Advantages of a Cubesat Receiving Station Located in the South of the Indian Ocean

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We are eight students at the LBO Bois d'Olives Senior High School. Under the supervision of our Science and Technology teachers, we work on the CRIS-LBO receiving station (Cubesat Reunion Island Station at Lycée de Bois d'Olives). We are in Reunion, a beautiful island with a European advanced technological environment, located in the Indian Ocean, not far from the equator in the South Hemisphere, with a very favourable climate, well protected for operations. This is a geographical area with fewer stations than in the North Hemisphere, where often nobody else can see the satellites. The CRIS-LBO station covers a large part of the Indian Ocean and allows a greater extension of the receiving stations network on the surface of the globe, to obtain data that we can share with NASA, technological Universities and other organisations in the World. Our station offers many advantages. We can track cubesats and small satellites in low Earth orbit. With our setup, we can also envision communicating with the astronauts of the ISS. And most of all our station is located opposite to California and similar installations at JPL in Pasadena. The two reception sites are complementary for interplanetary cubesats, which will be visible from either station, depending on the orientation of the Earth. With this project, we can interact with students in other countries, do attractive learning and discoveries. With the experience that we are going to acquire, why not also build our own cubesat and send it to space to track its trajectory, make observations and measurements, receive information and data. This may contribute to a worldwide recognition of space activities in our island and to its scientific fame. Locally, the CRIS-LBO station may even become an asset for a different kind of exponential tourism, both experiential and scientific.

Key words : Reunion Island; Cubesat; NASA/JPL; ISS; Tracking Station

1. Eight 16 years old students

Eight students (Fig.1) of the Lycée Bois d'Olives (LBO), a senior technical high school, participate in the project CRIS (Cubesat Reunion Island Station), accompanied with their two professors of science and technology and with a former member of the Education Committee of the International Federation of Astronautics who has already worked in Japan. These educators are resourceful people fully ready to help these students who want to integrate the world of space.

2. Reunion Island, a particularly favorable location

Reunion is a magnificent island for its landscapes, situated in the southern hemisphere in the Indian Ocean, in the North of the tropic of Capricorn between Madagascar and Mauritius.

The climate of Reunion is favorable, tropical with a short cyclonic period without big risks for a station of reception with a good protection of the antenna for the operations.

Furthermore, it is endowed with the most modern infrastructures, possesses a strong economic growth and also features the most advanced technologies, as well as the adequate materials to maintain our tracking station.

Fig.1. Here is the team which operates the CRIS ground station for satellite reception at the Bois d'Olives high school.
We are all volunteers, full of projects to come

3. The CRIS station, characteristics and coverage

Fig. 2. This is the antenna of the station CRIS,
with its rotator and its preamplifier

Antenna : M2-436CP42UG 2x21 elements (Fig. 2)
Rotator : Yaesu G-5500 Azimuth & Elevation
Preamp : MKU-LNA-432-A by Kuhne
Feeder line : 50 ohm approx 10 meters

Fig. 3. This is the CRIS control ground station,
with the controller of antenna, the transceiver and the computer

List of the equipement of the station (Fig. 3)

Rotator Remote Control : Yaesu G-5500
External Control Interface : EA4TX-ARS-USB
Multiband Transceiver : HF/UHF/VHF Kenwood TS-2000
Power Supply : HQ Power PS1330 – 13.8 volt – 30 amp
PC Intel Core i3-4130 CPU @ 3.40 Ghz - 64 bits -
OS Windows 7 Pro – SP1 – 2009
Skype and Internet access

This satellite station of reception and data recovery is situated at the Bois d'Olive High School. It can cover a big part of Indian Ocean. Its presence in Reunion would be an advantage in the data recovery for the operators of satellites.

Its location is ideal given that very few stations are in this Southern hemisphere and even less in Indian Ocean, much less than in the Northern hemisphere (Fig. 4a et 4b).

Thus the station CRIS-LBO covering a big part of Indian Ocean will allow to expand the network of stations on the surface of the globe by bringing more data and precision on this sector and afterward to share them with the NASA, the technological universities and the other world organizations which launched Cubesats and other satellites.

Fig. 4a. The coverage of the station CRIS
with planisphere centered on Europe and Africa

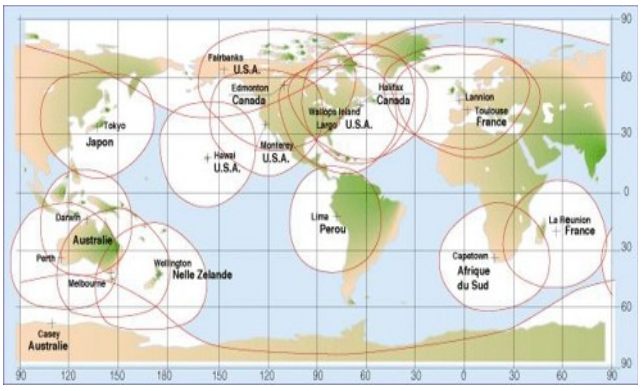


Fig. 4b. The coverage of the station CRIS
with planisphere centered on Americas

4. CRIS station capabilities

This tracking station CRIS presents a lot of advantages. It can track satellites passing through its tracking coverage area and download data from the satellites.

Among these satellites there are cubesats (satellites in low orbit as small as a shoes box) and ISS. With this station we shall also be able to communicate with the astronauts of ISS.

The students of the team have a 7 days 24 hours access to the station (because satellites do not operate 7:30 am to 5 pm).

Thus, Reunion Island's CRIS-LBO will have the capability of collecting data from cubesats over the Indian Ocean. The stored data will be sent back to California to be shared with NASA and technological universities or other organizations.

4.1 Cubesats

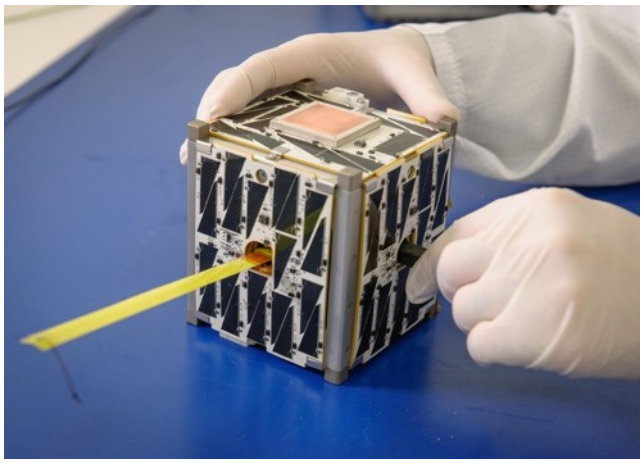


Fig. 5. A typical cubesat

A cubesat (Fig. 5) is a simple and little expensive satellite easy to build. It takes hardly the size of a box for shoes and can be launched in orbit by group. For example the Russian rocket Dnepr has launched a cluster of about thirty cubesats.

We can put inside it several things (plants, objects, liquids).

As the engineer Robert Staehle of JPL says : « The only limit of what we can put in a cubesat is science and your imagination ». The ground station CRIS-LBO on Reunion Island can collect the information sent by these satellites when they pass in its zone of acquisition.

4.2. The Cubesat's specifications

A set of specifications is updated regularly by the creators of the standard to define exactly the external characteristics and certain internal characteristics for safety reasons, and tests which developers have to satisfy before the launch:

* The specifications define the external dimensions, the limits concerning the center of gravity of the satellite, the mass.
* The pyrotechnics devices are forbidden.
* No constituent may be liberated in space.
* The chemical stored energy (battery) must be lower than 100 watts-hours.
* The implementation of the propulsion system has to require to deactivate three safeties.
* The propulsion system and the stored dangerous products have to conform to safety standards defined in AFSPC (Air Force Space Command).
* The system providing the energy must be deactivated until its ejection to prevent the start up of the satellite. Three different switches have to prevent any inconvenient accidental switching on.
* The deployable elements must be activated only 30 minutes after the ejection;
* No radio signal must be generated as long as it did not pass at least 45 minutes since the ejection in orbit.
* A list of tests to be realized is indicated and norms to be respected in the domain. The operator of the launcher has all freedom to fix other requirements of test.

5. CRIS-LBO at the antipodes of California

Reunion being at the opposite side of the Earth with respect to California offers a considerable advantage : the CRIS ground station may complement the similar installations at Pasadena. Both reception areas are complementary for the interplanetary cubesats, which are within the reach of one or the other station, whatever the orientation of the Earth (Fig. 6).

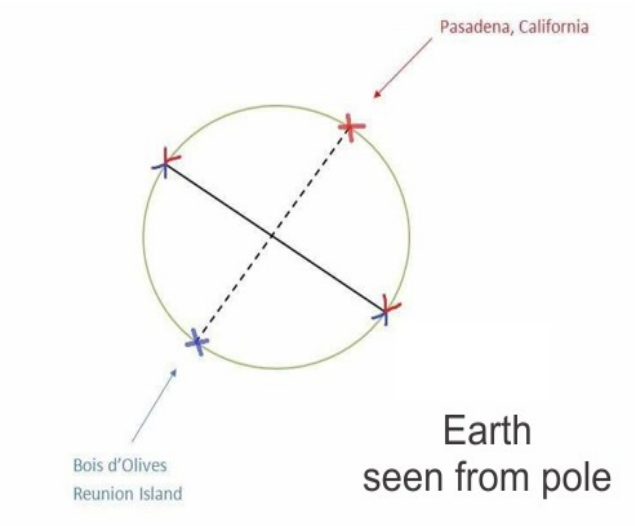


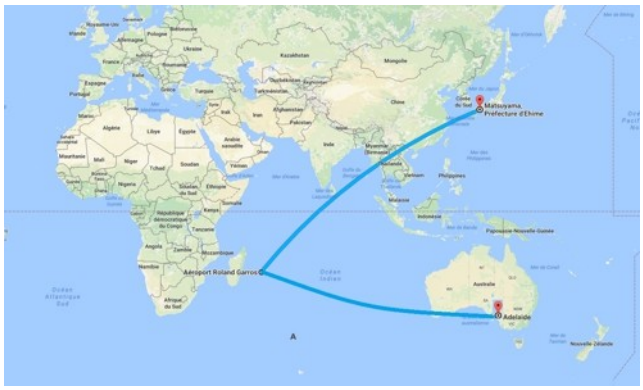
Fig.6 : Respective location of California and Reunion

6. An outstanding educational opportunity

With this project, we can interact with students coming from other countries and enrich ourselves with a lot of learning and new attractive discoveries.

After the experience that we are going to acquire, why not even also build our own cubesat and send it to space to follow its trajectory, to make observations, measures and to receive information and data.

6.1. The journey in Japan and in Australia



The journey Reunion Japan will be laborious because there is no less than 10 750 km between both places. It takes one day and 10 hours of flight by plane. In Japan we shall go to Matsuyama, Ehime who is in the southwest of Japan not far from the town Hiroshima.

Having voted for knowing which student was going (because of the one author policy) it is Vincent Dinnat who was chosen to do the coordination and present the CRIS-LBO station to the ISTS conference from 3 till 9 June 2017.

6.1. The ISTS conference

The ISTS (International Symposium on Space Technology and Science) has for main theme this year " Open up a New Age of Space Discovery - Strange Cuckoo flies to New Space Frontier from Matsuyama ". The new projects of space exploration and the results of research will be presented by engineers and scientists.

It would also allow us to make experimental discoveries of the space activities.

6.2. The IAC-2017 conference

An other important objective is the IAC conference in Adelaide in Australia in September 2017, where we hope to go with the whole CRIS student group.

7. Future of Reunion in Space

Reunion thus possesses the skills to develop its space sector thanks to its numerous assets and its infrastructures. First of all to install a station of reception of Cubesats in Reunion is for our island a big opportunity.

Indeed, this island will be known all over the world in the sector of the space activities. So if we develop the space activities of Reunion it will favor making our island better known and contribute to its scientific recognition.

Thus, locally the station CRIS-LBO could even become an element of a different tourism, experiential by its concrete aspects, and even exponential because of the considerable scientific and spatial development of the activities. It can also attract the tourists and the scientists who maybe will want to experiment here in the future.

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