COLIBRÍ Pipeline

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COLIBRI meeting, OHP, 01/12/25

Context

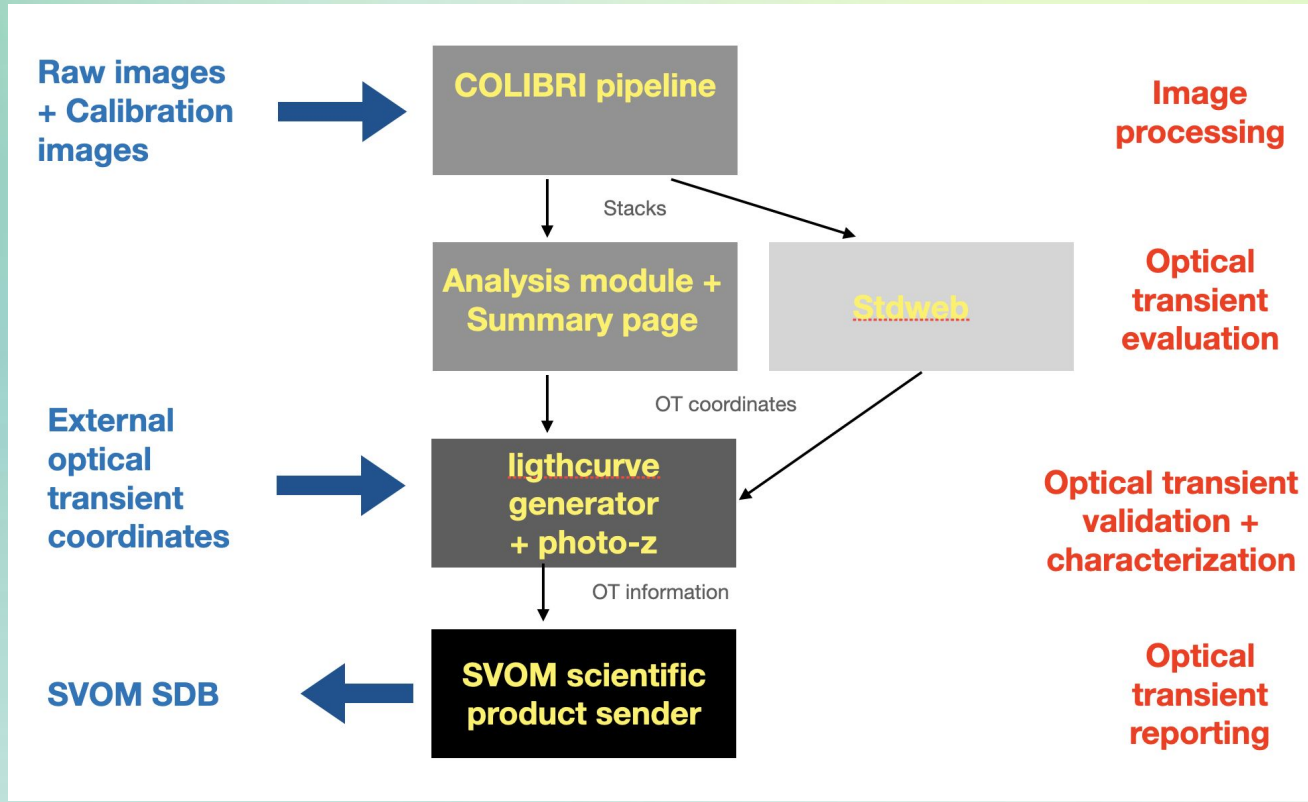
The colibri image analysis pipeline was built, based on a pipeline from N.Butler (e.g. RATIR, DDOTI), to meet the specific needs of the scientific subject :

- Aims to produce in real time reduction of the images (one by one as they appear in the disk)
- Aims to produce in real time stacking of the images, with temporal steps to build the lightcurve
- Aims to produce in real time sources extraction and photometric calibration to identify transient candidates.
- Parallel processing of all the filters
- Creation of an html page to display all these results for the shifter

→ To have everything in hand to identify potential counterpart and vet them via color/slope diagnostic **within minutes after the first image**.

→ Also provide “offline” mode for anybody that needs to produce a final lightcurve

Shifter's tools



Context

Current Online mode strategy :

- Detect new images in real time (watchdog), reduce images one by one while they arrive, trigger a pipeline process for each combination of Target/Filter that contain [3,16,32,64] images.

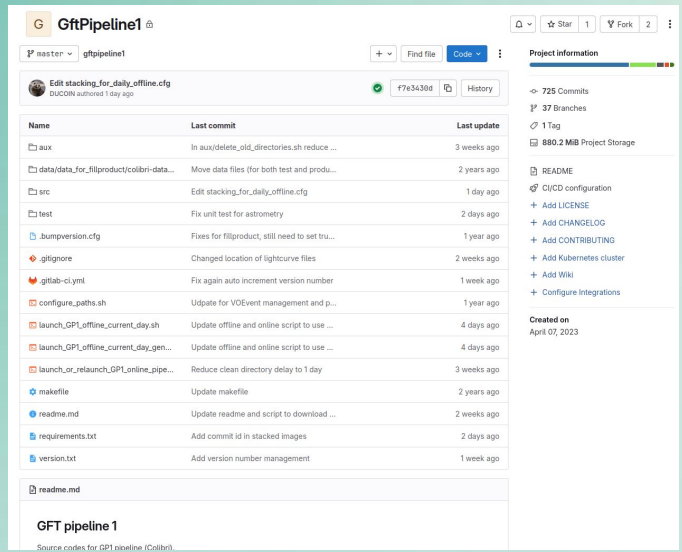
  * online mode setup chose to produce only stacka/stackb and full stack -> optimize running time while providing the main scientific output required for GCN/real time analysis (photometry, localisation, temporal slope estimation). With the recent improvement of the computing time, we are currently testing to increase the default number of intermediate stack.

- Automatically at the end of the night (13h30 UTC), a run with “all” the images in an offline like approach is launched.

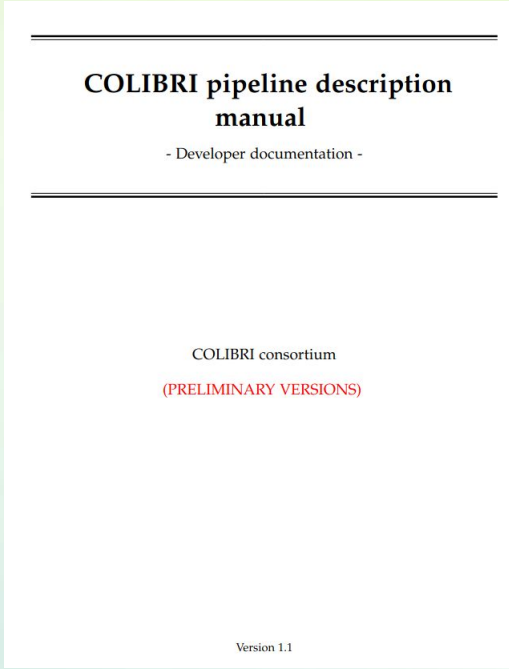
  * All Target/Filter combinations are run with all images available at the end of the night -> Reduction of individual images is done. Produce all sub-stack of images (with 4 by 4 steps) to have a short timestamp lightcurve.

Context

Dedicated git project :
With “how to install” docs



Dedicated developer manual and a simplified user guide :


COLIBRI pipeline description manual

- Developer documentation -

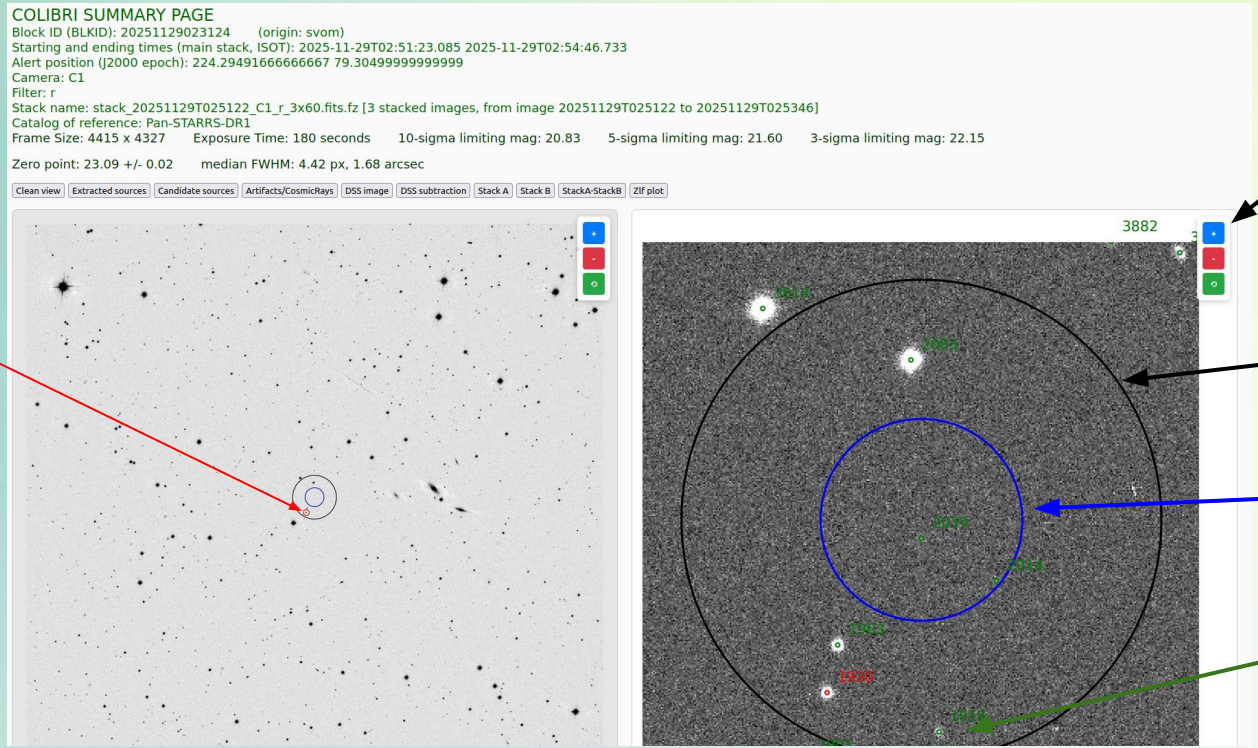
COLIBRI consortium

(PRELIMINARY VERSIONS)

Version 1.1

Overview of the results

A few words on the results pages (before the dedicated hand on session):



Uncatalogued sources

Catalogued sources with significant magnitude variation (none here)

Zoom tool

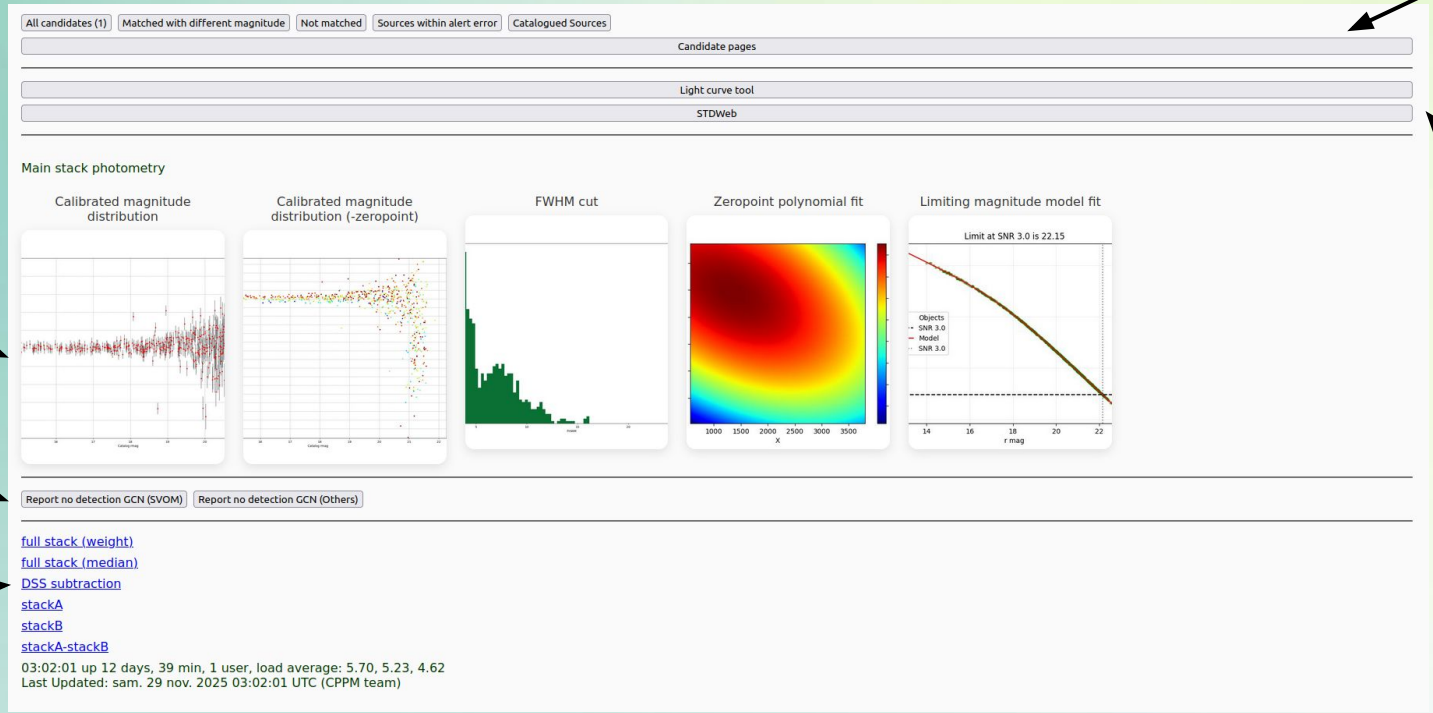
Extended alert localisation

Alert localisation

All the 'good' extracted sources

Overview of the results

A few words on the results pages (before the dedicated hand on session):



Link to the candidate list page

Link to the LC tool and stdweb for crossmatch/validation

Photometry quality check plots

Produce GCN non detection template

DL the stacks images

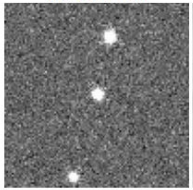
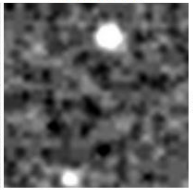
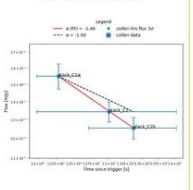
Overview of the results

A few words on the results pages (before the dedicated hand on session):

Candidate Pages

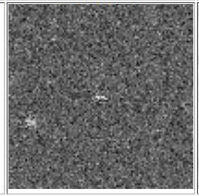
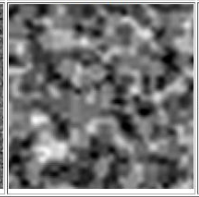
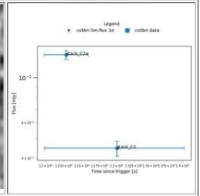
Golden candidates

Candidate 2255

Source ID	Matching type	Detection level	LSDR10 object	Solar system object	Main stack	DSS stack	Light curve
2255	not_matched	49σ	no	no			

Other candidates

Candidate 2336

Source ID	Matching type	Detection level	LSDR10 object	Solar system object	Main stack	DSS stack	Light curve
2336	not_matched	10σ	no	no			

Candidate :

Not matched with the reference catalog or matched with differences mag greater than 1 mag and detected at >5σ and within the extended alert region.

Golden candidate :

Candidate and detected at >3σ in stacka and detected at >3σ in stackb

Overview of the results

A few words on the results pages (before the dedicated hand on session):

Source 1930

Trigger summary (external alert)

Trigger time [ISOT]	2025-11-29T02:31:24.697
Trigger coordinates (J2000)	224.2949 79.3050 +/- 0.0070 deg (0.4200 arcmin, 25.2000 arcsec)

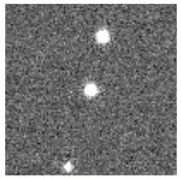
COLIBRÍ summary (main stack)

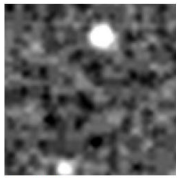
Coordinates [J2000]	Distance from alert [deg]	Magnitude [AB]	Detection (main stack)	Detection (stack A)	Detection (stack B)
224.3287 79.2930 +/- 0.0001 deg (0.5 arcsec)	0.0135 (0.81 arcmin, 48.6 arcsec)	18.24 +/- 0.03	92σ	58σ	75σ

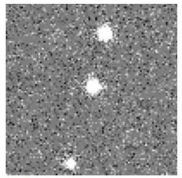
Catalogs summary

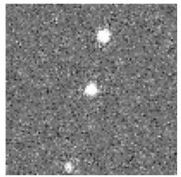
Coordinates (Pan-STARRS-DR1)	Magnitude (Pan-STARRS-DR1) [AB]	Coordinates (LegacySurvey-DR10) [J2000]	Magnitude (LegacySurvey-DR10) [AB]	Solar system object [J2000 epoch, AB mag]
none none	none +/- none	none none	none +/- none	none

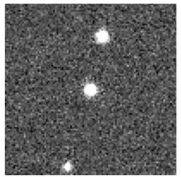
Source visualization


Full stack frame

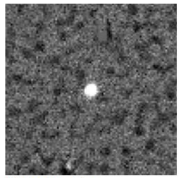

DSS frame


Median stack


Stack A frame


Stack B frame

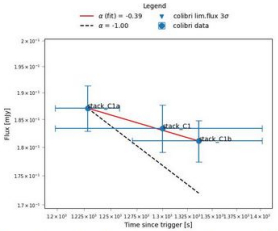

stackA-stackB subtraction


DSS subtraction

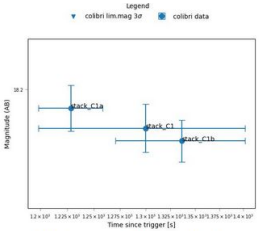
Overview of the results

A few words on the results pages (before the dedicated hand on session):

Light curve for Source 1930



Light curve with main stack, stackA, and stackB points



Light curve in AB magnitudes

Detailed information on Source 1930

Stack type	MAG (AB)	Mid time [ISOT]	Starting time (ST) [ISOT]	ST-T0 [s]	Ending time (ET) [ISOT]	ET-T0 [s]	Exposure [s]	3sigma lim. mag. (AB)	5sigma lim. mag. (AB)
Main stack	18.24 +/- 0.03	2025-11-29T02:53:04.909	2025-11-29T02:51:23.085	1198.39 (19.97 min, 0.33 h)	2025-11-29T02:54:46.733	1402.04 (min, h)	180 (3 min)	22.15	21.60
Stack A	18.22 +/- 0.02	2025-11-29T02:51:53.023	2025-11-29T02:51:23.085	1198.39 (19.97 min, 0.33 h)	2025-11-29T02:52:22.960	1402.04 (23.37 min, 0.39 h)	60 (1 min)	21.65	21.08
Stack B	18.26 +/- 0.02	2025-11-29T02:53:41.069	2025-11-29T02:52:35.404	1198.39 (19.97 min, 0.33 h)	2025-11-29T02:54:46.733	1402.04 (23.37 min, 0.39 h)	120 (2 min)	21.95	21.39

Light curve tool | STDWeb

Report Detection [SVOM]

First detection | Follow-up

Report Detection [Others]

First detection | Follow-up

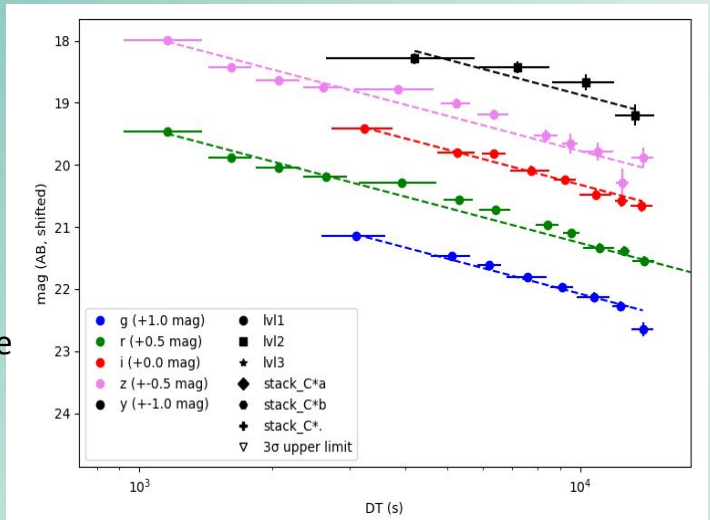
Link to the LC tool, with information pre-inputted

GCN template assuming this candidate as the afterglow.

Upper layer tool of the pipeline

Multi-band lightcurve looking at all COLIBRI archival data

User friendly tool. You provide RA-Dec matching radius and date :



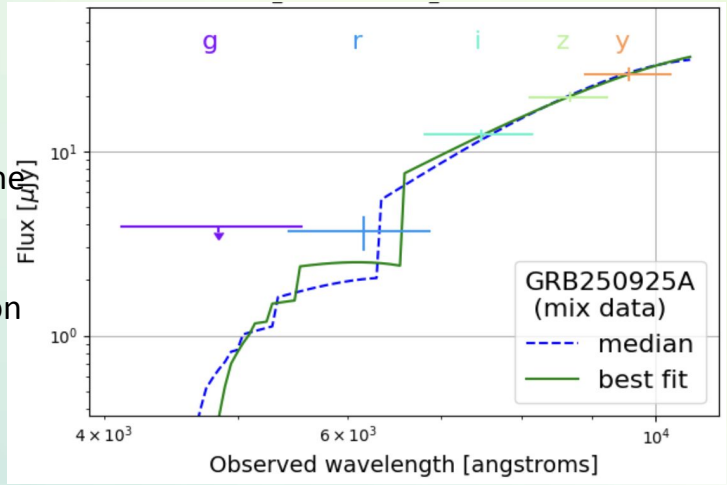
Link with the online pipeline already made

Link Between the two Under construction

Photometric redshift estimation

Corre et al. (2018), Proc. SPIE 10705, 12.2313127

Fitting a power-law model to the multi-band using the LMC/SMC/MW extinction curve.
Already used several times
(e.g. GCN 42004/42095)



Pipeline validation

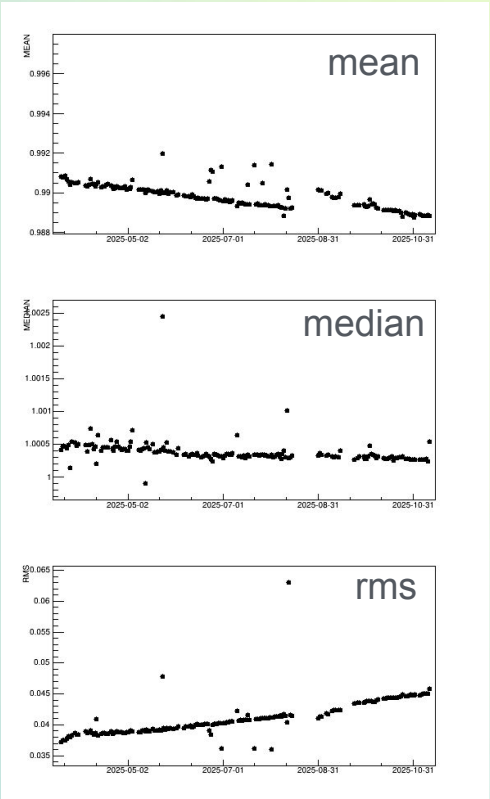
Main validation of the pipeline :

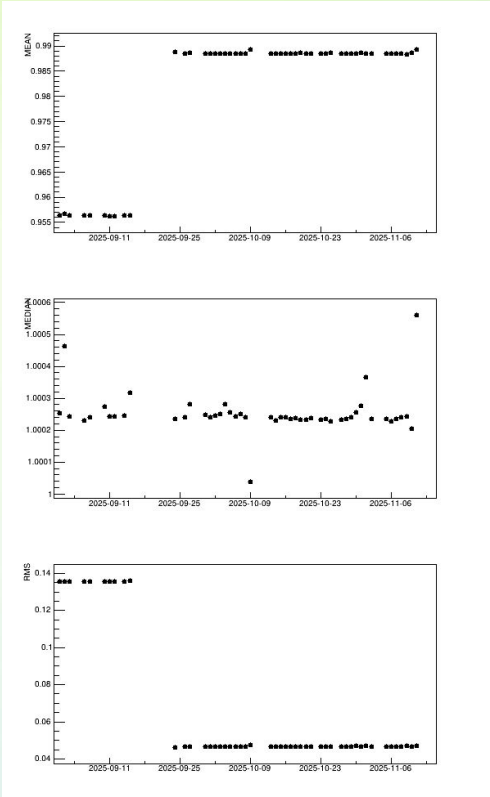
- Calibration
- astrometry
- photometry
- analysis
- Global performances

Validation of the calibration procedure

After each night, calibration images are processed to create the masters:

<u>Automatic validation:</u>
mean/median/rms of the candidate masters and on the difference with the previous approved masters



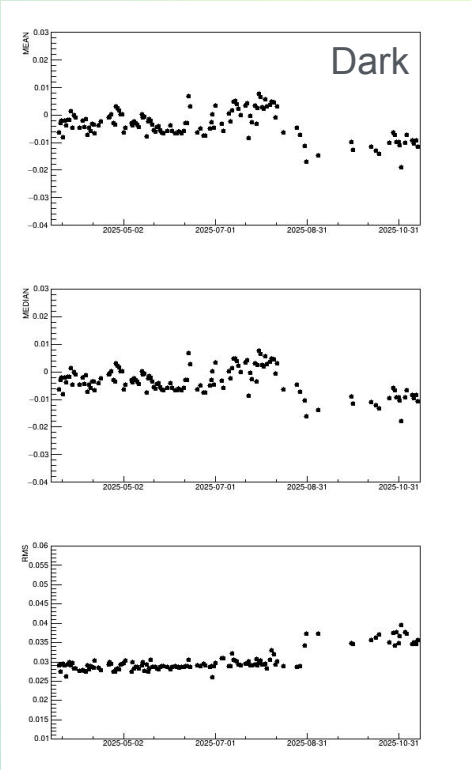


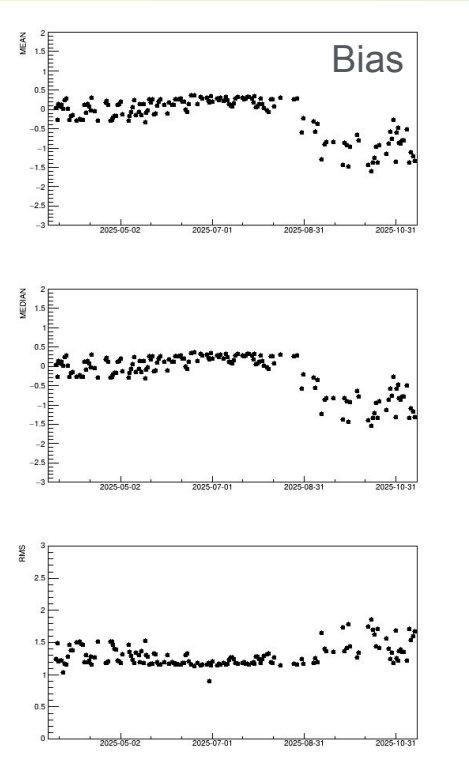
Flat r

Validation of the calibration procedure

After each night, calibration images are processed to create the masters:

<u>Automatic validation:</u>
mean/median/rms of the candidate masters and on the difference with the previous approved masters



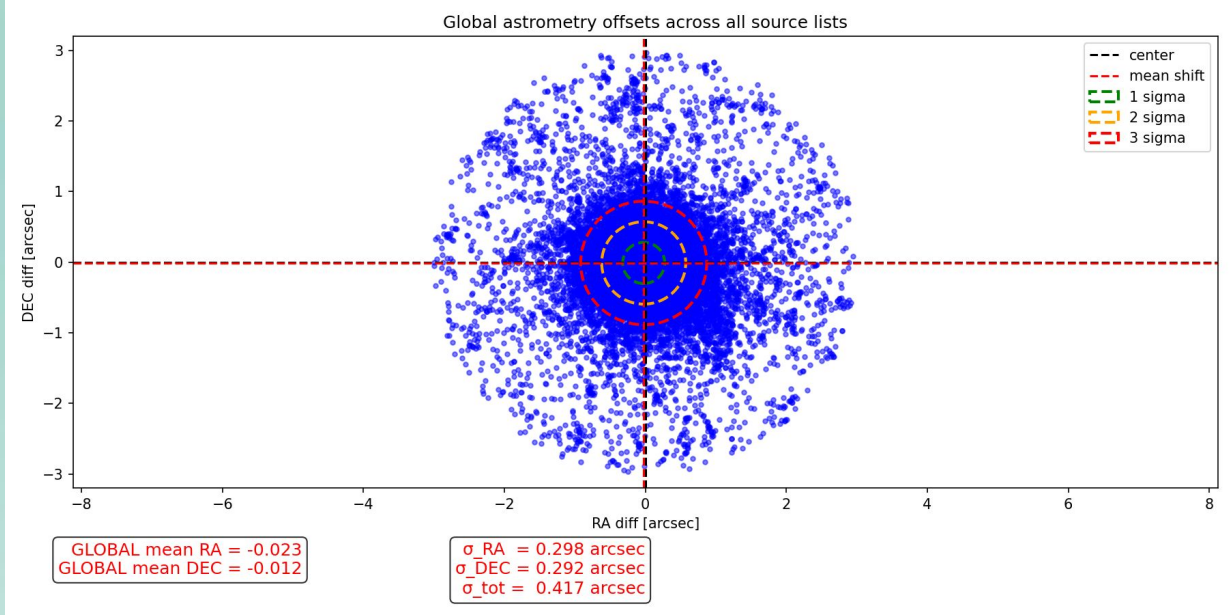


C1

GFT Pipeline validation

Astrometry validation :

We used >200 fields random, removing the one too close to the galactic plane and computed the astrometric error using GAIA DR3 as reference.



GFT Pipeline validation

Photometry validation :

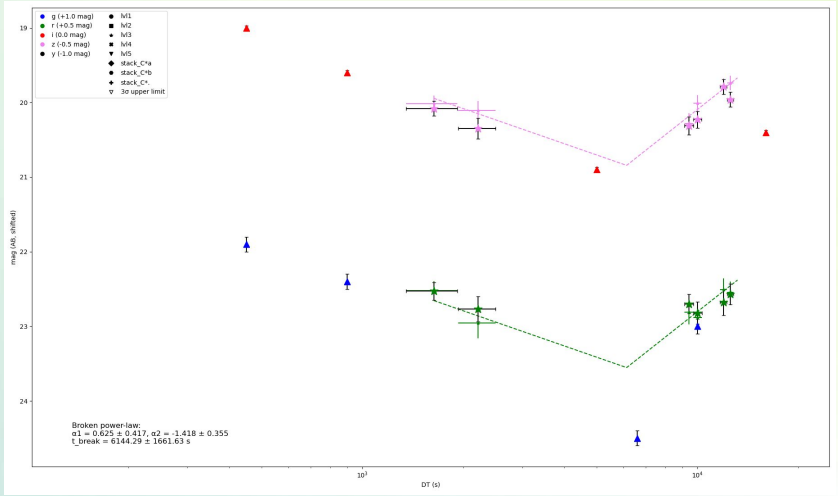
The online results photometry can be validated by the shifter for all the runs via the available calibrations plot on the HTML page :

GFT Pipeline validation

Photometry validation : Photometry method in a few points :

- Pre-extract sources with Sextractor to estimate the FWHM
- Build a smoothing filter and an aperture using the FWHM, and extract aperture magnitude with Sextractor
- Compute the zeropoint as a x,y polynomial function (e.g. order 2) calibrating against PAN-STARRs or SkyMapper
- Use sigma-clipping for the zeropoint error estimation
- For B band and skymapper y band use polynomial color term to be calibrated
- Upper limit is computed fitting a noise model (constant background noise plus Poissonian noise with constant gain).

Cross-check of the photometry quality has been done against [stdPipe] for all the DDRAGO filters in several occasions e.g. with a recent one GRB251026A:



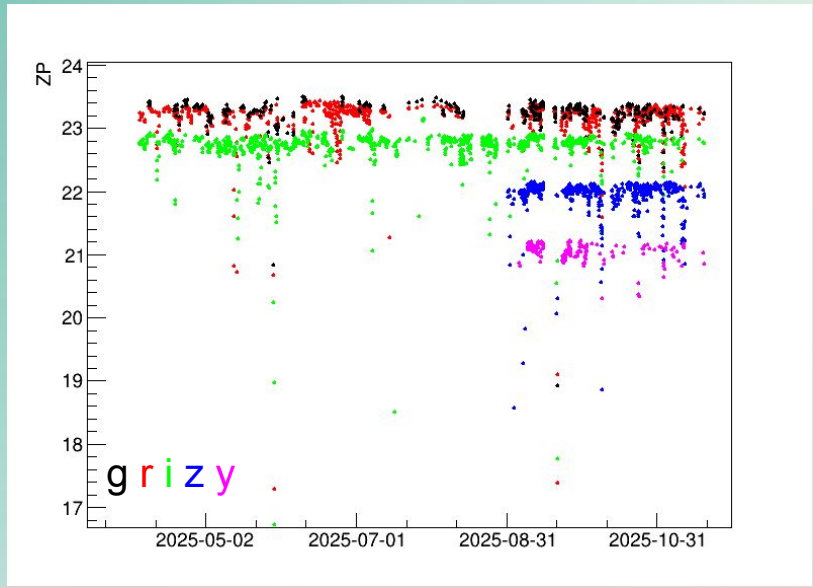
GFT Pipeline

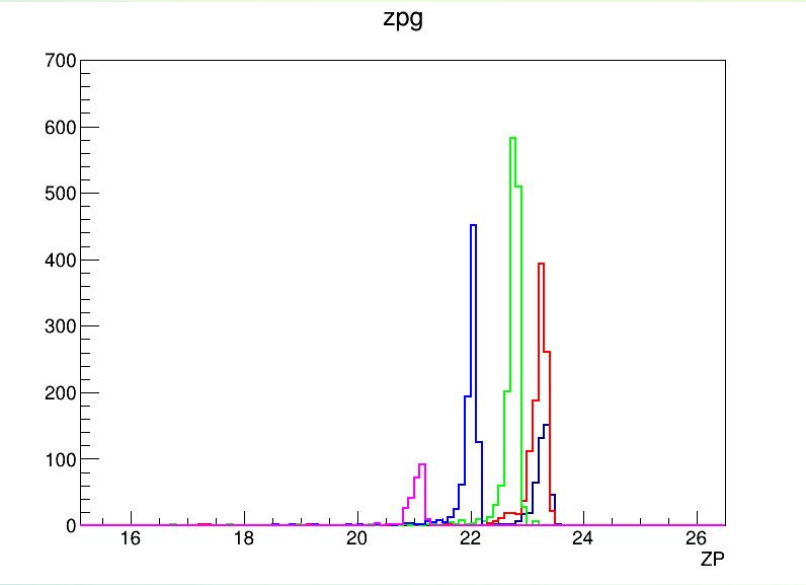
Photometry validation :

ZP stability from 2025-03-19 to 2025-11-09:

MEAN = 23.24 23.16 22.71 21.96 21.05

MEDIAN = 23.35 23.27 22.83 22.06 21.10

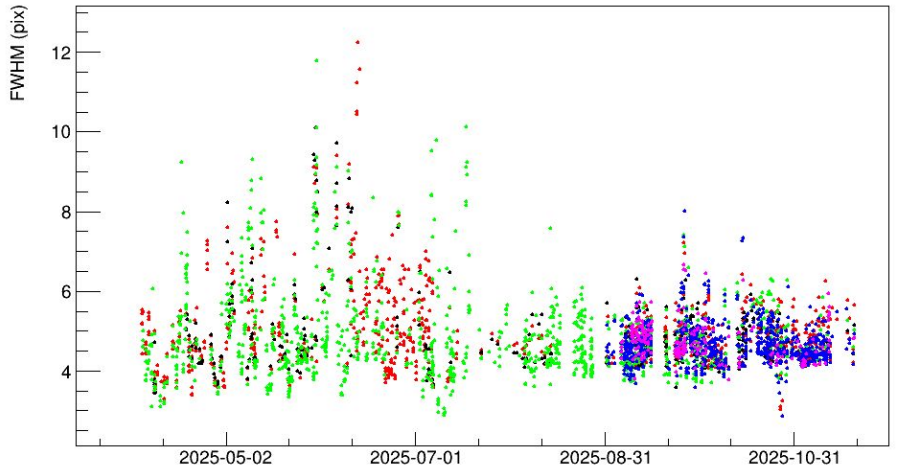


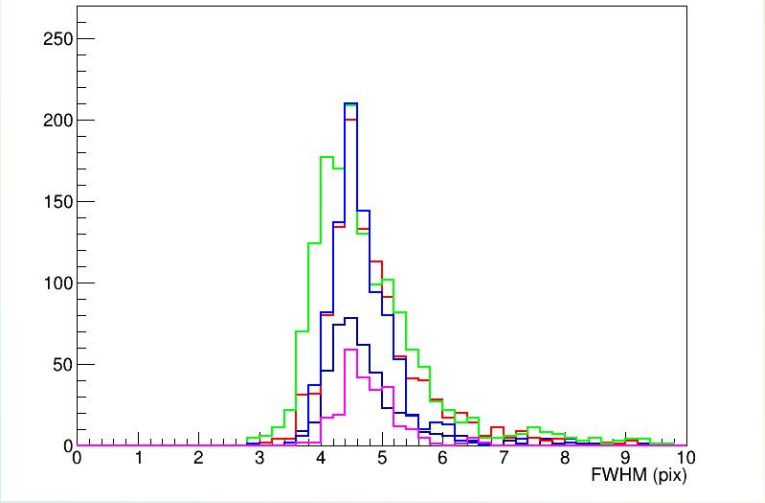


GFT Pipeline

Photometry validation :
Same for the FWHM from 2025-03-19 to 2025-11-09:

MEAN (pix) = 4.84 4.89 4.78 4.68 4.79
MEAN (sec) = 1.84 1.86 1.81 1.78 1.82
MEDIAN (pix) = 4.63 4.71 4.57 4.61 4.75
MEDIAN (sec) = 1.76 1.79 1.74 1.75 1.80





GFT Pipeline

Detection validation from GRB 251001B to GRB 251125B :

Dedicated page : link

SVOM-COLIBRI

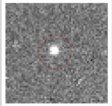
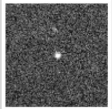
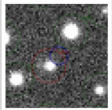
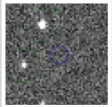
Recherche:

Aperçu | Activité | DMS | Wiki | Configuration

Wiki » List of the publications »

Modifier | Surveiller | ...

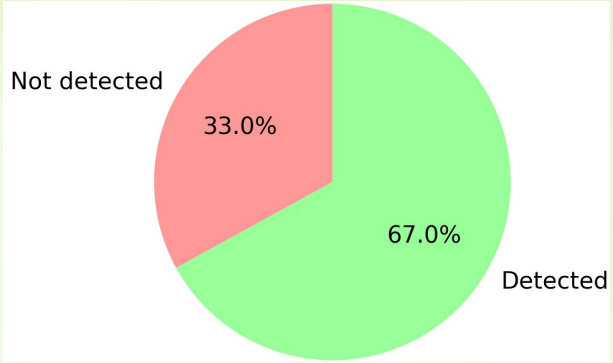
Pipeline performance study

GRB	Detected ?	Extracted as candidate ?	Cutout	Pipeline first results link	Lightcurve
GRB 251001B	g: yes r: yes i: yes z: yes y: yes	g: yes at 3 images r: yes at 3 images i: yes at 16 images z: yes at 3 images y: yes at 64 images		https://www.colibri-obs.org/wp-includes/redux/20251002/PRPID_1000/BLKID_20251001141719/VSTID_0/	
GRB 251002A	g: yes r: yes i: yes z: yes y: yes	g: yes at 16 images r: yes at 3 images i: yes at 3 images z: yes at 16 images y: yes at 32 images		https://www.colibri-obs.org/wp-includes/redux/20251003/PRPID_1000/BLKID_20251002201452/VSTID_0/	
GRB 251003A	g: No (break in g) r: yes i: yes z: yes y: yes	g: No r: yes at 3 images i: yes at 3 images z: yes at 3 images y: yes at 3 images		https://www.colibri-obs.org/wp-includes/redux/20251003/PRPID_1000/BLKID_20251003015830/VSTID_0/	
GRB 251005C	No, optical candidate (SVOM/VT) too faint for our image				

GFT Pipeline

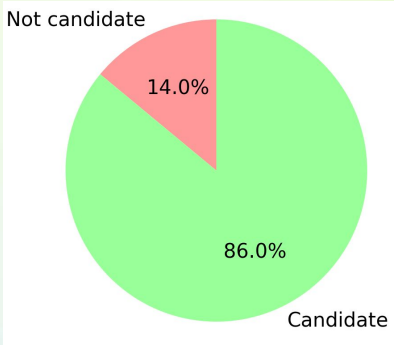
From 01/10 to 25/11 :

- **21 GRB** followed
- **14 GRB** detected by COLIBRI
- **4** With no OT found by the community
- **3** Where COLIBRI observation were to late or not deep enough (clearly nothing in the images)



On the 14 detected GRBs:

- **12 GRB** detected by the pipeline as candidate (One blended, one outside of the extended error region)
- **12 GRB** detected by the pipeline as candidate with the r band 3 images stack.



GFT Pipeline

Computing time of the pipeline with different images numbers :

End-to-end computation time from reduction to the OT candidates identification and creation of the HTML for the shifter

If stacking is changed to median only, it's reduced the stacking phase significantly

Images #	3	16	32	64
Reduction	13s	34s	67s	132s
Astrometry	10s	48s	94s	188s
Stacking (weighted)	38s	104s	204s	450s
Photometry	25s	26s	25s	30s
Analysis	136s	200s	195s	225s
Summary	2s	2s	2s	3s
Total : Offline Online	 3mn 45s 3mn 32s	 6mn 49s 6mn 15s	 9mn 47s 8mn 40	 17mn 08s 14mn 56s

GFT Pipeline

Computing time comment :

- First iteration (3 images) available in less than 5mn

- Very stable computing time

- Stacking computing time is large due to the choice of weighted stack (that are slightly deeper)

- Computing time typically increase due to the parallel processing of the two cameras and 5 filters

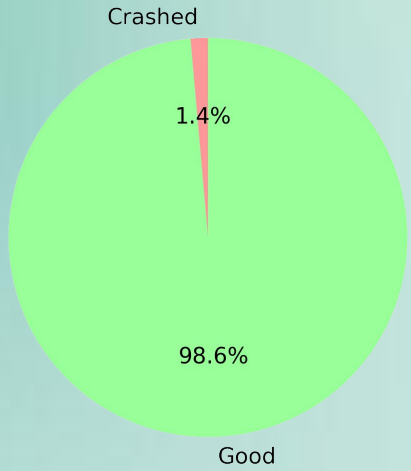
- Access to the pipeline results is right now limited by the download of the results to LAM (where shifters have access),
→ **Bypass this issue giving access to the shifter to the pipeline results directly via mexico machine.**

GFT Pipeline

Pipeline online processing efficiency study (begining of September to mid November) for the real-time:

Launched iteration

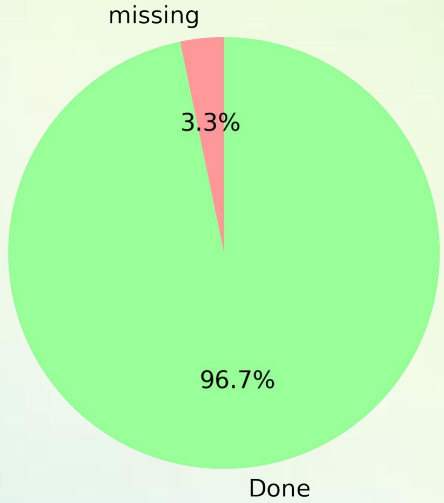
3722 pipeline iterations launched, 53 crashed (1.4%).



75 % of theses crashed concern the 3 images iteration :
Bad median stack quality leading astrometry failure

Missing_iteration

124 missing iterations identified (3.2 %)



Most of these missing results concern the redux_all
due to a disk space issue in the machine,
already fixed (new disk added).

GP pipeline

GP Pipeline (same as for alerts) is runned every day at 13h30 UT with the calibration master images of the same night.

It processes all images of PRPID = 202**-20**

For the output, we provides the main stack + the catalogue of calibrated extracted sources + validation information

```
colibri@marmex:/shared/redux/20251129/PRPID_2001/BLKID_3/VSTID_0/INSTRUME_C1/FILTER_r/BINNING_1/redux_all/results$ ls *
metadata.txt  reduction_check.jpg  stack_stack__C1_r_1.log

output_photometry:
FWHM_estimation_stack_C1.jpg                                    stack_C1.fits_MAG_APER_1_zeropoint_dist.jpg
Model_limiting_mag_stack_C1.fits.jpg                            stack_C1.fits_MAG_APER_1_zeropoint_error_rejection.jpg
stack_C1.fits_calibrated.txt                                    stack_C1.fits_MAG_APER_1_zeropoint_polyfit_alone.jpg
stack_C1.fits_calibrated.txt_limitsources.txt                   stack_C1.fits_MAG_APER_1_zeropoint_polyfit.jpg
stack_C1.fits_calibrated.txt_limitsources.txt_afterMatching.txt stack_C1.fits_MAG_AUTO_diff_pos_matched.jpg
stack_C1.fits_calibrated.txt_limitsources.txt.border.txt        stack_C1.fits_MAG_AUTO_edges_cut.jpg
stack_C1.fits_calibrated.txt_limitsources.txt_catVSstack_magnitudes.pdf stack_C1.fits_MAG_AUTO_FWHM_cut.jpg
stack_C1.fits_calibrated.txt_limitsources.txt_magdifference_catalog.pdf stack_C1.fits_MAG_AUTO_galaxies_cut.jpg
stack_C1.fits_MAG_APER_1_diff_pos_matched.jpg                   stack_C1.fits_MAG_AUTO_magnitude_diff_matched.jpg
stack_C1.fits_MAG_APER_1_edges_cut.jpg                          stack_C1.fits_MAG_AUTO_zeropoint_dist.jpg
stack_C1.fits_MAG_APER_1_FWHM_cut.jpg                           stack_C1.fits_MAG_AUTO_zeropoint_error_rejection.jpg
stack_C1.fits_MAG_APER_1_galaxies_cut.jpg                       stack_C1.fits_MAG_AUTO_zeropoint_polyfit_alone.jpg
stack_C1.fits_MAG_APER_1_magnitude_diff_matched.jpg             stack_C1.fits_MAG_AUTO_zeropoint_polyfit.jpg

utility:
images  stacks
```

Summary

Pipeline:

- Ready to use, results through the mexico machin for the shifters
- Some updates in progress (see next slide)
- Hands-on session just after for the persons interested

Perspectives

Main points:

- Image cleaning (by Nikos)
- Interface photo-z tool (by Ny-Avo)
- Test pipeline with CAGIRE test images
- Interface with SVOM SDB for the scientific products
- Continue effort to reduce the processing time

Hands-on

GET READY !!!

Hands-on

First example SVOM GRB 251129A, r band 3 images :

Let’s start with an easy case to familiarize yourself with the results page.

You are welcome (especially if you are shifter) to go through the page in parallel with me:

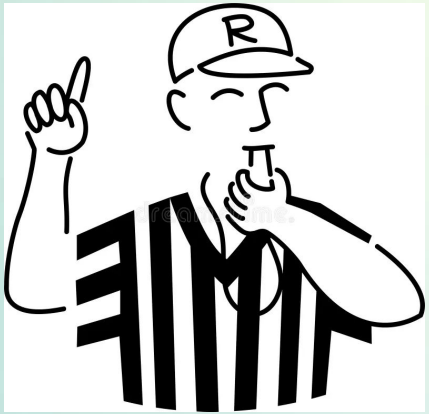
LINK TO THE RESULTS PAGE

Hands-on

First example SVOM GRB 251129A, r band 3 images :

RESULTS :

ANTI-CHEAT VERSION, NO SOLUTION IN THIS VERSION OF THE SLIDES



Hands-on

Second example EP GRB 251130A, z band 16 images :

Let’s try a more difficult one with a larger error region and several candidates proposed.

We let you some minutes to look at the results page and guess the afterglow candidate :

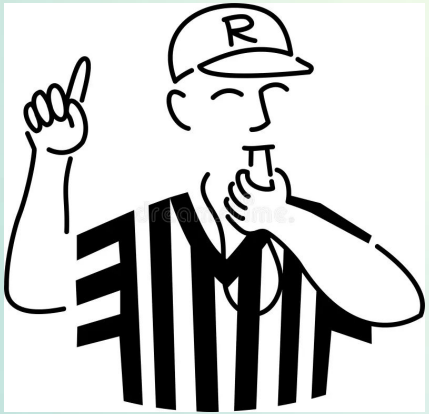
LINK TO THE RESULTS PAGE

Hands-on

Second example EP GRB 251130A, z band 16 images :

RESULTS :

ANTI-CHEAT VERSION, NO SOLUTION IN THIS VERSION OF THE SLIDES



Hands-on

Third example GRB 251023A, r band redux_all:

Another one with a larger error region and several candidates proposed.

We let you some minutes to look at the results page and guess the afterglow candidate :

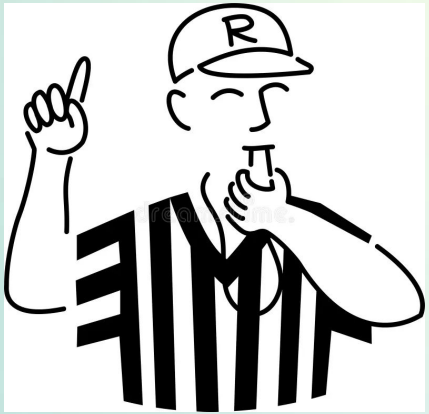
LINK TO THE RESULTS PAGE

Hands-on

Third example EP 251023A, r band redux_all:

RESULTS :

ANTI-CHEAT VERSION, NO SOLUTION IN THIS VERSION OF THE SLIDES



Hands-on

Fifth example EP 251023B, z band redux_all:

Another one with a larger error region and several candidates proposed.

We let you some minutes to look at the results page and guess the afterglow candidate :

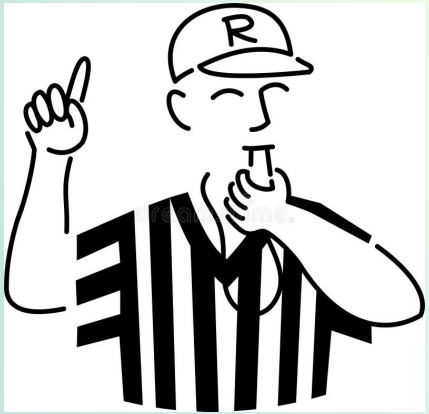
LINK TO THE RESULTS PAGE

Hands-on

Fourth example GRB 251023B,z band redux_all:

RESULTS :

ANTI-CHEAT VERSION, NO SOLUTION IN THIS VERSION OF THE SLIDES



Hands-on

Fourth example GRB 251129B, z band redux_all:

Another one with a larger error region and several candidates proposed.

We let you some minutes to look at the results page and guess the afterglow candidate :

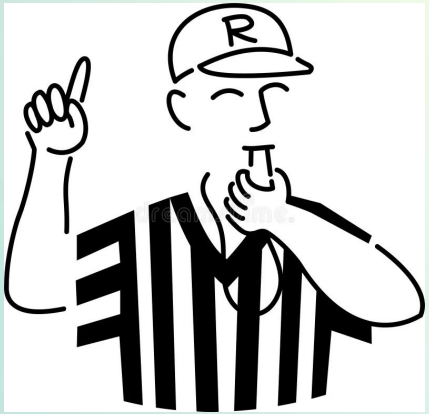
LINK TO THE RESULTS PAGE

Hands-on

Fourth example GRB 251129B, z band redux_all:

RESULTS :

ANTI-CHEAT VERSION, NO SOLUTION IN THIS VERSION OF THE SLIDES



Hands-on

MERCI !