



# *Comparison of cluster finder algorithms on cosmoDC2 data*

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Annecy

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# Outline

## Cosmology from cluster count

Cluster catalog  
Selection function

Mass-richness  
relation

Cosmology  
(cluster  
abundance)

Likelihood

- Scope of the project
- Cluster catalog status
- Performance comparison
- redMaPPer/WaZP comparison

DESC project 248 ([link](#))

## Comparison of cluster finder algorithms on DC2 data

- Comparison on both cosmoDC2 and DC2 datasets
- Use of CLEVAR for catalog matching and for performance estimation (common framework, try to automatize)
- Algorithms: redMaPPer, WaZP and AMICO

Several DESC  
friend projects

### Part 1. Overall comparison

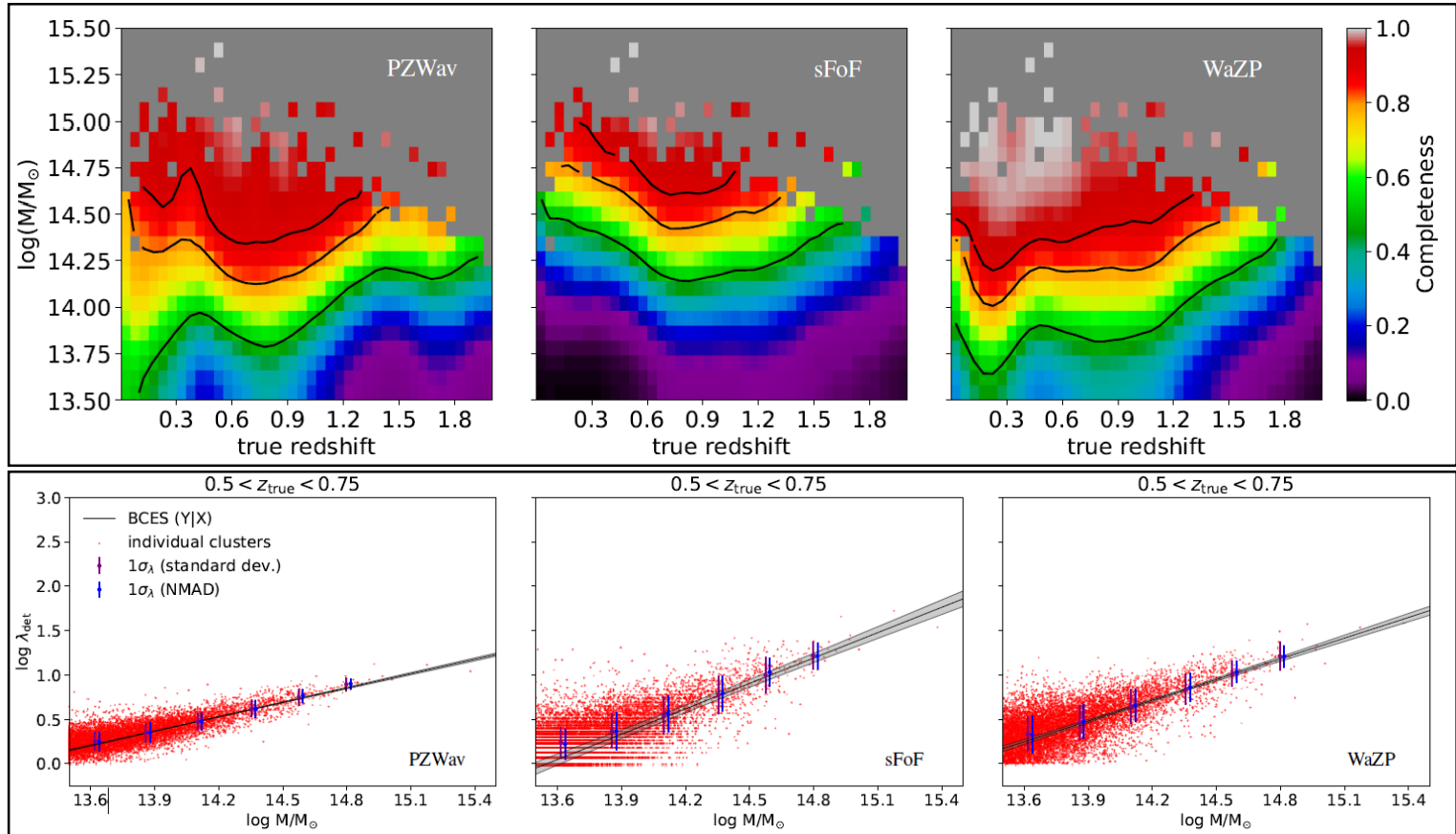
- Completeness and purity
- Mass-richness scaling relation
- Cluster redshift coverage and accuracy

### Part 2. Direct (1-to-1) comparisons between catalogs

- Matched/unmatched clusters
- Properties for matched clusters:  
richness, redshift, centering, etc.

# Euclid Cluster Finder Challenge

Euclid preparation III. Galaxy cluster detection in the wide photometric survey, performance and algorithm selection [[arXiv:1906.04707](https://arxiv.org/abs/1906.04707)]



Goal: select the best-for-Euclid-mission cluster detection algorithms  
6 detection algorithms considered  $\rightarrow$  2 selected (AMICO and PZWav)

# Catalog status

Sky areas:

cosmoDC2: 440 deg<sup>2</sup>

cosmoDC2 small: 57 deg<sup>2</sup>

DC2: 303 deg<sup>2</sup>

**cosmoDC2**

**GCR**

cosmoDC2\_v1.1.4\_small

cosmoDC2\_v1.1.4



**redMaPPer**

**GCR**

- cosmoDC2

True z, with close-to-perfect error model  
 $\Lambda > 5$

cosmoDC2\_v1.1.4\_redmapper\_v0.8.1

- DR6 catalog

dc2\_redmapper\_run2.2i\_dr6\_wfd\_v0.8.1



**WaZP**

cosmoDC2 small  
z-band

- True z  
Run 6563

- z-smearred (0.03)  
Run 6684

- Photo-z (BPZ)  
Run 6685



**AMICO**

cosmoDC2 small

Photo-z (BPZ)


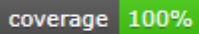
Catalog still in validation



# CLEVAR

DESC package developed by M. Aguena (as DESC pipeline scientist)

## Cluster Evaluation Resources (CLEvAR)

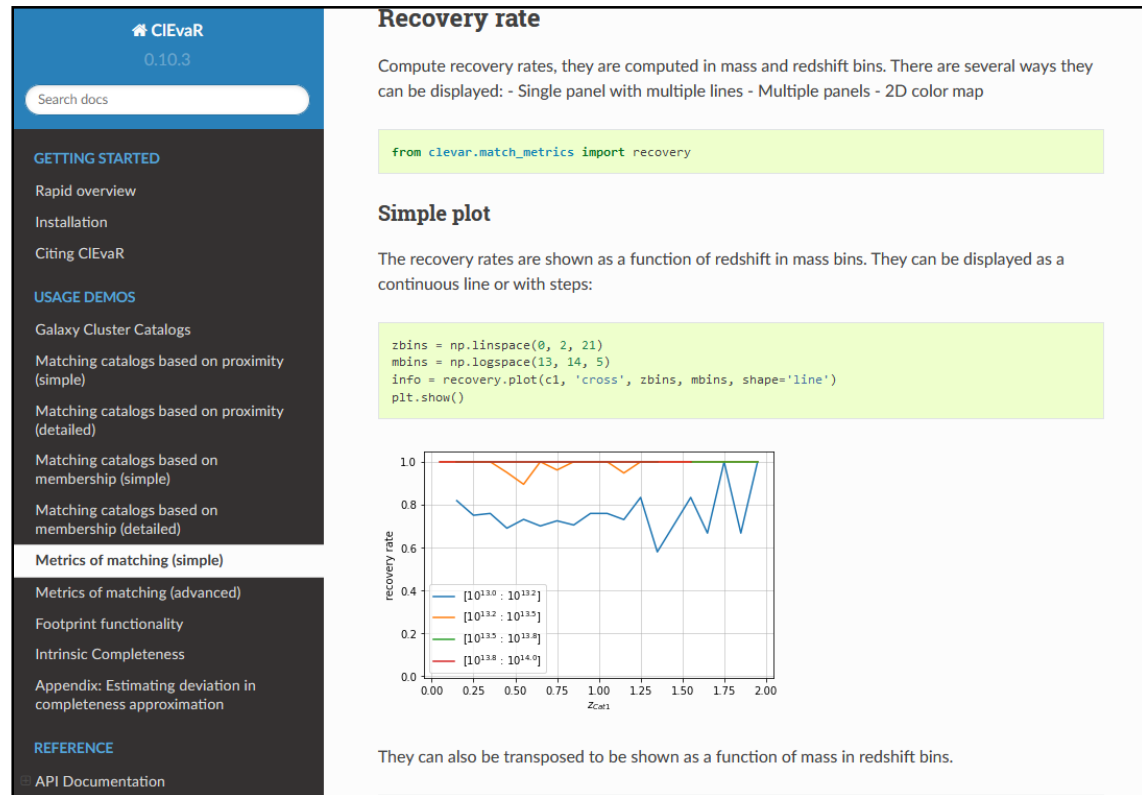
  Library to validate cluster detection. A detailed documentation of the code can be found at <https://lsstdesc.org/clevar>.

<https://github.com/LSSTDESC/clevar>

Matching between catalogs  
(proximity or membership)

Recovery rates

Scaling relations  
(e.g mass-richness)



**CLEvAR**  
0.10.3

Search docs

GETTING STARTED

- Rapid overview
- Installation
- Citing CLEvAR

USAGE DEMOS

- Galaxy Cluster Catalogs
- Matching catalogs based on proximity (simple)
- Matching catalogs based on proximity (detailed)
- Matching catalogs based on membership (simple)
- Matching catalogs based on membership (detailed)

Metrics of matching (simple)

Metrics of matching (advanced)

Footprint functionality

Intrinsic Completeness

Appendix: Estimating deviation in completeness approximation

REFERENCE

- API Documentation

### Recovery rate

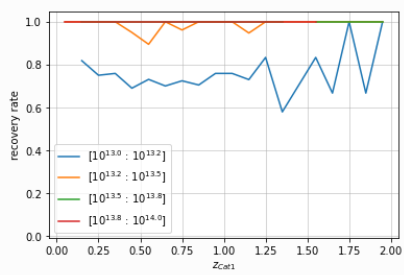
Compute recovery rates, they are computed in mass and redshift bins. There are several ways they can be displayed: - Single panel with multiple lines - Multiple panels - 2D color map

```
from clevar.match_metrics import recovery
```

### Simple plot

The recovery rates are shown as a function of redshift in mass bins. They can be displayed as a continuous line or with steps:

```
zbins = np.linspace(0, 2, 21)  
mbins = np.logspace(13, 14, 5)  
info = recovery.plot(c1, 'cross', zbins, mbins, shape='line')  
plt.show()
```

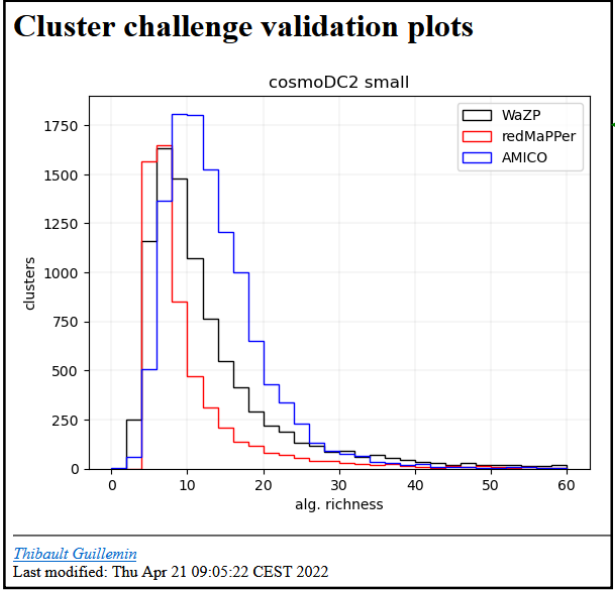
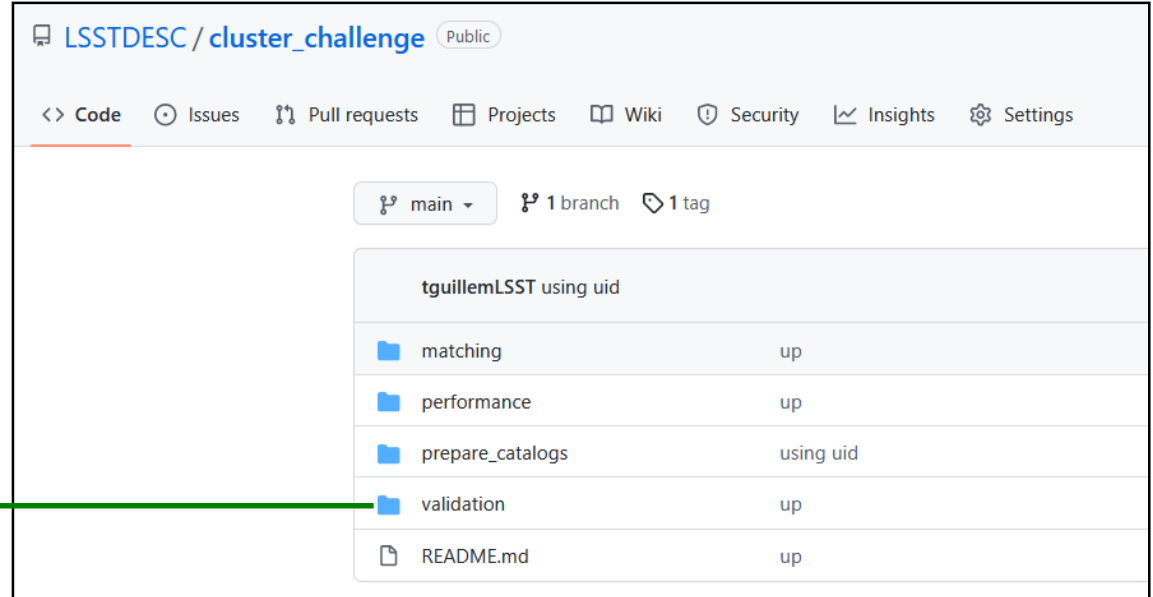


They can also be transposed to be shown as a function of mass in redshift bins.

# Putting tools in place

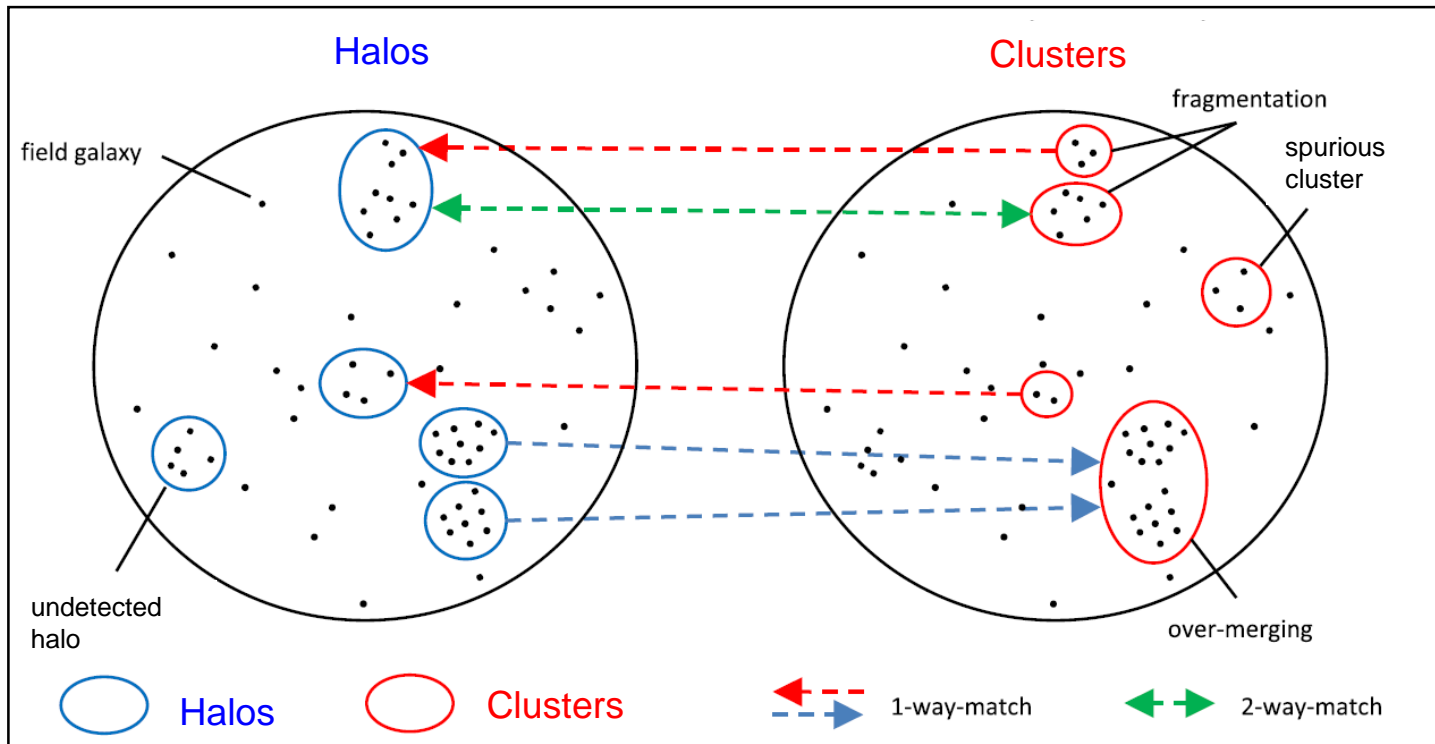
Dedicated package, heavily using CLEVAR

[https://github.com/LSSTDESC/cluster\\_challenge](https://github.com/LSSTDESC/cluster_challenge)



# Cluster-halo matching

Complex task, several procedures possible



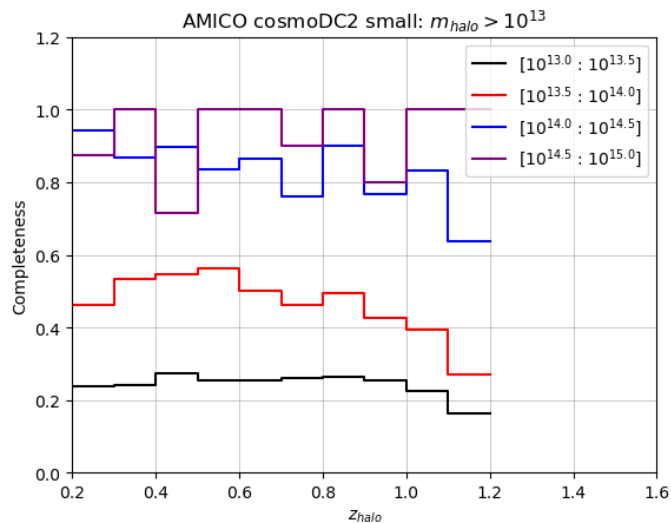
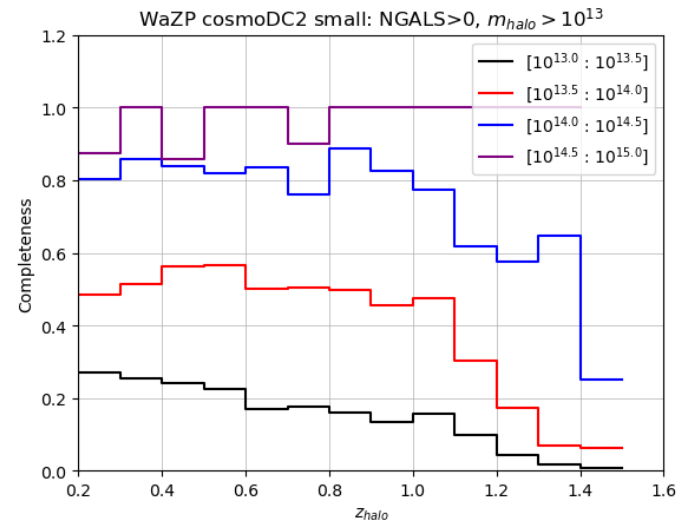
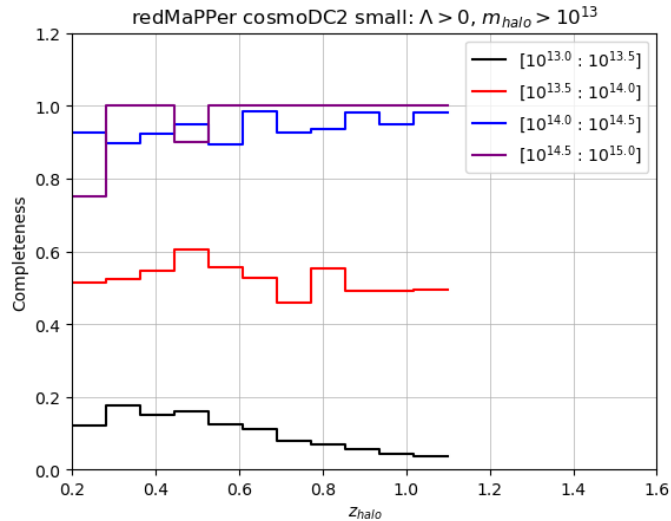
Adapted from [arXiv:0903.3411](https://arxiv.org/abs/0903.3411)

Matching performed with CLEVAR  
proximity: 'delta\_z':0.05, 'match\_radius': '1 mpc'  
cross-matched pairs selected



# Completeness

$$\text{Completeness}(m,z) = N_{\text{cl\_cross\_matched}} / N_{\text{halos}}(m,z)$$

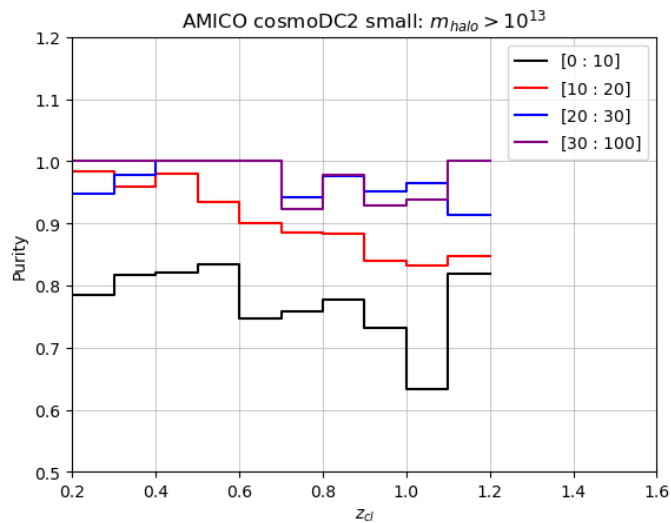
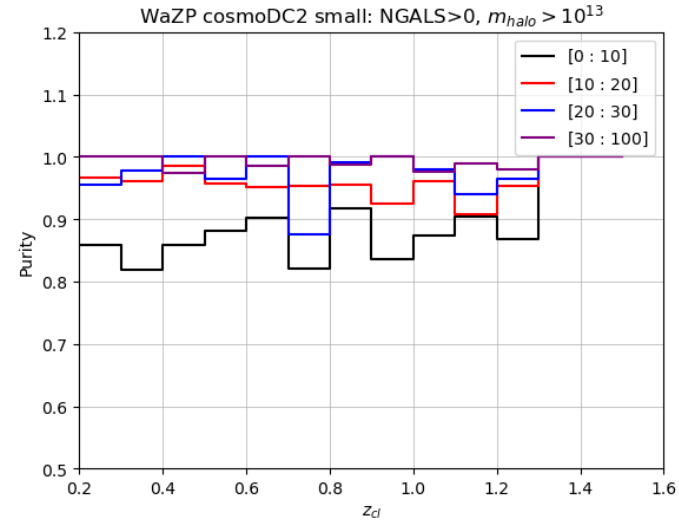
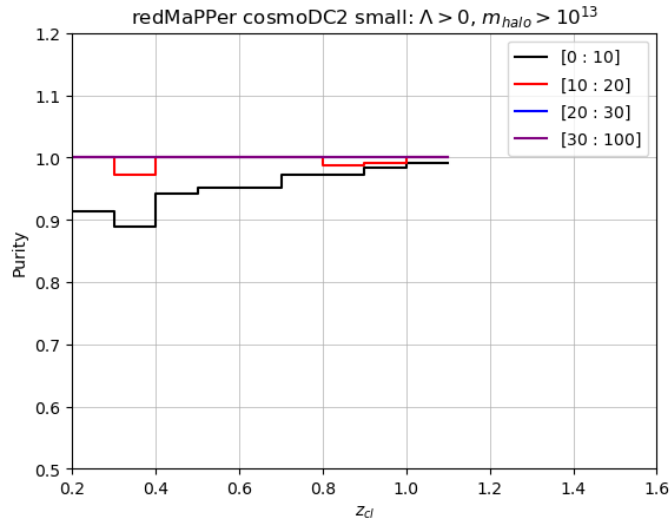


Completeness > 80% for  $m > 10^{14}$

WaZP: completeness ~60% for  $m > 10^{14}$  in  $z$  range 1.1-1.5

# Purity

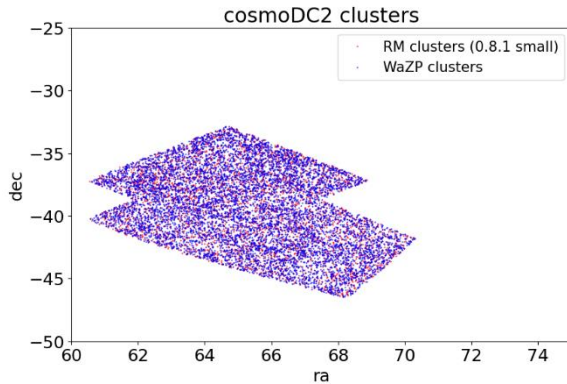
$$\text{Purity}(r,z) = N_{\text{halo\_cross\_matched}} / N_{\text{cl}}(r,z)$$



Richness definitions  
are different

High purity even at very low  
richness: to be checked...

# redMaPPer/WaZP direct comparison (1/2)

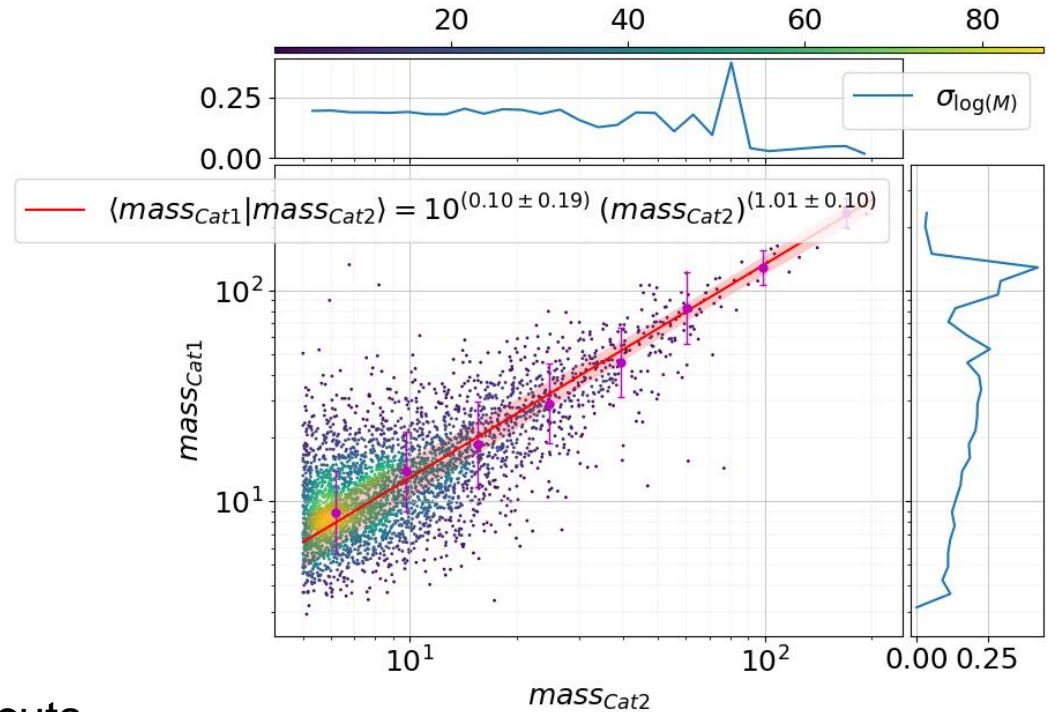


cosmoDC2 small area  
Restricting to  $z_{cl} < 1.15$

After NGALS > 25 and  $\lambda > 20$  cuts

	N_all	N_cross	N_excl
WaZP	668	380 (57%)	288 (43%)
redMaPPer	536	380 (71%)	156 (29%)

## WaZP-redMaPPer richness-richness relation

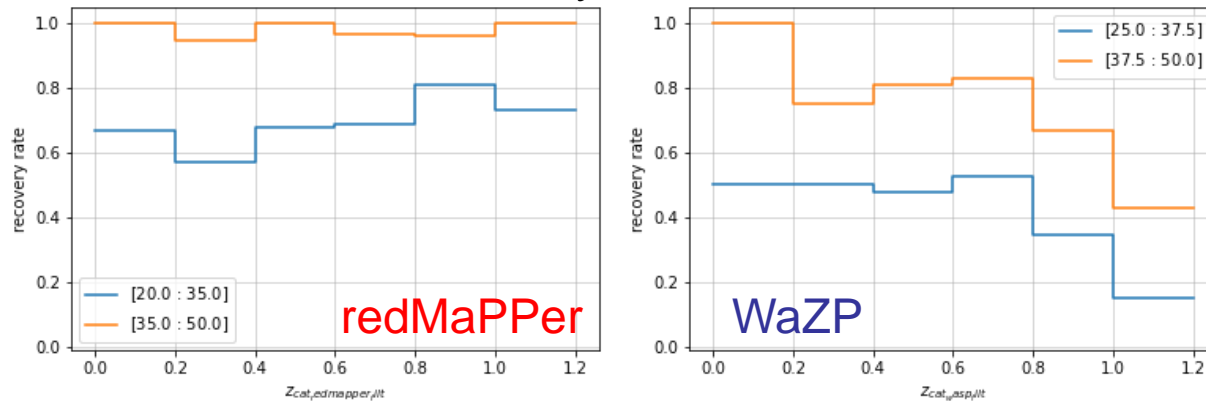


**NGALS > 25 ↔  $\lambda > 20$**   
**(similar to DES Y1 analysis)**

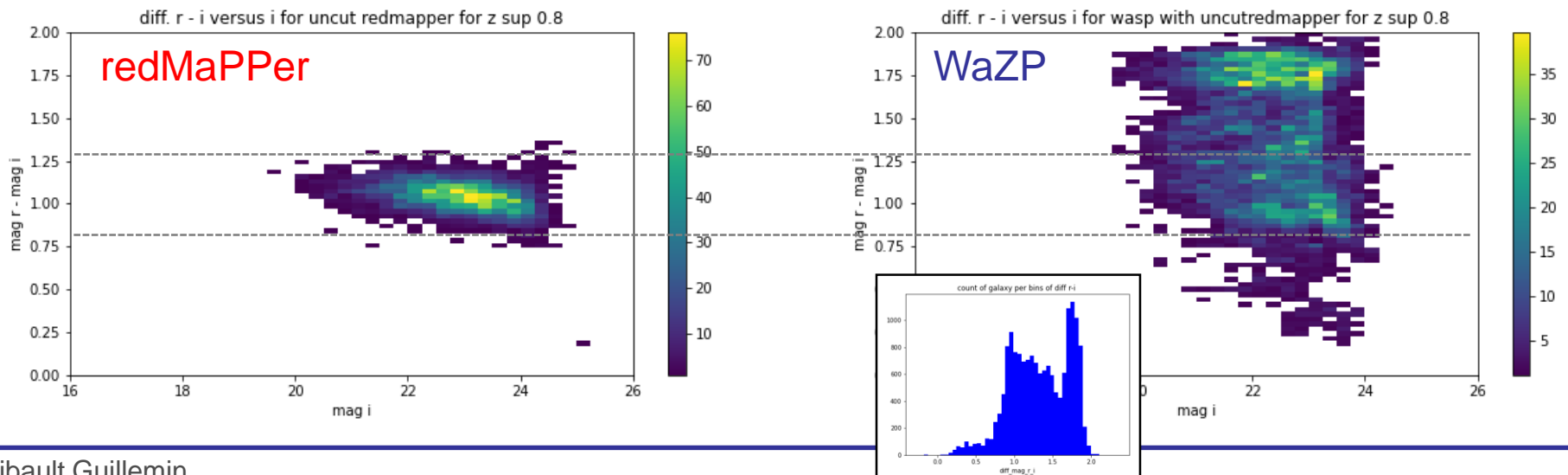
# redMaPPer/WaZP direct comparison (2/2)

Stage de Franck Lesplingart  
(M1) en cours au LAPP

## Recovery rate as a function of redshift



## Color-magnitude diagrams (cross-matched pairs, $z_{cl} > 0.8$ )



# Conclusion

- Cluster comparison project now active
  - ➔ Catalogs being prepared and tools being put in place
- Mass-richness studies just started
- Determine selection functions (completeness, purity and mass-richness relation)
- Analyse DC2 catalogs
- Goal: publication around Summer 2023