Progress report for "ROBUSTA" cubesat University Montpellier 2

DOCUMENTATION NOTICE		
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Date : ***1/03/2010***	Signature: 	Status: **Reviewed**

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Table of contents

1 INTRODUCTION

This report contains the development state of the satellite named ROBUSTA to date of March 2010. This satellite is developed by the University Montpellier 2 which includes the faculty of sciences, the IUT (University Institute of Technology) of Nîmes and Polytech’ Montpellier (school of engineering). Robusta is more than a satellite. It is a broad education program aiming at drawing students toward science and engineering careers. Therefore, it is mandatory that all the tasks leading to the completion of the project are performed not only by graduate students, but also by students in their first years of education program. 150 students have already contributed during the two first years of the project.

The payload on-board ROBUSTA will contribute to validate a radiation testing methodology developed at the UM2 and currently evaluated by ESA and a consortium (CNES, TAS, EADS-ASTRIUM, ESNIS). It should propose a solution to the concern of Enhanced Low Dose Rate Sensitivity (ELDRS) of bipolar integrated circuits. The experiment consists of flying a voltage comparator LM139 and a voltage amplifier LM124, both with date codes known to exhibit ELDRS and very strong radiation induced degradation.

2 LIST OF ABBREVIATIONS

ABBREVIATION	LEGEND
AFSK	Audio Frequency Shift Keying
AGWPE	Application GateWay Packet Engine
CAN	Controller Area Network
ELDRS	Enhanced Low Dose Rate Sensitivity
HW	Hardware
IUT	University Institute of Technology
OS	Operating System
OSL	Optically Stimulated Luminescence
PhP	Hypertext Preprocessor
PIC	Programmable integrated circuit
RTC	Real Time Clock
SMC	Surface Mounted Component
SW	Software
TID	Total Ionization Dose
µC/OS-II	Microcontroller/Operating system II
UM2	University Montpellier 2

3 OVERALL ASSESSMENT AND CRITICALITIES (IF ANY)

ROBUSTA is divided in four subsystems developed in parallel, as well as a mechanical structure and a ground segment. The subsystem "controller" manages the satellite tasks by means of an operating system currently being developed. It is the link between all subsystems. The overall power management is handled by the "power" subsystem. The payload is supported by the subsystem "experiment". The data will be sent by the subsystem "Radio-communication" and received by the ground station.

The degradation of key parameters of LM124 and LM139 (in+, in-, icc+, icc-, $Vout_{max}$, $vout_{min}$) will be recorded on a 12 hours basis and compared to the predictions issued [1] from a new ground based test method. In addition, the dose received by the devices during the last 12 hours, and the temperature will also be recorded. TID will be monitored using a novel sensor based on Optically Stimulated Luminescence jointly developed by university lab Institut d'Electronique du Sud (IES-UM2) and CNES. This sensor is identical to those employed on CARMEN and SET1.

At this stage each subsystem prototype is being validated and integration phase to final cubesat dimensions is going on. Communication and task management tests between boards are still going on to check the overall compatibility and operation of both hardware and the software. Integration and qualification tests are being prepared and a study about a failure mode analysis is in progress.

4 TECHNICAL STATUS

This section includes the technical status of each subsystem of the Cubesat.

Experiment subsystem: prototype in progress

Status:

- *The design of the third prototype is in progress*
- *The functional analysis has been updated*

Development:

- *Measurement of power consumption for the different operation modes of the subsystem is in progress*

Integration:

- *The final layout design of the payload is in progress*
- *Integration of the OSL sensor is in progress*

[1] J. Boch, F. Saigné, R. D. Schrimpf, J-R. Vaillé, L. Dusseau S. Ducret, M. F. Bernard, E. Lorfevre, and C. Chatry "Estimation of Low Dose Rate Degradation on Bipolar Linear Integrated Circuits Using Switch-ing Experiments", IEEE Trans. Nucl. Sci., vol. 52, pp. 2616-2621, 2005.

Testing:

- *Power distribution circuit tests have begun*
- *Communication tests between the experiment and controller subsystems have been performed with success*
- *Test measurements of devices under test both radiated and non radiated are going on*

	Design	Manufacturing/ Procurement of items	Integration	EM	FM	FM Test
Experience						
HW	100%	100%		80%		
SW	100%			99%		
Parameter measurement						
HW	100%		100%	90%		
SW	100%	100%				
OSL sensor						
HW	100%	100%	70%	50%		
SW	95%	100%	70%			
Temperature sensor						
HW	100%	100%	100%	100%		
SW	100%	100%				
Environmental calculus			3D model	Sector analysis		Shielding
Radiation Analysis						

Power subsystem: prototype in progress

Status:

- *The PCB which supports the solar cells has been designed*
- *A new design of the whole subsystem is in progress to take into account addressing problems between the supply of subsystems and the supply for nichrome wire*

Integration:

- *Searching for new components to match new supply voltage requirement*
- *First prototype of the PCB which supports the solar cells will be fabricated*

Mass:

- *Estimation for battery: 68g*
- *Solar cells with interconnect : 45g*

Testing:

- *New components for supply the 6V, 7.8V and 5V voltage will be tested*
- *Tests of current and voltage battery measurements controlled by the controller board have been realized with success*

	Design	Manufacturing/ Procurement of items	Integration	Prototype Test	FM	FM Test
Power						
HW	100%	93%	85%	80%		

Controller subsystem: prototype in progress

Status: No main progress since last report

- *Modification of the Petri net to take into account the satellite modes going on*
- *Development of the real time programming is still going on*

Development:

- *Data power telemetry is in discussion*
- *Overall communication procedures between the controller subsystem and the radio-communication subsystem is in progress*

Mass:

- *Estimation: 51g*

Testing:

- *Implementation and communication tests with the power measurement subsystem going on*

	Design	Manufacturing/ Procurement of items	Integration	Prototype Test	FM	FM Test
Controller						
HW	100%	95%	85%	65%		
SW	70%	60%		20%		
Sequential operating system						
SW	100%	85%	55%	10%		
Real Time Operating System						
SW	80%	70%		15%		
Petri Network						
SW	100%					
Real Time Clock (RTC)						
HW	100%	100%		100%		
SW	100%	100%		100%		
CAN BUS						
HW	100%			90%		
SW	100%			90%		

New Petri Network tasks oriented						
SW	100%					

Radio-communication card: prototype in progress

Status: Overall status in progress

- *Functional analysis finished*
- *New prototype in progress*

Under Development:

- *New antennas are tried*
- *Antenna deployment system under development*
- *Design for the reception or transmission of asynchronous 1200bits/sec data and use in Bell 202-to-UART data conversion in progress*
- *Development of the PIC software is going on. PIC is intended for communication between CAN bus and radio- communication board*
- *Consumption of the reception board is 300mW and must be improved*
- *Consumption of the general reset part must be improved*

Mass:

- *Estimation for antenna: still estimated 16g*
- *Gross estimation for the radio subsystem: 130g*

Testing:

- *New antennas to be tested*
- *Antenna deployment system with both antennas and power subsystem to be done*
- *Testing between deployment system and power board to be performed.*
- *More tests are to be performed on the POM material, in particular tests should be performed under vacuum*
- *Test of communication between controller board and radio-communication board to be done*

Ground segment

Status:

- *RF wires are connected. Antennas are completely installed*
- *Ground station identification number asked for via AMSAT members*

Development:

- *Mounting of the hardware of ground station near to be finished*
- *Applicative layer of the ground station program under study*
- *Code for reset signal to be sent to the satellite in progress*

Testing

- *Communication between PC and transceiver to be tested.*

	Design	Manufacturing/ Procurement of items	Integration	Prototype Test	FM	FM Test
Communication						
Board system						
HW	79%	72%	10%	69%		
SW	62%	90%		72%		
Ground station						
HW	95%	100%		82%		
SW	68%	95%		72%		

Mechanical architecture

Status:

- *A first prototype for testing the structural test equipment has been manufactured*
- *Test interfaces between the cubesat and the shaker have been manufactured*
- *Two more prototypes for testing structural test equipment and antennas deployment will be machined in the mass*

Development:

- *Improvement of the manufacturing process is in study*
- *The fixation system for solar cells is under study*

Integration:

- *The mechanical structure of the satellite will be machined in the mass*

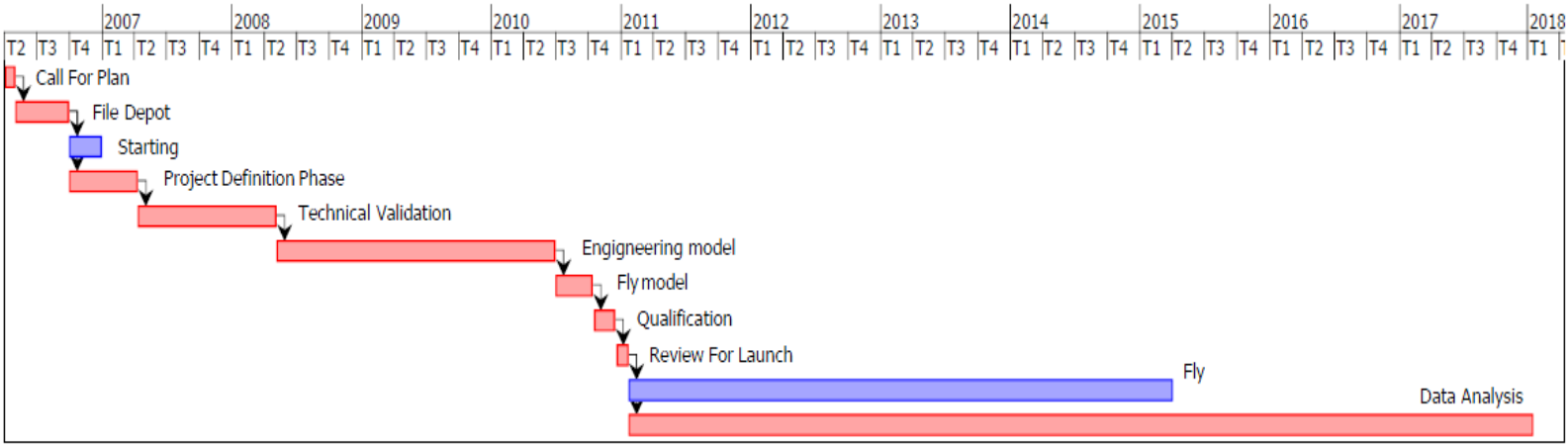
Mass:

- *Mechanical structure: 175g*
- *New mass budget to be done*

	Design	Manufacturing/ Procurement of items	Integration	Prototype Test	FM	FM Test
mechanical structure						
structure	100%	95%		33%		

5 SCHEDULE

Below the schedule for the cubesat development in a Gantt chart form. For more detail, view a Gantt diagram in annex.



6 NON-COMPLIANCES AND REQUESTS FOR WAIVERS/DEVIATIONS

This section describes any non-compliances that is currently present in the design of the Cubesat and if applicable a request for waiver or a deviation from the standard. The entire list of non-compliances and references to agreements must be included (e.g. date of emails).

7 ACTION ITEM LIST

The integration of satellite to final dimension is going on. For this each team has set their targets.

Until next report:

Experiment subsystem

- *The Engineering Model designed must be finished*
- *The OSL sensor must be integrated in the Engineering Model*
- *Another communication and task management test with the controller subsystem must be realized*

- *A new radiation analysis must be performed taking into account the update of orbit data*
- *The power distribution circuit must be integrated and tested*

Action	Responsible	Date Due	Completion
Experiment overall management: J.R Vaillé, N. Roche and C. Deneau			
Power measurement	L.Youssouf	28/02/10	90%
Communication and task management test		31/05/10	0%
New radiation analysis		31/05/10	0%
OSL sensor integration	M. Bernard	28/02/10	70%
Design of the Engineering Model	R. Guasch-Mari	31/03/10	70%
Integration and tests of the power distribution circuit	C.Deneau	31/03/10	40%

Controller subsystem

- *Programming real time operating system tasks to be finished*
- *The treatment of commands sent from ground station to be implemented*
- *Tests with the other subsystems for validation of the management task to be performed*
- *Communication tests with the other subsystems for validation of the communication protocol to be done*

Action	Responsible	Date Due	Completion
Control overall management: J. Boch, J.M. Gallière,			
Integration of the prototype	A. Lihard	15/12/08	100%
Flatsat prototype	A. Lihard, J. Lioure	15/12/08	100%
Find an Real time OS for implement Petri network	A. Lihard	01/12/08	100%
Design of the Petri network	J. Lioure	15/12/08	100%
RTC Tests	J. Lioure	01/12/08	100%
New de-latch circuitry system	S. Abidi	16/04/09	100%
New layout with the new de-latch circuitry system	S. Abidi	27/04/09	100%
Manufacturing of the new prototype	S. Abidi	1/06/09	100%
Test of the power measurement system	Y. Bouab	01/02/10	95%
Programming the real time operating system tasks	R. Badsi	28/02/10	80%
Scheduling tasks tests	R. Badsi	15/04/10	40%

Power subsystem

- *Manufacture the first PCB which supports the solar cells to be done*
- *Design a new prototype which takes into account the addressing problem encountered in the first one*
- *Testing with all the other subsystems*

Action	Responsible	Date Due	Completion
Power overall management: Mr. Gervois Mr. Giamarchi			
Finish Flatsat prototype	C.Munera J.Michel	February	100%
Integration of the prototype		April	100%
New prototype card		August	100%
Test of prototype		September	100%
Design of new prototype		March	In progress
Study for gluing down the solar cells into place	L. Pradier	December	100%
Manufacturing of PCB	L. Pradier	February	In progress

Radio communication board

- *PIC programming to be finished*
- *Change of quartz for emission at 437,325 MHz instead of 435,325 MHz to be done and tested*
- *Power consumption to be improved*
- *Antenna studies to be continued*
- *Completion of new design for the radio-subsystem regarding cubesat size*
- *Mass budget to be refined*

Ground segment

- *Different tests are needed for each protocol layer. Programming of data processing to be continued*
- *Connection between the transceiver and the computer to be done*
- *Communication between the ground station and the radio-communication card to be performed and tested*
- *Real-situation tests to be performed*

Action		Responsible	Date Due	Completion
Radio-Communication: overall management : S. Jarrix, A. Pénarier, P. Nouvel				
radio communication board	Flatsat	A. Doridant	15/03/10	90%
	Finish PIC programming	N. Boureghda	28/03/10	74%

	PIC board implementation	N. Boureghda	28/03//10	58%
	General reset system implementation	M. Chadelas, J. Euzière	28/02/10	65%
	Study of antenna, balun, deployment mechanism	A. Doridant, S. Jarrix	28/02/10	78%
	completion of design regarding cubesat size	M. Blain, J. Bonefacino, R. Roux, E. Diallo, T. Ngyen-Ba	28/03/10	4%
	mass budget to be done	M. Doridant	28/02/10	5%
Ground segment	Continue the mounting and test of antennas	M. Gasia	20/01/10	99%
	Test of antennas	M. Gasia	07/07/10	50%
	PC-to Transceiver com	V. Gasia	15/07/10	40%
	Mounting of rotors	V. Gasia	14/12/09	99%
	Data processing programming	M. Gasia	28/04/10	61%

Mechanical architecture

- *Supply mechanical structures for tests*
- *Mass budget to be redefined*

Action	Responsible	Date Due	Completion
Mechanical structure: overall management: B. Clotilde and T. Fiol			
Design of a modified one-block satellite	S.Noguier R.Julien J.Compain P.Gomez J.Leclerc F.Fernandez	8/12/08	100%
Design of a modified multi-part satellite		8/12/08	100%
Building of a multi-part prototype		15/12/08	100%
Building of a one-block prototype		15/12/08	100%
Preparation of the main building and assembly		1/02/09	100%
Main Building and assembly of 3 cubes	P.Gomez W.Bouzazi J.Bosquet	01/03/10	In progress

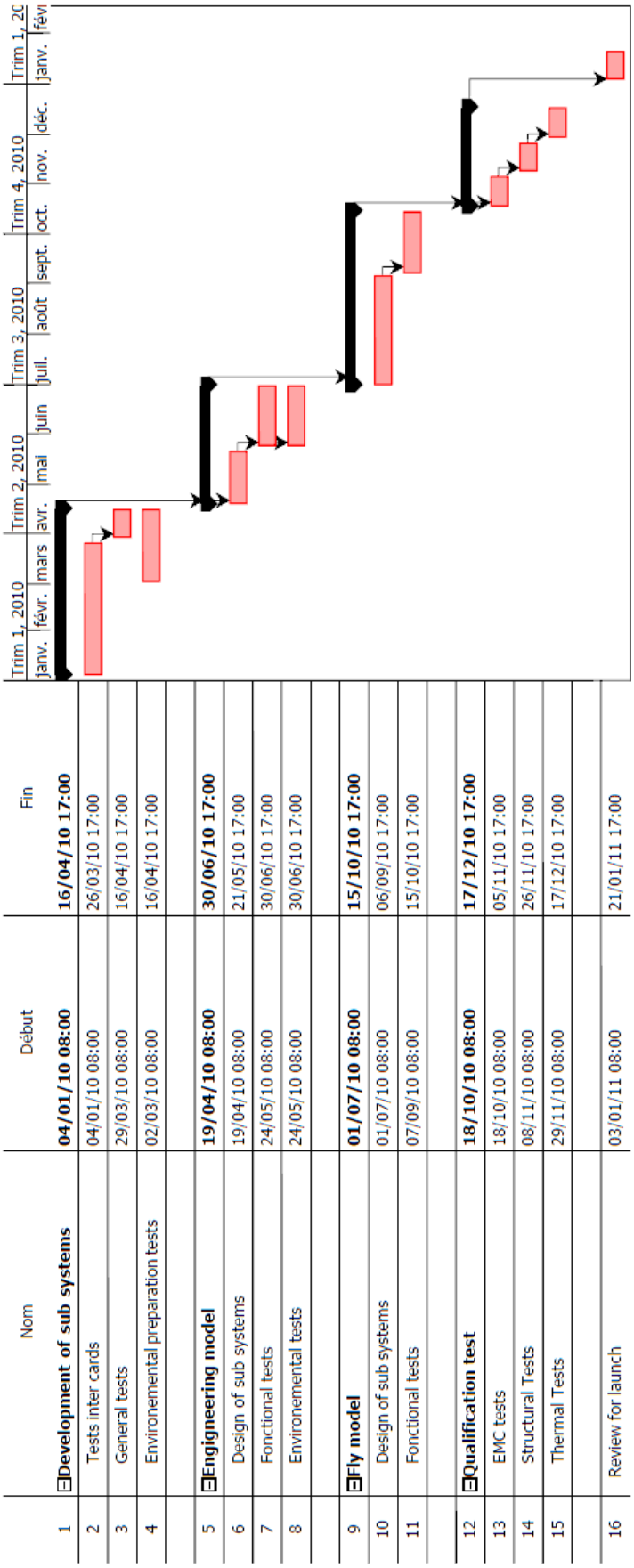
8 BUDGETS

This point of document describes the planned mass for each component. The matrix below summarises this budget.

Mass budget				
		Project : *ROBUSTA* *date : March* 1st		
Equipment	Description	Specified mass (kg)	Current mass (kg)	uncertainties (kg)
experience module	*perform experience*	*0,15*	0.095	
communication module	*perform communication between ground and satellite*	*0,25*	0.103	
	Antenna of satellite		0.016	
control module	*manager of internal communications*	*0,15*	0.051	
Mechanical Structure	*external structure*	*0,2*	0.178	*+/- 0,02*
	Panel structure		0.200	
	screws			
power module	*Power management*	*0,25*	0.032	
	Battery		0.068	
Mother board			0.030	
TOTAL		Specified mass : 1	*0.773* *1*	

9 ANNEX

Planning in a Gantt chart form:



	Nom	Début	Fin
1	**Development of sub systems**	**04/01/10 08:00**	**16/04/10 17:00**
2	Tests inter cards	04/01/10 08:00	26/03/10 17:00
3	General tests	29/03/10 08:00	16/04/10 17:00
4	Environemental preparation tests	02/03/10 08:00	16/04/10 17:00
5	**Engigneering model**	**19/04/10 08:00**	**30/06/10 17:00**
6	Design of sub systems	19/04/10 08:00	21/05/10 17:00
7	Fonctional tests	24/05/10 08:00	30/06/10 17:00
8	Environemental tests	24/05/10 08:00	30/06/10 17:00
9	**Fly model**	**01/07/10 08:00**	**15/10/10 17:00**
10	Design of sub systems	01/07/10 08:00	06/09/10 17:00
11	Fonctional tests	07/09/10 08:00	15/10/10 17:00
12	**Qualification test**	**18/10/10 08:00**	**17/12/10 17:00**
13	EMC tests	18/10/10 08:00	05/11/10 17:00
14	Structural Tests	08/11/10 08:00	26/11/10 17:00
15	Thermal Tests	29/11/10 08:00	17/12/10 17:00
16	Review for launch	03/01/11 08:00	21/01/11 17:00