



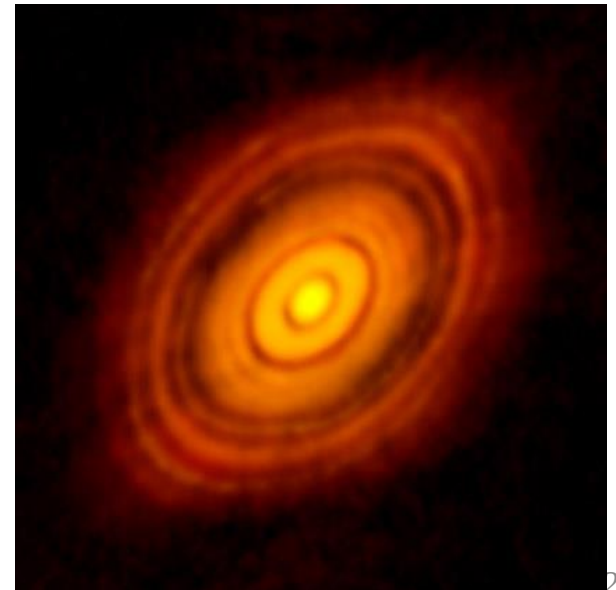
# NSF Division of Astronomical Sciences (AST) Update

April 1, 2015

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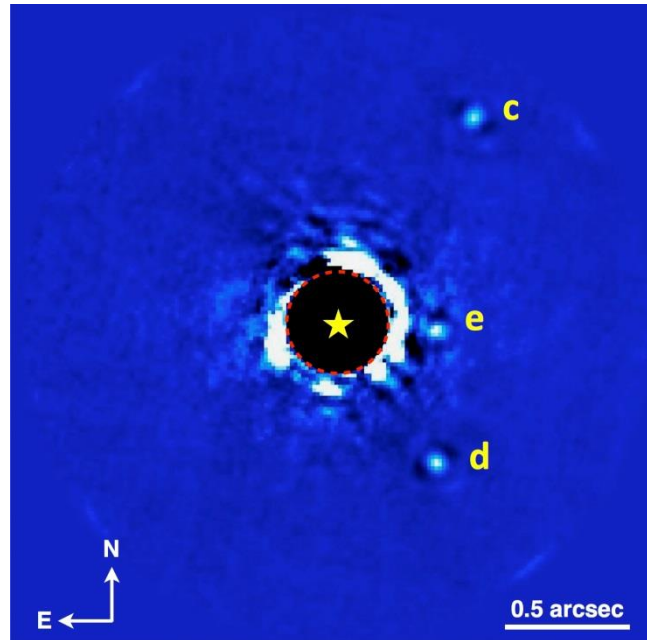
# ALMA Construction Completed

- Top-level science objectives:
  - Image dust-continuum emission from evolving galaxies as early as 500Myr after the Big Bang ( $z \sim 10$ ).
  - Determine the chemical composition and dynamics of star-forming gas in normal galaxies like the Milky Way but  $\frac{3}{4}$  of the way across the Universe ( $z \sim 3$ ).
  - Measure the gas kinematics in young disks in nearby molecular clouds and detect the tidal gaps induced by planet formation.
- Construction completed; Cycle 3 proposal call opened.

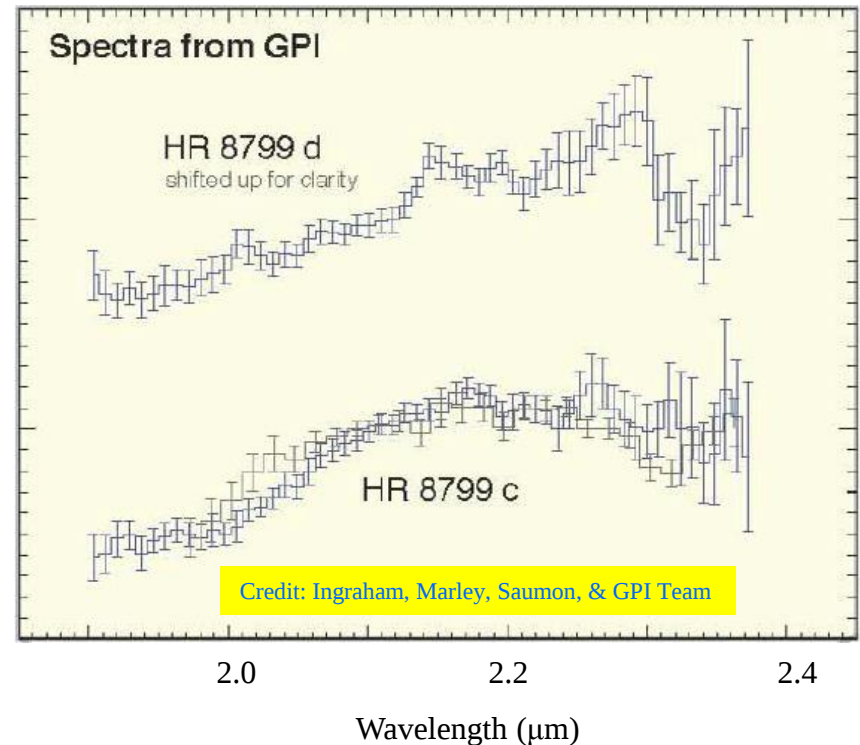




# Gemini Planet Imager: HR 8799



Credit: Marois, Ingraham, & GPI Team

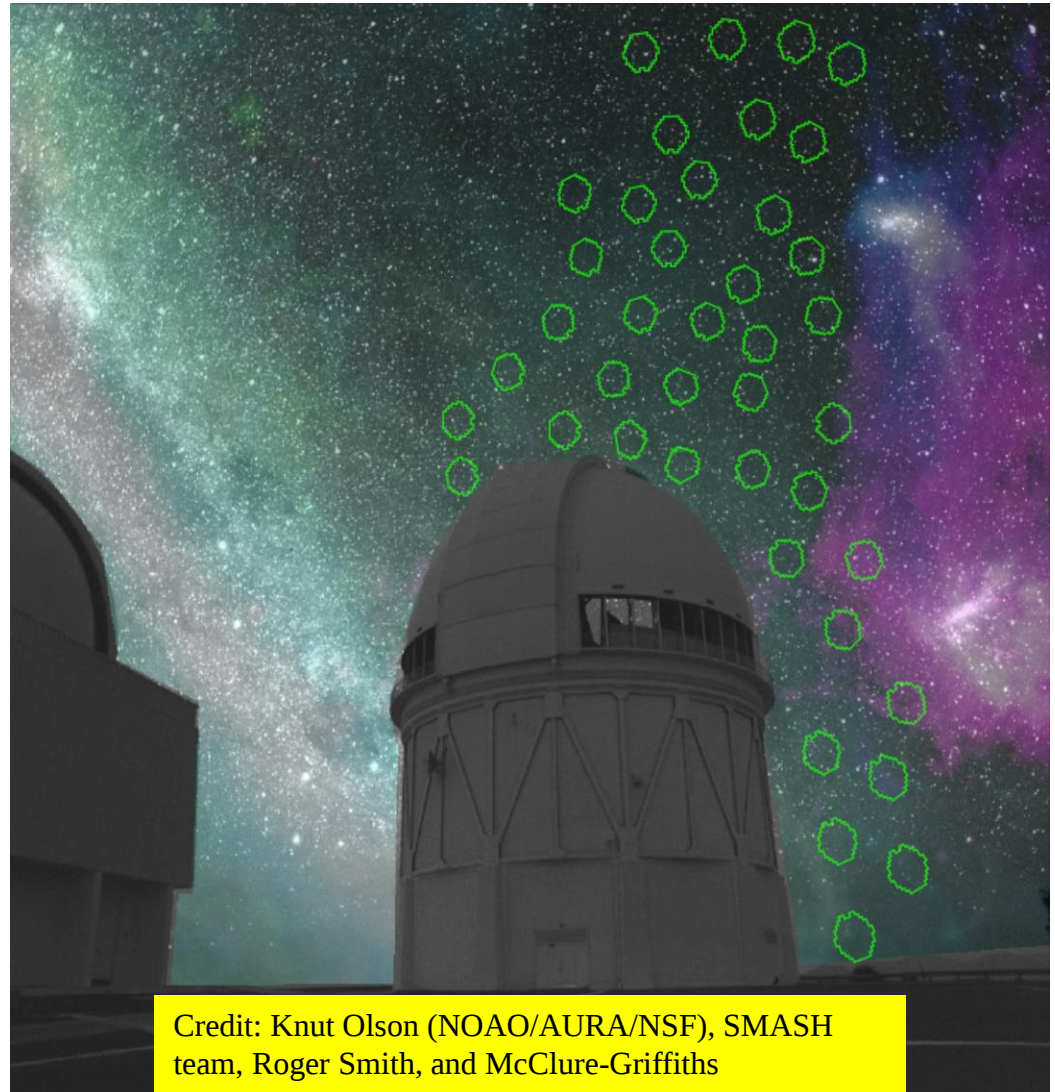


- HR 8799 image and exoplanet spectroscopy at 2.2  $\mu\text{m}$
- Planets have similar colors, but the spectral shapes indicate significant differences in atmospheric clouds or composition
- Data from early commissioning run of GPI



# The Local Group, with DECam at CTIO

- SMASH=Survey of the Magellanic Stellar History
  - Identified stars belonging to the LMC at 20 deg. (17 kpc) from the LMC (Nidever et al., January AAS)
  - Left-over debris from formation and interaction
- Recent discoveries of numerous dwarf galaxies in Local Group



Credit: Knut Olson (NOAO/AURA/NSF), SMASH team, Roger Smith, and McClure-Griffiths



# Major Construction Projects





# FY 2015 Budget Estimates

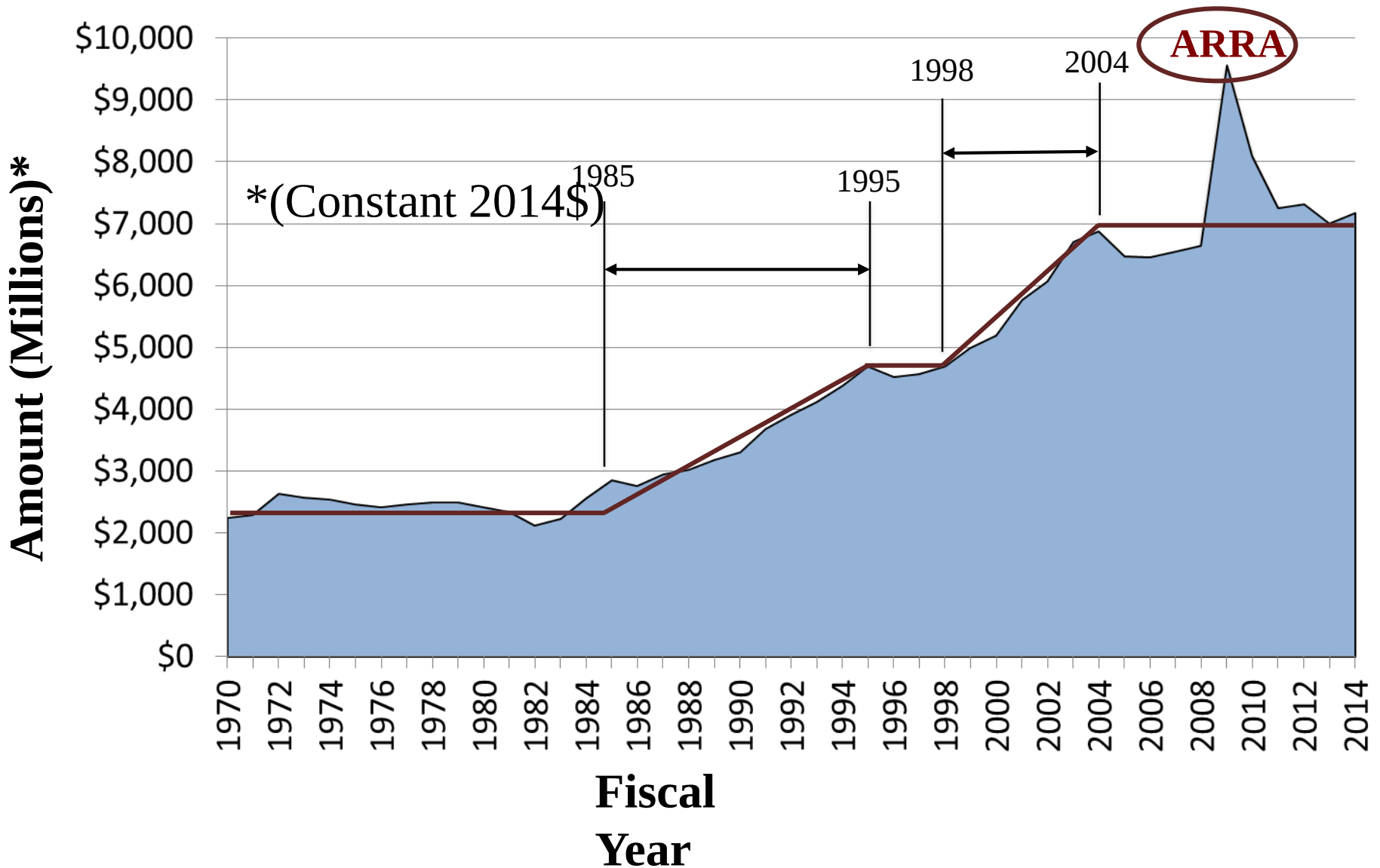
- The FY 2016 Budget Request submitted to Congress includes FY 2015 “Estimates” for NSF accounts and divisions, just being finalized as NSF FY 2015 Plan
  - Estimates reflect the NSF spending plan submitted to Congress for approval, within the CRomnibus appropriation
  - LSST and DKIST construction are fully funded at the request levels of \$79.64 million and \$25.12 million, respectively
  - MPS Directorate (+3.2%) and AST Division (+3.4%) both received increases above the FY 2015 request that were somewhat higher than the NSF Research and Related Activities account (+2.2%)
    - MPS and AST percentages relative to the FY 2014 appropriations are very close to the overall NSF change for the R&RA account
  - Highlights for AST in FY 2015
    - First year of DKIST operations ramp, increase in ALMA ops
    - Expect to hold AAG steady, or increase \$1-2M from FY 2014
    - MSIP held relatively steady (down \$1M from FY 2014, as planned)



# FY 2016 Budget Request

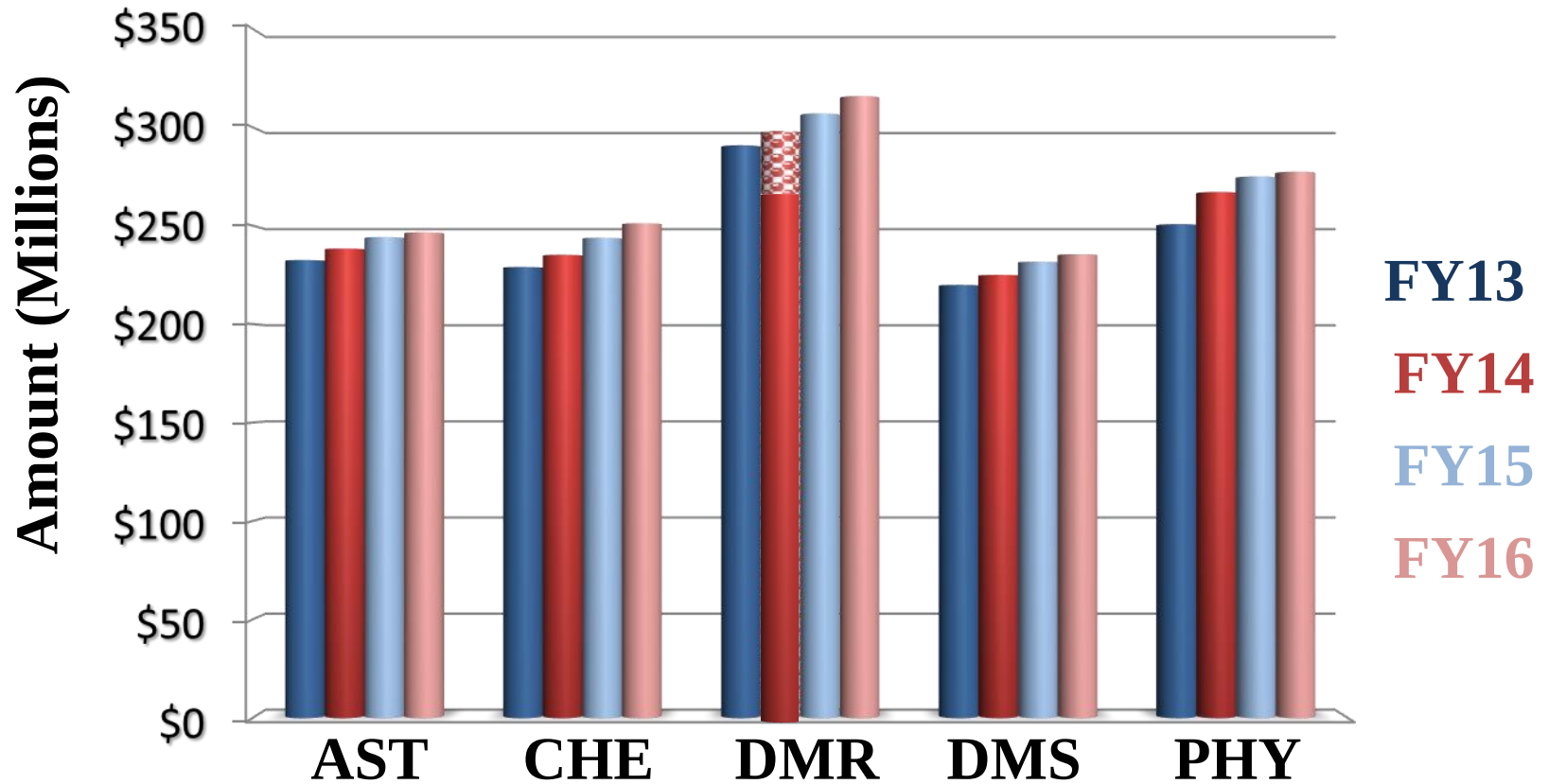
- The President's Budget Request for NSF is for an overall increase of 5.2% for NSF, with a 4.3% increase over FY 2015 in Research and Related Activities
  - MPS (+2.2%) and AST (+1.0%) do less well than other parts of NSF
  - LSST and DKIST construction continue to be funded fully, at \$99.67 million and \$20.00 million, respectively
  - Overall Budget Request is well above the discretionary spending levels set by the Budget Control Act ("sequestration")
  - See AAS Public Policy Blog for an analysis of all Astronomy in the FY 2016 budget request
- AST highlights
  - Second year of DKIST operations ramp, ALMA held flat
  - NOAO reduced scope, special projects on Mayall, WIYN
  - Significant increase in MSIP (\$13 million to \$18.72 million)
  - AAG would decrease several million dollars

# NSF Funding History



# MPS Budgets

**FY 2013** + 4.0% **FY 2014** + 2.8% **FY 2015** + 2.2% **FY 2016**  
\$ 1250 M → \$ 1300 M → \$ 1337 M (estimate) → \$ 1366 M (request)



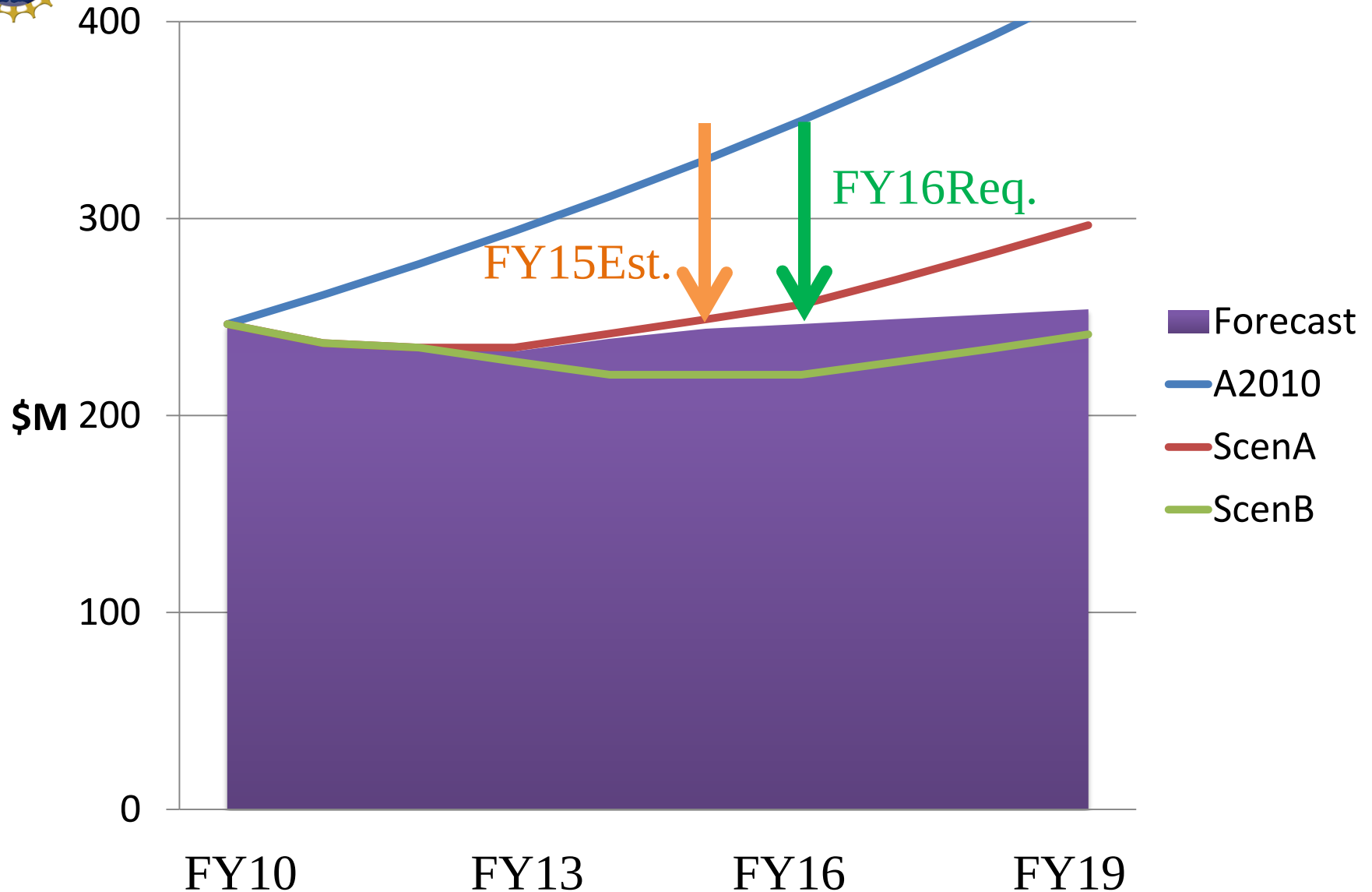


# FY 2016 Request

| \$M          | FY14<br>Actual | FY15<br>Est | FY16<br>Req | 15/14 | 16/15 | 16/14 |
|--------------|----------------|-------------|-------------|-------|-------|-------|
| NSF<br>Total | 7161           | 7344        | 7724        | 1.025 | 1.052 | 1.078 |
| NSF<br>R&RA  | 5805           | 5934        | 6186        | 1.022 | 1.042 | 1.066 |
| MPS          | 1298           | 1337        | 1366        | 1.030 | 1.022 | 1.052 |
| AST          | 239            | 244         | 247         | 1.024 | 1.010 | 1.034 |
| PHY          | 267            | 275         | 277         | 1.030 | 1.009 | 1.038 |



# NWNH Budget vs. Actual AST Budget





# President's Budget Request—A Primer

OMB sets NSF budget level, includes initiatives

NSF holds out funds for initiatives, distributes rest to Directorates

Directorates divide among Divisions, using fancy algorithms based on past spending, play in new initiatives, etc.

Strong constraints on how Divisions can allocate funds

AST discusses priorities throughout year, focusing on NRC and Advisory Committee recommendations

Responsible stewardship of national facilities

Some allocations directed to priorities such as mid-scale

For flat budgets, flexibility is at the margins



# Decadal Survey and Portfolio Review

- AST relies on National Academy of Sciences decadal surveys in setting long-term priorities for ground-based astronomy program
  - *New Worlds, New Horizons in Astronomy and Astrophysics (NWNH)*, was released in 2010
  - *NWNH* assumed increase of 4%/yr in AST purchasing power
  - *NWNH* suggested carrying out a “senior review” if AST purchasing power was flat
- Portfolio Review Committee was commissioned as a broadly representative subcommittee of the MPSAC, to recommend program that could best address the science questions advanced by *NWNH*
  - Committee report was delivered in August 2012
  - Recommended a balance of small, medium, and large programs that would require divestment of numerous operating facilities from AST budget



# Decadal Survey (*NWNH*) Status

- AST recently released a Dear Colleague Letter (NSF 15-044) describing the responses to each of the significant *NWNH* recommendations to AST, as well as the status of the major facility divestments recommended by the Portfolio Review
- Highlights: LSST construction start, and beginning of Mid-Scale Innovations Program (MSIP)
- Lowlights: No funds available for the recommended increases in various grants programs; instead, those programs were retrenched to enable the ramp-up of ALMA Operations and to find modest funds for MSIP
- Partnership and other divestment activities are ongoing, and quite complex
  - Interagency discussions, partnership solicitations, environmental studies, etc.



# Generic Divestment Response Process

- Pursuing partnerships with universities, institutes, and federal agencies through meetings & negotiations
- In 2014, NSF (Office of General Counsel) hired an engineering firm for all NSF environmental contract work
  - Undertaking engineering feasibility and baseline environmental review to identify feasible alternatives for facilities
    - NSF is presently reviewing drafts of studies for several facilities (both individual telescopes and entire sites)
  - Will be followed (2015-2016) by formal environmental review processes as necessary, leading to preferred alternatives for facilities that do not have viable partnerships in view



# Facility Futures

| Telescope       | Status                                                           |
|-----------------|------------------------------------------------------------------|
| KPNO 2.1m       | Open ops ended; proposals for new operator under evaluation      |
| Mayall 4m       | Slated for DESI, pending DOE funding; bridge from NSF            |
| WIYN 3.5m       | NOAO share to NASA-NSF Exoplanet Research Program                |
| GBT             | Partner discussions in progress; engineering study under way     |
| VLBA            | Partner discussions in progress; engineering study under way     |
| McMath-Pierce   | Bridge to university-led consortium? engineering study under way |
| GONG/SOLIS      | SOLIS moved off Kitt Peak; GONG requests in FY 2016 budget       |
| Dunn Solar Tel. | Engineering study under way; partner meeting at Sac Peak 5/27    |
| Arecibo         | Post-2016 status in discussion; engineering study under way      |
| SOAR            | Post-2018 status to be reviewed                                  |



# Some Potential Divestment Outcomes

- Partnership Options
  - Facility or telescope continues as an important science capability, albeit with reduced open access, with much reduced (or no) NSF funding
  - Telescope/facility repurposed for science with significant NSF funding
  - Telescope/facility operations maintained with new mission and funding source, with little science availability
  - Telescope operations curtailed, new mission for site
- Mothballing or decommissioning of telescopes and/or sites



# A Strategic Look at the Decade

- AST has successfully started the two highest priority “Large Ground-Based Projects” from *New Worlds, New Horizons*
- Budgetary realities have prevented realization of most other recommendations that require additional funding
  - AST spending was \$246.53 million in FY 2010, and President’s Budget Request proposes \$246.55 million for FY 2016
  - Main research grants program (AAG) stabilized in FY 2013-FY2015 at level of about \$44 million, resulting in a funding rate of 15-16%
    - NWNH assumed a base level of \$46 million in FY 2010, their recommended \$8 million increase, plus inflation, would have resulted in an FY 2016 budget near \$60 million



# Cost Commitments/Background

- AST is committed to operations of DKIST (annual operations cost of ~\$18 million in FY 2021) and LSST (annual NSF operations cost of ~\$26 million in FY 2022)
- MSIP program started at ~\$14 million/yr in FY 2014, with FY 2016 request for \$18.7 million (*NWNH* recommended \$40 million)
- AAG (~\$44 million in FY 2015) and ATI (~\$7.5 million) are well below *NWNH* recommended values
  - *NWNH* recommendation, after accounting for inflation, would have resulted in an AAG budget near \$60 million in FY 2015
- Divestment is unlikely to realize more than ~\$20 million in annual savings



# An Ambitious Best-Case Scenario for 2022

- Fully operate high-priority facilities from Portfolio Review: LSST, DKIST, ALMA, VLA, Gemini, CTIO, ½ GONG (assuming 2.5% inflation per year, this requires an additional ~\$15 million/yr over FY 2015)
  - Revisit futures for Arecibo, SOAR, possibly Gemini-N
- Increase AAG to \$60 million/yr, ATI to \$12 million/yr, MSIP to \$25 million/yr (all below *NWNH* recommendations)
- Keep all other programs flat (no inflation increases)
- This would require an increase of >\$65 million in annual budget from FY 2015 to FY 2022, or an AST budget of ~\$310 million in FY 2022
  - 26% above FY 2016 President's Request Budget
  - 35% above a hypothetical FY 2016 AST budget if it had been reduced by ~7% due to Budget Control Act



# What Else Might We Be Doing?

- Robust instrumentation program? (upcoming OIR committee recommendation?)
- LSST Level 3 Data Products? (OIR committee, *NWNH*)
- Small grants with observing time on key facilities? (*AANM*)
- GSMT operations/instrumentation? (*AANM*, *NWNH*)



# Mid-Decadal Survey Statement of Task

- Given funding circumstances that are substantially below those described in *NWNH*, the committee's review will describe:
  - The most significant scientific discoveries, technical advances, and relevant programmatic changes in astronomy and astrophysics since *NWNH*;
  - How well the Agencies' programs address the strategies, goals, and priorities outlined in *NWNH* and other NRC reports;
  - Progress toward realizing these strategies, goals, and priorities; and
  - Any actions that could be taken to maximize the science return of the Agencies' programs.
- Ground rule: No re-visiting of *NWNH* priority ordering



# Sample AST Issues for Mid-Decadal

- In view of actual budgets, has AST responded well to *NWNH*?
  - “Flat-budget” scenario discussed on p. 240 of *NWNH* has come true
  - Were Portfolio Review and subsequent AST actions appropriate?
- *NWNH* (p. 239) gave recommendations for staging different recommendations that might be viewed as priorities among grants, MSIP, and other large programs; AST will continue with this assumption unless told otherwise
  - Window for investment in GSMT construction is closing
  - Relative weighting of MSIP and individual small grants?
- Divestment is complicated and takes a long time; is there a reason to do another Portfolio Review this decade?
- Anything to say about CMB development? (NASA medium size recommendation, also a P5 recommendation)