MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Scuola Nazionale Biennale "Rivelatori ed Elettronica per Fisica delle Alte Energie, Astrofisica, Applicazioni Spaziali e Fisica Medica“ - VI Edizione

INFN Laboratori Nazionali di Legnaro
23-27 Marzo 2015

S. Manea

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Research Activities on Electronic Components for Space in Brazil

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Legnaro – 25 march 2015

Structure of Presentation

1. Instituto Nacional de Pesquisas Espaciais – INPE
2. Research in Radiation effects in Electronic Components.
3. Space Electronic Components Area
4. Use of Commercial off the Shelf - COTS
5. Infrastructure for Design and Radiation Test
6. Agreements
7. Open Discussion

SÃO JOSÉ DOS CAMPOS – SÃO PAULO

AREA: 1099,6 km²

SÃO JOSÉ DOS CAMPOS - BRASIL

POPULATION: 680.000

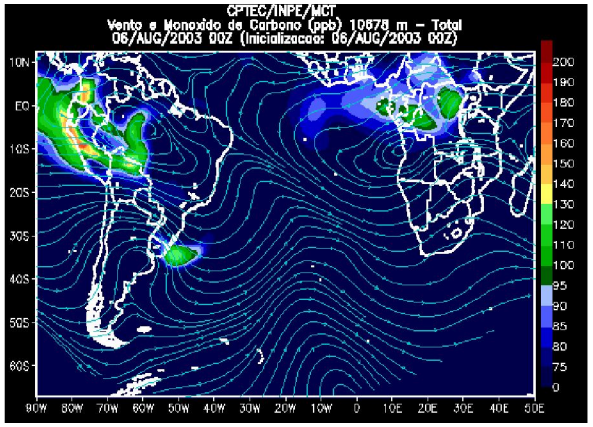
BRAZILIAN NATIONAL SPACE RESEARCH INSTITUTE

INPE: Space R&D for Brazil in the 21st Century

BRAZILIAN FEDERATIVE REPUBLIC (*PRESIDENT*)

SCIENCE, TECHNOLOGY AND INOVATION MINISTRY

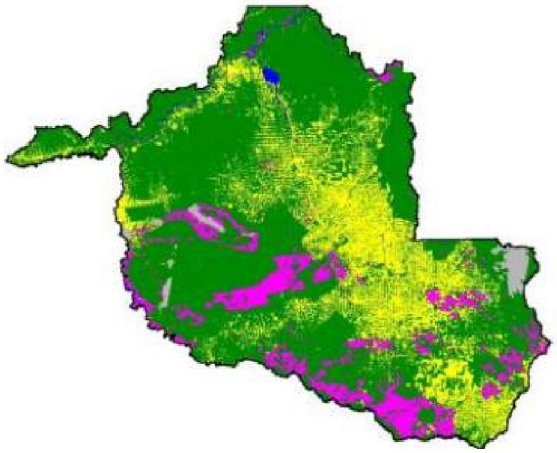
- **AEB**
- **INPE**



INPE – Instituto Nacional de Pesquisa Espaciais

MISSION

1. *Satellite Design*
2. *Earth Remote Sensing*
3. *Universe Observation*
4. *Weather Forecast*
5. *Space Weather Monitoring*
6. *Wild Fire Detection at Amazonia*
7. *Monitoring Deforestation in Amazonia*
8. *Antarctica Weather and Water Quality*
9. *Lightning Detection*
10. *Space Materials Research*
11. *Pos Graduation Courses*



INPE

1200 Researchers and Technologist

1500 Support

800 Candidate DSc and MSc

INPE: CONVERTING DATA INTO KNOWLEDGE

SATELLITES

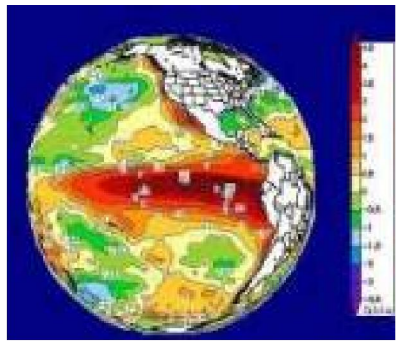
Earth observation, scientific, and data collection satellites

GROUND SYSTEMS

Satellite control, reception, processing and distribution of satellite data

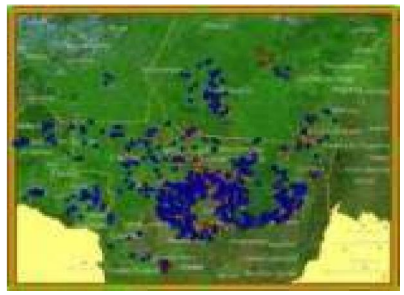
ANALYSIS AND MODELLING

Space Weather, Weather Prediction and Earth System Science

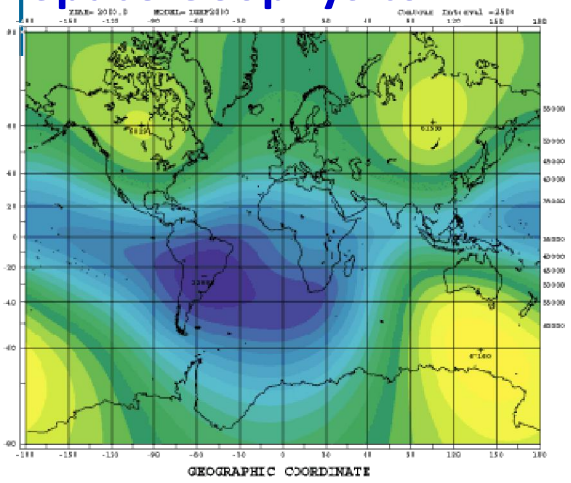


SOCIETAL BENEFITS

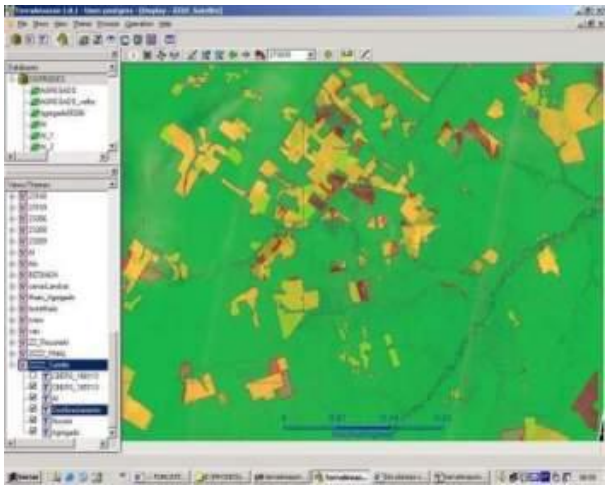
Innovative products to meet Brazil´s needs



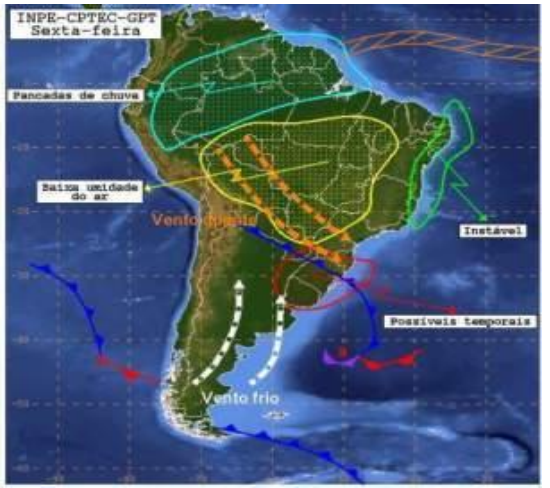
Space Geophysics



Remote Sensing

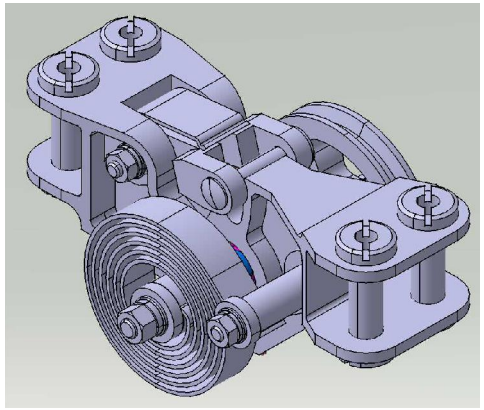


Meteorology



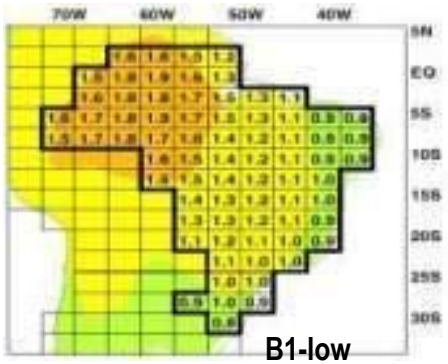
INPE combines research and applications

Astrophysics



Space Engineering

Computing



Earth System Science

Focus on Social Benefits of Space

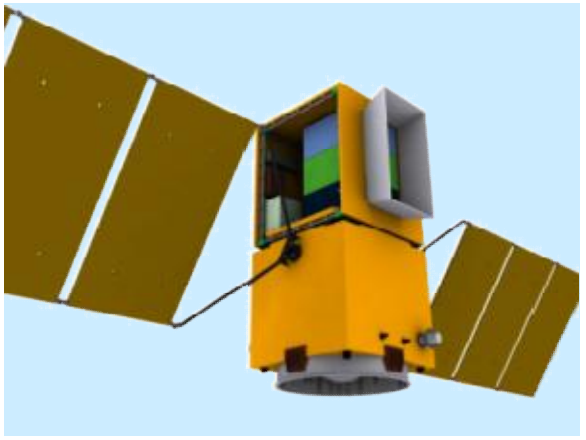
Agriculture

Energy

Ecosystems

Climate Change

Weather and natural disasters

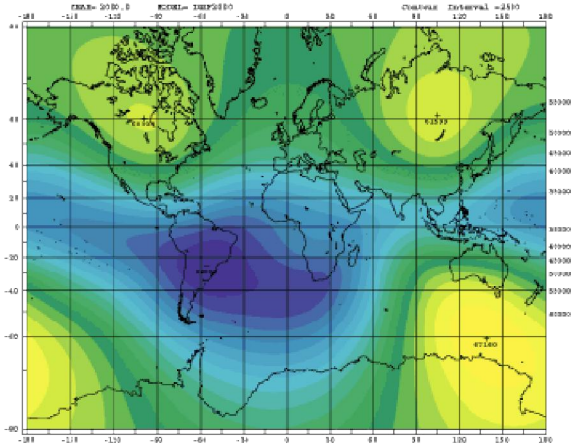


Technological innovation

Challenges

Territory

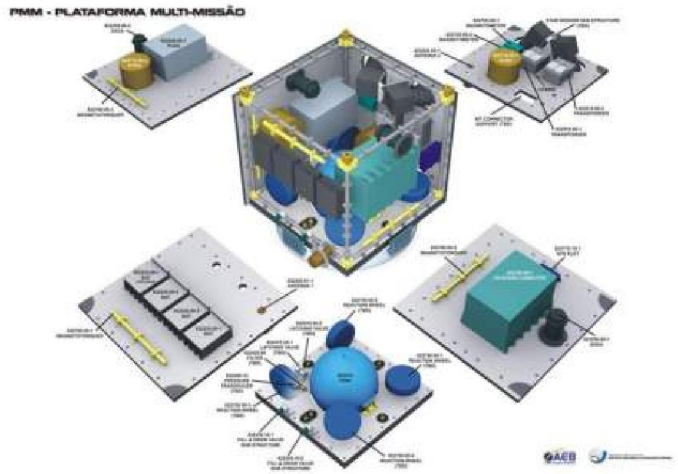
Regional meteorological space



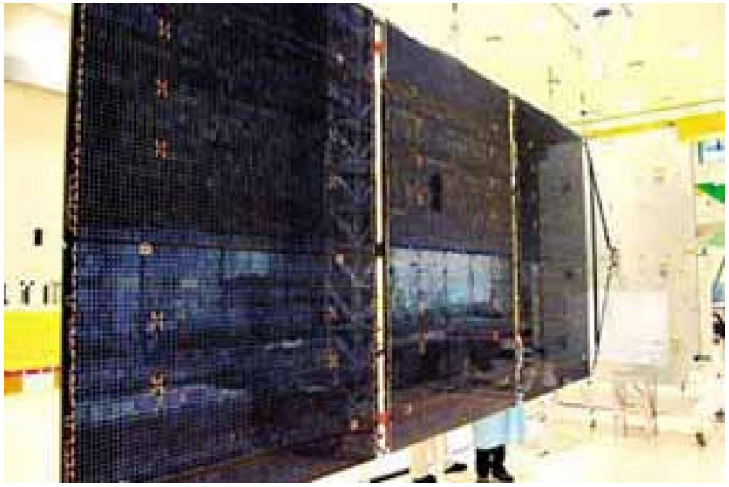
Sun-Earth interaction space

Outer space

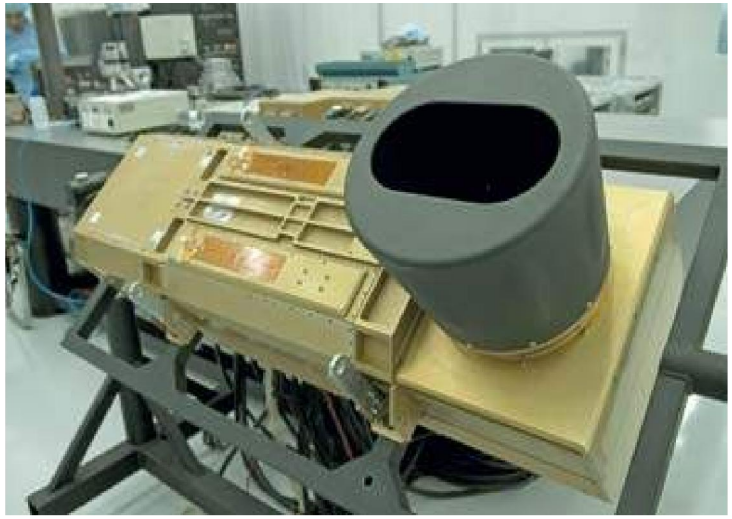
MMP – Multi Mission Platform



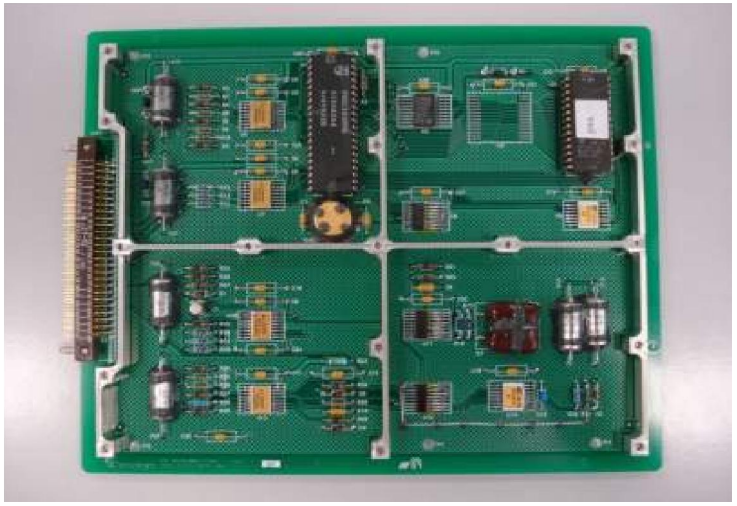
CBERS solar panels



INPE is the main drivers of innovation in space technology



Camera MUX-Free



CBERS onboard computer

Integration and Testing Lab - LIT

Complete infrastructure for assembly, integration and testing of satellites
70,000 hours of industrial tests per year

Integration of Satellite in INPE

LIT – Integration and Testing Lab

CBERS 3

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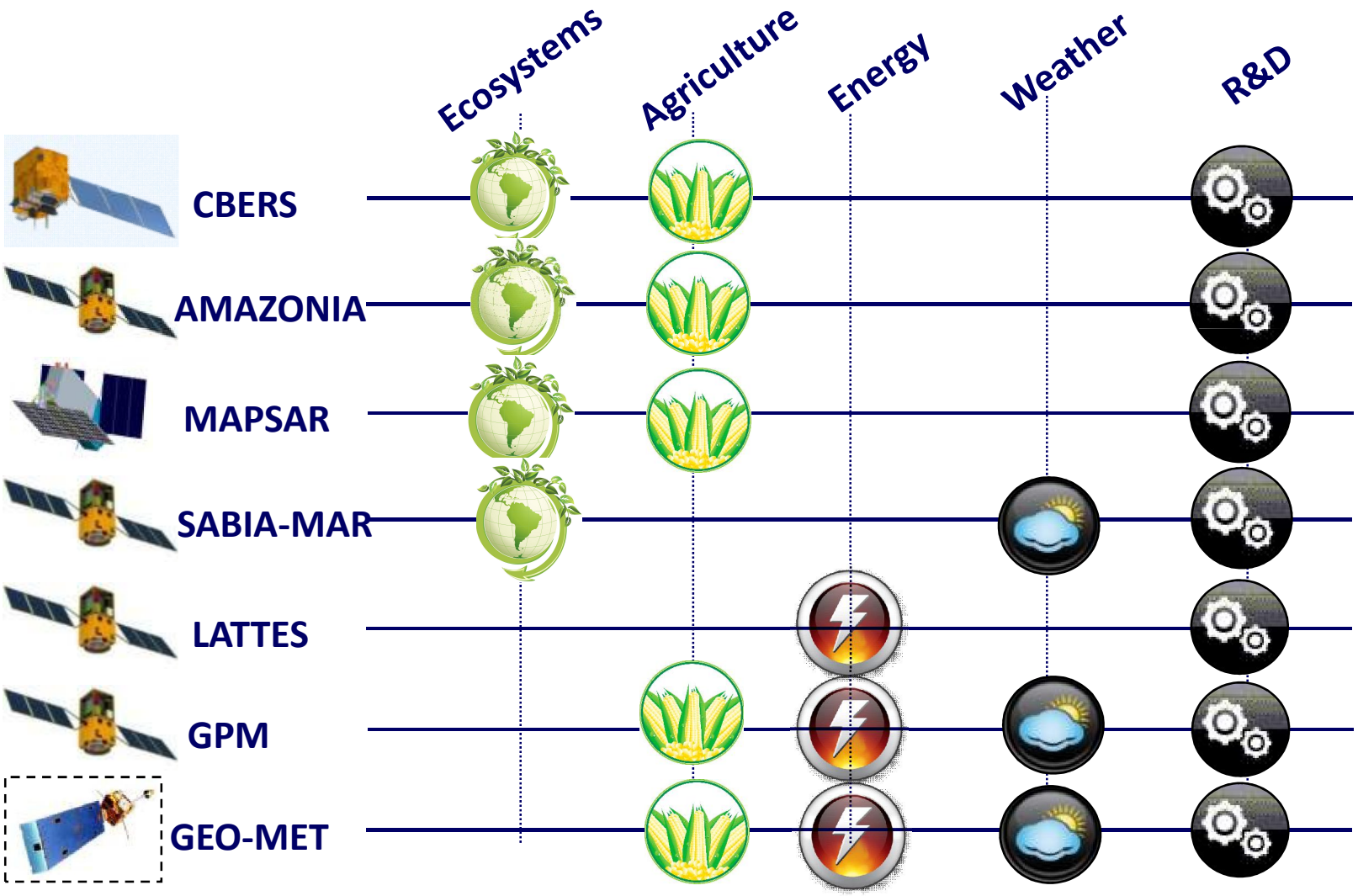
Applications of Brazilian satellites



CBERS-2B Launch (19 September 2007)

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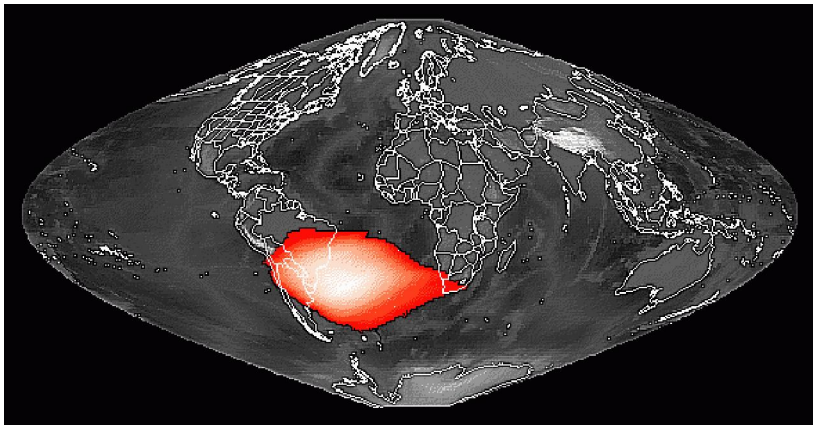
South Atlantic Anomaly



- SAA is a distortion of the earth's magnetic field allows the proton belts to extend to very low altitudes in the region of Brazil and in part of the South America
- Low Earth Orbiting satellites will be exposed to high energy protons in this region

Why Design Tolerant Systems

- **The Space Radiation Environment**
  - SAA in Brazilian territory – Reliability
- **Technological Independence**

Brazilian Satellites

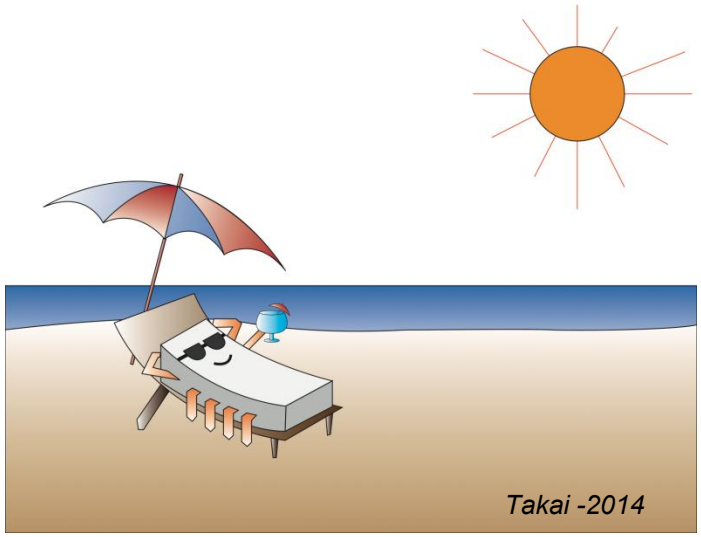
1- Earth Remote Sensing Satellite – LEO

2- Scientific Satellite – LEO

3- Communication Satellite - GEO

Radiation Effects in Electronic Components

- Radiation Effects Prediction Techniques
- Designing Tolerant Systems
- Infrastructure of the Radiation Test
- Radiation Effects Testing Databases



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Space Electronic Components Area

Plans for Satellite Area

- Reliability of Satellite Missions using RadHard Components

- Reliability of Scientific Satellite Mission using **COTS**

Goals

Mission: Reliability of Satellite Missions using **RadHard Components**

Memories

- SRAM, NVM

Emulation:

- FPGA SRAM and anti-fuse

Processors:

– Single and multi-core

Interfaces for high speed communications:

– SpaceWire, 1553, CAN

On-board high speed processing

– Cameras, Data Recorders, SAR

Satellite power

– DC-DC, In-Rush and Latch-up protection

Goals

Mission: Reliability of Scientific Satellite Mission using **COTS**

1. **Satellite control commands (AOCS)**
   - Protection against TID and SEE
2. **On-board high speed communication**
   - Immunity to TID and SEE
3. **On-board high speed processing**
   - Immunity to TID and SEE
4. **Satellite power**
   - In-Rush and Latch-up protection

Special Functions for Space - ASICs

Integrated Circuit - Command and Control
Assure integrity of the command on satellite (payload and control) - protection of the mission from catastrophic failures

Integrated Circuit - SpaceWire Interface
Assure integrity and high speed data communication bus on-board (control and payload). - ESA protocol

Integrated Circuit - In-Rush Protection
Assure integrity of the power supply bus on-board (control and payload).

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Space Electronic Components Area

Plans for COTS Area

- Start investigation to understand limits
- Performing extensive evaluations of various COTS components
- Select manufactures
- Establish a COTS risk

Space Electronic Components Area

Plans for COTS Area

- Validate COTS meet data sheet performance as specified
- Determine COTS reliability
- Determine COTS robustness beyond vendor specification
- Identify screening and qualification methodologies
- Identify vendors & product quality and reliability
- Establish a COTS data base

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Centro de Tecnologia da Informação Renato Archer

CTI Design House

(IC, Hibryd, ASICs, Analog and Digital)

Instituto de Estudos Avançados – DCTA

Ministério da Defesa

Infrastructure for TID Test
(Total Dose Ionizing)

- Cobalto 60 source - 5k curies (Ci)
- Neutron Source - Deutério–Trítio 14 MeV

Universidade do Estado de São Paulo - USP

Instituto de Física

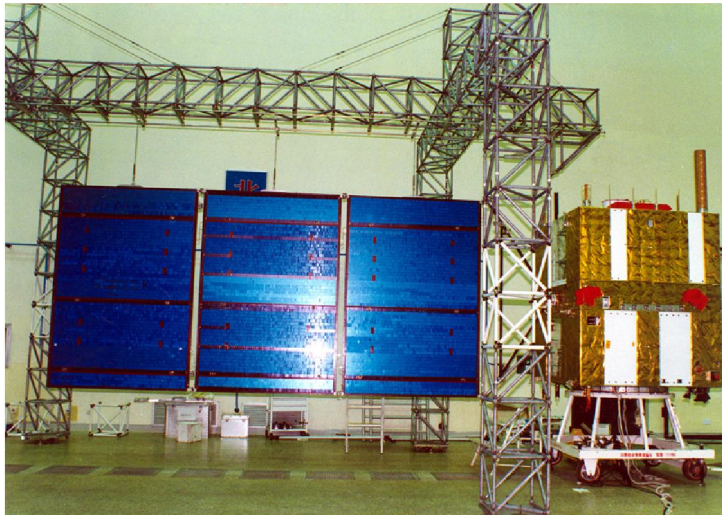
IFUSP

INFRASTRUCTURE FOR SEE TEST (Single Events Effects)

1.7 MV Pelletron Electrostatic Accelerator
8 MV Pelletron Electrostatic Accelerator

LINAC Accelerator -14MV.

Instituto Nacional de Pesquisas Espaciais - INPE

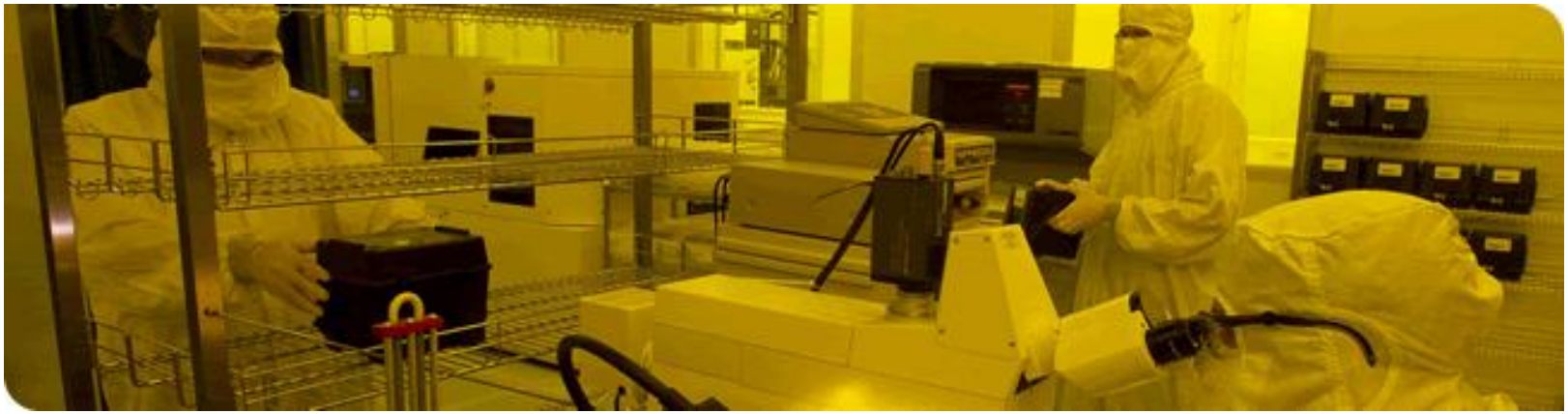


INFRASTRUCTURE FOR RADIATION EFFECTS ANALISYS

INFRASTRUCTURE FOR SPACE ENVIRONMENTAL TEST (Vibration, Thermal, Vacuum)

INFRASTRUCTURE FOR ELECTRONIC TEST

Brazilian Foundry



CEITEC S.A Semiconductors

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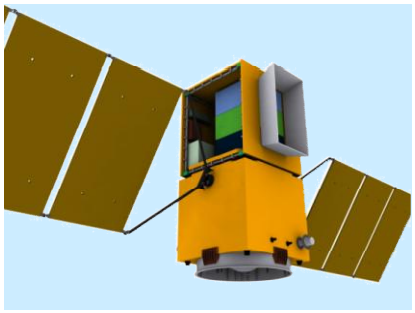
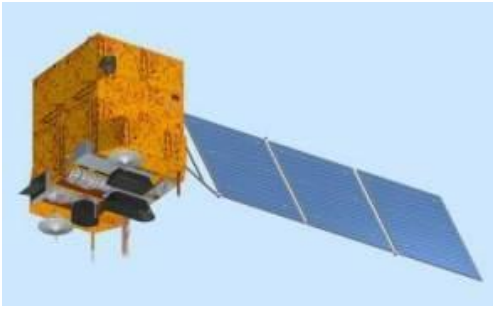
Agreements

Brazilian University

- Instituto Tecnológico da Aeronáutica - ITA
- Faculdade de Engenharia Inaciana - FEI
- Instituto de Tecnologia Mauá - MAUÁ
- Universidade de São Paulo - USP
- Universidade Federal do Rio Grande do SUL –UFRGS
- Universidade Federal de Santa Maria – UFSM
- Universidade Federal de Minas Gerais-UFMG
- Universidade Estadual Julio de Mesquita – UNESP
- Universidade do Vale do Paraiba - UNIVAP

Agreements





Bilateral agreements

- China: CAST - CBERS program, Space Weather
- France: GEO satellite, Scientific Satellite
- USA – NASA – Scientific Satellite
- Italy – ASI, UNIPD – Radiation Effects
- Argentina – INVAP – AOCS, Sabiá-Mar LEO satellite

Thank You!

Questions?

VI Workshop on the Effects of Ionizing Radiation on Electronic and Photonic Devices for Aerospace Applications

ITA – Instituto Tecnológico da Aeronáutica - DCTA

São José dos Campos, SP, Brazil, October 20-22, 2015

silvio.manea@inpe.br