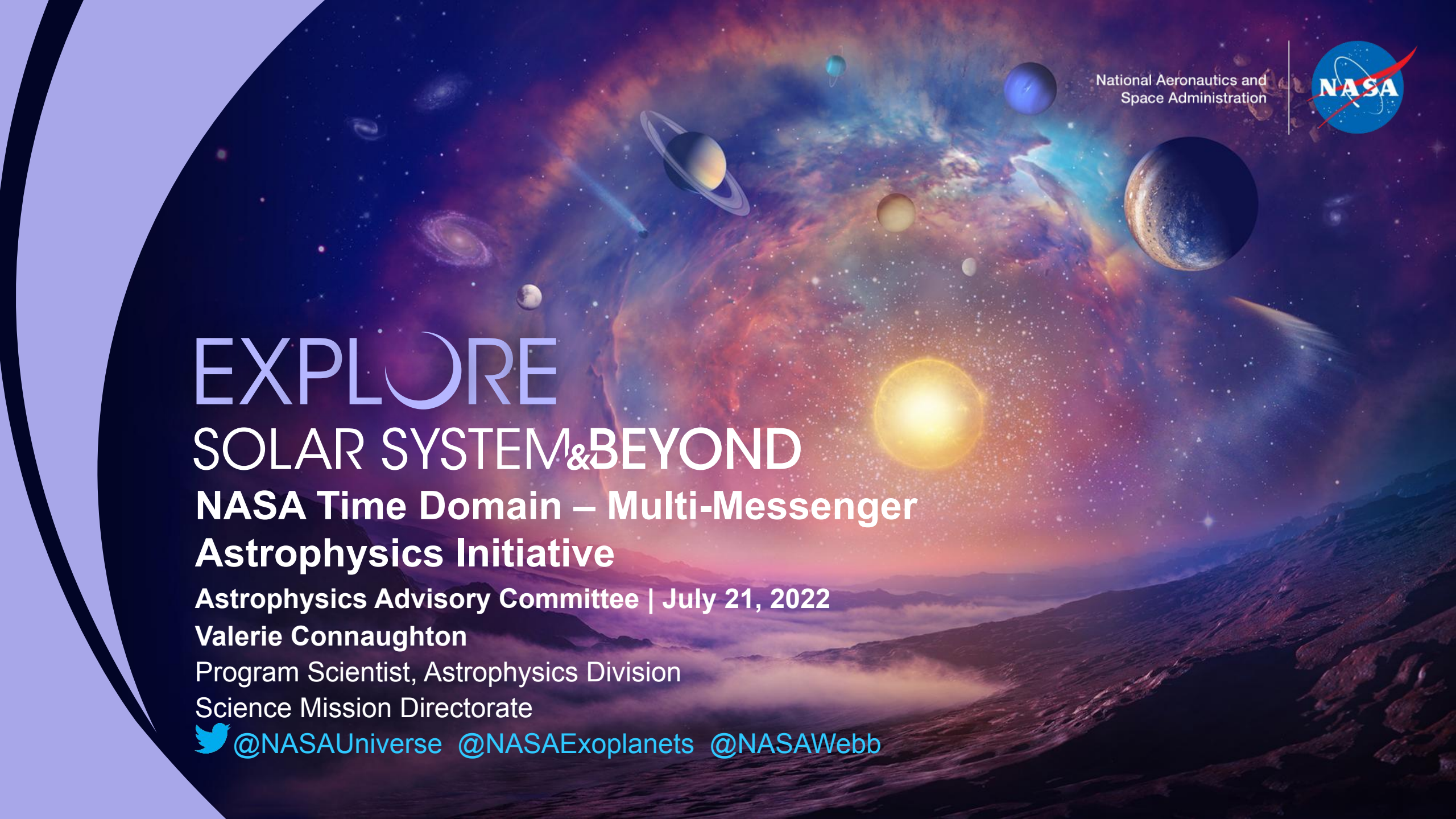

NASA Time Domain – Multi-Messenger Astrophysics Initiative

Astrophysics Advisory Committee | July 21, 2022

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APAC Recommendations from March 2022

Recommendation (TDAMM)	**Response**
The APAC advises APD to consider the merits of establishing a Time Domain and Multi-Messenger Astrophysics (TDAMM) sub-committee of the APAC and develop a draft TOR for the committee's consideration at its 2022 fall meeting.	See Valerie Connaughton's "Time Domain and Multi-Messenger Astronomy" presentation on Day 2 of this meeting.

Guiding Documents

- TDAMM in Astro2020 in 7.19 and scattered throughout report. Synopsis:
  - TDAMM has high scientific value for NASA – ahead of the Probes in priority
  - Work horses (Swift and Fermi) are old and sustaining facilities such as these are needed for TDAMM
  - NASA should be advised of high space-based priorities for TDAMM by a committee that considers the upcoming status of ground and international facilities
  - Future Great Observatories play important role in TDAMM that should be considered in design (ability to plan / repoint on useful timescales).
- Senior Reviews of Operating Missions 2019, 2022 e.g., from 2019: "In an era where both time domain astronomy and multi-messenger astronomy are becoming increasingly important, with several missions (XMM-Newton, Swift, NICER) playing complementary, although broadly similar, roles in providing soft X-ray coverage for NASA science priorities, the RoM panel encourages the XMM-Newton GOF to seek ways to educate its user base as to when XMM-Newton is the best instrument to employ in such studies, and to provide advice as to when a different mission, e.g., NICER, might be a more suitable choice. The panel recognizes that each of these missions has unique capabilities and wishes to encourage discussion among these mission teams as how to maximize science output from the mission portfolio viewed as a whole."
- Gravitational-Wave Electromagnetic counterpart Task Force report of 2019. Findings regarding coordination of space telescopes, ToOs, transient alerts, archives, funding opportunities, recognition for ECRs, needed space-based capabilities (largely echoed in Astro2020).

NASA Time Domain & Multi Messenger (TDAMM) Mission Portfolio

Wide-field monitors
Follow-up including Late / Deep
Non-photon messengers
Other Time Domain Assets

Operating Missions

- Hubble
- Chandra
- Gehrels Swift
- Fermi
- CALET (w/ JAXA)
- AMS (DOE mission)
- NICER
- NUSTAR
- TESS
- JWST
- Keck
- IRTF

Missions in Development

- BurstCube (cubesat)
- BlackCat (cubesat)
- Glowbug (ISS)
- PUEO (balloon payload)
- StarBurst (Pioneer)
- ULTRASAT (w/ ISA)
- COSI (SMEX)
- Roman
- LISA (w/ ESA)
- XRISM (w/ JAXA)

Future Missions under study or being proposed

- THESEUS (w/ ESA)
- AstroGam (w/ ESA)
- Proposed Pioneer
- Proposed Mission of Opportunity
- Proposed MIDEX
- Future Probe

TDAMM pervades NASA Astronomy

- If much of NASA astronomy could be viewed as Time-Domain Astronomy, what should NASA's considerations be in prioritizing TDAMM according to Astro2020?

  - **Coordination.** Recognizing and working within the interagency and international landscape
    - Priority and sequence of missions addressing needed capabilities
    - Timing (and duration) of missions
  - **Sustaining.** Keeping necessary capabilities in space to enable TDAMM for all
    - Workhorses as well as new capabilities
  - **Prioritizing.** Launching new telescopes in the context of TDAMM as a whole rather than viewing them as independent missions
    - Astro2020 recommends a TDAMM program on top of existing Explorer program – difficult in current funding landscape.
      - International partnerships and Pioneer program can help.
  - **Foundations.** Maintaining or developing the infrastructure to maximize TDAMM science (next slide)

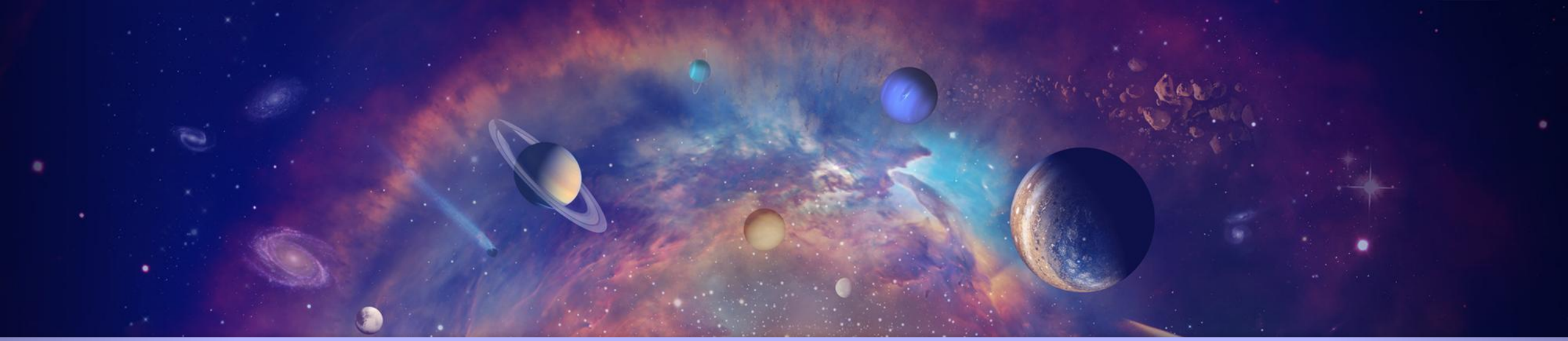
TDAMM Infrastructure

Infrastructure	Needed for TDAMM initiative
Transient Alerts	• Current NASA system (GCN) dates to 1990s • GSFC Transient Alert Coordination Hub (TACH) active in upgrading since 2018 • TACH and collaborators will update GCN for the Rubin era – Directed by HQ and coordinated with NSF and community
Archives and software	• SMD Science Platform to make NASA archives interoperable • Interagency interoperability recommended in Astro 2020 • Software development for multi-mission analysis – funding, hosting
Coordinated TDAMM observations among NASA missions	• Existing and future NASA Space assets deployed more efficiently for TDAMM – '23 study for centralized TDAMM GI program • Blue skies: this includes non-NASA assets in future
Space Communications	• TDRSS gracefully dying – NASA's commercial solution to be responsive to TDAMM needs • Inter-satellite communications desirable
Proposal opportunities	• How well do current NASA programs support TDAMM researchers?
Interagency coordination	• Both infrastructure and assets (space and ground) to be coordinated across agencies – NSF / NASA Program Officer group – need community working groups too.

Community input vital!
See Grant Tremblay's PhysPAG presentation earlier today for ToR of first TDAMM SAG. Others in the works!

Path to an Advisory Committee

- TDAMM is broad: what are the priorities NASA should help address in space? Community workshop: https://pcos.gsfc.nasa.gov/TDAMM/ August 22– 24 in Annapolis.
  - White Paper with identified science priorities to be produced by SOC in Fall ’22
  - Potential international partners to be invited to discuss models for collaborating
- Advisory Committee to be formed following workshop to prioritize the capabilities needed to address the scientific priorities identified in the White Paper.
  - Committee should consider ground-based TDAMM facilities and their schedules
  - Committee needs to view TDAMM in international context
  - Because TDAMM is broad, interagency. and international, an inclusive committee may be large and unwieldy.
    - One focusing on the highest priorities in the White Paper would need to be refreshed once its work is done.
    - Recruit expertise based on priorities in WP and have limited terms with a product to advise NASA and then reform the committee with new priorities?
    - Is this best done by an APAC Sub-Committee?



BACKUP

Time Domain & Multi-Messenger Initiative

Actions are being developed to address Time Domain Astrophysics and Multi Messenger (TDAMM) recommendations of the 2020 Decadal Survey

- Operating NASA missions continue to make significant contributions to TDAMM and NASA expects future missions to pursue this science:
  - NASA is making investments in infrastructure – transient alerts, data archives, communications, software – which are essential to maximize scientific return; funding for these investments is included in the FY23 budget request.
  - Responding to transient astrophysical phenomena involves multiple ground- and space-based assets and NASA is studying efficiencies in how to deploy its fleet
  - Astro 2020 urges TDAMM be addressed across agencies and NASA is standing up interagency and international working groups to address this coordination
- TDAMM will be an initiative with extensive interagency and international cooperation, shaped using broad community input
  - Prioritizing the science NASA should address. Community workshop this 22-24 August 2022: https://pcos.gsfc.nasa.gov/TDAMM/
  - Partner-led TDAMM missions with NASA contributions
  - NASA missions with international partner contributions