



# Astrophysics

Committee on Astronomy  
and Astrophysics

**Paul Hertz**

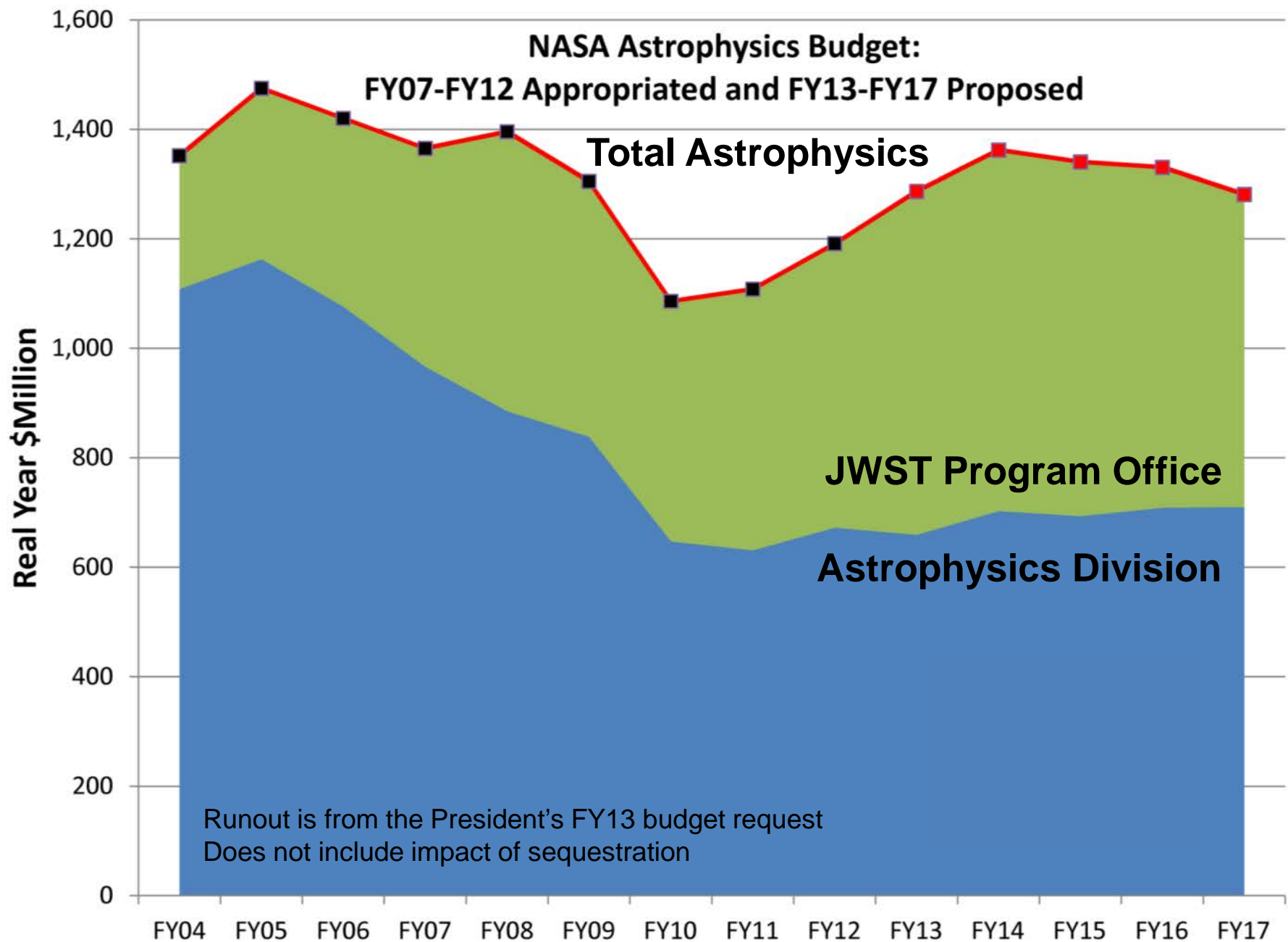
Director, Astrophysics Division

March 7, 2013

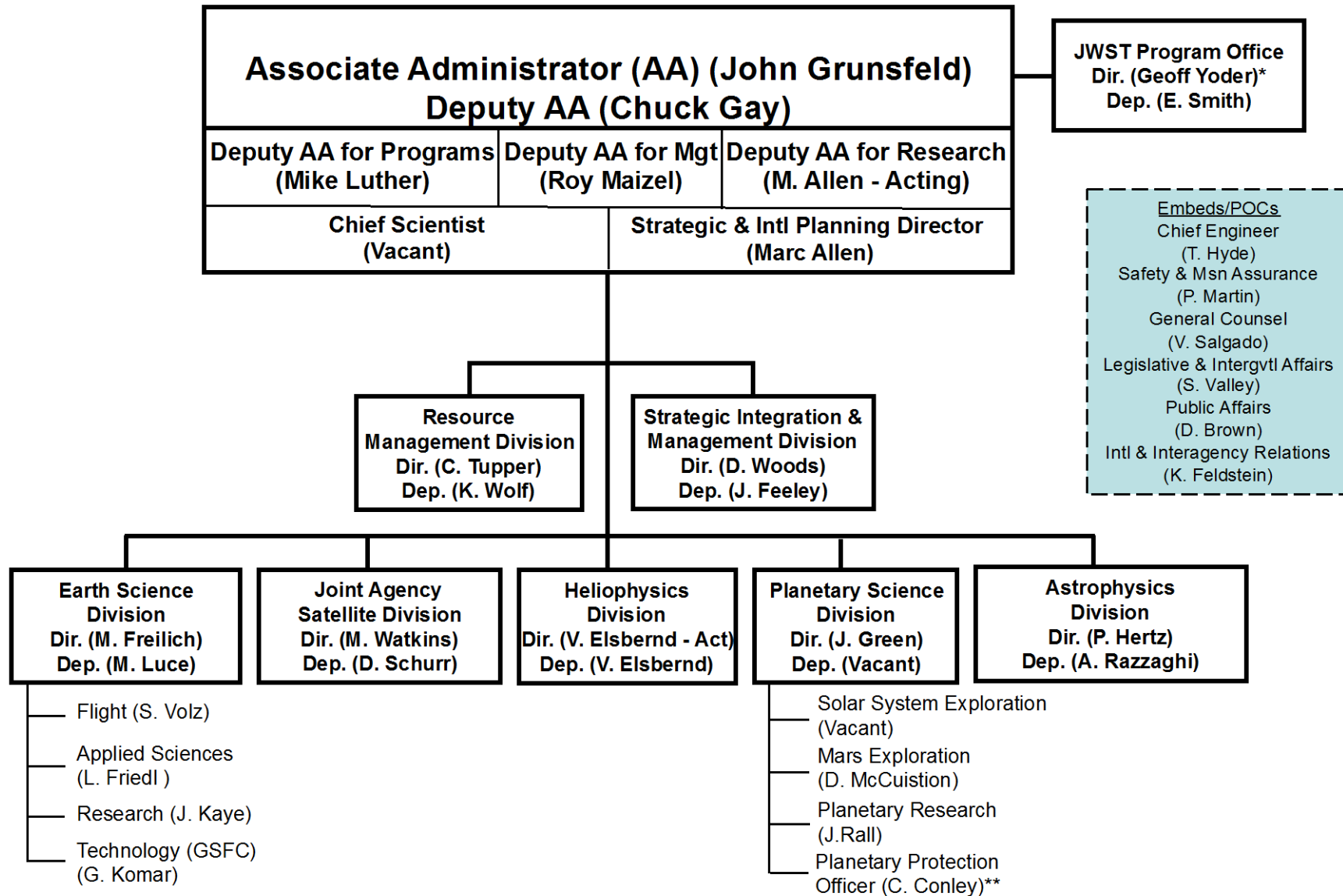


# The Big Picture.....

- **This is a time of opportunity for NASA Astrophysics**
  - The total Astrophysics budget is at a high level.
  - Large and small space-based observatories spanning the electromagnetic spectrum are currently studying the universe.
  - The James Webb Space Telescope, the highest priority of the community, is on schedule for an October 2018 launch.
  - Astounding suborbital-class investigations are being conducted on sounding rockets, balloons, and the International Space Station.
  - Individual investigators are leading data analysis, theory, and technology development projects selected through open, competitive, peer reviewed solicitations.
  - We are preparing for the strategic mission that will be developed following JWST.
- **The budgetary future is uncertain**
  - “If you can’t live with uncertainty, please don’t come to work at NASA Headquarters.” (Paul Hertz, quoted in Space News, 2012 Nov 11 issue)



# SMD Organization

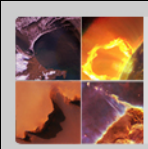


\* Direct report to NASA Associate Administrator

\*\* Co-located from the Front Office

January 2013





# Division Personnel Changes (6/12-2/13)

## Departures

- Aug 28, 2012 Chris Davis (completed IPA, to Liverpool U)
- Aug 31, 2012 Rita Sambruna (1 year detail to Office of Strategic Form)
- Sep 28, 2012 Jaya Bajpayee (completed detail, returned to GSFC)
- Nov 30, 2012 Michael Moore (retired after 32 years with NASA)
- Feb 8, 2013 Ilana Harrus (completed IPA, to NSF Astronomy Div)

## Arrivals

- Jun 4, 2012 Larry Petro (IPA from STScI)
- Aug 1, 2012 Michael Garcia (IPA from CfA)
- Aug 20, 2012 Keith MacGregor (IPA from NCAR)
- Sep 10, 2012 Andrea Razzaghi (Deputy Division Director)
- Sep 10, 2012 Joan Centrella (detailee from GSFC)
- Sep 10, 2012 Christie Ashley (detailee from Planetary Science Div)
- Jan 3, 2013 Tony Carro (detailee from Planetary Science Div)
- Jan 3, 2013 Debra Wallace (IPA from USC Beaufort)

## Transitions

- Oct 26, 2012 Billy Lightsey (ends detail at HQ, continues at MSFC)

# Astrophysics Division Organization Chart

February 11, 2013

## Resource Management

Omana Cawthon +  
Peifen Anawalt +

## Director

Paul Hertz

## Deputy Director

Andrea Razzaghi

*Lead Secretary:* Leslie Allen (acting)

*Secretary:* Christie Ashley \*

*Program Support Specialist:* Sheila Gorham

## Cross Cutting

*Technology Lead:* William (Billy) Lightsey \*

*Strategic Integration:* Joan Centrella \*

*Division E/PO POC:* Hashima Hasan (Lead Comm Team)

*Division PAO POC:* Lisa Wainio \*

*Information Manager:* Lisa Wainio \*

## Astrophysics Research

*Program Manager:* Linda Sparke

*Astrophysics Data Analysis:* Doug Hudgins, Debra Wallace

*Astrophysics Theory:* Linda Sparke

*Origins of Solar Systems:* Larry Petro \*

*APRA lead:* Michael Garcia \*

*Cosmic Rays, Fundamental Physics:* Joan Centrella\*,  
Vernon Jones, Keith  
MacGregor\*

*Gamma Ray/X-ray:* Michael Garcia\*,  
Lou Kaluzienski, Wilt Sanders\*

*Optical/Ultraviolet:* Michael Garcia, Richard  
Griffiths, Hashima Hasan,  
Mario Perez \*, Larry Petro \*

*IR/Submillimeter/Radio:* Richard Griffiths, Doug  
Hudgins, Larry Petro,  
Glenn Wahlgren\*

*Lab Astro:* Glenn Wahlgren\*

*Data Archives:* Hashima Hasan

*Astrophysics POC for Sounding Rockets:* Wilt Sanders \*

*Balloons Program:* Vernon Jones (PS), Mark Sistilli (PE)

## Programs / Missions

### Program Scientist

### Program Executive

### Exoplanet Exploration (EXEP)

#### LEADS

Keck

Kepler

LBTI

NExScI

**Doug Hudgins**

Hashima Hasan

Doug Hudgins

Hashima Hasan

Hashima Hasan

**Tony Carro \***

Mario Perez \*

Tony Carro \*

Mario Perez \*

Mario Perez \*

### Cosmic Origins (COR)

#### LEADS

Herschel

Hubble

JWST

SOFIA

Spitzer

**Michael Garcia \***

Glenn Wahlgren \*

Richard Griffiths \*

Hashima Hasan

Glenn Wahlgren \*

Glenn Wahlgren \*

**John Gagosian**

John Gagosian

John Gagosian

N/A

John Gagosian

John Gagosian

### Physics of the Cosmos (PCOS)

#### LEADS

Chandra

Euclid

Fermi

Planck

ST-7/LPF

XMM-Newton

**Richard Griffiths \***

Wilt Sanders \*

Richard Griffiths \*

Lou Kaluzienski

Joan Centrella \*

Wilt Sanders \*

Lou Kaluzienski

Lia LaPiana

Lia LaPiana

Lia LaPiana

Lia LaPiana

Lia LaPiana

Anne-Marie Novo-Gradac

Lia LaPiana

### Astrophysics Explorers (APEX)

#### LEADS

Astro-H

GALEX

NuSTAR

Suzaku

Swift

WISE

**Wilt Sanders \***

Lou Kaluzienski

Larry Petro \*

Lou Kaluzienski

Lou Kaluzienski

Michael Garcia \*

Hashima Hasan

**Anne-Marie Novo-Gradac**

Anne-Marie Novo-Gradac

Anne-Marie Novo-Gradac

Mark Sistilli

Anne-Marie Novo-Gradac

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+ Member of the Resources Mgmt Division

\* Detailee, IPA, or contractor

JWST now part of the JWST Program Office.

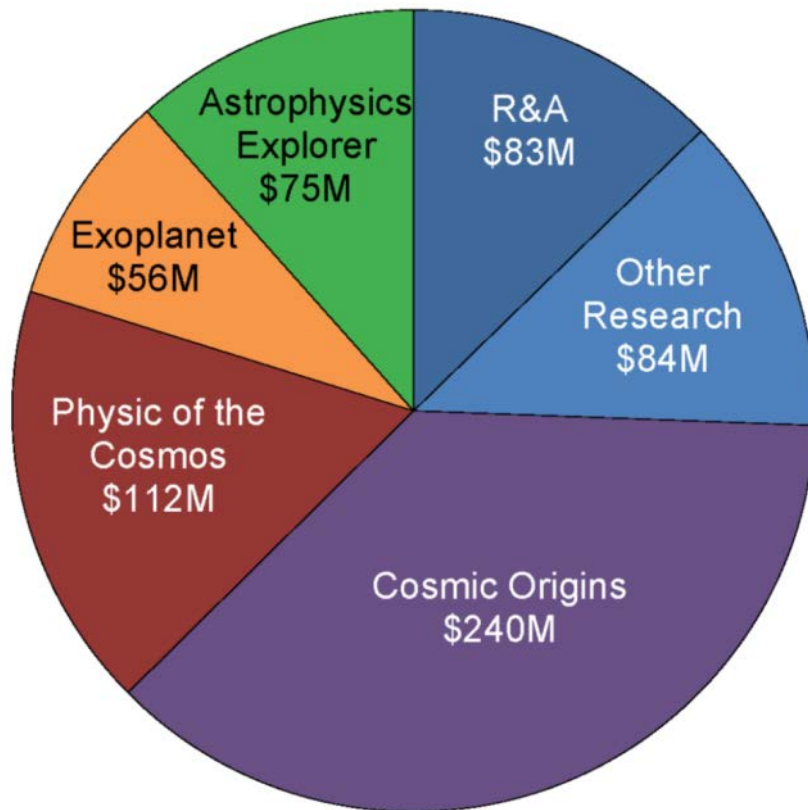
Kelly Johnson on detail until Aug. 2013.

Rita Sambruna on detail until Sept. 2013



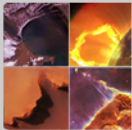
# FY2013 President's Budget Request

**Total FY13 Budget (excluding JWST)\*  
\$649M**



- ❖ Final funding levels pending an FY13 appropriation by Congress and the concurrence of Congress on NASA's initial FY13 operating plan
- ❖ Does not include impact of sequestration

- Astrophysics Research includes:
  - R&A Programs (APRA, ADAP, ATP, OSS, RTF, TCAN)
  - Research Support: Balloon Program, Astrophysics Data Archives, Senior Review Wedge
- Cosmic Origins includes:
  - Hubble, SOFIA, Herschel, Spitzer, technology development
- Physics of the Cosmos includes:
  - Chandra, Fermi, Planck, XMM, LPF, Euclid, technology development
- Exoplanet Exploration includes:
  - WFIRST, Kepler, Keck Ops, LBTI, technology development
- Astrophysics Explorer includes:
  - Astro-H, NuSTAR, Swift, WISE, WMAP, Suzaku, GALEX, EX-1 and EX-MO, future Explorers

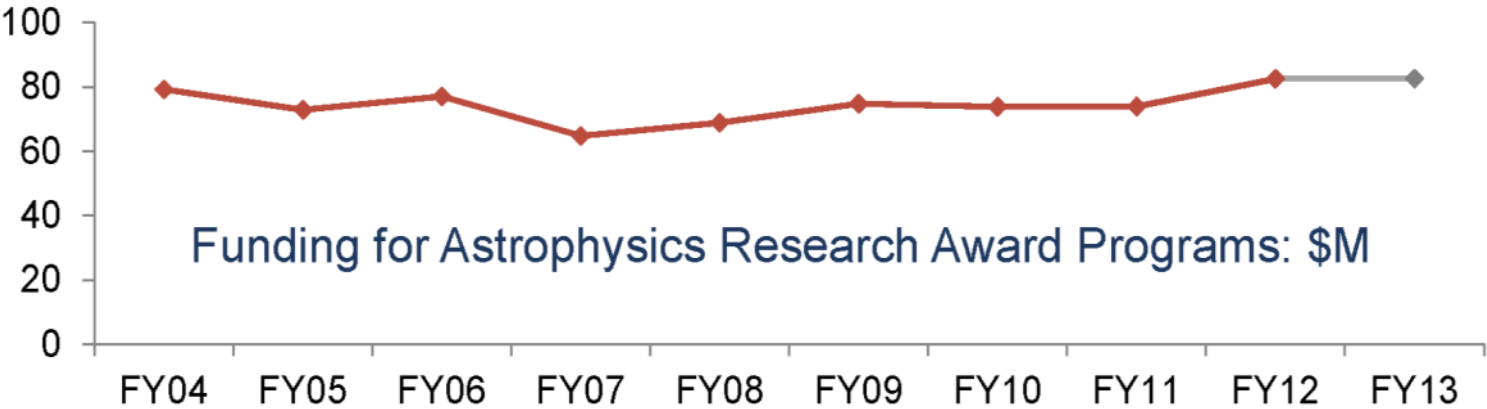
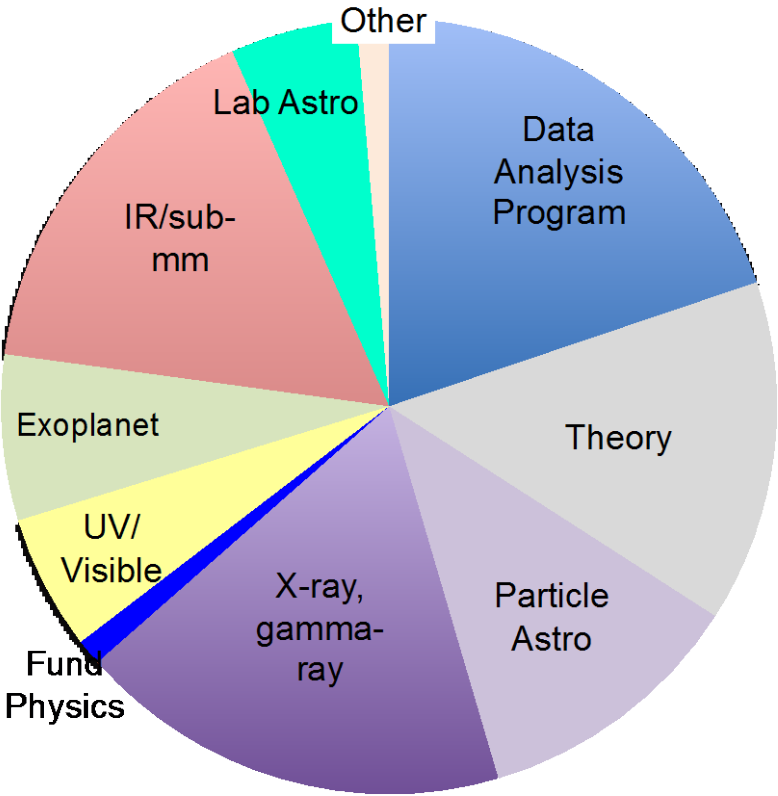


# Astrophysics Research Awards

## Most recent competitions:

	Proposals Rec'd	Year-1 \$M	Success
RTF-11	16	0.6	19%
APRA-11	162	12	27%
SAT-11	48	8	21%
ADAP-12	291	9	31%
OSS-12	46	2	26%
ATP-12	181	4	15%

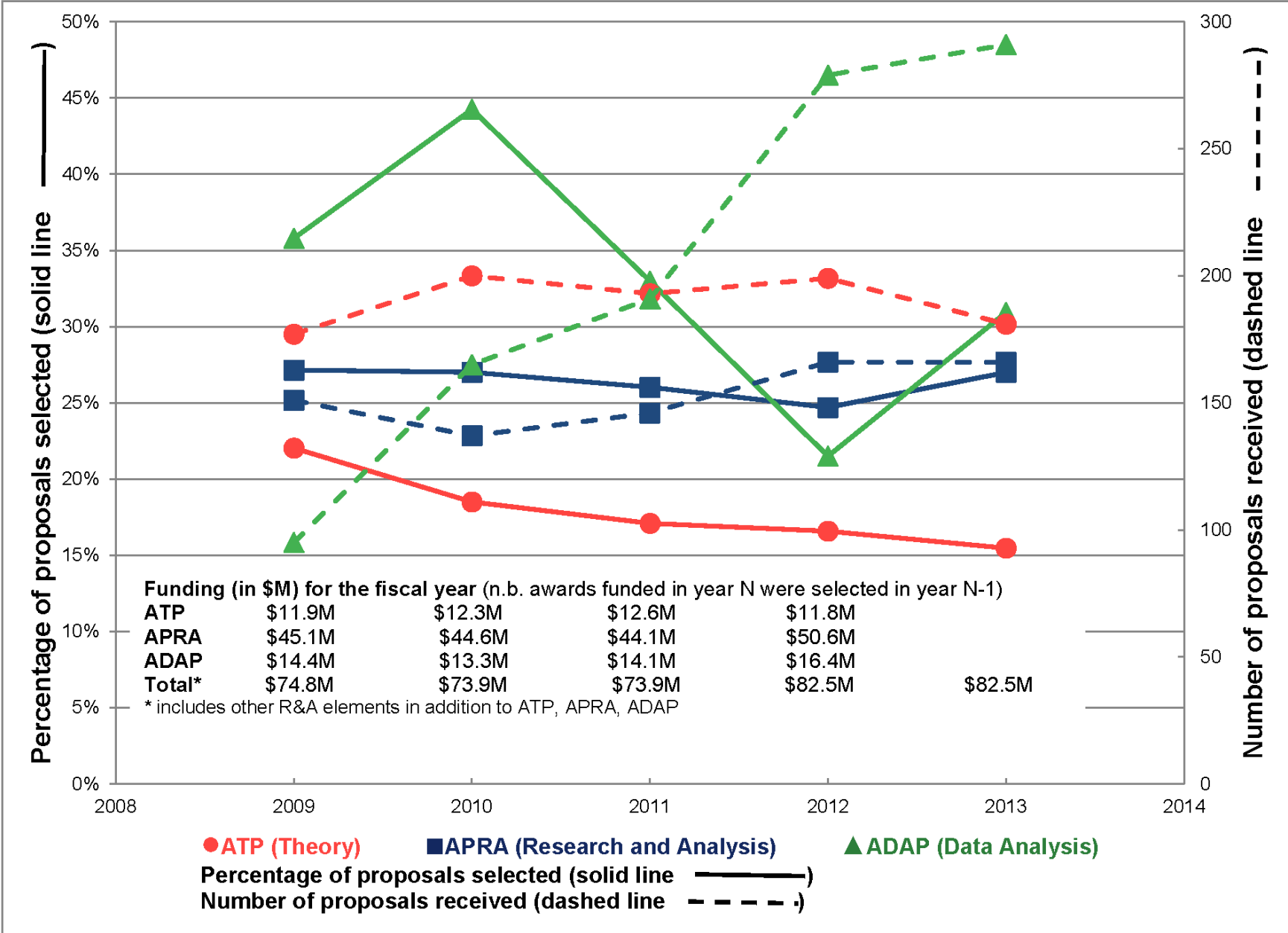
Split of \$82.562M spent in FY12  
PI Award programs plus management overhead

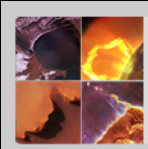






# Astrophysics R&A Funding Trends





# New Opportunity: TCAN

## Theory & Computational Astrophysics Networks

- Astro2010 recommended that NASA, NSF, and DoE jointly provide awards to Theory and Computation Networks that address major theoretical questions raised in Astro2010 that are ripe for a breakthrough.
- **Theoretical and Computational Astrophysics Networks (TCAN) is a joint program with NSF.**
  - The text of this solicitation can be found on the NSF web page at <http://go.usa.gov/Yehz>
  - Information for NASA proposers is in Appendix D.12 of ROSES-12.
  - All proposals must be submitted via NSF's FastLane at <https://www.fastlane.nsf.gov/>
  - Proposers and their institutions must be registered in FastLane for proposal submission.
- **The window for proposal submission on FastLane opened on February 1, 2013 and closed on February 14, 2013.**
  - The NASA point of contact for TCAN, Joan Centrella, can be reached at [Joan.Centrella@nasa.gov](mailto:Joan.Centrella@nasa.gov) or (202) 358-2522.
  - The NSF point of contact for TCAN, Thomas Statler, can be reached at [tstatler@nsf.gov](mailto:tstatler@nsf.gov) or (703) 292-4910.
- **Received over 100 proposals for over 30 networks.**



# Program Update - Kepler

- Announced additional 461 planet candidates (61 HZ candidates of all sizes, including one super-Earth around sun-like star) at AAS.
- Completed Quarter 15 Month 3 Science Data download.
- Elevated friction on wheel 4 seen in X-band on January 7, 2013.
  - After observing persistence of elevated friction, wheel placed in rest position for 10 days starting January 17.
  - Reaction wheels restarted on January 27, less than 1 hour spent in low speed state.
  - Returned to science mode on January 28.
- Full analysis of the resulting wheel performance is in work. Resting did not have an effect on the observed drag torque.
- Mitigation plan is in work, it will include modifications to the fault protection software.
  - First high rate data since resting period will be obtained on March 6.

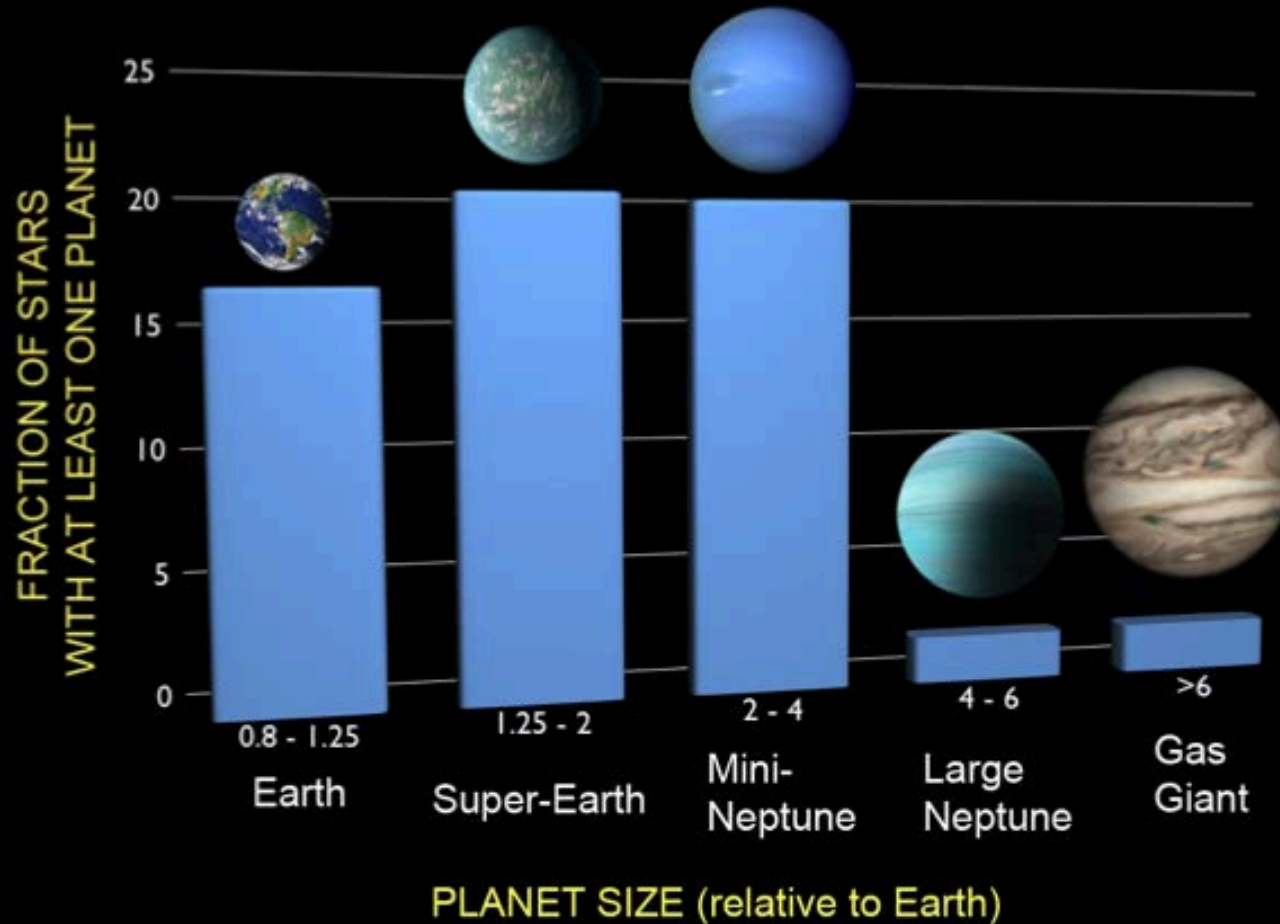


Kepler

# Occurrence Rate versus Size

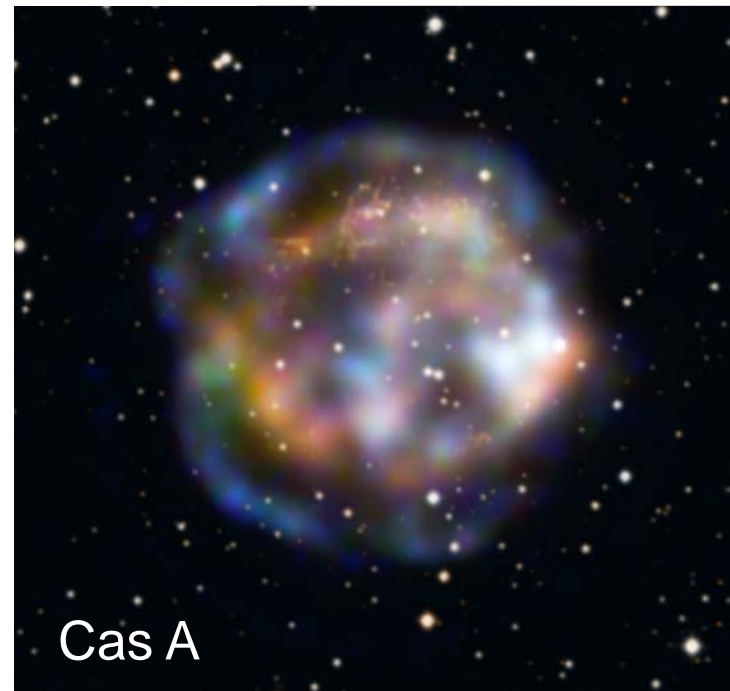
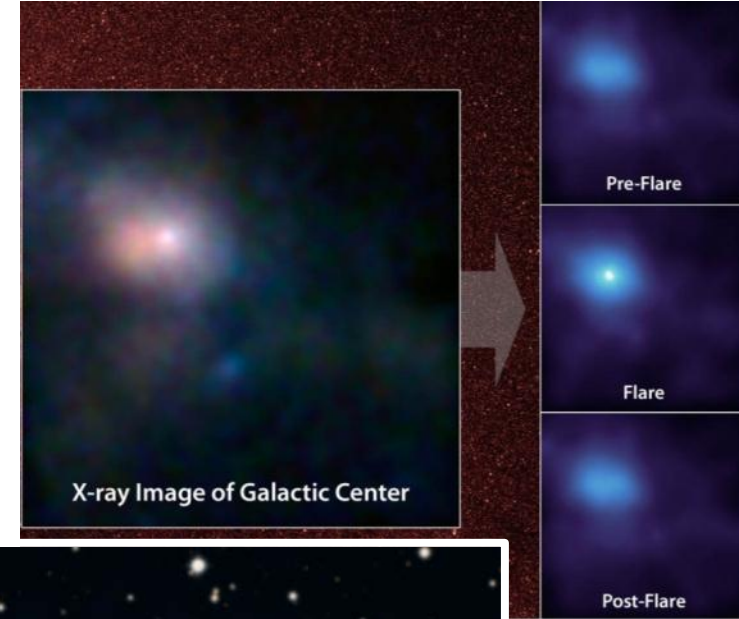


$P < 85$  Days, with Purity and Completeness Corrections



# Program Update - NuSTAR

- 2-year Prime Mission started Aug 1, 2012.
- Early pointing and alignment issues have largely been mitigated.
  - Unexpected thermal displacements of both the star tracker camera head units and mast structure.
  - Initial alignment of star cameras was off by ~4mm instead of the planned 1mm.
- Loss of ASI Malindi ground station has been mitigated.
  - ASI providing U of Rome Malindi ground station for NuSTAR.
  - KASAT commercial ground station in Singapore has been contracted as backup.
- Science observations proceeding well.
  - NuSTAR working with other missions for coordinated observations (e.g., viewing 3C273 along with Chandra, XMM-Newton, Swift, Suzaku, and INTEGRAL).



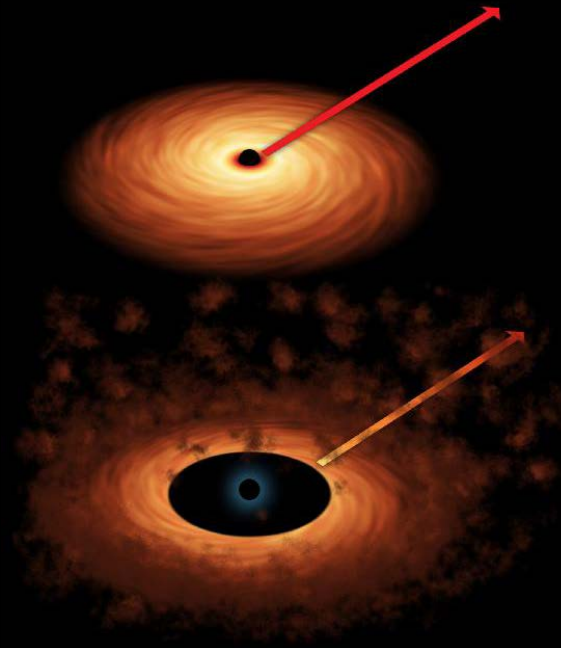
Blue: 15-20 keV  
Green: 8-10 keV  
Red: 4.5-5.5 keV

Cas A

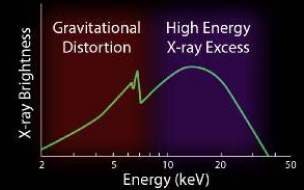




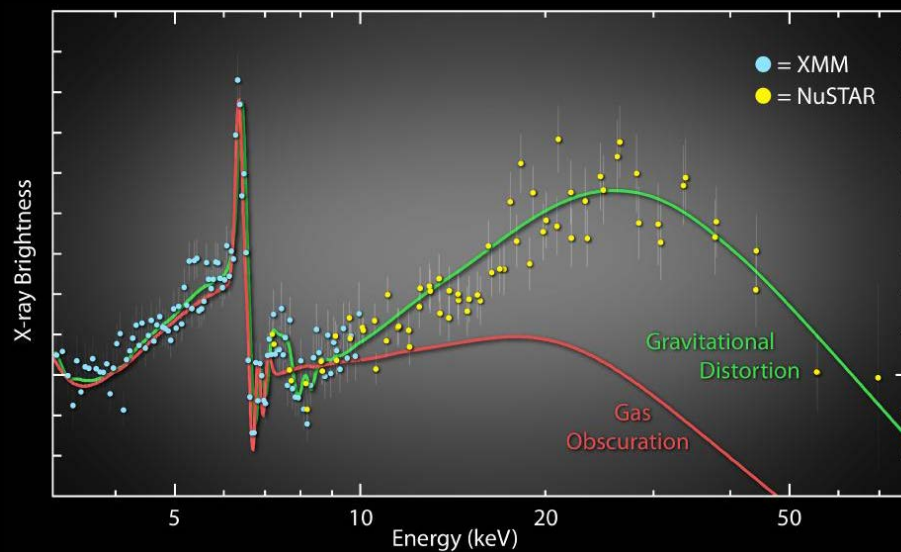
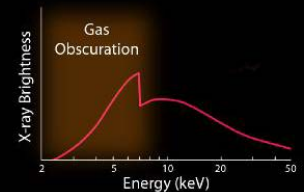
# NuSTAR Helps Solve Riddle of Black Hole Spin

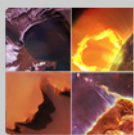


Prograde Rotation Model



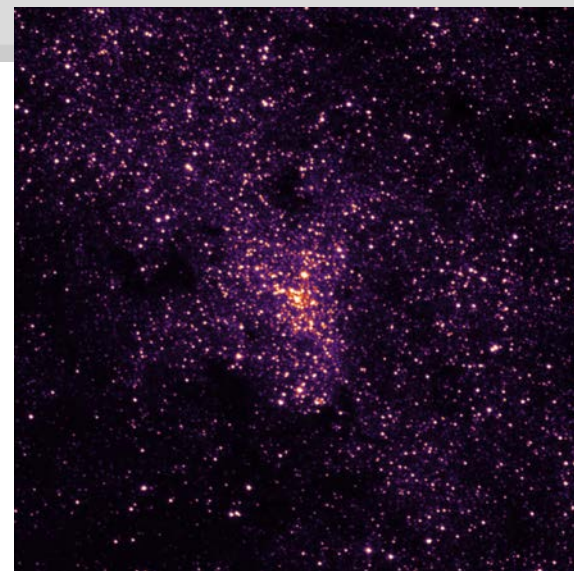
Foreground Obscuration Model



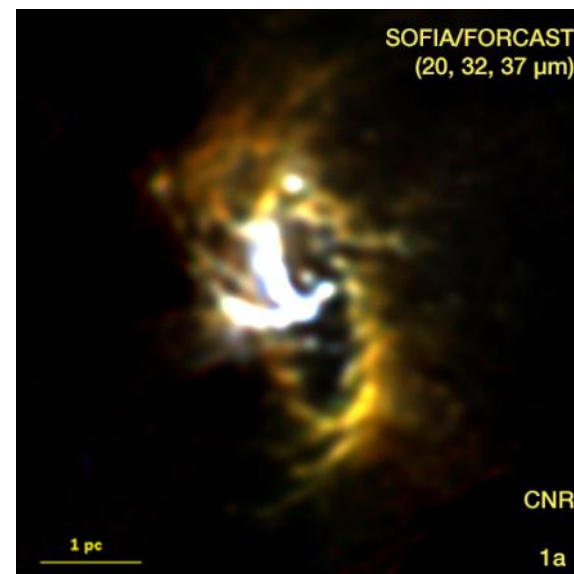


# Program Update - SOFIA

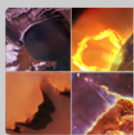
- Conducting observatory Verification and Validation (V&V) flights through March 7.
  - All hardware upgrades including avionics and new Focal Plane Imager (FPI) have been V&V'd.
  - HIPO commissioned.
  - V&V of updated MCCA (software) on March 5 & 7.
- Commissioning of FORCAST, GREAT, FLITECAM conducted during March-May.
  - Includes some GTO science flights.
- Cycle 1 Science scheduled for April-Nov 2013.
  - First Cycle 1 science flight is now scheduled for April 12 with GREAT.
  - On May 4, a Pluto occultation observation using HIPO is planned.
  - Cycle 1 includes first Southern Hemisphere deployment to New Zealand in July.
- Cycle 2 call will be in late spring/early summer 2013.
  - Cycle 2 observations planned to start in February 2014.



Hubble image of the same region at the same scale.

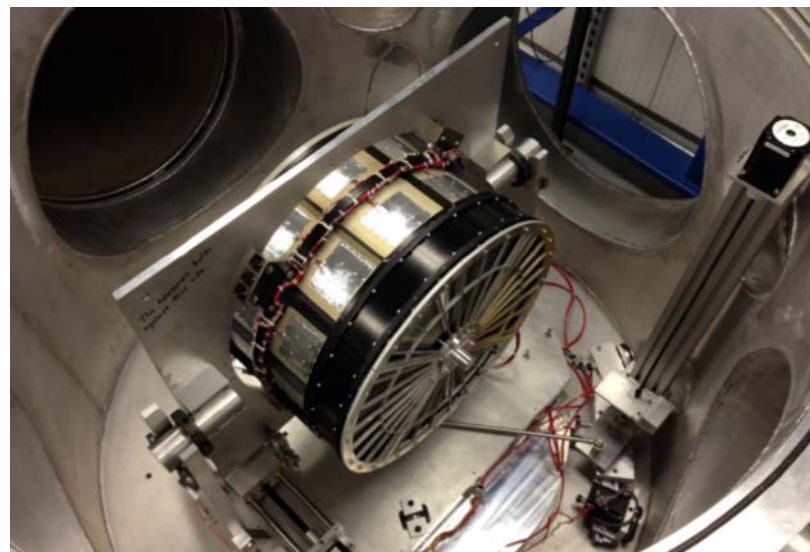


SOFIA FORCAST image of Milky Way Circumnuclear Ring 15



# Program Update - Astro-H

- NASA flight model hardware fabrication is on track.
  - NASA detector verified to have  $\sim 5\text{eV}$  resolution ( $7\text{eV}$  requirement).
  - Flight mirror #1 completed Acceptance Review on Jan 30. Packed and ready to ship to JAXA.
- Severe issue with JAXA cryocoolers identified.
  - Cryocoolers produce microphonics that induce heating in the NASA microcalorimeter detector which degrades the resolution to  $\sim 60\text{ eV}$ . (Requirement =  $7\text{eV}$ ).
  - Vibrations must be reduced to acceptable levels for the mission to meet minimum science requirements.
  - JAXA is working redesign of cryocooler suspension system.
- JAXA schedule under review to accommodate resolution of these issues.
- New official Launch Readiness Date of 2015 was announced by JAXA (was Feb 2014).



FM x-ray Mirror in testing at GSFC



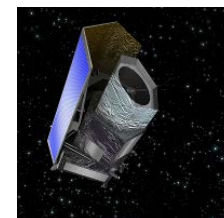
Mirror #1 Complete





# Program Update - Euclid

- ESA and NASA signed the MOU in January 2013.
- NASA's portion of the project approved to enter Phase B on Dec. 21, 2012.
  - NASA is providing flight sensor chip subsystems (SCS or triplet) for the NISP instrument; SCS consists of H2RG sensor chip subassembly, SIDECAR ASIC, and flex-cable.
  - NASA Euclid project is at JPL.
  - Characterization of SCS will be done at GSFC.
  - NASA Confirmation is planned for late Summer 2013.
- NASA has selected 3 proposals for Euclid science investigations.
  - ESA has appointed Jason Rhodes (JPL) to the ESA Euclid Science team. This confirms NASA's selection and nomination.
  - NASA nominated to ESA 40 members of the Euclid Consortium and Jason Rhodes to the Euclid Consortium Board. Euclid Consortium approved NASA's nominations in Jan 2013.
    - Precision Studies of Galaxy Growth and Cosmology Enabled Through a Physical Model for Nebular Emission --- PI R. Chary (Caltech), 3 members.
    - Looking at Infrared Background Radiation Anisotropies with Euclid --- PI A. Kashlinsky (GSFC), 7 members.
    - Constraining Dark Energy and Gravity with Euclid --- PI J. Rhodes (JPL), 36 members
- ESA NRE Design Review held Feb 5-6, 2013).
  - The first production detector wafers from the NRE phase contract were produced the week of Feb 5-6.
  - Acceptance testing has begun.
  - Yield from recent JWST detectors produced by Teledyne has been very high. Mitigates concerns about yield for Euclid detectors.



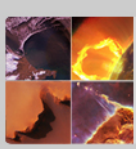


# Program Update – WFIRST

- **WFIRST Science Definition Team (SDT) delivered its final report in August 2012**
  - First Design Reference Mission (DRM1) is a proof of concept that a mission can be constructed that is compliant with the Astro2010 recommendation. [1.3m mirror, current technology detectors, 5 year mission]
  - Second Design Reference Mission (DRM2) does not duplicate capabilities of Euclid, LSST, and JWST in advancing science objectives of WFIRST and looks for cost savings. [1.1 m mirror, evolved technology detectors, 3 year mission]
  - SDT report shows that (a) DRM1 is fully responsive to the objectives of Astro2010 and (b) DRM2 offers a low-cost near-IR survey opportunity, but the limited 3-year life precludes full compliance with Astro2010 goals.
- **Astrophysics Focused Telescope Assets (AFTA) SDT studying use of 2.4m telescope assets for advancing the science objectives of WFIRST.**
  - See next slide.
- **WFIRST Study Office at GSFC is continuing to revise DRM and study trades.**
- **NASA is investing in evolved detector technology through the competitive SAT program.**
  - Enable the continued maturation of the H4RG-10 near-IR detector array to TRL-5.
  - Achieve HgCdTe detector design/process improvements that will benefit WFIRST and other applications.

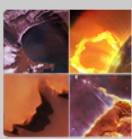
<http://wfirst.gsfc.nasa.gov/>





# Astrophysics Focused Telescope Assets (AFTA) Study

- **Seven month study planned to assess the use of the 2.4m telescope to implement an Astro2010 mission to accomplish the WFIRST science.**
- Science Definition Team formed to support study activities.
- Recent decisions made by SDT:
  - GEO orbit (firm baseline).
  - 3 x 6 array of H4RG10 detectors.
  - Grism (not prism) for the spectrograph.
  - Diffraction limited at 1.2 micron (versus 1.0 micron in prior DRMs).
  - Coronagraph will be a Lyot with a shaped pupil mask.
  - Cut down baffling so obscuration will be 30% instead of the current 40%. This is being done for the coronagraph instrument.
  - Completed observatory configuration trade – spacecraft is below the payload which is lighter and more serviceable than the spacecraft wrapped around the telescope.
- SDT face-to-face meeting held in conjunction with AAS Meeting in Long Beach on Jan 10-11, 2013. Last SDT face-to-face meeting will be held Mar 18-19 at GSFC.
- **Preliminary findings are that science increase over WFIRST DRM1 and DRM2 is substantial.**



# Study on Applications of Large Space Optics (SALSO)

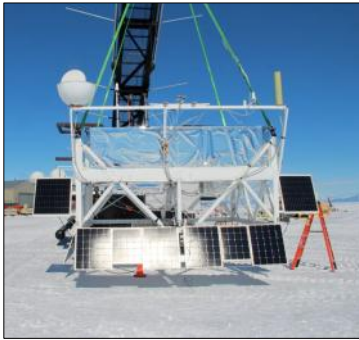
- In June 2012, NASA announced that it had acquired the use of two sets of 2.4m space-qualified telescope optics systems and supporting components.
- Although their most obvious applications are in astrophysics, **NASA is interested in identifying possible uses for these systems to address a broader range of its science, exploration, and technology goals.**
  - In November 2012, NASA released an RFI soliciting broad community inputs focused on utilization of the telescope assets for Agency goals in space technology, human exploration and operations, heliophysics, planetary science, and astrophysics (excluding a wide field infrared survey).
  - A workshop was held February 5-6, 2013, in Huntsville AL to provide a forum for concept presentation and discussion of innovative ideas.
  - Astrophysics concepts included UV/Visible observatories, exoplanet observatories, solar system observatories, time domain observatory, deep imaging observatories, exo-ecliptic observatory, binocular observatory, balloon borne observatory, etc.
  - Non-astrophysics concepts included heliophysics observatories, Mars orbiting observatory, optical communications node, orbital debris survey, etc.
- **NASA will use all of the information gathered to formulate and evaluate future strategies for utilizing the assets to advance Agency goals.**
  - A final study report will contain the workshop briefings. This report will be completed about May 2013 and publicly released thereafter.



# Antarctic Campaign 2012-2013

## **Super-TIGER** (R. Binns, WUStL)

Trans-Iron Galactic Element Recorder, measure ultra-heavy cosmic rays. Launched Dec 8, 2012; landed Feb 1, 2013. [New duration records.](#)



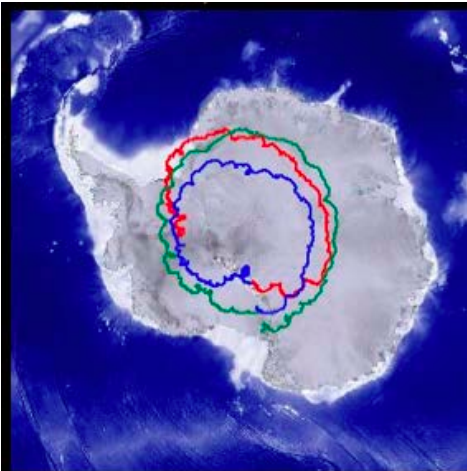
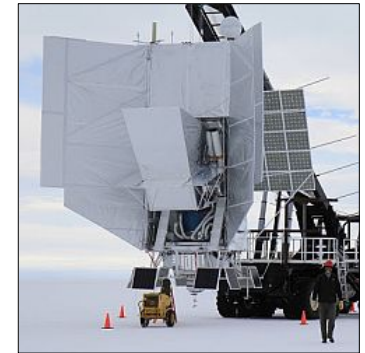
## **BLAST** (M. Devlin, U Penn)

Balloon-borne Large-Aperture Submillimeter Telescope, map large-scale magnetic fields of star forming molecular clouds. Launched Dec 25, 2012; landed Jan 10, 2013.

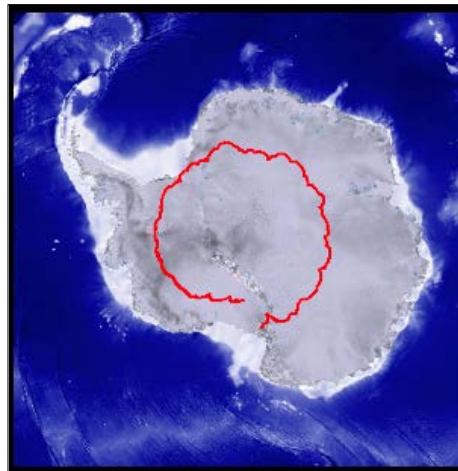


## **EBEX** (S. Hanany, U Minn)

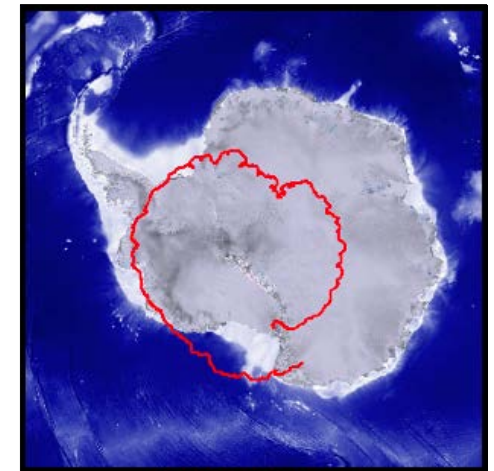
The E and B Experiment, measure the intensity and polarization of the cosmic microwave background. Launched Dec 28, 2012; landed Jan 23, 2013.



*Flight Complete*  
Total Flight Time  
55 days, 1 hour, 34 minutes



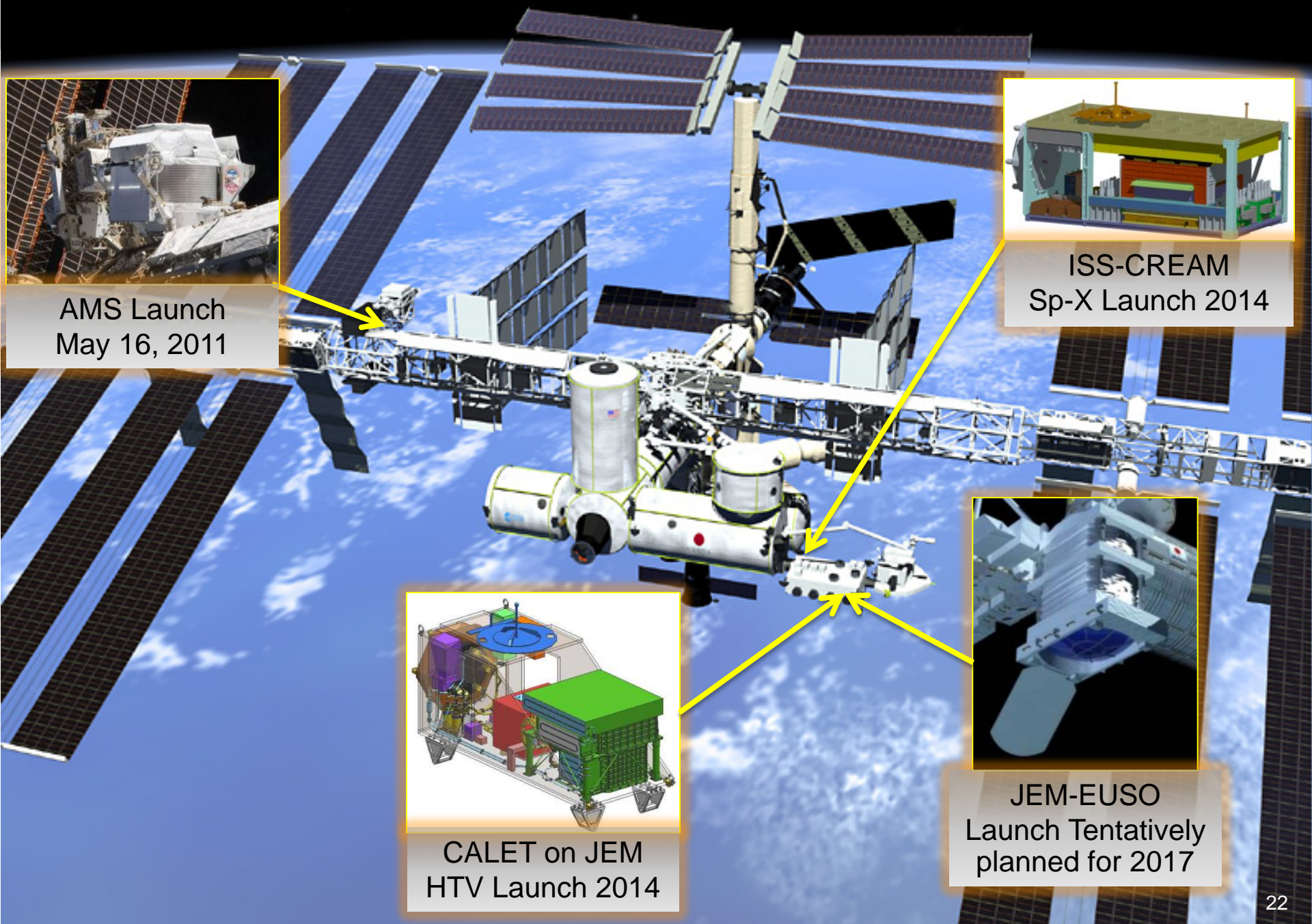
*Flight Complete*  
Total Flight Time  
16 days, 3 hours, 17 minutes



*Flight Complete*  
Total Flight Time  
25 days, 11 hours, 39 minutes



# Astrophysics on the ISS: A Cosmic-ray Observatory



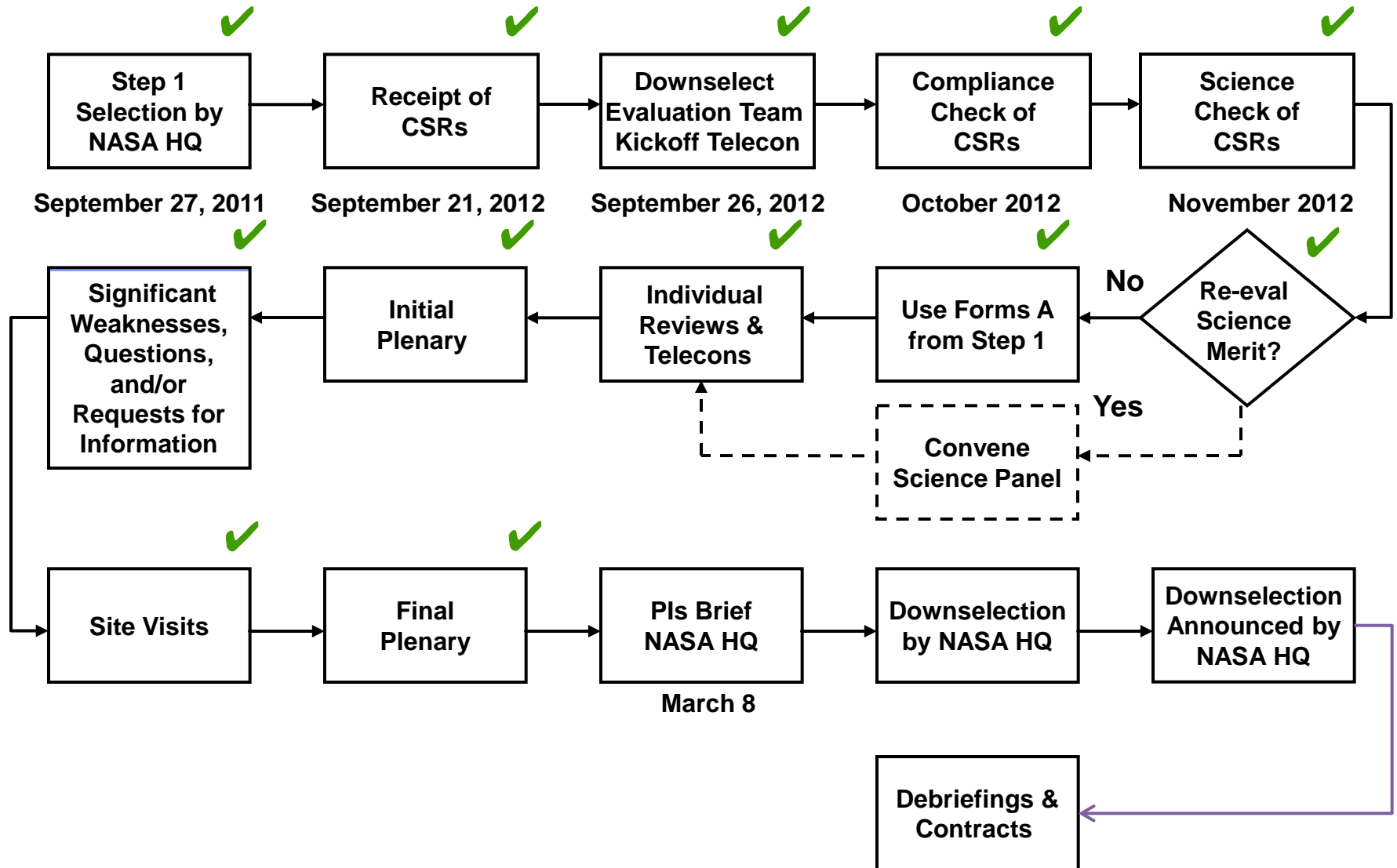
AMS Launch  
May 16, 2011

ISS-CREAM  
Sp-X Launch 2014

CALET on JEM  
HTV Launch 2014

JEM-EUSO  
Launch Tentatively  
planned for 2017

# Explorer Downselect CSR Evaluation Flow



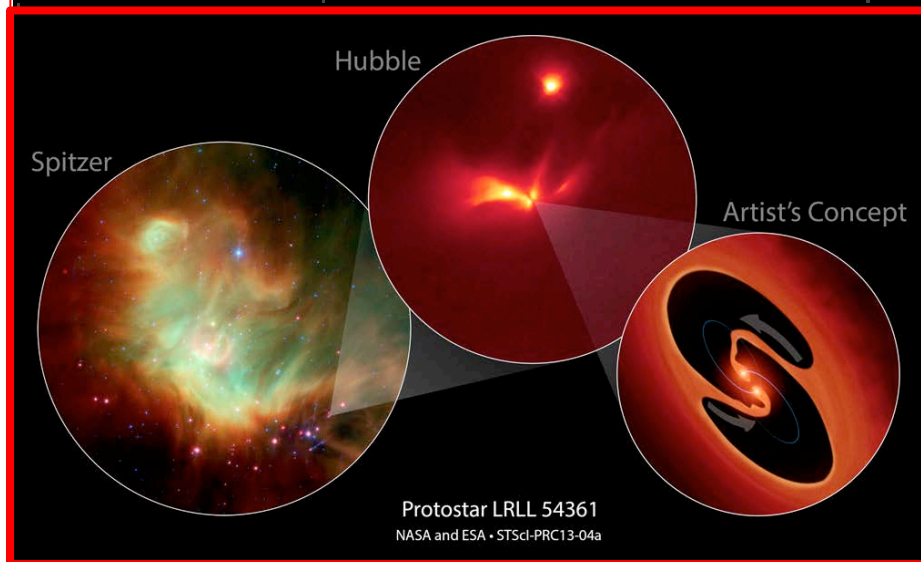


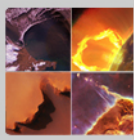
# Cosmic Origins Science Highlights



## Strobe-like Flashes Discovered in a Suspected Binary Protostar

**February 7, 2013:** A mysterious infant star, swaddled inside a dusty blanket, behaves like a police strobe light. The newly discovered object offers clues into the early stages of star formation, when a lot of gas and dust is being rapidly sucked into a newly forming binary star. Every 25.34 days, the object, designated LRL 54361, unleashes a burst of light. The flashes may be due to material suddenly being dumped onto the growing protostars, unleashing a blast of radiation each time the stars get close to each other in their orbits. The phenomenon has been seen in later stages of star birth, but never in such a young system, nor with such intensity and regularity.

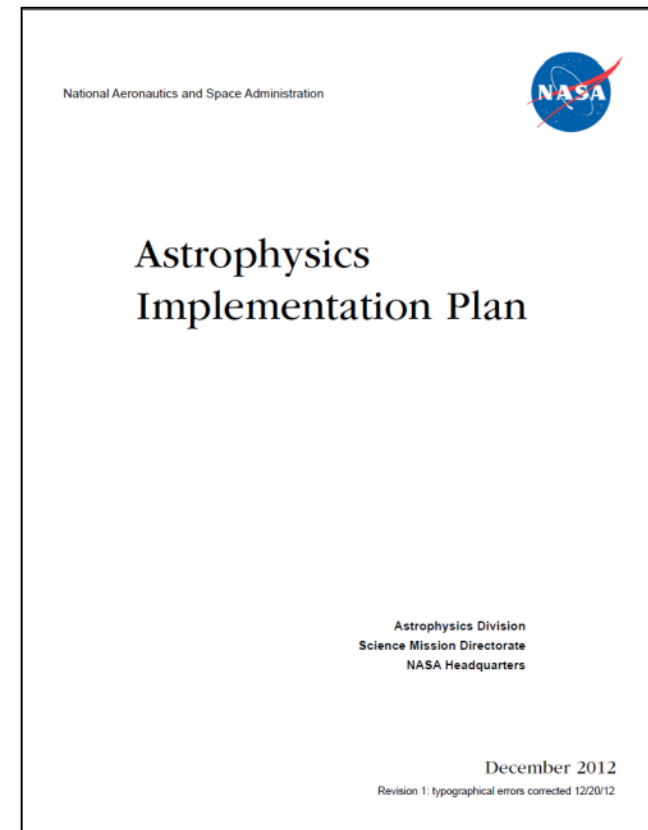




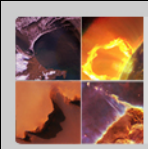
# Astrophysics Implementation Plan

- **Astrophysics Implementation Plan**

- White paper developed by Astrophysics Division.
- Describes Astrophysics Division strategy in response to the Decadal Survey recommendations.
- Consistent with current (FY13) budget guidance.
- Was discussed with the Committee on Astronomy and Astrophysics (CAA) and the NAC Astrophysics Subcommittee (APS) prior to finalization.



- The Astrophysics Implementation Plan is available for download at <http://science.nasa.gov/astrophysics/documents/>



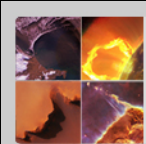
# Astrophysics Near-term Goal and Strategy

- **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.
- **The strategy is to use the science and prioritized activities of the Astro2010 Decadal Survey to guide strategy and inform choices.**
  - In the absence of new missions, progress against decadal priorities is maintained through the core research program, through continued operation of existing missions and their GO programs, through the suborbital programs, and through frequent Explorer opportunities.
- **In order to prepare for a new strategic mission**
  - A near term program of mission concept studies and technology development will be undertaken.
  - These studies will inform a mid-decade decision on which mission will begin formulation starting as early as FY17.



# Response to Decadal Survey

Scale	Decadal Survey Recommendation	Response included in the FY 2013 President's Budget Request
Large	WFIRST	SDT and DRMs in FY 2011 and FY 2012; AFTA study in FY 2013; technology investments in detectors through SAT program; participation in Euclid
Large	Explorer Augmentation	Augment budget to support selection of 2 EX missions, 2 SMEX missions, and 4 Missions of Opportunity over a decade; MO AO in 2012, SMEX AO in 2013/2014, and EX AO in 2015
Large	LISA	Complete ST-7/LISA Pathfinder mission; technology investments through SAT program; Community Science Team (CST) study in 2012
Large	IXO	Technology investments through SAT program; CST study in 2012; potential probe study
Medium	New Worlds Technology	Technology investments through technology testbeds and SAT program; probe studies in FY 2013 and FY 2014
Medium	Inflation Probe Technology	Technology investments through APRA program including three suborbital balloon payloads; complete Planck mission and data analysis; potential probe study after Planck results



# Response to Decadal Survey

Scale	Decadal Survey Recommendation	Response included in the FY 2013 President's Budget Request
Small	Astrophysics Theory Program Augmentation	Small augmentation starting in FY 2012 and maintained
Small	(Definition of) a future UV-optical space capability	Technology investments through SAT program; science driver studies in FY 2012 and responsive mission studies in FY 2013 leading toward next decadal survey
Small	Intermediate Technology Development Augmentation	Initiated SAT program in FY 2010
Small	Laboratory Astrophysics Augmentation	Augmentation to select laboratory consortia
Small	SPICA (U.S. contributions to JAXA-led)	Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity
Small	Suborbital Program Augmentation	Small augmentation for payloads; augmentation to support development of ULDB platforms and WASP
Small	Theory and Computation Networks (NASA, NSF, DOE)	Solicitation for proposals in FY 2013 (with NSF)
N/A	Additional core program augmentations	Initiated Nancy Grace Roman Technology Fellows program; small augmentation for ADAP program; small augmentation for APRA program

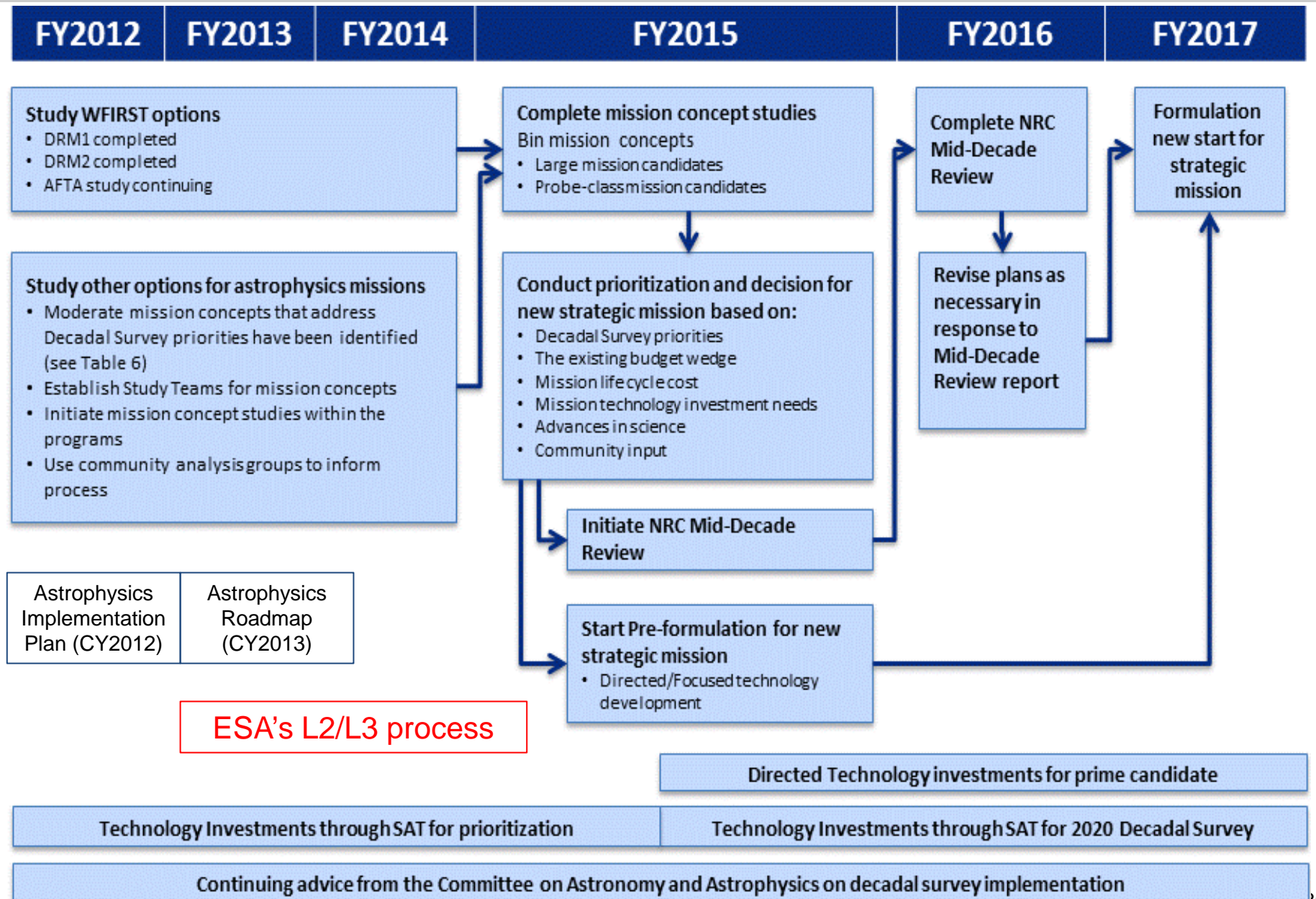


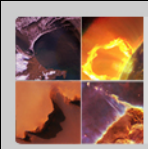


# Preparing for the Next Strategic Mission

Strategic Mission Concepts	Derived from Recommendation	Status of Studies	Plan for Future
WFIRST: Large Strategic Mission (DRM1)	Large 1st : WFIRST	Completed in 2012	Candidate large mission for mid-decade
WFIRST: Probe-size Strategic Mission (DRM2)	Large 1st : WFIRST	Completed in 2012	Candidate probe for mid-decade
Use of the 2.4m telescope assets to advance the science of WFIRST (study includes an optional second instrument to advance exoplanet science)	Large 1st : WFIRST (Medium 1: New Worlds Technology)	Started in 2012	Candidate large mission for mid-decade
Gravitational Wave missions to advance the science of LISA	Large 3rd : LISA	Completed in 2012	Candidate large mission for next decade; candidate for international partnership
X-ray missions to advance the science of IXO	Large 4th : IXO	Completed in 2012; under consideration for study in 2014	Candidate probe for mid-decade; candidate large mission for next decade; candidate for international partnership
Exoplanet probes to advance the science of a planet characterization and imaging mission	Medium 1st : New Worlds Technology	Planned for 2013	Candidate probe for mid-decade; candidate large mission for next decade
Cosmic Microwave Background Polarization Probe	Medium 2nd : Inflation Probe Technology	Study under consideration for study in 2015	Candidate probe or large mission for next decade
Science and technology drivers for a UV/Visible mission	Small: (Definition of) a future UV-optical space capability	Started in 2012	Candidate probe or large mission for next decade

# Astrophysics Near-term Strategy



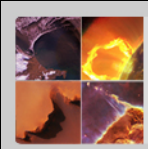


# Astrophysics Implementation Plan: Responding to the Decadal Survey

- **WFIRST**

- **If WFIRST is not started right away, and if it is not launched in this decade, is it still the first priority?**
  - CURRENT PATH: NASA is proceeding as if the answer is yes. WFIRST is the highest priority for a new start in 2017 with a launch in the 2020s, if funding is available.
  - “If WFIRST development and launch are significantly delayed beyond what was assumed by NWNH, one of the key considerations that led to this relative ranking is no longer valid.” (Burrows-Kennel Report, p 1)
- **If NASA decides to continue studying the use of the 2.4m telescope assets, would such a mission (AFTA) satisfy the WFIRST prioritization?**
  - CURRENT PATH: NASA is proceeding as if the answer is yes. If AFTA delivers more science than DRM1 for a comparable cost, it is preferred. If AFTA delivers more science for >\$2B, it is not preferred.
  - “The committee considers that in the current budget climate, allowing any major mission to exceed \$2 billion in total cost to NASA would unacceptably imbalance NASA’s astrophysics program.” (NWNH, p 214)

n.b. For all of these issues, NASA’s current path is included in the Astrophysics Implementation Plan, which was presented to the CAA in November 2012 and incorporated CAA member comments.

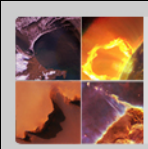


# Astrophysics Implementation Plan Responding to the Decadal Survey

- **PROBES**

- **If NASA cannot start a large mission to immediately follow JWST, then is a strategic probe more responsive to the Decadal Survey than no strategic mission at all?**
  - CURRENT PATH: NASA is proceeding as if strategic probes can be responsive to the Decadal Survey, but only if the science of the probes flows from the science of the prioritized activities.
- **Does the WFIRST probe (DRM2) follow from the WFIRST prioritization?**
  - CURRENT PATH: The WFIRST probe can only accomplish 60% of the WFIRST science objectives in the prime mission. NASA has not yet presumed the answer to this question, one way or another.
- **Does the NCAL X-ray probe follow from the IXO prioritization?**
  - CURRENT PATH: NASA is proceeding as if the answer is yes
  - “The key component of the IXO focal plane is an X-ray microcalorimeter.” (NWNH, p 214) “We find that the extraordinary capability of a large-area X-ray calorimeter mission will address the greatest number of IXO science themes.” (X-ray CST Report, Executive Summary)
- **Does an Exoplanet probe follow from the New Worlds Technology prioritization?**
  - CURRENT PATH: Pending the results of the SDT studies, NASA is proceeding as if the answer is might be yes.





# Astrophysics Implementation Plan Responding to the Decadal Survey

- **International Collaborations**

- **Can a contribution to a foreign mission (e.g. SPICA) be a full SMEX?**
  - CURRENT PATH: NASA is proceeding as if the answer is "no." NASA will make large contributions to foreign missions (larger than an Explorer MO) as strategic investments rather than as proposed Missions of Opportunity.
  - "It is unfortunate that this reduced budget scenario would not permit participation in the JAXA-SPICA mission unless that mission's development phase is delayed." (NWNH, p 238)
- **Is NASA participation in an ESA L2/L3 mission responsive to the Decadal Survey prioritizations?**
  - CURRENT PATH: NASA is proceeding as if the answer is yes if the science of the ESA L2/L3 mission flows from the science of the prioritized activities in the Decadal Survey.
- **Can NASA contribute to foreign missions that are not in the Decadal Survey?**
  - CURRENT PATH: Contributions to foreign missions whose science does not flow from the science of the prioritized activities in the Decadal Survey may be proposed as Explorer MOs.
  - "Most small missions and contributions to non-NASA programs can be competed within the Explorer program and are best handled there through the peer-review process." (NWNH, p 218)



# Astrophysics Roadmap Overview

- **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
  - Take the recent decadal survey as the starting point and build upon it
  - Multiple paths (science areas) forward
  - Way stations at 10 & 20 years in the future, full vision at 30 years out
  - Call out science and technology challenges
- **Note that the roadmap**
  - is *not* a mini-decadal survey with recommendations and priorities;
  - is *not* an implementation plan;
  - *is* a long-range vision document with options, possibilities and visionary futures.
- **The Roadmap Charter is available at:**  
<http://science.nasa.gov/science-committee/subcommittees/nac-astrophysics-subcommittee/astrophysics-roadmap/>



# Astrophysics Roadmap Overview

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

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



# Astrophysics Roadmap Process and Schedule

- **Meetings:**

- The team will meet regularly using telecons and video conferencing.
- First face-to-face (F2F) meeting March 27 and 28 at GSFC.
- Plan additional F2F meetings.
- First community workshop: May 6-7, 2013 at STScI.

- **Community Input:**

- Community is invited to submit abstracts of science and technology challenges.
- A subset of these will be selected for presentation at May workshop.
- NOTE: Suggestions or recommendations for specific missions or implementation plans are NOT solicited.

- **Reporting**

- APS Chair Brad Peterson is ex officio member of Roadmap team.
- Roadmap chair will give regular reports to the APS.
- High-level themes ready for approval by APS by August 30, 2013.
- Final report ready for approval by APS with public release by Dec.16, 2013.



# Astrophysics Missions timeline

Last updated: December 20, 2012

