



Graduate Students  
Association

*XVIII ENCITA  
17/10/2012*

Jorge Gripp  
Academic Director - APG-ITA

*An overview of the graduate  
programs and research at ITA*



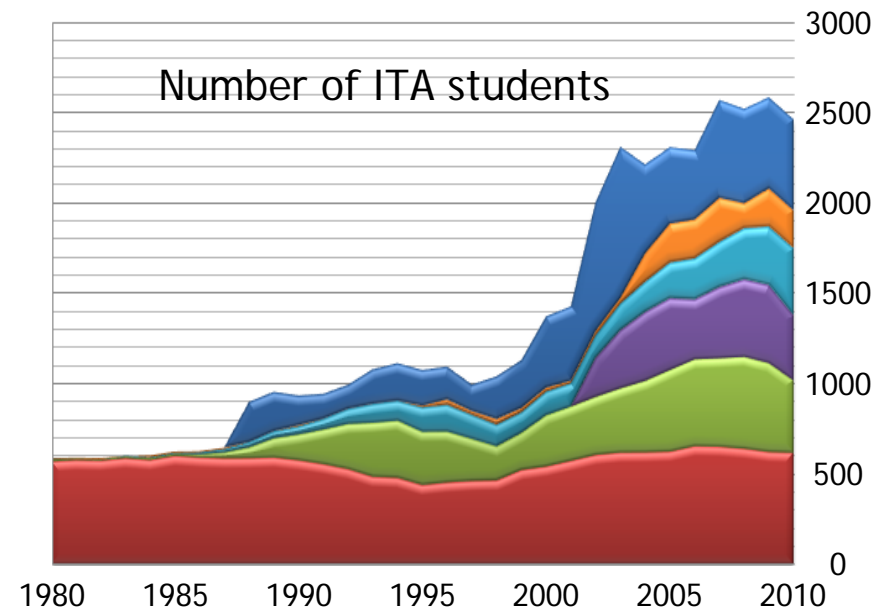
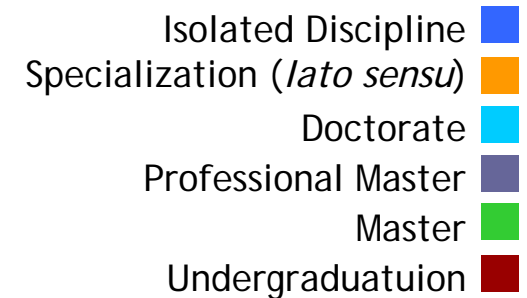


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# ITA Graduate Programs

# History

## *Graduate programs growth*





# Graduate Programs

ITA offers graduate courses to conduct research in the fields of:

**Physics**

**Aeronautical & Mechanical Engineering**

**Electronic & Computer Engineering**

**Aeronautical Infrastructure Engineering**

**Space Science & Technology**

Most students have financial aid from governmental agencies (CAPES, CNPq, or FAPESP) or companies.

The number of graduate students is:

Master of Science **380**

Professional Master **300**

Doctor of Science **370**





# APG-ITA

## Graduate Students Association

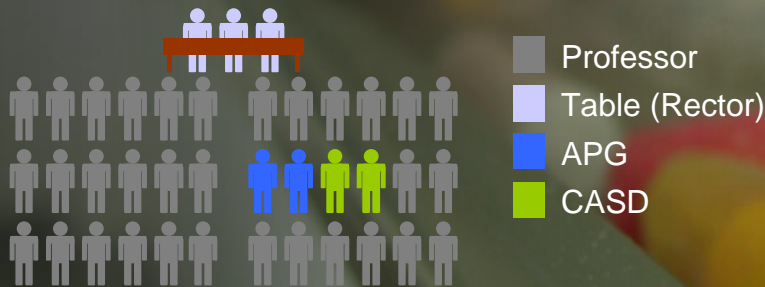


Represents students of **Master**, **Professional Master** and **Doctorate** programs at ITA. APG-ITA is always discussing **academic subjects** together with ITA professors at Academic Council and CPG.

During 2012, helped organize 5 ITA **events**. APG-ITA also coordinates **engineering projects** with the private sector, offering scholarships for professors and students.

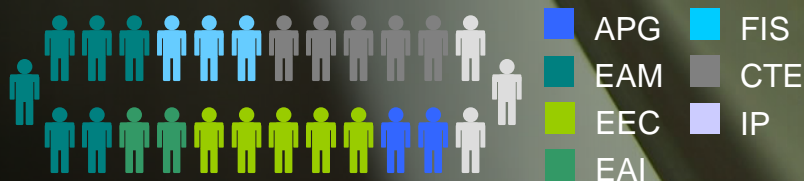
### ITA Academic Council

(2 APG representatives, bimonthly meetings)



### Graduate Programs Council - CPG

(2 APG representatives, biweekly meetings)



### Events 2012

APG helped organize of the following events:

Jan		
Feb	ITA Physics Summer Meeting. Feb, 13-17	
Mar		
Apr	Automotive Manufacture Workshop. Apr, 25	
Mai		
Jun	ITA Graduate Programs graduation. Jan, 02	
Jul		
Aug		
Sep	Defense symposium. Sep, 25-28	
Oct		
Nov	Science Fair and Undergrad Research Meeting. Oct, 16-17	
Dec		

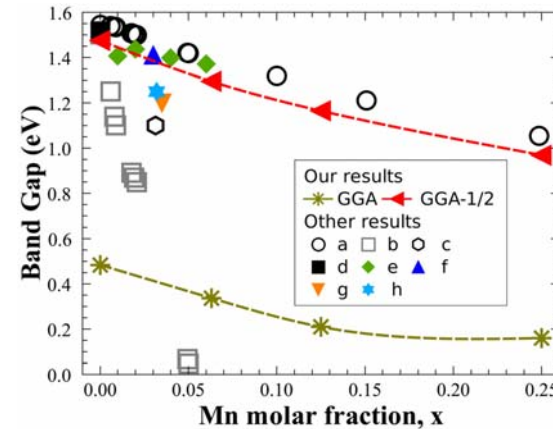
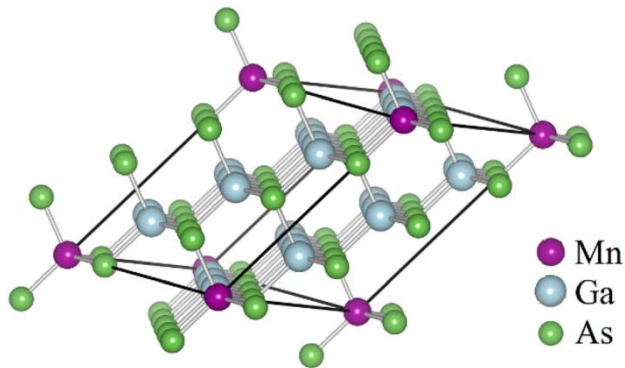


## 2 Research projects at ITA

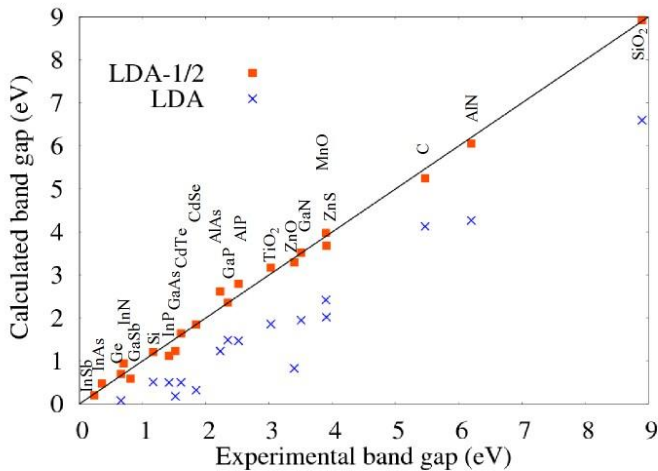




# Semiconductors & Nanotechnology



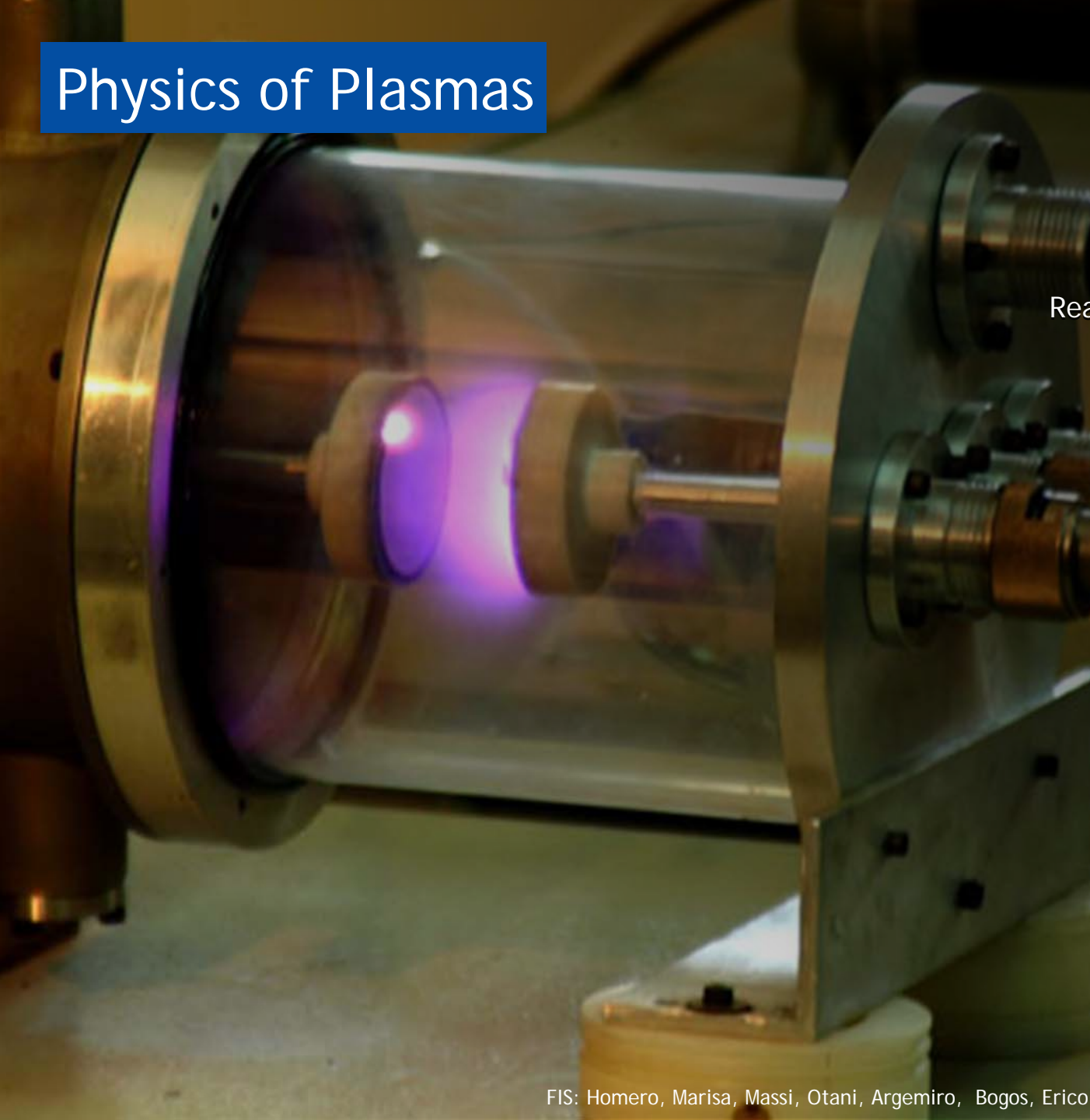
GaMnAs: Efficient and precise simulation of magnetic semiconductor materials, that will integrate processors and memories of future. Received an award:



LDA-1/2 Method to calculate semiconductors gap. Comparison with experimental data shows the developed method is much more precise than the conventional method (LDA)

Young author best paper award. International Conference of the Physics of Semiconductors, 2012

# Physics of Plasmas



Reactor for thin film deposition  
for application in electronic  
and solar devices



Surface treatment of  
rubber using plasma

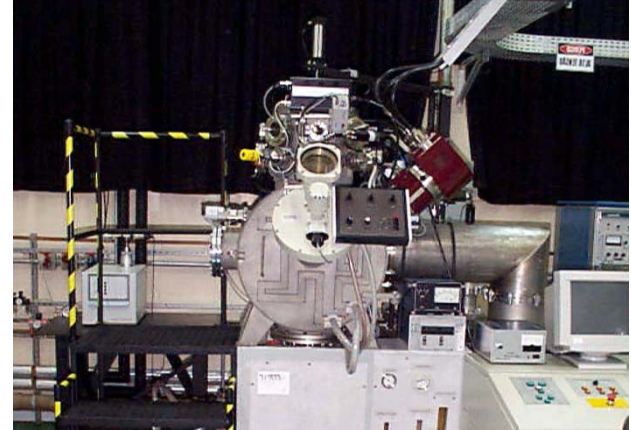
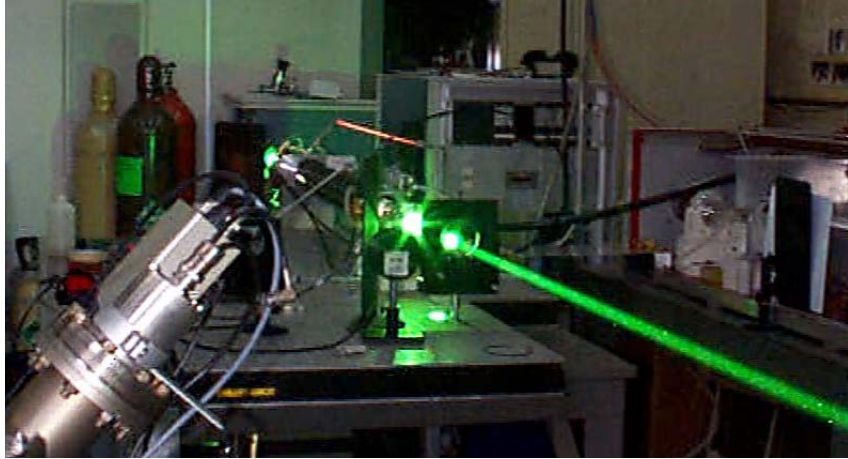


Atmospheric Reentry  
Simulation Chamber



# Atomic and Molecular Physics

## *Lasers*



Isotropic separation using lasers



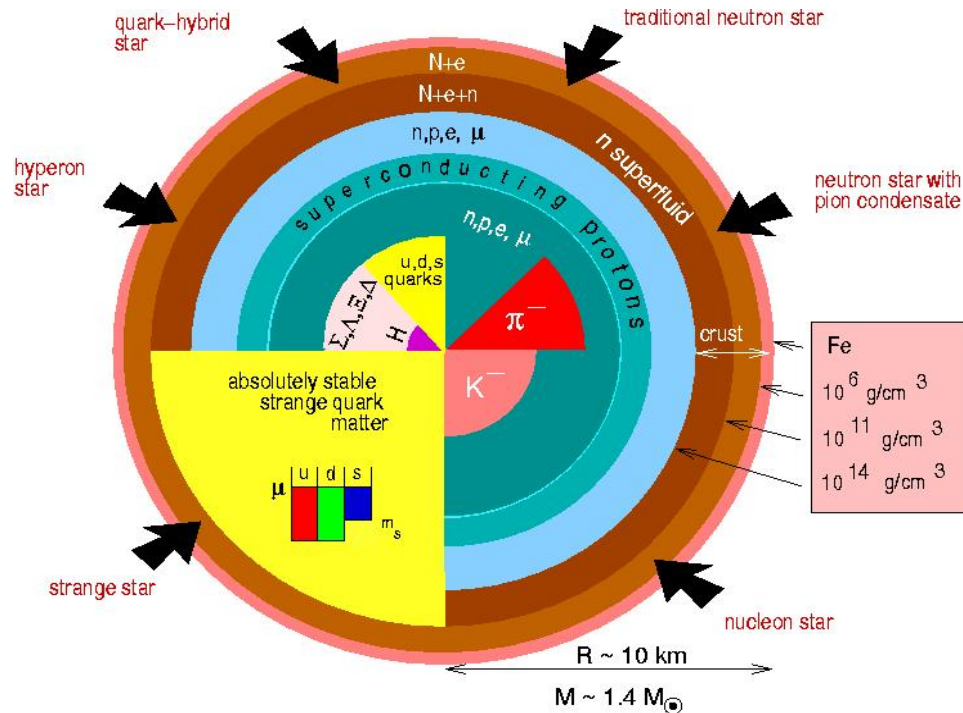
Development of Copper vapor lasers and dye lasers.



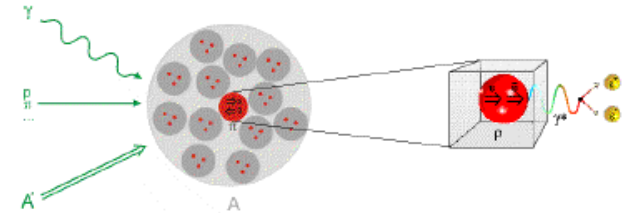
Production of precision components for the development of lasers

# Nuclear Physics

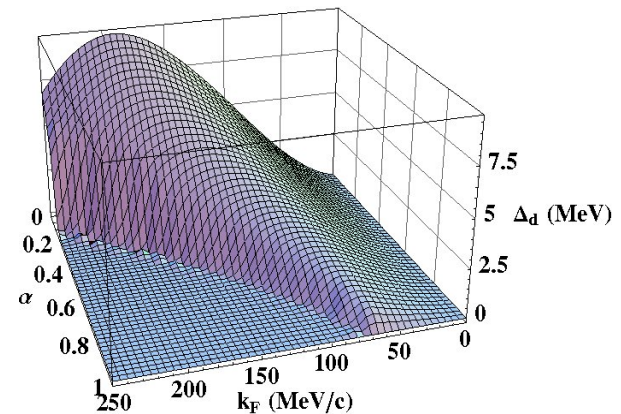
## *Theoretical studies*



Nuclear reactions



Nuclear structure and hadrons



Quantum field theory, cosmology, and gravitation

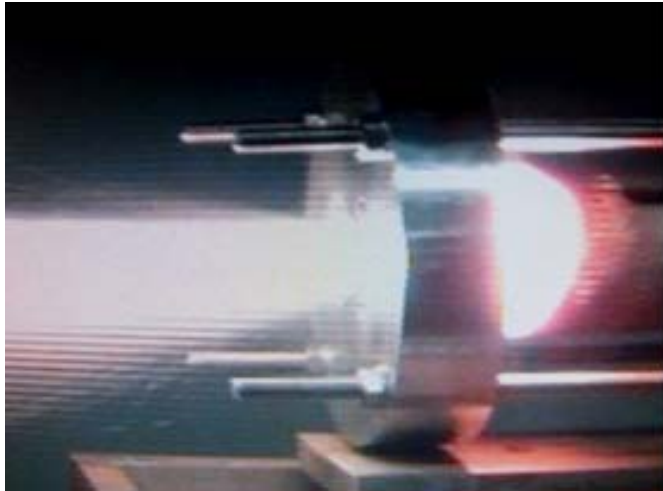


# Hybrid rocket motor

*Fuel: hydrocarbon. Oxidizer: pressurized O<sub>2</sub>*

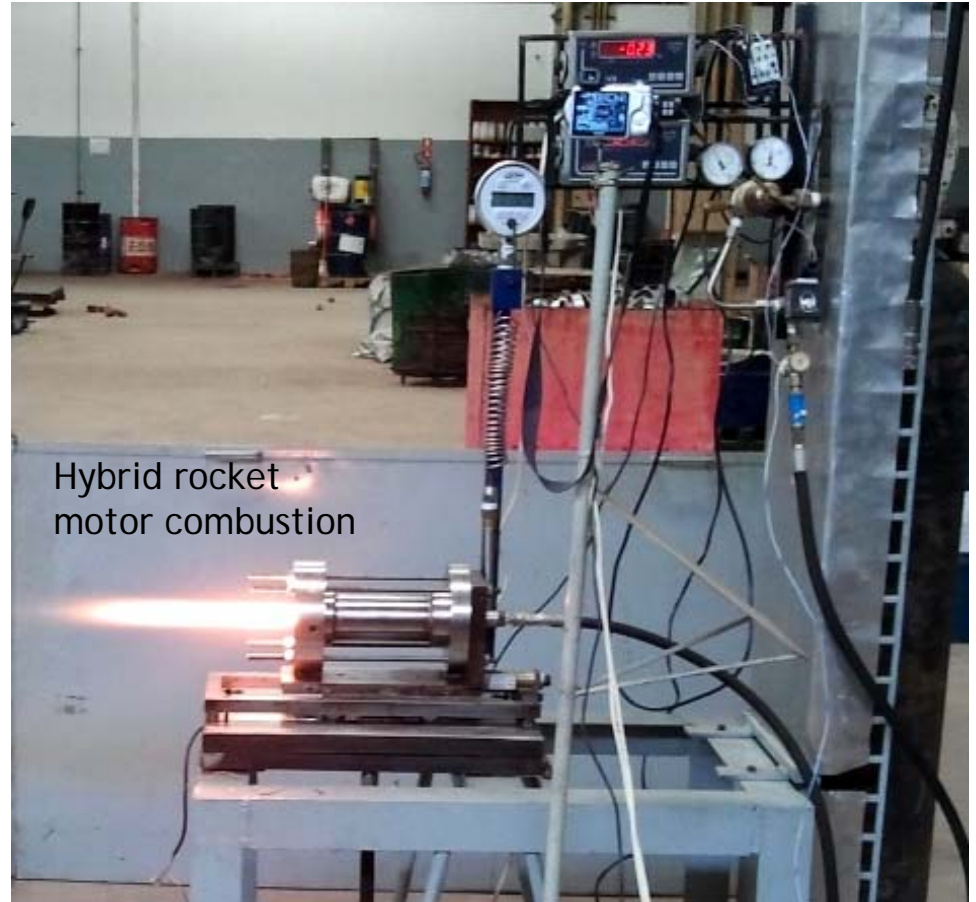


Rotational injectors improve fuel combustion efficiency



Combustion experiment using paraffin as fuel

Goal: improve the rocket motor energetic efficiency



Hybrid rocket motor combustion

Used in the propulsion of satellite launch vehicles (in the superior stages)

# ITASAT

## University satellite

### Projeto pioneiro

O primeiro microsatélite construído por universitários brasileiros tem o objetivo de coletar dados ambientais e meteorológicos

#### Órbita

O satélite dará uma volta completa em torno da Terra a cada 90 minutos



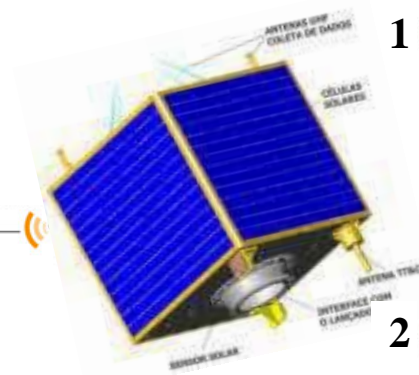
Custo final

**R\$ 5 milhões**



**Peso: 85kg**

Alcântara (MA)



**1** Uma vez em órbita, o equipamento funcionará como um repetidor. Cerca de 700 plataformas implantadas na Terra farão a coleta de dados como temperatura, pressão, umidade e velocidade dos ventos. Esses dados serão enviados para o satélite

**2** O Itasat retransmitirá essas informações para duas estações possíveis. No caso do Brasil, em Cuiabá (MT) e outra em Alcântara (MA)

**3** As estações receberão esses dados e os transmitirão para Cachoeira Paulista (SP), onde fica a sede do Inpe. Tanto o satélite quanto as plataformas possuirão antenas que possibilitarão a comunicação

**4** Os dados coletados serão transmitidos constantemente aos usuários interessados, formando uma rede de comunicação

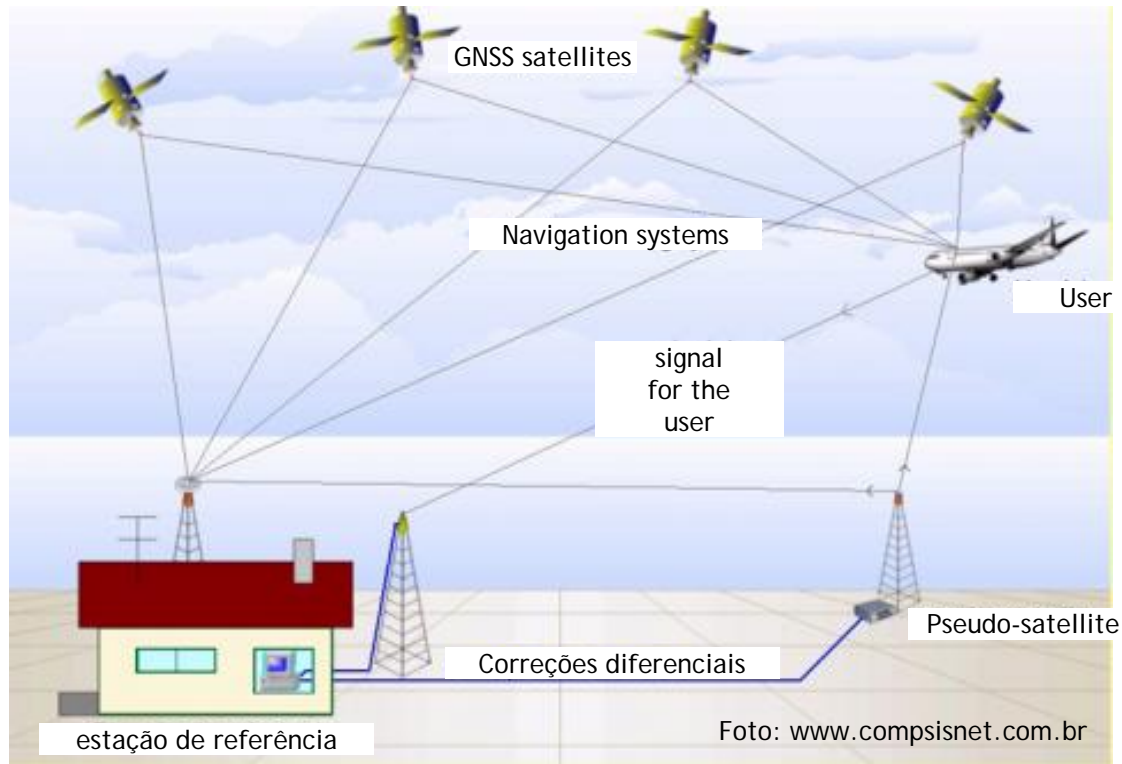
#### Capacitação

Inserido no plano plurianual voltado para o desenvolvimento e lançamento de satélites tecnológicos de pequeno porte, o projeto tem o principal objetivo de promover a capacitação brasileira de profissionais. Somente em 2009, envolveu 32 alunos de graduação, 23 de mestrado e cinco de doutorado

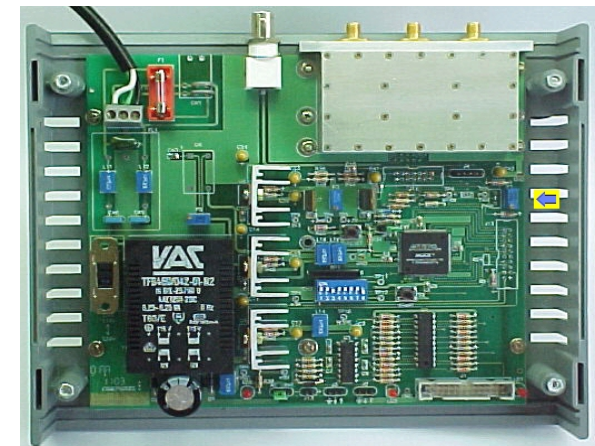
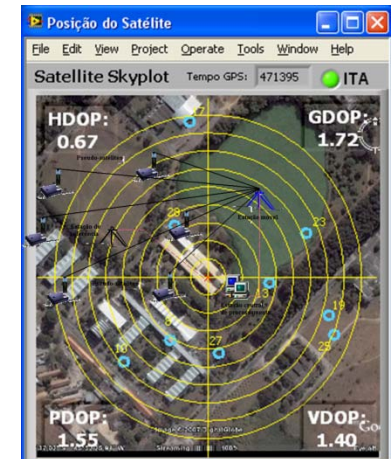
Antena de recepção  
Cuiabá (MT)

Sede do Inpe





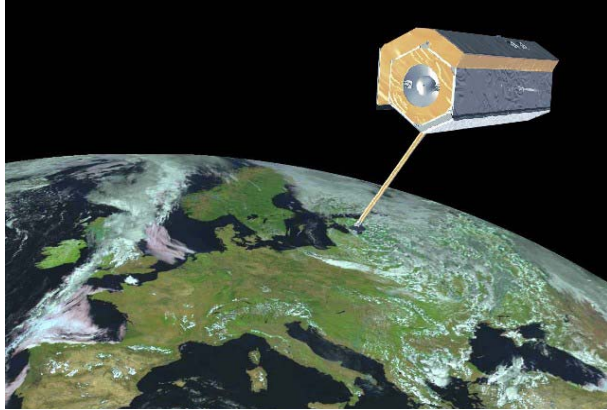
Correction of GNSS (GPS) signal errors using a GPS pseudo-satellite



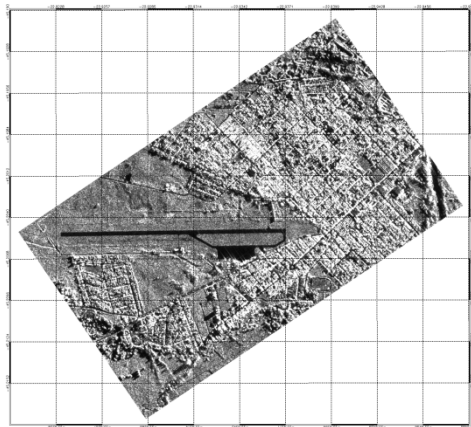
GPS Pseudo-satellite prototype

# SAR

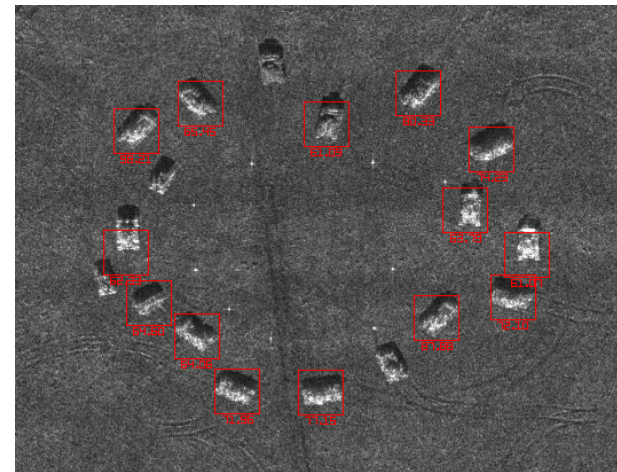
## *Processing the Synthetic Aperture Radar signal*



TerraSAR-X satellite developed by DLR and Astrium GmbH (Germany)



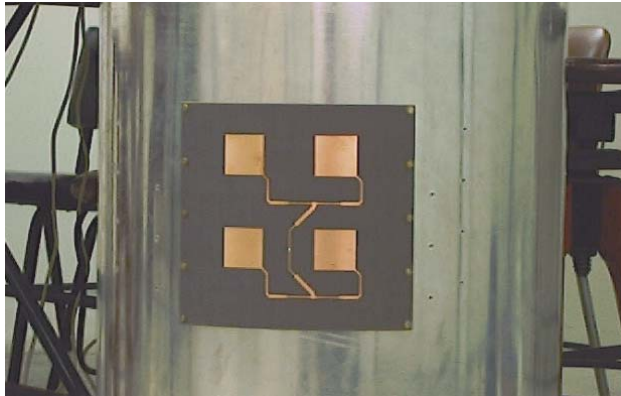
Geocoding (Earth mapping)



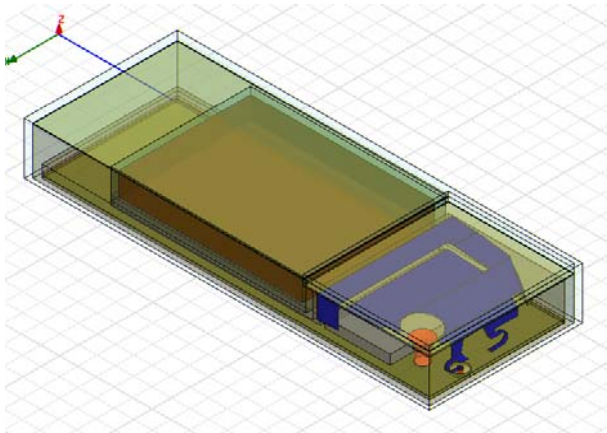
Target detection



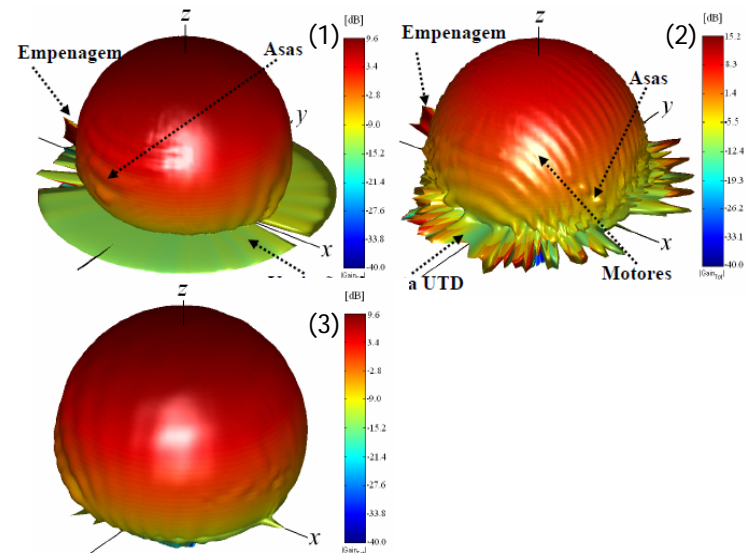
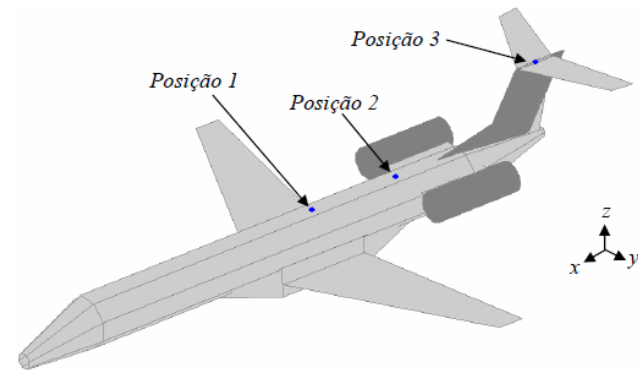
# Microstrip antennas



Array of 4 microstrip antennas used in sonda IV rocket



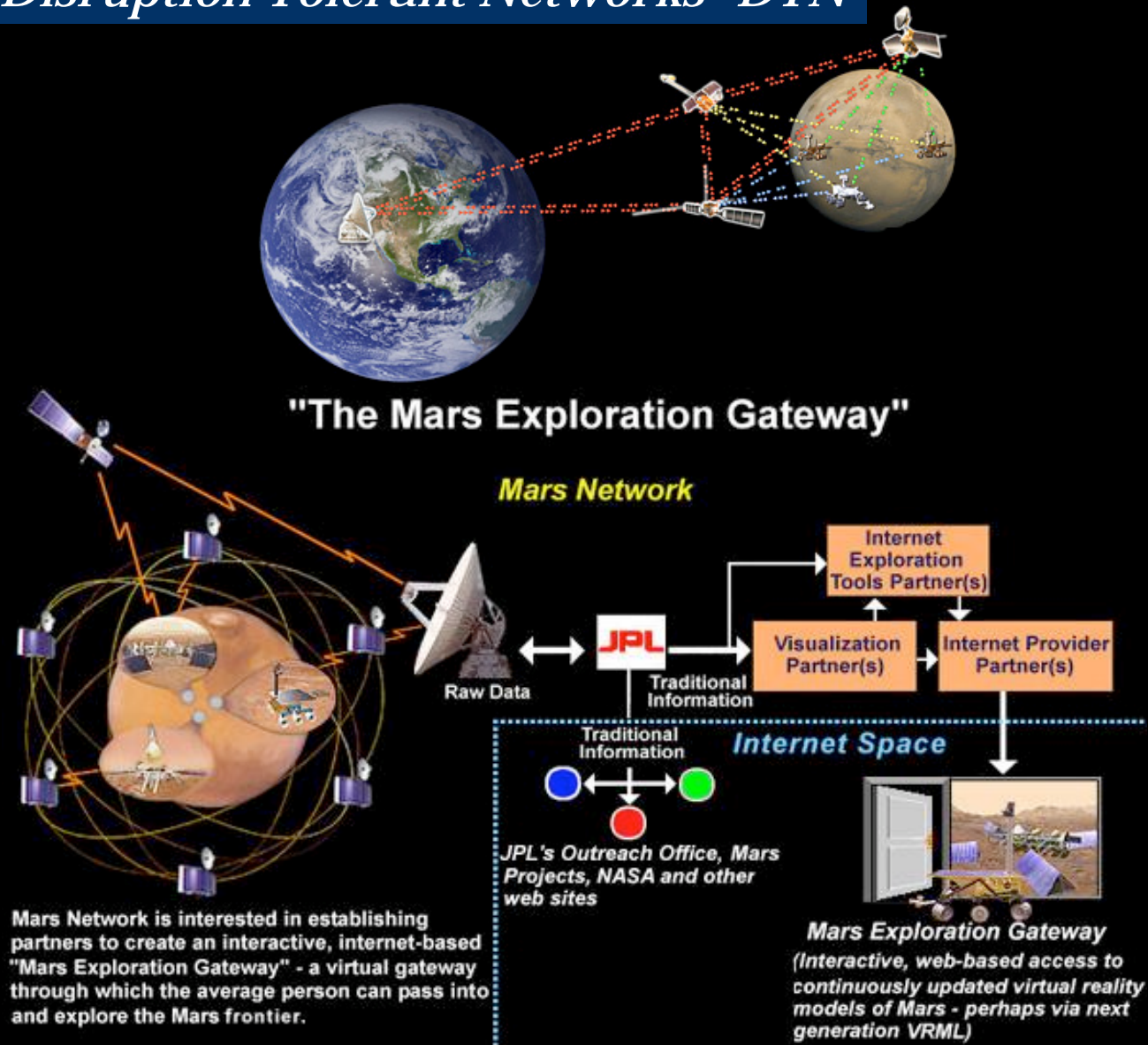
Antenna used in mobile phone



Irradiation diagram of microstrip antenna AMRCT positioned over an airplane in 3 different positions

# Interplanetary Internet

## *Delay and Disruption Tolerant Networks- DTN*

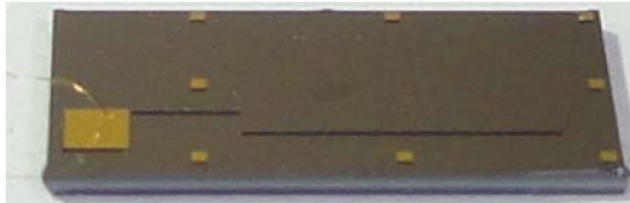




# MEMS accelerometer

## *Inertial navigation*

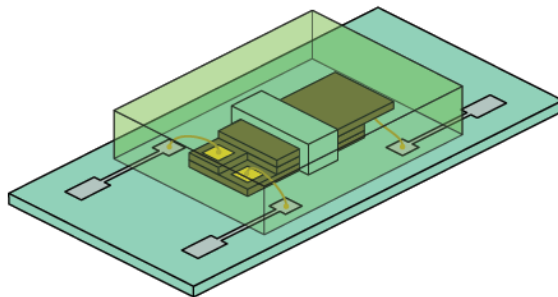
Sensor MEMS Layout:



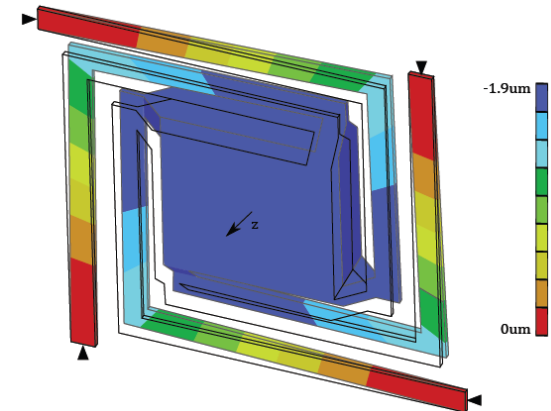
External board



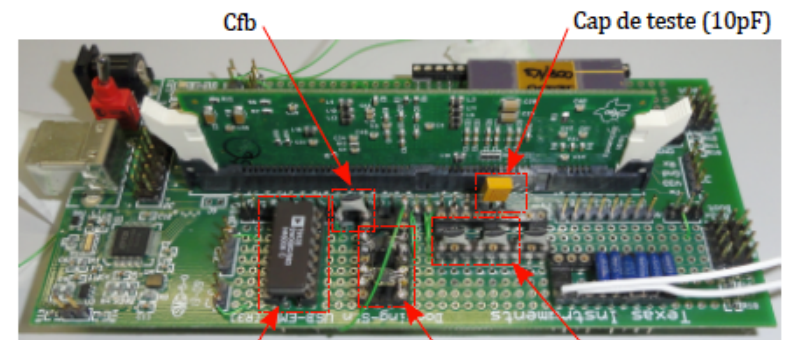
Central board



Sensor board assembly



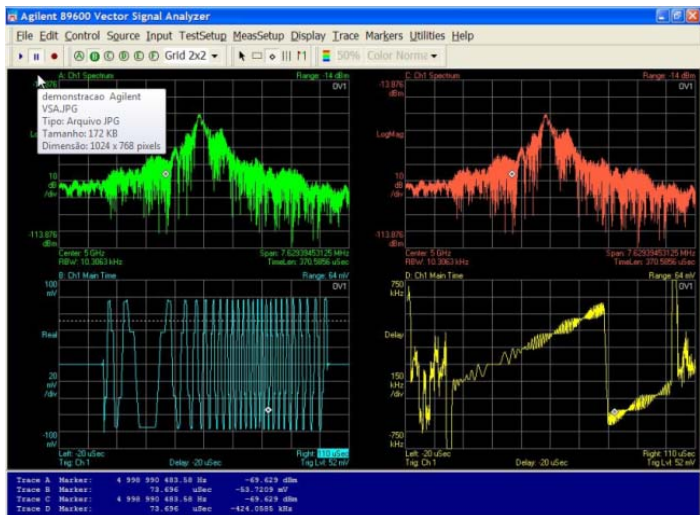
Simulation of the sensor central board deformation using finite element method.



Reader circuit board

# Electronic warfare

## *Radio frequency and radar*



Measurement and characterization of emitters/sensors from 300kHz to 20GHz



Radar Saber

Development of secondary surveillance radar with IFF (identification friend and foe) Mode 4 (military cryptography)

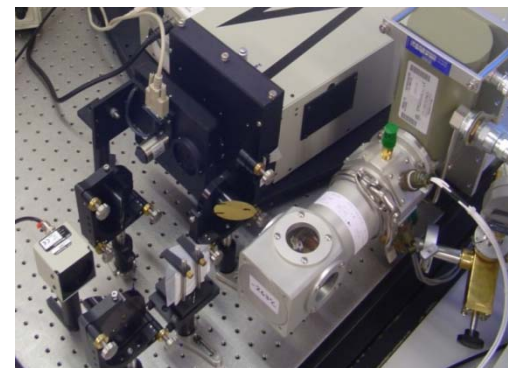
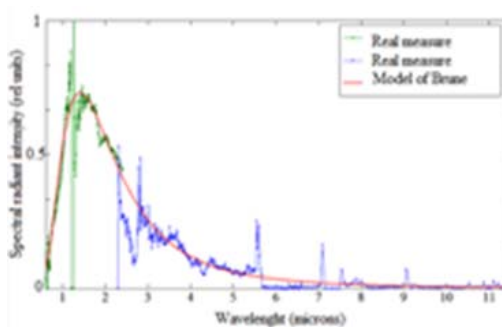
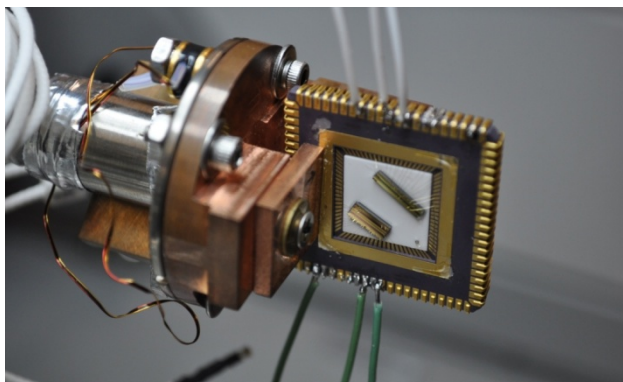


Radar signal generation during operational tests



# Electronic warfare

## *Infrared detectors*



Infrared guidance of air-to-air missile  
A-Darter

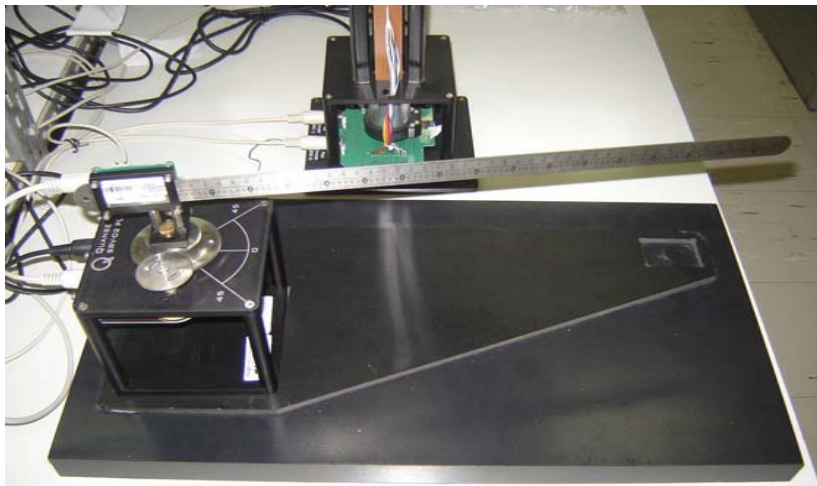
Measurement of infrared signatures of flares  
and aircrafts

Goal: Project, prototyping and characterization of Infrared detectors and emitters in the range of  $0,7\mu\text{m}$  to  $15\mu\text{m}$ .

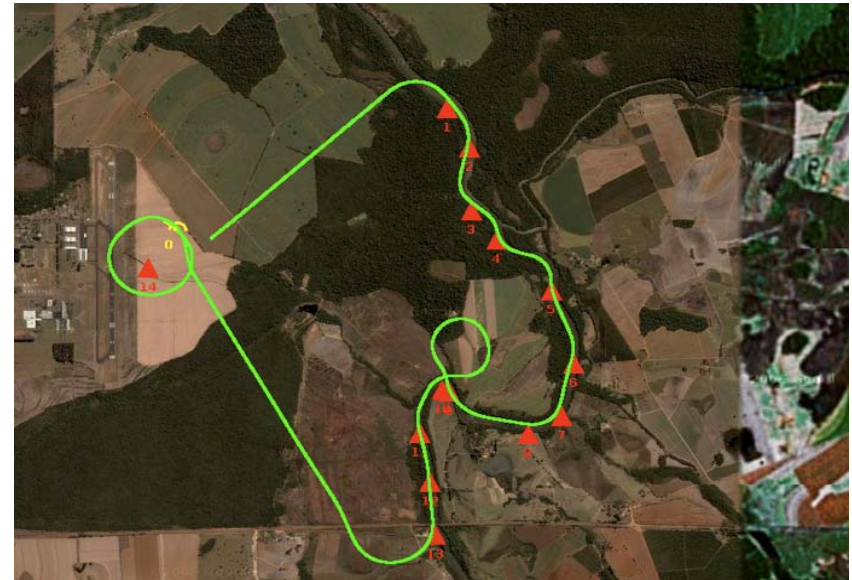
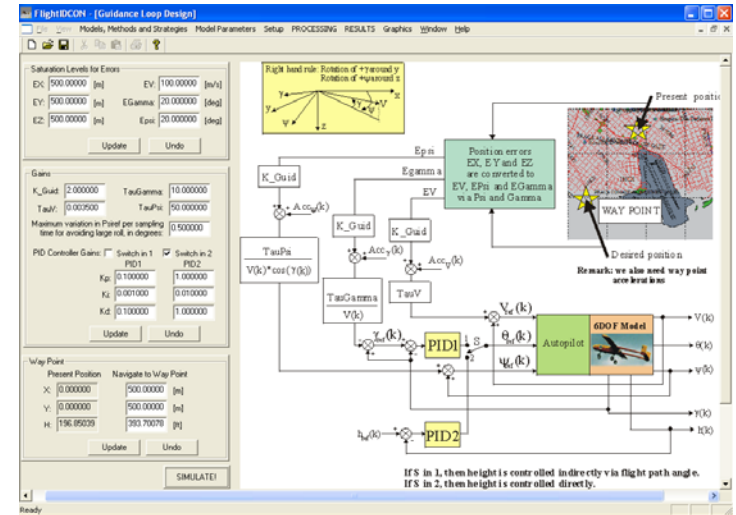
# Control Theory



Control of a quadcopter



Control of a thin link



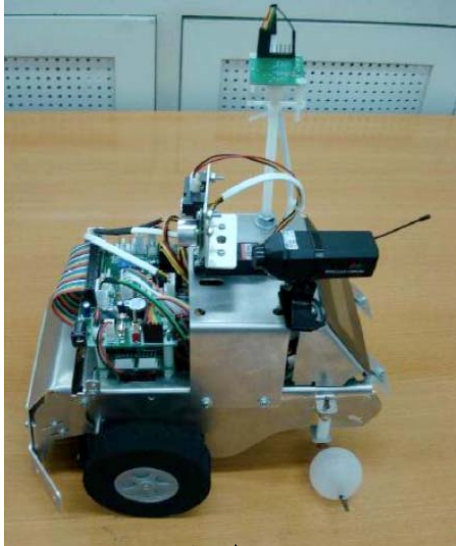
Identification, navigation and control of an aircraft



# Wheeled Robot

## *Navigation and Mapping*

Trekker Robot  
Rotation, translation and sensors



Results

Movement commands and  
sensors data

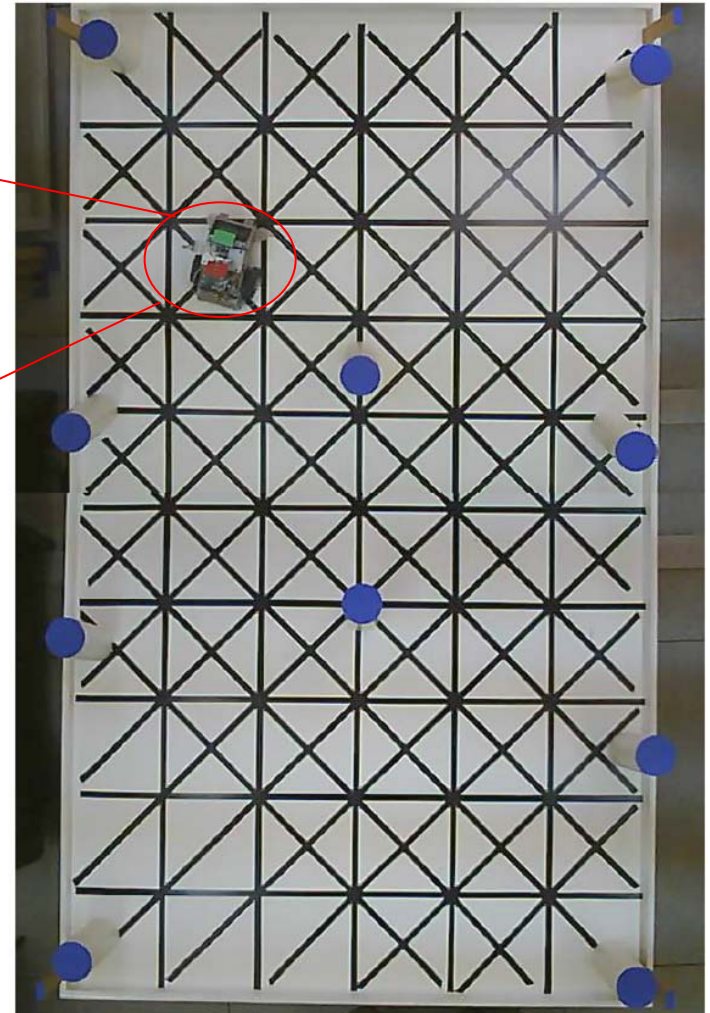
PC



Localization and tracking  
algorithms



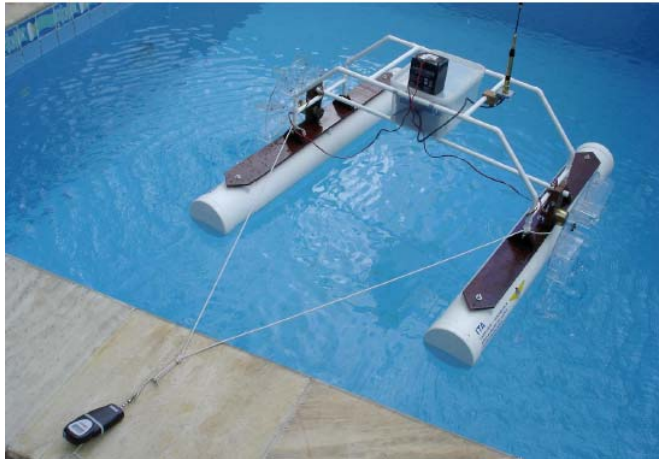
Serial  
Zigbee



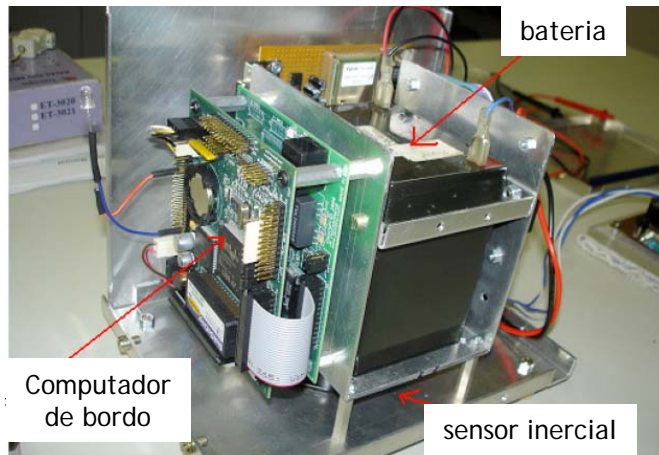
Robot environment

# Intelligent boat

## *Integrated INS/GPS and compass*



Propulsion force measurement



Boat control system

INS = Inertial Navigation System

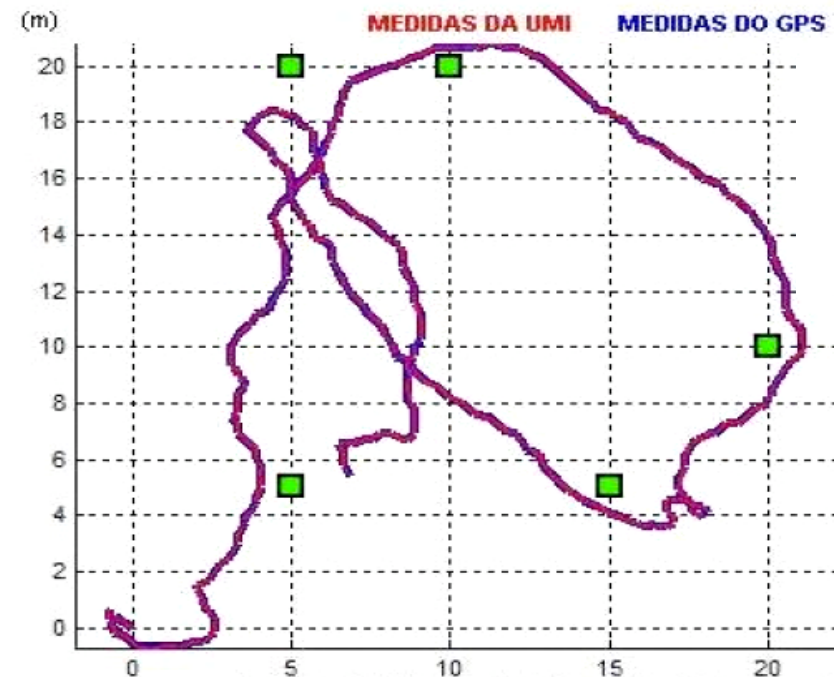


Chart of boat track

ELE: Douglas, Chiepa, Cairo



# UAVs

## *Unmanned Aerial Vehicles*

ITA presented a electric power transmission  
line inspection UAV at RIO+20 conference.  
Partnership ITA/CHESF/CESAR



Development of small  
aircrafts for electric power  
transmission lines  
inspection, borders  
monitoring,  
agriculture  
support, etc.



# UAVs

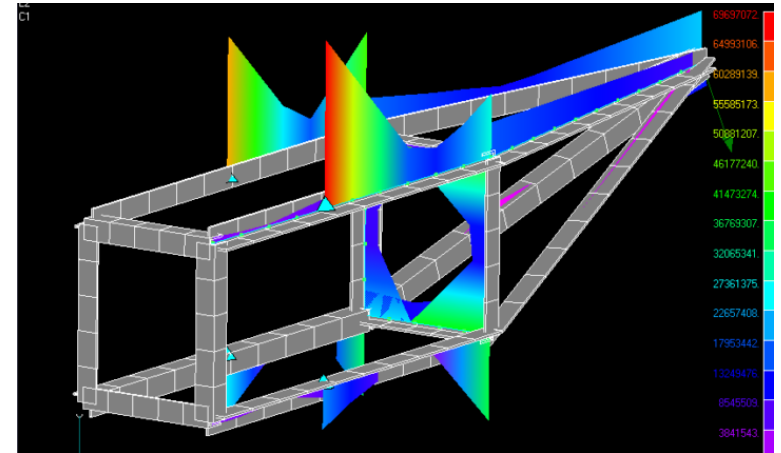
## *Electric power transmission lines inspection*



Aeronave Alfa



Aerodynamical tests



Structural analysis



Motor and propeller experiments

Goal: Developing an unmanned aerial vehicle able to detect problems in a electric power transmission line

ELE/AER/MEC: Adabo, Giovanni, Jacques, Cairo, Rizzi, Girardi, Paglione, Amilcar, Cristiane, Bussamra, Montestruque, Góes



# UAV automatic landing

## *Control and identification*



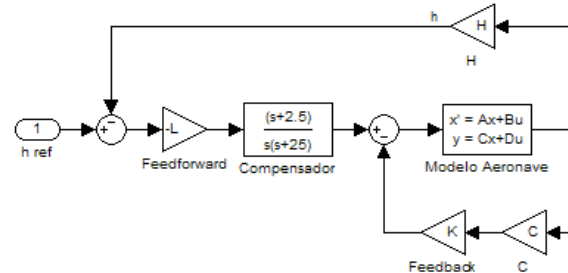
mini-UAV Alpha60



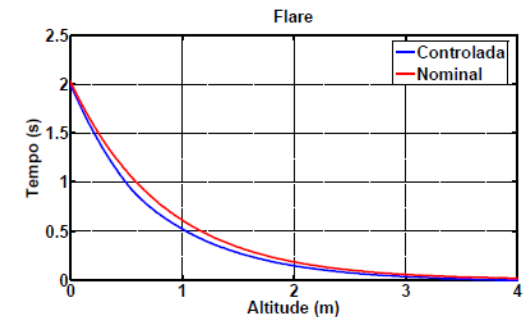
Wind tunnel experiments



CAD representation



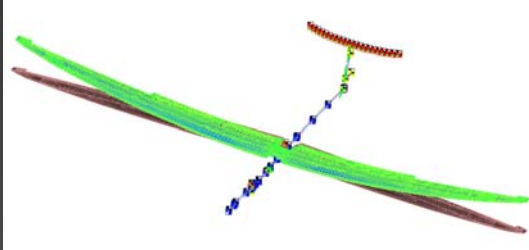
Flare control structure



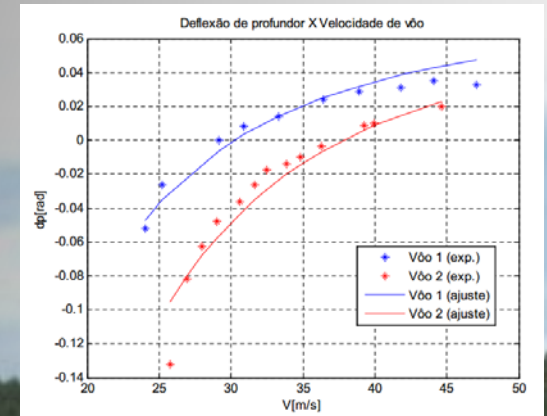
Height control in the flare phase

Dynamical identification and control

# Glider aircraft



Aeroelasticity and flight dynamics  
control studies



Flight tests





# Helicopters

Flight test at IPEV using neural network for speed estimation



Structural dynamics analysis of the Alpha One helicopter fuselage



# Airplanes

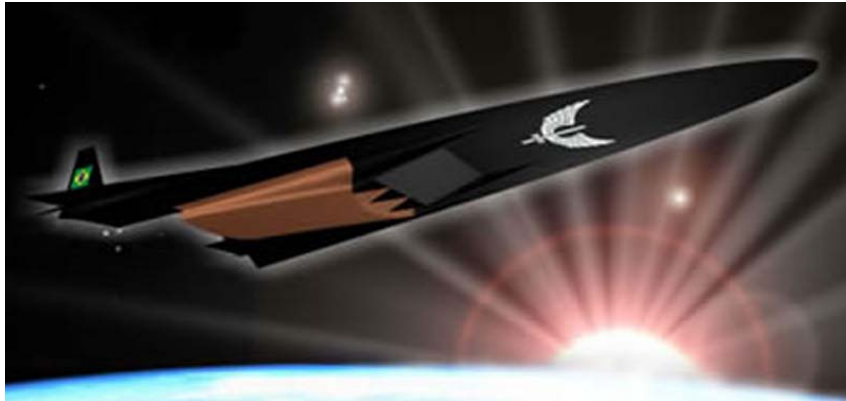
## *Professional Master in Aeronautical Engineering*



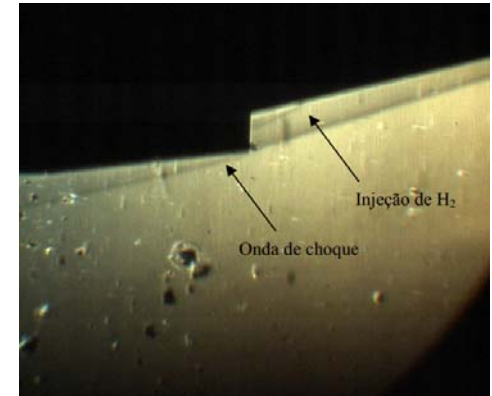
ITA has a partnership with Embraer, a Brazilian aircraft manufacturer, to graduate Master of Aeronautical Engineering students since 2001. In the end of the course, students present theses in several fields of aeronautics.



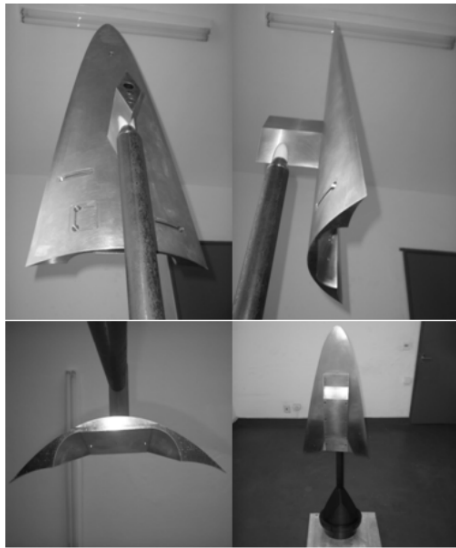
# Hypersonic vehicles



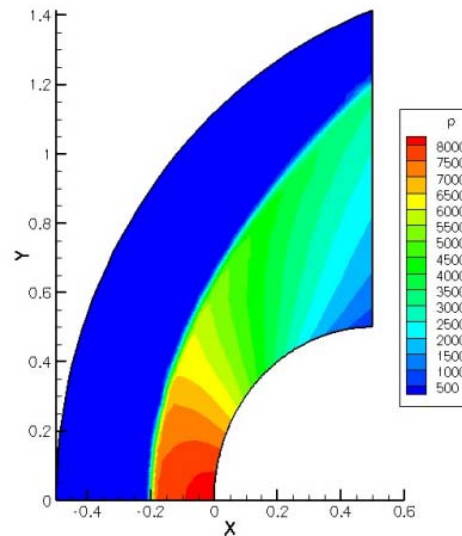
Hypersonic vehicle 14-X



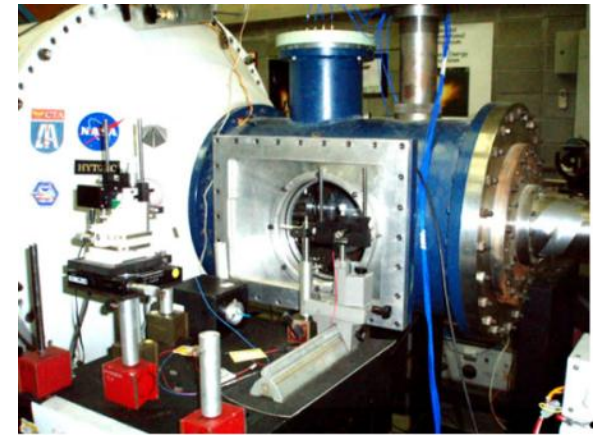
Supersonic combustion in the supersonic wind tunnel



14-X prototype used at aerodynamic experiments



Numerical analysis of high speed air flow



IEAv shock tunnel

# Gas turbines

## Applications

1. Propulsion of airplanes
2. Generation of electric energy, usually in the industry

## Aeronautical Turbine

Development and manufacturing of the first Brazilian aeronautical turbine.

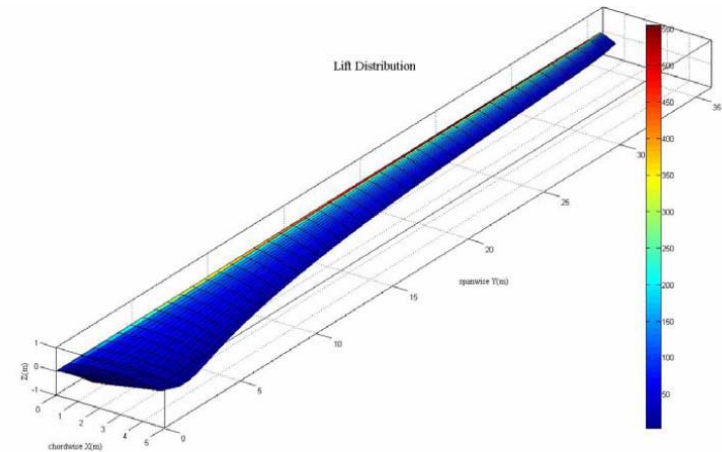




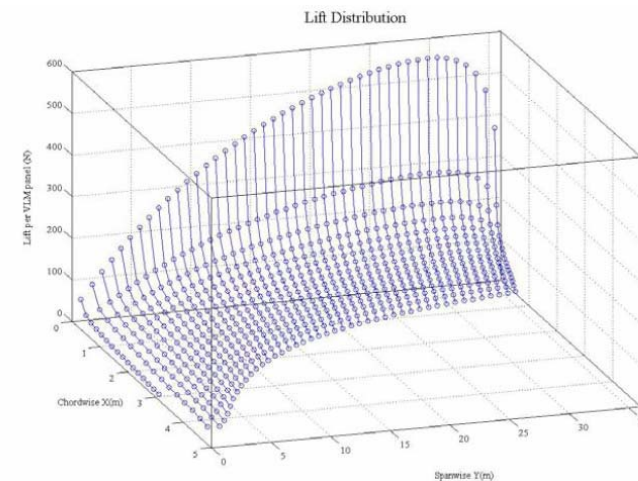
# Wind turbines



24 kW low-cost generator



Blade design optimization

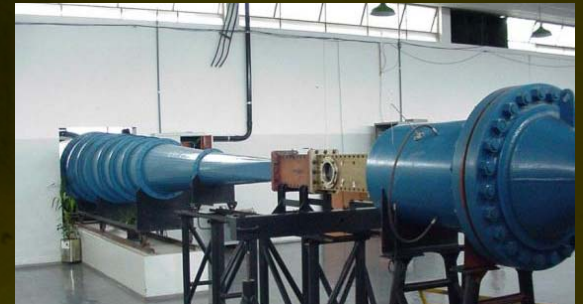


Aerodynamics/aeroelasticity analysis

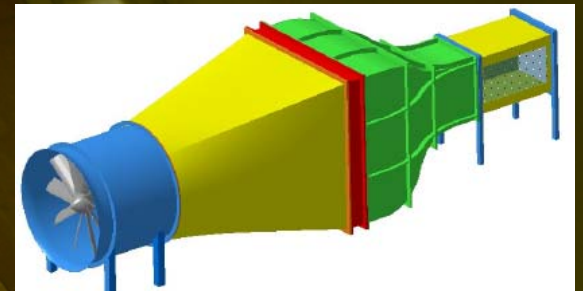
# Wind tunnel experiments



Educational and research wind tunnel



Supersonic wind tunnel



Aeroelastic tests wind tunnel

Length = 40m  
Max width = 4m  
Max height = 4,6m  
Mach number = 0,23  
Wind speed = 280 Km/h  
Test section:  $4 \times 1 \times 1,26 \text{ m}^3$



# Solid mechanics

## *Composite materials*



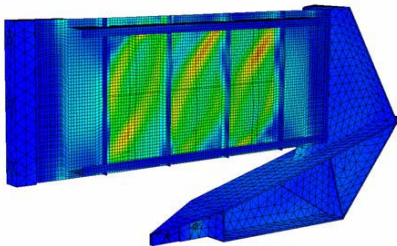
Manufacturing process: resin infusion



Impact resistance and damage tolerance



Buckling characterization and modeling



(a) Numerical prediction

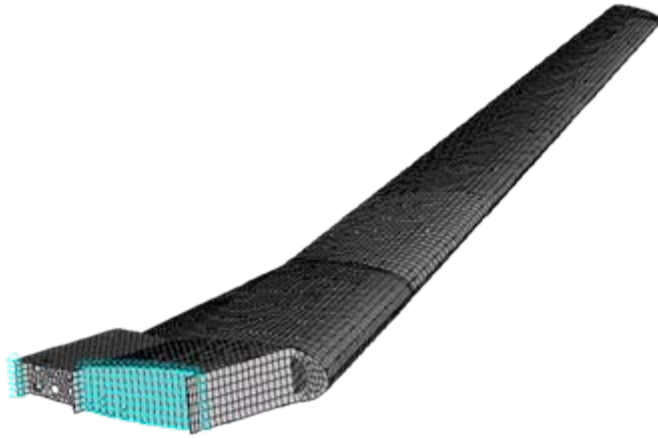


(b) Experimental

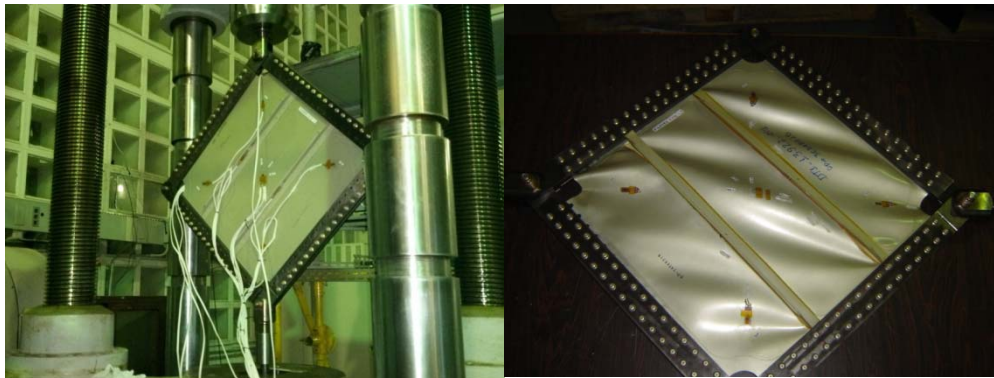
Failure characterization and modeling

# Solid mechanics

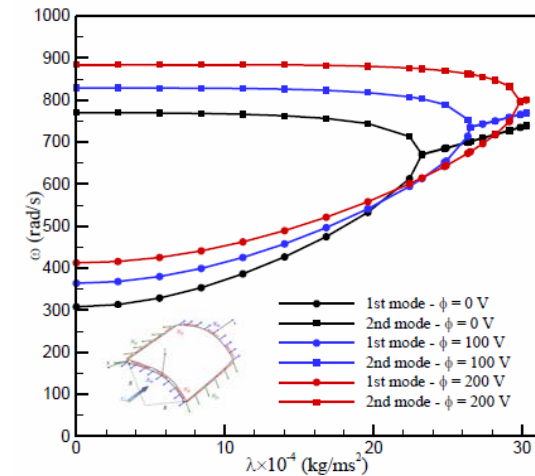
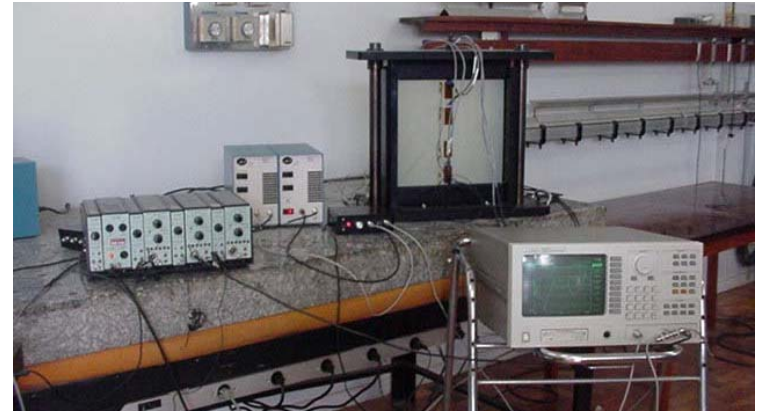
## *Metallic structures*



Structures optimization



New manufacturing technologies. Structural performance of aeronautical panels manufactured using: FSW (Friction Stir Welding), FML (Fiber Metal Laminate) & Bonding



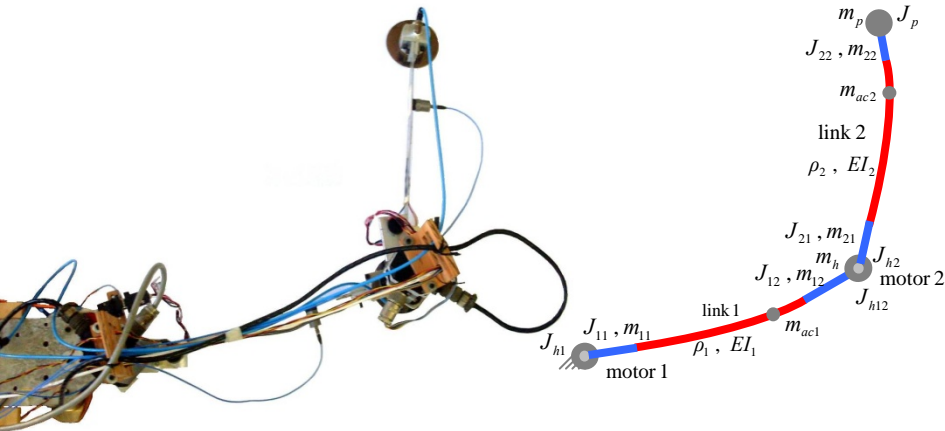
Smart structures

Piezoelectric materials applied to natural frequencies, buckling load and flutter control



# Flexible structures

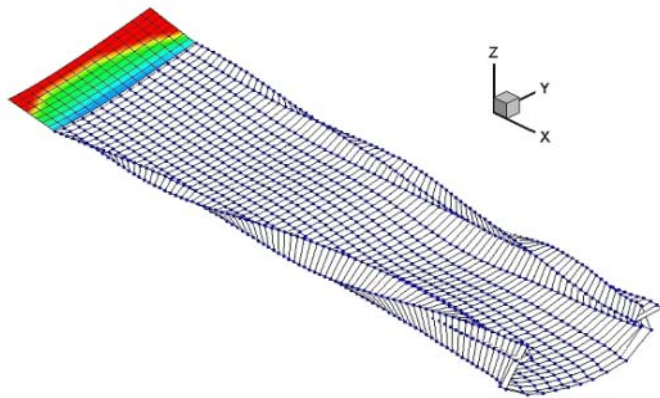
## *Vibration minimization and aeroelasticity*



Flexible robotic manipulator  
Modeling, identification, and control



Aeroelastic test of composite  
material wing



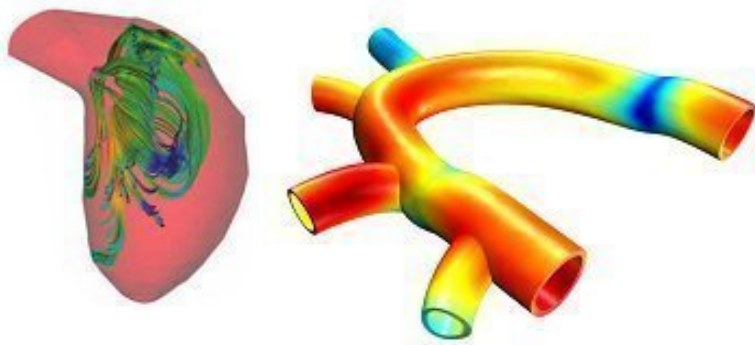
Aeroelastic model of very flexible  
structures



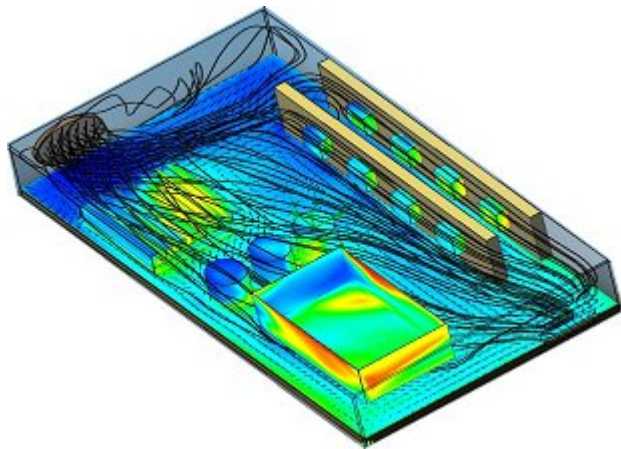
Aeroelastic measurement using laser  
vibrometer

# CFD - *Computational Fluid Dynamics*

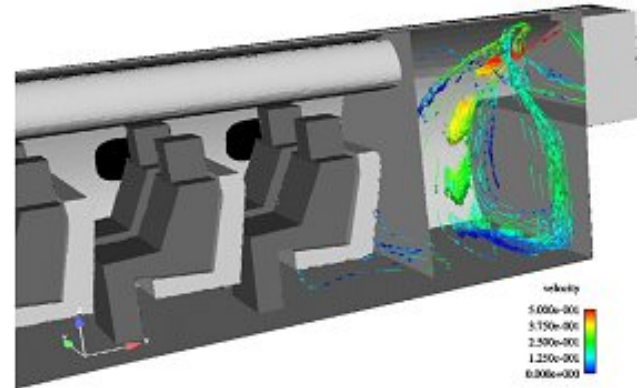
## *Fluid flow and heat transfer simulation*



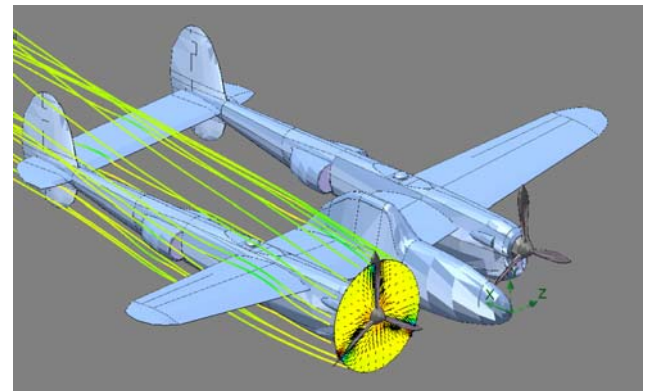
Blood flow and mechanical stress in the blood vessel



Heat flow inside an electronic device



Air flow inside an aircraft

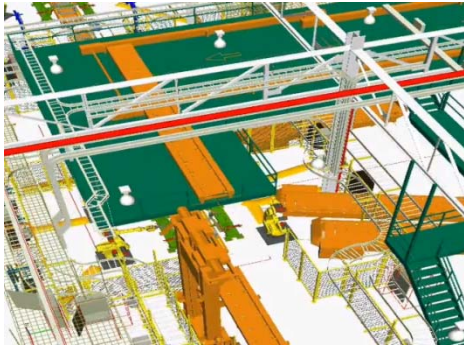


Air flow around an aircraft

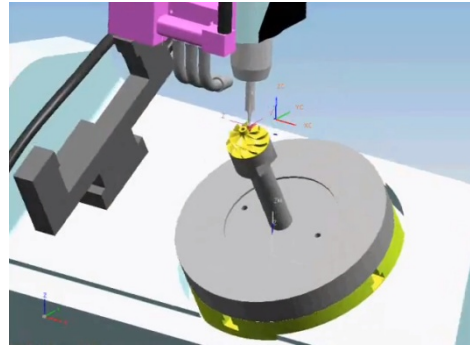


# Manufacturing

## *Manufacturing Competence Center*



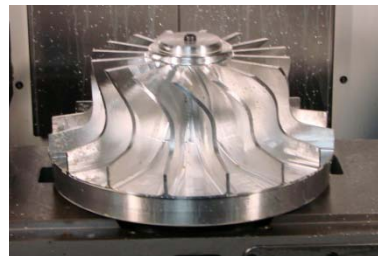
Digital manufacturing



Rapid prototyping



Machining and manufacturing processes



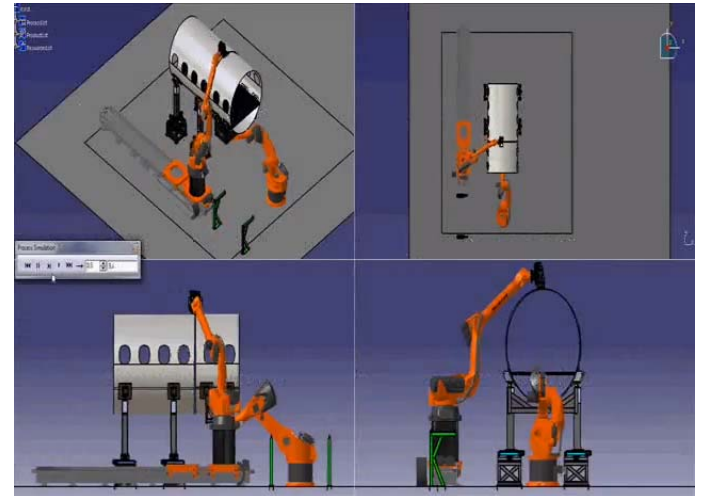
Cutting fluid

# Industrial automation

## *Manufacturing Competence Center*



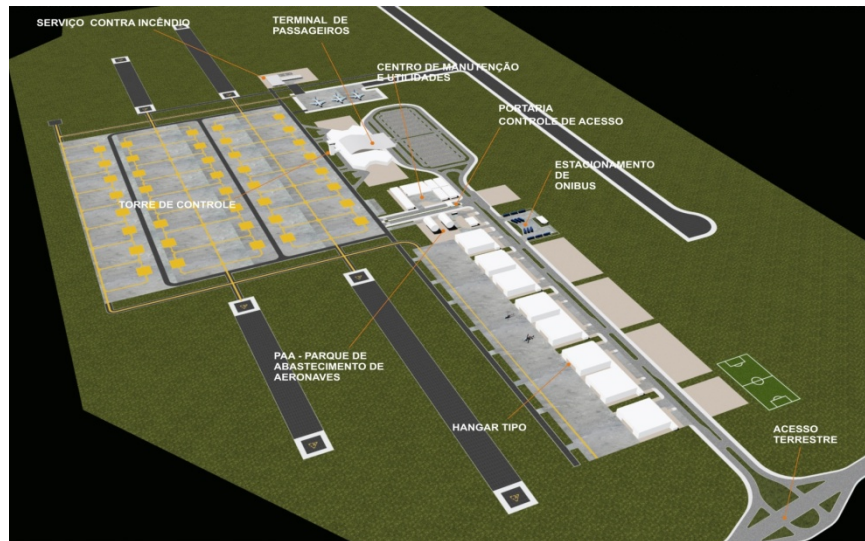
Foto: Germano Lüders/EXAME.com



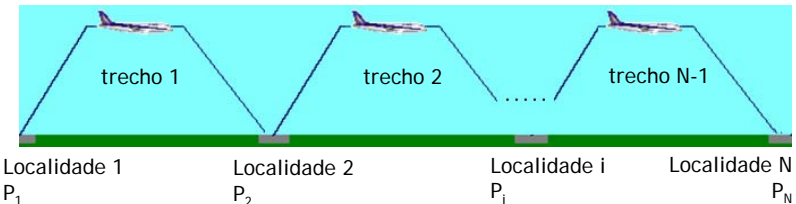
Automation of part of aircrafts fuselage assembly



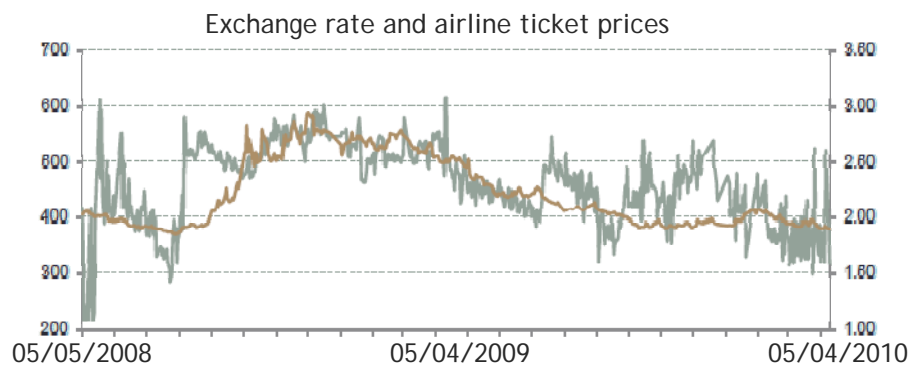
# Air transportation



São Tomé (Rio de Janeiro state) airport planning



Minimization of refueling costs considering multiple stops



Airline ticket price studies at airports of São Paulo state



Air transportation studies

# Airport runways

## *Tropical soils technology*



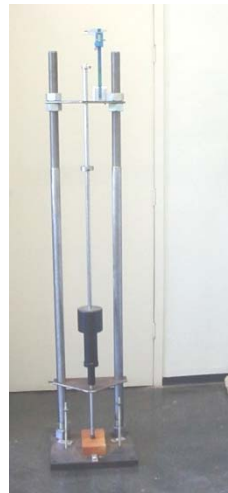
Studies for placement of airports



Use and behavior of lateritic soils in the construction of airport runways



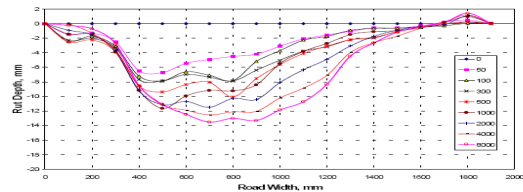
Development of equipments used to tropical soils studies



Study of airport runways damages



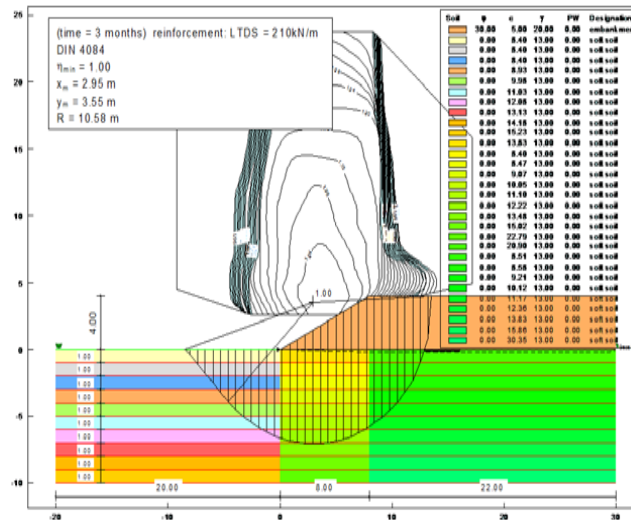
# Pavements, reinforcement and stabilization



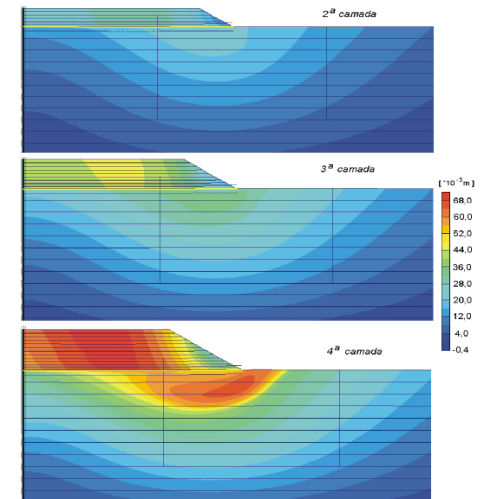
## Field experiments



## Laboratorial tests



## Modeling

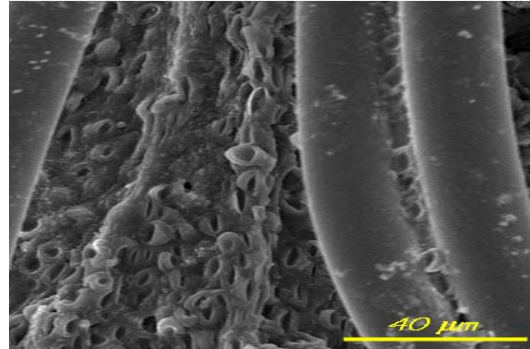


# Environmental protection

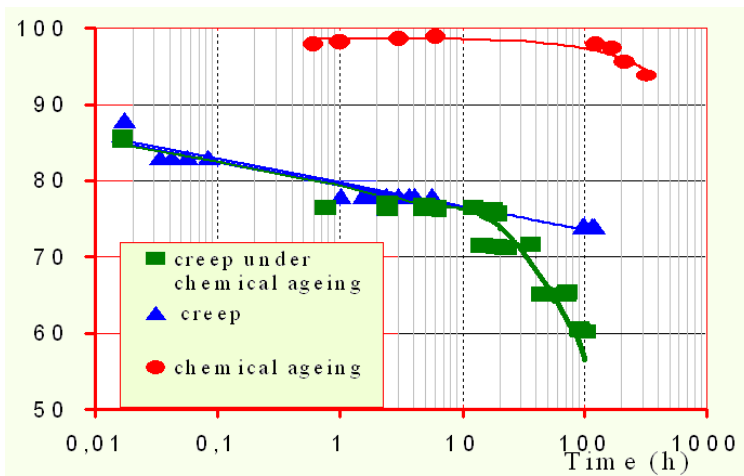
## *Geotechnics and geosynthetics*



Landfill site



Mining tailings



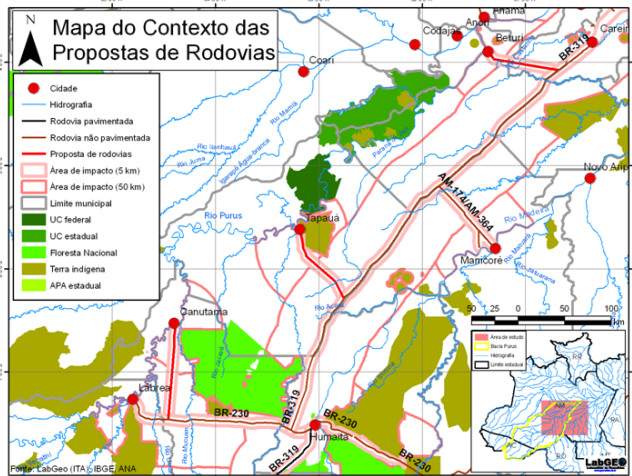
Geosynthetics over chemical attack



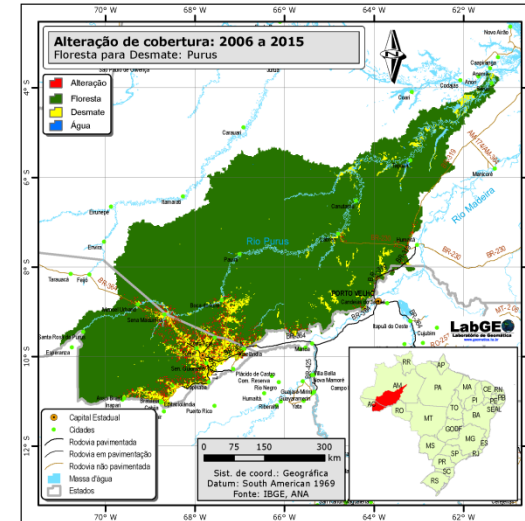
Industrial residue. Geosynthetic exhumed



# Environmental technology and protection



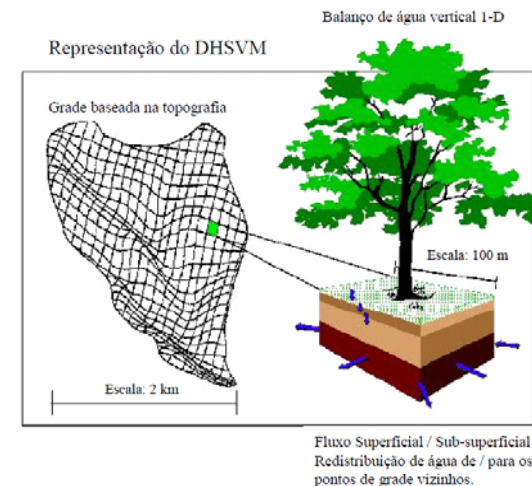
Environmental impact analysis of the roads connected to BR-319 highway



Deforestation simulation of Purus river basin



Drainage systems. Protection of a slope in the side of Tamoios highway



Hydrological modeling

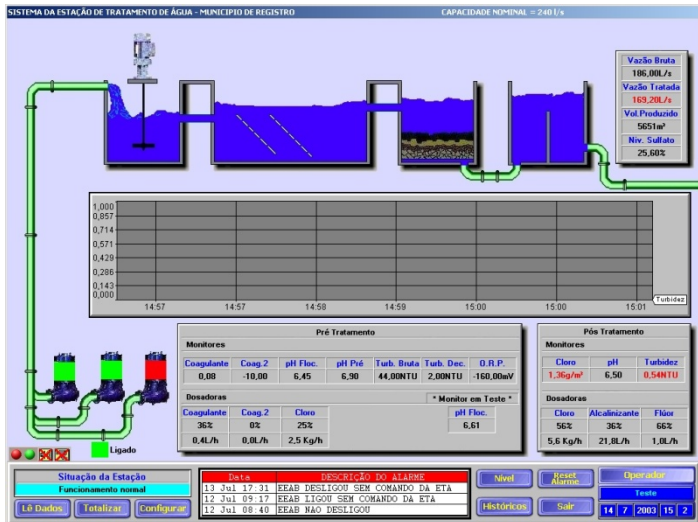
# Sanitary engineering



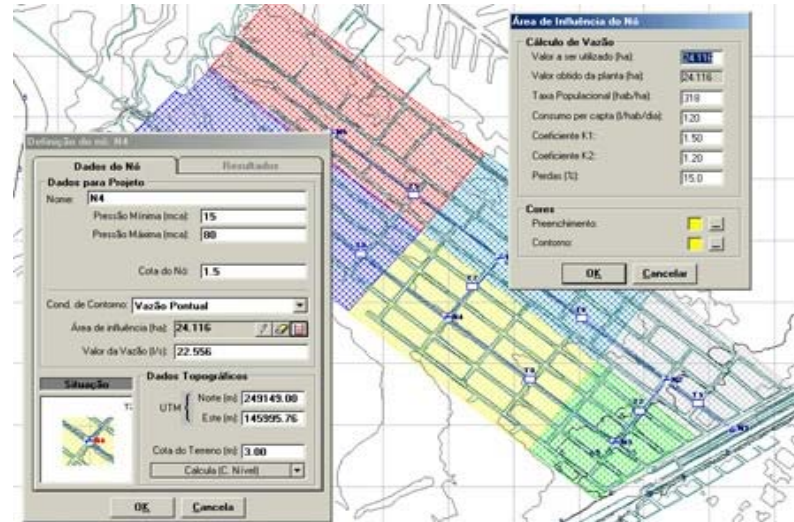
Water and sewage treatment



New technologies and equipments for water reuse



Rain water usage



Automation of sanitary systems





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Academic Director