ISAE general presentation

Frédéric Thivet, Scientific VP

www.isae.fr
In Toulouse
France – Europe

In the heart of the Aerospace Campus
Toulouse, a major international complex for aeronautics and space

- **Toulouse**
  850,000 inhabitants

- **Aerospace Valley world-class industry cluster**

- **The main European Pole for Aeronautics and Space**

  - **Aeronautics**: AIRBUS, EADS, ATR, SAFRAN, THALES, Liebherr Aerospace, Rockwell Collins, Latécoère, Air France
    - Manpower: 53,000 - including 5,000 researchers
    - Leading European centre for civil aviation industry

  - **Space**: ASTRIUM, THALES ALENIA SPACE, CNES
    - Manpower: 12,000 (25% of the European manpower)
    - Leading European centre for satellites industry and earth observation
6 founding members (2007)

- INP Toulouse
- INSA Toulouse
- ISAE
- UT1 Capitole (Economy, Law, Mgmt)
- UT2 Le Mirail (Arts, Languages, Social Sci.)
- UT3 Paul Sabatier (Sciences & Med.)

Goals

- Research To promote regional research
- Ph.D To coordinate Ph.D. Programs and theses delivery
- Attractivity To enhance international visibility and attractivity
- Projects To develop societal and multi-disciplinary projects
- Insertion To enhance professional insertion of graduates
- Services To gather service activities to the benefits of students
- Opening To associate all regional higher education and research establishments

Key figures

- Students 94,000
  - Bachelor 40,000
  - Master 27,500
  - Ph.D. 4,000
  - Other pgms 22,500
- Ph.D. Programs 15
- Laboratories 172
- PhDs defended per year 781
- Professors 6,520
- Permanent staff 6,113

April 26, 2012
• 1909 creation of Ecole supérieure d’aéronautique et de constructions mécaniques by colonel Jean-Baptiste Roche
  • 1930 becomes Ecole nationale supérieure d’aéronautique (SUPAERO)
  • 1968 moves to Toulouse
  • 1972 becomes Ecole Nationale Supérieure de l'Aéronautique et de l'Espace

• 1945 creation of Ecole nationale des travaux aéronautiques (ENTA)
  • 1957 becomes Ecole nationale d'ingénieurs des constructions aéronautiques (ENICA)
  • 1961 moves to Toulouse
  • 1979 becomes Ecole Nationale Supérieure des Ingénieurs des Constructions Aéronautiques (ENSICA)

• 2007 SUPAERO and ENSICA become ISAE
  ISAE is a founding member of Université de Toulouse

• 2009 SUPAERO is 100 years old
### Staff - Budget
- Staff: 440
- Budget: 60 M€

### Students
- 1500 incl. 26% from abroad
- SUP & N6K grad. pgms: 1000
- MSc and Advanced Masters: 300
- Ph.D: 200

### Lecturers
- 2000
- +36 000 h/an

### Network
- 17 000 alumni

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April 26, 2012
The French & European Academic System

High School Diploma (Baccalauréat) → National Competitive Exam → Bachelor's Degree → Master's Degree → PhD

- Preparatory Courses
- Bachelor's
- Master's
- PhD

- SUPAERO Graduate Program
- ENSICA Graduate Program
- MS Programs
- Post-Graduate Programs
ISAE Graduate and Post-Graduate Programs

- **2 Engineer Graduate pgms (3 yrs)**
  - SUPAERO Graduate Program
  - ENSICA Graduate Program

- **3 Masters of Science (2 yrs after a BSc)**
  - Aerospace Mechanics and Avionics (AMA)
  - Aeronautical and Space Systems (AESS)
  - Global Navigation Satellite System (GNSS)

- **18 Advanced Masters (1 yr postgraduate)**
  - 14 in Toulouse – 10 taught in English
  - 1 with HEC, in Toulouse & Paris
  - 3 with CAUC, in Tianjin – PR China

- **Continuing Education**

- **5 Research Masters**  
  in addition w/ SUPAERO or ENSICA graduate programs
  - Fluid Dynamics, Energetics and Transfers
  - Mechanical Engineering
  - Astrophysics, Space Sciences, Planetology
  - Fundamental and Applied Mathematics
  - Computer Science and Telecommunications

- **6 PhD Programs**
  - Mechanics, Energetics, Civil Eng’g, Processes
  - Electrical Engineering, Telecoms
  - Universe, Space and Environment Sciences
  - Mathematics, Computer Sc., Telecoms
  - Systems
  - Aeronautics and Astronautics
A comprehensive set of Advanced Masters

- Project Management
- Aerospace project management
- Finance Engineering and Models
- Aeronautical Maintenance & Support
- Aerospace Systems Propulsion
- Experimental Flight Test Engineering
- Embedded-Systems
- Aviation Safety Aircraft Airworthiness
- Systems Engineering
- Aeronautical & Space Structures
- Aerospace Electronics & Telecommunications
- Helicopter Engineering
- Aeronautical Systems
- Space Communication Systems
- Space Systems Engineering
- English
- French
• SUPAERO graduate Program, in 3 specialization semesters
  • Telecom & Navigation
  • Signal & Image (esp. GIS & DEM)
  • Computer-based Systems

• MSc Aeronautical and Space Systems
  • Space Application Stream:
    • Earth Observation
    • Space Telecom
    • Space navigation

• MSc Global Navigation Satellite System

• Advanced Master: Space Communication Systems
Training and Research Demonstration Projects

- **Micro Air Vehicles**
  - IMAV Conference and Flight Competitions

- **Micro Transat Challenge**
  - ISAE i-Boat prototype
  - Micro-transat: world record in 2010 (still holding): 108 km of autonomous navigation on sea

- **Perseus**
  - ISAE – ONERA cooperation
  - 2011 CNES C’Space micro-launchers: a world 2\textsuperscript{nd} hybrid propulsion demonstration

- **CanSat**
  - ISAE – University of Samara cooperation
  - a 2012-2014 project

- **QB50**
  - an international network of 50 CubeSats for multi-point, in-situ measurements in the lower thermosphere and re-entry research
  - ISAE – ONERA cooperation, CNES Support, VKI Call
Identity profile

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> MSc and Advanced Masters: 300
> Ph.D : 200

Training Programs
> SUPAERO graduate program
> ENSICA graduate program
> 3 Masters of Science
> 18 Advanced Masters
> 5 Research Masters
> 6 Ph.D programs

In Europe, 25% of M degrees in AE are delivered by ISAE

Network
> 17 000 alumni

Lecturers
> 2000
> +36 000 h/an
ISAE research policy and skills

Frédéric Thivet, Scientific VP

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ISAE Research

Key figures 2011
- 175 scientific and technical staff
- 240 Ph.Ds and post-docs
- +10% / yr from 2007 to 2011:
  - Profs and Researchers + 15% 126
  - Rank A publis /fac./yr + 44% 1.1
  - HDR + 27% 52
  - PhD + 78% 213
  - Turnover + 57% 24.6 M€
  - Patents + 100% 9

Research Policy
- A strong link between Training and Research
- An internat. training centre for masters and Ph.D
- A good balance between academic production and technological innovations
- Aeronautics, Space, Embedded Systems and connex systems

Local Networks
- Univ. of Toulouse
- Aerospace Valley
- STAE Ntwk of excel.
- AA PhD program

Long-term Partnerships
- Strategic Partnership
- Communication Networks
- Mechanical Engineering
- Telecoms for Space and Aeronautics

Industry Chairs
- CRISTAL ASTRIUM-ISAE - space imagers
- SAFRAN ISAE HEC – innovation management
Staff: 17
- 2 Faculty
- 4 PhD students
- 5 engineers and technical staff
- 3 pilots, 3 aircraft mechanics

Laboratory resources
- Satellite simulator
- Satellite ground station network (coop. with MIT)
- Aerospace systems design & modeling tools
- Full flight simulator: generic, fully configurable, airliner FFS

Flying assets
- 9 light training aircraft
- 1 advanced instrumented TB20 aircraft
Institut Supérieur de l’Aéronautique et de l’Espace

DAEP
Aerodynamics, Energetics and Propulsion
Head: Prof. Laurent Joly, laurent.joly@isae.fr

Staff: 44
- 17 Faculty
- 10 PhD students
- 17 Technical staff

Laboratory resources
- Hot-wire anemometers
- Laser Doppler Velocimetry
- Particle image
- Variable Pressure/Temperature

Research Themes
- Turbulence and modelling
- Turbomachines and propulsion
- Advanced aerodynamics and flow control
- Aeropropulsion of micro-air vehicles

Specific facilities
- S4 large wind tunnel
- SABRE low-Re wind tunnel
- Jet engine test bench
- Compressor test bench
- Turbochargers test bench

Partnerships
- ONERA
- Airbus, Safran, Dassault Aviation
- Liebherr Aerospace, Honeywell Garrett
Staff: 53
- 14 Faculty (+10 visiting)
- 18 PhD students
- 19 Technical staff

Production and study resources
- Workshop, CAD/CAM
- Metrology (3D, surfaces)

Laboratory resources
- Static mech testing and fatigue from 3 to 30t
- Dynamics: Hopkinson bars, low-energy impact, gun
- Physico-chemical characterisation of materials
- Workshop for composites
- NDT, microscopy (SEM, ESEM)

Specific facilities
- Modular frames for structures testing
- Drop tower
- Climatic chambers

Research Themes
- Damage to composite materials in aerospace st.
- Fatigue of metallic materials and structures
- Dynamics: Vibrations Dissipation and Structural Control
- Advanced numerical methods for mechanics

Partnerships
- CNES, ONERA
- Airbus, EADS IW, Latécoère, Eurocopter
DMIA
Mathematics, Computer Science and Control Design
Head: Prof. Patrick Sénac, patrick.senac@isae.fr

Staff: 70
- 26 Faculty
- 29 PhD students
- 15 Technical staff

Laboratory resources
- Computing cluster
- Cooperative robotics
- Network emulator
- Control and command of systems

MARS team
Systems Modelling and Architecture
- Mathematical modelling, simulation, operation management
- Critical Systems Engineering
- Communication networks

Partnerships
- ONERA, LAAS-CNRS
- TeSA: CNES, Thales Alenia Space
- Ratier-Figeac

ADIS team
Control, Dynamics and Interface of Systems
- System engineering, modelling & control
- Aircraft design
- Human factors
Staff: 53
- 22 Faculty
- 21 PhD students
- 10 Technical staff

Laboratory resources
- Advanced electronic and optical instrumentation
- Faraday cages
- Laser sources
- Wafer probers
- Many electronic / optical simulation softwares

4 Research Groups
- MOSE: Microwaves and optics for embedded systems
- CIMI: Integrated matrix image sensors
- SCAN: Signal, Communication, Antennas, Navigation
- SSPA: Space Instrumentation

Partnerships
- ONERA, CNES, ESA, DGA, Astrium, Thales, Airbus, IPGP
CMOS Research on Imagers for Space Technologies and Applications Chair including
- Research: excellent academic performances
- Industrial realisations

World firsts
- PEA LOLA 2008 → world 1st
  - Optical link b/w a satellite and a plane
- GOCI 2010 → world 1st
  - Geostationary Ocean Color Imager
  - ASTRIUM satellite for South Korea
- ESA Sentinel 2 2013
  - VNIR sensor
  - GMES Program
Focus on research on Space communication

Michel Bousquet

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Institut Supérieur de l’Aéronautique et de l’Espace

Training and Research Departments

**DAEP** Aerodynamics, Energetics & Propulsion
- Turbulence and Instabilities
- Turbomachinery and Propulsion
- Advanced Aerodynamics and Flow Control
- Aerodynamics and Propulsion of MicroUAV

**DEOS** Electronics, Optronics & Signal Processing
- MOSE Microwaves and Optronics for Embedded Systems
- CIMI Integrated 2D Imager Design (CMOS)
- SCAN Signal, Communication, Antennas, Navigation
- SSPA Space Systems

**DMSM** Mechanical Eng’g, Structures & Materials
- Damage to Composite St.
- Fatigue of Metal Mat. & St.
- Dynamics of St.
- Advanced Numerical Methods

**DMIA** Mathematics, Computer Sciences & Control
- MARS Modeling and Architecture of Systems
- ADIS Control, Decision and Interface of Systems

**LACS** Languages, Arts, Cultures & Society

**CAS** Aeronautics & Space Center
Institut Supérieur de l’Aéronautique et de l’Espace

SCAN research team
Signal, Communications, Antennas, Navigation

➢ Research Topics
  ➢ Antenna array processing
    • Signal and Direction of Arrival Detection, Anti-Jamming
    • Beam Forming (space-time adaptive filtering)
    • Radar Signal Processing (moving target detection)

Satellite Communication Systems
  • Architectures, Air Interface (modulation, coding, multiple access...)
  • Propagation Impairments Modelling and Mitigation
  • System Performance assessment, Radio Resource Management

Satellite Navigation Systems (GNSS)
  • Receiver Architectures, Interference Mitigation, Waveforms
  • Performance Assessment & Augmentations (urban, indoor...)
  • Hybridization Techniques

➢ Partnerships
  ▪ TeSA (Aerospace Communications Cooperative Research Lab.)
  ▪ Thales Alenia Space, Thales Avionics, Thales Airborne Systems
  ▪ SatNEx Network of Excellence, ONERA, DLR, ESA, CNES, DOD

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Smart Antennas Research: Estimation, Detection
Space-Time Adaptive Processing

- Satellite SDMA
- Airborne Radar STAP
- Jamming and multipath cancellation

SDMA: Space Division Multiple Access
STAP: Space Time Adaptive Processing
SATCOM research: Example of Multimedia Communication System & Research Topics

- Propagation Impairments & Fade Mitigation Techniques
- Modulation & Coding
- Multiple Access
- User terminals
- DVB-RCS
- DVB-S2
- Gateway beam
- Backbone
- FMT Control logic
- Web, mail servers
- WWW
- ISP
- Ressource Management QoS IP
- Satellite Service Subscriber Network
- Satellite Terminal
- Network Control Center
- On-board processing
  - Antenna array processing
  - Space Division Multiple Access (SDMA)
• Smart antennas

• Hybridization GNSS with
  - Inertial devices (MEMS), other sensors
  - Telecom systems
Objectives
- Quality of Service monitoring in networks
- Performances evaluation in embedded networks
- Protocols and mechanisms for wireless networks
- Error detection and correction for networks
- Information routing in spontaneous networks

Results
- Distributed Discovery and Management of Alternate Internet Paths with enhanced QoS
- Wireless Network Emulation
- Toward a Versatile Transport Protocole
- Full duplex switch Ethernet for military aircraft applications
- 4 patents in the last 2 years

Partnerships
- Airbus
- Thales Alenia Space
- Dassault
- NewCom (Networks of Excellence in Wireless Communication)
- ResCom Direction, ResCom Expert Committee member
Industrial relationships and international development

Michel Bousquet

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Research with industry
12 frame agreements on a 5-yr basis

2 Chairs supported by Industry

- EADS Astrium – **CRISTAL** Chair – Research on CMOS Imagers for Space Technologies and Applications
- SAFRAN-HEC-ISAE Chair on innovative program management – Application to aerospace

2 Common Laboratories

- Thales Alenia Space, Rockwell Collins, CNES, 4 academic partners – **TeSA** – Telecom for Space and Aeronautics
- EADS IW – ICA – **3AS** Research Group – Advanced Analysis for Aeronautical Structures

8 Frame agreements with an active research section

- AIRBUS – advanced aerodynamics, structures, optical link, human factors
- SAFRAN (Sncema, Turbomeca, Technofan) – off-design engine operation, engine modeling, turbofan
- EUROCOPTER – helicopter engineering, composite structures, vibrations
- MBDA Missile Systems – european collaborative agreement (w/ Cranfield, Munich, U. Pise, ETSIA Madrid)
- BERTIN TECHNOLOGIES – convertible micro-aerial vehicles
- CEA – shock/fluid interface interactions
- LIEBHERR, SOGETI
A strategic partnership with 14 companies
- ACCENTURE
- AKKA TECHNOLOGIES
- AIR FRANCE
- ALTRAN
- CNES
- DASSAULT
- LIEBHERR
- EADS AIRBUS
- EADS ASTRIUM
- EADS EUROCOPTER
- EADS SOGERMA
- SAFRAN
- THALES
- ZODIAC AEROSPACE

Many conferences made by companies intended for ISAE students
- Made by SUPAERO or ENSICA alumni
- Visits

ISAE SUPAERO Foundation
- Contribute to the national and international influence of ISAE
- Support the international mobility of students and professors
- Foster the development and influence of research
- Encourage social openness at ISAE
International relations

- **Co-operation with many universities in the World**
  - 80 academic partners (universities) in 25 countries (TU Munich, TU Berlin, ULB, UPM, UPC, Cranfield, Politecnico Milano, MIT, Stanford, Georgia Tech, NUAA, NPU Xi’an…),
  - 39 double degree possibilities (through a particular agreement): mobility between 18 and 24 months from the 3rd year,
  - Substitution of one or two semesters (mostly through ERASMUS) mainly during the 3rd year.

- **Internships abroad**
  - Many students achieve their master thesis abroad and so they start their career in a foreign country.
- **Outgoing students**
  - **Obligation** for the SUPAERO and ENSICA students to stay abroad:
    - at least 2 months (academic exchange, internships, projects),
  - **55 SUPAERO students** in academic exchange abroad during the year 2009-2010,
  - **32 ENSICA students** in academic exchange abroad during the year 2009-2010
    - mostly United States, United Kingdom, Germany, Sweden, Canada
    - but also China, Japan, Denmark, Russia, Switzerland or Netherlands…

- **Incoming students in the SUPAERO and ENSICA graduate pgms**
  - **101 students** (2009-2010)
    - mostly from Spain, Belgium, Italy, Germany, Brazil, Portugal.
Identity profile

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Lecturers
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- +36,000 h/an

Network
- > 17,000 alumni

Students
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- SUP & N6K grad. pgms: 1000
- MSc and Advanced Masters: 300
- Ph.D: 200

Research
- 126 faculty + 50 technical staff
- 100 scientific projects / yr
- 24.6 M€ Turnover

Training Programs
- SUPAERO graduate program
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International
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- EuMAS - Erasmus Mundus Master - European Masters Course in Aeronautics and Space Technology
- PEGASUS - Partnership for a European Group of Aeronautics and Space Universities (23 partners)
- TIME - Top industrial managers for Europe (41 partners)
- SIAE - Sino Institute of Aeronautics Engineering (Tianjin, China)

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