

National Aeronautics and
Space Administration



Time-Domain and Multi-Messenger Astronomy Update

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Upcoming TDAMM missions

- Compton Spectrometer and Imager (COSI) Launch Readiness Date (LRD) August 2027
- NEO Surveyor – TDAMM aspect of Planetary IR mission LRD NET June 2028
- NASA Participation in Israeli Space Agency's ULTRASAT LRD June 2026
- Downselect of Explorers in 2024: Star-X and UVEX (Mid-EX) with a targeted launch of FY '29, MoonBeam and LEAP (MoO) targeted launch of FY '28
- Pioneers: StarBurst LRD 2026, PUEO 2024, TIGERISS 2026
- SmallSats & ISS: GlowBug launched to ISS 3/15/23, BurstCube early 2024, BlackCat LRD 2024.
- Roman – Julie McEnery update
- LISA – NASA contribution to ESA mission
- APRA: suborbitals such as AdAPT & technology development

Infrastructure

- Operating missions: Ongoing study of the possibility optimizing the NASA fleet for TDAMM through centralized planning, proposal submission, Target-of-opportunity initiation, and science-driven coordination of observations
- HQ studying future of Space Communications as TDRSS is replaced by commercial solution
 - Impact agency-wide - TDAMM is a science driver, particularly of Demand Access Service (DAS)
- HQ directed funding for 2 NASA center-based TDAMM projects:
 - Upgrade of General Coordinates Network (GCN) at GSFC
 - Development of multi-mission design & analysis tools at MSFC

TDAMM GOF Motivation, Study Deliverables and Mission

(Brian Humensky & Chris Roberts from PhysCOS PO)

“answering the science questions of the next decade requires a multi-wavelength and multi-messenger approach [and] the synergy of space, ground and even underground facilities.” (Astro 2020, 2-47)

In October 2020, the Physics of the Cosmos Program embarked on a study to consider the organizational, programmatic and technical aspects of implementing a TDAMM General Observer Facility (GOF).

The study shall deliver a report and supporting materials with the following content:

1. A set of top-level requirements and architecture concept models for a TDAMM GOF.
2. Processes for TDAMM community engagement, proposal solicitations and award management.
3. A motivating set of TDAMM science cases and an analysis of the associated agreements, tools, process flows and interfaces necessary to support those cases.
4. One or more implementation strategies for the Phase 1 TDAMM GOF to achieve an initial operating capability by FY26.
5. A best-value recommendation for a particular implementation strategy if more than one option is evaluated.

The mission of the TDAMM GOF is to foster “all of astrophysics” science cases using complex time-sensitive observations beyond the capabilities of any individual observatory or mission team.

TDAMM General Observer Facility Study Activities

The study team is engaging stakeholders throughout the science lifecycle, seeking to identify opportunities where enhanced coordination would improve efficiency or TDAMM scientific outcomes.

Strategic Coordination	Tactical Coordination	Operational Coordination	Archival Coordination
Timescale: 1+ Years	Timescale: Hours-Months	Timescale: Seconds-Hours	Timescale: Permanent
<ul style="list-style-type: none"> Establish & sustain a TDAMM Call for Proposals Engage PhysPAG/SIG/SAGs to identify and validate science cases and follow-up observation needs. Establish & sustain a common architecture for coordinated space-based follow-up operations. Advise new missions about TDAMM Astrophysics Enterprise interfaces and best practices. Support Senior Review Board, Decadal and other strategic planning activities. 	<ul style="list-style-type: none"> Survey the existing coordination fora and agreements among missions. Survey the set of tools used by General Observers to construct TOO requests and to predict observing parameters. Investigate tactical mission science planning processes. Develop and document the information flows, activities, and interfaces needed to improve tactical multi-mission coordination. 	<ul style="list-style-type: none"> Investigate and document the information flows, activities, and interfaces between astrophysical alert systems (e.g., GCN) and individual mission Flight, Science and Mission Operations Centers. Identify science and mission state, status, and constraint parameters that would be needed for tactical multi-mission coordination. 	<ul style="list-style-type: none"> Investigate whether current archives allow sufficient metadata tagging and discovery of datasets associated with a TDAMM science proposal. Assess whether spatial and temporal search parameters and visualizations are adequate for TDAMM archival research.

Study design includes:

- Review of the literature, regular interchanges with subject matter experts, weekly meetings with the study advisory group, site visits to science & mission operations centers, presentations to HQ.
- A mission questionnaire was recently sent out to NASA mission leads.
- A pilot for TDAMM GOF cross-mission coordination activities and technical coordination mechanisms is under consideration for the L/V/K O4 run, approximately May 2023-Nov 2024.

General Coordinates Network (GCN)

(from Judy Racusin, GCN ISFM lead)

Modernizing NASA's transient alert broker - serving the astronomical community since 1992

GCN serves as TDAMM infrastructure distributing transient alerts to the astronomical community from space-based missions (NASA, non-NASA) and ground-based observatories including the gravitational wave network and neutrino observatories.

New Web Portal: <https://gcn.nasa.gov>

The screenshot shows the GCN web portal. The main heading is "The new GCN: Multimessenger astronomy alerts delivered over Kafka". Below this, there is a diagram illustrating the network's infrastructure, including space-based missions (Large Missions, Medium Missions, Small Sat, CubeSats) and ground-based observatories (Gravitational Wave Interferometers, Ground-based Telescopes, Chandra X-ray Observatory, Neutrino Detectors). The diagram shows data streams from these sources converging on a central globe labeled "General Coordinates Network (GCN)".

Below the diagram, there is a section titled "The new GCN" with three options for streaming notices in real time:

- For legacy applications: **GCN Classic**
- Recommended: **GCN Classic over Kafka**
- Coming soon: **GCN Kafka**

The date 3/27/23 is displayed in the bottom left corner.

GCN Notices – machine readable alert messages with fixed schema

- Now streaming via Kafka data streaming protocol
- Self-managed subscriptions to receive alerts via email
- Beginning to onboard new notice types in new system

GCN Circulars – human-written observation reports

- Complete overhaul of backend and frontend coming soon
- Self-managed subscriptions
- New submitters approved via peer endorsement
- Web form for submitting
- New searchable archive

The new GCN

- operates in the cloud with high reliability and uptime
- is open source on <https://github.com/nasa-gcn>
- has many enhancements and new features in development

Multi-messenger Astrophysics Community Tools and Support

(from Colleen Wilson-Hodge, MSFC)

Objectives: 1) develop standard software toolkits for gamma-ray missions, 2) develop multi-mission subthreshold search tools, and 3) modernize interplanetary network localization

Progress: Plan for software release established

Plan for unit testing and documentation is based on predecessor software development

Standard software toolkit development

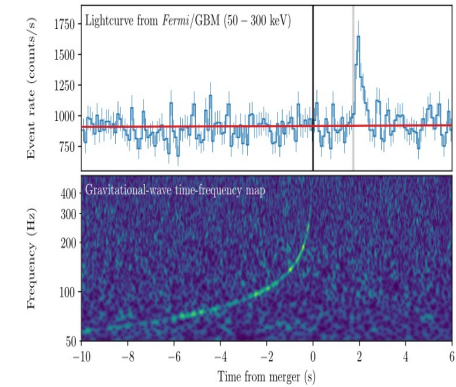
Expand the GBM data tools for us with other gamma-ray missions with release of new Gamma-ray Data Tools

Initial release only supports GBM. More missions soon.

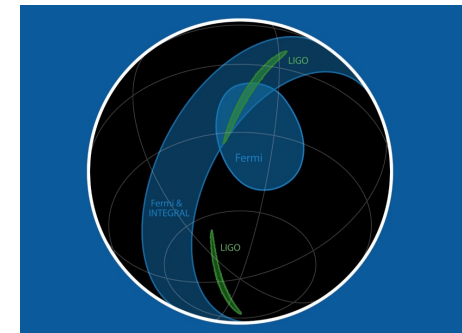
Subthreshold search – Generalization for public release underway

IPN modernization – engaged with the GTN SAG to determine community priorities & development underway

TDAMM application – these tools will serve many smallsat/cubesat teams and broaden the access to their results for the community, increasing the number of potential joint gamma-ray/gravitational wave events



GRB 170817A gamma-ray and gravitational wave signals



Interplanetary Network Localization for GRB 170817A

International & Interagency

- Splinter meeting involving 9 space agency leads held last August
- 2nd splinter held last week welcoming 2 more space agencies + NSF (Phys & Ast)
- Discussion on possibilities for collaboration quickly homed in on the need for coordination, standards, data access, other infrastructure issues.
 - We agreed that further discussion on these issues was desirable
 - One or more working groups to be established to advance in these areas

Community

- PhysCOS sponsored 2022 TDAMM workshop in Annapolis MD
 - TDAMM White Paper produced by Scientific Organizing Committee of Annapolis meeting and workshop participants, and presented at scientific meetings:
https://pcos.gsfc.nasa.gov/TDAMM/docs/TDAMM_Report.pdf
- Physics of the Cosmos Program Analysis Group (PhysPAG):
 - New Science Interest Group (SIG) on TDAMM being spun up – HEAD splinter session 3/26/23 - cross-PAG interest
 - New Science Analysis Groups (SAGS) on 2 TDAMM-related issues:
 - The future of Gamma-Ray Transient Networks – kickoff January 2023:
<https://pcos.gsfc.nasa.gov/sags/gtnsag/gtn-sag.php>
 - TDAMM Science Drivers for next-generation (post-TDRSS) Space Communications (presented here).

The TDAMM White Paper – Next Steps?

- The TDAMM White Paper describes open science questions for NASA space missions –next steps may prompt a TDAMM SAG within the new TDAMM SIG:
 - The scope of the science questions is vast
 - What capabilities (wavelength, measurement, sensitivity, field-of-view) are needed to address each one?
 - What are the science gaps to close before defining the needed capabilities (e.g., theory, analysis, lab astro)
 - What non-NASA partner observations (if any) are needed?

Backup

