The NanosatC-Br1 The First Brazilian Cubesat, and Beyond

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How we got here

- INPE South Regional Center
  - Located in the campus of The University of Santa Maria – UFSM
- Cooperation INPE – UFSM
- Undergrad student scholarship – 2007/8
- 2010 – decision to make it happen
Main objective and strategy

To provide a very low cost space mission to brazilian researchers

- Platform and ground station purchased
- Development of the payloads by brazilian universities and research institutions
- Development of the mission specific ground software and interfaces (small student company)
- AIT at INPE and s/c operation by students
- Gradual substitution with locally made subsystems
  - Technological parks
  - Small companies
Objectives:
- Scientific
- Technological
- Student practice

1U platform and GS purchased from ISIS, through international bid in 2010
- Delivery 2011

Payloads
- Magnetometer – INPE
- Fault tolerant FPGA – UFRGS
- IC on/off driver – SMDH/UFSM
Payloads

- Magnetometer to measure the magnetic field mainly at the SAMA – South Atlantic Magnetic Anomaly – INPE
- Fault tolerant FPGA
  - Software
  - Radiation tolerant
  - UFRGS
- IC on/off driver – SMDH/UFSM
  - Radiation resistance by design
  - Software library validation
  - IC manufactured in Germany
  - Demand by INPE
Payload board

FPGA - ProASIC3E

Hardware components and connections diagram.
P/L board mfg and AIT
Tests
Launch

- June 19th
- Yasny launch center
  - DNEPR
Launch
Launch
Launch sequence

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Santa Maria GS
ITA GS
Contact!
Operation

- **VHF/UHF**
  - Amateur radio frequencies

- **Two ground stations in Brasil for the project**
  - UFSM and ITA – São José dos Campos, SP
  - Both operated by students
  - Support from the amateur radio community in Brazil and abroad.

- **Data basis for NanosatC–Br1 at INPE hdq.**
  - Data uploaded from the two stations (P/L + HK)
  - Access through the site of the project restricted area
Operation

- Safe mode – Morse code
  - Initial condition
  - Beacon w. 10 info
  - Amateur radio decoding

- Nominal mode – Digital BPSK
  - Beacon with 60 columns

- HK + P/L log files

- Spinning
  - Detumbling mode
Results

- **Academic**
  - Two students hired permanently by INPE as civil servants
  - Four others in Ph.D. programs
  - About 15 undergraduate students per year
  - Other students in other projects
  - Five other projects in other universities/institutions
Results

- **Scientific**
  - Three months of data available for the Earth magnetic field – three components of each vector.

- **Extented life**
  - Command it in North hemisphere
  - Change to nominal beacon
Earth magnetic field data over SAMA
Results – technological
And beyond

- **NanosatC–Br2 (2U)**
  - Langmuir probe
  - Attitude determination system
  - Other ICs
  - Launch – 1stQ – 2016 – Falcon 9

- **CONASAT**
  - 8U (8.4kg.) – total redundancy
  - Data collection mission
  - Payload transponder EM in tests
  - Plataform delivered in October
  - 6 to 8 cubesats constellation
Br-2 EM platform and one P/L
CONASAT

8U satellite operational in orbit

TT&C Ground Station
- Uplink command and control
- Downlink telemetry and status
- Downlink payload data

Remote Terminal
- Collects environmental data
- Uplink payload data
Coverage em Revisit Times

• 3 orbital planes with 2 sats in each
Coverage and Revisit Time

One hour revisit time X no. of orbital planes

![Graph showing coverage and revisit time](image-url)
CONASAT
And beyond

- SERPENS – 3U – Univ. of Brasilia
  - Launch to the ISS in August
- ITASAT– 1 – 6U
  - Launch together with NanosatC–Br–2 with a Falcon–9 in 1stQ2016
- Possible international cooperations ongoing
- Strong program at INPE for scientific cubesats
- Possibility of private ventures
Conclusions

- Support from the Brazilian Space Agency, funding agencies and federal budget.
- Skepticism had to be overcome.
- Cube and nanosats seem to have their path opened to new and more demanding missions in the country.