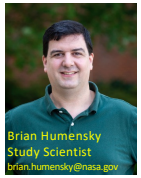
ACROSS: Supporting Time Domain and Multi-Messenger Astrophysics





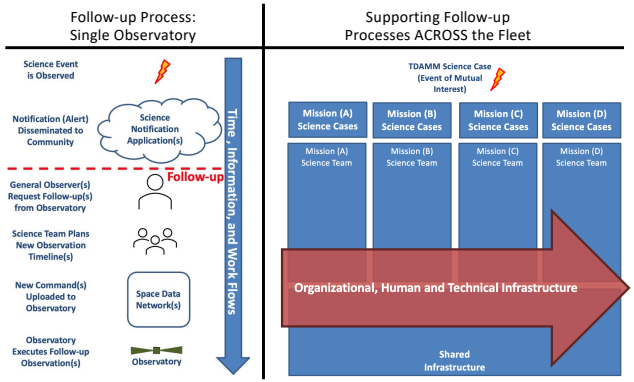
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The Astro2020 Decadal Survey recommended an investment in **Time Domain and Multi-Messenger Astrophysics (TDAMM)** as the top-priority sustaining activity in space for the coming decade. One aspect of NASA's response to this recommendation is a study, led by the Physics of the Cosmos Program Office, of how a structure akin to a General Observer Facility might be implemented that would provide support to both missions and observers as they pursue TDAMM science. Here, we present some initial observations of needs in the community, and potential concepts for such an entity. We invite discussion with both missions and observers to better understand their needs and concerns.

ACROSS Pilot Phase

- ❑ Two-year pilot phase (2024-25) emphasizing development of cross-observatory science-support ops concepts, tools, and infrastructure to facilitate follow-up observations.
- ❑ Implemented as **Astrophysics Cross-Observatory Science Support (ACROSS)** Initiative.
- ❑ Targeting capabilities to support observers and observatory (mission) science teams.
- ❑ Developing a TDAMM-focused solicitation, targeting first call for proposals in 2026.



Coordinated Observing Campaigns

- ❑ Why are coordinated observations hard?
  - ➢ Few missions see the full sky; every mission has unique constraints.
  - ➢ Observation planning cycles for different missions vary greatly.
  - ➢ "Visibility" vs "Schedulablity": The latter is a more complete description of the possibility of scheduling a coordinated target.
  - ➢ Campaigns require ground and space coordination.
- ❑ ACROSS will provide both tools and expertise for coordinating large campaigns, e.g.:
  - ➢ Slack for dedicated discussion of high-priority events and potential need for follow-up observations.



Cross-Mission Science Feasibility Tools

- ❑ Development of APIs, Calculators, Databases and Queries.
- ❑ Pointed X-Ray Missions: Swift, NICER, NuSTAR, and IXPE.
  - ➢ Target Visibility and Observability.
  - ➢ Mission Science Planning and Scheduling Feasibility.
  - ➢ Target History.
  - ➢ Long- and short-term plans for observatories.
- ❑ For monitoring missions (e.g., Fermi), determine whether an event of interest was:
  - ➢ Coincidentally detected.
  - ➢ Last observed/within the instrument field of view.
  - ➢ When it will next be observed/within the instrument field of view.

Community Support

- ❑ Joint analysis tutorials and training sessions at the next TDAMM Workshop, anticipated Fall 2024.
- ❑ Planned: Helpdesk – let us help you coordinate "ACROSS" multiple observatories.

Mission / Multi-mission ToO Pages

- ❑ Provide a customizable toolkit for Mission ToO Pages:
  - ➢ Support existing missions who would find it useful.
  - ➢ Support in-development missions, especially SmallSats / CubeSats.
  - ➢ Provide API access for ToO submission, to allow for automatic submission, e.g. from GRB Missions / LIGO / Rubin Transient Brokers.
- ❑ Incorporate "Smart" features into toolkit over time:
  - ➢ Leverage APIs, Calculators, Databases and Queries to build single or multi-mission ToO requests.
  - ➢ To the extent practical, expose observation feasibility to user as they are building request.

Time Domain / Multi-Messenger Web Portal

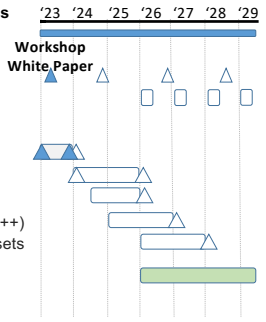
- ❑ Capability summaries for missions / observatories contributing to time domain and multi-messenger astrophysics, initially for Swift, NICER, NuSTAR, IXPE and Fermi.
- ❑ Links to Target of Opportunity submission pages.
- ❑ Links to NASA or community-led tools useful for reporting, planning observations, analyzing data.
- ❑ Links to funding opportunities and relevant conferences / workshops.
- ❑ Events of Interest pages:
  - ➢ Static, curated by humans, updated quarterly.
  - ➢ Dynamic: near-term observing plans and recent observation history for popular ToOs.
    - ➢ For example, most popular events/sources ranked by # of ToO requests (start with Swift, add others as able).

https://asd.gsfc.nasa.gov/multimessenger

TDAMM RA Development Targeting 2026 Call

- ❑ TDAMM Research Announcement (RA) development targeting a call in 2026 – several paths under exploration:
  - ➢ An RA targeted specifically at development of tools or observing modes that will enable new science cases.
  - ➢ An opportunity for funding of DDT observations made by non-flagship missions, like those provided by the flagships in response to DDTs.
  - ➢ An RA designed to fill the gaps between existing mission calls and remove the risk of double jeopardy by explicitly supporting observing programs that require coordination between two or more observatories.

Timeline



- ❑ **Science Planning and Process**
  - ➢ PhysPAG/TDAMM SIG Coordination
  - ➢ TDAMM Workshops
  - ➢ Annual Call for Proposals
- ❑ **System Development**
  - ➢ Initial Study Phase
    - ○ Pilot for NASA assets
    - ○ Phase 1: NASA Assets
    - ○ Phase 2 US Assets (NSF++)
    - ○ Phase 3 International Assets
- ❑ **Operations**
  - ➢ Capability Sustainment & Continuous Improvement

Feedback Welcome

ACROSS CAN ONLY SUCCEED WITH YOUR SUPPORT! We are eager to discuss with missions/observatories and observers where barriers to time-domain and multi-messenger science are, your suggested solutions, and your feedback. **Reach out to Brian Humensky (brian.humensky@nasa.gov), Chris Roberts (christopher.j.roberts@nasa.gov), or any of the team members mentioned above.**