

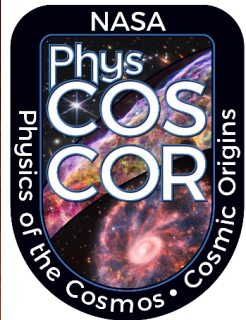
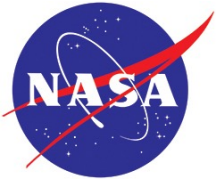
ACROSS

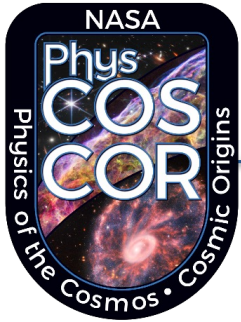
ENABLING TIME DOMAIN AND MULTI-MESSENGER ASTROPHYSICS

Brian Humensky, Physics of the Cosmos Chief Scientist
Jamie Kennea (Penn State), ACROSS Lead Scientist
Chris Roberts, TDAMM Study/ACROSS Manager

Core Team:

- Dan Kocevski, Michelle Hui (Marshall)
- Tom Barclay, Christina Hedges, Tyler Pritchard, Kirill Vorobyev, Samuel Wyatt (Goddard)



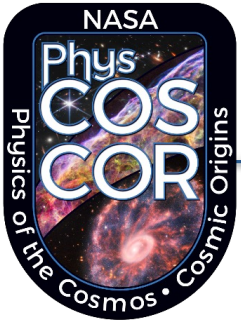


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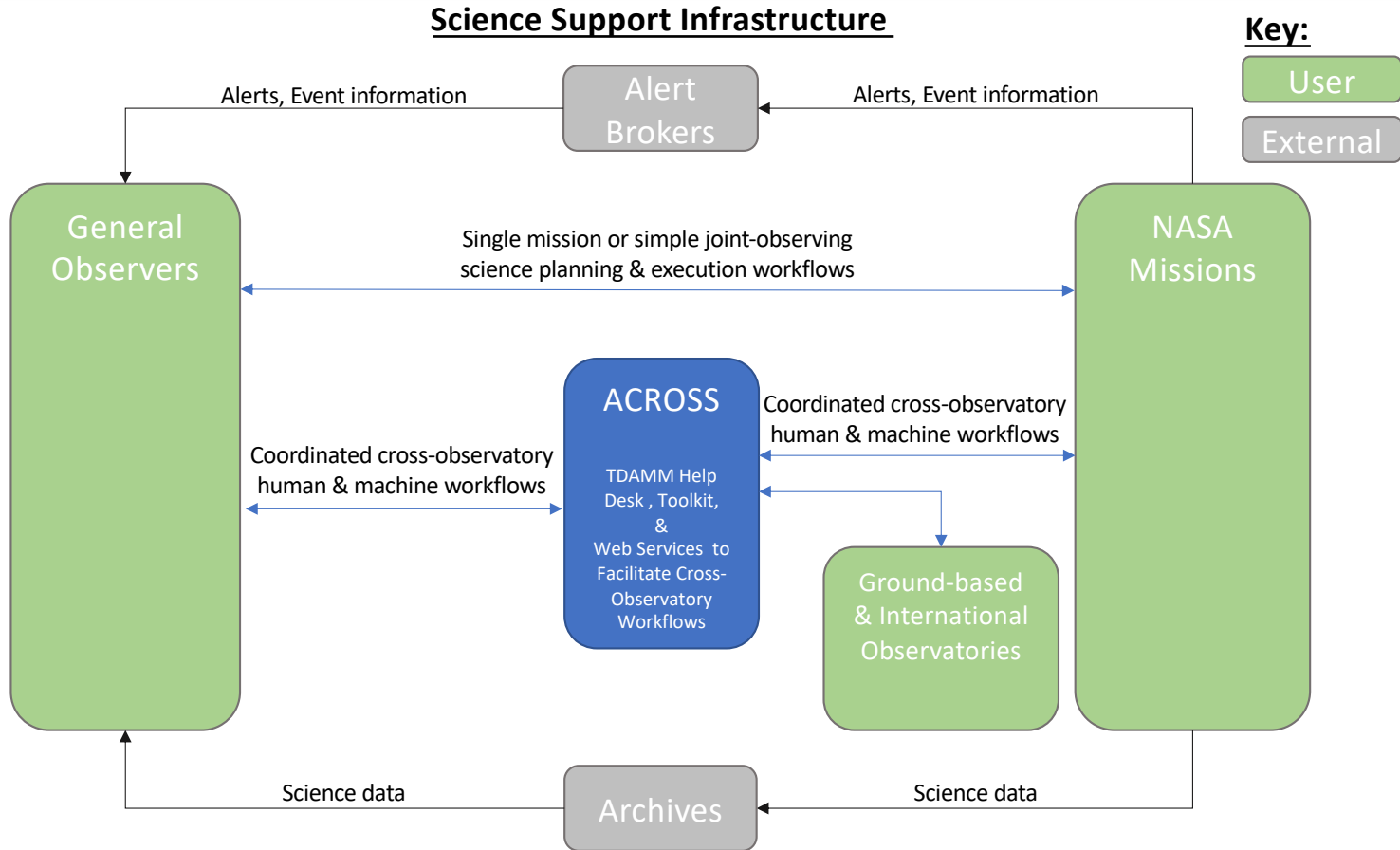


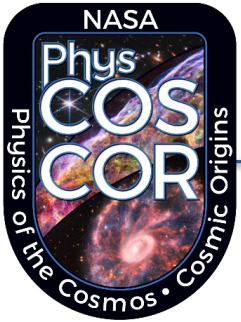
- **The PhysCOS Time-Domain and Multi-Messenger (TDAMM) Initiative responds to a top priority of the Astro2020 decadal report recommendation and has been tasked with:**
 1. Organizing or supporting **TDAMM workshops**,
 2. Conducting a three-year **TDAMM Study** investigating policy, processes and technical coordination mechanisms to enable TDAMM science, and
 3. Recommending one or more potential implementations for enabling TDAMM science support.

- **The Astrophysics Cross-Observatory Science Support (ACROSS) pilot project is an outcome of the first year of the TDAMM study, which identified needs for:**
 1. Software & data systems to facilitate TDAMM science workflows,
 2. TDAMM help desk to provide expertise & facilitate coordination, and
 3. TDAMM community grant program to incentivize scientific innovation.



High-Level Architecture: Future-State Context Diagram





High-Level Architecture: Future State Context Diagram



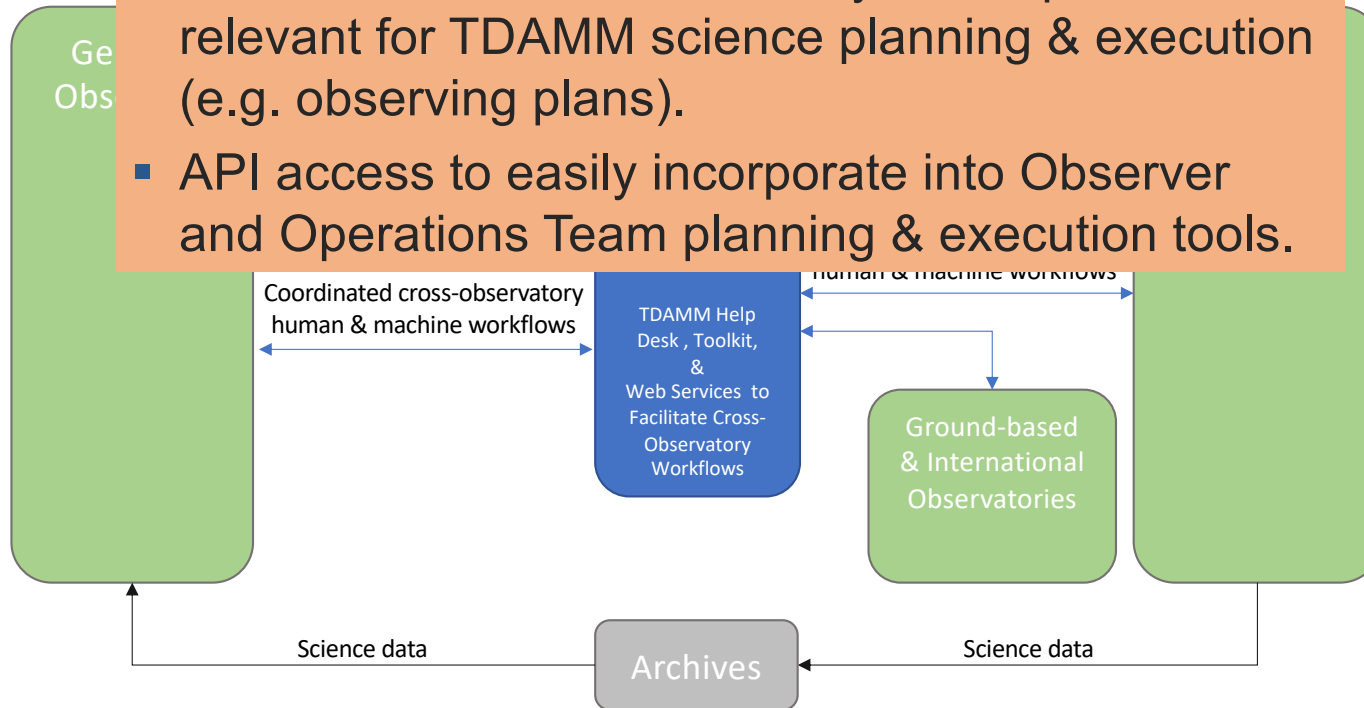
Science Support Infrastructure

Key:

- User (green box)
- External (grey box)

Observatory Workflow Status Data Feeds

- Live feed of NASA observatory status parameters relevant for TDAMM science planning & execution (e.g. observing plans).
- API access to easily incorporate into Observer and Operations Team planning & execution tools.





High-Level Architecture: Future State Context Diagram

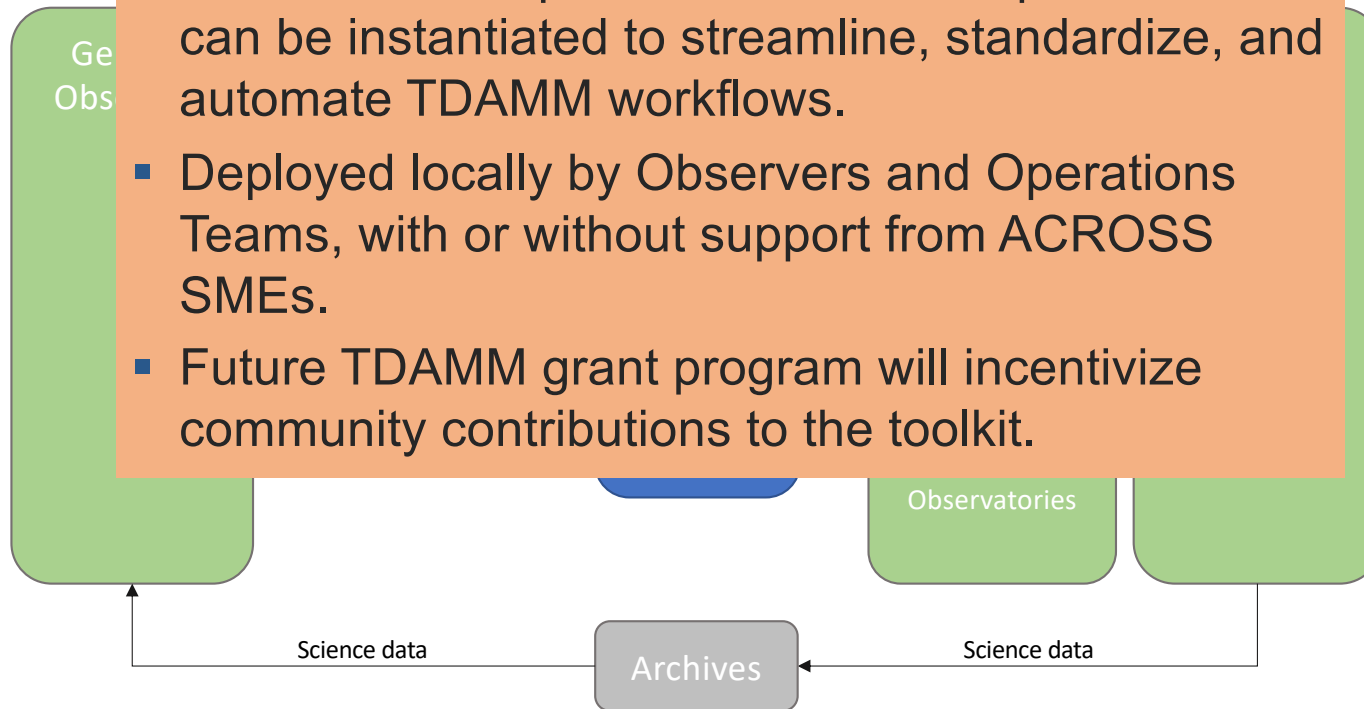
Science Support Infrastructure

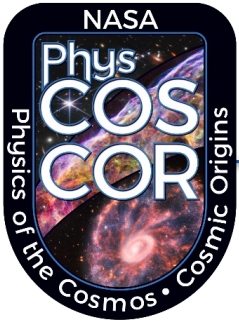
Key:

- User (green box)
- external (grey box)

TDAMM Toolkit

- A collection of open-source software products that can be instantiated to streamline, standardize, and automate TDAMM workflows.
- Deployed locally by Observers and Operations Teams, with or without support from ACROSS SMEs.
- Future TDAMM grant program will incentivize community contributions to the toolkit.





High-Level Architecture: Future State Context Diagram



Science Support Infrastructure

Key:

User

External

TDAMM Web Services

- Accessed through our portal
- Organizes and displays status data feeds
- Services are cloud-hosted, with human and machine interfaces, and provide:
 1. Science Situational Awareness Multi-observatory follow-up planning & feasibility analysis tools
 2. Follow-up hub for, e.g., ToO requests
 3. Follow-up decision support & recommendations

Science data

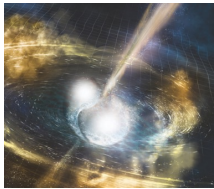
Archives

Science data

Ge
Obs



ACROSS: Key Progress So Far



- **Pre-coordinated gravitational-wave follow-up plans among current NASA X-ray missions and XMM-Newton during the LVK O4 runs.**

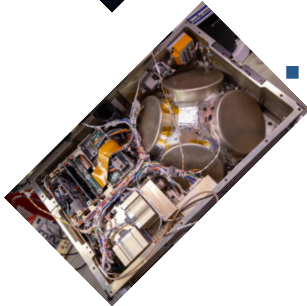
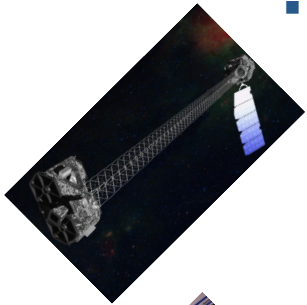
- Established an O4-follow-up Slack channel for rapid science team coordination.
- Demonstrates a value-added function provided by an ACROSS TDAMM Help Desk.

- **Established interfaces to receive NuSTAR near-future/recent-past observing plans**

- Fills a gap in science situational awareness for both observers and science teams.
- Serves as a pathfinder for how ACROSS manages and implements value-added interfaces with current NASA mission science teams and systems.

- **Developed a Minimum Viable Product TDAMM web service for BurstCube**

- Supports reprioritization and downlinking of priority science event data.
- Serves as a pathfinder for how ACROSS manages and implements value-added interfaces with in-development mission science teams and systems.

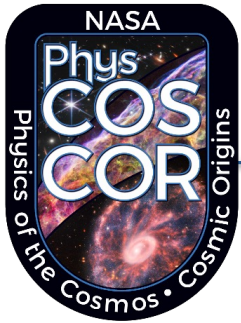




BURSTCUBE Download of Opportunity

Results Per Page 10 Page 1

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1429	2024-05-07 04:17:02.813191	2024-05-07 04:16:32.362000	Show Trigger Info	Requested	Probability inside FOV: 70.86%.
1430	2024-05-07 04:21:42.772780	2024-05-07 04:16:32.352000	Show Trigger Info	Requested	Probability inside FOV: 25.74%.
1428	2024-05-06 10:21:49.349371	2024-05-06 10:20:29.884000	Show Trigger Info	Requested	Probability inside FOV: 8118%.
1426	2024-05-06 03:08:55.334730	2024-05-06 03:08:28.606000	Show Trigger Info	Requested	Probability inside FOV: 73.55%.
1427	2024-05-06 03:13:32.946403	2024-05-06 03:08:28.600000	Show Trigger Info	Requested	Probability inside FOV: 72.66%.
1425	2024-05-05 13:41:07.250758	2024-05-05 13:35:52.585000	Show Trigger Info	Requested	Probability inside FOV: 100.00%. Dump time partially inside SAA.
1424	2024-05-05 13:36:25.368835	2024-05-05 13:35:52.582000	Show Trigger Info	Requested	Probability inside FOV: 100.00%. Dump time partially inside SAA.
1423	2024-05-04 16:20:49.768921	2024-05-04 16:19:06.495000	Show Trigger Info	Requested	Probability inside FOV: 56.39%.
1422	2024-05-04 13:33:26.040873	2024-05-04 13:31:47.236000	Show Trigger Info	Requested	Probability inside FOV: 92.41%.
1421	2024-05-04 13:03:59.468894	2024-05-04 13:02:07.514000	Show Trigger Info	Rejected	Probability inside FOV: 3.63%. Trigger was occulted at T0.



BURSTCUBE Download of Opportunity

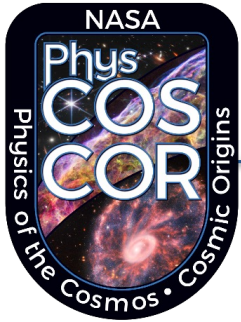
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trigger_instrument: HI_L1
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trigger_duration: null
classification: Burst
justification: LVK trigger S240504ca (Burst) @ 2024-05-04 13:31:47.236000 (GPS 1398864725.236). FAR: 1 every 0.003065590354177731 years.
igwn_alert_type: PRELIMINARY
igwn_false_alarm_rate: 0.0000103367

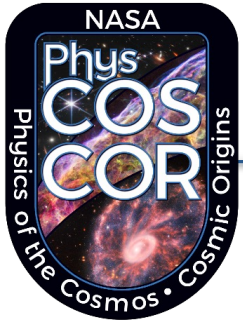
[Close](#)



ACROSS: Next Steps



- **Complete the NASA open-source software release authorization process.**
 - Will allow us to migrate code to a publicly accessible Github repository.
 - Will make it easier to engage with the community on tool development and integration.
- **Acquire a permanent web domain name.**
 - Will enable publishing our web portal at a convenient, easy-to-remember location.
- **Incorporate state/status data streams from additional missions.**
 - Including NICER and IXPE: if we haven't already, we will be reaching out soon.
- **Continue developing ACROSS API and web portal.**
 - API provides direct access to available data streams for integration into observer or mission workflows.
 - Web portal will provide state/status visualization and central clearinghouse for information.



Study Year 2: Coordinating with U.S. Ground Assets

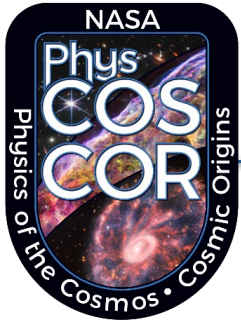


- **Objectives:**

1. Assess the landscape of infrastructure efforts among the ground-based community.
2. Understand what information from the NASA fleet needs to be exposed to the ground-based community and vice versa.
3. Discuss what tools, platforms, or services can be shared or co-developed between NASA and the ground-based community.

- **Tasks & Status:**

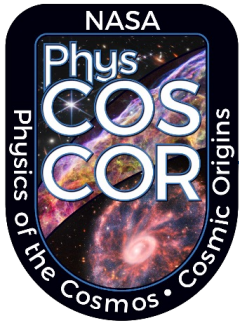
- Participated in the NOIRLab-hosted [Windows on the Universe: Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem](#) workshop and white paper.
 - Using the [white paper](#) recommendations to inform the TDAMM GO Program design.
- Meeting with developers of widely used ground observatory software infrastructure tools (TOM Toolkit, SkyPortal, YSE PSE, AEON) to understand workflows, options for interfacing ACROSS data streams and web services.
- Meeting with observers to survey user experience of coordinating observing campaigns between ground and space assets.
- Holding monthly meetings with the ACROSS Advisory Group to provide status and receive feedback.



TDAMM Community Grant Program & Current Status



- **Subject to funding availability and suitable mechanism, Phase I study identified opportunities for community grants in 3 areas,**
 1. Development of tools and observing modes that enable new TDAMM science cases.
 2. Funding unplanned TDAMM-related observations made by smaller missions (analogous to flagship DDT opportunities).
 3. An overarching TDAMM science call for proposals designed to streamline or fill the gaps between existing joint observing calls, remove the risk of double jeopardy, and explicitly support observing programs which require coordination between two or more observatories.
- **National Science Foundation's recent Windows on the Universe Workshop and White Paper validated our Phase I study findings**
 - NSF recently released an infrastructure grant program "Multi-Messenger Coordination for Windows on the Universe."
- **We will continue definition and refinement of the grant program design, in consultation with stakeholders, Missions and Program Scientists for other NASA Grant programs, targeting 2026 call pending availability of funding.**



ACROSS Is Hiring!



- **Looking for a full-stack astronomer to assist in developing tools and infrastructure and conduct TDAMM science.**



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Support Scientist / Developer (AP095)

Department: Data Science
Location: Greenbelt, MD

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Support Scientist / Developer

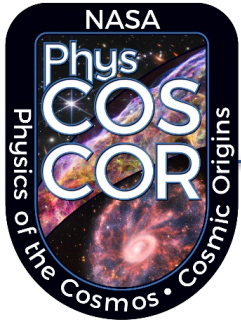
Telophase Corporation is seeking a highly skilled Support Scientist to join our Multi-Mission Time-Domain Astrophysics Infrastructure team at NASA. This role calls for a committed individual who will help guide the development of APIs for access to NASA science data and services, web applications, and scientific Python packages for time-domain astrophysics. A significant part of the role will also encompass tasks such as triaging and assigning issues and reviewing pull request on GitHub. The role requires an individual who has a keen interest in continuous learning, possesses exceptional collaboration skills, and is committed to delivering high-quality work.

Primary Responsibilities:

- Actively contribute to open source, team-oriented projects. This involves managing GitHub issues, reviewing pull requests, and automating testing and deployment workflows using GitHub Actions.
- Architect and implement APIs for programmatic access to NASA open data.
- Design and build UX for NASA science web applications.
- Develop test suites for web applications, write and edit technical documentation, and maintain configuration control using tools such as Git.
- Enhance and broaden the scope of Python tools and Node.js web apps by working across different languages and frameworks.
- Perform original scientific research (~20% FTE), ideally utilizing capabilities resulting from the above activities.

Required:

- Ph.D. in Astronomy, Astrophysics, Physics, or related field.
- Experience with time-domain and multi-messenger astrophysics infrastructure.



Summary



- **The Astrophysics Cross Observatory Science Support (ACROSS) pilot project was developed as a result of the 1st year of the TDAMM study.**
- **ACROSS's objective is to partner with observers and science teams to provide services and infrastructure that enable the full potential of time domain and multi-messenger (TDAMM) science.**
- **The study continues, to understand how this coordination can extend to ground-based and international observatories.**
- **What we're developing:**
 - TDAMM Toolkit & API sharing observatory state and status information, observing plans, observability constraints, and target of opportunity (ToO) request pages.
 - Web Portal: links to tools, ToO requests, funding opportunities, conferences, and Events of Interest pages.
 - TDAMM Research Announcement: Initial call targeted for 2026, subject to availability of funds.
 - Community support: help desk, documentation, tutorials, and workshops.
- **Feedback welcome! We want to make ACROSS as useful as possible!**

