# The Fraction of Radio-Loud AGN in the EDFN

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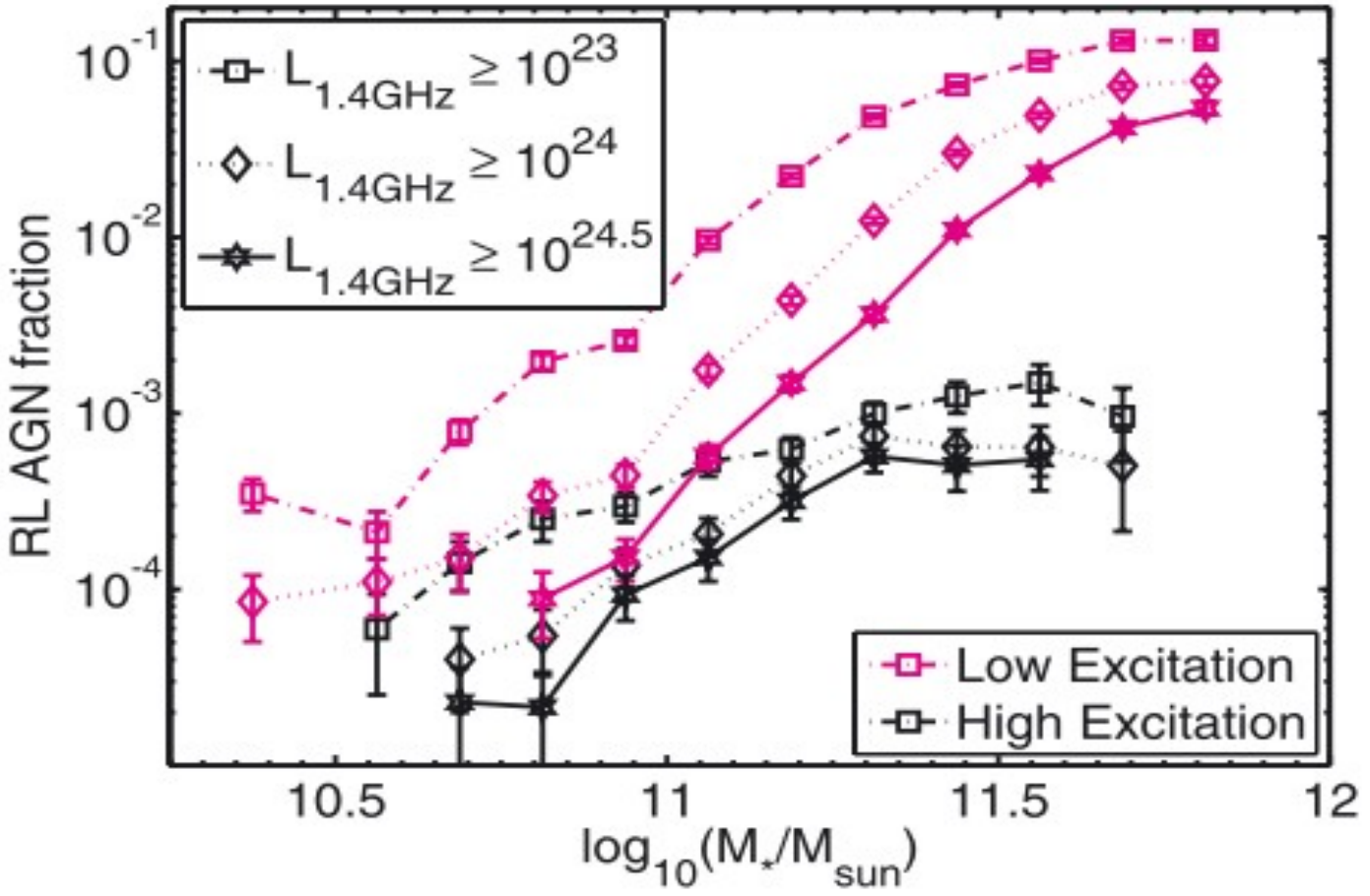
Collaborators: Huub Röttgering, Sonal Garg
LOFAR Family Meeting 2025

Universiteit Leiden
Leiden Observatory

Sterrewacht Leiden

# Radio-Loud AGN Fraction as a Function of Stellar Mass

- Local Universe ($0 < z < 0.3$):
  RL AGN fraction $f_{AGN} \propto M_*^{2.5}$




NVSS & FIRST + SDSS
Janssen et al. 2012

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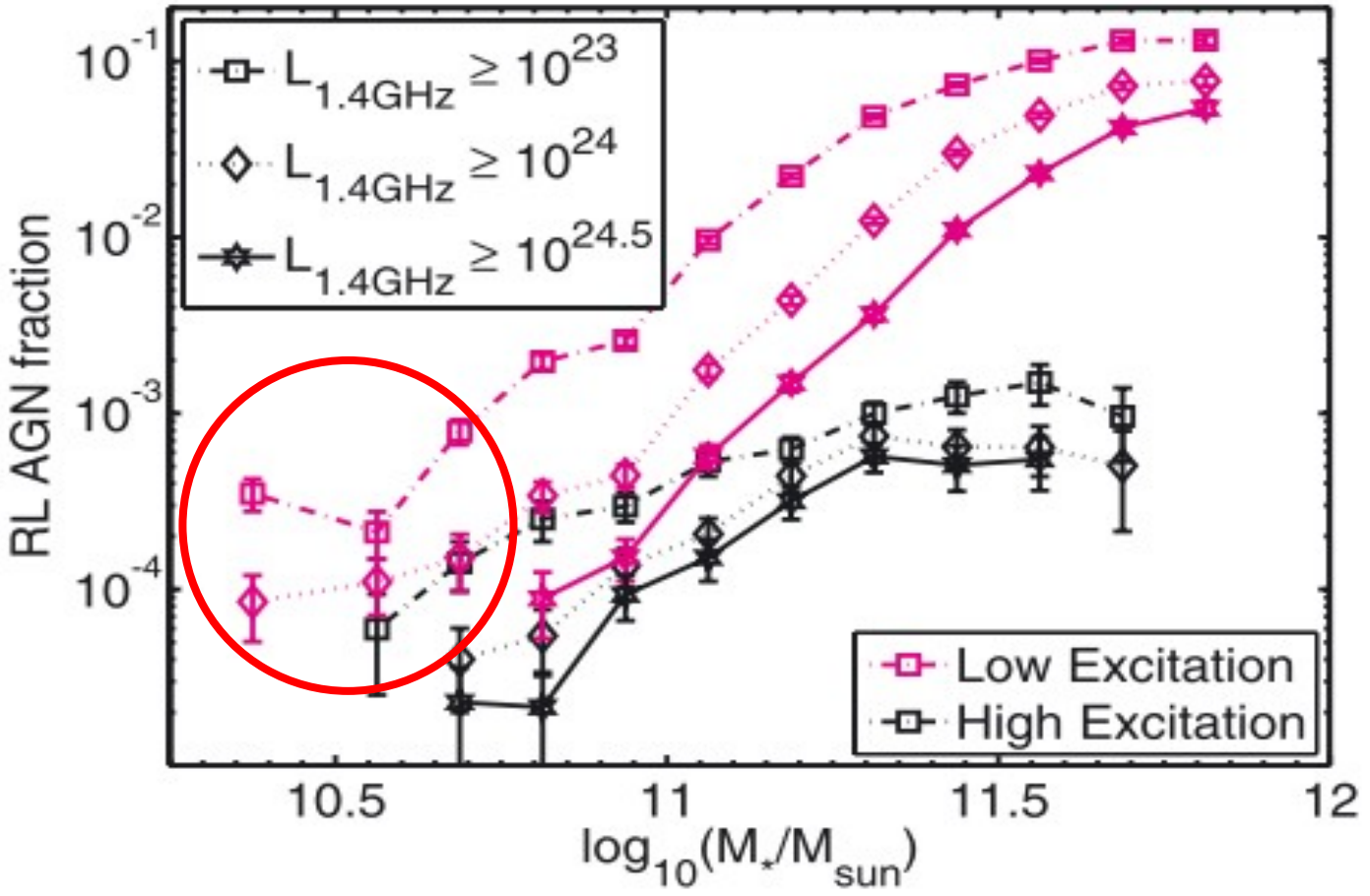


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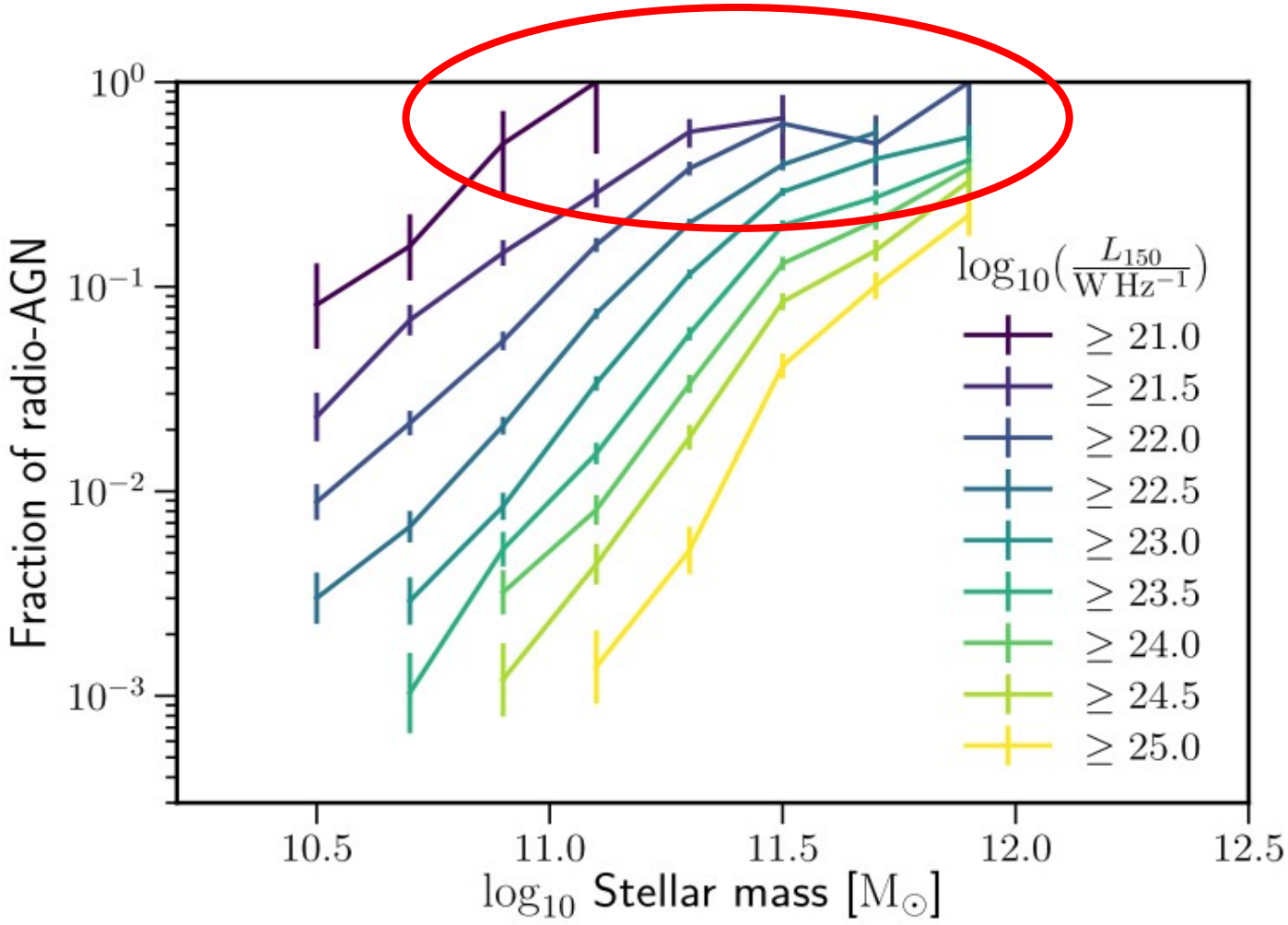


LoTSS DR1 + SDSS
Sabater et al. 2019

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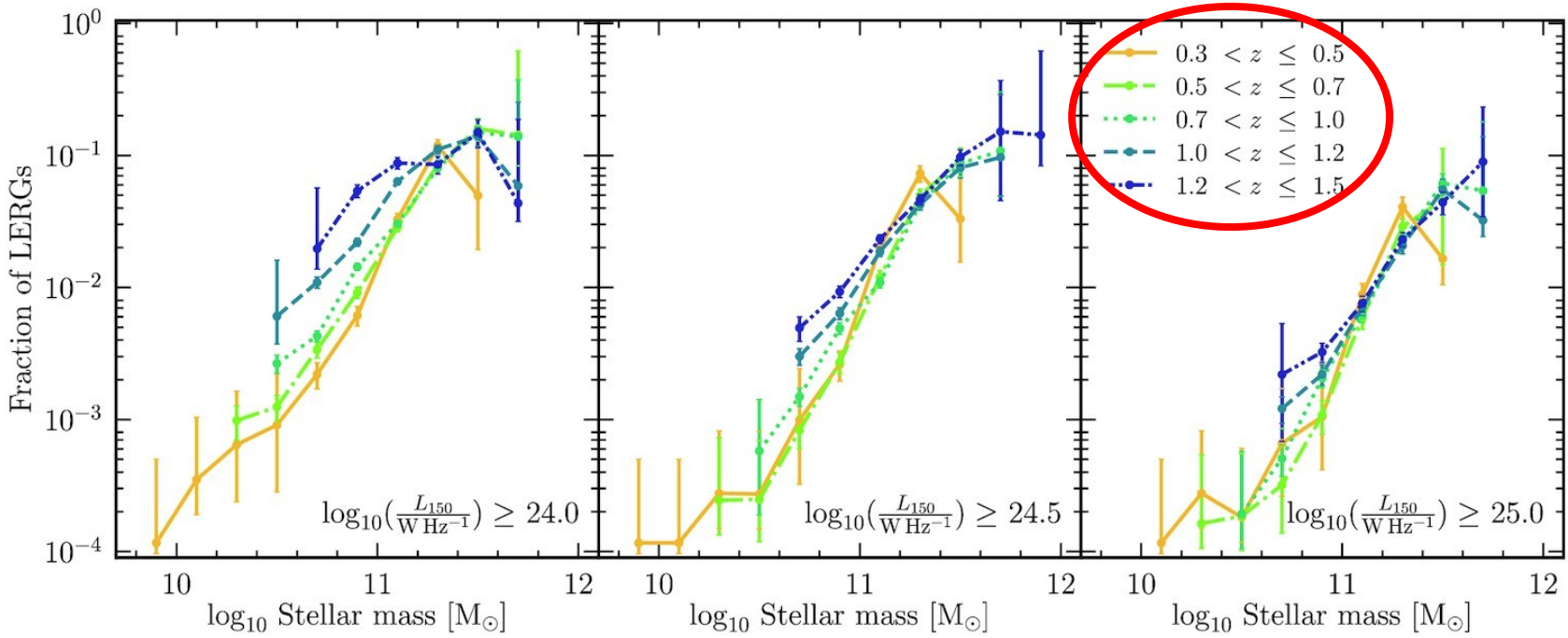
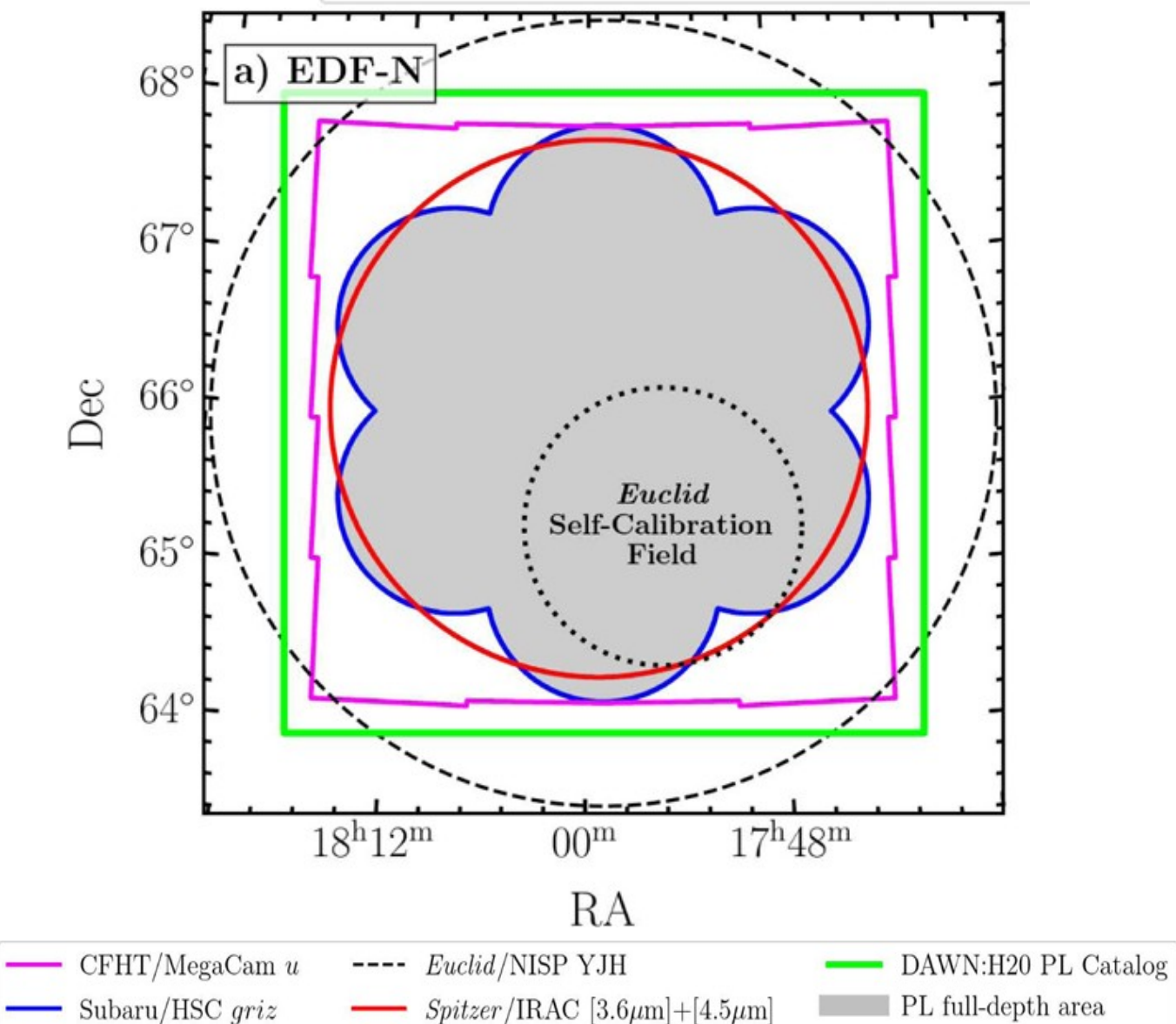
- A break at $M_* \approx 10^{10.5} M_\odot$ ?
- Reaches (almost) 100% for heaviest galaxies
- Evolution with redshift?
- With Euclid: Extend to higher z and lower $M_*$ in the EDFN

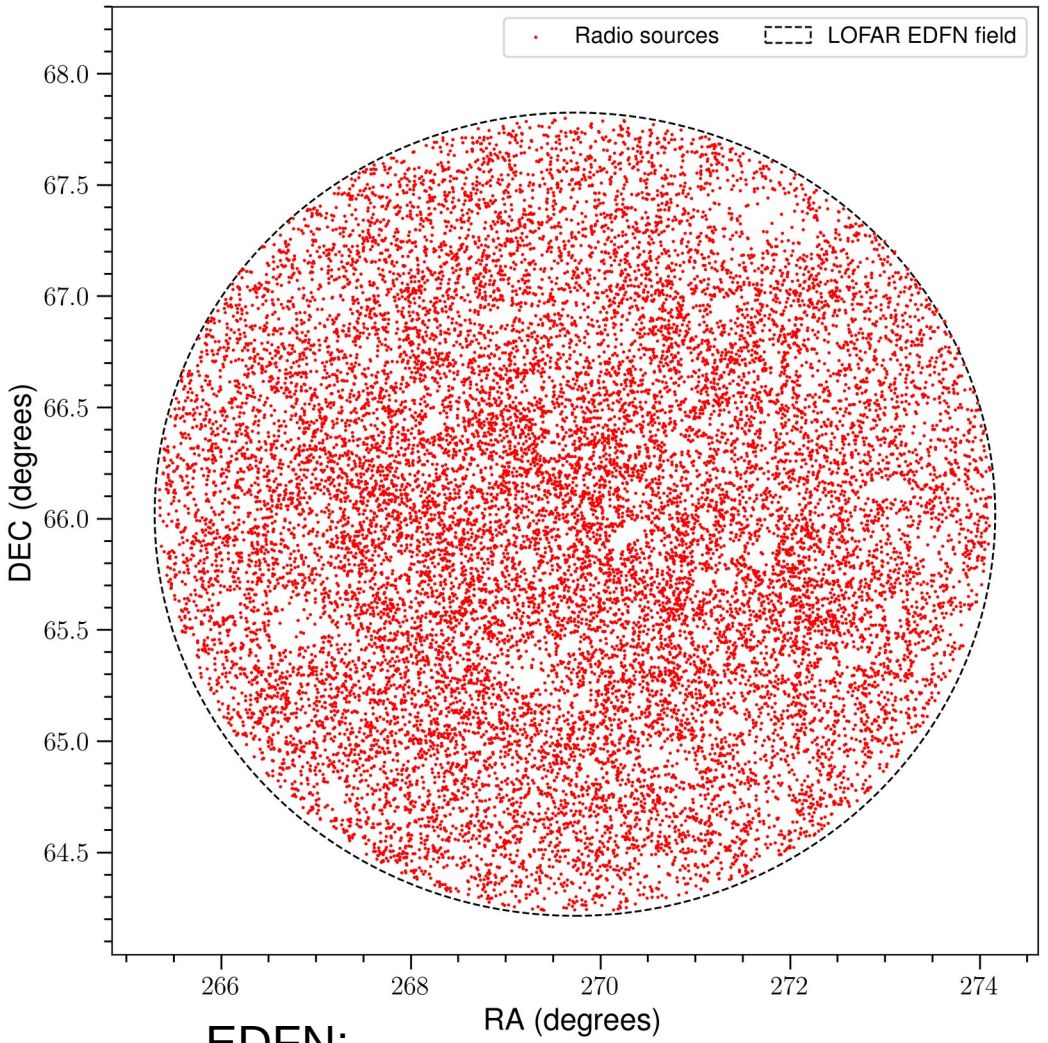



LOFAR Deep Fields (ELAIS-N1, Lockman Hole, Boötes)
Kondapally et al. 2022

# Euclid Deep Field North (EDFN)

EC: Zalesky et al. 2025




EDFN:
~23 deg2
~23k LOFAR sources (Bondi et al. 2024)

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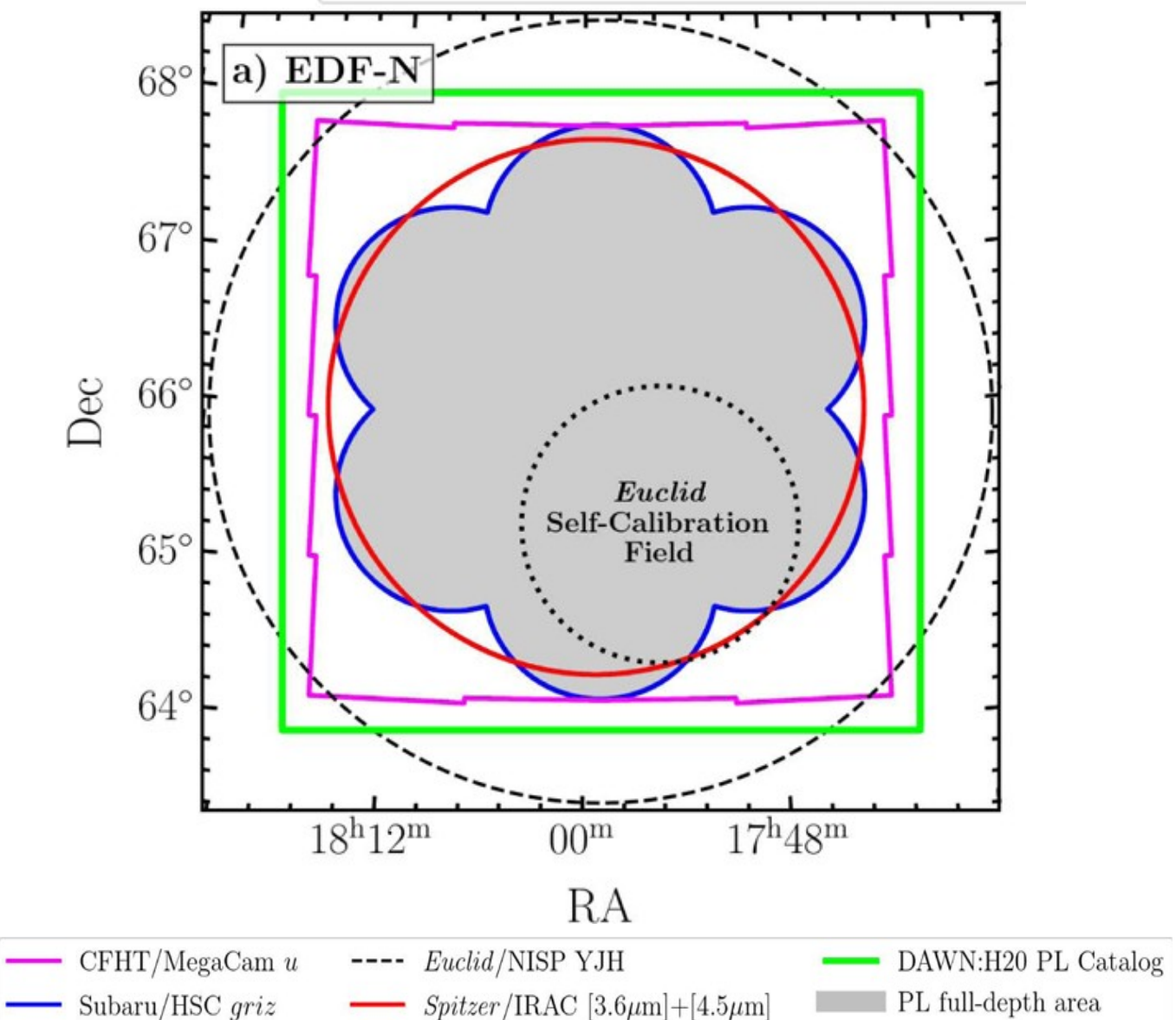
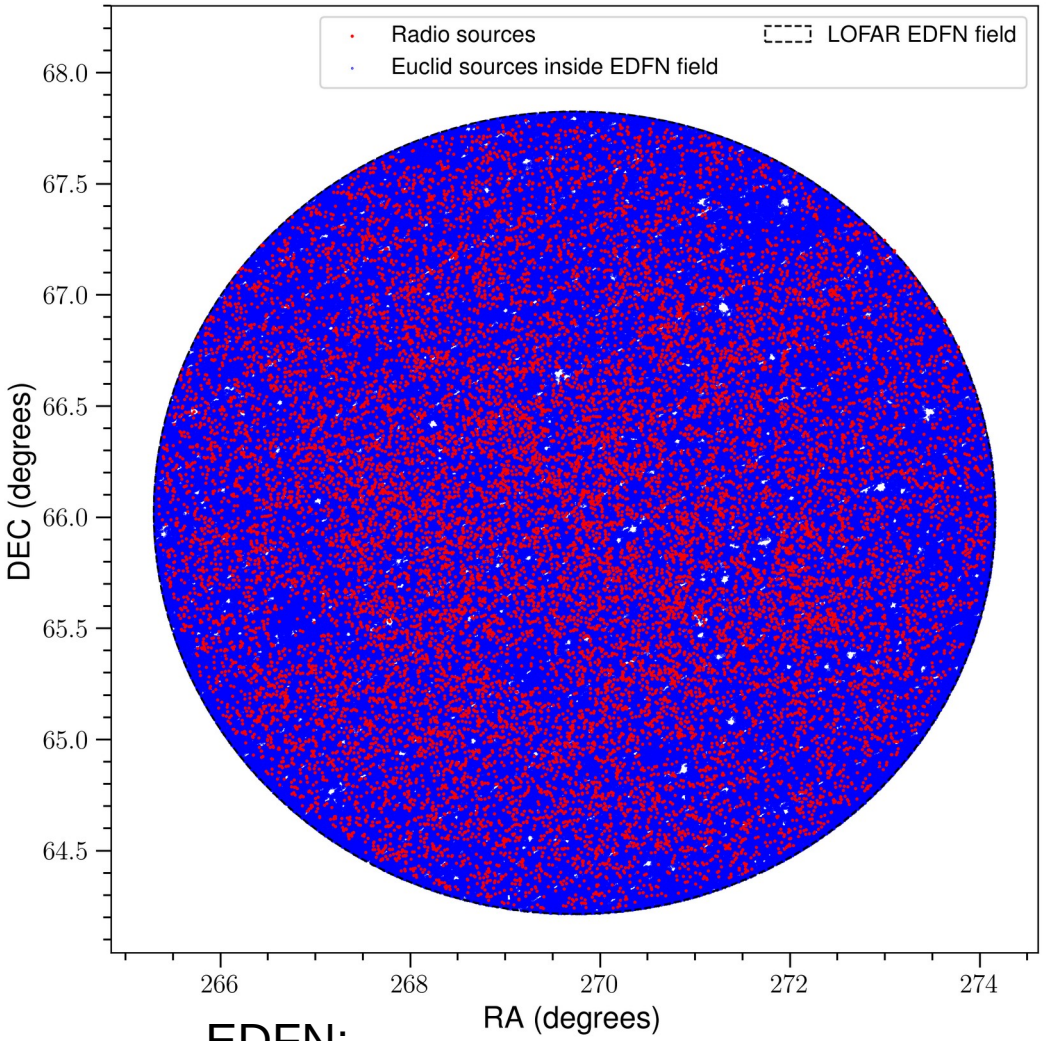


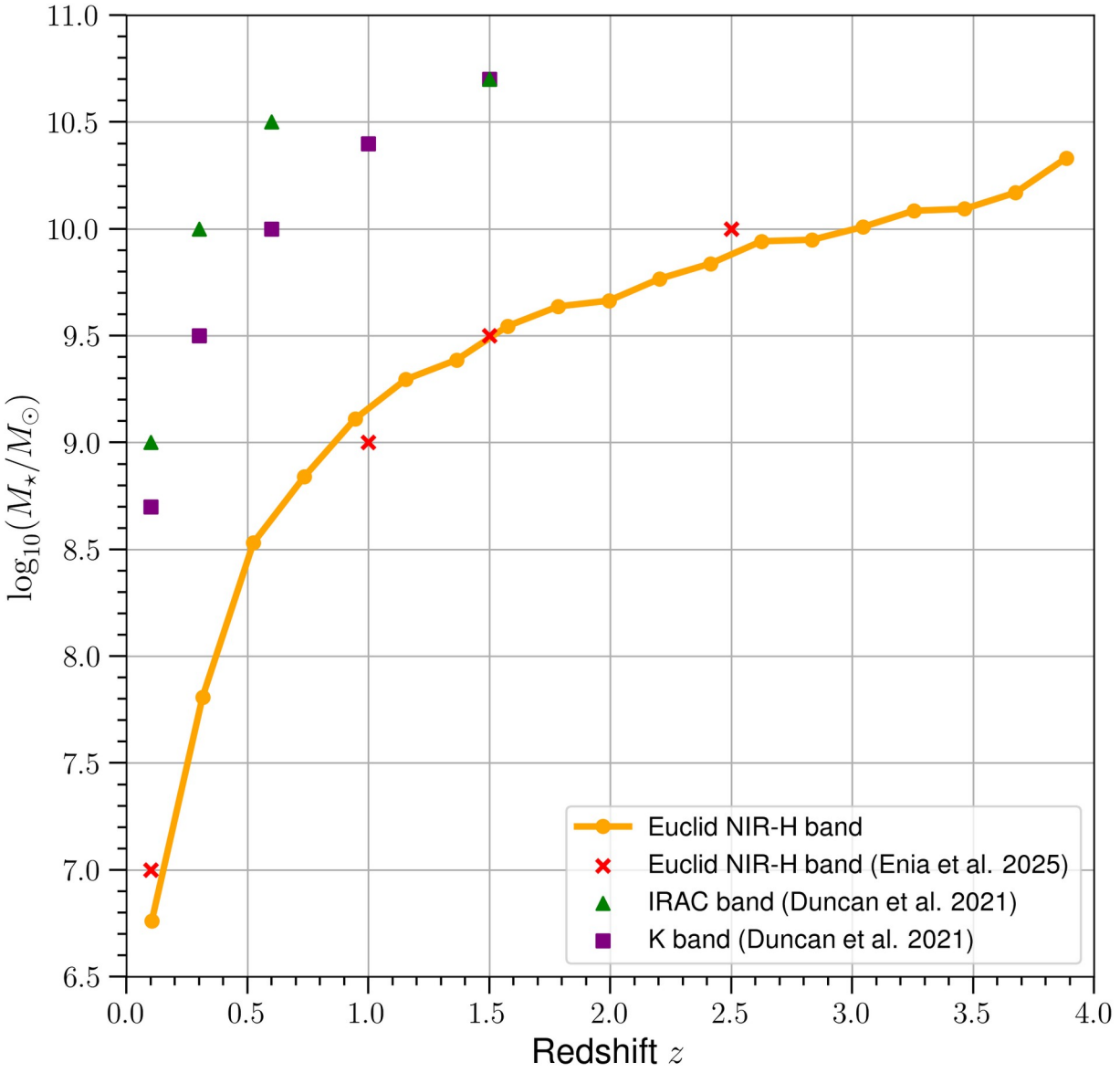




EDFN:
~23 deg2
~23k LOFAR sources (Bondi et al. 2024)
~11m Euclid sources

# Stellar Mass Completeness Limit

Compare stellar mass completeness limit with LOFAR deep fields: ELAIS-N1, Boötes, Lockman Hole (Duncan et al 2021)

Euclid is great at finding low-mass galaxies!



# Cross-matching Euclid Q1 & LOFAR

**Euclid Q1**

All EDFN sources: 11,378,352

↓

After quality cuts & in LOFAR FoV: 1,377,734

**LOFAR EDFN deep field**

Radio catalogue: 23,309 (Bisigello et al. Subm.)

↓

Radio sources with Euclid source within 1.5 arcseconds: 9,253

# Cross-Matching Contamination

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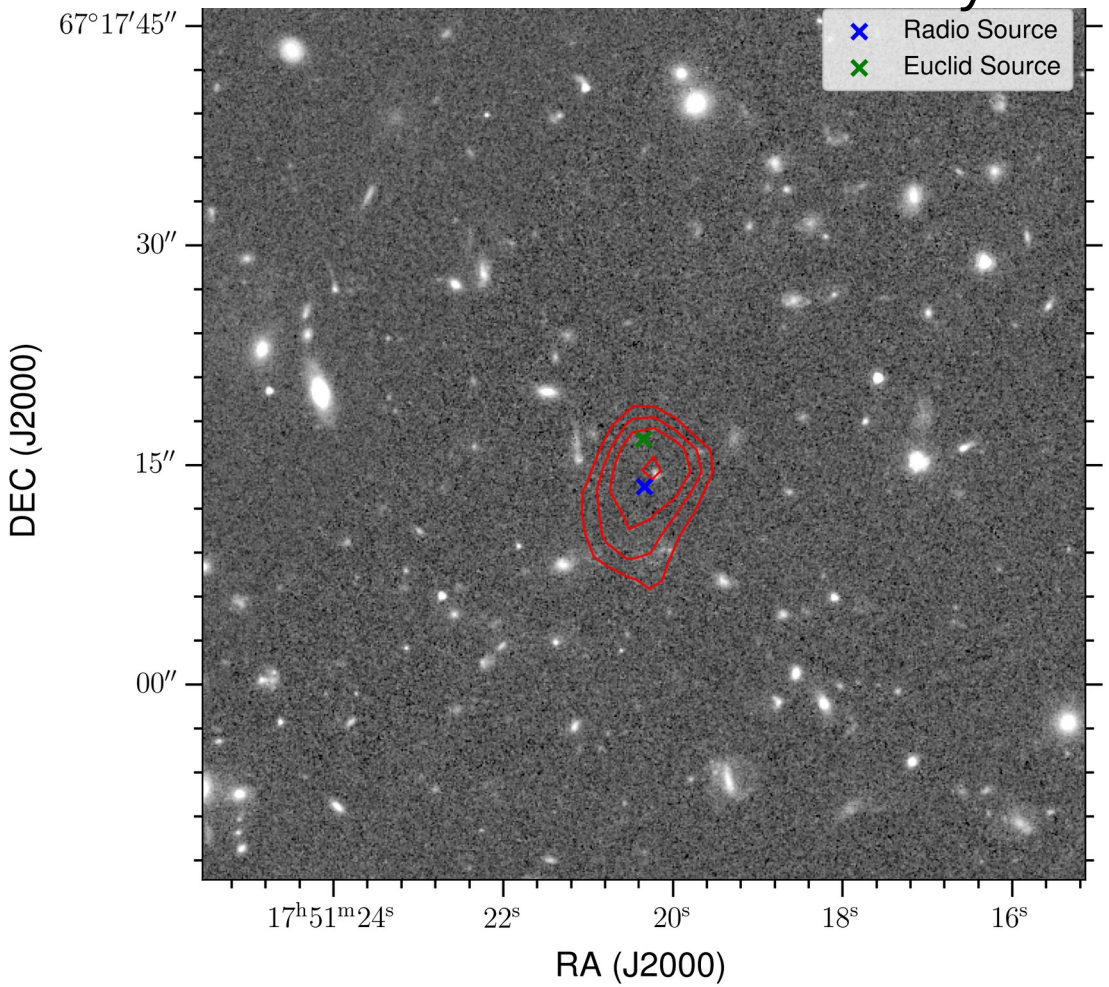
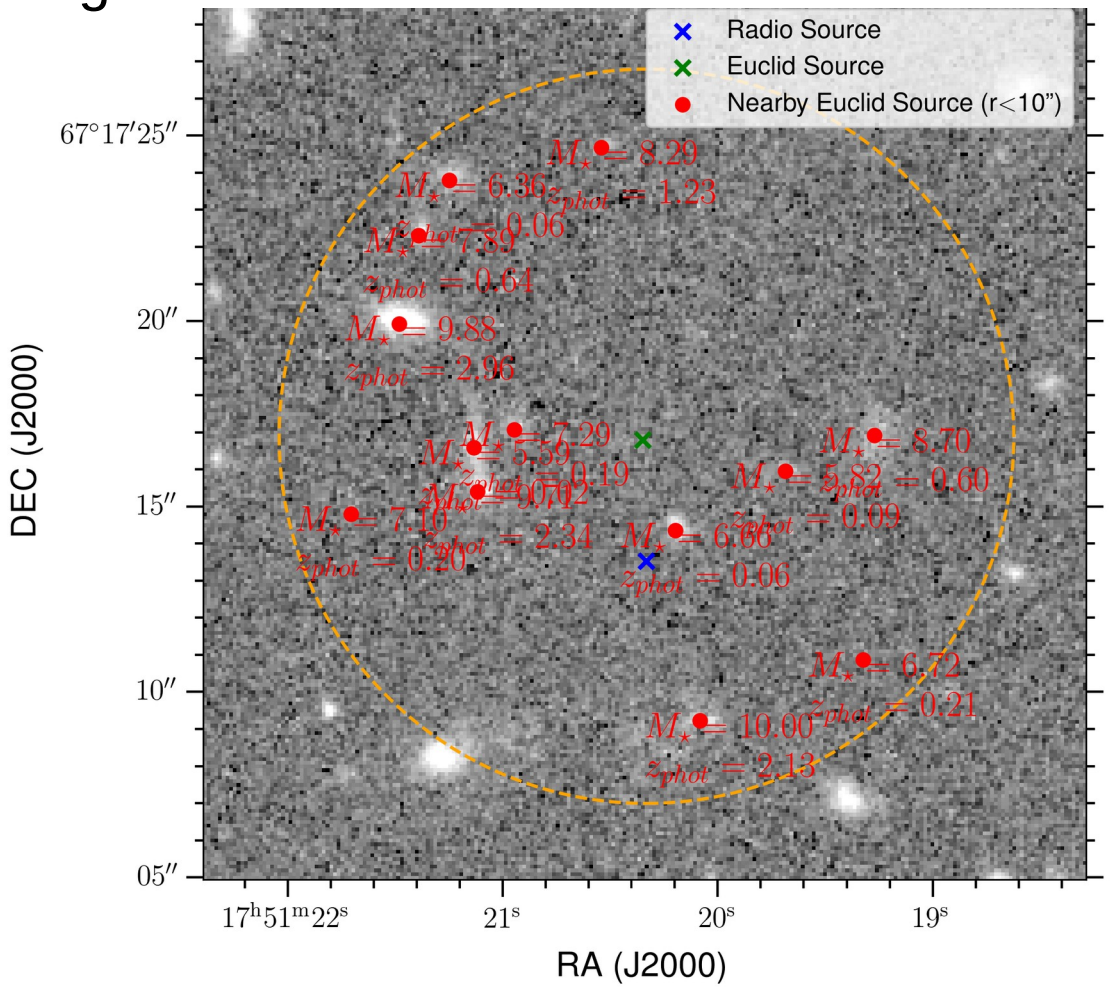
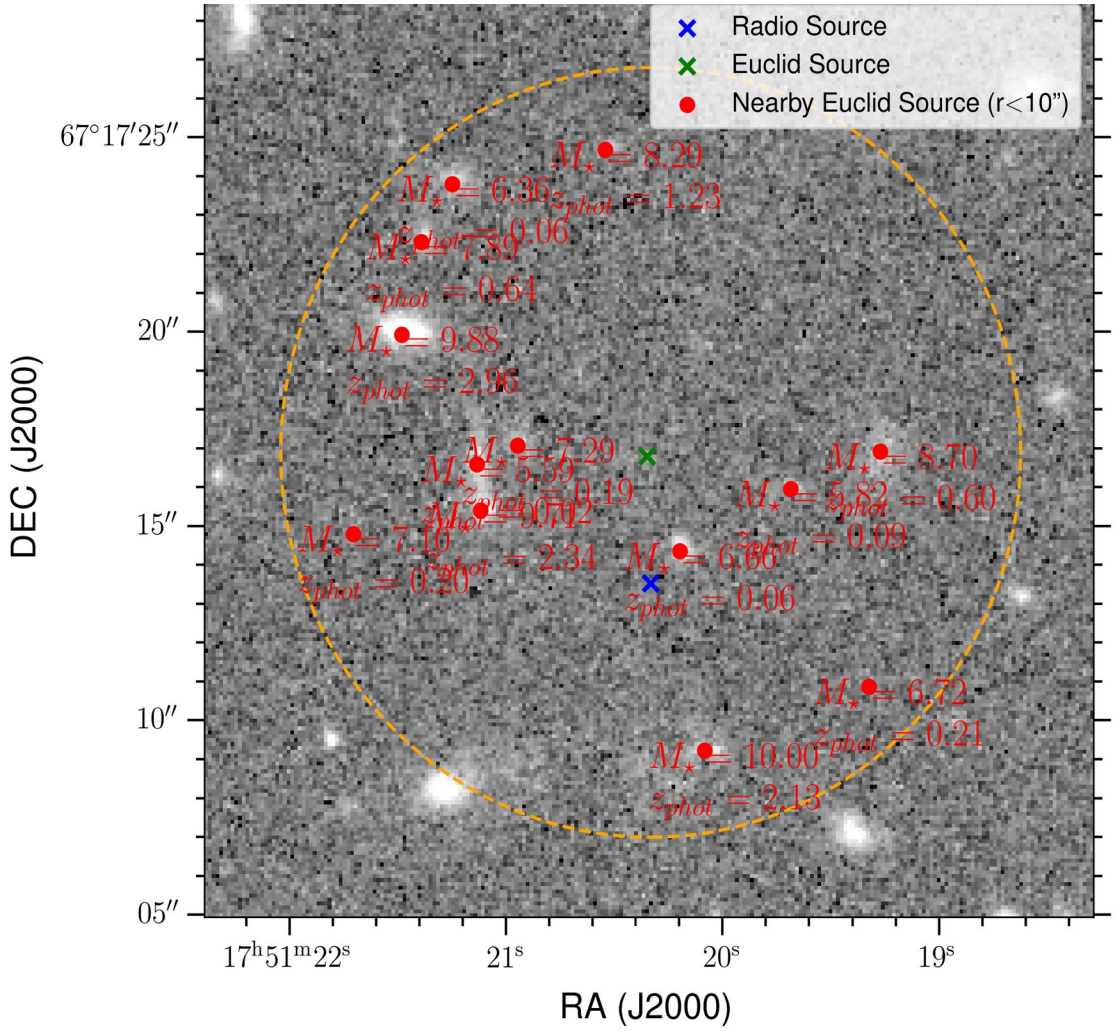
Maybe a bit too good...



# Cross-Matching Contamination

Before filtering (SNR, Physical paramers)

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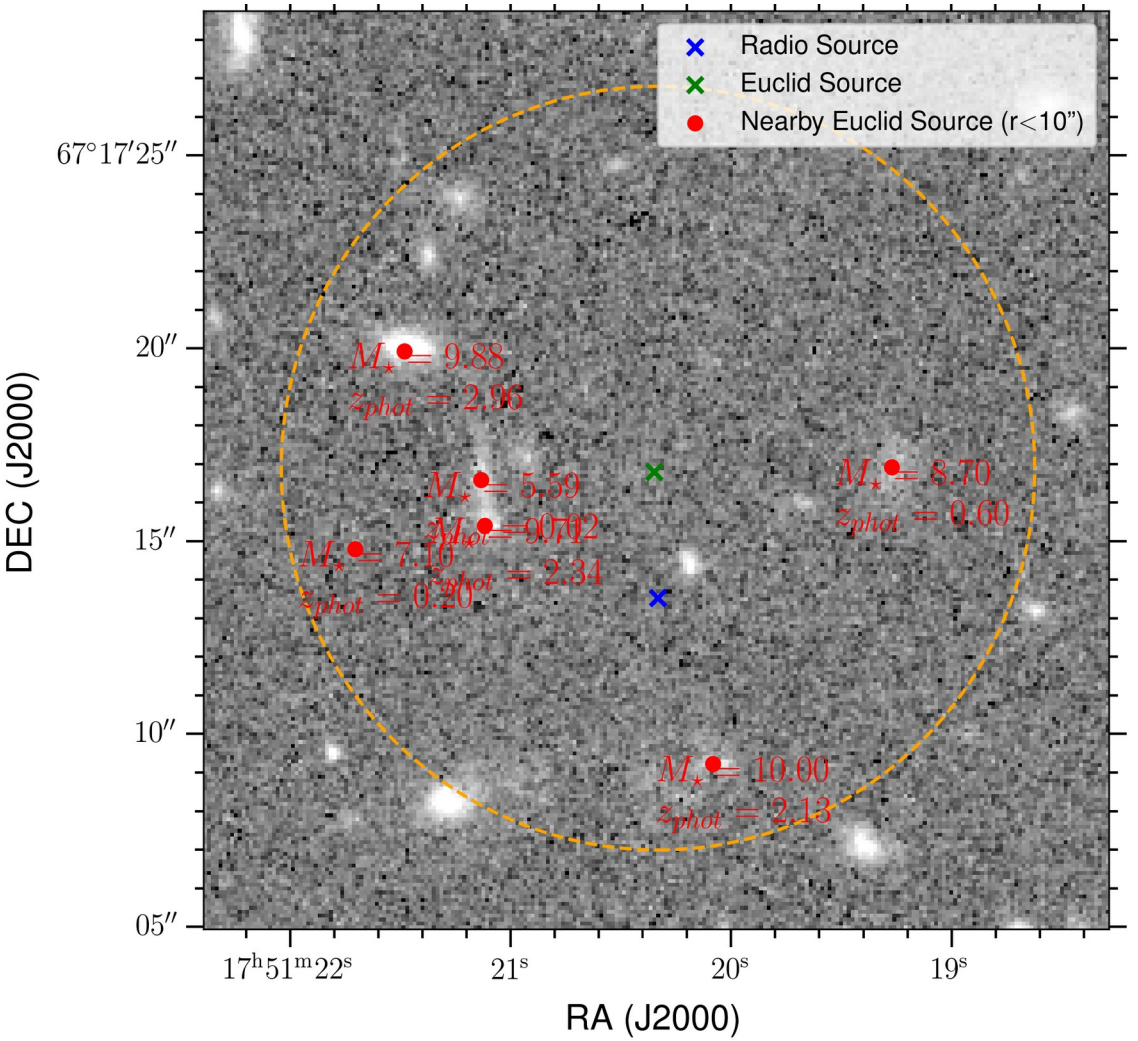
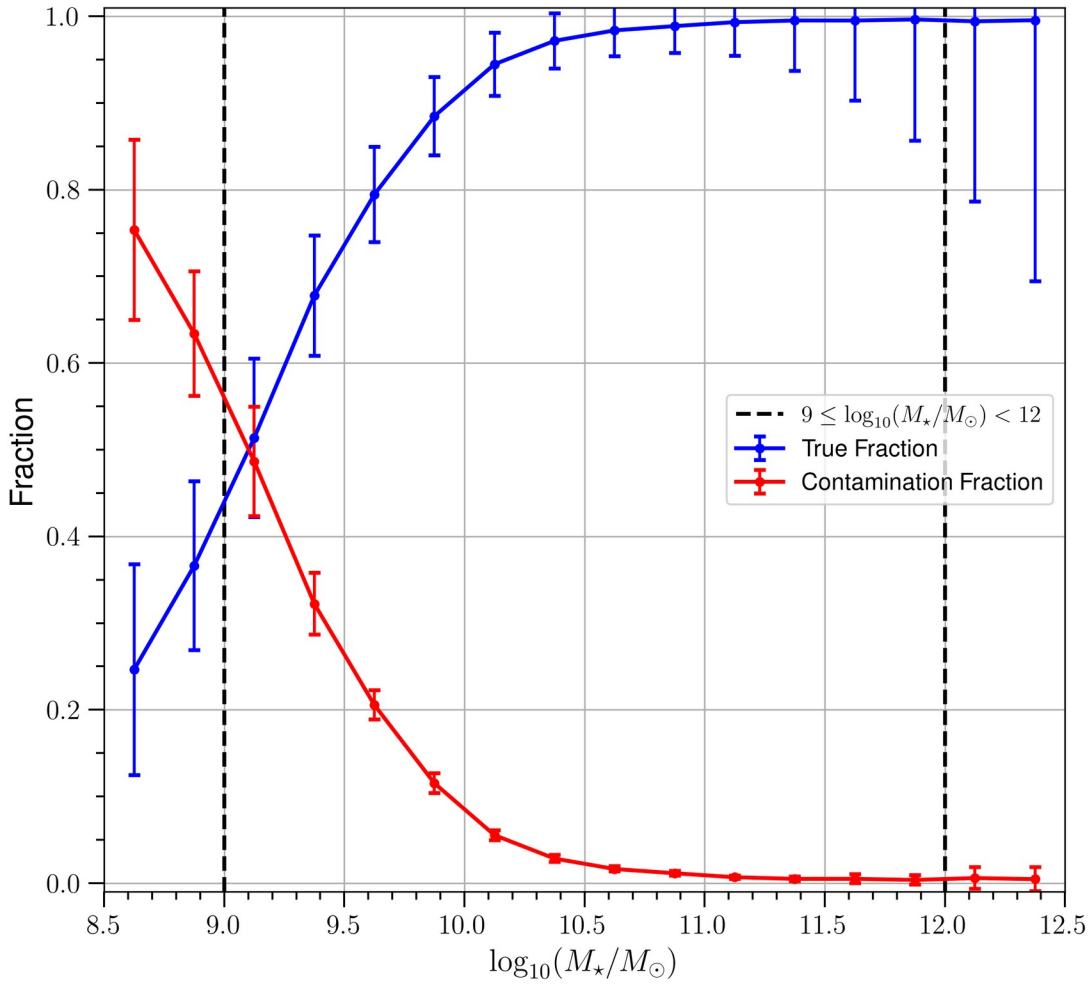


# Cross-Matching Contamination

Estimate contamination through calculating matching fraction for random coordinates in EDFN within 1.5 arcseconds

Make use of Likelihood Ratio (LR) method to improve cross-matching



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Remove sSFR > $10^{-8}$ $yr^{-1}$: 6,075 (EC: Tucci et al. 2025)

# Radio-Loud AGN Classification

Radio Luminosity – Star Formation Rate relation (Das et al. 2024):

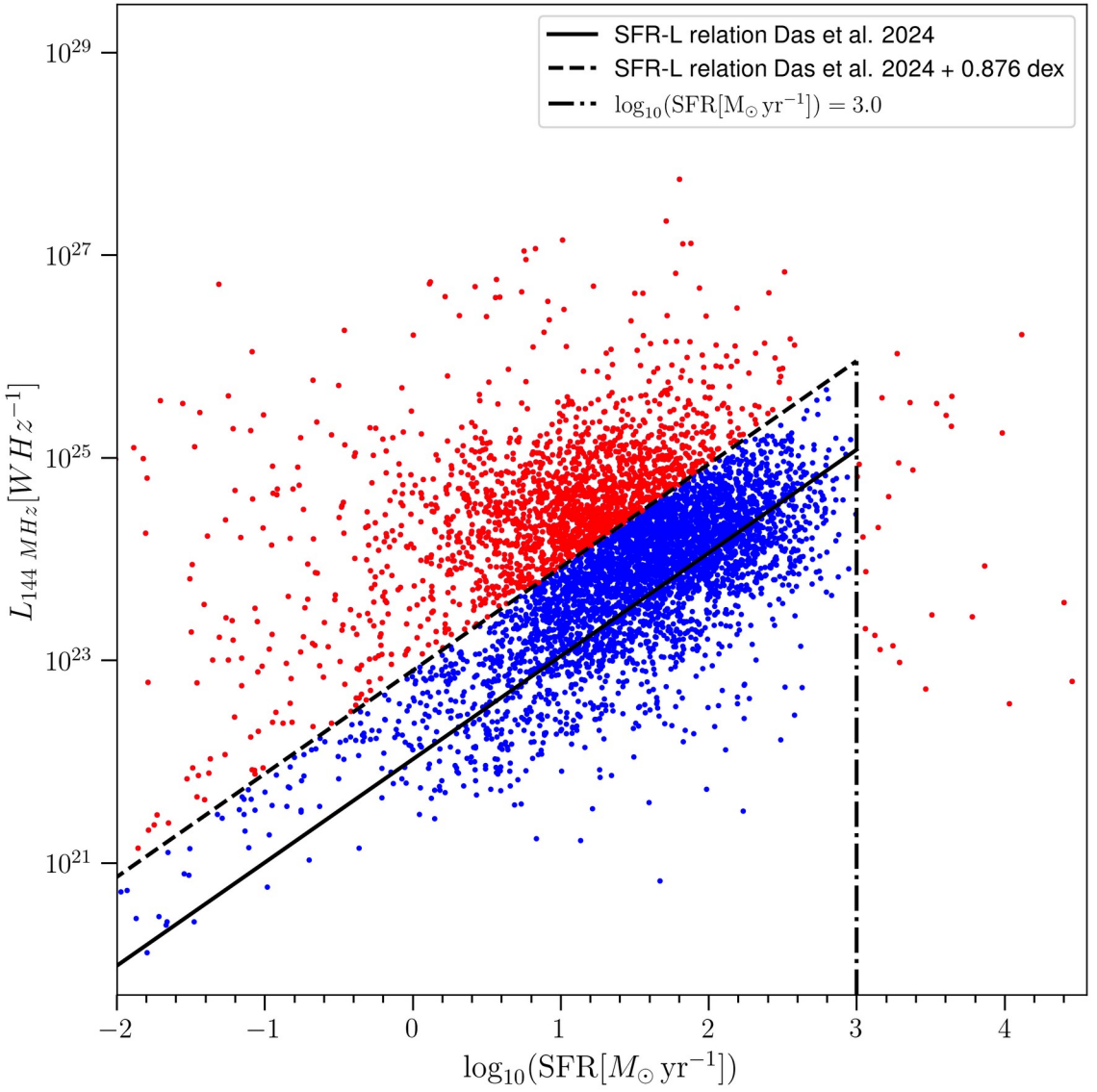
$L_{150\ MHz} = L_0\ \psi^{\beta}$

with $\log_{10}(L_0) = 22.024 \pm 0.006$ and $\beta = 1.019 \pm 0.009$

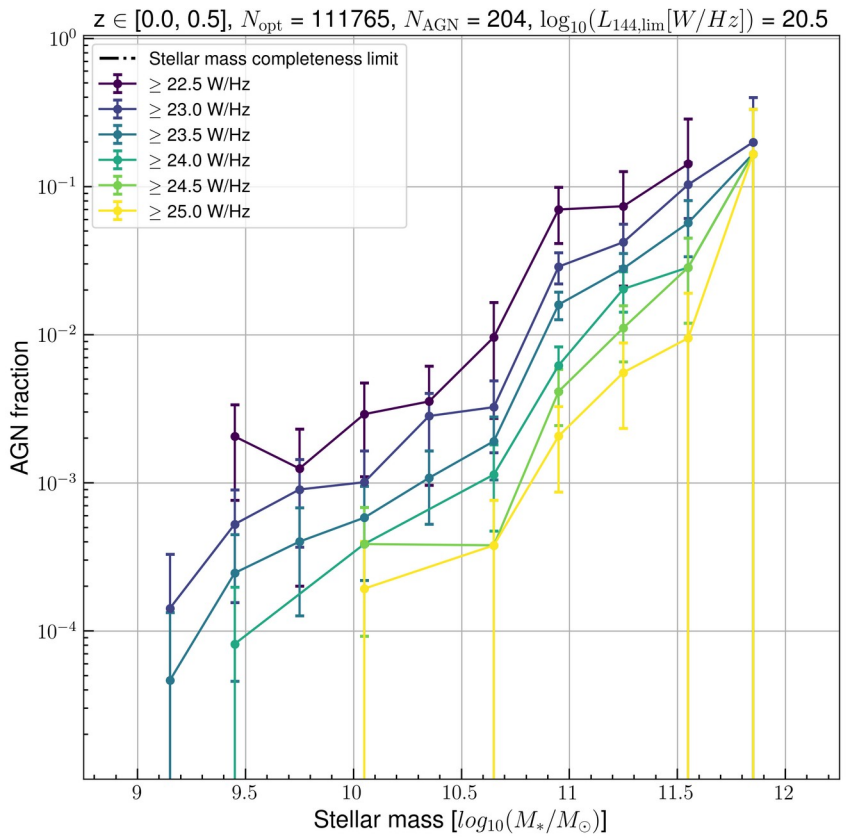
6,075 matched sources

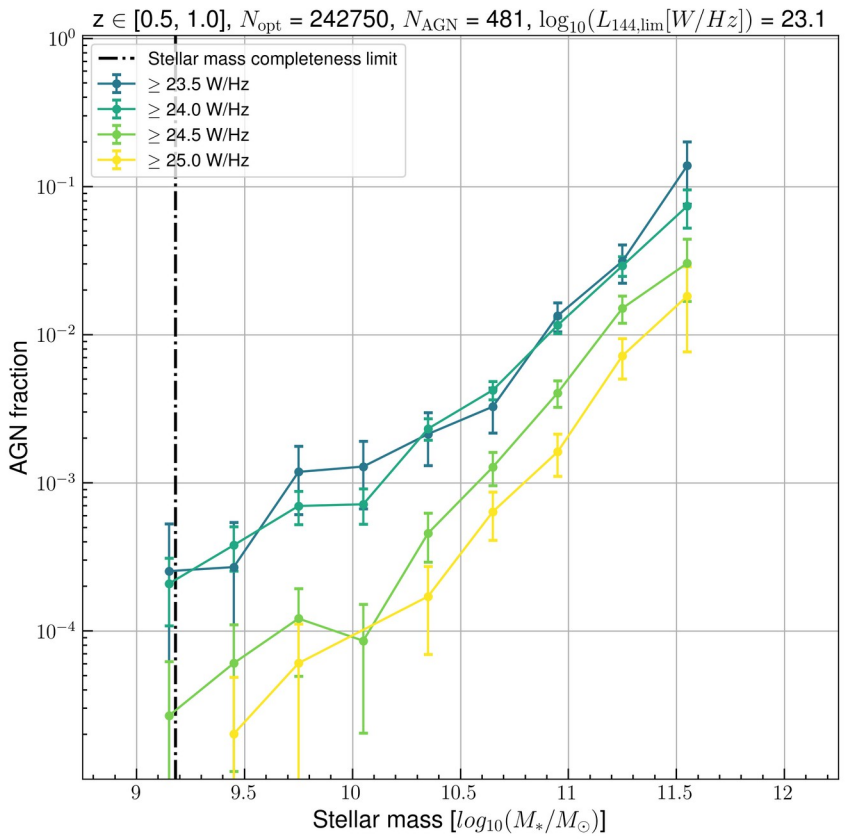
↓

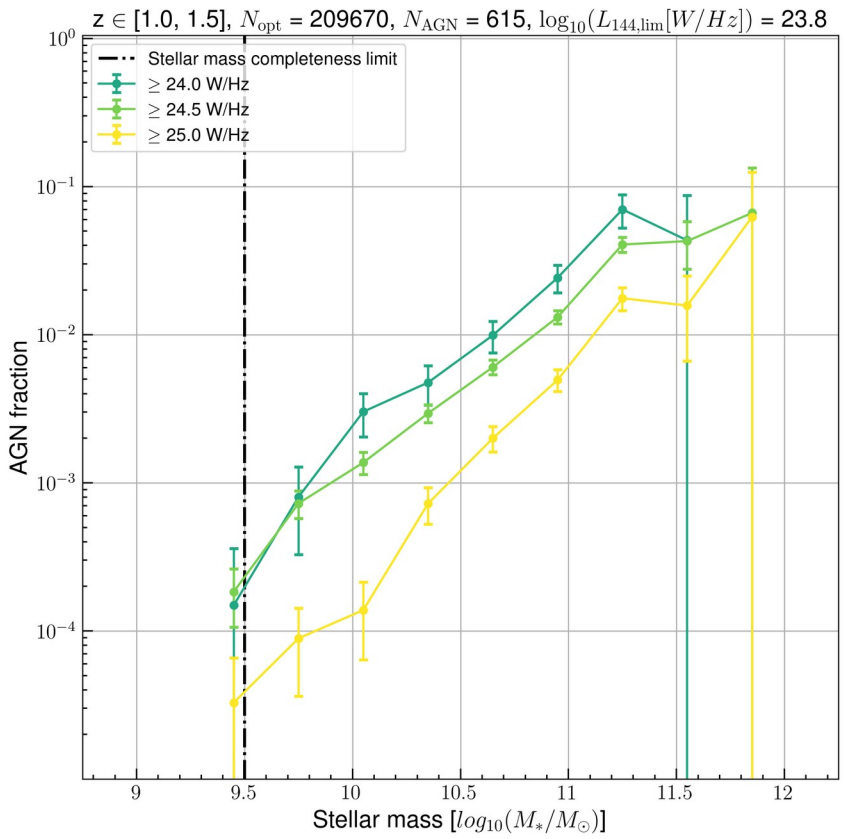
2,076 matched AGN (34.2%)



# Radio-Loud AGN Fraction in the EDFN

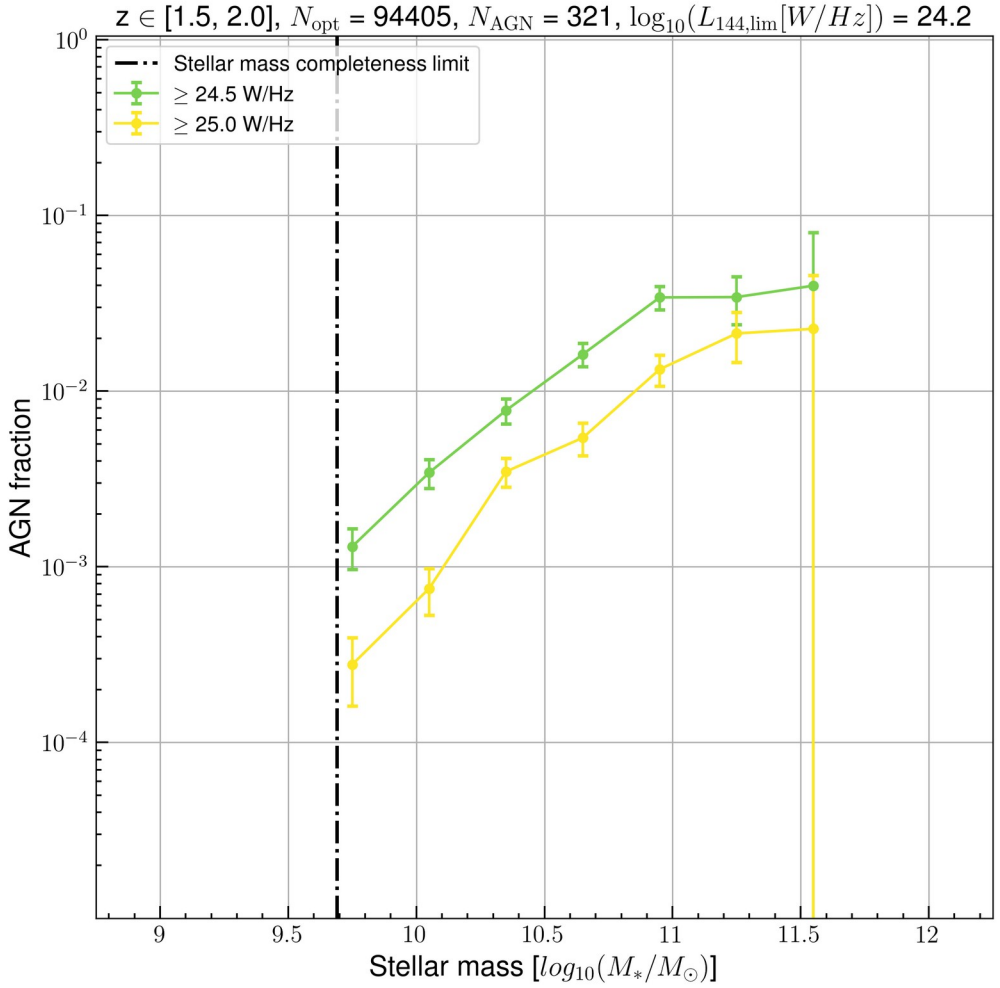


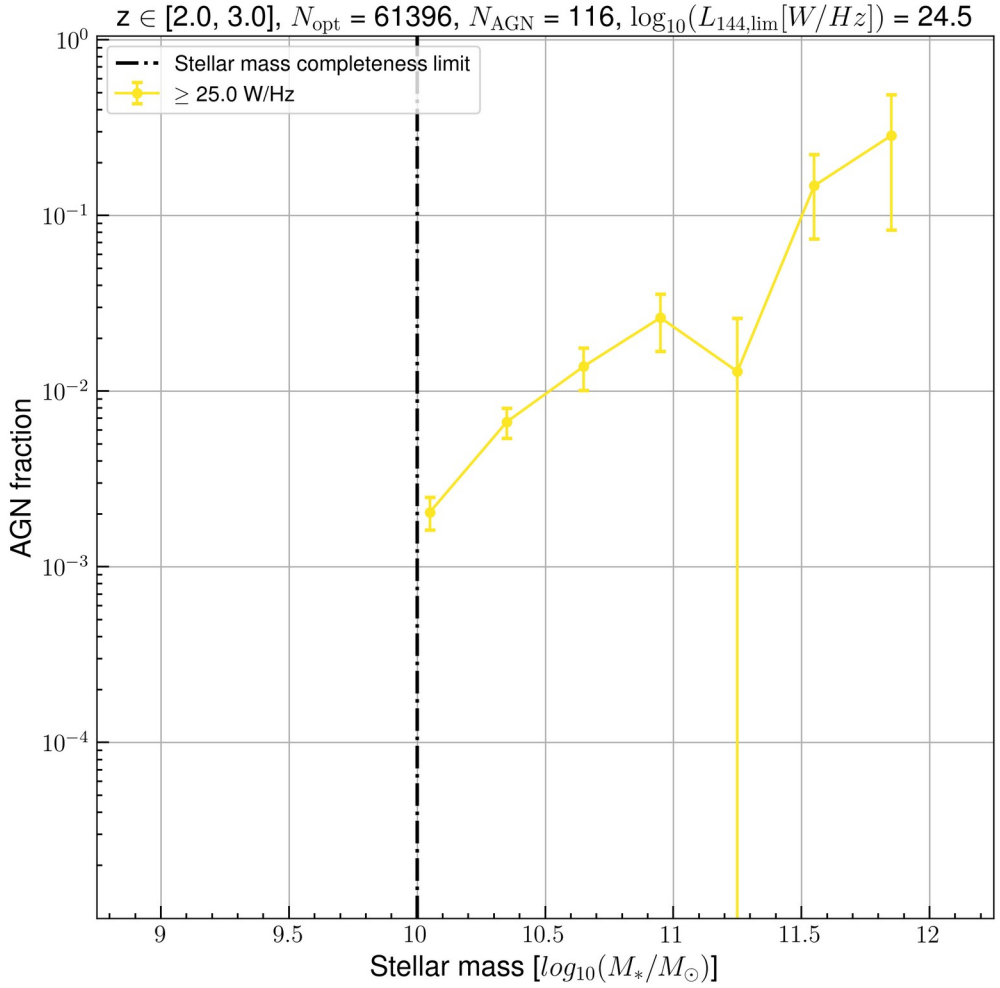



# Radio-Loud AGN Fractions in the EDFN

## Towards higher redshift



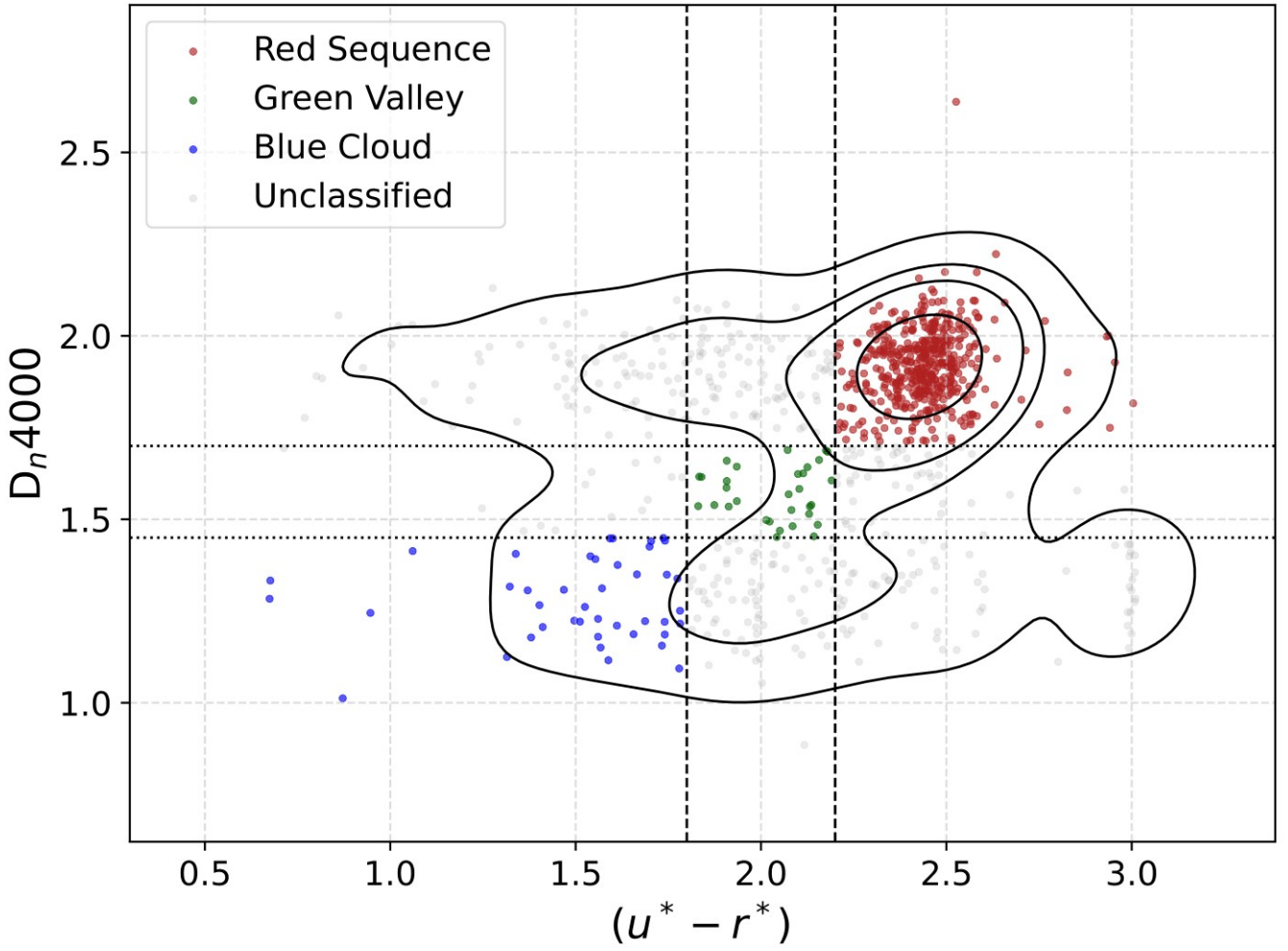



# Colour Evolution of Radio-Loud AGN

- Use 4000 Å break strength and (u-r) colour to separate red and “dead” galaxies from blue galaxies
- Study redshift evolution using two samples:

1) Low-z: Heckman & Best 2012

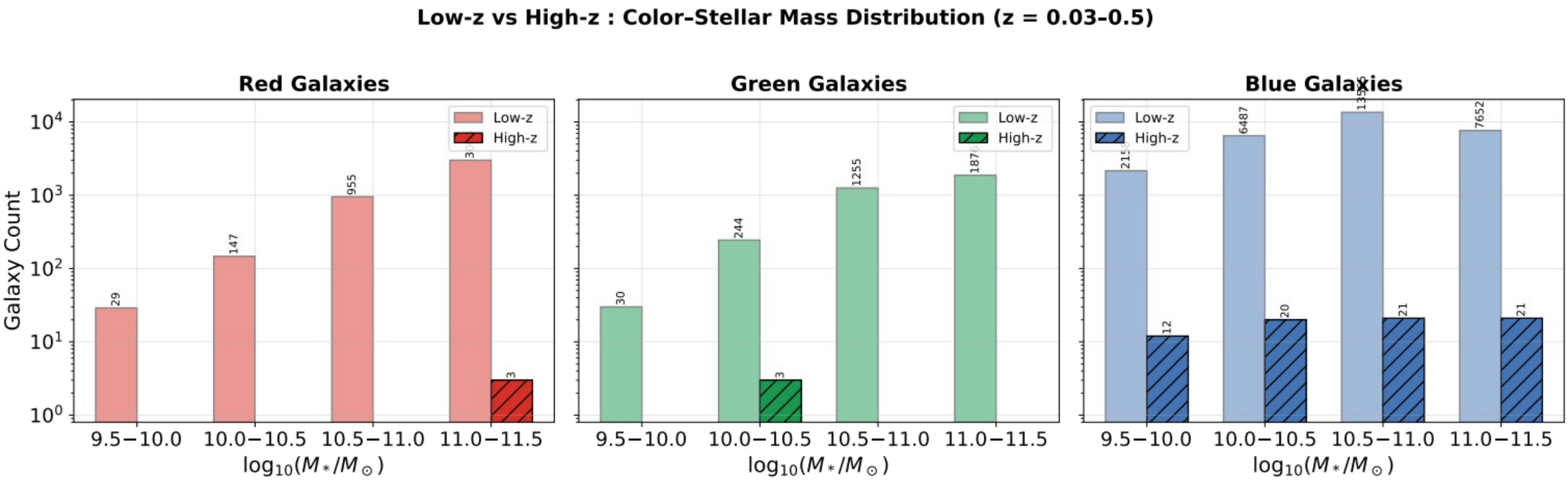
2) High-z: EDFN (LOFAR + Euclid)




Garg, Visser et al. in prep.

# Colour Evolution of Radio-Loud AGN

Explore the overlap in the surveys

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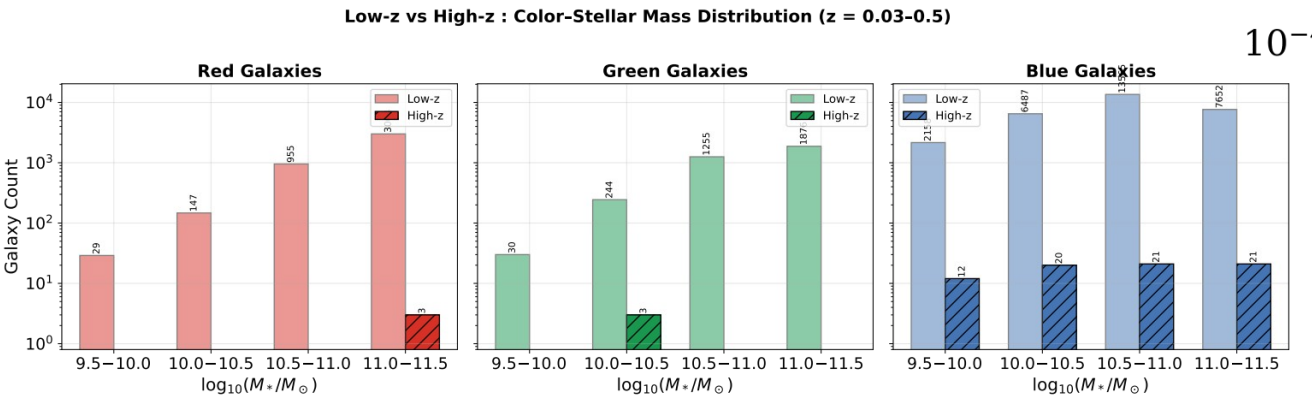
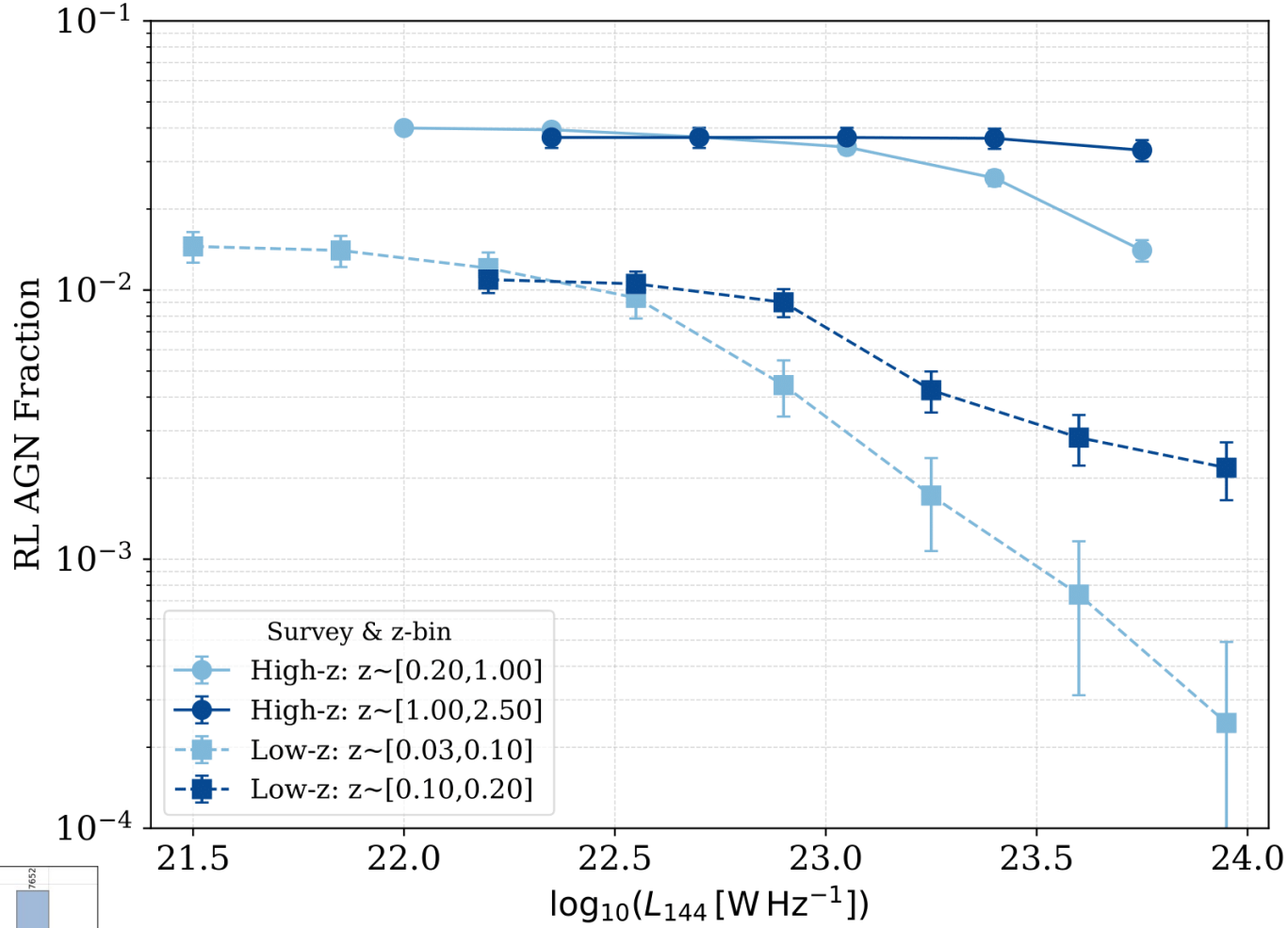
# Colour Evolution of Radio-Loud AGN

Blue sources show evolution with redshift

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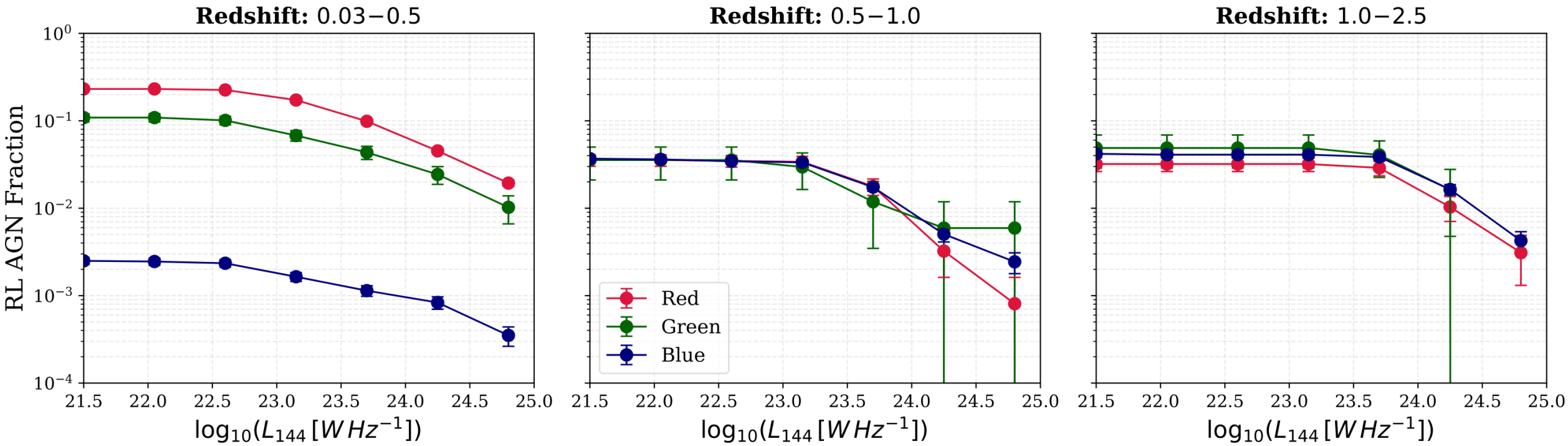


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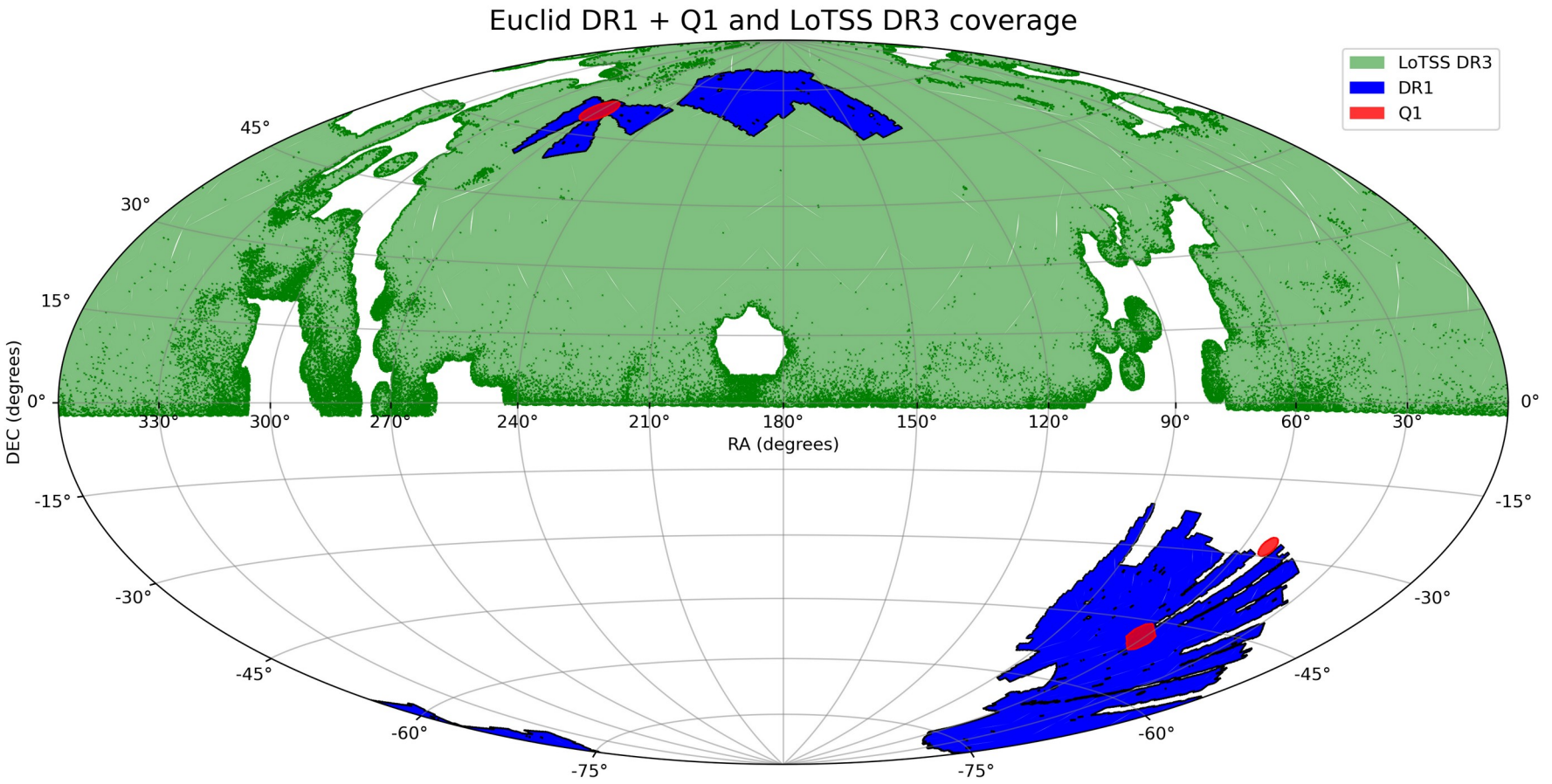
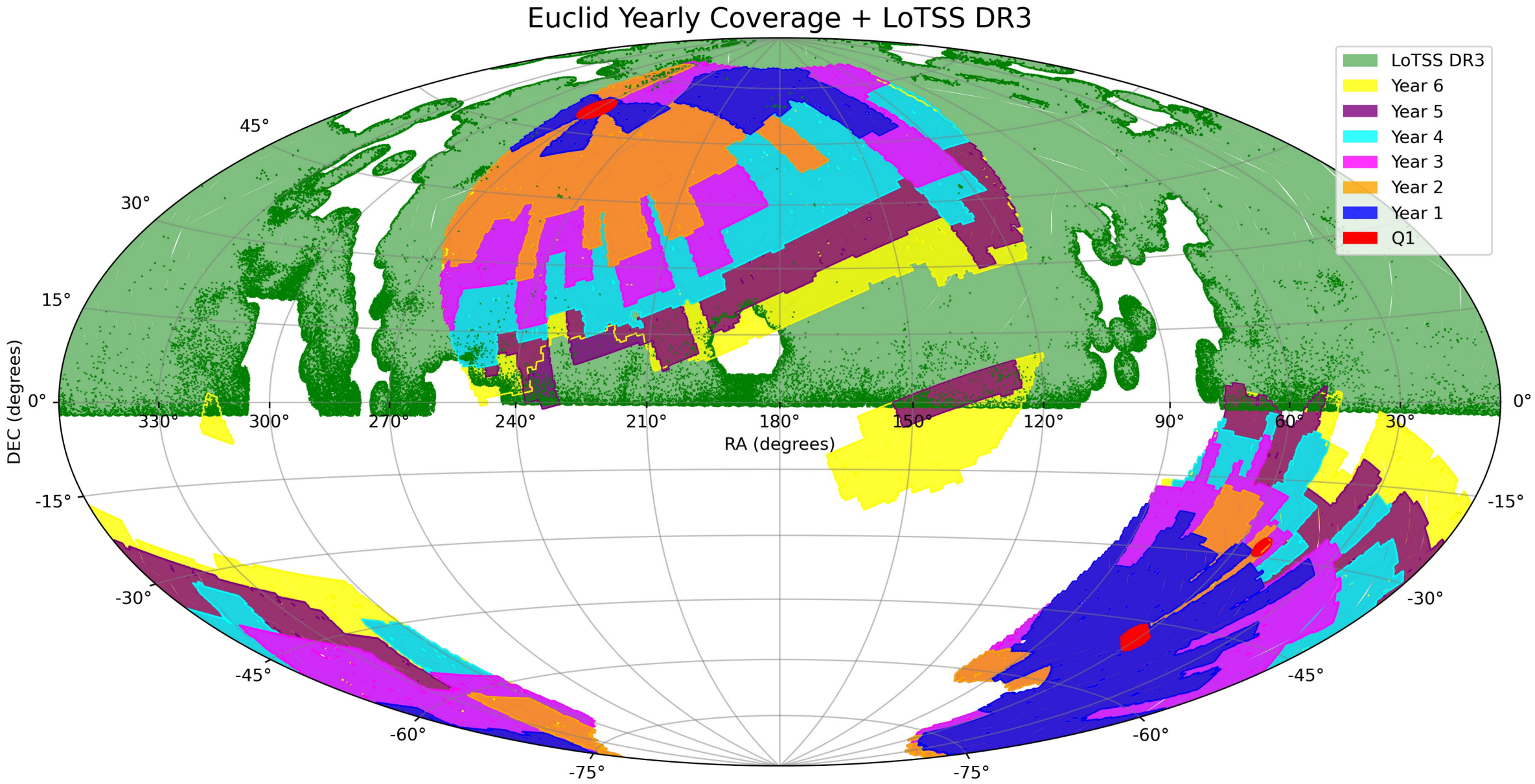
# Towards Euclid DR1 in October 2025




Euclid DR1 coverage:
~500 deg2 in the North
~650k LoTSS DR3 sources
~23k EDFN sources
~200 million Euclid galaxies

# LOFAR + Full Euclid Survey



# Conclusions

- Radio-loud AGN fractions follow powerlaw over large redshift and stellar mass windows
- Galaxy colours reflect radio-loud AGN evolution
- Huge potential in combining LOFAR & Euclid

Thank you for listening!
Any questions?