Current status of the SVOM GRB Trigger

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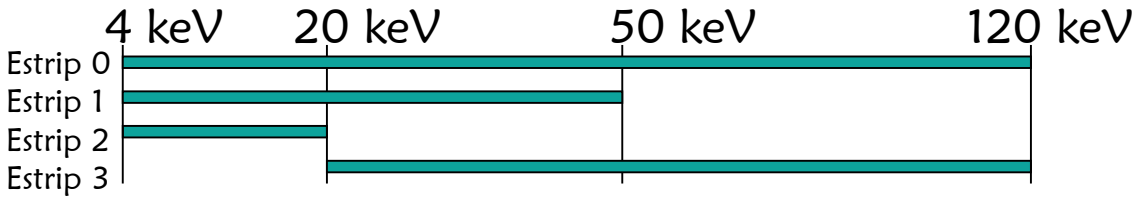
ECLAIRs

Outline

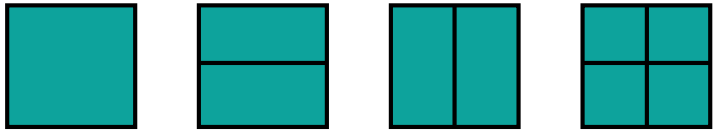
1. Counts buffer
2. Count rate trigger
3. Image trigger
4. Onboard image processing
5. Features under development

Counts buffers

- Counts are stored in 36 buffers:
  - 4 energy strips to help in differentiation of GRBs classes



  - 9 detector zones to help in out-of-axis GRBs detection

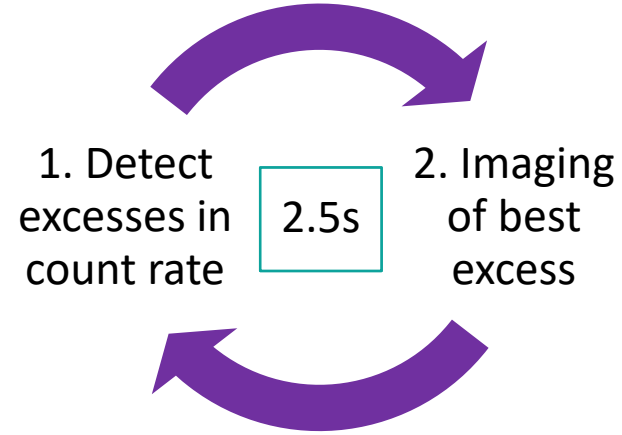


Triggers algorithm: *as currently implemented (S. Schanne, Qianmen presentation). Final version under development*

Count rate trigger

Cycle process runs every 2.5s working on

4 energy strips and 9 detector zones



1. **Detect excesses in count rate**

- Update the **background model B** (x36)
- Detected counts in each time scale from **10ms** to **20.48s** (x36) are compared to the background model → significant excesses ($\boldsymbol{SNR_{cnt} = \frac{N-B}{\sqrt{B}} > Thres_{cnt}}$) stored in the **excess buffer**

2. **Imaging of the best unprocessed excess**

- Detector plane image (shadowgram) is built with photons of best excess (for corresponding timescale and energy strip)
- Shadowgram is **deconvolved** → **sky image**
- Search for excess away from known sources and Earth
- GRB alert if $SNR_{image} > Thresh_{img}$

Count rate trigger

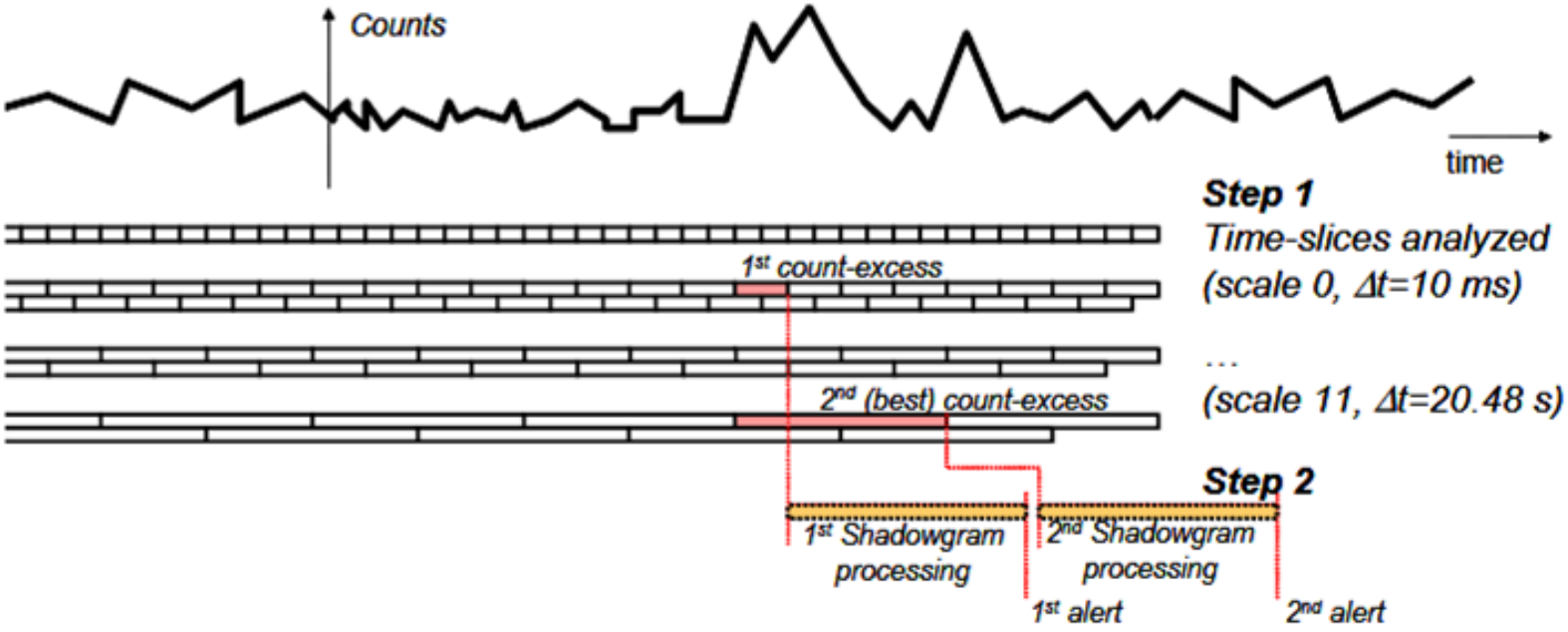
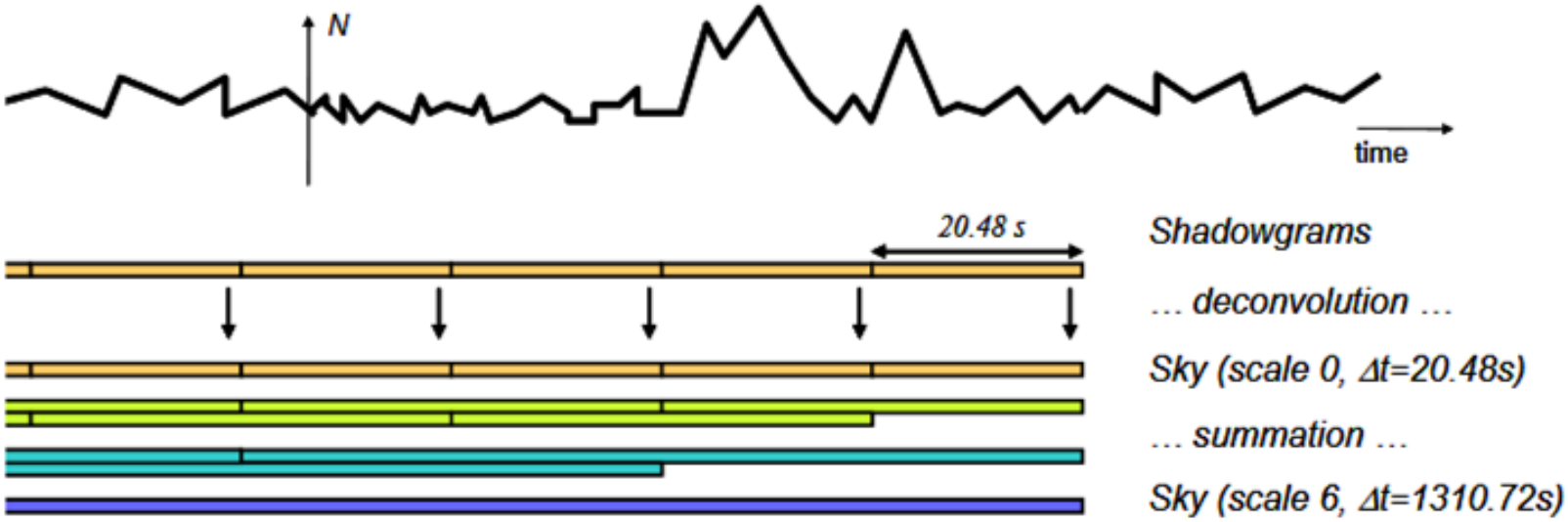


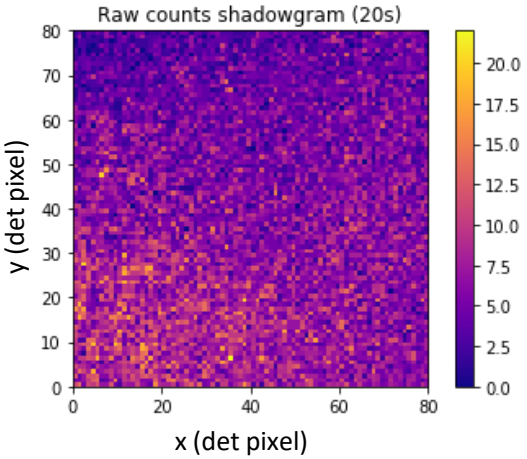
Image trigger

Cycle process runs every 20.48s working on 4 energy strips:

- Shadowgram: from photons in memory from last 20.48s scale
- Cleaning of the shadowgram (see slide 7)
- Shadowgram is **deconvolved** → **sky images** (in counts and variance)
- Summation of sky images (counts and variance) up to 20min
- For each scale, **SNR sky image:** $\boldsymbol{SNR_{image} = \frac{Counts}{\sqrt{Variance}}}$
- For each scale, excess is searched in SNR image away from known sources and Earth
- GRB alert if $SNR_{image} > Thresh_{img}$



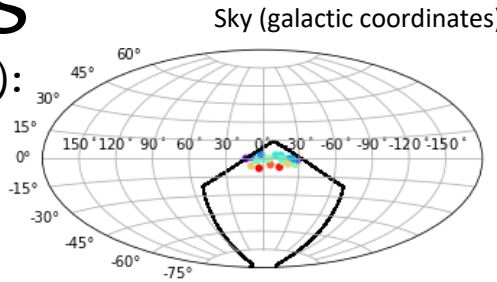
Onboard images processing

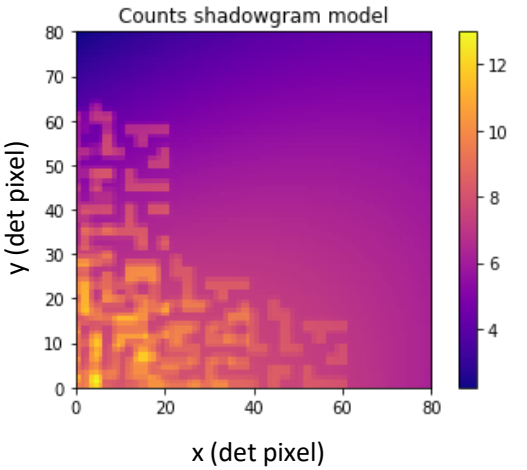


Raw shadowgram (counts in 20s):

- Earth modulated CXB
- GRB contribution ?
- Known sources, depending on pointing (yes in this case)

→ source-illumination models are known





Model shadowgram (counts in 20s):

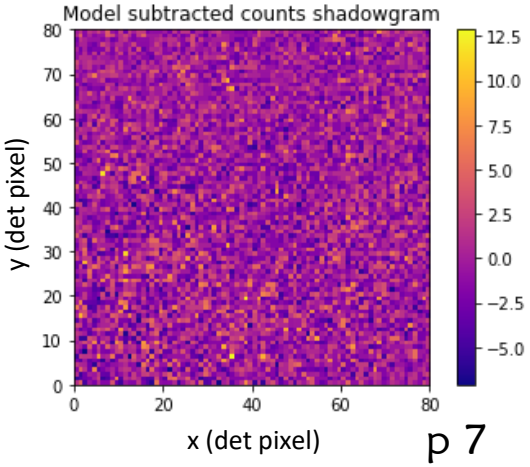
- Quadratic CXB (6 parameters):

$$m = ax^2 + by^2 + cx + dy + exy + f$$

- Known sources models (1 parameter per source = flux, maximum of 5 sources)
- Fitting to raw shadowgram

Model subtracted shadowgram (counts in 20s):

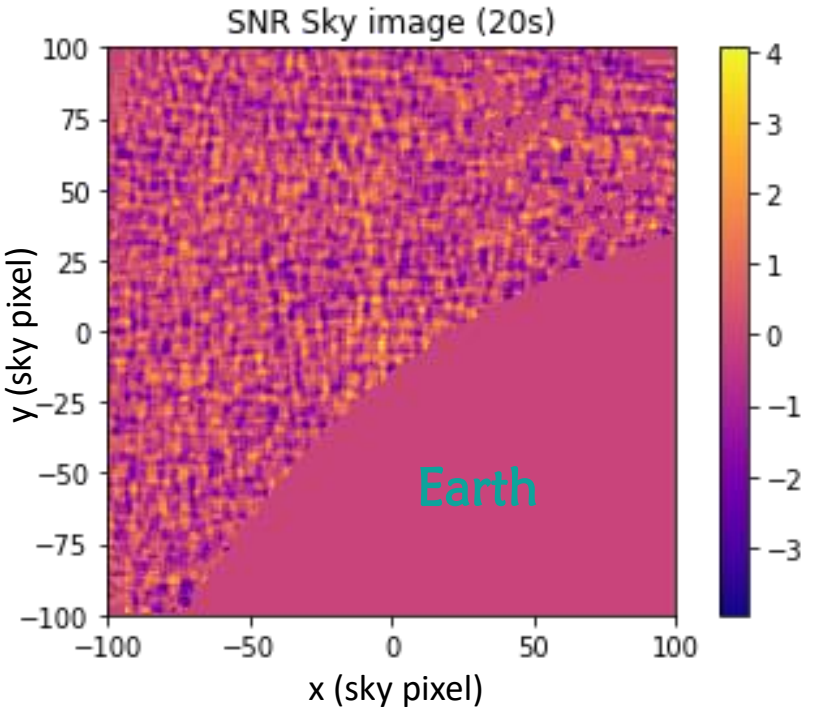
- Reduced non uniformity due to Earth modulated CXB
- Reduced sources contribution (non subtracted ones remain but are fainter)

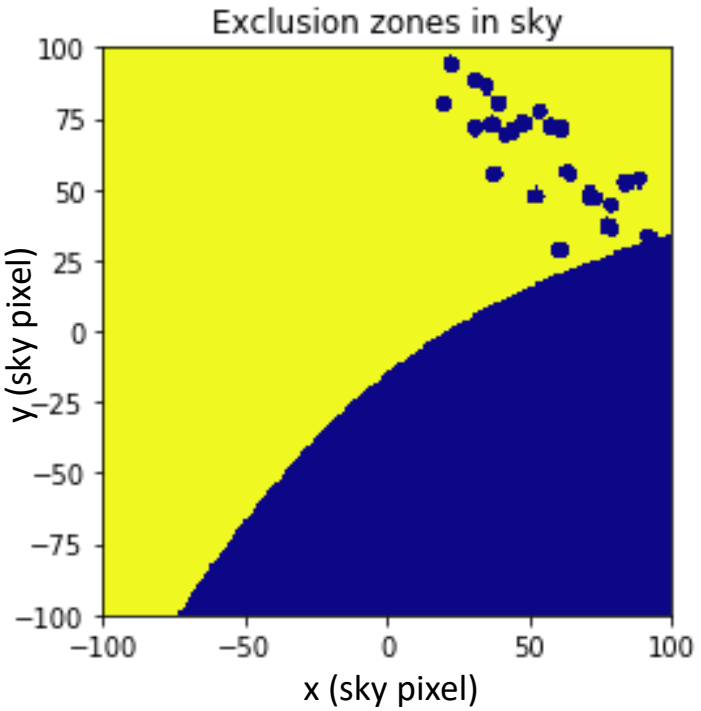


Onboard images processing

Déconvolution of cleaned shadowgram → sky (SNR in 20s):

- Part is occulted by Earth
- Exclusion of known source zones





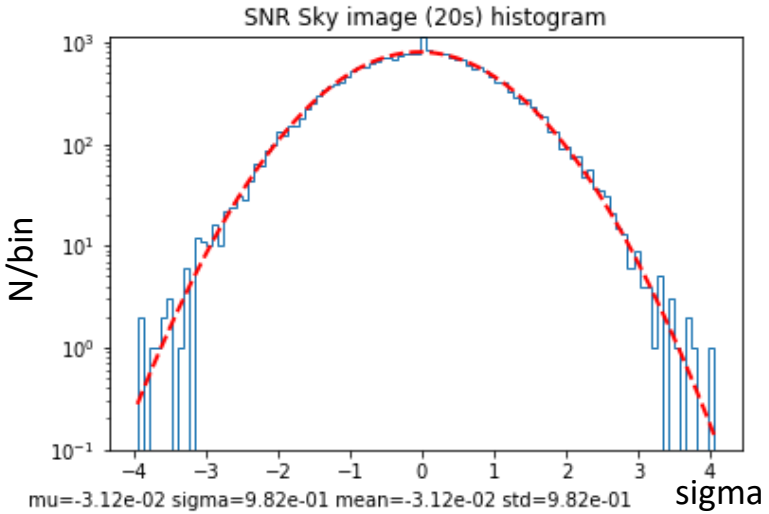
Onboard images processing

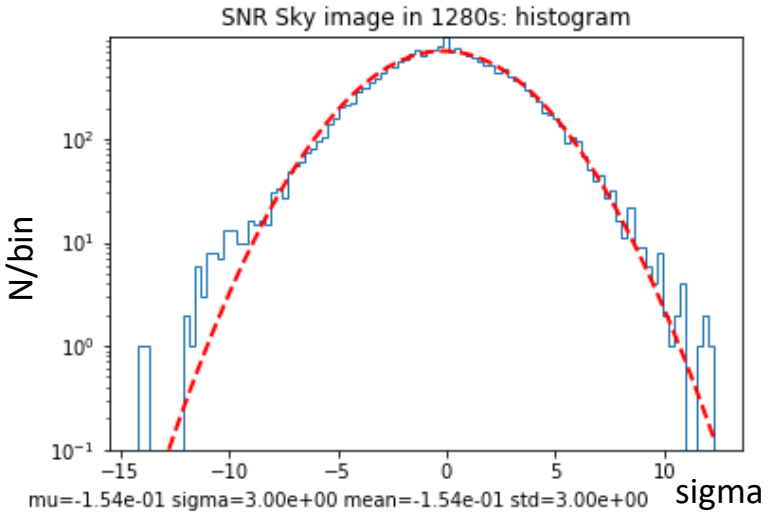
Histogram of pixel values in SNR sky image (without excluded zones)

In "well cleaned" sky: standard deviation of pixels distribution ≈ **1 sigma**

In a "noisy" sky (eg: coding noise of uncleaned sources in 20min sky images, CXB remaining when Earth is in field of view): standard deviation of pixels distribution > **1 sigma**

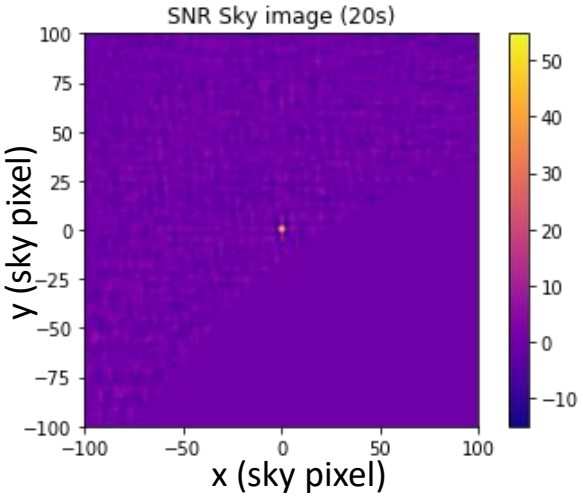
Image trigger SNR could be adapted with dispersion of pixels in sky SNR image

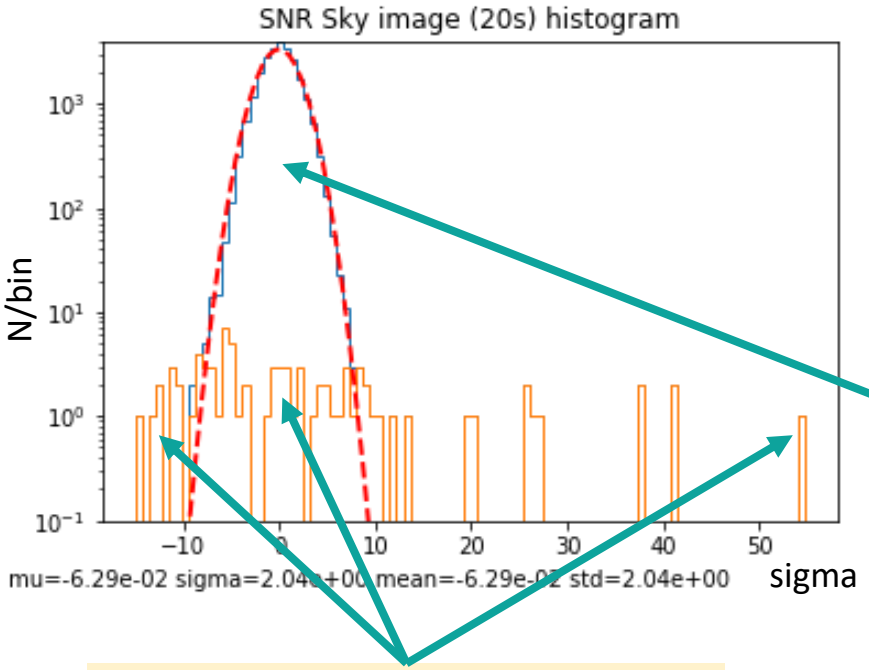




Onboard images processing

In case of a GRB (here GRB 000126)



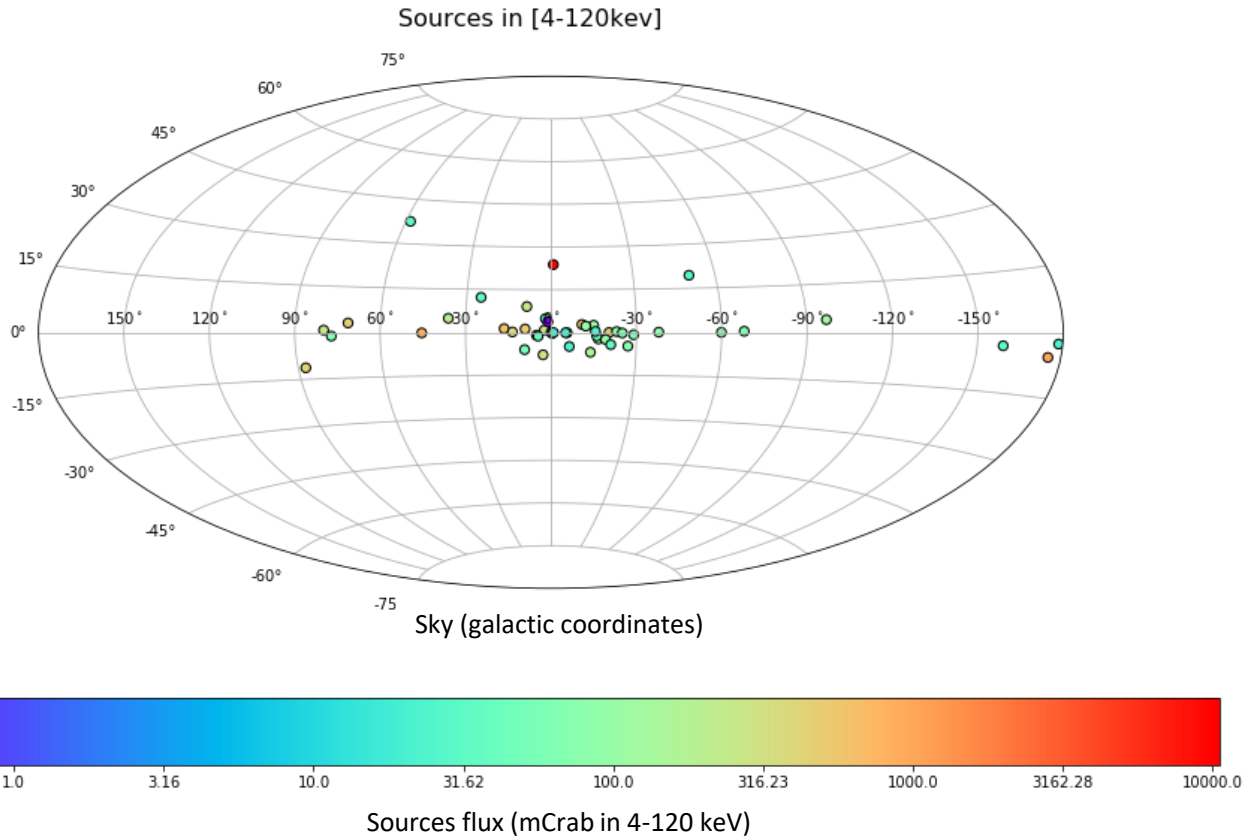


Pixels outside exclusion (sources + Earth) and GRB zones.

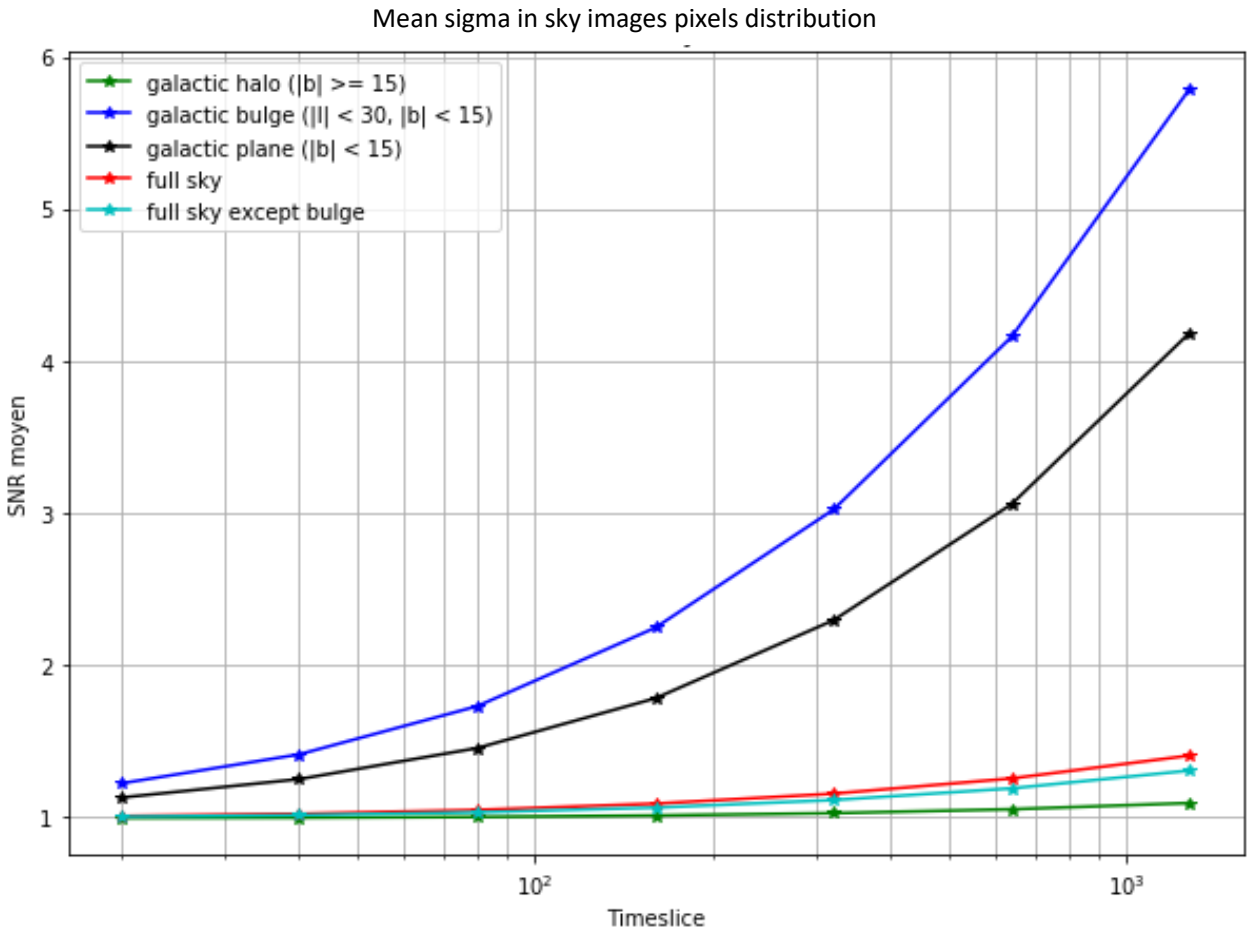
Std = 2σ caused by GRB coding noise

Pixels in circle centered on GRB position, radius = 5 sky pixels

Onboard images processing



Onboard images processing

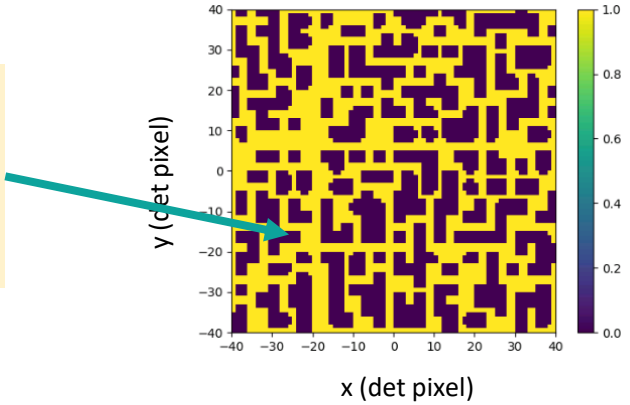


Sky is more noisy in the galactic bulge due to uncleaned sources in longer timeslice

Features under development

- Some detectors pixels can be inhibited in the triggers (for one or more energy strip and detector zones); those illuminated by bright sources (e.g. Sco X-1).

These detector pixels won't be used for the deconvolution (40% if totally coded)



- Triggers can be used on known source positions to detect outbursts: sources flux in counts/s is given by the fit of the model to the shadowgram. Outburst detection if flux > threshold in catalog (to be determined)

- Adaptive image trigger threshold using the sky SNR pixel distribution.

- Image subtraction to remove fast variation of known sources in count rate trigger

Conclusion

- Count rate trigger for short timescales
- Image trigger for longer timescales
- Algorithms are still under development