Synergies between DECam/DES and DESI

Paul Martini, The Ohio State University
On behalf of the DESI Collaboration

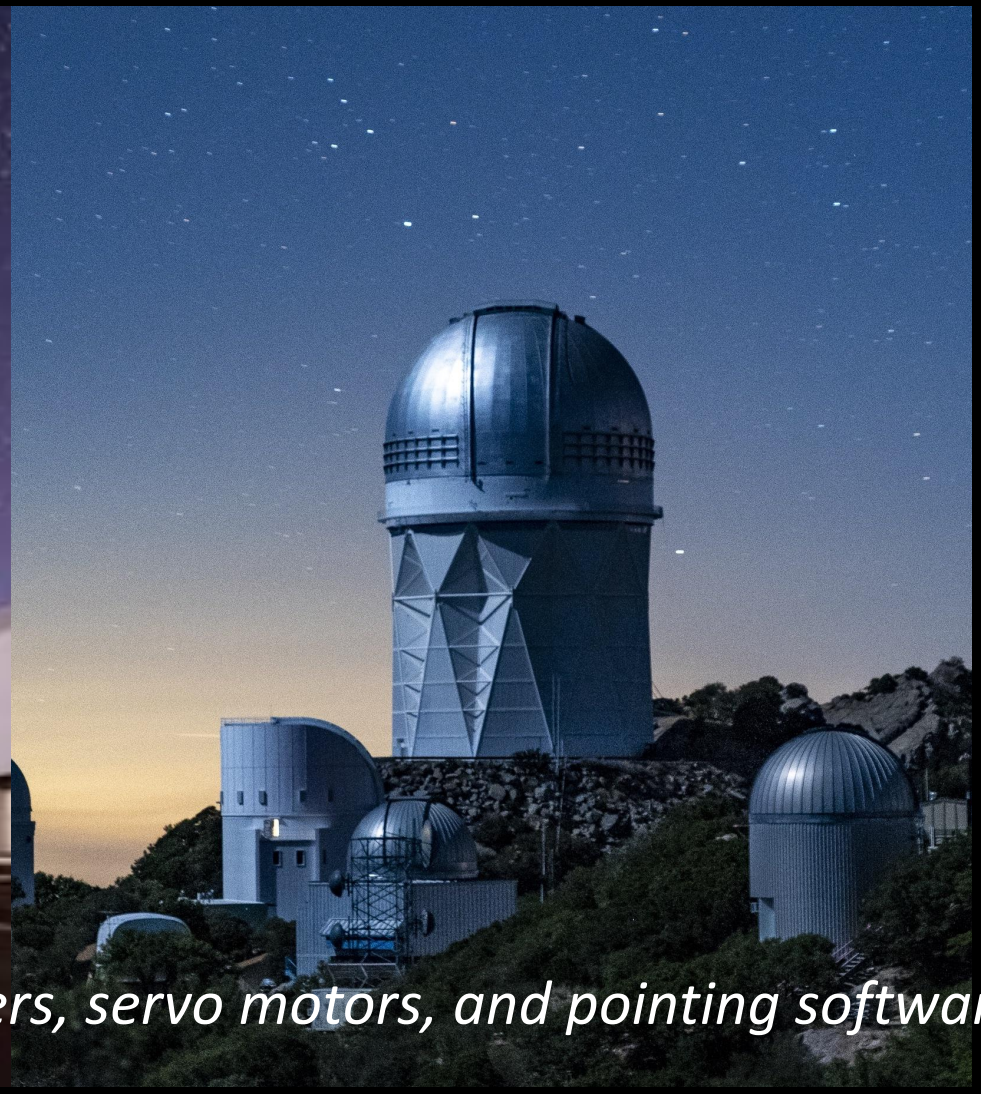
DECAM at 10 years - Looking back, looking forward
September 12-14, 2022
Tucson, AZ

synergy: the interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects

DARK ENERGY SPECTROSCOPIC INSTRUMENT

U.S. Department of Energy Office of Science

A Tale of Two Telescopes



Many upgrades including computers, encoders, servo motors, and pointing software

Image Credits: NOIRLab

DARK ENERGY SPECTROSCOPIC INSTRUMENT

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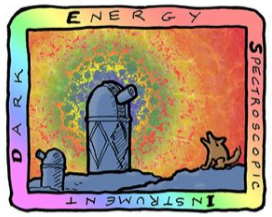
A Tale of Two Instruments

Outline:

1. Instrumentation synergies
2. Status of DESI
3. Concept of successive instrument development

Image Credits: NOIRLab



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Instrumentation Synergies

- Corrector Barrel
- Cage, Vanes, Hexapod
- Lens Mounts
- CCDs
- Active Optics System
- Instrument Software
- Telemetry Database
- Installation
- Management structure and personnel

So many!

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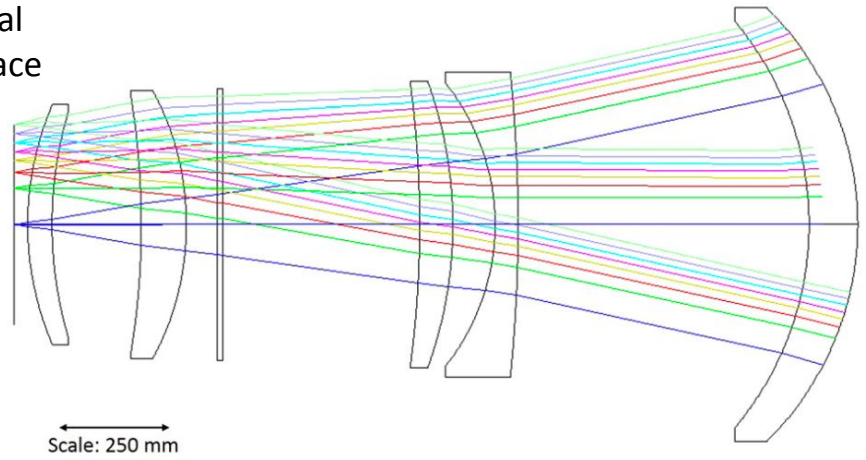
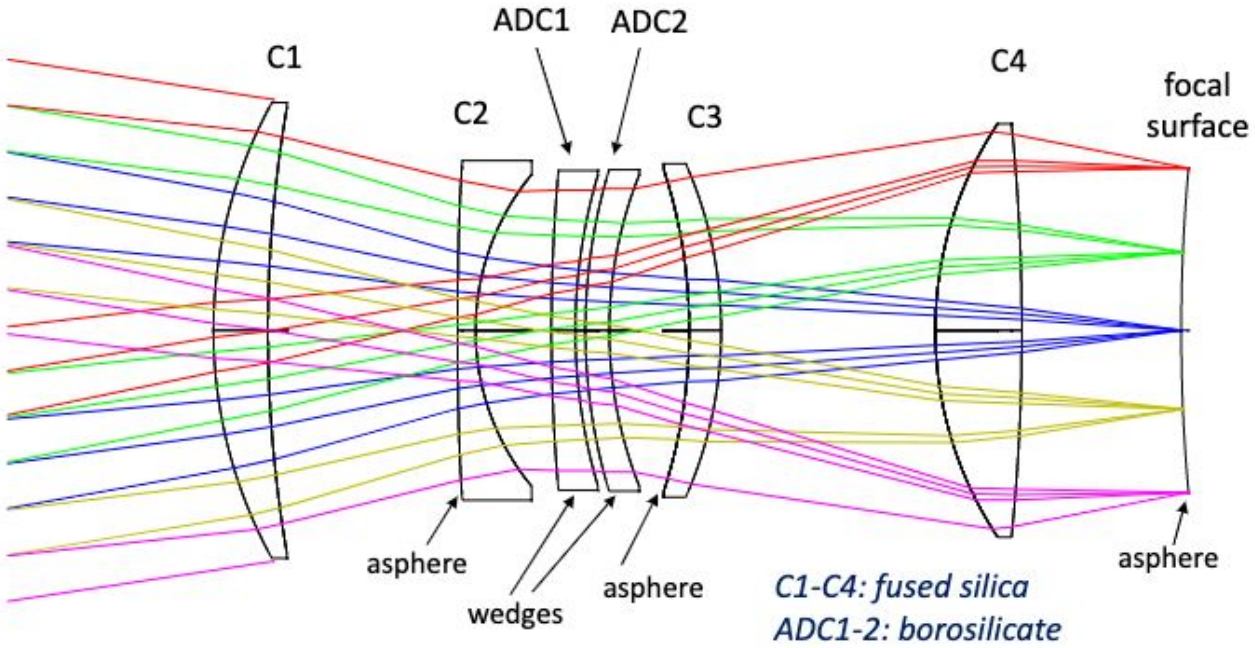
Optical Design



All DECam lenses are fused silica



Same relative scale

Flaugher, Diehl, Honscheid et al. (2015)

Miller, Besuner, Levi, et al. (2018)

DARK ENERGY SPECTROSCOPIC INSTRUMENT

U.S. Department of Energy Offi

Corrector Barrel, Vanes, Cage

Flaugher, Diehl, Honscheid et al. (2015)

Silber, Fagrelius, Fanning et al. (2022)

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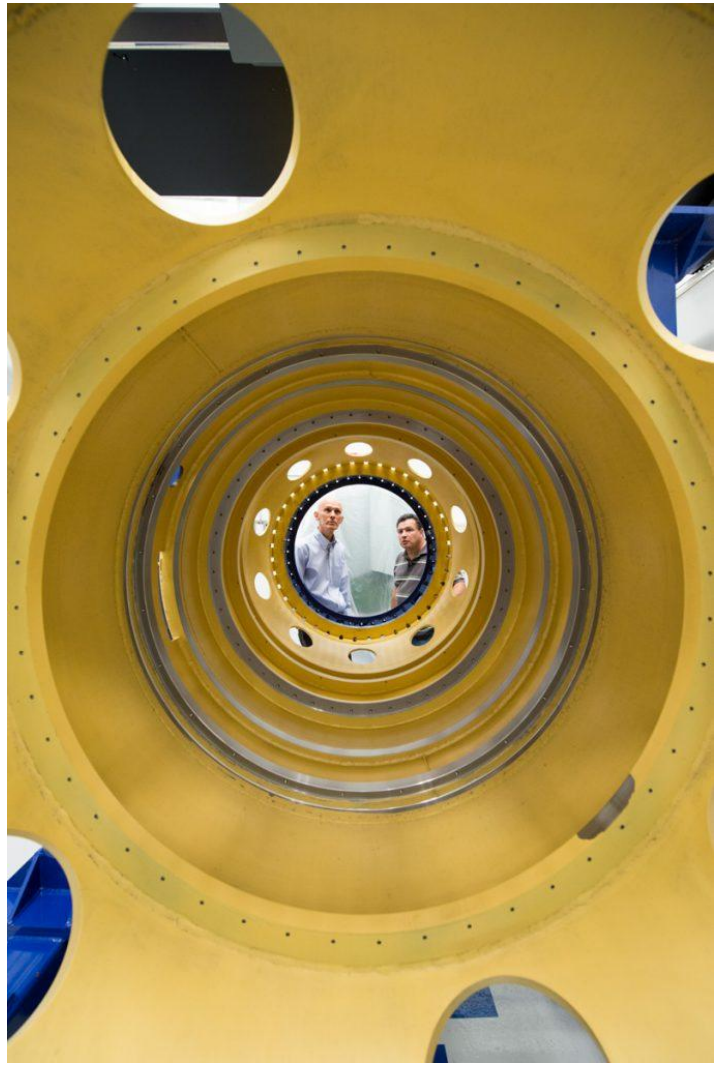
Precision Metrology



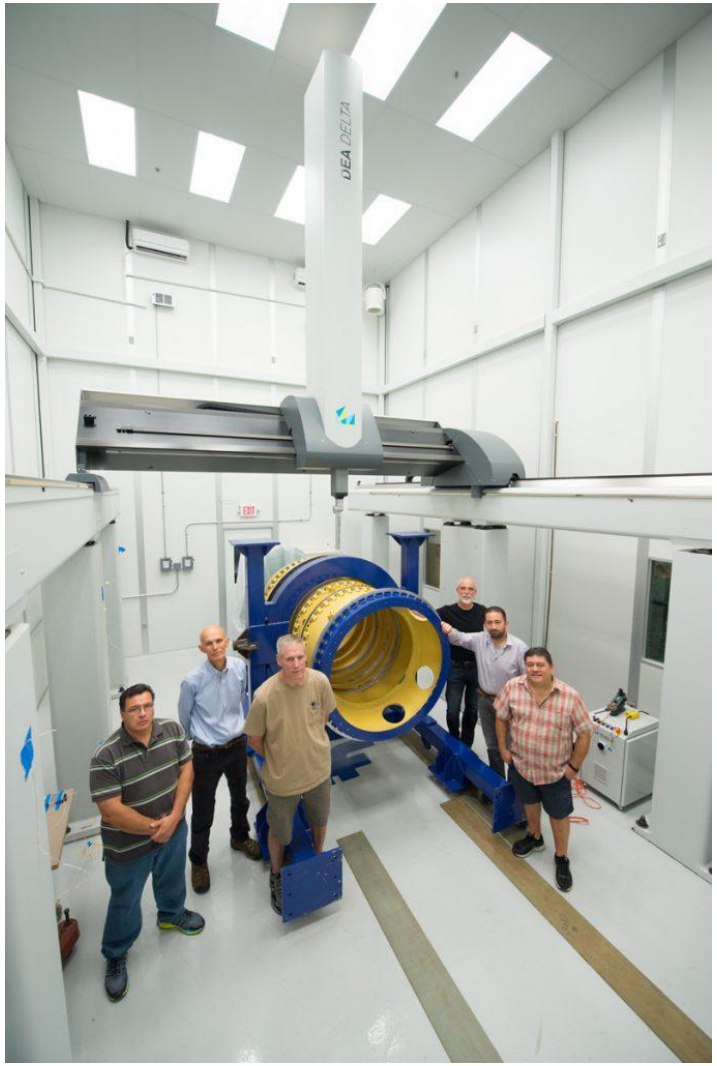


Image Credits: Fermilab

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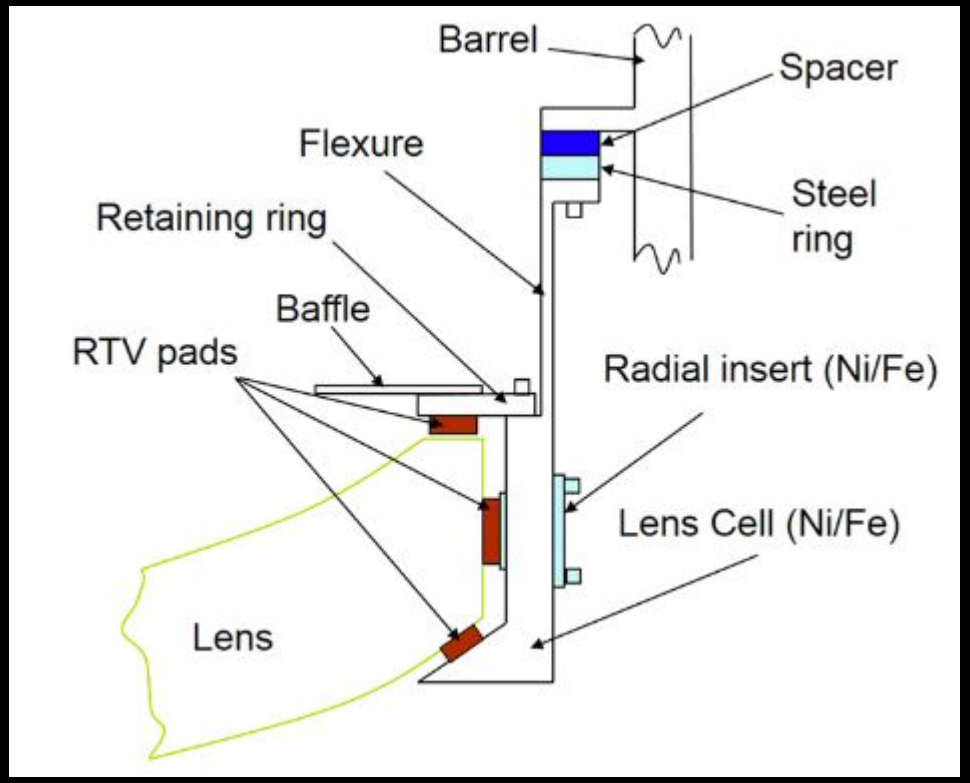
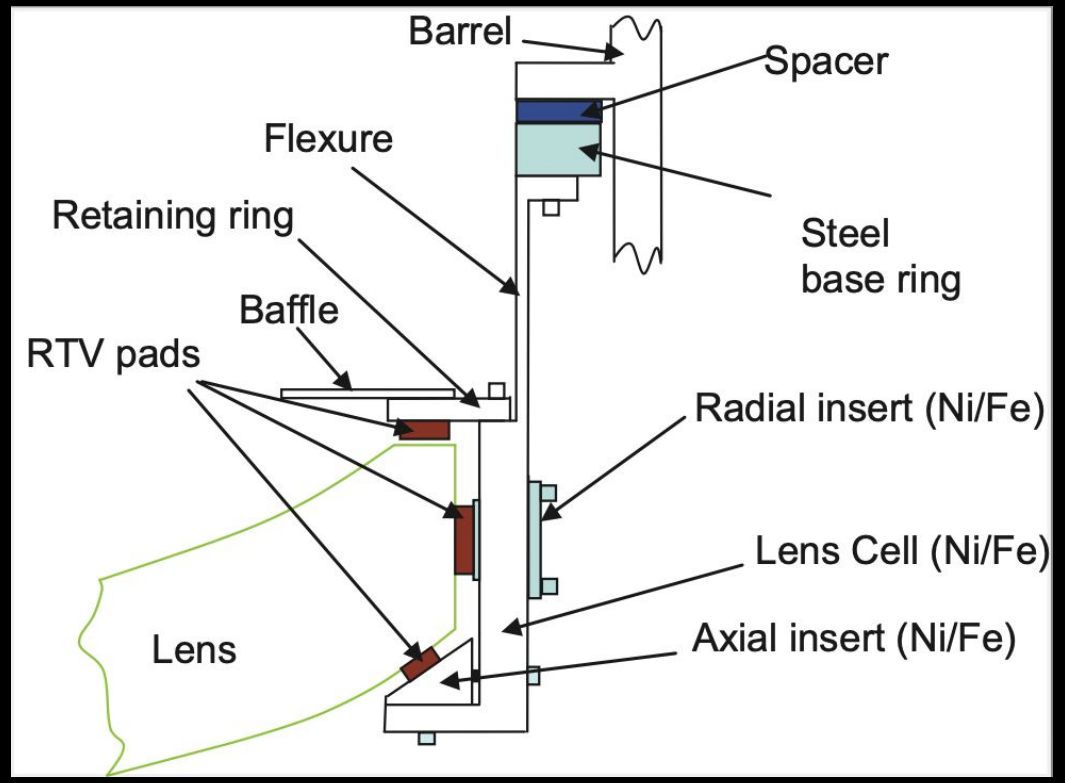
Lens Mounts



Flaugher, Diehl, Honscheid et al. (2015)



Doel et al. (2016)

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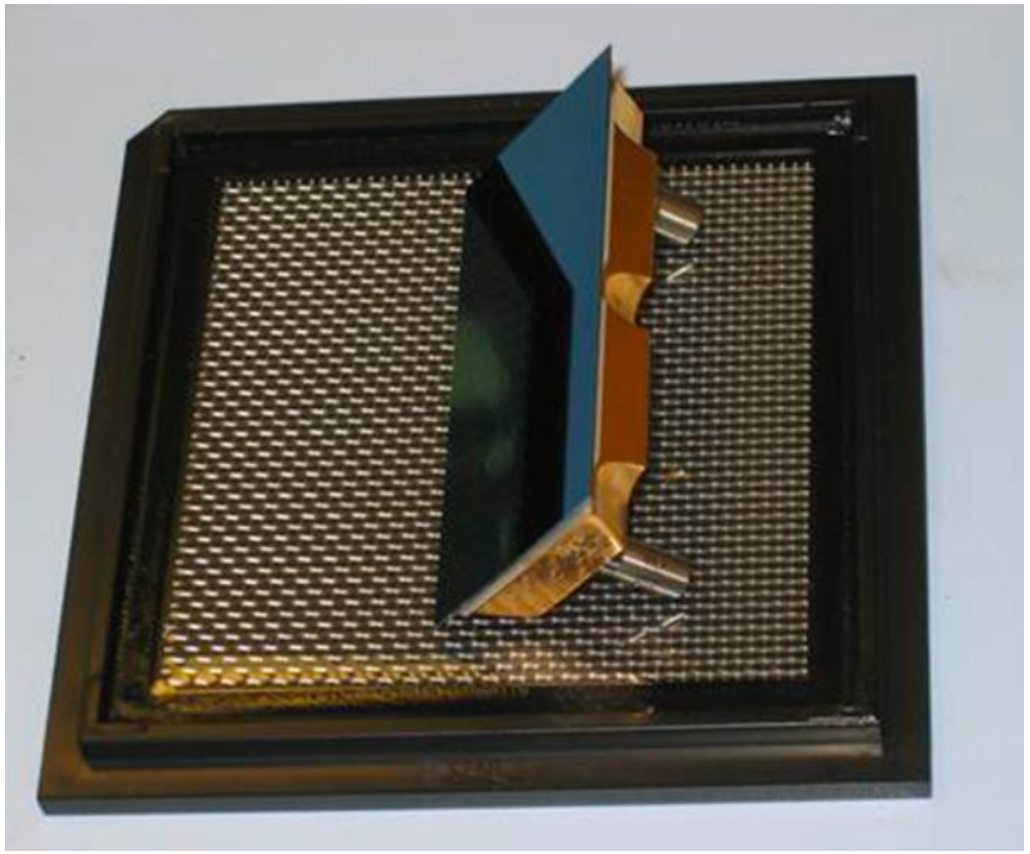
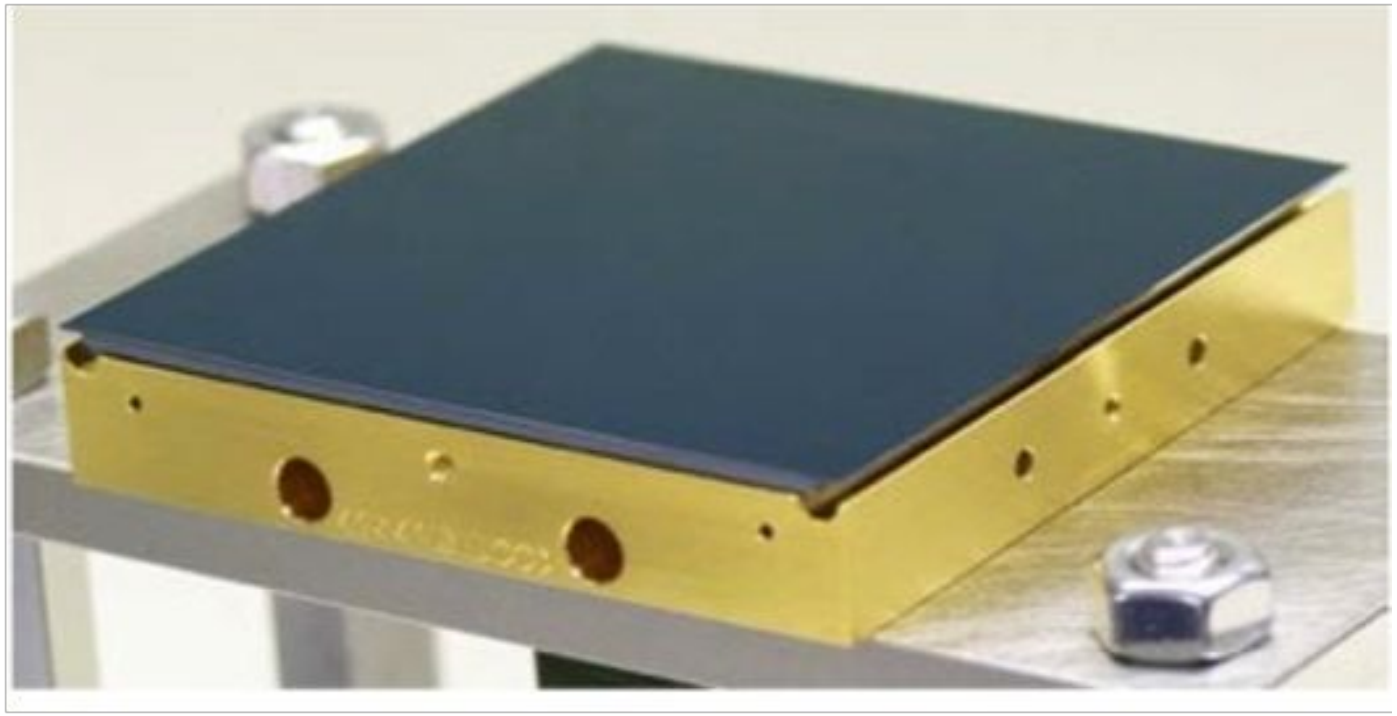
CCD Development





Both use thick, red sensitive, deep depletion devices designed by LBL and packaged by FNAL

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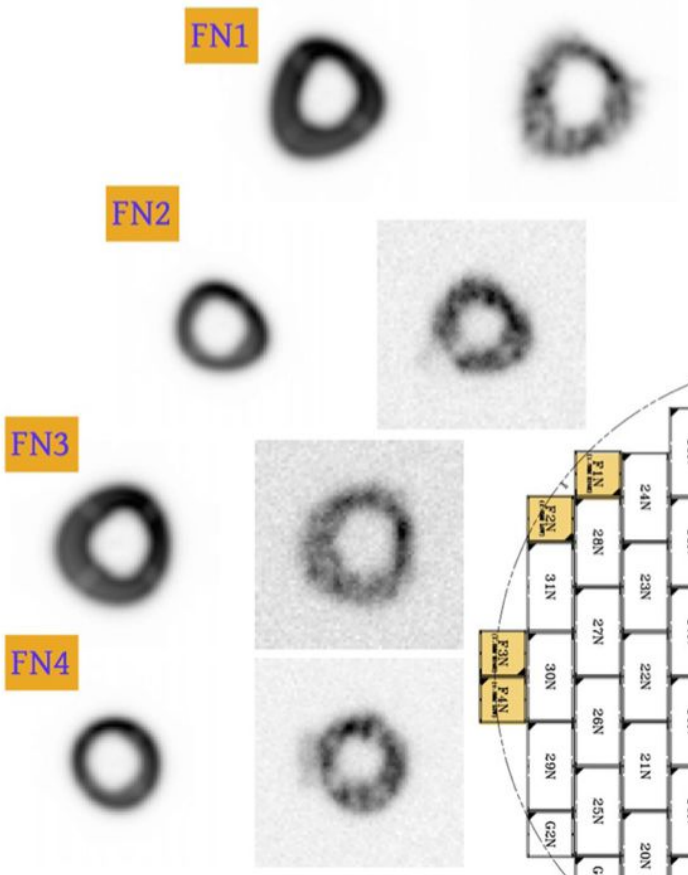
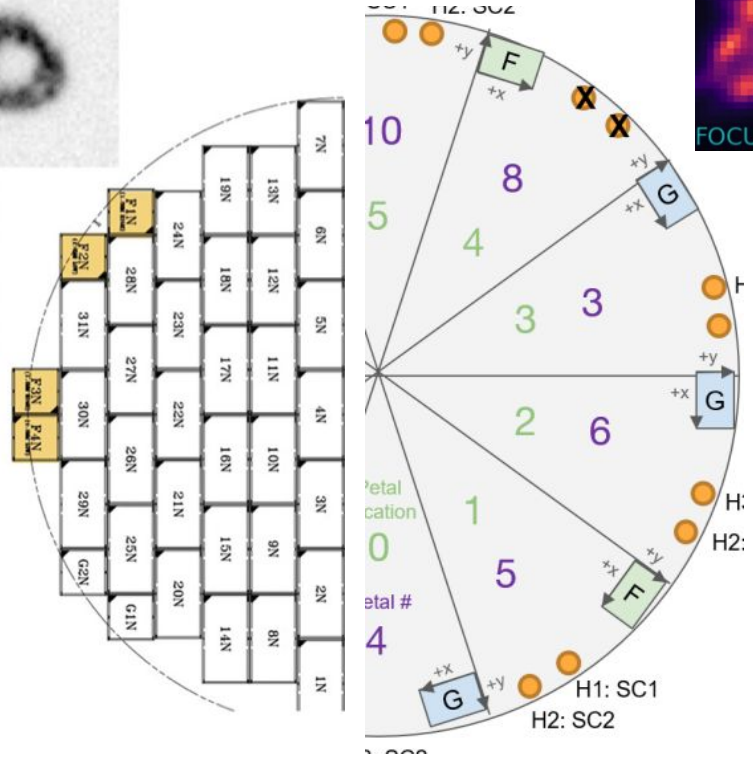
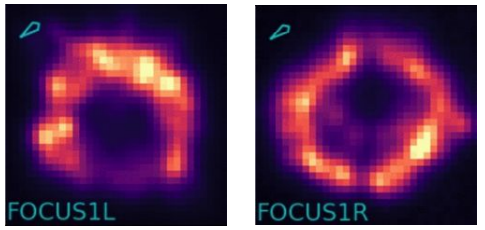
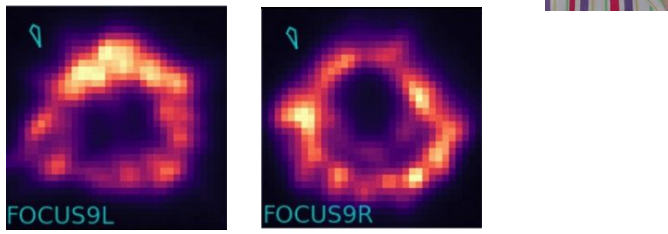
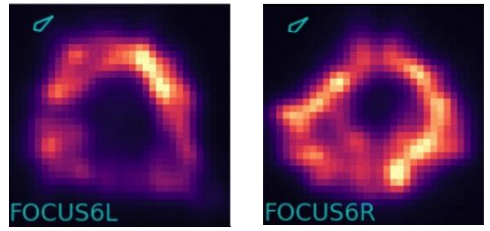
Active Optics System

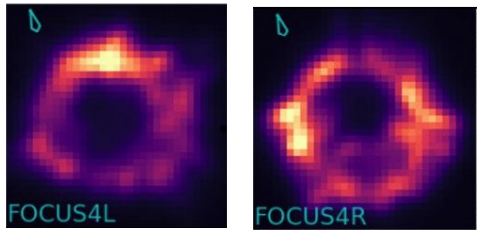










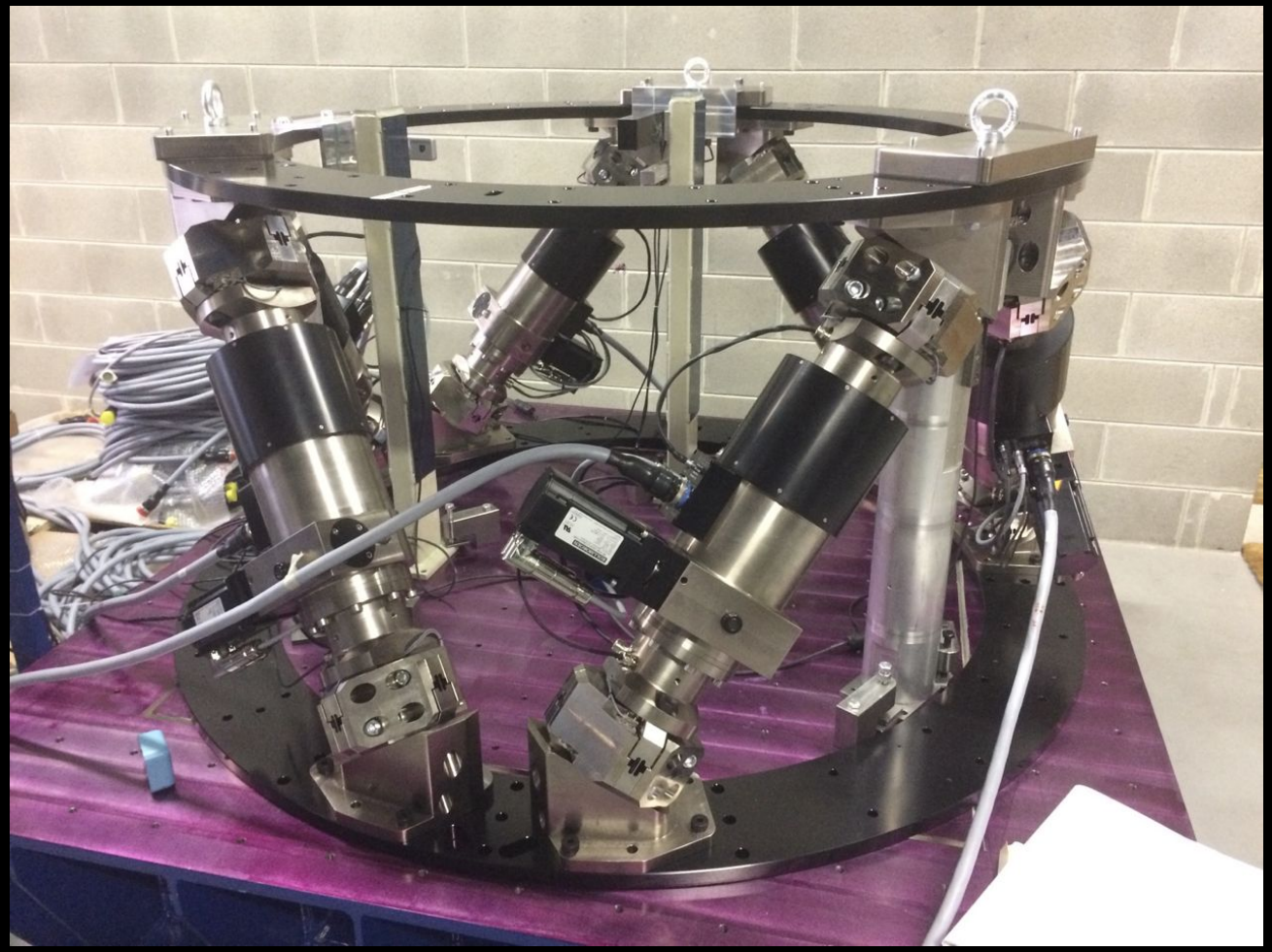


Roodman, Riel, & Davis (2014)

Silber, Fagrelius, Fanning et al. (2022)

DARK ENERGY SPECTROSCOPIC INSTRUMENT

Hexapod



Flaugher, Diehl, Honscheid et al. (2015)

Miller, Doel, Gutierrez et al. (2022)

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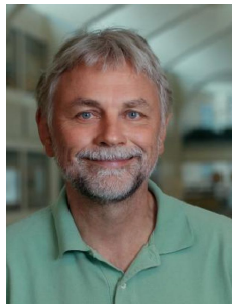
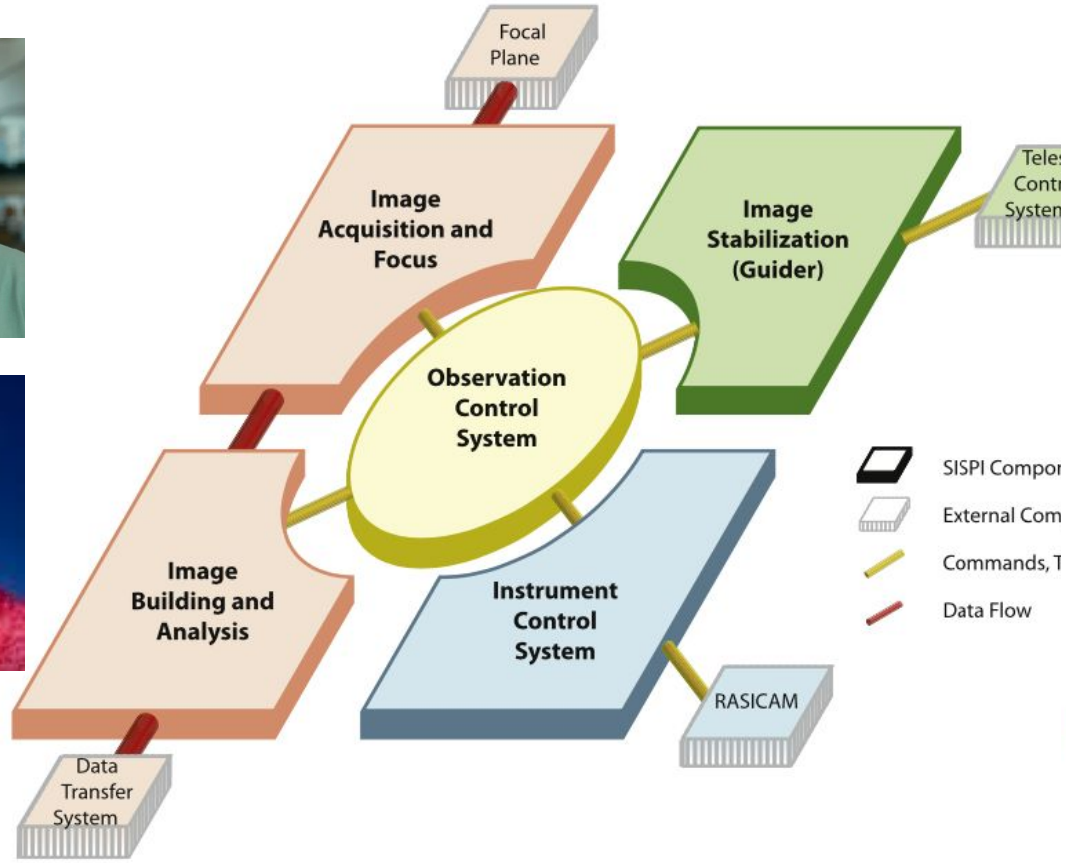
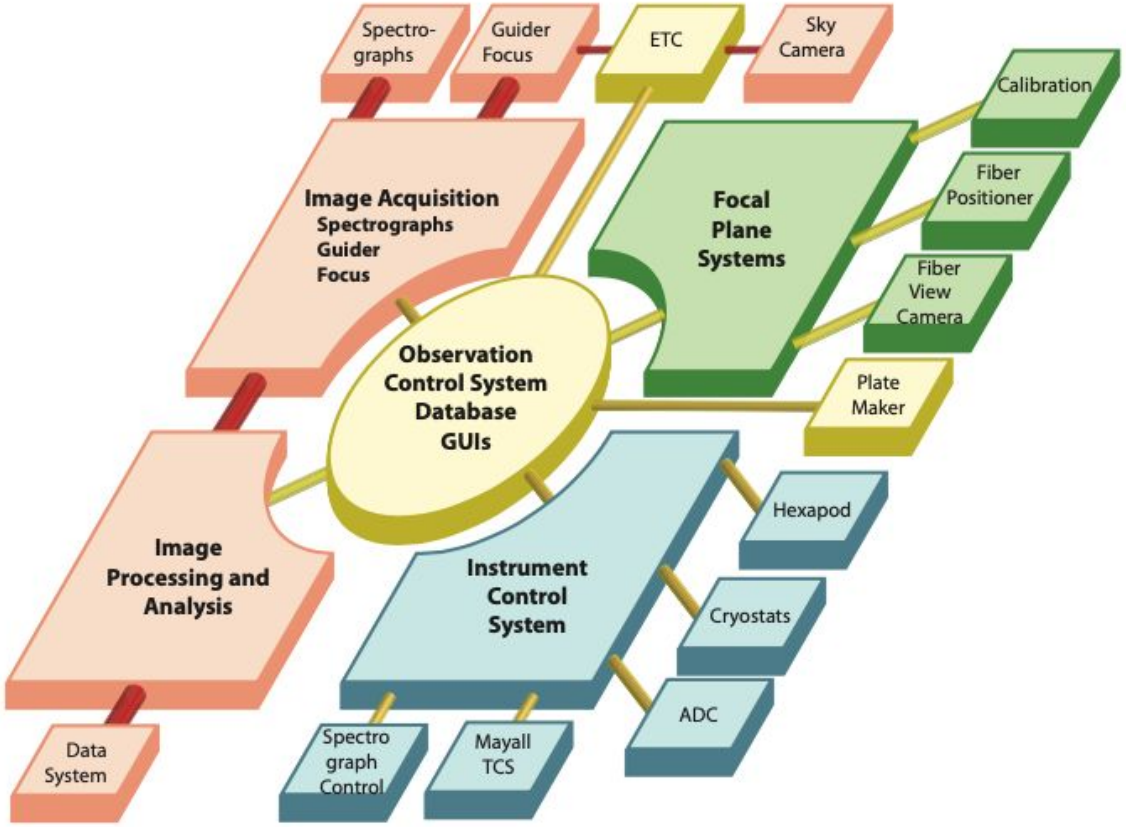
Instrument Software + Database







Honscheid et al. (2012)

Honscheid et al. (2016)

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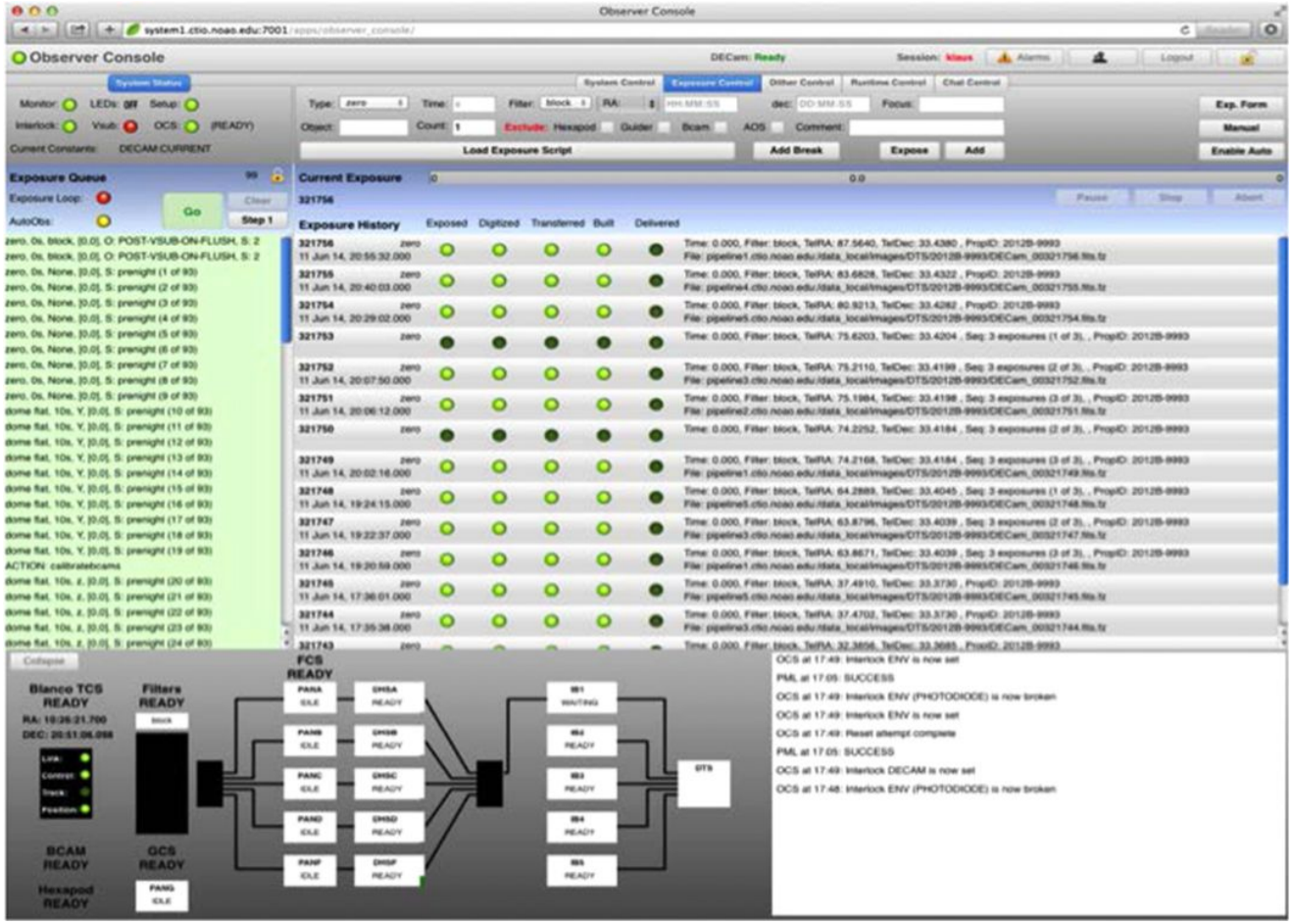
Instrument Software



Honscheid et al. (2012)

DESI Collaboration (2022)

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Telescope Installation

Flaugher, Diehl, Honscheid et al. (2015)

DESI Collaboration (2022)

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Management, Planning, People

- DOE project management
- Experience in astronomy community with DOE project management
- Leadership
- Commissioning Planning
- Science Verification / Survey Validation

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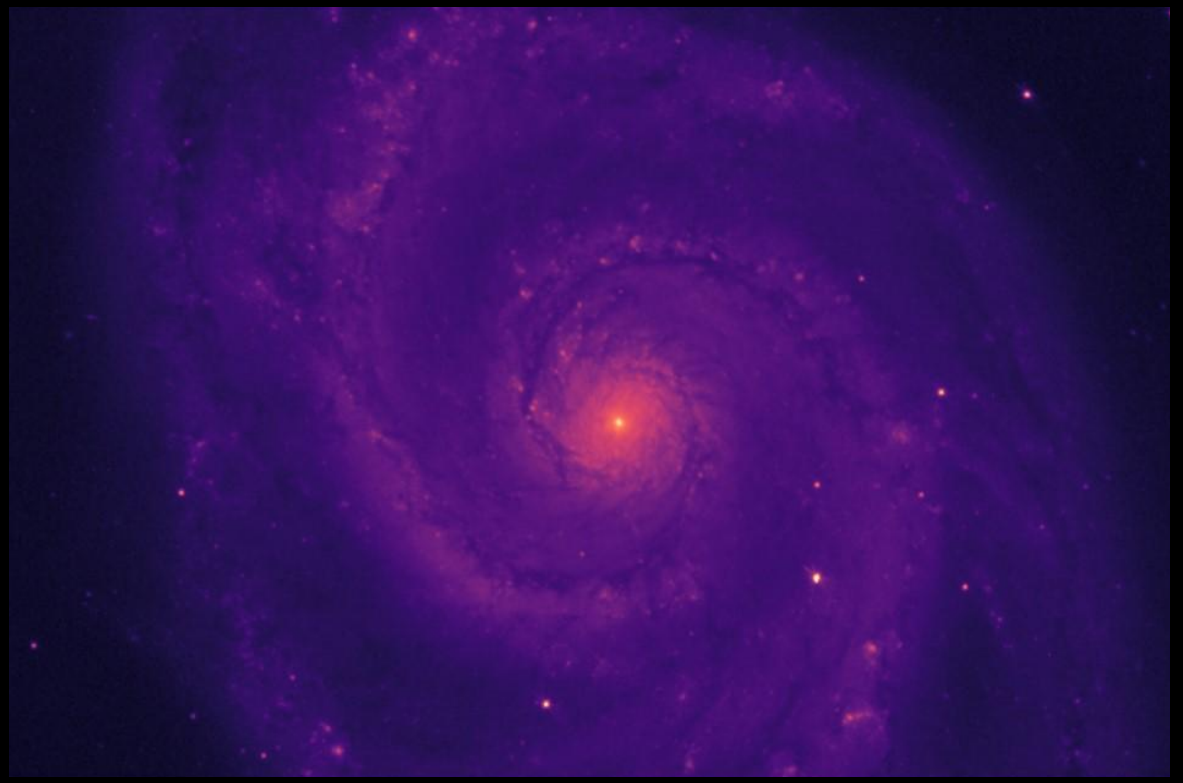
First Light Images



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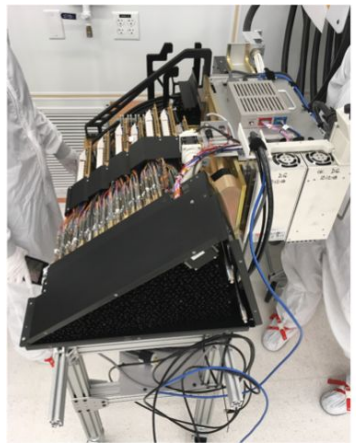
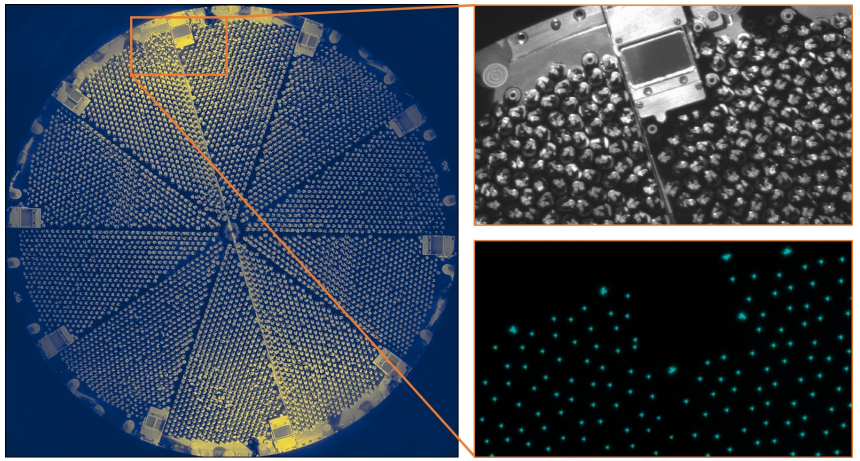
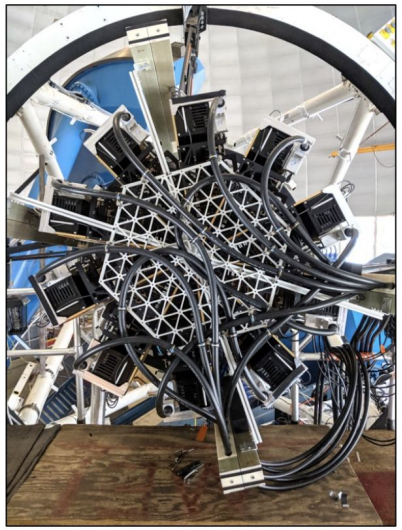
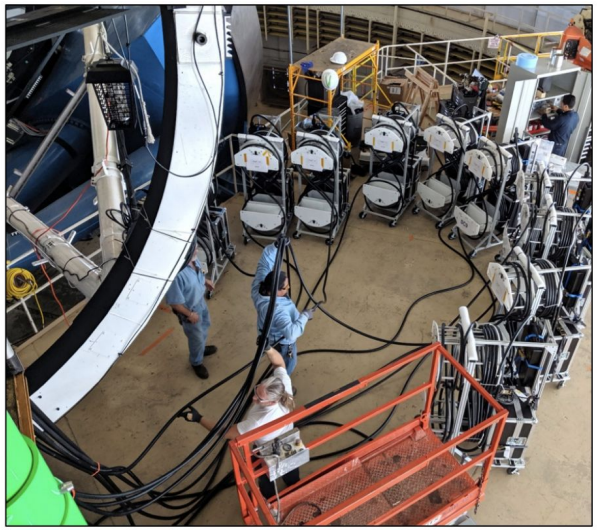
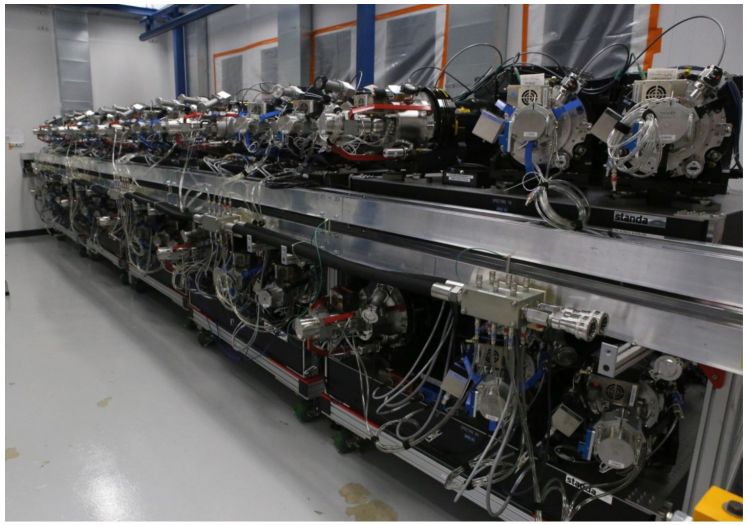
More instrumentation



+FVC, +Sky Monitor

See DESI Collaboration (2022) arxiv:2205.10939 and Silber, Fagrelius, Fanning et al. (2022) arxiv:2205.09014

DARK ENERGY SPECTROSCOPIC INSTRUMENT

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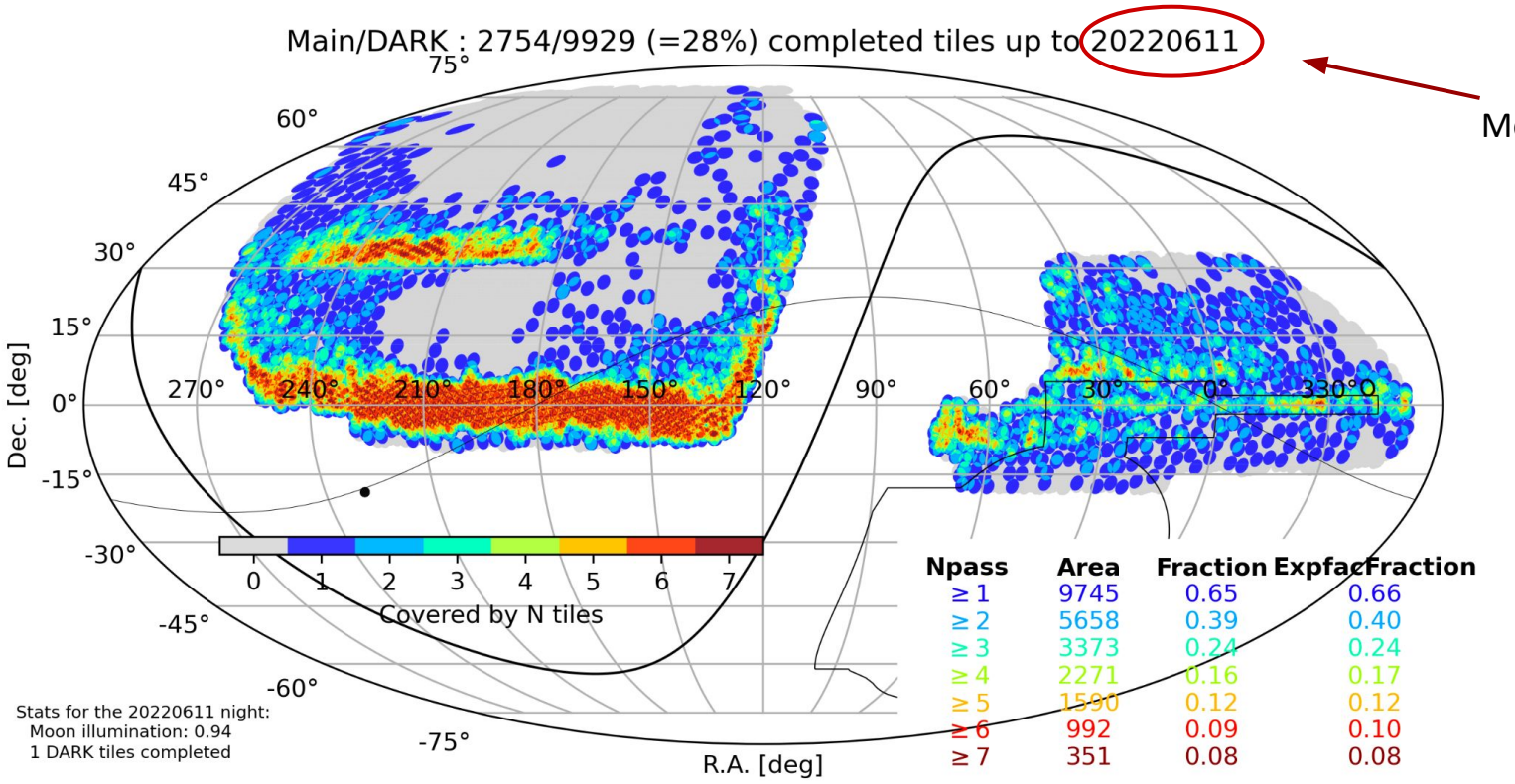
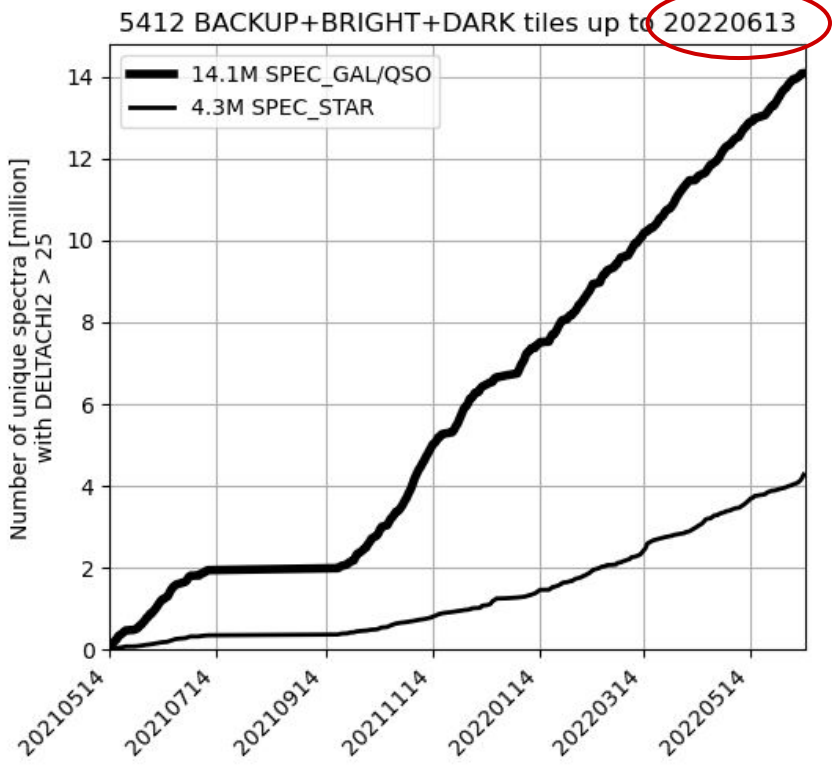
DESI survey status

We have already observed 14.1M Galaxies and Quasars + 4.3M stars!



More soon -- just getting restarted!



DARK ENERGY SPECTROSCOPIC INSTRUMENT

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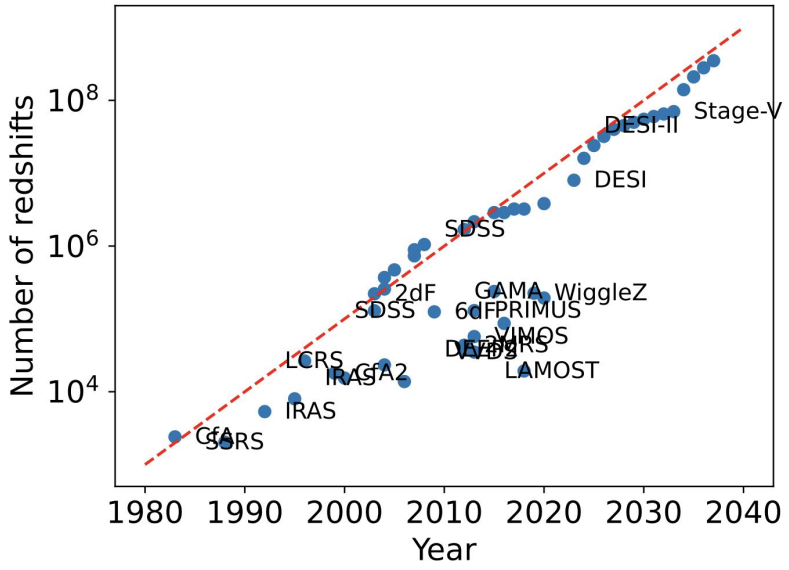
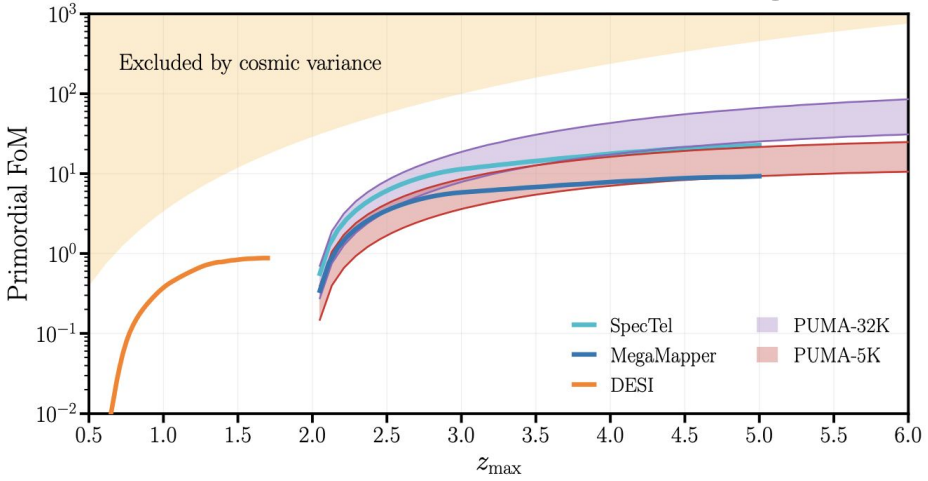
Virtues of Successive Development

- Lots of cost savings from lessons learned, use of proven solutions
- Extend the investment in instrument R&D across more projects
- Maintain groups of experts, which is especially difficult in university groups
- University groups are important to train the next generation of instrument builders
- *Science case for more observations remains compelling (e.g. primordial inflation)*



Schlegel et al. (2022)



Ferraro et al. (2022) arxiv:2203.07506

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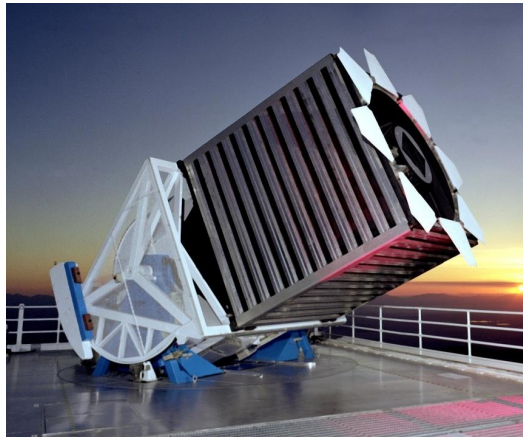
Evolution

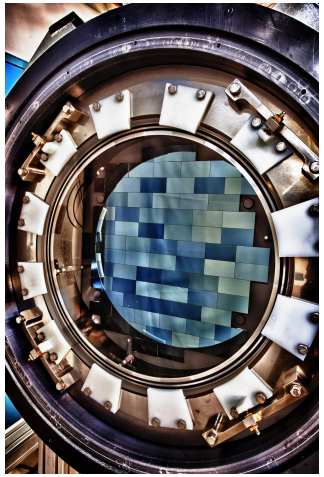
Astrolabe
ca. 200 BCE

…

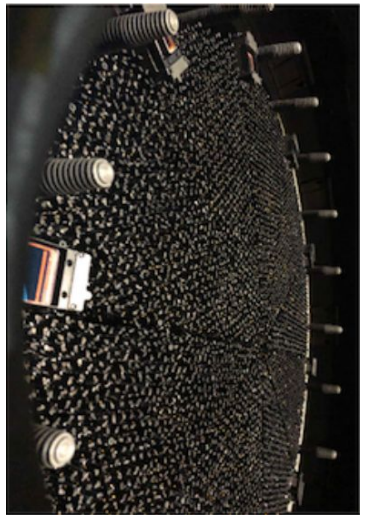
SDSS
ca. 2000



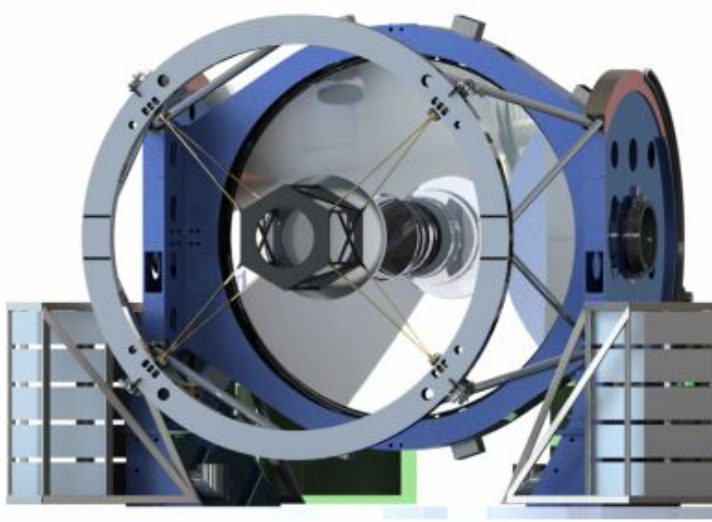
DECam
ca. 2010



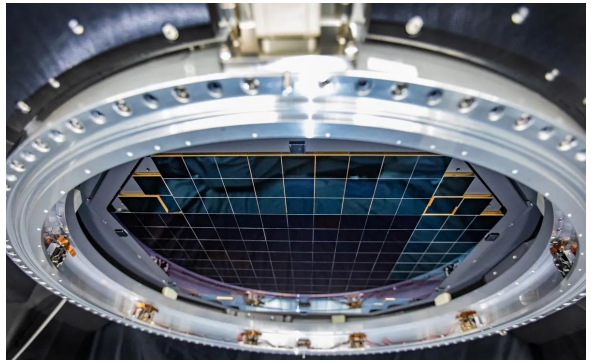
DESI
ca. 2020



MegaMapper, MSE, SpecTel



Rubin Observatory



Not to scale!

DARK ENERGY SPECTROSCOPIC INSTRUMENT

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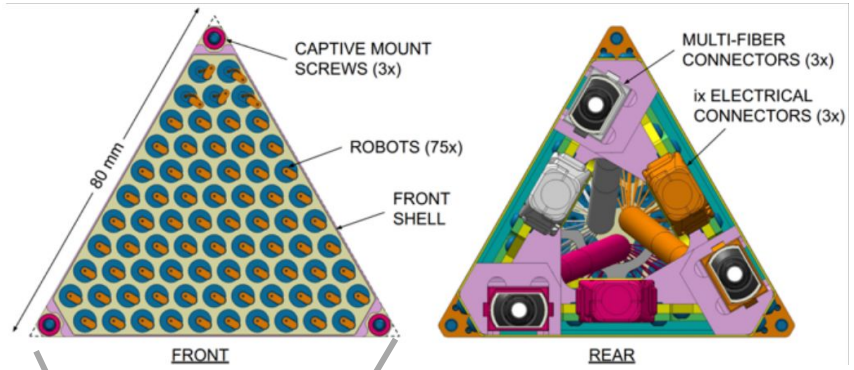
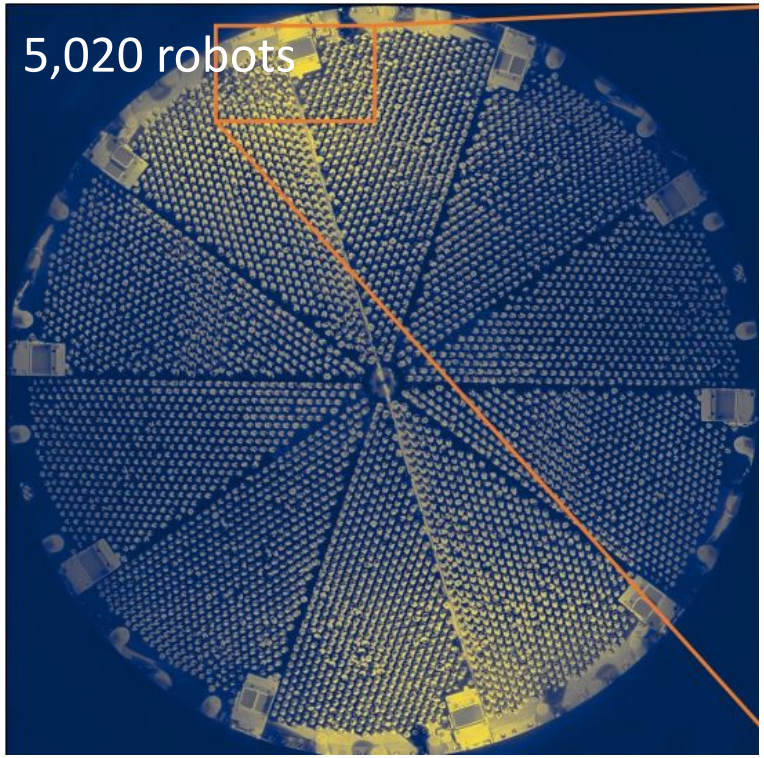
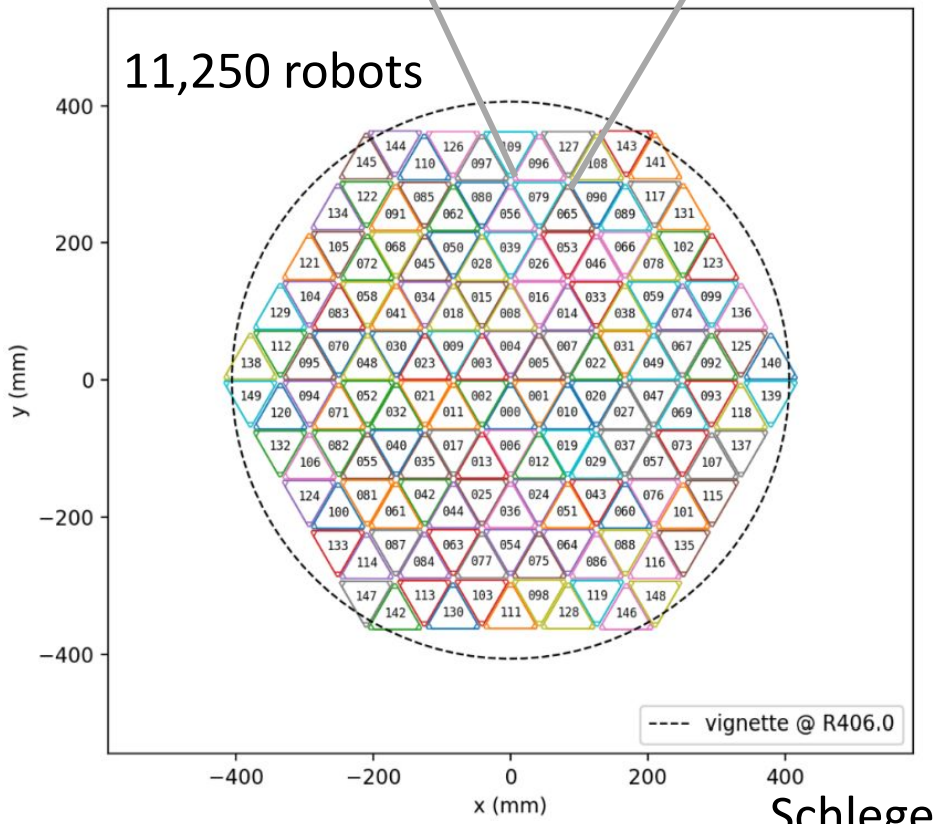
Evolution



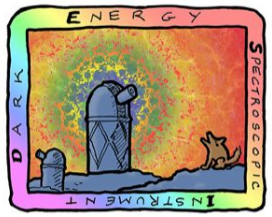
DESI



DESI Upgrade



Schlegel et al. (2022)



DARK ENERGY SPECTROSCOPIC INSTRUMENT

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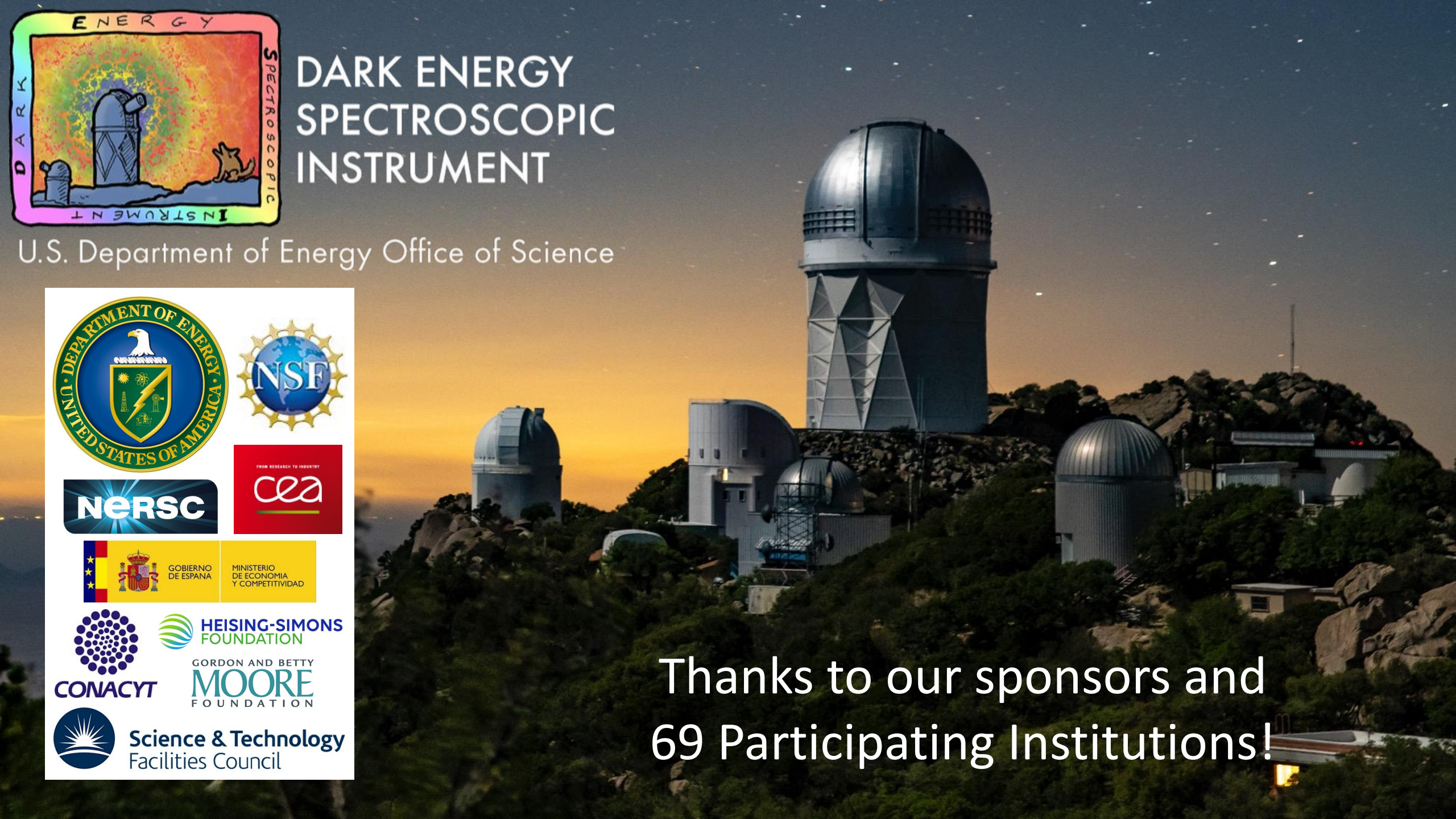
Summary

- Lots of cost savings from lessons learned, use of proven solutions
- Extend the benefits of instrument R&D across more projects
- Maintain groups of experts, which is especially difficult in university groups
- University groups important to train the next generation of instrument builders
- *Science case for more observations is very compelling!*

	Experiment type	Concept	Redshift Range
DESI	spectro	5000 robotic fiber fed spectrograph on 4m Mayall telescope	$0.1 < z < 2.0$
Rubin LSST	photo	*ugrizy* wide FoV imaging on a 6.5m effective diameter dedicated telescope	$0 < z < 3$
SPHEREx	narrow-band	Variable Linear Filter imaging on 0.25m aperture from space	$0 < z < 4$
MSE+[†]	spectro	up to 16,000 robotic fiber fed spectrograph on 11.25 m telescope	$1.6 < z < 4$ (ELG+LBG samples)
MegaMapper	spectro	20,000 robotic fiber fed spectrograph on 6m Magellan clone	$2 < z < 5$
SpecTel[†]	spectro	20,000-60,000 robotic fiber fed spectrograph on a dedicated 10m+ class telescope	$1 < z < 6$
PUMA	21 cm	5000-32000 dish array focused on intensity 21 cm intensity mapping	$0.3 < z < 6$
mm-wave LIM concept	mi-crowave LIM	500-30000 on-chip spectrometers on existing 5-10m telescopes, 80-300 GHz with R∼300-1000	$0 < z < 10$

Snowmass 2021 Topical Group Report, *Dark Energy and Cosmic Acceleration in the Modern Universe*
https://snowmass21.org/cosmic/start

NAS Decadal Report: *Pathways to Discovery in Astronomy & Astrophysics for the 2020s*
https://www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020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GOBIERNO DE ESPANA
MINISTERIO DE ECONOMIA Y COMPETITIVIDAD
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