Cosmic Origins Program Update

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COPAG Workshop
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- **Technology Priorities**
- SAT Proposal
- Funding Outlook

Technology Advancement

- PCOS and COR each convene a Technology Management Board (TMB) to review community-identified technologies that point toward future missions

- Output is prioritized list of investments; one purpose is as input to SAT call for proposals

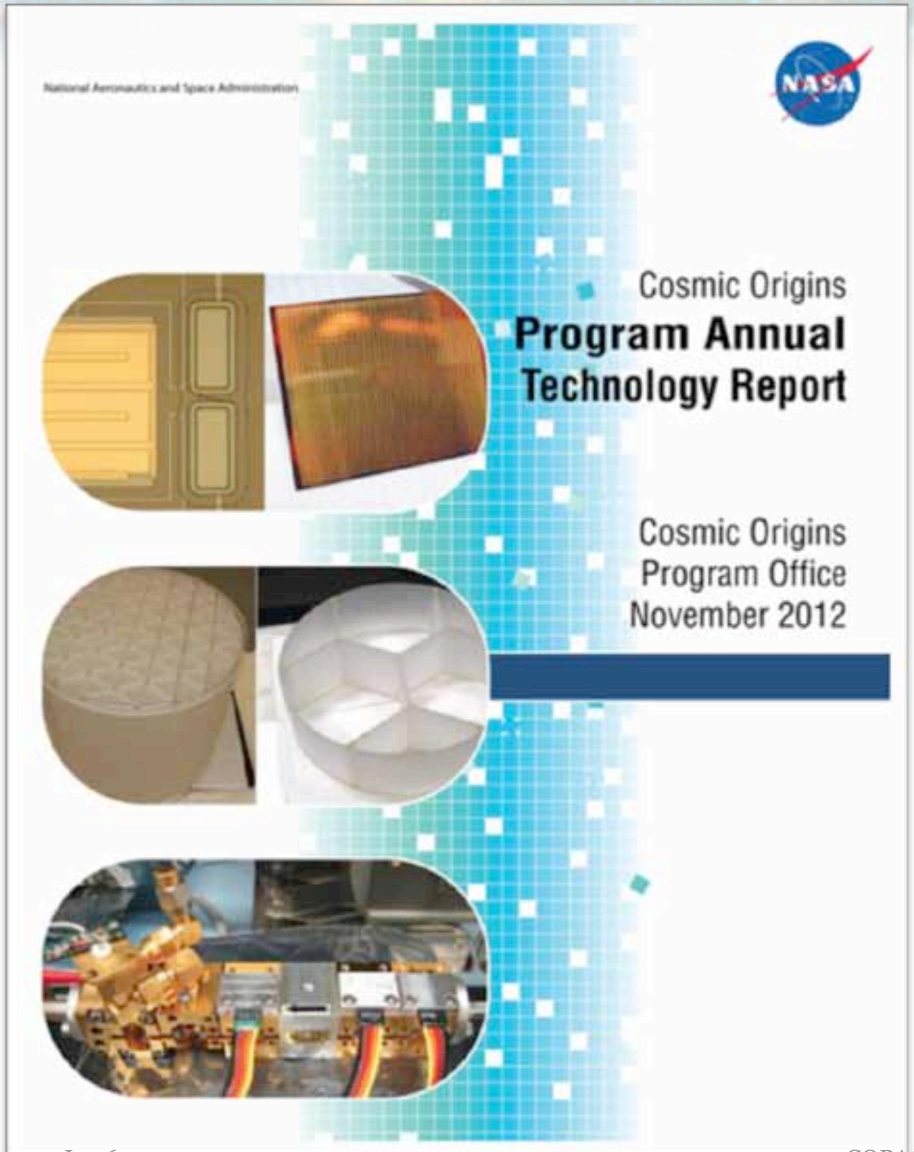
Technology++

- Program Office implements technology maturation, inheriting needs from the broadest community
- Stakeholders identify science needs
- PAG = formal introduction mechanism

COR Starting Point

1. High QE, large format UV detectors
2. Photon counting UV large-format detectors
3. High Reflectivity UV coatings
4. Large, low-cost, lightweight precision mirrors for UV/visible Telescopes
5. Deployable lightweight precision mirrors for UV/visible Telescopes
6. Very large format, low noise visible/IR detector arrays
7. Photon counting visible/IR detector arrays
8. Large format, low noise Far-IR direct detectors
9. Ultralow-noise far-IR direct detectors
10. Large, cryogenic far-IR telescopes
11. Interferometry for far-IR telescopes
12. High-Performance Sub-Kelvin Coolers
13. Coherent far-IR detector arrays
14. High-Efficiency Cryocoolers
15. High-Efficiency Spectrometers

PATR



- Contains status of COR-funded technology developments
- Provides new technology needs prioritization.
- Available online! http://cor.gsfc.nasa.gov

The Program Annual Technology Report (PATR)

- The PATR is an annual report that summarizes the Program's technology development activities for the year. It consists of an Executive Summary and 4 (significant) Sections:

  1. Provides an overview of the Program and its technology development activities
  2. Provides a status of the Program's technology development activities for the prior year and announces the new SAT award selections.
  3. Summarizes the technology needs obtained from the community.
  4. Provides a prioritized list of technology needs for the coming year to inform the SAT proposal calls and selection decision (information is also used to inform other NASA technology programs such as SBIR and other OCT planning)

- PATR is updated annually and is released in October to support annual technology development planning.

Annual Technology Needs Identification and Prioritization

- A Program technology needs identification and prioritization process has been implemented for PCOS and COR since last year
- 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 scientific priorities, benefits and impacts, timeliness, and effectiveness of investment.
- 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 a need and a customer

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Overview of the Technology Needs 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, technical 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, and effectiveness of investment.
- The technology needs and the resulting priorities are published each year in the PATR.

COR Technology Needs Prioritization

COR Technology Needs Prioritization	
High QE, large format UV detectors	**Priority 1.** Contains technology needs that the TMB has determined to be of the highest interest to the Cosmic Origins program and recommends that they **should** be invested in first, when funding is available
Photon counting UV large-format detectors	
High Reflectivity UV coatings	
Ultralow-noise Far-IR direct detectors	
Very large format, low noise Optical/IR detector arrays	**Priority 2:** Contains technology needs that the TMB feels are worthy of pursuit and **would** be invested in, if funding allows
Large, low-cost, light-weight precision mirrors for Ultra-Stable Large Aperture UV/Optical Telescopes	
Large format, low noise Far-IR direct detectors	
Photon counting Optical/IR detector arrays	
Heterodyne Far-IR receiver arrays	
High efficiency cryocoolers	**Priority 3:** Contains technologiy needs that are deemed to be supportive of COR objectives but, for various reasons, do not warrant investment at the present, although they **could** be invested in, if significant additional funding is available
High efficiency UV multi-object spectrometers	
Large, cryogenic far-IR telescopes	
High Performance Sub-Kelvin Coolers	
Deployable light-weight precision mirrors for future Very Large Aperture UV/Optical Telescopes	
Interferometry for far-IR telescopes	

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Summary

- The PATR is published annually to inform the community of the Program's technology development activities, technology needs and their prioritization.
- The community identifies technology needs by working with the PAG or through direct submission using the program web site.
- The Program TMB prioritizes these needs based on a published set of criteria
- These technology needs and priorities are published each year in the PATR along with the status of technologies that were funded the previous year.
- The program references these priorities and this report over the following year as the calls for technology proposals are drafted and investment decisions are made.
- This process improves the transparency and relevance of technology investments, provides the community a voice in the process, and leverages the technology investments of external organizations by defining needs and a customer.

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COR Top Priorities

- High-QE, large-format UV detectors – QE (>70%), large-format (>2k × 2k) detectors for operation at 100–400 nm or broader .
- Photon-counting, large-format UV detectors – For spectroscopy, high QE (>50%), very low-noise ($<10^{-7}$ ct/pixel/s), large-format (>2k × 2k) photon-counting detectors for operation at 100–400 nm or broader .
- UV coatings –high reflectivity, high uniformity, and wide bandpasses, operating from visible to wavelengths below 100 nm .
- Ultra-low-noise far-IR direct detectors – For spectroscopy at wavelengths between ~30 µm and ~300 µm;
  NEP ≈ 3×10^{-21} W/√Hz arrayable in a close-packed configuration in at least one direction

SAT Language

- Detectors:
  - High-QE, large format, photon counting & ultralow-noise
  - From Extreme UV to Far-IR
  - Unchanged?

SAT Language

- UV Coatings:
  - Reflective, antireflective, wavelength-selective
  - Emphasis on Lyman UV (900-1300Å)

  - Changes from previous:
    - Allows A/R coatings; dichroics, filters
    - De-emphasizes Al + protective layer

SAT Language

- Optics:
  - Scalable manufacturing, test, control to sizes of at least 4m
  - Advances in: areal density, production time, cost, precision, short UV wavelengths, surface controls
  - Changes from previous:
    - Size from 2m → 4m
    - Removed cryogenic optics; emphasize Lyman UV

SAT Language

- Added sentence about lower-tier priorities:
  - Heterodyne far-IR receiver arrays for, e.g., SOFIA
  - High performance cryocoolers for space flight for future far-IR mission
- Added language allowing piggyback on suborbital flight (balloon or sounding rocket)
- Added language about reporting requirements for funded SAT PIs

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National Aeronautics and Space Administration
Cosmic Origins Program Office

Astrophysics Funding

	FY04 Final $k	FY05 Final $k	FY06 Final $k	FY07 Final $k	FY08 Final $k	FY09 Final $k	FY10 Final $k	FY11 Final $k	FY12 Projected
Particle Astro	$ 8,248	$ 7,671	$ 8,544	$ 7,631	$ 6,672	$ 8,201	$ 8,260	$ 8,243	$ 8,585
High Energy	$ 14,548	$ 13,693	$ 14,779	$ 12,782	$ 12,406	$ 13,886	$ 14,110	$ 13,911	$ 14,548
UV/Opt/IR/ Sub-mm	$ 20,409	$ 18,742	$ 21,851	$ 17,442	$ 19,094	$ 22,353	$ 21,534	$ 21,295	$ 23,032
Other	$ 1,019	$ 854	$ 338	$ 394	$ 594	$ 670	$ 673	$ 641	$ 1,627
APRA Total	$ 44,224	$ 40,960	$ 45,511	$ 38,250	$ 38,765	$ 45,110	$ 44,577	$ 44,090	$ 47,791
Orig Solar Systems	$ 4,209	$ 3,872	$ 4,150	$ 3,673	$ 2,965	$ 3,000	$ 2,807	$ 2,944	$ 2,978
Astro Theory Program	$ 7,860	$ 7,363	$ 10,245	$ 10,227	$ 11,696	$ 11,890	$ 12,262	$ 12,577	$ 13,226
R&A (399131)	$ 56,293	$ 52,195	$ 59,906	$ 52,150	$ 53,426	$ 60,000	$ 59,646	$ 59,611	$ 63,995
ADAP/LTSA	$ 16,986	$ 15,700	$ 15,189	$ 12,641	$ 12,013	$ 14,384	$ 13,258	$ 14,132	$ 16,320
Core Research	$ 73,279	$ 67,895	$ 75,095	$ 64,791	$ 65,439	$ 74,384	$ 72,904	$ 73,743	$ 80,315
TPF/FS	$ 2,000	$ 2,000		(Foundation Science; now in ATP)					
Beyond Einstein FS	$ 4,000	$ 3,000	$ 2,000						
ASMCS (399131)	Mission concept studies				$ 3,452	$ 442			
PCOS SR&T				(Fundamental Physics; now in APRA)			$ 968	$ 184	
Technology Fellows									$ 600
TOTAL	$ 79.3M	$ 72.9M	$ 77.1M	$ 64.8M	$ 68.9M	$ 74.8M	$ 73.9M	$ 73.9M	$ 80.9M
		$7M cut	smaller cut	15% cut	partial recovery	more recovery	flat	flat	growth!

In response to the Astro2010 Decadal Survey recommendations:
-- The budget for research awards increased by 10% in FY12
-- Theory and Computation Networks: AAAC studying NASA-NSF program
-- Suborbital program (payloads, balloons) growth deferred

From Hertz 11/2012

National Aeronautics and Space Administration
Cosmic Origins Program Office

Future SR&T?

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Astrophysics	**631.1**	**672.7**	**659.4**	**703.0**	**693.7**	**708.9**	**710.2**
Astrophysics Research	146.9	164.1	176.2	189.1	205.1	211.5	218.7
Astrophysics Research and Analysis	59.6	64.6	64.2	65.5	66.8	68.2	69.5
Balloon Project	26.8	31.6	31.3	31.2	32.8	34.2	34.3
Other Missions and Data Analysis	60.5	67.9	80.6	92.3	105.4	109.2	114.8
Keck Single Aperture	2.2	2.3	2.4	2.4	2.5	2.5	2.5
Astrophysics Data Analysis Program	14.1	16.3	18.3	18.5	18.5	19.1	19.1
Astrophysics Data Curation and Archival	20.8	20.1	20.0	19.6	21.7	22.1	22.2
Astrophysics Senior Review			16.3	24.5	33.5	35.2	40.0
Education and Public Outreach	13.2	15.4	10.1	10.1	10.1	10.1	10.1
Directorate Support - Space Science	10.1	13.7	13.5	13.9	14.0	14.5	14.5
Directed Research and Technology				3.3	5.2	5.6	6.4
Cosmic Origins	229.1	237.3	240.4	228.5	215.1	205.3	205.7
Hubble Space Telescope (HST)	91.7	95.7	98.3	98.3	94.3	90.2	90.5
SOFIA	79.9	84.2	85.5	88.0	88.0	86.0	85.9
Other Missions And Data Analysis	57.6	57.4	56.6	42.2	32.8	29.1	29.3
Spitzer Space Telescope	22.7	17.8	9.8				
Herschel	24.6	24.0	20.8	15.8	5.8		
Cosmic Origins SR&T	7.9	10.6	19.4	19.5	20.7	21.7	21.8
Cosmic Origins Future Missions	0.7	1.0	1.7	1.7	1.0	2.0	2.0
Cosmic Origins Program Management	1.7	4.0	4.9	5.2	5.3	5.4	5.5

From Hertz 11/2012; notional FY14+

Technology Buckets

- Strategic Astrophysics Technologies (SAT) – Competed via ROSES
  - Program priorities established and documented in the COR Program Annual Technology Report (PATR)
  - SAT call for proposals is informed by the priorities in PATR
  - Selection of the proposed technologies is based in part on the program priorities – thus consistency is ensured!
- Targeted Technologies (formerly "Directed")
  - Tied to a specific mission concept
  - Documented in a Technology Development Plan
  - Vetted through a TMB
- Unique Infrastructure – Directed/Competed
  - Capability that serves the community
  - Examples include optical test beds and detector development and characterization labs at NASA Centers or academic institutions

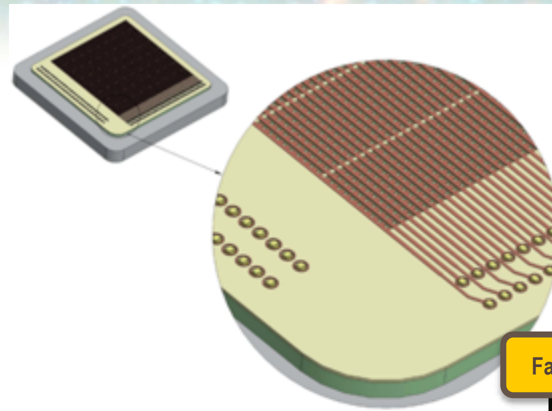
COR SAT Selections for FY12+

Proposal Title	PI	Institution	Area
Advanced UVOIR Mirror Technology Development for Very Large Space Telescopes	Phillip Stahl	Marshall Space Flight Center	*Advanced, Normal Incidence Optics*
High performance cross-strip micro-channel plate detector systems for spaceflight experiments	John Vallerga	UC Berkeley	*UV Detectors*
Enhanced MgF2 and LiF Over-coated Al Mirrors for FUV Space Astronomy	Manuel Quijada	Goddard Space Flight Center	*Ultraviolet Coatings*

National Aeronautics and Space Administration
Cosmic Origins Program Office

COR Technology Progress at End of Year

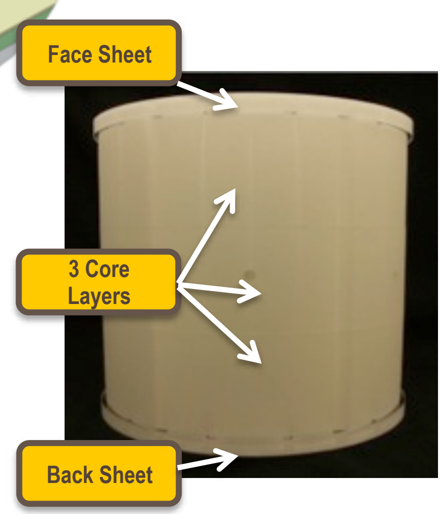
- Cross Strip MCP detector systems for spaceflight – John Vallerga/UC Berkeley
  - Major designs complete & in fabrication



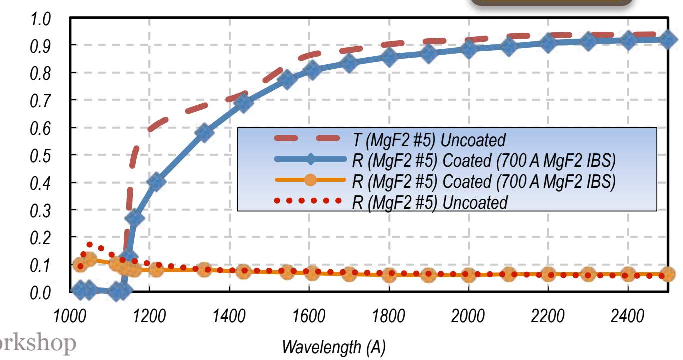
50mm XS anode on hermetic backplate

- Advanced UVOIR Mirror Technology Development Dr. Phil Stahl/MSFC
  - Demonstrated deep core mirror fab

Deep core mirror



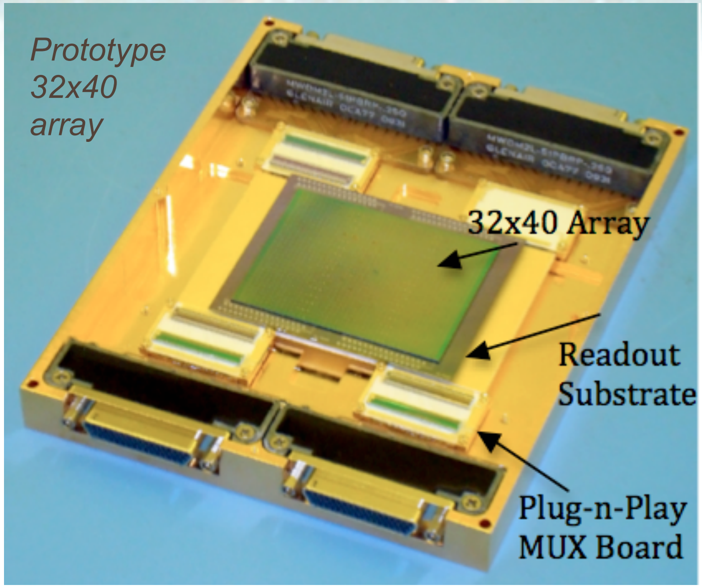
- Enhanced MgF2 and LiF Over-coated Al Mirrors for FUV Space Astronomy Dr. Manuel Quijada/GSFC
  - Coatings of MgF_2, LuF_3 made



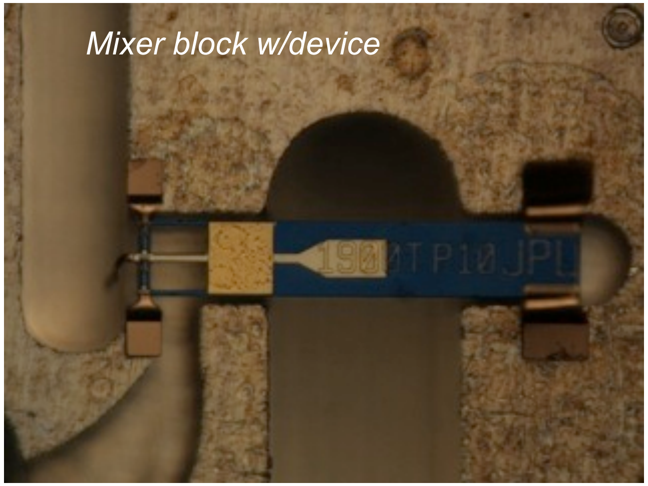
Reflectivity

COR Technology Progress at End of Year

– Superconducting TES Bolometer Arrays for Far Infrared Imaging, Spectroscopy, and Polarimetry – Harvey Moseley/GSFC
  - All component technologies demonstrated
  - Selected for SOFIA/HAWC+ instrument upgrade (SOFIA 2nd Gen); starting now



– Heterodyne Technology for SOFIA – Dr. Paul Goldsmith/JPL
  - Completed mixer blocks and multipliers for 1.9THz



National Aeronautics and Space Administration
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COR SAT Selections for FY13+

Proposal Title	PI	Institution	Area
Ultraviolet Coatings, Materials and Processes for Advanced Telescope Optics	Kunjithapatham Balasubramanian	JPL	*UV Coatings*
Kinetic Inductance Detector Imaging Arrays for Far-Infrared Astrophysics	Jonas Zmuidzinas	Caltech	*Far-IR Detectors*
Improvement of the Performance of Near-Infrared Detectors for NASA Astrophysics Missions	Selmer Anglin	Teledyne	*UVOIR Detectors*
H4RG Near-IR Detector Array with 10 Micron Pixels for WFIRST	Bernie Rauscher	GSFC	*UVOIR Detectors*
High Efficiency Detectors in Photon Counting and Large Focal Plane Arrays for Astrophysics Missions	Shouleh Nikzad	JPL	*UVOIR Detectors*

Need from Community

- Articulate the key drivers for Inflation Probe, SOFIA, & future Far-IR Observatory
  - Science Requirements
  - Technology development needs
  - Timeliness
- Identify alternative mechanisms for achieving PCOS/COR science goals
  - Suborbital concepts
  - Coordination with ground-based facilities
  - Technology leading to Explorers, etc.
- Identifying important areas for future SAT calls

Help?

- Technology Needs – Add to PATR/SAT
- Alternatives to Major Missions
- Things Missing from the Portfolio?