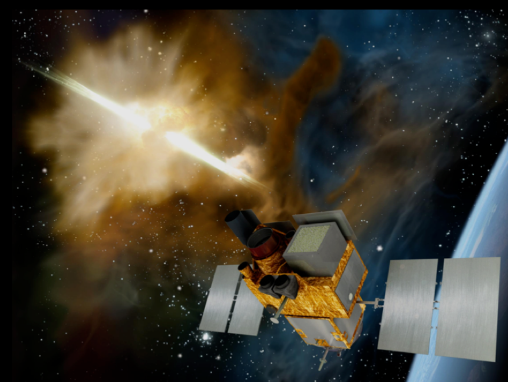
SVOM CORE PROGRAM: GAMMA-RAY BURSTS

Frédéric Daigne (Institut d'Astrophysique de Paris)
on behalf of the SVOM collaboration

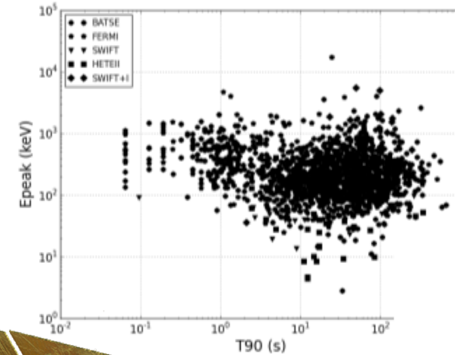


SVOM

SVOM CORE PROGRAM: GRB STUDIES

THE EXPECTED SVOM GRB SAMPLE

GRB TRIGGER



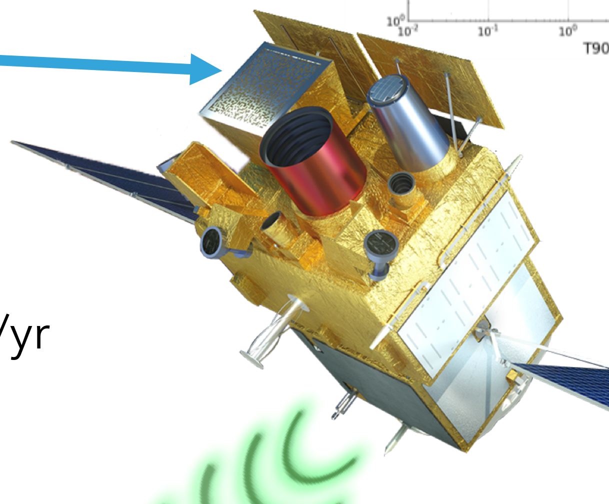
Original catalogs

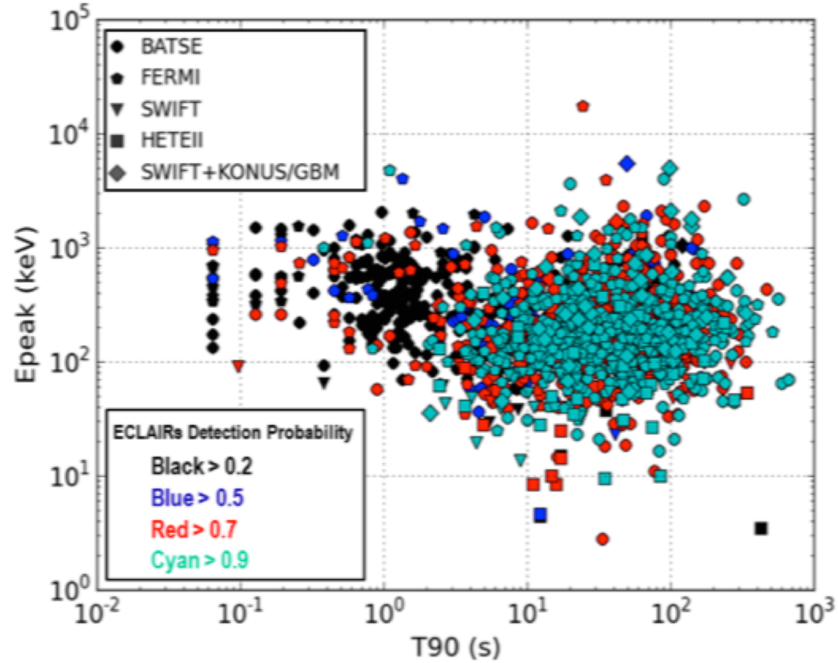
Simulation in ECLAIRs

ECLAIRS

(4 -150 keV)
~ 2 sr
Loc. < 12′

42-80 GRBs/yr





ECLAIRs is sensitive to all classes of GRBs

Classical long GRBs

Soft GRBs (XRR, XRF)

Short GRBs
(but with a moderate efficiency)

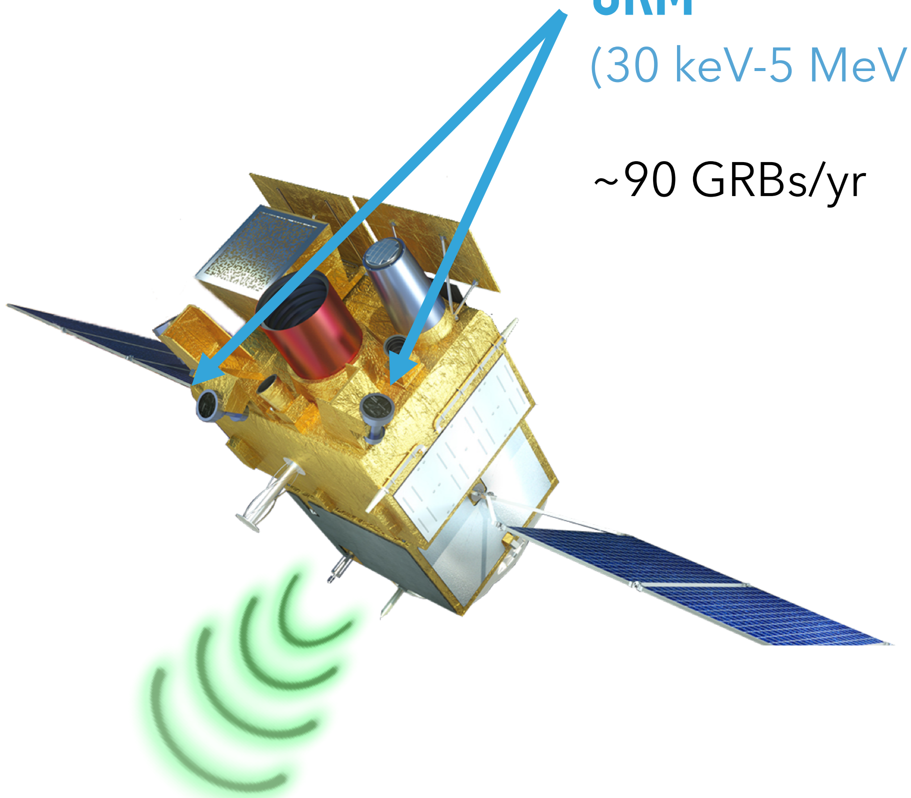
Detection probability by ECLAIRs
(simulations by S. Antier)
(Wei, Cordier et al. « Scientific prospects of the SVOM mission », arXiv:1610.06892)

GRB TRIGGER

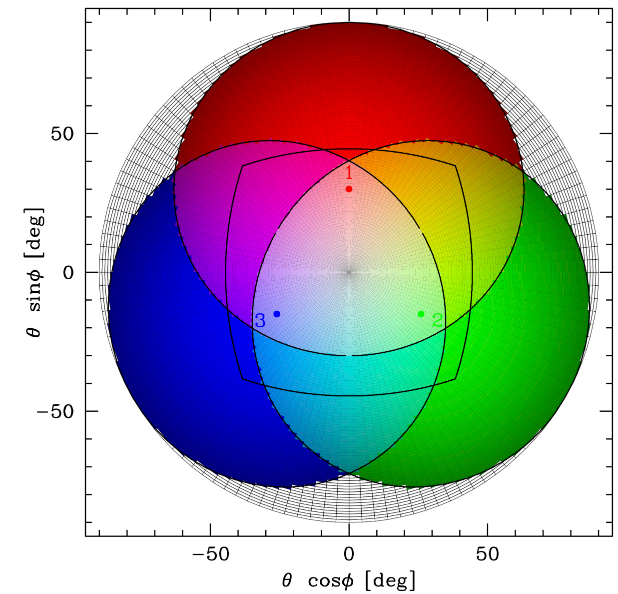
GRM

(30 keV-5 MeV) ~ 5.6 sr Loc.: 5-10° (3 GRDs)

~90 GRBs/yr



GRM field of view:



GRM has a larger field of view than ECLAIRs

ECLAIRs sensitivity to short GRBs can be improved by combining ECLAIRs+GRM

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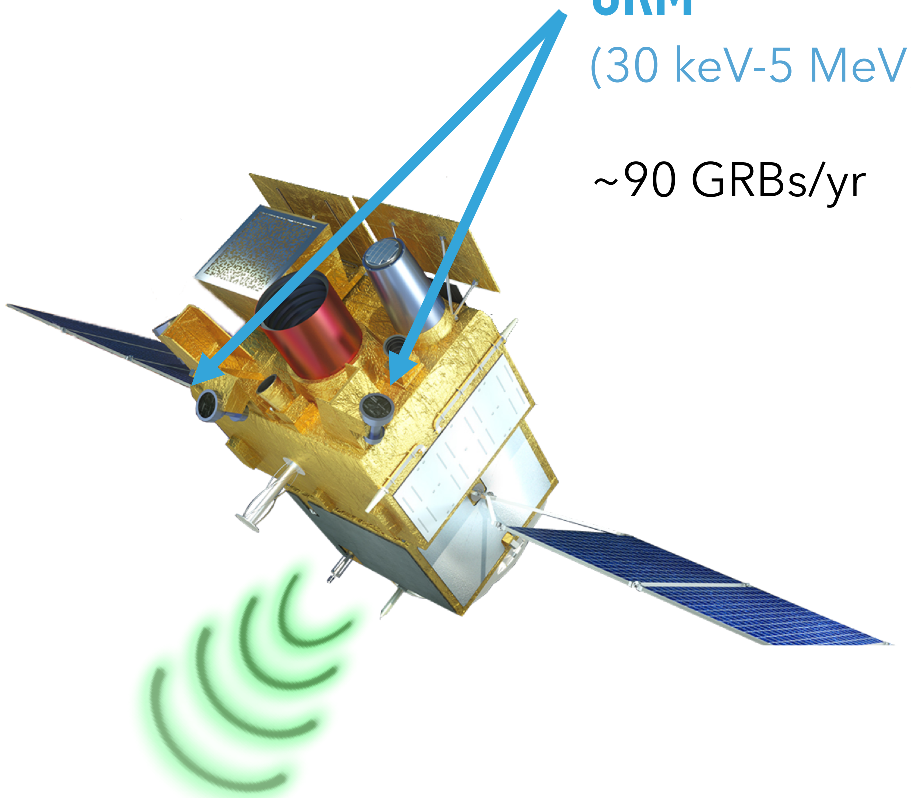

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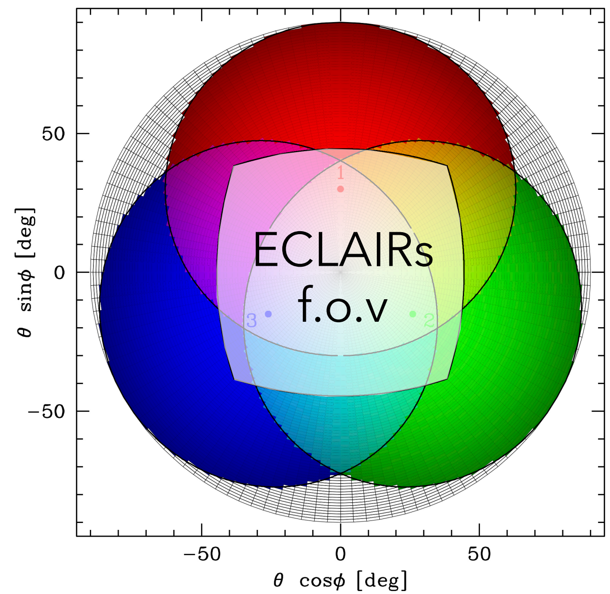

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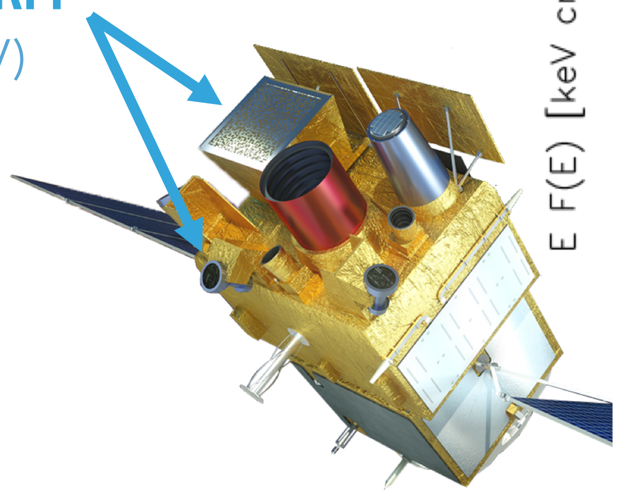
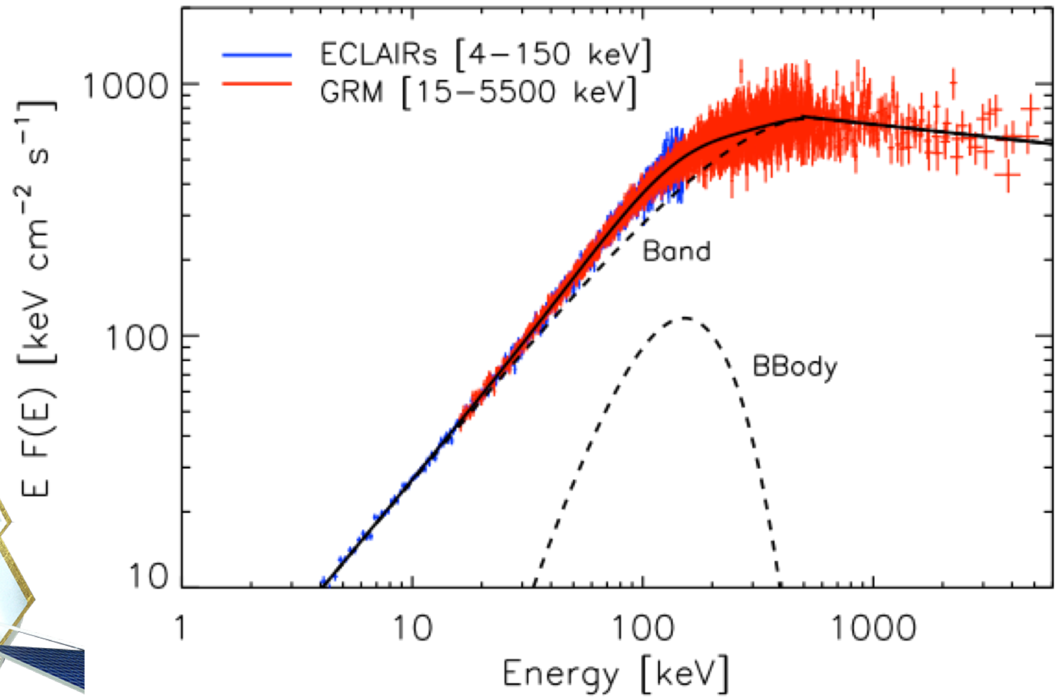
PROMPT EMISSION

ECLAIRS+GRM

(4 keV-5 MeV)





Multi-component spectrum of the Fermi burst GRB 100724B simulated in ECLAIRs+GRM. (Bernardini et al. 2017)

GWAC

2x5000 deg^2

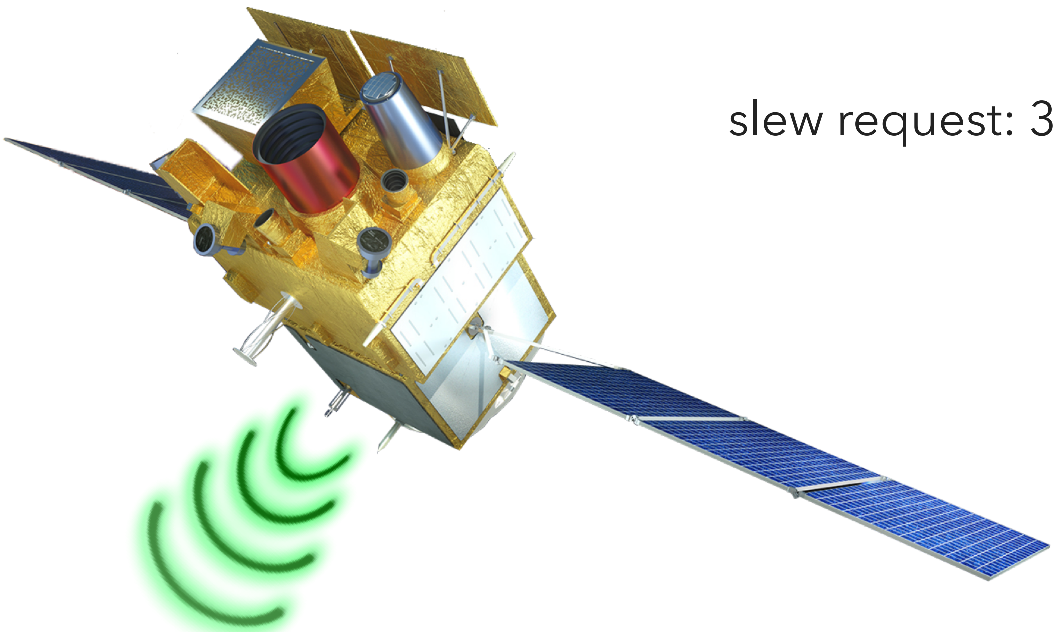
m_{lim} ~ 16-17

prompt
visible emission
in ~16% of cases

ECLAIRs+GRM can measure the prompt spectrum over 3 decades in energy

GWAC will add a constraint on the associated prompt optical emission in a good fraction of cases.

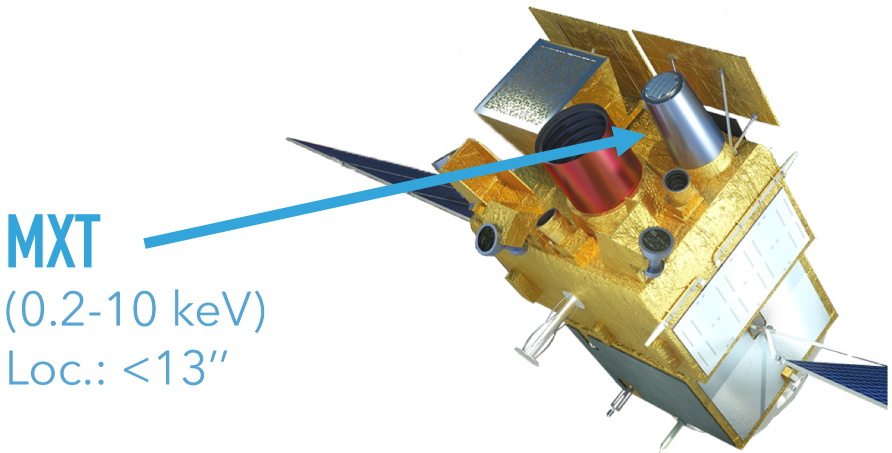
SLEW REQUEST

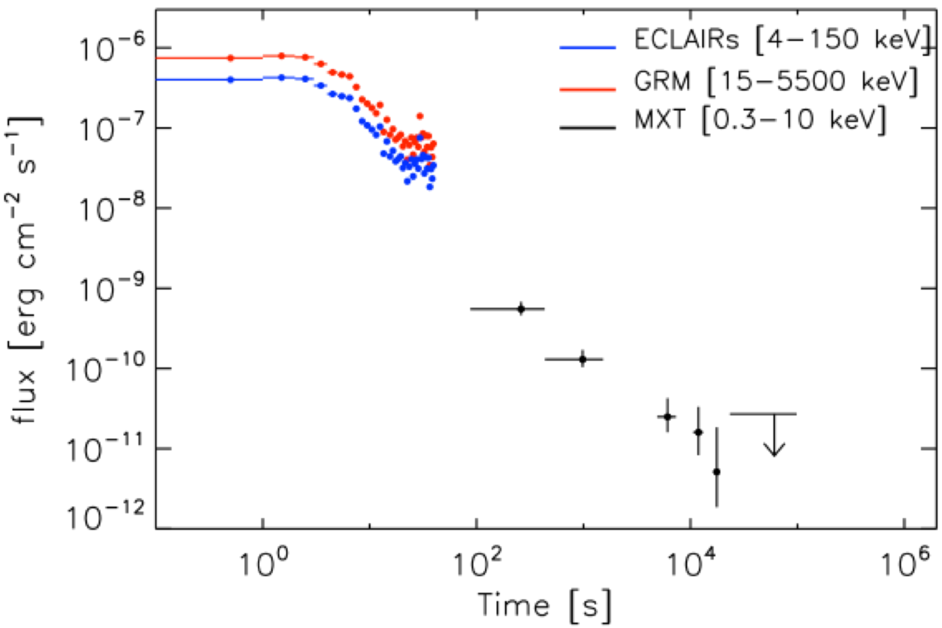


slew request: 36-72 GRB/yr

alert in near-real time: VHF

AFTERGLOW





The X-ray afterglow of the Swift burst GRB 091020 simulated in MXT.
(Wei, Cordier et al. « Scientific prospects of the SVOM mission », arXiv:1610.06892)

MXT can detect and localize the X-ray afterglow in >90% of GRBs after a slew.

AFTERGLOW & DISTANCE

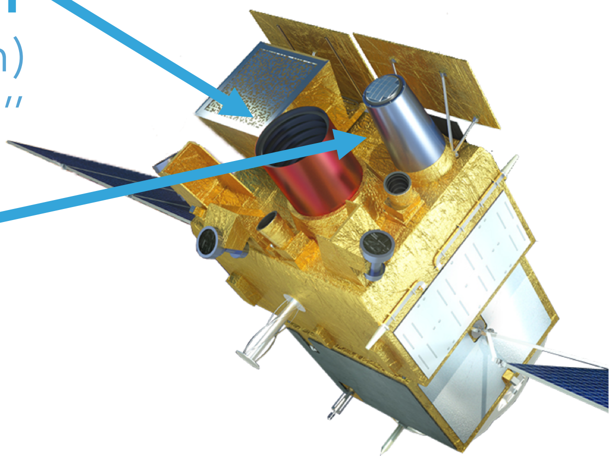
VT, C-GFT and F-GFT will detect, localize and characterize the V-NIR afterglows (lightcurve+photo-z).

Early observation by large telescopes are favored by SVOM's pointing strategy.

Redshift measurement is expected in ~2/3 of cases.

A major goal: GRB physics + cosmology

VT
(400-1000 nm)
Loc.: <1″



MXT
(0.2-10 keV)
Loc.: <13″

GWAC
2x4000 deg^2
m_{lim} ~ 16-17

C-GFT
1.2 m
400-950 nm

F-GFT/COLIBRI
1.3 m
400-1700 nm
multi-band

(Very) Large telescopes

LONG-TERM FOLLOW-UP


X-Shooter at VLT (Kueyen telescope)

Long-term afterglow

- GRB Physics (energetics, environment, …)

Host galaxy studies

- Physics of GRB progenitors (morphology, SFR, offset, …)
- GRBs as a tool for cosmology (e.g. sample of high-z galaxies, SFH, …)

Rapid/long-term follow-up does not depend on the SVOM collaboration only and requires a dedicated effort. *See S. Basa & S. Vergani's presentation*.

A GRB SAMPLE WITH A COMPLETE DESCRIPTION

A unique sample of 30-40 GRB/yr with

- **prompt emission over 3 decades (+ optical flux/limit: 16%)**
- **X-ray and V/NIR afterglow**
- **redshift**
- **long term follow-up (host galaxy, etc.)**

	Swift	Fermi	SVOM
Prompt	Poor	Excellent 8 keV -100 GeV	**Very Good 4 keV - 5 MeV**
Afterglow	Excellent	> 100 MeV for LAT GRBs	**Excellent**
Redshift	~1/3	Low fraction	**~2/3**

Physical mechanisms at work in GRBs

Nature of GRB progenitors and central engines

Acceleration & composition of the relativistic ejecta

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

Low-luminosity GRBs / X-ray rich GRBs / X-ray Flashes and their afterglow

GRB/SN connection

Short GRBs and the merger model

GW association – MMA context: *see Cyril Lachaud's presentation*.

GRBs as a tool for cosmology

Sample of high-z galaxies – star formation history – first generation of stars?

SVOM CORE PROGRAM

DATA POLICY

DATA PROCESSING:

The transient nature of GRBs and the need for a near-real time reaction requires a specific organization.

- Dedicated pipeline for VHF data
- Burst advocate
- Notices/alerts
- Etc.

See F. Piron & A. Claret's presentation.

DATA POLICY:

GRB community outside SVOM:

- **An open policy** (most SP are public) **is mandatory** to favor the best follow-up of SVOM GRBs, and thus the best scientific return.
- See Swift and Fermi's examples
- The list of public SP is defined is SR3 *(« Scientific Requirements for the Core Program »)* and can evolve after the launch (to have more public SP).

Most Science Products (SP) of the Core Program are public:

- Most of the SP produced from VHF data
- Significant fraction of the SP produced from X band data
  (main exception: spectra)

Diffusion:

- Alerts and notices in near real-time
- On-line « SVOM GRB table »
  (this table will also collect some information coming from outside SVOM: e.g. spectro-z)

Within the SVOM collaboration: co-Is have access to all data.

Any researcher outside SVOM can associate with a co-I for a specific study.

CONCLUSION

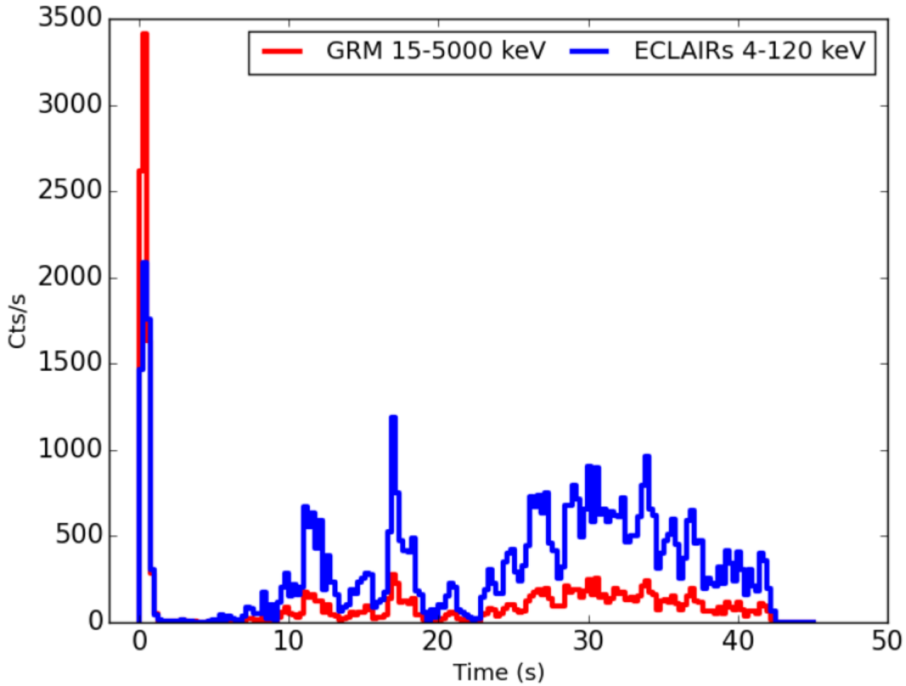
- SVOM will build a unique sample of 30-40 GRB/yr:
  - prompt emission over 3 decades
    (+ optical: 13-27%)
  - X-ray and V afterglow
  - redshift

- This sample will include classical long GRBs but will also
  - probe poorly described classes
    (especially low-luminosity GRBs, XRF/XRR, …)
  - detect short–hard GRBs related to compact binary mergers

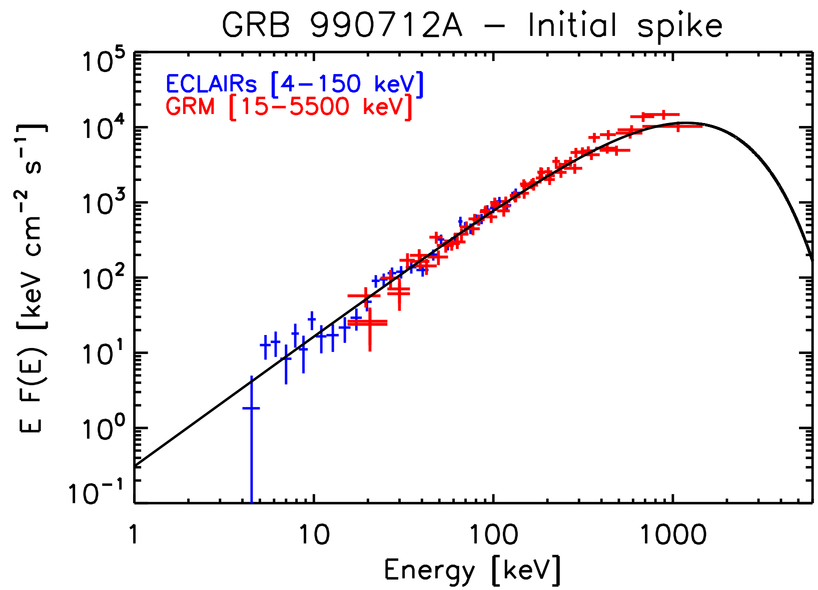
- This sample will allow to address several fundamental questions:
  - Accretion/ejection – Relativistic jets
  - Particle acceleration – VHE emission:
    synergy with the new generation of VHE/ν detectors
  - GRB diversity & the fate of massive stars
  - Short GRBs and the physics of BNS/NSBH: *synergy with GW detectors*
  - GRBs as a tool for cosmology: sample of high-z galaxies, star formation history, first generation of stars?
  - etc.

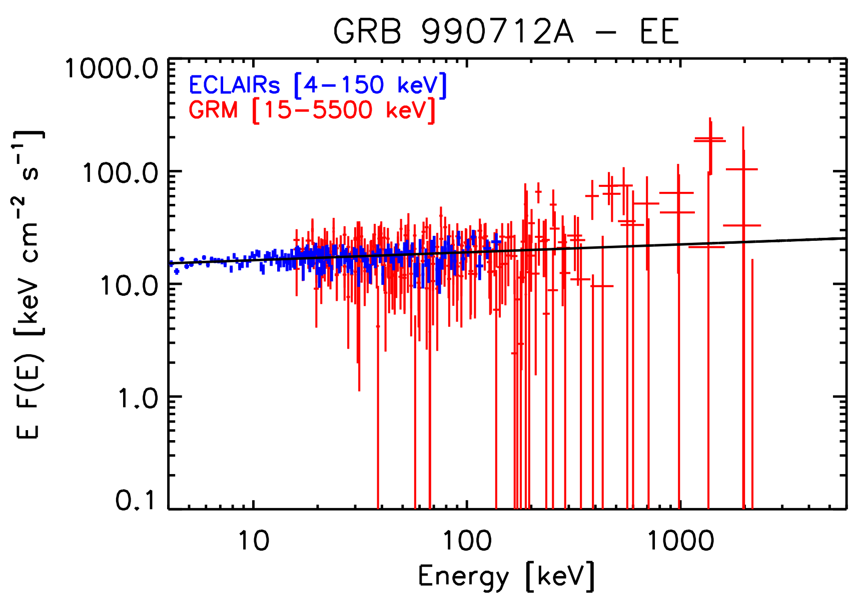
Supplementary Material

ECLAIRS + GRM OBSERVATION OF A SHORT GRB



Simulation of a short GRB with a soft tail in ECLAIRs+GRM (990712A)
Simulation
by S.Antier, M.-G. Bernardini, F. Xie et al.





(Bernardini et al. 2017)
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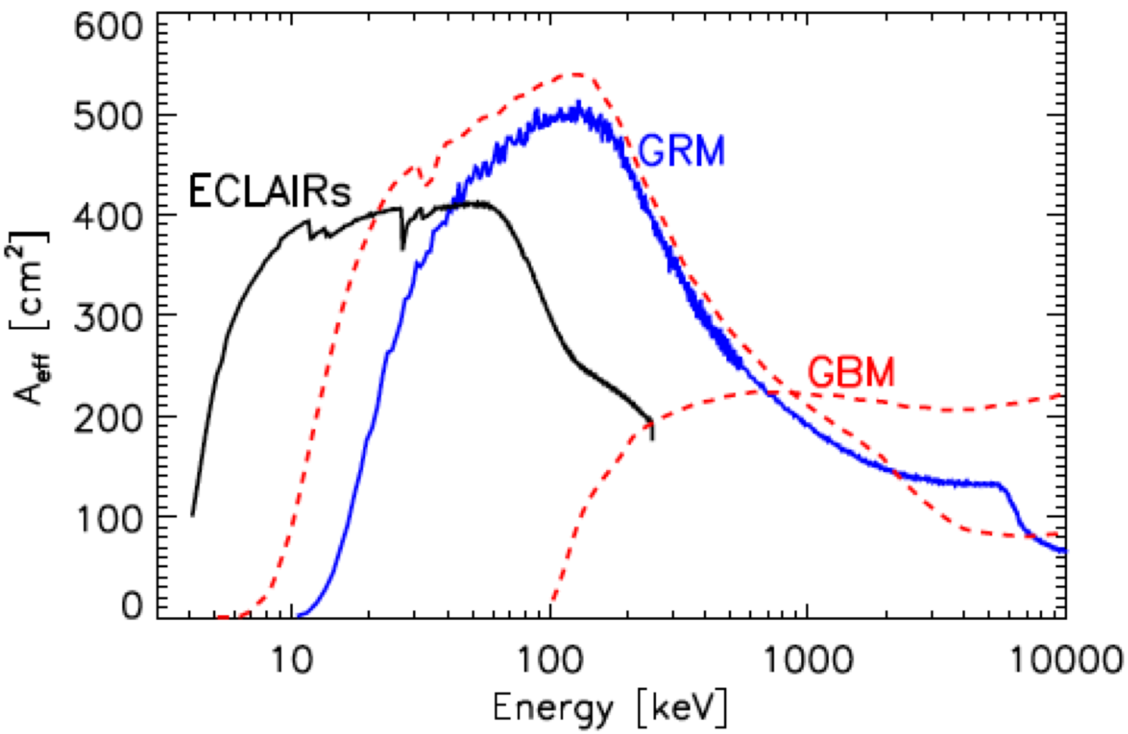
ECLAIRS + GRM SPECTRUM

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

(Bernardini et al. 2017)

Effective area:



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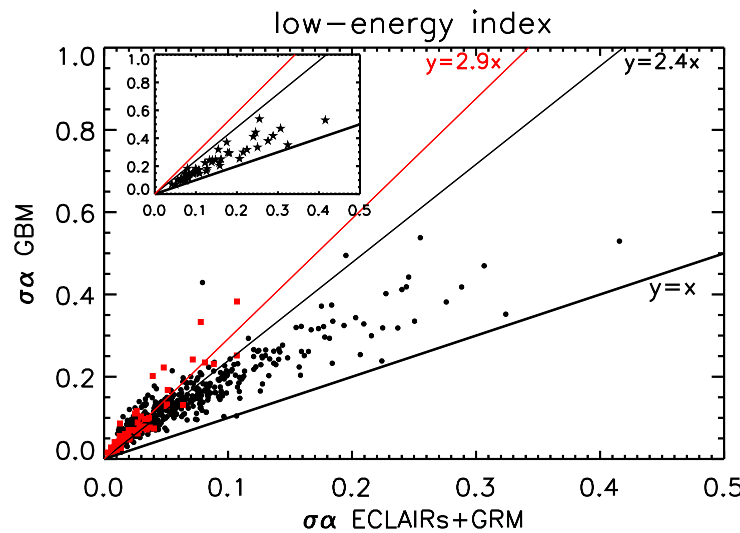
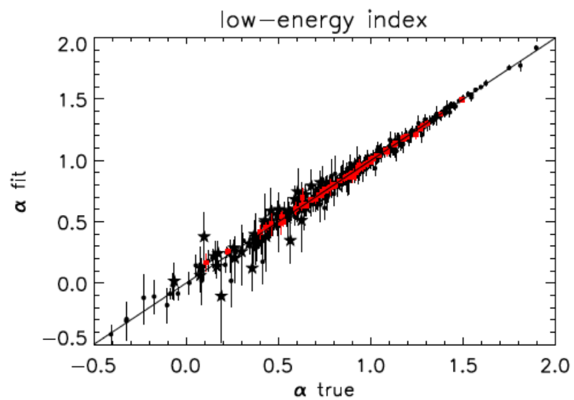
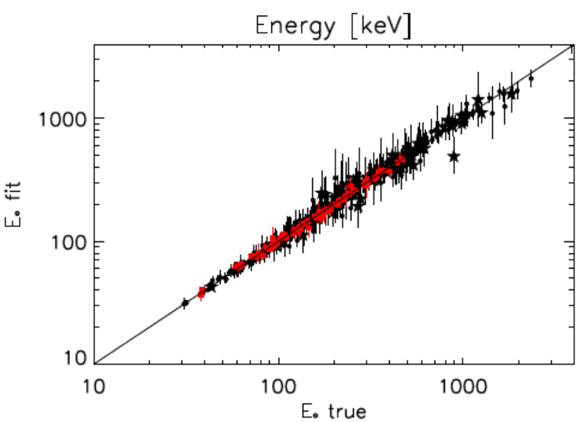


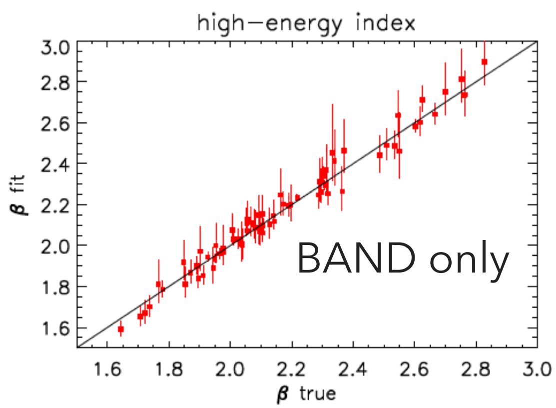
★ short GRBs



Error on low-energy slope:
SVOM vs GBM

ECLAIRs+GRM spectroscopic performances:
highly competitive,
at least as good as Fermi/GBM





Peak energy, low/high-energy slope

A GRB SAMPLE WITH A COMPLETE DESCRIPTION

- **Prompt emission:**

ECLAIRS:	47-82 GRB/yr	GRM:	~90 GRB/yr
ECLAIRs+GRM:	~40-60 GRB/yr	GWAC:	13-27% of alerts

- **Slew requests:** 36-72 GRB/yr
- **X-ray afterglow (MXT):** 90% of cases after a slew
- **Visible afterglow (VT):** 66% of slews followed by at least 5 min of visibility
- **Visible+NIR afterglow: (F-GFT+C-GFT)** 37% of ECLAIRs triggers (75% with LCOGT)
- **Early observation possible with a VLT:** 85% of MXT localizations
- **Redshift measurement expected in 2/3 of burst**

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- X-ray and V afterglow
- redshift