Performance of AMICO on cosmoDC2 simulation

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DC2 DESC projects : AMICO validation project & galaxy cluster algorithm comparison project
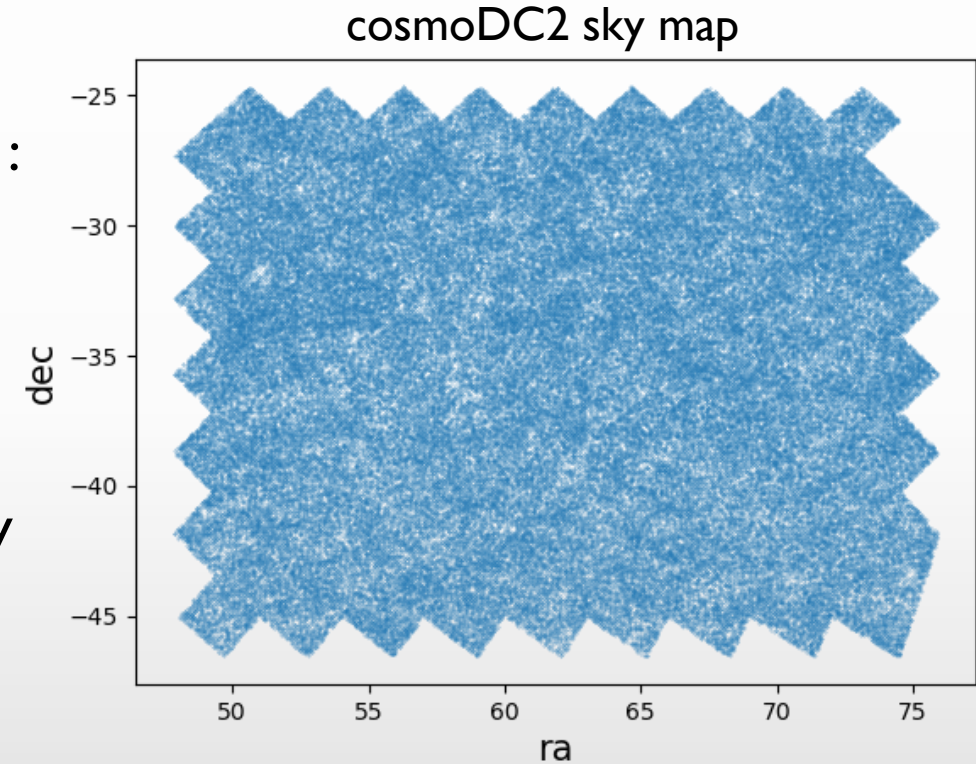
LSST France meeting

Grenoble

June 8, 2023

DESC science requirements

- First ingredients required for cluster abundance Cosmology :

  - ➤ Cluster catalogs
  - ➤ Selection function

- DESC science plan → Several galaxy cluster algorithms ready for Y1 Rubin data

cosmoDC2 sky map

AMICO algorithm

- AMICO = Adaptative Matched Identifier of Clustered Objects

- New algorithm being added to DESC galaxy cluster algorithms

- Optimal Filtering → Non biased signal amplitude estimator with minimal error

- Amplitude + uncertainty + likelihood on 3D maps → cluster detection

- Iterative procedure after first cluster detection

- Galaxy member association to clusters
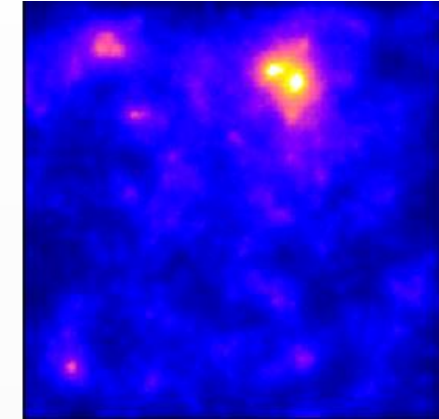
1x1 deg² Amplitude map
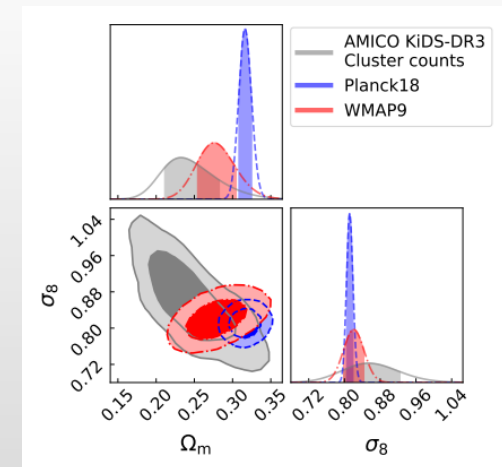
KiDS constraints with AMICO

arXiv:1705.03029v2

AMICO on cosmoDC2 catalogs

- This work : AMICO run on i-band with mag_i < 25.3

- AMICO gives two tables :

  ➢ Cluster table → redshift, position, richness, …

  ➢ Galaxy member table → associated cluster id + membership probability, magnitudes, field probability

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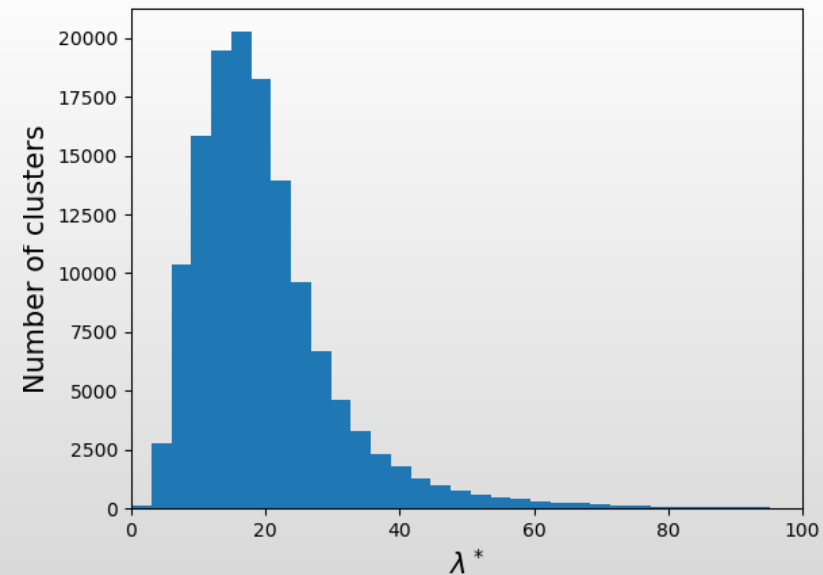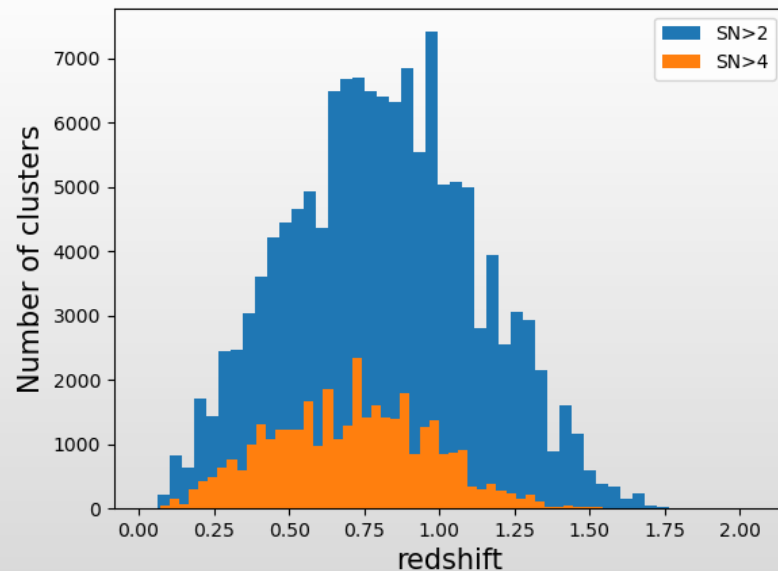
Matching procedure

- Cross-matching = bijective association

- This study :

  ➢ Clevar proximity matching
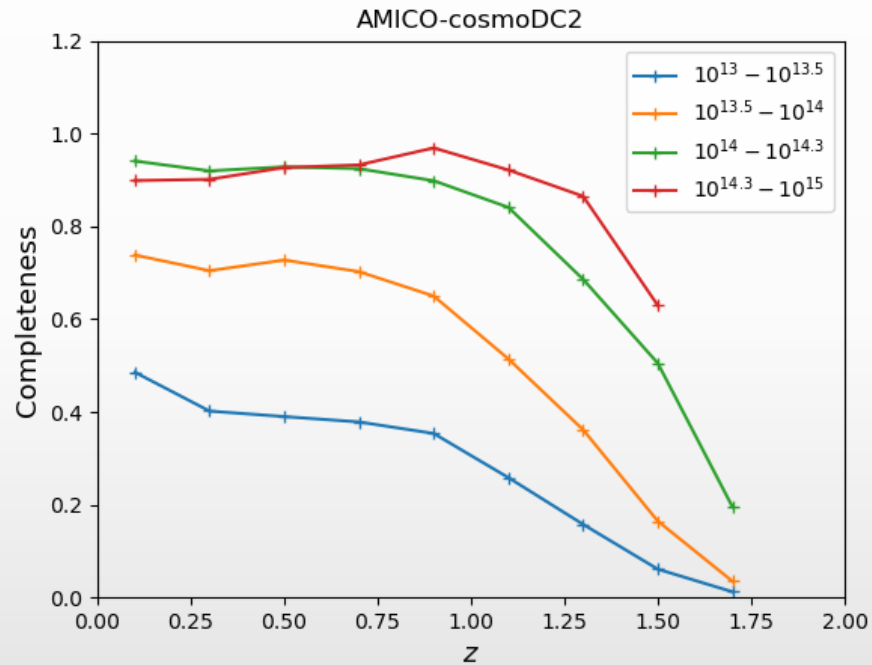 ➢ Matching halos with $M_{halo} > 10^{13} M_{\odot}$

	N_{all}	N_{cross}	N_{excl}
AMICO	135 916	110 954 (82%)	24 962 (18%)

AMICO mass richness relation
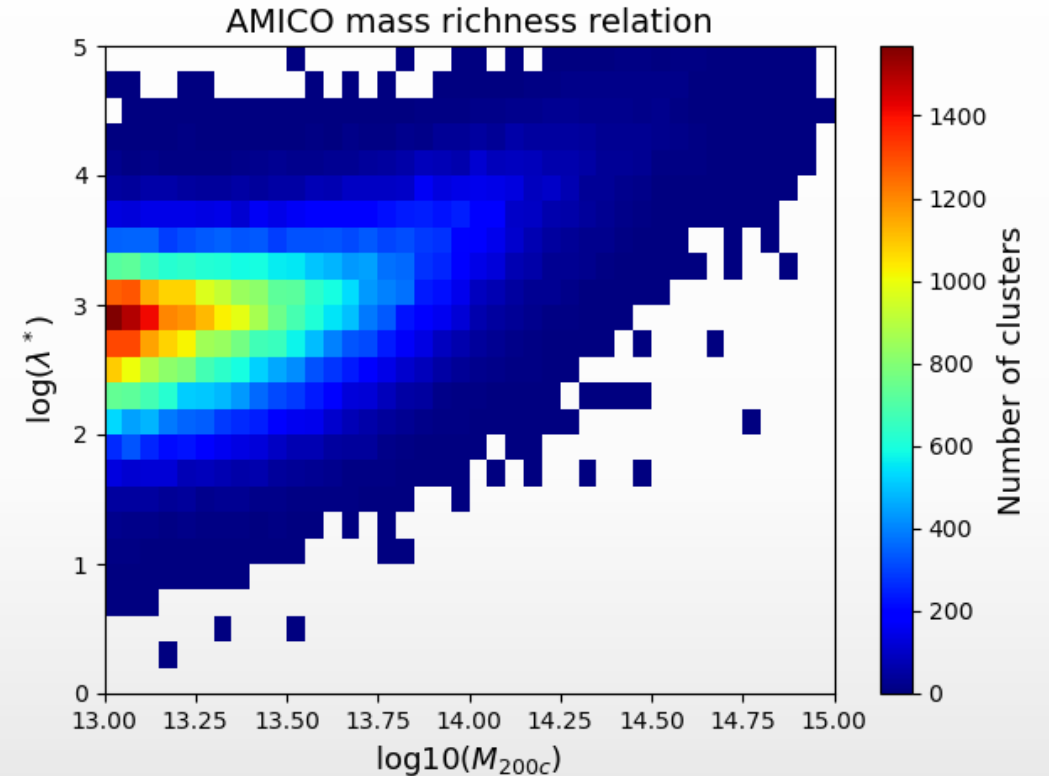
$M_{200c} \simeq 10^{14} \rightarrow \lambda^* \simeq 35$

Completeness and purity

$$\text{Completeness(m,z)} = N_{\text{cross matched clusters}}/N_{\text{halos}} \text{ (m,z)}$$

$$\text{Purity (m,z)} = N_{\text{cross matched halos}}/N_{\text{clusters}}\text{(m,z)}$$

- z < 1.0, m ≈ 10^{14} M$_\odot$ → Completeness > 90%
- z = 1.4, m ≈ 10^{14} M$_\odot$ → Completeness ≈ 60%
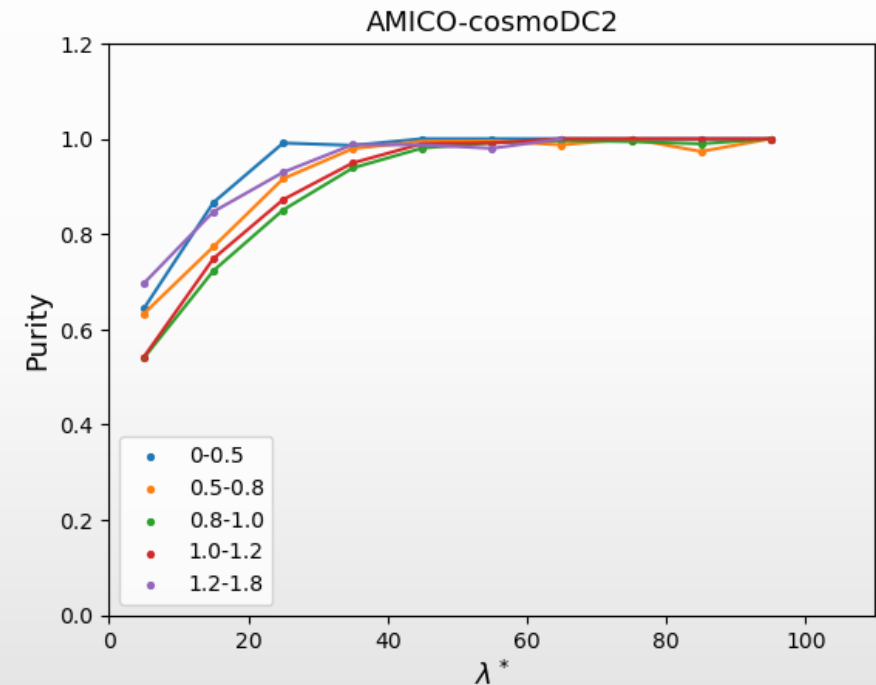
λ^* > 30 → Purity > 90%

Comparison to redMaPPer

Before cuts : $N\_clusters_{AMICO} \simeq 136000, \lambda_{AMICO} > 0$

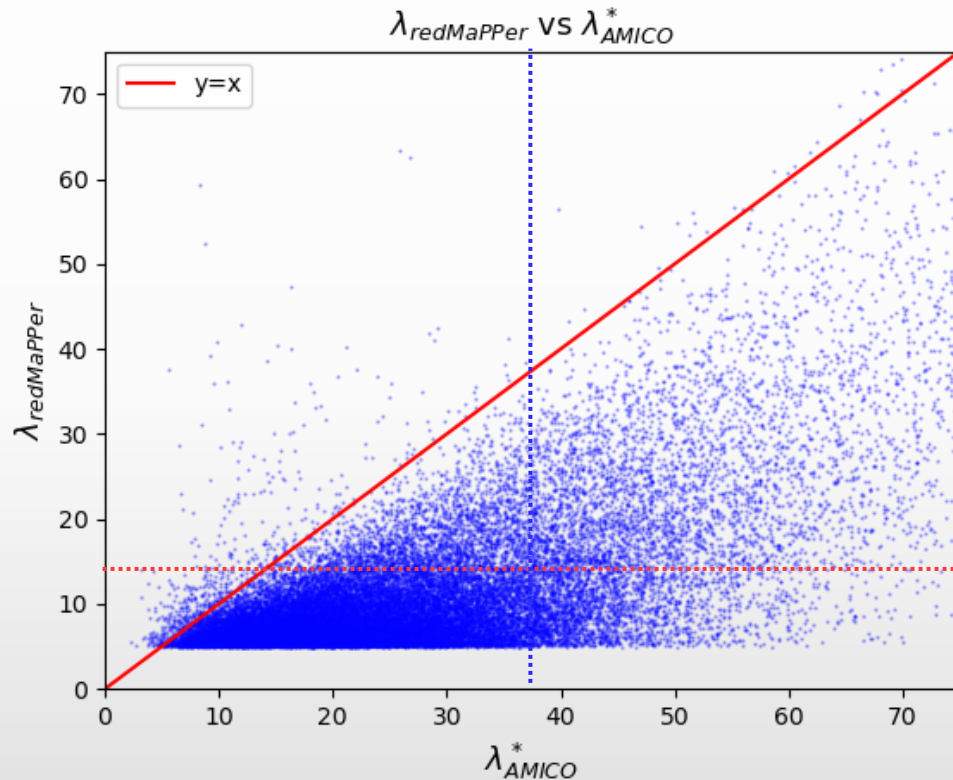$N\_clusters_{RedMapper} \simeq 46000, \lambda_{RedMapper} > 5$

- We want to define relevant cuts to get similar densities
- Richness definitions are not the same

After cuts matching results
$(z \in [0, 1.15], \lambda_{RM} \geq 14$ & $\lambda_{AMICO} \geq 38)$

	N_{all}	N_{cross}	N_{excl}
AMICO	8219	4749 (57%)	3470 (43%)
redMaPPer	7892	4749 (60%)	3143 (40%)

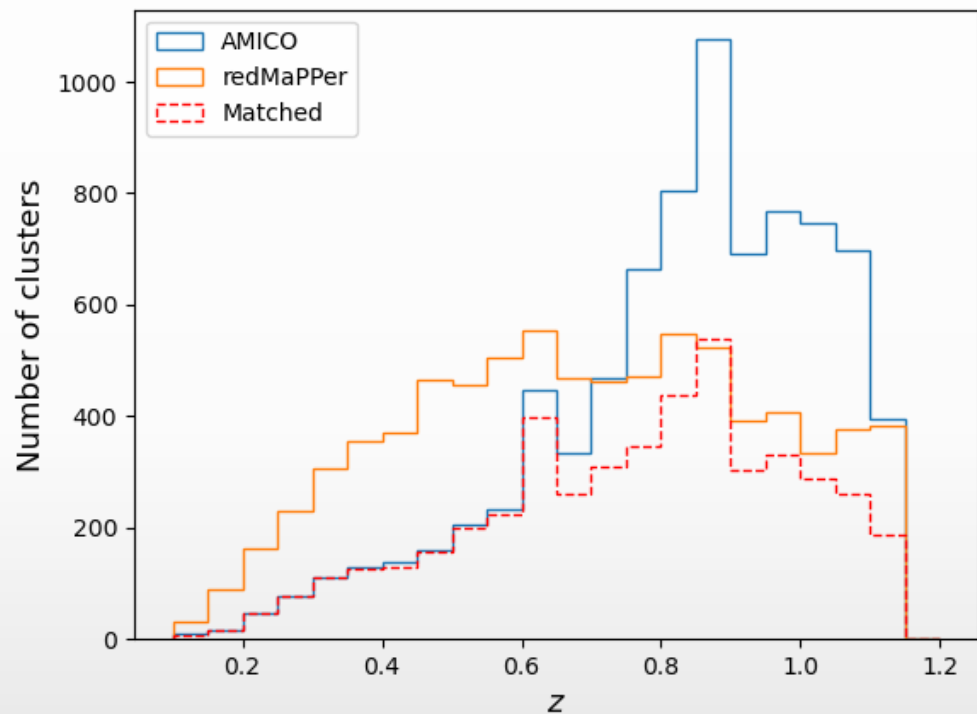Nathan Amouroux
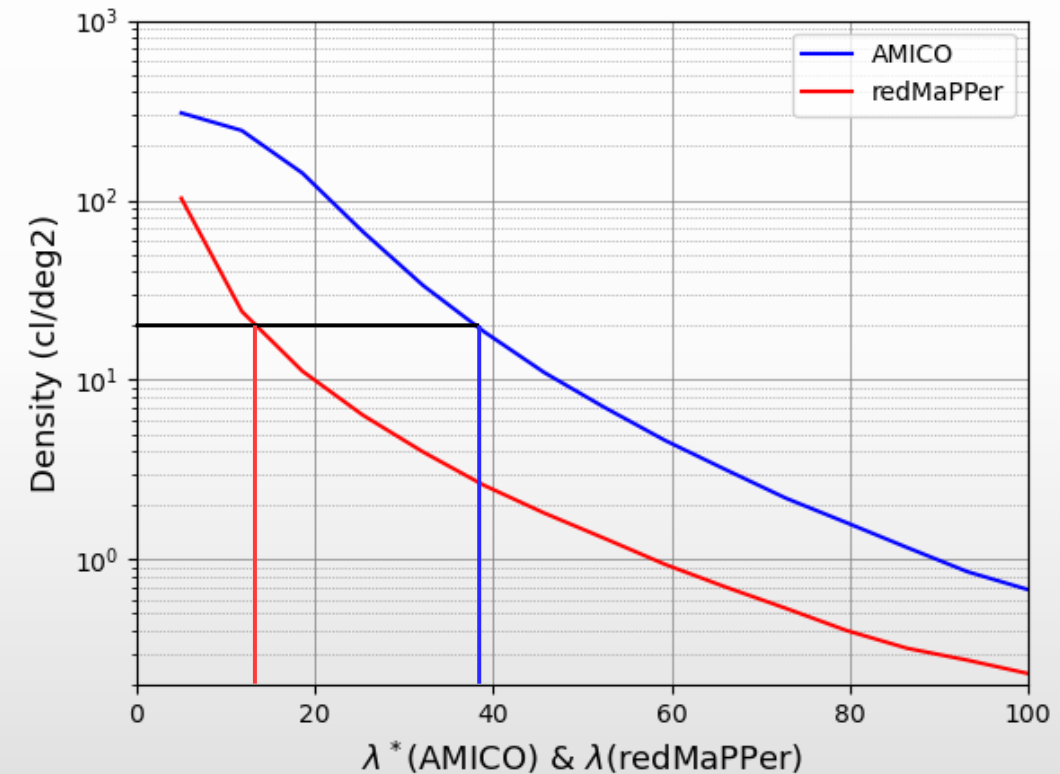
Richness correlation

$\lambda_{redMaPPer}$ vs λ^*_{AMICO}
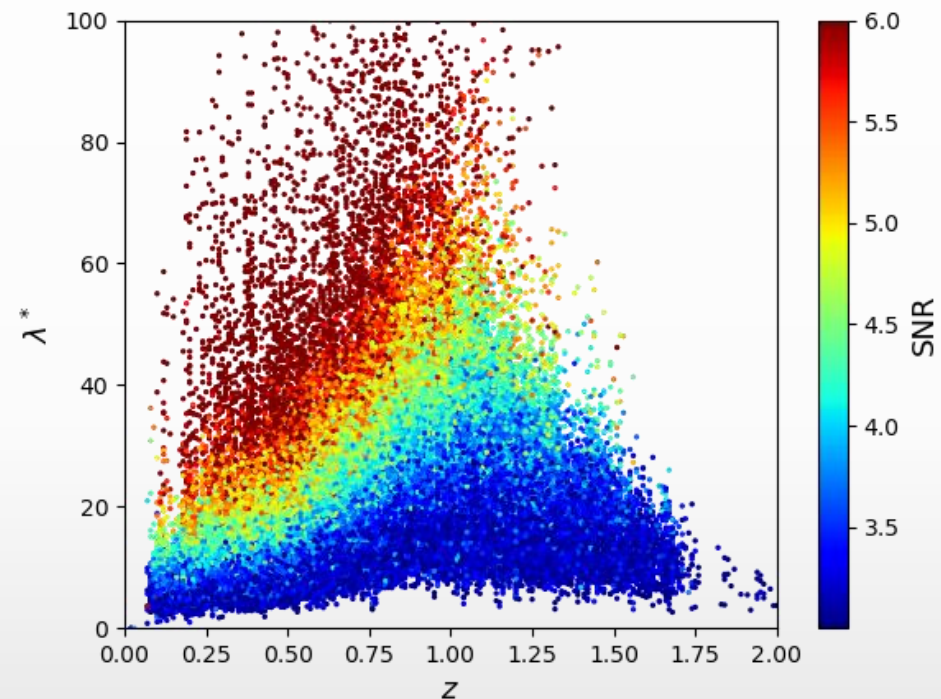
- Higher richness values for AMICO

- Large AMICO dispersion at given value

  ($\lambda_{RedMapper} = 20 \rightarrow \lambda^*_{AMICO} \sim [25, 50]$)

- Next slides clusters are from those cuts

Redshift distributions

- High richness samples have significantly different distributions

- Correlation z-λ^* → bias in AMICO sample selection in particular at low redshift

- SNR : alternative selection criteria under study has lower redshift dependency

Colors of member galaxies

- Using matched clusters members

- Expected red sequence population visible for redMaPPer

- Secondary population for AMICO at higher redshift for $\Delta\text{mag} \simeq 0.3$

- Investigating galaxies found by AMICO but not by redMaPPer

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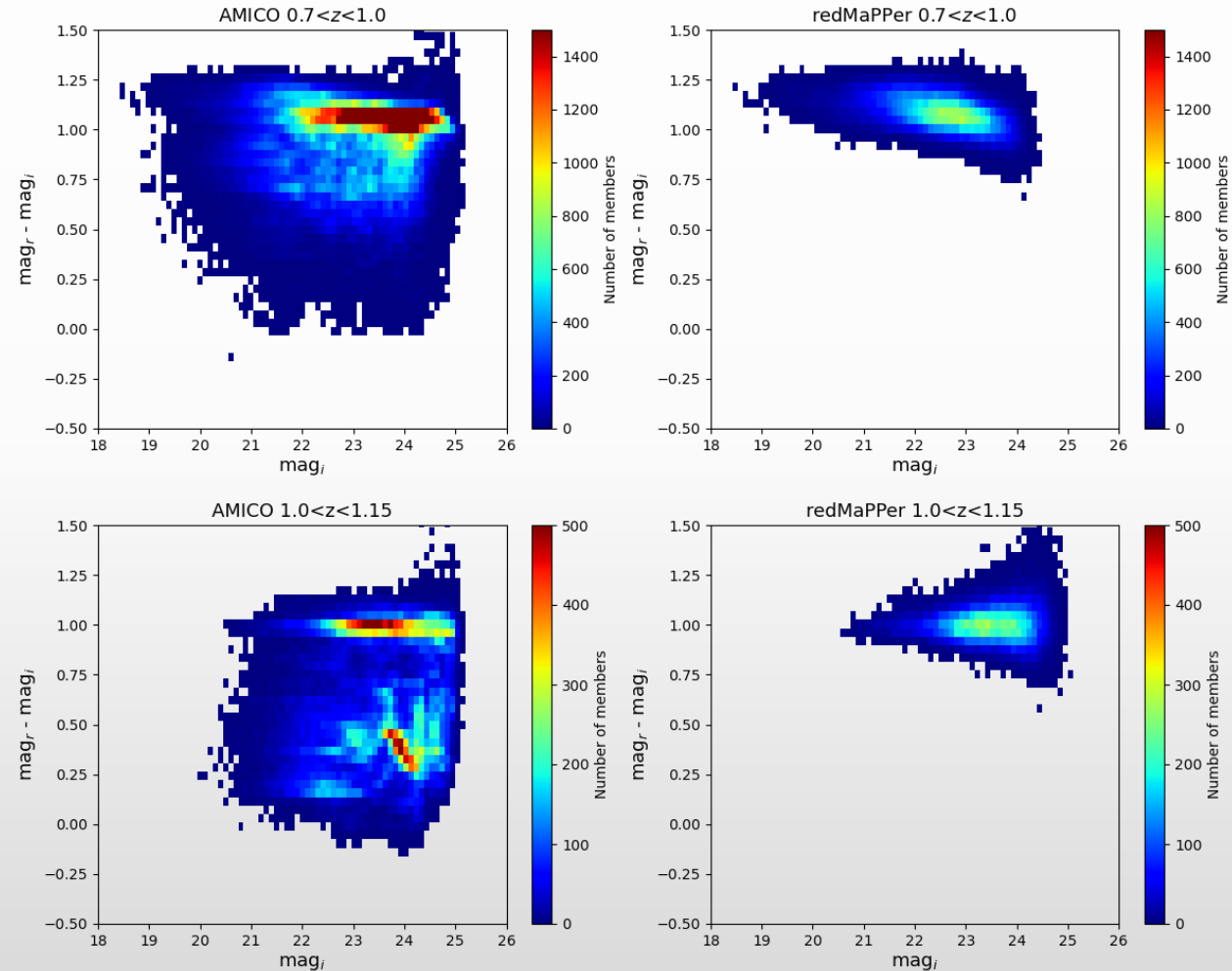
Conclusion

➢ AMICO run on cosmoDC2 catalog soon avaible in DESC

➢ First algorithm performances estimated

➢ First AMICO-redMaPPer comparison, focused on high richness clusters

❖ <u>NEW</u> : AMICO just run on DC2 data