IGOSat : The educational nano-satellite project from the LabEx UnivEarthS, carrying 2 payloads from APC and IPGP

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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

IGOSat is the first CubeSat from the Paris Diderot University, and its 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 200 people participated (from few hours to 6 months). At launch (2019), more than 300 students will have worked on 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 and for constellations.

Created in 1999, more than 500 CubeSats has been launched in 15 years.1 Unit is a 10 cm^3 cube, and a CubeSat is made of 1 or more units. IGOSat is a 3U CubeSat.

Scientific Objectives

IGOSat is a nano-satellite carrying 2 scientific instruments :

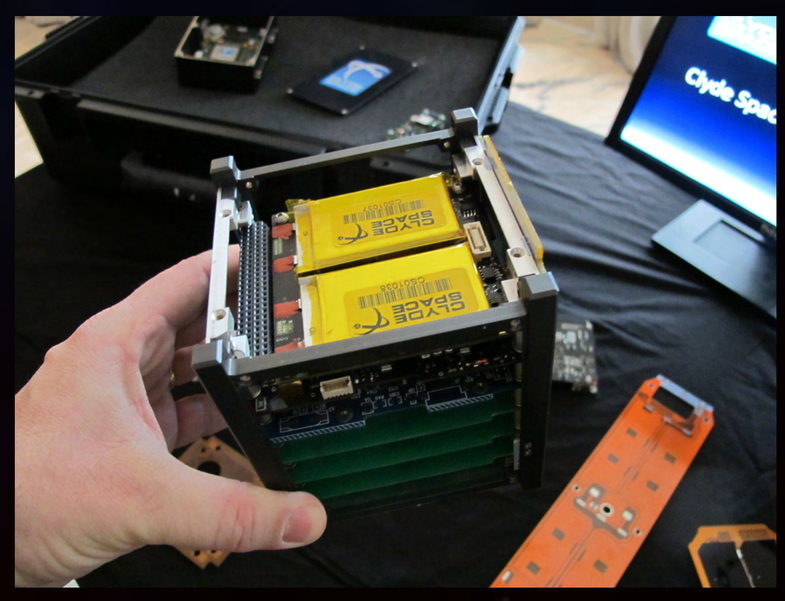
1. a state-of-the-art high-energy particles scintillator (CeBr3 with a Silicon Photo Multiplier) for detecting gamma rays and electrons above the poles and the South Atlantic Anomaly (SAA).
2. a Dual-frequency GPS receiver to observe the Total Electronic Content (TEC) of the Ionosphere through GPS occultations, 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.

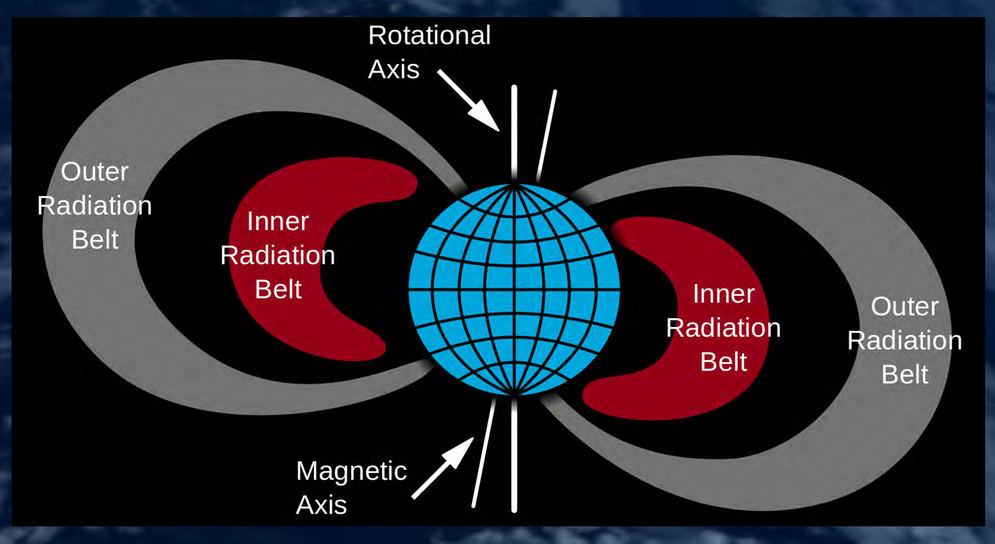
The entire satellite is homemade.



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 and the electrons in the low part of the Van Allen Belts (in the North and the South poles), as well as in the South Atlantic Anomaly.

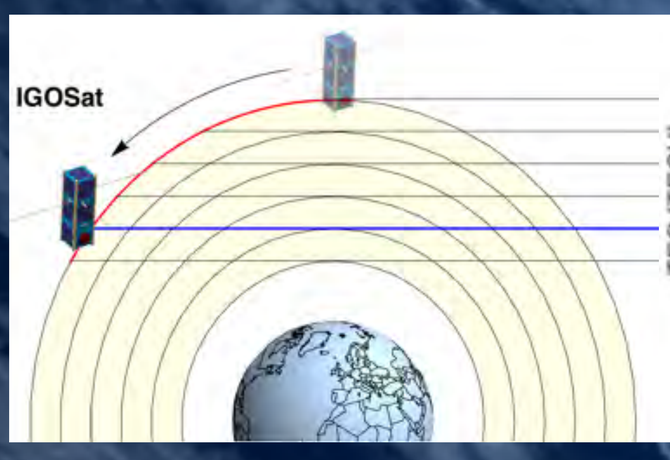


Van Allen Belts around the Earth. IGOSat will perform the scintillator observations in the low part of the inner radiation belt and in the South Atlantic Anomaly (SAA). See Hien Phan and Mathieu Leverge for more informations.

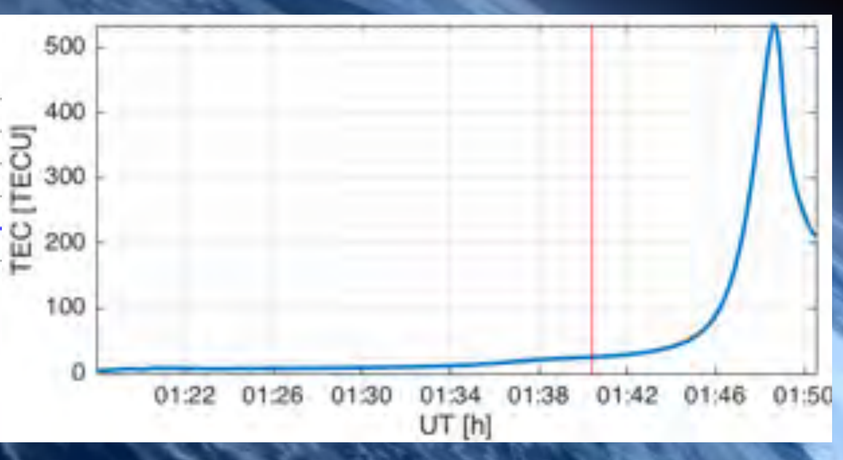
The GPS Payload

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 gravitational waves in the Ionosphere occurring during violent geophysics events such as earthquakes and tsunamis.



Descending radio-occultation principle. The GPS signal is coming from the right. At the beginning of the observation, the signal is not modified by the TEC.



Example of a TEC measurement during a descending radio occultation.

A typical radio-occultation takes less than 10 minutes and it is possible to observe almost all the time.