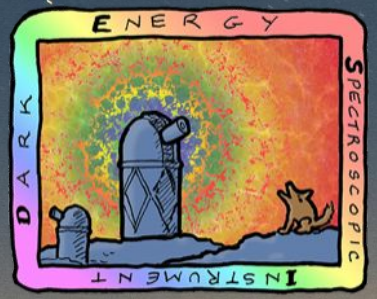
Dark Energy Spectroscopic Instrument and its extension

Latin American community participating in DESI

Jaime Forero-Romero (UNIANDES, Colombia)
Alma X. González Morales (Universidad de Guanajuato, México)
On behalf of many LATAM DESI members



DARK ENERGY SPECTROSCOPIC INSTRUMENT

U.S. Department of Energy Office of Science

Thanks to our sponsors and

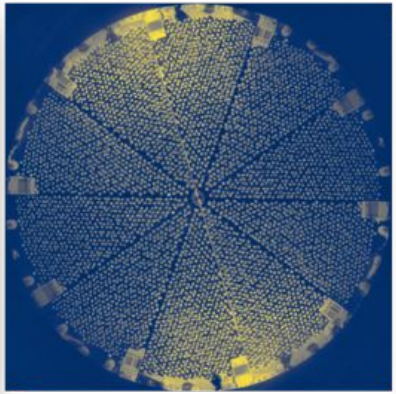
and 65 more institutions.

Dark Energy Spectroscopic Instrument (DESI)

Goals:

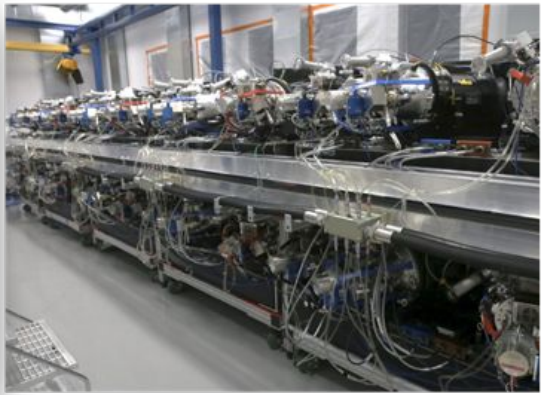
- Obtain the spectra of about 40 million galaxies and quasars during a 5 year survey.
- Measure the expansion of the Universe through cosmic history trough the BAO and RSD techniques mainly.
- Investigate on Dark Energy and Dark Matter nature, as well as on neutrinos mass, modified gravity, etc.

4-m Telescope at Mayall in Kitt Peak Arizona, USA



5000 fibers and robotic positioners in the focal plane

8 sq.deg. Field of View
14,000 sq. deg coverage



10 Spectrographs: 360-980 nm range

DESI's First Cosmological Results

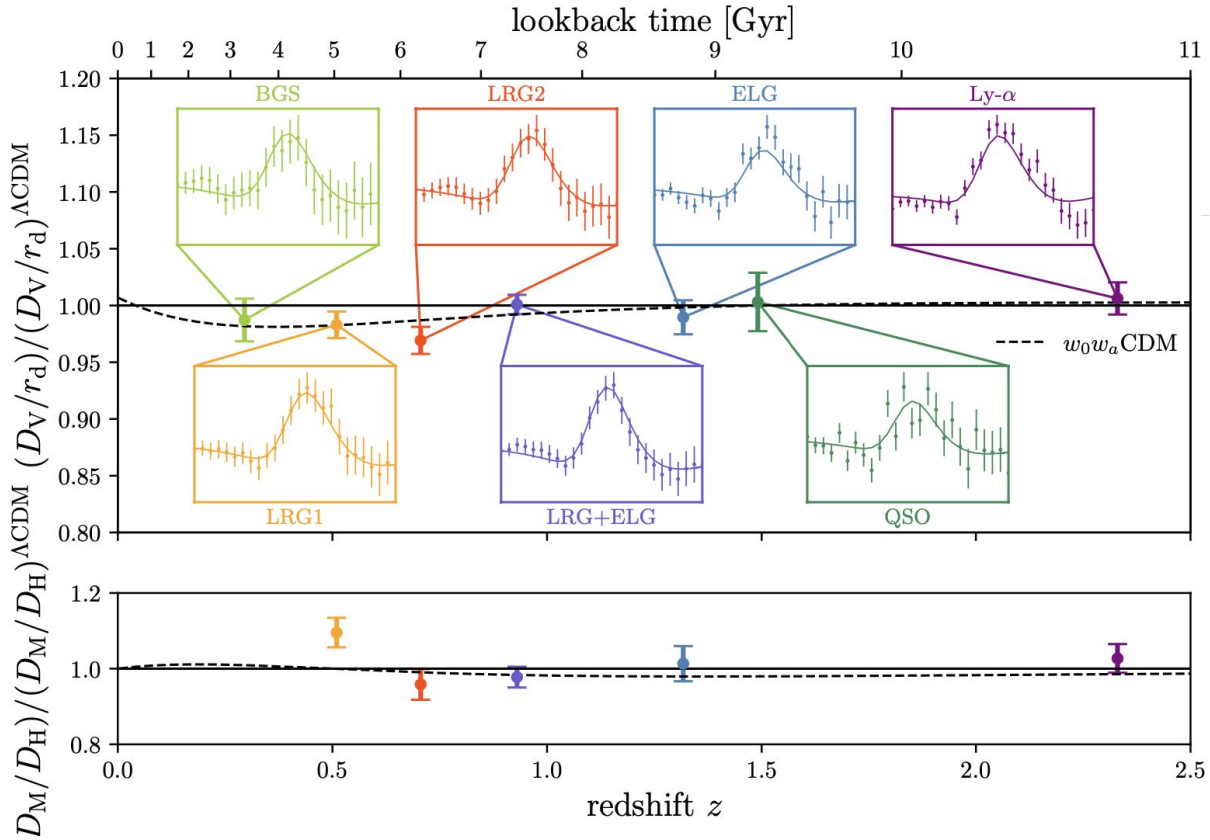


Image Credit: Arnaud de Mattia/DESI collaboration

A Tantalizing 'Hint' That Astronomers Got Dark Energy All Wrong

Scientists may have discovered a major flaw in their

The New York Times

First Results from DESI Make the Most Precise Measurement of Our Expanding Universe

- Berkeley Lab Press
- APS 2024, Rencontres de Moriond 2024
- Cosmology talks (Youtube), CONAHCyt
- entre otros…

https://newscenter.lbl.gov/2024/04/04/desi-first-results-make-most-precise-measurement-of-expanding-universe/

https://data.desi.lbl.gov/doc/papers/

DESI 2024

https://data.desi.lbl.gov/doc/papers/

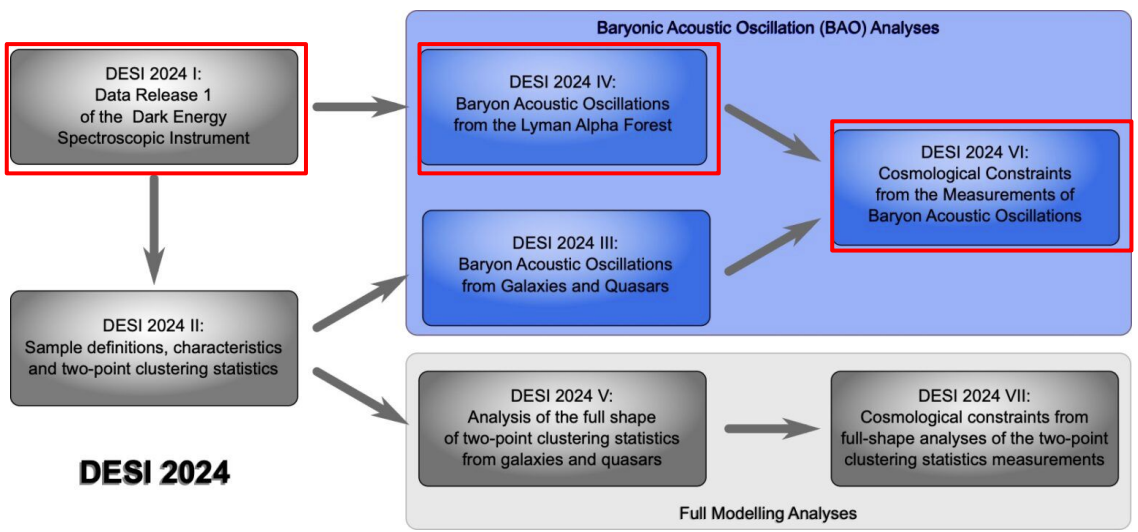
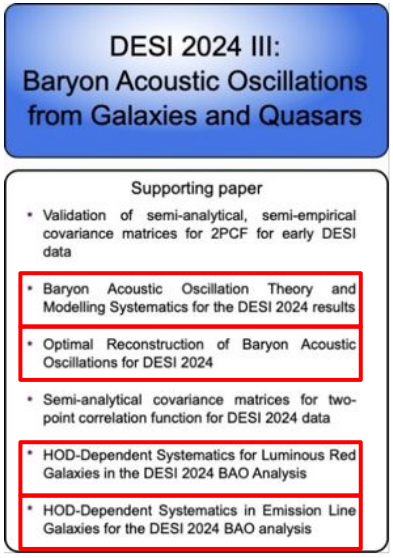
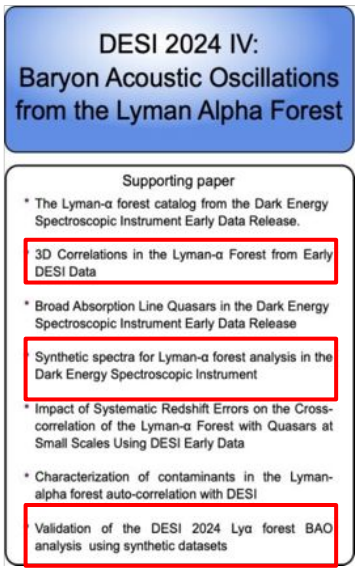


Image Credit: Gustavo Niz





+6 supporting articles on April 11th

Non-exhaustive examples of papers with LATAM leading and/or really important contributions…

Significant LATAM participation in many of these publications as well.

LATAM role

México

Colombia

Members previously formed in LATAM institutions

DESI-Mx

- Mexican participation present since 2011.
  - Axel de la Macorra and Jorge Cervantes main pioneers, both involved in DESI planning .
  - CONAHCYT signed MOU in 2015 to support mexican participation.
- Current participation involves 19 members at UNAM, 11 at UG, 3 at CINVESTAV and 1 at ININ.
  - 8 Full Participants: Alejandro Aviles (ICF-UNAM, former CONAHCYT researcher), Jorge L. Cervantes-Cota (ININ), Axel de la Macorra (Mexico RPG contact, IF-UNAM), Tonatiuh Matos (CINVESTAV), Gustavo Niz (DCI-UG), Luis Ureña (DCI-UG), Octavio Valenzuela (IA-UNAM), and Mariana Vargas-Magaña (IF-UNAM).

- One continuing participant application under revision: Alma González (UG, former CONAHCYT researcher)
- 26 Sponsored Members: 15 (IF/IA/ICF-UNAM), 8 (UG), 2 CINVESTAV.
- One external collaborator: Sebastien Fromenteau (ICF-UNAM)

DESI Sponsored members from Mexican institutions: Jesus Antonio Astorga (CINVESTAV), Sergio Felipe Beltran (UG), Brenda Izamar Tapia Benavides (IF-UNAM), Alvaro Callejas Tavera (IIMAS-UNAM), Rodrigo de la Cruz (UG), Miguel Enriquez Vargas (ICF-UNAM) , Diego Gonzalez (DCI-UG), Hiram K. Herrera-Alcantar (DCI-UG), Jose Lozano (IF-UNAM), Flor de María Lozano-Rodríguez (DCI-UG), Jennifer Meneses Rizo (IF-UNAM), Gerardo Morales-Navarrete (IF-UNAM/ININ), Andrea Muñoz-Gutiérrez (IA-UNAM), Claudio Nahmad Arcaraz (IF-UNAM), Hernan Enrique Noriega (ICF-UNAM/IF-UNAM), Erick Paniagua (IF-UNAM), Gustavo Perez-Sanchez (DCI-UG), Holman Daniel Quintero Salazar (DCI-UG), Sadi Ramírez Solano (IF-UNAM), Hugo Rivera (IF-UNAM), Fanny Arlin Rodríguez Martínez (IF-UNAM), Johnatan Osvaldo Román-Herrera (DCI-UG), Zenaida Berenice Sánchez Méndez (IA-UNAM), Jose Arturo Trelles Hernandez (IA-UNAM), Jose Antonio Vázquez (IA-UNAM).

DESI-Mx Main science interests and contributions.

- **Galaxy BAO and RSD measurements:** Mainly** at IF and ICF at UNAM have contributed to efforts in,
  - Mock catalogs and challenges
  - BAO and Full-shape DESI pipelines
  - Analysis of systematics.
- **Lyman-alpha measurements:** Mainly** at UG have contributed to efforts regarding,
  - Measurement of 3D correlation functions and P1D statistics.
  - Creation of realistic datasets.
- **Cosmological interpretation of measurements**: within LCDM model and non-LCDM models –both for alternative DE and DM models (IF, ININ, CINVESTAV, UG) --
- **Other topics:**
  - Galaxy clustering full shape modelling and other compression techniques
  - Higher order statistics in galaxies and Lyman-alpha
  - Measurements of Neff and neutrino masses
  - Milky Way Survey: Mocks and DM substructure
  - LSST-DESI synergies

** There has been some collaboration among mexican and LATAM, in general, participants.

DESI-Mx

Contributions to infrastructure and operations.

- Voting member of DESI Institutional Board since its foundation: Axel de la Macorra[B] for México Regional Participation Group (RPG)
- Non-voting member of Institutional Board: Gustavo Niz[B] for UG
- Chair of Publication Board: Gustavo Niz[B](2021-to date)
- Chair of Meetings committee: Mariana Vargas-Magaña[B] (2020-2023)
- Chair of ECS committee: Andrea Múñoz[B]
- Co-chair of Lya-WG (2018-2021), Lya Y1 KP co-lead and member of science committee (2018-early 2024): Alma González[B]
- Members of meetings committee: Axel de la Macorra and Jorge Cervantes.
- Members of publication board: Alejandro Aviles, Mariana Vargas-Magaña
- Members of outreach committee: Alma González.
- Recurrent support for observation shifts.

[B]:This and other “service” work has granted **Builder** status to 3 full participants and 2 sponsored members (1 PhD female member).

Colombia

- 1 Full participant: Dr. Jaime Forero-Romero (UNIANDES)
- Present since 2012, highly involved in DESI planning.
- Non-voting member of the Institutional Board
- DESI Builder
- Current sponsored Members: Miguel Perdomo
- Continuing participant: John Suárez-Pérez (moving to a teaching position to the TEC de Monterrey Guadalajara–Mexico–, got PhD at Uniandes).
- Former sponsored postdocs: David Sierra-Porta, Luz Angela Garcia.

Colombian participation has focused in building software infrastructure

- **Data systems:** Build, test and document the software infrastructure supporting DESI. Mainly fiber assignment and target selection. (J.E Forero-Romero)
- **Survey Operations:** Support the daily operations of the instrument. Continuous vetting of the spectroscopic reductions. (J.E. Forero-Romero)
- **Survey Design:** Develop software to design and validate the survey design (J.E. Forero-Romero)
- **DESI Bright Galaxy Survey (BGS):** Design and validation of the Bright Galaxy Survey (D. Sierra-Puerta)
- **Lyman-alpha measurements:** Creation of realistic datasets (L. A. Garcia)
- **DESI outliers:** Developing Machine Learning techniques to finding outliers in the data as support for the science working groups (J.F. Suarez-Perez)
- Recurrent support for observation shifts.

Other DESI participants.

1. Uendert Andrade (Posdoc University of Michigan, got PhD at Observatório National, Brazil)
2. Benjamin Camacho (PhD at U. Barcelona, got BSc at IF-UNAM)
3. Cristhian Garcia-Quintero (PhD at UT Dallas, got BSc at UAS-Mexico)
4. Hiram Herrera-Alcantar (Moving as posdoc to CEA France, got PhD at DCI-UG)
5. Miguel de Icaza Lizaola (Posdoc at KASI, got MsC at IA-UNAM/IF-UNAM),
6. Leonel Medina Varela (PhD at UT Dallas, got BSc at UAS-Mexico)
7. Alejandro Pérez Fernández (PhD at Max Planck Institute for extraterrestrial Physics, got MsC at IF-UNAM)
8. Enrique Paillas (Posdoc U. Waterloo, got PhD at Pontifical Catholic University of Chile)
9. Bernardita Ried Guachalla (PhD Stanford University, got MSc U. de Chile).

Mostly graduate students and postdocs, that obtained their PhD, MsC, etc, degree at a LATAM institutions and now are elsewhere...

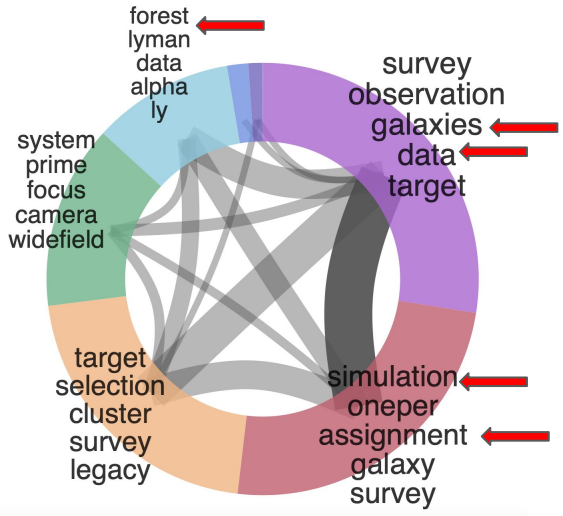
Retired DESI members from LATAM

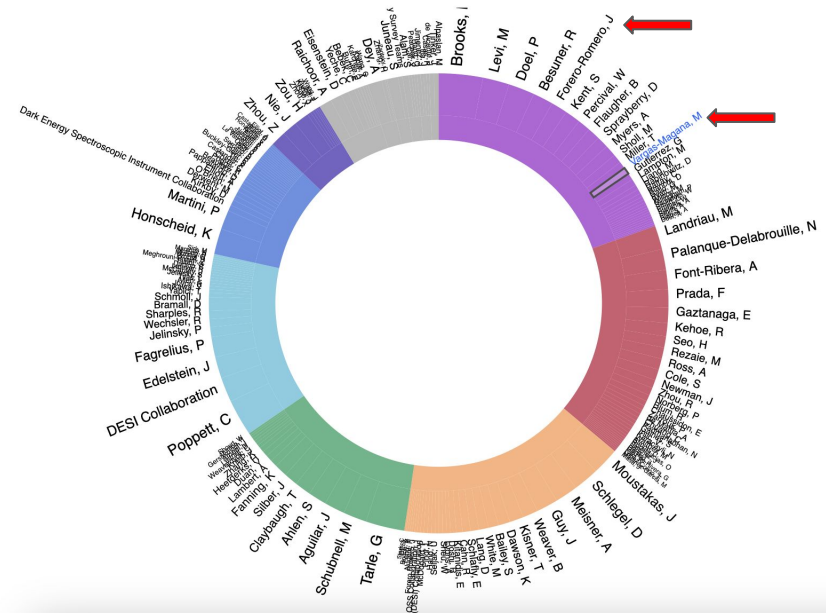
- México: 17 (1 Full Participant, 16 Sponsored)
- Colombia (UNIANDES): 3 (Sponsored)
- Brazil (LineA): 11 (2 Full Participant, 9 Sponsored)

Reasons for retirement includes changes of institution, research interests, or career path.

We know of at least couple of examples of past DESI LATAM members that have transitioned from academia to data science workforce.

195 DESI Papers, LATAM participation and networking is visible!



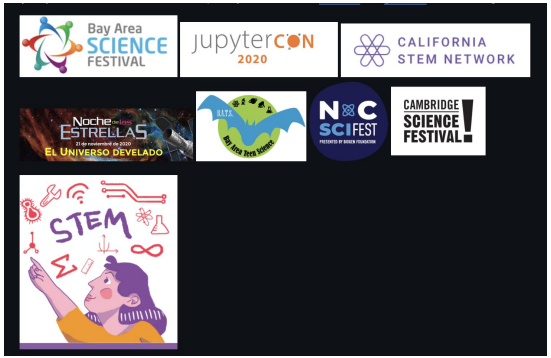


145/195 papers (submit/published) with at least 1 senior researcher in LATAM as co-author.

About a dozen of DESI papers signed as primary authors (non-alphabetical) by at least one member affiliated to a LATAM institution.

Not trivial given the [DESI publication policy]

Outreach efforts



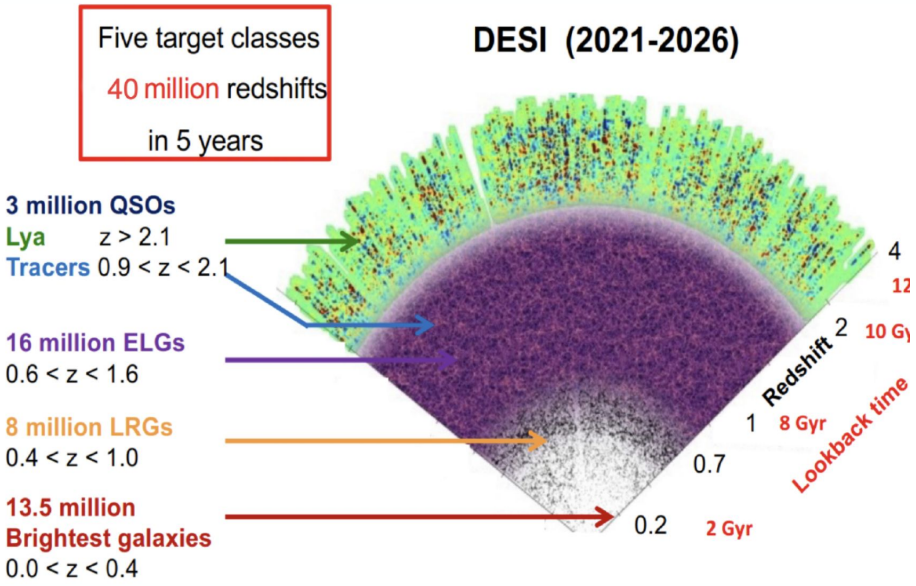
Next event: October 2024, Chihuahua for the CNF

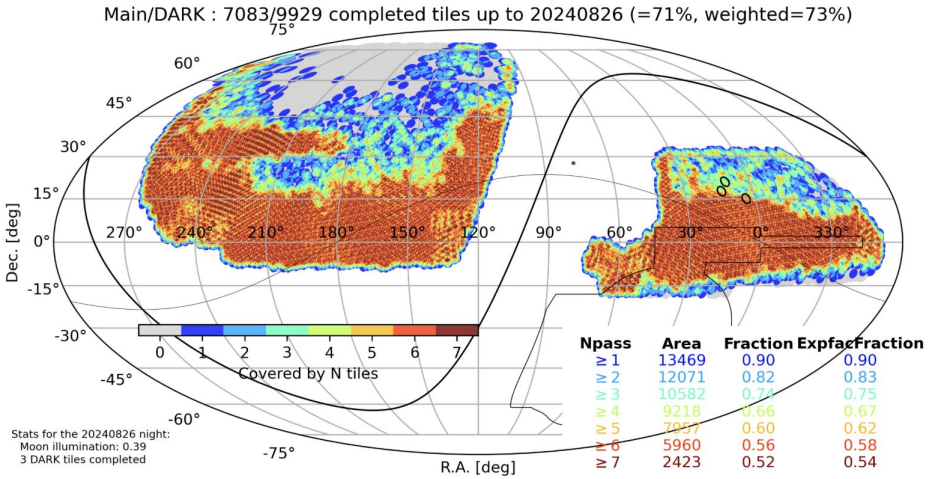
DESI webpages in spanish and portuguese

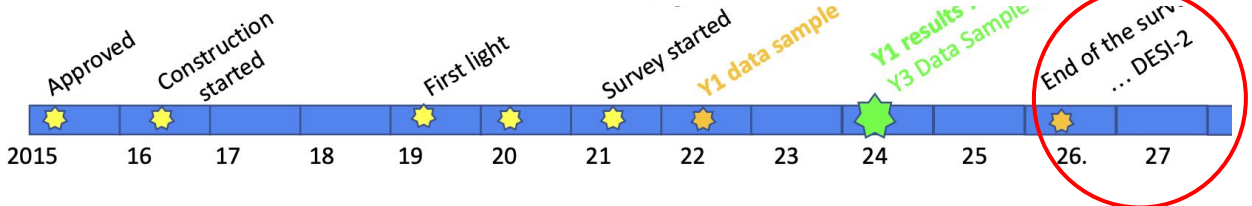
/ science /

science overview
cosmology and dark energy
redshifts and distance
mapping the universe
the DESI science mission
the DESI survey
imaging surveys

DESI Goals and Timeline







DESI extension science drivers

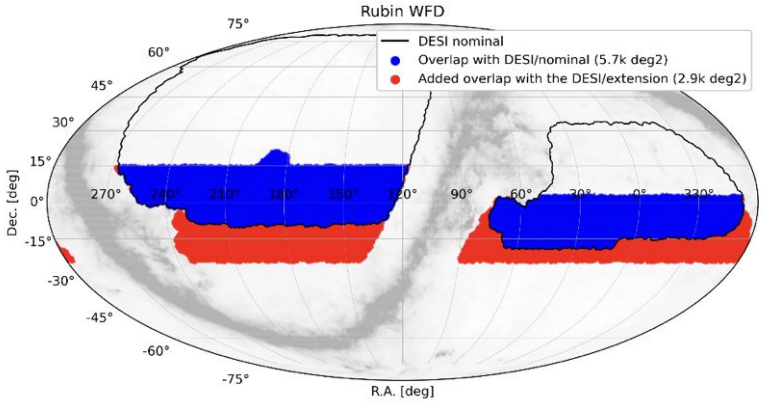
- To pin down the nature of dark energy and unravel the fundamental physics driving cosmic acceleration.
- To enhance DESI's ability to discriminate between ΛCDM and models with time-evolving dark energy equations of state.
- To maximize synergies with other cosmological probes, including weak lensing, CMB lensing, and galaxy-galaxy lensing.
- Nominal DESI is going very well, we are ahead of schedule

DESI extension current plans

- Extend operations by 2.5 years, from June 2026 to December 2028.
- Expand the survey footprint from 14,000 deg2 to 17,000 deg2.
- Add two more dark time passes and one more bright time pass to the
- existing survey strategy.
- Increase the LRG target density by 50% using a new selection of bluer galaxies.
- Improve the fiber assignment efficiency for ELGs from 69% to 82%.

DESI extension expectations

- Increase the total number of spectroscopically confirmed galaxies and quasars from 39 million to more than 63 million.
- Improve the inverse variance of the BAO measurements by 22% across all redshifts.
- Increase the overlap with the Rubin Observatory footprint by 50%.
- Increase the overlap with CMB experiments, such as the Atacama Cosmology Telescope (ACT), the Simons Observatory (SO) and CMB-S4 footprint by 50%.
- Achieve a 35% increase in the Dark Energy Task Force Figure of Merit from the BAO and CMB measurements.
- We are still assessing the impact on Lya science.



Possible overlap of DESI extension with Rubin.
Credit: DESI collaboration

Expected Challenges from the DESI Extension

- Maintaining instrument performance over the extended period.
- Ensuring consistent data quality at higher air mass observations.
- Managing the increased data volume and computational requirements.
- The extension will require approximately $30 million in additional funding over 2.5 years, for:
    - Extended operations of the instrument and telescope
    - Data processing and analysis
    - Personnel costs

For the LATAM community:

- No additional cost beyond the initial buy-in but we'll need continuous funding for maintaining the active participation we have so far.
- We need more good junior members, personnel power in general, to continue leading projects.

How to increase LATAM impact on DESI**

- Bring back/retain talent to LATAM: continuing participant status applies for many of them: you get a great researcher with a DESI participation as bonus…
- New buy ins; maybe not a priority but it would be desirable.
  - It's expensive (~$250K USD/PI for DESI-I, see DESI bylaws) but it might be a good time to join given the DESI extension.
  - Continuing participants can get a discount…
- Foster DESI external collaborations on key topics for LATAM communities.
- Fund mobility: even though we have strong groups at home, we need Juniors to go abroad to interchange knowledge, face international "competition", make their work and capabilities visible, etc., in order to make even more meaningful contributions.
- Transfer of knowledge: prepare non-DESI participant for use of public data.
- Outreach programs to showcase astronomy, data science, IA, etc. etc. Make the society aware of big discoveries, and even bigger yet to come…

**This is the corresponding authors opinion and might not reflect the full DESI-MX, nor the DESI, views on the topic.

Conclusion

It is especially important that we maintain the momentum generated by the LATAM community in the current DESI collaboration, and let our countries benefit from the transfer of knowledge and technology that the DESI extension will generate.

Thanks to our main funding agencies in Colombia and México

Colombia

- COLCIENCIAS Contrato No. 287-2016, Proyecto 1204-712-50459.
- Programa de investigadores postdoctorales, Departamento de Física,
- Universidad de los Andes.
- Vicerrectoría de Investigación y Creación, Universidad de los Andes.

Mexico

- CONAHCYT individual grants
- Dirección de Apoyo al posgrado y la Investigación, UG individual grants (DAIP-UG-Mexico).
- PAPIIT-DGAPA-UNAM individual grants (UNAM-Mexico)
- Centro de Investigación y de Estudios Avanzados (Cinvestav, Mexico)