# Impact of photometric redshifts on cluster detection in the DC2 simulation

**Michel Aguena, Dominique Boutigny, Thibault Guillemin + Brazil CWG (LIneA)**

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DESC Project (EC approved)

# Intro

Galaxy clusters are the largest gravitationally bound structures in the Universe. Their abundance can tell us about the components and evolution of the Universe.

Goals
- Characterize the galaxy cluster detection using the WaZP cluster finder on DC2
  - Selection function
  - Cluster redshift
  - Mass proxy
- Evaluate the impact of observational effects on the detection
  - **Redshift**
  - Magnitude
  - Lensed positions
  - Object detection from observations
- Red-sequence in clusters

# Wavelet Z-Photometric (WaZP)

Developed by C. Benoist                    DES Y1 paper

- Galaxies are selected in redshift slices based on PDZ's from photo-z algorithms
- Clusters are detected as overdensities in wavelet based density maps
- No assumption on the galaxy populations of clusters (e.g.  red sequence)
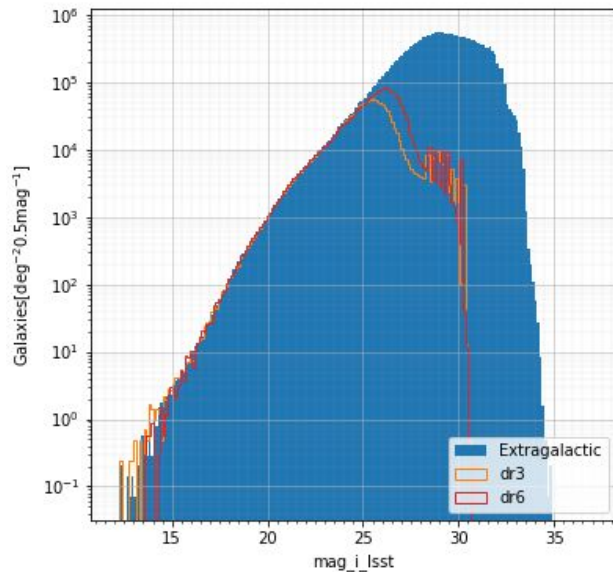- Produces cluster membership probabilities for galaxies



Z = 0.45
Z = 0.35
Z = 0.25
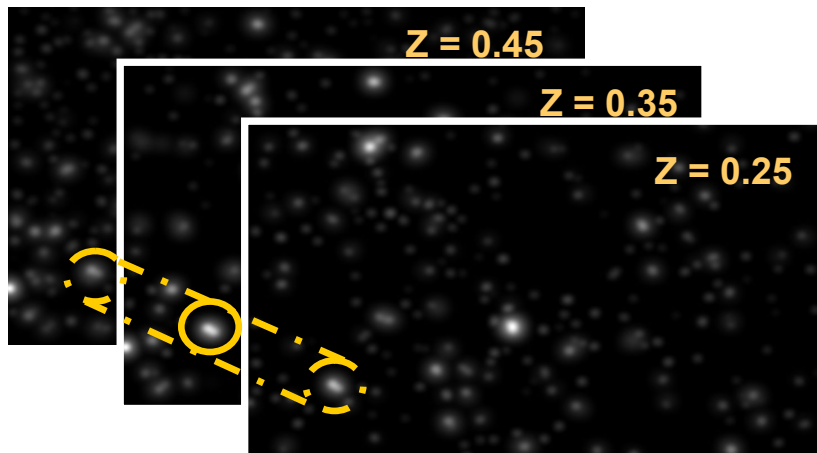
*A 3 deg² tile*

# DC2 Catalogs - cosmoDC2 v1.1.4

- **True catalog:**
  - extragalactic galaxy catalog (True, Observed magnitudes and redshifts)
- Observations (run 2.2i):
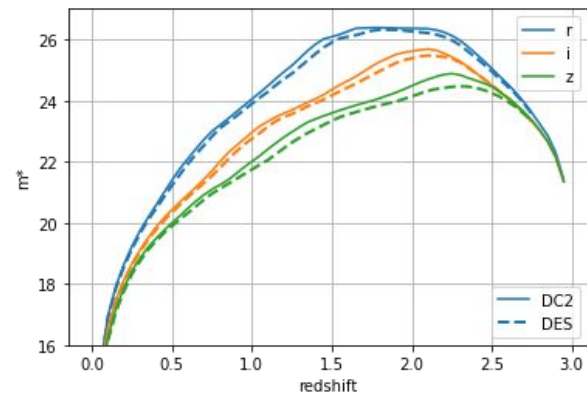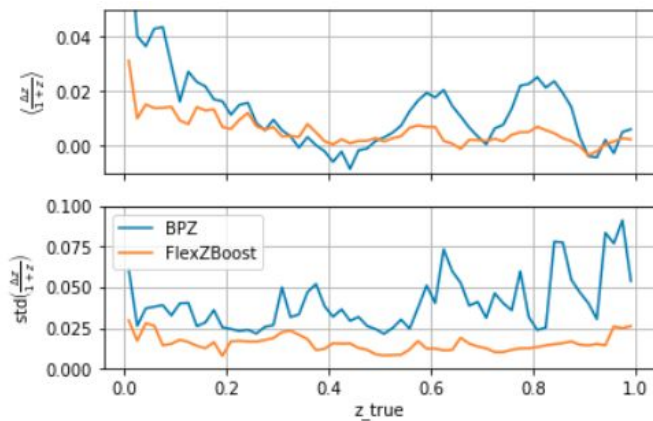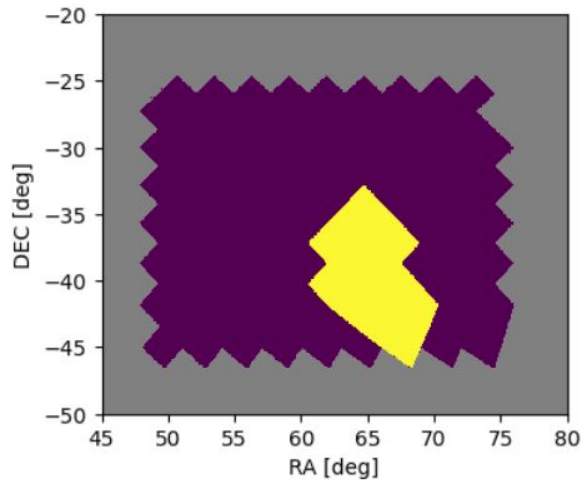  - DR3/DR6 (True, Observed magnitudes and redshifts)

# Updates on results

cosmoDC2 (8x the small catalog)
50k clusters -> 400k clusters

FlexZBoost photo-z (BPZ used before)
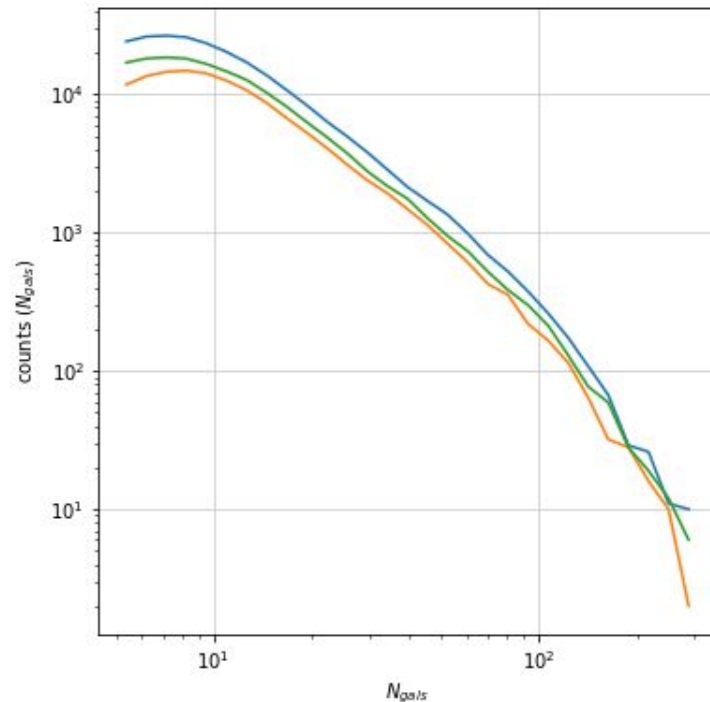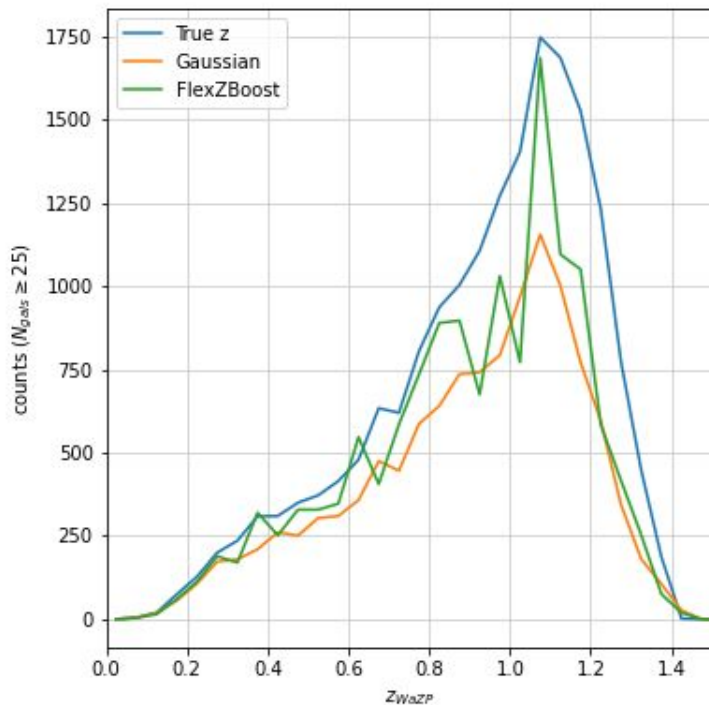σfzb=0.016, σbpz=0.04

Update m* with LSST filters
Improve detection at high z

# Current catalogs

- **cosmoDC2 extragal.**
- **Redshift: True, gaussian noise and FlexZBoost photo-z**

# **Comparing to the truth**

Matching WaZP clusters with DM Halos:
- 450k halos of mass>10^13 Msun
- using ClEvaR (membership matching)



## Cluster Evaluation Resources (ClEvaR)

Build and Check `passing`  coverage `100%`  Library to validate cluster detection. A detailed documentation of the code can be found at https://lsstdesc.org/clevar.



All of these functions with scatter plot can also fit a relation:

```
info = scaling.redshift_density_metrics(
    c1, c2, 'cross', ax_rotation=45,
    add_fit=True, fit_bins1=20)
```
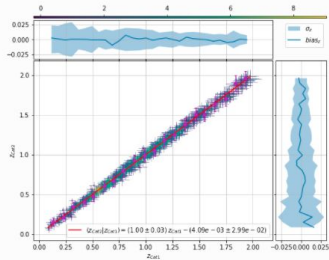
Cover fraction with NFW 2D flatcore window.

$$CF(R) = \frac{\sum_{r_i < R} w_{NFW}(r_i) df(r_i)}{\sum_{r_i < R} w_{NFW}(r_i)}$$
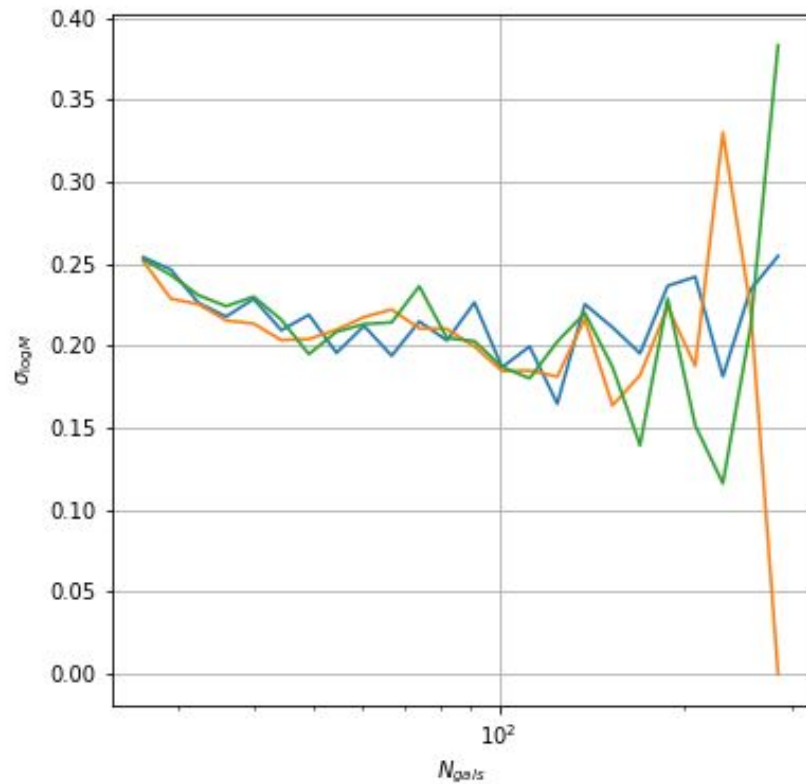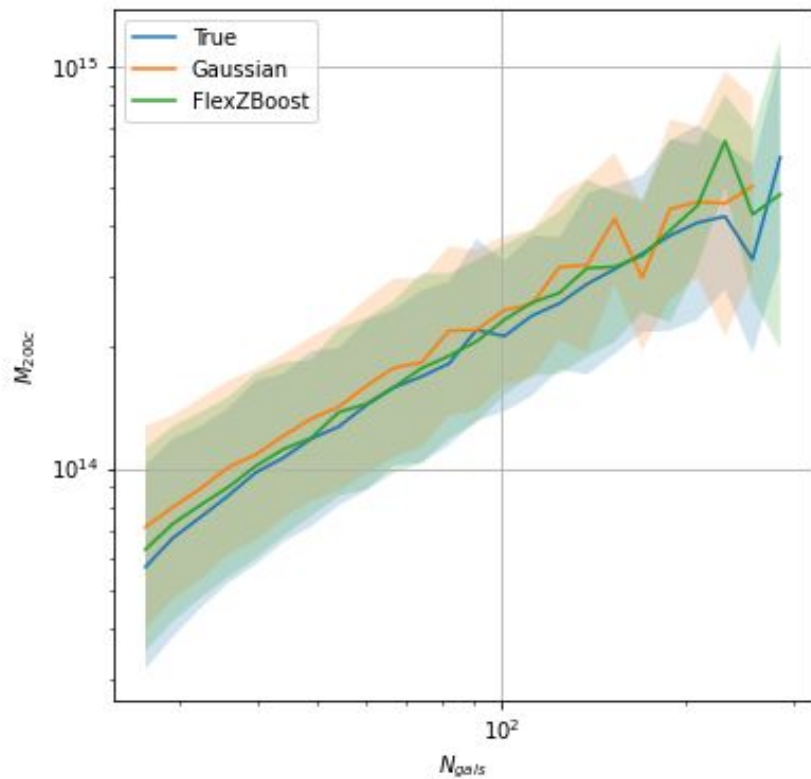
where the index $i$ represents pixels of the footprint, $r_i$ is the distance between the cluster center and the pixel center, $R$ is the aperture radius to be considered and $w_{nfw}$ is the NFW 2D flatcore window function.

Parameters:
- **cl_ra** (*float*) – Cluster RA in deg
- **cl_dec** (*float*) – Cluster DEC in deg
- **cl_z** (*float*) – Cluster redshift
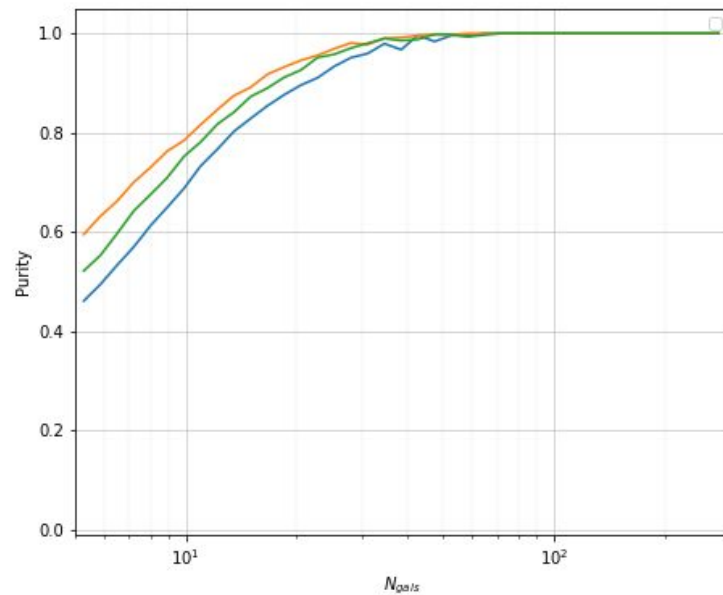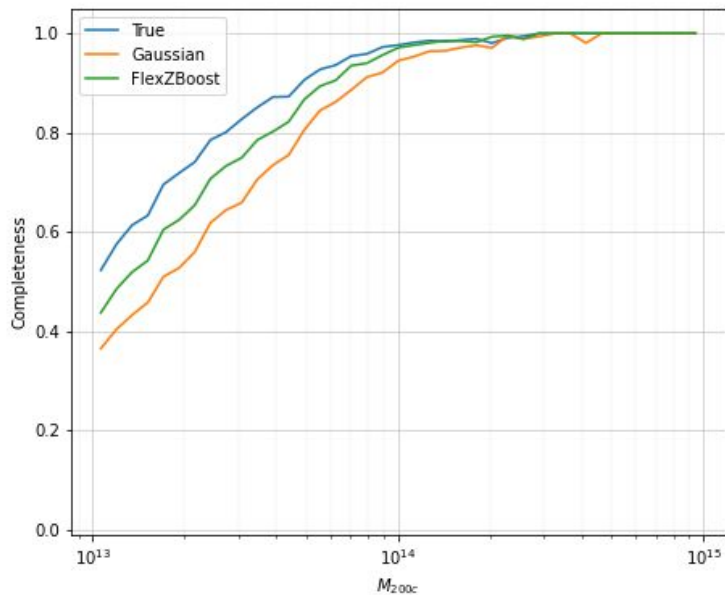- **cl_radius** (*float*) – Cluster radius

# Redshift
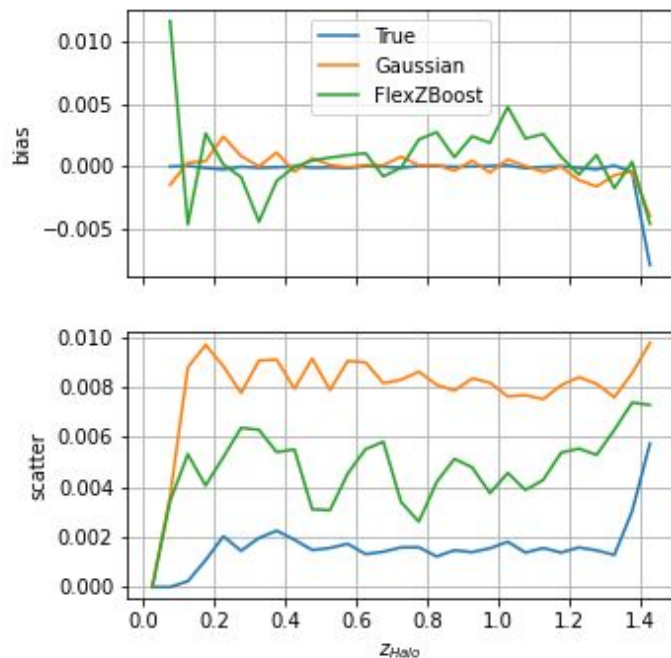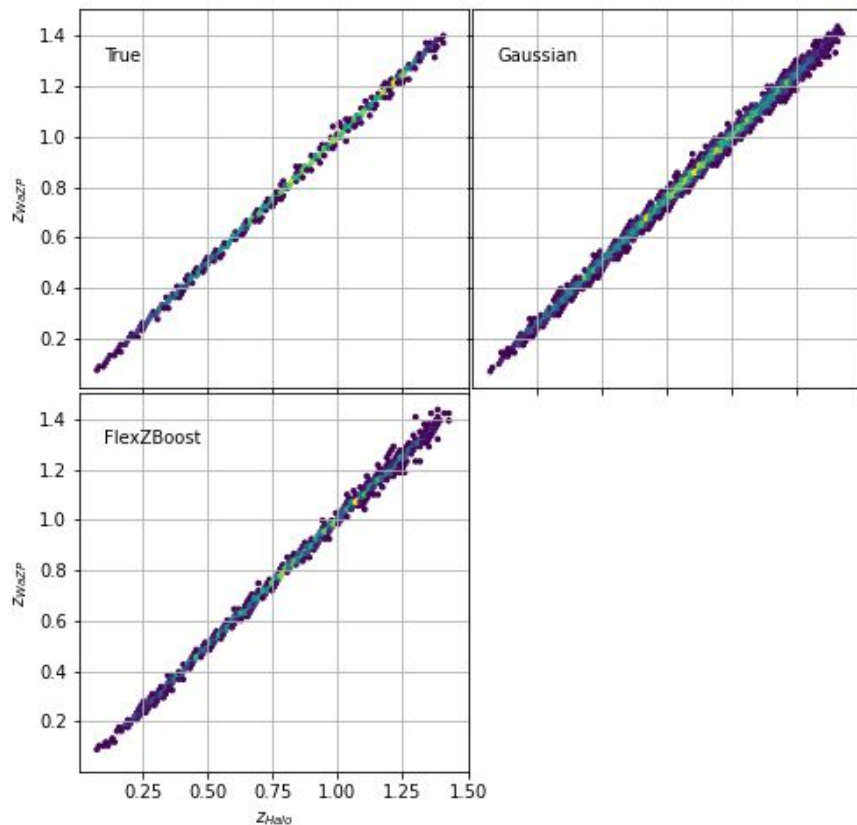
# Mass Proxy

# Selection function

Matching WaZP clusters with DM Halos using ClEvaR (membership matching)

# Conclusions

- **Uncertainties on redshift have a small impact on the detection of lower mass clusters (<10e13Msun)**
- **Quality of clusters detected is related to the redshift the scatter of input galaxies**
- **Gaussian case with slightly higher scatter presented worse results than FlexZBoost**
- **The use of different redshifts did not impact the richness estimation of clusters**

## Next steps

- **Run with lensed positions**
- **Make catalogs available to collaboration (by summer)**
- **Run on observed catalogs**
- **Evaluate over-merging and fragmentation of detections**