The eclgrm-vhf pipeline: analysis tasks and methods

F. Piron, ECLGRM-VHF IS training (2026/05/12)

Goal of this presentation

- **Present the eclgrm-vhf pipeline running at the French Science Center (FSC)**
  - Architecture, activation conditions, workflow (analysis tasks)
- **Present the analysis tasks performed by the pipeline**
  - Inputs, data analysis method, outputs (scientific data products)
  - Highlight the key analysis parameters (very few) that are most useful to the shifter

Useful documents

- Shift procedure: ”Procedure for ECLAIRS / GRM Instrument Scientists on shift: working with VHF data in real time”
- Pipeline article in RAA (SVOM special issue): “The GRB joint scientific analysis pipeline of the ECLAIRs and GRM instruments on board SVOM”
- Pipeline full documentation (for experts) – installation, usage, targets, workflow & tasks, algorithms, products: Welcome to eclgrm-vhf’s documentation!

Procedure for ECLAIRS / GRM Instrument Scientists on shift: working with VHF data in real time

Frédéric Piron (version 1.2 – May 9, 2026)

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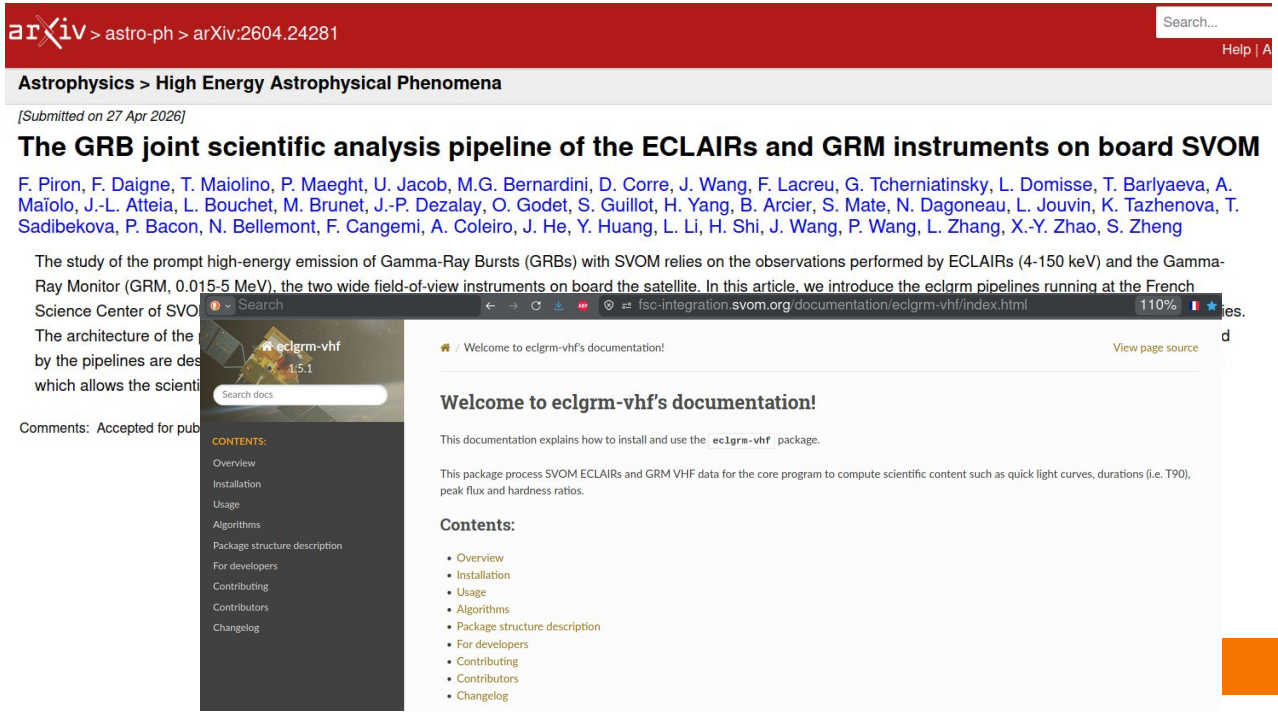

arXiv > astro-ph > arXiv:2604.24281

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[Submitted on 27 Apr 2026]

The GRB joint scientific analysis pipeline of the ECLAIRs and GRM instruments on board SVOM

F. Piron, F. Daigne, T. Maiolino, P. Maeght, U. Jacob, M.G. Bernardini, D. Corre, J. Wang, F. Lacreu, G. Tcherniatinsky, L. Domisse, T. Barlyaeva, A. Maïolo, J.-L. Atteia, L. Bouchet, M. Brunet, J.-P. Dezalay, O. Godet, S. Guillot, H. Yang, B. Arcier, S. Mate, N. Dagoneau, L. Jouvin, K. Tazhenova, T. Sadibekova, P. Bacon, N. Bellemont, F. Cangemi, A. Coleiro, J. He, Y. Huang, L. Li, H. Shi, J. Wang, P. Wang, L. Zhang, X.-Y. Zhao, S. Zheng

The study of the prompt high-energy emission of Gamma-Ray Bursts (GRBs) with SVOM relies on the observations performed by ECLAIRs (4-150 keV) and the Gamma-Ray Monitor (GRM, 0.015-5 MeV), the two wide field-of-view instruments on board the satellite. In this article, we introduce the eclgrm pipelines running at the French Science Center of SVO

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Comments: Accepted for pub

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eclgrm-vhf 1.5.1

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Changelog

Welcome to eclgrm-vhf's documentation! View page source

Welcome to eclgrm-vhf's documentation!

This documentation explains how to install and use the `eclgrm-vhf` package.

This package process SVOM ECLAIRs and GRM VHF data for the core program to compute scientific content such as quick light curves, durations (i.e. T90), peak flux and hardness ratios.

Contents:

- Overview
- Installation
- Usage
- Algorithms
- Package structure description
- For developers
- Contributing
- Contributors
- Changelog

The eclgrm-vhf pipeline: architecture, activation

1

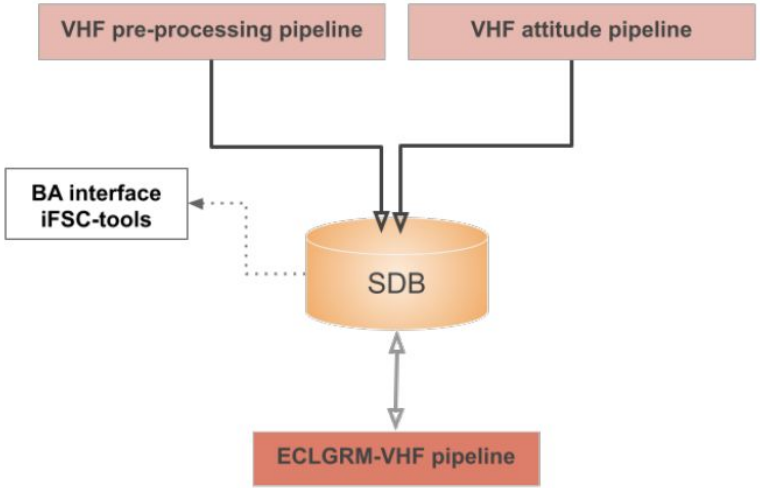
Purpose

- Use the ECLAIRs and GRM VHF data to compute rapidly all the scientific data products (SDPs) characterizing the prompt high-energy emission of a GRB candidate in real time
  - GRB and background count light curves
  - Emission duration, on-ground detection significance
  - Peak count fluxes, hardness ratios
  - Early classification (likely GRB type or other astrophysical event)
- Produce figures and control plots (“ancillary files”) at each step of the data analysis sequence to assess the quality of the results

Dependencies

The pipeline needs:

- The vhf-preproc pipeline → SDPs containing the time and localization of the onboard alert(s), and the onboard count light curves (OBLCs)
  - OBLCs are built around a reference time REFT in different pre-defined energy bands and with pre-defined time resolutions
- The vhf-attitude pipeline → SDPs containing the satellite attitude and orbital position
  - Unevenly sampled around the reference time
- The Science Database (SDB) to fetch or send SDPs



Trigger scenarios

The availability of VHF alert and light curves depends on the onboard trigger scenario

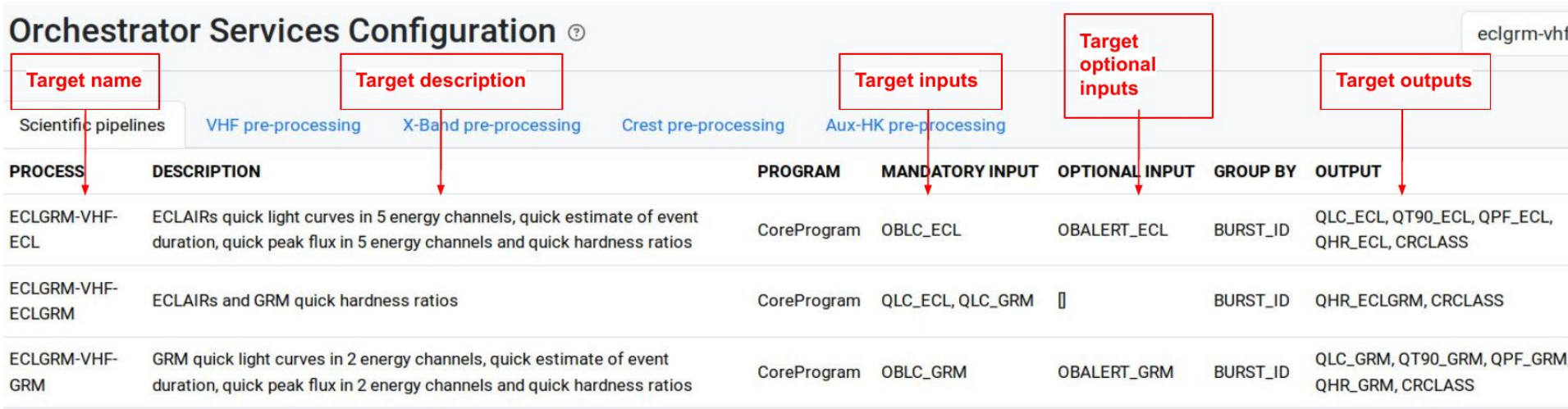
Trigger scenario → Available product ↓	ECL first	GRM first	GRM-only
OBALERT_ECL	✓	✓	×
OBLC_ECL	✓ (if timescale<624 s)	✓	×
OBALERT_GRM	×	✓	✓
OBLC_GRM	✓	✓	✓

- GRM VHF alert is not produced (trigger not allowed) if ECL already triggered (“ECL first”)
  - Even if strong signal in the GRM
  - But OBLC are available to assess the GRM detection on the ground
    - GRM independent detection can reinforce the ECL detection (e.g. faint / off-axis GRB)
- ECL VHF OBLCs are not produced if the best alert obtained during the first 12 s of onboard processing is an IMT with timescale>624 s
  - Otherwise, REFT (“0” of the light curves) = trigger window start time for this best alert

Automated mode (activation by the FSC orchestrator)

- Depending on which input SDPs are available at a given time in the SDB, the FSC orchestrator activates specific eclgrm-vhf processes or targets

- The onboard trigger scenario can not be known in real time → 3 targets have been defined to cover all possible scenarios
  - ECLGRM-VHF-ECL target: ECL OBLC processing (activated only if ECL trigger on a timescale<624s)
  - ECLGRM-VHF-GRM target: GRM OBLC processing (always activated, even if GRM did not trigger)
  - ECLGRM-VHF-ECLGRM target: only if the previous two targets were activated and successful.



PROCESS	DESCRIPTION	PROGRAM	MANDATORY INPUT	OPTIONAL INPUT	GROUP BY	OUTPUT
ECLGRM-VHF-ECL	ECLAIRs quick light curves in 5 energy channels, quick estimate of event duration, quick peak flux in 5 energy channels and quick hardness ratios	CoreProgram	OBLC_ECL	OBALERT_ECL	BURST_ID	QLC_ECL, QT90_ECL, QPF_ECL, QHR_ECL, CRCLASS
ECLGRM-VHF-ECLGRM	ECLAIRs and GRM quick hardness ratios	CoreProgram	QLC_ECL, QLC_GRM	[]	BURST_ID	QHR_ECLGRM, CRCLASS
ECLGRM-VHF-GRM	GRM quick light curves in 2 energy channels, quick estimate of event duration, quick peak flux in 2 energy channels and quick hardness ratios	CoreProgram	OBLC_GRM	OBALERT_GRM	BURST_ID	QLC_GRM, QT90_GRM, QPF_GRM QHR_GRM, CRCLASS

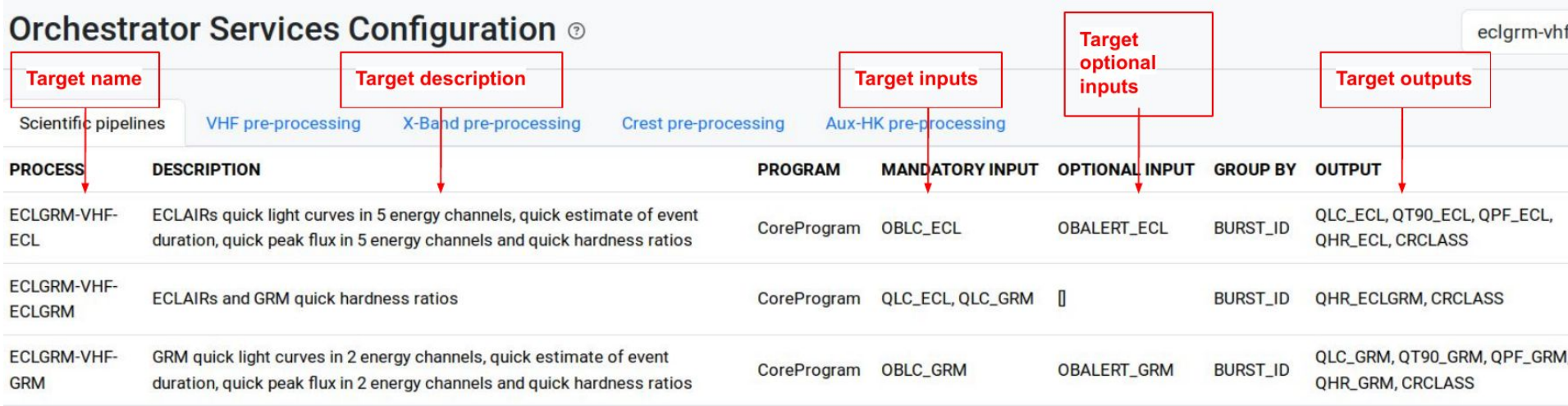
Automated mode (activation by the FSC orchestrator)

- The eclgrm-vhf pipeline runs sequentially, queuing each new process until the current one completes
- Usually, multiple processes are successively executed for the same burstID as new VHF LC packets arrive and OBLCs are updated in the SDB
- However, the vhf-preprocessing pipeline does not create a new OBLC each time a new VHF LC packet is received
- Instead, it groups the packets so that the eclgrm-vhf pipeline is activated a few times only in total (between 1 and 6 typically)
    - The number of VHF LC packets downloaded to the ground is 64 (22 high priority + 42 low priority) for each instrument
- Each process is rapid and takes less than one minute, typically
- Besides this automated mode (orchestrator), the pipeline can be restarted manually by the shifter (see next presentation on the eclgrm-ui user interface)

The eclgrm-vhf pipeline: analysis tasks 2

Workflow

- Each target consists in a series of successive analysis tasks, each of them producing 1 SDP
- Each task operates as follows: retrieval of the SDP FITS templates, download of the input files, initialization of the task parameters, execution of the scientific algorithms, filling of the output SDP FITS files with the analysis results, export to the SDB along with the ancillary files



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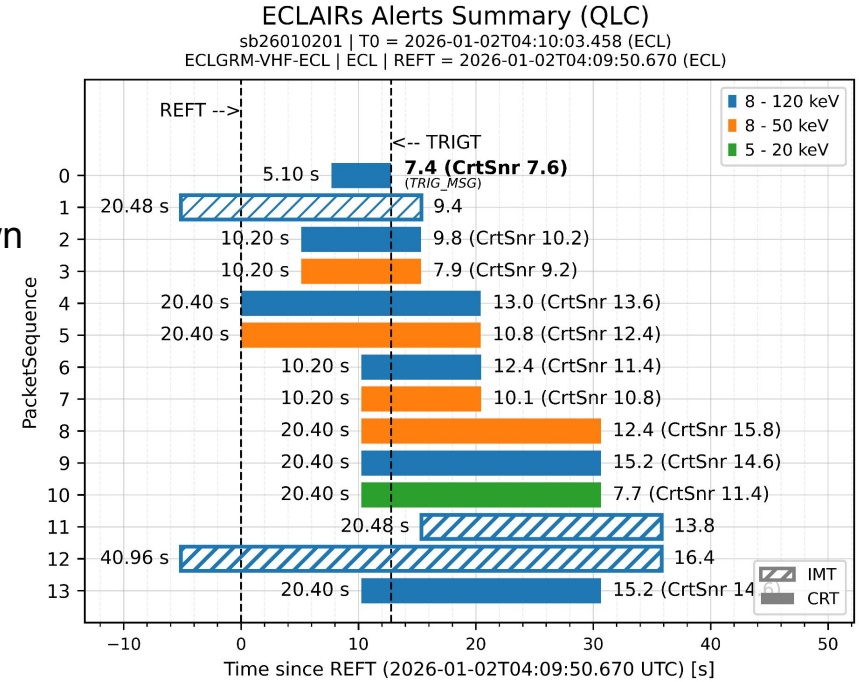
ECLGRM-VHF-ECLGRM	ECLAIRs and GRM quick hardness ratios	CoreProgram	QLC_ECL, QLC_GRM	[]	BURST_ID	QHR_ECLGRM, CRCLASS
ECLGRM-VHF-GRM	GRM quick light curves in 2 energy channels, quick estimate of event duration, quick peak flux in 2 energy channels and quick hardness ratios	CoreProgram	OBLC_GRM	OBALERT_GRM	BURST_ID	QLC_GRM, QT90_GRM, QPF_GRM QHR_GRM, CRCLASS

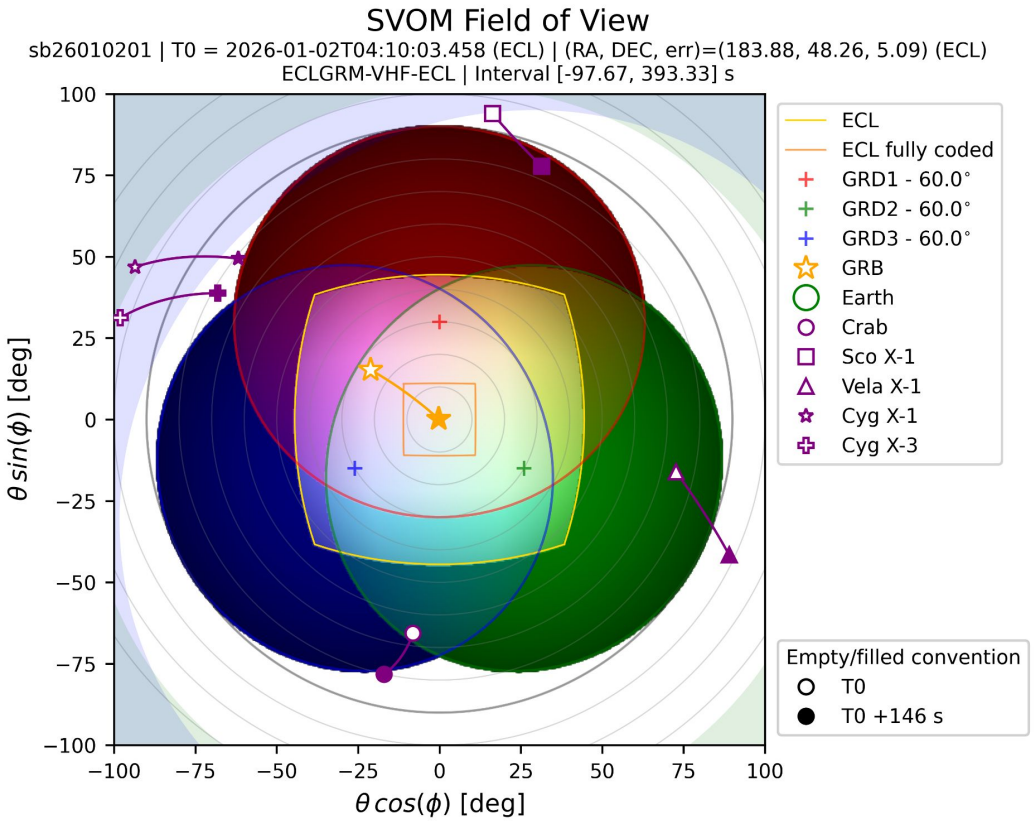
The QLC task (quick light curves) : informative plots

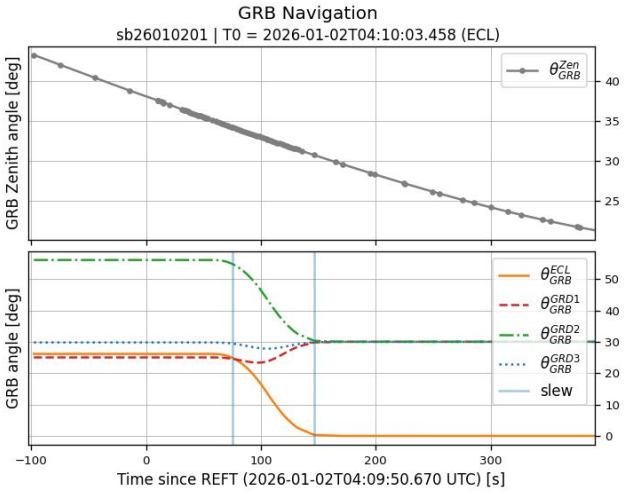
To help understand the observational context around the trigger time:

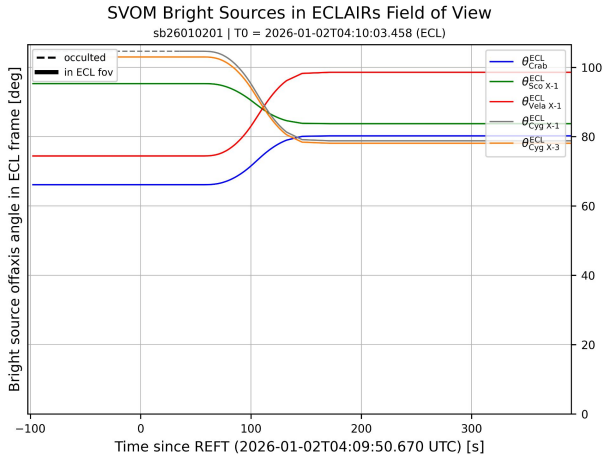
- If ECLAIRs trigger: summary of onboard alert(s)
- Navigation plots
  - Pointing directions of the instruments
  - Angular positions of the GRB and of nearby known X-ray sources in the ECL and GRB FoV
  - GRB angular distance to the Earth's limb and possible source occultation by the Earth



The QLC task (quick light curves) : informative plots







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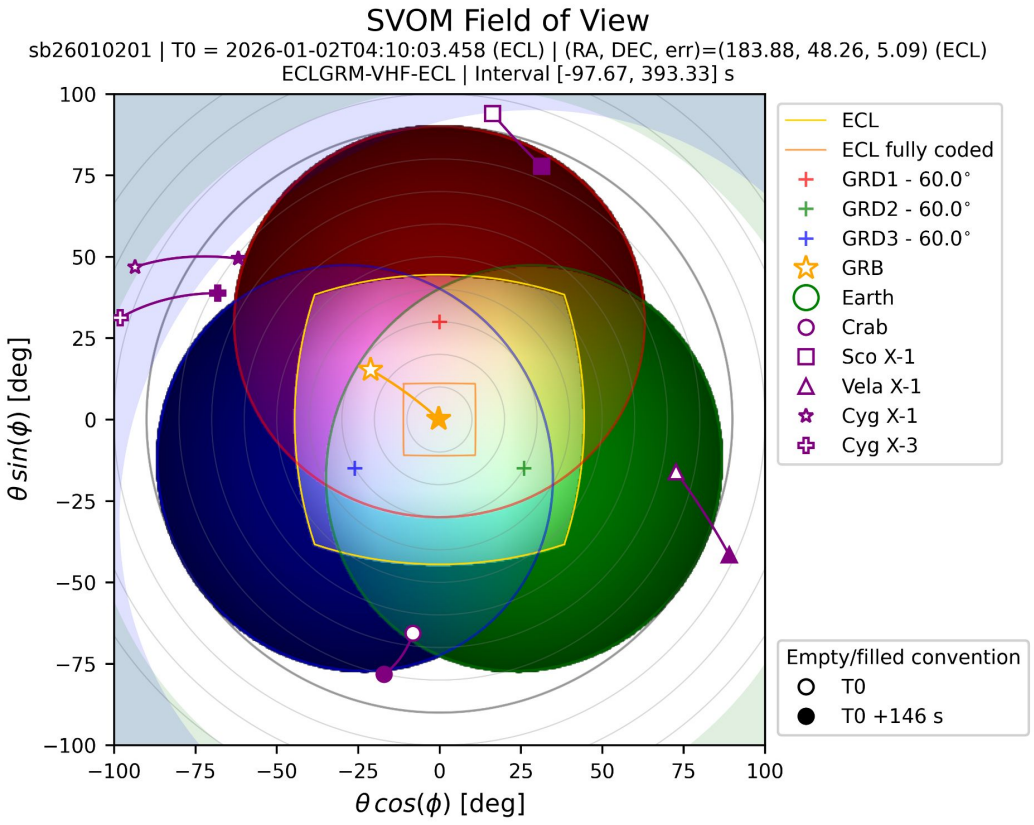
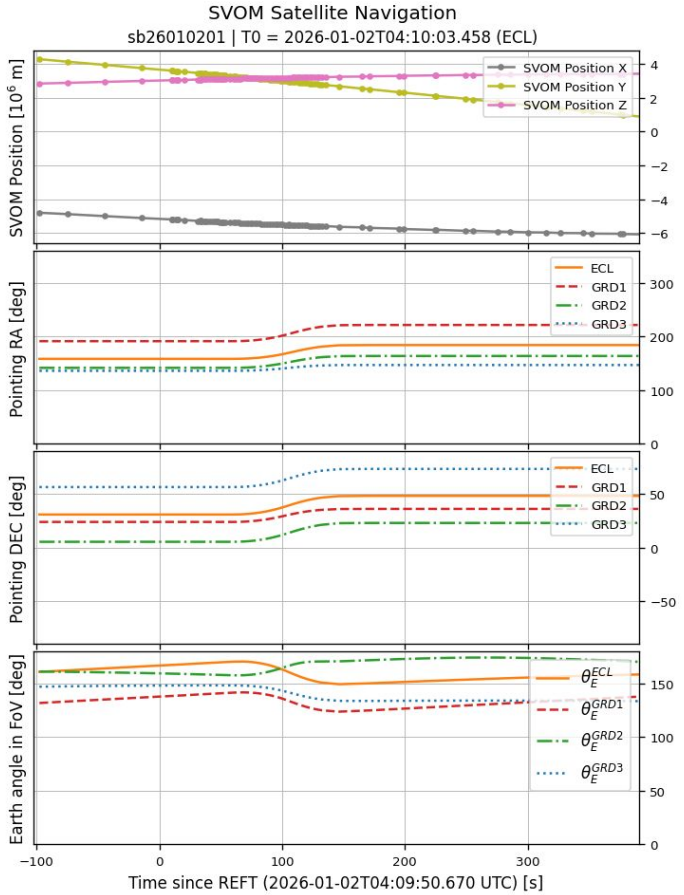
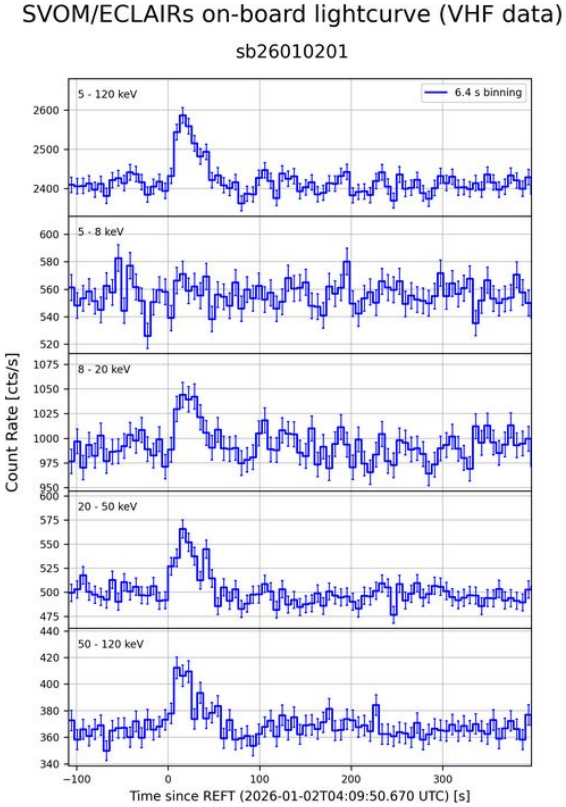
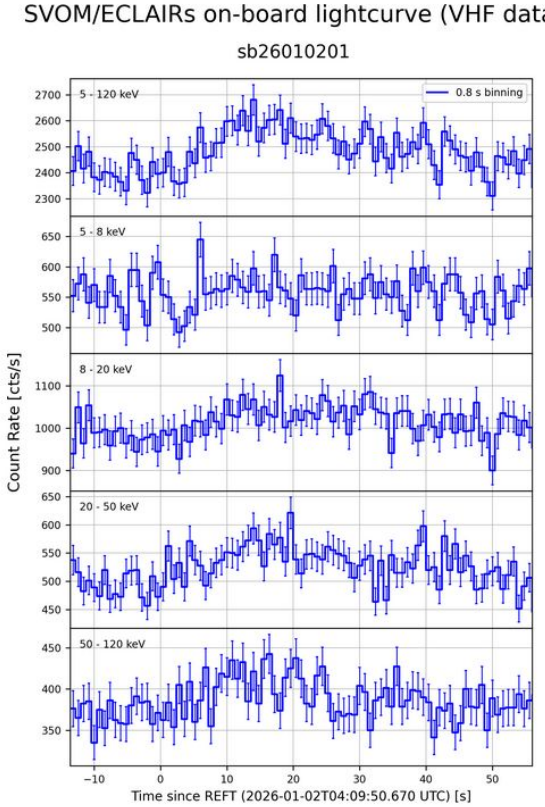
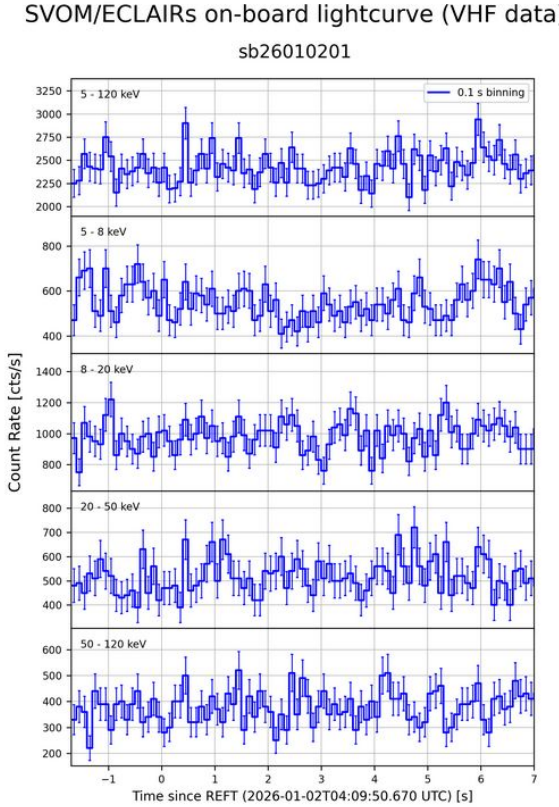




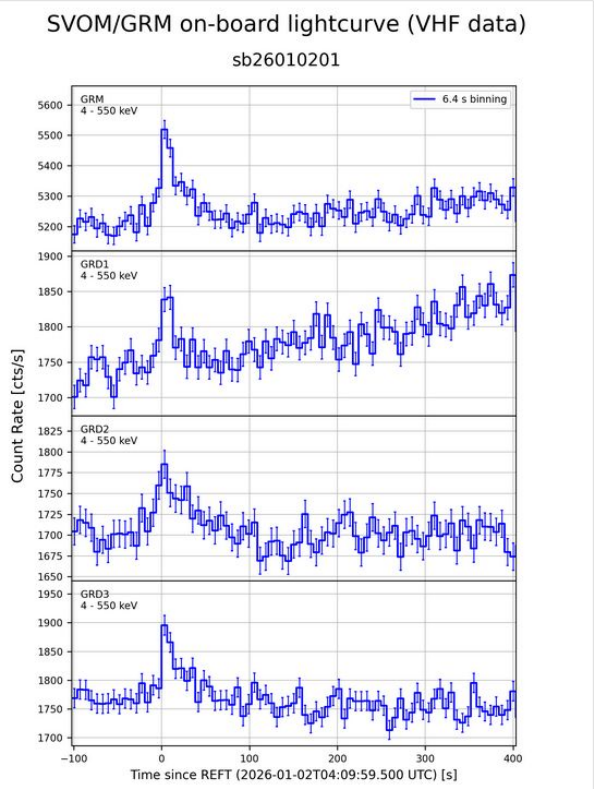
The QLC task (quick light curves) : public plots (ECL)

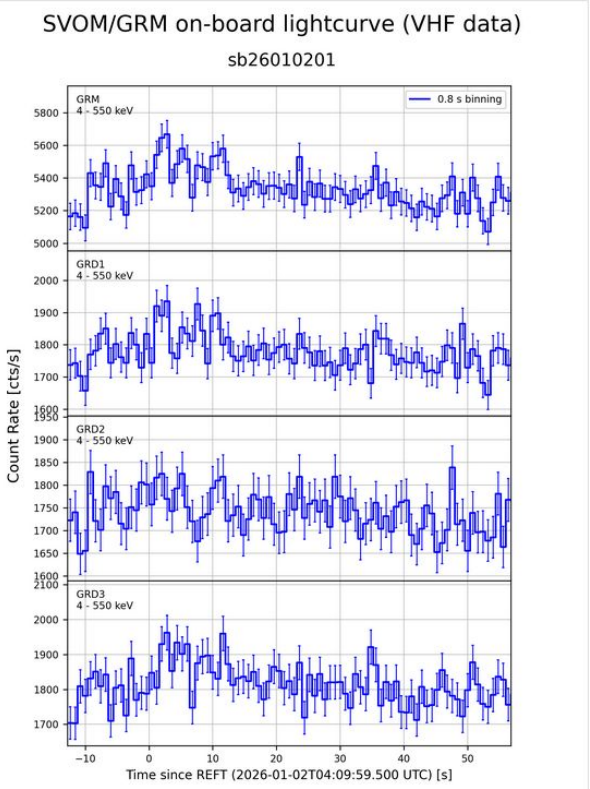


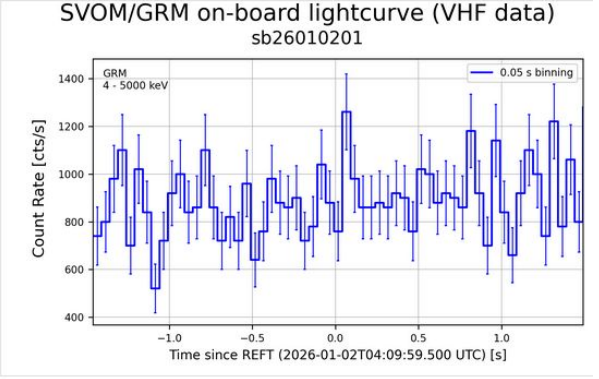




The QLC task (quick light curves) : public plots (GRM)







- The GRM 1-ms OBLC is rebinned to 50 ms, covering a few seconds only around REFT

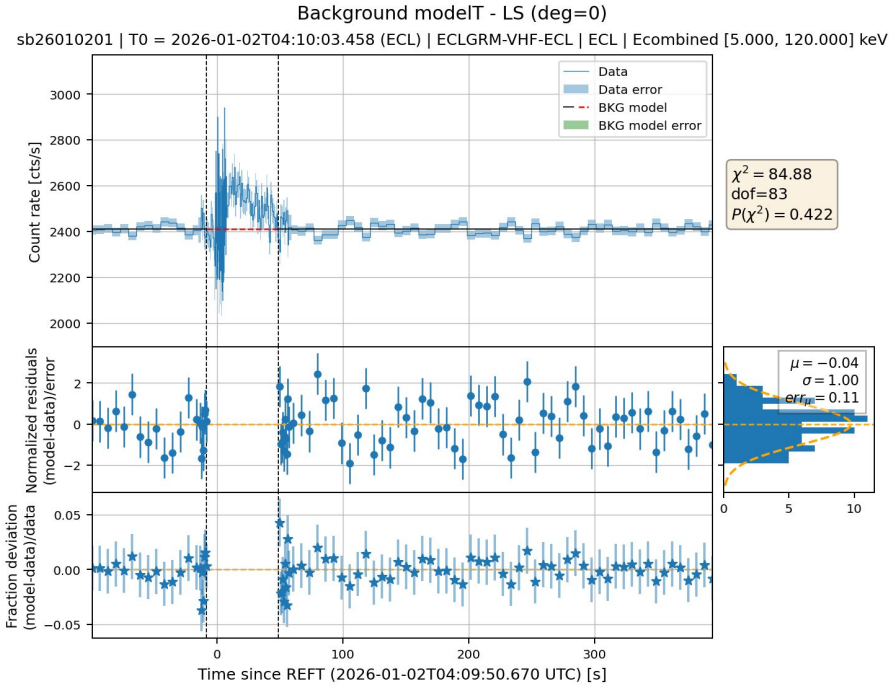
The QLC task (quick light curves) : background fit

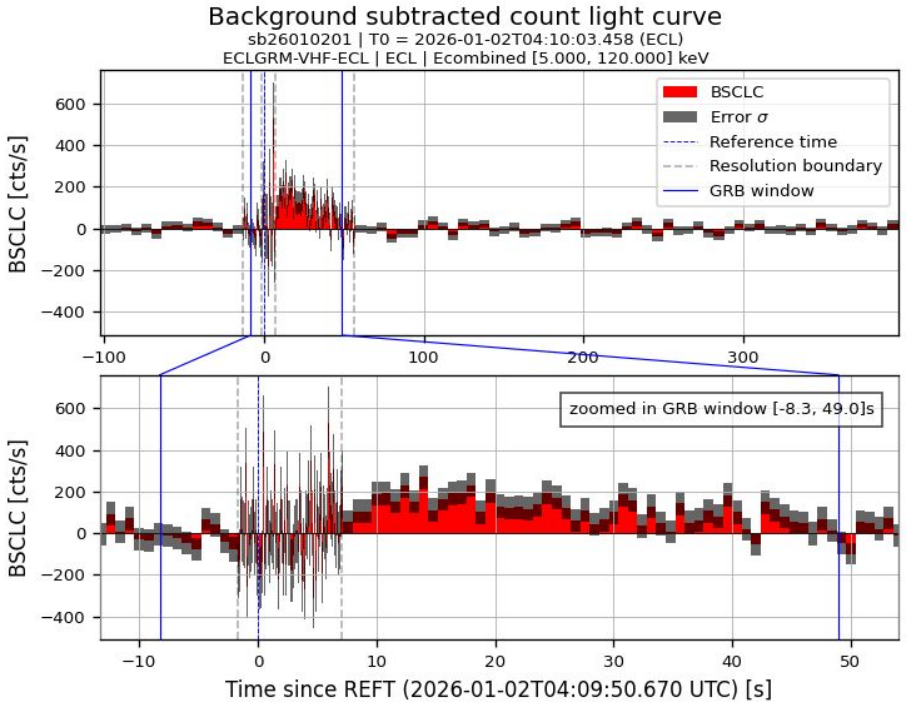
- Creates count light curves (CLCs) in each detector / instrument (ECL, GRD1,2,3, GRM) from the OBLCs in the different energy bands (+ combined energy band)

- Default mode: uses Bayesian Blocks to define and optimize the two bkg periods (pre/post burst time intervals OFF1 and OFF2) for each CLC, along with the best-fit bkg model
- Two background models are available (see A. Maïolo's PhD thesis)
  - ModelT, a polynomial function of time: for slow bkg variations (no slew or Earth behind the satellite)
  - ModelE, a polynomial function of $\cos[\theta_{Earth}(t)]$ between the detector's main axis and the direction of Earth center → better results in case of slew
  - ModelAuto (default mode): selects ModelT/E from Earth position and $\cos[\theta_{Earth}(t)]$ variations
- Computes a background-subtracted count light curve (BSCLC) for each CLC
  - Note: faint and/or extended emission sometimes visible only after background-subtraction

- Key parameters that can be tuned by the shifter (manual mode):
  - start/stop times of the overall analysis window (`twindow_min/max`)
  - start/stop times of the two OFF intervals for the bkg fit (`t_left/right`)
  - background model and polynomial order (`ModelE/T and porder`)

The QLC task (quick light curves) : background fit

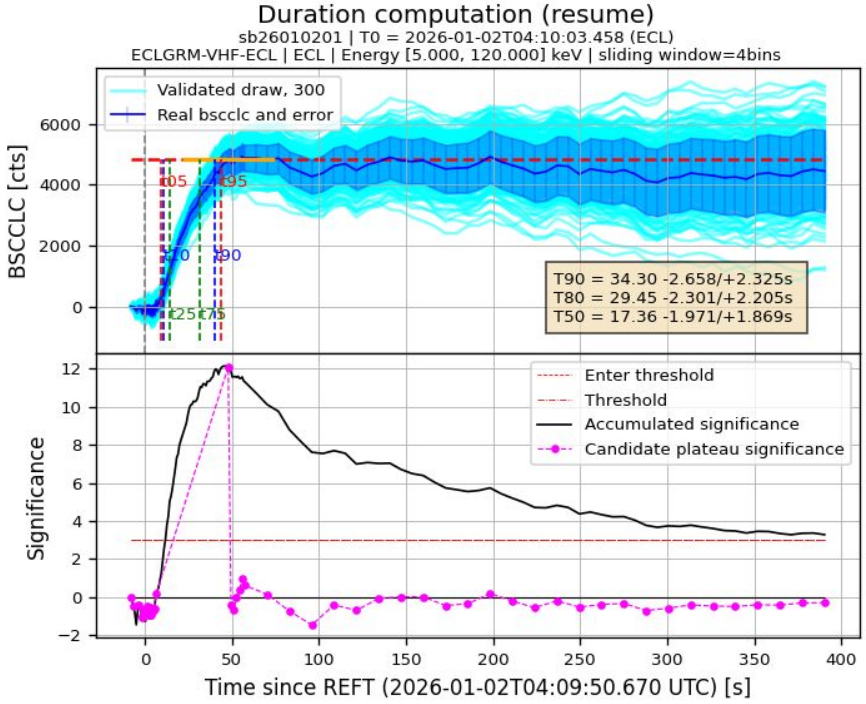


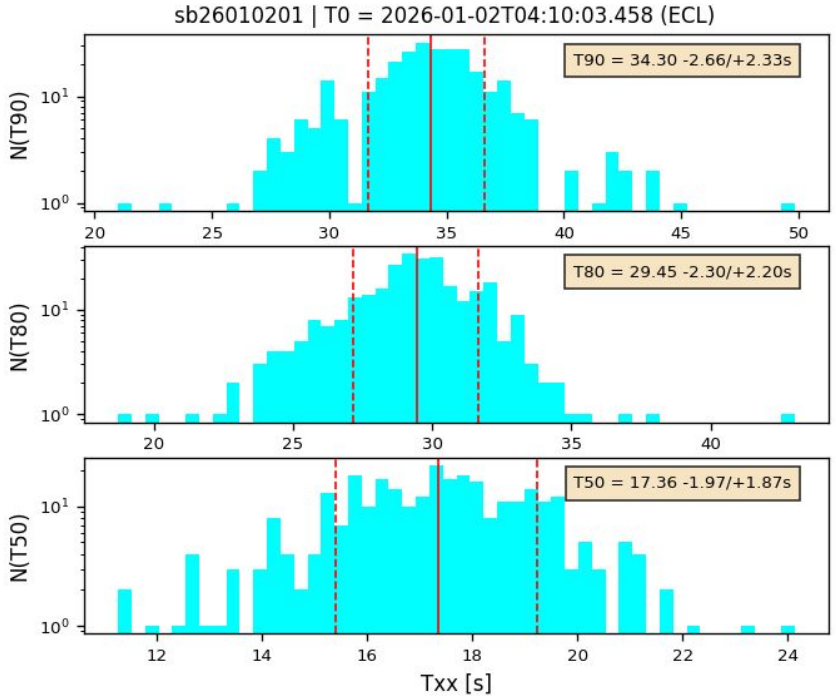


The QT90 task (quick duration)

- Estimates the GRB signal duration in a selected energy band (see slide 21)
  - Method used in the Fermi/LAT first GRB catalog
- Simulates (300 by default) CLCs through Poisson resampling, and computes their background-subtracted cumulative count light curves (BSCCLCs)
- Identifies automatically the plateau (100% accumulation level = photon fluence) at the end of each BSCCLC and computes
  - The times tx at which x% of the total signal counts is reached
  - The distribution of the durations QT90 = t95 − t05, QT80 = t90 − t10, and QT50 = t75 − t25
  - The final times and durations: median of their respective distributions, with 68% (asymmetric) errors
- Computes the on-ground significance of the GRB signal in the QT90 time interval following the prescription of Vianello (2018)
  - Very useful for the GRM in the ECL first scenario
- Key parameters that can be tuned by the shifter (manual mode):
  - Number of resampled CLCs (`n_draw`): smaller (speed up the tests) or larger (accurate error)
  - QT90 energy band (`eband_qt90`): 5-20/50 keV to increase SNR for faint bursts

The QT90 task (quick duration)





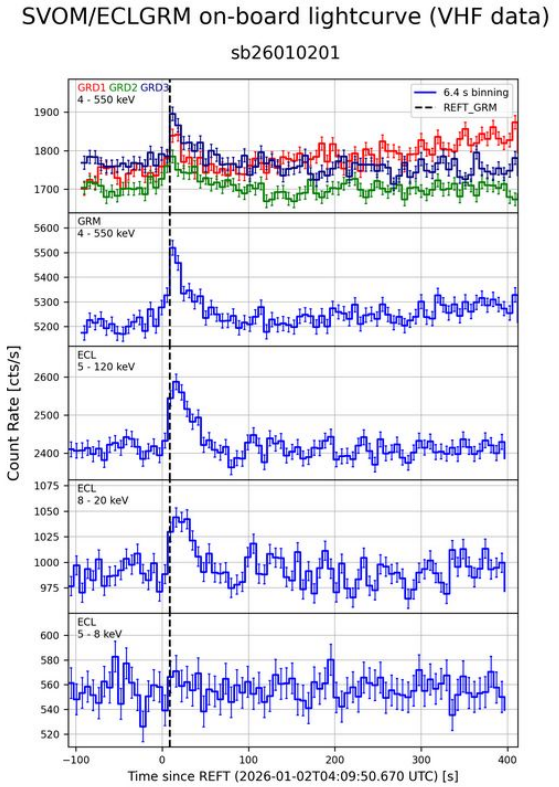
The QPF & QHR tasks (quick peak flux & hardness ratio)

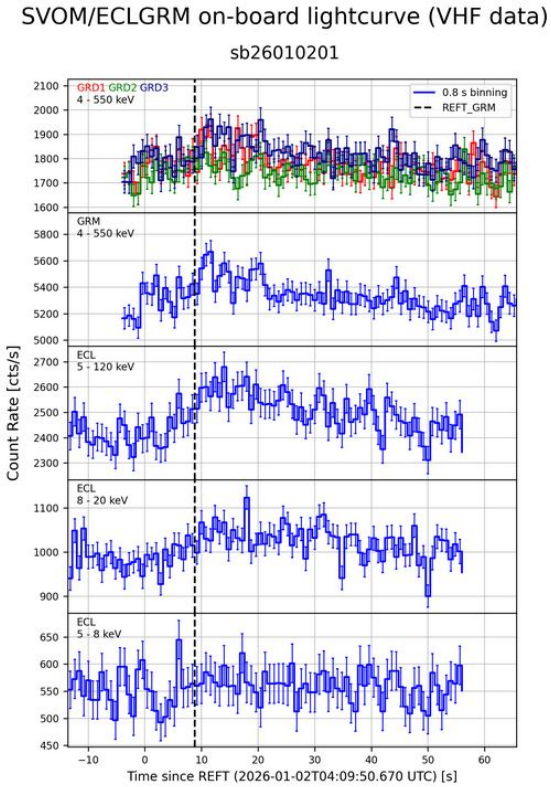
- QPF: for each BSCLC, finds the maximum count rate and associated peak time
- QHR: ratio of the total numbers of signal counts in the QT90 time interval between two energy bands (high/low)
  - Indicator of the spectral behaviour of a GRB: helps discriminate among different classes (short, long, X-ray rich, X-ray flash...)

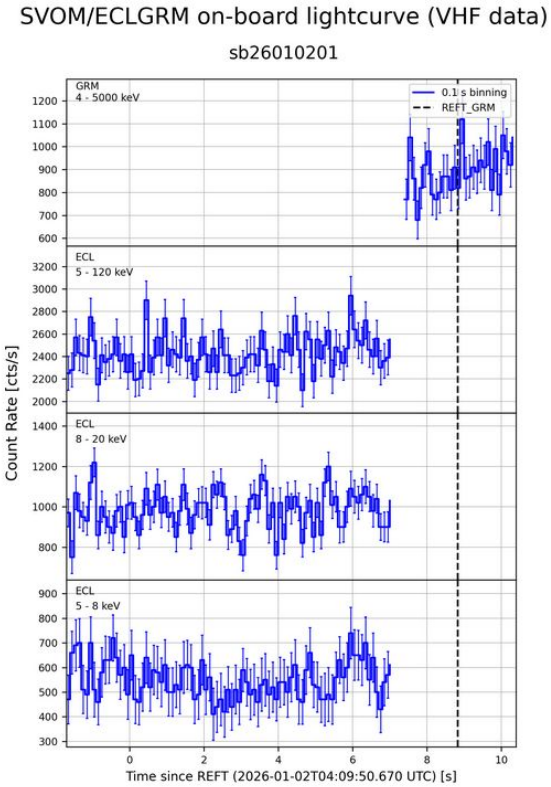
Table 1 Time Resolutions and Energy Bands in the *eclgrm-vhf* Pipeline. The mid and best time resolutions for the OBLCs are available only in a limited time interval around the trigger time. The OBLC time resolutions and energy bands are pre-defined on board. The QT90 and QHR energy bands are the default values used in the pipeline automated mode.

Time resolutions and energy bands	VHF-ECL target	VHF-GRM target
OBLC pre-defined time resolutions (s)	low: 6.4 ; mid: 0.8 ; best: 0.1	low: 6.4 ; best: 0.8 ; high*: 0.001
OBLC pre-defined energy bands (keV)	1: 5-8 ; 2: 8-20 ; 3: 20-50 ; 4: 50-120	1: 4-550 ; 2: 550-5000
QT90 default energy band	1+2+3+4	1
QHR default energy bands	4/1 ; 4/2 ; 4/(1+2)	2/1
	VHF-ECLGRM target	
QHR default energy bands	(GRM 2)/(ECL 1+2+3+4), (GRM 1)/(ECL 1), (GRM 1)/(ECL 1+2)	

The QHR_ECLGRM task : joint public plots







- The GRM 1-ms OBLC is rebinned to 0.1 s, covering a few seconds only around REFT

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