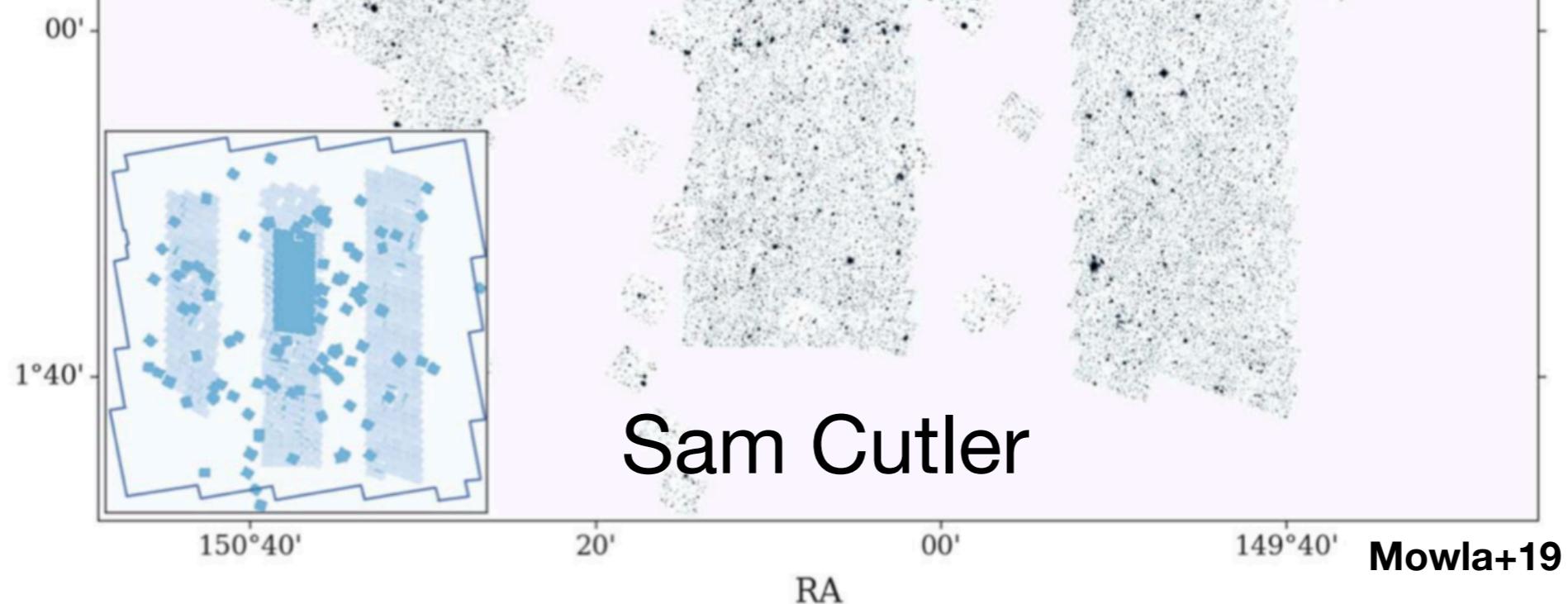


Diagnosing DASH

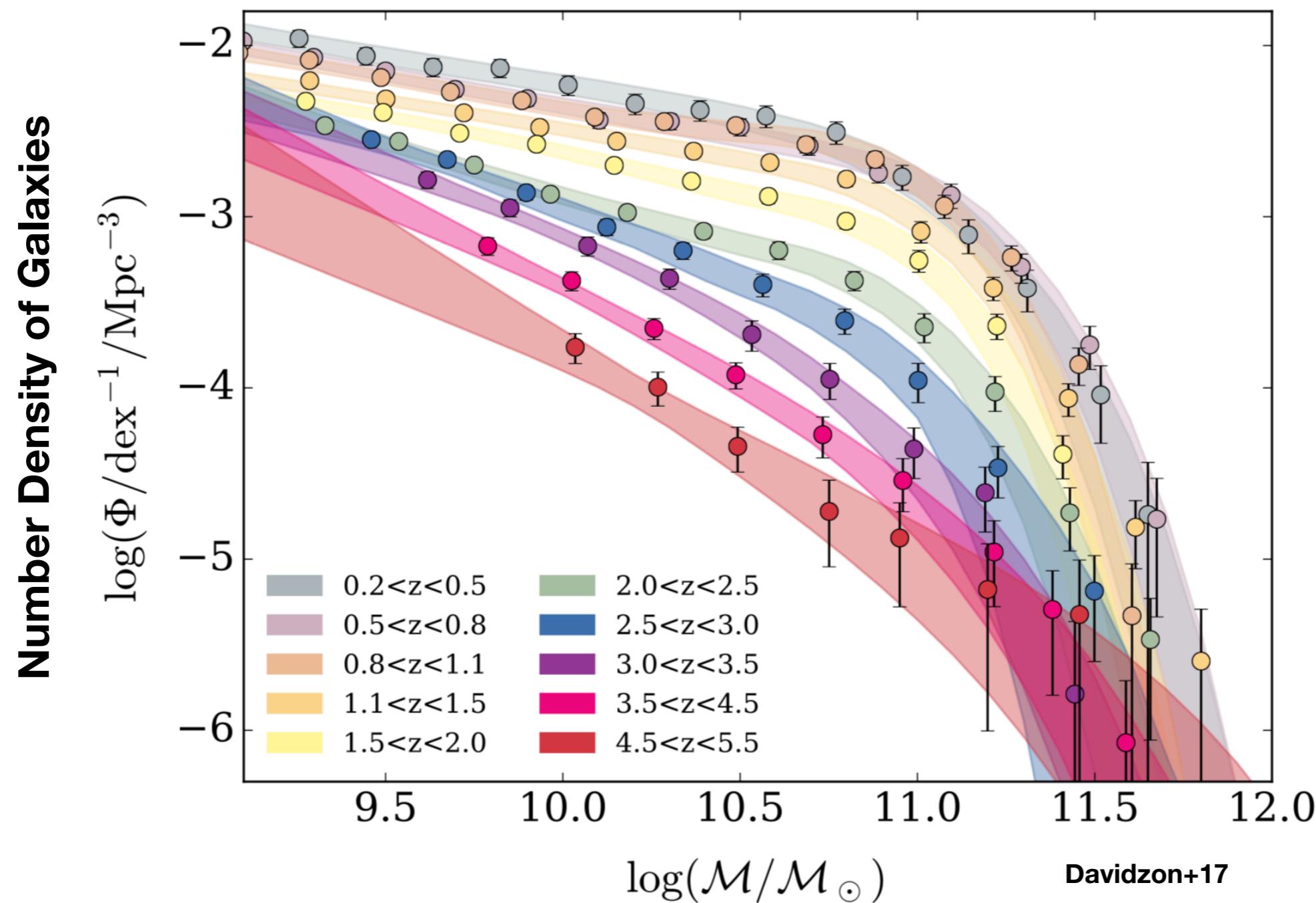
The COSMOS-DASH morphological catalog
and insights on the low mass size mass relation



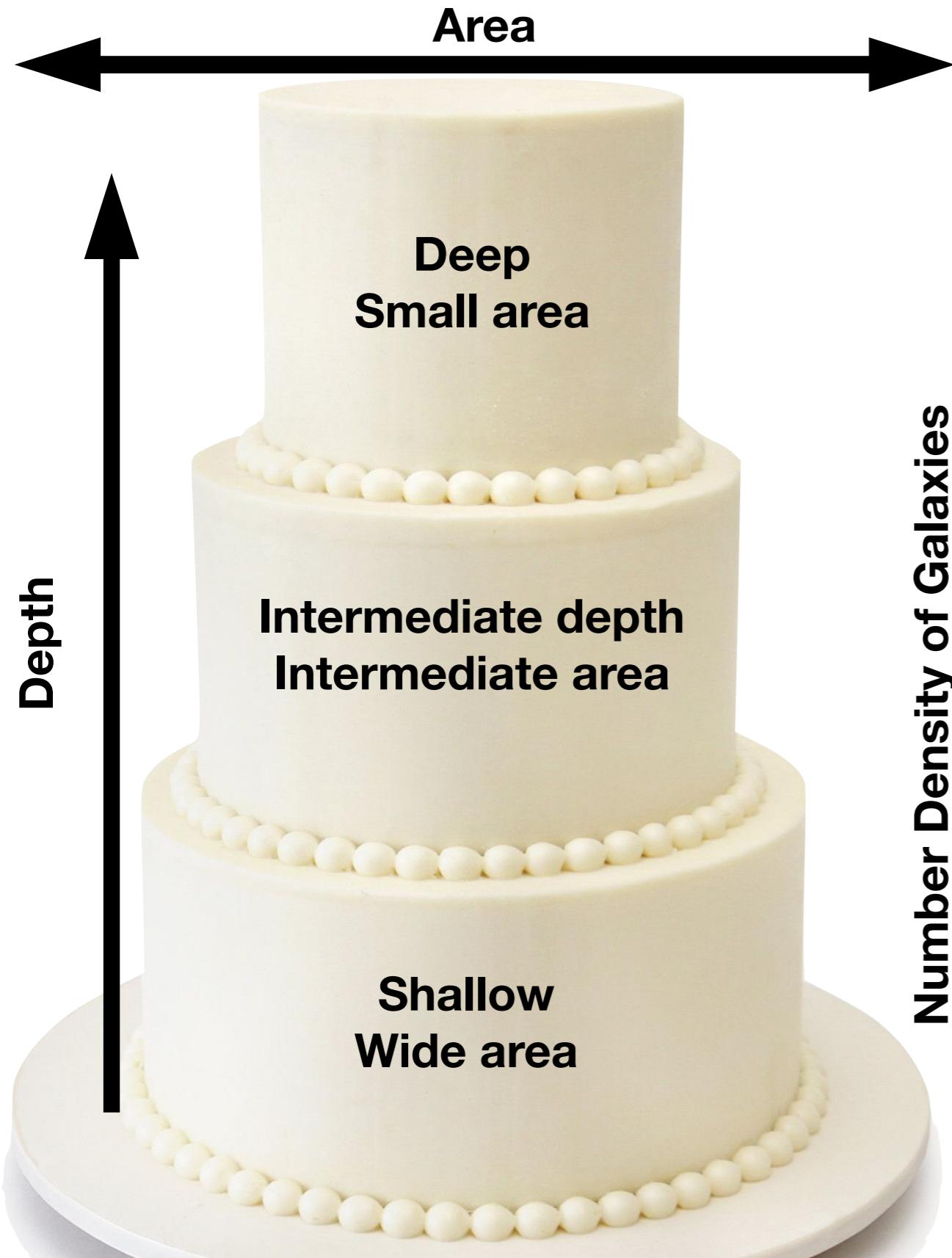
Outline

1. What is DASH and why do we need it?
2. The COSMOS-DASH Survey and Morphological Catalog
3. Quantifying and qualifying DASH Morphologies
4. The effect of environment on the low-mass size mass relation

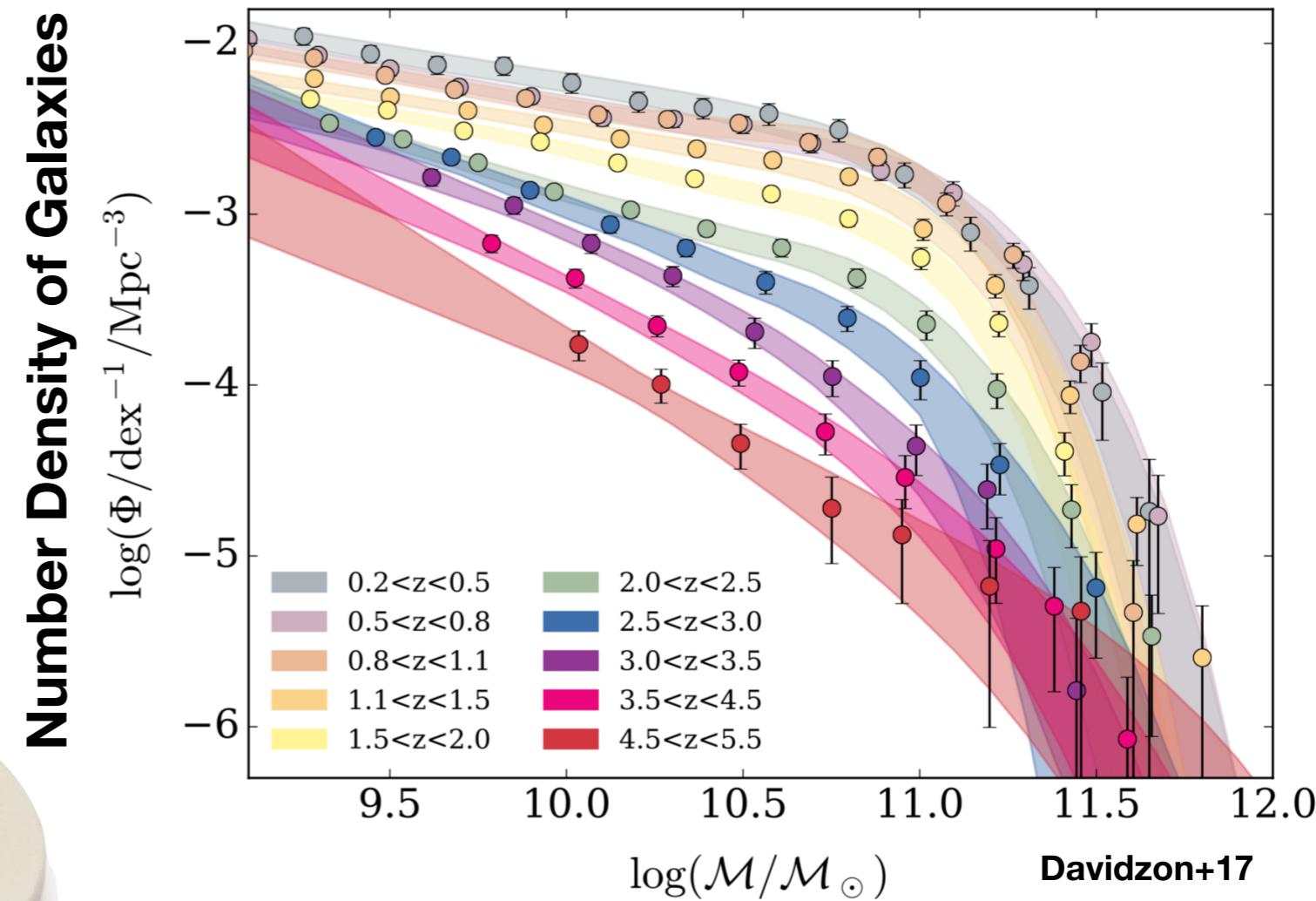
The Galaxy Stellar Mass Relation



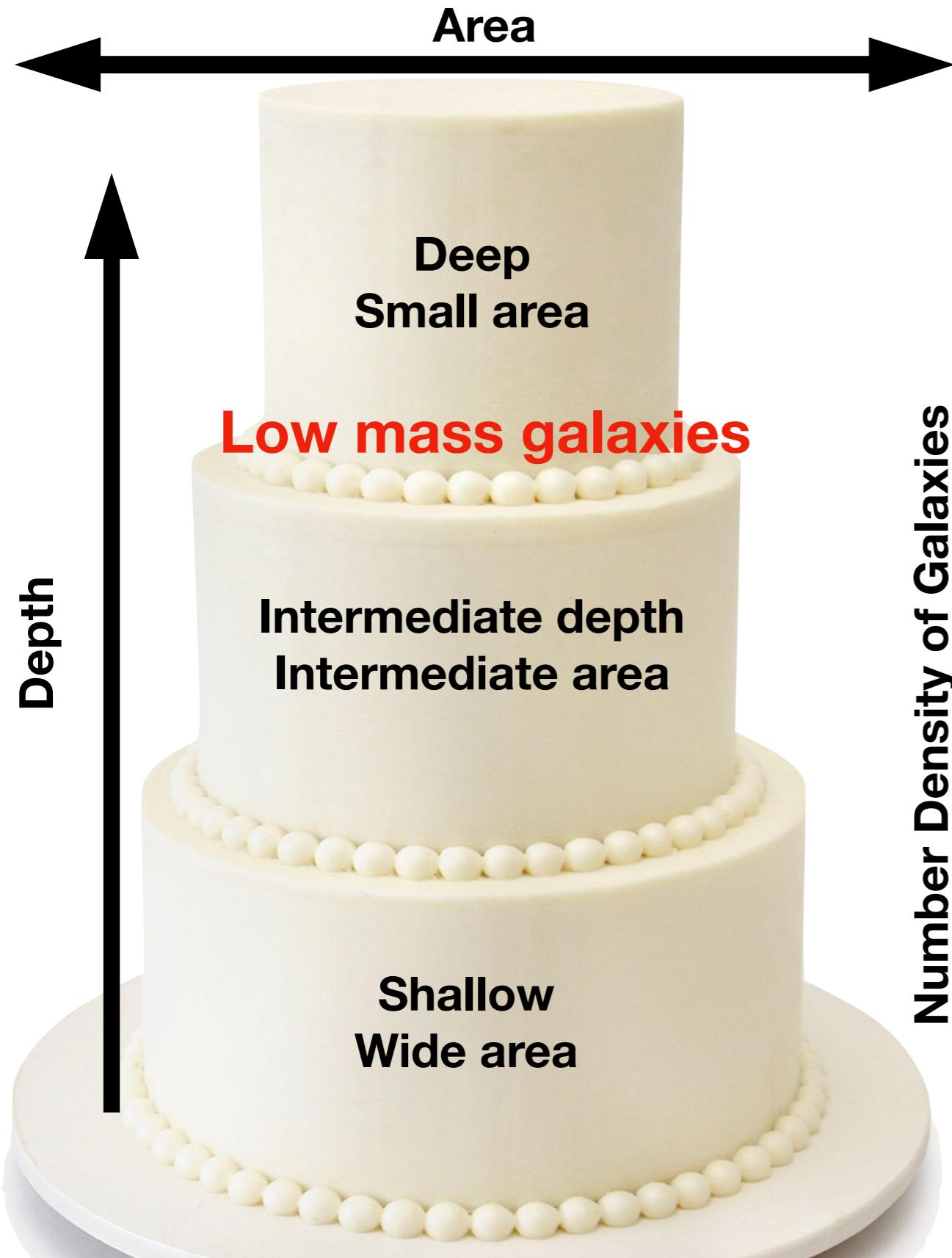
The “Wedding Cake” Approach



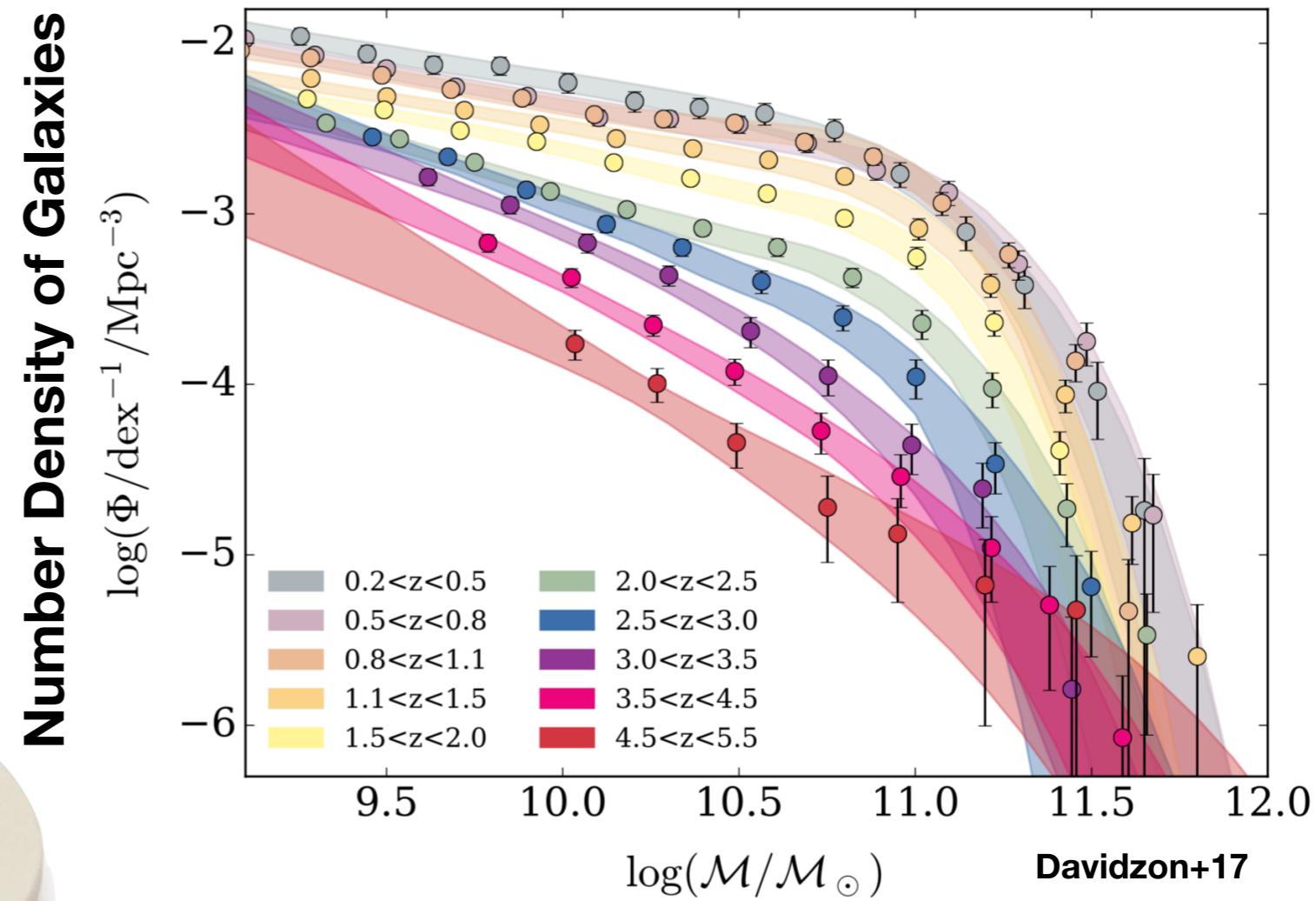
Shape of galaxy stellar mass function drives approach



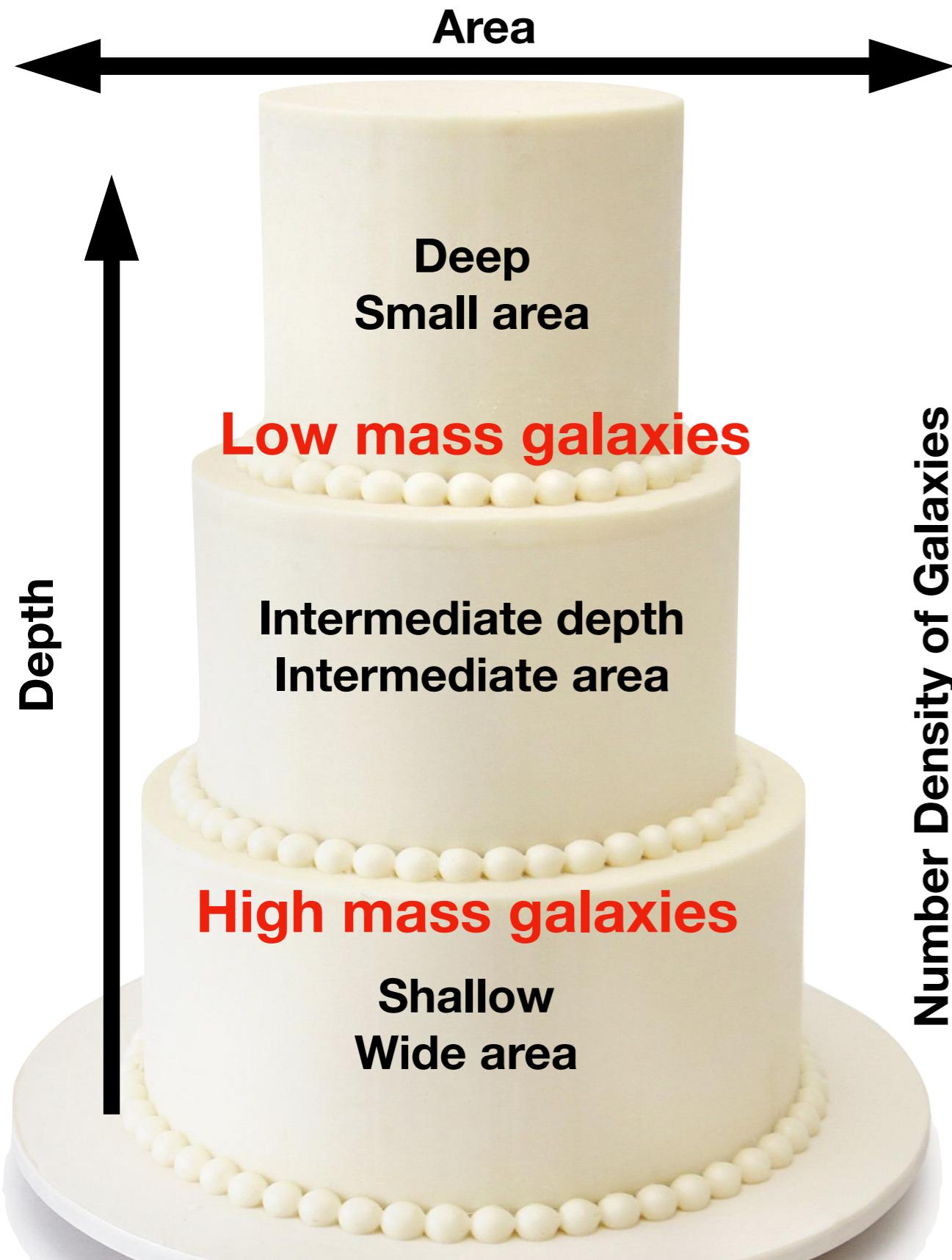
The “Wedding Cake” Approach



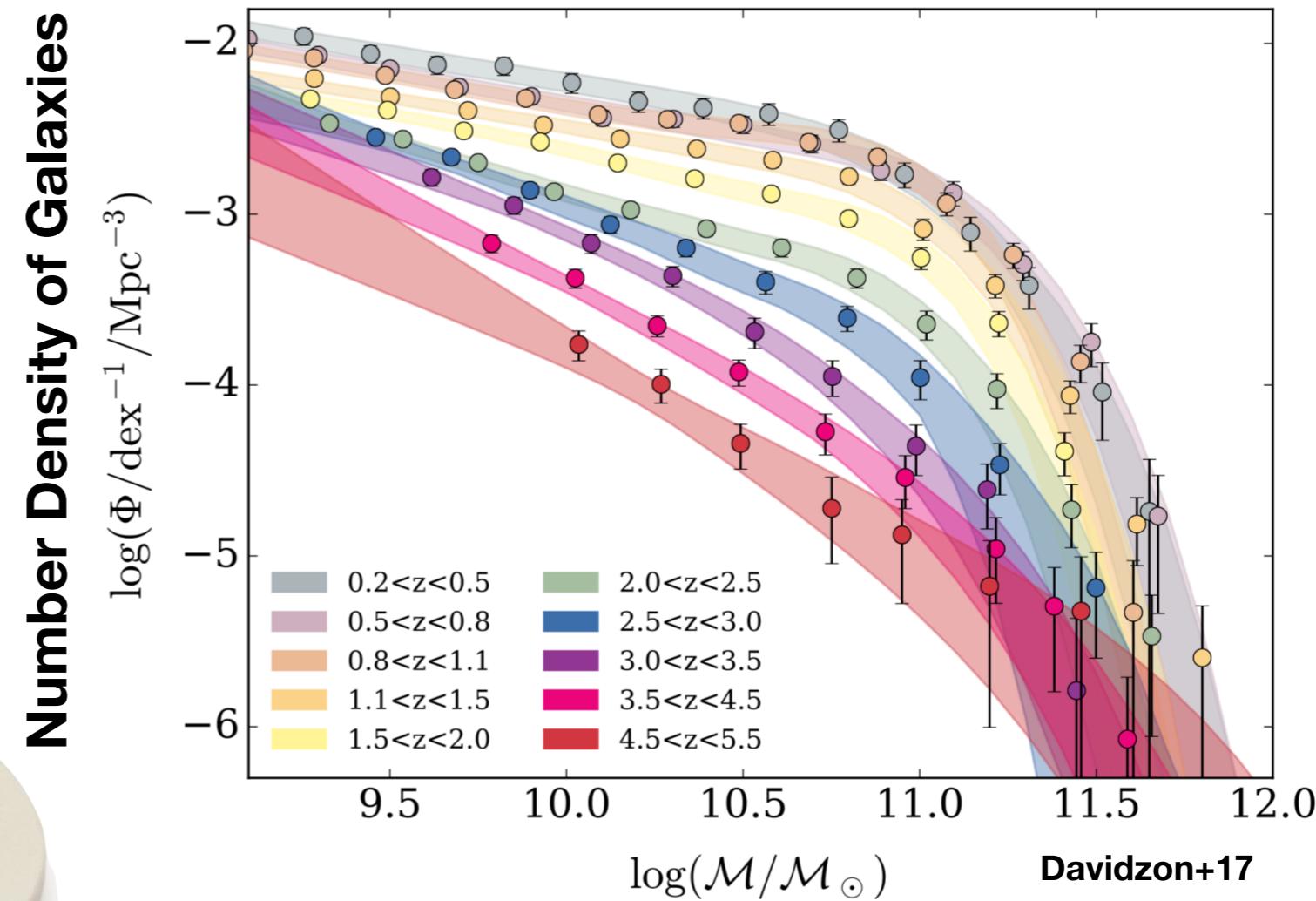
Shape of galaxy stellar mass function drives approach



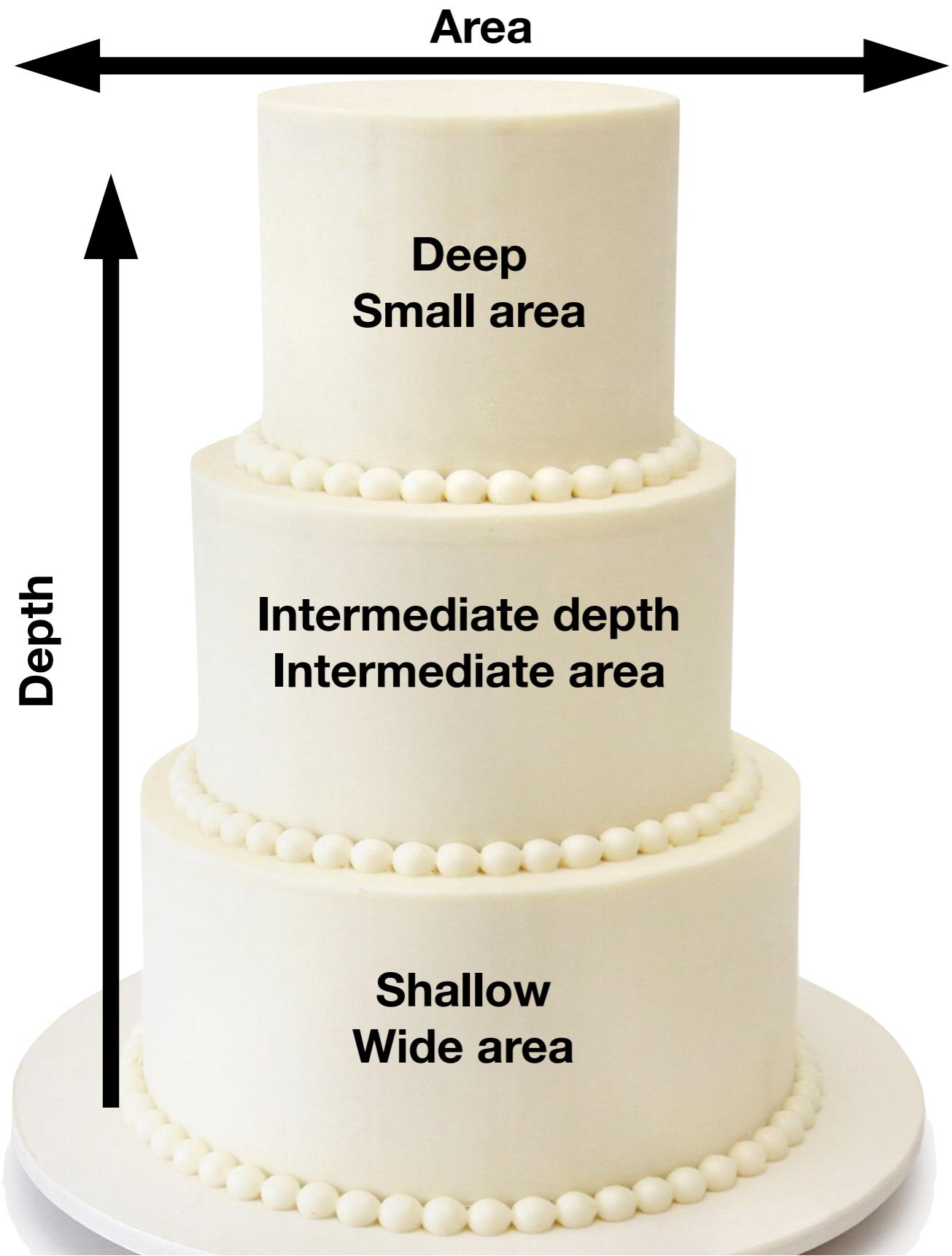
The “Wedding Cake” Approach



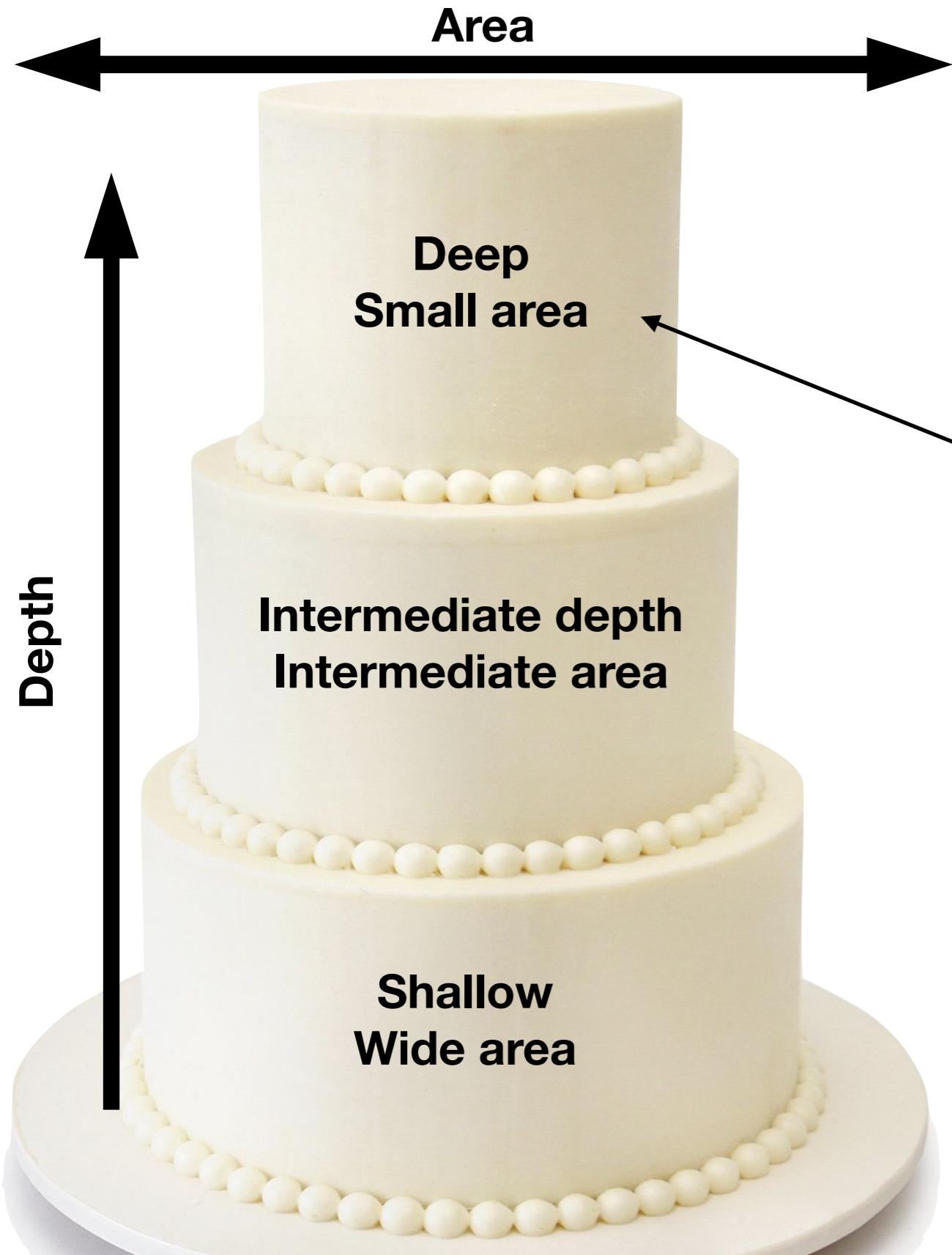
Shape of galaxy stellar mass function drives approach



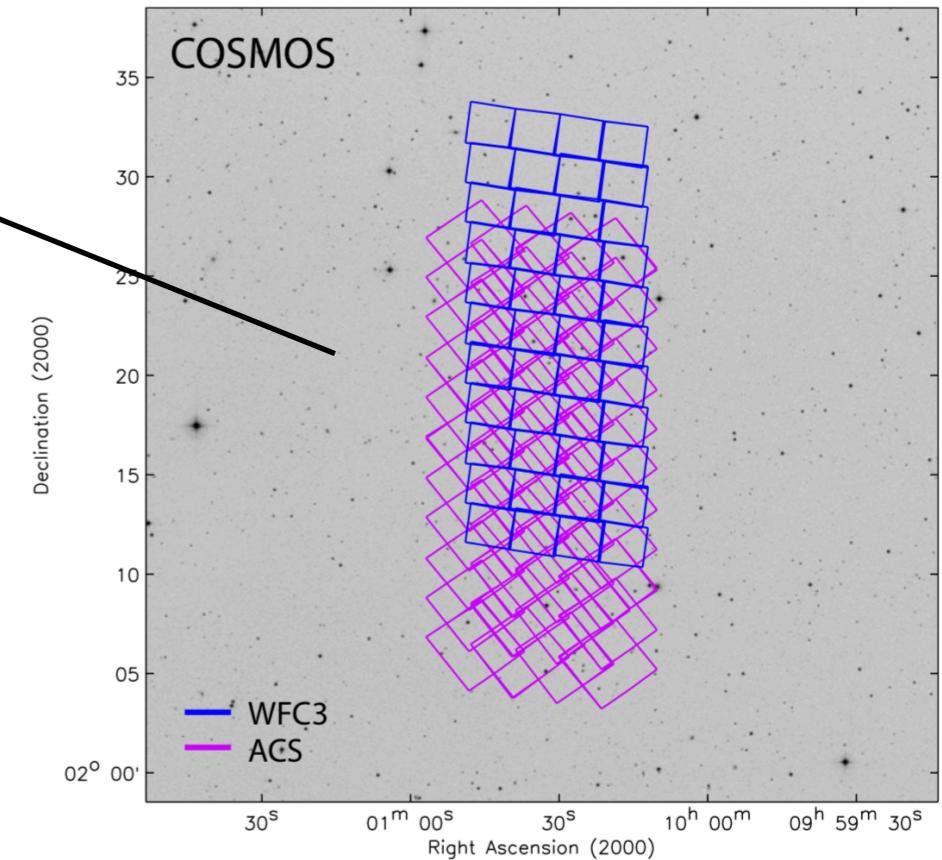
The “Wedding Cake” Approach



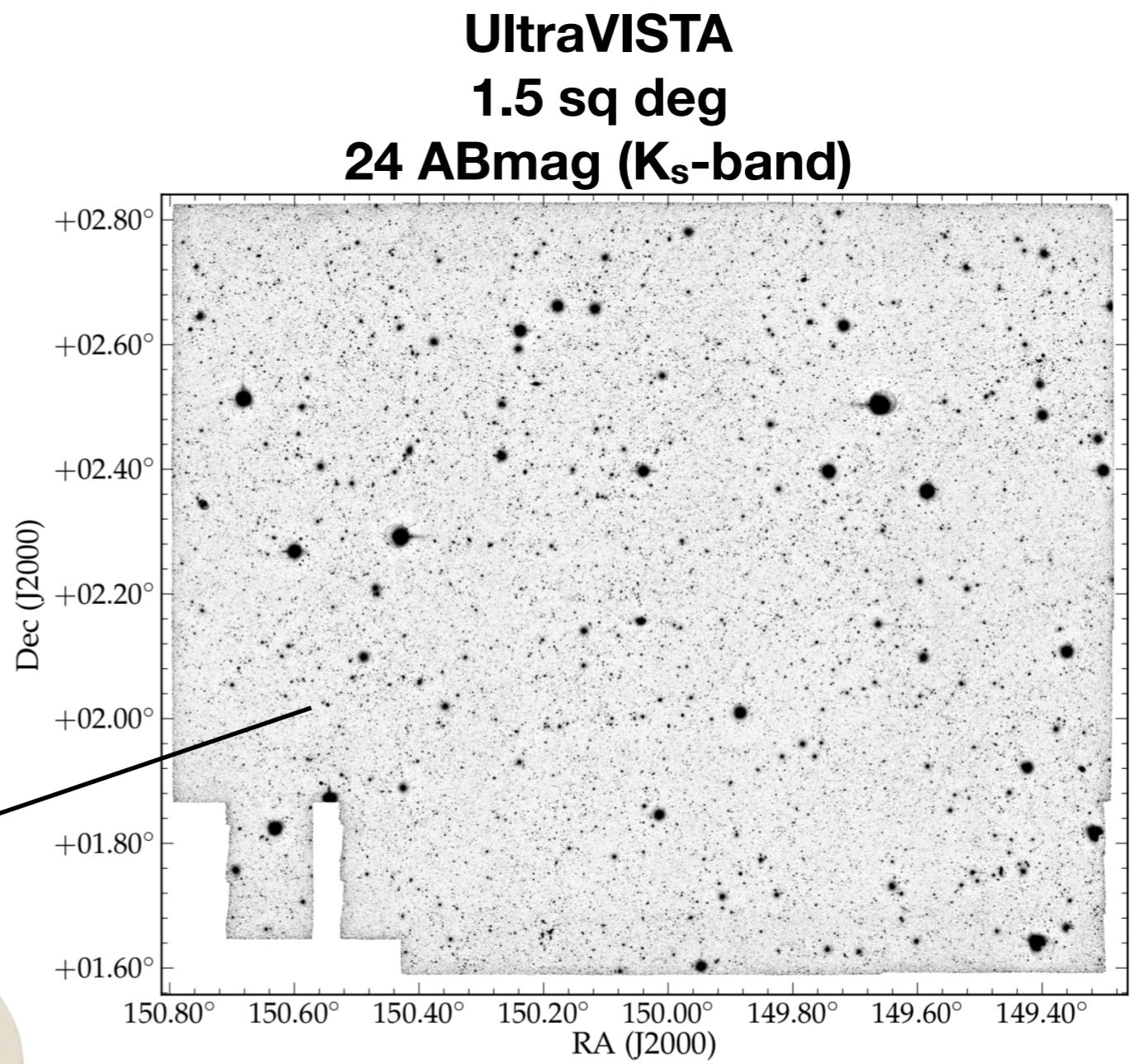
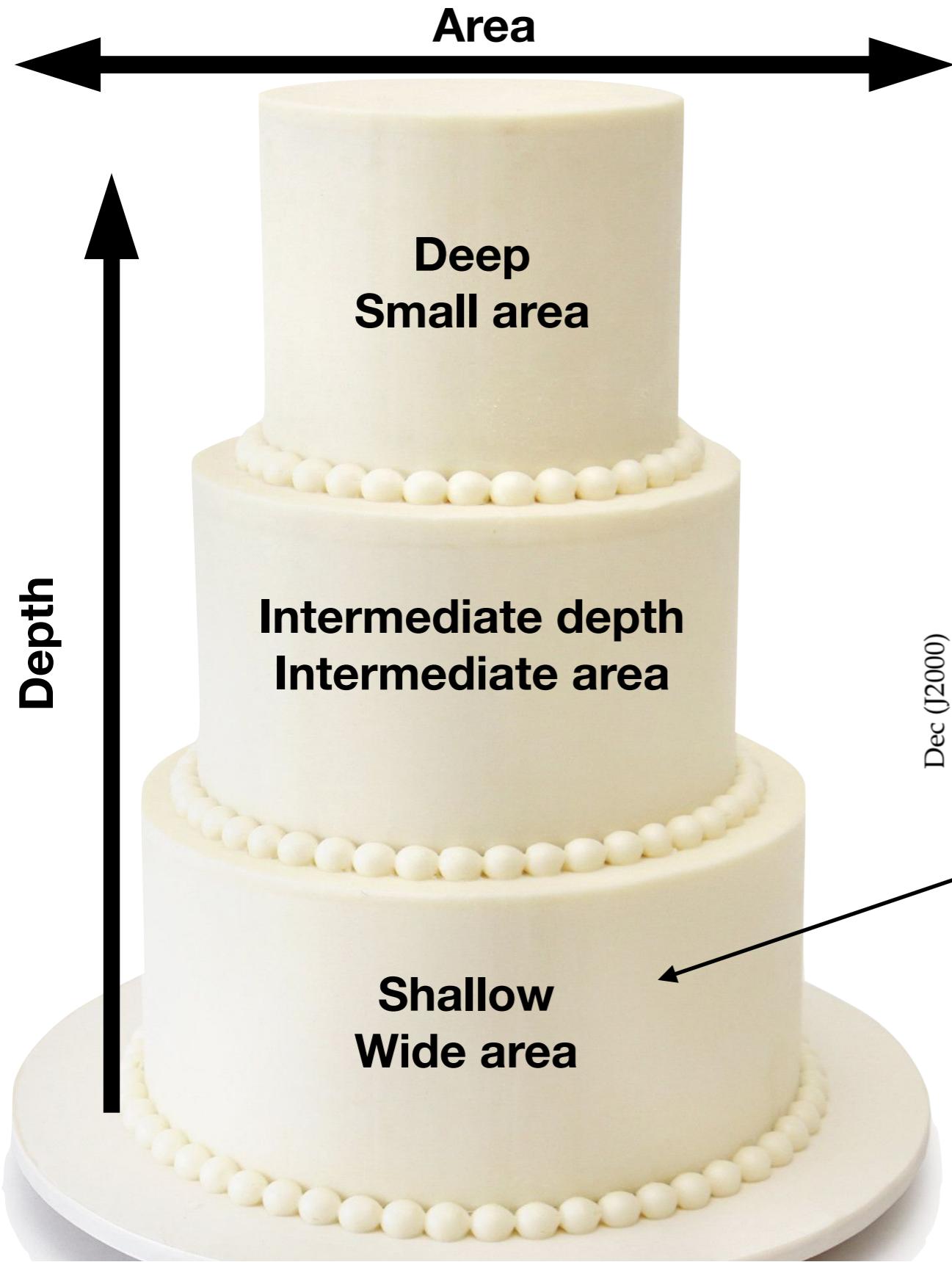
The “Wedding Cake” Approach



CANDELS
0.25 sq deg
27 ABmag (H-band)

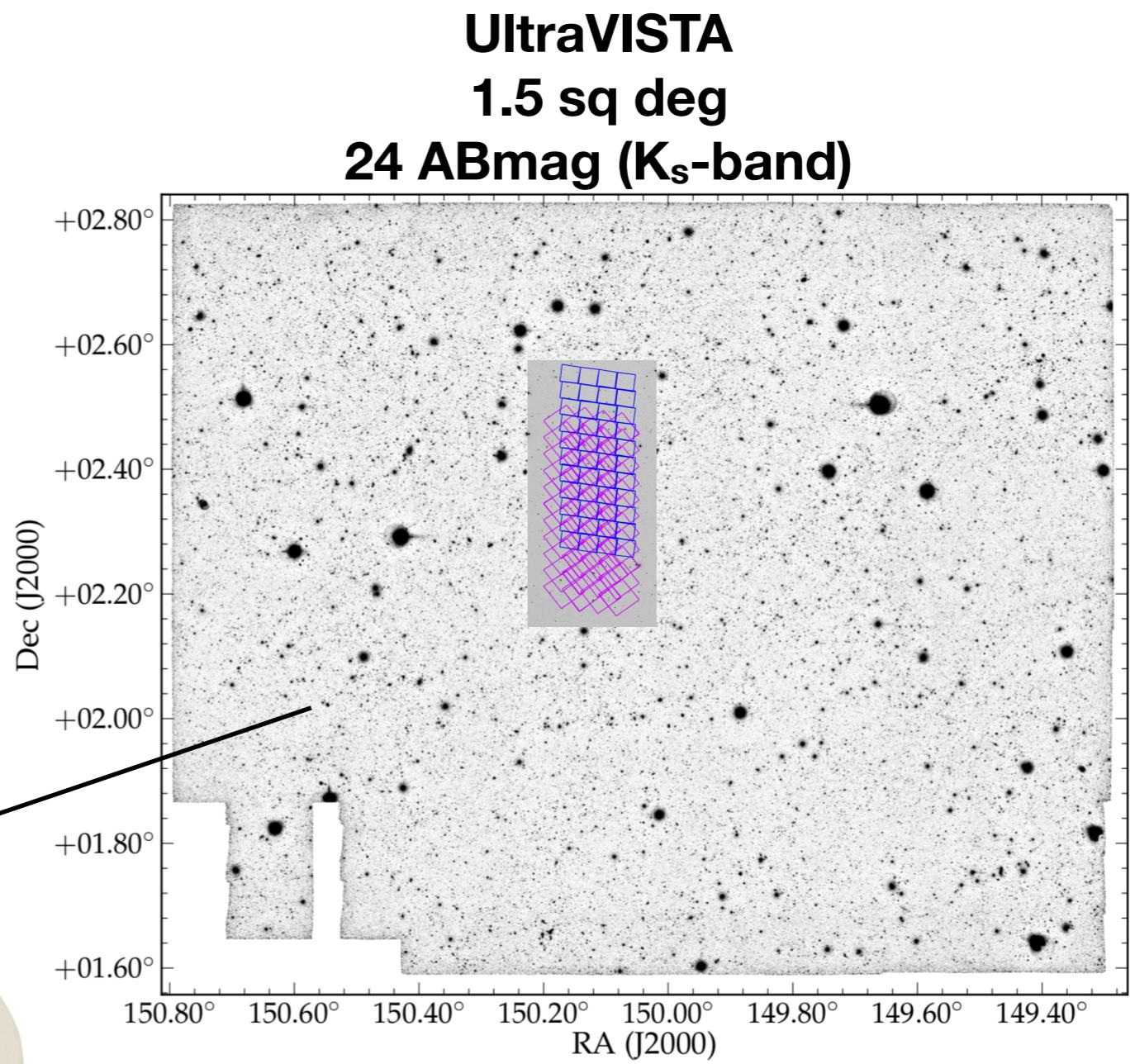
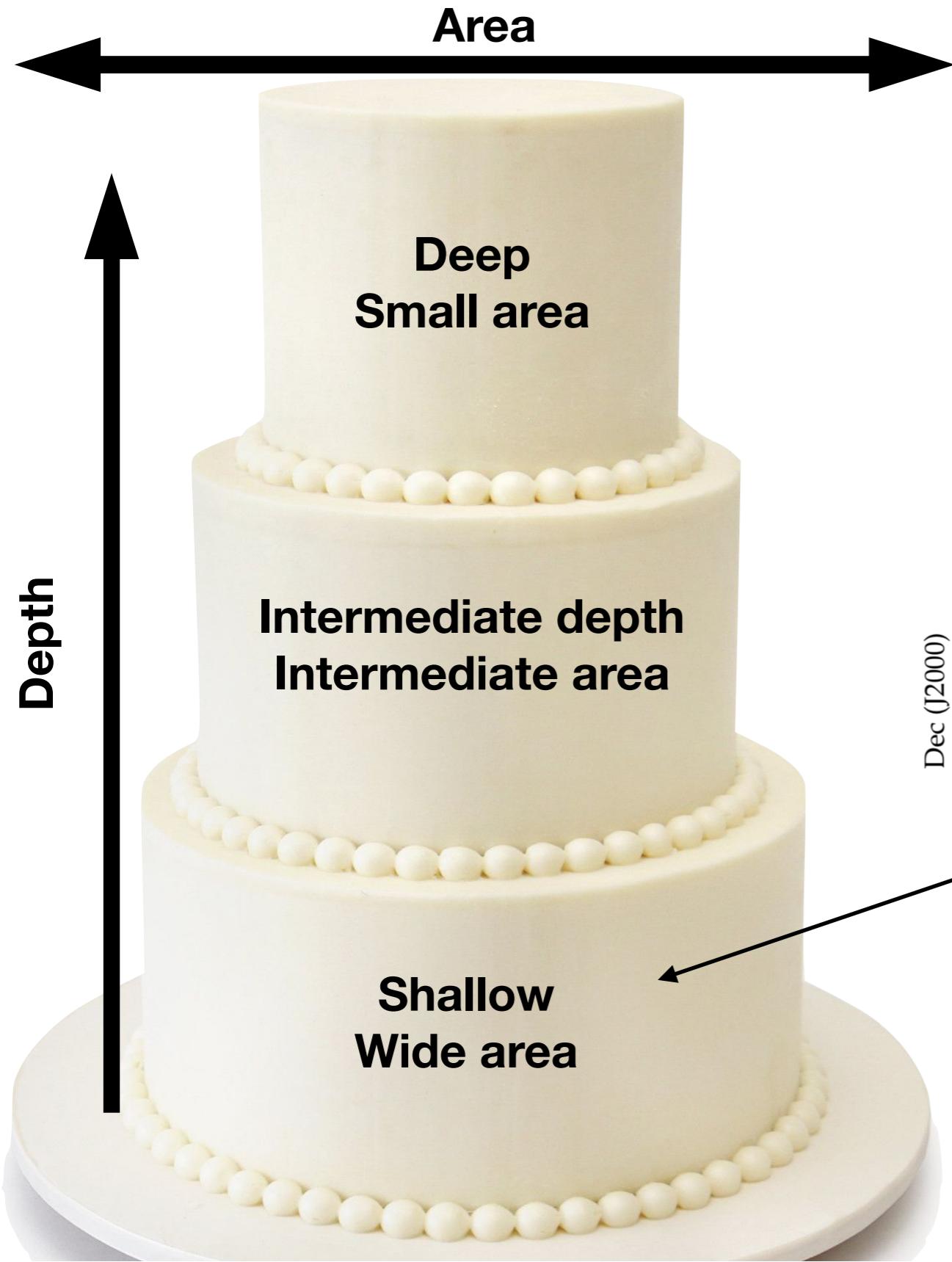


The “Wedding Cake” Approach

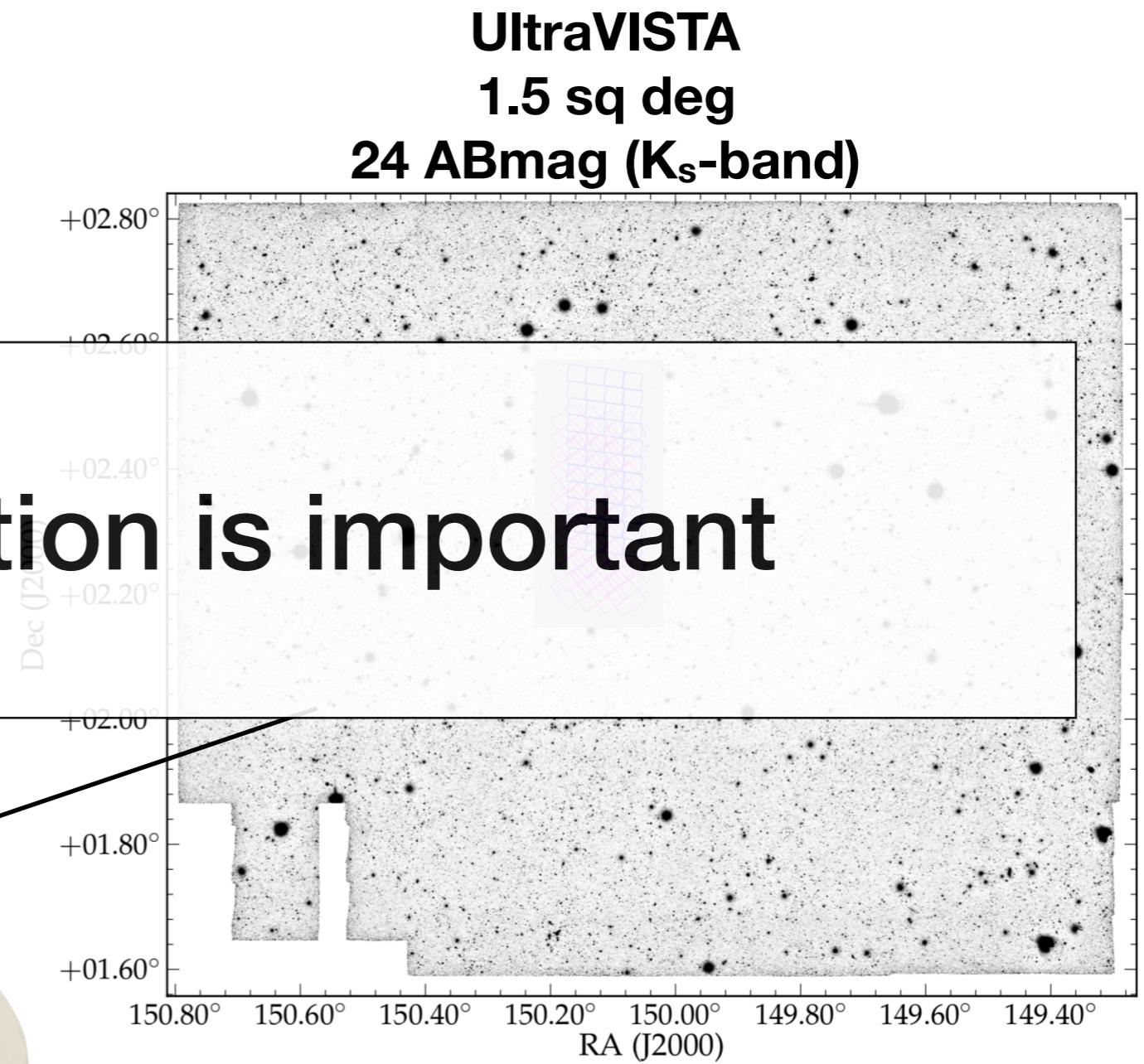
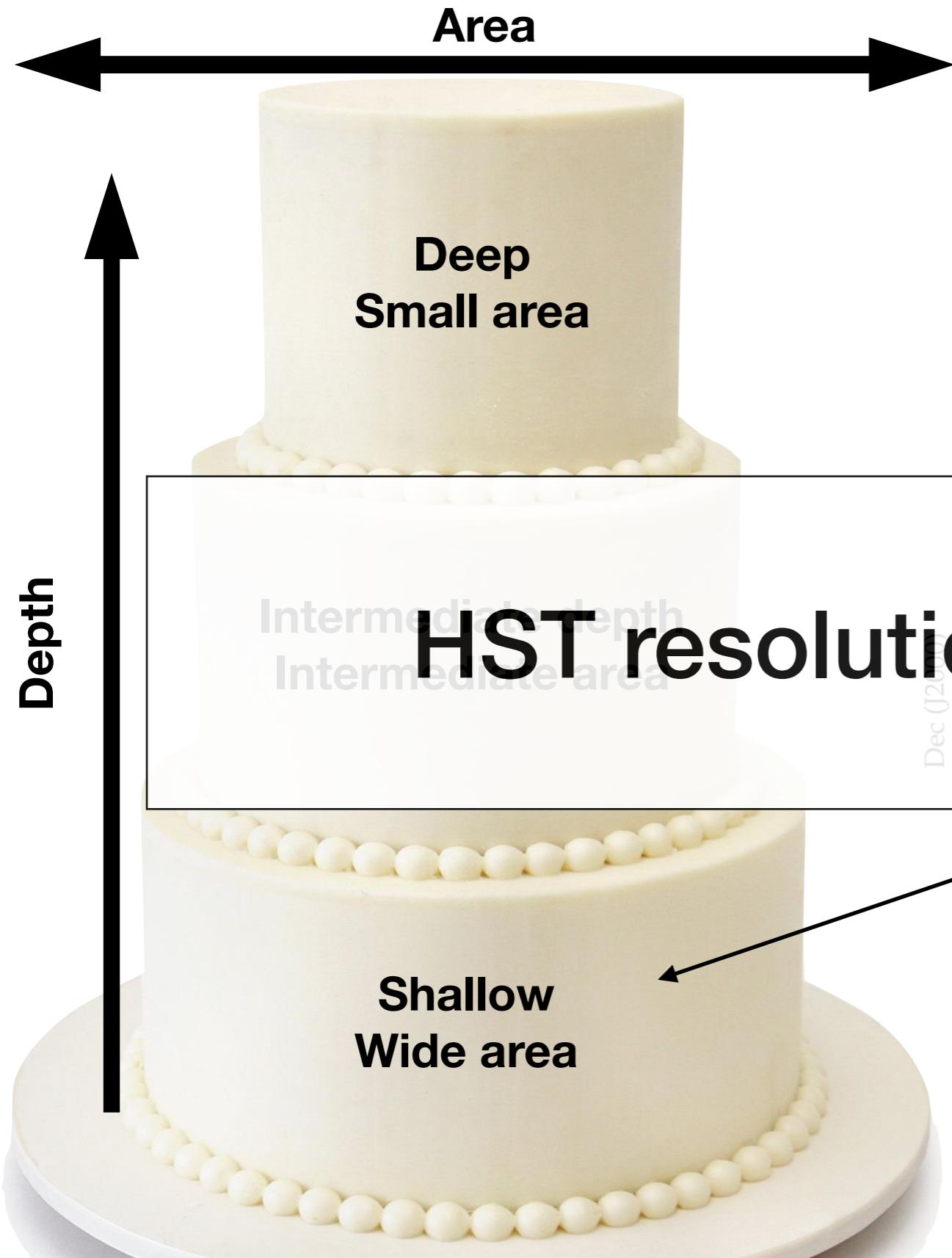


McCracken+12

The “Wedding Cake” Approach

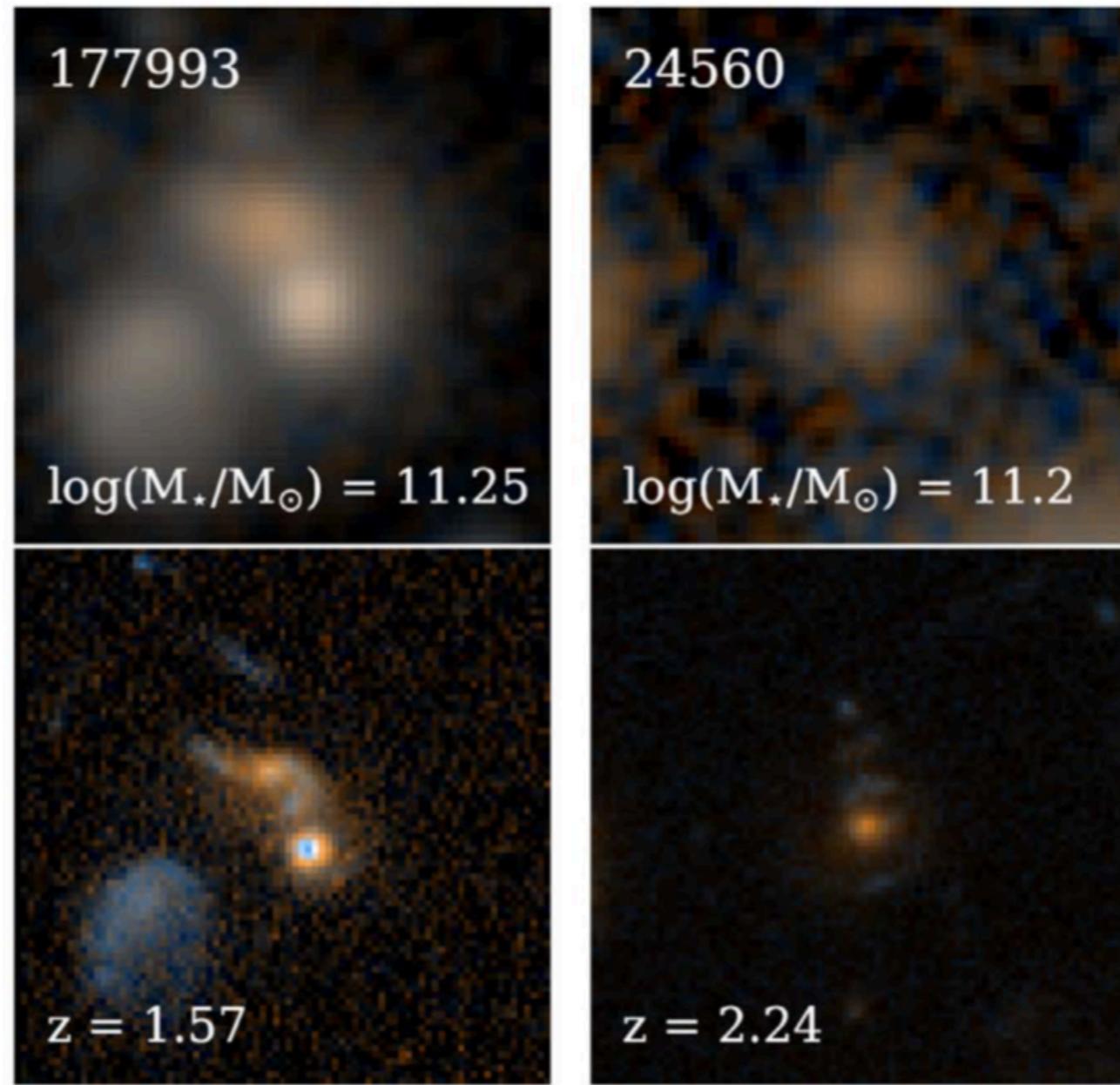


The “Wedding Cake” Approach



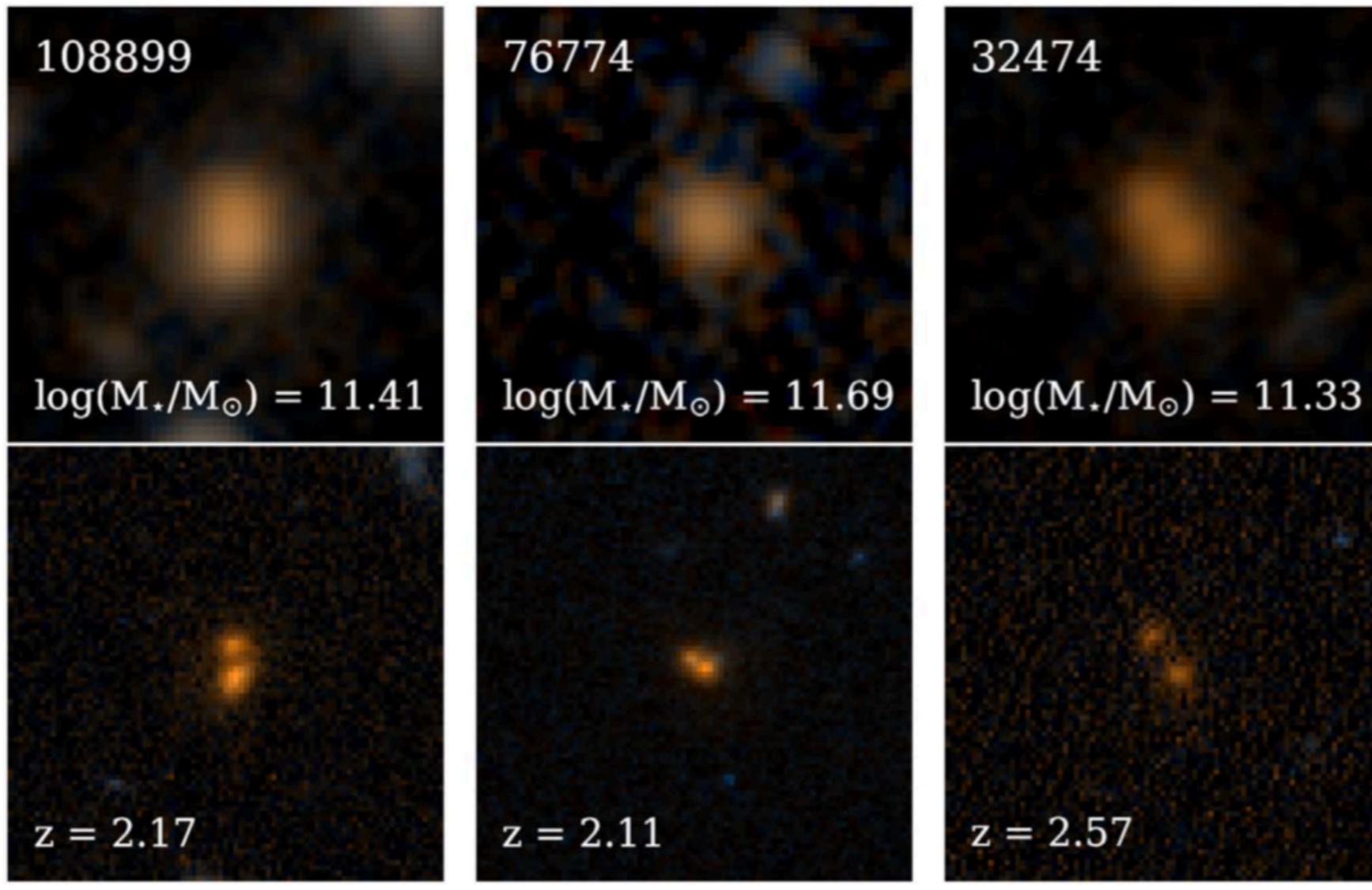
McCracken+12

1) Morphologies require high resolution



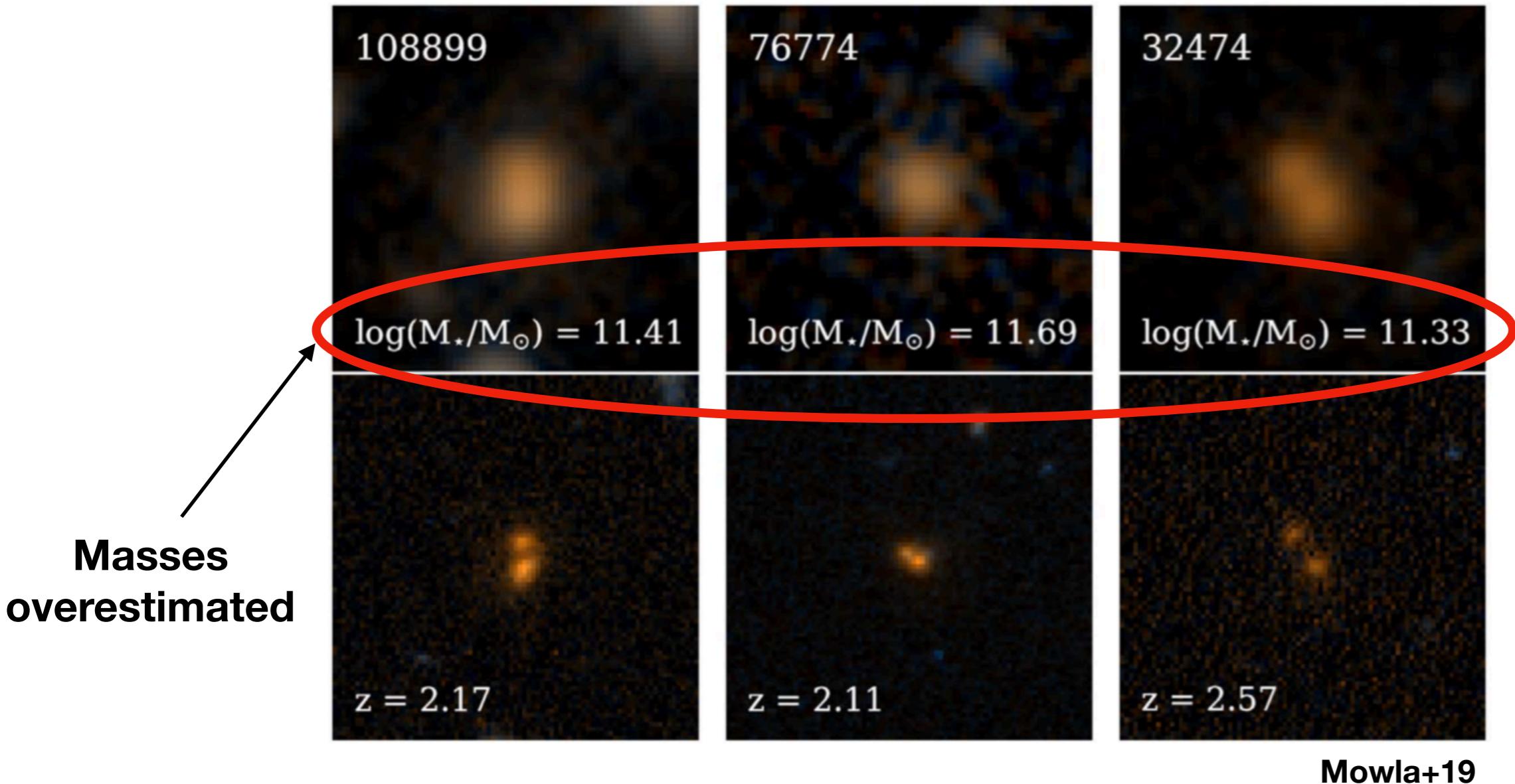
Mowla+19

2) Blending significant at high redshift

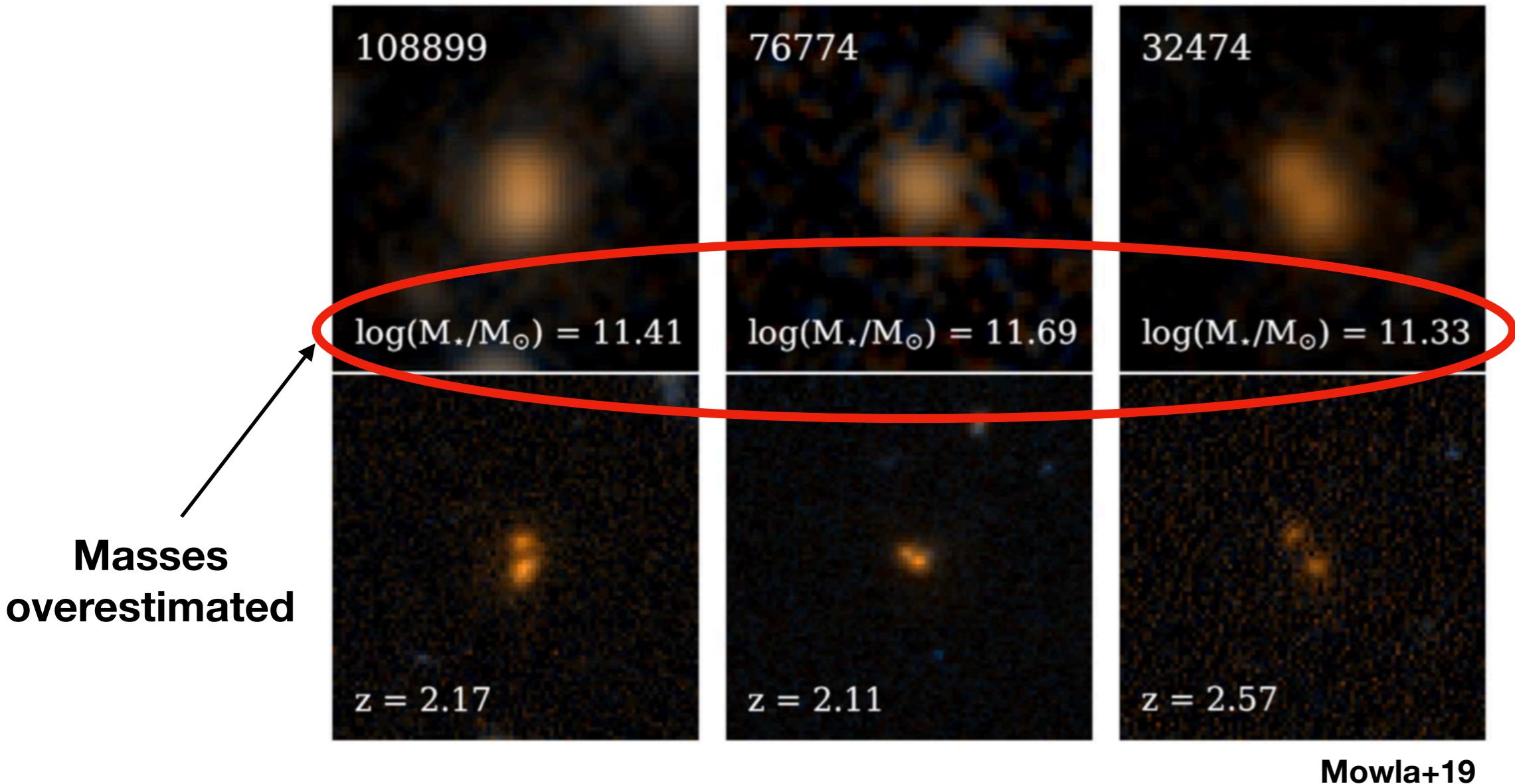


Mowla+19

2) Blending significant at high redshift

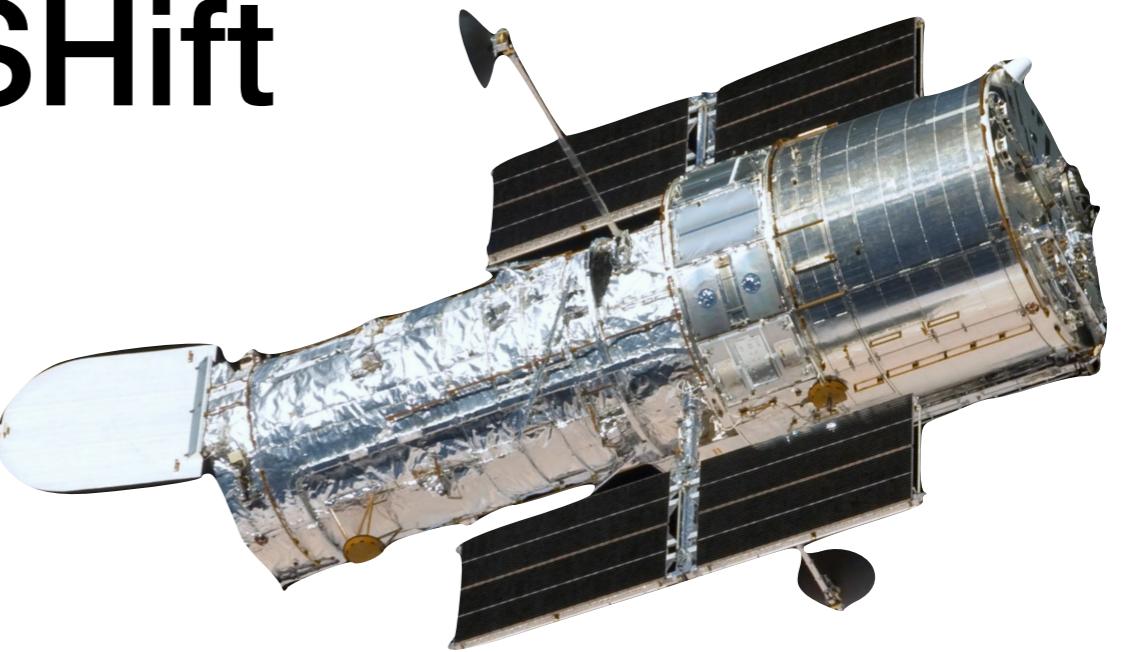


2) Blending significant at high redshift



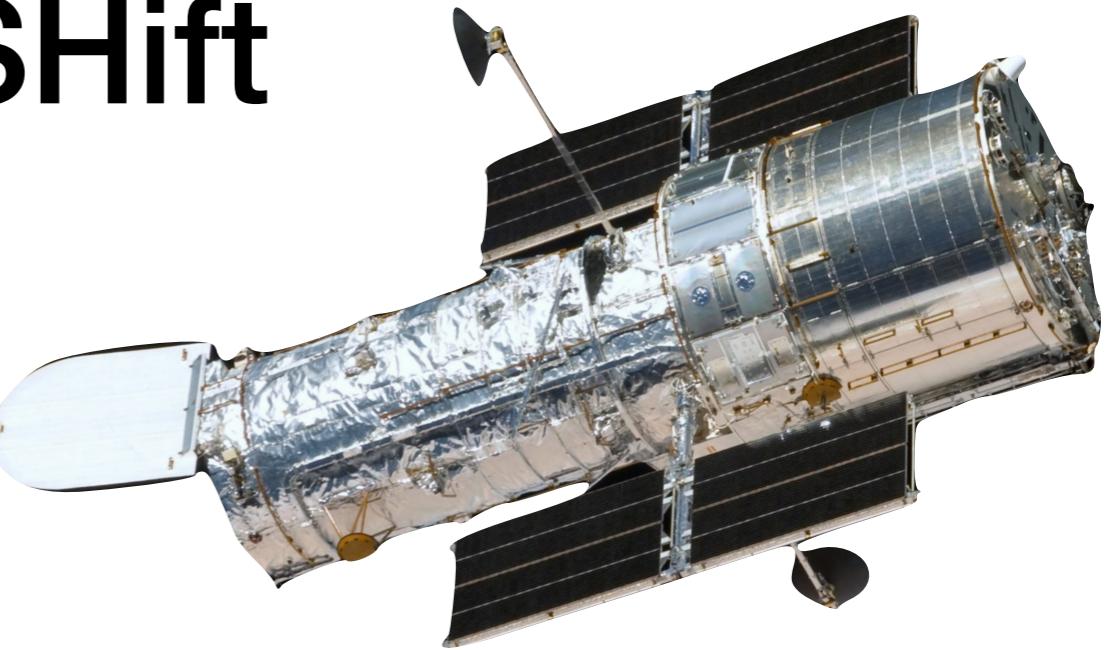
Need wide field HST imaging...

Drift And SHift



Drift And SHift

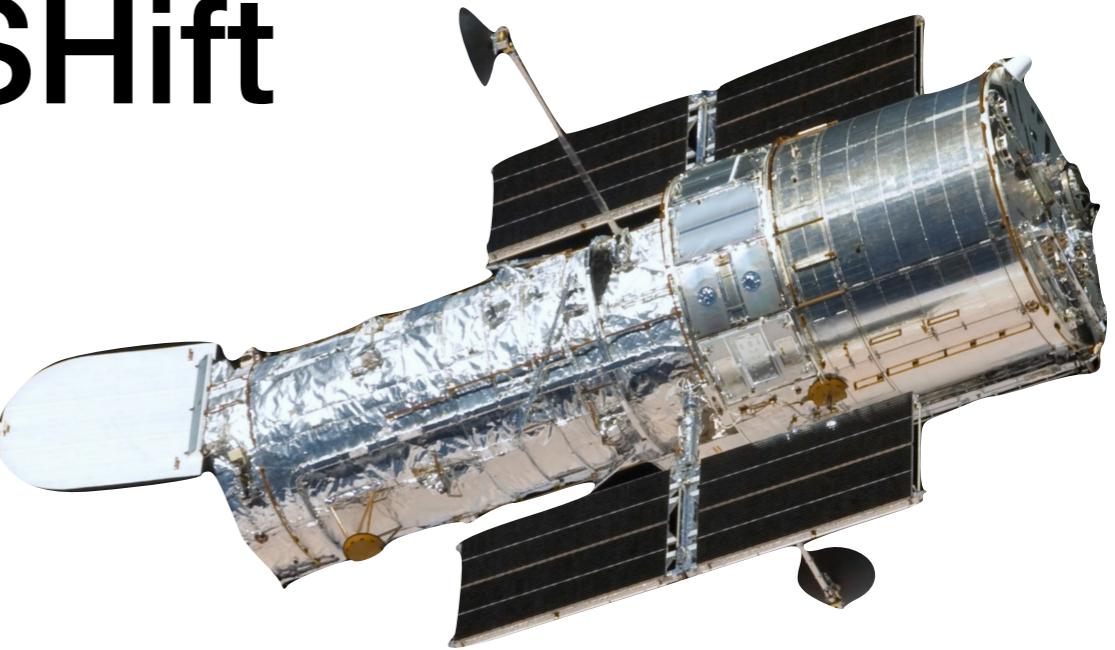
2 reasons for HST inefficiency:



Drift And SHift

2 reasons for HST inefficiency:

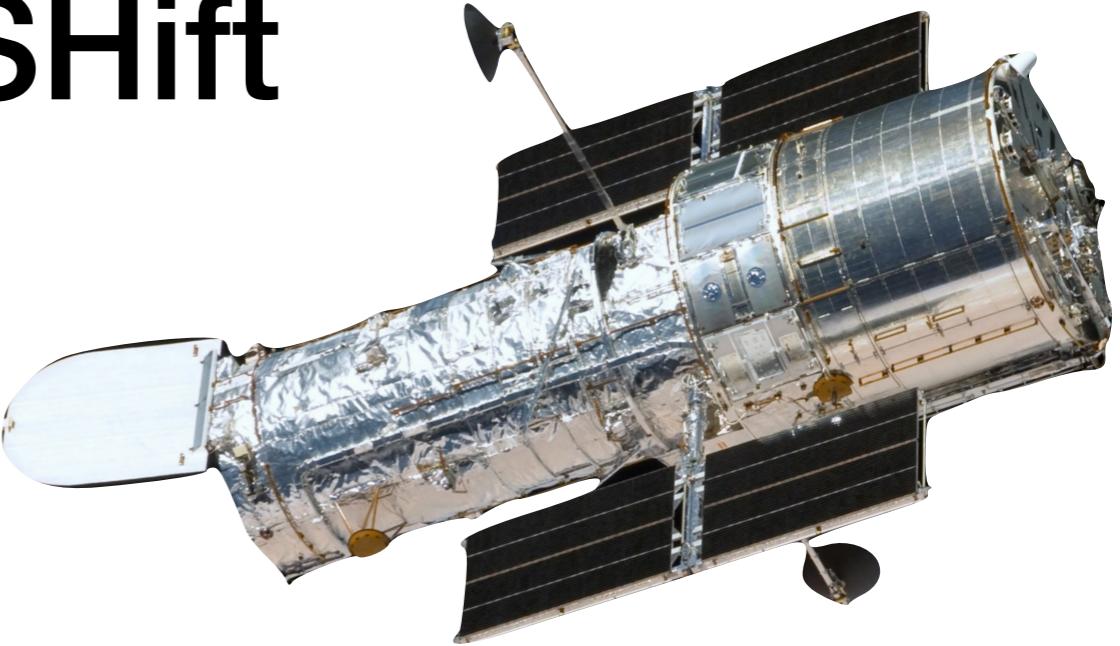
1. 4.6" FOV (750 pointings/deg²)



Drift And SHift

2 reasons for HST inefficiency:

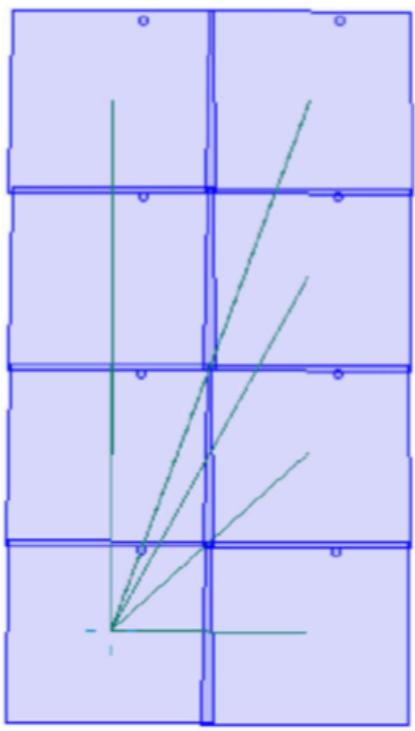
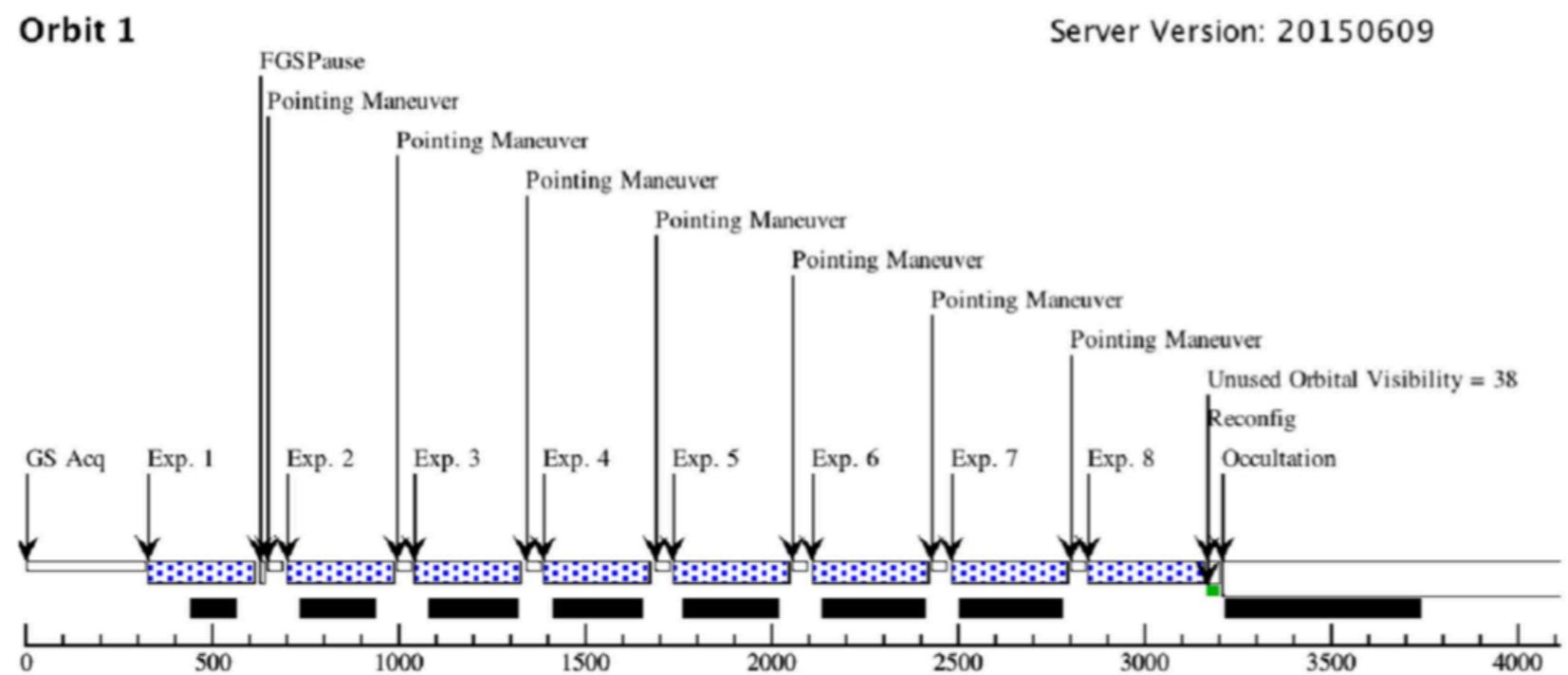
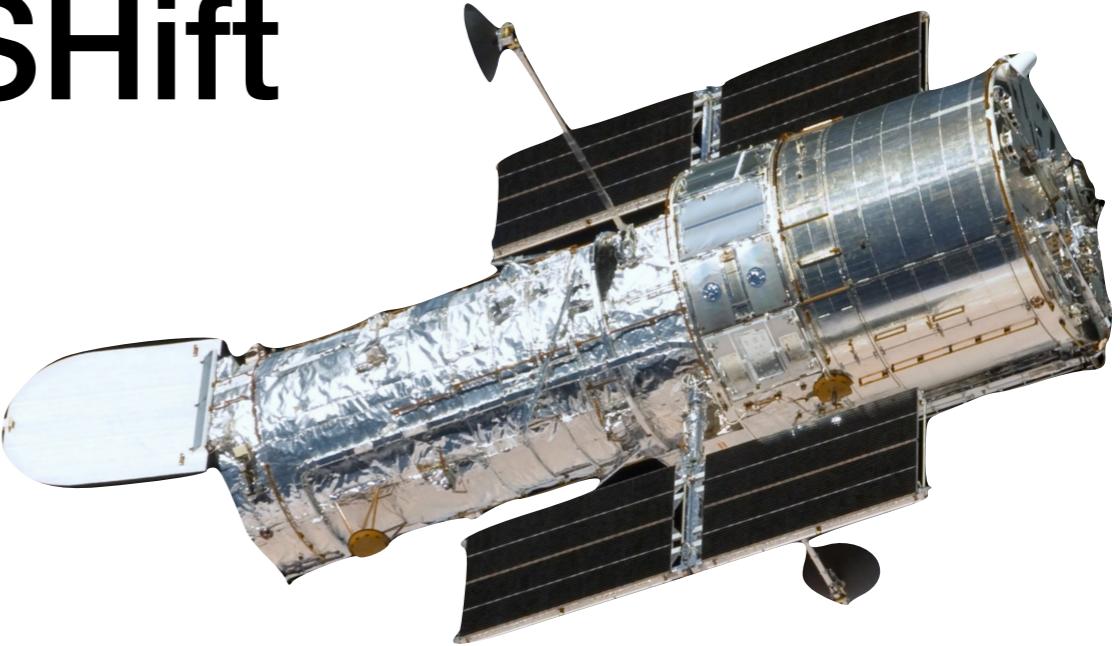
1. 4.6" FOV (750 pointings/deg²)
2. Guide star acquisition overhead (in NIR: 1 pointing/orbit)



Drift And SHift

2 reasons for HST inefficiency:

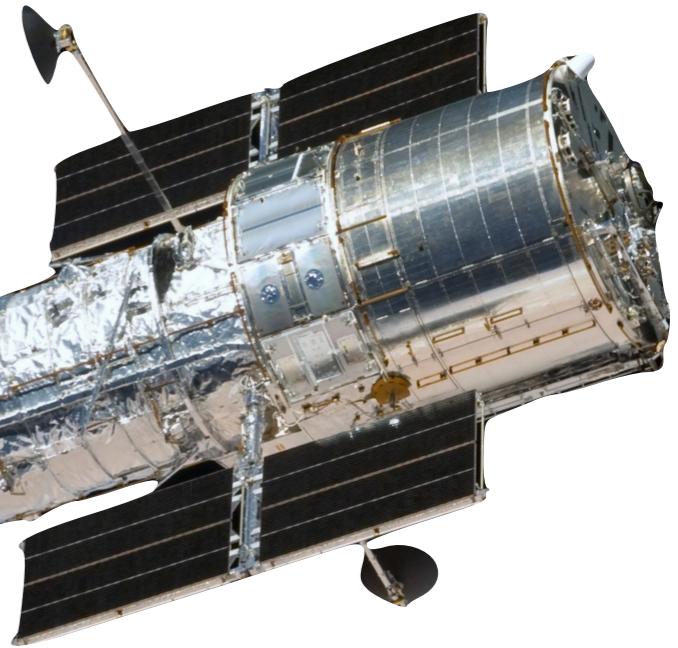
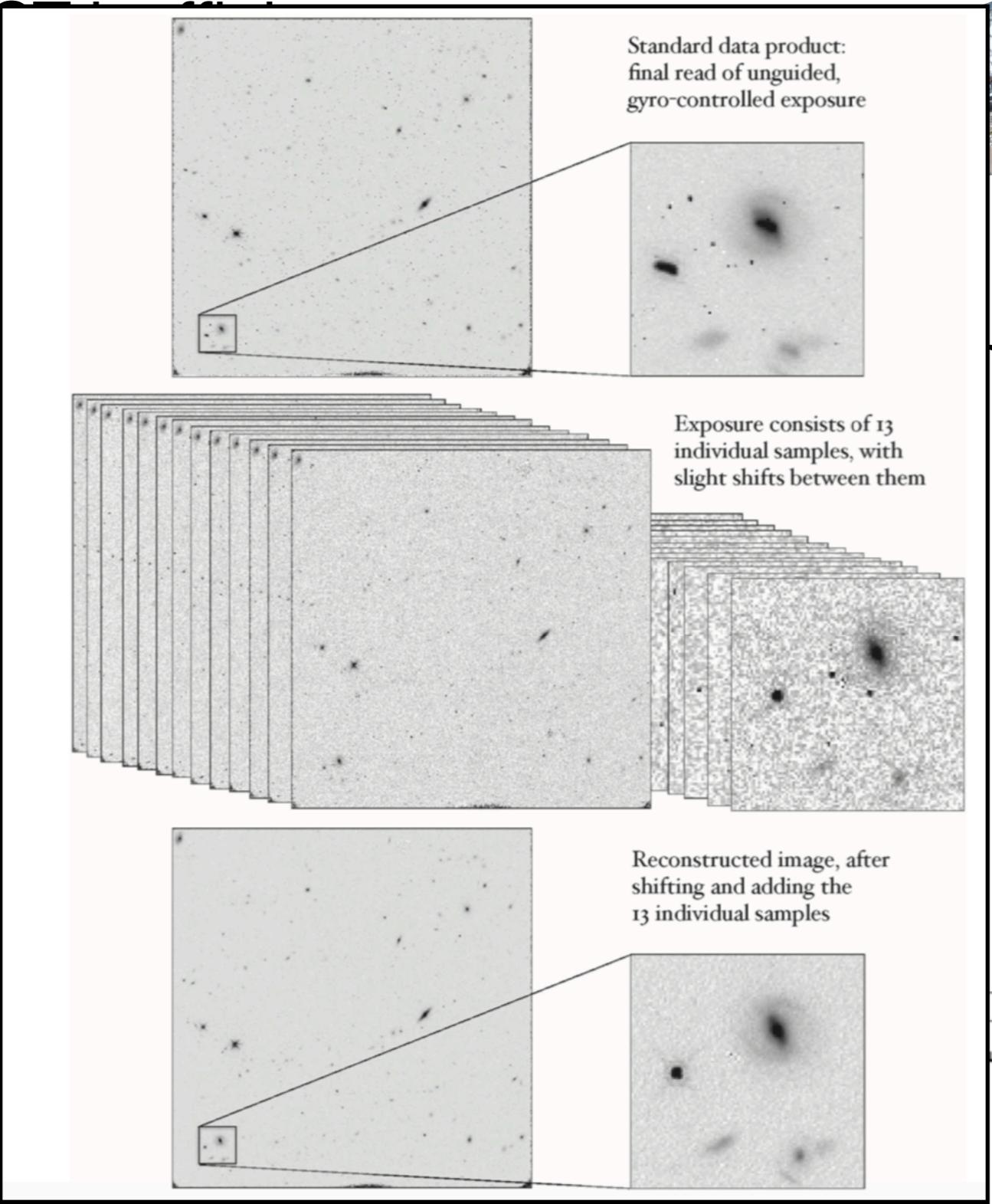
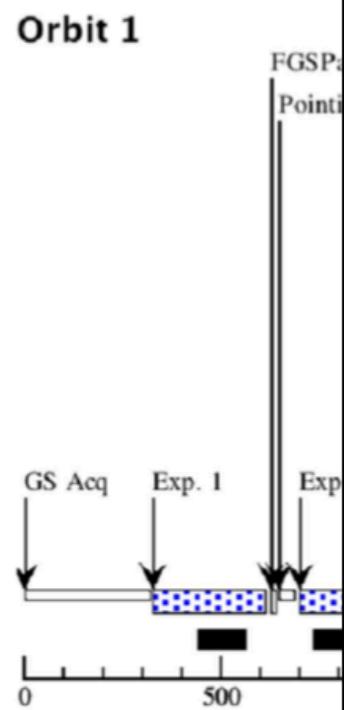
1. 4.6" FOV (750 pointings/deg²)
2. Guide star acquisition overhead (in NIR: 1 pointing/orbit)



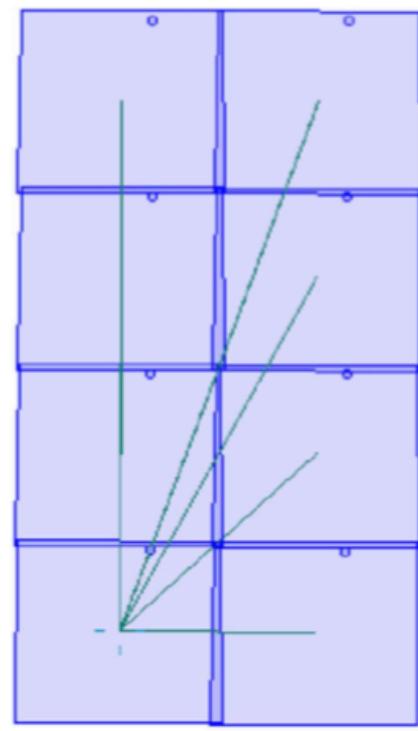
Drift And SHift

2 reasons for HS

1. 4.6" FOV (75%)
2. Guide star absence



pointing/orbit)

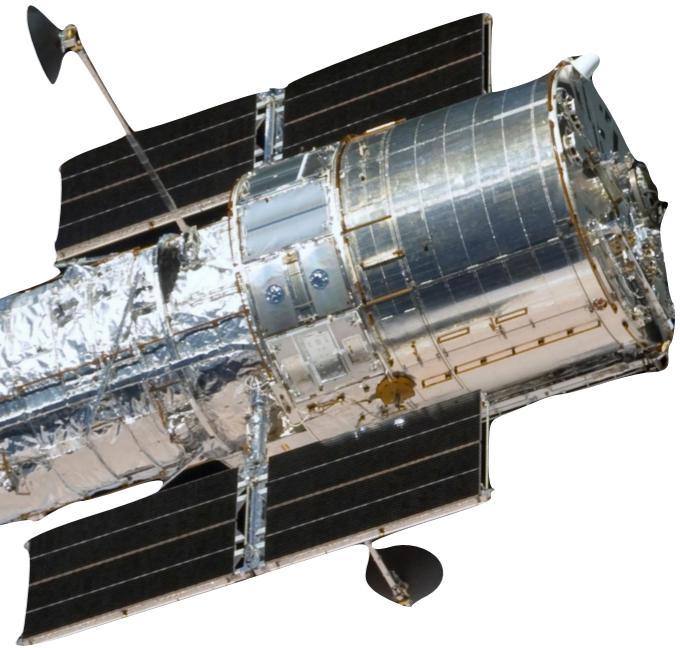
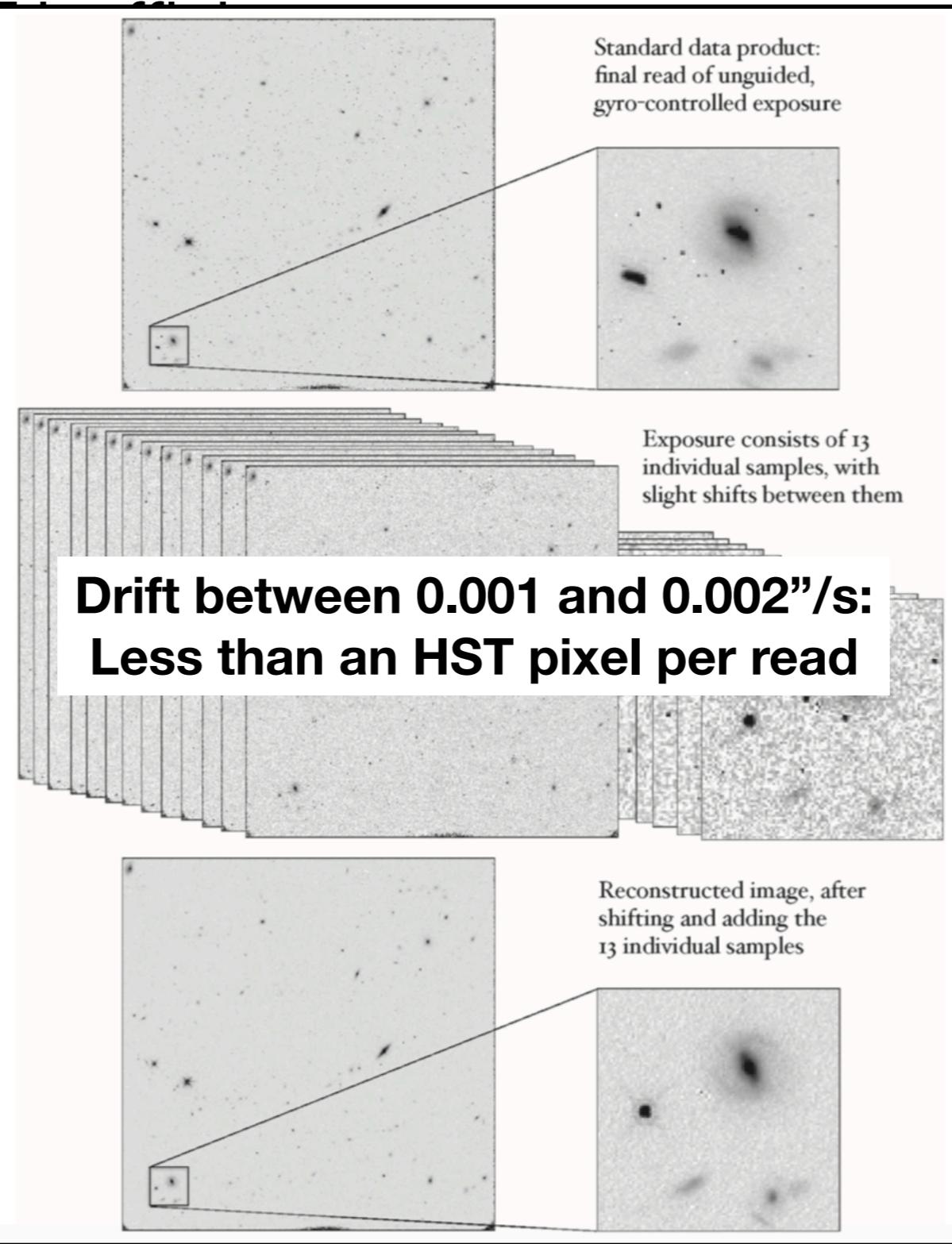
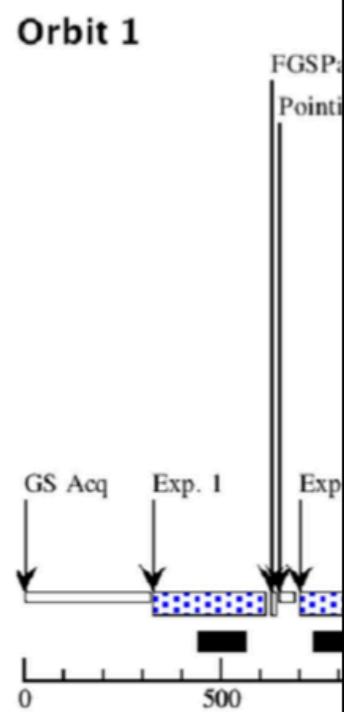


Momcheva+17

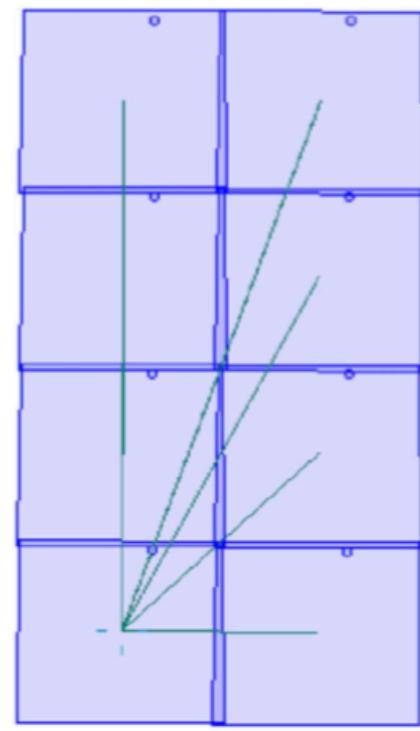
Drift And SHift

2 reasons for HST drift:

1. 4.6" FOV (75% of the sky)
2. Guide star acquisition



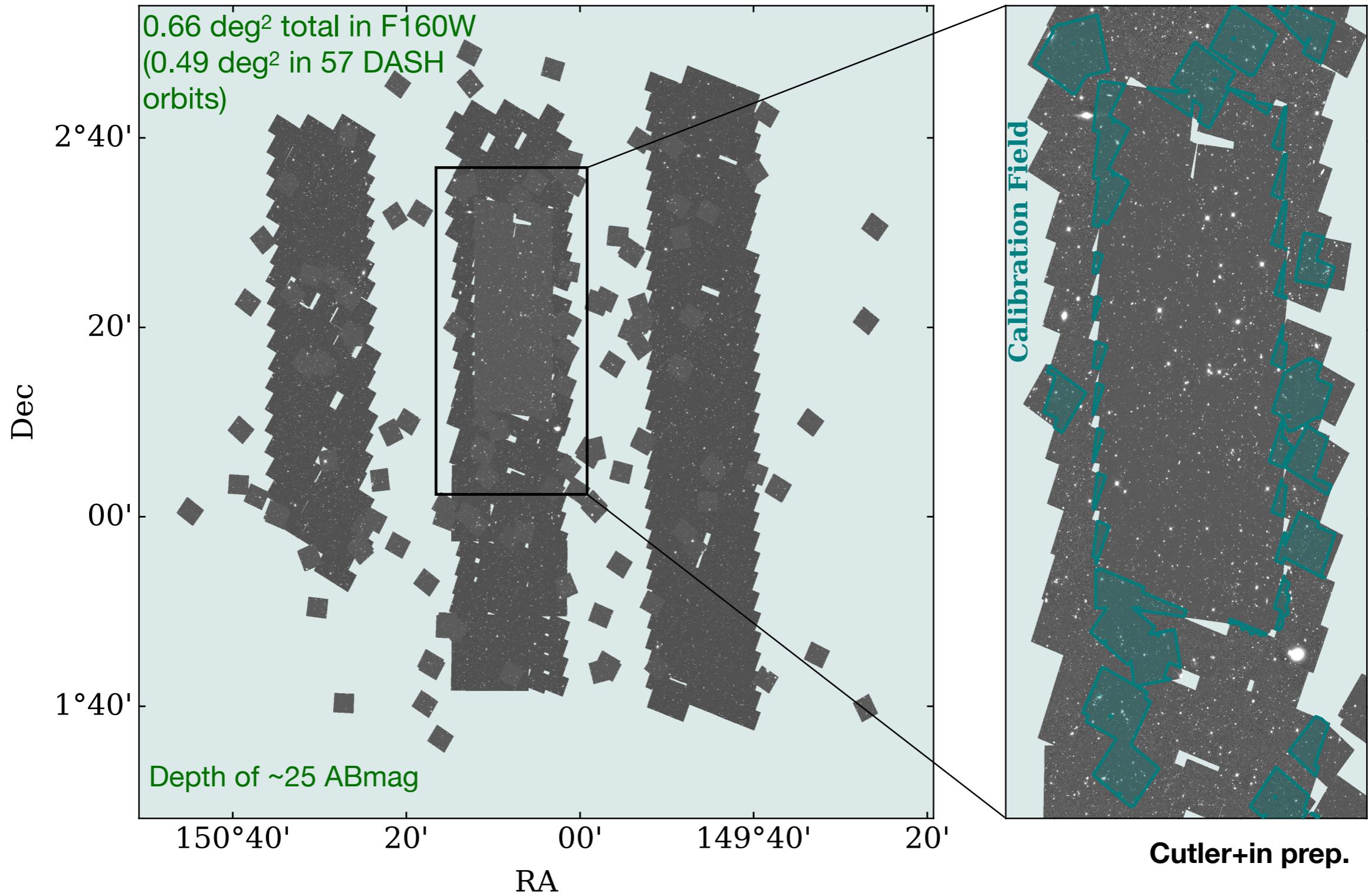
(pointing/orbit)



Momcheva+17

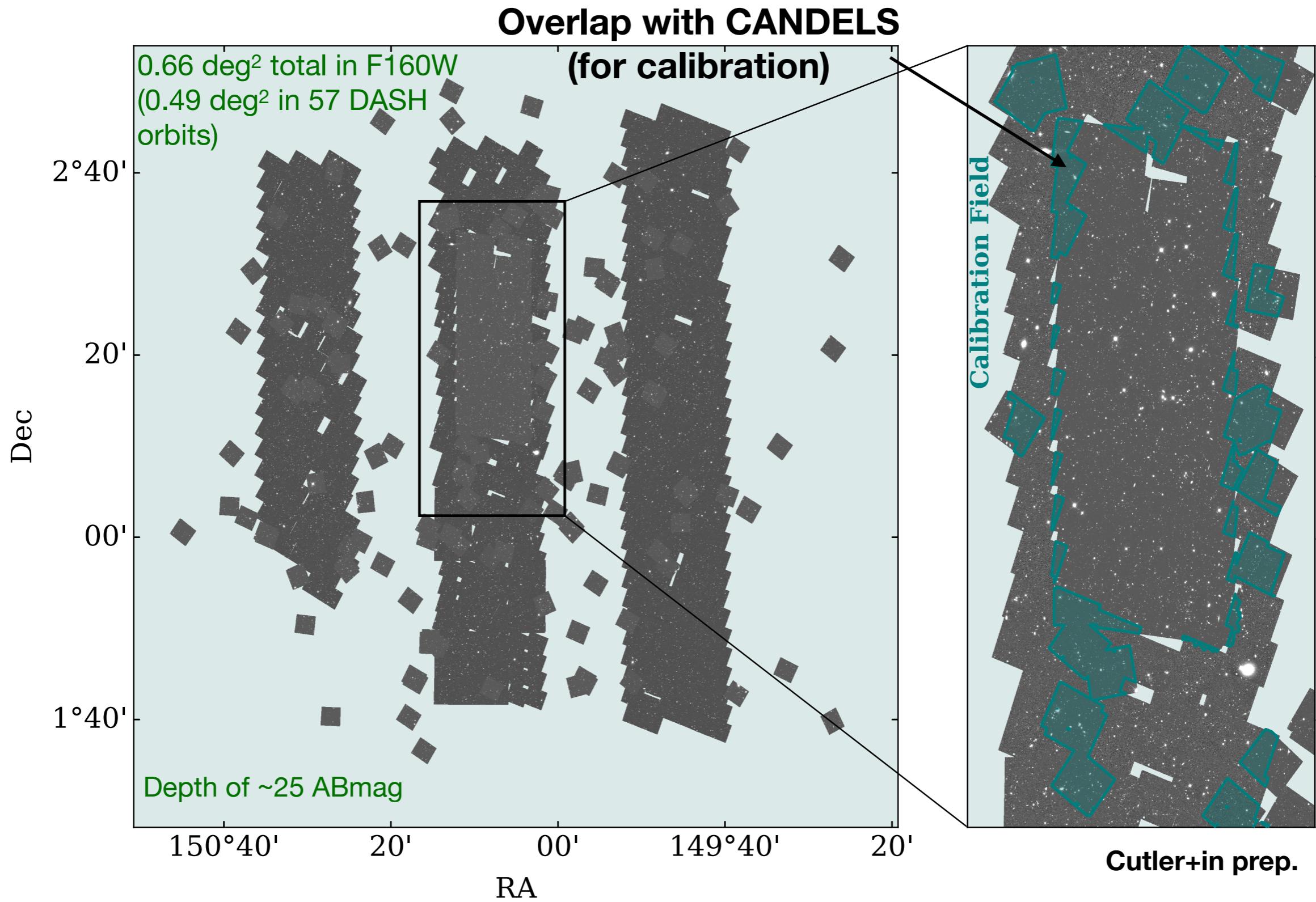
COSMOS-DASH Survey

HST-GO-14114, PI: P. van Dokkum



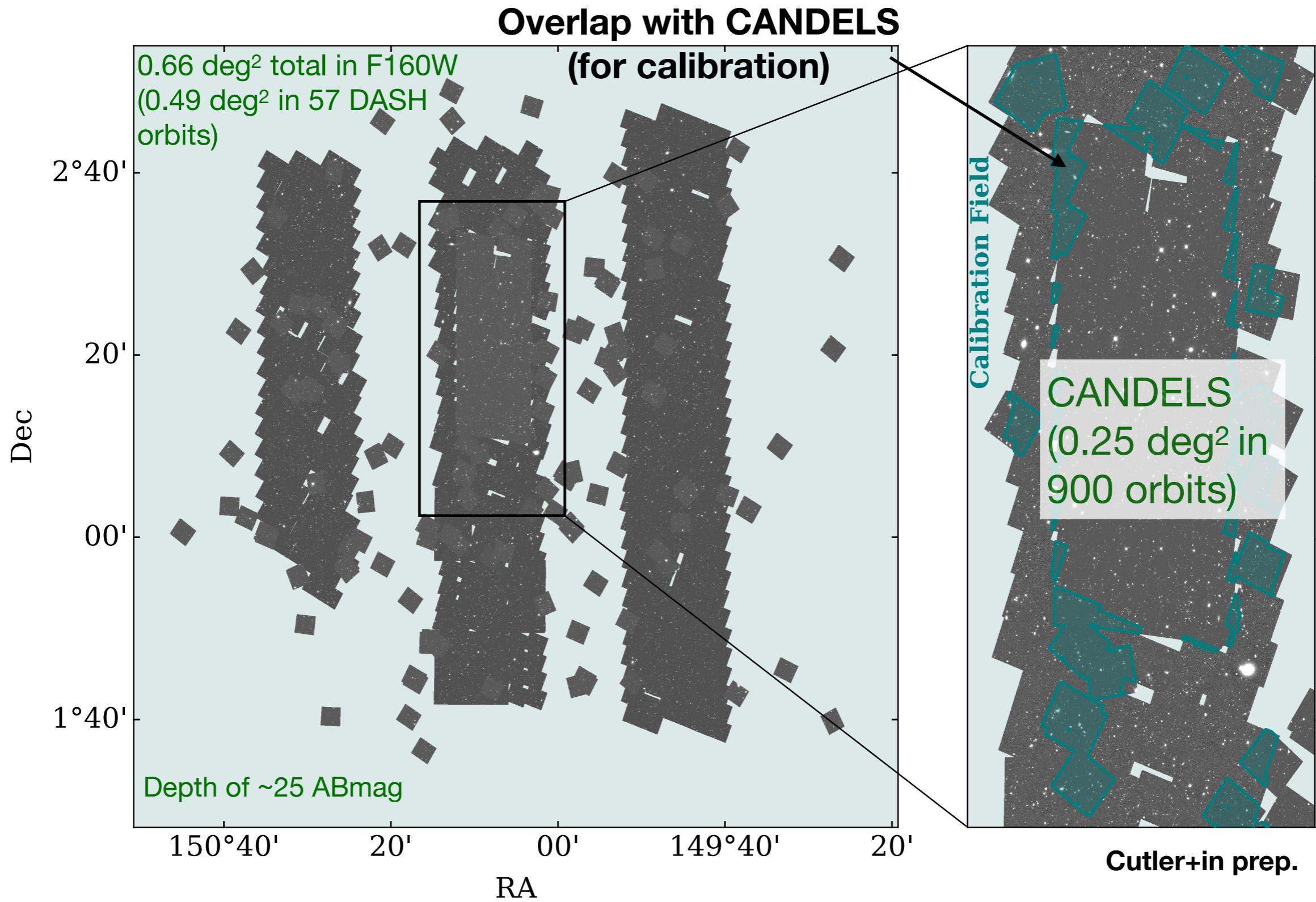
COSMOS-DASH Survey

HST-GO-14114, PI: P. van Dokkum



COSMOS-DASH Survey

HST-GO-14114, PI: P. van Dokkum



COSMOS-DASH Survey

HST-GO-14114, PI: P. van Dokkum

Overlap with CANDELS

0.66 deg² total in F160W
(0.49 deg² in 57 DASH
orbits)

(for calibration)

2°40'

ield

How good are DASH morphologies?

Dec

00'

1°40'

Depth of ~25 ABmag

150°40'

20'

00'

149°40'

20'

RA

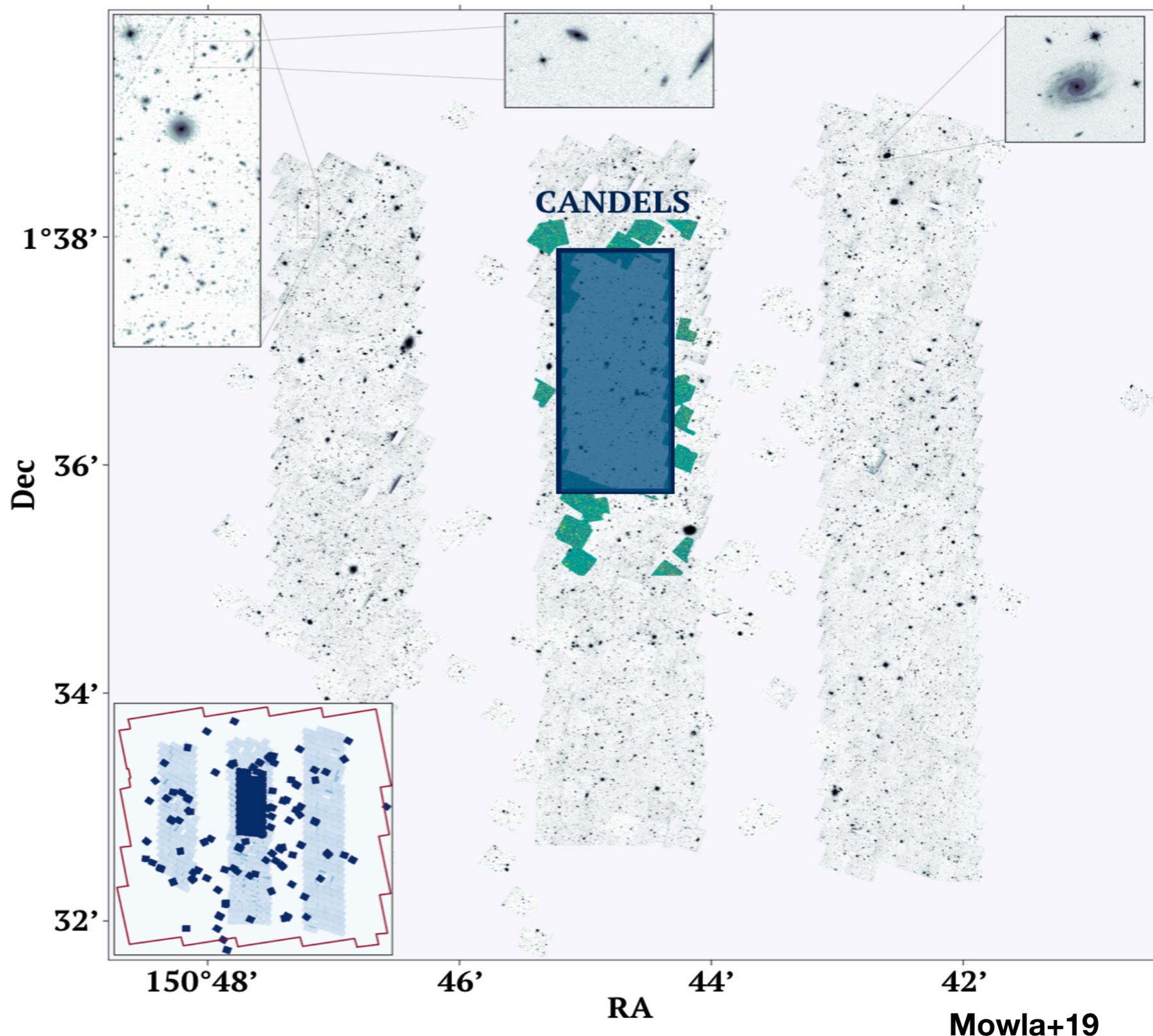
900 orbits)

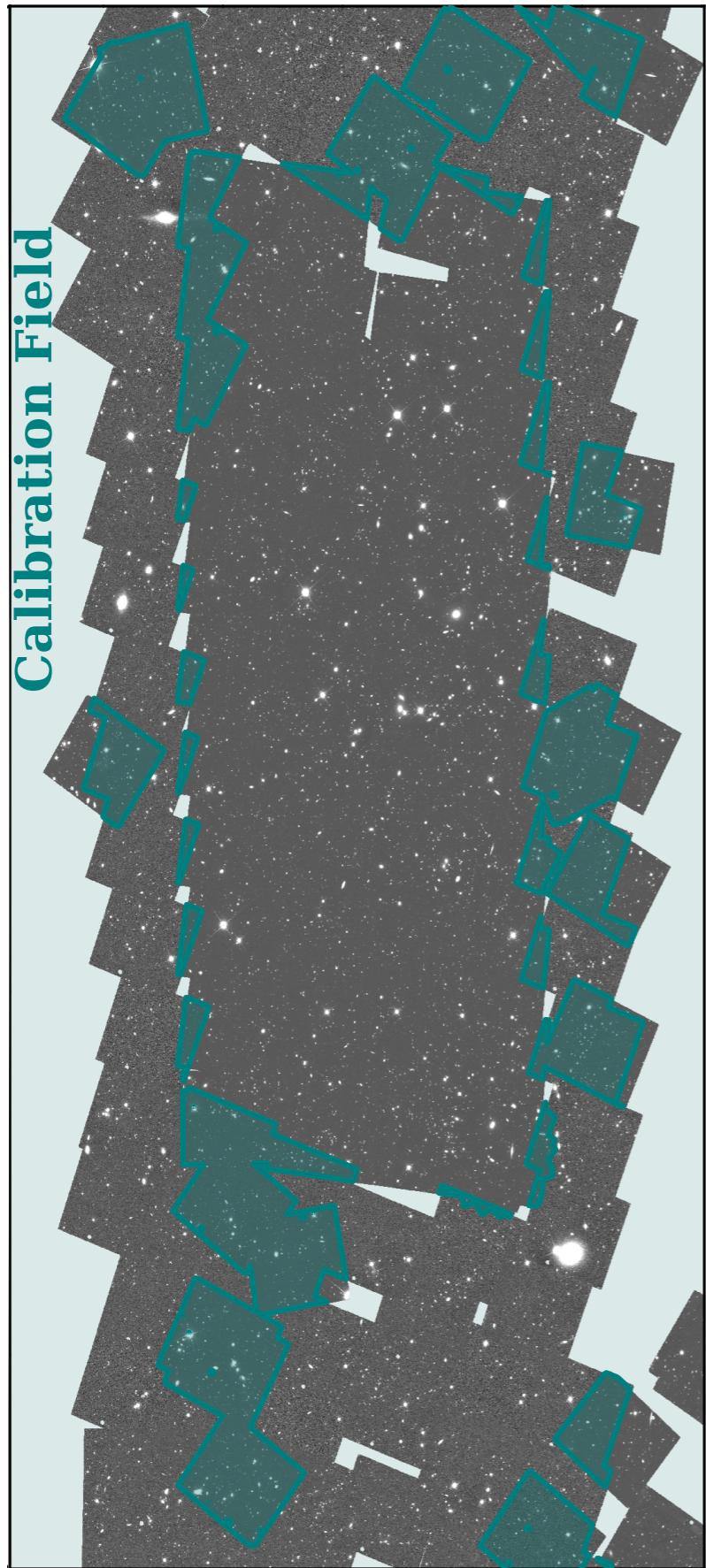
Cutler+in prep.

COSMOS-DASH Sample

Cross match *HST*
selected photometric
catalog to UltraVISTA
(Exclude galaxies in
CANDELS)

SNR>10 identifies
51,534 galaxies total
in our catalog





Calibration Field

Cross match to
CANDELS morphological
catalog

SNR>5 identifies 483
galaxies total

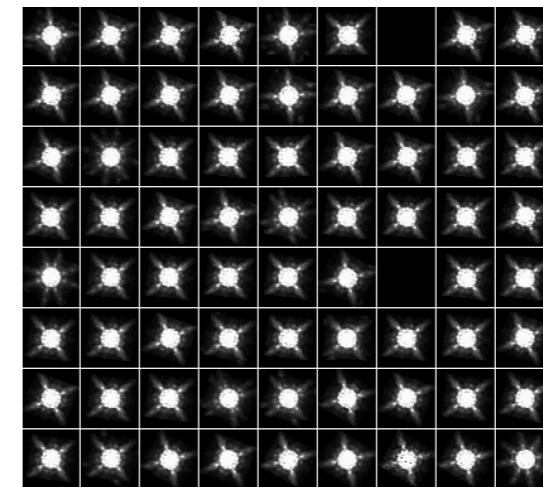
CANDELS- and DASH-
only reductions to
constrain and estimate
parameter error on DASH
morphologies

GALFIT Pipeline

1. Image and segmentation cutouts with *Montage*



2. *SExtractor* (Bertin & Arnouts 1996) to get initial guesses



3. PSFs with *grizli* (Brammer 2019)

4. Sérsic model fit with *GALFIT* (Peng et al. 2002)

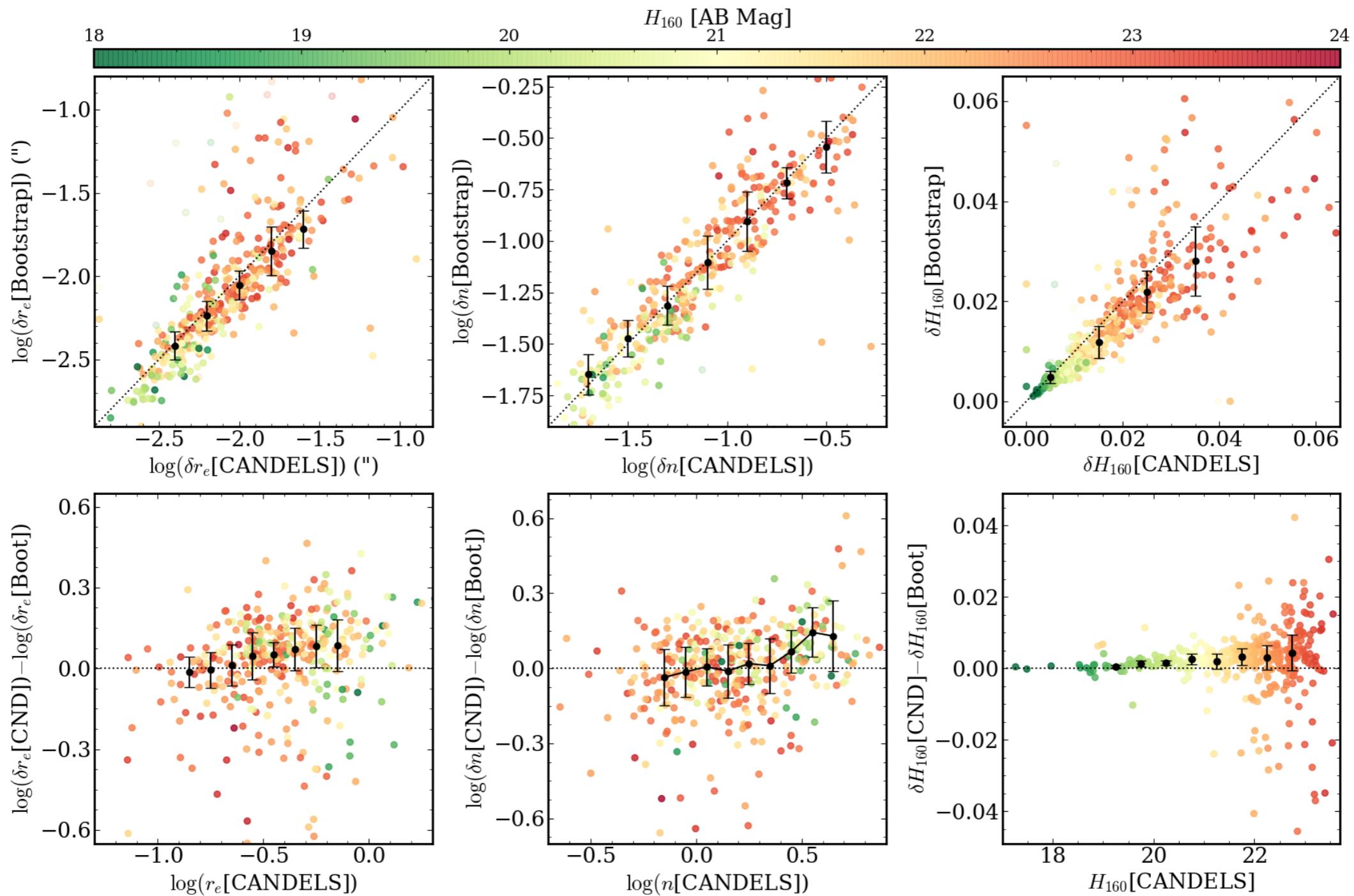
5. Tabulate and flag model parameters

```
# ID RA DEC flag use mag dmag re dre n dn q dq pa dpa kron f_F160W_auto
e_F160W_auto f_F160W_tot e_F160W_tot snr flag_limit_r flag_limit_n
5_sigma_depth chi chi_nu
# ID: Object identifier from UVISTA DR2 catalog
# RA,DEC: Right ascension and declination (J2000; decimal degrees)
# flag: 0=good, 1=suspicious, 2=bad, 3=failed, 4=no coverage (see Cutler et
al.)
# use: 1=Galfit flag<2,re>FWHM (see Cutler et al.)
# mag: GALFIT best-fit magnitude
# dmag: Uncertainty in GALFIT magnitude
# re: GALFIT best-fit effective (half-light) radius in arcsec
# dre: Uncertainty in GALFIT effective radius in arcsec
# n: GALFIT best-fit Sersic index
```

Parameter Errors

Fit 483 galaxies in DASH- and CANDELS-only reductions of calibration field

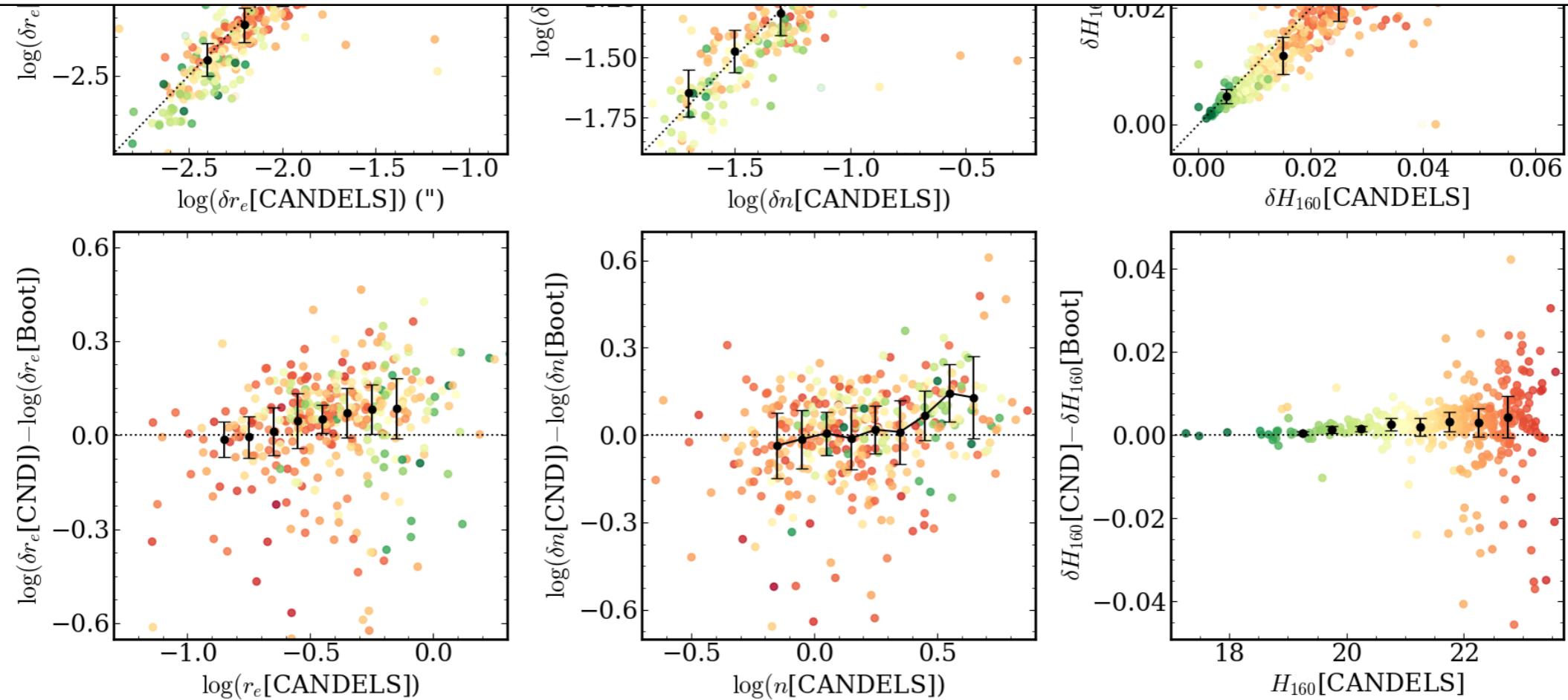
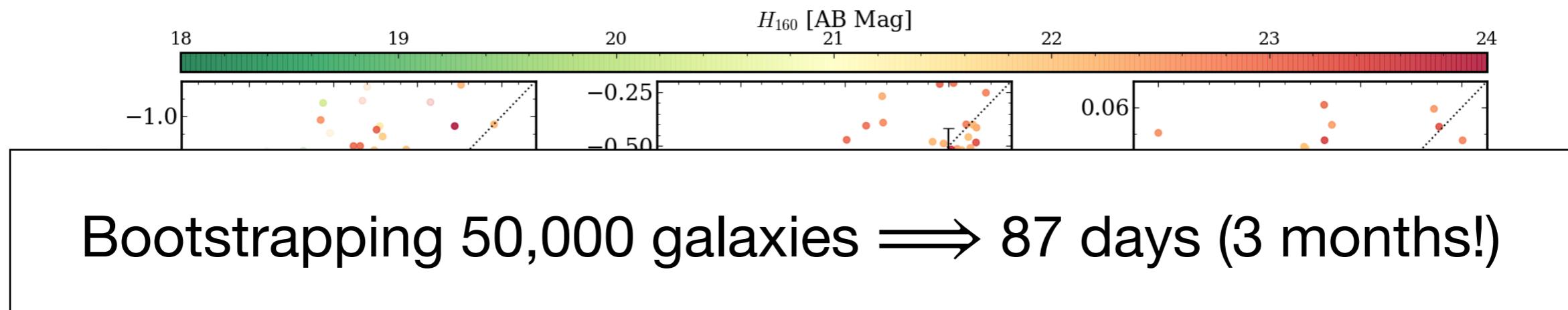
Use bootstrapping to estimate errors (noise map+empty apertures)



Parameter Errors

Fit 483 galaxies in DASH- and CANDELS-only reductions of calibration field

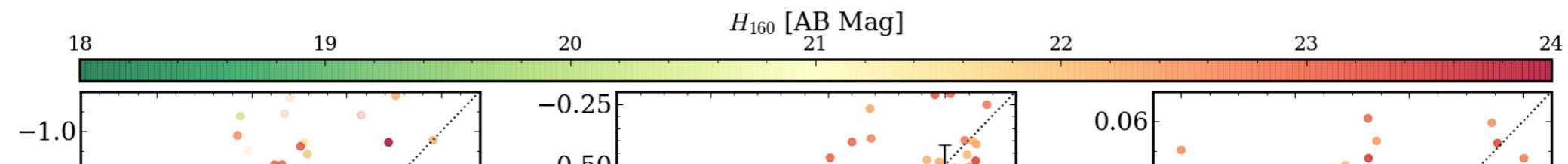
Use bootstrapping to estimate errors (noise map+empty apertures)



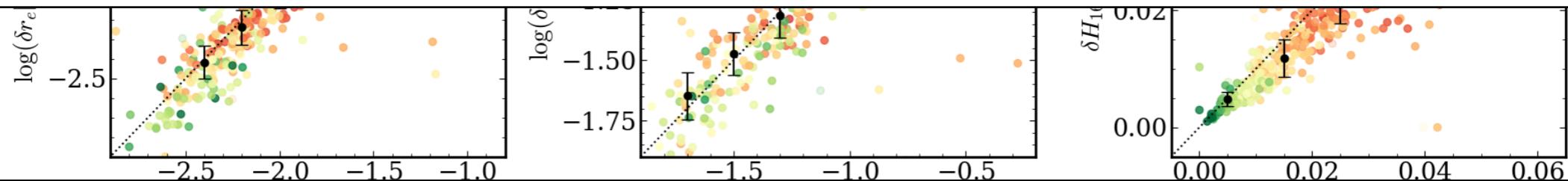
Parameter Errors

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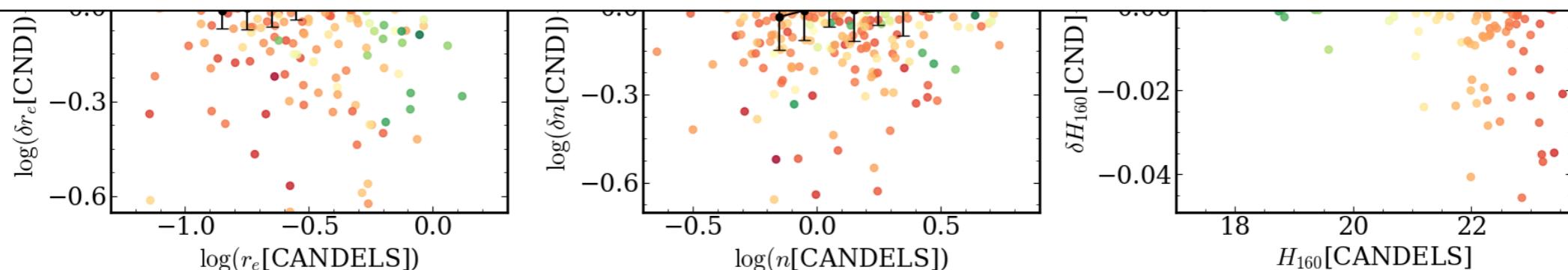


Bootstrapping 50,000 galaxies \Rightarrow 87 days (3 months!)

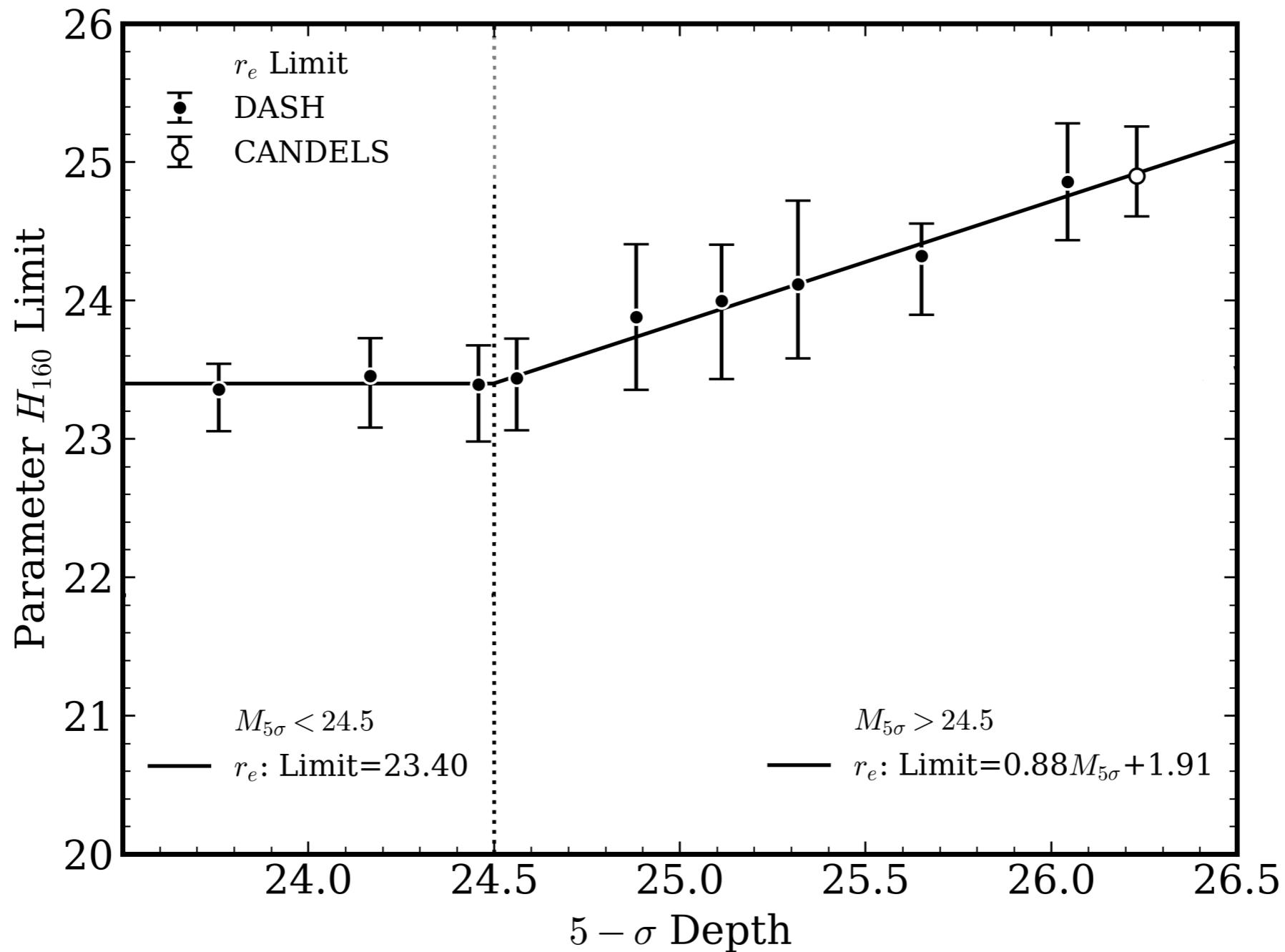


Instead: Estimate errors through SNR weighted average of galaxy analogue errors

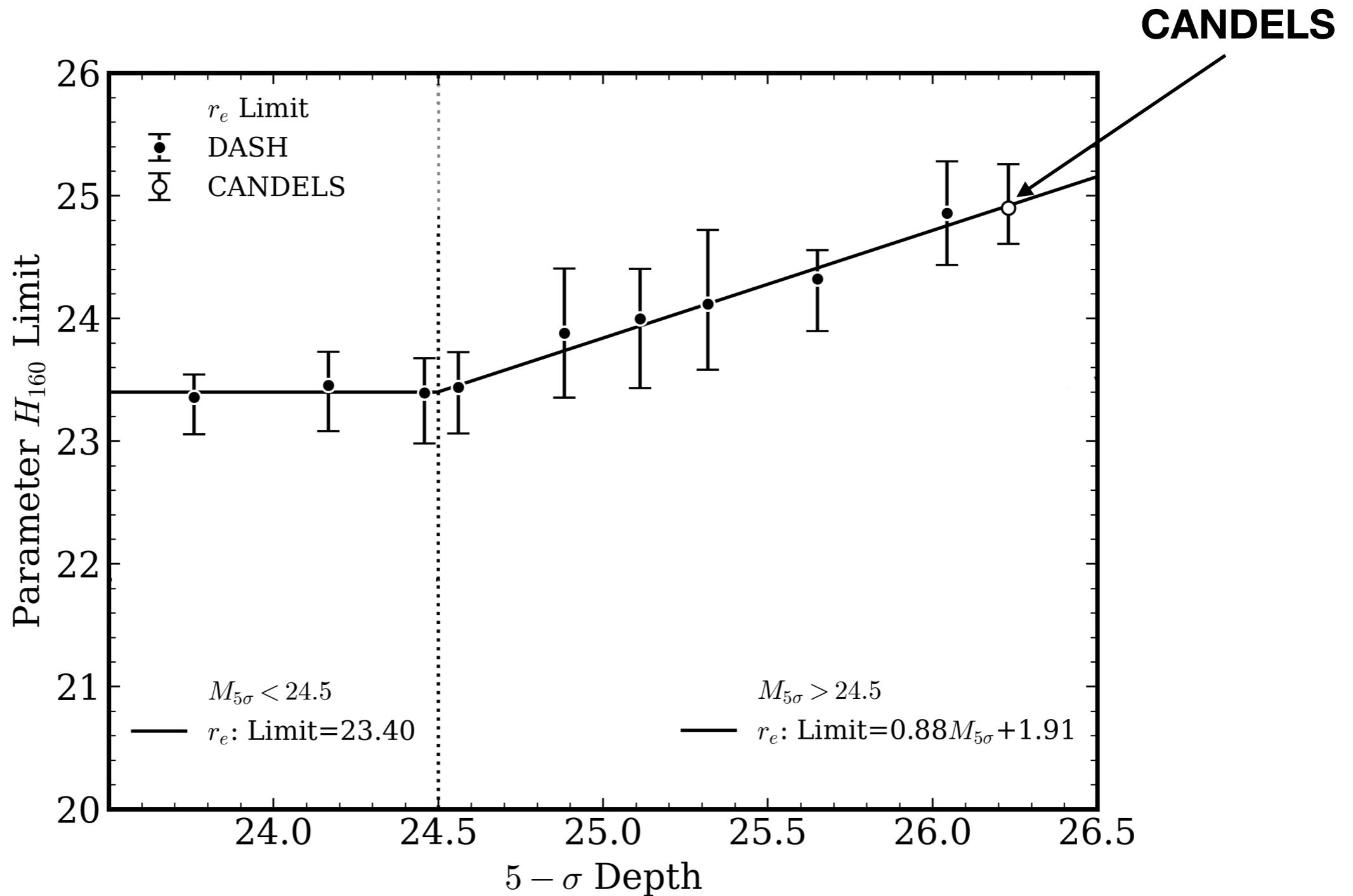
(See van der Wel et al. 2012)



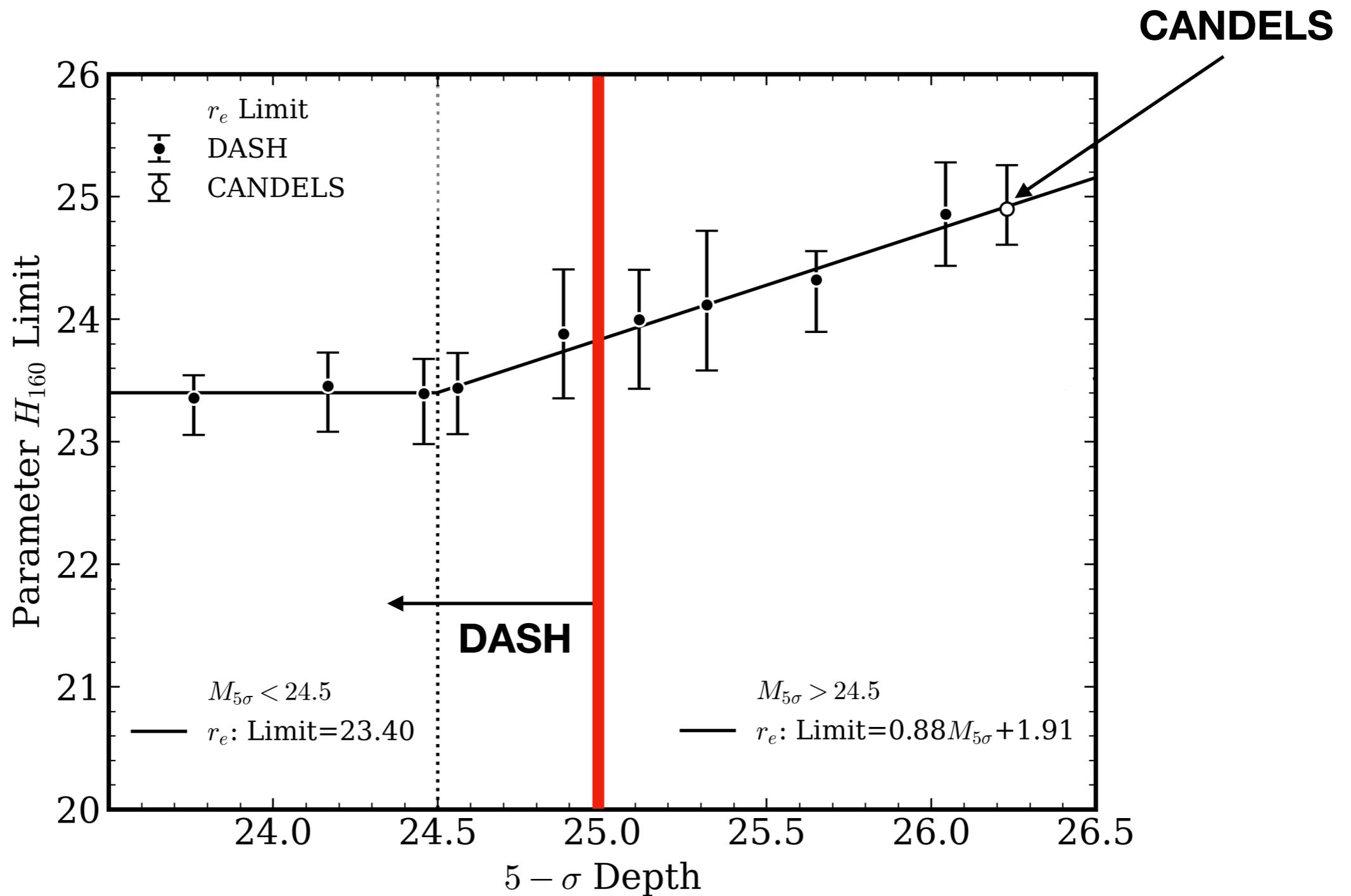
Magnitude Limits



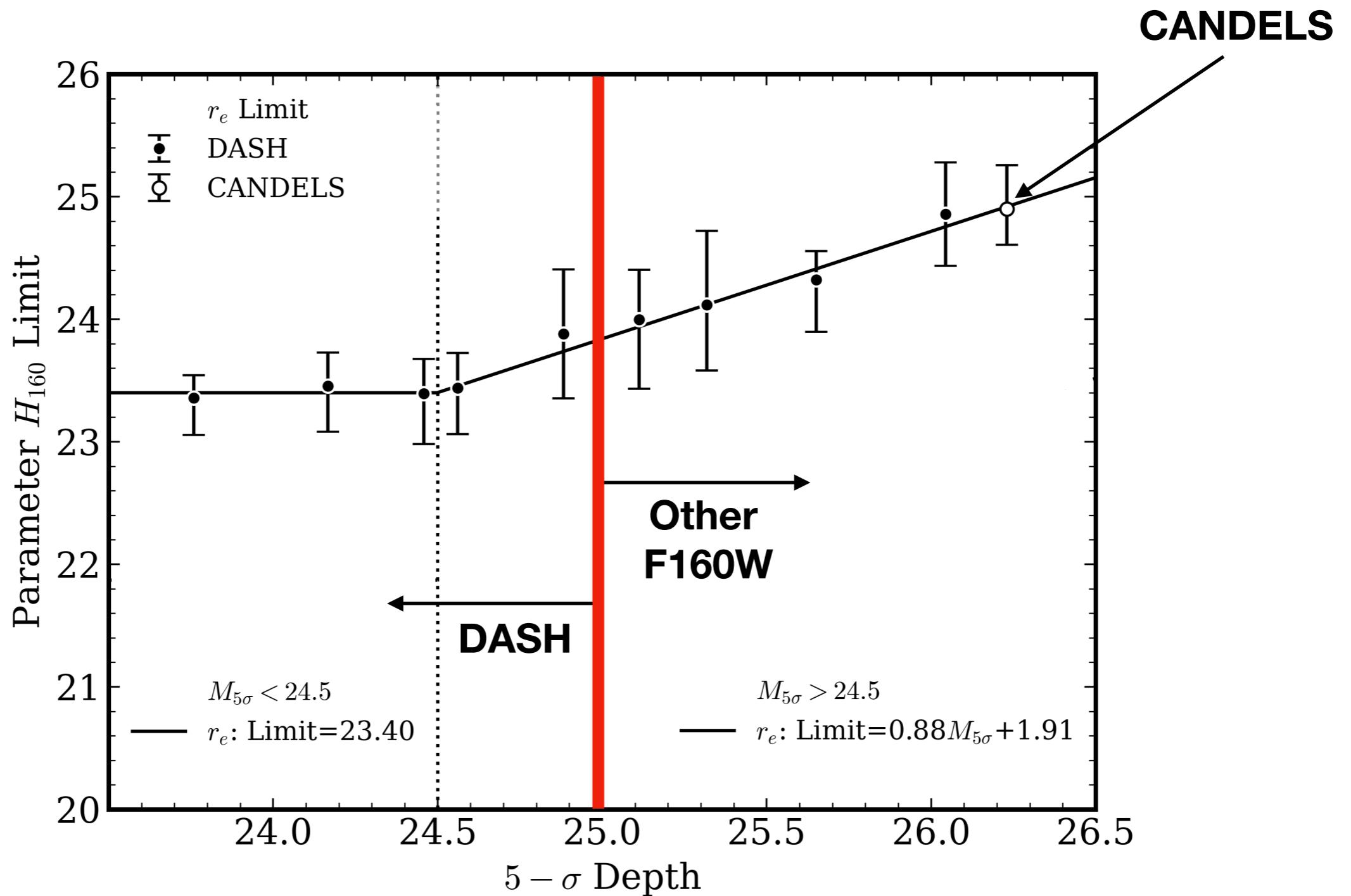
Magnitude Limits



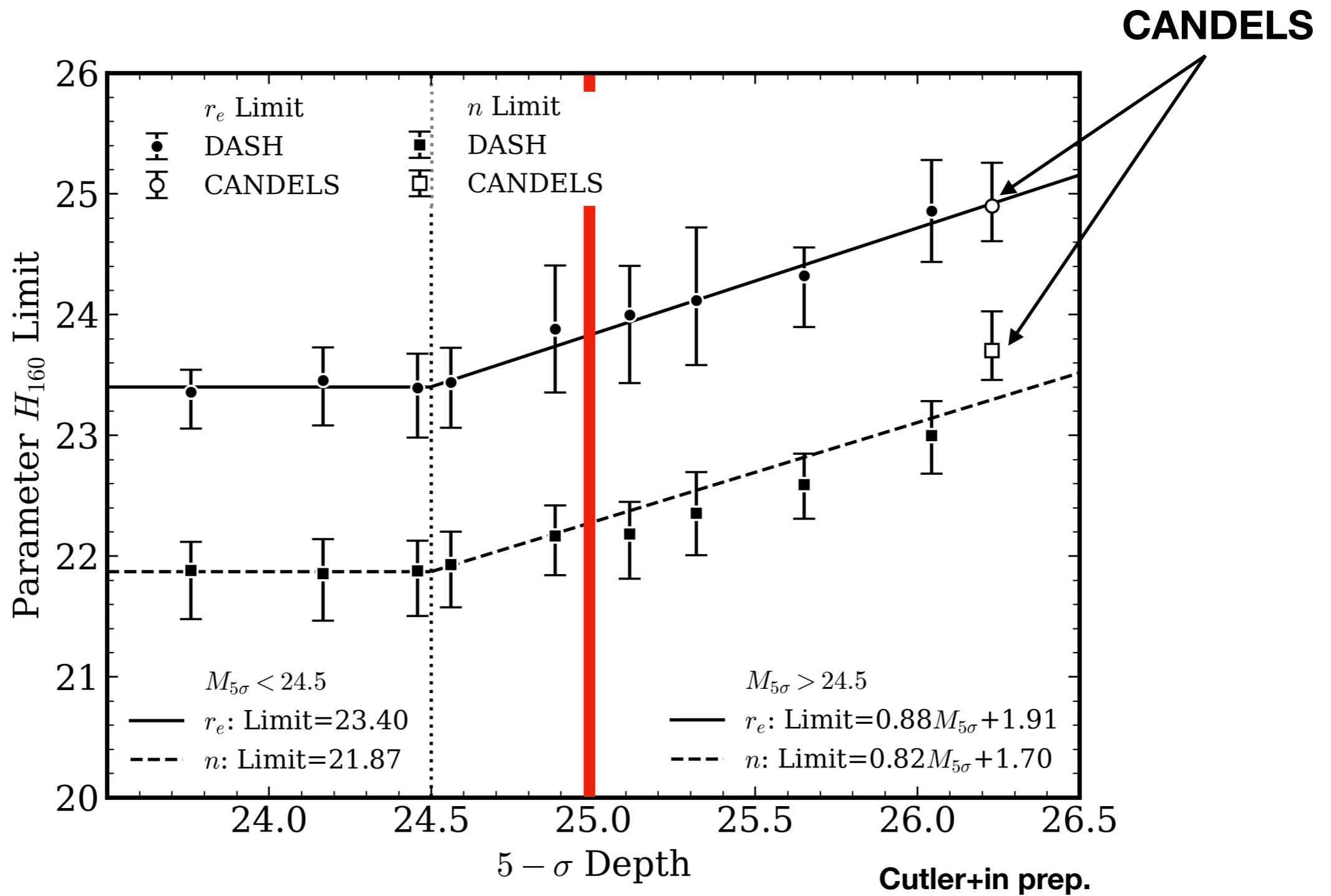
Magnitude Limits



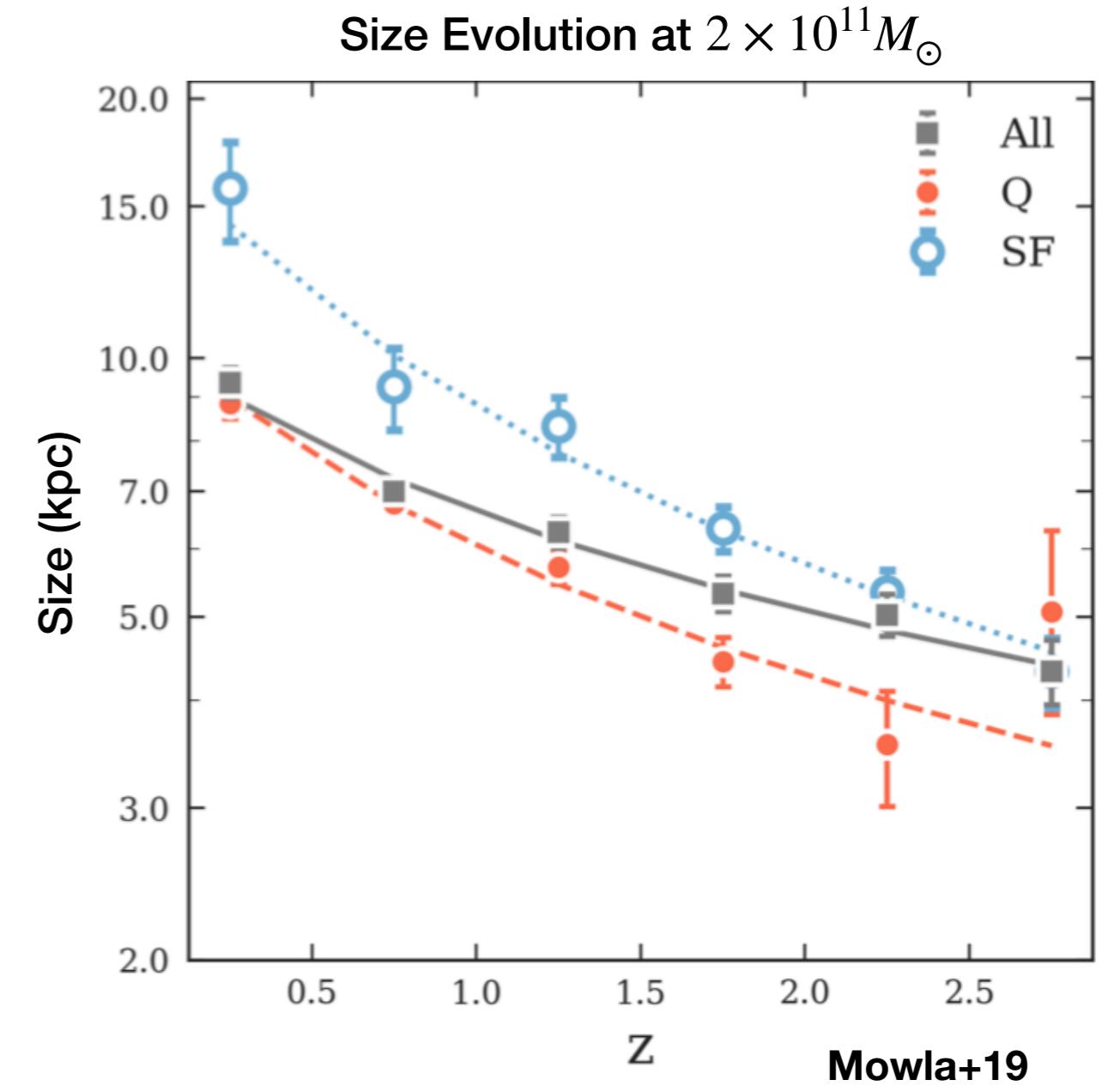
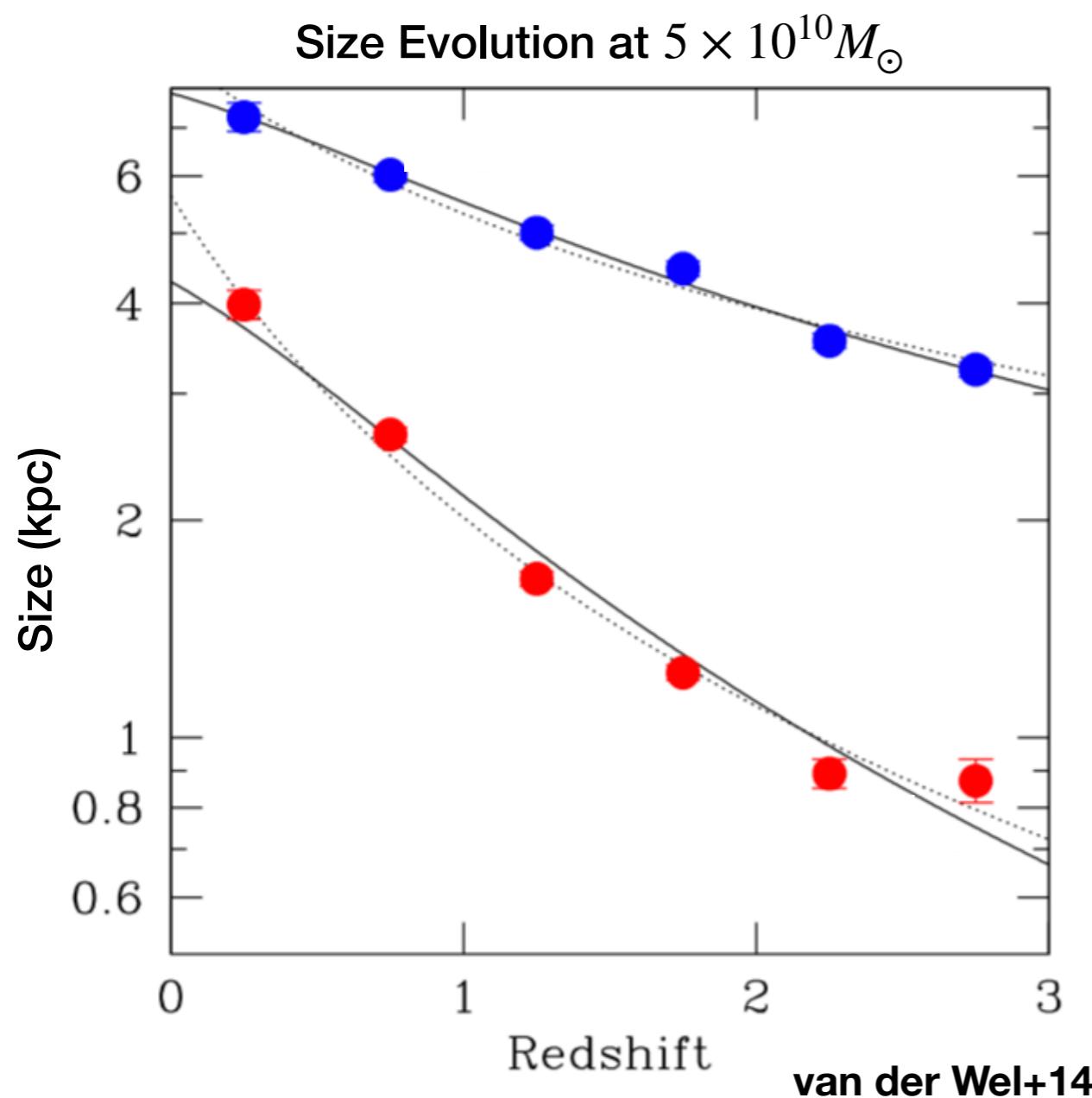
Magnitude Limits

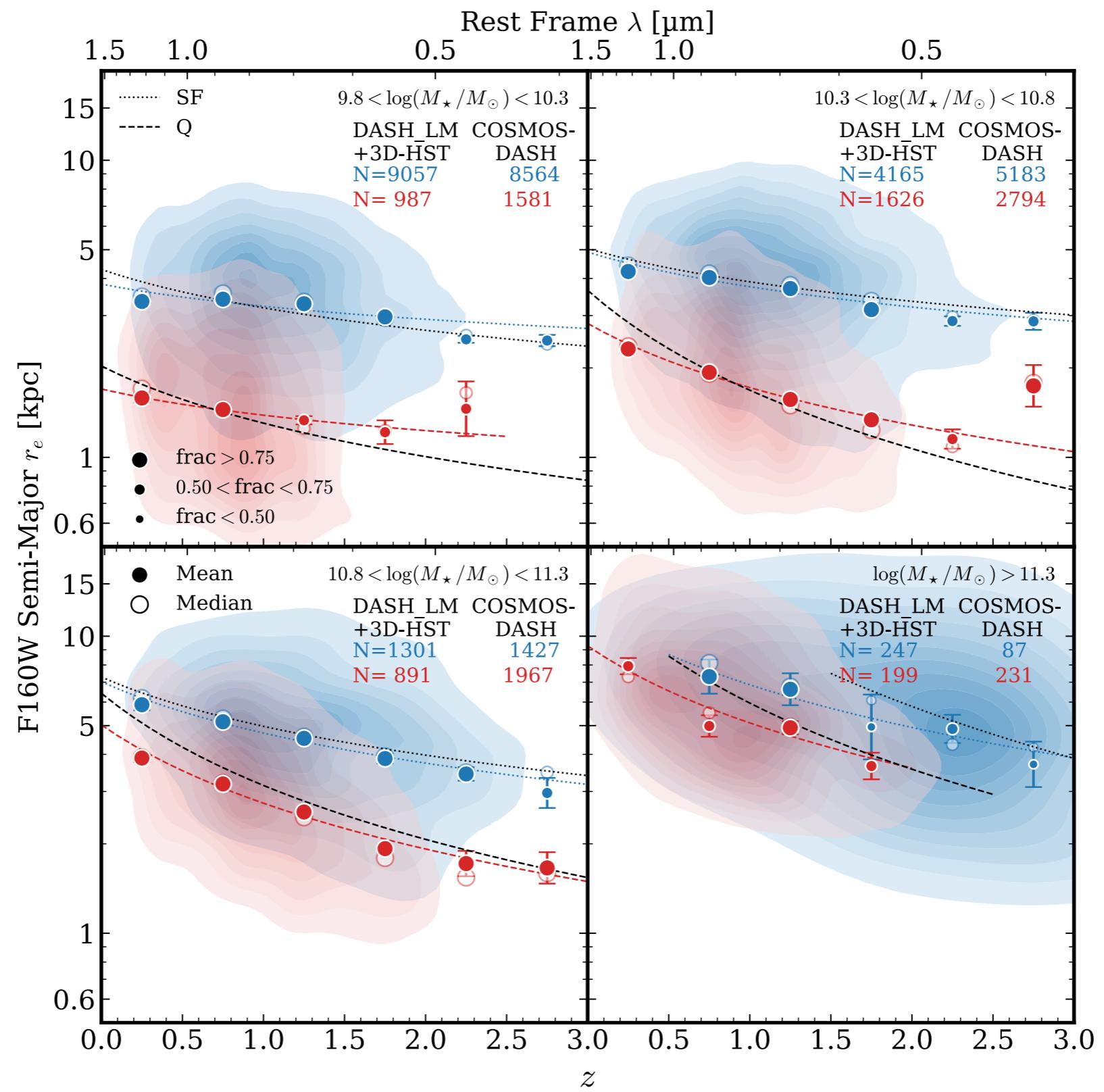


Magnitude Limits

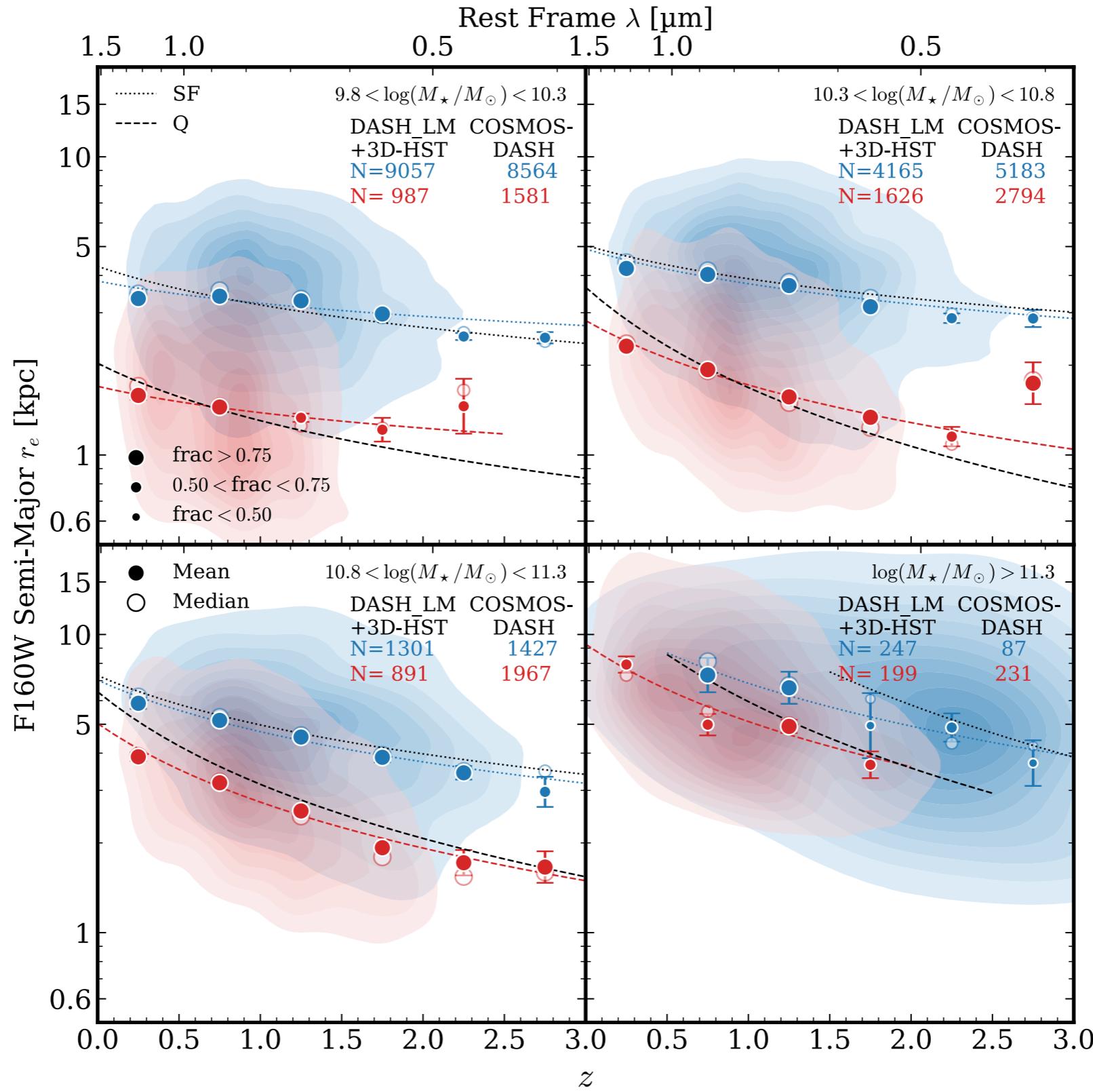


Size Evolution

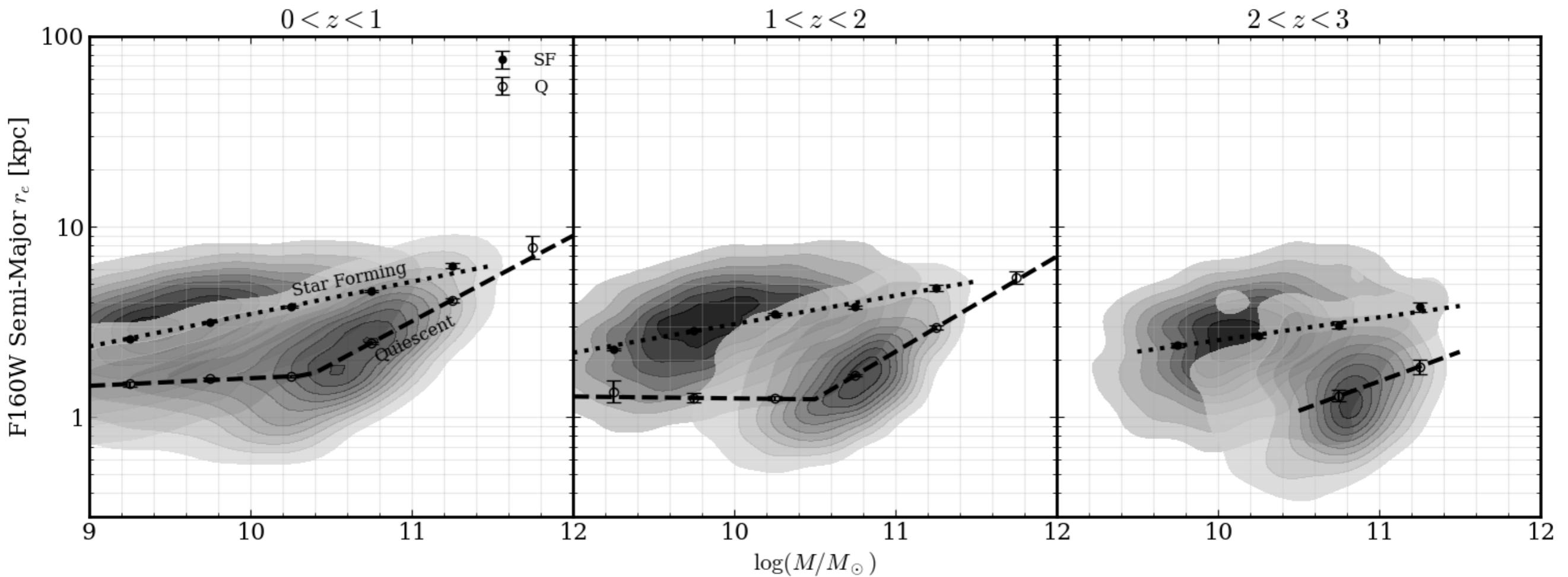




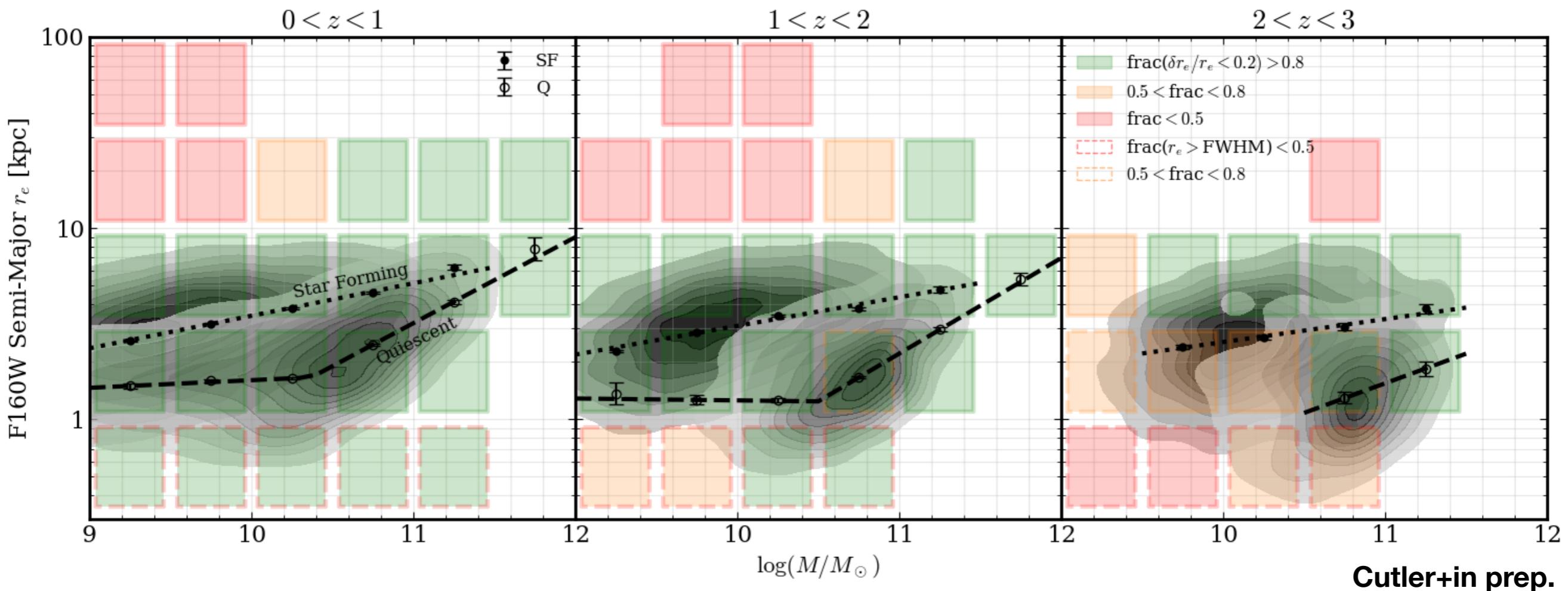
Size Evolution in DASH is consistent with CANDELS/3D-HST, even at low masses!



Size Mass

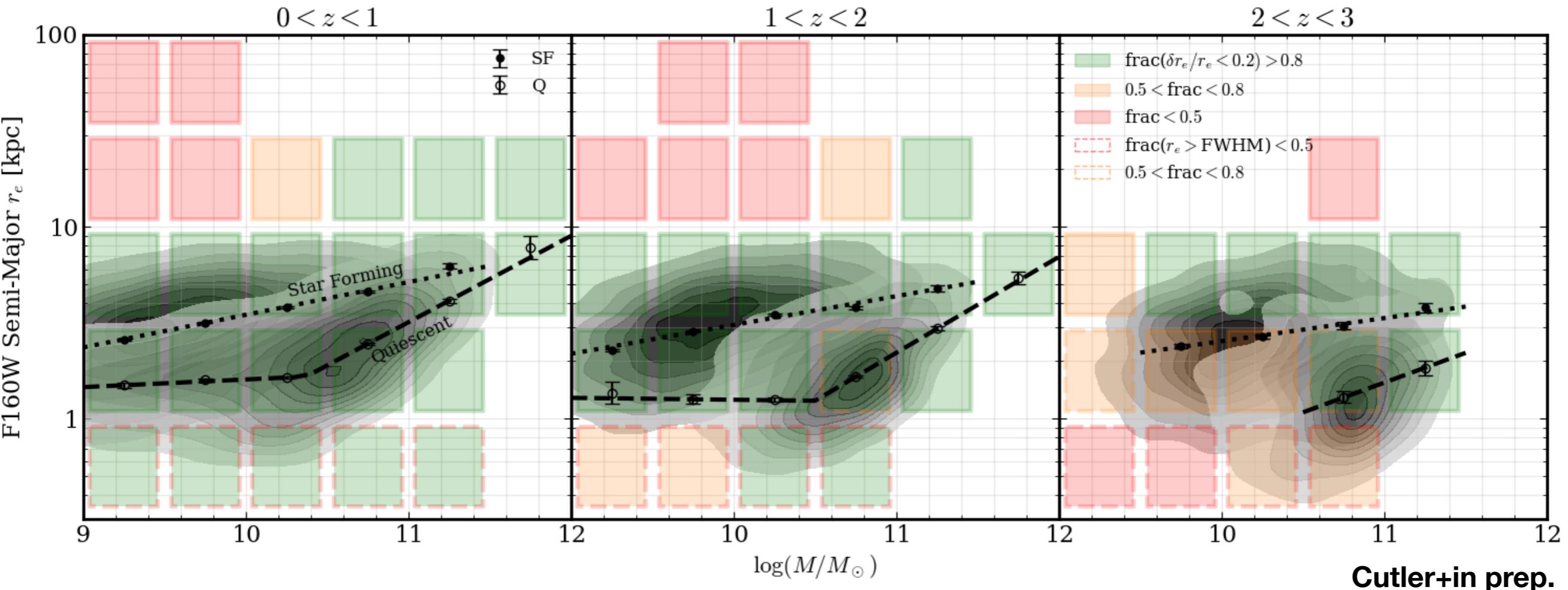


Size Mass



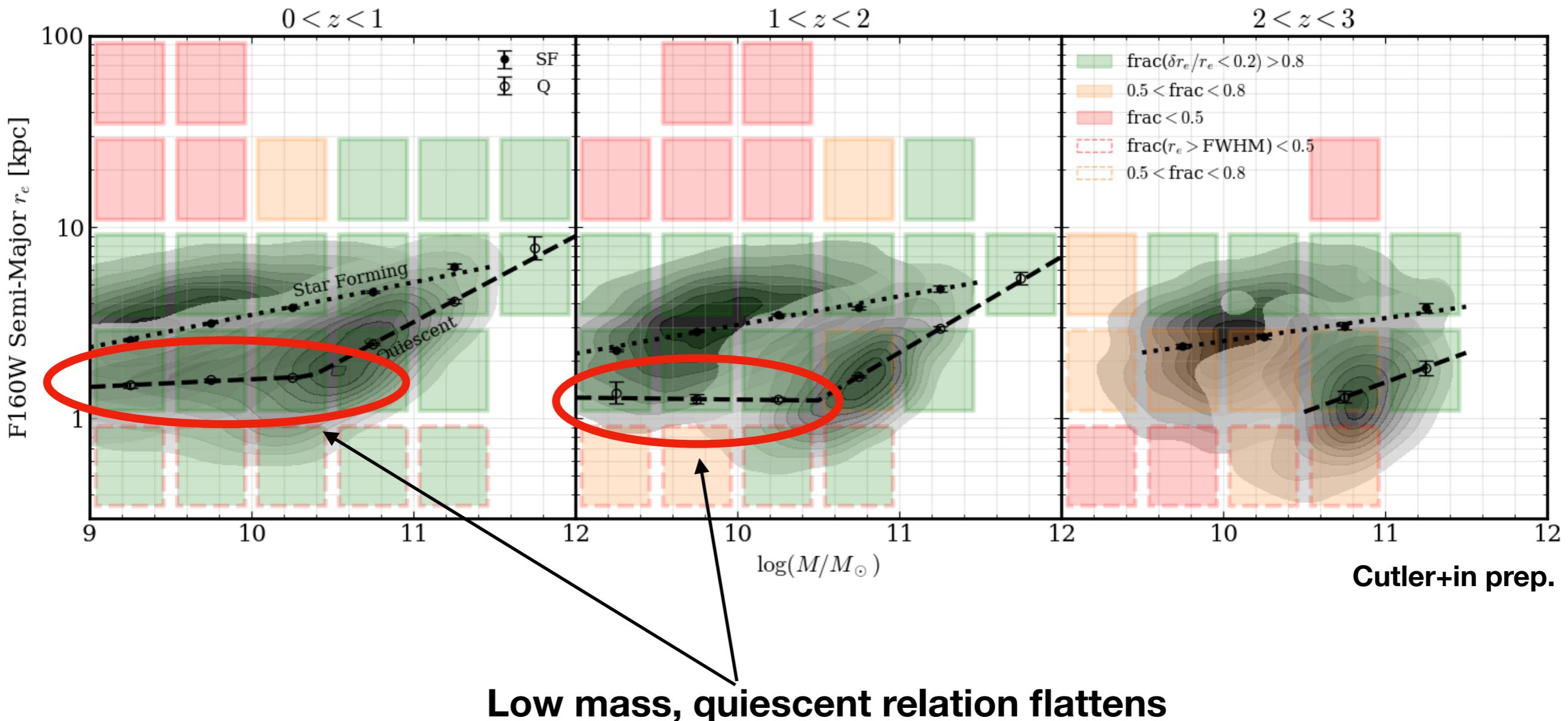
Size Mass

DASH observations are sufficient for a wide range of sizes and masses

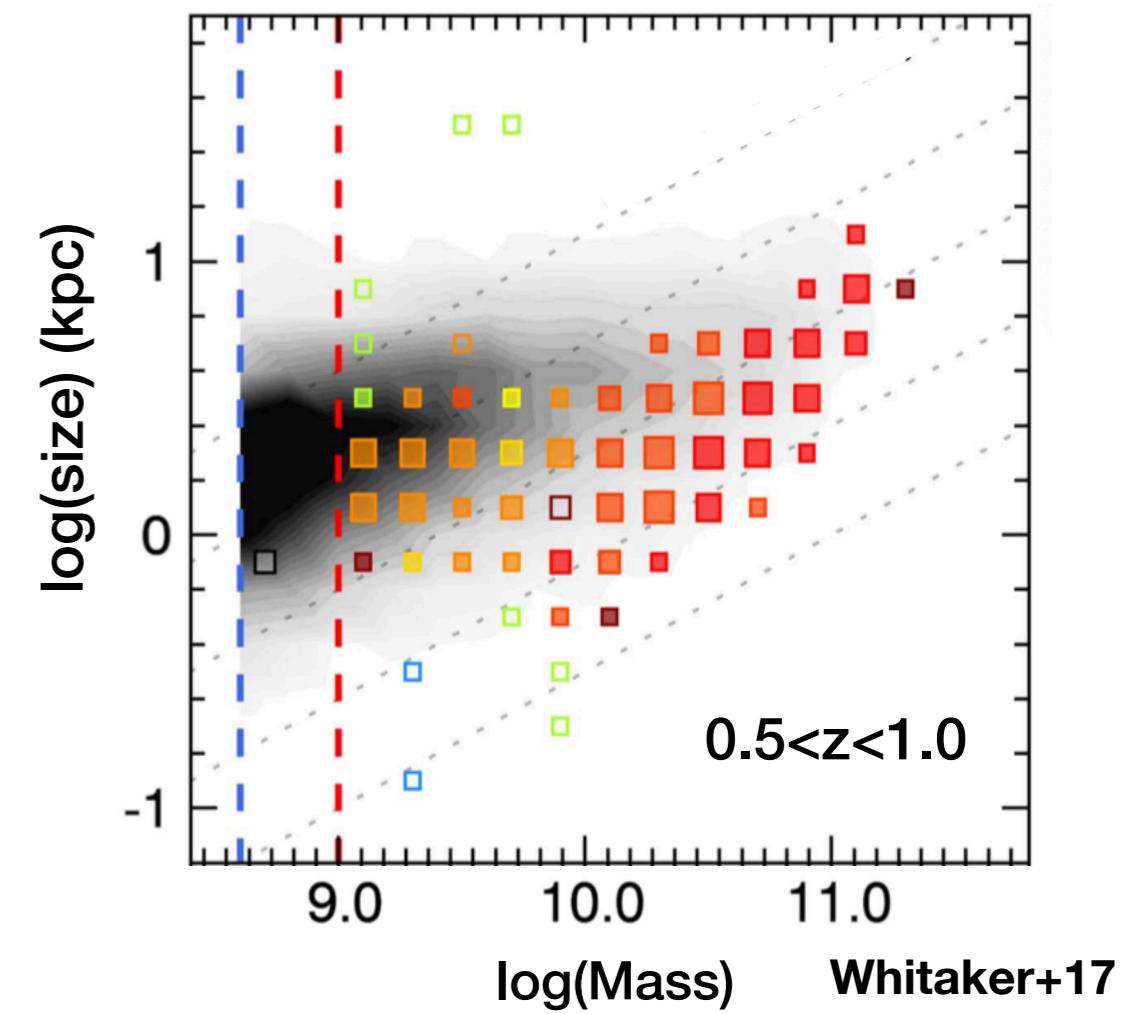
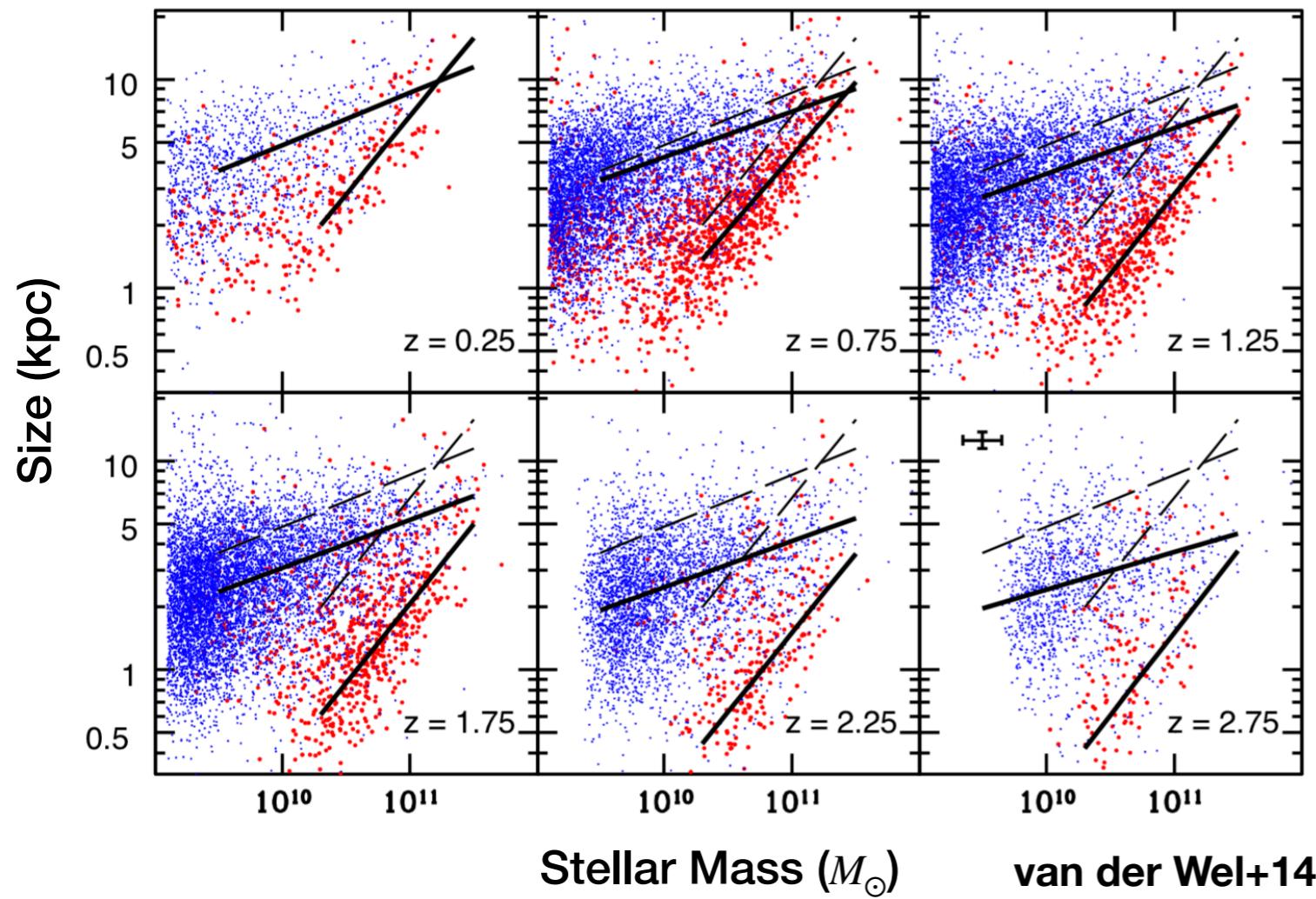


Size Mass

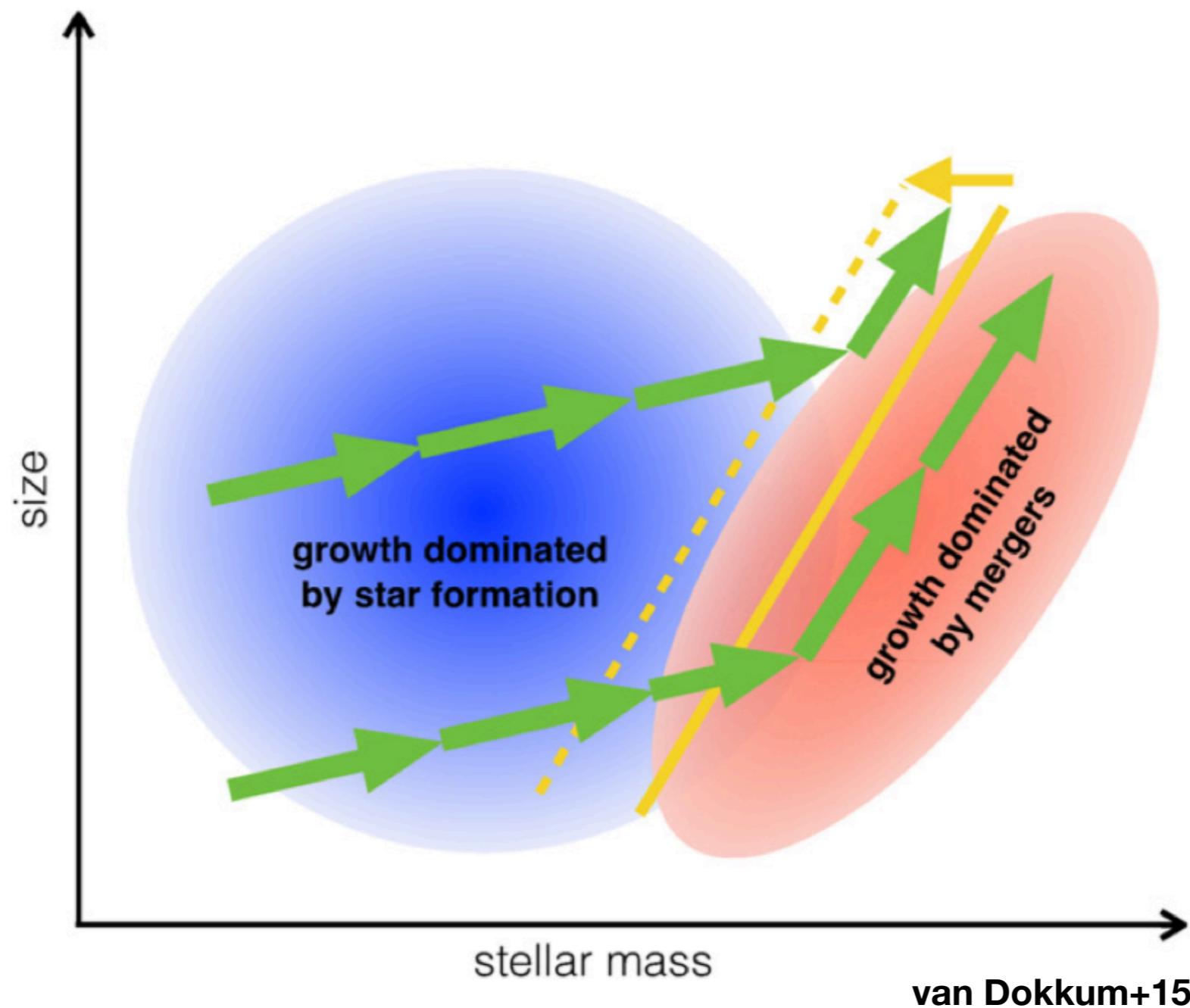
DASH observations are sufficient for a wide range of sizes and masses



Size Mass Flattening



Environmental Dependence



Environmental Dependence

Massive star-forming galaxies



Quenching

+

Late stage mergers



Massive quiescent galaxies



Environmental Dependence

Massive star-forming galaxies



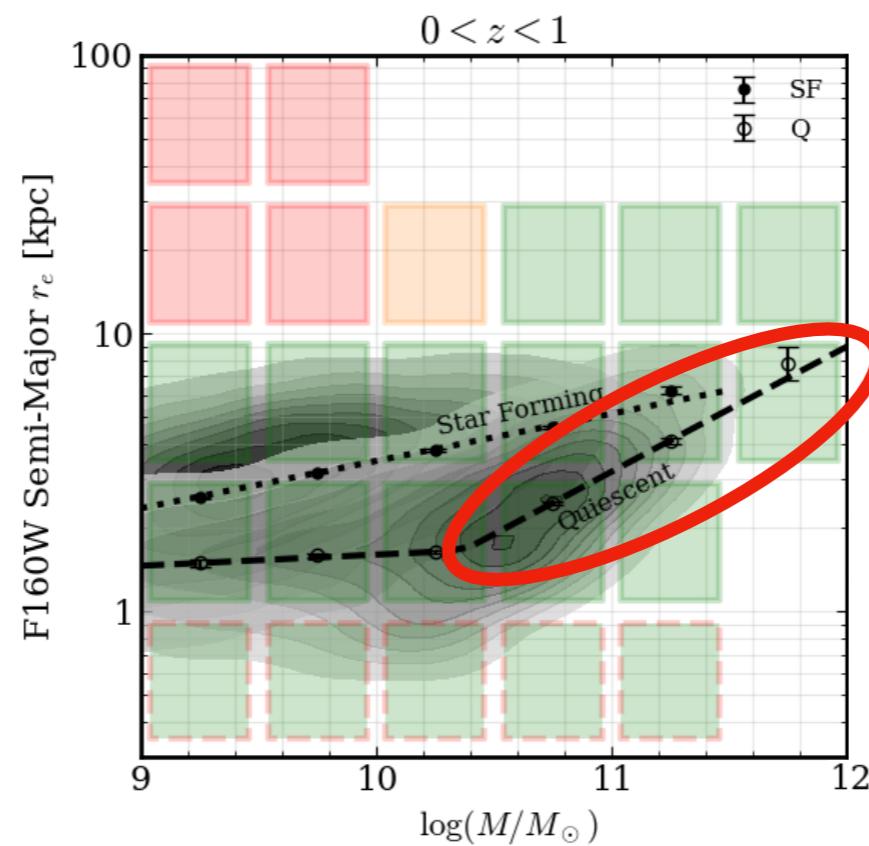
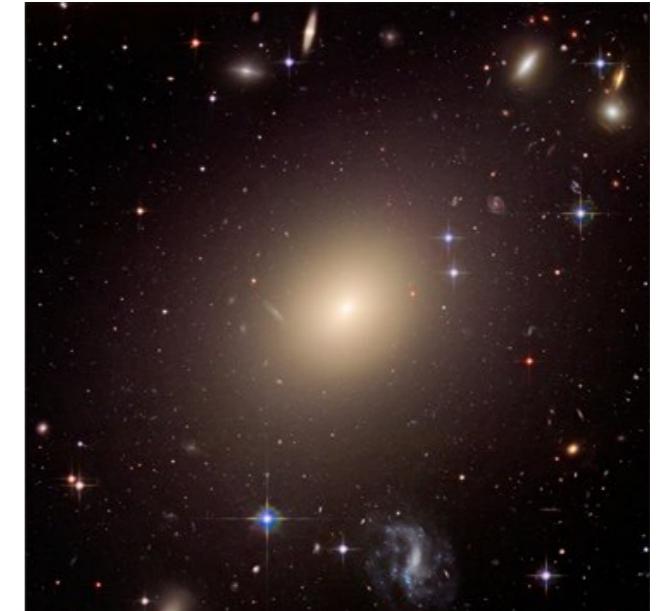
Quenching

+

Late stage mergers



Massive quiescent galaxies



Environmental Dependence

Massive star-forming galaxies



Quenching

+

Late stage mergers



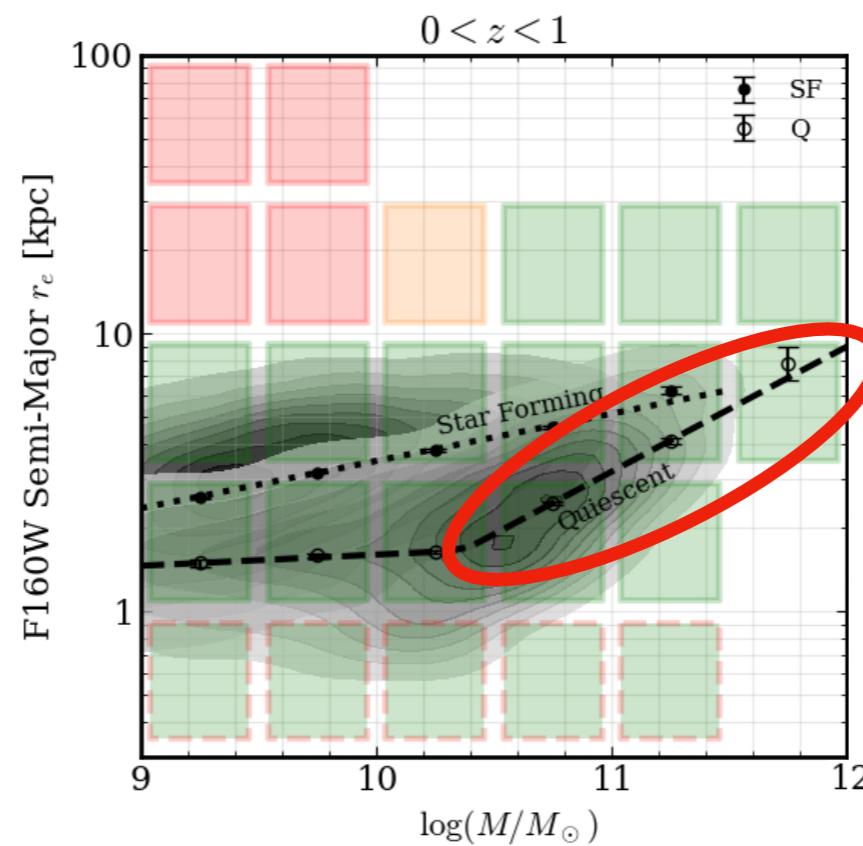
Massive quiescent galaxies



Galaxy shape and size changes:

More elliptical

More compact



Environmental Dependence

Massive star-forming galaxies



Quenching

+

Late stage mergers



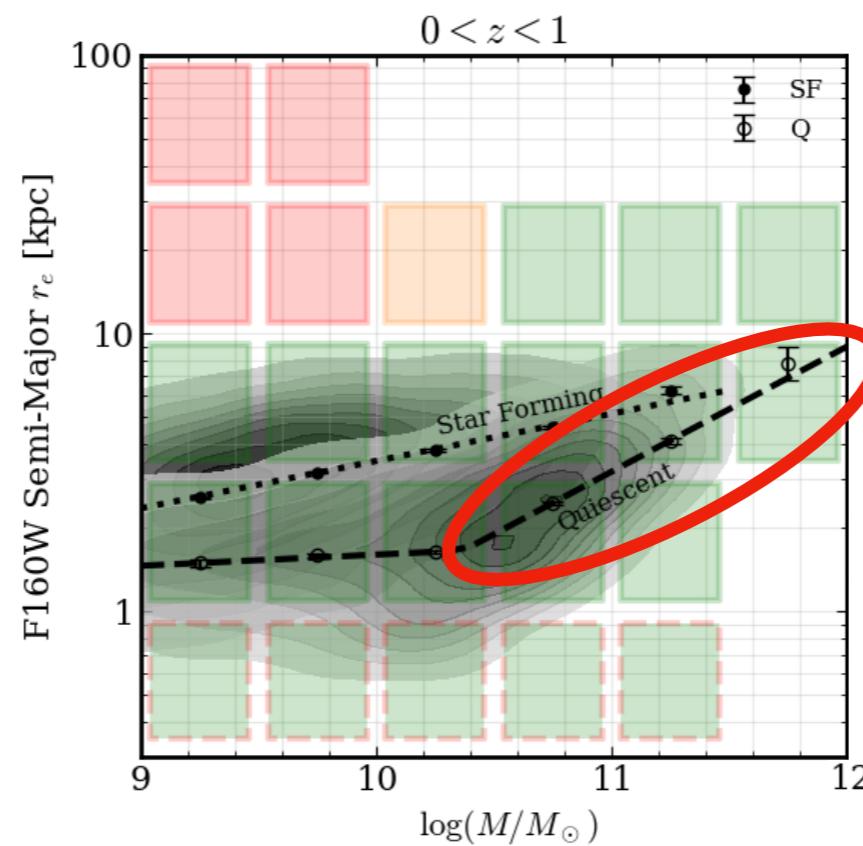
Massive quiescent galaxies



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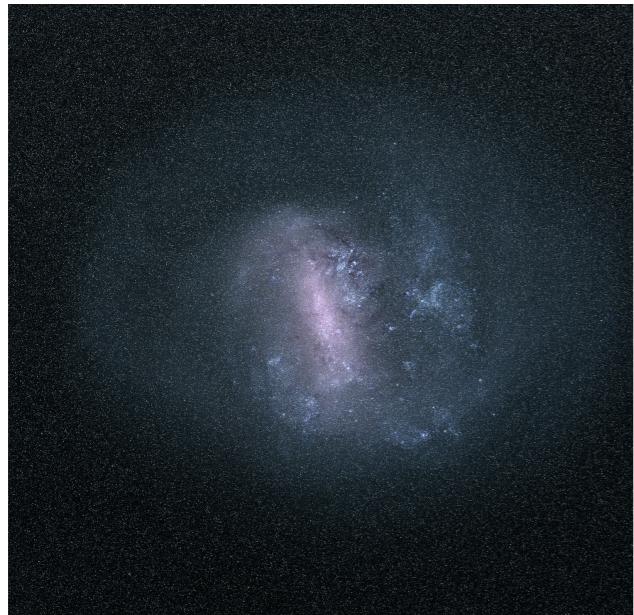
More compact



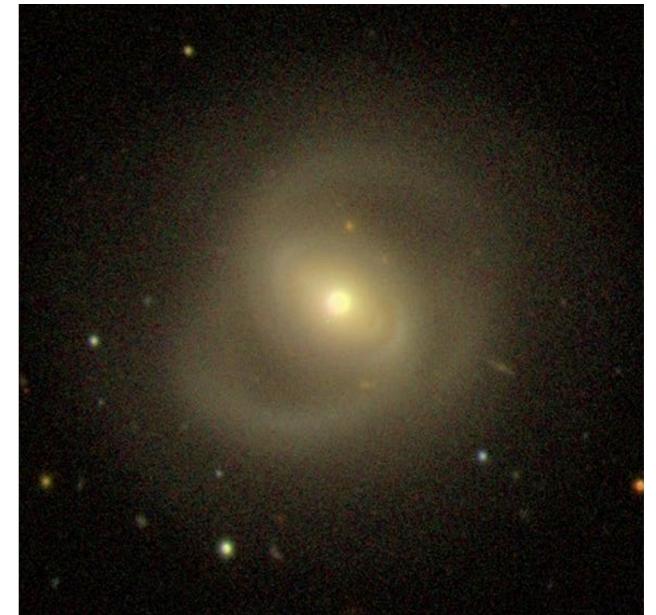
Occurs in overdense environments (clusters, filaments)

Environmental Dependence

Low mass star-forming galaxy



Low mass quiescent galaxy

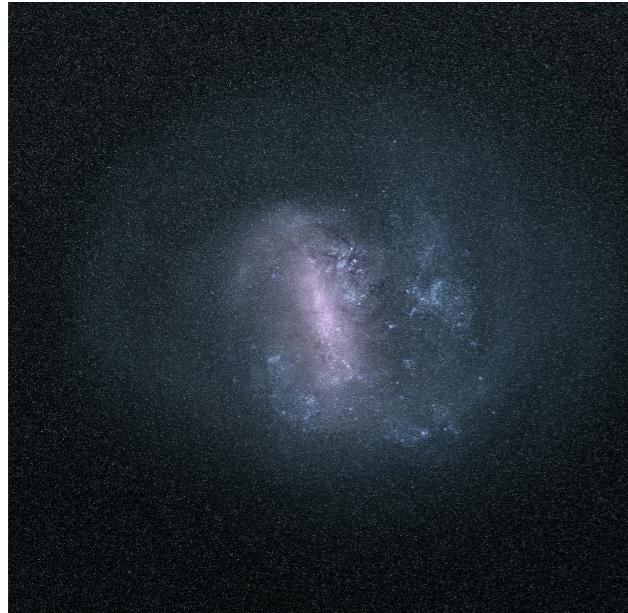


Quenching through
gas expulsion

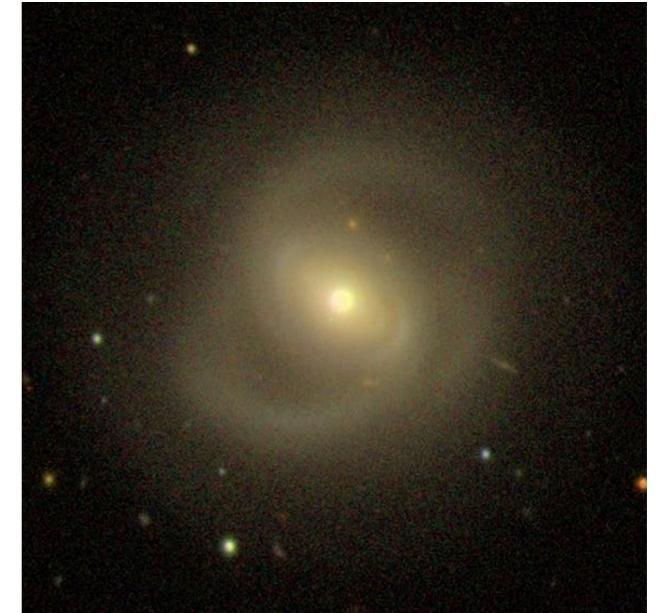


Environmental Dependence

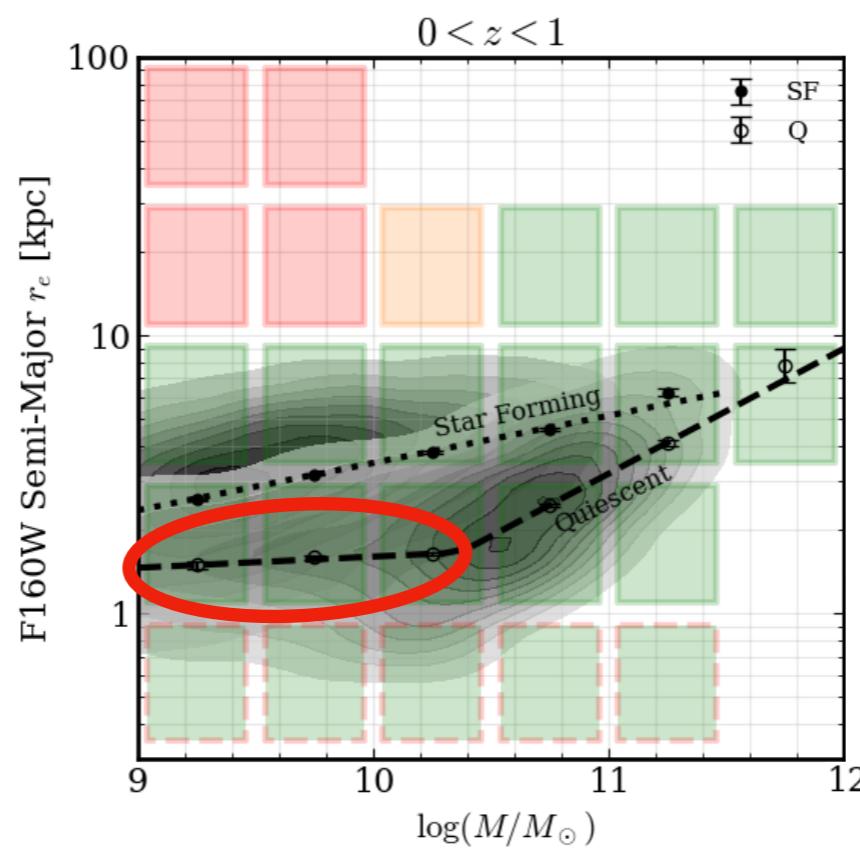
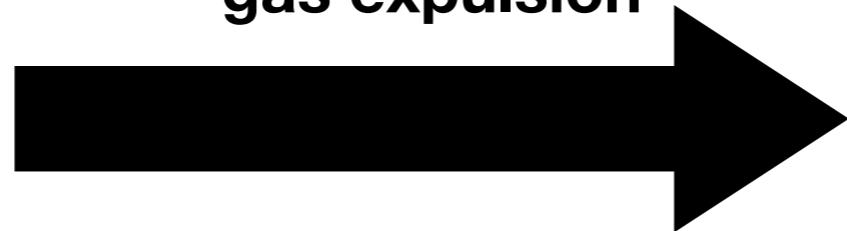
Low mass star-forming galaxy



Low mass quiescent galaxy

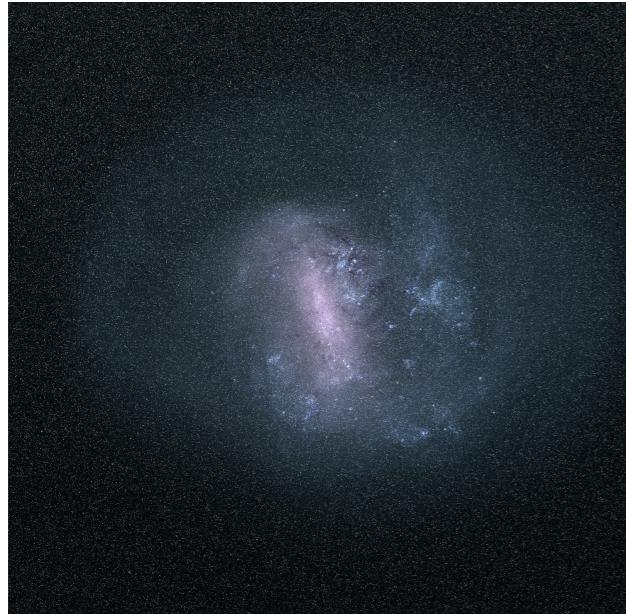


Quenching through
gas expulsion



Environmental Dependence

Low mass star-forming galaxy

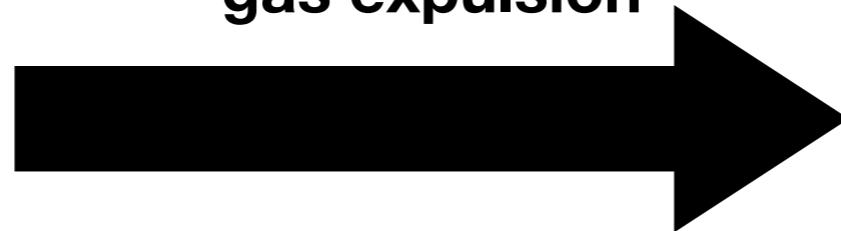


Galaxy shape and size changes less:

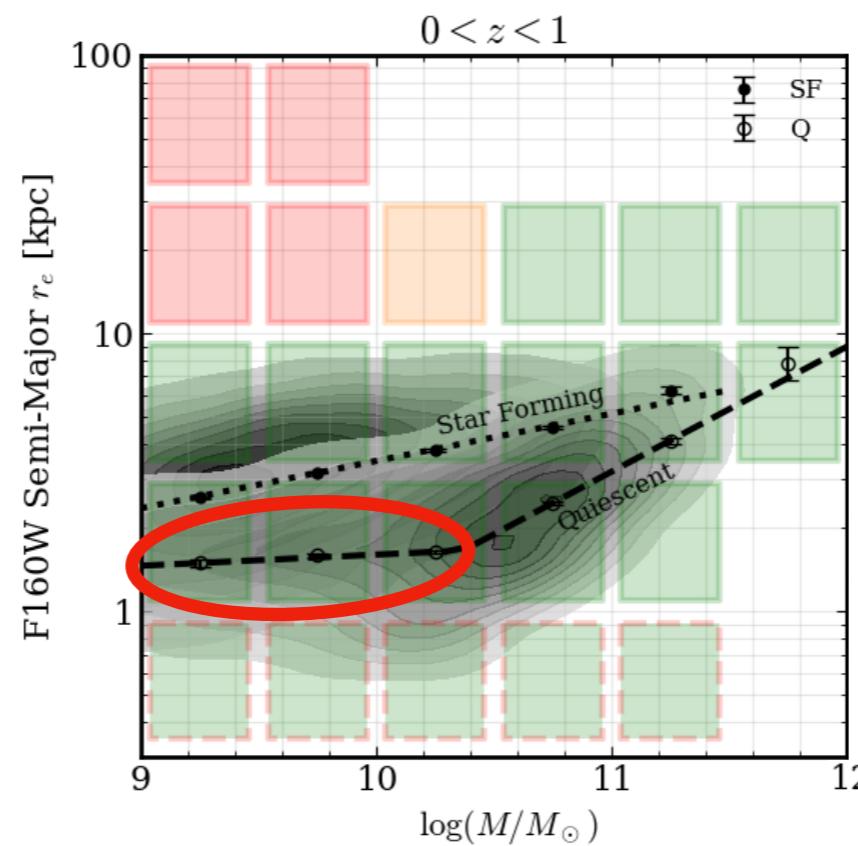
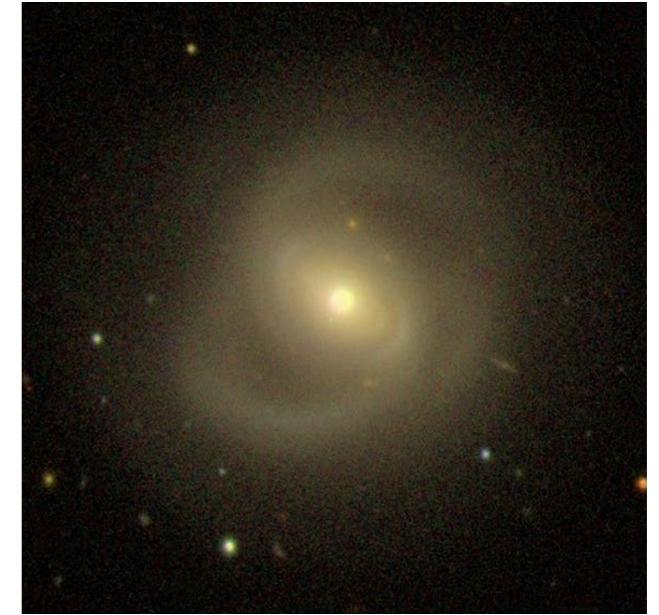
More disk-like

Similar size to star forming galaxies

Quenching through gas expulsion

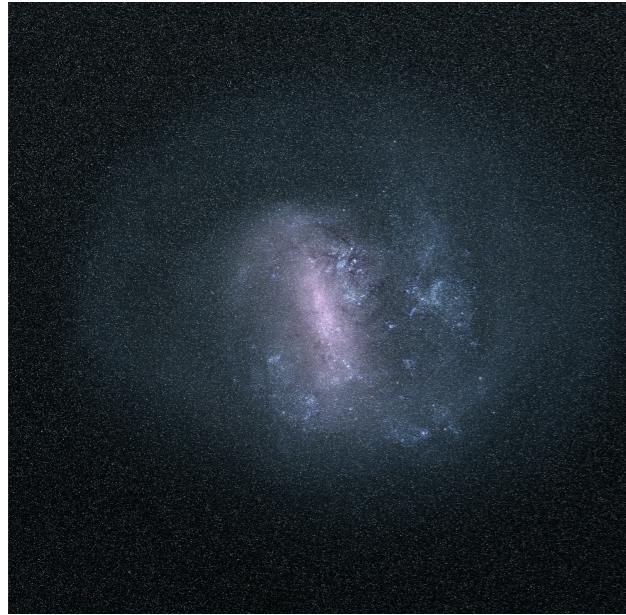


Low mass quiescent galaxy



Environmental Dependence

Low mass star-forming galaxy

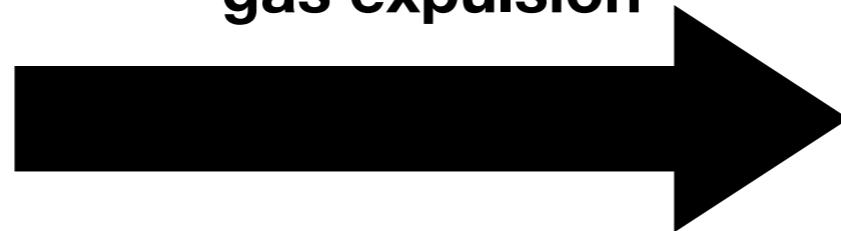


Galaxy shape and size changes less:

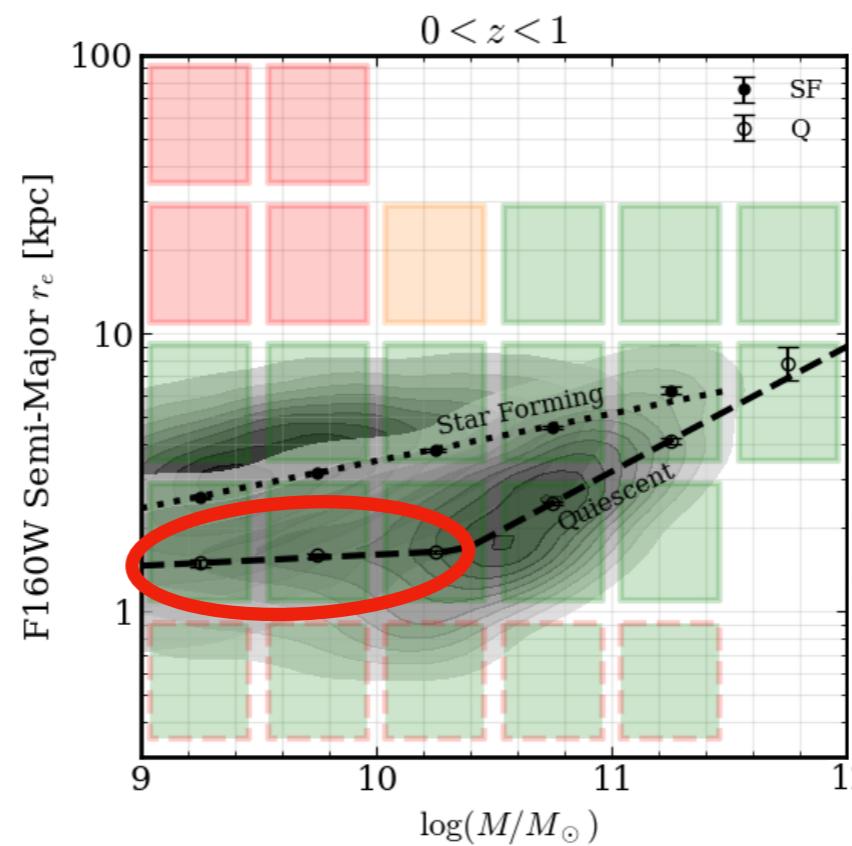
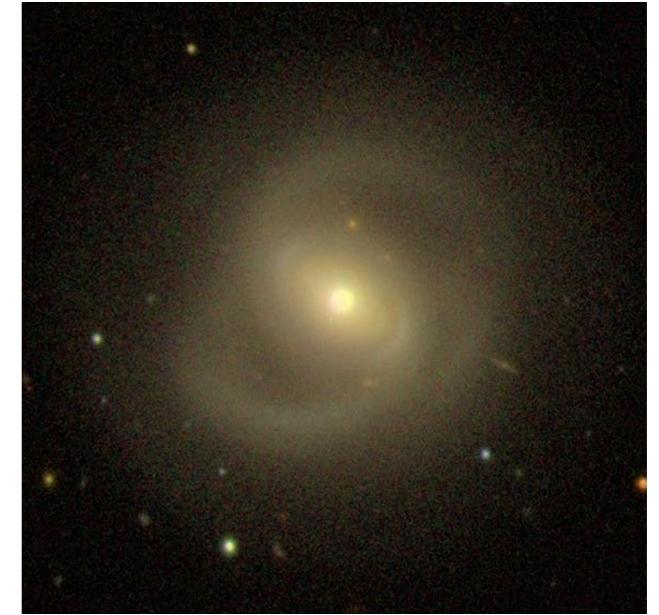
More disk-like

Similar size to star forming galaxies

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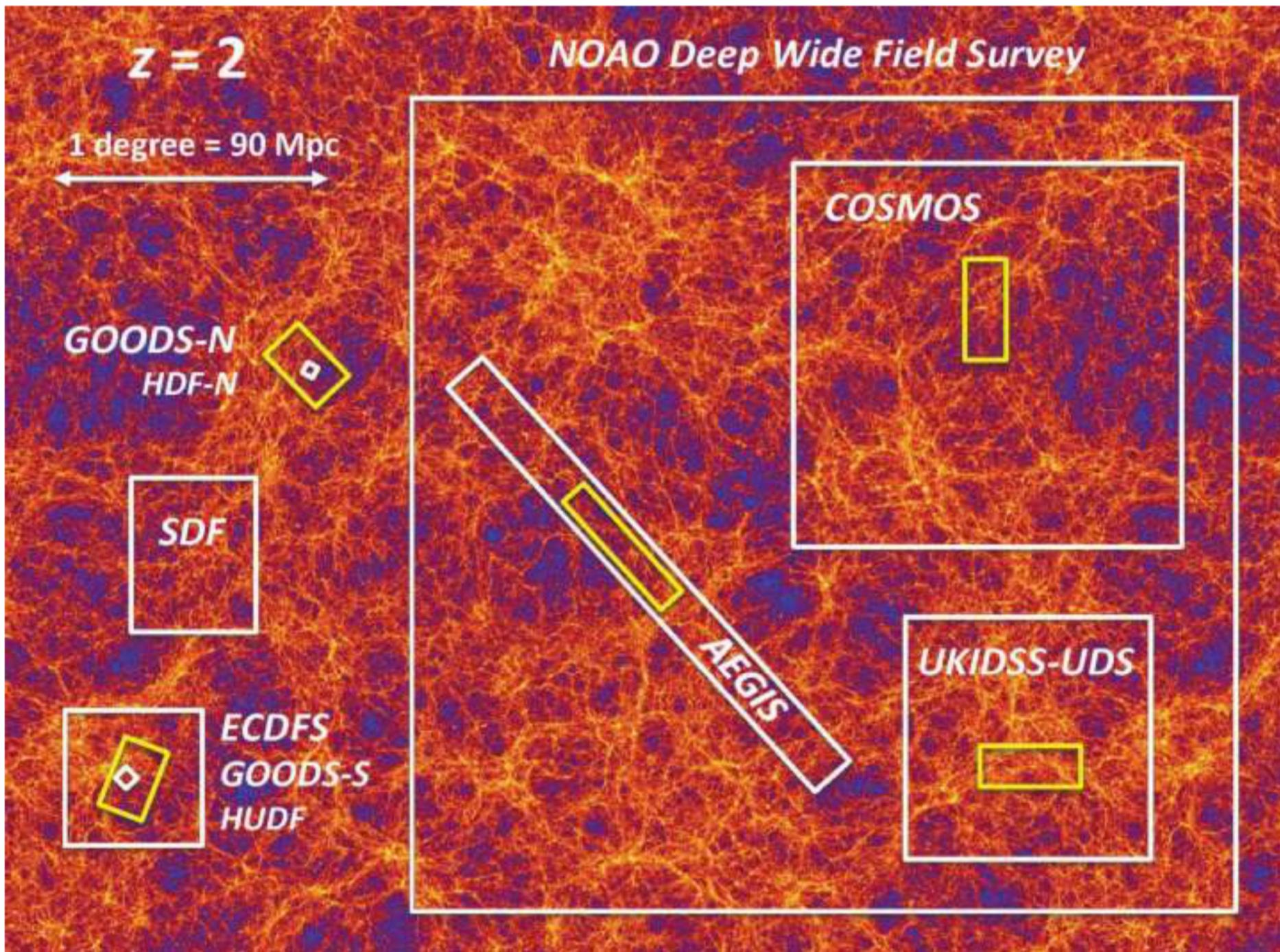
Low mass quiescent galaxy



Occurs in underdense environments

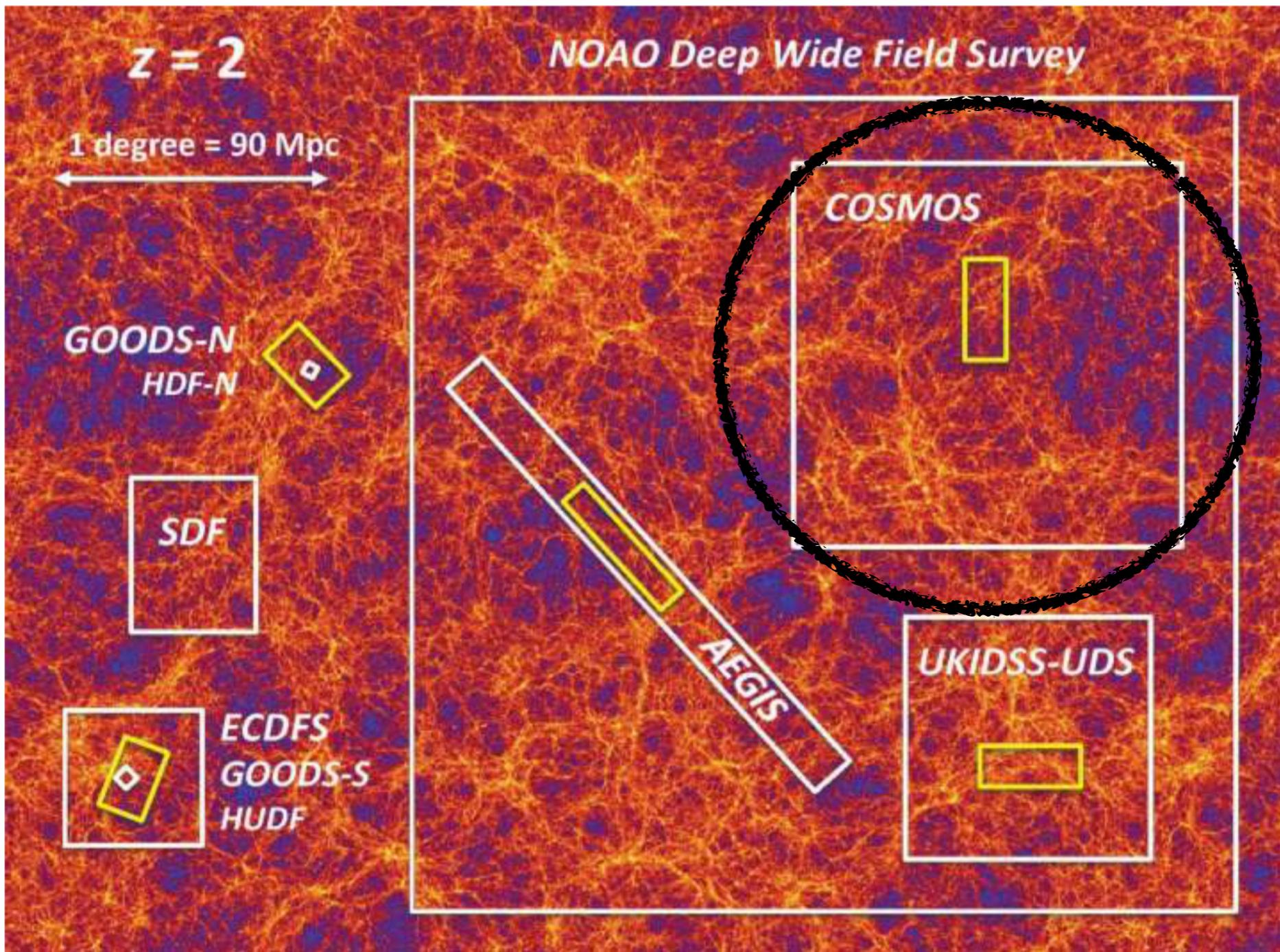
Environmental Dependence

Have large, continuous area to probe range of environments



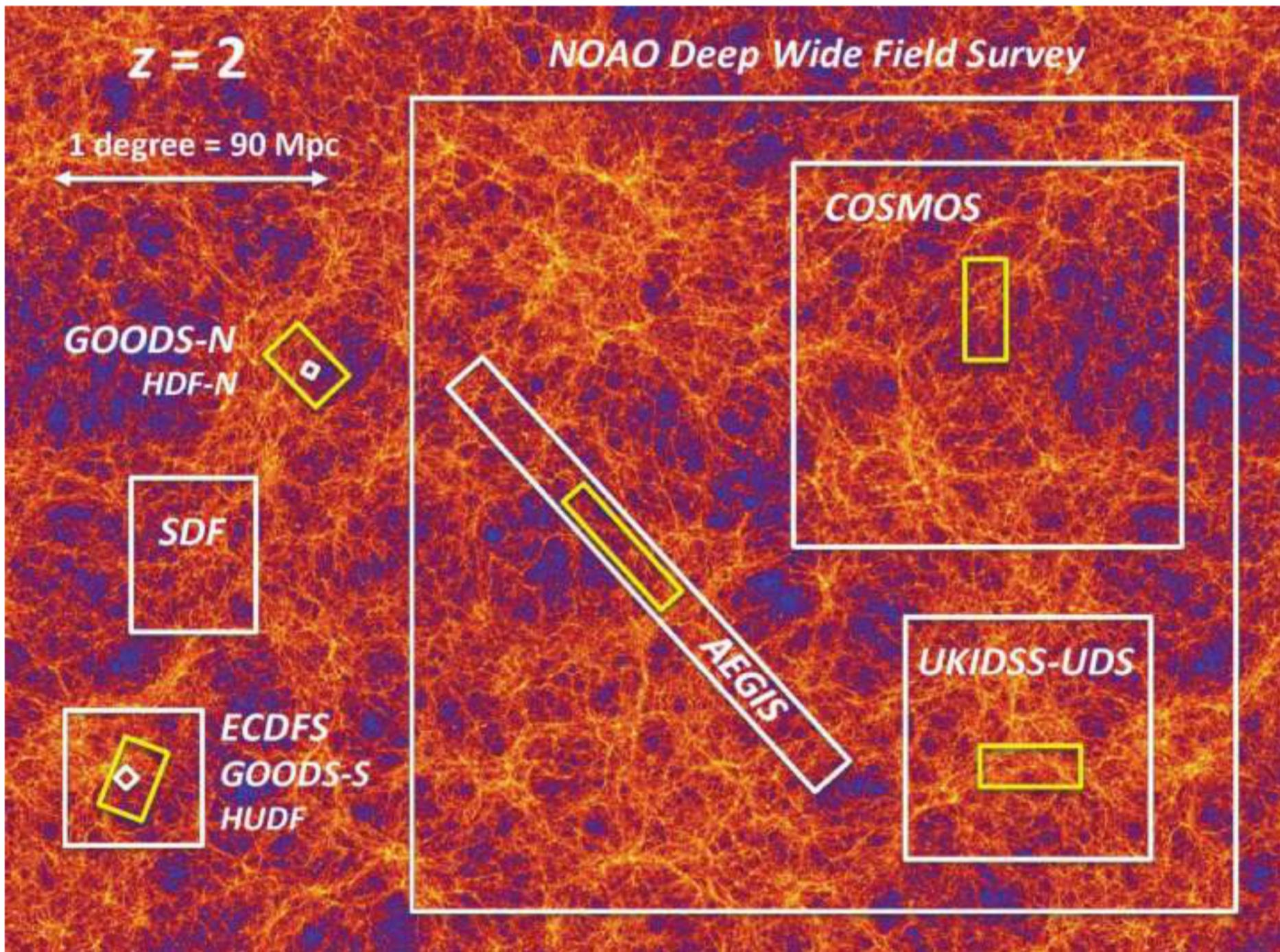
Environmental Dependence

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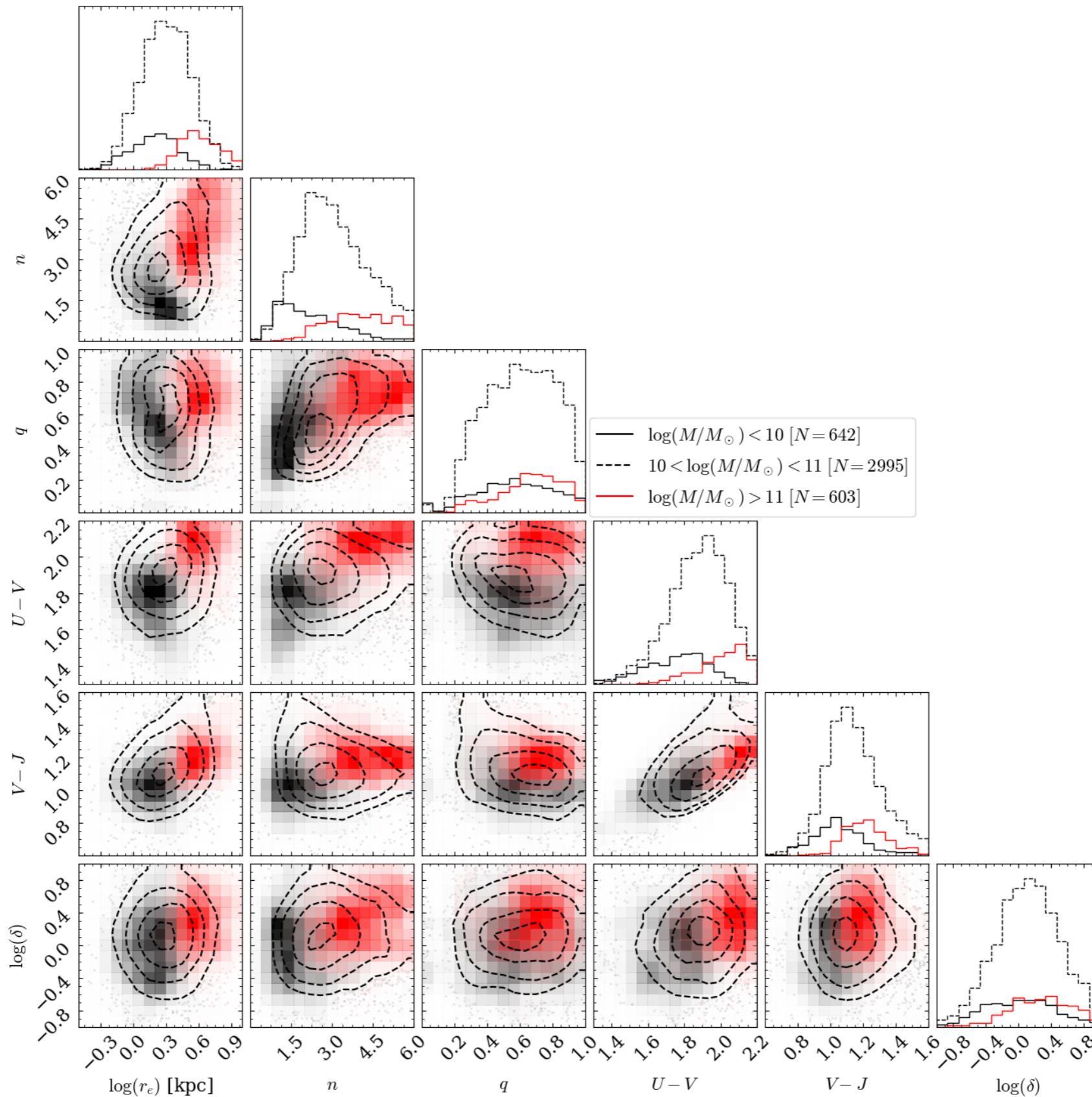


Environmental Dependence

Cross match DASH to COSMOS galaxy field density catalog
(Darvish et al. 2017)

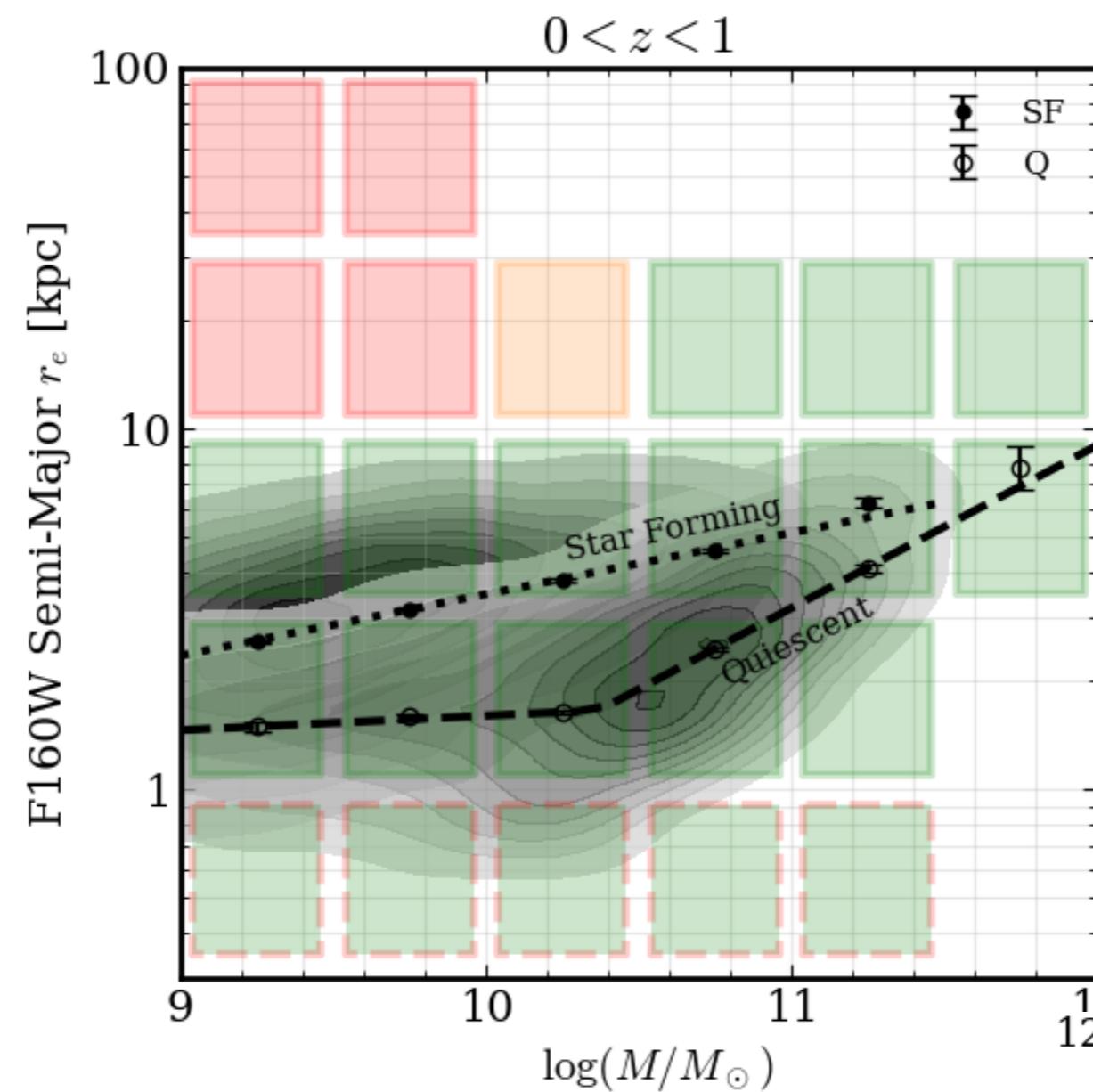


Many other parameters play a significant role in environment and evolution



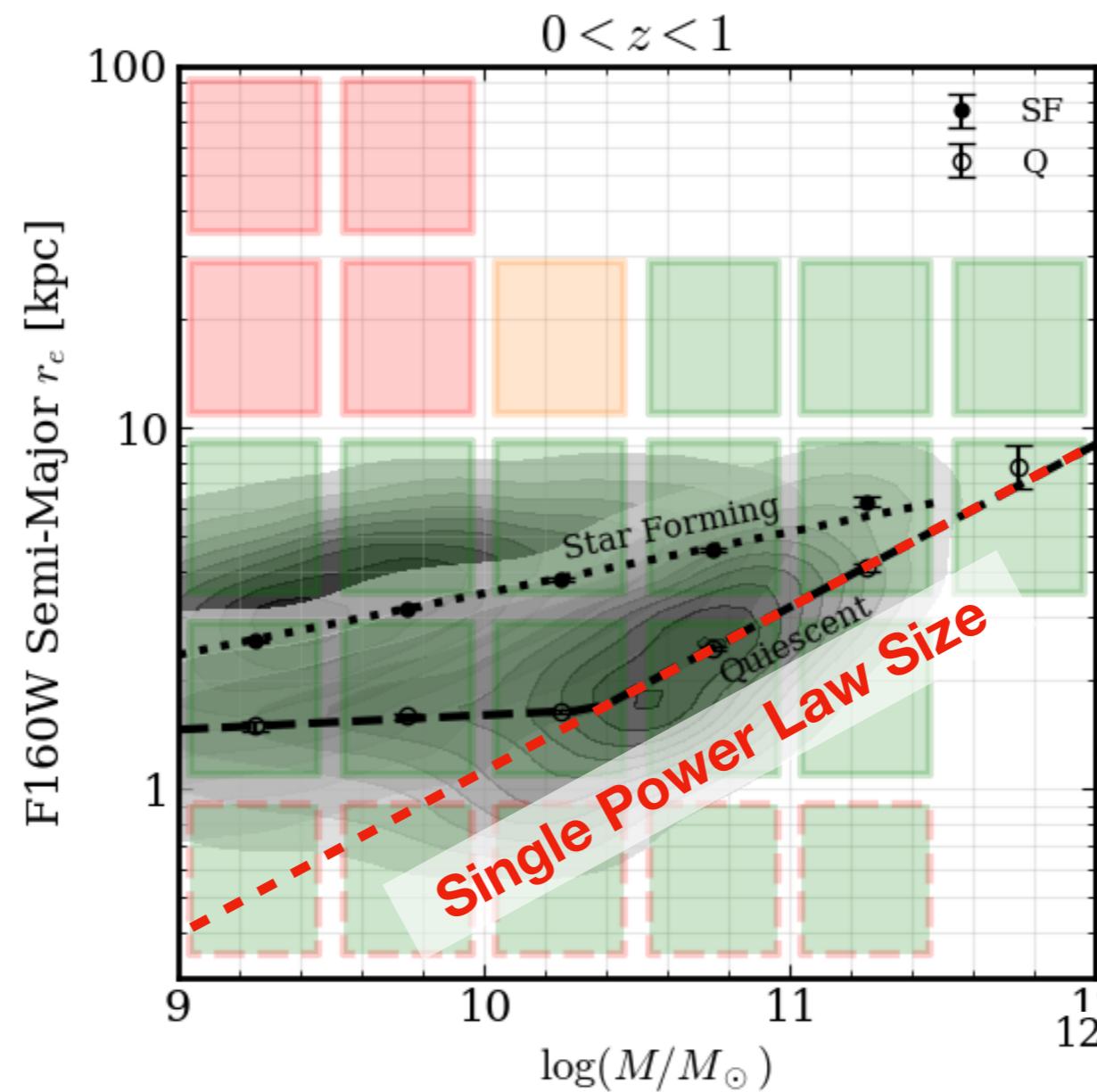
Environmental Dependence

Look at change in *quiescent* size with environment

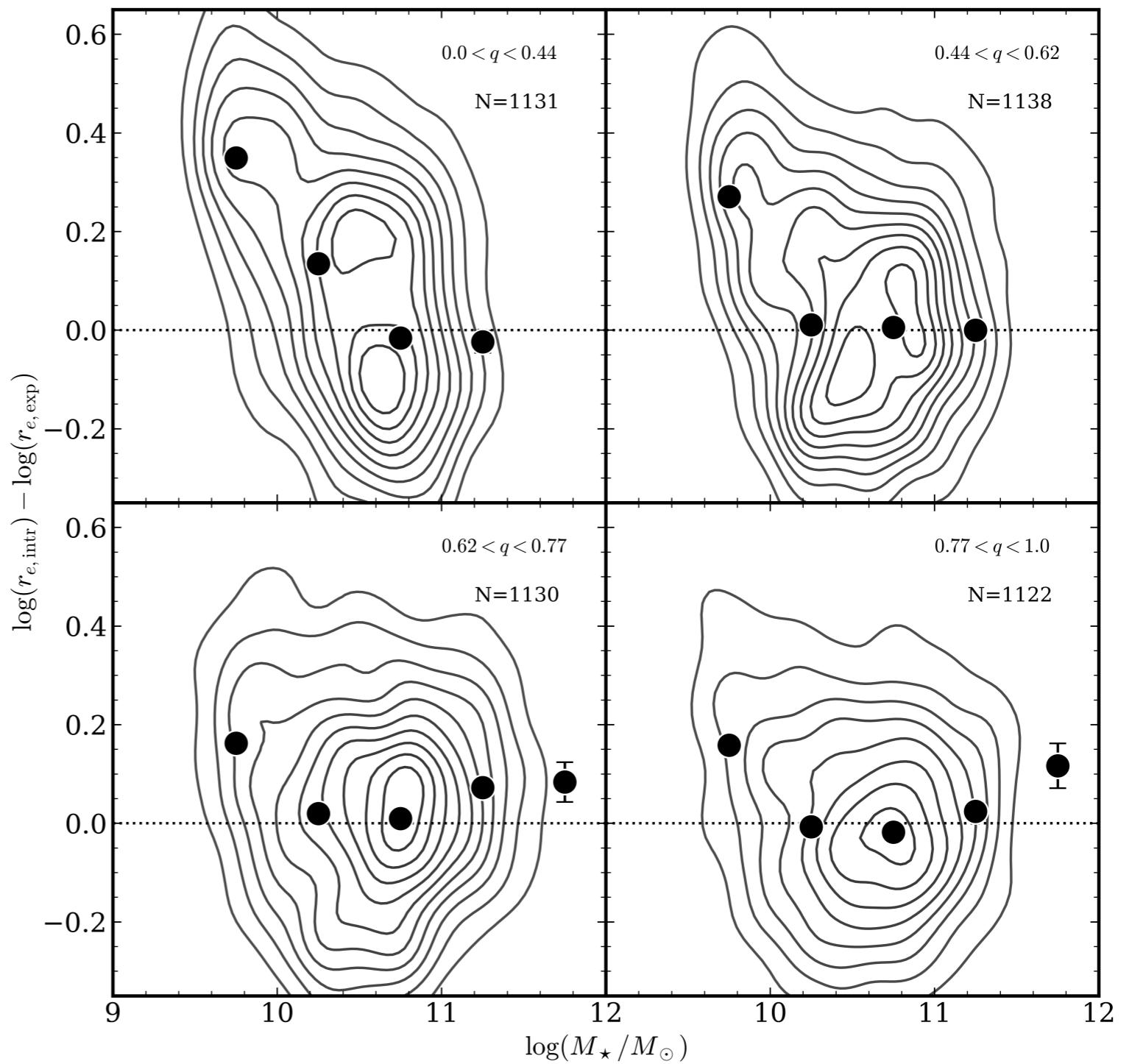


Environmental Dependence

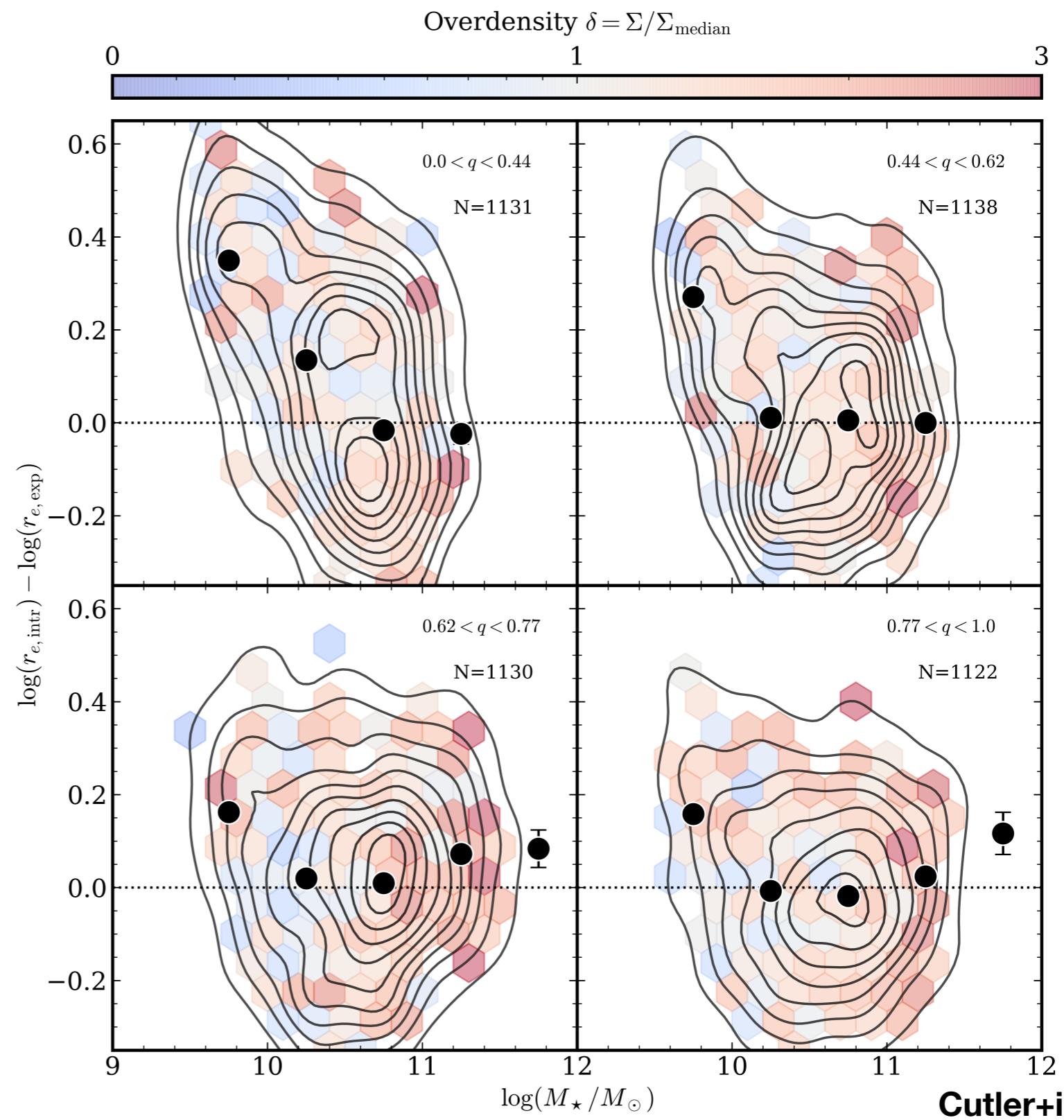
Look at change in *quiescent* size with environment



Axis Ratio and Environment



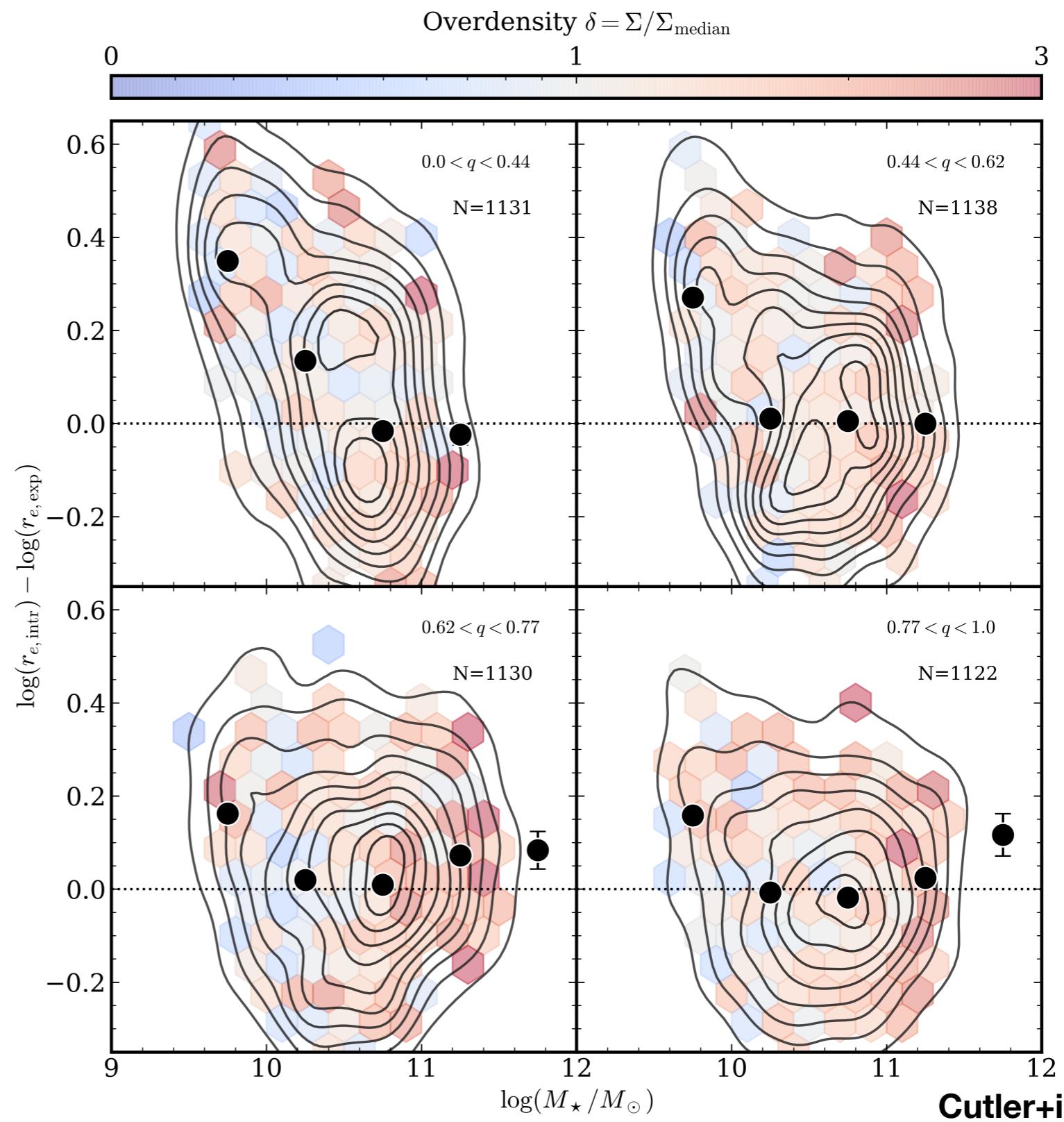
Axis Ratio and Environment



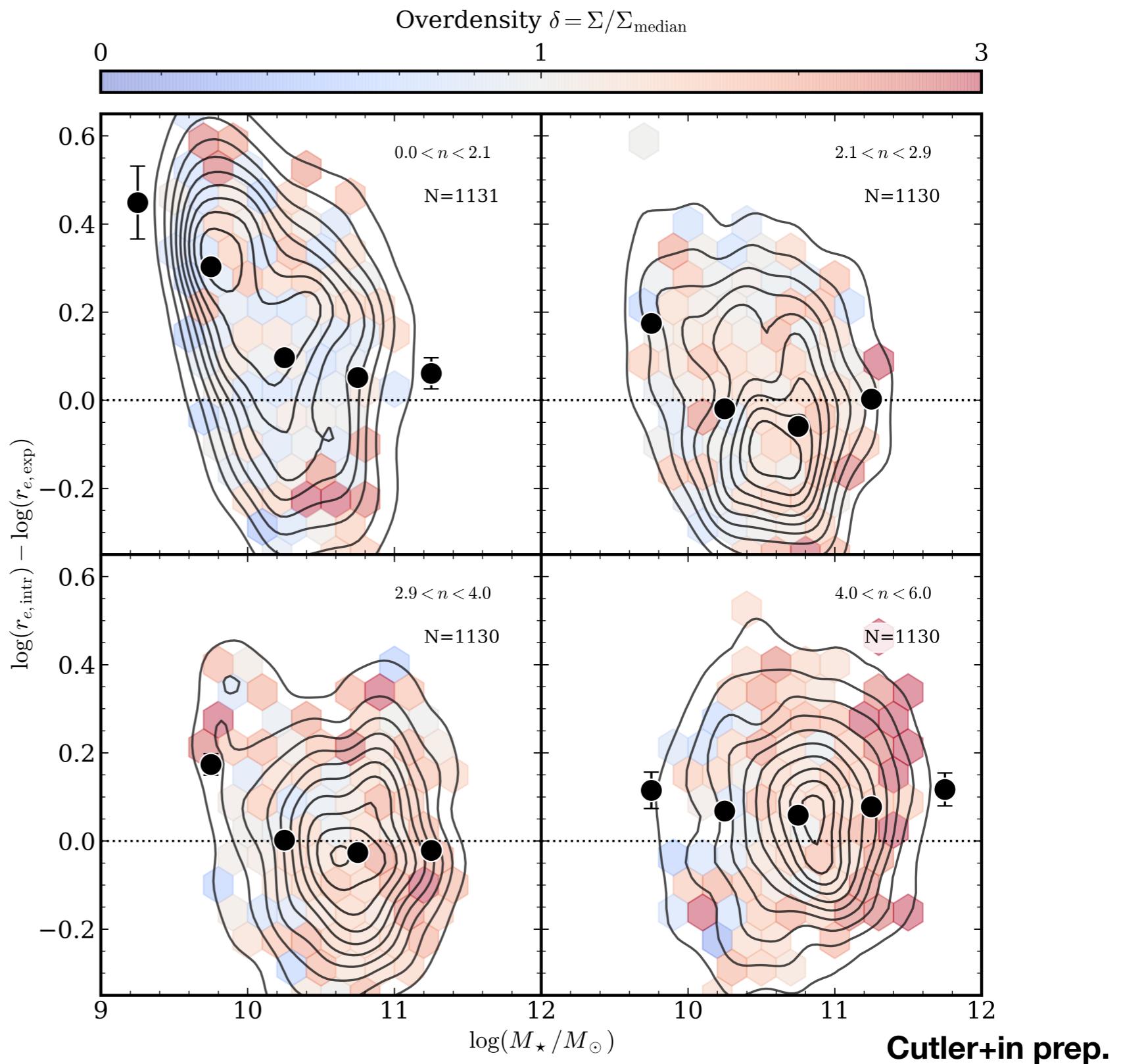
Axis Ratio and Environment

Larger sizes for
smaller axis
ratios

Smaller axis ratios in underdense environments



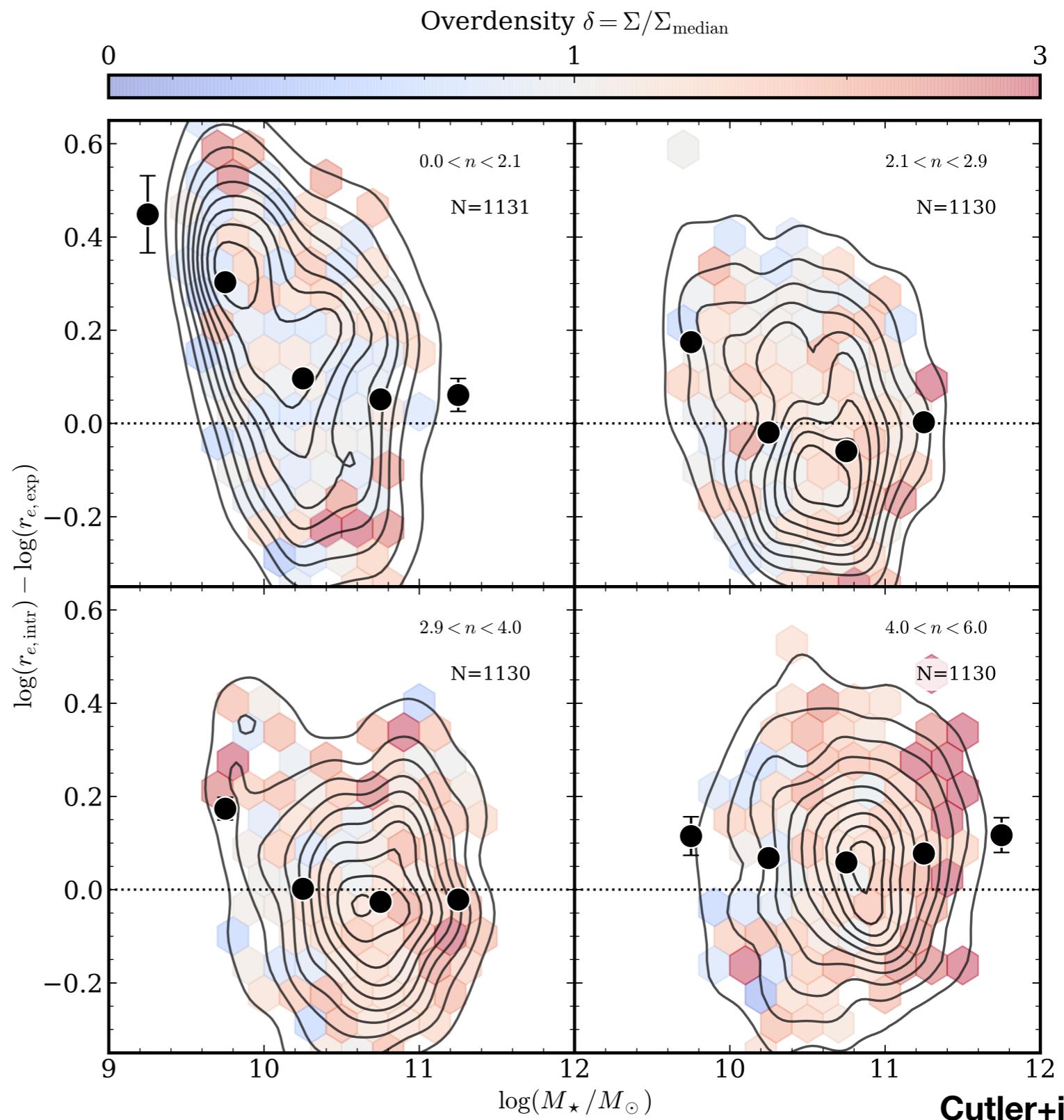
Sérsic Index and Environment



Sérsic Index and Environment

Larger sizes for
smaller Sérsic
indices

Smaller Sérsic
indices in
underdense
environments



Summary

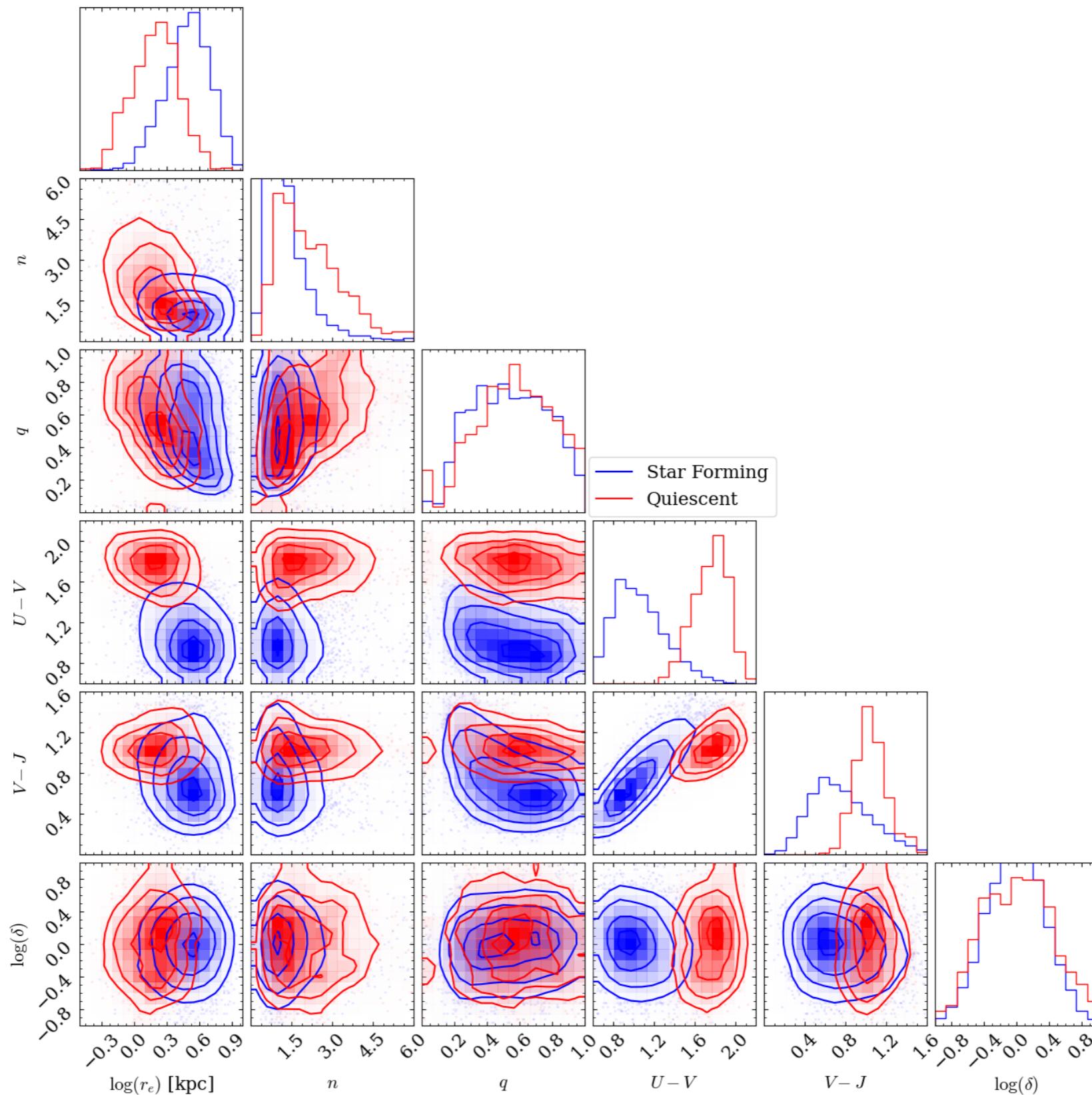
1. *HST*-selected COSMOS-DASH morphological catalog
2. Robust sizes to $H_{160} \sim 23$ and Sérsic indices to $H_{160} \sim 22$
3. Consistent size evolution with CANDELS/3D-HST morphologies
4. DASH results can produce results for a wide range of sizes and masses
5. Observe a flattening of the size mass relation for low mass quiescent galaxies
6. Trends with axis ratio, Sérsic index, and field density point to an environmental dependence of the size mass flattening

Parameter Errors

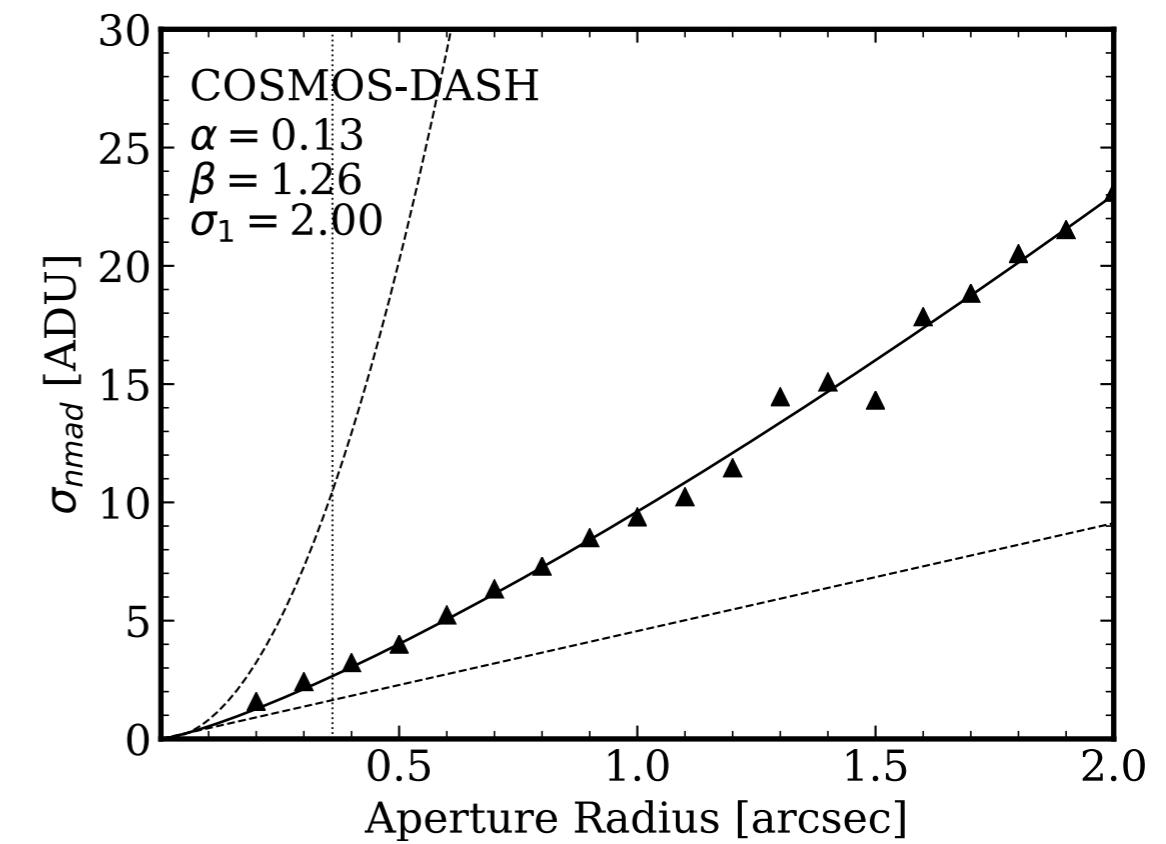
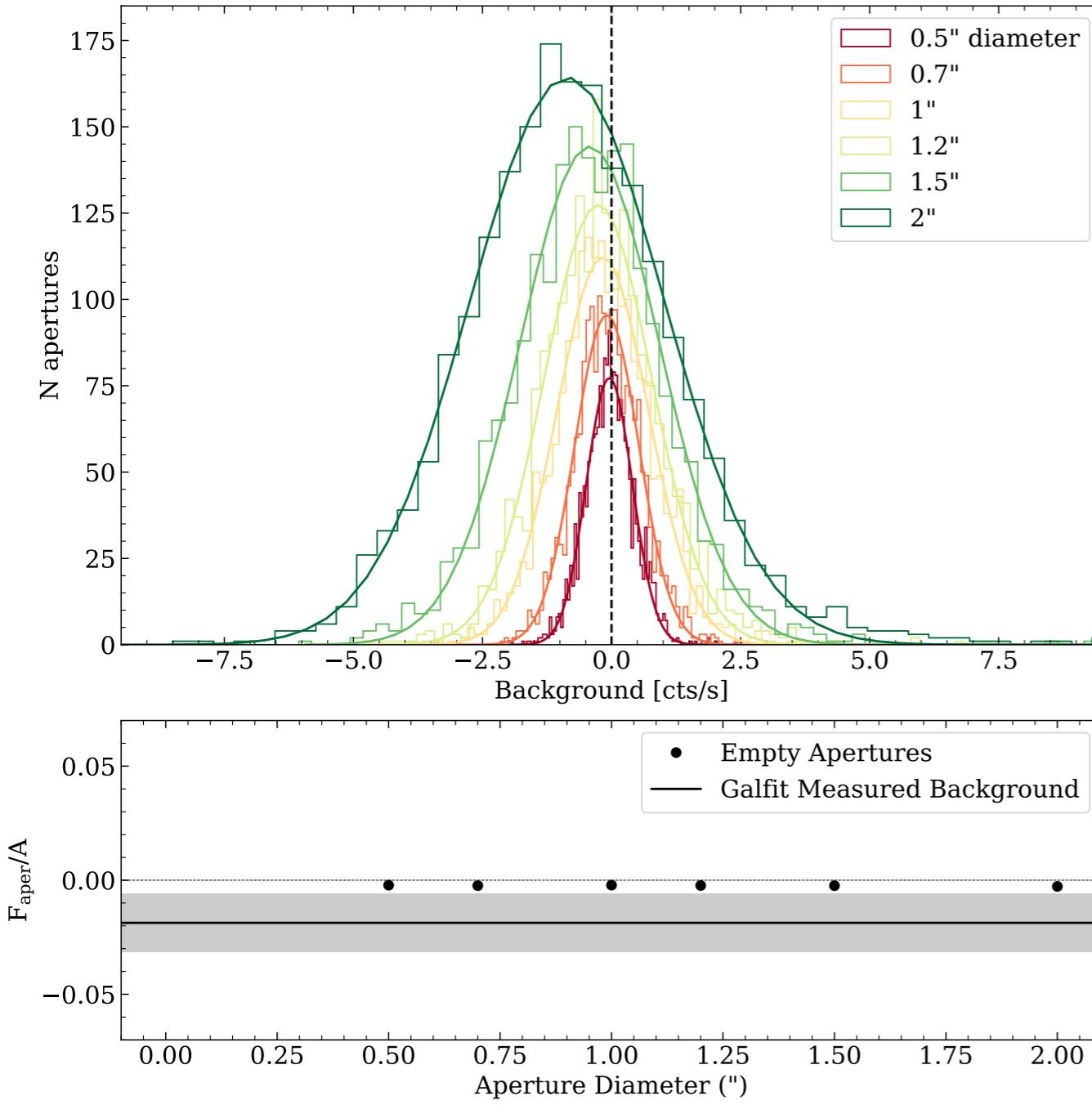
Use “similar galaxies” approach (van der Wel et al. 2012):

1. Create parameter “position” vector for every galaxy in calibration field and DASH sample
 $(m_i/\sigma(\vec{m}), \log n_i/\sigma(\log \vec{n}), \log r_i/\sigma(\log \vec{r}))$
2. For each DASH galaxy, find 25 galaxies with shortest “distance” between calibration field
3. SNR weighted average of bootstrapping errors

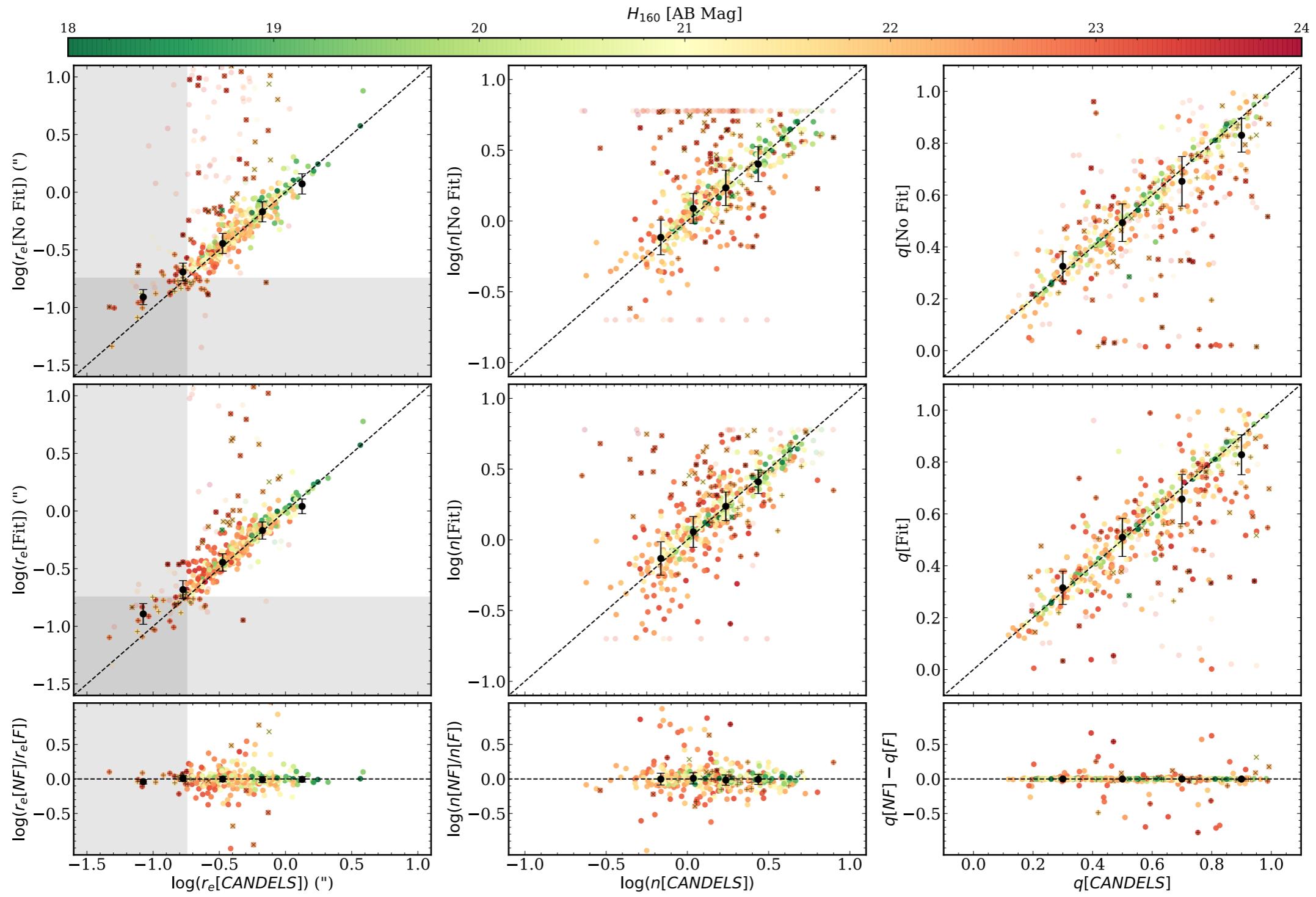
Low mass star forming and quiescent galaxies still occupy different populations



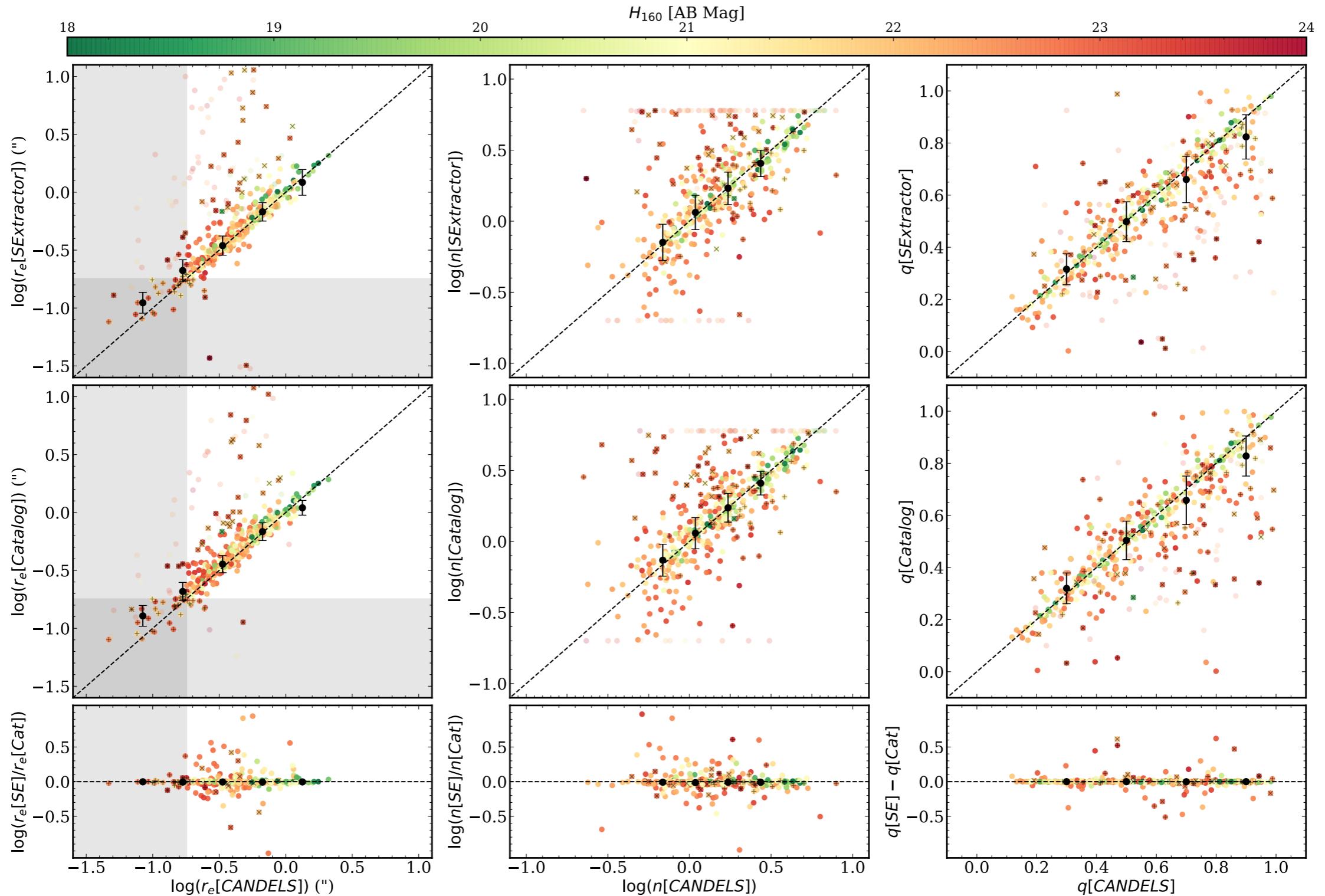
Empty Apertures

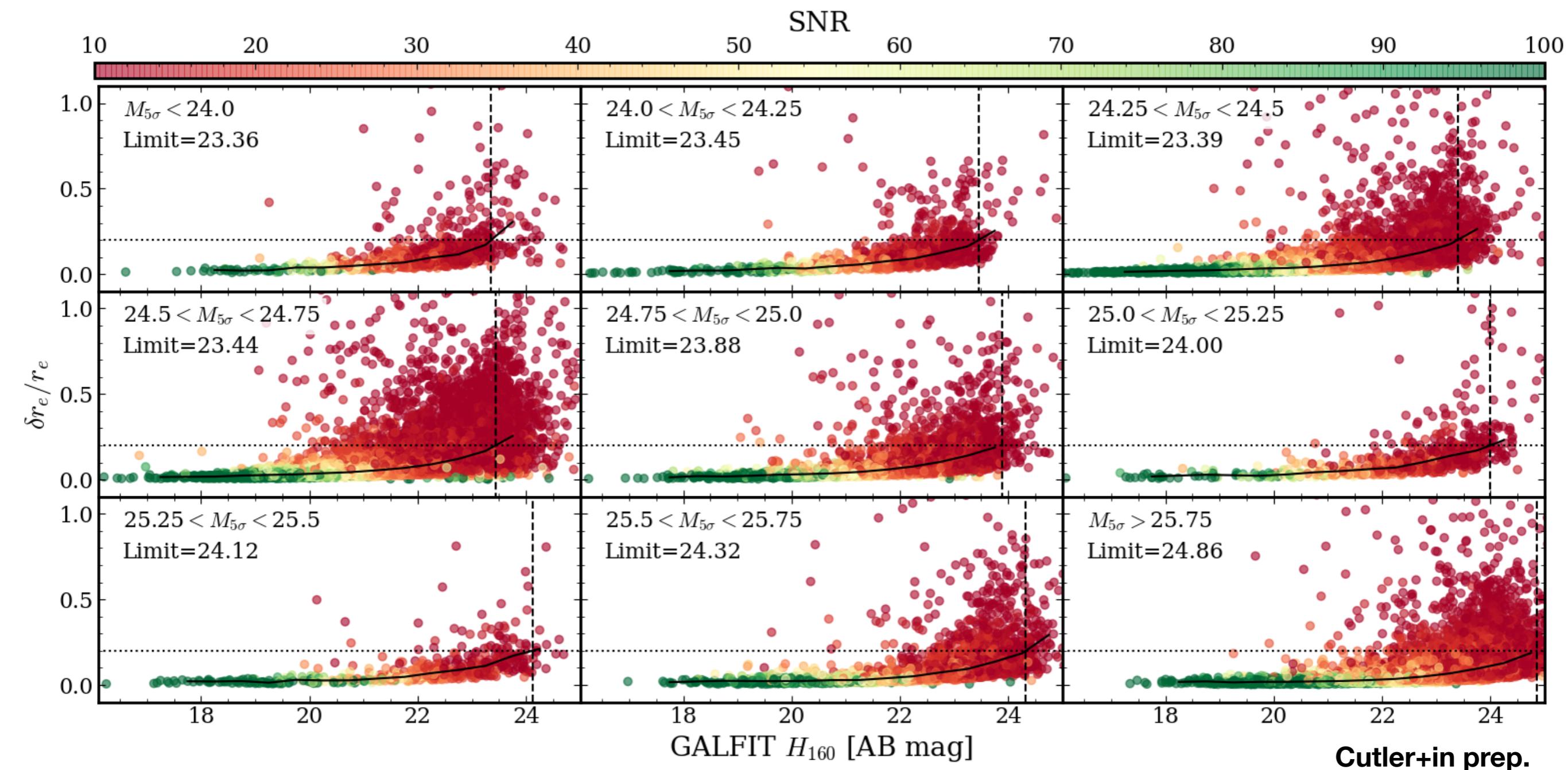


Background Subtraction

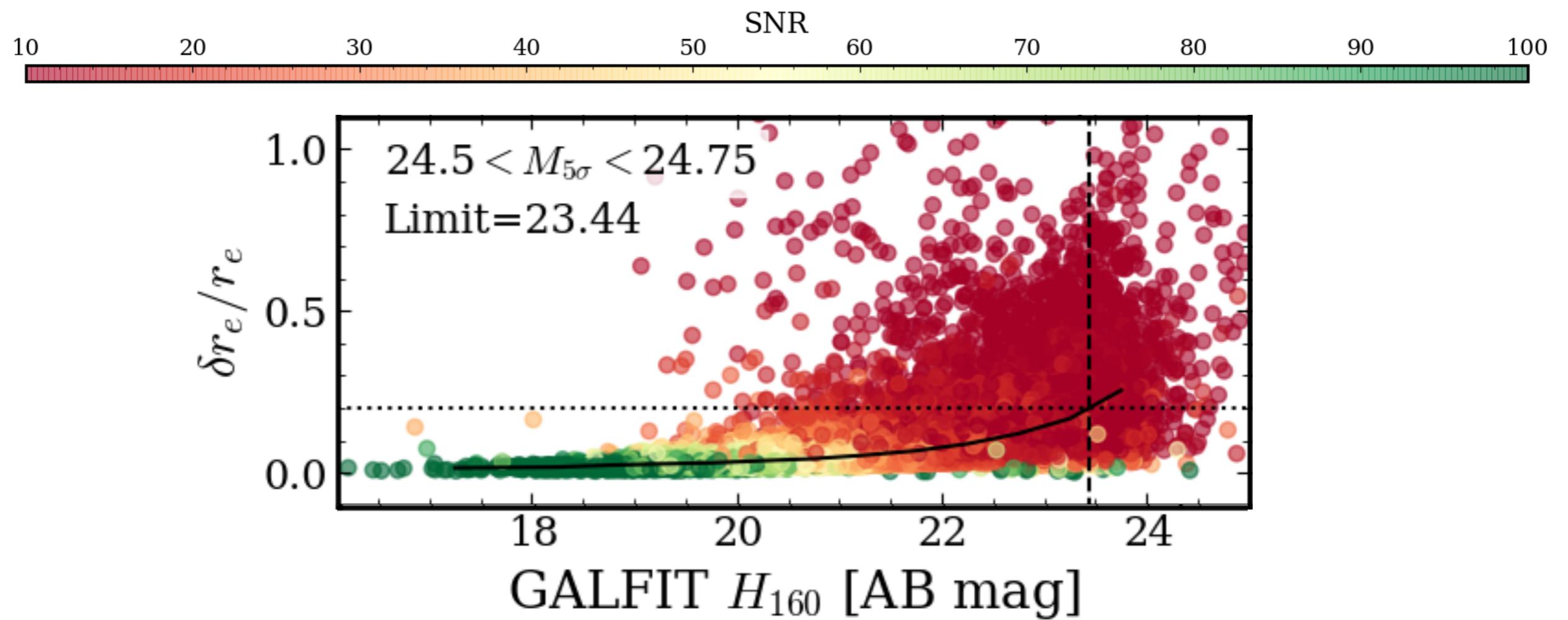


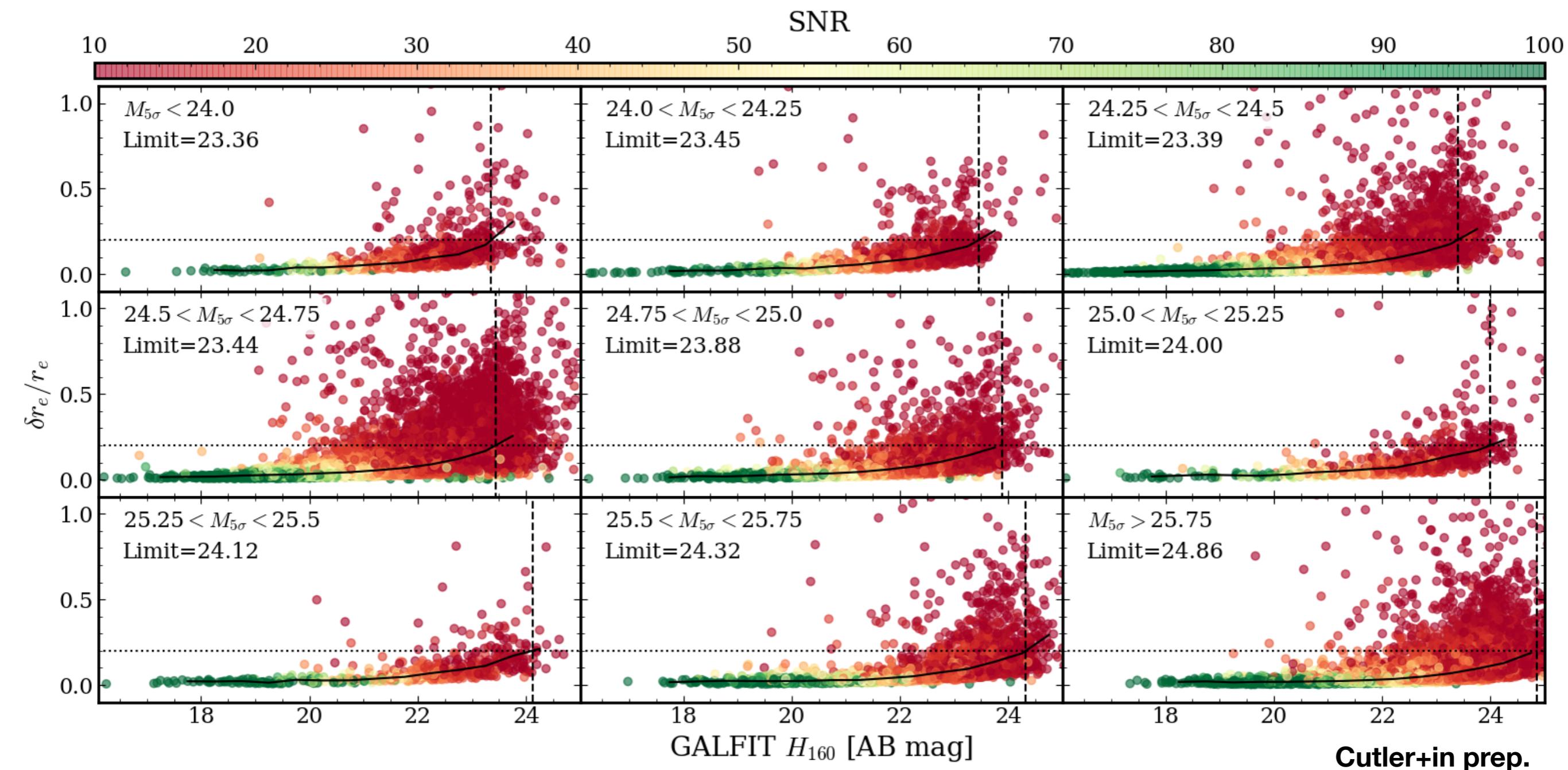
Segmentation Map





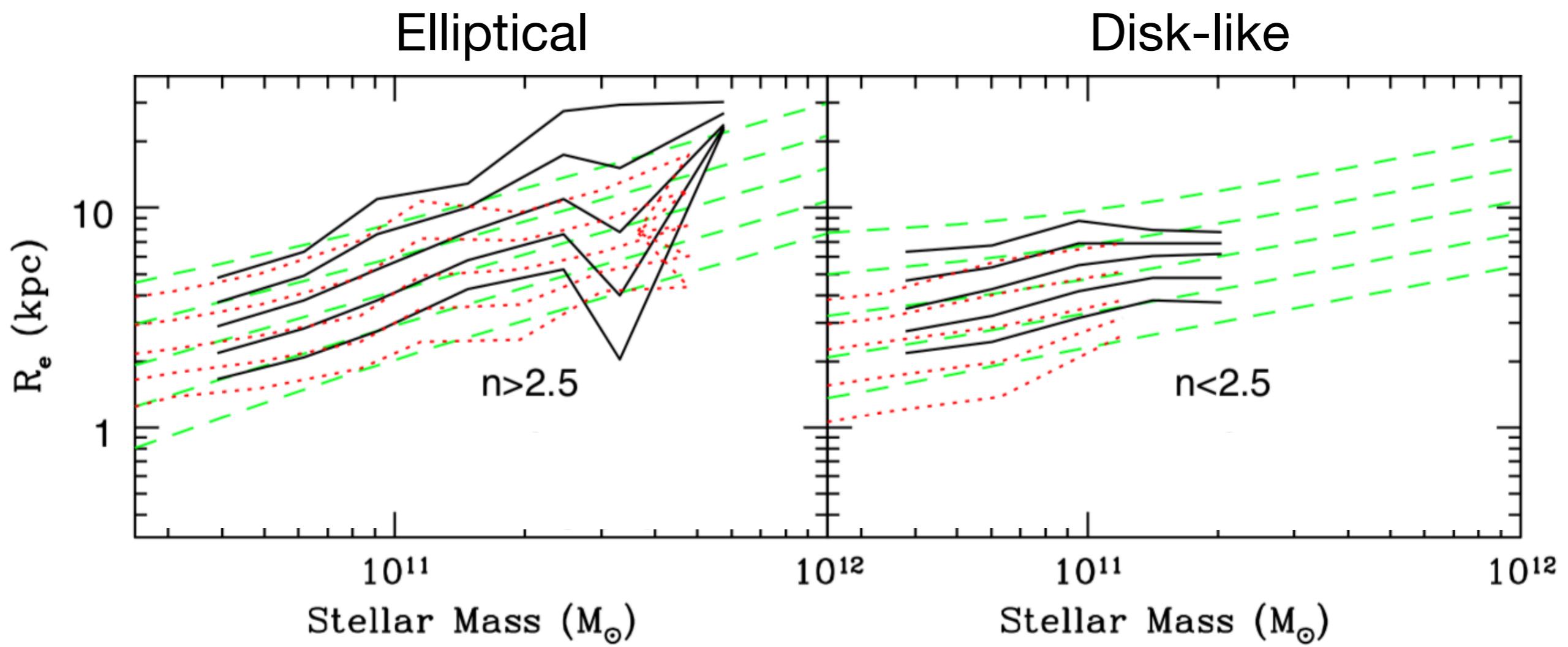
Cutler+in prep.





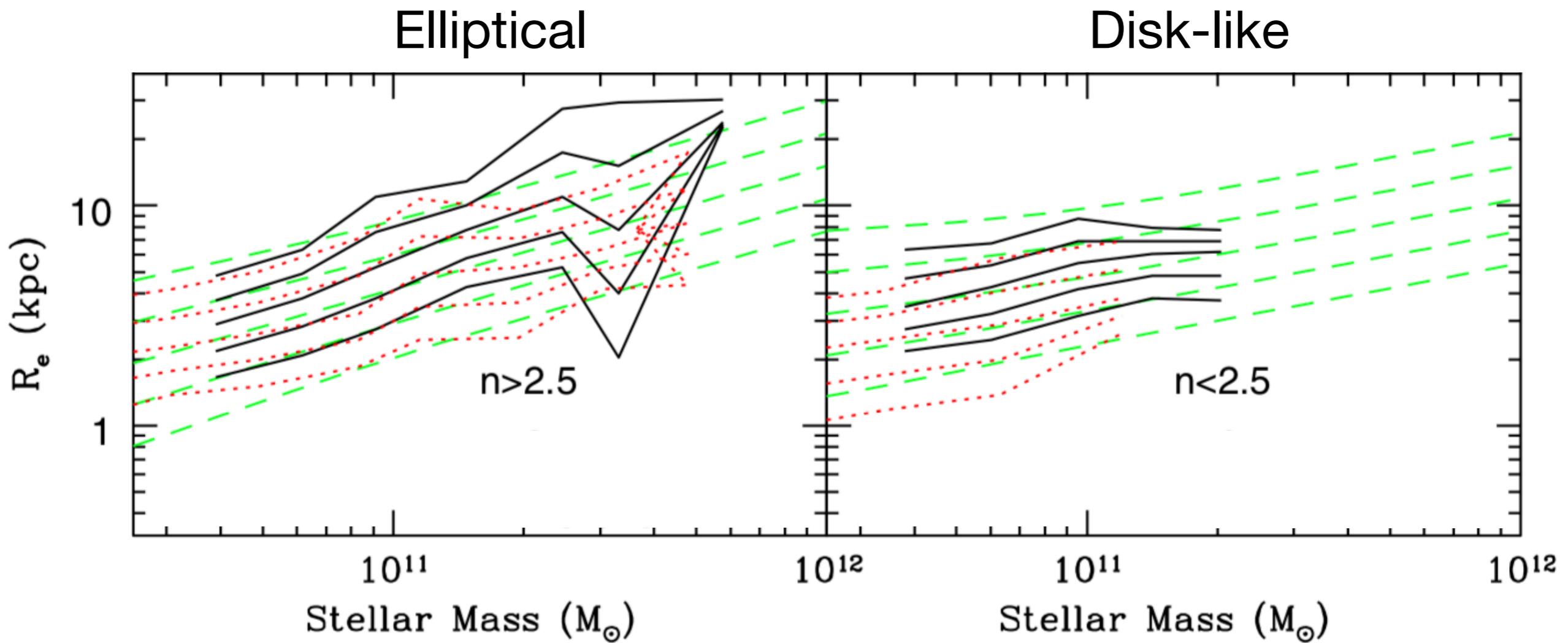
Cutler+in prep.

Similar Findings

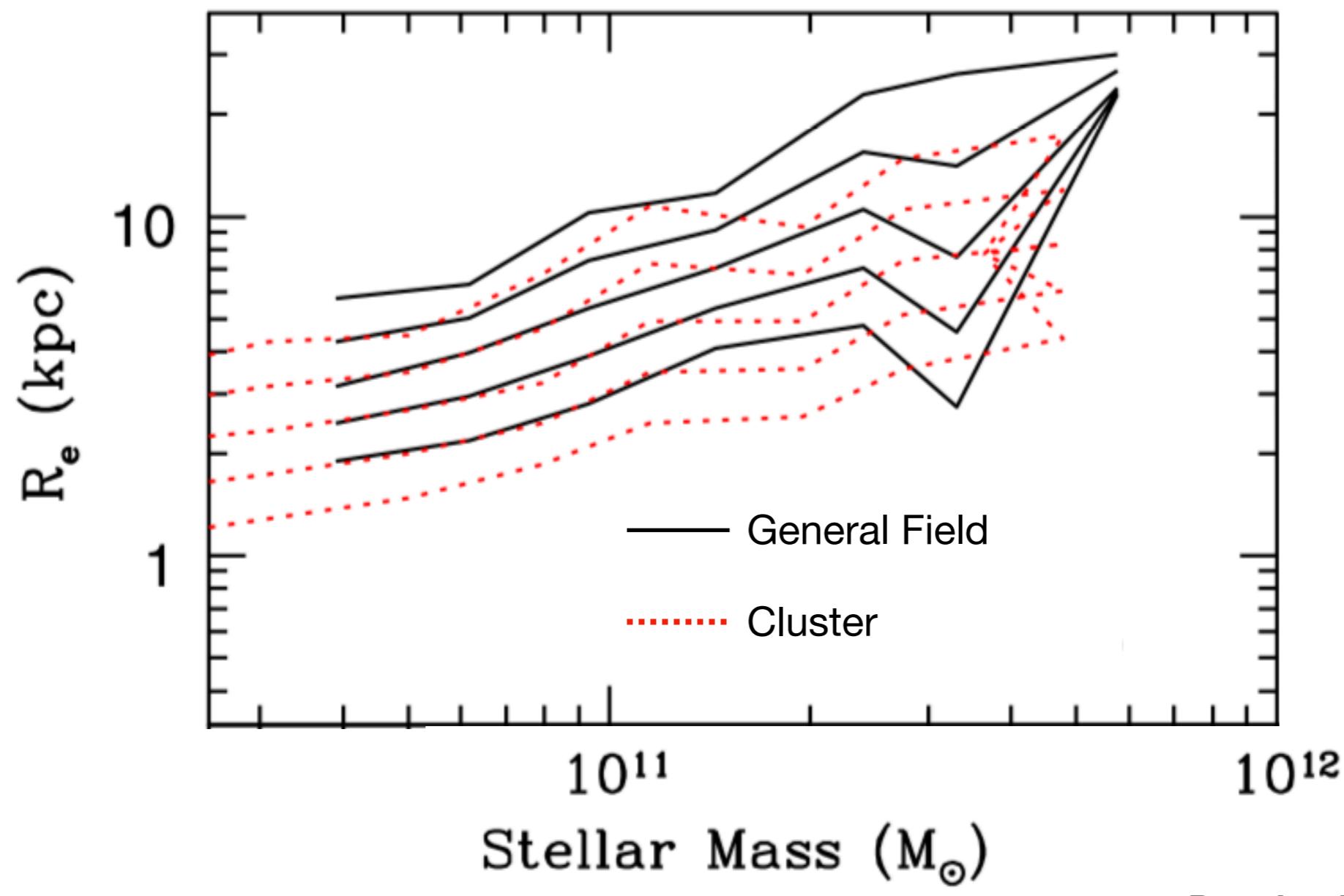


Similar Findings

More disk-like galaxies have flatter size-mass relation



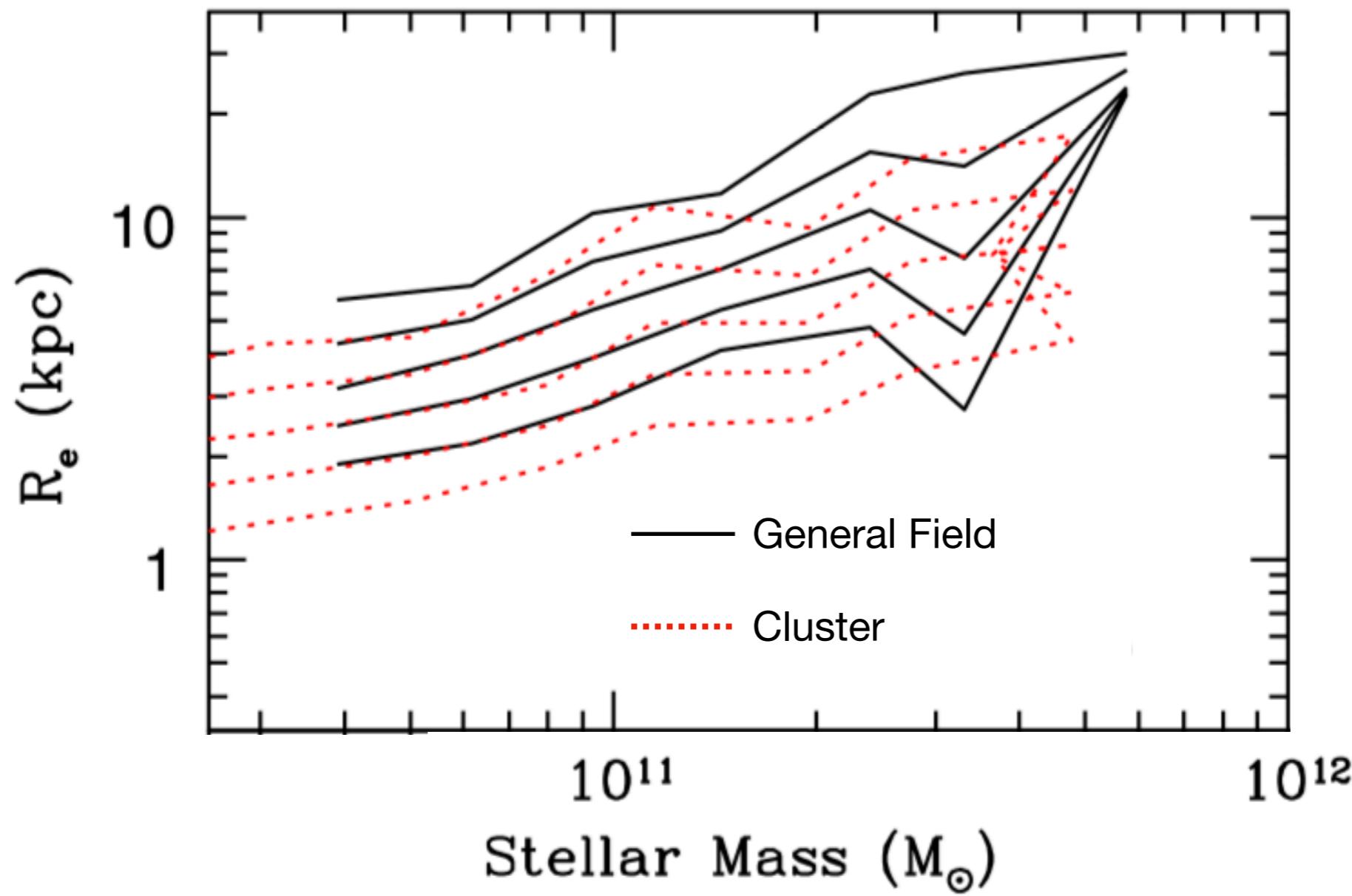
Similar Findings



Poggianti+13

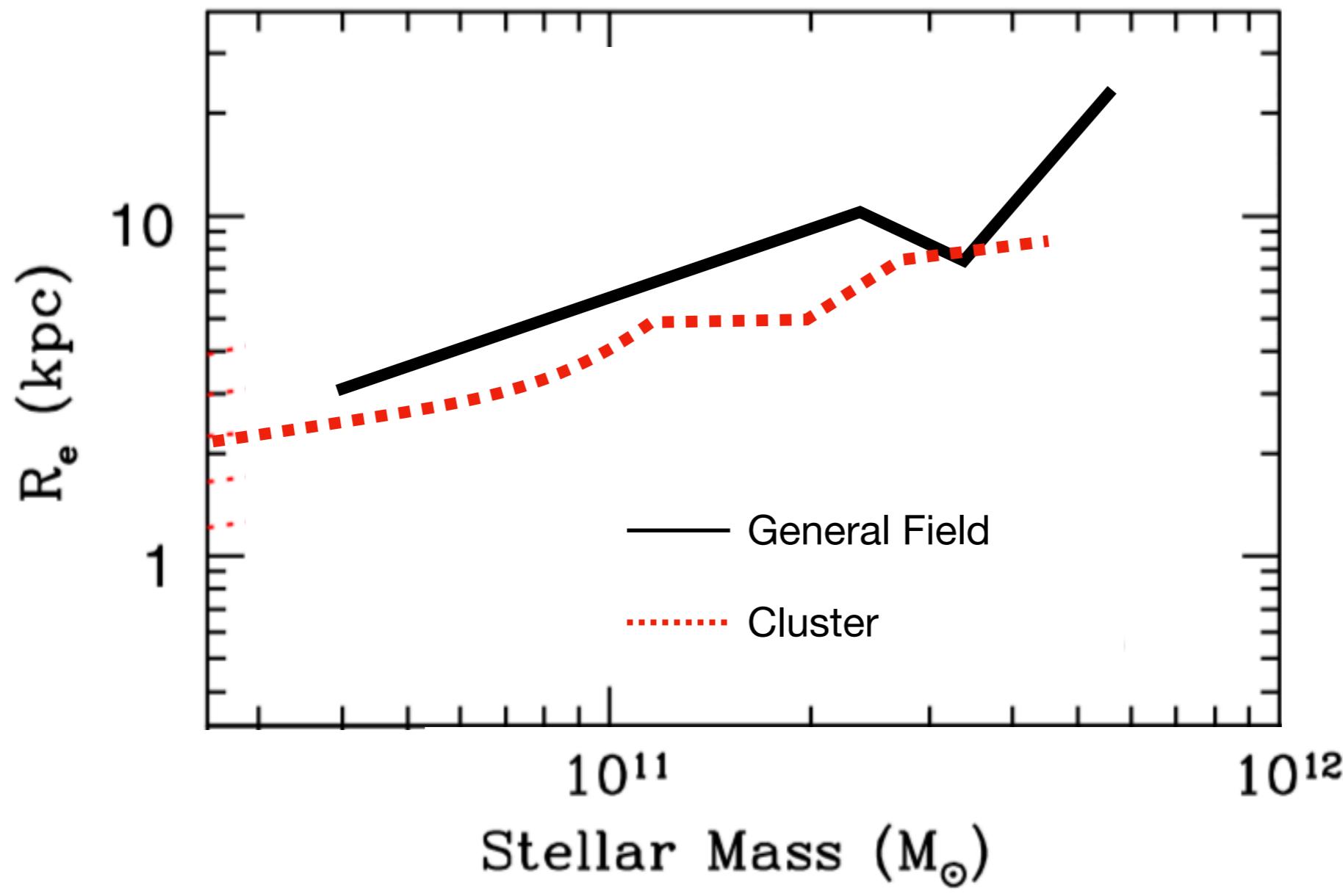
Similar Findings

Low mass cluster galaxies are smaller by $1-\sigma$



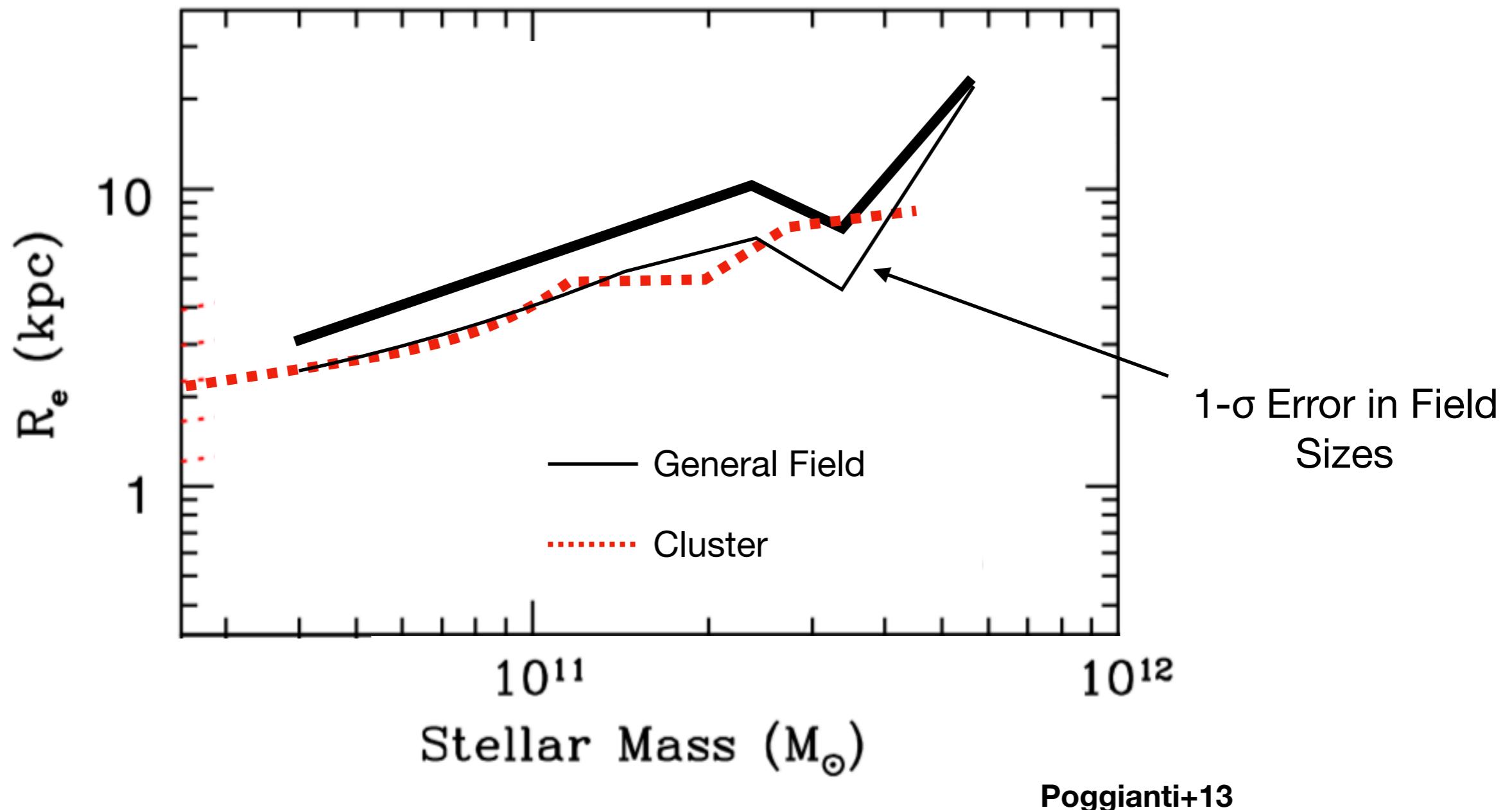
Similar Findings

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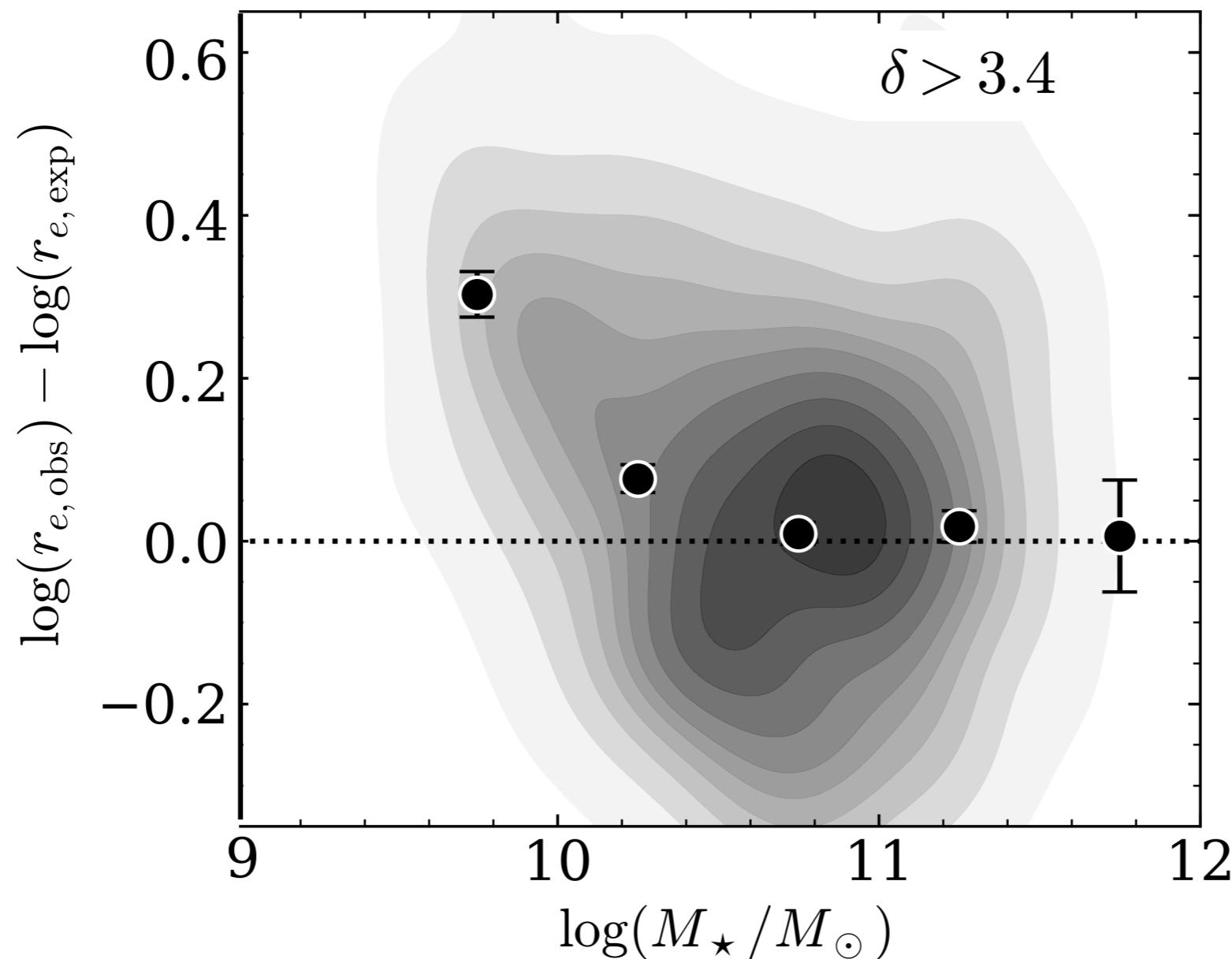
Similar Findings

Low mass cluster galaxies are smaller by $1-\sigma$



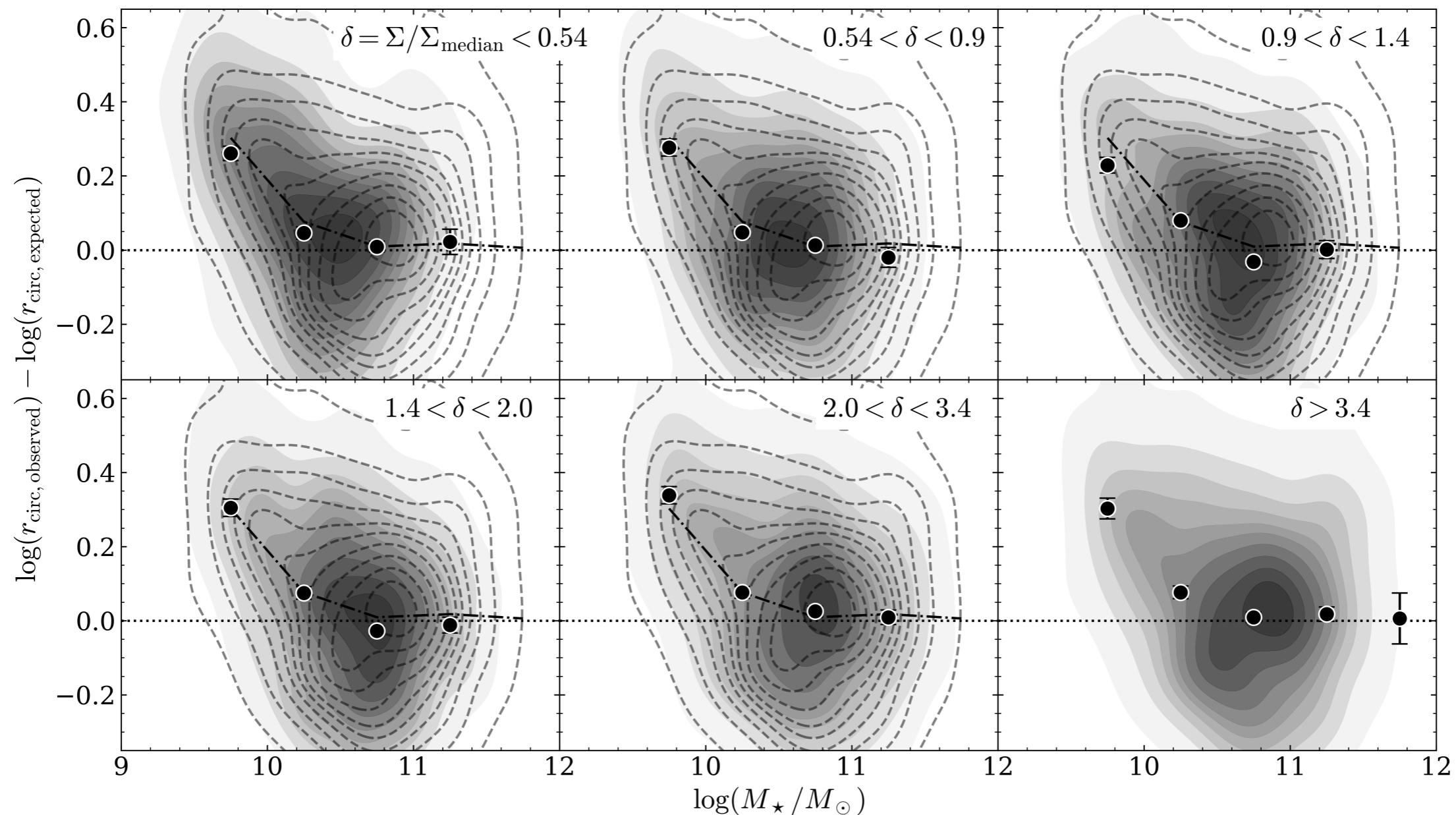
Environmental Dependence

Cross match DASH to COSMOS galaxy field density catalog
(Darvish et al. 2017)



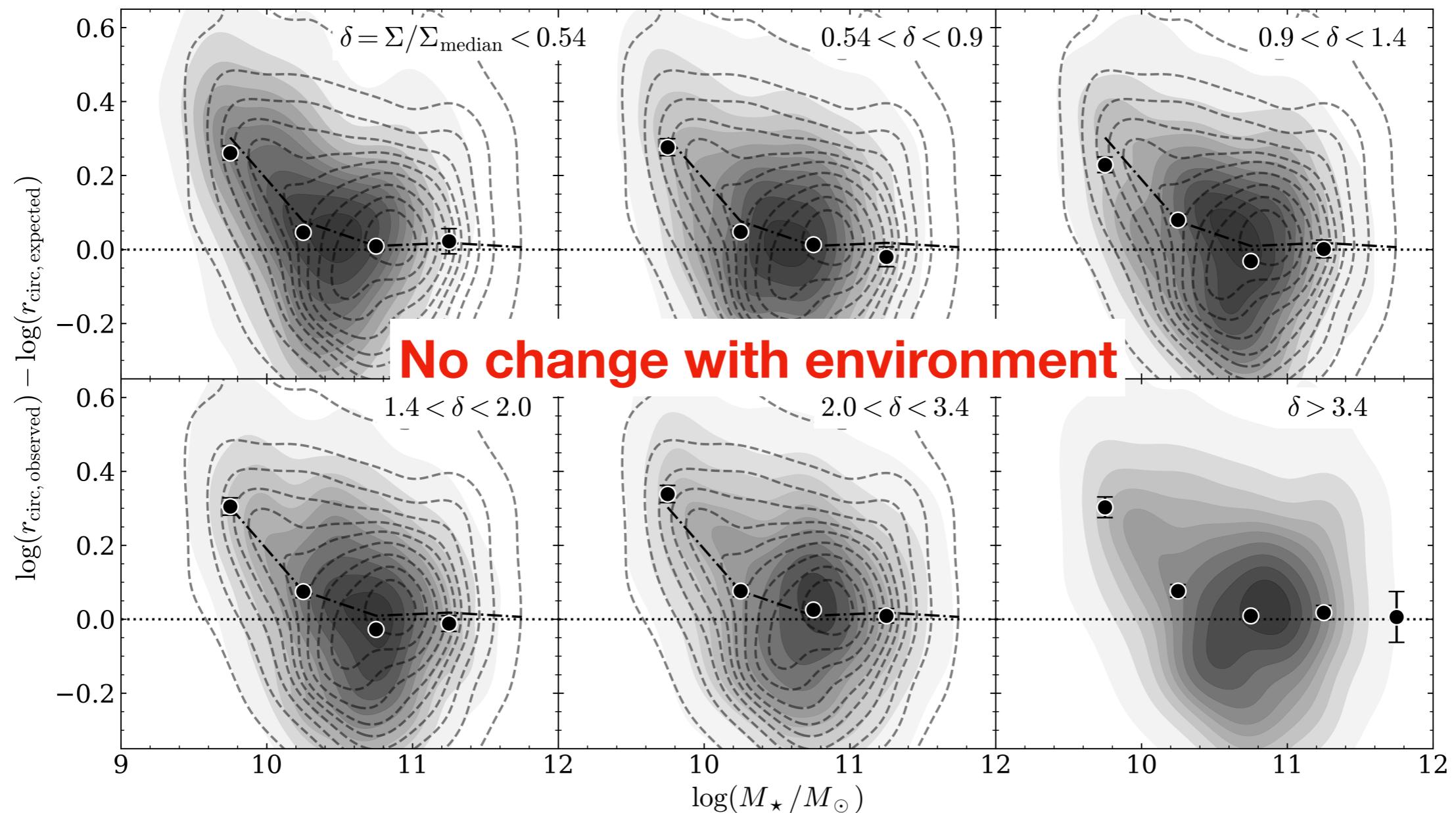
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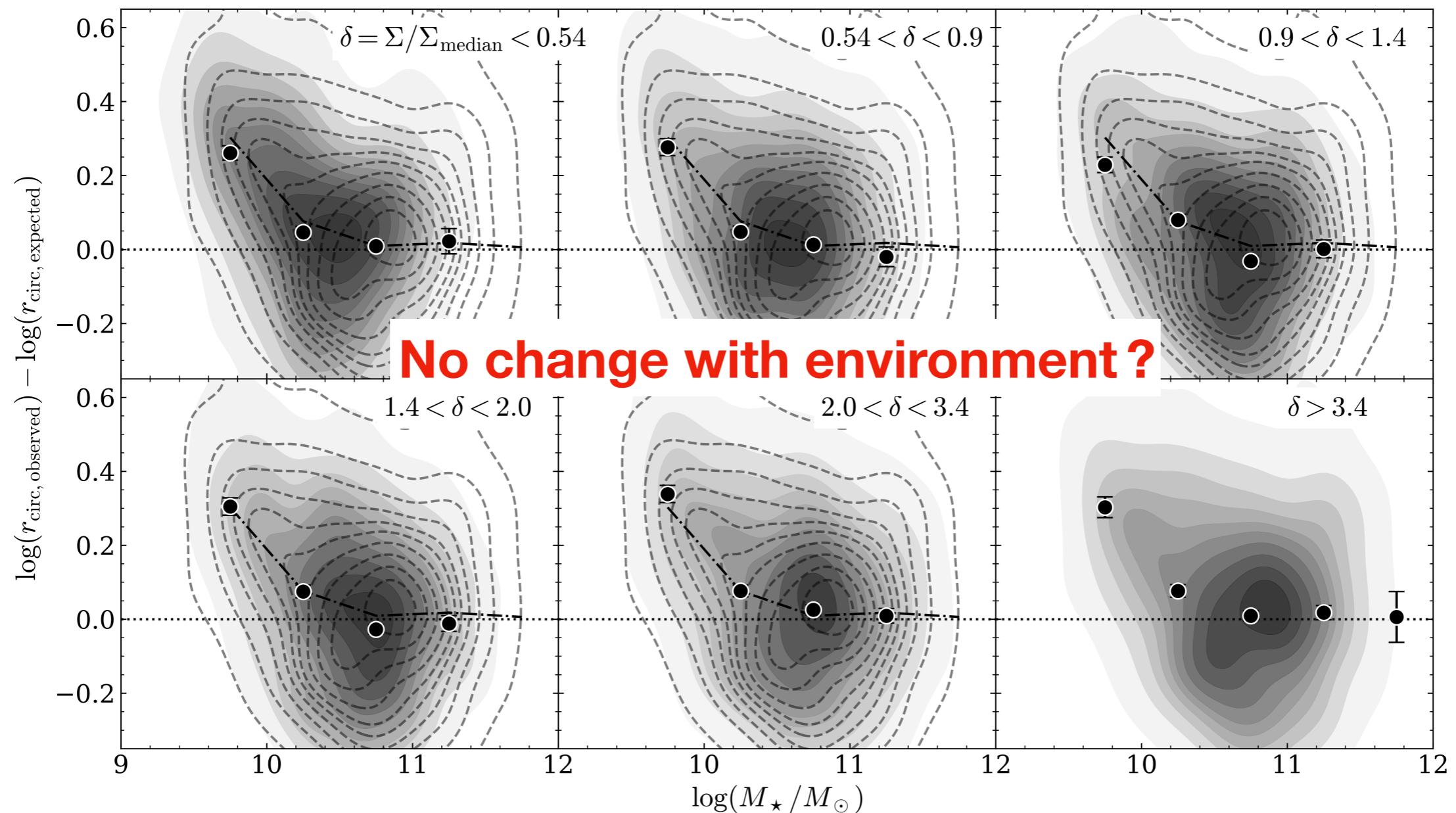
Environmental Dependence

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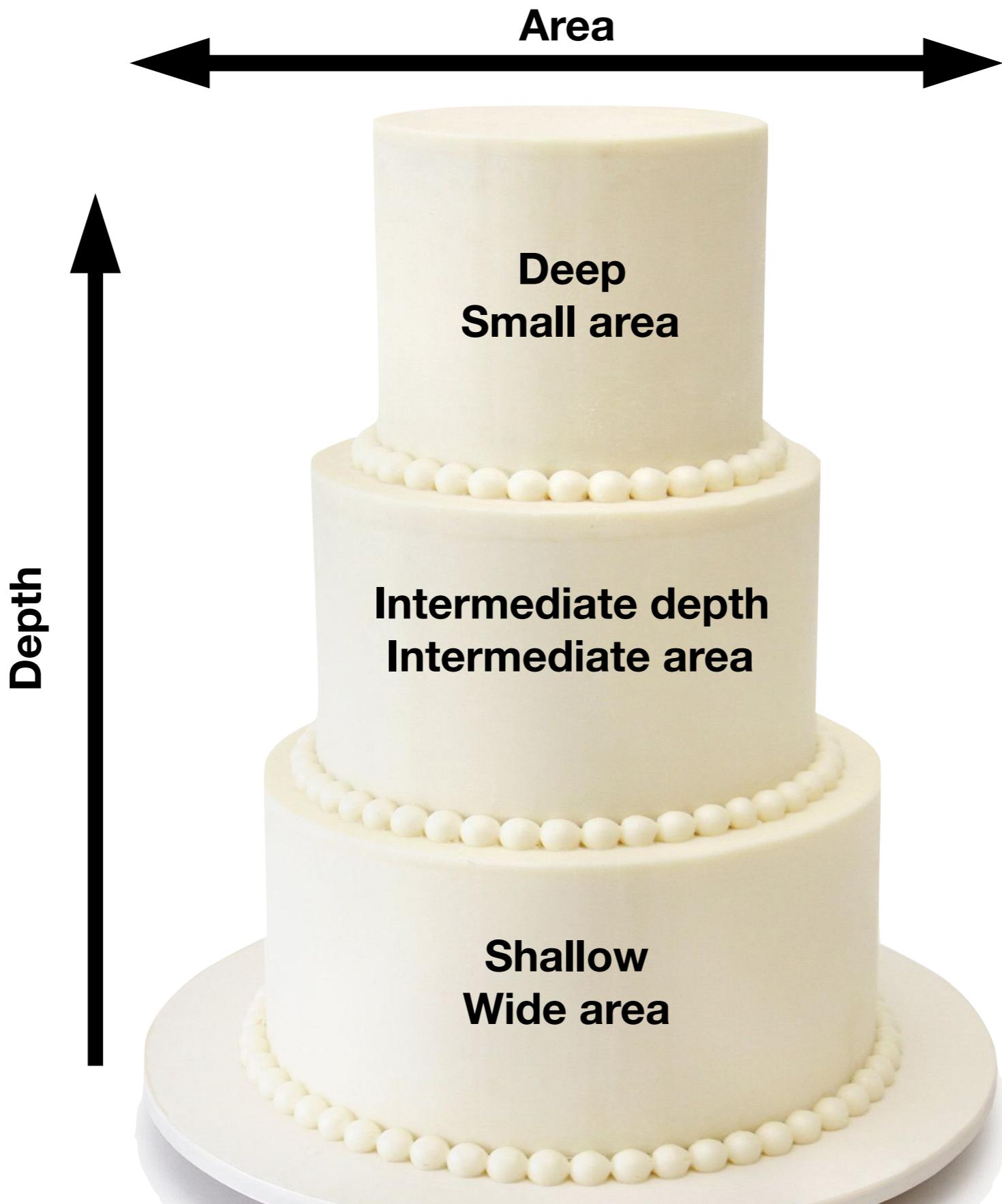


Environmental Dependence

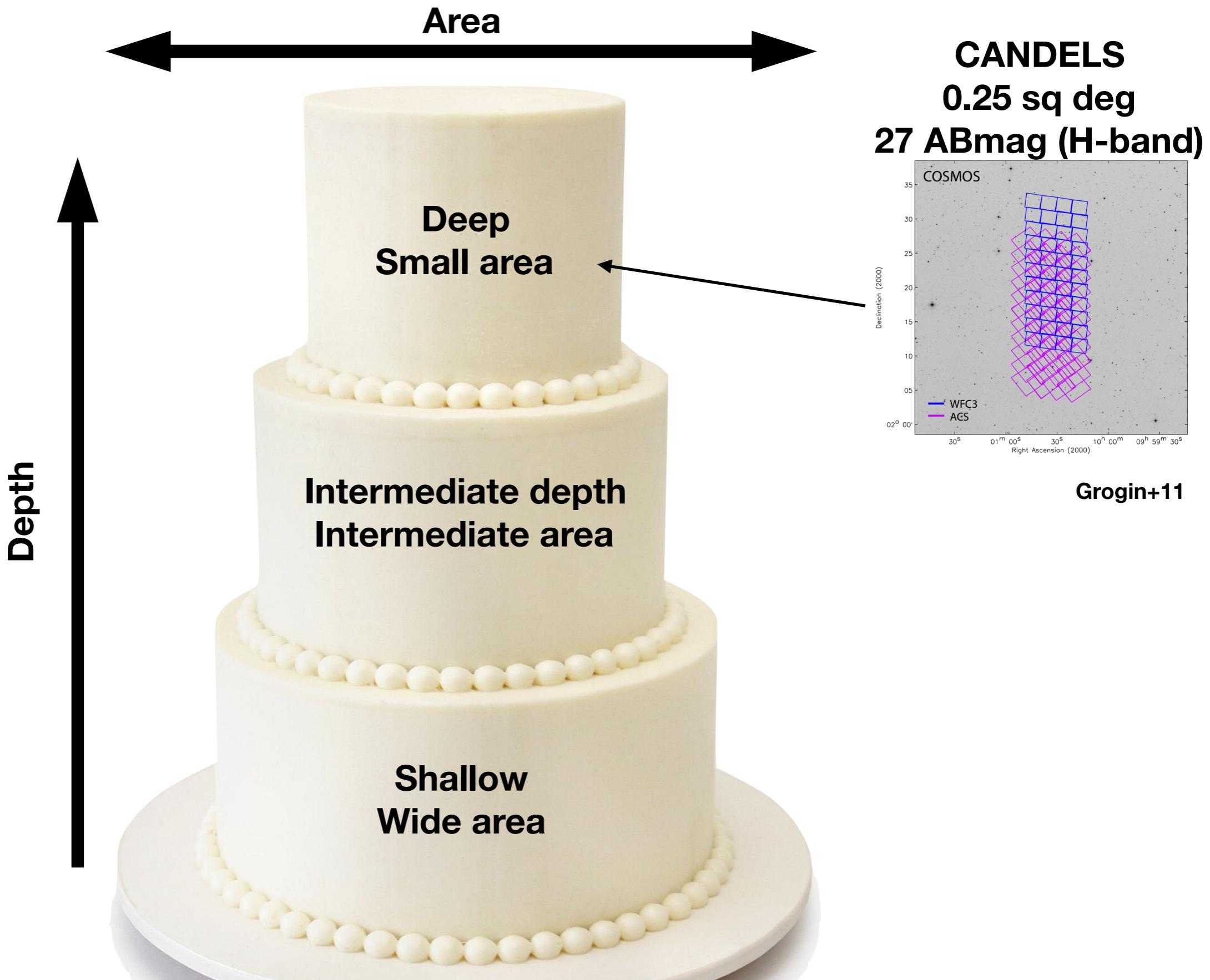
Cross match DASH to COSMOS galaxy field density catalog
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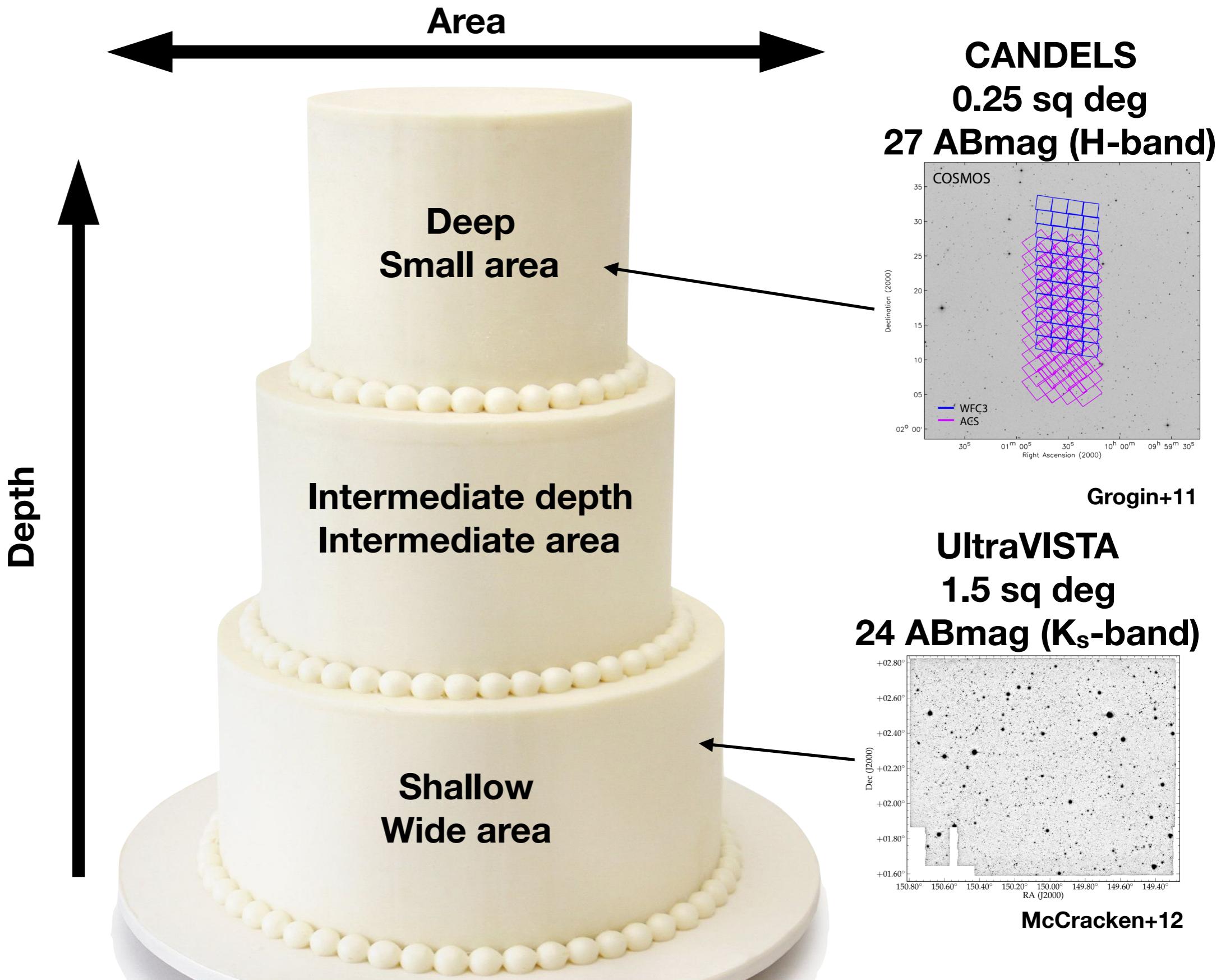
The “Wedding Cake” Approach

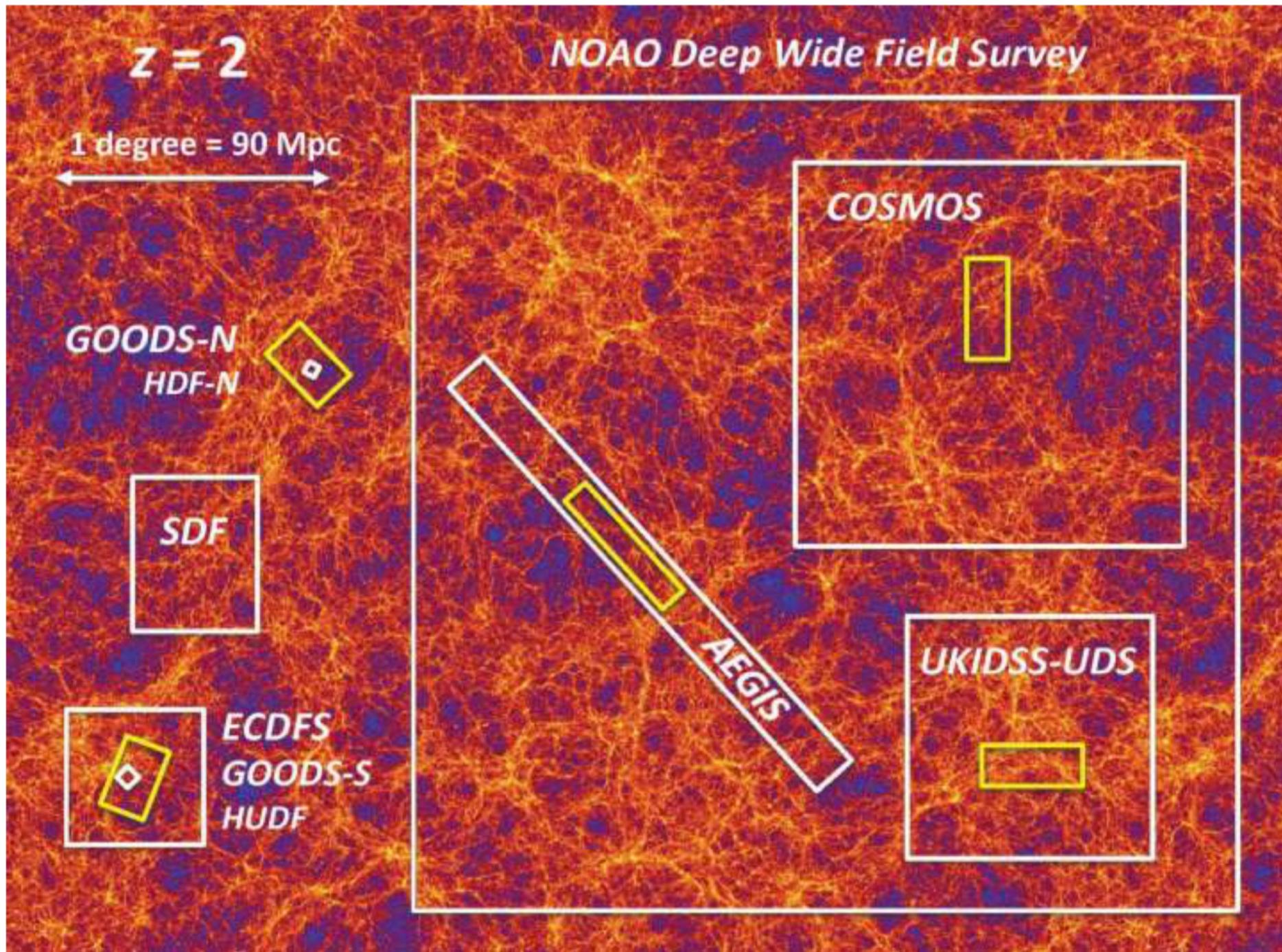


The “Wedding Cake” Approach

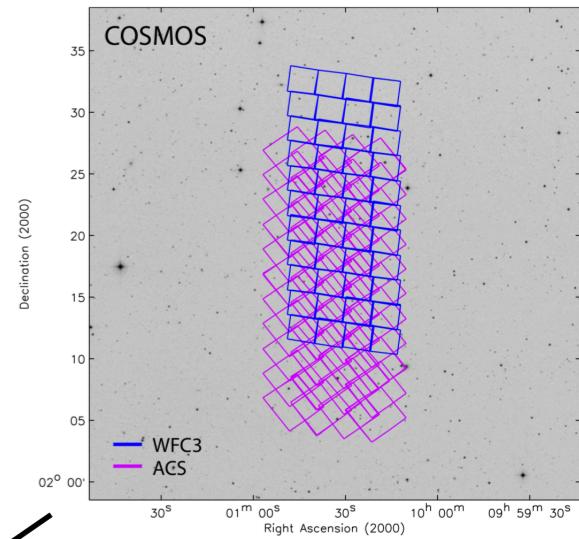
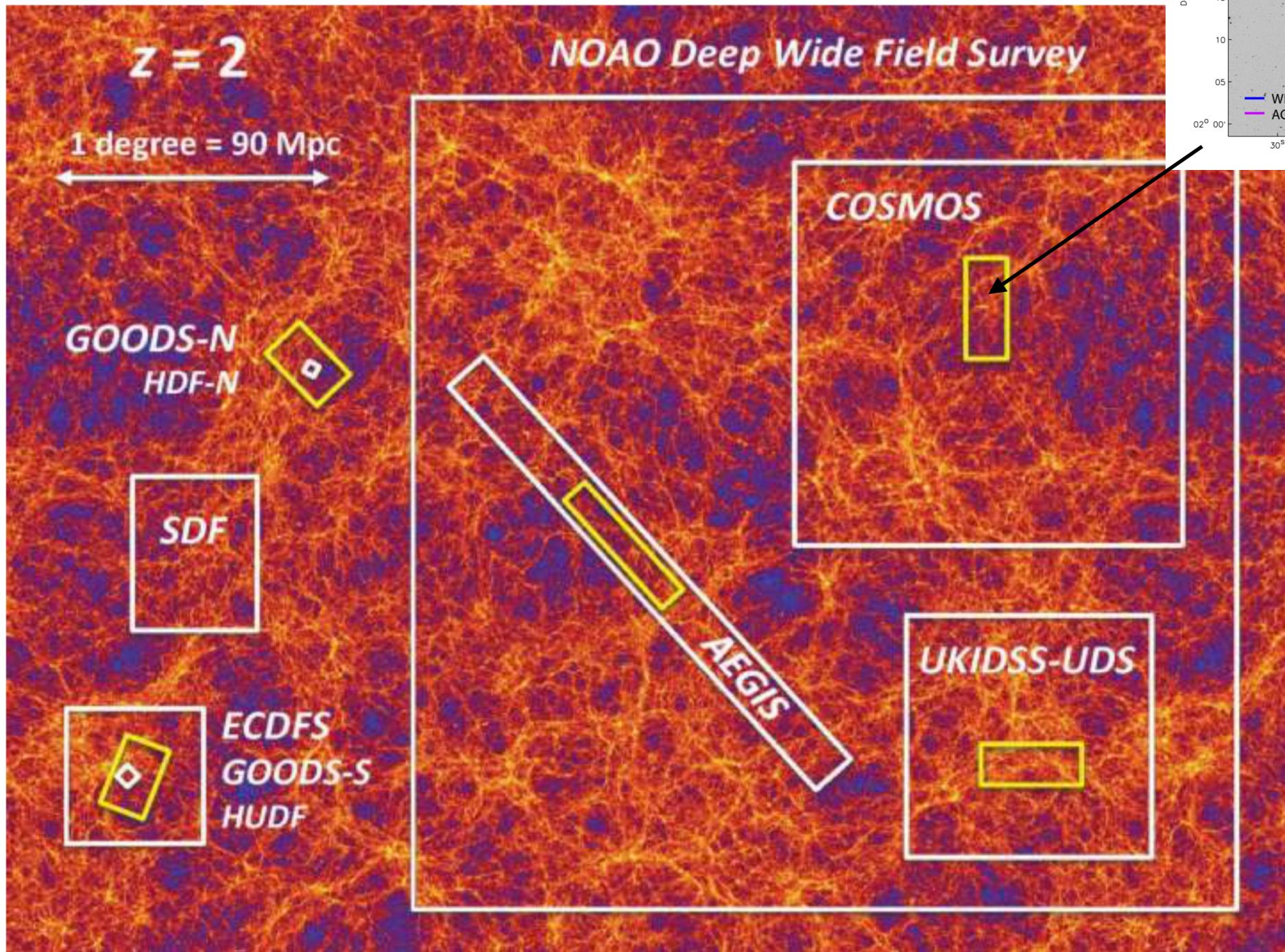


The “Wedding Cake” Approach



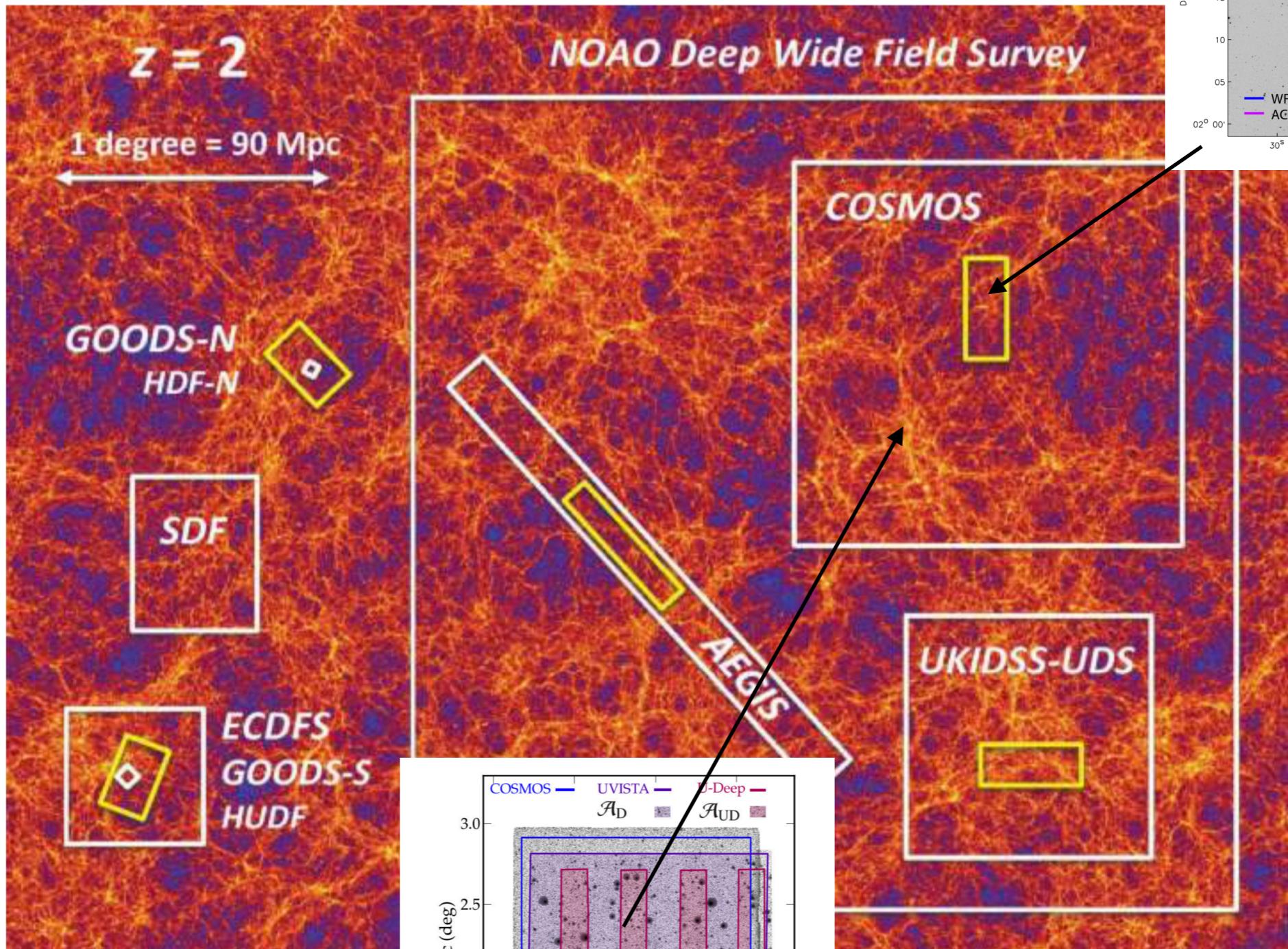


Madau & Dickinson 14



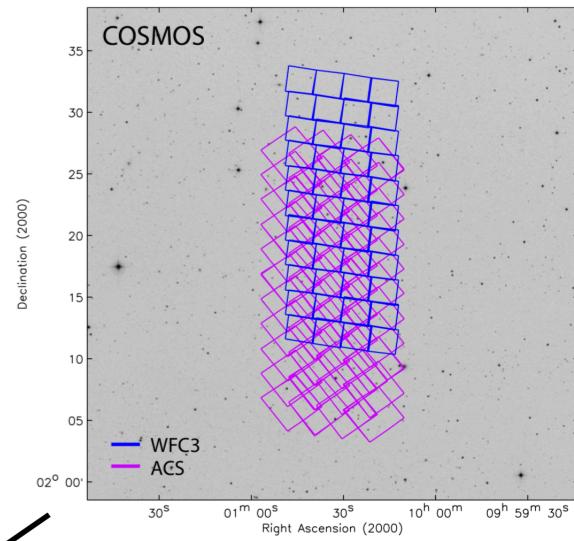
Grogin+11

Madau & Dickinson 14



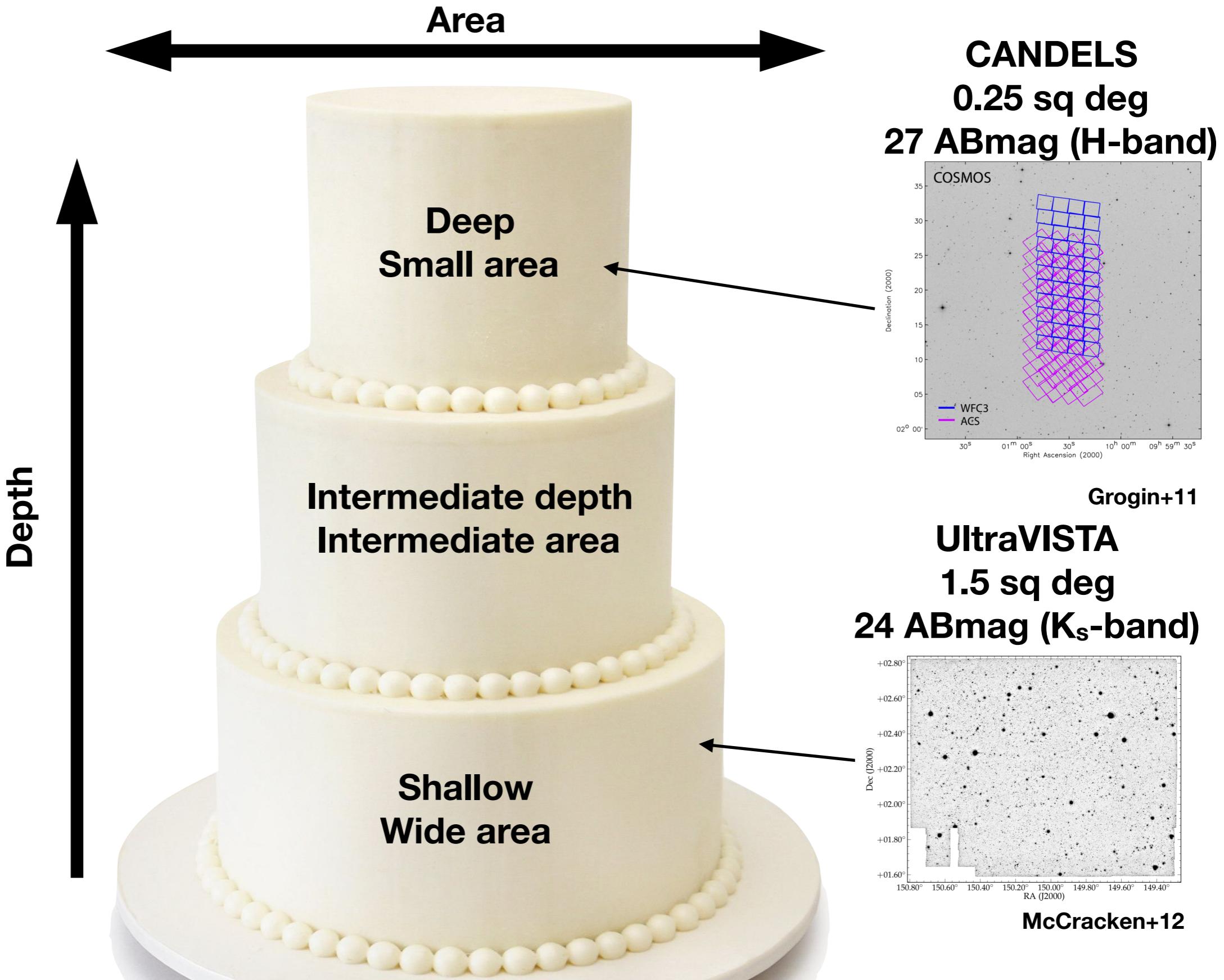
Madau & Dickinson 14

Davidzon+17



Grogin+11

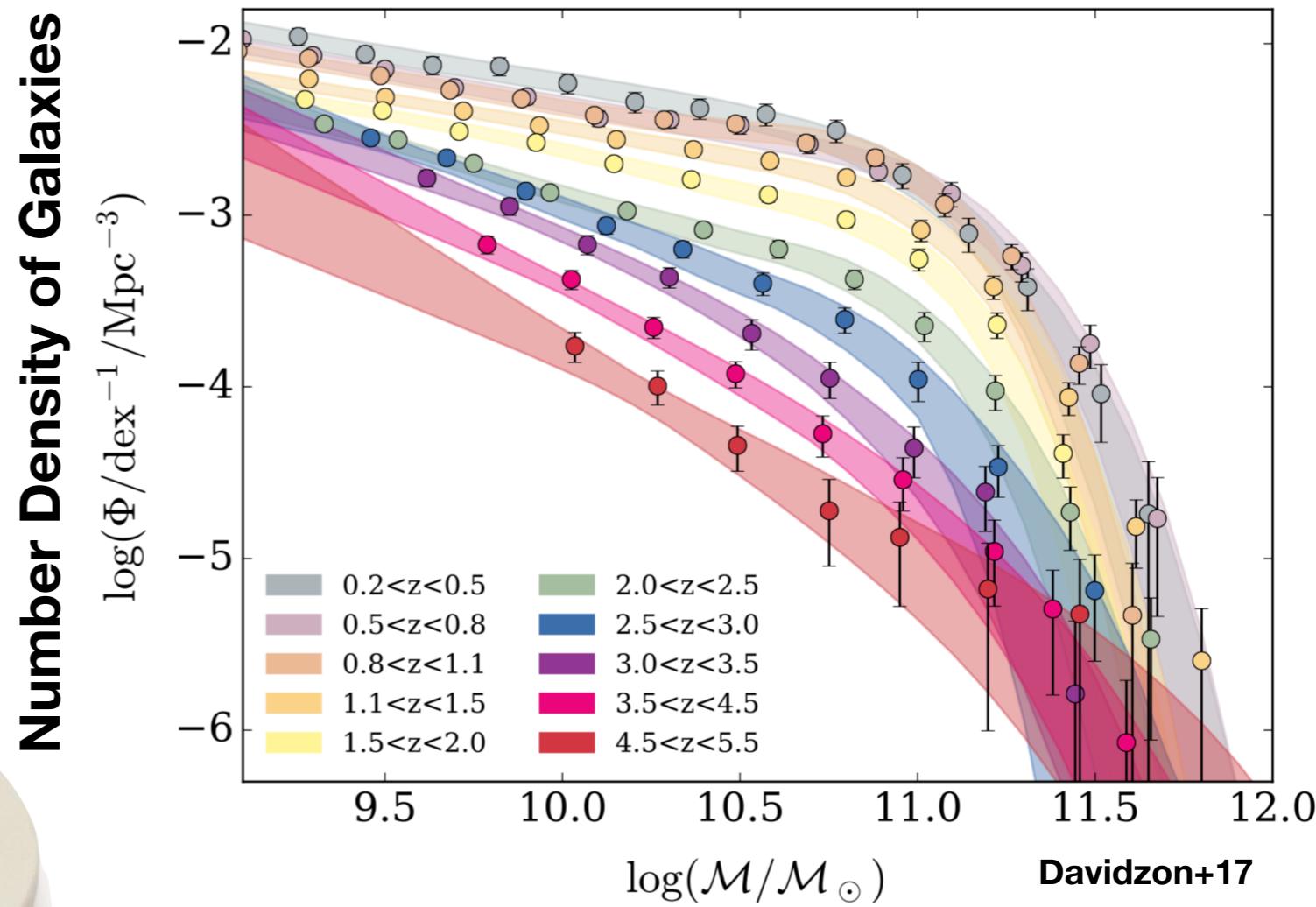
The “Wedding Cake” Approach



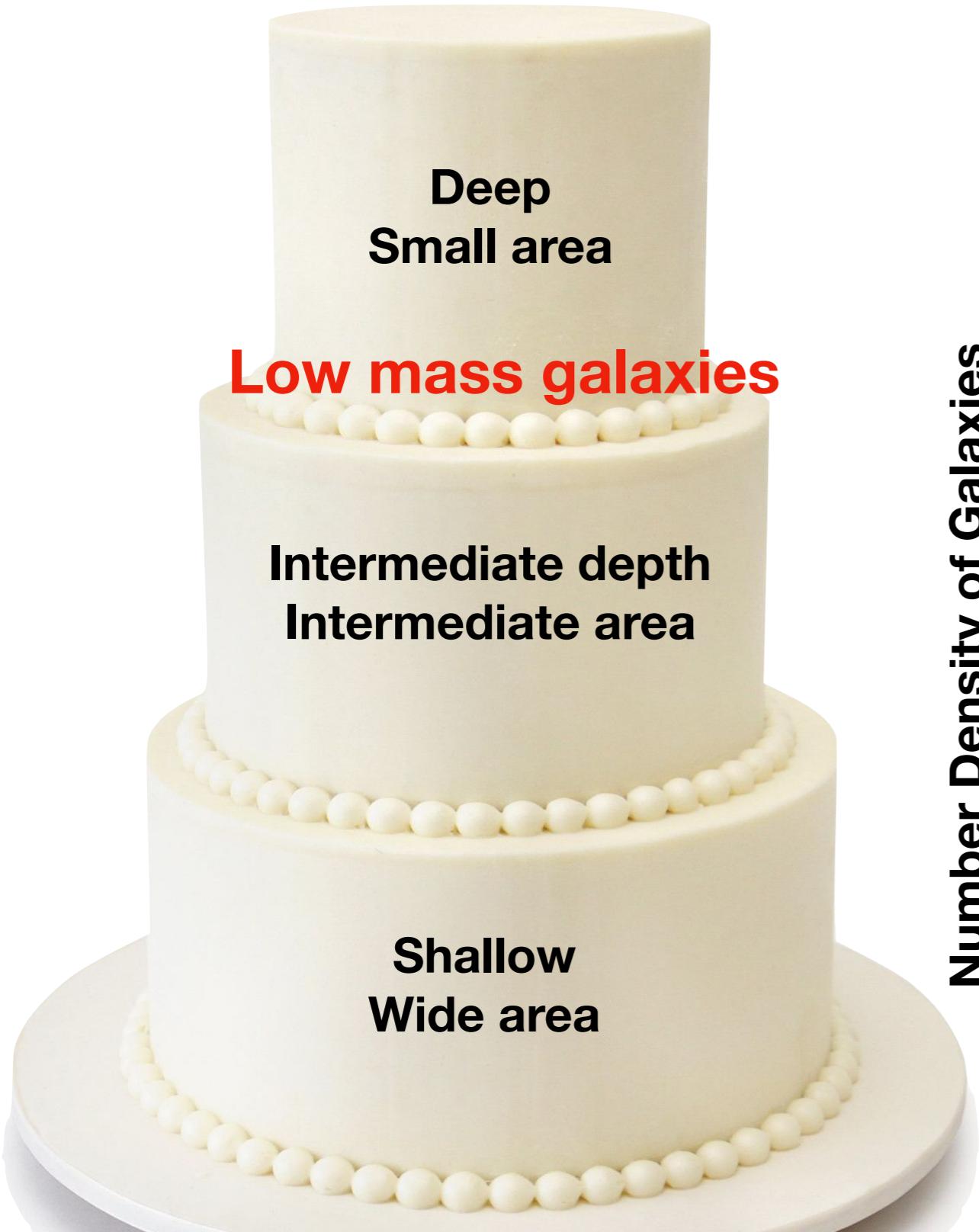
The “Wedding Cake” Approach



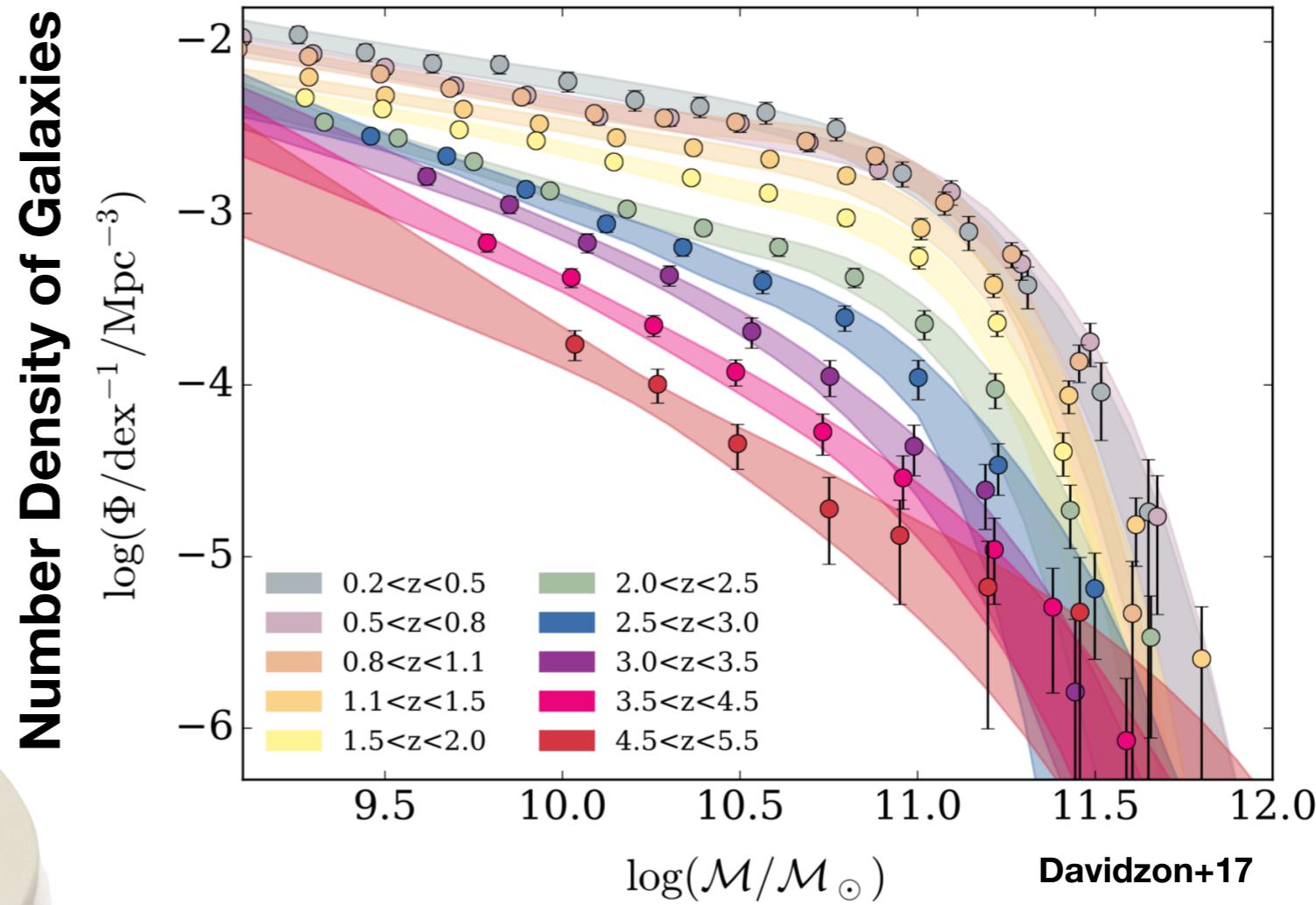
Shape of galaxy stellar mass function drives approach



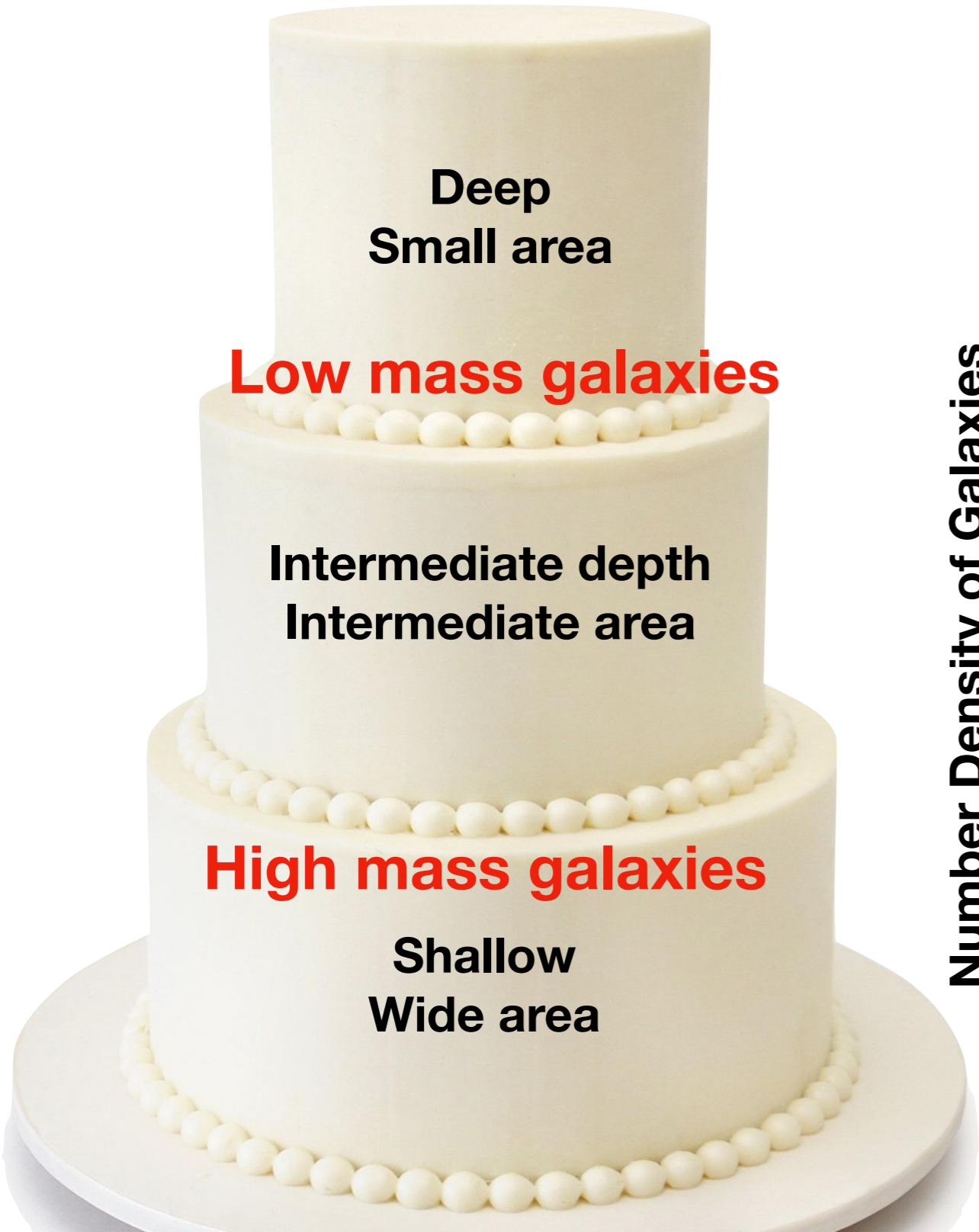
The “Wedding Cake” Approach



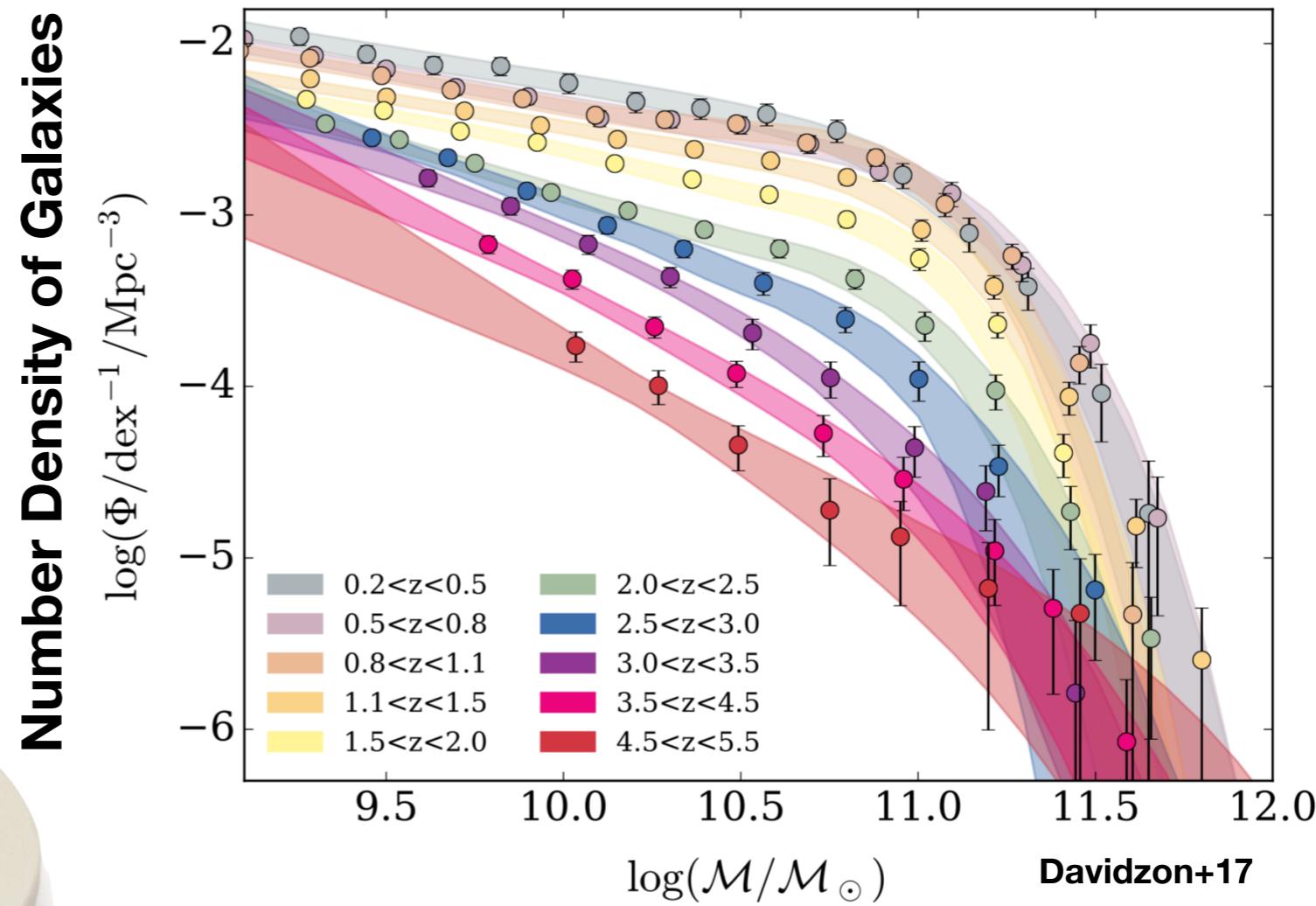
Shape of galaxy stellar mass function drives approach



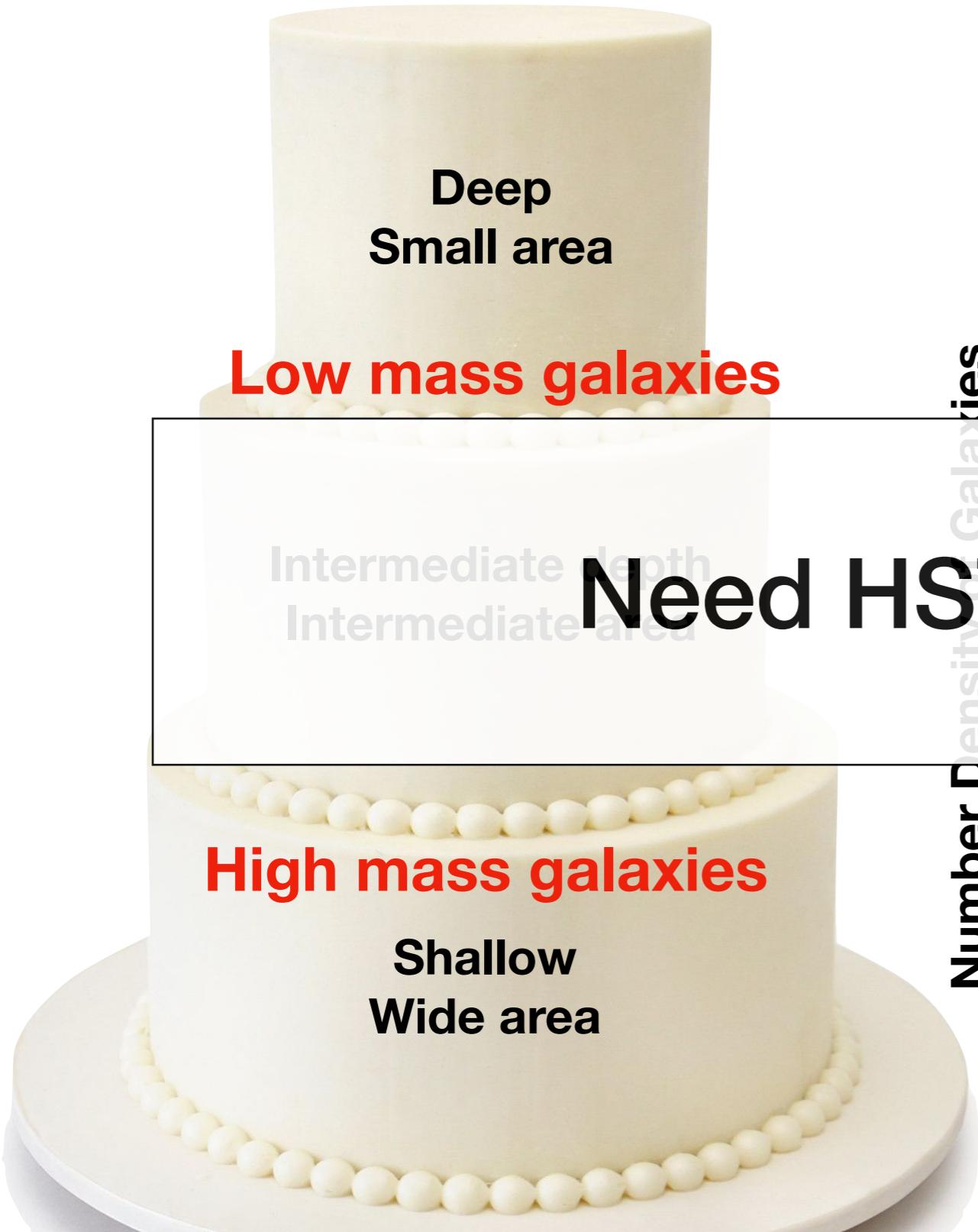
The “Wedding Cake” Approach



Shape of galaxy stellar mass function drives approach



The “Wedding Cake” Approach



Shape of galaxy stellar mass function drives approach

