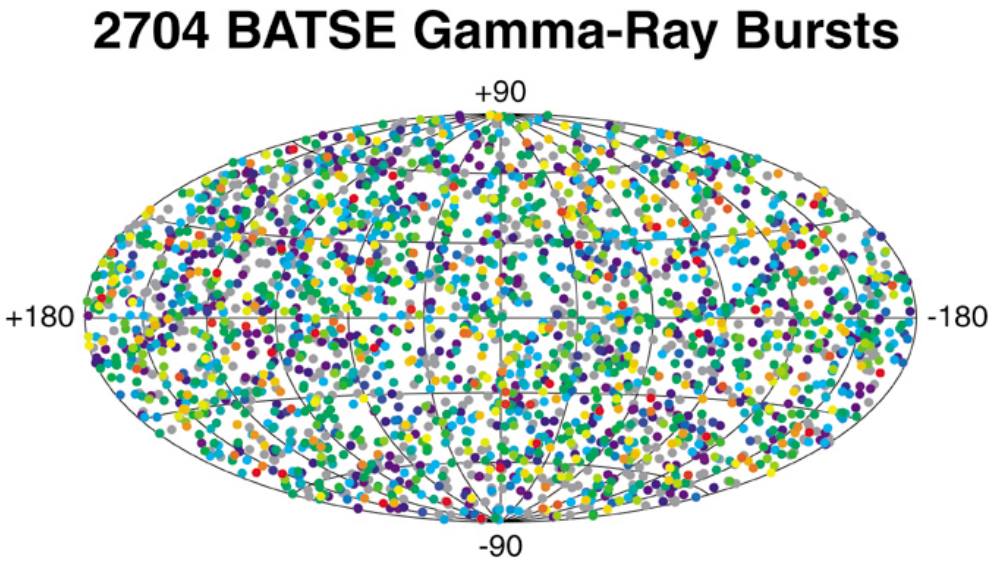
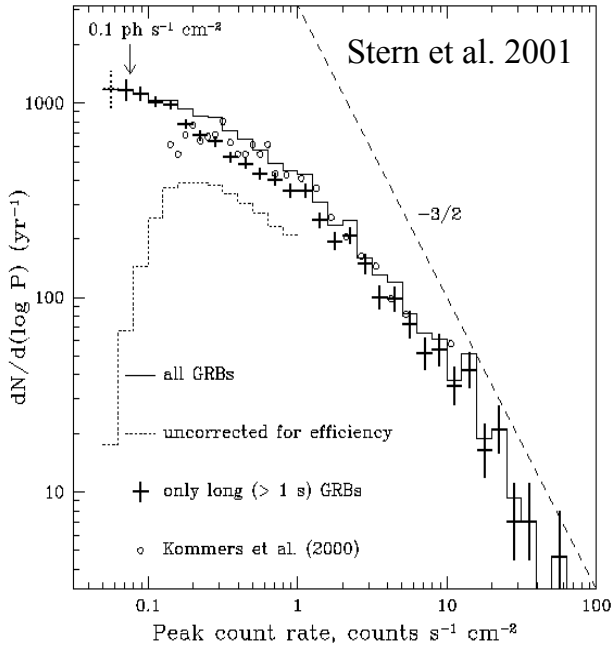
SVOM: alla ricerca dei GRB più distanti

Diego Götz
CEA-SAp Saclay

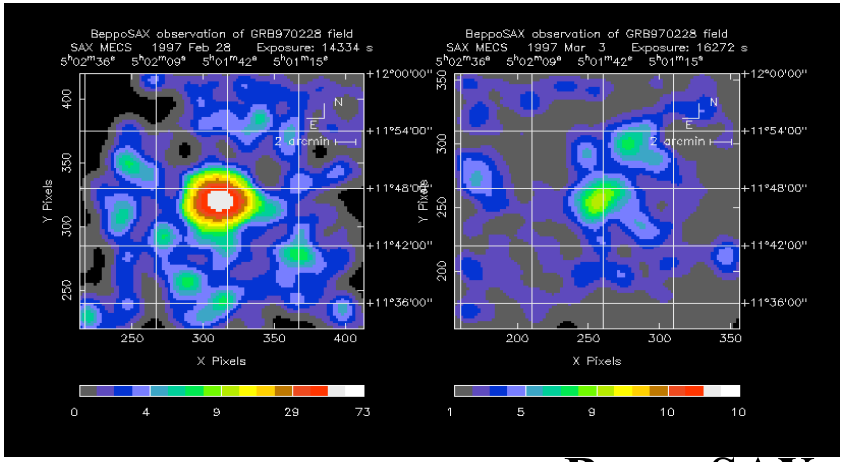
Gamma-Ray Bursts in una slide





Banda gamma (20 keV – 1 MeV):

- Sorgenti intense
- Spettri non termici (SR+IC)
- Durata e curva di luce variabili su tempi scala da ~ms a ~100 s
- E ~ 10^{51}-10^{54} ergs (iso)



BeppoSAX

Sorgenti cosmologiche:
$0.1 < z < 6.3$

X, Ottico, Radio:

· Emissione ritardata (afterglow) non termica
· E dello stesso ordine
· Decadimento del flusso a legge di potenza

- Misura della posizione con precisione dell'arcsec e possibilita` di misurare *z*

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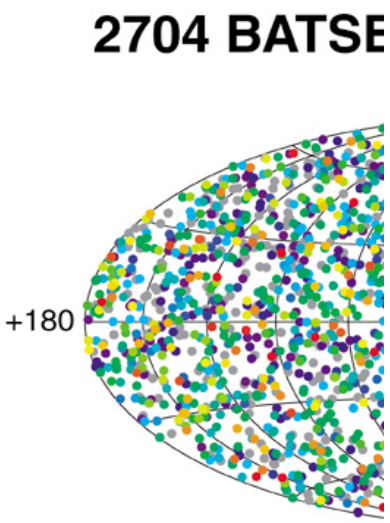
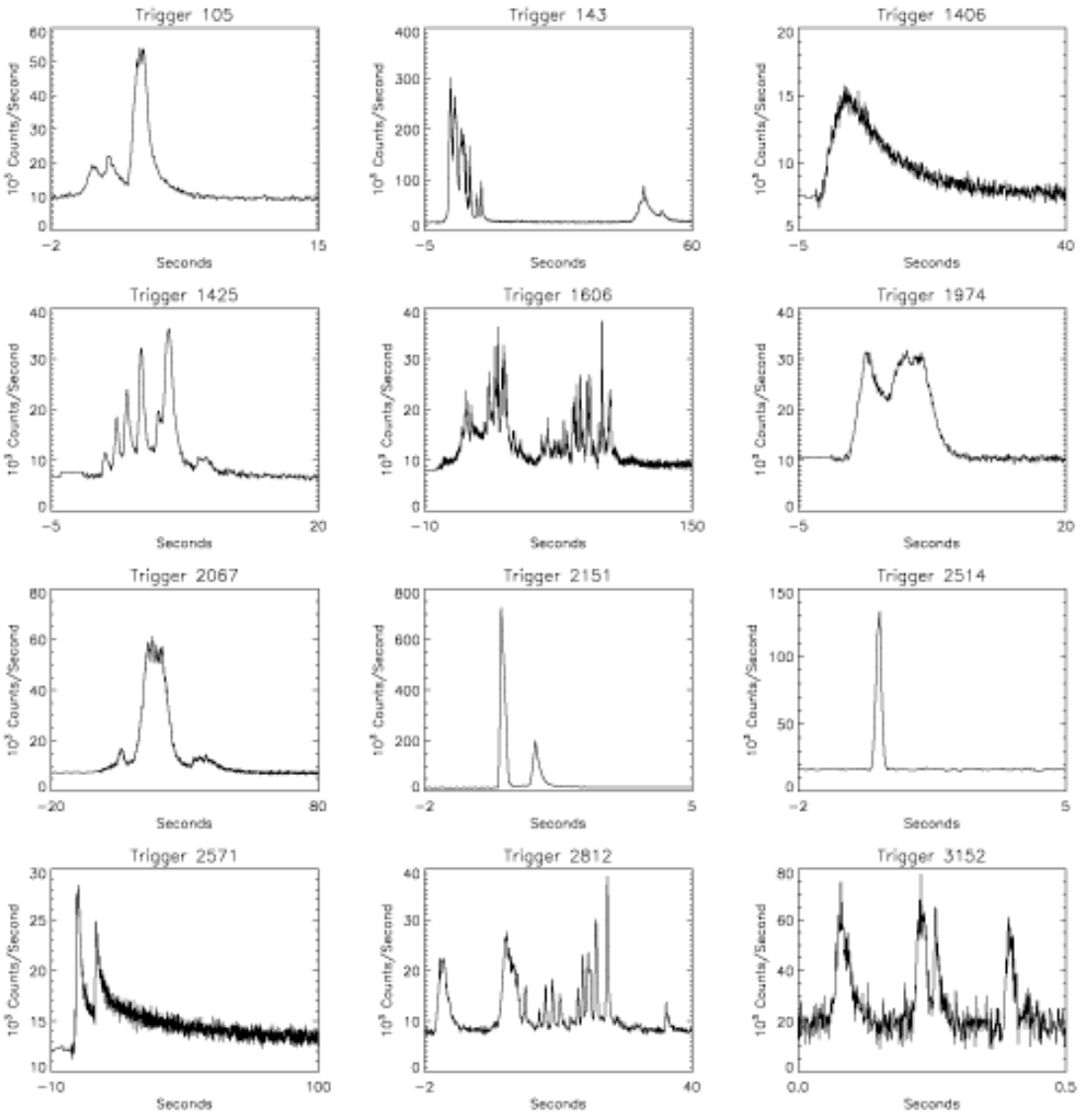
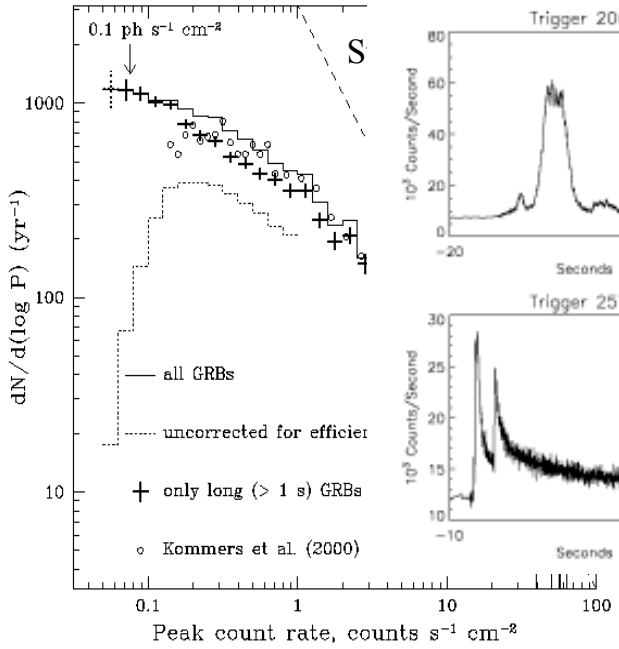
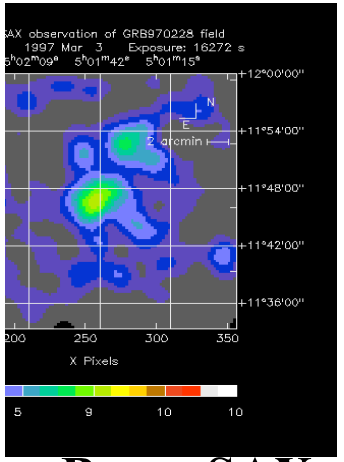






1 MeV):

-IC)
ariabili su
) s



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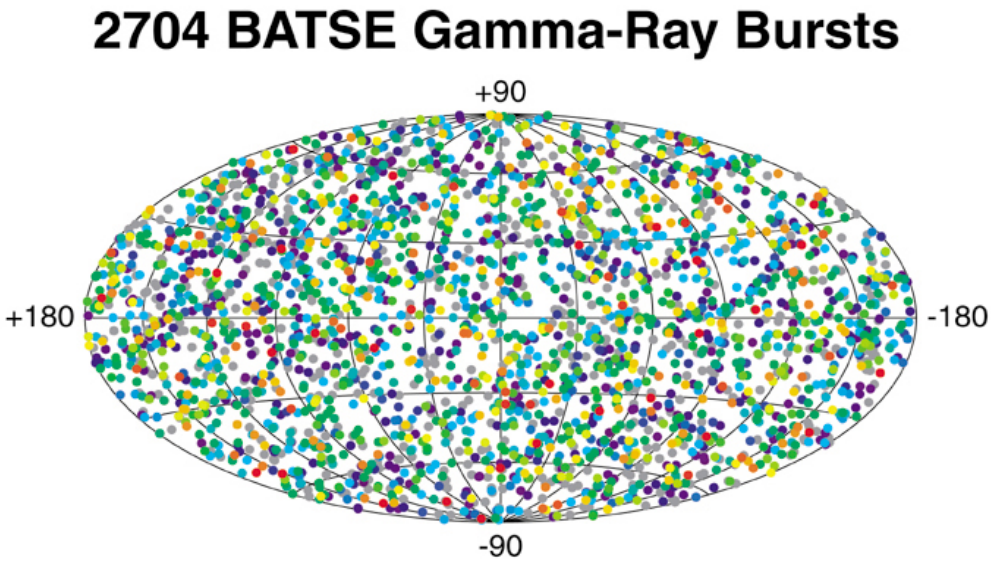

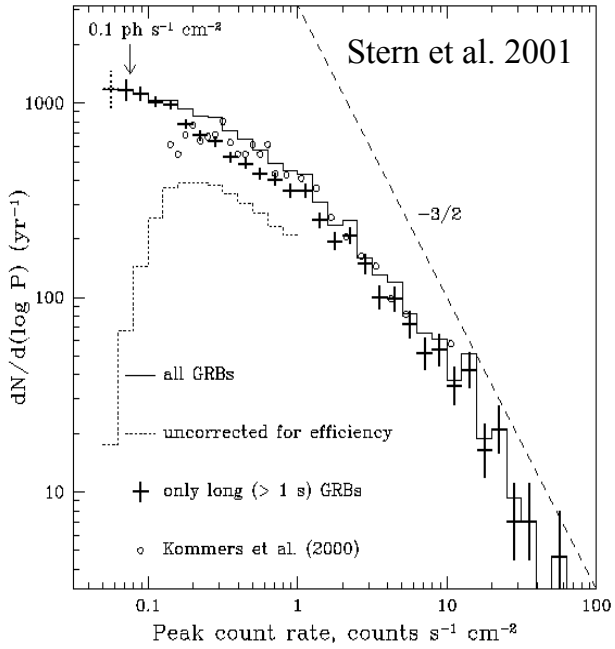

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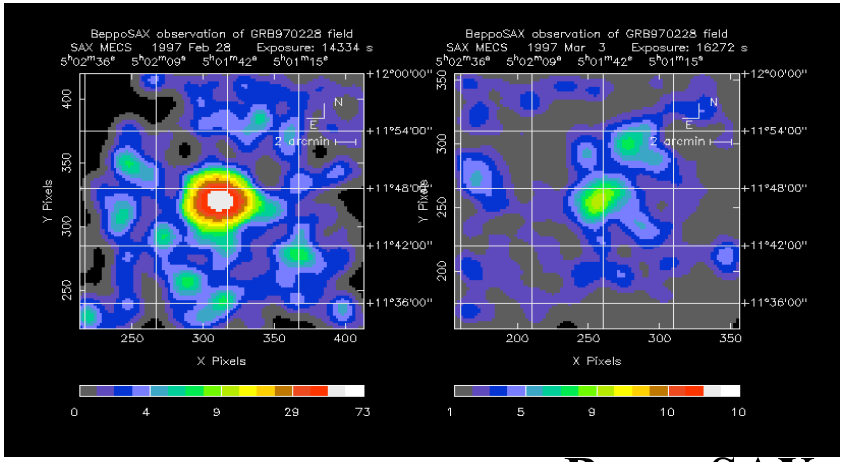

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Svom Scientific requirements (high-energy aspects)

- Study the nature of the prompt emission
- Study the relationship between prompt and afterglow emissions
- Explore the central engine, in particular through the precursor
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- Explore the central engine, in particular through the precursor
- Determine the nature of the progenitor star, the condition of a judicious use of GRBs in cosmology
- In the post-Swift era, it is crucial to collect as much information as possible on a single burst (Amati, Ghirlanda relations, etc.)

Specifications for SVOM's high-energy devices

- To detect during the nominal duration of the mission at least 200 GRBs of all kinds: short GRBs (from few ms to 1-2 s), long GRBs (from 2 s to > 100 s), GRBs rich in X-rays (possibly high z GRBs)

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Hubble diagram

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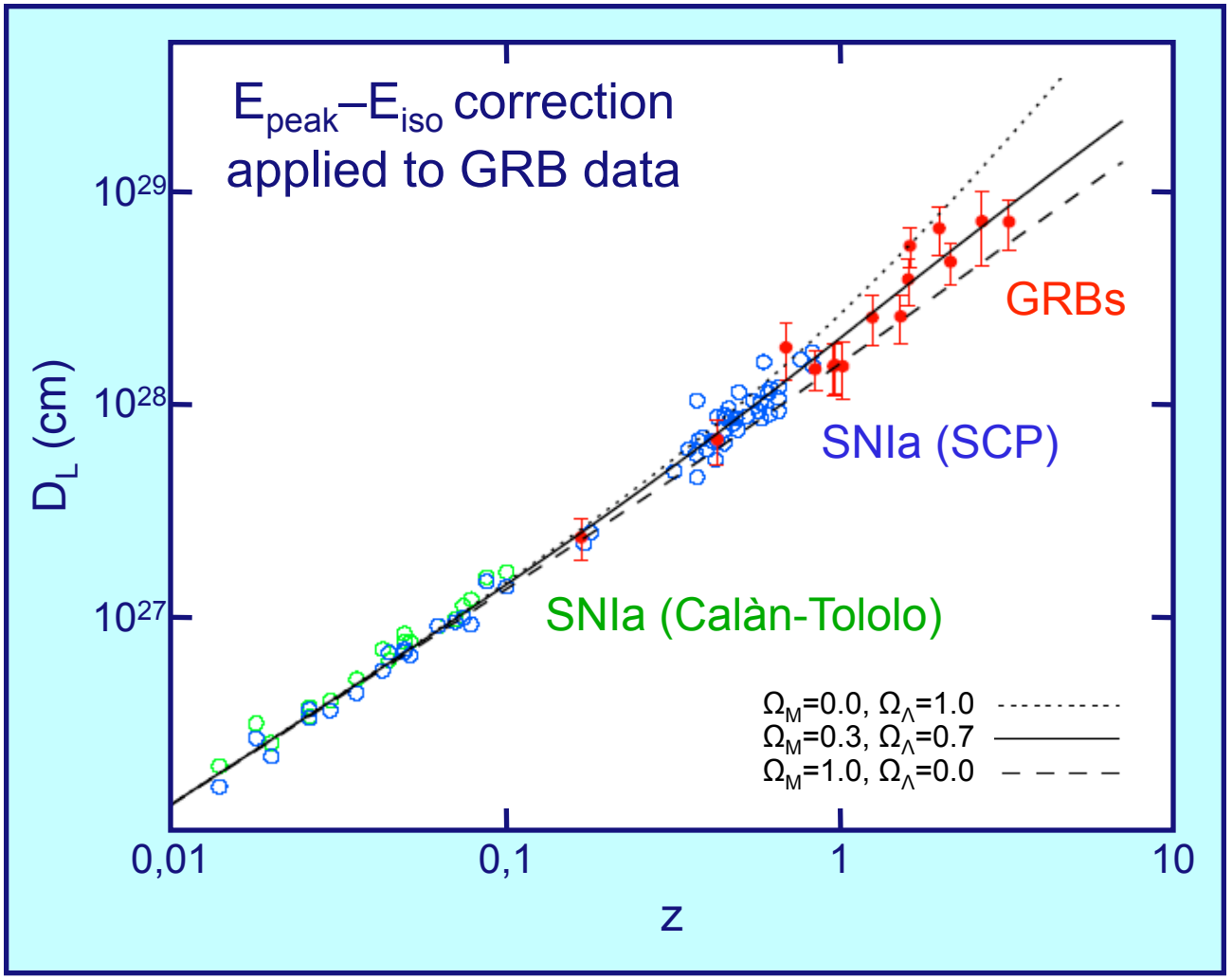

Ghirlanda et al., ApJ 613, L13, 2004

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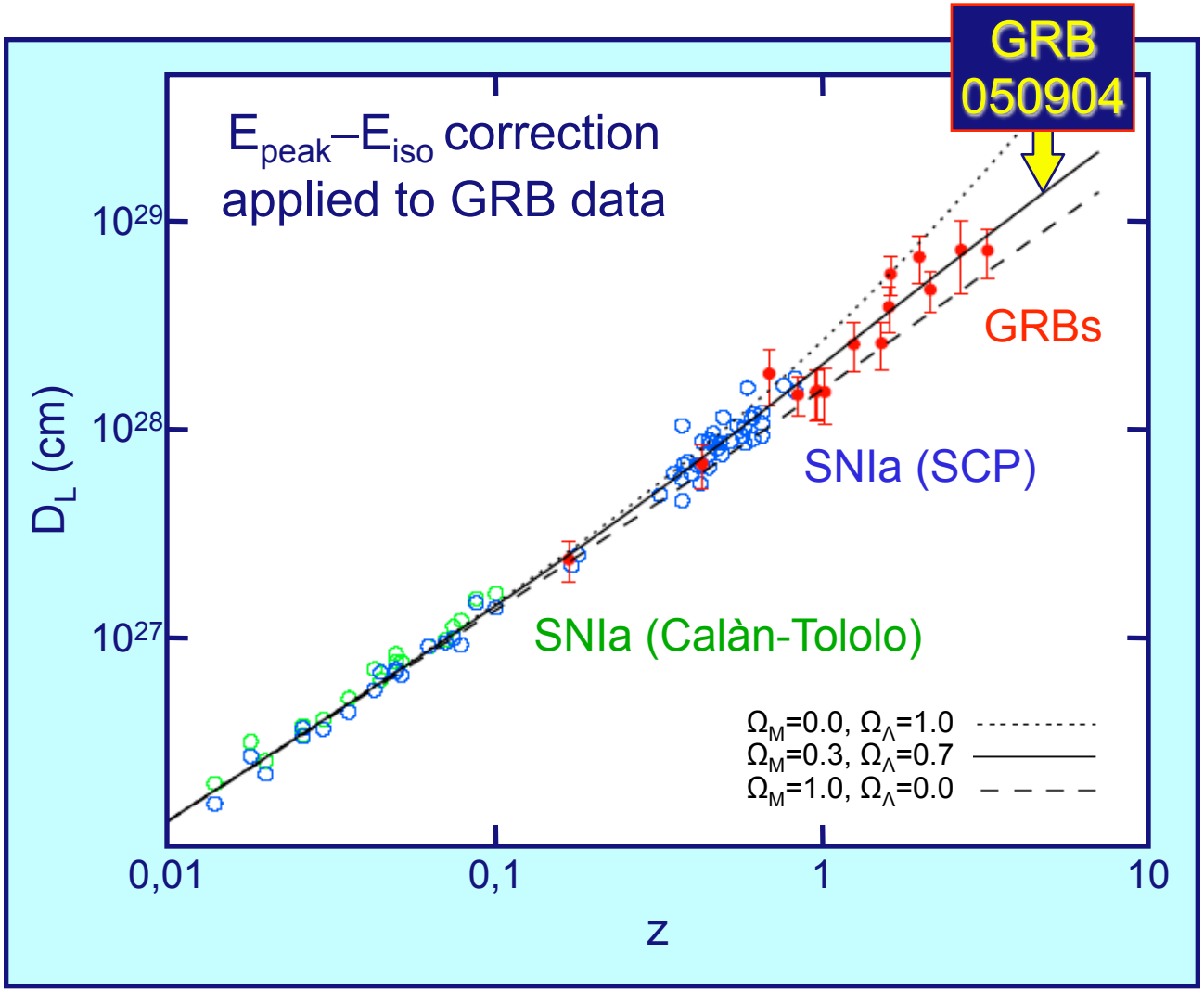

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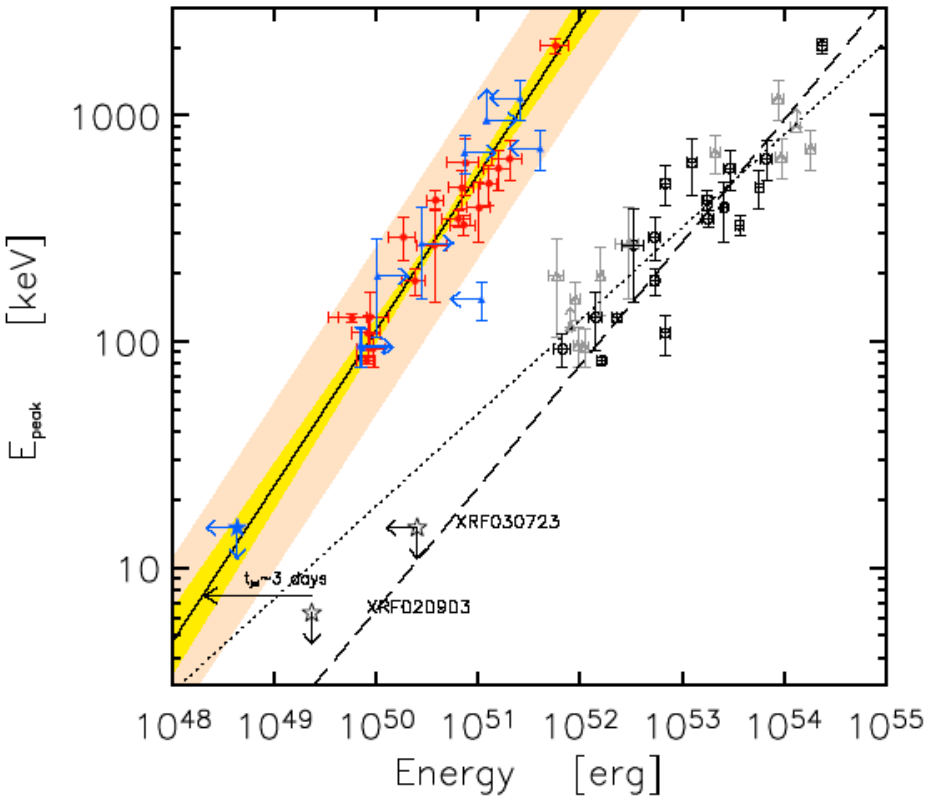
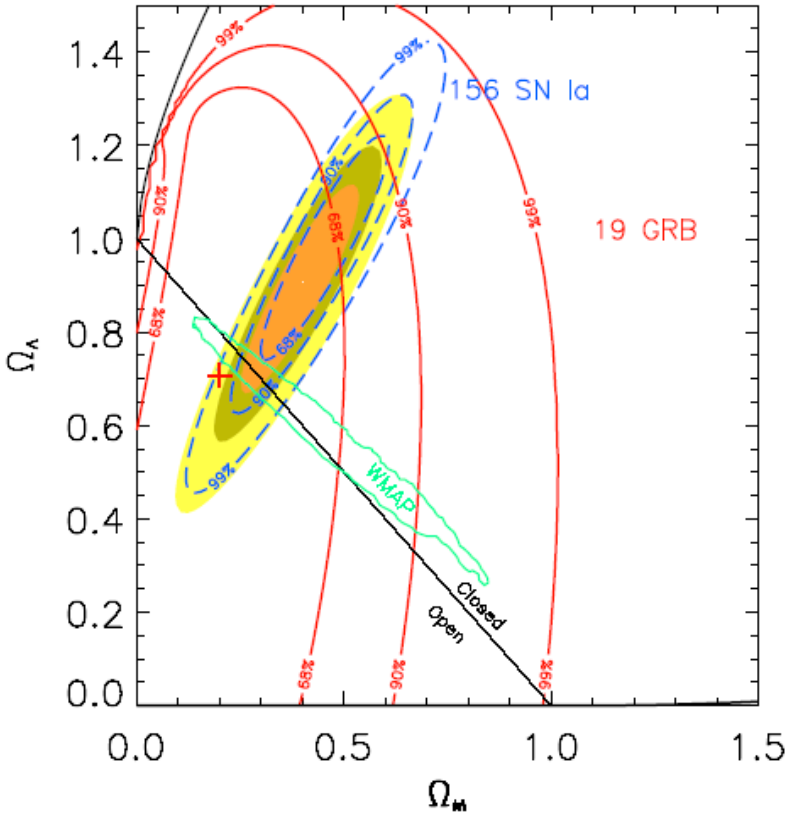
GRBs as cosmological tools





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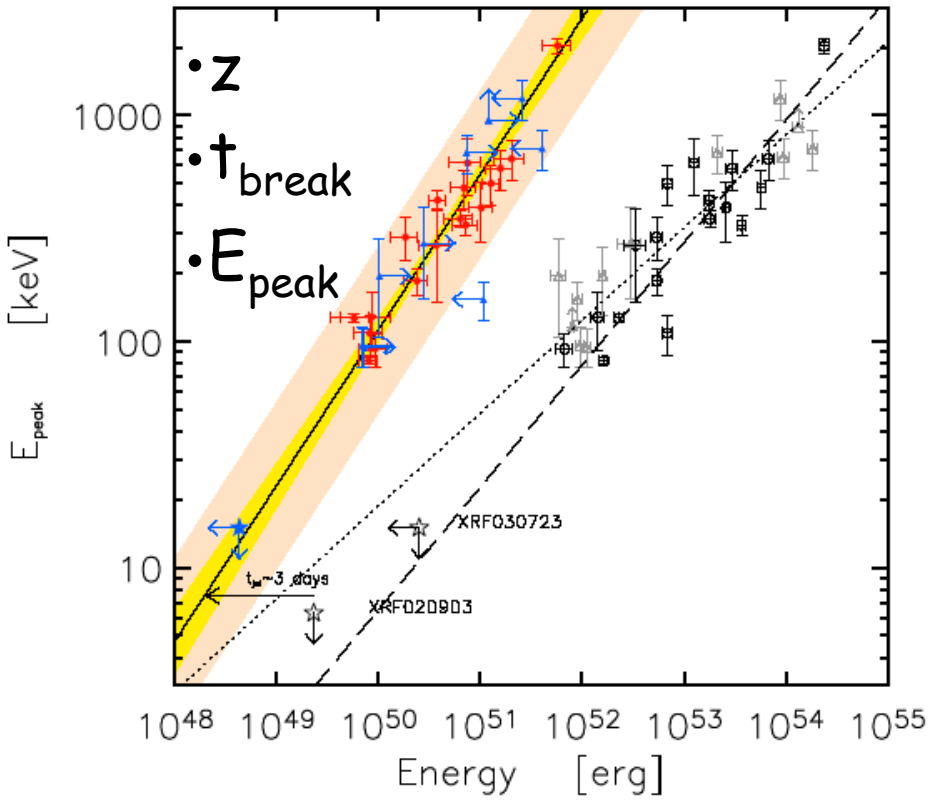

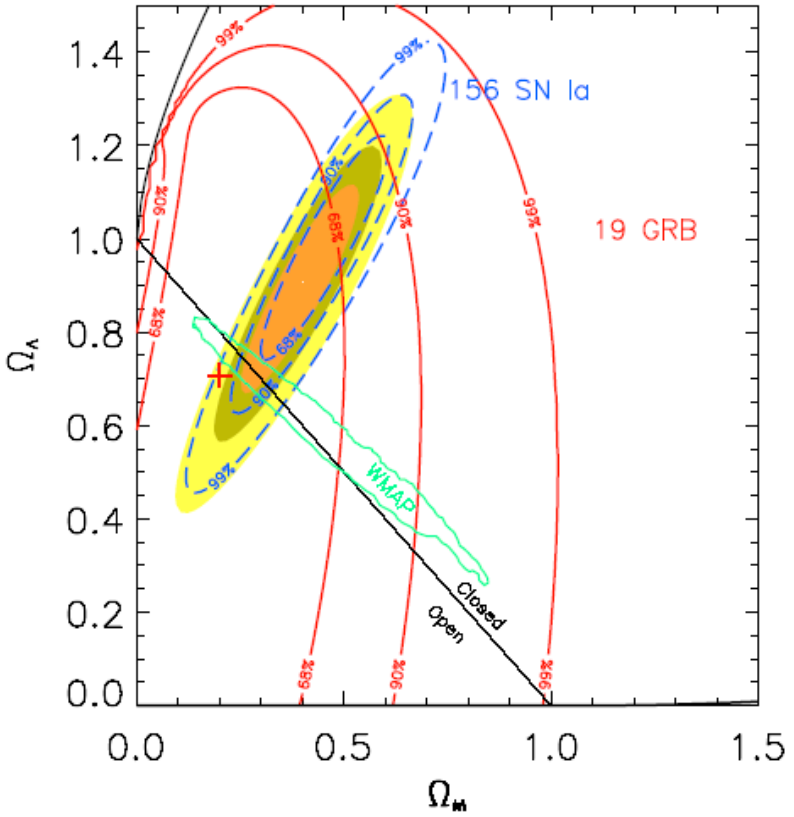

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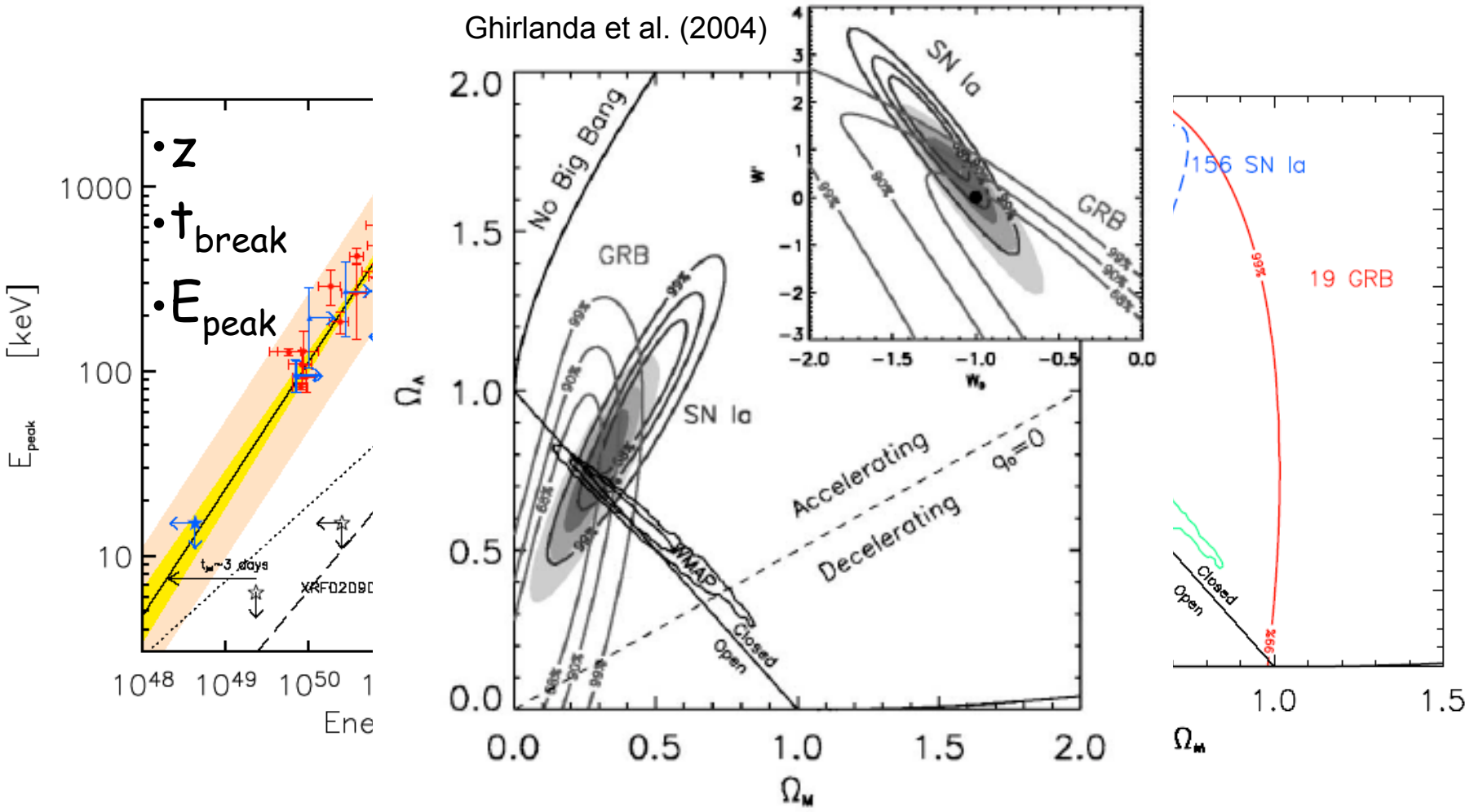

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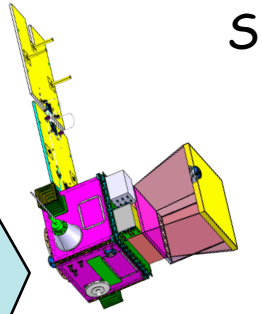
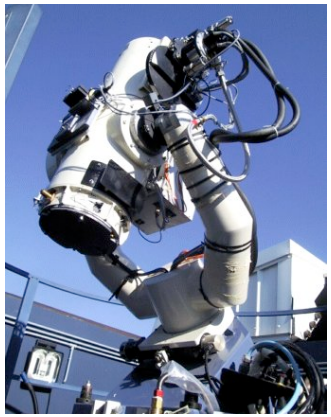
  - ➡ Adjustment of the observing program to allow in 75% of the cases follow up observations with large 8 m telescopes

SVOM





Mission Operation Center

Dedicated Robotic Telescope (GFT)
. Rapid Repointing
. Day/Night Constraints (N>2)
. Sesitivity limit: few hours

Large Telescopes (8m class)
. Large Sensitivity
. Constraits on the observable sky
(impact on the pointing strategy)
. Sensitivity limit: few days

$\Delta t < 1mn \quad \Delta r \leq 10$ arcmin

$\Delta t < 5mn \quad \Delta r \leq 1$ arcsec

THE ECLAIRs microsatellite heritage

1- A set of X-ray and gamma-ray space telescopes (CXG / SXCs)

2- A real time process unit able to localize the source (UTS)

The space segment

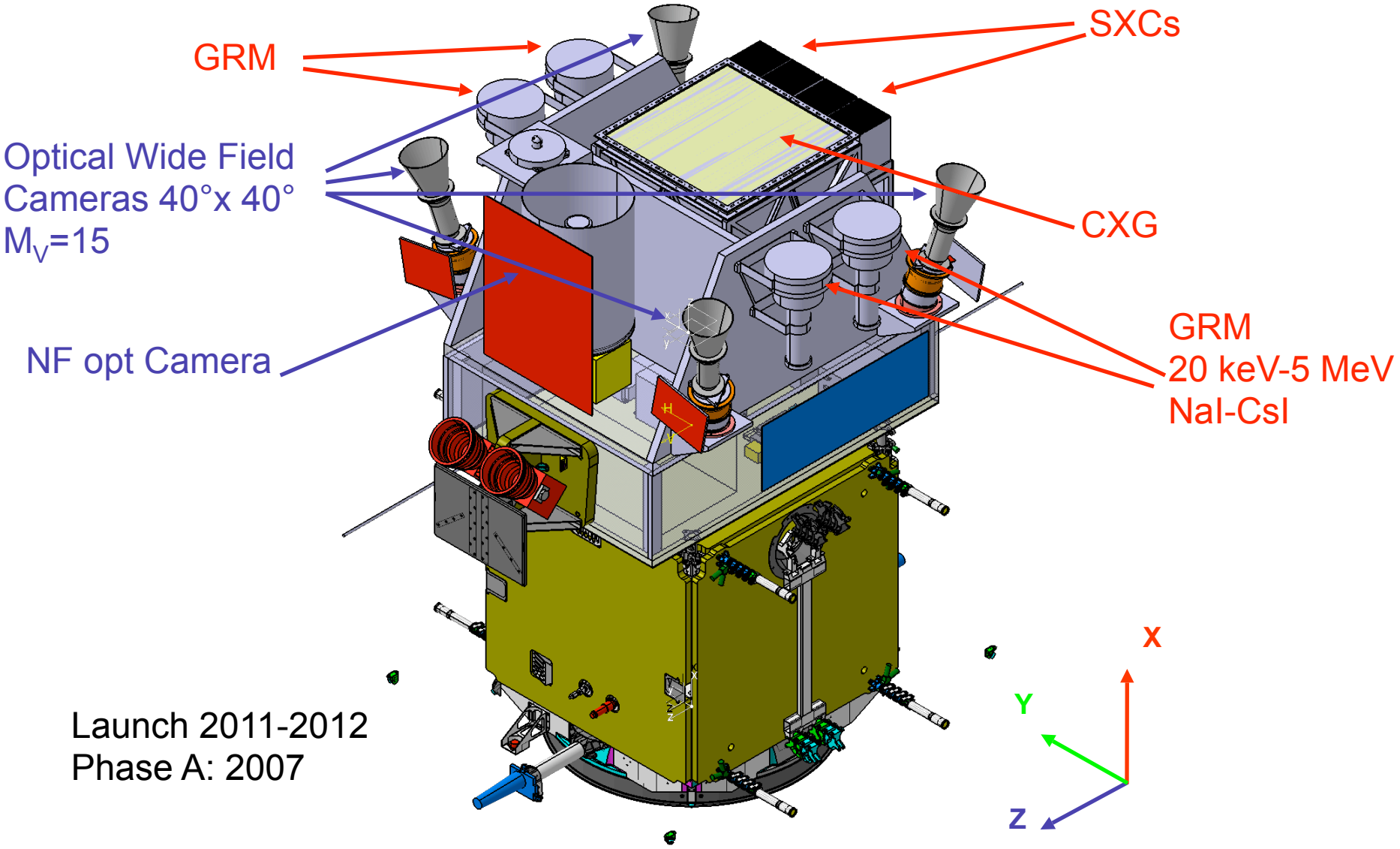
3- An alert network (The VHF network)

4- A dedicated ground robotic unit (GFT)

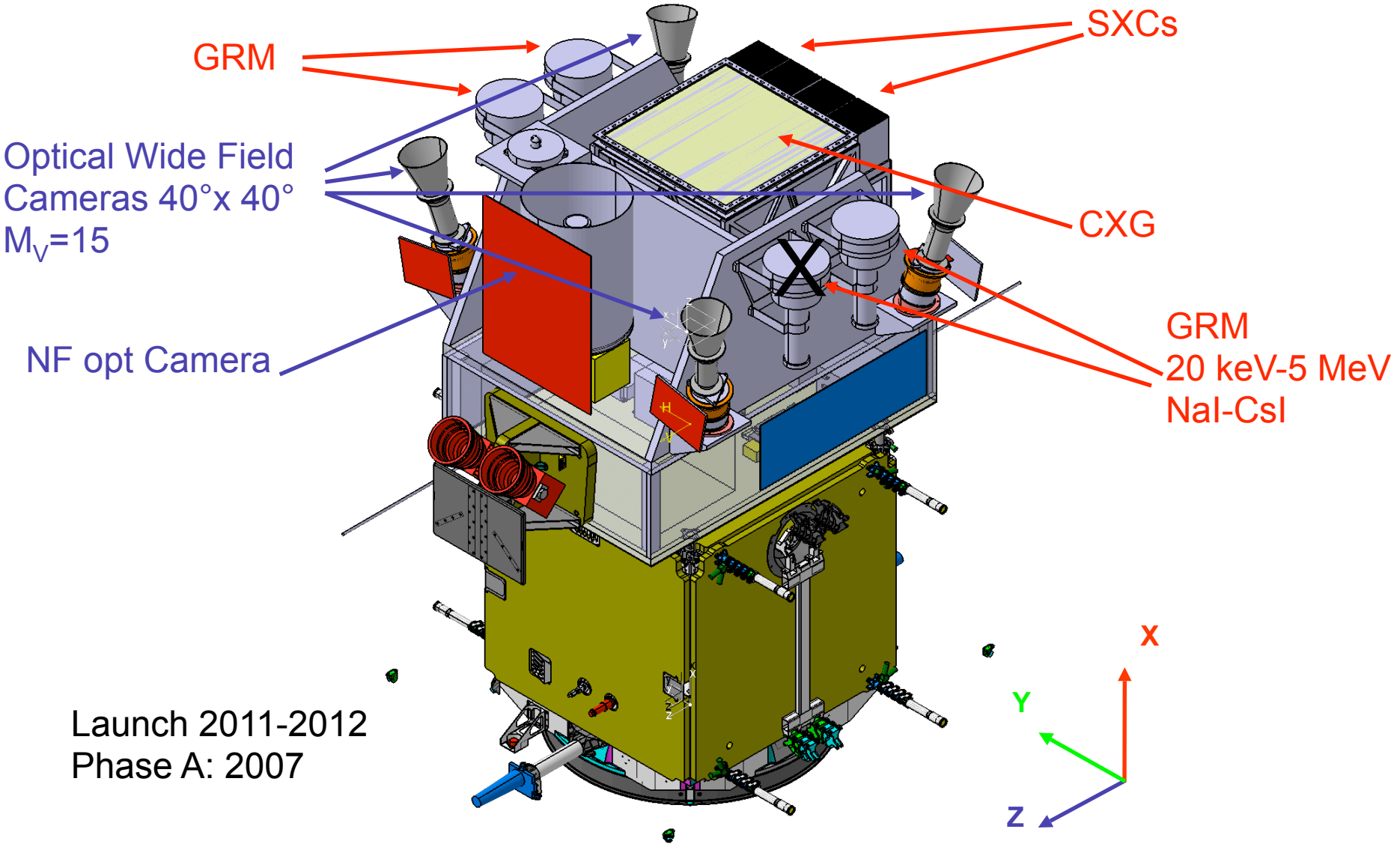
5- A ground segment

The ECLAIRs Instrumnent Characteristics

	CXG *IBIS/ISGRI heritage*	SXCs *HETE II heritage (MIT)*
Energy range	4 – 300 keV	1-12 keV
Field of view	2 sr	2 sr
Sensitive area	1024 cm^2 CdTe 6400 : 4mm x 4 mm pixels	96 cm^2 Si 1k x 1K : 24µm x 24µm pixels
Mask open fraction	30%	20%
Burst localization rate	80 $year^{-1}$	40 $year^{-1}$
Source localization	10 arcmin for 5σ	<1 arcmin for 5σ



Launch 2011-2012
Phase A: 2007



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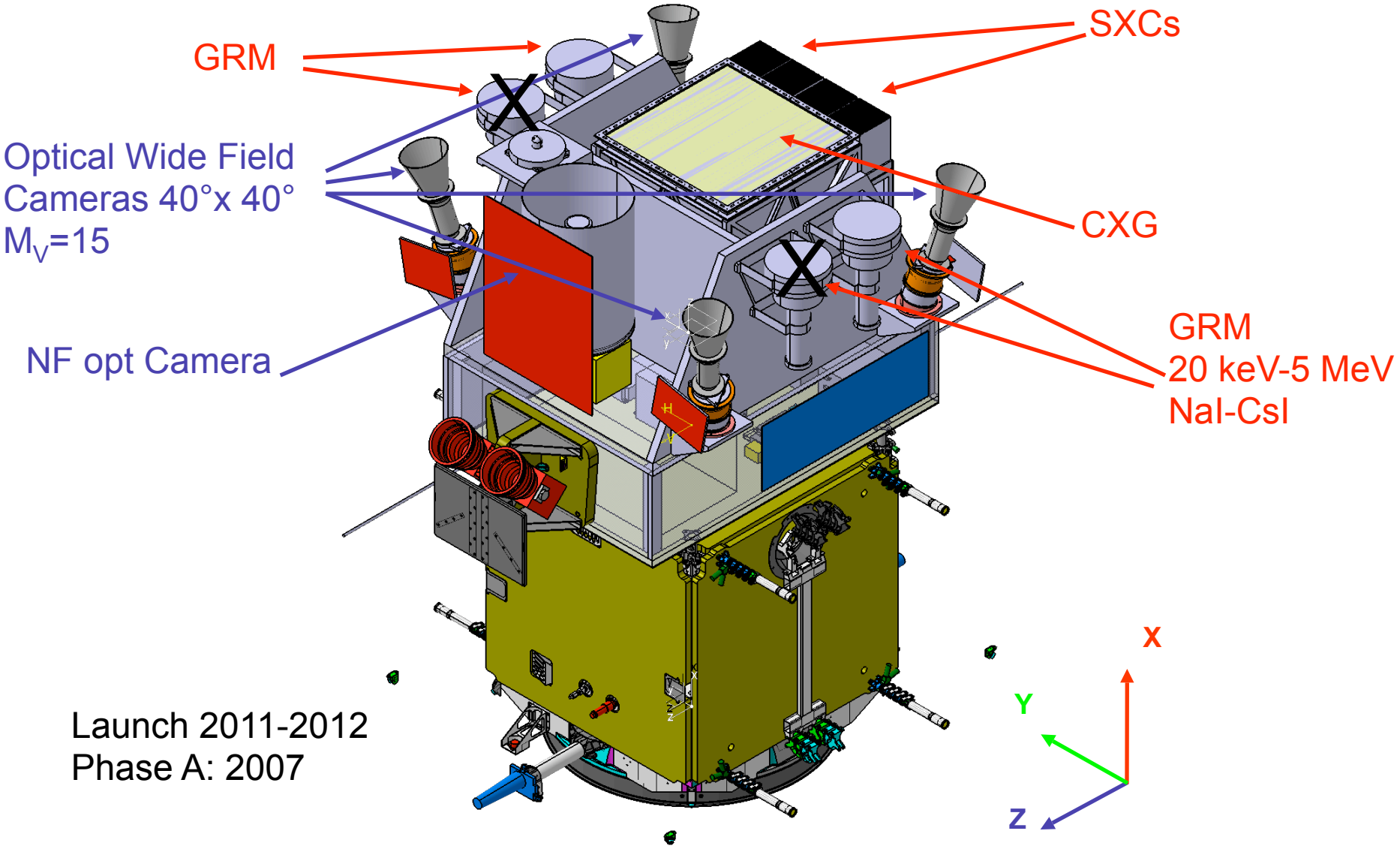

Launch 2011-2012
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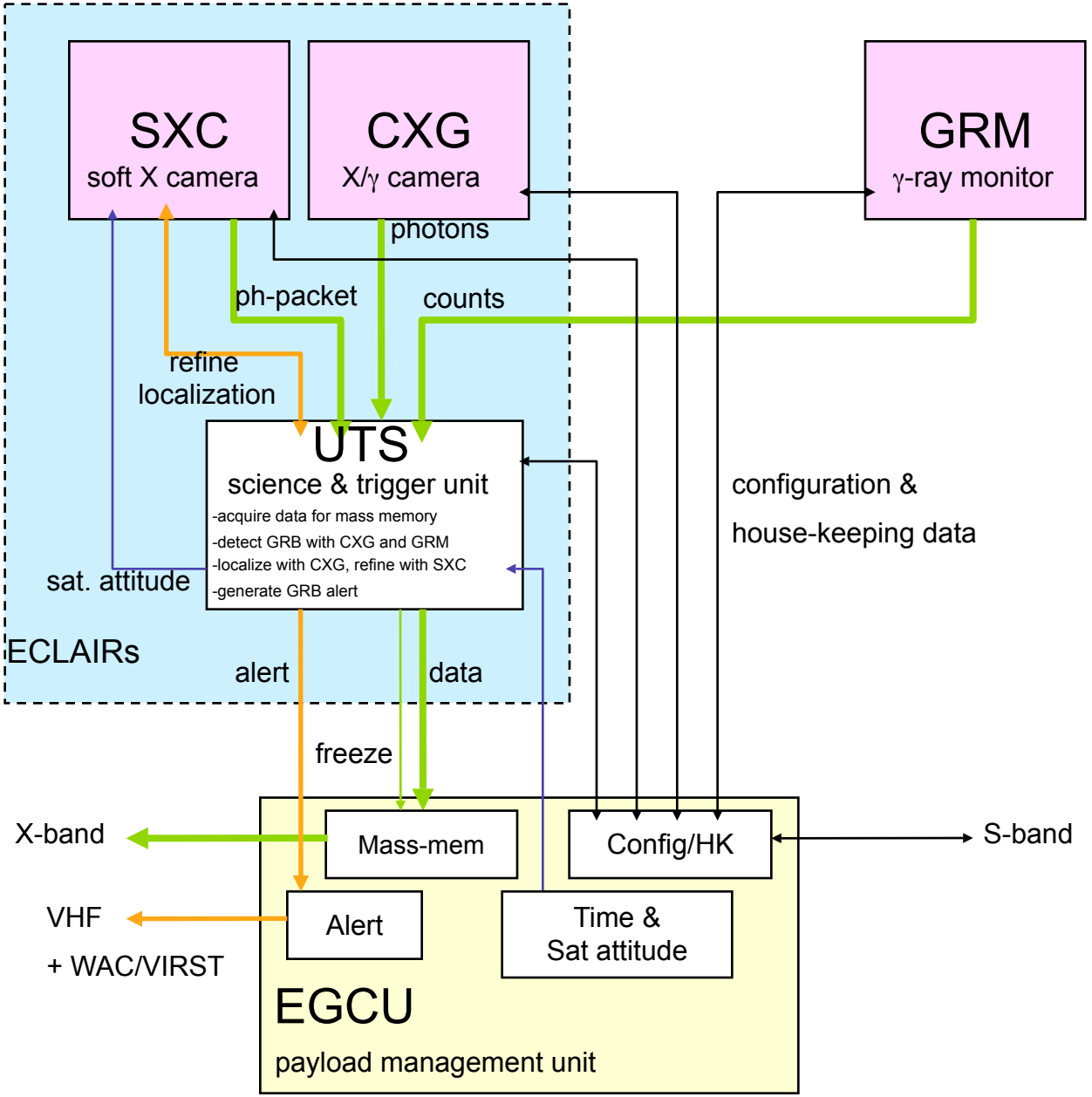
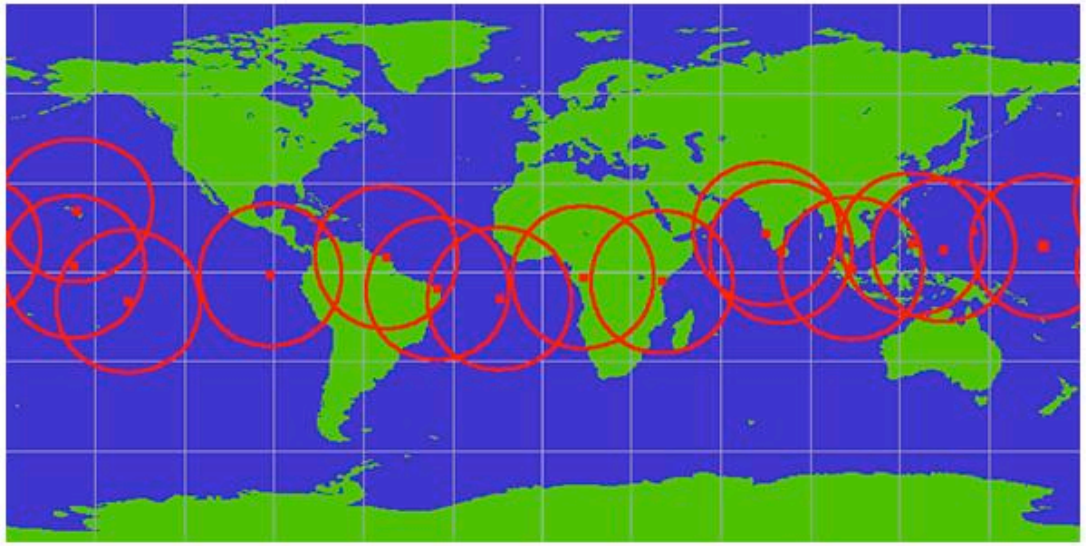
ECLAIRs

The Alert strategy

Time after trigger	Number of bursts (enitre mission)	Error Box	
t0 + 10s < T<t0 + 1mn	200 bursts	10 arcmin	CXG
	100 bursts	<1 arcmin	SXC
t0 + 5 mn	40 bursts	1 arcsec	GFTs

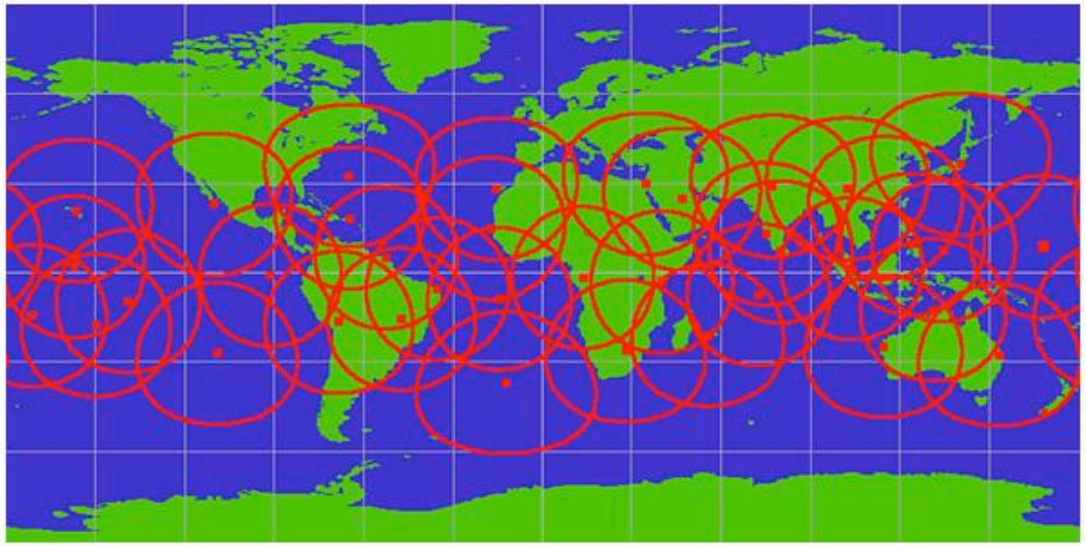

SXC
soft X camera
CXG
X/γ camera
GRM
γ-ray monitor
photons
ph-packet
counts
refine
localization
UTS
science & trigger unit
-acquire data for mass memory
-detect GRB with CXG and GRM
-localize with CXG, refine with SXC
-generate GRB alert
configuration &
house-keeping data
sat. attitude
ECLAIRs
alert
data
freeze
X-band
Mass-mem
Config/HK
S-band
VHF
+ WAC/VIRST
Alert
Time &
Sat attitude
EGCU
payload management unit

HETE2
15 stations



i = 30 °
h = 600 km

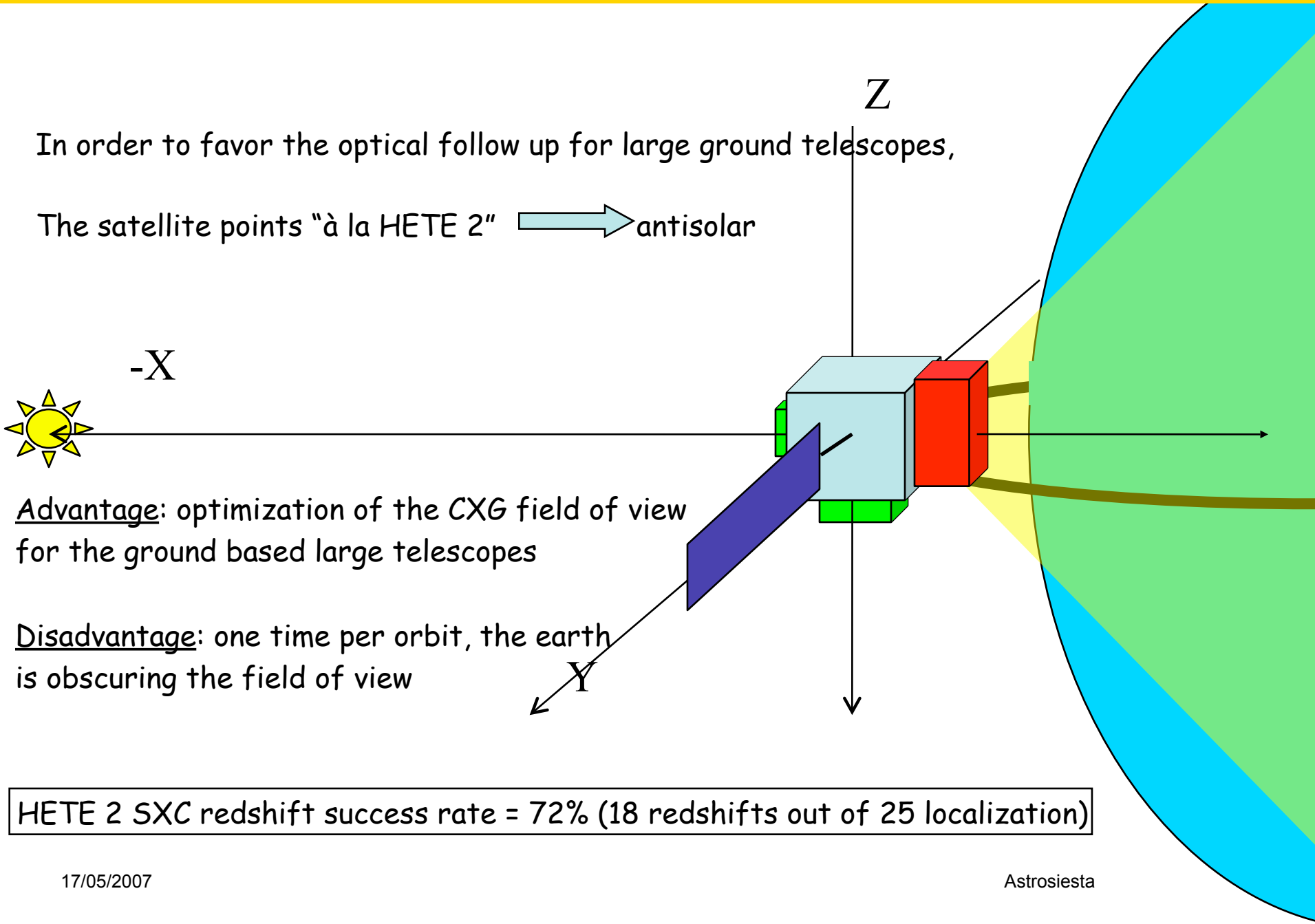
SVOM
38 stations



Pointing strategy / antisolar pointing motivations

In order to favor the optical follow up for large ground telescopes,

The satellite points "à la HETE 2" ⇒ antisolar



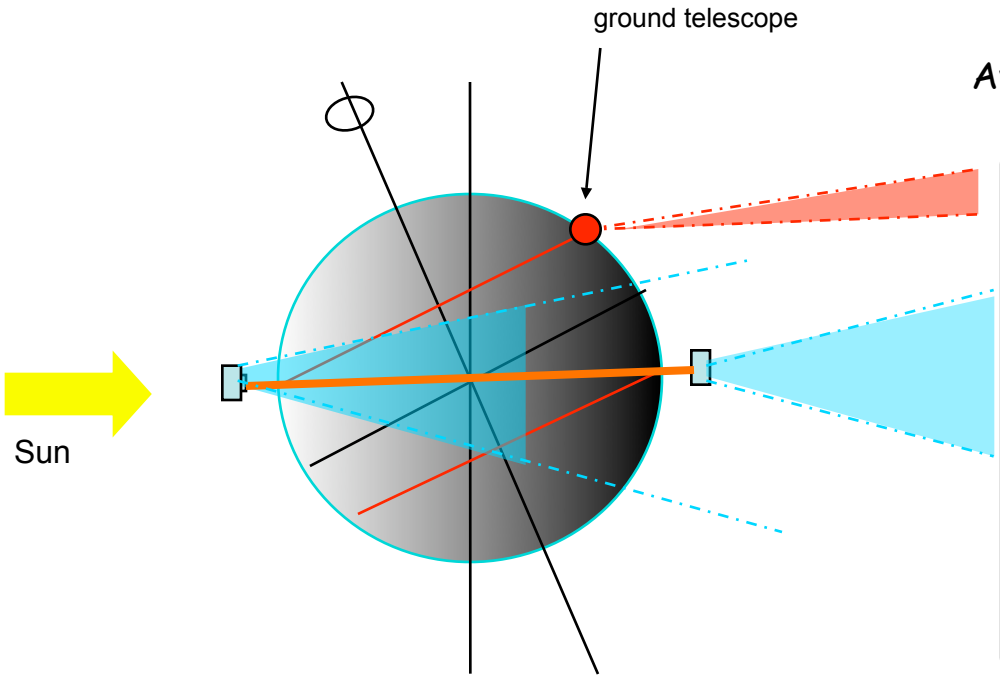
Advantage: optimization of the CXG field of view for the ground based large telescopes

Disadvantage: one time per orbit, the earth is obscuring the field of view

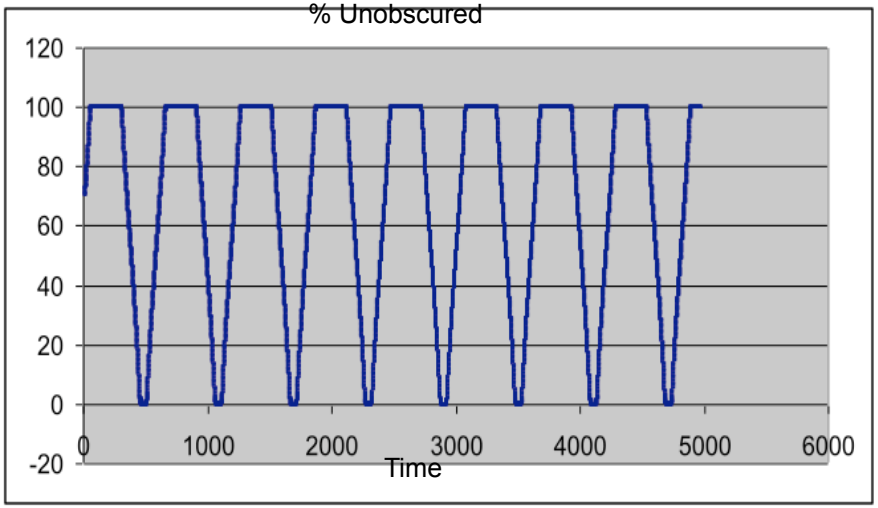
HETE 2 SXC redshift success rate = 72% (18 redshifts out of 25 localization)

Pointing strategy / antisolar pointing motivations

The world large telescopes are located at tropical latitudes



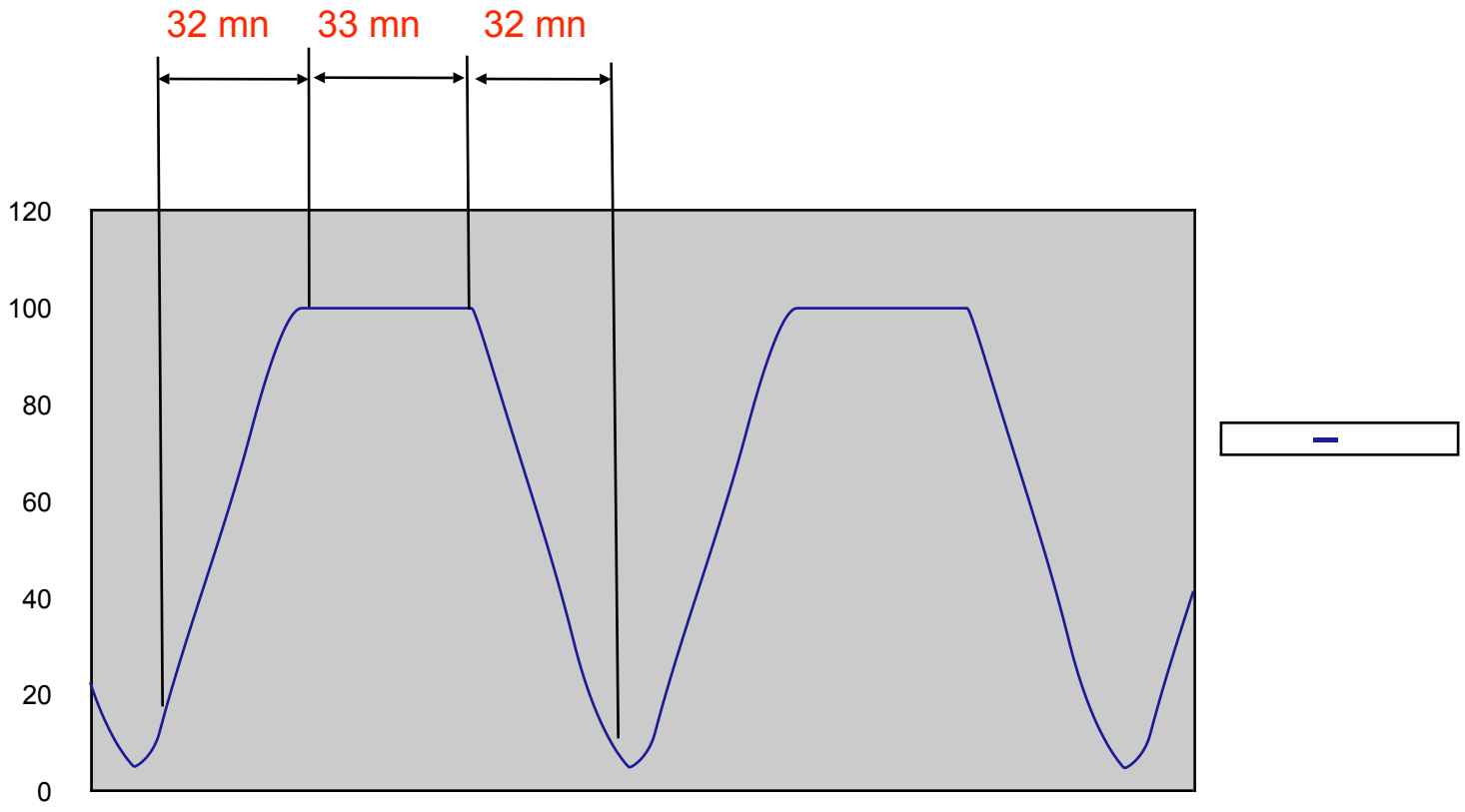
Averagely 67% of the field of view (2sr) is useful



The satellite is always aiming at the direction of the night

The center of the CXG field of view is far above the horizon for tropical ground telescopes

Pointing strategy / antisolar pointing motivations

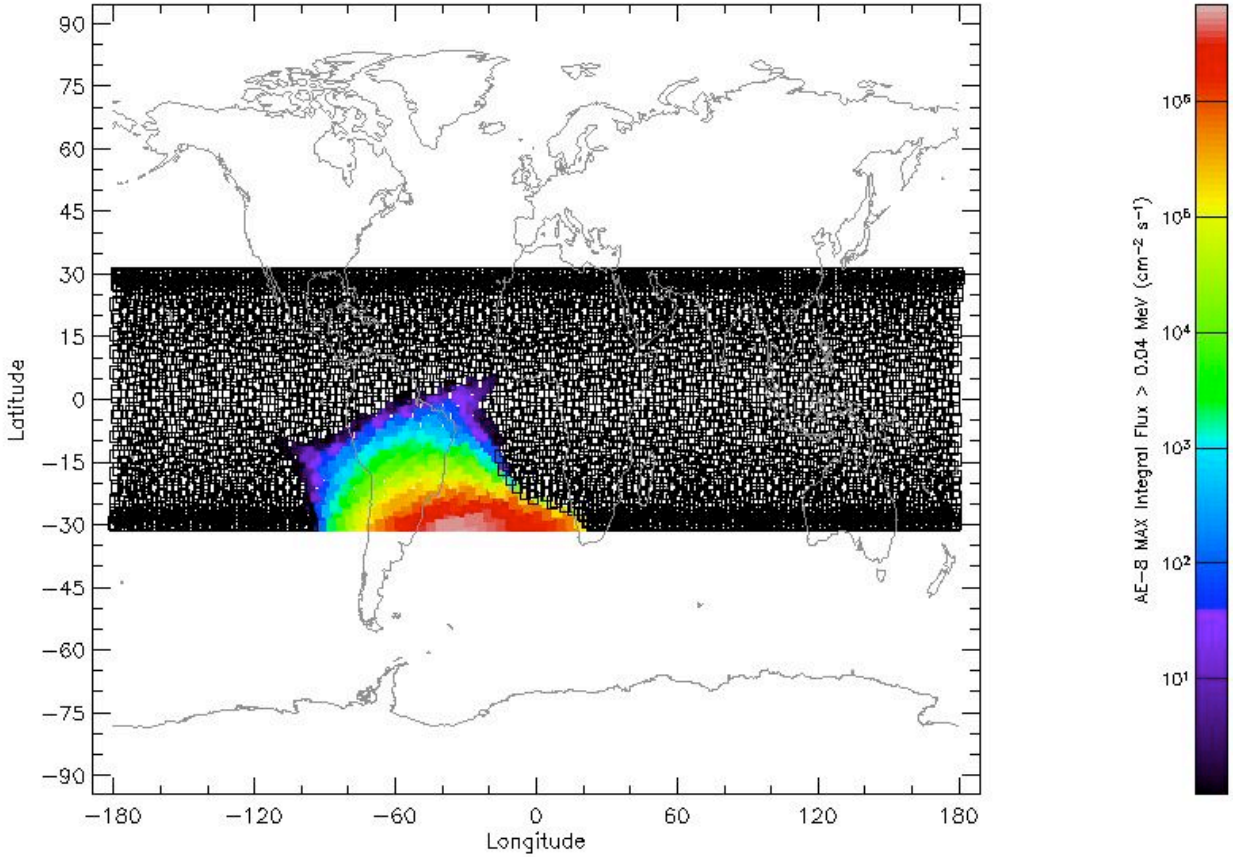


Inclination = 30°
Altitude = 600 km

Pointing strategy / antisolar pointing consequences

Exposition factor (1)

The South Atlantic Anomaly

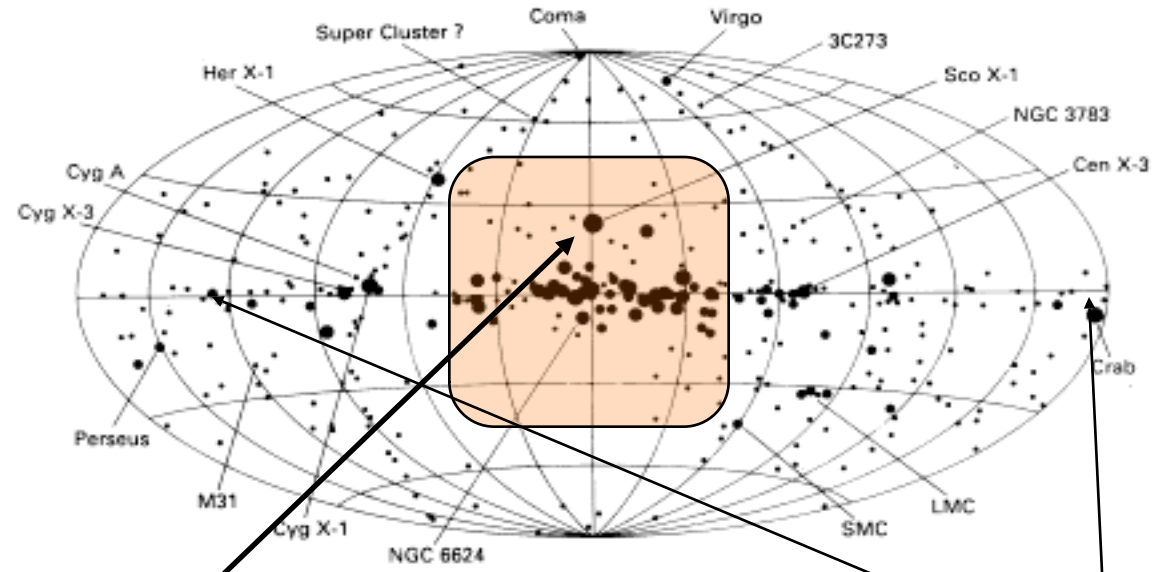


i = 30° h=600km Dead time ≈ 13%

Pointing strategy: the γ-ray sky constraint

Uhuru X-ray map

X-ray sources from the *Fourth Uhuru Catalog* displayed in galactic coordinates. The size of the symbol representing a source is proportional to the logarithm of the peak source intensity. The 339 X-ray sources observed with the UHURU (SAS-A) X-ray observatory are displayed. (Adapted from Forman, W. *et al.*, *Ap. J. Suppl.*, **38**, 357, 1978.)

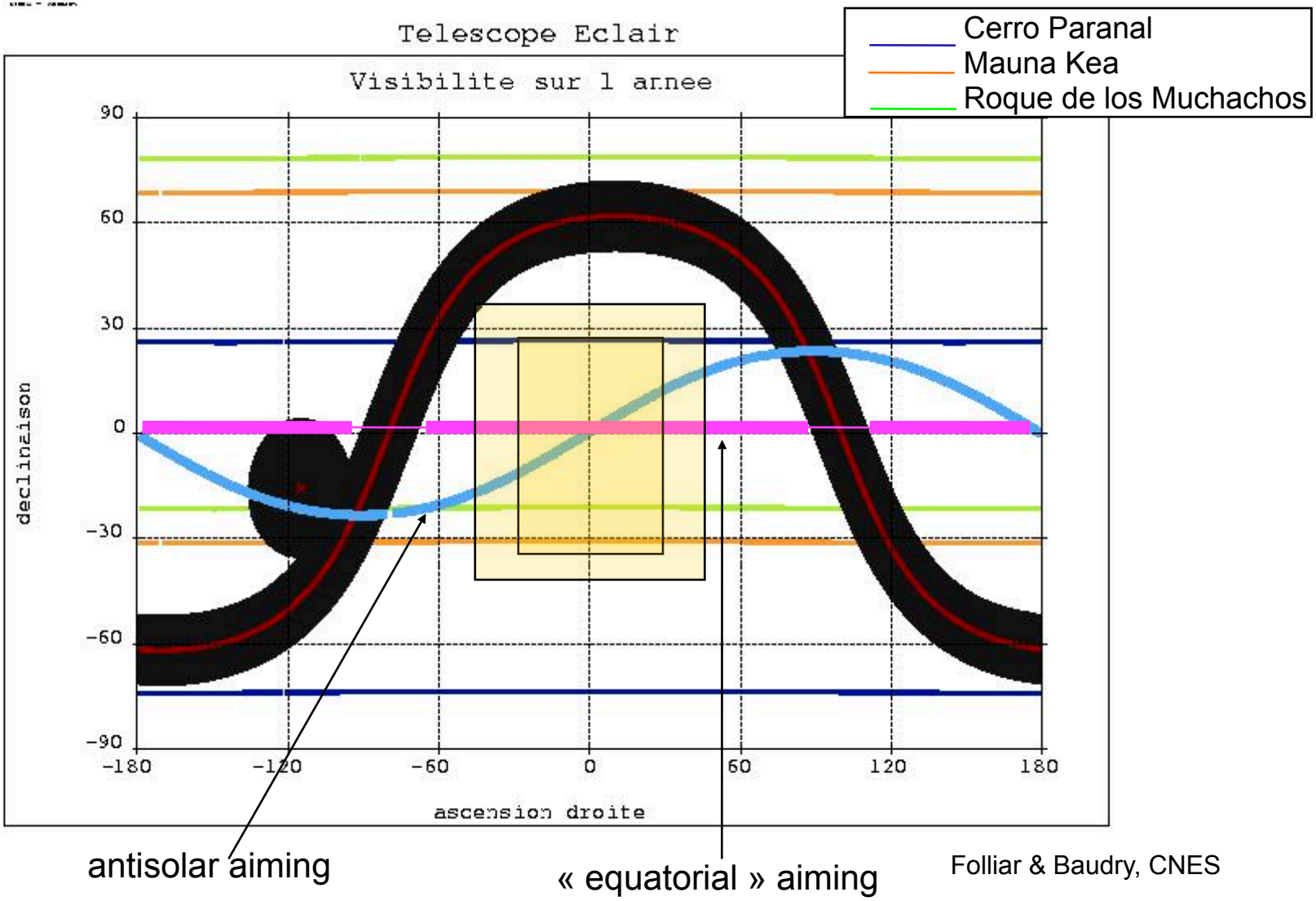


ScoX1

Galactic plane

Pointing strategy: Optimization

ONE YEAR



Folliar & Baudry, CNES

Summary

ECLAIRS/SVOM will provide accurate localizations (10'⇒1') for 80⇒40 bursts yr^{-1}

2 dedicated robotic telescopes

For all the bursts broad band X/γ (1 keV-5 MeV) spectra will be available (E_{peak}!)

The on board Wide Field Optical Camera will provide simultaneous coverage and precursors search

The pointing strategy will be optimized in order to enhance the follow up possibilties for large ground based telescopes (redshift!)