

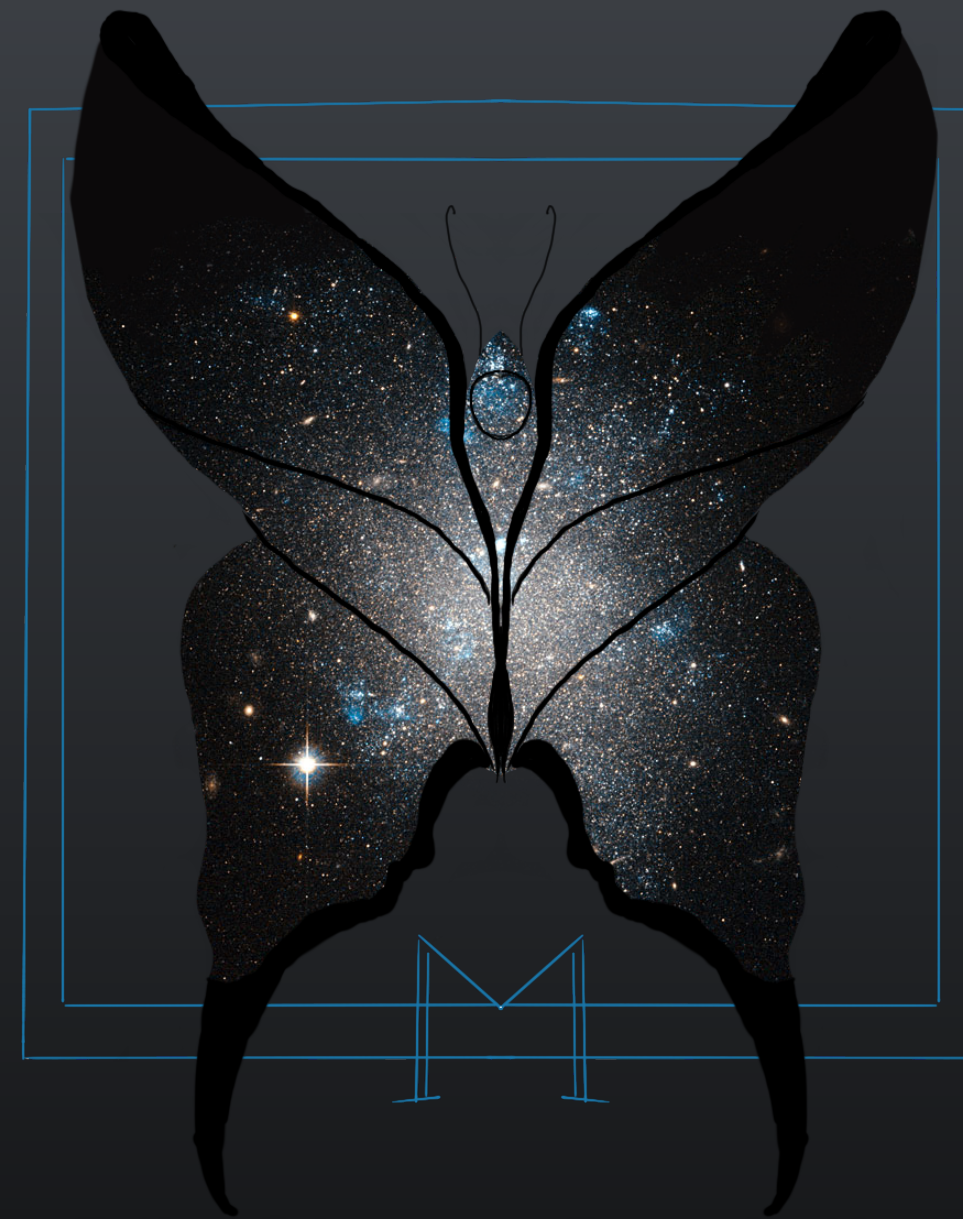
The Merian Survey: characterizing dark matter and feedback in star-forming dwarf galaxies with medium-band filters on DECam

Yifei Luo

University of California Santa Cruz

Collaborators:

Alexie Leauthaud (co-PI), **Jenny Greene (co-PI)**, **Shany Danieli**, **Erin Kado-Fong**, Song Huang, **Ting Li**, **Jiaxuan Li**, **Abby Mintz**, **Yue Pan**, Robert Lupton, Lee Kelvin, Robel Geda, Vivienne Baldassare, Erik Wasleske, Diana Blanco, Zheng Cai, Yifan Li, Mingyu Li, Xiaojing Lin, Alyson Brooks, **Dilys Ruan**, Annika Peter, **Joy Bhattacharyya**, Arka Banerjee, ...

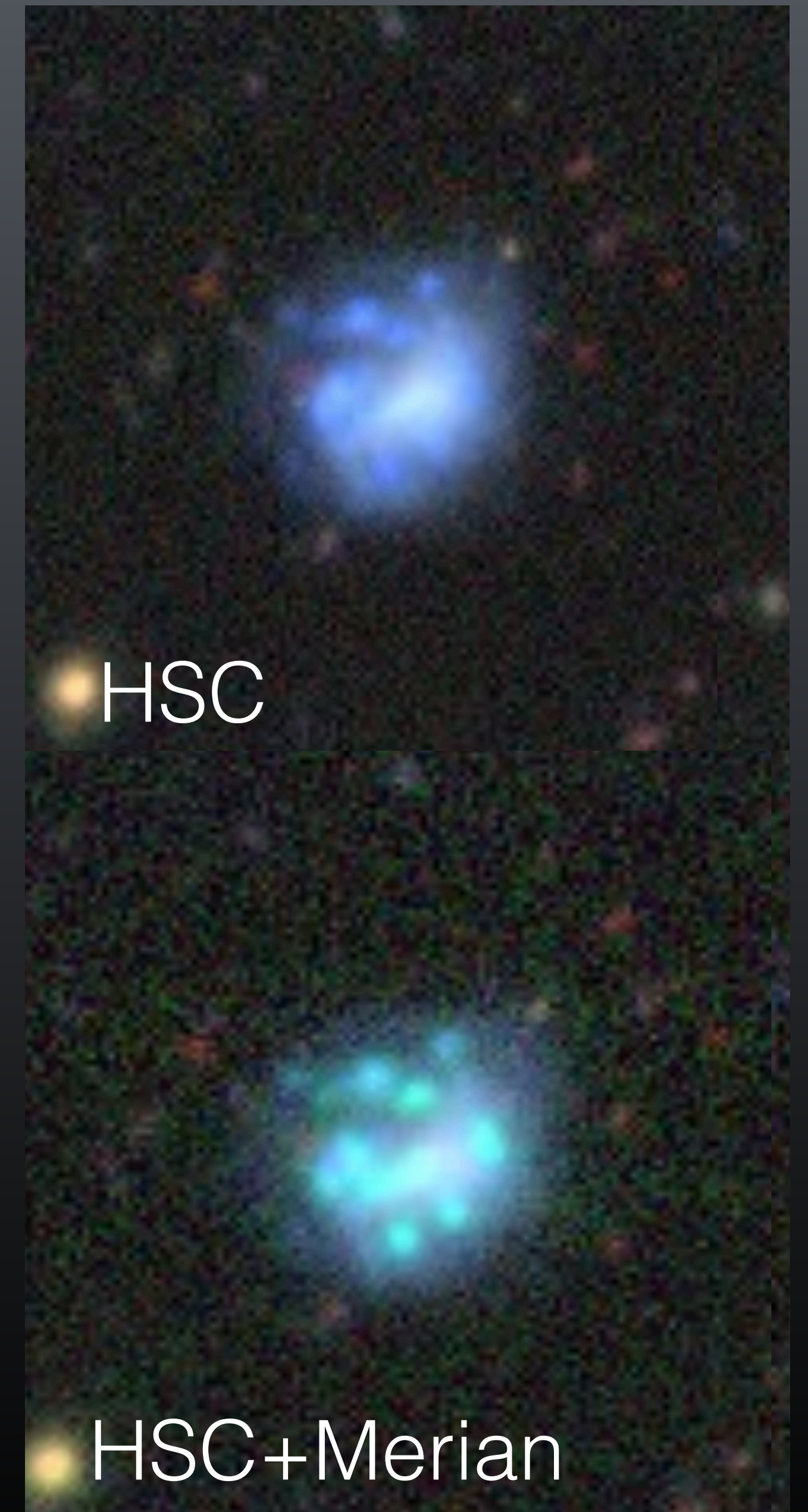


July 9, Chicago

Dwarf Galaxies, Star Clusters, and Streams in the LSST Era

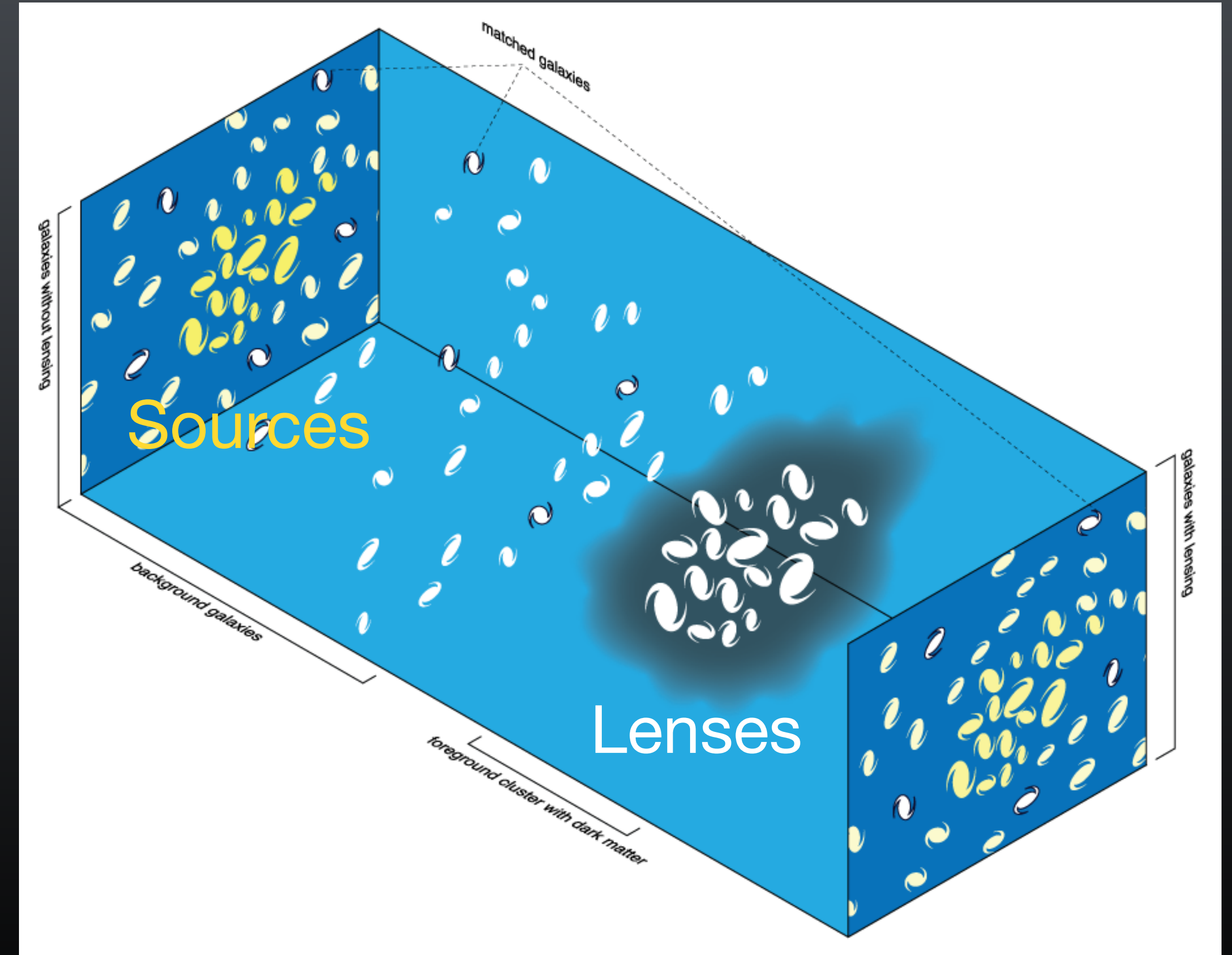
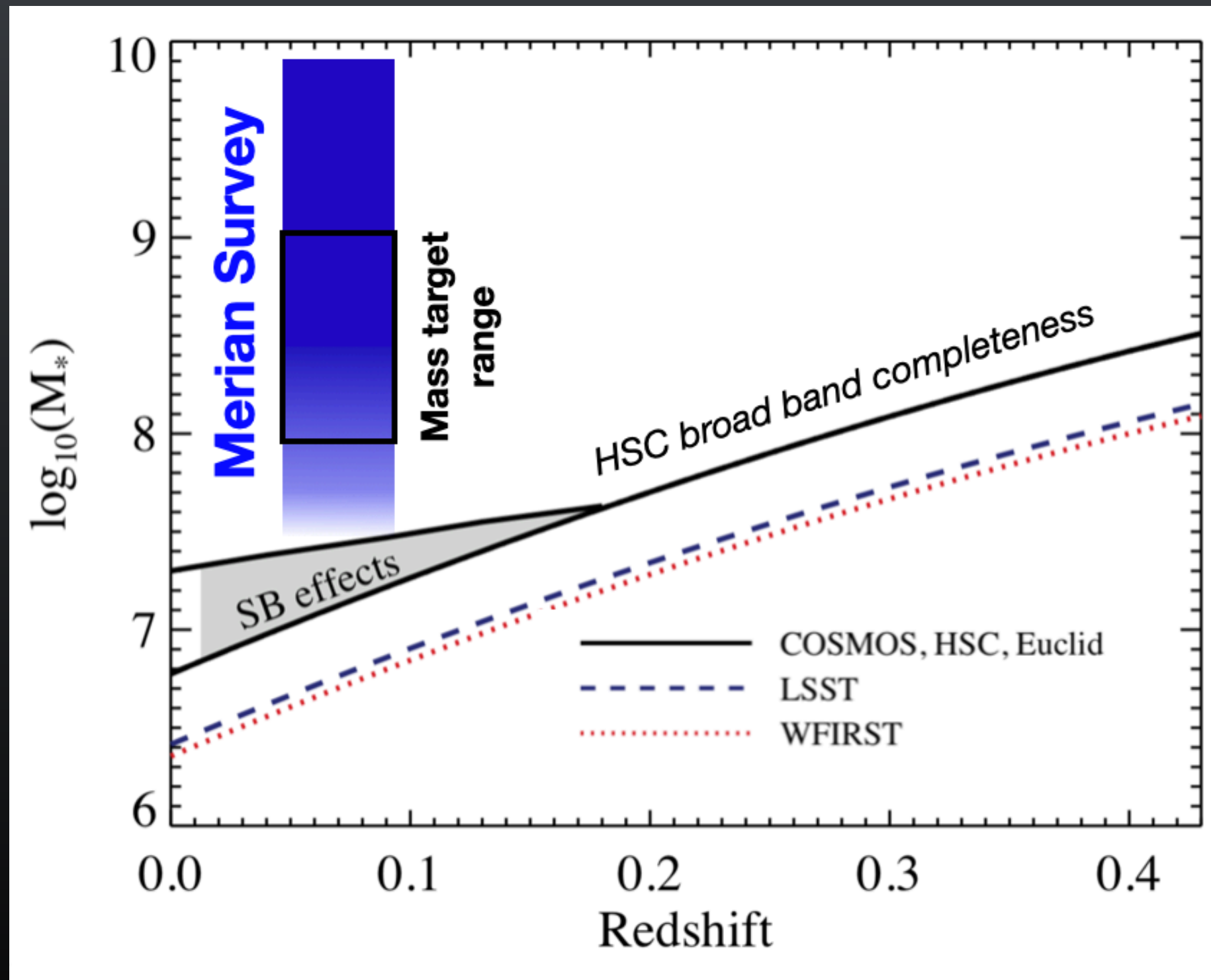
The Merian Survey

- Two medium-band filters (N708/N540) for H α and OIII in order to find $\sim 100,000$ dwarf galaxies ($10^8 - 10^9 M_{\odot}$) at $z \sim 0.1$
- 64 full nights on the CTIO-4m Dark Energy Camera (DECam) to cover 800 deg^2 in HSC-SSP field
- Core science goals: constrain dark matter and feedback in star-forming dwarf galaxies

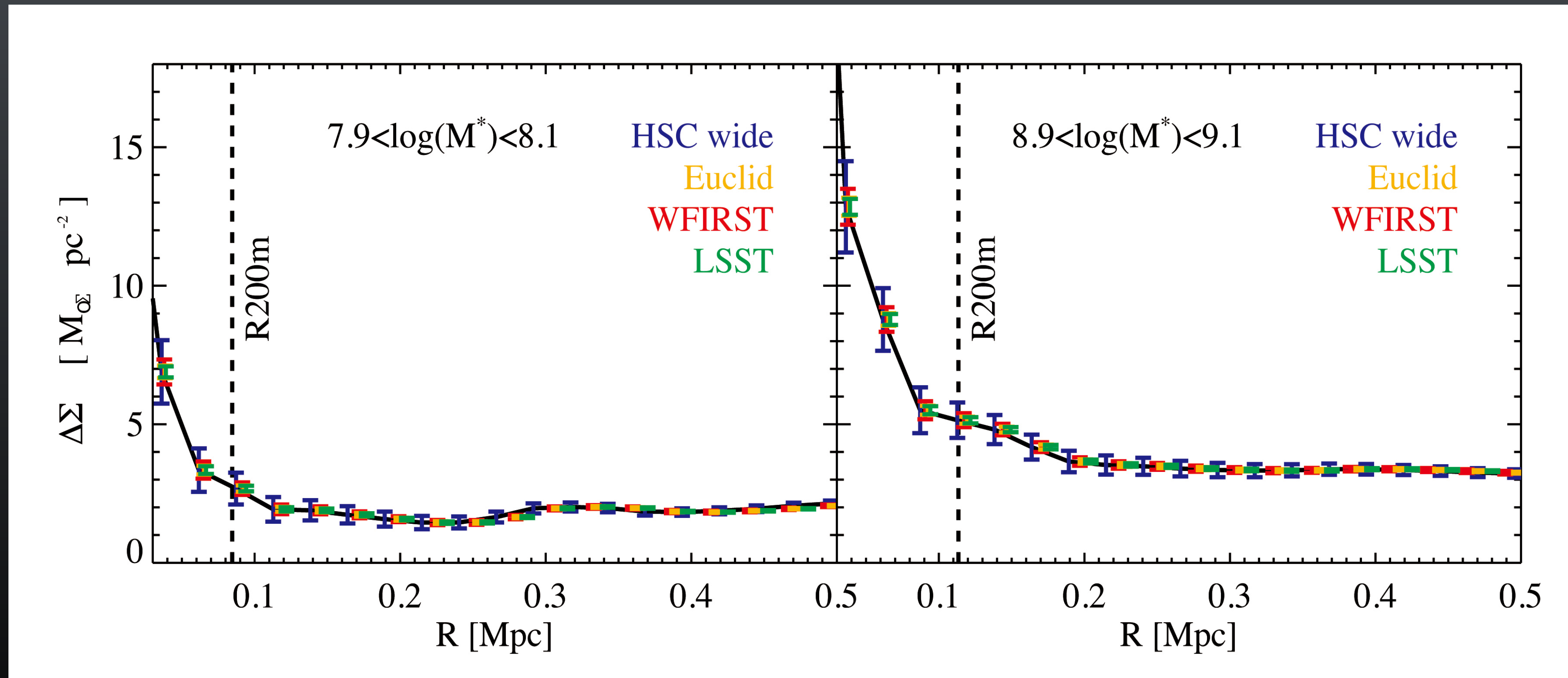


Weak gravitational lensing

- Constrain dark matter halo out to R_{vir}
- Need large sample of lenses



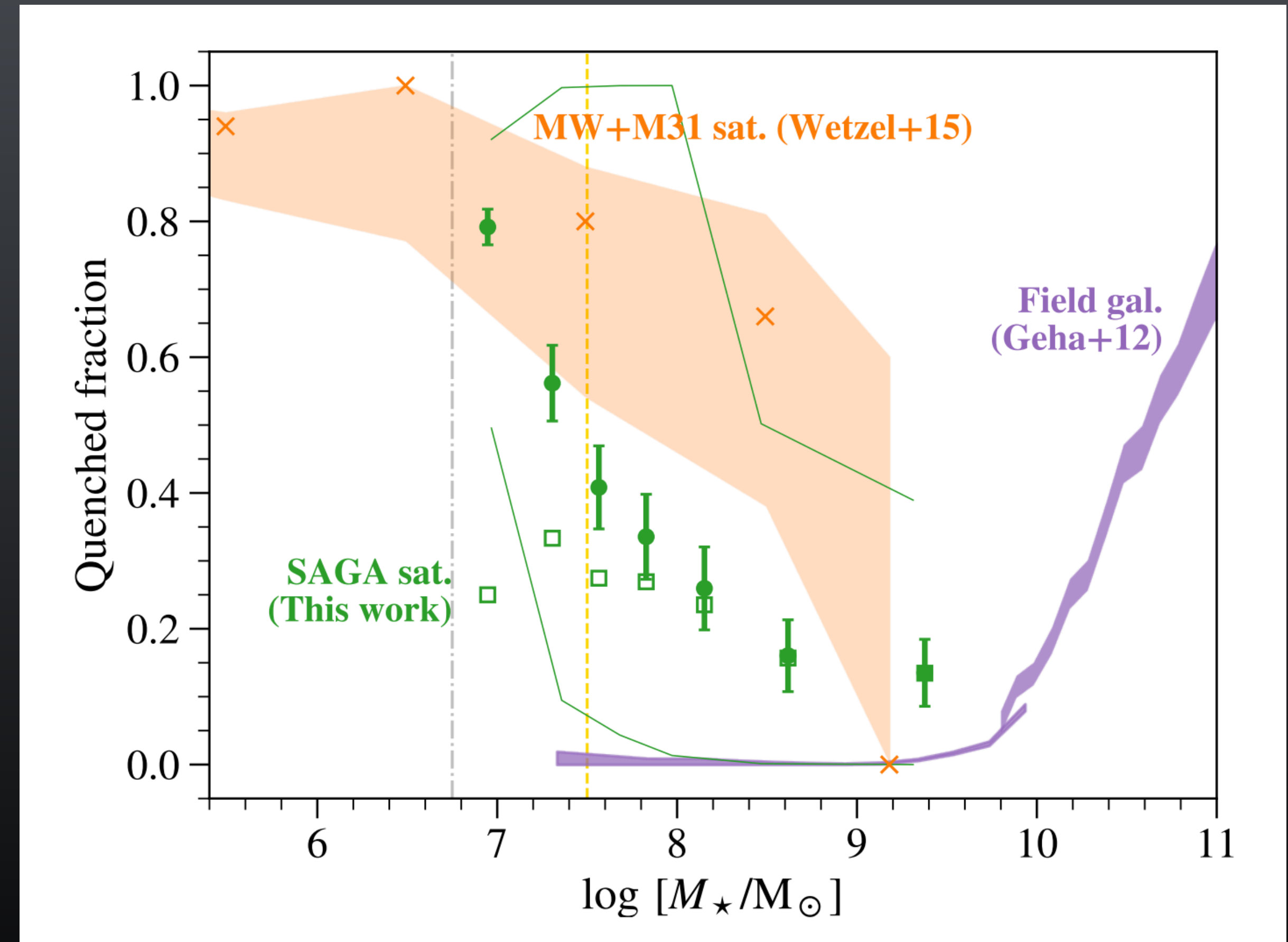
Simulations shows HSC can already detect enough low-mass galaxies down to 10^8 Msun with high completeness to get a decent lensing signal

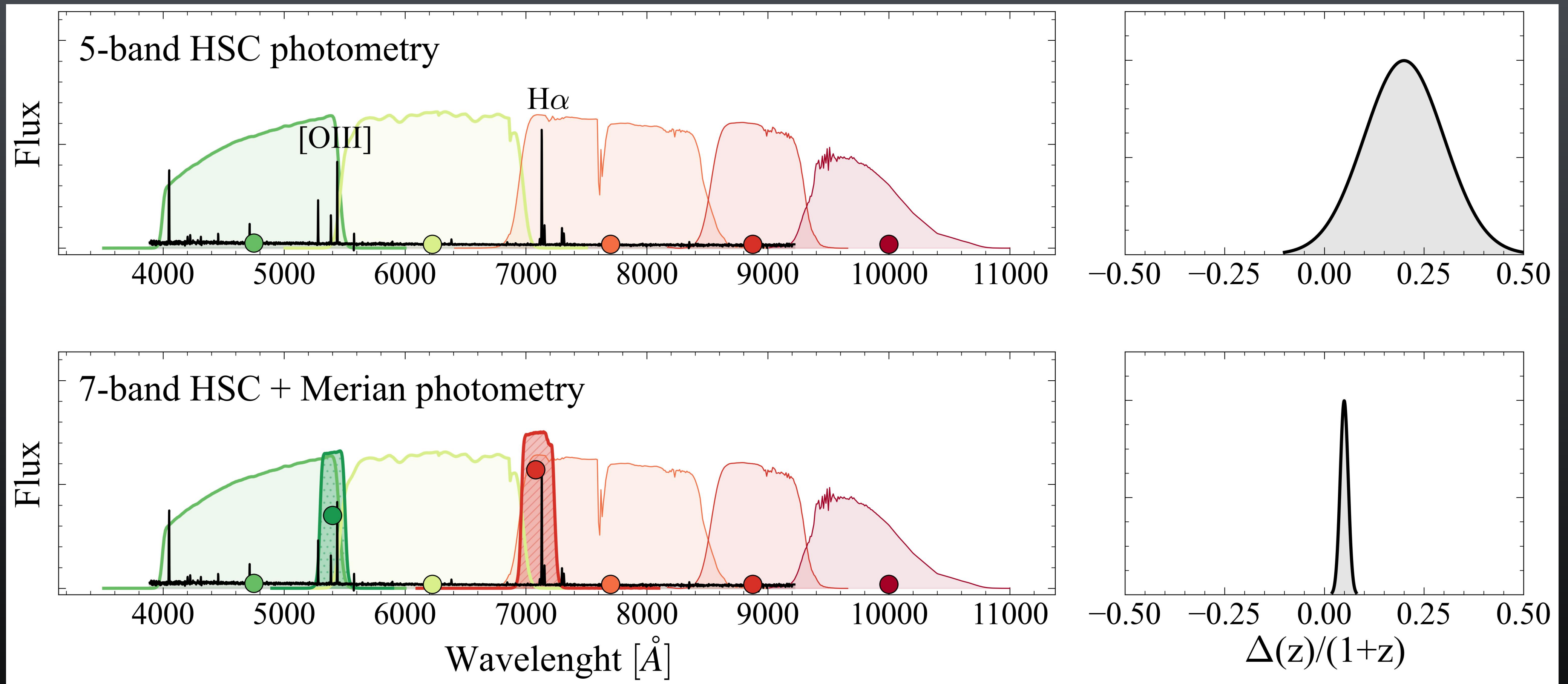


Leauthaud et al. 2020

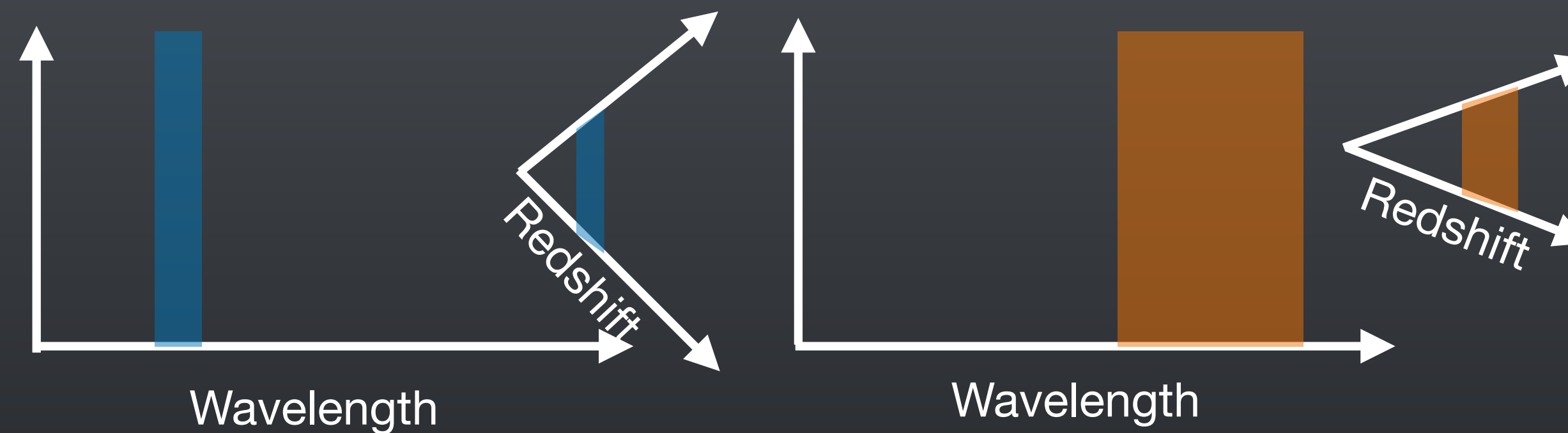
Improve photo-z's at $z < 0.2$

- Optical broad-band photo-z's are not optimal for dwarf galaxies at $z < 0.2$
- Quenched fraction for galaxies in mass range $10^8 - 10^9 M_{\odot}$ is low ($\sim 5\%$)
- Emission lines from HII regions can provide additional information to improve the photo-z precision



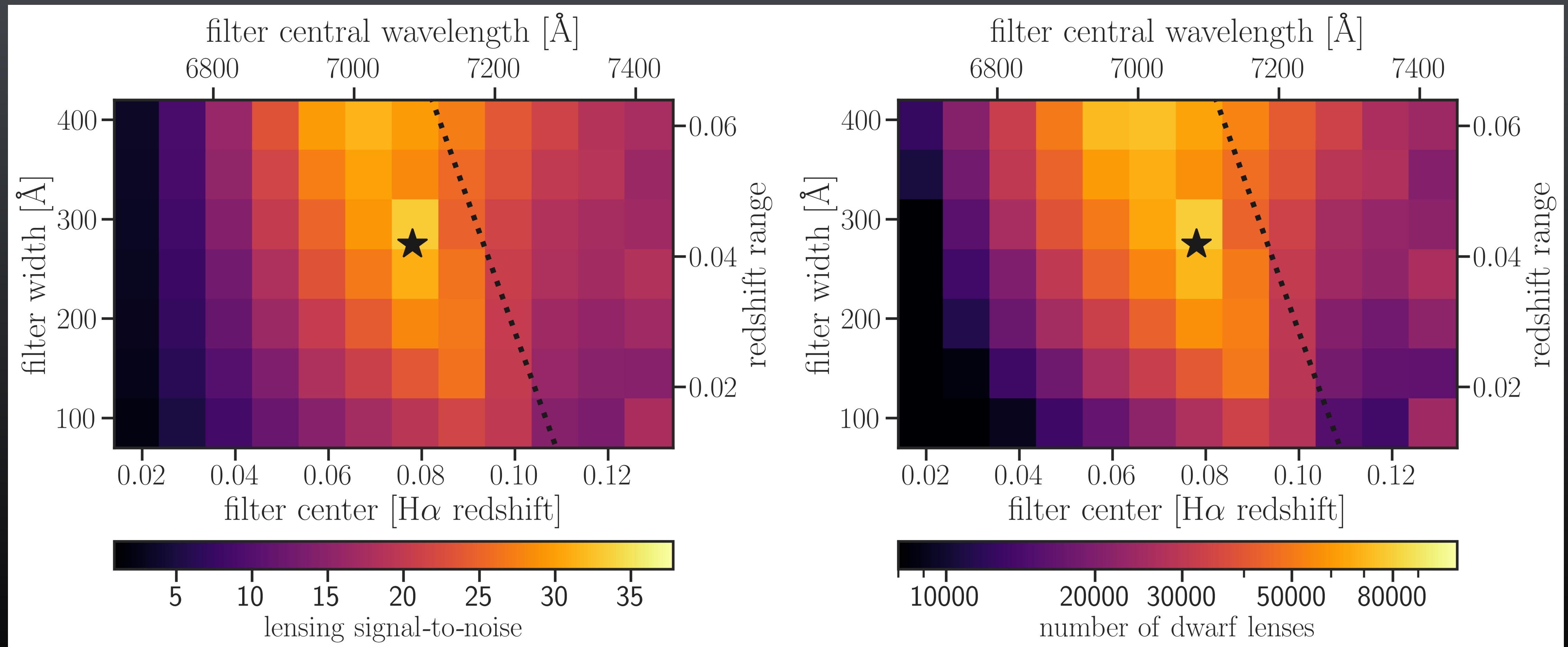


Tradeoffs in the central wavelength & filter width

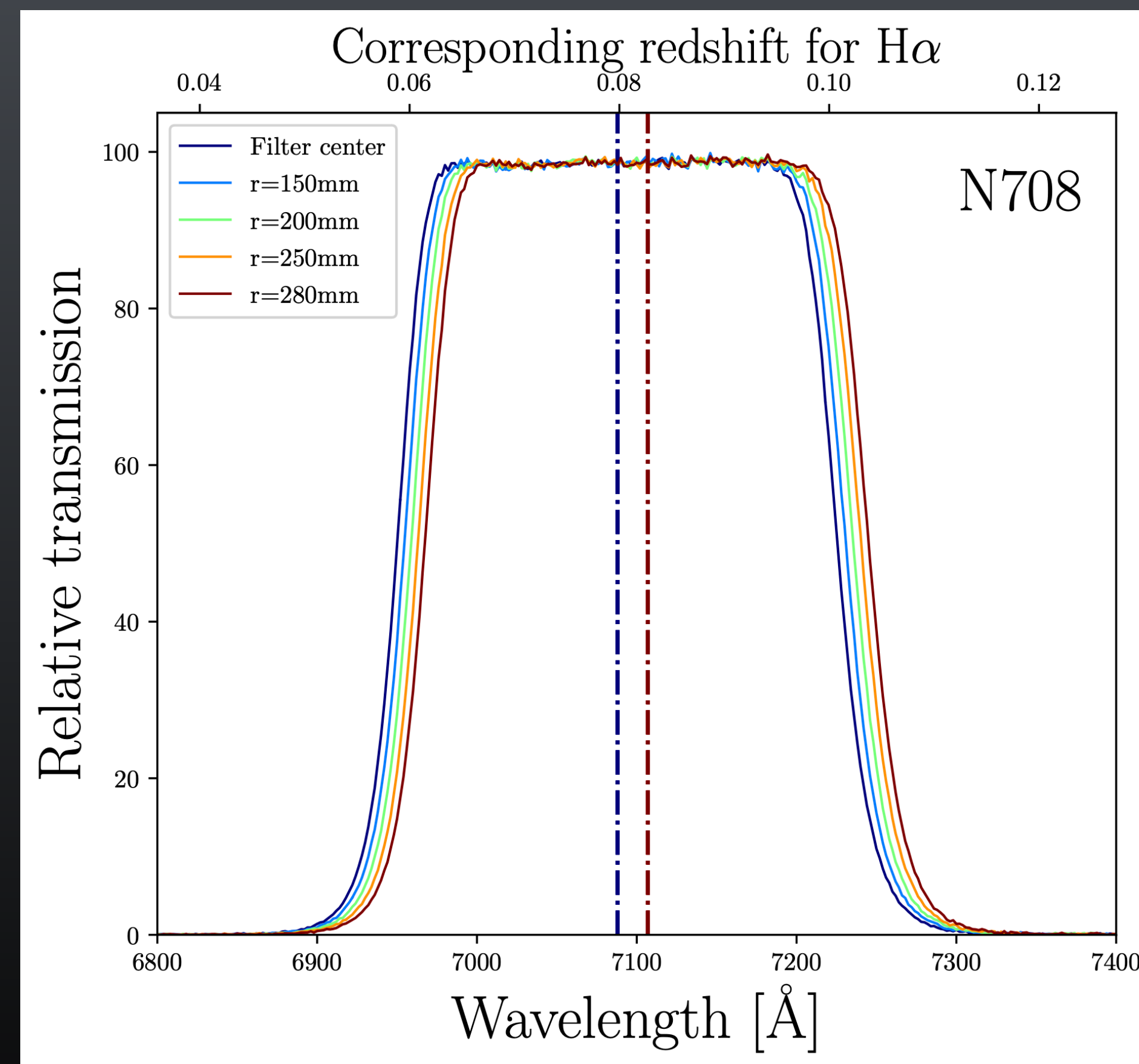
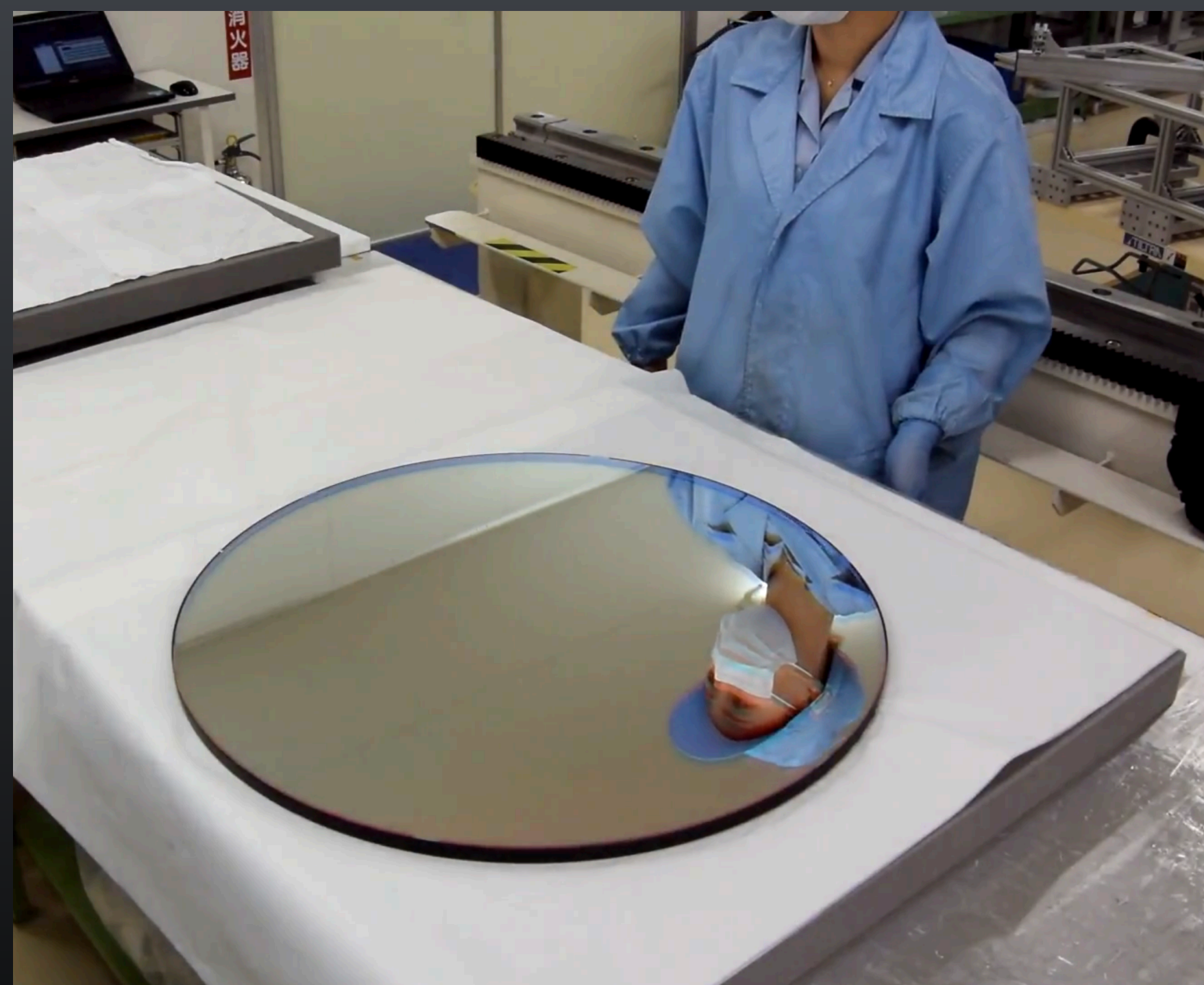


- longer central wavelength & wider filter width = larger volume = higher lensing S/N
- longer central wavelength = fainter dwarf galaxies = longer exposure time = less volume with fixed survey time
- wider filter width = weaker S/N of emission line detection = fewer dwarfs detected

Optimize lensing S/N for different filter design



Merian filter transmission across the DECam focal plane

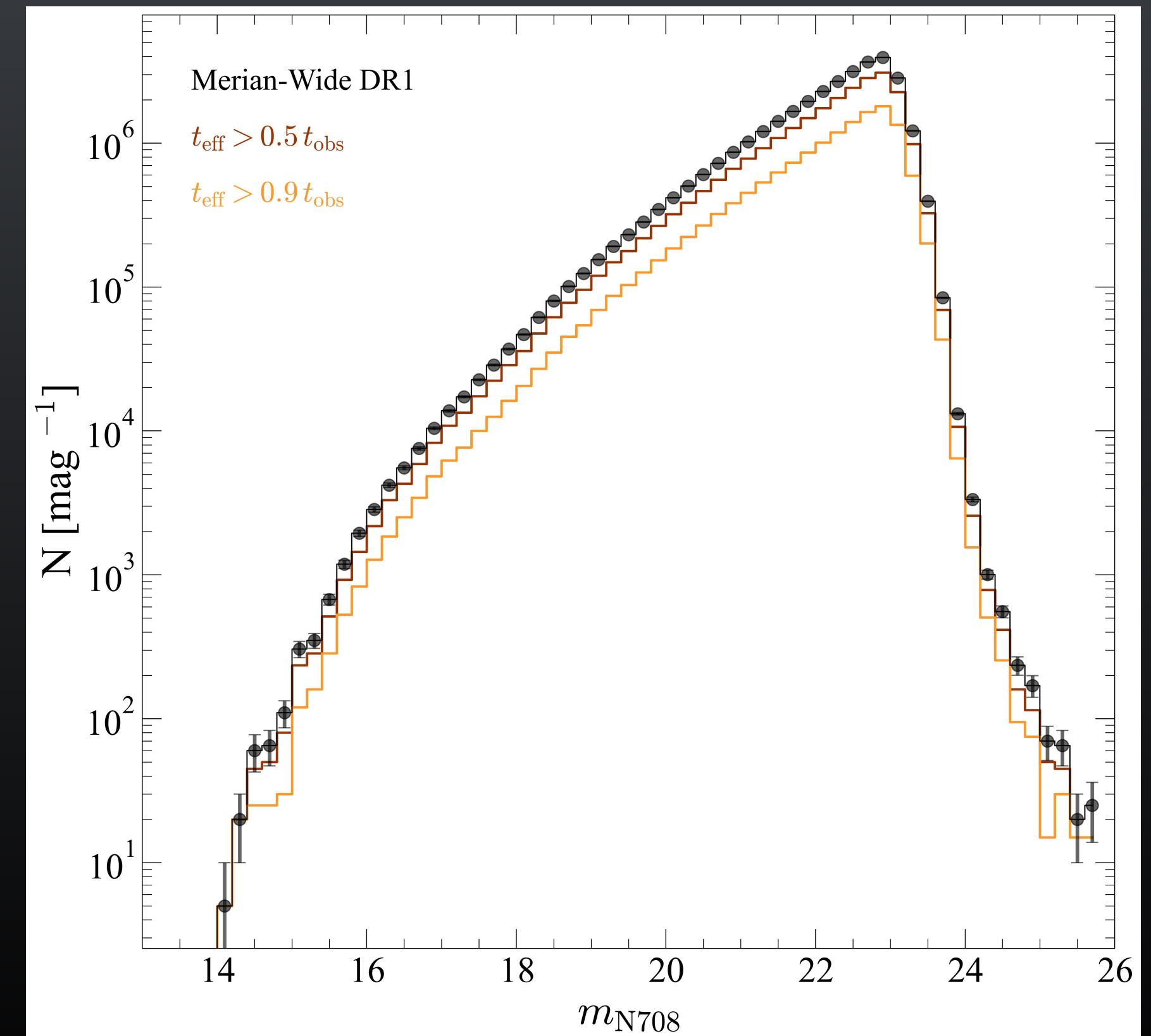
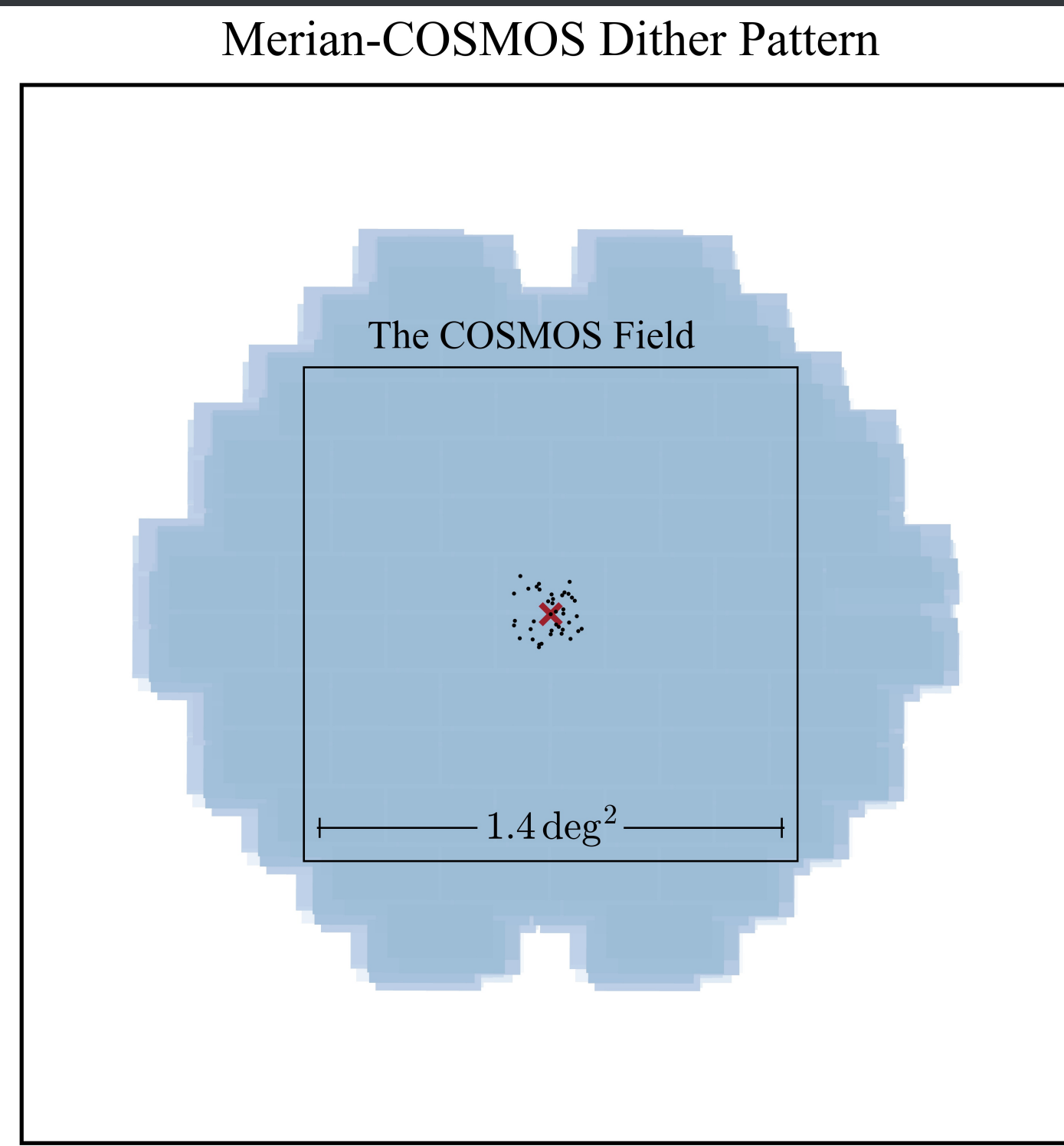
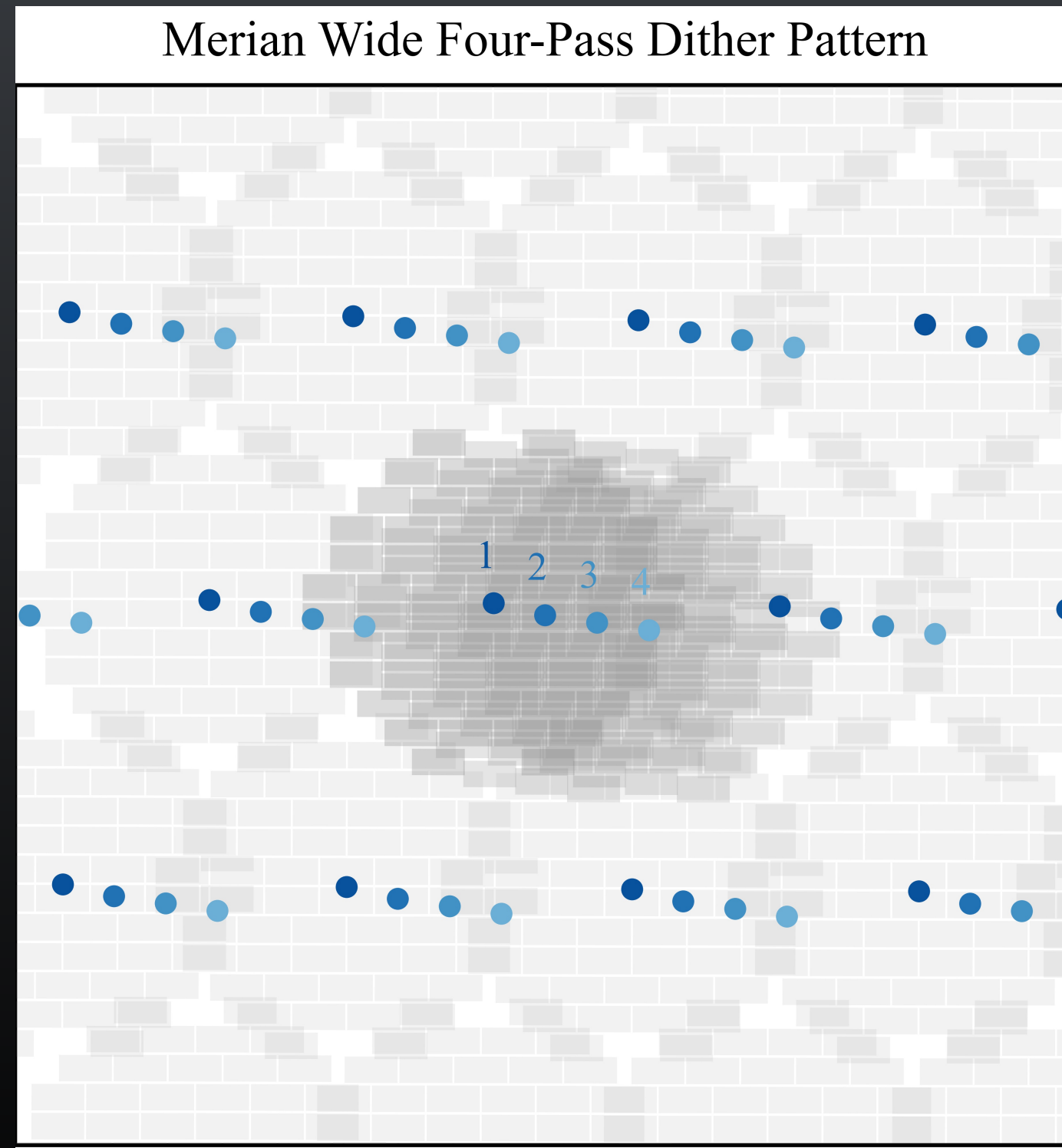


Merian Wide ($\sim 800 \text{ deg}^2$):

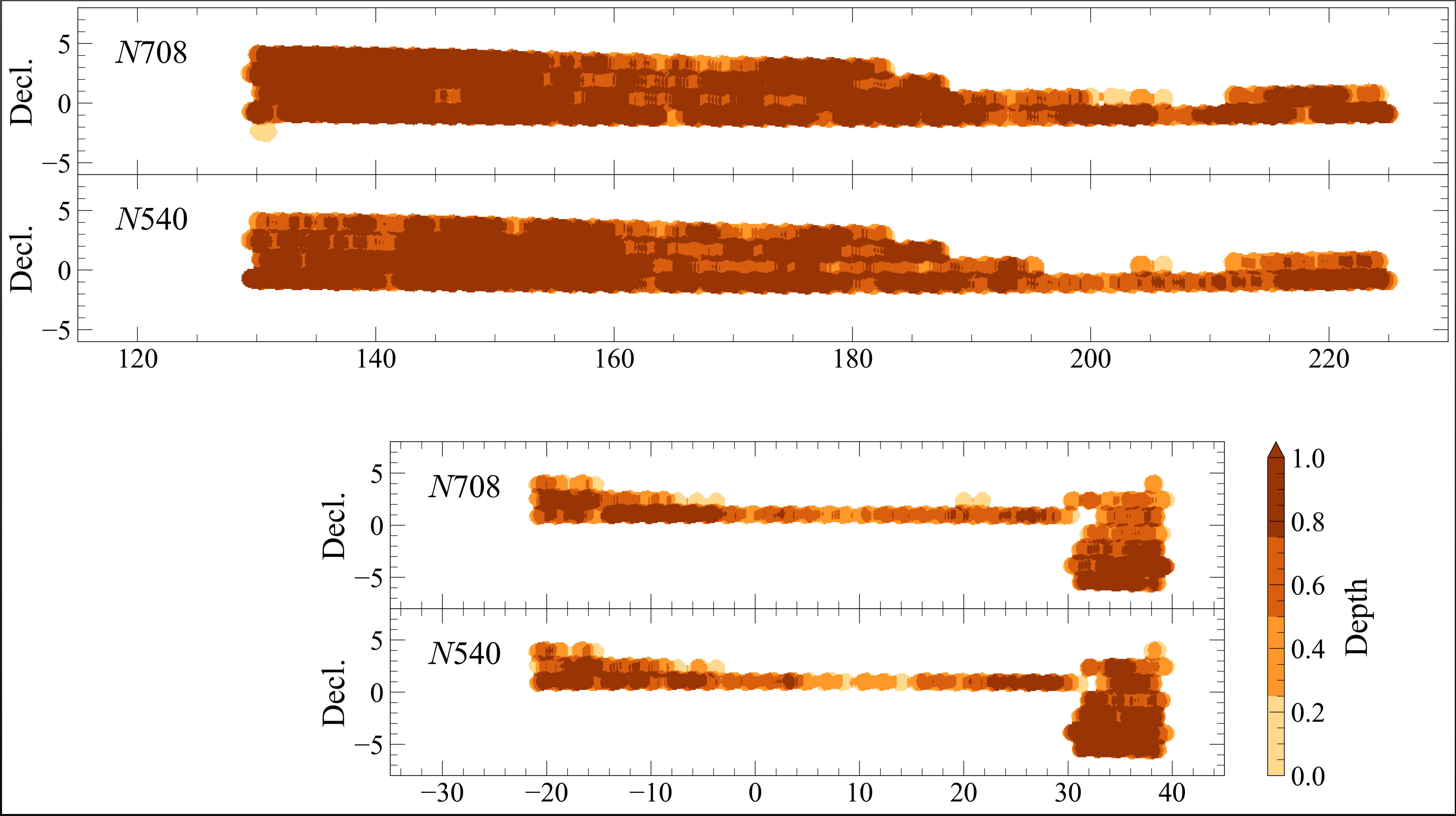
- 4x10 min for N708 (H α)
- 4x15 min for N540 (OIII)

Merian Deep ($\sim 2 \text{ deg}^2$):

- 40x10 min for N708 (H α)
- 40x15 min for N540 (OIII)



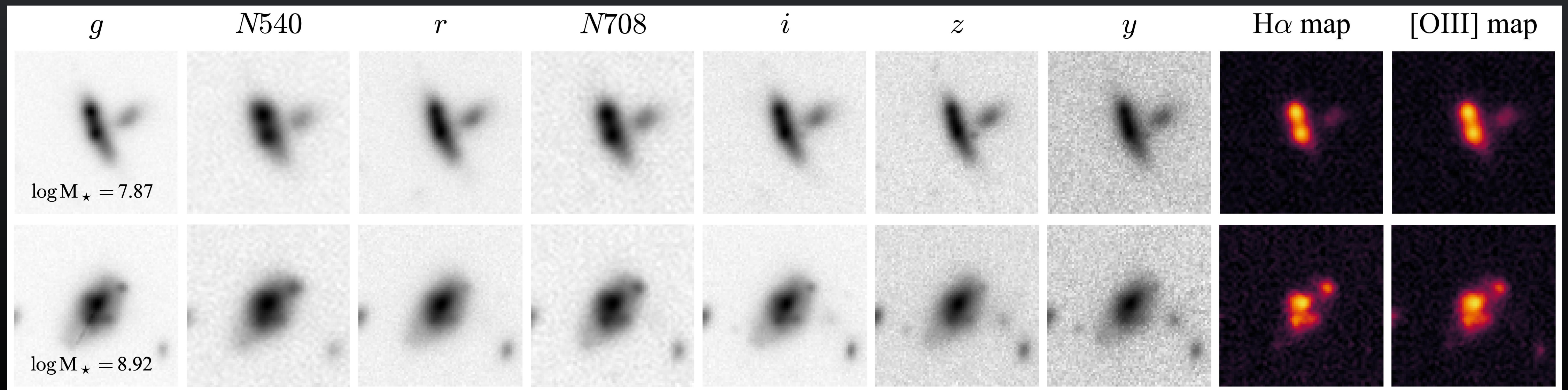
Merian has finished $>500 \text{ deg}^2$ with decent depth

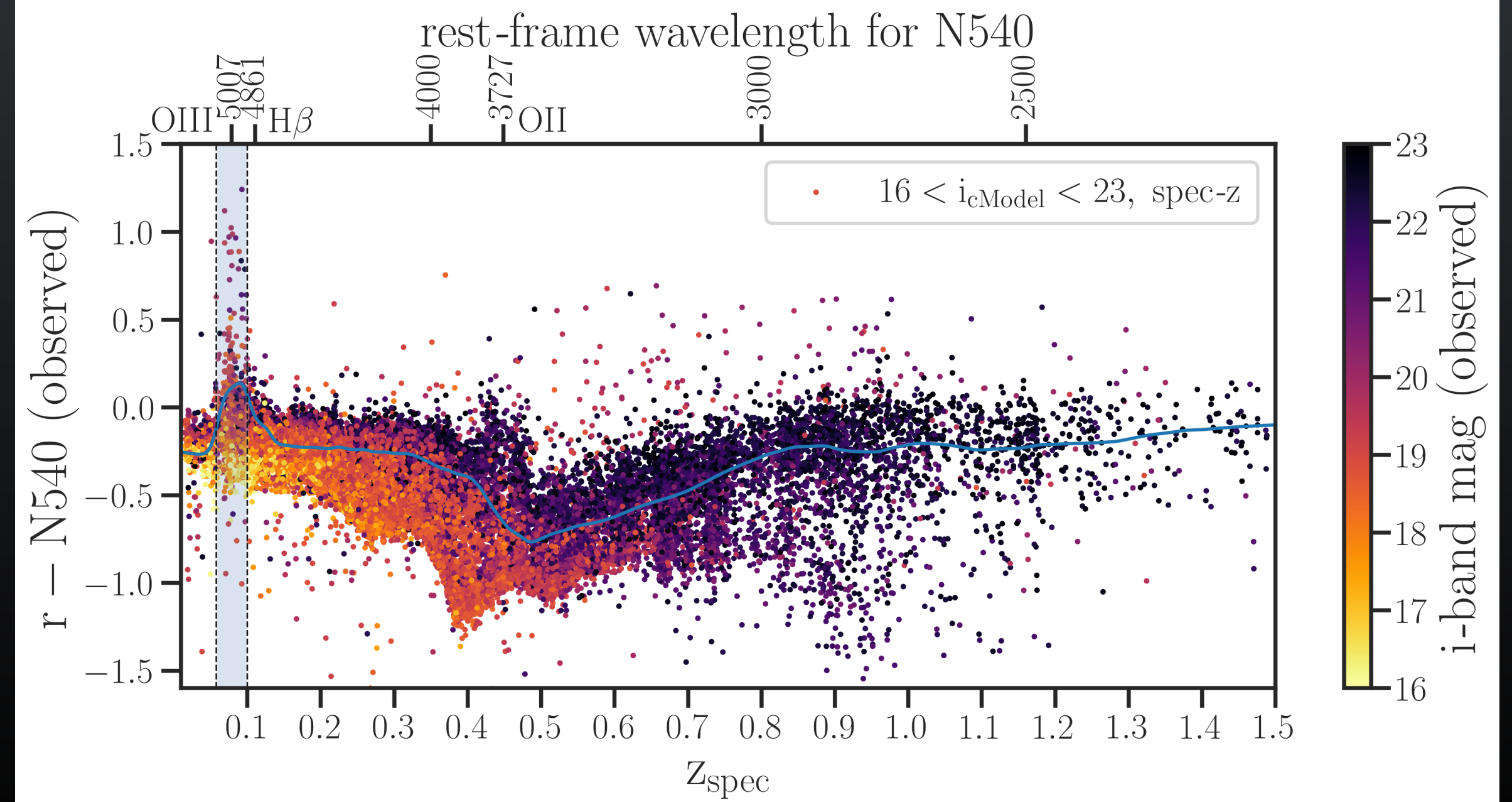
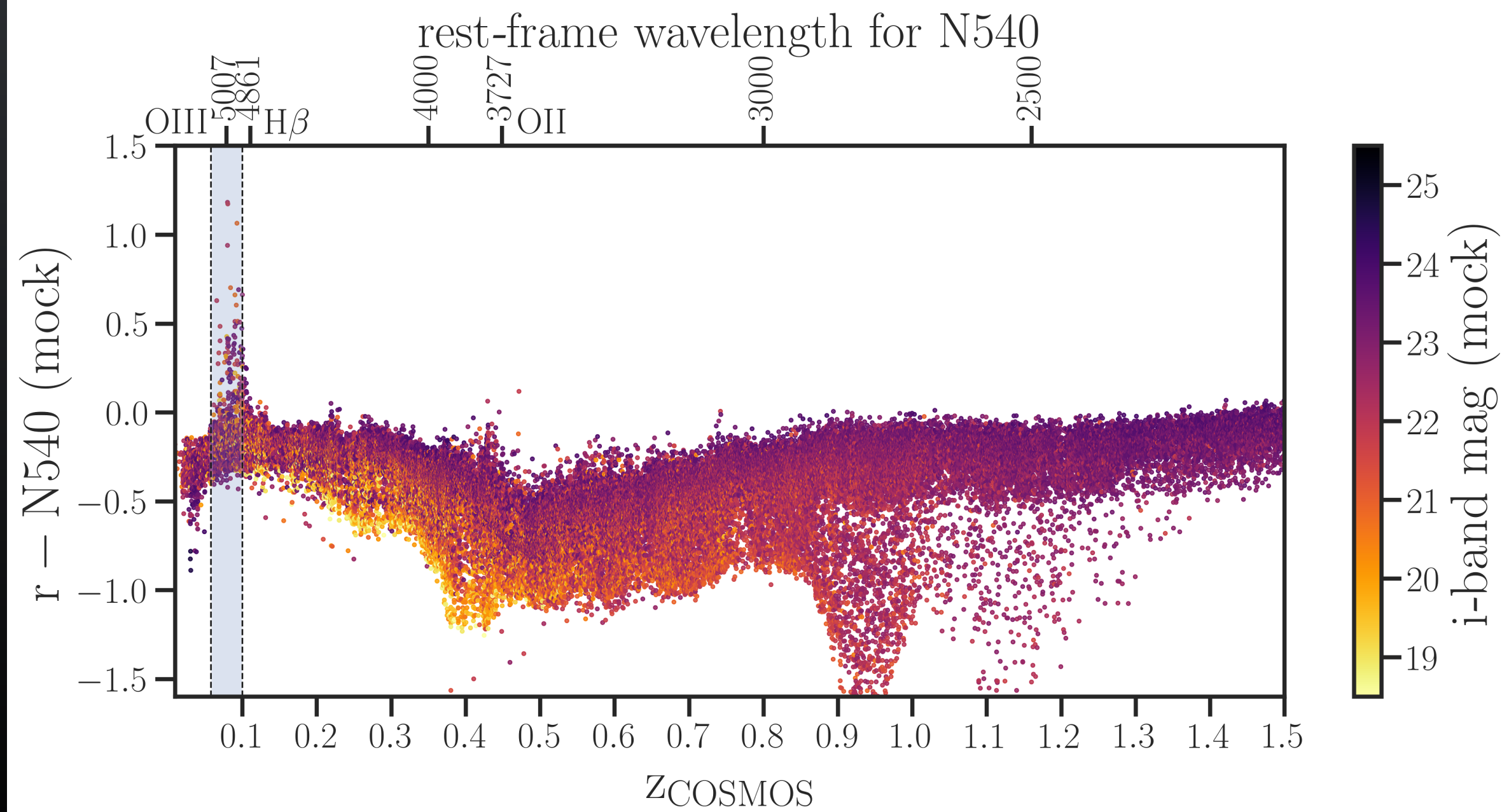
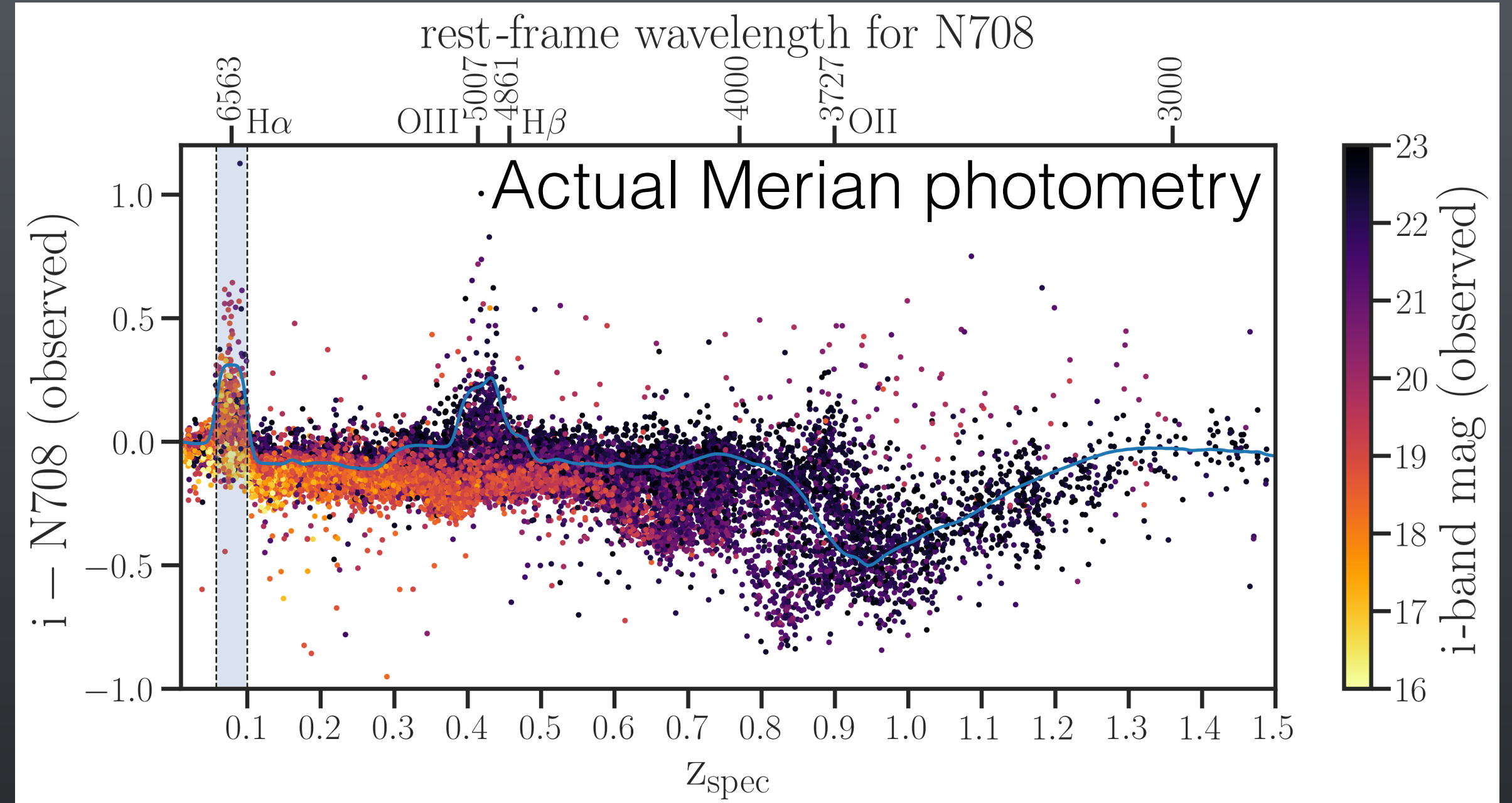
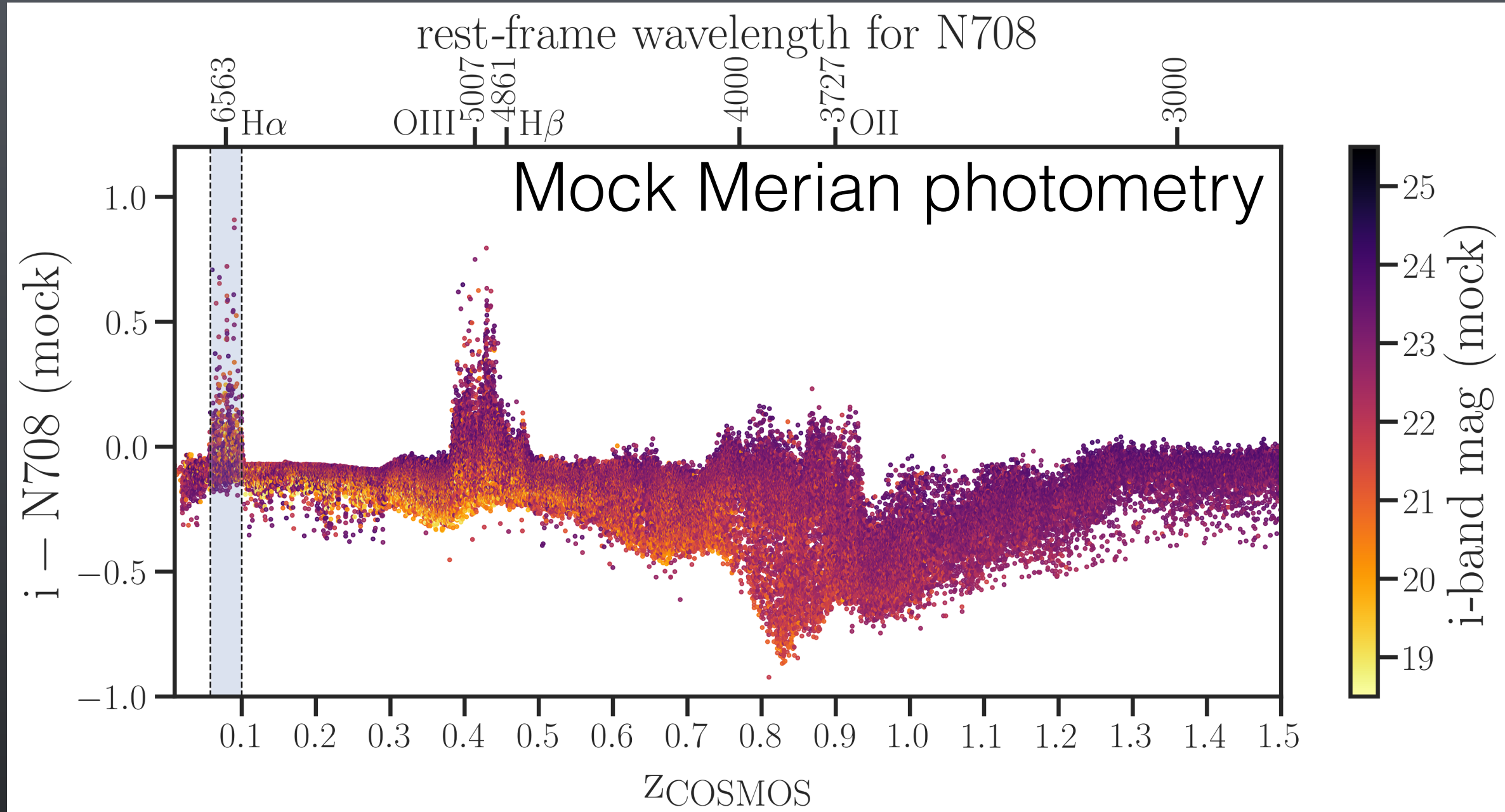


Merian data reduction pipeline: LSSTpipe

- Merian DR1: 230 deg²: full depth full color region
- Photometry on HSC broad-bands based on Merian footprint
- Gaussian-aperture-and-PSF (GAAP) photometry
- One of the first survey reduced with LSSTpipe

Danieli et al. submitted to ApJ

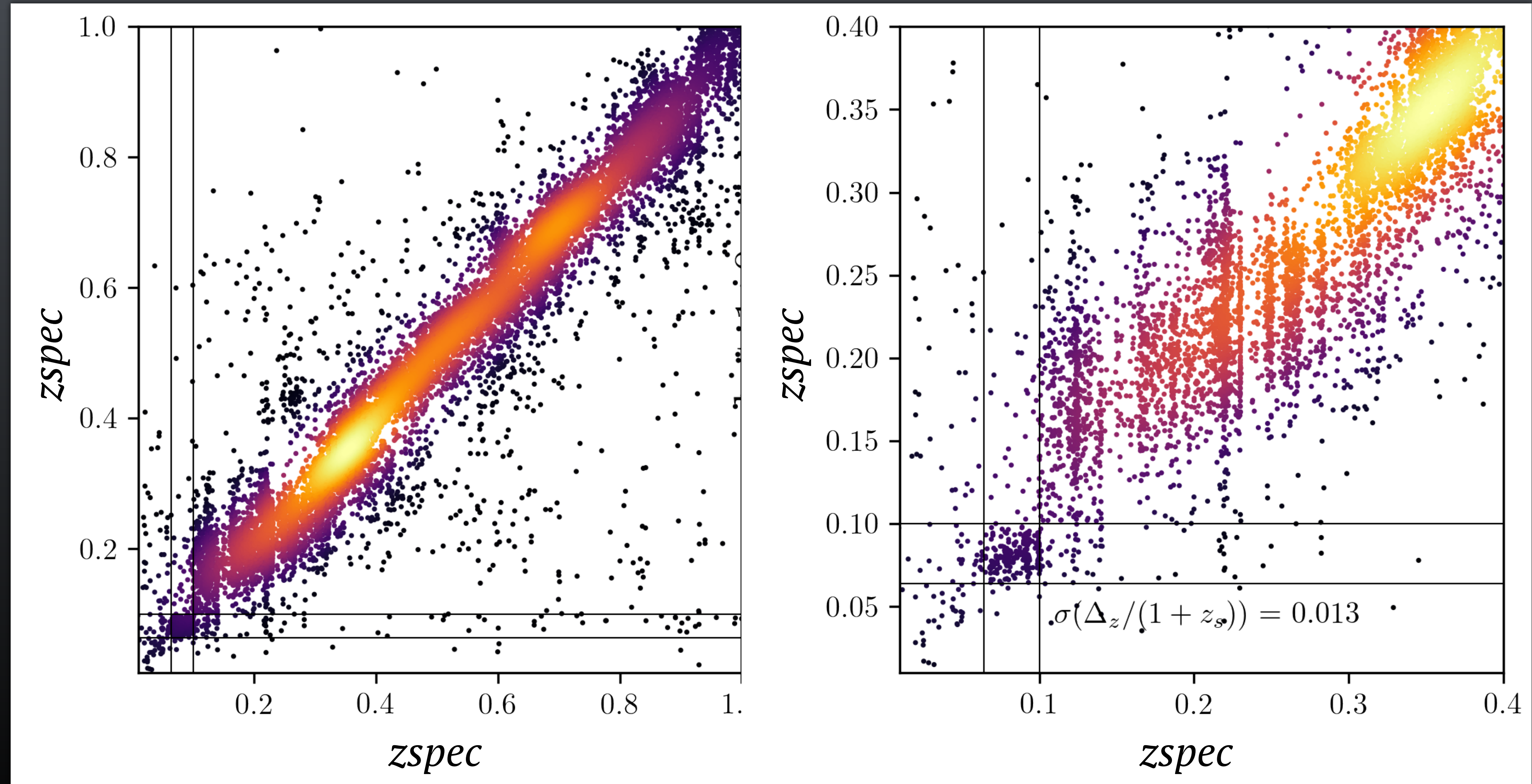




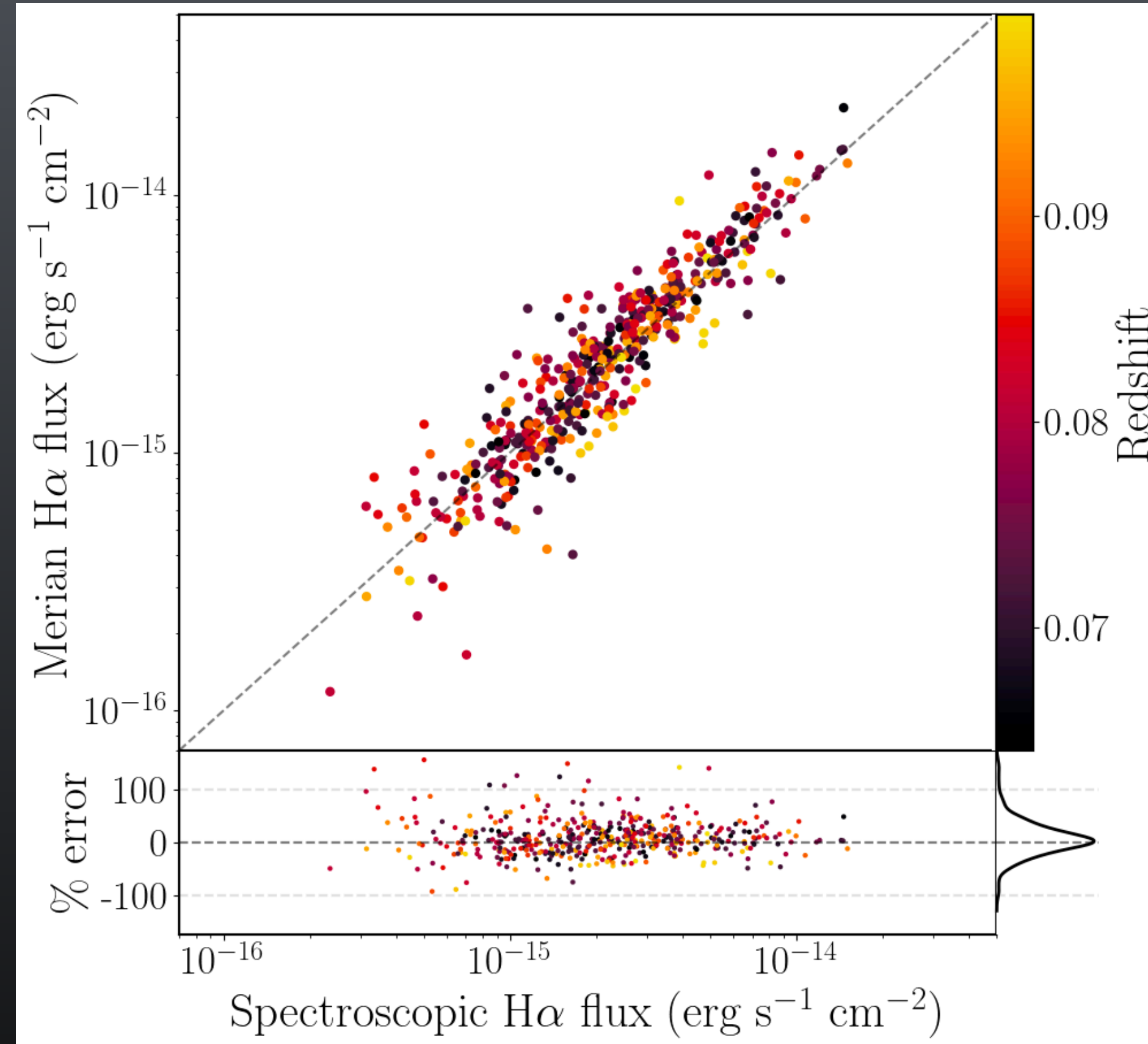
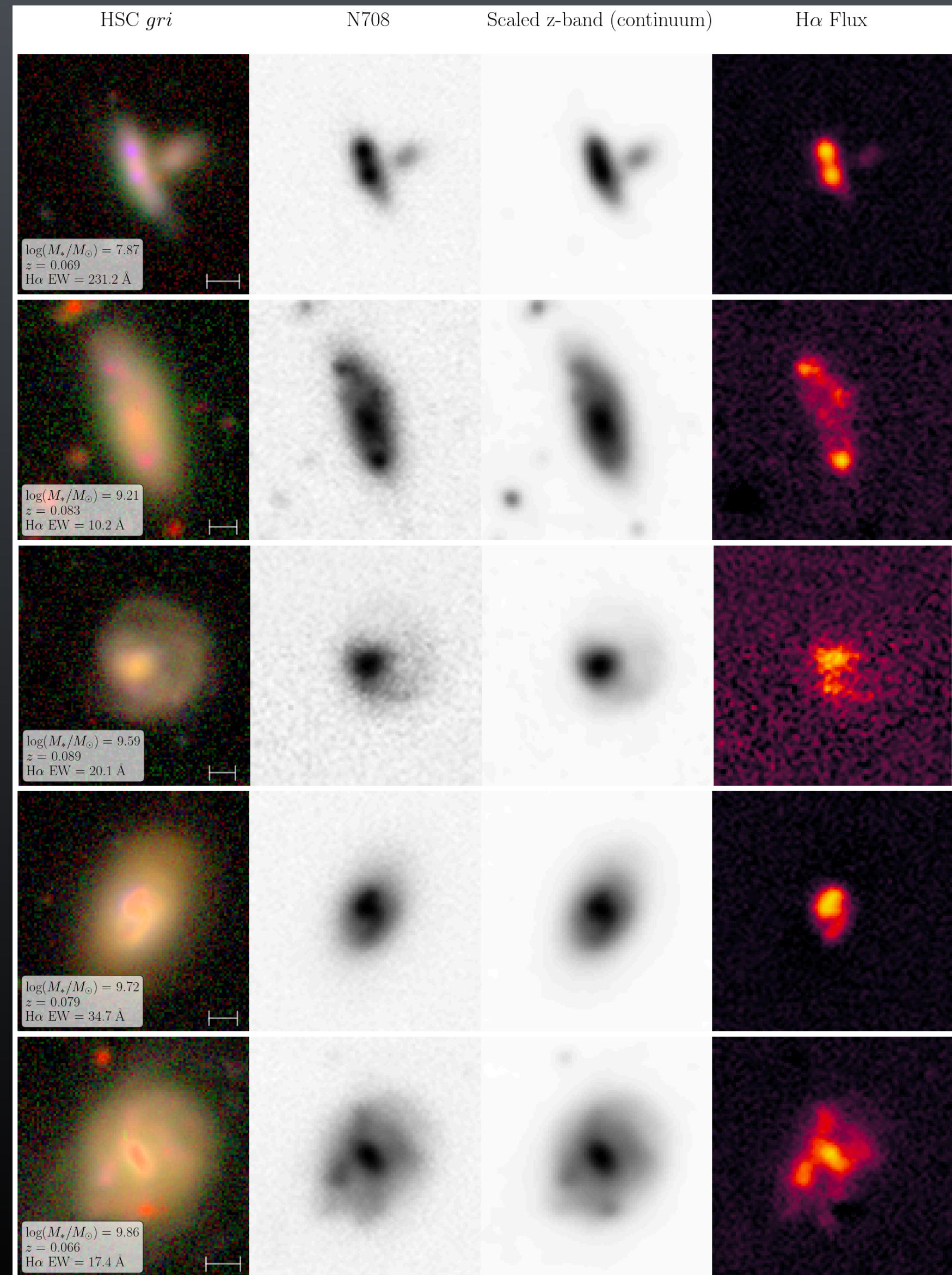
Merian spec-z calibration sample

- Collecting spec-z's with Keck/DEIMOS, Magellan/IMACS and DESI down to $i \sim 23$ mag
- >6000 spectra for Merian objects have been collected (and increasing)
- Combining redshifts from previous surveys (COSMOS, GAMA, SDSS, etc.)

Merian template fitting photo-z's achieve a precision of ~ 0.015

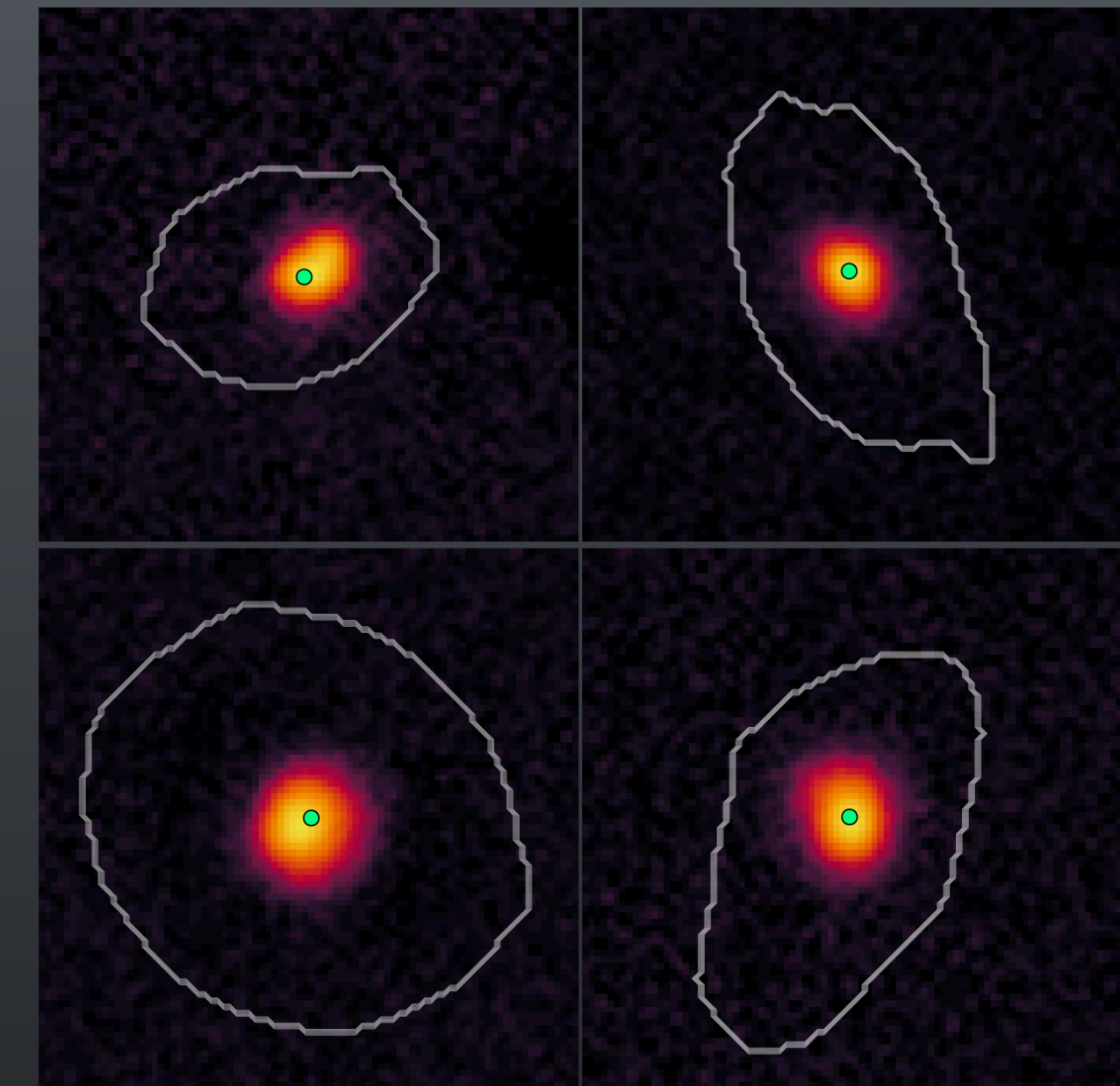


Medium-band flux excess for spec-z confirmed galaxies

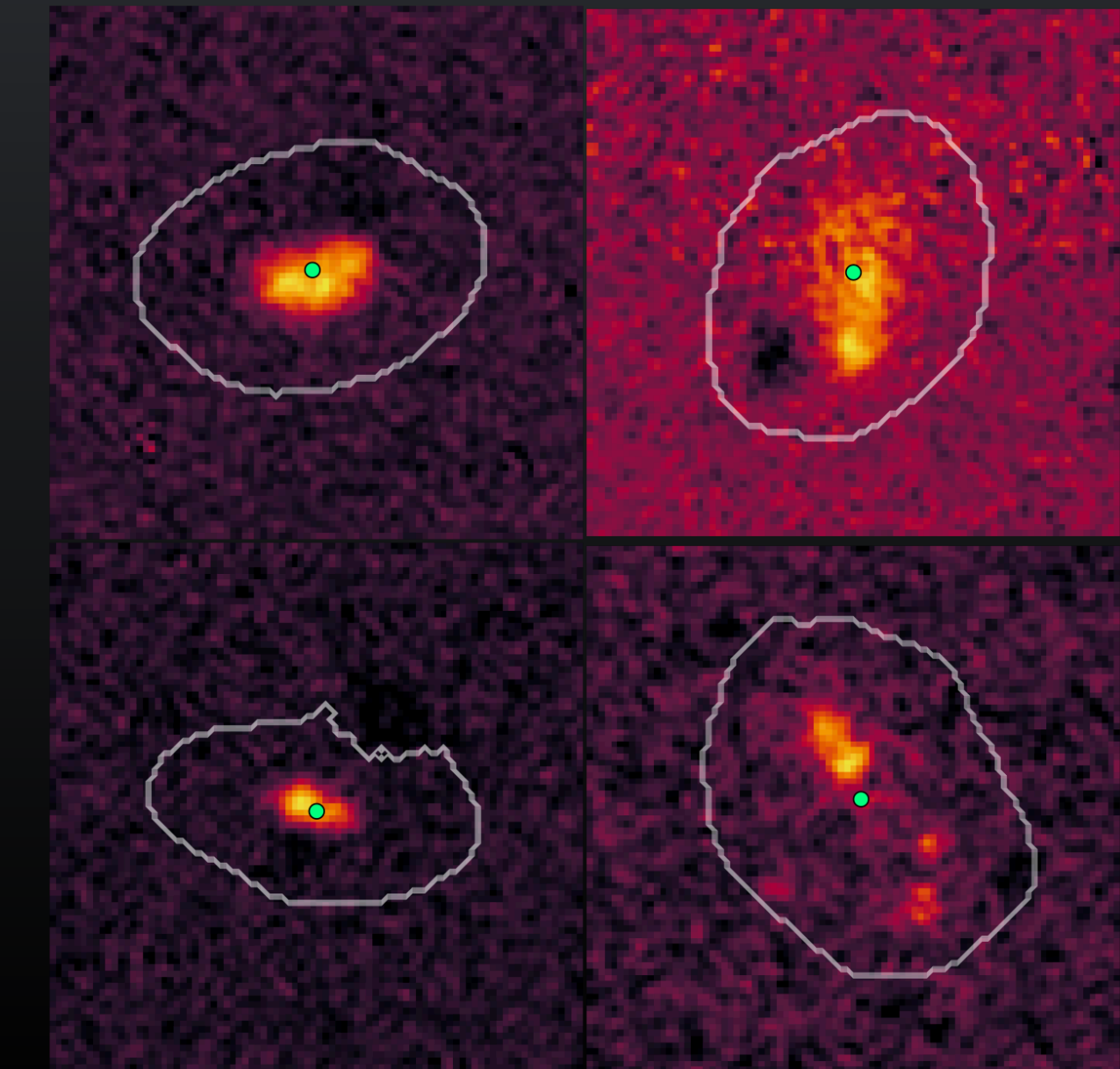


Mintz et al., submitted to ApJ
(go see her poster #25!)

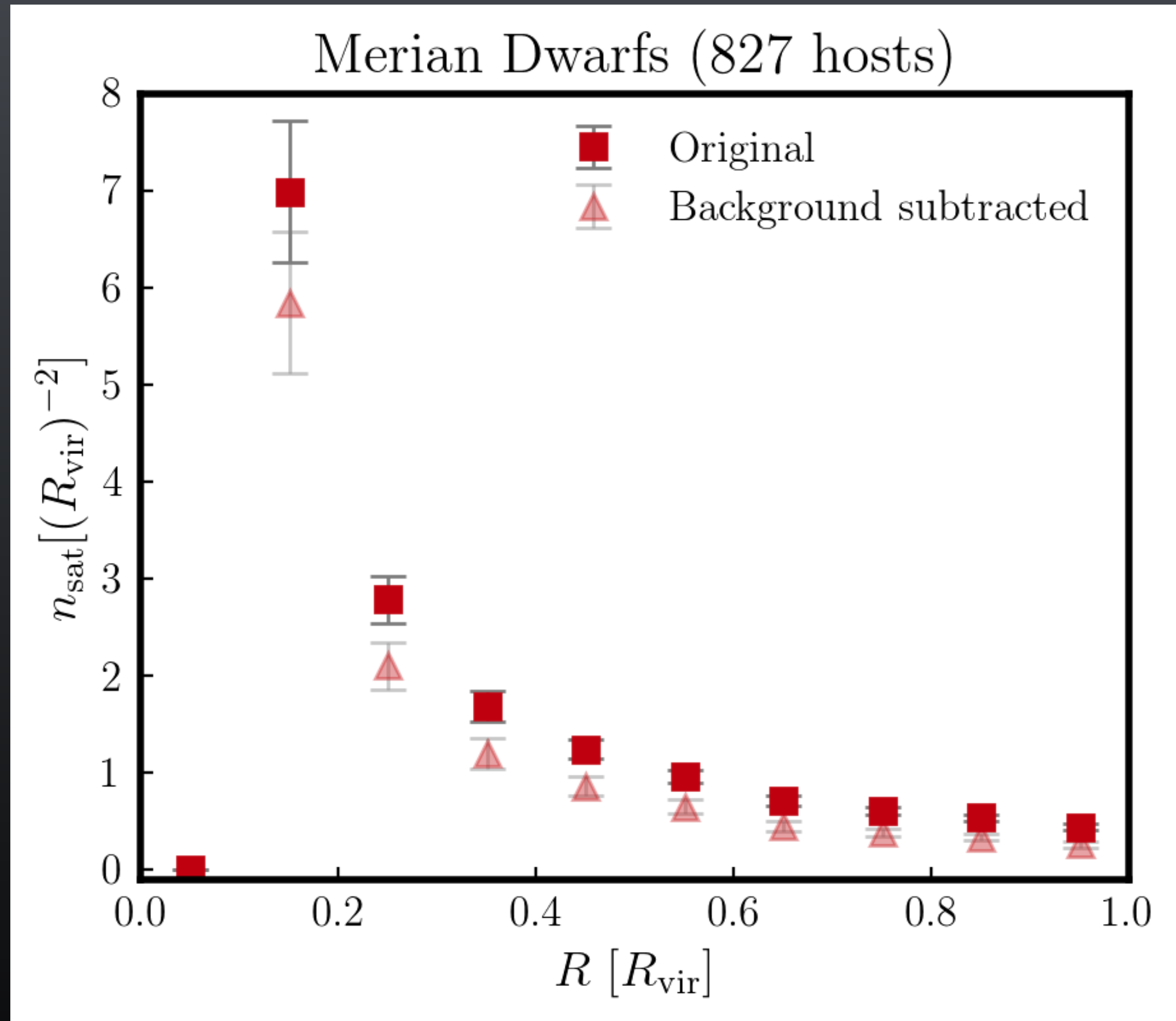
High SSFR



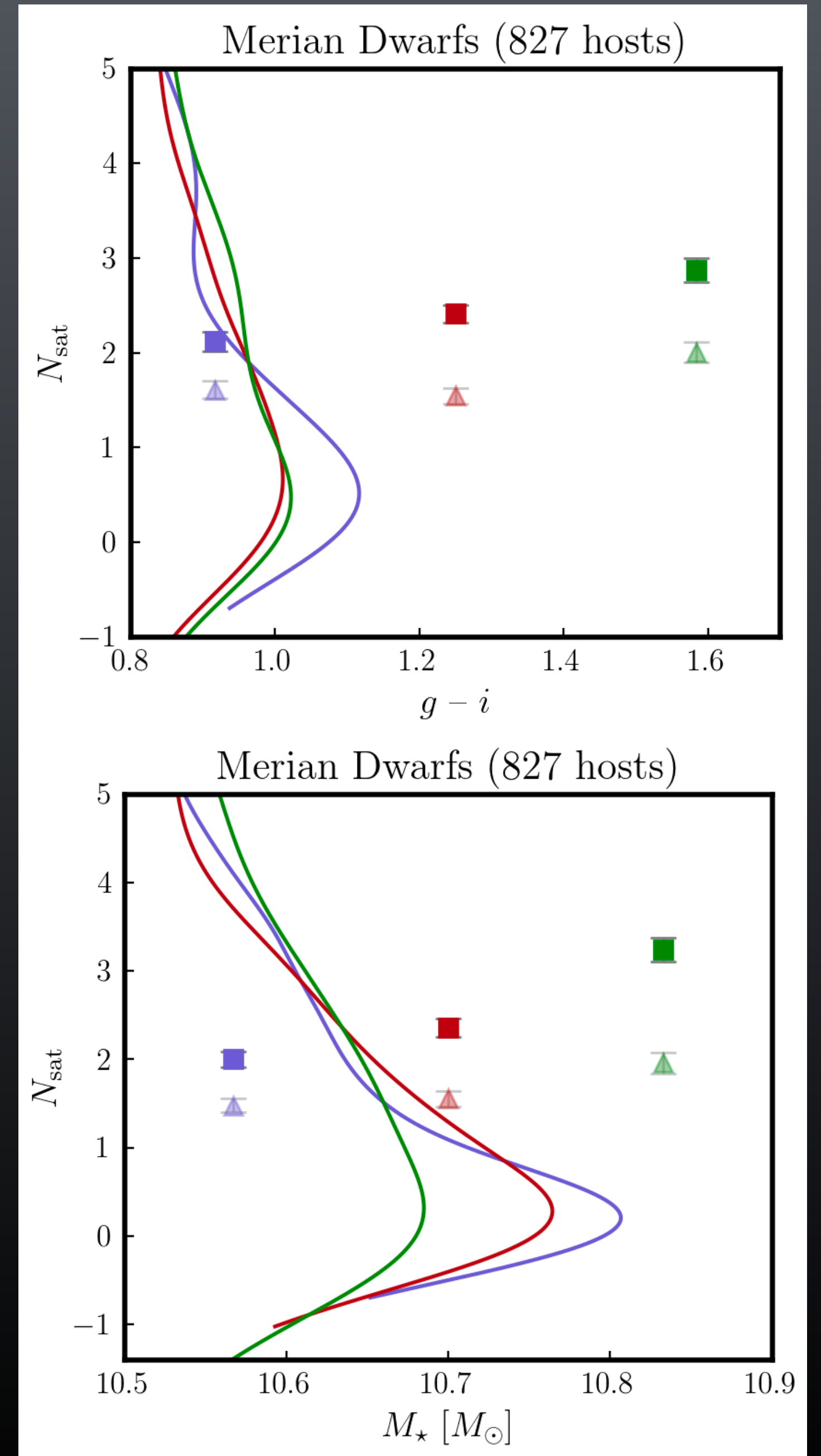
Low SSFR



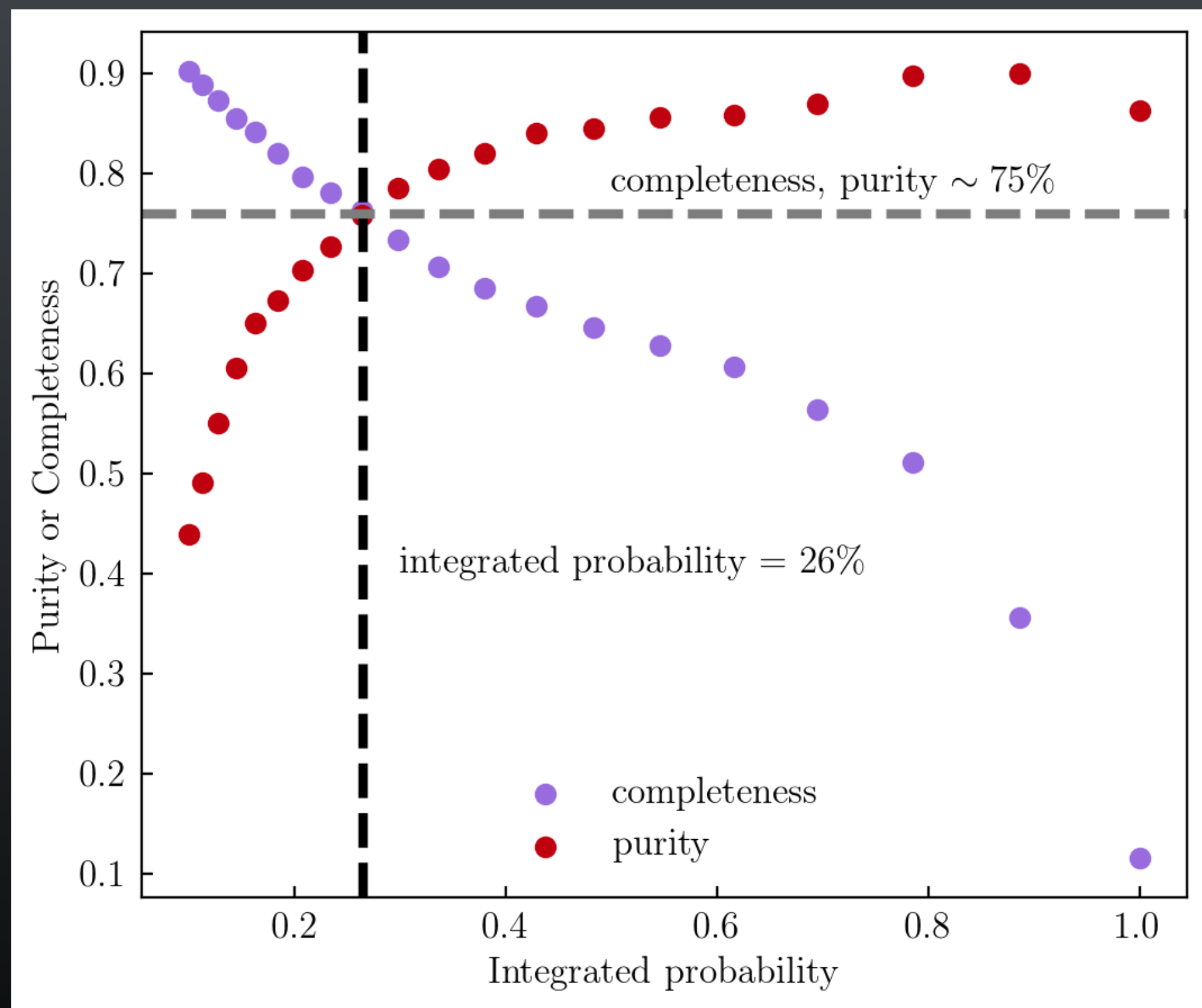
Satellite properties around MW analogs



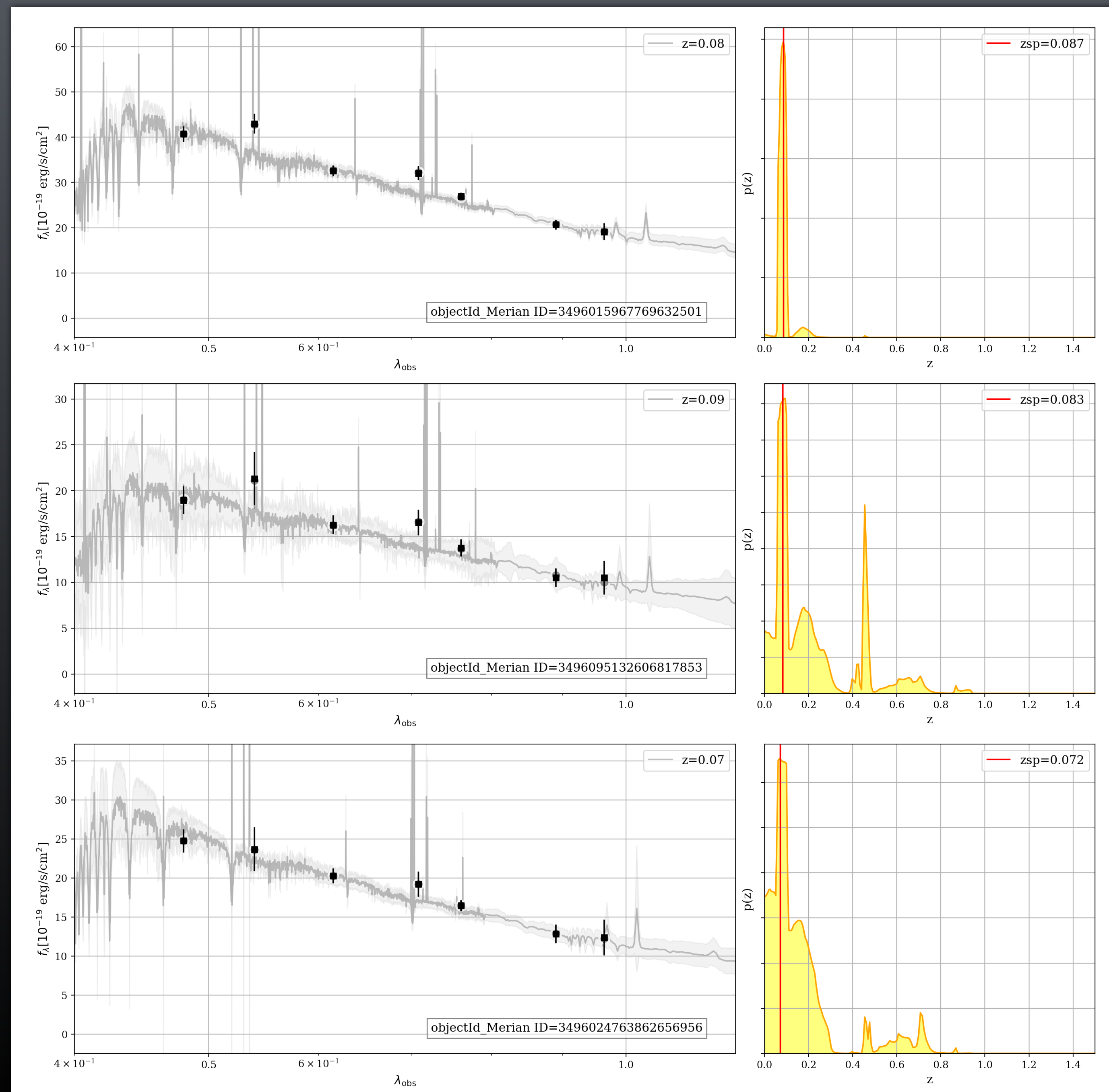
Pan et al. in prep (go see her poster #30!)



Beyond photo-z point estimation

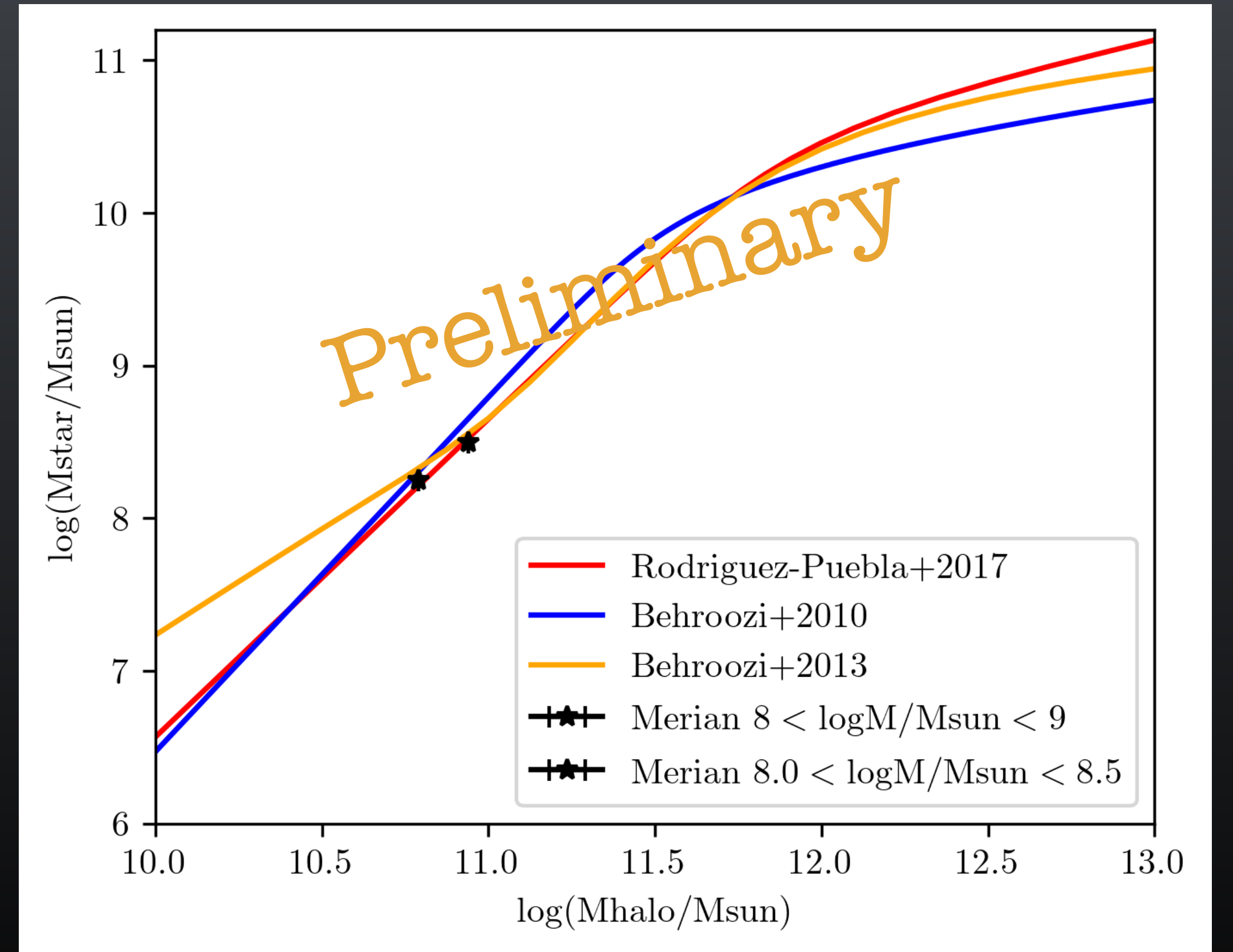
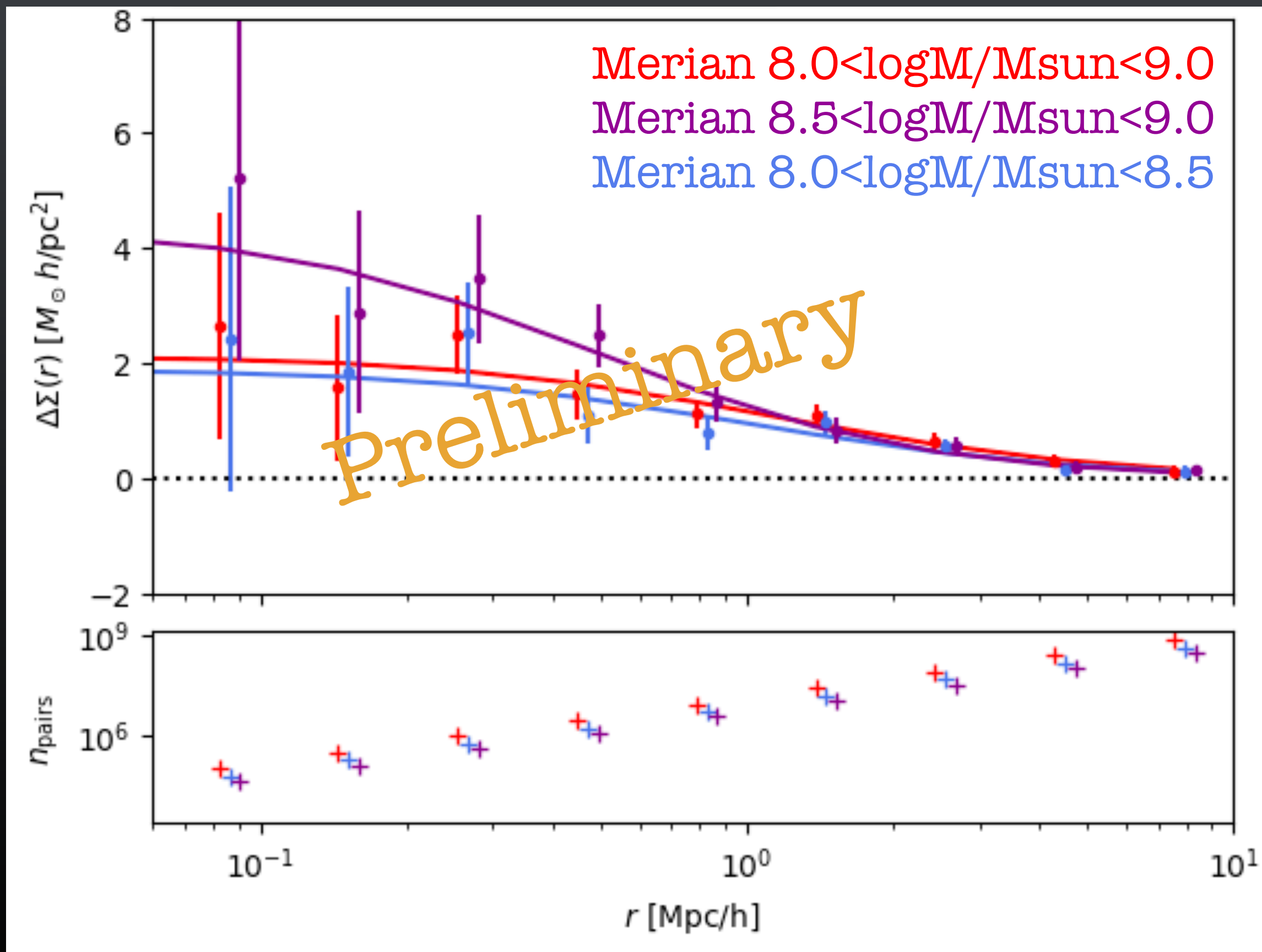


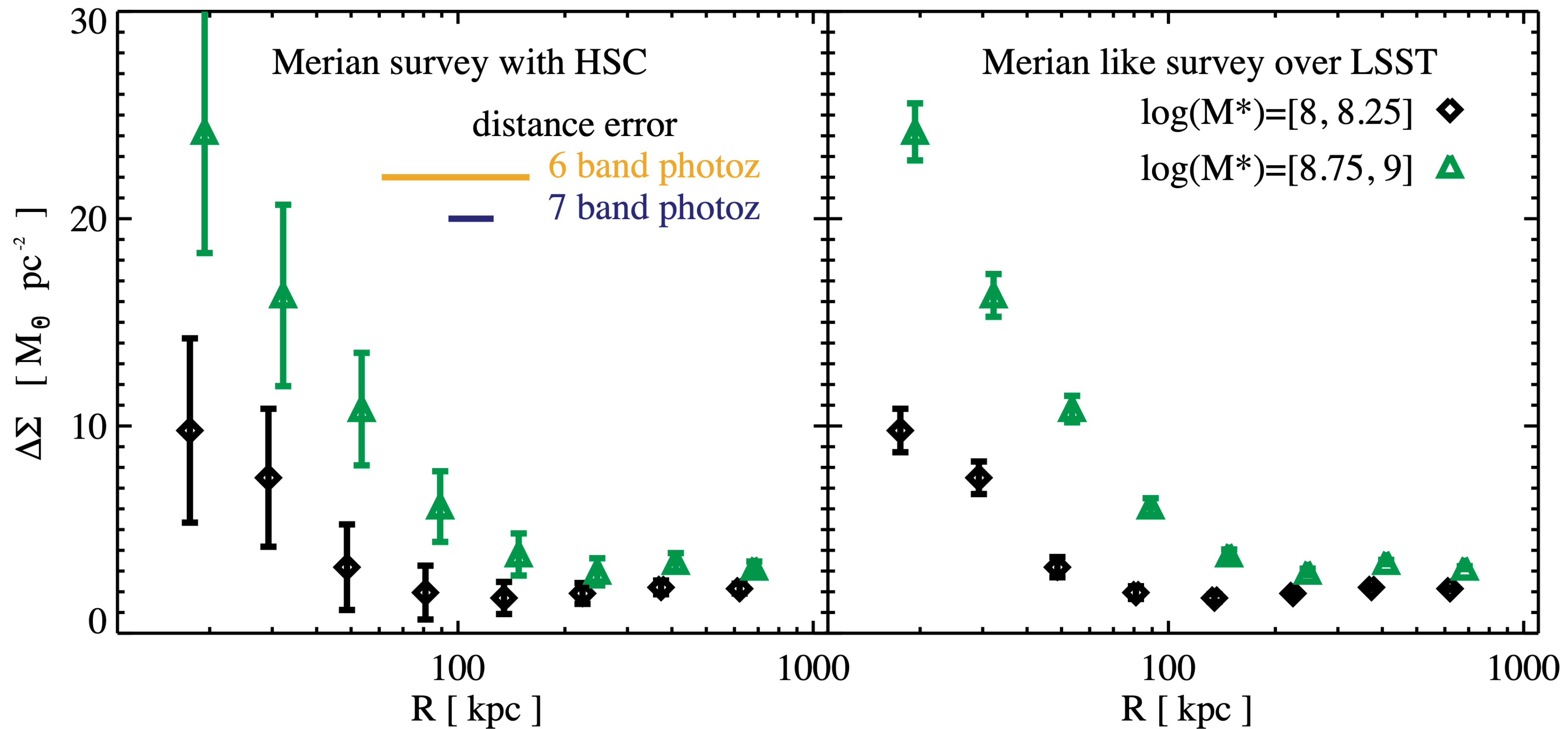
Credit: Yue Pan



First Merian dwarf lensing signal

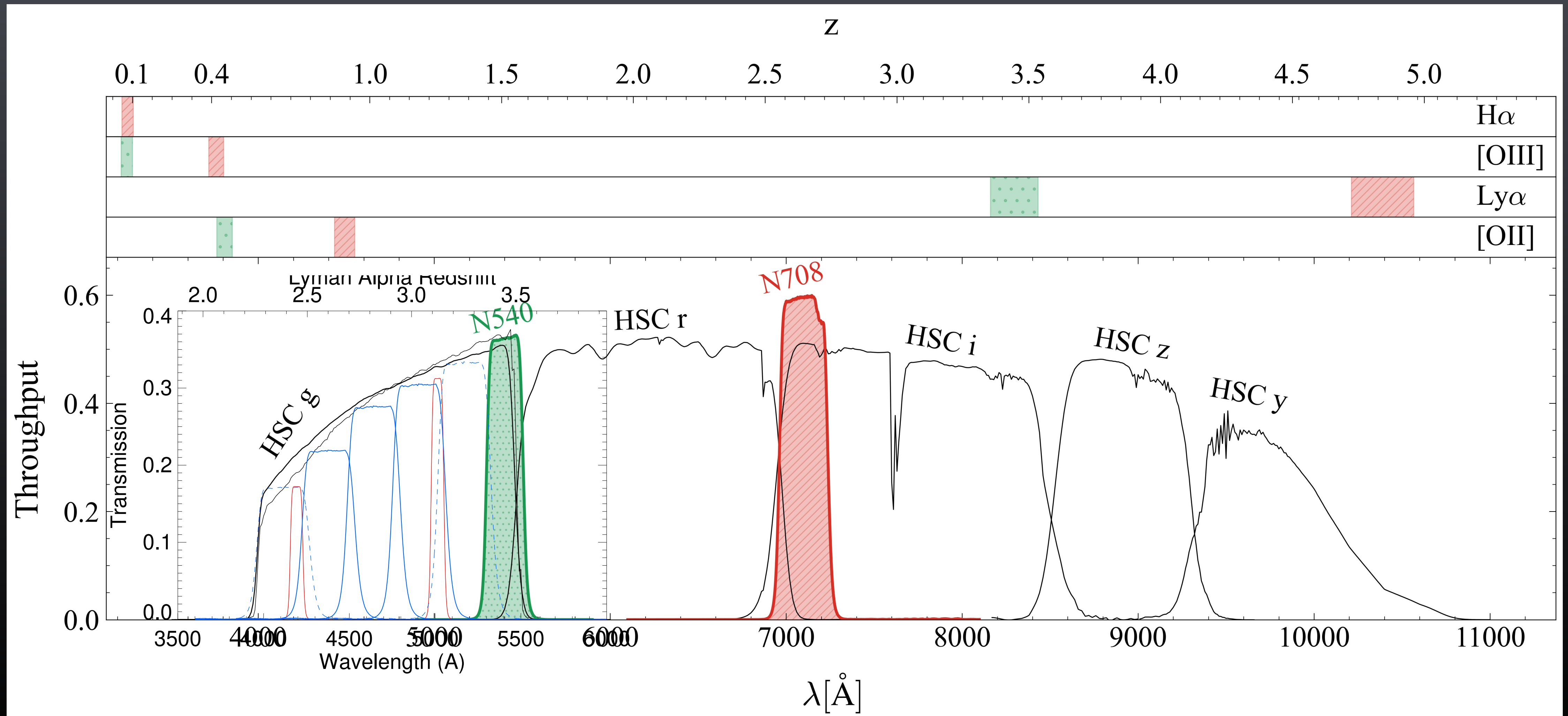
- $\sim 30\%$ of the Merian final footprint - lensing S/N > 10
- More modeling is underway





- LSST can constrain dwarf lensing with much higher lensing S/N
- Medium-band surveys for LSST should be considered

Meridian filters N708/N540 + DESI-2 filters



Summary

- Merian is a new medium-band imaging survey with 64 nights on DECam to cover 800 square deg in the HSC SSP wide field
- Two new medium-band filters N708 and N540 will find $\sim 100,000$ dwarf galaxies ($10^8 - 10^9 M_{\odot}$) at $0.05 < z < 0.1$
- Merian photo-z's provide a precision of ~ 0.015 , could be improved with $p(z)$
- We have detected weak lensing signal around dwarf galaxies within 30% of Merian total footprint
- More Merian early science papers will be out soon!

