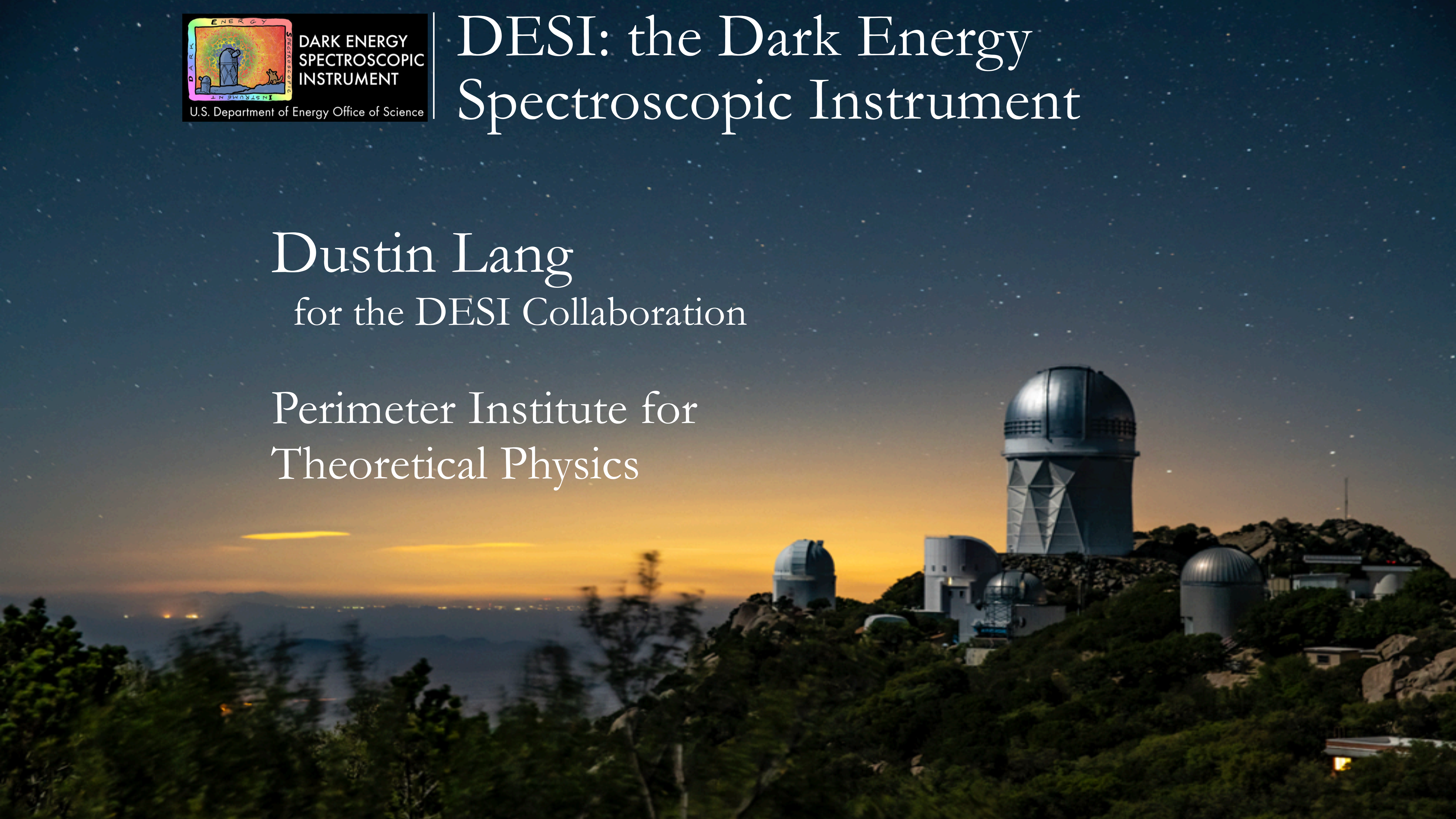




DESI: the Dark Energy Spectroscopic Instrument

Dustin Lang
for the DESI Collaboration

Perimeter Institute for
Theoretical Physics





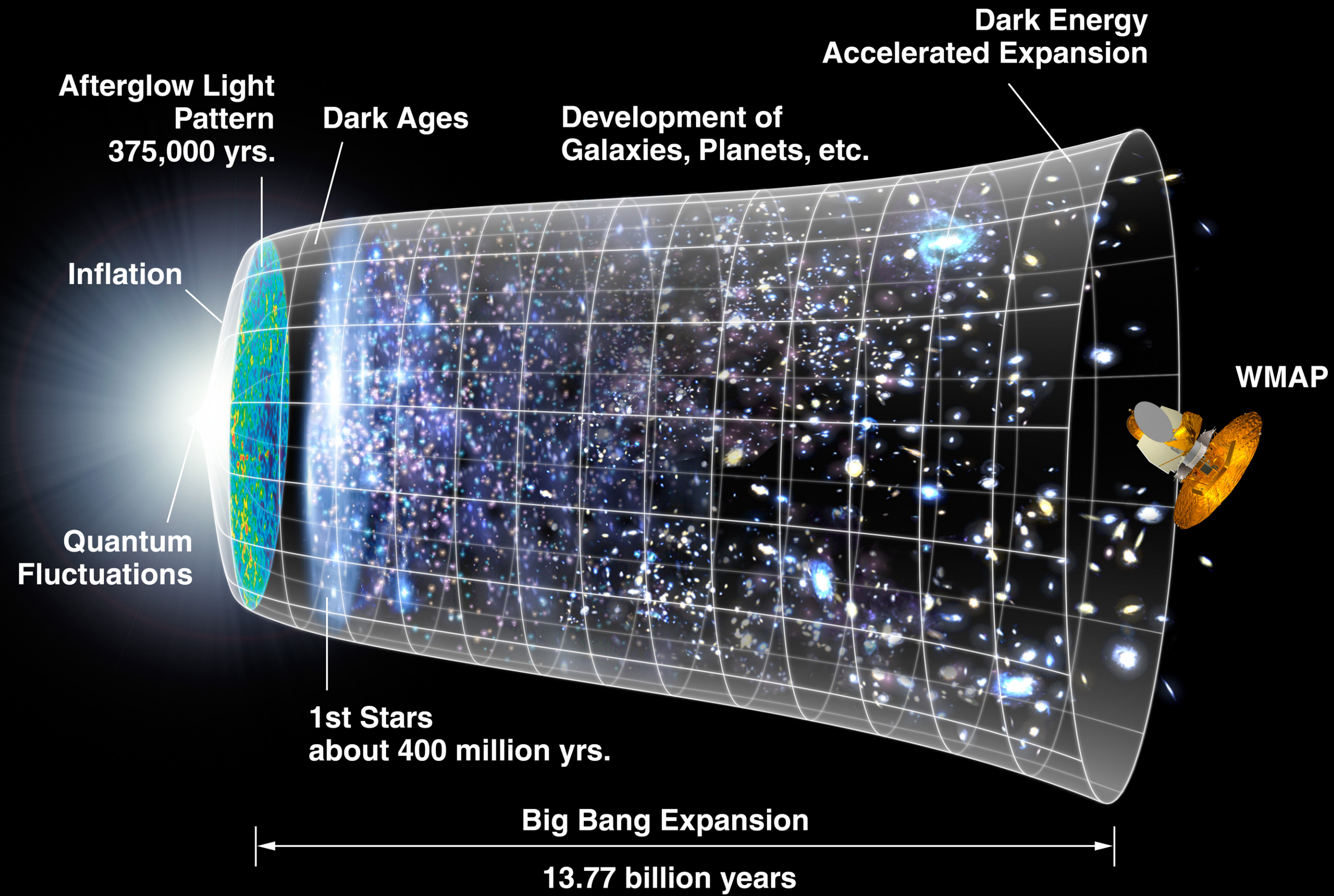
DESI: the Dark Energy Spectroscopic Instrument

Dustin Lang
for the DESI Collaboration

Thanks to the U.S. Department of Energy,
Heising-Simons Foundation, Moore Foundation,
and 69 participating institutions (lead: Lawrence Berkeley Lab)

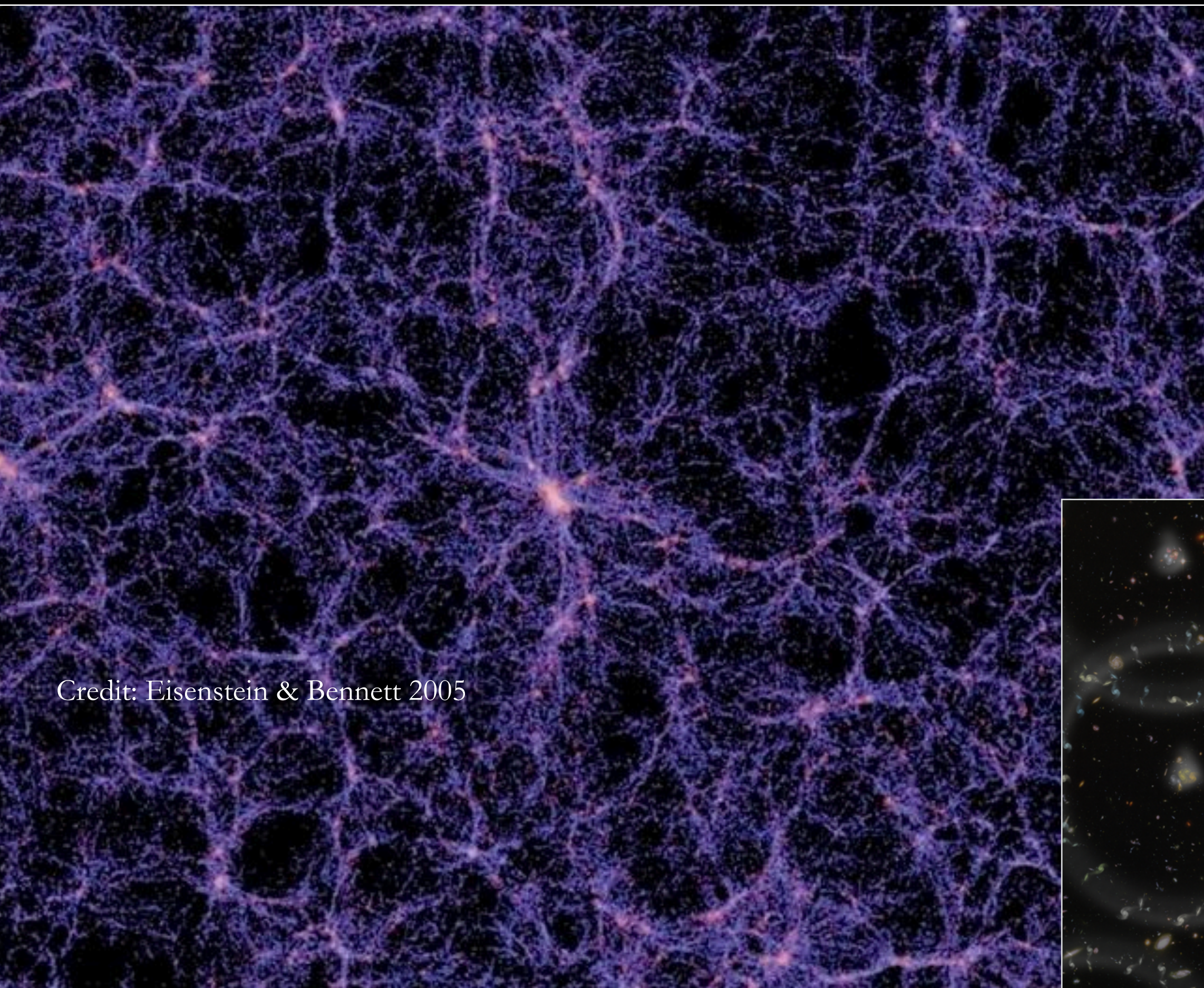


DESI's main science goal: understand Dark Energy



Credit: NASA/WMAP Science Team

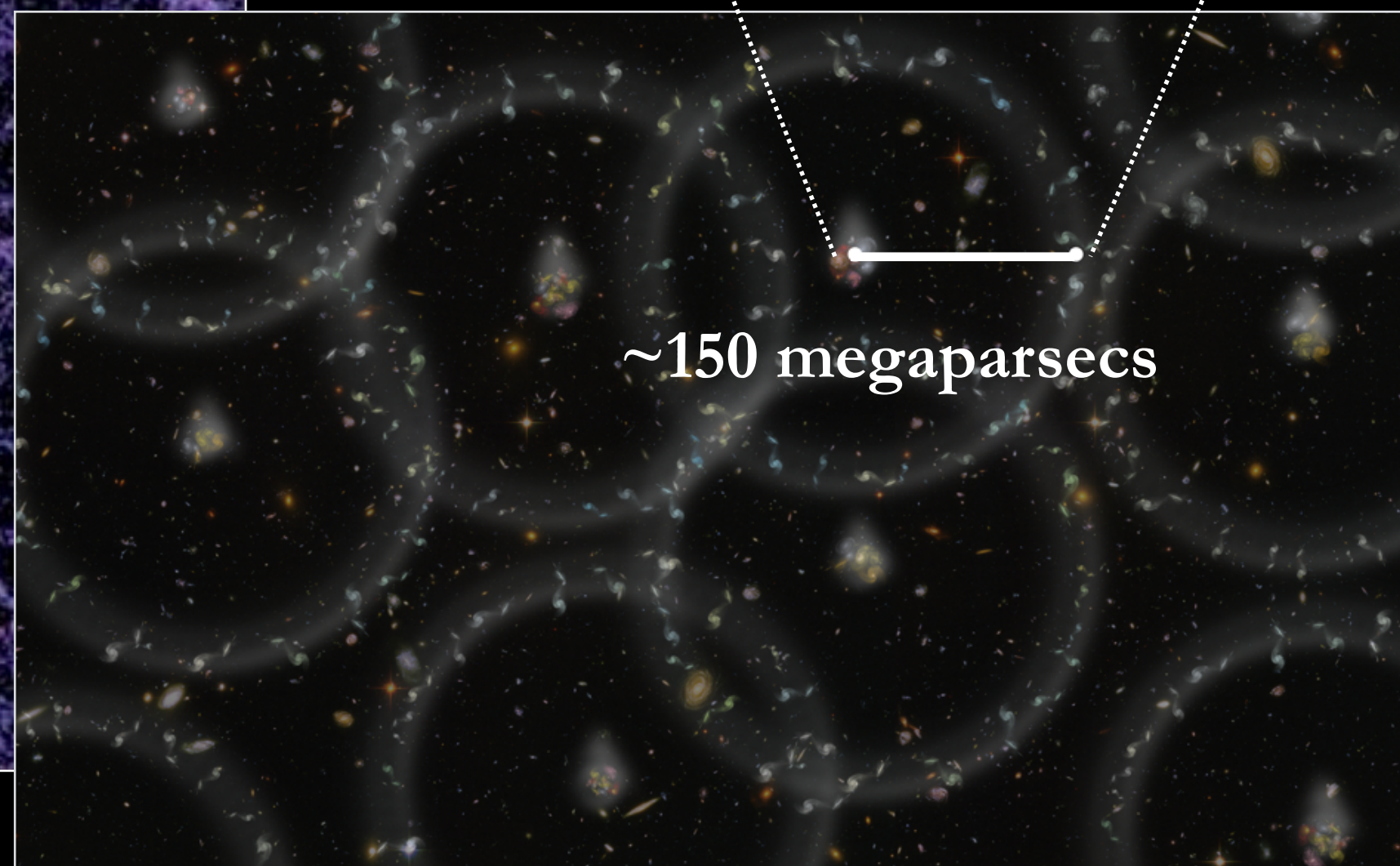
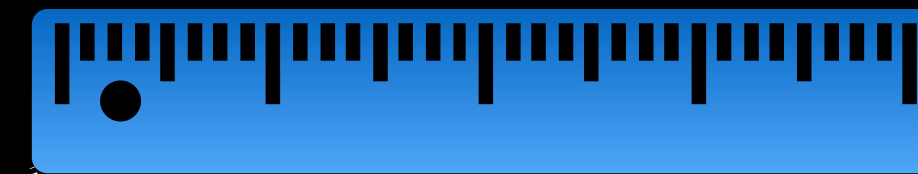
DESI measures the size of the universe (at different cosmic times) using a standard ruler: the Baryon Acoustic Oscillation (BAO) feature in the clustering of galaxies



Credit: Eisenstein & Bennett 2005

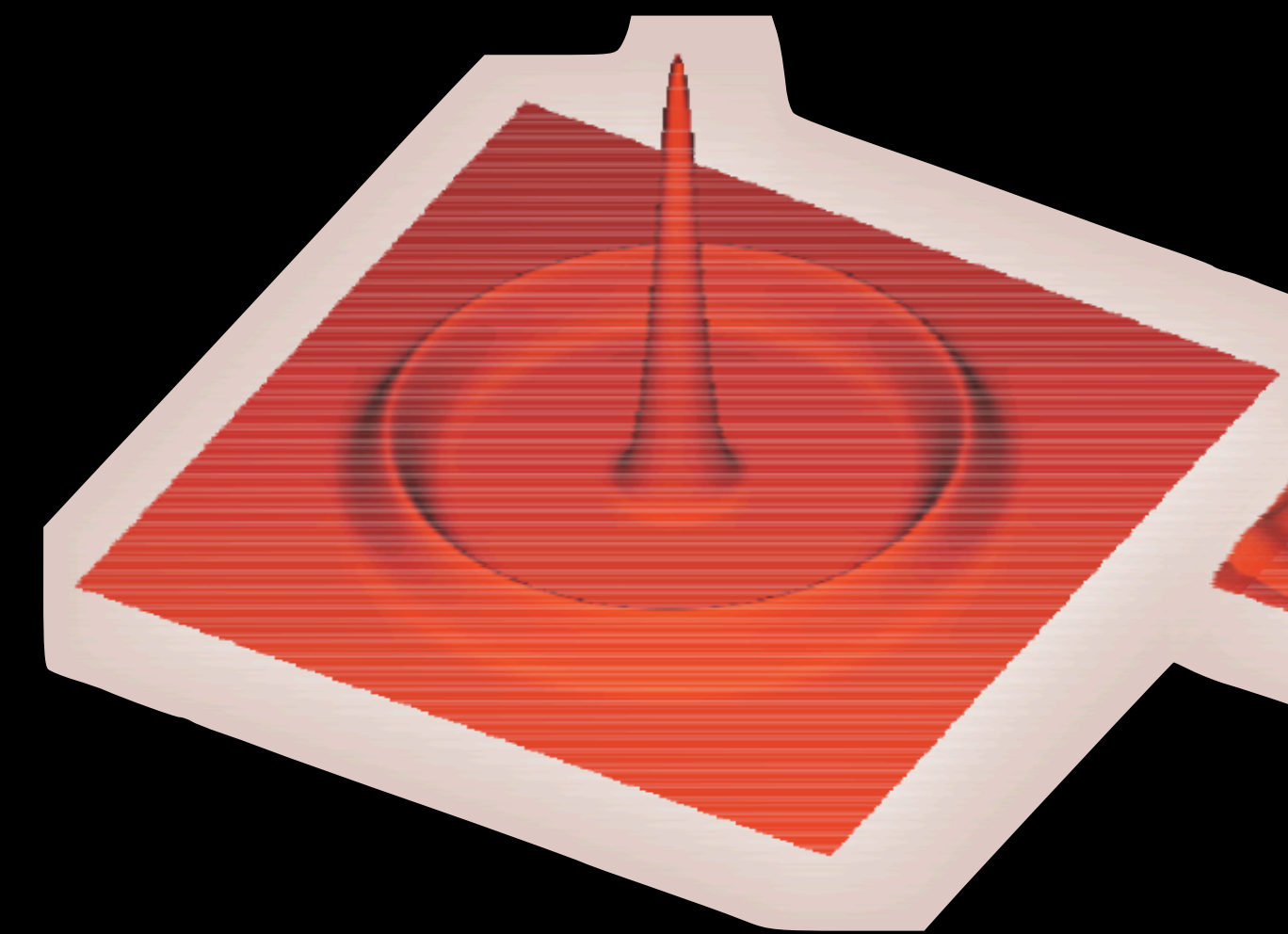
Credit: Millenium Simulation

standard ruler

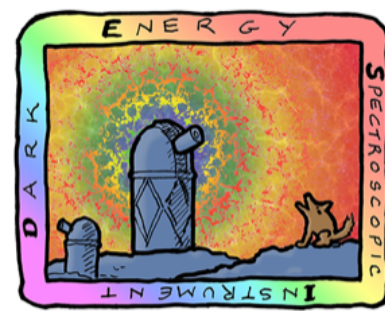


~ 150 megaparsecs

Credit: Z. Rostomian (LBNL)



Credit: Eisenstein & Bennett 2005

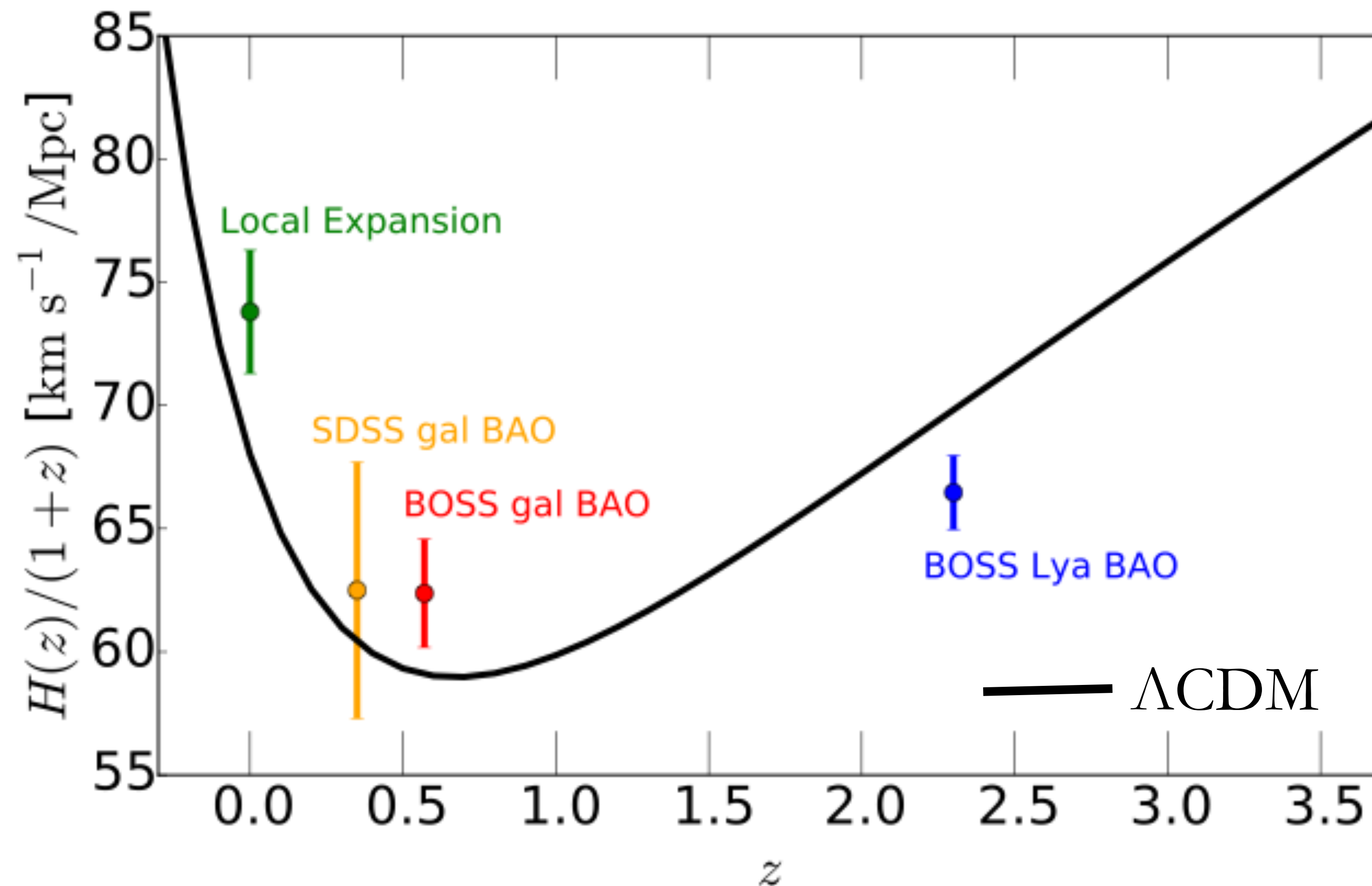


DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

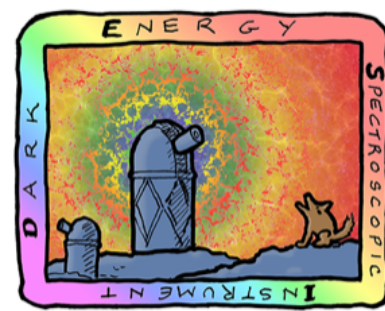
U.S. Department of Energy Office of Science

DESI will place sub-percent constraints on dark energy and the expansion history of the universe.

Expansion Rate



Credit: DESI Collaboration+2016

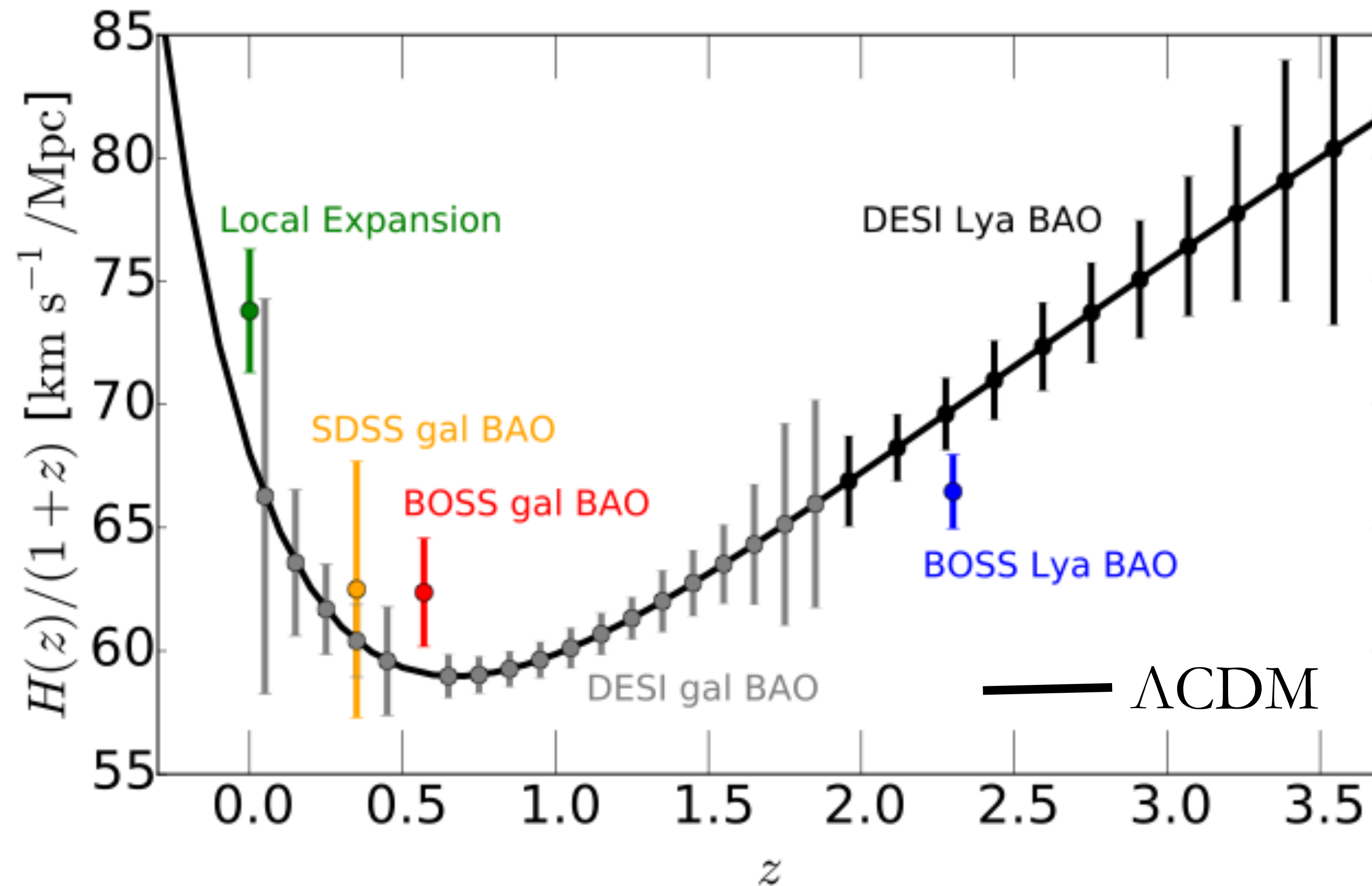


DARK ENERGY
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DESI will place sub-percent constraints on dark energy and the expansion history of the universe.

Expansion Rate



Credit: DESI Collaboration+2016

DESI is producing the most detailed 3D map of the universe, ever.

- 5-year survey (2021-2026)
- 5 target classes, ~40M redshifts
- 14,000 deg² footprint (1/3 sky)

3 million QSOs

Lya $z > 2.1$

Tracers $0.9 < z < 2.1$

16 million ELGs

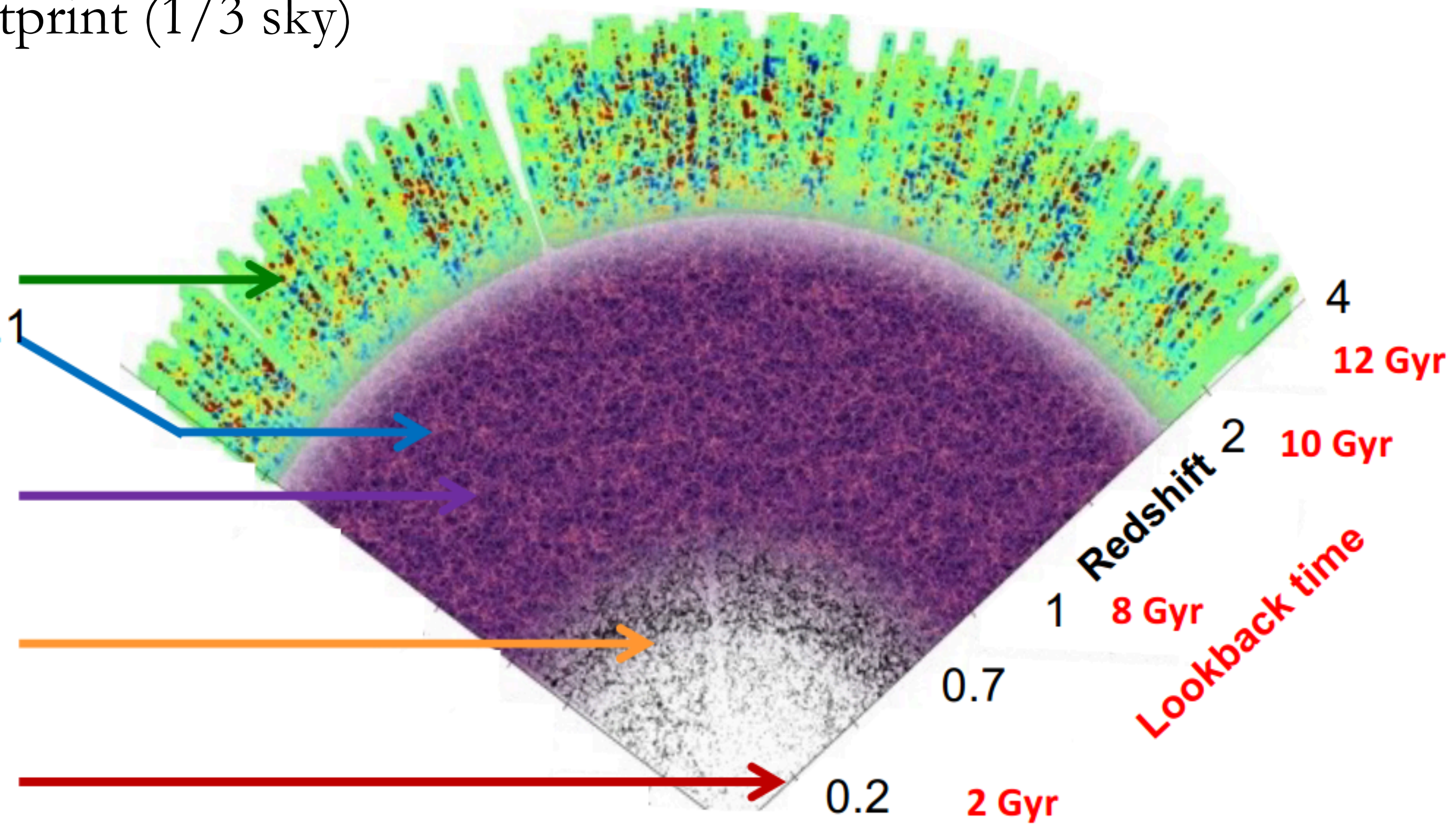
$0.6 < z < 1.6$

8 million LRGs

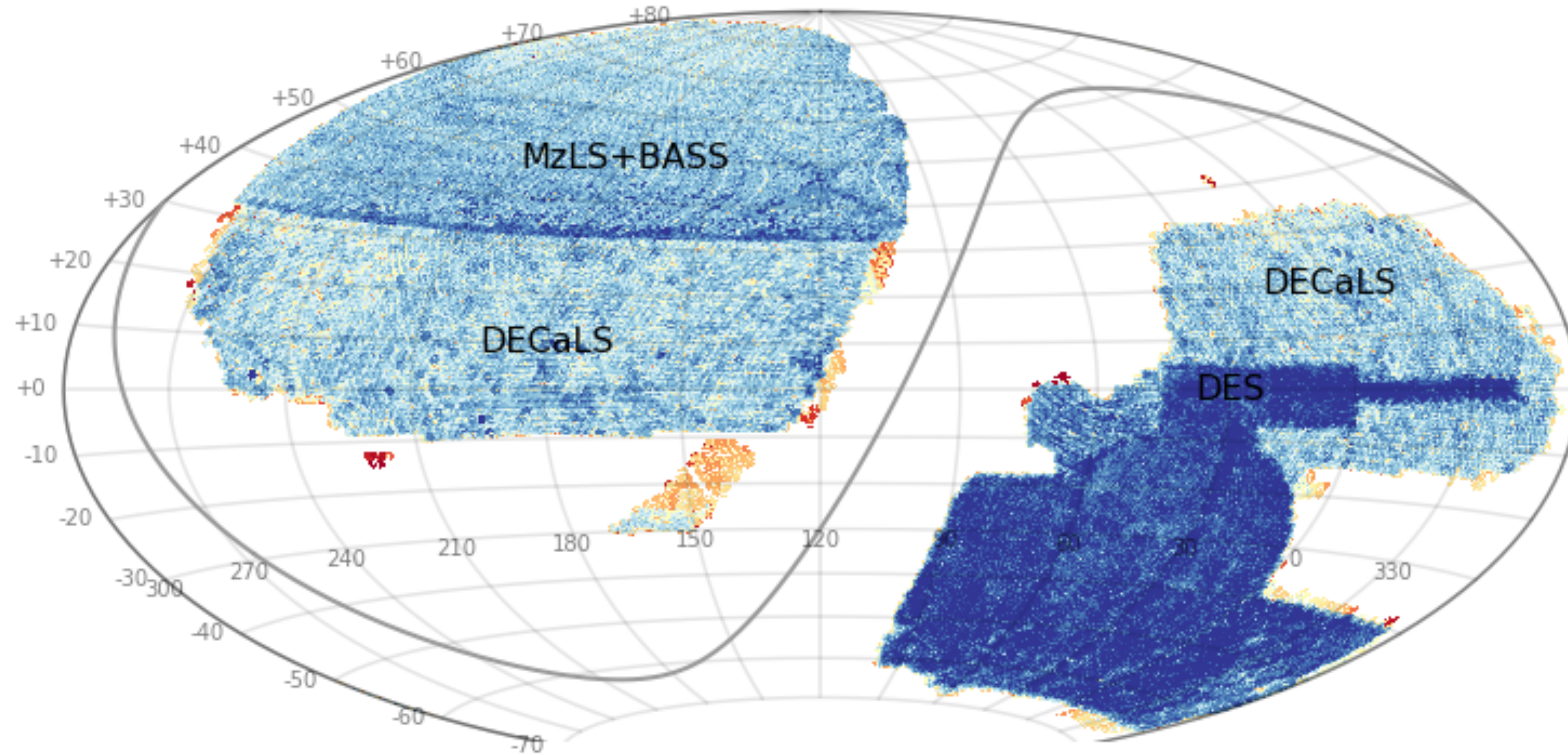
$0.4 < z < 1.0$

13.5 million Brightest galaxies

$0.0 < z < 0.4$



DESI targets are selected from the
 $\sim 20,000 \text{ deg}^2$ *Legacy Imaging Surveys*



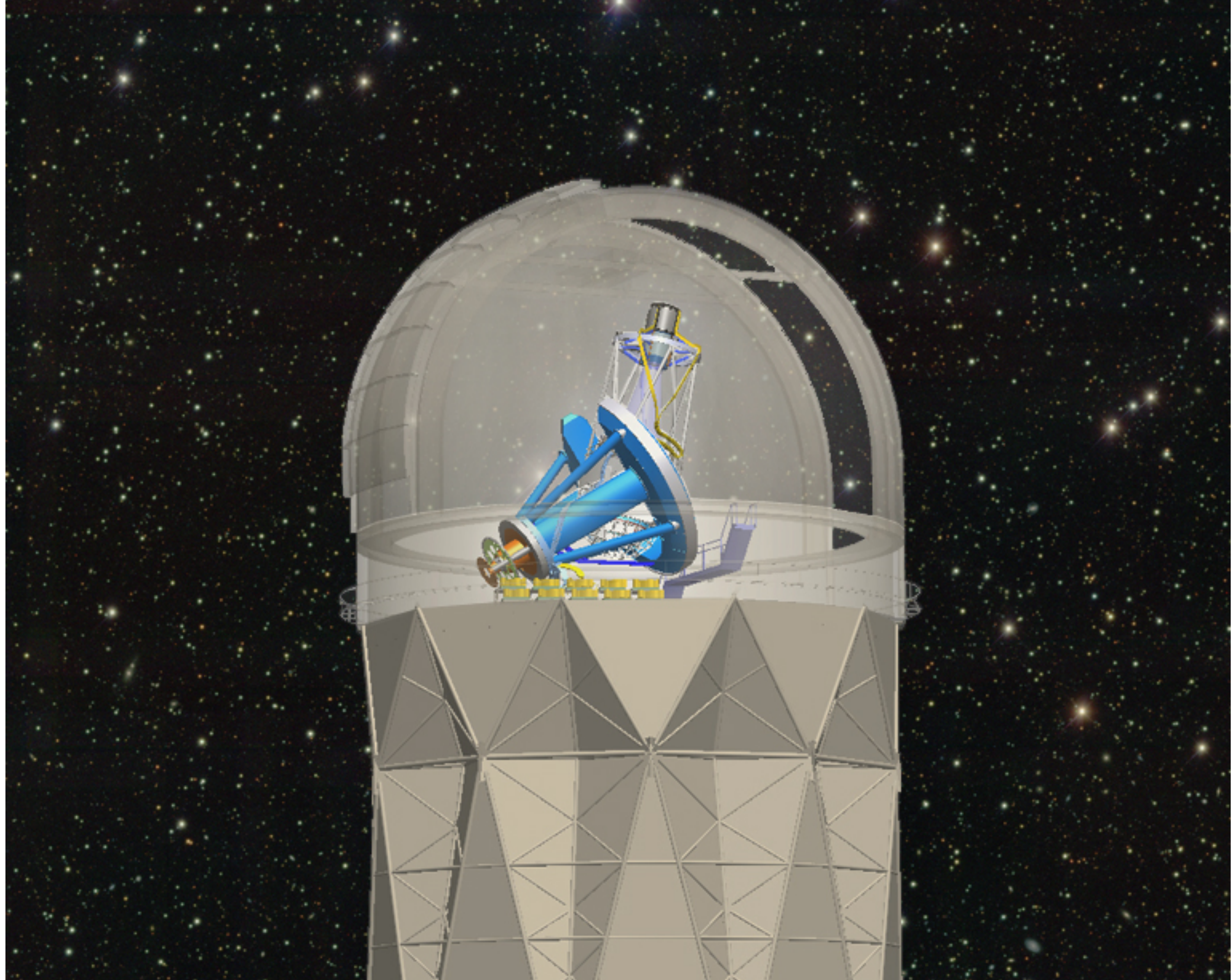
A. Dey et al. 2019
H. Zou et al. 2020

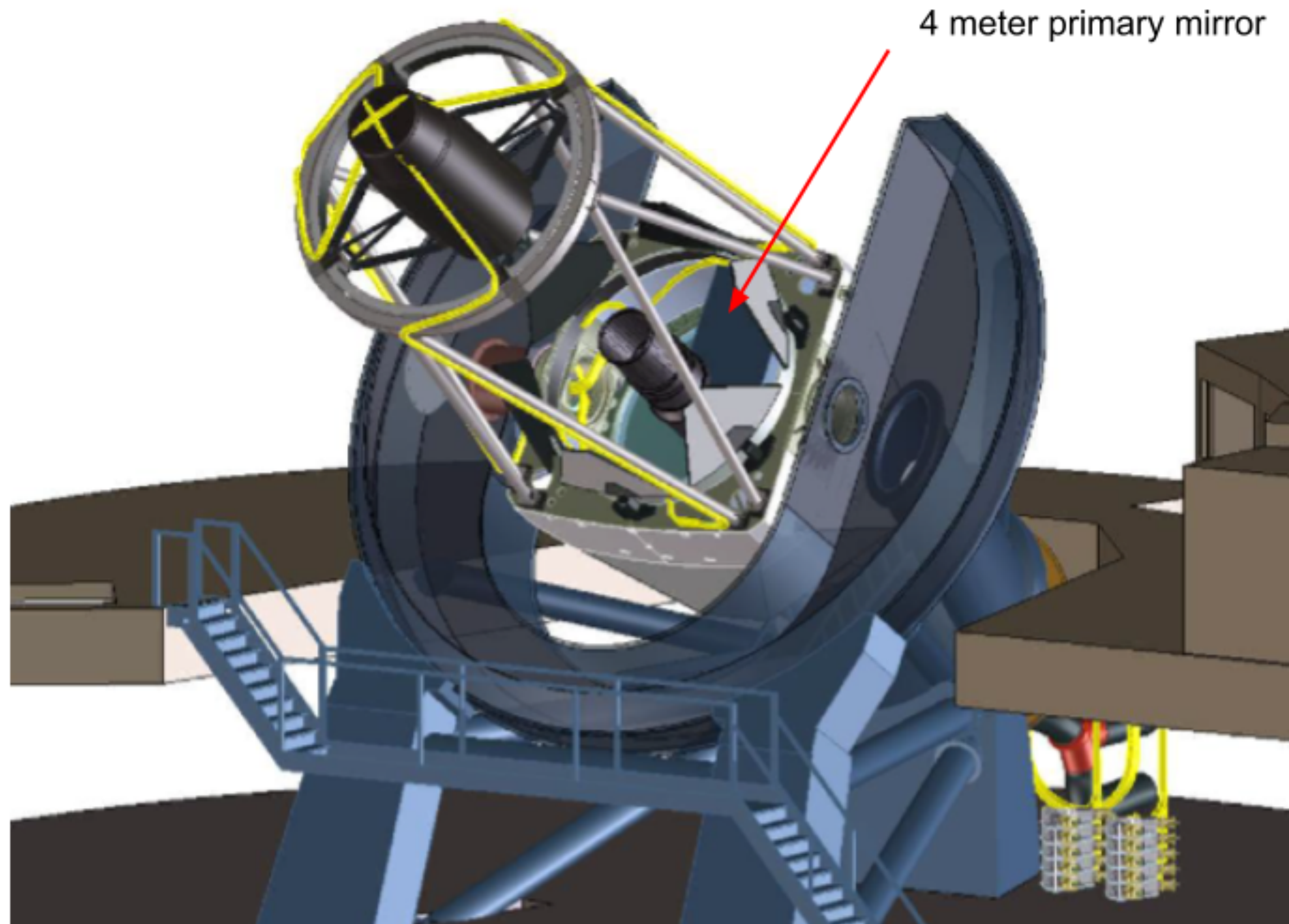
- Data Release 9: legacysurvey.org/dr9
- Interactive sky viewer: legacysurvey.org/viewer

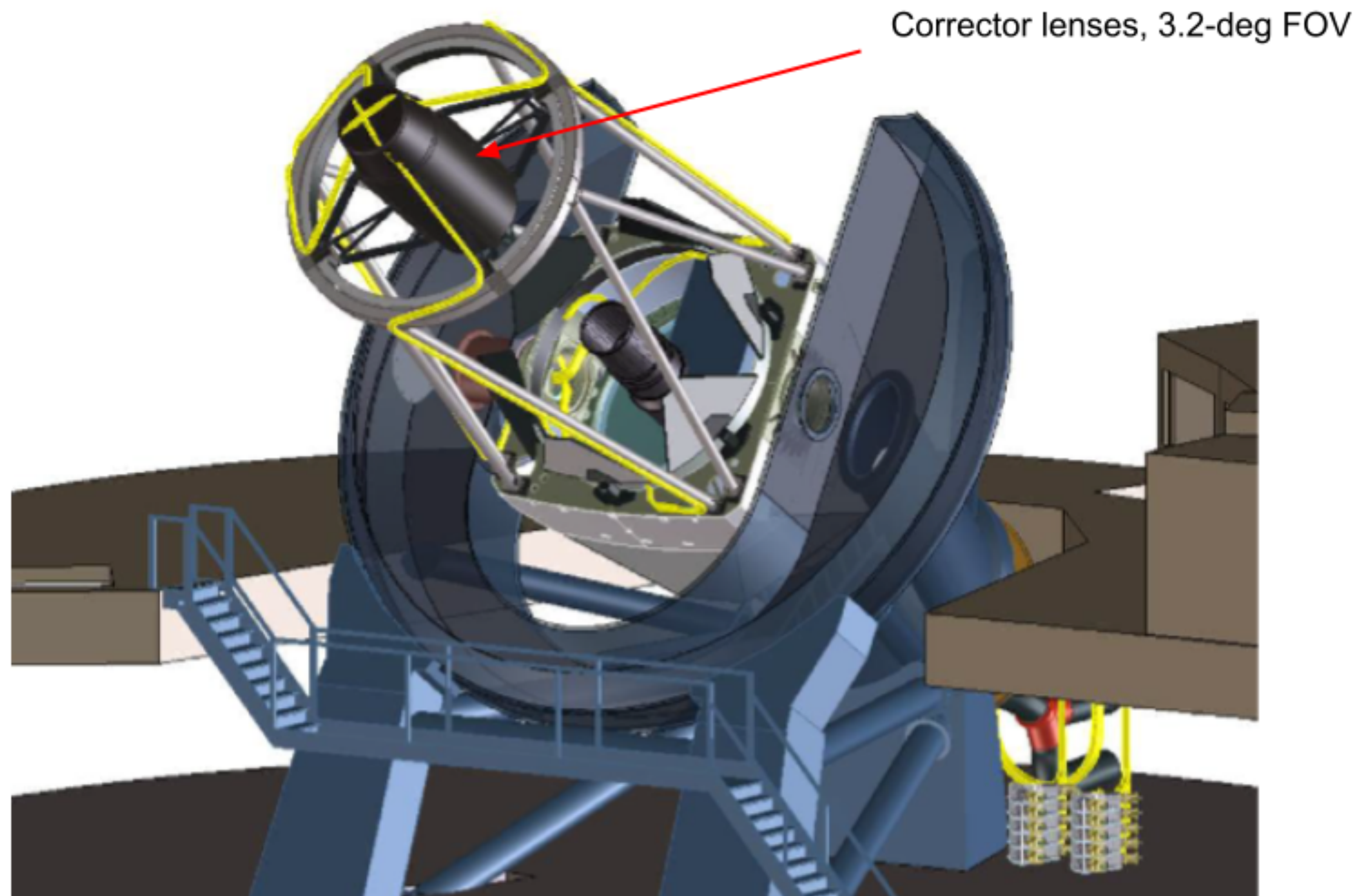
Kitt Peak National Observatory
Iolkam Du'ag

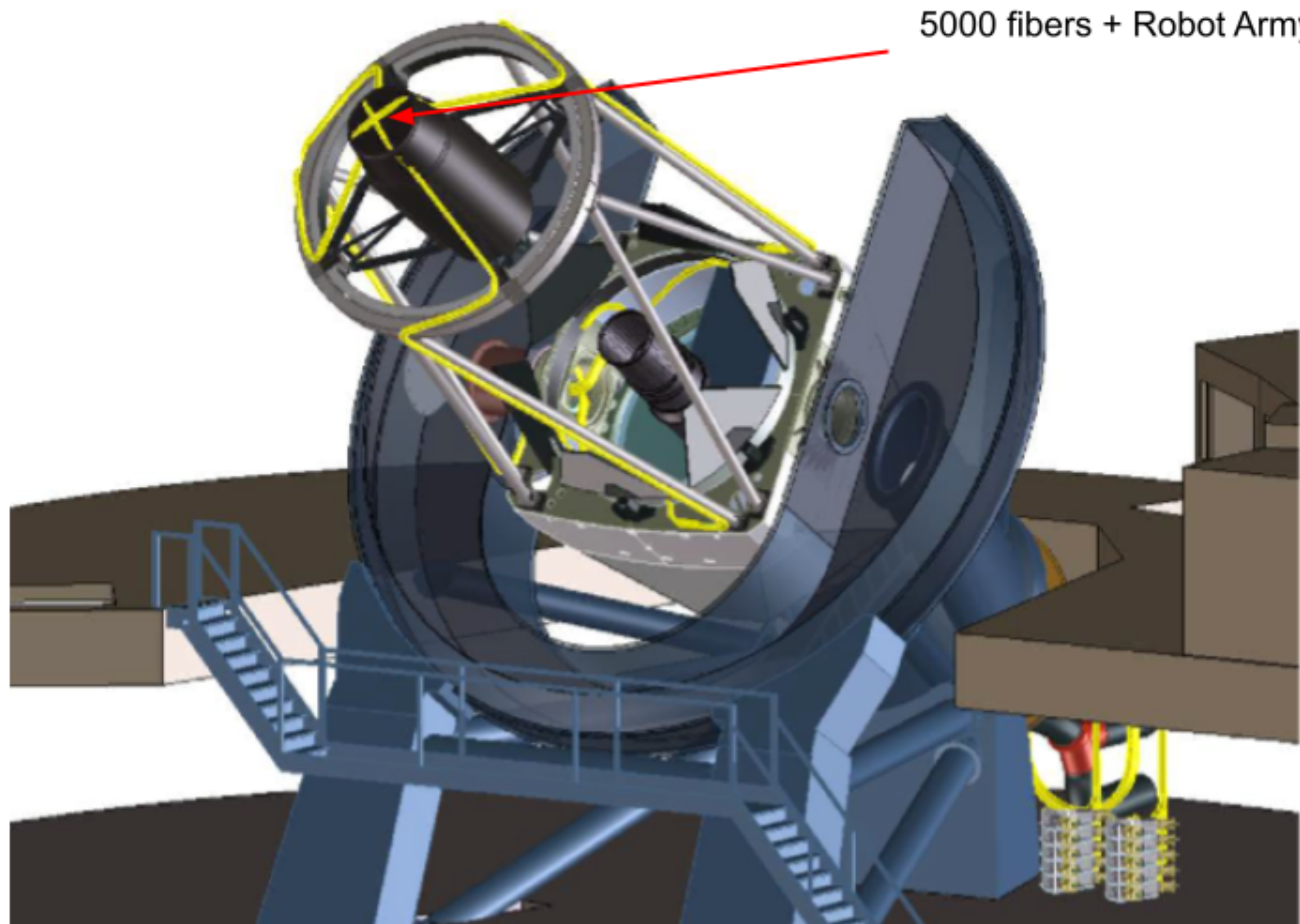


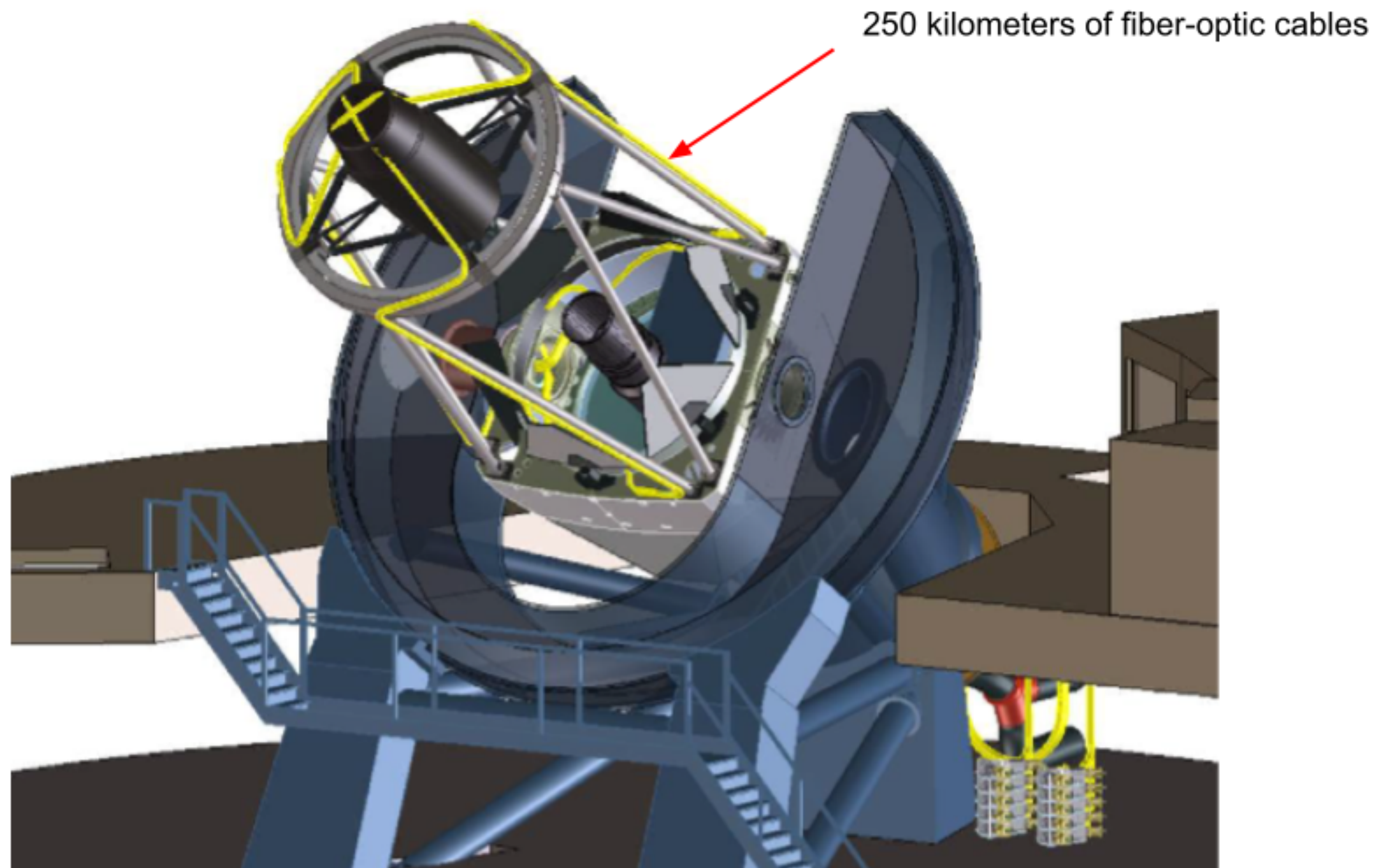
Mayall Telescope

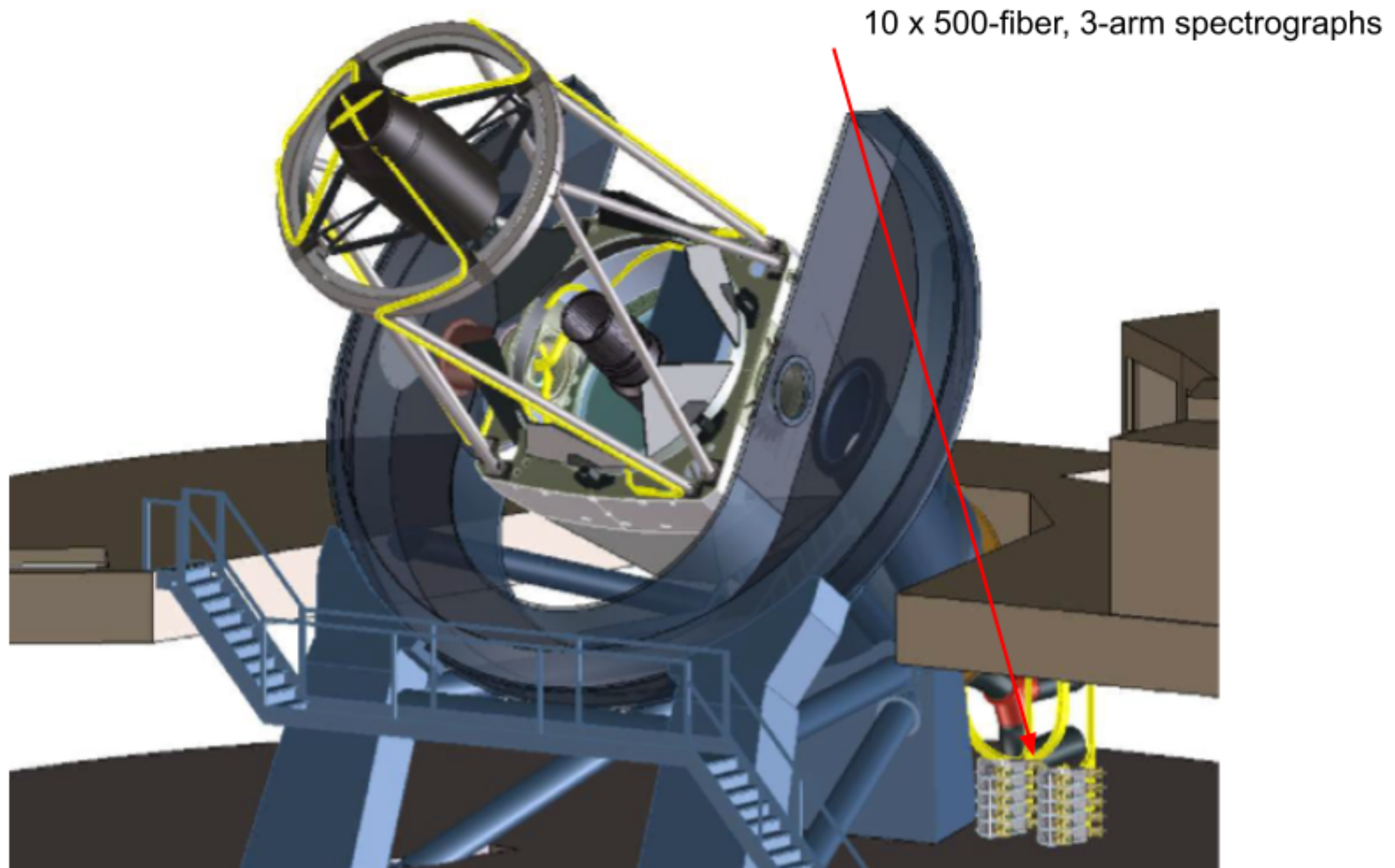


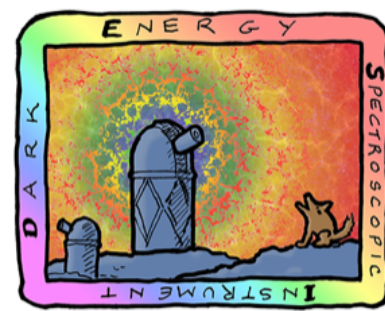








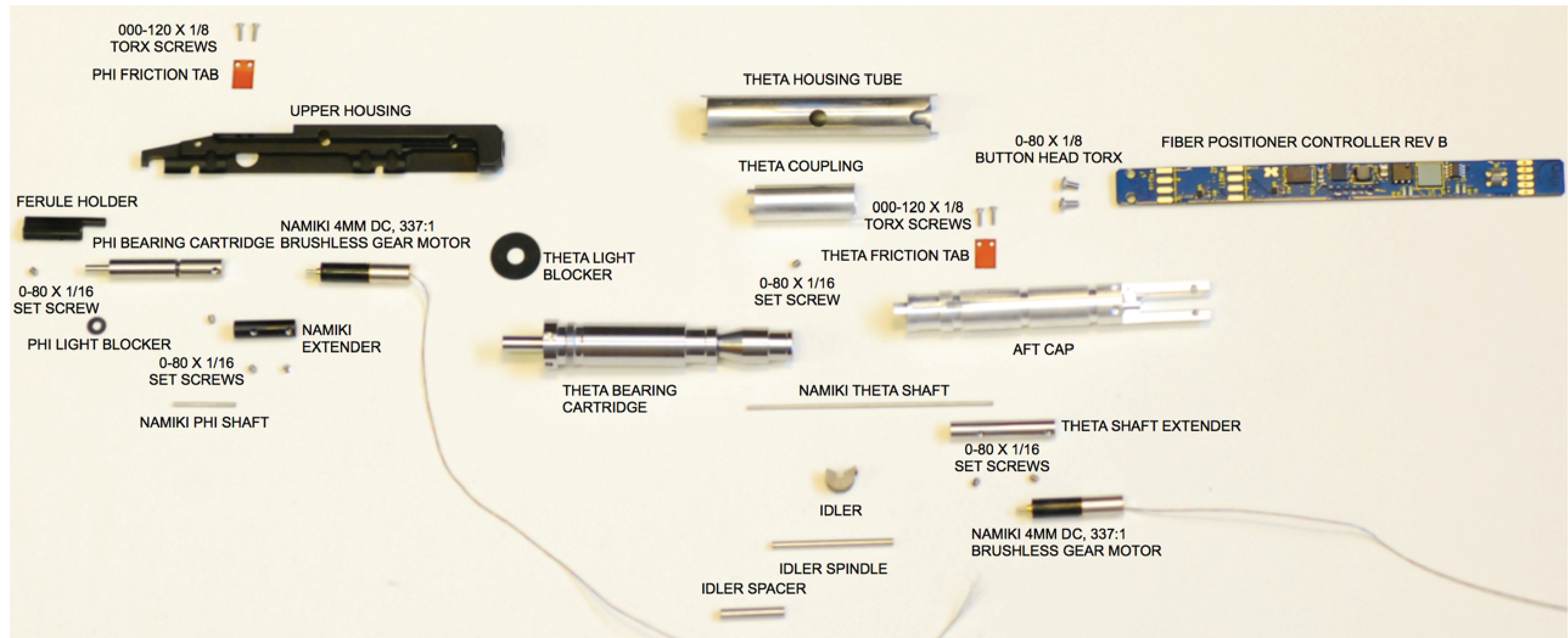
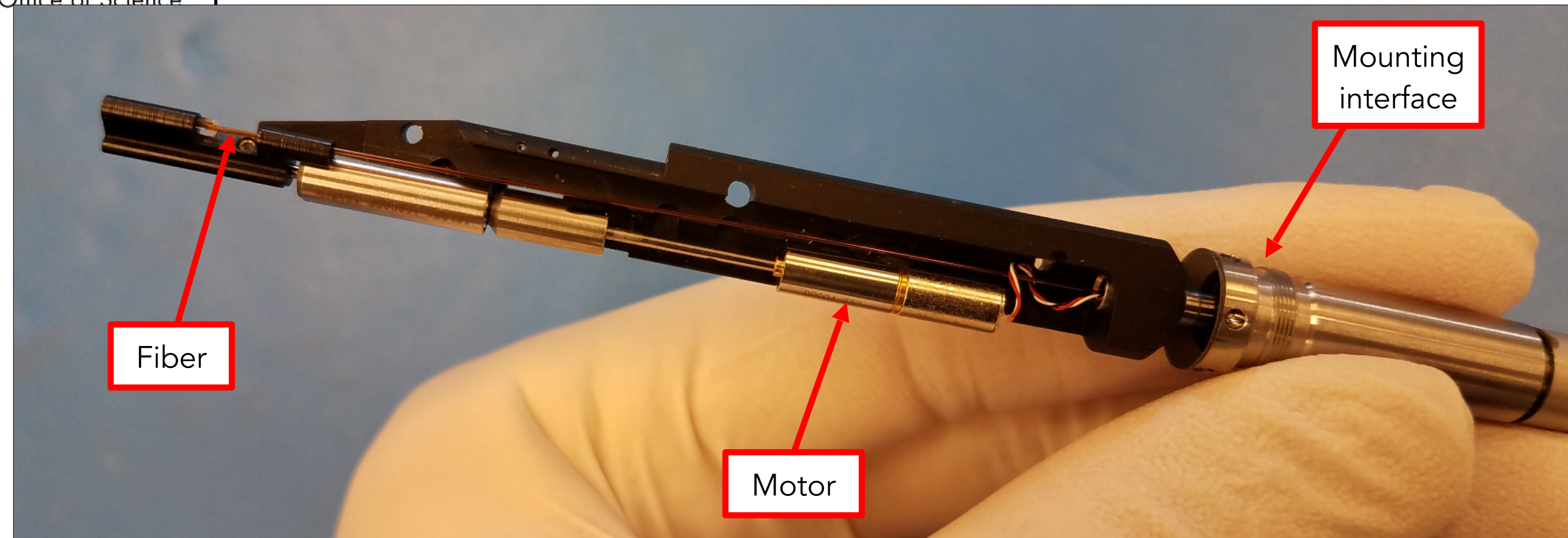


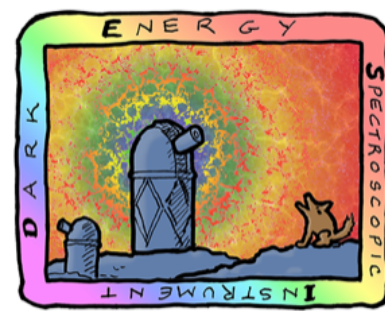


DARK ENERGY SPECTROSCOPIC INSTRUMENT

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DESI fiber robot positioners

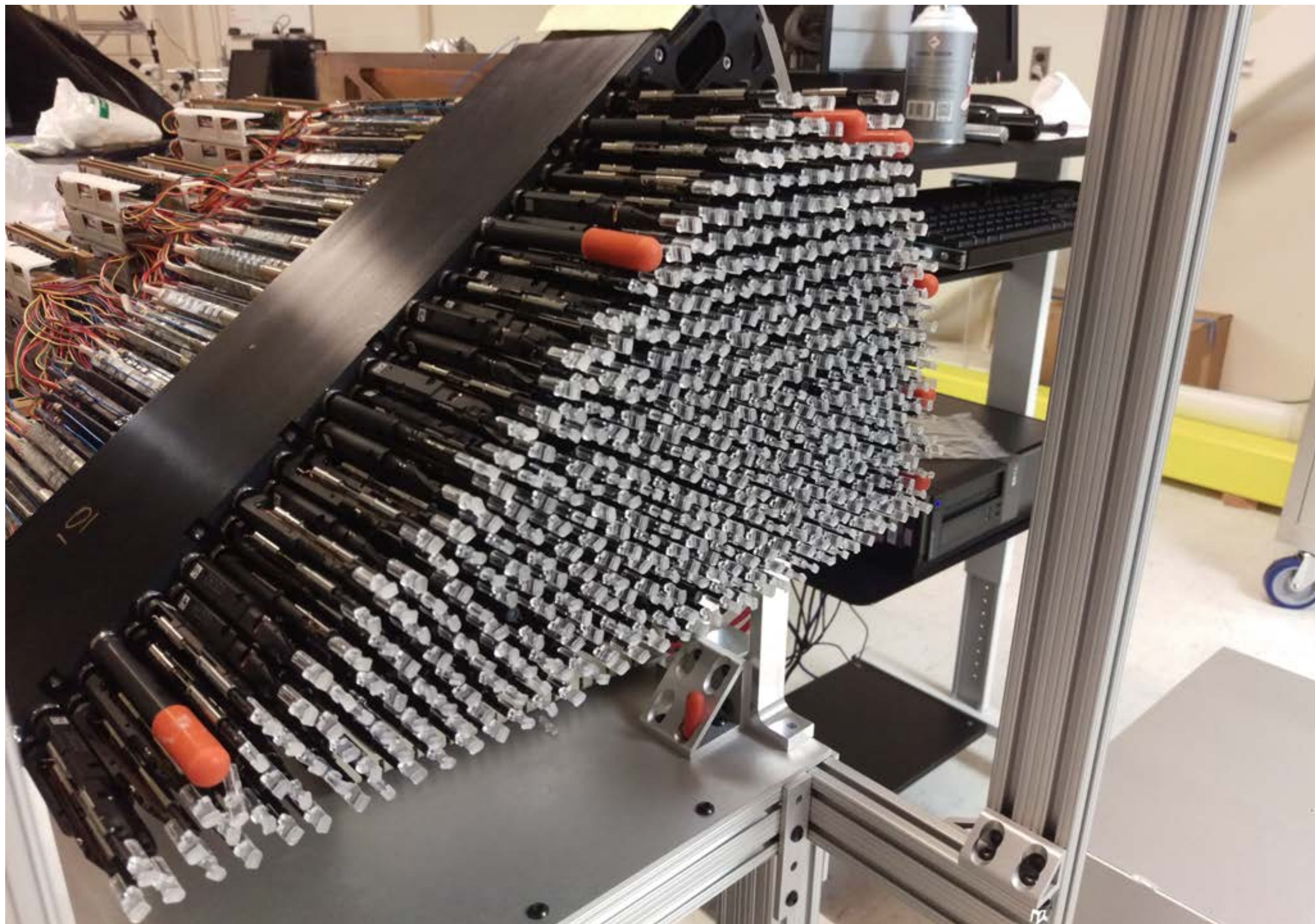


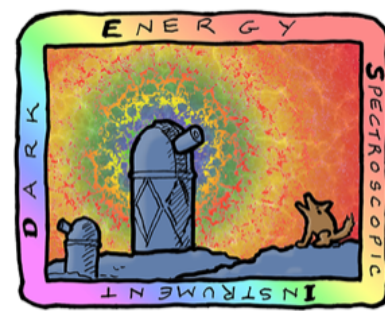


DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

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DESI “petal”

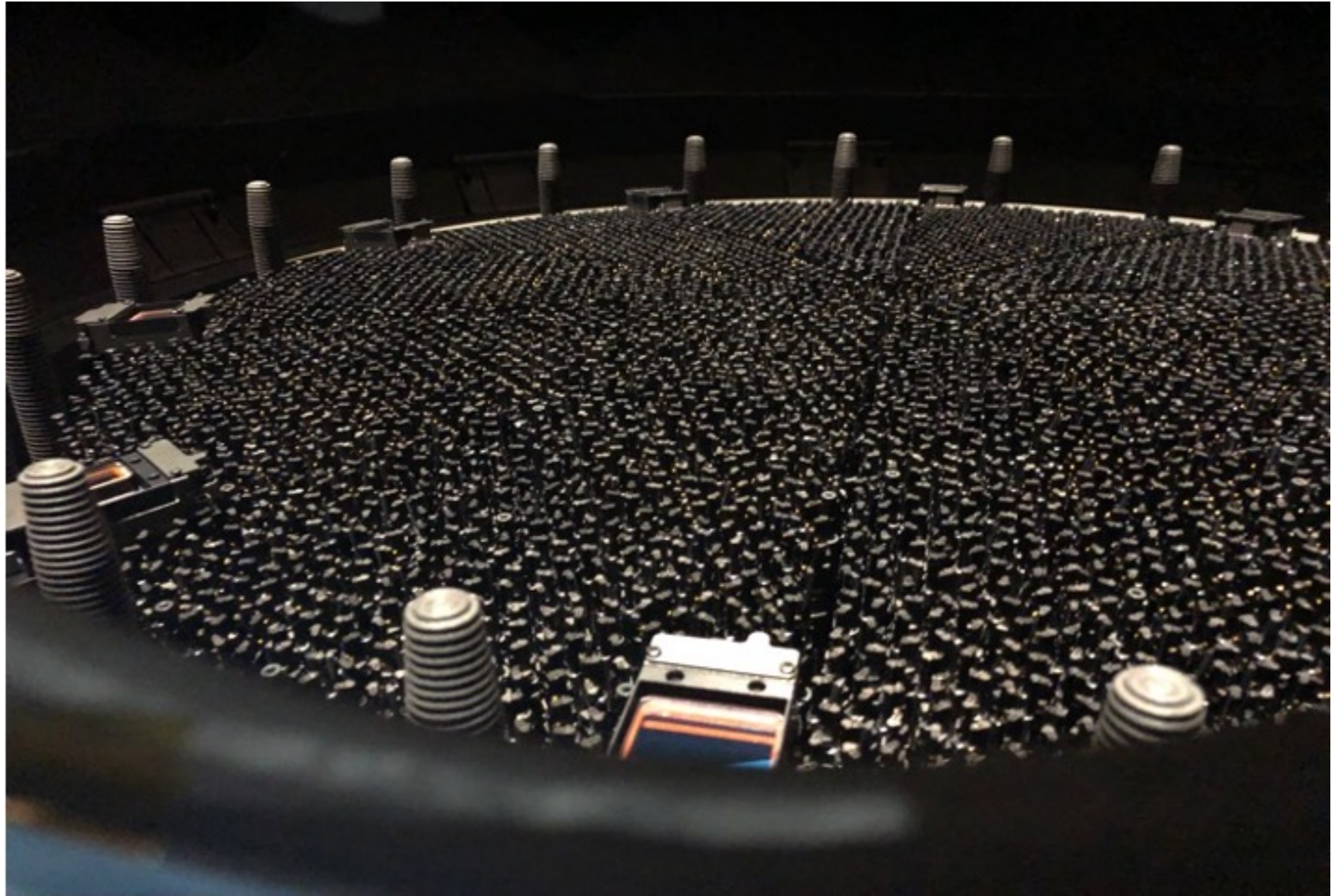


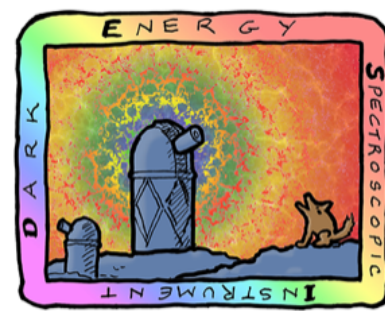


DARK ENERGY
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DESI full focal plane

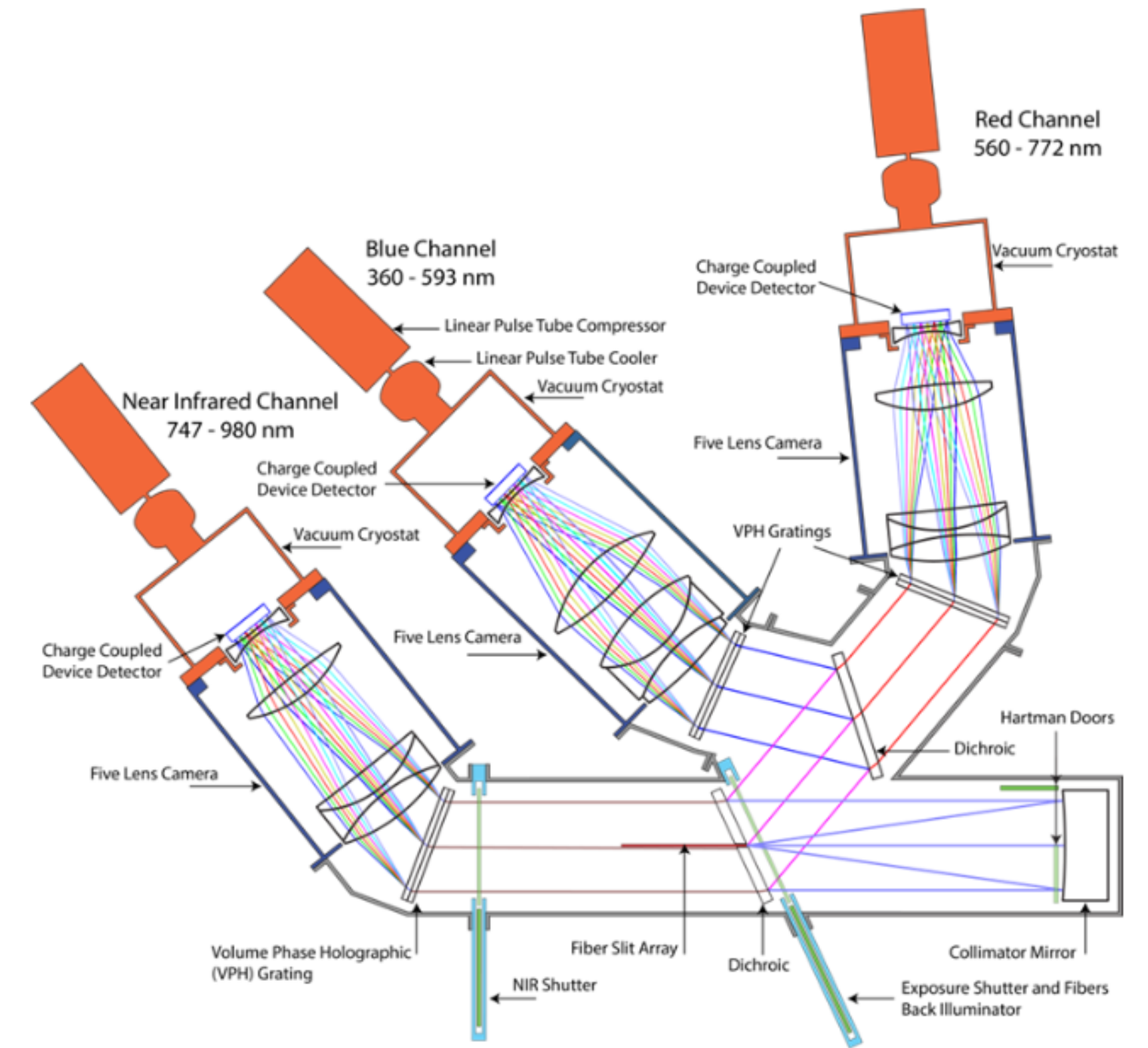
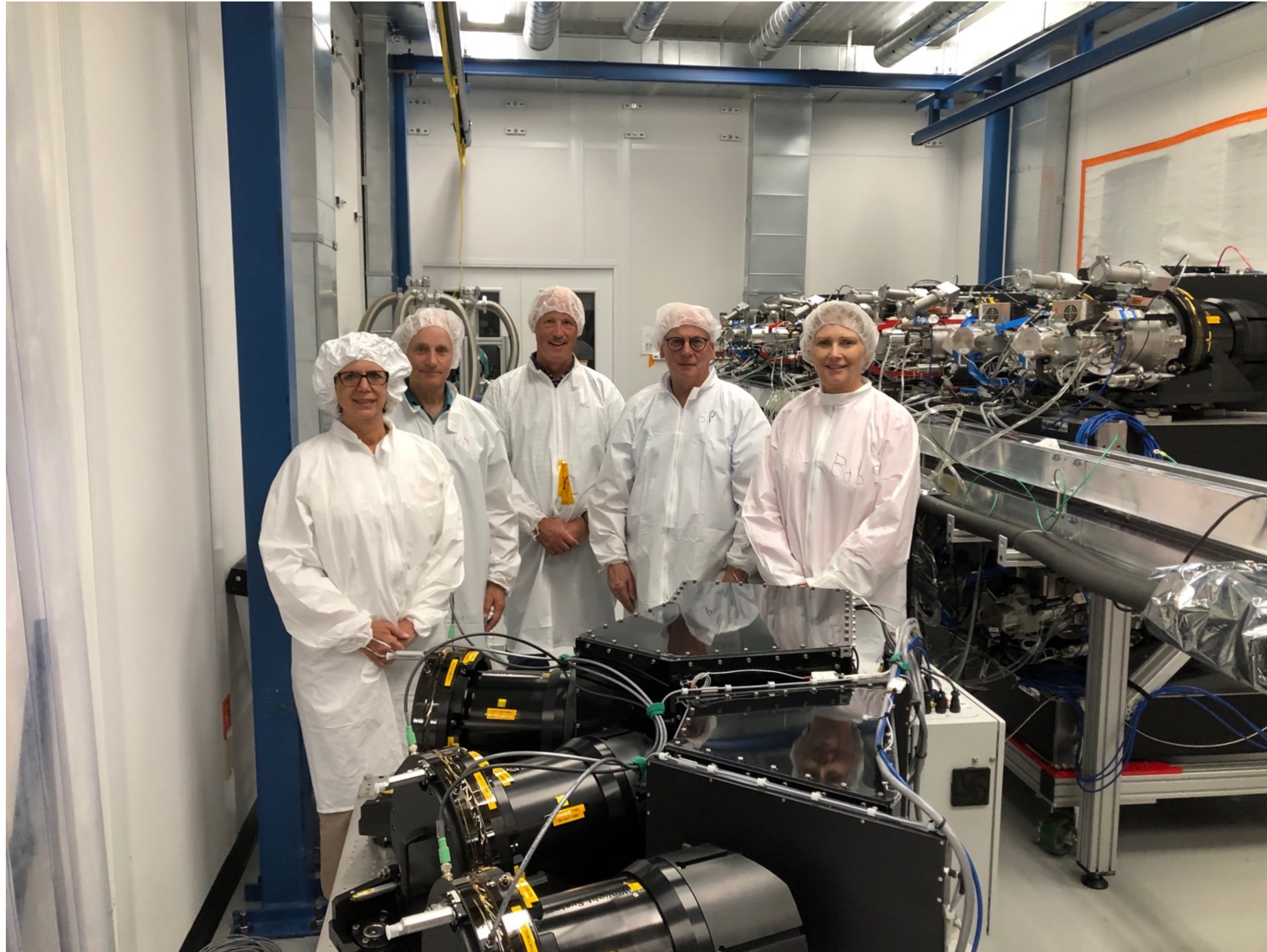


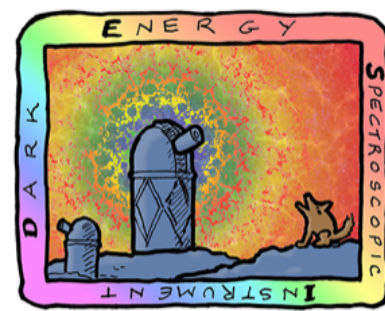


DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

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DESI spectrographs

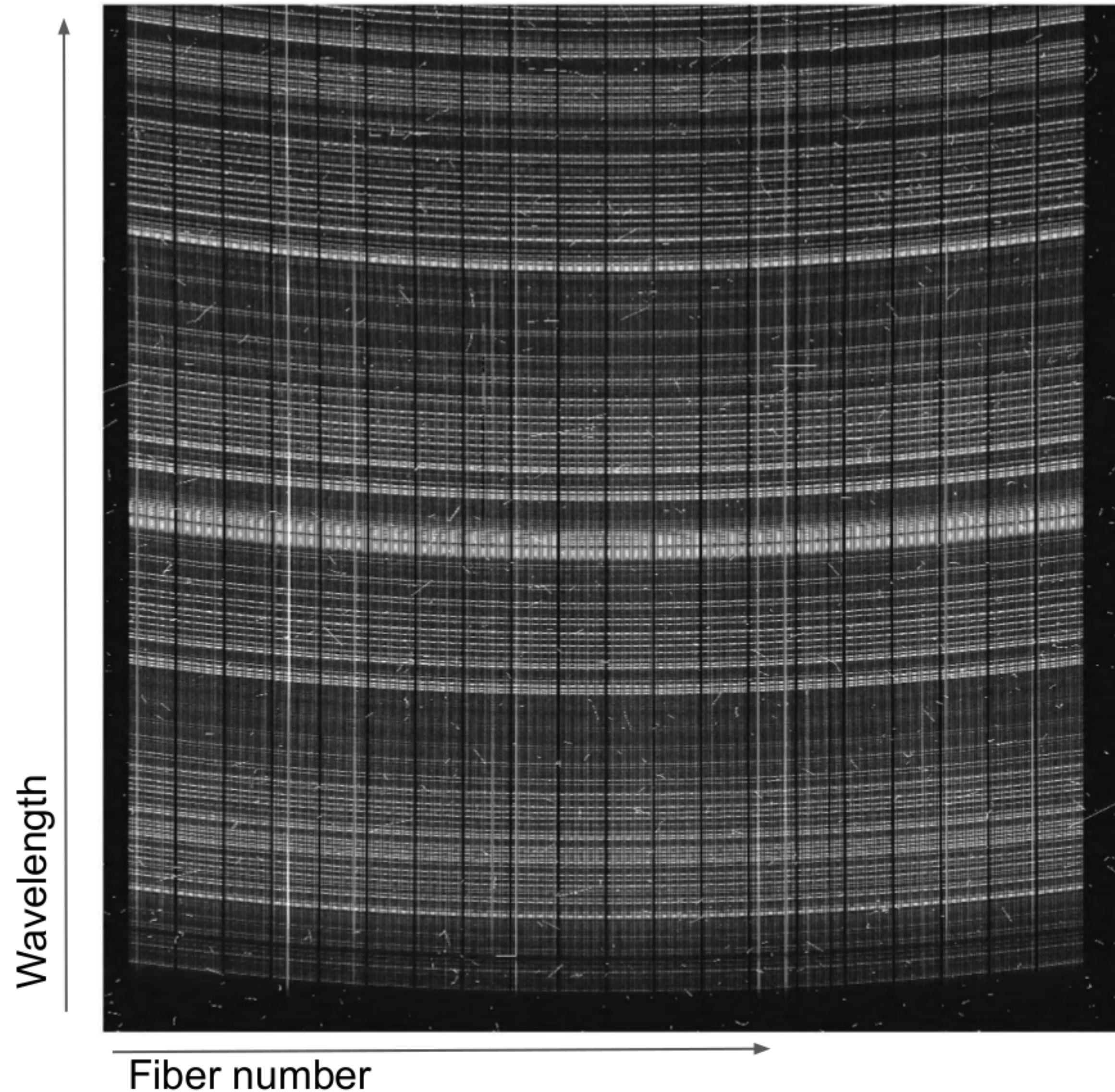




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DARK ENERGY
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INSTRUMENT

DESI raw data

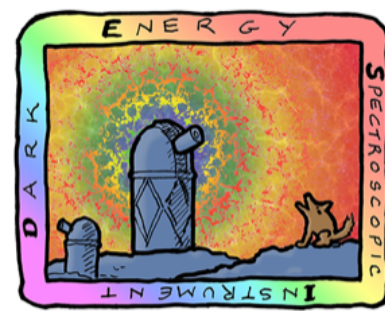


One (near-IR channel) CCD

500 fibers (columns)

Curved horizontal lines are the
the sky spectrum

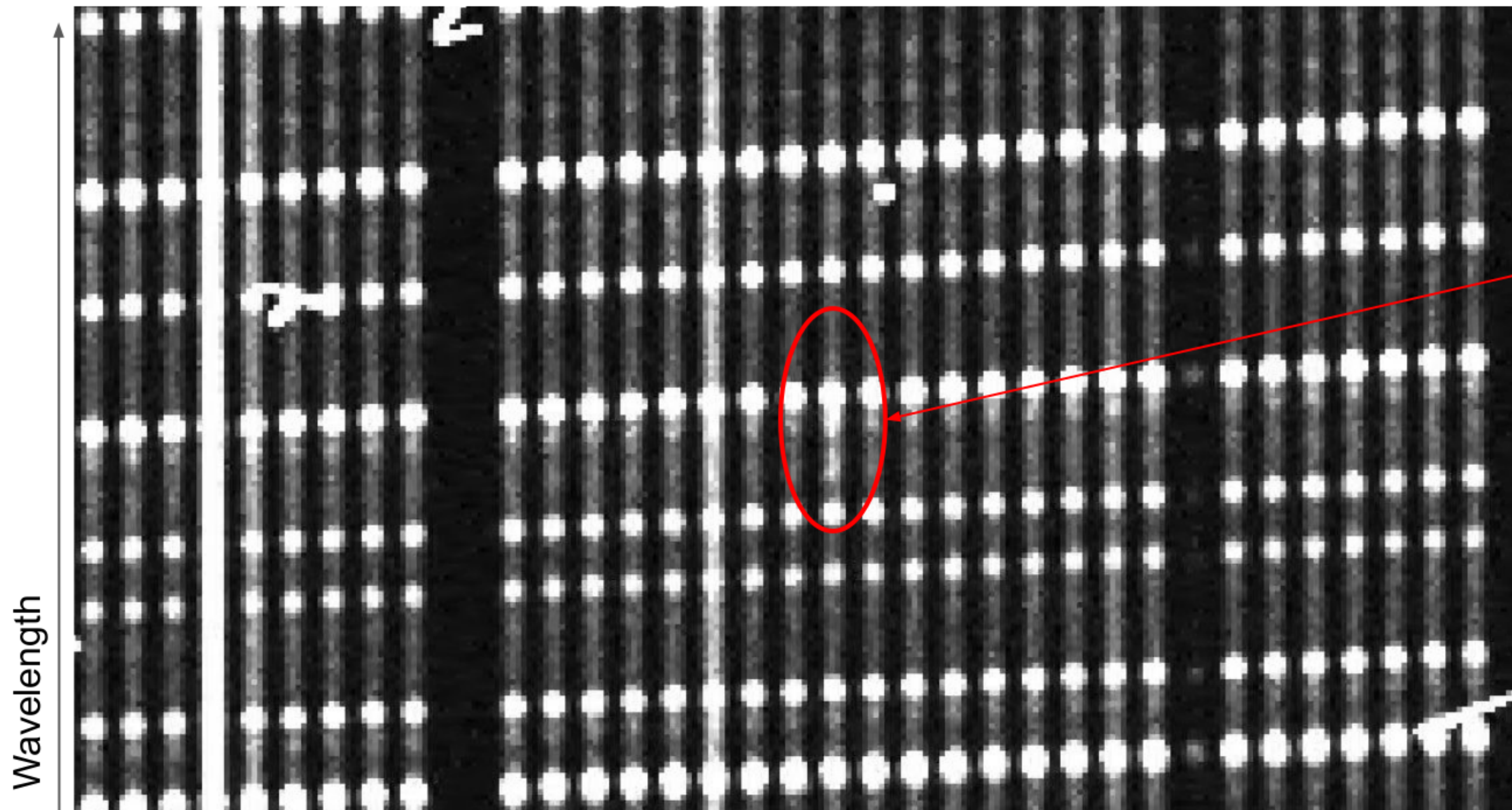
Credit: Julien Guy (LBNL)



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DARK ENERGY
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INSTRUMENT

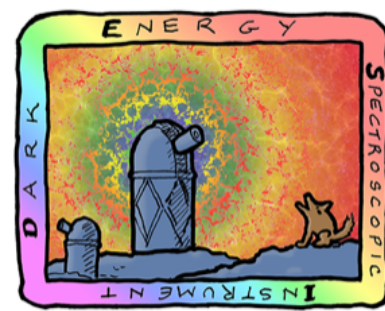
DESI raw data



[OII] doublet
from an Emission Line
Galaxy (ELG)
At $z = 1.09$
In fiber #358

Fiber number

Credit: Julien Guy (LBNL)

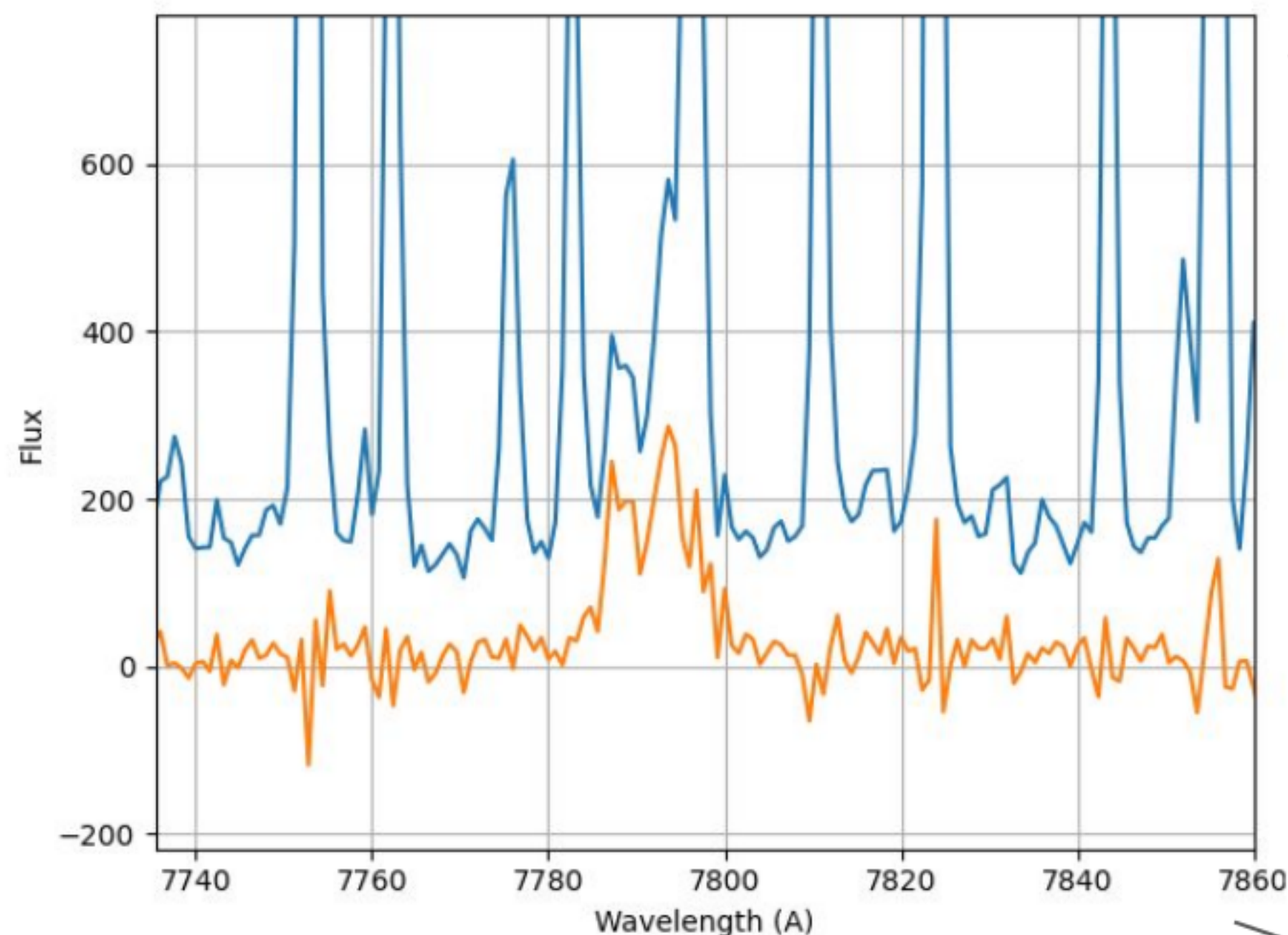


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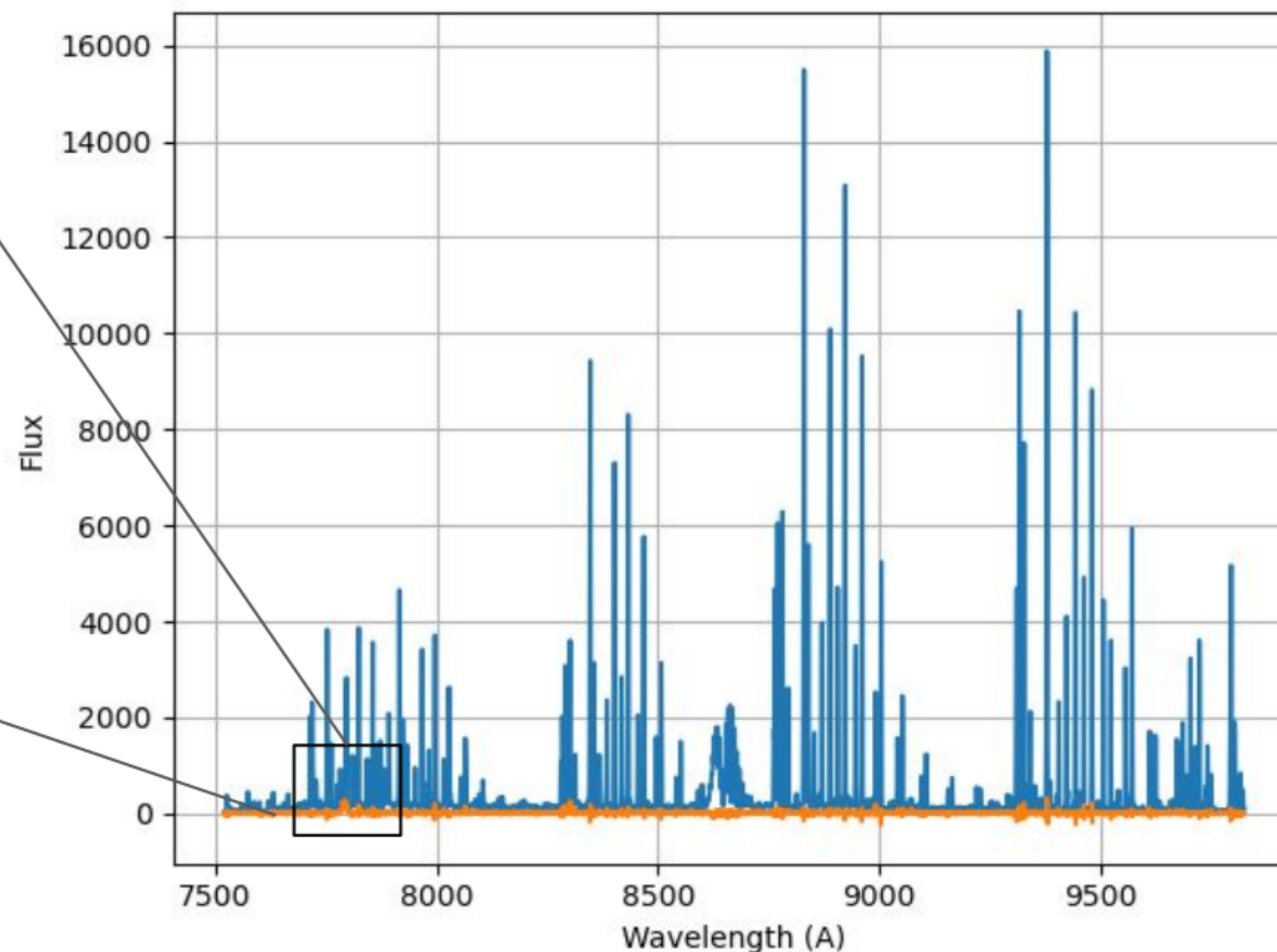
DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

DESI raw data

Extracted spectrum of fiber #358 for this exposure before and after the subtraction of the sky background



[OII] doublet from an Emission Line Galaxy between 7780 and 7800A ($z = 1.09$) in fiber #358

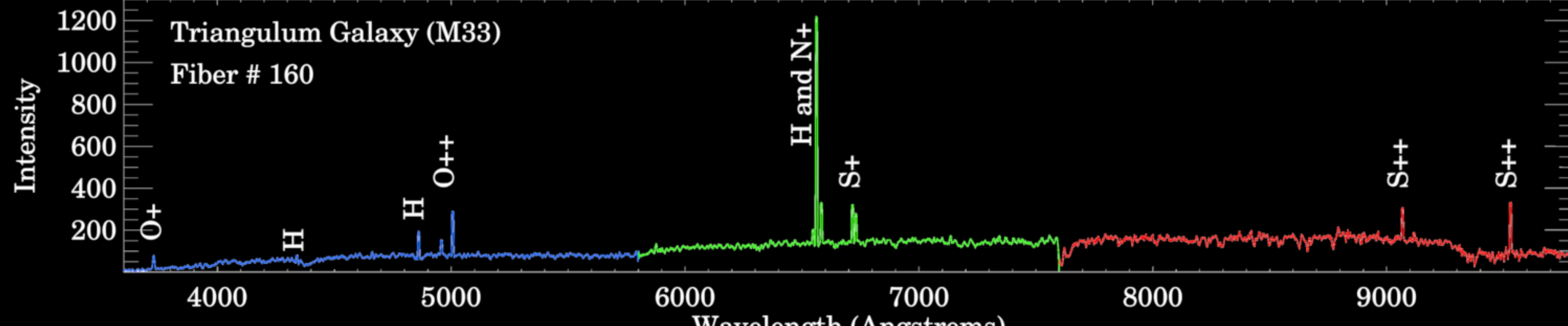


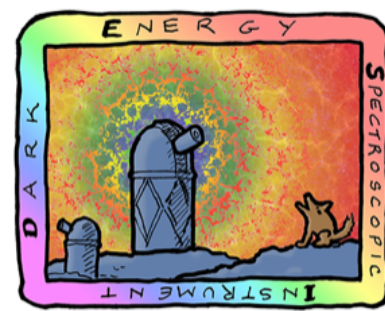
Credit: Julien Guy (LBNL)

DESI "First Light" on Oct 22, 2019

500 fibers on Triangulum Galaxy (M33)

3.2 degrees

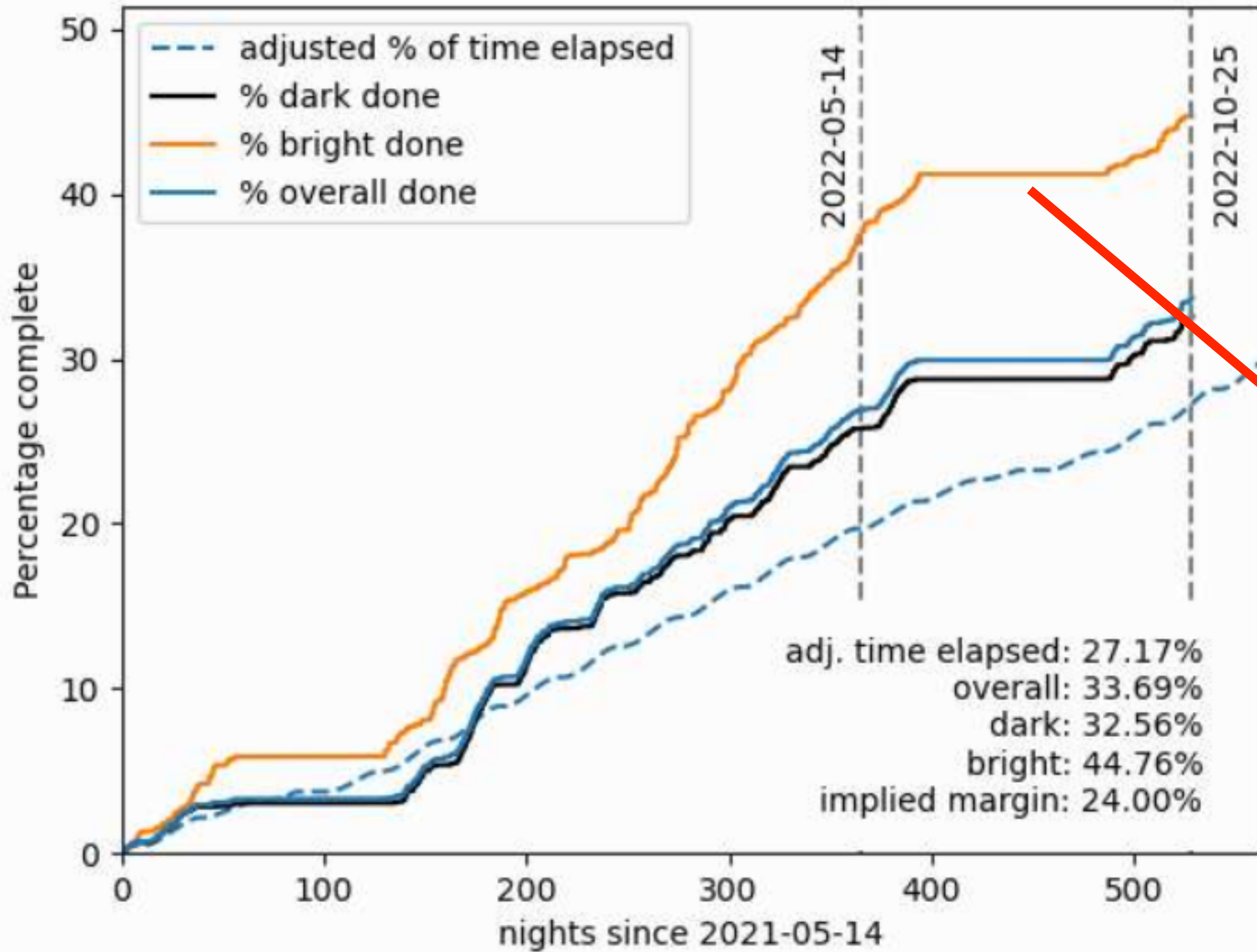




DARK ENERGY
SPECTROSCOPIC
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DESI survey rate - ahead of schedule



→ **13 million galaxies+quasars is far more than all surveys prior to DESI !**

→ **Contreras wildfire swept over Kitt Peak**

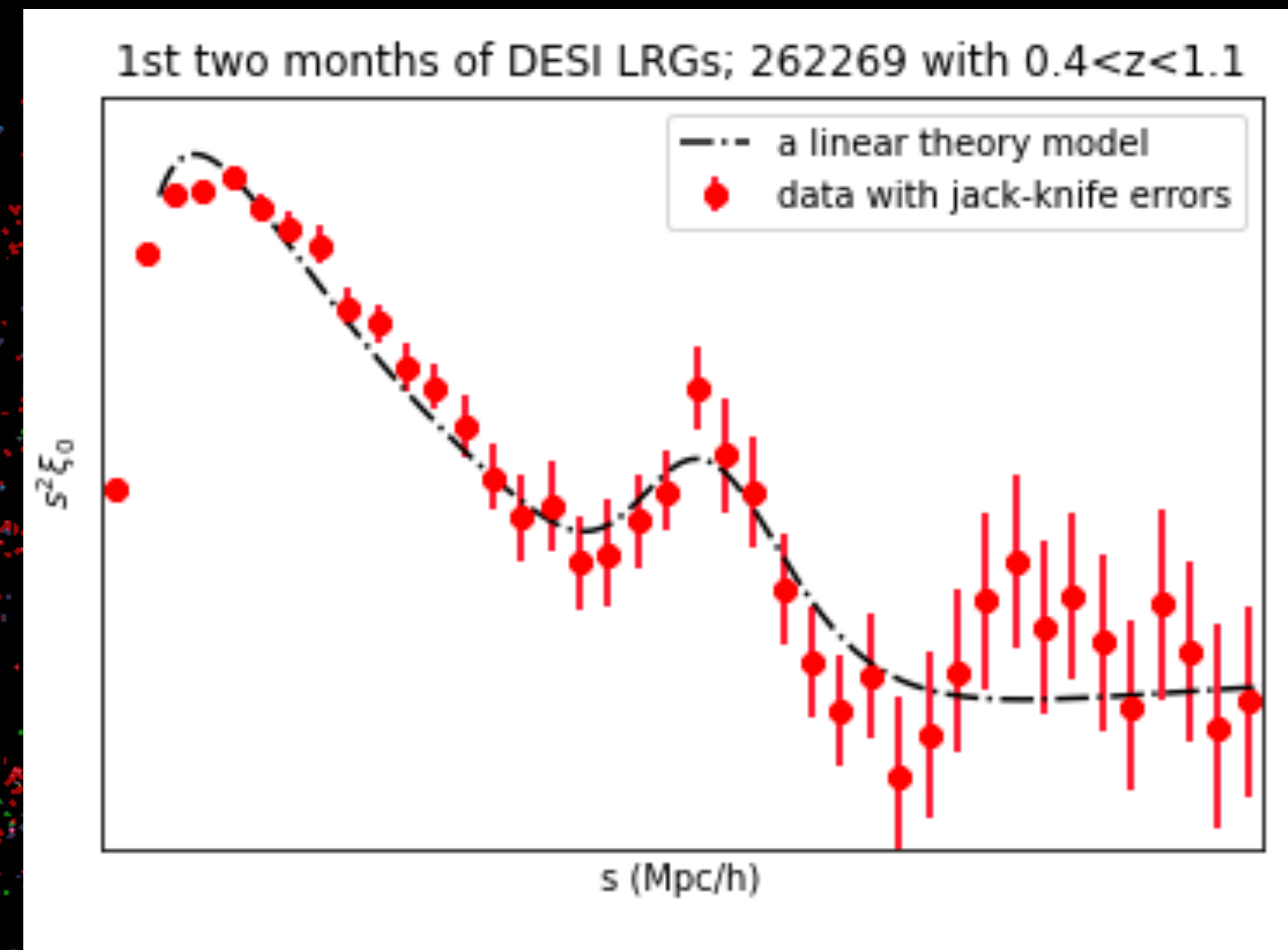
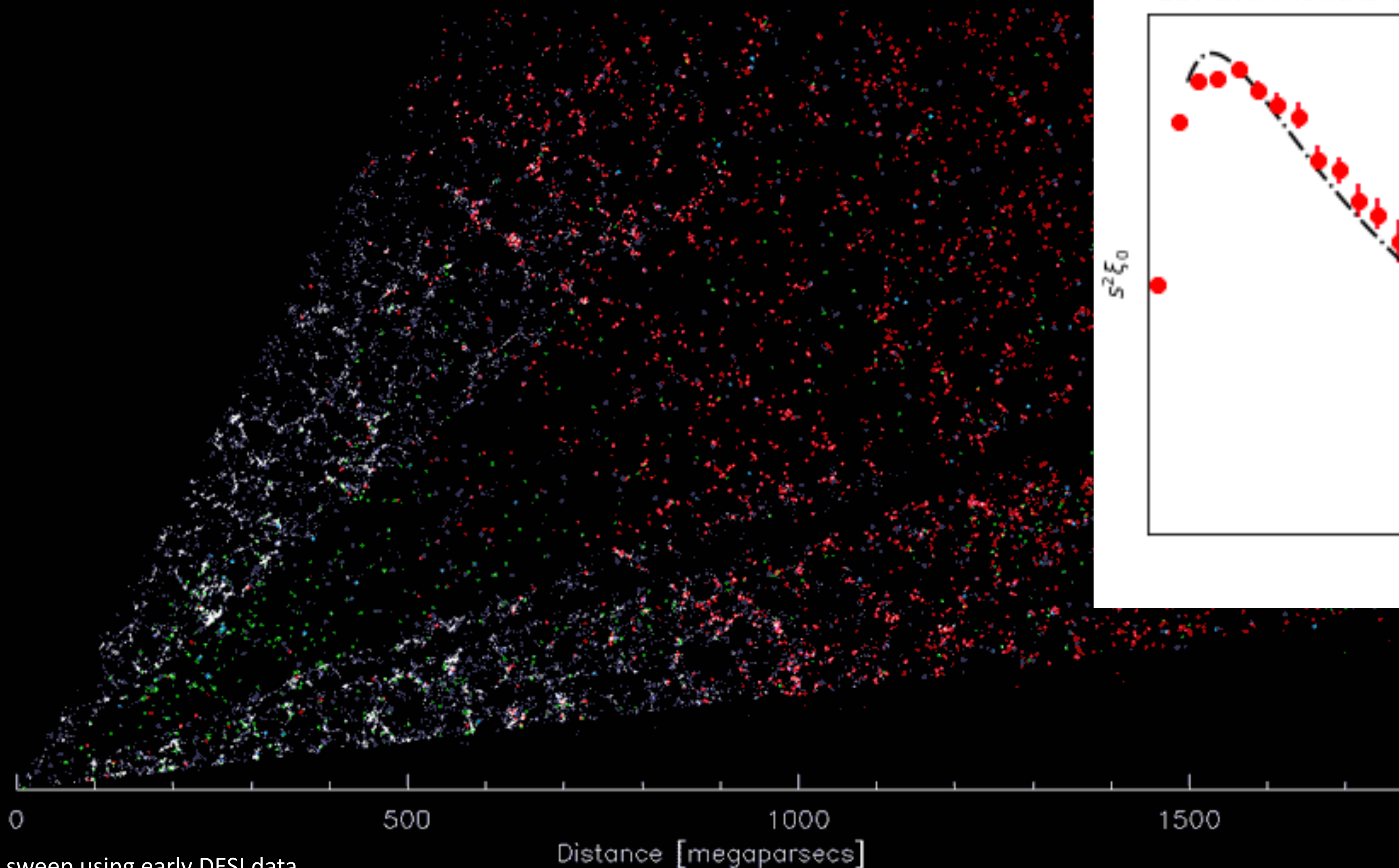


Image Credit: KPNO/NOIRLab/NSF/AURA

Z:1
2022-06-17 05:49:11
KPNO Mayall 4m

DESI on track for cosmology results in 2023

Large-scale clustering from 1st two months (unblinded) data





Thanks to our sponsors & 69 participating institutions!



RA,Dec = 194.9405, 27.9433, zoom 13

GALAXY (BROADLINE) z=0.020

QSO z=6.755 (Zwarn=0x5)

SDSS redshifts near Coma cluster

+

—

GALAXY z=0.463
GALAXY z=0.024

GALAXY z=0.017

GALAXY z=0.021

GALAXY z=0.022

GALAXY z=0.028

GALAXY z=0.023

GALAXY (BROADLINE) z=0.019

GALAXY z=0.025
GALAXY z=0.022

GALAXY z=0.031

GALAXY z=0.025

GALAXY z=0.018

100 arcsec GALAXY z=0.021 GALAXY z=0.021

GALAXY z=0.023

GALAXY z=0.024

GALAXY z=0.024

GALAXY z=0.027

GALAXY z=0.024

Contrast: 1

Brightness: 1

Jump to object: coma cluster

Custom catalog upload (FITS table; RA,Dec,[name]):
Choose File No file chosen Upload

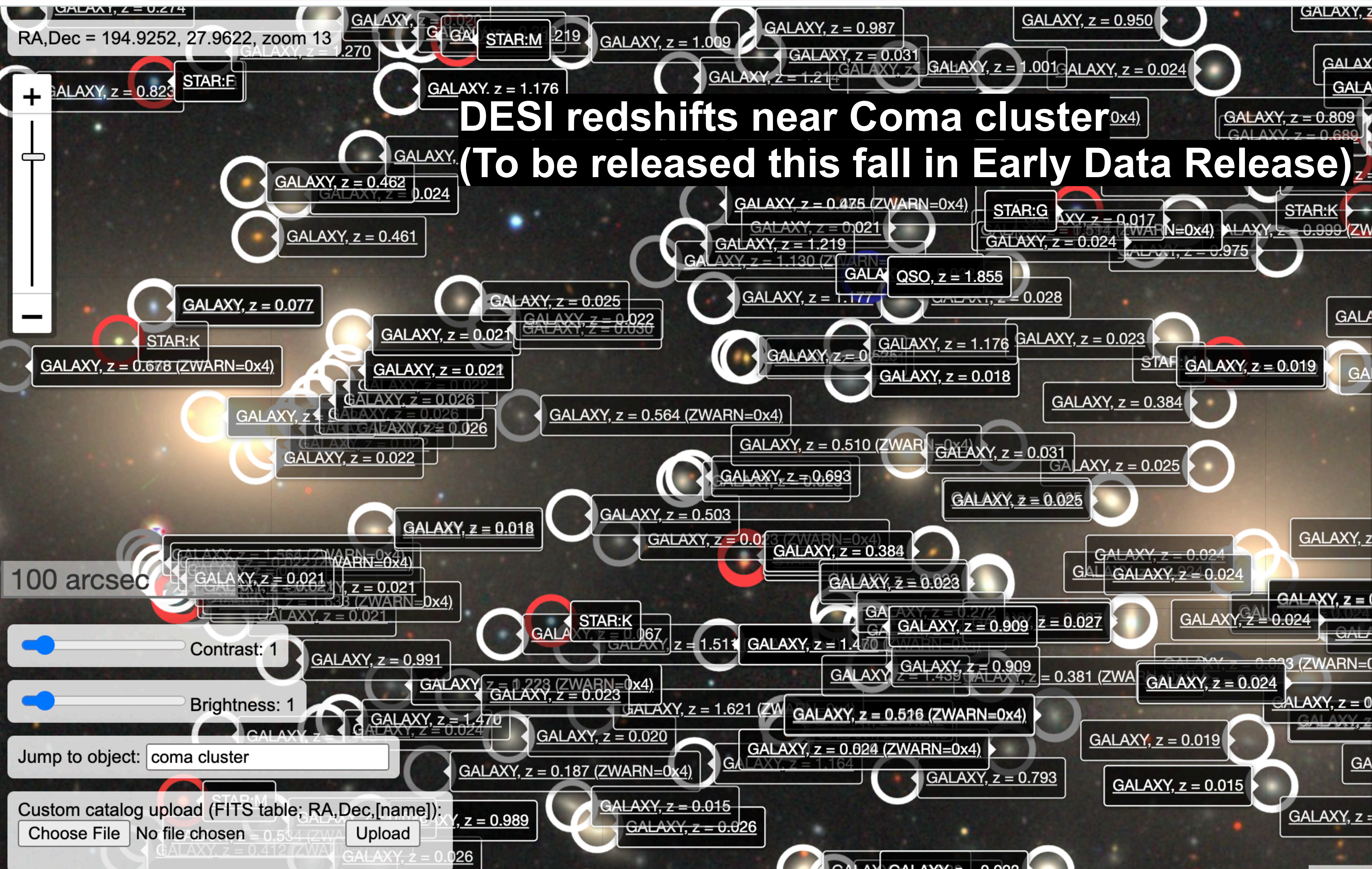
GALAXY z=0.027

GALAXY z=0.026

GALAXY GALAXY z=0.023

- Images
 - Legacy Surveys DR9 images
 - Legacy Surveys DR9 models
 - Legacy Surveys DR9 residuals
 - Legacy Surveys DR9.1.1 COSMOS
 - Legacy Surveys DR9.1.1 COSMOS
 - Legacy Surveys DR9.1.1 COSMOS
 - + Legacy Surveys DR9-north images
 - + Legacy Surveys DR9-south images
 - + Older Legacy Surveys
 - + unWISE W1/W2 NEO6
 - + More surveys

- Overlays
 - + Boundaries
 - + Imaging catalogs
 - Spectroscopy
 - MaNGa IFU Spectra
 - SDSS Spectra
 - SDSS Spectro Plates
 - DEEP2 Spectra
 - DESI
 - DESI Footprint
 - DESI Fibers
 - DESI Denali tiles
 - DESI Denali spectra
 - DESI daily tiles
 - DESI daily spectra
 - DESI Dark-time Targets (DR9/M
 - DESI Bright-time Targets (DR9/
 - DESI Dark-time Secondary Targ
 - DESI Bright-time Secondary Ta



- Images
 - Legacy Surveys DR9 images
 - Legacy Surveys DR9 models
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 - DESI
 - DESI Footprint
 - DESI Fibers
 - DESI Denali tiles
 - DESI Denali spectra
 - DESI daily tiles
 - DESI daily spectra
 - DESI Dark-time Targets (DR9/M)
 - DESI Bright-time Targets (DR9/M)
 - DESI Dark-time Secondary Targets
 - DESI Bright-time Secondary Targets

DESI survey rate — we're ahead of schedule

Main/DARK : 2462/9929 (=25%) completed tiles up to 20220512

