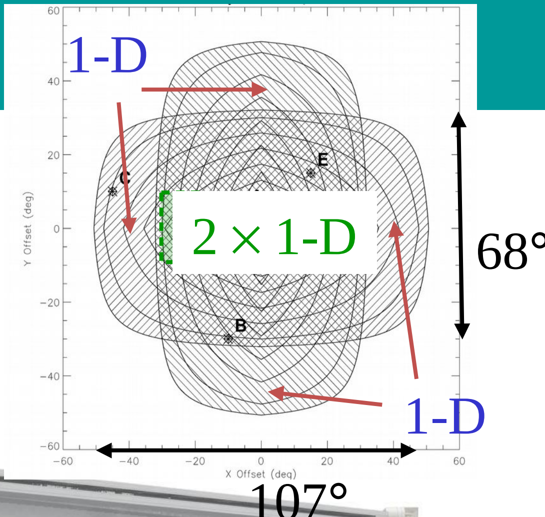
Lessons learned from the observation of GRBs with AGILE

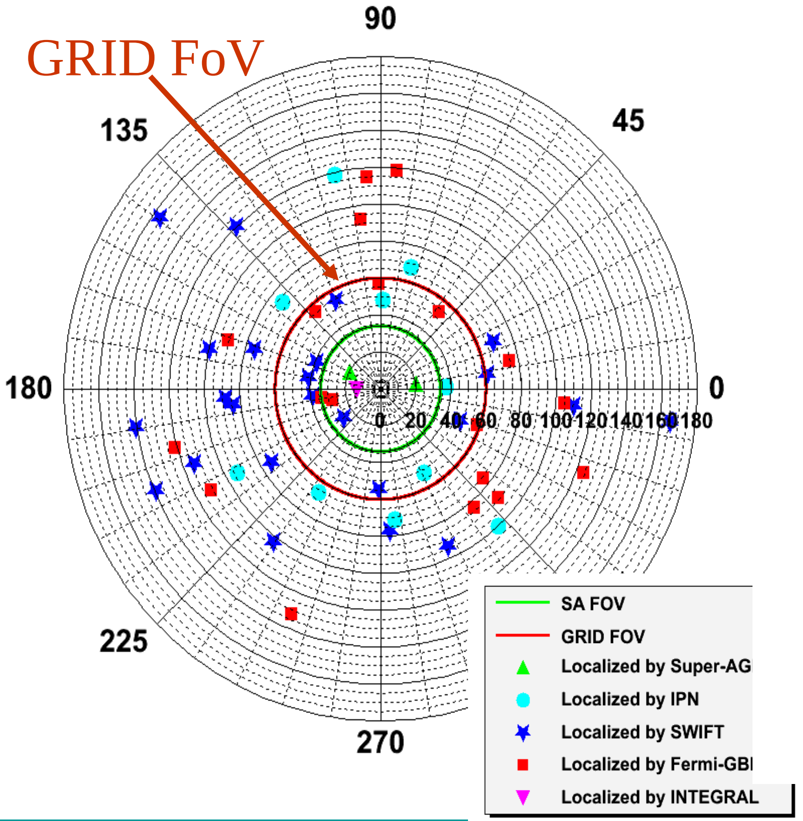
Ettore Del Monte (*IAPS*)
on behalf of a larger collaboration

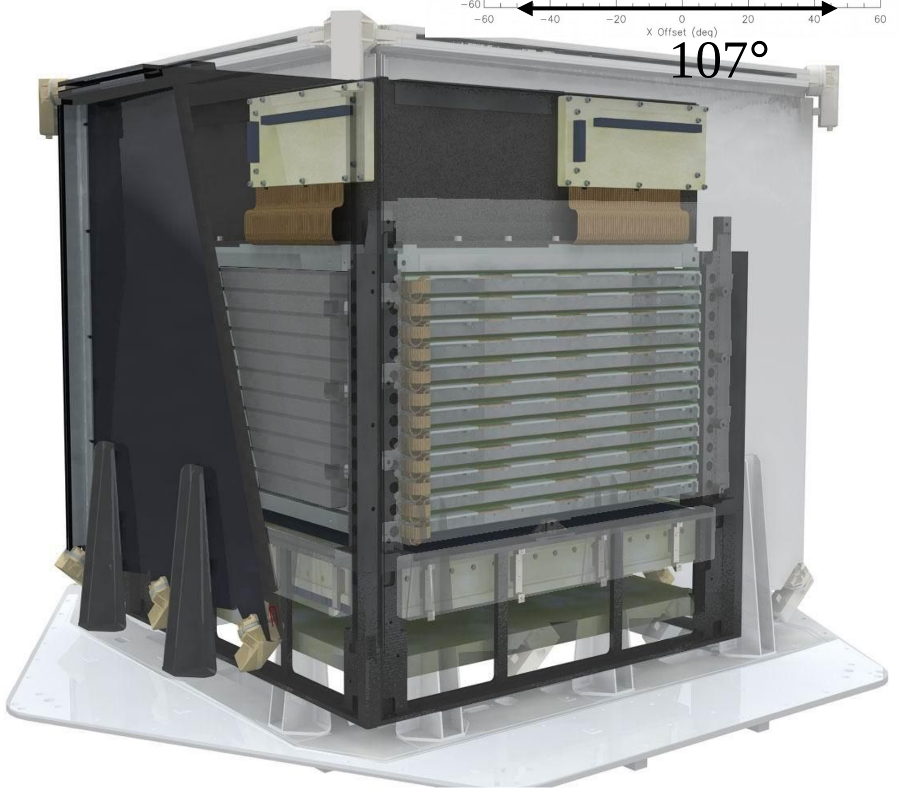
Outline

- Performances of the instrumentation
  - Field of View
  - Stable background over the orbit
- Data downlink and processing
  - Photon-by-photon data
  - Data downlink at (almost) all passages
  - Fast data processing and transmission
- Organisation, shifts, networking, ToOs
- Policy for publications
- There is always room for improvement!

Large field of view

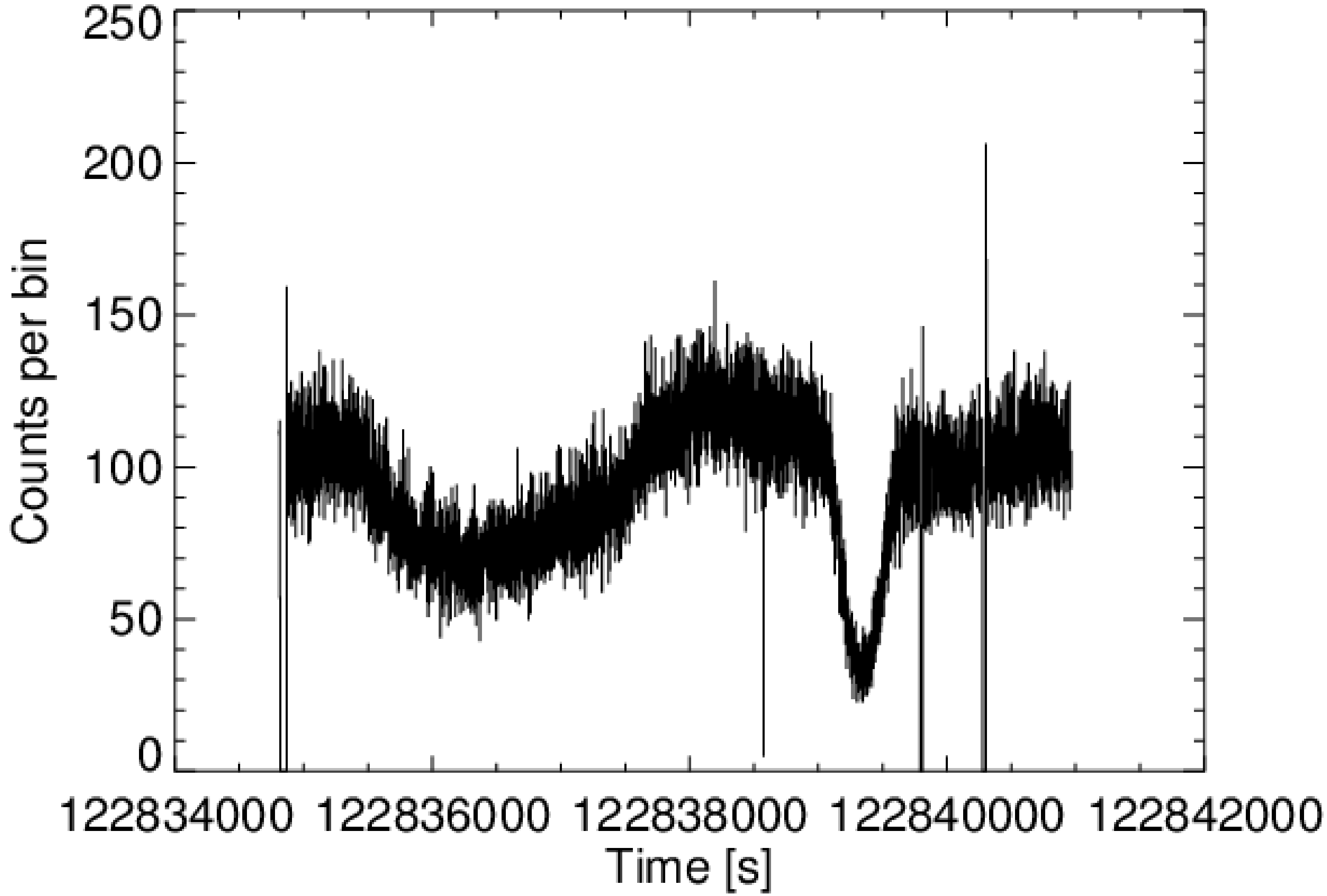






Stable background over the orbit

1. 5°



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Photon-by-photon data

- In SuperAGILE
  - This allowed us to develop flexible algorithms of transient search running on the lightcurves
    - at different timescales (64 ms to 8.192 s)
    - requiring coincidence between the four SuperAGILE detectors, to reduce the probability of spurious detections
  - The lightcurves are accumulated on ground, after the pipeline of data reduction (automatically running)
  - In case of trigger, the imaging procedure automatically starts in the interval of time and can be refined by the user
- But not in MCAL
  - The MCAL data of transients (GRBS and TGFs) are downlinked only on trigger
  - Consequently, the MCAL team spent a large effort to tune the thresholds and the intervals of time before and after the trigger, to optimise the amount of data downlinked per orbit

Data rapidly available for analysis

In AGILE we decided to transfer immediately the telemetry to the ASDC and the institutes on the orbit timescale

1. Downlink of the data in almost al passages over the Malindi station (14 – 15 per day);
2. Immediate preprocessing of the data (TM parsing and conversion to FITS format);
3. Rapid and automatic transfer to the ASDC and institutes via Telespazio at Fucino;
4. Automatic pipeline of data reduction (to produce the event list);
5. Automatic trigger to search GRBs and other transients on the event list.

Automatic data processing and fast reaction

This started in SuperAGILE:

1. GRB search procedure automatically running on the lightcurves immediately after the downlink and the pipeline;
2. Fast alert (email, call to mobile phone) in case of detection (threshold on the significance)
3. Web page to produce the images on time intervals selected by the user;
4. Automatic conversion of coordinates, to avoid possible mistakes even late at the night…
5. Shifts to monitor the data, including during holidays! Short report on a wiki page
6. Initially only in SuperAGILE, now a similar but independent system has been developed for the GRID

Networking (IPN and others)

The Interplanetary Network (IPN) is a network of researchers who study GRBs and other transients;

Main advantages of the participation to the IPN:

- Share the information on detections, e.g. to verify if another satellite detected a low significance trigger at the same time;
- Obtain with the triangulation method the position of events not localised otherwise. This happens e.g. to GRBs not localised by SuperAGILE (too faint or in the 1D coded region);
- Publication of catalogues of GRBs, e.g. to complement Swift or other dedicated instruments;

All the AGILE instruments joined the IPN when the nominal scientific operations started.

Swift follow-up

1. AGILE does not include an autonomous repointing system
2. But there is Swift!!!
3. The Swift team reacts to almost all requests of ToO for GRBs and other transients;
4. If possible, the Swift team replans the satellite operations to observe a mosaic of pointings e.g. when an error box larger than the XRT FoV is provided (e.g. GRB 070724B, Gravitational Waves events);

Policy for publication

- Publish rapidly!
- Young researchers as leading authors (in charge of writing, submitting, correcting and re-submitting papers)
- Fast internal refereeing process
- Go to conferences to present your results!

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Astronomy & Astrophysics

LETTER TO THE EDITOR

GRB 070724B: the first gamma ray burst localized by SuperAGILE and its Swift X-ray afterglow★

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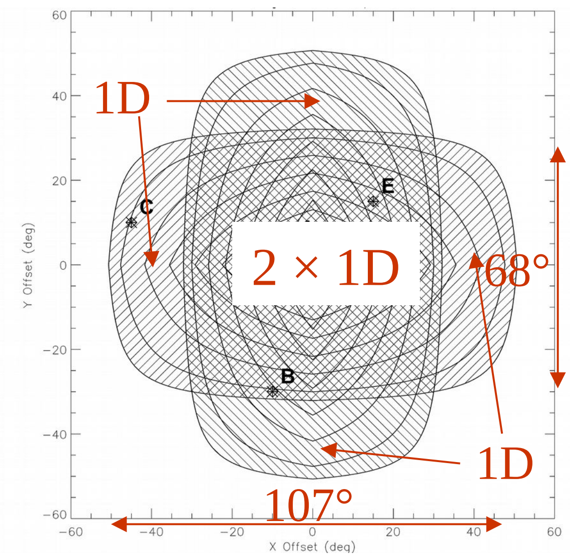
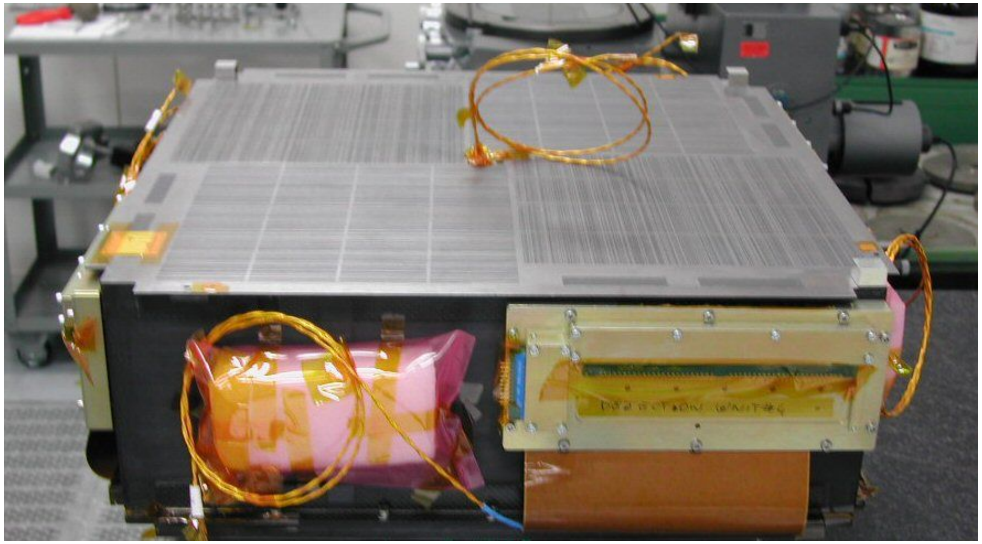
There is always room for improvement

FoV:	68° × 68° (2 × 1D);
	107° × 68° (1D);
source location accuracy:	6 arcmin pixel size;
	1 – 2 arcmin (intense sources);
dead time:	5 μs (with 2 μs resolution);
sensitivity:	15 mCrab (5σ in 1 day);
	1 Crab (3σ in 10 s);
energy band:	20 – 60 keV;
energy resolution:	8 keV FWHM;



Instrument features:

- 40 × 40 × 14 cm^3 dimensions;
- 10 kg weight;
- 12 W power consumption;
- photon-by-photon transmission;



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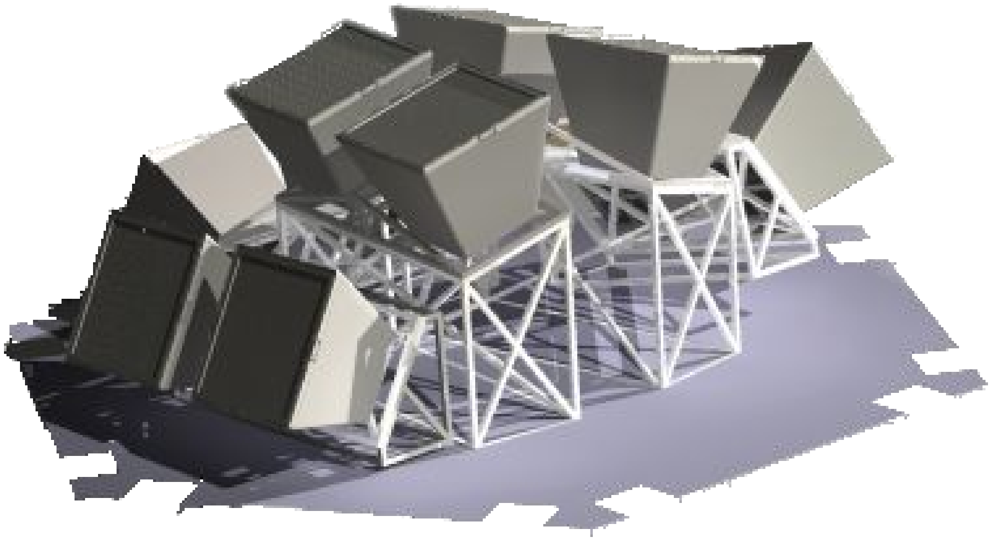
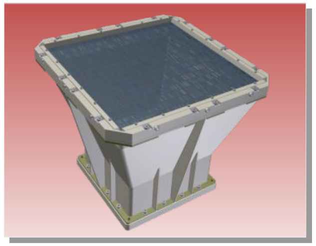




5 Units

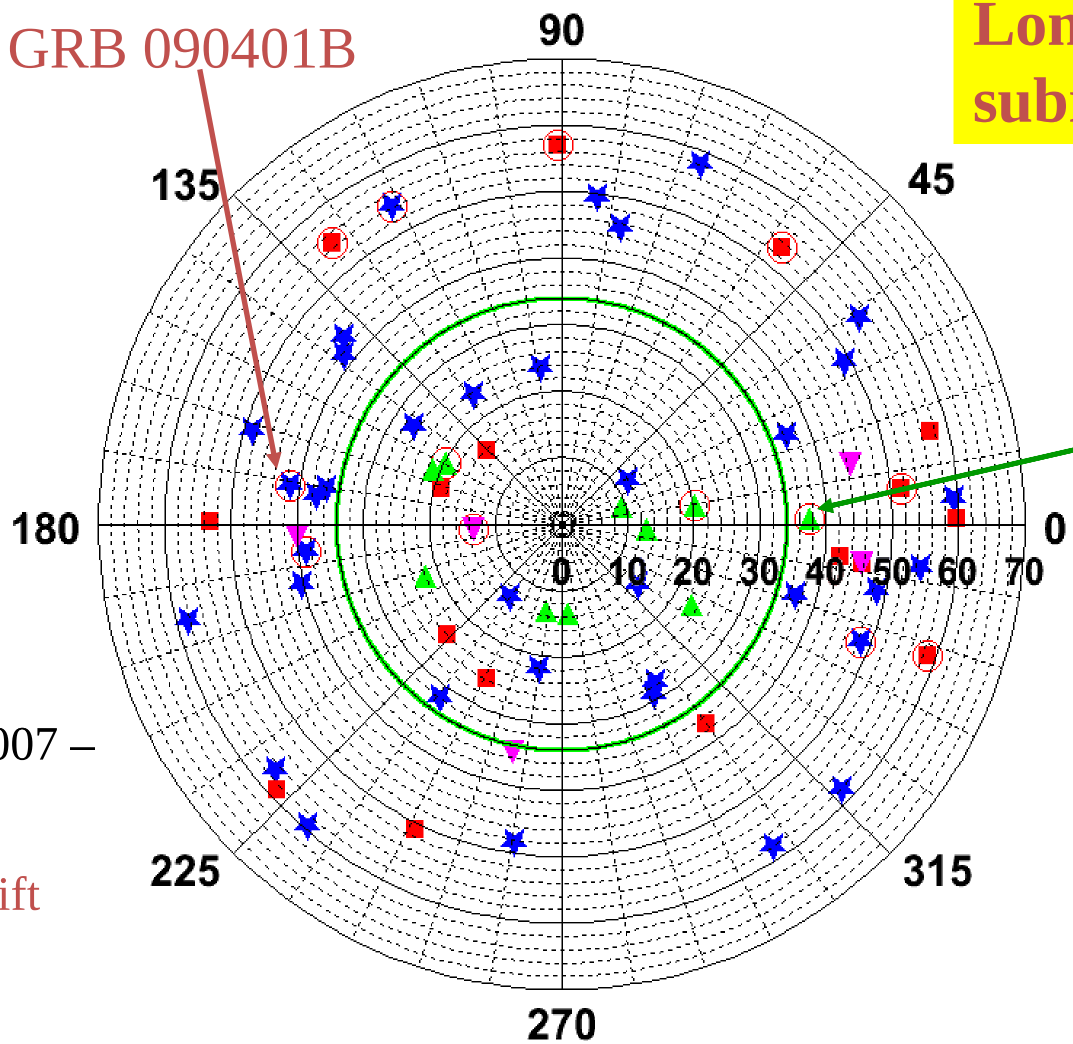
10 Cameras

FIELD OF VIEW	5.5 steradian
POSITION ACCURACY (10σ)	1 arcmin
ENERGY RANGE	2-50 keV
ENERGY RESOLUTION	300 eV @ 6 keV
COLLECTING AREA	1820 cm^2
TIME RESOLUTION	10 μs (trigger) ~minutes (images)
SENSITIVITY (5σ, GALACTIC CENTER)	270 mCrab (3s) 2.1 mCrab (1day)
GROUND TRANSMISSION OF GRB COORDINATES	< 30s

Backup slides

Large field of view

Longo et al. 2011, submitted to A&A



68 GRBs in the GRID-FOV July 2007 – October 2009:

36 localized by Swift
17 localized by Fermi-GBM
10 localized by SuperAGILE
5 localized by INTEGRAL

Backup slides

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1. ORBCOMM fastlink did not work as expected, the transfer time of the dedicated packets were not faster than the TM downlink;
2. Onboard SuperAGILE imaging does not work as expected ???
3. MCAL photon-by-photon data would have been really useful to run ground trigger algorithms on the lightcurves;
4. The SuperAGILE energy threshold is ~18 keV (e.g. no detection of low energy GRB features studied by BeppoSAX). Now we can design an X-ray monitor (cfr. LOFT) with ~2 keV energy threshold thanks to SDDs
5. The MCAL energy threshold is ~350 keV (e.g. no photospheric emission detected). Now the X-Gamma-rays Spectrometer (XGS) instrument aboard THESEUS has ~??? keV lower threshold.

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High temporal resolution

1. The time resolution of the AGILE instruments is
    1. SuperAGILE: 2 μs TBC
    2. MCAL: ? μs TBC
    3. GRID: 100 μs TBC
2. For high intensity transients this allows to
    1. run triggers on short timescale (=> low and stable background)
    2. detect rapid fluctuations of flux

3. Grafico di una curva di luce di SuperAGILE