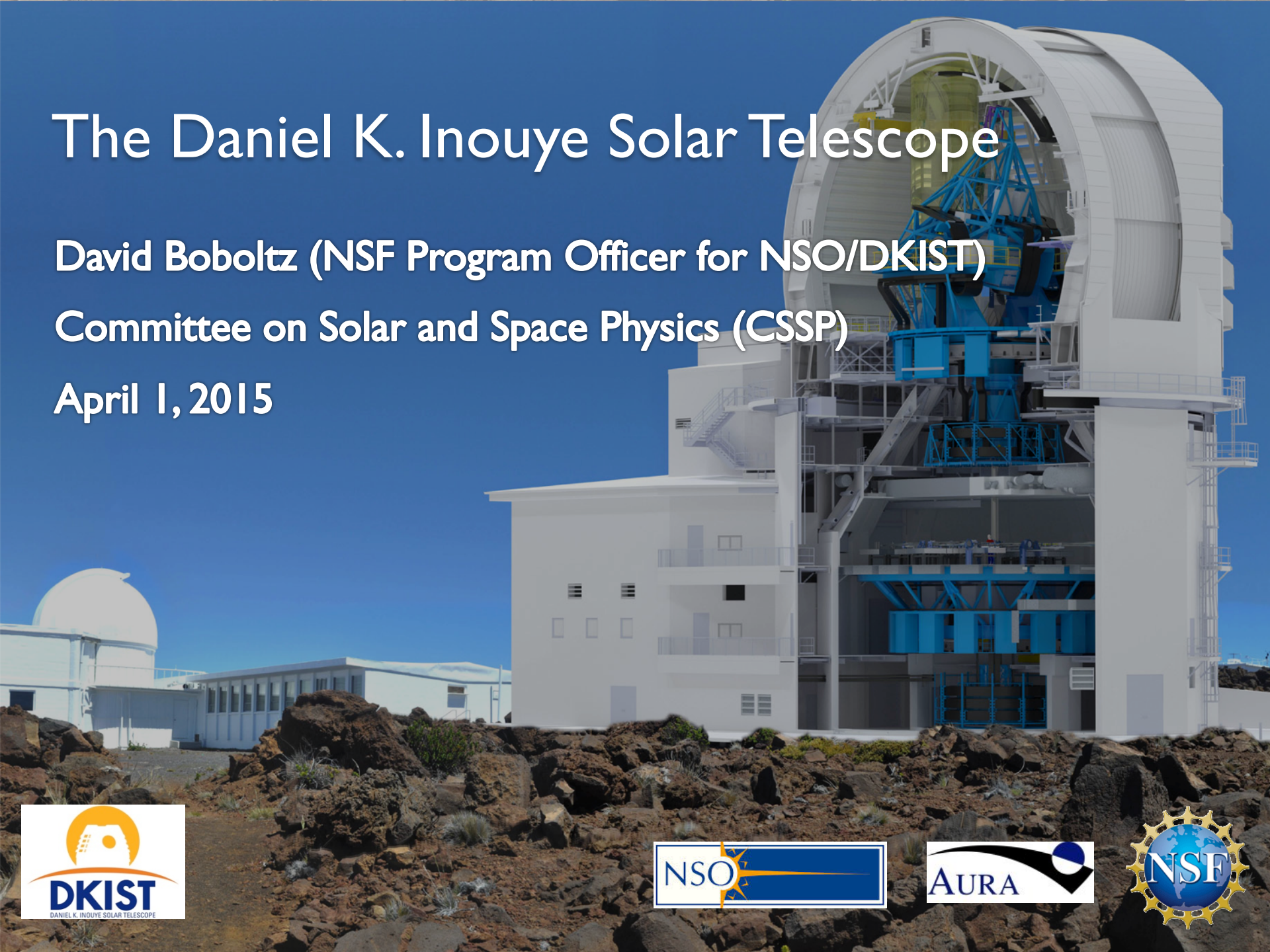
The Daniel K. Inouye Solar Telescope

David Boboltz (NSF Program Officer for NSO/DKIST)

Committee on Solar and Space Physics (CSSP)

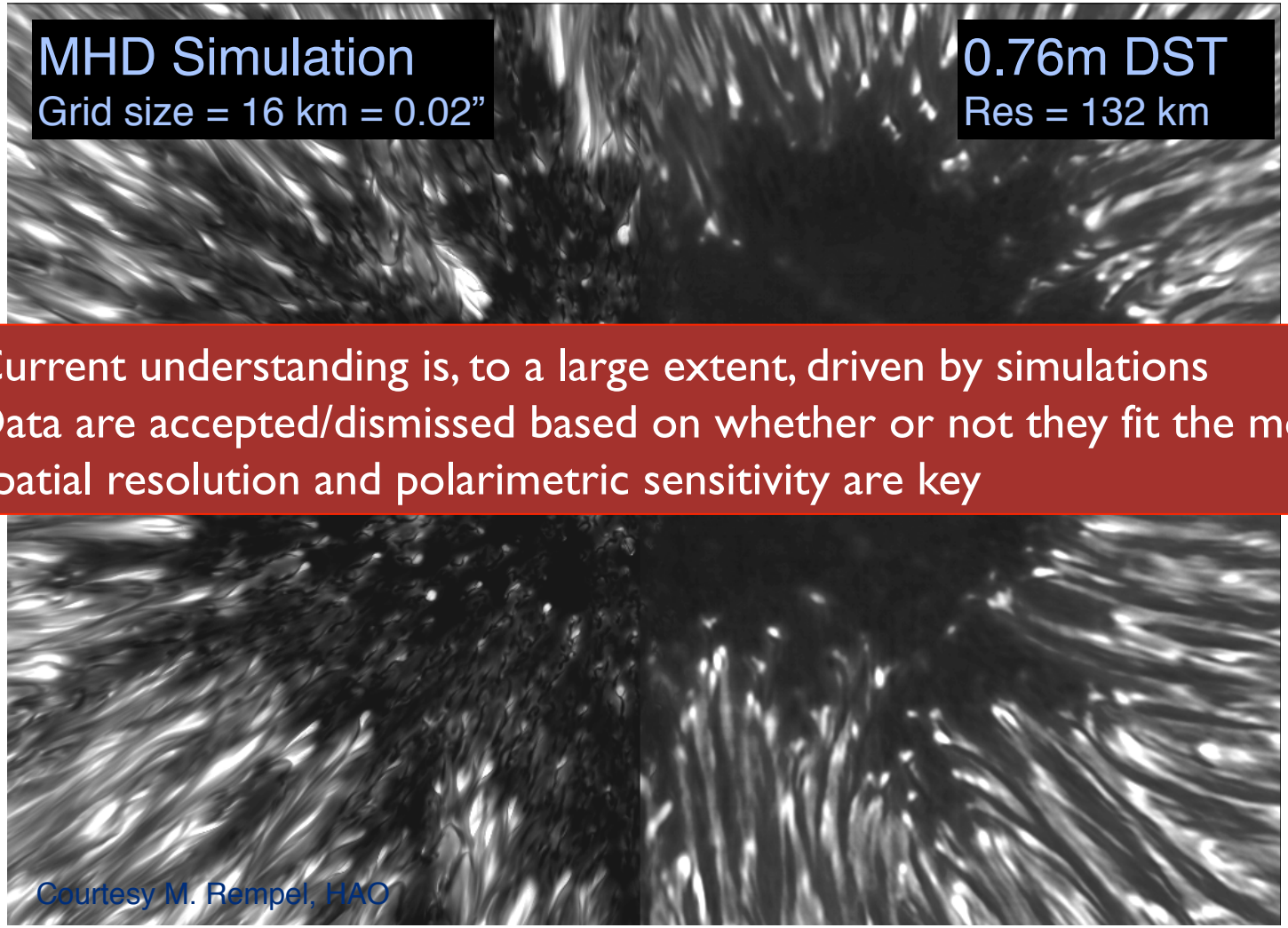
April 1, 2015



The DKIST Science Case

- Magnetic fields control the inconstant Sun.
- Changes in the solar magnetic field produce: solar flares, coronal mass ejections, and variations in the solar wind, and space weather
- Space weather has potentially profound impacts on human society by:
  - driving terrestrial climate;
  - hazards to humans and commercial aviation;
  - endangering satellites, communication networks, and the power grid.
- Magnetic fields are the "dark energy" problem of solar physics.
- DKIST will probe the magnetic fields at all levels of the solar atmosphere down to length scales (20-30 km). No other facility, existing or planned, ground- or space-based, can do this.
- DKIST's relevance re-affirmed by recent NRC Astronomy & Astrophysics (2010) and Solar and Space Physics (2012) Decadal Surveys.

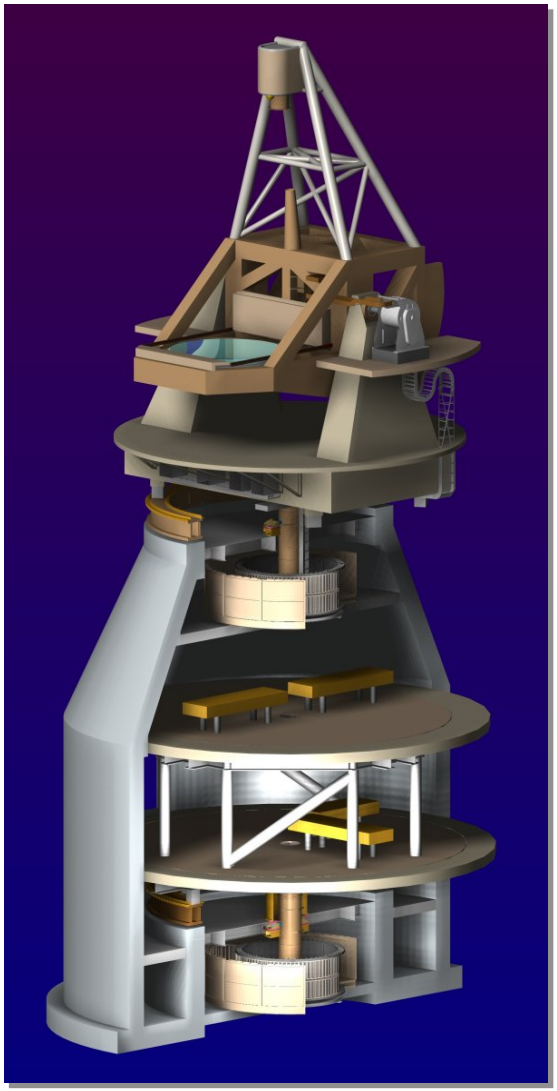
Simulation vs. Observation



- Current understanding is, to a large extent, driven by simulations
- Data are accepted/dismissed based on whether or not they fit the model
- Spatial resolution and polarimetric sensitivity are key

DKIST Overview

- Technical Specifications:
  - 4-m, off-axis Gregorian (all reflective), alt-az mount
  - Integrated adaptive optics
  - Enclosure with thermal control and dust mitigation
  - Wavelength sensitivity from 0.3 - 28 microns (near-UV to infrared)
  - Field of view: 3 arcmin
  - Angular resolution: <0.03 arcsec
  - Polarization accuracy: <0.01%



DKIST will be the world's flagship facility for ground-based solar physics observation and the first large U.S. public-access solar telescope constructed in the past 30 years.

DKIST Site Atop Haleakala, Maui, HI

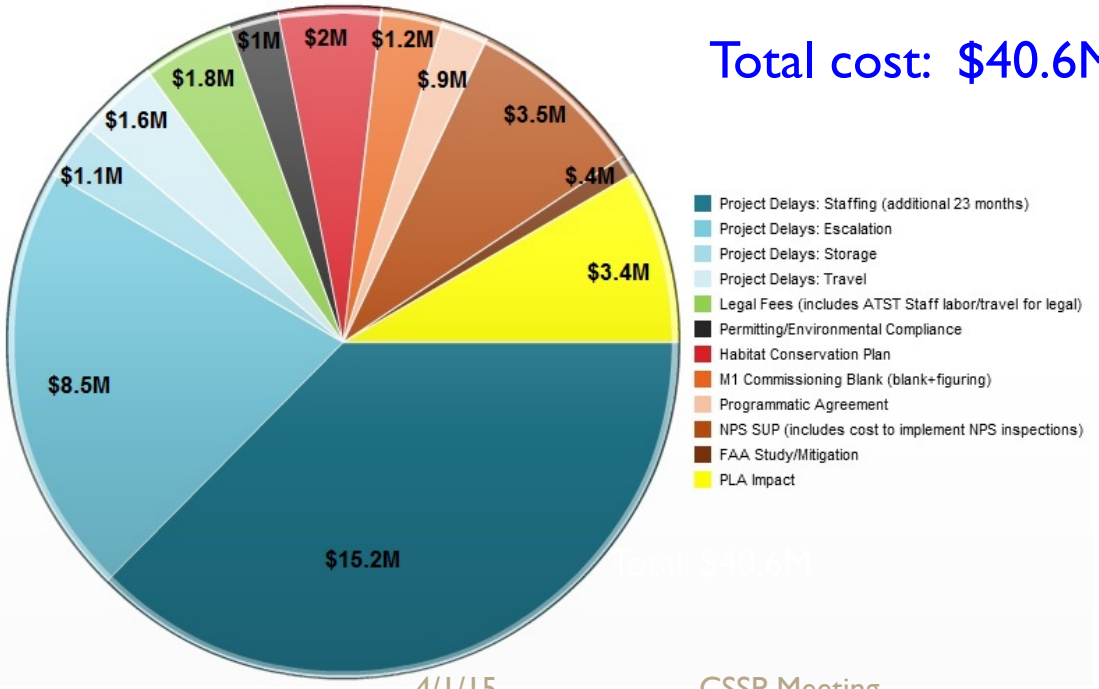
DKIST Chronology

• Final Design Review established the project baseline	May 2009
• Awards totaling $298M authorized (NSB-09-57)	Aug. 6, 2009
• Federal environmental compliance completed	Dec. 2, 2009
• Construction funding (ARRA &MREFC) awarded	Jan. 2010
• Anticipated access to Haleakala site pending Conservation District Use Permit (CDUP) issued by Hawaii Board of Land and Natural Resources (BLNR)	June 2010
• CDUP Issued by BLNR	Dec. 2, 2010
• CDUP challenged by Kilakila o Haleakala	Dec. 3, 2010
• Contested case hearing	July 2011
• Final arguments presented to BLNR	Sept. 14, 2012
• BLNR issues final decision affirming the CDUP	Nov. 9, 2012
• Final access to site granted	Nov. 30, 2012
• Groundbreaking on site	Dec. 1, 2012

Total delay of 30 months relative to original baseline – June 2010 to December 2012

Ramifications of Delay

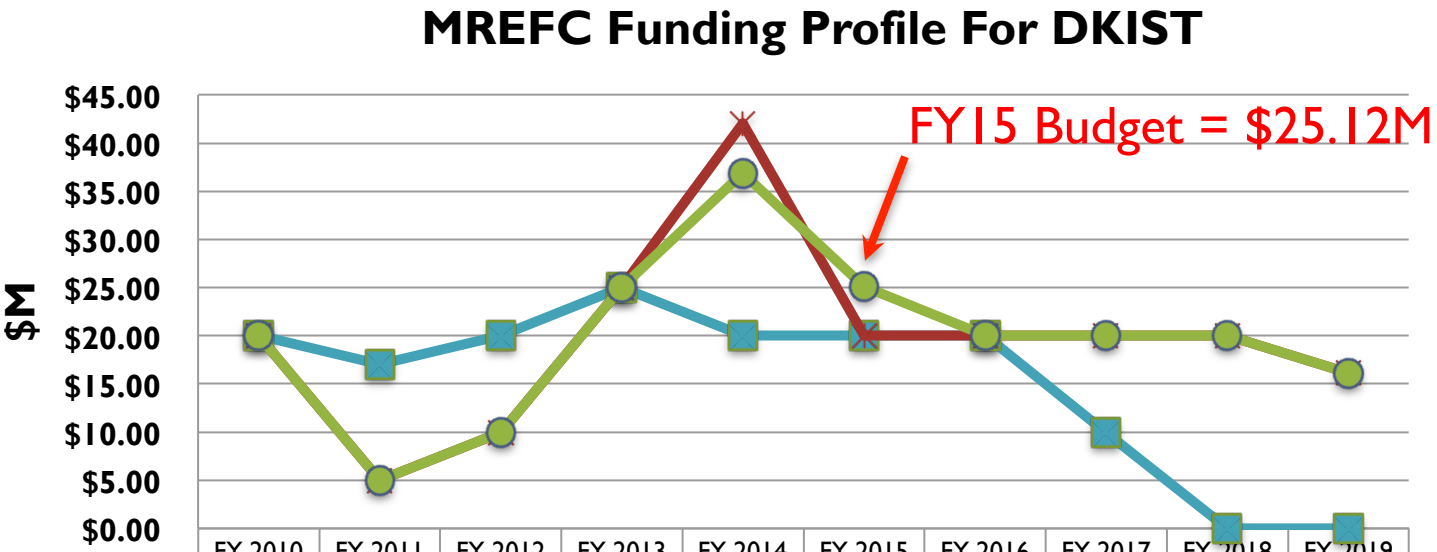
- 2009 project baseline was no longer valid. Progress measured against the original schedule shows large negative variances.
- The delay and other "unknown unknowns" result in cost growth.
- Additional budgetary complexity due to the expiration of ARRA funds at the end of FY 2015.



Total cost: $40.6M

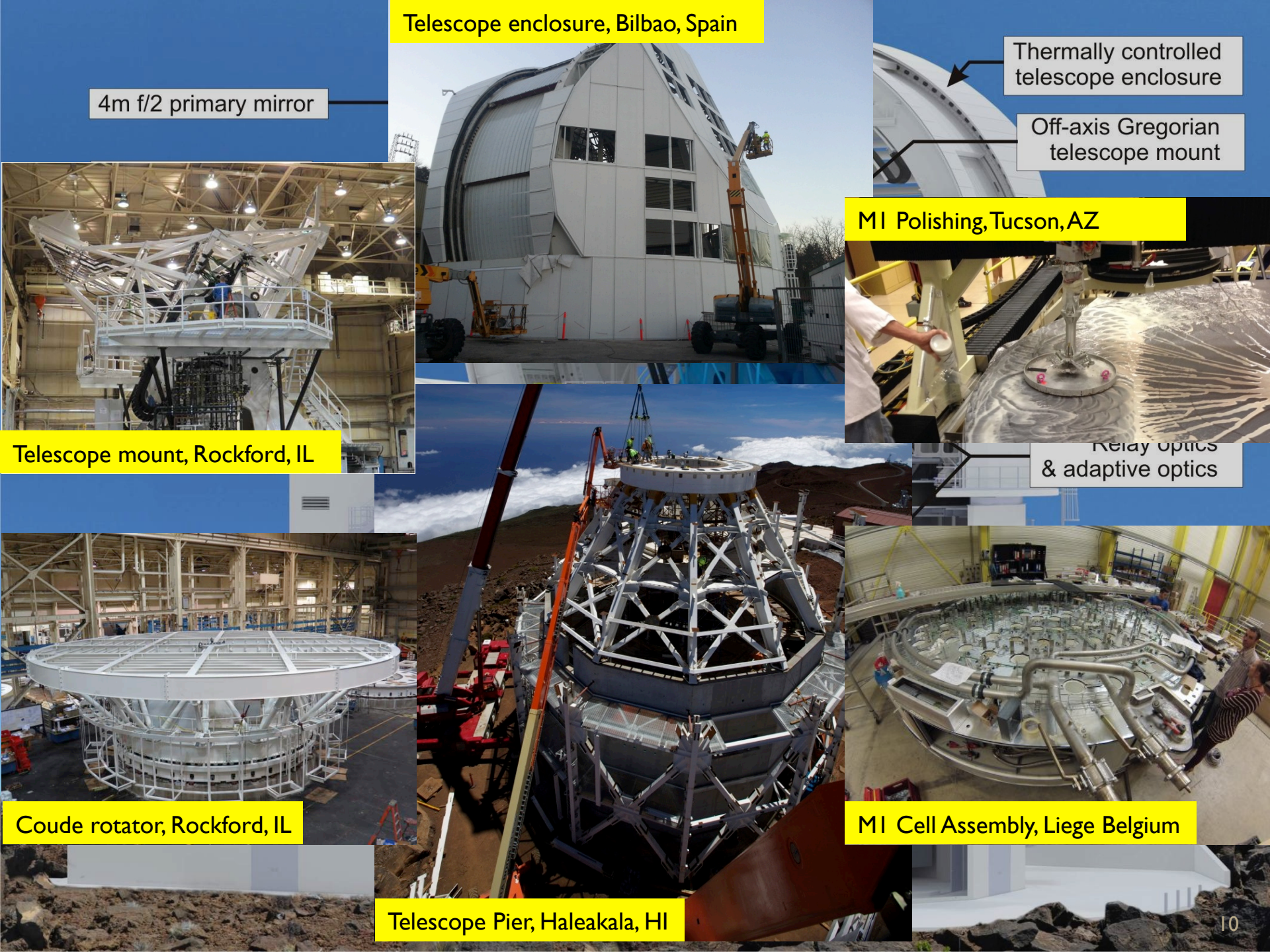
DKIST Revised Baseline

- Approved by the NSB Aug. 2013 (NSB-13-42)
- Total Project Cost = $344,128,808 ($47.4M contingency)
  - This is a $46.2M (16%) increase from original baseline
  - Additional funding all in fiscal years 2017 through 2019

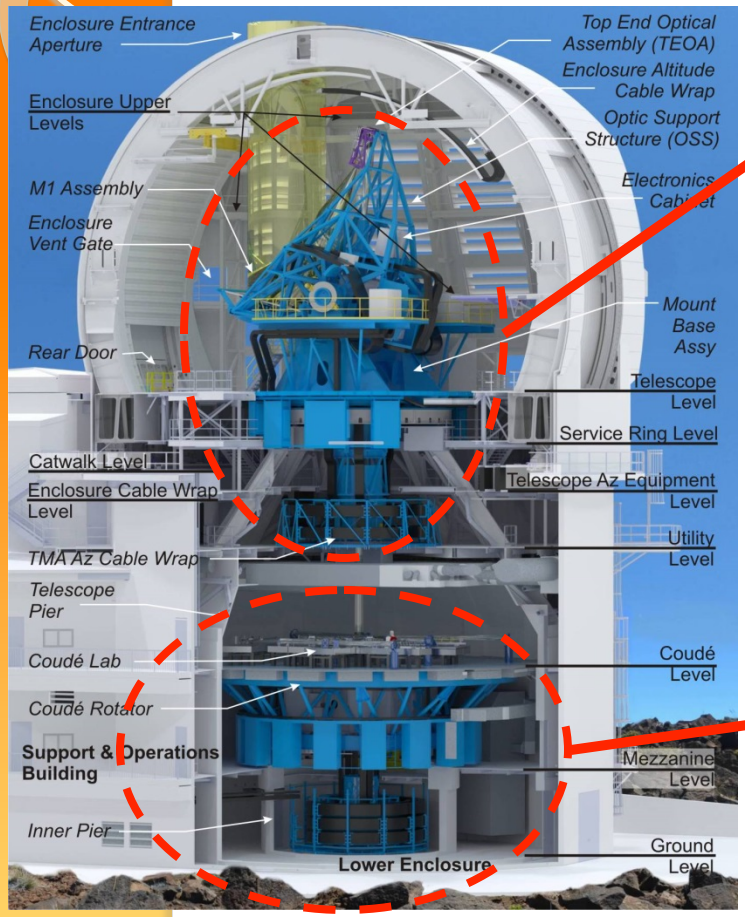


	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Original	$20.00	$17.00	$20.00	$25.00	$20.00	$20.00	$20.00	$9.93	$0.00	$0.00
Rebaseline	$20.00	$5.00	$10.00	$25.00	$42.00	$20.00	$20.00	$20.00	$20.00	$16.13
Updated	$20.00	$5.00	$10.00	$25.00	$36.88	$25.12	$20.00	$20.00	$20.00	$16.13

Technologies and knowledge required to build DKIST are drawn from the global scientific and engineering communities


Telescope enclosure, Bilbao, Spain
4m f/2 primary mirror
Thermally controlled telescope enclosure
Off-axis Gregorian telescope mount
M1 Polishing, Tucson, AZ
Telescope mount, Rockford, IL
& adaptive optics
Coude rotator, Rockford, IL
M1 Cell Assembly, Liege Belgium
Telescope Pier, Haleakala, HI

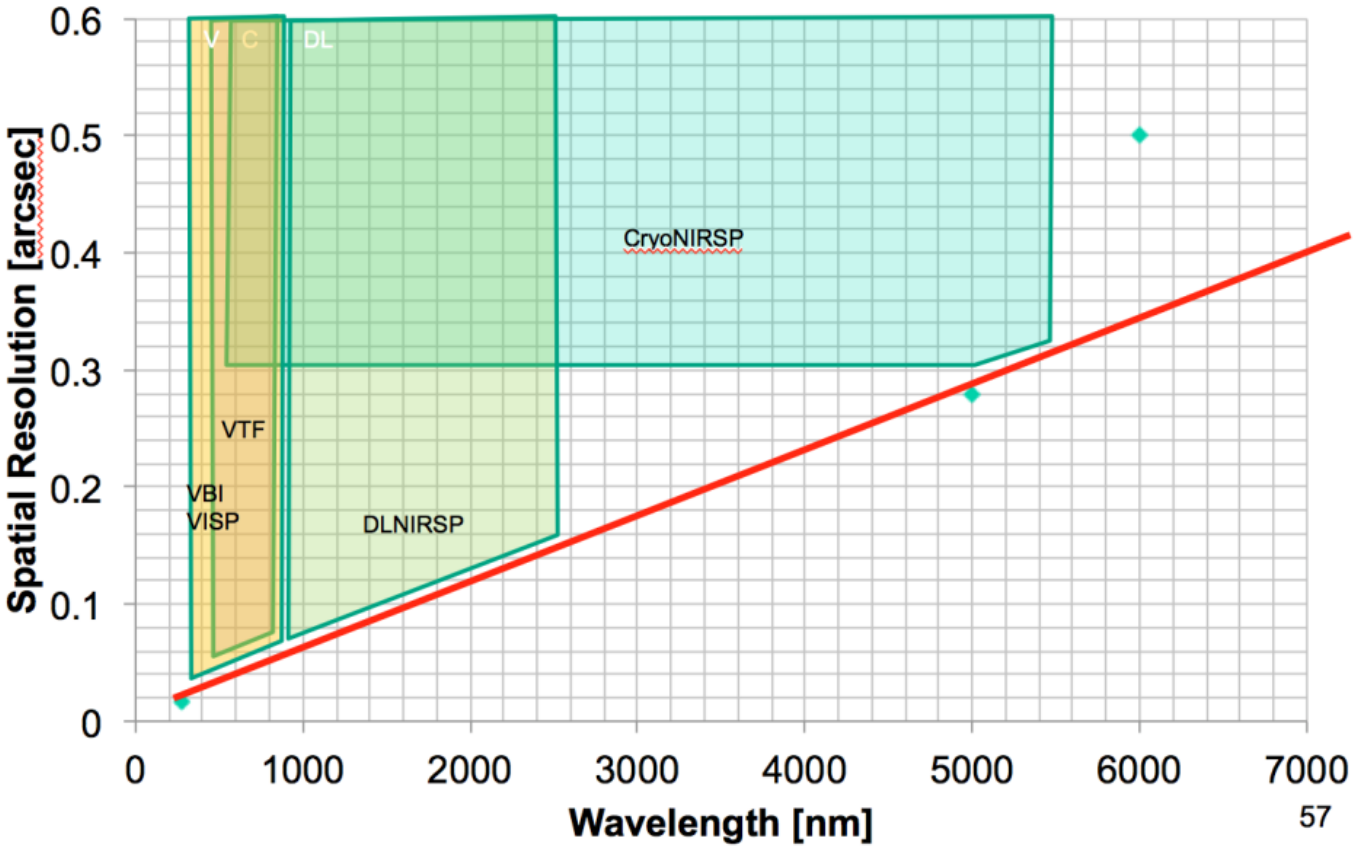
Telescope Structures



Alt-Az Telescope Mount

Coudé Rotator Platform

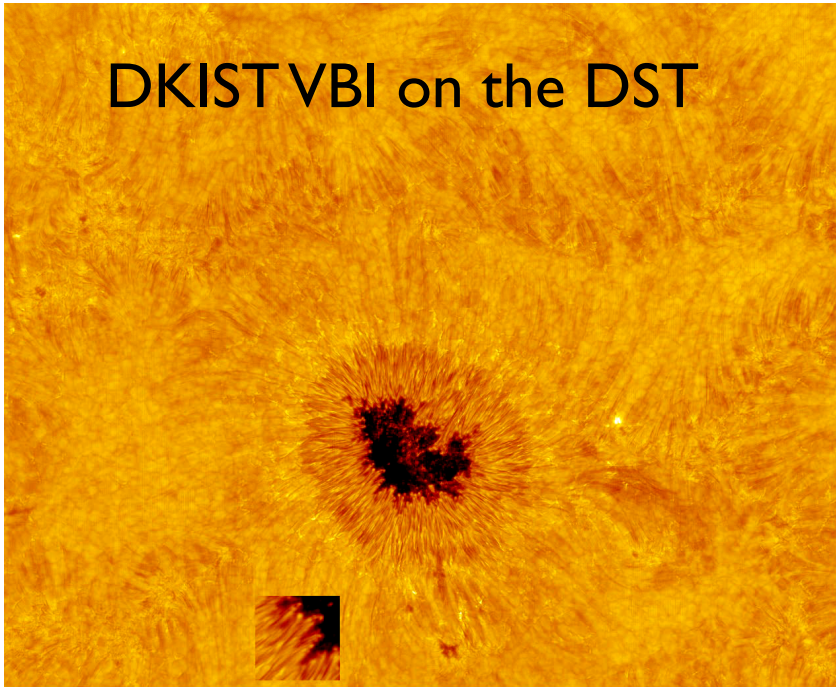
DKIST Instrumentation



- Visible Broadband Imager (VBI)
- Visible Spectropolarimeter (ViSP)
- Visible Tunable Filter (VTF)
- Diffraction-Limited Near-Infrared Spectropolarimeter (DL-NIRSP)
- Cryogenic Near-Infrared Spectropolarimeter (Cryo-NIRSP)

Instrument Development Status

- VBI
  - Integration in NSO Boulder lab continues
- CRYO-NIRSP
  - CDR & Fabrication Contract
- DL-NIRSP
  - CDR & Fabrication Contract in progress
- ViSP
  - CDR scheduled for May 2015
- VTF
  - PDR scheduled for June 2015



Recent Partnership Development

- UK Proposal for development and delivery of visible cameras 4k x 4k, 30 Hz (~ $6.5M)
  - "Queen's University Belfast plays leading role in construction of the world's biggest solar telescope" QUB Press Release, undated http://www.eurekalert.org/pub_releases/2015-02/qub-qub020915.php
  - "World's biggest solar telescope set for 2019 completion in Hawaii" Gizmag Space, February 14, 2015 http://www.gizmag.com/dkist-worlds-biggest-solar-telescope-2019/36088/

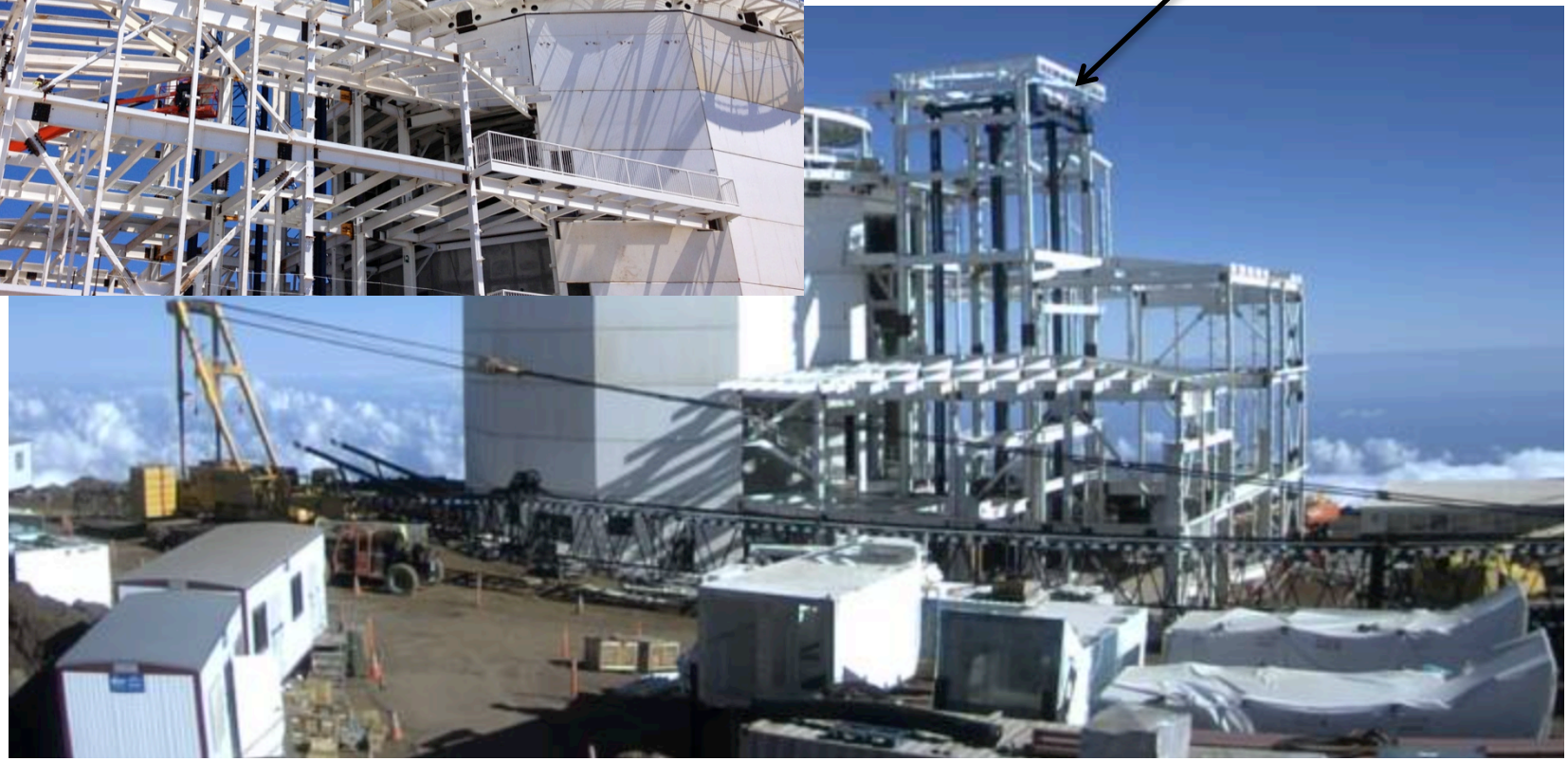
Poor Weather at the Site (Jan. – Feb. 2015)

- Result: some DKIST schedule slip
- Current completion date: Sept. 19, 2019

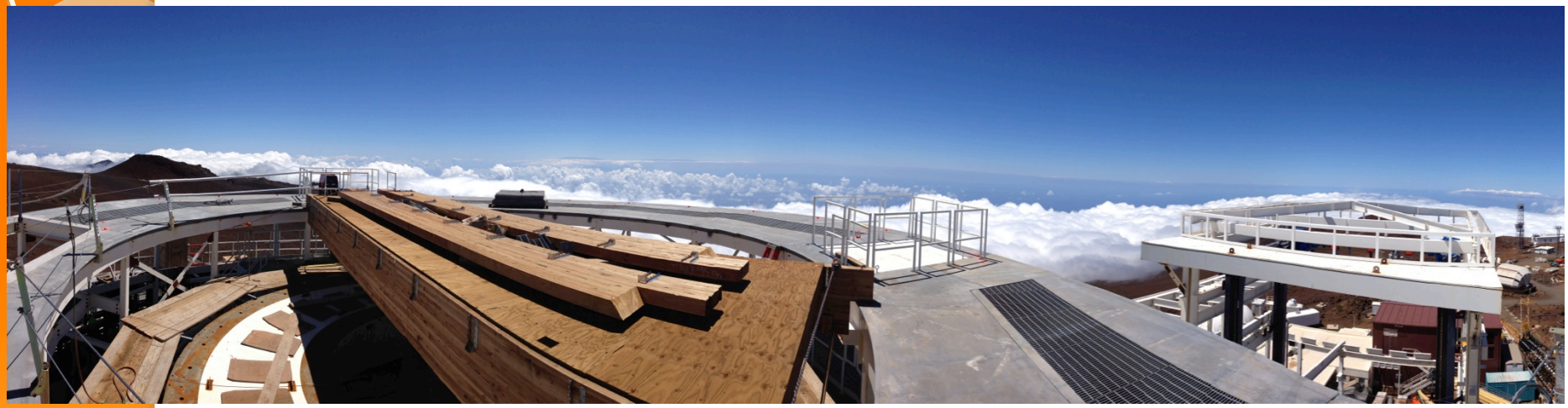
Construction Status as of Last Week

First Ring Girder Section of Upper Enclosure

Platform Lift

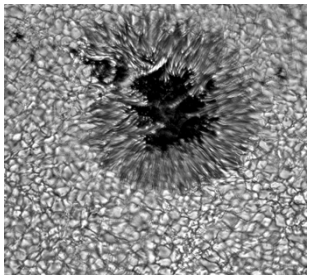


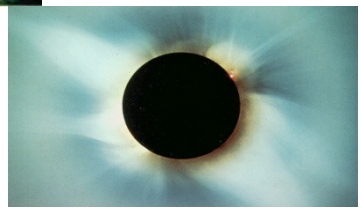
Construction Status as of Last Week



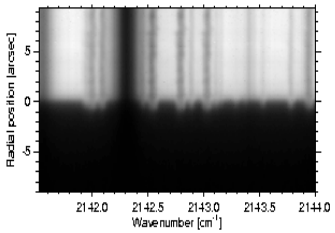
DKIST Will Replace Current National Solar O/IR Facilities

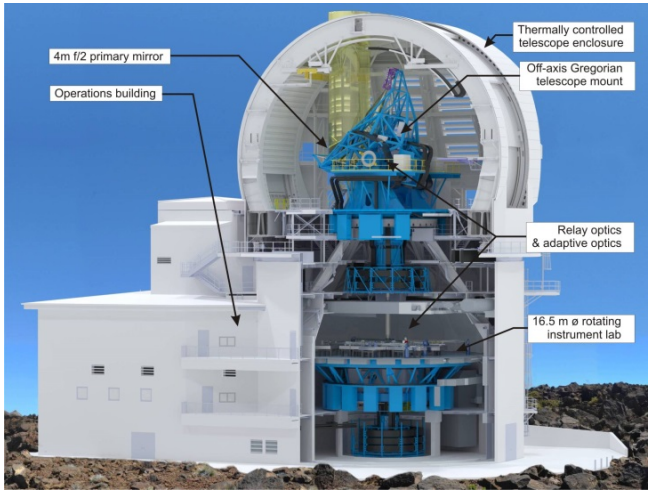
Dunn Solar Telescope
Evans Solar Facility
Sacramento Peak, NM



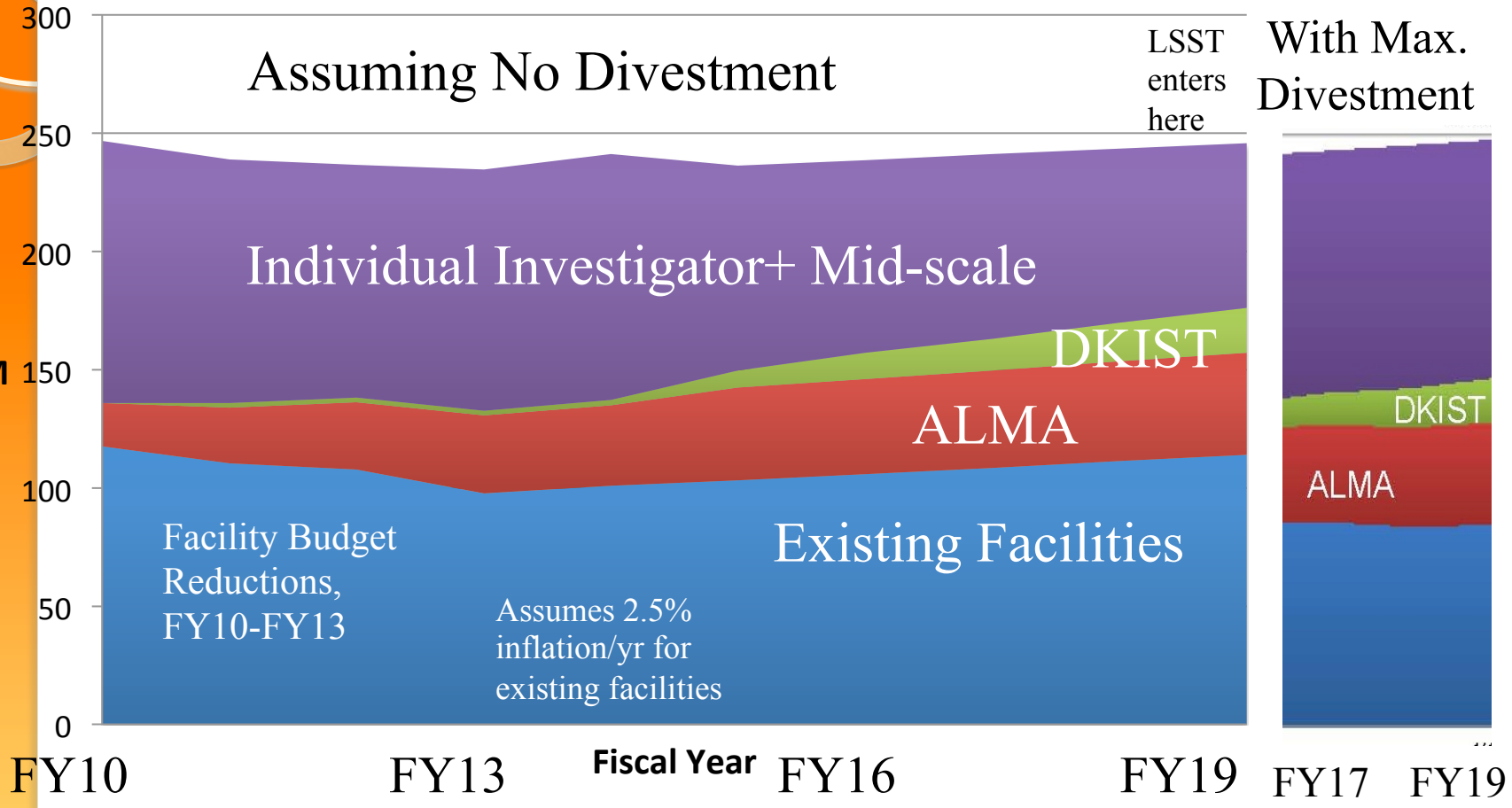


McMath-Pierce, Kitt Peak, AZ



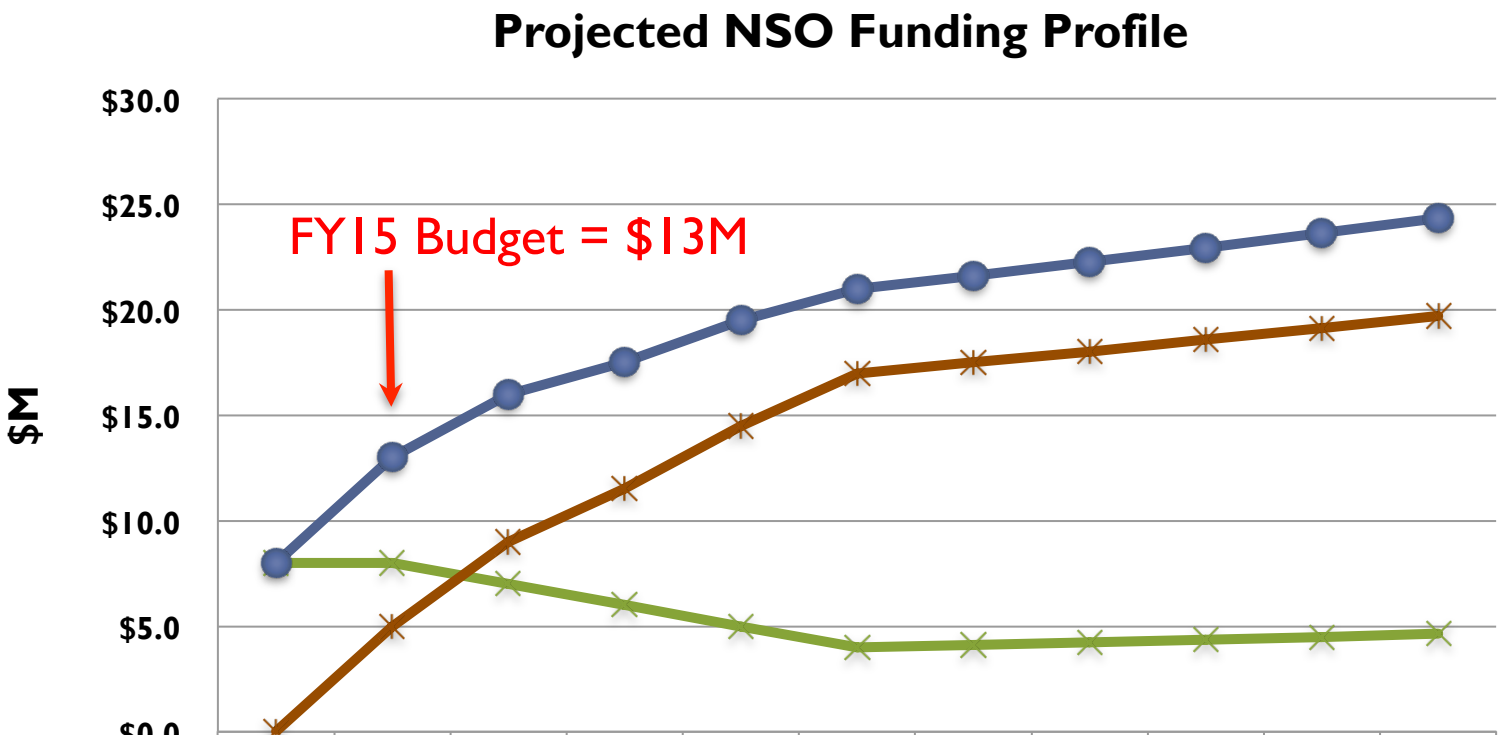


DKIST in the AST Portfolio



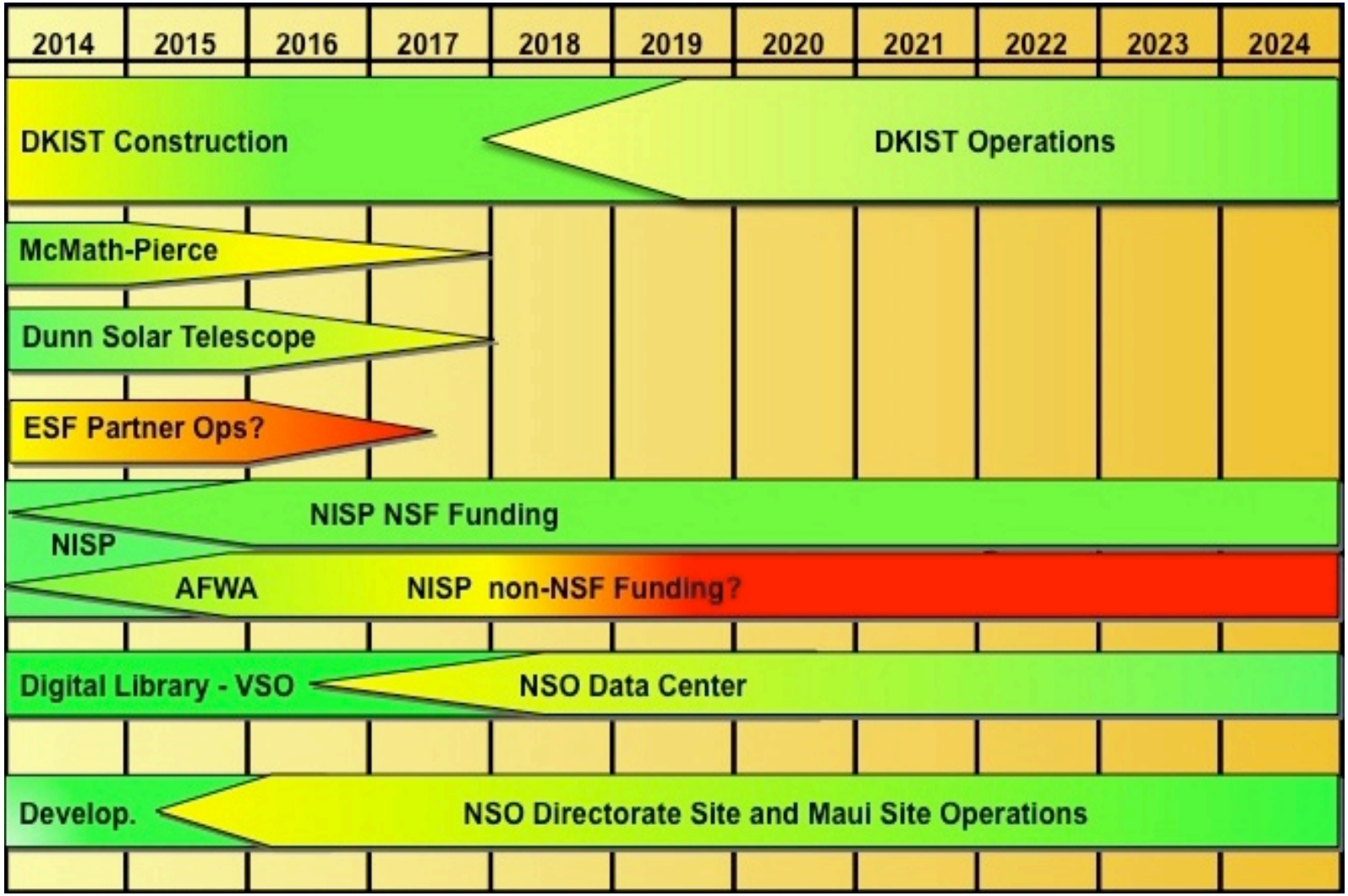
AST budget assumption: FY15=Request, 1%/yr growth thereafter

Proposed DKIST Operations Ramp



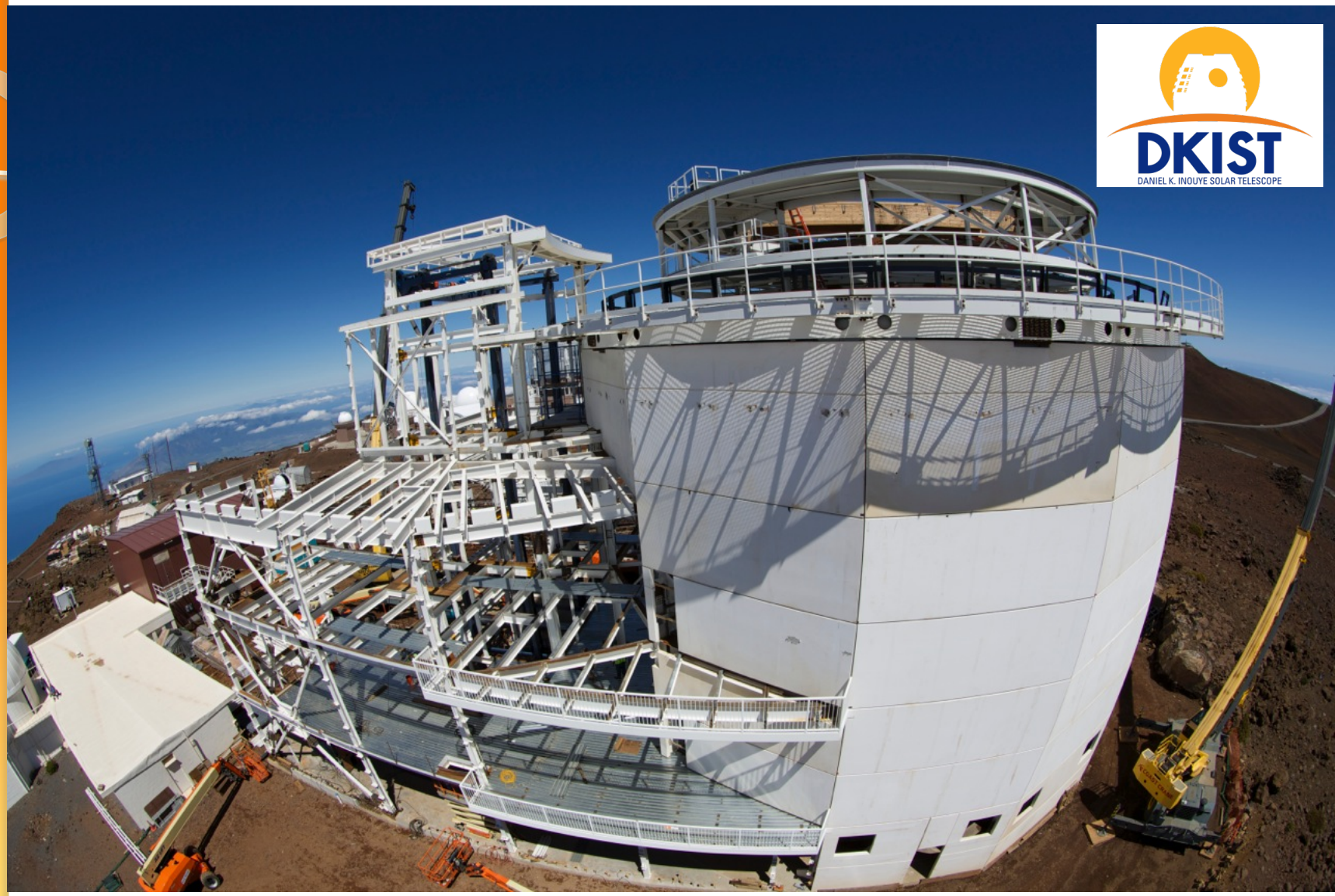
	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
NSO Base	$8.0	$8.0	$7.0	$6.0	$5.0	$4.0	$4.12	$4.24	$4.37	$4.50	$4.64
DKIST Ops.	$0.0	$5.0	$9.0	$11.5	$14.5	$17.0	$17.51	$18.04	$18.58	$19.13	$19.71
Total, NSO	$8.0	$13.0	$16.0	$17.5	$19.5	$21.0	$21.63	$22.28	$22.95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

A Time of Transition for the NSO



Transforming the Ground-based Solar Community

- Support of the NSO move to the campus of the University of Colorado, Boulder (CU) co-located with CU-LASP
  - Places NSO squarely in the center of the Solar and Space Physics Community
  - Boulder Solar Alliance: NSO, CU-LASP, NCAR-HAO, NOAA-SWPC, SwRI
- AST Program Officers have been increasing contact with AGS Program Officers to find synergies and potential projects for co-funding
- AST Program Officers have been presenting at the SPD Agency Town Halls to raise awareness of DIKIST science within the solar community.
- The ground-based solar community is mobilizing
  - Special DKIST Science Town Hall at TESS/SPD meeting Apr. 28-May 1, 2015
  - Efforts will be led by NSO and the DKIST Science Working Group (SWG)
  - Dr. Mark Rast (CU) to lead efforts to gain community involvement in DKIST
- AST Program Officers and Management: increasing involvement in Space Weather on a Federal level (Executive priority)
  - National Space Weather Strategy – OSTP, NSF, NASA, FEMA, NOAA, DOE, DOJ, NRC, DOD, USGS, DHS…


DKIST
DANIEL K. INOUYE SOLAR TELESCOPE