DESC-CL activities

D. Boutigny, N. Chotard, C. Combet, M. Penna-Lima

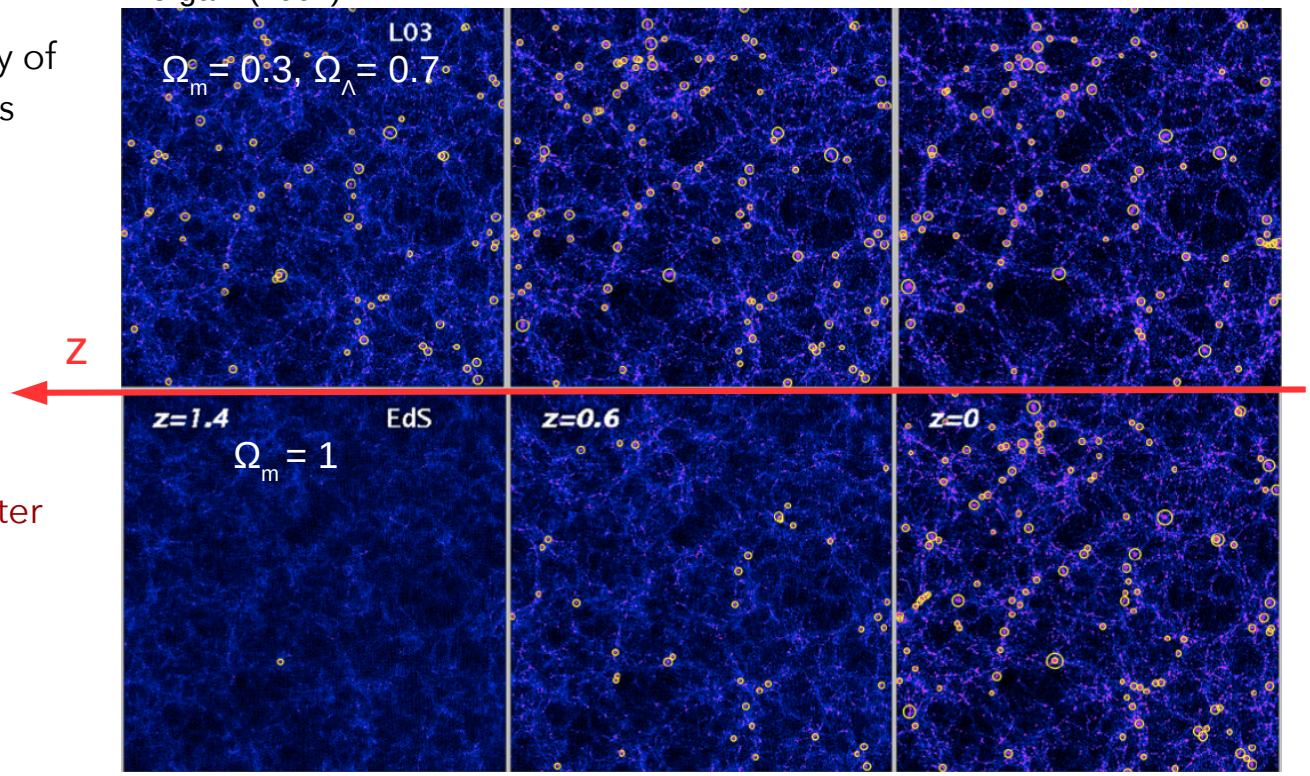
Cluster cosmology with cluster counts

- Halo mass function = number density of haloes (clusters) as a function of mass and redshift d*n(M,z)/dM*

- *dn(M,z)/dM* depends on cosmology
  - Expansion history
  - Growth of structures

➡ Cluster counts are at the core of cluster cosmology

Borgani (2001)



In mass bin *a* and redshift bin *i*

$$N(M_a, z_i) = \frac{\Delta\Omega}{4\pi} \int_{z_i}^{z_{i+1}} dz \frac{dV}{dz} \int_{M_a}^{M_{a+1}} dM\ n(M, z)$$

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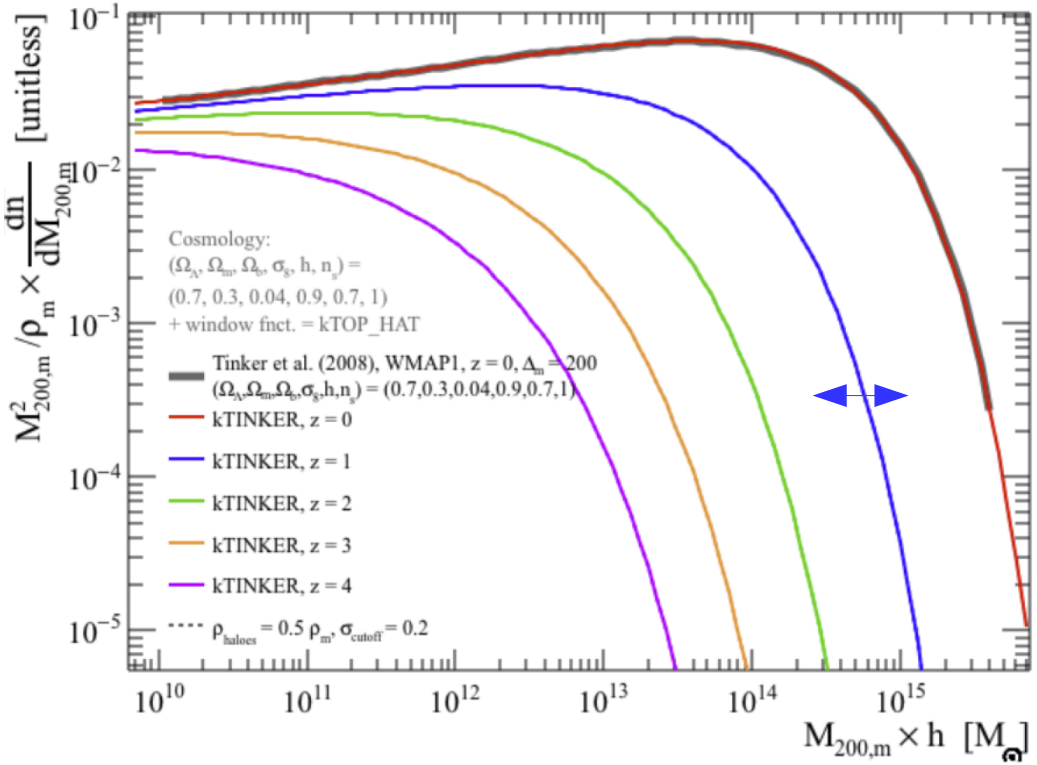

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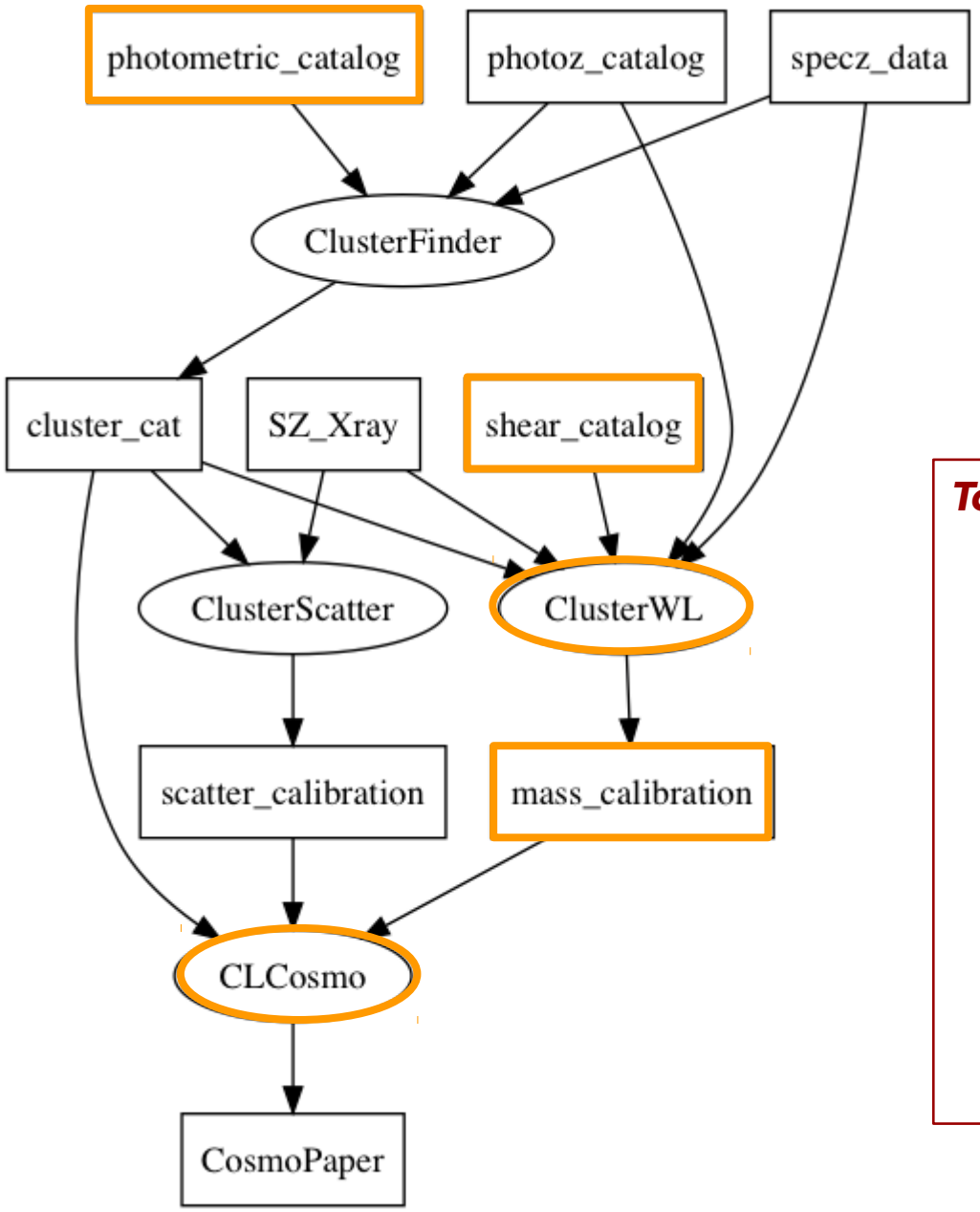
1. predict mass function *n(M,z)* = *f*(cosmology)
2. build cluster catalog ('cluster observable' + redshift)
3. determine cluster masses (mass – observable relationship)
4. cosmological parameters from likelihood analysis

Cluster cosmology is currently limited by mass estimation
→ Need to reach 1% mass calibration (WL masses)

DESC-CL WG (conveners: A. von der Linden, E. Rozo)



DESC-CL pipeline as proposed by S. Bocquet following über-pipeline discussions

Where we (DESC-CL@IN2P3) contribute / wish to contribute

Topics often discussed in the WG

- Cosmo pipeline/überpipeline
- Forecast paper / SRD – cluster cosmology including systematics
- DESCQA DC2 validation for cluster-related work.
- CLMassMod – key project from SRM. Cluster WL and mass modeling and verification code.
- CLAbsMass
- (De-)blending

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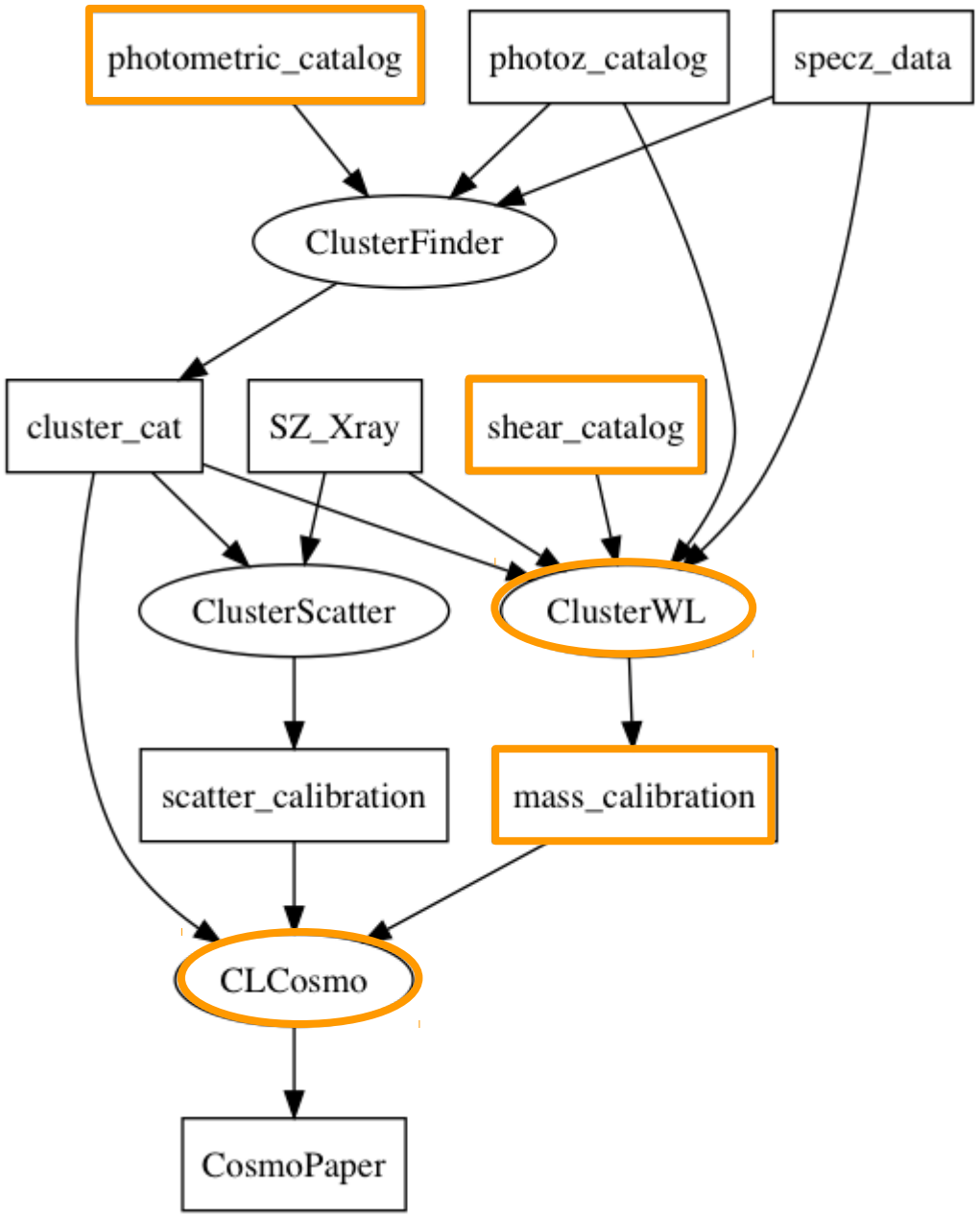

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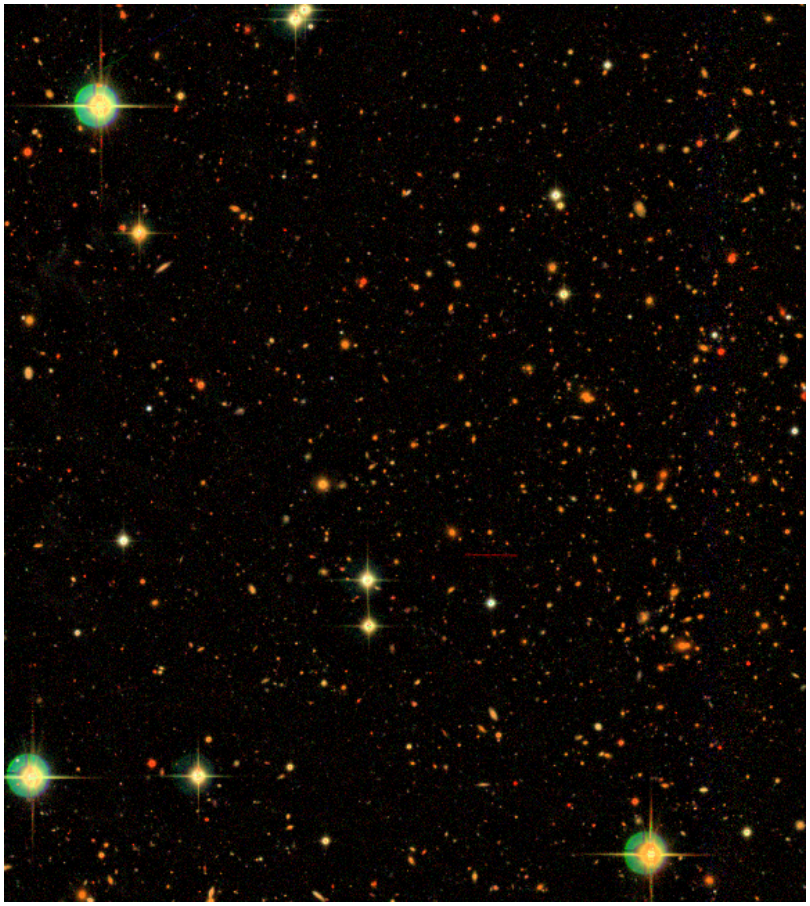
DESC-CL@IN2P3 - this talk

1. From images to catalogs with DM stack
2. Catalog checks / validation
3. From catalogs to WL mass
4. Towards cluster cosmology

Cluster reprocessing using DM-stack

- Up until recently – manual reprocessing: 3 CFHT clusters, SXDS field (6 clusters)
- Currently reprocessing ~800 CFHT visits for ~40 galaxy clusters
  - Consistent reprocessing for these visits
  - Should be able to compute the mass of some of these clusters
- Getting ready to process HSC data to get more clusters: start with CAMIRA x HST clusters?

MACSJ2243.3-0935 (z=0.447)

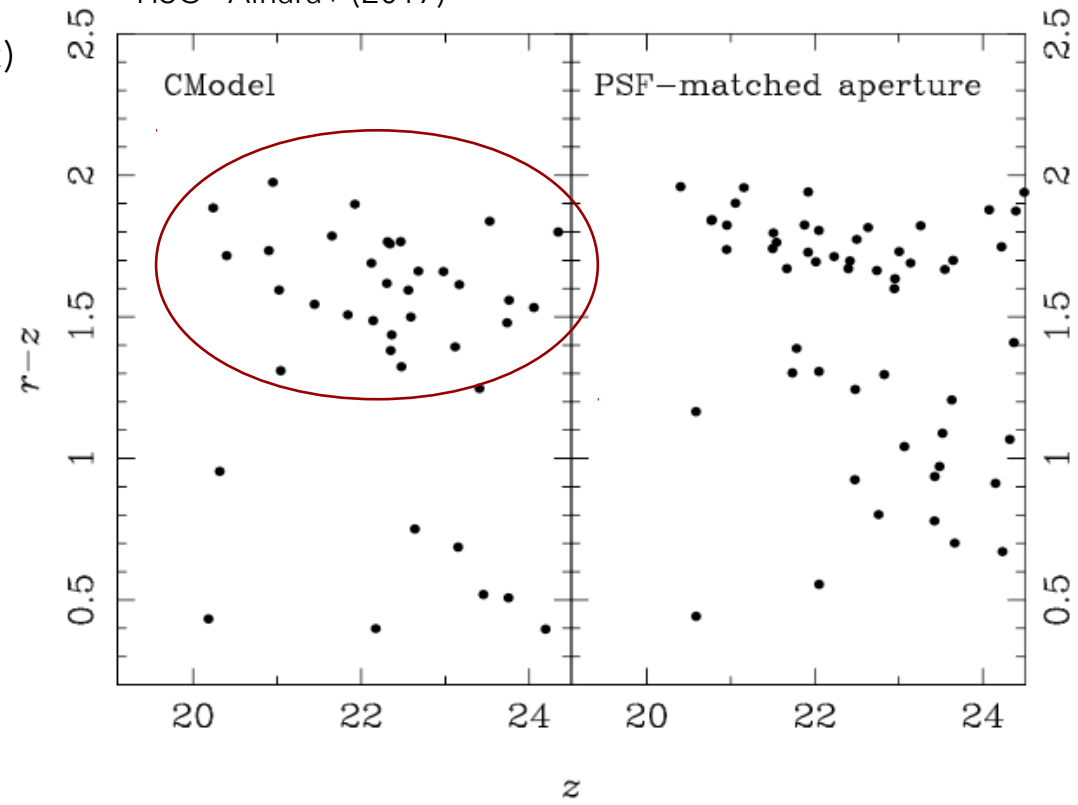


Deblending – an issue in cluster cores

- Cluster cores = crowded areas (especially at high-z)
  → deblender failures
  → poor photometry of each 'child'

- Poor photometry → poor red sequence
  → Cluster finders may miss clusters or misidentify the brightest galaxies (RedMaPPer, CAMIRA)

HSC – Aihara+ (2017)



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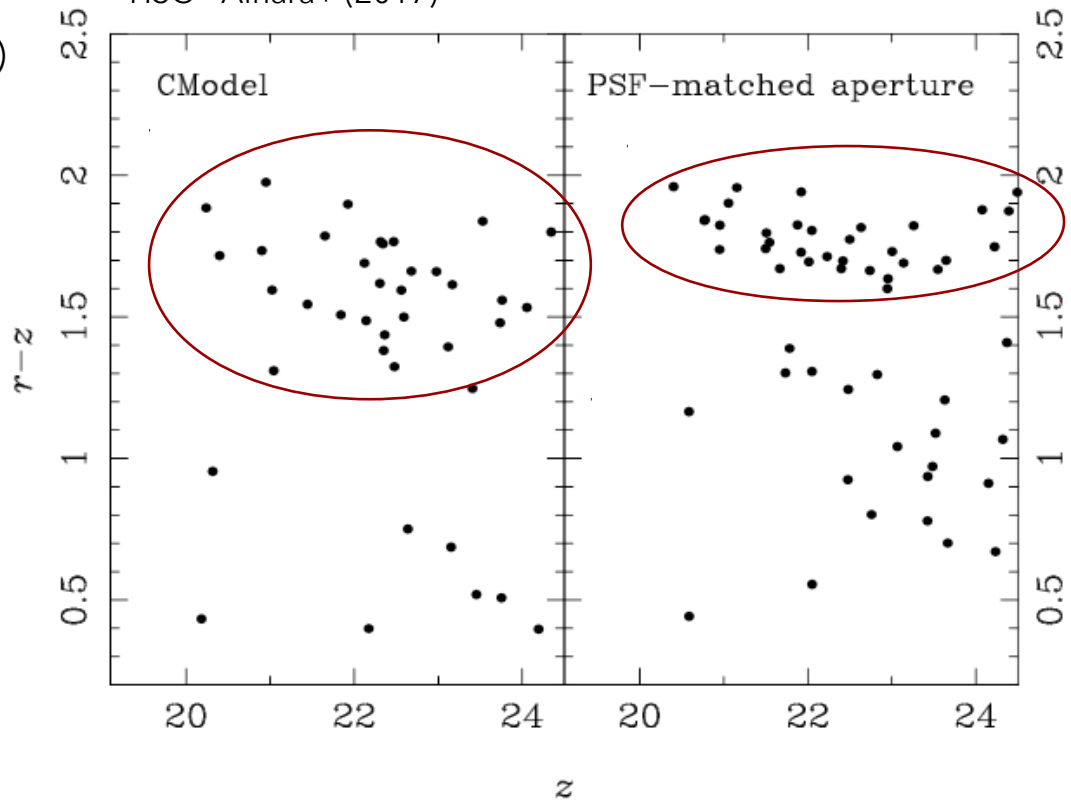
- HSC release :
  → CModel (standard one we have in the stack)
  → afterburner photometry (aperture photometry at children positions, on undeblended images)

HSC – Aihara+ (2017)



On going work

→ Reproduce this effect from HSC catalogues (unconclusive so far)
→ Compare to stack-reprocessed clusters
→ Would be a good diagnostic to assess deblender quality in cluster fields

Clusters pipeline (≠cosmo pipeline): from catalog to mass

https://github.com/nicolaschotard/Clusters

- Read in DM-stack catalogues (shapeHSM)
  Stored into astropy tables, single hdf5 file
  First cuts (S/N, star/galaxy)

- Estimate Galactic extinction at objects locations (SFD, Schlafy, Planck2015, Green)

- Photoz estimation: BPZ and LePhare available. Zero points correction (BIGMACS). More codes?

- Background galaxy selection (hard or PDZ-based)

- Shear, mass, potential maps (I. Dell'Antonio)

- WL mass estimation using D. Applegate's code `pzmassfitter` (WTGIII): lin or log mass sampling, w/wo WTG STEP2 shear calibration (KSB),…

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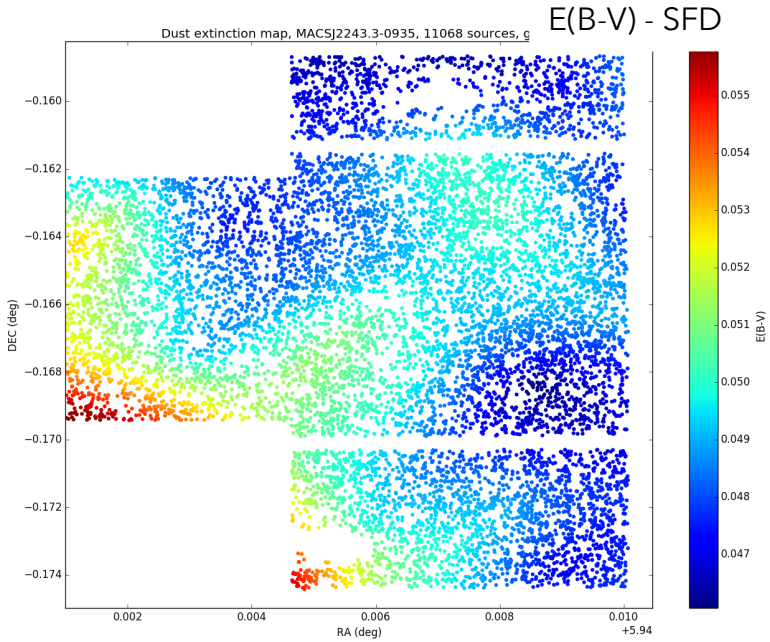

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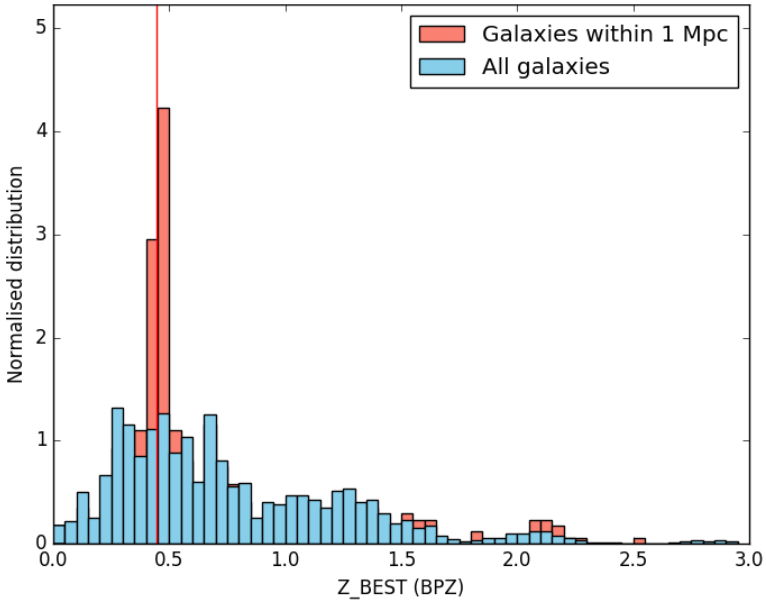

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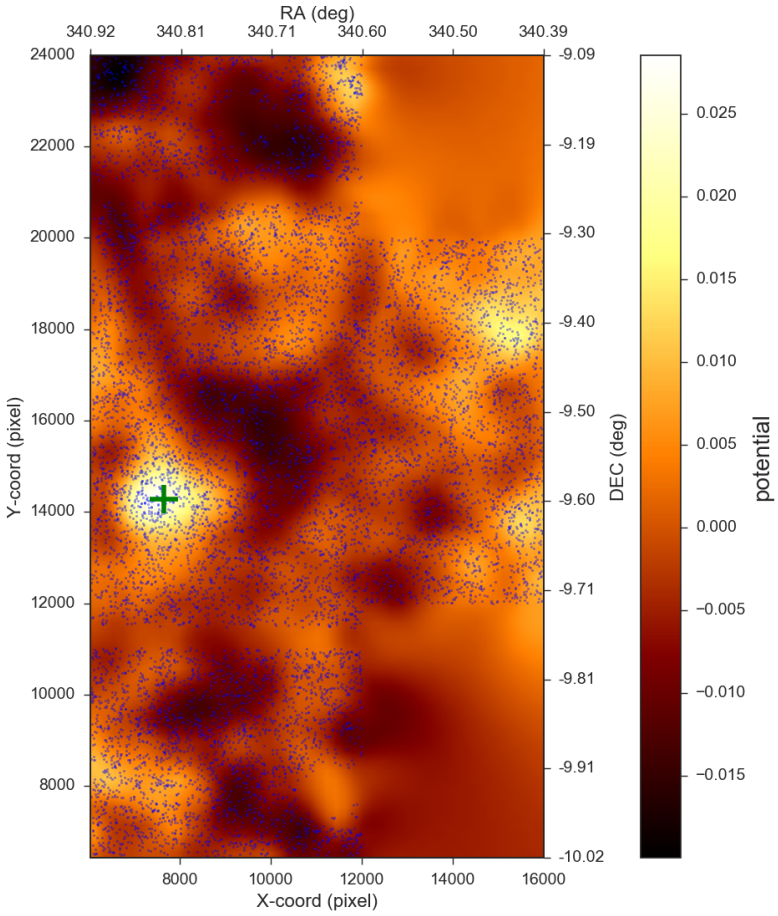

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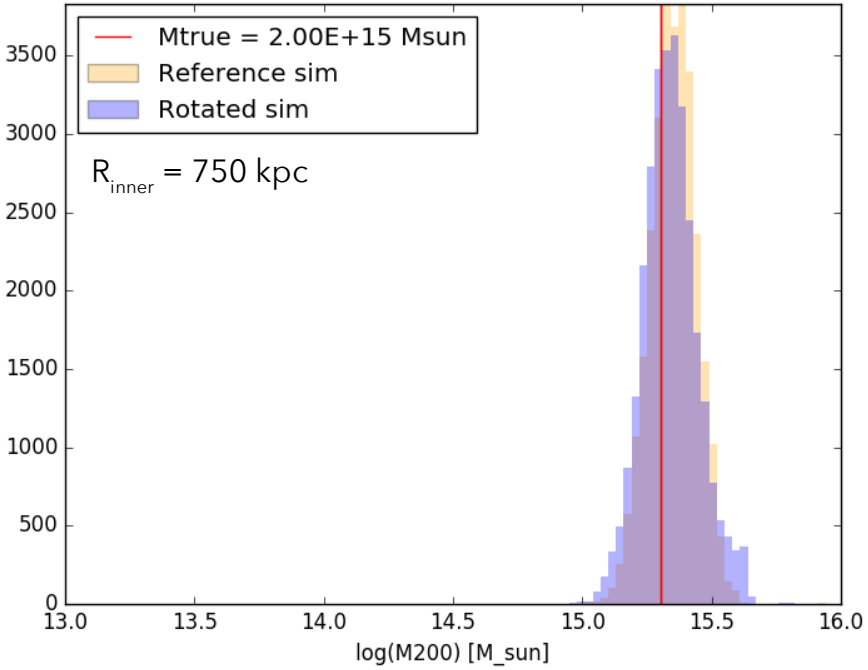
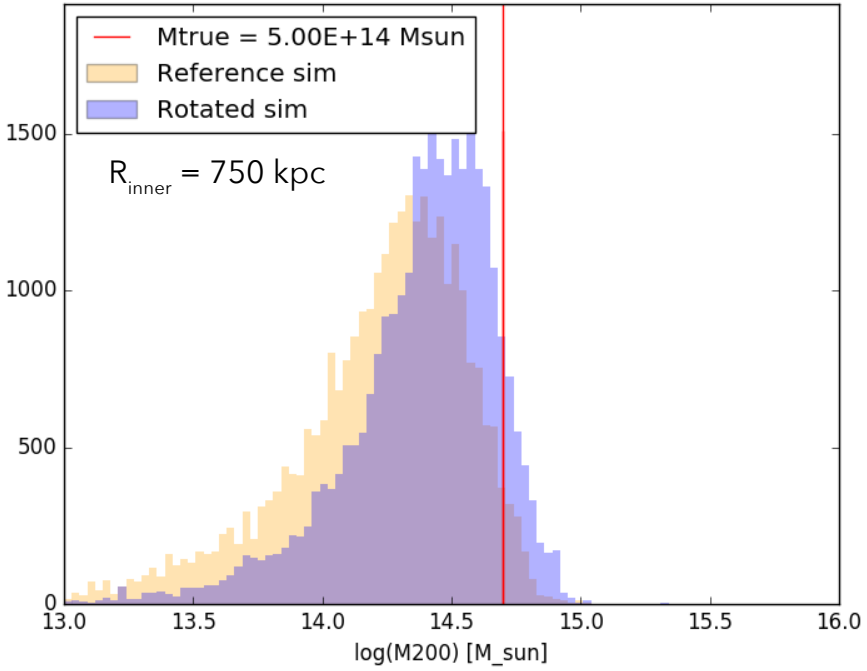
Cluster pipeline – validation on simulations (with R. Liu, I. dell'Antonio)

- 4 x 2 simulated cluster fields processed through DM stack, using obs_file
  - NFW clusters from 5.10^{14} to 2.10^{15} M_{sun}, c = 4
  - z_cluster = 0.3
  - z_bkg_gal = 1.5 → generate fake p(z)
  - no cluster/foreground galaxies
  - for each cluster, pairs of simulations w/wo 90 degree rotation of galaxy stamps (HST) (otherwise identical)

- DM stack output catalog processed through Clusters pipeline (skipping unnecessary steps)





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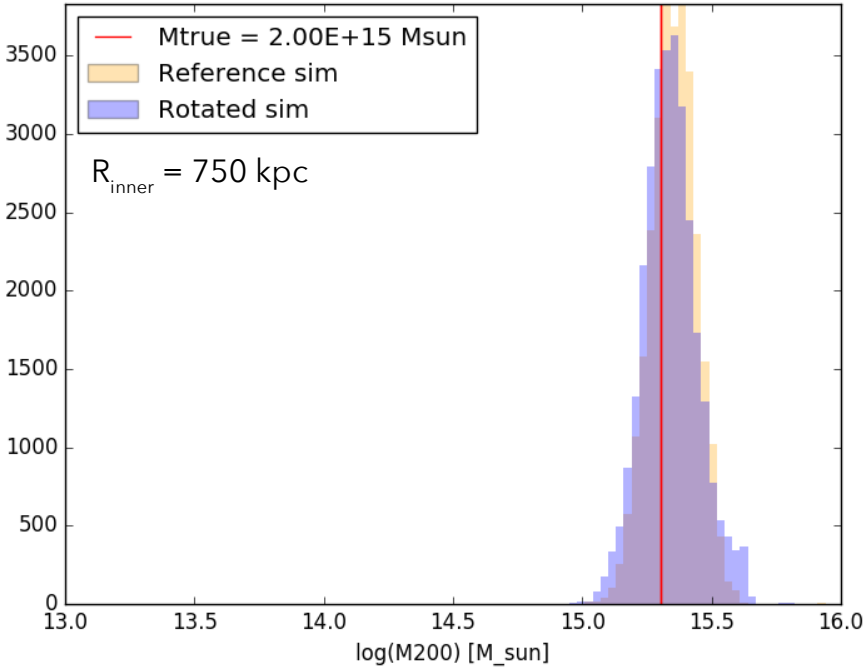
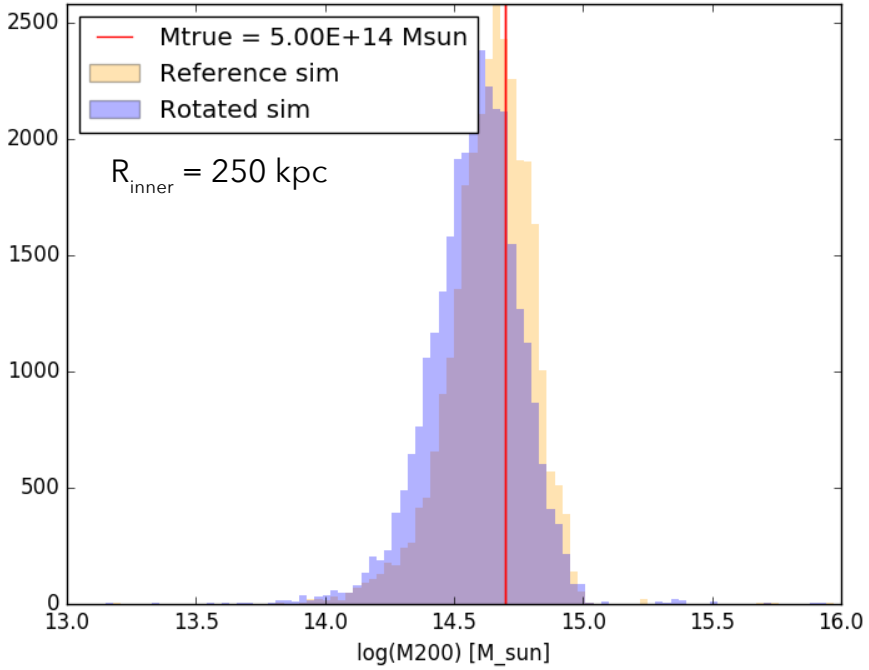
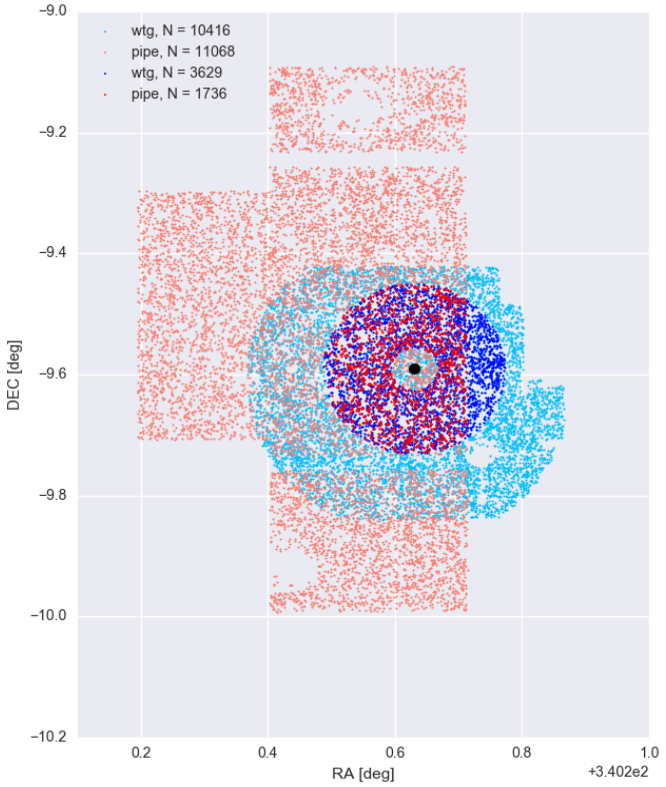
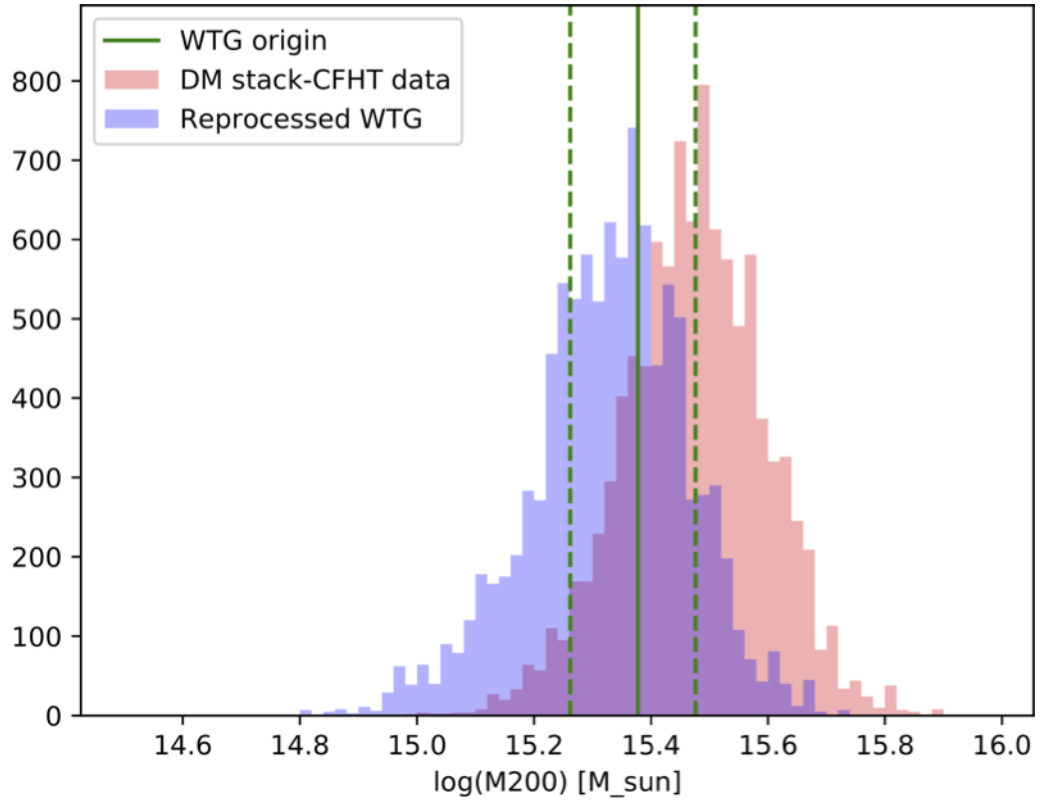




Cluster pipeline – validation on data - MACSJ2243.3-0935





- Main differences with WTG analysis:
  - Data set (MegaCam versus MegaCam+SuprimeCam), depth → ~2-3 times less galaxies
  - No color recalibration, zero-point correction for running photoz
  - No shear calibration for ShapeHSM yet
- Nonetheless, compatible results :)

NumCosmo and CLMassMod

CLMassMod (SRM): Galaxy cluster weak-lensing (WL) mass modeling and verification code.

Implementation in **NumCosmo** (Numerical Cosmology library);

- Based on D. Applegate's code;
- Theoretical modeling: WL quantities (mass density surface, convergence, shear, reduced shear);
- Improvements: including observational/cosmological terms (miscentering, one- and two-halo terms...); generalization to consider any mass distribution (NFW, Dimer & Kravtsov, Einasto…);
- Likelihood for the reduced shear (WG discussing other WL observations to be also used);
- Statistical analyses: mass estimate and calibration, and concentration-Mass relation.

Conclusions

- Reprocessing with DM stack:
  - → Ongoing automatised reprocessing of the WtG clusters using CFHT data
  - → Planned reprocessing of HSC clusters
  - → Combine CFHT/HSC
  - → DES first data release?

- Tests at the catalog level:
  - → Started some deblending-related activity
  - → Need to define clear objectives/metrics

- 'Clusters' package development: current version does the job but
  - → plan to add more functionalities/options
  - → probably need to increase our visibility / interface with others

- Contribution to CLMassMod + cosmology
  - → Ongoing implementation of cluster mass in NumCosmo
  - → Need to start discussion with CCL and TJP