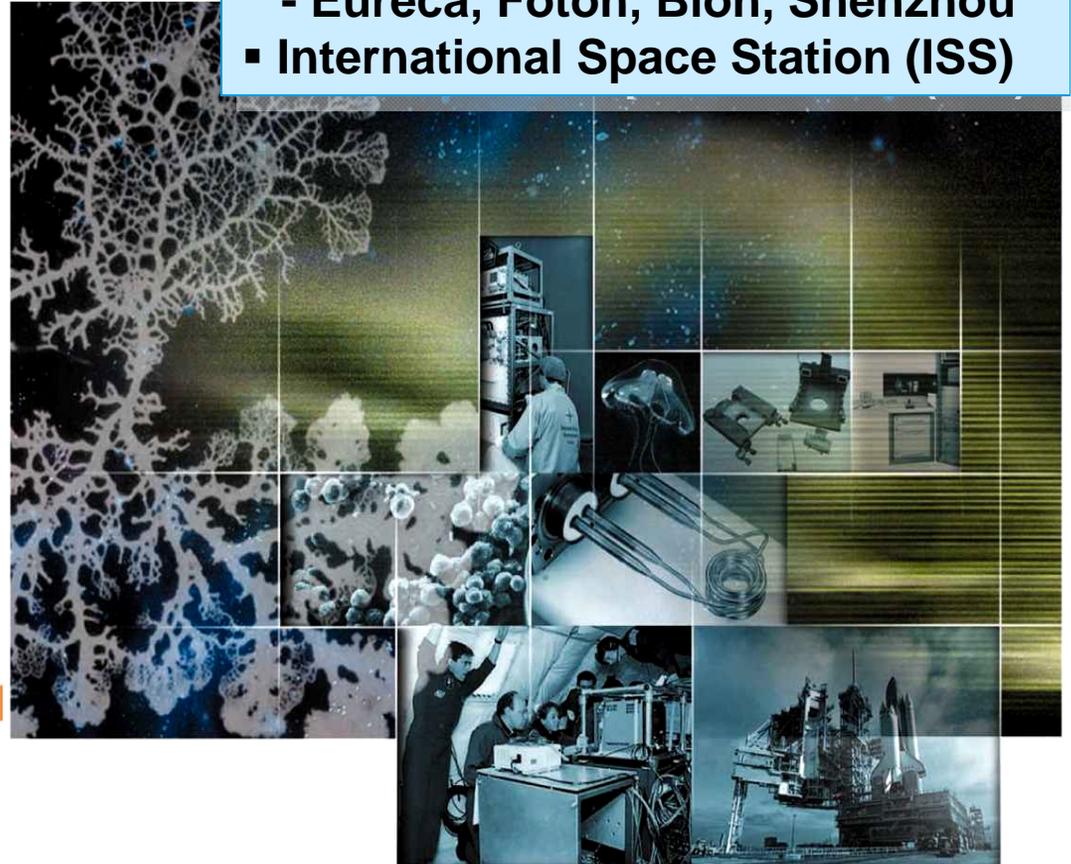
Astrium – Microgravity Payload Center

Development and operation of experiment facilities for space research in the field of:

- **Life Sciences**
 - Biology, cell cultures
 - human physiology, countermeasures
 - biotechnology
- **Physical Sciences**
 - materials science
 - fluid physics
 - Combustion
 - fundamental physics
 - atomic clocks
- **Lab Support Equipment**
 - Freezer/Cooler
 - Glovebox (MSG)
- **Energy & Life Support**

... for „missions“ on

- Sounding rockets, Drop towers
- Parabolic flights
- Space Shuttle, Spacelab
- Re-entry vehicles, capsules
 - Eureka, Foton, Bion, Shenzhou
- International Space Station (ISS)

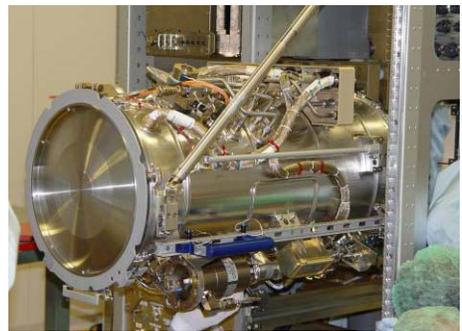
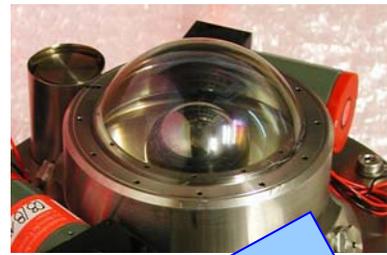


The Astrium Advantage – Experience: Heritage of the Microgravity Payloads Center

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In the past >30 years the Payload Center developed more than 20 experiment facilities and instruments mainly for ESA, DLR, CNES, CSA, NASA, JAXA, CMSEO ...



Material Science Lab



SIMBOX

We are involved in almost each Manned μ g- Mission!!



FSLP, D1, D-2, IML-1, IML-2, IML-3, IML-4, STS-95, STS 107, 4x Shuttle to MIR, Eureka, Foton 1,2,3, ISS

- The Payload Center develops the facilities, supports astronaut training and prepares and supports the experiments
- Cooperations with Agencies, Scientists, University and specialised small companies

Involvement:

- 15 Shuttle/Spacelab Missions
- all 29 ISS Increments
- Capsules: Bion, Foton, Shenzou



How to support new space customers

Motivation

- **To support the users of tomorrow**
 - countries with no access to space
 - for research, education (pupils, students)

- **Our approach**
 - Teaming with NanoRacks
 - Provision of a proven experiment platform, experiment-H/W and training
 - Cooperation with / involvement of local partners

What is NANORACKS ?

- Commercial company formed in 2009 to provide quality hardware and services for the U.S. National Laboratory onboard the International Space Station
- has two Research Platforms onboard the U.S. National Laboratory which can house plug-&-play payloads using the CubeSat form factor.
- signed customer pipeline of over 50 payloads, including domestic and international educational institutions, research organizations and government organizations

Current Position:

- leadership position in understanding the emerging commercial market for low-earth orbit utilization

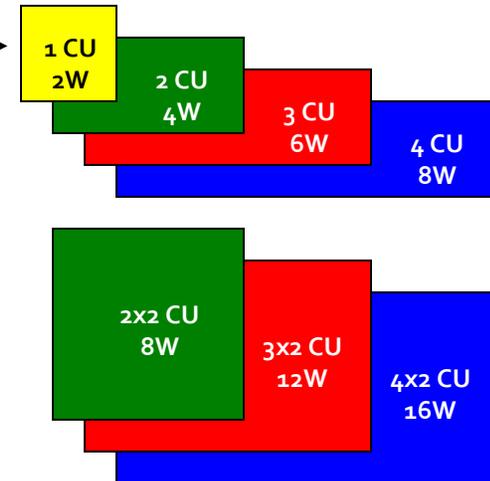
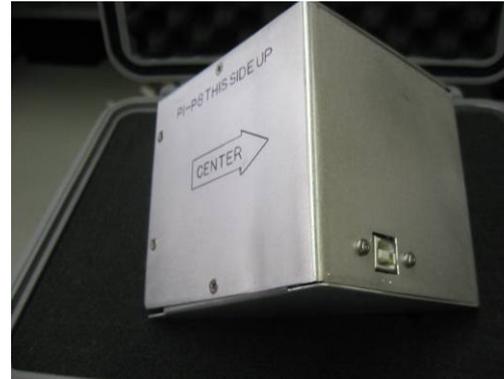
CubeLab Module Approach

can hold up to 16 payloads in the CubeSat form factor

NanoRacks Modules: use in free configuration

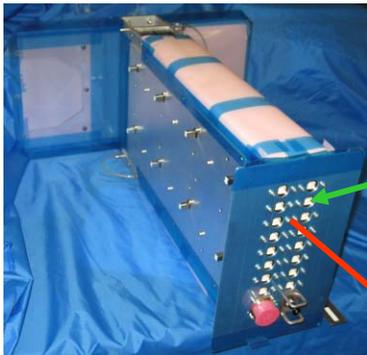
Specification per Cube

- Maximum Mass per CU: 1kg
- Maximum Power per CU: 2 Watts
- Maximum Voltage: 5 VDC
- Maximum Current per CU: 400 mA
- Maximum Cooling per CU: 2 Watts
- Power & Data: USB-I/F
- Crew Time: to be negotiated if needed
- Delivery : L-6h to Late Access
- Return Mass: Soyuz limit to 1 kg
- Transport Method: Cargo Transfer Bags

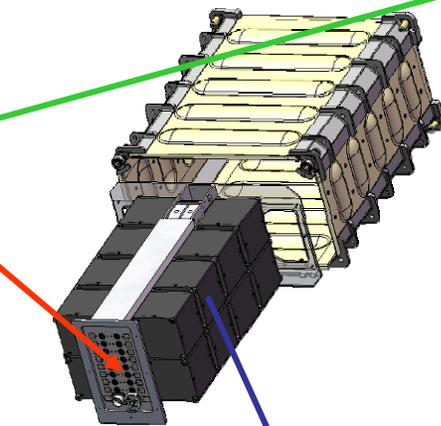


- Nanoracks is a ISS National Laboratories Payload
- Two Nanoracks Cube Lab Frames were installed on 19A and ULF4
- Modules can be flown on any ISS transportation vehicle

- Payloads can fly on any launch vehicle
- Commercial Pathway to Station
- NanoRack Modules can work in or out of the frame



Nanoracks
CubeLab Frame



NanoRacks CubeLab Modules



Nanoracks
CubeLab Frame
in ISS Locker



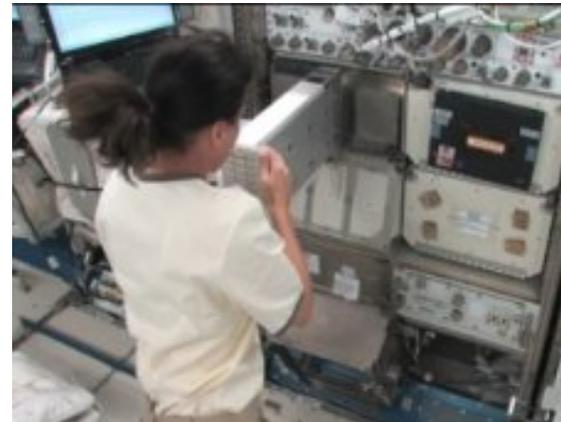
ISS EXPRESS Rack 4, Lockers 3 and 7

Partnership: **ASTRIUM** & **NANORACKS** AN EADS COMPANY

- NanoRacks provides autonomous access to space research within a short time period
- Astrium provides the gravitational research platform (centrifuge), a complete “construction kit”, and 30 years of knowledge



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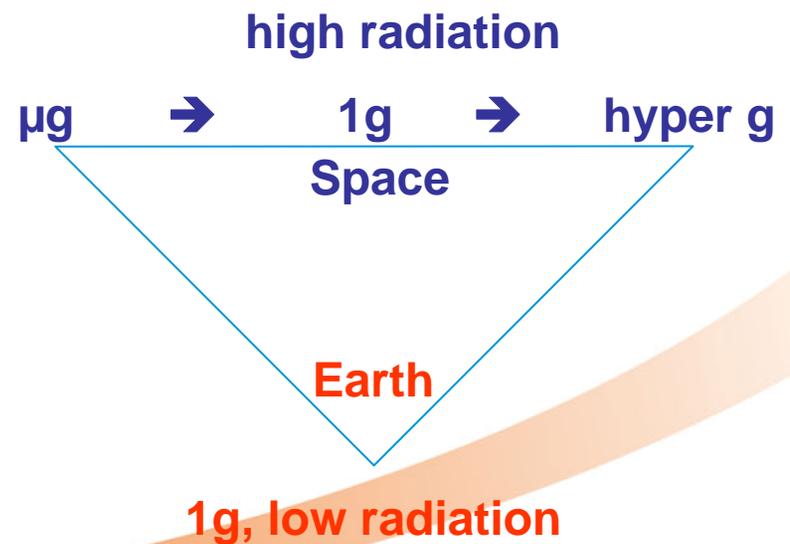
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Partnership: **ASTRIUM** & **NANORACKS** AN EADS COMPANY

Why a Centrifuge?

- To differentiate between radiation and gravity effects
- To perform:
 - Gravity threshold experiments
 - Gravity dose experiments
 - 1xg reference experiments



Partnership: **ASTRIUM** & **NANORACKS** AN EADS COMPANY

... combine the advantages of both:

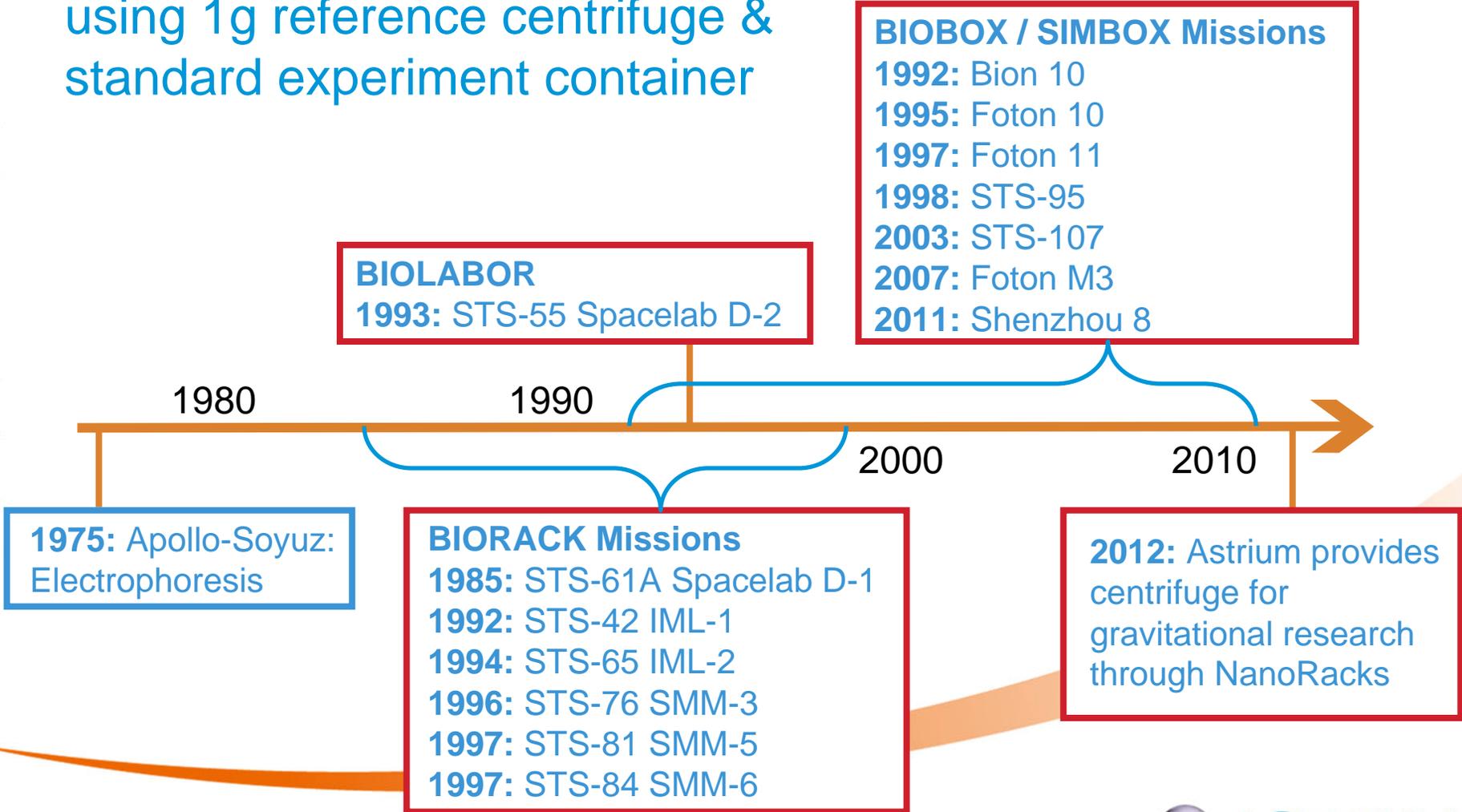
- Shortend payload integration schedule and cost efficient access via NanoRacks
- Access to artificial gravity centrifuge by use of Astrium's Biorack Type-1 EC form-factor
- Access to large portfolio of already existing experiment hardware
- Compatibility to other ISS- & non-ISS facilities

The Astrium Advantage

- 30 Years of Space Research Experiences
 - Experience in Microgravity Payloads in all disciplines
 - Experienced Experts / Payload Team
- Large Inventory of Flight Proven Experiment Designs

The Astrium Advantage – 30 Years of Space Research Experience, using 1g reference centrifuge & standard experiment container

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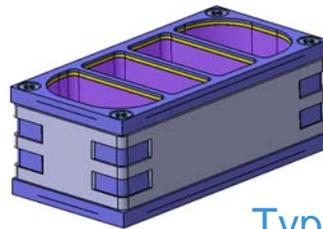
The Astrium Advantage – Inventory

The BIORACK experiment standard is continued until today.

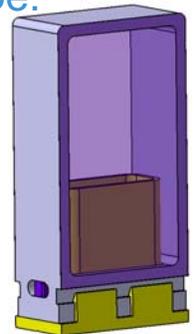
It delivered since 1985 the impressive record of:
more than 25 Missions with
>130 experiments and
>300 publications in peer reviewed journal.

130 Experiments produced a huge variety of **flight proven experiment designs**, which are available to the scientific community.

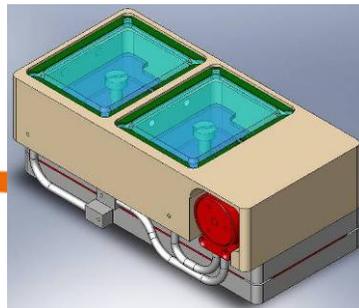
Type: Mini-Auaria
(for Nematodes, Drosophila,
Algae, Mikro-organism)



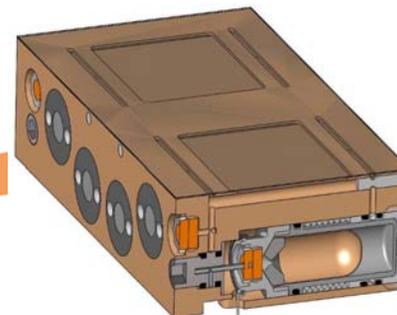
Plant Cultivation Type:
(for Rice and Arabidopsis)



Type: Cell cultivation/fixation
(for plant Calli, human Cells)



Type: Plunger box:
(for human Cells)



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The Astrium Advantage

– Inventory of automated experiments for Shenzou 8 –



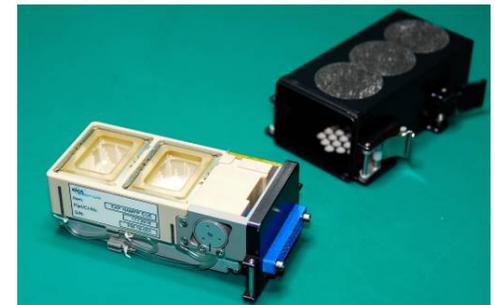
Aquarium – “Biotope”



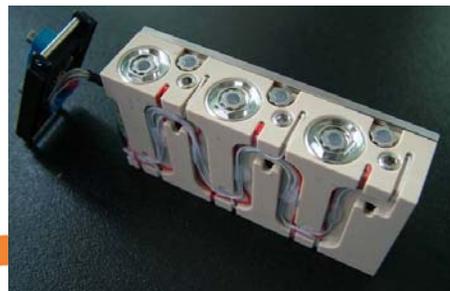
Plant Cultivation



Type V –
Cell cultivation/fixation



Mini-Aquarium (8 chambers)



Plunger Unit –
Human Cell Cultures



Type IV – Cell Cultures

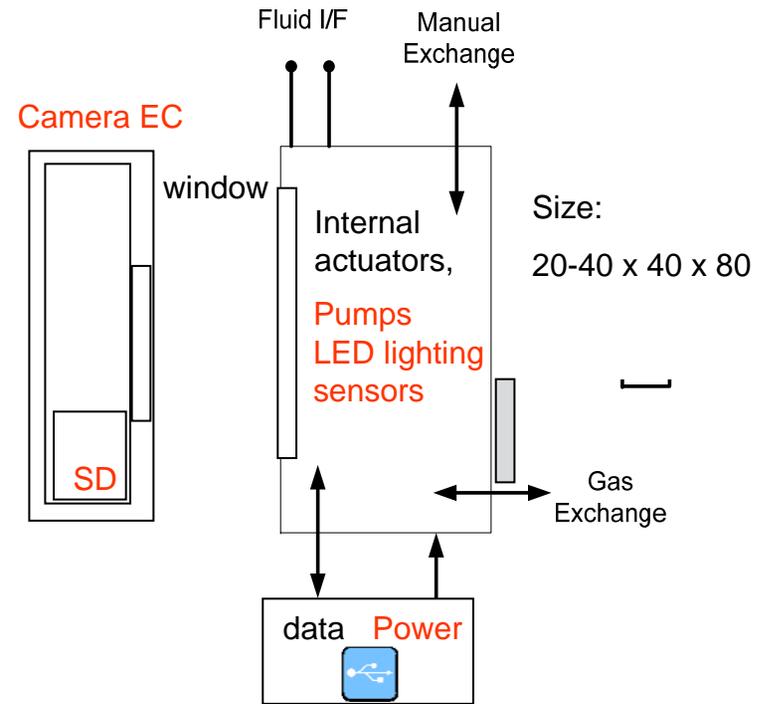
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The Astrium Advantage

– General Functionalities –



- EC Interfaces and capabilities were continuously upgraded during 130 experiments.
- SIMBOX for Shenzhou now offers continuous power for internal LEDs and pumps. An EC based camera could provide video observation



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The Astrium Advantage – Experience

The key for the success of the Astrium Friedrichshafen team is the excellence to understand the scientific objectives & to translate them into technical and operational requirements



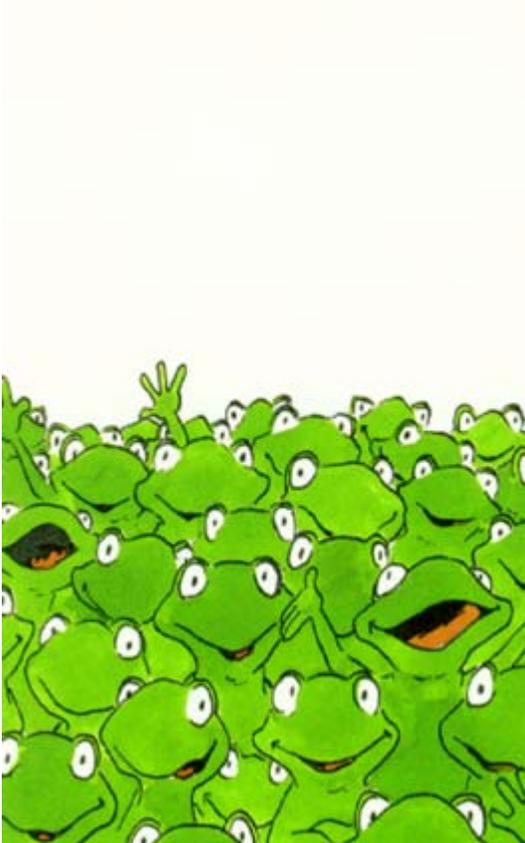
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The Astrium Advantage – The Payload Team



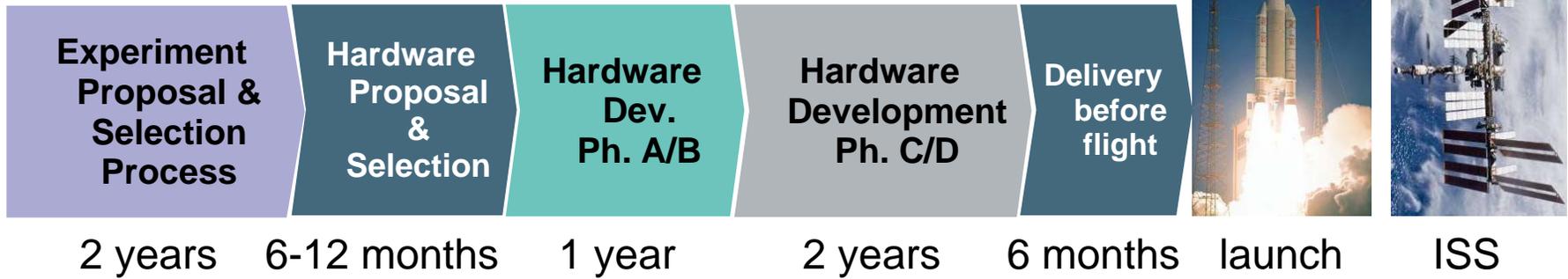
- More than 100 people of multiple qualifications (science & engineering) are working in integrated teams
- Long-term continuity in staff
- **Education:** Biology, chemistry, physics, engineers for mechanics, aeronautics, electronics, S/W & biomedicine
- Key focus on the interface of science to the experiment hardware
- **Experience:** Requirement Extraction, payload development, experiment support, mission support, -preparation, -training, -integration, logistics, scenarios, test & verification
- **Cooperation** with scientists, universities, small companies

New User Advantages

- Your opportunity to start own activities in microgravity science education and research – affordable and fast:
 - Cost Advantage:
 - **Access** to Astrium expertise
 - **Access** to large inventory of test designs from previous space missions (> 130)
 - Time Advantage:

The New User Advantage: Time

- Science-oriented Approach:**
 typical for peer-reviewed experiments



up to several years from AO to execution

- Product-oriented Approach:**
 typical for commercial & educational experiments

Contract with NanoRacks



10 months
0,8 - 1 year



launch → ISS

Key Message

- Microgravity research today is considered as an exotic tool



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Thank You for Your Attention !

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Courtesy NASA

