CubeSat OGMS-SA

Outgassing Material Study by Spectroscopy Analysis

3U Student CubeSat

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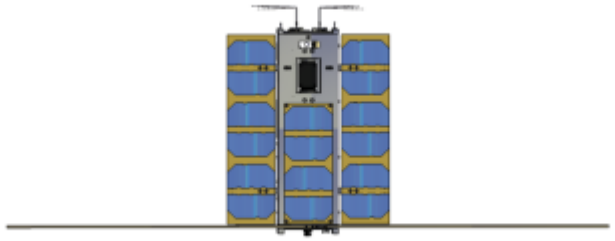
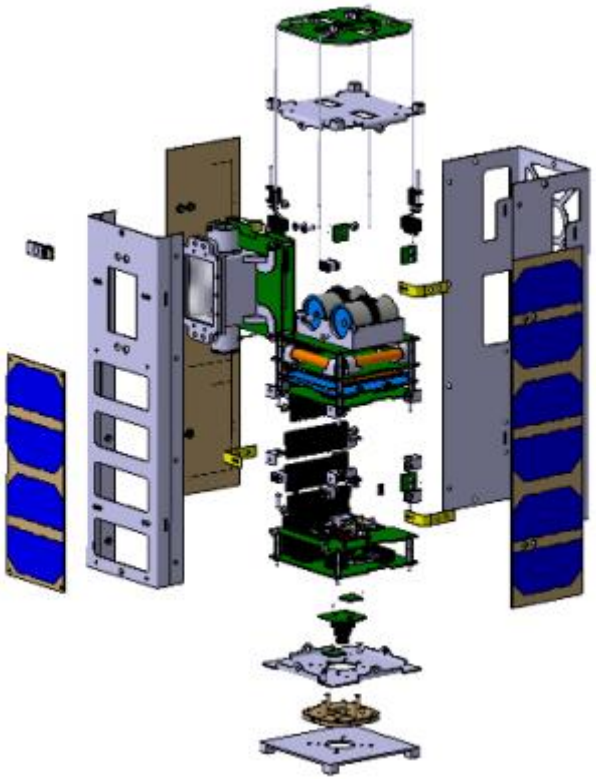
OGMS-SA





34 cm

3 kg

Several schools & universities

40 students up to now

≈ 10 Watts

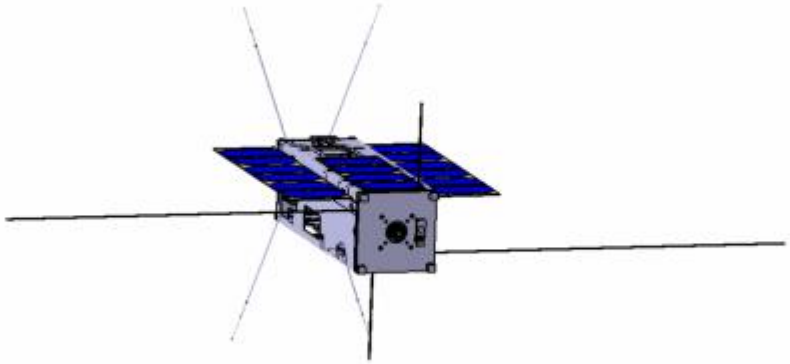
3U CubeSat

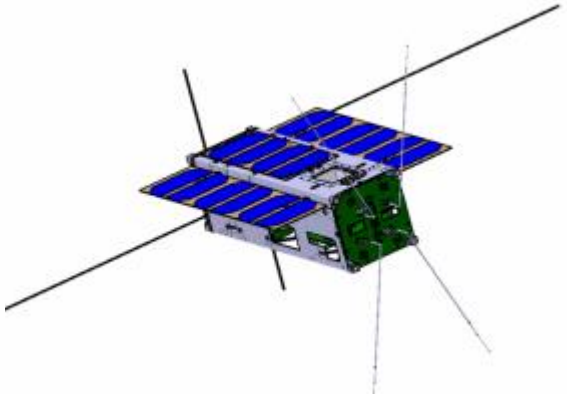
In-Orbit **demonstrator**

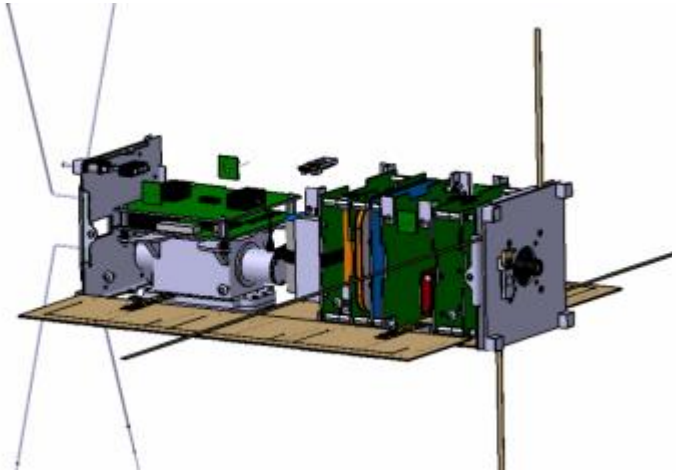
Student nanosatellite

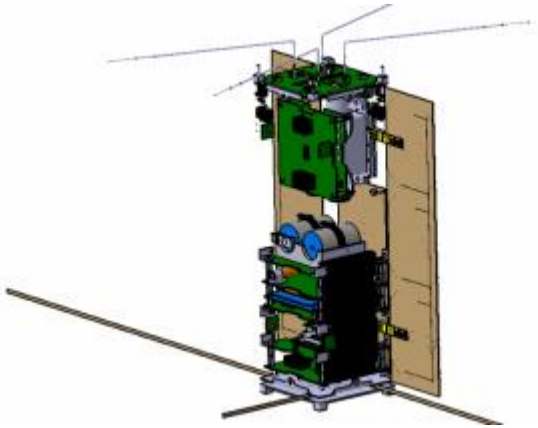
Phase C within **QB50** project

OGMS-SA

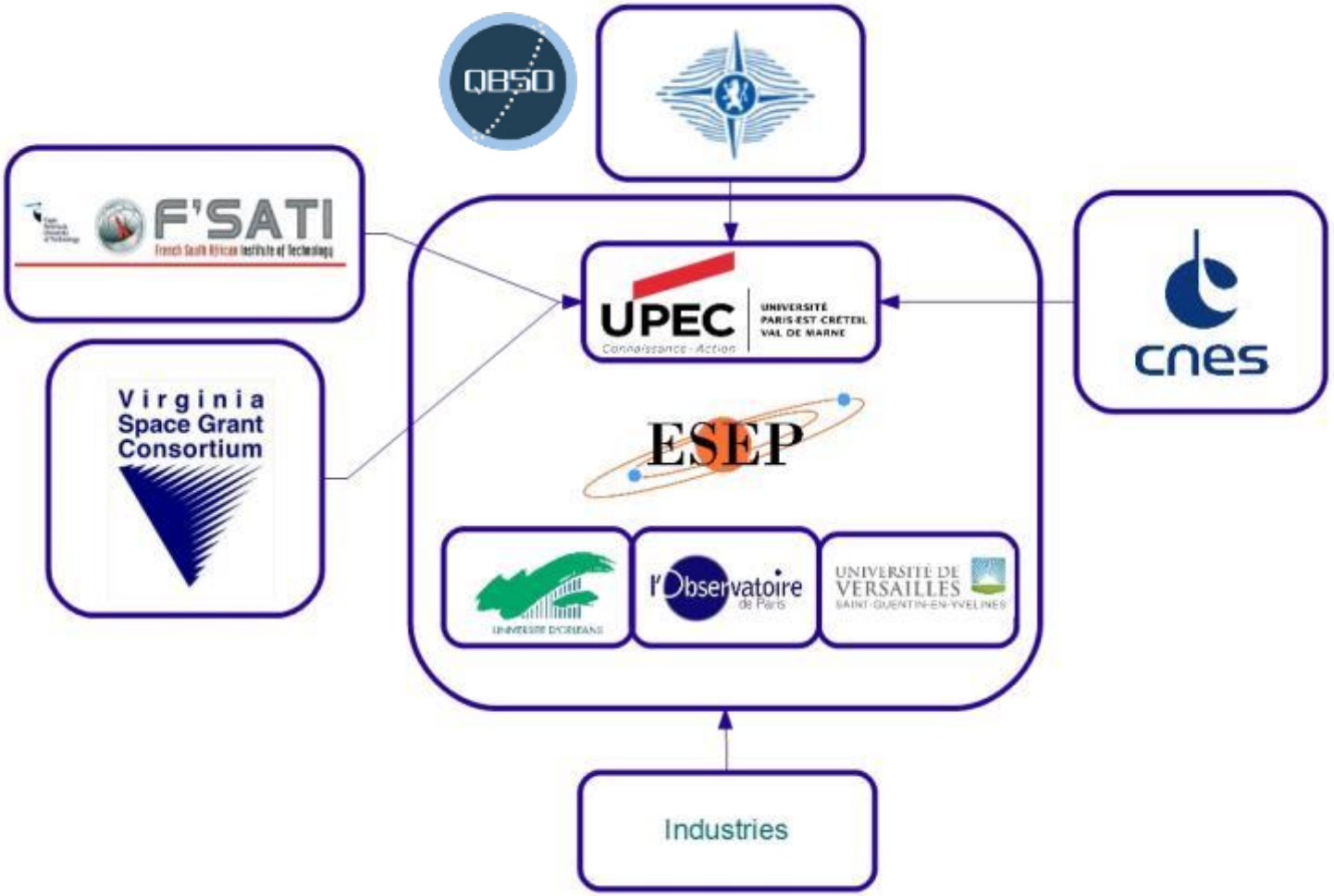








Institutional Organisation



CubeSat Goals for LISA/UPEC/ESEP

- 10 years project :
  - Complete **Home Made 3U CubeSat Plateform** with 1U free for Scientifique Payload
  - **Scientific Payload** for Gas Trace and Organic Compound Analysis (contamination, organics survey, etc.)
  - Space Technology **training for young engineers** (and select them for integration in our engineering space team)

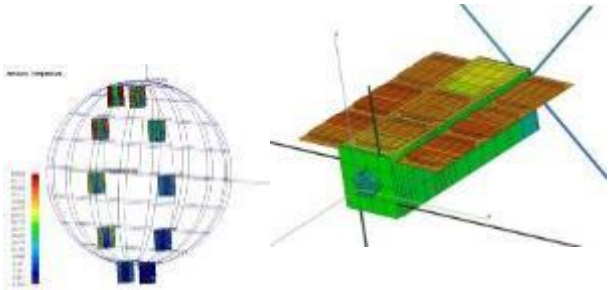
Institutionnal supports

ESEP :

- Support for educationnal aspects and training

CNES (JANUS) :

- Funding support
- Expertise Support (reviews, solar cells integration…)
- Tools and formations



Industries :

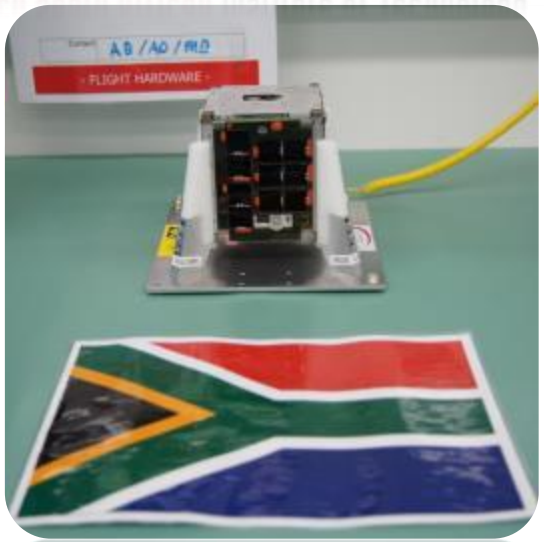
- ITP Engines UK - Esatan-TMS

Thermal Analysis

Internationnal Links : CPUT - South Africa

Cape Peninsula University of Technology

F'SATI
French South African Institute of Technology

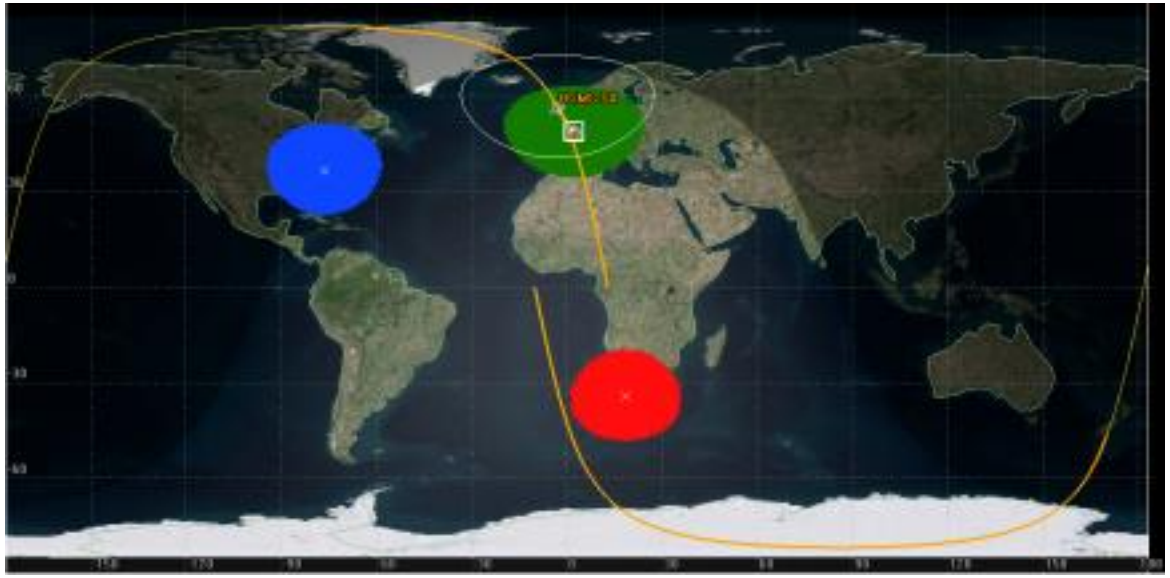


ZACube-1
First South African CubeSat

CMC 2 UHF/VHF
Engineering Model

Ground Stations Network

- Three UHF/VHF ground stations potentially available to download data (CPUT + VSGC)



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Student's project

Build a project **team** with several specialties

- Master degrees,
- IUT,
- Engineer's School

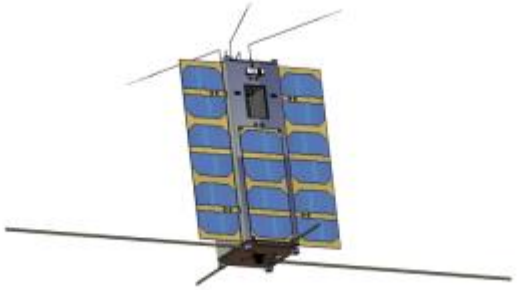
- Around 15 students per year working on the project during lectures and student's training course (2 – 6 months)

  ~ **40 students** up to now

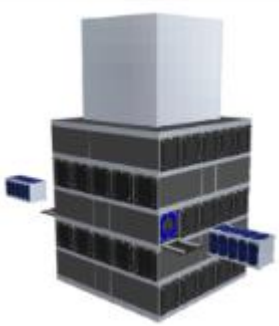
OGMS-SA
Student's project

Year	During lectures	Internships
2012/2013	14	5
2013/2014	6	10
2014/2015	*6*	*5 ?*

Benefits : team work, space project implication, international collaborations and student exchanges,…



QB50 Project



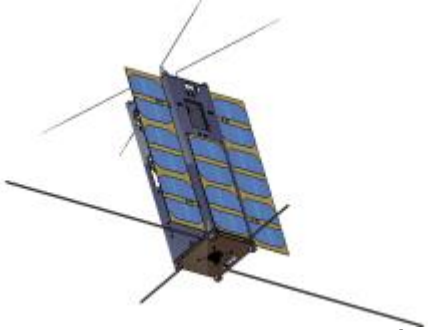
Constellation of 40 2U CubeSat dedicated to lower thermosphere studies

10 satellites for technological in orbit demonstration

Sun-synchronous **orbit** at ~400 km in lower thermosphere

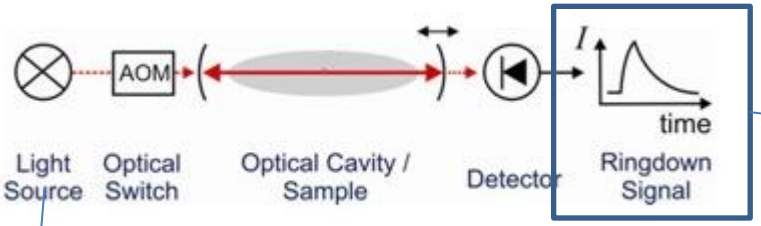
Launch planned for Jannuary 2016

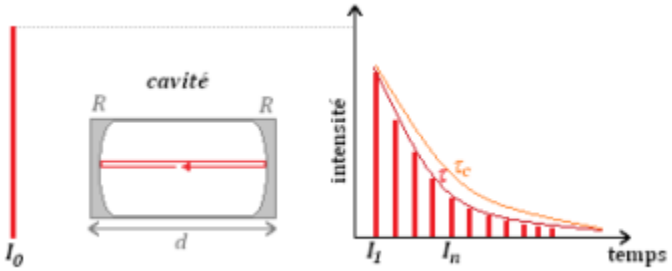
LV : Cyclone 4 from Alcantara (Brasil)

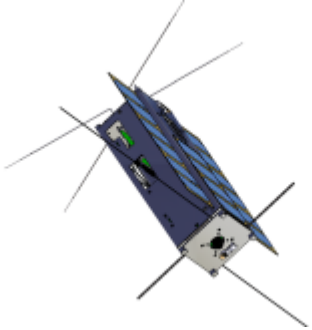


Payload
CRDS

Technological mission: the goal is to test a **CRDS** *(Cavity Ring Down Spectrometer)* in space environment





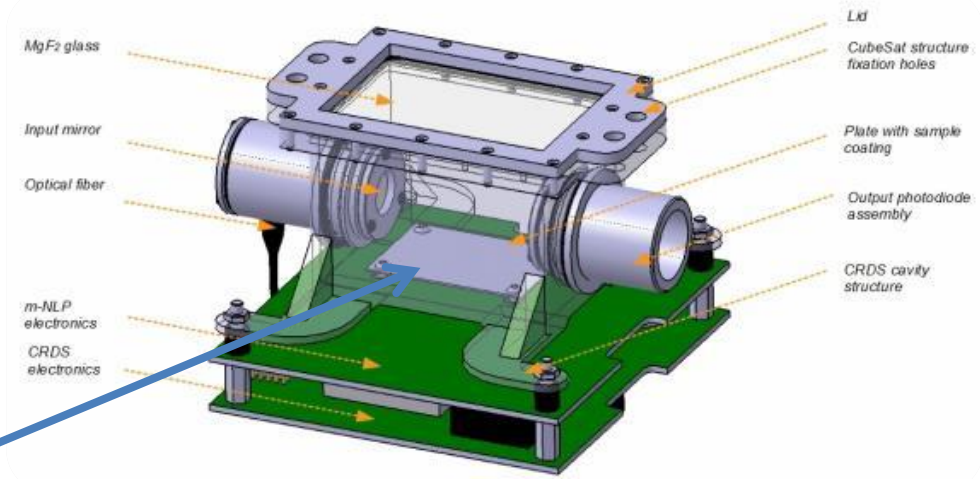


Payload
CRDS

Short term : Non scientific results expected : **technological validation** of the CRDS in space

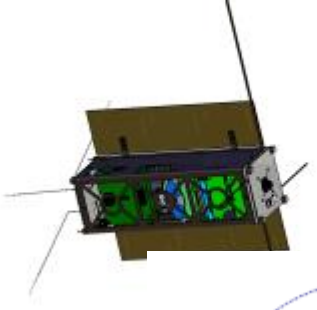
Long term : Study of the **organic molecule degradation** in space environment (UV + cosmic rays)

TiO2 sample inside the cavity full of **CO2**

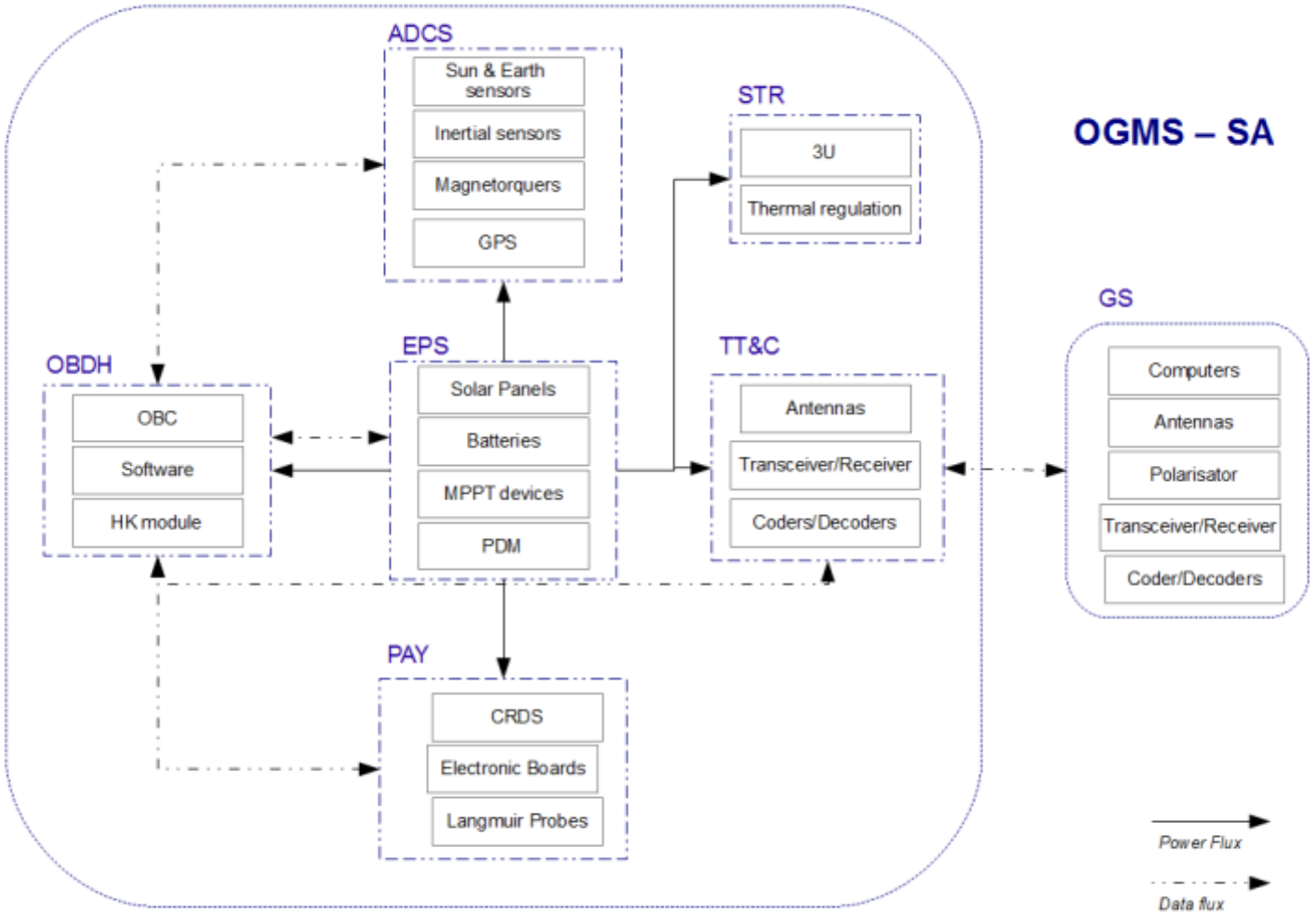


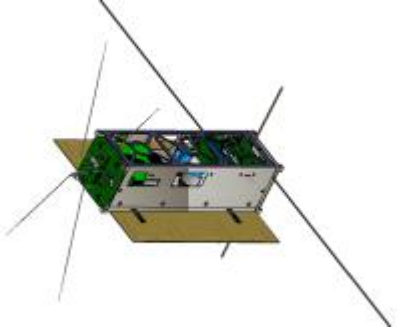
-> Absorption of CO2 at 2 µm

-> Attitude requirement : +X face pointing Sun



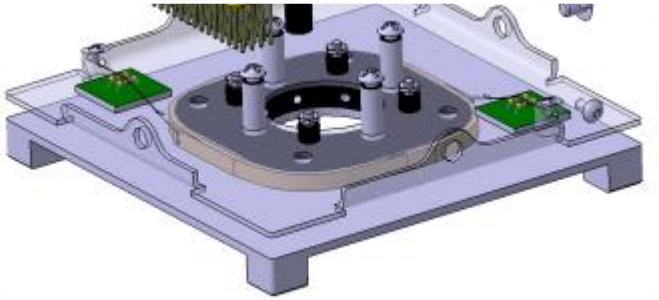
The CubeSat


ADCS
Sun & Earth sensors
Inertial sensors
Magnetorquers
GPS
STR
3U
Thermal regulation
OGMS – SA
GS
Computers
Antennas
Polarisator
Transceiver/Receiver
Coder/Decoders
OBDH
OBC
Software
HK module
EPS
Solar Panels
Batteries
MPPT devices
PDM
TT&C
Antennas
Transceiver/Receiver
Coders/Decoders
PAY
CRDS
Electronic Boards
Langmuir Probes
Power Flux
Data flux



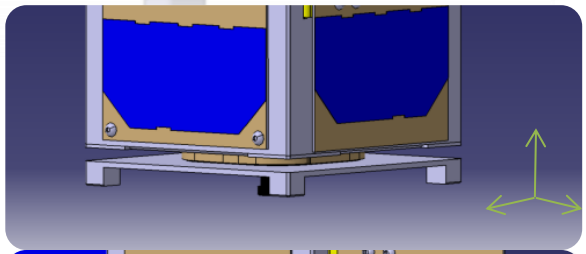
OGMS-SA : Communications

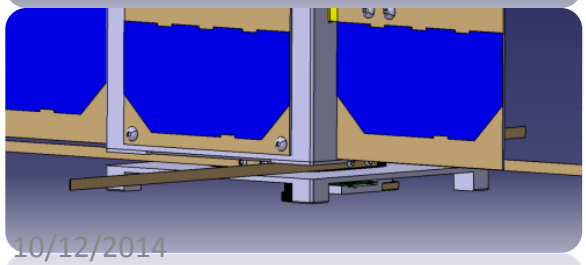
*Use of **radio amateur UHF / VHF bands***



***Home made** antennas and deployment system*

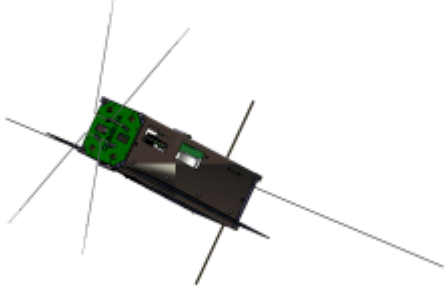
***CPUT CMC 2** UHF/VHF board*





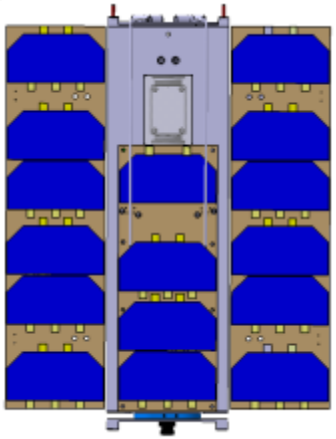
Most optimist data budget :

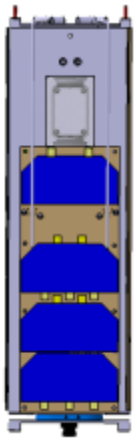
OGMS-SA Data Budget				
Only data which will be transferd to the Ground station is taken into account in this databudget				
	Data per Day (bits)	*Data per Day (bytes)*	*Needed transfer time (s)*	*Needed transfer time (min)*
CRDS	11 568 000	1 446 000	1205	20,1
Camera	2 457 600	307 200	256	4,3
Housekeeping	1 470 560	183 820	153	2,6
m-NLP	2 000 000	250 000	208	3,5
Total (without margin)	17 496 160	2 187 020	1823	30,4
Total (with margin)	**22 745 008**	**2 843 126**	**2369**	**39,5**

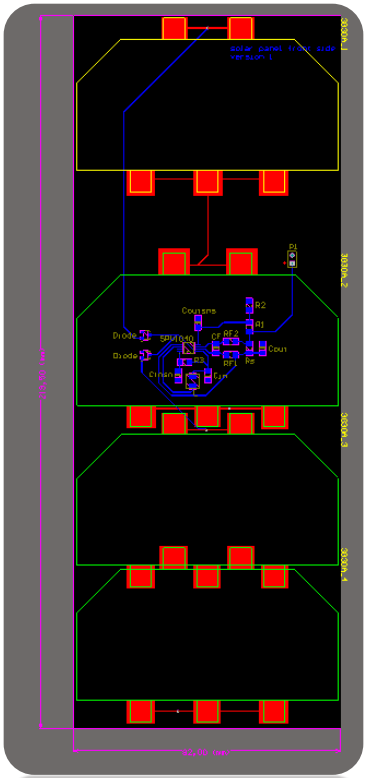


OGMS-SA: Power Supply

16 solar cells on the “front side” of the CubeSat
+ 4 on the “back side”



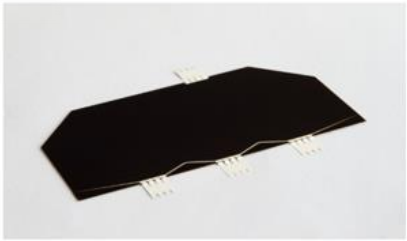


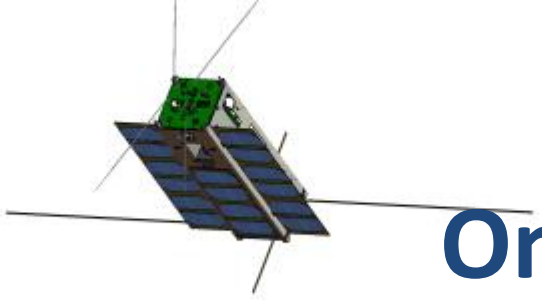


***CNES** handles the solar panels integration*

Same deployment mechanisms than antennas, using metal strips

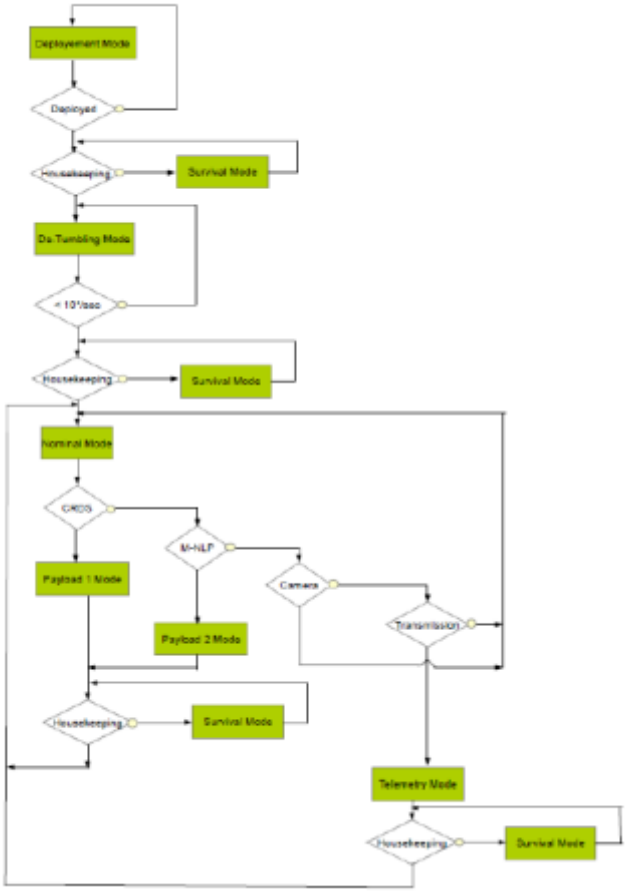
AOP of 10-11 Watts if reference attitude reached and deployments OK



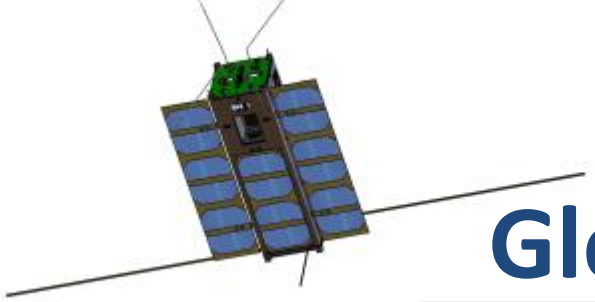


OGMS-SA : On board computer

FPGA Xilinx + embedded **Microblaze** for ADCS operations

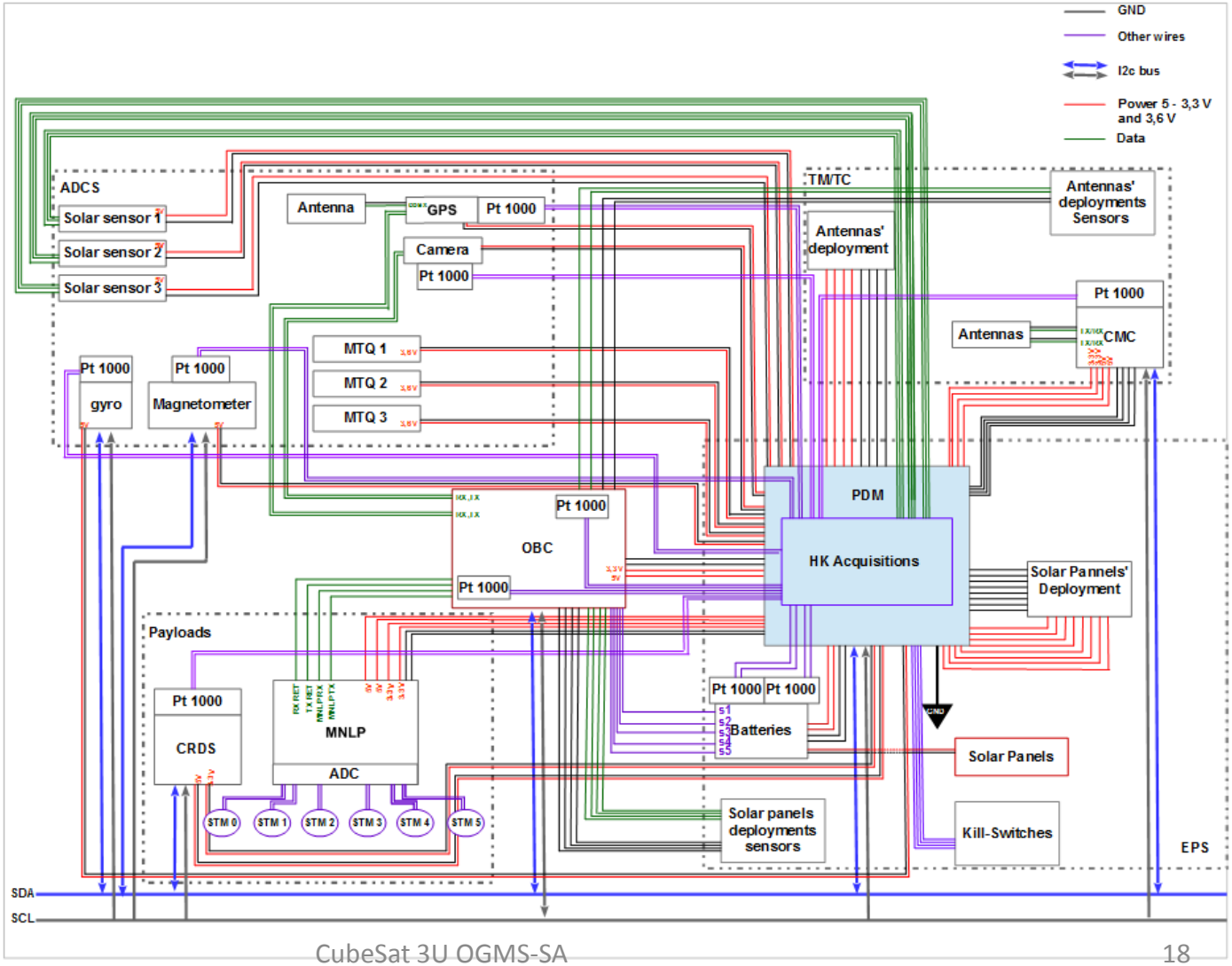


An independent microcontroller will be in charge of the **Housekeping** data collection



OGMS-SA : Global architecture

Power and data links map realized by the students during the internships period in 2014



Budgets

Sub-System	Mass (g)	Margin (g)	Mass with Margin (g)	Percentage of system mass
STR	654	130.8	784.8	27
ADCS	289	44.5	333.5	11
EPS	442.8	57.7	500.5	17
OBDH	90	18	108	4
TT&C	111.4	22.3	133.7	5
Payload	700	140	840	28
Integration	200	40	240	8
TOTAL	2487.2	453.19	**2940.39**	100

			Average Duty Cycle by Mode (%)						
Loads	Power Consumption (W)	Number of Units ON	Survival mode	Nominal mode	Deployment mode	De-Tumbling Mode	Telemetry Mode	Payload 1 mode	Payload 2 mode
EPS	0,6	1	100	100	100	100	100	100	100
PDM	0,2	1	100	100	100	100	100	100	100
Sun Sensor	0,05	3	0	100	0	0	100	100	100
Camera	0,08	1	0	100	0	0	0	0	0
GPS	1,2	1	0	100	0	0	0	0	0
Magnetorquers	0,2	3	0	100	0	100	100	100	100
Magnetometer	0,05	3	0	100	0	100	100	100	100
Gyroscope	0,05	3	0	100	0	100	100	100	100
Motherboard	1,5	1	20	100	50	100	100	100	100
Communication board Rx	0,15	1	100	100	0	100	100	100	100
Communication board Tx	6,188	1	0	0	0	0	23	0	0
CRDS electronics	9,673	1	0	0	0	0	0	30	0
Langmuir Electronics	1	1	0	0	0	0	0	0	47
Sum loads (W)			1,25	4,63	1,55	3,20	4,77	6,25	3,82
Efficiency			0,8	0,8	0,8	0,8	0,8	0,8	0,8
Power Consumed (W)			1,56	5,79	1,94	4,00	5,97	7,81	4,78
Power Generated (W)			3,77	11,32	3,77	5,66	11,32	11,32	11,32
Power Margin (%)			58,55	48,87	48,61	29,33	47,29	30,96	57,82

Reviews

PDR in 2013 and **CDR during summer 2014** done by student team

-> Several RIDs mostly concerning

- Attitude control simulation and modelization
  - ↳ Associated power budget
- Structural analysis
- Integration of the QB50 sensor set m-NLP

Consolidated budgets established

Schedule and prospects

Main Prospects

-> Protoflight model in progress and to be assembled and test as soon as possible.

-> CRDS payload ready to be tested on an optical bench

-> Vibration tests will be held soon

… VS …

QB50 milestones :

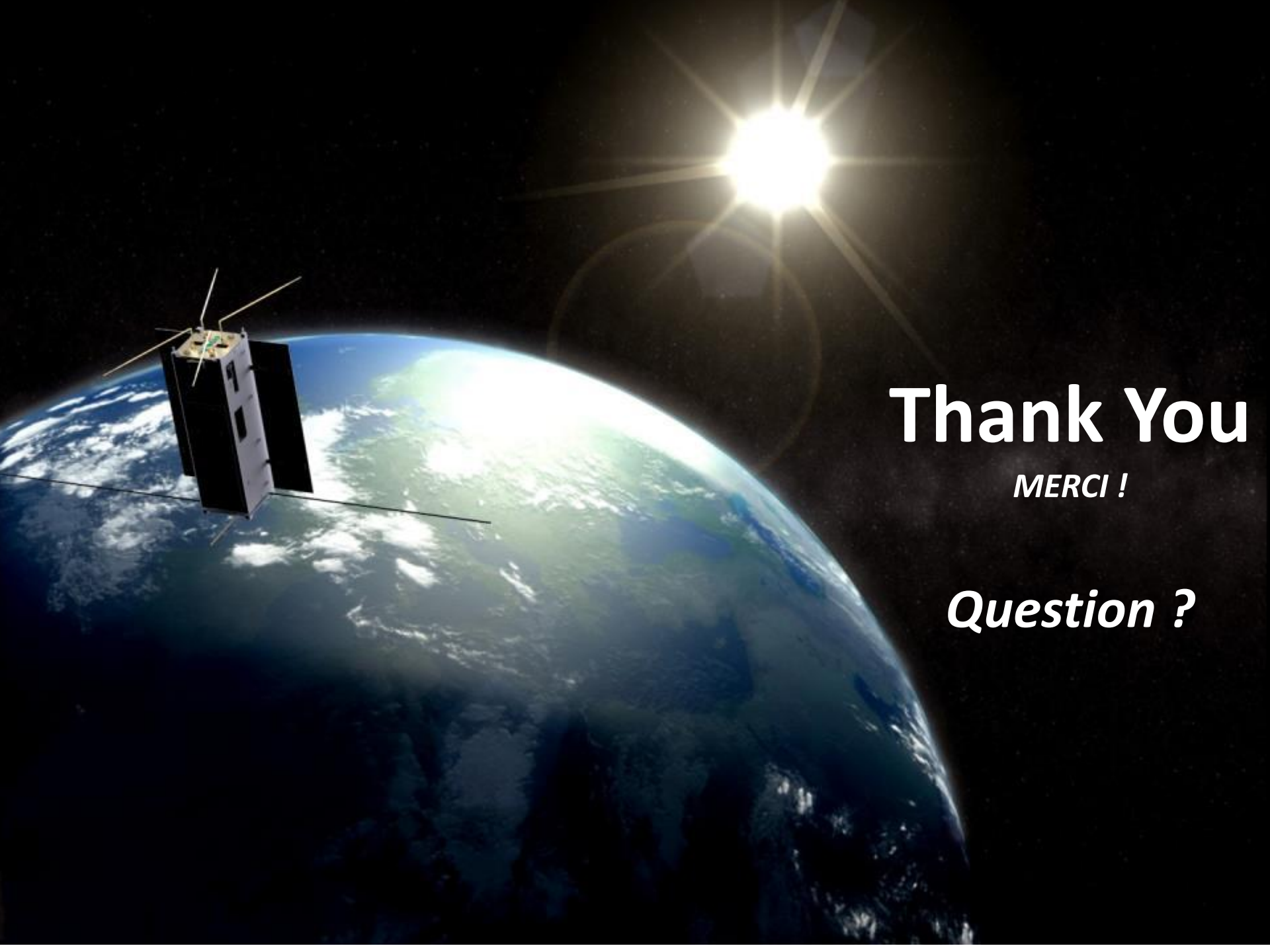
-> 15th October 2014 : AIT Reviews package delivery

-> 15th June 2015 : FRR and flight model delivery to ISIS

Common troubles :

-> Takes time to put all organization in place (institutions, facilities,...)

-> Students turn over


Thank You
MERCI !
Question ?