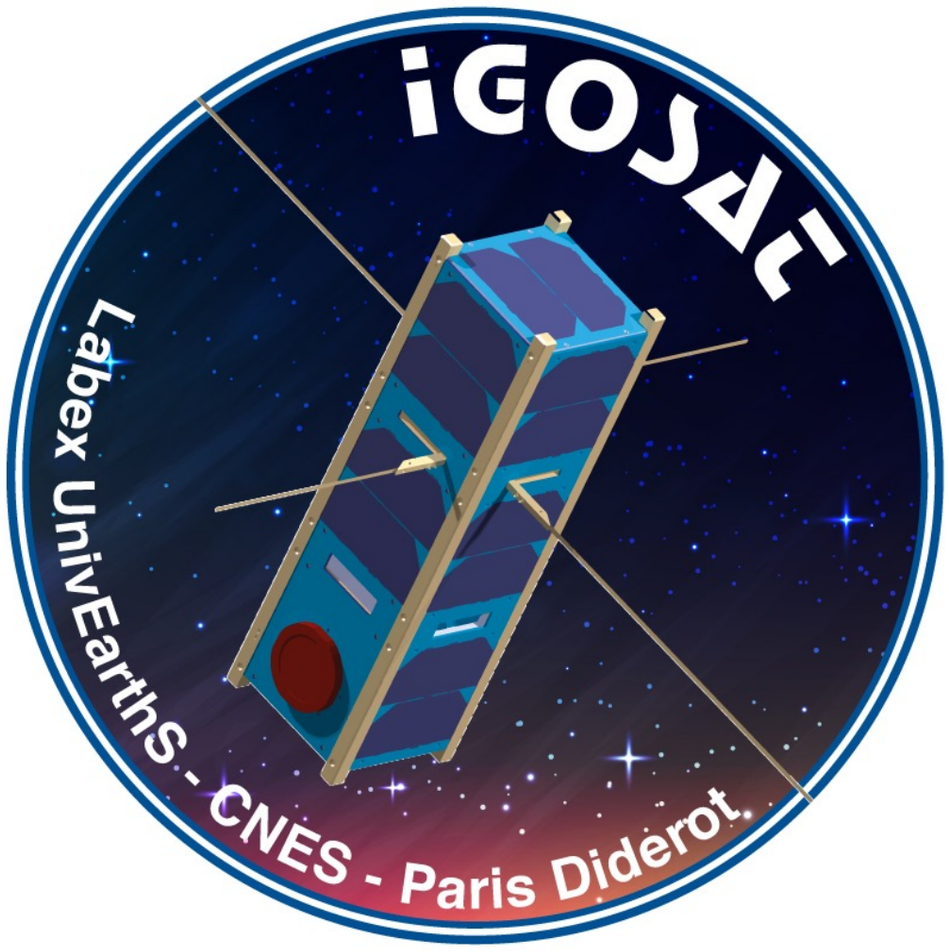
Ionospheric & **G**amma-ray **O**bservations **Sat**ellite



IGOSat (Ionospheric & Gamma-ray Observations Satellite), an educational CubeSat project with scientific return through technology demonstration

7th Nanosat Symposium - October 2016

Marco Agnan, Hubert Halloin, Hana Benhizia, Philippe Laurent, Pierdavide Coïsson, Hien Phan

IGOSat : Context

Origins : proposal within the LabEx UnivEarthS at Paris Diderot University :

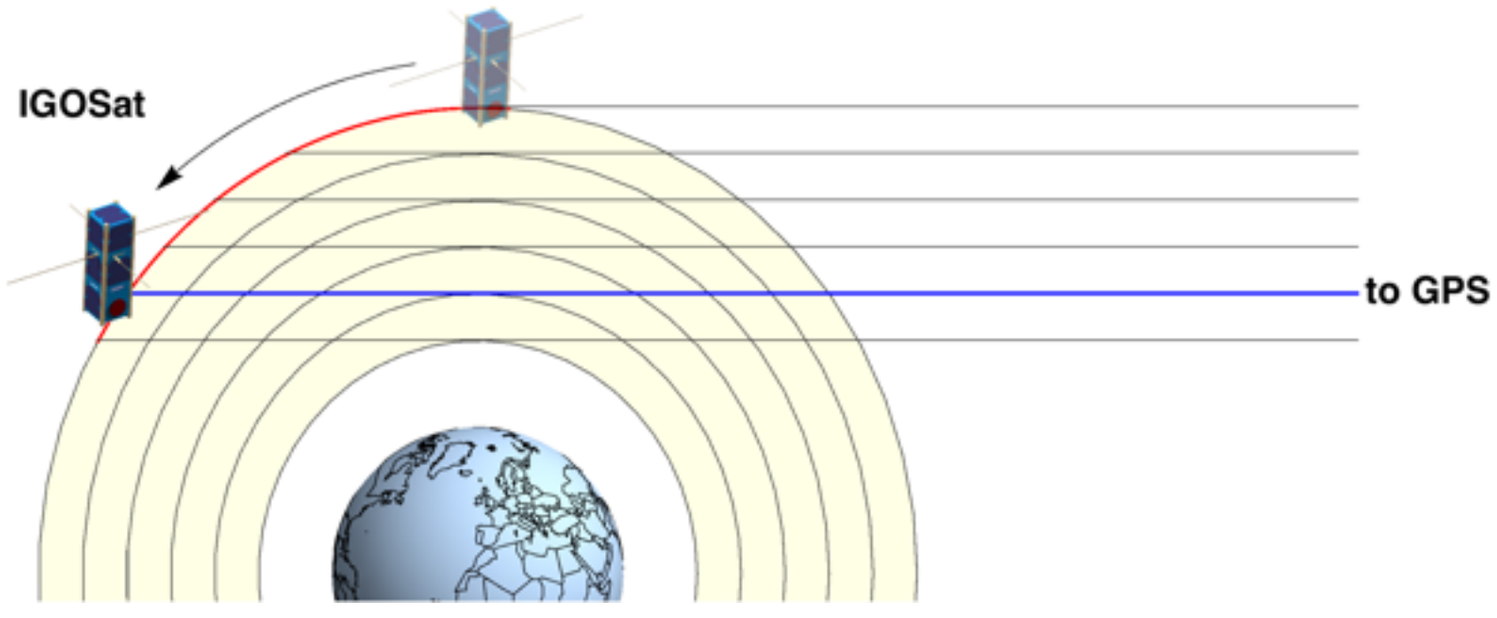
- APC (AstroParticule & Cosmologie);
- IPGP (Institut de Physique du Globe de Paris);

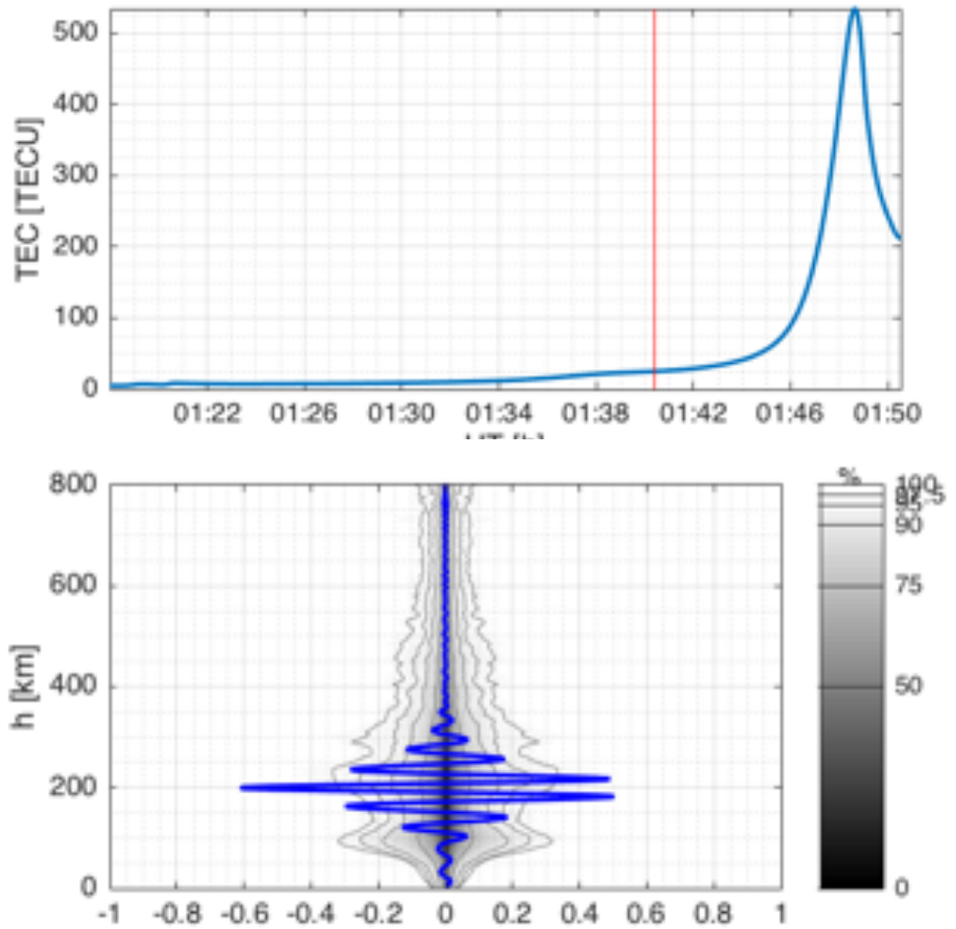
Support : project within the JANUS program (Educational CubeSats) from CNES (Centre National d'Etudes Spatiales) since 2012, until 2019.

Brief Timeline : Student Project.

- 2012/2015 : feasibility studies, preliminary design;
- 2015/2016 : Flat-Sat, Engineering Model, STM;
- 2016/2017 : Tests, Validations;
- 2018/2019 : Launch, Opérations.

IGOSat : GPS Payload





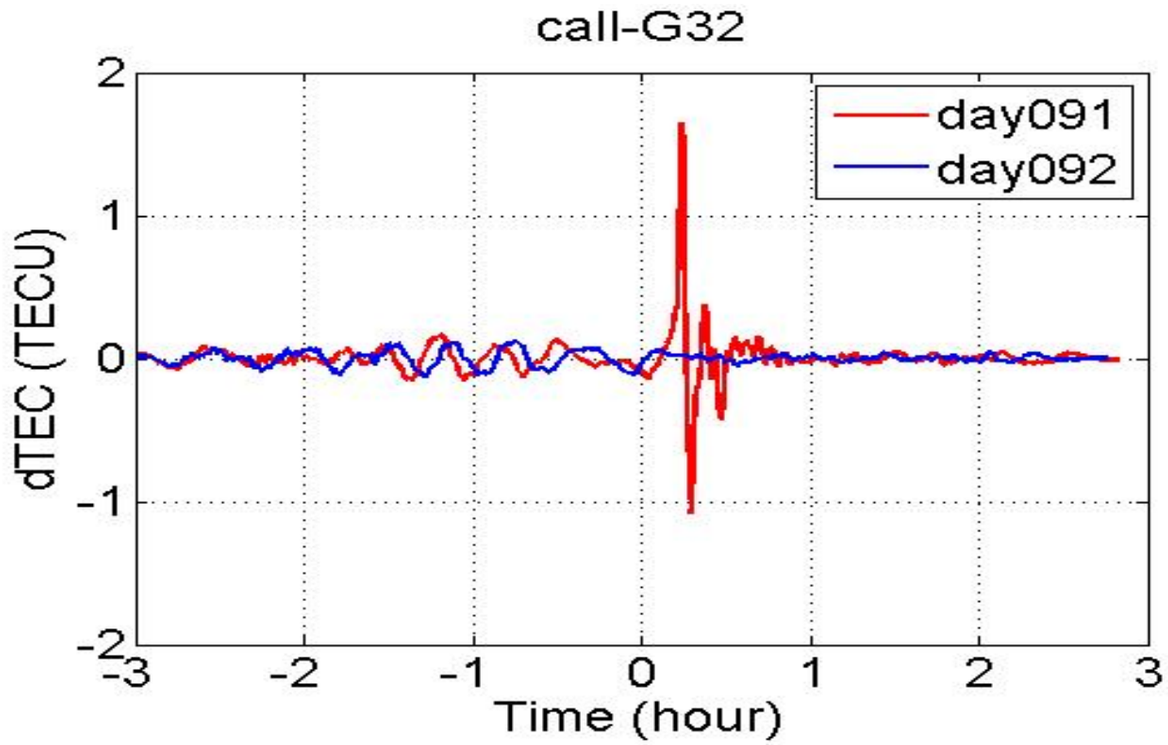
Scientific Objective :

To observe Total Electron Content (TEC) profiles with GPS signals measurements (L1 and L2)

Scientific Interests :

To detect violent variations of the TEC that may be caused by acoustic waves in the Ionosphere (tsunamis, earthquake…);

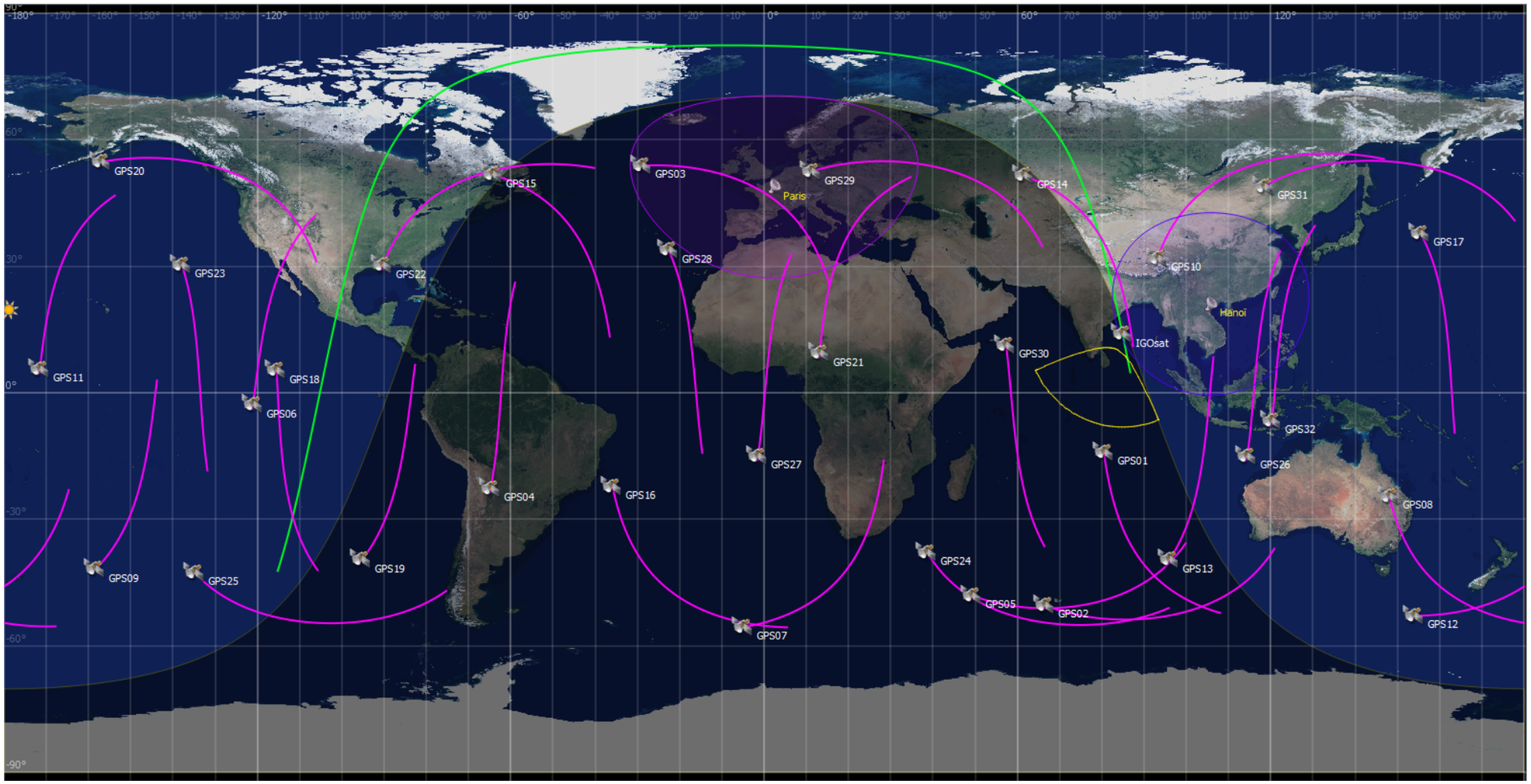
IGOSat : GPS Payload



Example of what IGOSat may observe (opportunity mission) :

Ionospheric perturbation during the Chile earthquake in 2014, measured from a ground station with GPS signals.

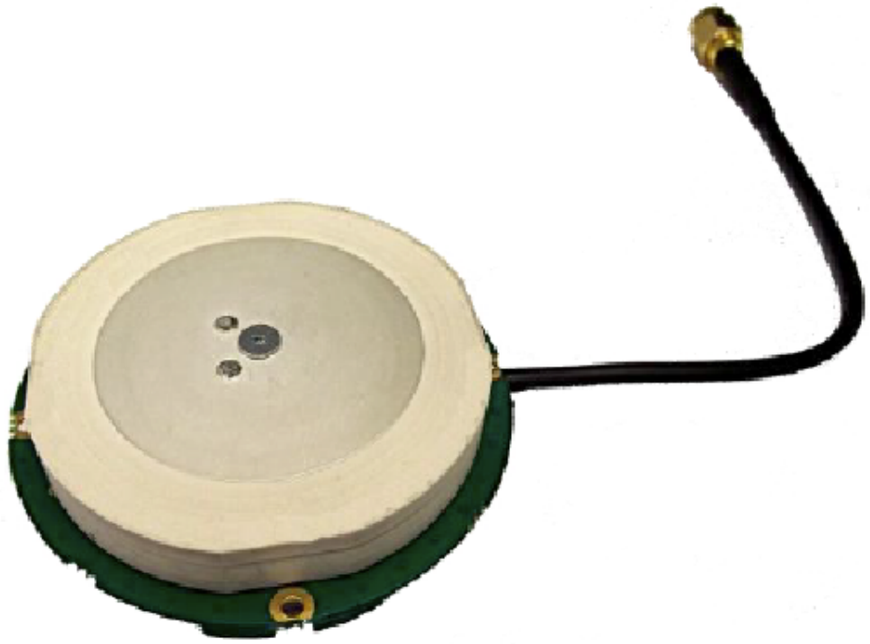
IGOSat : GPS Payload



Mission Analysis:

Between 50 and 60 full radio-occultation per day, with an altitude between 600 and 750 km. Objective = 40 per day.

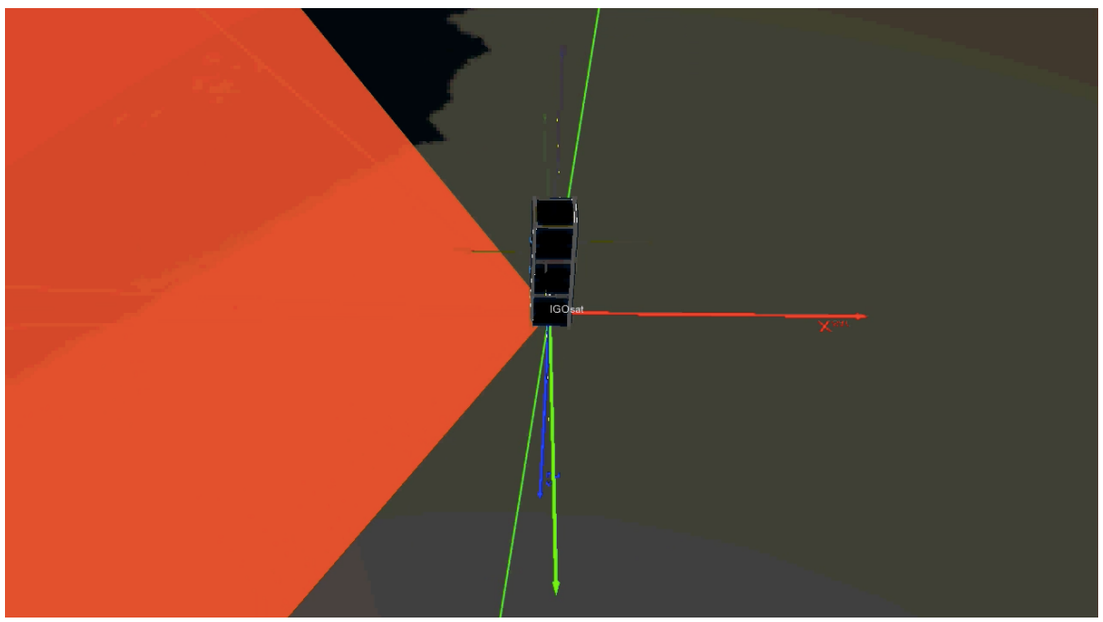
IGOSat : GPS Payload

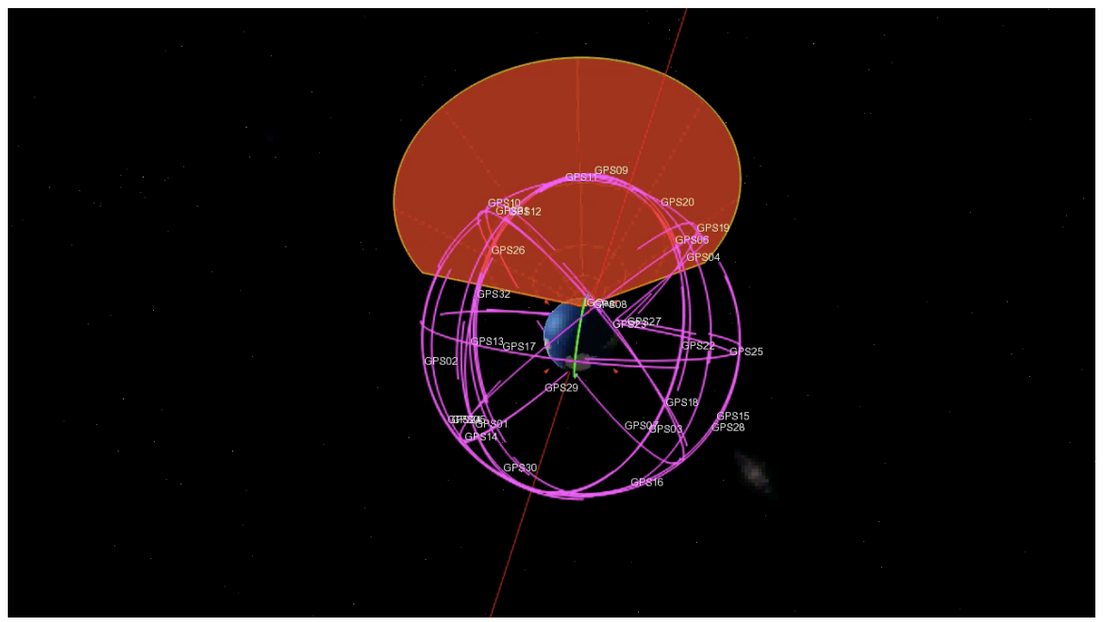


www.tallysman.com/wp-content/.../TW3870E_Datasheet_rev1

www.cubesatkit.com/docs/.../DS_CSK_GPSRM_1

Full instrument composed with COTS.





IGOSat : Scintillator Payload

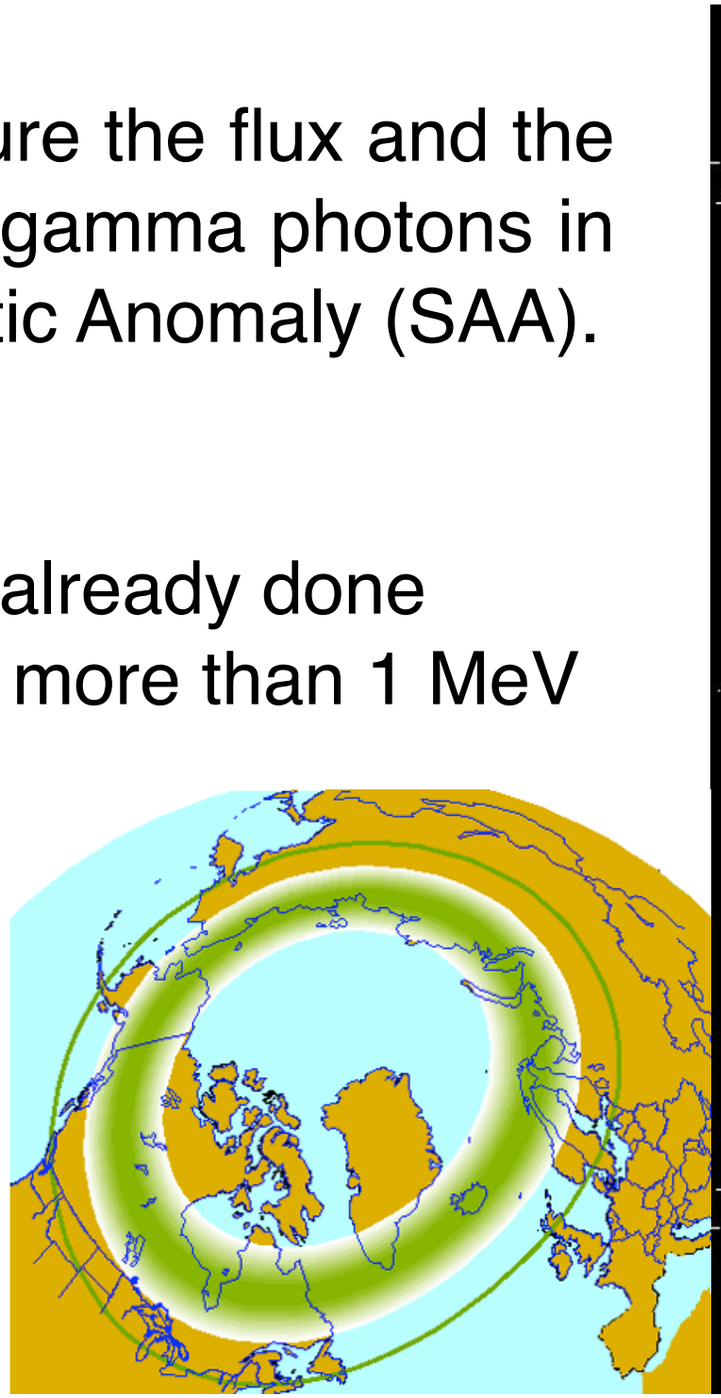
Scientific Objective : To measure the flux and the energy of the electrons and the gamma photons in the poles and in the South Atlantic Anomaly (SAA).

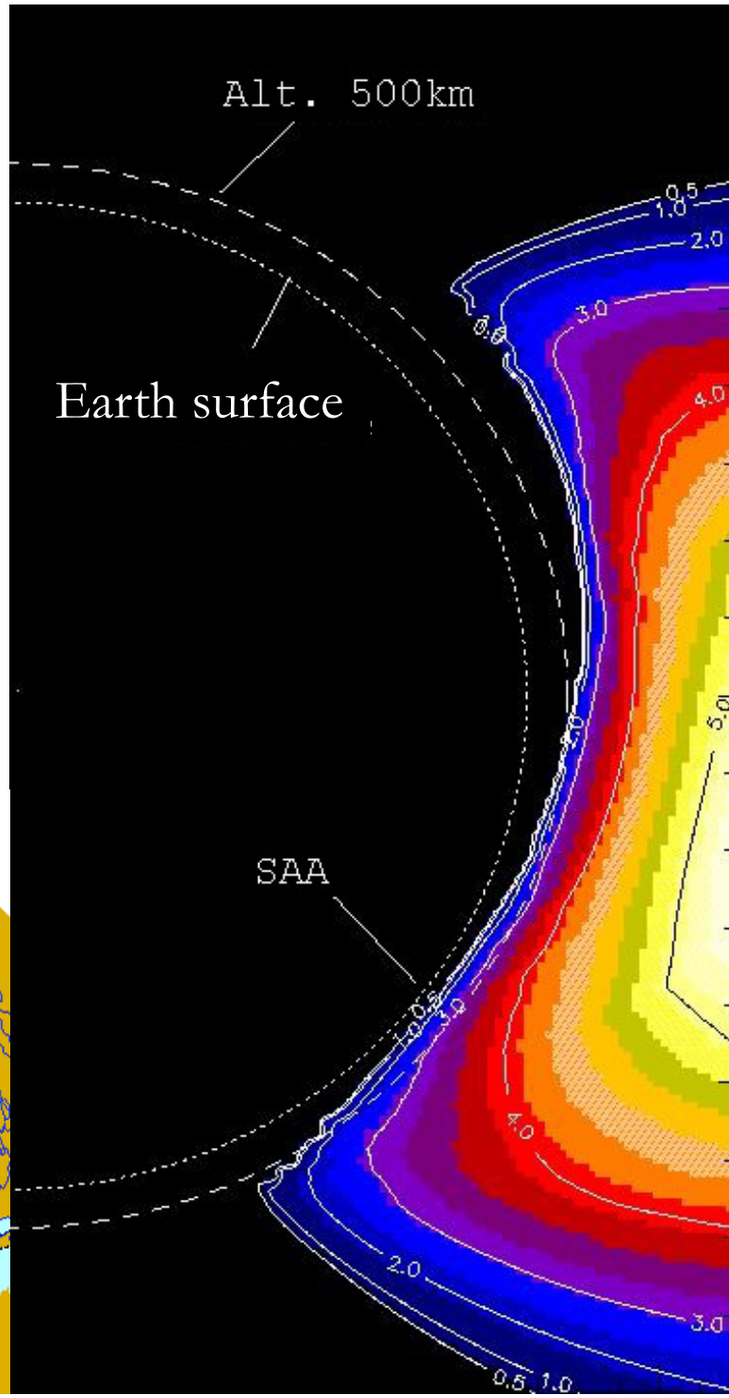
Scientific Interests :

- To improve the measurements already done
- No gamma ray observations to more than 1 MeV

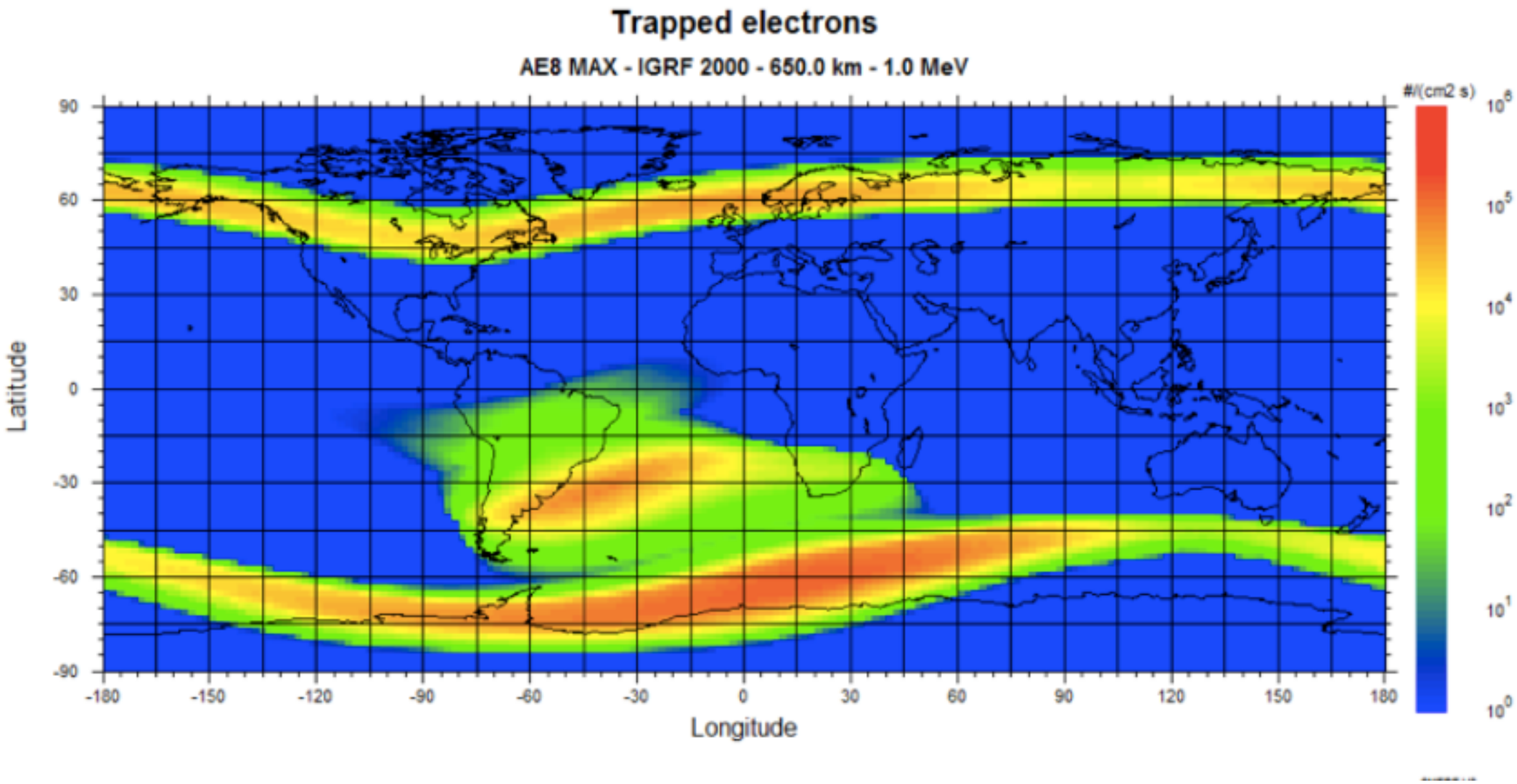
Technological Interests :

- use of silicon photomultiplier (never used in space);
- Specific design of scintillator : CeBr3 surrounded by plastic scintillators.





IGOSat : Scintillator Payload



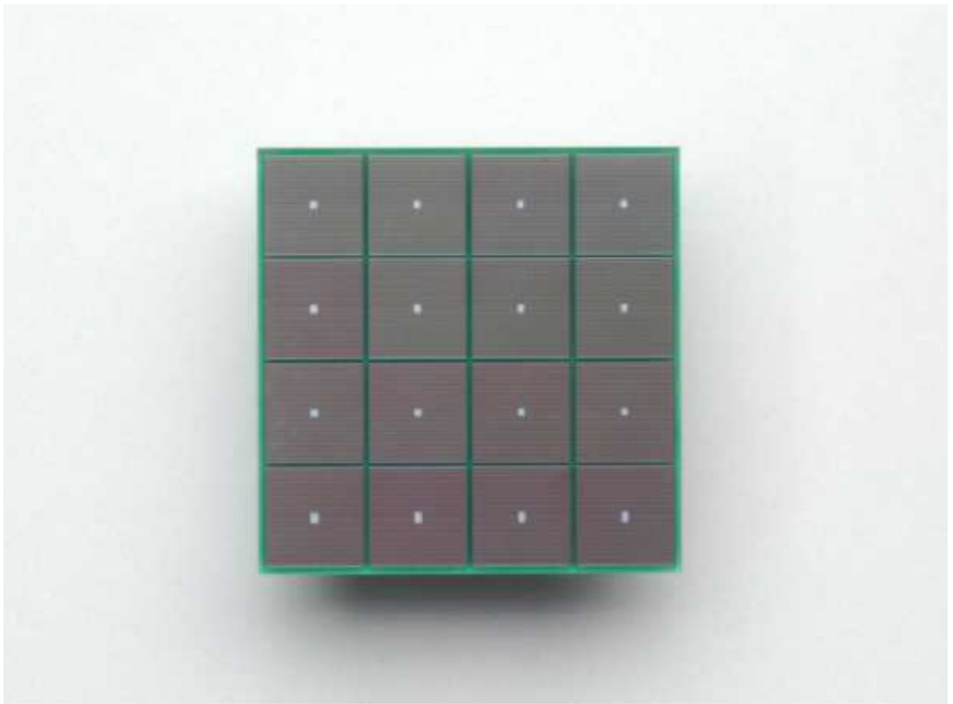
Objectives :

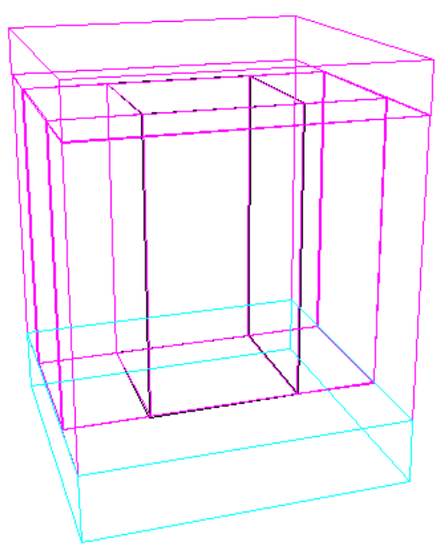
- Spectra of gamma radiation from 20 keV to 2 MeV
- Spectra of electrons from 1 MeV to 20 MeV

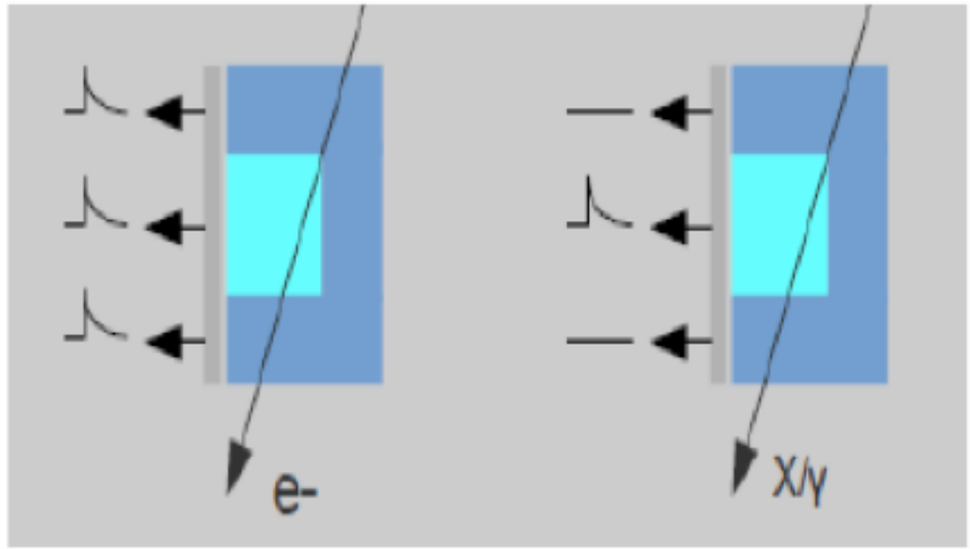
IGOSat : Scintillator Payload

Detector :

- plastic scintillator sensitive to electrons;
- cristal scintillator (CeBr3) sensitive to electrons and gamma photons;
- SiPM (Silicon PhotoMultiplier) : never used in space (technology demonstration).



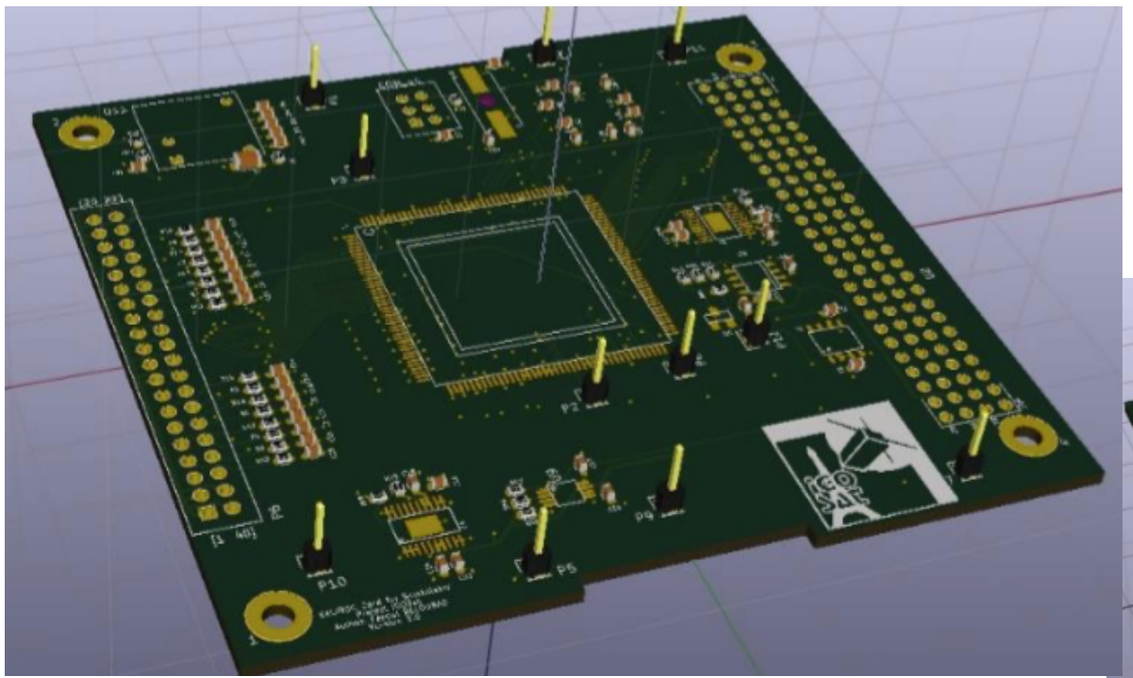


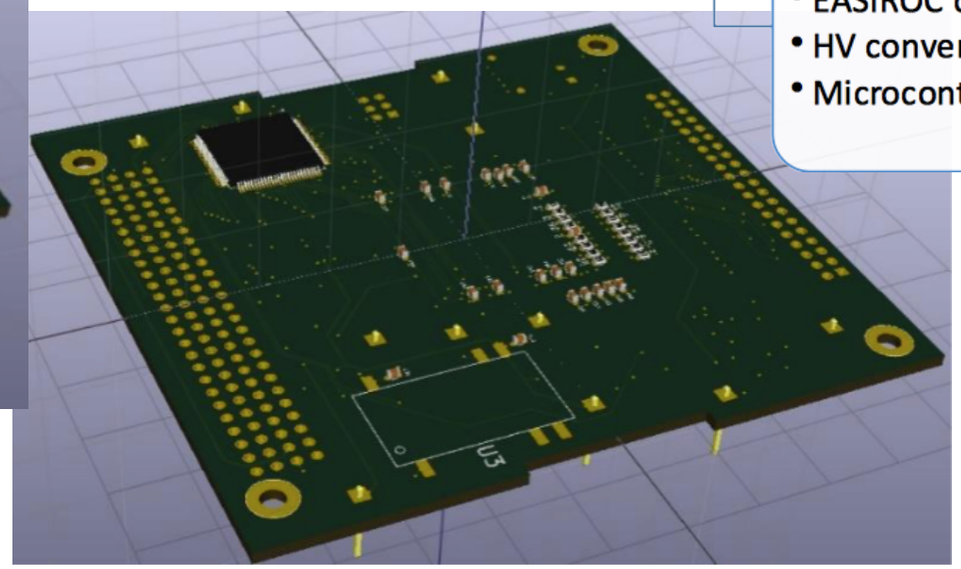


IGOSat : Scintillator Payload

EASIROC Chip :

- electronic component made for particle physics in accelerators;
- 32 inputs (16 needed).





Scintillator

Scintillator board

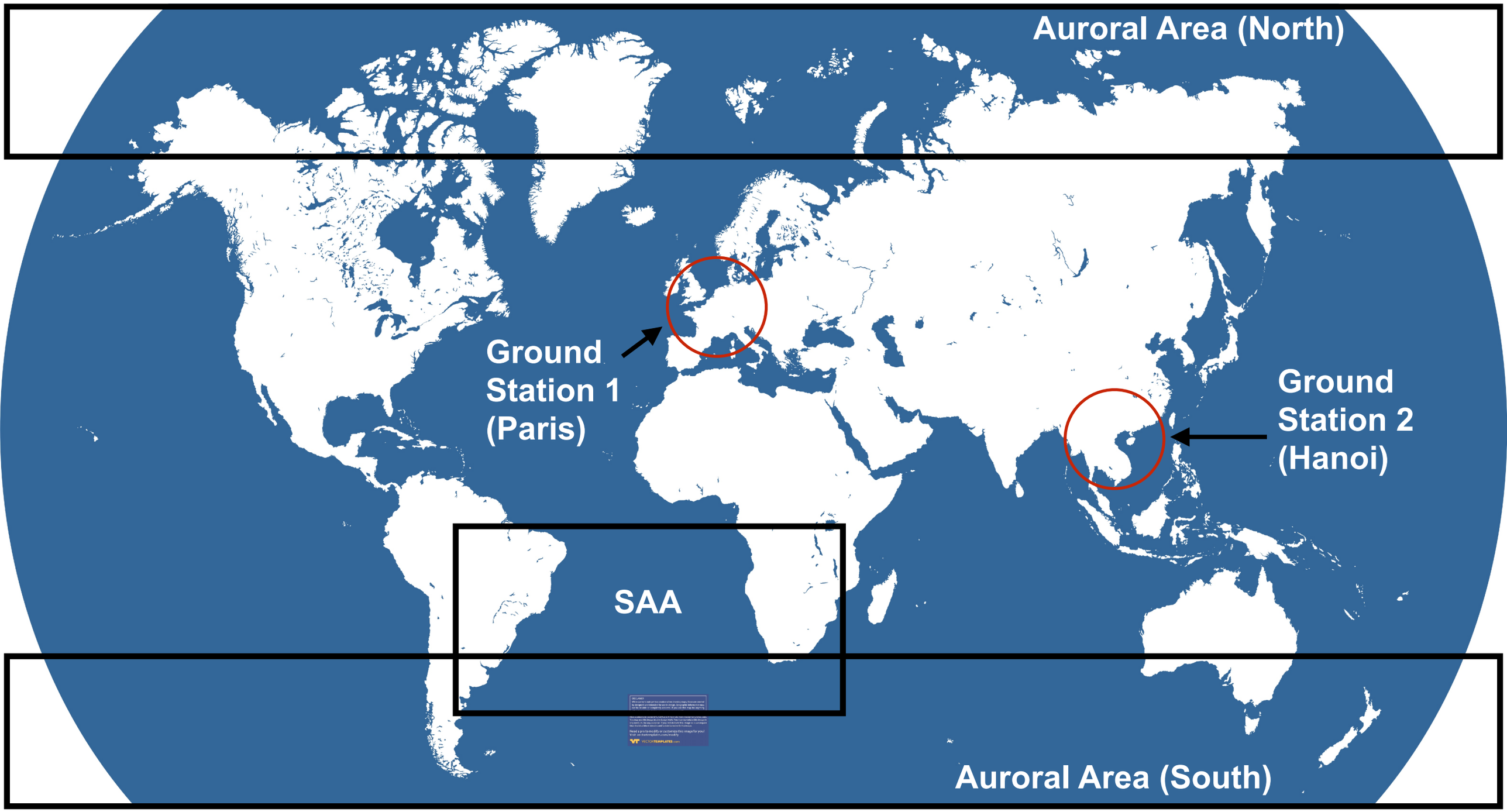
- Cristal: **CeBr3** from Hellma Materials
- Plastic: **BC-412** from Saint-Gobain
- SiPM/MPPC: **S13361-6050AE-04** from HAMAMATSU

EASIROC board

- EASIROC chip
- HV conversion
- Microcontroller

OMEGA Microelectronics

IGOSat : Mission Profile



IGOSat : Educational Return

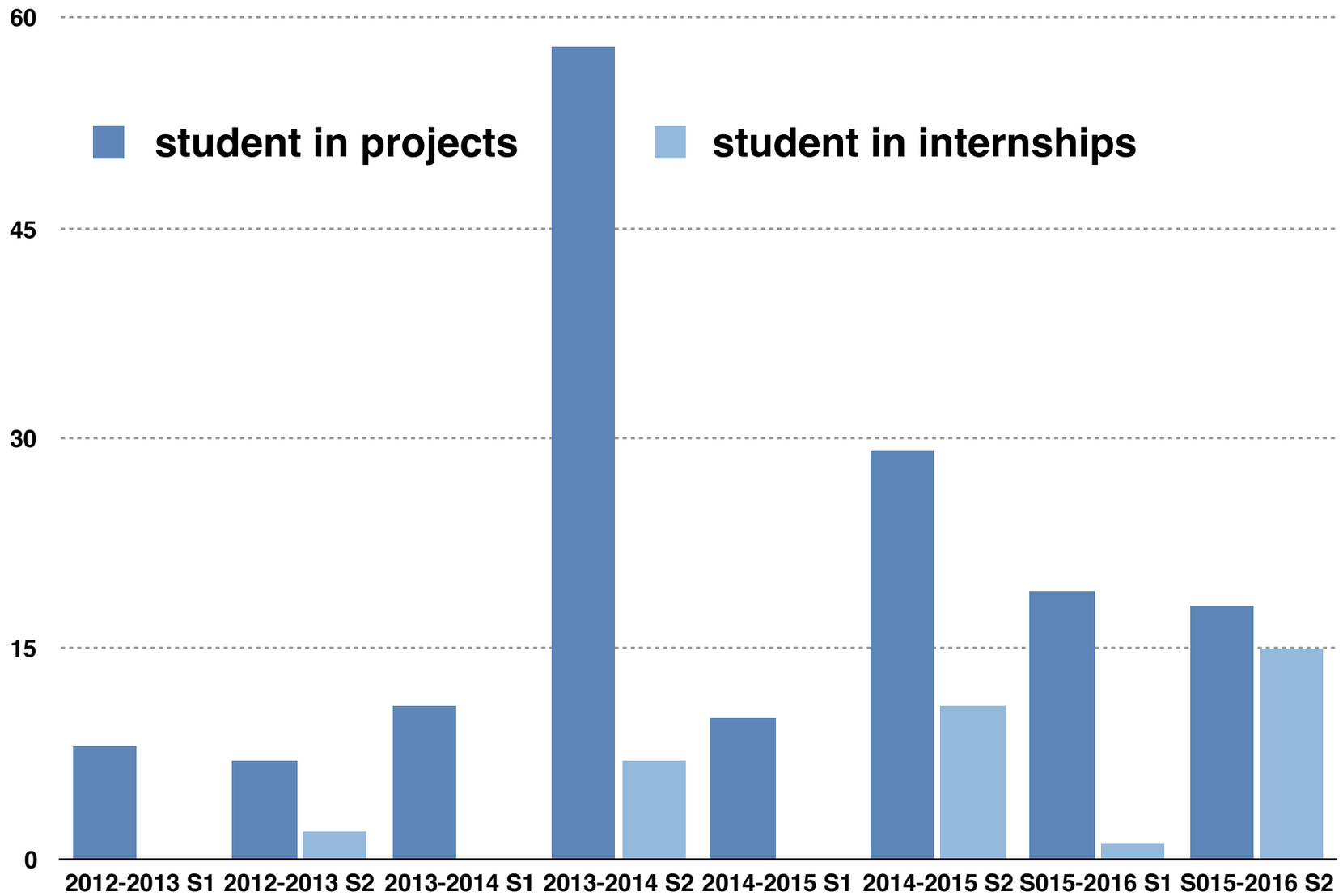
Since 2012, approximately 200 students have been working on the project.

Students domain :

- physics (astrophysics and geophysics);
- engineering;
- computer science;

but also :

- Cinema;
- journalism…



Thank You

agnan@apc.in2p3.fr