# 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 A Tale of Two Telescopes

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

Image Credits: NOIRLab



#### DARK ENERGY SPECTROSCOPIC INSTRUMENT A Tale of Two Instruments

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## Outline:

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



## c Instrumentation Synergies

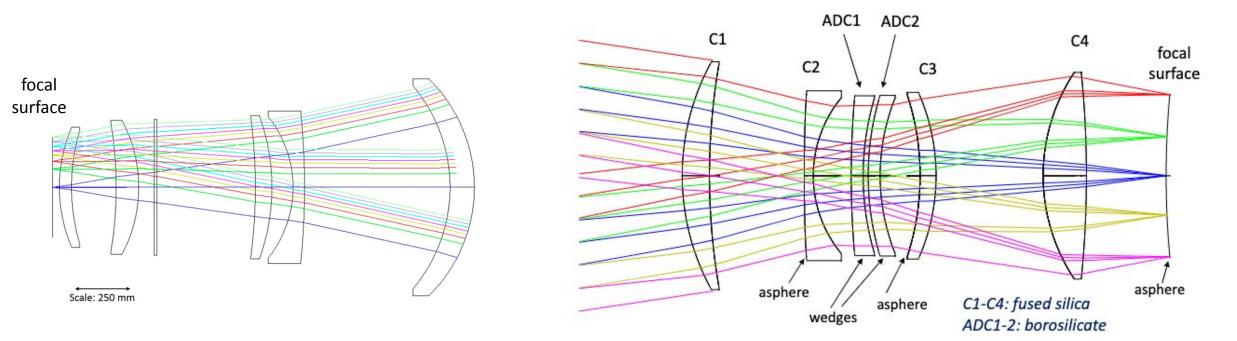
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- Corrector Barrel
- Cage, Vanes, Hexapod
- Lens Mounts
- CCDs
- Active Optics System
- Instrument Software
- Telemetry Database
- Installation
- Management structure and personnel

So many!



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All DECam lenses are fused silica

Same relative scale

Flaugher, Diehl, Honscheid et al. (2015)

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

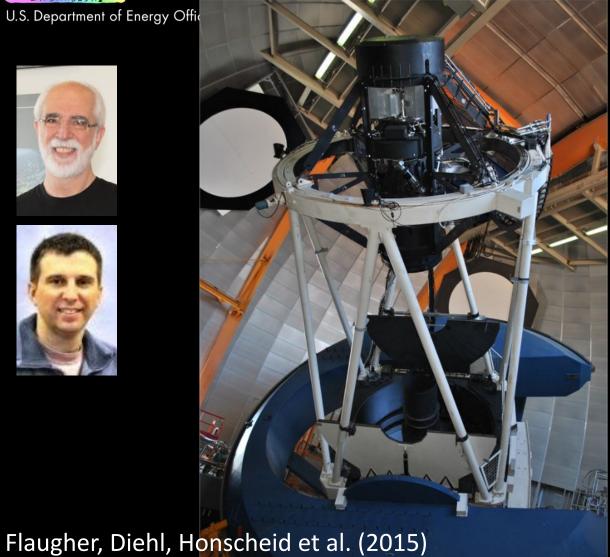


### DARK ENERGY Corrector Barrel, Vanes, Cage SPECTROSCOPIC INSTRUMENT

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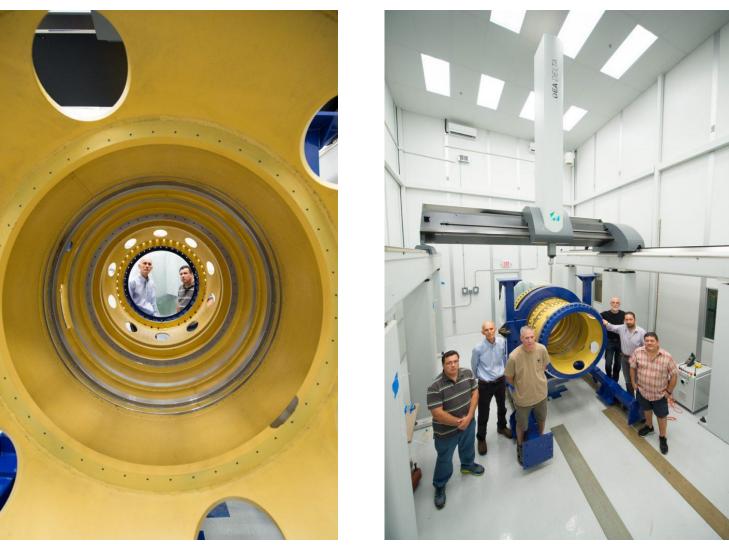
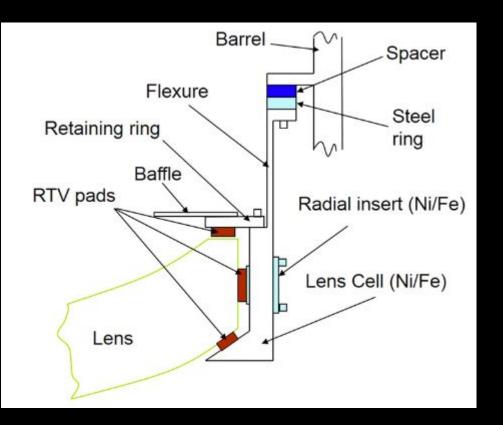


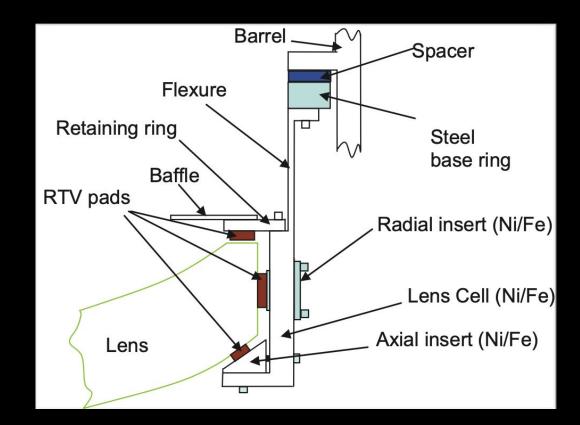
Image Credits: Fermilab



# Lens Mounts

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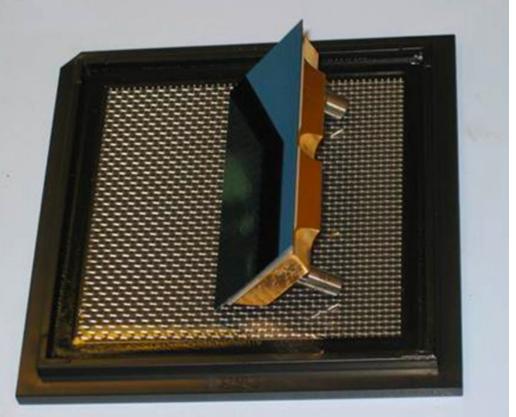


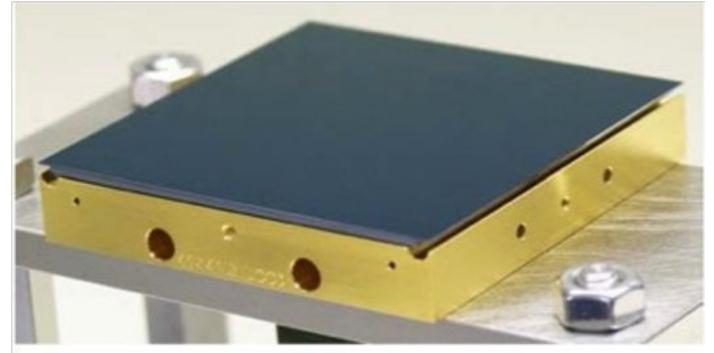
Flaugher, Diehl, Honscheid et al. (2015)

Doel et al. (2016)

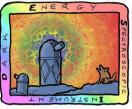


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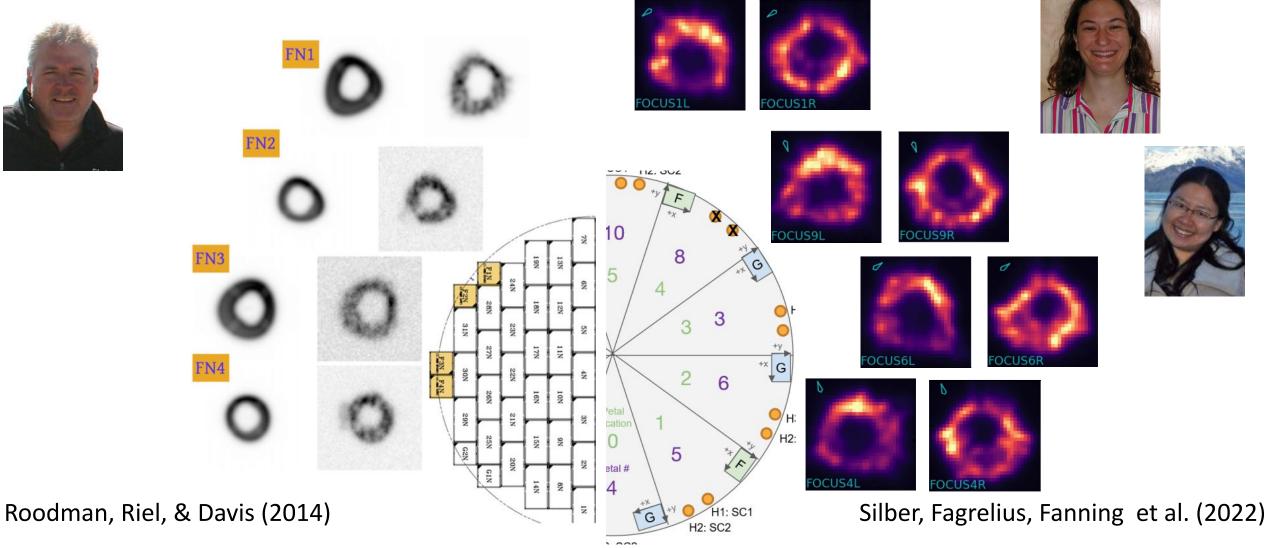




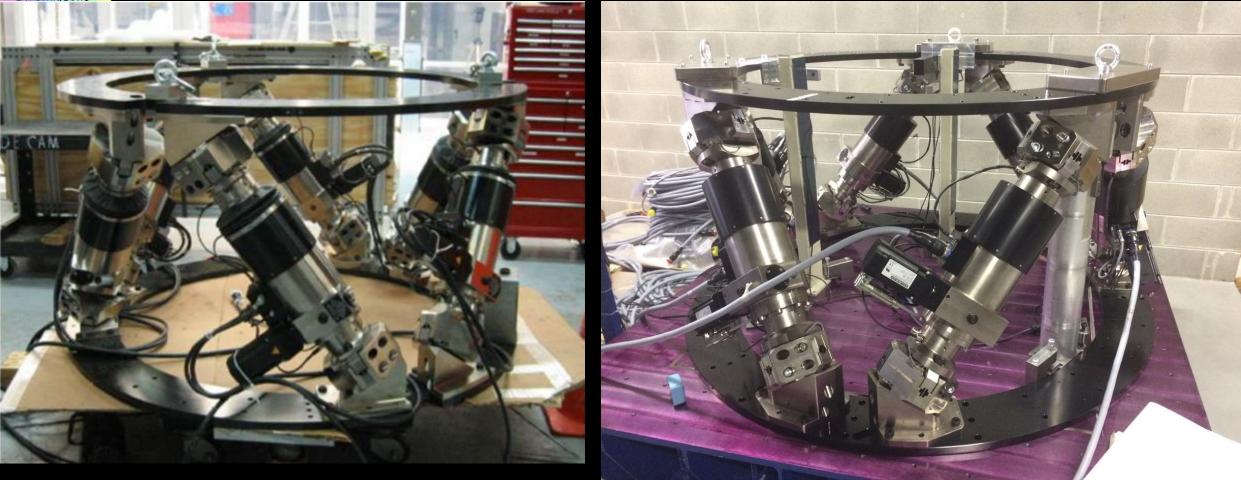
Both use thick, red sensitive, deep depletion devices designed by LBL and packaged by FNAL



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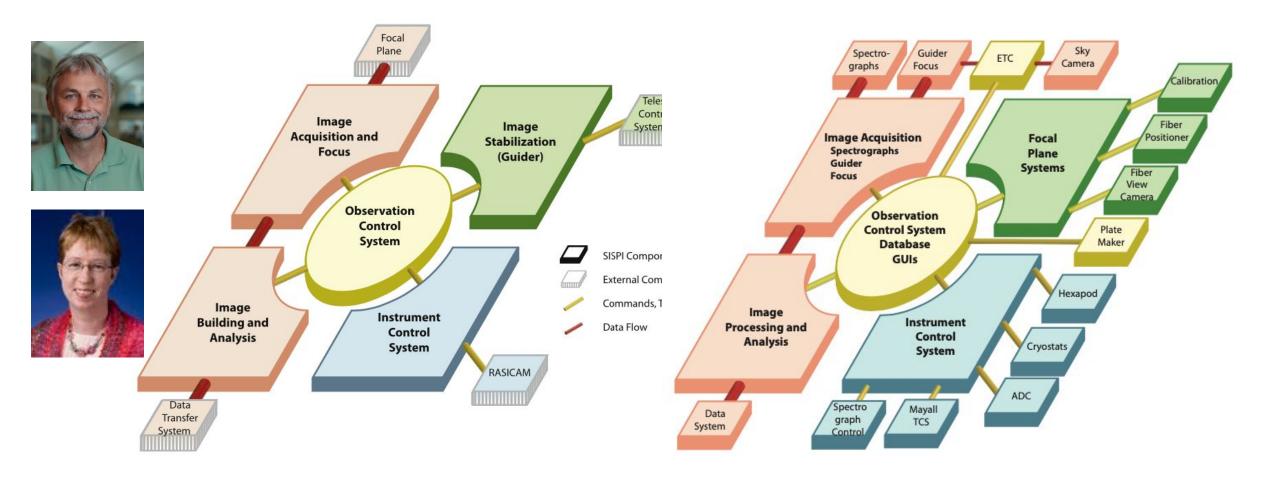
Flaugher, Diehl, Honscheid et al. (2015)

Miller, Doel, Gutierrez et al. (2022)



## **DARK ENERGY** SPECTROSCOPIC Instrument Software + Database

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Honscheid et al. (2012)

Honscheid et al. (2016)



## DARK ENERGY SPECTROSCOPIC Instrument Software

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INSTRUMENT

		O Observer Console DESI: Ready Session: klaus_2	🗼 Alarm 🔮 🧟 Logout 🛛 🙍
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## Honscheid et al. (2012)

## DESI Collaboration (2022)



# Telescope Installation

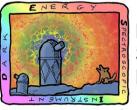
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Flaugher, Diehl, Honscheid et al. (2015)

**DESI Collaboration (2022)** 



## DARK ENERGY SPECTROSCOPIC Management, Planning, People

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

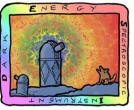




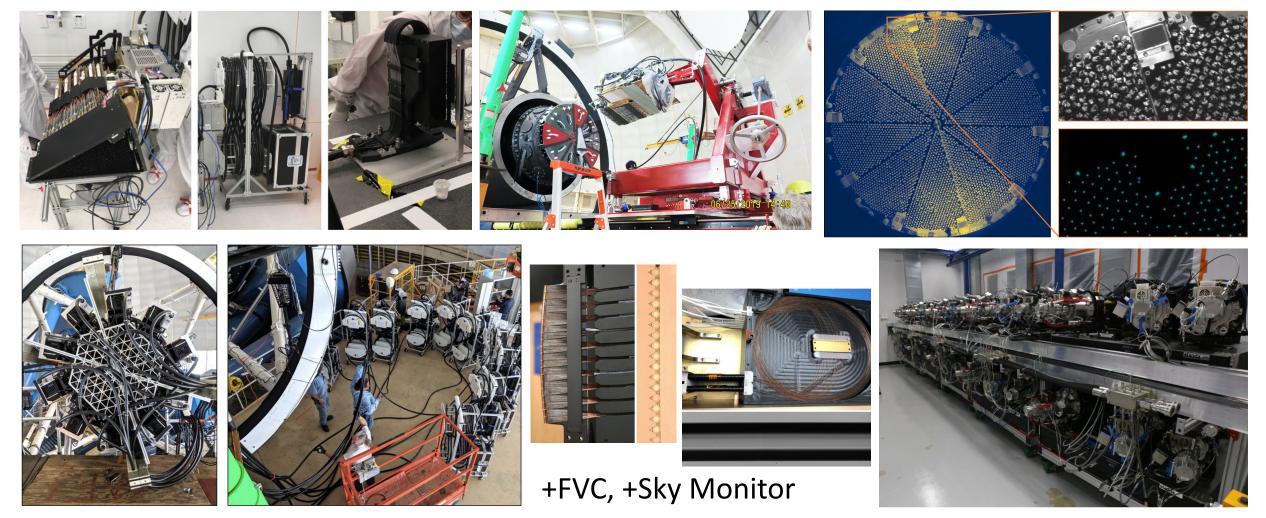


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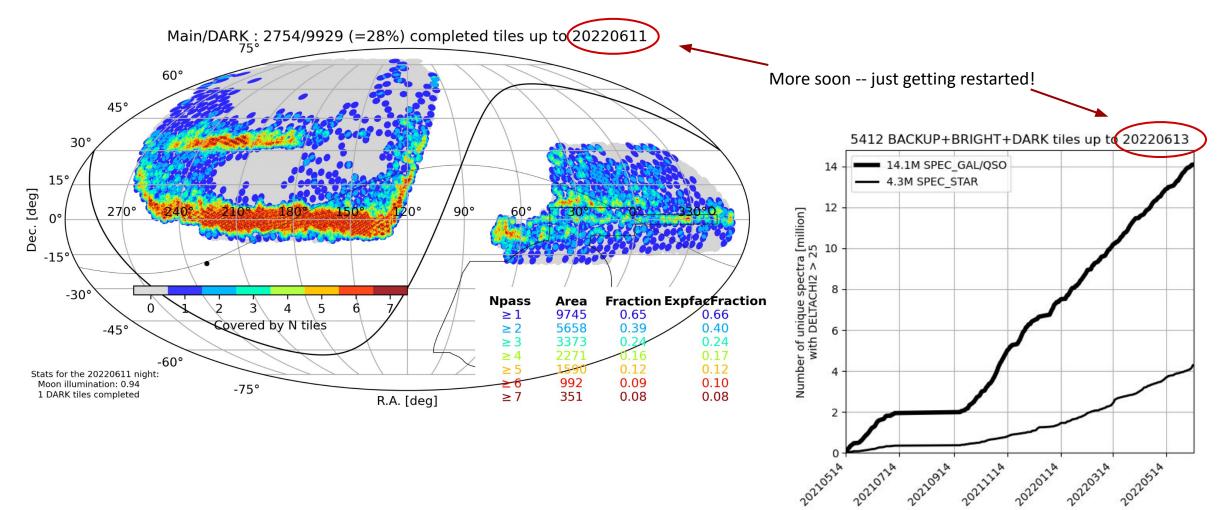


See DESI Collaboration (2022) arxiv:2205.10939 and Silber, Fagrelius, Fanning et al. (2022) arxiv:2205.09014



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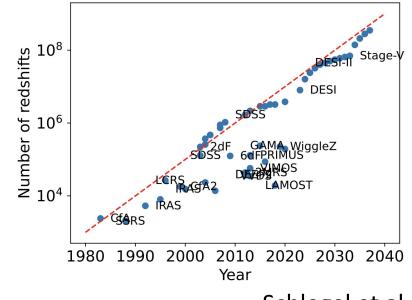
We have already observed 14.1M Galaxies and Quasars + 4.3M stars!

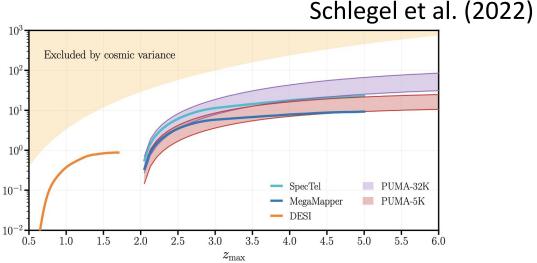




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- Lots of cost savings from lessons learned, use of proven solutions
- Extend the investment in instrument R&D across more projects
- Maintain groups of experts, which is especially difficult in university groups
- University groups are important to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





Ferraro et al. (2022) arxiv:2203.07506

Primordial FoM





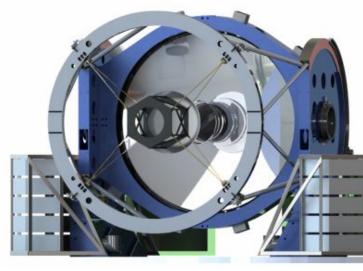
SDSS

ca. 2000

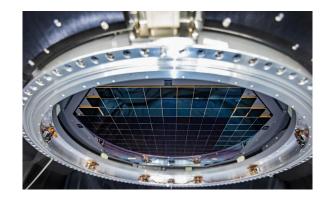
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## MegaMapper, MSE, SpecTel

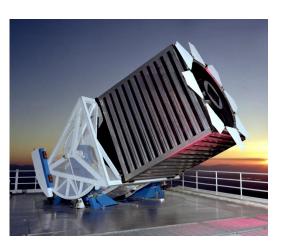


## Rubin Observatory



Astrolabe ca. 200 BCE

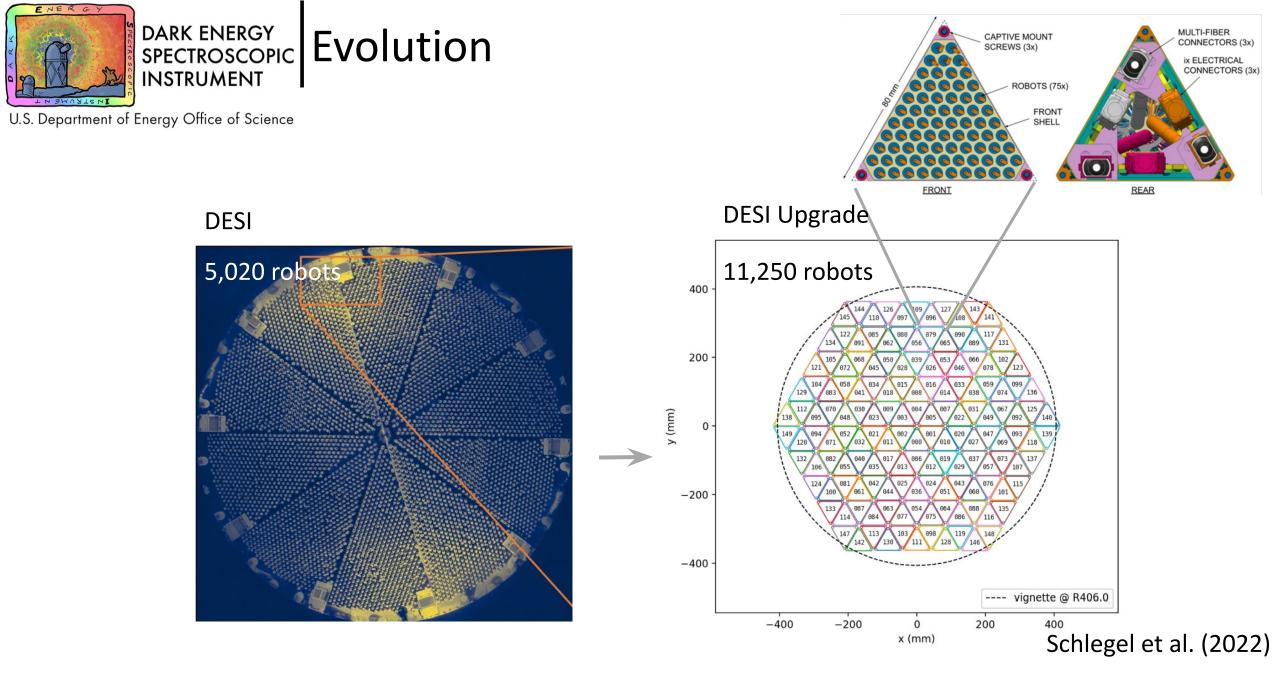




DECam ca. 2010 **DESI** ca. 2020



Not to scale!





#### K ENERGY CTROSCOPIC RUMENT

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- 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!



	-		
	Experi- ment type	Concept	Redshift Range
DESI	spectro	5000 robotic fiber fed spectrograph on 4m Mayall telescope	0.1 < z < 2.0
Rubin LSST	photo	<i>ugrizy</i> 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
$MSE+^{\dagger}$	spectro	up to 16,000 robotic fiber fed spectrograph on 11.25 m telescope	$\begin{array}{c} 1.6 < z < 4 \\ (\text{ELG+LBG} \\ \text{samples}) \end{array}$
MegaMapper	spectro	20,000 robotic fiber fed spectrograph on 6m Magellan clone	2 < z < 5
$\mathrm{SpecTel}^\dagger$	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	$\begin{array}{c} 500\text{-}30000 \text{ on-chip} \\ \text{spectrometers on} \\ \text{existing 5-10m} \\ \text{telescopes,} \\ 80\text{-}300 \text{ GHz with} \\ \text{R}{\sim}300\text{-}1000 \end{array}$	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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