LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Built an optically selected galaxy clusters catalogue

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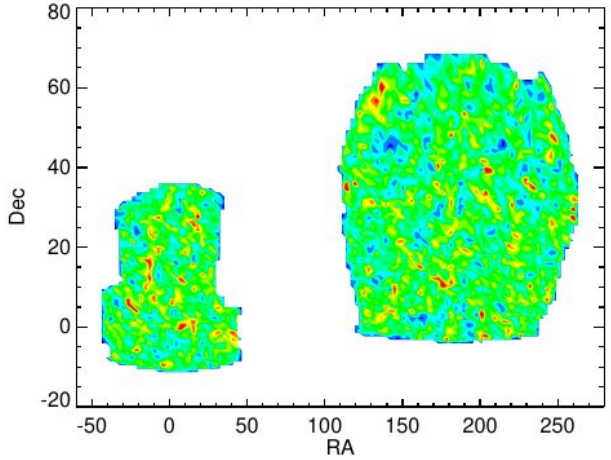
Galaxy Cluster detection

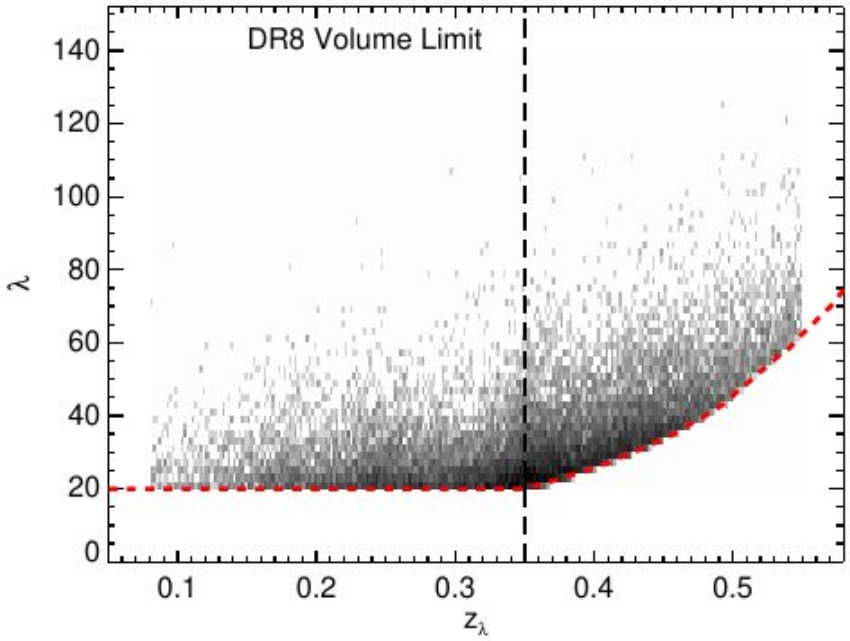
- Detect cluster in different wave bands
- Cluster detection in optical (NIR) bands
- Comparison with X-ray, SZ selected clusters
- What we can ask to a detection algorithm

REDMAPPER (red-sequence matched-filter Probabalistic Percolation)

REDMAPPER: clusters are found as overdensities of red-sequence galaxies.
Iterative self-trained red sequence model with redshift evolution. It uses all colors from *ugriz*.
Red sequence model+radial and luminosity filters.

Richness is the sum of the membership probabilities.





Cluster catalog > 25000 with Richness > 20 redshift [0.08,0.55] fmask < 0.2 from SDSS DR8 galaxy photometric catalogue in 10000 deg2

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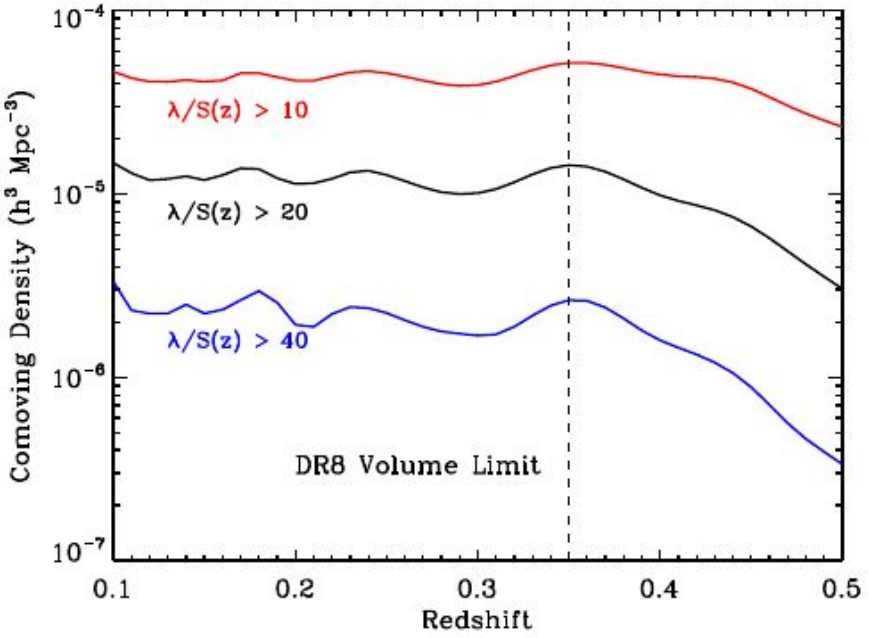

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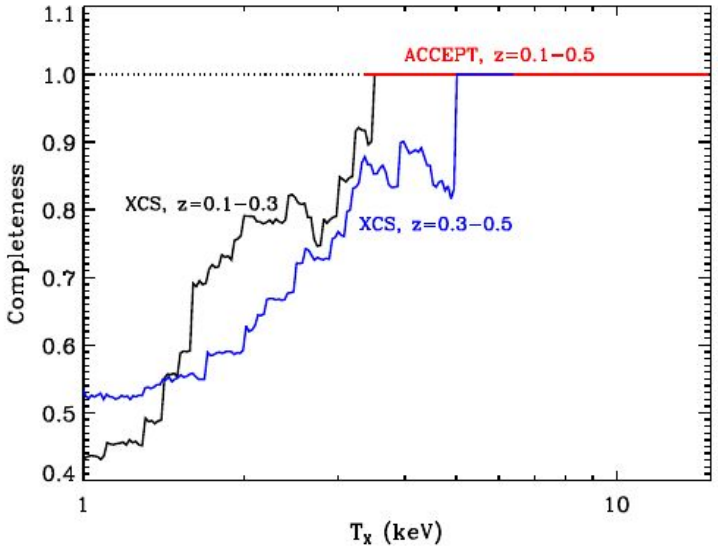
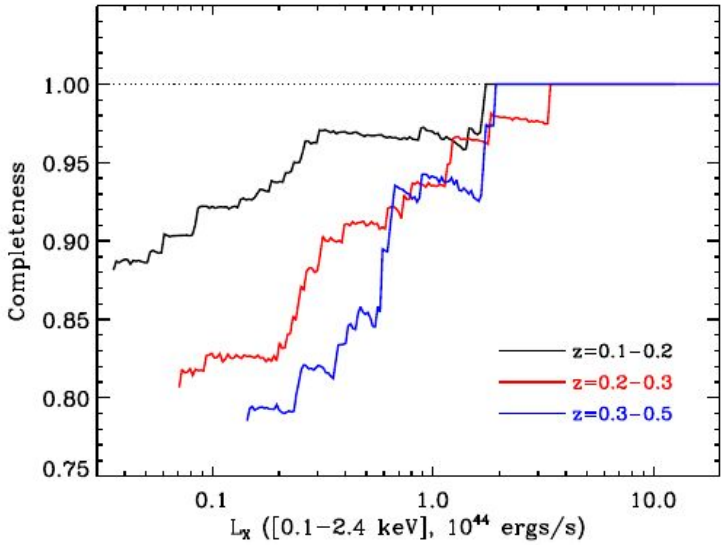


MCXC (Meta-Catalog of X-ray detected Clusters of galaxies, Piffaretti+2011): RASS + serendipitous clusters ROSAT

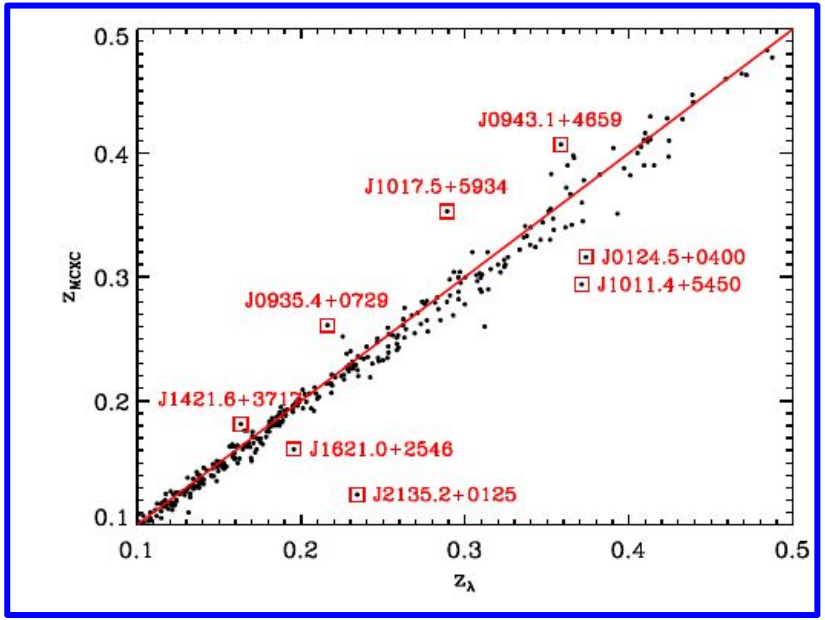
XCS (XMM Cluster Survey, Mehrtens+12) serendipitously detected clusters. Of these, 402 with temperature estimations (not core-excised).

ACCEPT: compilation of cluster catalog with deep Chandra

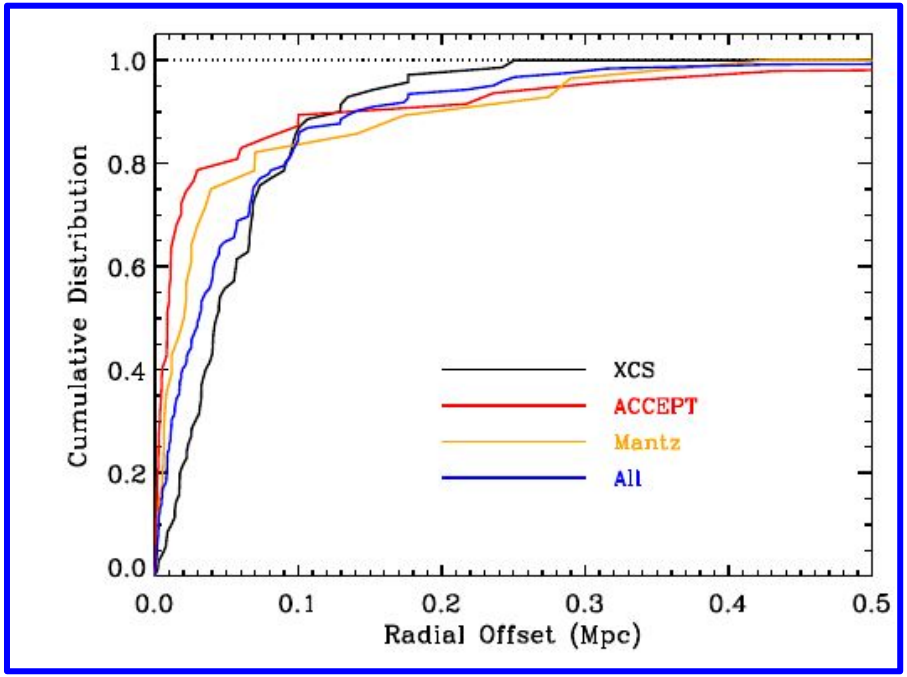


Rozo & Rykoff+14

REDMAPPER (red-sequence matched-filter Probabalistic Percolation)



Comparison wrt XCS, ACCEPT, and MCXC cluster samples



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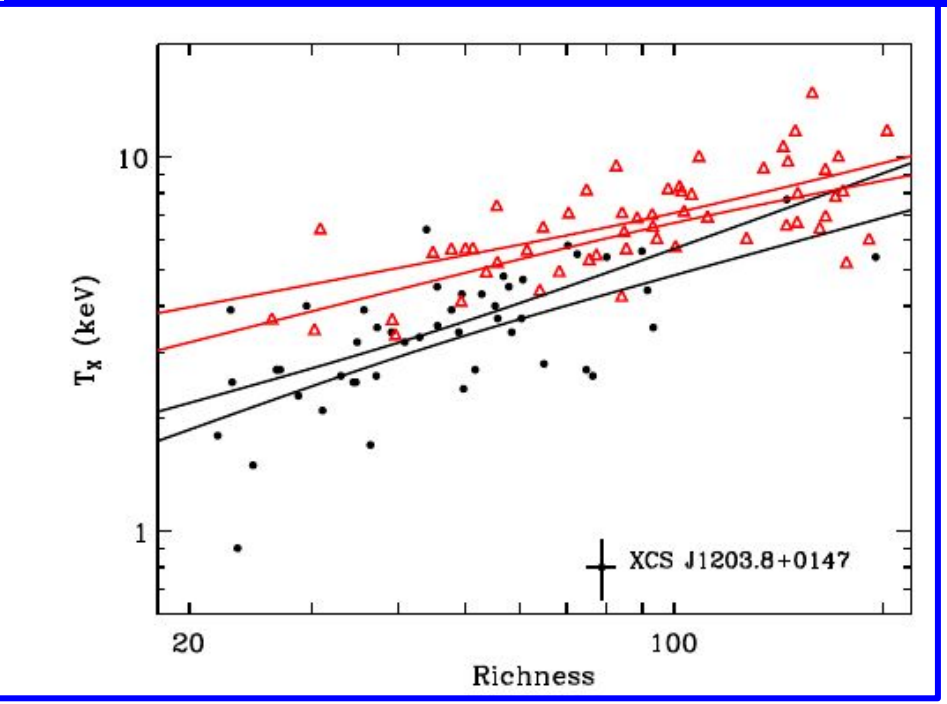
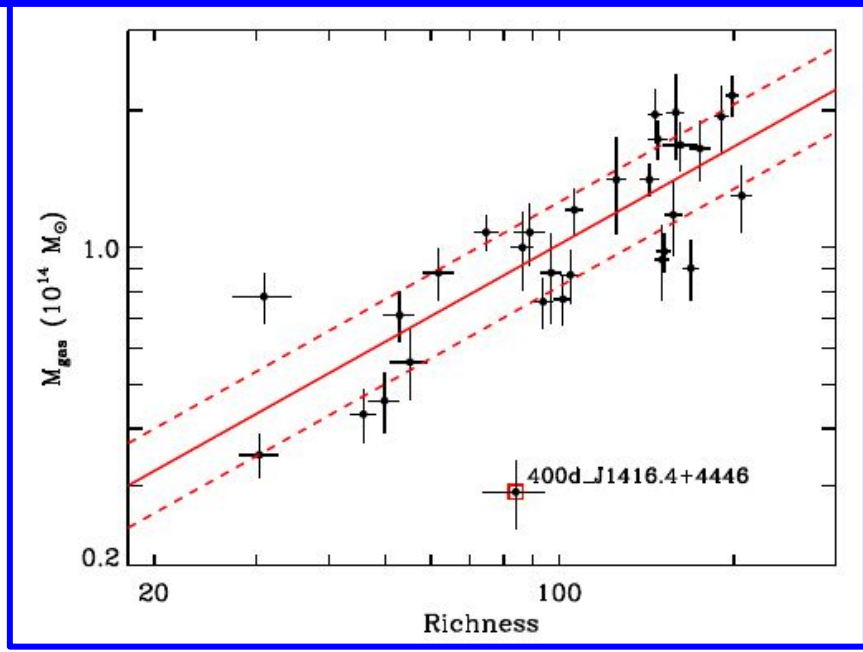




Comparison wrt XCS, ACCEPT, and MCXC cluster samples

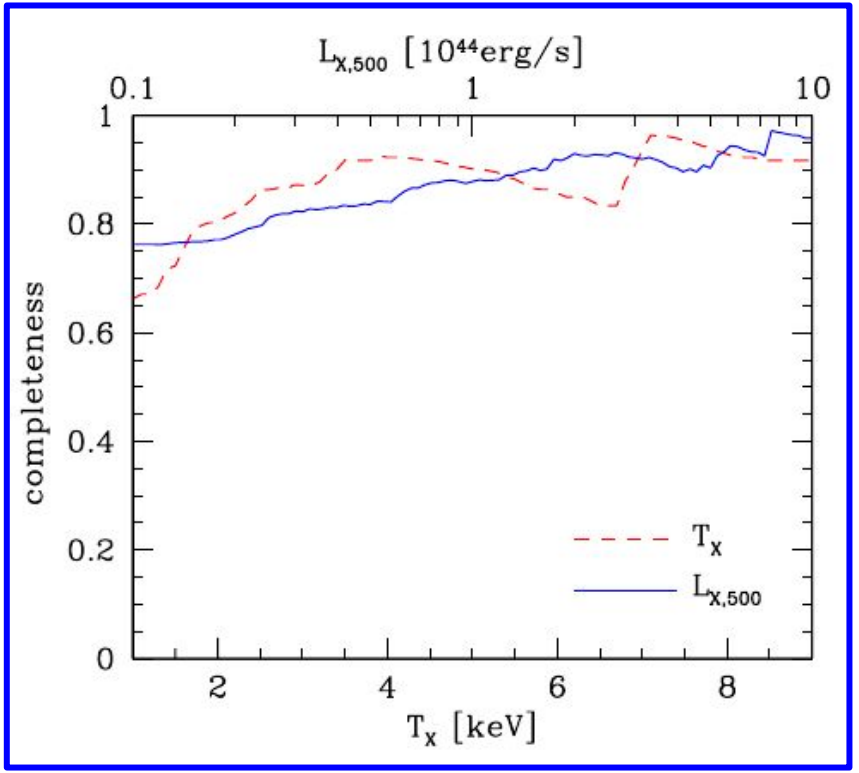
Rozo & Rykoff+14

CAMIRA (Cluster finding Algorithm based on Multi-band Identification of Red-sequence gAlaxies)

CAMIRA fits all photometric galaxies with a SPS model of Bruzual & Charlot (2003) to compute likelihoods of being red-sequence galaxies as a function of redshift. The model is calibrated using spectroscopic galaxies, which are used to derive residual colors of SPS model fitting as a function of wavelength and redshift.

Richness: number of red member galaxies with stellar masses M* > 10^10.2 Msun within R < 1 Mpc/h
Center is the BCG

Completeness wrt XCS, ACCEPT, and MCXC cluster samples



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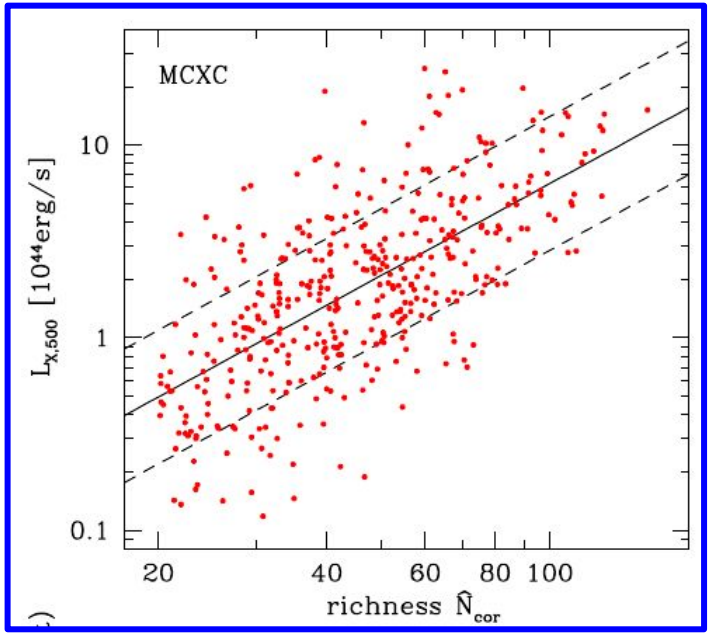

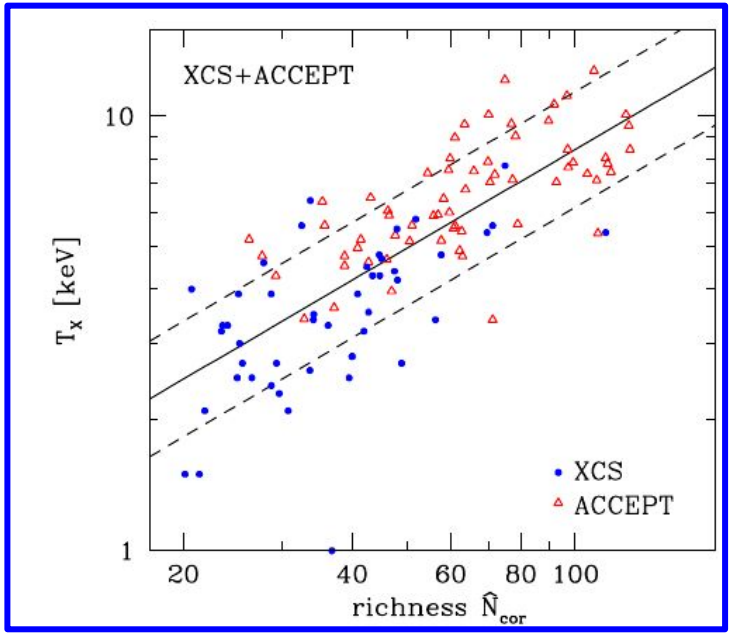

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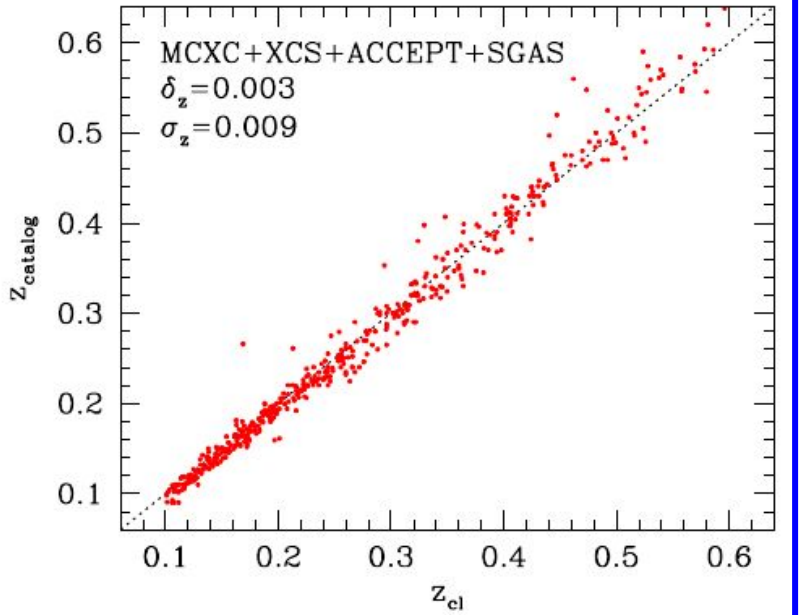

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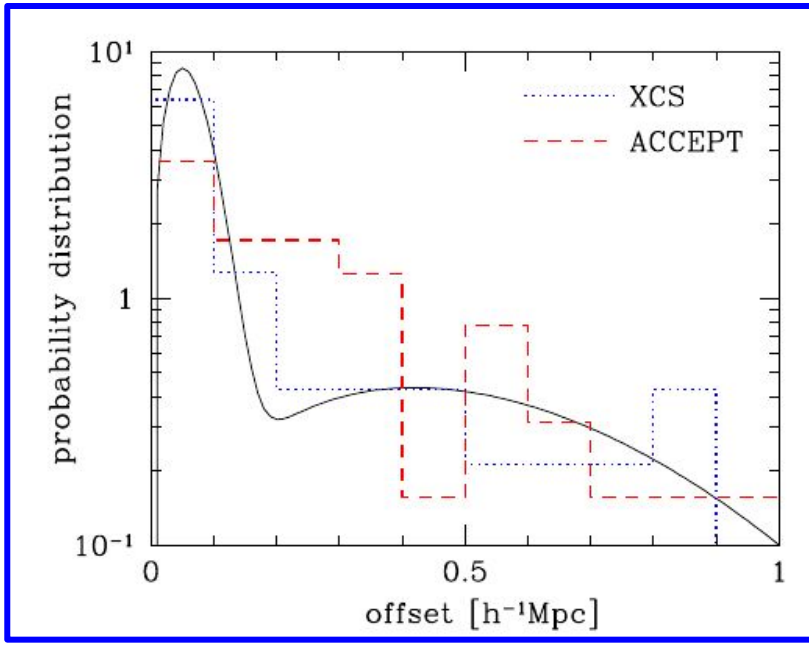


YOLO-CL (You only look once)

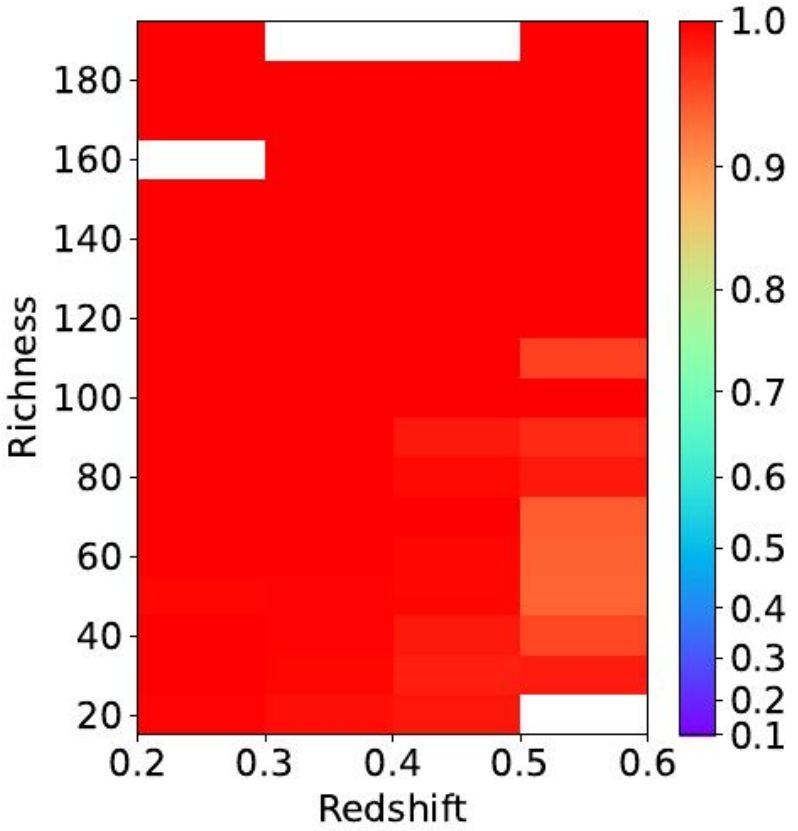
New Machine Learning based algorithm:
previous MLs apply “localizer” network on a given image, at multiple locations and at multiple scales, and assign a detection probability.

YOLO applies a single neural network to the full image, combining the detection and classification into a single process.

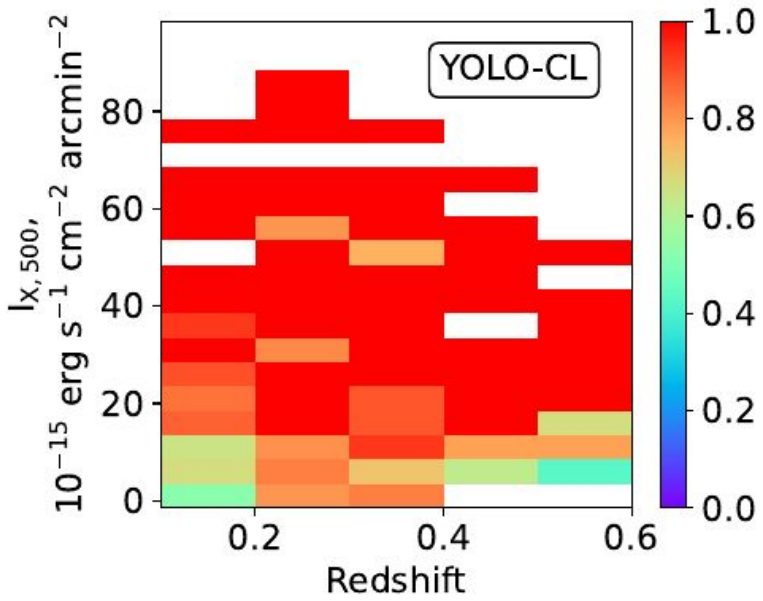
YOLO-CL trained using three color images (with g, r, i) of 12000 from redMaPPer cluster catalog and the SDSS blank field images.

Richness: number of cluster members above a given luminosity.

YOLO-CL vs redMaPPer (SDSS DR8)



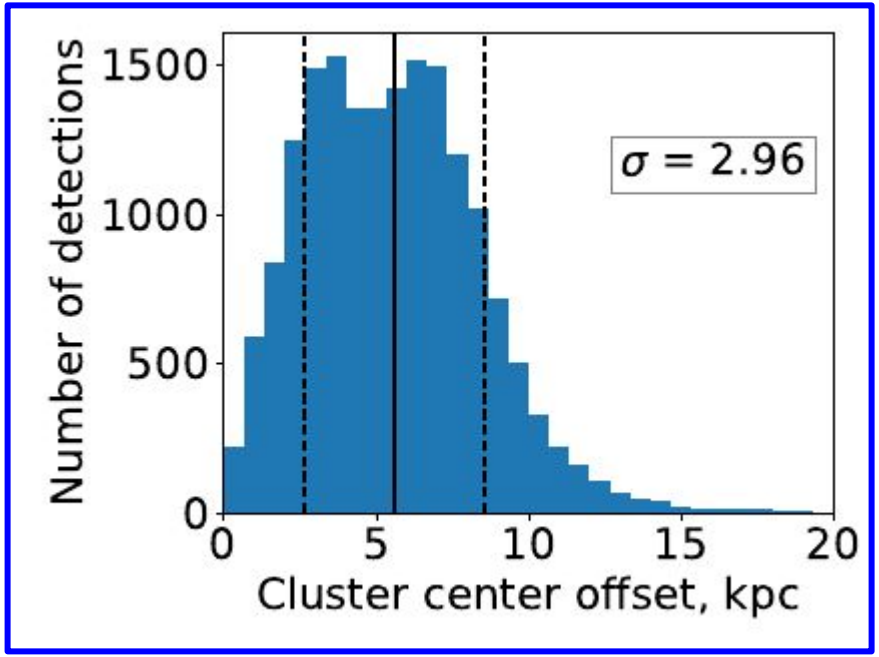
YOLO-CL



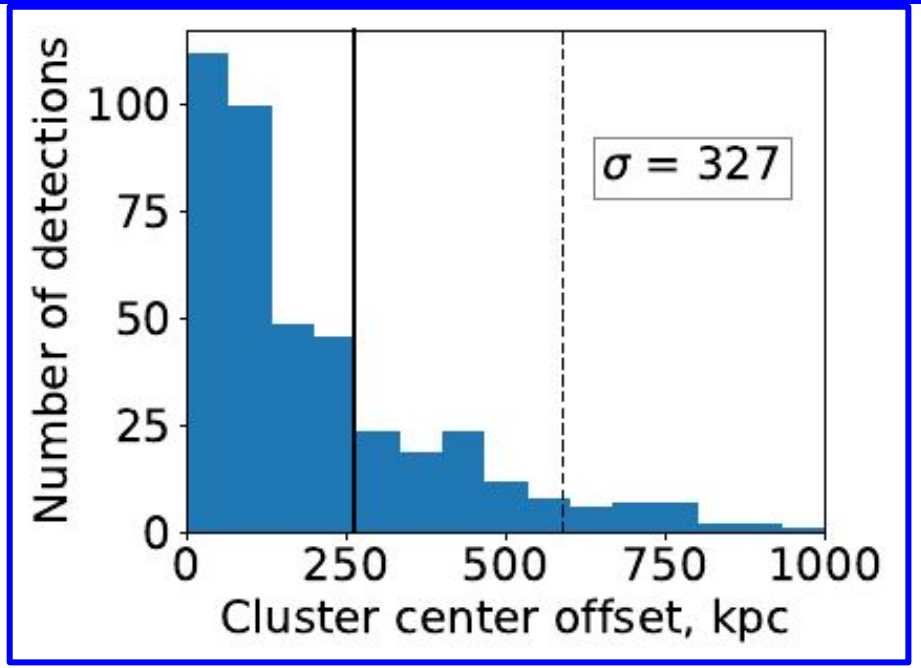
The YOLO-CL cluster detection completeness with respect to MCXC2021 as a function of redshift and mean X-ray surface brightness.

see also Krippendorf+23 on eFEDS

YOLO-CL



The distribution of the angular distance between cluster centers
detected by YOLO-CL and redMaPPer



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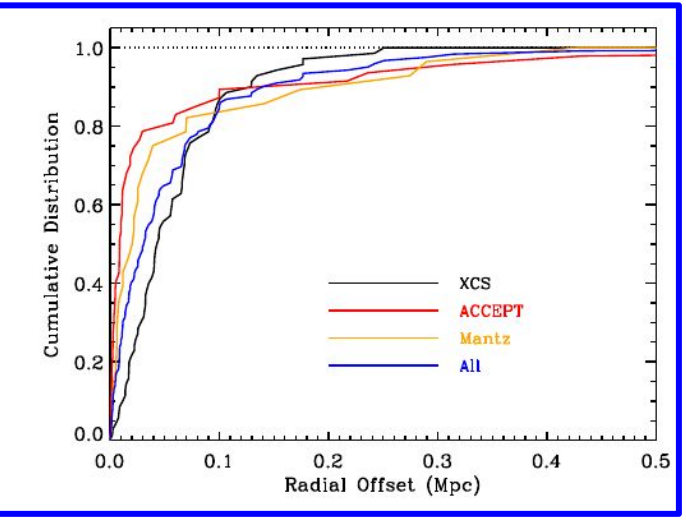
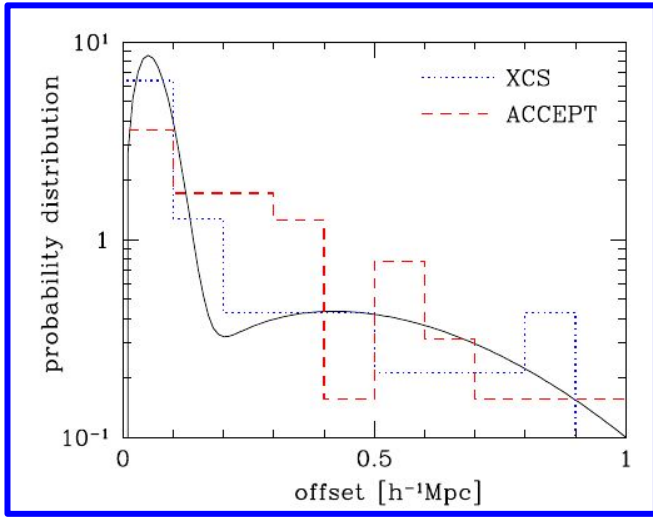
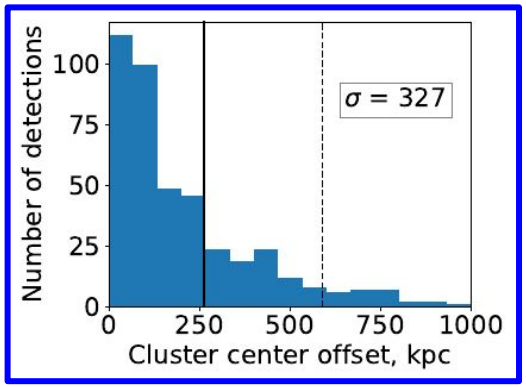
Algorithm comparison



REDMAPPER



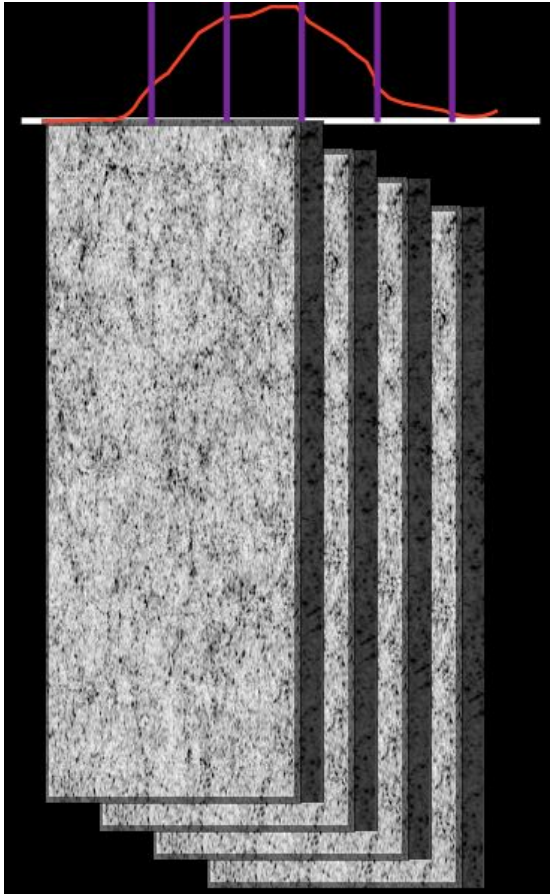


YOLO-CL

CAMIRA

PzWav detection algorithm

- Use of full P(z) for every galaxy
- Search performed in overlapping redshift slices
- Smoothing using a difference of Gaussians kernel within each slice to detect clusters
- Merges detection lists from redshift slices



Gonzalez+14, Adam+19

PzWav detection algorithm

For each given redshift slice, insert every galaxy weighted by P(z) - > Density map

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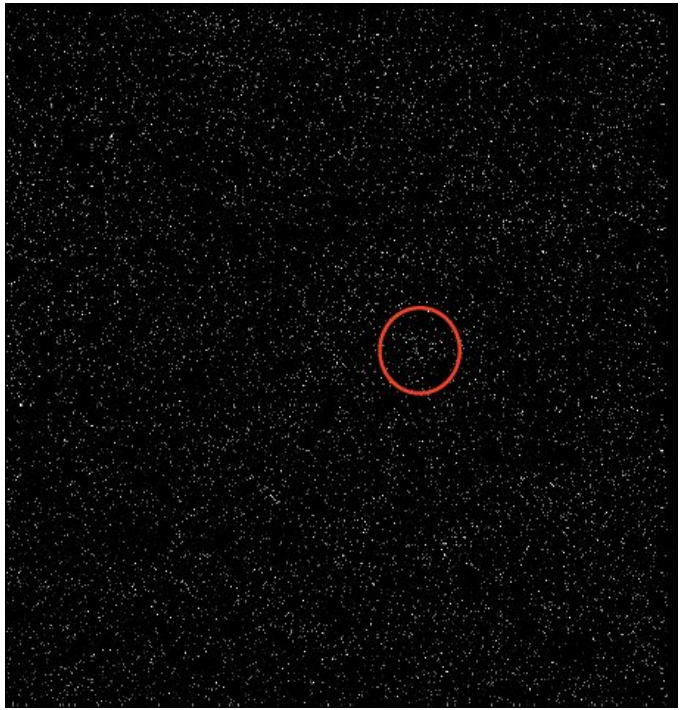

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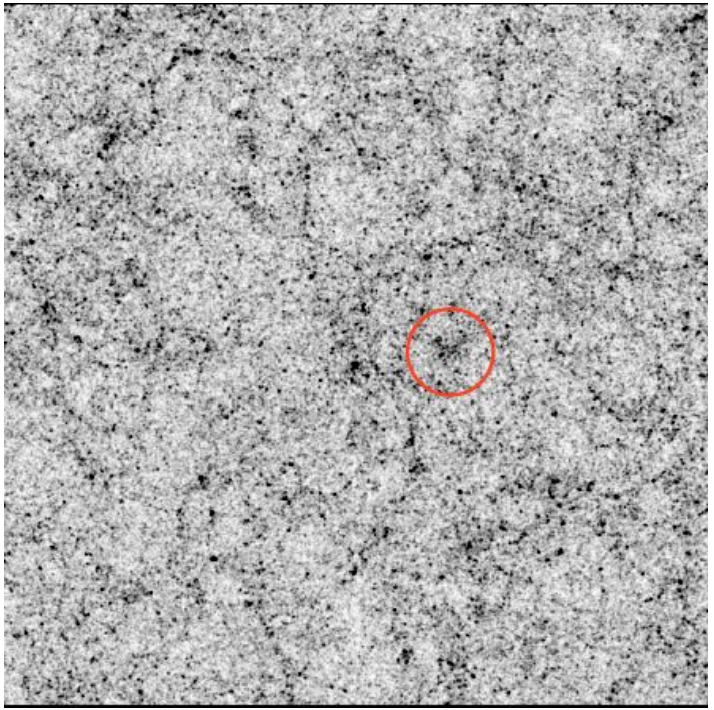
Smooth with Gaussian difference kernel -> Smoothed map



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PzWav detection algorithm

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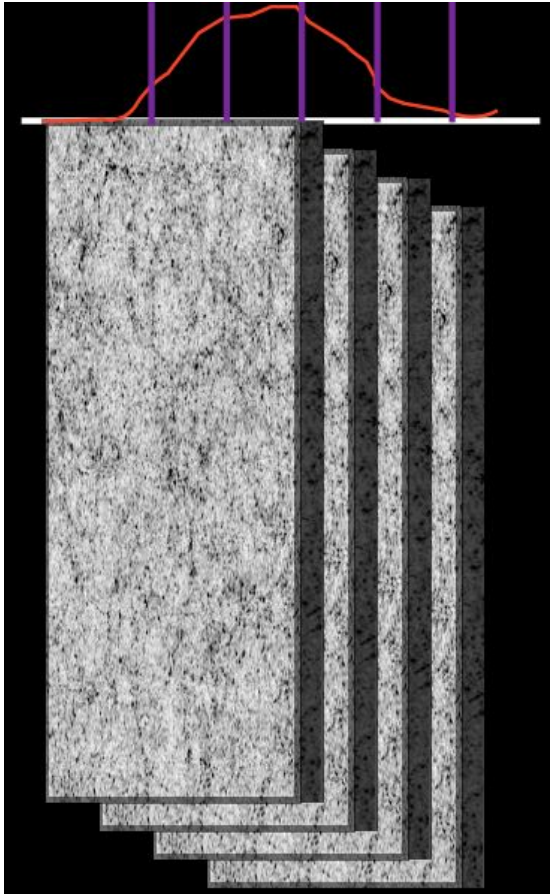
- cluster centroids corresponds to the peak location of each detected overdensity from the smoothed density maps
- the observable is the peak amplitude of each detected overdensity

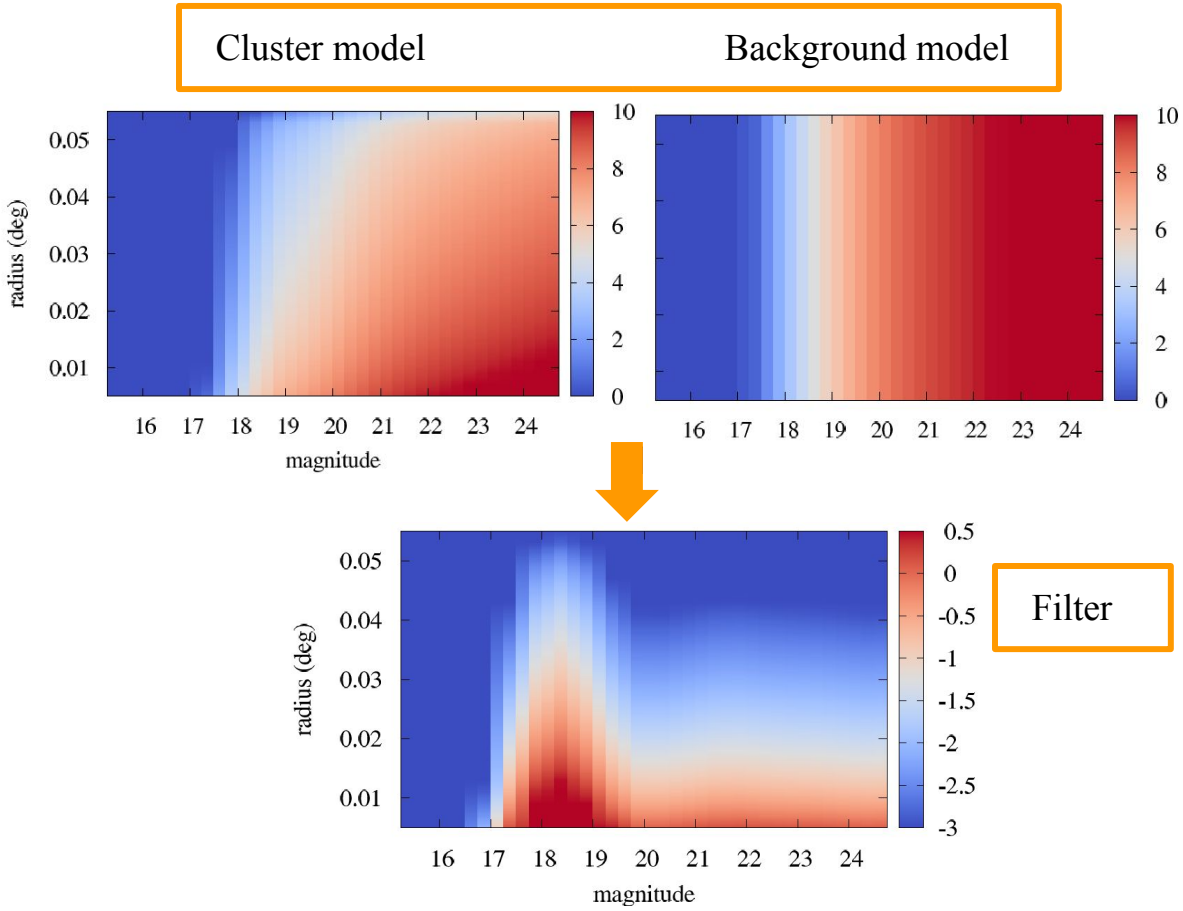


Gonzalez+14, Adam+19

AMICO detection algorithm

AMICO = Adaptive Matched Identier of Clustered Objects based on Optimal Filtering

- Definition of the filter given a cluster and background model in each z slice
- Built the amplitude 3D map
- Select candidates
- Galaxy membership probability
- Cleaning map from detection
- Repeat down to the S/N limit



Bellagamba+18, Maturi+19

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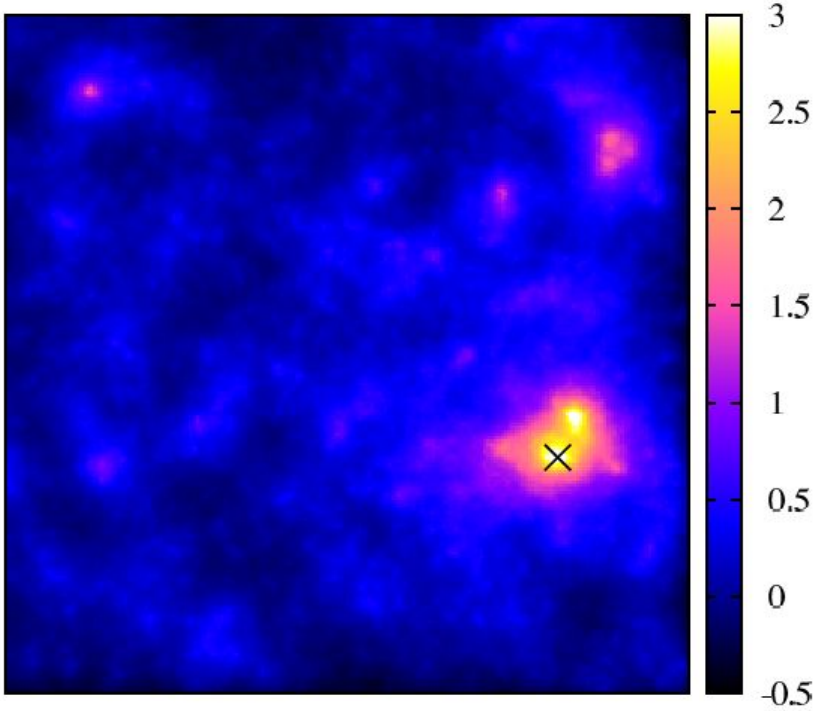

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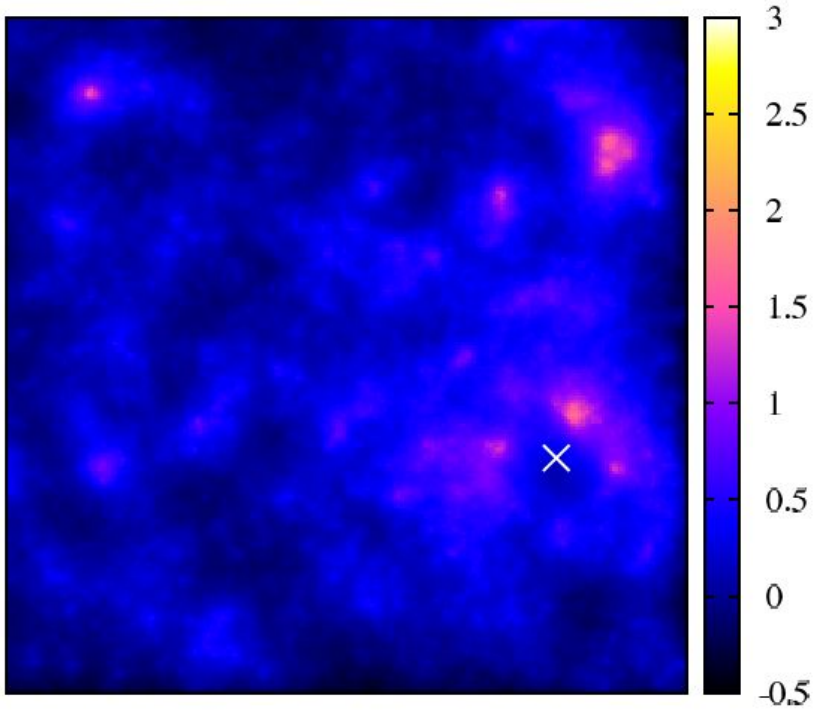
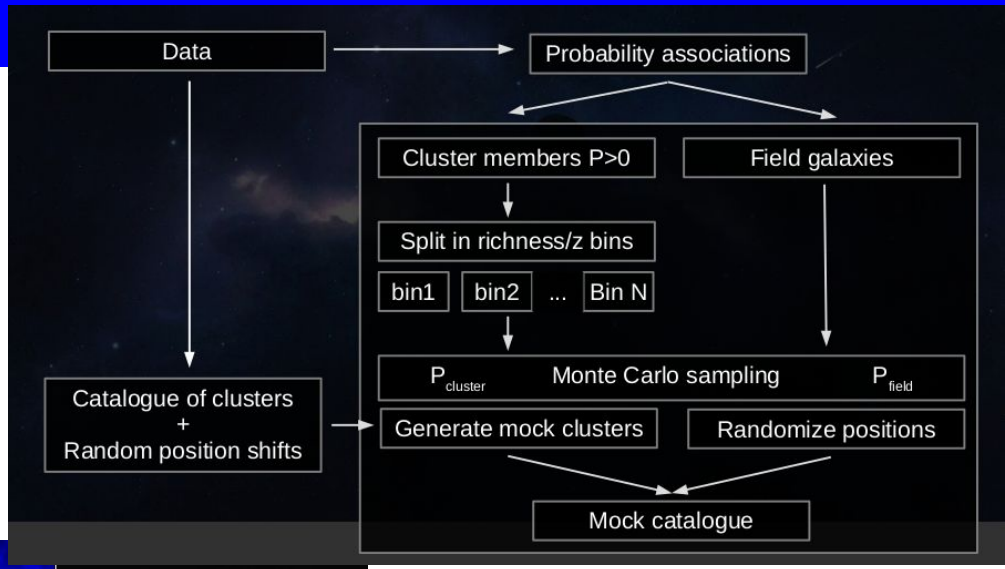
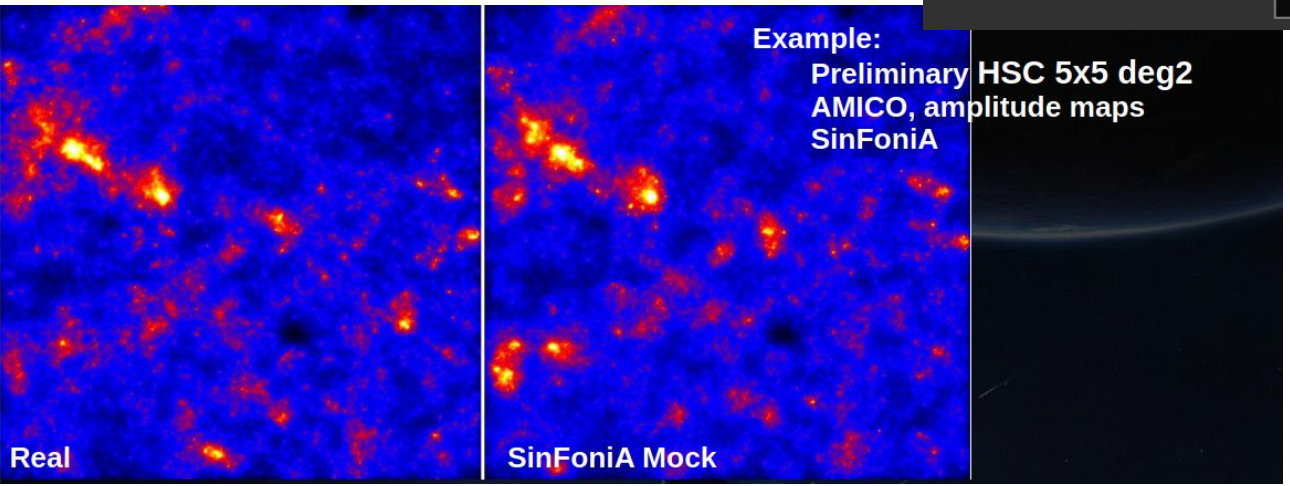


Bellagamba+18, Maturi+19

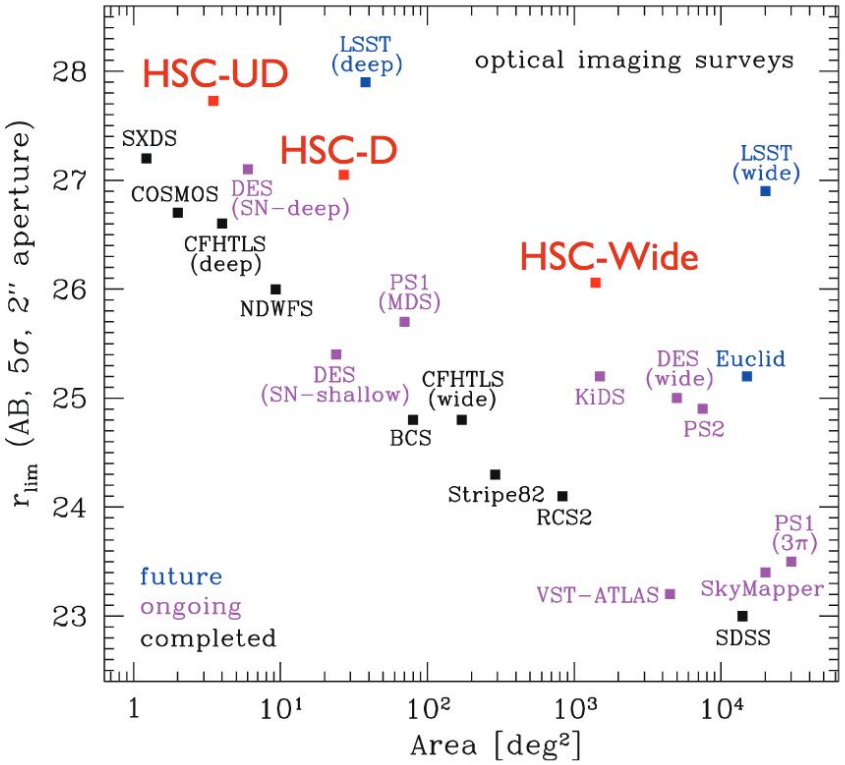
2)SELECTION FUNCTION: Sinfonia



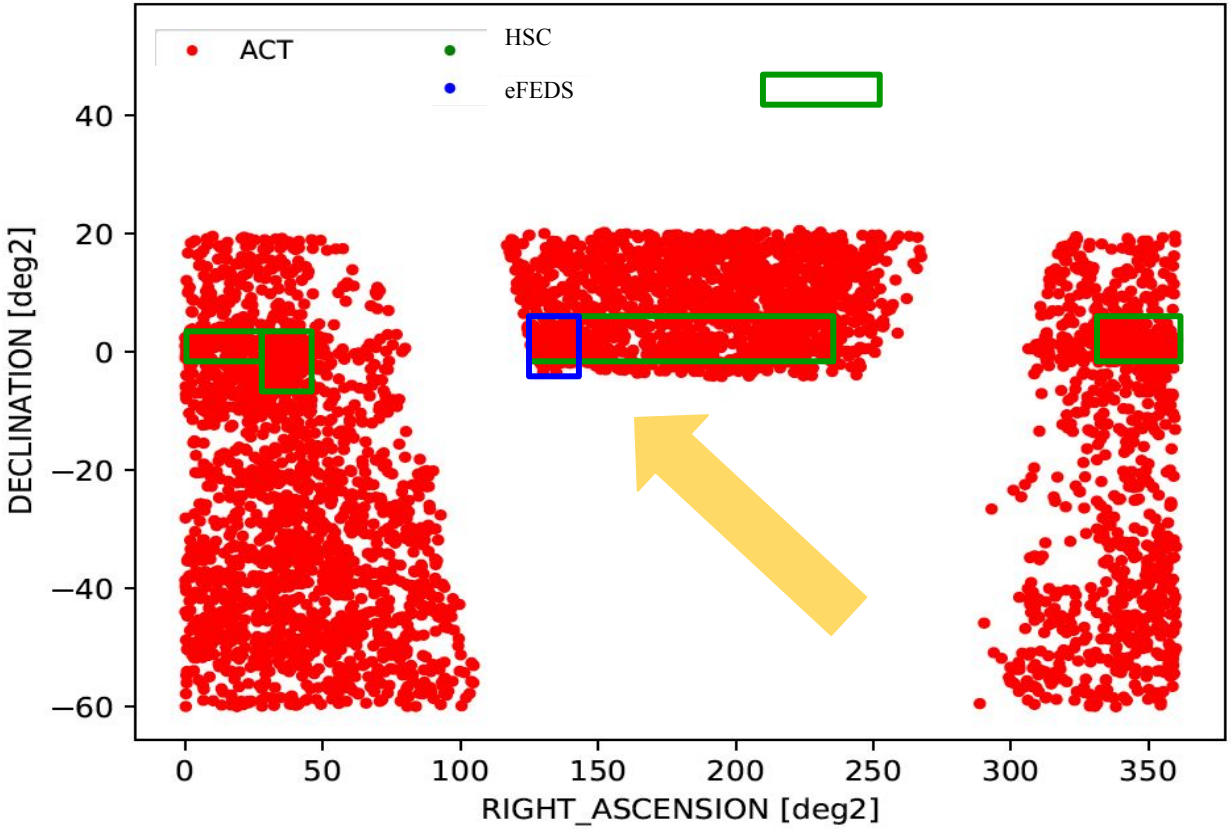


Road to Euclid: test on current data sets

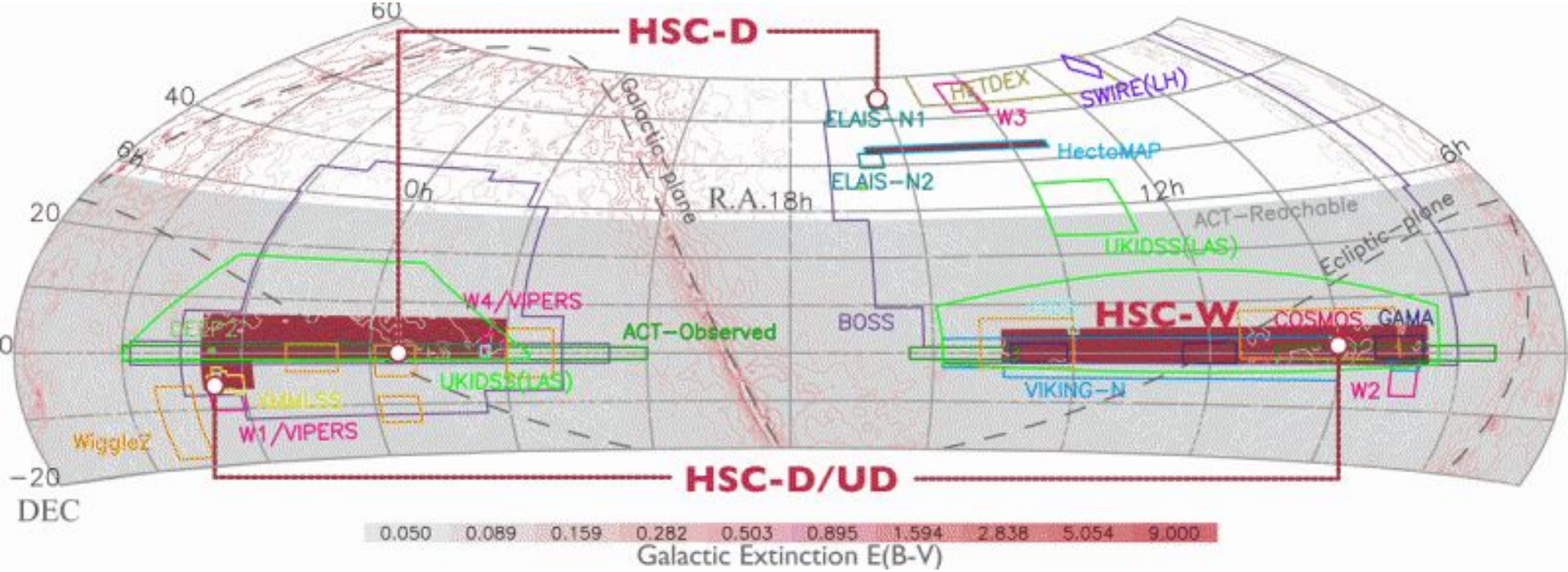
HSC = Hyper Suprime Camera (on Subaru telescope)



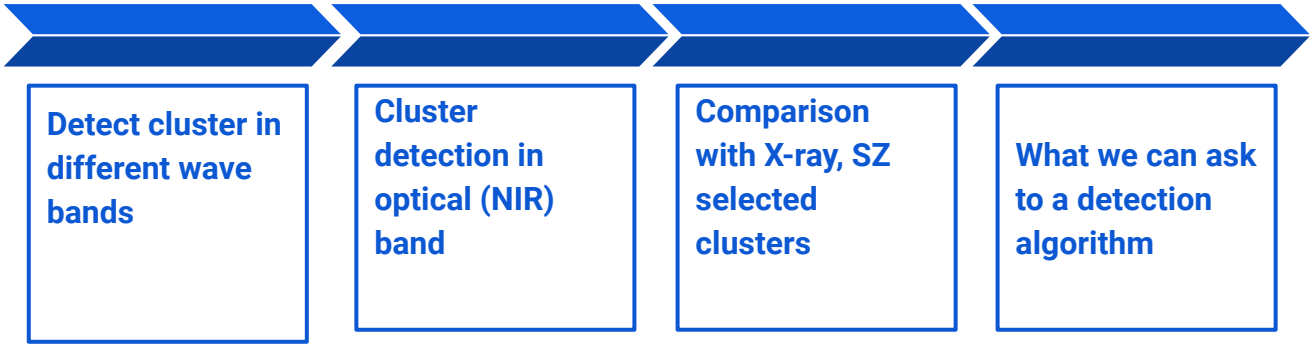
Testing survey area



HSC SURVEY


HSC-D
HSC-W
HSC-D/UD
ELAIS-N1
ELAIS-N2
W3
HETDEX
SWIRE(LH)
HectoMAP
ACT-Reachable
UKIDSS(LAS)
Ecliptic plane
Galactic plane
R.A.18h
0h
6h
12h
60
40
20
0
−20
DEC
W4/VIPERS
DEEP2
ACT-Observed
BOSS
COSMOS
GAMA
W2
VIKING-N
UKIDSS(LAS)
XMMLSS
W1/VIPERS
Wiggle Z
0.050
0.089
0.159
0.282
0.503
0.895
1.594
2.838
5.054
9.000
Galactic Extinction E(B-V)

Conclusions



- Model/Training sample: pros&cons of each algorithm
- Properly deal with complicated masks
- Detect clusters on a wide redshift range
- Center definition: relation with cosmological observables
- Cluster observable: well calibrated and characterized observable mass relation
- Computational efficiency
- Unbiased, complete, pure sample at low richness (selection cut)