
# PROGRESS REPORT FOR THE "ROBUSTA" CUBESAT UNIVERSITY MONTPELLIER 2

System nomenclature: EA
Type of document: EN
Date of creation: June 1ST 2011

AMSAT-F


**EN_EA**_2011-06-01

| | Edition | Verification | Approbation |
|---|---|---|---|
| ***Name*** | Dhombres Stephanie | S. Jarrix<br>L. Dusseau | L. Dusseau |
| ***Date*** | 30/05/2011 | 30/05/2011 | 30/05/2011 |
| ***Signature*** | SD | SJ |  |
| ***Contributing authors*** | ***A. Aviat, R. Badsi, T. Balard, B. Benarabi, J. Bonefacino, A. Blain, A. Bonnefoy, N. Boureghda, B. Clotilde, C. Deneau, S. Dhombres, A. Doridant, A. Dubedat, L. Dusseau, V.Gasia, F. Giamarchi, G. Gibert, J. Landi, S. Perez, V. Ponsa, L. Pradier, N. Roche*** | | |
| ***Contact*** | Prof. L. Dusseau<br>dusseau@ies.univ-montp2.fr<br>tel : +33 4 67 14 38 25 | | |

Table of update

| Version | Date | Modifications |
|---|---|---|
| 1 | 06/01/2011 | Update of document |

# Table of contents

# 1. Introduction

This report contains the development state of the satellite named ROBUSTA to date of June 2011. 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 |
|---|---|
| ABS | Acrylonitrile Butadiene Styrene |
| AFSK | Audio Frequency Shift Keying |
| AGWPE | Application Gate Way Packet Engine |
| ARCEP | French authority for electronic communications |
| CAN | Controller Area Network |
| ELDRS | Enhanced Low Dose Rate Sensitivity |
| EQM | Electrical qualification model |
| 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 in final cubesat dimensions is being validated. 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.

## 4. Technical Status

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

***<u>Experiment subsystem: Flight Model in progress</u>***

Status:

- *The design of the Qualification Model is finished*
- *The layout of the Qualification Model is finished*

Development:

- *Measurement of power consumption for the different operation modes of the subsystem on the EQM is in progress*
- *Measurement of current consumption on the OSL dosimeter has been performed with success taking into account the specifications*
- *Optimization of software must be completed*
- *Implementation of actions to be taken after reception of commands from ground station is in progress*

Integration:

- *Integration of the OSL sensor on the Qualification Model is finished*

[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.

Mass:

- *Estimation : 39.01g*

Testing:

- *Operational tests on engineering model were preformed with success*
- *Communication and task management tests with the controller subsystem in real time configuration is in progress*
- *Operational tests on the Qualification Model must performed*

| | Design | Manufacturing/ Procurement of items | Integration | EM | EQM | EQM Test | QM | QM Test |
|---|---|---|---|---|---|---|---|---|
| Experience | | | | | | | | |
| HW | 100% | 100% | 100% | 100% | 100% | 99% | 99% | 0% |
| SW | 100% | | | 100% | | 99% | | 0% |
| Parameter measurement | | | | | | | | |
| HW | 100% | | 100% | 100% | 100% | 100% | 100% | 0% |
| SW | 100% | 100% | | | | 100% | | 0% |
| OSL sensor | | | | | | | | |
| HW | 100% | 100% | 100% | 100% | 100% | 99% | 99% | 0% |
| SW | 95% | 100% | 100% | | | 99% | | 0% |
| Temperature sensor | | | | | | | | |
| HW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| SW | 100% | 100% | | | | 100% | | |
| Environmental calculus | | | 3D model | | Sector analysis | | Shielding | |
| Radiation Analysis | | | 98% | | 85% | | 70% | |

***Power subsystem: No progress for this month***

Status:

- *Motherboard and central plates have been manufactured*
- *Problem with solar cells : supply of special glue for solar cells delayed*
- *Design for deployment of Connectors for solar cell panels being designed*

Integration:

- *Assembly of the power board prototype has been done*

Mass:

- *Estimation for battery: 68g*
- *Solar cells with interconnects : 45g*
- *Power management board : 50g*

Testing:

- *Testing of the power board prototype is going on*
- *Mounting solar cells will begin as soon as glue is supplied*

| | Design | Manufacturing/ Procurement of items | Integration | Prototype Test | FM | FM Test |
|---|---|---|---|---|---|---|
| Power | | | | | | |
| HW | 100% | 96% | 97% | 90% | | |

***Controller subsystem:***

Status: ***no progress for this month***

- *Design of a new electronic board (QM) with no battery for the real time clock supply completed.*
- *Electrical tests on new prototype done and satisfactory.*
- *Functional Analysis is done.*
- *Final list of Components is being implemented.*

Development:

- *Development of the real time programming is still going on*

Mass:

- *Estimation: 34.61g*
- *Mass budget updated*

Testing:

- *Communication and task management tests with the experiment subsystem in real time configuration are in progress with EM prototype.*

| | Design | Manufacturing/ Procurement of items | Integration | EM Test | QM design | QM Test |
|---|---|---|---|---|---|---|
| Controller | | | | | | |
| HW new model | 95% | 05% | 0% | 0% | 80% | |
| SW | 95% | 95% | | 80% | 80% | |
| Sequential operating system | | | | | | |
| SW | 100% | 85% | 55% | 10% | | |
| Real Time Operating System | | | | | | |
| SW | 95% | 95% | | 80% | 80% | |
| Petri Network | | | | | | |
| SW | 100% | | | | | |
| Real Time Clock (RTC) | | | | | | |
| HW | 100% | 100% | | 100% | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| SW | 100% | 100% | | 100% | | |
| CAN BUS | | | | | | |
| HW | 100% | | | 100% | | |
| SW | 100% | | | 100% | | |
| New Petri Network tasks oriented | | | | | | |
| SW | 100% | | | | | |

***Radio-communication board: prototype in progress***

Status:

- New prototype design with one board for emission and one board for reception is being tested

Under Development:

- Operational tests on the radio board without program implemented in PIC microcontroller in progress.
- Software debugging in progress.

Mass:

- Antenna and support antenna system: 3.96g
- Estimation for the radio subsystem: 81.27g

Testing:

- AX25 coding under test
- PIC software under test
- Modulation index to be redefined

- Expecting new quartz with a better accuracy in order to respect the ARCEP specifications (carrier accuracy at 1/10000).
- Communication between OBC and radio board being debugged
- The "circuit breaker" is under test with respect to command from ground station.

***Ground segment***

Status:

*No progress since last progress report*

| | Design | Manufacturing/ Procurement of items | Integration | QM | Emission Test | Reception Test |
|---|---|---|---|---|---|---|
| Radio communication board | | | | | | |
| Board system | | | | | | |
| HW | 100% | 91% | 100% | 95% | 98% | 50% |

| | | | | | | |
|---|---|---|---|---|---|---|
| SW | 85% | 9% | | 79% | 60% | 60% |
| Ground station | | | | | | |
| HW | 99% | 100% | | 90% | 90% | 90% |
| SW | 80% | 95% | | 72% | 0% | 0% |

***Mechanical architecture***

Status:

- *Structures are being manufactured according to the latest –and definitive- version of the design. Structures are nearly finished (90%)*
- *Solar cells assembly: work in progress.*

Development:

- *Several structures are being manufactured , solar cells assembly procedure in progress*
- *Glue tests are scheduled with new glue and adequate equipment.*

Integration:

- *Implementation of an integrated cubesat in progress*

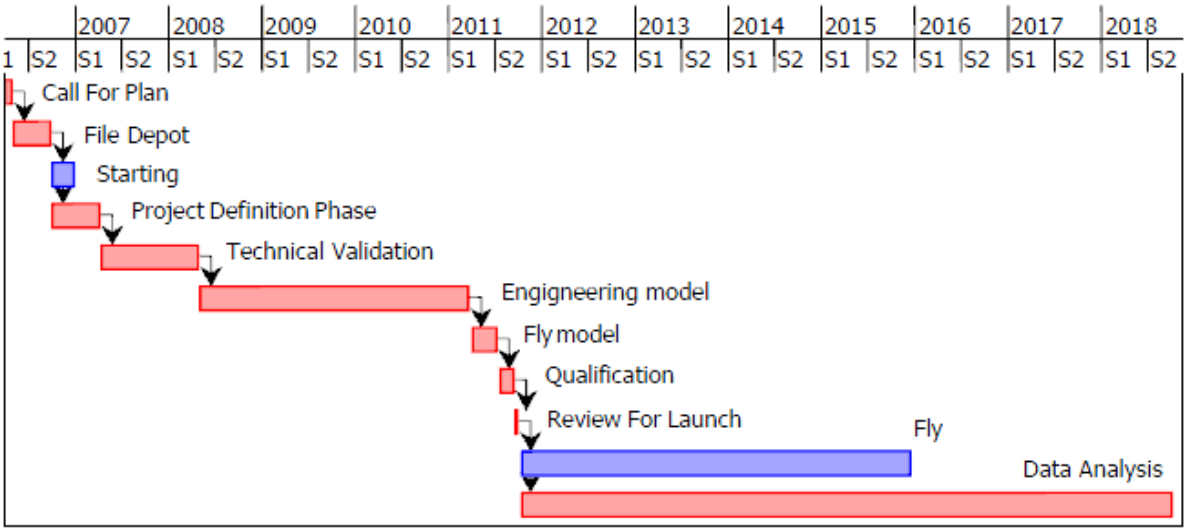
Mass:

- *Mass budget file and Components file : 95%*

| | *Design* | *Manufacturing/ Procurement of items* | Integration | Prototype Test | FM design | FM Test |
|---|---|---|---|---|---|---|
| mechanical structure | | | | | | |
| Structure (new design) | 99.9% | 25% | 5% | 0% | 80% | |

## 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

## 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***

- *Communication and task management test with the controller subsystem in real time situation is in progress*
- *Radiation and shielding analysis must be continued*
- *Software implementation must be validated*
- *The Qualification Model must be mounted and tested*

| Action | Responsible | Date Due | Completion |
|---|---|---|---|
| Experiment overall management: J.R Vaillé, N. Roche and C. Deneau | | | |
| Communication and task management test in real time on the EQM | C. Deneau<br>N. Roche | 15/04/10 | 100% |
| New radiation analysis | M. Bernard | 30/06/10 | 90% |
| Layout of the Qualification Model | C. Deneau | 15/11/10 | 100% |
| Operational tests on the Electrical Qualification Model | C. Deneau<br>N. Roche | 30/06/10 | 99% |
| Software implementation | R. Badsi<br>C. Deneau | 30/06/10 | 99% |
| Electrical tests interface with power board | N. Roche | 30/11/10 | 100% |

| | | | |
|---|---|---|---|
| Mounting of the Qualification Model | C. Deneau | 30/06/10 | 70% |
| Tests on the Qualification Model | C. Deneau | 30/07/10 | 0% |

***Controller subsystem***

- *Programming real time operating system tasks to be optimized*
- *Tests with the other subsystems for validation of the management task are to be continued*
- *Communication tests with the other subsystems for validation of the communication protocol to be pursued*
- *Design of the QM prototype to be finished and tested*

| Action | Responsible | Date Due | Completion |
|---|---|---|---|
| Control overall management: J. Boch, J.M. Gallière, | | | |
| Test of the power measurement system | Y. Bouab | 01/02/10 | 100% |
| Programming the real time operating system tasks | N. Bonniol | 15/03/11 | 90% |
| Scheduling tasks and communication tests | R. Badsi | 01/10/10 | 100% |
| Implementation of a test bench | R.Badsi | 31/07/10 | 100% |
| Design of the new prototype | | 15/12/10 | 100% |
| Routing and test of the new prototype | A. Maitrot | 01/07/11 | 85% |

***Power subsystem***

- *Test with the others subsystems to be done*
- *Design of the "solar cell" subsystem must be done*

| Action | Responsible | Date Due | Completion |
|---|---|---|---|
| Power overall management: Mr. Gervois Mr. Giamarchi | | | |
| Design of new prototype | | March 2009 | 100% |
| Study for gluing down the solar cells into place on the QM model | G. Gibert | 01/07/11 | 90% |
| Manufacturing of PCB | L. Pradier | February 2010 | 100% |
| Mounting and test the new prototype | | October 2010 | 100% |
| Power board production | | 01/07/2011 | 55% |
| Finalize the design of "solar cell" subsystem | G. Gibert | 01/07/11 | 90% |

***Radio communication board***

- *PIC programming to be debugged*

- *Final tests for the reliability of the general reset system should be undertaken.*
- *More tests have to be performed on the POM material, in particular tests should be performed under vacuum.*
- *Consumption and communication tests to be done*

***Ground segment***

- *Calibration of hardware to be refined.*
- *Software for telecommand to be tested.*
- *Different tests undertaken for each protocol layer.*
- *Programming of data base to be continued.*
- *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 | Finish PIC programming | A. Aviat | 05/07/11 | 85% |
| | PIC board implementation | G. Mula, A. Dubedat | 05/05/11 | 100% |
| | General reset test | A. Blain, J. Bonefacino | 05/07/11 | 20% |
| | Study of antenna, balun, deployment mechanism | A. Doridant, A. Blain, | 15/02/10 | 100% |
| | completion of design regarding cubesat size | A. Blain, A. Doridant G. Auvray | 15/01/11 | 100% |
| | mass budget to be done | J. Bonefacino, B. Benarabi | 05/07/11 | 88% |
| | Circuit breaker system | T. Balard N. Martinez | 15/06/10 | 82% |
| | Emission and reception parts implementation EM | J. Bonefacino, B. Benarabi, A. Blain | 15/03/10 | 100% |
| | Emission tests | J. Bonefacino B Benarabi | 05/07/11 | 55% |
| | Reception tests | J. Bonefacino B Benarabi | 05/07/11 | 55% |
| | Communication tests with other boards | J. Bonefacino B Benarabi | 05/07/11 | 60% |
| | QM model : implementation | J. Bonefacino B Benarabi | 05/07/11 | 88% |

***Mechanical architecture***

- *Supply mechanical structures according to the definitive design*
- *Optimize the manufacturing process*
- *Optimize the assembly of the solar cells by designing and producing new tools*

| Action | Responsible | Date Due | Completion |
|---|---|---|---|
| Mechanical structure: overall management: B. Clotilde, T. Fiol,V.Ponsa | | | |
| Building of a one-block prototype | S.Noguier<br>R.Julien<br>J.Compain<br>P.Gomez<br>J.Leclerc<br>F.Fernandez | 15/12/08 | 100% |
| Preparation of the main building and assembly | | 1/02/09 | 100% |
| Supply structure for tests | B; Clotilde | 01/07/11 | 66% |
| Assembly of solar cells : design of devices related to , and production ( rapid prototyping) | G. Gibert | 01/07/11 | 80% |
| Mass budget file | B.Clotilde<br>T.Fiol<br>V.Ponsa | 24/03/11 | 98% |
| Components File | T.Fiol<br>G.Gibert<br>V.Ponsa | 01/07/11 | 97% |
| Soldering of antennas | S. Jarrix,<br>A. Blain | 01/07/11 | 99% |

## 8. Budgets

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

New mass budget is going on.

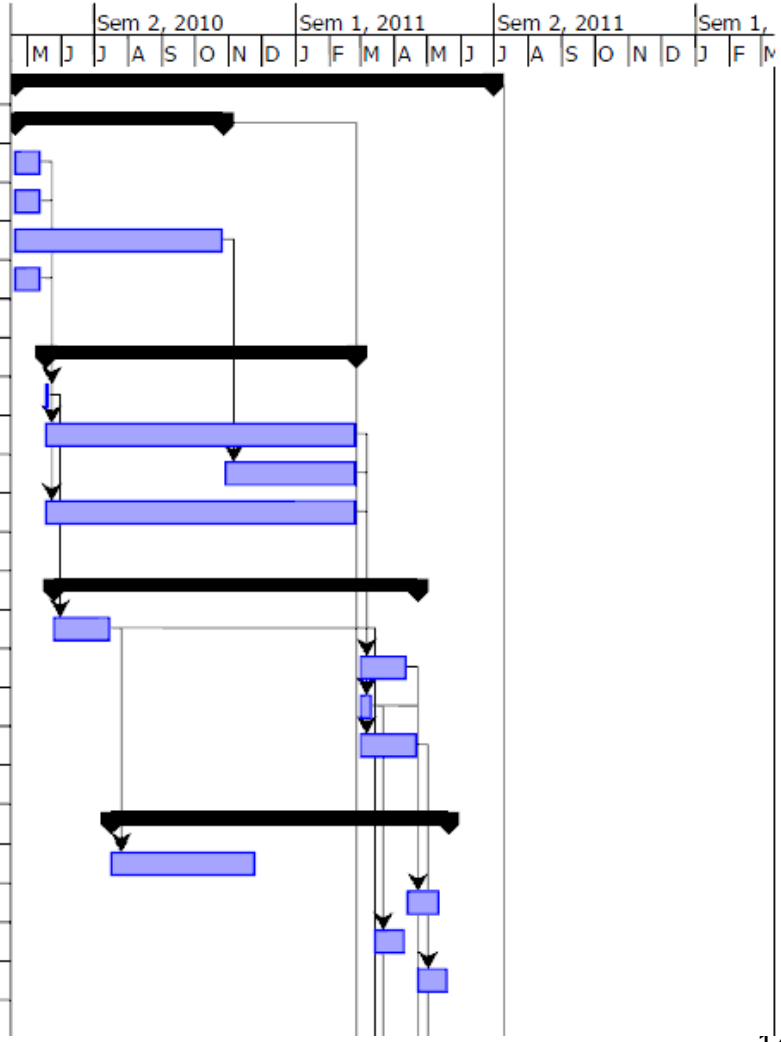
| **Mass budget** | | | | | |
|---|---|---|---|---|---|
| | | | Project : *ROBUSTA*<br>Date : June 1st 2011 | | |
| Equipment | Description | Number | Specified mass (kg) | Current mass (kg) | uncertainties (kg) |
| *Payload module* | *perform experience* | *1* | *0,15* | 0.03901 | |

| | | | | | |
|---|---|---|---|---|---|
| *Radiocommunication module* | *perform communication between ground and satellite* | *1* | *0,25* | 0.08127 | |
| *On board computer module* | *manager of internal communications* | *1* | *0,15* | 0.03461 | |
| *Mechanical Structure* | *external structure* | *1* | *0,2* | 0.521515 | |
| *Power board module* | *Power management* | *1* | *0,25* | 0.21586 | |
| *Mother board* | | *1* | | 0.04018 | |
| TOTAL | | | Specified mass : 1 | *932.4480*<br>*1* | |

## 9. Annex

Planning in a Gantt chart form:

| | Nom | Début | Fin |
|---|---|---|---|
| 1 | **Engigneering / Qualification model** | **19/04/10 08:00** | **29/06/11 17:00** |
| 2 | **Design of sub systems** | **19/04/10 08:00** | **27/10/10 17:00** |
| 3 | Power Board | 19/04/10 08:00 | 14/05/10 17:00 |
| 4 | Payload | 19/04/10 08:00 | 14/05/10 17:00 |
| 5 | Radiocommunication Board | 19/04/10 08:00 | 27/10/10 17:00 |
| 6 | On Board Computer | 19/04/10 08:00 | 14/05/10 17:00 |
| | | | |
| 7 | **Manufacturing** | **17/05/10 08:00** | **25/02/11 17:00** |
| 8 | Power Board | 17/05/10 08:00 | 21/05/10 17:00 |
| 9 | Payload | 17/05/10 08:00 | 25/02/11 17:00 |
| 10 | Radiocommunication Board | 28/10/10 08:00 | 25/02/11 17:00 |
| 11 | On Board Computer | 17/05/10 08:00 | 25/02/11 17:00 |
| | | | |
| 12 | **Functional tests** | **24/05/10 08:00** | **21/04/11 17:00** |
| 13 | Power Board | 24/05/10 08:00 | 15/07/10 17:00 |
| 14 | Payload | 28/02/11 08:00 | 12/04/11 17:00 |
| 15 | Radiocommunication Board | 28/02/11 08:00 | 11/03/11 17:00 |
| 16 | On Board Computer | 28/02/11 08:00 | 21/04/11 17:00 |
| | | | |
| 17 | **Environemental tests** | **16/07/10 08:00** | **20/05/11 17:00** |
| 18 | Power Board | 16/07/10 08:00 | 26/11/10 17:00 |
| 19 | Payload | 13/04/11 08:00 | 13/05/11 17:00 |
| 20 | Radiocommunication Board | 14/03/11 08:00 | 11/04/11 17:00 |
| 21 | On Board Computer | 22/04/11 08:00 | 20/05/11 17:00 |



| | | | |
|---|---|---|---|
| 22 | **Integration/Functional Tests** | **25/02/11 09:00** | **06/05/11 17:00** |
| 23 | PB+OBC | 25/02/11 09:00 | 14/03/11 09:00 |
| 24 | PB+PL | 25/02/11 09:00 | 14/03/11 09:00 |
| 25 | PB+RB | 14/03/11 08:00 | 18/03/11 17:00 |
| 26 | PL+OBC | 25/02/11 09:00 | 14/03/11 09:00 |
| 27 | RB+OBC | 22/04/11 08:00 | 28/04/11 17:00 |
| 28 | PB+OBC+PL | 14/03/11 09:00 | 29/04/11 17:00 |
| 29 | All Board | 02/05/11 08:00 | 06/05/11 17:00 |
| 30 | Mecanic Integration | 25/02/11 09:00 | 09/03/11 09:00 |
| | | | |
| 31 | **Environemental Preparation Tests** | **06/06/11 08:00** | **29/06/11 17:00** |
| 32 | EMC test, Where ? | 06/06/11 08:00 | 29/06/11 17:00 |
| 33 | Structural tests, Where ? | 06/06/11 08:00 | 29/06/11 17:00 |
| 34 | Thermal test, Where ? | 06/06/11 08:00 | 29/06/11 17:00 |
| 35 | Vaccum test, Where ? | 06/06/11 08:00 | 29/06/11 17:00 |
| | | | |
| 36 | **Fly model** | **30/06/11 08:00** | **21/10/11 17:00** |
| 37 | Design of sub systems | 30/06/11 08:00 | 28/07/11 17:00 |
| 38 | Fonctional tests | 03/10/11 08:00 | 21/10/11 17:00 |
| | | | |
| 39 | **Acceptance test** | **24/10/11 08:00** | **23/12/11 17:00** |
| 40 | EMC tests | 24/10/11 08:00 | 11/11/11 17:00 |
| 41 | Structural Tests | 14/11/11 08:00 | 02/12/11 17:00 |
| 42 | Thermal Tests | 05/12/11 08:00 | 23/12/11 17:00 |
| | | | |
| 43 | Review for launch | 26/12/11 08:00 | 13/01/12 17:00 |