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.*

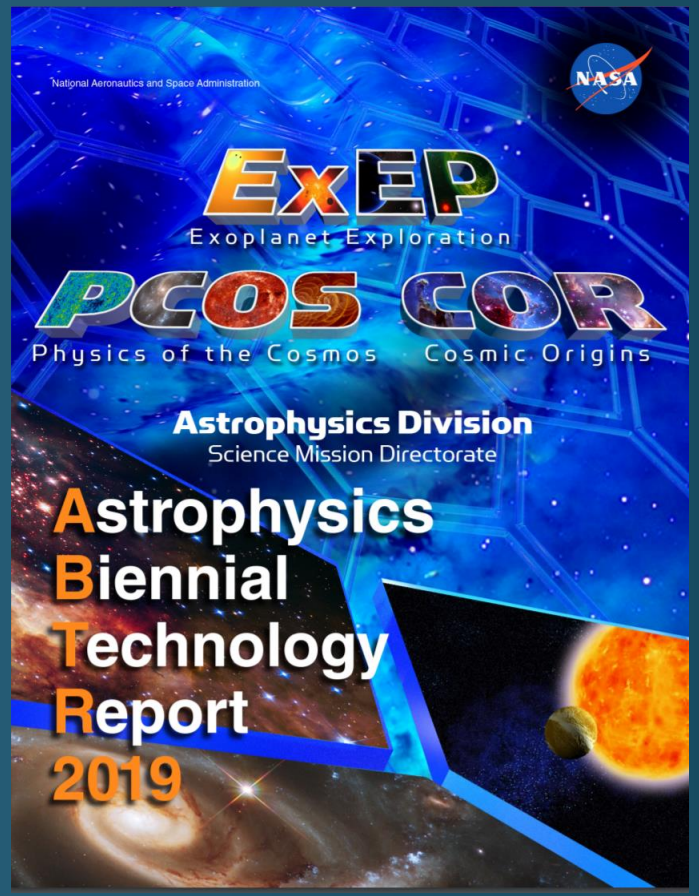
How can the astrophysics community participate in technology planning and development?

- **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)

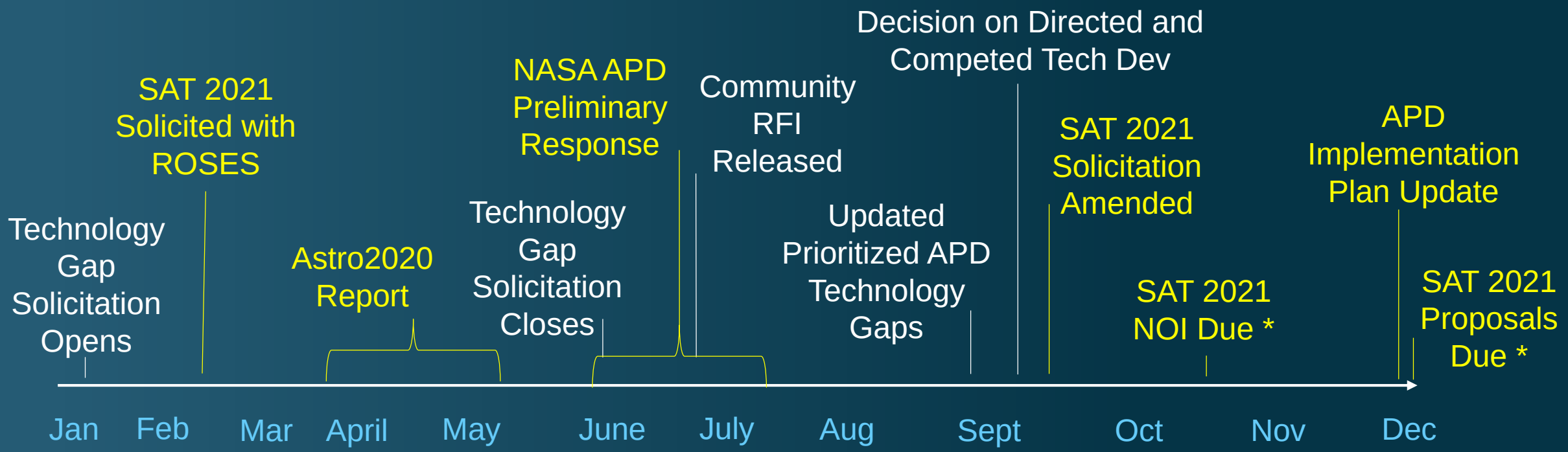
Tier 1 Technology Gaps
Angular Resolution (UV/Vis/NIR)
Coronagraph Contrast
Coronagraph Contrast Stability
Cryogenic Readouts for Large-Format Far-IR Detectors
Fast, Low-Noise, Megapixel X-Ray Imaging Arrays with Moderate Spectral Resolution
High-Efficiency X-Ray Grating Arrays for High-Resolution Spectroscopy
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). 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: 6×10^{-10} raw contrast at 10% bandwidth, angles of 3-15 λ/D (HLC demo in HCIT); obscured pupil: 1.6×10^{-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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  - Opher Ganel (Program Technologist; opher.ganel@nasa.gov)
- 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/))

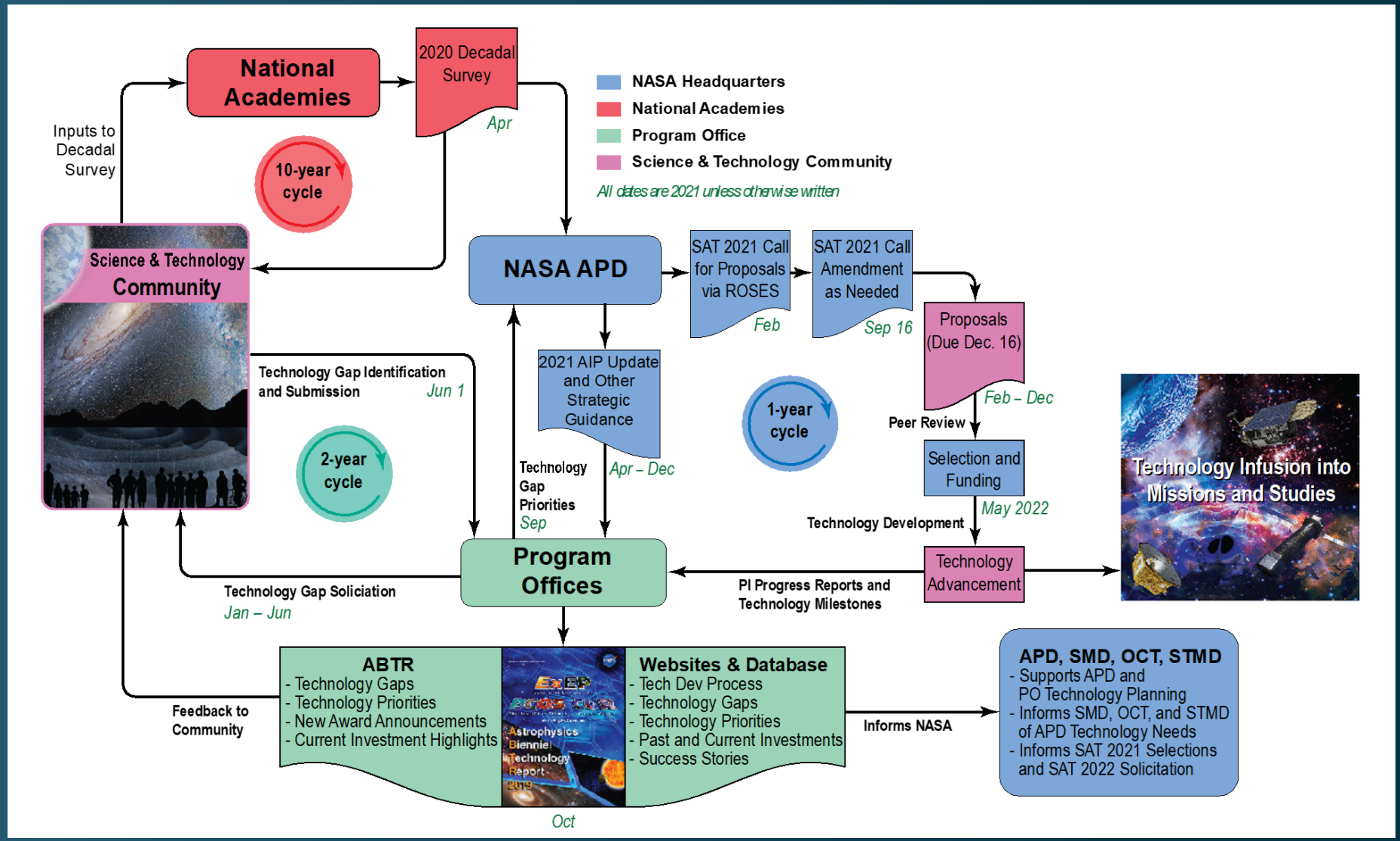
• Technology gap* submission deadline	~ June 1
• Community-wide technology RFI released	~ June-July
• Updated technology gaps posted	~ September 16
• ABTR** 2021 with new gap priorities published	~ mid-October
• SAT 2021 solicitation (ROSES)	~ February 14
• SAT 2021 solicitation amendment	~ September 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

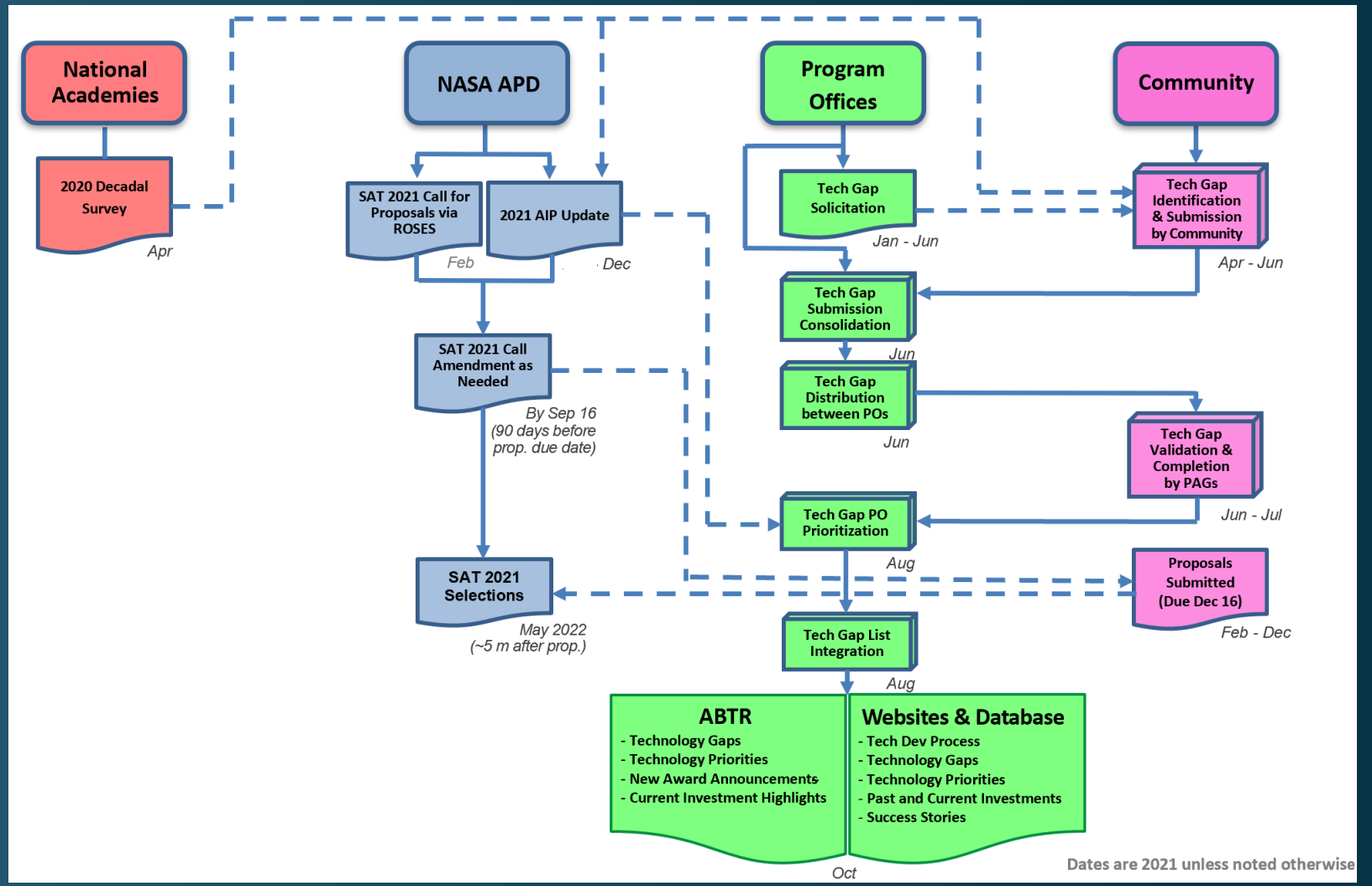
Additional Material

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