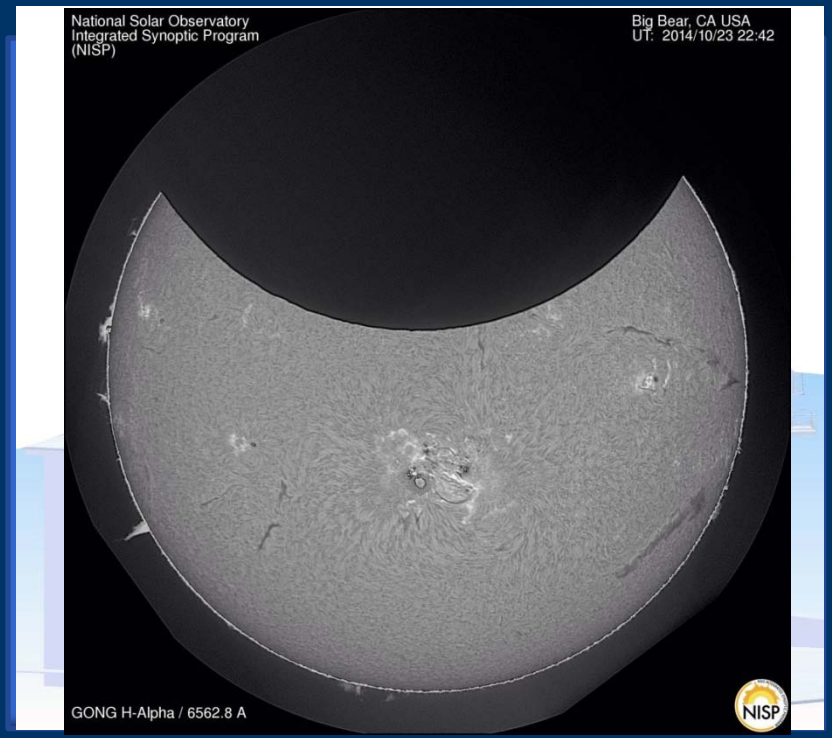
Building The Daniel K. Inouye Solar (DKIST) Telescope (formerly ATST)



PI
National Solar Observatory

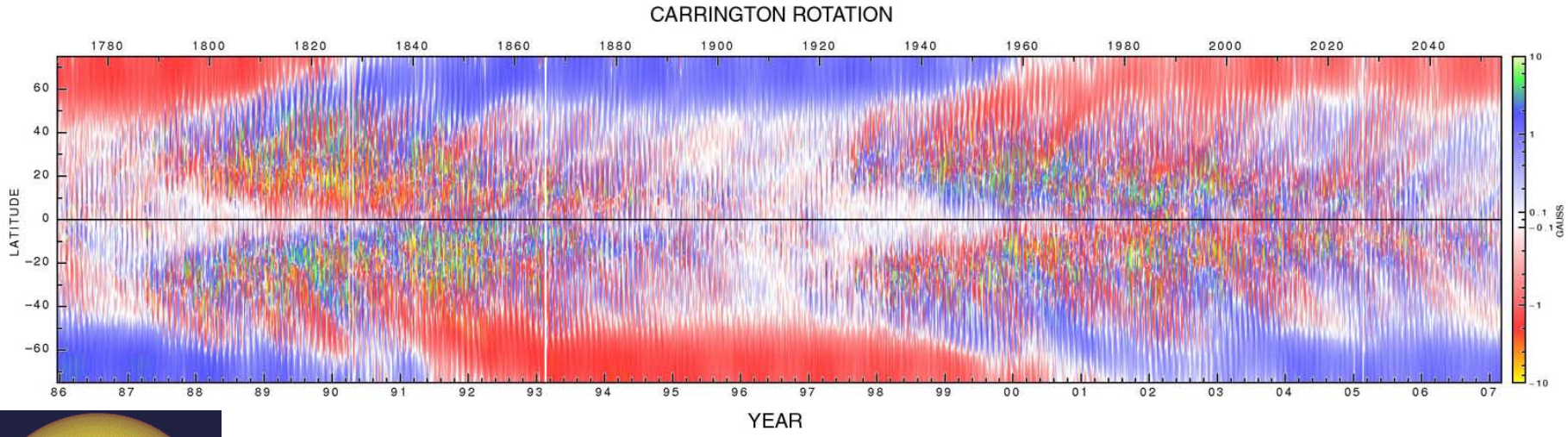
Co-PIs
High Altitude Observatory
New Jersey Institute of Technology
University of Hawai'I
University of Chicago

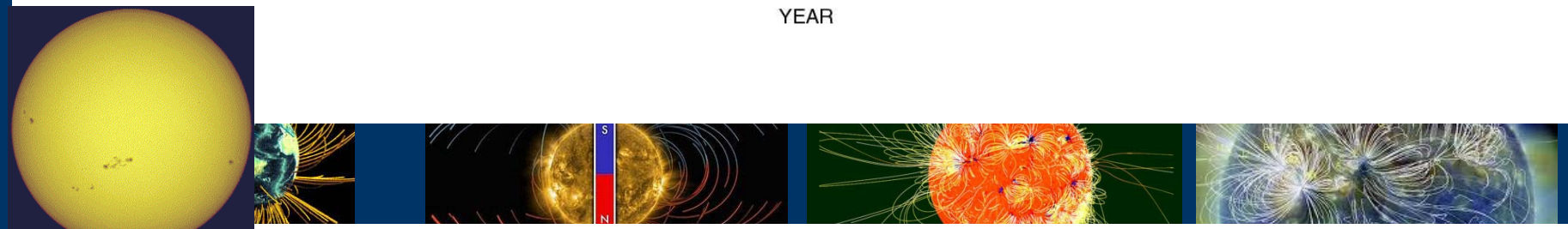
Stephen L. Keil
NSO Emeritus Scientist

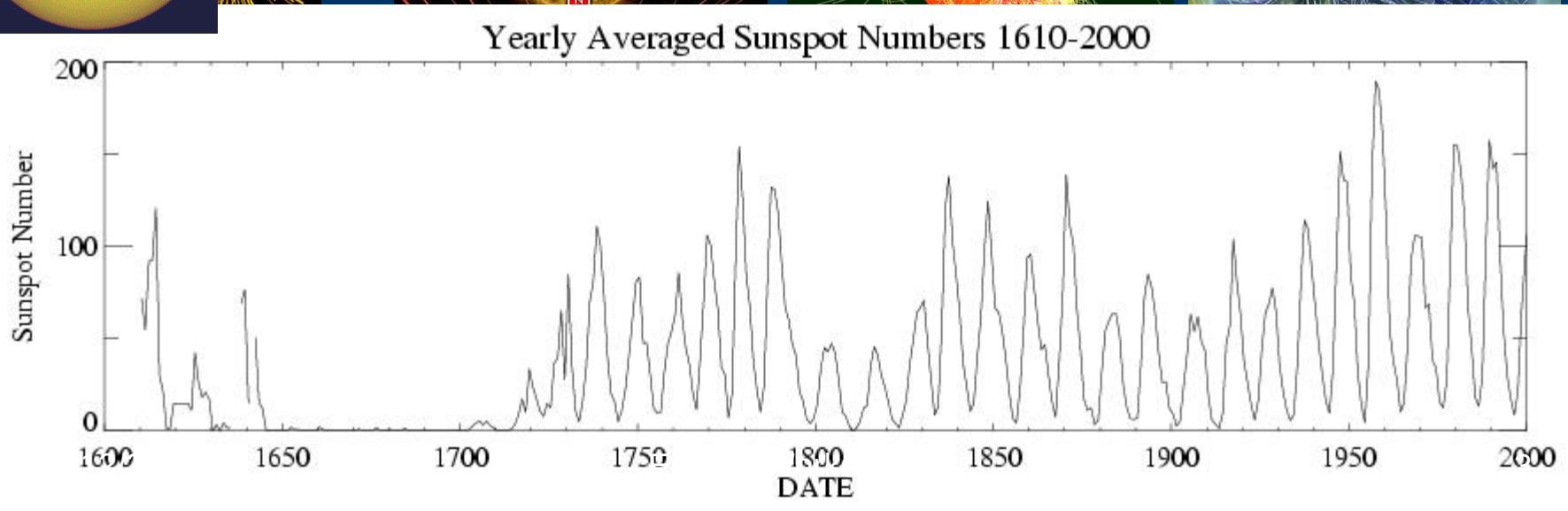
What is the DKIST Project?

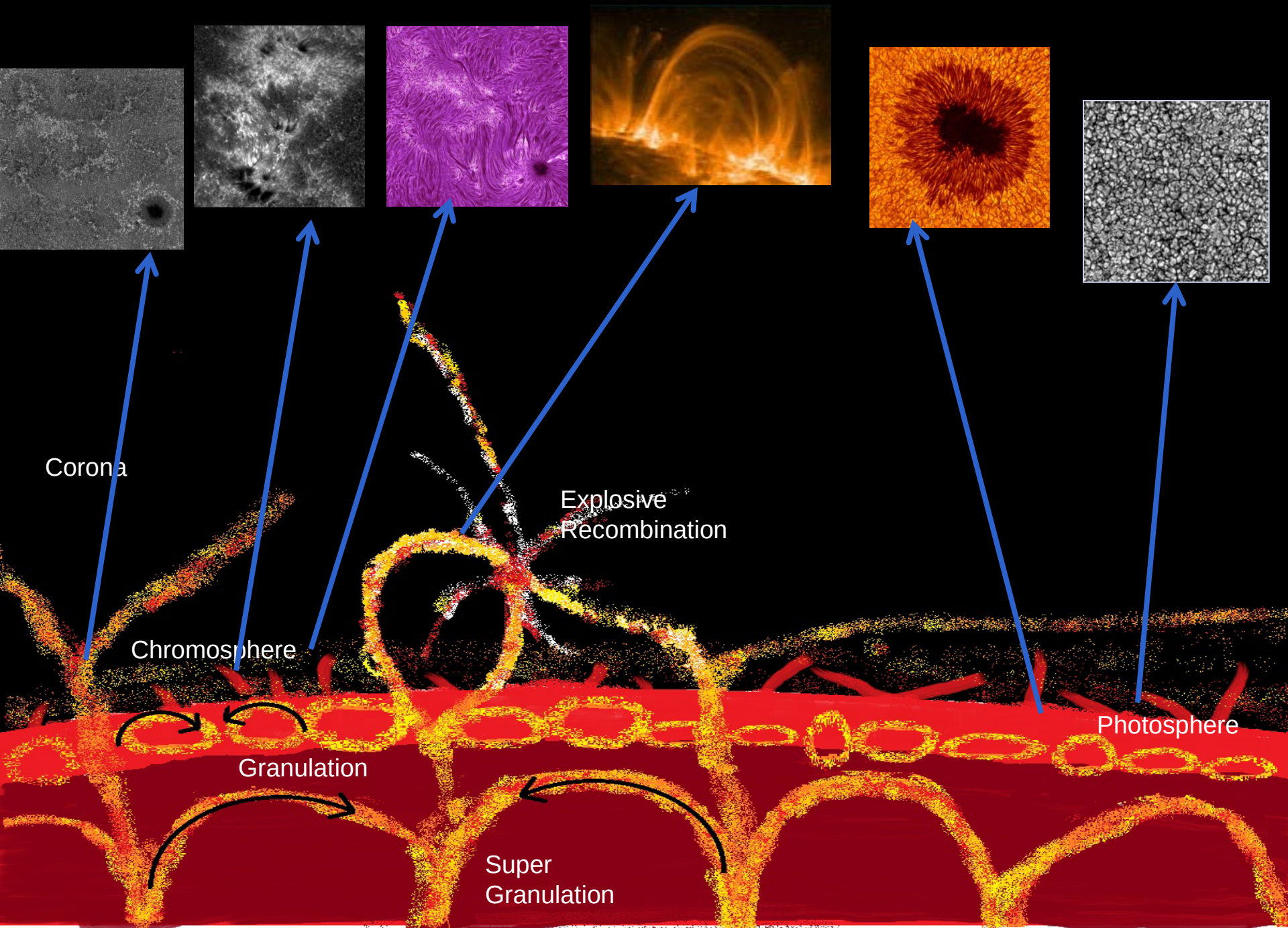
- ~Ten year long construction project (2010-2019)
  - Design and build project
  - 4-meter class solar observatory
- Funded by the National Science Foundation (NSF):
  - $340M total cost ($297M + recovery of mitigation funds)
    - $146M American Recovery and Reinvestment Act of 2009 (ARRA)
    - Remainder Major Research Equipment & Facilities Construction (MREFC)

PHOTOSPHERIC MAGNETIC FIELDS - plus or minus 10 gauss








Corona
Chromosphere
Explosive
Recombination
Photosphere
Granulation
Super
Granulation

Courtesy F. Woeger

430nm

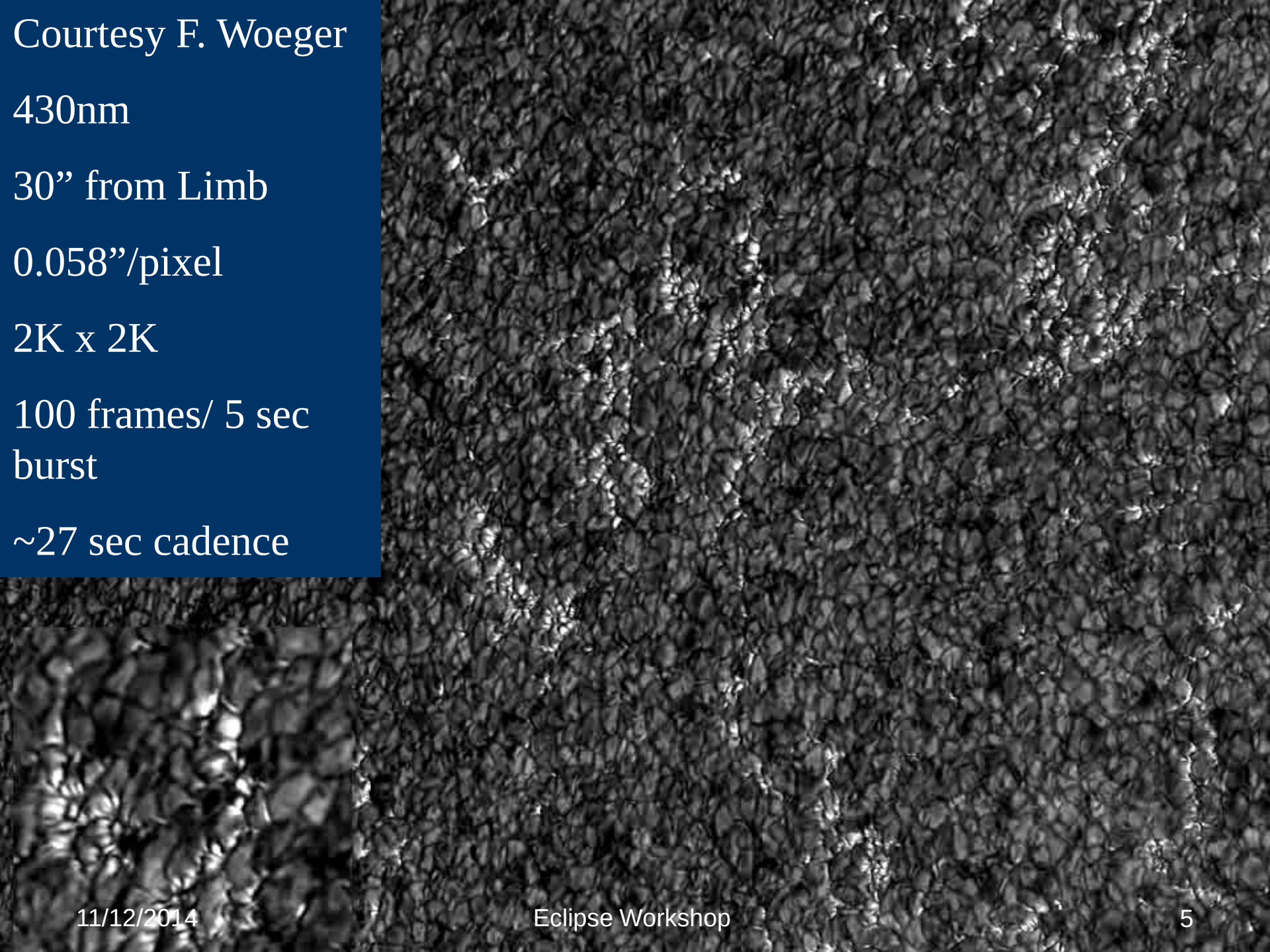
30” from Limb

0.058”/pixel

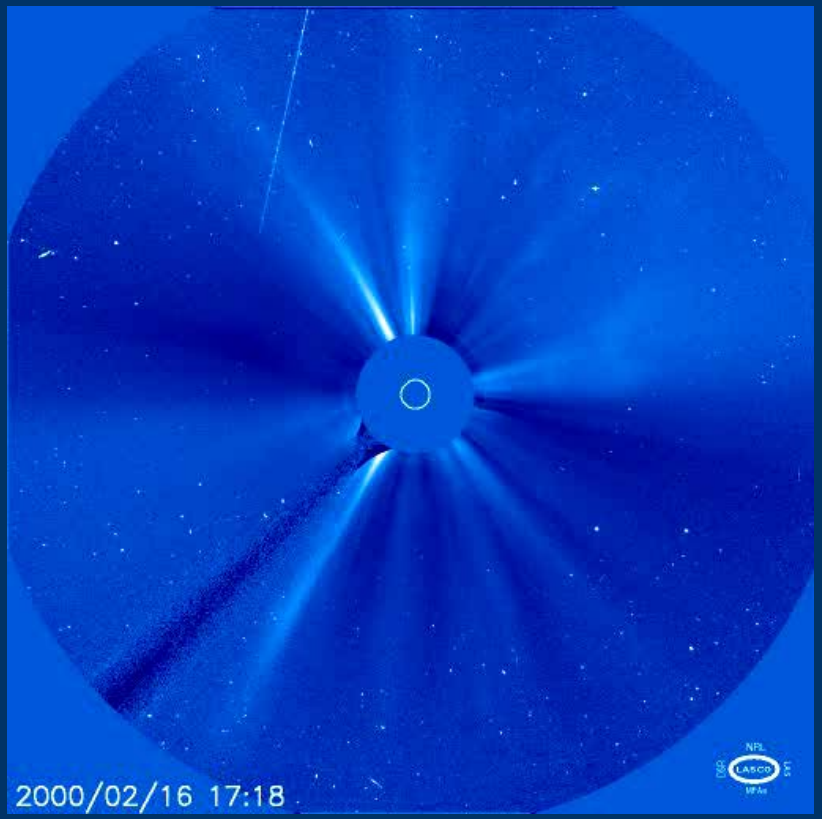
2K x 2K

100 frames/ 5 sec burst

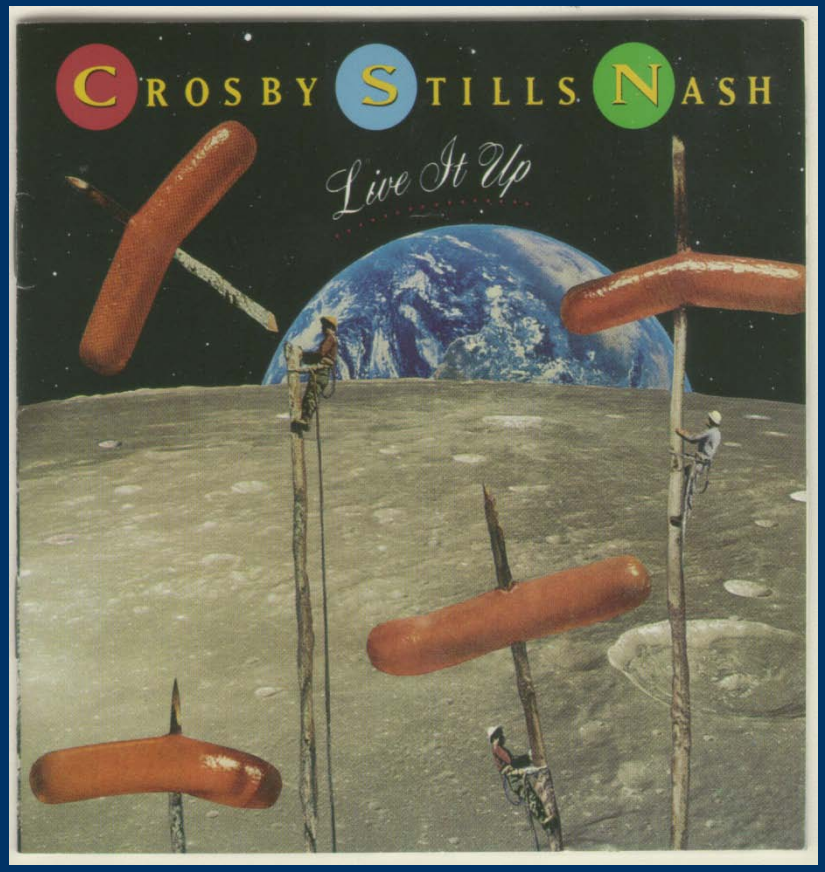
~27 sec cadence

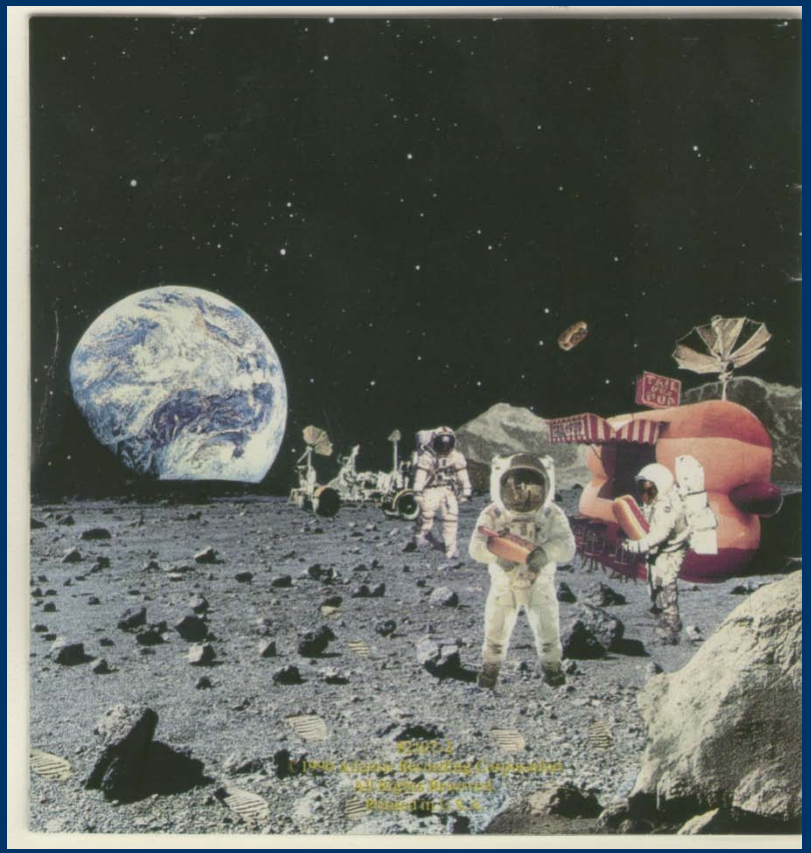


Solar Wind and Mass Ejections



Living with a star
(the many impacts of space weather)

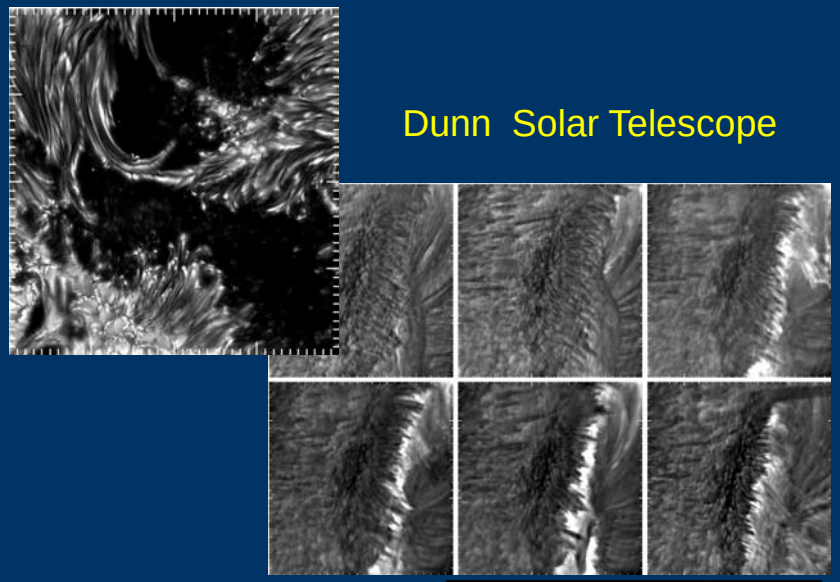




DKIST Science Objectives

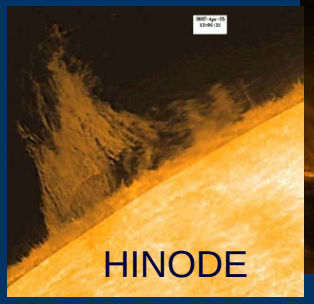
Magnetic Fields and Structure on their Fundamental Scales – a systems approach to the solar atmosphere

- Structure and dynamics of the solar atmosphere
  - Heating of chromosphere and corona
  - Flares and coronal mass ejections – fundamental physics of space weather drivers
  - Dynamo processes
  - Surface dynamo



Dunn Solar Telescope

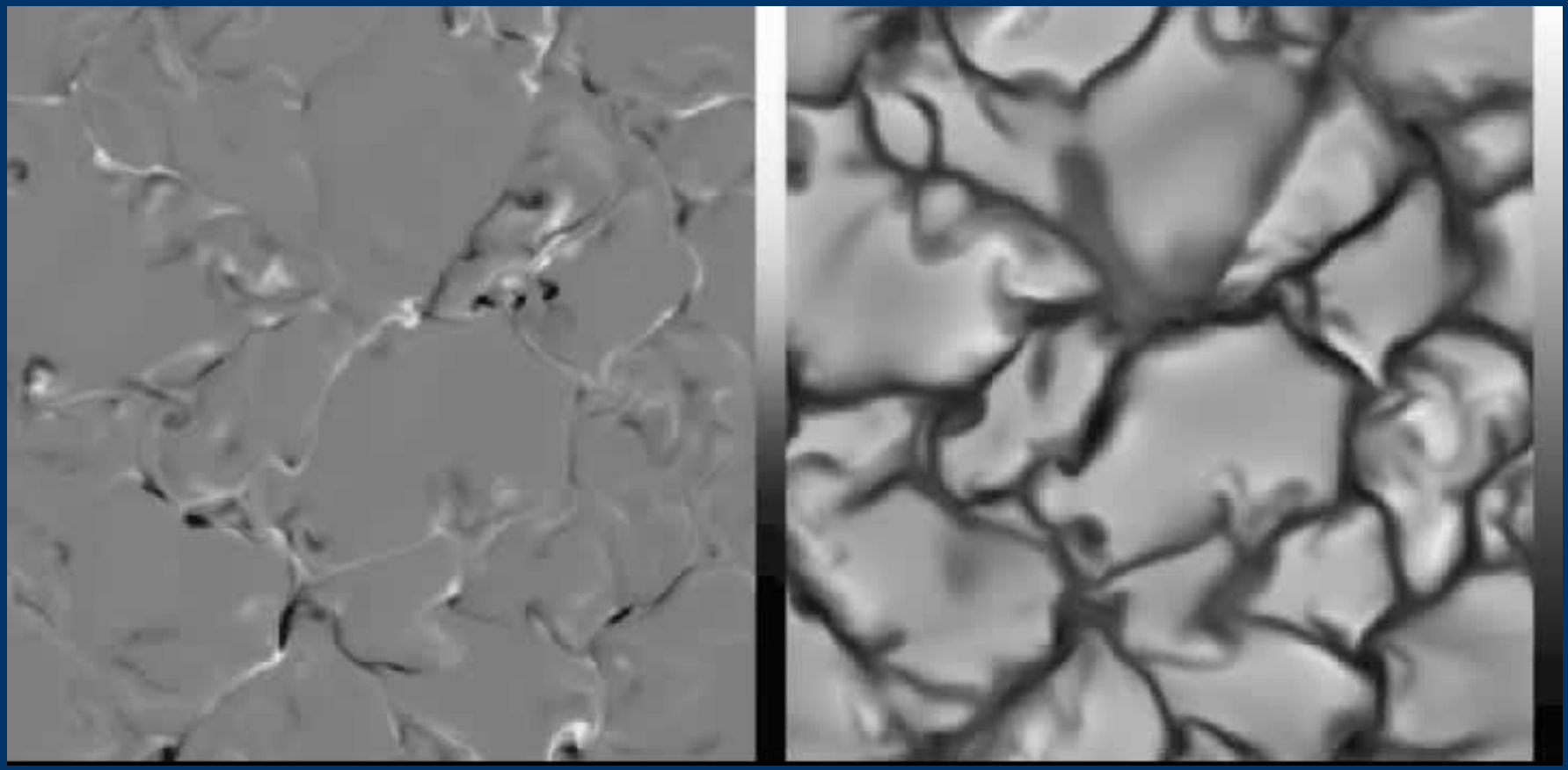
- Precise magnetic field measurements throughout the dynamic solar atmosphere
  - Photosphere, chromosphere, coronal



HINODE

Trace

Why ATST Magnetoconvection

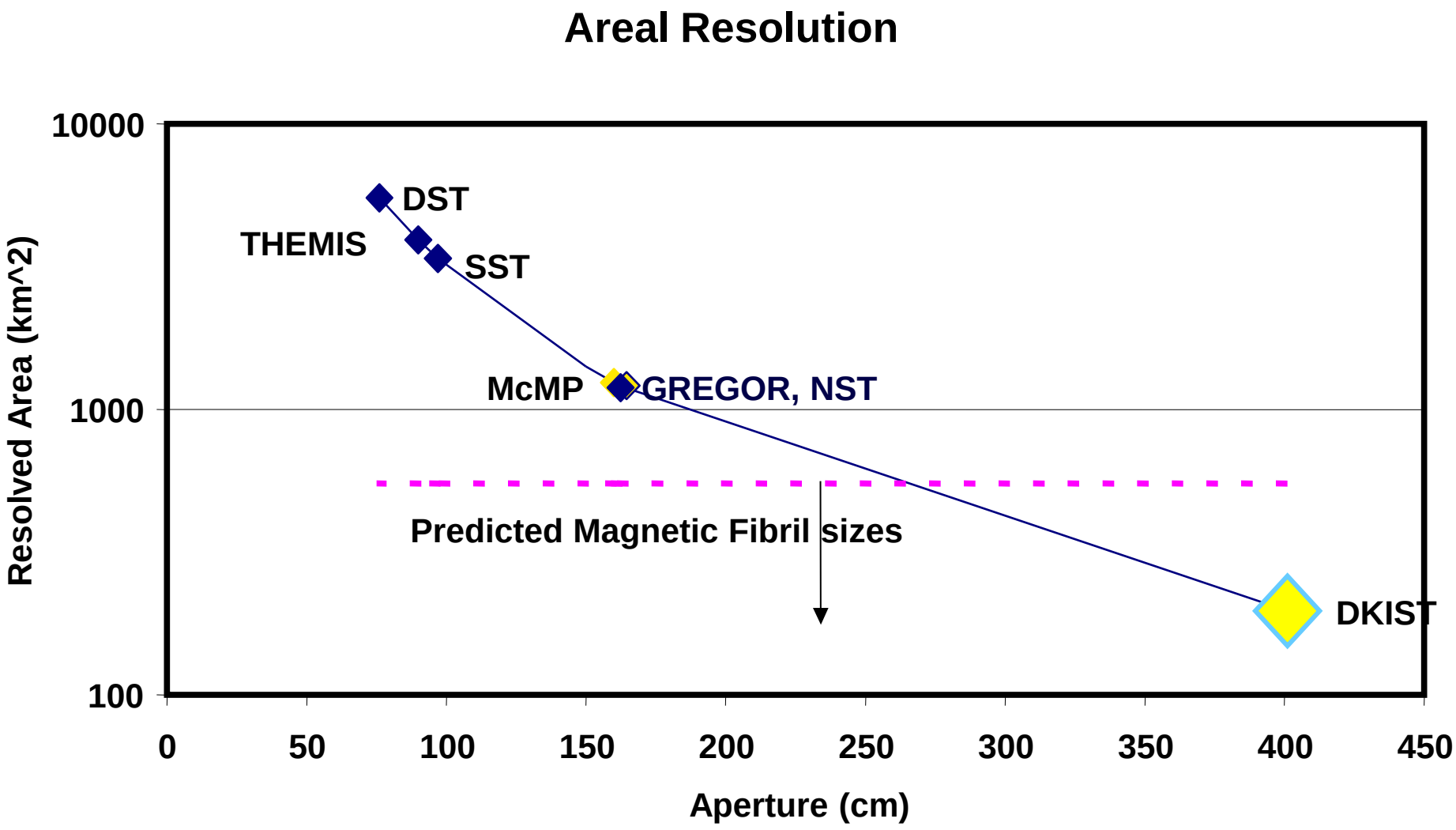


Magnetic Field

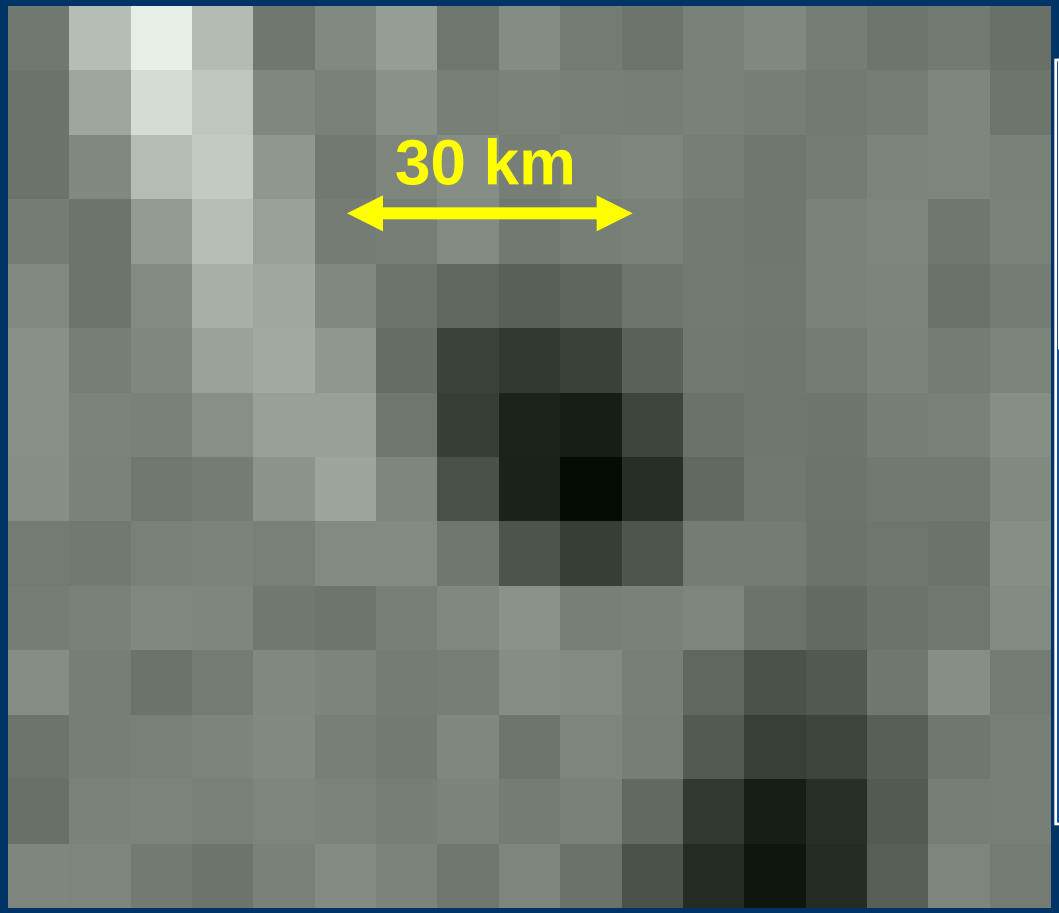
Intensity

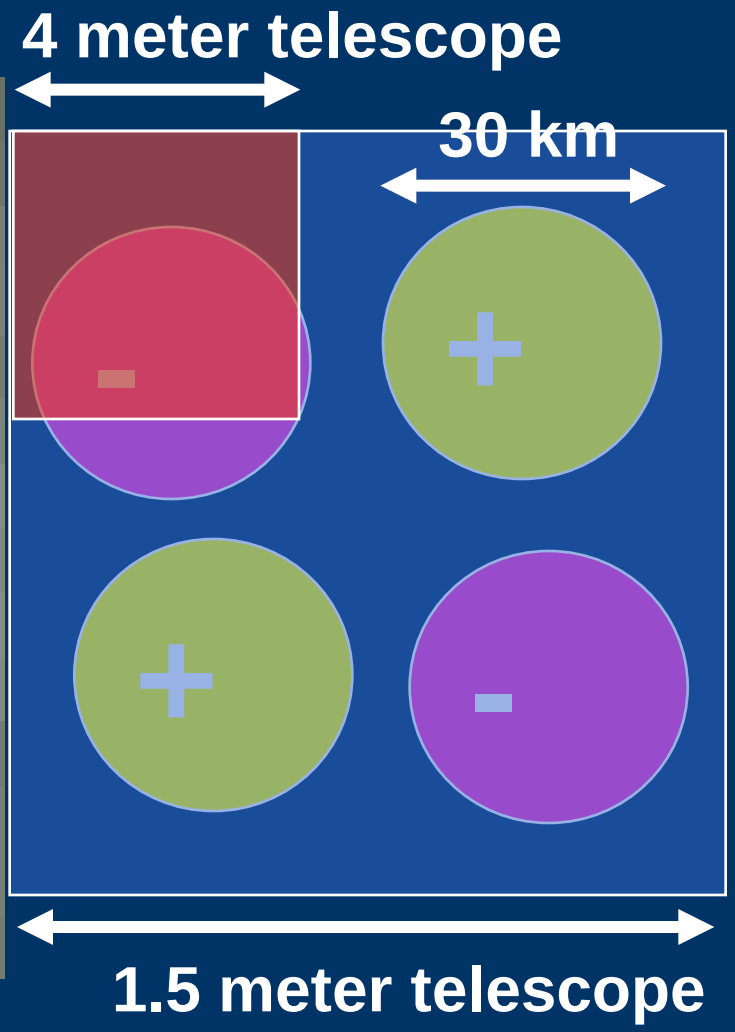
Courtesy Stein and Nordlund

Comparison with other Telescopes

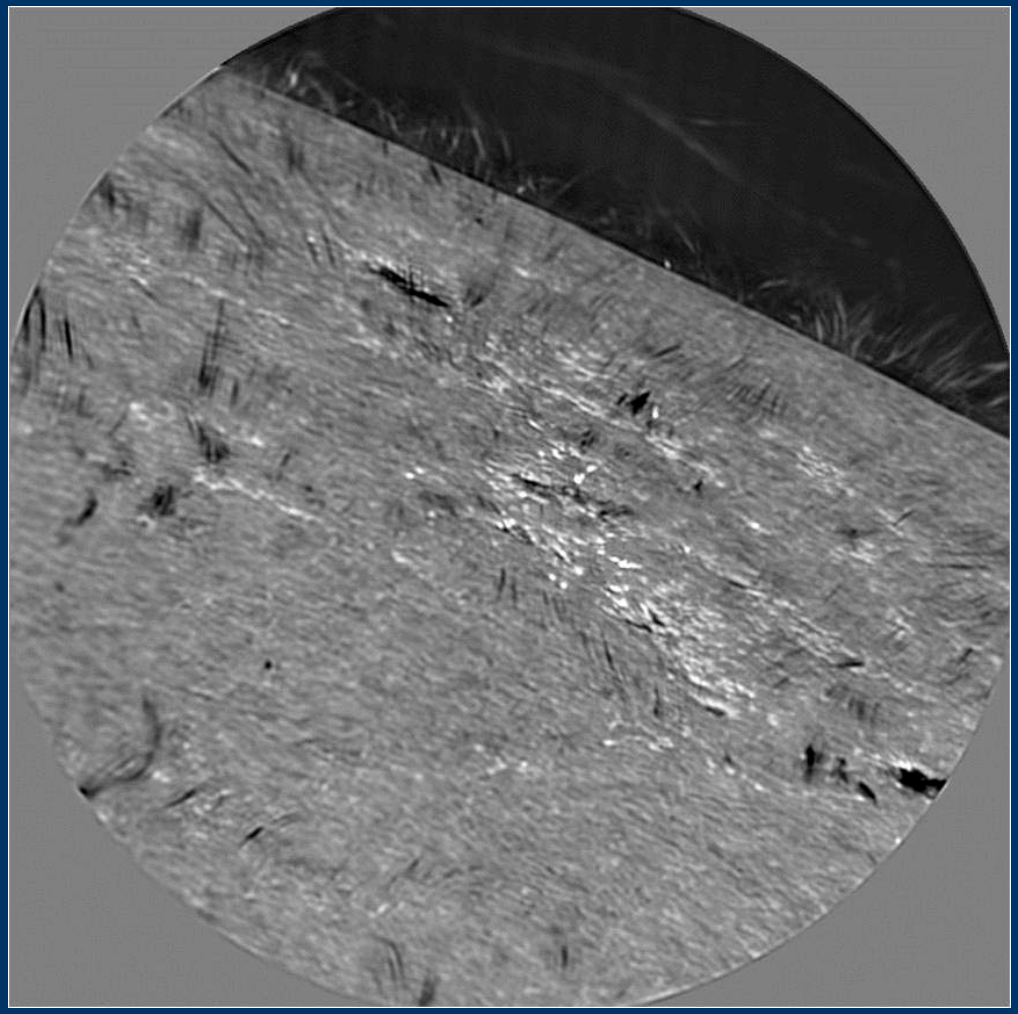


Resolution Elements





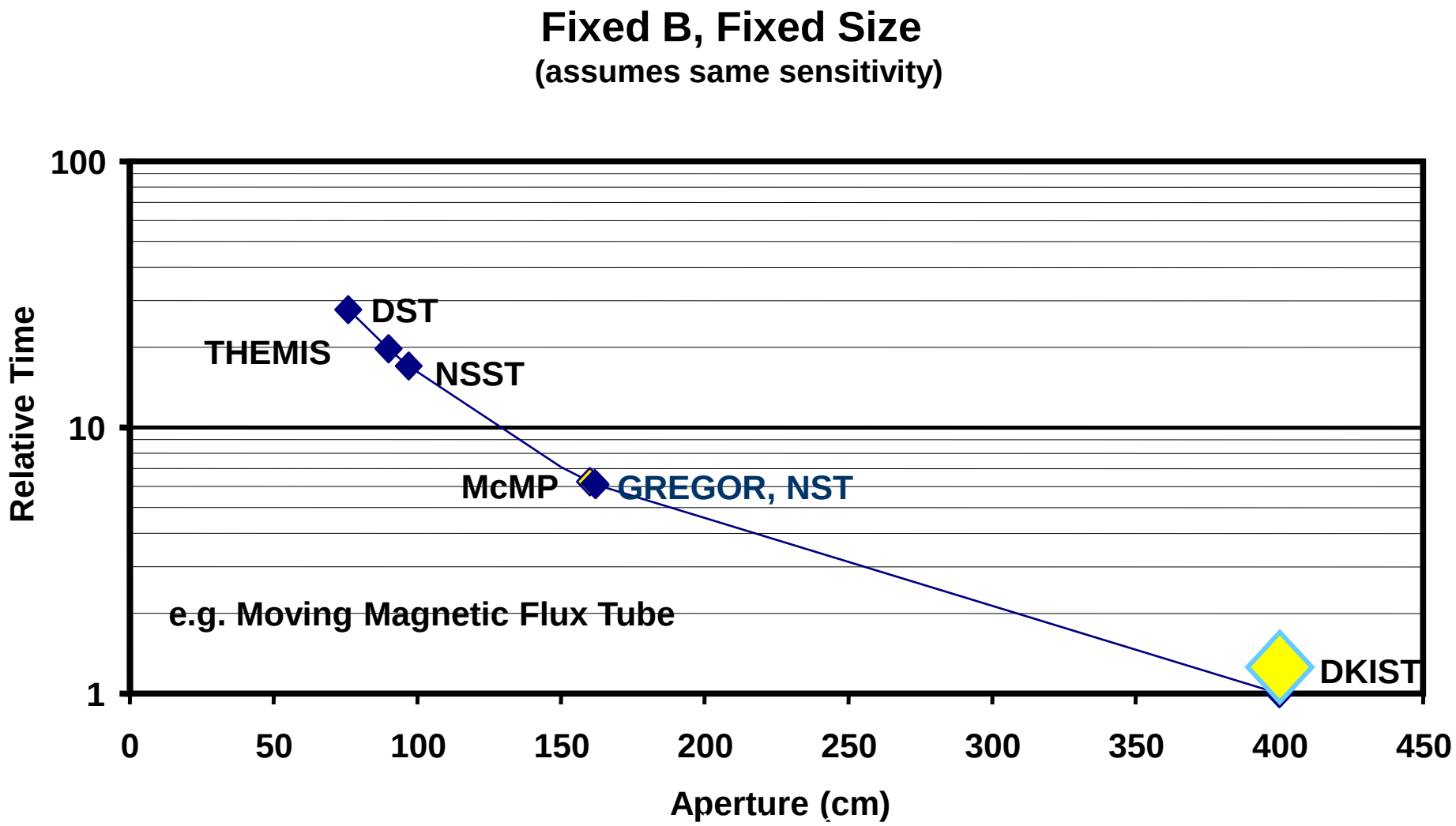
Why DKIST
Coronal and Chromospheric Heating



IBIS (tunable filter)
at the
Dunn Solar Telescope

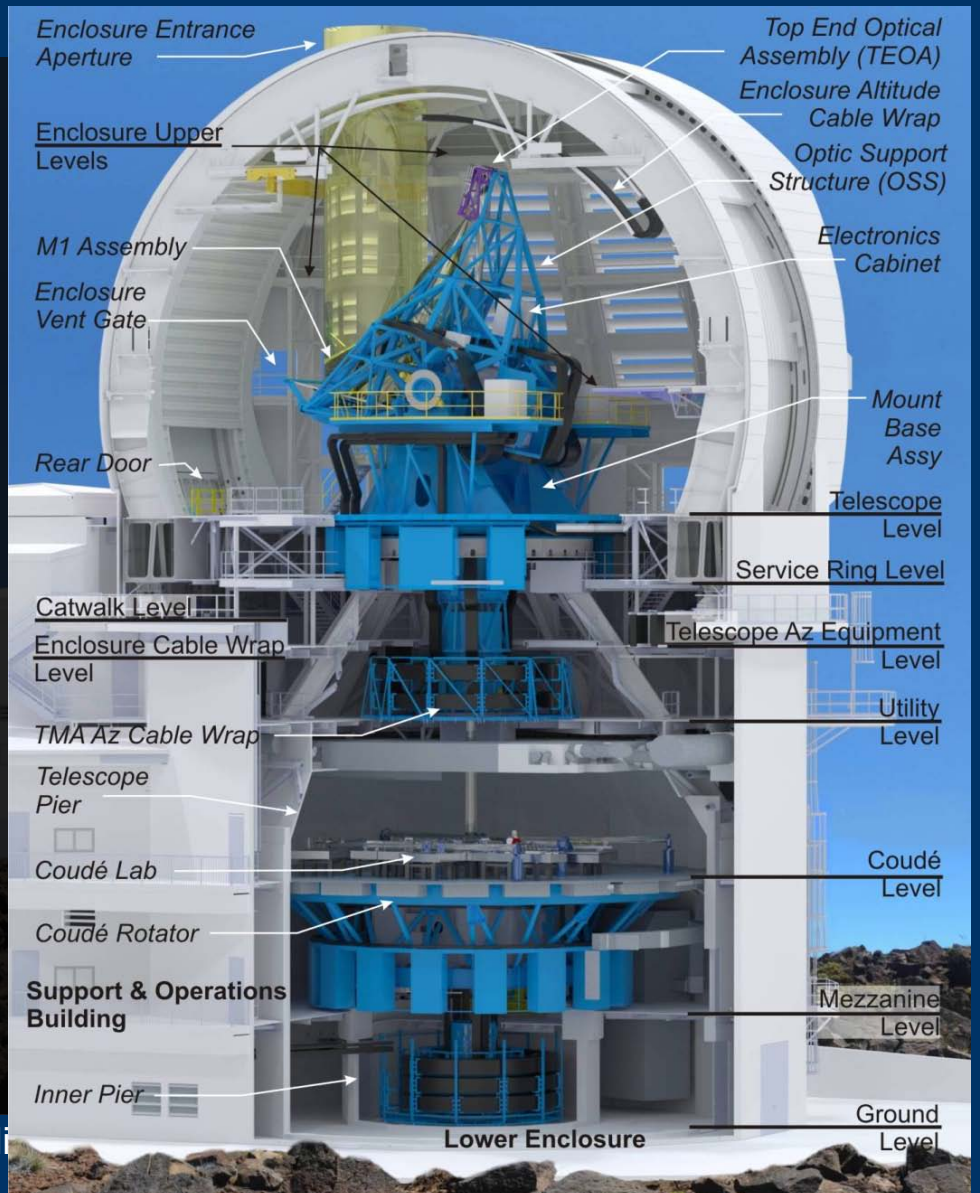
Courtesy of Kevin Reardon

Comparison with other Telescopes



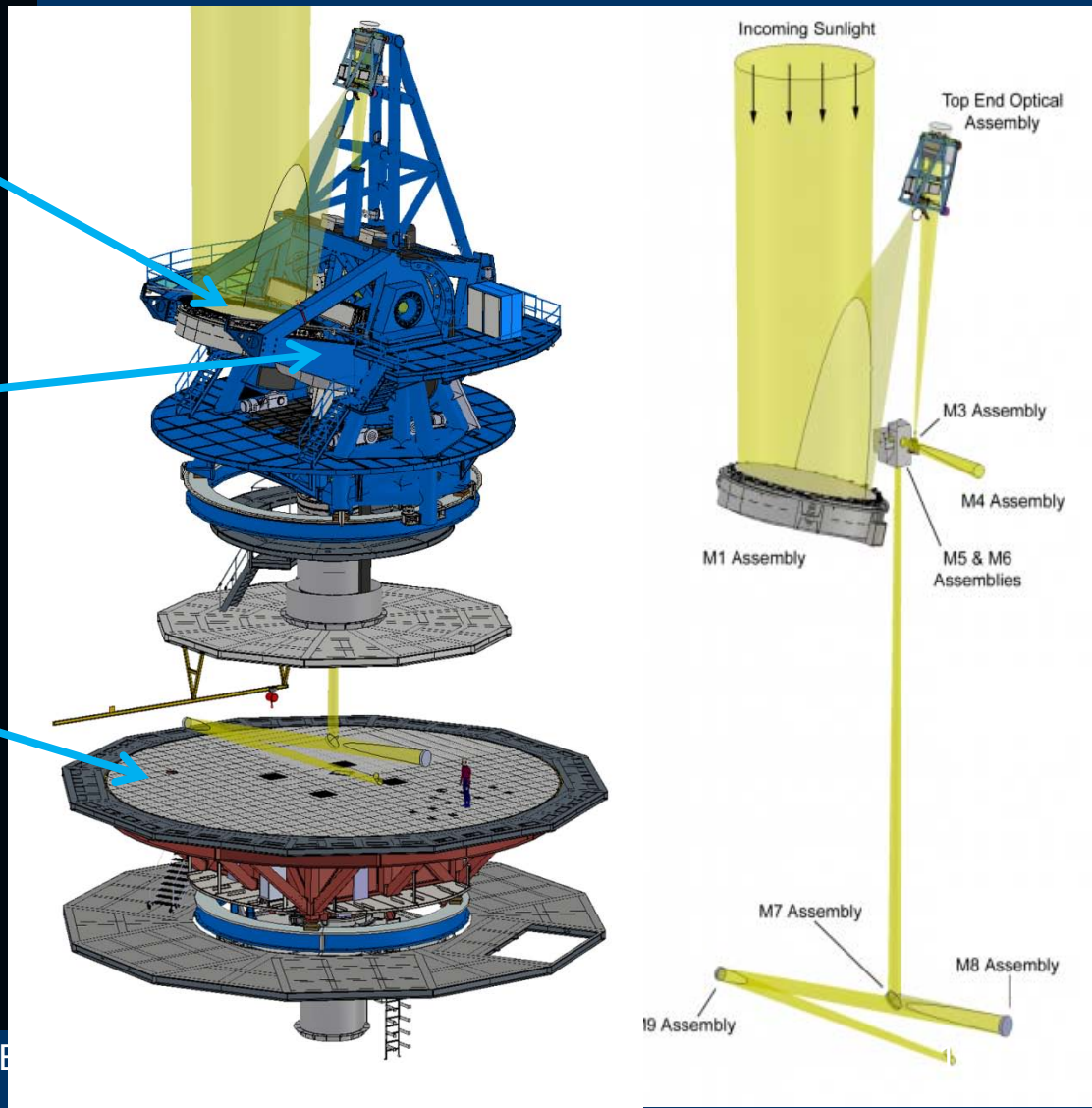
What is the DKIST

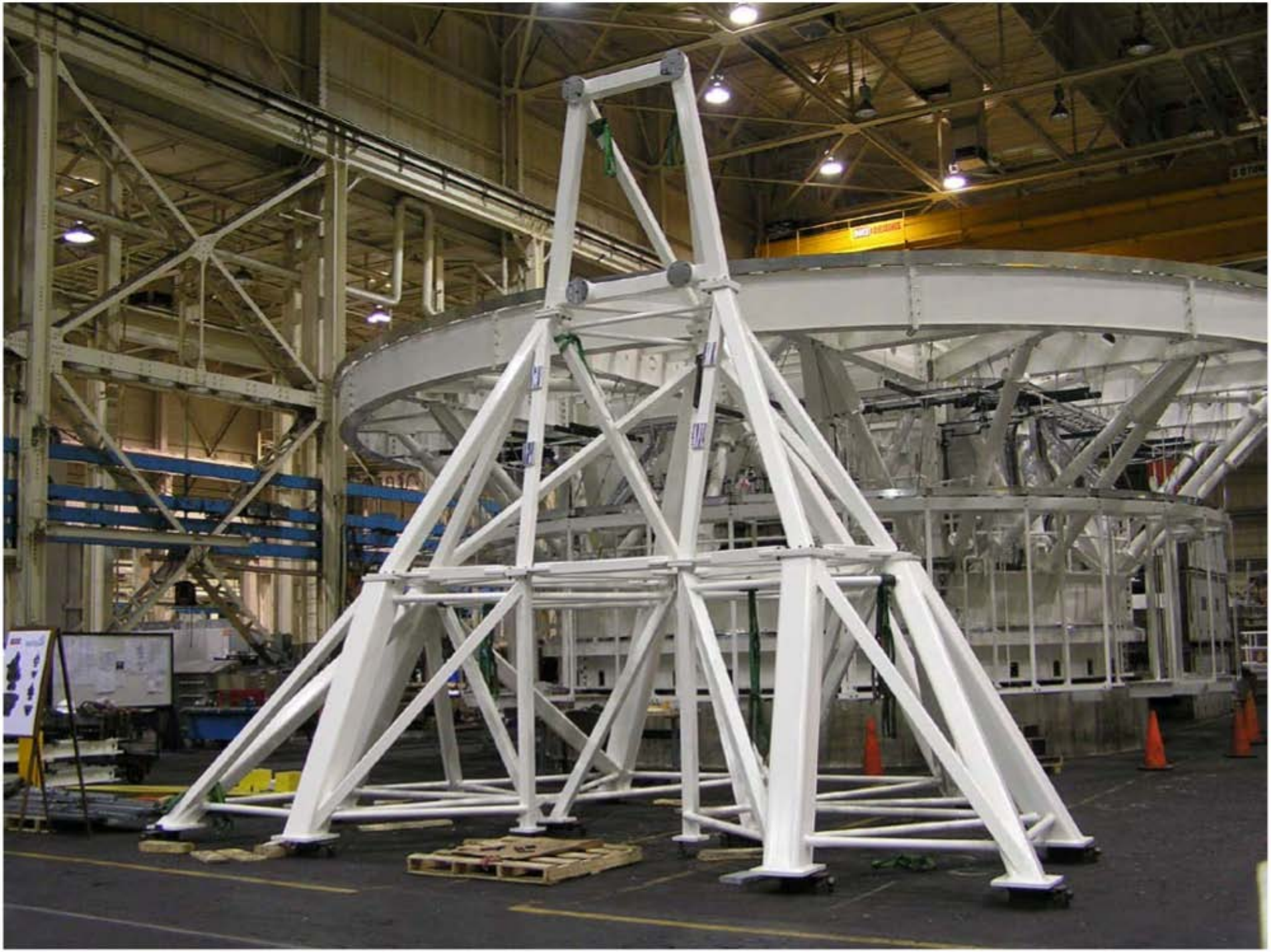
- 4m aperture, off-axis Gregorian (reflective)
- Altitude-over-azimuth mount
- Rotating coudé instrument platform
- Integrated adaptive optics
- Integrated Instrumentation
- Hybrid enclosure with thermal control and dust mitigation

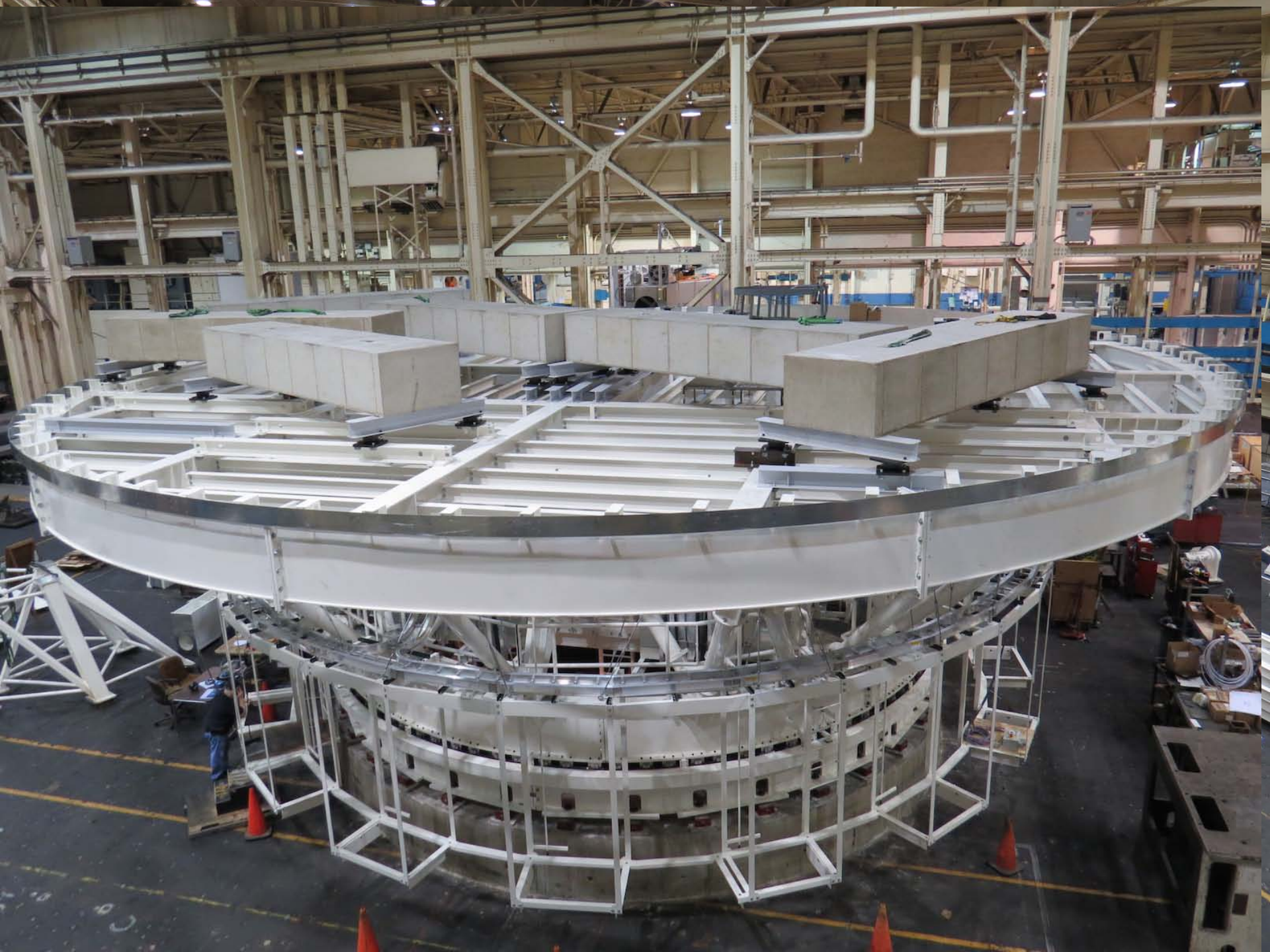


Telescope Mount Assembly (TMA)

- 4m aperture, off-axis Gregorian (reflective)
- Al-Az mount
- Rotating coudé instrument platform





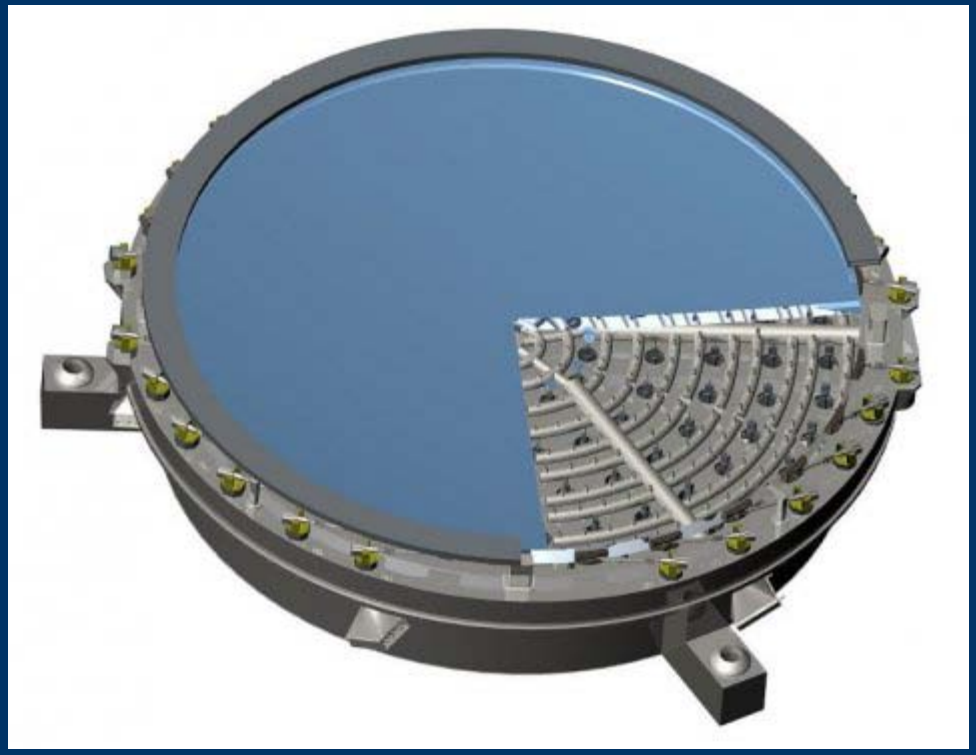


Testing Coudé Rotator

M1 Assembly

2010				2011				2012				2013				2014				2015				2016				2017				2018				2019			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Bid				Design								Procure, Fab, Test								Ship				SAT								IT&C							

1. M1 Blank(s): Schott AG, Mainz, Germany
2. Figuring & Polishing: University of Arizona, College of Optical Sciences, Tucson, AZ
3. M1 Cell + Actuators + Thermal Control: AMOS SA, Angleur-Liege, Belgium



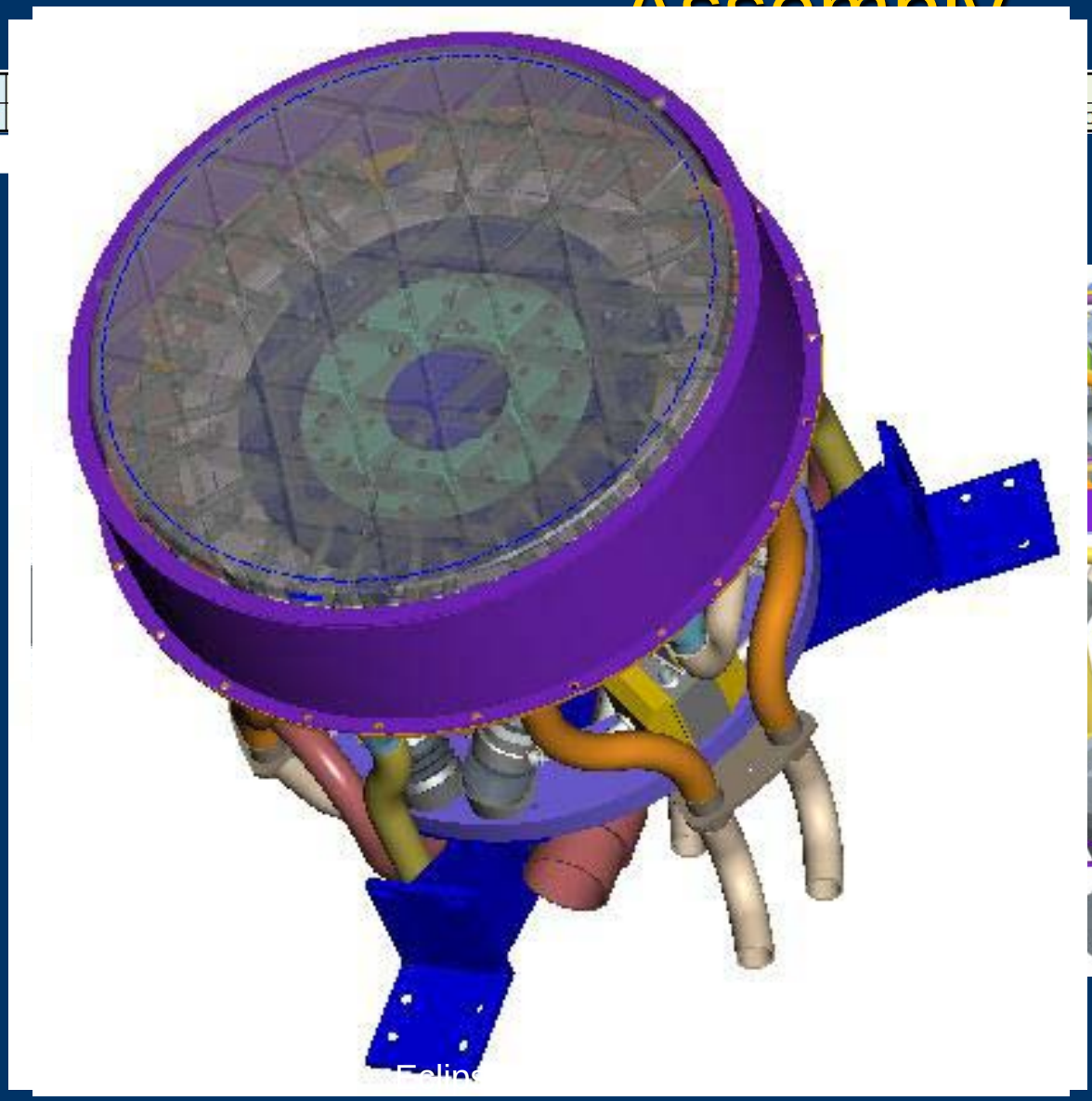
4m Primary Mirror Assembly

M1 Assembly (cont.)

M2/Top End Optical Assembly

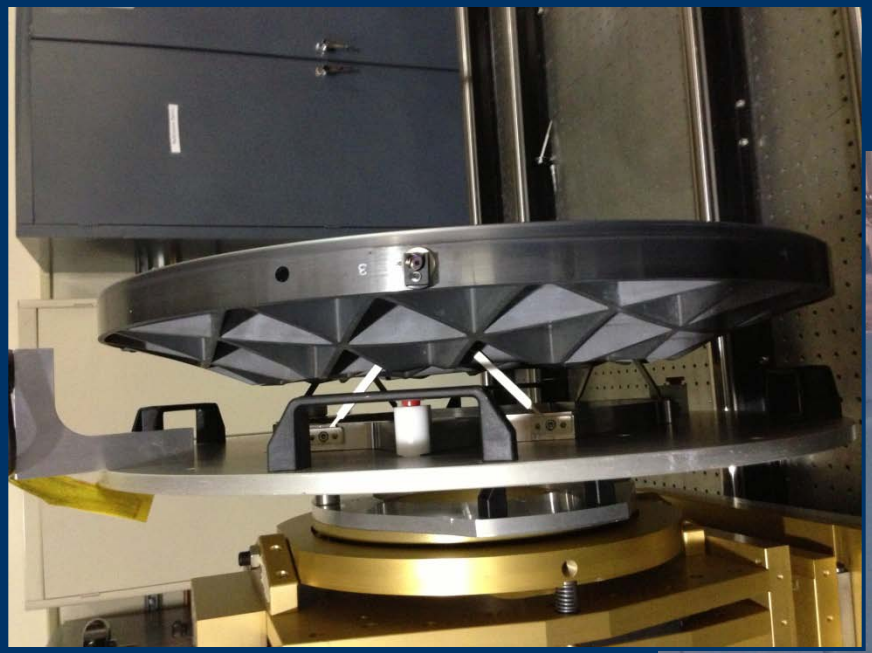
2010				2011								2018				2019			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Bid																		

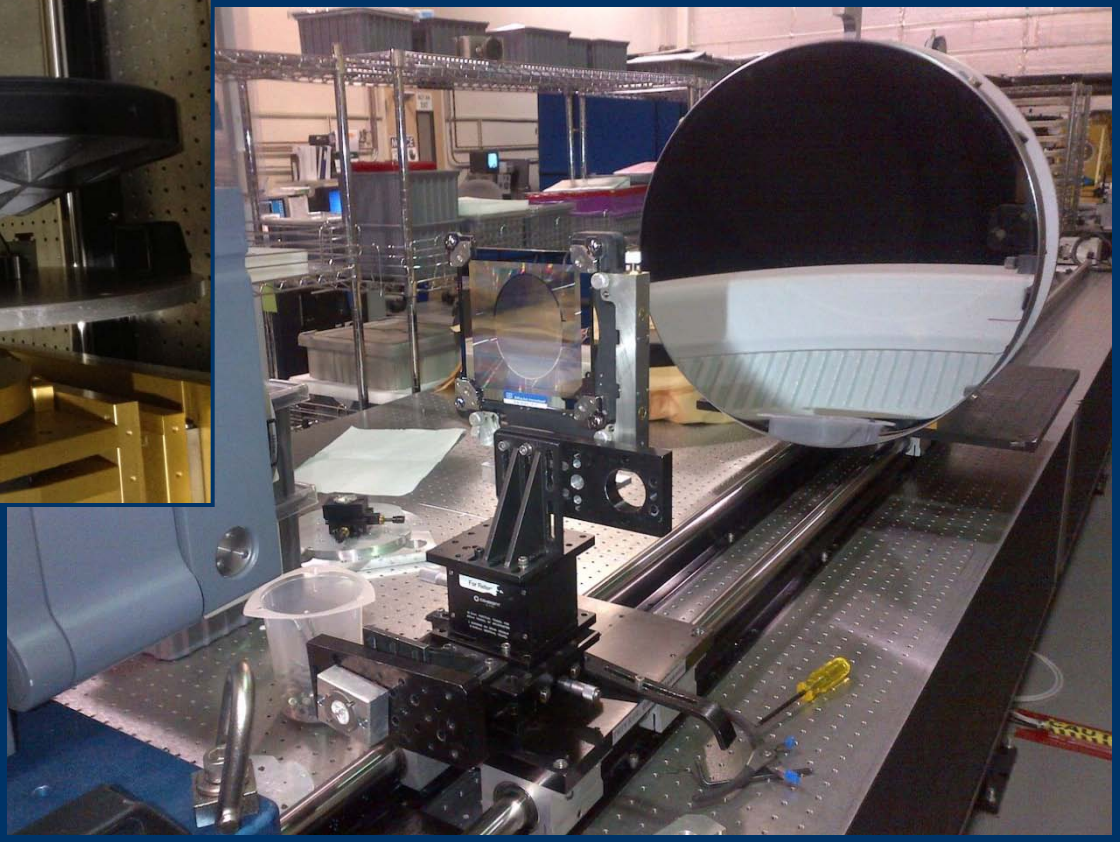
-
  -
  -
  -
-



M2/Top End Optical Assembly - Testing

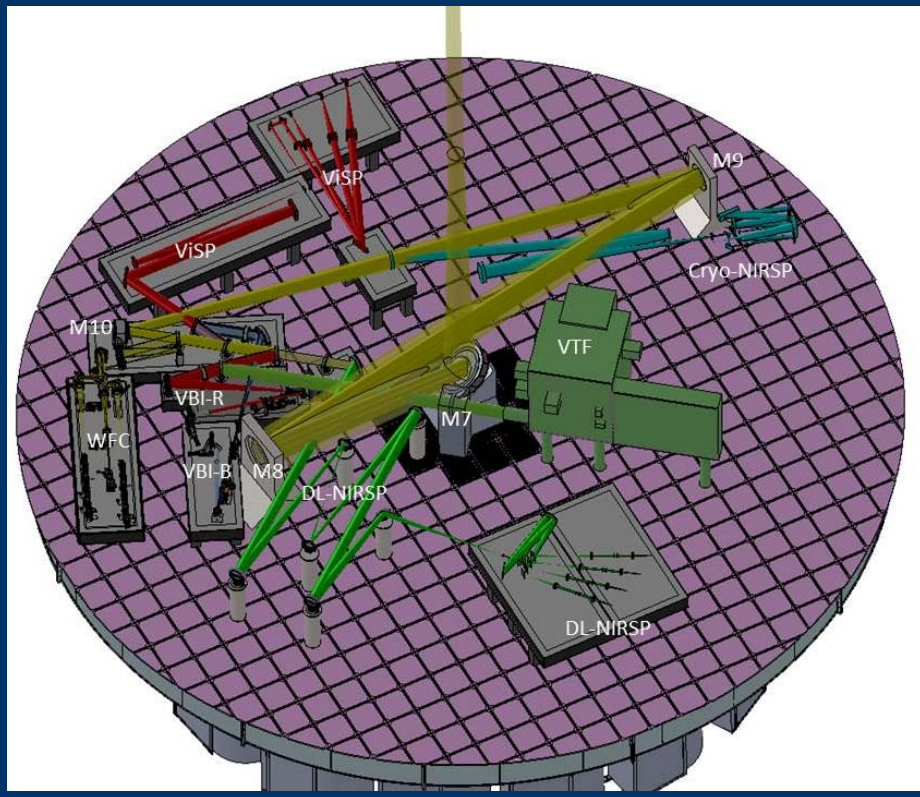
620 mm diameter
Silicon-Carbide





What is the DKIST

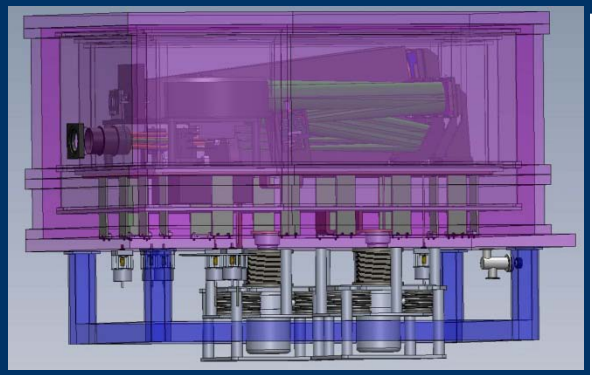
- Integrated adaptive optics.
- Fixed & visitor instrumentation
- Field of view: 5 arc minutes.
- Angular resolution 0.03 arc second (at 500nm).
- Polarization accuracy <0.01%
- Wavelength sensitivity from 0.3-28 microns.
- Service & PI access modes of operation

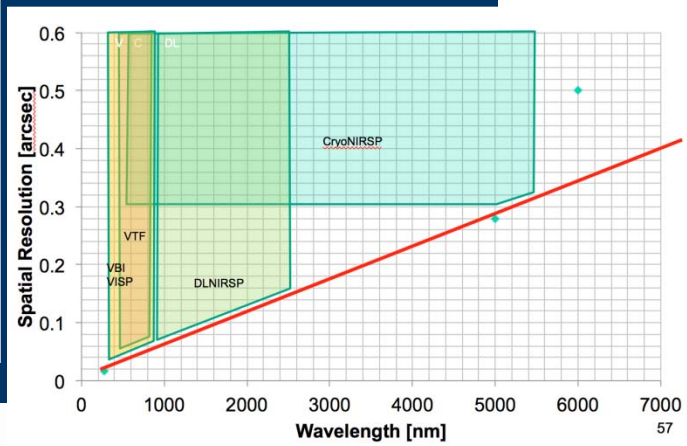


DKIST Instruments

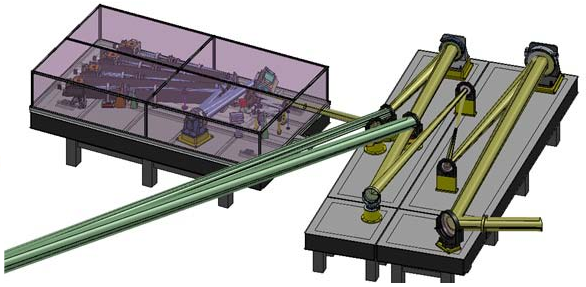
2010				2011				2012				2013				2014				2015				2016				2017				2018				2019			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Design																				Procure, Fab, Test								Ship				Site Assembly & Test							

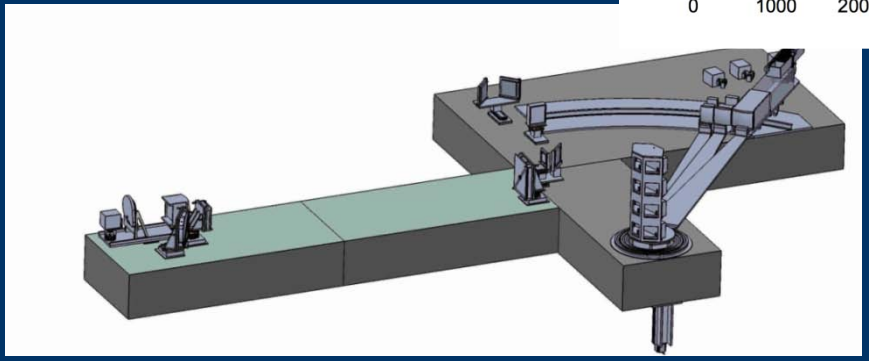
Cryogenic Near-Infrared Spectro-Polarimeter (Univ. of Hawai`i/IfA)



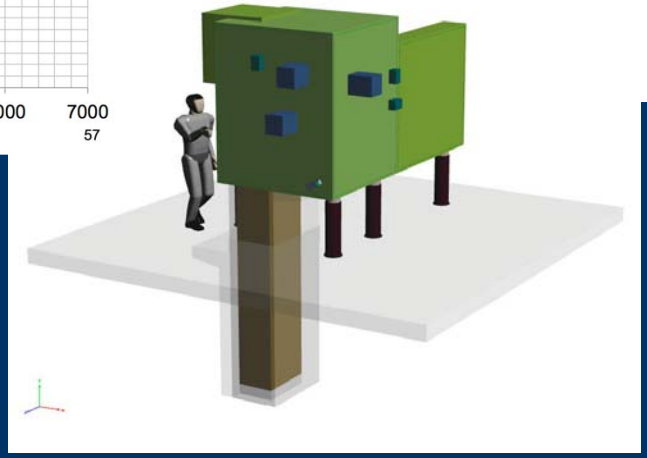


Diffraction-Limited Near-Infrared Spectro-Polarimeter (Univ. of Hawai`i/IfA)





Visible Spectro-Polarimeter (High Altitude Observatory)

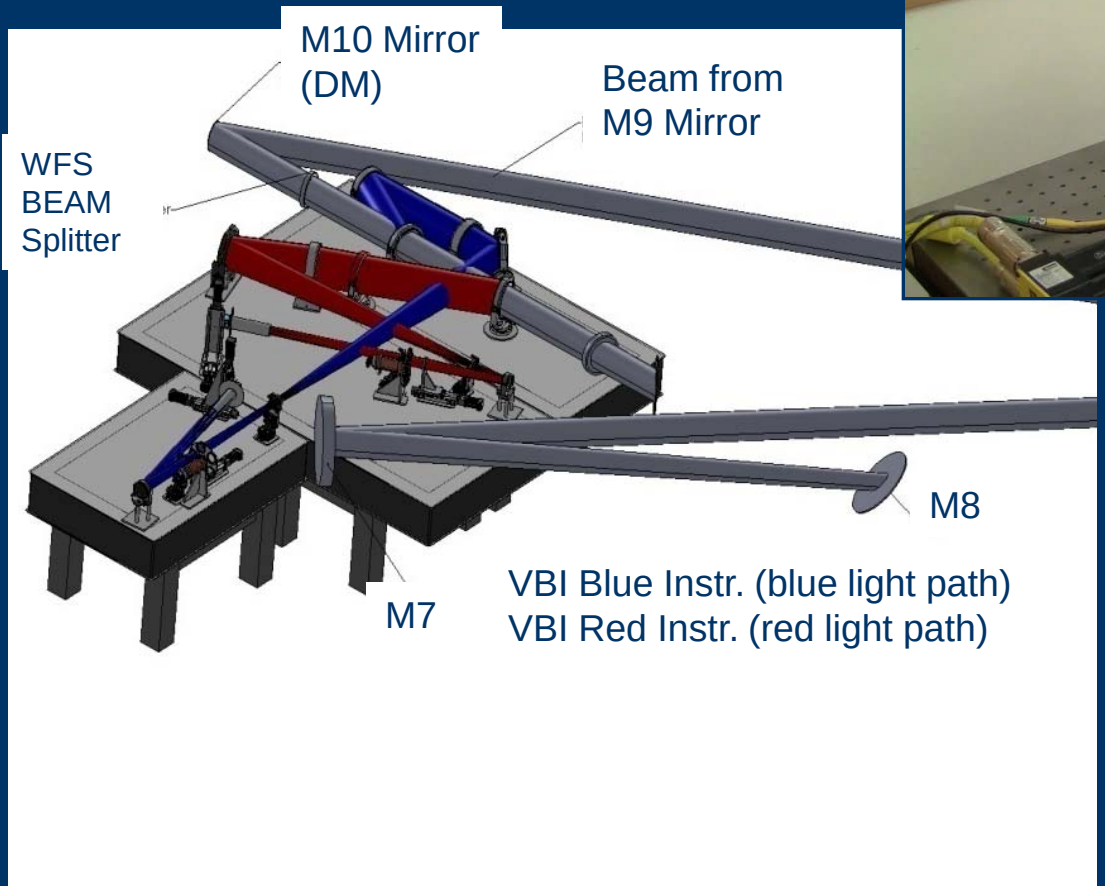


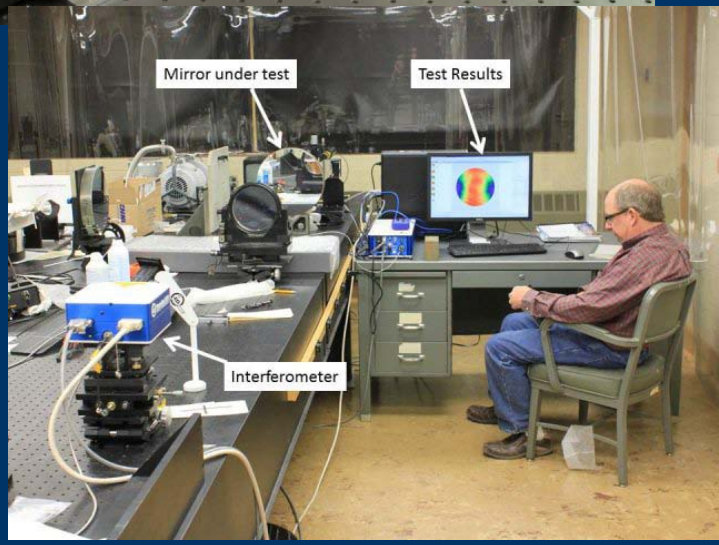
Fabry-Perot Visible Tunable Filter (Kiepenheuer Institute for Solar Physics)

DKIST Instruments (cont.)

Visible Broadband Imager

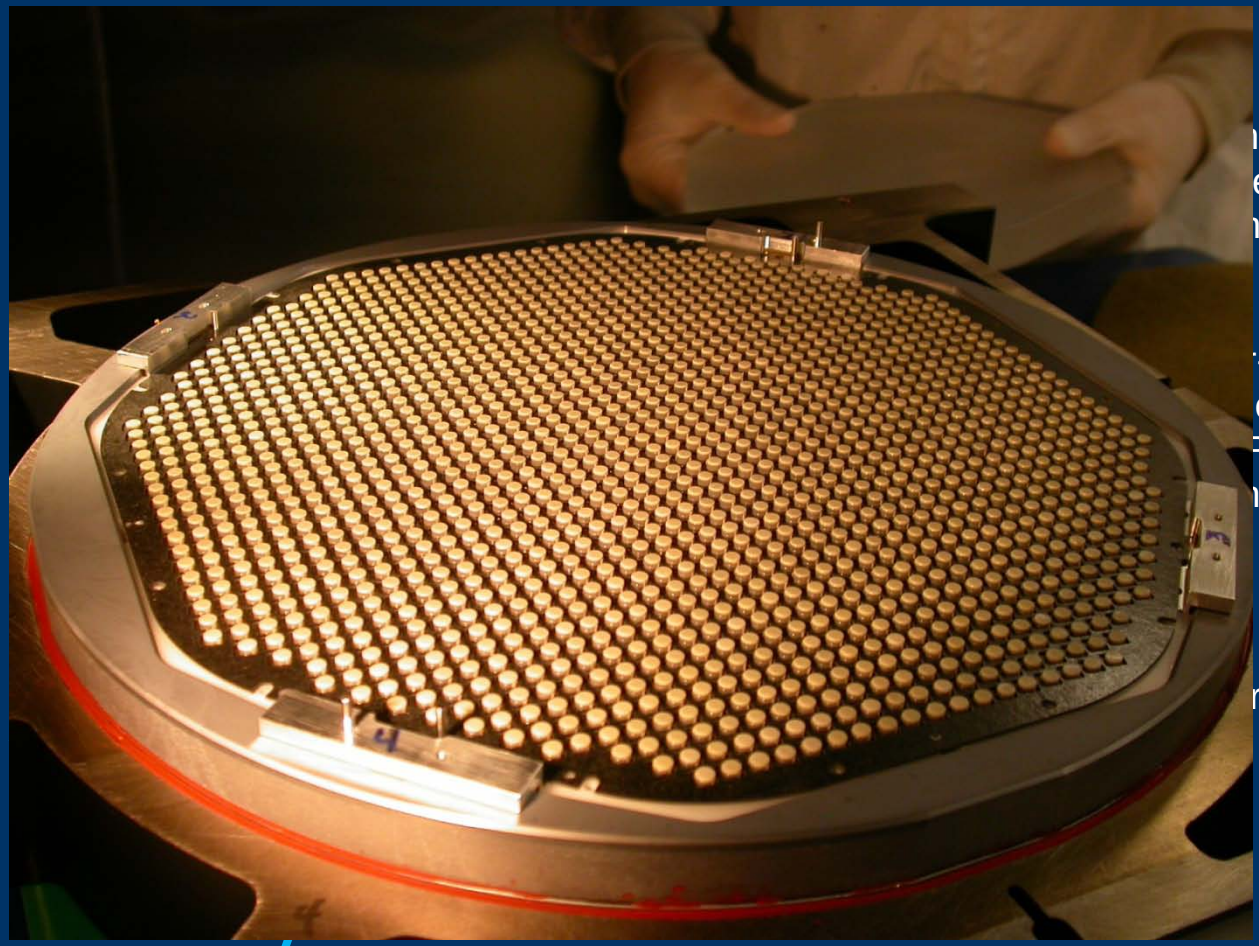
(NSO/DKIST Project)





First Light Instrumentation

Adaptive Mirror and Wavefront Correction



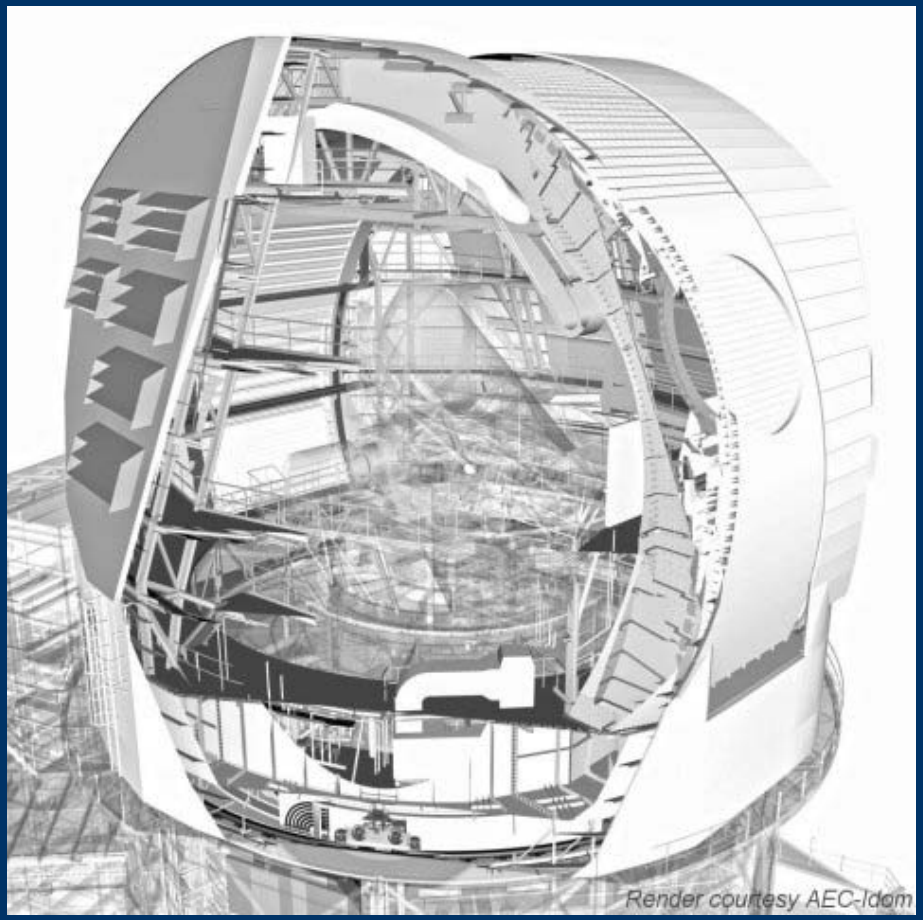
Visble Tunable Filter
Red Channel (VBI-R)
Blue Channel (VBI-B)
390 – 860 nm

Diffraction Limited Near-IR
Spectro-Polarimeter (DL – NIRSP)
900 – 2300 nm

Enclosure

2010				2011				2012				2013				2014				2015				2016				2017				2018				2019			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Bid				Design								Procure, Fab, Test								Ship				Site Assembly & Test													

- Contract with AEC-IDOM, Minneapolis, MN and Bilbao, Spain:
  1. Design & Analysis
  2. Procure, Fabricate, Factory Assembly, Test, Disassemble, Pack & Ship
  3. (Site Erect)



Enclosure Base Ring

Arch Girders and Trusses

Enclosure (cont.)

Shutter Drive “Crawler” Test Rig

Factory Assembly in Bilbao, Spain (July, 2013)

uction

Assembly of the

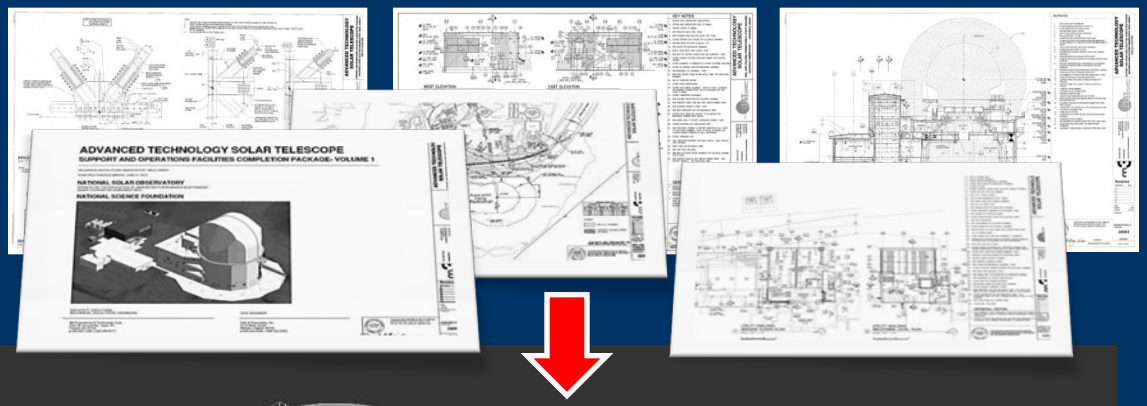
hutter Sector is

ure

Site & Support Facilities Construction

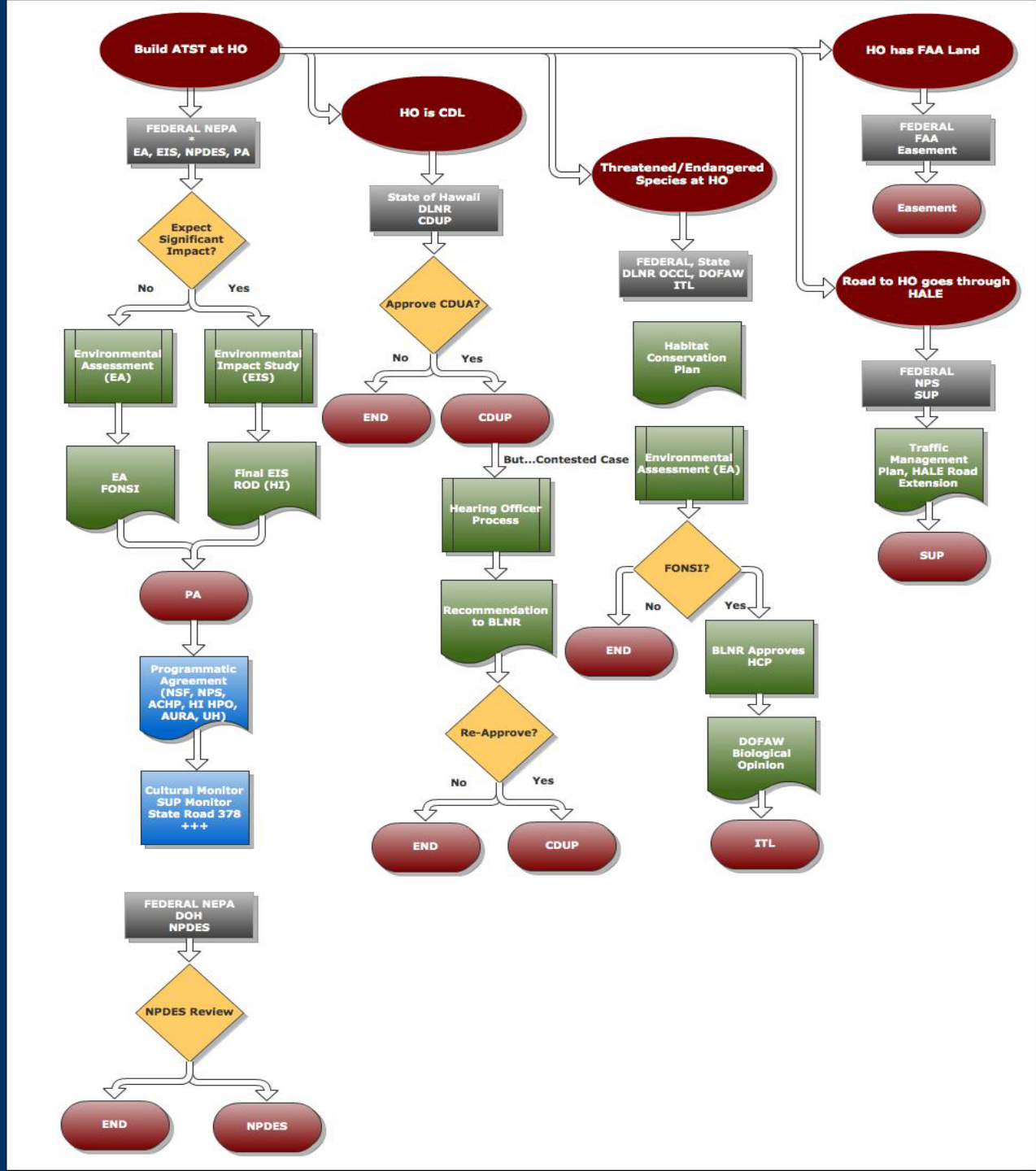
2010				2011				2012				2013				2014				2015				2016				2017				2018				2019			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
												Design				Fab & Site Construction																							

- Architectural & Engineering (A&E): M3 Engineering, Tucson, AZ
- Construction: DKIST acting as General Contractor:
  - Excavation
  - Concrete
  - Steel Fab
  - Steel Erect/Assemble
  - Electrical
  - Mechanical
  - Finishwork/TI
  - 3rd Party Inspectors



Where is DKIST being Built

Simplified Permitting Flow-Chart

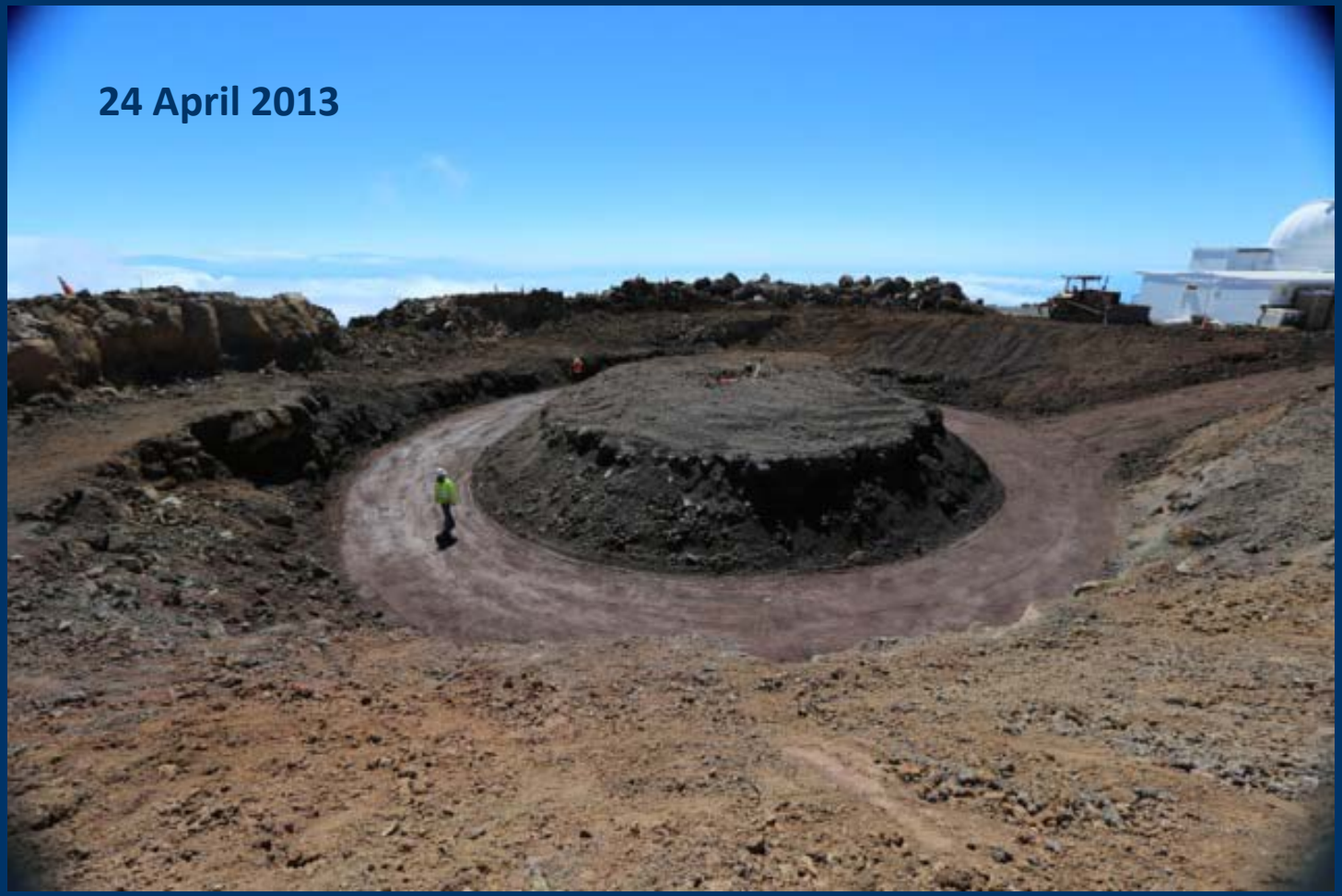


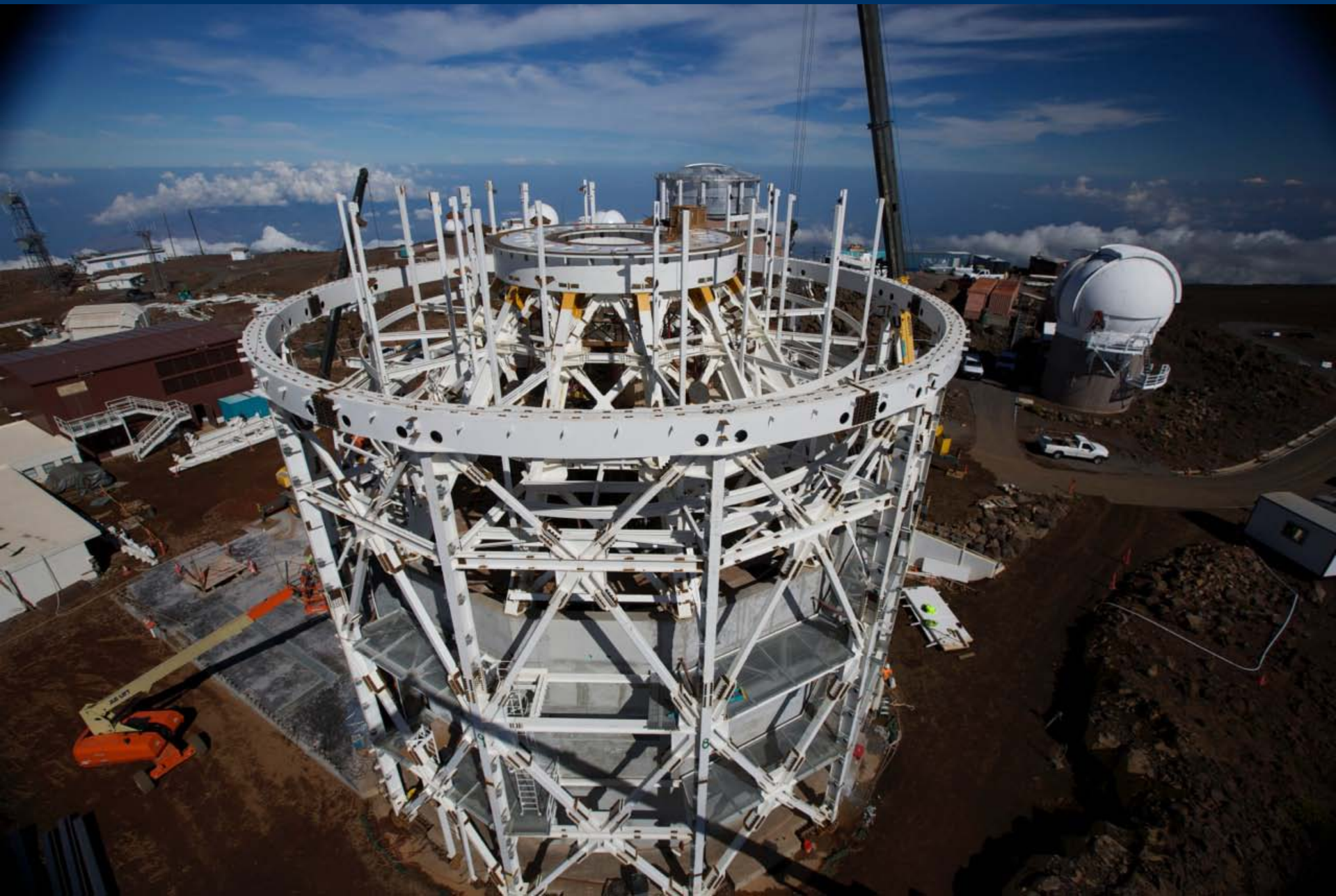
Ground Breaking Blessing Ceremony

Ground Breaking Blessing Ceremony

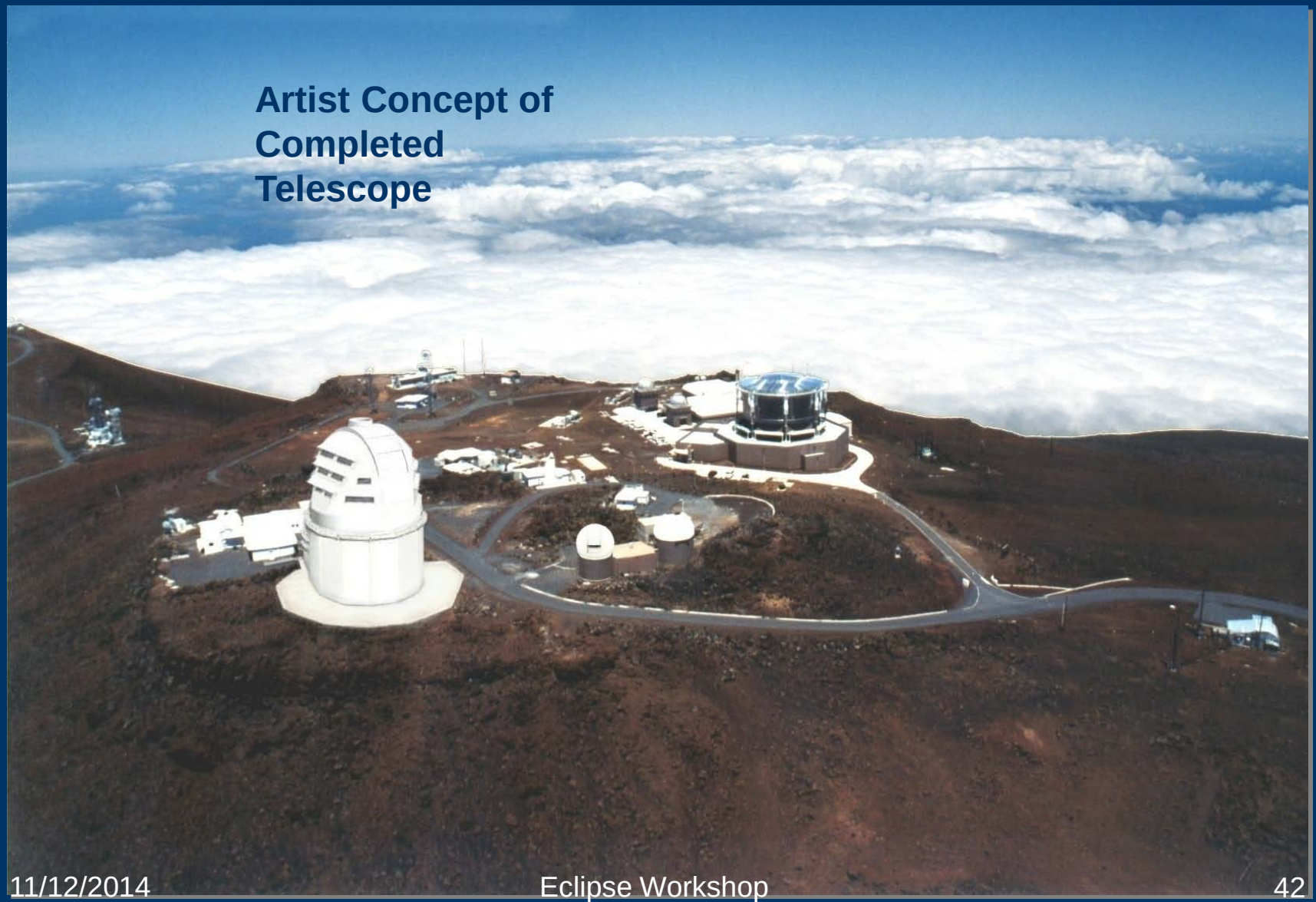
Early Site Construction

Site Construction Foundation Preparation





DKIST atop Haleakalā, Maui



Contact Information

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Joe McMullin, Project Manager, 1-520-318-8105
Tom Berger, Project Scientist, 1-575-7134

For More Information see:

http://DKIST.nso.edu

END