

# Future Large Gamma-ray Mission Concepts Working Group

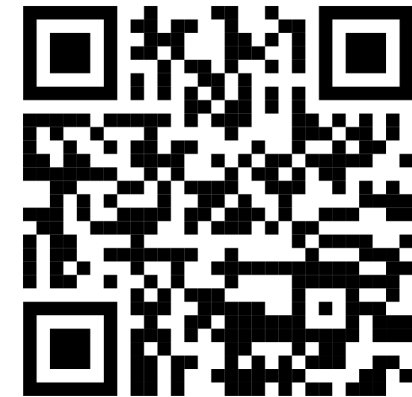
Co-chairs: Henric Krawczynski ([krawcz@wustl.edu](mailto:krawcz@wustl.edu))  
Liz Hays ([elizabeth.a.hays@nasa.gov](mailto:elizabeth.a.hays@nasa.gov))

GR SIG Update

17 April 2026

# FLAG working group status

- What we are doing:
  - Collect and synthesize community input on capabilities and technologies that will motivate consideration of potential large (Probe-class or Flagship-class, >~\$1B) gamma-ray mission concepts for implementation in the next decade.
- Community survey on capabilities and technologies open! Initial inputs received. <https://forms.gle/5EXFEbYMkoERCXiYA>
  - Important for today:
    - Identify gaps in inputs. What is missed?
    - Draw on these to fill request for mission concept studies for ASTRA
- Next steps:
  - Identify ASTRA input for GR SIG (May)
    - Next brainstorming/discussion session in 2 weeks
  - Compile draft report (June)
    - Summarize mission concepts
    - Present approaches that address high priority astrophysics science
    - Lay out a path for additional future development needs
  - Hybrid FLAG working session at AAS 248 in Pasadena, CA, on Monday, June 15, from 10 – 11:30 AM PDT
  - FLAG can be highlighted as part of the Fermi Gamma-ray Astrophysics AAS Special Session on Monday, June 15, from 2 – 3 PM PDT



# For reference: Request for ASTRA concepts

As part of NASA's Astrophysics Strategic Technology & Research Accelerator (ASTRA) initiative, the community, through the PAGs, is being asked to propose mission concept studies for the next generation of strategic missions.

This is an important opportunity to shape NASA's priorities for the 2030s and beyond. The goal is to identify a small set (4-6 across all areas of astrophysics) of compelling mission concepts (in the >\$1B class) that address the most important open questions in astrophysics and that could be advanced through the ASTRA incubator program.

Useful links: [ASTRA initiative](#), [ASTRA charge to the PAGs](#), [ASTRA presentation](#) (starts at minute 8, ASTRA is discussed starting min 27)

To support this effort, we are asking each SIG to:

- Review the context:** familiarize yourselves with the ASTRA document and key NASA strategy documents (e.g., [Astro2020](#), [Enduring Quests](#), etc.).
- Assess science priorities:** identify the most important science questions for your community from the [Astro2020 Decadal Survey report](#), the long-term vision in [Enduring Quests](#), [Daring Visions](#), and any relevant SAG activities since ~2020. Highlight any gaps that your community identifies.
- Consider the evolving landscape:** discuss which science questions will be addressed by planned facilities (Webb, Roman, HWO, potential IR/X-ray probes, and international missions), and which will remain open.
- Think broadly about mission concepts:** think broadly about what future >\$1B-scale missions would best address those open questions. Please be expansive. Consider what you would prioritize for the *entire astrophysics community*, not only your subfield.
- Engage your community:** solicit input for mission concepts particularly relevant to your SIG, consolidate overlapping ideas, and ensure that the science case clearly drives the mission concept your community would like to endorse or propose.

## Timeline:

- ~1 month: brief report summarizing science priorities and gaps
- ~6 weeks: initial set of mission concepts that you would like PhysPAG to discuss and bring to the table.

# Community Survey Update

Received 17 submissions from 15 contributors. Responses cover a broad range of capabilities and address multiple measurement types.

Thank you to contributors and their teams!

Bindu Rani, Tsuguo Aramaki, Zorawar Wadiasingh, Adrien Laviron, Richard Miller, Regina Caputo, Andreas Zoglauer, Dustin Swarm, Tom Shutt, Constantinos Kalotharakos, Daniel Shy, Fabian Kismet, Jim Buckley, Sophie Fendler...

We are still open for inputs and you can send thoughts, comments, questions directly to Henric and Liz.

# Community Survey Update – Science Applications

What community science uses are envisioned for a mission application with this capability?

12 responses

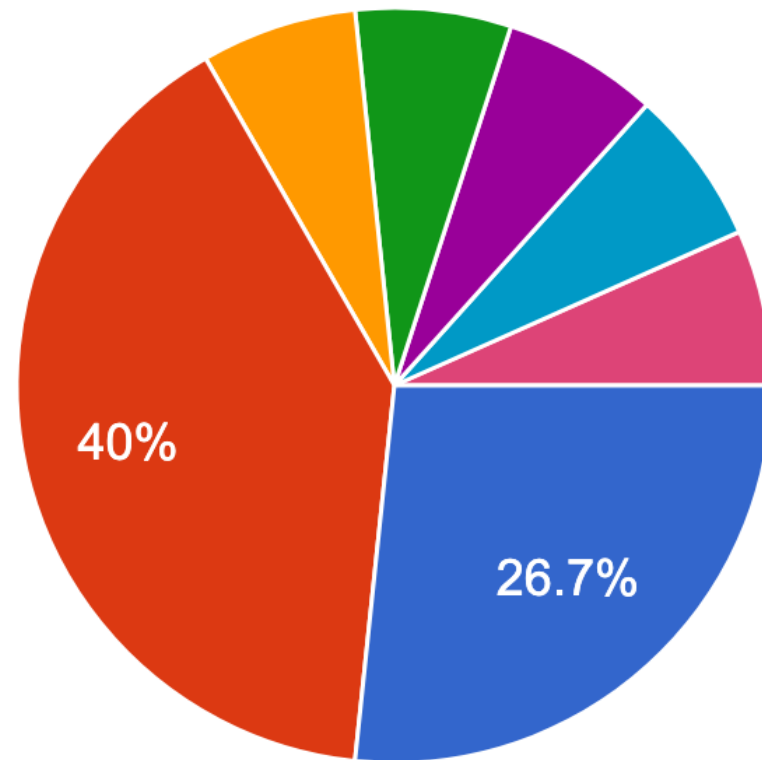
- **Multi-messenger and Transient Astrophysics:** Key uses include observing MeV emission from gravitational-wave events (neutron star mergers), high-energy neutrino sources, and ultra-high-energy cosmic ray accelerators. This also involves rapid discovery and localization of compact-object mergers and short Gamma-Ray Bursts for follow-up, time-resolved studies of relativistic jet structure, and broader wide-field monitoring of transients.
- **Dark Matter and Fundamental Physics:** Envisioned applications include MeV gamma-ray observations and antimatter-based indirect dark matter searches, searching for monoenergetic gamma-ray lines from dark matter annihilation or decay, and testing strong-field Quantum Electrodynamics (QED) through signatures of photon splitting and magnetic pair creation in magnetars and high-field pulsars.
- **Nuclear Astrophysics and Chemical Evolution:** This involves tracing nucleosynthesis sources (e.g., Al-26 and Ti-44) and the Ni-56 decay chain in extragalactic supernovae to directly constrain explosive nucleosynthesis yields, as well as constraining the origin of galactic positrons via precise 511 keV line measurements.
- **Compact Objects and Source Characterization:** Community science uses include measuring coronal electron temperature and size for Active Galactic Nuclei (AGN), completing the Compton-thick AGN census, conducting phase-resolved spectroscopy and polarimetry of bright young pulsars and magnetars, and characterizing the evolution of energetic transients through the MeV gap.
- **Survey and Timing:** A proposed mission would function as an all-sky survey, with data made public within 24 hours to support a guest investigator program. Another application is nanohertz gravitational-wave studies using a gamma-ray pulsar timing array, offering synergy with radio timing arrays and enabling discovery and long-term timing of a larger millisecond pulsar (MSP) sample.

*Synopsis assisted by Gemini*

# Initial inputs from the survey

What mission scale is anticipated for a concept using this technology or technologies?

15 responses

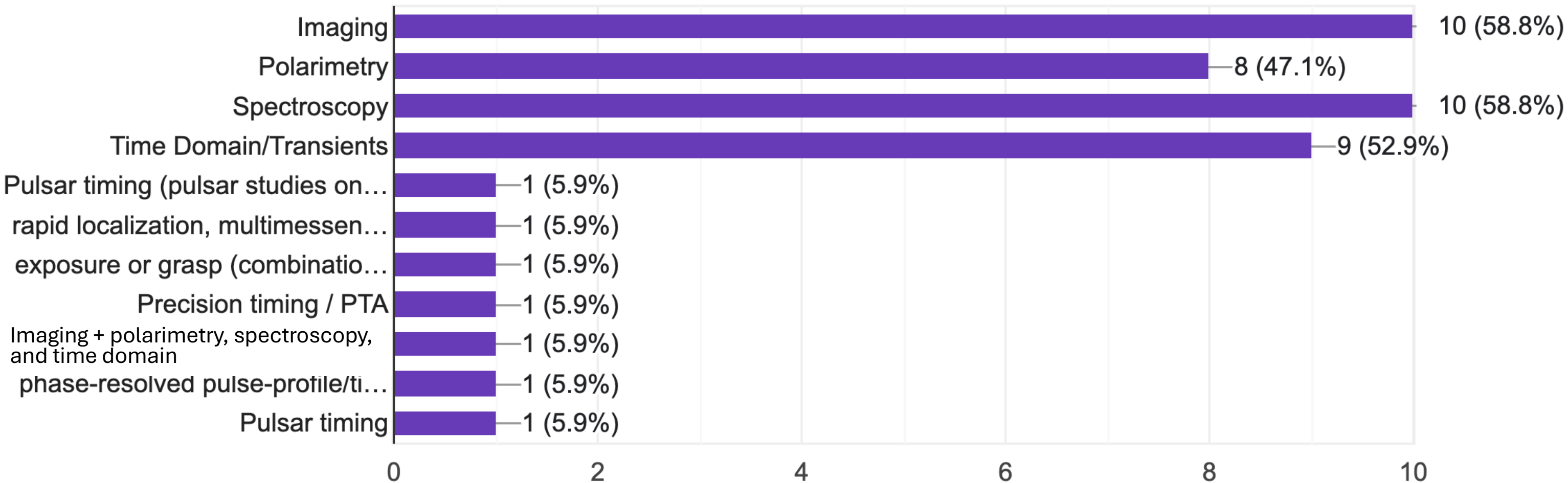


- Flagship
- Probe
- We have not yet attempted to quantify how the demonstrated low mass scali...
- Begin with a balloon experiment before moving to the satellite mission
- Any
- Between probe and flagship, or flagship
- Explorer class for a positron annihilation imager, though a probe would be nee...

# Types of capabilities

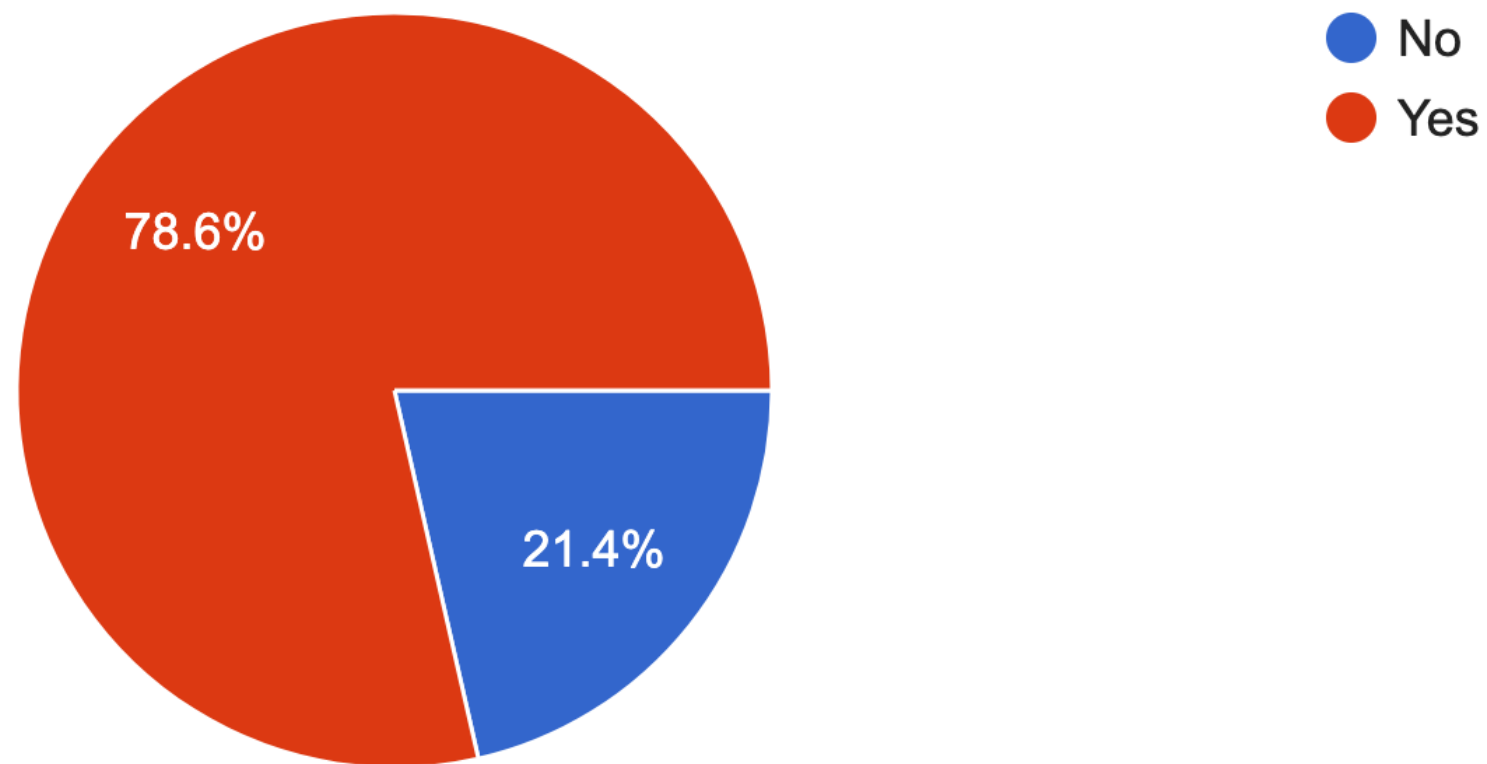
What categories best describe this capability

17 responses



# For low TRL technology: has it been submitted as a 2024 Astrophysics Technology Gap to NASA?

14 responses



# Energy range of submissions

**Broad Gamma-ray Coverage (sub-MeV to multi-GeV):** Several concepts aim for wide energy coverage, with ranges, for example, of 0.2 MeV to >10 GeV, 0.1 MeV to ~10 GeV, and 30 MeV to 10 GeV.

**Low-Energy/Compton Regime (keV to low MeV):** A core focus for many responses is the low-energy gamma rays with ranges, for example, of 0.1-100 MeV, 0.2–100 MeV, 0.1-20 MeV, 0.2–5 MeV minimum, and 0.1-10 MeV core science band.

**High-Energy/Pair Regime (up to TeV):** A few responses indicate sensitivity into the higher end of the gamma-ray spectrum, such as 500 keV to 1 TeV.

Targeted energy ranges include 450–550 keV for positron annihilation studies, 60–165 keV for line spectroscopy, and 100–600 keV for accretion/nucleosynthesis.

# Field of View

- **Wide Field of View (FoV):** Many responses indicated a need for a very wide FoV, frequently stating **Close to 2 Pi** or **Near 4pi** steradians, with some specifying **Near-360° instantaneous** coverage.
- **Extensive Sky Coverage:** Desired instantaneous coverage ranged from **>25% of the sky** to **>10 times the acceptance of Fermi-LAT**, with some strategies suggesting deploying 2 or 3 instruments to achieve **4pi sky coverage**.
- **Targeted Imaging FoV:** Specialized missions specified smaller fields of view, such as a **30 arcminute** FoV for observing large globular clusters, or a slightly larger **~1 degree** FoV for studying the Galactic Center.

# Performance and target goals received on many key metrics

- Energy resolution, Line sensitivity, Polarization sensitivity, Source localization, Time resolution/accuracy, Reporting latency
- Sensitivity
  - Multiple responses aim for a significant increase in sensitivity compared to previous missions, with goals ranging from **More than an order of magnitude improved to >10 times the acceptance of Fermi-LAT** or **>10× improvement over COSI** in the Compton regime.
  - **Performance Metrics (Compton & Pair Regimes):** Detailed studies in the Compton regime show sensitivities potentially falling to  **$\sim 10^{-13}$  erg/cm<sup>2</sup>/s between 1 MeV and ~20 MeV**. In the pair regime, initial estimates suggest a performance reaching  **$\sim 5 \times 10^{-14}$  erg/cm<sup>2</sup>/s at a few GeV**.
- Angular resolution
  - Targets for improvement include being 2-3 times better than Fermi-LAT at  $>100$  MeV and reaching  $<0.1$  deg resolution for a source of spectral index  $E^{-2.5}$  with no cutoff up to 10 GeV. Sub-degree performance is sought in the pair regime, with one response targeting  $<0.1^\circ$  at multi-GeV energies and another targeting  $0.1$  deg at 1 GeV. Targets for the Compton regime include  $\sim 1$  deg. at 511 keV and  $\sim 0.5$  deg. at 2 MeV (approaching the Doppler-broadening limit), which would be a factor of 3–4 improvement over COSI. Angular Resolution Measure (ARM) including electron tracking is a few degrees at  $\sim 1$  MeV, improving to  $< 1$  deg. above a few MeV.
  - **Targeting Arcminute Resolution:** Techniques to achieve angular resolution  $<10$  arcminutes would exceed the performance of coded aperture mask instruments

# Questions for the working group

- What is missing?
  - More specific details on inputs coming in the next week for your review to help with that.
- Should we establish standard reference benchmarks for performance in priority science areas?
  - E.g. sensitivity, resolution, and polarization benchmarks
- For next discussion
  - What strategies will help us make a strong science motivated case for a large mission study?