CENTRO DE ASTROBIOLOGÍA · CAB
ASOCIADO AL NASA ASTROBIOLOGY PROGRAM

CSIC INTA

Mock redshift surveys of the (sub-)mm-wavelength sky

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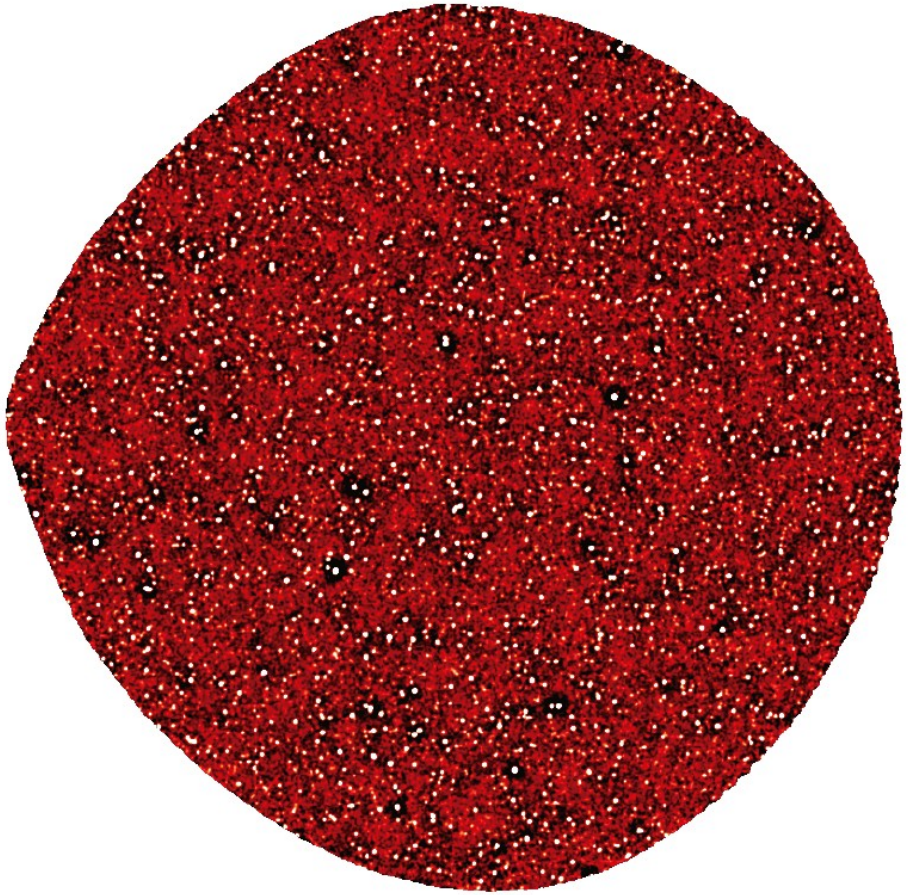
Aldo Rodríguez-Puebla
Vladimir Ávila Reese

MILGATZ



MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
AGENCIA ESTATAL DE INVESTIGACIÓN

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TolTEC, the international collaboration

http://toltec.astro.umass.edu/

Continuum camera 1.1/1.4/2.1mm simultaneous imaging/polarimetry: 7716 detectors

Mounted at 50m Large Millimeter Telescope Alfonso Serrano (LMT)

PI: Grant Wilson, UMass, USA

Project Scientist: Itziar Aretxaga (CAB CSIC-INTA, Spain / INAOE, Mexico)

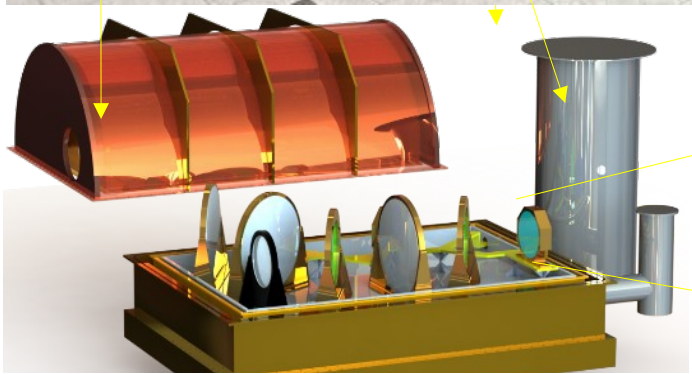
Deputy Project Scientist: Alexandra Pope, UMass, USA

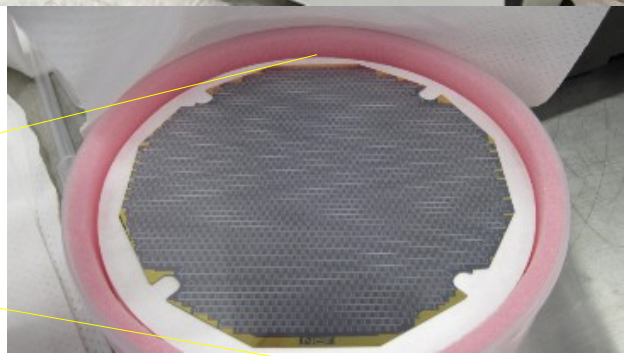
Project Manager: Stephen Kuczarski, UMass, USA

7 partner institutions in USA, Mexico, UK

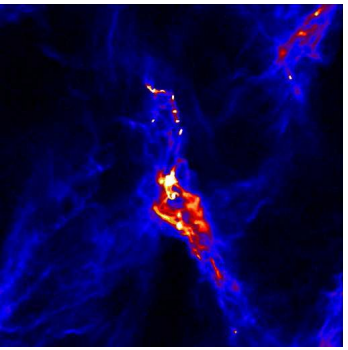
~70 scientists in Instrument and Sci. Teams

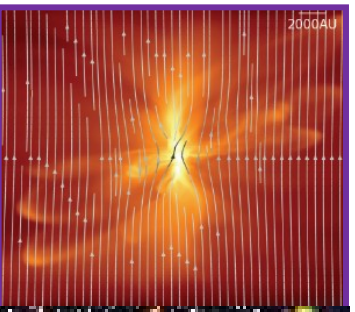
~300 scientist in Working Groups defined the Public Surveys TolTEC will do with 400 hours for the first 4 Legacy Surveys

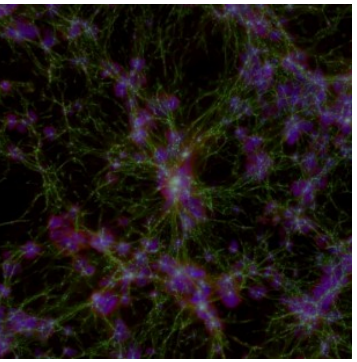




Instalation at the telescope, 2021-2022
1st light July 2022
Commissioning Dec 2022 -



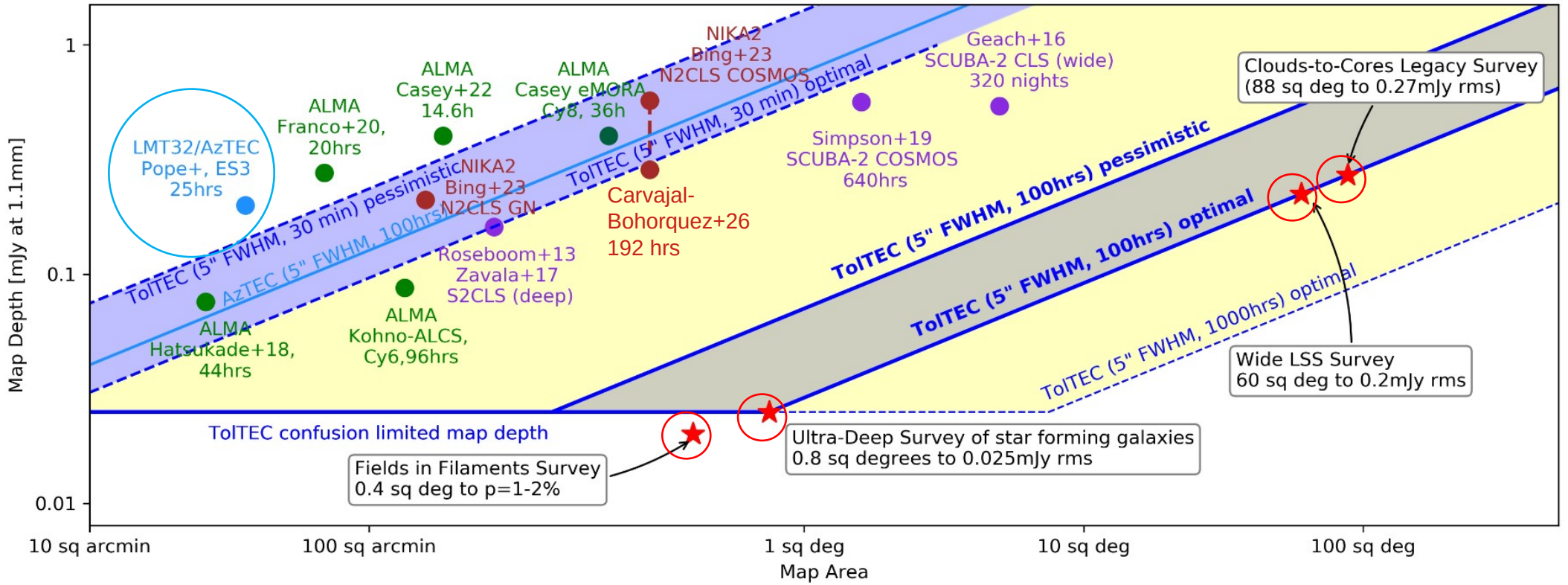




TolTEC Legacy Surveys

4 public surveys to carry out with 100 hr / each:

The Clouds-to-Cores Legacy Survey (C2C): 88 sq. deg $RMS_{1.1mm}$=0.27 mJy/beam
The Fields in Filaments Legacy Survey (FiF): 0.4 sq. deg p=1-2%
The Ultra-deep Survey of Star-forming Galaxies (UDS): 0.8 sq. deg $RMS_{1.1mm}$=0.025 mJy/beam
The Large Scale Structure Survey (LSS): 60 sq. deg. $RMS_{1.1mm}$=0.2 mJy/beam



DSFG cosmologicaly motivated mock surveys

(Nava Moreno, Montaña, Aretxaga, Rodríguez-Puebla, Ávila-Reese, 2024, 2026)

Araceli Nava
INAOE

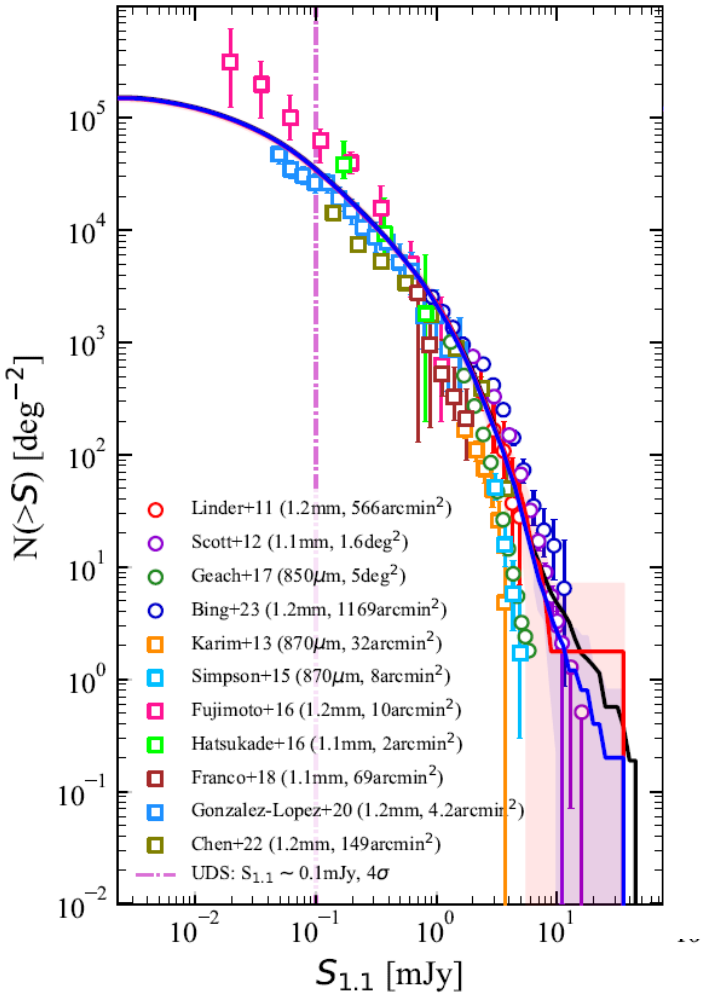
1. Dark matter halo simulation (MultiDark-Planck and Bolshoi-Planck, N-body simulation):

- **area: 5.3 deg²**, stellar mass: $M_\star \geqslant 10^{8.75}\ M_\odot$, z = 0 – 7 to match UDS
- **area: 100 deg²**, stellar mass: $M_\star \geqslant 10^{9.5}\ M_\odot$, z = 0 – 7 to match LSS

2. Relate dark matter halos and galaxies (Update of Rodríguez-Puebla et al. 2017) for each halo: M_*, SFR

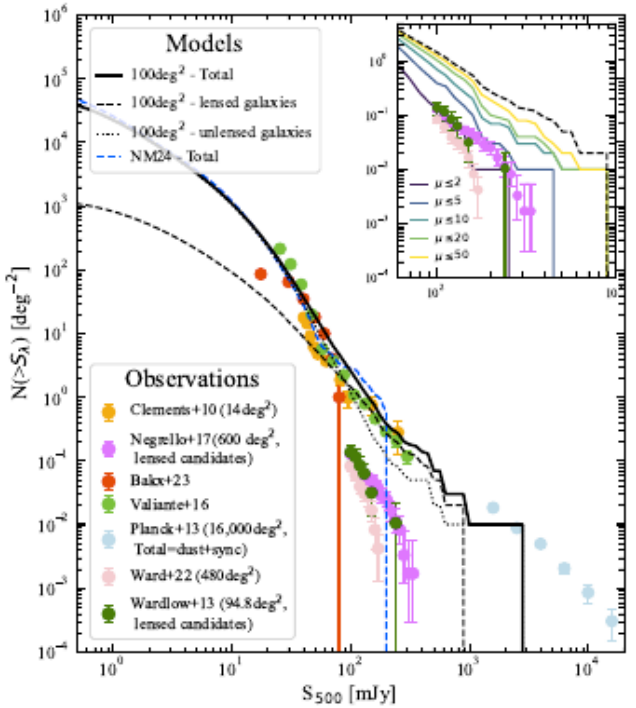
3. Properties of Dusty Star-Forming Galaxies (DSFGs):
   Obscured fraction ($f_{obs} = SFR_{IR}/SFR_{TOT}$) empirically
   (z< =2.5, Whitaker et al. 2017, z > 2.5 Dunlop et al. 2017)

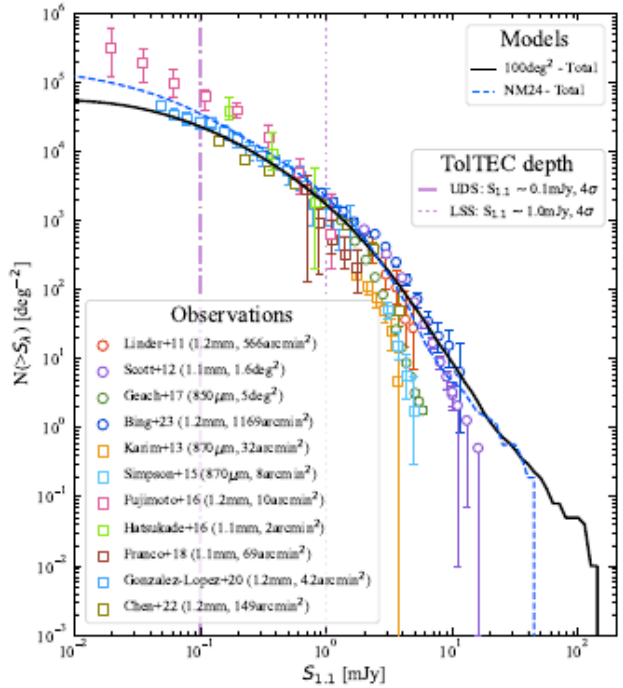
- $SFR_{IR} = f_{obs}\ SFR_{Tot}$ and L_{IR} (Kennicutt 1998).
- T_d following Casey et al. (2018) and it is corrected by CMB effects (da Cunha et al. 2013), emissivity index within observed range
- S_{obs} was obtained by considering a modify blackbody SED (z, L_{IR}, T_d).
- Lensing included through the point-like approximation for galaxies in line of sight

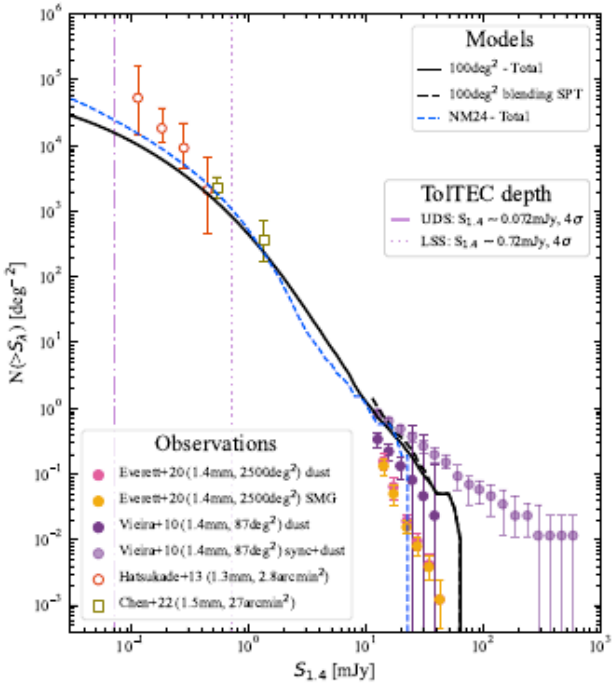


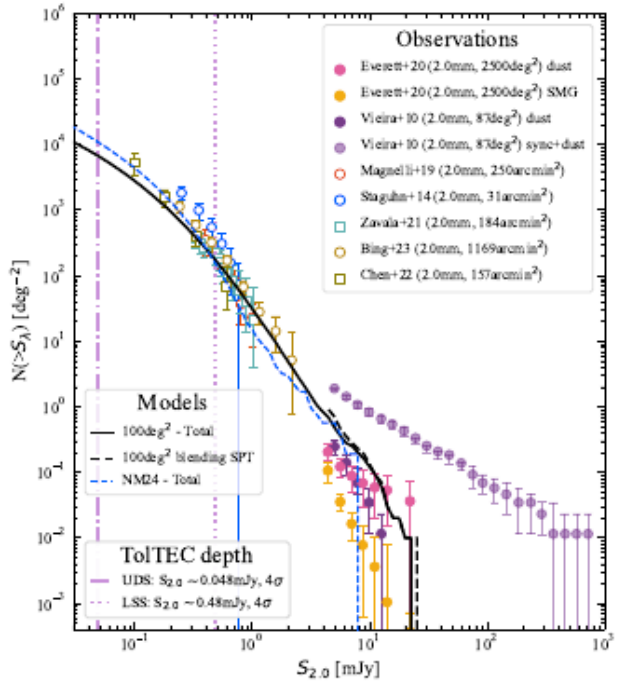
DSFG mock tests for LSS 100 sq. deg.

(Nava Moreno et al. 2026)

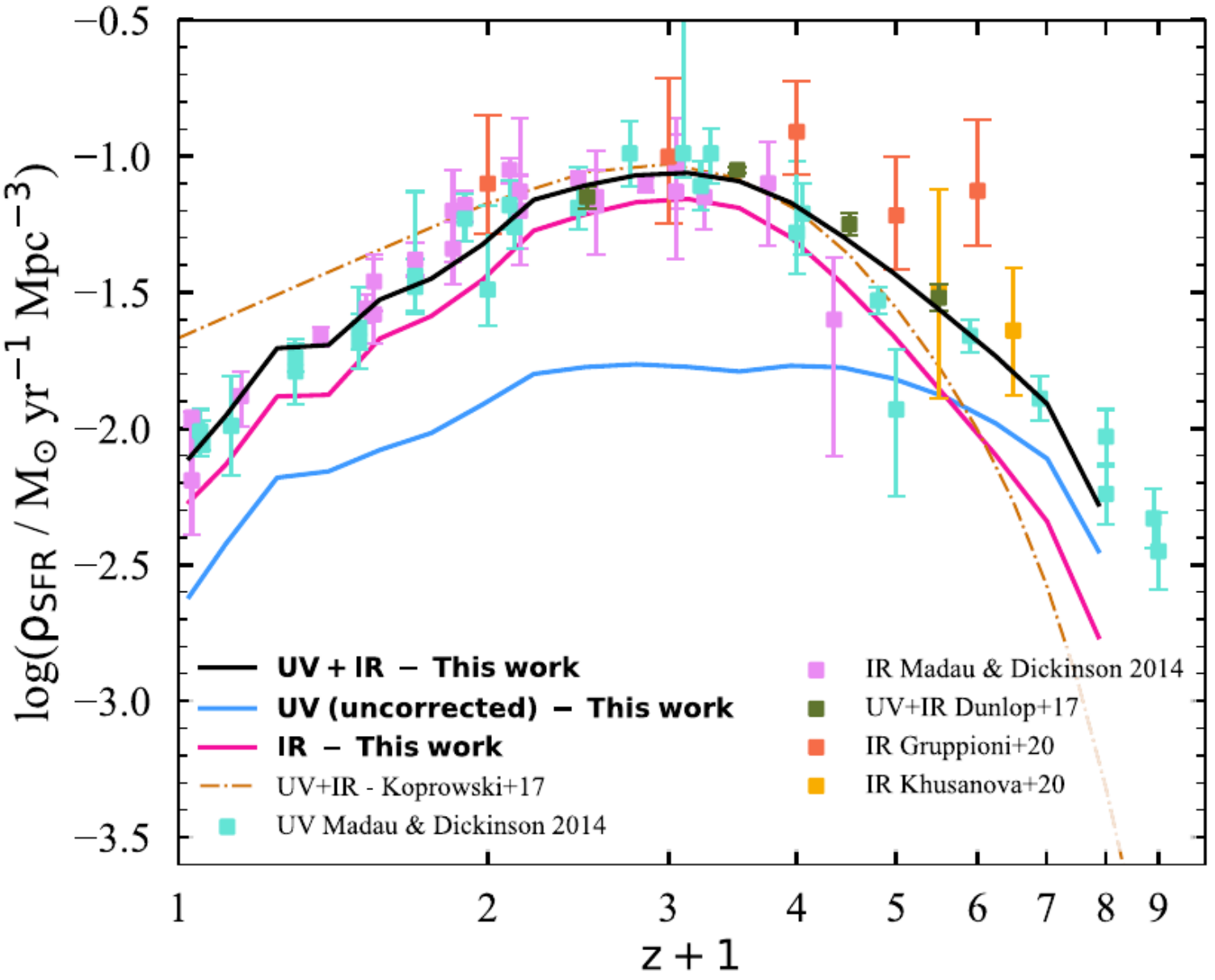




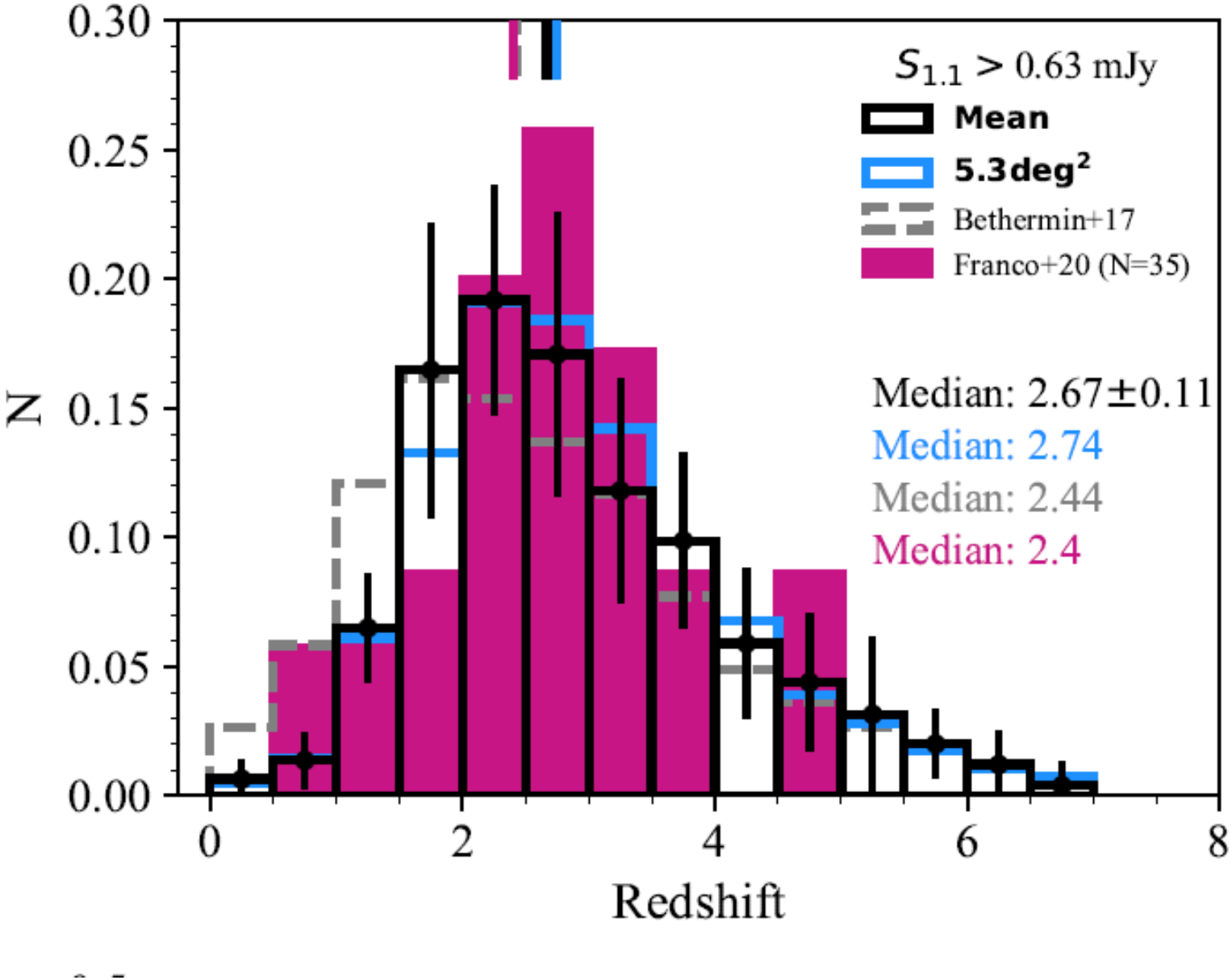




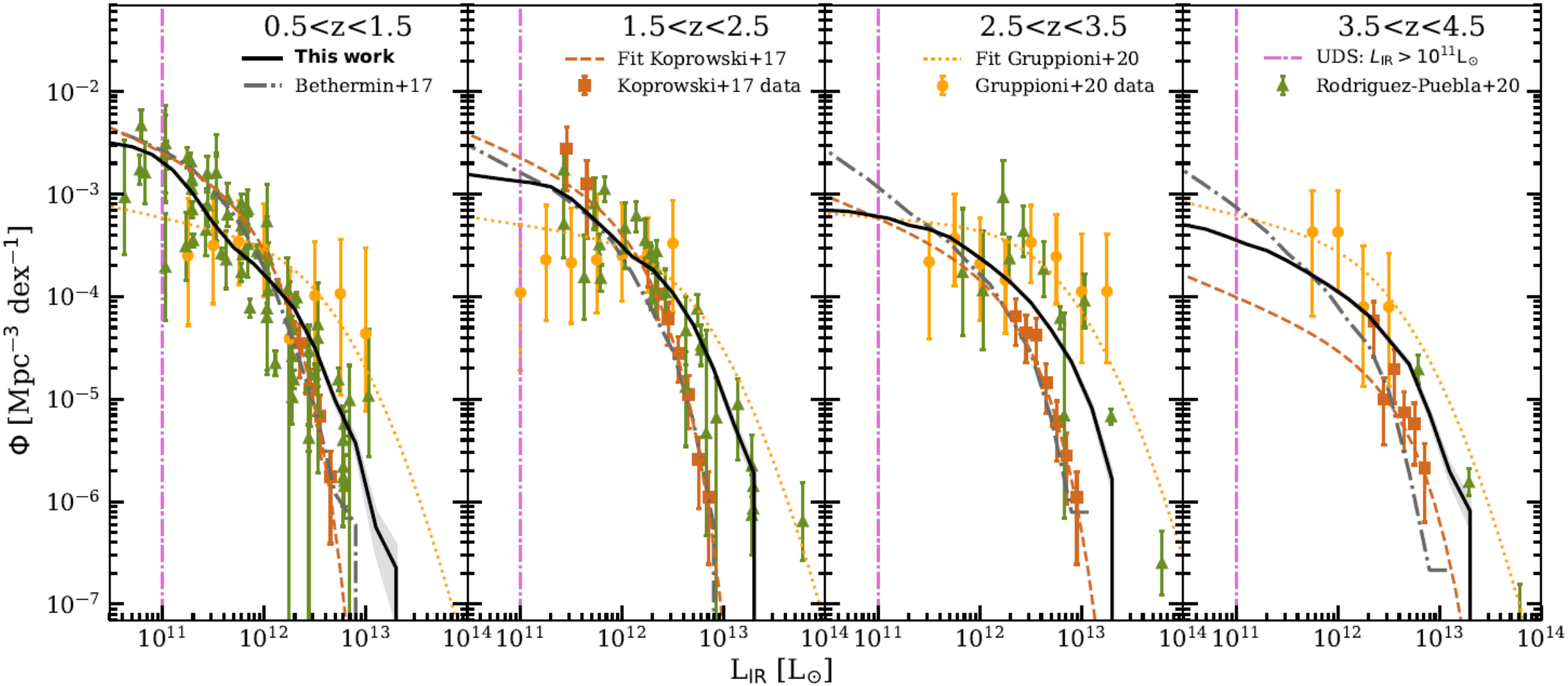
Predicted contribution to SFH



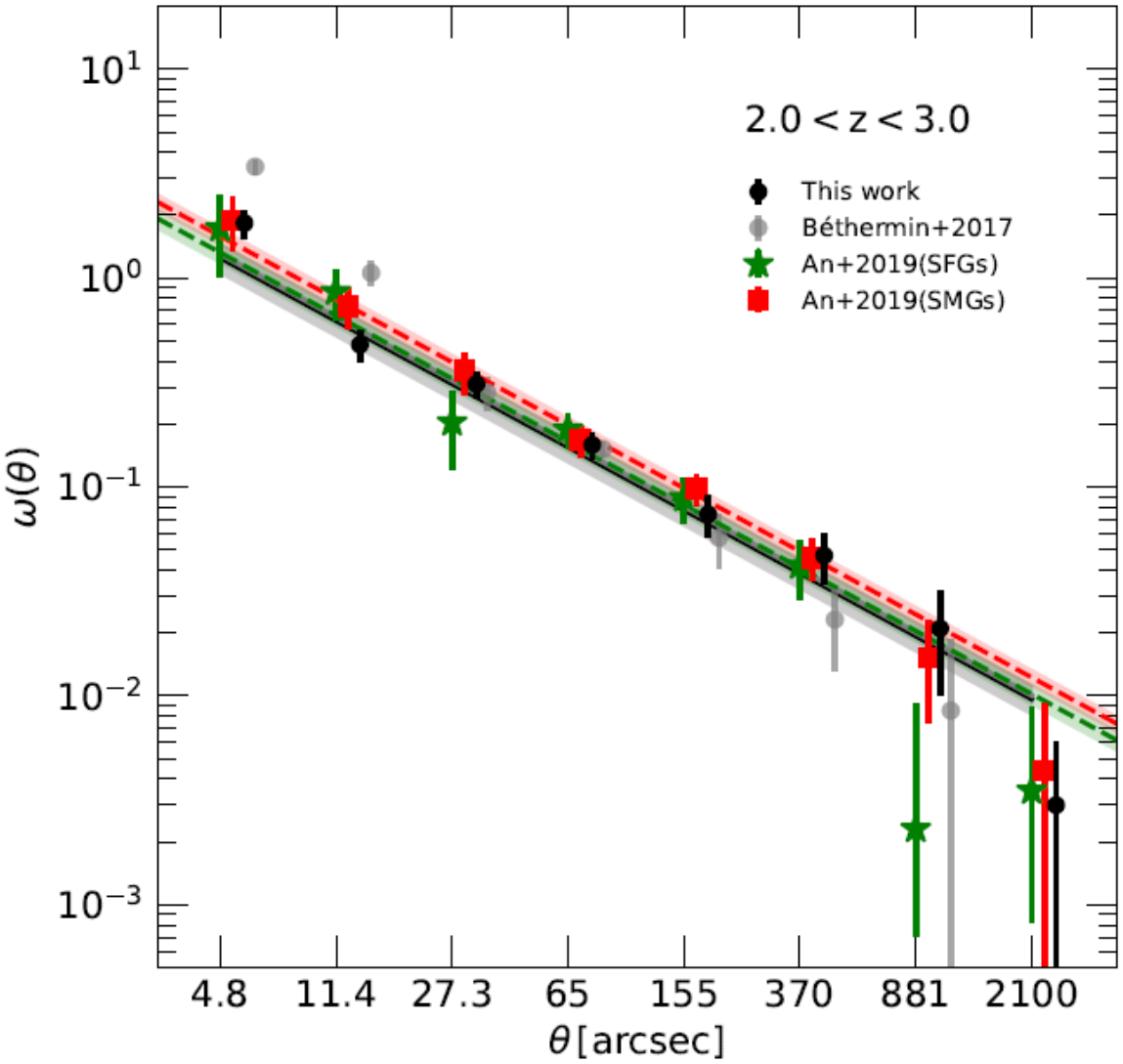
DSFG mock catalogue tests: redshift distributions



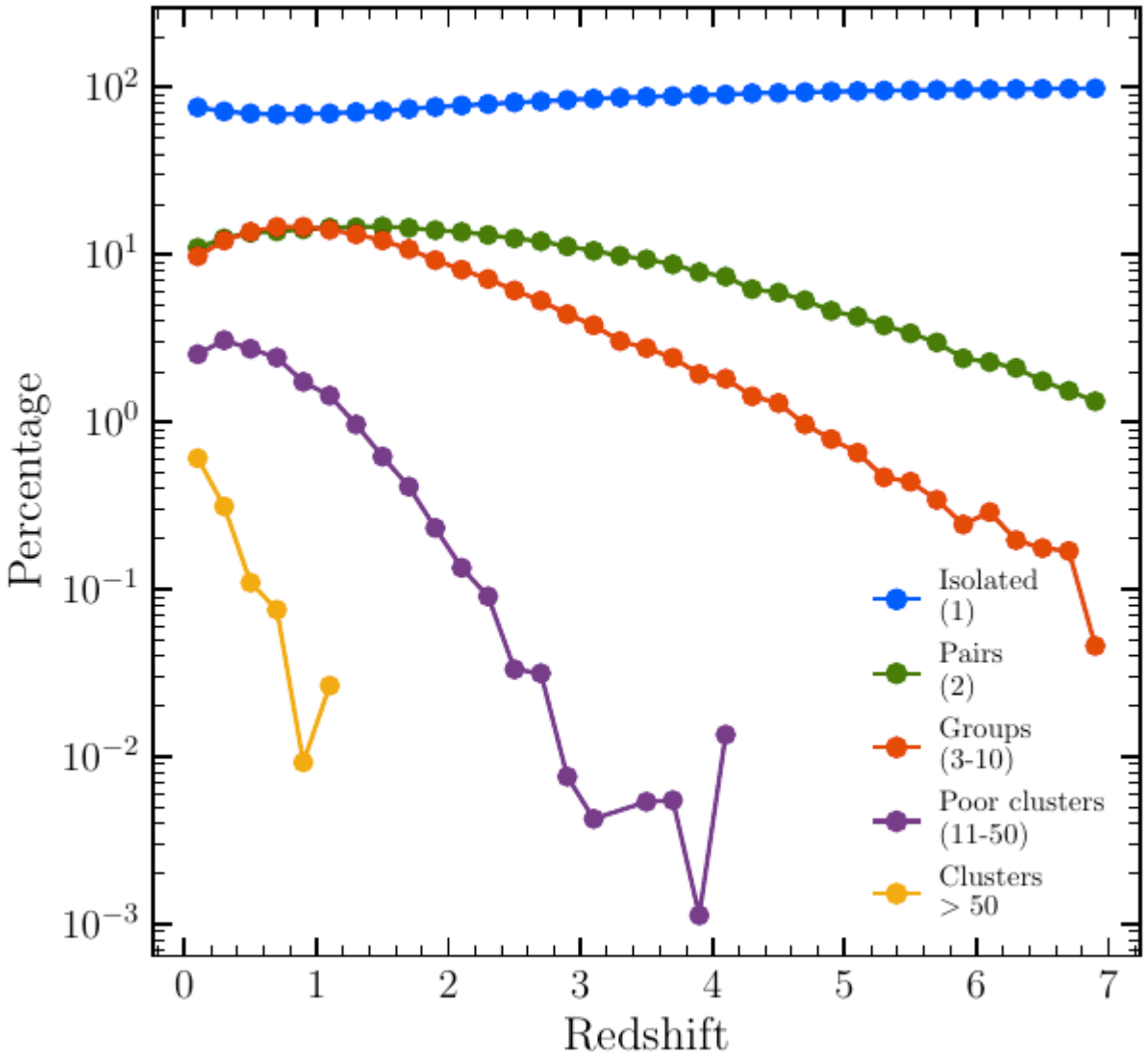
DSFG mock catalogue tests: luminosity functions

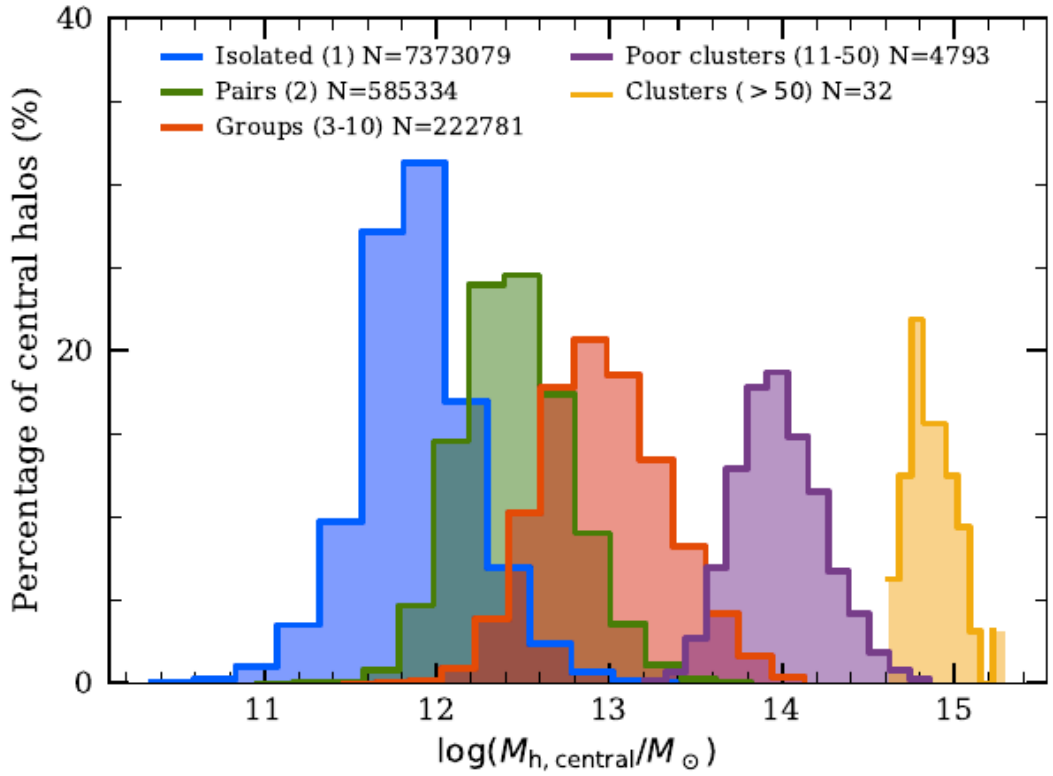


DSFG mock catalogue tests: environments

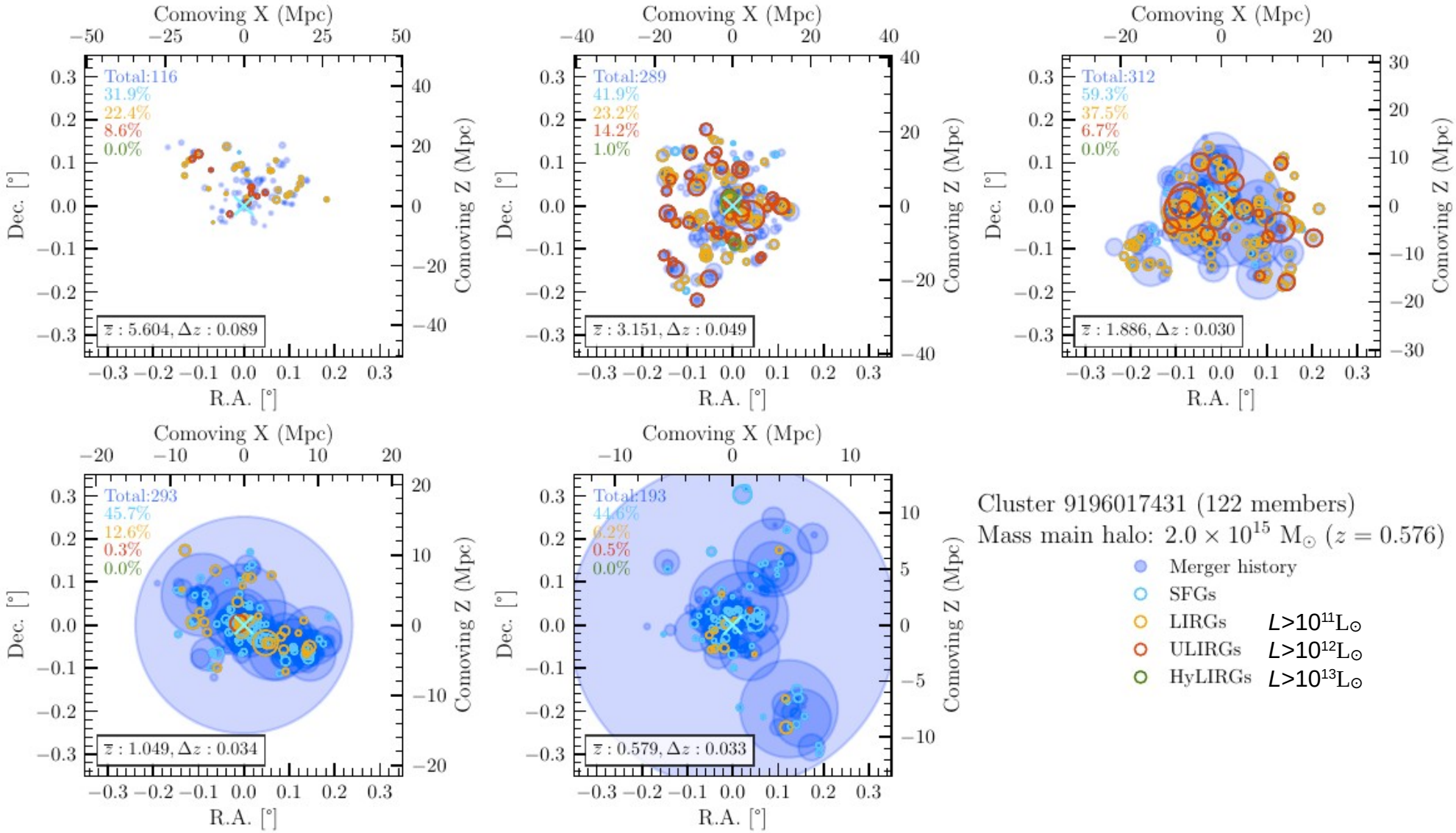


DSFG mock for LSS: structures in 100 sq. deg.

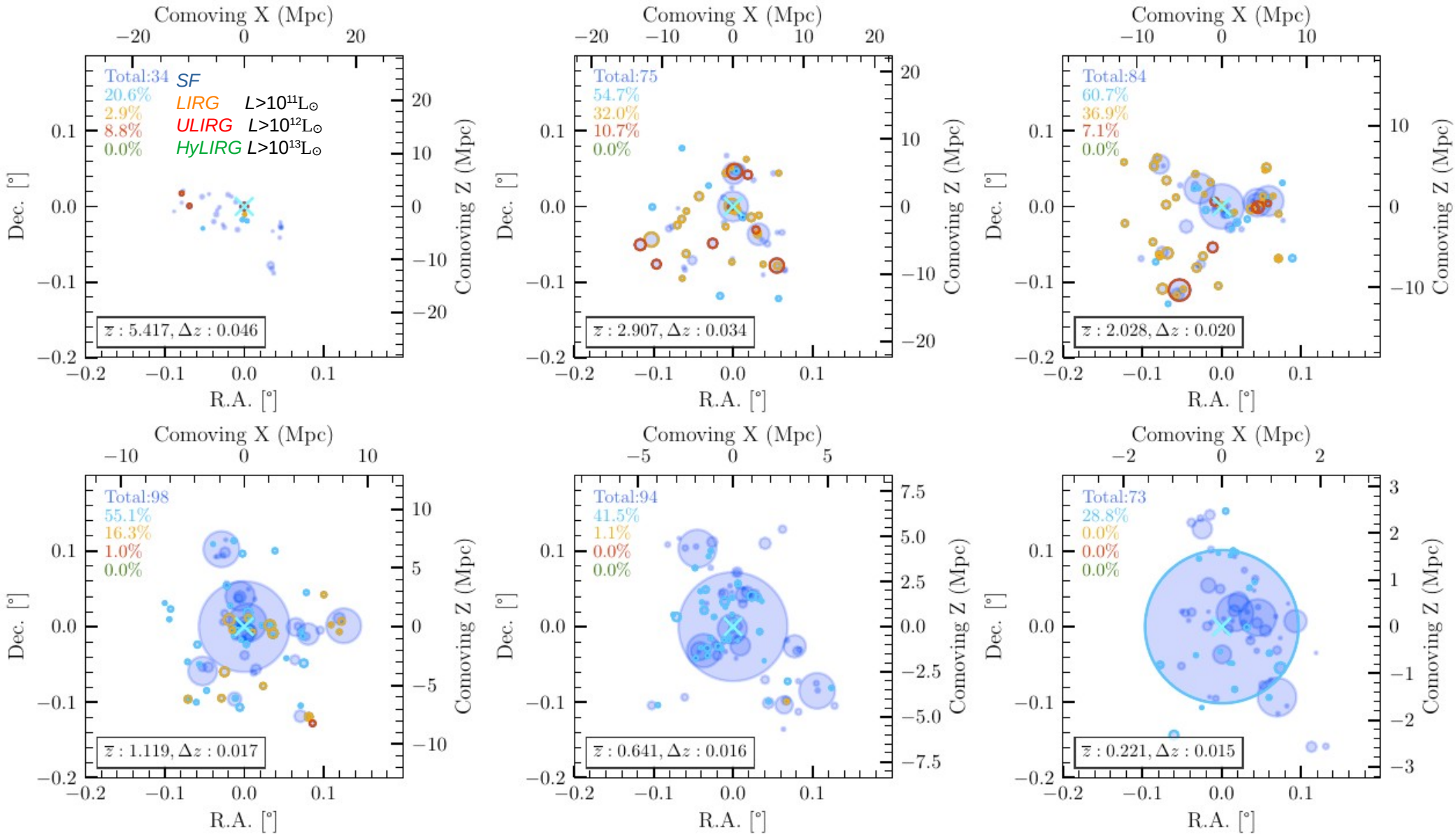


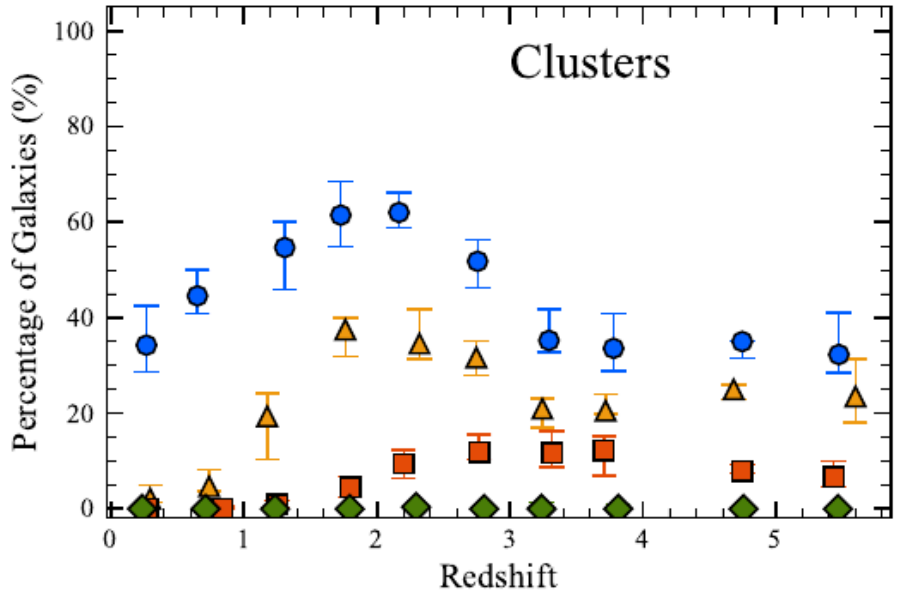


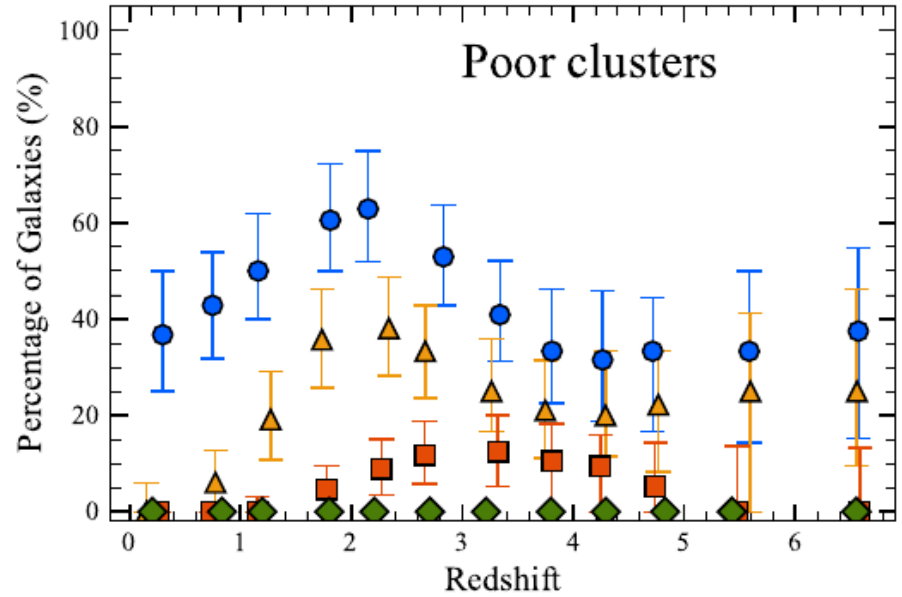
Evolution of rich clusters

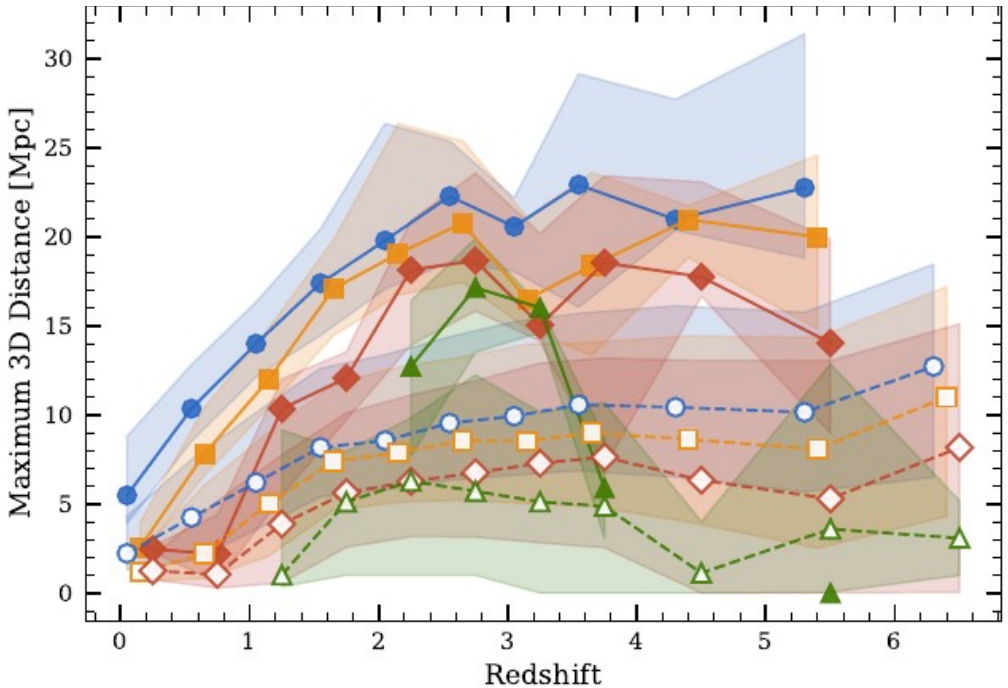


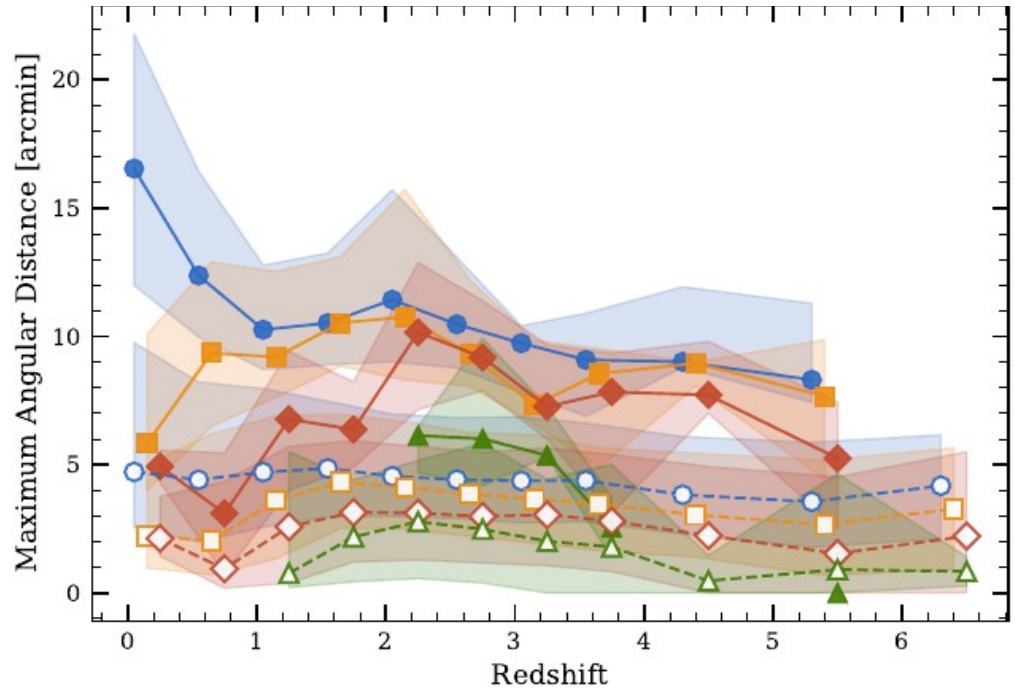
Evolution of rich clusters



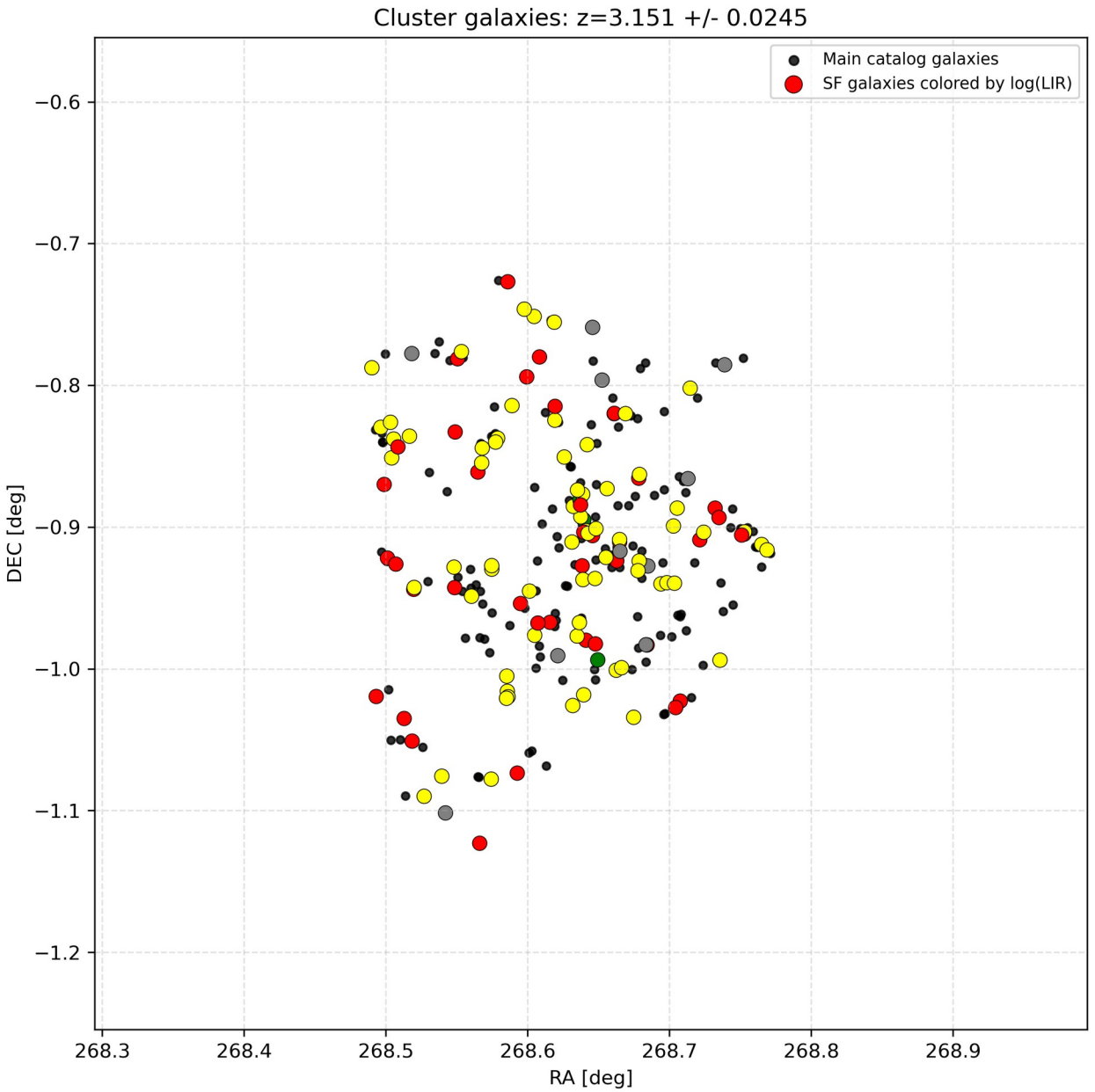

Clusters
Percentage of Galaxies (%)
Redshift

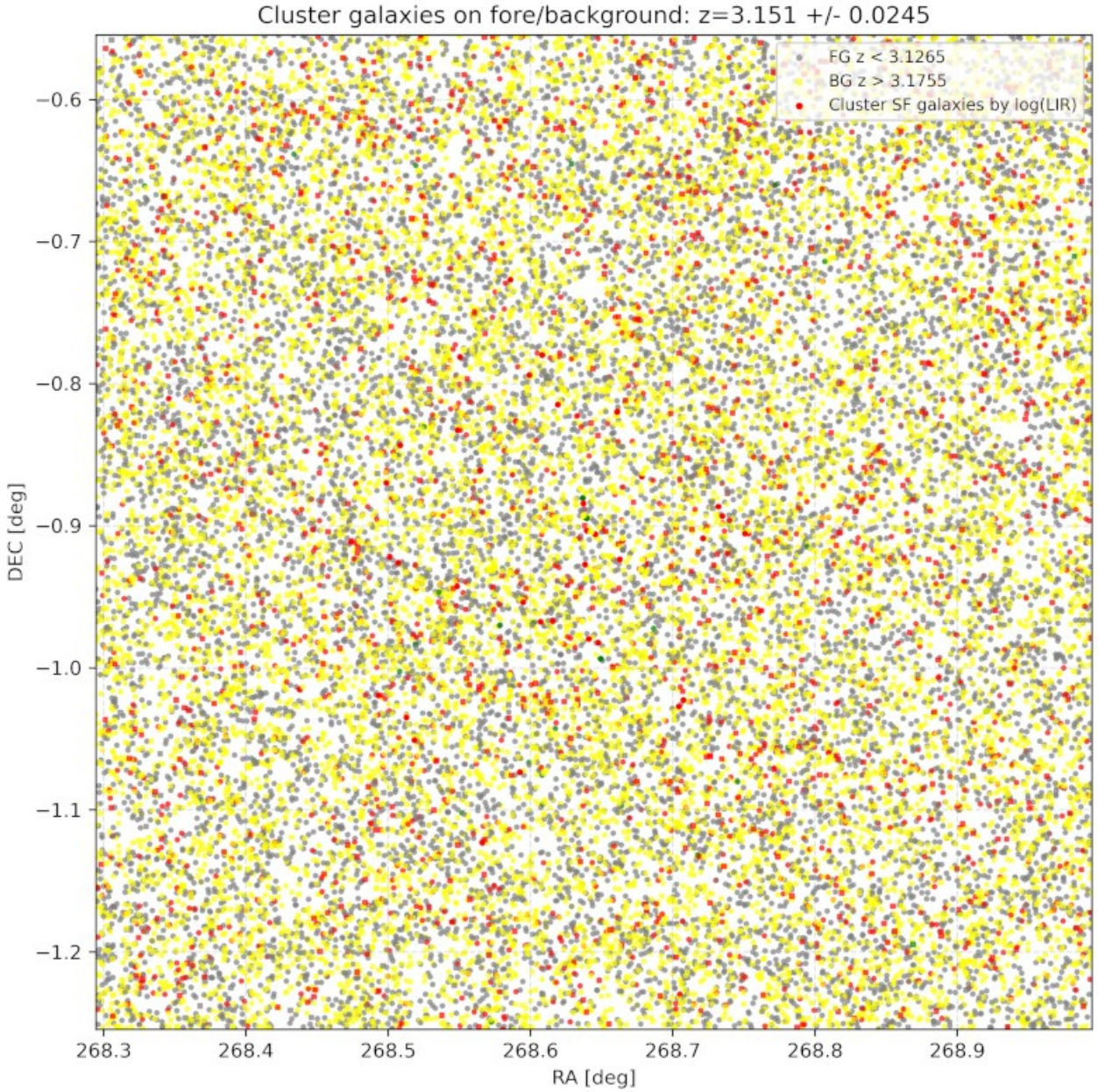

Poor clusters
Percentage of Galaxies (%)
Redshift


Maximum 3D Distance [Mpc]
Redshift

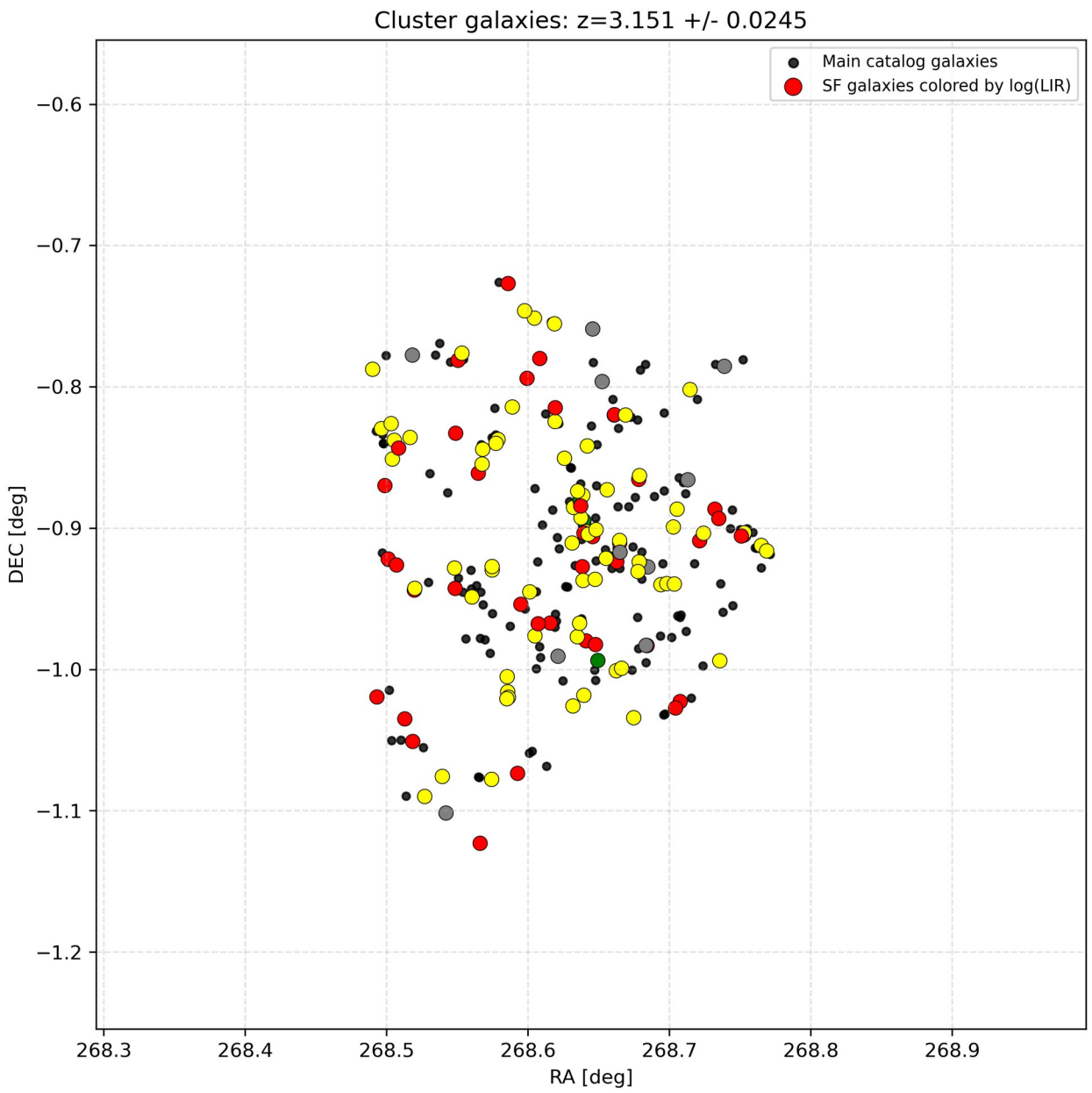

Maximum Angular Distance [arcmin]
Redshift

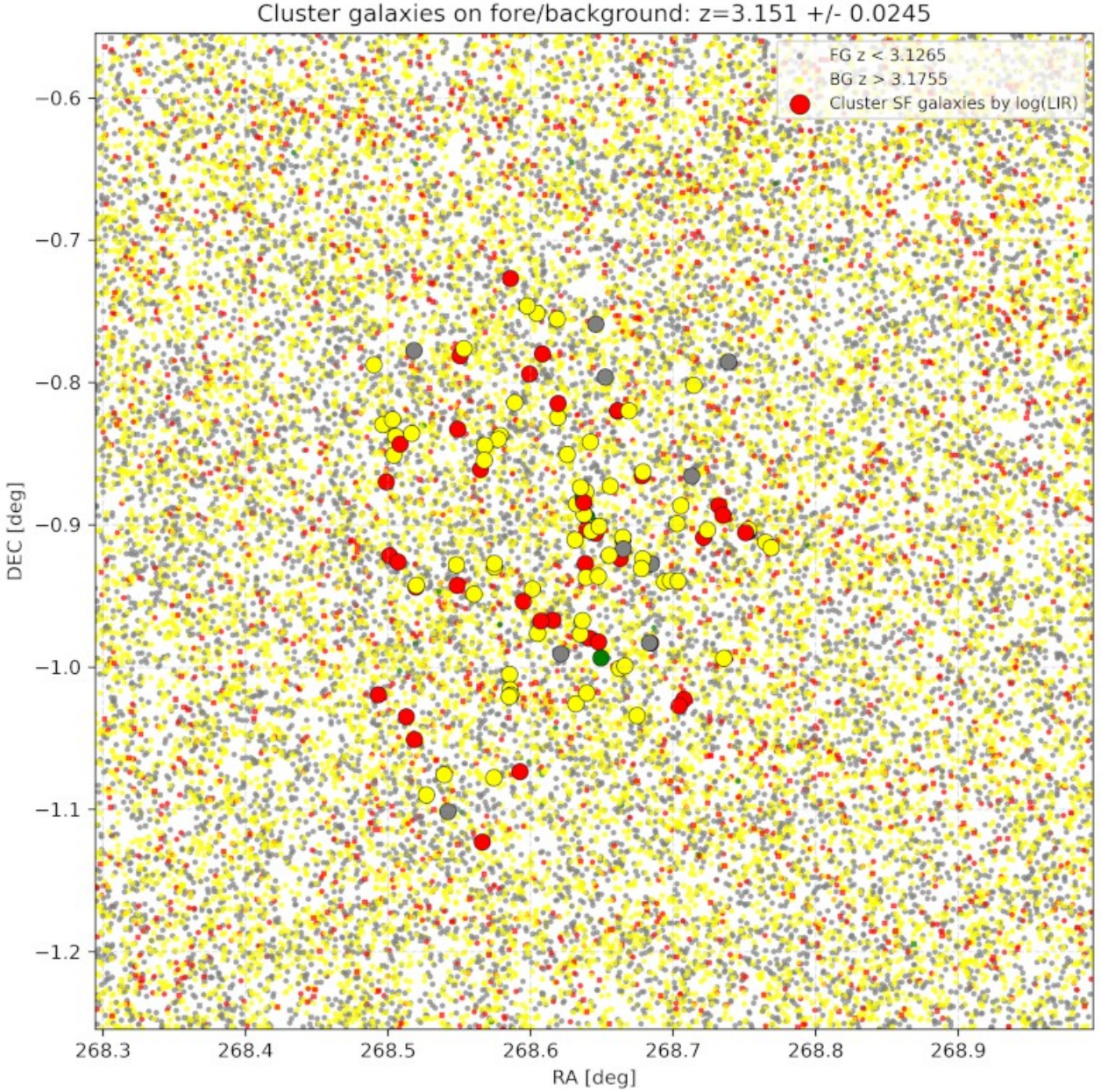
The difficulty of finding rich clusters without *z*-information



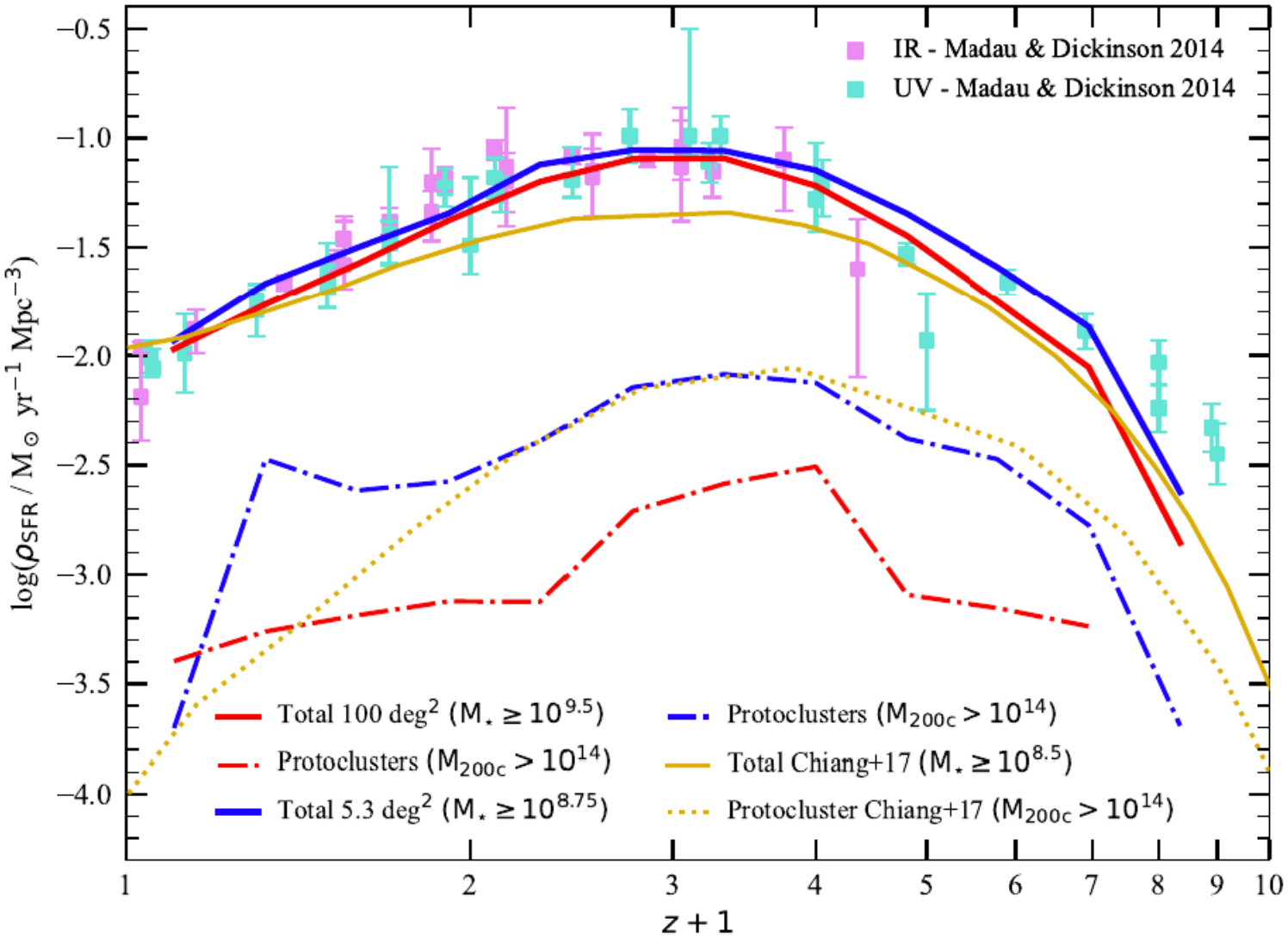


The difficulty of finding rich clusters without z-information





Predicted contribution to SFH



ALMA gives us a view on the LIRG regime in small fields. Although these results are to explore the build-up of stellar mass and the chemical evolution of the Universe, we still need deep panoramic surveys like those that TolTEC/AtLAST will provide to characterize the population of dust-eshrouded star formation at $L>10^{11}L_{sun}$ at $z<10$. .

We have built cosmologically motivated mock redshift surveys of the DSFGs to constrain the expected differences between SMGs and LIRGs at $z<7$ in the TolTEC Legacy Surveys – available online

They reproduce reasonably well DSFG population statistics explored so far of $L\sim10^{12}\,L_{sun}$ systems

They allow us to correct for systematics in the completion and accuracy of observational catalogs at millimeter-wavelengths

Protoclusters are well traced in projected areas by DSFGs at $z>1$, such that the percentage of DSFGs is 20-40%

TolTEC will give us a more comprehensive view of dust-eshrouded star formation at $L>10^{11}L_{sun}$ at $z<10$.

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