MORE THAN A CUBESAT!!

2008 CUBESAT
DEVELOPERS WORKSHOP

10TH APRIL 2008

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BACKGROUND

- INTA: National Institute for Aerospace Technology. Under supervision of Ministry of Defense
- New line in cubesats → a reliable platform to provide "easy" access to Space (low cost / short development)
- Satellites launched:
  - INTASAT (1974)
  - MINISAT (1997)
  - NANOSAT 1A (2004)
- Satellites under development:
  - NANOSAT 1B (Q4/2008)
  - OPTOS (Q1/2009)
  - MICROSAT (TBD)
  - NATIONAL EARTH OBS. SYSTEM (OPTICAL & SAR)

PROJECT DESCRIPTION

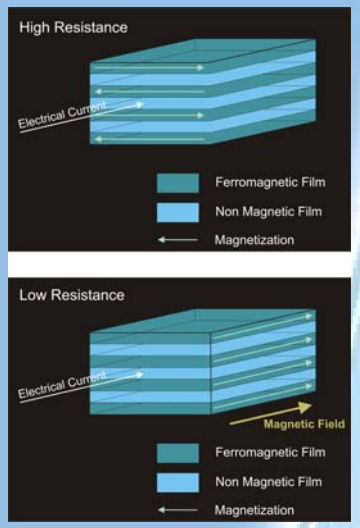
- INTA project with external collaborations (TTC, ADCS)
- Looking for reliability:
  - Manag. Eng. & Design like the “big ones”
  - Components qualification: MIL-STD-883B
- Model philosophy:
  - STM – EQM - FM
- LEO sun-synchronous
- Mission objectives:
  - platform qualification + payloads

PAYLOADS (I)

MAGNETISM

GMR (Giant Magneto-Resistance)

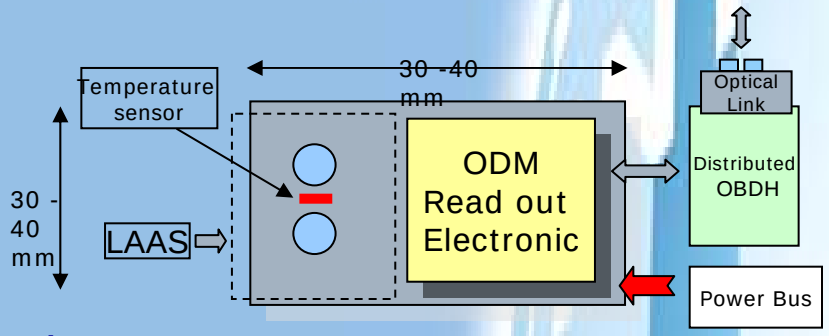
- Objectives:
  - Magnetic field measurement
  - Characterization of new materials



RADIATION

ODM (OPTOS Dose Monitoring):

- Objectives:
  - Dosimeters with commercial RadFET
  - Total dose acquisition
  - Correlate with simulation data

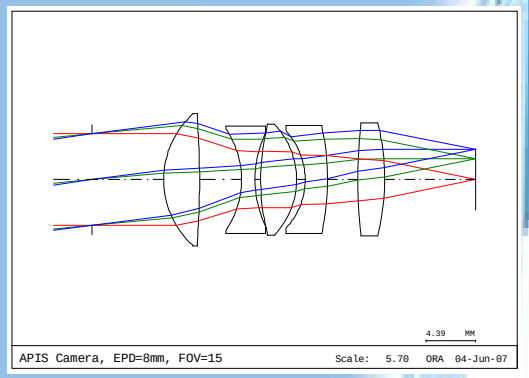


PAYLOADS (II)

OPTICS

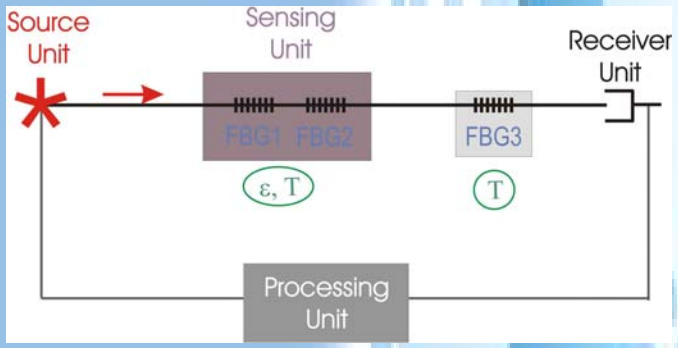
APIS (Athermalized Panchromatic Imaging System):

- Objectives:
  - Passive thermal control (± 20º)
  - Material degradation
  - Image acquisition



FIBOS (Fiber Bragg Gratings for Optical Sensing):

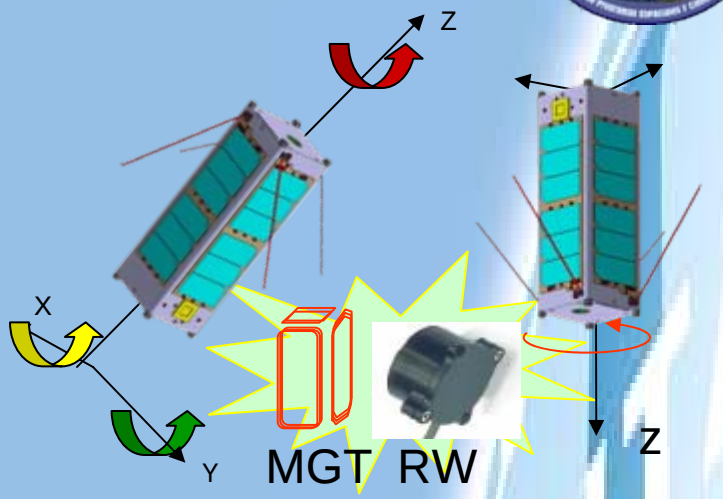
- Objectives:
  - New devices characterization
  - Temp. measurement



SUBSYSTEMS (I)

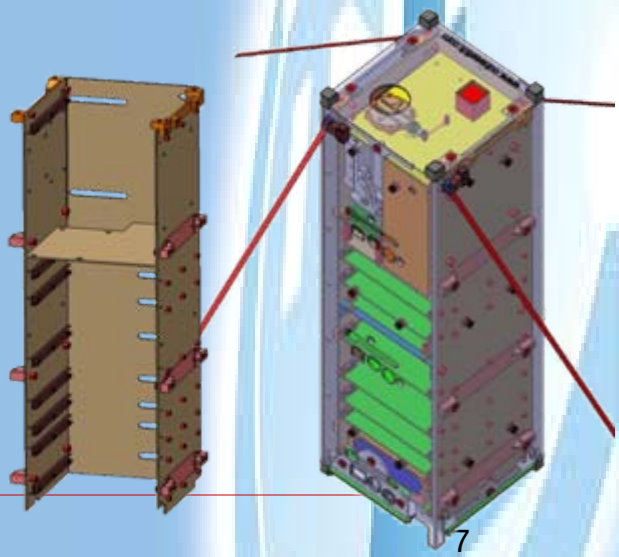
ADCS

- Inertial orientation
- Sensors:
  - 2 mini TNO SSOs (–Z, –Y)
  - 1 MGM triple-axes Honeywell 1043
  - 1 sensor of Sun presence (+Z)
- Actuators:
  - 3 MGTs (X, Y, Z) + 1 RW Astrofein (Z)
- Modes: Ini-Nom-Obs-Safe



S&M

- Cubesat standard external structure
- Composite internal structure & optical path
- Shutter mechanism for CMOS protection



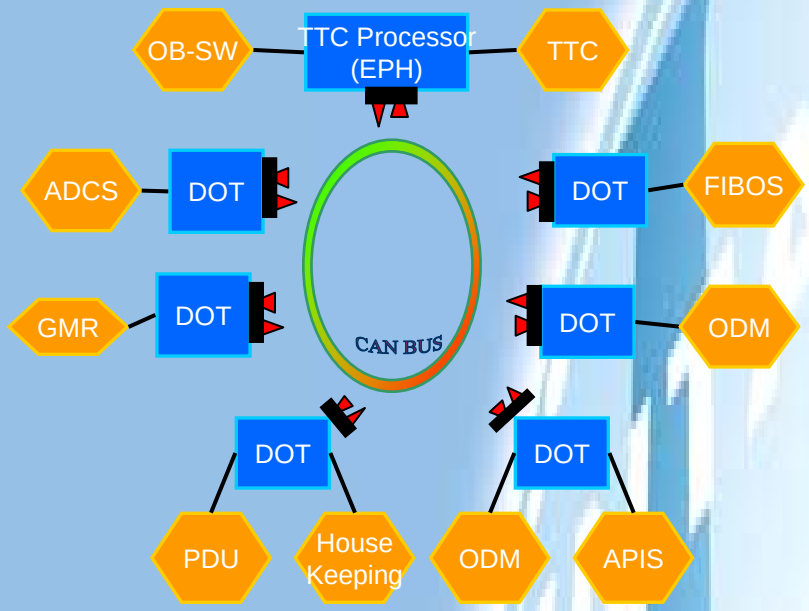
SUBSYSTEMS (II)

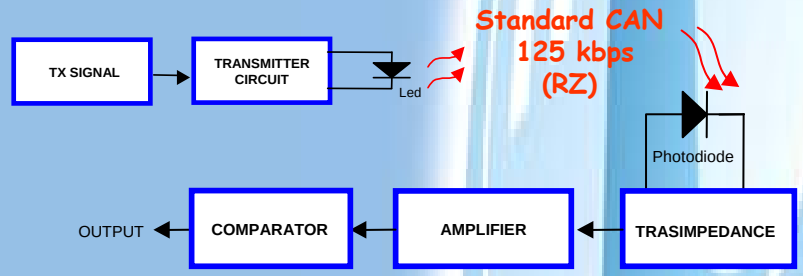
OBDH

- Services:
  - ADC
  - P/L & S/S control
  - Latch-up supervision
- Distributed architecture
- Programmable Logic Devices:
  - MicroBlaze in FPGA Virtex II-1000
  - CPLDs CoolRunner II

OBCOM

- Tx (infrared) / Rx (photodiode)
- Reduced CAN protocol
- Optical path

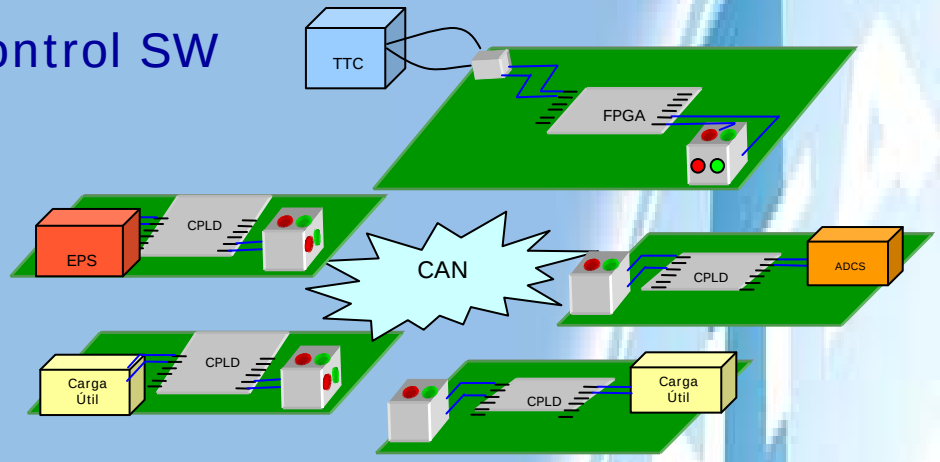




SUBSYSTEMS (III)

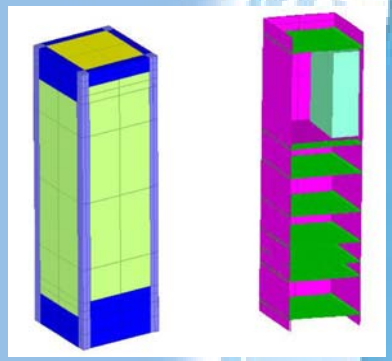
OBSW

- Distributed HW ➔ Distributed control SW
- SW elements:
  - CAN drivers
  - TTC drivers
  - ADCS SW
  - Application SW



TCS

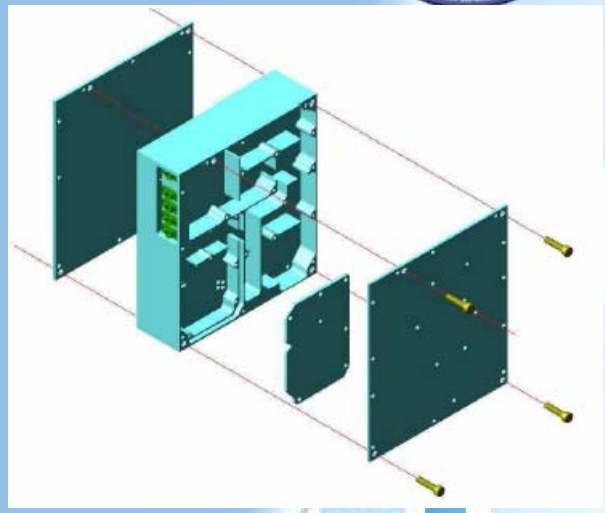
- Passive control
  - Paints
  - Conductive elements
- Operation warranted during the whole orbit



SUBSYSTEMS (IV)

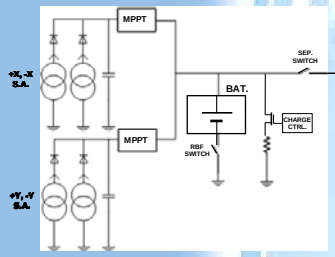
TTC

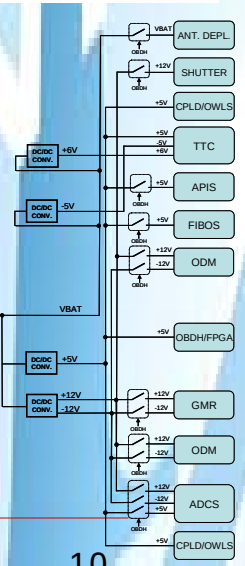
- 4 monopoles - 402 MHZ (Tx & Rx)
- Omnidirectional diagram
- Transponder working in half-duplex
- Modulation:
  - D/L: phase with Manchester pulses (SP-L)
  - U/L: phase with data sub-carrier (PM/BPSK)



EPS

- 4 PCB Solar Panels with 6 ATJ cells each ➔ 7.2 W EOL
- SAFT MP 176065 Li-ion Battery
- DC-DC converters: +3.3/+5/±12/+4/±5.5 V
- Distribution with flexible circuit

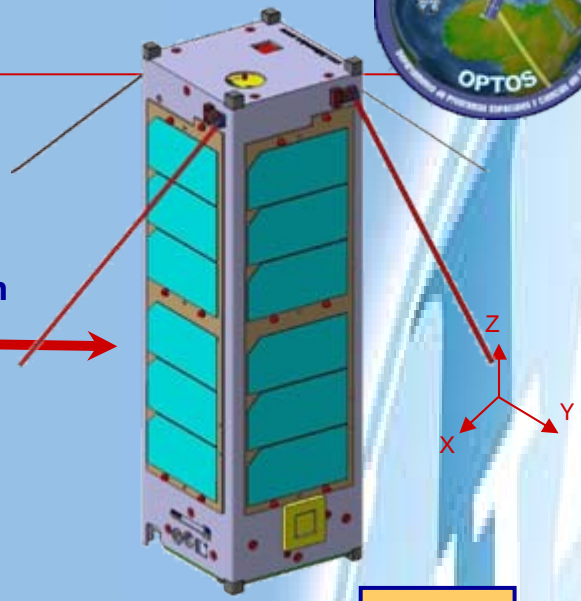




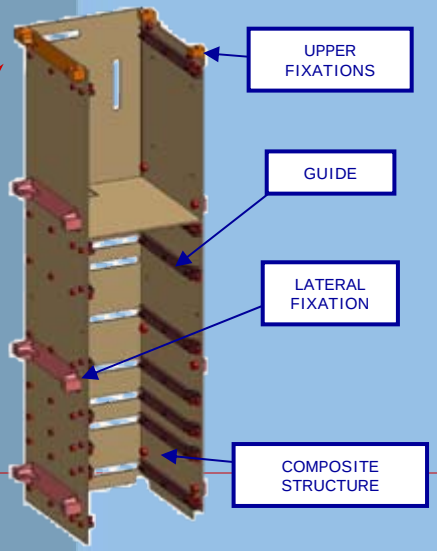
SYSTEM CONFIGURATION

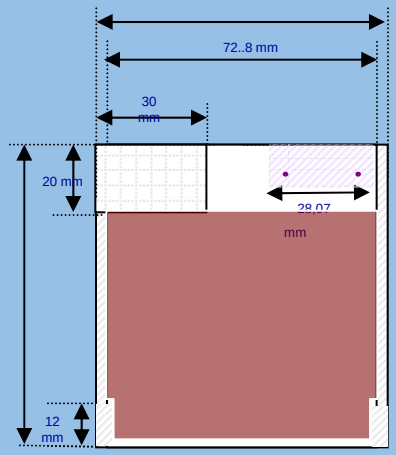
External Structure:
CUBESAT KIT 3U

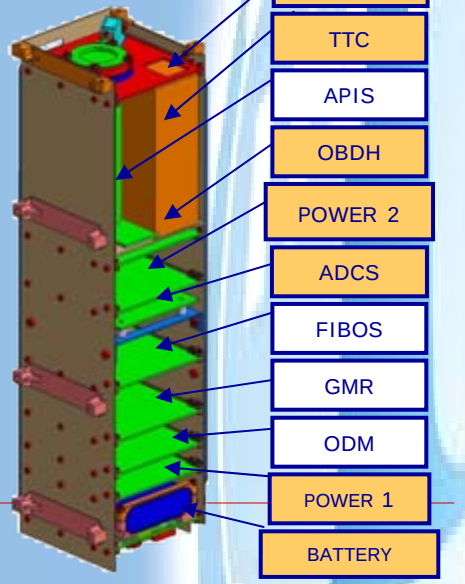
External Configuration



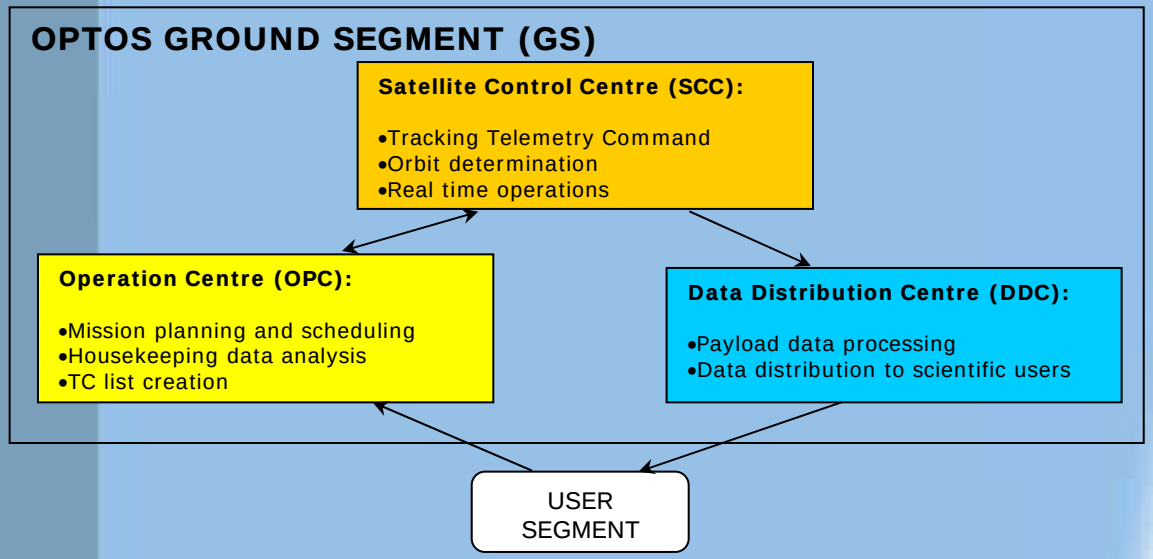
Internal Configuration







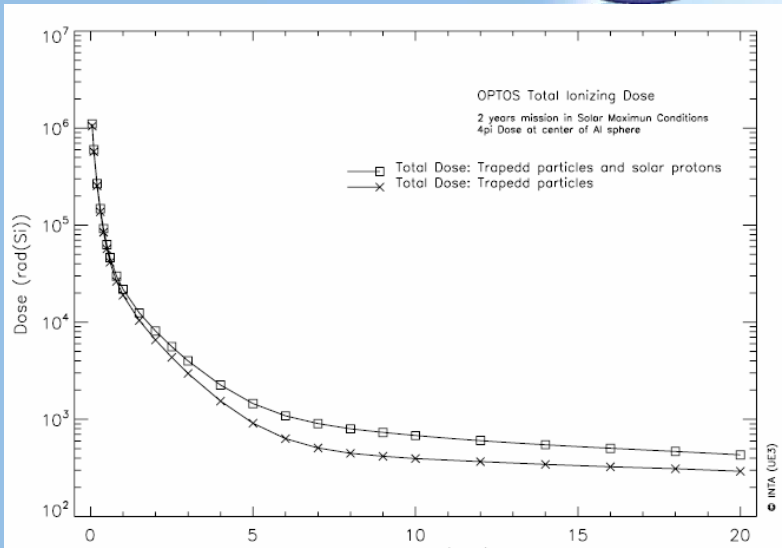
GROUND SEGMENT

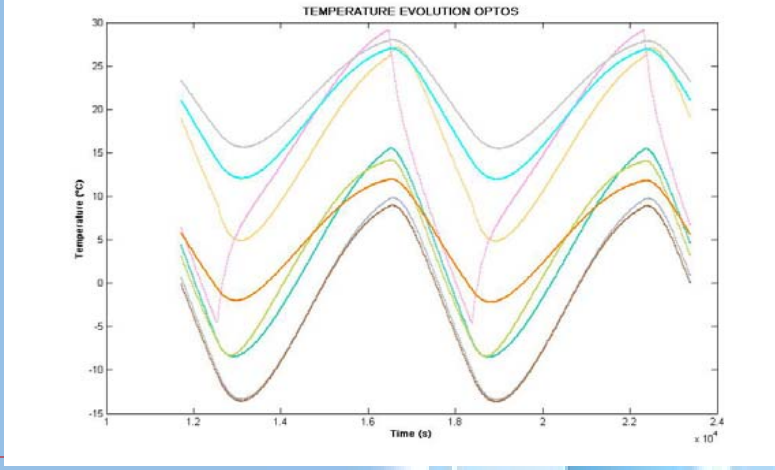


- Antenna array: 4 Yagi (Gain ~ 15 dBi each)
- Tracking (Positioning system)
- Transceiver:
  - EIRP (Effective Isotropic Radiated Power) ~ 35 dBW
  - G/T ~ 13 db/K
  - C/N_0 ~ 55 dB Hz
- SW & communication protocol developed at INTA

MISSION (I)

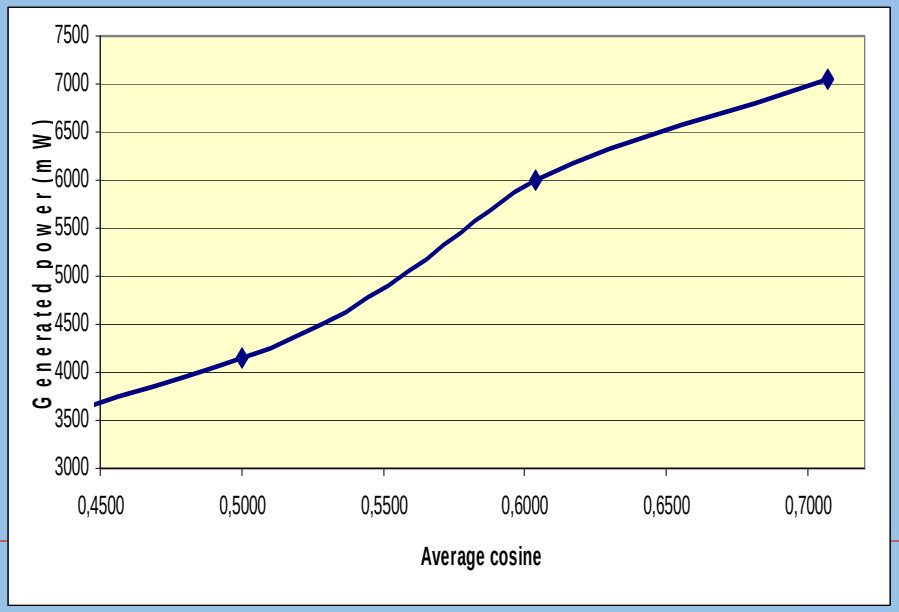
- OPTOS is developed keeping in mind a need for a long lasting mission operations platform.
  - Radiation: Requirement set for survivability over 9 krads.
    - 100% margin over estimation in life time
  - Thermal: Comfortable margins
    - Thermal maximum estimated through analysis is 18ºC below operability requirements
    - Thermal minimum estimated through analysis is 25ºC above operability requirements





MISSION (II)

- Power: designed for a 1.5 years lifetime
  - Solar panel/battery degradation not an issue within our life-time goals
- Military components included where possible
  - COTS validated through testing campaign
- Orbit degradation not an issue



MISSION (III)

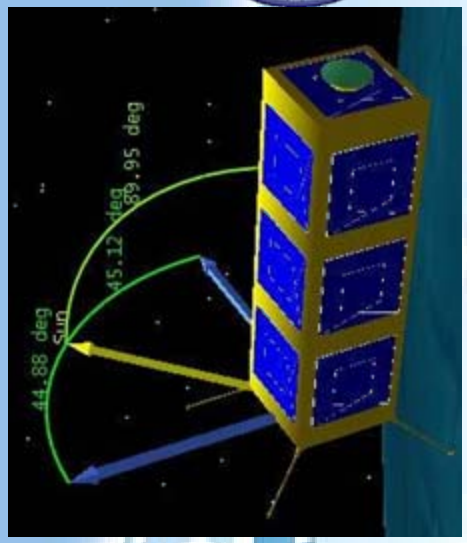
- A high platform survivability can be ensured by:
  - Thorough testing campaign
  - Attitude optimization

AIV WORKFLOW

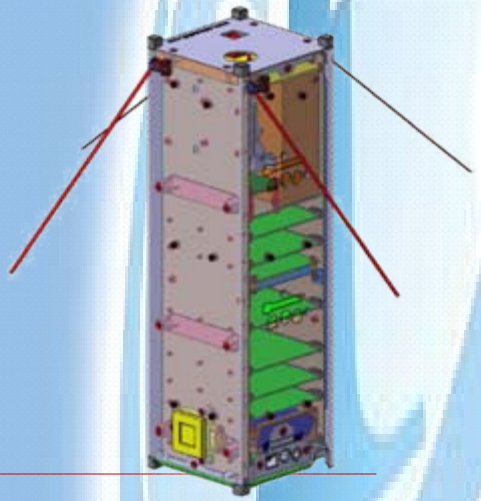
NON CRITICA ITEMS MODE		CRITICAL ITEMS MODELS
BB (Functional & electr representative) (Compon COTS)		BB (Mechanical, functional & electrical representative) (Components COTS)
CDR		CDR
EQM (No necessary Fl Standard)		EQM (Flight Standard)
FM (Flight Standard)		FM (Flight Standard)

ATTITUDE OPTIMIZATION

- Selected a fixed position relative to the Sun orientation
  - ‘Z’ axis: 90º to the Sun
  - ‘X’ and ‘-Y’ axis: 45º to the Sun



- Benefits?
  - Attitude: Sun sensor points constantly to the Sun (when Sun visible)
  - Power:
    - 40% more solar energy than a single face pointing to the Sun,
    - 17% more solar energy than spinning
  - Thermal:
    - Heat distribution through radiation
    - Heat dissipation through conduction



MISSION OPERATIONS PREVIEW

CONCLUSIONS

- Objective: qualify a **reliable** platform + payloads
- Upgraded cubesat
- New technologies in platform and subsystems
- INTA keeps open a line in cubesats