

# Anlagen zur Schwereelosigkeitsforschung in FN

Raumfahrt und Technologie Projekte

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DLR - Raumfahrt-Industrietage in Friedrichshafen  
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All the space you need



# ASTRIUM Microgravity Payloads

Development & operation of experiment facilities for space research

## Life Sciences

- biology
- human physiology
- Biotechnology
- protein crystallization

## Physical Sciences

- materials science
- fluid physics
- fundamental physics

## Lab Support Equipment

- Freezer/Cooler
- Microgravity Sciences Glovebox



Mainly on ISS but also

- Sounding rockets
- Parabolic flights
- Reentry vehicles

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# Activities in Payload Projects

## Studies & Breadboarding

to get first hand experience of science and feasibility



## Facility Development & Construction

to meet the scientific and space requirements for demanding research

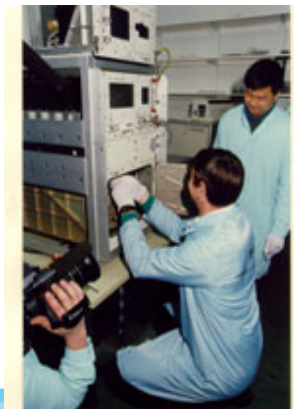


## Experiment samples & containments



fitting perfectly with the related facility

## Crew Training



theoretical and hands-on training for astronauts

## Operations



## Refurbishment, Spares, Sust. Engin.



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# Procurement-Strategie von TO5 “Energy, Life Support & Payloads” bei *RF-Projekten*

- Astrium (Anteil typisch 40%)
  - Prime, System Engineering, System-AIT
- Space KMUs
  - Subsysteme
- Technologie KMUs
  - Space-Modifikationen vom kommerziellen Komponenten
- Auswahl der Partner nach Erfahrung, Geo-return und industriepolitischen Vorgaben



# Procurement-Strategie von TO5 “Energy, Life Support & Payloads” bei *Technologie-Projekten*

- Astrium (Anteil ca. 40%)
  - Prime, Anwendungsanalyse, System Engineering, System-AIT
- Technologie KMUs (Anteil ca. 40%)
  - Verifikation und Anpassung von Komponenten mit spezifischen neuen Anlagen- & Experiment-Technologien
  - Aufbau der Demonstratormodelle
  - Design & MAIT für Subsysteme
  - Mechanik, Optik, Steuerung, S/W
- Universitäten und Auftragsforschungspartner (Anteil ca. 20%)
  - State-of-the-art Technologien
  - Machbarkeitstests
- Auswahl der Partner ausschließlich nach technologischer Expertise

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# External Payload

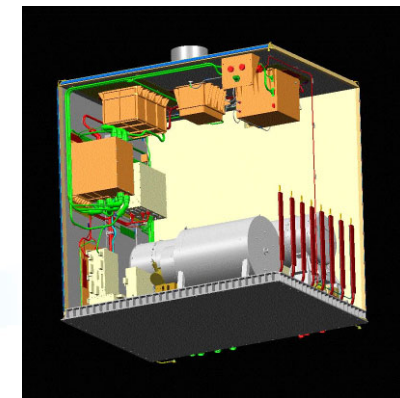
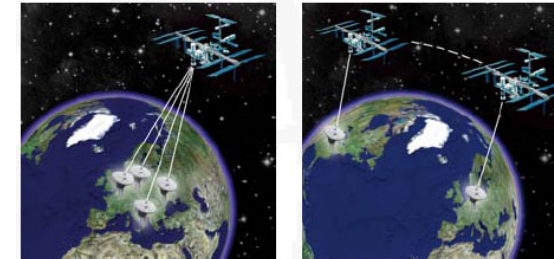
## ACES - Atomic Clocks Ensemble in Spaces

### Scientific Objectives

- Clock comparison experiments between space and ground atomic clocks
- Fundamental physics tests with unprecedented accuracy (e.g. test of Einstein's theory of relativity),
- Applications in time and frequency metrology, geodesy, global positioning and navigation.

### Configuration

- PHARAO, a cesium atomic clock, developed and provided by CNES
- Space Hydrogen Maser, SHM, provided by Switzerland
- Microwave Link (MWL)
- Frequency Comparison Device (FCDP)
- GNSS Receiver



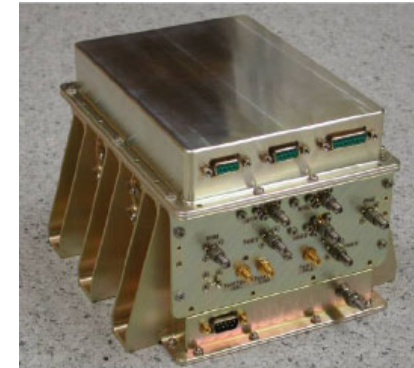
# Atomic Clocks Ensemble in Spaces, ACES

## Development Status

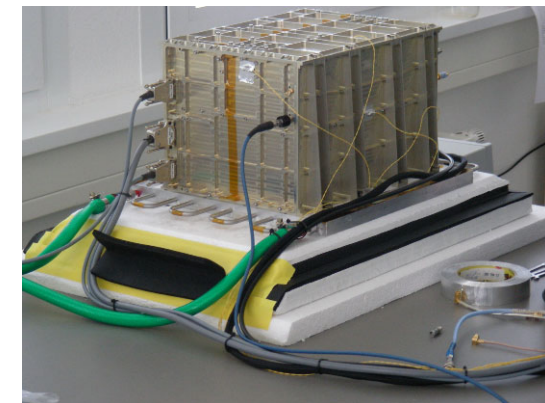
- ACES is in EM Phase
- MWL and FCDP EMs available
- MAIT of first MWL GT in progress
- EM System Test with EM PHARAO and EM SHM in preparation
- Payload CDR in preparation
- Ground Segment PDR in preparation

## Programmatic Status

- Funding for ACES FM Phase available, launch in 2013



**FCDP EM**



**MWL EM**



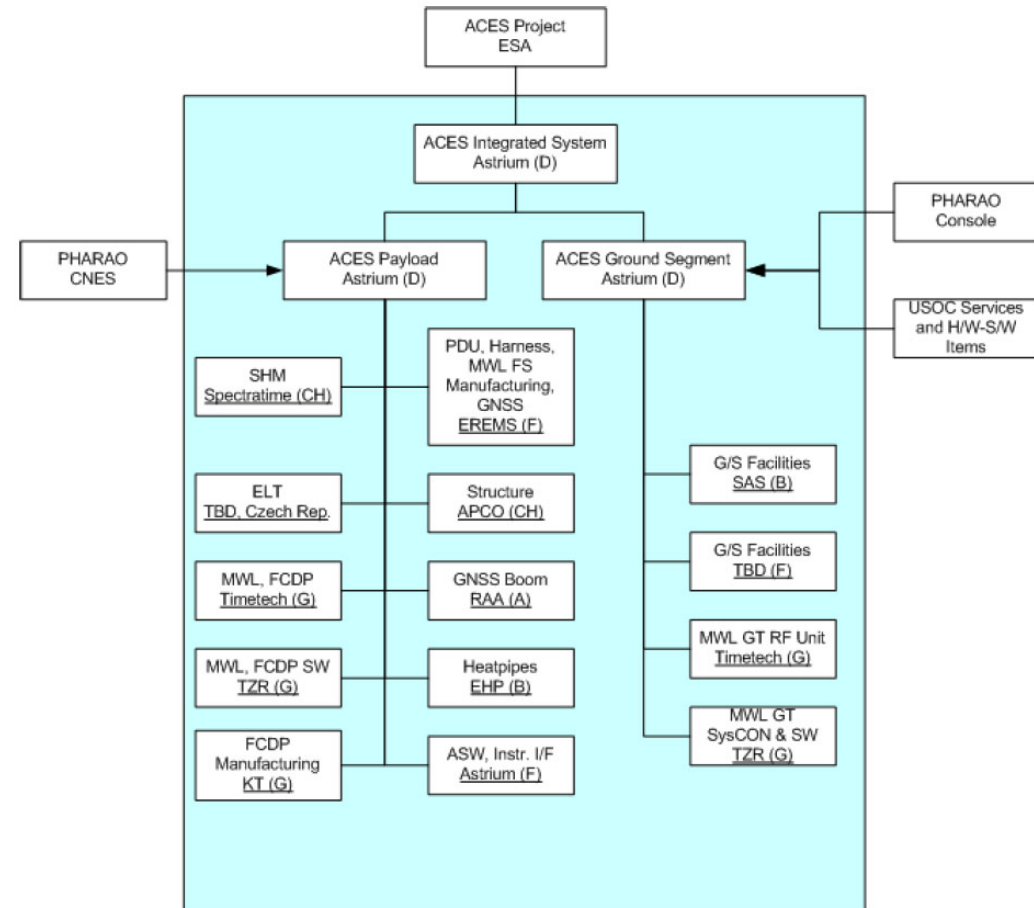
**MWL Ground  
Terminal**

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# Atomic Clocks Ensemble in Spaces, ACES

## Teaming

- Astrium is prime contractor for the payload and ground segment development
- Several Astrium sites are involved
  - Friedrichshafen
  - Bremen
  - Ottobrunn
  - Toulouse
  - Bordeaux
- A large team of subcontractors and suppliers is supporting the development, in Germany
  - Timetech, Stuttgart
  - TZR, Stuttgart
  - Kayser-Threde, Munich
  - Astyx, Munich



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# Fluid Science Experiment Container Cimex

## Convection and Interfacial Mass Exchange (CIMEX)

- Dr. P. Colinet, Dr. O. Kapov University Brussels (coordinators);
- Team: Prof. J. Thome, EPFL; Prof. J. Ward, Univ. Toronto;

## Science Objectives:

- CIMEX is addressing the mass transfer process through interfaces and their coupling with surface-tension driven flows and instabilities that affect mass and energy transfer

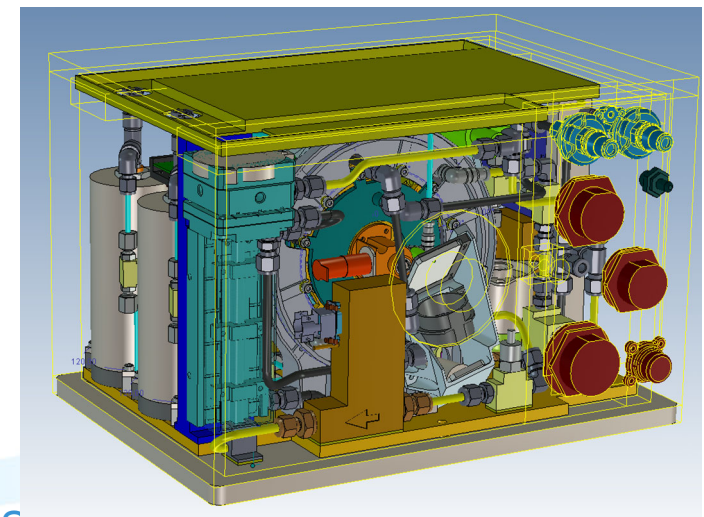
## Key Technical Features

- Variable flow rates, pressures, vapor concentrations of pure ethanol, ethanol-water mixtures in nitrogen.
- Optics inside EC (Tomography for experiment cell, IR Schlieren for evaporating surface control)

## Programmatic status:

- Phase C/D (December 2007 – December 2010)
- PDR Finished: July 2008
- CDR Finished: July 2009
- Launch: tbd - 2011

**Teaming:** Astrium (D), Verhart (B), BLU (I), HFT (I), MARS (I)



# Physical Science - Electromagnetic Levitation

## EML-EDR on ISS

### Science Objectives

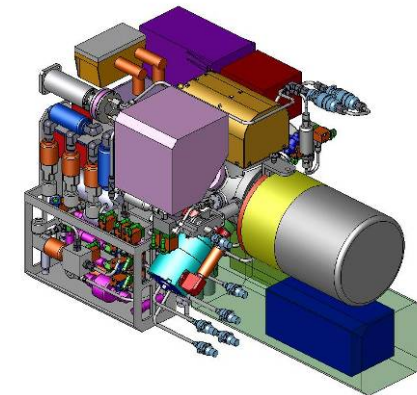
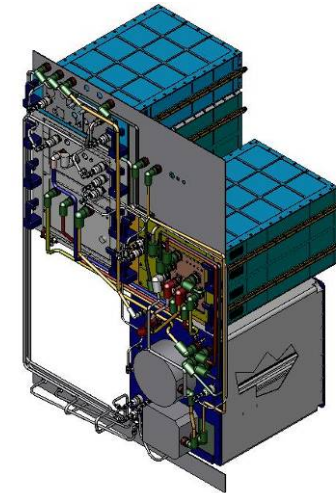
- Solidification experiments on undercooled materials and thermophysical properties measurements of liquid metals above and below the liquidus

### Key Technical Features

- Containerless processing
  - melting/solidification of metals and alloys ( $d=5-8\text{mm}$ )
  - processing temperatures:  $500\text{ }^{\circ}\text{C} \rightarrow 2200\text{ }^{\circ}\text{C}$
- Positioning and heating by electromagnetic levitation
- Ultra-high vacuum ( $< 5 \cdot 10^{-8}\text{ hPa}$ ) or gas atmosphere (99.9999%, 1-400 hPa)
- Diagnostics/stimuli
  - pyrometers: high resolution, high speed
  - video: precision and high-speed cameras (illumination at low sample temperatures)
  - nucleation trigger sensor, radiometer, quadrupole mass spectrometer, electrical coupling of sample to levitation fields, DC magnetic damping

### Status:

- MRR (Manufacturing Readiness Milestone) June 2009
- Launch in 2011



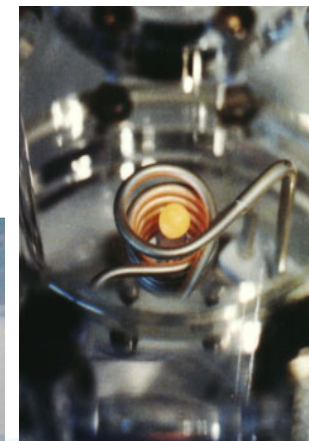
# Physical Science - Electromagnetic Levitation TEXUS-EML

## Objectives

- Measurement of thermo-physical properties of liquid metals and alloys, e.g. surface tension, viscosity, thermal expansion, specific heat, etc
- Application of results for better accuracy computer simulations of casting processes to shorten development times (car engines, turbine blades, medical implants, etc.)

## Status

- first successful flight in November 2005
- second flight part of TEXUS campaign in November 2007
- third flight planned in 2009



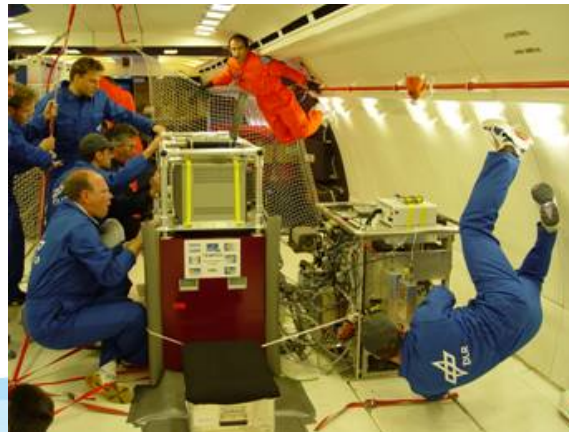
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# Physical Science: Electromagnetic Levitation Parabolic Flights

- **TEMPUS:**
  - Campaigns performed under DLR contract
  - Regular flights since 2001
  - At least one campaign per year from Bordeaux or Cologne
  - 13 campaigns, > 2000 parabolas

**Significant interest by non-space industry in electromagnetic experiments**



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# Life Science

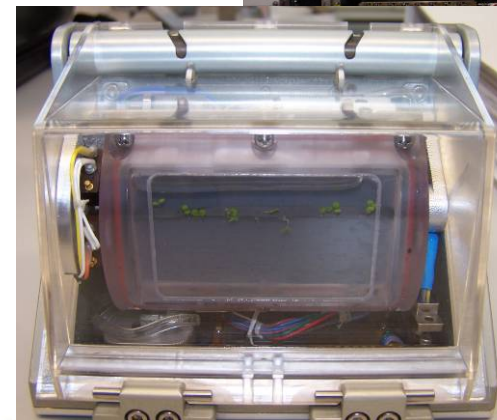
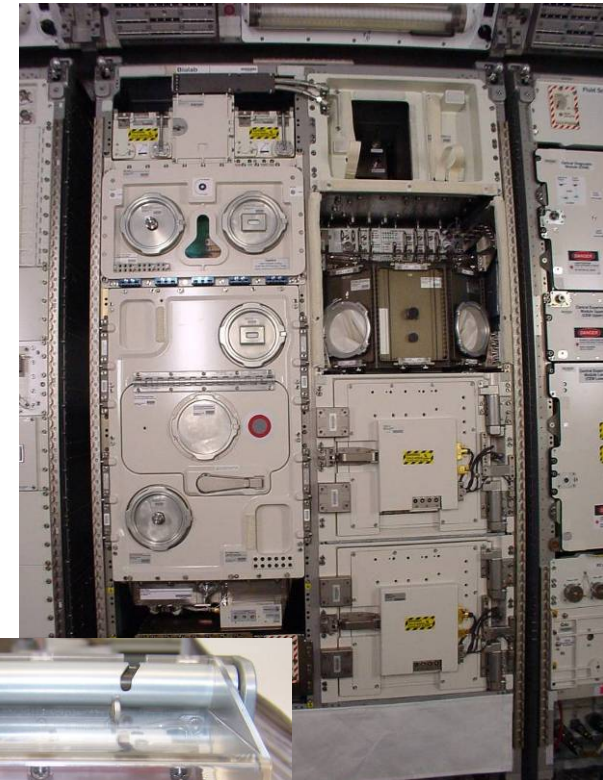
## Biology Experiments in BIOLAB

- **Science Objectives:**

Biological experiments in the field of cell cultures, micro organisms, small plants and invertebrates

- **Key Technical Features:**

- Based on Experiment containers
- Incubator, 18°-40°C with
  - 2 centrifuges, 10<sup>-3</sup> g to 2g
  - Automatic gas composition & control
- Automatic fluid handler
- Integrated freezer, cooler
- Integrated glovebox with sterilisation capability
- Integrated microscopy & spectroscopy



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# Life Science

## Biology Experiments in BIOLAB

### Development Status

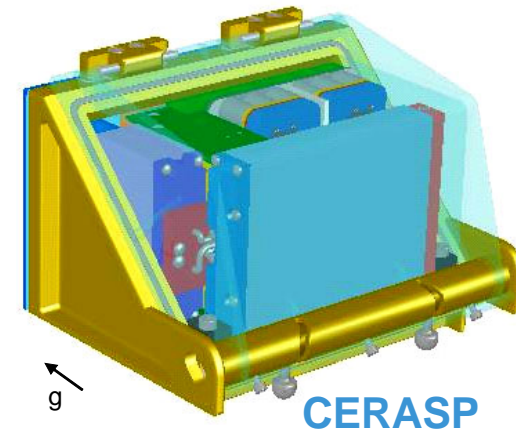
- Experiments WAICO completed in orbit
- Experiment TRIPLELUX delivery in 2009

### Programmatic Status

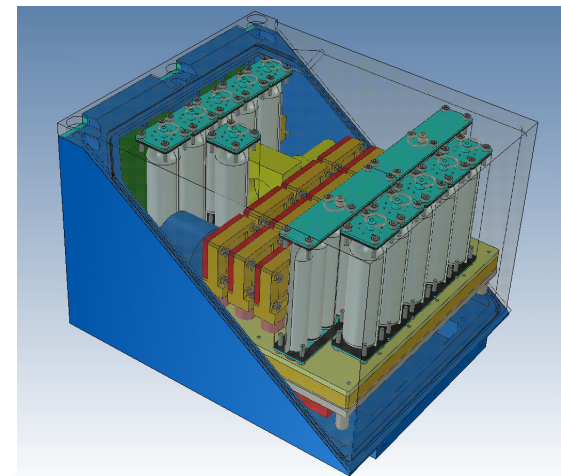
- ESA Contract for Experiments RHOCYT & CERASP expected in 2009

### Teaming

- VDD, B (RHOCYT)
- KI, I (RHOCYT & CERASP)
- DTM, I (RHOCYT & CERASP)
- ENSO, CH (RHOCYT)
- QSA, Karlsruhe (Strahlungsquelle CERASP)



RHOCYT



## Auszug der deutscher Unterauftragnehmer und Zulieferer (2007-2009)

Lieferant	Ort	Projekt
Kusch Feinwerktechnik	Bermatingen	Fertigung und Entwicklungsunterstützung
Freyer GmbH&Co.KG	Tuningen	Zerspanungstechnik
Ziegler GmbH	Bermatingen	Zerspanungstechnik
Dietrich	Meckenbeuren	Zerspanungstechnik
Pink GmbH	Wertheim	Fertigung und Entwicklungsunterstützung / Unterauftragnehmer
EnTech GmbH	Ravensburg	Fertigung und Entwicklungsunterstützung
Hermann Waldner GmbH&Co.KG	Wangen	Apparate und Gerätebau
Kern GmbH	Großmaiseid	Kunststofftechnik
Carl Kurt Walther GmbH&Co.KG	Haan/Düsseldorf	Schnellkupplungssysteme
Pfeiffer Vacuum GmbH	Asslar	Vakuumtechnik
BEST Fluidsysteme GmbH (Swakelog)	Reutlingen	Fluidsysteme
ASP GmbH	Salem	Fertigung und Entwicklungsleistungen, Elektronik / Unterauftragnehmer
W.L. Gore & Associates GmbH	Pleinfeld	Kabel und Kabelbaugruppen
OHB System	Bremeb	Unterauftragnehmer
Kayser Threde	München	Unterauftragnehmer
Astyx	München	Unterauftragnehmer
Timetech	Stuttgart	Unterauftragnehmer
TZR	Stuttgart	Unterauftragnehmer

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## Wir suchen generell Zulieferer oder Unterauftragnehmer im Bereich

- Fertigung und Entwicklungsunterstützung
- Prototypenbau
- Elektronikentwicklung und Fertigung
- PCB und Kabelbaumfertigung
- Fluidhandling
- Test und Dokumentation



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