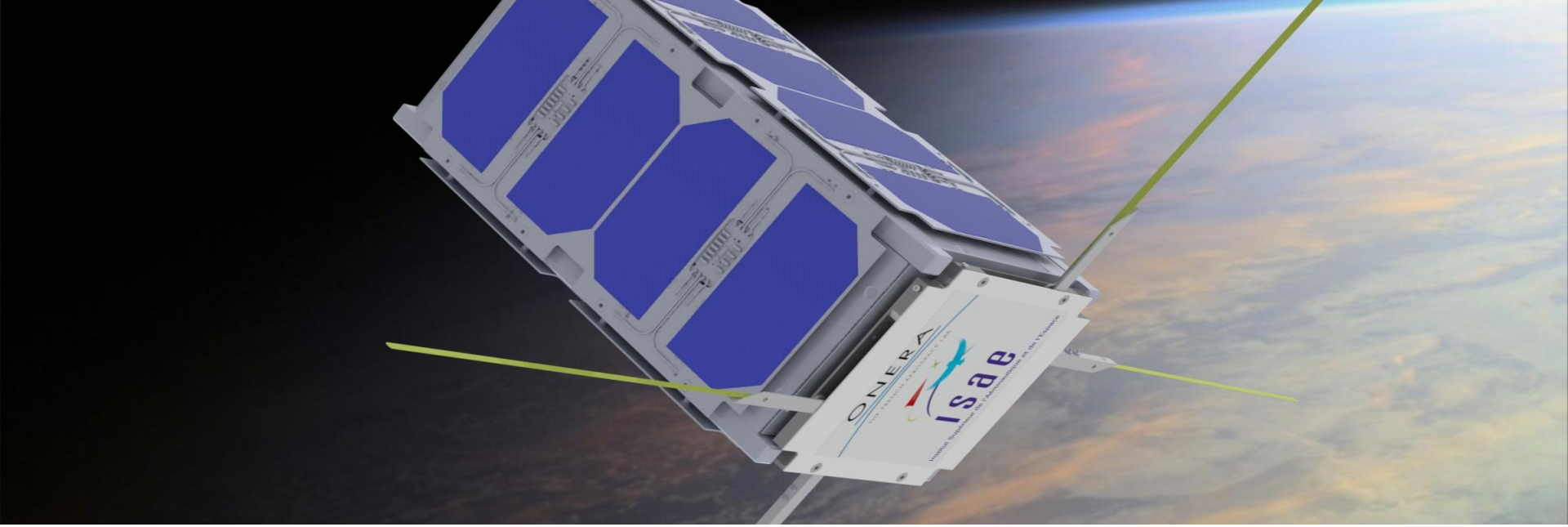


Space higher education and research at Aeronautical and Space Institute ISAE-SUPAERO (Toulouse, FRANCE)

isae
Institut Supérieur de l'Aéronautique et de l'Espace
SUPAERO

Since 1909, leader of aerospace engineering higher education

1909 — Creation of l'Ecole Supérieure d'Aéronautique or **« SUPAERO »** by **Colonel Roche**

PARIS

1930 — Nationalization : **Ecole Nationale Supérieure d'Aéronautique**

1945 — Creation of l'**Ecole Nationale des Travaux Aéronautiques**

1961 — L'**ENTA** becomes **ENICA** and moves to Toulouse

1968 — **SUPAERO** moves to Toulouse and becomes l'**Ecole Nationale Supérieure de l'Aéronautique et de l'Espace (ENSAE)**

1979 — L'**ENICA** becomes **ENSICA** (Ecole Nationale Supérieure d'Ingénieurs Constructions Aéronautiques)

TOULOUSE

2007 — Creation of a single institution, **ISAE**

2015 — ISAE-SUPAERO on a single campus

SUPAERO

ENTA – ENITA - ENSICA

ISAE-SUPAERO

Toulouse – the European aerospace capital

- **Toulouse area**
  - 850 000 inhabitants
  - 115 000 students
  - One of the oldest universities in Europe (1229)

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

- **The main European Pole for Aeronautics and Space**
  - **Aeronautics (600 companies)**: **AIRBUS , ATR, SAFRAN, THALES, Daher-Socata, Liebherr Aerospace, Latécoère, Air France, Stelia, Rockwell Collins, UTC Aerospace**
    - Manpower : **85 000** (Airbus : 22 000) , including **5 000** researchers
    - Leading European centre for civil aviation industry
  - **Space**: **CNES, AIRBUS Defence & Space, THALES ALENIA SPACE**
    - Manpower : **12 000** (**25%** of the European manpower)
    - Leading European centre for satellites industry and earth observation

ISAE-SUPAERO – main figures

1909
Foundation

34
Programs in Aerospace engineering

650
Graduates/year (Master and PhD)

1 700
Students (total)

200
PhD students

31%
International students

1800
Lecturers

21 500
Alumnis

32
International degree agreements

Since 1909 - outstanding engineers, great managers and astronauts

Henri Coanda
Designer of the first jet aircraft

1910

1913

Marcel Bloch-Dassault
Founder of Dassault Aviation

Henri Ziegler
President of Aérospatiale
1st administrator of Airbus Industrie

1931

1966

Frédéric d'Allest
Ariane program director,
President of CNES,
1st President of Arianespace

Lionel Suchet
General director,
CNES (French space agency)

1982

1983

Jean-François Clervoy
Astronaut

Alain Bellemare
President and managing director Bombardier

1985

1992

Guillaume Faury
President Airbus Commercial Aircraft

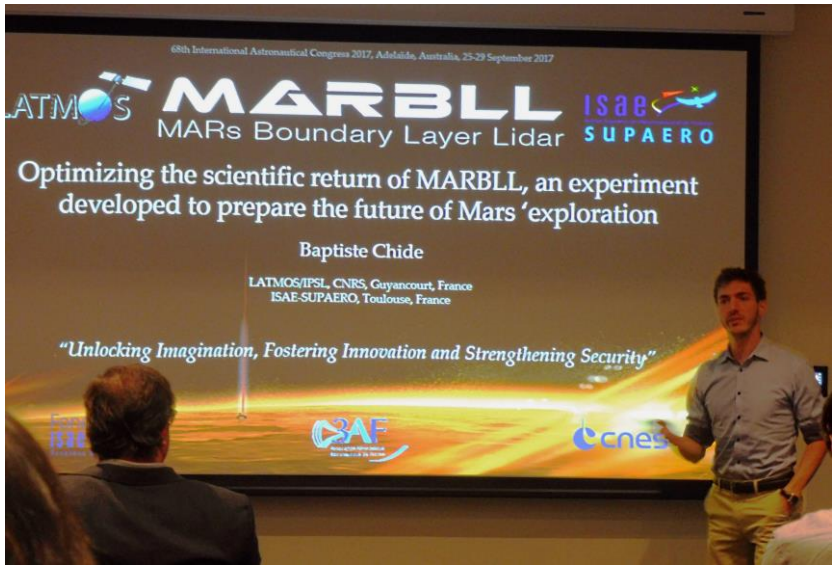
Thomas Pesquet
Astronaut

2001

International Astronautical Congress 2017, Adelaide

Baptiste Chide (ISAE-SUPAERO alumni 2017)

Obtained the 1st student price for the study on MARBLL (Mars Boundary Layer Lidar), an instrument to measure martian wind profile from the surface



Masters of Science & Advanced masters

1 Master of Science in Aerospace Engineering (in English)

2 years incl. 6 months internship

Key assets

- High-level training in aeronautical and space engineering and science
- Expose students to the European and French technologies and cultures

Publics

- Students with Bachelor of Engineering or Science

Main outlines

- Accredited National Degree by Ministry of Higher Education and Research
- Teaching based on the European Credit Transfer System (ECTS)
- 4-semester program
- Technology and science-oriented master

14 Advanced Masters

10 in English, 4 in French

1 year incl. 6 months internship

Key assets

- High level specialization courses meeting specific needs of the French, European and Foreign aerospace industry
- Provide global market with high qualified specialists

Publics

- Students and professionals with a master degree
- Professionals with a Bachelor degree and at least 3 years of experience

Main outlines

- Accredited by the *Conférence des Grandes Ecoles (CGE)*
- 2-semester program
- Professionally-oriented, focusing on a specific subject

MSc in Aerospace Engineering
2 year program in English

Before ISAE → ISAE

Undergraduate studies abroad

Bachelor degree in engineering or sciences.

MSc : 1st year

Semester 1 / Semester 2

Common Core – Foreign languages

Common Core

Research project

Common Core

Elective Courses

Industry Placement (optional)

MSc : 2nd year

Semester 3 / Semester 4

Common Core – Foreign languages

Research project

Major : 6 choices incl. space systems

In-depth program (optional)

Master thesis

Internship can be performed in CNES (French space agence) or in space industry

Semester 3 : majors (220h) & research project

Research project (150h)

Advanced Aerodynamics and propulsion

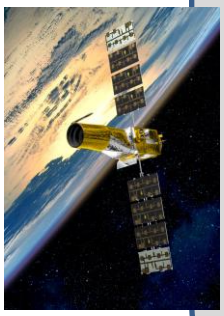
Aerospace structures — ADO

Aerospace systems and control — ADO

Embedded systems

Space systems

Systems engineering — ADO



ADO: Aicraft design & operation track

Post-master programs - Advanced masters

1 year program

Experimental Flight Test Engineering

Systems Engineering

Space Systems Engineering

Option Space exploration

Aerospace project management

Embedded-Systems

Project Management

Aerospace Systems Propulsion

Space Applications & Services

with Airbus Defense & Space

Aviation Safety Aircraft Airworthiness

Aeronautical Maintenance & Support

Helicopter, Aircraft, & Drone Architecture

with Airbus Helicopters

Aeronautical Engineering

Major Flight Test Engineering

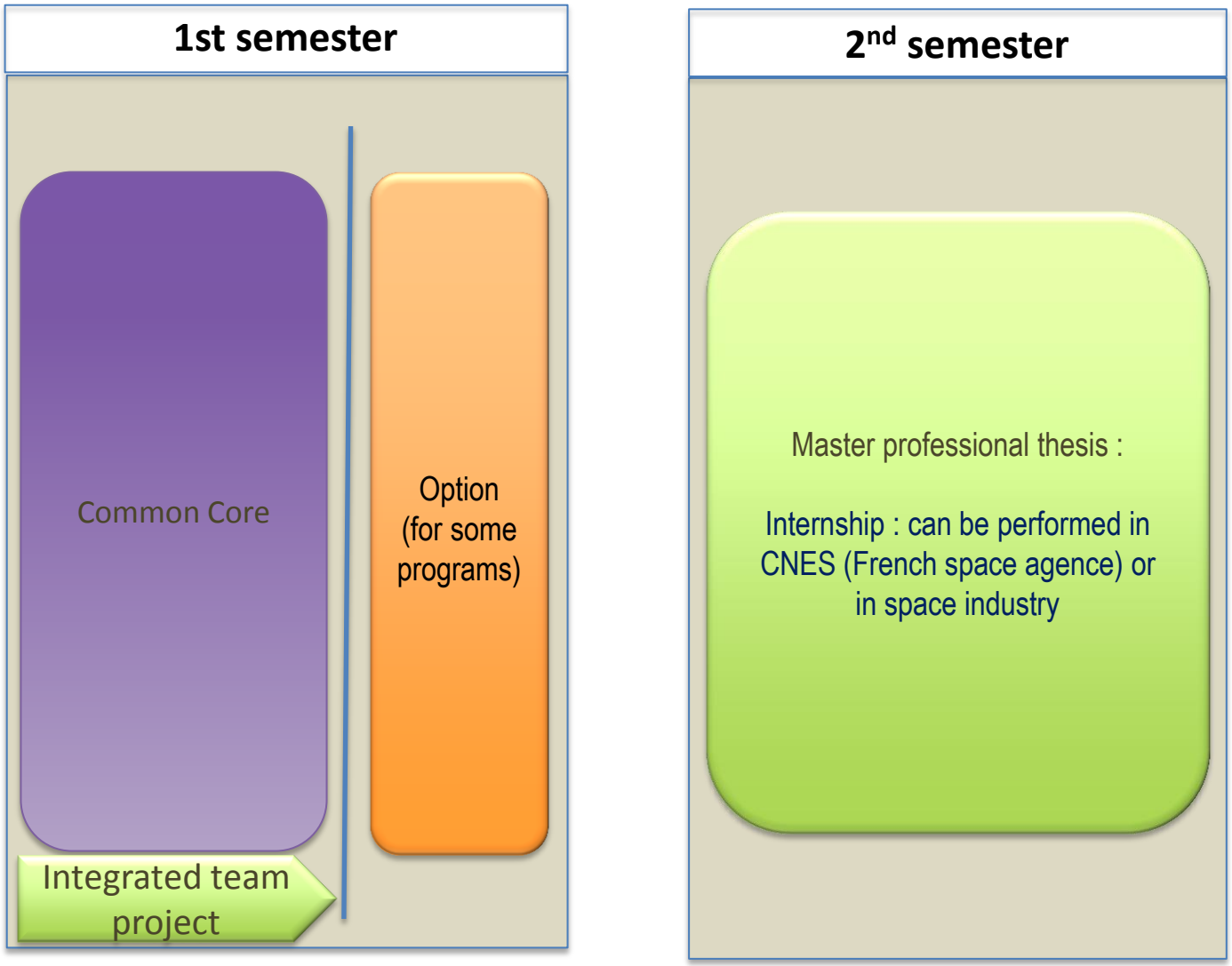
Aeronautical & Space Structures

Adv. Manufacturing Processes for Aerostructures

English

French

Post-master programs - Advanced masters



Continuing education : short courses for professionals

- **Certificates (1-3 months courses)**
  - Earth remote sensing and observation systems, Helicopters, Aerospace Maintenance & Support, UAV systems…

- **EUROSAE : subsidiary company for continuing education in France and overseas**
  - 250 short specialized courses in aerospace engineering (2 days to 2 weeks)

  (aerospace systems design, project management, risks and costs management, lean manufacturing, supply chain, quality, certification..etc)
  - 2600 trainees per year mostly from aerospace companies

- **ECATA (European Consortium on Advanced Training in Aeronautics and Space)**
  - Composed of major European aerospace universities and companies (Airbus, Safran, Dassault Aviation, Alenia, BAE systems, SAAB)
  - Aerospace Business Integration program : training of high potential managers

isae
Institut Supérieur de l'Aéronautique et de l'Espace
SUPAERO

Our campus, Toulouse (south of France)

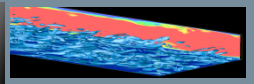
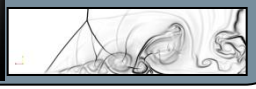
isae
Institut Supérieur de l'Aéronautique et de l'Espace
SUPAERO

Training and Research Departments

DAEP — Aerodynamics, Energetics & Propulsion

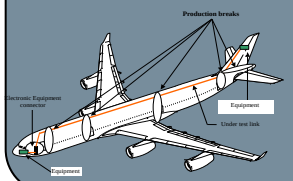
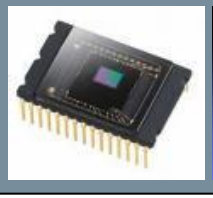
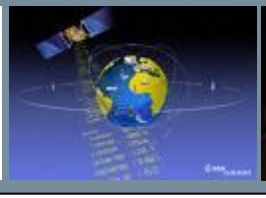
Turbulence and Instabilities
Turbomachinery and Propulsion
Advanced Aerodynamics and Flow Control
Aerodynamics and Propulsion of MicroUAV



DEOS — Electronics, Optronics & Signal Processing

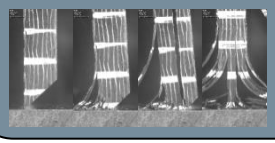
Microwaves and Optronics for Embedded Systems
Integrated 2D Imager Design (CMOS)
Signal, Communication, Antennas, Navigation
Space Systems

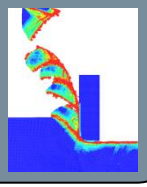





DMSM — Mechanical Eng'g, Structures & Materials

Damage to Composite St.
Fatigue of Metal Mat. & St.
Dynamics of St.
Advanced Numerical Methods

Institut Clément Ader



DCAS — Design & Control of AeroSpace vehicles

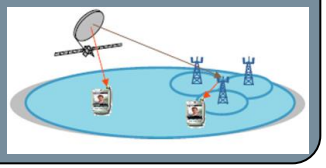
Aerospace vehicles design
Automation and systems control
Neuroergonomy for air transportation security



LACS — Languages, Arts, Cultures & Society

DISC — Complex Systems Engineering

Operations Research and Applied Mathematics
Systems Modelling and Architecture
Communication networks

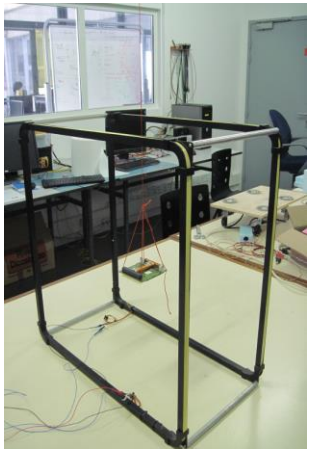



Training and research facilities/tools for space activities

- **Aerospace systems design, modeling, simulation tools**
  Mission analysis, satellite simulation

- **15 clean rooms for satellites integration and optoelectronics characterization**
  500 m^2, ISO 7-8 class

- **System and environmental tests facilities**



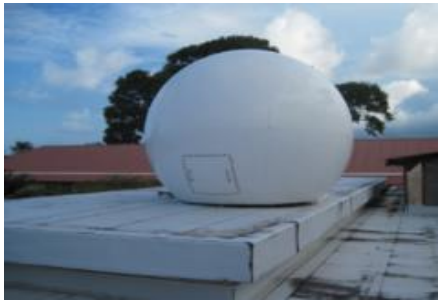
Training and research facilities/tools for space activities

- **Satellite command and control center**

  Full ground segment for TM/TC
  Space link extension with CNES S-band ground station

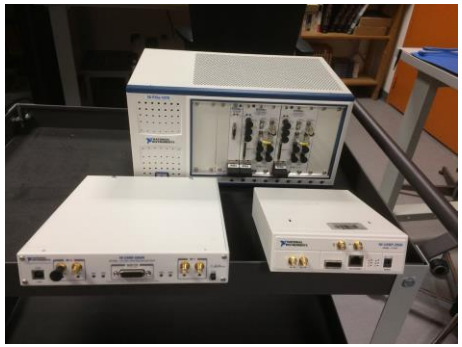
- **Ground stations for satellite tracking and operation**

  Toulouse : UHF/VHF, Cayenne : S-band



- **Lab room for geostationary satcoms (in cooperation with IMT)**

  Fixed and fly away Ku/Ka-band antennas, satellite channel emulator…



Micro launchers - student research projects

PERSEUS Program supported by CNES

- Two stages SERA micro launchers (launched from Kiruna in Sweden)
- C'Space micro rockets campaigns in France
- New ITN network on launchers

Nanosatellites projects

EntrySat (3U, phase D)
- Study of atmospheric re-entry
- ISAE /Von Karman Institute

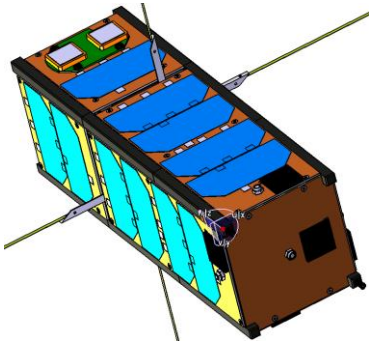
Eye-Sat (3U)
- command/control and system enginering
- Ground segment (TETX + CCC..)
- CNES / ISAE / ENAC / Paris Sud Cachan

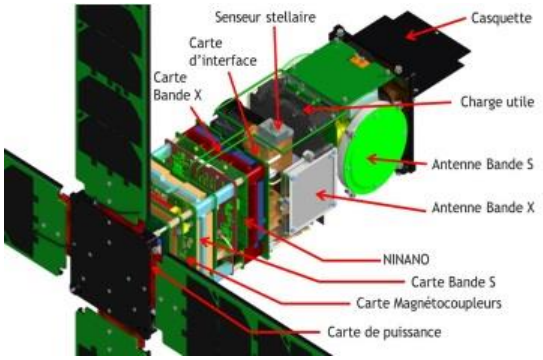
NIMPH (3U, phase B)
- Test of opto-hyperfrequency components
- ISAE / LAAS / UPS / Thales Alenia Space

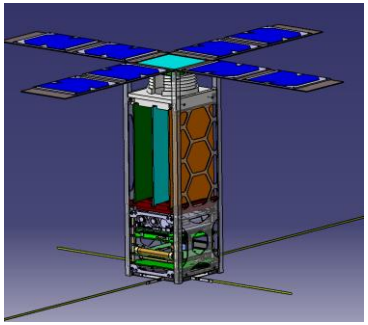
ATISE (12U, Phase B)
- Study of aurora borealis (CSUT / CSUG)

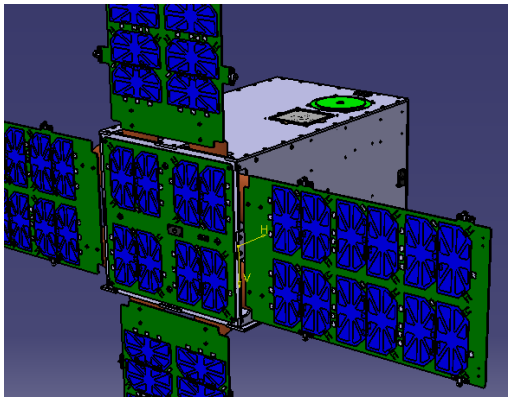
SPECTRA (3U, → Phase 0)
- Radio-frequency spectrum monitoring
- CSUT / ENSTA-Bretagne

CORSE (1U, → Phase 0)
- Radiations monitoring (CSUM/ CSUT)





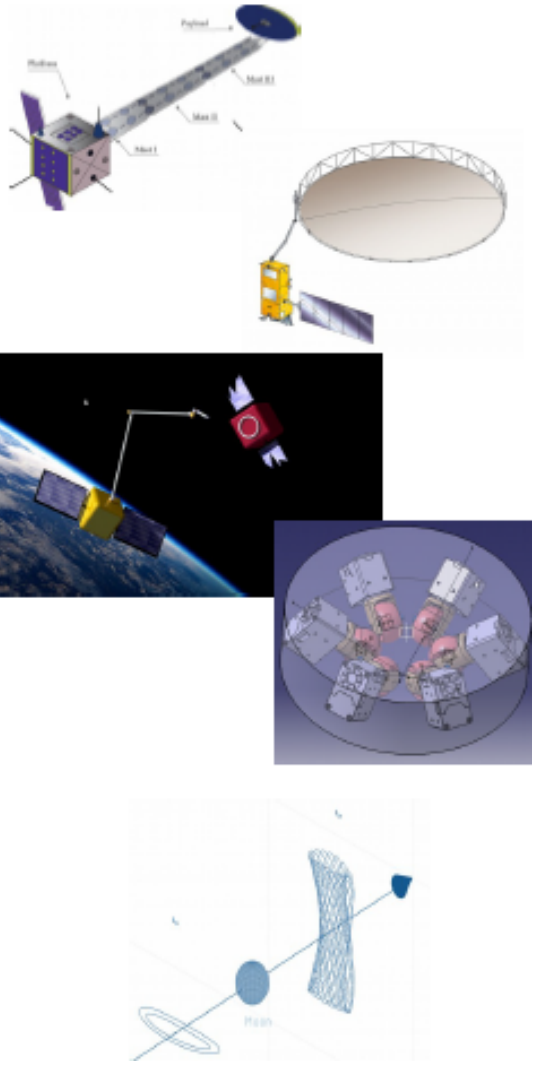




Space systems design and control

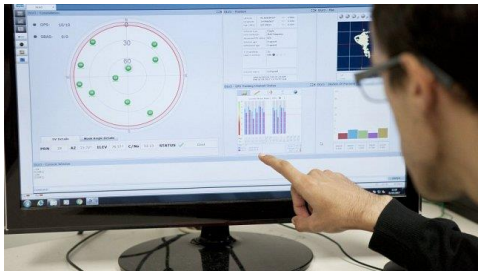
Wide range of research topics : examples of recent PhD

- Mechanical/control integrated design of highly flexible space Structure
- Boom and attitude control integrated-design of BIOMASS satellite
- Modeling, control and guidance of a Space Robot
- New congurations of Control Moment Gyros (CMGs) clusters
- GNC for electromagnetic formation flying satellites
- Dynamics about and between the Lagrangian points of the Sun-Earth-Moon system



Electronics, Optoelectronics, Telecommunications for space applications : research topics

- **Space communication systems** : study of satellite link issues with propagation channel modeling, implementation of modulation and coding techniques, jamming interference mitigation approaches



- **GNSS hybrid navigation systems** : design of multi-constellation receivers. Improving the performances of GNSS systems in harsh environments

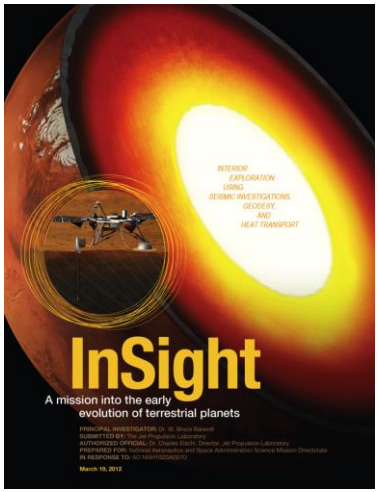
- **Image sensors design** : design of integrated matrix imagers.
  → CMOS microelectronic sensors fly on ESA Sentinel-2 satellite

- **Optoelectronics for payloads and aerospace communications** : characterization and modeling of photonic components, design of optoelectronic payloads for satellite-based high speed data transmission (>10Gbps)

Payloads for planetary missions

Participation in NASA InSight mission to Mars

- InSight mission to Mars : launch 2018
- Seismometer SEIS Core Mission Instrument developed in cooperation with CNES, IPGP

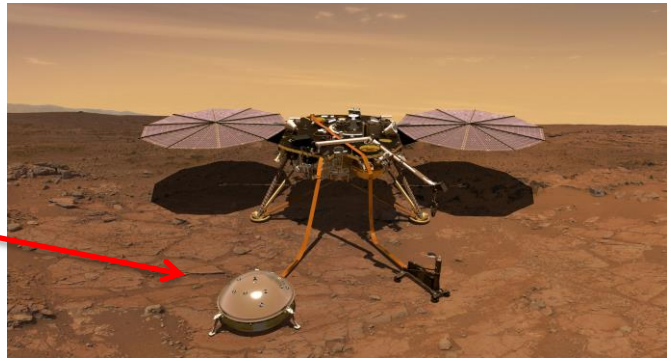


➢ Science objectives

- Tell the « story » of telluric planets
- Determine a Mars Internal structure Model
- Determine Mars seismic activity and meteoroid flux
- First geophysical observatory on mars 40 years after Viking

➢ ISAE SUPAERO contribution :

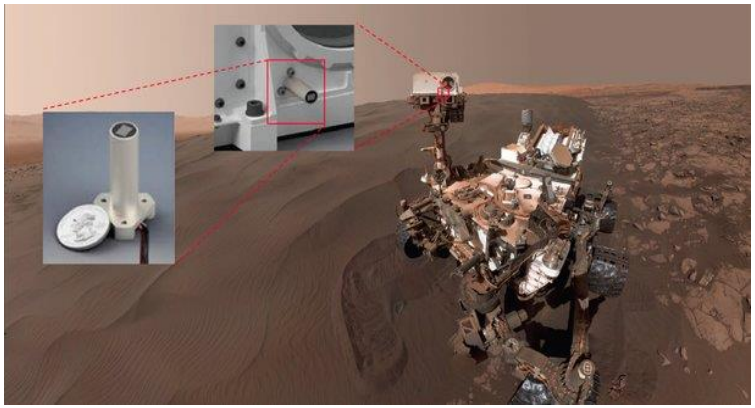
- Seismometer performances & instrument models
- Software support
- Science operations definition
- Science ground segment



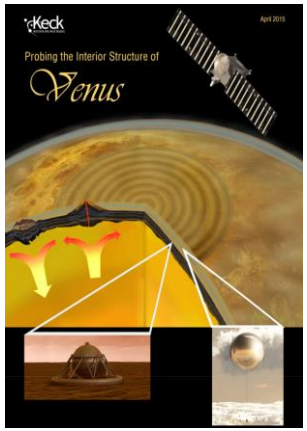
Payloads for planetary missions

Other space instrumentation projects

- Mars microphone on board MSL 2020 : dynamics of Mars atmosphere
- Pressure sensor on board VENUSGEOX : detection of Earthquakes on Venus



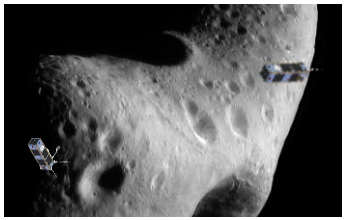
Microphone on SuperCam (NASA Mars 2020 project), developed in collaboration by ISAE-SUPAERO with CNES



KISS study of Venus seismology from ground, balloons and orbit

Nanosat lander on an asteroid : SEISCube (study)

Instruments : seismometers, accelerometers, gyroscopes



Space Advanced Concepts Lab

Main research topics

Space debris
On-orbit Servicing
Manned space exploration
Reusable launch vehicles
Large space structures

Sponsorship:

AIRBUS DEFENCE & SPACE

ARIANEGROUP

Vibrant student life

Thank you for your attention

Visit us on www.isae-supaero.fr

Contact : mikhail.stepanov@isae-supaero.fr