

TARANIS

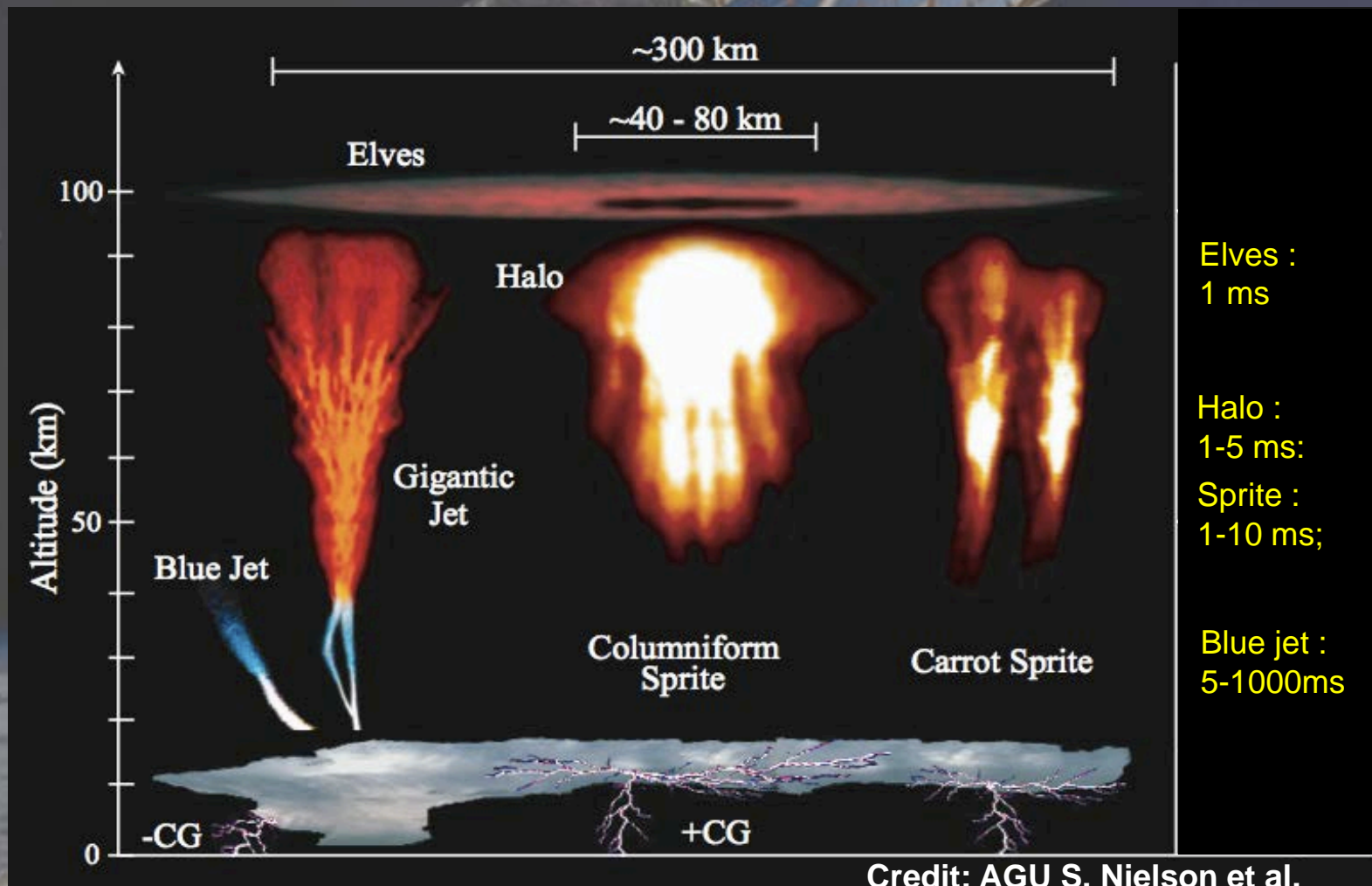
Jean-Louis Pinçon
LPC2E, Université d'Orléans/CNRS, France

Plan

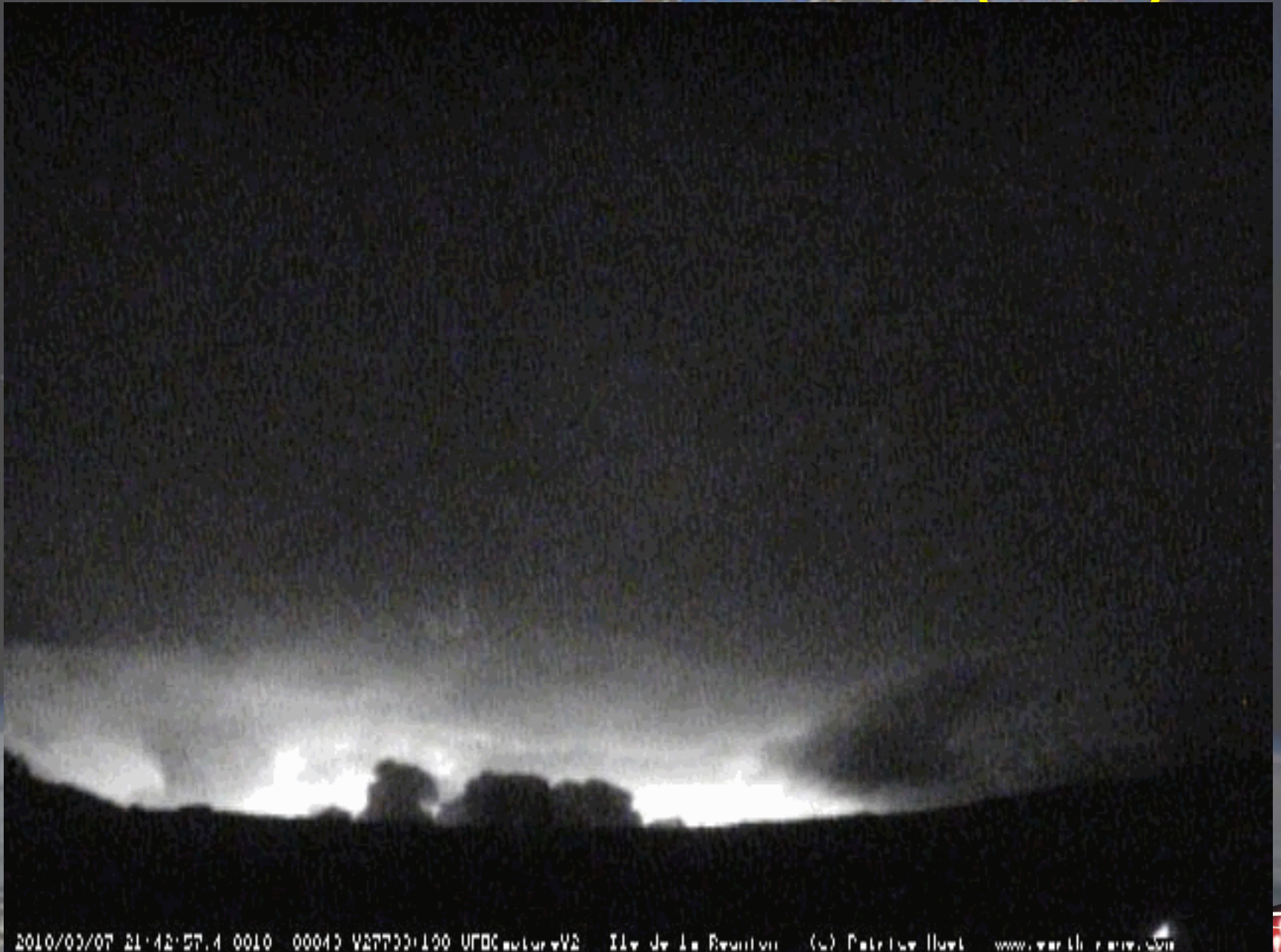
- Les Transient Luminous Events (TLE)
- Les Terrestrial Gamma-ray Flashes (TGF)
- La mission TARANIS

Transient Luminous Events (TLEs)

- 1st TLE (Sprite) observation by Franz et al., 1990
- Correlation with lightning



Transient Luminous Events (TLEs)

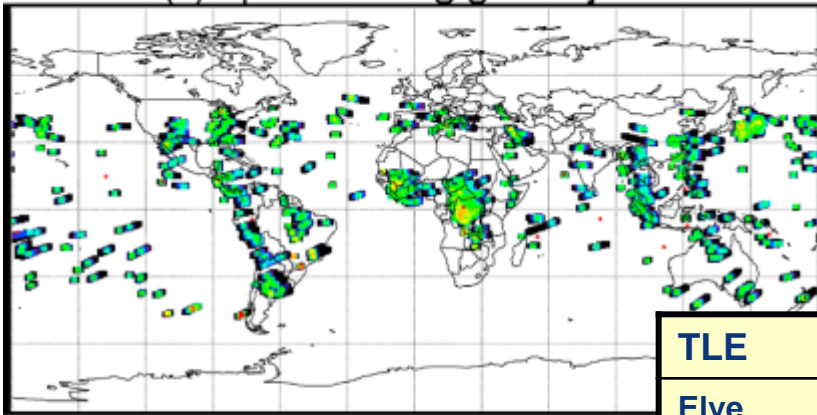


2010/03/07 21:42:57.4 0010 00043 427733-100 UFDC motor v2 Ile de la Reunion (c) Patrick Huet www.earthcam.com

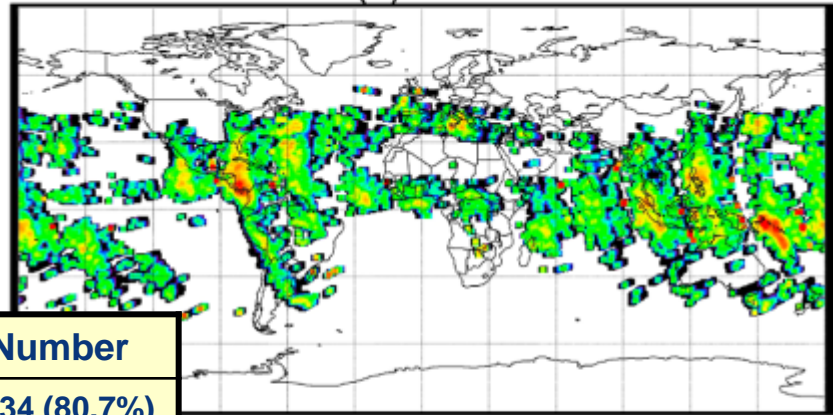
Transient Luminous Events (TLEs)

TLEs observed by ISUAL (July 2004 - June 2007)

(a) sprites and gigantic jets

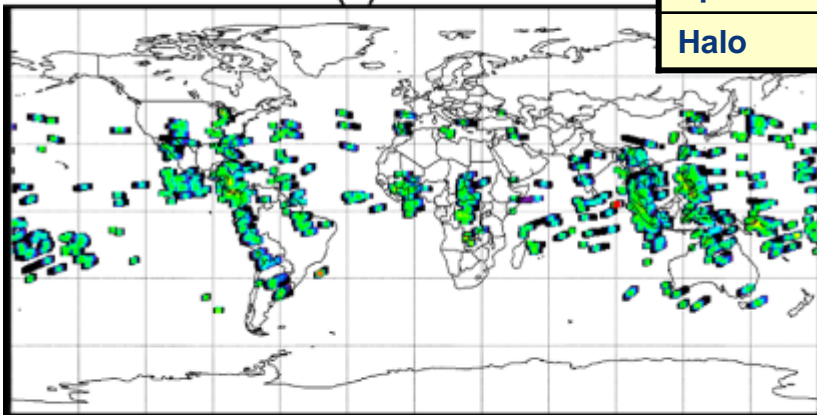


(b) elves

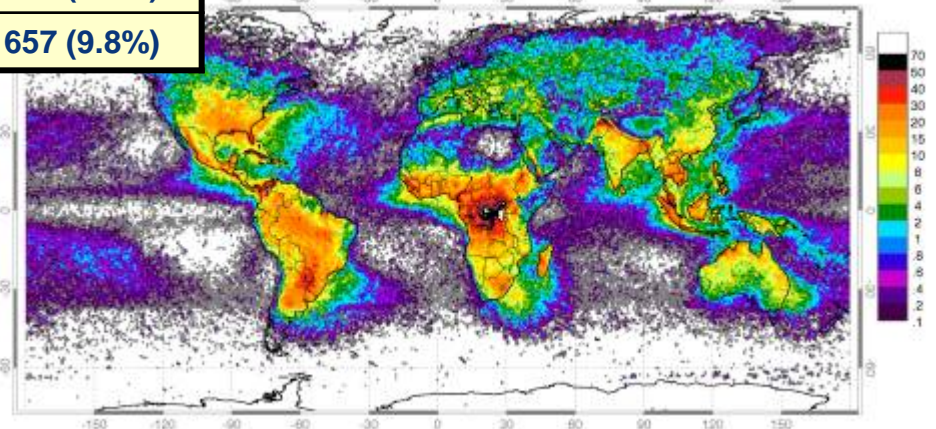


TLE	Number
Elve	5434 (80.7%)
Sprite	633 (9.4%)
Halo	657 (9.8%)

(c) halos

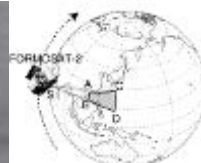


(d) éclairs



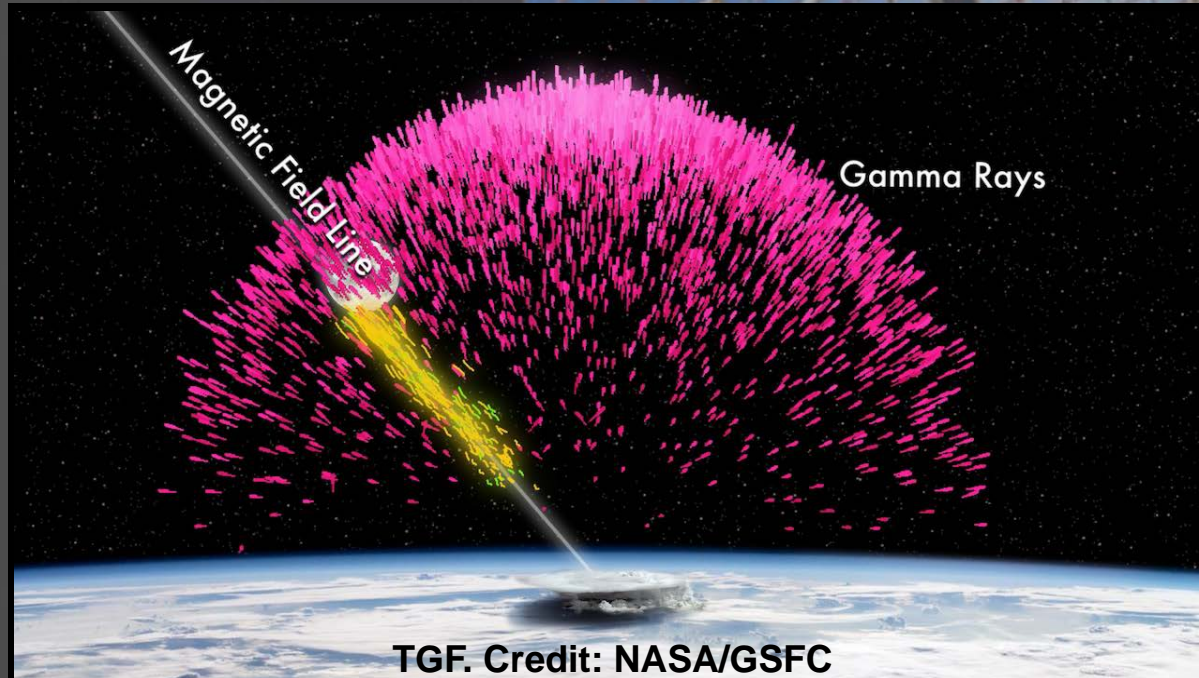
$10^{-4.5}$ $10^{-4.0}$ $10^{-3.5}$ $10^{-3.0}$ $10^{-2.5}$ $10^{-2.0}$ $10^{-1.5}$ $10^{-1.0}$ $10^{-0.5}$ (#/yr/km²)

a), b) c) from Chen et al. (2008). d) : from Christian et al., (2003).



	AB	Limb	CD
Distance (km)	2310	3190	4130
Size (km)	912	1219 ($h = 223$)	1590

Terrestrial Gamma ray Flashes (TGFs)



Typical maximum Energie: 30 MeV.
Typical duration: fraction of ms.
Global occurrence rate: > 400 000/year (1/min).
Typical flux: 1 photon/cm² at low altitude orbit

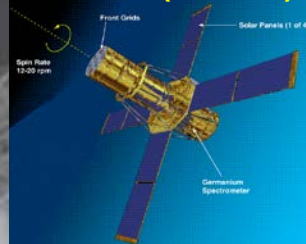
Terrestrial Gamma ray Flashes (TGFs)

- Discovery by Fishman et al., 1994
- Correlation with thunderstorm areas

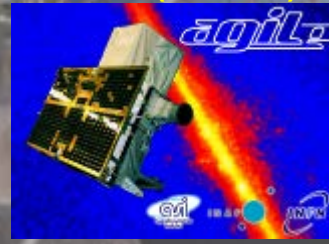
CGRO (1991-2000)



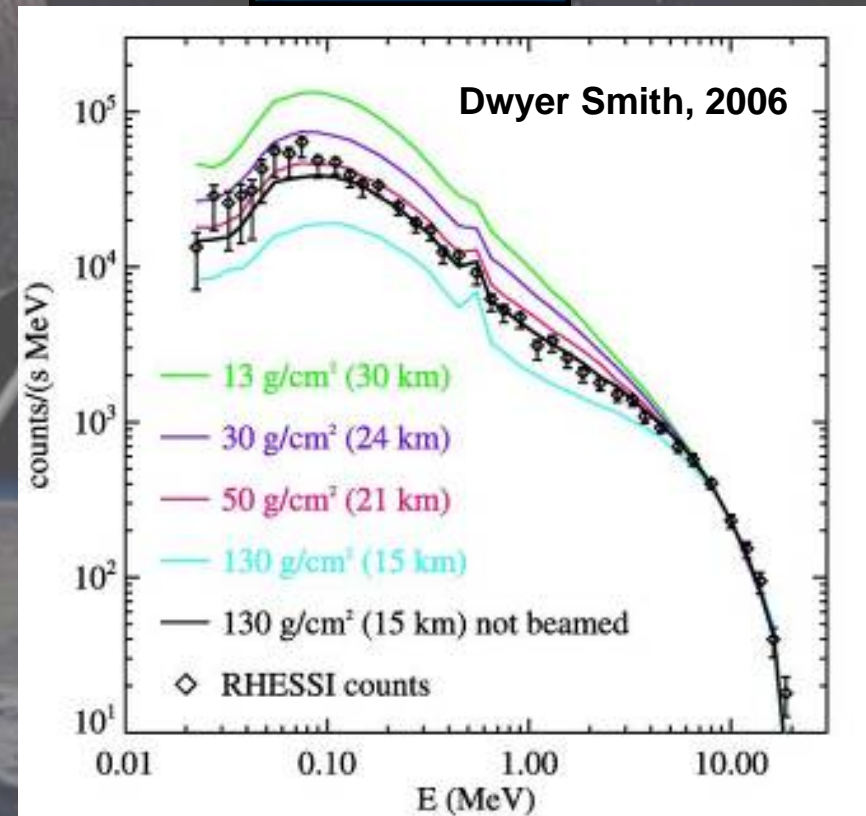
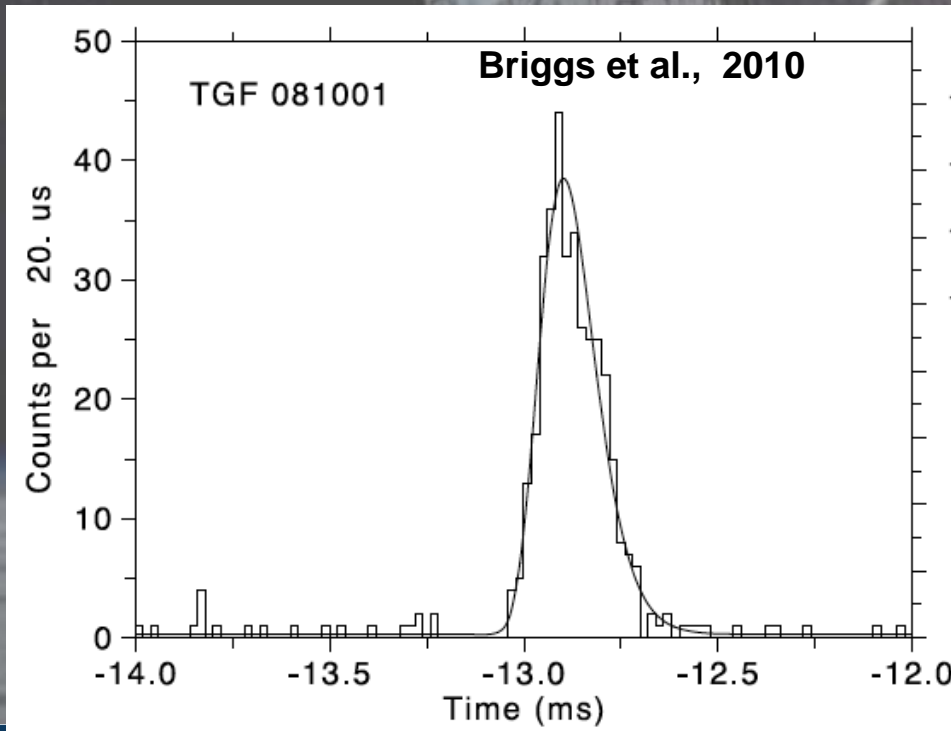
RHESSI (2002-...)



AGILE (2007- ...)

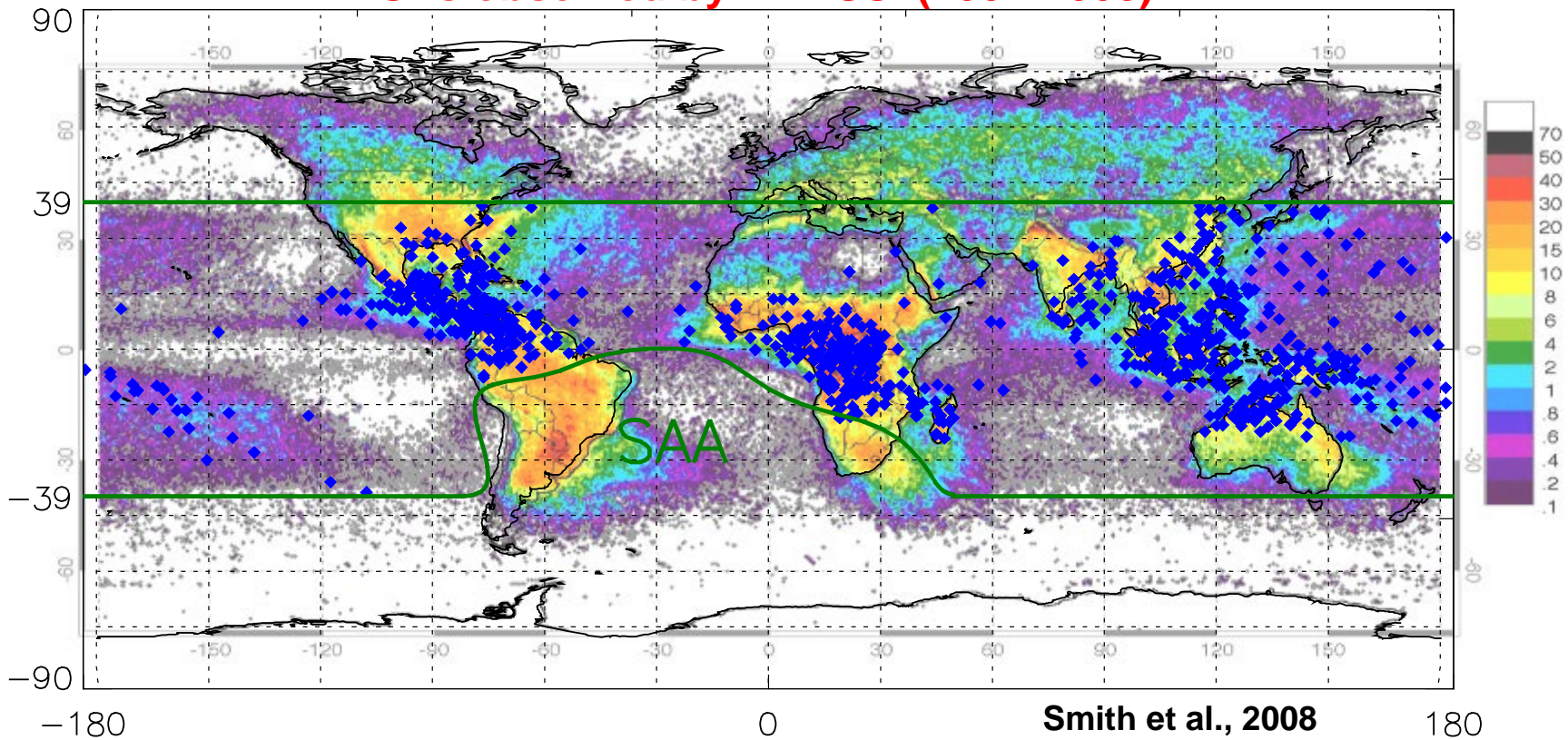


Fermi (2008-...)



Terrestrial Gamma ray Flashes (TGFs)

TGFs observed by RHESSI (2002-2008)



More than 800 TGF
between 2002 and 2008:

3 TGF/week



Since 2010 a
special TGF mode
is used:

30 TGF/week!

TLEs and TGFs : the remaining questions

TLEs:

- Microphysics of TLEs?
- Relationship between thunderstorms and the various TLEs?
- Correlation between Jets and lightning?

TGFs:

- Generation mechanisms?
- What are the real flux and spectra at S/C altitude?
- Are TGFs dangerous for flight passengers?
- Link with low altitude TLEs (jets)?
- Link with electron/positron beams?

TLE et TGF :

- Impact to high atmospheric chemistry?
- Impact to the Global Electric Circuit?



Need of simultaneous observations of TLEs and TGFs from Nadir

Tool for the Analysis of RAdiation from lightNing and Sprites

- Combined Nadir observations of TLEs and TGFs.
- High resolution measurement of energetic electrons.
- Wave field measurements over the frequency range [DC - 35 MHz].



- Dimension: $\sim 1\text{m}^3$
- Mass: $\sim 200\text{ kg}$

Orbit

- Sun-synchronous
- Inclination: 98°
- Altitude: 700 km

Subsystems

- Memory: 16 Gbits
- X band: 16.8 Mb/s

Data: 4 GB/day

Time stamping accuracy

- Absolute: $\pm 1\text{ ms}$
- Relative: 10 μs

Pointing accuracy

- localization: 5 km

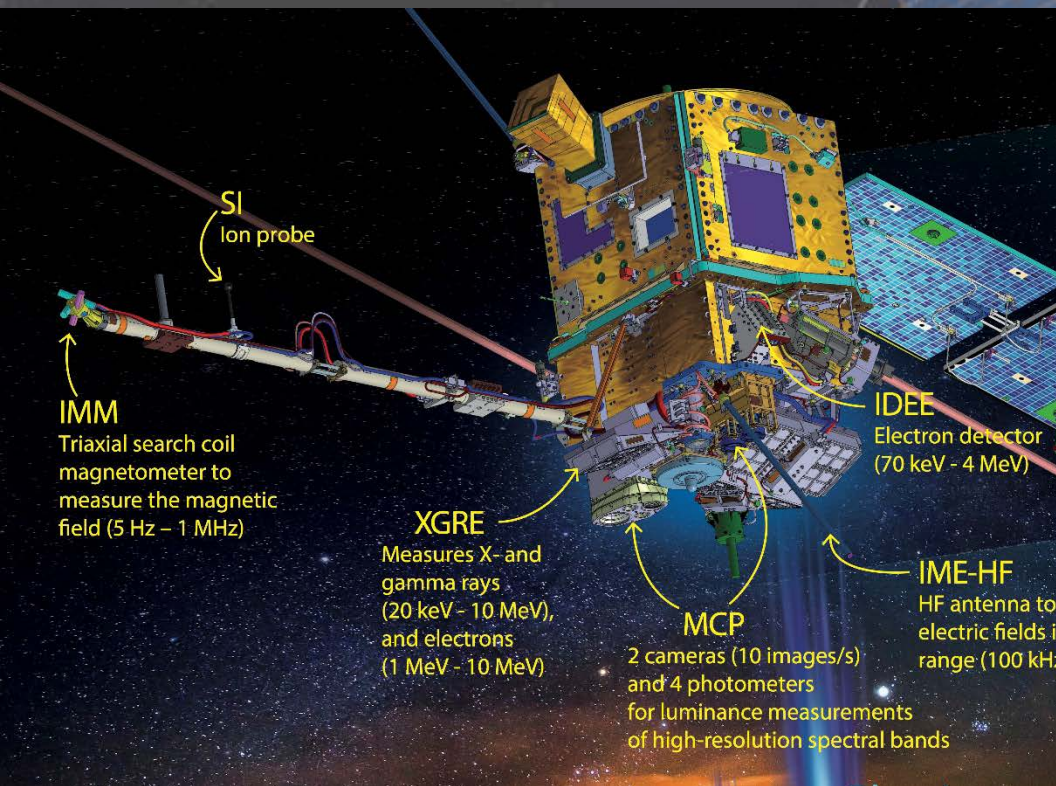


Scientific objectives of TARANIS

- **To advance the physical understanding of the links between TLEs, TGFs and environmental conditions** (*lightning activity, geomagnetic activity, atmosphere/ionosphere coupling, occurrence of Extensive Atmospheric Showers, etc*).
- **To identify the signatures associated with these phenomena** (*electron beams, associated electromagnetic or/and electrostatic fields*) **and to provide inputs to test generation mechanisms.**
- **To provide inputs for the modelling of the effects of TLEs, TGFs and bursts of precipitated and accelerated electrons** (*lightning induced electron precipitation, runaway electron beams*) **on the Earth's atmosphere.**



Scientific payload accommodation



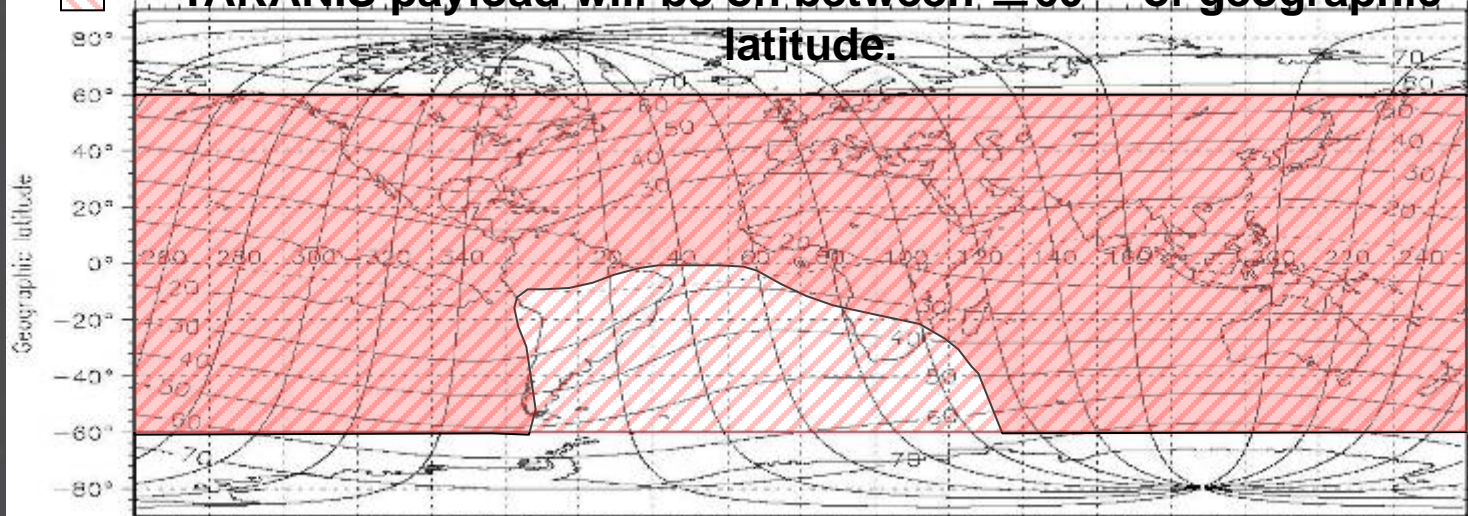
MCP	Lightning micro-camera TLE micro-camera 4 Photometers	PI: Th. Farges (CEA)
XGRE	X and y detectors: [20keV – 10MeV] e ⁻ : [1 MeV – 10 MeV]	PI: P-L. Blelly, IRAP (F) and F. Lebrun, APC (F)
IDEA	Two e ⁻ detectors: [70keV – 4MeV]	PI: J-A. Sauvaud, IRAP (F) + Univ. Prague (Cz)
IMM	Triaxial search coil : [5Hz – 1MHz] 0+ whistler detector	PI: J-L. Pinçon, LPC2E (F) + Univ. Stanford (USA)
IME-BF	LF-E antenna : [DC – 1MHz] Ion probe	PI: E. Seran, LATMOS (F) + GSFC (USA)
IME-HF	HF-E antenna: [100kHz – 35MHz]	PI: J-L. Rauch, LPC2E (F) + Univ. Prague, IAP (Cz)



**TOWARDS
THE EARTH**

TARANIS: Event and Survey

 **TARANIS payload will be on between $\pm 60^\circ$ of geographic latitude.**



 **Optical measurements only during night.
X and Gamma measurements outside SAA.**

Survey data:

Continuous monitoring of the background conditions.

2 GB of low resolution data per day!

Event data:

Triggered when a priority event is detected (TLE, TGF, electron beam, burst of electromagnetic/electrostatic waves), then all instruments record and transmit high resolution data.

2 GB of high resolution data per day!

TARANIS event data

TARANIS

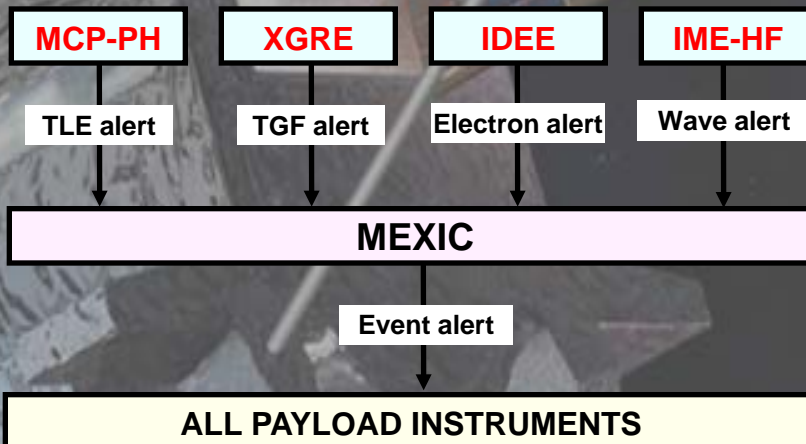
Mass memory: 16 Gbits

X-band telemetry: 16.8 Mbits/s

2 GBytes of event data per day

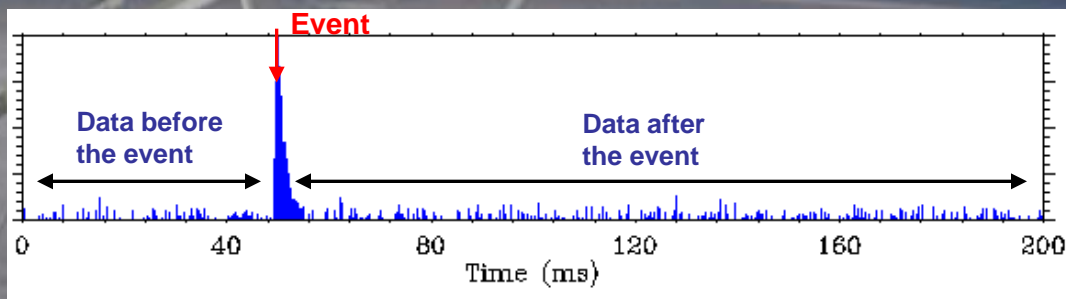
- On average 12 events per half-orbit (T=100mn)
- A maximum of 36 events per half-orbit

4 triggering instruments

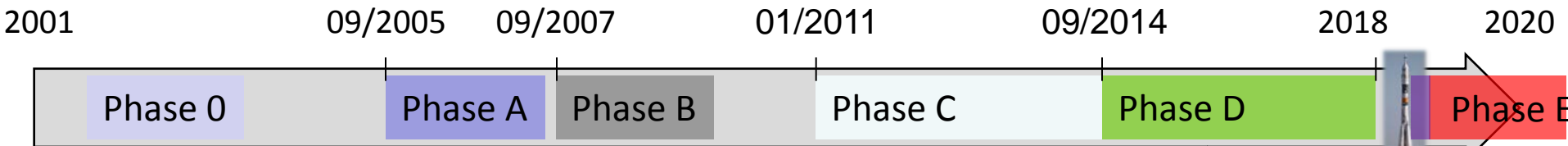


Multi EXperiment Interface Controller to power and to manage the whole scientific payload.

On-board analyzers will include event buffer memory sized to record high resolution data both before and after the trigger



Planning



Now: integration and qualification of instruments

Next steps:

- analyzer integration in MEXIC
- instrument integration on the payload

Phase D :

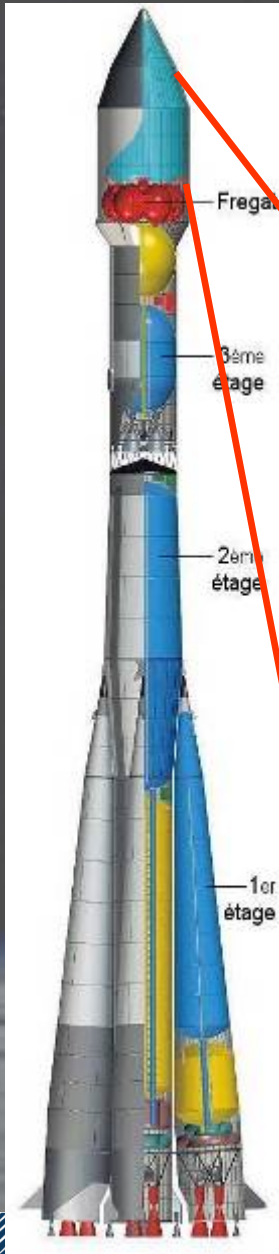
- Qualification Technique Système : 03/2015 – 09/2016
- Livraison finale du CMS-T : 12/2016
- Qualification Opérationnel Système : 05/2017 – 02/2018

- AIT Payload: 06/2016 – 01/2017
- AIT Satellite: 01/2017 – 01/2018
- FAR : 01/2018

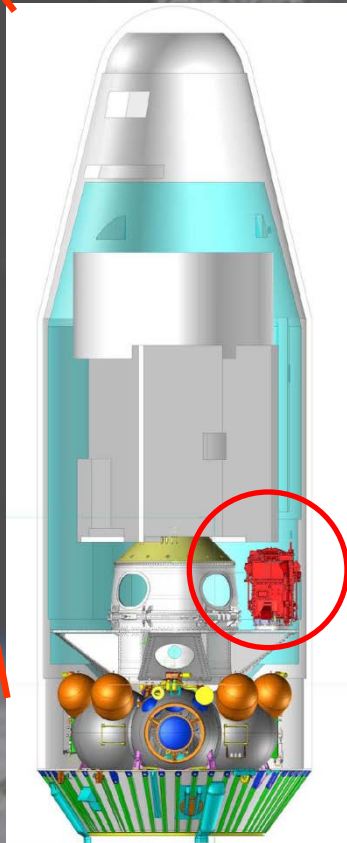
- Ready to Launch: mid-2018
- Launch : end of 2018 with EarthCare (ESA) or other sat



TARANIS LAUNCH



SOYUZ
~4,8 tons
SSO orbit



KOUROU
2018

TARANIS - CMST

<https://taranis.lpc2e.cnrs.fr/taranis/>

The TARANIS data Server will provide the scientific community with the following services:

- 1) TARANIS data downloading
- 2) TARANIS QuickView/QuickLook access
- 3) TARANIS data online processing

A satellite is shown in space, with its solar panels extended. The Earth's horizon is visible in the background. The word "MERCI!" is written in large, yellow, bold letters across the center of the image.

MERCI!