

DC2 Cluster Detections with WaZP

Rance Solomon (LAPP)

LSST-France meeting
Paris
Nov. 2024



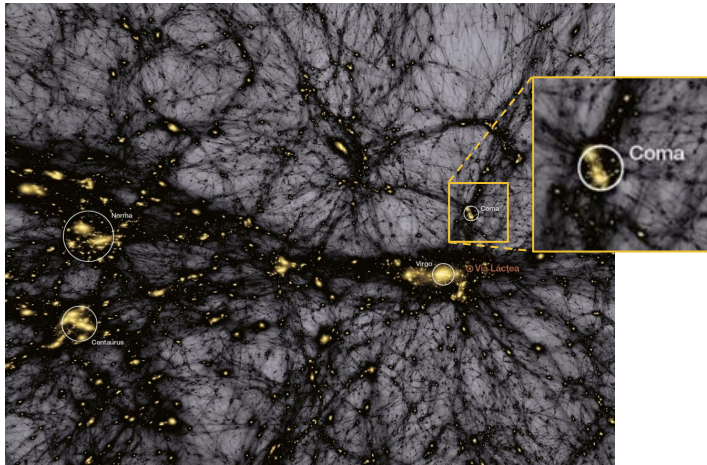
Cluster Cosmology



Typical clusters:

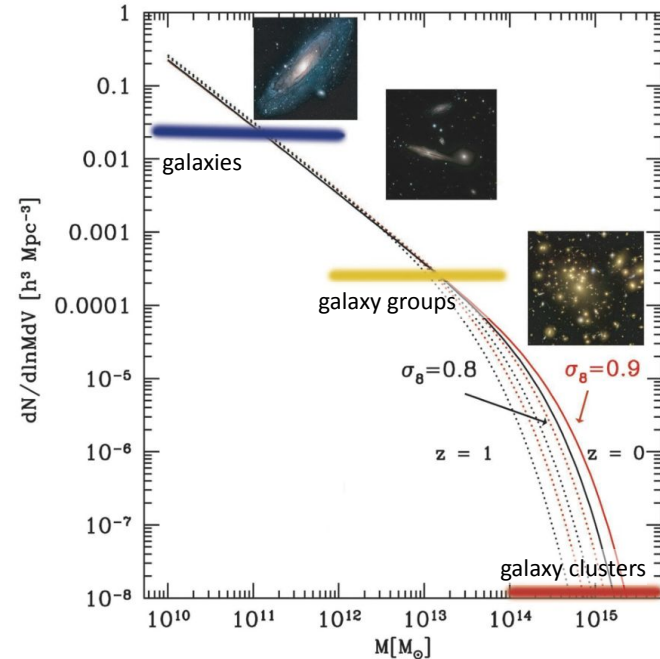
Mass: 10^{13} - $10^{15}M_{\text{sun}}$
Physical size: $\sim 1\text{Mpc}$
No. of galaxies: 10 - 1000

← **Example cluster:**
SMACS J0723.3-7327
Mass: $\sim 10^{15}M_{\text{sun}}$
Radius: $\sim 1\text{Mpc}$



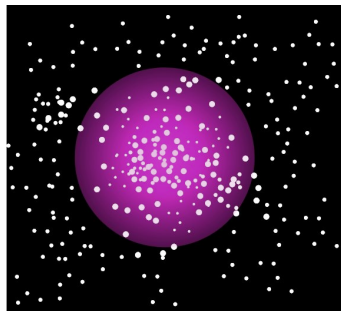
Clusters provide a strong probe for:

- dark energy
- dark matter
- modified gravity
- sum of neutrino masses

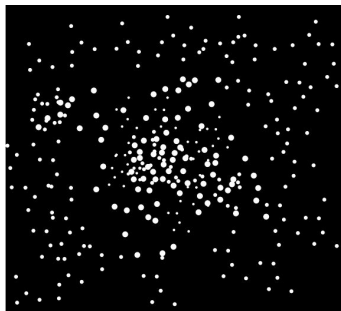


modified from [LSST Science Collaboration, 2009](#)

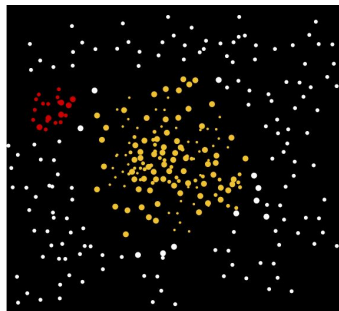
Cluster Composition & WaZP Detection



Truth



Observation



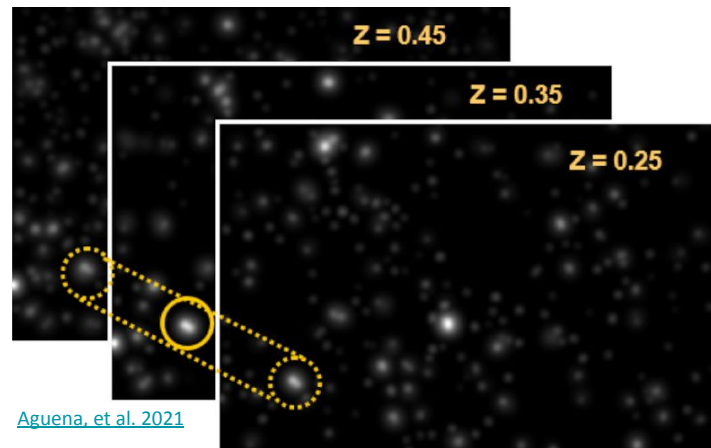
Detection

- 90% dark matter (gravitational lensing)
- 9% intra-galactic gas (X-ray & SZ effect)
- 1% galaxies (optical)

The WaZP Cluster Finder: (developed by Christophe Benoist – Nice, Fr)

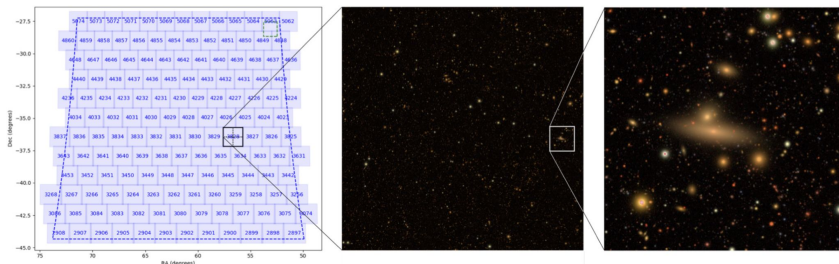
- detection in wavelet-based density maps in RA-DEC-z space
- minimal assumptions on cluster properties
- tested on DES with good agreement to redMaPPer

Now with a new version, we now prepare it to be included in DESC pipelines by validating on DC2 simulated catalog.



[Aguena, et al. 2021](#)

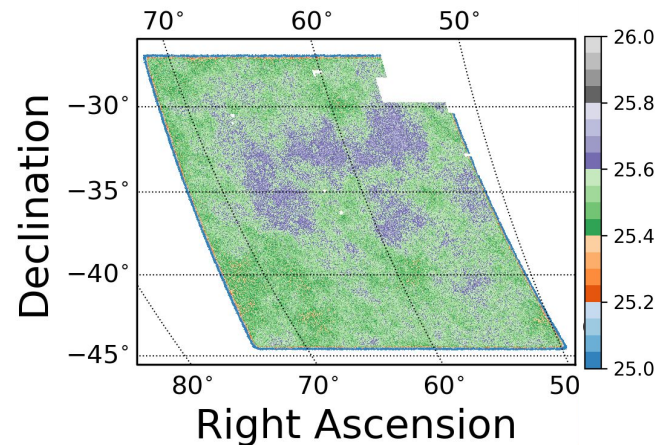
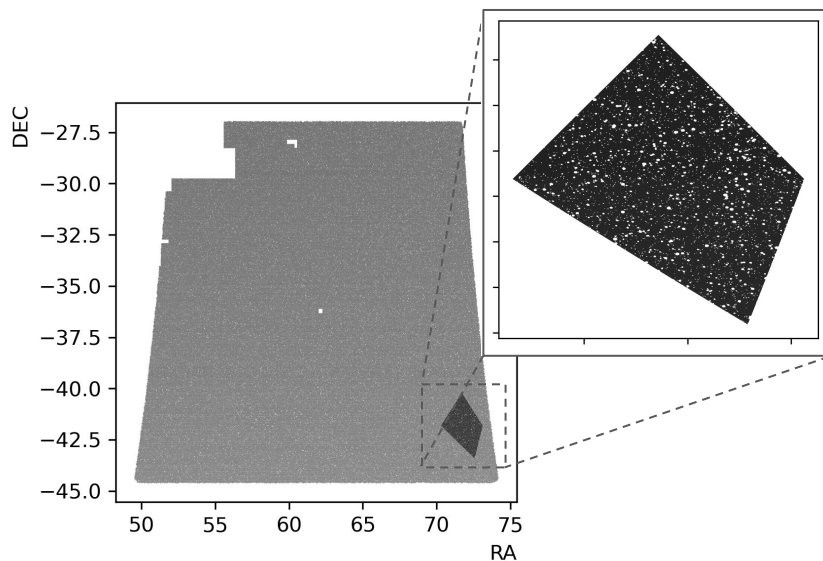
DC2 Catalog



LSST DR6-like images were built from cosmoDC2 simulated catalog.

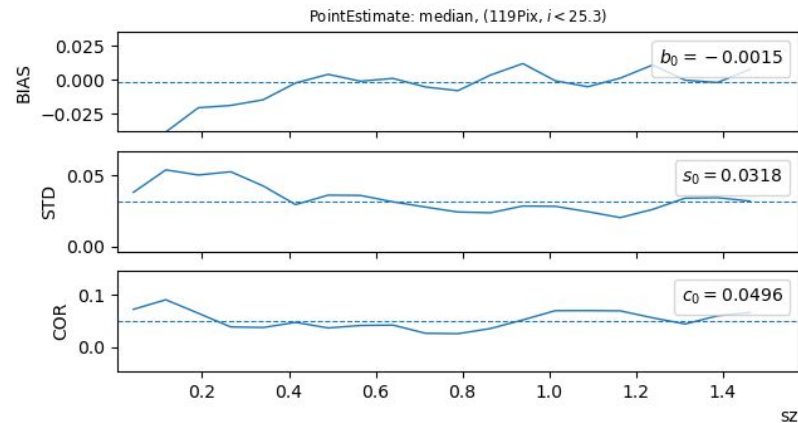
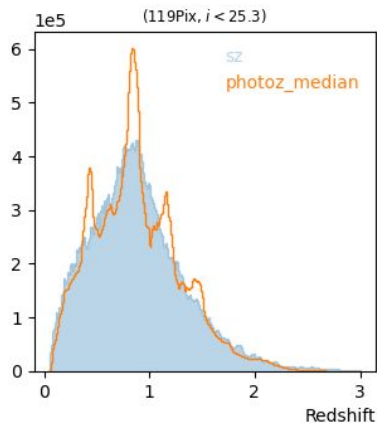
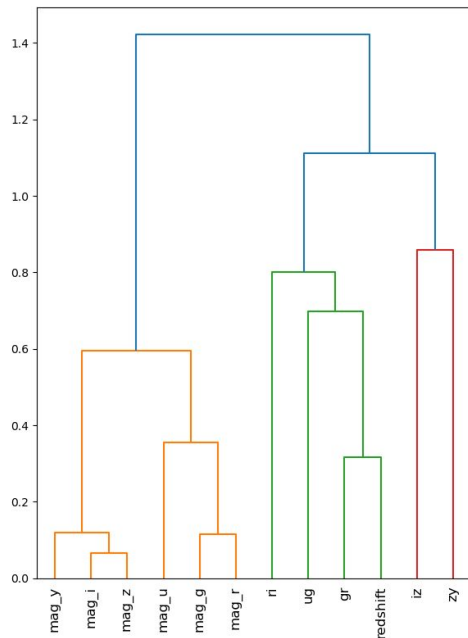
Catalog is **very near to real LSST data** including:

- blending,
- PSF estimated mags,
- varying depth,
- stars (w/o diffraction spikes)



DC2 Photo-z

Decision Tree Structure



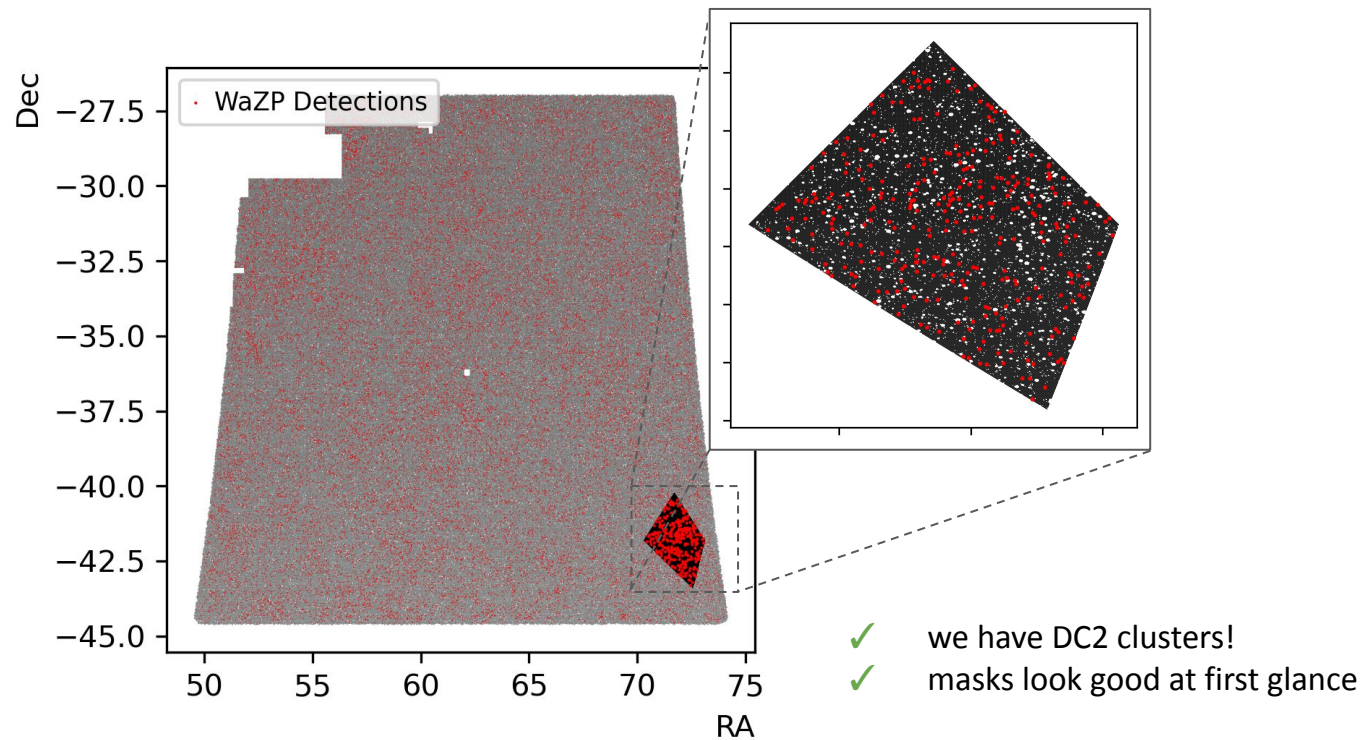
DC2 galaxy photo-z's produced with TPZ in the LSST Rail pipeline.

- FZB systematics caused significant bottle neck in project.
- Work with Sam Schmidt of PZ WG, a sufficient photo-z catalog was produced.
- Performance will improve in finalized pz-codes.
- **STD = 3%** (1-2% is expected)
- Will be added to GCR after qp is incorporated.

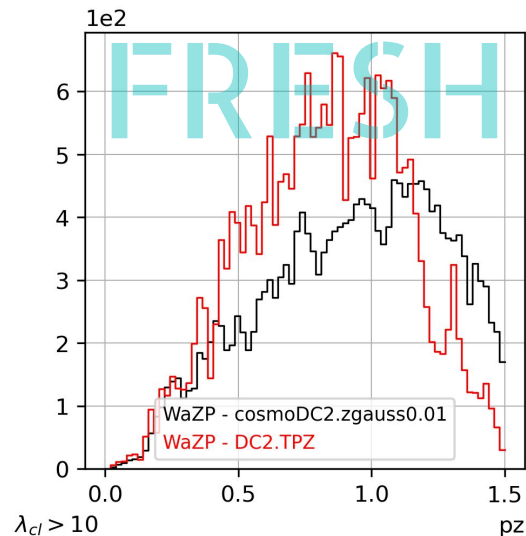
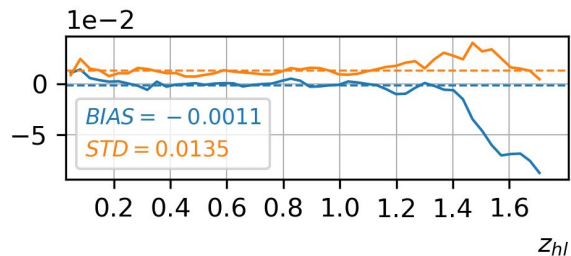
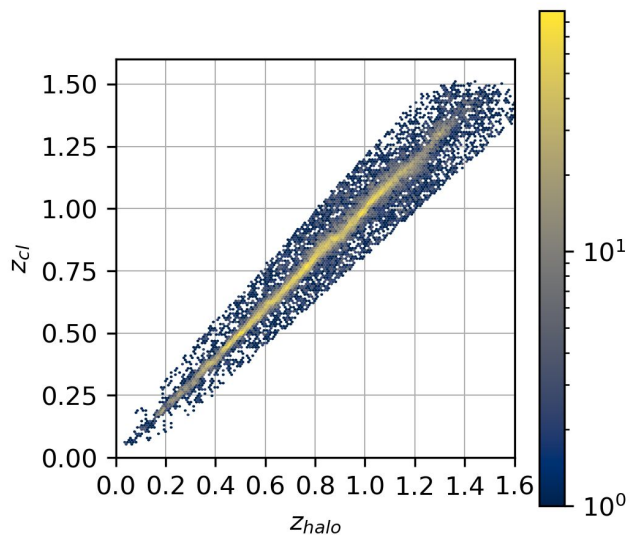
WaZP Run on DC2



WaZP Run on DC2

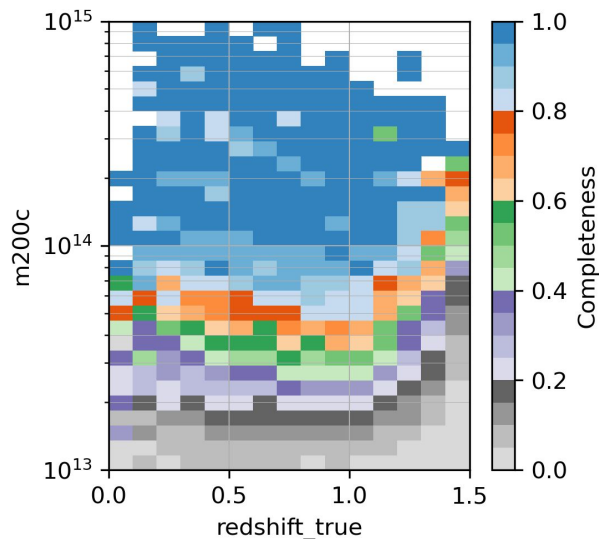


WaZP Run on DC2

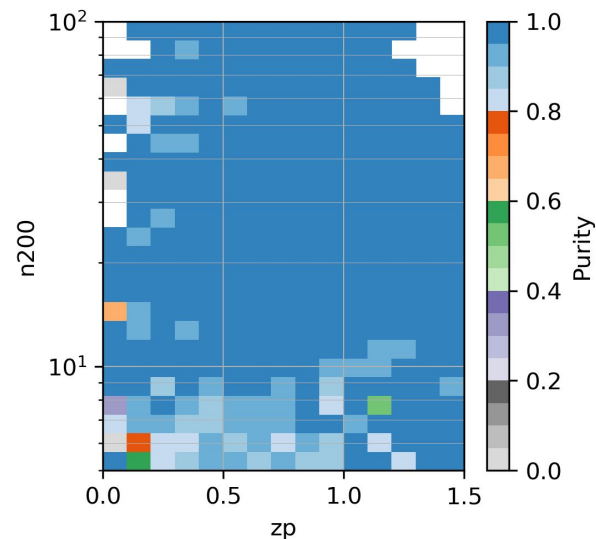


- ✓ we have DC2 clusters!
- ✓ masks look good at first glance
- ✓ cluster redshifts well centralized
- ? cluster redshifts differ from Gaussian photo-z

WaZP Run on DC2

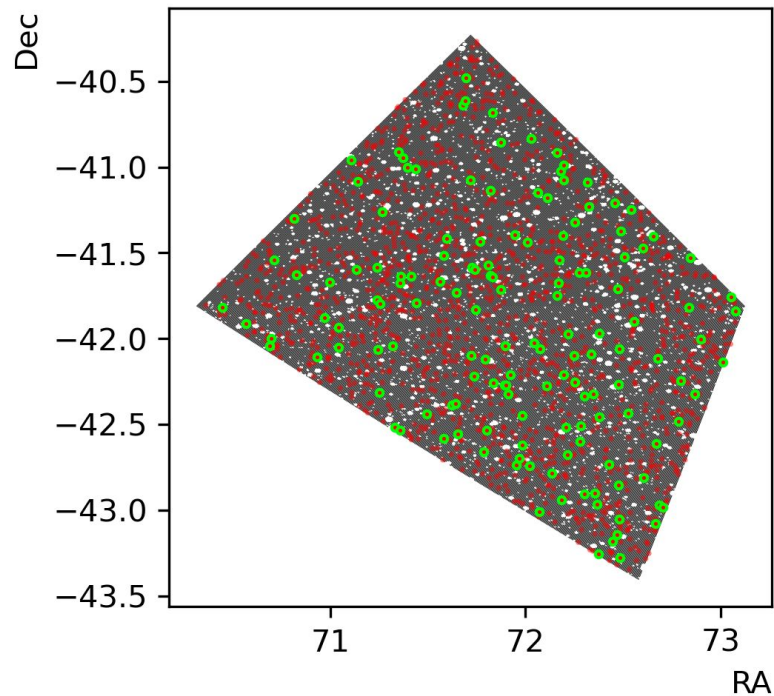


- ✓ Massive halos ($>10^{14}M_{\odot}$) are complete up to $z \approx 1.2$.
- Investigation into the drop at high redshift is needed.
- A scatter of massive undetected halos should be looked into.



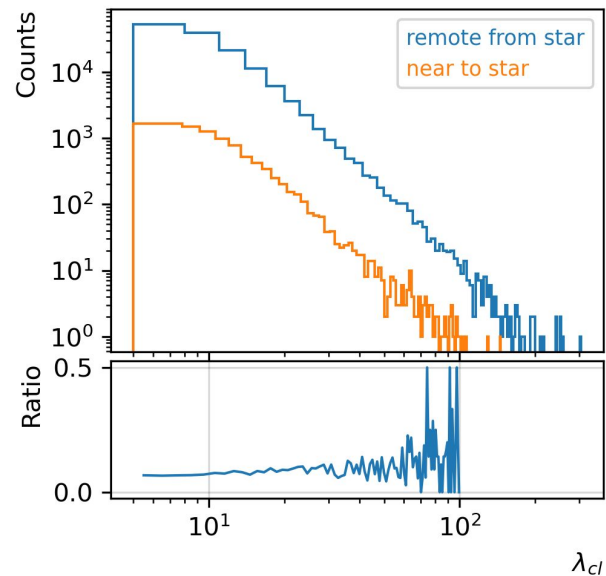
- ✓ Great purity down to small clusters.
- Some massive, low z unmatched clusters require investigation (sub-structures?).

WaZP Run on DC2



Now looking into effect of bright star mask.

For clusters **within 25 arcsec of a hole:**



Conclusion & Future Work

- WaZP cluster finder has undergone significant changes from DES Y1 run.
- After long side quests with photo-z and Bright Object masks we finally have a DC2 WaZP cluster catalog.
- Paper is being written now.

Immediate Future:

1. Follow up on incompleteness at high redshift.
2. Further investigation into star masks.
3. **Get that paper.**

Longterm Future:

1. Make cluster catalog available on GCR.
2. Test at scale – skysim5000 run is ongoing at LineA.
3. Consider how to handle sub-structure detections.
4. Improve on photo-z's.