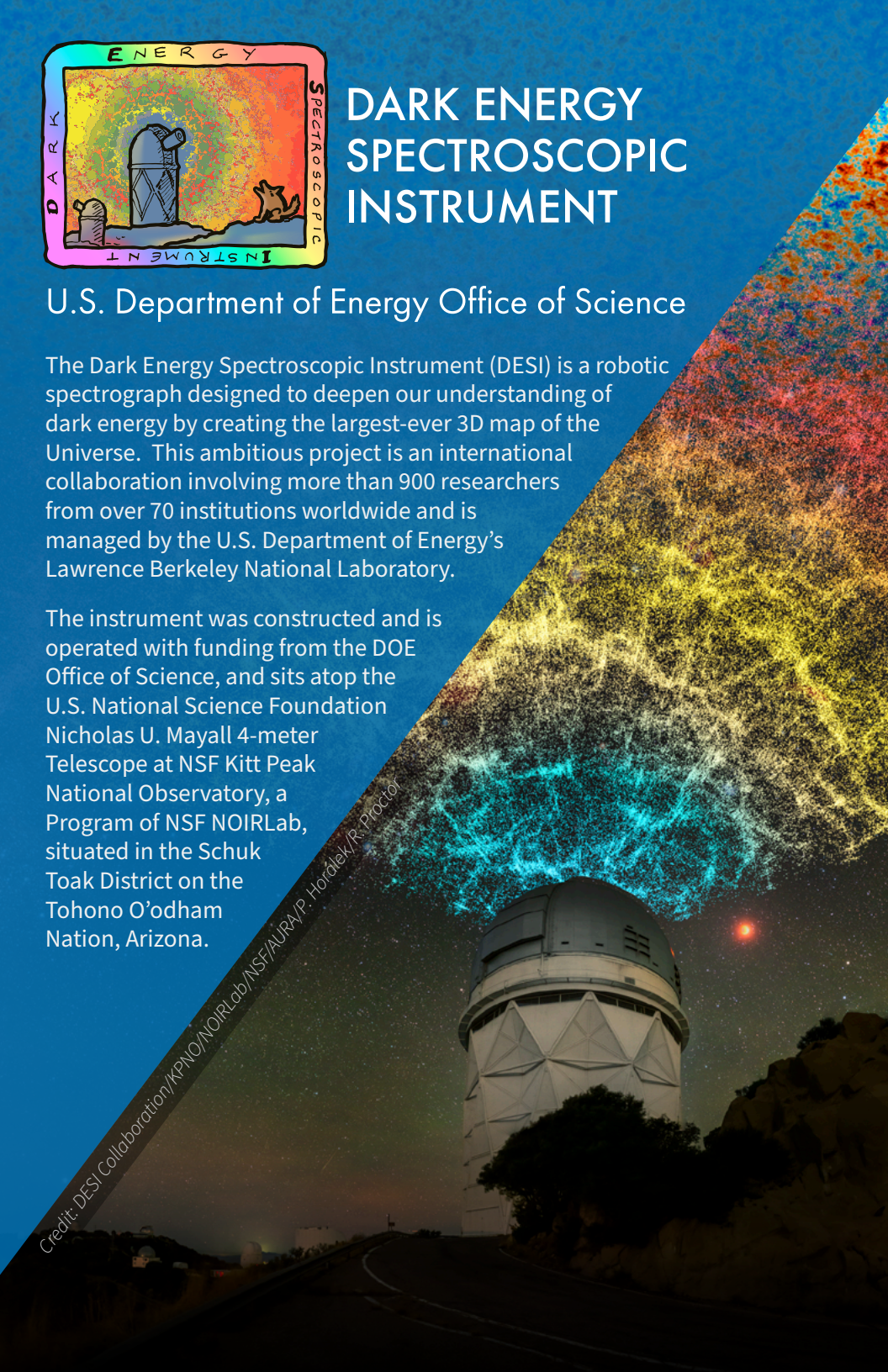
DARK ENERGY SPECTROSCOPIC INSTRUMENT

U.S. Department of Energy Office of Science

The Dark Energy Spectroscopic Instrument (DESI) is a robotic spectrograph designed to deepen our understanding of dark energy by creating the largest-ever 3D map of the Universe. This ambitious project is an international collaboration involving more than 900 researchers from over 70 institutions worldwide and is managed by the U.S. Department of Energy's Lawrence Berkeley National Laboratory.

The instrument was constructed and is operated with funding from the DOE Office of Science, and sits atop the U.S. National Science Foundation Nicholas U. Mayall 4-meter Telescope at NSF Kitt Peak National Observatory, a Program of NSF NOIRLab, situated in the Schuk Toak District on the Tohono O'odham Nation, Arizona.



Credit: DESI Collaboration/KPNO/NOIRLab/NSF/AURA/P. Horálek/R. Proctor

What Is DESI Mapping?

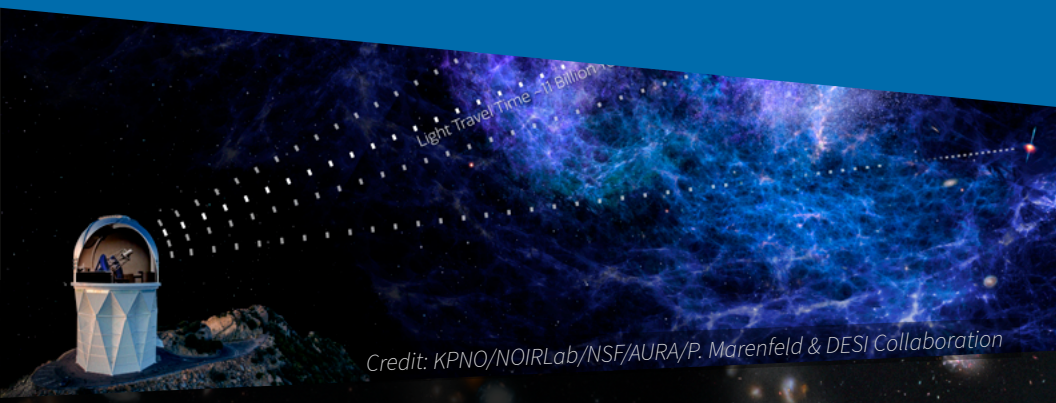
DESI maps the large-scale structure of the Universe by collecting spectra and measuring redshifts (a proxy for distance) for over 50 million astrophysical sources. These sources include:

Credit: DESI collaboration

Credit: KPNO/NOIRLab/NSF/AURA/T. Slovinsky

- **Bright Galaxy Sample (BGS):** A low-redshift, magnitude-limited sample.
- **Luminous Red Galaxies (LRG):** A higher-redshift sample of massive, old galaxies.
- **Emission-Line Galaxies (ELG):** Younger galaxies with ionized oxygen emission lines in their spectra.
- **Quasars (QSO):** Distant galaxies with active galactic nuclei.

DESI also leverages the **Lyman-alpha forest** — absorption lines in QSO spectra — to trace hydrogen gas between distant galaxies and Earth. Additionally, DESI is gathering spectra from over 10 million stars within the Milky Way, helping us better understand the distribution and dynamics of dark matter in our galaxy.



Credit: KPNO/NOIRLab/NSF/AURA/P. Marenfeld & DESI Collaboration

What Has DESI Found Out About Our Universe?

DESI's first year of observations has produced remarkable cosmological insights. Highlights include:

- Precise measurements of Baryon Acoustic Oscillations (BAO) over a wide range of redshifts reveals a statistical preference for a **time-varying dark energy** over a cosmological constant, although the standard ΛCDM model fits the data fairly well.
- Constraints on the sum of the **neutrino masses** to less than 0.072 eV (95% confidence).
- Precise measurements of BAO yield a measurement of the **Hubble constant** of 67.97 ± 0.38 km/s/Mpc when combined with cosmic microwave background (CMB) data.
- These findings demonstrate DESI's unparalleled accuracy in probing fundamental physics and pose intriguing questions for future data releases.

You Can Use DESI data!

Credit: Dark Energy Survey/DOE/FNAL/DECam/CTIO/NOIRLab/NSF/AURA

DESI's rich dataset — including spectra, redshift measurements, target photometry, and large-scale structure catalogs — is publicly available, accompanied by software and tutorials for data access and analysis.

- The **Early Data Release** with 1.8 million spectra is already available.
- The **First Full Data Release** with over 20 million spectra will be launched in summer 2025.

Explore DESI data at data.desi.lbl.gov.

DESI is supported by the DOE Office of Science 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, the Science and Technology 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, the Ministry of Science and Innovation of Spain, and by the DESI member institutions.

Kitt Peak National Observatory sits atop I'oligam Du'ag (Manzanita Shrub Mountain). Astronomers are honored to be permitted to conduct scientific research on the sacred mountain located in the homelands of the Schuk Toak District within the Tohono O'odham Nation. We honor their past, present, and future generations, who have lived here for time immemorial and will forever call this place home.

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