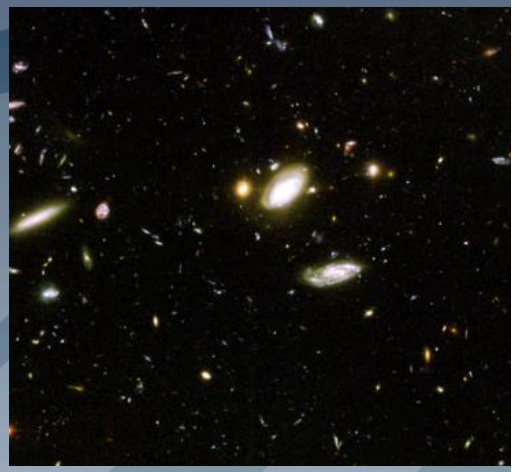
National Aeronautics and Space Administration

Astrophysics

NASA Headquarters Updates



ExoPAG #15

Grapevine, TX
January 2, 2017

Martin Still
ExoPAG Executive Secretary
Astrophysics Division
Science Mission Directorate
Martin.Still@nasa.gov

Content

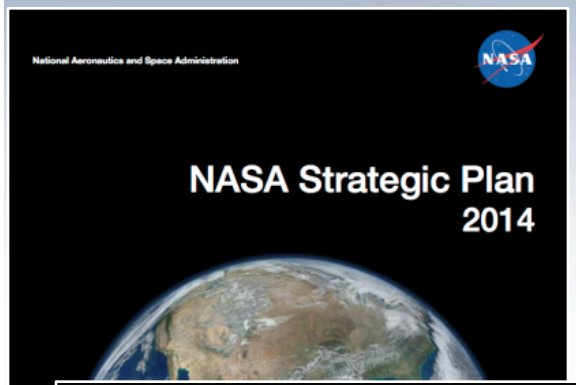
1. Big Picture
2. ExoPAG Status
3. Current Missions Status
4. Future Missions Status
5. Decadal Studies Status
6. Ground-based Facility Status
7. Research and Analysis Status

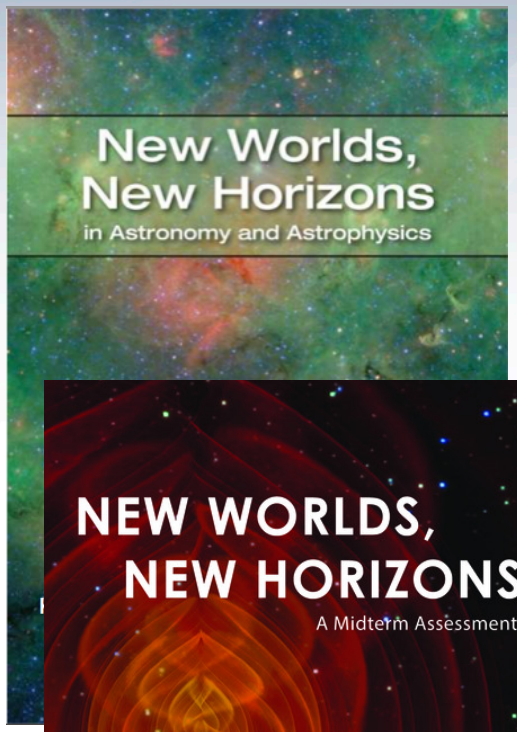
FY 2017 Budget Update

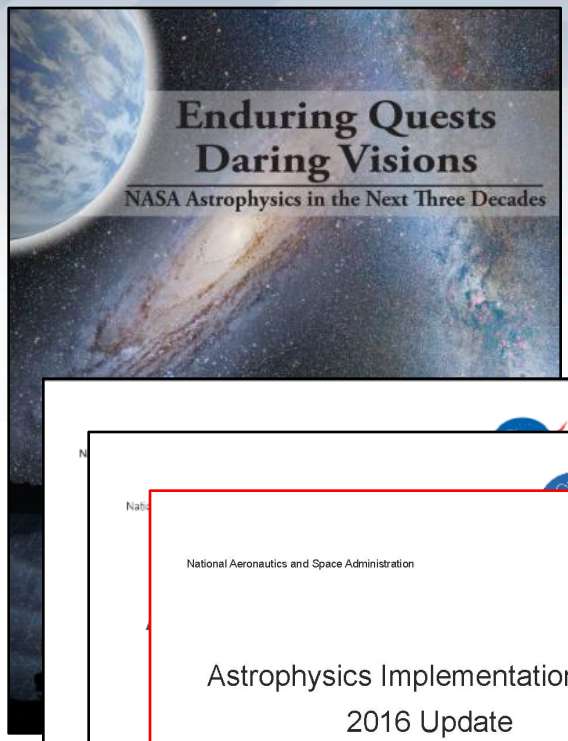
- FY17 budget request sent to Congress in February 2016
  - The FY17 budget request fully supports NASA astrophysics plans including Webb Telescope, WFIRST, Explorers, R&A, etc.
- Both House and Senate appropriations committees have marked up the FY17 NASA budget request
  - Each chamber directed specific – but different – changes in spending from the FY17 budget request (NASA planning budget)
- Neither chamber of Congress has passed a NASA appropriations bill

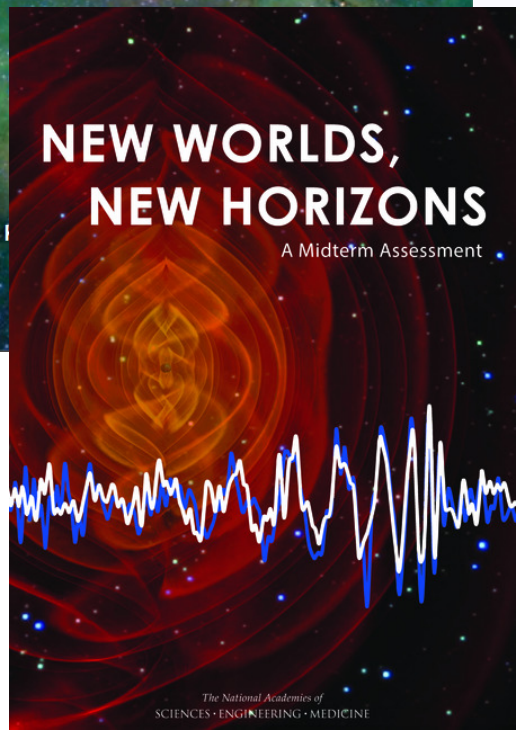
- Before October 1, Congress passed and the President signed a continuing resolution to fund the Government until December 9.
- On December 9, Congress passed and the President signed a continuing resolution to fund the Government until April 28.
- Neither continuing resolution contained any special language regarding NASA astrophysics.
- The continuing resolution keeps the Government operating at the FY16 appropriated budget level. All NASA astrophysics projects and activities can continue as planned under the continuing resolution.

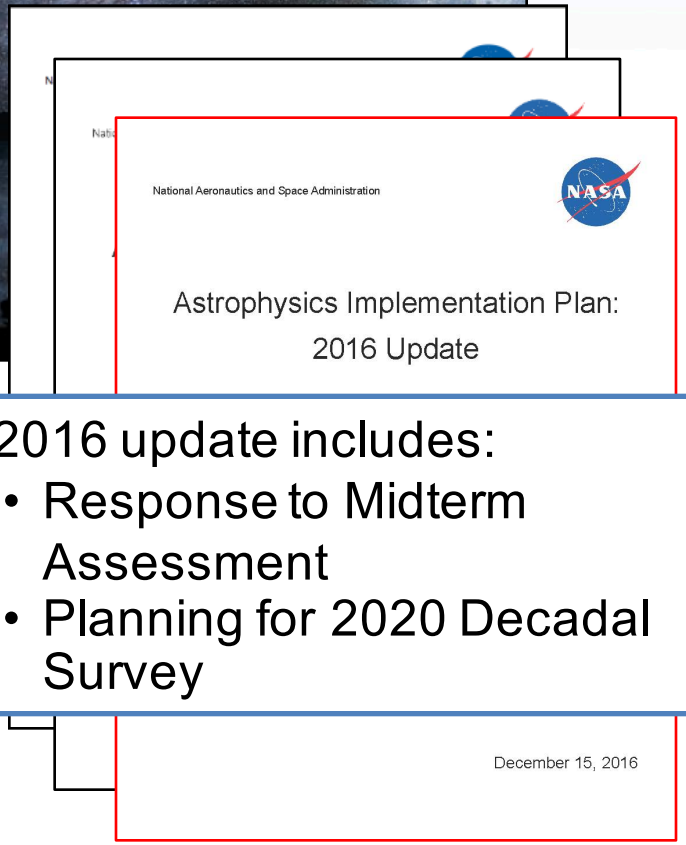
Astrophysics Driving Documents











2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey

http://science.nasa.gov/astrophysics/documents

Responding to the 2010 Decadal Survey
Responding to the Midterm Assessment

Prioritized Recommendation	NASA plans (partial list)
LARGE ACTIVITIES	
WFIRST	In Phase A, launch in mid-2020s, control costs
Explorers	Executing 4 AOs per decade
LISA	Partnering on ESA's space-based gravitational wave observatory; increased contribution
IXO	Partnering on ESA's Athena x-ray observatory
MEDIUM ACTIVITIES	
Exoplanet technology	WFIRST coronagraph, reductions being considered for starshade and coronagraph technology development beyond the WFIRST coronagraph
Inflation Probe technology	3 balloon-borne technology experiments
SMALL ACTIVITIES	
R&A augmentations	R&A up 20% since FY10; not targeted except TCAN
Mid-TRL technology	Initiated Strategic Astrophysics Technology program; focused on identified missions
Suborbital missions	Initiated super pressure balloon capability

NASA Astrophysics Community Groups

- Federal Advisory Committees
  - Committee on Astronomy and Astrophysics (NRC Space Studies Board)
  - Astronomy and Astrophysics Advisory Committee (NSF/NASA/DOE)
  - Astrophysics Subcommittee (NASA Advisory Council)
- Program Analysis Groups
  - Cosmic Origins Program Analysis Group – COPAG
  - ***Exoplanet Exploration Program Analysis Group – ExoPAG***
  - Physics of the Cosmos Program Analysis Group – PhysPAG
- Operating Mission Users Groups (examples)
  - Hubble Space Telescope Users Committee
  - Chandra Users Committee
  - Spitzer Science Users Panel
  - SOFIA Users Group
- Science and Technology Definition Teams
  - Far Infrared Surveyor / Origins Space Telescope
  - Habitable Exoplanet Imaging Mission
  - Large UV/Optical/IR Surveyor
  - X-ray Surveyor

- To get involved with a mission users group, contact the Center Project Scientist or Users Group Chair for any mission
- To volunteer for a Federal Advisory Committee or a Program Analysis Group, sign up for the Astrophysics NSPIRES email list and respond to our annual call for self-nominations

ExoPAG Status

Exoplanet Program Analysis Group

- The ExoPAG is an open, interdisciplinary forum that:
  - provides a conduit for community input into NASA's Exoplanet Exploration Program (ExEP)
  - conducts analyses in support of ExEP science objectives and their prioritization
- The ExoPAG Chair is a member of the NASA Advisory Council Astrophysics Subcommittee

The ExoPAG Executive Committee (EC)

- Helps the ExoPAG Chair:
  - capture and organize community input
  - keep the community informed of ongoing activities and opportunities within the exoplanet program
  - oversee ExoPAG analyses
  - prepare ExoPAG findings and inputs to the Astrophysics Subcommittee
- Is selected to reflect the broad range of scientific disciplines and interests represented in exoplanet exploration
- New members will be selected by the Astrophysics Division Director in the new year

ExoPAG Executive Committee

Name	Home	Year
Alan Boss (chair)	Carnegie Institution	2/3
Rus Belikov	NASA ARC	3/3
Maggie Turnbull	Global Science Institute	3/3
Lucianne Walkowicz	Adler Planetarium	3/3
Daniel Apai	Arizona	2/3
David Ciardi	NExScI	2/3
Shawn Domagal-Goldman	NASA GSFC	2/3
Tiffany Glassman	Northrop Grumman	1/3
Dimitri Mawet	Caltech/JPL	1/3
Tyler Robinson	UC Santa Cruz	1/3

EC members in their third year will be rolling off the committee in the Spring

Call for Nominations: https://exoplanets.nasa.gov/exep/exopag

Deadline: Jan 13, 2017

Science Analysis Group Status

https://exoplanets.nasa.gov/exep/exopag/sag

Delivered	SAG	Title	Lead
2015	8	Requirements and Limits of Future Precision Radial Velocity Measurements	Latham, Plavchan
2015	9	Exoplanet Probe to Medium Scale Direct-Imaging Mission Requirements and Characteristics	Soummer
2015	10	Characterizing the Atmospheres of Transiting Planets with JWST and Beyond	Cowan
2014	11	Preparing for the WFIRST Microlensing Survey	Yee
--	12	Scientific potential and feasibility of high-precision astrometry for exoplanet detection and characterization	Bendek
--	13	Exoplanet Occurrence Rates and Distributions	Belikov
--	14	Characterization of Stars Targeted for NASA Exoplanet Missions	Stassun
--	15	Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions	Apai
--	16	Exoplanet biosignatures	Domagal-Goldman
--	17	Community Resources Needed for K2 and TESS Planetary Candidate Confirmation	Ciardi
--	18	Metrics for Direct-Imaging with Starshades	Glassman, Turnbull
--	19	Exoplanet Imaging Signal Detection Theory and Rigorous Contrast Metrics	Mawet, Jensen-Clem

Current Missions Status


Spitzer
8/25/2003
Kepler
3/7/2009
Formulation
Implementation
Primary Ops
Extended Ops
WFIRST
Mid 2020s
LISA Pathfinder (ESA)
12/3/2015
Webb
2018
Euclid (ESA)
2020
Chandra
7/23/1999
XMM-Newton (ESA)
12/10/1999
TESS
2017
Swift
11/20/2004
NuSTAR
6/13/2012
Fermi
6/11/2008
Hubble
4/24/1990
CREAM (on ISS)
2017
NICER (on ISS)
2017
SOFIA
Full Ops 5/2014

2016 Astrophysics Senior Review
NASA Implementation Decisions

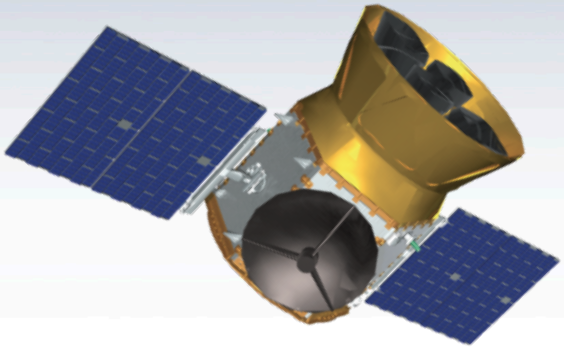
Mission	Extend?	SR2018?	Comments
Hubble	Yes	Yes	
Chandra	Yes	Yes	
Fermi	Yes	Yes	Reduced budget
Kepler/K2	Yes	No	End-of-mission plan
NuSTAR	Yes	Yes	
Spitzer	Yes	No	Reduced budget; end-of-mission plan
Swift	Yes	Yes	Augmentation for automation
XMM	Yes	Yes	Augmentation for GO program

- Maintain all 8 missions in operation, with K2 and Spitzer ending.
  - Spitzer ending in mid-FY19 after providing significant precursor work for JWST and after JWST commissioned.
  - Kepler/K2 ending in FY19 when fuel is exhausted.
- Maintaining all 8 missions will require some reductions in mission funding in order allow the overarching finding (the continuation of all missions) to be implemented.

Future Missions Status

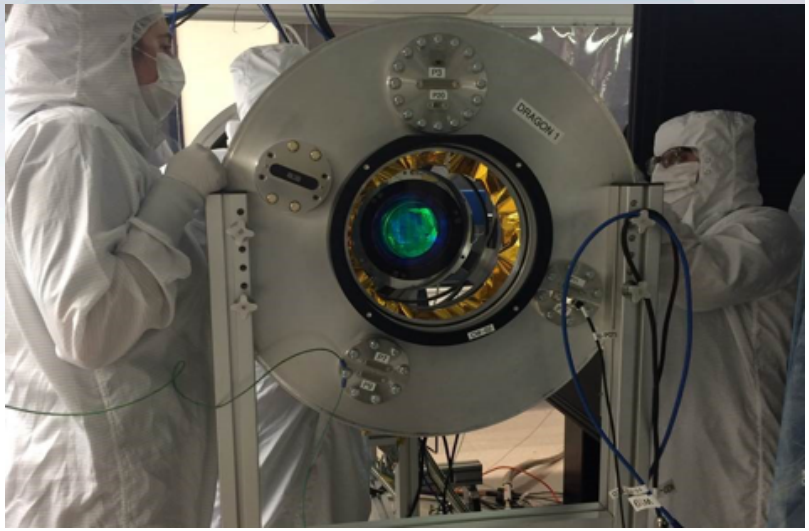
TESS

Transiting Exoplanet Survey Satellite



CURRENT STATUS:

Both instrument and spacecraft bus are currently on schedule to be delivered ~Mar 2017 to begin Observatory Integration.



Flight Camera #1 Cold Optical Testing at MIT/Kavli

Medium Explorer (MIDEX) Mission

PI: G. Ricker (MIT)

Mission: All-Sky photometric exoplanet mapping mission.

Science goal: Search for transiting exoplanets around the nearby, bright stars.

Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view, operating in the Visible-IR spectrum (0.6-1 micron).

Operations: NLT June 2018 launch with a 3-year prime mission including 2 years of spacecraft operations and an additional 1 year ground-based observations and analysis. High-Earth elliptical orbit (17 x 58.7 Earth radii).

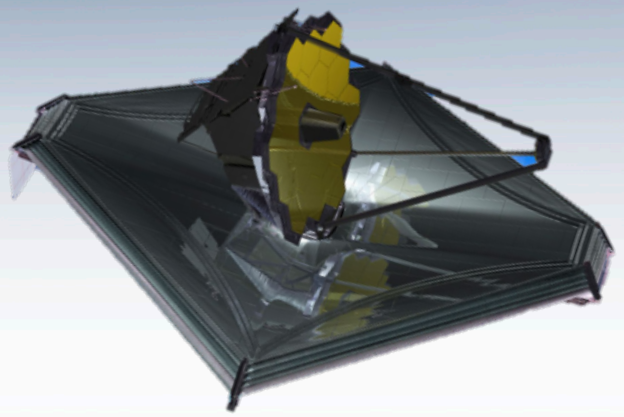
http://tess.gsfc.nasa.gov

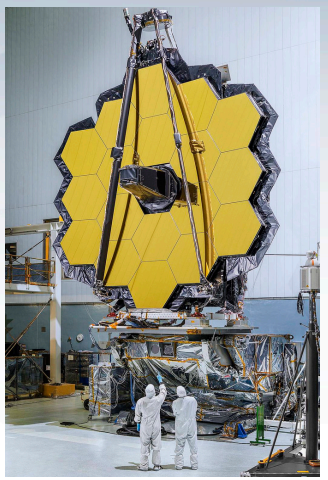
UPCOMING EVENTS:

- Fall 2016 - Spring 2017 – TESS spacecraft bus integration and instrument integration ongoing
- Spring - Fall 2017 – TESS Observatory integration and test
- Spring 2017 – System Integration Review (SIR) and KDP-D
- Fall 2017 – TESS delivery to KSC payload processing facility
- Dec 2017 – Launch readiness date from Cape Canaveral FL (pending review of recent SpaceX pad anomaly)

James Webb Space Telescope

http://jwst.nasa.gov





2016 Accomplishments

- Science payload, telescope + instruments completed
- Ambient environmental testing of science payload started
- Spacecraft assembly nearly completed
- Completed 3rd and final test of Pathfinder Telescope and ground support equipment at JSC in support of 2017 test of flight hardware

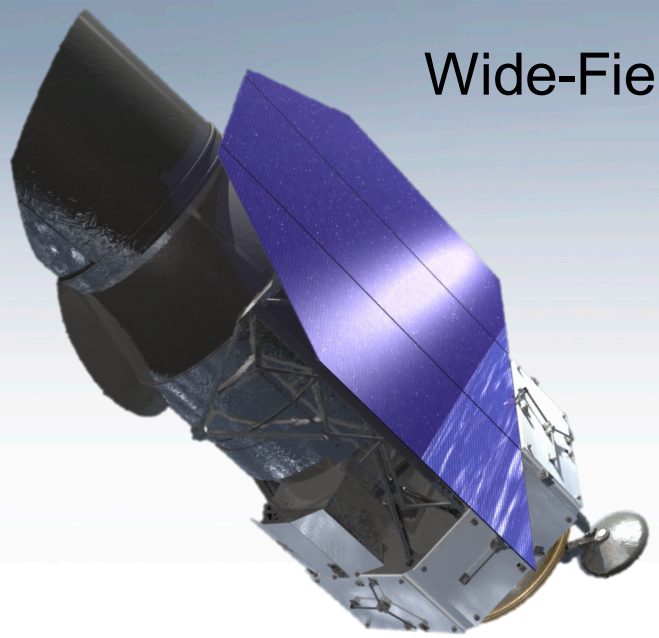
2017 plans

- Complete ambient testing of combined Telescope and instruments
- Complete spacecraft bus
- Integrate spacecraft and sunshield
- Cryo-vacuum testing of the science payload at JSC
- Issue calls for Early Release Science and Cycle 1 proposals
- Flight operations rehearsals and training

JWST Town Hall: Thursday, 6:30-8:30 pm, Grapevine C
"Proposing for the James Webb Space Telescope"

WFIRST

Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

Science themes: Dark Energy, Exoplanets, Large Area Near Infrared Surveys

Mission: 2.4m widefield telescope at L2; using existing hardware, images 0.28deg^2 at 0.8-2μm

Instruments (design reference mission): Wide Field Instrument (camera plus IFU), Coronagraph Instrument (imaging/IFS)

Phase: Currently in Formulation (Phase A)

CURRENT STATUS:

- Mission new start on February 17, 2016, when the NASA Associate Administrator approved WFIRST to begin Phase A
- Working toward System Requirements Review in June 2017 and start of Phase B in October 2017.
- WFIRST does not have a starshade; but NASA is studying a starshade for the next Decadal Survey's consideration.
  - Starshade compatibility is being studied during Phase A; mandated minimum impact on WFIRST.
  - NASA will decide by fall 2017 whether to maintain starshade compatibility.
- National Academies' Midterm Assessment stressed need for cost control on WFIRST.
  - Consistent with current NASA approach to managing design/development of the mission.
- On track for completing maturation of new technologies in 2017.
- In-guide budget supports launch in mid-2020s.

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

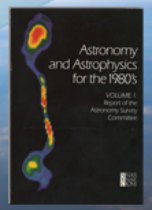
WFIRST Town Hall: Thursday, 7:30-9:00 pm, Grapevine B
"WFIRST Status and Science Opportunities"

Decadal Studies Status

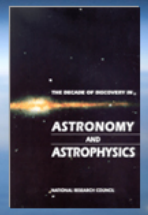
ASTROPHYSICS

Decadal Survey Missions

1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra



1991
Decadal Survey
Spitzer, SOFIA

2001
Decadal Survey
JWST

2010
Decadal Survey
WFIRST

Preparing for the 2020 Astrophysics Decadal Survey

- NASA has begun to study large mission concepts as input to the 2020 Decadal Survey
  - A well informed Decadal Survey makes better recommendations
- NASA appointed Science and Technology Development Teams and initiated four large mission concept studies
  - Far Infrared Surveyor / Origins Space Telescope
  - Habitable Exoplanet Imaging Mission
  - Large Ultraviolet/Optical/Infrared Surveyor
  - X-ray Surveyor
- Science and Technology Definition Teams have a significant role and responsibility
  - Develop science case
  - Flow science case into mission parameters
  - Assess technology gap list
  - Direct trades of science vs cost/capability
- All teams have met in several face-to-face meetings since early this year
  - Teams are planning for quarterly face-to-face meetings in FY17

http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/

Special Session: Saturday, 10:00-11:30 am, Grapevine B
"NASA's 2020 Decadal Studies: An Update"

Preparing for the 2020 Decadal Survey
Large Mission Concepts

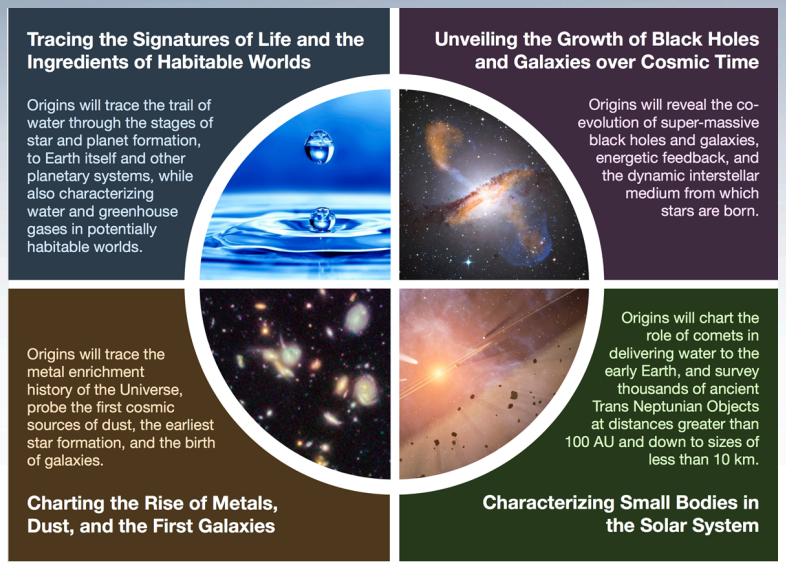
NASA has assembled Science and Technology Definition Teams (STDTs) for each of the four large mission candidates to enable Mission Concept Studies as input to the 2020 Decadal Survey.

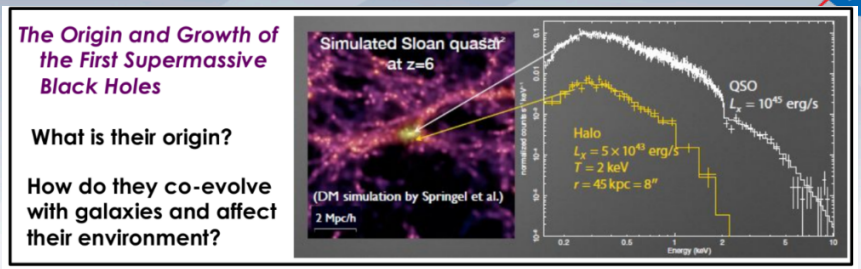
	Community STDT Chairs	Center Study Scientist	Study Lead Center	HQ Program Scientist
Far IR Surveyor asd.gsfc.nasa.gov/firs	Asantha Cooray* Margaret Meixner	David Leisawitz	GSFC	Kartik Sheth
Habitable Exoplanet Imaging Mission www.jpl.nasa.gov/habex	Scott Gaudi* Sara Seager	Bertrand Mennesson	JPL	Martin Still
Large UV/Optical/IR Surveyor asd.gsfc.nasa.gov/luvoir	Debra Fischer* Bradley Peterson	Aki Roberge	GSFC	Mario Perez
X-ray Surveyor wwwastro.msfc.nasa.gov/xrs	Feryal Ozel* Alexey Vikhlinin	Jessica Gaskin	MSFC	Dan Evans

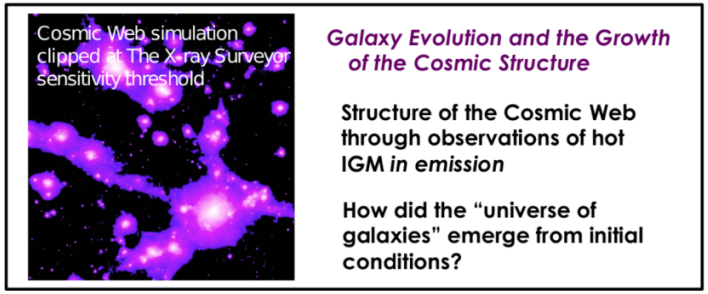
* Astrophysics Subcommittee member

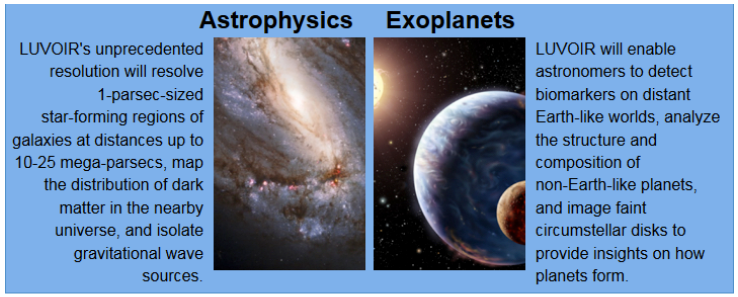
http://science.nasa.gov/astrophysics/2020-decadal-survey-planning

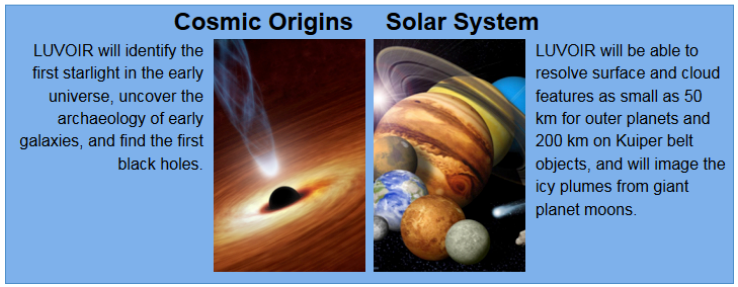
Large Mission Concepts - Science

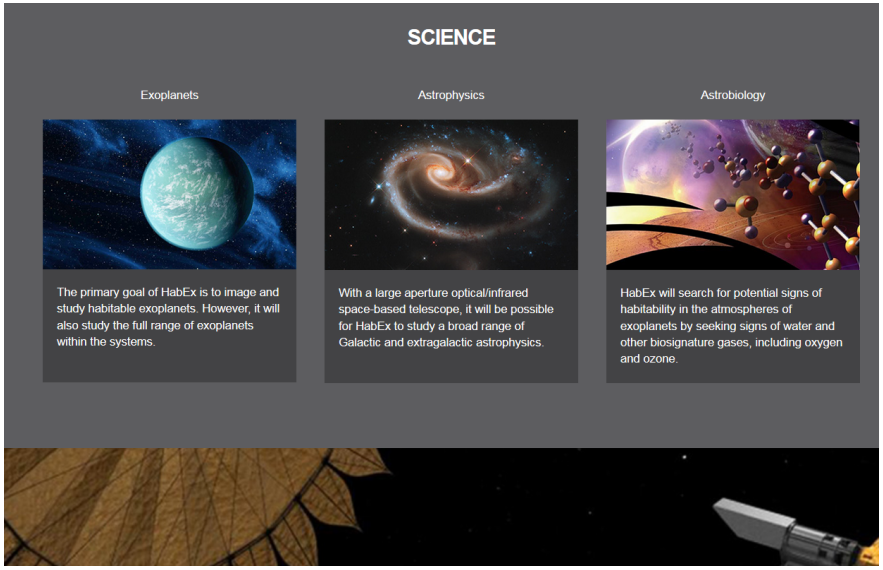












Joint PAG meeting tomorrow afternoon
Special Session: Saturday, 10:00-11:30 am, Grapevine B "NASA's 2020 Decadal Studies: An Update"

Astrophysics Probes

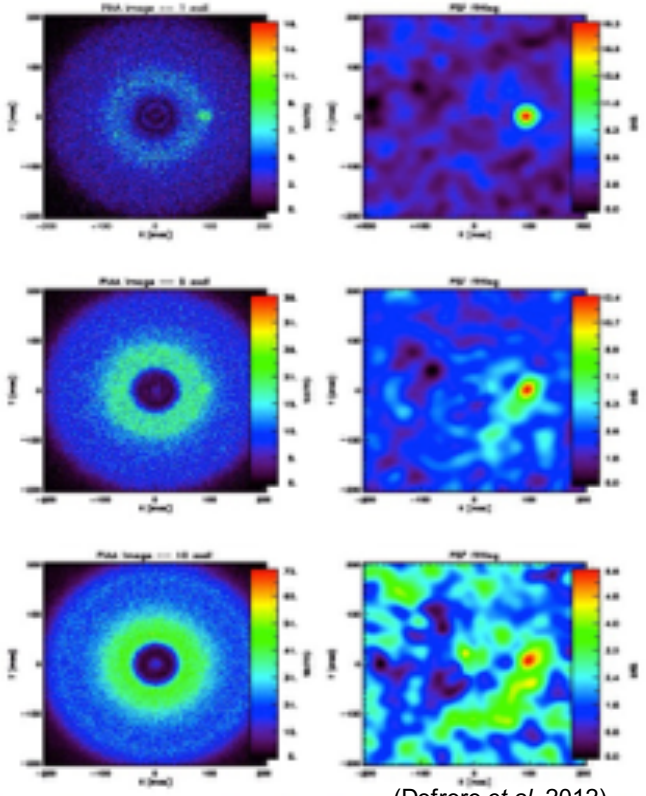
- NASA is soliciting mission concept ideas for medium-size missions as part of community preparations for the 2020 Decadal.
  - An Astrophysics Probe is defined as a mission with total lifecycle cost (NASA's Phase A through E) in the range $400M to $1B
  - NASA will provide funding to selected PI-led mission concept study teams, as well as fund a run with a mission design center at GSFC (IDC) or JPL (Team X), as well as a cost assessment at the end of the study
  - Proposals for Astrophysics Probe mission concept studies were received on November 15
- NASA received 27 compliant proposals spanning all areas of astrophysics, and expects to select 5-8 proposals for Astrophysics Probe mission concept studies
- Next Steps:
  - Selection targeted for February 2017
  - Award initiation targeted for March 2017
  - Community workshop at the Winter 2018 AAS meeting
  - Final reports due to NASA in September 2018
- NASA will submit the final reports and the results of the NASA cost assessment to the 2020 Decadal Survey Committee

Ground-based Facilities Status

LBTI HOSTS Survey Status

Hunt for Observable Signatures of Terrestrial Systems

- Survey of mid-IR emission from exozodiacal dust in the habitable zones of nearby main sequence stars, using the LBTI's N-band nulling mode
- HOSTS's goal is to inform the design of future space missions to directly detect and characterize exo-Earths
- CY16 hampered considerably by weather, technical and operational problems
- Cancellation/Continuation review occurred Jul 2016. **Conclusion: continue LBTI project and complete the HOSTS survey (35 targets) by fall of 2018, subject to changes in project execution**
- NASA and U. of Arizona working to negotiate an extension to the Task Order for LBTI to extend period of performance and funding though FY18
- LBTI will have a Project Assessment Review Feb 2017, and a continuation/closeout review at the close of the 2017A observing semester (Jul 2017)



(Defrere *et al.* 2012)

LBTI science report: Phil Willems @ ExoPAG #15, Jan 3 11am

NN-Explore Exoplanet Investigations with Doppler spectroscopy (NEID)

- NN-EXPLORE held the NEID instrument Detailed Design Review (DDR) and the NOAO port adapter and facilities Preliminary Design Review (PDR) on Nov 29
- NEID on schedule for first-light on the 3.5-m WIYN telescope (2019)
- NN-EXPLORE continues the GO program for current instruments on WIYN (next deadline Mar 2017)
- Targeted to exoplanet research, with particular emphases on follow-up observations of Kepler and K2 targets, and observations in preparation for TESS

- NN-Explore is a joint initiative between NASA and the NSF
- Purpose: discovery and characterization of exoplanets using the Radial Velocity technique in the few x 10 cm regime
- NEID Instrument team lead by Suvrath Mahadevan: Penn State, U. of Pennslyvania, Macquarie U., Physical Research Lab. (India), NIST/Colorado and NASA GSFC

Research and Analysis Status

Proposal Opportunities Planned for 2017

NuSTAR General Observer - Cycle 3	January 13, 2017	ROSES-16 D.10
Fermi Guest Investigator - Cycle 10	January 20, 2017	ROSES-16 D.6
Habitable Worlds	January 20, 2017	ROSES-16 E.4
NESSF	February 1, 2017	NSPIRES
Spitzer DDT	Feb 28, 2017 & Sep 12, 2017	ssc.spitzer.caltech.edu
Chandra General Observer - Cycle 19	March 15, 2017	cxc.harvard.edu
Nancy Grace Roman Technology Fellowship	March 17, 2017	ROSES-16 D.9
Strategic Astrophysics Technology (SAT)	March 17, 2017	ROSES-16 D.8
Astrophysics Research and Analysis (APRA)	March 17, 2017	ROSES-16 D.3
Hubble General Observer - Cycle 25	April 7, 2017	www.stsci.edu
Astrophysics Data Analysis (ADAP)	May 16, 2017	ROSES-17 D.2
Exoplanet Research Program (XRP)	May 25, 2017 (Step 2)	ROSES-17 E.3
SOFIA Cycle 6	Approx early July	www.sofia.usra.edu
Astrophysics Theory Program (ATP)	July 27, 2017	ROSES-17 D.4
SOFIA next-generation instrumentation	Approx August	ROSES-17 D.13
JWST Early Release Science	August 18, 2017	jwst.stsci.edu
Swift Guest Investigator – Cycle 14	September 21, 2017	ROSES-17 D.5
Keck Observing	Approx October	nexsci.caltech.edu/missions/KSA/
XMM-Newton - Cycle 17	October 2017	heasarc.gsfc.nasa.gov
JWST Cycle 1	November 30, 2017	jwst.stsci.edu
K2 Guest Investigator – Cycle 6	December 14, 2017 (Step 2)	ROSES-17 D.7
TESS Guest Investigator – Cycle 1	9 months before launch	ROSES-17 D.11

New Process for Nancy Grace Roman Technology Fellowship

RTF gives early career researchers the opportunity to develop the skills necessary to develop flight instrumentation projects in order to eventually become PIs of future missions; to develop innovative technologies; and to put early-career instrument builders on track for long-term positions.

1 For early-career applicants:

- **Submit APRA proposal**
- **Tick RTF box, include one-page application**
- **Undergo successful review, APRA proposal selected**
- **Receive the title "Roman Technology Fellow"**

2 When a previously selected RTF gains a permanent or permanent-track position:

- **Submit proposal for up to $300k in Fellowship Funds**
- **Undergo successful review**
- **Use Fellowship Funds to start lab or research group**

NASA Named Fellowships (NNF)

Einstein, Hubble, and Sagan Fellowships

Starting FY18 (fellows selected in early 2017), a fraction of Named Fellowship budget is re-allocated to community grants (Astrophysics R&A programs)

Why: To restore balance of $$ between research grants & NNF, which has changed from 10:1 to 6:1 over the last decade.

- **Rebalance of $$ → Reduction in total number of fellowships**
  - Current $$ should support ~30 NNFs – will be reducing to ~24 NNFs per year*
  - *NOTE: Actual numbers often higher because not all fellows stay for all three years / money freed up allows more fellows to be selected*
- **Large overlap in applications → combine application & review process into a single application & review**
  - Reduces work for applicants, letter writers, reviewers
  - NNF symposia will continue
- **The changes will NOT alter the current balance or the mix of science topics within the NNF program**

NASA Astrophysics Postdoctoral Fellowships
Einstein, Hubble, and Sagan Fellowships

- **Starting FY18 (fellows selected in early 2017), a fraction** of Postdoc Fellowship budget is re-allocated to community grants (Astrophysics R&A programs)
- **Why**: To restore balance of $$ between research grants & postdoc fellowships, which has changed from 10:1 to 6:1 over the last decade.
- **Large overlap in applications to Hubble/Einstein/Sagan → combine application & review process into a single application & review**
  - Reduces work for applicants, letter writers, reviewers
  - Hubble/Einstein/Sagan symposia to continue
- **Rebalance of $$ → Reduction in total number of fellowships**
  - Current $$ supports ~100 Fellowships – will be reducing to ~75 Fellowships (~25 new Fellows per year)
  - Frees up additional ~$6M for R&A after fully implemented
- **The changes will not alter the current balance or the mix of science topics within the overall Postdoc Fellowship program**

Visiting Program Scientists at NASA HQ

Steward the US Space Astro Program

- Bring your unique experience and perspective to the HQ team and provide strategic advice towards meet NASA's scientific goals.
- Help NASA maximize the scientific return from its missions and research programs.
- Provide key linkage to the astrophysics community and help guide the long term planning of the astrophysics program.

What's in it for me? Become an expert in

- How science is enabled on the national and international stage.
- What makes a proposal successful for research programs and for missions / Explorers.
- Leading teams and multi-million dollar budgets.

Have a tangible and visible impact on the science done by NASA and our community - you can make a difference!

What NASA is looking for

- Great team players & communicators.
- Ability to work on multiple programs & missions at the same time.
- Disciplinary expertise (e.g., data analysis, mission experience, theory, instrumentation).
- Ability to place knowledge in the broad context of US astrophysics.

Application Deadline: January 31

- Only a CV + cover letter – rolling evaluations.
- Must have a long-term position at a US institution.
- Start date is flexible. Individual research time is negotiable. Position renewable for up to 6 years.
- For more info, reach out to any HQ scientist here or email Dan Evans (daniel.a.evans@nasa.gov).

http://jobregister.aas.org/job_view?JobID=56263

Backup Slides

Transition – NASA Agency Review Team

Chris Shank

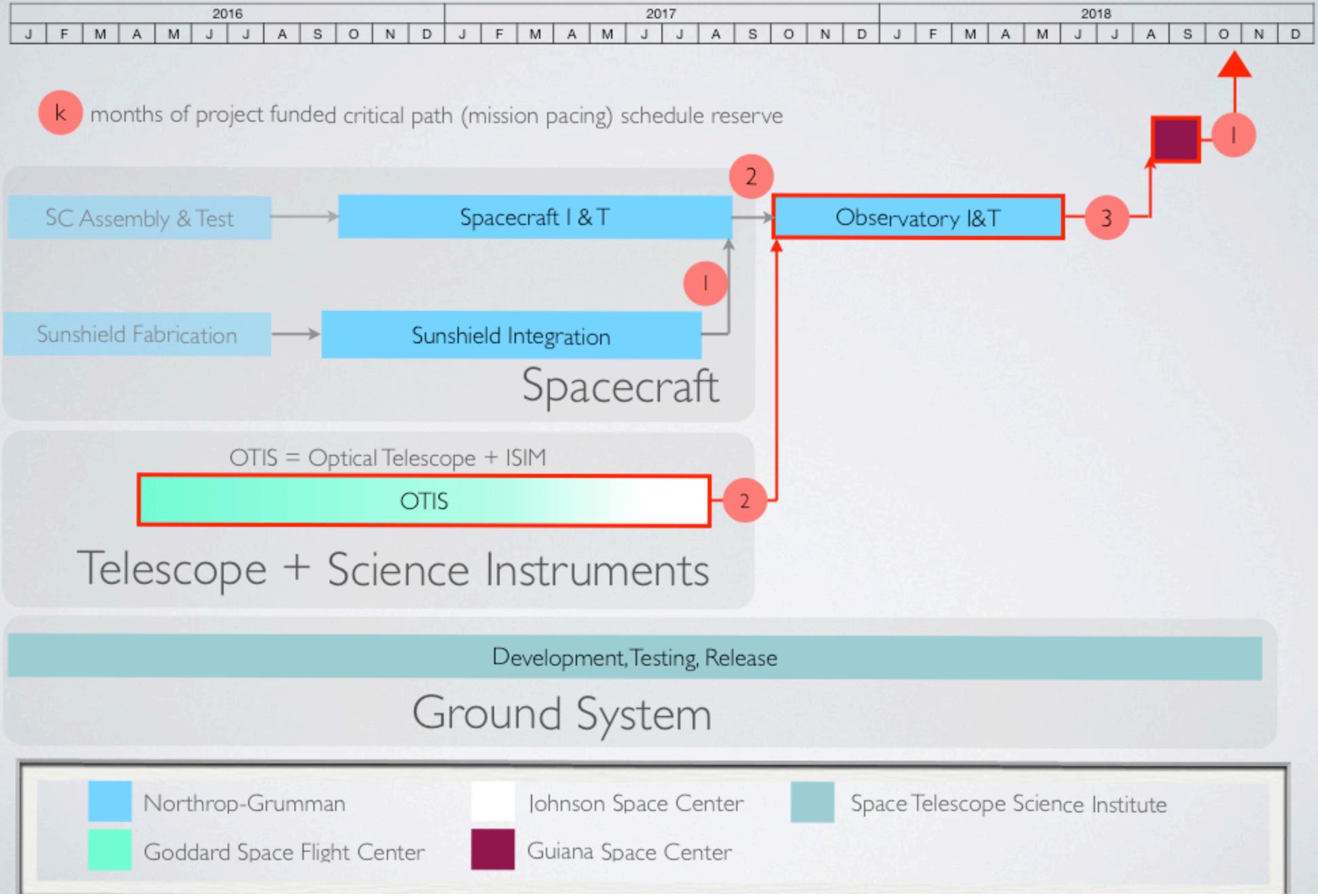
Jack Burns

Mid-December	Members named
Now	Data gathering
January and beyond?	Policy recommendations formed
After January 20	New administration enacts new policies

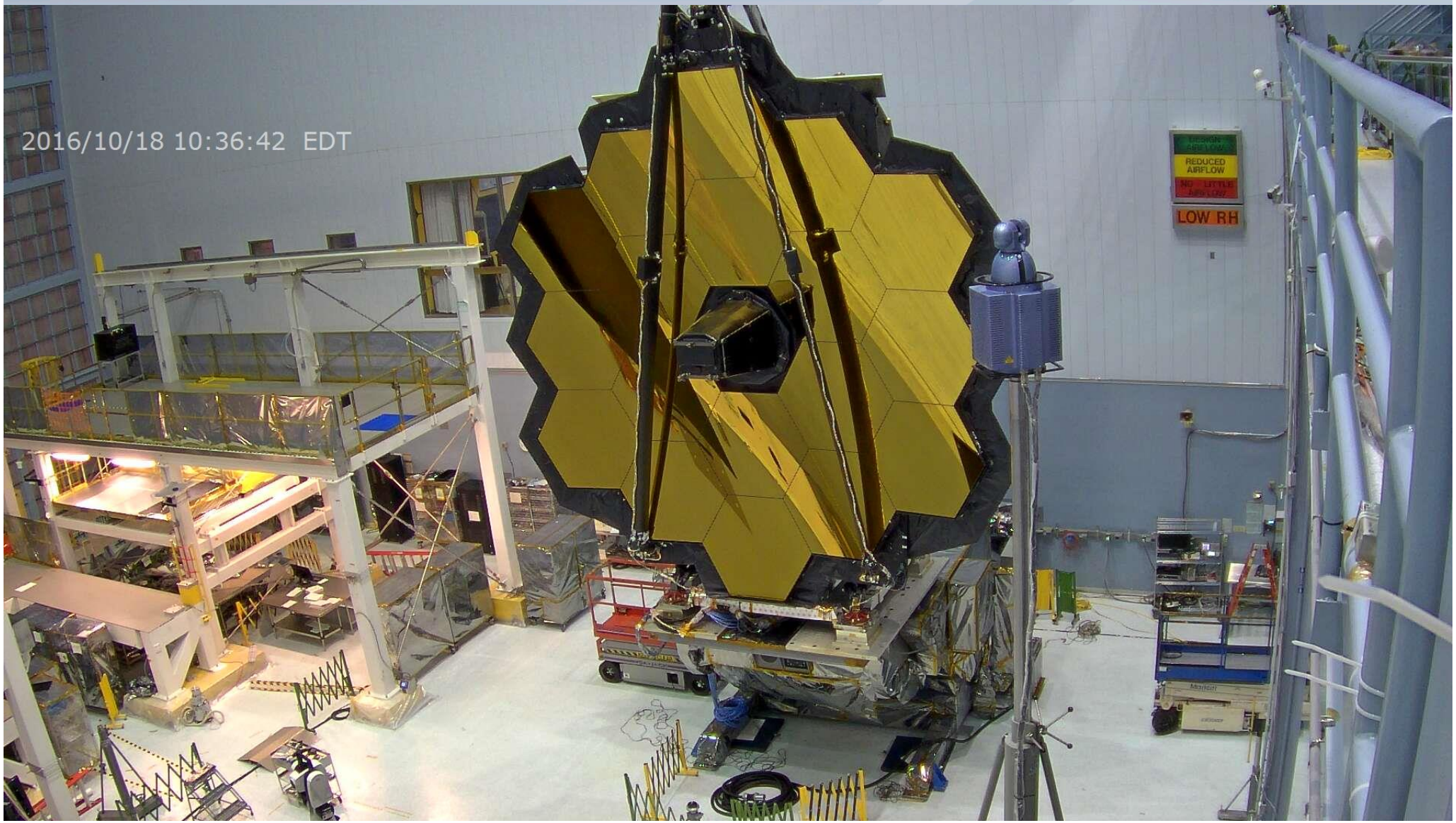
Chris Shank (ex-House staff, ex-NASA HQ) – Space policy, Engineer

Greg Autry (USC) – Entrepreneurship, Space tourism
Jack Burns (Colorado U) – Astrophysicist, AAS VP
Steve Cook (Dynetics, ex-NASA MSFC) – Rockets, Engineer
Rodney Liesveld (ex-NASA) – Space policy (civil and security)
Sandra Magnus (AIAA, ex-NASA Astronaut) – Space advocacy, Engineer
Jeff Waksman (ex-House staff) – Research

Webb Simplified Schedule



Webb OTIS (@ GSFC)

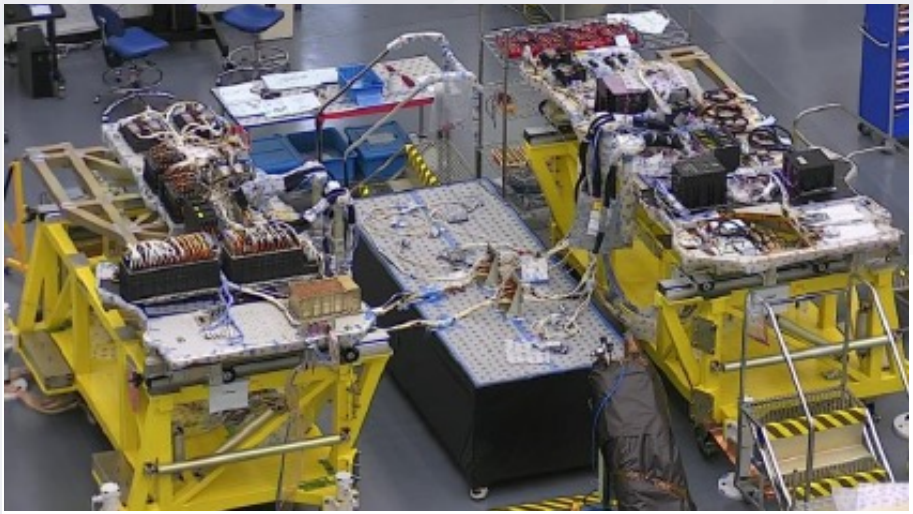


OTIS = **O**ptical **T**elescope Element and **I**ntegrated **S**cience Instrument Module

Webb Pathfinder Test (@ JSC)

Webb Spacecraft

- All electronics and harnessing installed
- MIRI cryocooler compressor assembly and radiator panels installed
- Sunshield core assembly installation commenced
- Solar Array in test



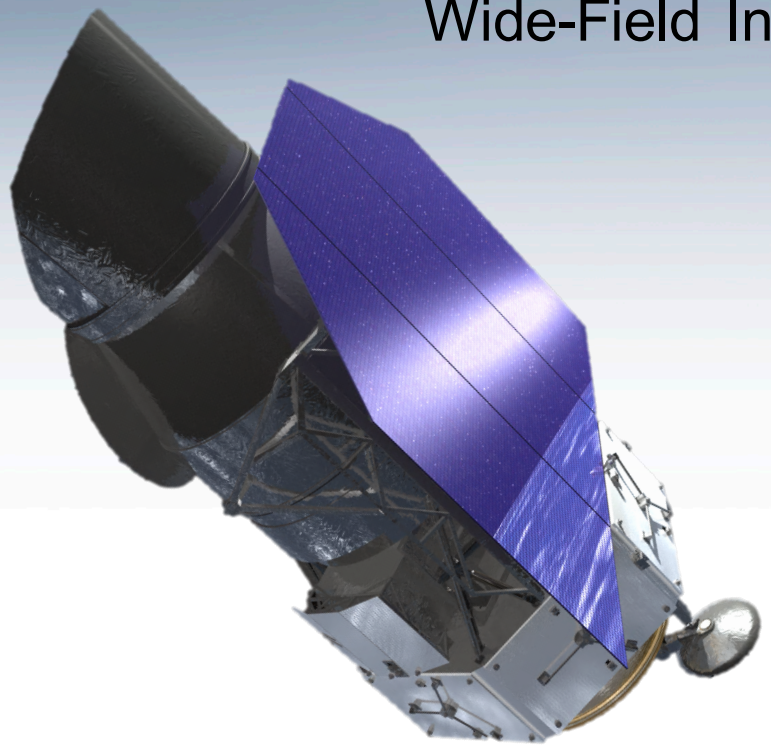
Webb Summary

- Program remains within replan budget and on time for October 2018 launch readiness date.
- Project is concluding manufacturing phase and is transitioning into integration and test. There are new, first time challenges associated with this phase.
- Community engagement is less than one year away.

JWST Town Hall: Thursday, 6:30-8:30 pm, Grapevine C
"Proposing for the James Webb Space Telescope"

WFIRST

Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

Science themes: Dark Energy, Exoplanets, Large Area Near Infrared Surveys

Mission: 2.4m widefield telescope at L2; using existing hardware, images 0.28deg^2 at 0.8-2μm

Instruments (design reference mission): Wide Field Instrument (camera plus IFU), Coronagraph Instrument (imaging/IFS)

Phase: Currently in Formulation (Phase A)

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

CURRENT STATUS:

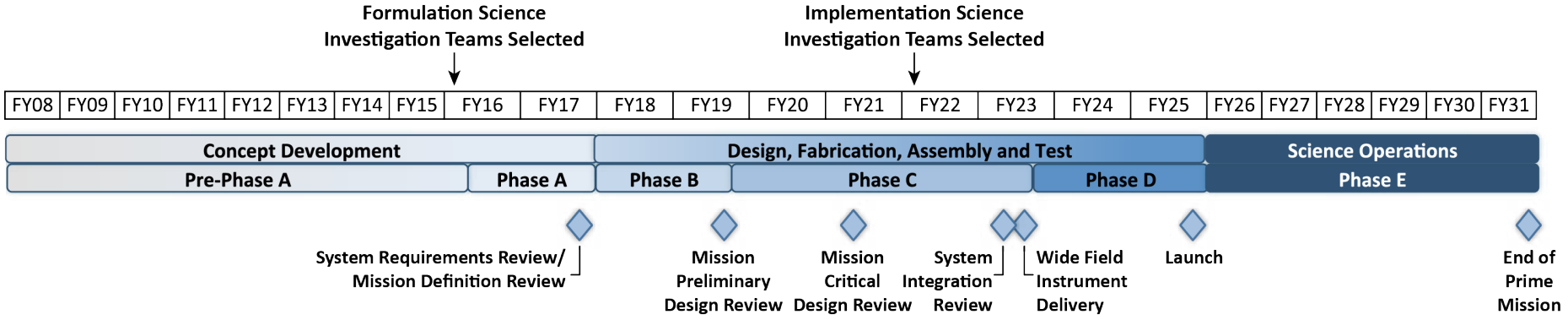
- Mission new start on February 17, 2016, after the KDP-A decision when the NASA Associate Administrator approved WFIRST to begin Phase A
- Working toward System Requirements Review (SRR) in June 2017 and KDP-B decision (start of Phase B) in October 2017.
- Standing Review Board member selection underway.
- WFIRST does not have a starshade; but NASA is studying a starshade for the next Decadal Survey's consideration.
  - Starshade compatibility is being studied during Phase A; mandated minimum impact on WFIRST.
  - NASA will decide before KDP-B whether to maintain starshade compatibility.
- National Academies' Midterm Assessment stressed need for cost control on WFIRST.
  - Consistent with current NASA approach to managing design/development of the mission.
- On track for TRL-6 of new technologies in 2017.
- FY17 budget request matches FY16 appropriation of $90M. In-guide budget supports launch in mid-2020s.

WFIRST Development


Flight Primary Mirror Assembly


Primary Mirror Instrumentation and Thermal Control

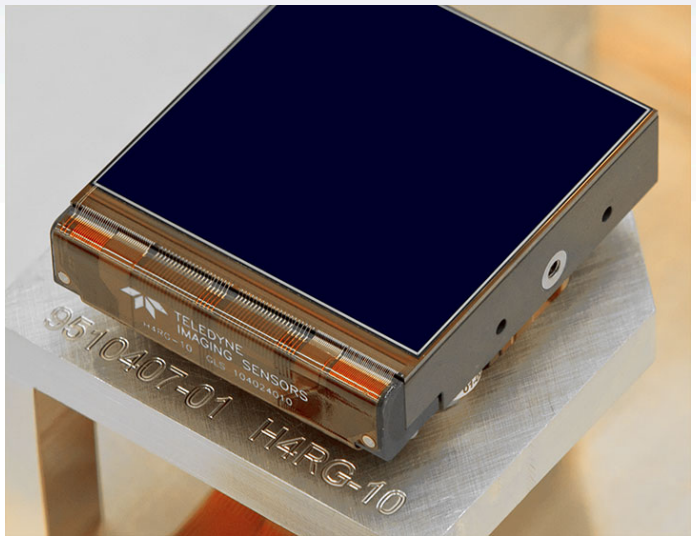

Spacecraft Mockup



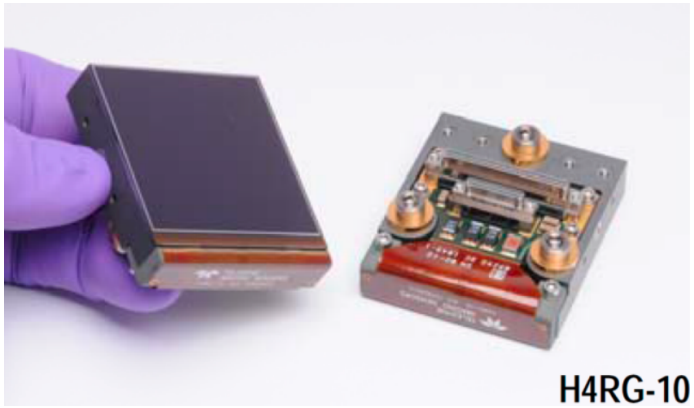
Timeline for WFIRST with major events; dates are for illustration purposes only

WFIRST Detector Technology Milestones

MS #	Milestone	Milestone Date
1	Produce, test, and analyze **2 candidate passivation techniques** (PV1 and PV2) in **banded arrays** to document baseline performance, inter-pixel capacitance, and shall meet the following derived requirements: dark current less than 0.1 e-/pixel/sec, CDS noise less than 20 e-, and QE greater than 60% (over the bandpass of the WFI channel) at nominal operating temperature.	7/31/14 ✔
2	Produce, test, and analyze **1 additional candidate passivation technique** (PV3) in **banded arrays** to document baseline performance, inter-pixel capacitance, and shall meet the following derived requirements: dark current less than 0.1 e-/pixel/sec, CDS noise less than 20 e-, and QE greater than 60% (over the bandpass of the WFI channel) at nominal operating temperature.	12/30/14 ✔
3	Produce, test, and analyze **full arrays with operability > 95%** and shall meet the following derived requirements: dark current less than 0.1 e-/pixel/sec, CDS noise less than 20 e-, QE greater than 60% (over the bandpass of the WFI channel), inter-pixel capacitance ≤3% in nearest-neighbor pixels at nominal operating temperature.	9/15/15 ✔
4	Produce, test, and analyze final selected recipe in **full arrays demonstrating a yield of >20%** with operability > 95% and shall meet the following derived requirements: dark current less than 0.1 e-/pixel/sec, CDS noise less than 20 e-, QE greater than 60% (over the bandpass of the WFI channel), inter-pixel capacitance ≤3% in nearest-neighbor pixels, persistence less than 0.1% of full well illumination after 150 sec at nominal operating temperature.	9/15/16 ✔
5	Complete environmental testing (vibration, radiation, thermal cycling) of one SCA sample part, as per NASA test standards.	12/1/16



Detector Characterization Lab, GSFC



WFIRST Coronagraph Technology Milestones

MS #	Milestone	Milestone Date
1	First-generation reflective Shaped Pupil apodizing mask has been fabricated with black silicon specular reflectivity of less than 10^{-3} and 20 μm pixel size.	7/21/14 ✔
2	Shaped Pupil Coronagraph in the High Contrast Imaging Testbed demonstrates 10^{-8} raw contrast with narrowband light at 550 nm in a static environment.	9/30/14 ✔
3	First-generation PIAACMC focal plane phase mask with at least 12 concentric rings has been fabricated and characterized; results are consistent with model predictions of 10^{-8} raw contrast with 10% broadband light centered at 550 nm.	12/15/14 ✔
4	Hybrid Lyot Coronagraph in the High Contrast Imaging Testbed demonstrates 10^{-8} raw contrast with narrowband light at 550 nm in a static environment.	2/28/15 ✔
5	Occulting Mask Coronagraph in the High Contrast Imaging Testbed demonstrates 10^{-8} raw contrast with 10% broadband light centered at 550 nm in a static environment.	9/15/15 ✔
6	Low Order Wavefront Sensing and Control subsystem provides pointing jitter sensing better than 0.4 mas rms per axis and meets pointing and low order wavefront drift control requirements.	9/30/15 ✔
7	Spectrograph detector and read-out electronics are demonstrated to have dark current less than 0.001 e/pix/s and read noise less than 1 e/pix/frame.	8/25/16 ✔
8	PIAACMC coronagraph in the High Contrast Imaging Testbed demonstrates 10^{-8} raw contrast with 10% broadband light centered at 550 nm in a static environment; contrast sensitivity to pointing and focus is characterized.	9/30/16 …
9	Occulting Mask Coronagraph in the High Contrast Imaging Testbed demonstrates 10^{-8} raw contrast with 10% broadband light centered at 550 nm in a simulated dynamic environment.	9/30/16 …