“Rolling and tumbling” – Status of the SuperAGILE experiment

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ABSTRACT

The SuperAGILE experiment is the hard X-ray monitor of the AGILE mission. It is a 2 x one-dimensional imager, with 6-arcmin angular resolution in the energy range 18 – 60 keV and a field of view in excess of 1 steradian. SuperAGILE is successfully operating in orbit since Summer 2007, providing long-term monitoring of bright sources and prompt detection and localization of gamma-ray bursts. Starting on October 2009 the AGILE mission lost its reaction wheel and the satellite attitude is no longer stabilized. The current mode of operation of the AGILE satellite is a Spinning Mode, around the Sun-pointing direction, with an angular velocity of about 0.8 degree/s (corresponding to 8 times the SuperAGILE point spread function every second). In these new conditions, SuperAGILE continuously scans a much larger fraction of the sky, with much smaller exposure to each region. In this paper we review some of the results of the first 2.5 years of “standard” operation of SuperAGILE, and show how new implementations in the data analysis software allows to continue the hard X-ray sky monitoring by SuperAGILE also in the new attitude conditions.

Keywords: Hard X-ray Astronomy, Coded Aperture Imaging, Silicon Microstrip Detectors, Spinning Operative Mode

1. THE AGILE SATELLITE MISSION

AGILE[1] (Astrorivelatore Gamma ad Immagini LEggero, Light Imaging Gamma-ray Space Detector) is the first small scientific mission of the Agenzia Spaziale Italiana (ASI, Italian Space Agency) and has been launched on 23 April 2007 on an equatorial orbit with ~560 km altitude, ~2.5 degrees inclination and ~100 minutes period. AGILE exploits for the first time on a satellite-borne mission the technology of silicon detectors for the imaging of gamma rays and hard X-rays. In fact both its imaging instruments, the Silicon Tracker[2,3] (the pair conversion stage of a gamma-ray telescope) and SuperAGILE[4] (a hard X-ray monitor), are based on the same silicon microstrip detector tiles, with 9.5 cm × 9.5 cm surface, 121 µm pitch and 410 µm thickness, manufactured by Hamamatsu. The AGILE payload includes also a NaI(Tl) Minicalorimeter (MCAL[5]) and is enclosed by a plastic scintillator Anticoincidence[6] system. The Silicon Tracker and MCAL form the Gamma Ray Imaging Detector (GRID[7]).

The GRID, converting gamma rays into electron-positron pairs with tungsten layers and measuring the position of electrons and positrons in silicon microstrip detectors, can image photons of energy between 30 MeV and few GeV with a field of view (FoV) of about one fifth of the Sky and a Point Spread Function of 1 – 2 degrees at energy above 300 MeV[7] (68% containment radius). Thanks to the solid state technology, the GRID reaches a dead time as low as 100 µs and a time accuracy of 2 µs, as guaranteed by the AGILE Payload Data Handling Unit[8].

The MCAL[5] is composed of two orthogonal layers of 15 NaI(Tl) bars each, read out on both sides using silicon PIN photodiodes. The scintillator bar surfaces are polished and wrapped in such a way to exhibit an exponential light attenuation law to a good approximation level. The position of the photon interaction can thus be reconstructed with a resolution of 1 – 2 cm. The instrument has an energy band from 350 keV to 100 MeV, an overall energy resolution of about 18 % at 1275 keV and a timing resolution better than 2.8 µs.

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2. THE SUPERAGILE INSTRUMENT

2.1 Features and scientific performances

Tight constraints on the volume and dimensions of the AGILE payload required to locate the SuperAGILE hard X-ray monitor within the field of view of the GRID, to which it is also aligned, inside the anticoincidence shield. In order to keep the probability of pair conversion under 10 % and to respect tight mass and financial budget constraints, the detector of SuperAGILE is constructed using the same silicon microstrip tiles used for the Silicon tracker.

SuperAGILE is a coded aperture imager with two pairs of 1D microstrip detector modules, with spatial resolution of 121 μm, arranged along orthogonal directions. The coded mask is manufactured with chemical etching of a single tungsten layer of 120 μm thickness, glued on a carbon fiber layer of 500 μm thickness that provides robustness and rigidity, and is located at ~14 cm distance from the detector, thus giving an angular resolution of 6 arcmin. The resulting field of view is composed of two crossed 1D rectangular regions of 107 × 68 degrees and, in the central square region (68 × 68 degrees), the imaging is twice 1D. The instrument average dead time is 5 μs and the time tag is provided by the data handling with a resolution of 2 μs. The resulting imager[9] is compact (~40 cm × ~40 cm × ~14 cm), lightweight (about 10 kg including the interface electronics boxes) and has low power consumption (around 12 W). In pointing mode the SuperAGILE sensitivity reaches ~18 mCrab at 5σ significance level in one day (~50 ks of net exposure).

2.2 Software and data analysis

The SuperAGILE telemetry data are always provided in photon-by-photon mode and are downlinked every orbit to the Malindi Ground station, with a period of about 100 minutes. With a FoV of about 1 sr, efficient automatic data processing, source identification and flux measurement is of paramount importance. For this reason, all the tasks of the SuperAGILE telemetry download, data reduction, images reconstruction and fluxes extraction are arranged in an automatic pipeline[9,10] autonomously running after every satellite contact with the ground station. The flux of the detected sources, evaluated in the energy band between 18 and 60 keV, are listed in the publicly available webpage http://agile.asdc.asi.it/sagilecat_sources.html . In nominal pointing conditions, the fluxes are estimated with an exposure of about 3 ks while, in spinning mode, longer integration times are required to obtain equivalent exposures, as shown in the description of the spinning dedicated pipeline in sec. 4.4.

3. HIGHLIGHTS OF THE SUPERAGILE RESULTS

Thanks to its wide field of view and good angular resolution, SuperAGILE can simultaneously monitor many sources in the hard X-ray band. The wide field of view is especially important in the localization of transient events, e.g. Gamma Ray Bursts and X-ray Bursts, and the moderately good sensitivity, low dead time and possibility of analysing the data in photon-by-photon mode allow the high resolution study of the lightcurves of bright objects, e. g. Compact Galactic Sources. In this section we sketch the highlights of the SuperAGILE scientific results, grouped depending on the source class. Other results of the SuperAGILE observations are summarized in a dedicated publication[9].

SuperAGILE localized about 1 Gamma Ray Burst (GRB) per month when operated in pointing mode and the first one, GRB 070724B[11], was localized when the satellite was still in its early Commissioning Phase. Given the moderate thickness of the collimator walls, about twice as much GRBs are detected outside the field of view and provided to the InterPlanetary Network[12] for triangulation, a localization method based on the time delay of the detection of the same event by satellite experiments located far away in different positions in the Solar System. The observation of GRBs involves all the instruments of the AGILE payload, GRID, MCAL and SuperAGILE. From the comparison of the light curves at different energy bands AGILE found that the GRB prompt emission above ~25 MeV generally extends longer than the corresponding emission at hard X-rays (e. g. GRB 080514B[13]) and its onset may also be delayed (e. g. GRB 090510[14]).

The SuperAGILE bandpass and sensitivity are certainly not optimal for the study of extragalactic sources. Only a few bright Active Galactic Nuclei were detected during the first two years, noticeable cases being the radiogalaxy Cen A, the BL Lac source Markarian 421[15], serendipitously detected in a hard X-ray flaring state peaking at approximately 55 mCrab during a one-week AGILE target-of-opportunity observation toward the blazar W Comae, and the flat spectrum radio quasar 3C273[16], showing an indication of a possible anti-correlation between the gamma and X-ray emissions and observed by AGILE during a three week campaign.

With its wide FoV, SuperAGILE is simultaneously monitoring many Compact Galactic Sources and studying their flux variation over time. In particular, we observed the whole orbital period and three more pre-periastron passages of the high mass X-ray binary GX 301-2[17] for a total net observation time of about 3.7 Ms. We also studied the temporal properties of Cyg X-1[18], applying for the first time the analysis of the first order structure function to a Galactic Source, and we found *antipersistence* in the source emission, when a flux increase in the past is probably followed by a decrease in the future, with a negative feedback mechanism. The techniques used in the study of GRBs allowed the localization of the much softer X-ray bursts, thermonuclear explosions on the surface of a neutron star. X-ray bursts often herald the reactivation of a low mass X-ray binary system after a period of quiescence, as detected by SuperAGILE in the case of IGR J17473-2721[19] and 4U 1608-522.

4. SUPERAGILE IN THE SPINNING OPERATIVE MODE

4.1 Operating conditions

On October 2009 AGILE lost its reaction wheel and its capability to point toward a specified direction in the Sky. After that time the satellite switched to a spinning operative mode, in which it rotates around the axis pointed toward the Sun. Since the solar panels cannot be reoriented, the angle between the Sun and the panels (Z direction) is required to be 90±1 degrees. The AGILE reference frame is composed of three mutually orthogonal axis: Y is the satellite pointing axis (boresight), Z is the Sun-pointing direction and X is the third orthogonal axis. The SuperAGILE detector is in the plane defined by the X and Z axis. Since the detectors are 1D, a pair of them measures the angular distance of the Astrophysical sources from the X axis and the other ones from Z.

The spinning angular velocity can be set via telecommand and has been reduced from about 3 degree/s down to 0.8 degree/s. In this condition in one day the GRID and SuperAGILE scan about 70 % and 50 % of the Sky respectively (see fig. 1). Given the solar constraints, the Sky regions available to AGILE are on the circle at 90 degrees from the Sun. Two regions are not accessible, and thus not exposed in the figure, and correspond to the Solar and anti-Solar directions.

The main contribution of the SuperAGILE background is due to the Cosmic Diffuse X-ray Background[20]. The satellite rotation in spinning mode introduces a strong background modulation, at the fundamental frequency of 2.2×10^{-3} Hz (corresponding to 0.8 degrees/s) and its harmonics. Another consequence of the spinning is the apparent "transit" of the sources within the field of view, in a direction almost parallel to the X axis and at a velocity of about 0.8 degrees/s, corresponding to 8 times the Point Spread Function in SuperAGILE. The duration of the "transit" depends on the position of the source within the field of view and on the orientation of its path. The almost triangular response function of the SuperAGILE collimator, combined with the steep variation of the effective area off-axis, produces an additional modulation of the sources counting rate in the SuperAGILE time series.

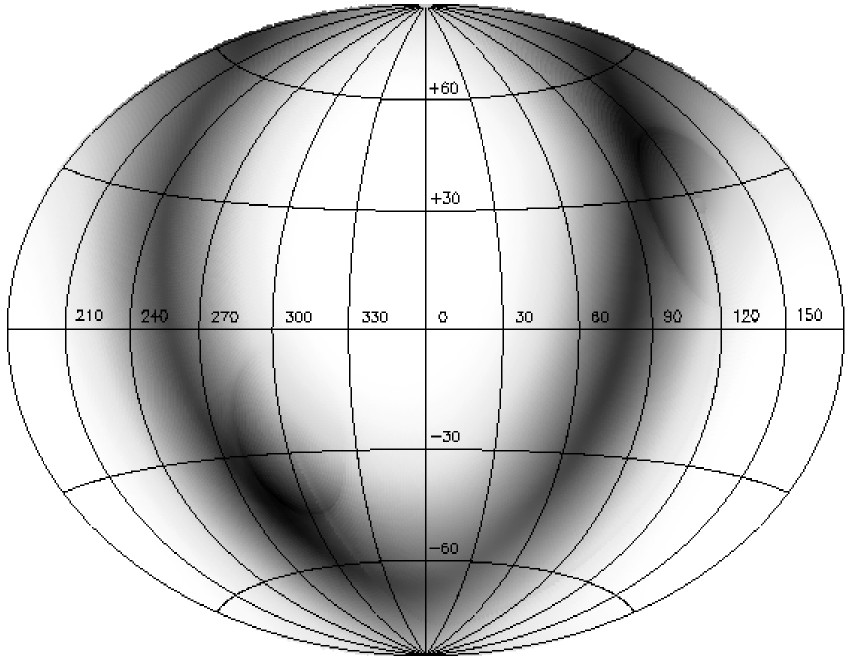

Fig. 1: SuperAGILE net exposure map in Galactic coordinates with four days integration.
The maximum exposure is ~7×10^5 cm^2 s.

4.2 Fast Fourier Transform correction of the GRB trigger algorithm

GRBs are a major scientific topic for AGILE and, for this reason, both SuperAGILE and MCAL are equipped with on-board and on-ground trigger algorithms[21,22], searching for significant increases in the counting rate, in timescales ranging from less than 1 ms to 8 s, with respect to the background, integrated on time intervals ranging from 8 s up to 262 s. The duration of the time intervals of signal and background integration and the detailed coincidence logic in the SuperAGILE and MCAL segmentation are selected via telecommand. While the MCAL background is not significantly affected by the spinning operative mode, thus both the on-board and on-ground triggers are left unchanged, the modulation of the SuperAGILE background does not allow to use the on-board trigger in this condition and required important modifications in the ground based algorithm.

In presence of the periodic modulation, introduced by the satellite spinning, we exploited the Fast Fourier Transform (FFT) to study and correct the effect. In the FFT of the SuperAGILE time series the fundamental frequency is around 2.2×10^{-3} Hz and the first harmonic is at about 4.4×10^{-3} Hz. The first step of our correction procedure is thus the extraction of the FFT of the time series accumulated during one orbit, of about 6000 s duration. Then we apply a dedicated filter to reduce the amplitude of the low frequency components introduced by the spinning mode. The filter has an attenuation of 100 between 10^{-3} Hz and 5×10^{-3} Hz and a steep high-pass filter up to 8×10^{-3} Hz, above which the amplitude is not attenuated. The very low frequency components, below 10^{-4} Hz, are not attenuated. The filter has been defined empirically as a result of the trade off with two requirements: reduce the low frequency components introduced by the background modulation in the spinning mode without attenuating the high frequency impulsive signal of the GRBs. For this reason we tested the filter on the SuperAGILE lightcurves of GRBs, bright and faint, detected in pointing mode and we optimized the attenuation factor at the various frequencies, verifying that the suppression of the low frequency components does not significantly affect the GRB signal to noise ratio. Finally, the FFT filter algorithm does not importantly slow down the on-ground trigger software.

After the introduction of the filter, GRB 100201A has been detected through the collimator shielding walls and GRB 100331B[23] and 100528A[24] have been detected and localized. An example of a lightcurve before and after the filtering with the FFT-based algorithm is shown in fig. 2. The origin of time in the figure is the trigger time (31 March 2010 at

21:08:36 UT) of GRB 100331B, the bump extending until ~50 s. The improvement in the signal to noise ratio given by the filter is clearly seen in the figure.

We had already developed a fast-running and reduced version of the SuperAGILE imaging software, specifically optimized to localize fast transients such as Gamma Ray Bursts and X-ray Bursts. With the satellite in spinning mode, the transit of the sources within the field of view represents an upper limit to the integration time of the images since the attitude reconstruction and correction is less accurate if an objects “moves” more than a few degrees. A typical maximum value for the integration time is consequently of 10 – 12 s, during which an objects moves by 8 – 10 degrees. We estimated the significance level of the GRBs already localized by SuperAGILE in pointing mode by rescaling the integration time to 10 s and we found that about half of them would also be localized in the current operating conditions. For this reasons we expect that the overall rate of GRB localizations by SuperAGILE, about one per month, would be reduced of a factor of two – three in spinning mode. The preliminary results are in agreement with the expected reduced rate.

4.3 Modification of the imaging algorithms in spinning mode

The SuperAGILE data analysis pipeline[9,10] required to be fundamentally modified after the switch to the spinning operative mode. In fact the satellite is not pointed toward a fixed direction in the Sky but rotates, spanning a region of the order of 68 × 360 degree. The SuperAGILE standard pipeline includes a procedure to correct the wobbling of the sources in the images, introduced by the satellite attitude pointing variations (~0.1 degree/s). The procedure cannot compensate variations bigger than few degrees and, in spinning mode, this means that only images accumulated for a few seconds, when the SuperAGILE sensitivity is enough to localize only the brightest sources (e.g. GRBs), can be corrected, as shown in sec. 4.2 above.

In the processing of the data in spinning mode we thus adopt a completely different approach: we select the data belonging to the same field in the Sky and we *a posteriori* reconstruct the images by accumulating photons detected from the same field but at different times. For this purpose we divide the Sky swept by the satellite boresight into small regions (hereafter called *slices*) and we identify the intervals of time in which the satellite boresight is contained within each *slice*. With this choice the attitude variations in each *slice* are so small that the attitude correction procedure can effectively correct the effect of the wobbling on the images. The selected intervals of time are formatted into Good Time Intervals (GTIs), a standard format to define such intervals in Astrophysics, that are then used to select the photons from the overall list and to accumulate the images. The *slice* dimensions are the result of a trade-off between the accuracy of the attitude reconstruction and correction algorithms, requiring small *slices* to effectively correct the blurring introduced by the satellite wobbling and attitude variations, and the computation time, huge in case of many small *slices*. The result of the trade-off between the number and the computation time is a *slice* dimension of 6 × 6 degrees. With this choice the transit time of a source in a 6 degrees *slice*, depending on the position of the source path within the field of view, is of the order of 7 s, adequate for the attitude correction procedure.

In one day the net exposure of a single *slice* is ~500 s and, in this short interval, the expected sensitivity at 5σ significance level is ~160 mCrab, obtained by rescaling the sensitivity in pointing mode (~18 mCrab at the same significance level in one day, corresponding to 50 ks of net exposure). To improve the instrument sensitivity we select longer integration times, 3.5 and 7 days, in which the expected values obtained with the same method are ~90 mCrab and ~60 mCrab respectively.

A dedicated algorithm is used to filter the background fluctuations in the images and is tuned in order to avoid the position of known sources. The sources flux is estimated from the images basing on two different approaches: the detection of objects exceeding a given signal to noise ratio in the image (bright sources search) and the *a priori* extraction of the flux of sources contained in our reference catalogue (catalogue search), without taking into account the significance of the peaks in the images. The reference catalogue contains 85 sources of flux above 10 mCrab in the SuperAGILE energy band (18 – 60 keV). With the first method we can find unidentified sources in the images but with a sensitivity undoubtedly worse than in pointing mode. The second method allows to reach a higher sensitivity, since the flux is extracted and summed from many *slices*, but it may be applied only to sources of known position, from our reference catalogue. After both methods are applied separately to the images of each *slice*, the properties of the sources observed in the whole integration are reconstructed from the combination of the results of all the single *slices*.

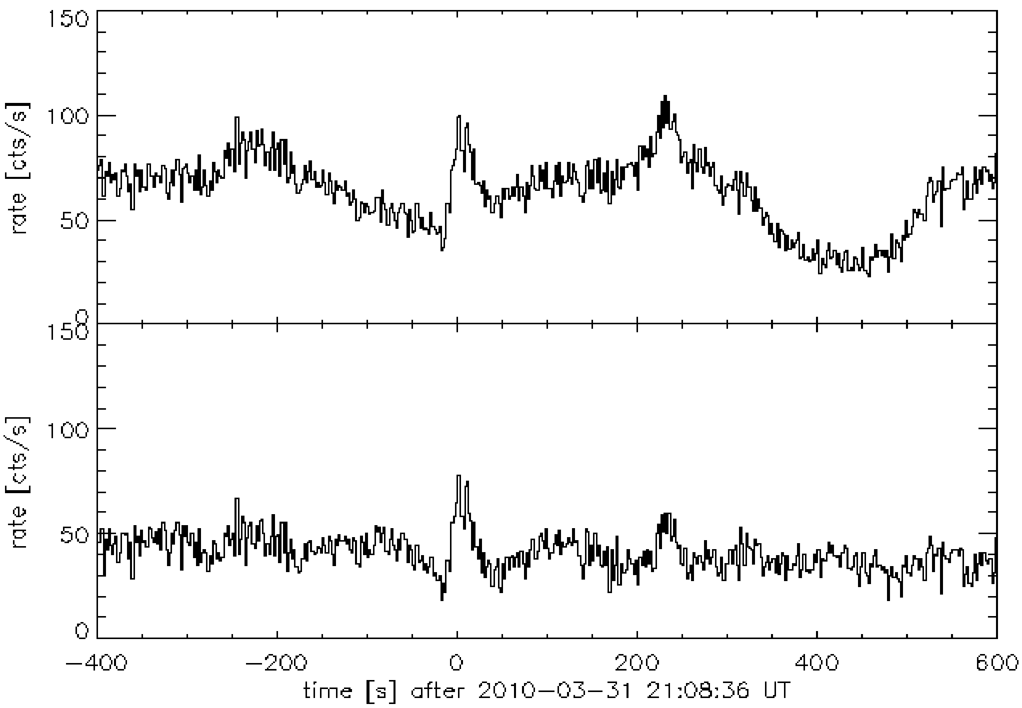

Fig. 2: SuperAGILE lightcurve of GRB 100331B before (top) and after (bottom) the filtering with the FFT-based algorithm. The origin of time is the trigger time of GRB 100331B.

4.4 The SuperAGILE SPInning PIpeline (SPIPI)

We arranged the algorithms outlined above in the SuperAGILE SPInning PIpeline software (SPIPI), written using a combination of C, IDL and python procedures. SPIPI is run periodically on time intervals of 3.5 and 7 days duration, selected as the result of the trade off between the instrument sensitivity and the drift of the sources in the images (~1 degree/day), with about 100 *slices* of 6 × 6 degrees. The SPIPI results are files in FITS format containing the list of detected sources, with position, flux and significance measures, and the estimation of the flux of the sources contained in the reference catalogue that are within the SuperAGILE field of view in the given integration. Below we briefly describe the main tasks of SPIPI.

4.4.1 Generation of the event list

The telemetry data are downlinked during each satellite contact, of 100 minutes period, and archived at the ASI Science Data Center (ASDC). The first step of the spinning pipeline is the data reduction process, in which the amplitude and the time tag of each detected photon are reconstructed and the data are arranged in an event list, stored in FITS standard format. This first step is the same as in the SuperAGILE standard pipeline[10], used to process the data in pointing mode.

4.4.2 Reconstruction of the AGILE attitude

Initially the AGILE attitude during the whole integration interval is reconstructed. A specific coordinate transformation allows to define the *slices* and to build the GTIs, that are then used to select the photons belonging to each *slice* from the complete event list. An example map of the *slices* for a four days integration (the same as in fig. 1) is shown in fig. 3.

4.4.3 Attitude and exposure reconstruction, generation of the *slice* images

Basing on the GTIs, the satellite attitude and the exposure map of each *slice* are reconstructed. During the attitude correction procedure the threshold equalization is also introduced. The SuperAGILE coded aperture imaging algorithm is then applied, without significant variations with respect to the pointing mode, and the *slices* images are extracted. During this phase, a dedicated filter algorithm is used in order to reduce the high frequency components and to increase the signal to noise ratio in the image.

4.4.4. Bright sources and catalogue sources search

Two methods of flux extraction are independently applied to the images, the bright sources and catalogue sources search. In the first algorithm, the counts in the peaks in each image are integrated on an interval corresponding to the SuperAGILE PSF and compared to the background. A source is detected if the integral of its peak exceeds a threshold, set at 5σ significance level. The reference catalogue used in the second method contains 85 sources, selected with a flux above 10 mCrab in the hard X-ray band. In this case the counts at each source position are extracted in an interval corresponding to the PSF from the images where the source is within the field of view and then all the counts from the same source are combined.

4.4.5 Summary and visualization of the results

Several cuts, e. g. on the significance level and coherence of the flux from the images in the two directions, are then applied to the results in order to avoid fake detections and to increase the reliability of the flux measurements. The resulting FITS files corresponding to the combination of the detected and catalogue selected sources are archived, uploaded to a dedicated MySQL database, provided to the public web page of ASDC and arranged on a team-restricted web page, used for the quicklook. The data may be visualized as an animation showing the position and flux of the sources in each *slice* and their exposure. A superposition of the sources from the catalogue search of a SPIPI integration on the corresponding exposure map is shown in fig. 4.

4.5 Estimation of the SuperAGILE scientific performances in spinning mode

The AGILE attitude is reconstructed using a pair of Star Trackers, located on the sides of the payload. The study[9] of the SuperAGILE Point Source Location Accuracy (PSLA) in pointing mode with a Raster Scan toward the Crab Nebula resulted in a value better than 1.2 arcmin (for a signal to noise ratio bigger than 10) and evidenced that the attitude reconstruction represented the main systematic contribution, 0.8 arcmin.

Following the manufacturer's specifications, the Star Trackers are significantly less accurate when operated in spinning mode and the accuracy in the two SuperAGILE directions is different, being worse in the direction of the spinning rotation. Moreover, in the particular current conditions the PSLA depends on the integration time, since the accuracy and reliability of the attitude correction procedures depends on the "motion" of the sources within the field of view. A preliminary estimation of the SuperAGILE PSLA in spinning mode is shown in fig. 5, where the distance between the position of GRB 100331B from SuperAGILE and Swift/XRT (with an uncertainty of 2 arcsec on the position) is shown as a function of the integration time. The distance has a clear minimum around 8 – 10 s, while it increases at shorter time, due to the smaller significance of the SuperAGILE image, and at longer time, because of the inaccuracy in the attitude reconstruction. At the minimum distance the GRB significance is 10.4σ.

The SuperAGILE net exposure of a *slice* with the dimensions selected for SPIPI amounts to ~500 s in one day, ~1750 s in 3.5 days and ~3500 s in one week. By rescaling the SuperAGILE sensitivity in pointing mode to the current values of the integration, we obtain an expected sensitivity of ~160 mCrab in one day, ~90 mCrab in 3.5 days and ~60 mCrab in one week, all values at 5σ significance level. We found that the sensitivity measured from the SuperAGILE data with integration of 3.5 and 7 days is in good agreement with the expected values. From preliminary evaluations of the source flux we found a reduction of about 20 – 30 % with respect to the values measured in pointing mode, due to the increased width of the peaks in the images because of the residues of the wobbling produced by the variations of the satellite attitude. The measured fluxes are in good agreement with the publicly available measurements of the Swift/BAT satellite (http://heasarc.nasa.gov/docs/swift/results/transients/), working in the similar energy band of 15 – 50 keV. The lightcurves based on the flux values derived from the catalogue search algorithm will be available starting from July 2010 on the same public web page (http://agile.asdc.asi.it/sagilecat_sources.html) at the ASDC as used in the pointing mode.

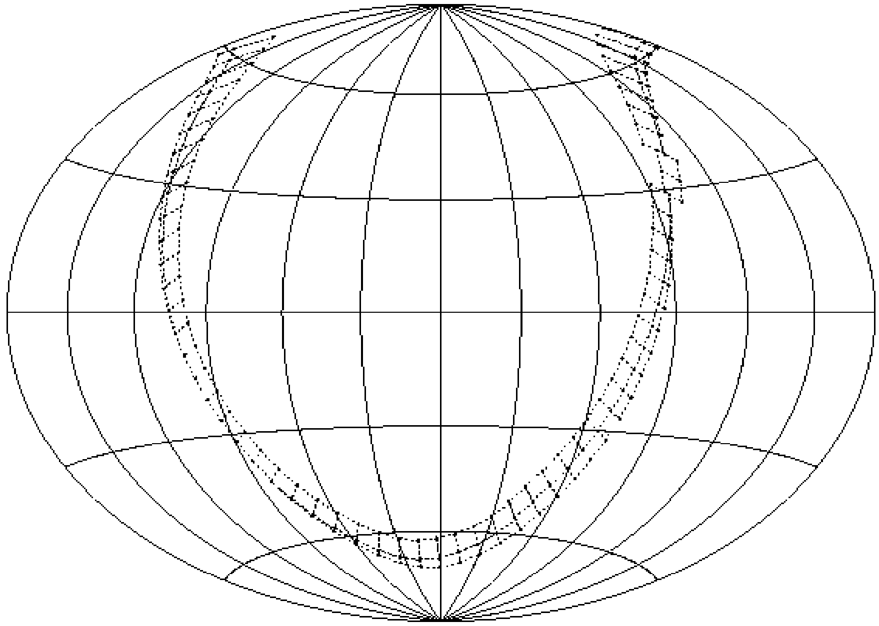

Fig. 3: Map in Galactic Coordinates of the *slices* in a four day-long integration (the same as in Fig. 1). Each *slice* defines a region in which the effect in the SuperAGILE images of the wobbling in the photon position due to the variations of the satellite attitude can be effectively corrected.

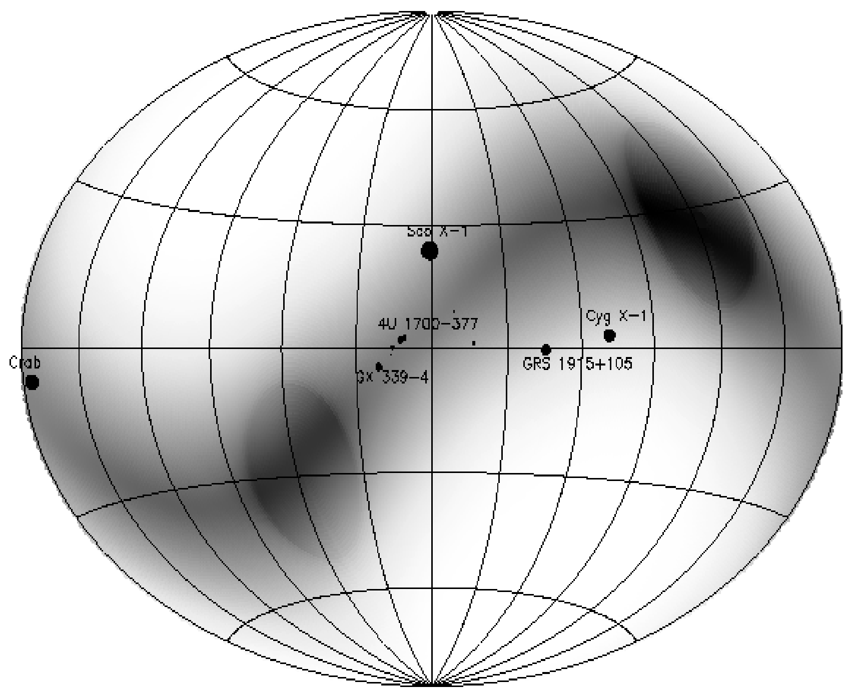

Fig. 4: Map in Galactic coordinates with the superposition of the sources observed by SuperAGILE in the catalogue search (the symbol dimension is proportional to the reconstructed flux) and the net exposure (in grey scale). The name of the sources near the Galactic Center has been omitted for clarity.

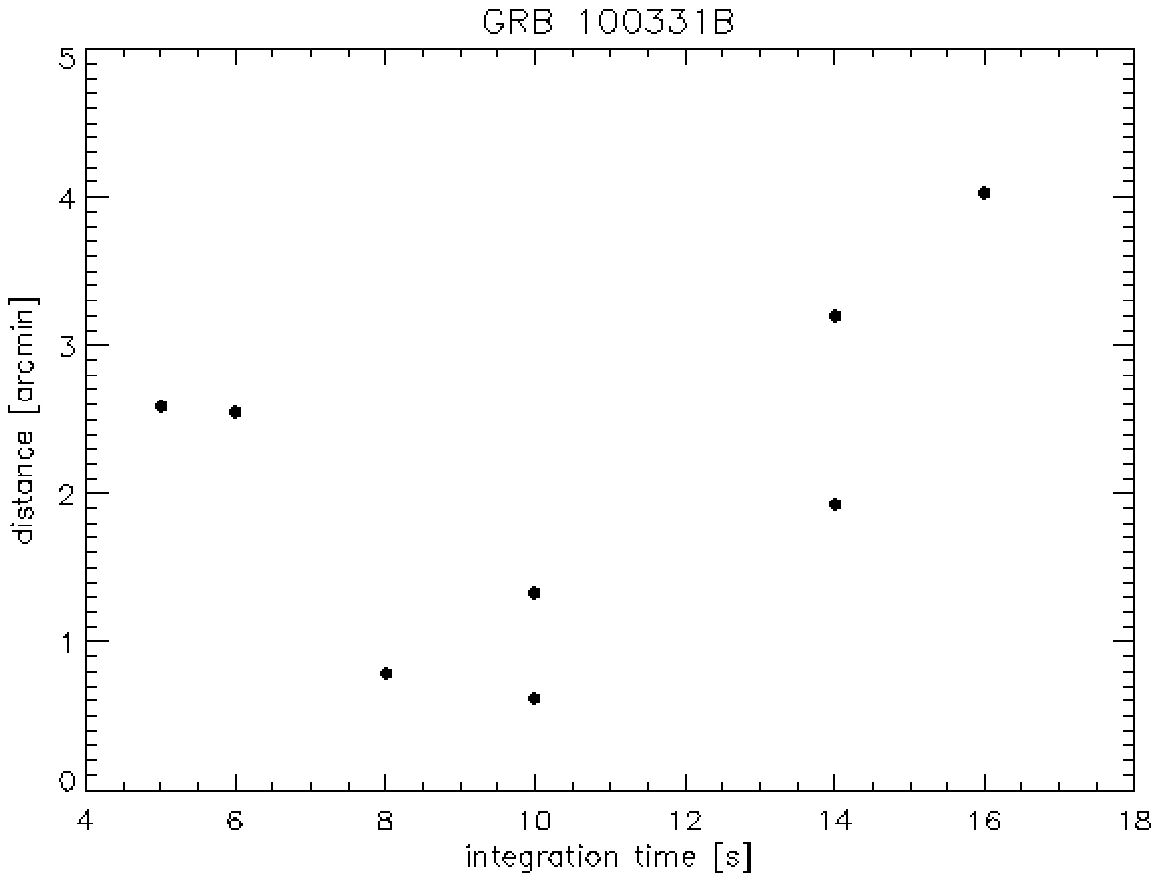

Fig. 5: Preliminary estimation of the PSLA in spinning mode from the distance between the position of GRB 100331B measured by Swift/XRT and SuperAGILE depending on the integration time.

5. CONCLUSIONS

SuperAGILE, the hard X-ray monitor of AGILE, is a coded aperture instrument with two 1D crossed silicon microstrip technology-based detector modules and a tungsten and carbon fiber coded mask. The imaging is twice 1D in the central region of the field of view, of 68 × 68 degrees. On October 2009 AGILE lost its reaction wheel and switched to a spinning mode, with a rotation around the axis pointed toward the Sun.

We had to significantly modify the GRB triggering and the SuperAGILE imaging procedure in order to adapt them to the new operating conditions. The main correction to the Gamma Ray Burst trigger is the introduction of a FFT-based filter, that attenuated of a factor of about 100 the interval of frequencies introduced by the satellite spinning, ranging from $\sim 10^{-3}$ Hz to $\sim 8 \times 10^{-3}$ Hz. The filtered time series, obtained with the reverse FFT, is used in the search of Gamma Ray Bursts, X-ray Bursts and other fast transients. Due to the "transit" of the sources in the field of view, the integration time of the burst images is limited at 10 – 12 s.

The SuperAGILE data reduction pipeline has been modified and adapted to the new working conditions by subdividing the Sky region swept by the satellite boresight into *slices* of 6 × 6 degrees, selecting via Good Time Intervals the photons from the complete event list depending on the satellite attitude and accumulating the images of each *slice*. The comparison of the integral of the peaks in the image with the background (bright sources search method) and the extraction of the counts at the position of the sources in the reference catalogue (catalogue search method) are used to find the flux of the observed sources. Several cuts are applied to the results to increase the reliability of the flux measurements. The preliminary results of the catalogue search method have been verified with the publicly available lightcurves of Swift/BAT (operating in the similar energy band of 15 – 50 keV) and are in good agreement.

The "transit" of the sources within the field of view introduces a dependence of the Point Source Location Accuracy on the integration time, with preliminary minimum values around ~1 arcmin for bright sources like GRBs. The expected SuperAGILE sensitivity at 5σ significance level in spinning mode is ~160 mCrab in one day, ~90 mCrab in 3.5 days and ~60 mCrab in one week and the preliminary measurements are in agreement with such expected values.

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