

Agenda

(Presentations at pcos.gsfc.nasa.gov/phypag)

- **12:30PM – PCOS/PhysPAG, Ann Hornschemeier, GSFC, PCOS Project Office**
- **12:45 PM—Inflation Probe in the light of Planck/Suborbital programs, Shaul Hanany (REMOTE PRESENTER)**
- **12:55 PM - LISA in the light of eLISA, Neil Cornish for the GWSAG**
- **1:05 PM—Gamma-Ray SAG—the Next Steps, Liz Hays**
- **1:15 PM—Cosmic Ray SAG—the Next Steps, Angela Olinto**
- **1:25 PM—Audience questions/Comments**
- **1:30 PM—Adjourn**

- **NOTE ALSO, Presentations from HEAD last week by:**
 - **Jay Bookbinder, AXSIO in the light of Athena**
 - **Daniel Stern, WFIRST in the light of Euclid**



PhysPAG

(on behalf of John Nousek, PhysPAG chair)

+

PCOS in the Astrophysics Implementation Plan

(on behalf of Richard Griffiths, NASA HQ)

+

FY 13 PCOS Program Office Update

ANN HORNSCHEMEIER

Chief Scientist, Physics of the Cosmos Program

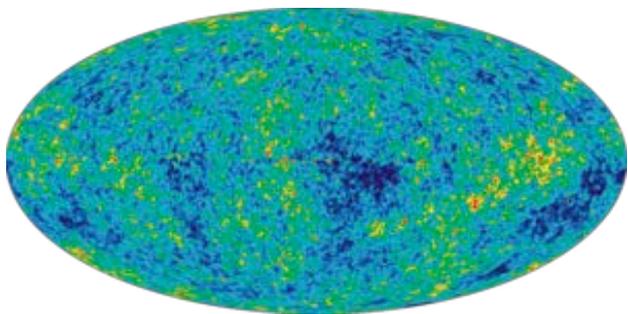
<http://pcos.gsfc.nasa.gov>

Deputy Chief Scientist: Alan Smale

HQ Program Executive: Lia LaPiana

HQ Program Scientist: Richard Griffiths

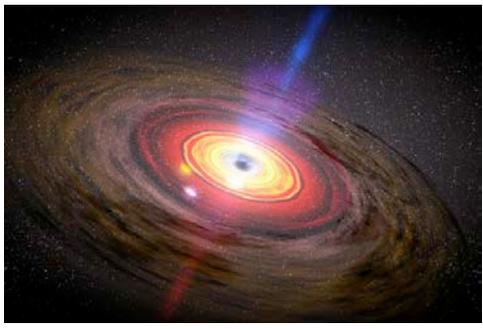
HQ Deputy Program Scientist: Wilt Sanders



Physics of the Cosmos Science Objectives



- Expand our knowledge of dark energy
- Precisely measure the cosmological parameters governing the evolution of the universe and test the inflation hypothesis of the Big Bang
- Test the validity of Einstein's General Theory of Relativity and investigate the nature of spacetime
- Understand the formation and growth of massive black holes and their role in the evolution of galaxies



- Explore the behavior of matter and energy in its most extreme environments
- *(Note that the language of these science objectives is currently being reviewed by NASA HQ)*

PhysPAG Charter (Terms of Reference)

from John Nousek, PhysPAG Chair

- The Physics of the Cosmos Program Analysis Group (PhysPAG) is responsible for soliciting and coordinating community input in the development and execution of NASA's Physics of the Cosmos (PCOS) Program
- PhysPAG serves as a community-based forum for analysis in support of PCOS objectives, architecture planning, and activity prioritization.
- PhysPAG formally presents findings of its analyses to NASA SMD through the NASA Advisory Council (NAC).
- The Chair of the PhysPAG is drawn from the membership of the NAC Astrophysics Subcommittee
- The PhysPAG Chair is assisted by an Executive Committee that supports planning and activities of the group
- Executive Committee:

Jason Rhodes, JPL

Shaul Hanany, Univ. of Minnesota

Jay Bookbinder, Harvard-Smithsonian
Chicago

Liz Hays, GSFC

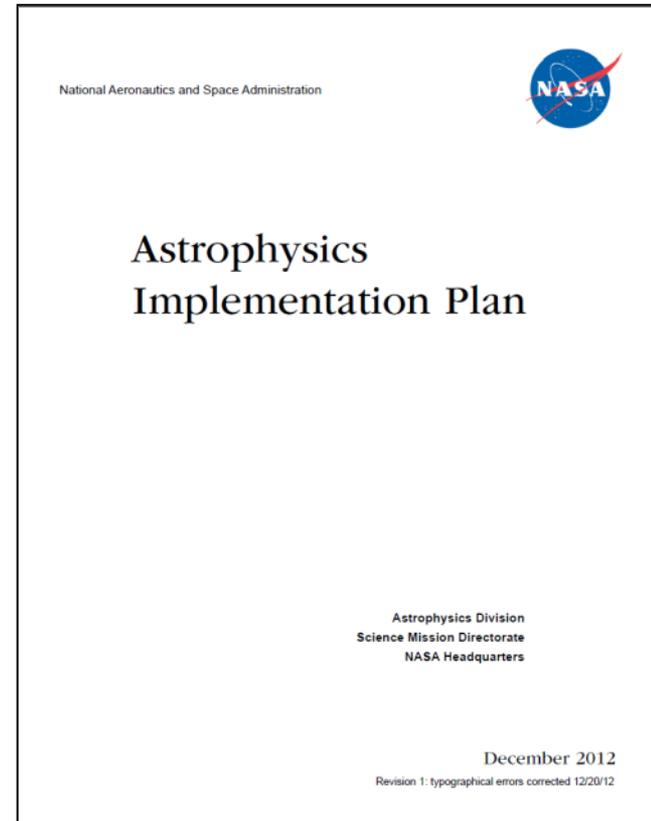
Guido Mueller, Univ. of Florida

Angela Olinto, Univ. of

Astrophysics Implementation Plan (Richard Griffiths, NASA HQ)

- **Astrophysics Implementation Plan**

- White paper developed by Astrophysics Division
- Describes Astrophysics Division strategy in response to the Decadal Survey recommendations
- Was discussed with the Committee on Astronomy and Astrophysics (CAA) and the NAC Astrophysics Subcommittee (APS) prior to finalization
- The Implementation Plan is consistent with the budget as of December 2012 (the notional runout of the President's FY13 budget request). The Plan will evolve with changes in the budget (e.g. FY13 sequestration, FY14 President's budget request).
- The Astrophysics Implementation Plan is available for download at <http://science.nasa.gov/astrophysics/documents/>



Astrophysics Near-term Goal and Strategy

(Richard Griffiths, NASA HQ)

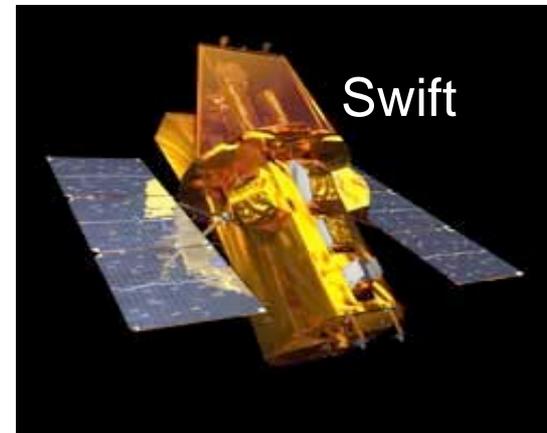
- **The goal is to be prepared to start a new strategic Astrophysics mission to follow JWST as soon as funding becomes available while continuing to advance the science during the interim.**
 - It cannot be assumed that the authority to start a new large mission (i.e., WFIRST) will be granted in 2017, therefore concepts for moderate cost missions, probes that cost no more than approximately \$1B, must also be considered.
 - Any mission concept studied must derive from the science objectives of the Decadal Survey's prioritized activities.
 - A near term program of mission concept studies and technology development is being continued
 - These studies will inform a mid-decade decision on which mission will begin formulation starting as early as FY17.

PCOS Operating Missions

OPERATING



RELATED

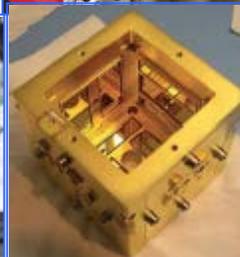
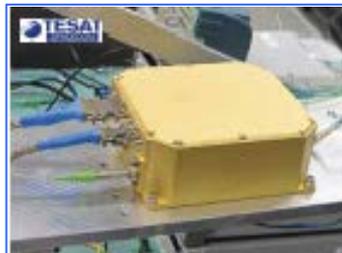
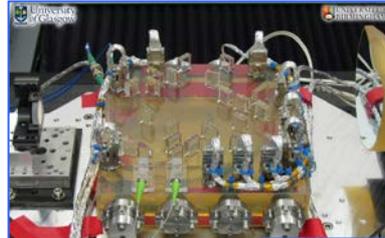
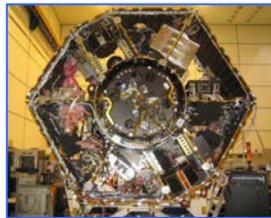
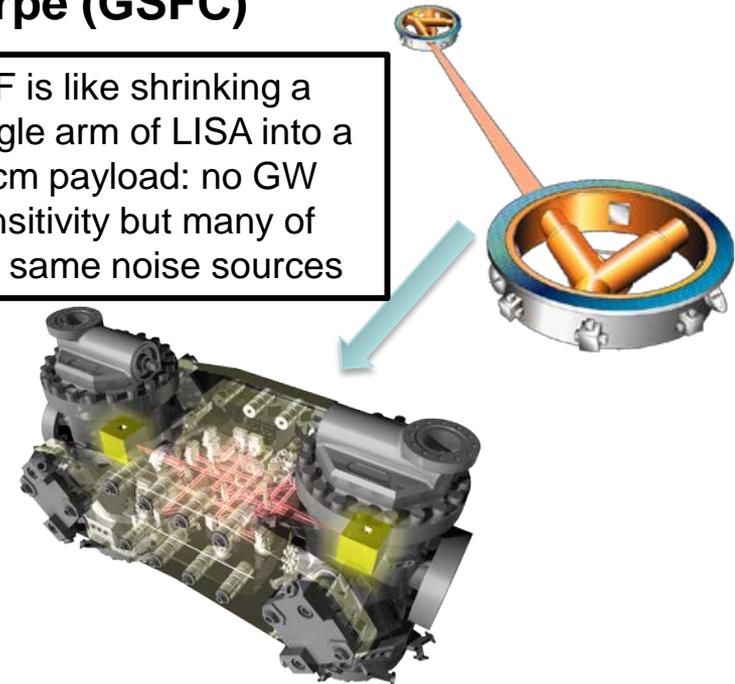


LISA Pathfinder

U.S. study scientist: Ira Thorpe (GSFC)

| | |
|----------------------------|--|
| Purpose | Demonstrate essential technology for future space-based GW missions |
| Scientific Payloads | LISA Test Package (LTP) - Europe ST7 - NASA |
| Measurement Goal | Drag-free flight of test masses with atto-g residual accelerations |
| Status | LTP – finalizing construction ST7 – delivered & integrated Spacecraft – undergoing I&T |
| Anticipated Launch | 2015 |

LPF is like shrinking a single arm of LISA into a 30cm payload: no GW sensitivity but many of the same noise sources



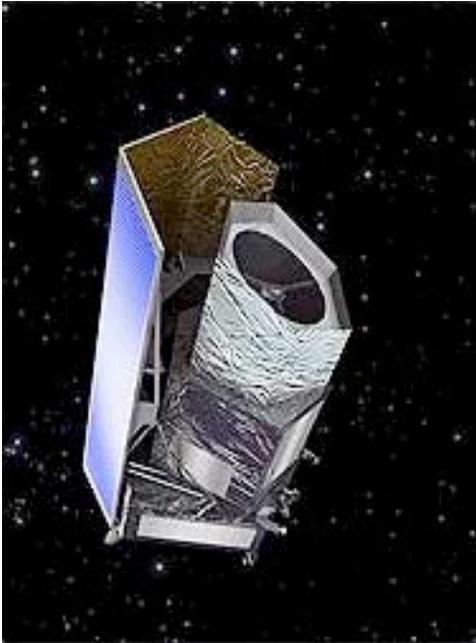
LPF hardware is nearly complete and has been subjected to an extensive ground test campaign. Clockwise from top left: LPF spacecraft, LTP optical bench, LTP laser, LTP electrode housing, ST7 thruster unit.

Euclid – NASA Contribution

HQ Program Executive: Lia LaPiana

HQ Program Scientist: Richard Griffiths

- NASA's contribution to ESA's Euclid mission:
 - Near Infrared Spectrograph and Photometer (NISP) flight subassemblies (detector + ASIC + cryo-cable = 'triplet') that meet ESA's requirements for testing & characterization.
 - Currently in Phase B.
- Euclid Project assigned to JPL under NASA's PCOS Program:
 - JPL Euclid Project Manager – Ulf Israelsson
 - JPL Euclid Project Scientist – Michael Seiffert
- **NASA now has a seat on the Euclid Consortium Board, the Consortium's governing body, and on the ESA Euclid Science Team:**
 - 40 U.S. scientists selected to participate in Euclid Science Team with P.I.s Jason Rhodes (JPL), Sasha Kashlinsky (GSFC) and Ranga-Ram Chary (Caltech)
- PCOS Program Office: provides programmatic insight and oversight; worked with NASA HQ on tailoring NPR 7120.5 for Euclid; appointed the Independent Review Team; and provides the Euclid Mission Manager (Tom Griffin).
- Euclid Science Data Center study underway (IPAC)



Current Gravitational-Wave Activities

NASA study scientist:
Tuck Stebbins

NB: Gravitational waves likely will be detected by LIGO before JWST launches

● Preparing Technology Development Plans for two tracks

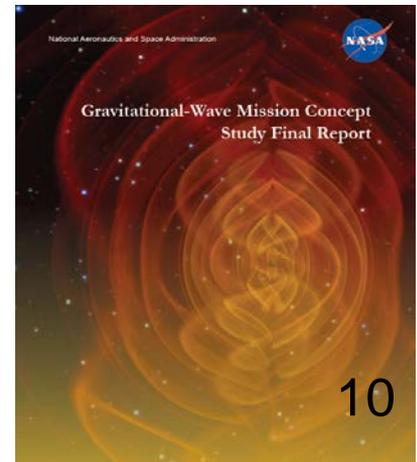
1. ESA-led partnership on L2 (TRL5 by 2018)
 - Lasers
 - Telescope
 - Phase Measurement System
 - Micronewton thrusters
2. NASA-led partnership after Astro2020 (TRL 5 by 2020)
 - Optical bench
 - Gravitational Reference Sensor

● Participating in the eLISA Consortium in support of L2/L3

- Attending meetings, preparing a white paper for May 2013 deadline
- L2/L3 call allows international participation up to 20% of the European contribution

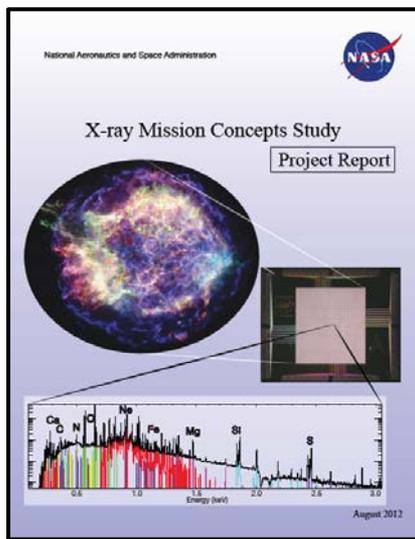
● Concept refinement for future NASA-led partnership

- Preferred concept is the Space-based Gravitational-wave Observatory Mid (SGO Mid) from the 2012 study.
 - Scaled-down LISA, retaining 3 arms
 - Delivers most of the Astro2010 endorsed science
- Exploring trade studies for risk and cost reduction



Current X-ray Study Activities

NASA study scientist: Rob Petre



X-ray observatories in the \$1B class that address all or most of the IXO science objectives are feasible for start within this decade, but only if technical risk is controlled through advance development of key technology to TRL-6

● X-ray Technology Development Plan (TDP)

- Focusing on technology for near term opportunity (probe class mission)
 - 5-10 arcsec mirrors, calorimeters, gratings
- Cost and schedule to advance these technologies to TRL 6

● Preparations for FY2014 Probe-class mission study

- Revisit science case (via X-ray SAG subcommittee)
- Determine key technical and mission trades using notional mission concepts as starting point

● Discussions with European counterparts about participation in L2/L3 X-ray mission

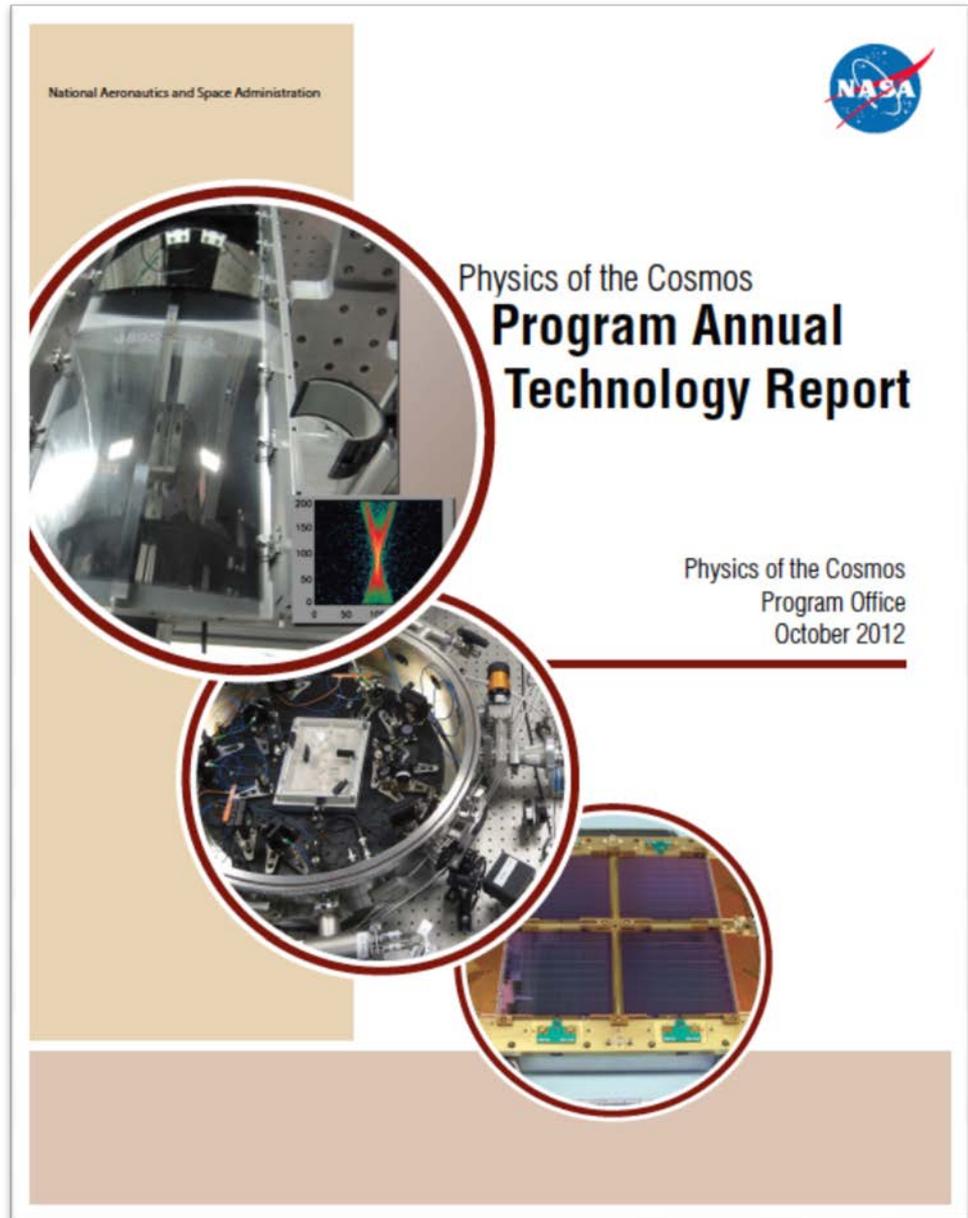
- L2 science white papers due in May: European X-ray community is preparing Athena science white paper
- Potential NASA participation at ~15-20 percent level

Current Inflation Probe Activities

- **According to the NASA astrophysics implementation plan, there are no formal PCOS activities for IP for 2013**
- **There is a possible study planned for 2015 after the Planck CMB polarization results are released**

Technology Prioritization

- The PCOS Program Annual Technology Report (PATR) describes the Program's technology management activities
- **The PATR summarizes progress on all currently-funded SAT programs.**
- **The PATR defines priorities for technology investments for the upcoming year.** The technology needs are prioritized using a set of criteria (described in the report).
- The PCOS Program Analysis Group (PhysPAG) is the main conduit for collecting technology needs identified by the community.



Upcoming PCOS Community Interaction Opportunities

- We likely will have sessions in January 2014 at the AAS meeting in Washington, D.C.
- Future opportunities TBD
- MORE INFO: pcos.gsfc.nasa.gov/phypag

Astrophysics Roadmap Overview

(Richard Griffiths, NASA HQ)

- **An Astrophysics Roadmap will be developed by a task force of the Astrophysics Subcommittee (APS) during 2013**
 - Create a compelling, 30-year vision for astrophysics at NASA
- **Meetings:**
 - The team will meet regularly using telecons, video conferencing and a couple F2F meetings
- **Community Input:**
 - Community submitted abstracts of science and technology challenges
- **Reporting**
 - ApS Chair Brad Peterson is ex officio member of Roadmap team
 - Final report ready for approval by ApS with public release by Dec.16, 2013
- **The Roadmap Charter is available at**
<http://science.nasa.gov/science-committee/subcommittees/nac-astrophysics-subcommittee/astrophysics-roadmap/>

Astrophysics Roadmap Overview

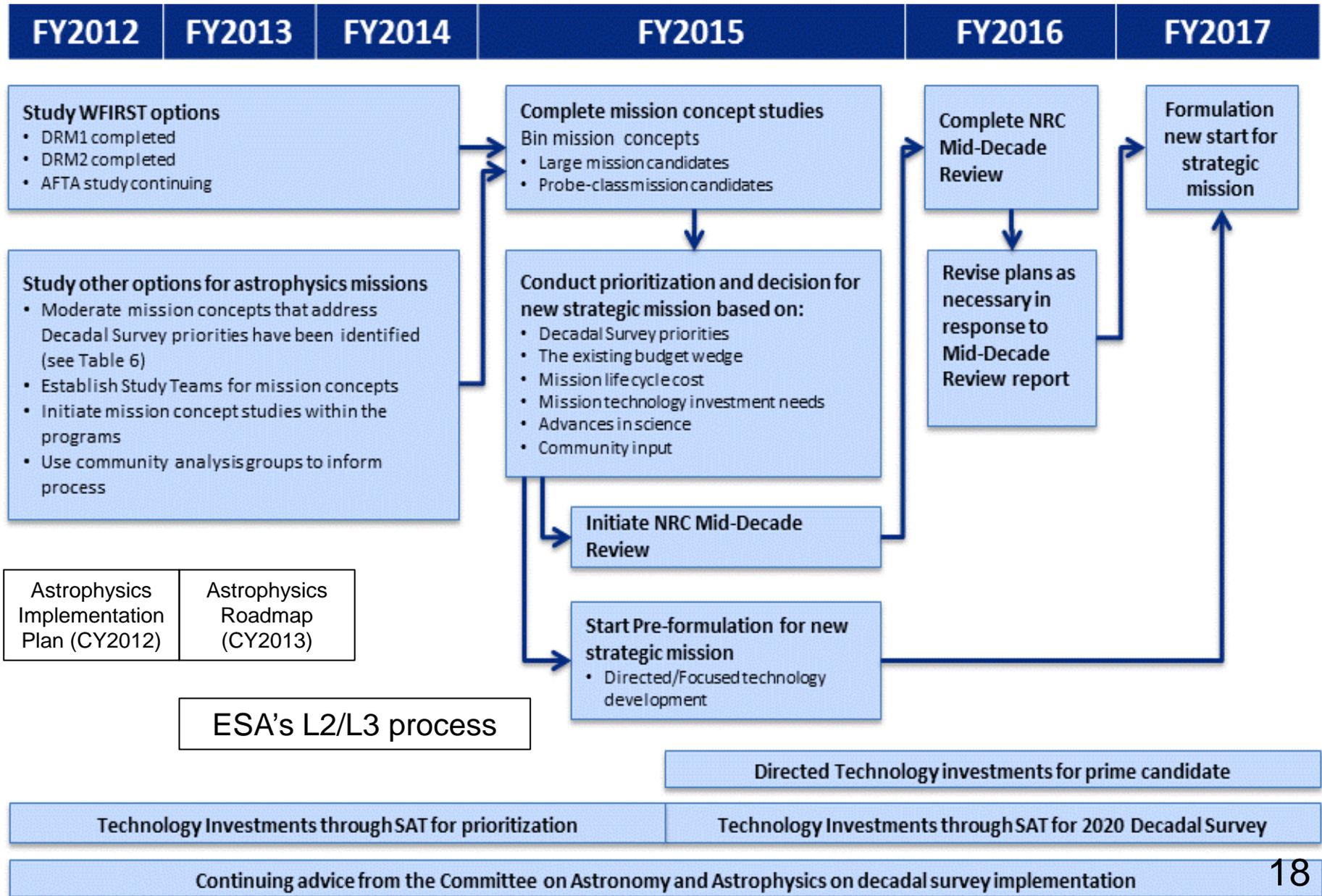
(Richard Griffiths, NASA HQ)

- **Excellent team with broad expertise and visionary thinkers**
 - Many early and mid-career scientists on the team

| | | | |
|--|----------------------|-------------------------|---------------------|
| Chryssa Kouveliotou (<i>Chair</i>) | <i>NASA MSFC</i> | Dieter Hartmann | <i>Clemson</i> |
| Joan Centrella (<i>Exec Sec</i>) | <i>NASA HQ</i> | Jason Kalirai | <i>STScI</i> |
| Brad Peterson (<i>APS Chair, Ex Officio</i>) | <i>Ohio State</i> | Heather Knutson | <i>Caltech</i> |
| Eric Agol | <i>Univ. Wash</i> | Michael Niemack | <i>Cornell</i> |
| Natalie Batalha | <i>NASA Ames</i> | Feryal Ozel | <i>Univ Arizona</i> |
| Misty Bentz | <i>Georgia State</i> | Chris Reynolds | <i>Univ MD</i> |
| Neil Cornish | <i>Montana State</i> | Aki Roberge | <i>NASA GSFC</i> |
| Alan Dressler | <i>Carnegie Obs</i> | Kartik Sheth | <i>NRAO</i> |
| Enectali Figueroa-Feliciano | <i>MIT</i> | David Weinberg | <i>Ohio State</i> |
| Scott Gaudi | <i>Ohio State</i> | Jonas Zmuidzinas | <i>JPL/Caltech</i> |
| Olivier Guyon | <i>Univ Arizona</i> | | |

BACK-UP SLIDES

Astrophysics Near-term Strategy



MOONI PCOS Program Office Leadership

- ** Program Manager: Mansoor Ahmed a.k.a. Mooni)
- ** Deputy PM: Tom Griffin
- ** Deputy PM: Mark Brumfield
- Chief Scientist: Ann Hornschemeier
- Deputy Chief Scientist: Alan Smale
- ** Chief Technologist: Mark Clampin
- ** ACTO Chief Technologist: Thai Pham

**** = Shared with COR, Cosmic Origins**



TOM



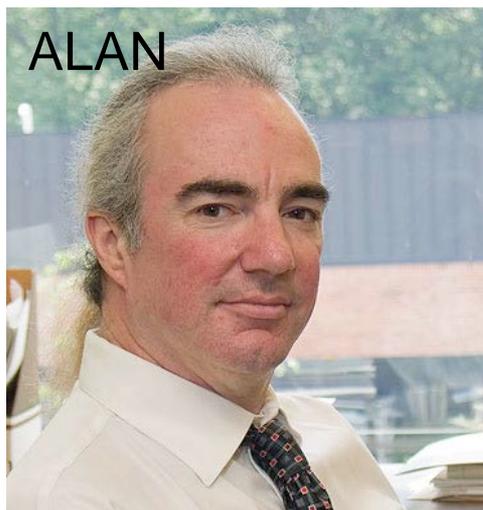
MARK B



THAI



ANN



ALAN



MARK C

PCOS SAT Technologies Selected for Development Starting in FY12 for 2 Years

| Title | PI | Institution | Area |
|--|-----------------|--------------------|-----------|
| Development of Fabrication Process for Critical-Angle X-ray Transmission Gratings | M. Schattenburg | MIT | X-ray |
| Antenna-Coupled Superconducting Detectors for Cosmic Microwave Background Polarimetry | J. Bock | JPL/Caltech | Inflation |
| Directly-Deposited Blocking Filters for Imaging X-ray Detectors | M. Bautz | MIT | X-ray |
| Off-plane Grating Arrays for Future Missions | R. McEntaffer | University of Iowa | X-ray |
| Development of Moderate Angular Resolution Full Shell Electroplated Metal Grazing Incidence X-ray Optics | P. Reid | SAO | X-ray |

PCOS SAT Technologies Selected for Development Starting in FY13 for 2 Years

| Title | PI | Inst. | Area |
|---|--------------|----------|-------|
| Next generation X-ray Optics: High Resolution, Light Weight, and Low Cost (| W. Zhang | GSFC | X-ray |
| Demonstrating Enabling Technologies for the High-Resolution Imaging Spectrometer of the Next NASA X-ray Astronomy Mission | C. Kilbourne | GSFC | X-ray |
| Colloid Microthruster Propellant Feed System for Gravity Wave Astrophysics Missions | J. Ziemer | JPL | GW |
| Telescope for a Space-based Gravitational Wave Mission | J. Livas | GSFC | GW |
| Advanced Laser Frequency Stabilization Using Molecular Gasses (co-funded with OCT GCTP) | J. Lipa | Stanford | GW |

PCOS/COR Education and Public Outreach

Award-winning Team

- Team members have won numerous awards, including NASA Exceptional Public Service Medal (2011), NASA Honor Awards (2009, 2011), Goddard Team Award for Outreach (2008), Goddard Honor Award for Outreach (2011) and ASD Peer Awards (2011, 2012)

Substantial Achievements

- AfterSchool Universe Program: 12-session astronomy program for middle-schoolers, has reached >12,000 children in 3 yrs; 900+ facilitators in 44 states + DC and Puerto Rico; 58 certified trainers
- Big Explosions & Strong Gravity: day-long Girl Scouts event has reached thousands of girls; now being broadened to other young audiences
- Blueshift Podcast/Blog: behind the scenes look at PCOS/COR science, missions, news, has 22,000+ Twitter followers; ~8,500 Facebook fans

Strong Future

- Continuing involvement/expansion of the above, plus:
- Space Forensics: presents astronomical mysteries in the style of crime scene investigations
 - Cornerstone of PCOS/COR EPO effort - piloted in 2007 – four cases currently under development – standards-based classroom packages developed 2013-2014 - interactive website, traveling museum kiosk planned for future years
- Multiwavelength Universe Tour: video clips + online interactive photo studio to provide the public with a multiwavelength view of astronomical objects



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 ($\sim 1,000$ pixels): 2.5 eV FWHM at 6 keV; extended array: 10 eV FWHM at 6 keV. | X-ray |
| | Dimensionally stable optical telescope: stringent length (μm) 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 |