National Aeronautics and
Space Administration

EXPLORE SCIENCE

# NASA Astrophysics Technology Needs: Plans for Factoring in the Decadal Survey's Recommendations

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# NASA Astrophysics
# 2021 Technology Plans

1. How will the recommendations from Astro2020 factor into APD’s technology planning?

2. How can the community participate in the technology development and planning?

# How will the recommendations from Astro2020 factor into APD's technology planning?

- **APD will respond to the Astro2020 Committee publicly on which of the recommendations it will commence first and expected timelines.**
  - ❑ *Preliminary response within a couple months of the released Astro2020 report*
  - ❑ *Completed Implementation Plan targeting Dec 2021*

- **A list of technology needs will then be updated and re-prioritized.**

- **APD will decide which technology development activities will be directed and competed.**
  - ❑ *A community-wide RFI is planned to be released to gather a wide range of information pertaining to the Astro2020 recommendations such as new innovations, approaches, architectures, and qualified sources.*
  - ❑ *The SAT solicitation can be part of a competed approach reflecting space mission priorities and longer-term technology development.*

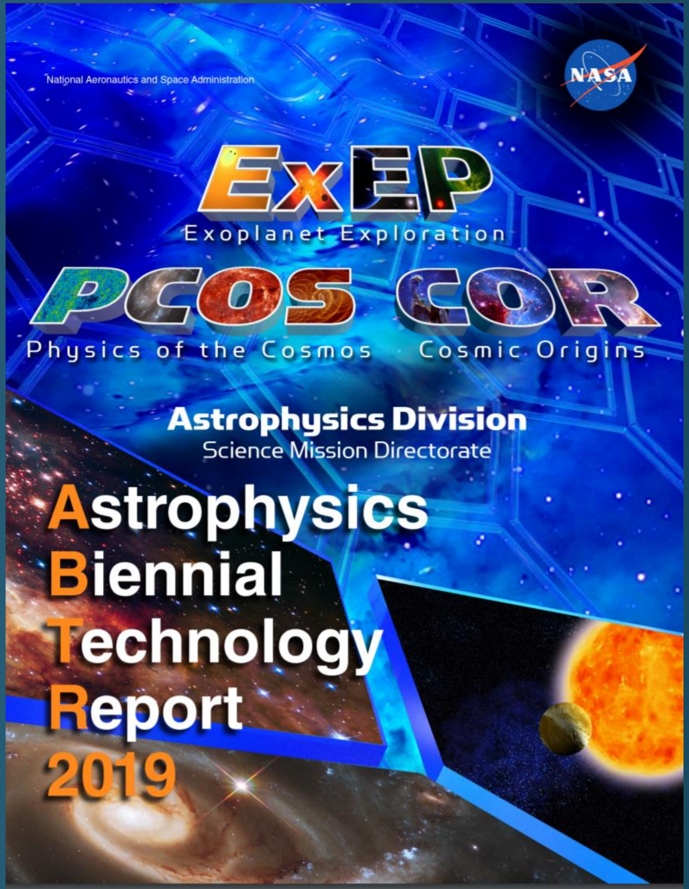
# How can the astrophysics community participate in technology planning and development?

- **Review our current technology gaps and propose new ones during the open solicitation period.**
  - ❑ *Technology Gaps and Technology Gap Form: https://apd440.gsfc.nasa.gov/technology.html*
  - ❑ *Jan 8 – June 1 (will defer if Astro2020 report is released later than mid-May)*

- **Respond to the community-wide RFI.**
  - ❑ *Released within two months of the public Astro2020 report*

- **Propose to the SAT element of the ROSES-2021 solicitation *(pending NASA's plans in response to the Astro2020 recommendations).***
  - ❑ *ROSES-2021 solicitation ~ 2/14/21*
  - ❑ *Amendment to ROSES-2021 expected ~ 9/16/21 will confirm the SAT solicitation*
  - ❑ *If confirmed, NOI's due ~ 10/22/21 and proposals due ~ 12/16/21*

# NASA Astrophysics Technology Needs




https://apd440.gsfc.nasa.gov/technology.html

| Tier 1 Technology Gaps |
|---|
| Angular Resolution (UV/Vis/NIR) |
| Coronagraph Contrast |
| Coronagraph Contrast Stability |
| Cryogenic Readouts for Large-Format Far-IR Detectors |
| Fast, Low-Noise, Megapixel X-Ray Imaging Arrays with Moderate Spectral Resolution |
| High-Efficiency X-Ray Grating Arrays for High-Resolution Spectroscopy |
| High-Resolution, Large-Area, Lightweight X-Ray Optics |
| Large-Format, High-Resolution, UV/Vis Focal Plane Arrays |
| Large-Format, High-Spectral-Resolution, Small-Pixel X-Ray Focal-Plane Arrays |
| Large-Format, Low-Noise and Ultralow-Noise Far-IR Direct Detectors |
| Large-Format, Low-Noise, High-QE Far-UV Detectors |
| Next-Generation, Large-Format, Object Selection Technology for Multi-Object Spectrometers for LUVOIR |
| Vis/NIR Detection Sensitivity |

| Tier 2 Technology Gaps |
|---|
| Advanced Millimeter-Wave Focal-Plane Arrays for CMB Polarimetry |
| Detection Stability in Mid-IR |
| Heterodyne FIR Detector Arrays and Related Technologies |
| High-Efficiency Object Selection Technology for UV Multi-Object Spectrometers |
| High-Performance Spectral Dispersion Component/Device |
| High-Reflectivity Broadband FUV-to-NIR Mirror Coatings |
| High-Throughput Bandpass Selection for UV/Vis |
| Large-Format Object Selection Technology for Multi-Object Spectrometers for HabEx |
| Starshade Deployment and Shape Stability |
| Starshade Starlight Suppression and Model Validation |
| Stellar Reflex Motion Sensitivity – Astrometry |
| Stellar Reflex Motion Sensitivity – Extreme Precision Radial Velocity |

| Tier 3 Technology Gaps |
|---|
| Advanced Cryocoolers |
| High-Performance, Sub-Kelvin Coolers |
| Large Cryogenic Optics for the Mid-IR to Far-IR |
| Long-Wavelength-Blocking Filters for X-Ray Micro-Calorimeters |
| Low-Noise, High-QE UV Detectors |
| Low-Stress, Highly Stable X-Ray Reflective Coatings |
| Photon-Counting, Large-Format UV Detectors |
| Polarization-Preserving Millimeter-Wave Optical Elements |
| UV Coatings |
| UV Detection Sensitivity |
| UV/Vis/NIR Tunable Narrow-Band Imaging Capability |
| Warm Readout Electronics for Large-Format Far-IR Detectors |

| Tier 4 Technology Gaps |
|---|
| Compact, Integrated Spectrometers for 100 to 1000 μm |
| Optical-Blocking Filters |
| Rapid Readout Electronics for X-Ray Detectors |
| Short-Wave UV Coatings |

| Tier 5 Technology Gaps |
|---|
| Advancement of X-Ray Polarimeter Sensitivity |
| Far-IR Spatio-Spectral Interferometry |
| High-Precision Low-Frequency Radio Spectrometers and Interferometers |
| Mid-IR Coronagraph Contrast |
| Ultra-High-Resolution Focusing X-Ray Observatory Telescope |
| Very-Wide-Field Focusing Instrument for Time-Domain X-Ray Astronomy |
| Wide-Bandwidth, High-Spectral-Dynamic-Range Receiving System for Low-Radio-Frequency Observations on the Lunar Far Side |

- Technology gap descriptions and prioritization are published in the ABTR.
- A revised Report will come out ~ October incorporating Astro2020 recommendations.

Green: An STDT identified technology

# NASA Astrophysics Technology Needs (an Example)

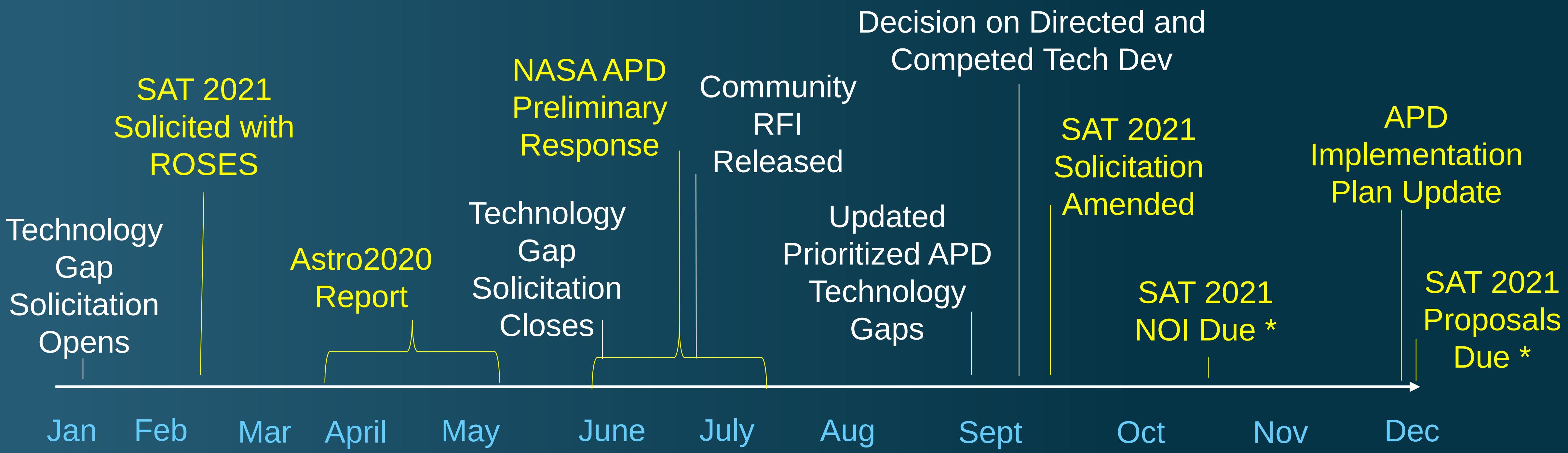
| Tier 1 Technology Gaps |
|---|
| Angular Resolution (UV/Vis/NIR) |
| Coronagraph Contrast |
| Coronagraph Contrast Stability |
| Cryogenic Readouts for Large-Format Far-IR Detectors |
| Fast, Low-Noise, Megapixel X-Ray Imaging Arrays with Moderate Spectral Resolution |
| High-Efficiency X-Ray Grating Arrays for High-Resolution Spectroscopy |
| High-Resolution, Large-Area, Lightweight X-Ray Optics |
| Large-Format, High-Resolution, UV/Vis Focal Plane Arrays |
| Large-Format, High-Spectral-Resolution, Small-Pixel X-Ray Focal-Plane Arrays |
| Large-Format, Low-Noise and Ultralow-Noise Far-IR Direct Detectors |
| Large-Format, Low-Noise, High-QE Far-UV Detectors |
| Next-Generation, Large-Format, Object Selection Technology for Multi-Object Spectrometers for LUVOIR |
| Vis/NIR Detection Sensitivity |

https://apd440.gsfc.nasa.gov/tech_gap_priorities.html

| Gap Name | Description | Current State-of-the-Art | Performance Goals and Objectives |
|---|---|---|---|
| **Angular Resolution (UV/Vis/NIR)** | The capability to resolve the habitable zones of nearby star systems in the UV/Vis/NIR band, with a large space telescope. | Monolith: 3.5-m sintered SiC with < 3 µm SFE (Herschel); 2.4-m ULE with ~10 nm SFE (HST); Depth: Waterjet cutting is TRL 9 to 14", but TRL 3 to >18". Fused core is TRL 3; slumped fused core is TRL 3 (AMTD).<br>Segmented: (no flight SOA): 6.5 m Be with 25 nm SFE (JWST); Non-NASA: 6 DOF, 1-m class SiC and ULE, < 20 nm SFE, and < 5 nm wavefront stability over 4 hr with thermal control | Large (4–16 m) monolith and multi-segmented mirrors for space that meet SFE < 10 nm rms (wavelength coverage 400–2500 nm); Wavefront stability better than 10 pm rms per wavefront control time step; CTE uniformity characterized at the ppb level for a large monolith; Segmented apertures leverage 6 DOF or higher control authority meter-class segments for wavefront control. |
| **Coronagraph Contrast** | The capability to suppress starlight with a coronagraph to the level needed to detect and spectrally characterize Earth-like exoplanets in the habitable zones of Sun-like stars. | unobscured pupil: $6\times10^{-10}$ raw contrast at 10% bandwidth, angles of 3-15 λ/D (HLC demo in HCIT); obscured pupil: $1.6\times10^{-9}$ raw contrast at 10% bandwidth across angles of 3-9 λ/D (WFIRST) | Maximized science yield for a direct imaging telescope/mission. ≤ $10^{-10}$ raw contrast, >10% throughput, IWA ≤ 3 λ/D, obscured/segmented pupil |

# Planned 2021 Technology Timeline

Always consult NSPIRES for actual dates (https://nspires.nasaprs.com/)




* Contingent on SAT amendment in Sept 2021

# Questions about NASA Astrophysics Technology?

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- ExEP Program Office:
  - ❖ Nick Siegler (Chief Technologist; nsiegler@jpl.nasa.gov)
  - ❖ Brendan Crill (Deputy Chief Technologist; bcrill@jpl.nasa.gov)

# Estimated Key Technology Dates in 2021

(If Astro2020 is released after mid-May some dates will change;
always consult NSPIRES for actual dates (https://nspires.nasaprs.com/))

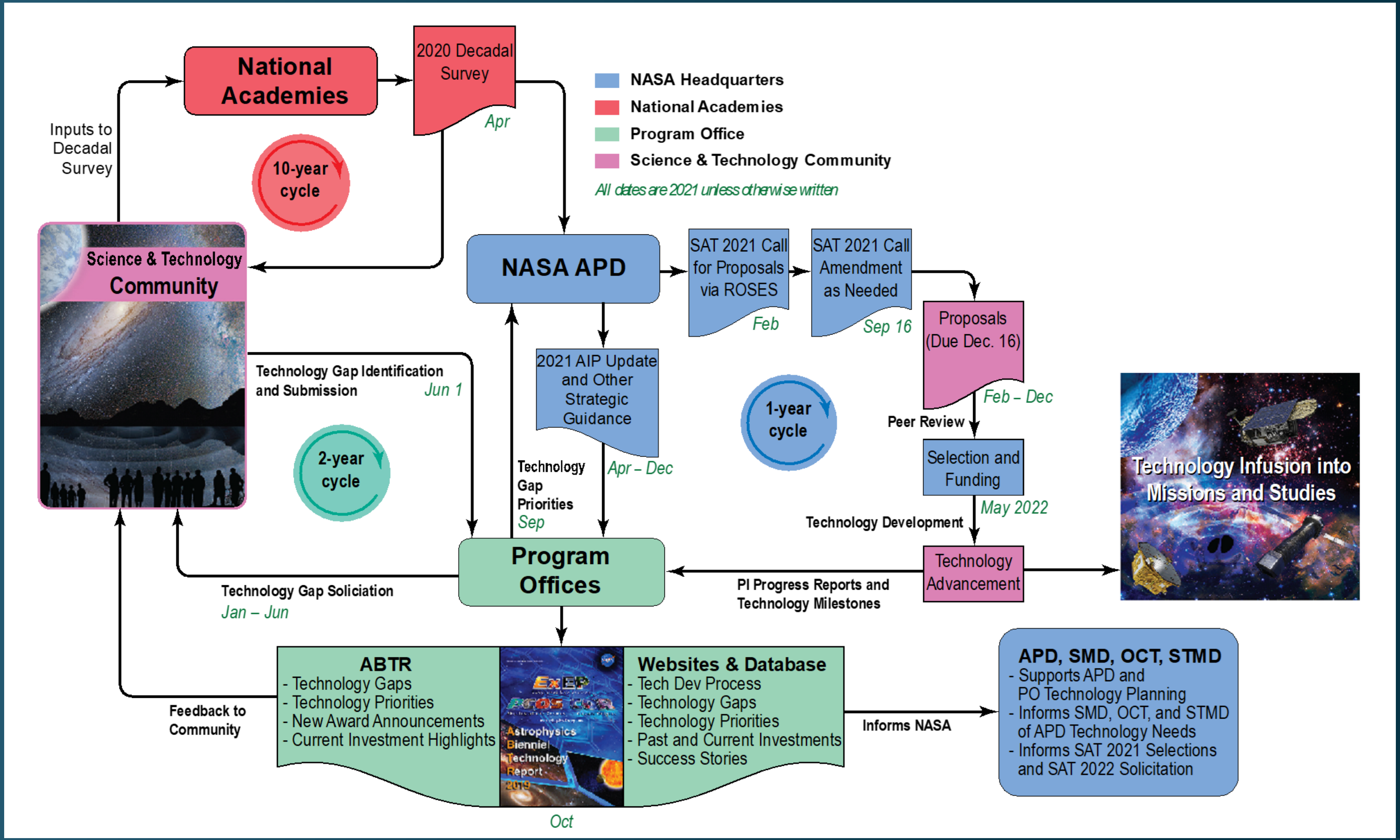
- Technology gap* submission deadline ~ June 1
- Community-wide technology RFI released ~ June-July
- Updated technology gaps posted ~ September 16
- ABTR** 2021 with new gap priorities published ~ mid-October
- SAT 2021 solicitation (ROSES) ~ February 14
- SAT 2021 solicitation amendment ~ September 16
- Pending SAT 2021 amendment:
  - ❖ NOI's due ~ October 22
  - ❖ Proposals due ~ December 16

* Current gaps, priorities, and submission form with instructions available at https://apd440.gsfc.nasa.gov/tech_gap_priorities.html

** ABTR: Astrophysics Biennial Technology Report 2019 available at https://apd440.gsfc.nasa.gov/technology.html

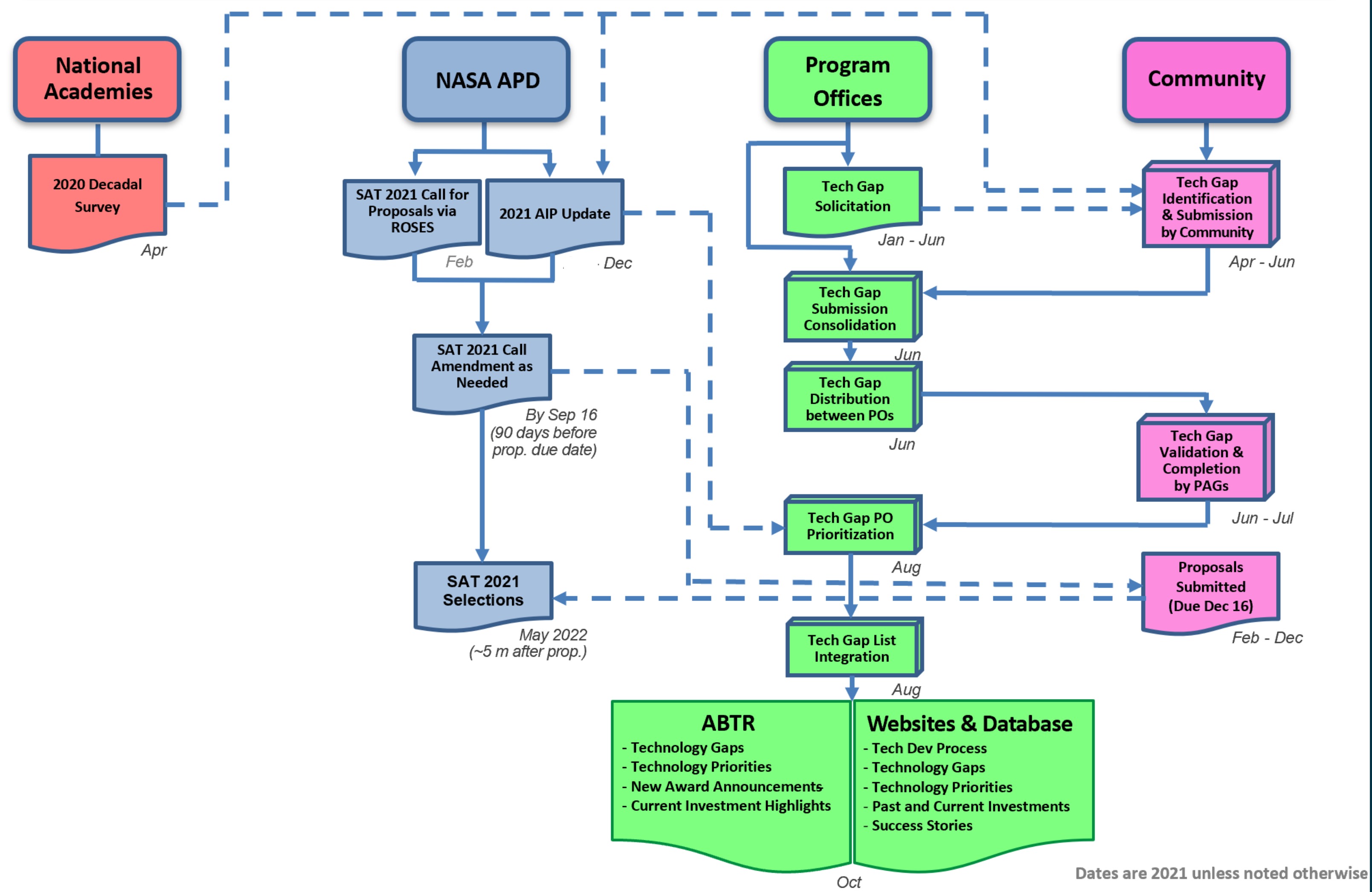
# Additional Material

# Technology Advancement Flow




Dates are best estimates

# Technology Gap Prioritization and SAT Flow




Dates are best estimates

# APD Technology Gaps by STDT

| Technology Gap Name | STDT |
|---|---|
| Vis/NIR Detection Sensitivity | HabEx |
| Starshade Starlight Suppression and Model Validation | HabEx |
| Starshade Deployment and Shape Stability | HabEx |
| Large-Format Object Selection Technology for Multi-Object Spectrometers for HabEx | HabEx |
| Low-Noise, High-QE UV Detectors | HabEx |
| Photon-Counting, Large-Format UV Detectors | HabEx |
| Short-Wave UV Coatings | HabEx |
| Coronagraph Contrast Stability | LUVOIR |
| Angular Resolution (UV/Vis/NIR) | LUVOIR |
| Coronagraph Contrast | LUVOIR |
| Large-Format, Low-Noise, High-QE Far-UV Detectors | LUVOIR |
| Large-Format, High-Resolution, UV/Vis Focal Plane Arrays | LUVOIR |
| Next-Generation, Large-Format, Object Selection Technology for Multi-Object Spectrometers for LUVOIR | LUVOIR |
| High-Reflectivity Broadband FUV-to-NIR Mirror Coatings | LUVOIR |
| UV Detection Sensitivity | LUVOIR |
| UV Coatings | LUVOIR |
| Fast, Low-Noise, Megapixel X-Ray Imaging Arrays with Moderate Spectral Resolution | Lynx |
| Large-Format, High-Spectral-Resolution, Small-Pixel X-Ray Focal-Plane Arrays | Lynx |
| High-Efficiency X-Ray Grating Arrays for High-Resolution Spectroscopy | Lynx |
| High-Resolution, Large-Area, Lightweight X-Ray Optics | Lynx |
| Low-stress, Highly Stable X-Ray Reflective Coatings | Lynx |
| Long-Wavelength-Blocking Filters for X-Ray Micro-Calorimeters | Lynx |
| Large-Format, Low-Noise and Ultralow-Noise Far-IR Direct Detectors | Origins |
| Cryogenic Readouts for Large-Format Far-IR Detectors | Origins |
| Heterodyne FIR Detector Arrays and Related Technologies | Origins |
| Detection Stability in Mid-IR | Origins |
| Large Cryogenic Optics for the Mid IR to Far IR | Origins |
| High-Performance, Sub-Kelvin Coolers | Origins |
| Advanced Cryocoolers | Origins |
| Warm Readout Electronics for Large-Format Far-IR Detectors | Origins |
| Compact, Integrated Spectrometers for 100 to 1000 µm | Origins |
| Mid-IR Coronagraph Contrast | Origins |