On behalf of the
DES Collaboration

Galaxy clustering with the Dark Energy Survey Year 3 data

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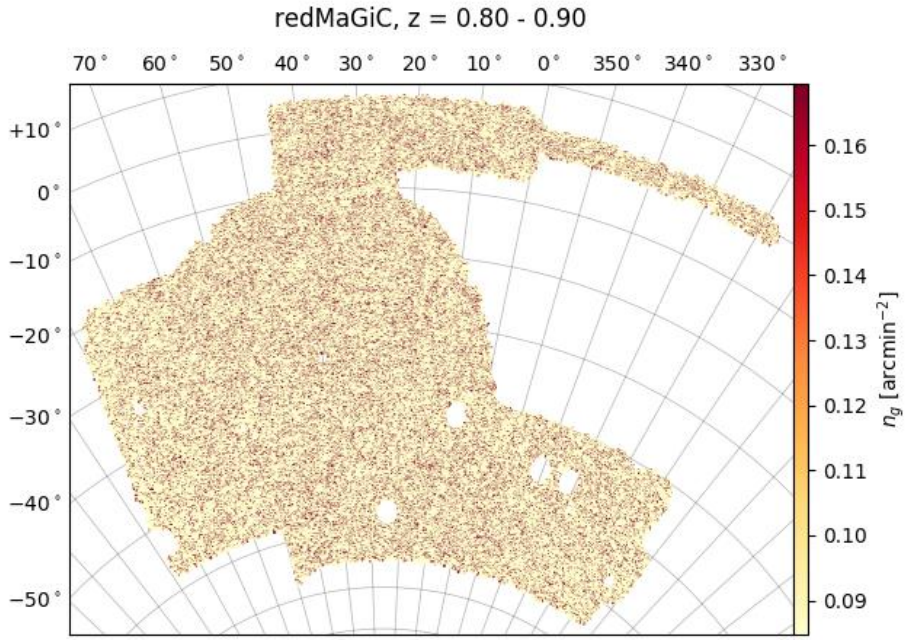
The Dark Energy Survey is an international collaboration whose main goal is to unveil the nature of dark energy. For this purpose, it has performed a 6-year photometric survey from the Blanco Telescope at Cerro Tololo (Chile), covering nearly 5000 deg^2 of the southern sky with the filters *g, r, i, z* and *Y* and reaching magnitudes up to $i = 23.7$ and redshifts of about 1.2. One of DES's most powerful probes to constrain cosmological parameters is the angular galaxy clustering, described by the two point angular correlation function, $w(\theta)$, especially when combined with weak lensing measurements. As part of the measurement, we must take special care of any spurious signal introduced by spatially varying observing conditions and survey properties, such as exposure time and seeing, or astrophysical sources of contamination, like galactic extinction or stellar density. In order to get rid of this impact, Survey Property maps are created and an iterative process is applied to the data together with these maps. The aim of this contribution is to introduce this systematic decontamination procedure focusing on the analysis of the first three years of data, and to showcase the measurement of $w(\theta)$ in two different galaxy clustering samples, redMaGiC and MagLim, and its validation in their corresponding simulations. New, preliminary results from clustering for Year 3 data will be shown.

Context of the research

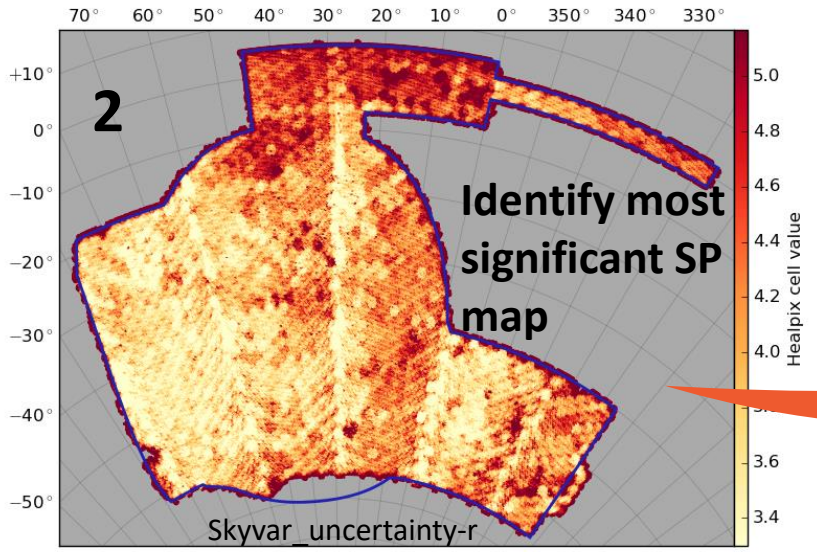
- One of the main probes for the large scale structure (LSS) of the Universe is the use of **two point correlation functions.** The combination of correlation measurements of shapes of pairs of galaxies (shear-shear), positions and shapes (galaxy-galaxy lensing) and positions with positions (galaxy clustering) has proven to provide tight constraints on cosmological parameters. This is the so called **3x2pt** by the Dark Energy Survey (DES) Collaboration T. M. C. Abbott *et al., Phys.Rev.D* 98 (2018) 4, 043526
- Before using any of these correlation functions, one must take special care of systematic effects. **Focusing on galaxy clustering,** the main sources of systematic error are **photometric redshift errors, observing conditions and astrophysical sources of contamination**
- Observing conditions and astrophysical sources (stellar density and galactic extinction) are characterized by **Survey Property (SP) maps** -> 102 of these maps!
- So, in order to obtain reliable cosmological information, it is necessary to perform **systematic mitigation** procedures and validate the impact of the methodology applied
- Both the decontamination procedure and the weights validation tests are applied to 3 different galaxy samples: **redMaGiC** E. Rozo *et al., Mon.Not.Roy.Astron.Soc.* 461 (2016) 2**, MagLim and the BAO sample**

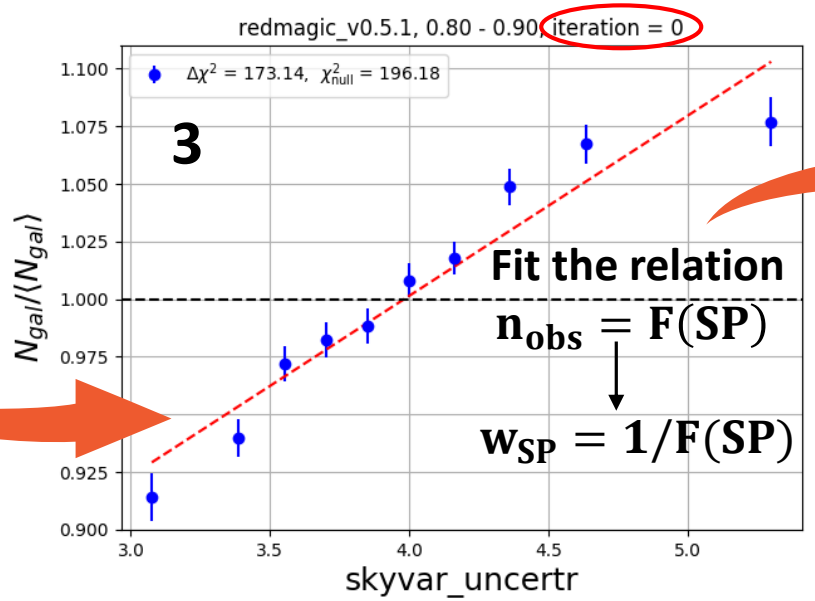


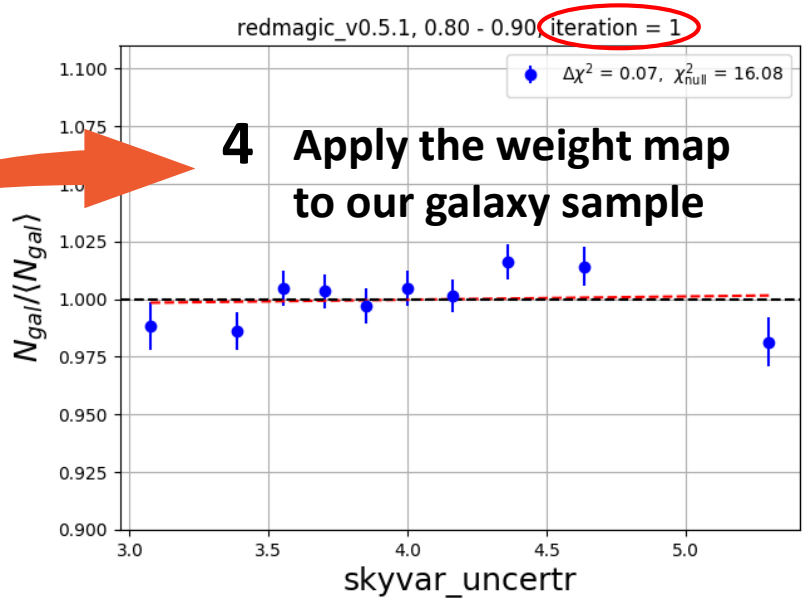
Methodology

- The goal is to characterize and **mitigate the impact** of different contaminants on the $w(\theta)$ signal
- Pipeline: J. Elvin-Poole *et al., Phys.Rev.D* 98 (2018) 4, 042006

1 Fix a significance threshold for the contamination



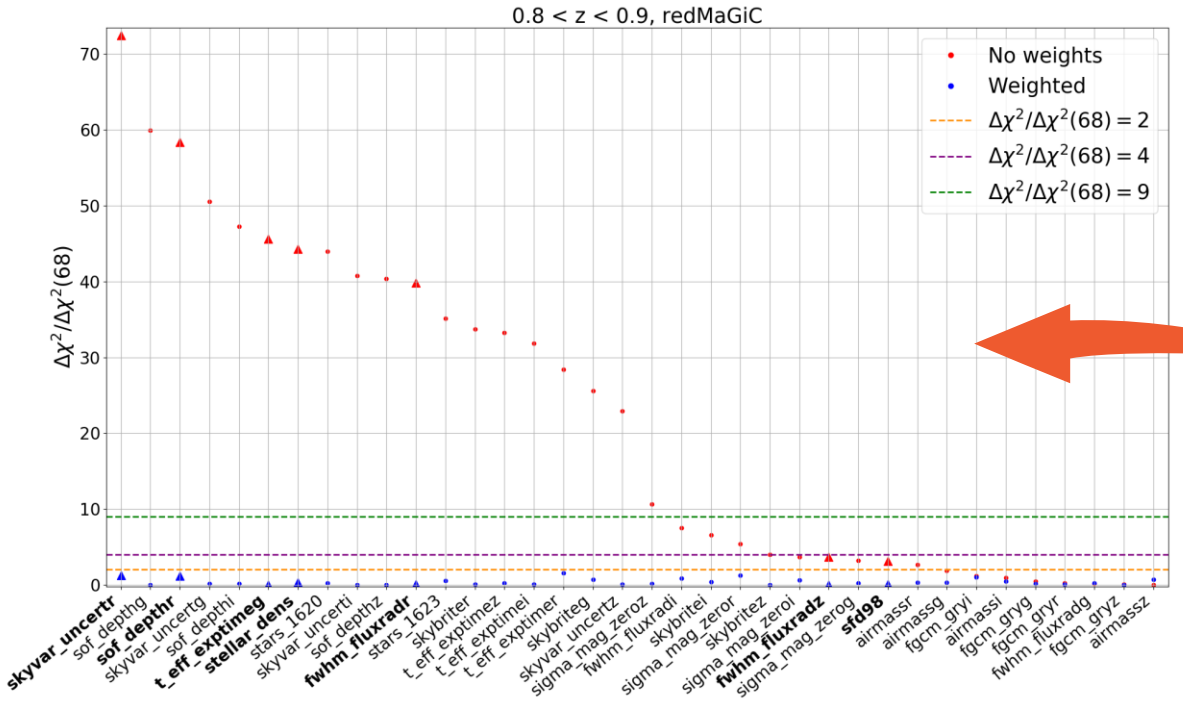




5 Re-evaluate significance of SPs and repeat iteratively

- Weights validation:
  1. Does our method combined with the **estimator for $\mathbf{w(\theta)}$** (Landy-Szalay) induce a bias?
  2. Is there **over-correction** by setting a significance threshold that is too strict?
  3. Is there an **uncorrected residual** systematic contamination by setting a too relaxed threshold?
  4. How does the method impact the **covariance of $\mathbf{w(\theta)}$?**

Results



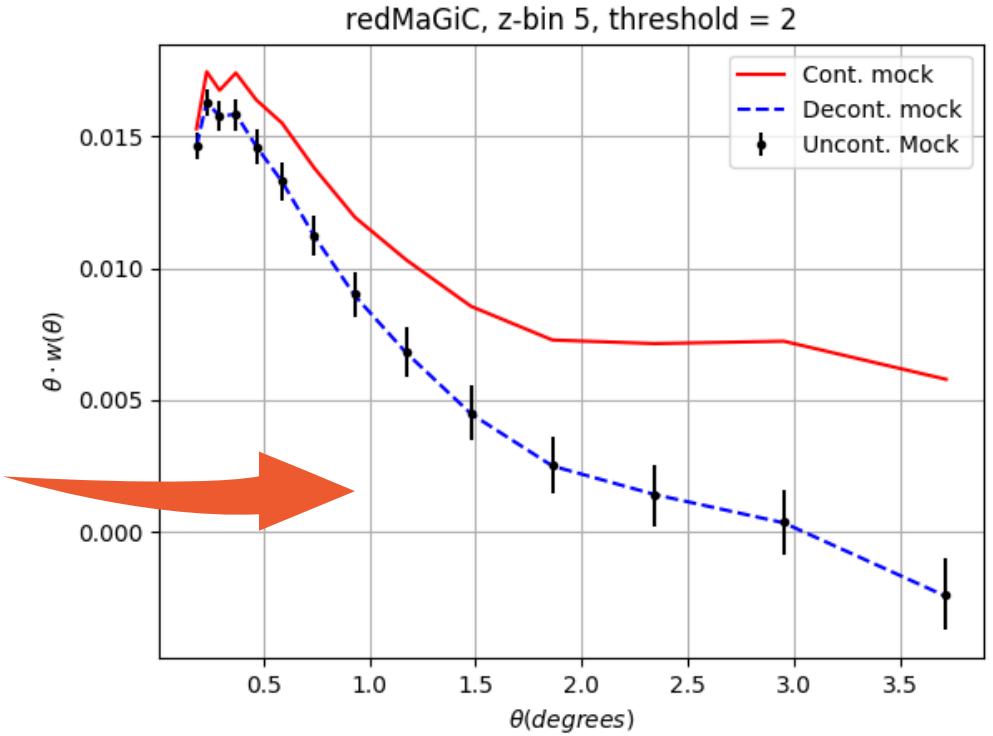
Iterative process:

- The most contaminant SP map is identified **at each step** and the salaxy sample is **weighted by it**
- The process stops at different stages depending on how strict the **significance threshold** is
- At the end, all SPs have a significance smaller than the threshold -> **the contamination has been removed!**
- However, does this method **impact our results?** -> **Weights validation**

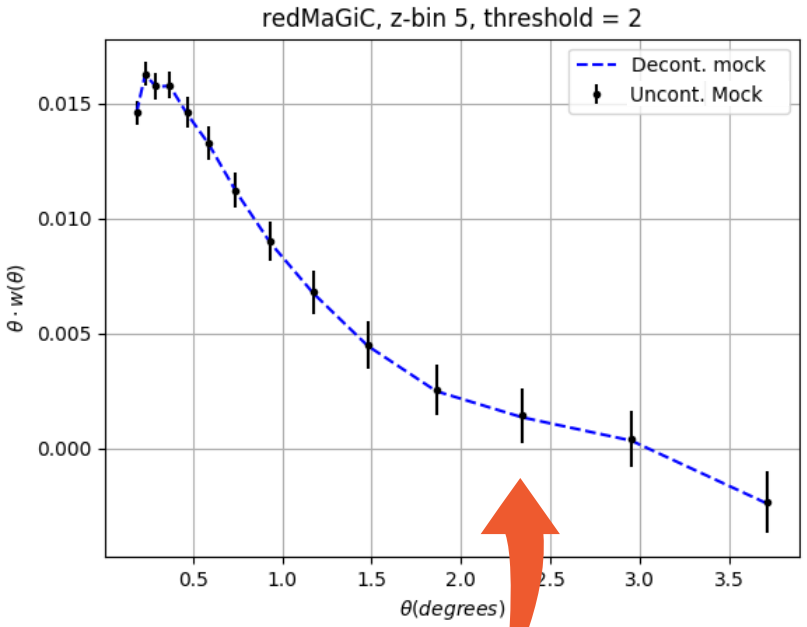
To validate these weight maps, we **contaminate** a set of 1000 **log-normal mock simulations** with the same contamination from the data

Estimator bias:

- The combination of the Landy-Szalay estimator and the weights applied to the data **could bias the recovered $\mathbf{w(\theta)}$**
- To isolate this effect, we **decontaminate** each contaminated mock by **the same contaminating SP maps** as found on the data



Results

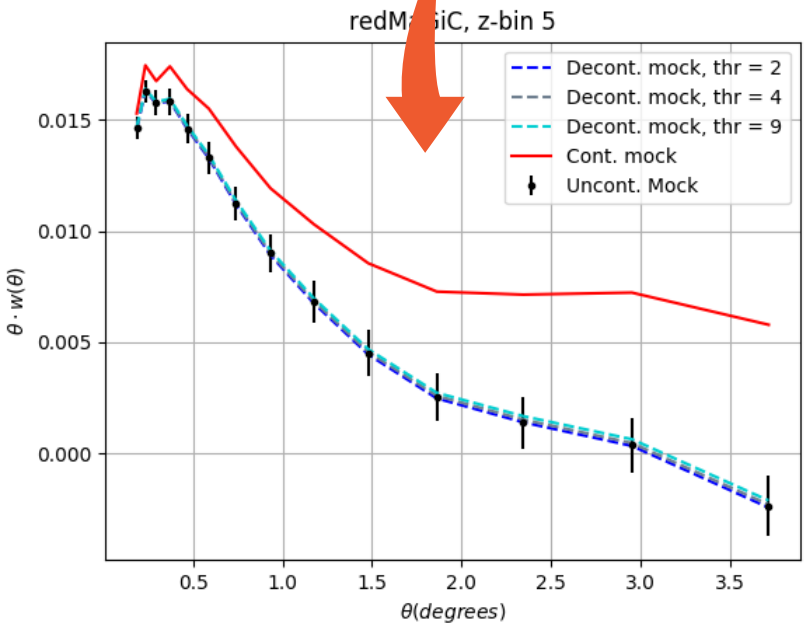


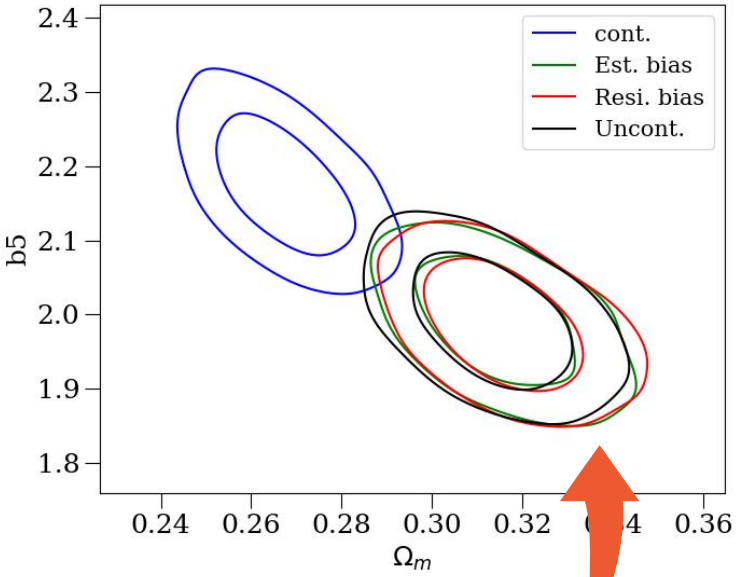
False correction bias:

- Due to the large number of SP maps, **chance correlations** can happen, specially for very strict thresholds
- We test this by applying the decontamination method to log-normal mocks **with no contamination added**

Residual systematic bias:

- On the other hand, if the chosen threshold is too relaxed, some sytematic contamination could **remain uncorrected**
- We check this by **running the pipeline** at different thresholds and with no restrictions on **contaminated mocks**





Impact on the covariance:

- The corrections applied to the data can **alter the covariance** of $w(\theta)$
- We test the impact of each of the possible biases by obtaining contours from the log-normal mocks (with known input cosmology) for each case and checking their **amplitude and structure**

Impact and prospects for the future

- **The mitigation** of contamination coming from observing conditions and astrophysical sources is **critical** to obtain reliable cosmological information. Not only for galaxy clustering, but also **for other studies like primordial non-Gaussianities,** since the signal introduce by systematic contamination resembles that from PNG
- In the coming months the Dark Energy Survey will conclude the analysis of its third year of observations (Y3). All this methodology (and many more tests) will be applied to our galaxy lens samples (redMaGiC and MagLim) and to our BAO sample
- **The increase in area** from Y1 to Y3 in DES's footprint has made possible to significantly **reduce the statistical errors.** For this reason, additional **care of systematic uncertainties** must be taken. During Y3 we have not only improved and applied the methodoloy explained here, but we have also added more tests to better **understand the uncertainties of the corrections:**
  - Due to the increased number of SP maps available, we have also studied the correlations between them to **optimized the method**
  - We have studied the impact of the contamination as a function of masked area
  - We have introduced a **generalization** of our current significance metric. This **alternative metric** takes into account the **"clustering" of the SP maps** to calculate their significances and serves as a cross-check for the classical metric
- We expect to further improve this new tests and metric in order to **apply them to Y6 analysis**