SVOM MXT Pipeline Processing

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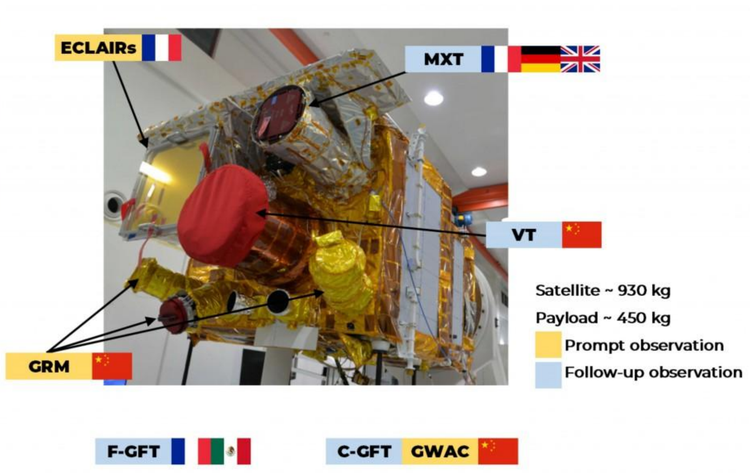
The Space-based multi-band astronomical Variable Objects Monitor (SVOM) mission, a joint Sino-French collaboration launched in 2024, is designed to detect, localize and study gamma-ray bursts (GRBs) and other high-energy transients. Among its onboard instruments, the Microchannel X-ray Telescope (MXT) plays a central role by providing follow-up X-ray observations of GRB afterglows and other transient phenomena with high sensitivity in the 0.2–10 keV range.

To ensure timely and accurate scientific exploitation of MXT observations, a dedicated ground processing pipeline has been developed. This pipeline automatically ingests raw event lists, performs calibration, background and time filtering, and corrects instrumental effects, produces science-ready data products such as images and light curves and spectra of detected sources.

Mission



The spacecraft comprises four main instruments:

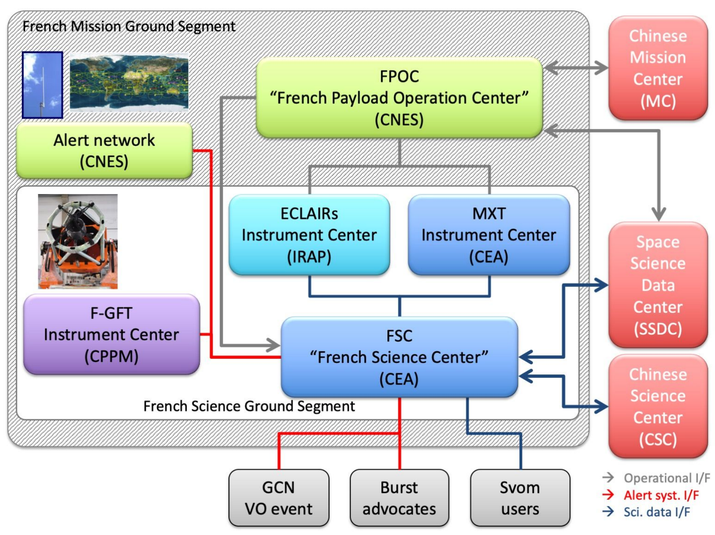
- the ECLAIRs telescope to detect and locate gamma-ray bursts in the X-ray and low-energy gamma-ray bands (from 4 to 250 keV)
- the MXT (Microchannel X-ray Telescope) to observe gamma-ray bursts in the soft X-ray range (0.2 to 10 keV)
- the GRM (Gamma Ray Burst Monitor) gamma-ray burst detector to measure the spectrum of high-energy bursts (from 15 keV to 5000 keV)
- the VT (Visible Telescope) operating in the visible range to detect and observe the visible emission produced immediately after a gamma-ray burst

The satellite is placed in low Earth orbit with an inclination of 30 degrees, an altitude of 625 km, and an orbital period of 96 minutes.

Space observations are complemented by a large number of ground-based instruments, including:

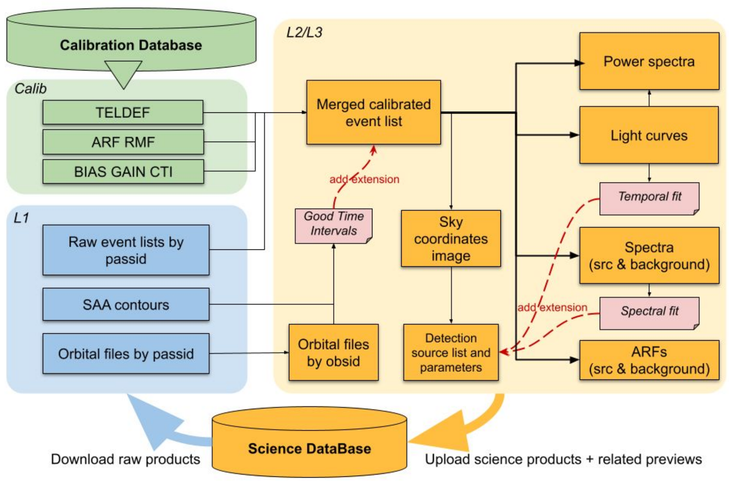
- Ground Follow-up Telescopes (GFT) in Mexico and China to accurately measure the coordinates of the gamma-ray burst
- Ground-based Wide Angle Camera (GWAC) in China to study the prompt emission of some of the detected bursts from the ground in the visible range

FMGS



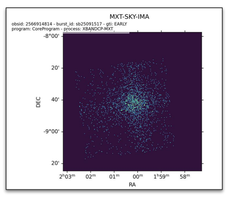
- The FMGS (French Mission Ground Segment) is designed to support the full range of mission operations and scientific exploitation activities.
- Within this framework, the majority of the science-related tasks, including data reception, processing, archiving, and distribution to the scientific community, are carried out at the French Science Center (FSC).
- In parallel, the activities directly linked to instrument operations, such as calibration, performance monitoring, and maintenance of instrument-specific expertise, are managed by dedicated Instrument Centers (namely the EIC, MIC, and GIC).
- The FSC and the Instrument Centres (ICs) work together as an integrated unit known as the French Science Ground Segment (FSGS). This ensures that scientific and technical responsibilities within the French contribution to the mission are organised coherently.

Pipeline

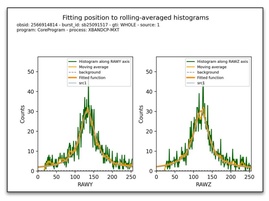


- The processing workflow consists of a sequence of about 40 individual Python tasks that are grouped into four different stages.
  - data access and preparation
  - events calibration and filtering
  - X-ray image and source detection
  - source products extraction
- The FSC has developed a generic task scheduler, *Pipeline-Bricks*, which is capable of executing any workflow described in this manner. The workflow execution is controlled by a REST API, which is standard across all FSC pipelines. This API governs various functions, including start, kill, log access, status access, and more. Each pipeline instance is operated as a Docker image deployed in the FSC infrastructure.
- The processes are triggered by a global orchestrator each time a complete set of requested input files is made available in Science Database (SDB)

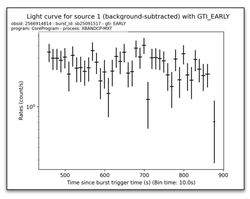
Some outputs for event *sb25091517* detected on 2025-09-16T00:10:00Z



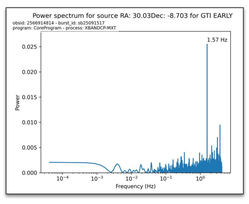
MXT sky image of **sb25091517**, a flare of **1RXS J020013.6-084106** actually. The cross PSF is typical of lobster-eye optics.



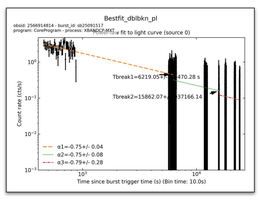
The source position is first computed from the Gaussian fits of the accumulated count histograms along the detector axis.



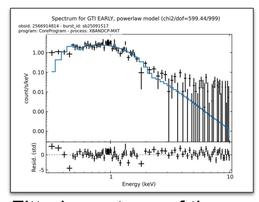
Light curve of the early observation (500" from the event) which is meant to enclose the GRB afterglow with a lower noise.



Power spectrum of the early light curve

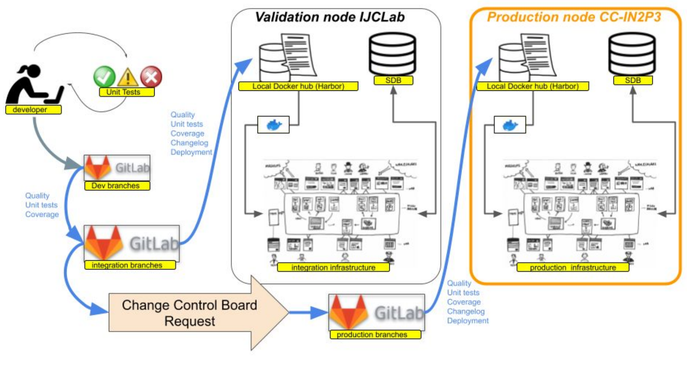


Light curve covering the whole observation. The blanks correspond to the unavailability of the instrument (e.g. Earth occultation).



Fitted spectrum of the source. Different models are tested (BB, PL) on both early and whole observation time

Deployment



- All ten institutes follow a common workflow for development and deployment.
- CI scripts operate many checking at each stage.
- Contributors from all 10 institutes use the same development cycle, which is based on a local GitLab instance for development and deployment.
- Whenever something is changed in the Git repository, CI scripts check the code quality and the test coverage. The process is canceled in case of failure.
- All FSC modules are delivered as Docker images after being validated against quality standards and test coverage.
- Each new feature is first deployed in an integration infrastructure, which is similar to the production infrastructure
- The deployment in the production node is only carried out after the integration work has been validated and approved.