National Aeronautics and Space Administration

Astrophysics

Astronomy and Astrophysics Advisory Committee

Paul Hertz
Director, Astrophysics Division

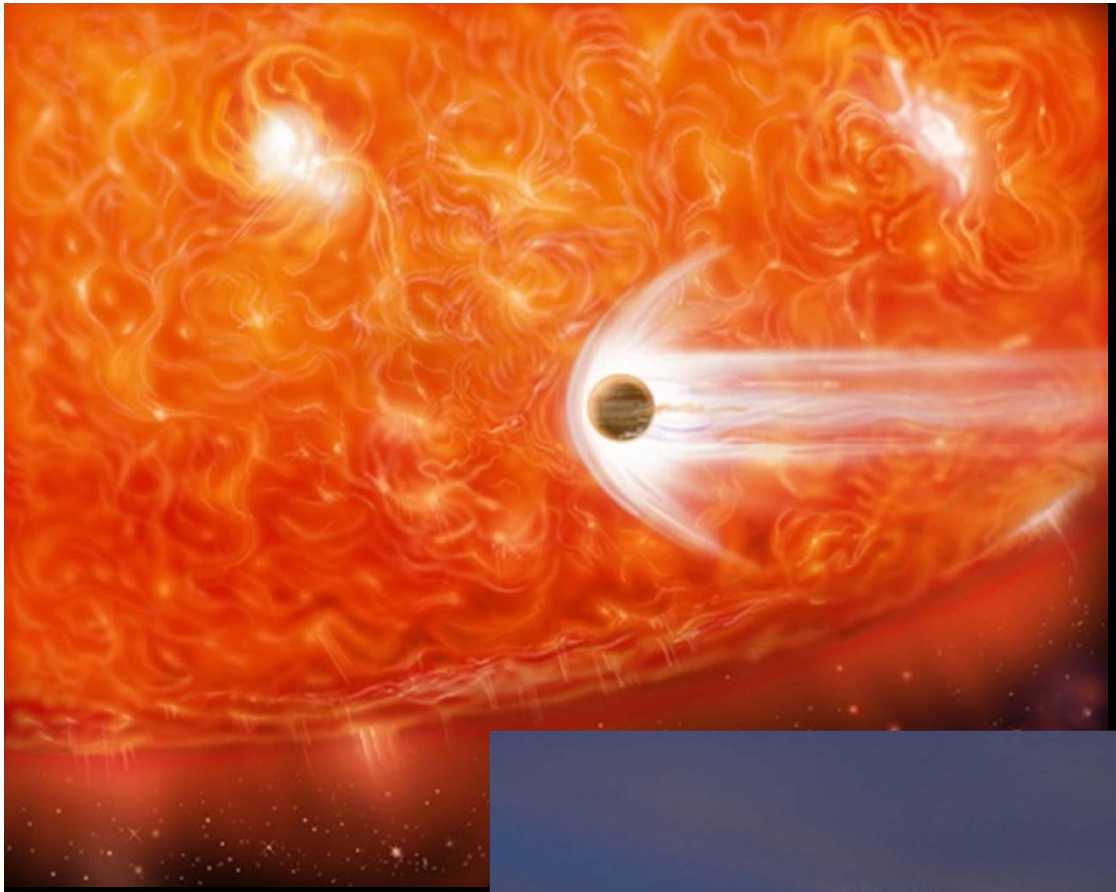
November 30, 2012

www.nasa.gov

NASA Astrophysics Division Update

Presented at the AAAC
November 30, 2012

Paul Hertz
Director, Astrophysics Division, NASA



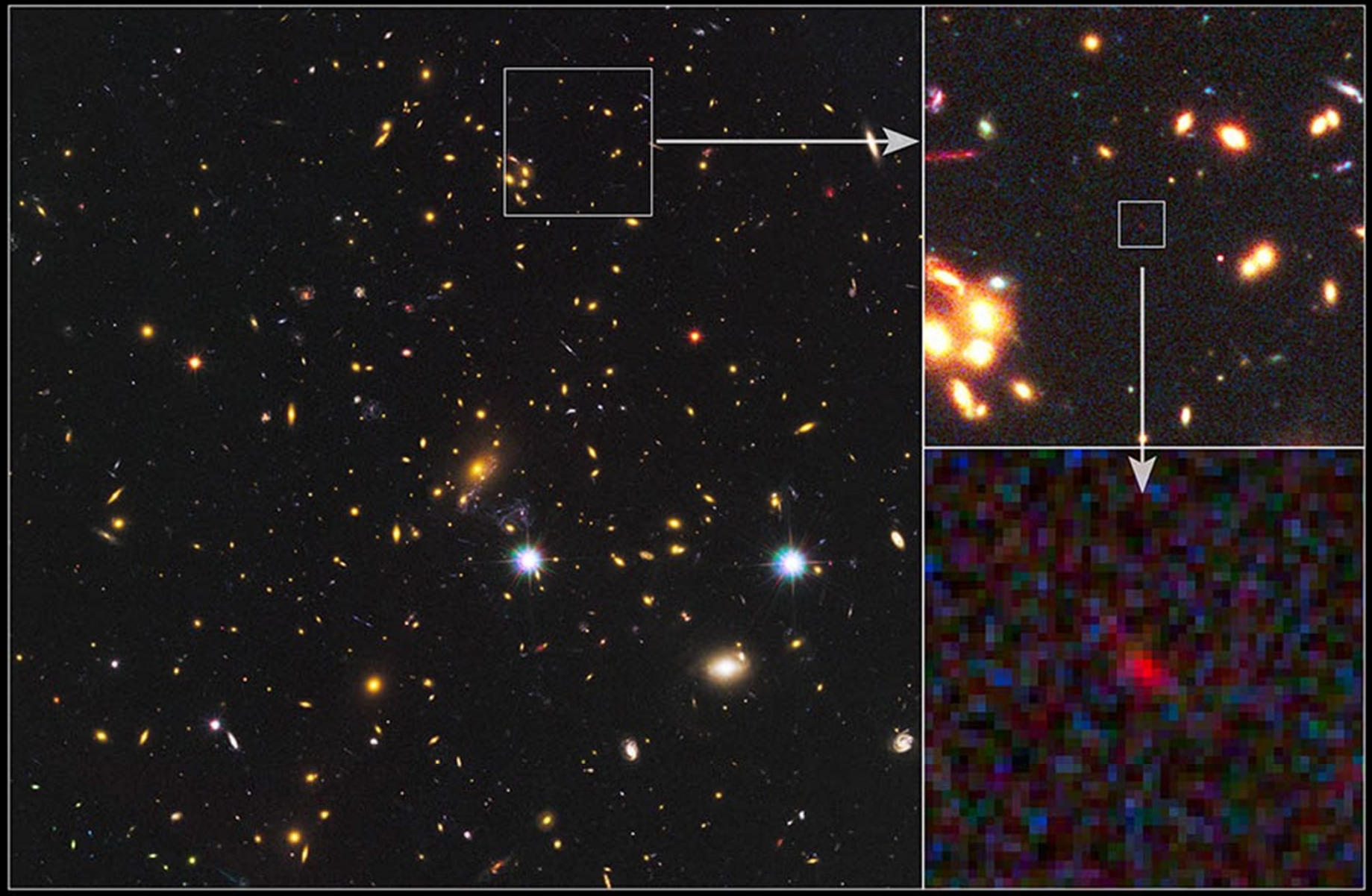
Credit: NASA

- Evidence of a planet's destruction by its aging star has been found by an Intl team of astronomers.
- The missing planet was devoured as the star began expanding into a red giant.
- Evidence includes:
  - the star’s peculiar chemical composition (Abnormally high Li); and
  - the highly unusual elliptical orbit of its surviving planet.

Credit: Marty Harris/McDonald Obs./UT-Austin

This research was funded by the Origins of Solar Systems (OSS) program element of the Astrophysics Research Program

M. Adamow, A. Wolszczan, et al., Ap.J., 754:L15 (2012)



Galaxy Cluster MACS J1149+2223

High-Redshift Galaxy MACS1149-JD

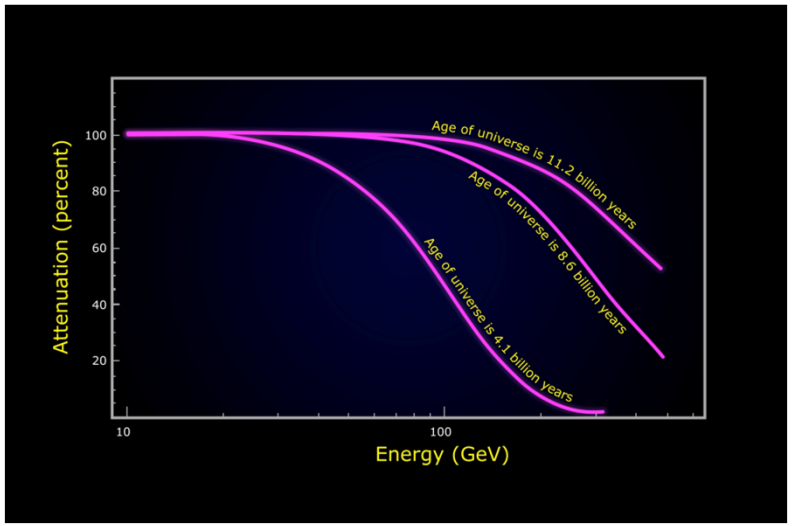
A Distant Gravitationally-Lensed Galaxy at Redshift = 9.6

NASA / ESA / STScI/ W. Zheng (JHU), and the CLASH team

Hubble Space Telescope • ACS • WFC3

ssc2012-12a

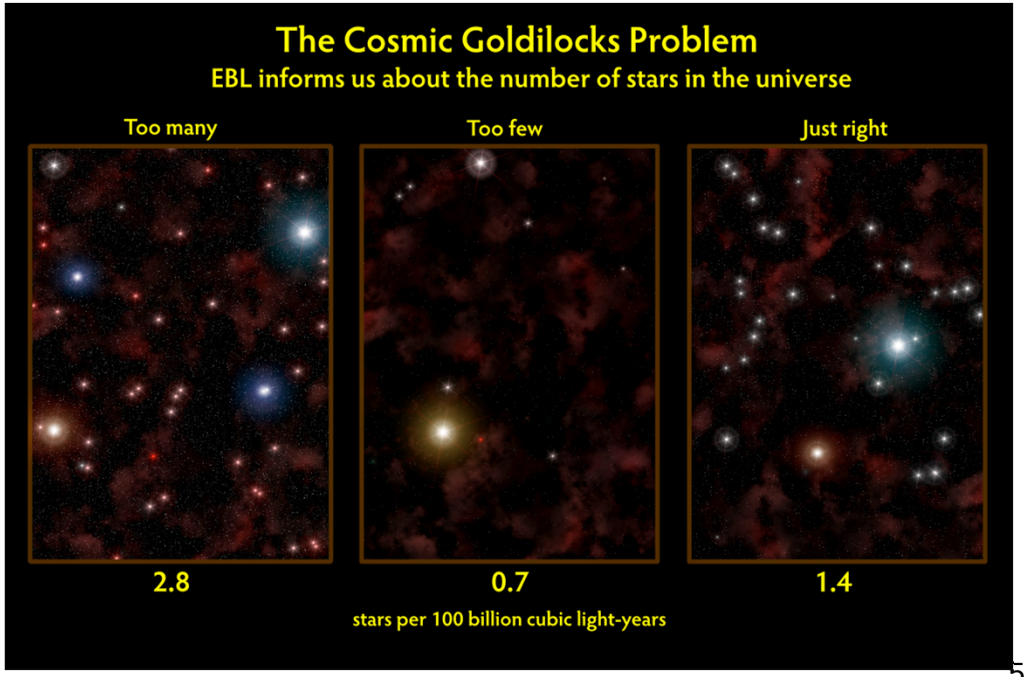
Cosmic ‘Fog” Produced by Ancient Starlight is Measured



Fermi measured the amount of gamma-ray absorption in blazar spectra produced by ultraviolet and visible starlight at three different epochs in the history of the universe.

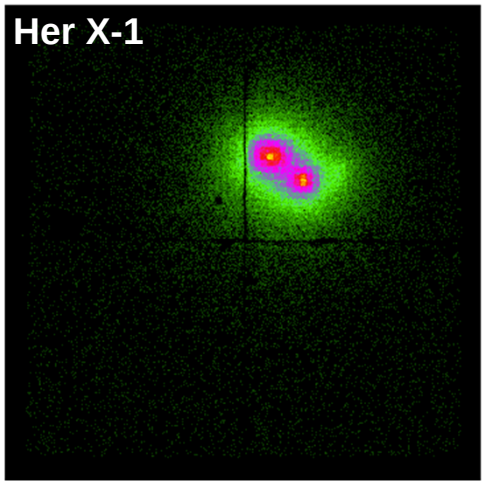
From this measurement, scientists were able to estimate the fog's thickness. To account for the observations, the average stellar density in the cosmos is about 1.4 stars per 100 billion cubic light-years, which means the average distance between stars in the universe is about 4150 light-years.

- Scientists studied gamma-ray signals from 150 strongly detected blazars.
- Gamma rays produced in jets travel across billions of light-years to Earth, and some will interact via inverse-Compton on ambient visible and UV light emitted by stars that formed throughout the history of the universe.
- More distant blazars show fewer gamma rays at higher energies, especially above 25 GeV, thanks to absorption by the cosmic fog. The farthest blazars are missing most of their higher-energy gamma rays.

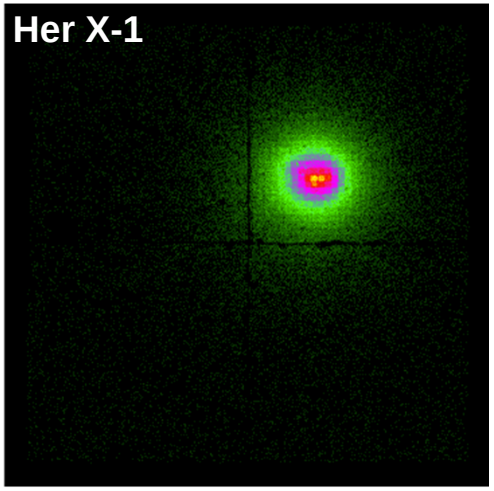


Program Update - NuSTAR

- JPL Post-Launch Assessment Review successfully completed July 24, 2012.
- 2-year Phase E (Prime Mission Operations) started August 1, 2012.
- On-orbit science instrument calibration more complex than anticipated.
  - Unexpected thermal displacements of both the star tracker camera head units and mast structure.
  - Initial alignment was ~4mm instead of the planned 1mm.
- However, early pointing and alignment issues have now been resolved. Science observations proceeding well.
  - Full width half maximum is now <18 arcseconds.
  - Half power diameter is now <60 arcseconds.
- NuSTAR working with other missions for coordinated observations (e.g., viewing 3C273 along with Chandra, XMM-Newton, Swift, Suzaku, and INTEGRAL).
- NuSTAR PI Fiona Harrison and colleagues have submitted the first NuSTAR science paper, a letter to “Nature” on NGC1365.
- Image release on October 23, 2012, concerning X-ray flares at the Galactic Center.

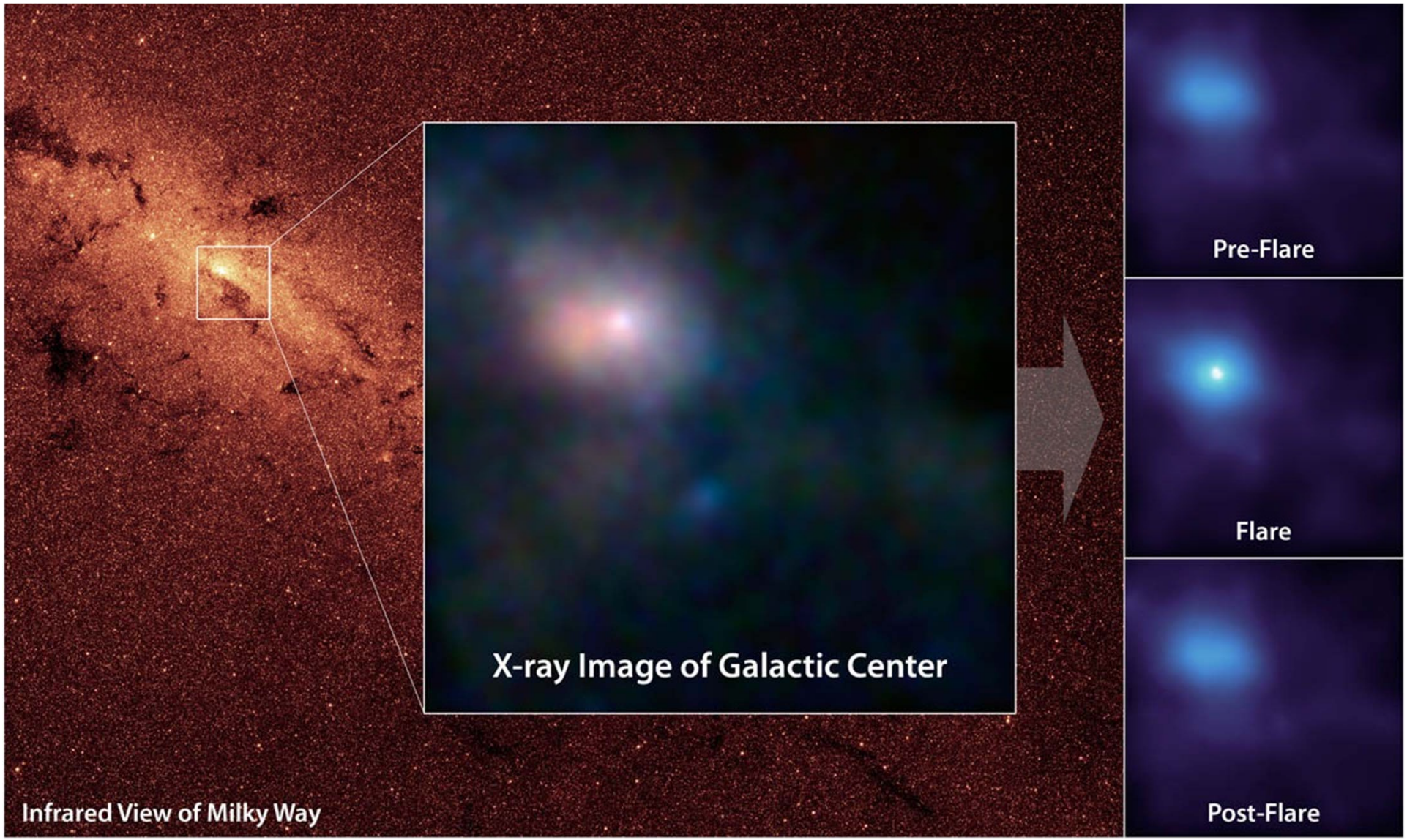


NuSTAR raw data before camera head unit alignment update - spot shifts by 4mm per orbit



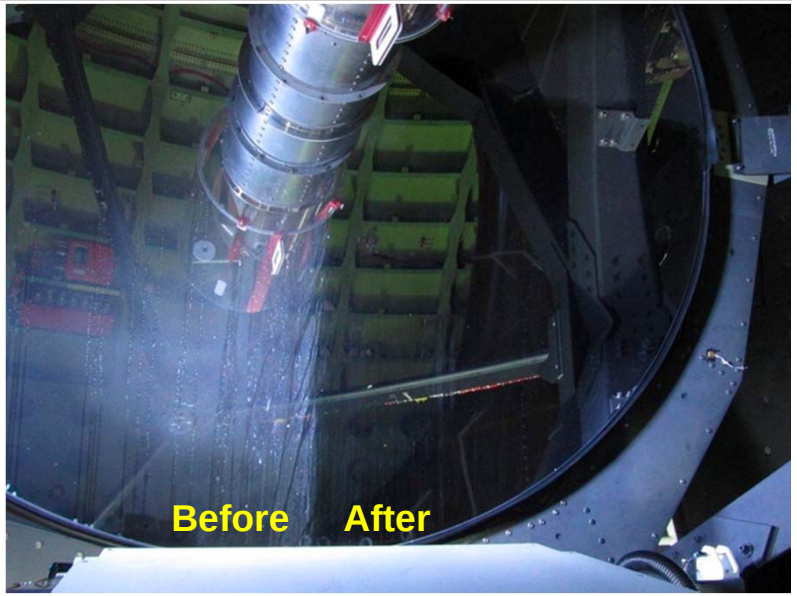
NuSTAR raw data after new camera head unit alignment update

NuSTAR Galactic Center

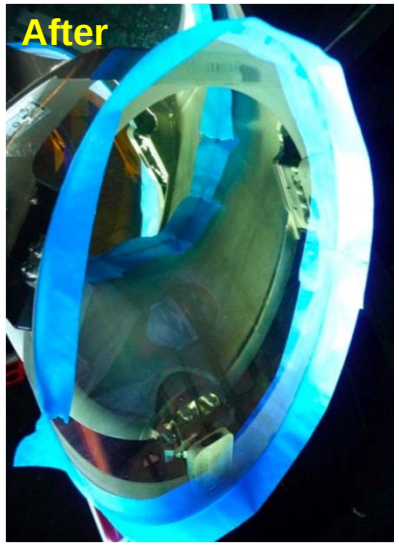


Program Update - SOFIA

- NASA accepted combined JPL + JHU/GSFC proposal for Upgraded HAWC+ instrument. PI is Darren Dowell of JPL.
  - Upgrade includes new detectors and polarimetric capability.
- Announced Cycle 1 Science Investigations selections.
  - 37 US science investigations selected.
- Finishing up Segment 3 Down Time:
  - Completed installation of upgraded cockpit avionics system.
  - Completed Water Wash of telescope mirrors with significant improvement in optical properties.
  - Completed installation of Mirror Coating Facility at Dryden Aircraft Operations Facility, with first mirror recoat scheduled for August 2013.
  - Completed Ground-Based Verification and Validation testing on upgraded observatory, demonstrating significant improvements in system performance compared to 2011 Early Science campaign.
  - In-flight V&V tests planned for December 2012.
  - First science flight is scheduled for the second week of January 2013.



SOFIA Primary Mirror Water Wash Results

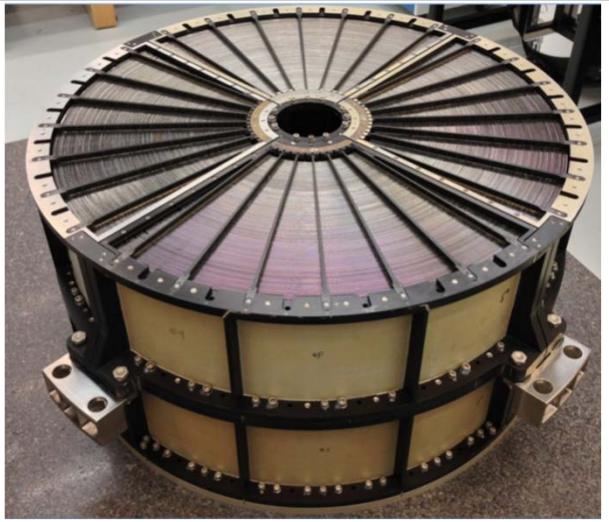


Program Update – SOFIA (continued)

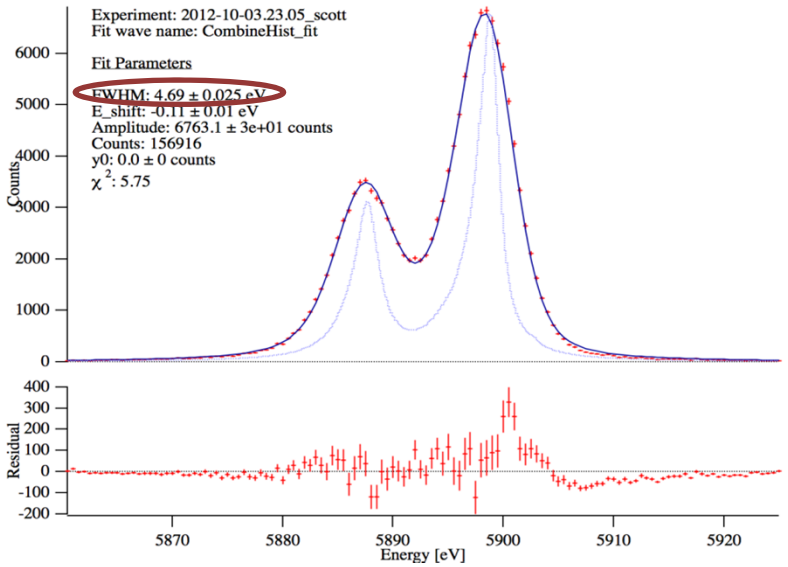
- Upgraded Focal Plane Imager (FPI) delivered by German contractor to be installed in early CY 2013. Greater sensitivity of Upgraded FPI will improve telescope pointing performance.
- Planning for July 2013 southern hemisphere deployment to Christchurch NZ for Cycle 1 GO observations.
- Planning for required heavy maintenance of both aircraft platform and telescope assembly in 2014.
- Planning SOFIA's transition to the operations phase. Includes (a) hiring additional staff, which is already underway; (b) ensuring that staff health and safety are protected as the flight rate increases; (c) ensuring that the team is organized as effectively as possible to coordinate many parallel activities.
  - Implementing recommendations of 2011 OORT review.
- To finish planned instrument commissioning, system verification, and 200-hour general observer campaign during CY2013 will be a challenge.

Program Update - Astro-H

- Cryogenic testing of engineering model (EM) instrument started Aug 23 and was halted Aug 31 due to a cryogen leak in JAXA EM dewar.
  - Working with JAXA to revise the I&T schedule to accommodate the dewar leak and a failed NASA heat switch, which failed during testing.
  - Heat switch recovery product team has down-selected to a new design.
  - Validated method for recovering 50 mK operation of EM detector in JAXA EM dewar with failed heat switch.
- All four quadrants of the SXS mirror are complete.
- Cryogenic testing of EM instrument will resume in November/December after completion of vibration testing in early November.
- Flight model detector array is complete and has been fully characterized. Composite resolution for all 36 channels is 4.69 eV. (Requirement is 7 eV).



Astro-H SXS flight model X-ray mirror.



Resolution of Astro-H SXS flight model detector exceeds 7 eV requirement.

Program Update – Euclid & GEMS

Euclid

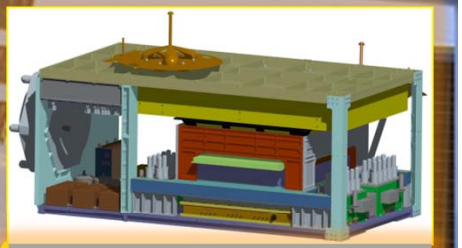
- Proposals received Aug. 31 for NASA-selected members of the Euclid Science Team, Euclid Consortium, and Euclid Consortium Board. Selection in process.
- ESA signed a non-recurring engineering (NRE) contract with Teledyne in Aug.
- JPL and ESTEC managers have begun work on Joint Project Implementation Plan.
- ESA/NASA Bilateral held in Oct.
- MOU between NASA and ESA is in concurrence cycle. To be signed in Dec. following ESA Council meeting.
- Combined KDP-A/B scheduled for late Dec. 2012.

GEMS

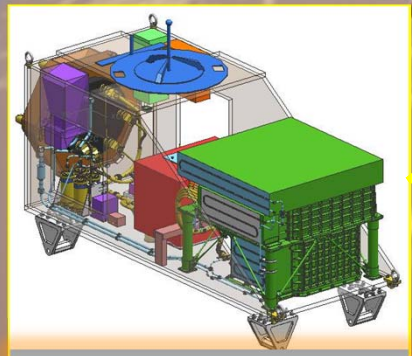
- Termination letter sent to GSFC Sept 10, 2012.
  - Close out plan received at HQ for review and approval.
  - Lesson Learned report received at HQ.
  - Closeout will be completed by Dec. 31, 2012.

Astrophysics on the ISS: A Cosmic-ray Observatory

AMS Launch
May 16, 2011



ISS-CREAM
Sp-X Launch 2014

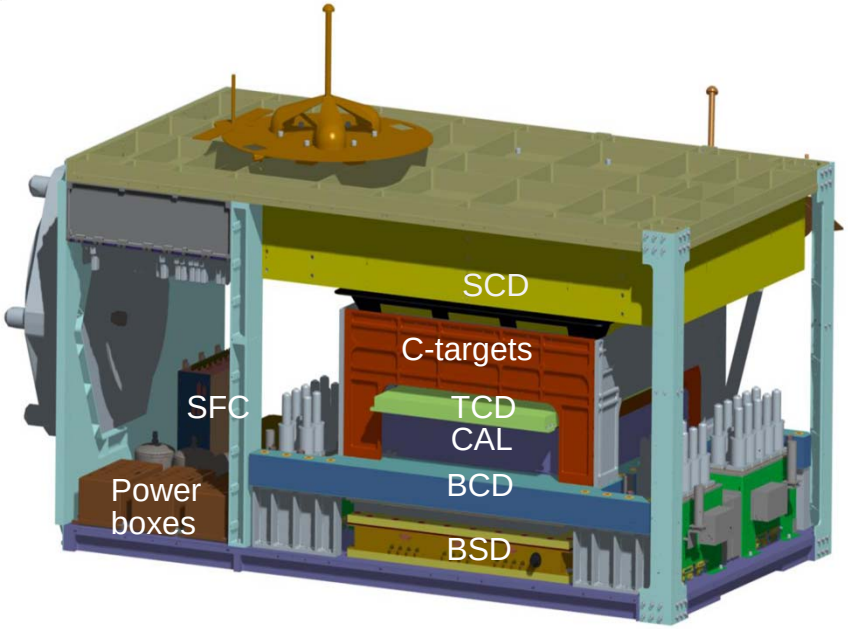


CALET on JEM
HTV Launch 2014

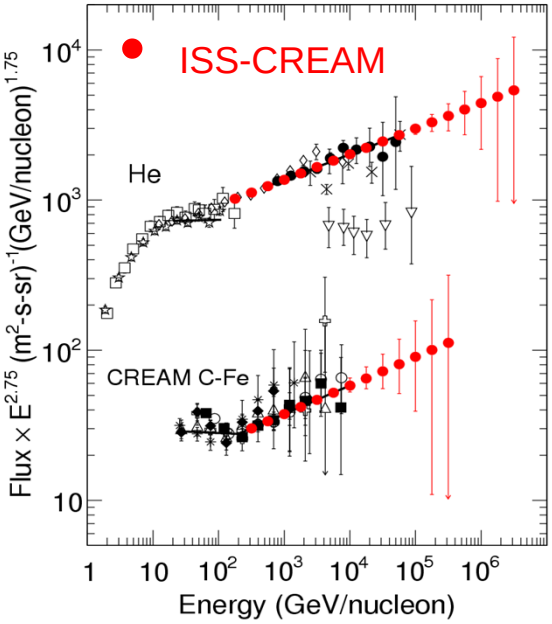
JEM-EUSO
Launch Tentatively
planned for 2017

Cosmic Ray Energetics And Mass for the ISS (ISS-CREAM)

US-led NASA Mission planned for launch in 2014 by Space-X CRS 5



Mass: ~1200 kg
Power: ~ 600 W
Nominal data rate: ~350 kbps



- ISS-CREAM was selected in response to a ROSES-10 proposal to repackage a balloon-borne instrument for accommodation on the ISS/JEM-EF.
- ISS-CREAM will measure cosmic ray energy spectra from 10^{12} to $>10^{15}$ eV with individual element precision over the range from protons to iron to:
  - Probe cosmic ray origin, acceleration and propagation.
  - Search for spectral features from nearby/young sources, acceleration effects, or propagation history.
- The instrument design and functionality were proven with 6 successful balloon flights around Antarctica that accumulated 161 days of exposure.

Explorer Program

- FY13 budget request does not support an AO for both missions and missions of opportunity (MOs) in late CY12.
  - First priority in the Explorer program is to complete Explorers in development: SXS/Astro-H.
  - Second priority is to downselect and fund the development of one mission and one Mission of Opportunity (MO) from the projects currently conducting Phase A studies (FINESSE/TESS, GUSSTO/NICER).
  - Third priority is to issue new AOs leading to the development of additional missions.
- Funding planned for GEMS will remain in the Explorer Program (subject to budget approval).
  - Immediately begin the new projects when they are downselected in Spring 2013.
  - Advance the next mission AO.
- The Astro2010 Decadal Survey that “NASA should support the selection of two new astrophysics MIDEX missions, two new astrophysics SMEX missions, and at least four astrophysics Missions of Opportunity (Mos) over the coming decade.” Astrophysics Division is planning a series of AOs (subject to budget approval):
  - An AO for an MO with a $60M cost cap in Sept 2012; proposals due Dec 14, 2012.
  - An AO for a SMEX in late-2013/early 2014 with the cost cap and date TBD.
  - An AO for an EX and MO in 2015 with the cost cap and date TBD.

Astrophysics Focused Telescope Assets (AFTA) Study

- **Seven month study planned to assess the use of the 2.4m telescope to implement a NWNH mission to accomplish the WFIRST science**
  - Study started in October 2012 and will be completed by May 2013.
  - GSFC leads study and is responsible for mission systems, spacecraft, instrument carrier, and wide-field instrument. JPL provides telescope management and engineering support.
  - The observatory is modular to reduce I&T costs and preserve the possibility of on-orbit evolution through commercial servicing.
  - Development schedule and cost estimate to be developed.
  - Study to include an option to add a coronagraph for exoplanet science as an example of a secondary instrument.
- **Science Definition Team formed to support study activities.**
  - Co-Chairs, David Spergel (Princeton U.) and Neil Gehrels (GSFC).
    - 1st face-to-face meeting Nov 19-20 at GSFC.
    - 2nd face-to-face meeting Jan 10-11 at AAS-Long Beach & IPAC.
    - 3rd face-to-face meeting Mar 14-15 at GSFC.
  - SDT report, which includes a Design Reference Mission (DRM), due by April 30, 2013.
  - HQ Aerospace CATE/ICE on AFTA DRM, due by May 30, 2013.

http://wfirst.gsfc.nasa.gov/science

AFTA: Mock up of the 2.4m telescope at GSFC

Broad Study for Other Uses of Telescope Assets

- Meet objectives in Strategic Guidance Memo of 13 August 2012:
  - "SMD will lead a broad study to assess a range of potential uses of these assets across SMD portfolio . . . beyond Decadal priorities to include NASA strategic priorities. These include integration with HEOMD and Space Technology as active partners, taking into account higher risk mission architectures, advanced technologies, and lower cost."
- Strategies
  - Engage SMD, HEOMD, and STP in all phases of planning, execution, and wrap-up
  - Solicit the external world as broadly as possible to access original thinking
  - Utilize the technical resources across the Agency to
    - Optimize study output quality
    - Foster buy-in for the process and outcomes
- Plan Forward
  1. Broadly solicit abstracts for mission concepts through RFI released Nov 27, 2012.
  2. Select abstracts received for those that best address Agency intent:
     - Highest value to science, human spaceflight, and space technology
     - Innovation
     - Cross-cutting value across directorate objectives and programs
     - Make good use of Agency capabilities, current and future
  3. Workshop for by-invitation presentation and discussion of selected abstracts on Feb 5-6, 2013 in Huntsville.
  4. Select and combine subset of concepts for the best value and feasibility.
  5. Design studies by Center mission design labs.
  6. Integration of final report for consideration in FY15 budget development.

http://www.nasa.gov/salso

NASA Astrophysics Division Implementation Plan

Presented at the AAAC
November 30, 2012

Paul Hertz
Director, Astrophysics Division, NASA

Astrophysics Near-term Strategy

- 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.
  - Support for all of these is maintained in the President's FY13 budget request.
- In order to prepare for a new mission, a near term program of mission concept studies and technology development will be undertaken, with the goal of informing a mid-decade decision on which mission(s) will begin formulation starting as early as FY17.
  - Currently there are no new starts for large missions. Moderate missions ("probes") will be studied, in addition to a large mission (WFIRST), to be prepared for a mid-decade decision.
  - Mission concepts studied must derive from the science objectives of the prioritized activities in the Decadal Survey.

Astrophysics Near-term Program

- The President's FY 2013 budget request for the Astrophysics Division includes:
  - An Astrophysics Explorer Program that can support four mission selections and four Missions of Opportunity (MO) selections over a decade (depending on the cost caps chosen and launch vehicle availability).
  - Extensions of astrophysics operating missions and their associated GO programs.
  - Continued development and operation of the SOFIA airborne observatory.
  - A new program for mid-TRL level technology development.
  - An augmented competitive Astrophysics Research Program that maintains growth realized in FY 2012.
  - New research opportunities: Theory and Computation Networks (in partnership with NSF), laboratory astrophysics consortia, and the Nancy Grace Roman Technology Fellowships for early career researchers.
- Following the formulation of the Presidents FY 2013 budget request and an NRC report, NASA has undertaken a partnership with ESA to provide a contribution of detector subsystems for the NISP instrument on the Euclid mission in exchange for appointing NASA-selected members in the Euclid Consortium and the Euclid Science Team.

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 Technology	Complete ST-7/LISA Pathfinder mission; technology investments through SAT program; Community Science Team (CST) study in 2012
Large	IXO Technology	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

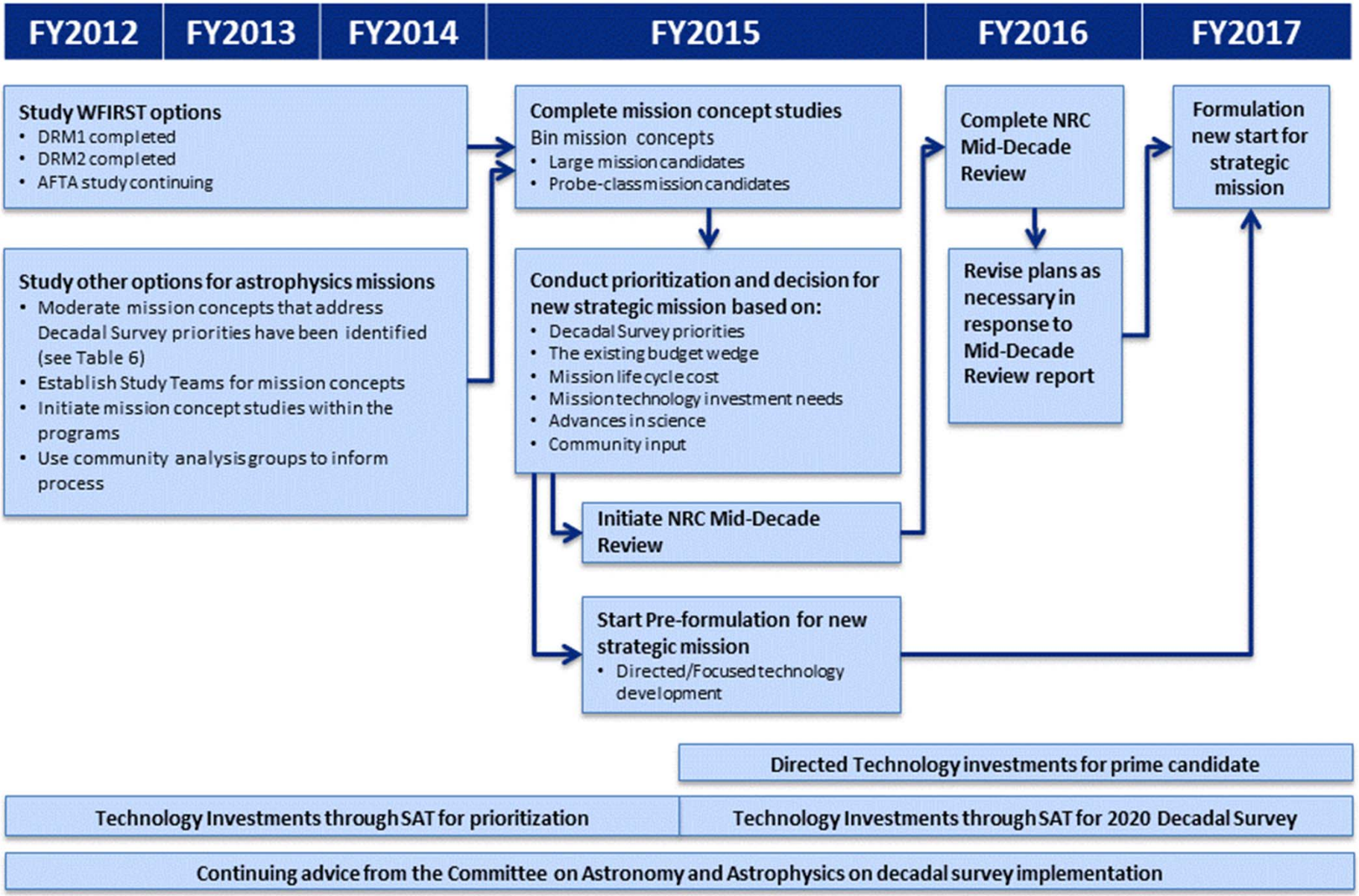
Response to Decadal Survey

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 Technology	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 Technology	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

- An Implementation Plan white paper describing the Astrophysics Division strategy in response to the Decadal Survey recommendations, consistent with current budget guidance, is under development.
  - Has been reviewed by the Committee on Astronomy and Astrophysics and the Astrophysics Subcommittee.
  - Is now being reviewed within NASA for formal clearance.
  - Will release to the community before the Long Beach AAS meeting (January 6-10, 2012); target release date is December 14, 2012.
  - Will be discussed at the NASA Town Hall in Long Beach (January 8, 2012).
- This presentation is derived from the white paper.

NASA Response to March 2012 Annual Report

Presented at the AAAC
November 30, 2012

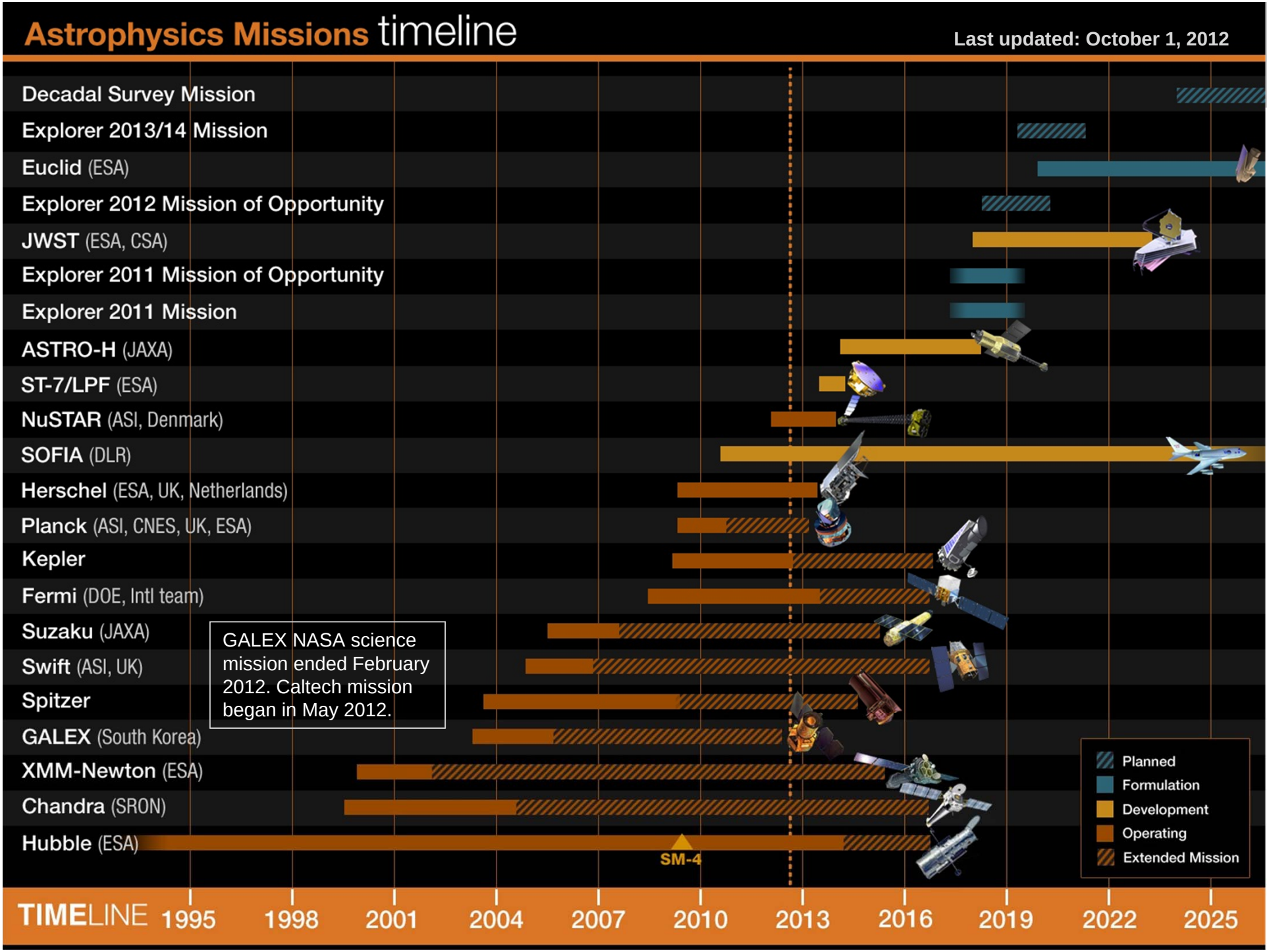
Paul Hertz
Director, Astrophysics Division, NASA

From AAAC March 2012 Annual Report

AAAC Findings	NASA Response
Severely constrained budgets are delaying the implementation of many of the NWNH recommended projects. The AAAC is concerned about the impact of these constraints on the ability of the U.S. to maintain its scientific and technical leadership (§2).	Agree. NASA Astrophysics Implementation Plan describes for the community how NASA will implement the Decadal Survey within the budget constraints.
The AAAC applauds this new [JWST] plan while at the same time urging NASA to do everything possible to continue a healthy balanced program of large, medium, and small-scale projects while still fully supporting JWST (§2.1).	Agree. NASA will continue to initiate new medium-scale (Explorers) and small-scale (Suborbital, core research, technology, and analysis) projects. JWST re-baseline is fully funded to enable success. A new large-scale project cannot be started until JWST approaches launch when funding becomes available.
The NASA budget projections preclude investment in future large missions until JWST launches, putting WFIRST on a course to launch no sooner than the middle of the next decade. The AAAC was pleased to hear of the plans for the design ii reference missions but is concerned that the lack of other investment in WFIRST and the subsequent delayed launch could jeopardize its utility (§2.3).	Agree. NASA plans to invest >$5M in WFIRST in FY13. This includes studies and detector technology development. NASA will ask the CAA whether the delayed launch of WFIRST impacts it utility and priority.

From AAAC March 2012 Annual Report

AAAC Findings	NASA Response
The AAAC is concerned about declining levels of funding for technology development within NASA, NSF, and DOE. Maintaining technology development is essential to enable the discoveries that will take place in future decades, and to maintain the technical leadership of the U.S. (§2.8).	Agree. NASA has made difficult choices in balancing mission development, mission operations, research and analysis, and technology development within the fixed budget. Most APRA grants are low TRL technology development or suborbital investigations, and all SAT grants are mid-TRL technology development.
The AAAC notes that the strategic role of the CAA complements the AAAC, which has a more tactical role and an emphasis on interagency coordination (§2.16).	Agree. NASA has engaged the CAA to review its implementation of the Decadal Survey.
Interagency coordination and interactions on a number of joint projects including the LSST, the Theory and Computation Networks (TCN), Fermi and the Dark Energy Survey (DES) are good (§3).	Agree.
The AAAC finds that SOFIA is advancing toward mission maturity and has demonstrated early scientific return. The AAAC recommends that NASA provide timely updates to the committee and its other advisory apparatus (§1.9).	Agree. NASA includes updates on SOFIA in all Division Updates to the APS, CAA, and AAAC. NASA is offering a tour of SOFIA to AAS Long Beach attendees.


Astrophysics Missions timeline
Last updated: October 1, 2012
Decadal Survey Mission
Explorer 2013/14 Mission
Euclid (ESA)
Explorer 2012 Mission of Opportunity
JWST (ESA, CSA)
Explorer 2011 Mission of Opportunity
Explorer 2011 Mission
ASTRO-H (JAXA)
ST-7/LPF (ESA)
NuSTAR (ASI, Denmark)
SOFIA (DLR)
Herschel (ESA, UK, Netherlands)
Planck (ASI, CNES, UK, ESA)
Kepler
Fermi (DOE, Intl team)
Suzaku (JAXA)
Swift (ASI, UK)
Spitzer
GALEX (South Korea)
XMM-Newton (ESA)
Chandra (SRON)
Hubble (ESA)
SM-4
GALEX NASA science mission ended February 2012. Caltech mission began in May 2012.
Planned
Formulation
Development
Operating
Extended Mission
TIMELINE
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025