The SVOM mission

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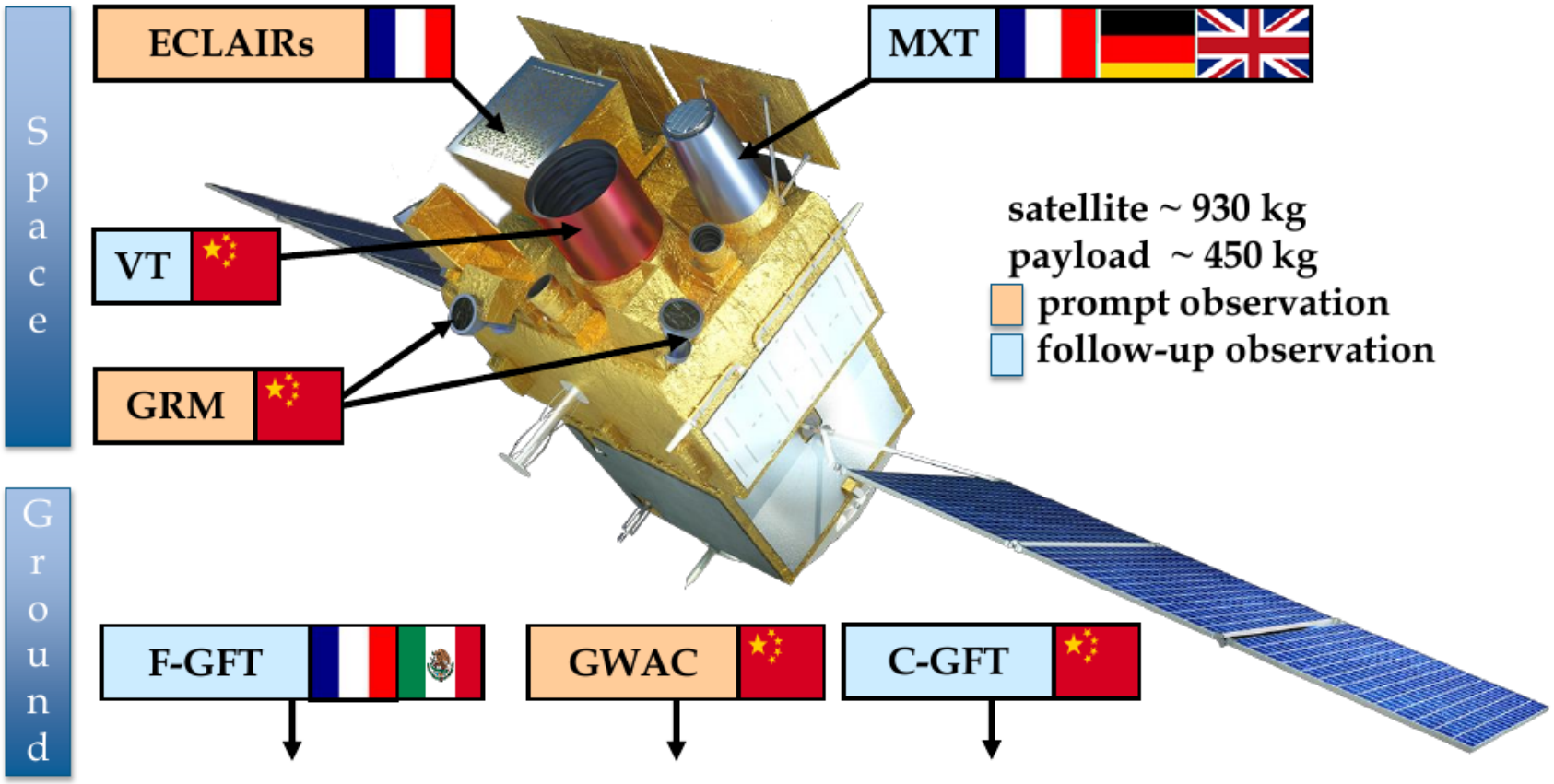
on behalf of the SVOM consortium

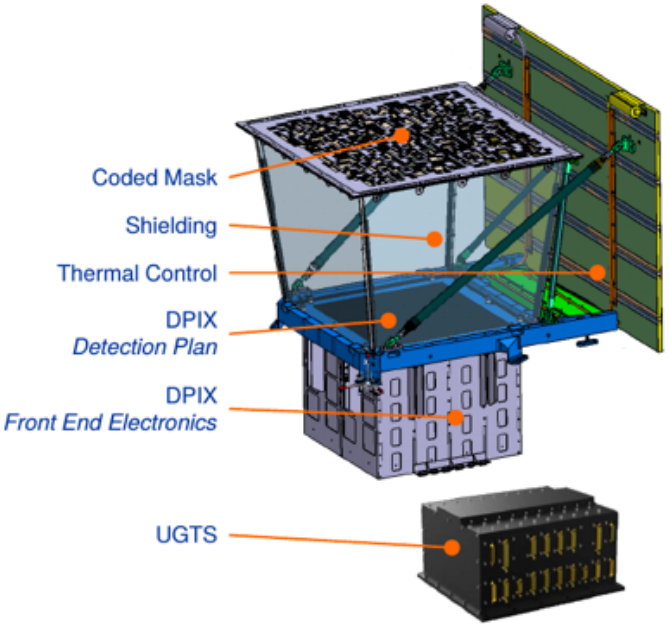
The SVOM mission

Bilateral collaboration between France (CNES) and China (CAS, CNSA)
(with the contribution of the University of Leicester and the Max Planck Institut für Extraterrestische Physik)

« Space-based multi-band astronomical Variable Objects Monitor »
Launch in Dec. 2021, for 3+2 years

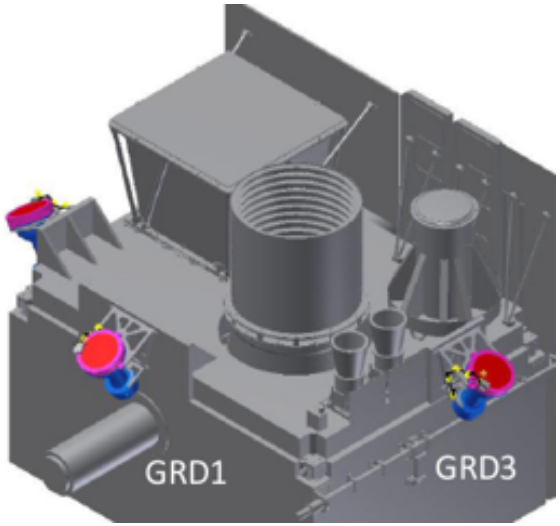


SVOM instruments I



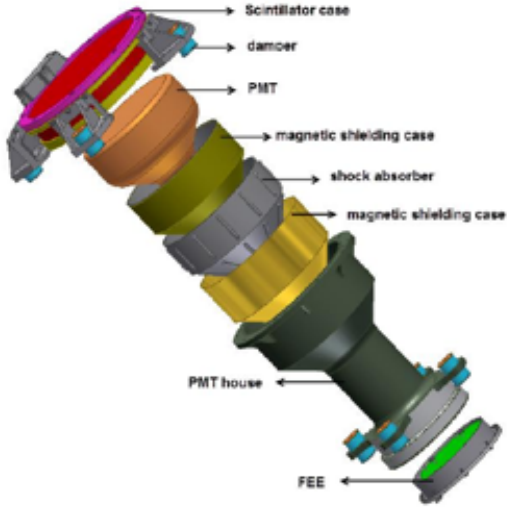
ECLAIRs (CNES, IRAP, CEA, APC)

- 40% open fraction
- Detection plane: 1024 cm²
- 6400 CdTe pixels (4x4x1 mm3)
- FoV : 2 sr (zero sensitivity)
- Energy range: 4-150 keV
- Localisation accuracy <12' for 90% of the sources at detection limit
- Onboard trigger and localization: about 60 GRBs/year

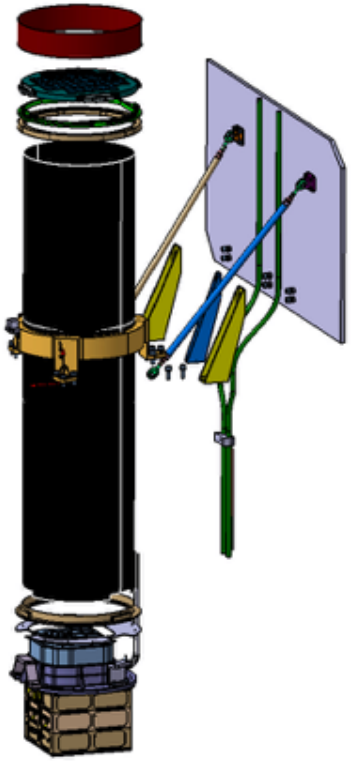


Gamma-Ray Monitor (IHEP)

- 3 Gamma-Ray Detectors (GRDs)
- NaI(Tl) (16 cm Ø, 1.5 cm thick)
- Plastic scintillator (6 mm) to monitor particle flux and reject particle events
- FoV = 2 sr per GRD
- Energy range: 15-5000 keV
- Aeff = 190 cm² at peak
- Rough localization accuracy
- Expected rate: ~90 GRBs / year

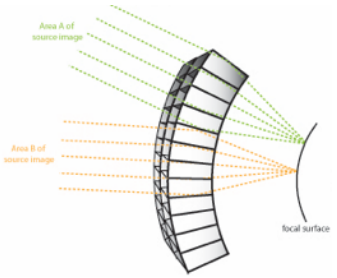


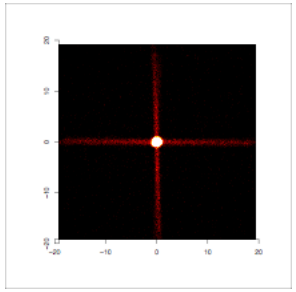
SVOM instruments II



Microchannel X-ray Telescope (CNES, CEA, UL, MPE)

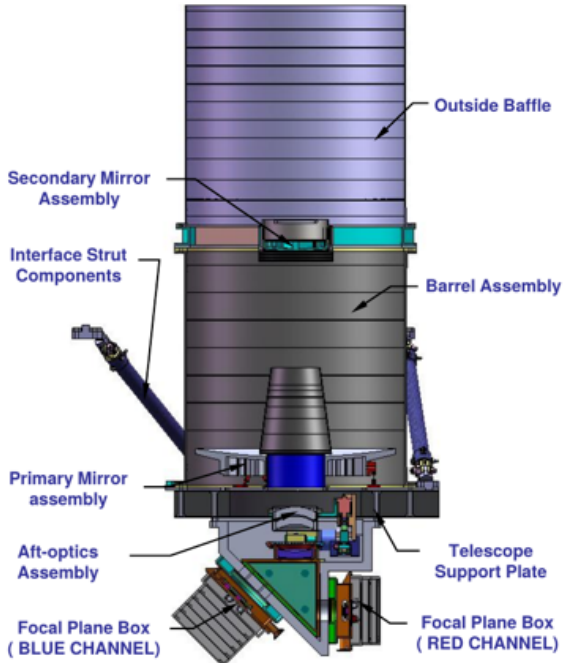
- Micro-pores optics (Photonis) with square 40 micron size pores in a “Lobster Eye” configuration (UL design)
- pnCCD (MPE) based camera (CEA)
- FoV = 64x64 arcmin²
- Focal length: 1 m
- Energy range: 0.2-10 keV
- Aeff = 27 cm² @ 1 keV (central spot)
- Energy resolution: ~80 eV @ 1.5 keV
- Localization accuracy <13” within 5 min from trigger for 50% of GRBs (statistical error only)





Visible Telescope (XIOMP, NAOC)

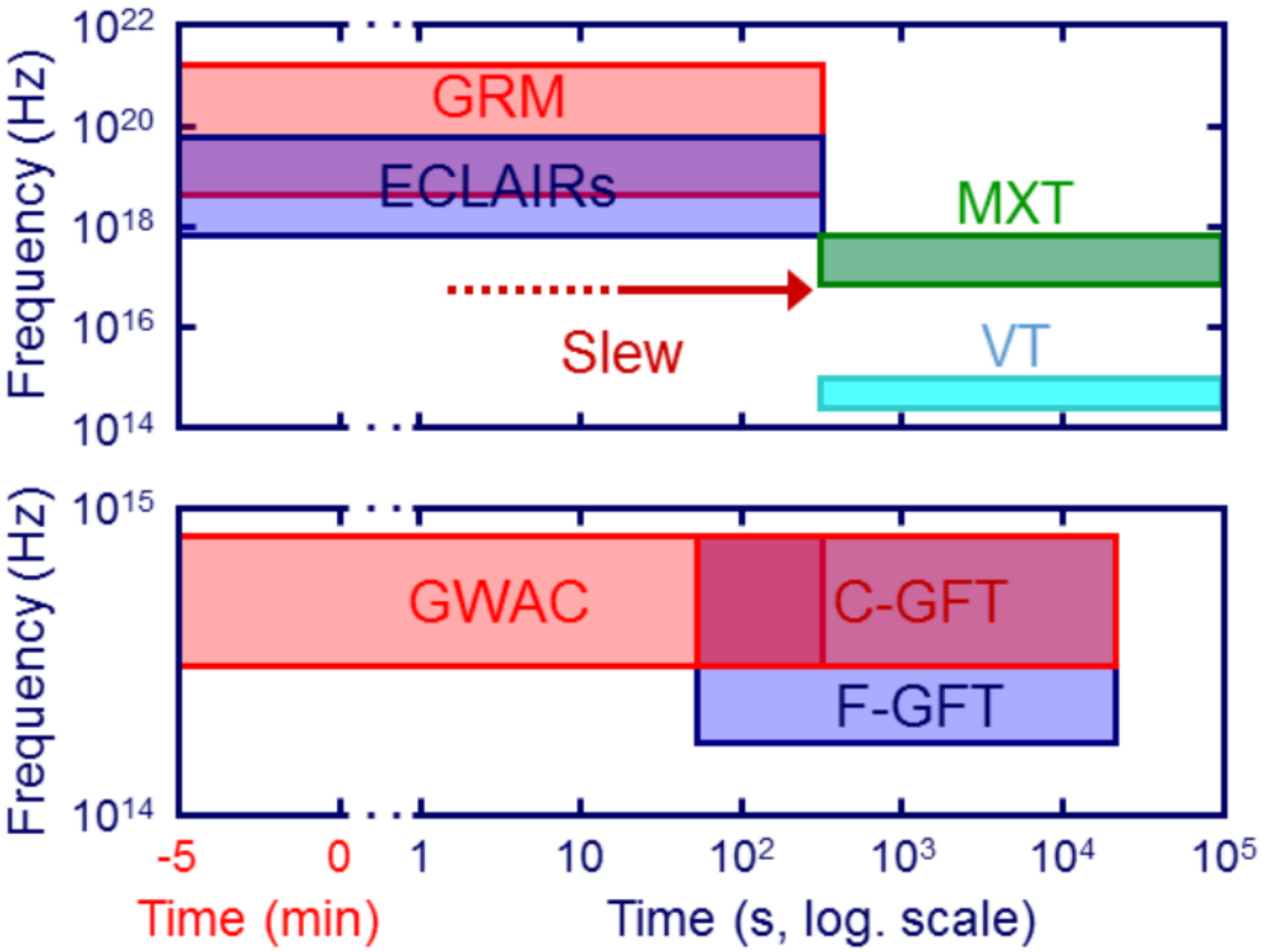
- Ritchey-Chretien telescope
- 40 cm Ø, f=9
- FoV = 26x26 arcmin²
- Covering ECLAIRs error box in most cases
- 2 channels: blue (400-650 nm) and red (650-1000 nm)
- 2k * 2k CCD detector each
- Sensitivity MV=22.5 in 300 s
- Will detect ~80% of ECLAIRs GRBs
- Localization accuracy <1”



Ground instruments

- **Ground-based Wide Angle Camera (GWAC)**
  - Ali (China) and CTIO (Chile) observatories, operational in 2017
  - 36 camera units, 5400 deg^2
  - 500-850 nm; MV=15 in 10 s
- **Chinese Ground Follow-up Telescope (C-GFT)**
  - Robotic 1-m class telescope, Xinglong observatory
  - FoV = 21x21 arcmin^2, 400-950 nm
- **French Ground Follow-up Telescope (F-GFT)**
  - Robotic 1-m class telescope, San Pedro Martir (Mexico)
  - FoV = 26x26 arcmin^2
  - Multi-band photometry (400-1700 nm, 3 simultaneous bands)
- **Contribution to the LCOGT network (12x1m+2x2m tel.)**
- >75% of ECLAIRs-detected GRBs immediately visible by one ground telescope (GFTs+LCOGT)

Spectro-temporal coverage

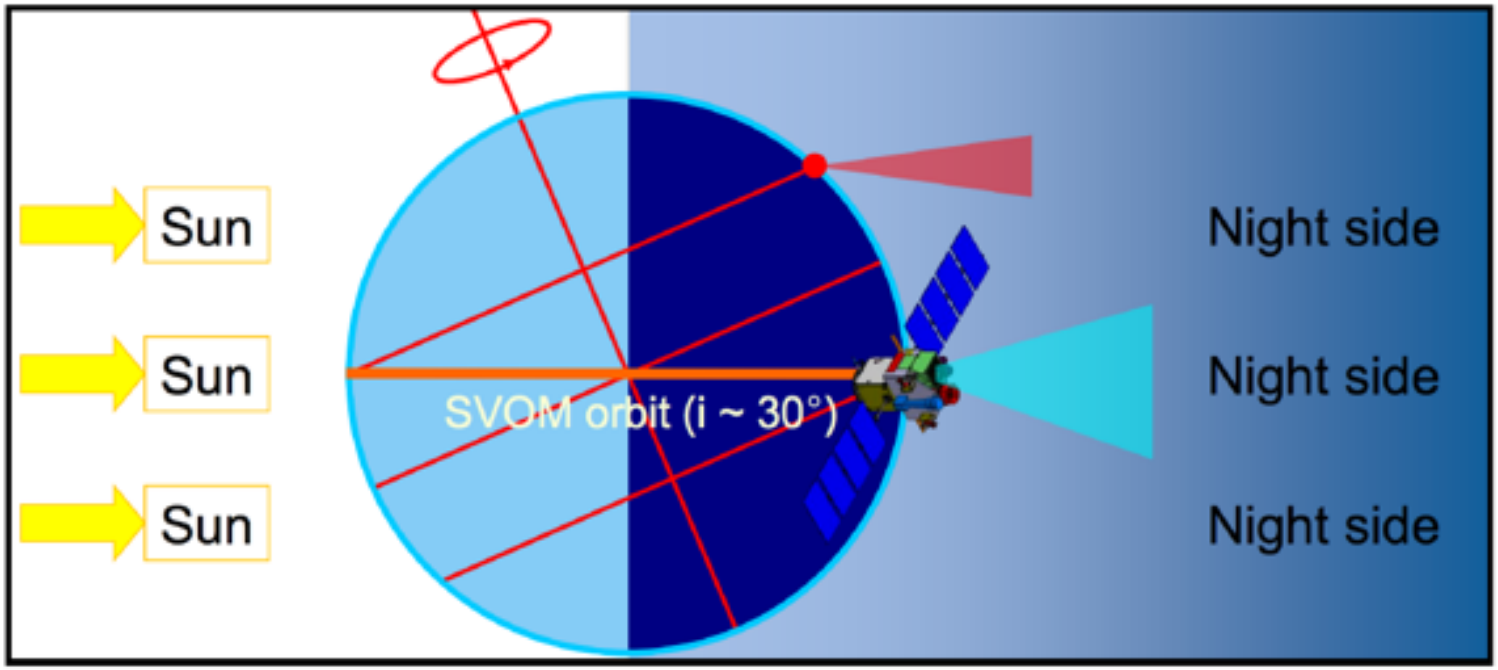


Space

Ground

SVOM Orbit and pointing strategy

- Launched from Xichang (Sichuan) by an LM-2C rocket
- Circular low Earth orbit at 625 km of altitude with an inclination of about 30°
- Nearly anti-solar pointing (so-called « B1 » attitude law) -> Earth in the field of view (65% of duty cycle for ECLAIRs, about 50% forMXT and VT)
- Avoidance of the Galactic plane (most of the time) and Sco X-1
- Slew capability: 45° in 5 minutes (including stabilization)
- GRB follow-up during 14 orbits (about 1 day)

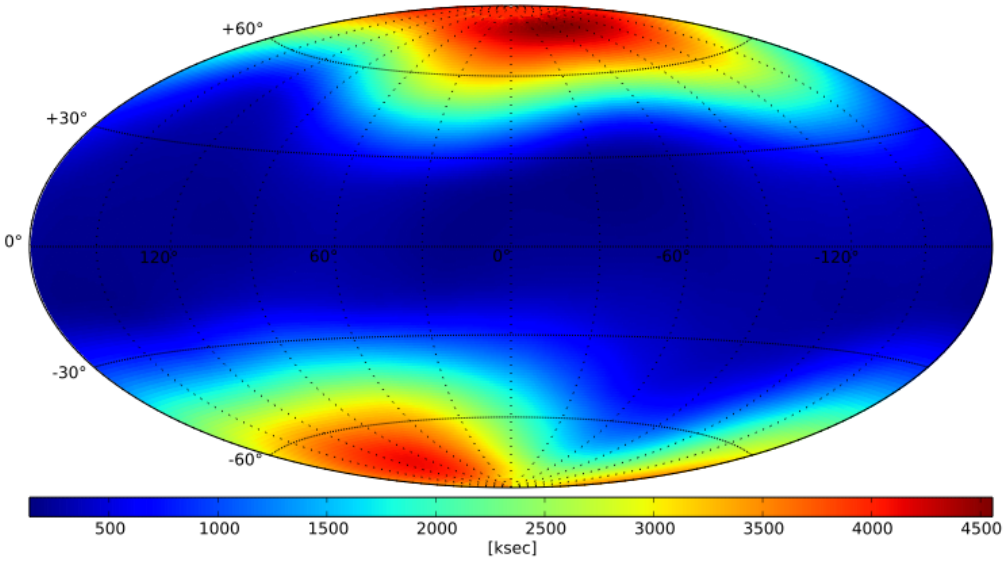


One year of observation

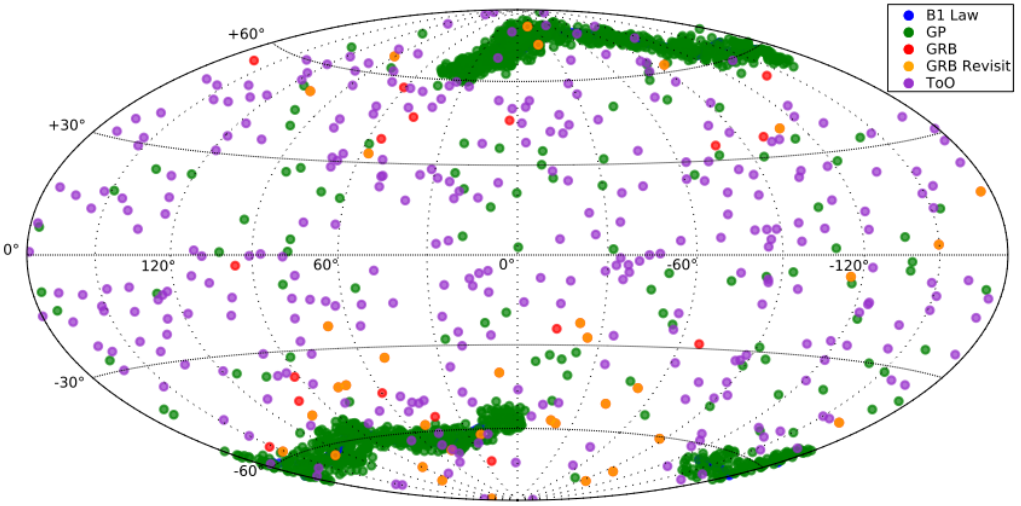
ECLAIRs exposure map (65 GRBs/year, 1 ToO per day) :

- 4 Ms in the direction of the galactic poles

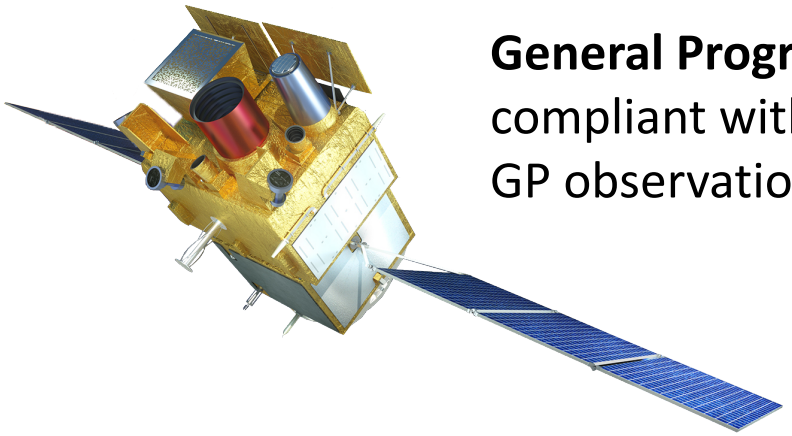
- 500 ks on the galactic plane



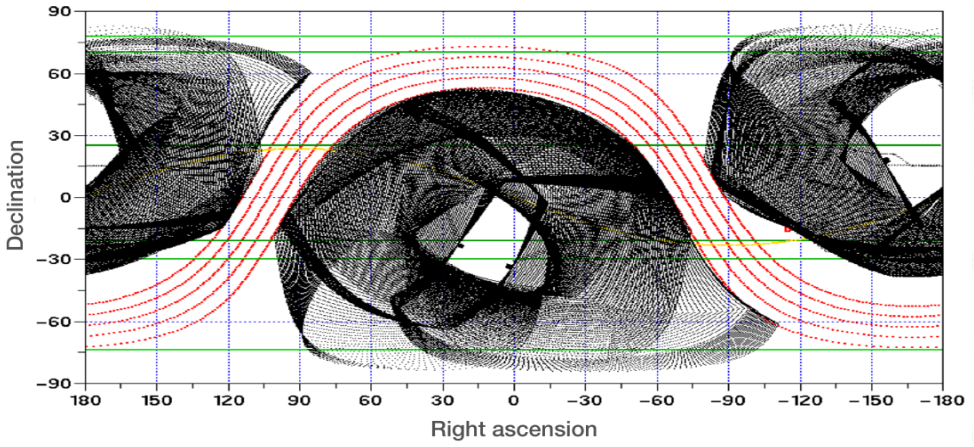
Corresponding MXT and VT pointing directions



SVOM observation programs (1/4)



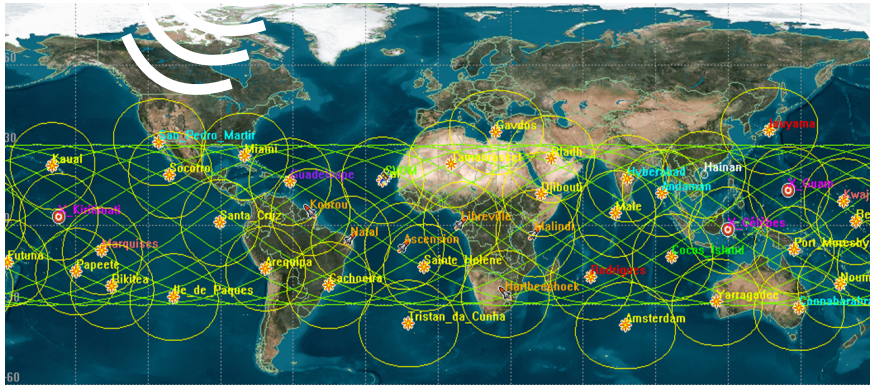
General Program (GP): astrophysical targets of interest mostly compliant with the satellite attitude law.
GP observation plan is uploaded to the satellite every 2 weeks.



How to apply ?
Call for observation proposals once per year. Selection by a TAC.

Example : survey of the Virgo cluster (TDEs, AGNs)

SVOM observation programs (2/4)



Core program (CP):

Autonomous transient detection by ECLAIRs :

- known source (repointing only if above a given threshold)
- unknown source : GRB (Core Program : CP) or other astrophysical transient (GP)

All transients will be notified in short time scales (<30s for 65% of alerts) to the FSC and then to the community.

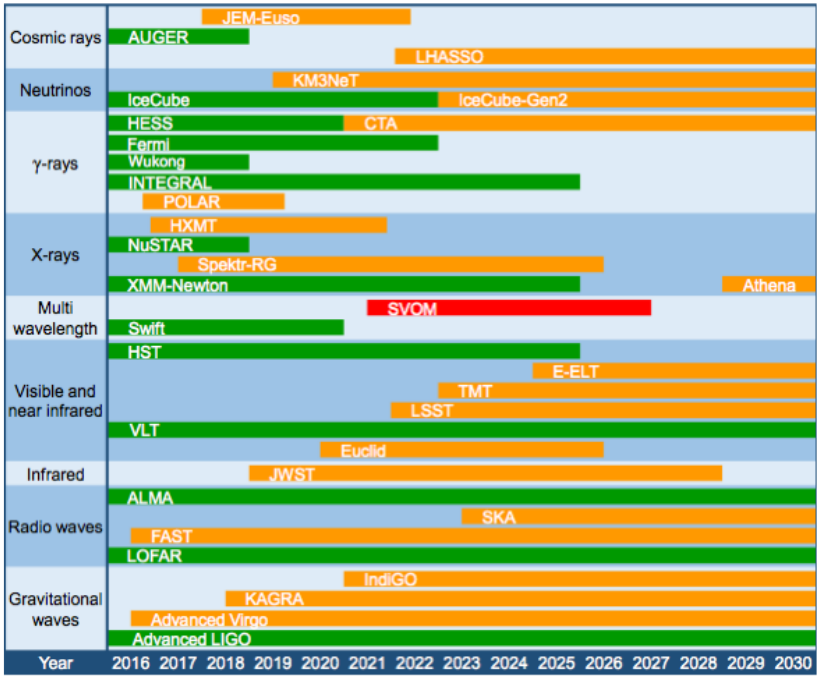
SVOM has been designed for autonomous detection, fast repointing, short timescales alert and follow-up

SVOM observation programs (3/4)

Transient/event detected by other facilities

Target of Opportunity program (ToO):

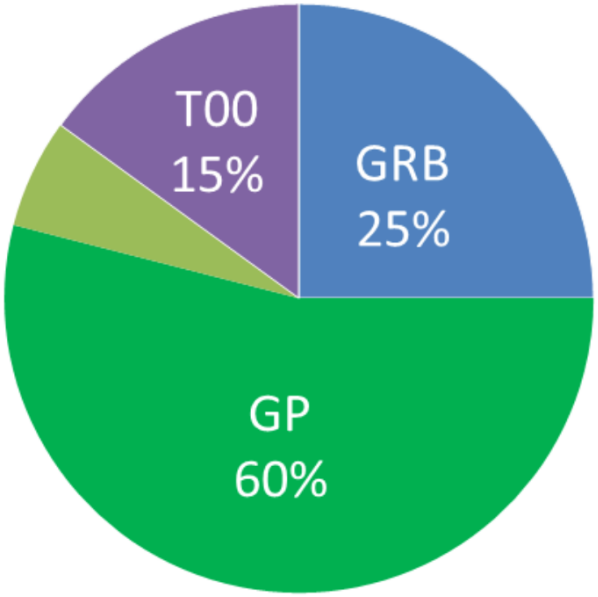
=> send commands to the satellite to trigger observations from the ground



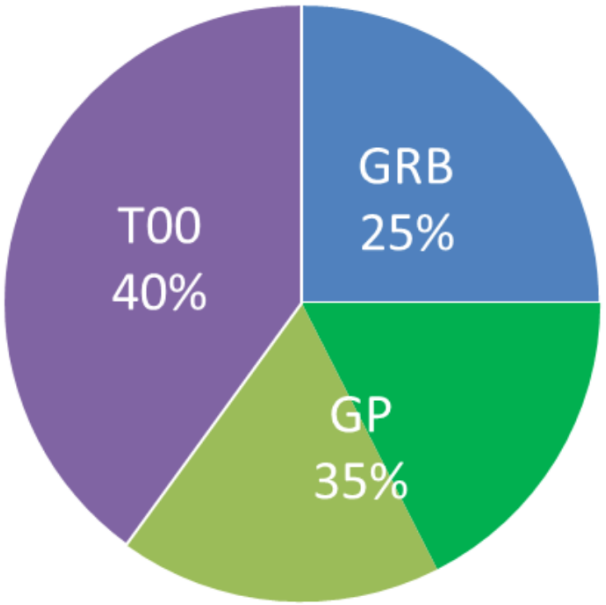
Complex operations at system level

SVOM observation programs (4/4)

Nominal mission
1 ToO per day, 10% of GP outside B1 law



Extended mission
5 ToOs per day, 50% of GP outside B1 law



From 1 ToO/day and as much as 5 ToO/day in the extended mission.

GP reduced but more tolerance to escape the B1 law.

ToO program:ToO-NOM and ToO-EX

ToO-NOM is the nominal ToO which covers the basic needs for efficient transient follow-up.

Scientific target :

- GRB revisit (CP; user : BA)
- Pre-planned observations through a GP proposal waiting for a known source to flare (AGN,…)
- New transient

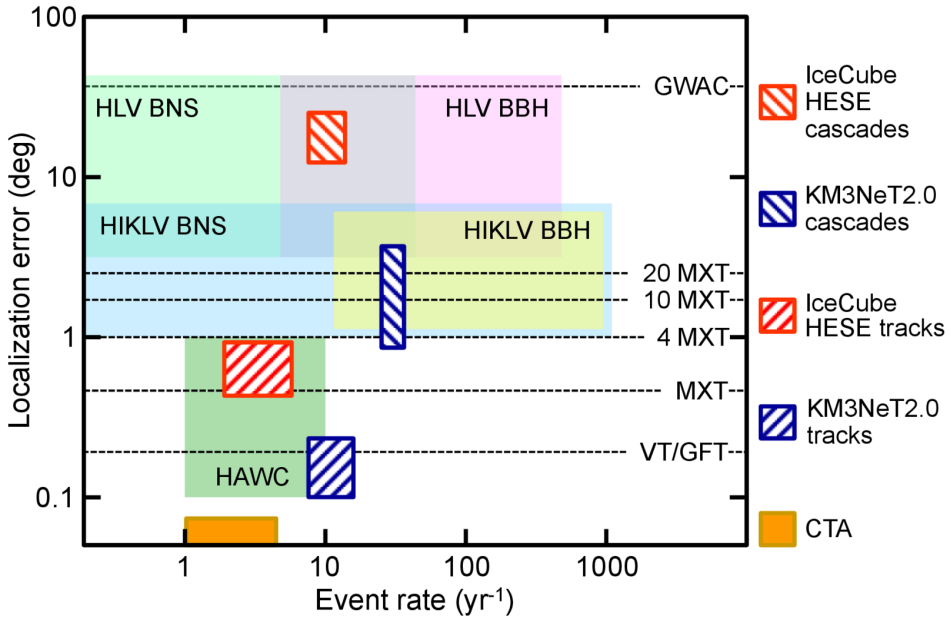
Main characteristics :
Frequency : 1/day
Standard delay : < 48h
Duration : 1 orbit (or more)

ToO-EX is the exceptional ToO which covers the needs for a fast ToO-NOM in case of an exceptional astrophysical event we want to observe rapidly.

Main characteristics :
Frequency : 1/month
Standard delay : < 12h
Duration : 7-14 orbits

ToO program: ToO-MM

ToO-MM is the ToO dedicated to EM counterpart search in response to a multi-messenger alert. What differs from the ToO-NOM and ToO-EX is the unknown position of the source within a large error box…



Main characteristics :
Frequency : 1/month
Standard delay : < 12h
Duration : 7-14 orbits
Max : 3 tiles/orbit

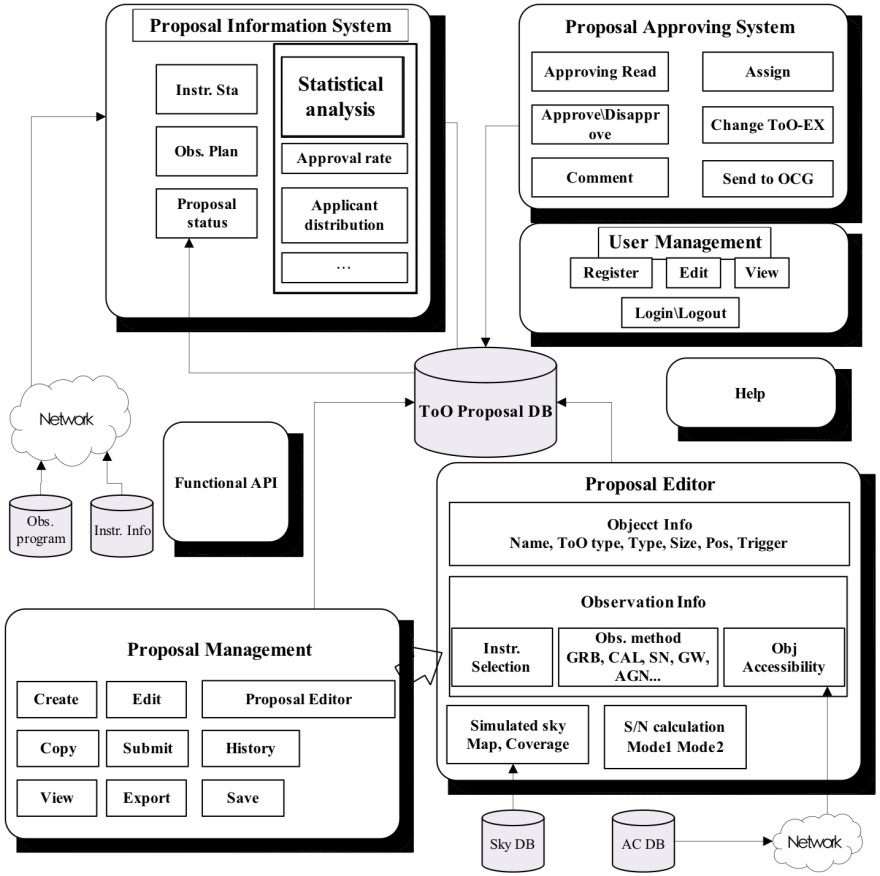
MXT photons sent through the VHF network for an immediate analysis on the ground

User application to request a ToO

ToO proposal support :

- Proposal preparation
  - Feasibility
  - Observation strategy
  - Instrument health
- Approval
- Progress monitoring
- Data acquiring

External interfaces :
External accessibility server
Satellite and instrument status server
Observation status database
User interface
APIs for ToO-MM



SVOM & LIV

- **Core program**:
  - SVOM observes 1/6th of the sky with ECLAIRs (4-150 keV) and half sky with GRM (15-5000 keV), allowing the detection and the localization (with ECLAIRs) of new or highly active high-energy transient sources.

  →SVOM alerts are distributed in near real-time

- **General program**:
  - The GP permits monitoring known sources of interest (e.g. blazars)

- **ToO observations**:
  - SVOM offers the possibility to observe flaring or transient sources in NIR, Vis, RX and γ simultaneously, within 1 day.

Conclusion

- From 2022 to 2027+ the combination of SVOM and ground-based observatories will provide first class data about the phenomenology of explosive cosmic phenomena, leading to a better understanding of the physical processes at work in these sources. Eventually, this will allow to probe the various manifestations of LIV in much greater detail.

Summary

SVOM: Multi-wavelength mission devoted to the transient sky

- Main characteristics: space and ground instruments linked together
- In operation from 2022 to 2027+
- French labs involved: CEA-Irfu,IRAP,LAM, OAS, GEPI, IAP, APC, LUPM, CPPM, LAL

Mission in time domain astronomy

- Target transients sources: GRB, SGR, X-ray binaries, AGN, TDE, supernovae, TGF
- Expected scientific return:
  - prompt emission in gamma-rays, hard X-rays and visible of transient events
  - afterglow emission in X-rays, visible, IR
- Expected advances in X-ray flashes, ultra-long GRBs…

	Instrument	Band sensitivity	Description of the instruments
Space	ECLAIRs	Hard X-ray	Coded mask telescope (1024 cm2 CdTe) , FOV 2 Sr
	GRM	Gamma-ray	NaI Scintillating crystal + PM detectors, FOV >2 Sr
	VT	Visible	40cm telescope, FOV 26 arcmin2, lim mag 22,5 /300s exp
	MXT	X-ray	Lobster Eye optic, FOV 1 deg2
Ground	GWACs	Visible	36 camera units, covering 5200 deg2, lim mag:16 /10s exp
	GFTs + LCOGT	Visible + IR	

Additional information

- The SVOM web site: http://www.svom.fr/

- The SVOM Science Case :

http://cdsads.u-strasbg.fr/abs/2016arXiv161006892W

- You're invited to the next SVOM science meeting in Paris, on January 26th,2018

https://indico.in2p3.fr/event/16725/