IAA-AAS-CU-17-03-03

NANOSATC-BR2, 2 UNIT CUBESAT, POWER ANALYSIS, SOLAR FLUX PREDICTION, DESING AND 3D PRINTING OF THE FLIGHT MODEL FROM THE UFSM & INPE'S NANOSATC-BR, CUBESAT DEVELOPMENT PROGRAM

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Technical Session: Mission

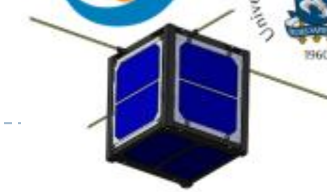
4th IAA Conference on University Satellites Missions & CubeSat Workshop

International Academy of Astronautics – IAA

Rome – Italy

December 4th – 7th, 2017

NANOSATC-BR1– NCBR1



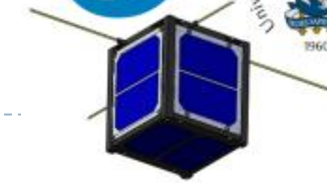
- Objectives:
  - Scientific
  - Technological
  - Student engagement
- 1U platform and GS purchased from ISIS, through international bid in 2010
  - Delivery 2011
- Payloads
  - Magnetometer – INPE/MCTIC
  - Fault tolerant FPGA - UFRGS
  - IC on/off driver – SMDH/UFSM

NANOSATC-BR1– NCBR1

- **It is operational until today**; **3 year and 5 months** generating data from the payloads and platform subsystems;
- All payloads are with nominal performances;
- Energy power subsystem is with low voltage in the batteries;
- It is not possible anymore to download log files;
- The data **is presently obtained by nominal beacon:**

  (165 kbytes of data per beacon); at 30 sec. Interval.
- The **World Amateur Radio Network** is currently providing data.

NANOSATC-BR2 – NCBR2



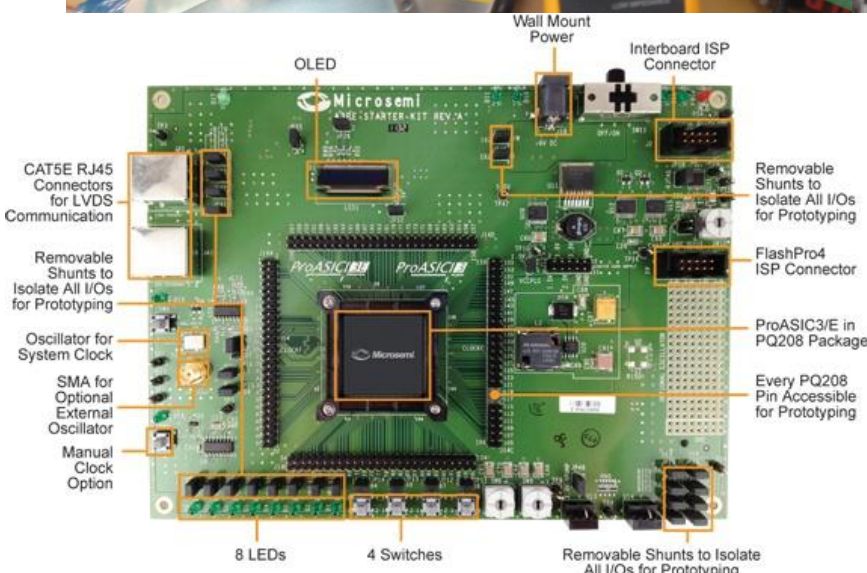
- Payloads:
  - **Langmuir** Probe (INPE/MCTIC);
  - **Attitude Determination System**:
    (Cooperation INPE/MCTIC with UFMG - UFABC);
  - **Other ICs** – by SMDH and UFRGS with INPE/MCTIC;
  - Two **Magnetometers.**

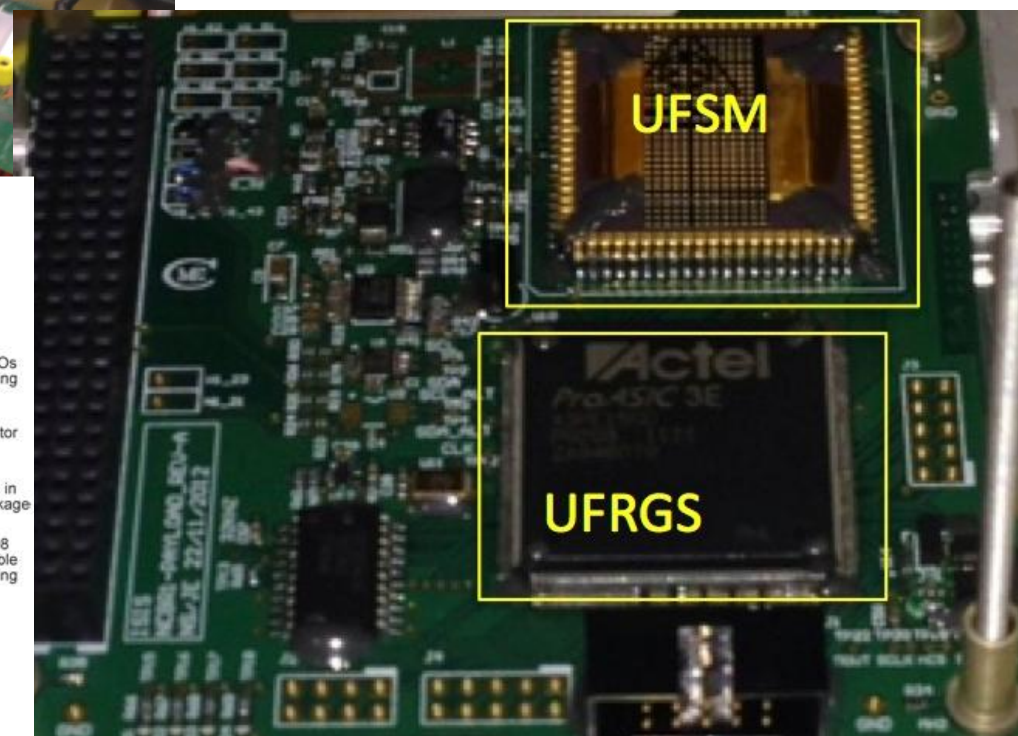
- **Launch** – through international bid in 2018

NANOSATC-BR2 – EM Platform

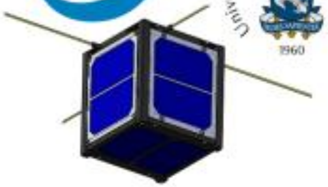
EM Platform

Payload





NANOSATC-BR2 – 3D MODEL



Objective:

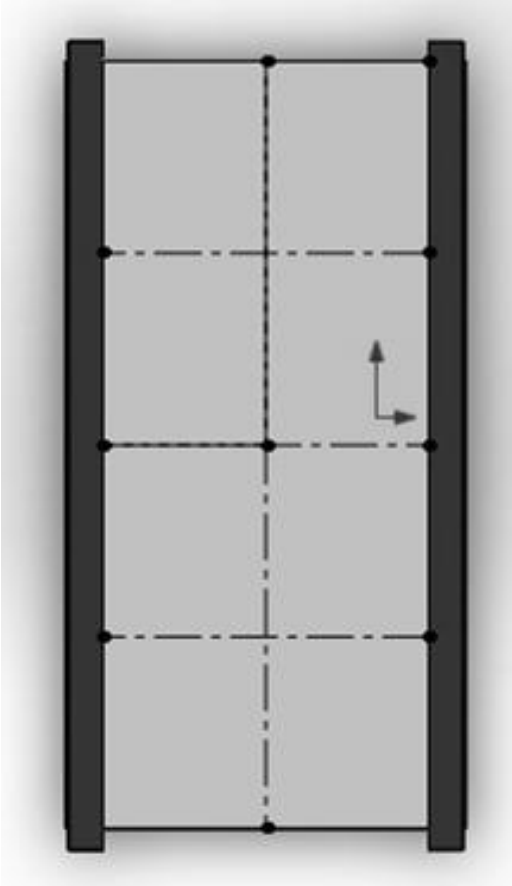
Help students better understand the satellite
Satellite Model to be exposed worldwide

Steps:

- Design the Model;
- 3D Print the Model;

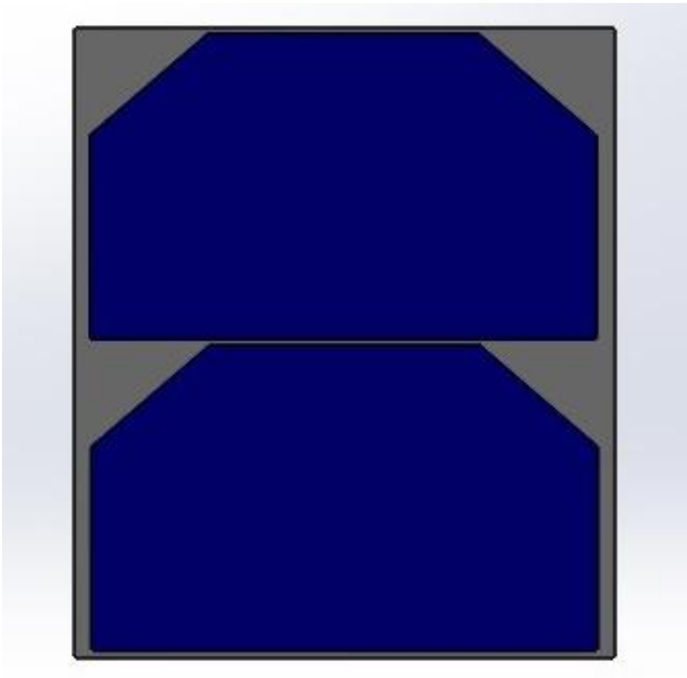
NANOSATC-BR2 – 3D MODEL

- A reliable connection between the CubeSat and the launch vehicle is made through the P-POD
- The P-POD rails measure 227mm, since it is longer than the satellite



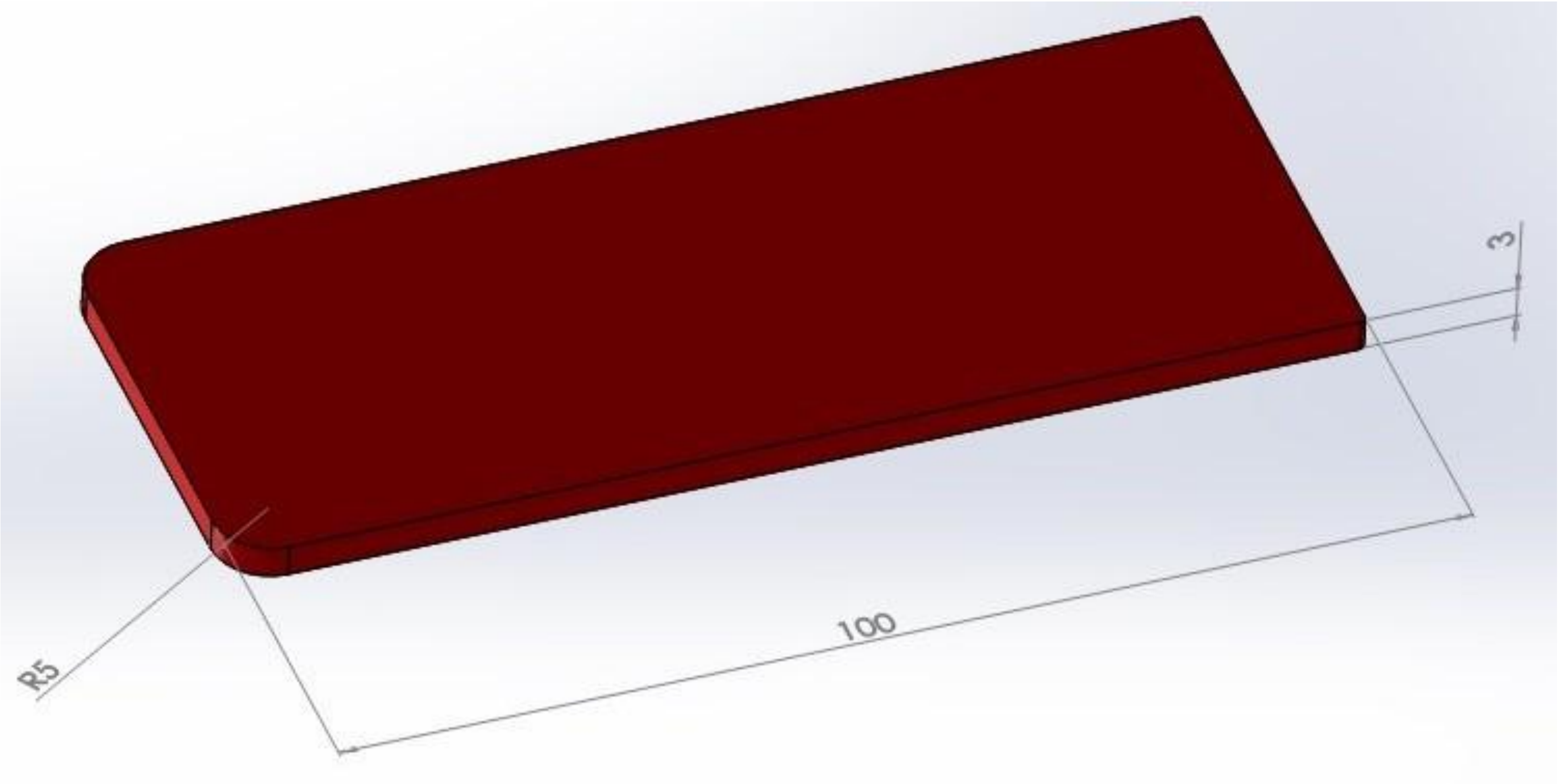
NANOSATC-BR2 – 3D MODEL

- The solar cells attached to the structure were designed following Innovative Solutions in Space (ISIS) standard design



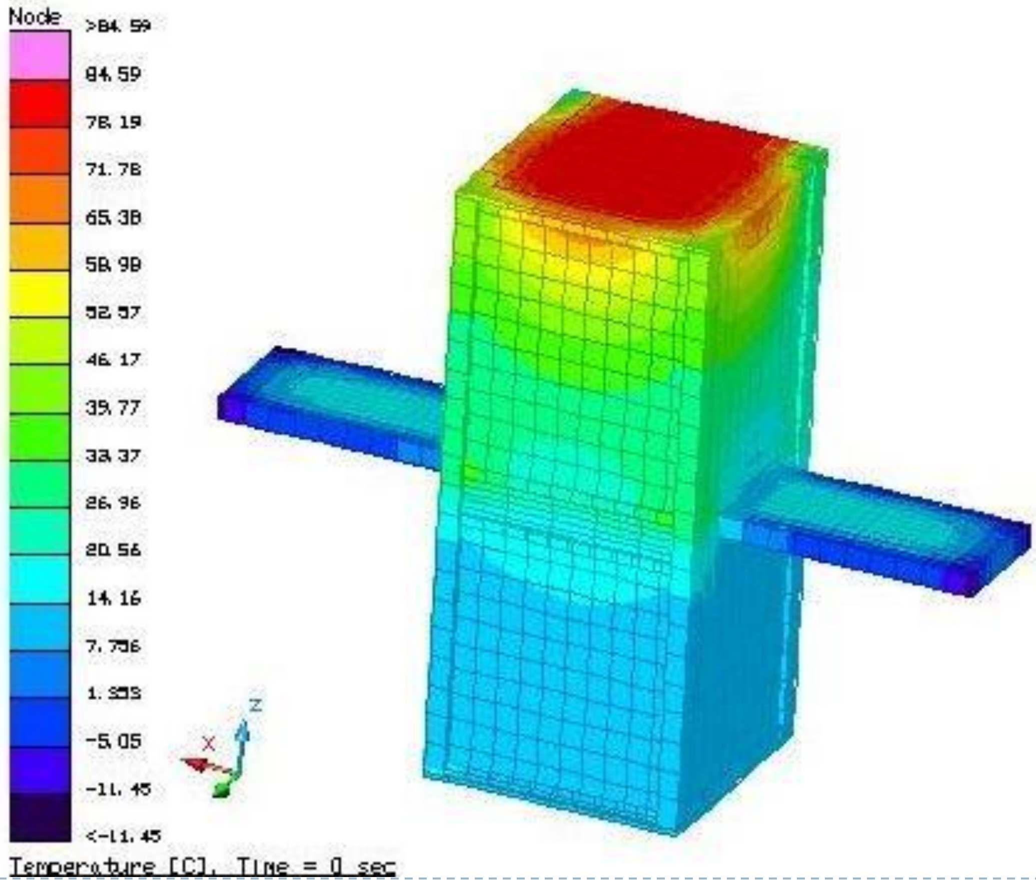
NANOSATC-BR2 – 3D MODEL

- It has a rectangular design, although it has fillets on its corners



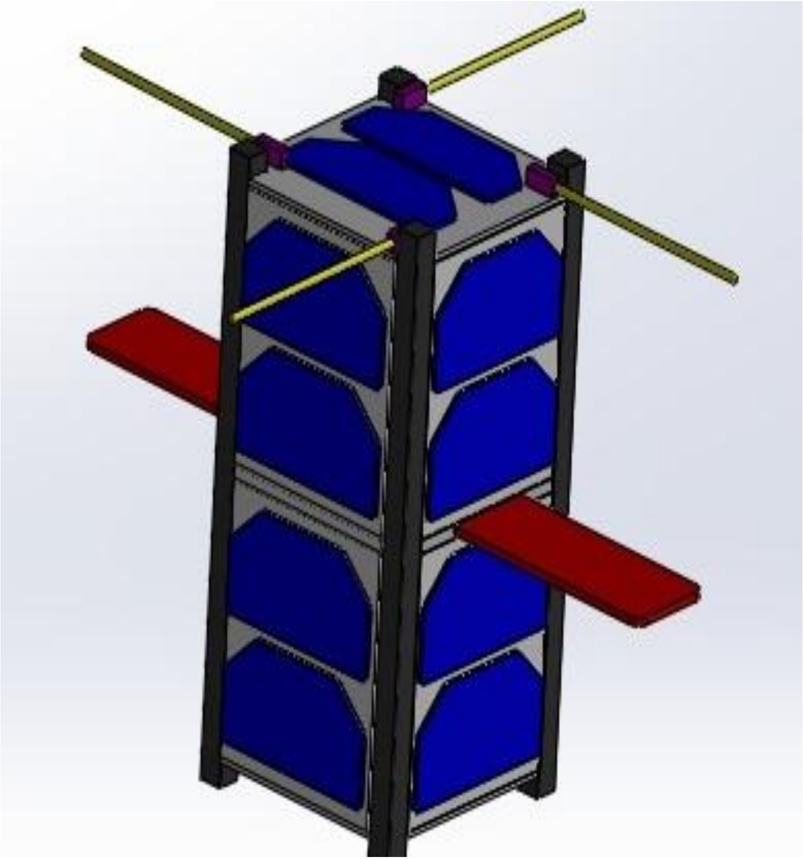
NANOSATC-BR2 – 3D MODEL

- The final conception for the Langmuir Probe is attached on 2 sides of the NANOSATC-BR2



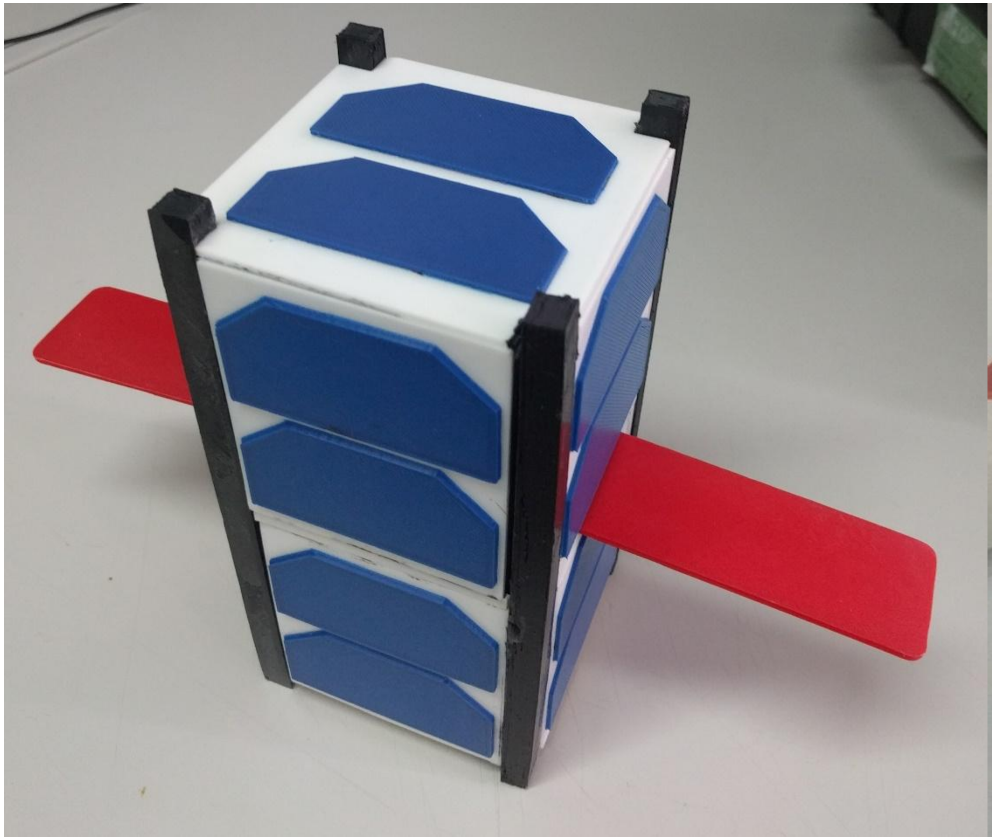
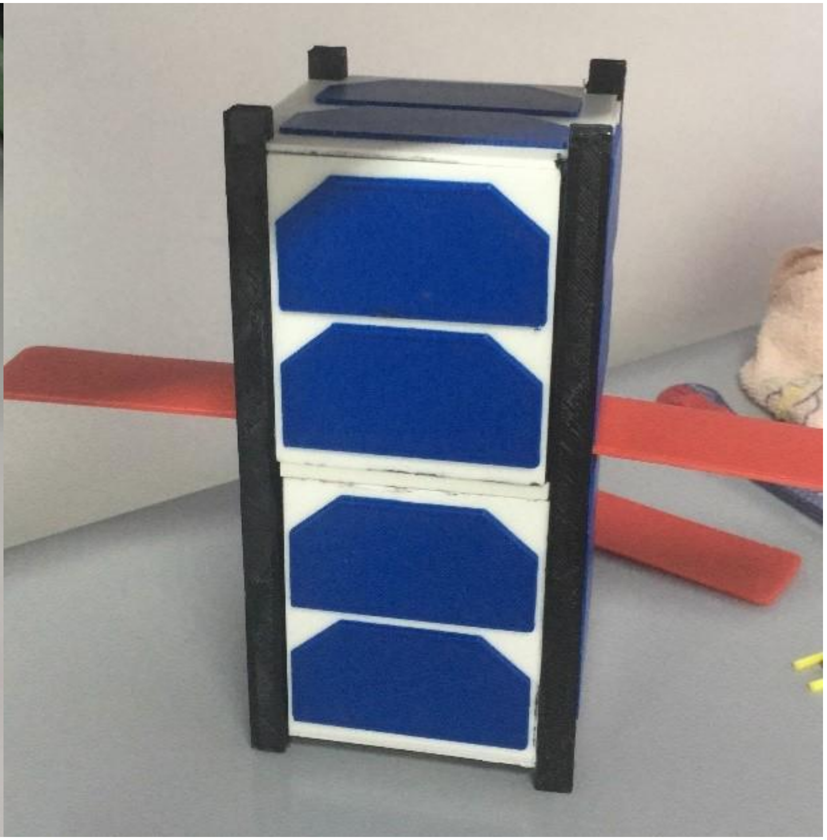
NANOSATC-BR2 – 3D MODEL

- The final model has the Langmuir Probe and the Antennas in the upper face

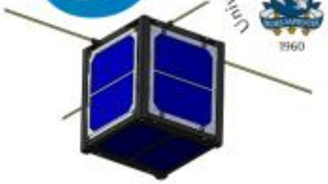


NANOSATC-BR2 – 3D MODEL

- 3D Printed Model

NANOSATC-BR2 – Simulation



Objective:

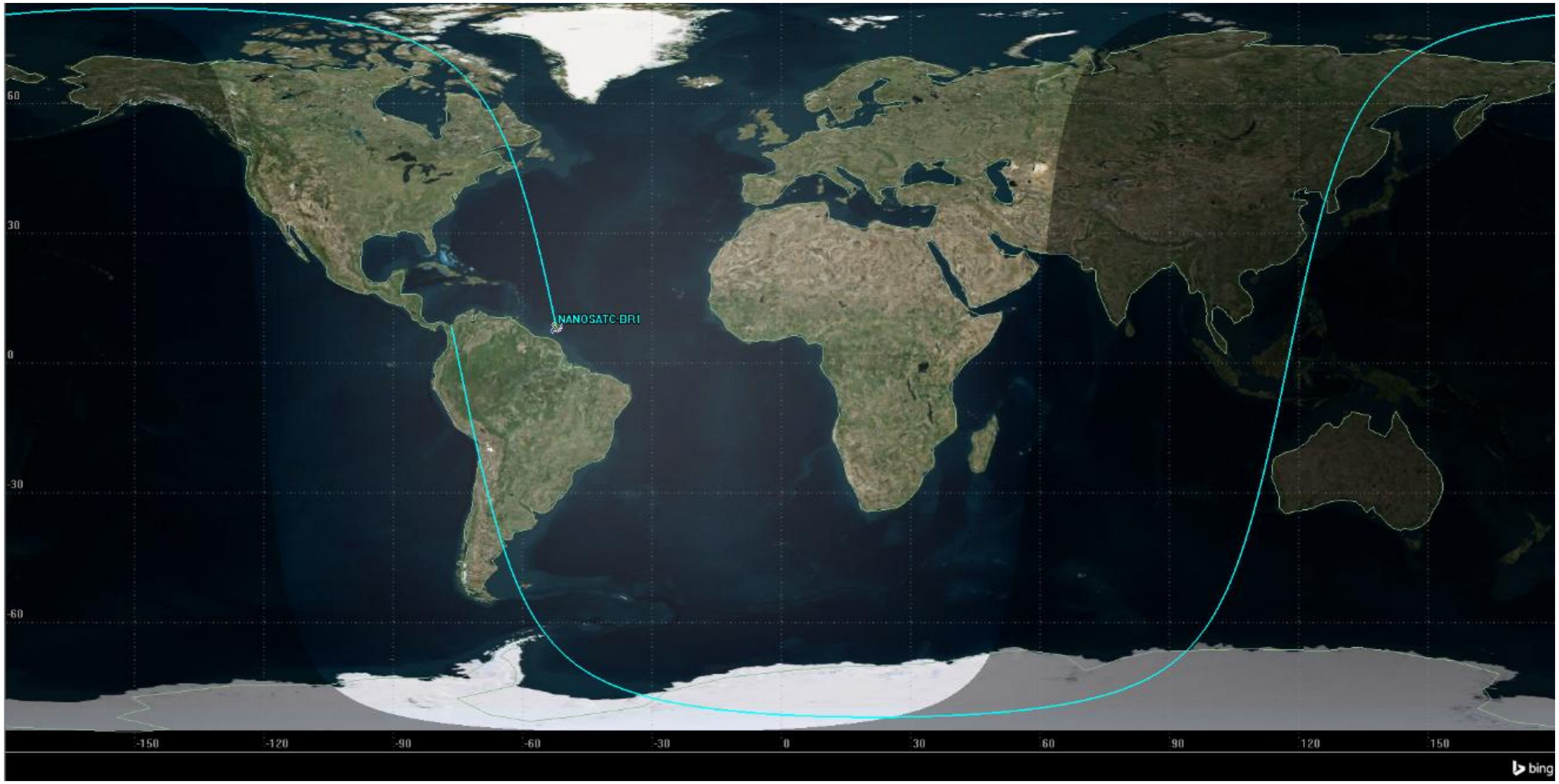
Obtain Power Balance.

Steps:

- Estimate Power Generation;
- Estimate Power Consumption;

NANOSATC-BR2 – Simulation

- To estimate Power Generation, the NCBR1 orbit is considered for the NCBR2

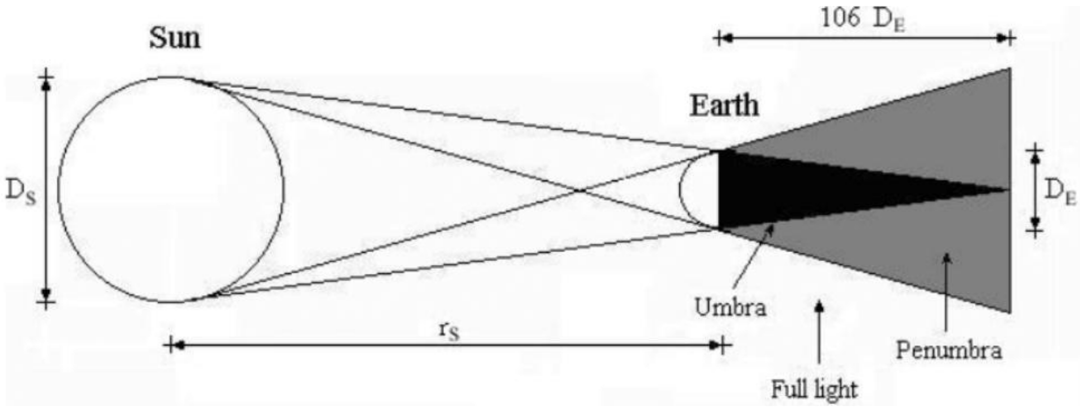


NANOSATC-BR2 – **Simulation**

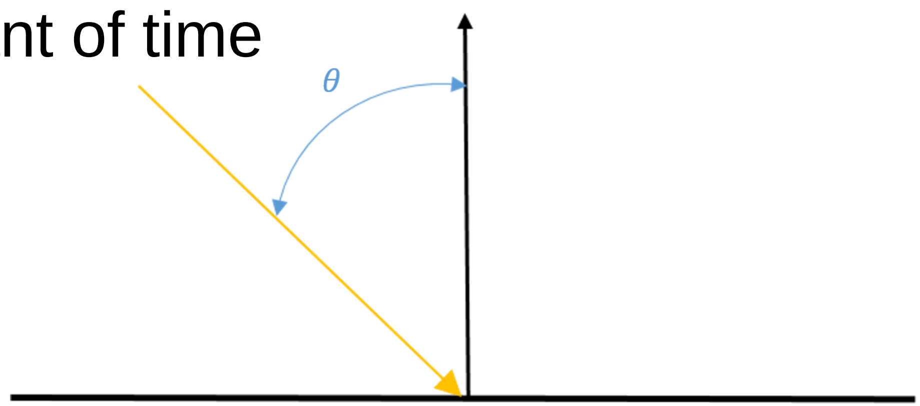
- Orbit
  - Polar: 98° Inclination
  - Eccentricity: 0,00113
  - Velocity: 7,5 km/s
  - Semi-major Axis: 6997 km
  - Orbit Period: 97 minutes

NANOSATC-BR2 – Simulation

- Umbra estimated for the orbit: 34 minutes

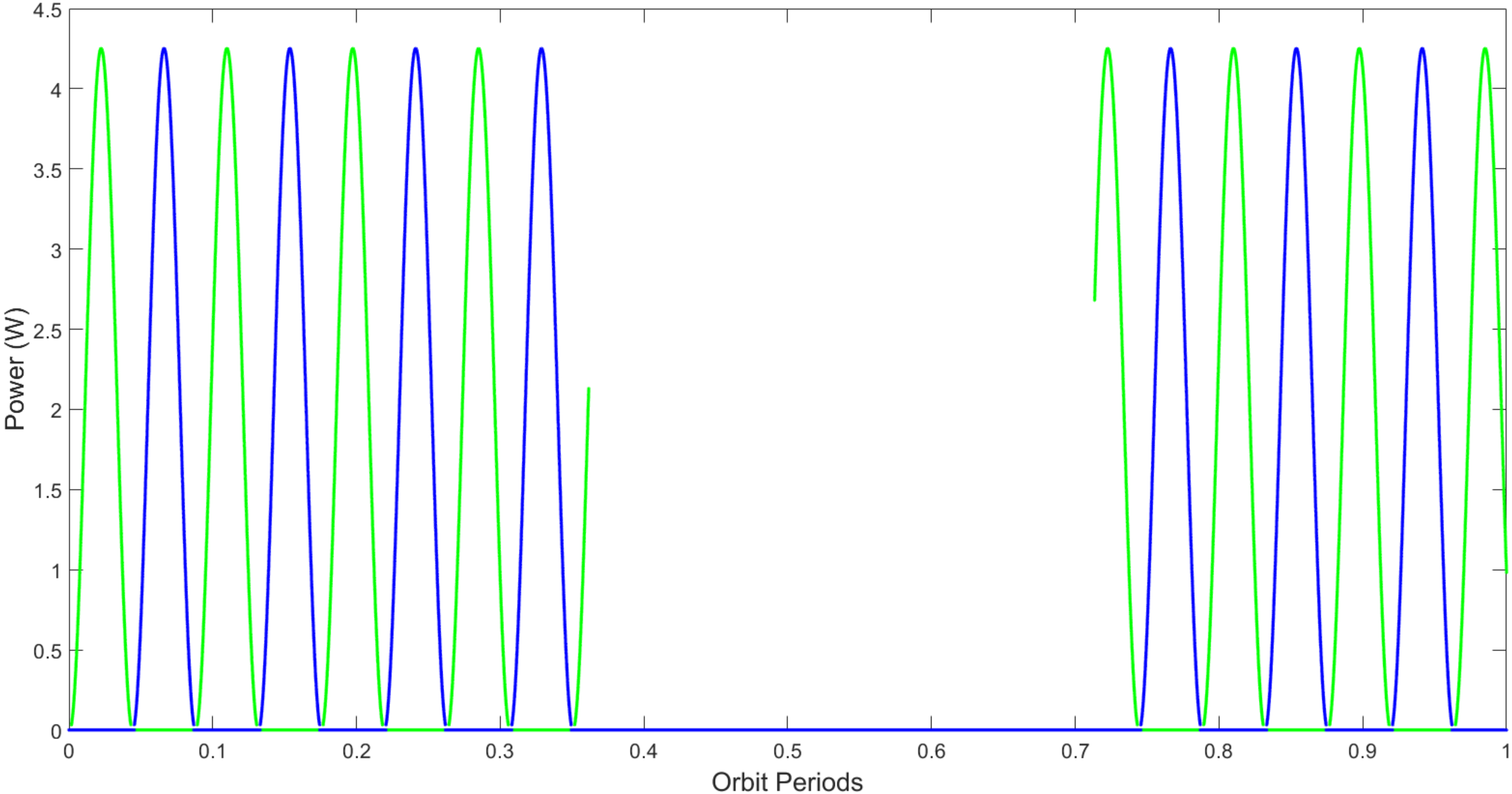


- Angle between sun vector and area vector is determined in each instant of time



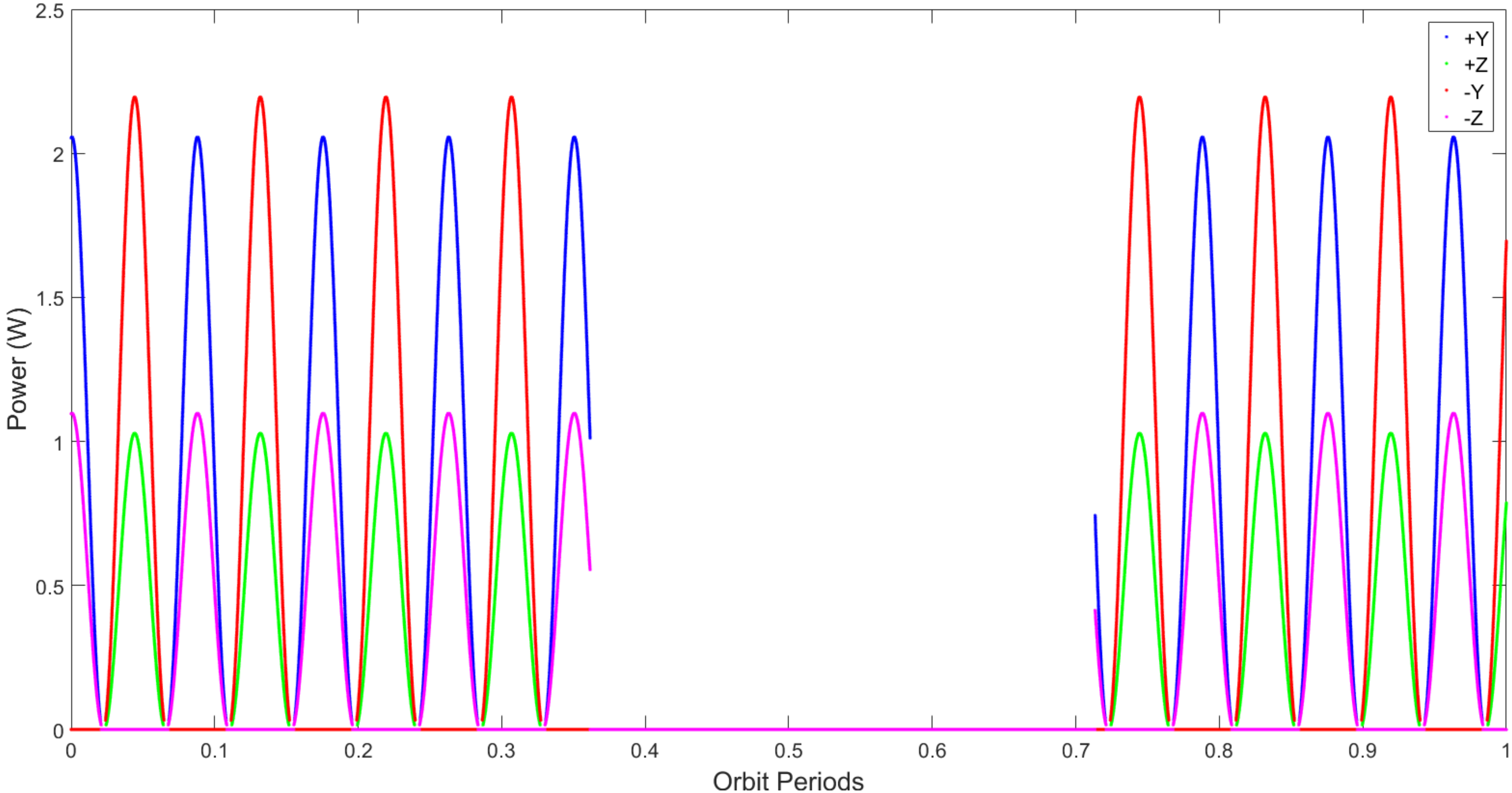
NANOSATC-BR2 – Simulation

- Power Generation in faces +X and -X



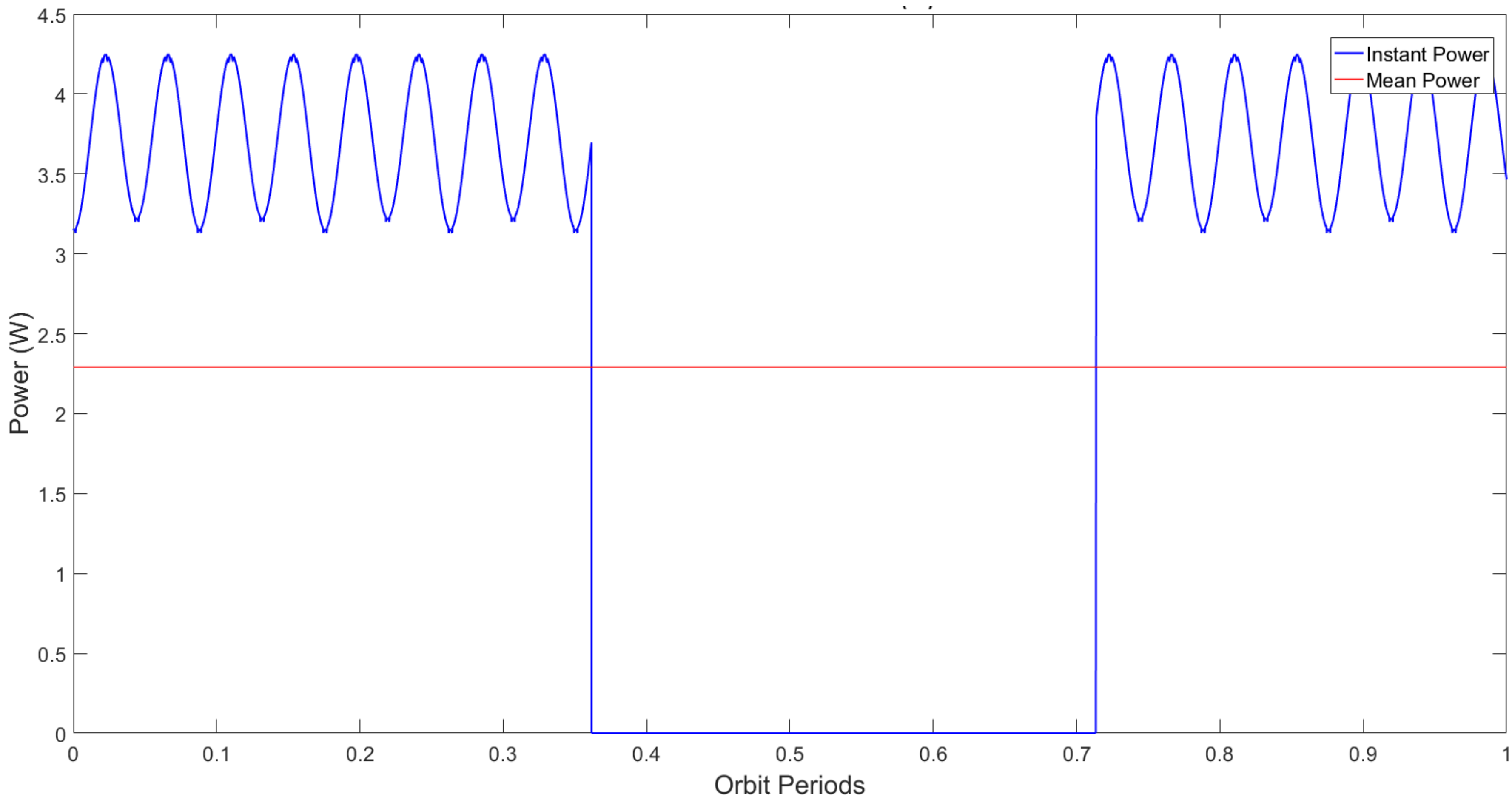
NANOSATC-BR2 – Simulation

- Power Generation in faces +Y,+Z,-Y,-Z

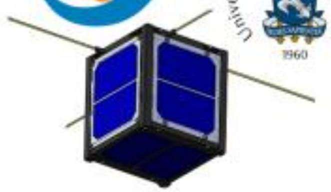


NANOSATC-BR2 – Simulation

- Power Generation



NANOSATC-BR2 – Simulation



- Power Consumption (Components)

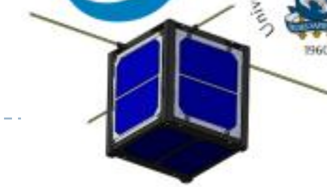
Components	Maximum Consumption	Duty Cycle	Consumption with duty cycle
Electric Power Subsystem	0,249 W	100 %	0,249 W
Board Computer	0,380 W	100 %	0,380 W
Receiver (TRXUV RX)	0,237 W	100 %	0,237 W
Transmitter (TRXUV TX)	0,787 W	4,2 %	0,033 W
Antenna system	0,040 W	100 %	0,040 W
2 Magnetometers (XEN 1210)	0,031 W	100 %	0,031 W
FPGA	0,049 W	100 %	0,049 W
2 SMDH ICs	0,030 W	100 %	0,030 W
Langmuir Probe	0,930 W	100 %	0,930 W
Attitude Determination System SDATF	0,271 W	100 %	0,271 W
TOTAL			**2,25 W**

NANOSATC-BR2 – Simulation

- Power Balance

Components	Maximum Consumption	Duty Cycle	Consumption with duty cycle
Electric Power Subsystem	0,249 W	100 %	0,249 W
Board Computer	0,380 W	100 %	0,380 W
Receptor (TRXUV RX)	0,237 W	100 %	0,237 W
Transmitter (TRXUV TX)	0,787 W	4,2 %	0,033 W
Antenna System	0,040 W	100 %	0,040 W
2 Magnetometers (XEN 1210)	0,031 W	100 %	0,031 W
FPGA	0,049 W	100 %	0,049 W
2 SMDH ICs	0,030 W	100 %	0,030 W
Langmuir Probe	0,800 W	**73,4 %**	0,683 W
Attitude Determination System SDATF	0,271 W	100 %	0,271 W
TOTAL			**2,003 W**

NANOSATC-BR2 – Simulation

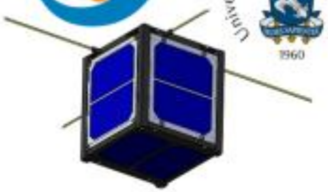


With the Simulation, Thermal Radiation was determined

Hot Case

Angular velocity X axis (rad/s)	Angular velocity Y axis (rad/s)	Angular velocity Z axis (rad/s)	Mean Heat Flux Solar Incidence (W/m^2)	Mean Heat Flux Eclipse (W/m^2)
0	0	0	454,03	54,24
0,087	0,087	0,087	518,52	55,91
0,1221	0,035	0,070	523,3	55,91
0,2618	0,2618	0,2618	518,31	55,92
0,5235	0,5235	0,5235	518,36	55,92
1,047	1,047	1,047	518,35	55,91
1,57	1,57	1,57	518,33	55,92
Mean Value			509,88	55,67

NANOSATC-BR2 – Simulation



Cold Case

Angular velocity X axis (rad/s)	Angular velocity Y axis (rad/s)	Angular velocity Z axis (rad/s)	Mean Heat Flux Solar Incidence (W/m^2)	Mean Heat Flux Eclipse (W/m^2)
0	0	0	395,41	26,32
0,087	0,087	0,087	452,24	27,13
0,1221	0,035	0,070	457,21	27,13
0,2618	0,2618	0,2618	452,02	27,13
0,5235	0,5235	0,5235	452,09	27,13
1,047	1,047	1,047	452,09	27,13
1,57	1,57	1,57	452,07	27,13
Mean Value			444,73	27,01

NANOSATC-BR2 – Conclusions

- The **3D Model** is **complete** and ready to be used by students and exposed in events worldwide;

- **Power Generation** and **Thermal Radiation** were estimated;

- **Positive Power Balance** was achieved reducing **Langmuir's** Probe **Duty Cycle** for **73.4%.** Can operate during solar incidence and eclipse;

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The NANOSATC-BR Program site is: www.inpe.br/crs/nanosat/

Thank you

Grazie

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