INVAP in Space

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ITU Symposium on Small Satellites

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Key Data

CORPORATION

INVAP operates as a private listed company with no public budget allocation and no tax exemptions

CREATION

September 1st, 1976

OWNERSHIP

Province of Río Negro, Argentina

AREAS OF ACTIVITIES

Nuclear Technology – Aerospace Technology – Government and Defense – Industrial Technology and Alternative Energies – Information & Communication Technology

ANNUAL SALES

200 million USD

WORKFORCE

1400 employees, 80 % of them are scientists, engineers and technicians

SUBSIDIARIES/BRANCHES

Australia, Brazil, Egypt, USA, Venezuela and Saudi Arabia

Value Proposition

INVAP supplies high technology strategic products to corporations and government agencies worldwide, developed by interdisciplinary teams under contract provisions balancing technical challenges, budget and schedule constraints.

- INVAP works in close **association with the customer during the complete life-cycle of each project.** This helps to ensure a fruitful **Know-How and Technology Transfer** process
- INVAP works in **multi-national, multi-cultural projects**, and routinely deals with the necessary **commercial, safeguard and regulatory environments** of the aerospace, defense and nuclear industries.
- INVAP **core activities are developed in-house:** Design, prototyping, manufacturing, integration, functional & environmental testing are done all under one roof.
- INVAP has full **control of technologies and processes** that go into the end products: this ensures a **long-term commitment** to customers´ programs.

Areas of Activities

Nuclear Division

Design, construction and commissioning: Nuclear research reactors, critical facilities, radioisotope production plants, fuel manufacturing plants, waste management systems, spent fuel storage facilities.

Digital Terrestrial TV Area

Design, implementation and deployment of terrestrial digital TV systems.

Industrial and Alternative Energies Division

Products and Services

- Wind turbines
- Robots and special machines
- Food drying systems
- Chemical processes
- Hydro-kinetic, hydraulic turbines
- Equipment for the Oil & Gas industry

Medical Systems Area

Design and construction of:

- Medical equipment
- Radio-therapy equipment
- Radio-therapy simulators
- Turnkey Radio- therapy centers

Aerospace and Government Division

AEROSPACE:
Design and construction of space systems from concept design to operations:

- LEO and GEO satellites.
- Spacecraft bus
- Electro-optical & microwave payload
- Flight worthy components
- In-orbit operations

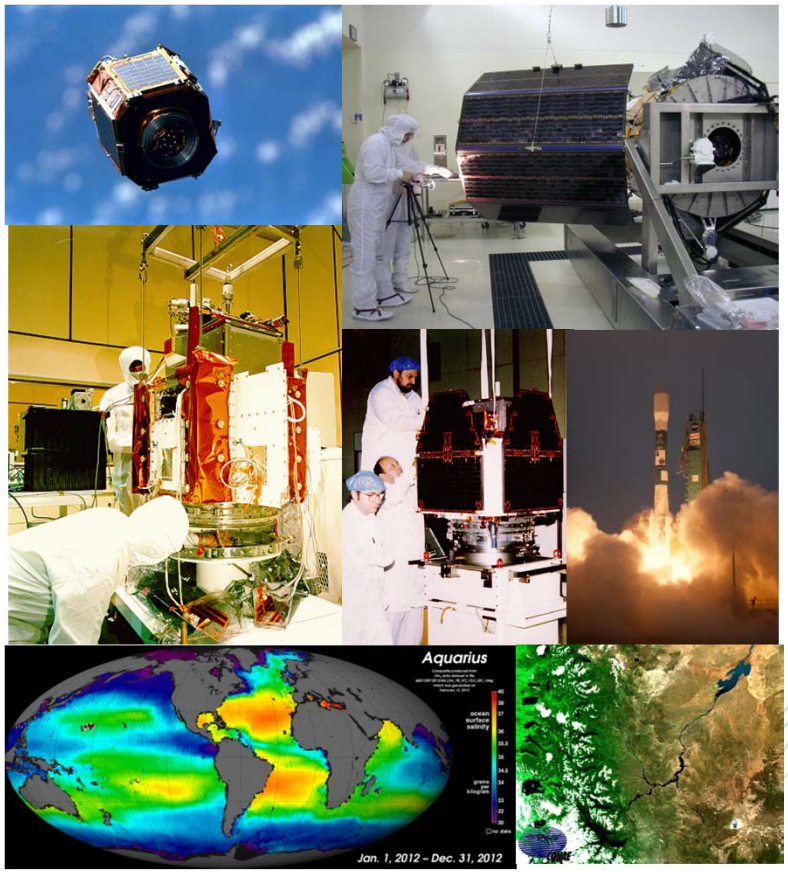
GOVERNMENT & DEFENSE:
Design and construction of radar systems for:

- Air traffic control
- Defense
- Meteorological applications

Aerospace Division: Heritage

Earth Observation Satellites: SAC Program

The SAC program was implemented after the signature of a collaboration agreement between CONAE and NASA in 1991. It consisted of a series of 4 LEO satellites (SAC-A, SAC-B, SAC-C and SAC-D) carrying instruments for scientific and remote sensing applications with the purpose of studying and understanding our planet.



INVAP participation in the Program

- Mission design
- Project Management
- Platform design and manufacturing
- Payload design and manufacturing
- Satellite Integration and Testing
- Launch campaign
- Launch and Early Orbits Operations
- Platform and Payload commissioning

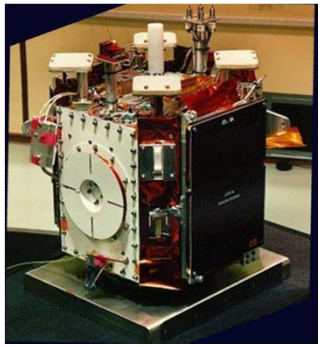
SAC-D 2011

Highlight	NASA's decision to use a platform designed, manufactured and integrated entirely by INVAP, for the Aquarius instrument, is a clear sign of trust in INVAP´s capabilities
Objective	Provide monthly global maps of the sea water surface salinity, to understand the ocean processes and climate change.
Mass	1350Kg
Payload	Main instrument: Aquarius. Other instruments including: Atmospheric Sounder (Italy), Debris and Radiation mapper (France), High Sensitivity camera, NIR camera and MW Radiometer (Argentina)

SAC-C 2000

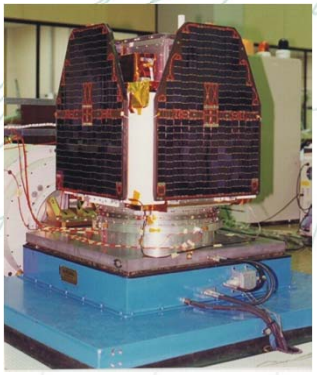
Highlight	SAC-C spacecraft became part of a "morning constellation", composed by Terra, Landsat-7, SAC-C and the EO-1.
Objective	Study the structure and dynamics of the atmosphere and ionosphere, and earth´s magnetic field
Mass	485Kg
Payload	3 Electro-Optical cameras (Argentina) and 4 instruments from: USA, Denmark, Italy, France

SAC-A 1998



Highlight	Designed, manufactured, integrated and tested in 10 months
Objective	Technology Demonstration
Mass	68Kg
Payload	Electro-Optical camera

SAC-B 1996



Highlight	Gave birth to a new branch of technological development and engineering capabilities in the Argentina
Objective	Study solar physics and astrophysics through the examination of solar flares, gamma ray bursts and diffuse cosmic X-ray
Mass	191Kg
Payload	4 Scientific Instruments: 2 USA, 1 Italy and 1 Argentina

Geostationary Telecommunication Satellites: ARSAT Program

INVAP was the main contractor for the telecommunication satellites for the national telecommunication operator, ARSAT.
ARSAT-1, ARSAT-2 and ARSAT-3 comprise the Argentine Geostationary Telecommunications Satellite System.

INVAP´s Participation:

- Design
- Manufacturing
- Integration
- Functional and environmental testing
- LEOP
- Operators training and operation support

ARSAT-1 and ARSAT-2 were successfully launched by the Ariane 5 launcher in 2014 and 2015. They were located into orbital slots 72°and 81 ° west, respectively.

Aerospace Division

Capabilities, Facilities, Equipment and Infrastructure

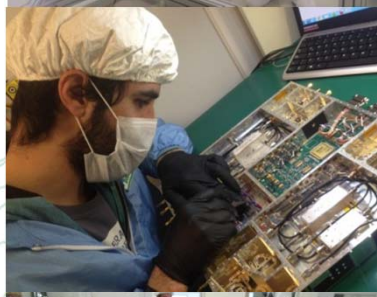
End-to-End Product Development

INVAP is capable of implementing full satellite projects **offering end-to-end developments, built-to-order products and turnkey solutions**: from the mission concept to the placement in orbit and complete operation of the satellite.

Design, manufacturing, assembly, integration and test capabilities in all subsystems:
Electronic, Harness, Software, Structures, Thermal Control, Propulsion, AOCS, Communications and EO Payloads, System and subsystem level AIT.

Other In-house capabilities: Full spacecraft analytical **modeling**; satellite functional **simulators; alignment, metrology and calibration; f**light **operation** engineering; **LEOP and Commissioning.**





World class facility for Satellite AIT

- Capacity for integration of up to 4 large satellites simultaneously
- 500 m2 class 100.000
- Bonded storage: class ISO 8 for flight hardware storage
- 4 adjacent support rooms (300 m2) which communicate with the hi-bay

Optical Facilities

In-house facilities (200m2) for the electro-optical design since 1992.
Capability for the full development of electro-optical instruments, from conceptual design, to manufacturing and testing.

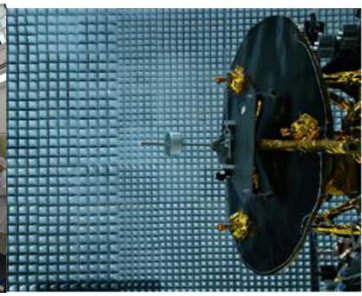
CEATSA TESTING FACILITIES

Functional and environmental tests **at box, assembly and system levels** are performed in-house for the space, aeronautic, electronic, defense and automotive industries. The testing facility is strategically located next to the high-bay clean room, easily allowing the passage of satellites and other space products for their environmental testing campaigns.

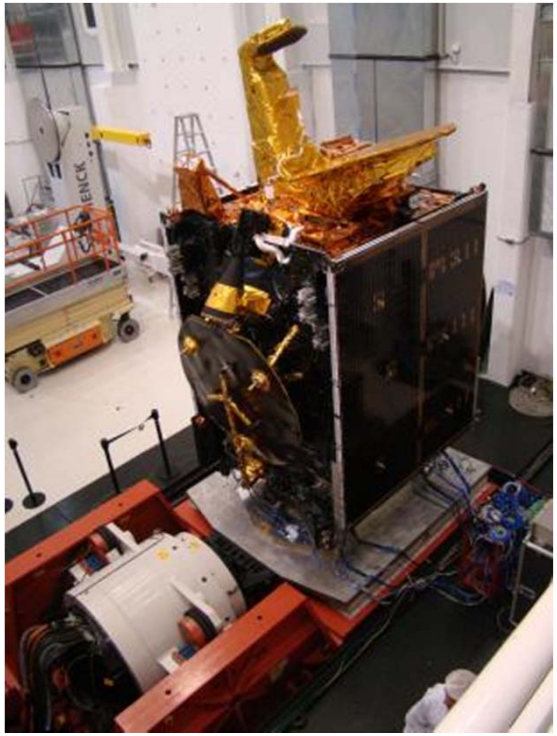
FAES building includes the following test equipment:
- Thermal-Vacuum Chamber
- Vibration test system
- Direct Field Acoustic Test System
- Mass Properties Measurement equipment
- Antenna Measurement system







CEATSA Testing Facilities



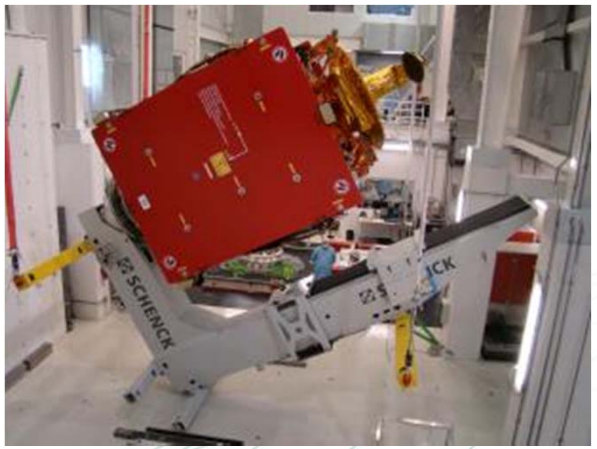
Vibration Test System

Bare force capability force: 289 kN
Frequency range: 5 Hz – 2000 Hz
Slip table: 2.5 m x 3 m work area.
Max. load: 20 t
Head expander: 2.5 m diam.
Max. load: 20 t

Thermal Vacuum Chamber

External Dimensions: 5.2 m diameter by 6 m long
Vacuum: 10-7 Torr
Temperature: -150 ºC to +150 ºC
up to 1000 thermocouples temperature monitoring.

CEATSA Testing Facilities



Acoustic Tests System

This facility reproduces the acoustic environment, generating programmable frequency vibrations of up to 146 dB in the frequency ranges of 31.5 to 8000 Hz.

Antenna Measurement

Measures: antenna and/or system gain, radiation pattern, efficiency, directivity, phase and polarization.

Specifications:

Near field horizontal scanner

Dimensions: 18 x 19 m.

Height: 6 m

Precision: ±0.015º

Mass Properties

Intended to verify the physical characteristics of a system.

Specifications

Max. load: 10 t

Max. static moment: 500 kg

Current Developments

SAOCOM 1A/B Polarimetric L-Band SAR

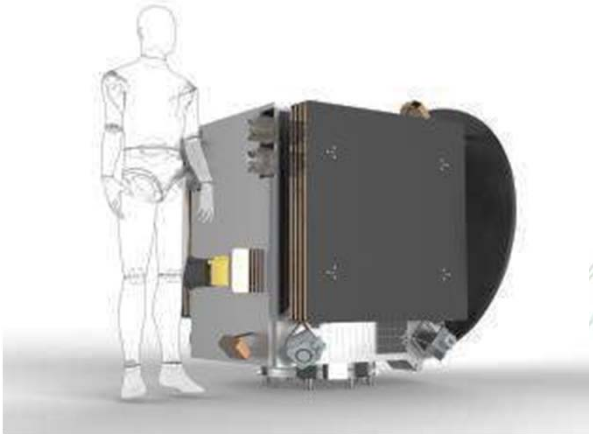
- The SAOCOM mission includes 2 satellites weighting about 3 tons each, both carried out simultaneously, to be launched 1 year apart.
- Their main Objective: prevention of natural disasters by means of the Polarimetric L-Band Synthetic Aperture Radar (SAR).
- The SAOCOM satellites will form part of the joint Italian-Argentine SIASGE constellation (an emergency management system) together with 4 Italian satellites carrying X-band SARs.

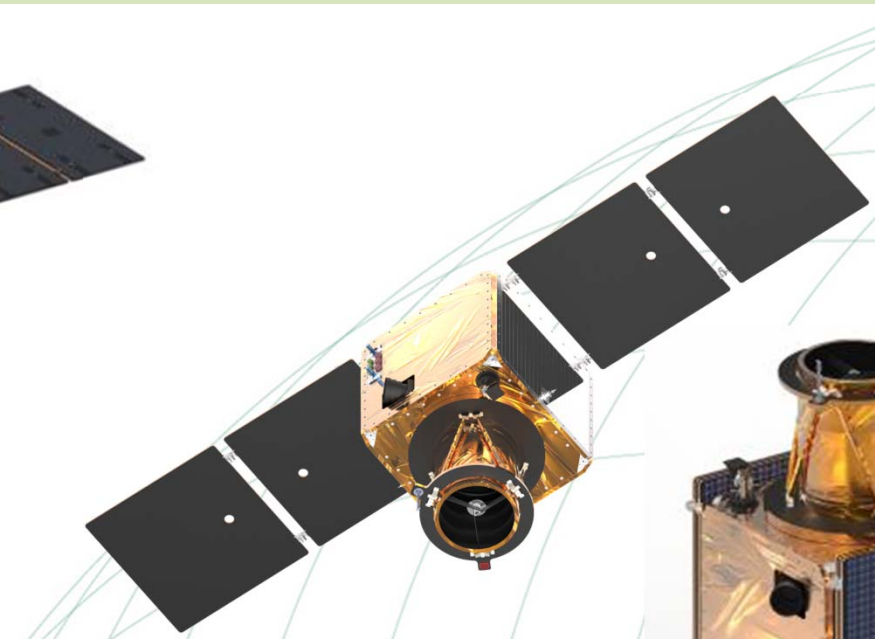
SAR general characteristics:

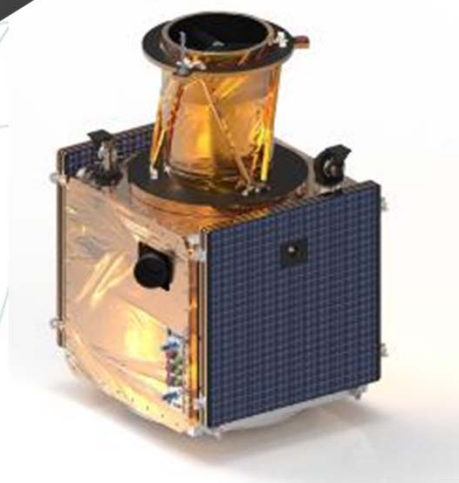
- Frequency: L Band (1,275 GHz)
- Orbit type: sun-synchronous
- Orbit height: 620 km
- Resolution: 10 to 100 m
- Instantaneous coverage: 30 to 350 km
- Angle of incidence: 20 to 50 degrees

SMALL MULTI-PAYLOAD PLATFORMS FOR LEO & GEO APPLICATIONS

INVAP is capable of developing small multi-mission platforms which can be easily adapted in order to carry different payload:
- Earth Observation satellites carrying electro-optical and microwave payload
- Full electric Small GEO satellites suitable for telecommunications and meteorological applications.

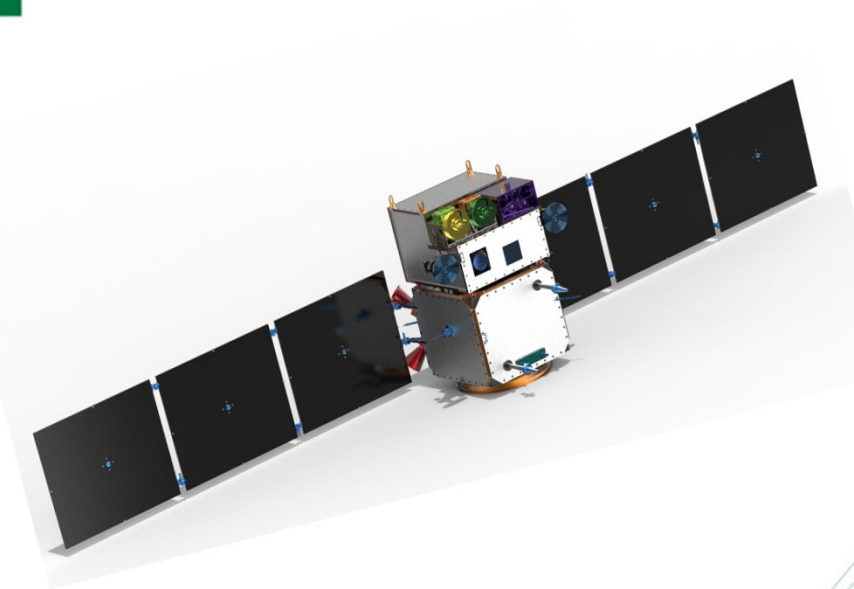






OCEAN COLOR SATELLITES: SABIA-MAR

The SABIA-Mar satellites consist of 2 Brazilian - Argentine LEO satellites flying in constellation. INVAP is the main contractor for the satellites and, in addition to the design, manufacturing, integration and testing, is also responsible for providing two of the three main cameras of the mission.
With a lifetime of 5 years, SABIA-MAR will be launched by the end of 2020



Objectives:

- Monitor the ocean surface, coastal regions and internal waters: in low, medium and high resolutions.
- Collect data and provide information related to water and food production, through high spectrum, geometric and temporal resolution images
- The satellites will be built in cooperation between CONAE and INPE (Brazil)

Distributed Architecture Missions

Distributed architecture consists of small satellites (segments) which work in a collaborative way to meet mission requirements.

Segment Characteristics:

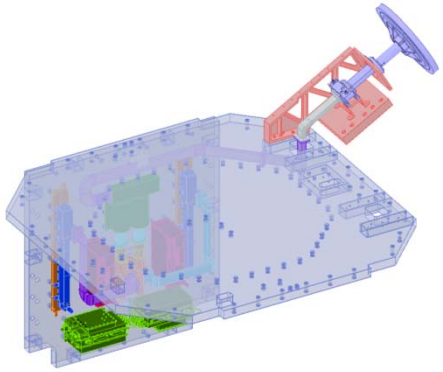
- Segments will operate in network and navigate as a cluster.
- Any segment shall be removed without affecting the system.
- New segments can be added to the systems in order to: replace segments, increase the systems capacities.
- Distributed payload: The system shall integrate an instrument which will allow obtaining a better performance than with a single satellite.
- Segments must have their own navigation, propulsion, power and communications capabilities.
- Designed to be compatible with the domestic launch vehicle developed by CONAE (Tronador II).

COMMUNICATION SUBSYSTEMS

HIGH DATA RATE COMMUNICATION SYSTEM (UNDER DEVELOPMENT)

High Data Rate communication system and a standard TM&TC system in one box.
It can achieve more than 6 Gbps in less than 4 kg of equipment mass.
This equipment can be used as a data relay system allowing communication LEO to LEO in Ka band or LEO to GEO in any of the commercial available frequencies.
The System includes a traditional channel with PCM/BPSK/PM in low bit rate or high bit rate in standard QPSK or GMSK an adaptive data rate according to the channel communication behavior.

TYPICAL HIGHT DATA RATE SYSTEMS USED IN LARGE SATELLITES (SAOCOM)



- X-Band (8.0 to 8.4Ghz) high data rate data download subsystem up to 310Mbps
- Two 8PSK channels of 155.5Mbps each
- Formatted data according to CCSDS recommendations.

- +25 years of expertise delivering State of the Art satellites for the Argentinean Space Agency CONAE and the National Operator ARSAT
- Heritage as Prime Contractor for LEO and GEO missions
- Compliant with the most rigorous standards, including NASA and ESA
- Capabilities to cover the full cycle in-house development for the design, manufacturing, integration, testing and in-orbit operation
- Focus on Customer needs including Technology Transfer

Thank you for your attention
Any questions?

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