



TARANIS

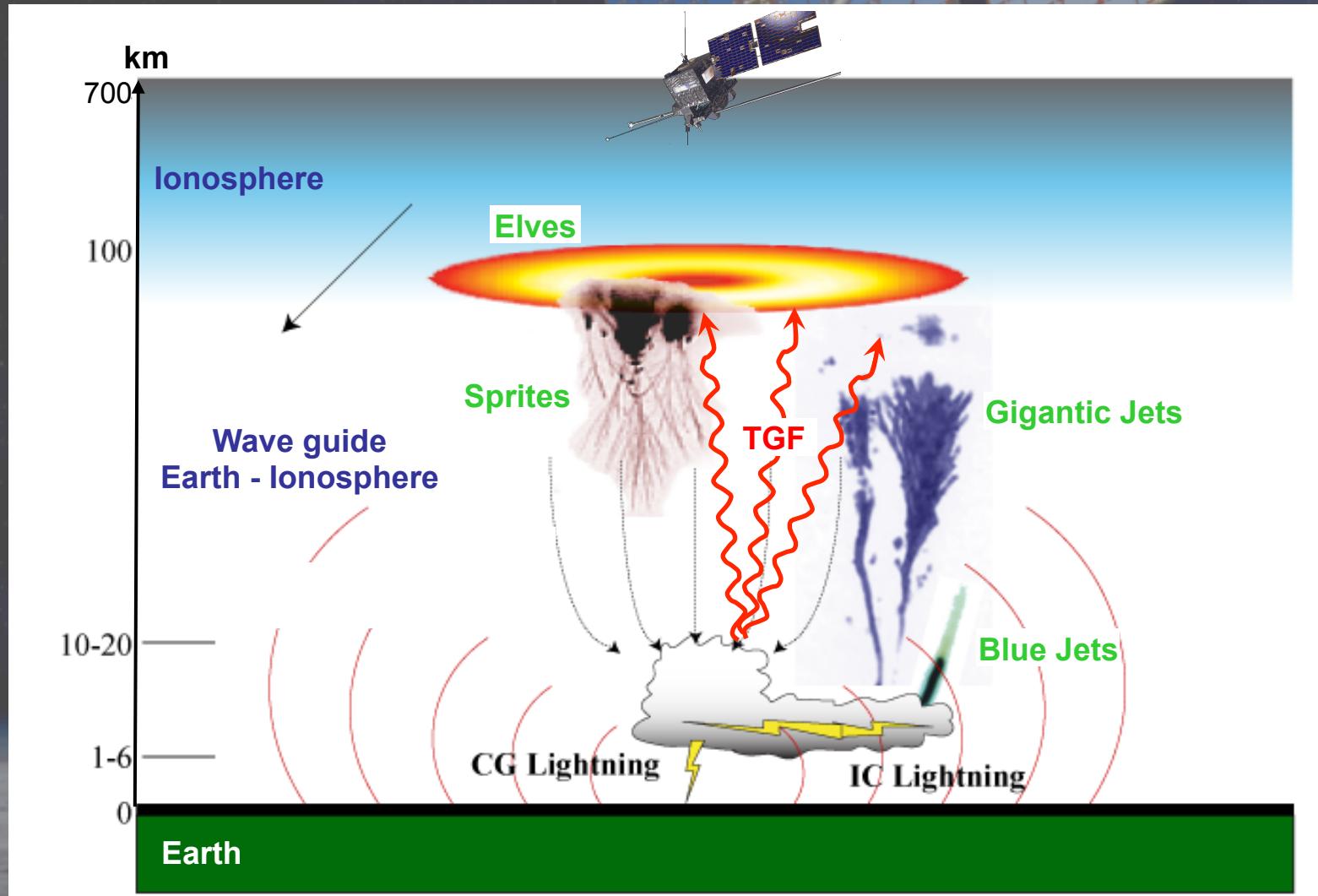


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Orléans/CNRS

ILWS Meeting 2 August, 2014 Moscow

Discovery of TLEs and TGFs above thunderstorms

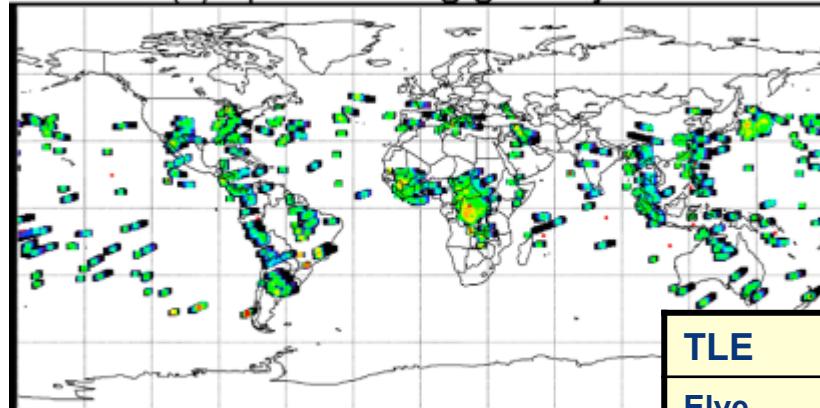




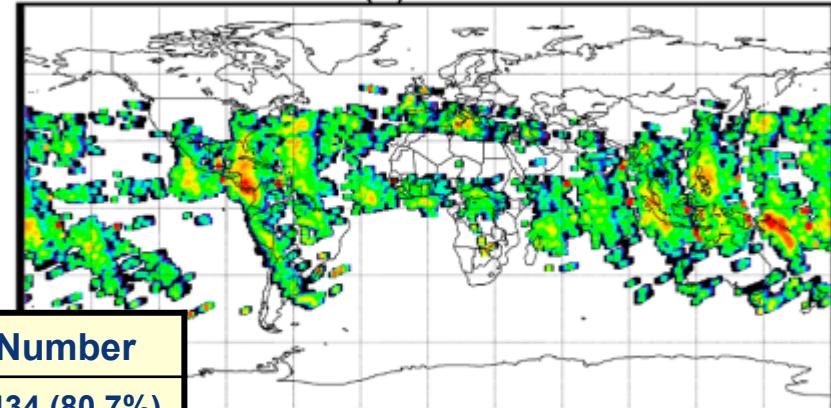
Transient Luminous Events (TLEs)

TLEs observed by ISUAL (July 2004 - June 2007)

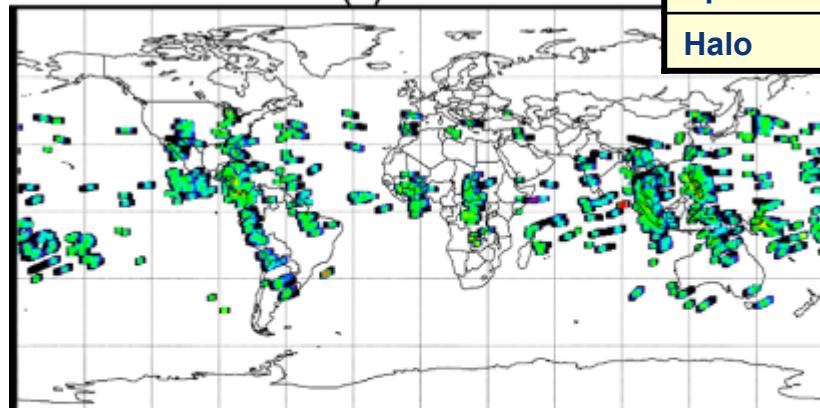
(a) sprites and gigantic jets



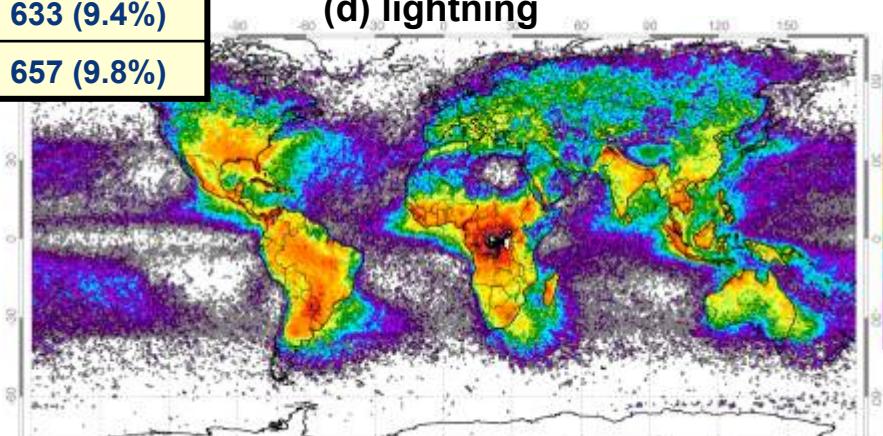
(b) elves



(c) halos

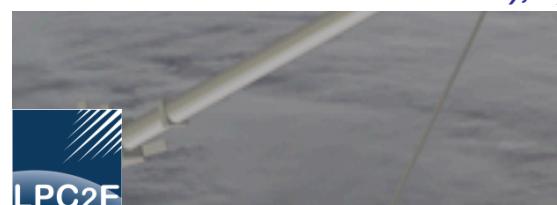


(d) lightning



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

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



LPC2E

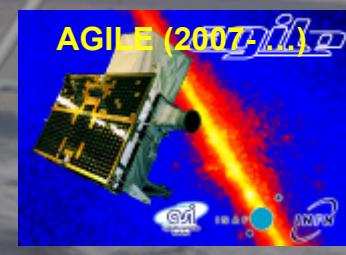
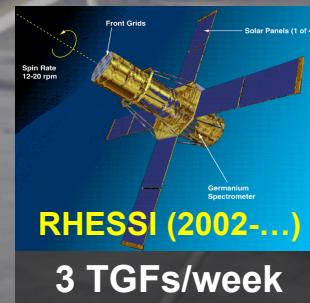
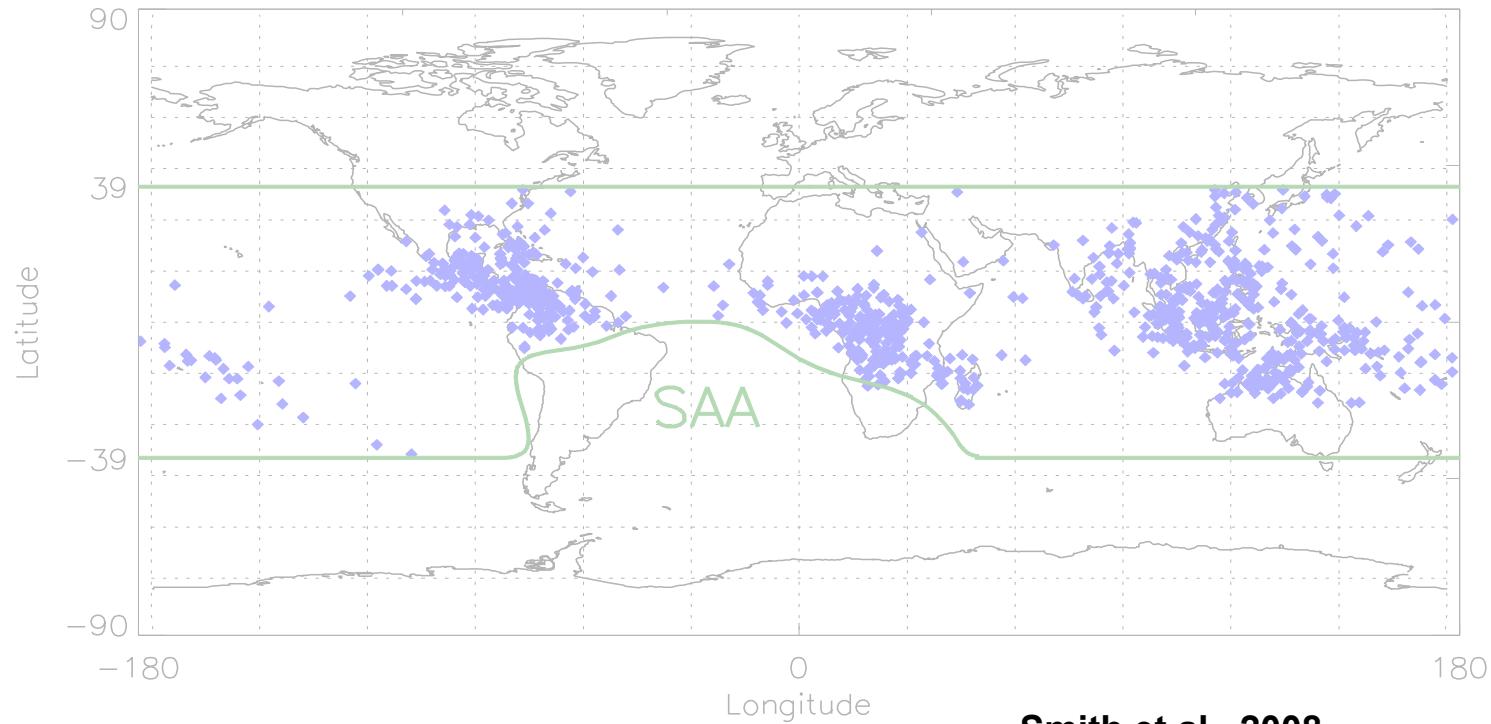
	AB	Limb	CD
Distance (km)	2310	3190	4130
Size (km)	912	1219 ($h = 223$)	1590



Terrestrial Gamma ray Flashes (TGFs)

TGFs observed by RHESSI (2002-2008)

RHESSI: TGF events (March 2002 – June 2008)





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: ~ 1m³
- Mass: ~ 200 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: ±1 ms

Pointing accuracy
- localization: 5 km

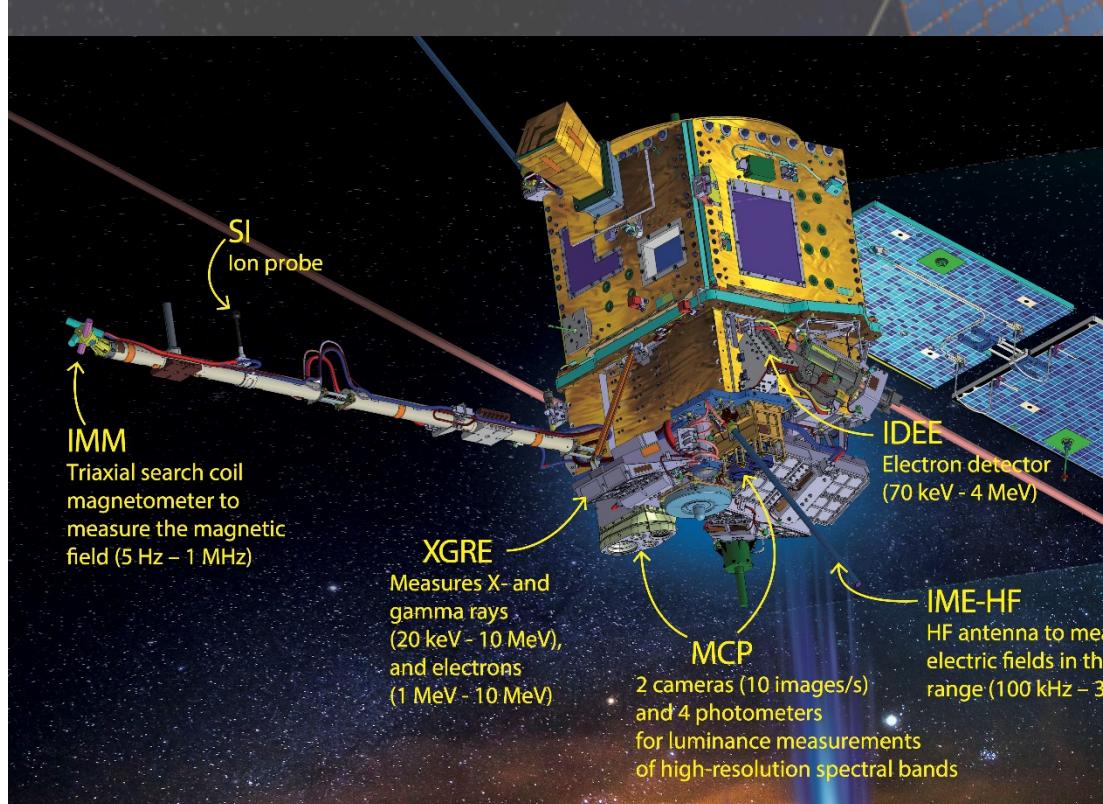


Scientific objectives of TARANIS

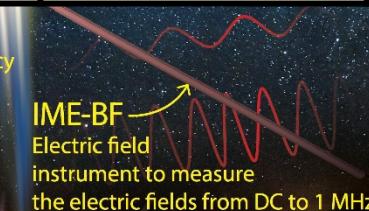
- To advance the physical understanding of the links between TLEs, TGFs and environmental conditions (*lightning activity, geomagnetic activity, atmosphere/ionosphere coupling, occurrence of Extensive Atmospheric Showers, etc.*).
- To identify the signatures associated with these phenomena (electron beams, 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: E. Blanc, CEA (F) and 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)
IDEE	Two e- detectors: [70keV – 4MeV]	PI: J-A. Sauvaud, IRA (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)

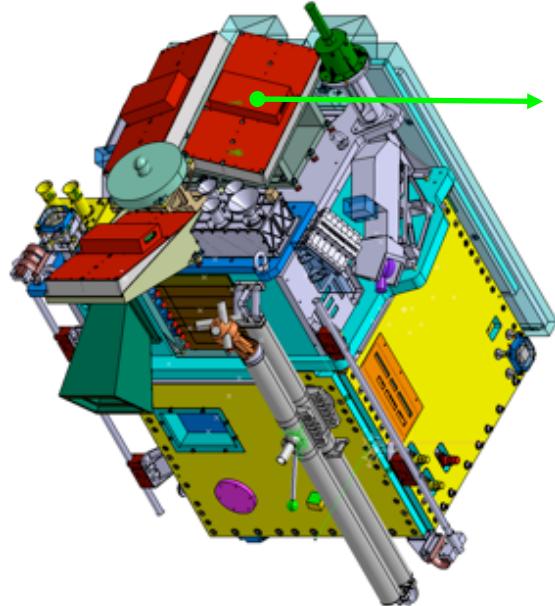


TOWARDS
THE EARTH



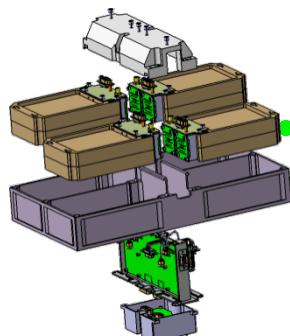
XGRE (PIs : P-L Blelly (IRAP) et F. Lebrun (APC))

Three sensors facing the Earth placed on TARANIS spacecraft with different orientations and one analyzer.



XGRE experiment

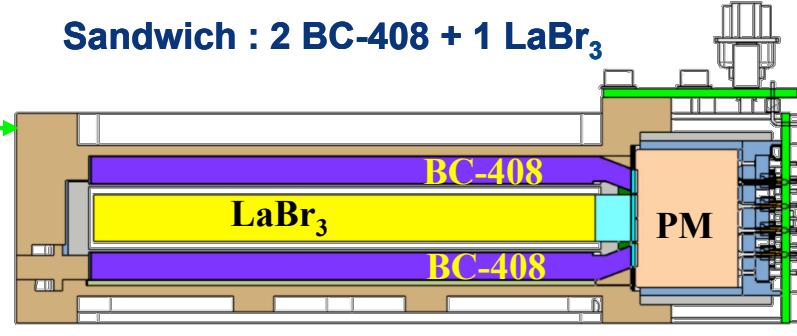
- 3 sensors
- Total detection area
~ 800 cm²



XGRE Sensor

- 4 Detection Units
- ADC converters
- 12 bits (LaBr₃)
- 10 bits (BC408)
- Fast electronics
- dead time = 300 ns

Sandwich : 2 BC-408 + 1 LaBr₃



LaBr₃ (photons)

- Fast (pulse pile up < 150 ns)
- Good linearity
- Good spectral resolution

BC-408 (electrons)

Gamma-Rays: energy range [20 keV – 10 MeV]
(accuracy: 30% at 20 keV ; 10% at 511 keV).
Electrons: energy range [1 MeV – 10 MeV]

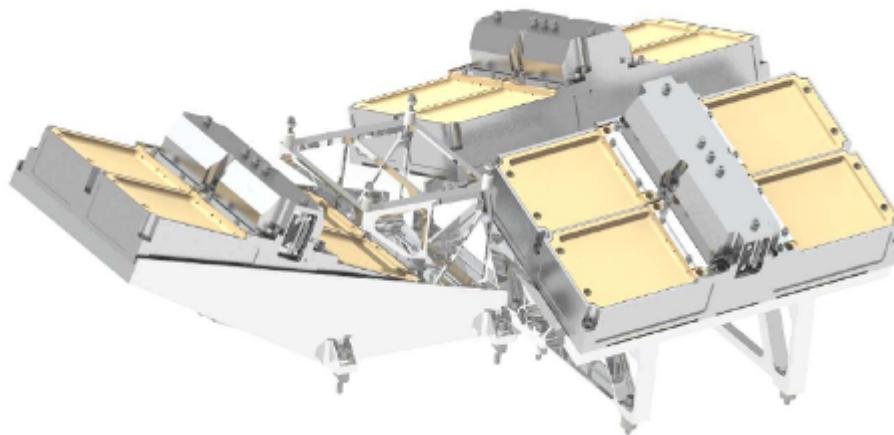




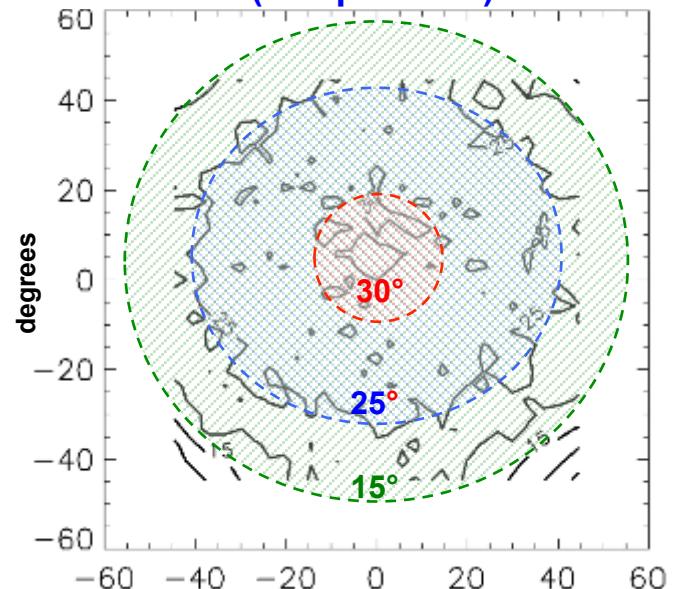
XGRE (PIs : P-L Blelly (IRAP) and F. Lebrun (APC))

Spatial localization

- Three planes ($\sim 20^\circ$ inclination)

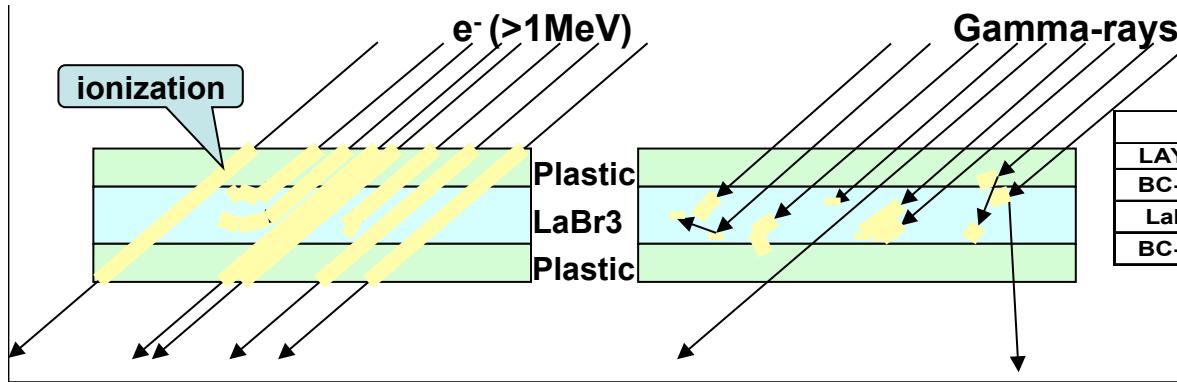


Arrival direction accuracy (100 photons)



Separation photons - electrons

- Coincidence/anti-coincidence between LaBr3 and BC408



- 2 spectrometers

- ◆ nadir
- ◆ zenith

- Energy range

- ◆ 60 keV – 5 MeV

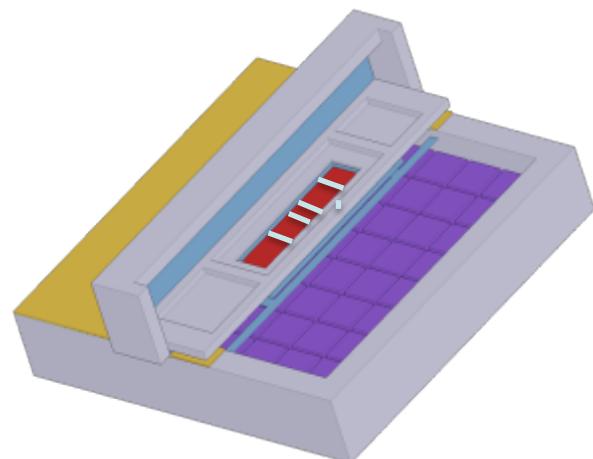
$\Delta E = 16 \text{ keV}$ [60 keV – 500 keV]

$\Delta E = 60 \text{ keV}$ [500 keV – 5 MeV]

- 8 angles

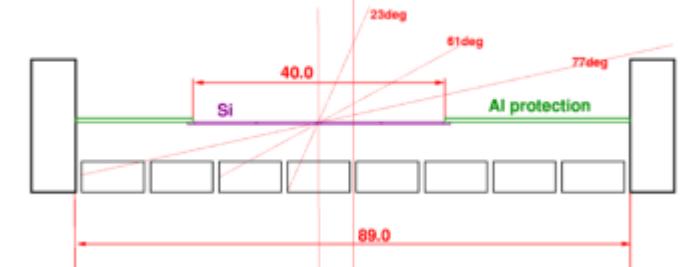
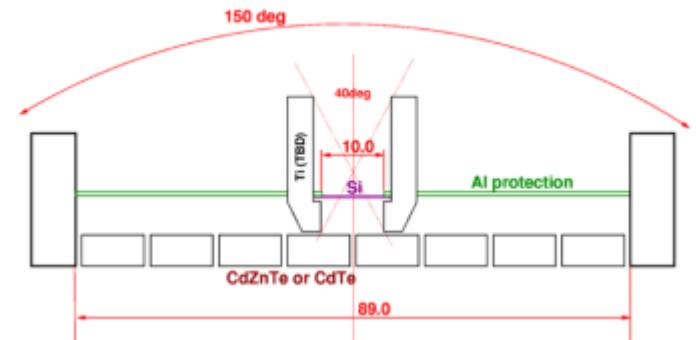
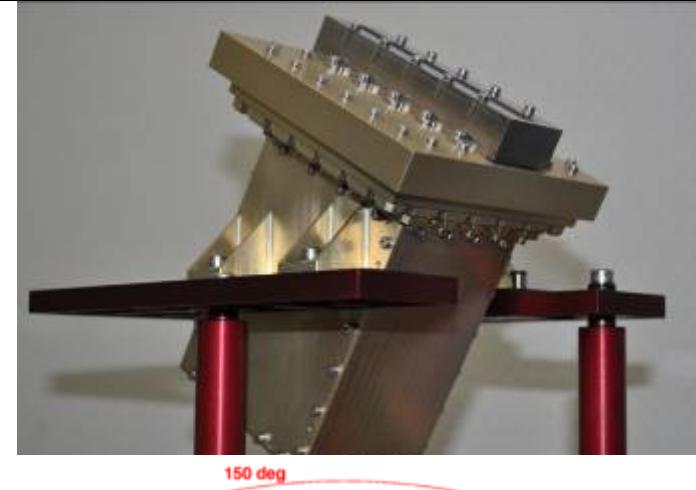
[60 keV – 500 keV] Field of view = 150x40°

[500 keV – 5 MeV] Field of view = 150x150°



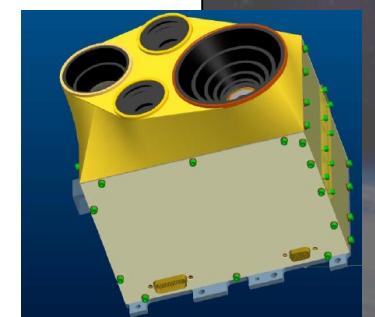
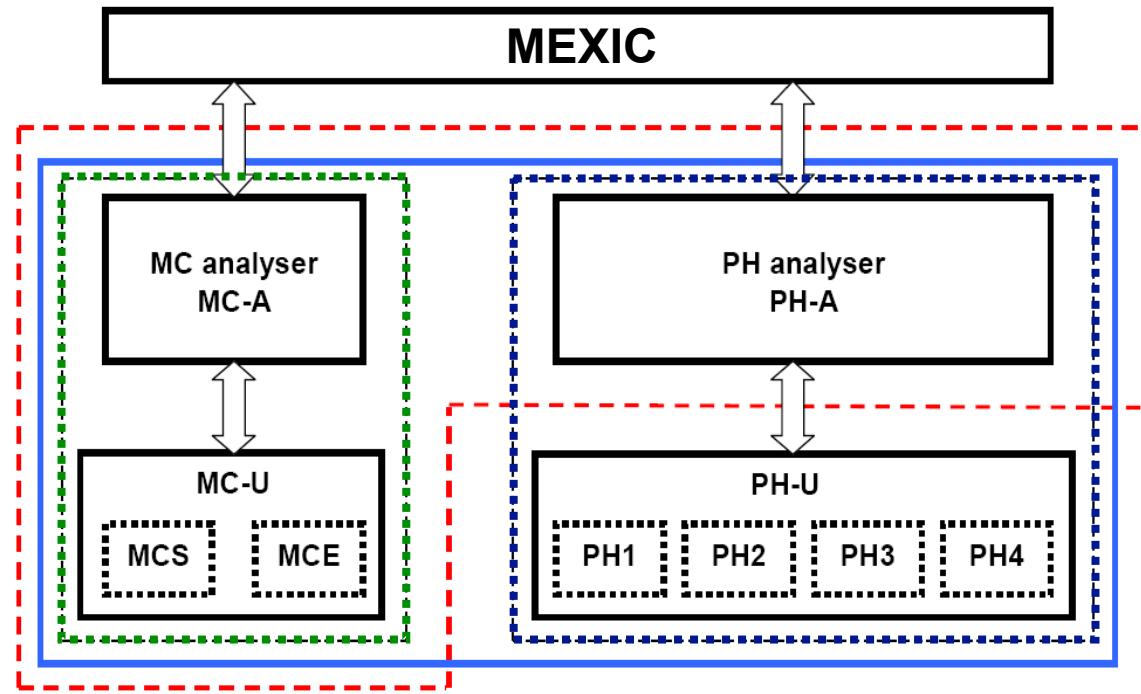
■ Silicium, 5 cells

■ CdTe, 64 cells



MCP: Instrument and team

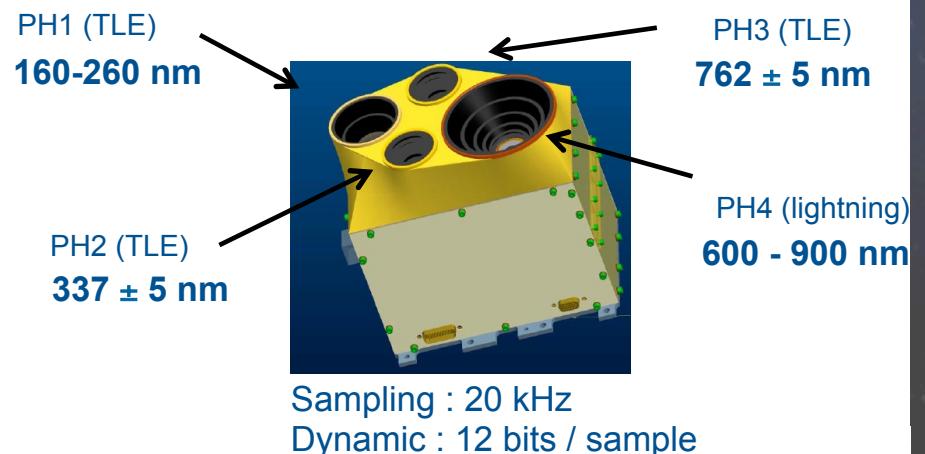
MCP: PI E. Blanc and Th. Farges (CEA)



MCP- PH Units

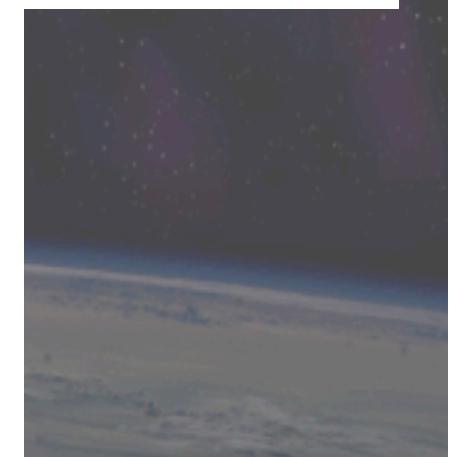
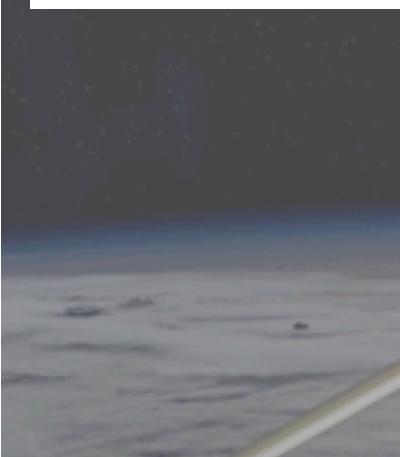
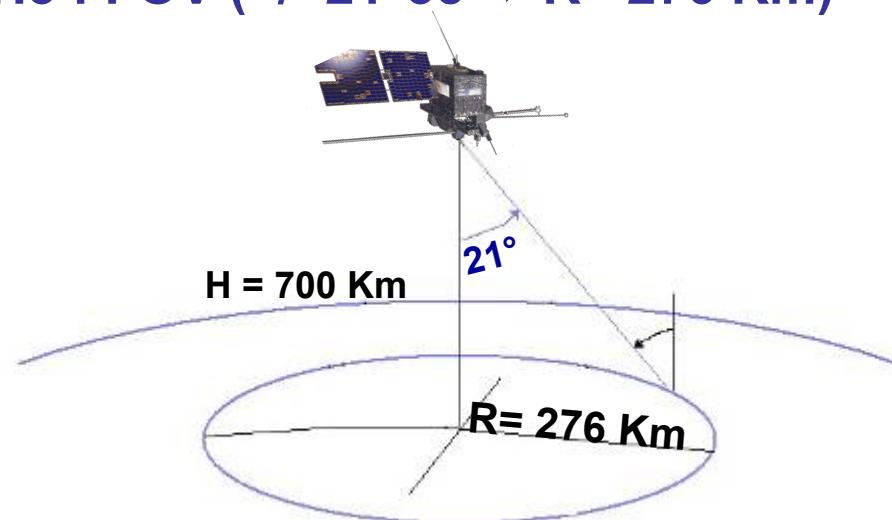
➤ Spectral bands

- **PH1: UV-C** 160 - 260 nm
- **PH2: UV-A** 337 ± 5 nm
- **PH3: NIR** 762 ± 5 nm
- **PH4: Red - NIR** 600 – 900 nm



➤ Field Of View (FOV):

PH1 – PH2 – PH3 : FOV ($\pm 21^\circ$) $\Rightarrow R = 276$ Km)

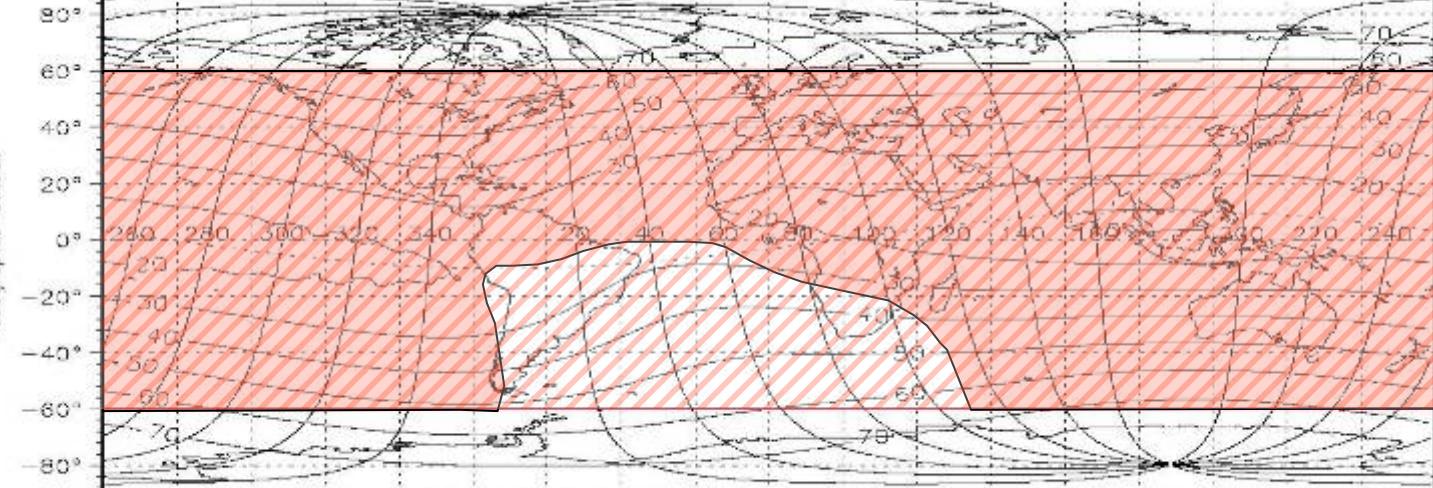


TARANIS: Event and Survey



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

Geographic latitude



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

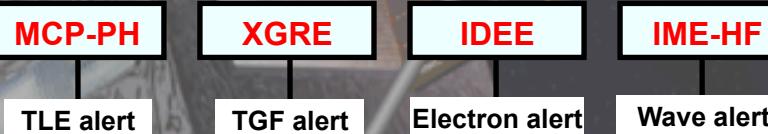
2 GB of high resolution data per day!

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

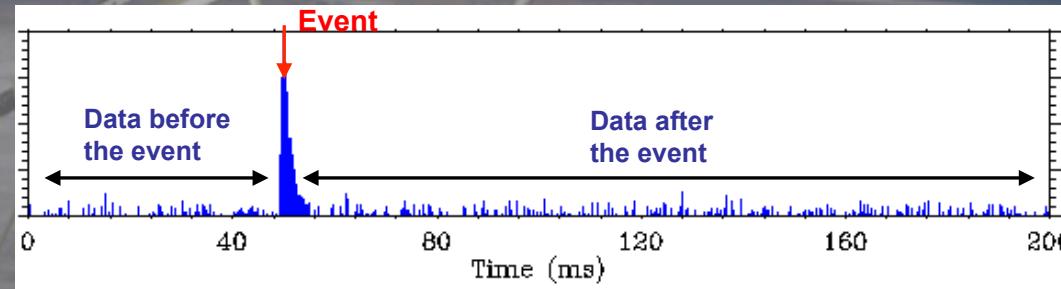
Multi EXperiment Interface Controller to power and to manage the whole scientific payload.

MEXIC

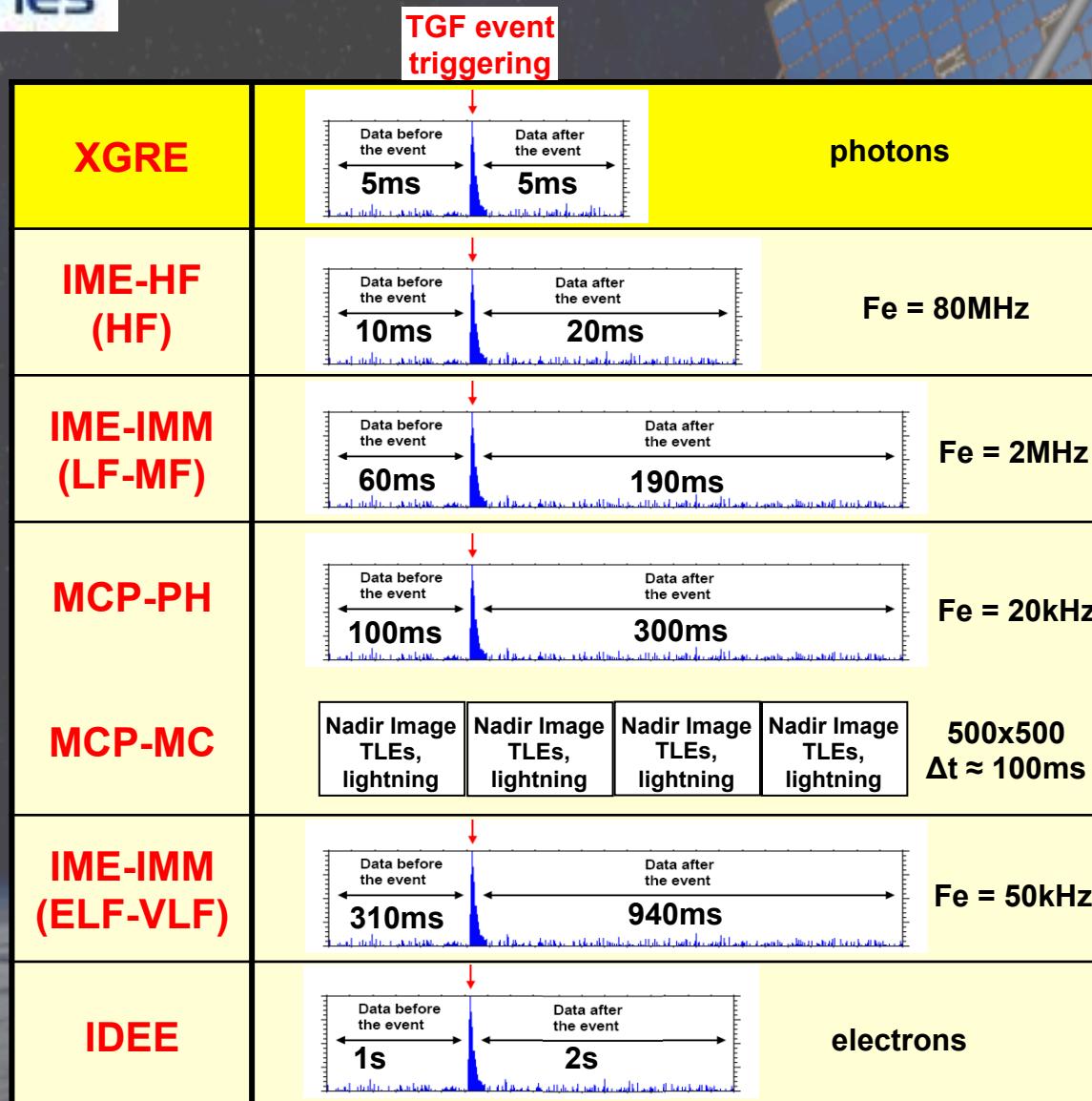
Event alert

ALL PAYLOAD INSTRUMENTS

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



TARANIS event data (2/2)



Time stamping accuracy

Absolute accuracy:

1 ms (comparison with ASIM, balloon, and ground based measurements).

Relative accuracy:

10 μs (comparison between TARANIS experiments).

TARANIS Status & Launch

2011

2012

2013

2014

2015

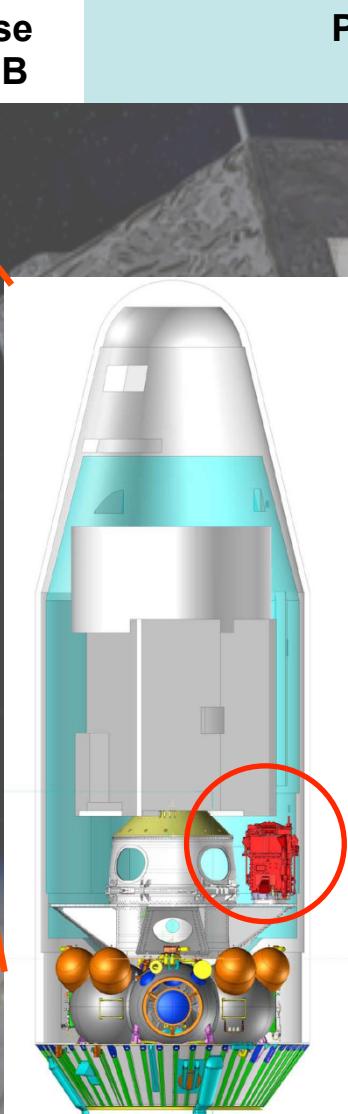
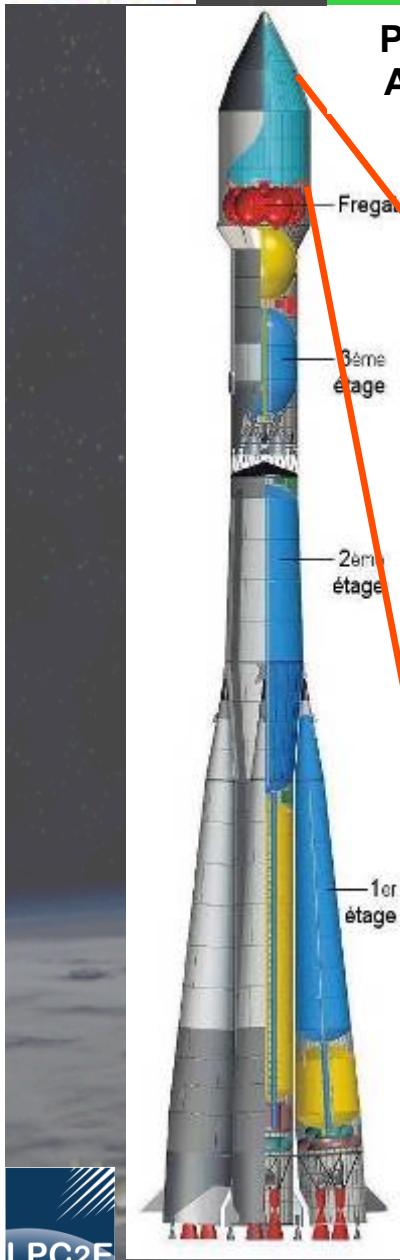
Phase
A & B

Phase C
(EM)

Phase D
(FM)

AIT

KOUROU
2017



SOYUZ
~4,8 tons SSO



TARANIS: Data policy

		Data access					
		Mission PI	Instrument PI	Instrument Lead Co-I	Instrument Co-I	Guest Investigator	Public
Data & Products	Raw Survey data	Yes	instrument	instrument PI agreement required	No	No	No
	Raw Event data	Yes	instrument	instrument PI agreement required	No	No	No
	Calibrated Survey data	Yes	Yes	Yes	instrument	CST agreement required	No
	Calibrated Event data	Yes	Yes	Yes	instrument	CST agreement required	No
	Quickview Survey	Yes	Yes	Yes	Quicklook + instrument	CST agreement required	Quicklook only
	Quickview Event	Yes	Yes	Yes	Quicklook + instrument	CST agreement required	No
	Plot Survey data	Yes	Yes	Yes	instrument	CST agreement required	No
	Plot Event data	Yes	Yes	Yes	instrument	CST agreement required	No
	Auxiliary data	Yes	Yes	Yes	Yes	Yes	No

TARANIS data will be available via the TARANIS data server
T+24H : TARANIS data server (access via login)
T+18 months : CDPP data server (no login needed)



TARANIS Data Server

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**