Le projet BELISAMA

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RIKEN, Tokyo

Historical context

Observing gamma rays emitted during thunderstorms from the ground is a young science, which took off in Japan ... thanks to the GROWTH collaboration …

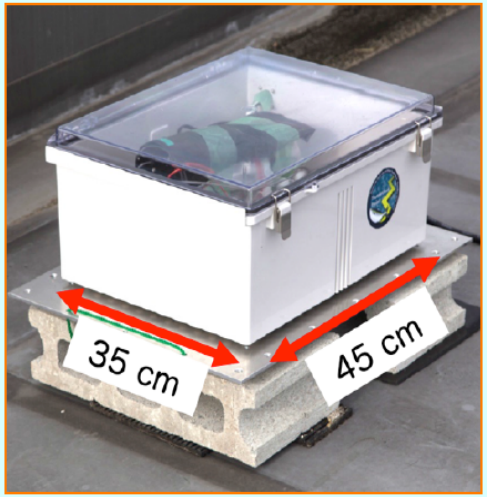
GROWTH collaboration

(Gamma-Ray Observations of Winter THunderclouds)

- Winter thunderstorms along Sea of Japan is energetic and has low altitude → good location for observation.
- Remotely operated detectors (ref. similar to satellites)
- Continuous from 2006, now fielding 15 detectors.
- Small but fruitful project, young researchers contribute.

→ now becoming one of the main projects for us.

Hardware development is also well alligned

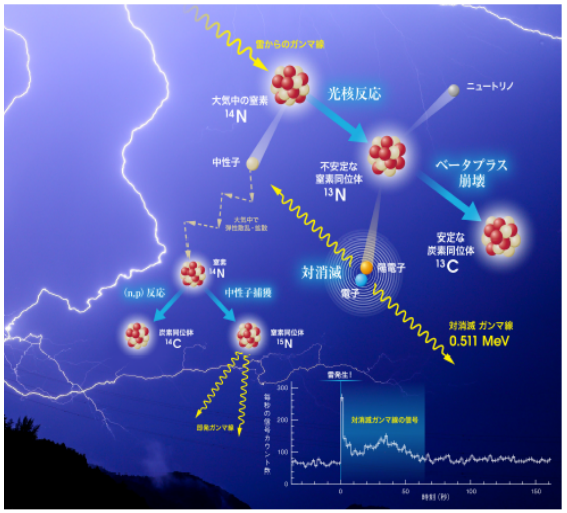


New Findings 2017

nature
International journal of science

Altmetric: 1131 Citations: 1

physicsworld TOP 10 BREAKTHROUGH 2017



Letter

Photonuclear reactions triggered by lightning discharge

Teruaki Enoto ✉, Yuuki Wada, Yoshihiro Furuta, Kazuhiro Nakazawa, Takayuki Yuasa, Kazufumi Okuda, Kazuo Makishima, Mitsuteru Sato, Yousuke Sato, Toshio Nakano, Daigo Umemoto & Harufumi Tsuchiya

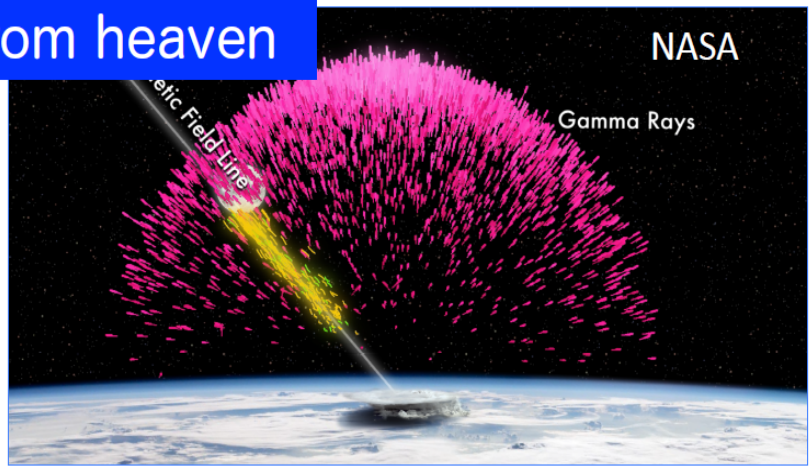
Enoto, Wada,, Nakazawa et al. 2017

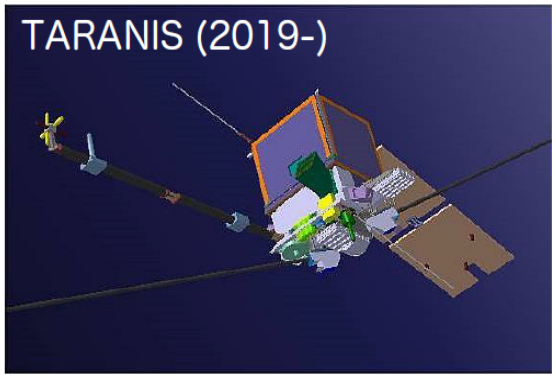
Key person

- The short TGE is a downward TGF (very intence), and its 100 ms component is of neutron origin.
- Together with 511 keV, they are direct evidences for photo-nuclear reactions in lightning.

“From heaven and the earth”

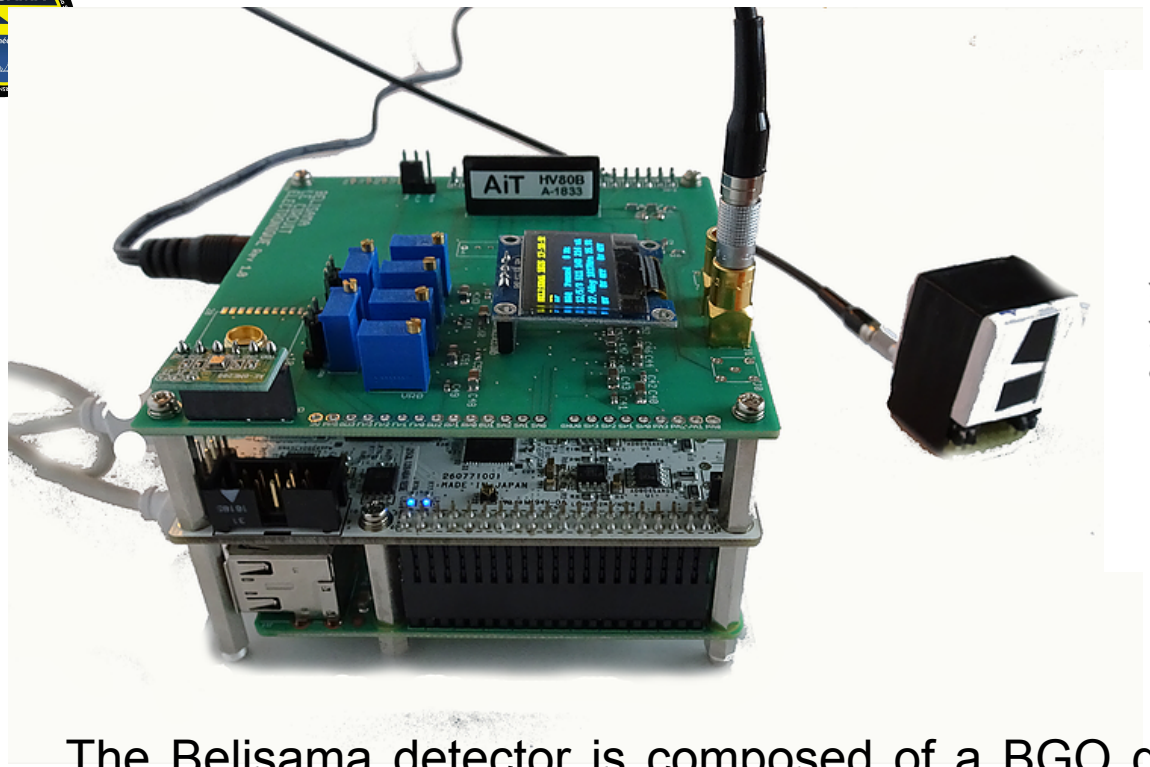
From heaven



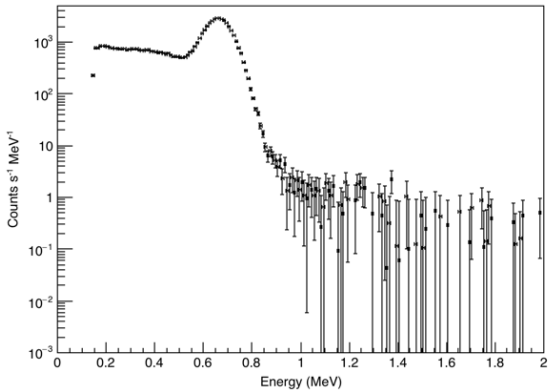


From the earth

The BELISAMA detector



BELISAMA 137Cs spectrum

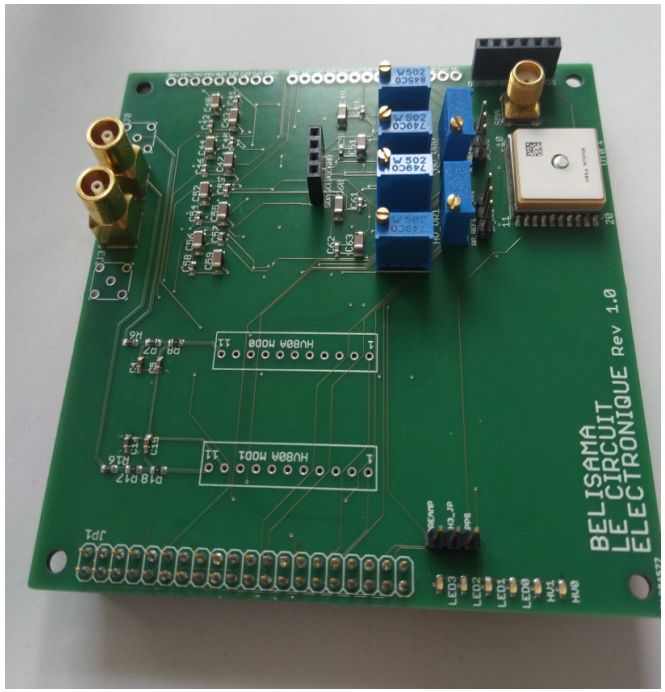


The Belisama detector is composed of a BGO detector, a SiPM, and two acquisition cards monitored by a Raspberry PI3. The data are foreseen to be sent from high school directly to a server at APC. They are afterward shown on a dedicated Web site, to be shared by all the high schools network.

The BELISAMA electronics

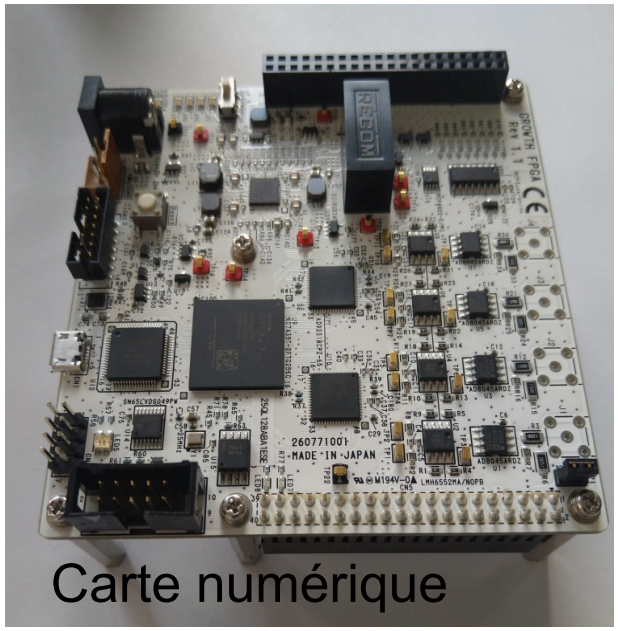
- The control and acquisition electronics (APC+UTokyo) are dedicated to the polarization of the SiPM, to the amplification and shaping of the signals generated by it and to their storage on a memory card.

This card is also equipped with a GPS to synchronize the data and an environmental sensor to determine the temperature, humidity and pressure surrounding the detector.



The BELISAMA electronics

A second card has the function of digitizing the signals and transmitting them to the Rapsberry PI 3, which is the on-board computer. The Rapsberry makes the communication with each of the Belisama subsystems and to store the data.



Carte numérique

Raspberry PI 3

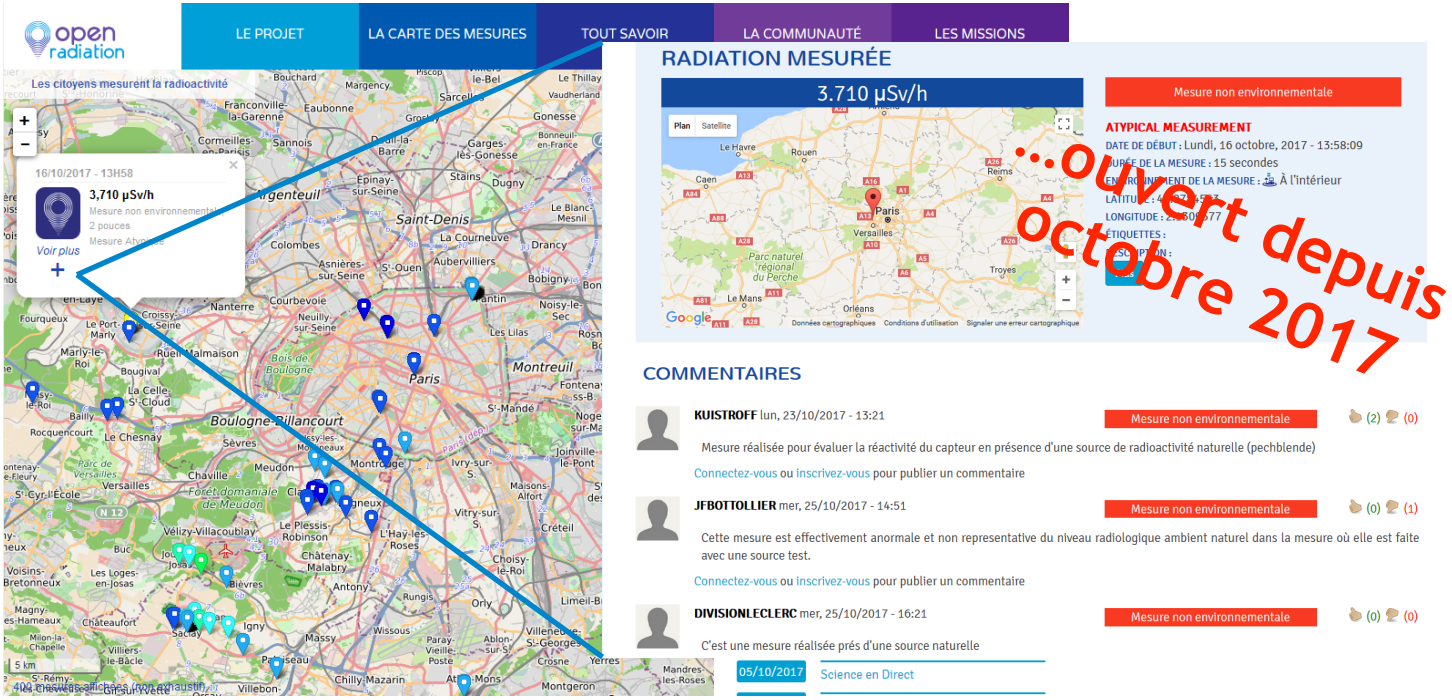
The BELISAMA network

- The gamma data will be recorded and dated by several Belisama detectors in different high schools.
- They will be reported on the dedicated website.
- We can thus compare the results of the different high schools and, for example, try to find where the signals received in coincidence by several high schools come from by triangularization ...
- The project is also made in collaboration with the OpenRadiation project.

BELISAMA Web site

https://ikhone.wixsite.com/belisama

Le citoyen mesure la radioactivité dans l'environnement



Un projet proposé par :

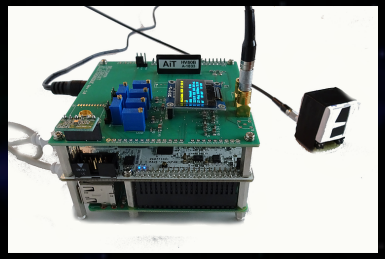
IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

UPMC SORBONNE UNIVERSITÉS

Planète Sciences une aventure pour les jeunes

iffo rme

TARANIS / XGRE



Some history …

TARANIS : CNES microsatellite proposed in 2002.

- 2008 : US left the project (gamma-ray detector).
- 2009/2010 : APC in collaboration with IRAP accepts to build this instrument on CNES supervision (⇒ XGRE) ...

- Jan. 2020 : delivery to CNES of the 3 XGRE FM sensors.
- Feb./Mar. 2020 : XGRE calibration on the satellite.
- May/June 2020 : RAV/CIO.
- Nov. 2020 : Launch !
- 2020-2023 : Instrument follow-up, calibrations, science.

XGRE FM delivery (01-02/2020)

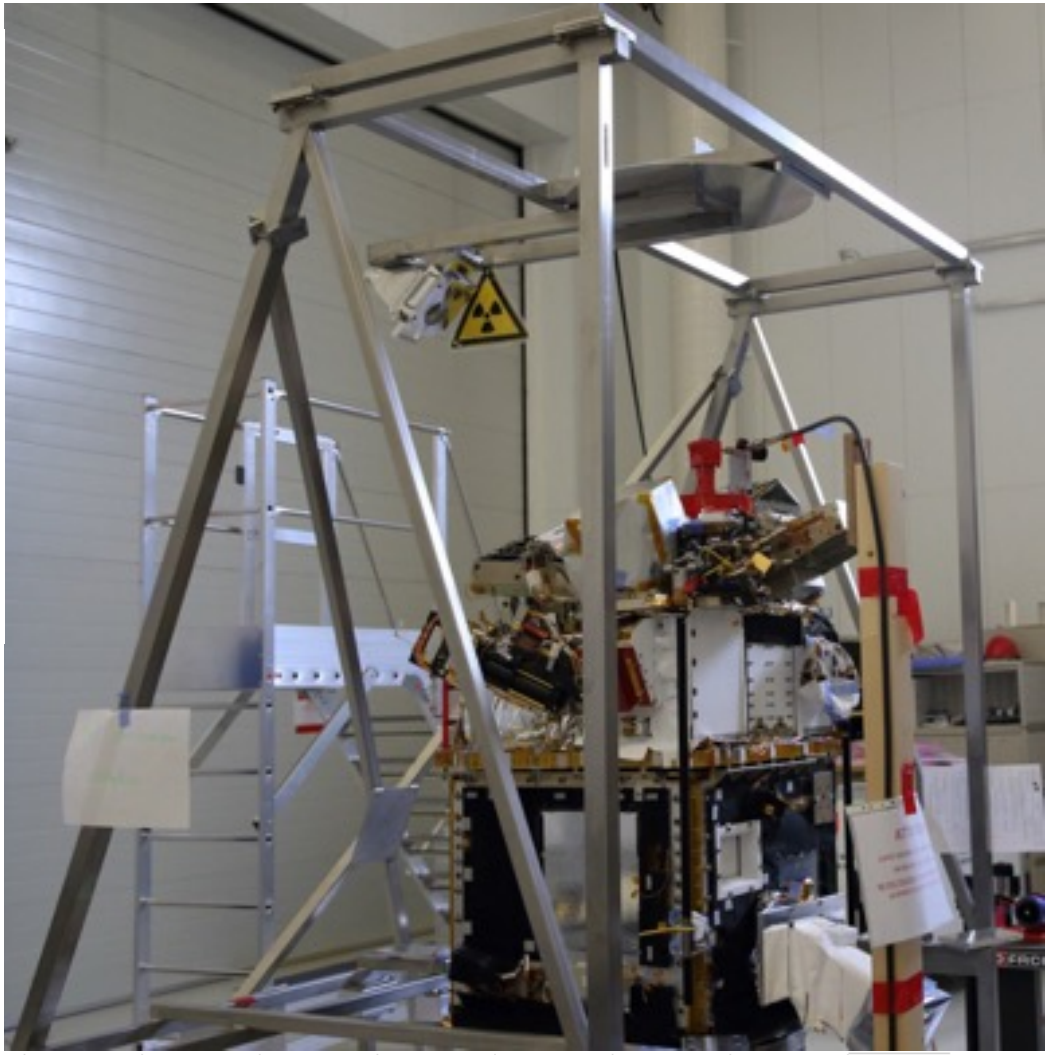
TARANIS team @ APC

BARONICK Jean-Pierre	Etudes Mécaniques
BREELLE Éric	Instrumentation
COLONGES Stéphane	Assurance Produit Electronique
COJOCARI Ion	Instrumentation
JUFFROY Corinne	Contrôle Projet et Qualité Projet
LAURENT Philippe	Responsable Scientifique
LINDSEY-CLARK Miles	AIT/AIV/ Chef de Projet
MEDJDOUB Ghania	Assurance Qualité Projet (NEXEYA)
PAILOT Damien	Instrumentation/ Chef de projet adjoint.
WADA Yuuki	Post-Doc (TGF science, calibration)

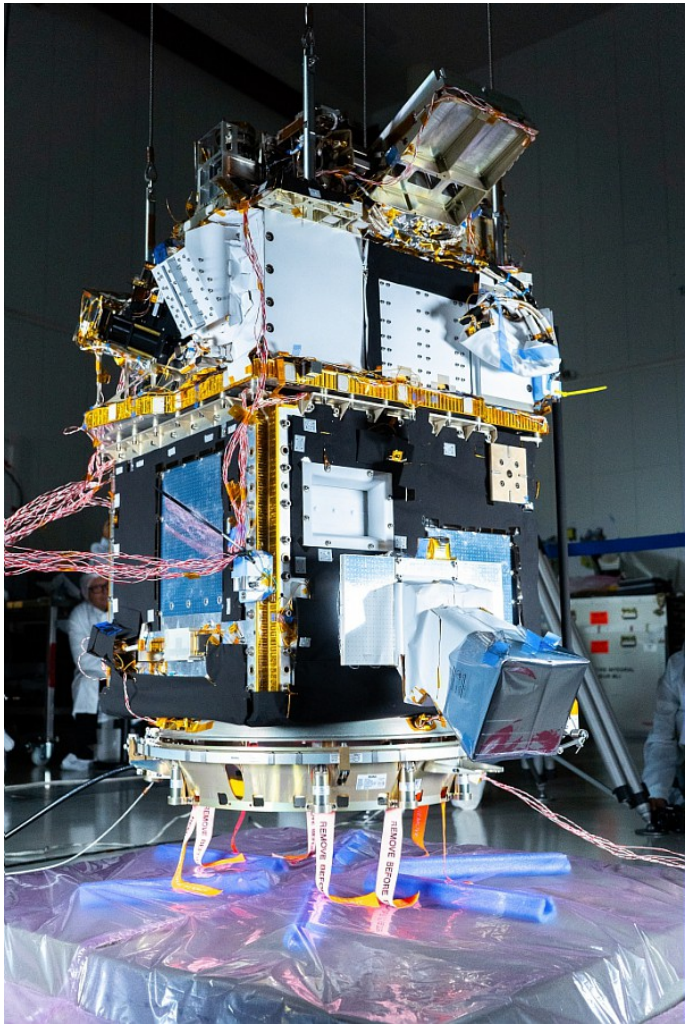
The XGRE FM sensors has been delivered to CNES and mounted on the satellite in Jan./Feb. 2020.

XGRE calibrations (02/2020)

The 3 XGRE sensors have been calibrated on the satellite during 2 weeks in Feb/March 2020 with radioactive sources at different positions.



TARANIS ready to fly !



- ✓ Flight acceptance review (FAR) successfully passed at CNES on May 2020.
- ✓ Funding and RH approved by CIO (CNES, labs) on June 2020.
- ✓ The TARANIS satellite fly on an Antonov airplane to Kourou today (23/09/20) !

In summary : TARANIS in space (2020 – 2023) …

With a launch expected on **Novembre 17th 2020**, the **TARANIS** CNES microsatellite is dedicated to the study of transient radio, optical and gamma-ray phenomena observed in association with **thunderstorms**.

⇒ Among the payload, the **XGRE** instrument is optimized to study terrestrial gamma-ray flashes (**TGF**) and terrestrial electrons beams **(TEB)**. With an averaged effective area of **425 cm^2**, XGRE should detect about **200** TGFs per year.

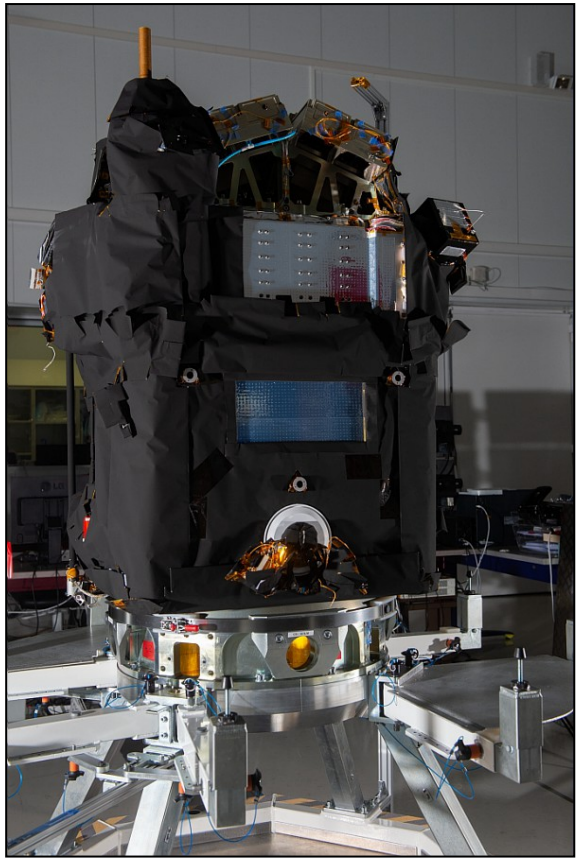
⇒ It will also detect **short Gamma-Ray Bursts (20/year)** and monitor **bright X-ray sources**, such as Crab and Cygnus X-1 on a 3,7 sr field of view with a few degrees position and microsecond timing accuracy.

⇒ After launch, **we have the responsibility to check the instrument performances and calibrate it** (6 months).

⇒ After this period, the satellite is declared **"ready to make science"** !

⇒ **TARANIS is a PI mission** ⇒ XGRE data belongs to the APC team and its collaborators (collaboration with Japan : **Yuuki Wada**)).

⇒ We will a **two years CDD CNES CDD funding** for the instrument follow-up, calibration and sciences (TGF and/or GRB).



The TARANIS satellite at CNES with the final (black) MLI.

TARANIS loss : 17/11/2020

Le Monde

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Partage

Espace : le satellite Taranis perdu peu après son lancement par une fusée Vega

L'engin, lancé dans la nuit du 16 au 17 novembre depuis Kourou, devait tenter de mieux cerner l'origine d'« événements lumineux transitoires » qui surviennent fugacement au-dessus des orages.

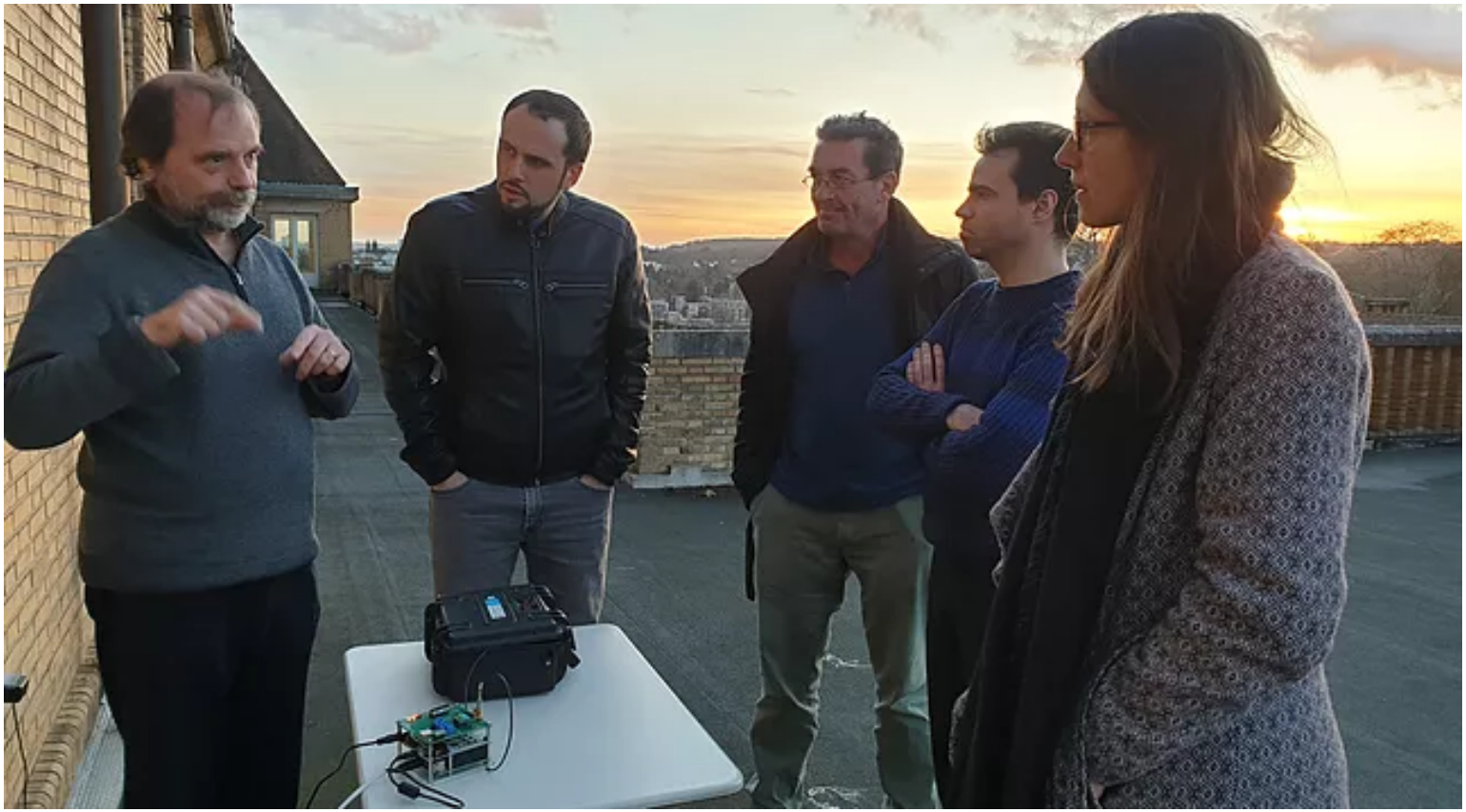
Par Vahé Ter Minassian • Publié le 17 novembre 2020 à 05h22 - Mis à jour le 17 novembre 2020 à 11h44

Lecture 5 min.

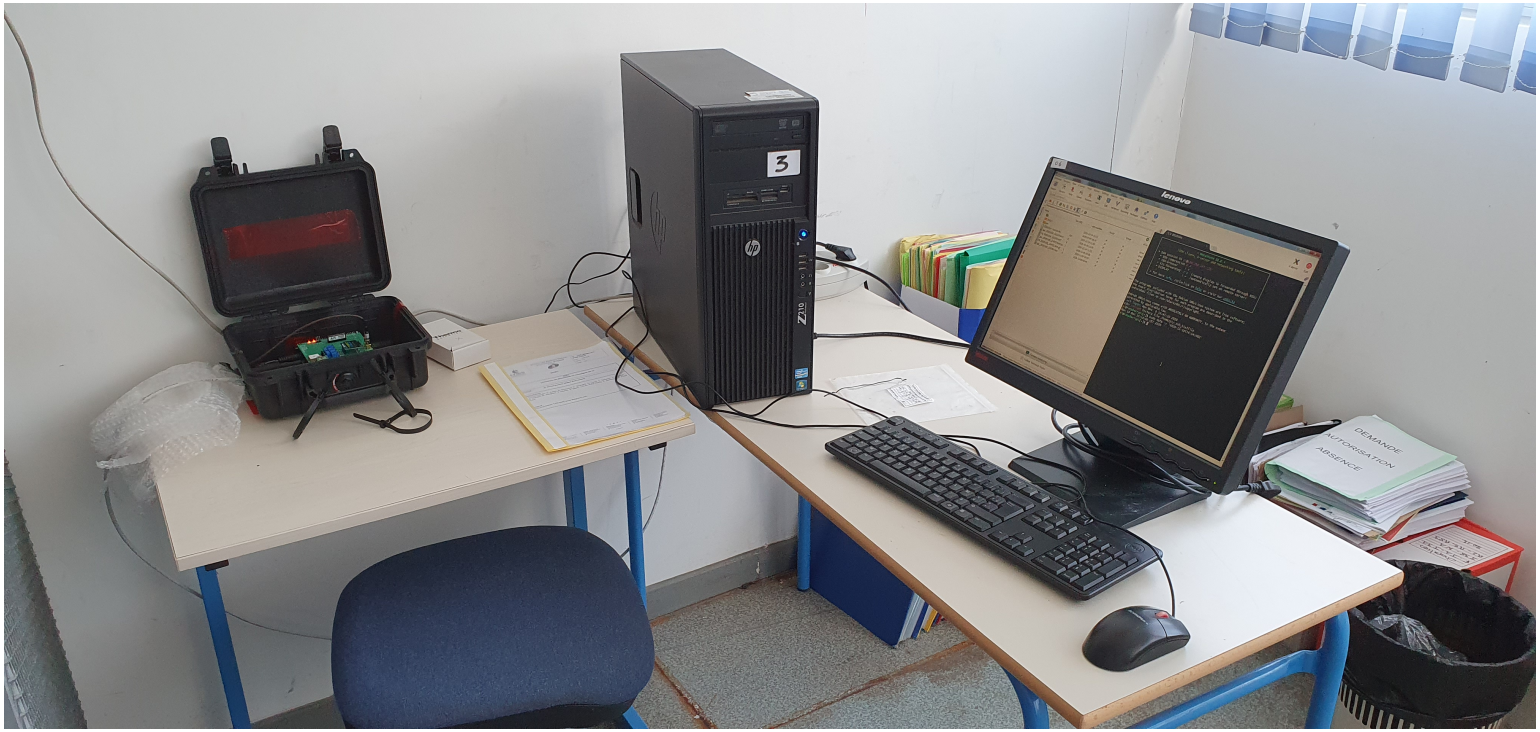
BELISAMA CONTINUES !

BELISAMA au lycée Corneille
La Celle St Cloud

BELISAMA au lycée Curie à Sceaux



BELISAMA au lycée Damas à Kourou (Guyane)



BELISAMA au collège Camus à la Norville

Harel' maths

L. HAREL - Collège A. Camus - 17 rue du Peuple la Lance - 91290 La Norville - laure.harel@ac-versailles.fr - 01 64 90 21 20

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Projet 2019-20

Projet 2019-20

Recherche

Articles récents

twitter

Futures installations

- We plan to install a Belisama detector to expand our thunderstorm and ambient radioactivity monitoring network at the following sites:

- Severac high school in Céret (Pyrénées Orientale)

- Paris-Meudon Observatory (january 2021)
- LPCEE Orleans
- « Jean-le-Bon » tower in Dijon
- Maido meteorological observatory (Réunion)

- Partnership with IRSN and OpenRadiation

Merci !!

BELISAMA

CNRS/APC

Philippe Laurent

Eric Bréelle

Jean-Luc Robert

Actions :

- **Loan to high schools a miniaturized gamma-ray detector**
- **Train teachers to radioactivity, instrumentation, photo-detection, data analysis (Python).**
- **Participation to a research program with high school students:**
  - **natural gamma-ray radiation (with IRSN "OpenRadiation" program).**
  - **study of the gamma-ray emission of thunderstorms on Earth, possibly in relation with TARANIS observations.**