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## SADCO Aerospace Applications of Control & Optimisation Workshop - Presentation of Astrium Space Transportation

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# SADCO Aerospace Applications of Control & Optimisation Workshop Paris, March 2nd 2011

## Presentation of Astrium Space Transportation

Gérald Pignié, CTO Office,

Head of the Technology Innovation Program

ASTRIUM Space Transportation, March 2<sup>nd</sup> 2011

All the space you need



# Astrium: part of EADS, a global leader in aerospace and defence

**EADS**



**Airbus  
Airbus Military**



**Eurocopter**



**Astrium**



**Cassidian**

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# Astrium at work



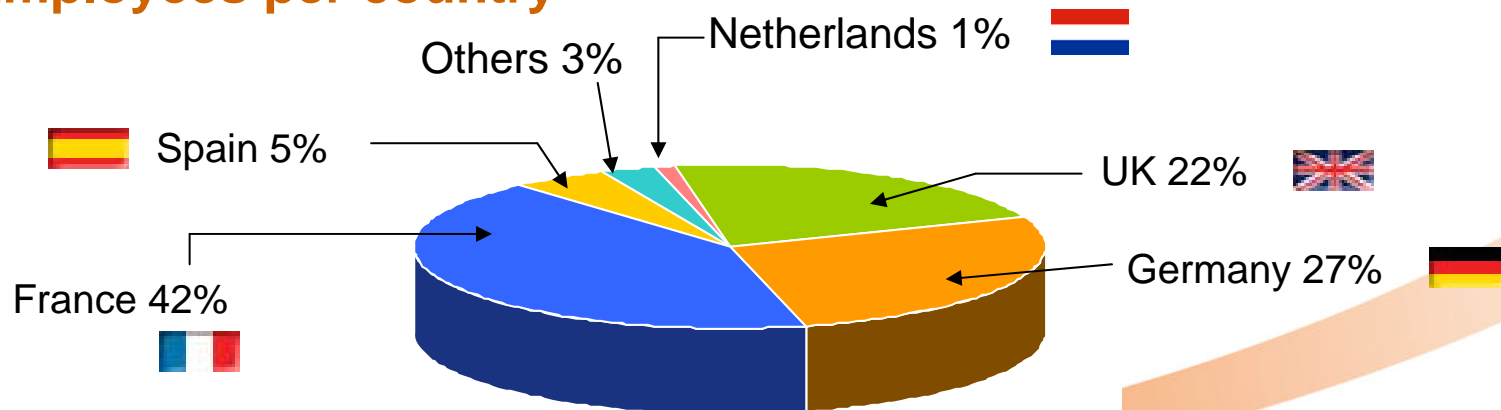
Astrium is a global space industry leader, with world-class expertise and extensive prime contractorship experience across all sectors of the space business

# Facts & Figures 2009

Employees: 15,000  
Sites: F, G, UK, S, NL  
Turnover: €4.8 billion  
Order backlog: €14.7 billion  
CEO: François Auque

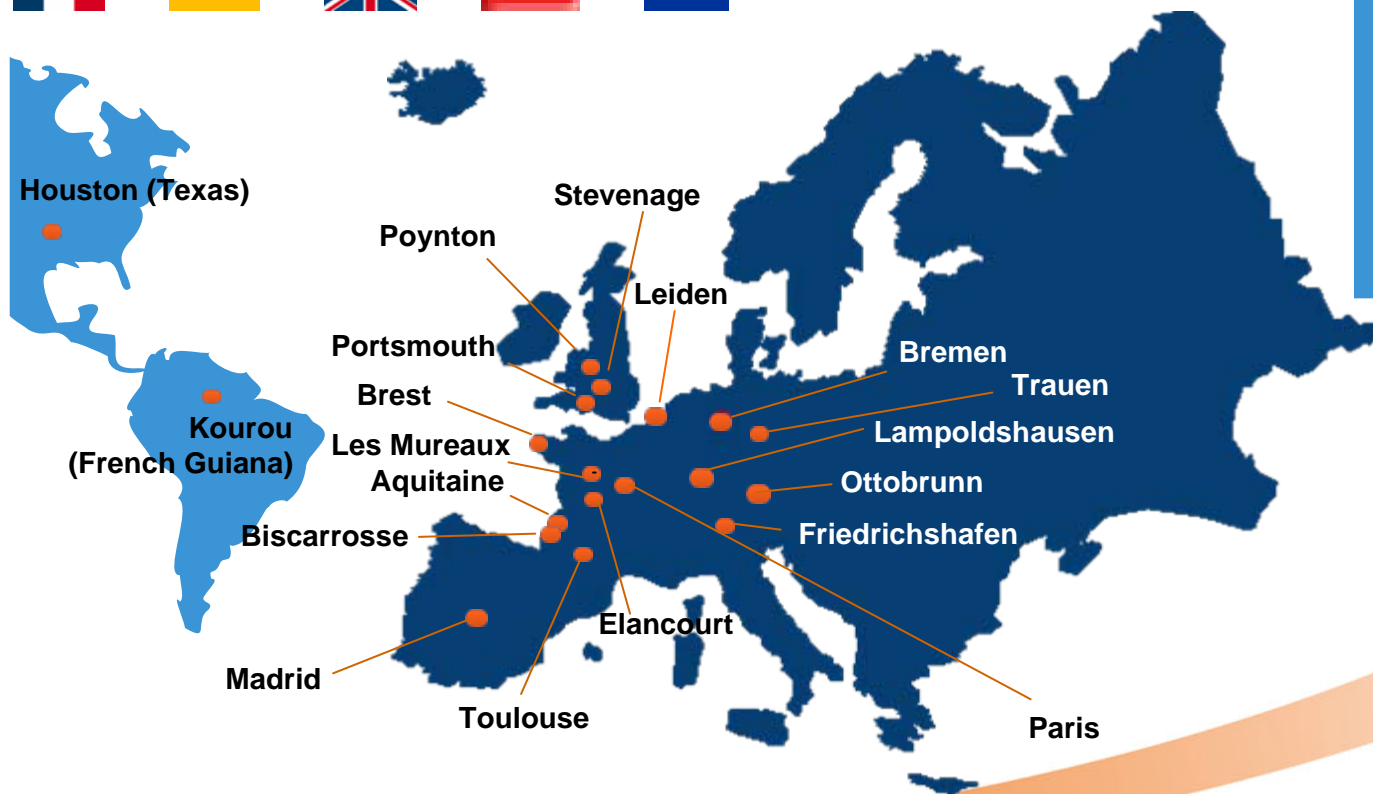


## Employees per country





# Astrium: the heritage and expertise of the leading European space nations



<b>Additional locations</b>	<b>France</b>
	Limeil-Brévannes (Sodern)
	<b>Germany</b>
	Backnang (Tesat)
	Potsdam (Infoterra)
	<b>UK</b>
	Colerne (Paradigm)
	Corsham (Paradigm)
	Farnborough (Infoterra)
	Guildford (SSTL)
Hawthorn (Paradigm)	
Leicester (Infoterra)	
Newcastle (Infoterra)	
Oakhanger (Paradigm)	
<b>Spain</b>	
Barcelona (Infoterra)	
<b>Saudi Arabia</b>	
Riyadh (GPT)	

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# Astrium's activities are based in three key areas

## 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

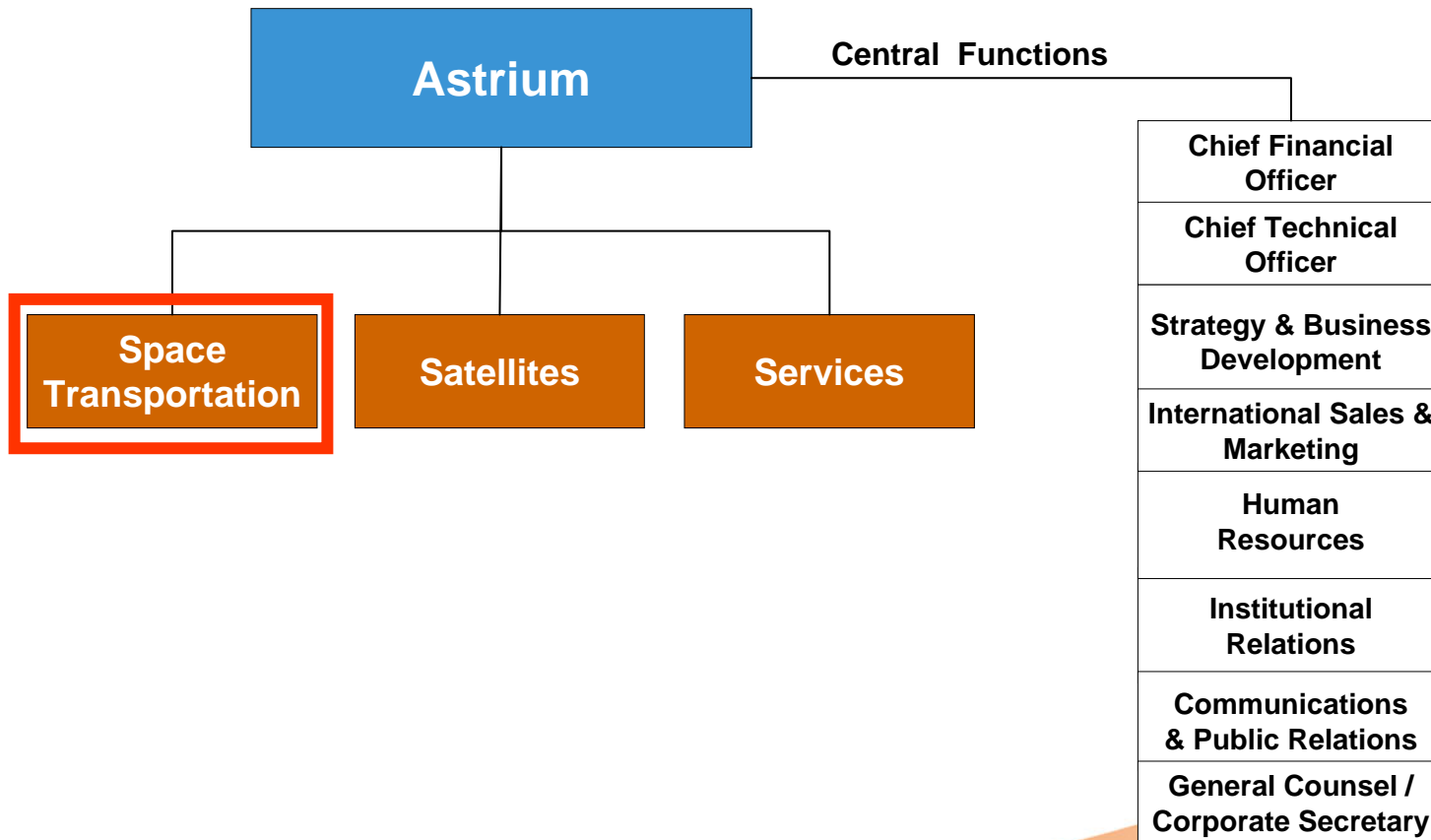


## Astrium Services

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



# Astrium: an integrated company





# Astrium Space Transportation

- The European prime contractor for space transportation, orbital infrastructure and manned space



CEO: Alain Charmeau

## Business Divisions:

- Launchers
- Defence
- Orbital System & Space Exploration
- Propulsion & Equipment

# Access to space

- Without launchers, no space activity would be possible

Astrium provides Europe with a full, flexible launch capability

- Ariane 5
- Soyuz
- Rockot



# A safer world

- Space systems have become key factors in defence and security systems. Astrium provides Space Defence systems, technologies and services.

ASTRIUM ST works on :

- Ballistic Missiles
- Future Space Defence Systems
  - Ballistic Missile Defence
  - Space Police
  - Space debris removal



# Man in space

- The International Space Station (ISS) is an uplifting example of international co-operation and ambition not only for advances in space technology and engineering, but also for all kinds of scientific research

Astrium is leading the European contribution to this project and was selected by ESA as prime contractor for major elements

- Columbus laboratory
- Automated Transfer Vehicle ATV
- Operation & utilisation

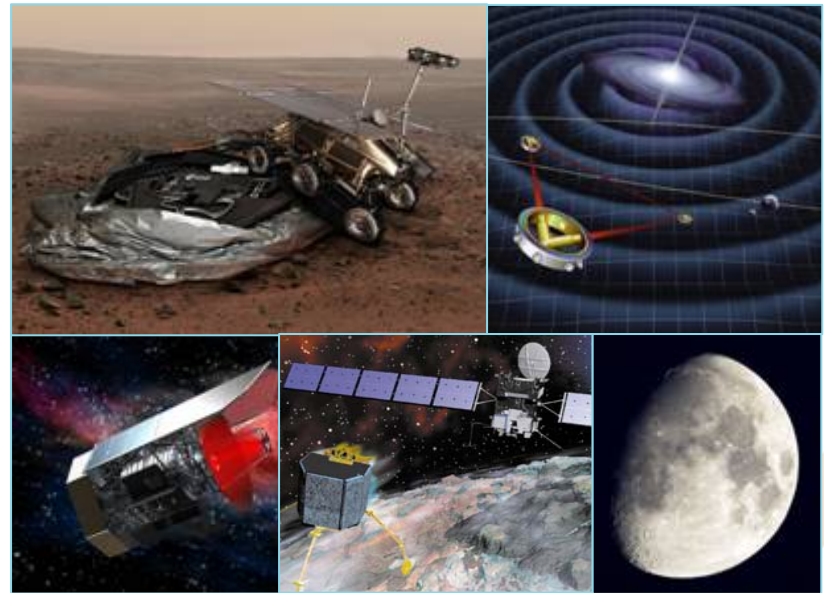


# Exploring the Universe

- From his earliest days, Man has been fascinated by the stars above

Astrium's technology enables us to explore the solar system and the secrets of the Universe

- Earth & Sun
- Planetary missions
- The wider Universe





# Home funded R&T/D Program at ASTRIUM-ST

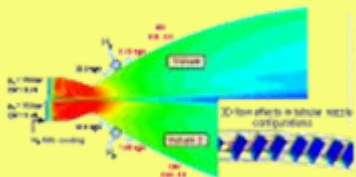
- The yearly home funded ASTRIUM-ST R&T/D Program gets a budget higher than 40 millions €, shared between France and Germany
- It is organised around five major flagship pluri-annual projects, so called the “Top Five”, receiving the biggest budgets, and several smaller projects (also plurianual), called “STEP”.
- The time frame for projects is typically 3 to 5 years.



# Top 5 Priority 2011-2014

## TEKAN/TARES

Keep leading position on  
Cryogenic Combustion Chambers



OTN

## HOMER

Developing Landing Technologies



BRE

LAM

OTN

TN

MU

AQ

## SPACE DEBRIS & ROBOTICS

Customer needs assessment  
and key technologies development



MU

BRE

## SELF

Shaping the European  
Launcher Future



MU

OTN

BRE

AQ

## SPACE POLICE

Space situational awareness  
& control



MU

BRE

AQ

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## Set of R&T/D STEP Projects

<b>AITS</b>
<b>Antenna Reflectors &amp; Satellite Structures &amp; Inflatable</b>
<b>Propulsion Energy Optimisation Management</b>
<b>Complex System Architecture / Picsar (incl. ATM ITB)</b>
<b>Dispensers</b>
<b>High Pressure Tanks</b>
<b>Human spaceflight avionics evolution</b>
<b>Infrastructures Safety</b>
<b>ISS Evolution</b>
<b>Metallic Structures Technologies</b>
<b>Missile Defence</b>
<b>New Generation Launcher</b>
<b>NEO deflection</b>
<b>Planetary Exploration Technologies</b>
<b>Propulsion Technologies</b>
<b>Pyrotechnic Systems</b>
<b>Re-entry Technologies</b>
<b>Robustness &amp; Margin Knowledge</b>
<b>Software Engineering</b>
<b>Space Electric &amp; Electronic Engineering</b>
<b>Special France Projects / Deterrence</b>
<b>Test, Control, Metrology</b>
<b>Thermoplastic Technologies</b>
<b>Upper stage</b>
<b>Virtual Products &amp; System Engineering</b>

# Partnerships with Universities & Labs

- To support Technology & Engineering Innovation, ASTRIUM ST has set up a large network of scientific partners, from the academic community, in many scientific domains.
- This network is flexible, and our will is to extend it, according to the evolution of our needs.

## Research & Partnerships in Mathematics

- In the domain of mathematics, we have already some partnerships, covering at least partly the topics presented in the following pages
- We are actively working on these topics as they are key for most of our major future programmes
- For some very innovative topics we are using the support of EADS Innovation Works research centre (IW)

# Brief overview of our needs in Mathematics (1)

- **Modelling & Simulation in Physics / Multi-physics:**
  - Large scale structures modelling
  - Fluids/structures interactions
  - Acoustics (acoustic at lift off, launchers blast wave modelling, ...)
  - Fluid mechanics (Aerothermodynamics of complex shapes, hot hypersonic flows, for Earth and planets entry/re-entry, unstationary flows modelling : buffeting, in transsonic regime, ...)
  - Thermal Modelling & Thermal Control of various spacecrafts (cryogenic propelled launchers, orbital S/C, re-entry vehicles, ...)
  - Electromagnetism Modelling in a very wide band of frequencies (for Antenna Design, Radar Cross Section Assessment, Electromagnetic Compatibility (EMC), hardening to Lightning, ...)
  - Transient phases modelling: stages separations, jettisoning of fairings and payloads, ...)
  - Fast dynamics (impact of debris on space structures, ....)

# Brief overview of our needs in Mathematics (2)

## ■ Stochastic Modelling

- Participation to the development of a common collaborative platform on uncertainties management: OPENTURNS: probabilistic and statistic toolbox (EADS, PHIMECA). Uncertainties management mastery is key for a Platform Integrator !
- New methods for enhanced stochastic simulation (Stratified Monte-Carlo, surfaces of response, particular approximation, sensitivity indices based methods, ...): How to get more confidence with smaller data drawings ?
- Modelling for quantitative methods in Reliability, Availability, Maintainability and Safety (RAMS)

## ■ Signal & Image Processing

- Images & Data fusion for space mission: hazard assessment and hazards/obstacle avoidance
- Discrimination of objects, for applications in defence, security, ...

# Brief overview of our needs in Mathematics (3)

- **Navigation, Guidance, Control & Missions Analysis**
  - Optimisation methods (functional & parametric methods)
  - New filtering methods for navigation (particular filtering)
  - New guidance methods (differential games, neural networks, tuning of guidance laws using genetic algorithms...)
  - **Systems & Control Theory: Robust control methods ( $H_\infty$ ,  $\mu$ -synthesis, LMI, LPV, robustness analysis: sum of square, IQC, optimisation methods for analysis & control synthesis...), Non-linear control (dynamic inversion, hybrid control, ... )**
  - Convex analysis for actuators selection
- **Computer Science & System Engineering**
  - Formal semantics of modelling & programming languages
  - Analysis & formal proof of Software (static analysis - abstract interpretation, model checking, and theorem proving)
  - Model Based System & Software Engineering



# Questions & Answers

Any questions?

We would be happy to answer them!

More details are available on: [www.astrium.eads.net](http://www.astrium.eads.net)

You may also contact directly :  
[gerald.pignie@astrium.eads.net](mailto:gerald.pignie@astrium.eads.net)