

Summary of Data Management Principles

Fermi GST Large Area Telescope

Experiment description

The Fermi Gamma-ray Space Telescope (*Fermi*) is a satellite observatory in low Earth orbit, surveying the high-energy gamma-ray sky. The primary instrument on *Fermi* is the Large Area Telescope (LAT), which detects gamma rays of energies from 20 MeV to greater than 300 GeV. The LAT is a pair-conversion telescope with a precision charged-particle tracker (TKR) and hodoscopic calorimeter (CAL), each consisting of 16 modules in a 4×4 array, plus a segmented anticoincidence detector (ACD) around the tracker array, covered by thermal blankets and a micro-meteoroid protection shield, with a programmable trigger and data acquisition system and an active thermal control system. One of the key scientific objectives is to search for signals of dark matter and other new physics. *Fermi* was launched from Cape Canaveral Air Station in Florida in June 2008. The LAT began its science mission in August 2008 and has operated with excellent efficiency since then.

DOE's roles in the experiment

The DOE partnered with NASA and international institutions to construct the LAT at the SLAC National Accelerator Laboratory. The DOE supports the operation of the LAT through the LAT Instrument Science Operations Center (ISOC) located at the SLAC National Accelerator Laboratory. The DOE and partner institutions also support the international LAT scientific Collaboration. The ISOC supports both the *Fermi* mission and the LAT Collaboration, by supporting LAT operations, LAT data processing, hosting and archiving, and LAT data analysis, in conjunction with NASA and members of the LAT Collaboration.

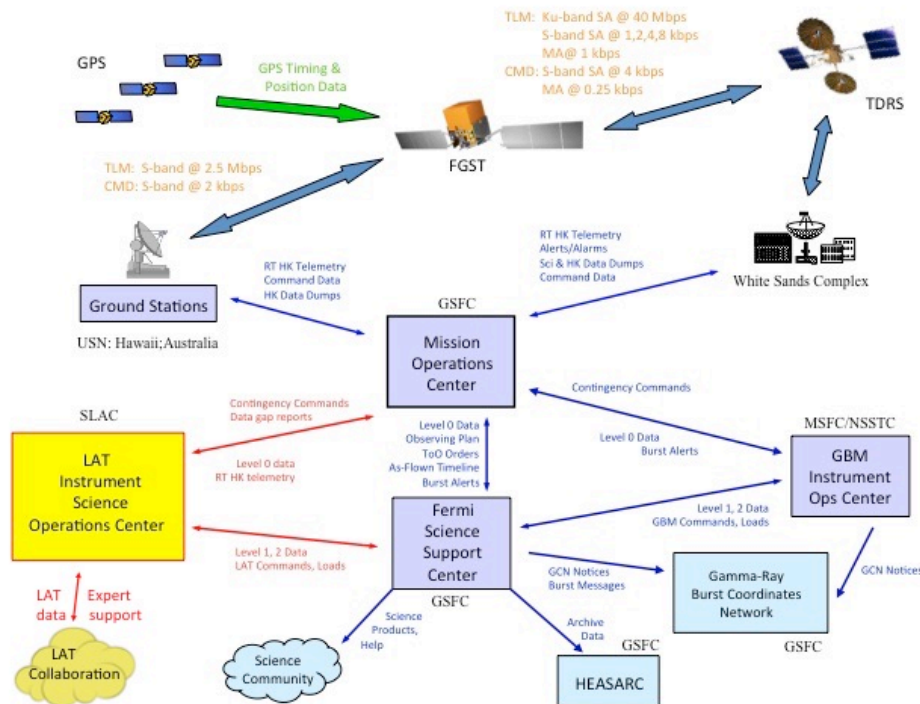
Partnerships

The US agencies supporting *Fermi* are NASA and the DOE. NASA is the lead agency for the *Fermi* mission and is responsible for the overall operation of *Fermi*. The DOE partners with NASA and international agencies to support the LAT on *Fermi*. NASA, DOE and international partner agencies in France, Italy, Japan and Sweden share some costs for the operation of the LAT and the ISOC and common scientific activities of the LAT Collaboration, through an International Finance Committee. By agreement between NASA, DOE and the international partner agencies, photon data from the LAT are made publicly available through NASA as soon as possible, while both photon and non-photon data from the LAT are available to the LAT Collaboration.

Organization – Agency/Lab level

NASA is the lead agency for the *Fermi* mission. The DOE partners with NASA and international agencies to support the LAT on *Fermi*. The lead laboratory for DOE's participation is the SLAC National Accelerator Laboratory.

Organization – Experiment level



The above figure shows the distributed activities in support of the *Fermi* mission. The overall *Fermi* mission is managed at NASA's Goddard Space Flight Center, with principal responsibilities assigned to the NASA Project Scientist (Dr. Elizabeth Hays), and Deputy Project Scientists (Dr. Judith Racusin, and Dr. David Thompson) and the NASA Mission Manager (Elizabeth Pumphrey). The Project Scientists coordinate closely with and are members of the LAT Collaboration. The principal interfaces of the ISOC are with the Mission Operations Center (MOC) and the Fermi Science Support Center (FSSC), both located at NASA's Goddard Space Flight Center (GSFC), and the LAT Collaboration. The MOC interfaces between the ISOC and the *Fermi* and LAT, and the FSSC is the interface to the broader scientific community using LAT data.

Collaboration

The Principal Investigator (PI) and Spokesperson for the LAT instrument and Collaboration is Prof. Peter Michelson of Stanford University. The research work of the Collaboration is organized into eight science groups which are overseen by an annually appointed Analysis Coordinator and Deputy Coordinator, selected from within the Collaboration. A Senior Scientist Advisory Committee controls the LAT Collaboration membership and sets Collaboration policies. The Collaboration membership policy allows for full and affiliated members, plus postdoctoral members, student members and technical/administrative members. The Collaboration has about 400 scientific members from more than 100 institutions in more than 20 countries, and includes around 100 affiliated scientists, around 100 postdoc members, and around 100 graduate students. Policy documents for the LAT Collaboration are available at <https://glast.sites.stanford.edu/> which is the home webpage for the LAT Collaboration.

Data policy management

The data management policy for the *Fermi* mission is documented and managed in a Project Data Management Plan (PDMP). The PDMP was prepared and is maintained by the FSSC at NASA, with concurrence by the NASA Program Scientist for *Fermi* and approval by the Fermi Project Scientist and the NASA Project Manager and/or Mission Manager, the instrument Principal Investigators, and the mission operations and data archive directors. The PDMP is publicly available from NASA at the FSSC, at <http://fermi.gsfc.nasa.gov/ssc/library/support/>. Other documents for the *Fermi* mission relevant to the PDMP also publicly available at this website include the Science Data Products Interface Control Document and the Science Data Products File Format Document.

Data Description & Processing

The LAT collects data continuously; data are stored temporarily on the spacecraft between high-speed downlinks to the ground, occurring about 15 times per day. The raw data are received at NASA's MOC where LAT Level 0 (L0) data are extracted and transferred to the ISOC at SLAC. The L0 data are archived at SLAC and automatically processed through event reconstruction and event classification and class filtering, to produce Level 1 (L1) data. The L1 data are segmented into datasets corresponding to single orbits of *Fermi* around the Earth. All of the L1 data are stored at SLAC for access by the LAT Collaboration. Automated Level 2 (L2) data processing is performed on L1 data at the ISOC and the resultant products delivered to the FSSC daily. Level 3 (L3) data are catalogs of detected gamma-ray sources produced by the LAT Collaboration, released in published papers and archived at the FSSC.

Data Products and Releases

LAT photon data in L1 format are transmitted from SLAC to the FSSC for immediate public release, about 15 times per day, typically a few hours after being detected by the LAT. The LAT L1 data for the entire science mission are infrequently reprocessed and re-released through the FSSC, when the LAT Collaboration produces major improvements to event reconstruction and/or classification for L1 processing. Public re-releases of LAT L1 photon data through the FSSC have occurred in August 2011 (Pass 7 L1 data), November 2013 (Pass 7R L1 data), June 2015 (Pass 8 L1 data), and November 2018 (Pass 8R3 L1 data). Automated L2 data products, which are lightcurves, having time binning on daily and weekly timescales, of known bright variable celestial sources, and also measurements of detected celestial transient sources, are generated and delivered daily by the ISOC to the FSSC for immediate public release. LAT low energy (LLE) data at energies below 100 MeV are also delivered to the FSSC for every gamma-ray burst and solar flare transient source detected by the LAT. Other LAT data products are also related to transient sources: GCN Notices of gamma-ray burst sources, distributed on the internet within seconds of detection by the LAT; GCN Circulars with refined information on detected gamma-ray burst sources, released within hours of detection by the LAT; Astronomer Telegrams for bright flaring gamma-ray sources, typically released within 1-2 days of the flaring event. The Fermi-LAT Collaboration also produces GCN Circulars for searches for gamma-ray transient counterparts to gravitational wave merger events detected by the LIGO/Virgo gravitational wave experiments and announced through LVC notices released by GCN.

Plan for Serving Data to the Collaboration and Community

All LAT L0 and L1 data (both photon and non-photon) are available to the LAT Collaboration through the ISOC at SLAC. All LAT photon L1 data and automated L2 data and an associated software suite of analysis tools are publicly available at the FSSC. Also available at the FSSC are L3 data such as the major gamma-ray source catalogs produced by the LAT Collaboration. The LAT L1 data and analysis tools are formatted and built to NASA's HEASoft specification, consistent with NASA's Office of Guest Investigators Program (OGIP) standards.

Plan for Archiving Data

Raw and L0 data from *Fermi* are digitally archived in the NASA High Energy Astrophysics Science Archive Research Center (HEASARC). All LAT photon L1, L2 and L3 data and the associated software suite of analysis tools will be digitally archived and publicly available at the HEASARC, <https://heasarc.gsfc.nasa.gov/>, for an indefinite period after the *Fermi* mission ends.

Plan for Making Data Used in Publications Available

The policy of the LAT Collaboration is to make available, on a website in a machine readable form, supplemental data for published papers, such as data points for tables and figures. The Collaboration website for such data is https://www-glast.stanford.edu/pub_data/.

Responsiveness to SC Statement on Digital Data Management

This data management plan fully follows the Department of Energy (DOE) Office of Science (SC) Statement on Digital Data Management.