EPSC Abstracts
Vol. 11, EPSC2017-135-3, 2017
European Planetary Science Congress 2017

Planetary exploration with nanosatellites: a space campus for future technology development

P. Drossart (1), B. Mosser (1) and B. Segret (1)
(1) LESIA, Observatoire de Paris, PSL Research University, CNRS, UPMC, Univ. Paris Diderot
(pierre.drossart@obspm.fr ; fax 33 1 45 07 79 59)

Abstract

Planetary exploration is at the eve of a revolution through nanosatellites accompanying larger missions, or freely cruising in the solar system, providing a man-made cosmic web for in situ or remote sensing exploration of the Solar System. A first step is to build a specific place dedicated to nanosatellite development. The context of the CCERES [1] PSL space campus presents an environment for nanosatellite testing and integration, a concurrent engineering facility room for project analysis and science environment dedicated to this task.

1. Introduction

The development of nanosatellites has reached a formidable increase during the last decade. It is sometimes described as a democratization of access to space for experiments in the context of universities and institutes. The specificity of the domain, and the interaction with university projects have raised the need for new approach in satellite developments, qualification and integration. Supported by space laboratories in France, the space campus CCERES intends to coordinate these efforts in relationship with institutional and entrepreneurial actors to develop a new domain of expertise.

1.1 Description of the scientific context

Three types of nanosatellites have been developed: educational, technological, and scientific. CCERES is working in the field of scientific and technological nanosatellites, in order to provide an answer to dedicated science questions, as well as paving the way for future missions through technological development of new instruments, by increasing their TRL. The CCERES campus joins science and education guides:

- ESEP: the "laboratoire d'excellence" ESEP[2] coordinates science activities and research and developmenet in the domain of technology for instruments of space mission. As a coordination of space laboratories in space research, it decides of the scientific selection of projects for the space campus

- The master degree OSAE[3] the educational frame for space projects, and surveys the development of projects

1.2 Facilities for nanosatellite development

The integration of nanosatellites projects is made within the facilities available in Paris Observatory for CCERES :

- Room for concurrent engineering: under the coordination of a system engineer, a project team is supported to design a pertinent mission profile and to size its key systems within a concurrent engineering process.
- Clean integration rooms and access to specialized facilities : different qualification and tests can be performed under controlled environment (bake out, thermal vacuum, plasma, etc.)

[1] Campus et Centre de Recherche pour l'Exploration Spatiale ; https://cceres.univ-psl.fr/
[2] Exploration Spatiale des Environnements Planétaires ; http://www.esep.pro
[3] Astronomical and space based systems engineering ; http://osae.obspm.fr

2. Current nanosatellite projects under study

A list of the projects considered for a support in the CCERES facilities is given in Table 1.

Table 1: list of nanosatellite projects supported within CCERES/ESEP

Name	Laboratory	Principal Investigtor
BIRDY-T	IMCCE	D. Hestroffer
CIRCUS	LESIA	K. Issautier
PICSAT	LESIA	S. Lacour
OGMS-SA	LISA	N. Grand
METEOR	IMCCE	N. Rambaux
GPU4SPACE	LESIA	D. Gratadour
SERB	LATMOS	M. Meftah

A selection of three projects is described in more details here, among these projects:

a) PICSAT

PICSAT is a nanosatellite project in final phase of construction [1]. It is aimed to detect a potential transit of the exoplanet beta-Pictoris b, predicted to occur in 2017 [2]. This 3-unit cubesat has been developed with a fine pointing optical fiber system to reach the sensitivity for transit photometry

b) CIRCUS

CIRCUS is a nanosatellite devoted to in-situ plasma measurements. It is developing a new technology of numerical radioreceptors, for space qualification. CIRCUS is also a prototype of a network of nanosatellites in the NOIRE projects [3], intended to study the heliosphere through space radio low frequency interferometry.

c) BIRDY-T

BIRDY-T is a nano-/micro-satellite technology for quasi-autonomous navigation in deep space with a pulsed plasma thruster (PPT) propulsion that could unlock new scientific and commercial applications [4, 5]. The first science case is a CubeSat for planetary geodesy that is released by a mothercraft in the vicinity of an asteroid. Then the autonomy of the CubeSat allows multiple flybys at very close range to perform radio-science measurements that probes the very local gravitational field. The precise orbit reconstruction will constrain the mass densities of the explored asteroid and yield major assumptions in the theories of planetary system formations.

3. Summary and Conclusions

The activities of CCERES space campus are growing toward a federation of different space campus in the area of Paris region Ile de France. By providing a panel of space integration and facilities, it participates to the construction of a network of supporting structure, with a unique environment of expertise to develop new projects.

Acknowledgements

We thank the financial support provided by PSL and the Observatoire de Paris for the Labex Exploration Spatiale des Environnements Planétaires (ESEP) (2011-LABX-030), through the ANR “Investissements d’avenir” via the “Initiative d’excellence” PSL* (convention ANR-10-IDEX-0001-02)

References

[1] Nowak, M.; Lacour, S.; Lapeyrère, V.; David, L.; Crouzier, A.; Dufoing, C.; Faiz, H.; Lemoult, T.; Trébuchet, P. Reaching sub-milimag photometric precision on Beta Pictoris with a nanosat: the PicSat mission. Proceedings of the SPIE, Volume 9904, id. 99044L 7 (2016).

[2] Lecavelier des Etangs, A.; Vidal-Madjar, A.The orbit of beta Pictoris b as a transiting planet. Astronomy & Astrophysics, Volume 588 (2016)

[3] Cecconi, B.; Laurens, A.; Briand, C.; Girard, J.; Bucher, M.; Puy, D.; Segret, B.; Bentum, M. Mapping the radio sky from 0.1 to 100 MHz with NOIRE. SF2A-2016: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics. Eds.: C. Reylé, J. Richard, L. Cambrésy, M. Deleuil, E. Pécontal, L. Tresse and I. Vauglin, held 14-17 June, 2016 at the Centre de Recherche Astrophysique de Lyon, pp.343-346 (2016)

[4] Segret, B.; Vannitsen, J.; Agnan, M.; Porquet, A.; Sleimi, O.; Deleflie, F.; Miau, Jiun-Jih; Juang, Jyh-Ching; Wang, K. BIRDY: an interplanetary CubeSat to collect radiation data on the way to Mars and back to prepare the future manned missions. Proceedings of the SPIE, Volume 9150, id. 91501N 11 pp. (2014).

[5] Segret, B. ; Hestroffer, D. ; Quinsac, G. ; Agnan, M. ; Vannitsen, J. On-board orbit determination for a deep space CubeSat (accepted), 31st ISTS / 26th ISSFD / 8th NSAT joint conference, Matsuyama, Japan, 3-9 June 2017