Space Missions in the Next Decade

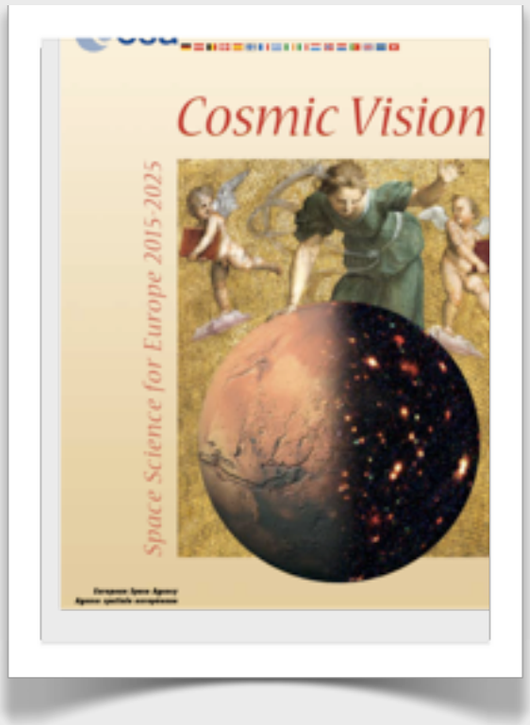
Stéphane BASA,

Laboratoire d'Astrophysique de Marseille

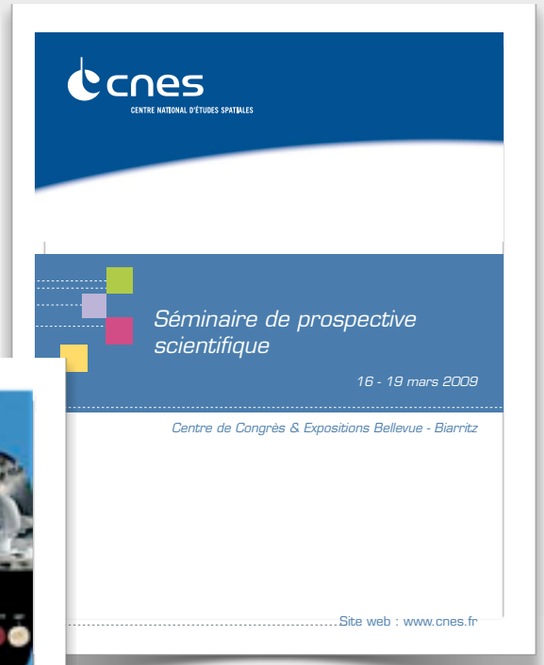
Observatoire Astronomique Marseille-Provence

Road Map

- **ESA, *Cosmic Vision* (2005):**
  - What are the conditions for planet formation and the emergence of life?
  - How does the Solar System work?
  - What are the fundamental physical laws of the Universe?
  - How did the Universe originate and what is it made of?



- **CNES, *Colloque de Prospective* (2009):**
  - Similar recommendations than ESA.



- **NASA, *Decadal Survey Astro* (2010):**
  - Cosmic dawn: Searching for the first stars, galaxies and black holes.
  - New worlds: Seeking nearby, habitable planets.
  - Physics of the Universe: Understanding Scientific Principles.

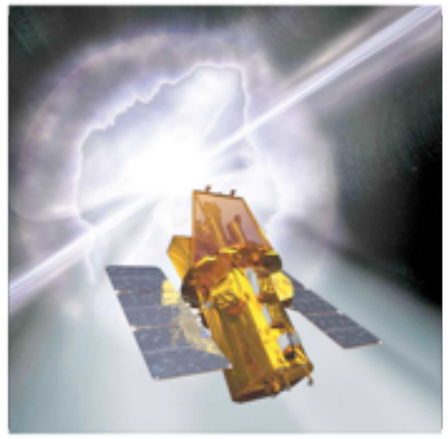
General Considerations

- **Many missions in operation:**
  - Spectral domain fully covered.
  - Operations impact the budget available for new developments.
  - ➡ *Probably one of the most favorable period for space science!*

- **But a programmatic context which is becoming <u>very difficult</u>:**
  - Recurrent JWST problems impact largely NASA budget.
  - ESA-NASA bilateral agreements are affected!
  - What about JAXA after disasters?

➡ ***Consider only the missions which could contribute to the follow-up:***
- ***Open widely to the community.***
- ***In operation in 2015-2025.***

Present Astronomical Facilities



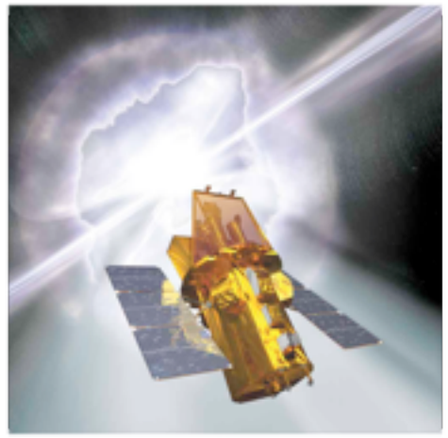
- **SWIFT,** a visible, to X-ray and gamma-ray satellite for GRB studies (NASA):
  - Launch date: 2004.
  - ToO capabilities.
  - But funding beyond 2012 could be an issue!

- **XMM-Newton and Chandra**: X-ray missions (ESA and NASA):
  - Launch date: 1999.
  - ToO capabilities.
  - Funded up-to 2012, but consensus to continue up-to ~2018.

- **INTEGRAL**, a gamma-ray mission (ESA):
  - Launch date: 2002.
  - No ToO capabilities.
  - Funded up-to 2012, but ***no*** consensus to continue.

- **FERMI**, a gamma-ray mission (NASA):
  - Launch date: 2008.
  - No ToO capabilities.
  - In operation for ~10 years.

Present Astronomical Facilities



- **SWIFT,** a visible, to X-ray and gamma-ray satellite for GRB studies (NASA):
  - Launch date: 2004.
  - ToO capabilities.
  - But funding beyond 2012 could be an issue!

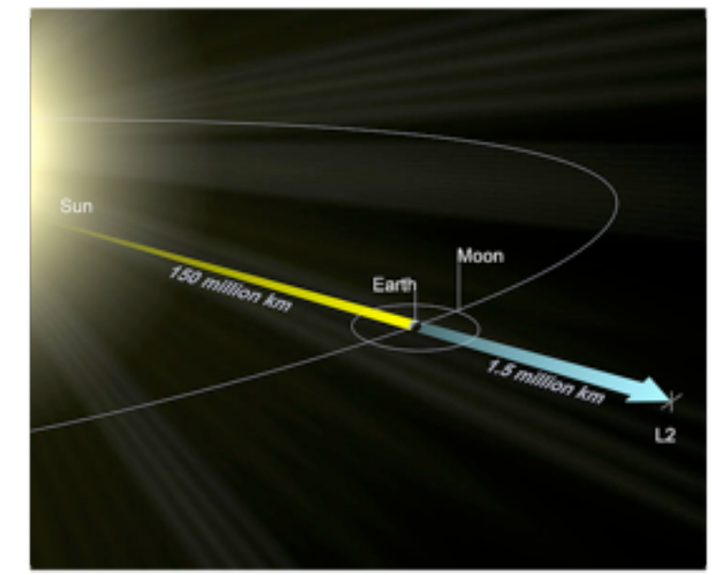
- **XMM-Newton and Chandra**: X-ray missions (ESA and NASA):
  - Launch date: 1999.
  - ToO capabilities.
  - Funded up-to 2012, but consensus to continue up-to ~2018.

- **INTEGRAL**, a gamma-ray mission (ESA):
  - Launch date: 2002.
  - No ToO capabilities.
  - Funded up-to 2012, but ***no*** consensus to continue.

- **FERMI**, a gamma-ray mission (NASA):
  - Launch date: 2008.
  - No ToO capabilities.
  - In operation for ~10 years.

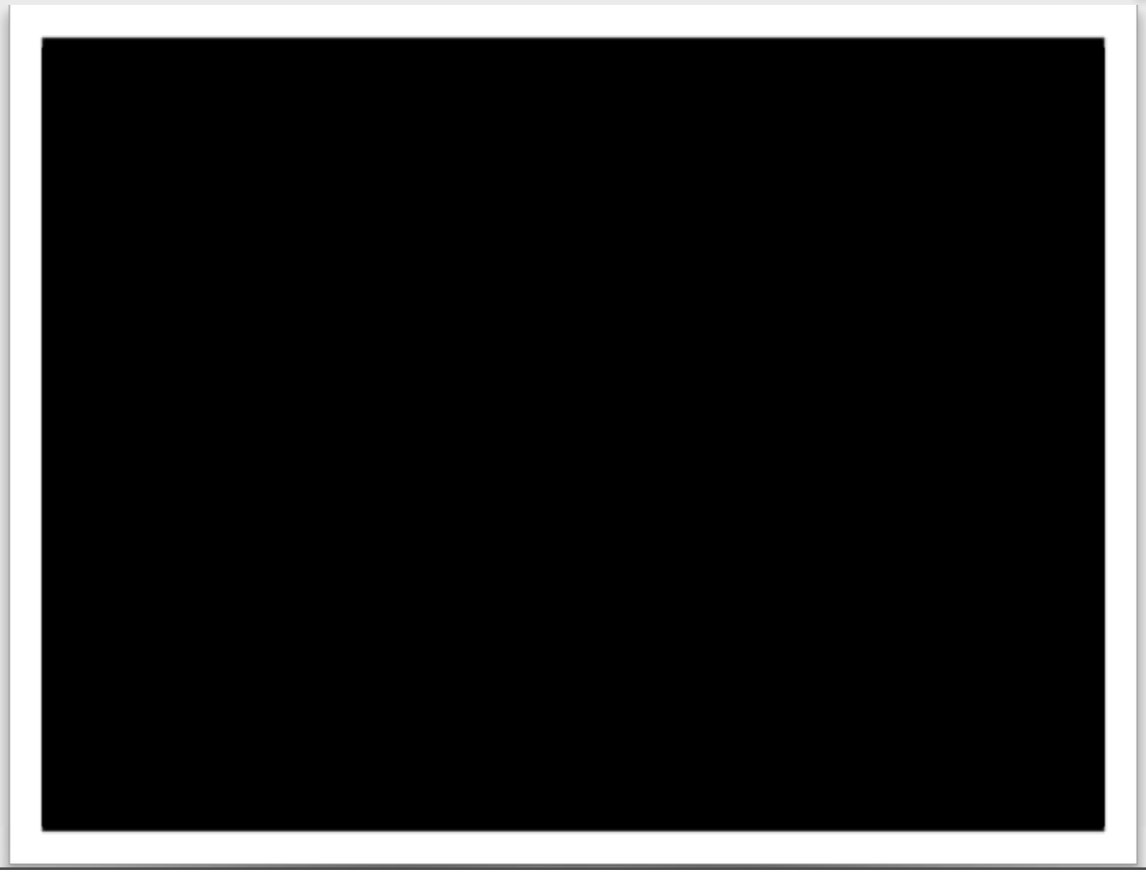
Facilities in the next decade

- What is relatively certain? -



• **JWST**, the next near-infrared space telescope (NASA and ESA):

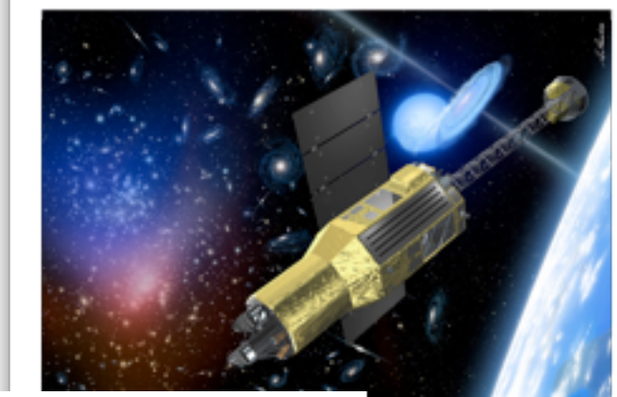
- Successor of the Hubble Space Telescope.
- *The most complex scientific payload never developed*.
- Still some major problems, which impact dramatically NASA budget!
- No ToO capabilities.
- Launch date: > 2018!

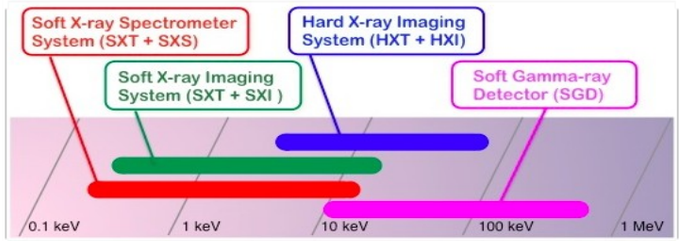


Facilities in the next decade

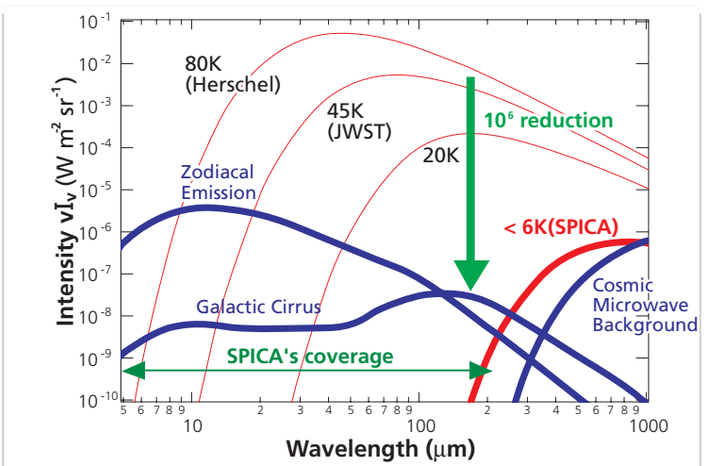
- What is relatively certain? -

- **Astro-H**, an X-ray mission (JAXA):
  - In the track of the Suzaku mission.
  - Complement to XMM-Newton, Chandra and Fermi.
  - No ToO capabilities.
  - Launch date: ~2014 (5 years operation).



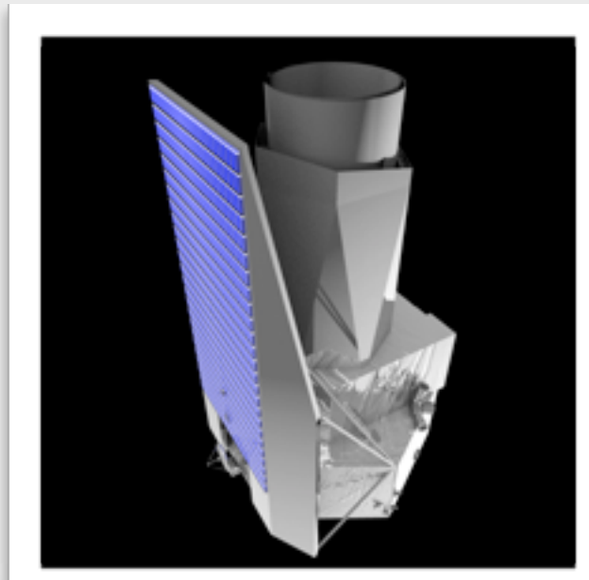


- **SPICA**, a far-infrared mission (JAXA, ESA):
  - Successor of the Akari and Herschel missions.
  - Not yet formally approved, but highly ranked by the agencies.
  - Launch date: ~2018 (5 years operation).



Facilities in the next decade

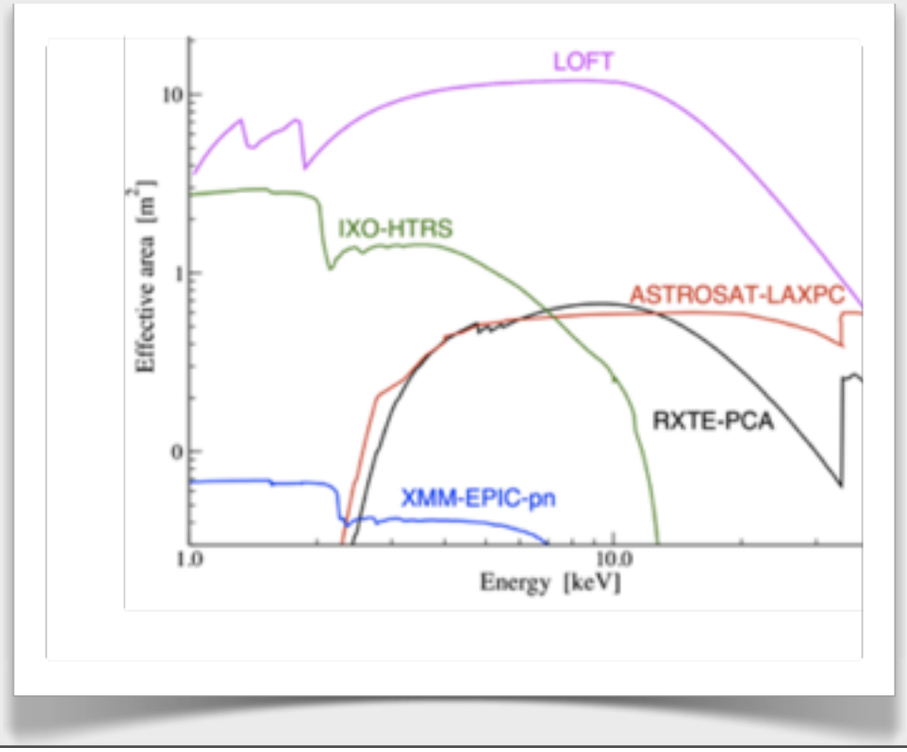
- What is less certain? -



- **EUCLID**, a wide field of view optical and near-infrared telescope (ESA):
  - Medium class mission proposal.
  - No ToO capabilities.
  - Not yet approved: selection in October 2011 (TBC).
  - Launch date: > 2020?

- **WFIRST**, a wide field of view optical and near-infrared telescope (NASA):
  - Top priority of the US Decadal Survey.
  - But scheduling difficult due to NASA budget problems and EUCLID proposal.
  - Launch date: > 2022?

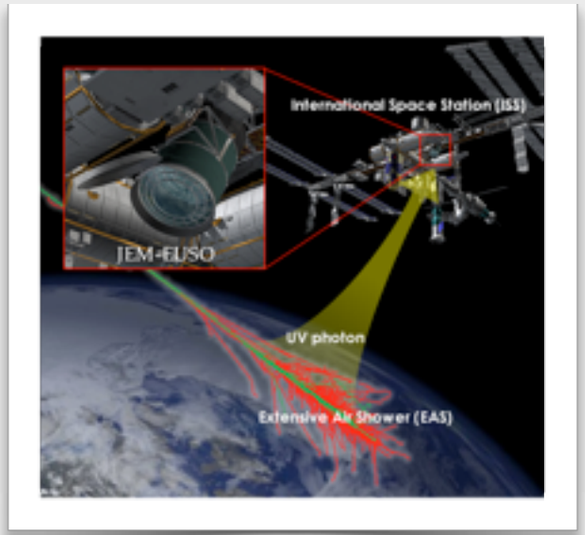
- **LOFT**, an X-ray mission with timing capabilities (ESA):
  - Medium class mission just proposed in 2010.
  - Under study at ESA: Assessment Phase.
  - Not yet approved: selection in October 2011 (TBC).
  - Launch date: > 2020?



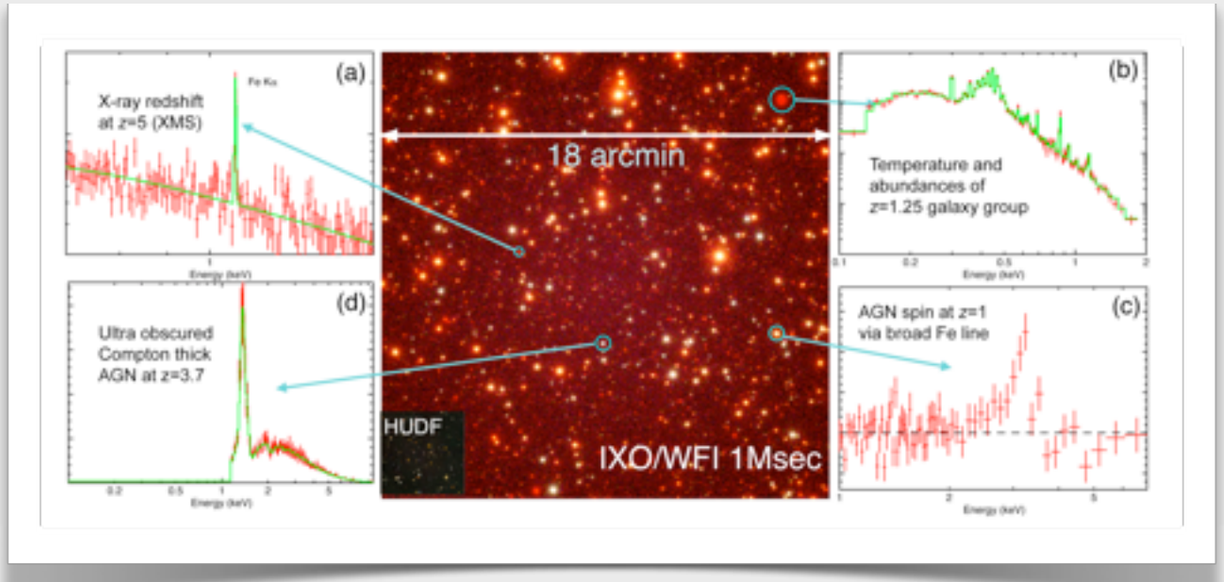
Facilities in the next decade

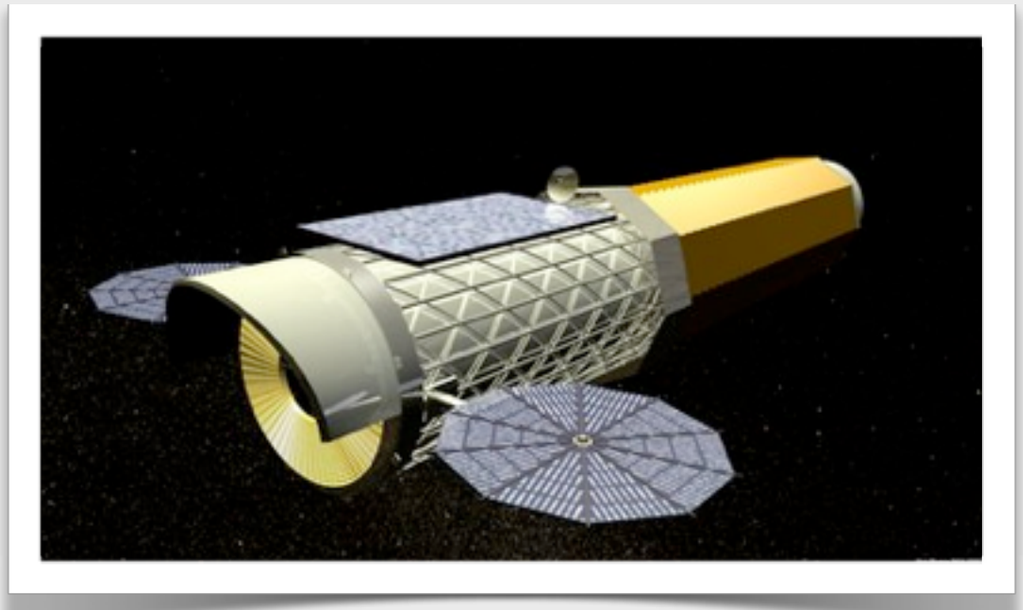
- What is more hazardous? -

- **JEM-EUSO**, a payload onboard ISS to detect UHECRs:
  - Difficult programmatic situation:
    - No clear statement from JAXA.
    - NASA doesn't support the mission.
  - Launch date: > 2015.



- **IXO**, an ambitious X-ray mission (ESA):
  - Not a NASA priority (Decadal Survey), ESA, in collaboration with JAXA, is studying the possibility to have a flagship mission.
  - Very ambitious Large mission: decision in February 2012 (TBC)?
  - Launch date (if selected): > 2022?



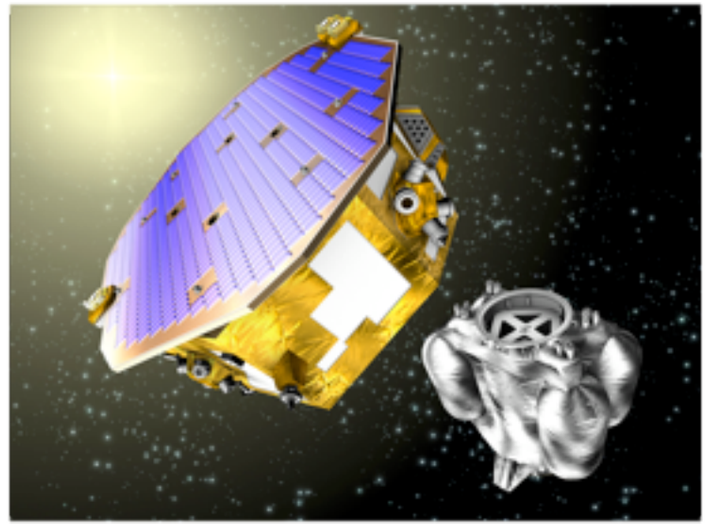


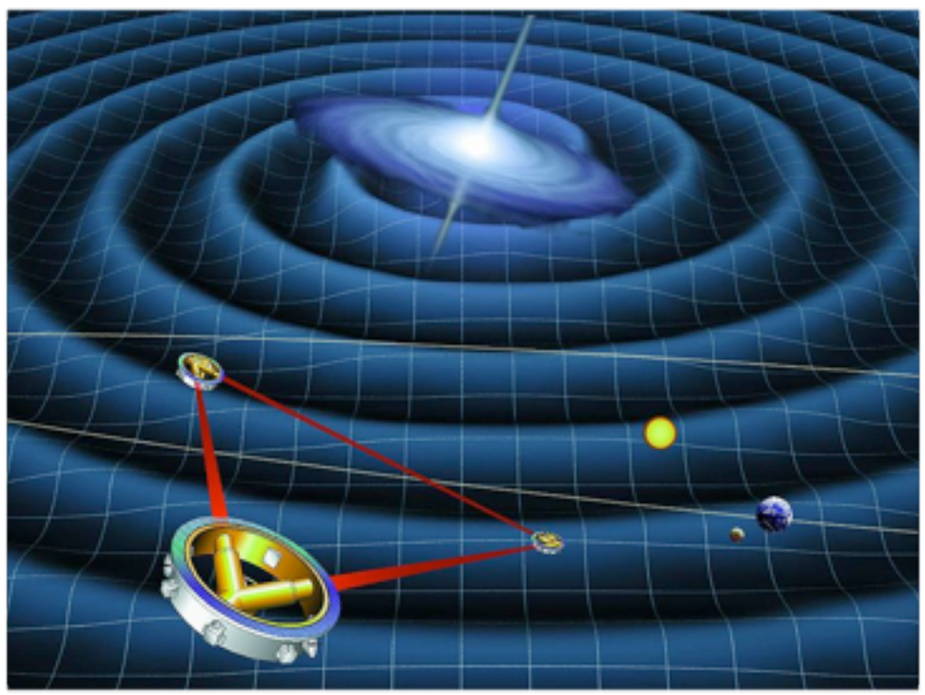
Facilities in the next decade

- What is more hazardous? -

- **LISA**, a gravitational wave mission (ESA):
  - LISA-Pathfinder:
    - Launch date: 2013.
    - But new problems: launch probably postponed by 2 years!

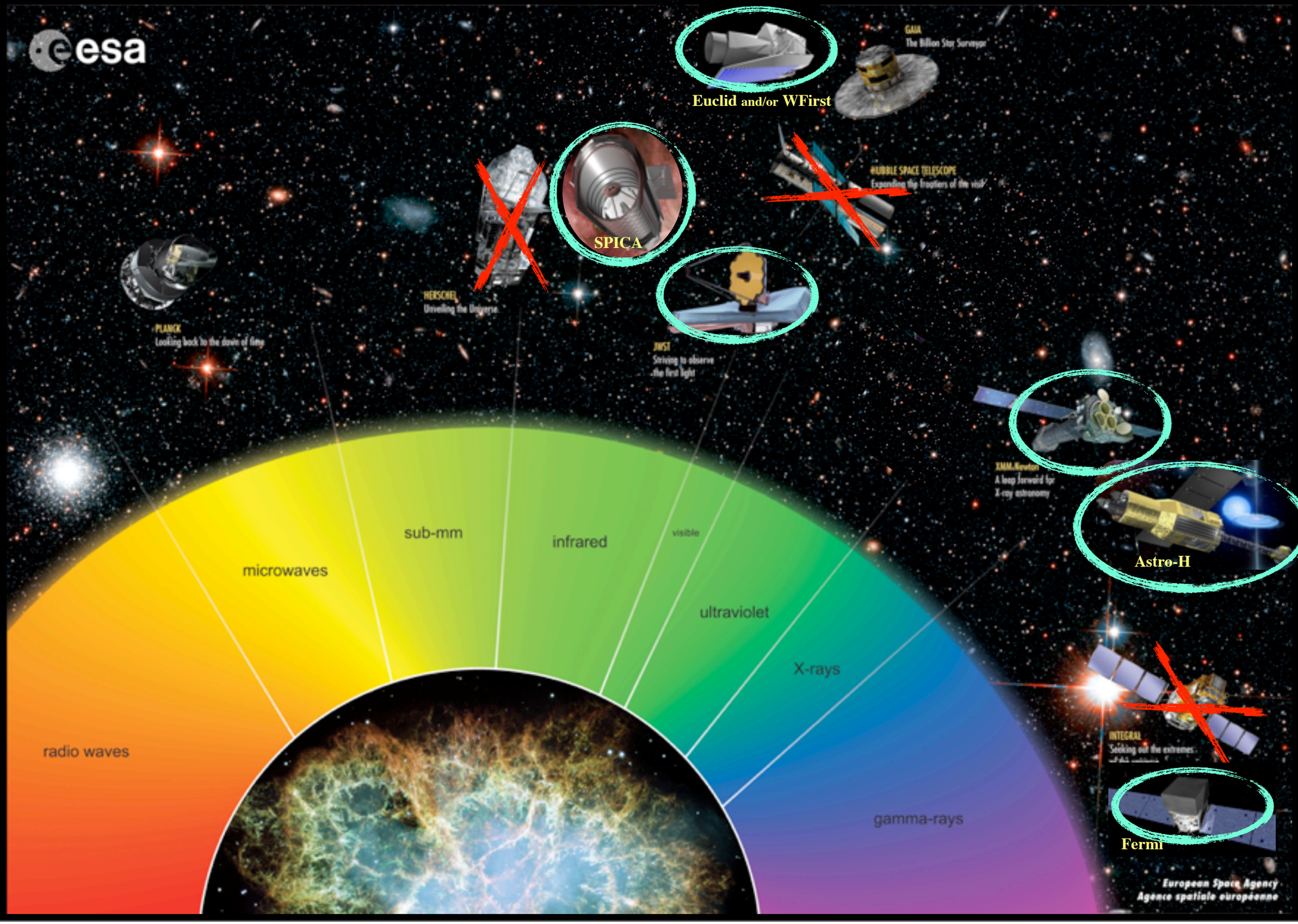
  - Not a NASA priority (Decadal Survey), ESA is studying the possibility to have a flagship mission.
  - Very ambitious Large mission: decision in February 2012 (TBC)?
  - Launch date (if selected): > 2022?





Panorama in 2015-2025?

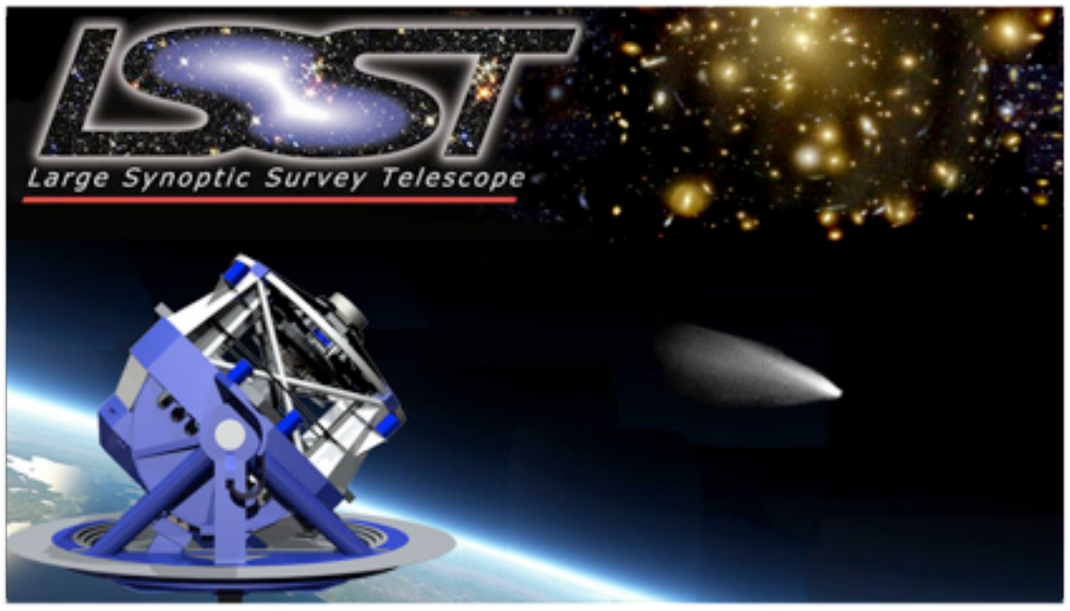
- A very difficult exercise! -

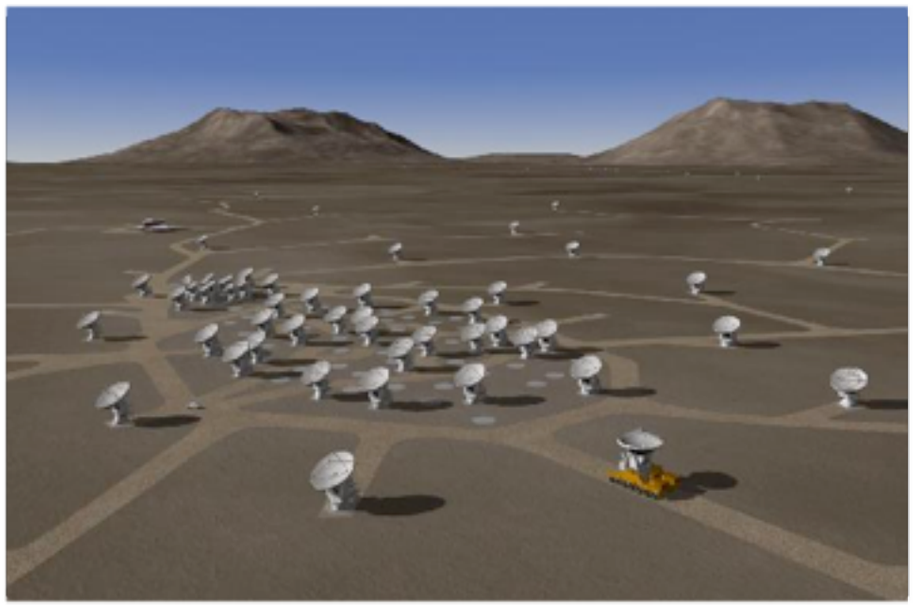


Mid-conclusion

- **Don’t forget ground capabilities!**
  - ToO always accepted.
  - New major projects will be fully operational:
    - ALMA, the largest radio-telescope.
    - LSST, a very ambitious large FoV optical telescope.

- **But also:**
  - NASA Explorer: response not yet known (june 2011?), but a good surprise could happen!
  - Sino-french bilateral agreement: SVOM.





Present satellites with GRB alert capabilities

Satellite	Instrument	FoV (sr)	Localization accuracy	Band	Operation
INTEGRAL	IBAS	0.02	12’	15 keV - 10 MeV	Oct ‘02 - …
SWIFT	BAT	1.4	15’	15 keV - 150 keV	Nov ‘04 - …
	SXT	24’	18”	0.2 keV - 10 keV	
FERMI	GBM	9.5	1.5°	8 keV - 30 MeV	May ‘08 - …
	LAT	2.4	15’	20 MeV - 300 GeV	

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

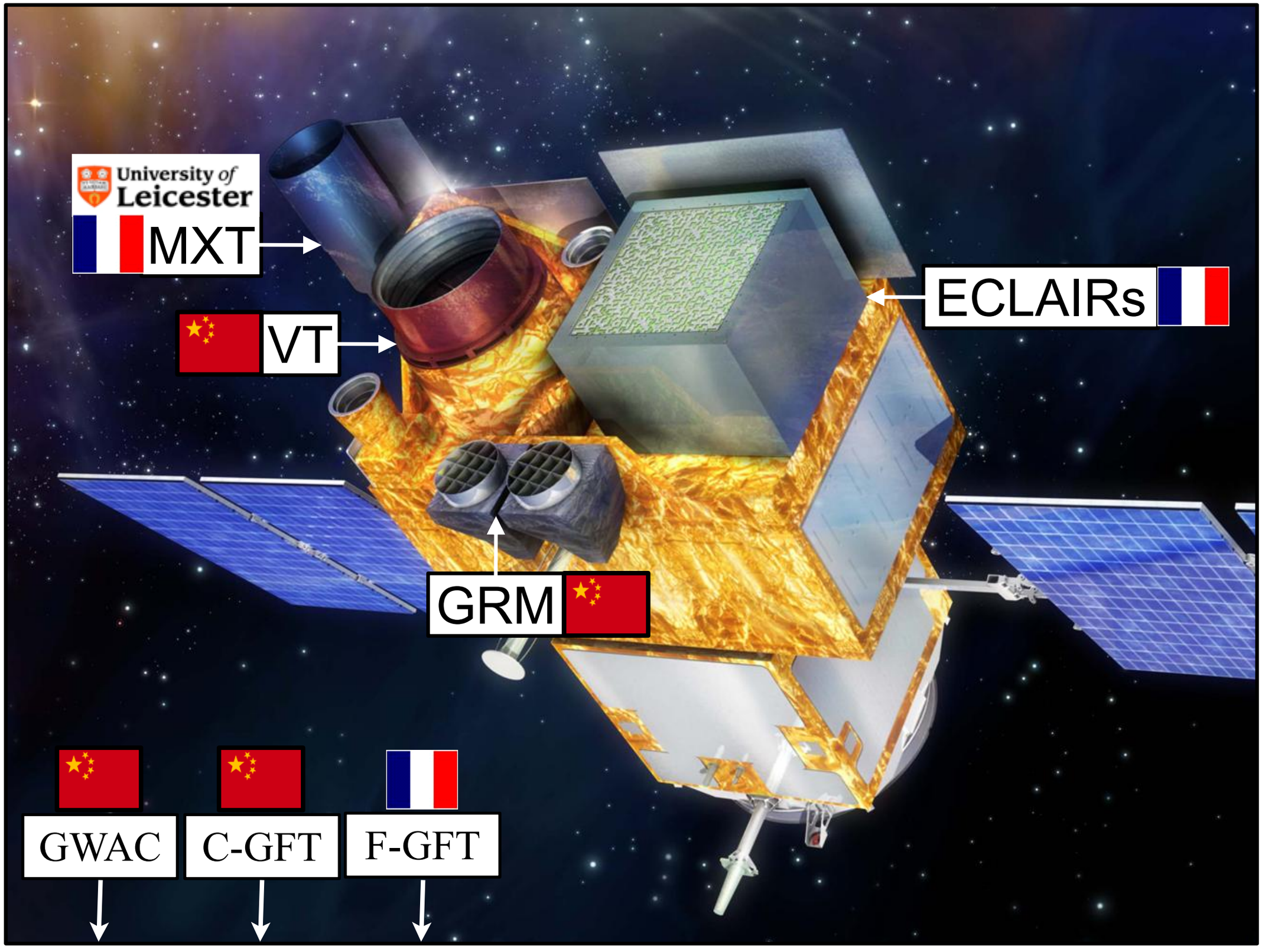
2008 SVOM Preliminary Review Requirement meeting successful

2010 SVOM Pre-Phase B meeting successful

2011 SVOM Phase B kick-off meeting

2016 Launch: >3 years lifetime

SVOM instruments

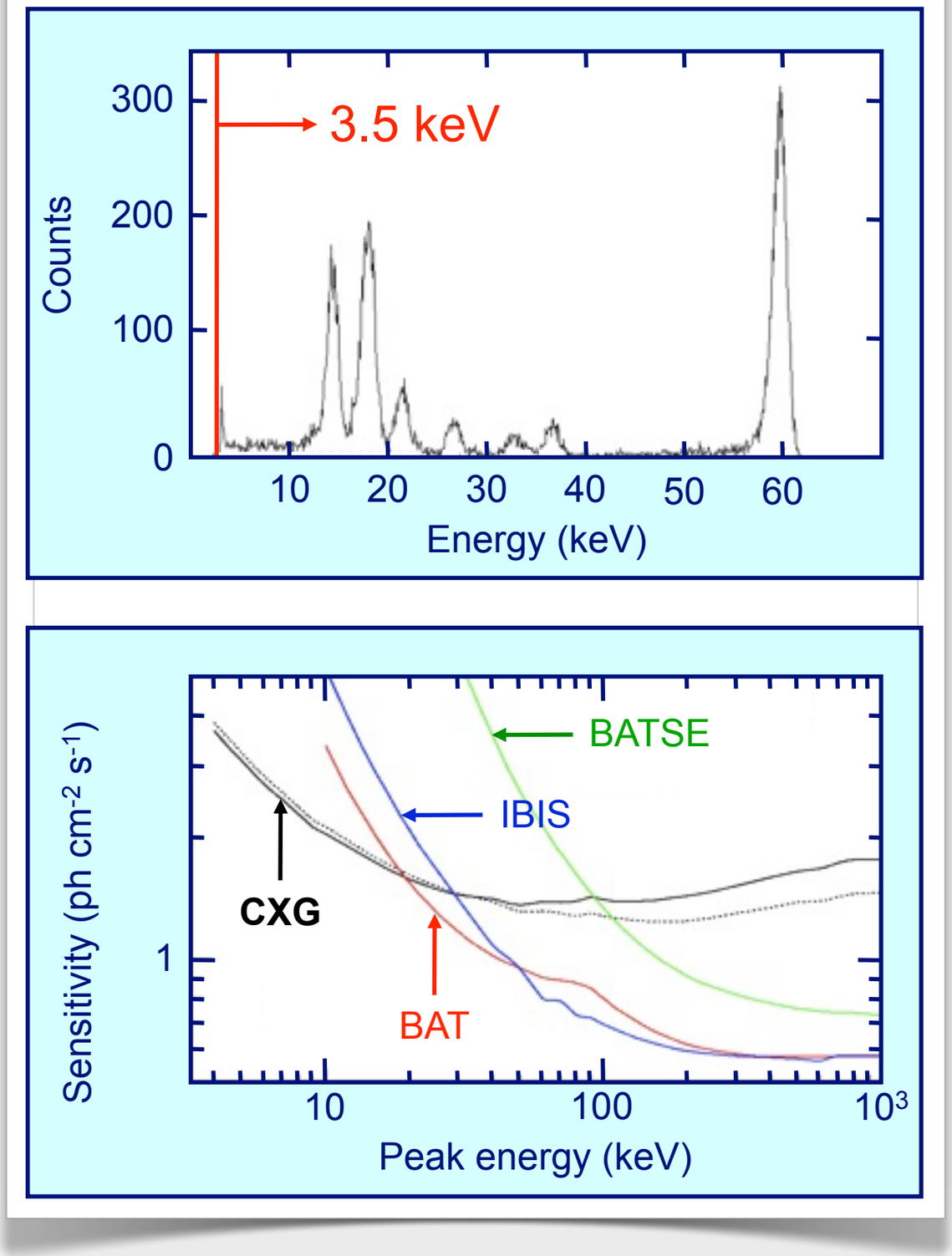


Space instruments performances

	Spectral band	Field of View	Localization Accuracy	GRBs/yr
GRM	50keV-5MeV	2 sr		~80
ECLAIRs	4-250 keV	2 sr	10 arcmin	~80
MXT	0.3-7 keV	1.1°	20 arcsec	~72
VT	400-650 nm 650-950 nm	21 × 21 arcmin^2	0.5 arcsec	~64

Nearly 20% of GRBs could be located at high redshift (z > 6)

Anticipated trigger performances



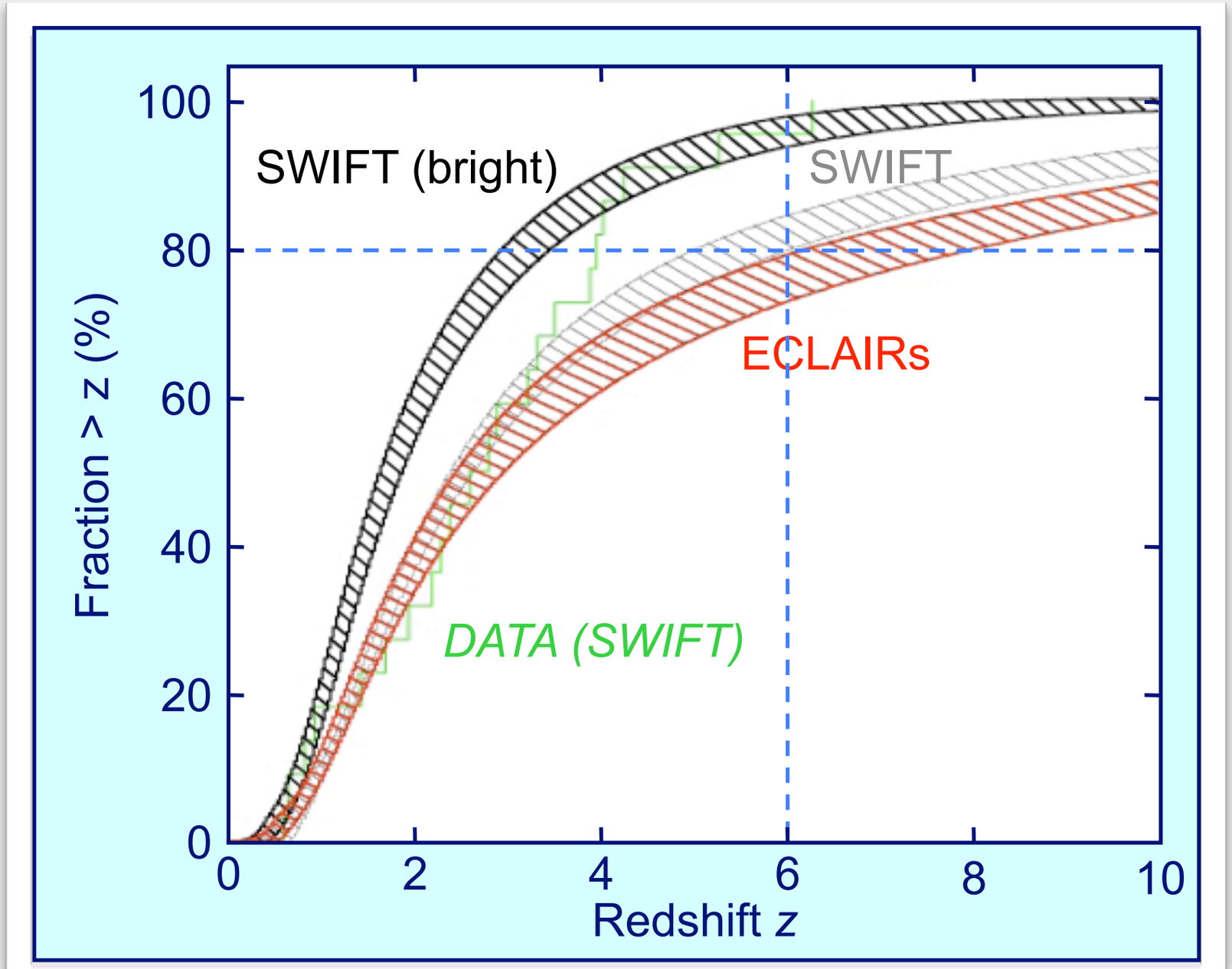
Instrument	Band (keV)	GRB/yr at z > 6
IBIS *INTEGRAL*	20-200	0.1-0.5
BAT *Swift*	15-150	1.3-4.0
CXG *SVOM*	4-50	2.0-4.0

CXG/SVOM

~ 80 GRB alerts/year

Salvatera et al. Astro-ph 2007

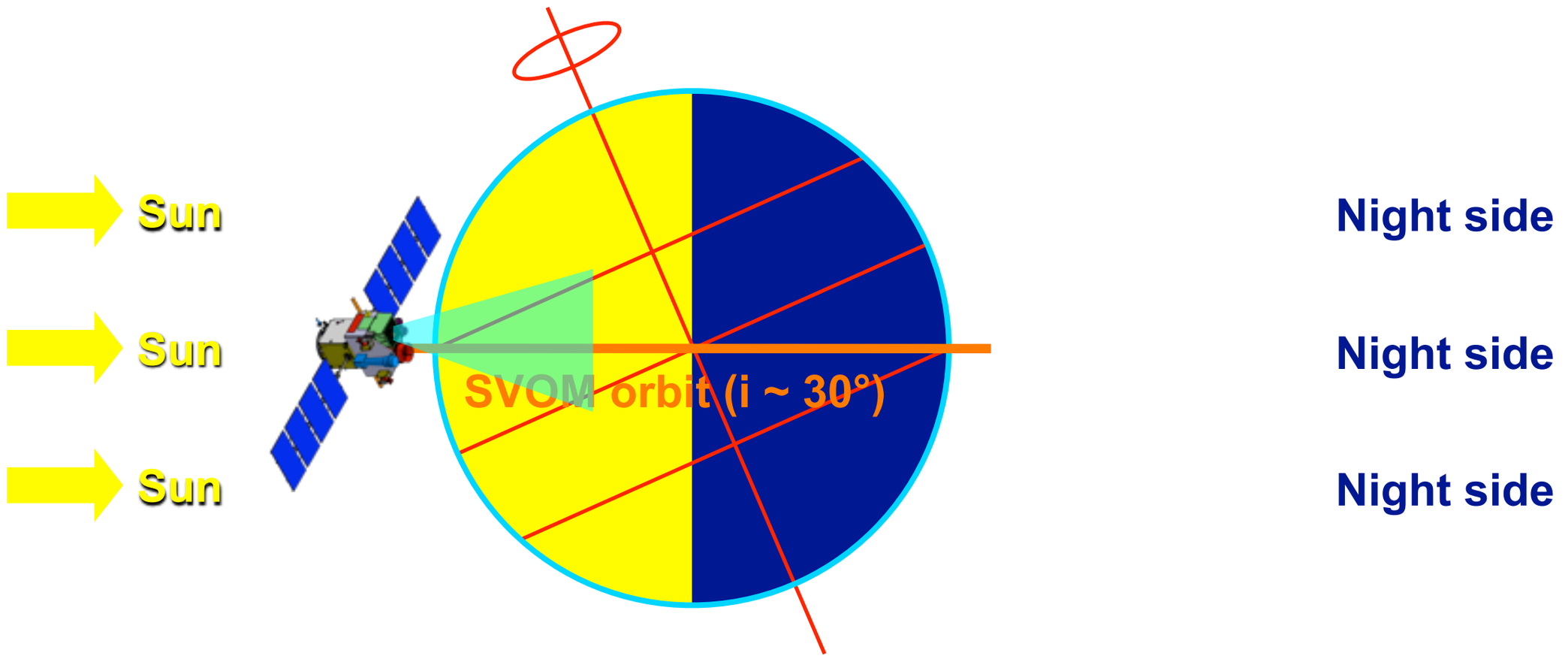
Anticipated redshift distribution



Simulated redshift distribution of long GRBs to be detected by ECLAIRs

Nearly 20% of ECLAIRs GRBs could be situated at high redshift (z > 6)

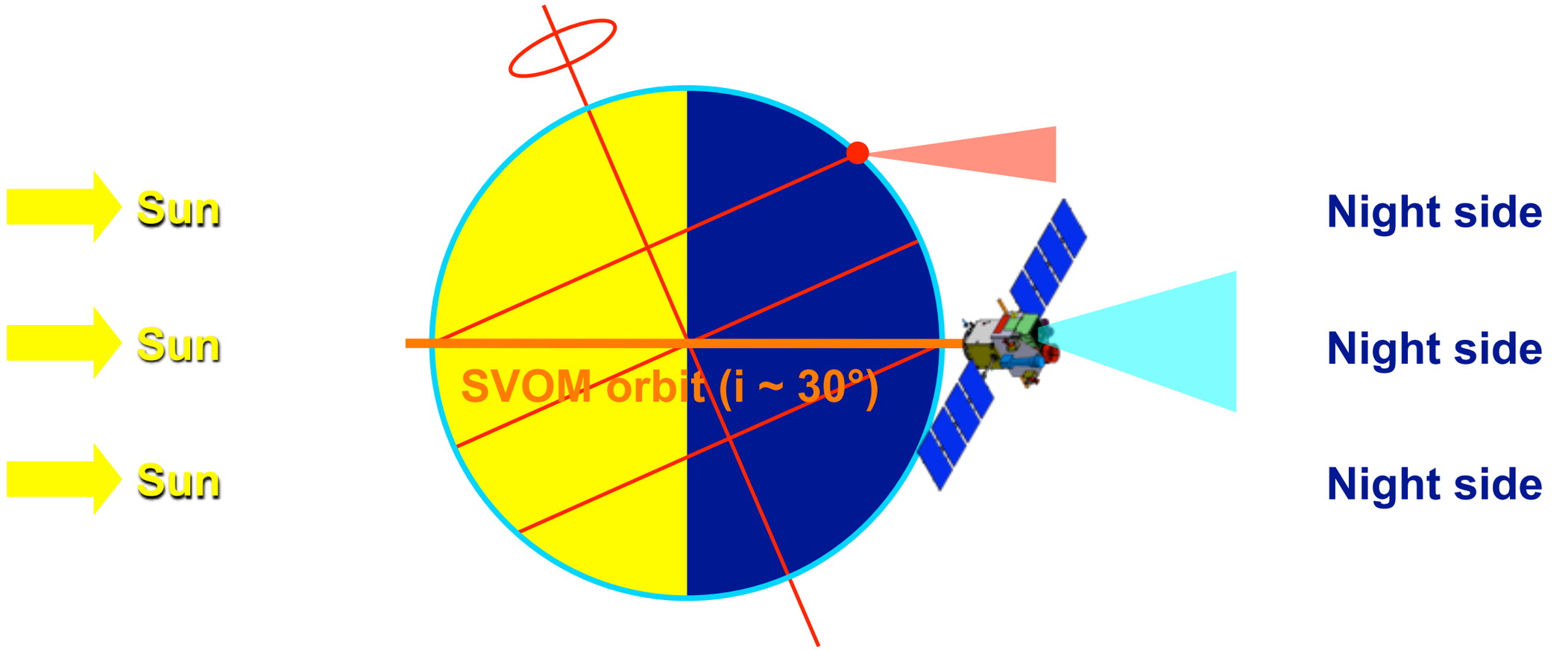
Pointing strategy: anti-solar



Most of the GRBs detected by SVOM to be well above the horizon

of large ground based telescopes all located at tropical latitudes

Pointing strategy: anti-solar



Most of the GRBs detected by SVOM to be well above the horizon

of large ground based telescopes all located at tropical latitudes

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)

Ground

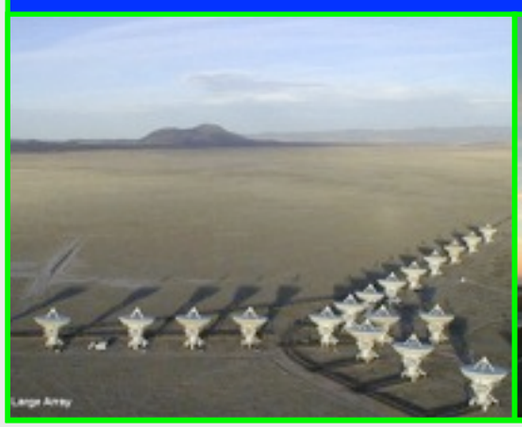
T_0 +1 min

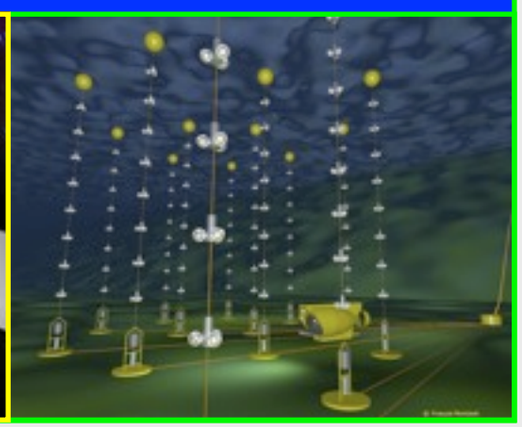
GWAC (V)

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

1-2 m robotic telescopes

Multi messenger follow-up





An open observatory

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

Routine observations and ToO open to the community!

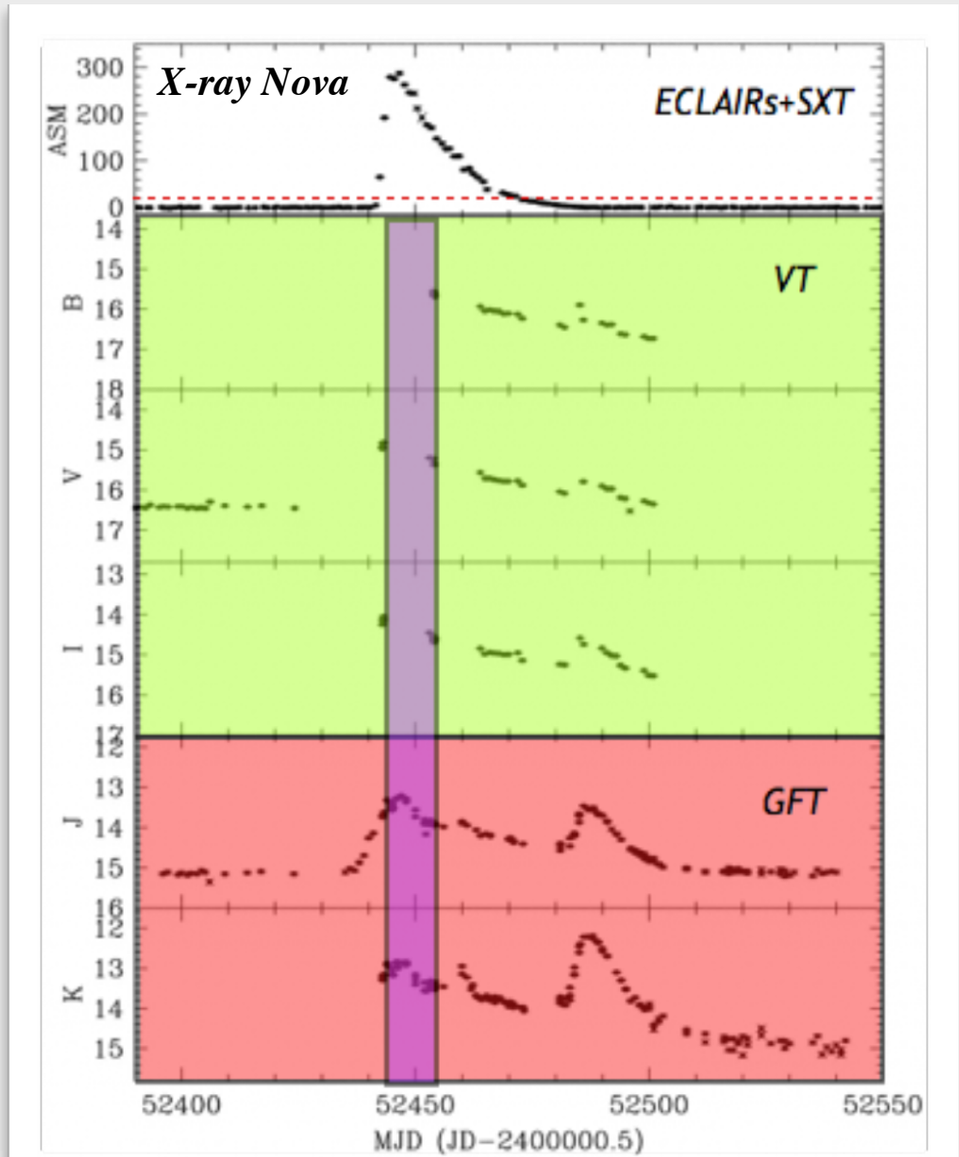
- Monitor intensity of a wide range of accreting sources, including the brightest AGNs (e.g. NGC4151, 3C273, …)

- 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

- …



SVOM compared to SWIFT

Prompt emission measurement

- More sensitive below 20-30 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

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

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 starts when china has confirmed the plateform selection.

SVOM Web page: http://www.svom.fr/

mercredi 6 avril 2011

Questions for a next 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