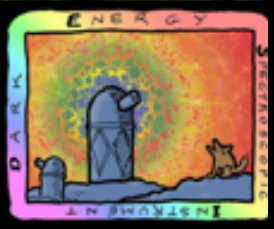
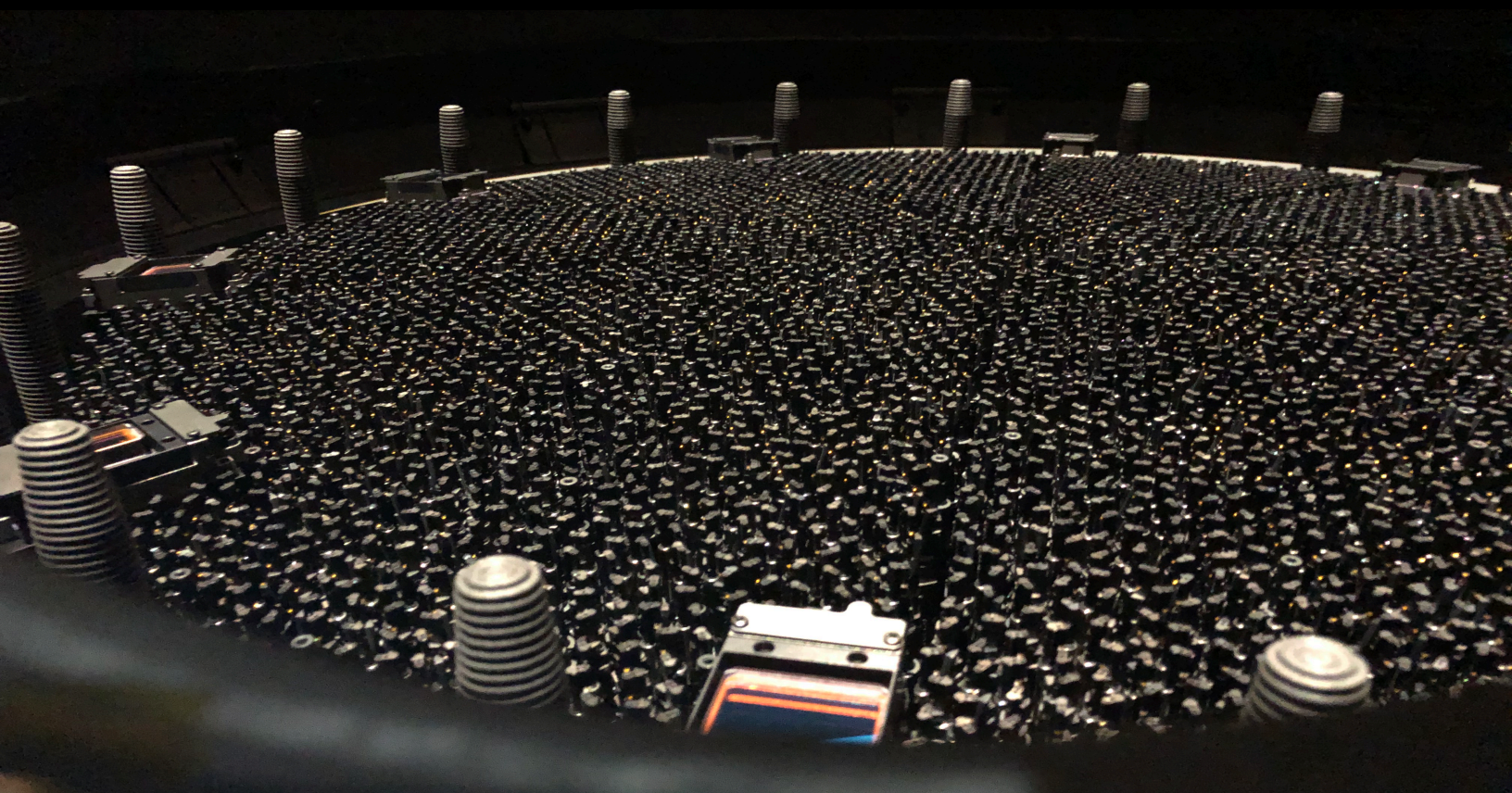


DARK ENERGY SPECTROSCOPIC INSTRUMENT



DESI FACTS

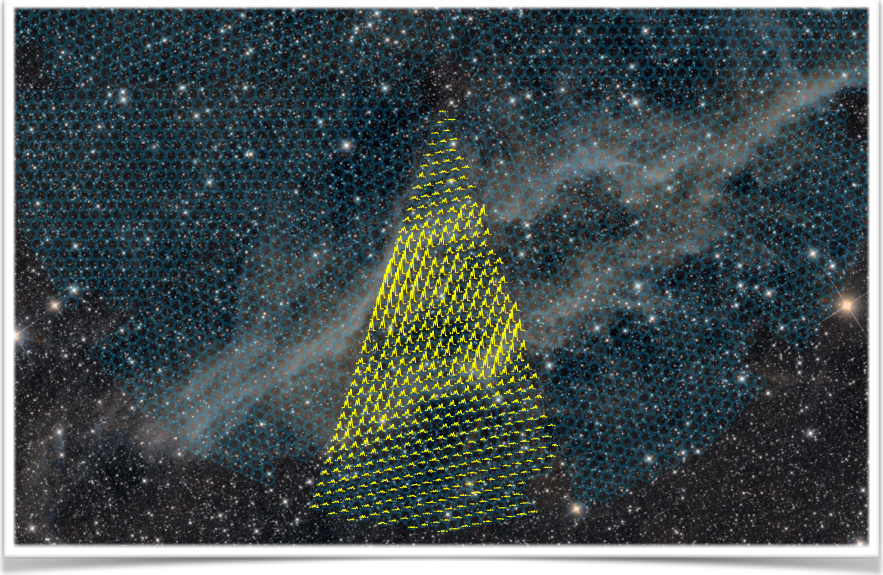
Dark Energy Spectroscopic Instrument Collaboration | desi.lbl.gov

What is DESI?

DESI is the world's premier instrument for spectroscopic surveys. With the ability to robotically position 5000 fibers on targets spread over an 8 deg^2 field of view within a minute, DESI is built for wide-field cosmological surveys. The fibers feed ten 3-arm high-throughput spectrographs that cover the wavelength range from 360-980nm at resolutions R=2000 (blue) to 5100 (red).

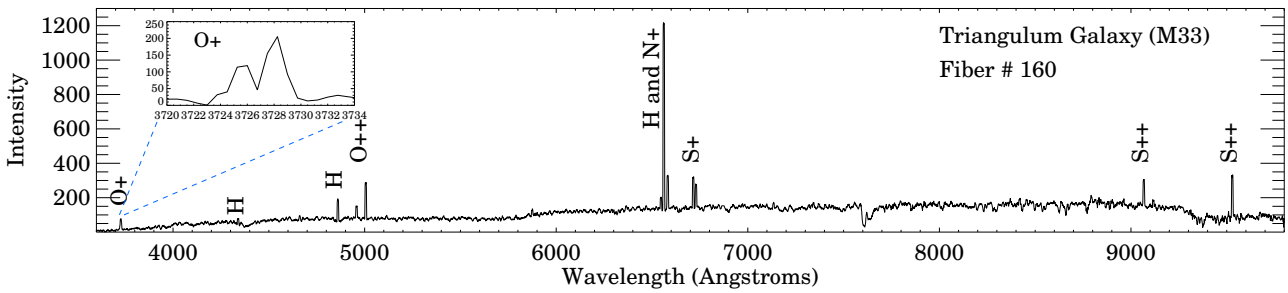
DESI's mission

DESI's primary mission is to map the expansion history of the universe to percent-level accuracy and thereby constrain the role of dark energy over cosmic time. DESI will also provide constraints on models of gravity, the mass of neutrinos, the growth of large scale structure, and inflation. DESI will do so by measuring redshifts for 35 million galaxies and QSOs to redshifts of 3.5 over an area of 14,000 deg^2.



DESI Completes Commissioning

On October 22, 2019, the Mayall 4m telescope's new focal plane was illuminated by light from the night sky, and the DESI instrument recorded spectra on the first of its 10 spectrographs. In March 2020, DESI successfully demonstrated the key performance parameters of the instrument. This includes refinement of the performance of the 8 square degree corrector, high-precision (10 micron) positioning of the fibers under active feedback, accurate calibration of the spectrographs, and on-sky commissioning of the whole user interface. Using the full DESI system, we collected the spectroscopy of many tens of thousands of survey targets. We have observed spectra of faint galaxies and quasars with redshift distributions and spectroscopic signal-to-noise that match well to what we expected. Due to the hiatus caused by the COVID-19 pandemic, the main 5-year survey will begin in spring 2021.



Target Class	Number of Targets	Redshift Range
Bright Galaxies (r<19.5)	10 million	0 < z < 0.4
Luminous red galaxies	4 million	0.4 < z < 1
Emission-line galaxies	17 million	0.6 < z < 1.6
Quasars	2.4 million	0.5 < z < 3.5
Milky Way stars	10 million	

DESI Targets

During dark time, DESI will target faint galaxies and quasars for its primary cosmological survey; during bright time, the targets will be bright galaxies (for a dense survey of the low-redshift universe) and stars in the Milky Way galaxy. Targets are selected using optical and mid-infrared photometry from the Legacy Surveys project (see legacysurvey.org).

Timeline

After a hiatus due to the COVID-19 pandemic, DESI is completing its Survey Validation, during which it will finalize its targeting and survey strategy. The 5-year science surveys will commence in spring 2021 and complete in 2026. Data products, including spectra and redshift catalogs, will be publicly released at regular intervals.

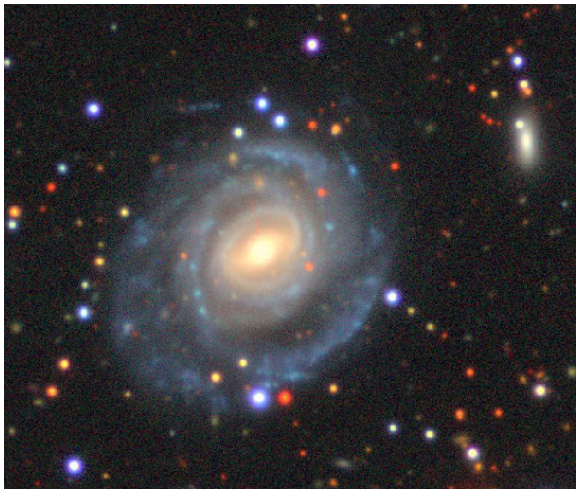
An International Collaboration

The DESI Collaboration includes 680 scientists spanning 28 US and 37 international institutions. DESI is supported by the Director, Office of Science, Office of High Energy Physics of the U.S. Department of Energy and by the National Energy Research Scientific Computing Center, a DOE Office of Science User Facility; additional support for DESI is provided by the U.S. National Science Foundation's National Optical-Infrared Astronomy Research Laboratory; the Science and Technologies Facilities Council of the United Kingdom; the Gordon and Betty Moore Foundation; the Heising-Simons Foundation; the French Alternative Energies and Atomic Energy Commission (CEA); the National Council of Science and Technology of Mexico, and by the DESI Member Institutions (see desi.lbl.gov for a full list).

The Legacy Surveys: Imaging the DESI sky

legacysurvey.org

In order to select targets for the DESI cosmological project, the collaboration undertook a public 3-band imaging survey covering the entire DESI footprint. The Legacy Surveys (LS) used data from the Blanco 4m telescope on Cerro Tololo in Chile and the Mayall 4m and Steward Observatory's Bok 2m telescopes on Kitt Peak (Iolkam Du'ag) in Arizona to image 14,000 deg^2 to *g,r,z* depths > 24.0, 23.4, 23.0 AB mag. The LS catalogs, which include mid-infrared photometry from newly coadded, multi-epoch WISE satellite data for all optical sources, are publicly available from NERSC at the link above and from the NOIRLab's archive at https://datalab.noao.edu/ls/dataAccess.php. The most recent version of this data (DR9) has recently been released. Legacy Survey optical and mid-IR images can be browsed at legacysurvey.org/viewer/.



For More Information

DESI:desi.lbl.gov

- DESI I: Science, Targeting and Survey Design, 2016, arXiv: 1611.00036
- DESI II: Instrument Design, 2016, arXiv.org:1611.00037
- Imaging Surveys: legacysurvey.org
- Overview of the DESI Legacy Imaging Surveys, 2019, AJ, 157, 168

DESI at a Glance

Mayall 4m Telescope	
Location	Kitt Peak National Observatory, Tohono O'odham Nation, Arizona
Coordinates	31°57'48"N, 111°36'00"W
Elevation	2,120 m
Primary mirror	3.8m diameter, f/2.8, 1.8m central DESI obscuration
Dark Energy Spectroscopic Instrument (DESI)	
Number of fibers	5,000
Field of view	8.0 deg^2 (corrected), 7.5 deg^2 (populated)
Corrector design	4 lenses + 2 ADC elements
Corrected focal ratio	3.68 (on-axis), 3.86 (average over FOV)
Fiber density on-sky	667 / deg^2
Focal-plane scale	67.5 μm/arcsec (on axis); 70.8 μm/arcsec (average over FOV)
Fiber core diameter	107 μm (1.5 arcsec)
Fiber pitch	10.4 mm, hexagonal close pack in 10 focal-plane wedges ("petals")
Fiber patrol region	Circular, 12 mm diameter
Repositioning time	< 45 s
Positioning accuracy	5 μm RMS
Guiding	10 guide-focus-alignment cameras, 1 per petal, 25 $arcmin^2$ each
Spectrographs	10 x 3-arm spectrographs, 500 fibers each
Wavelength range	360–980 nm
Spectral coverage & resolution	360–593 nm (Blue Channel): 2,000–3,200 566–772 nm (Red Channel): 3,200–4,100 747–980 nm (NIR Channel): 4,100–5,100
Detectors	30 CCDs, 4,096 x 4,096 pixels, 15 μm pitch
Read + dark noise	< 4 electrons
End-to-end throughput	43.0% @ 450nm, 45.4% @ 650nm, 50.5% @ 850nm (estimated, telescope x fiber system x spectrographs x detectors)
DESI Surveys	
Survey area	14,000 deg^2 fully covered by 2,000 pointings ("tiles")
Survey duration	5 years: 2020–2025
Survey strategy	Key Project (dark time): 10,000 tiles in 5 layers of 2,000 tiles each Bright Time Survey: 6,000 in 3 layers of 2,000 tiles each
Survey depth	10^{-17} erg/s/cm^2 for emission lines

DESI Membership: Aix-Marseille University; Argonne National Laboratory; Barcelona-Madrid Regional Participation Group; Brookhaven National Laboratory; Boston University; Carnegie Mellon University; CEA-IRFU, Saclay; China Participation Group; Cornell University; Durham University; École Polytechnique Fédérale de Lausanne; Eidgenössische Technische Hochschule, Zürich; Fermi National Accelerator Laboratory; Granada-Madrid-Tenerife Regional Participation Group; Harvard University; Korea Astronomy and Space Science Institute; Korea Institute for Advanced Study; Lawrence Berkeley National Laboratory; Laboratoire de Physique Nucléaire et de Hautes Energies; LinEA Brazil; Max Planck Institute; Mexico Regional Participation Group; NSF's National Optical-Infrared Astronomy Research Laboratory; Ohio University; Shanghai Jiao Tong University; Siena College; SLAC National Accelerator Laboratory; Southern Methodist University; Swinburne University; The Ohio State University; Universidad de los Andes; University of Arizona; University of Barcelona; University of California, Berkeley; University of California, Irvine; University of California, Santa Cruz; University College London; University of Florida; University of Michigan at Ann Arbor; University of Pennsylvania; University of Pittsburgh; University of Portsmouth; University of Queensland; University of Rochester; University of Toronto; University of Utah; University of Wyoming; University of Zurich; UK Regional Participation Group; Yale University.

Cover image: Top: The Nicholas U. Mayall Telescope (large dome) is the home for DESI and will spend the next 5 years mapping the universe and charting its evolutionary history. Bottom: The DESI focal plane, showing the 5000 fiber positions (500 per "wedge"). Ten CCD cameras, designed for guide, focus, and acquisition, are mounted on the outer edge of the field.