IGOSat : The educational nano-satellite project from LabEx UnivEarthS

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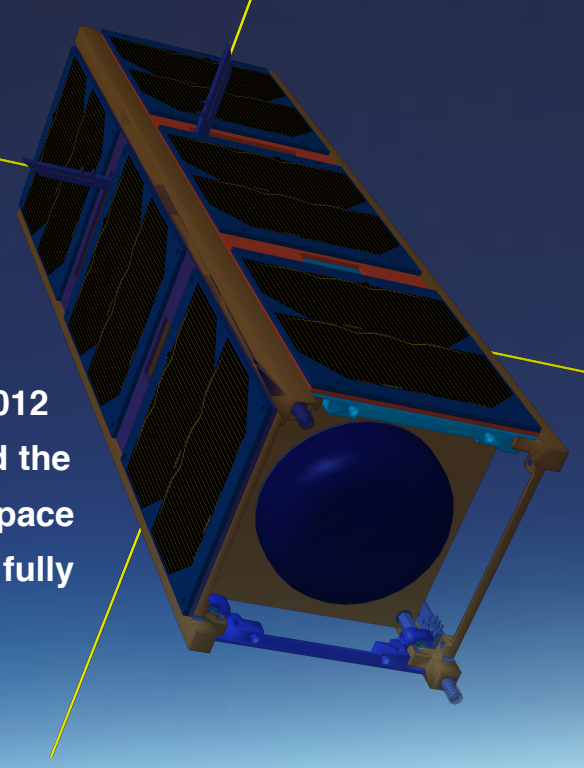


The Ionospheric & Gamma Ray Observations Satellite (IGOSat) project begun at the end of 2012 and aims to send a nano-satellite to space before the end of 2018. The project quickly received the support of the French Space Agency (CNES) through the JANUS Program (educational space projects). The Satellite will carry 2 scientific payloads developed by APC and IPGP, and is fully designed, tested and integrated by students from the Paris Diderot University and beyond…

Educational Objectives

The IGOSat project main purpose is to provide hands-on experience on design of a real satellite project to science and engineering students. Currently in phase B, more than 150 people participated (from few hours to 6 months). At launch, the project will be the gathered work of probably more than 300 students.

This project is the first CubeSat developed at the Paris Diderot University.

Scientific Objectives

IGOSat is a nano-satellite carrying 2 scientific instruments :

1. a state-of-the-art high-energy particles scintillator (LaBr3 with a Silicon Photo Multiplier) for detecting gamma rays and electrons above the poles and the South Atlantic Anomaly (SAA).

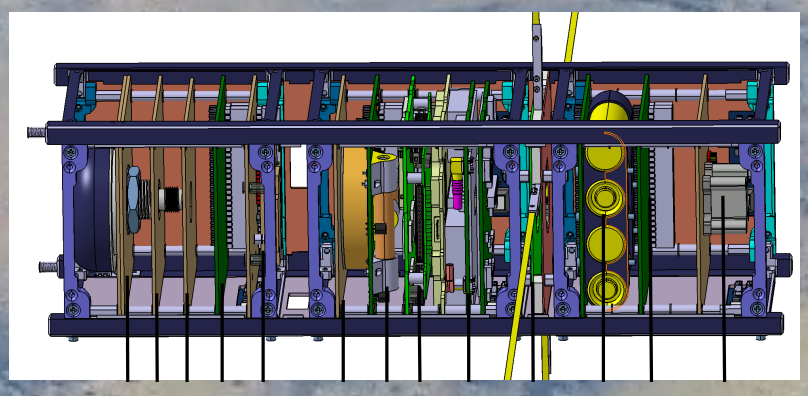
2. a Dual-frequency GPS receiver to observe the Total Electronic Content (TEC) of the Ionosphere through GPS occultations, by measuring the phase shifts of the L1 and L2 GPS carrier frequencies.

Both payloads will provide valuable measurements for the scientists from APC and IPGP working on the IGOSat project.

The Platform

Several subsystems will be carried onboard, to ensure success of the mission: the OnBoard Computer, the Attitude Determination & Control System, The Telecommunication System and the Electrical Power Supply.

Less than 30% of those sub-systems will be bought: most of the satellite is home made.

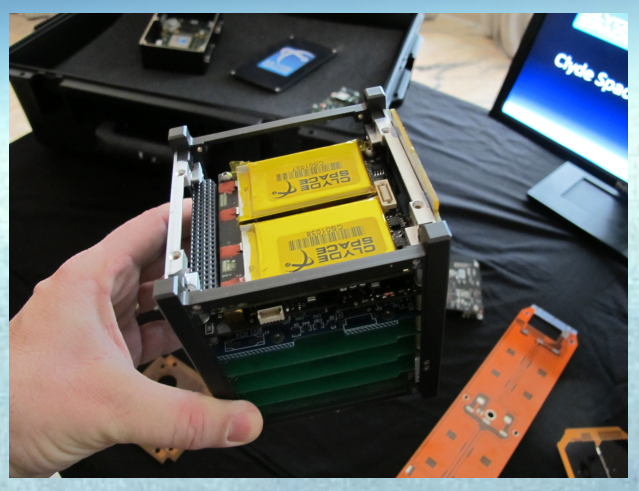


Preliminary configuration of IGOSat

What is a CubeSat ?

A CubeSat is a nano-satellite standard (mass inferior to 10 kg, and a length of few centimeters), used to reduce cost and complexity in the design. This standard is therefore particularly interesting for educational projects.

1 Unit is a 10 cm^3 cube, and a CubeSat is made of 1 or more units. IGOSat is a 3U CubeSat.

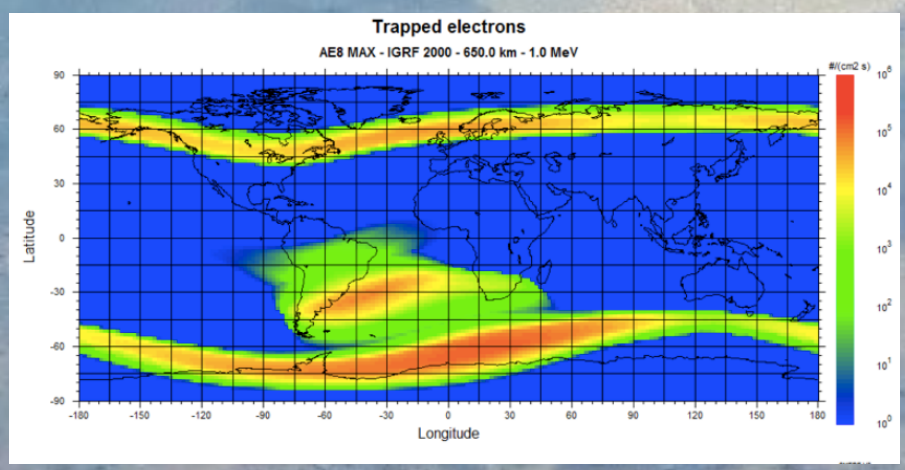


1U CubeSat structure from the company Clyde Space.

The Scintillator Payload

Constituted of a plastic scintillator, an organic scintillator, a Sillicium PhotoMultiplier and an ASIC, the Scintillator Payload will detect the gamma-rays from 20 keV to 2 MeV and the electrons from 1 MeV to 20 MeV. The purpose is to improve the measurements already done and to validate a new way of obtaining those data, with components that has never been flown before.

This payload uses the XGRE/TARANIS instrument (currently developed at APC) as a baseline. The picture below shows the areas of interest of this payload, constraining the orbit of the mission to a quasi polar orbit.



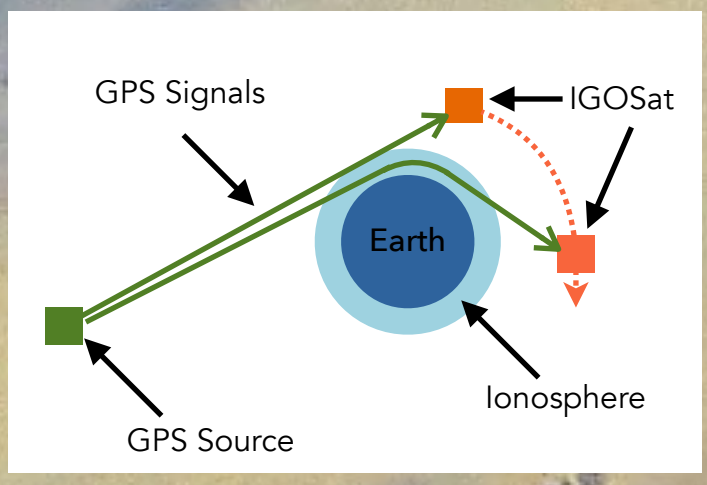
Simulation of the density of electrons of 1 MeV at 650 km of altitude.

The GPS Payload

The dual-frequency GPS antenna will measure the phase-shift between the two signals, induced by the TEC encountered during the propagation.

The radio occultation method described on the picture is used to obtain a TEC vertical profil of the Ionosphere.

By observing the time variations of the TEC, it is possible to detect acoustic or gravitational waves in the Ionosphere occurring during violent events (for example earthquakes/tsunamis).



Description of an IGOSat radio occultation from a GPS signal.