Space Science Data Center

Agenzia Spaziale Italiana

The AGILE data archive and data management system @ SSDC

C. Pittori (INAF-OAR), on behalf of the AGILE SSDC Team

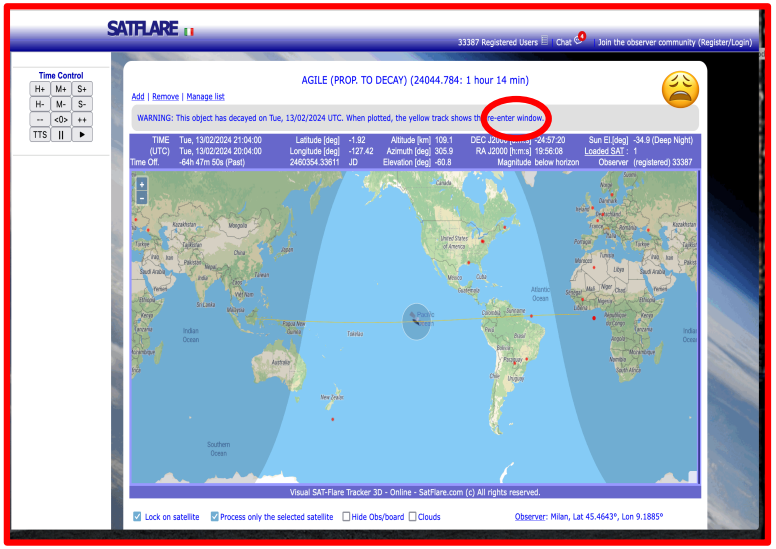
"Archives and Data Management Systems", 26–28 feb 2025 - CNR Bologna

AGILE: ~ 17 years of successful operations in space

ASI Mission with INAF, INFN participation designed for a nominal operative life of **two**+two years

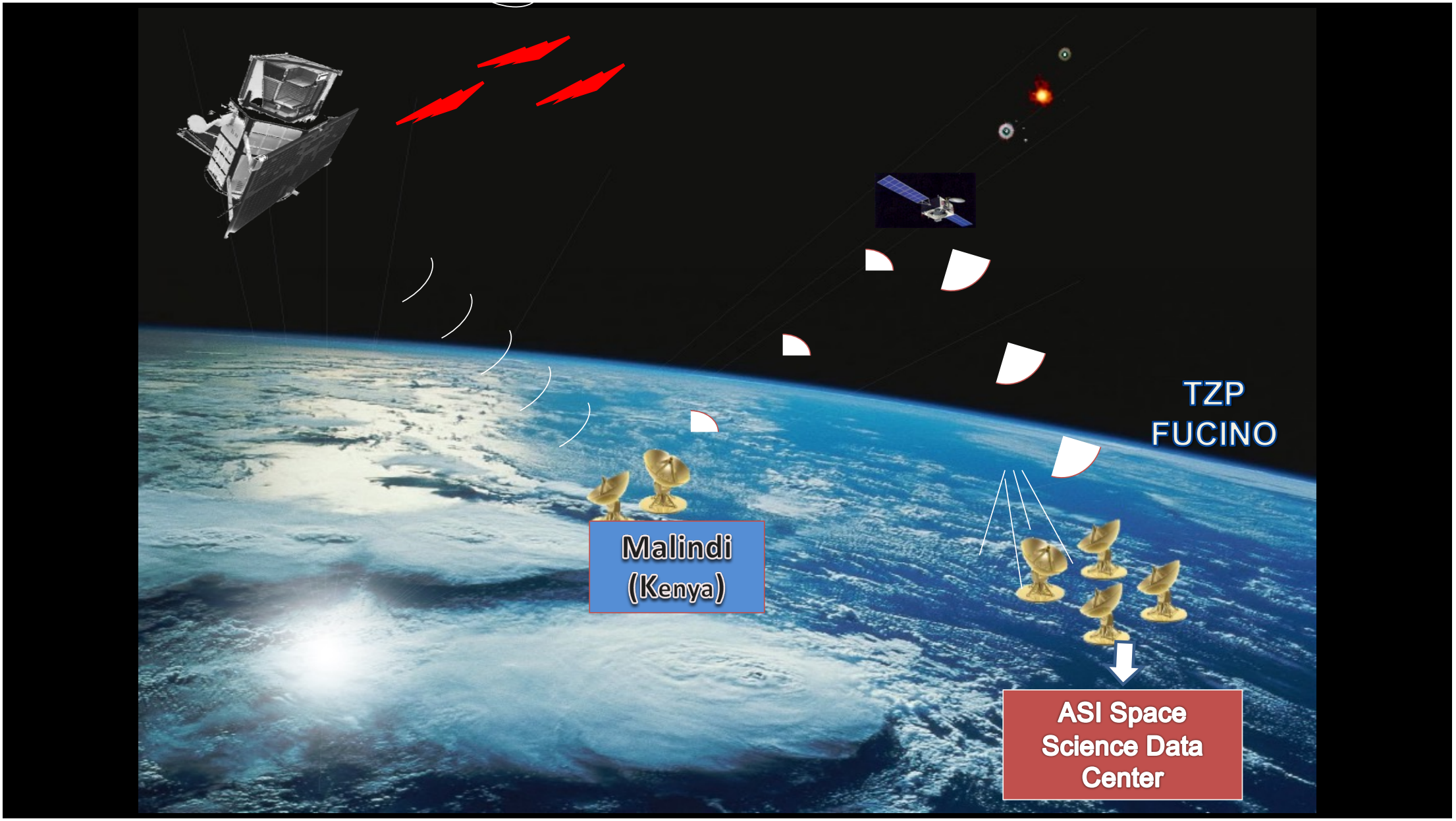
- Launch: Apr 23, 2007
- Science observations ended on Jan 18, 2024

Satellite re-entry on Feb 14, 2024, due to the natural decay of its low Earth orbit.



Fully operational, payload in nominal status till the end, active in:

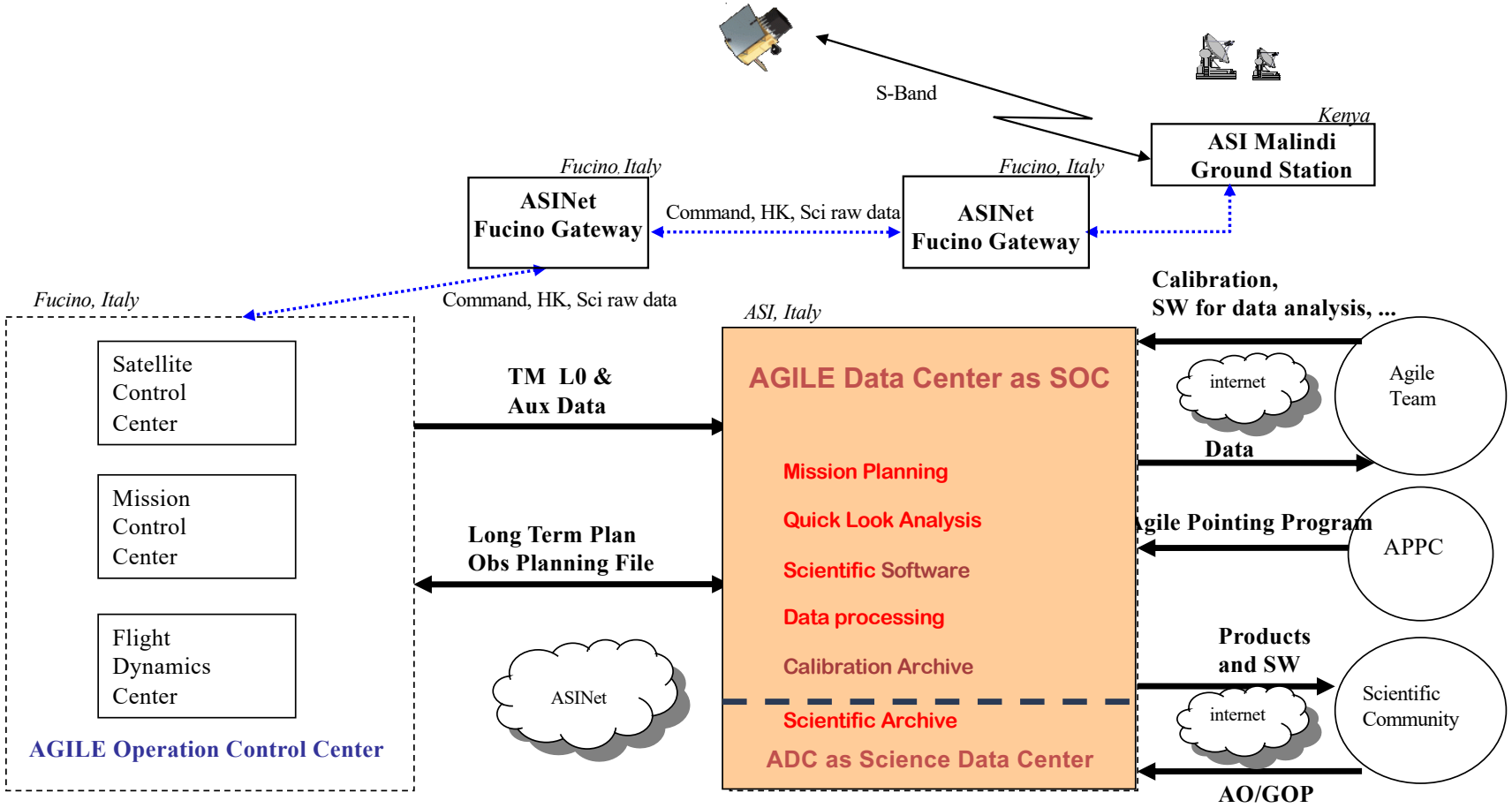
- **gamma-ray astrophysics**
- **terrestrial atmosph. & magnetosph. physics: Terrestrial Gamma-ray Flashes**
- **search of GW counterparts, neutrinos, Fast Radio Bursts, Solar flares and other transients**


TZP
FUCINO
Malindi
(Kenya)
ASI Space
Science Data
Center

AGILE

Science Data Center

AGILE GS Architecture:



The AGILE Data Center

at present:

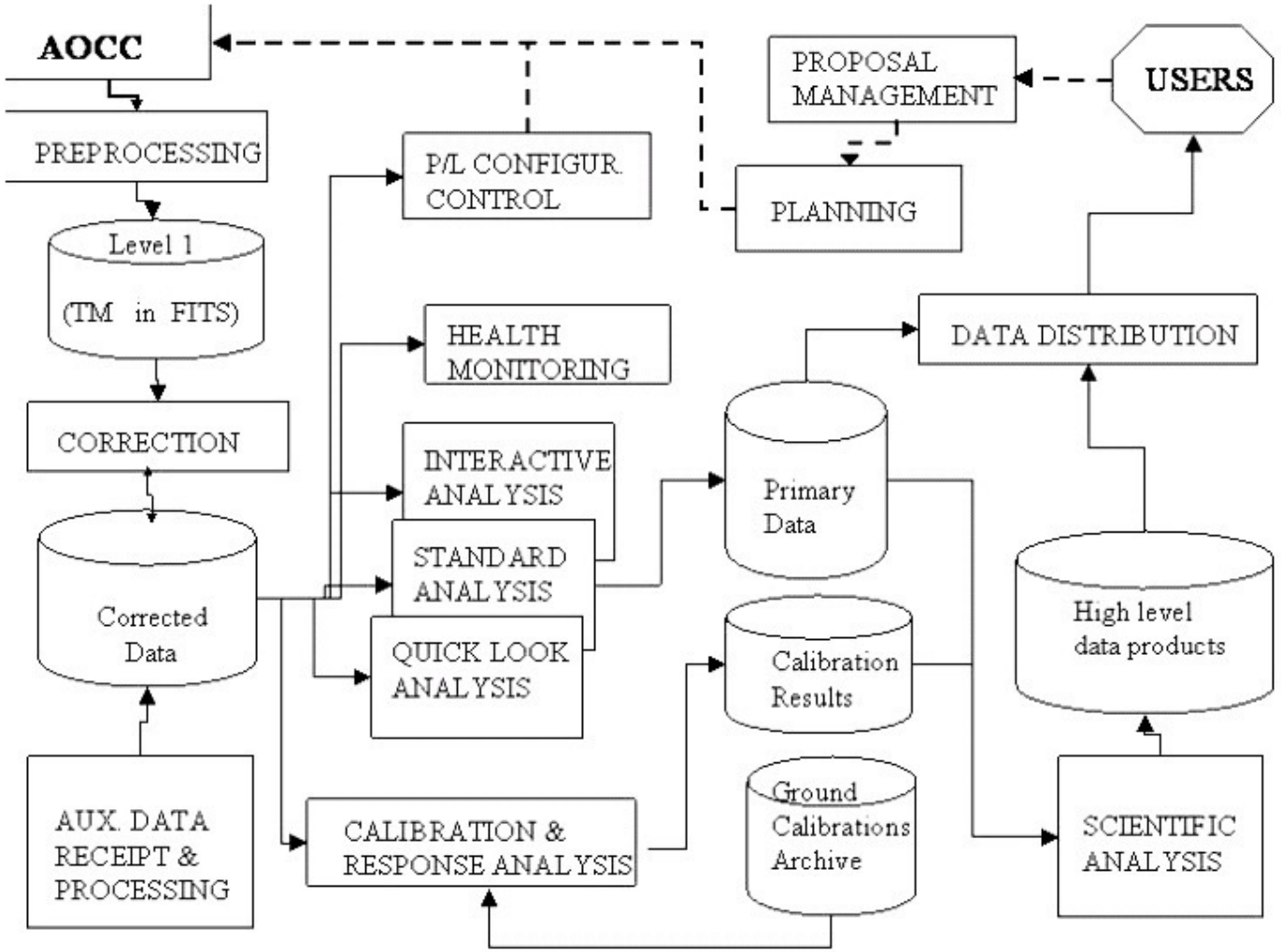
C. Pittori (*coord*), F. Lucarelli, F. Verrecchia (*deputy coord.*) and G. Fanari (*IT support)*

The **ADC**, part of SSDC, is in charge of all the scientific oriented activities related to the analysis and archiving of AGILE data

Different kinds of users:

- **Internal ADC operators**
- **AGILE Team scientists**
- **AGILE Guest Observers**
- **Scientific Community**

AGILE DATA CENTER HIGH-LEVEL ARCHITECTURE



Main AGILE Data Center subsystems (page 1/2):

- **Data acquisition:** receiving and storing the raw telemetry (TM data) and auxiliary data of the mission sent to SSDC from the TPZ control center (AOCC).

- **Preprocessing:** rewriting raw TM data into FITS format. The data, organized according to type, mode, etc., are archived as Level 0 (LV0) and Level 1 (LV1) telemetry packets.

- **Correction:** processing LV1 data to produce data structures and formats optimized for subsequent data analysis. The output is a repository of "corrected" data that contains additional information (conversion to physical units, derivation of new physical quantities, etc.).

- **Standard analysis:** processing the LV1 corrected data to generate the standard products or Level 2 data, (LV2). The output of the standard analysis is the generation of event files (.EVT) and files with auxiliary payload information (.LOG). This analysis, which guarantees the completeness of the LV2 data archive, is performed by Observation Block and is the basis of all subsequent scientific analyses. During the open **Announcement of Opportunity** (AO) periods, the subsystem also trimmed data around Guest Observer (GO) sources, creating proprietary data packages to be distributed.

- **Scientific analysis:** producing maps of the sky, to detect gamma-ray sources and study their characteristics: flux, spectrum, time variability, etc. Scientific analysis therefore consists in the preparation of higher-level Level 3 (LV3) data, i.e. products such as counts, exposure, and gamma-ray diffuse background (gas) sky maps, and source spectra and light curves.

Main AGILE Data Center subsystems (page 2/2):

Quick Look: the QL analysis consists of a **first, rapid analysis of the data** with the aim of highlighting phenomena of particular interest in the shortest possible time. After receiving corrected data using reference catalogs of high-energy sources, the process performs automatically the steps required by standard and scientific analysis in a simplified way, with standard parameters and on shorter time scales. The output consists in the generation of automatic alerts with position and flux of candidate gamma-ray sources and **transients**.

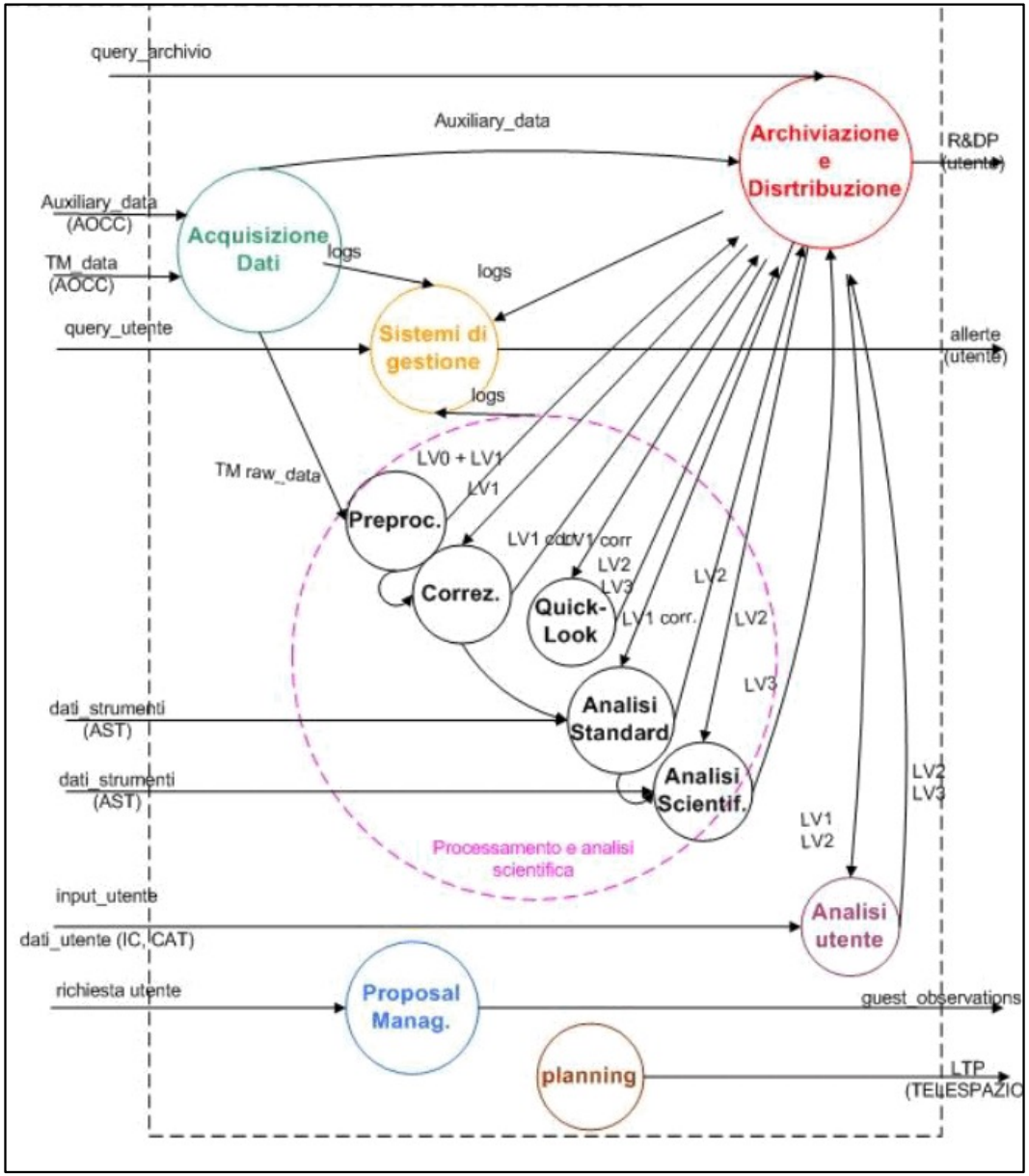
Monitoring of status and performance: subsystem for the control of operating conditions and for verifying the correct functioning of AGILE tools and pipelines.

Data Storage and Distribution: subsystem responsible for storing, managing, protecting, distributing, and accessing the data contained in the SSDC archives. It includes backup functionalities.

Proposal Management: allows Guest Observers (GOs) to request data from a sky region or a source area based on the observations planned for the AGILE satellite during an Announcement of Opportunity (AO) campaign. **During the first 4 years of the mission** the AGILE Pointing Plan (APP) was approved annually by the Agile Mission Board and made public in advance. This subsystem manages the GO proposals, supports the Data Allocation Committee (DAC) in evaluating and approving GO requests, and distributes the data to the selected GOs.

Planning: subsystem for the generation of the Long Term Plans (**LTP**s) to be sent to the TPZ Control Center (AOCC) in Fucino. The control center receives the LTP as input to create the actual telecommands to be sent on board. The following **constraints** related to the pointing are **automatically enforced** during the creation of Observation Blocks (OBs): the AGILE satellite is required to have the **solar panels always perpendicular to the sun**; OBs should not overlap in time, and they should not include double occultations of the star sensors by the Moon and the Earth. At the time of the creation of the **LTP**, an alert is raised by the subsystem in case there is the passage of the Moon in at least one of the star sensors field of view; the final verification of the occurrence of a double occultation the responsibility of the TPZ flight dynamics.

AGILE @ SSDC LOGICAL SCHEME



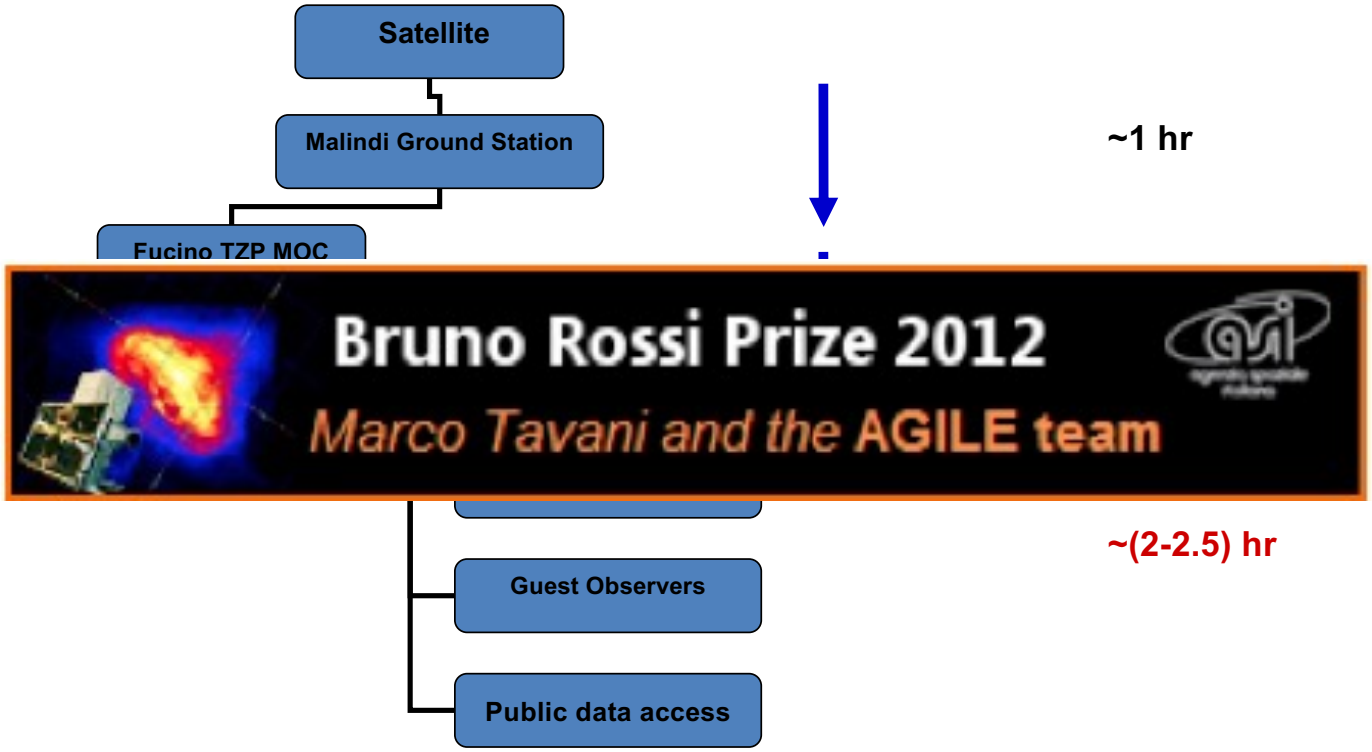
AGILE Flexible Database Web Interface

AGILE Flexible Database Web Interface: a tool for viewing and managing the **mission database** through a Web interface. It allows to operate on the data contained in a relational database and for the pipeline configuration and scheduling. The interface represents data relationships in a hierarchical way allowing **different kind of users** to login, navigate, read, insert, modify and download the linked data according to the mission data policy.

Requirement: the Web interface must be as flexible as possible, allowing to establish by table, by column, by user, etc., which data to represent, how to represent it, and what kind of operations can be performed on the data.

A central DB (tables in **MySQL DBMS**) maintains both the configuration and the record of all the files anda data processing and is used for synchronization of multiple pipeline requests.

AGILE: "very fast" Ground Segment

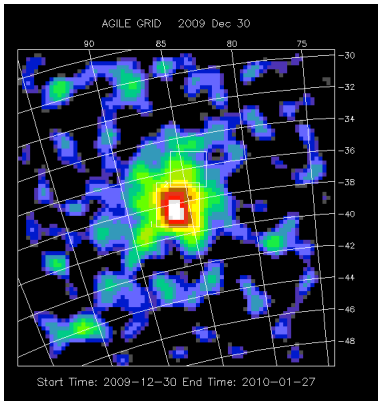


Since 2017 even faster: ~ 25 min latency. Optimized for GW counterpart hunt!

Record for a gamma-ray mission! AGILEScience App for mobile dev

Space Science Data Center

Easy on-line gamma-ray analysis: legacy archives and the AGILE-LV3 web tool

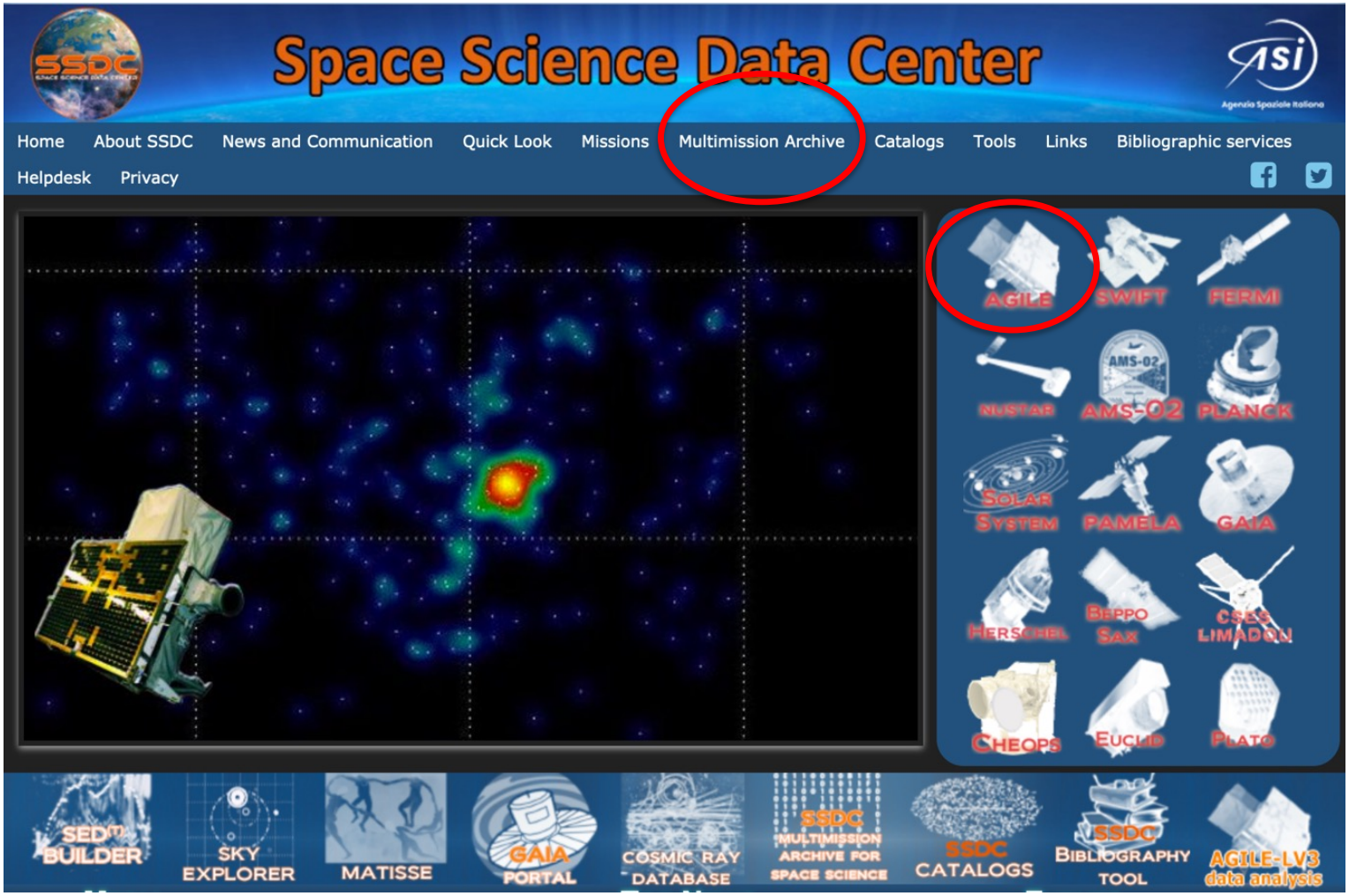


Do you have a favourite source or region in the sky and are you curious to know what is the AGILE gamma-ray satellite view of it during more than 13 years of observations? The AGILE-LV3 web tool does not require any locally installed SW or calibrations.

Tested also with students!

SSDC Science Gateway

Science Tools allow the on-line access to data within a multifrequency environment



On-line Access to Space Missions Data Archives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Mission Selected
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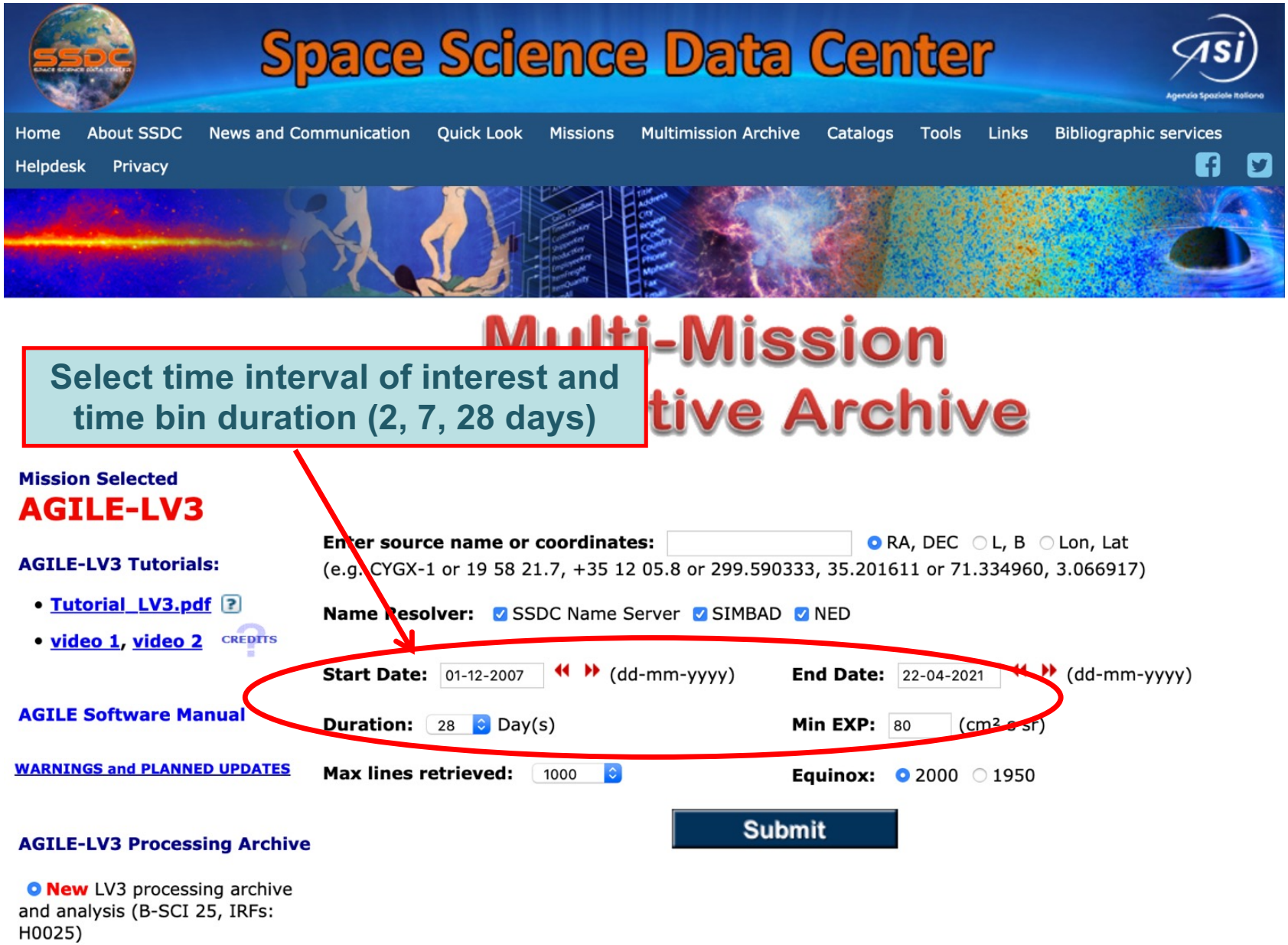
Tutorial_LV3.pdf
video 1, video 2
CREDITS
AGILE Software Manual
WARNINGS and PLANNED UPDATES
AGILE-LV3 Processing Archive
New LV3 processing archive and analysis (B-SCI 25, IRFs: H0025)
Enter source name or coordinates:
RA, DEC
L, B
Lon, Lat
(e.g. CYGX-1 or 19 58 21.7, +35 12 05.8 or 299.590333, 35.201611 or 71.334960, 3.066917)
Name Resolver:
SSDC Name Server
SIMBAD
NED
Start Date:
01-12-2007
(dd-mm-yyyy)
End Date:
22-04-2021
(dd-mm-yyyy)
Duration:
28
Day(s)
Min EXP:
80
(cm² s sr)
Max lines retrieved:
1000
Equinox:
2000
1950
Submit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Select time interval of interest and time bin duration (2, 7, 28 days)
Mission Selected
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Tutorial_LV3.pdf
video 1, video 2
CREDITS
AGILE Software Manual
WARNINGS and PLANNED UPDATES
AGILE-LV3 Processing Archive
New LV3 processing archive and analysis (B-SCI 25, IRFs: H0025)
Enter source name or coordinates:
RA, DEC
L, B
Lon, Lat
(e.g. CYGX-1 or 19 58 21.7, +35 12 05.8 or 299.590333, 35.201611 or 71.334960, 3.066917)
Name Resolver:
SSDC Name Server
SIMBAD
NED
Start Date:
01-12-2007
(dd-mm-yyyy)
End Date:
22-04-2021
(dd-mm-yyyy)
Duration:
28
Day(s)
Min EXP:
80
Max lines retrieved:
1000
Equinox:
2000
1950
Submit

QUERY INPUT:

- **Source name or sky coordinates** in your favorite sky coordinate system: **Equatorial, Galactic or Ecliptic.**

OUTPUT from the Database:

- All AGILE available observations of the source.
- **Light curve at a click of the mouse** with bins of the selected duration (28-day default).
- **Waiting time**: **from few seconds to few minutes** (depends on # of selected bins).

Added value toward easy space data exploitation

- Gamma-ray data analysis above 100 MeV is an **event by event analysis** that requires many steps (**no detector images**, but silicon strips signals activated by pair conversion of gamma-rays in the Si-tracker)

- The tool is a web interface for official interactive on-line Maximum Likelihood analysis on AGILE data with standard parameter values.

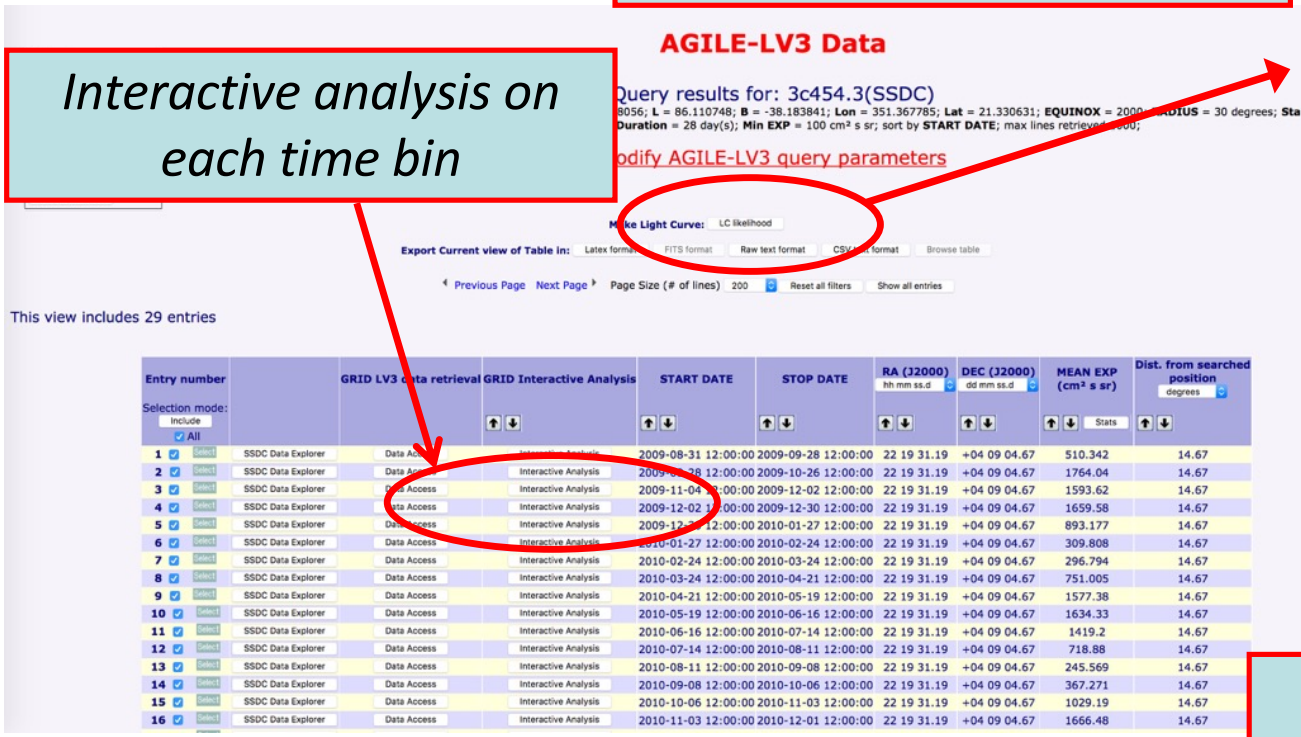
- The tool provides the estimate of flux and significance of a source in the selected period, taking into account all other known ɣ-ray sources in the region, the diffuse ɣ-ray background and other sources of background such as Earth albedo.

- The **AGILE-LV3 tool** analysis results can be easily inserted in the multi-mission SSDC spectral energy distribution (**SED**) Tool, and directly **compared with all data available from all other space missions**.

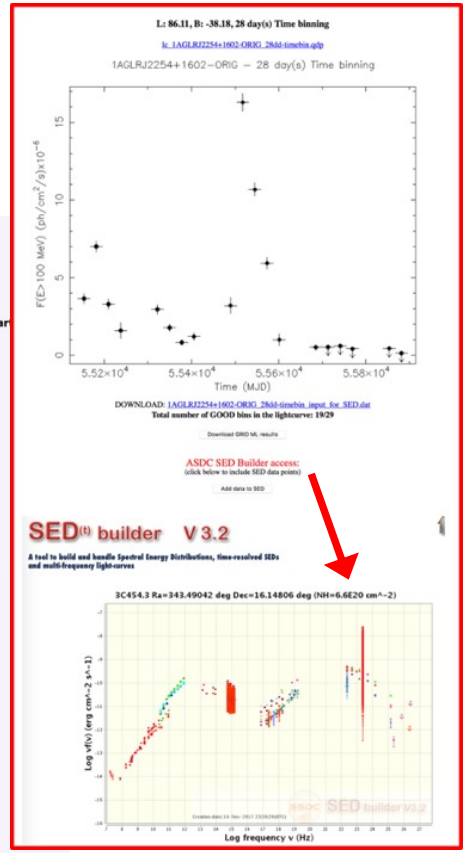
Space Science Data Center

Generate a gamma-ray lightcurve above 100 MeV

Interactive analysis on each time bin



Entry number		GRID LV3 data retrieval	GRID Interactive Analysis	START DATE	STOP DATE	RA (J2000) hh mm ss.d	DEC (J2000) dd mm ss.d	MEAN EXP (cm² s sr)	Dist. from searched position degrees
1	SSDC Data Explorer	Data Access	Interactive Analysis	2009-08-31 12:00:00	2009-09-28 12:00:00	22 19 31.19	+04 09 04.67	510.342	14.67
2	SSDC Data Explorer	Data Access	Interactive Analysis	2009-09-28 12:00:00	2009-10-26 12:00:00	22 19 31.19	+04 09 04.67	1764.04	14.67
3	SSDC Data Explorer	Data Access	Interactive Analysis	2009-11-04 12:00:00	2009-12-02 12:00:00	22 19 31.19	+04 09 04.67	1593.62	14.67
4	SSDC Data Explorer	Data Access	Interactive Analysis	2009-12-02 12:00:00	2009-12-30 12:00:00	22 19 31.19	+04 09 04.67	1659.58	14.67
5	SSDC Data Explorer	Data Access	Interactive Analysis	2009-12-30 12:00:00	2010-01-27 12:00:00	22 19 31.19	+04 09 04.67	893.177	14.67
6	SSDC Data Explorer	Data Access	Interactive Analysis	2010-01-27 12:00:00	2010-02-24 12:00:00	22 19 31.19	+04 09 04.67	309.808	14.67
7	SSDC Data Explorer	Data Access	Interactive Analysis	2010-02-24 12:00:00	2010-03-24 12:00:00	22 19 31.19	+04 09 04.67	296.794	14.67
8	SSDC Data Explorer	Data Access	Interactive Analysis	2010-03-24 12:00:00	2010-04-21 12:00:00	22 19 31.19	+04 09 04.67	751.005	14.67
9	SSDC Data Explorer	Data Access	Interactive Analysis	2010-04-21 12:00:00	2010-05-19 12:00:00	22 19 31.19	+04 09 04.67	1577.38	14.67
10	SSDC Data Explorer	Data Access	Interactive Analysis	2010-05-19 12:00:00	2010-06-16 12:00:00	22 19 31.19	+04 09 04.67	1634.33	14.67
11	SSDC Data Explorer	Data Access	Interactive Analysis	2010-06-16 12:00:00	2010-07-14 12:00:00	22 19 31.19	+04 09 04.67	1419.2	14.67
12	SSDC Data Explorer	Data Access	Interactive Analysis	2010-07-14 12:00:00	2010-08-11 12:00:00	22 19 31.19	+04 09 04.67	718.88	14.67
13	SSDC Data Explorer	Data Access	Interactive Analysis	2010-08-11 12:00:00	2010-09-08 12:00:00	22 19 31.19	+04 09 04.67	245.569	14.67
14	SSDC Data Explorer	Data Access	Interactive Analysis	2010-09-08 12:00:00	2010-10-06 12:00:00	22 19 31.19	+04 09 04.67	367.271	14.67
15	SSDC Data Explorer	Data Access	Interactive Analysis	2010-10-06 12:00:00	2010-11-03 12:00:00	22 19 31.19	+04 09 04.67	1029.19	14.67
16	SSDC Data Explorer	Data Access	Interactive Analysis	2010-11-03 12:00:00	2010-12-01 12:00:00	22 19 31.19	+04 09 04.67	1666.48	14.67



Multiwavelength Spectral Energy Distribution

THE AGILE LEGACY

AGILE archives and catalogs following VO standards and FAIR principles are available to the community through the ASI SSDC.

Science activities continue. All AGILE-GRID data **up to January 15, 2024 have been published. A data reprocessing is in progress.**

AGILE-LV3 online data analysis tool and /or open-source **Python software package Agilepy** (INAF-OAS) integrated with a dedicated **REST** data access system in SSDC. **SSDC future plan: deploy a multimission JupyterHub including Agilepy environment.**

With AGILE's re-entry, the in-orbit operational phase ended, but a new phase of scientific work on the satellite legacy data archive opens.

Work in progress on new catalogs with and without **Machine Learning** techniques. **Stay tuned for further results**.

Thank you AGILE!