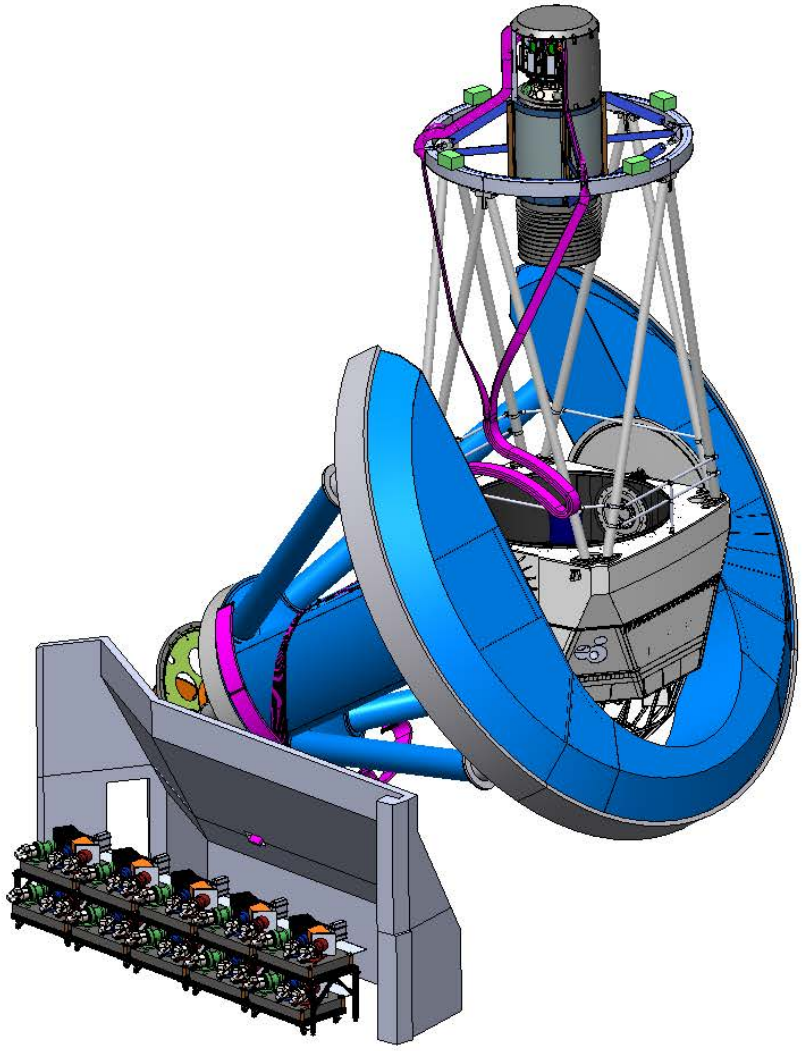


The Dark Energy Spectroscopic Instrument, DESI in 10mins

Will Percival

April 9, 2020

https://www.desi.lbl.gov/

https://arxiv.org/abs/1611.00036

https://arxiv.org/abs/1611.00037

DESI contributors (https://www.desi.lbl.gov/desi-builders)

Aguilar	Jessica	leadership of petal fabrication and assembly
Ameel	Jon	contributions to the focal plane electronics
Bailey	Stephen	leadership of the data systems and data pipeline development
Baltay	Charles	contributions to the fiber view camera
Bebek	Chris	leadership as Instrument Scientist
Besuner	Robert	leadership as Project Manager and Systems Engineer
Blanc	Pierre-Eric	contributions to the spectrographs
Blum	Robert	contributions to project management and governance
Bramall	David	contributions to the fiber system
Brooks	David	contributions of the wide-field corrector
Buckley-Geer	Elizabeth	contributions to the instrument control system
Burleigh	Kaylan	contributions to the imaging survey
Cahn	Robert	contributions to the design of the survey
Carton	Pierre-Henri	contributions to the spectrographs and cryostats
Claybaugh	Todd	contributions to the focal plane system
Cooper	Andrew	contributions to the support of the bright galaxy and milky way science
Dawson	Kyle	contributions to the design of the survey and survey validation
Derwent	Mark	contributions to the spectrographs
Dey	Arjun	leadership of the observations and contributions to the imaging surveys
Dhungana	Govinda	contributions to the data system
Dobson	Carl	contributions to the instrument software
Doel	Peter	leadership of the construction of the wide-field corrector
Duan	Yutong	contributions to the focal plane system
Edelstein	Jerry	contributions to the spectrographs
Eftekharzadeh	Sarah	contributions to the survey design
Eisenstein	Daniel	leadership as collaboration Spokesperson and contributions to the design of the survey
Elliott	Ann	contributions to the instrument operation pipeline
Estrada	Juan	contributions to the CCD packaging
Fagrelius	Parker	contributions to the instrument and its commissioning
Fanning	Kevin	contributions to the focal plane system
Flaugher	Brenna	leadership as Project Scientist and leadership of the AIT&C subsystem
Gaztanaga	Enrique	contributions to the imaging validation
Gutierrez	Gaston	leadership of the construction of the wide-field corrector
Guy	Julien	leadership as Project Scientist and contributions to the data pipeline
Harris	Stewart	leadership as Systems Engineer
Heetderks	Ian	contributions to the construction of the focal plane
Heetderks	Henry	leadership as Project Manager
Herrera	David	contributions to the imaging survey
Honscheid	Klaus	leadership of the development of the instrument control system
Ishikawa	Yuzo	contributions to the spectrographs
Jelinsky	Patrick	leadership of the construction of the spectrographs
Jelinsky	Sharon	contributions to the construction of the focal plane
Jimenez	Jorge	contributions to the construction of the guiders
Joyce	Richard	leadership as Instrument Scientist for NOAO/Mayall
Karcher	Armin	contributions to the detector electronics
Karkar	Sonia	contributions to the spectrographs
Kehoe	Robert	contributions to the data system and to project management
Kent	Stephen	contributions to the focal plane software
Kirkby	David	contributions to the survey design
Kisner	Theodore	contributions to the pipeline software
Kitanidis	Ellie	contributions to the imaging survey
Lambert	Andrew	contributions to the focal plane system
Landriau	Martin	contributions to the imaging survey
Lang	Dustin	contributions to the imaging survey
Lee	Jae Hyeon	contributions to target selection
Levi	**Michael**	**leadership of the DESI project as Director**
Magneville	Christophe	contributions to the spectrographs and cryostats
Martini	Paul	leadership as instrument scientist and contributions to the commissioning instrument
McDonald	Patrick	contributions to the survey design
Meisner	Aaron	contributions to the imaging survey
Miller	Tim	contributions to the wide-field corrector
Moustakas	John	contributions to the imaging survey
Myers	Adam	leadership of the target selection pipeline
Newman	Jeffrey	contributions to the target selection
Nie	Jundan	contributions to the imaging survey
Palanque-Delabrouille	Nathalie	leadership as Spokesperson and contributions to target selection
Pappalardo	Daniel	contributions to the spectrographs
Peng	Xiyan	contributions to the imaging survey
Percival	Will	contributions to the preparation of the galaxy and quasar clustering science survey
Poppett	Claire	leadership of the fiber system
Prada	Francisco	contributions to the fiber positioners
Probst	Ronald	contributions to the telescope and installation work
Rabinowitz	David	contributions to the fiber view camera
Raichoor	Anand	contributions to the target selection
Rockosi	Constance	leadership as Commissioning Scientist
Roe	Natalie	contributions to the project management
Ronayette	Samuel	contributions to the spectrographs
Ross	Ashley	contributions to the commissioning instrument
Schlafly	Edward	contributions to the imaging survey and to the focal plane
Schlegel	David	leadership as Project Scientist and contributions to the imaging survey
Schubnell	Michael	contributions to the fiber positioners
Sharples	Ray	leadership of the fiber system
Silber	Joseph	leadership of the construction of the focal plane
Sprayberry	David	leadership of the installation of the corrector and instrument
Staten	Ryan	contributions to the data system
Tarle	Gregory	contributions to the fiber positioners and for leadership as institutional board chair
Valdes	Francisco	contributions to the imaging survey
Weaver	Benjamin	contributions to the software infrastructure
Weaverdyck	Curtis	contributions to the fiber positioners
Wechsler	Risa	leadership as collaboration Spokesperson and contributions to survey leadership
Yeche	Christophe	contributions to the target selection and survey validation
Zhang	Kai	contributions to the focal plane
Zhang	Tianmeng	contributions to the imaging survey
Zhou	Zhimin	contributions to the BASS imaging survey
Zhou	Xu	contributions to the BASS imaging survey
Zhou	Rongpu	contributions to the target selection
Zou	Hu	contributions to the BASS imaging survey

DESI - the largest spectroscopic survey for dark energy

DESI is > 20x faster than SDSS (factor 5 from fibers, 4 from telescope)

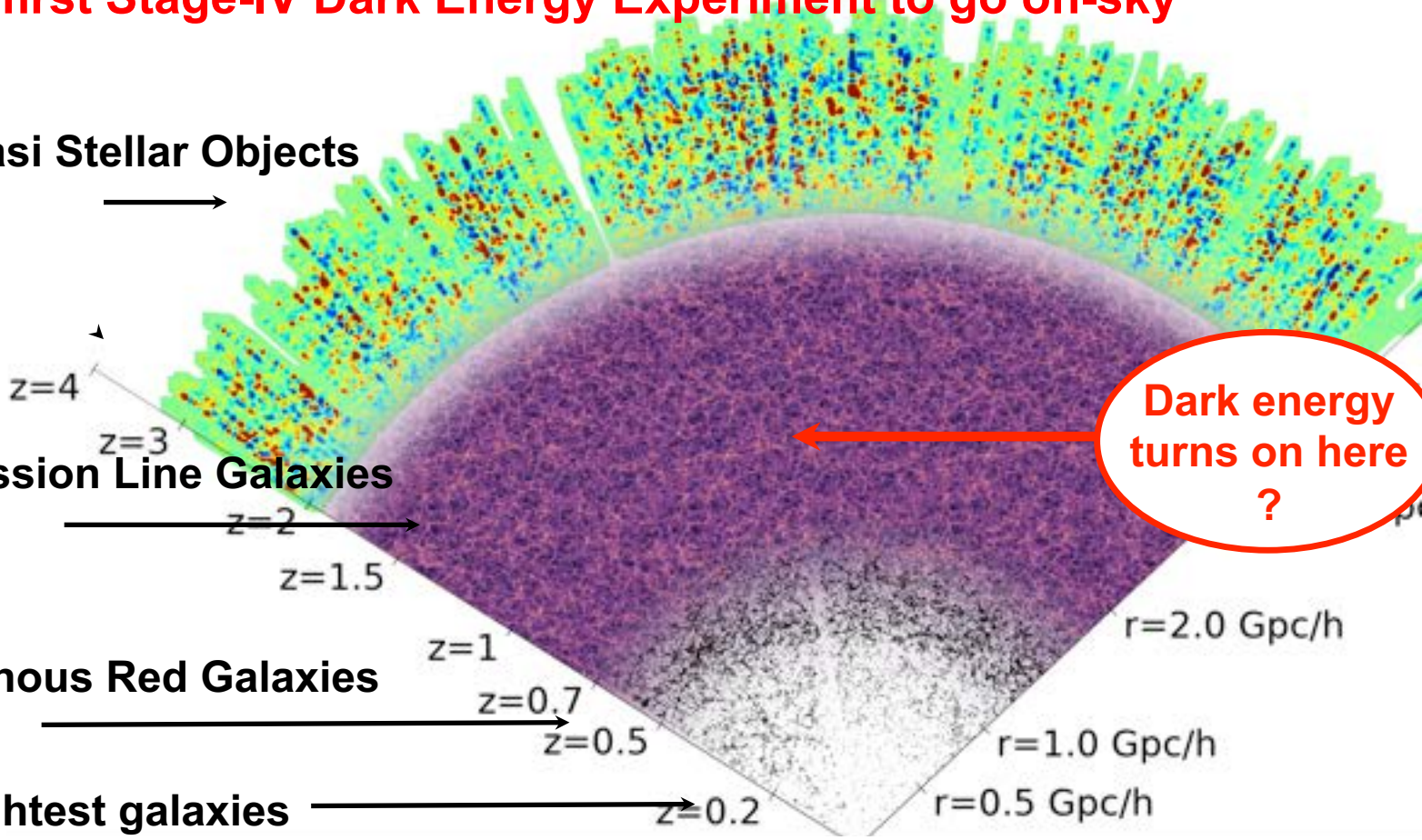
DESI is the first Stage-IV Dark Energy Experiment to go on-sky

2.4 million Quasi Stellar Objects (QSO)

17 million Emission Line Galaxies (ELG)

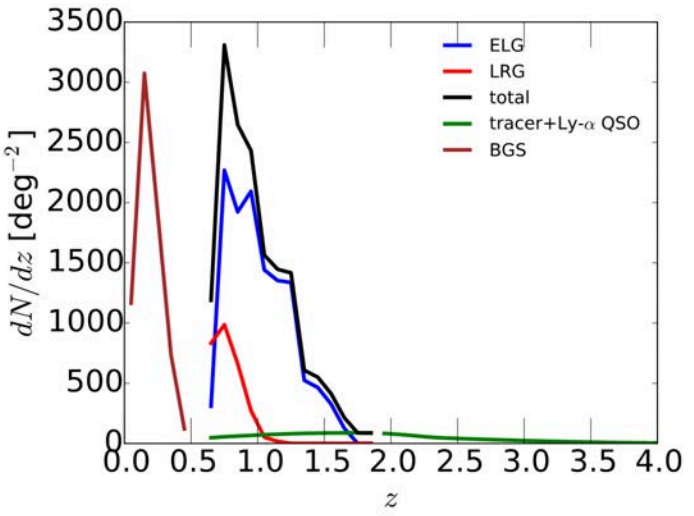
6 million Luminous Red Galaxies (LRG)

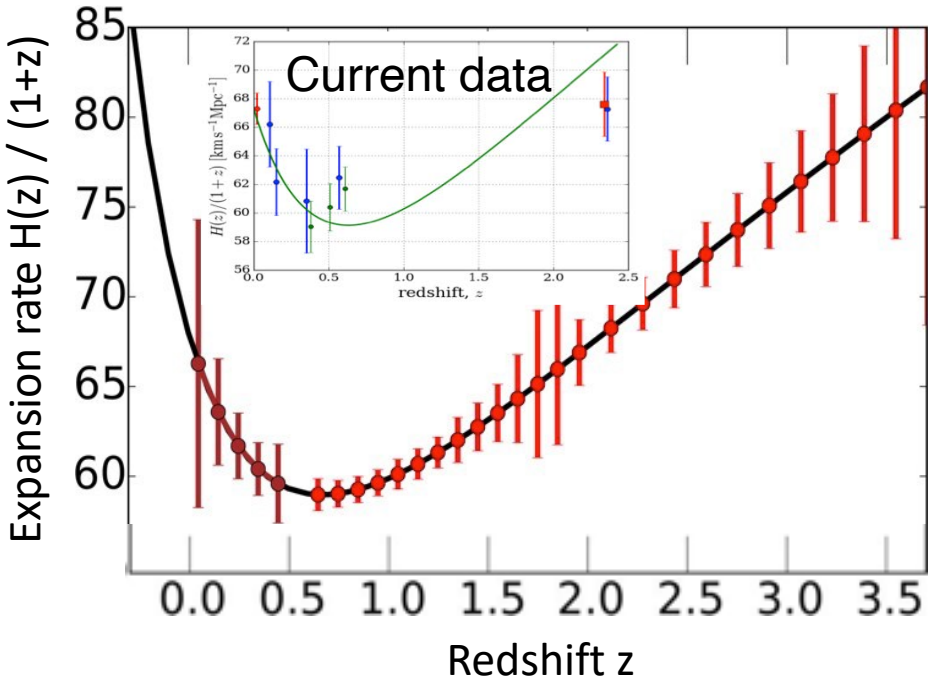
10 million brightest galaxies



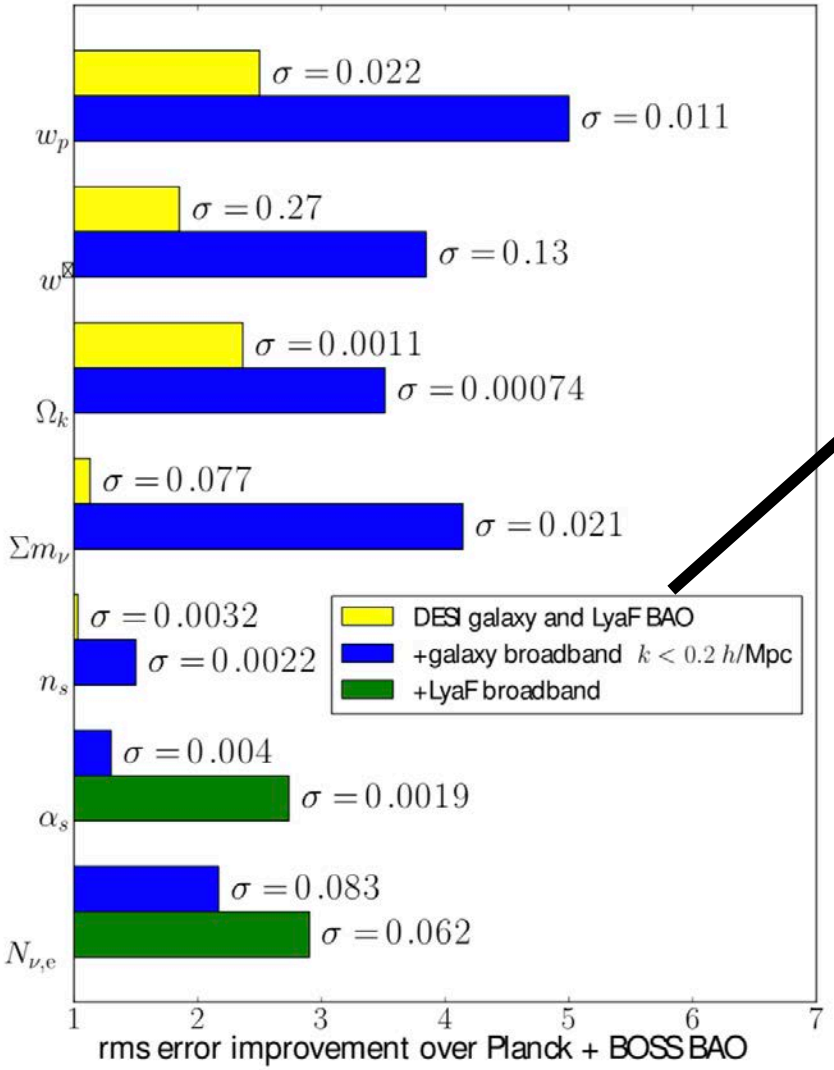
DESI will collect 35 million spectra

- 5 classes of observation
  - Bright Galaxies
  - Luminous Red galaxies
  - Emission Line Galaxies
  - Quasars as tracers
  - High redshift quasars for Ly-a forest
- Geometrical measurements using Baryon Acoustic Oscillations
- Growth measurements using Redshift Space Distortions
- Lots of other science, including cross-correlations with other surveys (including CCAT-prime)

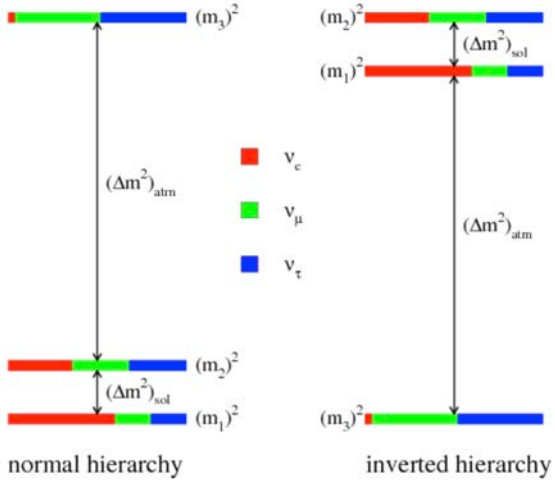




DESI cosmological predictions (arXiv:1611.00036)



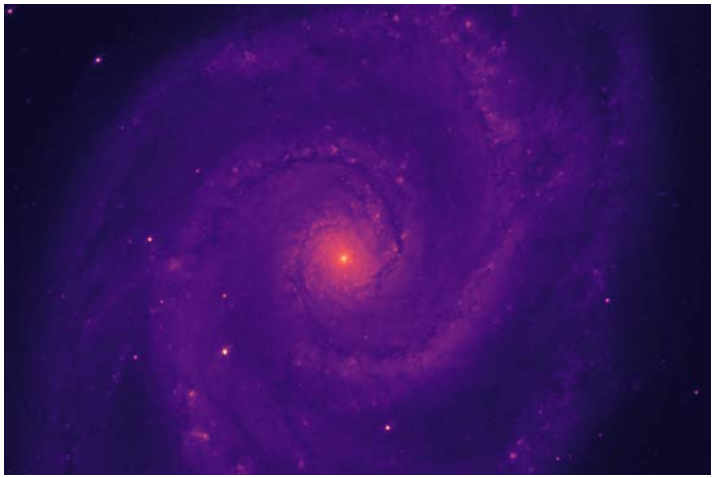
Data	$\sigma_{\Sigma m_\nu}$ [eV]	$\sigma_{N_{\nu,\mathrm{eff}}}$
Planck	0.56	0.19
Planck + BAO	0.087	0.18
Gal ($k_{\mathrm{max}} = 0.1h\,\mathrm{Mpc}^{-1}$)	0.030	0.13
Gal ($k_{\mathrm{max}} = 0.2h\,\mathrm{Mpc}^{-1}$)	0.021	0.083
Ly-α forest	0.041	0.11
Ly-α forest + Gal ($k_{\mathrm{max}} = 0.2$)	0.020	0.062



Total mass >0.059eV >0.10eV

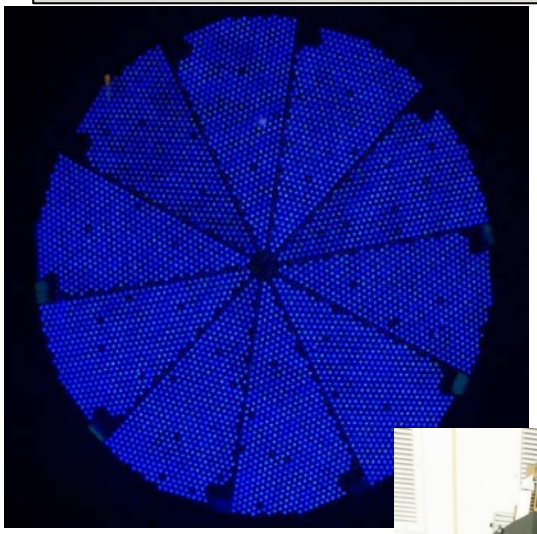
New wide-field optical corrector and focal plane are installed & working at the Mayall Telescope at Kitt Peak

- 6 lenses, largest ~1m in diameter
- First light of corrector images was measured to be 0.7 arcsec (April 1, 2019)
- Whirlpool galaxy as viewed by Commissioning Instrument

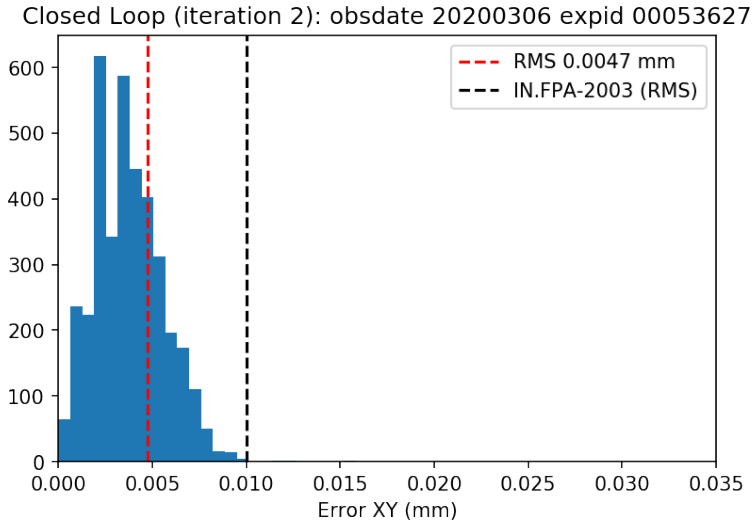


Installation and commissioning

Ten petals constructed

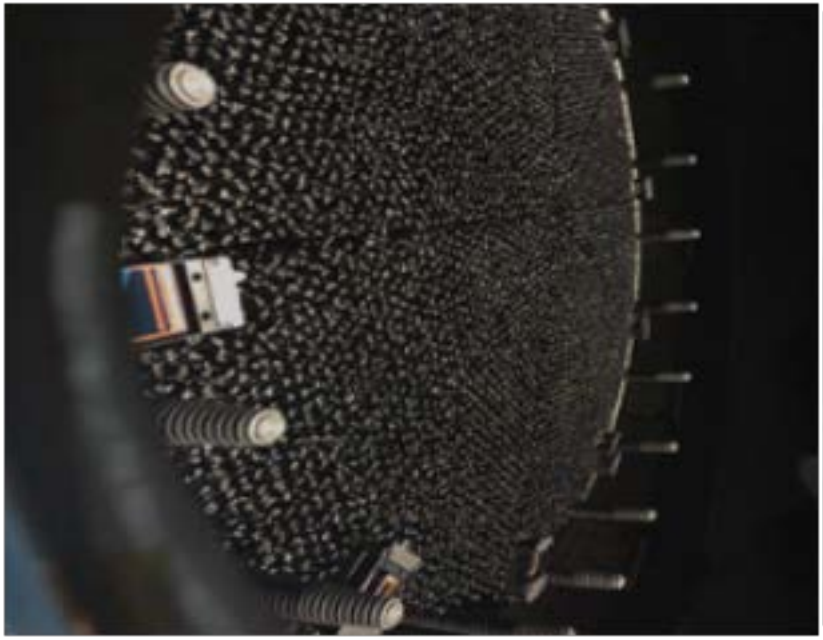


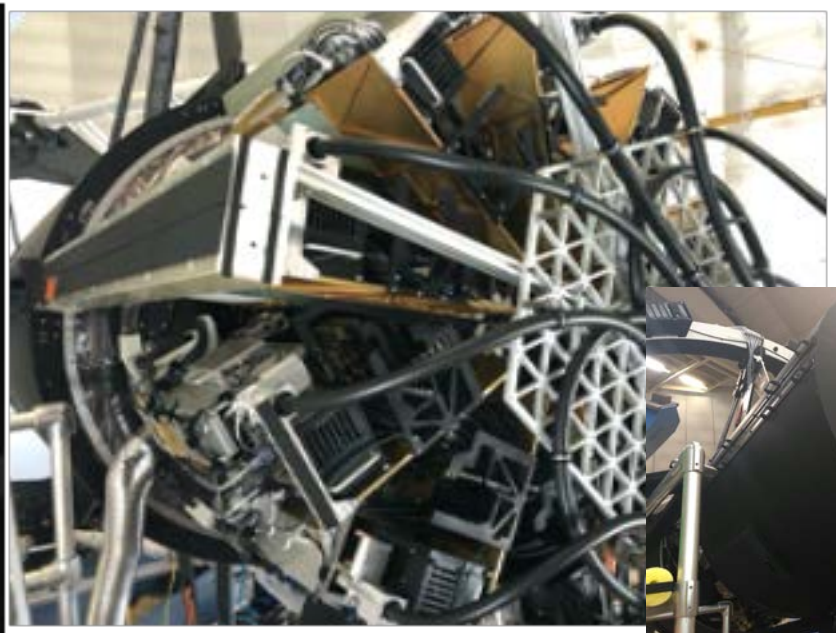
<5 µm rms typical positioning accuracy as-installed

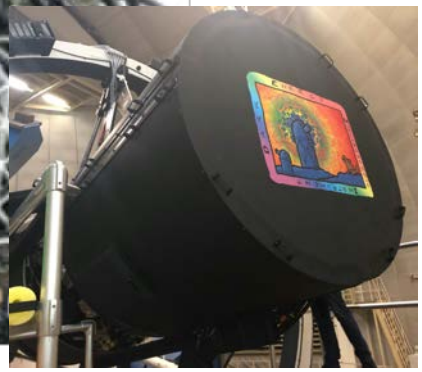


Ten petals installed

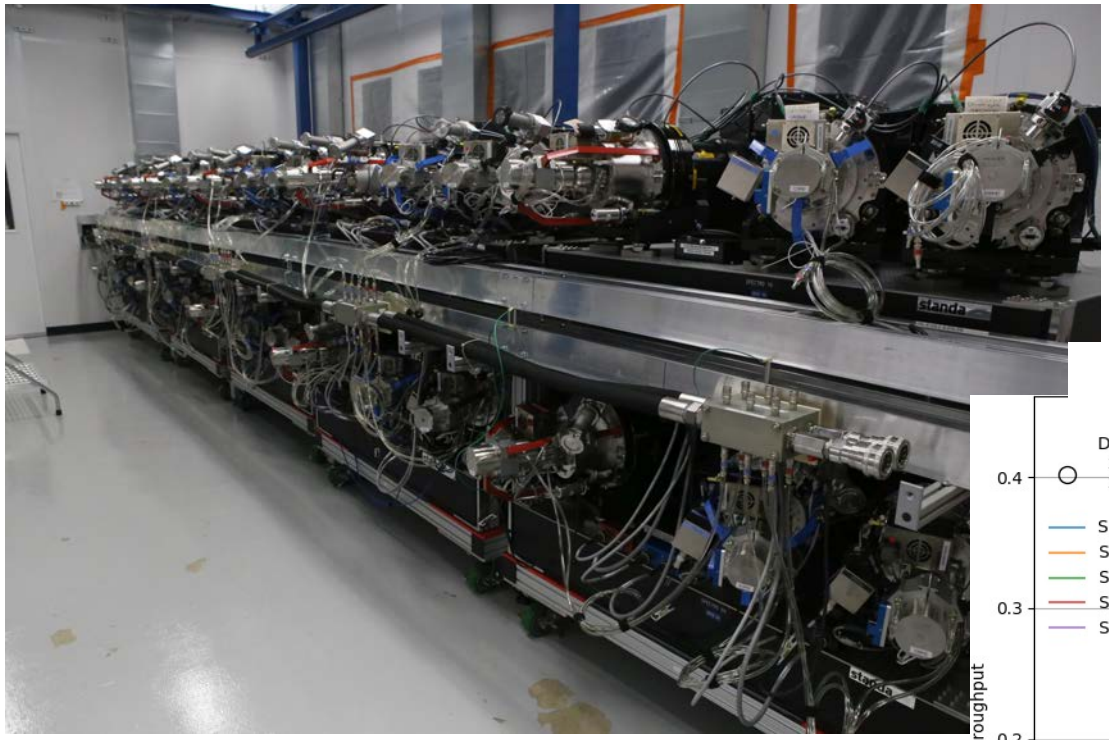
Installation of the focal plane instrument was completed in August, 2019. The picture below shows the fiber ends of the 5,000 robotic positioners on the focal plane.



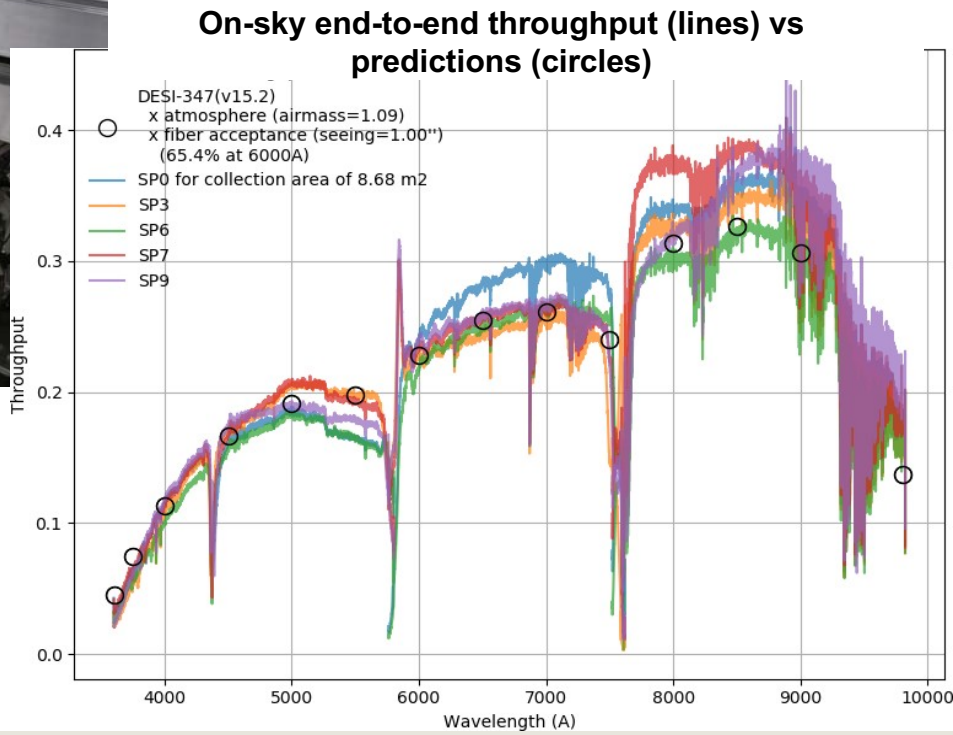




Ten spectrographs installed



10 DESI spectrographs
30 cryostats, 30 CCDs
500 million pixels!!



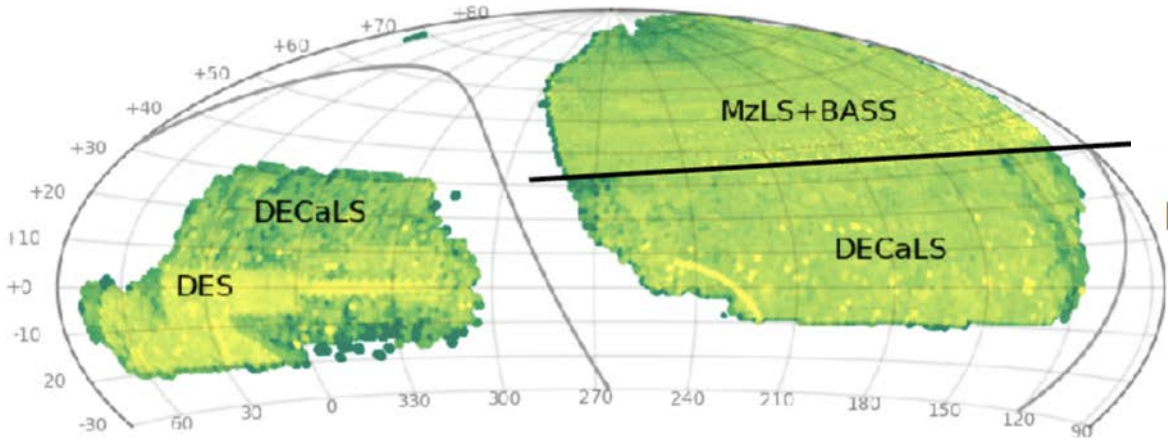
14,000 sq deg of Imaging data for targeting
All data public - http://legacysurvey.org

Three optical surveys completed
~1.5 mags deeper than SDSS

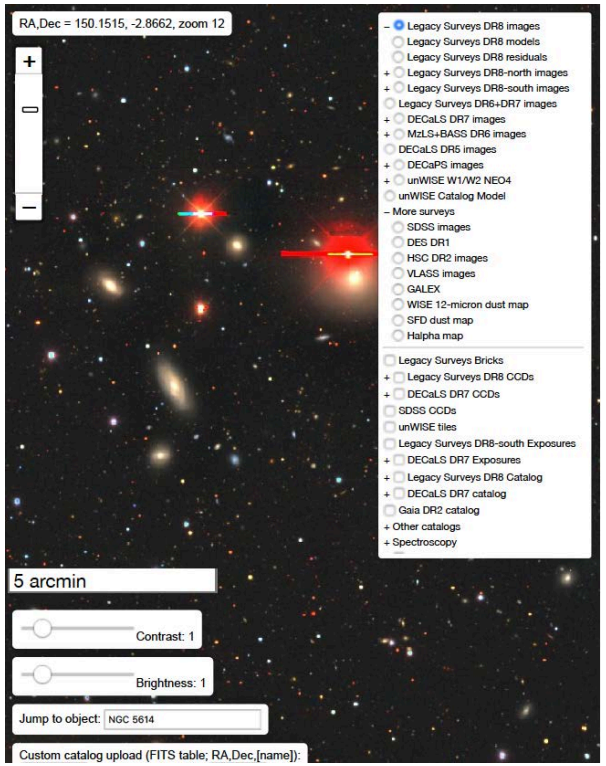
- **North** (*5k deg²*) — **BASS** gr-bands, **MzLS** z-band
- **South** (*9k deg²*) — **DECaLS** grz-bands

One infrared survey completed

- **All Sky WISE** (NASA satellite) W_1 W_2 bands

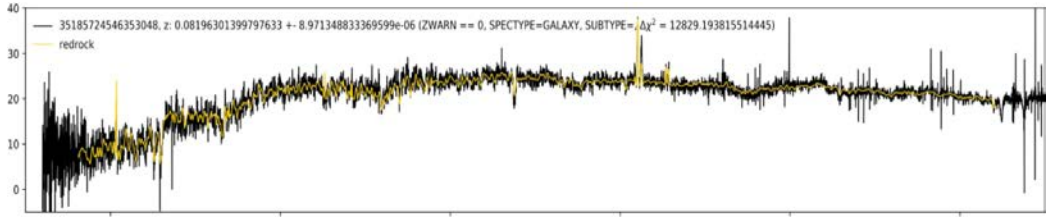


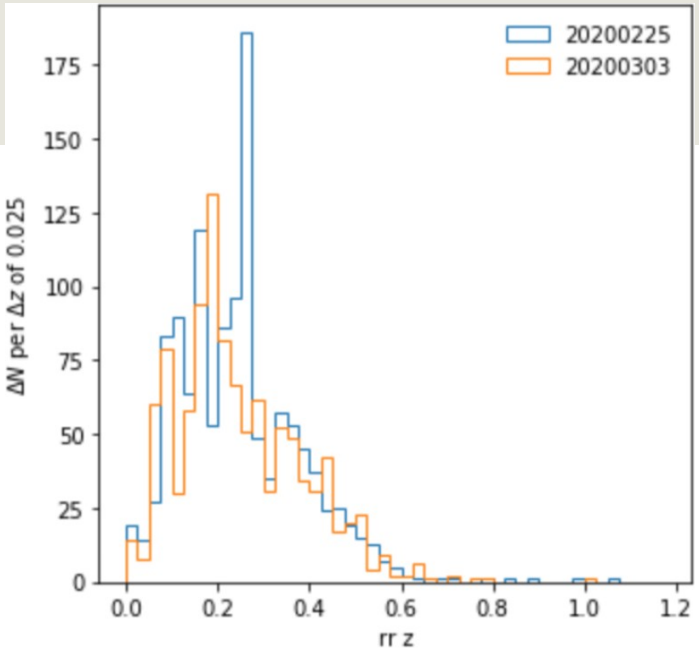
- Images combined using Tractor code
- DR8 published July 2019
- Final data release by Q2 2020
- Viewer and other tools available:



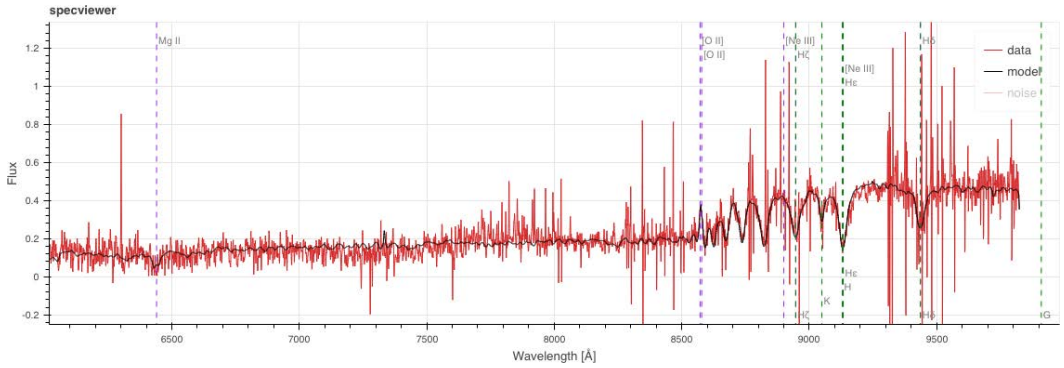
Mini-Survey Validation

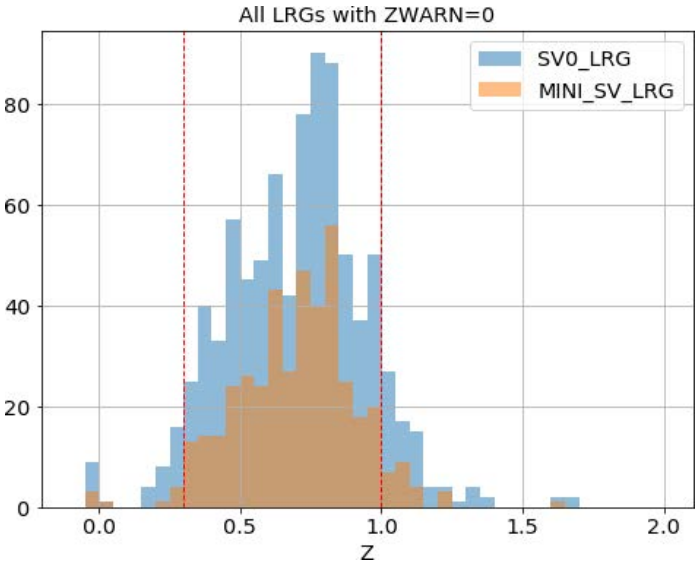
- Bright Galaxy Survey





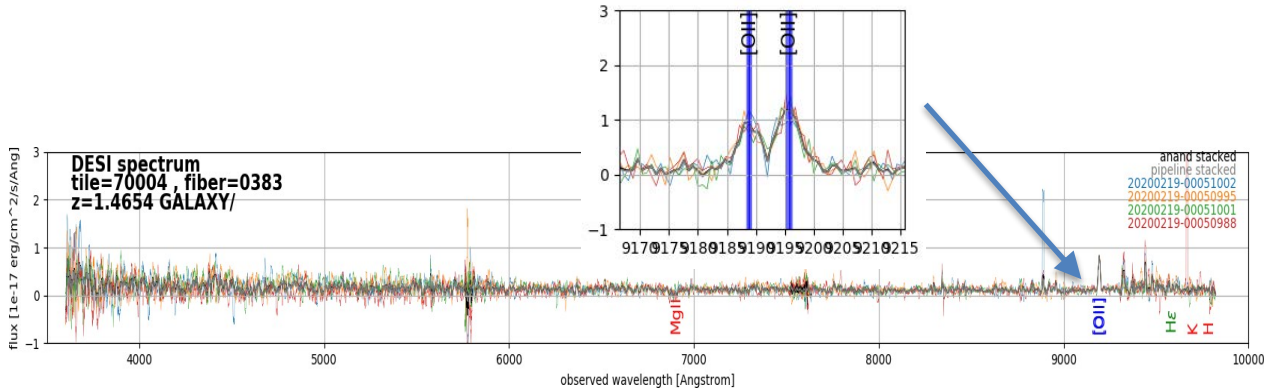
- Luminous Red Galaxy Survey

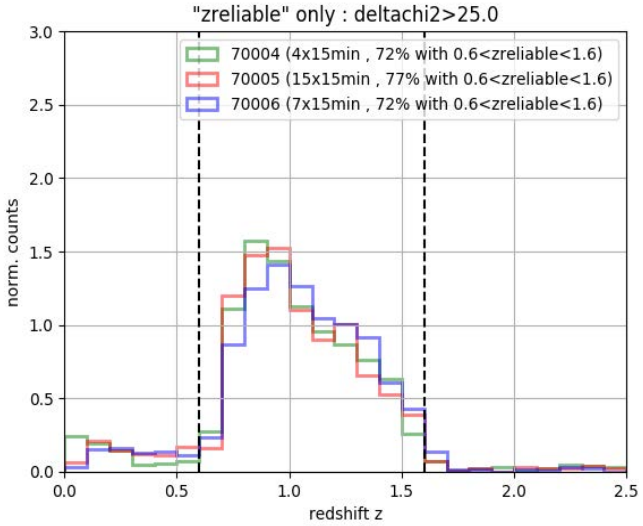




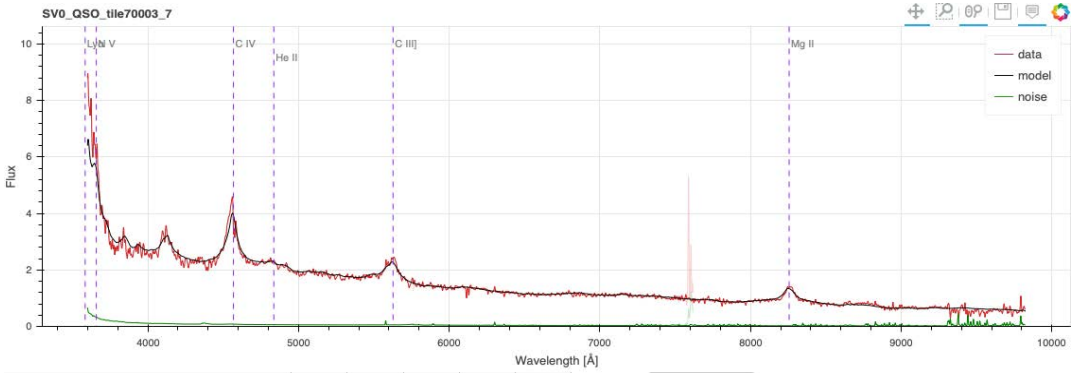
Mini-Survey Validation

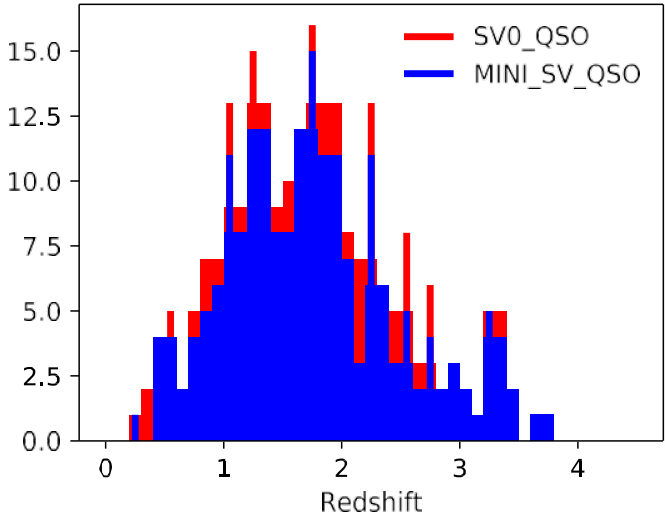
- Emission Line Galaxies (ELG)



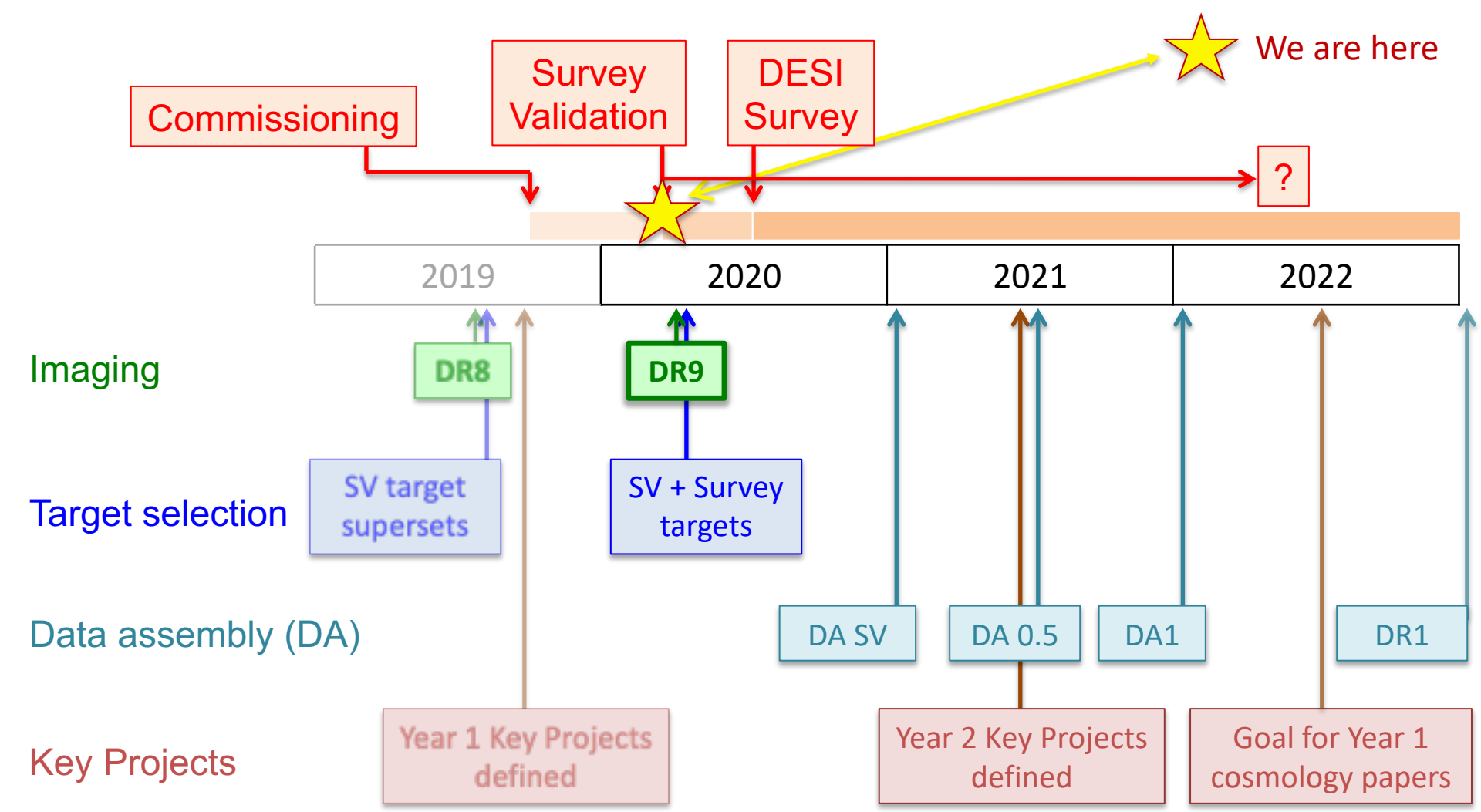


- Quasi-Stellar Objects (QSO)





Science can start as soon as safety permits

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