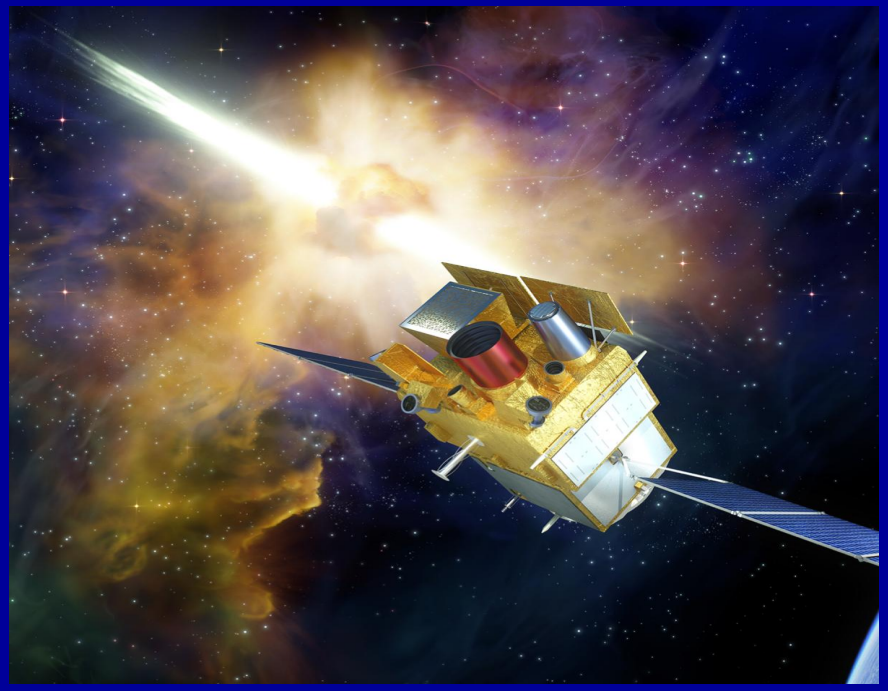
The Chinese-French SVOM mission

Dedicated to the Transient Sky



Liping XIN & Jianyan Wei (NAOC,CAS)

@SVOM Team

The 32nd Texas Symposium on Relativistic Astrophysics

Status of the SVOM mission

2001 SVOM proposed by Chinese side, Eclairs by French side

2006 Phase 0 kick-off meeting (March, Toulouse)
Phase 0 review (Sept., Shanghai)
CNSA/CNES MoU signed during the President visit (Oct., Beijing)

2007 Phase A kick-off meeting (March, Xi'an)
2008 Phase A review meeting (Oct., Beijing)

2010 SVOM funded by CNSA China
2014 SVOM funded by CNES France

2014 Phase B kick-off meeting (Sept., Shanghai)
2016 Phase B review meeting (July 4-8, Yantai)

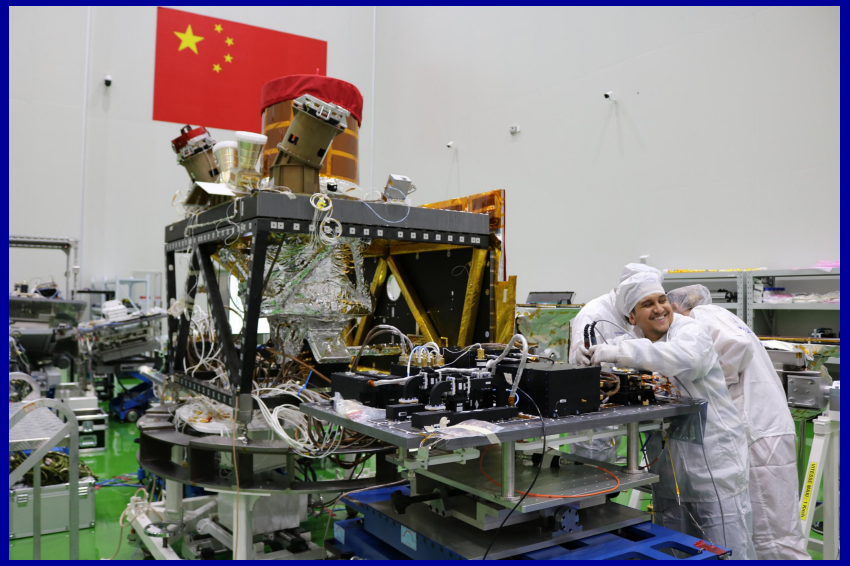
2017 Phase C kick-off meeting, and SIR review

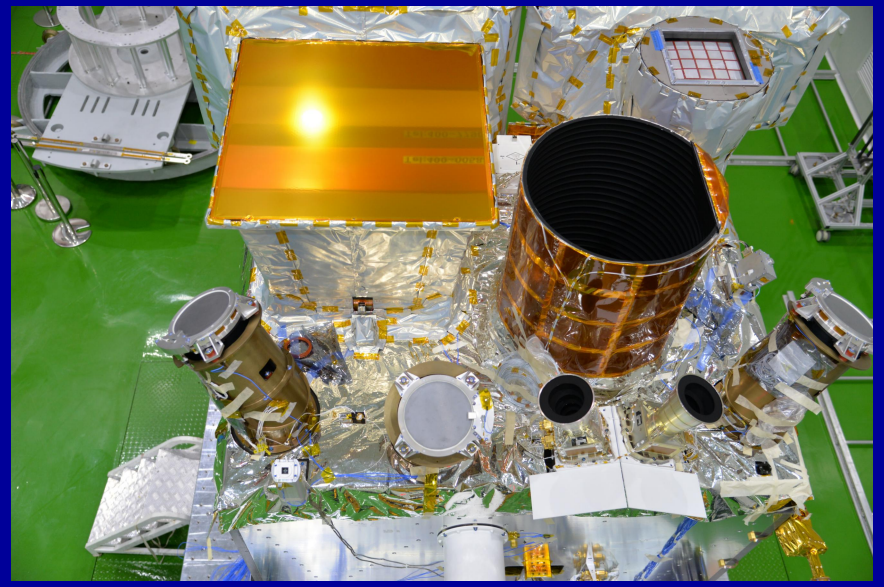
2020 Phase D kick-off meeting

2021-23 Payload FM, AIT, System tests

2024 SVOM launch at Xichang（西昌）, China


microsat

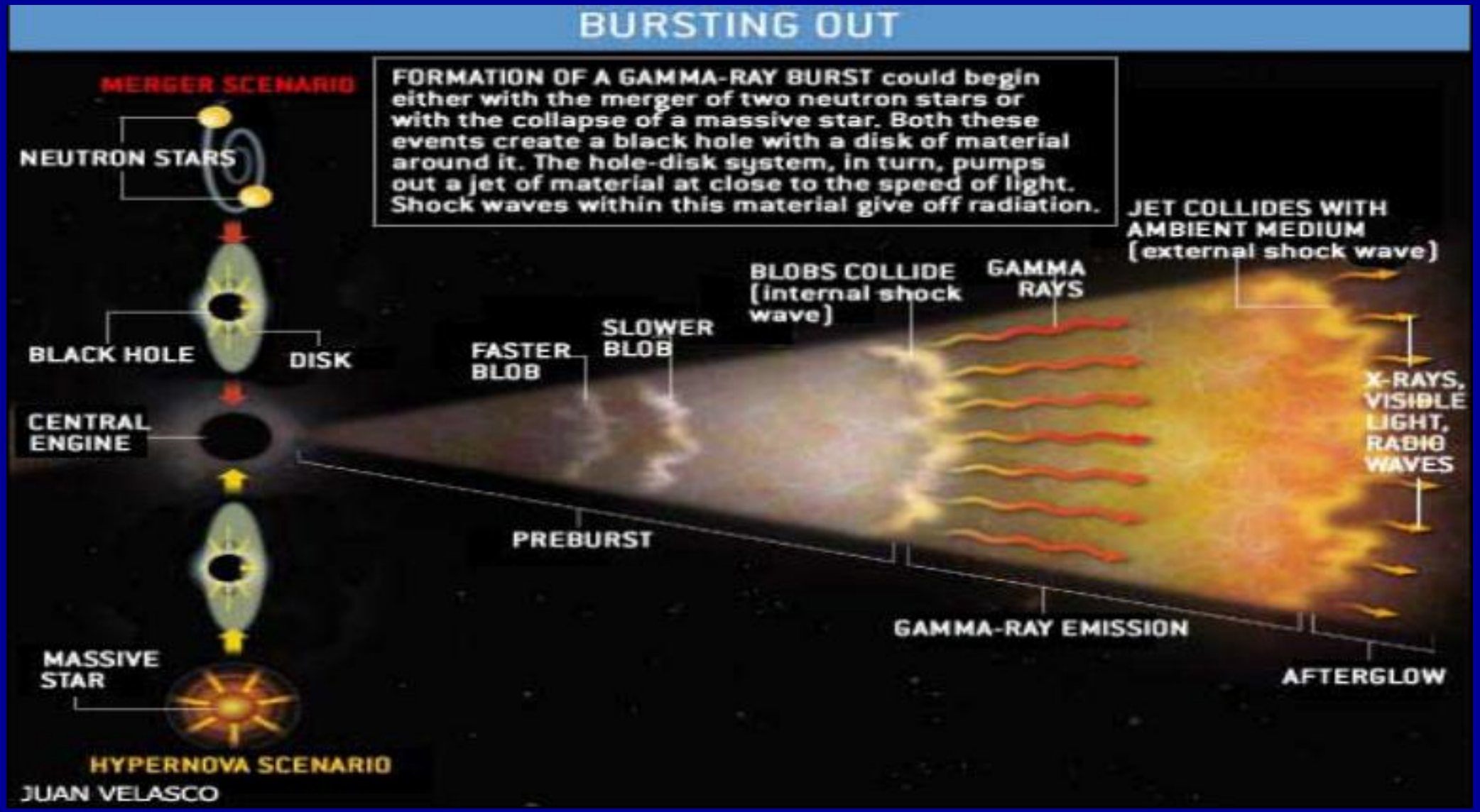




SVOM satellite

- Carried out FM tests in Shanghai
- Almost ready for transporting to the launching site
- Scheduled for the launching date in May, 2024. after the joint meeting by CNSA and CNES at Beijing in Nov

The standard fireball + shock model



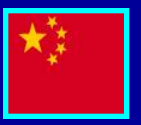
Scientific rationale of a new GRB mission

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
	Re-ionization of the universe
	Cosmological parameters
Fundamental physics	Origin of high-energy cosmic rays
	Probing Lorentz invariance
	Short GRBs and gravitational waves

Proposed scientific instruments

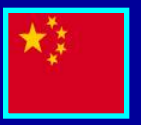
- ECLAIRs, the X-ray and soft gamma-ray trigger camera
  4-150KeV 2sr (~8000 Sq.deg)

- GRM, the gamma-ray spectro-photometer
  15KeV-5MeV ±60× 3Deg

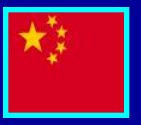


- MXT, the micro-channel soft X-ray telescope
  0.3-6KeV 65'×65'

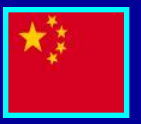
- VT, the visible telescope
  400-650nm, 650-950nm 26'×26'



- GWAC, an array of ground wide angle cameras
  500-800nm ~ 5000 Sq.deg.



- C-GFT, the Chinese ground follow-up telescope
  400-1000nm 21'×21' (1.5°×1.5°)



- F-GFT, the French ground follow-up telescope
  400-1700nm 30'×30'

SVOM scientific instrument arrangement

(Wei et al., 2016, SVOM white paper)

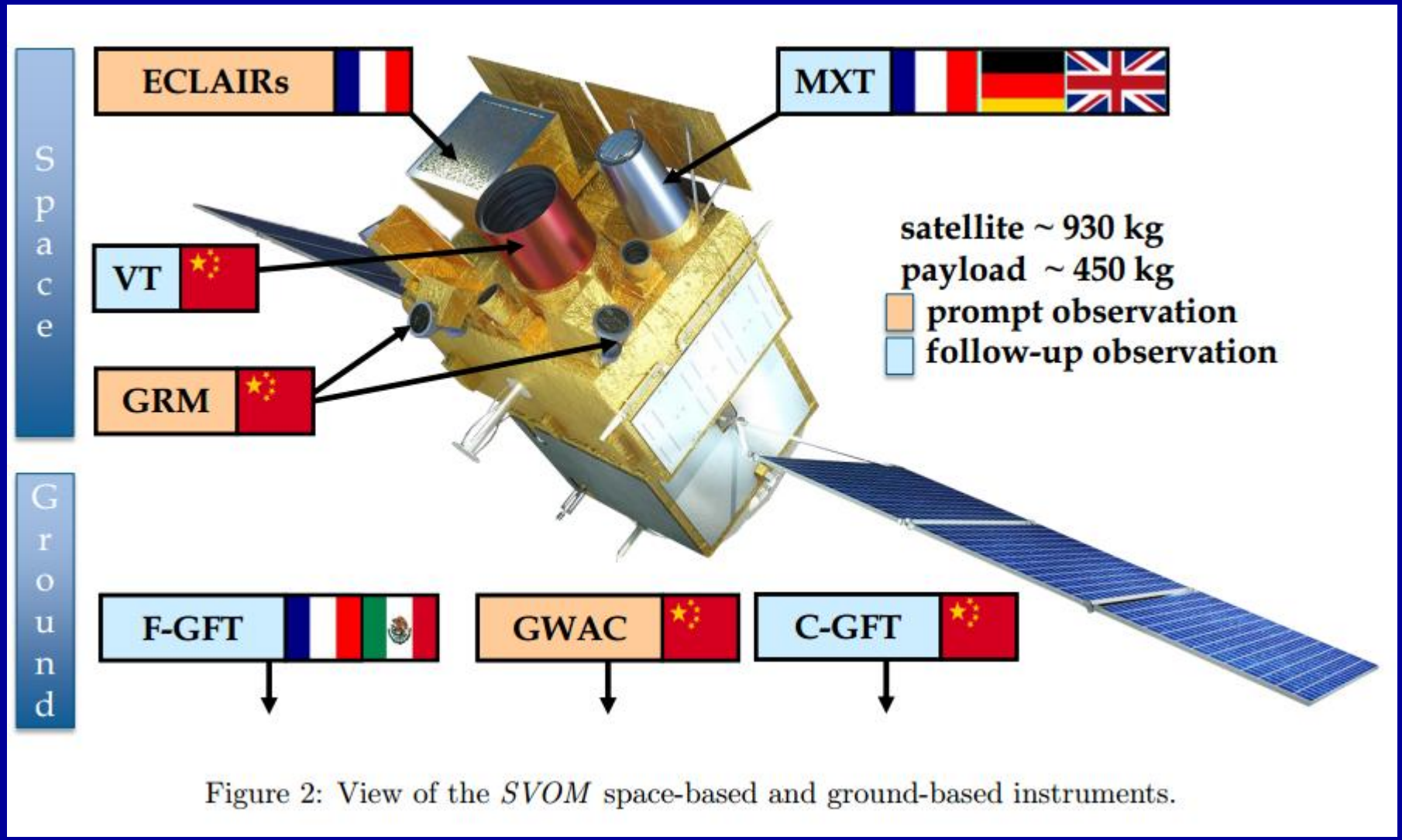
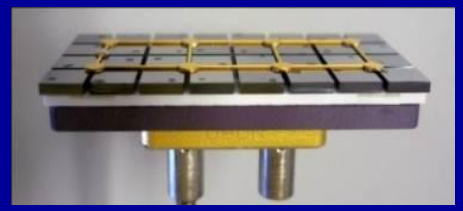
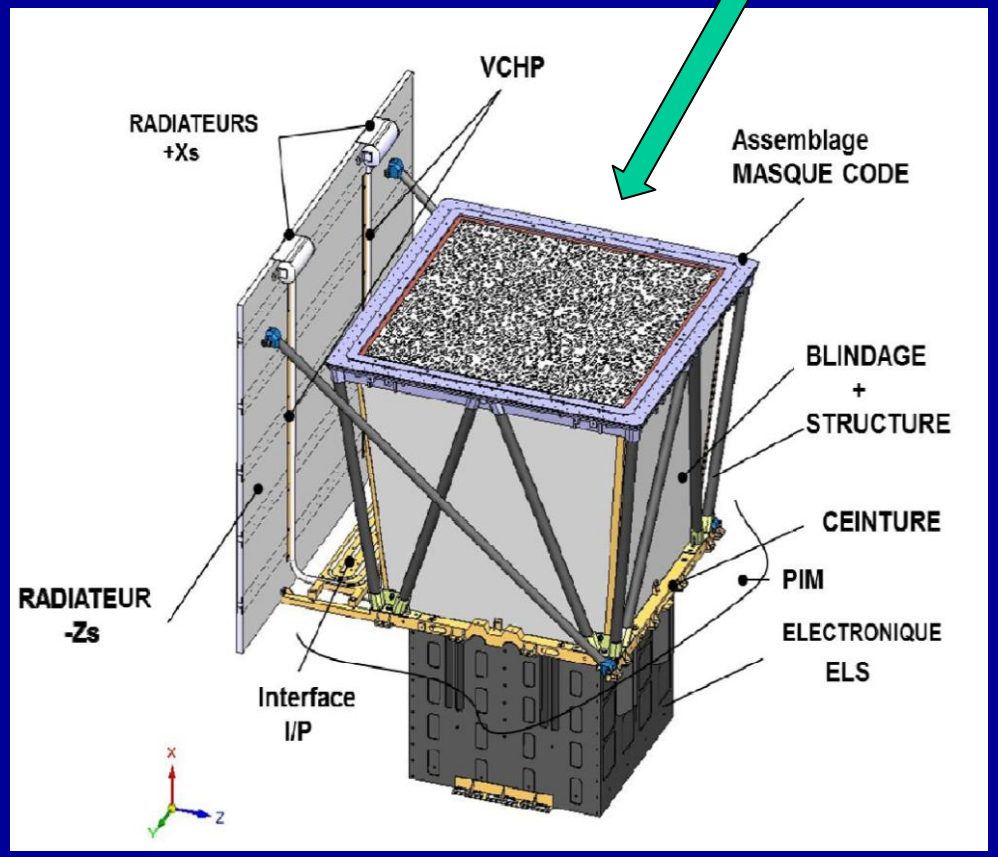


Figure 2: View of the *SVOM* space-based and ground-based instruments.

ECLAIRs: the trigger camera





Main characteristics

Coded mask telescope

Wide FOV : 2 Sr

6400 CdTe - 1024 cm^2

4 keV – 150 keV

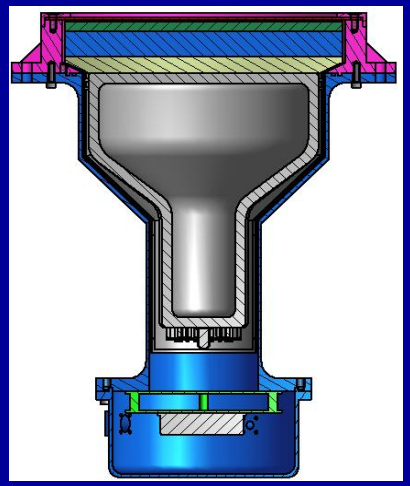
Anticipated performances

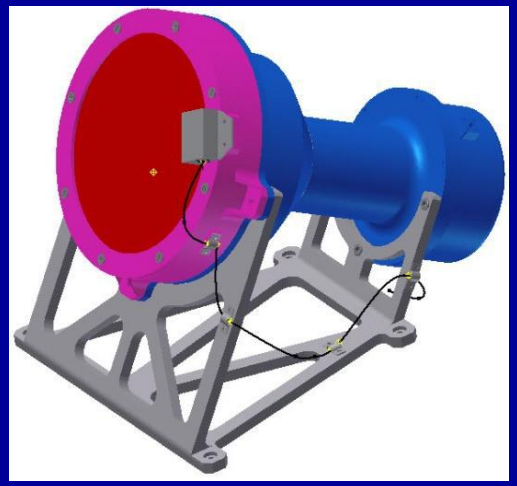
Loc. accuracy < 10arcmin

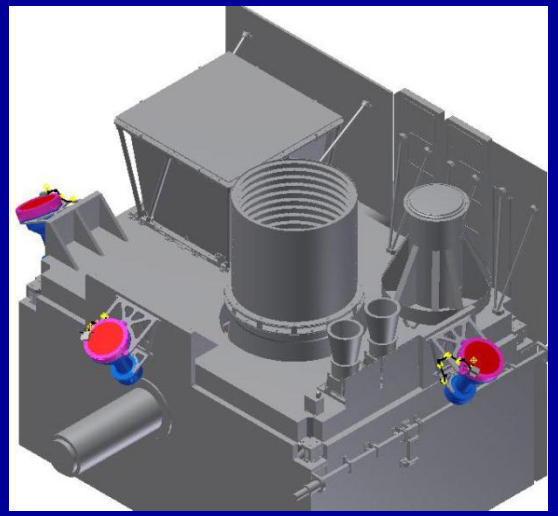
3 arcmin for bright burst

50~70 GRBs / year

GRM – The Gamma Ray Monitor







Main characteristics

NaI detectors

FOV : ±60 Deg.

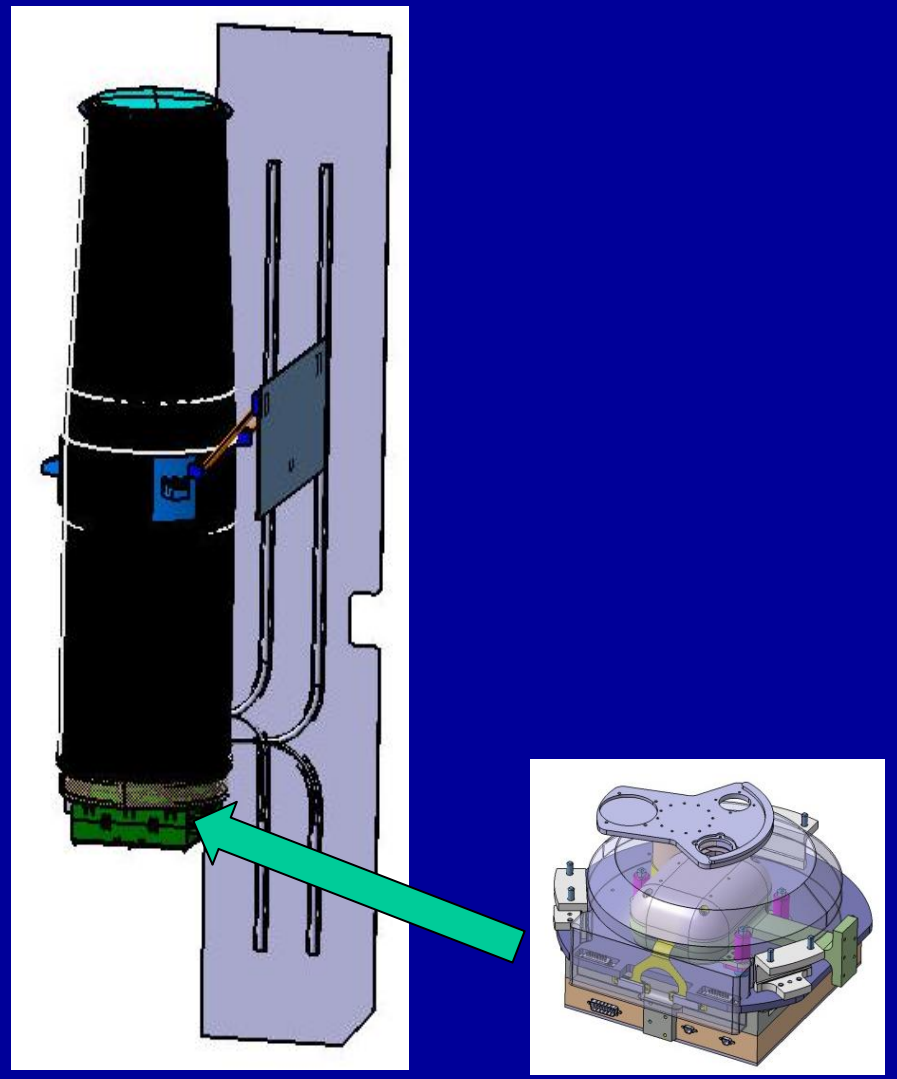
15 keV – 5 MeV

Anticipated performances

Loc. accuracy ~ 2 °

100 GRBs / year

MXT – The Multi-channel X-ray Telescope



Main characteristics

MCP X-ray optic

FOV ~ 1 deg^2

256 x256 PN CCD

0.3 keV – 6 keV

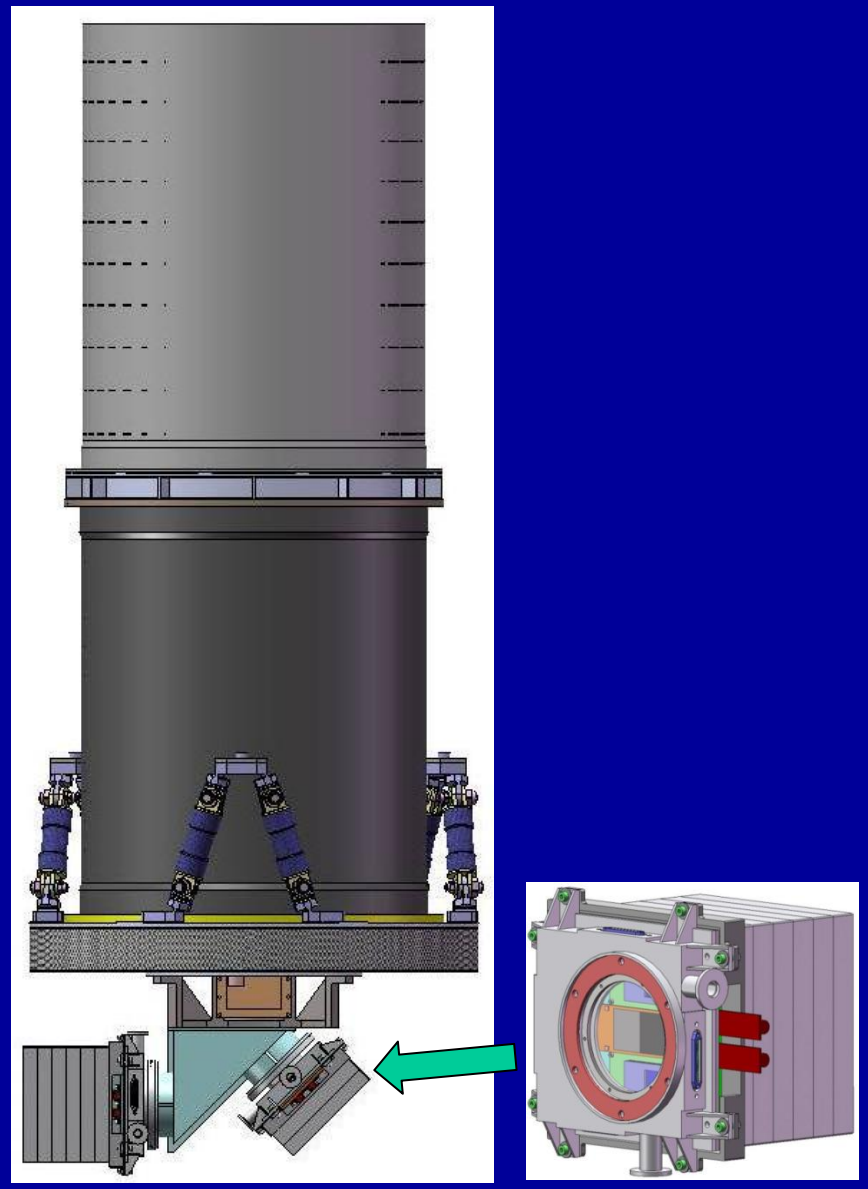
Anticipated performances

Loc. accuracy < 1 arcmin

20 arcsec for bright GRB

$5x10^{-12}$ erg cm^{-2} s^{-1} in 1000s

VT – The Visible Telescope



Main characteristics

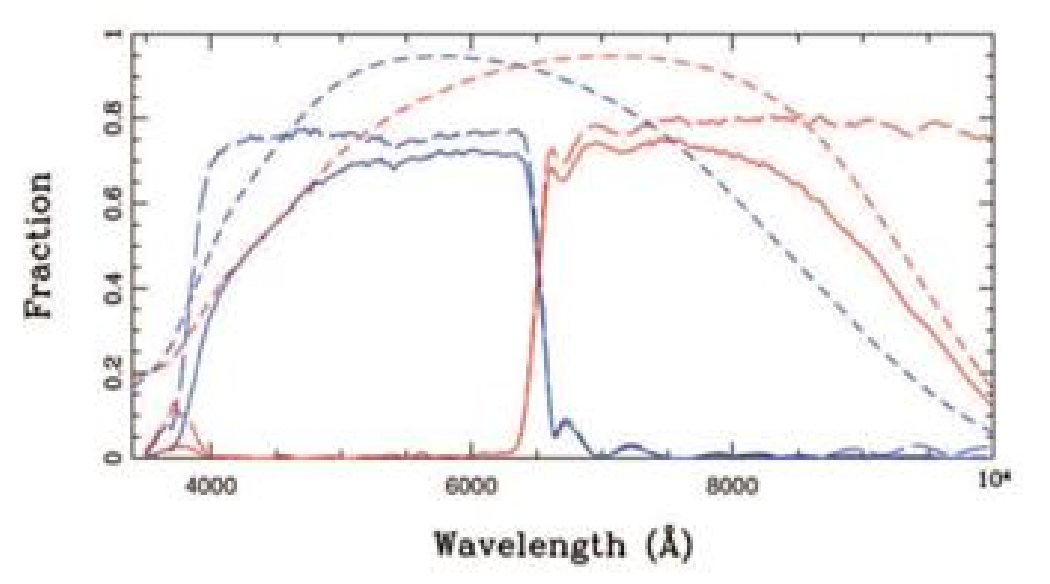
Ritchey Chretien Φ=40cm
FOV : 26 x 26 arcmin²
2 X 2048x2048 CCD
400 - 650 / **650 - 950** nm

Anticipated performances

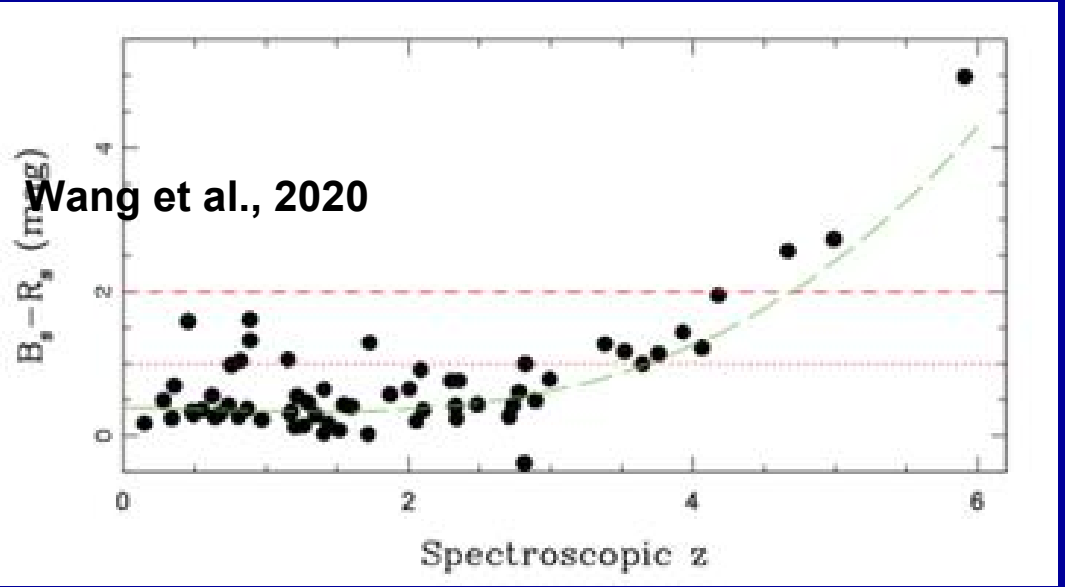
Loc. accuracy ~1 arcsec

Mv = 22.5 in 300s

VT: two-band for high-z GRBs



Quantum efficiency of VT



Redshift vs VT color

High-z GRB candidates:

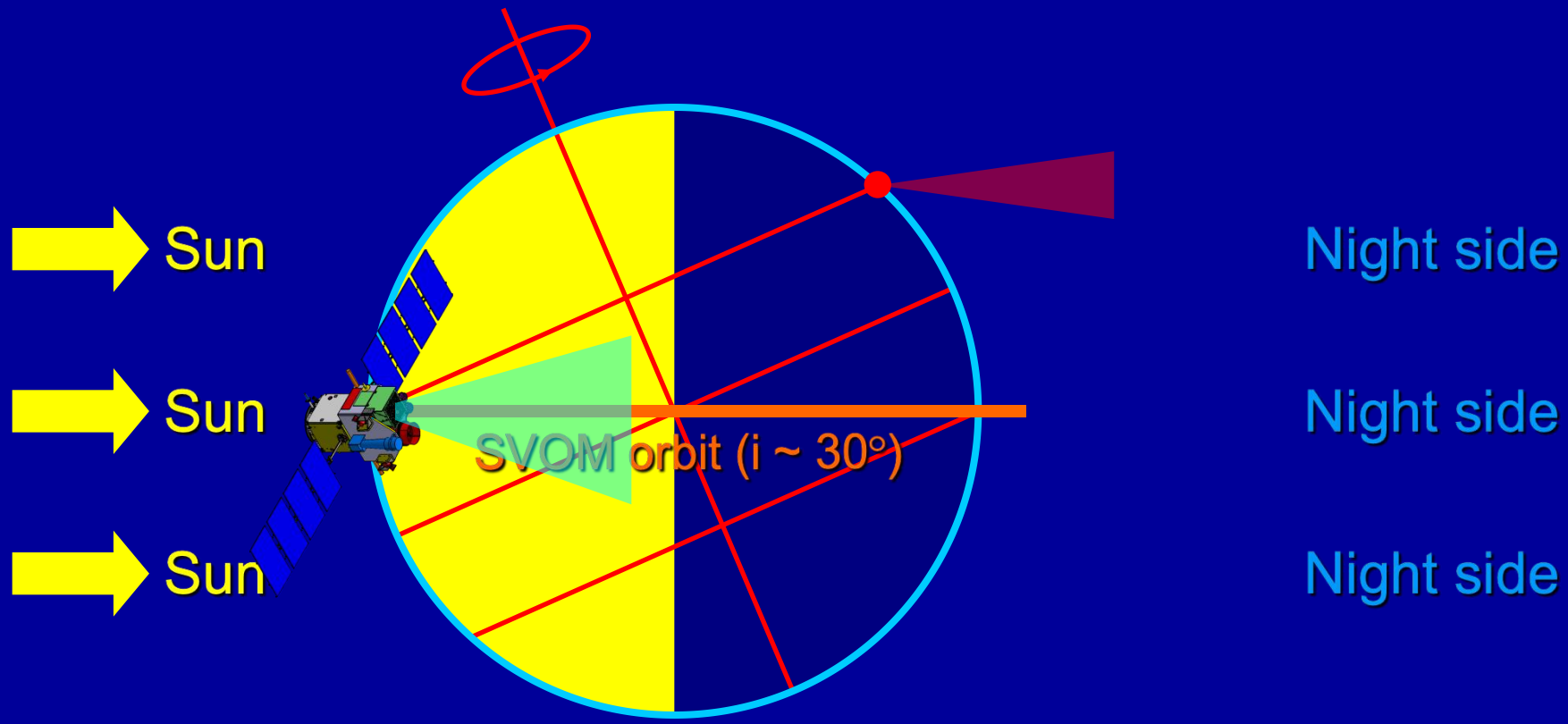
(1) VT B-R ~ 4, z~6;

(2) Detected by MXT, not by VT!

Space instruments performances

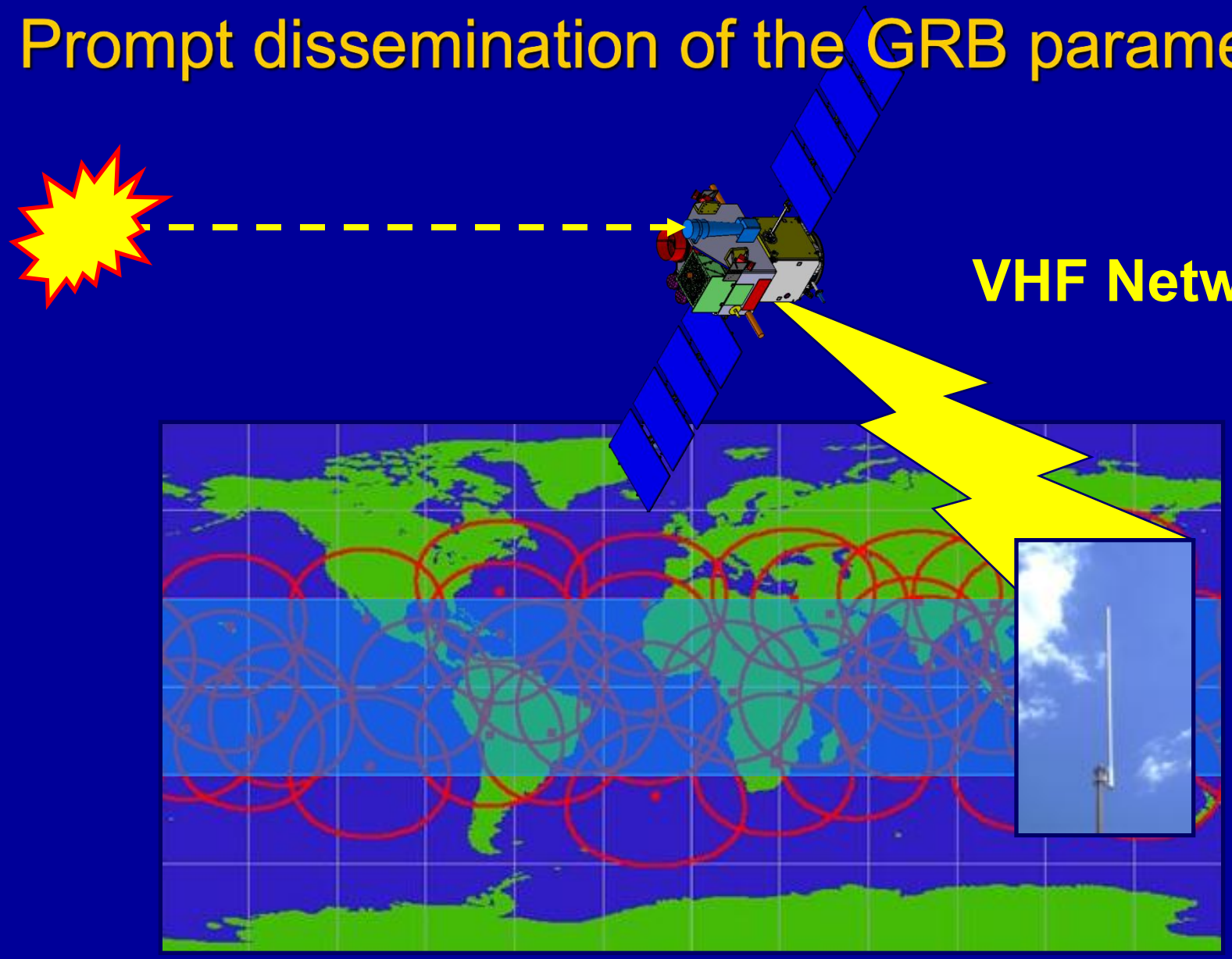
	Spectral band	Field of View	Allocation Accuracy	GRBs/yr (Dect. Rate)
GRM	30keV-5MeV	3 sr	~5 deg	~100
ECLAIRs	4-150 keV	2 sr	<10 arcmin	~70
MXT	0.3-6 keV	65× 65 arcmin	**~1 arcmin**	~90%
VT	400-650 nm 650-950 nm	26 × 26 arcsec	**<1 arcsec**	~80%

Pointing strategy: anti solar



About 75% of the GRBs detected by SVOM to be well above the horizon of large ground based telescopes all located at tropical latitudes

Prompt dissemination of the GRB parameters

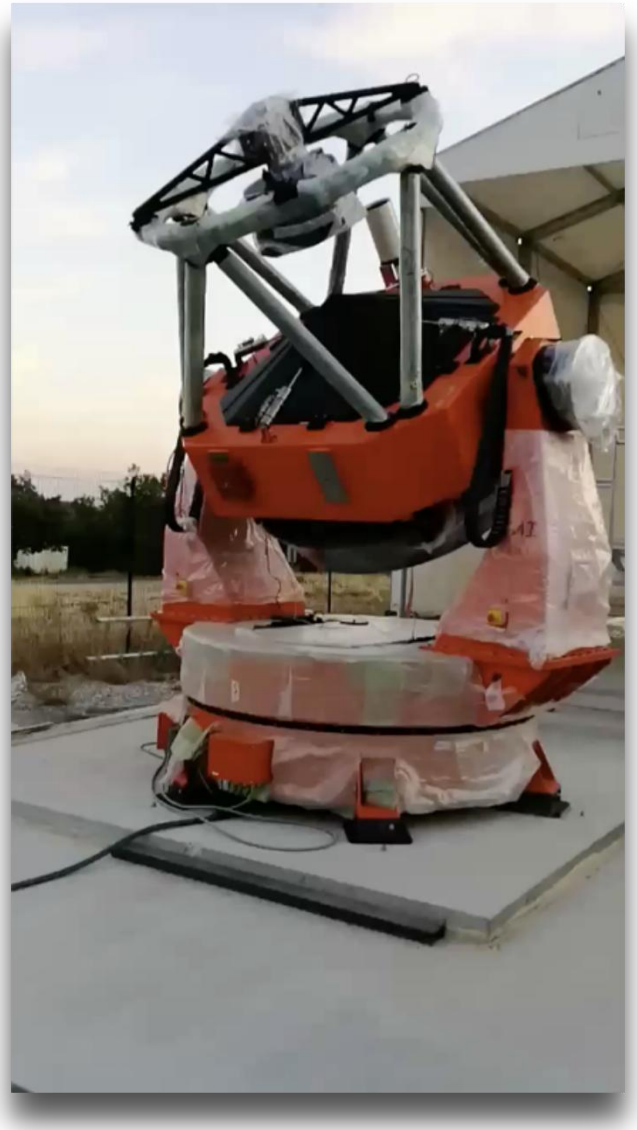


F-GFT at Mexico

COLIBRI & CAGIRE

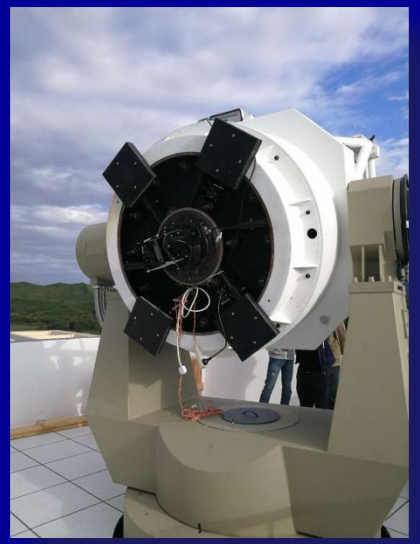
- Under very intensive AITs/AIVs at Observatoire de Haute-Provence, France:
  - Mirrors installed in the mount in August 2020.
  - Test camera developed by UNAM delivered (4kx4k sensor).
  - Control Center well developed: TCS, scheduler, GIC, data processing, database, etc. under tests all together in September 2021.
  - Transportation to Mexico and an installation on the site in 2023.

Photometry at 400-1700nm
FoV: 30'×30'



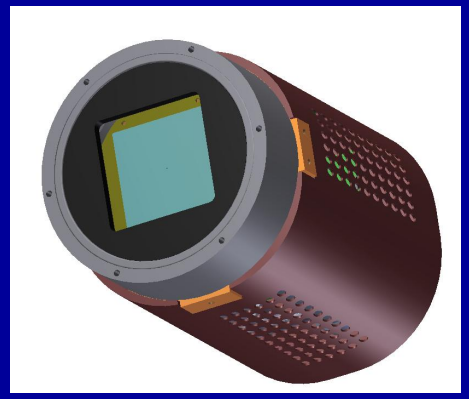
C-GFT： ChangChun 1.2m at China

		@Jilin
Altazimuth telescope	aperture	1.2 m
	3-channels (Cassegrain focus)	g,r,i 2kx2k CCD 21'X21'
	Prime Focus	4kX4k CMOS FOV=1.5degX1.5deg

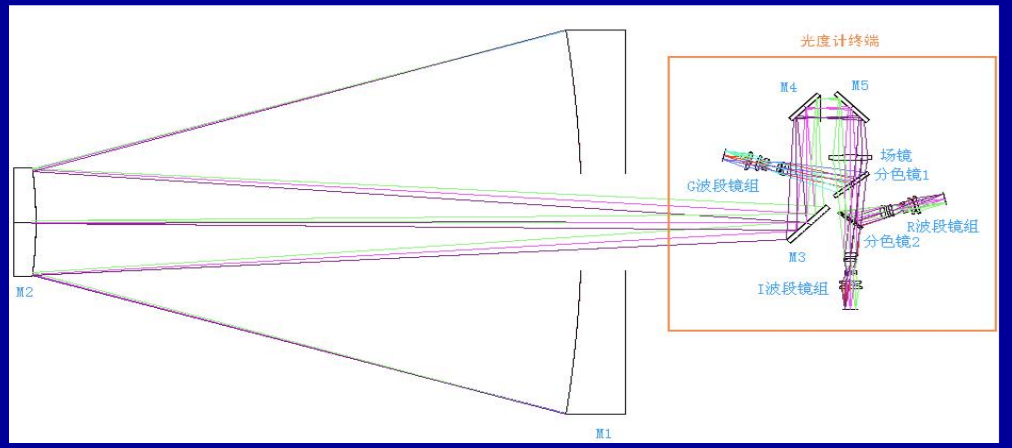


2020: set up the 3-channel system;
2022: CMOS camera ready, set up the main focus system

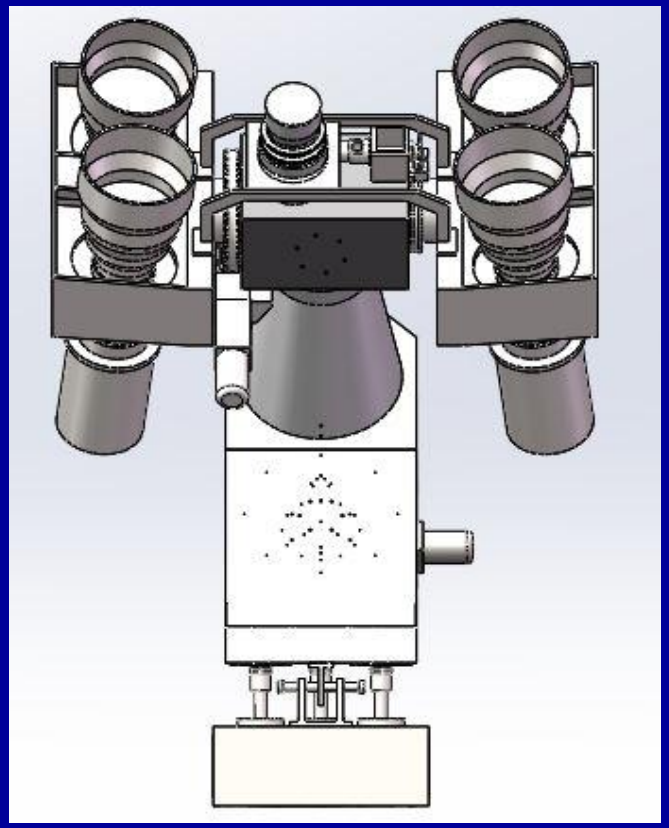
1.2m @jilin



4k*4k 15 um CMOS camera



Parameters of the GWAC at China



- Cameras: 36
- Diameter: 180mm
- Focal Length: 220mm
- Wavelength: 500 – 800nm
- Total FoV: ~5000Sq.deg
- Limiting Mag: 16.0V (5σ, 10sec)
- Self Trigger: in real time

Prompt optical emission detection down to M_V ~ 16.0 (10sec exposure)

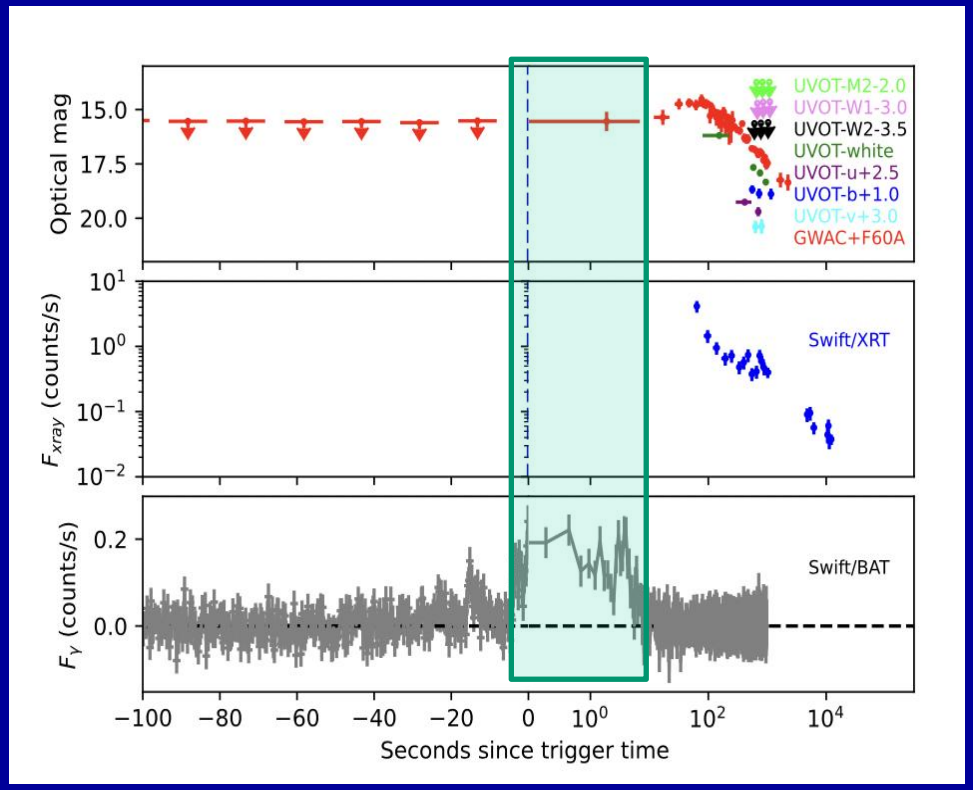
GWAC almost ready (10 Mounts + 40 cameras)

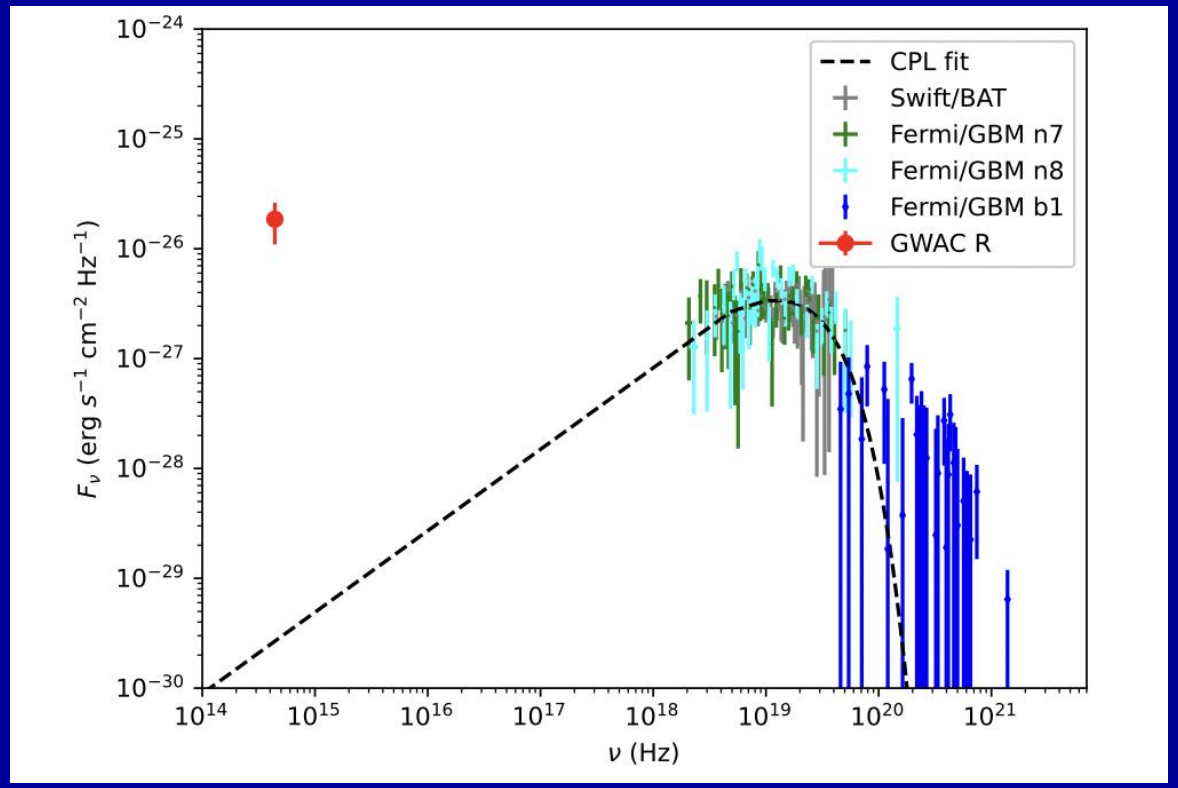
All GWACs are installed at Xinglong observatory, China
All GWAC are using SCMOS (much better time resolution and more stable)

North dome (16 cameras)

South dome (New 24 cameras)

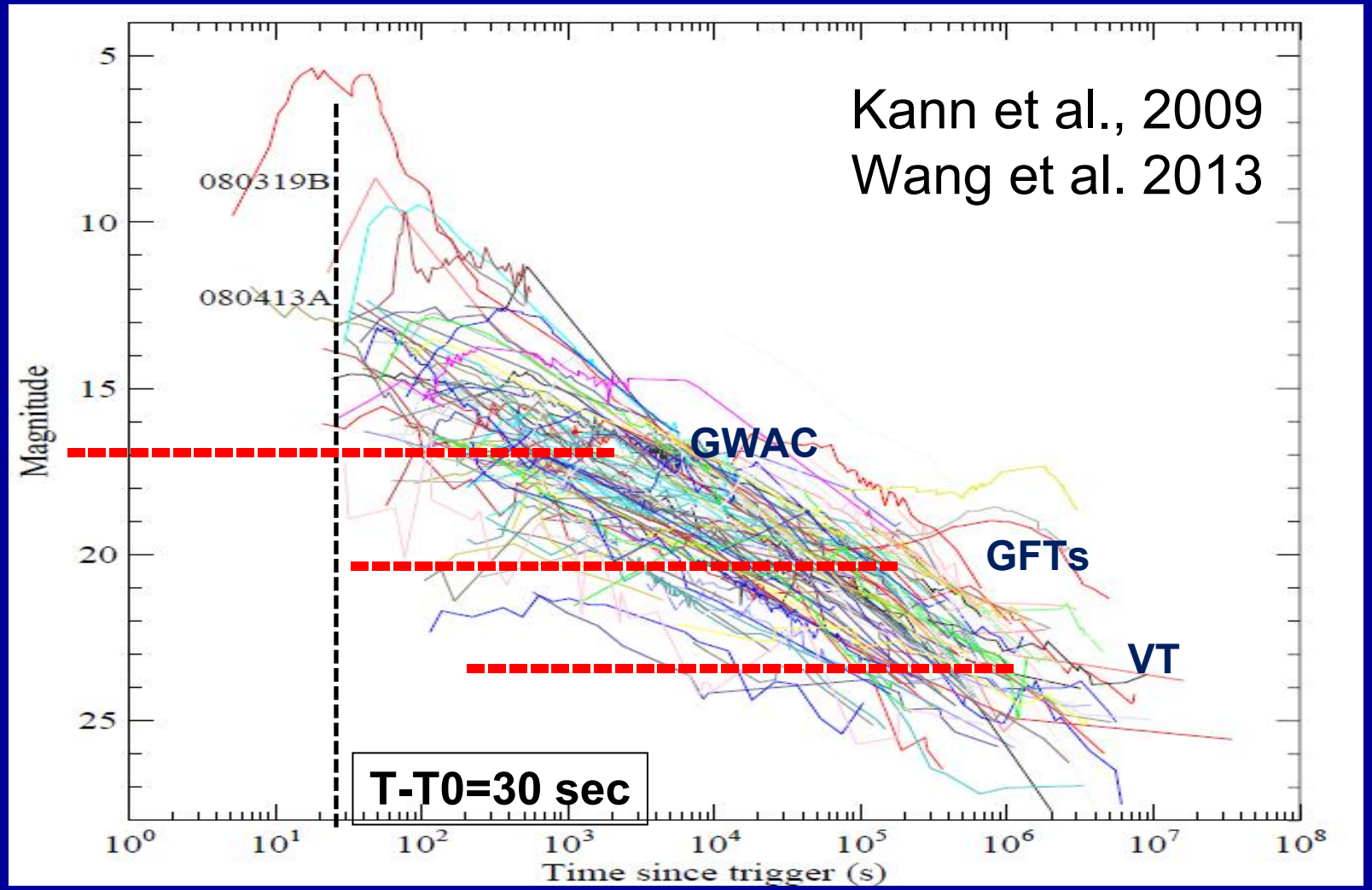
GWAC+Swift: Prompt emission of GRB 201223A





Xin et al., 2023, NatureAs

SVOM contributions on GRB optical light curves



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

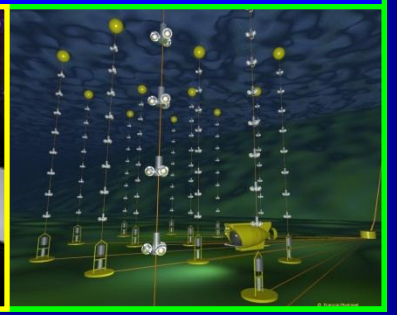
Ground

GWAC

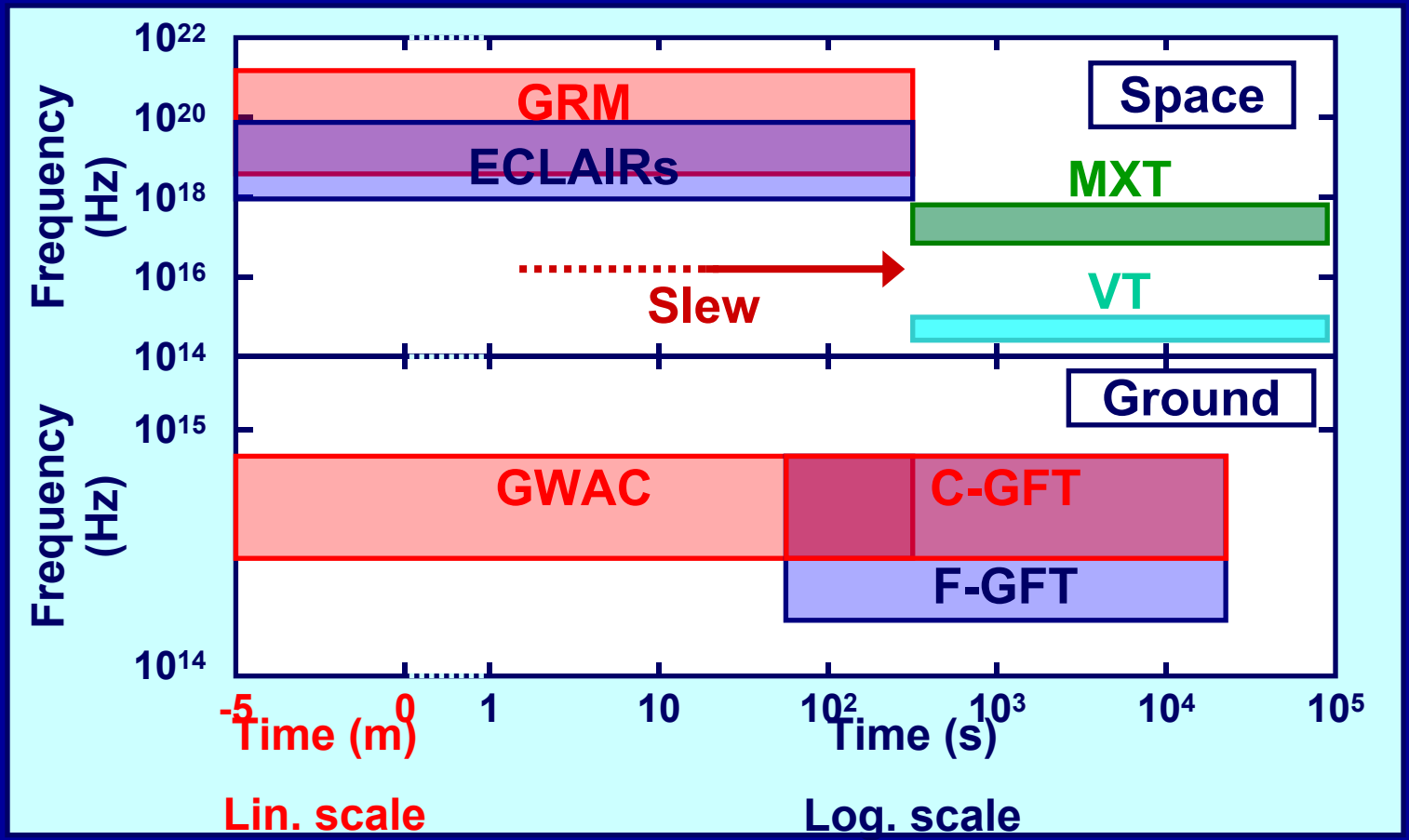
GFTs (g, r, i, J, H), LCOGT

1-2 m robotic telescopes

Multi messenger follow-up



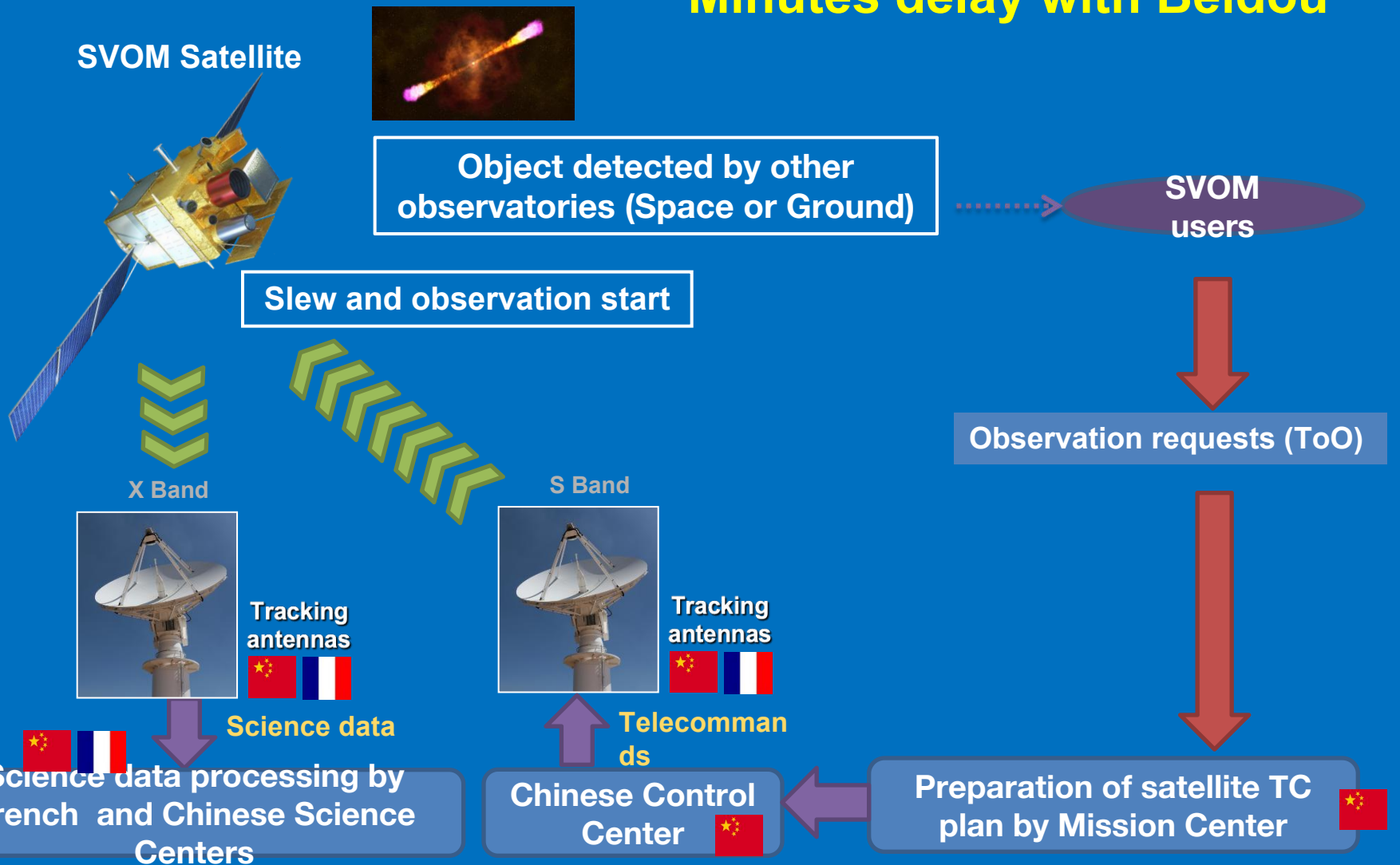
Multi-wavelength capabilities of SVOM



SVOM: a powerful multi-band observatory for transients

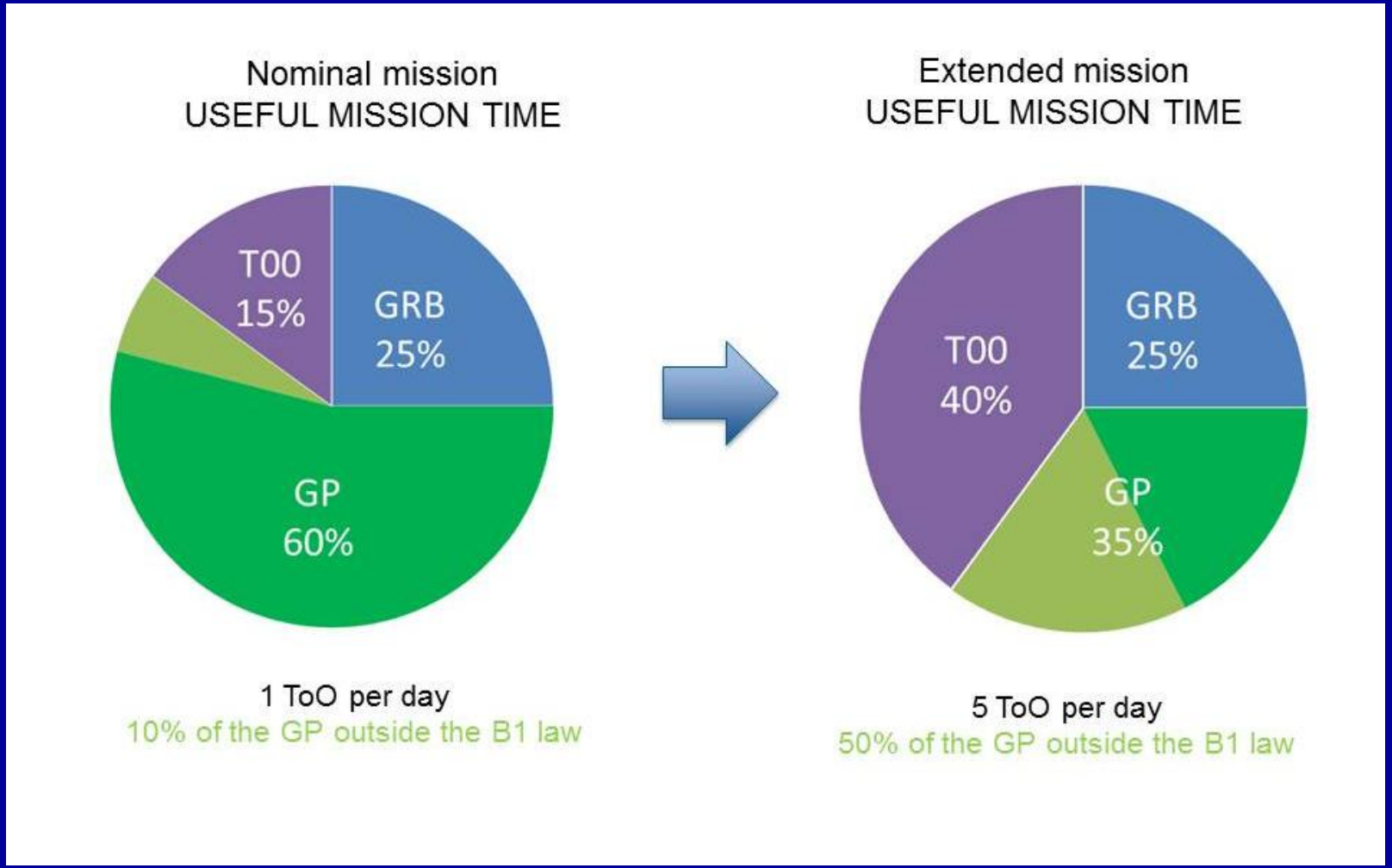
Operational Scenario for ToO

Minutes delay with Beidou



2019: + Beidou system backup for S-Band

SVOM repartition: useful observing time



SVOM: Summary

2024: launch at Xichang, China,

Scheduled for 3+2years

GRBs open for foreign Co-I,

ToOs open for public applications.

Core program

GRBs: triggers and follow-up observations

ToO program

ToO-Nom: proposed program by co-Is

ToO-Ex: ditinguished astronomical events

ToO-MM: GW events follow-ups

General program

MXT+VT: soft X-ray, optical with two bands (solar-like activate stars, AGNs…)