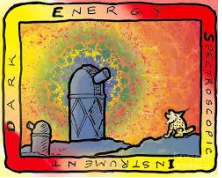


Institut de Física d'Altes Energies

# Forward modeling fluctuations in the DESI LRGs target sample using image simulations

**Hui Kong**
**IFAE Barcelona**
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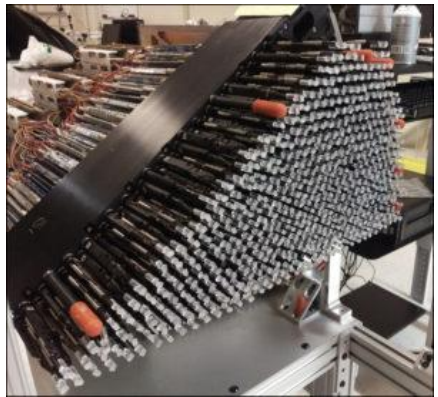
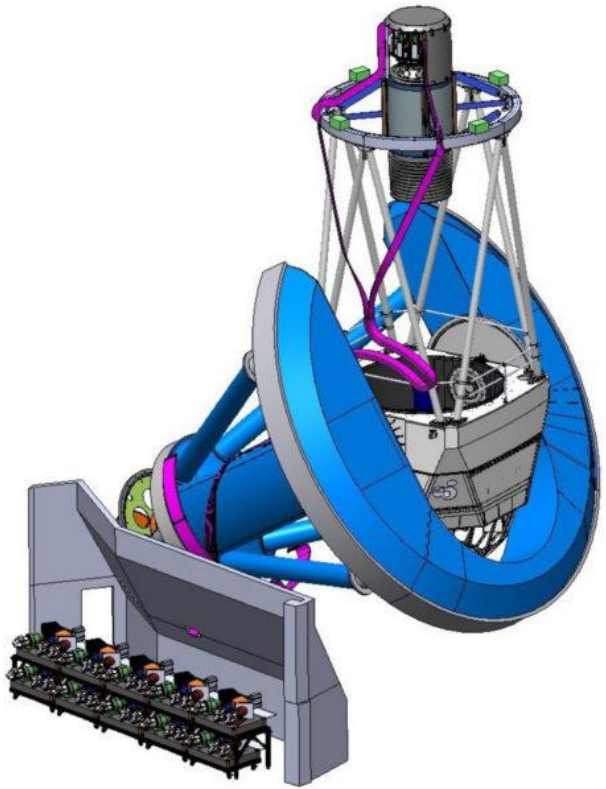
**Planes Complementarios AstroHEP**

# The Dark Energy Spectroscopic Instrument (DESI)

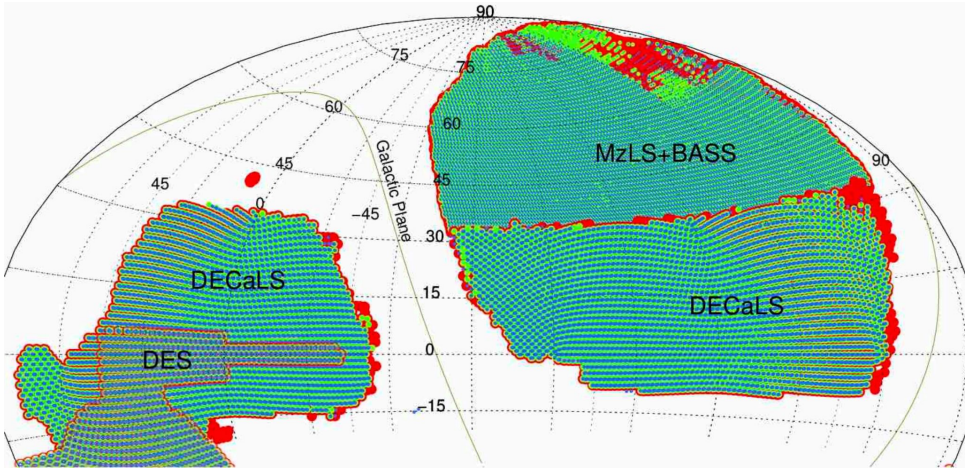
- DESI gets redshift for ~5000 targets at a time with robotic fibers
- Unprecedented 3D map of the universe with 30 million galaxies
- Science Goals:
  – Baryon Acoustic Oscillations
  – Redshift Space Distortions
  – Neutrino mass
  – Primordial non-gaussianity



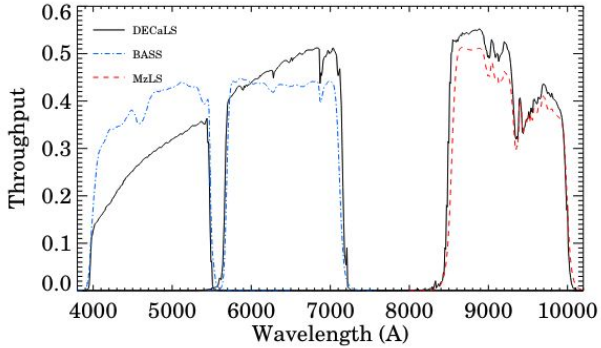


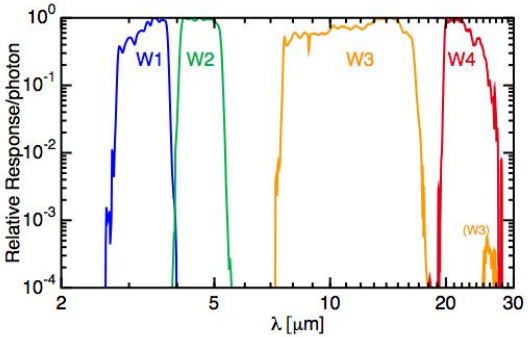
# Target Selection with the DESI Legacy Imaging Surveys

- Used for selecting targets for spectroscopic redshift measurement
- Optical bands: g, r, z
- Infrared bands: W1, W2




Dey et. al. (2019)



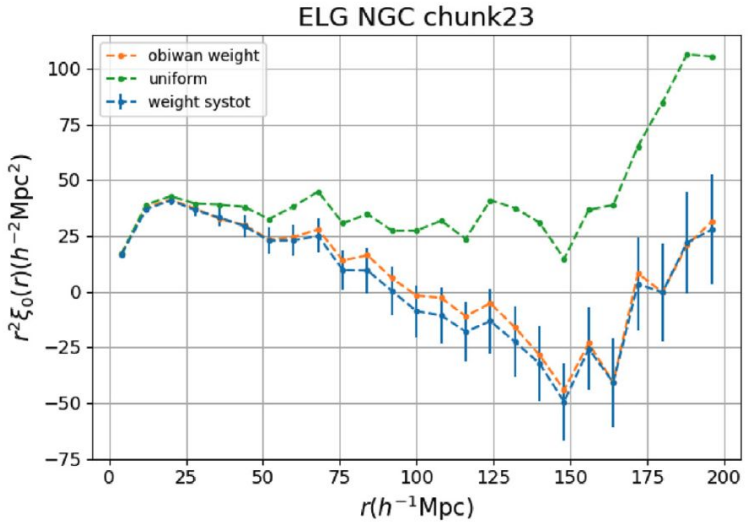



# Imaging systematics

Fluctuation of galaxy densities due to varying observing conditions

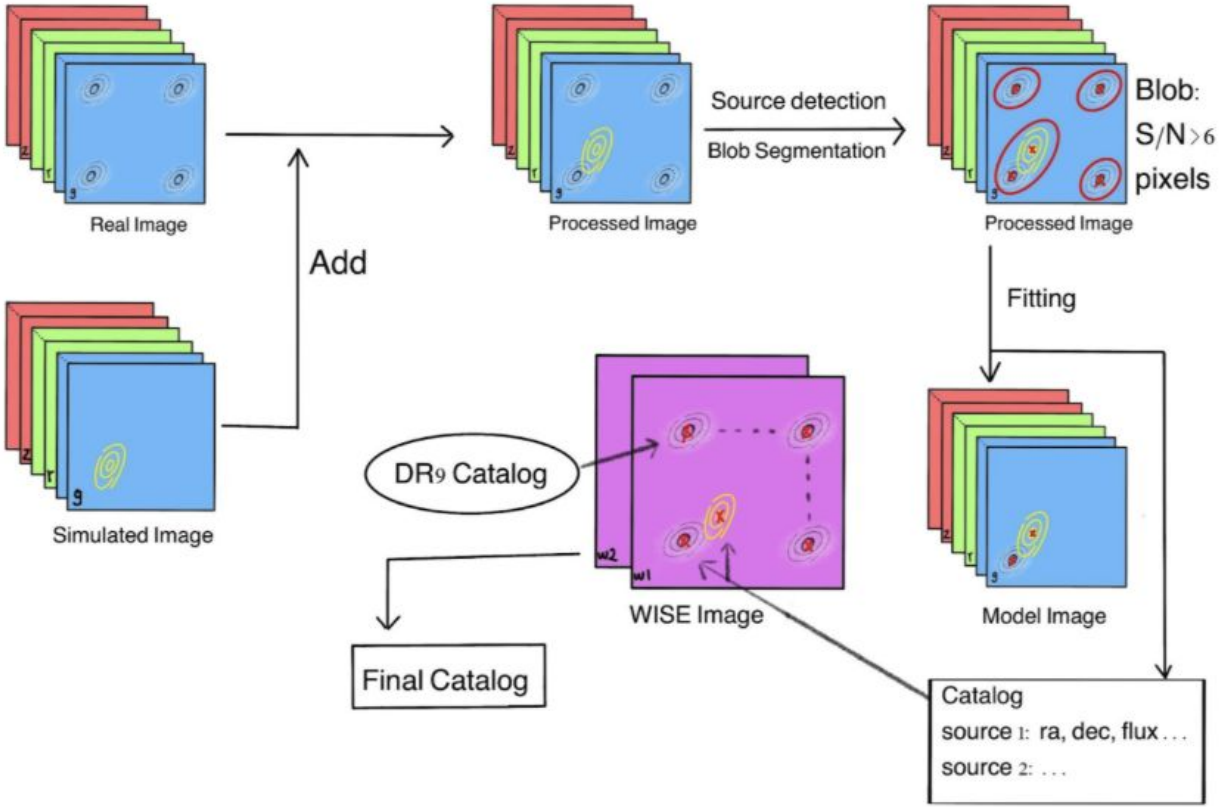
- Galactic dust extinction
- Point spread function (seeing)
- Image depth
- Stellar density

Signals from imaging systematics contaminate true cosmological signals




Kong et. al. (2019)

# Obiwan: Forward modeling imaging systematics with image simulations

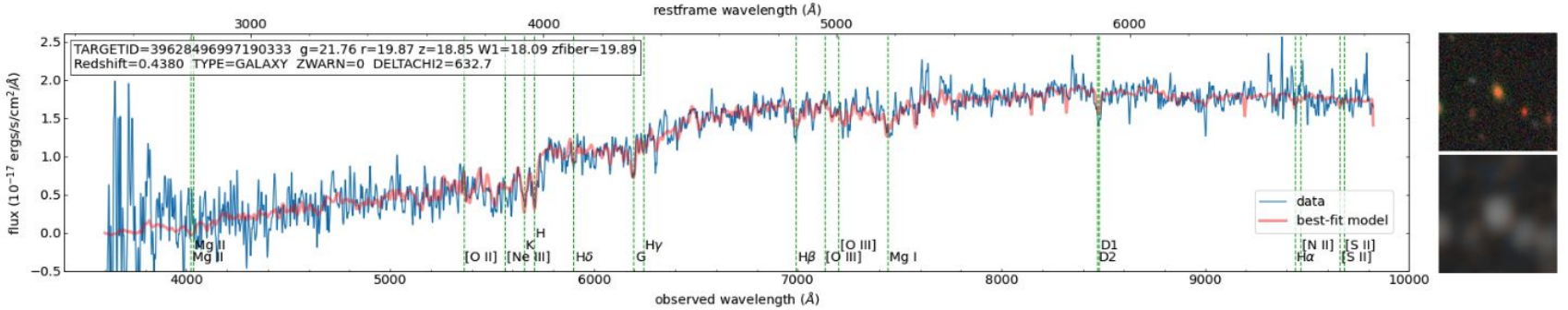


# DESI Luminous Red Galaxies (LRGs)

- LRG = Bright red galaxy at relatively low redshift
- Defined by a set of selection cuts on g,r,z,W1 band

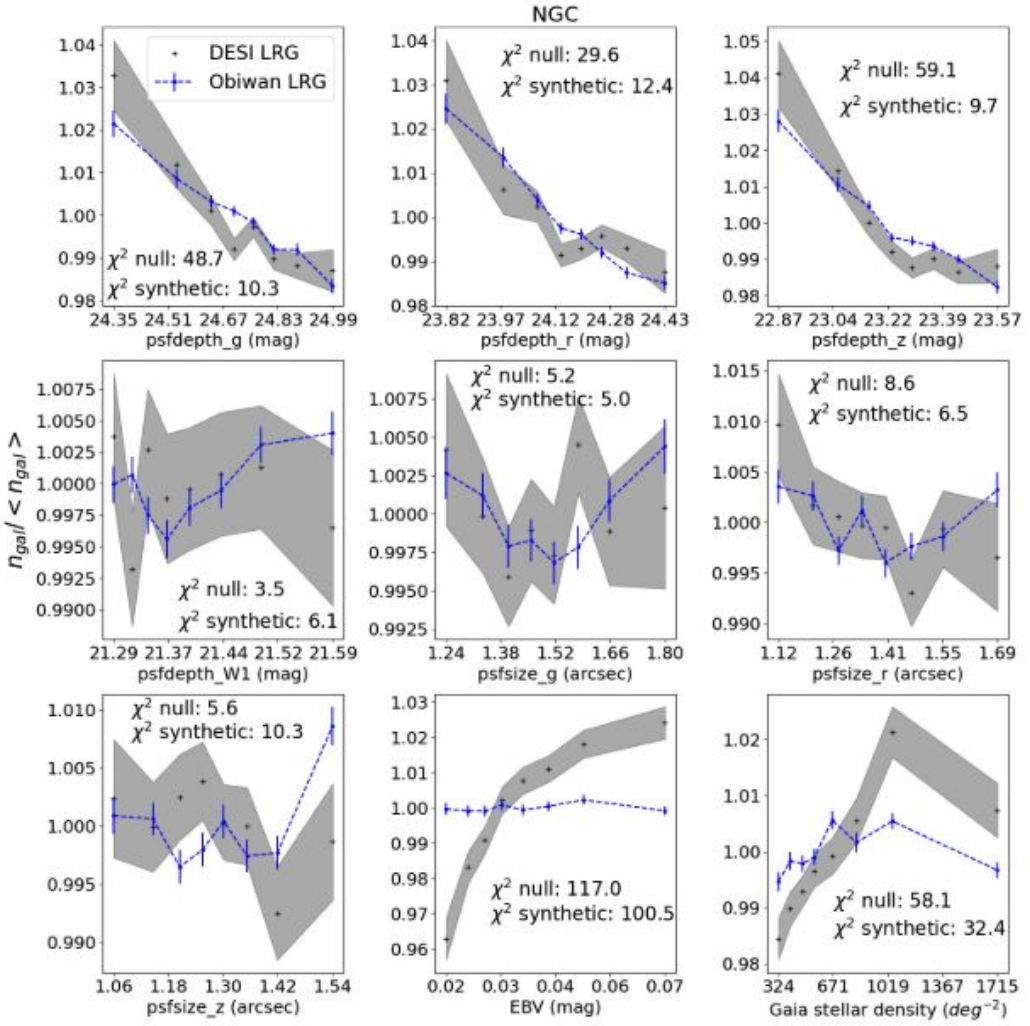
Zhou et. al. (2022)

| Cuts | Comment |
|---|---|
| South | |
| $z_{\rm fiber} < 21.7$ | Faint limit |
| $z - W1 > 0.8 \times (r - z) - 0.6$ | Stellar rejection |
| $((g - r > 1.3)$ AND $(g - r > -1.55 \times (r - W1) + 3.13))$ OR $(r - W1 > 1.8)$ | Remove low-z galaxies |
| $((r - W1 > (W1 - 17.26) \times 1.8)$ AND $(r - W1 > W1 - 16.36))$ OR $(r - W1 > 3.29)$ | Luminosity cut |



# Obiwan LRGs vs DESI LRGs

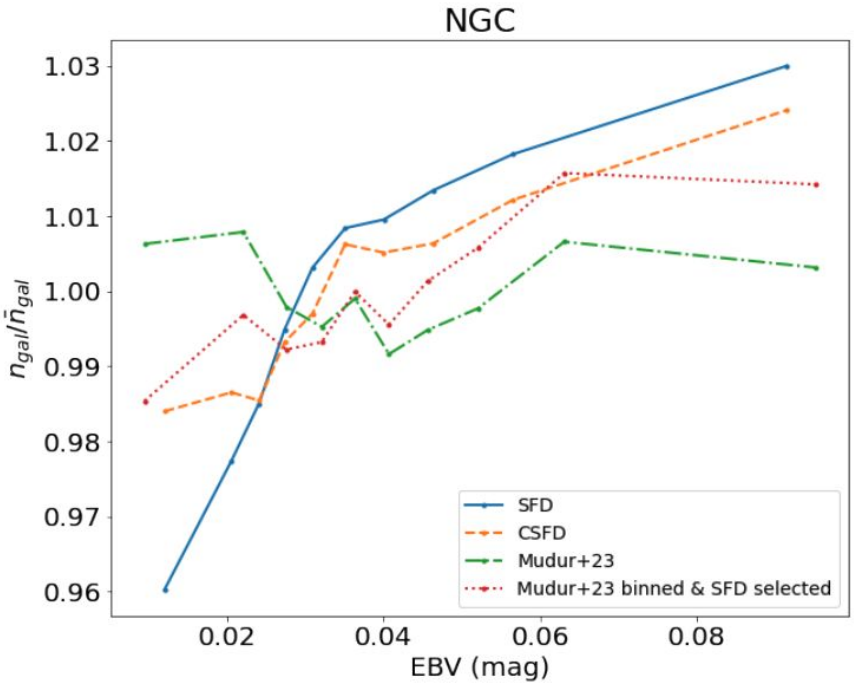
- Good recovery in galactic depth
- Large difference in the dust extinction map and the stellar density map




Kong et. al. (2024)

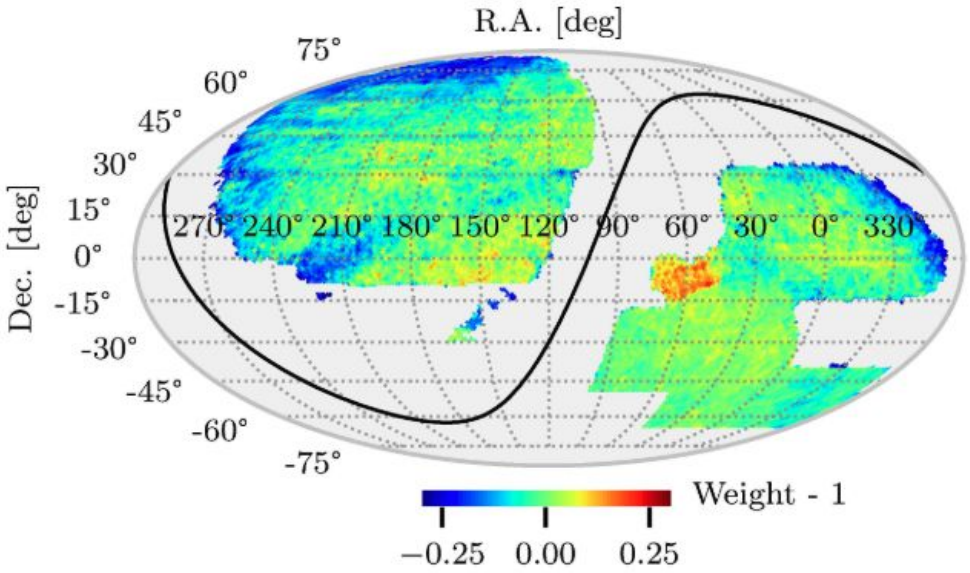
# Implications from Obiwan Simulations: extinction

- Dust extinction map has some unknown Large-Scale-Structure systematics, e.g. Cosmic Infrared Background



# The standard imaging systematics mitigation approach

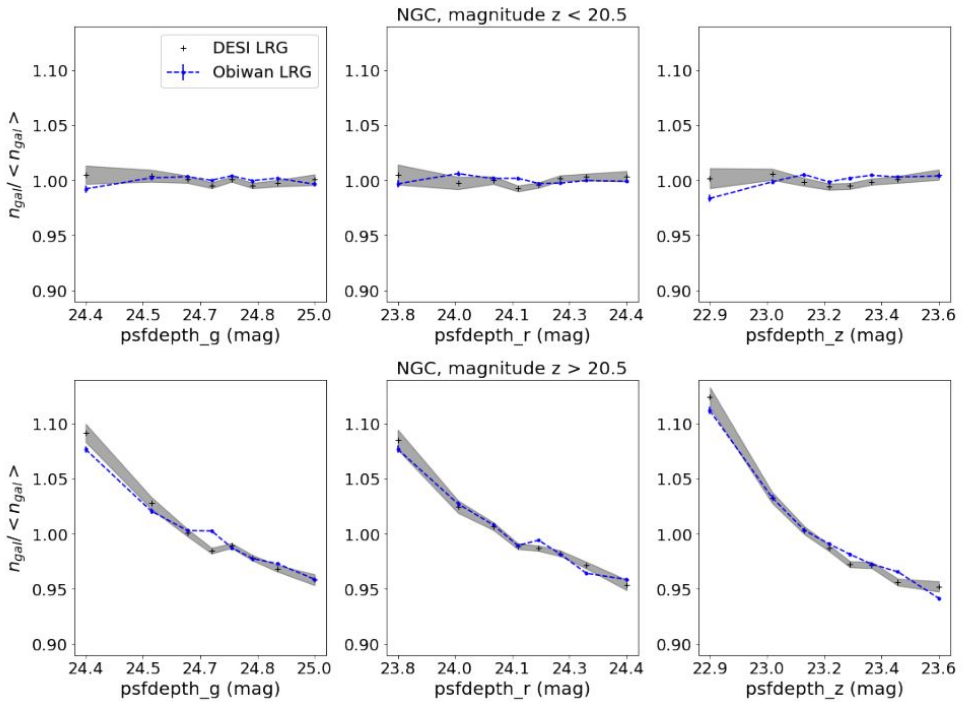
- Separate the images into tiny segments (healpix pixels)
- For each pixel, one imaging systematics weight is derived: w_sys




Edmond et. al. (2024)
For DESI Quasar targets

# Implications from Obiwan Simulations: depth

- Imaging systematics depends on the intrinsic brightness of galaxies, and it can be recovered with forward modeling




**Conclusion: Forward modeling imaging systematics is important for precision Cosmology!**