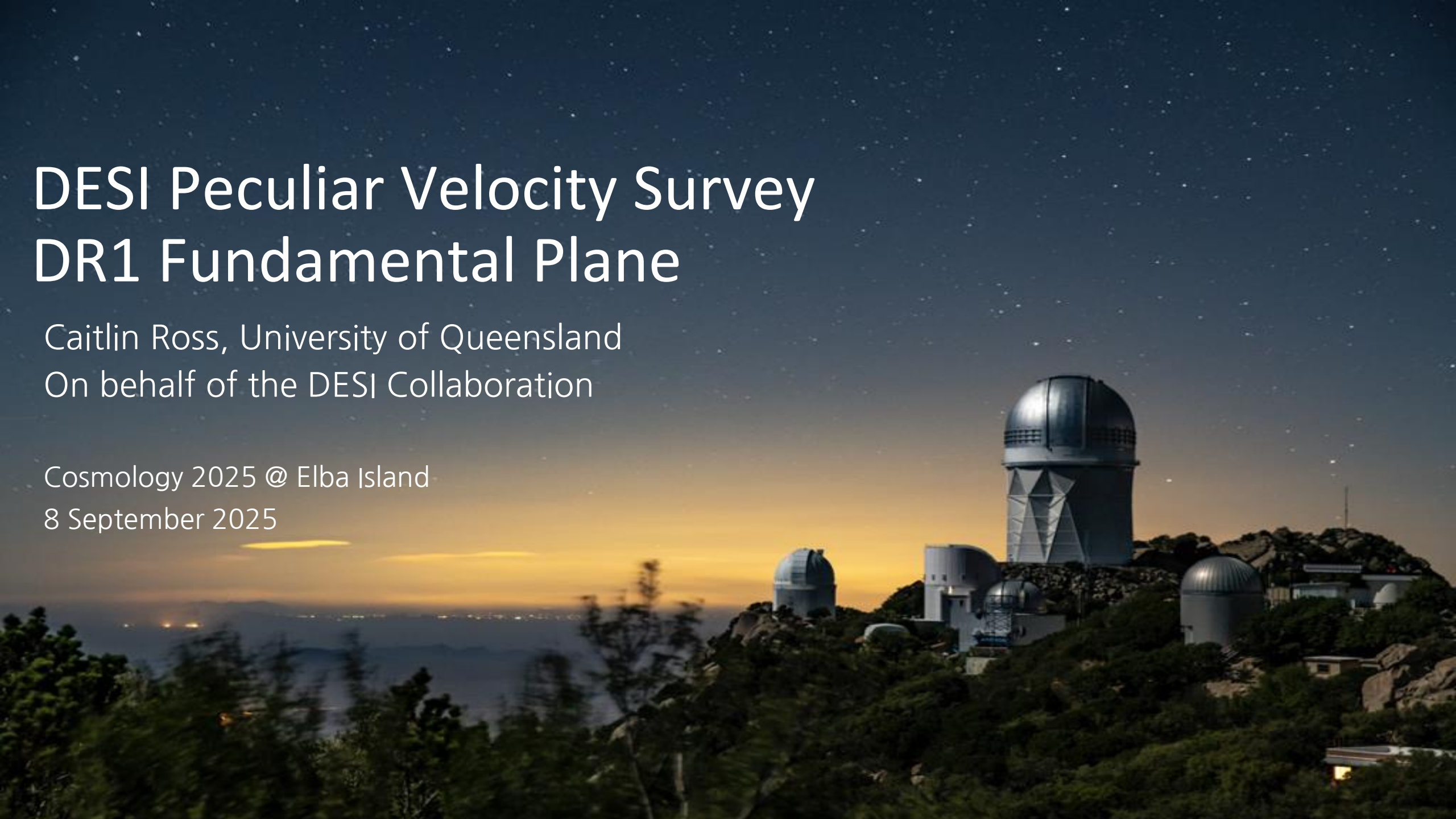
# DESI Peculiar Velocity Survey DR1 Fundamental Plane

Caitlin Ross, University of Queensland
On behalf of the DESI Collaboration

Cosmology 2025 @ Elba Island
8 September 2025



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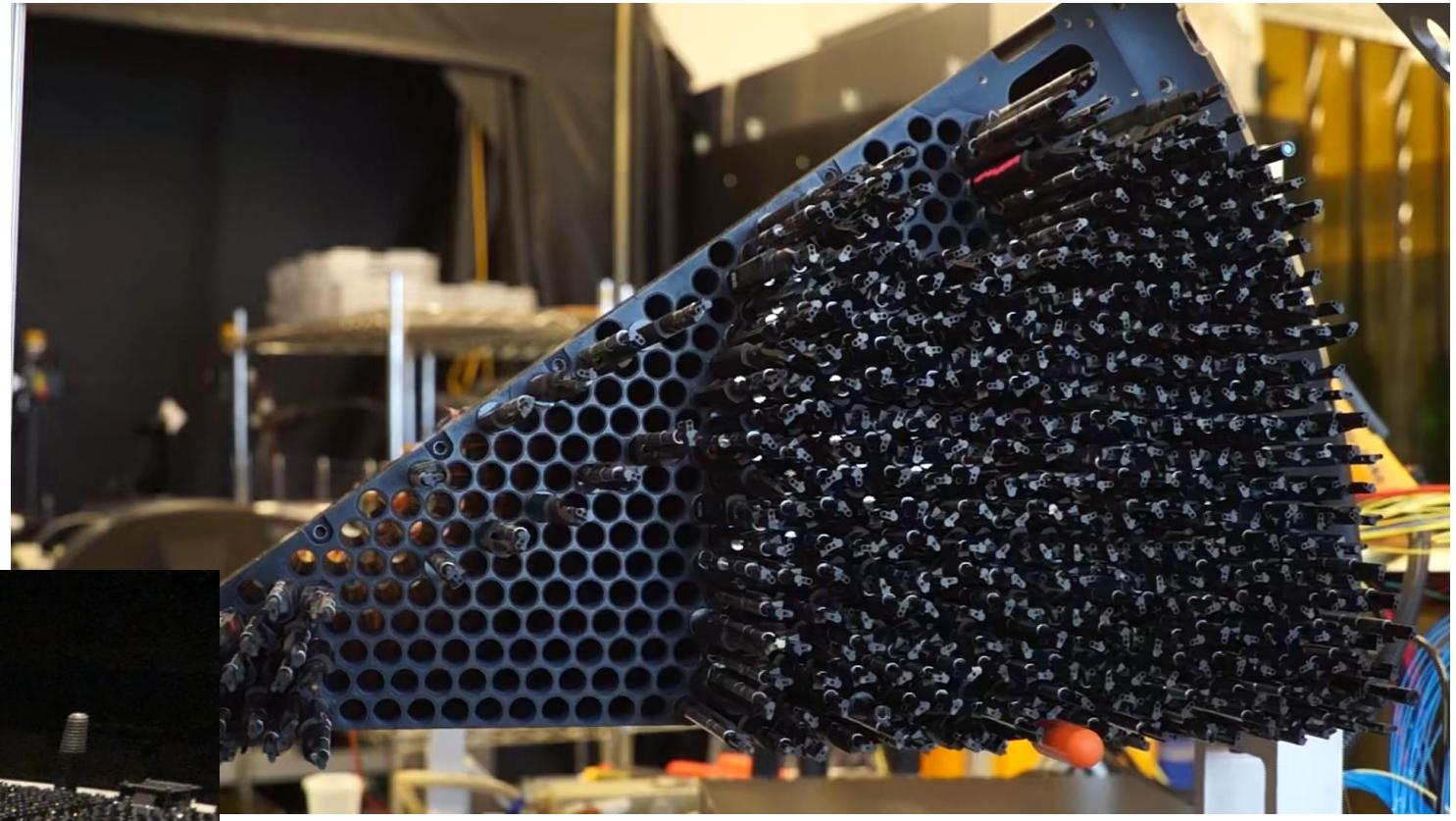
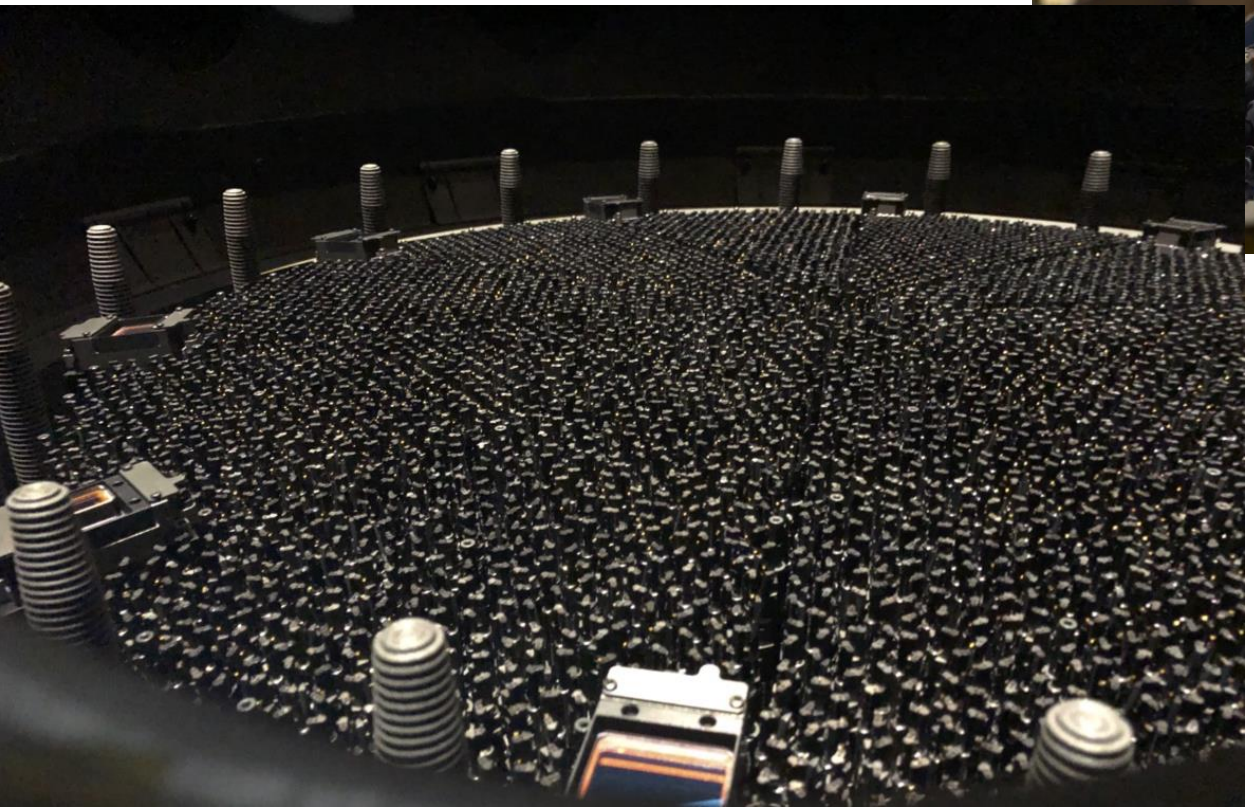
# 5000 robotically controlled fibres





Obtaining spectra approximately every 20 minutes

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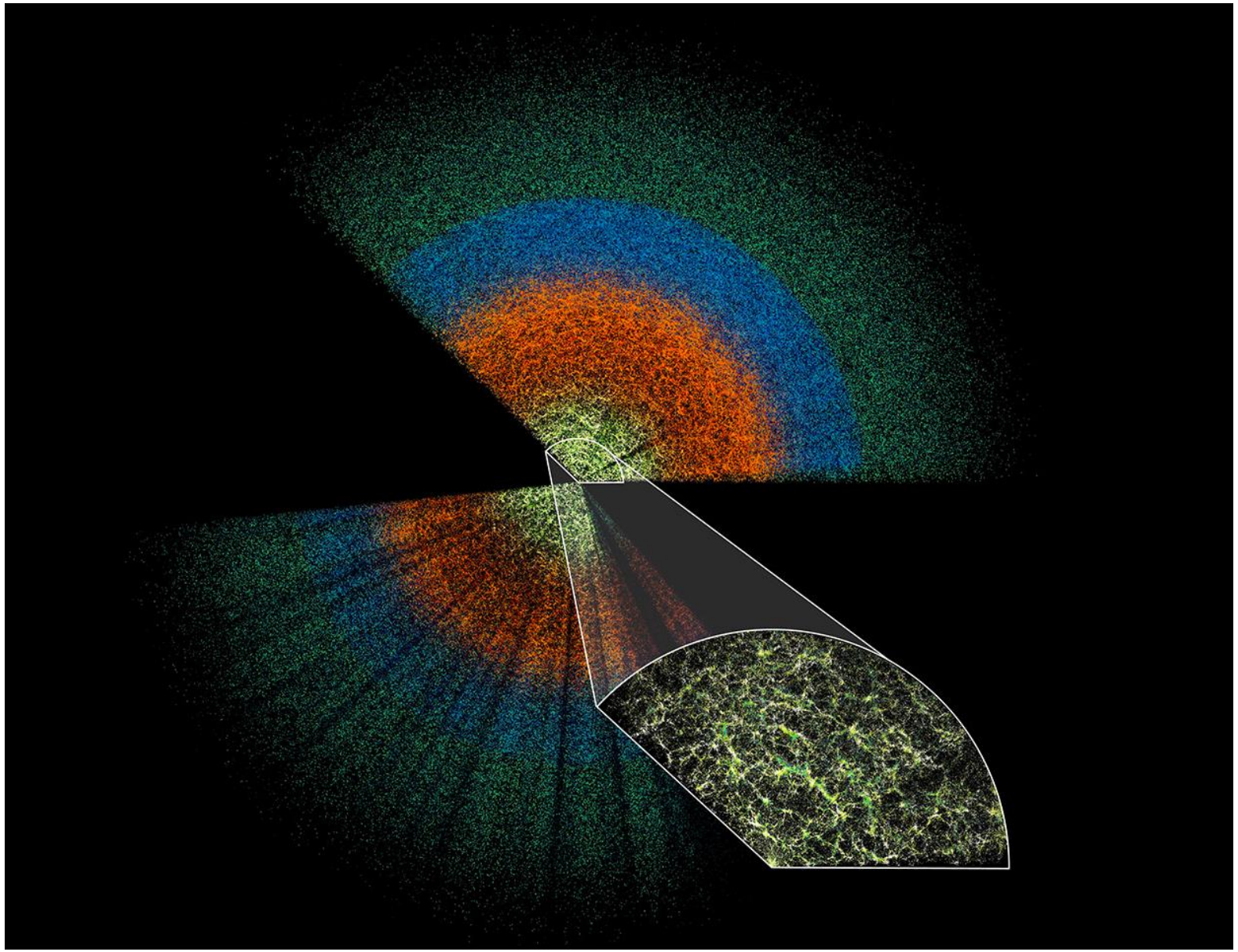
# Dark Energy Spectroscopic Instrument

## DESI Data Release 1

- 18.7 million objects:
  - 4 million stars
  - 13.1 million galaxies
  - 1.6 million quasars



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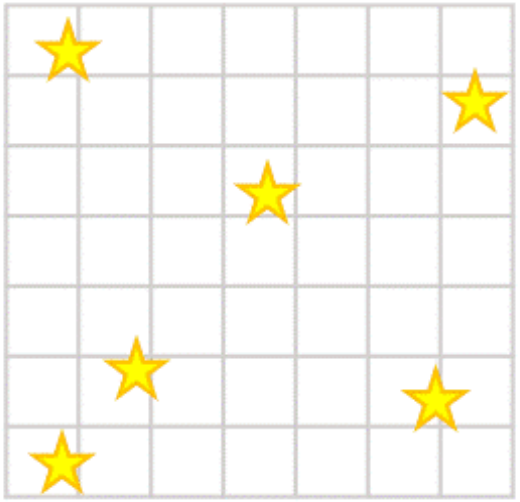
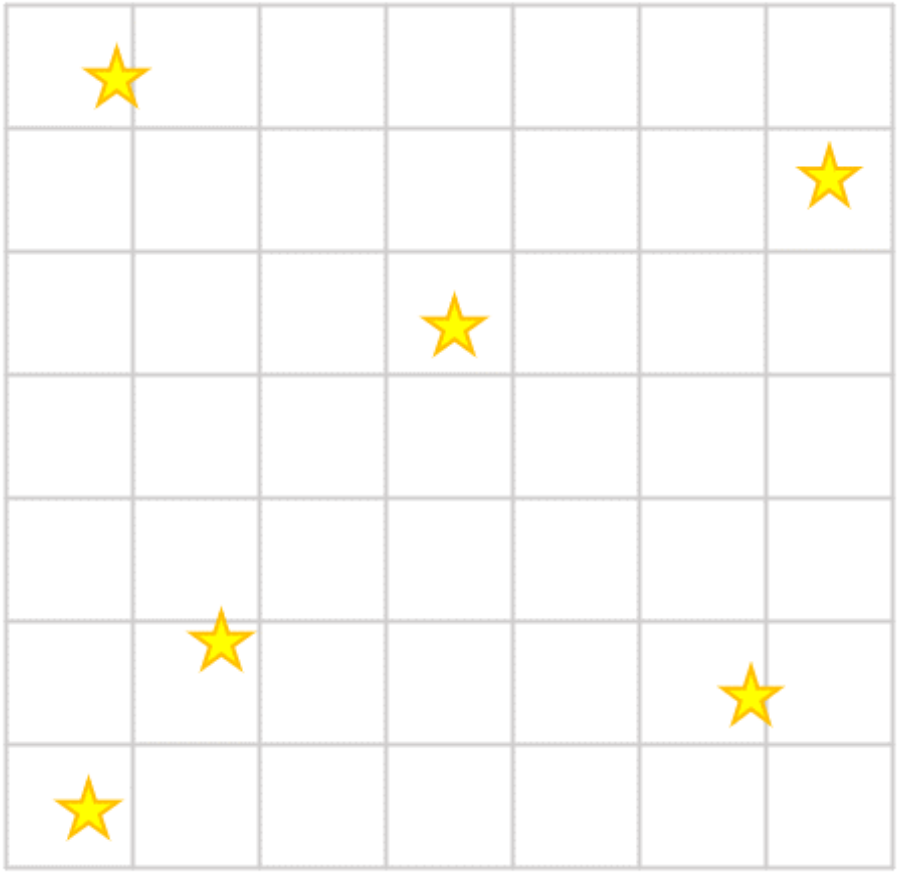
# What are peculiar velocities?





$$v_{cosmo} = H_0 D$$

$$v_{pec} = v_{tot} - v_{cosmo}$$

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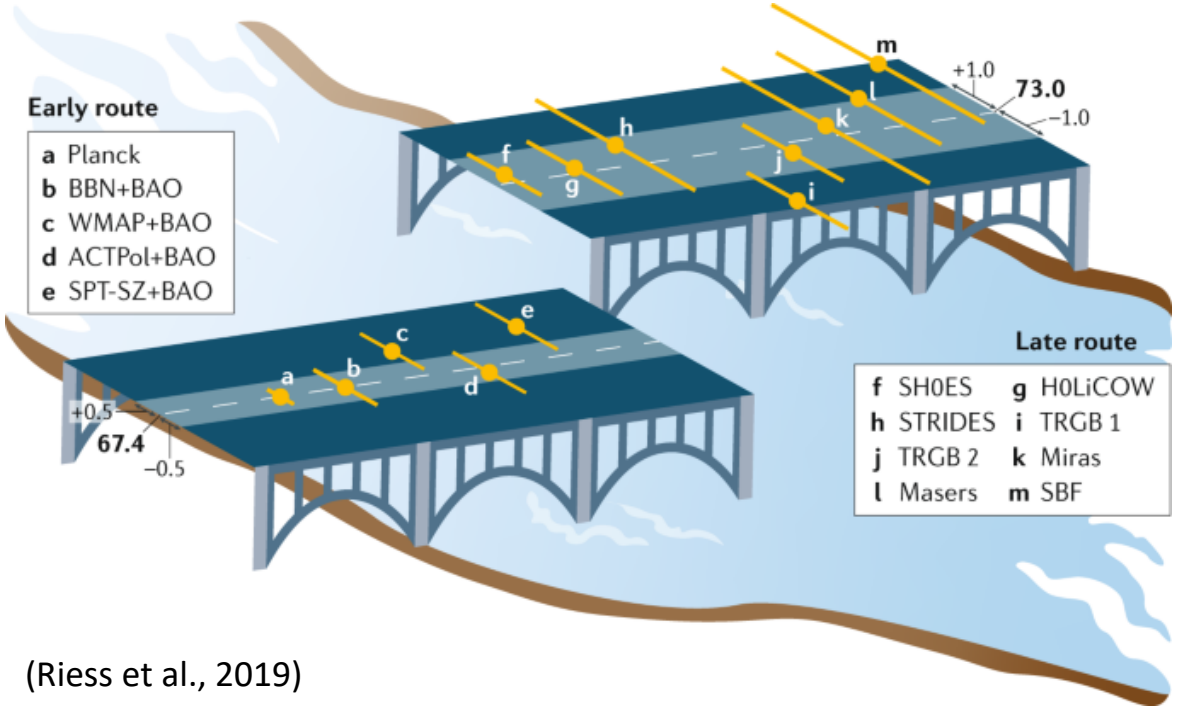
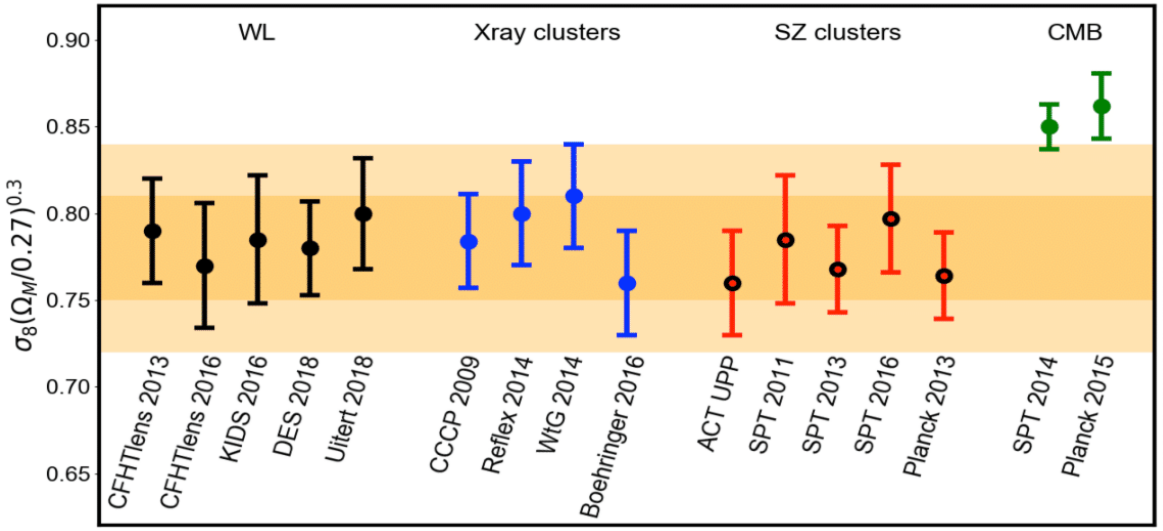
# Why measure PVs?

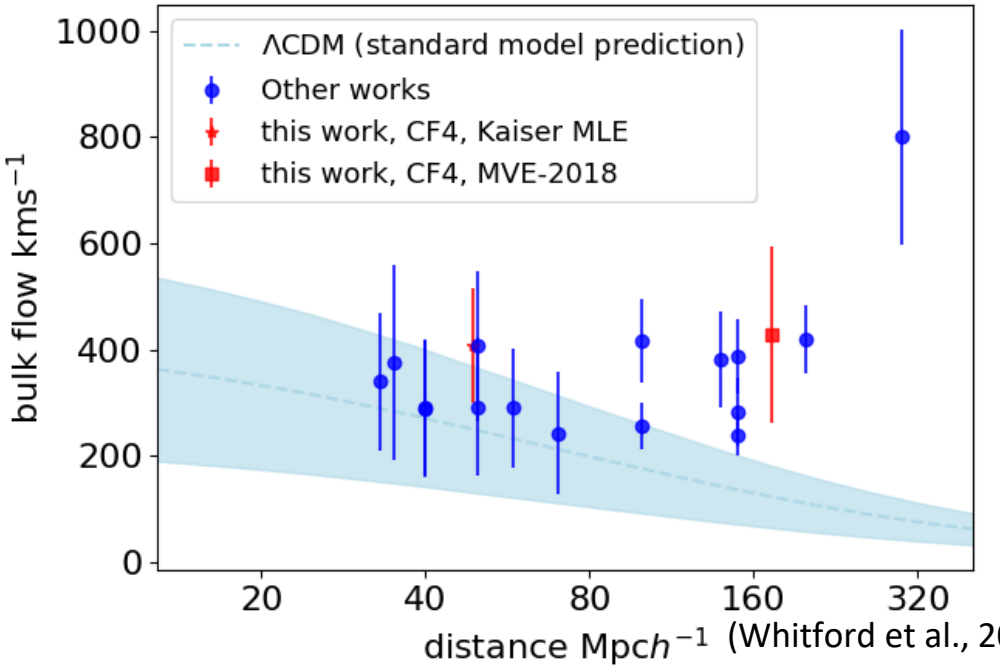
## 1. Tests of GR




(Riess et al., 2019)

(Douspis et al., 2018)




(Whitford et al., 2023)

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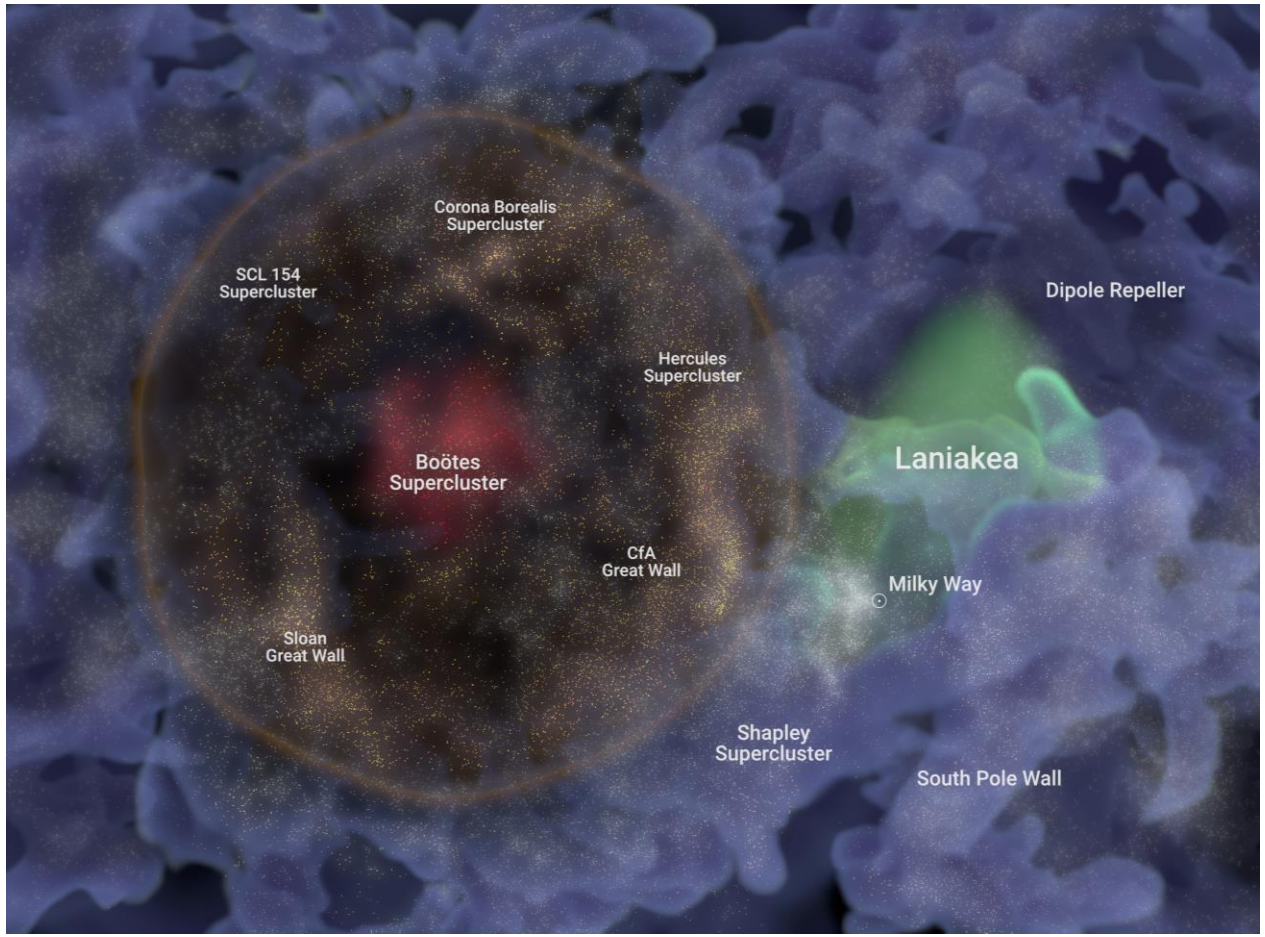
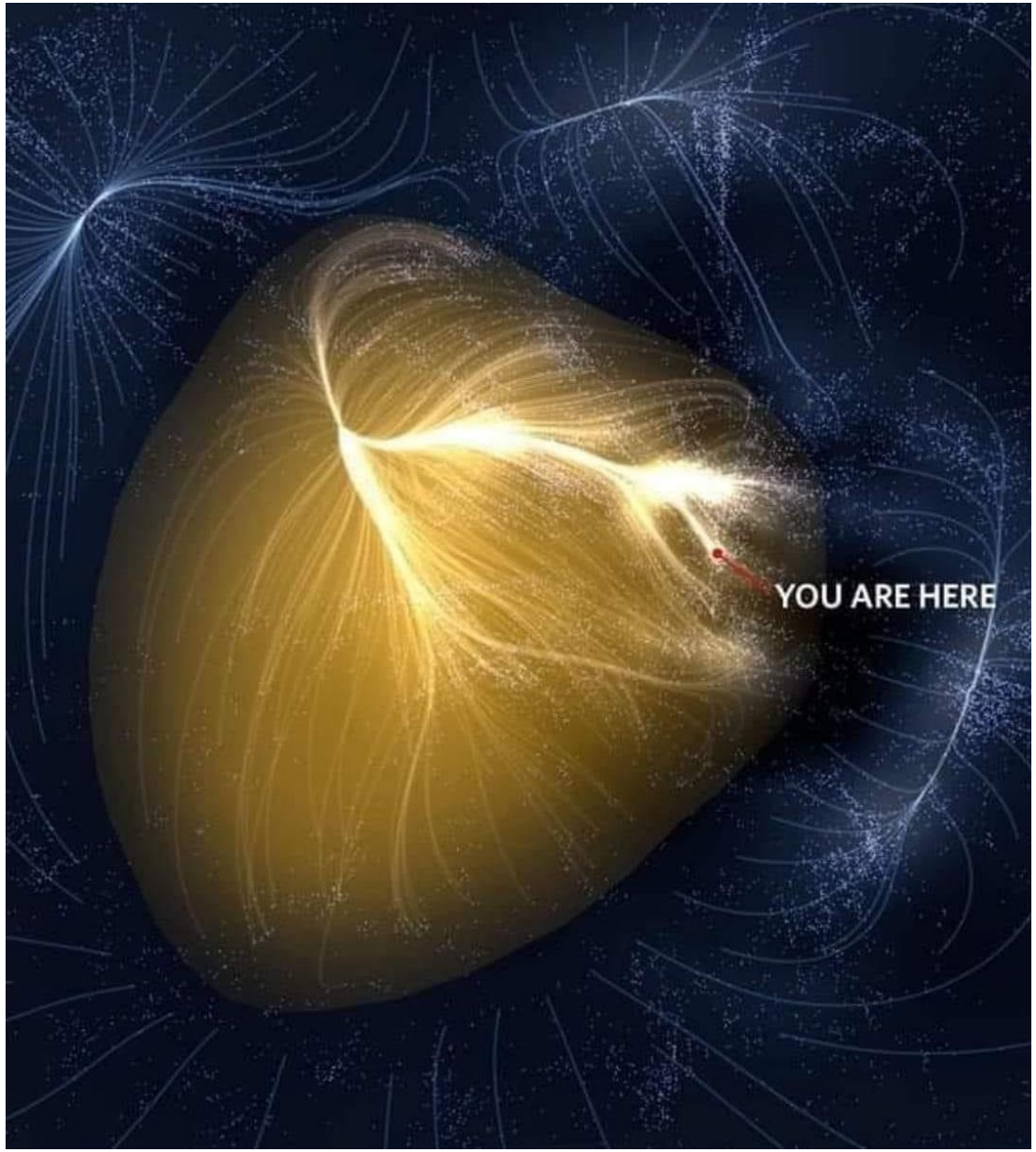
# Why measure PVs?

## 2. Local Structure



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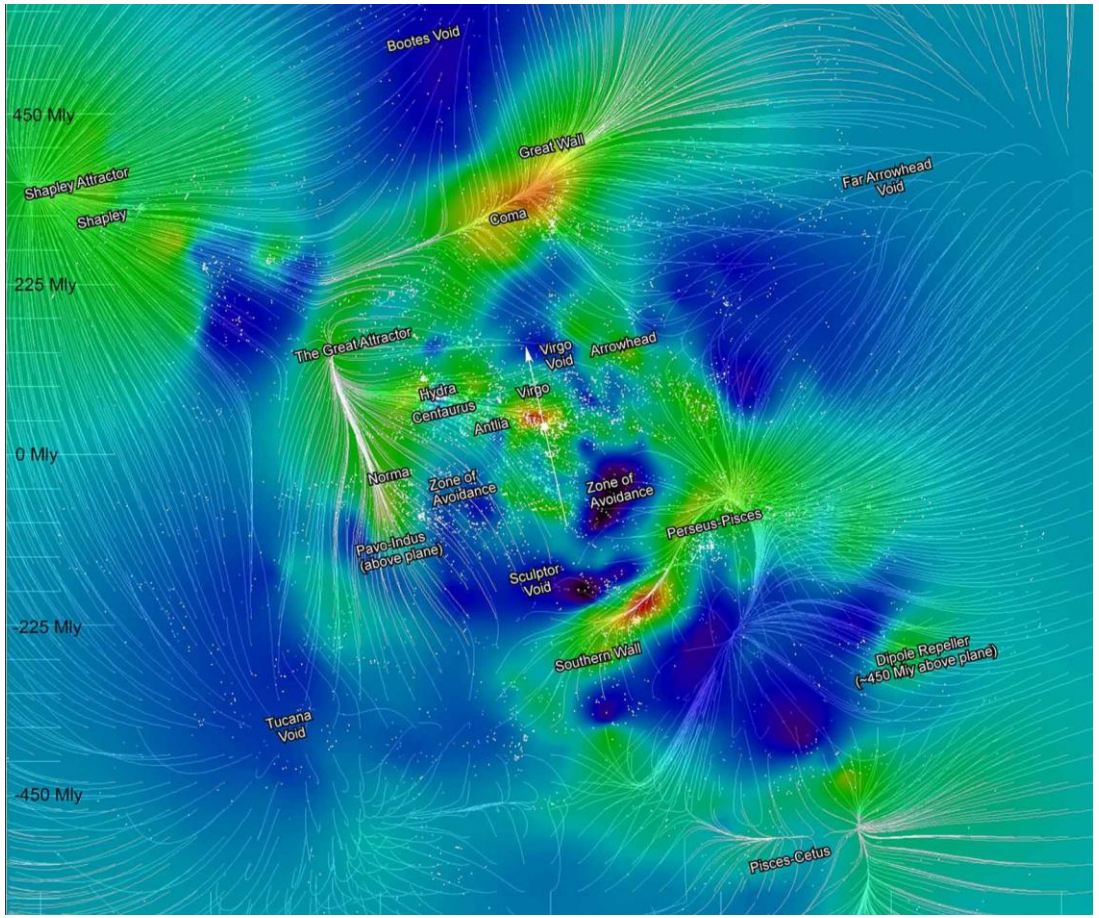
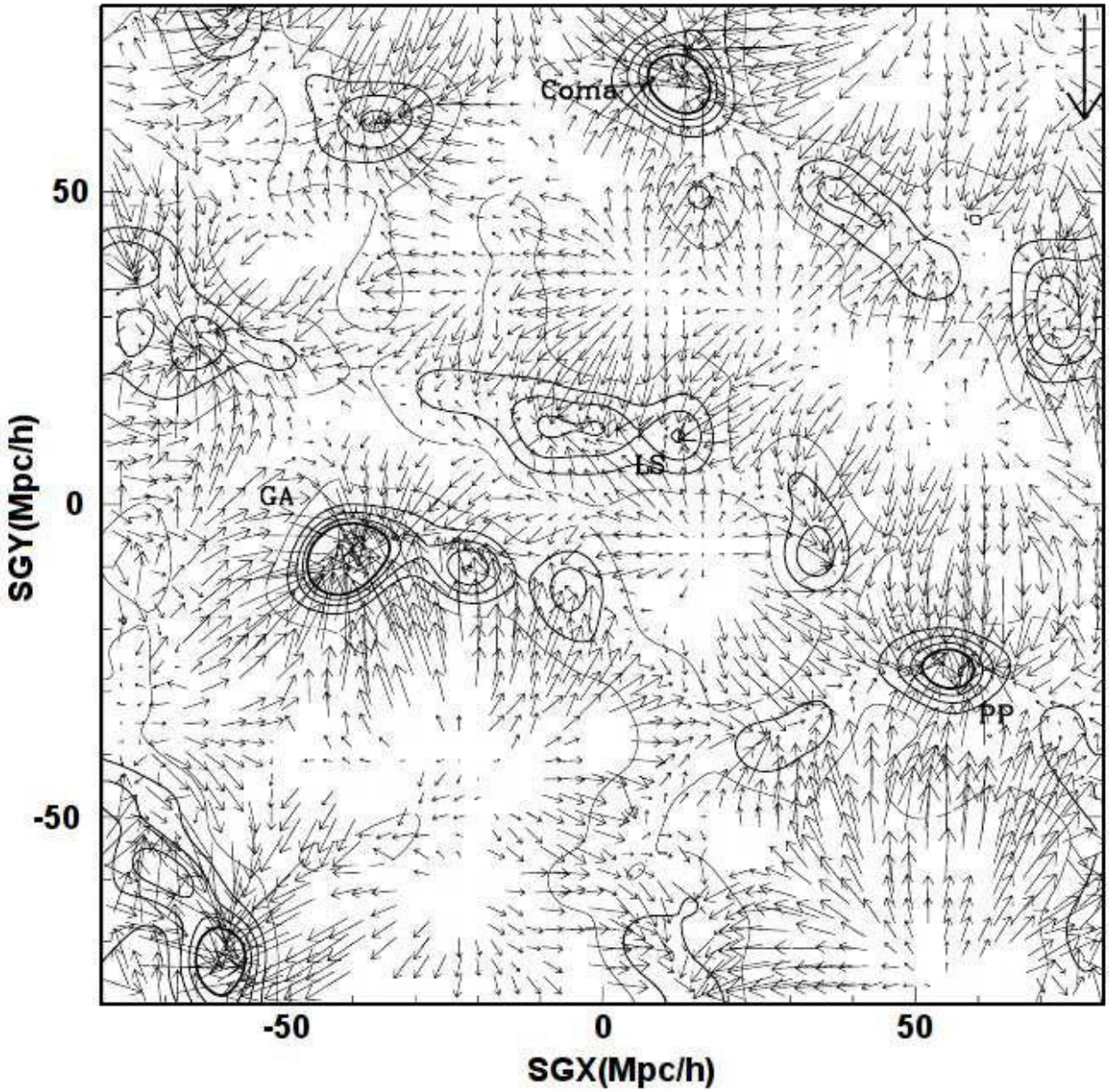
# Why measure PVs?

## 3. Reconstructions



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# DESI PV Survey

## Fundamental Plane

- Velocity Dispersion
- Surface Brightness
- Angular Diameter

## Tully Fisher

- Rotational velocity
- Apparent magnitude

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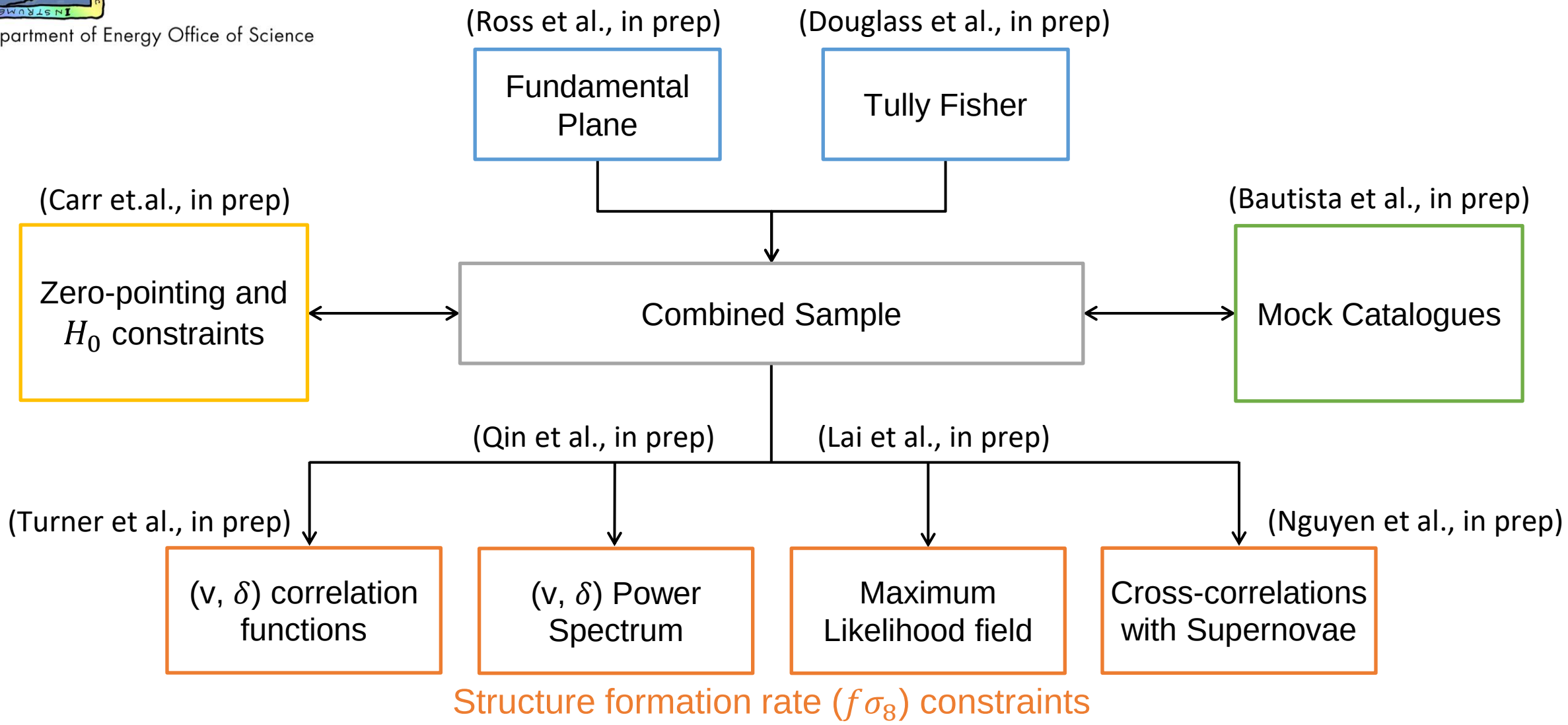
# Outcomes and DR1 papers



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# DR1 Fundamental Plane Sample

| Selection Criteria | # Remaining |
|---|---|
| SPECTYPE = GALAXY | 16 406 896 |
| ZWARN = 0 and DELTACHI2 > 30 | 13 977 157 |
| FLUX>0 and NOBS > 0 | 13 923 084 |
| $0.0033 < z < 0.1$ | 860 590 |
| de Vaucouleurs profile or Sérsic profile with $n_s > 2.5$ | 179 372 |
| $g-r, r-z$ colour cuts | 133 371 |
| Axial ratio $b/a > 0.3$ | 127 446 |
| Magnitude in range $10.0 < m_r < 18.0$ | 110 796 |
| Velocity dispersion in range $50.0 < \sigma_{vdisp} < 420$ | 108 487 |
| Single measurement per galaxy | 97 995 |
| No FP outliers | 96 469 |

- Quality Control
- Isolation of Early Type Galaxies
- Best measurement for galaxy
- Sigma Clipping (Calibration only)

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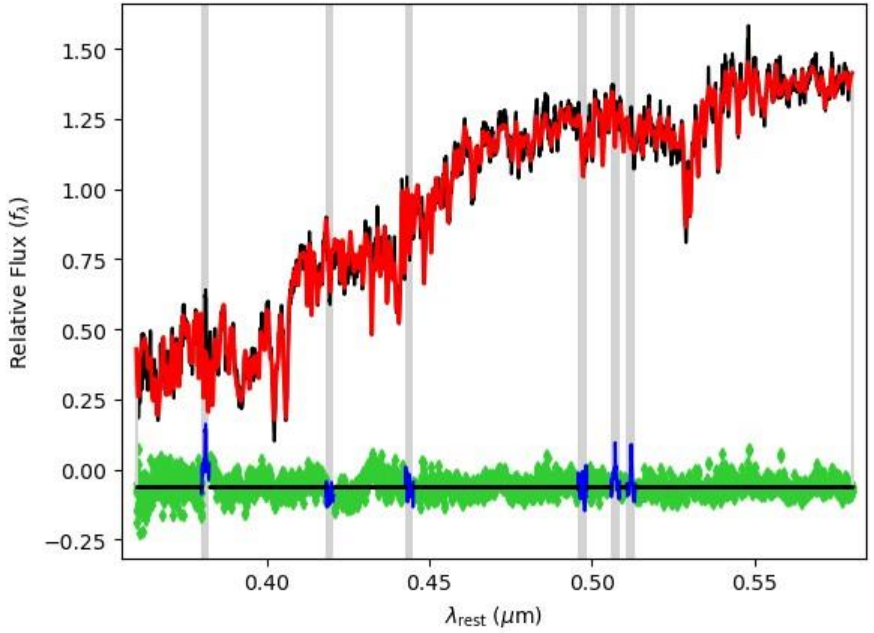
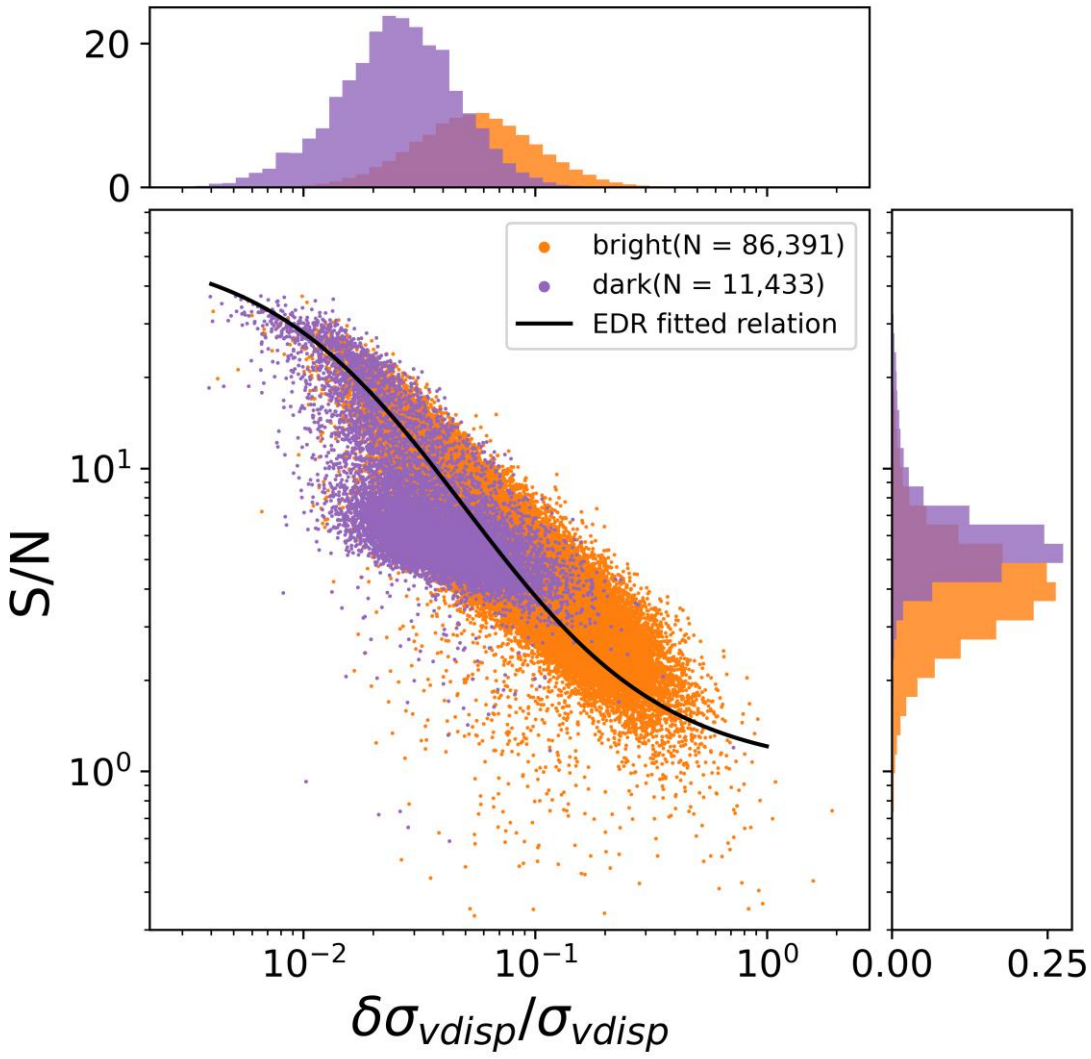
# Velocity Dispersions

## Fit Velocity Dispersions

- Penalised Pixel Fitting
  - Indo-U.S. Coudé Feed Spectral Library



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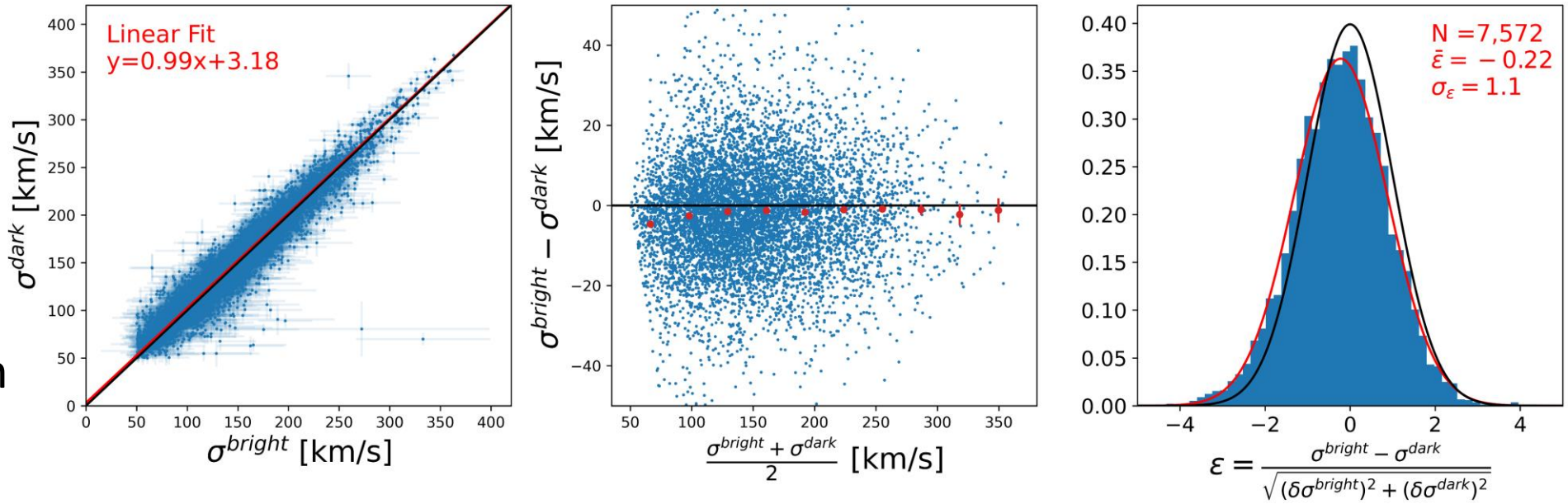
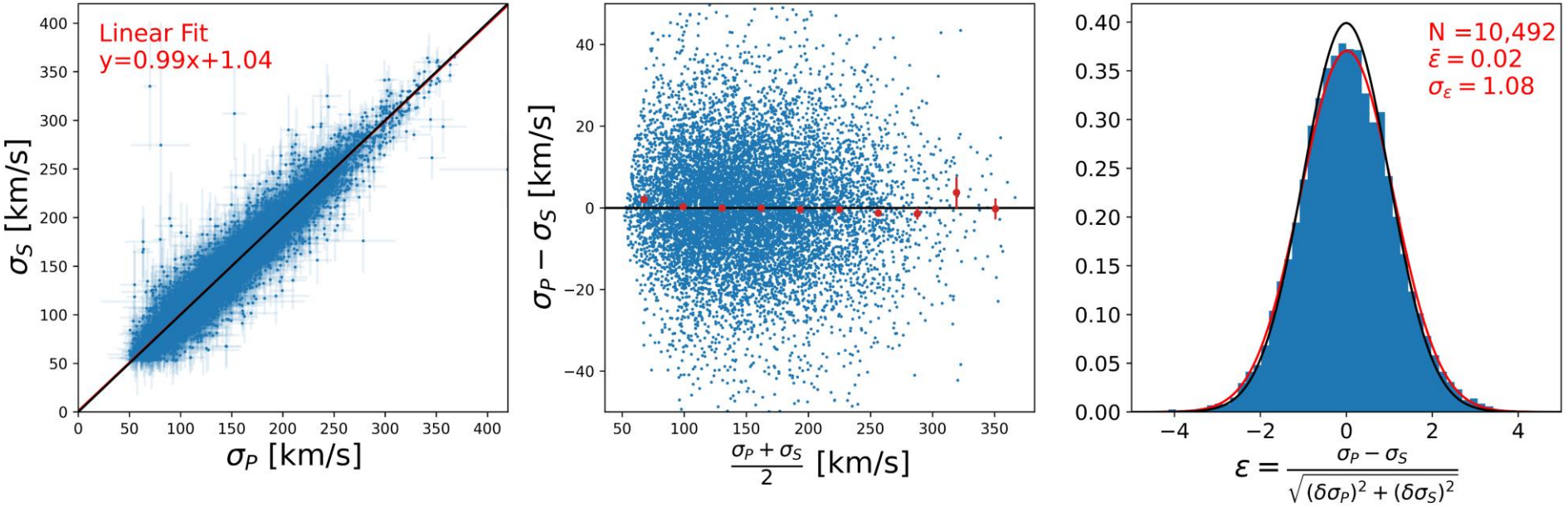
- Different observing conditions (for offsets between survey calibrations)




- Repeat observations (for error accuracy)



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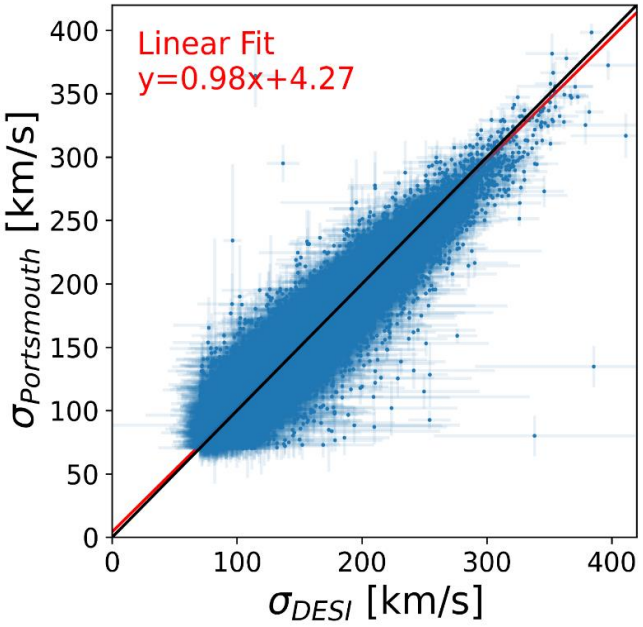
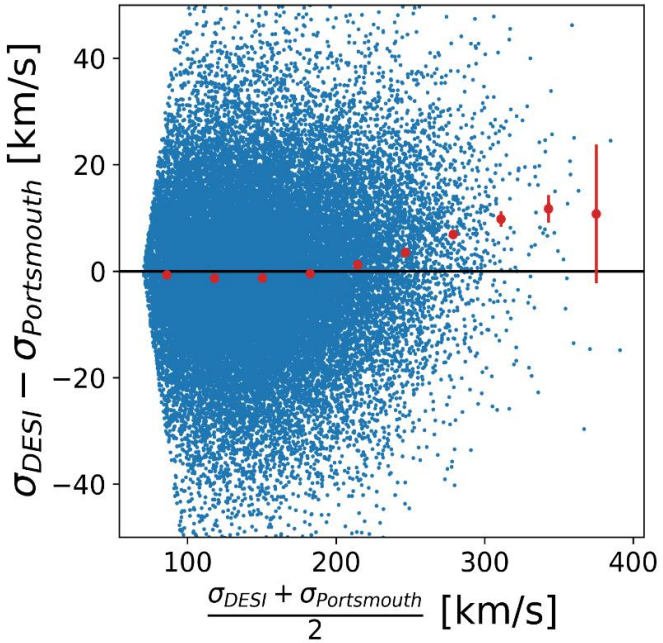
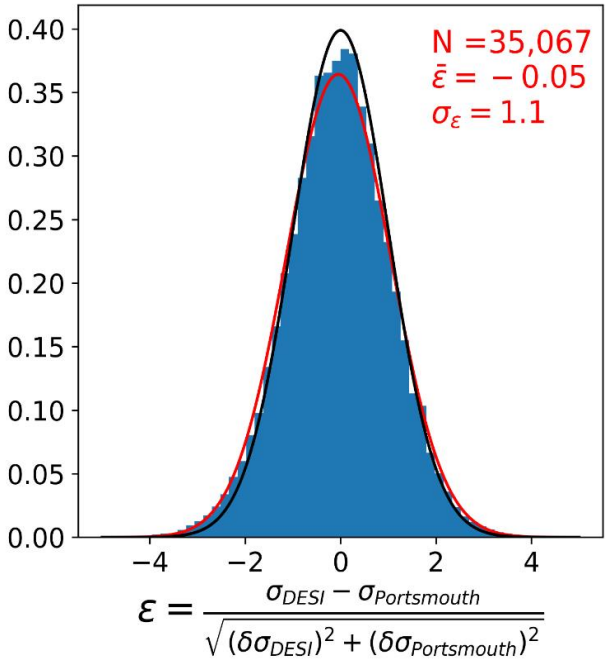
# Velocity dispersion validation

## Compare to SDSS

- Good agreement (0.05σ offset)



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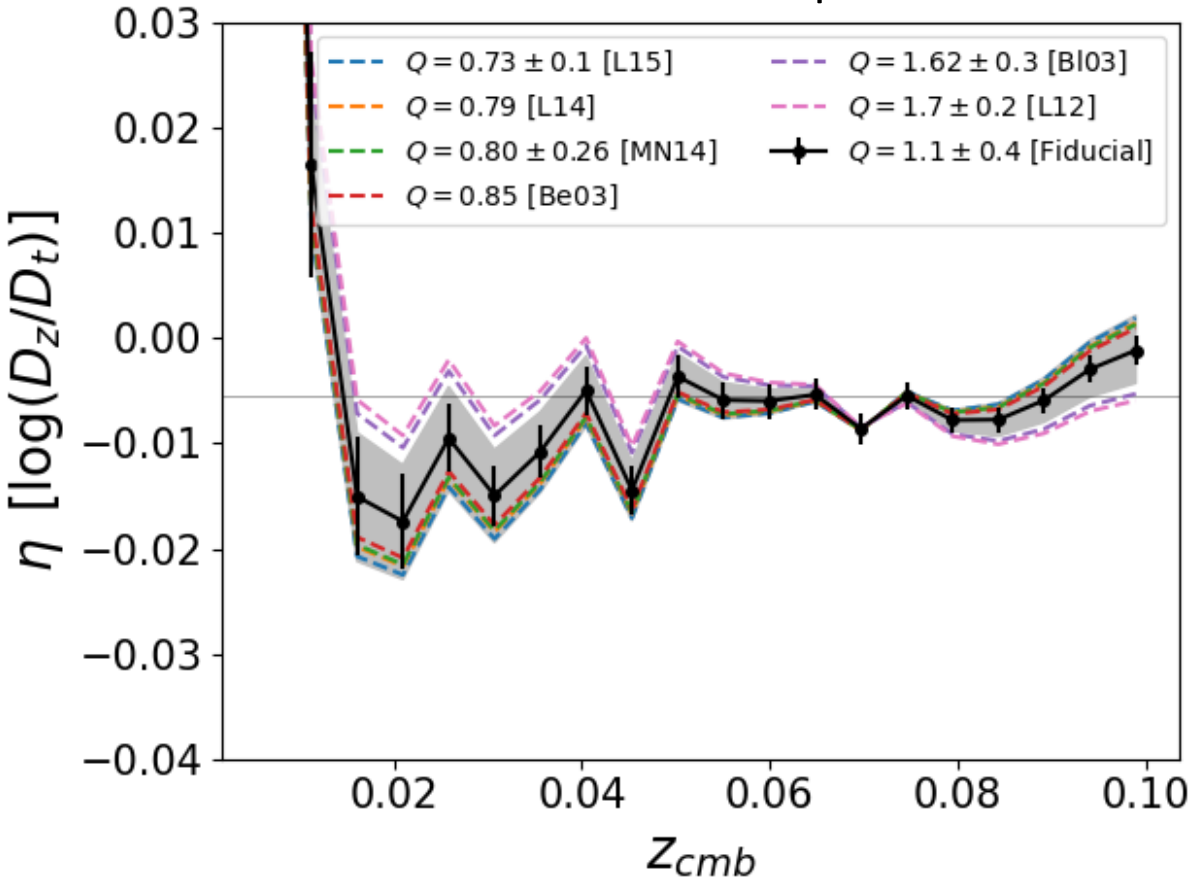
# Systematics

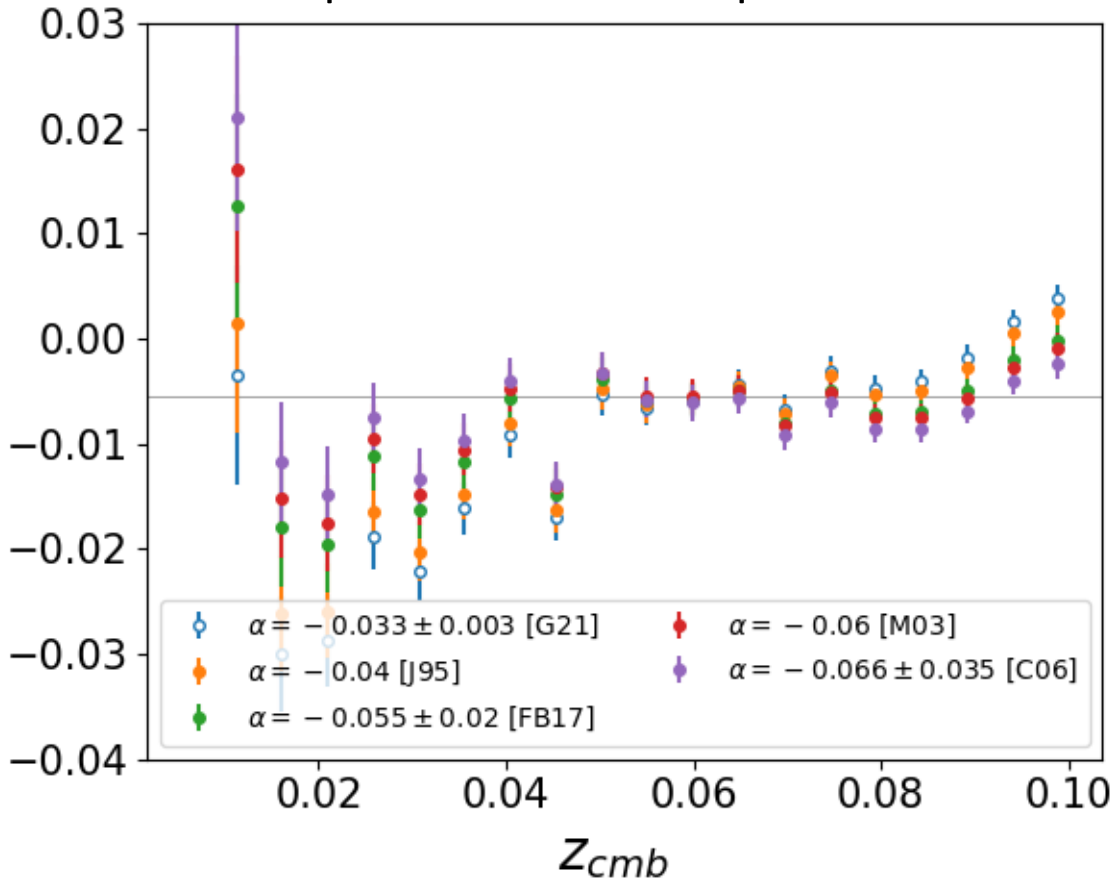
Corrects for evolution of intrinsic galaxy brightness

Corrects for fixed spectral fibre size

Evolution correction parameter




Aperture correction parameter



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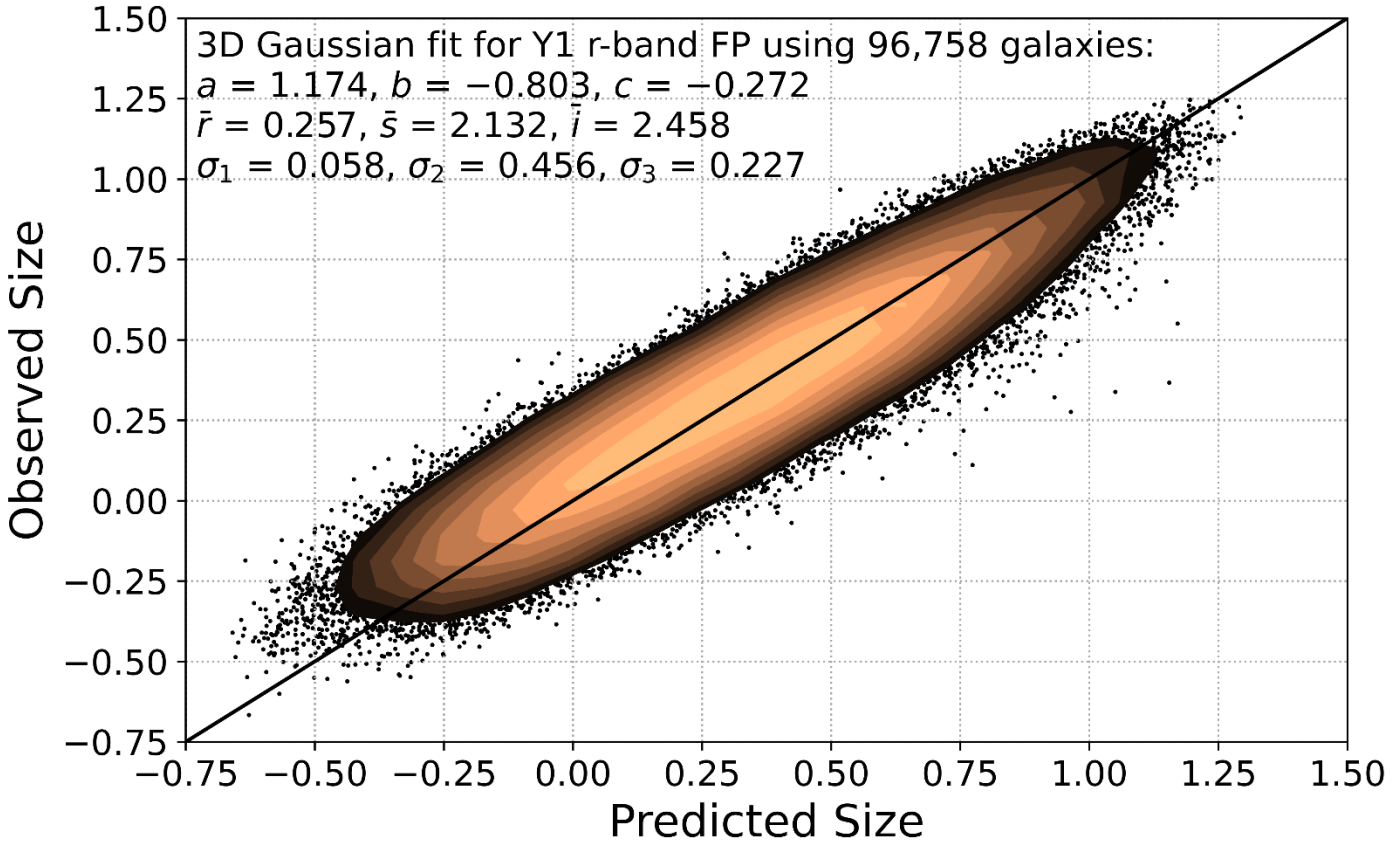
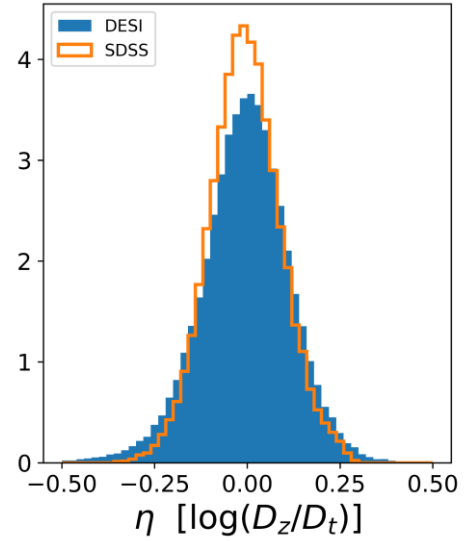
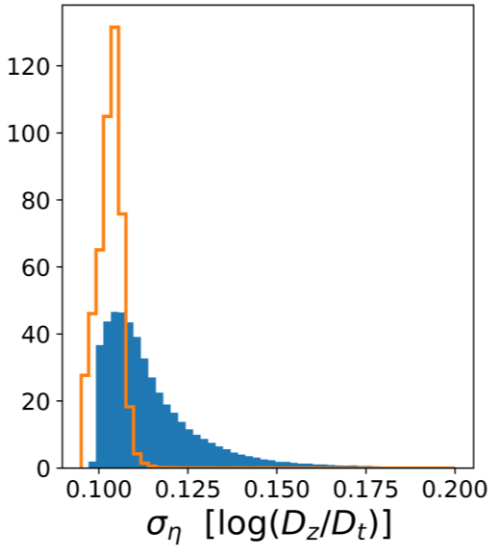
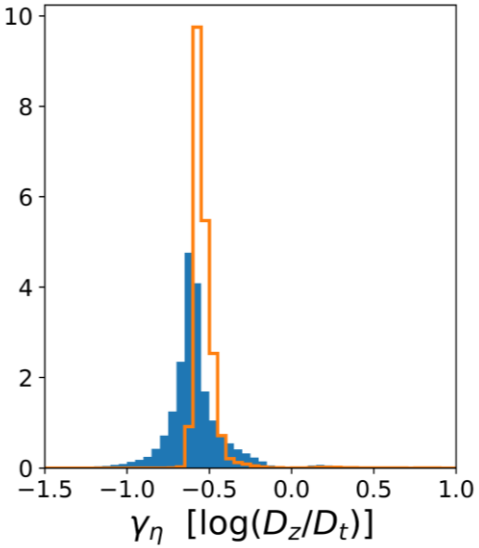
# DR1 Fundamental Plane Sample




~26% distance uncertainty



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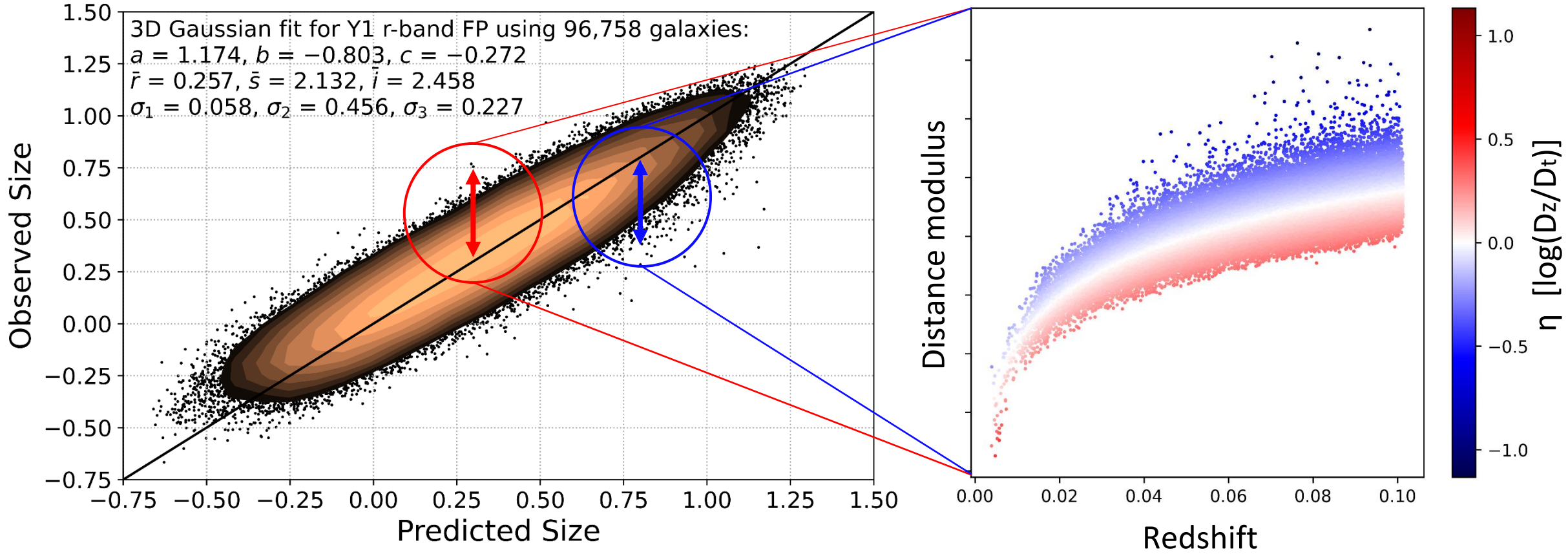

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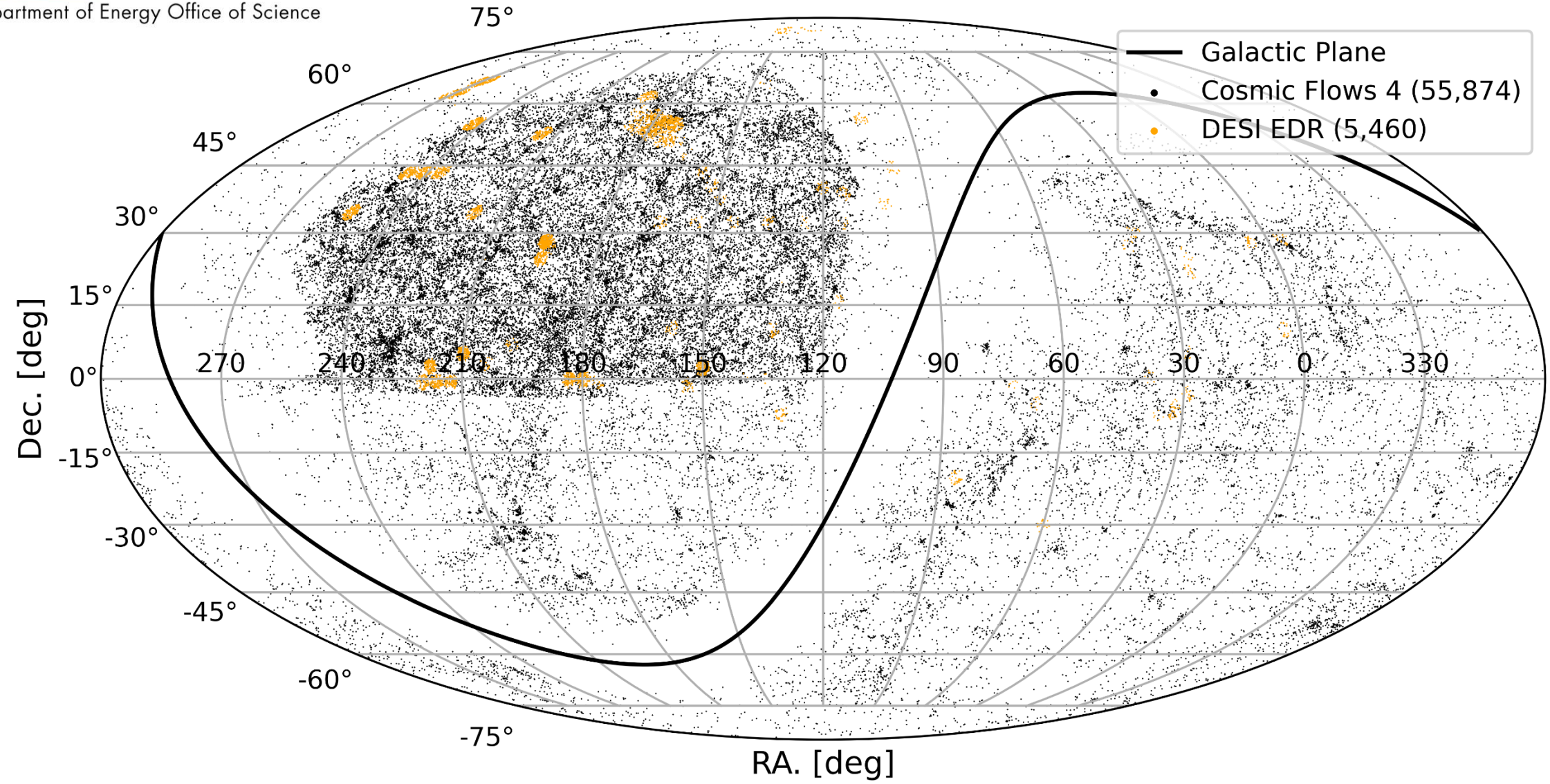
# Existing Measurements



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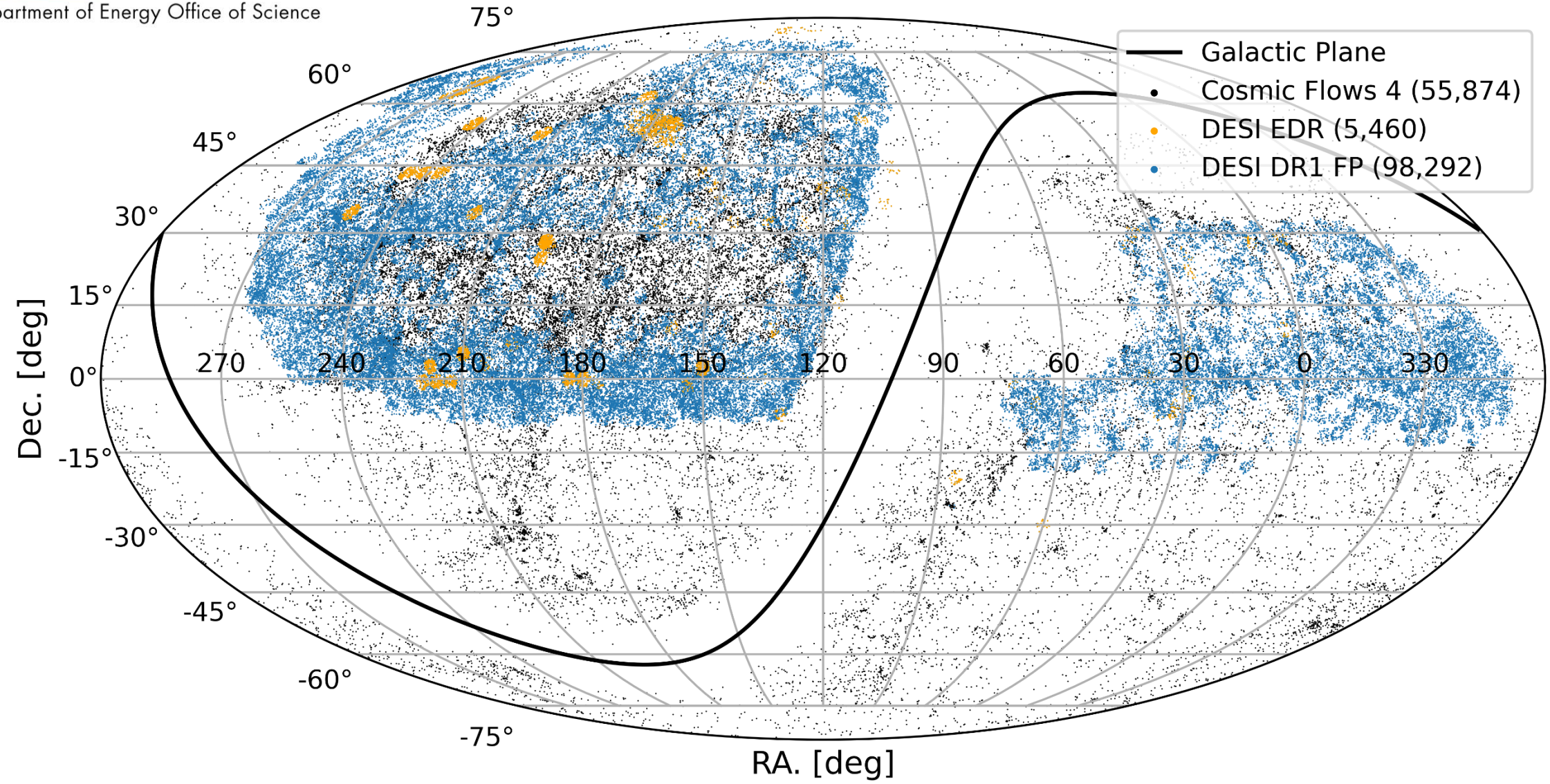
# DESI Measurements



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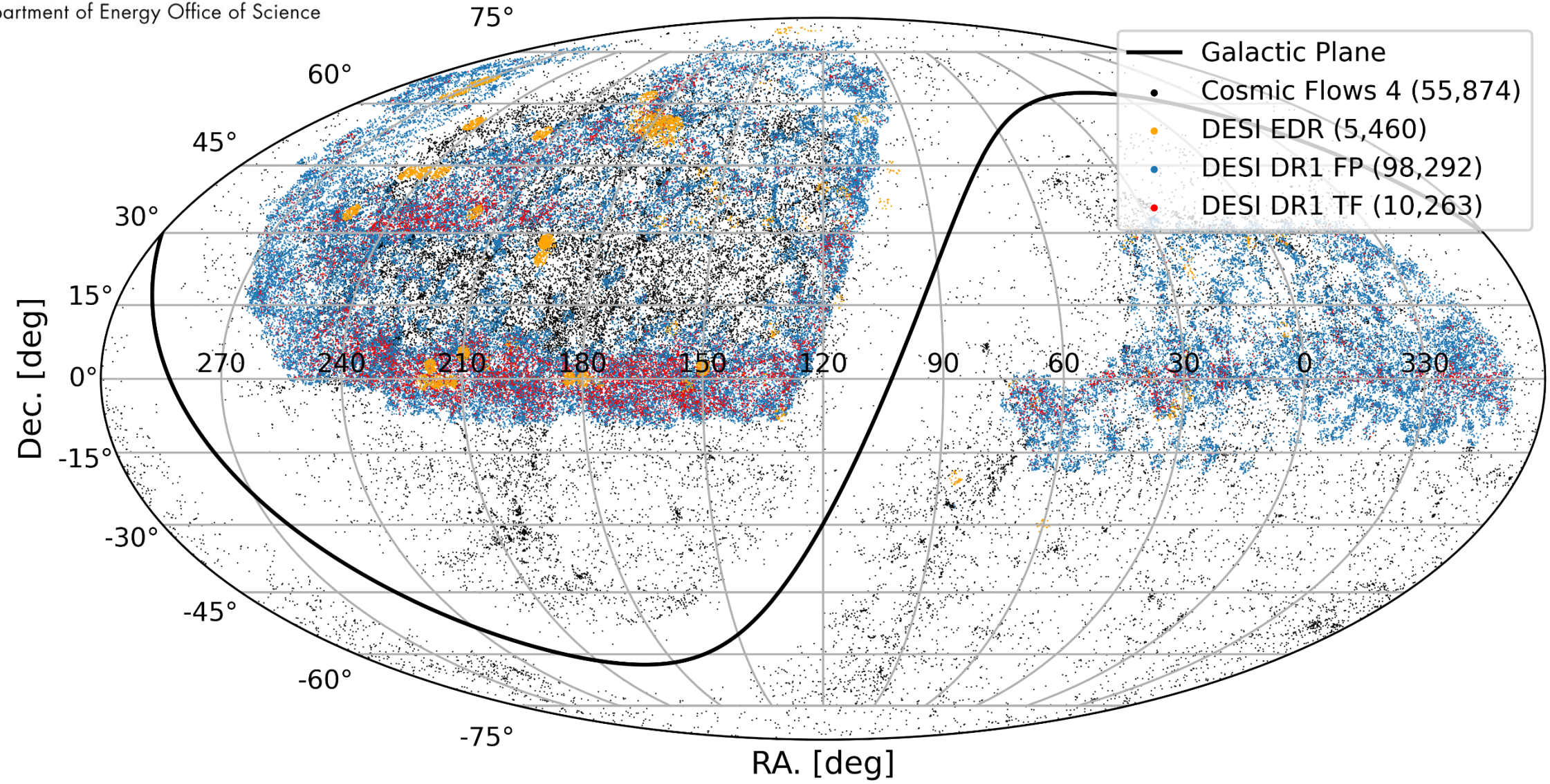
# DESI Measurements



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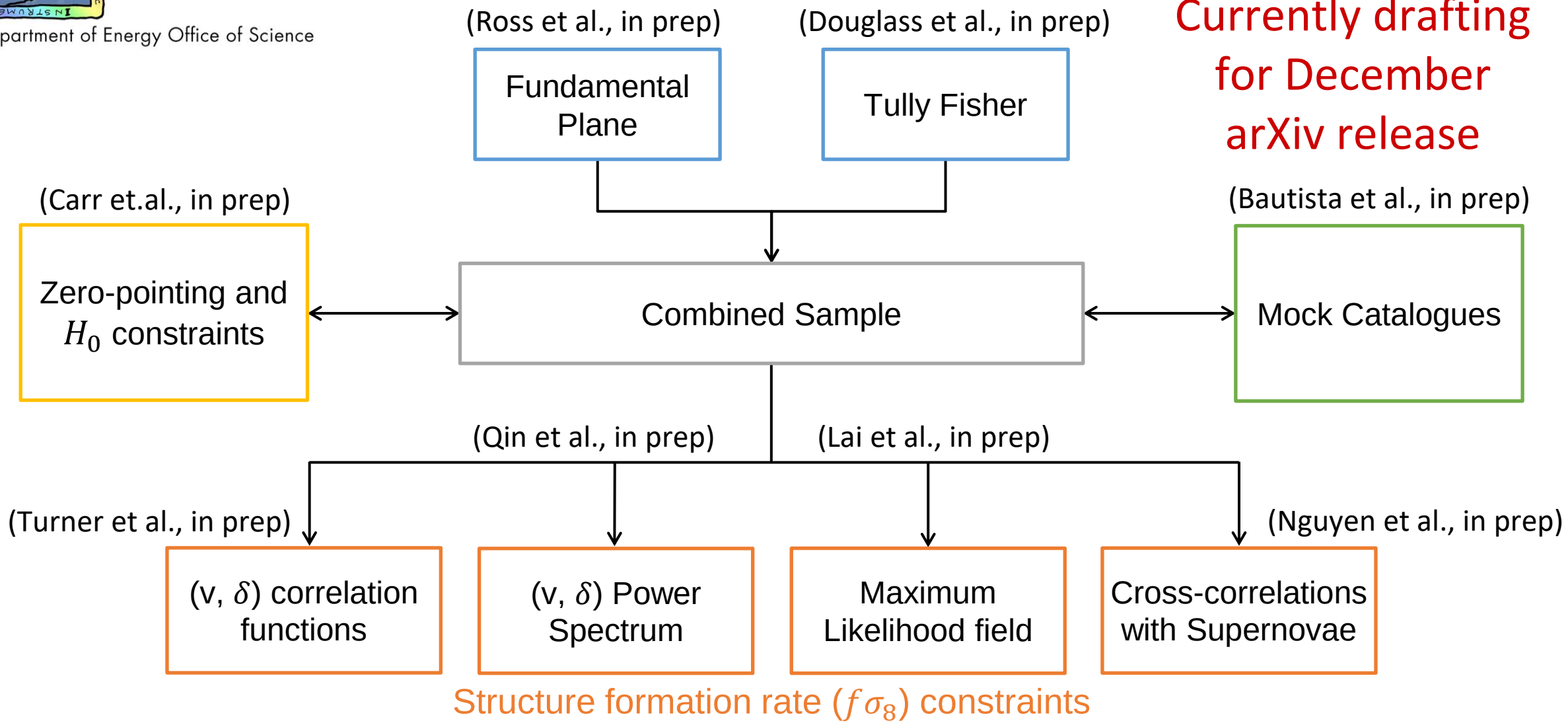
# DESI DR1 PV Survey

Currently drafting for December arXiv release



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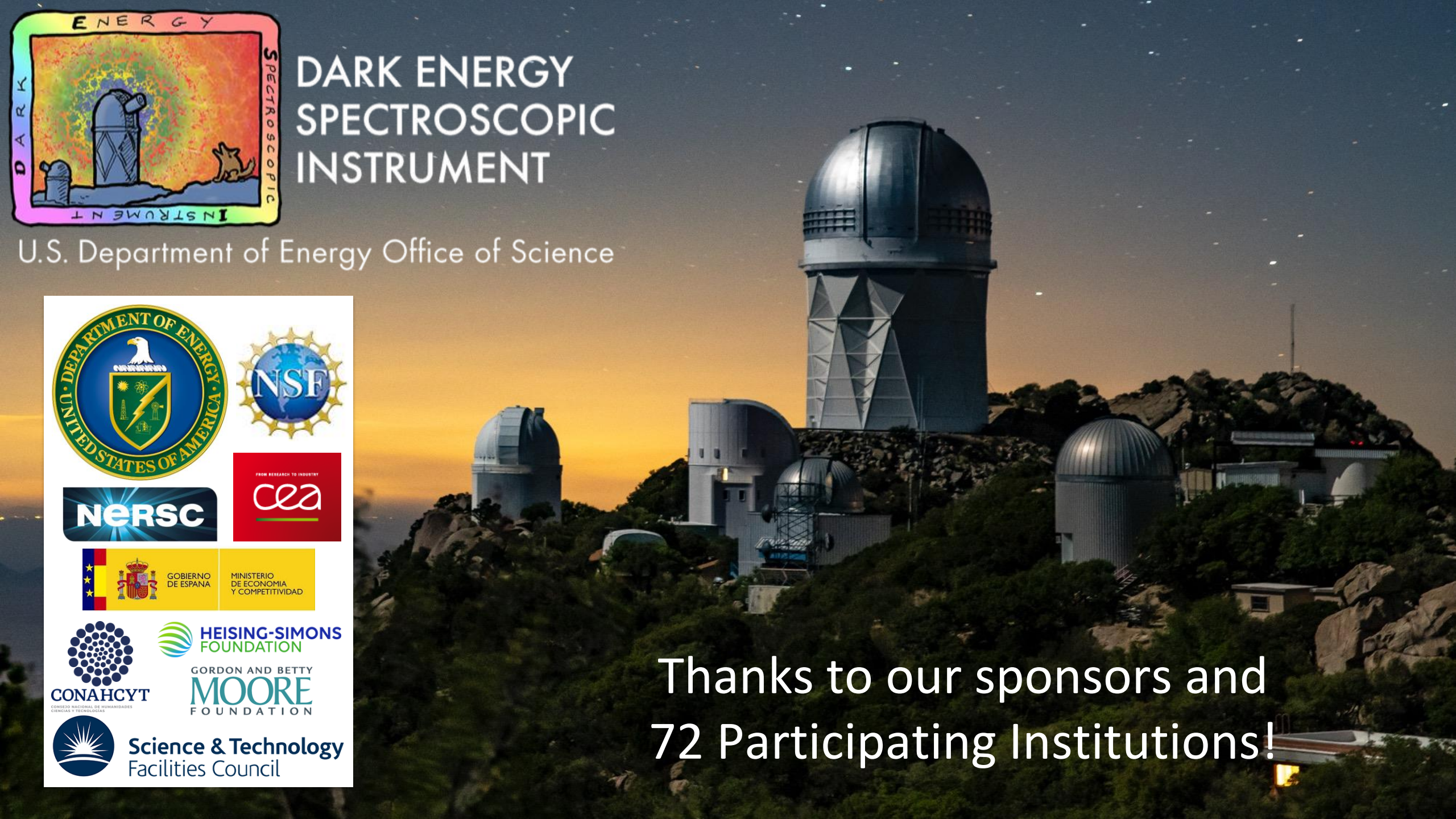

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