NSF Astronomy Update: The National Solar Observatory (NSO) and the Daniel K. Inouye Solar Telescope (DKIST)

Dave Boboltz (Program Officer, NSO/DKIST)

Committee on Solar and Space Physics (CSSP)

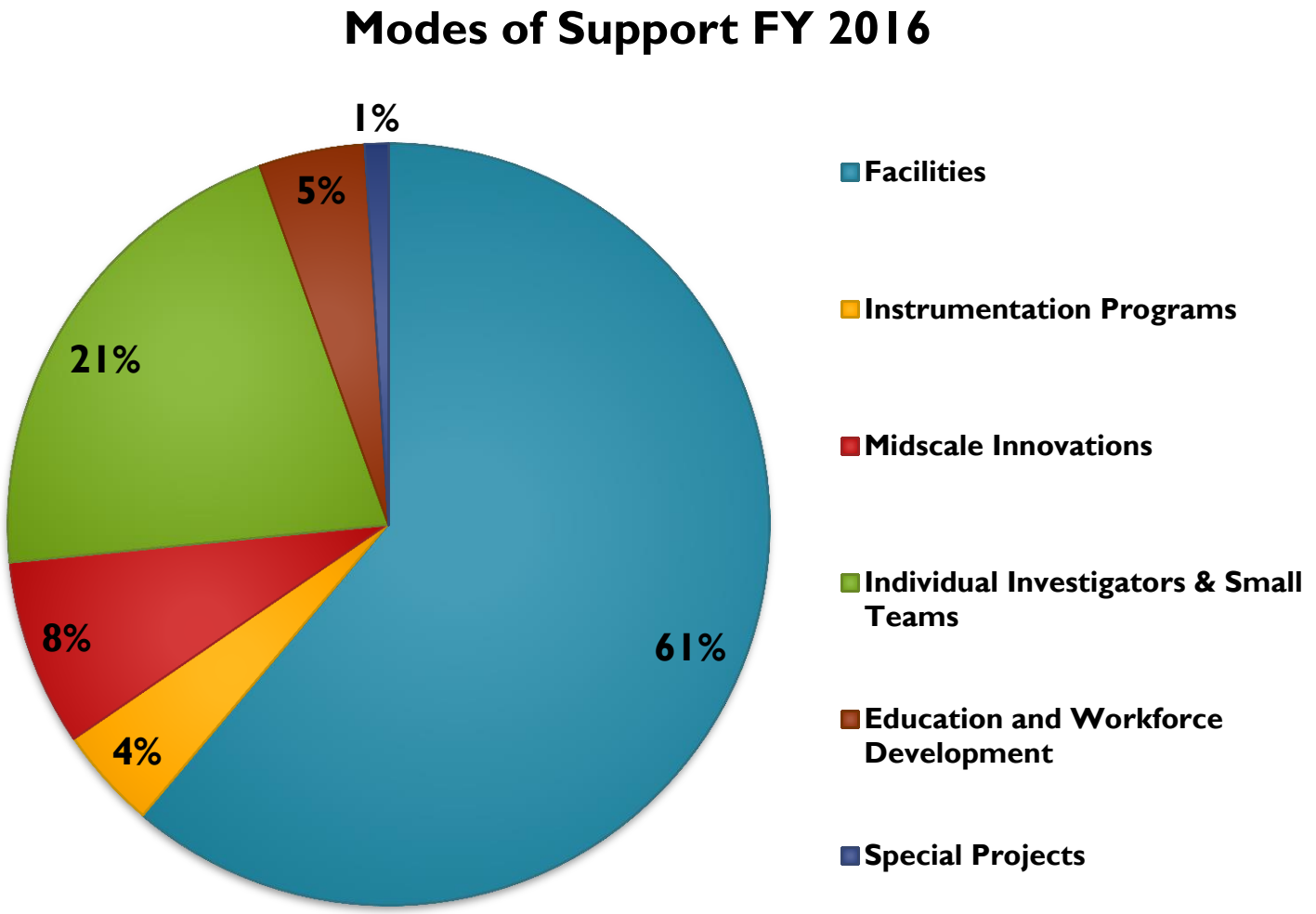
October 5, 2016

AST Budget within MPS and NSF

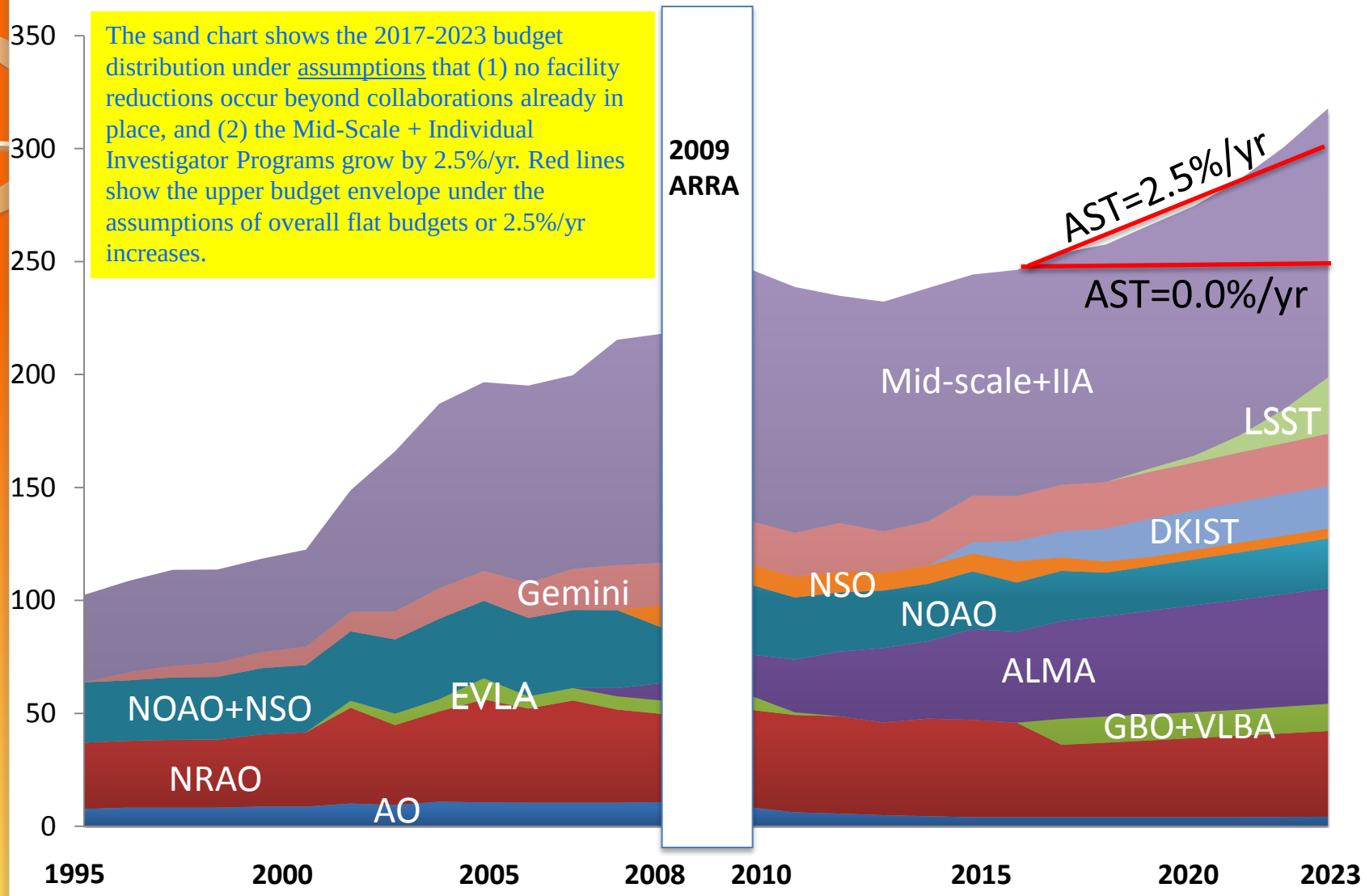
- FY 2017 Request Released on February 9, 2016
- DKIST Construction from MREFC line
- NSO/DKIST Operations funding from AST line

$M	FY15 Actual	FY16 Request	FY16 Approp.	FY17 Request Total	FY17 Request Disc.
NSF Total	7344	7724	7463	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
MREFC	200.8	200.3	200.3	193.1	193.1

Research Support Within AST

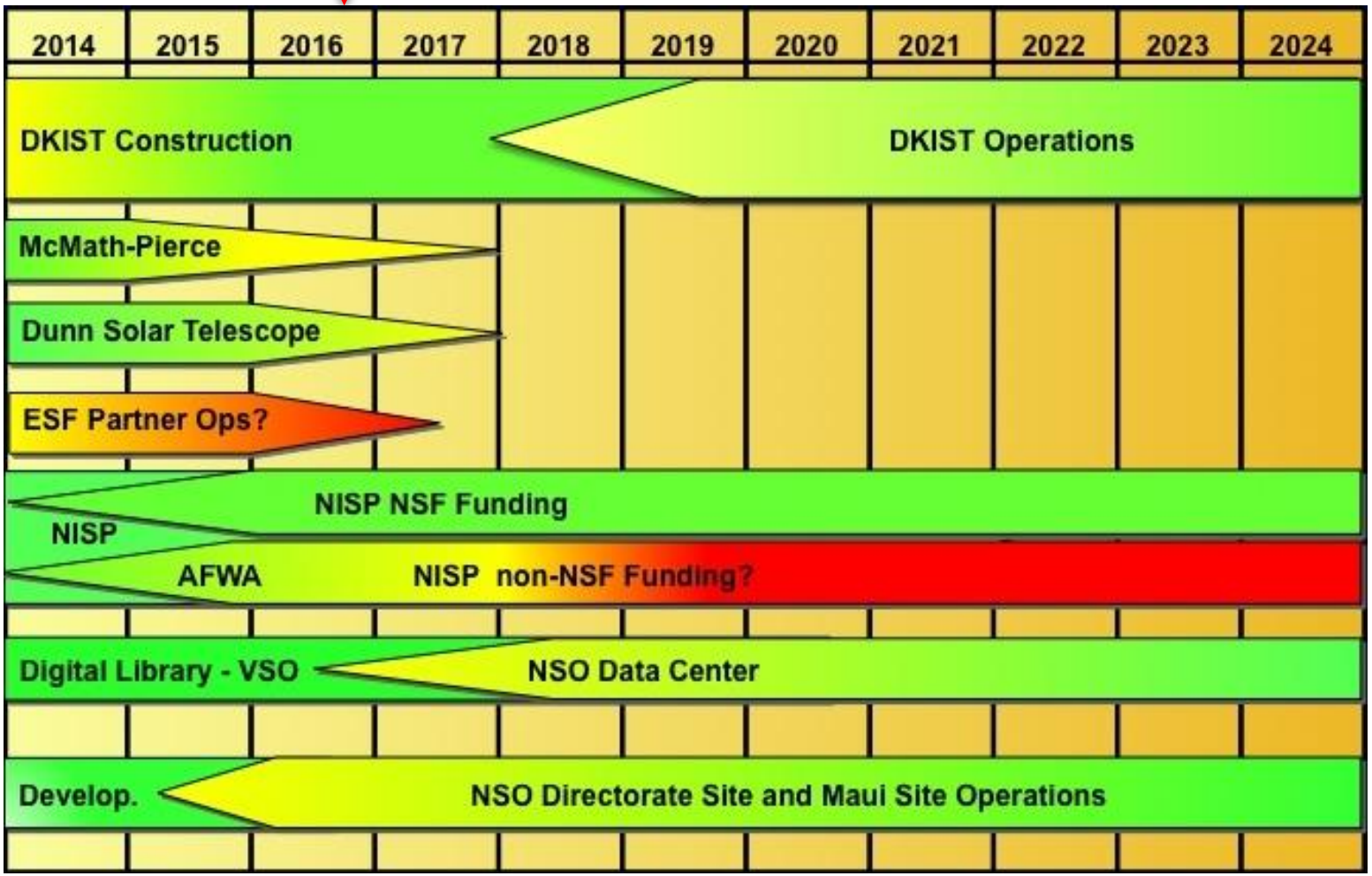


Hypothetical Budget Run-outs



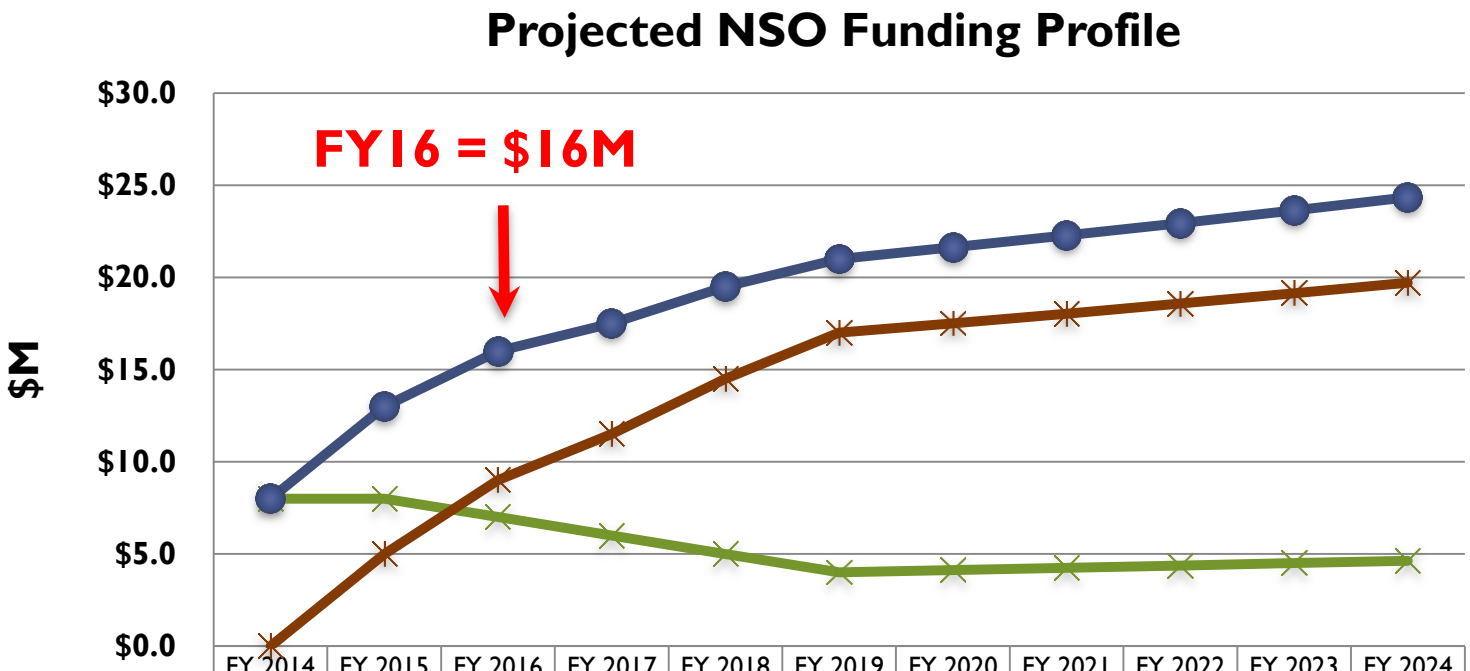
NSO Transition to DKIST Era

We are here



NSO Operations & Maintenance

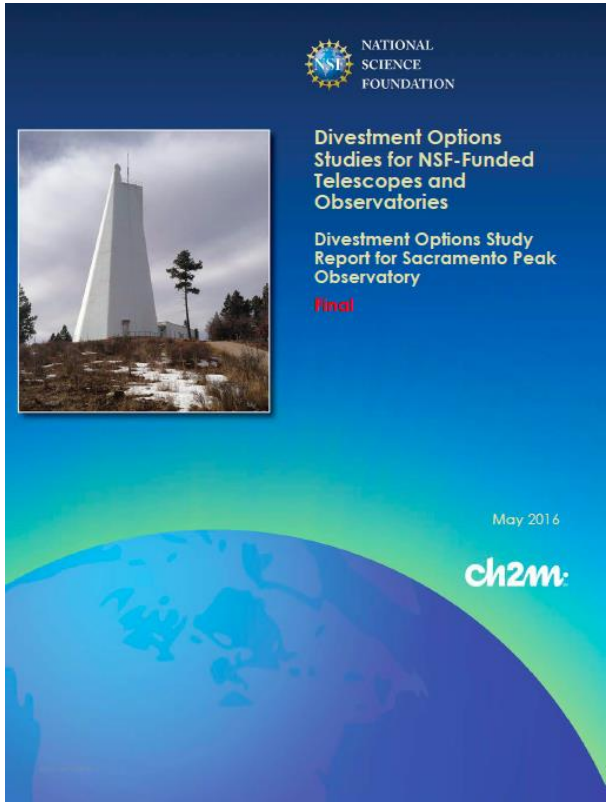
- Total R&RA through FY 2024 = $201.84M
- FY 2016 appropriation = $16M + $2.5M (GONG refurb.)



	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
NSO Base	$8.0	$8.0	$7.0	$6.0	$5.0	$4.0	$4.12	$4.24	$4.37	$4.50	$4.64
DKIST Ops.	$0.0	$5.0	$9.0	$11.5	$14.5	$17.0	$17.51	$18.04	$18.58	$19.13	$19.71
Total, NSO	$8.0	$13.0	$16.0	$17.5	$19.5	$21.0	$21.63	$22.28	$22.95	$23.64	$24.34

NSO Facilities on Sacramento Peak

- Recommended for divestment by the 2012 AST Portfolio Review
- NSF funding to NSO for Sac Peak operations projected to ramp down to the end of 2017
- Engineering feasibility study (CH2M Hill) completed May 19, 2016
- Environmental Impact Statement (EIS)/Section 106 process started
  - Notice of Intent, July 5, 2016
  - Public scoping meeting, July 21, 2016
  - End of public comment, Aug. 5, 2016
  - Draft EIS expected Dec. 2016



Bridge to the Sunspot Solar Observatory Consortium (SSOC)

- Met with National Solar Observatory (NSO) and representatives of universities seeking to create a consortium to operate Sac Peak, May 2015
- NM State Legislature failed to fund highly rated NMSU request for funds to enable consortium, Feb. 2016
- NMSU submitted a proposal to AST for funding to bridge the gap between NSO and SSOC, May 2016
- Proposal awarded Sept. 2016
- Still looking for SSOC members

NSO Facilities on Kitt Peak

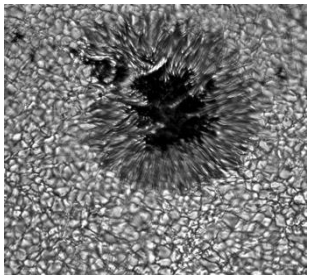
- Recommended for divestment by the 2012 AST Portfolio Review
- NSF minimal operations funding ramping down to 2017
- NSF engineering feasibility study (CH2M Hill) completed July 2016
- Recent negative developments
  - Tohono O'odham Community College voted against any participation
  - Northrop-Grumman StarShade proposal not funded by JPL
- Still open to collaborations

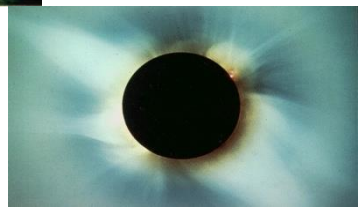
NSO Integrated Synoptic Program

- Consists of SOLIS and GONG
- Recommended for 50% ($2M/year) divestment by the 2012 AST Portfolio Review
- External Federal stakeholders: NOAA-SWPC, AFWA, NASA
- Increased Federal awareness (i.e. NSWS and NSWAP) of space weather assets like GONG
- Result: program to "operationalize" GONG in the FY2016 appropriation
  - $2.5M addition to NSF (through AST) for refurbishment
  - $1M/year addition to NOAA for operations
- August 2016: **Interagency Agreement NSF-NOAA signed!**

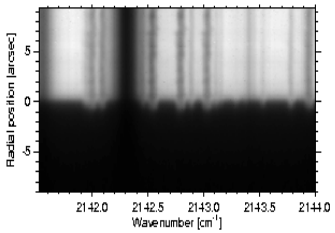
DKIST Will Replace Current National Solar O/IR Facilities

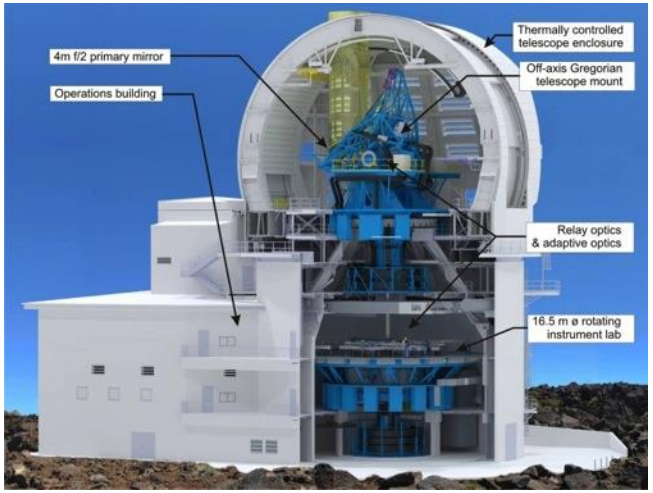
Dunn Solar Telescope
Evans Solar Facility
Sacramento Peak, NM





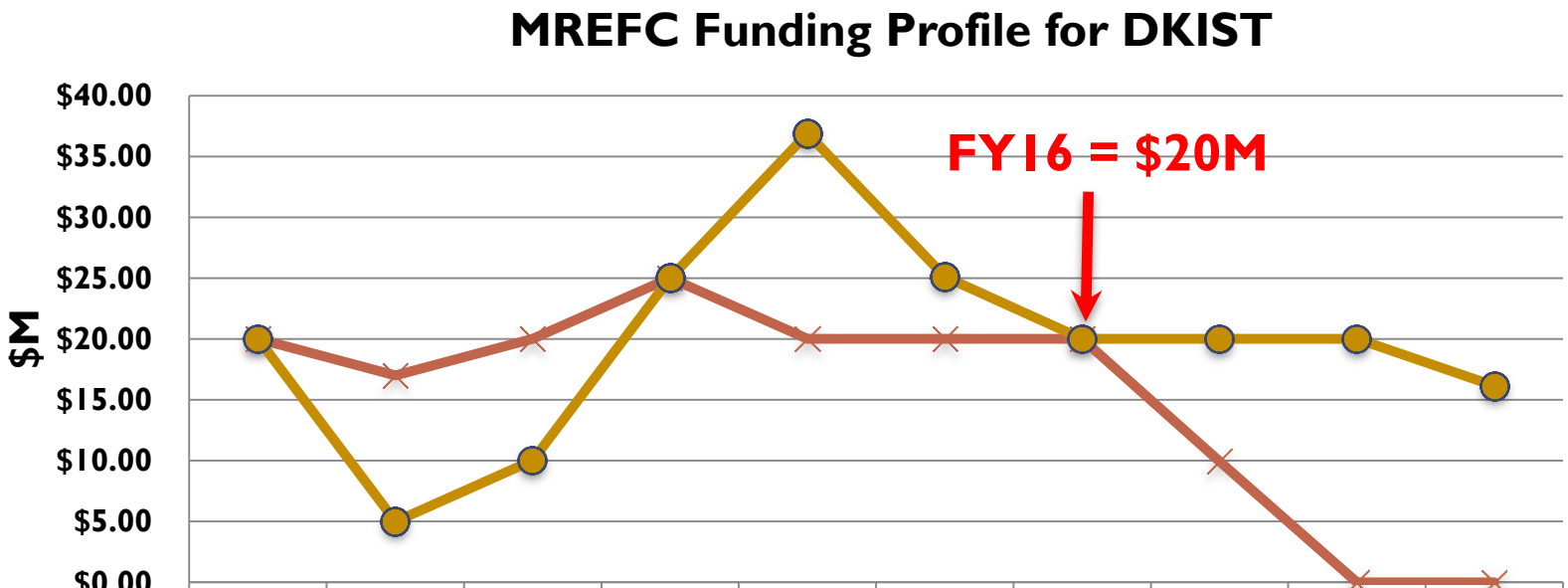
McMath-Pierce, Kitt Peak, AZ





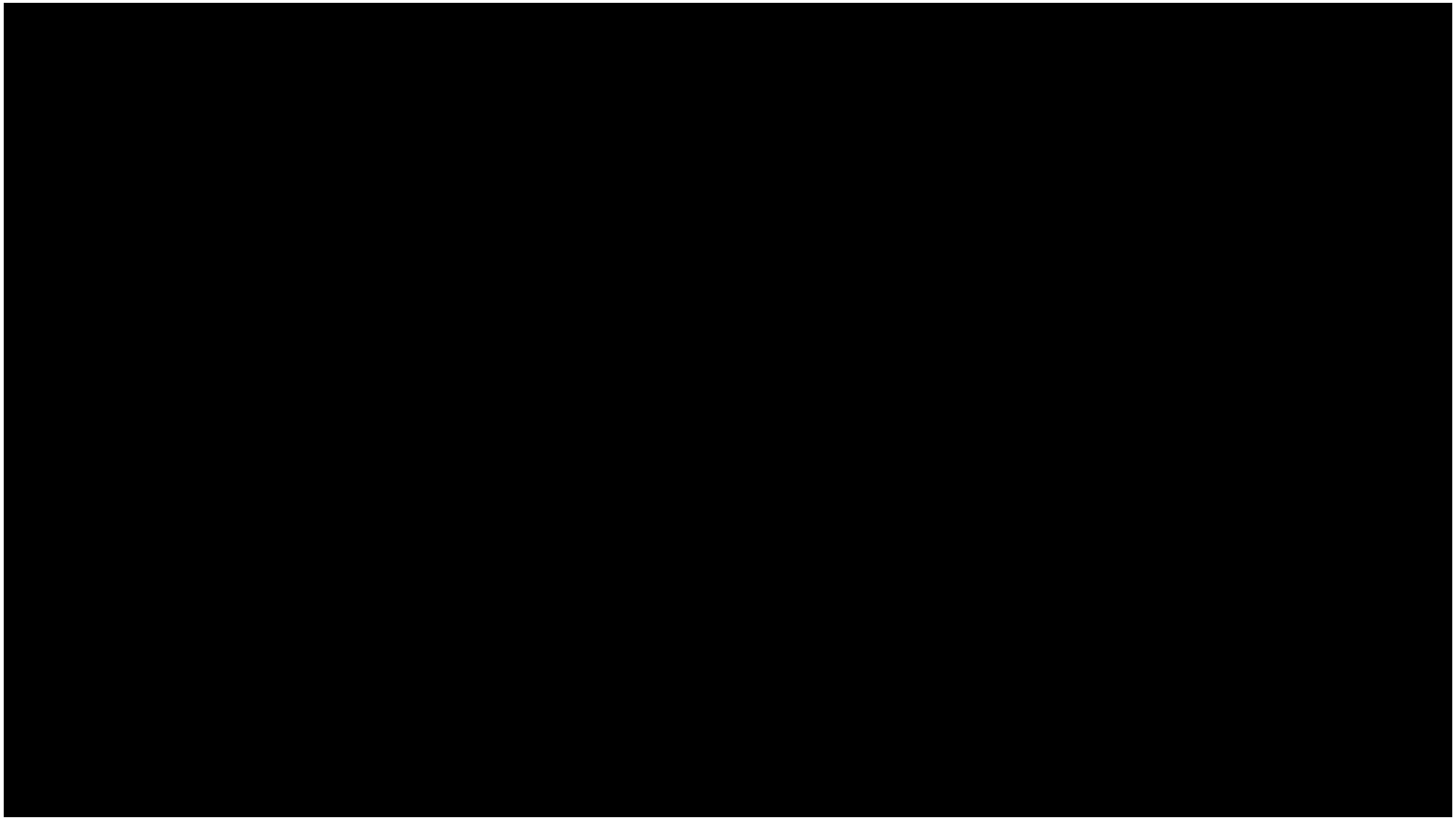
DKIST Construction Funding

- DKIST Re-baselined Total Project Cost = $344.13M
- ARRA $146M awarded FY 2010
- MREFC FY 2016 = $20M awarded

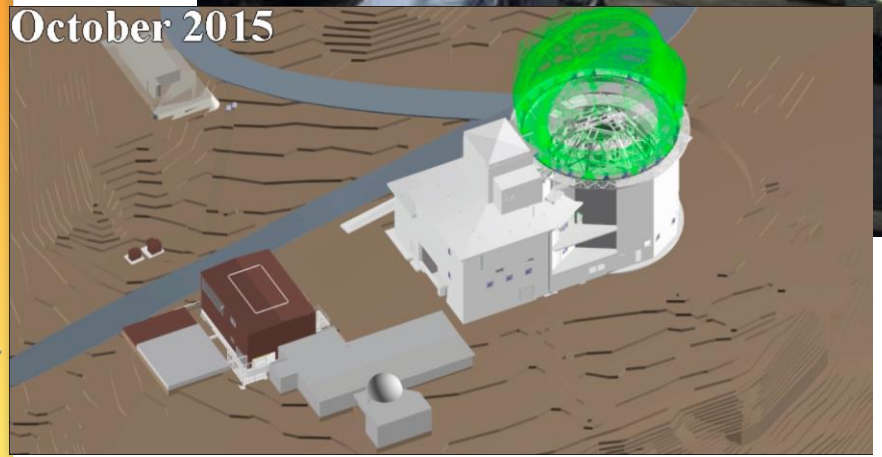


	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Original	$20.00	$17.00	$20.00	$25.00	$20.00	$20.00	$20.00	$9.93	$0.00	$0.00
Updated	$20.00	$5.00	$10.00	$25.00	$36.88	$25.12	$20.00	$20.00	$20.00	$16.13

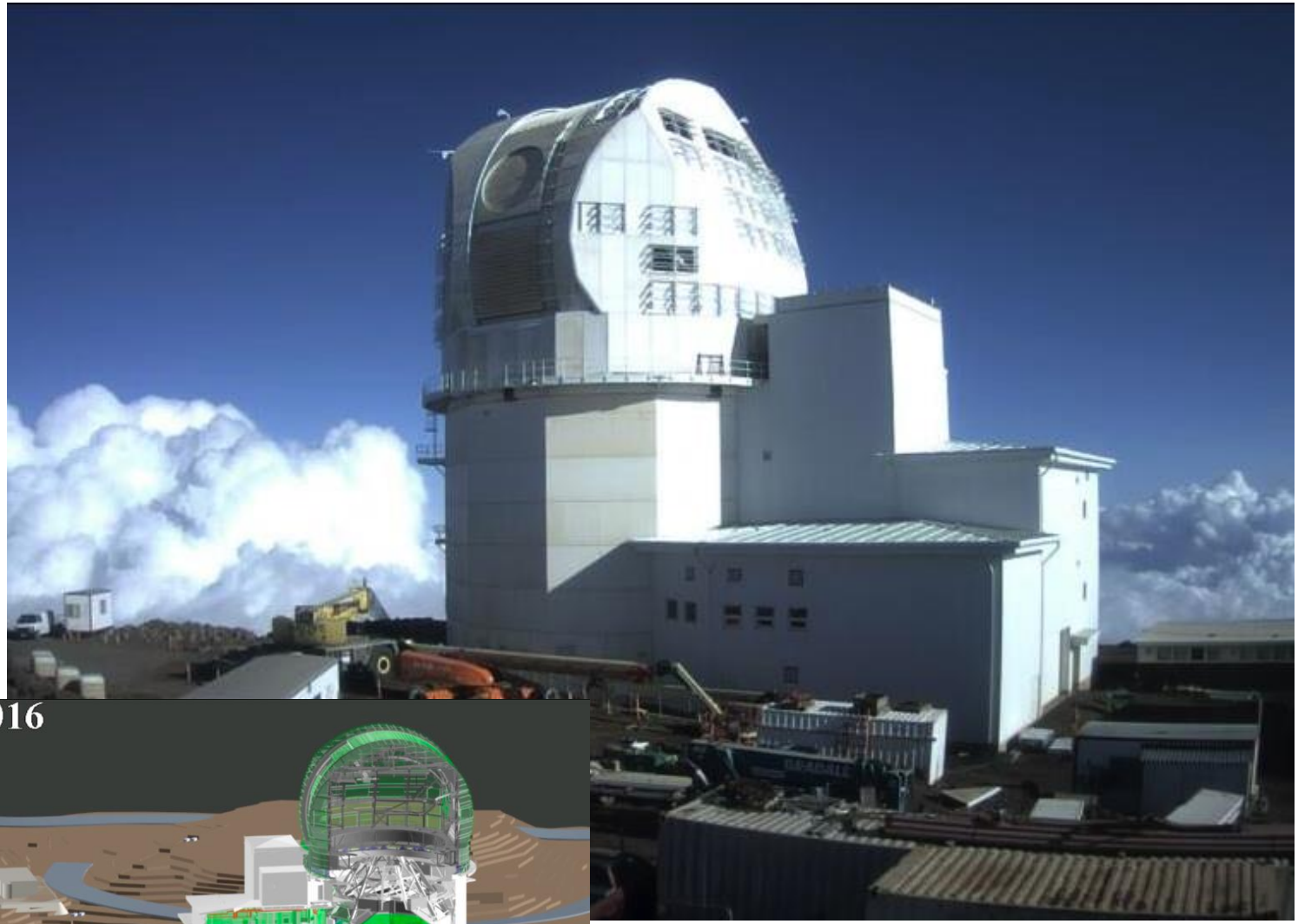
Planned Construction



Enclosure: CSSP, October 2015



Enclosure: CSSP, March 2016



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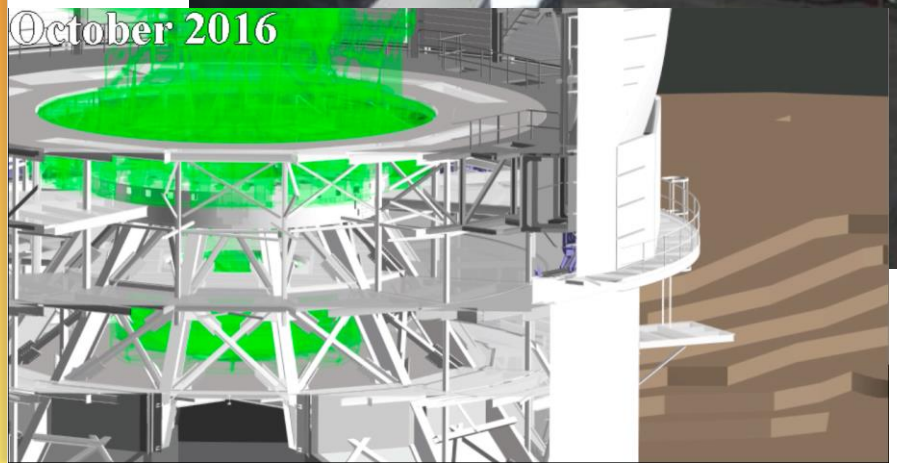
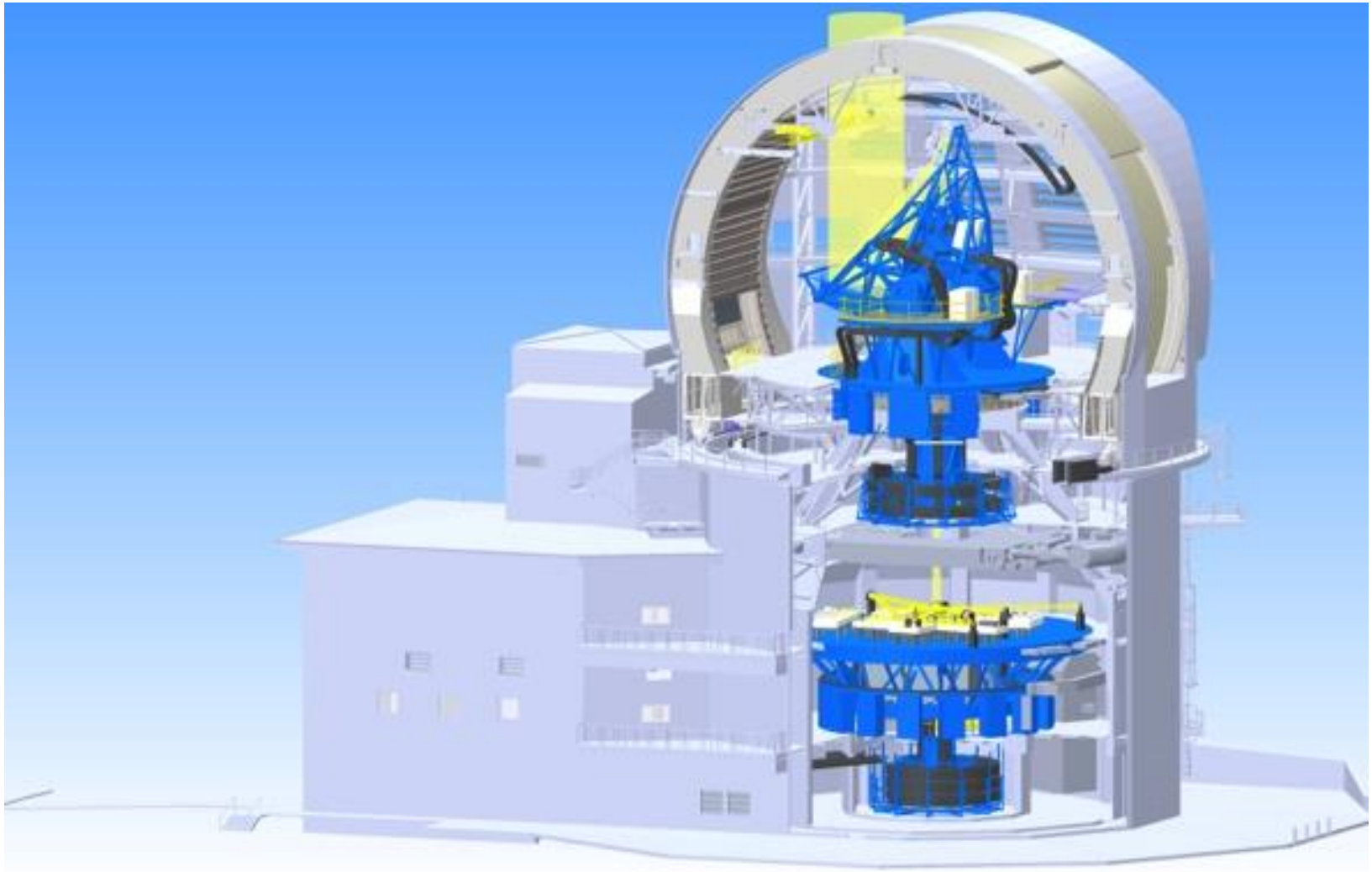
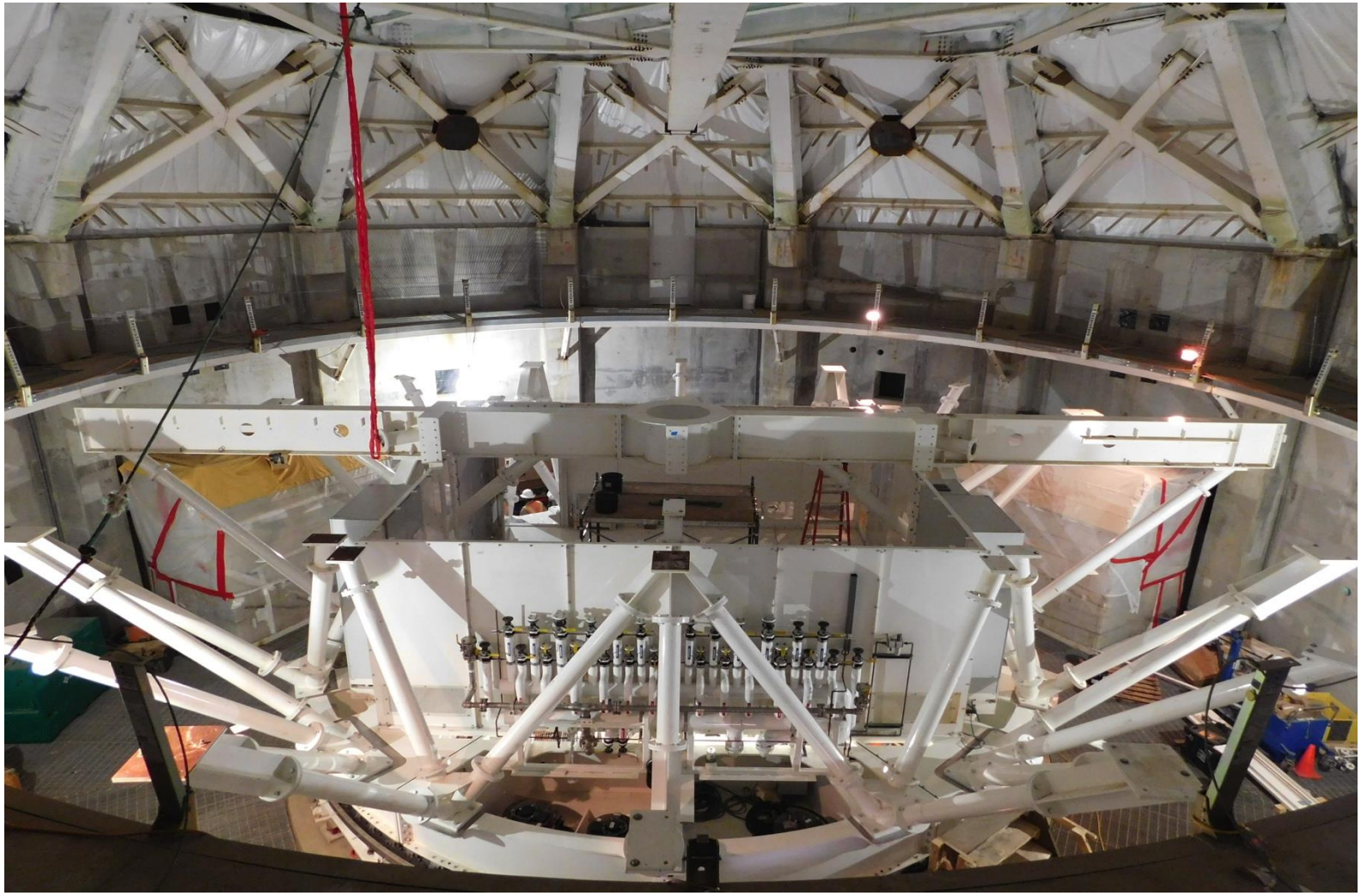


DKIST Cutaway View



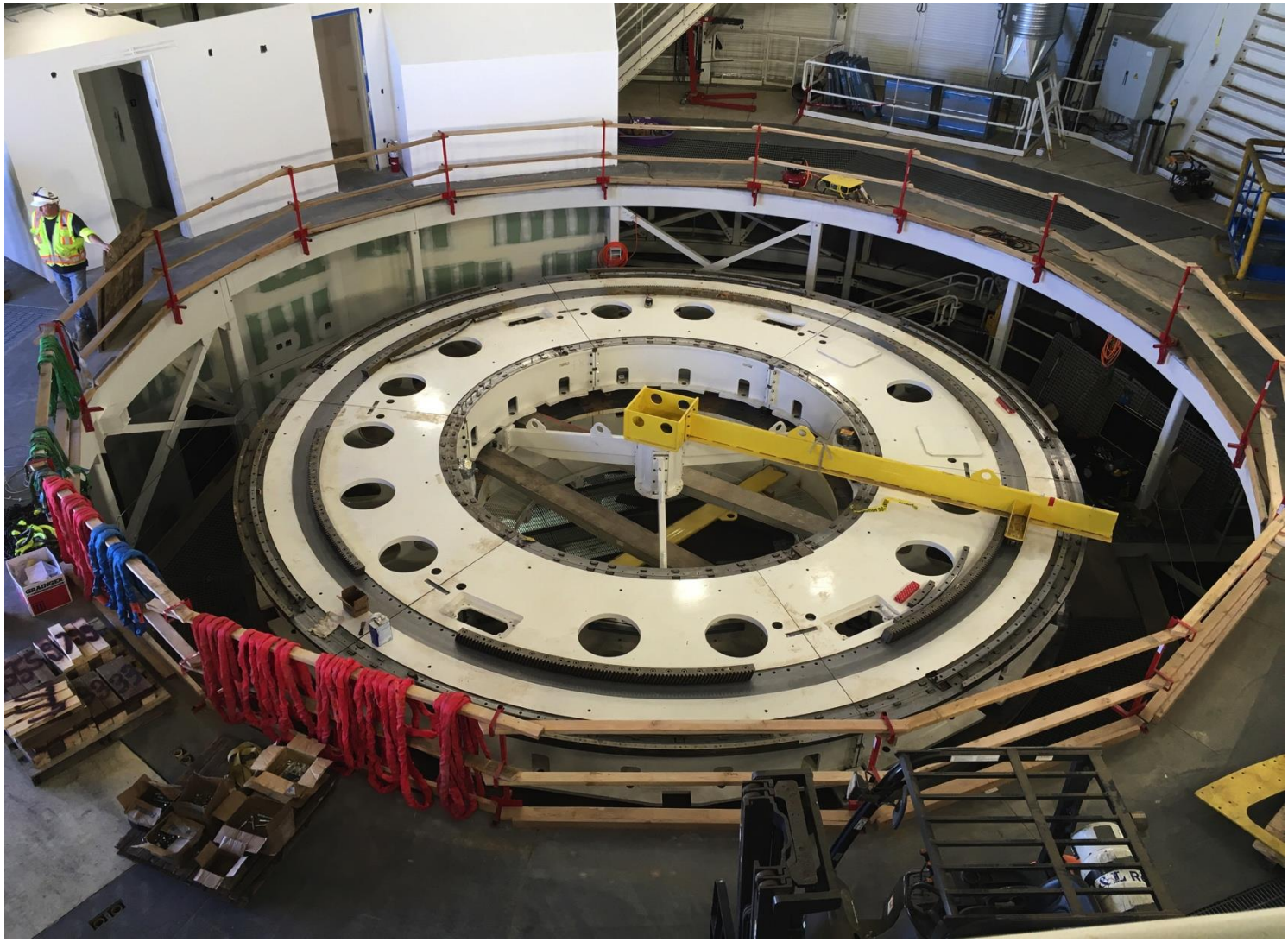
Coudé Rotator: CSSP, March 2016

Coudé Rotator: July 2016

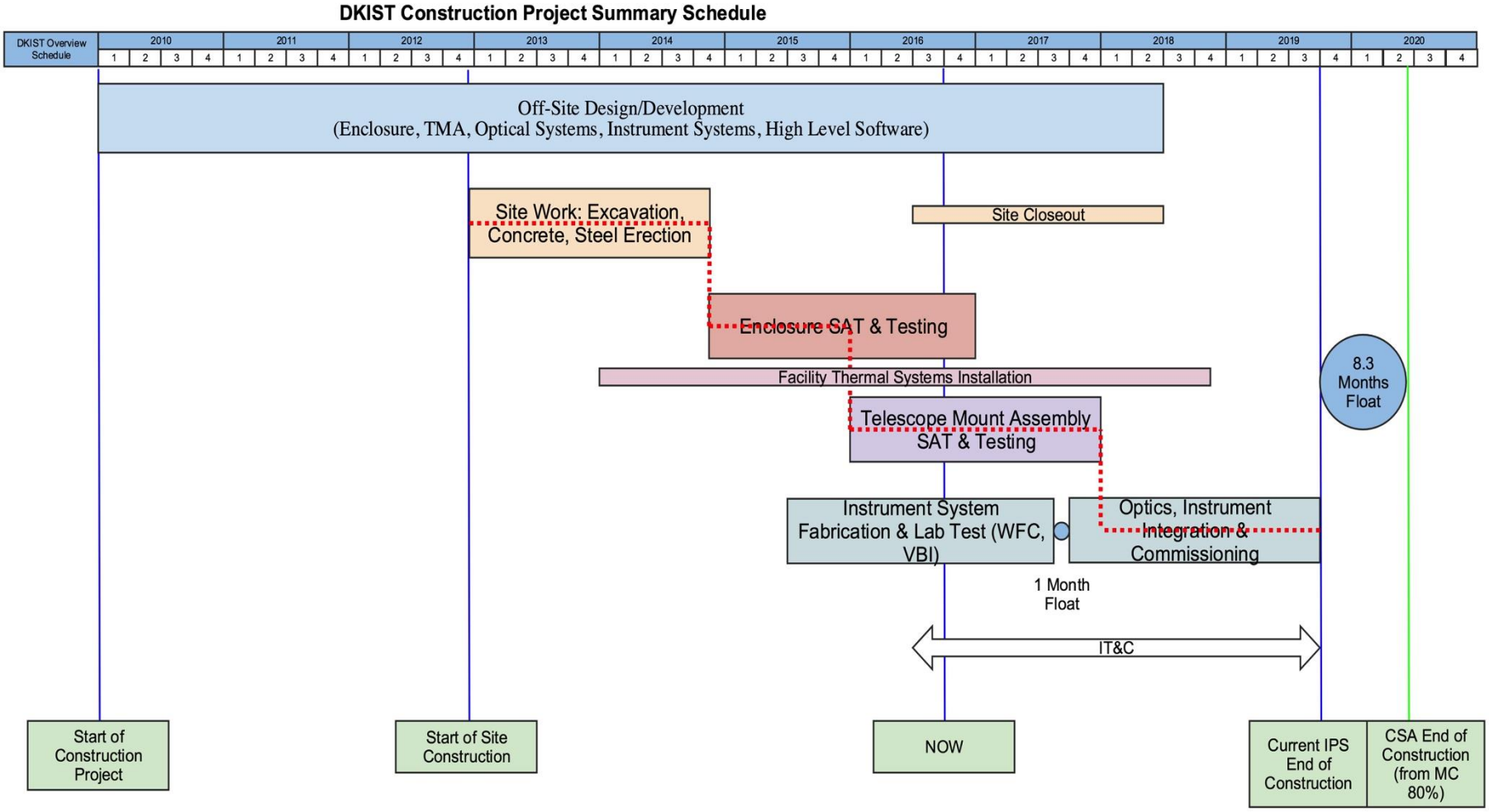


Coudé Rotator, CSSP October 2016

TMA Base Ring: September 2016



DKIST Summary Schedule

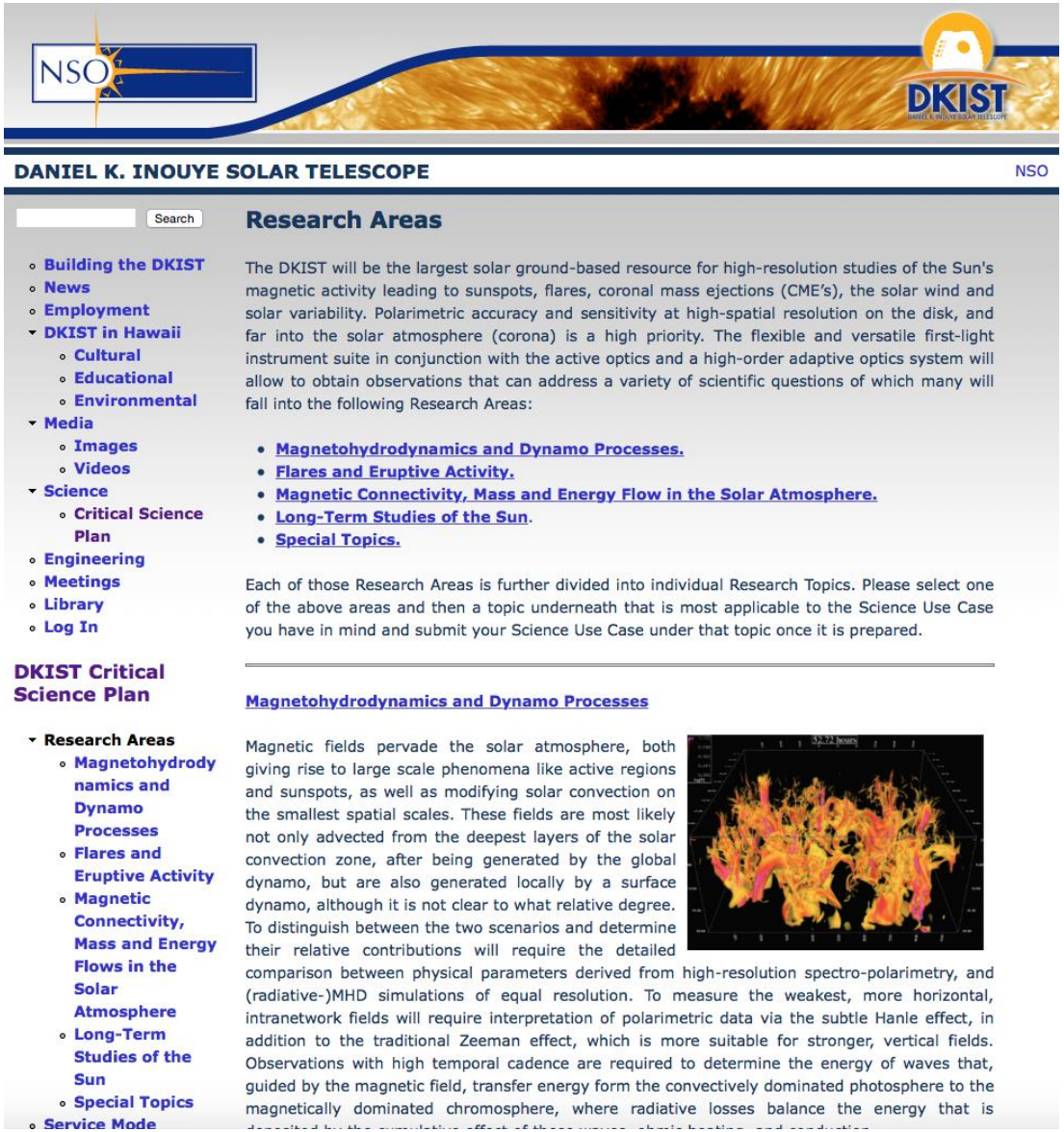


DKIST Site Construction

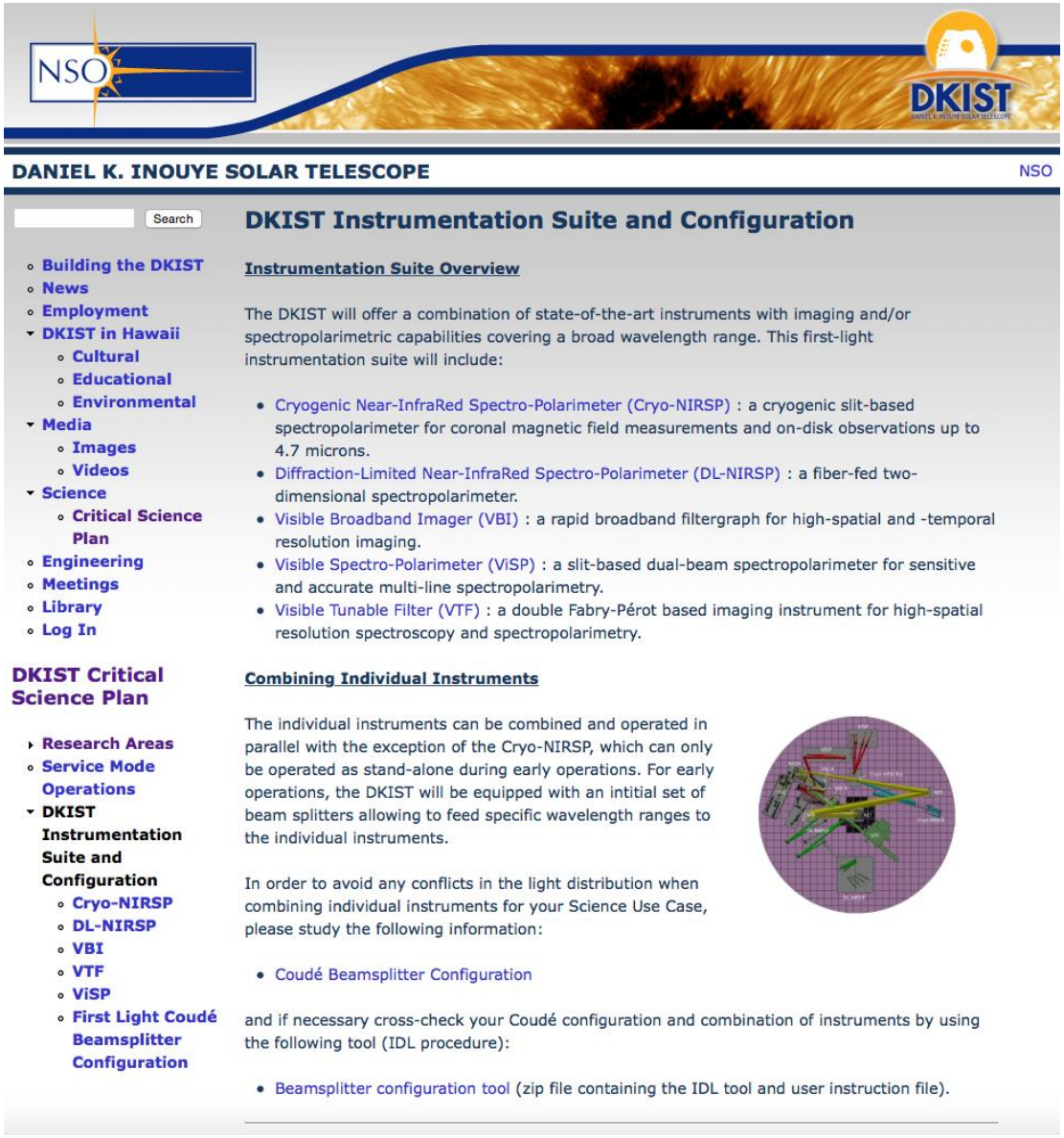
DKIST Critical Science Plan (CSP)

- http://dkist.nso.edu/CSP
- The CSP aims to define critical science goals for the first year of DKIST operations
- DKIST Science Working Group (SWG) headed by Mark Rast (CU)
- Next SWG meeting Oct. 11-13, 2016 at NMSU

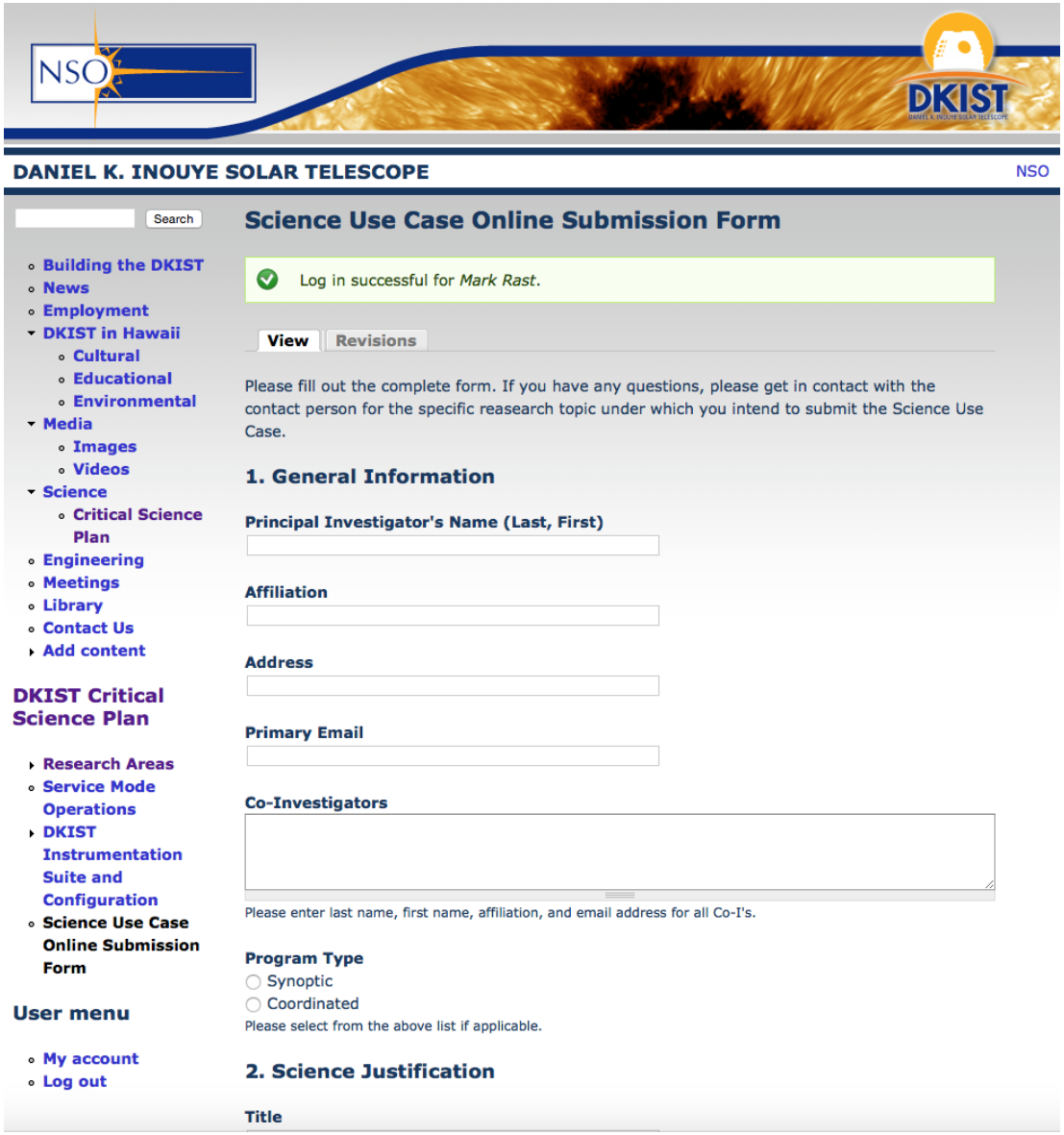
CSP Research Areas



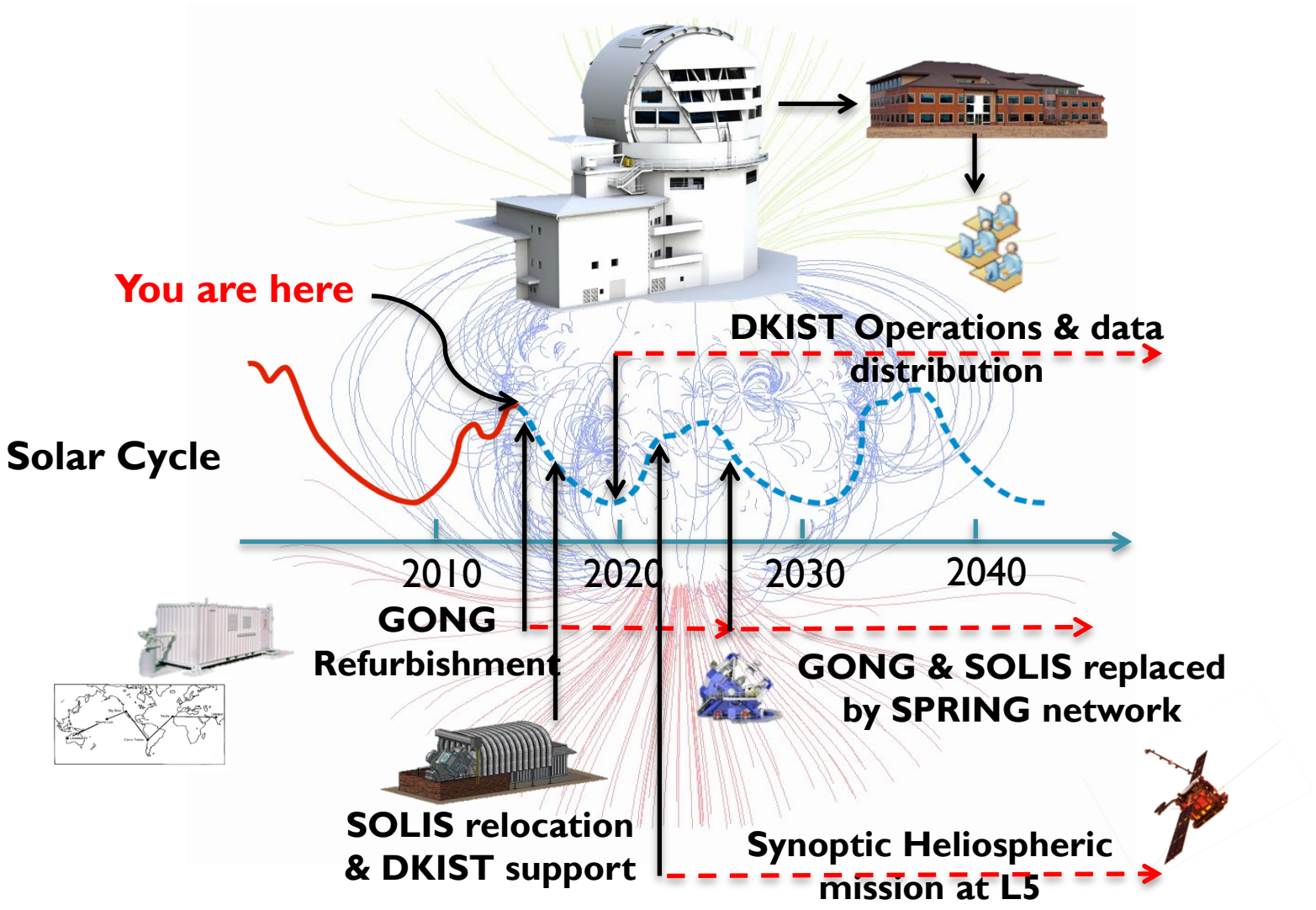
DKIST Instrumentation



Science Use Cases



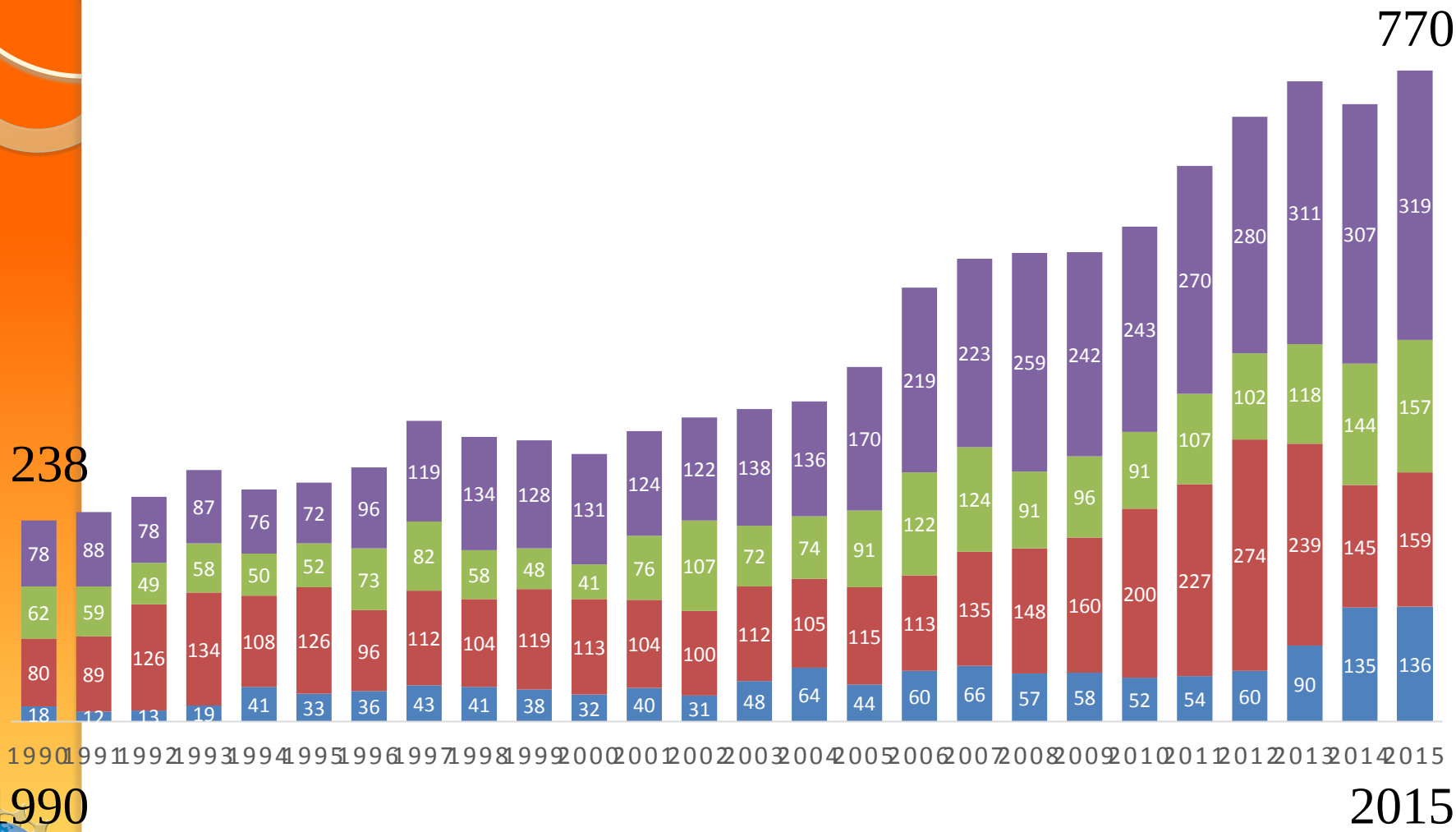
Transformation of NSO



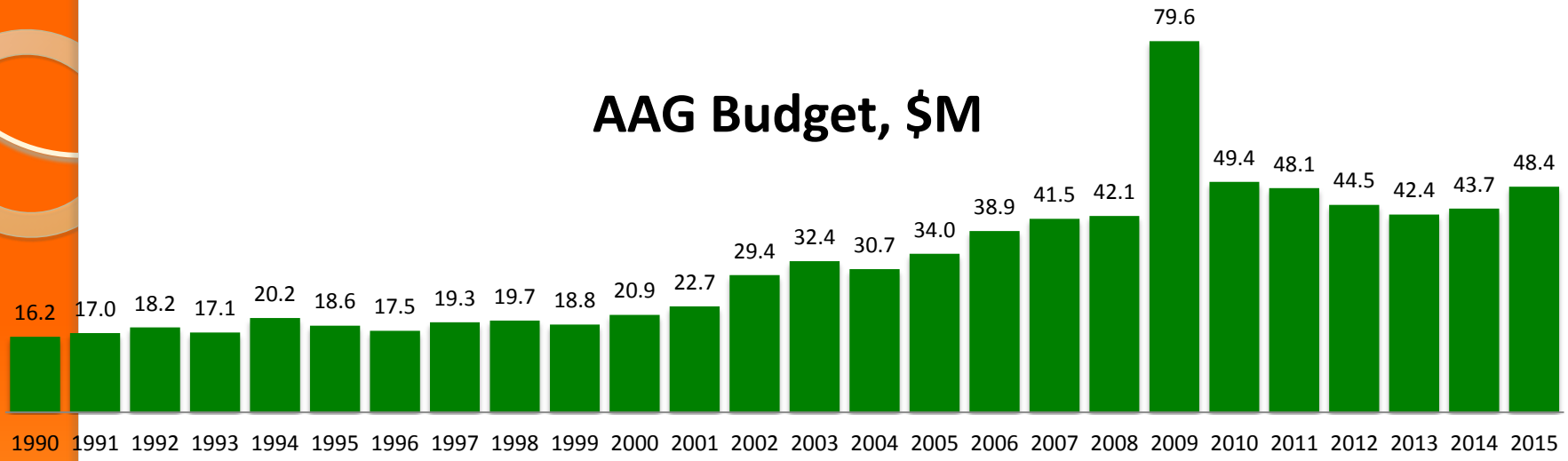
Individual Investigator Opportunities

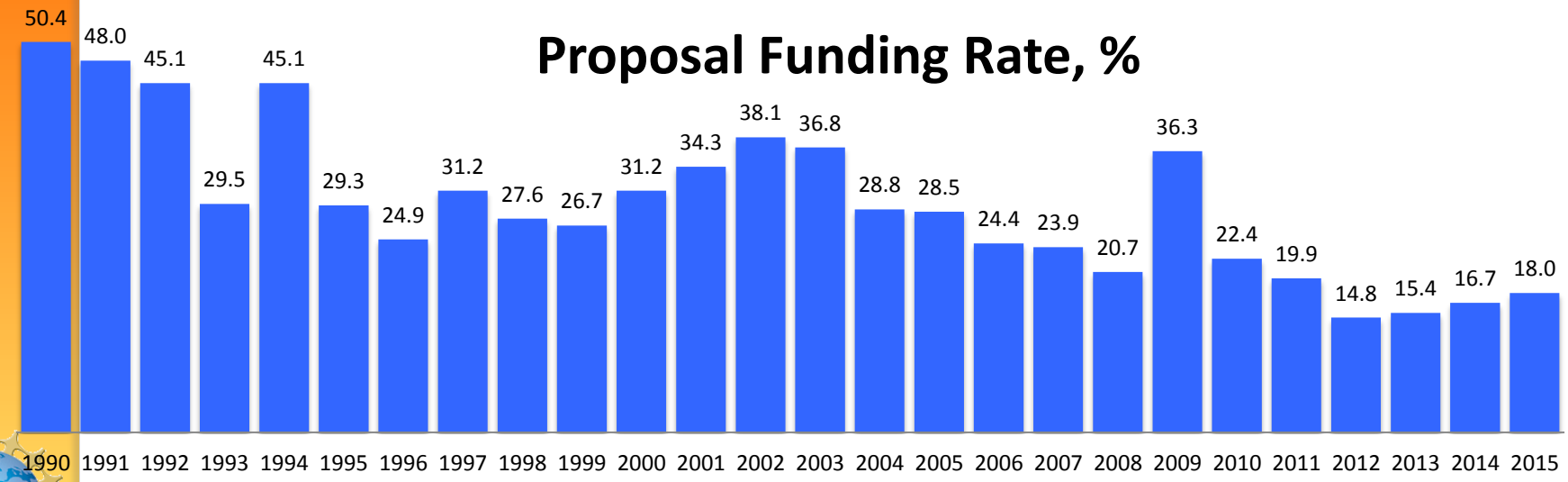
- AST runs several grants programs
- Workforce Development: CAREER and AAPF
- Instrumentation: ATI and MRI (NSF-wide)
- Midscale Innovations: MSIP
- Research: Astronomy and Astrophysics Grants (AAG)
  - AST's largest program ($48.4M FY2015)
  - Four major categories: EXC, GAL, SAA and PLA

AAG Proposals, 1990-2015



AAG Funding History, 1990-2015

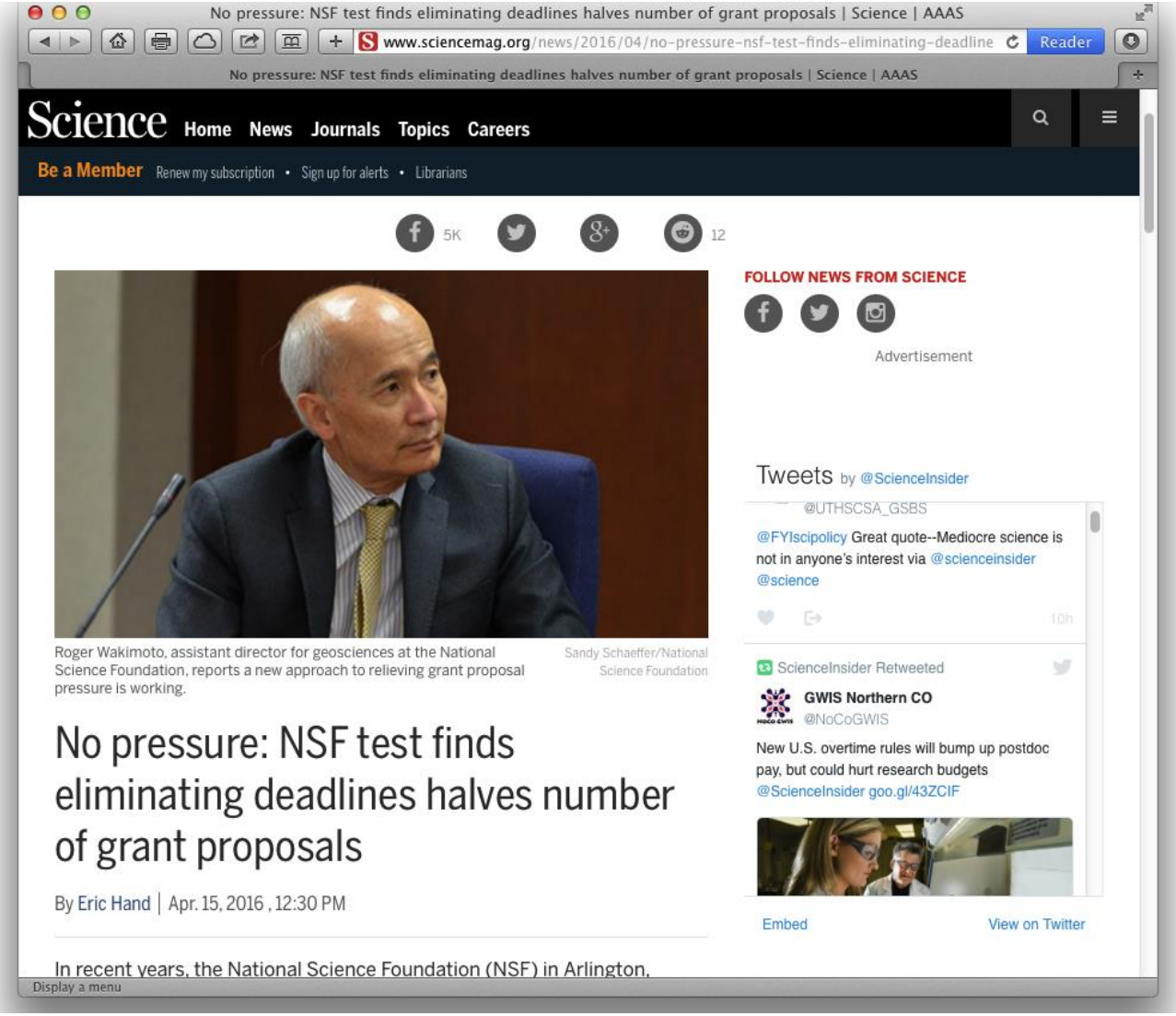




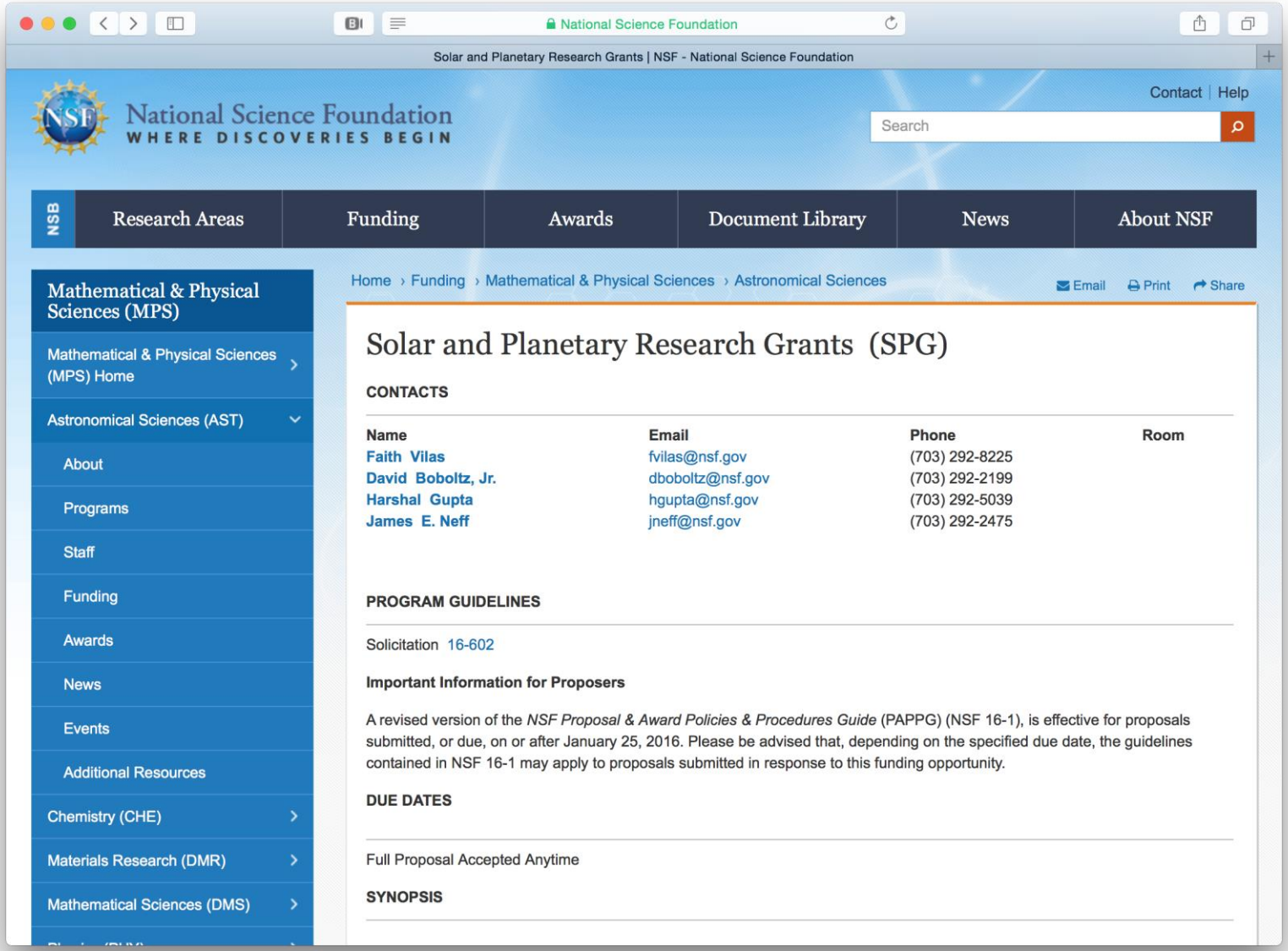
Solar Research Opportunities

- AAG open to all astronomical research including solar, however AST not a traditional home for solar research
- Getting the word out in advance of DKIST
  - Multiple talks in 2015: TESS/SPD, IRIS 4 workshop, IAU, etc.
  - Mark Rast (CU) on behalf of DKIST SWG: Coordinated submission of solar proposals to FY 2016 AAG program
- Results:
  - Critical mass (21 proposals) for panel
  - More proposals with DKIST in the title than ALMA
  - First-ever solar physics panel (SAA-SUN) in AST!
  - 19% success rate consistent with the rest of AAG

NSF/GEO Pilot Program Eliminating Proposal Deadlines



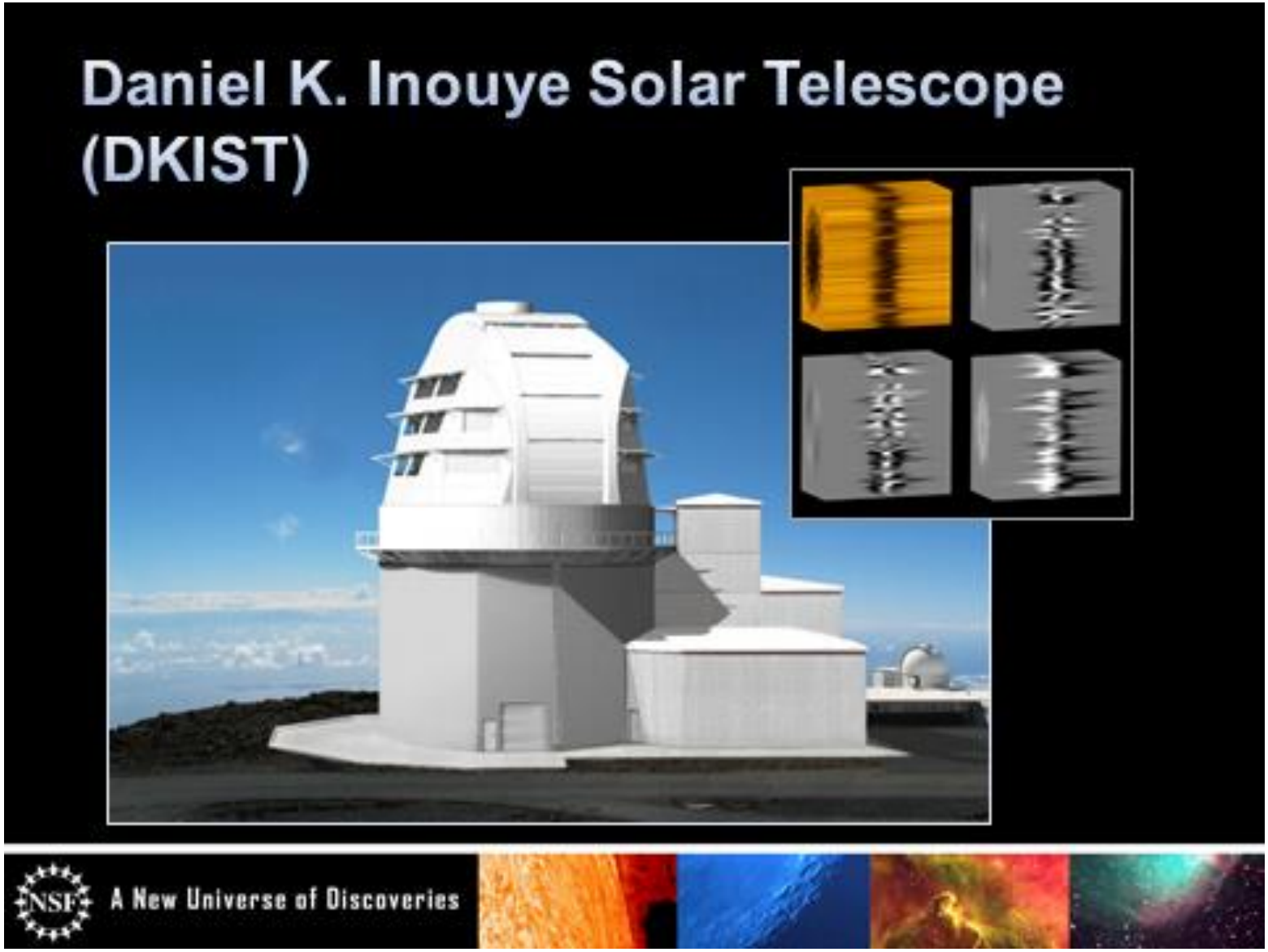
AST No-deadline SPG Pilot Program



Summary

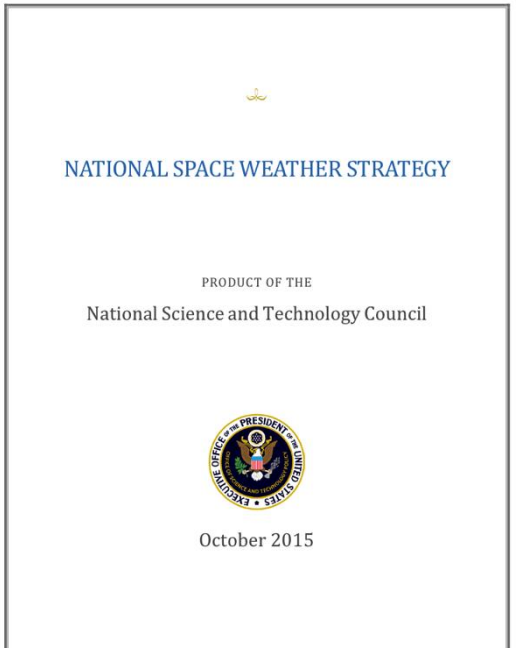
- DKIST will transform the ground-based solar community
- NSF (through AST) investing in ground-based solar physics via NSO, DKIST and SPG Program
- AST supported the NSO move to the campus of the University of Colorado, Boulder
- AST will continue to work with our colleagues in GEO/AGS to find synergies and potential projects for co-funding
- AST will continue its involvement in Federal space weather forums (NSWS, NSWAP)
- AST encourages conversations and proposals from the solar physics community

Back-up Slides



NSO and the NSWS/SWAP

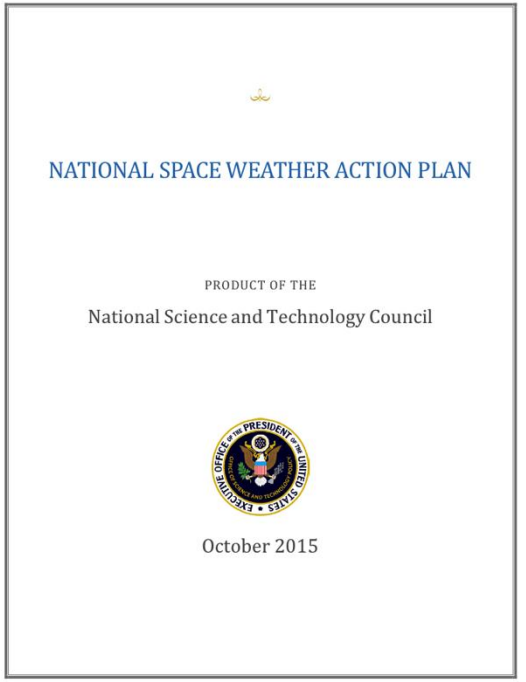
- NSF's National Solar Observatory can contribute to the National Space Weather Strategy and Action Plan through:
  - space weather observations (5.3)
  - forecasting improvement (5.4)
  - enhancing fundamental understanding of space weather (5.5)
  - international cooperation (6.2)
- See NSO White Paper at:
  - http://www.nso.edu/node/1290


NATIONAL SPACE WEATHER STRATEGY

PRODUCT OF THE

National Science and Technology Council

October 2015


NATIONAL SPACE WEATHER ACTION PLAN

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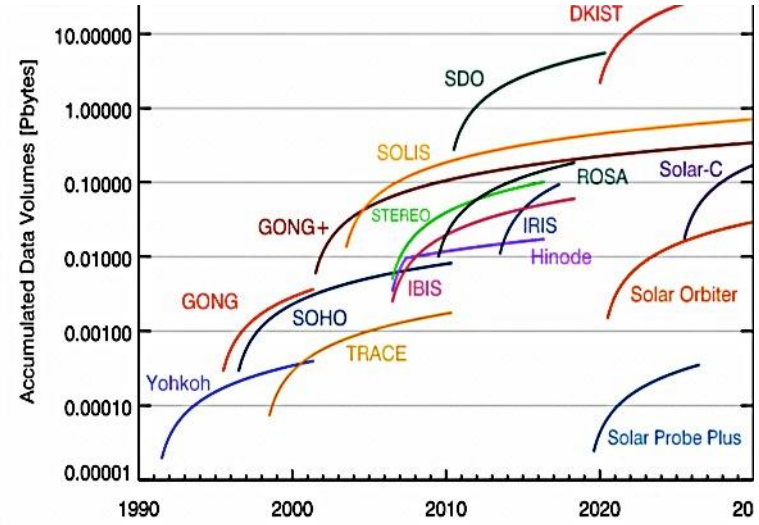
National Science and Technology Council

October 2015

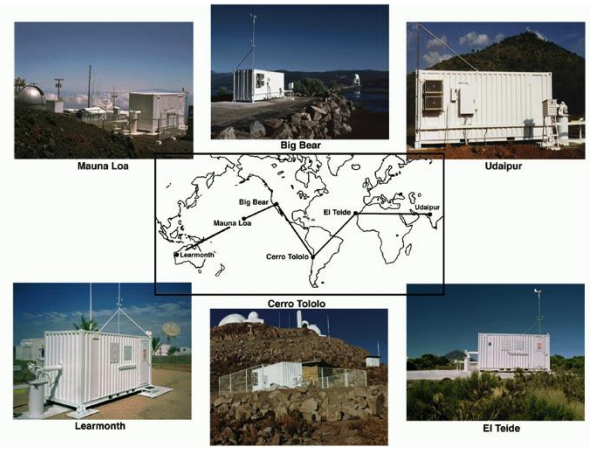
DKIST: SWAP 5.3.9, 5.4.2, 5.5.2, 6.2.2

- The Daniel K. Inouye Solar Telescope (DKIST) will host **new sensor technologies** (5.3.9, 5.4.2) and support **basic research opportunities** (5.5.2) through **international partnerships** (6.2.2)
- Key challenges:
  - Construction completion
  - Transition to operations
  - Big Data



NISP: SWAP 5.3.4

- The NSO Integrated Synoptic Program (NISP) contributes to a sustained or enhanced ground-based solar imaging including solar magnetic field and H-alpha data (5.3.4)
- Key challenges:
  - 2012 Portfolio Review recommended partial divestment
  - U.S. Air Force withdrawal of support for GONG operations
  - Need to integrate SOLIS vector-magnetograms into space weather models
- NSF – NOAA partnership for robust GONG operations



SPRING: SWAP 5.3.9, 5.4.2, 6.2.2

- NSO will contribute to the development and deployment of new operational space weather assets (5.3.9) and novel sensor technologies (5.4.2) leveraging international partnerships (6.2.2).
- Key challenges:
  - The Solar Physics Research Integrated Network Group (SPRING) is an international project currently led by the Kiepenheuer Institut für Sonnenphysik (KIS) in Germany, where science requirements are being written and instrument concepts being developed
  - The U.S. participation is through the NSO as a consultant on the European-led project
  - SPRING is in the conceptual stage and currently has no Federal funding.