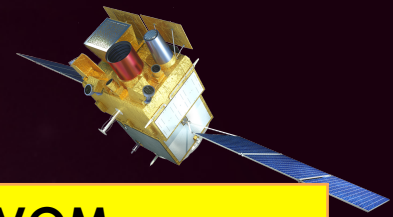




Predictions for SVOM GRB rates The future SVOM GRB sample

Frédéric Daigne
(Institut d'Astrophysique de Paris)





	Swift	Fermi	SVOM
Prompt	Poor	Excellent 8 keV-100 GeV	Very good 4 keV-5.5 MeV + visible
Afterglow	Excellent	/	Excellent
Redshift	~1/3	/	~2/3

▪ Physical mechanisms at work in GRBs

- nature of GRB progenitors and central engines
- acceleration & composition of the relativistic ejecta
- particle acceleration, non-thermal radiative processes
- interaction of the ejecta with the circumburst medium

▪ Diversity of GRBs: event continuum following the collapse of a massive star

- X-ray rich GRBs/X-ray Flashes and their afterglow
- underluminous GRBs/ultra-long GRBs/...
- GRB/SN connection

▪ Short GRBs and the merger model

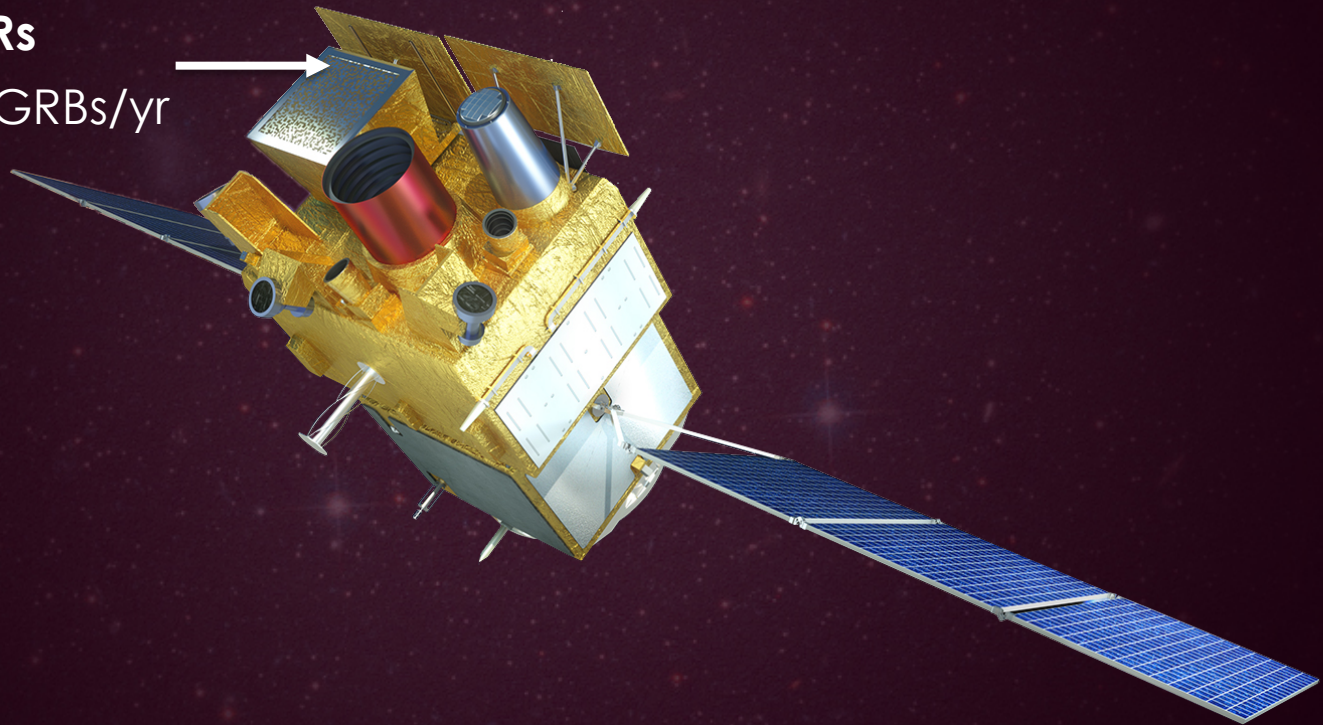
- GW emission from the final stages of orbital decay and merger
- Production of r-process elements in the neutron-rich merger ejecta
(kilonovae)

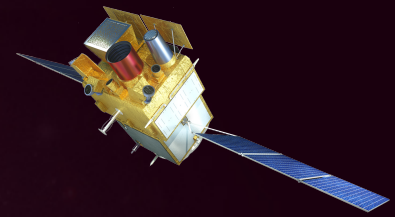


GRB trigger

ECLAIRs

47-82 GRBs/yr





- Simulations of GRBs in ECLAIRs ([S. Schanne](#))
 - Model of the instrument+trigger
 - Realistic background
- Simulated GRBs ([S. Antier & FD](#)):

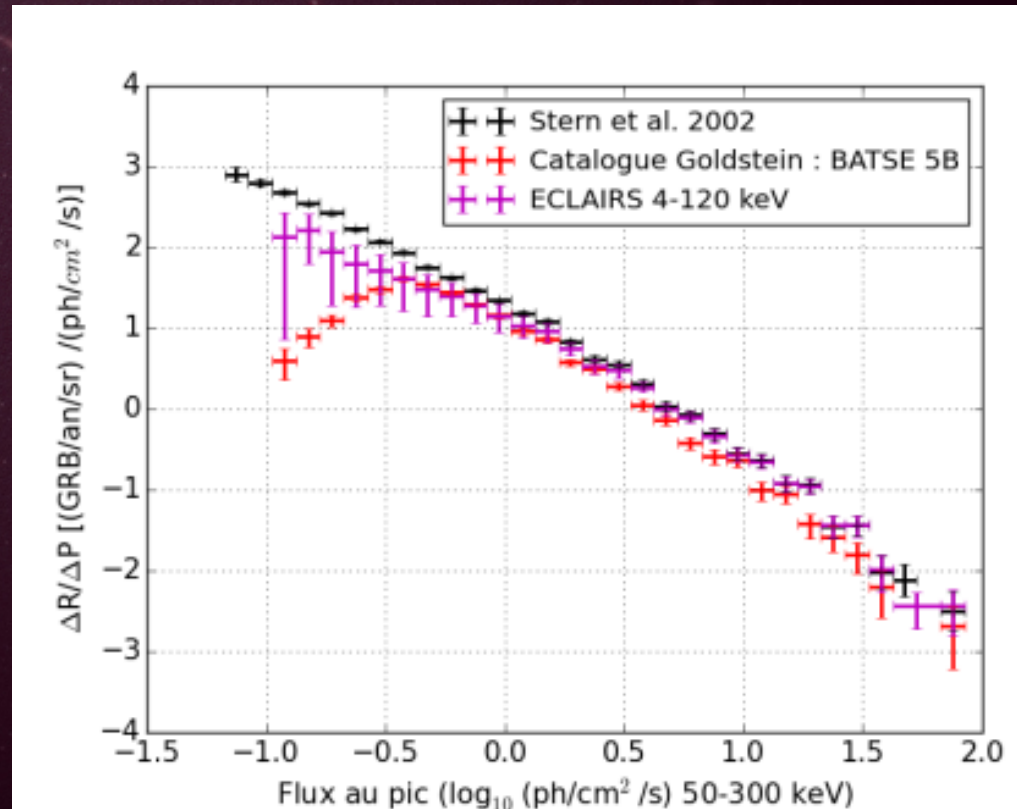
Catalog	Size	Ref	Note
BATSE	2037	Goldstein+ 13	Known detection efficiency Long & short GRBs
BATSE (spectroscopic)	333	Kaneko+ 06	Spectral evolution
HETE2 (FREGATE+WXM)	58	Pelangeon+ 08	Soft GRBs: XRF, XRR
Swift BAT	391	Sakamoto+ 11	Redshift ($\sim 1/3$)
Fermi GBM	783	Gruber+ 14	Accurate prompt spectrum
Swift BAT+GBM/Konus	84	Heussaff+ 15	Redshift + prompt spectrum

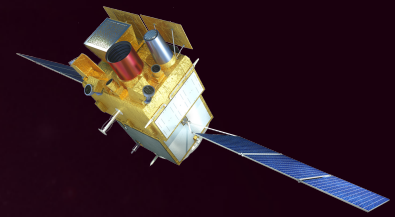
- For each simulated GRB: compute detection probability
(averaged over field of view assuming isotropic distribution for GRBs)



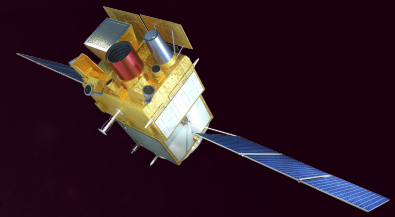
- Simulations: ECLAIRs detection probability per bin of peak flux
- Normalize from:
 - log N-log P BATSE corrected for efficiency (Stern+ 02)
 - ECLAIRs field of view & duty cycle
- Result: log N-log P ECLAIRs for BATSE-like GRBs

Predicted BATSE-like GRB
rate in ECLAIRs:
Low: 46 ± 6 GRB/yr
High: 57 ± 8 GRB/yr





- ECLAIRs low-energy threshold: 4 keV
- HETE-2: 18% of soft events XRF+XRR
(Pelangeon+ 08)
- Fermi/GBM: 9% of soft events XRR only
(Jenke+ 16)
- ECLAIRs simulations: high detection efficiency for these XRR/XRF
- Expected X-ray benefit for ECLAIRs = 9 to 18%
- ECLAIRs uses an image trigger like Swift/BAT, with longer timescales
- Simulations: expected image benefit for ECLAIRs = 9%
(comparing image trigger and count rate trigger)



Results:

Predicted GRB rate in ECLAIRs (GRB/yr)

6.5σ
(~alert threshold)

10σ
(~slew threshold)

Low

High

Low

High

BATSE-like GRBs

46 ± 6

57 ± 8

40 ± 6

49 ± 8

X-ray benefit

4 ± 1

10 ± 1

4 ± 1

9 ± 1

Image benefit

4 ± 1

5 ± 1

4 ± 1

4 ± 1

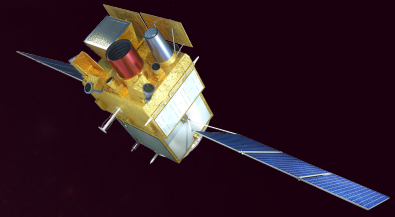
Total

54 ± 7

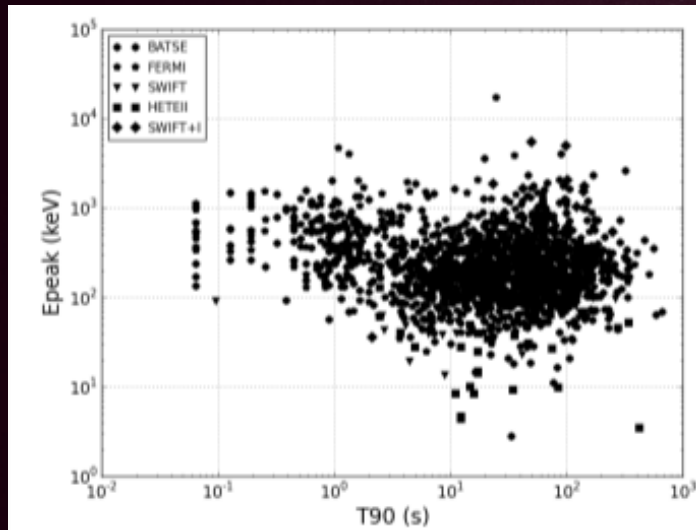
72 ± 10

47 ± 7

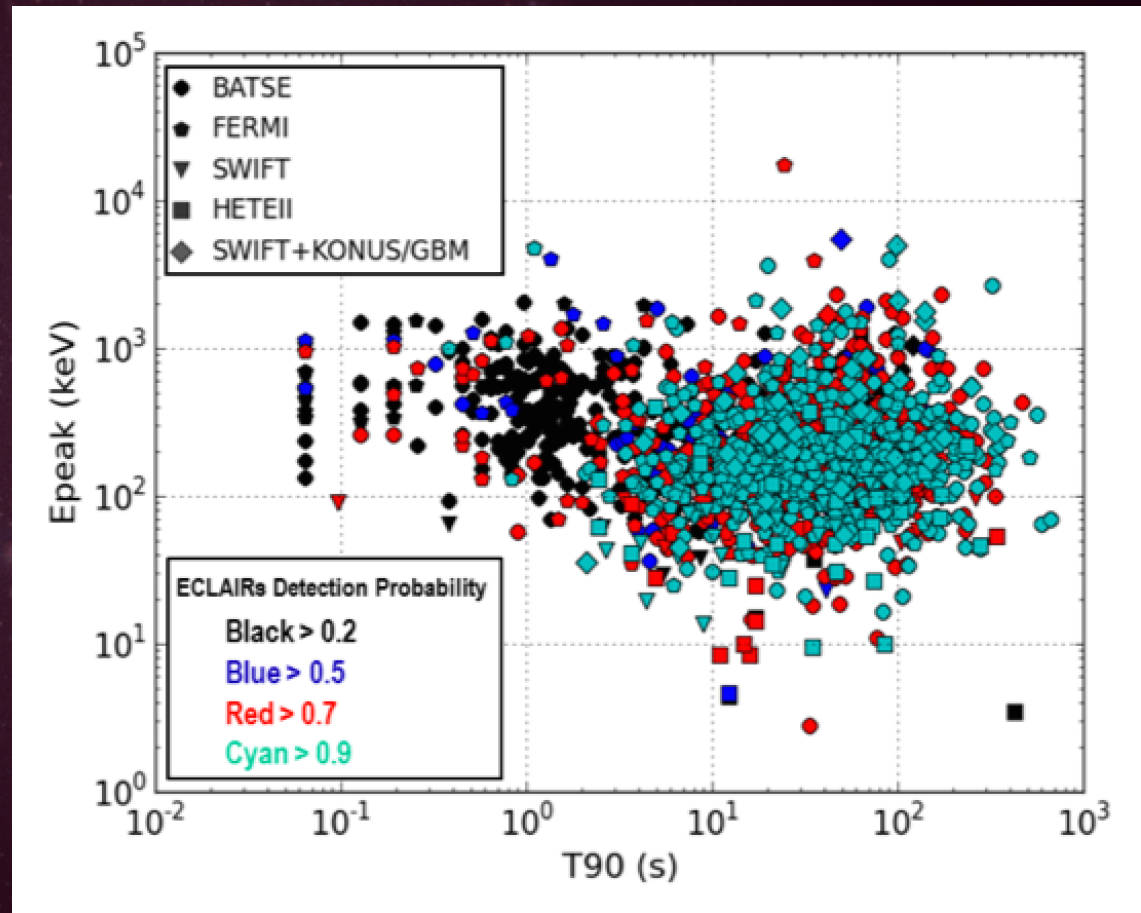
62 ± 10



- Detection probability in the hardness-duration plane:



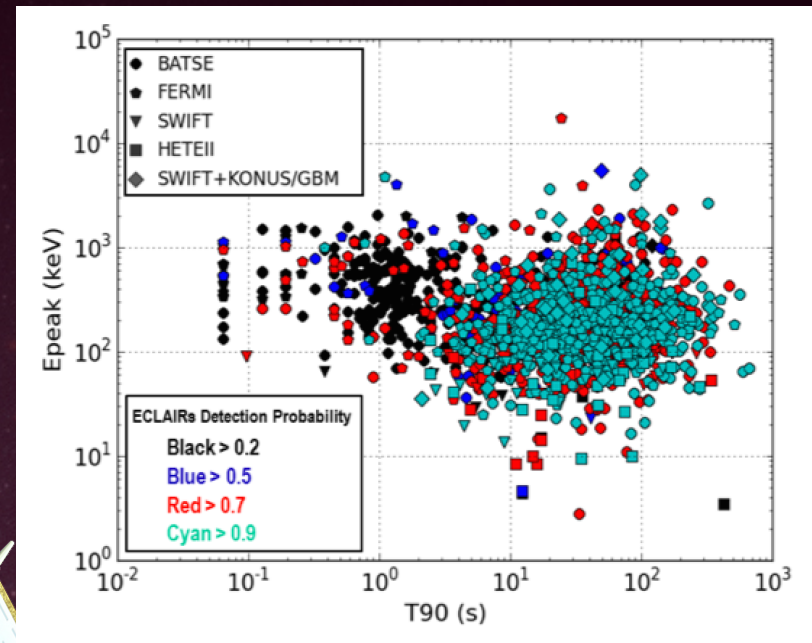
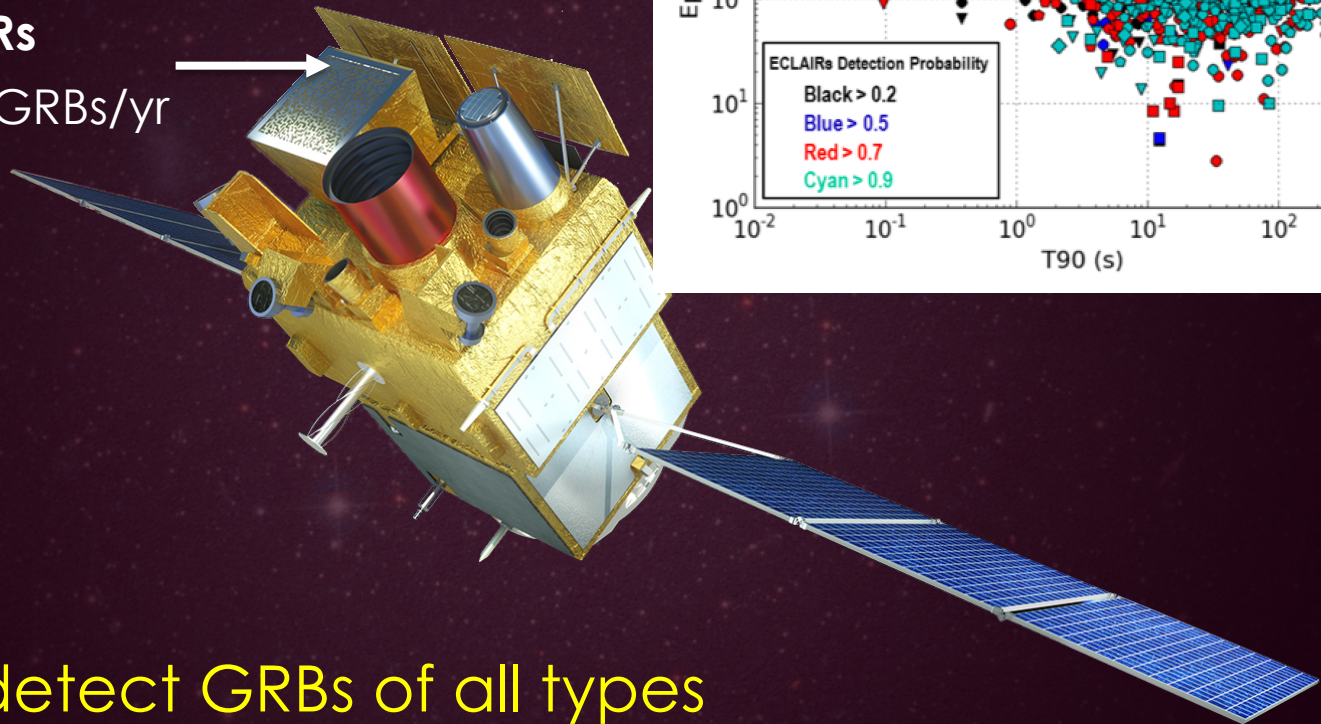
Original catalogs



Detection probability by ECLAIRs

ECLAIRs

47-82 GRBs/yr



ECLAIRs will detect GRBs of all types

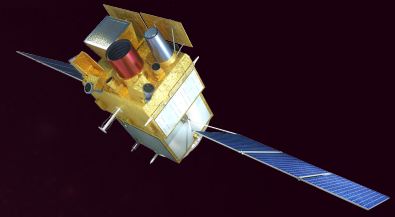
- Classical long GRBs
- Ultra-long GRBs (cf. D. Götz's talk)
- Soft GRBs (XRR, XRF)
- Short GRBs (but with a moderate efficiency)

GRM

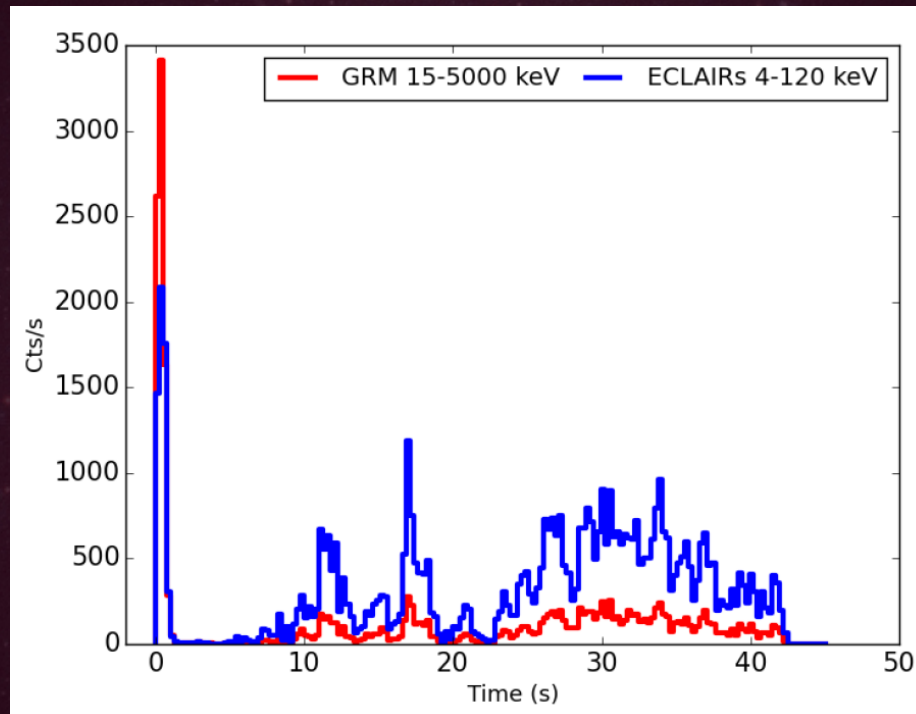
~90 GRBs/yr



- GRM has a larger field of view than ECLAIRs
- GRM is sensitive up to ~5 MeV
- Good sensitivity to short GRBs



- Simulation of a short GRB with an extended soft tail (GRB 990712A)



CEA+LUPM+IHEP

SVOM « white paper »
arXiv:1610.06892

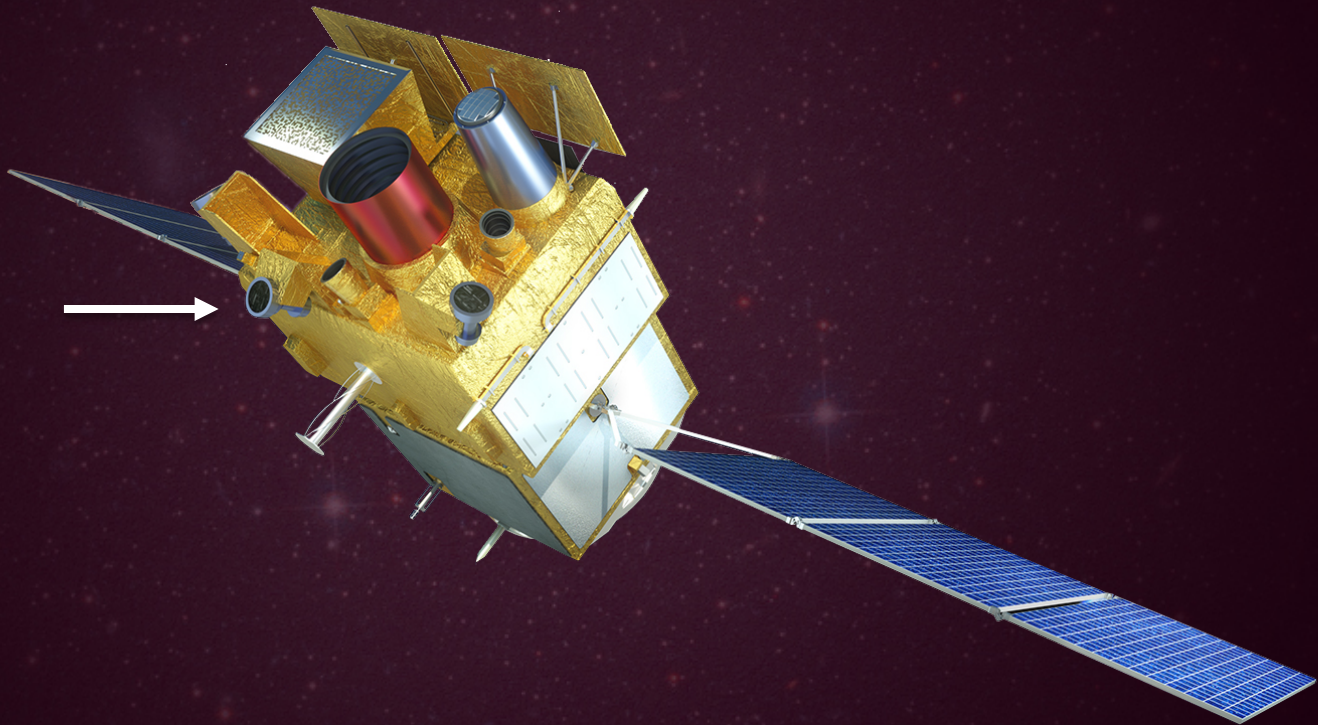
- ECLAIRs trigger efficiency can be improved using GRM information (lower threshold: see S. Schanne's talk)



GRB trigger

GRM

~90 GRBs/yr



SVOM sensitivity to short GRBs is improved thanks to GRM!



Prompt emission

ECLAIRs+GRM

~40-60 GRBs/yr

ECLAIRs+GRM

Prompt GRB emission
over 3 decades
(4 keV-5.5 MeV)

GWAC



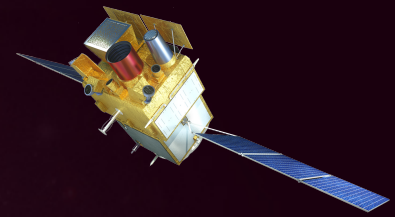
GWAC

prompt visible emission
observable in ~13-27 % of
cases (at least upper limit)

(CNES mission simulator/V. Morand)

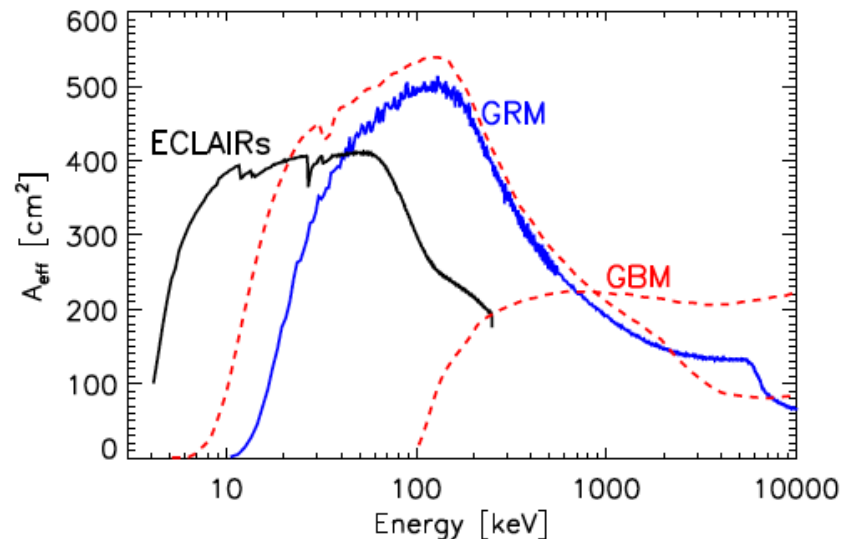


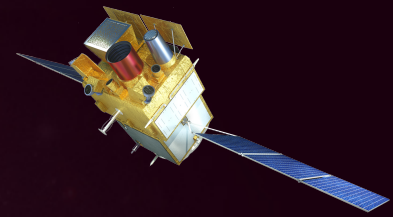
Field of view+night+weather+...



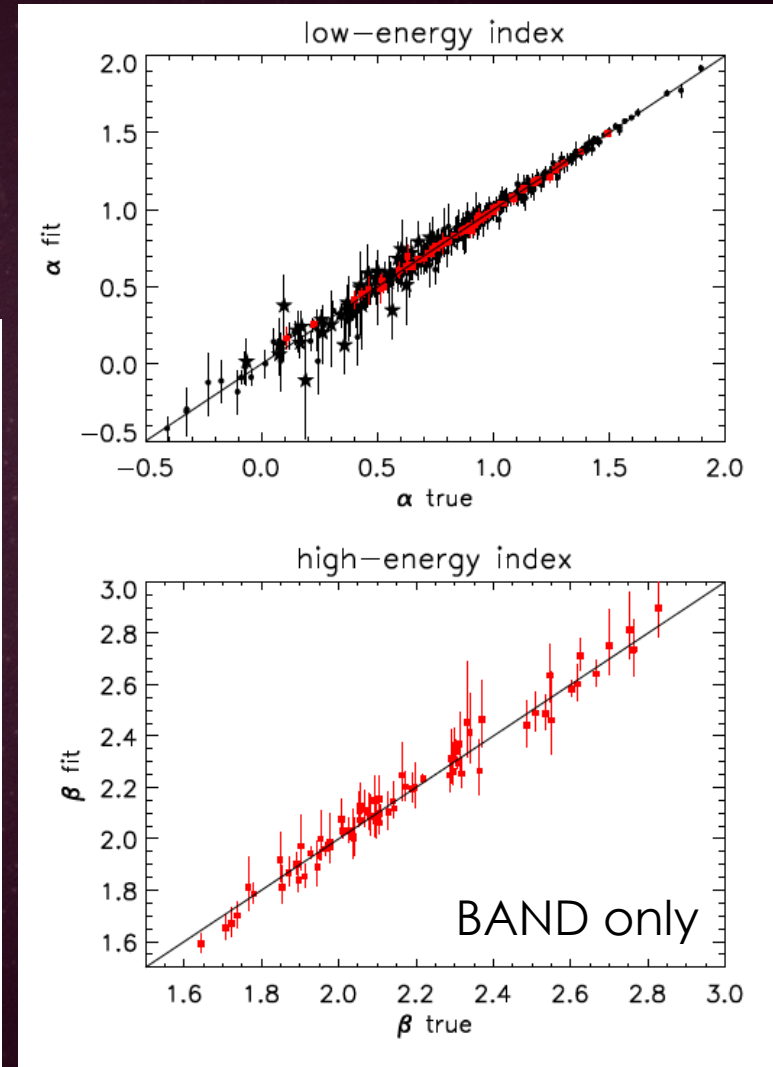
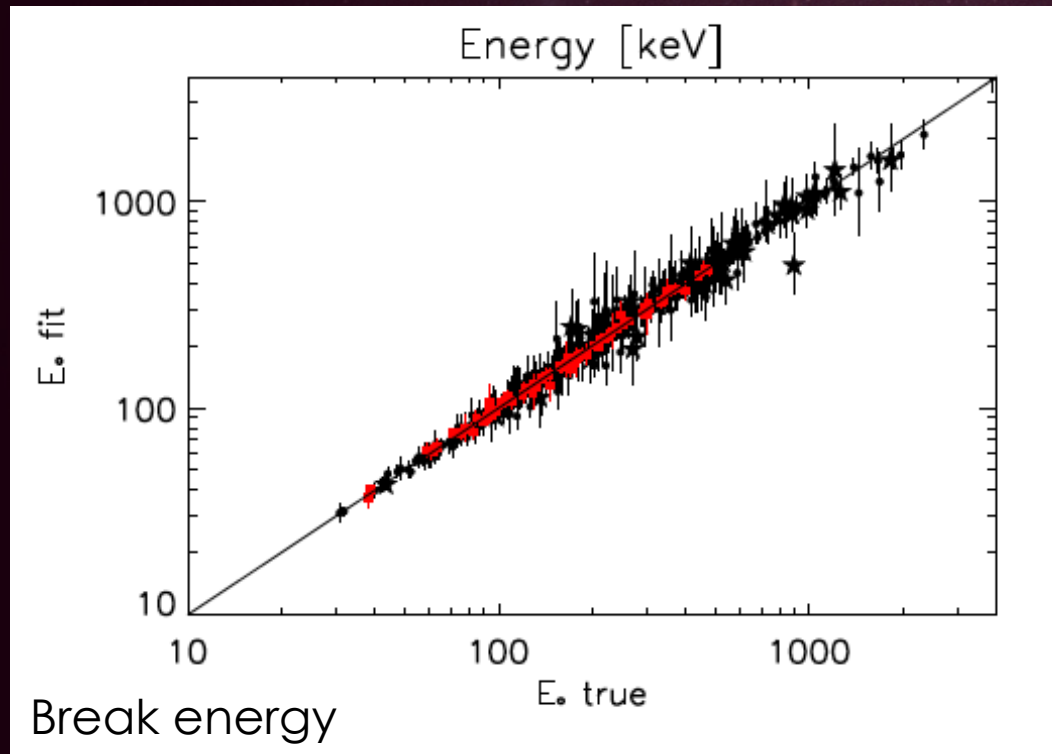
- Simulations of Fermi/GRB bursts
(catalog: Gruber+ 13)
521 bursts (BAND or COMP) including 50 short GRBs
- Simulation in ECLAIRs+GRM (burst on-axis in ECLAIRs, 30° offaxis in GRM)
(LUPM+IHEP)

Effective area:

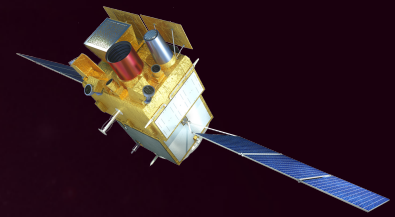




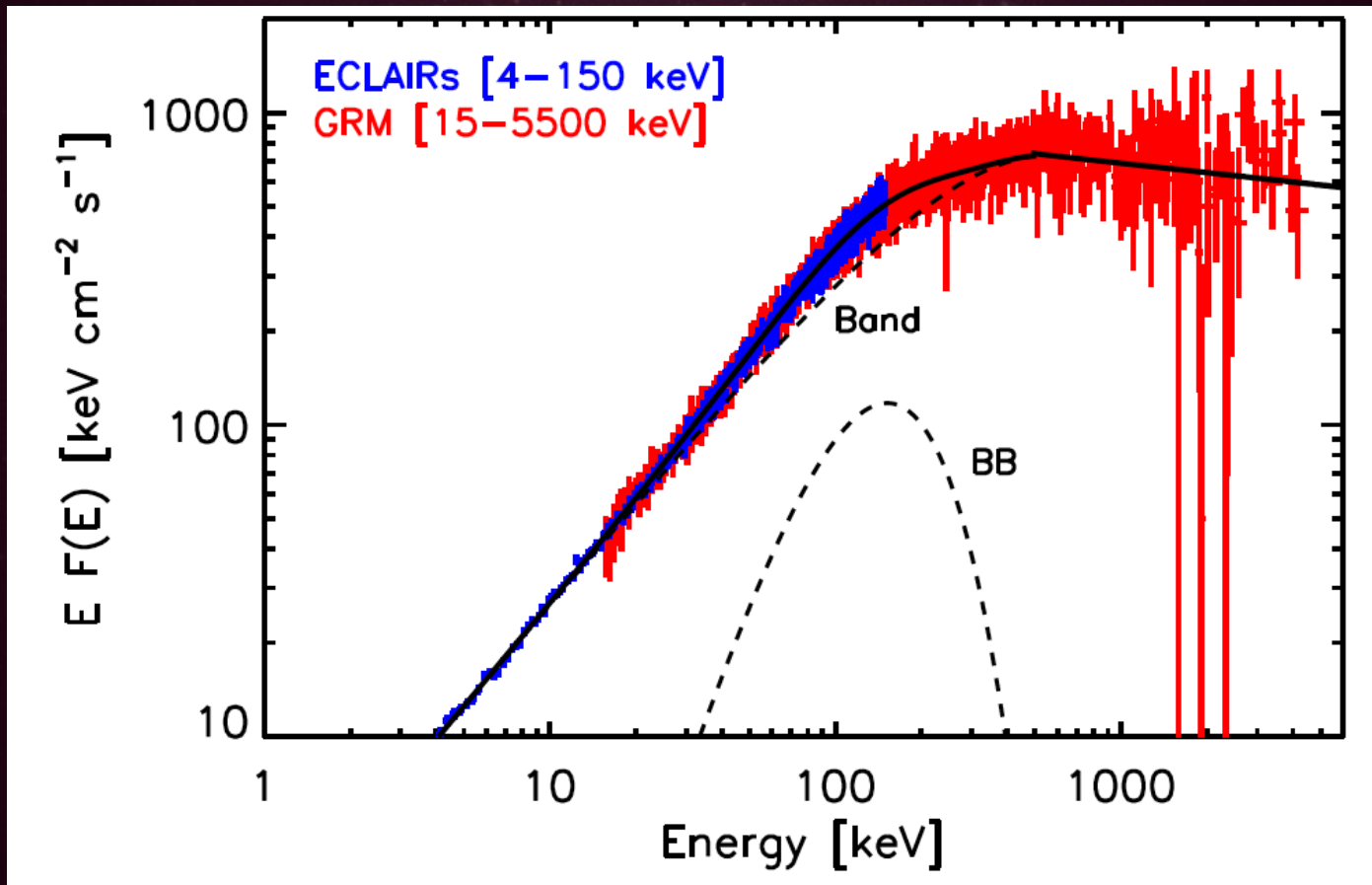
- Recovered spectral parameters:



★ short GRBs



- Multi-components spectra: the example of GRB 100724B (Guiriec+ 11)

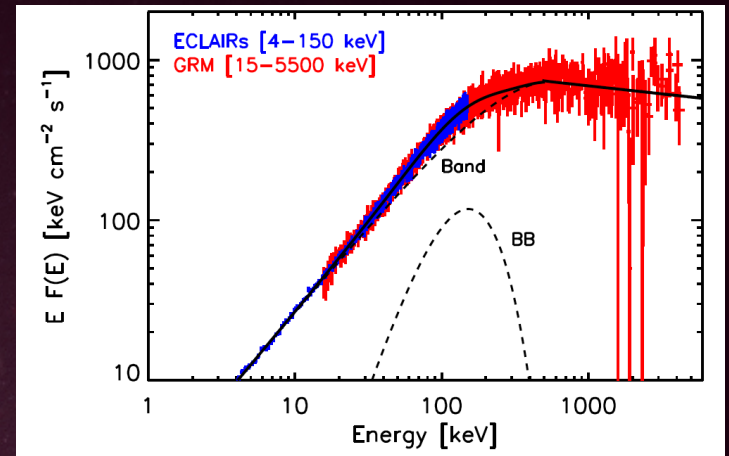
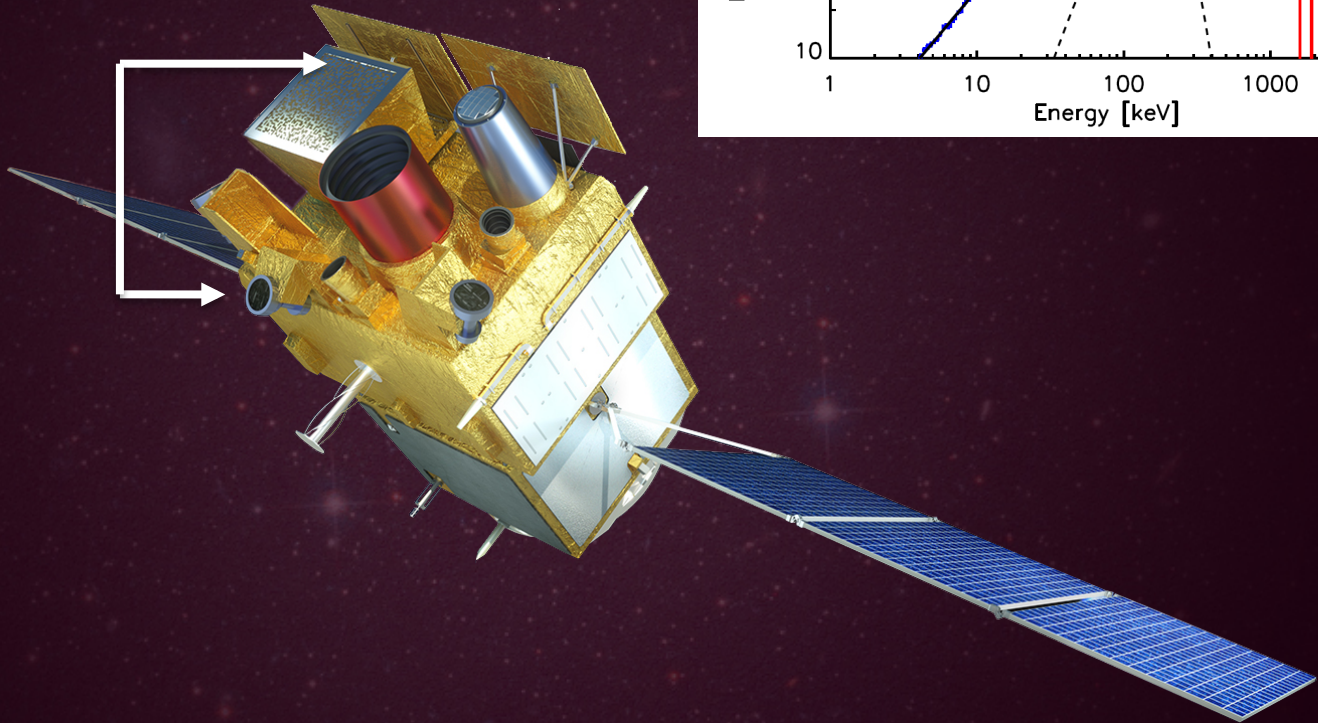


- The two components (BB+BAND) are accurately recovered !



Prompt emission

ECLAIRs+GRM
~40-80 GRBs/yr



Accurate spectral description of the prompt GRB emission
over 3 decades (4 keV–5.5 MeV)



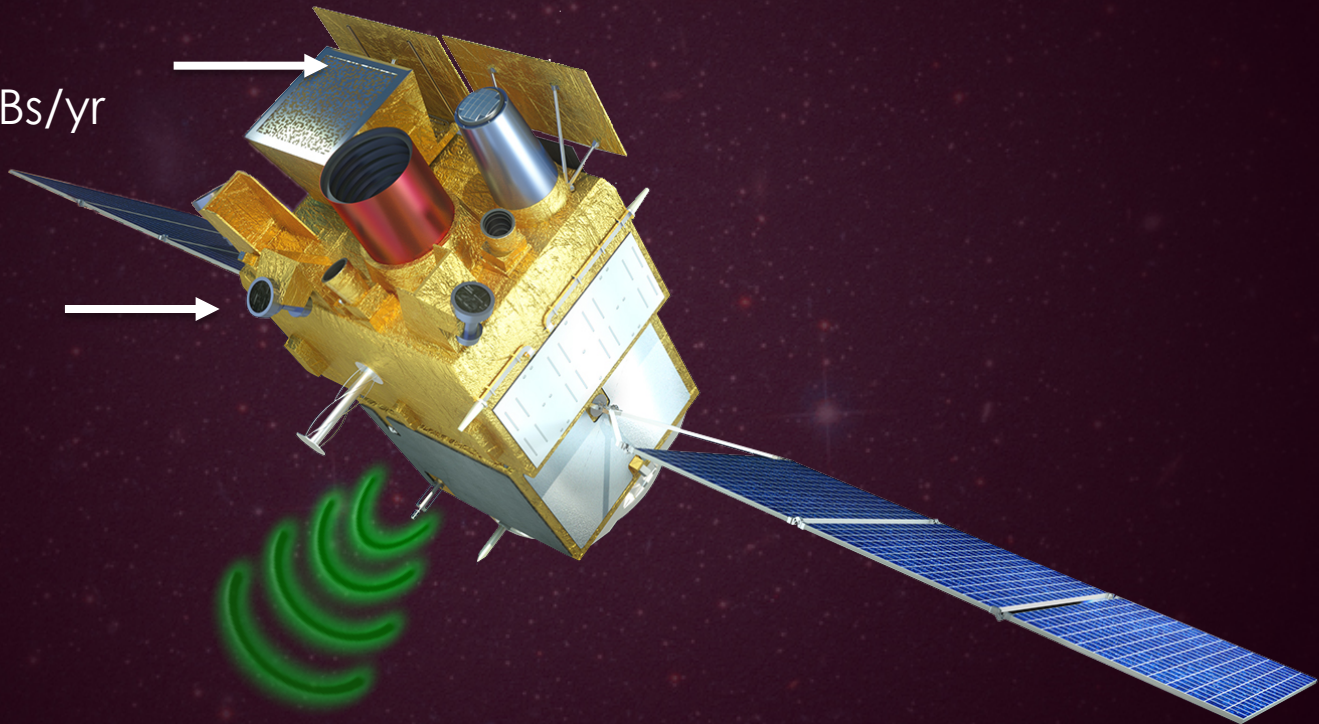
Slew requests

ECLAIRs

47-82 GRBs/yr

GRM

~90 GRBs/yr

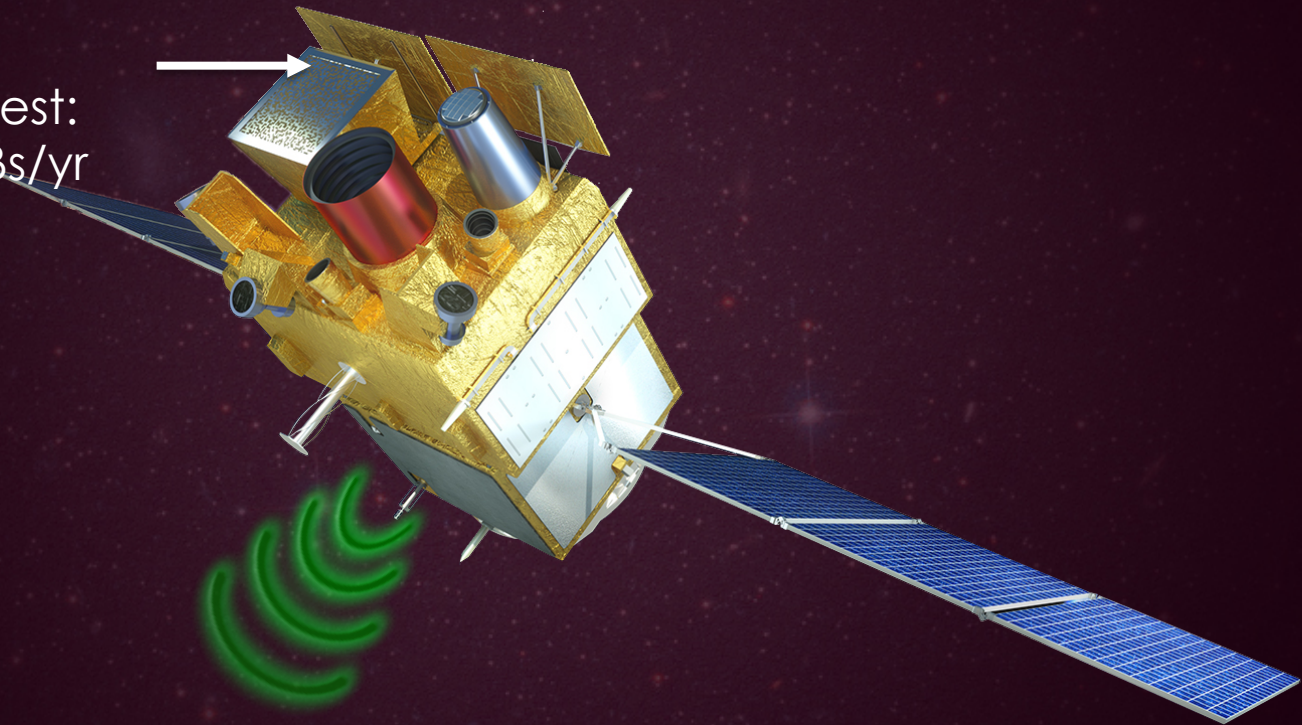


Alerts sent to ground
(VHF network)

Slew requests

ECLAIRs

Slew request:
36-72 GRBs/yr





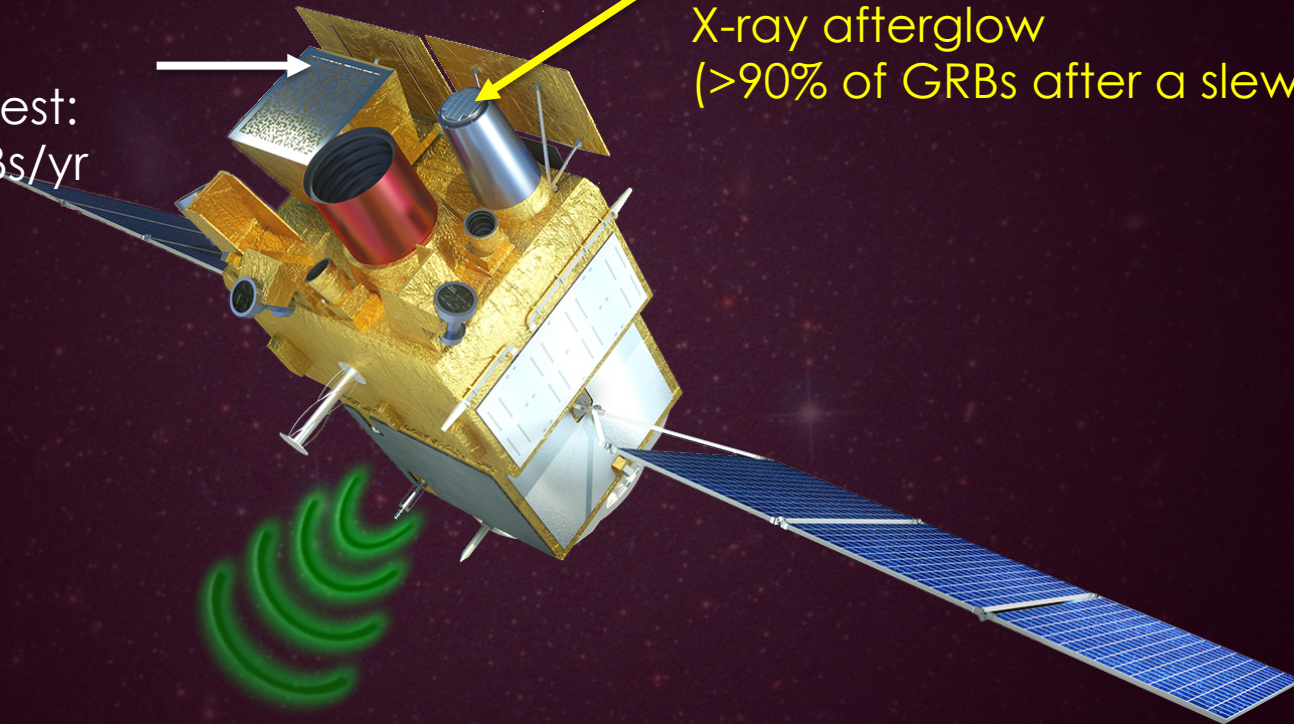
X-ray afterglow

ECLAIRs

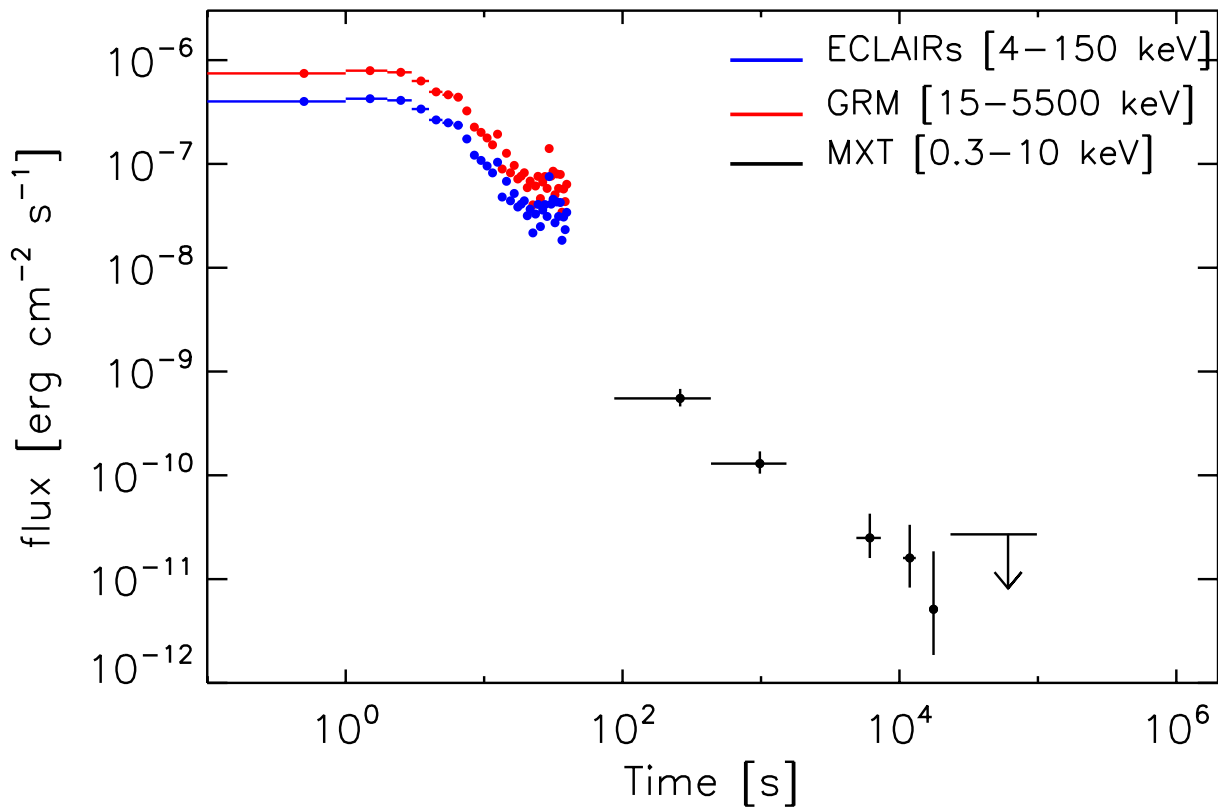
Slew request:
36-72 GRBs/yr

MXT

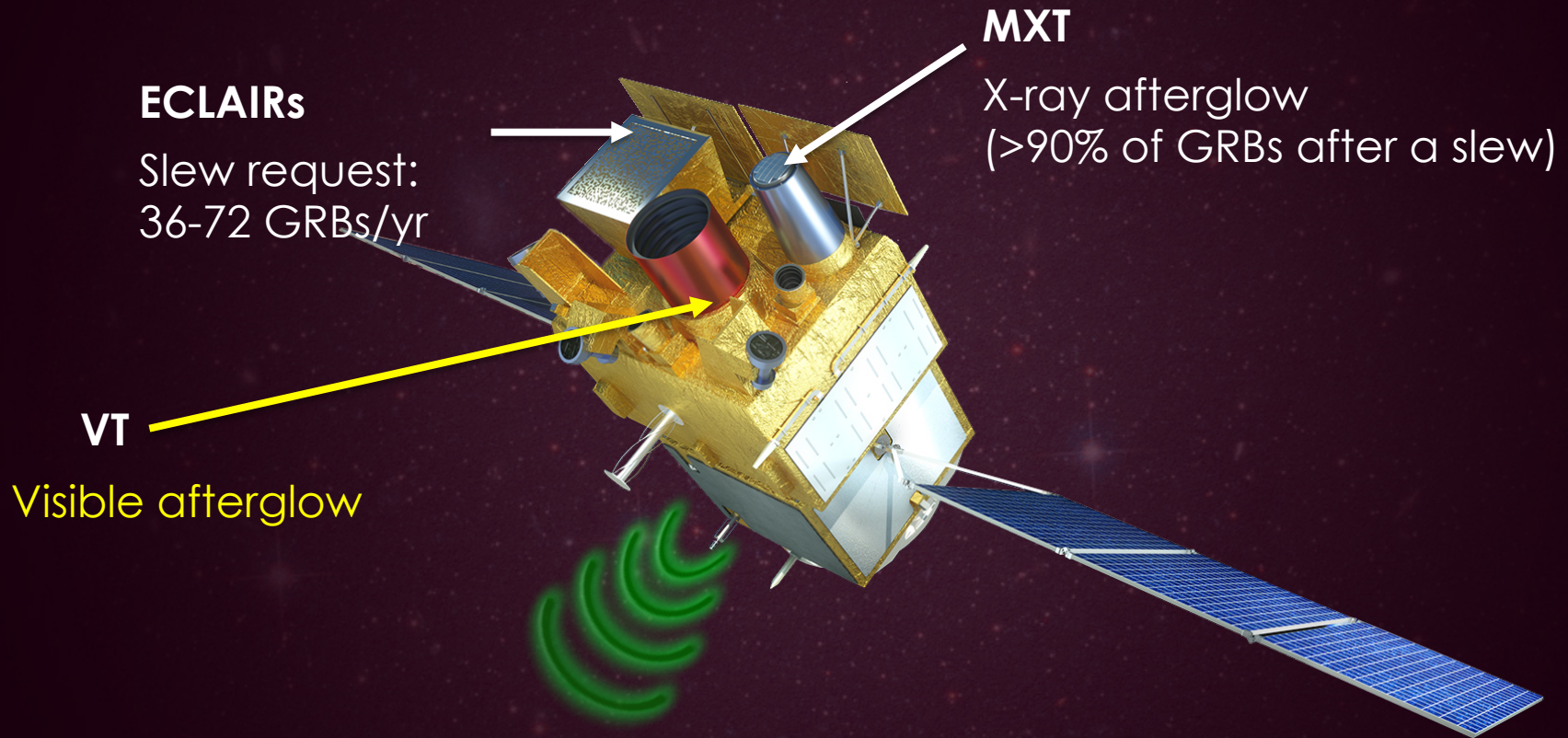
X-ray afterglow
($>90\%$ of GRBs after a slew)



- Simulation of GRB 091020 in ECLAIRs+GRM+MXT
(Swift GRB seen also by GBM)



V/NIR afterglow



66% of slews are followed by at least 5 min of visibility for MXT+VT

(CNES mission simulator/V. Morand)



Distance/host galaxy

ECLAIRs

Slew request:
36-72 GRBs/yr

MXT

X-ray afterglow
($>90\%$ of GRBs after a slew)

VT

Visible and NIR afterglow
+photometric redshift

GWAC

C-GFT/F-GFT

Early observation:

- F-GFT: 19% (NIR arm)
- C-GFT + F-GFT: 37 %
- C-GFT+F-GFT+LCOGT: 75%

(CNES mission simulator/V. Morand)

