2022 APD Technology Gaps: Prioritization Process and Results

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June 12, 2022
Purposes of Technology Gap List

- A technology gap is the difference between a capability needed to enable (or enhance) a future mission and the current state-of-the-art
- The Astrophysics Division maintains a prioritized Technology Gap List
- Program Office technologists carry out biennial technology gap prioritizations
  - **Identify technology gaps** applicable to Astrophysics strategic objectives
  - **Rank technology gaps** to prioritize for investment
  - **Inform the community** of Astrophysics technology needs through Astrophysics Biennial Technology Report (ABTR)
1. Technology gaps are solicited from the community, informed by the Decadal Survey
   - Planned to collect by 6/1/2021, delayed to 1/3/2022 due to Astro2020 release schedule
2. Program Office (PO) staff review the collected gaps and assign each to the Program that would be most impacted by closing it
3. Each PO consolidates the inputs for its Program and asks its community to review the gaps for accuracy and completeness before prioritization
4. A Technology Management Board (TMB) reviews and prioritizes the resulting gaps
   - TMB membership is diverse and includes senior members of Astrophysics Division, STMD, and the POs; technologists and scientists from the three POs; and subject matter experts
   - Prioritization is based on a published set of criteria (strategic alignment, benefits and impacts, urgency, and scope of applicability)
5. The lists from the three Programs is merged into a joint, prioritized Astrophysics technology gap list
How Did the Astro2020 Affect the 2022 Prioritization?

1. The strategic missions recommended by Astro2020 replaced the previous set of strategic missions (the TDAMM program was added, despite no missions specified)
   - IROUV Flagship
   - X-ray Flagship
   - Far-IR Flagship
   - X-ray Probe
   - Far-IR Probe
   - CMB Probe
   - TDAMM

2. The estimated launch timeline informed gap urgency
# Astrophysics Technology Gap Priorities

You can find this priority list in the ABTR, or at the above URL.

## Tier 1 Technology Gaps
- **Advanced Cryocoolers**
- **Coronagraph Contrast and Efficiency**
- **Coronagraph Stability**
- **Cryogenic Readouts for Large-Format Far-IR Detectors**
- **Heterodyne Far-IR Detector Systems**
- **High-Performance, Sub-Kelvin Coolers**
- **High-Reflectivity Broadband Far-UV-to-Near-IR Mirror Coatings**
- **High-Resolution, Large-Area, Lightweight X-ray Optics**
- **High-Throughput Bandpass Selection for UV/VIS**
- **High-Throughput, Large-Format Object Selection Technologies for Multi-Object and Integral Field Spectroscopy**

## Tier 2 Technology Gaps
- **Broadband X-ray Detectors**
- **Compact, Integrated Spectrometers for 100 to 1000 \( \mu m \)**
- **Far-IR Imaging Interferometer for High-Resolution Spectroscopy**
- **Far-IR Spatio-Spectral Interferometry**
- **Fast, Low-Noise, Megapixel X-ray Imaging Arrays with Moderate Spectral Resolution**
- **High-Efficiency X-ray Grating Arrays for High-Resolution Spectroscopy**
- **High-Resolution, Direct-Detection Spectrometers for Far-IR Wavelengths**
- **Improving the Calibration of Far-IR Heterodyne Measurements**
- **Large-Aperture Deployable Antennas for Far-IR/THz/sub-mm Astronomy for Frequencies over 100 GHz**

## Tier 3 Technology Gaps
- **Advancement of X-ray Polarimeter Sensitivity**
- **Detection Stability in Mid-IR**
- **Far-UV Imaging Bandpass Filters**
- **High-Efficiency Far-UV Mirror**
- **High-Efficiency, Low-Scatter, High- and Low-Ruling-Density, High- and Low-Blazed-Angle UV Gratings**

## Tier 4 Technology Gaps
- **Advanced Millimeter-Wave Focal-Plane Arrays for CMB Polarimetry**
- **Improving the Photometric and Spectro-Photometric Precision of Time-Domain and Time-Series Measurements**

## Tier 5 Technology Gaps
- **Complex Ultra-Stable Structures for Future Gravitational-Wave Missions**
- **Disturbance Reduction for Gravitational-Wave Missions**
- **Gravitational Reference Sensor**
- **High-Performance Spectral Dispersion Component/Device**
- **High-Power, High-Stability Laser for Gravitational-Wave Missions**
- **Laser Phase Measurement Chain for a DeSertGravitational-Wave Mission**
- **Micro-Newton Thrusters for Gravitational Wave-Missions**
- **Stable Telescopes for Gravitational Wave-Missions**
Gaps by Program

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What do These Priorities Mean?

- The technology gap list informs the SAT solicitation and selections; historically the focus has been on the first two priority tiers.

- However, gaps in lower tiers are not ignored:
  - Technologies that address any gap, whether solicited in SAT or not, may fit in APRA.
  - Gaps in lower tiers have at times moved to higher tiers in later cycles (a new Astrophysics Implementation Plan, AIP, is expected to be released by the end of 2022, and will inform the next cycle).
  - Astrophysics Division may decide to direct-fund technologies they deem important enough after considering programmatic aspects, for example through the work of the Technology Strategy Team (TST).
Where to find the 2022 Gap List
https://apd440.gsfc.nasa.gov/tech_gap-descriptions.html

You can download the details of all gaps in Excel from this page
Backup
Gap Submission Guidelines

1. Focus on technology gaps associated with missions prioritized in Astro2020

2. Submit gaps directly applicable to Program objectives (not ones outside our purview (e.g., associated with launch vehicle, rover, avionics, s/c systems, etc.)

3. Don’t include gaps that don’t require technology development, that are not well defined, that are redundant (duplicate, similar, or subsets of existing gaps), or where solutions are at TRL 6 or higher for the relevant strategic mission(s)

4. Inputs should be submitted as gaps between the current state-of-the-art and what’s required to achieve the science objective targeted, not specific solutions

5. Inputs should not endorse or advertise any organization, mission, or person

6. Inputs should not contain proprietary, or EAR/ITAR-restricted information

Full details are provided in the gap submission form instructions
Four Prioritization Criteria

- **Strategic Alignment**: How well does the technology align with astrophysics science and/or programmatic priorities set out in the Decadal Survey?

- **Benefits and Impacts**: How much impact does the technology have on applicable missions? To what degree does it enable and/or enhance achievable science objectives, reduce cost, and/or reduce mission risks?

- **Urgency**: Given the anticipated difficulty of maturing from current TRL of a full solution to TRL 6, assessed against the time available until the need-by-year, how urgently does the gap need to be addressed?

- **Scope of Applicability**: How crosscutting is the technology? How many Astrophysics programs and/or mission concepts (strategic or other) would benefit by closing the gap?