SVOM, the sino-french satellite for GRB studies

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Main SVOM milestones

2005 Sino-French discussions (CNES-CNSA) on a mini satellite mission
CNES-CNSA decision to study the SVOM mission

2006 SVOM Phase 0 kick-off meeting
SVOM phase 0 review – No critical issue
CNSA/CNES MoU signed during an official visit of the French President in China

2007 SVOM Phase A kick-off meeting

2008 SVOM Preliminary Review Requirement meeting successful

2010 SVOM Pre-Phase B meeting successful

2013 CNES-CNSA discussion for a project reorganization

2014 ***CNES-CNSA MoU updated and officially signed***
SVOM Phase B kick-off meeting

2021 Launch date

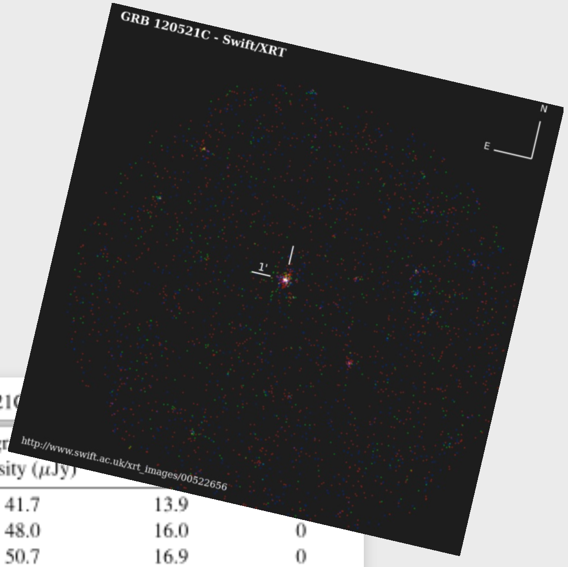
Questions for the SVOM mission

GRB phenomenon	- Diversity and unity of GRBs
GRB physics	- Acceleration and nature of the relativistic jet - Radiation processes - The early afterglow and the reverse shock
GRB progenitors	- The GRB-supernova connection - Short GRB progenitors
Cosmology	- Cosmological lighthouses (absorption systems) - Host galaxies - Tracing star formation - Reionization of the universe - Cosmological parameters
Fundamental physics	- Origin of high-energy cosmic rays - Probing Lorentz invariance - Short GRBs and gravitational waves

An exemple, GRB 120521C

Optical and Near-infrared Observations of GRB 120521C

Δt (days)	Telescope	Instrument	Band	Frequency (Hz)	Flux density[a] (mJy)	Uncertainty[a] (mJy)	Detection? (1 = Yes)
0.0316	WHT	ACAM	*R*	4.81e+14	0.000585	0.000195	0
0.0372	WHT	ACAM	*I*	3.93e+14	0.00109	0.000362	0
0.0379	NOT		*R*	4.81e+14	0.000702	0.000234	0
0.0405	WHT	ACAM	*z*	3.46e+14	0.00146	0.000408	1
0.0433	NOT		*I*	3.93e+14	0.00135	8.00e-05	0
0.106	WHT	ACAM	*z*	3.46e+14	0.00444	0.000555	1
0.108	WHT	ACAM	*z*	3.46e+14	0.00369	0.000669	1
0.109	WHT	ACAM	*z*	3.46e+14	0.00476	0.000615	1
0.111	WHT	ACAM	*z*	3.46e+14	0.0036	0.000625	1
0.112	WHT	ACAM	*z*	3.46e+14	0.00402	0.000651	1
0.115	WHT	ACAM	*z*	3.46e+14	0.00313	0.000717	1
0.117	WHT	ACAM	*z*	3.46e+14	0.00398	0.000653	1
0.119	WHT	ACAM	*z*	3.46e+14	0.00253	0.000748	1
0.12	WHT	ACAM	*z*	3.46e+14	0.00408	0.000635	1
0.122	WHT	ACAM	*z*	3.46e+14	0.0031	0.000725	1
0.124	WHT	ACAM	*z*	3.46e+14	0.00301	0.000649	1
0.126	WHT	ACAM	*z*	3.46e+14	0.00300	0.00068	1
0.208	PAIRITEL		*K*	1.37e+14	0.255	0.0848	0
0.208	PAIRITEL		*H*	1.84e+14	0.0932	0.031	0
0.208	PAIRITEL		*J*	2.38e+14	0.0633	0.0211	0
0.282	UKIRT	WFCAM	*K*	1.37e+14	0.0125	0.00134	1
0.318	UKIRT	WFCAM	*J*	2.38e+14	0.0112	0.00108	1
0.321	Gemini-North	GMOS	*z*	3.46e+14	0.00632	0.000316	1
0.324	Gemini-North	GMOS	*z*	3.46e+14	0.00664	0.000332	1
0.326	Gemini-North	GMOS	*z*	3.46e+14	0.00659	0.000329	1
0.329	Gemini-North	GMOS	*z*	3.46e+14	0.00601	0.000301	1
0.332	Gemini-North	GMOS	*z*	3.46e+14	0.00686	0.000343	1
0.334	Gemini-North	GMOS	*z*	3.46e+14	0.00627	0.000313	1
0.336	Gemini-North	GMOS	*z*	3.46e+14	0.00623	0.000311	1
0.339	Gemini-North	GMOS	*z*	3.46e+14	0.00553	0.000277	1
0.341	Gemini-North	GMOS	*z*	3.46e+14	0.00647	0.000323	1
0.344	Gemini-North	GMOS	*z*	3.46e+14	0.00604	0.000302	1
0.347	Gemini-North	GMOS	*z*	3.46e+14	0.00593	0.000296	1
0.349	Gemini-North	GMOS	*z*	3.46e+14	0.00594	0.000297	1
0.352	Gemini-North	GMOS	*z*	3.46e+14	0.00619	0.00031	1
0.354	Gemini-North	GMOS	*z*	3.46e+14	0.00569	0.000284	1
0.356	UKIRT	WFCAM	*H*	1.84e+14	0.0126	0.00135	1
0.514	Keck	LRIS	*g*	6.29e+14	0.000114	3.8e-05	0
0.516	Keck	LRIS	*I*	3.93e+14	0.000453	0.000151	0
0.579	Gemini-North	GMOS	*I*	3.93e+14	0.000495	0.000165	0
0.586	Gemini-North	GMOS	*z*	3.46e+14	0.00433	0.000374	1
1.05	WHT	ACAM	*z*	3.46e+14	0.00191	0.000108	1



VLA Observations of GRB 120521C

Δt (days)	VLA Configuration	Frequency (GHz)	Integration Time (min)	Integr density (μJy)		
0.15	CnB	4.9	15.28	41.7	13.9	
		6.7	15.28	48.0	16.0	0
		21.8	15.07	50.7	16.9	0
1.15	CnB	4.9	10.12	51.0	17.0	0
		6.7	10.12	57.3	19.1	0
		21.8	15.07	112	18.5	1
4.25	B	4.9	15.27	41.1	13.7	0
		6.7	15.27	54.5	14.3	1
		21.8	14.52	66.5	18.6	1
7.25	B	4.9	15.12	39.9	13.3	0
		6.7	15.12	48.8	14.2	1
		21.8	12.97	65.8	18.3	1
12.27	B	21.8	32.95	30.6	10.2	0
14.27	B	21.8	32.68	38.4	12.8	0
13.27[a]	B	21.8	...	26.2	9.2	1
29.25	B	4.9	24.87	35.7	11.9	0
		6.7	24.87	29.1	9.7	1
174.66	A	4.9	46.43	28.5	9.5	0
	A	6.7	46.43	23.4	7.8	0

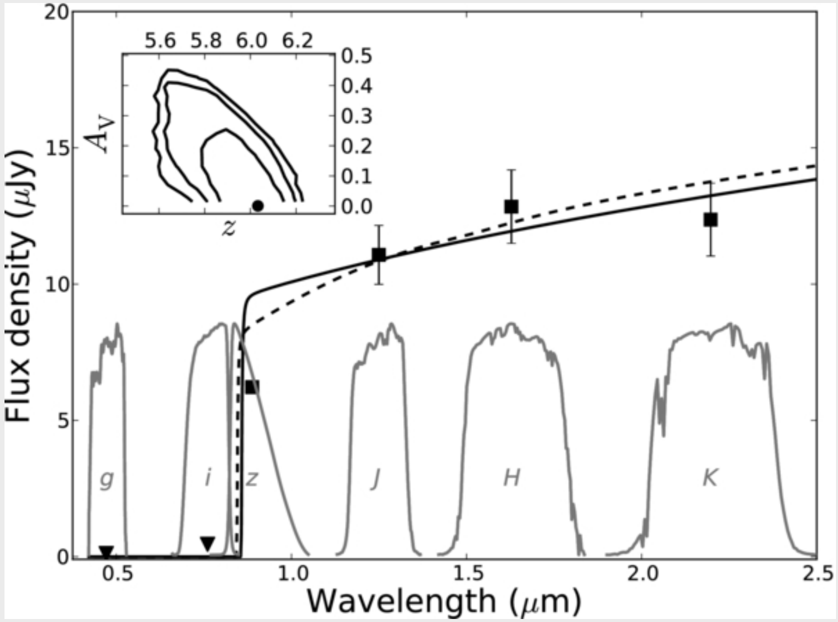
A typical multi-wavelength observation:

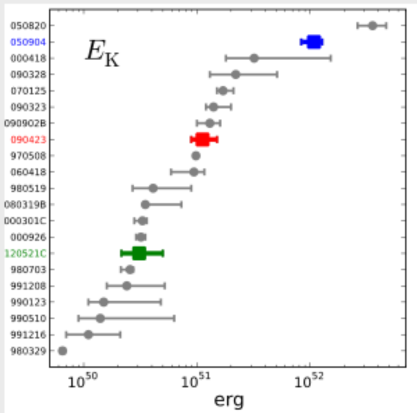
- *Optical and near-IR domains.*
- *But also in radio, X, etc.*

GRB 120521C

Thanks to these observations, possible to estimate key GRB properties:

- Distance.
- Energy.
- Matter density around the GRB.
- Jet opening angle.
- Etc.





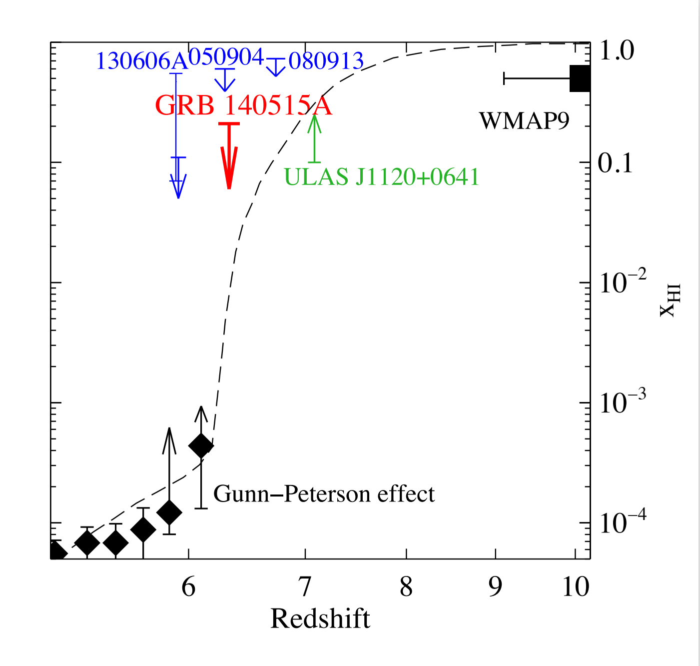
Fundamental to accede to these parameters in the SVOM era.

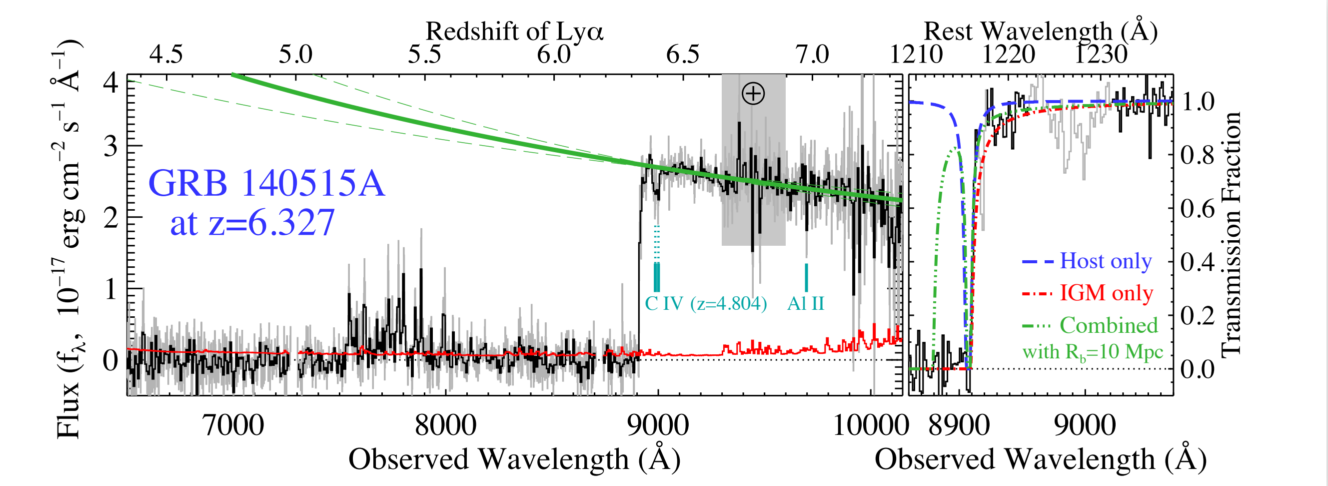
GRB 140515A

Also important to probe the deep Universe:

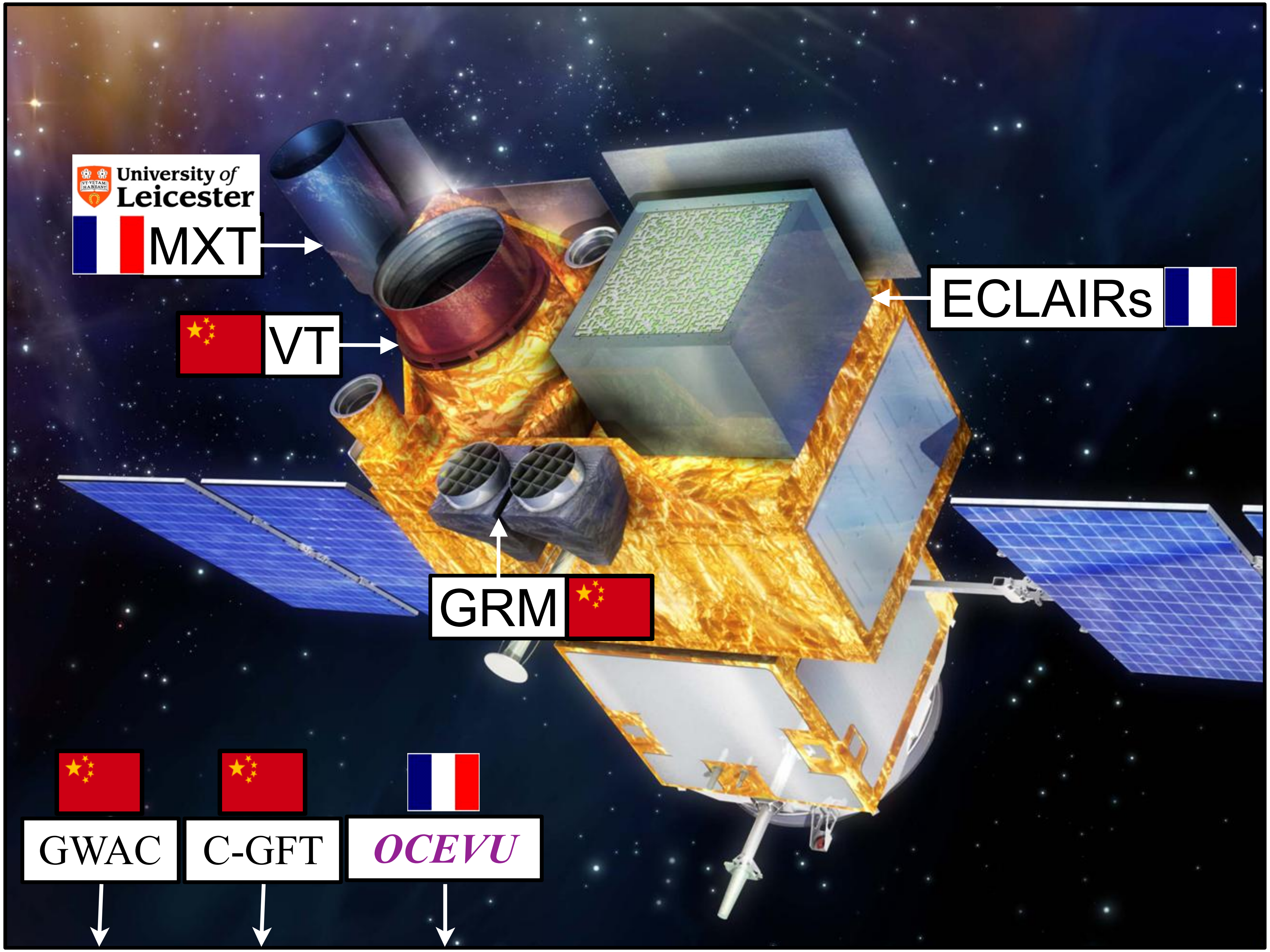
- First galaxies quest.
- Re-ionization era.
- Etc.

Once more time, follow-up is a key element for cosmological applications.





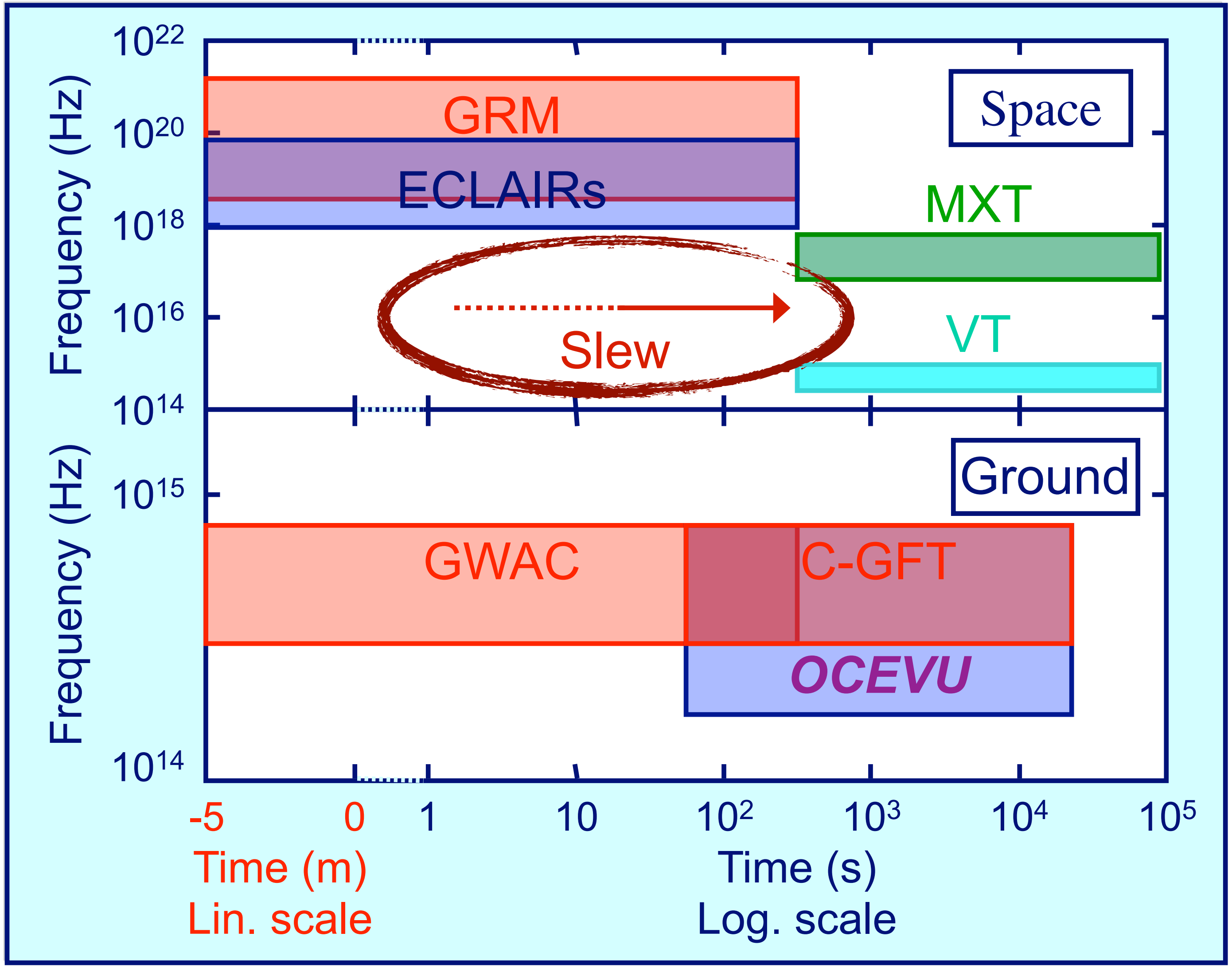
SVOM instruments



Space instruments performances

	Spectral band	Field of View	Localization Accuracy	GRBs/yr
GRM	50keV-5MeV	2 sr		~80
ECLAIRs	4-250 keV	2 sr	28 arcmin	~80
MXT	0.3-7 keV	1.1°	20 arcsec	~76
VT	400-650 nm 650-950 nm	26 × 26 arcmin^2	0.5 arcsec	~64

Multi-wavelength capabilities



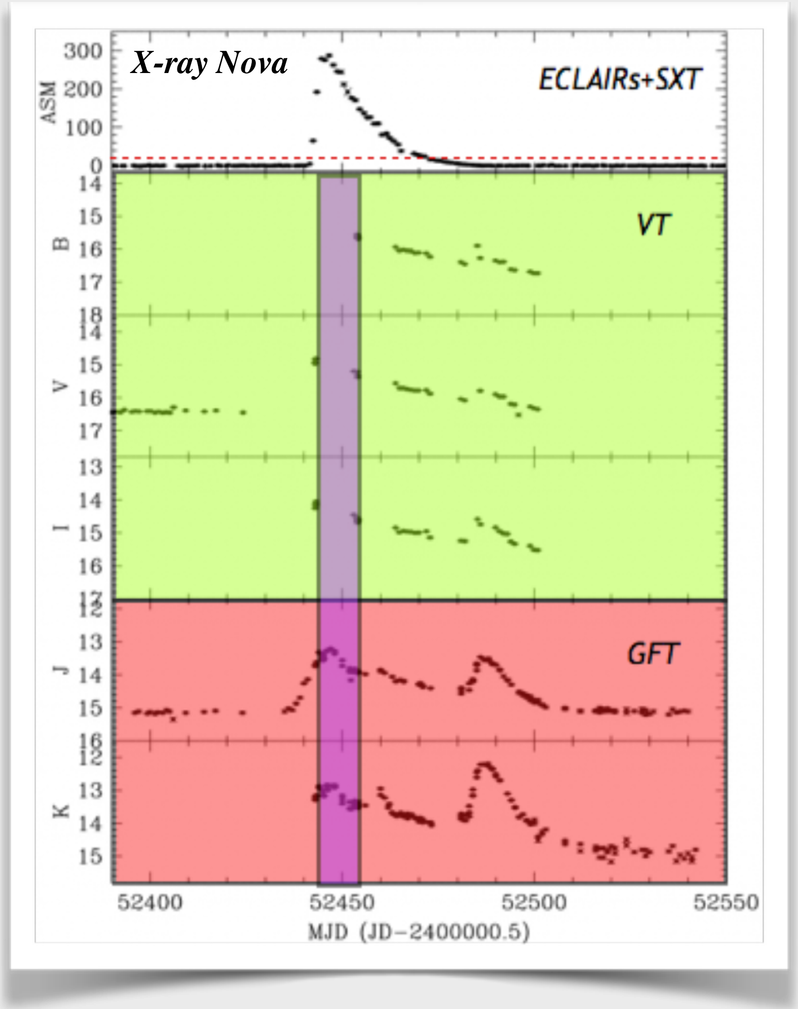
Space and ground instruments join to enable a complete coverage

SVOM Open Time

SVOM offers hard X-ray to visible and near-infrared coverage for multi-wavelength follow-up:

Routine observations and ToO open to the community!

- Monitor intensity of a wide range of accreting sources, including the brightest AGNs (e.g. NGC4151, 3C273, …)
- Study the diffuse X-ray/hard X-ray background from repeated Earth occultation
- Study of X-ray binaries
- Detection and follow-up of Supernovae and Novae
- Tidal Disruption Flares
- …



SVOM compared to SWIFT

Prompt emission measurement

- More sensitive below 20 keV (x3 at 10 keV)
- Lower threshold (3.5 keV Vs 15 keV)
- E_{peak} measurement capability
- Multi-wavelength capabilities: from visible band to MeV gamma rays

Afterglow emission measurement

- >10 more sensitive in the visible
- Sensitive in the 650-950 nm band

Follow-up observations

- **GRBs much easily scrutinized by the largest telescopes**
- **Dedicated follow-up robotic telescopes**

GRB observation strategy

Space

GRB trigger provided by ECLAIRs at time T_0

T_0 + 5 min

VT (V & R band photometry)
MXT (Soft X-ray photometry)

T_0 +1 min

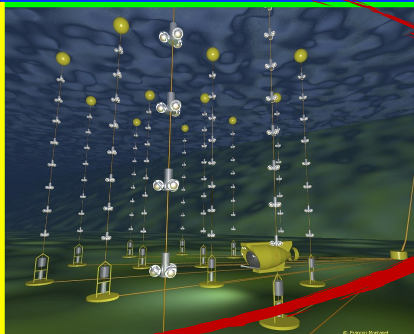
Ground

GWAC (V)

GFTs (B, V, R, I, J, H)

1-2 m robotic telescopes

Multi messenger follow-up



OCEVU follow-up facilities

OCEVU plays a key role:

- Since its inception, OCEVU planned to build a facility devoted to the SVOM and astroparticle follow-up.
- Phase 0 review organized end of November (chairman: J.L. Beuzit from IPAG); conclusions endorse by OCEVU Steering Committee:

➡ **OSTC endorses the SVOM Fast Follow-up Facility project and confirms that the budget initially allocated to this operation must only be used for that purpose.**

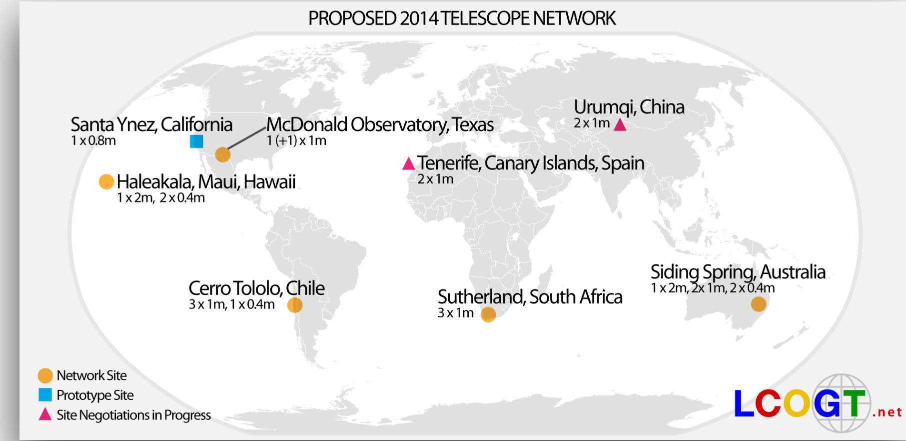
Concept based on:

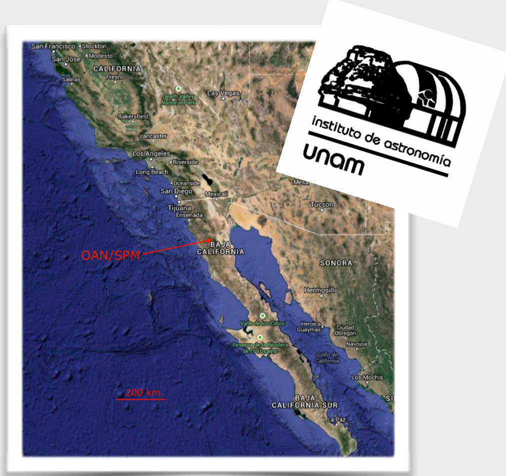
- Robotic 1-m class telescopes.
- Panchromatic observations: from visible to infrared (up-to H band)

Two solutions already identified:

- **Each one has its advantages and disadvantages.**
- **Phase A started in January 2015: end scheduled for June or September 2015.**

OCEVU follow-up facilities





A requirement endorsed by our tutorships

CNES prospective (March 2014):

- *Importance each time reminded by CNES committees: advisory astronomical committee, CERES and CPS.*

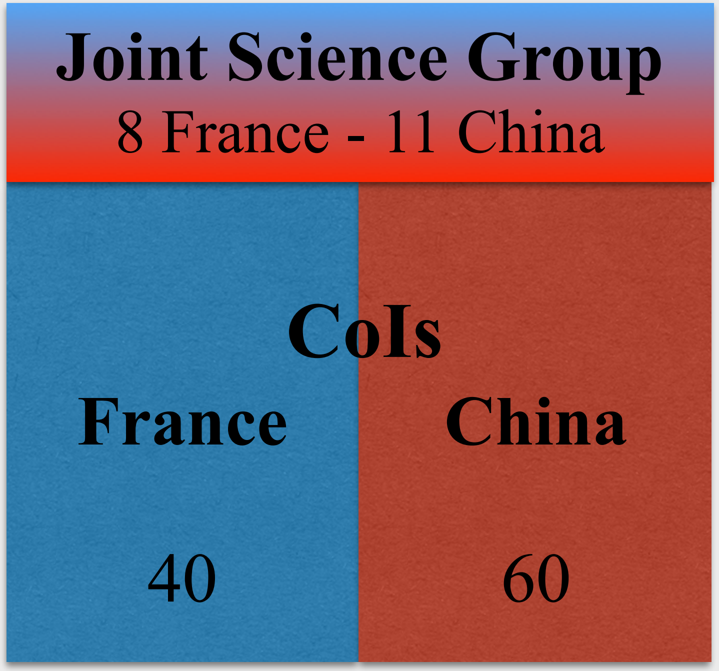
- *«Compte-tenu de l'importance du suivi photométrique depuis le sol pour l'exploitation scientifique de la mission Euclid, le groupe demande que les principaux partenaires, CNES, CNRS et CEA, parviennent à une solution garantissant le suivi sol de la mission, solution qui puisse s'appliquer aux futures missions SVOM et PLATO également très demandeuses. »*

INSU prospective (October 2014):

- *«Ce projet intègre des données sol et espace, toutes deux indispensables à la réussite de la mission. Pour garantir l'accès aux données sol, la communauté française doit accéder à au moins un télescope robotique à action rapide de la classe du mètre équipé d'une caméra panchromatique (du visible au proche infrarouge), via une participation à un réseau existant et/ou le développement d'un télescope dédié.»*

➡ ***Classified in P0.***

SVOM scientific organization



- 2 PIs
- 2 CoPIs

- 10 Instrument-PIs
- 2 Mission Scientists
- 1 General Program Manager

- 40 CoIs for France

SVOM
Data Release

DATA RELEASE	Core Program	General Program	ToO SVOM Co-Is	ToO Guest obs.
SVOM Co-Is Pre processed data	Immediately	After one year	immediately	immediately
Sci. Community Scientific products	A large fraction immediately All after 6 months	After one year	After six months	immediately

To conclude

A strong scientific case

- Understand the most energetic events in the Universe.
- Study the Dawn of the Universe.

An official context

- Project accepted and funded by CNES and CNSA.
- Phase-B started (launch date: 2021).

An important effort for OCEVU labs

- CPPM, IRAP, LAM (with OSU/OHP) and LUPM involve.
- OCEVU scientists play a key role in the SVOM projet since the beginning.