AGILE @ ASI Science Data Center
Community and User Support

Carlotta Pittori, ASDC
on behalf of the AGILE Data Center

SciOps 2013, ESAC Madrid, Sept 10-13
AGILE on PSLV-C8 Sriharikota, India
April 2007

The AGILE Payload: the most compact instrument for high-energy astrophysics: only ~100 kg
~ 60 × 60 cm

Payload

ASI Mission with INFN, INAF e CIFS participation

γ-ray astrophysics: 30 MeV - 30 GeV energy range and simultaneous X-ray capability between 18 - 60 keV
Working principle of AGILE and Fermi/GLAST: PAIR PRODUCTION $\gamma \Rightarrow e^+ + e^-$

- Pair production Si-Tracker telescopes with a calorimeter to measure energy and a scintillator system to veto charged particles background

- Charged particle background: $10^4$-$10^5$ times larger than the $\gamma$ signal

- Trigger based on the silicon planes

- Low power electronics
April 23, 2007: Launch!

Equatorial orbit: 550 Km, < 3º inclination angle
AGILE orbital parameters
Baseline equatorial orbit: 550 Km, 3° inclination

Semi-major axis: 6922.5 km (± 0.1 km)
Requirement: 6928.0 ± 10 km

Inclination angle: 2.48° (±0.04°)
Requirement: < 3°

Eccentricity: 0.002 (±0.0015)
Requirement: < 0.1°

TPZ orbital decay estimate:
Height < 400Km on 20/04/2017
(A/M=0.009 sqm/Kg)
Worst case (A/M=0.012 sqm/Kg): 02/11/2015
Best case (A/M=0.006 sqm/Kg): 29/04/2023

(March 2013 updated estimate, using recent solar flux “Schatten” forecasts + 2σ)
AGILE Telemetry raw data (Level-0) are down-linked every 100 min to the ASI Malindi ground station in Kenya and transmitted first to the Telespazio Mission Control Center at Fucino, and then to the AGILE Data Center (ADC). Raw data are routinely received at ADC within 5 min after the end of each contact.

**ADC main tasks are:**

- data processing (real-time and reprocessing) and production of the data archives (from raw data to scientific level data through calibration level data),
- preliminary data analysis (Quick Look Analysis),
- management of the Guest Observer Program and of the AOs
- management of the Mission Planning (Long Term Plan preparation and emission),
- data and software distribution to the scientific community
• The ADC, part of ASDC, is in charge of all the scientific oriented activities related to the analysis and archiving of AGILE data:

From scientific telemetry (TM) Level-0:
✓ Preprocessing → Level-1 data
✓ Quick-Look Analysis (transient detection)
✓ Standard analysis → Level-2 data (photon list)
✓ Scientific analysis (source detection, diffuse gamma-ray background)
✓ Archiving and distributing all scientific AGILE data

INPUT: Row data (TM Level-0)

Preprocessing: Level-1 data

Primary data generation: Quicklook & Standard analysis Level-2 data (photon list and logfile)

Scientific analysis: Level-3 data

OUTPUT: High level data products (count maps, spectra, light curves …)
ADC operation scheme:

1. **GS Activity & MCC Interface**
   - 1.1 Mission Planning
     - APP Manag (& OB status)
     - LTP/OPF Nominal
     - TOO/PRR
   - 1.2 Data Flow Monitoring
     - TM LV0
     - Auxiliary
     - OSM Manag
   - 1.3 Contingency Management

2. **Data Processing & Archiving**
   - 2.1 Automatic Pipeline Monitoring
     - AUX Branch
     - TM PPS Branch (LV0 → LV1)
     - Correction (LV0 → LV1corr)
   - 2.2 Archive Management and Data Backup
     - Calibration
     - HM Alert Manag.

3. **AO/GOP**
   - AO Data Request Manag
   - GO Data & SW Distribution
   - GO Help Desk

4. **Public WEB Pages & User Support**
   - GRID QLUSR
   - CALDB Updates
   - OB Bricks Validation
   - Scientific Analysis (LV3 refinement)
   - AGILE GRID & SA
     - Catalogs
     - On-line archive in MMIA and VO
   - FAQ & Scientific Help Desk
   - Documentation

5. **Payload Configuration Control**
   - Quick Scientific Monitoring
   - SuperAGILE pipeline
   - GRB Alert Manag.
Different kinds of users:

- Internal ADC operators
- AGILE Team scientists
- AGILE Guest Observers
- Scientific Community
ADC HW Architecture (2009)

Responsabile HW ASDC: M. Ricci, Sistemista ASDC: P. D’Angeli

- 6 Computing Server by ASDC
- 1 WEB server + Storage by ASDC
- 3 Computing Server by INAF

+ several virtual machines on ESXI 4.0 2U server (fast data reproc.)
AGILE Data Center at ASDC (up to June, 2012):
Carlotta Pittori *coordinator*, Patrizia Santolamazza, Francesco Verrecchia, Fabrizio Lucarelli (INAF), G. Fanari and S. Stellato (TPZ)

Paolo Giommi
ASDC Director

F. Tamburelli
(AGILE in calibrazione @ LNF)
First AGILE GRID light
ADC 24/5/2007

Commissioning Phase:
AGILE Vela PSR Count Map
(~ 20000 s)
AGILE Total Intensity Map (E> 100 MeV):
Pointing + Spinning (up to july 30, 2011)

“The First AGILE-GRID Catalog of High Confidence Gamma-Ray Sources” C. Pittori et al., A&A 506, 2009
(green circles, first year of operations)
ASDC interactive catalogs webpages
The ASDC SED Builder

Radiotelescopes

* Planck
* Swift
* AGILE and Fermi/CTA

New SED(t) v2.2: VO tools and TIME domain

See Paolo Giommi talk, Thursday morning
Virtual Observatory Standards (*in progress*) and Tool for OPerations on Catalogues And Tables (*Topcat*)
The AGILE MCAL Gamma-ray Burst Catalog

NEW: MCAL GRB Catalog
(M. Galli et al., 2013)
ADC interactive webpage

Flux Light Curve
For this burst, 1 count = $4.0 \times 10^{41}$ erg cm$^{-2}$ (observed flux).
Note that this is an average conversion factor: the true value may evolve with time.

Swift/XRT light curve of GRB 090510

Swift-XRT light curve of GRB 090510

Swift-XRT light curve repository at Leicester
Swift-BAT
Quicklook GBM lightcurve

GCN
Blog for Gamma Ray Bursts
Articles
SAO/NASA Astrophysics Data System
AGILE: “very fast” Ground Segment (with contained costs)

- Satellite
- Malindi Ground Station
- Fucino TZP MOC
- ASDC
  - AGILE Team
  - Guest Observers
  - Public data access

Automatic data processing:
- ~1 hr
- ~0.5 hr
- ~0.5-1 hr
- ~(2-2.5) hr

Record for a gamma-ray mission!
AGILE Science Alert System

- The system is distributed among the ADC @ ASDC and the AGILE Team Institutes (Trifoglio, Bulgarelli, Gianotti et al.)

- **Automatic Alerts to the AGILE Team are generated within** \( T_0 + 45 \text{ min (SA)} \) and \( T_0 + 100 \text{ min (GRID)} \)

- **GRID Alerts** are sent via email (and sms) both on a contact-by-contact basis and on a daily timescale

- Refined manual analysis on most interesting alerts performed every day (daily monitoring)

- **105 ATel** (48 in pointing + 57 in spinning) and **42 GCN** published up to Sept, 2013
Welcome to the AGILE Data Center Home Page at ASDC

These pages provide updated information and services in support to the general scientific community for the mission AGILE, which is a small Scientific Mission of the Italian Space Agency (ASI) with participation of INFN, IASF/INAF and CIFF.

AGILE is devoted to gamma-ray astrophysics and it is a first and unique combination of a gamma-ray (AGILE-GRID) and a hard X-ray (SuperAGILE) instrument, for the simultaneous detection and imaging of photons in the 30 MeV - 50 GeV and in the 18 - 80 keV energy ranges.

The AGILE Mission Board (AMB) has executive power overseeing all the scientific matters of the AGILE Mission and is composed of:

- AGILE Principal Investigator: Marco Tavani, INAF/IASF Rome (Chair)
- ASI Project Scientist: Paolo Giommi, ASDC
- ASI Mission Director: Giovanni Valentini, ASI
- Former ASI Mission Director: Luca Salotti, ASI (up to September 20, 2010)
- AGILE Co-Principal Investigator: Guido Barbiellini, INFN Trieste
- 1 ASI representative: Elisabetta Tommasi di Vignano
- Former ASI representative: Sergio Colafrancesco (up to June, 2010)

As specified in the Announcement of Opportunity Cycle-4, it is not possible to propose for ToO observations in response to AGILE Announcement of Opportunity.

Latest AGILE News

- (Apr 30, 2013) GRB 130427A: high energy gamma-ray detection by AGILE and Fermi
- (Apr 11, 2013) AGILE-MCAL Gamma-ray Burst Catalog on-line at ASDC
- (Mar 28, 2013) GRB 130327B: gamma-ray detection by AGILE
- (Mar 12, 2013) Sustained gamma-ray emission from the Crab Nebula and hard X-ray and Optical follow up reported
ADC Quick-Look Interface
(from AGILE Services restricted area)
ASDC Data Explorer Tool

Quick Look AGILE database and automatic light curves

Variability

Available parameters:
- Name
- RA
- Dec
- Galactic
- Cnts
- Err
- Sqrt(TS)
- Ximage
- Flux
- Err
- Distance from FOV
- Cent.
- Sp_Index
- SNR
- Err_sp_index
- Other_name1
- Other_name2
- Other_name3

Entry number | AGILE name | RA (J2000.0) | Dec (J2000.0) |
--- | --- | --- | --- |
1 Select | Data Explorer | AGL J0634+1816 | 194.78 | 4.67 |
2 Select | Data Explorer | AGL J1049+8055 | 128.53 | 34.83 |
3 Select | Data Explorer | AGL J0832-1233 | 236.49 | 15.76 |

Source: ASDC Multi-frequency Data Explorer: Web and VO data access and tools

URL: http://www.asdc.asl.it/showEntry.php#
Selected alerts sent via email, sms

Daily reports on a 48h time scale (sent twice a day)

Contact-by-contact alerts on a 48h time scale (sent every ~100 min)

(Figure adapted from M. Trifoglio et al.)
The variable Crab Nebula!

FIRST PUBLIC ANNOUNCEMENT
Sept. 22, 2010: AGILE issues the Astronomer’s Telegram n. 2855

Science Express (6 January 2011)
**LTP xml files sent via Data Router to TPZ MOC**

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**Scientific Observation (SO)**

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<td>TOO su 3C 454.3 in flaring, visto da Swift. Intervento del primo puntamento del Piano Estivo. l/127.364, b=28.007 3C454.3 si trova a 36.882 gradi di distanza!</td>
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<td>SO TOO 3C 454.3 prolongamento</td>
<td>SO TOO 3C 454.3 prolongamento</td>
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<td>2007-07-30 12:00:00</td>
<td>250200.000</td>
<td>NORMAL</td>
<td>Prolungamento del TOO su 3C 454.3 in flaring, visto da Swift. l/120.016, b=-29.569 3C454.3 si trova a 39.295 gradi di distanza!</td>
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**Commissioning 3 Velte Region (go)**

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<td>195.990</td>
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<td>Cygnus</td>
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<td>2007-07-13 12:00:00</td>
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**Commissioning 3 Velte Region (go)**

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<td>Cygnus</td>
<td>1</td>
<td>2007-07-13 12:00:00</td>
<td>2007-07-16 12:00:00</td>
<td>324.800</td>
<td>64.613</td>
<td>288200.000</td>
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</table>
Due to a malfunction of the rotation wheel, since November 4, 2009, AGILE is operating in a spinning observing mode and it is now surveying a large fraction of the sky every day. AGILE spinning sky view on a particular day:

All ADC functionalities and data processing promptly adapted to the new spinning configuration at no extra costs! No interruptions of the GOP.
On December 3-4, 2009 the AGILE satellite detected the strongest $\gamma$-ray flare ever observed ($E > 100$ MeV). The flaring $\gamma$-ray source is in the active galaxy 3C454.3 ($z=0.859$, $F_\gamma > 2 \times 10^{-5}$ ph cm$^{-2}$ s$^{-1}$, $L_{iso} = 6 \times 10^{49}$ erg s$^{-1}$).
AGILE: 6th year in orbit

• AGILE demonstrates for the first time the covering of ~ 1/5 of the entire gamma-ray sky (FoV ~ 2.5 sr) with excellent angular resolution and competitive sensitivity.

• AGILE shows for the first time an optimal performance of its gamma-ray and hard X-ray imagers.

• > 32678 orbits, Aug 28, 2013 (warning: your mission may last longer than planned!)

• Pointing observation mode up to October 18, 2009 and spinning observation mode since October 2009.

• Very good scientific performance, especially at ~ 100 MeV

• Guest Observer Program open to the scientific community:
  
  - Cycle-5 and Cycle-6: on-going data taking
AO1: Dec 1, 2007 - Nov 30, 2008
Status AGILE AO1: completed/public
Submitted proposals: 29
Approved/P. Approved: 24
Requested Targets: 122
Approved Targets: 100
Pulsars: 39
AGN: 31
3EG sources: 30

AO2: Dec 1, 2008 - Nov 30, 2009
Status AGILE AO2: completed/public
Submitted/Approved proposals: 15
14 PI, 74 co-PI
Requested/Approved Targets: 93
Pulsars: 21
AGN: 62
3EG sources: 10

AO3: Dec 1, 2009 - Nov 30, 2010
Status AGILE AO3: completed/public
Submitted/Approved proposals: 11
11 Proposals,
10 PI, 78 co-PI
Requested/Approved Targets: 67
Pulsars: 13
AGN: 37
3EG sources: 7
1FGL Sources: 10

AO4: Dec 1, 2010 - Nov 30, 2011
Status AGILE AO4: completed/public
Submitted/Approved proposals: 18
16 PI, 69 co-I
Requested/Approved Targets: 123
Pulsars: 43
AGN: 50
3EG sources: 5
1FGL Sources: 24
1AGL Sources: 1
# Agile Services as pittori

## Agile Data Request Edit as pittori

### Observation Proposal

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<th>Title</th>
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<td>2000-10-31</td>
<td>J. Cadet</td>
<td>As discussed in our scientific justification, the microwave to gamma-ray slope (alpha=nu/nu gamma) can be used as a viable figure of merit for blazar-like source identification in gamma rays. Taking into account the constraints from the observed extragalactic gamma-ray background, one can estimate the maximum duty cycle allowed for a selected sample of low energy obscured (QSO) blazars, in order to be detectable for the nominal sensitivity values of the AGILE gamma-ray experiment during AGILE AO Cycle 1. We apply for the data rights of ten LBL blazers from the new WMAP-3 yr catalog, sorted in decreasing order according to the proposed figure of merit, used as an indicator to identify good gamma-ray blazer candidates.</td>
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### Requested Target

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### Do Investigator

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### Justification

During AGILE AO Cycle 1 we were granted data rights for ten LBL blazers from the new WMAP-3 yr catalog, sorted in decreasing order according to the microwave to gamma-ray slope, proposed as a figure of merit to identify gamma-ray blazar candidates.

With the AGILE Cycle 1 accumulated statistic we obtained the upper limits reported in Table 2 over the whole Cycle 1 period, and we noticed that some of the candidate sources are just below the detection threshold (3o-17o). In this proposal we ask to have the opportunity to analyze the same sources also during the AGILE Cycle 2 in order to increase statistic and get better constraints on blazar temporal flux variability.

Being Fermi well operative, we will have also the possibility to compare AGILE results with Fermi data as soon as they will be published.

During AGILE AO Cycle 1 and Cycle 2 we were granted data rights for ten LBL blazers from the new WMAP-3 yr catalog, sorted in decreasing order according to the microwave to gamma-ray slope, proposed as a figure of merit to identify gamma-ray blazer candidates. With the AGILE three-year accumulated statistic we obtained the results reported in Table.
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AGILE Public Data Distribution from the ASDC MMIA

• **First Cycle-1 public delivery** (17 OBs): Jun 10, 2009  
  (data_release_note_v1)

• **Second Cycle-1 public delivery** (3 OBs): July 17, 2009

• **Publication of a reprocessed Cycle-1** (20 OB) dataset: Oct 6, 2009  
  (data_release_note_v2)

• **Complete Cycle-1 public data release** (29 OB): Dec 22, 2009  
  (data_release_note_v3)

• **Cycle-2 public delivery** (22 OB) and reprocessed Cycle-1 dataset: Oct 6, 2010  
  (data_release_note_v4)

• **Complete Cycle-1 and Cycle-2 (pointing) reprocessed data release**: Dec 21, 2010  
  (data_release_note_v5)

• **Cycle-3 and Cycle-4 (spinning) public deliveries**: Nov 9 - Dec 21, 2011 and  
  Nov 21, 2012  
  (data_release_note_v6 and data_release_note_v7)
New interactive on-line analysis tool developed at the ASDC for AGILE public data preview:

Ximage sw package adapted to gamma-rays

Allows web users to have a preview of the AGILE public data fields and perform an interactive preliminary analysis around a chosen sky position.
Swift XRT (X-ray) on-line analysis from MMIA

XRT On-line Analysis

Select data mode for analysis
- PC Mode
- WT Mode (3670 sec)

ASDC data reprocessing
- yes
- no

NOTE: the reprocessing may take a while (from about 30 seconds up to several minutes)

Task XRTPRODUCTS is running, please wait

Building Exposure Map, it may take a while (up to several minutes)
Data ready to be inserted in the SED
NEW: web interface for AGILE interactive on-line ML analysis on legacy $\gamma$-ray data archive under construction!! Stay tuned!

Warning: use AGILE imaging tool only as a preview of the $\gamma$-ray field. For the moment users should download data and use the official public AGILE software for scientific analysis:

**Index of /public/AGILE_SW_5.0_SourceCode**

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Apache Server at agile.asdc.asi.it Port 80

ML=Maximum Likelyhood
Some concluding remarks:

• Close collaboration between Instrument Team and Operations Team very important

• Plan for human resources to build and maintain mission legacy archives

• Involvement of both expert scientists and non-expert users (including students) to optimize user support and public tools

• Suggestion: future hands-on workshops on available data archive interfaces and tools (next SciOps?)
Backup slides
Table 3: AGILE Scientific Performance

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<th><strong>Gamma-ray Imaging Detector (GRID)</strong></th>
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<tr>
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<tr>
<td>Field of view</td>
<td>$\sim 3\text{ sr}$</td>
</tr>
<tr>
<td>Sensitivity at 100 MeV (ph cm$^{-2}$ s$^{-1}$ MeV$^{-1}$)</td>
<td>$6 \times 10^{-9}$ (5$\sigma$ in $10^6$ s)</td>
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<tr>
<td>Sensitivity at 1 GeV (ph cm$^{-2}$ s$^{-1}$ MeV$^{-1}$)</td>
<td>$4 \times 10^{-11}$ (5$\sigma$ in $10^6$ s)</td>
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<td>Angular Resolution at 1 GeV</td>
<td>$35\text{ arcmin}$ (68% cont. radius)</td>
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<td>Source Location Accuracy</td>
<td>$\sim 5\text{-}20\text{ arcmin}$ S/N$\sim 10$</td>
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<tr>
<td>Energy Resolution</td>
<td>$\Delta E/E\sim 1$ at 300 MeV</td>
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<tr>
<td>Absolute Time Resolution</td>
<td>$\sim 1\mu s$</td>
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<tr>
<td>Deadtime</td>
<td>$\sim 200\mu s$</td>
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<th><strong>Hard X-ray Imaging Detector (Super-AGILE)</strong></th>
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<td>Field of view</td>
<td>$107^\circ \times 68^\circ$ FW at Zero Sens.</td>
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<td>Sensitivity (at 15 keV)</td>
<td>$\approx 5\text{ mCrab}$ (5$\sigma$ in 1 day)</td>
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<td>Angular Resolution (pixel size)</td>
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AGILE Scientific Data Flow

Total AGILE data storage: \(\sim 1.3 \text{ TB/year}\). Consolidated archive (7-6-2102) including reprocessing (storage2) \(\sim 6.5 \text{ TB} + \) QL data (storage1) \(\sim 550 \text{ GB}\)

- Raw TM from MCC
- Telemetry Preprocessing
  - LV0 Data
  - LV1 Data
  - Data Correction
    - LV1corr Data
  - QL Standard Analysis
    - QL LV2 Data
  - Scientific Analysis
    - LV2, LV3 Data

- LV0 + LV1 Data

- LV1corr Data

- AGILE Mission Archive

- Auxiliary Data from MCC
- Auxiliary Data Processing

- Auxiliary Data

- User Data Processing

- AgileDataCenter@ASDC