NSF AST Program Update

March 30, 2016

Jim Ulvestad, Division Director, MPS/AST

@UlvestadNSF

High-Level Summary

- Outstanding science opportunities offered/developed
  - ALMA, EVLA, Dark Energy Camera, GPI, DKIST, LSST
  - ~110 research awards/yr in AAG, plus MSIP, ATI, AAPF, REU, PAARE
  - Interagency: DES, DESI, NN-EXPLORE (plus LSST, of course)
  - Beyond AST budget, NSF spent over $100 million on construction of AST facilities in FY 2015
- Unknown prospects for budget increases this decade
- Partnerships with NASA and DOE have strengthened
- Data-enabled science continues to grow in importance
- LIGO detection of gravitational waves may have substantial impact on field over next few years
- Awaiting results of mid-decadal review
- Challenges are many, but our community continues to make progress at the science frontiers

Division of Astronomical Sciences (AST)

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Division Director

David Boboltz
Acting Deputy Division Director

Craig McClure
Program Support Manager

Donna O'Malley
Financial & Operations Specialist

Vernon Pankonin
Senior Advisor

Elizabeth Pentecost
Project Administrator

Administration

Stephanie Hill
Program Assistant (Student)

Diana Phan
Program Analyst

Matthew Viau
Program Specialist

Vacant
Program Assistant

Individual Investigator Programs and Astronomy & Astrophysics Research Grants

James Neff
Program Director
IIP Coordinator; Education & Special Programs (REU, PAARE)

Richard Barvainis
Program Director
Extragalactic Astronomy & Cosmology

Glen Langston
Program Director
Galactic Astronomy

Harshal Gupta
Program Director
Astronomy & Astrophysics Postdoctoral Fellowships

Joan Wrobel
Program Director
CAREER; Extragalactic Astronomy & Cosmology

Faith Vilas
Program Director
Planetary Astronomy

Maria Womack
Expert
Stellar Astronomy & Astrophysics

Hugh Van Horn
Program Director
AAG Grants

Joe Pesce
Program Director
AAG Grants, Divestment

Vacant
Advanced Technologies & Instrumentation

Vacant
Major Research Instrumentation

David Boboltz
Theoretical & Computational Astrophysics Networks

Glen Langston
Enhancing Access to the Radio Spectrum

Facilities, Mid-Scale, & MREFC Projects

Christopher Davis
Program Director
Gemini Observatory

Philip Puxley
Program Director
National Radio Astronomy Observatory

Ralph Gaume
Program Director
Arecibo Observatory

Nigel Sharp
Program Director
Large Synoptic Survey Telescope

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Atacama Large Millimeter Array

ESM

Mangala Sharma
Program Director

Thomas Wilson
Program Director

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AST Position Openings

- AST has 3 openings for rotators under Intergovernmental Personnel Act (IPA)
  - Typically 2-3 years at NSF, while maintaining employment status at home institution
  - Per diem of $22,500/yr; up to 50 days of research time
  - Current ad closes March 31, 2016
- IPAs bring a different and important university perspective to the federal government, and can help translate federal requirements to the scientific community
- Deputy Division Director opening
  - Pat Knezek has moved to a Senior Advisor position, and is working with Advanced Cyber Infrastructure Division
  - Application deadline is May 23, 2016

Management Competitions

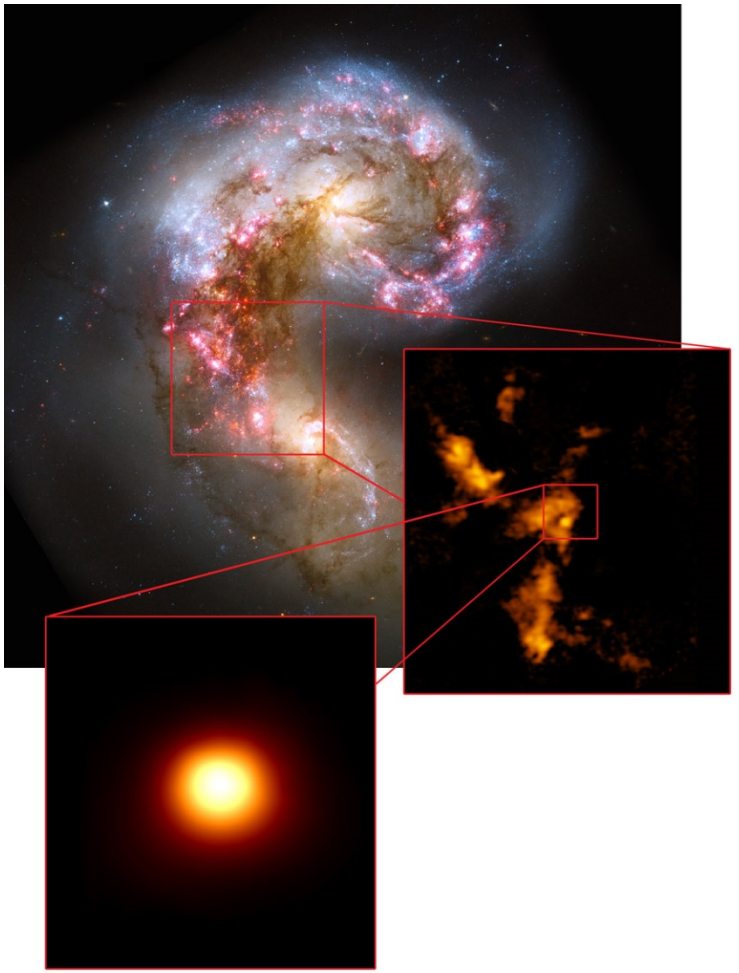
- NOAO competition concluded. AURA selected. New 5-yr cooperative agreement began on October 1, 2015
- NRAO competition concluded. AUI selected. New 10-yr cooperative agreement to begin on October 1, 2016
  - ALMA + VLA + Central Development Laboratory + associated administration
  - Green Bank Observatory and VLBA separated from NRAO beginning on October 1, 2016
- Gemini competition concluded. AURA selected. New 6-yr cooperative agreement to begin on January 1, 2017
- 10-yr renewal award to AURA for NSO (including DKIST) will run through September 30, 2024

Electromagnetic Spectrum Management

- Critical activity for protecting science capability in radio astronomy and other remote sensing activities
- AST continues to represent NSF in telecom regulation, domestic and international
  - Coordinate with satellite operators to minimize interference to NRAO, Arecibo; Coordinate National Radio Quiet Zone in WVa
  - Serve on Interdepartment Radio Advisory Committee; provide input to FCC proceedings
  - Establish regulations and technical standards, e.g., through ITU "working parties" and World Radiocommunication Conference (recent 2015, next 2019) – focus on coexistence of radio astronomy (<1--450 GHz!) with cell phones, mobile broadband, unmanned aircraft systems, communication satellites, public safety…
- EARS program continues in collaboration with CISE and ENG; AST is reducing investment in FY 2016
- Sponsor NRC Committee on Radio Frequencies

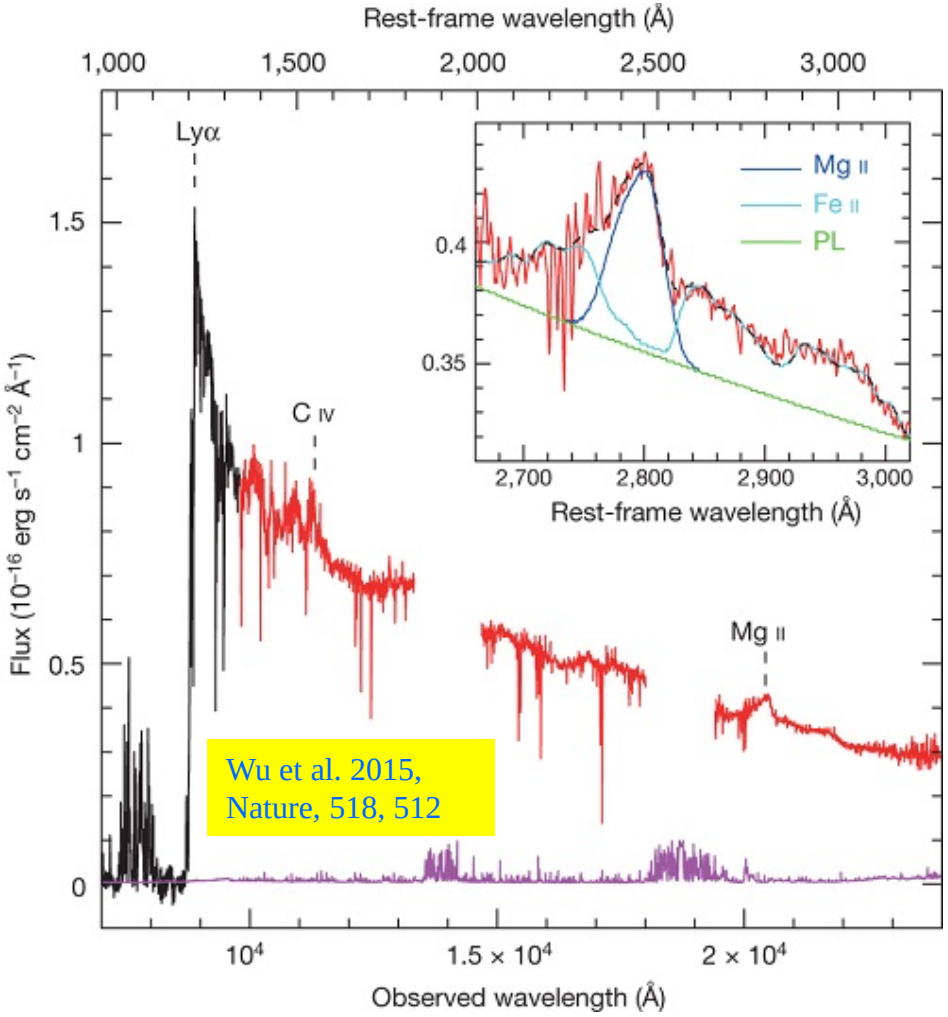
Atacama Large Millimeter/Submm Array (ALMA)

- Construction of ALMA was officially completed in 2015.
- ALMA is a joint project of North America (led by NSF), the European Southern Observatory, and East Asia, with a total construction cost of $1.4 billion.
- At upper right, an optical image of the merging “Antennae” galaxies is shown, progressively zoomed into a compact but intense source of millimeter radiation imaged with ALMA. This massive, dense, star-free cloud may be the first known example of a globular star cluster about to be born.



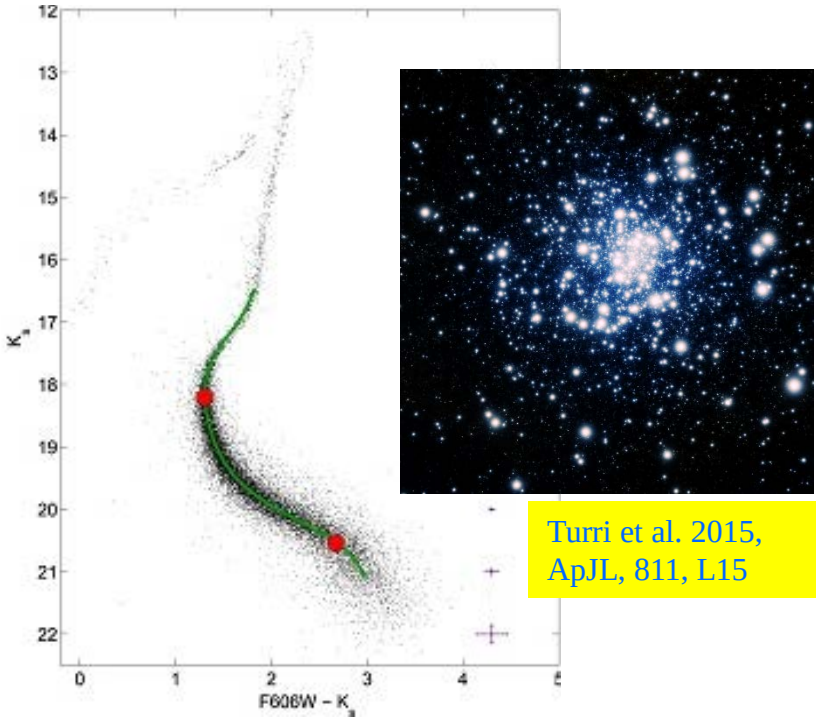
Credit: B. Saxton (NRAO/AUI/NSF); Images from NASA/ESA Hubble, B. Whitmore (STScI); K Johnson (U.Va.); ALMA (NRAO/ESO/NAOJ). (ApJ, 2015, 806, 35)

Gemini



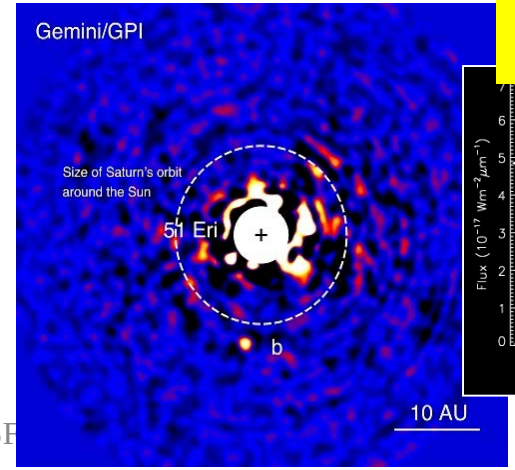
Wu et al. 2015, Nature, 518, 512

Above: GNIRS observations of z ~ 6.3 quasar challenge models of Black Hole growth.

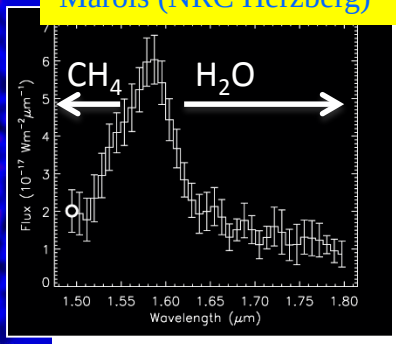


Turri et al. 2015, ApJL, 811, L15

Above: MCAO/GeMS photometry deepest ever in crowded field. **Below**: GPI discovers young Solar System Gas Giant analog.

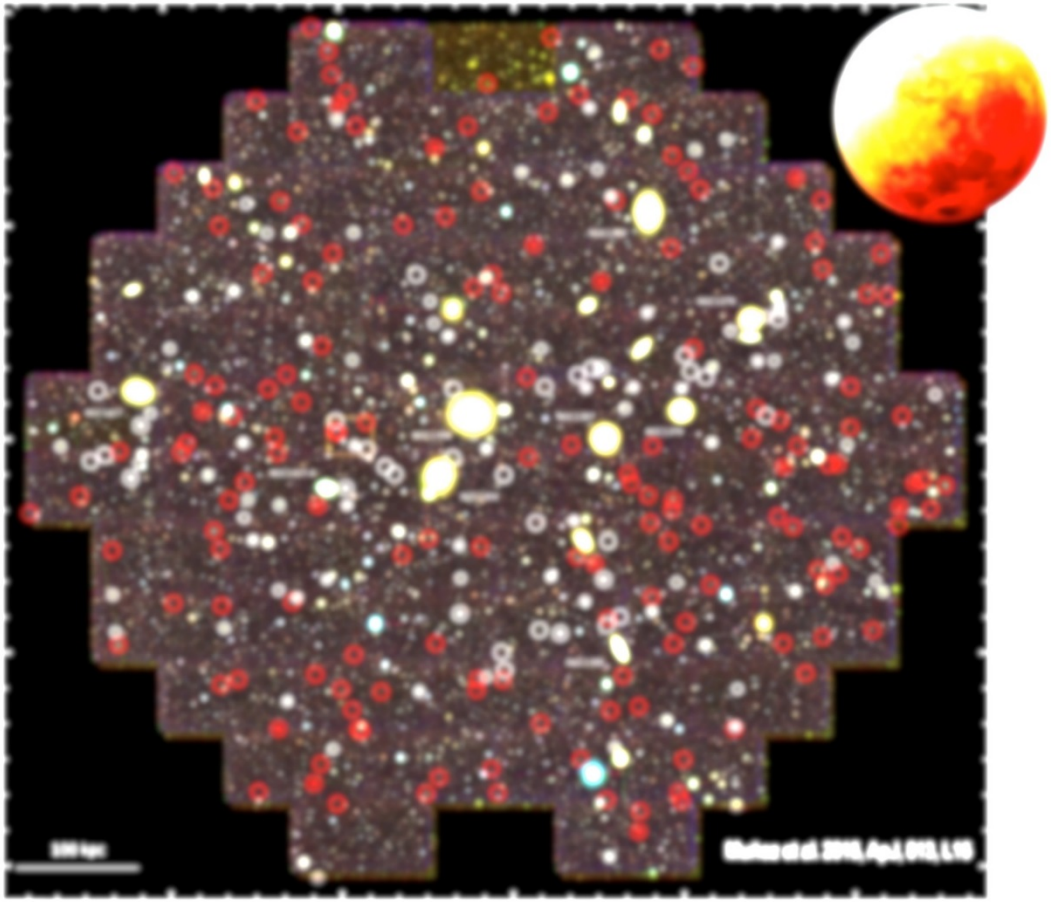


R. De Rosa (UCB), C. Marois (NRC Herzberg)



Next Generation Fornax Survey

- Dark Energy Camera on the CTIO 4-m telescope reveals numerous “new” (red circles in the 3-deg^2 field at right) dwarf galaxies in the Fornax cluster (Muñoz et al. 2015, ApJL, 813, L15)
- Total of 30 deg^2 being studied
- Possible solution to the “missing” dwarf galaxies predicted by cosmological simulations



Daniel K. Inouye Solar Telescope

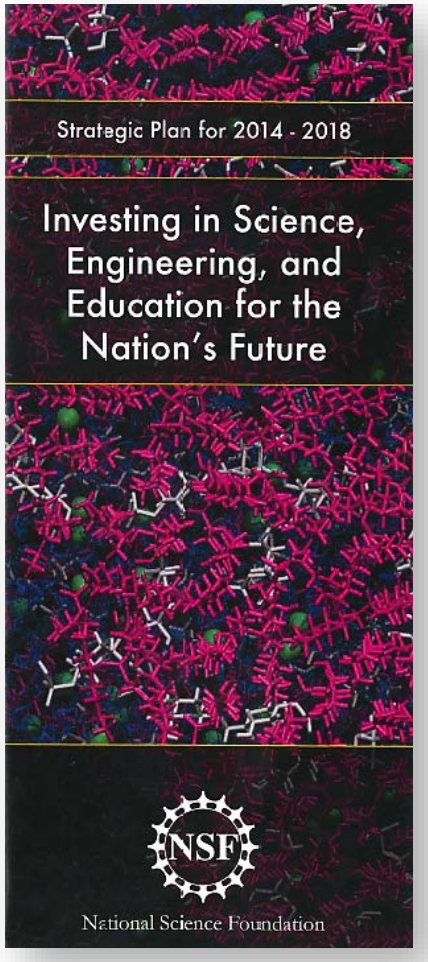
- Excellent construction progress, with some delays on site work because of poor weather in Hawaii
  - Scheduled for completion in 2019
- Data rate ≈ LSST data rate, but three years earlier!

Large Synoptic Survey Telescope

- NSF construction award made in August 2014
- Strong NSF/DOE partnership in construction and operations
- NRC committee studied OIR system in LSST era

NSF Funding/Budget

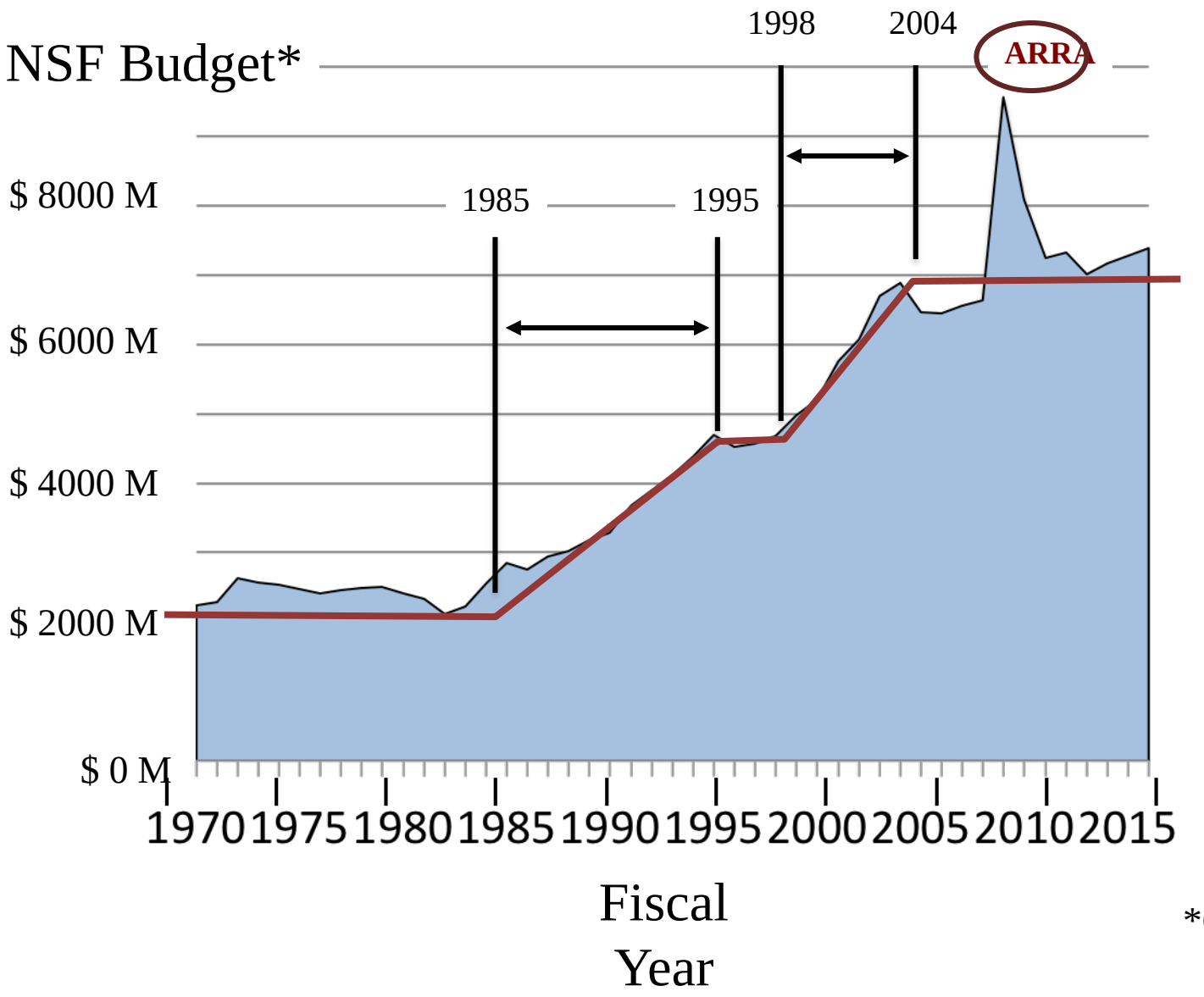
NSF Core Mission: Fundamental Research



NSF Strategic Goals

- Transform the Frontiers of Science and Engineering
- Stimulate Innovation and Address Societal Needs through Research and Education
- Excel as a Federal Science Agency

NSF Funding History



*Constant 2014$

FY 2017 NSF Request by Account ($M)

	FY 2016 Estimate	FY 2017 Discretionary		FY 2017 Mandatory	FY 2017 Total	
Research & Related Activities	$ 6034	$ 6079	0.8%	$ 346	$ 6425	6.5%
Education & Human Resources	880	899	2.1%	54	953	8.3%
Major Res Equip & Facilities Const.	200	193	-3.6%		193	-3.6%
Agency Operations & Award Mgmt.	330	373	13%		373	13%
National Science Board	4	4			4	
Office of the Inspector General	15	15			15	
Total NSF	**$ 7463**	**$ 7564**	**1.3%**	**$ 400**	**$ 7964**	**6.7%**

From FY 2017 Request "Overview"

- P. 2: "New one-year mandatory funding totaling $400 million will support the fundamental, curiosity-driven research that is NSF's principal contribution to the Nation's science and technology enterprise. In particular, this funding will support more scientists and engineers at the early stages of their careers – who bring particular expertise in data- and computationally-intensive activities"

- P. 7: "In FY 2017, support for several of NSF's astronomy and astrophysics facilities investments reaches a decision point. … Based on [the portfolio review] recommendations, NSF is developing potential divestment options for several facilities."

Mandatory vs. Discretionary

- "Discretionary" spending adheres to the two-year budget levels passed by Congress in late 2015
- "Mandatory" spending is spending that is funded by a dedicated revenue stream, and requires a Congressional action separate from the standard appropriation bill
  - An example is Social Security, with a dedicated revenue stream from salary withholding and employer contributions
  - NSF currently has a small amount of mandatory revenue from visa-waiver program
  - The FY 2017 request includes one year of "mandatory" spending for NSF
- NSF and AST are prepared to execute the total program in the President's Budget Request (sum of discretionary and mandatory spending)

FY 2015-2017 Budget for MPS & AST

$M	FY15 Actual	FY16 Request	FY16 Estimate	FY17 Request Total	FY17 Request Disc.
NSF Total	7344	7724	7464	7964	7564
NSF R&RA	5934	6186	6034	6425	6079
MPS	1337	1366	1349	1436	1355
AST	245.2	246.5	246.7	262.6	247.7

FY 2016/2017: Things to Note

- FY 2016 Estimate relative to FY 2015 Actuals
  - Facilities flat: DKIST and NSO ramp up, NOAO and NRAO go down
    - One-time NSO funding for GONG refurbishment
  - MSIP up by $6.3 million, from $12.95 million to $19.25 million
  - EARS drops from $6 million to $1 million, so AAG is likely to be fairly steady

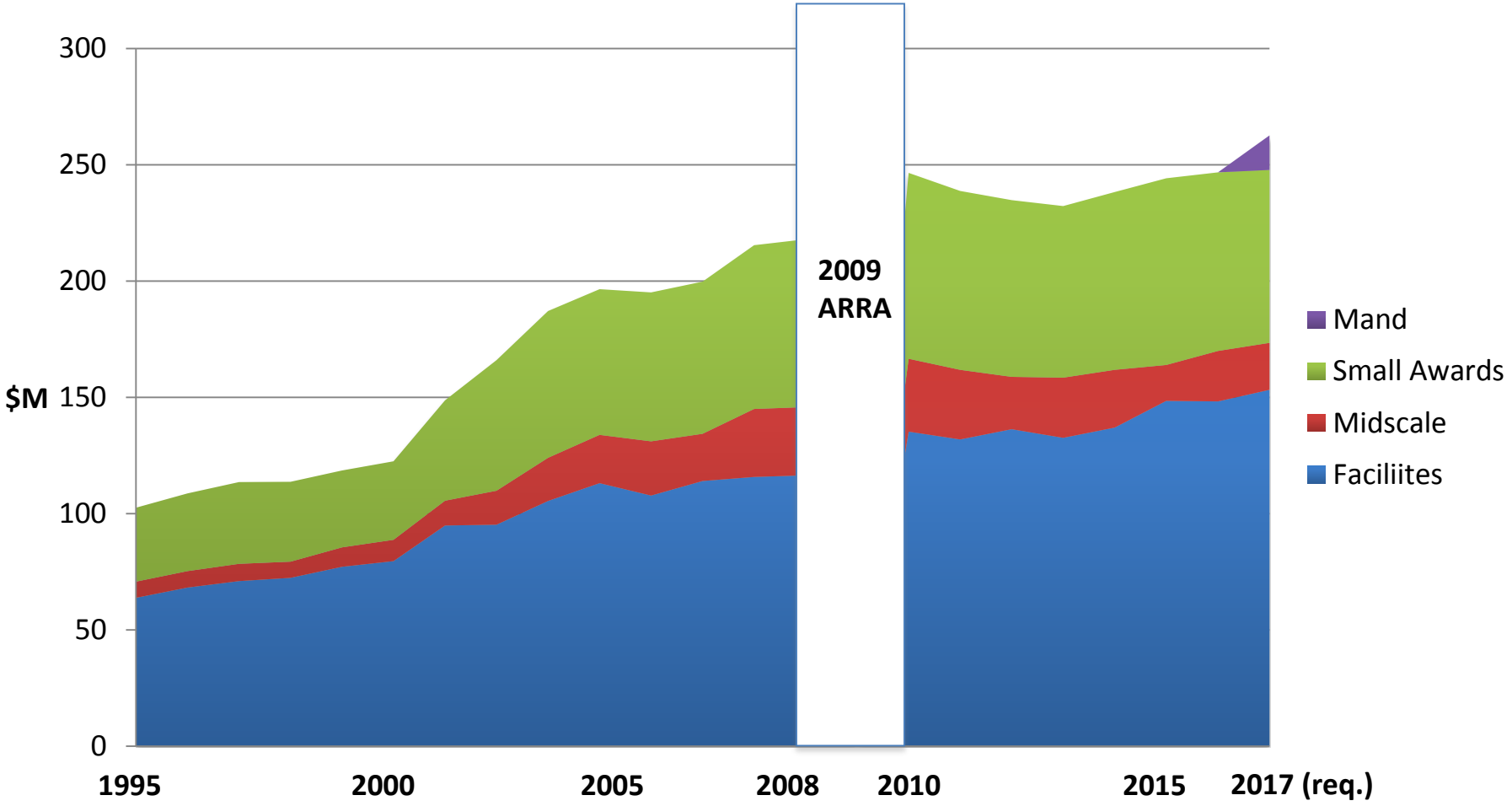
- FY 2017 Request relative to FY 2016 Estimate
  - Facilities rise by $5 million: DKIST and ALMA up, NSO down
    - GBO and VLBA separate from NRAO
  - MSIP drops by $1.25 million to $18.00 million
  - Small awards drop by $2.5 million in discretionary request, countered by $14.88 million increase in mandatory spending

FY 2017 AST Request: $262.6 M

Program	$M	Program	$M
ALMA	43.25	AAG	43.38
NRAO	32.00	MSIP	18.00
NOAO	21.83	ATI	8.00
Gemini	20.42	CAREER	4.90
DKIST	14.00	AAPF	2.40
GBO+VLBA	11.50	REU	2.00
NSO (sans DKIST)	6.00	PAARE	1.50
Arecibo	4.20	“Mandatory”	14.88
DKIST mitigation	2.00	Misc+expenses*	12.35

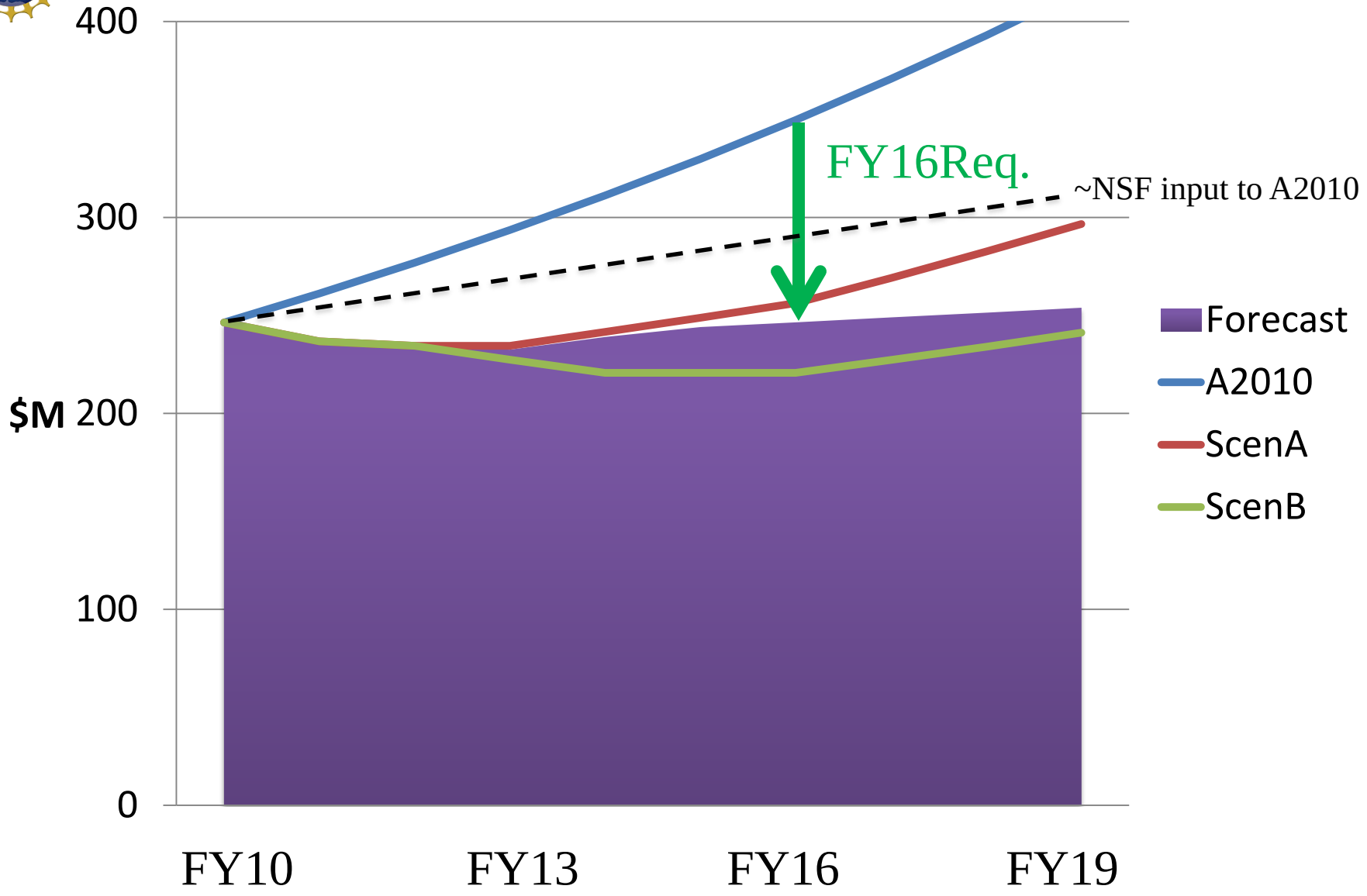
*Misc+expenses includes Panels, IPAs, GSMT, DESDM, KITP, SPT, Spectrum, Education/Special Programs, Aspen Center, NSF ops, unallocated grants, etc.

AST Budget Breakdown, 1995-2017



Portfolio Review/Divestment

NWNH Budget vs. Actual AST Budget



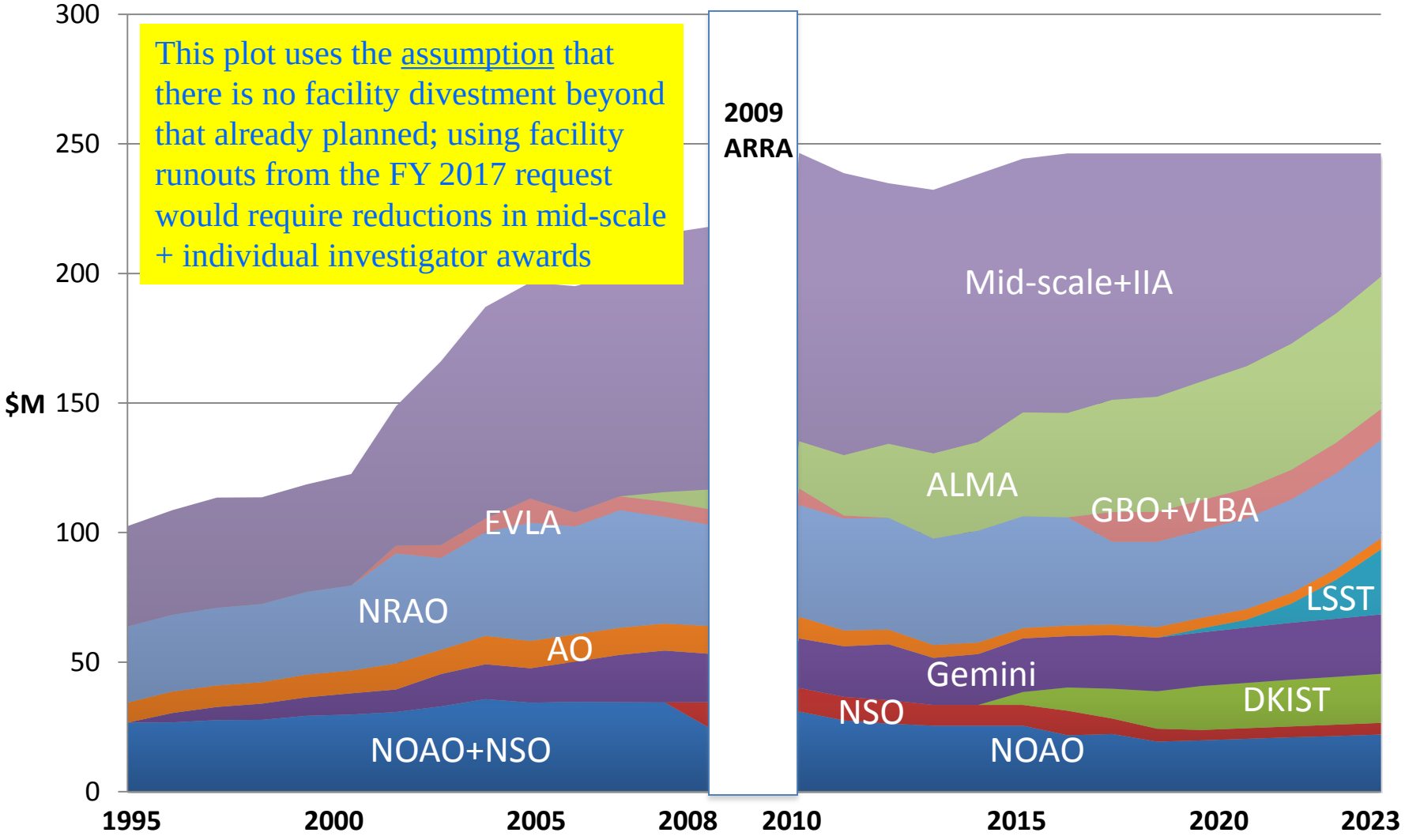
Next "Senior Review"

- *NWNH*, p. 32:
  - "NSF-Astronomy should complete its next senior review before the mid-decade independent review that is recommended elsewhere in this report, so as to determine which, if any, facilities NSF-AST should cease to support in order to release funds for (1) the construction and ongoing operation of new telescopes and instruments and (2) the science analysis needed to capitalize on the results from existing and future facilities."
- This became the AST Portfolio Review (PR)

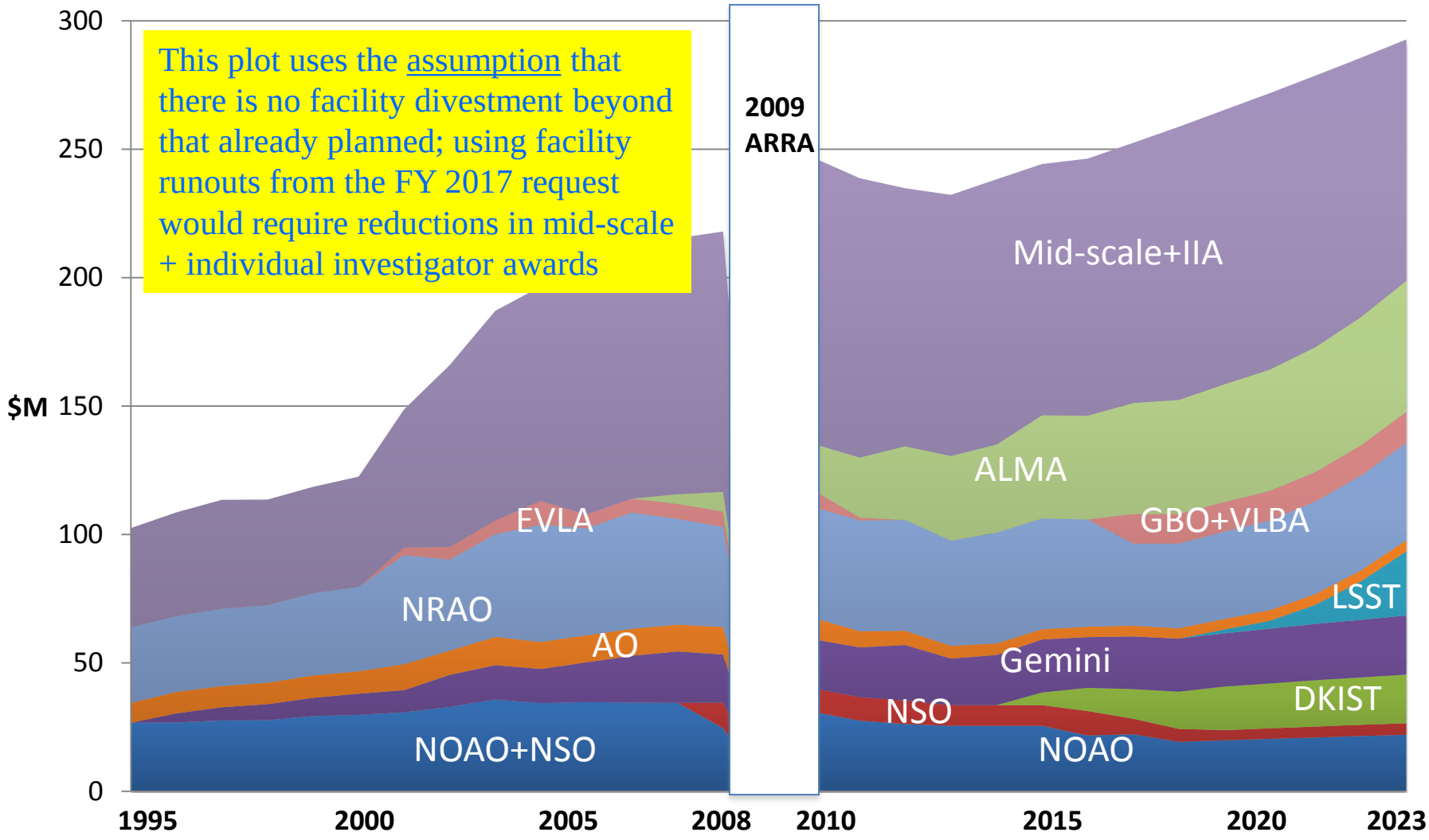
Portfolio Review Purpose & Outcome

- Portfolio Review Committee (PRC) was charged to recommend a balanced program, in realistic funding scenarios, that did the best job of responding to *NWNH* science program
  - Recommendations received in August 2012 resulted in a balance among facilities, mid-scale programs, and grants that stayed similar to the balance in 2010
- Why did PRC recommend divesting facilities, which reduces community access to research tools?
  - Need to retain balance between community research tools (large and mid-scale facilities) and direct research funding (mid-scale experiments and individual investigator awards) in order to best sustain the astronomical enterprise

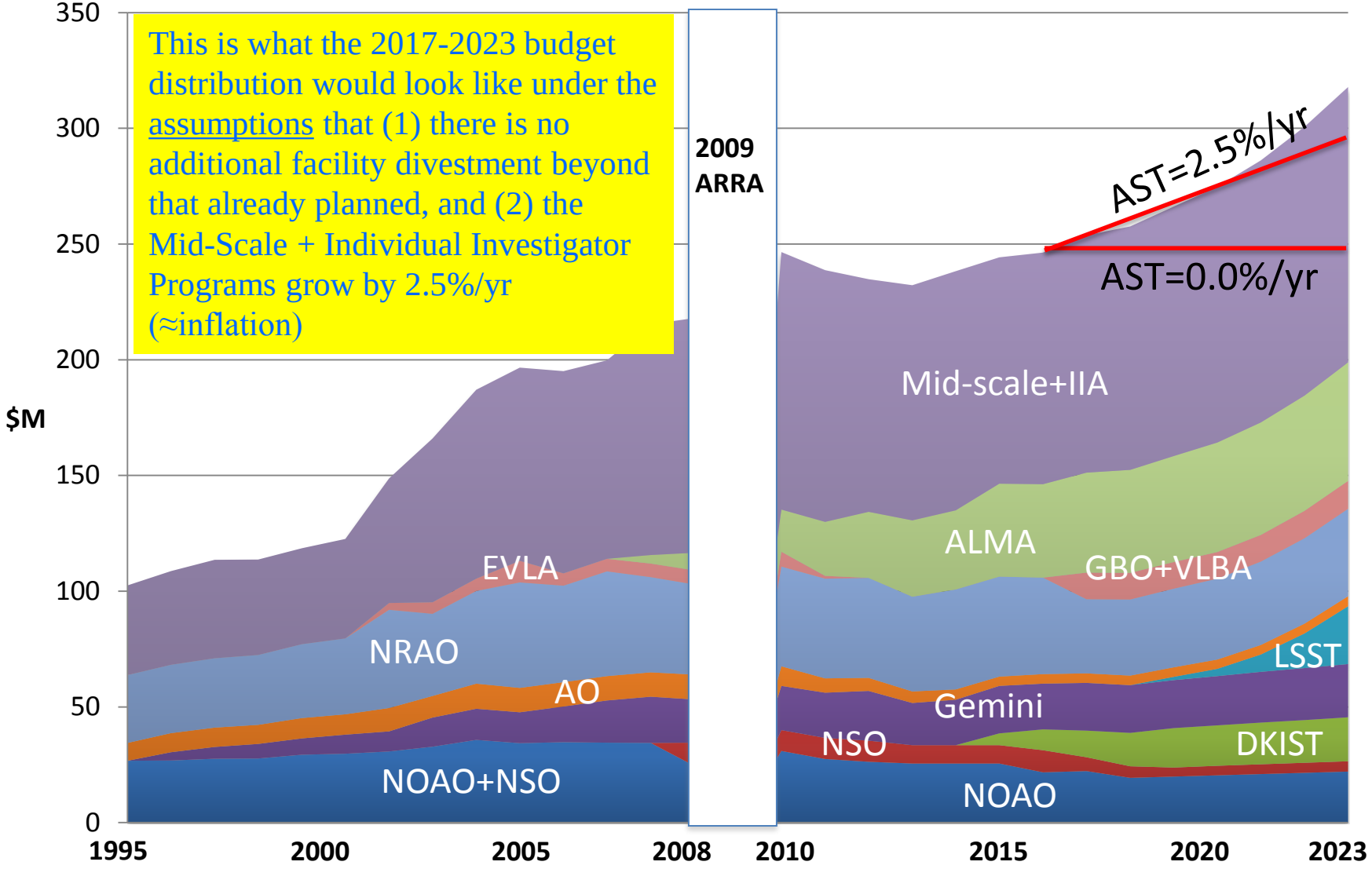
AST, Hypothetical 0.0%/yr Increase after FY16



AST, Hypothetical 2.5%/yr increase after FY16



Hypothetical "Constant" Individual Investigator Program



Divestment Activities

- Portfolio review identified facilities recommended for divestment from AST budget, or for future consideration
- NSF (through a contractor) is currently concluding feasibility studies for alternatives, including engineering assessments and baseline environmental surveys for a number of telescopes and observatories
  - Goals: Identify key issues, bound costs of different alternatives, and provide NSF information needed to assess viability of options
- Generic alternatives
  - New partnership arrangements (preferred, but complicated)
  - Conversion to new mission, including scope reductions
  - Mothballing
  - Decommissioning
- Real progress being made on partnerships, with ongoing negotiations in many cases

What Comes Next

- After receiving engineering reports during FY 2016, NSF will identify viable options for evolution of different facilities/telescopes
  - If new partner options are in place for a facility, development or completion of partner agreements may be the next step
  - Options such as scope reductions require study of alternatives, under National Environmental Policy Act
    - Formal and open process, including consultation of stakeholders and opportunity for comment/input
    - "No-action" alternative (i.e., continue operations as in the past) is always an alternative that must be considered
  - Following conclusion of formal alternative consideration, NSF will select a preferred alternative for each facility and then seek to execute that alternative

Facility Futures
(as of March 30, 2016)

Telescope	Status
KPNO 2.1m	Caltech-led consortium (Robo-AO) operating for FY 2016-2018
Mayall 4m	Slated for DESI; bridge from NSF; NSF/DOE MOU for transition
WIYN 3.5m	NOAO share to NASA-NSF Exoplanet Observational Research Program; NSF/NASA MOU in place
GBO	Feasibility study near conclusion; separation from NRAO in FY 2017
VLBA	Feasibility study under way; separation from NRAO in FY 2017
McMath-Pierce	Feasibiilty study under way; university-led consortium seeking funding
GONG/SOLIS	SOLIS is off Kitt Peak; GONG refurbishment; MOU with NOAA in draft form (NOAA sharing GONG operations costs)
Dunn Solar Tel.	Feasibility study near conclusion; partner discussions in progress
Arecibo	Feasibility study under evaluation; responses received January 15, 2016, to Dear Colleague Letter NSF 16-005 seeking viable concepts for future operations; GEO/AGS portfolio review nearing completion
SOAR	Post-2020 status to be reviewed

High-Level Upcoming Timeline

- March-April 2016: Receive results of engineering/environmental feasibility studies for AO, GBO, and Sac Peak.
- March-June 2016: Evaluate additional input for AO, GBO, and Sac Peak.
- April-June 2016: Decide on avenues/need for environmental review for AO, GBO, and Sac Peak. Initiate as needed.
- June-August 2016: Receive engineering/environmental feasibility study for VLBA.
- August-October 2016: Evaluate budget status and additional input for VLBA. Decide on avenue for environmental review, if needed.
- April-September 2017: Conclude any needed environmental review and consideration of alternatives for AO, GBO, and Sac Peak. Select preferred alternatives.
- Late 2017/Early 2018: Conclude environmental review and consideration of alternatives for VLBA, if necessary. Select preferred alternative.

OIR System Study

NRC/CAA OIR System Study

- "A Strategy to Optimize the U.S. Optical and Infrared System in the Era of the Large Synoptic Survey Telescope (LSST)"
- Recommended by AAAC in 2013
- Committee chaired by Debra Elmegreen, Vassar College
- Three face-to-face meetings in 2014
  - July 31/August 1; October 12-13; December 2-3
- Report delivered in April 2015
- NSF initial response in Dear Colleague Letter NSF 15-115, issued in August 2015
- Direction given to NOAO, per report recommendations
  - Extensive discussions and planning ongoing, with both NOAO and LSST

OIR System Recommendations-1

- R1: Direct NOAO to administer telescope-time exchange system
  - Action: NSF has tasked NOAO to carry out a market survey of community need for telescope time and data access brokering, assess responses for viability, terms and conditions, etc. NOAO also has been asked to lead a community-based planning effort on a viable operations structure for exchange.
    - NOAO asked to estimate additional resources needed to accomplish these tasks.
- R2: NOAO to lead community-wide planning process and facilitate System organizing committee. NSF would solicit proposals to meet prioritized capabilities.
  - A natural role for NOAO
  - Action: See responses to R3, R4c, and R4d below

OIR System Recommendations-2

- R3: Wide-field highly multiplexed spectroscopic capability
  - Community working group (R2) needed to define highest priority science case and instrument requirements.
  - Action: NSF wrote to NOAO and LSST in August asking them to work jointly on a workshop to develop specific requirements for R3 and R4.
    - NSF: "The report would assess and prioritize potential OIR System resources such as telescope apertures, wavelength ranges, instrument capabilities, number of observing nights, software and computing power, and data management and data product service to the community."
  - Action: NOAO and LSST proposed to the Kavli Foundation, which is supporting a workshop in May 2016 that should lead to a report responsive to the NSF letter, based on an ongoing input process leading up to the workshop

OIR System Recommendations-3

- R4a: Support development of event brokers for LSST
  - Action: NSF is funding several projects along these lines
    - Zwicky Transient Facility through MSIP
    - INSPIRE grant: Joint Arizona-NOAO (ANTARES project)
  - Special instance of the more global issue of development of Level 3 data products for LSST (see response to R7)
- R4b: Position Gemini-S for faint object spectroscopy early in era of LSST operations
  - Gen 4#3 instrument for Gemini may meet this recommendation
  - Action: Feasibility studies for Gen 4#3 completed, with summaries reported out at Gemini science meeting in June 2015
  - Action: Gemini Request for Proposals under construction, for release in 2016
  - Also see response to R4d below

OIR System Recommendations-4

- R4c: Ensure that OIR system time can be allocated for faint transient observations prioritized by LSST event broker
  - Action: NSF in discussion with Gemini partners and NOAO (see R4d)
- R4d: Enhance coordination among federal telescopes in Southern Hemisphere to optimize LSST follow-up
  - Action: NOAO asked to assess scientific productivity of SOAR and define its role in the era of LSST operations
  - Action: NOAO to assess its role in coordination of LSST follow-up
  - Action: NSF has told AURA that "a close synergistic relationship between NOAO and LSST would serve to optimize operational efficiencies, management efficiencies, and scientific productivity, and would thus be of maximal benefit to the scientific user community and a cost effective benefit to the US public"
  - Action: Gemini (Gemini Board + Observatory) is presently developing a post-2020 Strategic Science Vision

OIR System Recommendations-5

- R5: Plan for an investment in one or both Giant Segmented Mirror Telescopes
  - Action: MSIP competition is open to instrument proposals
- R6: Continue to invest in development of critical technologies, including Adaptive Optics and precision Radial Velocities
  - Action: Precision RV is a goal of NN-EXPLORE; NASA is selecting an Extreme Precision Doppler Spectrometer for implementation on the WIYN telescope, and usage during NSF/NOAO open time
- R7: Coordinated suite of schools, workshops, and training networks for training in instrumentation, software, and data analysis
  - Action: NOAO asked to take the lead in preparing community for LSST era and develop the concept of an LSST Community Science Center

Backup Slides

FY 2017 MPS Request by Division ($M)

	FY 2016 Estimate	FY 2017 Discretionary		FY 2017 Mandatory	FY 2017 Total	
Astronomical Sciences (AST)	$ 246.73	$ 247.73	0.4%	$ 14.88	$ 262.61	6.4%
Chemistry (CHE)	246.31	247.31	0.4%	14.85	262.16	6.5%
Materials Research (DMR)	310.03	311.03	0.3%	18.68	329.71	6.3%
Mathematical Sciences (DMS)	234.05	235.05	0.4%	14.12	249.17	6.5%
Physics (PHY)	277.03	278.53	0.5%	16.73	295.26	6.6%
Multidisciplinary Activities (OMA)	35.00	35.41	1.2%	2.13	37.54	7.3%
Total MPS	**$ 1349.15**	**$ 1355.06**	**0.4%**	**$ 81.39**	**$ 1436.45**	**6.5%**

Acronym Dictionary

- AAG=Astron. & Astrophys. Research Grants
- AAPF=Astron. & Astrophys. Research Fellowships
- ALMA=Atacama Large mm/submm Array
- AO=Arecibo
- AST=NSF Division of Astronomical Sciences
- ATI=Advanced Technologies and Instrumentation
- DES(DM)=Dark Energy Survey (Data Management)
- DESI=Dark Energy Spect. Inst.
- DKIST=Daniel K. Inouye Solar Telescope
- EARS=Enhancing Access to the Radio Spectrum
- EVLA=Expanded VLA
- GBO=Green Bank Observatory
- GONG=Global Oscillations Network Group
- GPI=Gemini Planet Imager
- GSMT=Giant Segmented Mirror Telescope
- IPA=Intergovernmental Personnel Act
- KITP=Kavli Institute for Theoretical Physics
- LIGO=Laser Interferometer Gravitational-wave Observatory
- LSST=Large Synoptic Survey Telescope
- MPS=NSF Directorate for Mathematical and Physical Sciences
- MREFC=Major Research Equipment & Facility Construction
- MSIP=Mid-Scale Innovations Program
- NN-EXPLORE=NASA-NSF Exoplanet Observational Research partnership
- NOAO=National Optical Astronomy Observatory
- NRAO=National Radio Astronomy Observatory
- NRC=National Research Council
- NSO=National Solar Observatory
- OIR=Optical/Infrared
- OMB=Office of Management and Budget
- PAARE=Partnerships in Astron. & Astrophys. Research & Education
- PHY=NSF Division of Physics
- REU=Research Experiences for Undergraduates
- SOLIS=Synoptic Long-Term Observations of the Sun
- SPT=South Pole Telescope