Astrophysics Projects Division

PCOS Physics of the Cosmos Program

COR Cosmic Origins Program

PCOS Technology Needs Identification and Prioritization Process

For discussion with PhysPAG

AAS Long Beach, CA

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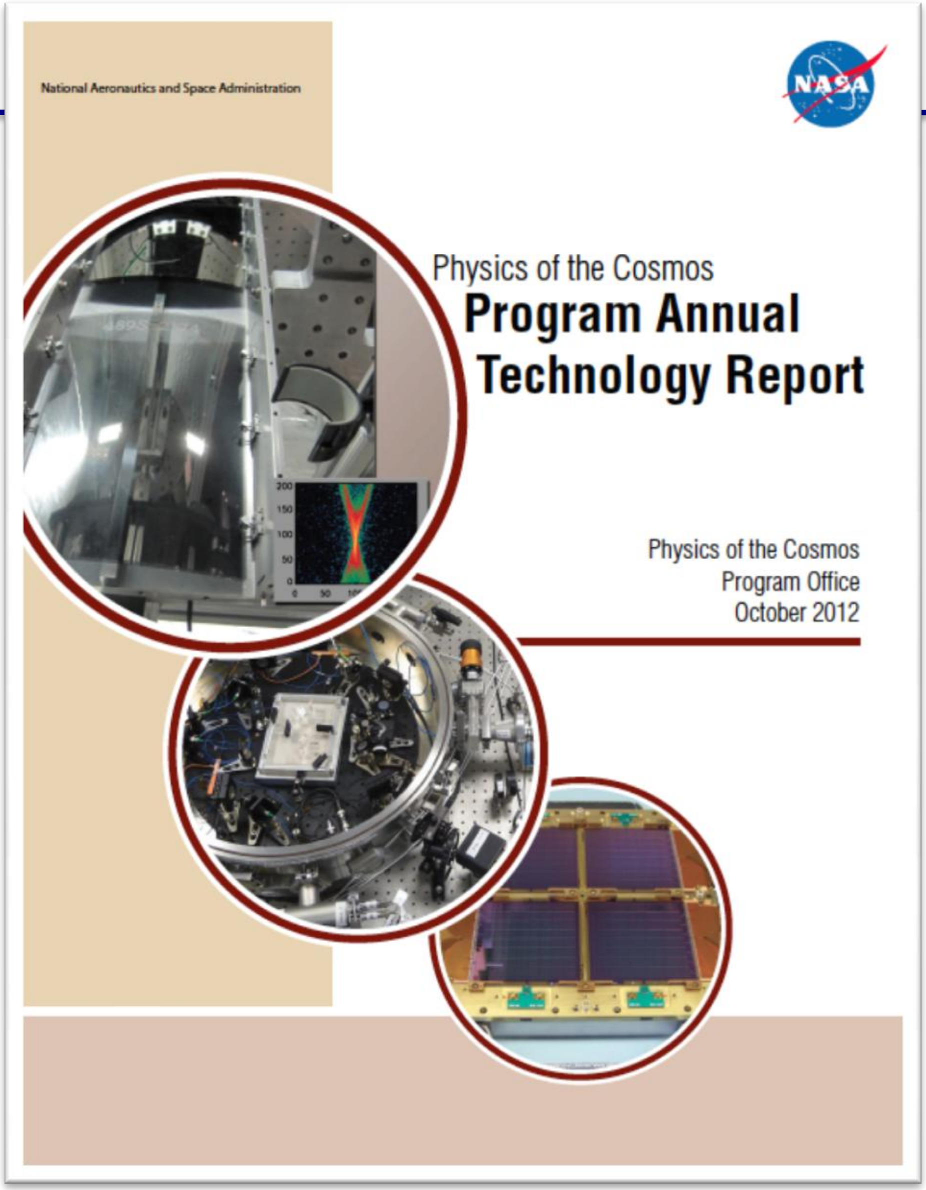
Thai Pham

Agenda

- How the PhysPAG can help
- Quick summary of last two year's PCOS technology needs identification and prioritization process
- Consideration for change to our process
- Open discussion

The 2012 PCOS PATR



The PCOS PATR can be downloaded from https://pcos.gsfc.nasa.gov

How the PhysPAG Can Help

- Provide feedback on technology identification and prioritization process
- Continue to collect and consolidate technology needs inputs for Program Office (PO) prioritization
  - Focus on achieving uniform definition of technology needs
  - Narrow needs down to what PAG sees as appropriate for consideration for strategic technology development
- Provide PO with needs list by the end of June
- Continue feedback dialogue – thank you!

Annual Technology Needs Identification and Prioritization

- A Program technology needs identification and prioritization process has been implemented for PCOS and COR for the last 2 years
- The objectives of this process are to:
  - Identify technology needs that are applicable and relevant to Program science objectives
  - Then prioritize these needs with respect to a published set of criteria
- The outcome of this process is used to:
  - Inform the Program's call for SAT proposals and other technology development Program planning (SBIR and other OCT activities)
  - Inform technology developers of the Program needs
  - Guide the selection of technology awards to be aligned with Program goals and science objectives
- This process is designed to:
  - Improve the transparency and relevance of Program technology investments
  - Inform the community about and engage it in our technology development process
  - Leverage the technology investments of external organizations by defining needs and a customer

Overview of the Technology Needs Identification and Prioritization Process

- The community identifies technology needs each summer by working with the PAG or through direct individual submission to the Program Office’s website.
- The Program Technology Management Board (TMB) reviews and vets community identified technology needs, defines their priorities, and recommends investment consideration.
  - TMB membership includes senior members of the Program at NASA HQ and in the Program Office, and when needed, subject matter expert(s) from the community.
- The TMB prioritizes the technology needs based on a published set of criteria that includes an 11-point assessment that addresses scientific priorities (Decadal Survey), benefits and impacts, timeliness, risk reduction and effectiveness of investment.
- The technology needs and the resulting priorities are published each year in the Program Annual Technology Report (PATR).

Prioritization Criteria Address …

- STRATEGIC ALIGNMENT- Aligns with scientific and/or programmatic priorities as determined by the Decadal Review, other community-based review or study, other peer review, or programmatic assessment

- BENEFIT/IMPACT- Degree of unique or enabling/enhancing capability the technology provides. Impact of the technology on the science, the implementation and the schedule. How many mission concepts can benefit from this technology? (cross-cutting)

- TIMELINESS of the technology investment. Time available before the technology is needed to be at TRL6.

- RISK REDUCTION- Reduction of risk profile (technical or programmatic (cost, schedule))

- EFFECTIVENESS- How well defined is the required technology. Is there a clear description of what is sought? Are there other sources of funding to mature this technology? Are there credible providers/developers of this technology?

Technology Needs Prioritization Criteria

#	Criterion	Weight	Score (0-4)	Weighted Score	General Description/Question	Score Meaning: 4	3	2	1	0
1	Scientific Ranking of Applicable Mission Concept	4	4	16	Scientific priority as determined by the Decadal Review, other community-based review, other peer review, or programmatic assessment. Captures the importance of the mission concept which will benefit from the technology.	Highest ranking	Medium rank	Low rank	Not ranked by the Decadal	No clear applicable mission concept
2	Overall Relevance to Applicable Mission Concept	4	4	16	Impact of the technology on the applicable mission concept. Captures the overall importance of the technology to the mission concept.	Critical key enabling technology - required to meet mission concept goals	Highly desirable technology - reduces need for critical resources and/or required to meet secondary mission concept goals	Desirable - offers significant benefits but not required for mission success	Minor implementation improvements	No implementation improvement
3	Scope of Applicability	3	4	12	How many mission concepts could benefit from this technology? The larger the number, the greater the reward from a successful development.	The technology applies to multiple mission concepts across multiple NASA programs **and** other agencies	The technology applies to multiple mission concepts across multiple NASA programs **or** other agencies	The technology applies to multiple mission concepts within a single NASA program	The technology applies to a single mission concept	No known applicable mission concept
4	Time To Anticipated Need	3	4	12	When does the technology need to be ready for implementation?	4 to 8 years (this decade)	9 to 14 years (early 2020s)	15 to 20 years (late 2020s)	Greater than 20 years (2030s)	No anticipated need
5	Scientific Impact to Applicable Mission Concept	2	4	8	Impact of the technology on the scientific harvest of the applicable mission concept. How much does this technology affect the scientific harvest of the mission?	Needed for applicable mission concept	Major improvement (> ~2x) to primary scientific goals	Only enables secondary scientific goals	Minor scientific improvement	No scientific improvements
6	Implementation Impact to Applicable Mission Concept	2	4	8	Impact of the technology on the implementation efficiency of the applicable mission concept. How much does this technology simplify the implementation or reduce the need for critical resources?	Needed for applicable mission concept	Enables major savings in critical resources (e.g., smaller launch vehicle, longer mission lifetime, smaller spacecraft bus, etc.) or reduces a major risk	Enables minor savings in critical resources or reduces a minor risk	Minor implementation improvement	No implementation improvements
7	Schedule Impact to Applicable Mission Concept	2	4	8	Impact of the technology on the schedule of the applicable mission concept. How much does this technology simplify the implementation to bring in the schedule?	Technology is likely to drive the applicable mission schedule.	Technology is likely to drive the schedule for a major subsystem/ component of the applicable mission concept	Technology is likely to drive the schedule for a minor applicable mission concept component	Technology is less likely to be a factor for the schedule of the applicable mission concept	Technology will not be a factor for the schedule of the applicable mission concept
8	Risk Reduction to Applicable Mission Concept	2	4	8	Ability of the technology to reduce risks by providing an alternate path for a high risk technology that is part of the applicable misssion concept.	Technology is a direct alternative to a key technology envisioned for the applicable mission concept. No other known alternate technologies	Technology is a direct alternative to a key technology envisioned for the applicable mission concept. At least one other known alternate technology	Technology is a direct alternative to a secondary technology envisioned. No other known alternate technologies	Technology is a direct alternative to a secondary technology envisioned. At least one other known alternate technology	No risk benefits or technology is already part of the applicable mission concept
9	Definition of Required Technology	1	4	4	How well defined is the required technology? Is there a clear description of what is sought?	Exquisitely defined	Well defined, but some vagueness	Well defined, but some conflicting goals not clarified	Not well defined, lacking in clarity	Poorly defined, not clear at all what is being described
10	Other Sources of Funding	1	4	4	Are there other sources of funding to mature this technology? If funding is expected to be available from other sources, this will lower the prioritization.	No, the Program is the only viable source of funding.	Interest from other sources can be developed during the development time of the technology	Interest from other sources is likely during the development time of the technology	Moderate investments (relative to the potential level for a NASA investment) in the technology are already being made by other programs, agencies, or countries.	Major investments (relative to the potential level for a NASA investment) in the technology are already being made by other programs, agencies, or countries.
11	Availability of Providers	1	4	4	Are there credible providers/developers of this technology? Where providers are scarce, there may be a compelling need to maintain continuity for the technology in the event there are no replacement technologies.	Potential providers/developers have insufficient capabilities to meet applicable mission concept needs.	Potential providers/developers have uncertain capability relative to applicable mission concept needs.	Single competent and credible provider/developer known	Two competent and credible providers/developers known	Multiple competent and credible providers/developers known

Changes in Consideration

- Technology needs list is unwieldy (>90 inputs) given that we can only afford to invest in ~5 SATs
  - Plan to reduce inputs for consideration. Options include:
    - ➟ Focus on technologies associated with NWNH
    - ➟ Focus on short and medium term needs in mid TRL (3-5) i.e. those with well defined, quantifiable paths to TRL 6.
    - ➟ Should we provide inputs to APRA for needs where current TRL is ~1-3
    - ➟ Remove matured technology needs (TRL >/= 6), engineering needs, duplications and similar needs statements
    - ➟ Focus on technologies for program objectives (launch vehicle, rover, avionics, spacecraft systems are best assess by OCT)
    - ➟ Emphasis on uniform description of technology need inputs
- Prioritization criteria can be reduced from 11 to 4

Draft Version of Revised Prioritization Criteria

Technology Needs Prioritization Criteria										
						Score Meaning				
#	**Criterion**	**Weight**	**Score 0-**	**Weight**	**General Description/Question**	**4**	**3**	**2**	**1**	**0**
1	Strategic Alignment	4	4	16	Technology enables or enhances a mission concept that is prioritized by the Decadal Review, other community-based review or study, other peer review, or programmatic assessment.	Highest ranking	Medium rank	Low rank	Not ranked by the Decadal but has applicable mission concept	No clear applicable mission concept
2	Benefits and Impacts	10	4	16	Impact of the technology on the applicable mission concept. Degree of unique or enabling/enhancing capability the technology provides toward the science objective and the implementation of the mission.	Critical and key enabling technology -required to meet mission concept objective(s)	Highly desirable technology significantly enhances science objective(s) and/or reduces need for critical resources	Desirable offers significant science or implementation benefits but not required for mission success	Minor science impact or implementation improvements	No science impact or implementation improvement
3	Scope of Applicability	3	4	12	How cross-cutting is the technology. How many mission concepts could benefit from this technology?	The technology applies to multiple mission concepts across multiple NASA programs **and** other agencies	The technology applies to multiple mission concepts across multiple NASA programs **or** other agencies	The technology applies to multiple mission concepts within a single NASA program	The technology applies to a single mission concept	No known applicable mission concept
4	Time To Anticipated Need	3	4	12	When does the technology need to be ready for a decision point or implementation?	Decision point is now or overdue, and implementation is needed within 7 years (this decade)	Decision point is now or overdue, or implementation is needed in 8 to 12 years (early 2020's)	Decision point is within 4 years, or implementation is needed in 13 to 17 years (late 2020's)	Decision point is 5 10 years away, or implementation is needed 18 years or later (2030's)	No anticipated need

Discussion

Back-up

PCOS Technology Needs Prioritization From 2012 PATR (top 2 of 4 priorities)

Priority	PCOS Technology Needs	Science
1	Large format Mercury Cadmium Telluride CMOS IR detectors, 4K x 4K pixels	Dark Energy
	High-resolution X-ray microcalorimeter: central array (~1,000 pixels): 2.5 eV FWHM at 6 keV; extended array: 10 eV FWHM at 6 keV.	X-ray
	Dimensionally stable optical telescope: stringent length (pm) and alignment (nrad) stability with low straylight	Gravitational Wave
	Metrology laser: 10 yr life, frequency-stabilized , 2W, low noise, fast frequency and power actuators	Gravitational Wave
	Lightweight, replicatable x-ray optics	X-ray
	High resolution X-ray gratings (transmission or reflection)	X-ray
	Large format (1,000-10,000 pixels) arrays of CMB polarimeters with noise below the CMB photon noise and excellent control of systematics	Inflation
	Micronewton thrusters: 10 yr. life, low contamination, low thrust noise	Gravitational Wave
	Lightweight precision mirror mounting structure	X-ray
2	High throughput anti-reflection coatings with controlled polarization properties	Inflation
	Stable and continuous sub-Kelvin coolers for detectors	Inflation
	High-throughput, light, low-cost, cold, mm-wave telescope operating at low backgrounds	Inflation
	Polarization modulating optical elements	Inflation

PCOS Technology Needs Prioritization From 2012 PATR (priority 3 of 4)

3	Gigapixel X-ray active pixel sensors	X-ray
	Very large format (>10^5 pixels) FPA with background-limited performance and multi-color capability	FarIR
	Molecular clocks/cavities with 10E-15 precision over orbital period; 10E-17 precision over 1-2 year experiment.	Fundamental Physics
	Cooled atomic clocks with 10E-18 to 10E-19 precision over 1-2 year experiment	Fundamental Physics
	Cryocooler <100 mK with 1 mK stability (IXO heritage)	X-ray
	Large throughput, cooled mm-wave to far IR telescope operating at background limit	FarIR
	Cooling to 50-300 mK	FarIR
	Megapixel microcalorimeter array	X-ray
	Coupling of ultra-stable lasers with high-finesse optical cavities for increased stability	Fundamental Physics
	Lightweight adjustable optics to achieve 0.1 arcsec high resolution grating spectrometer	X-ray

PCOS Technology Needs Prioritization From 2012 PATR (priority 4 of 4) 1 of 2

4	Coded aperture imaging: ~5 mm thick W and ~2.5 mm holes; ~0.5 mm W and ~0.2 mm holes	X-ray
	Wavefront sensing with cold atoms	Gravitational Wave
	Cooled Ge	Gamma
	Arrays of Si, CZT or CdTe Pixels	Gamma
	Finely pixelated CZT detectors for hard X-rays	X-ray
	ASIC on each ~20x20 mm crystal	X-ray
	Arcsecond attitude control to maintain resolution	X-ray
	Hard X-Ray grazing incidence optics with multi-layer coatings with at least 5" angular resolution	X-ray
	Loop Heat Pipe to radiators for ~-30 deg (Si) and ~-5 deg (CZT) over large areas	X-ray
	Low CTE materials	Gravitational Wave
	Large area atom optics	Gravitational Wave
	Long booms or formation flying	Gamma
	High rate X-ray Si detector (APS).	X-ray
	Compton telescope on single platform	Gamma
	1 m precision optics (1/1,000)	Gravitational Wave
	Sun-shield for atom cloud	Gravitational Wave
	Active cooling of germanium detectors	Gamma
	Passive cooling of pixel arrays	X-ray
	Low power ASIC readouts	X-ray
	Scintillators, cooled Ge	Gamma
	No optics; source isolation by collimator	X-ray
	ASIC readouts	Gamma
	Piezoelectric Adjustable X-ray Optics	X-ray
	Quadrant photodetector: low noise	Gravitational Wave
	ADC: 10 yr life, low noise (amplitude and timing)	Gravitational Wave

PCOS Technology Needs Prioritization From 2012 PATR (priority 4 of 4) 2 of 2

4	Depth graded multilayer coatings for hard X-ray optics	Next
	Laser interferometer ~1 kWatt laser	Gravitational Wave
	extendable optical bench to achieve 60 m focal length	X-ray
	Active cooling of germanium detectors	Gamma
	>3 m^2 Si (or CZT or CdTe) pixel arrays or hybrid pixels -- possibly deployable	X-ray
	Broadband X-ray Polarimeter	X-ray
	10 W near IR, narrow line	Gravitational Wave
	Finely pixelated detectors for high angular resolution hard X-ray imaging.	X-ray
	Gravity Reference Unit (GRU) with ~100x lower noise	Gravitational Wave
	focusing elements (e.g., Laue lens) on long boom or separate platform	Gamma
	Photocathodes, microchannel plates, crossed grid anodes	X-ray
	3 m precision optics	Gravitational Wave
	Low-frequency, wide-bandwidth, low-mass science antennas	21 cm
	Thin lightweight X-ray concentrator	X-ray
	Point source optimized X-ray concentrator	X-ray
	Lightweight, high throughput Fresnel optics	Near UV
	Advanced scintillators and readouts for gamma-ray detection	Gamma
	Lobster eye X-ray optics for all-sky monitors	X-ray
	Megapixel CCD camera	Gravitational Wave
	Ultra-low power, temperature resistant, radiation tolerant analog electronics	21 cm
	Ultra-low power, temperature resistant, radiation tolerant digital electronics	21 cm
	Autonomous low-power generation and storage	21 cm
	Thermal stability/control less than 10E-8 K variation	Fundamental Physics
	Low-cost launch vehicles for single payloads with few months mission durations	X-ray