Euclid photo-z measurements

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Heisenberg-Programm

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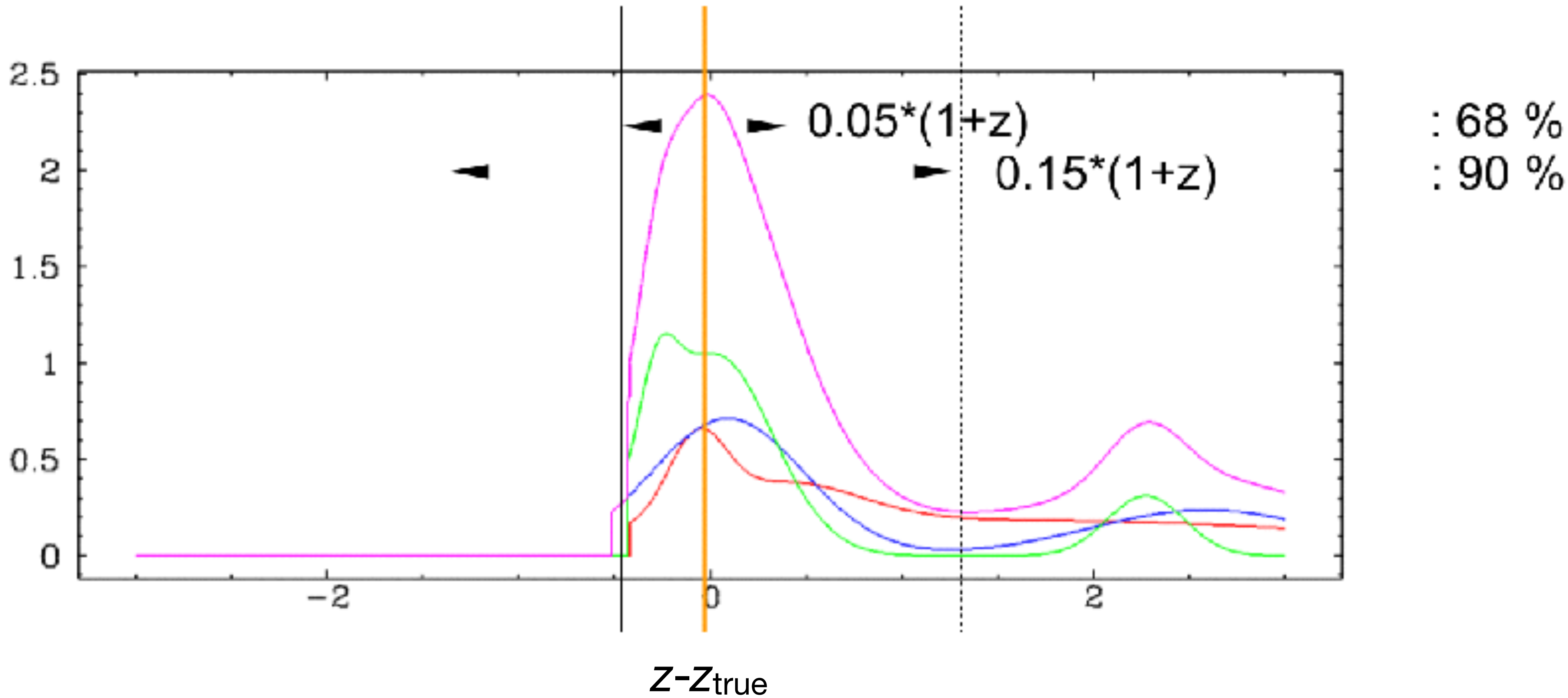
R-GDP-DL3-072

- The shape of the stacked PDF for each sub-set of galaxies in the range $0.2 < z < 2.0$ (TBD) used in the weak lensing analysis shall be such that: In each subset (bin) used for the weak-lensing analysis, the average of the true-z subtracted PDF (PDF(z-z_{true})) shall meet the following cumulative probability requirements:

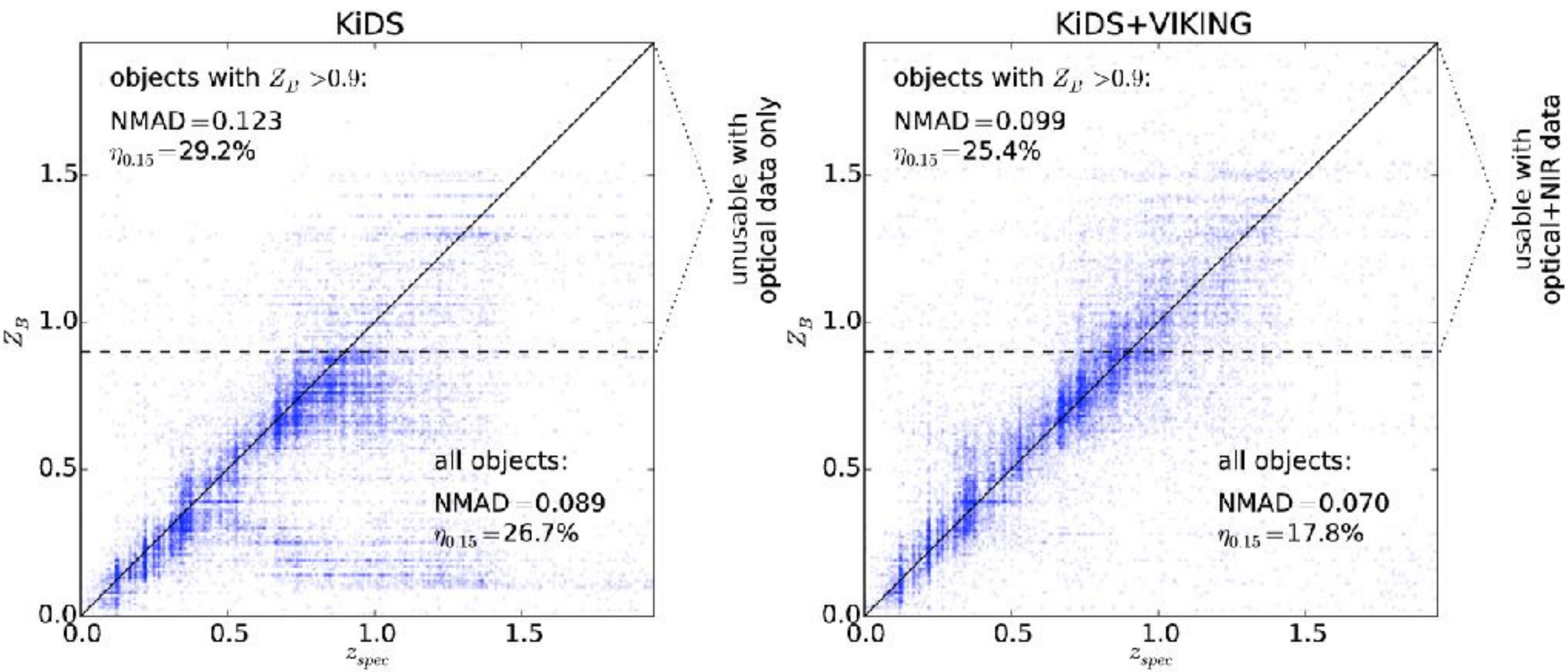
Within $\lvert z-z_{true}\rvert / (1+z)$	Fraction of probability
0.05	68 %
0.15	90 %

R-GDP-DL3-072



Credit: Jean Coupon

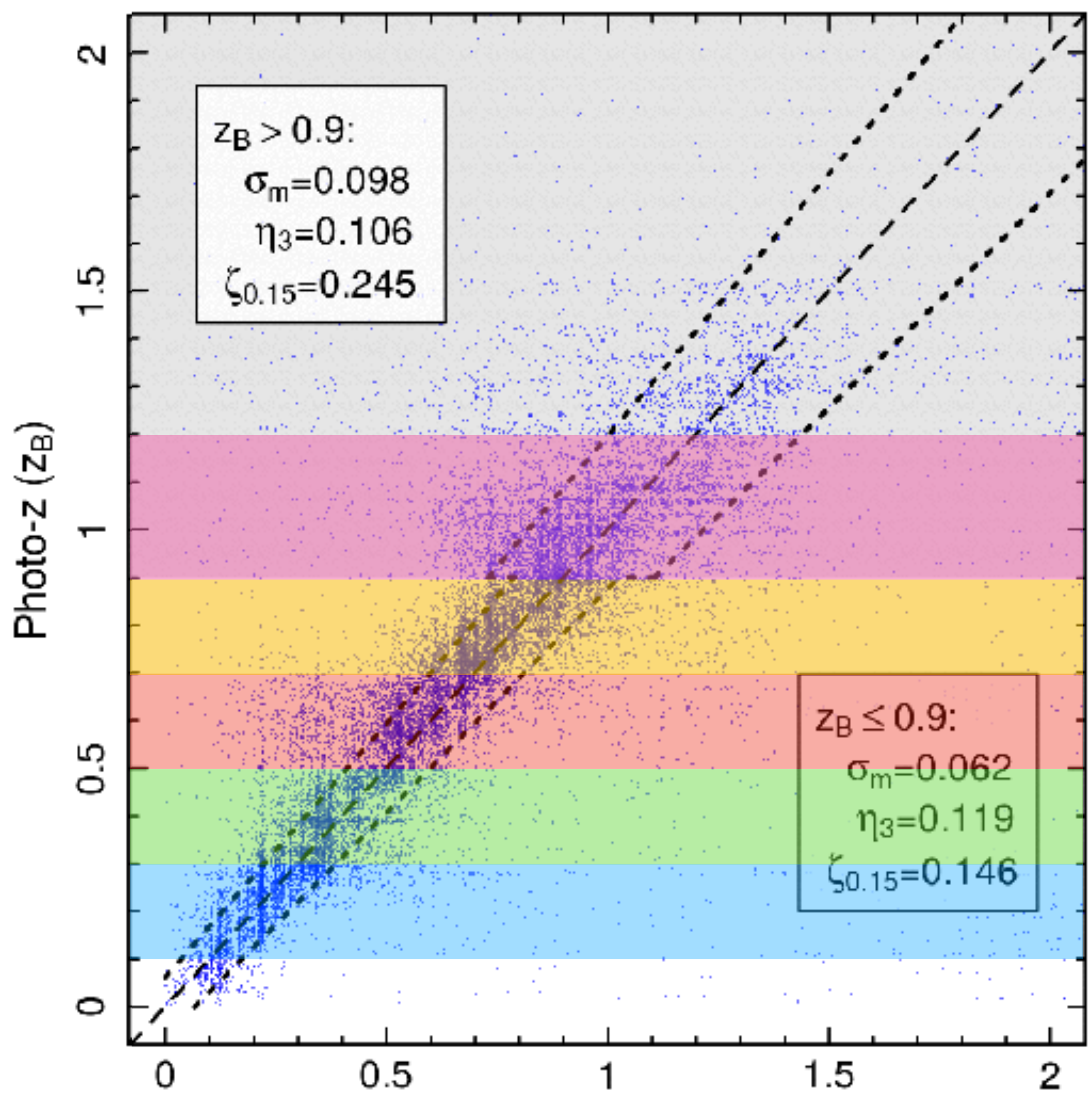
Benefits of NIR



- **Smaller S_8 error due to high-*z* galaxies.**
- **More robust redshifts -> better calibration.**

Wright et al. (2018)

Photometric redshifts



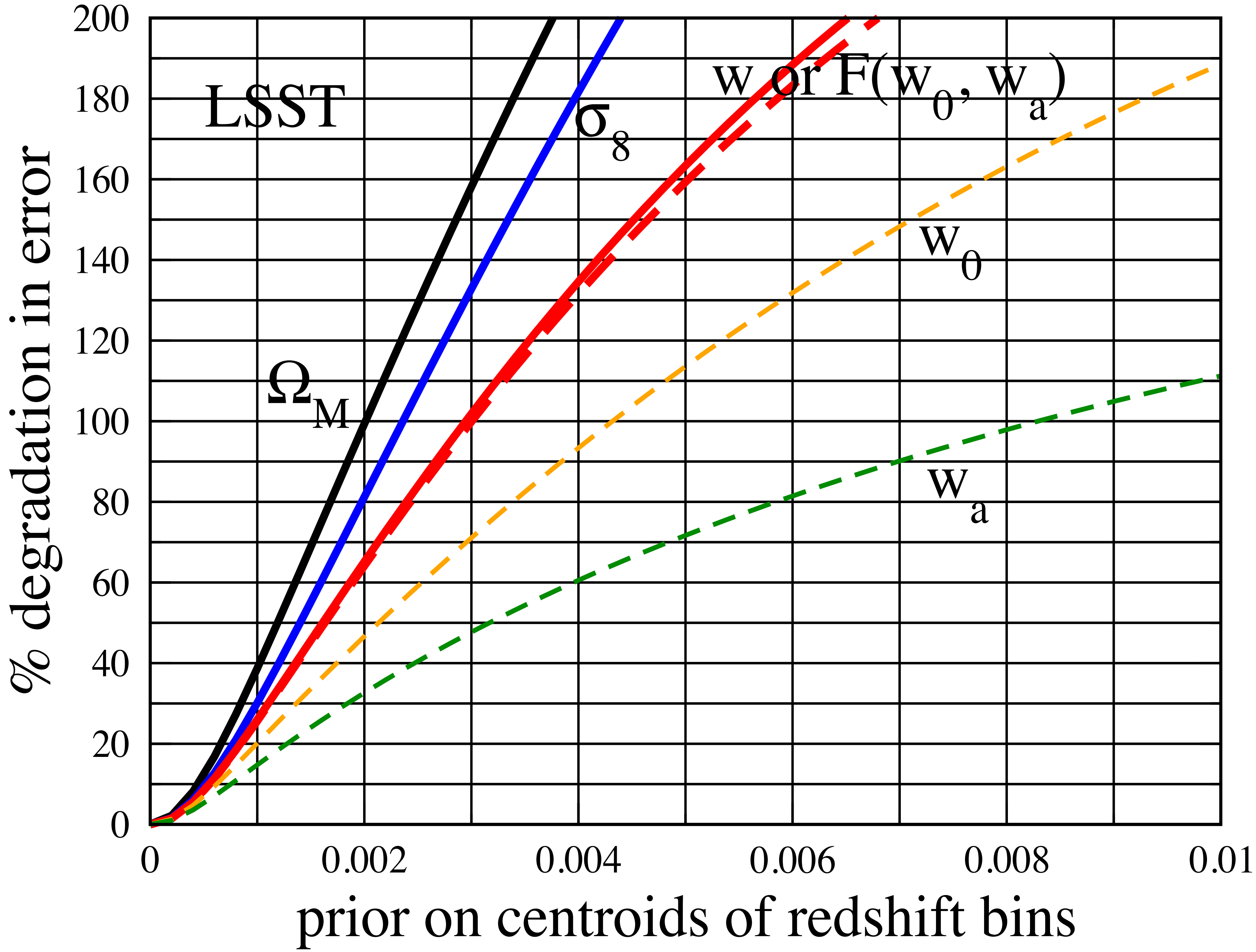
Wright et al. (2018)

Redshift dependence of cosmic shear

$$\langle\gamma^2\rangle \propto \sigma_8^2 \; z_s^{1.7} \; \Omega_m^{1.7} \; \theta^{\left(\frac{n-1}{2}\right)}$$

van Waerbeke et al. (2006)

Redshift dependence of cosmic shear



Huterer et al. (2005)

R-GDP-DL3-073

- The Ground Data Processing shall create subsets of galaxies (TBD) used in the weak lensing analysis, such that each subset has a redshift distribution $n(z)$ with a with a "weak lensing weight"-weighted mean value known to a accuracy of $< 0.002*(1+z)$.
- **This requirement is about the uncertainty of the bias not the bias itself!**

Euclid redshift calibration plan

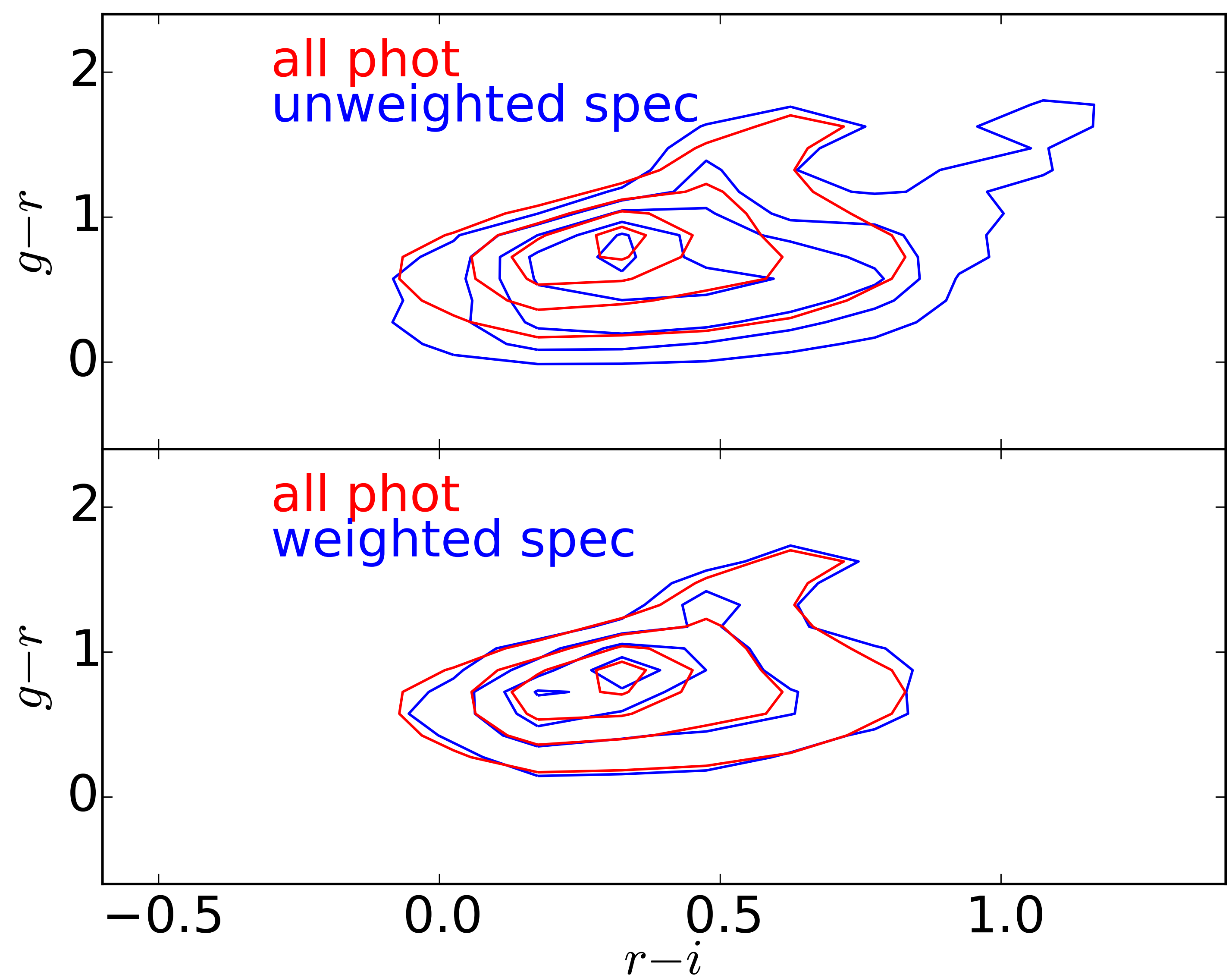
1. Direct calibration as fiducial method
    - Re-weight deep spec-z calibration sample (kNN, SOM).
    - Estimate redshift distributions from weighted spec-z.
2. Clustering-z for validation
    - Exploit cross-correlation of sources and objects with spec-z.
    - Independent large area spec-z reference sample.

Redundant only if both have similar precision and accuracy!

Most of this information will come from ground-based data!

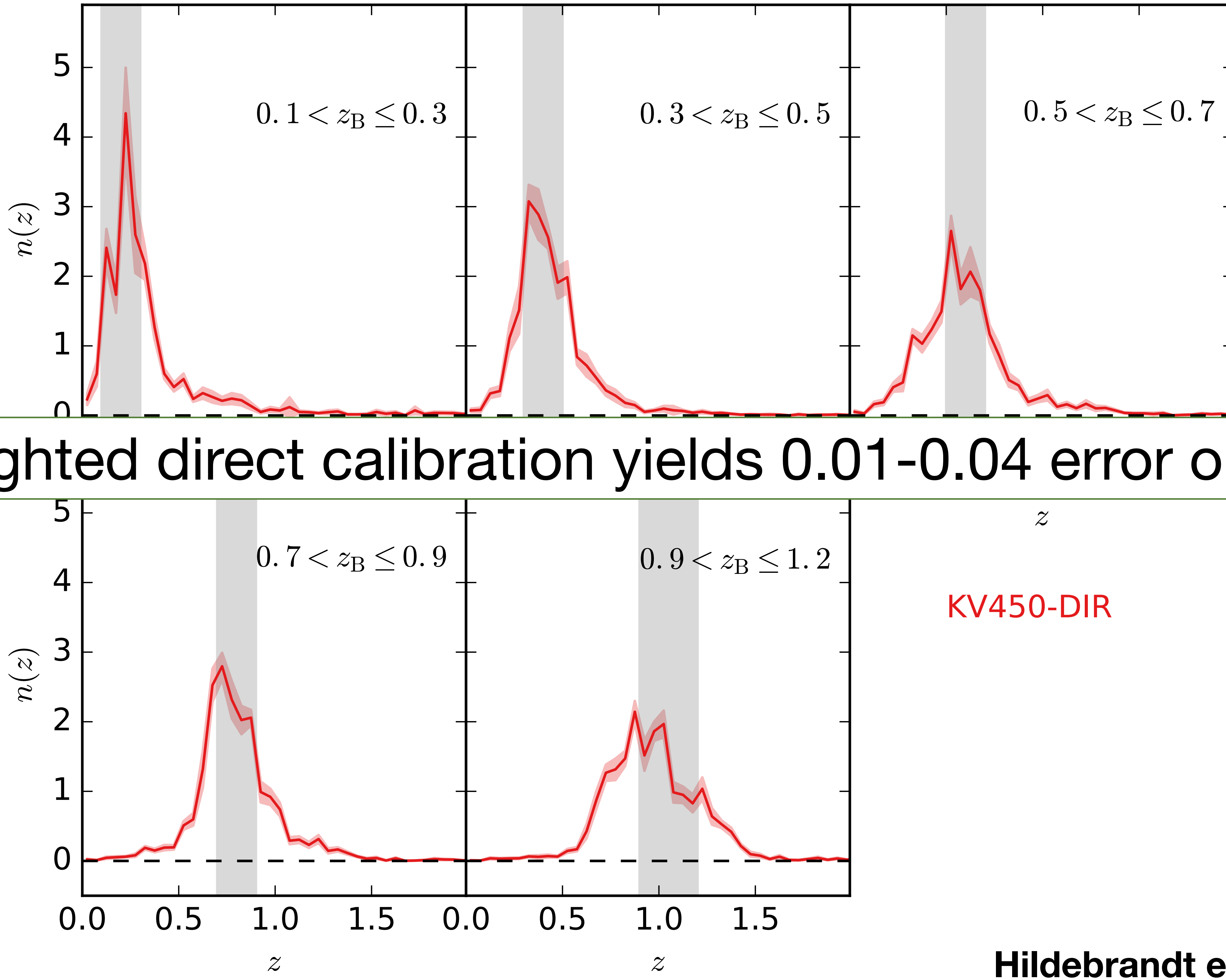
Direct photo-z calibration

- Re-weight spec-z surveys to be more representative (Lima et al. 2008)
- Only works if:
  - Magnitude space is fully covered (*r*<~24; C3R2).
  - Unique relation between magnitudes and redshifts (VIKING).



Hildebrandt et al. (2017)

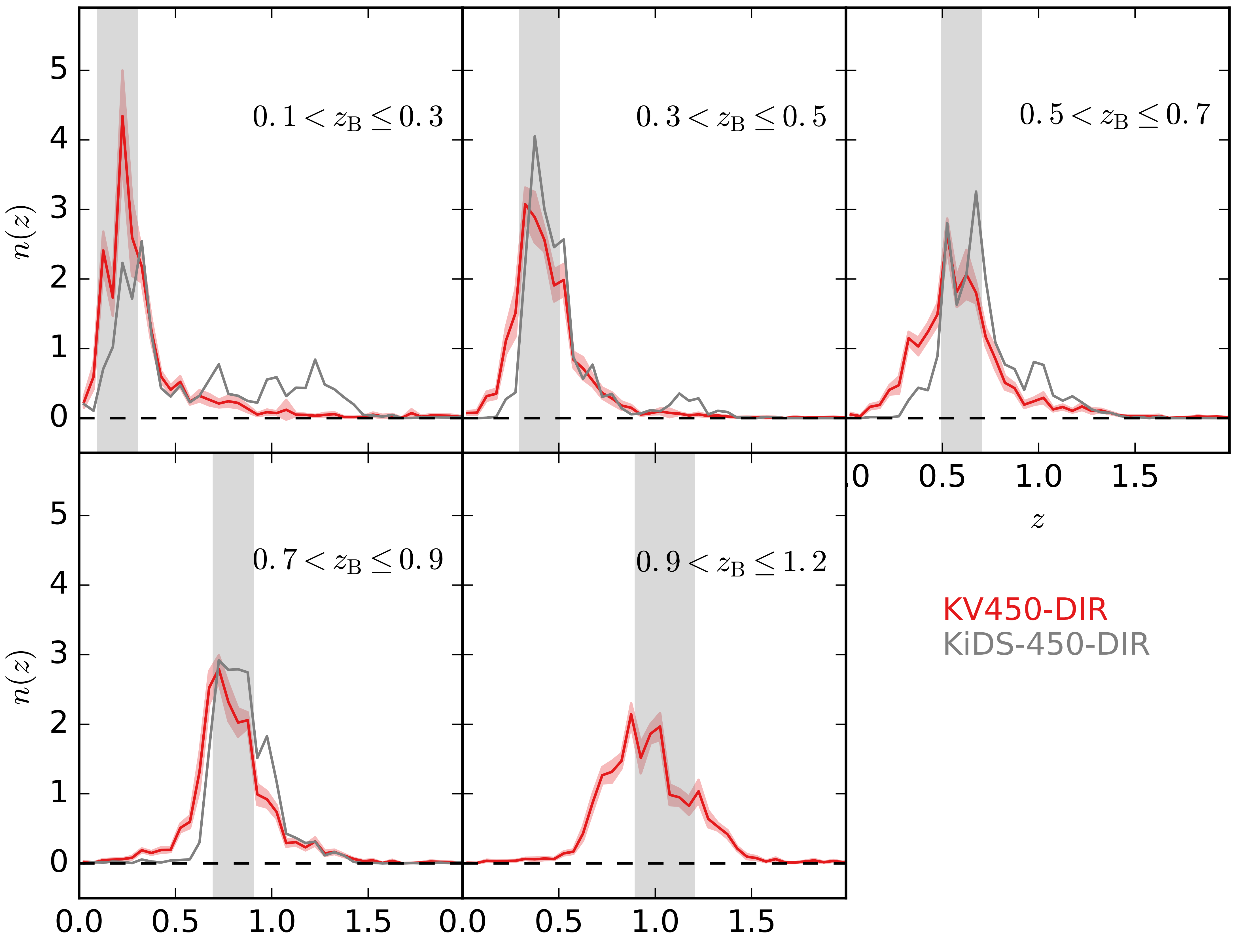
KV450 - *n(z)*



Weighted direct calibration yields 0.01-0.04 error on <z>.

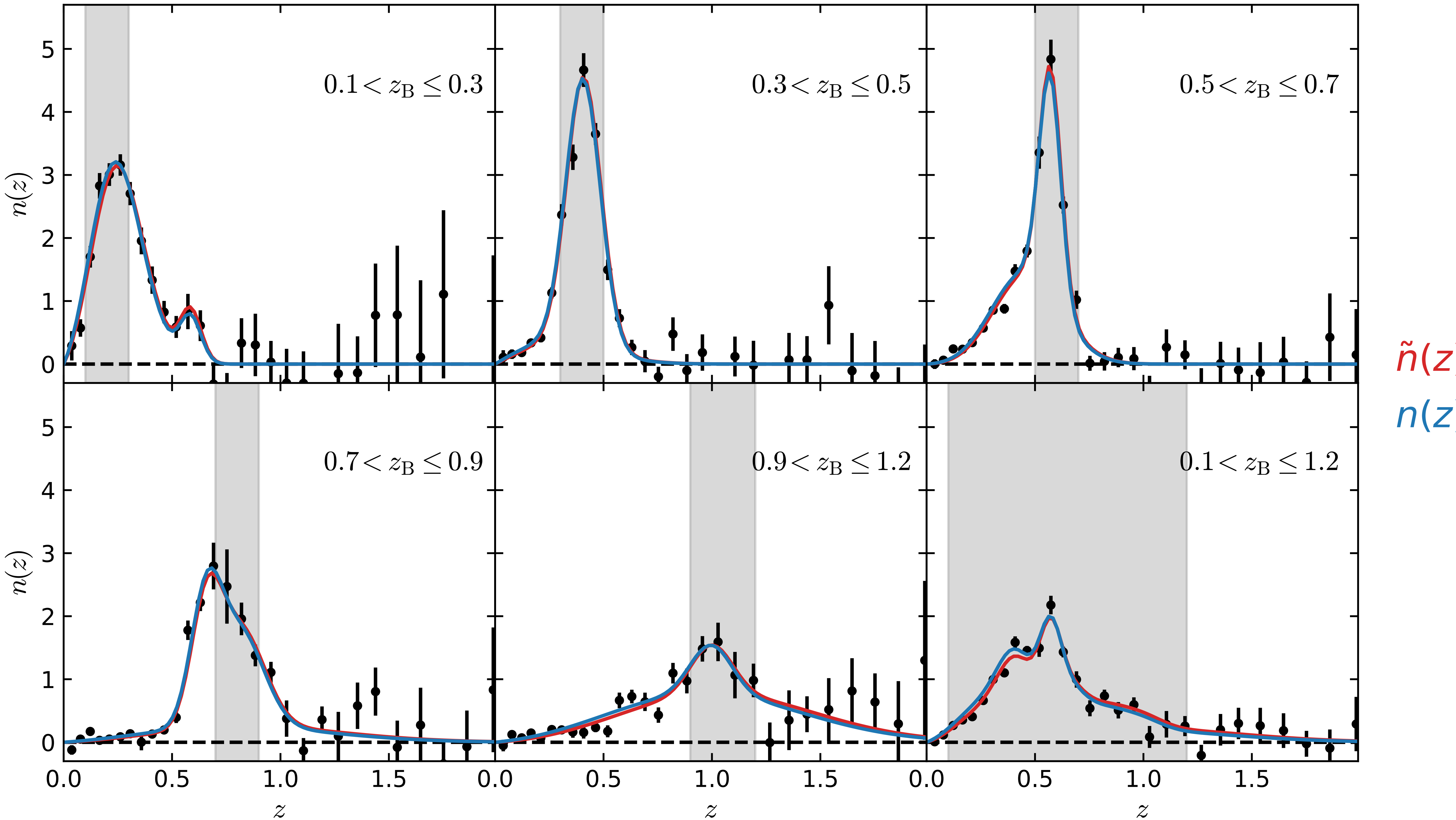
Hildebrandt et al. (2018)

KV450 - $n(z)$



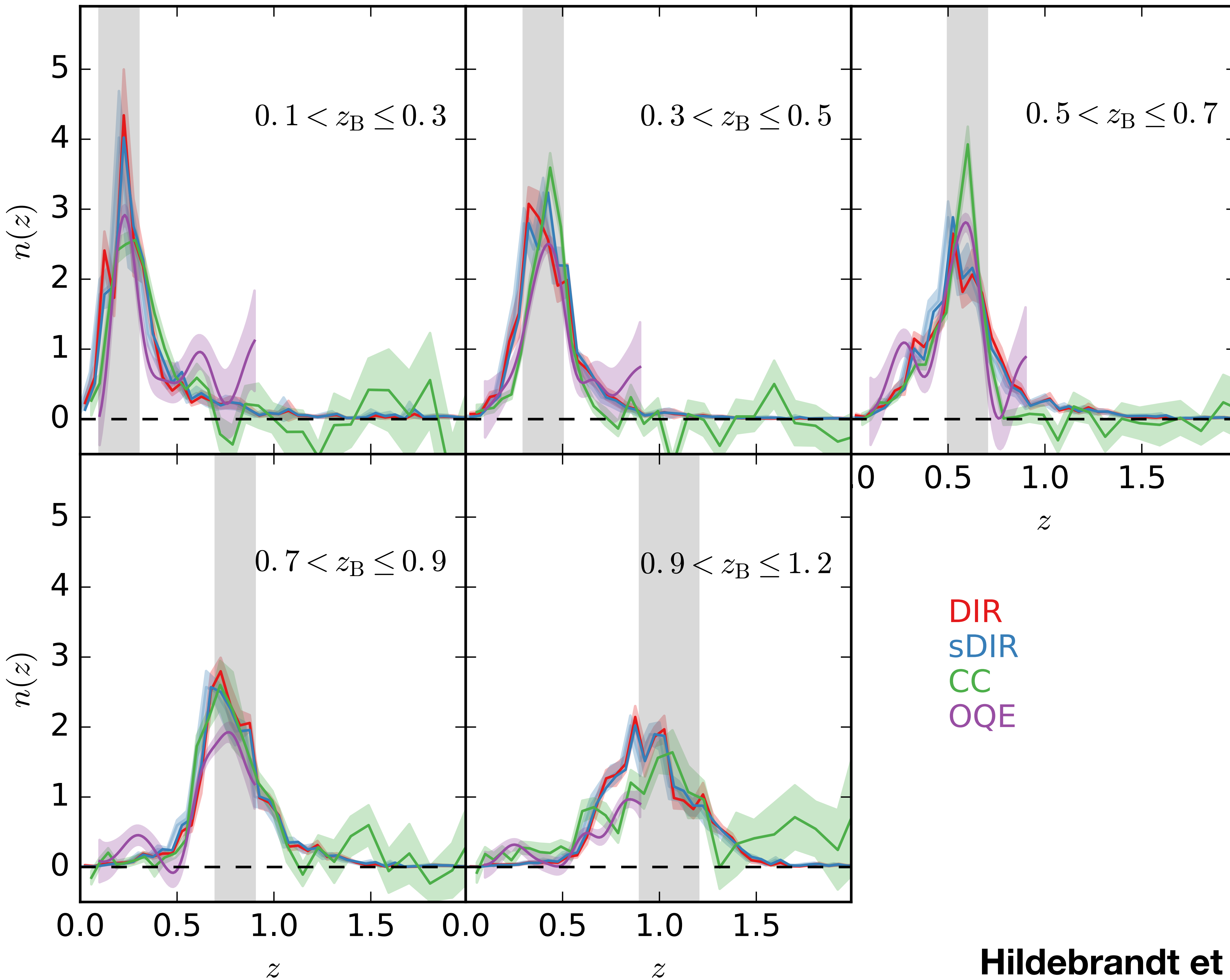
Hildebrandt et al. (2018)

KV450 clustering-z



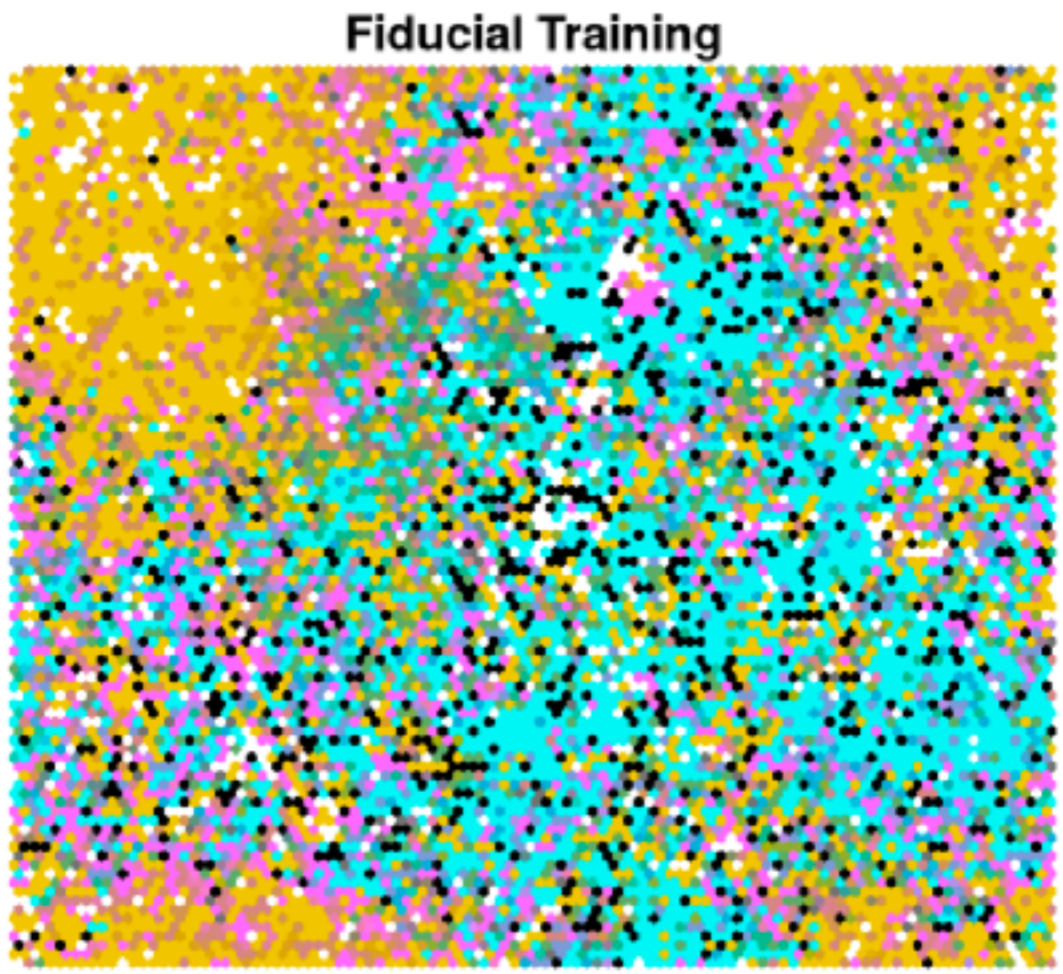
Hildebrandt et al. (2018)

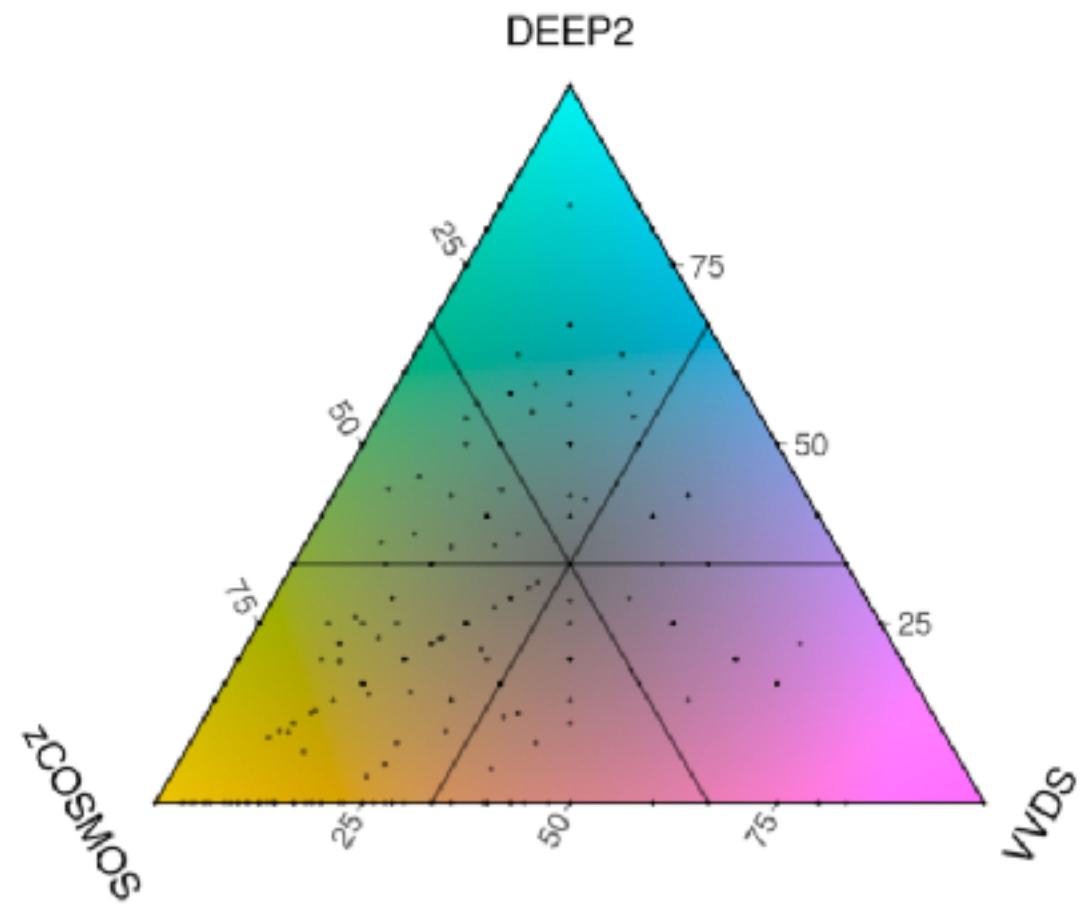
KV450 $n(z)$ consistency

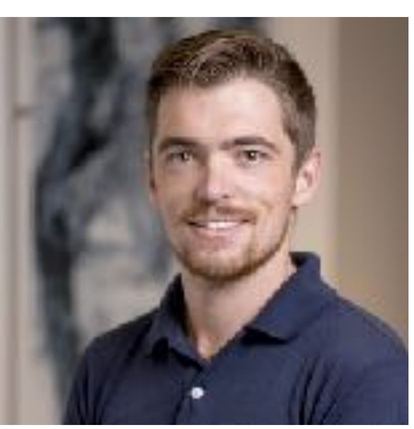


Hildebrandt et al. (2018)

Self-organising map



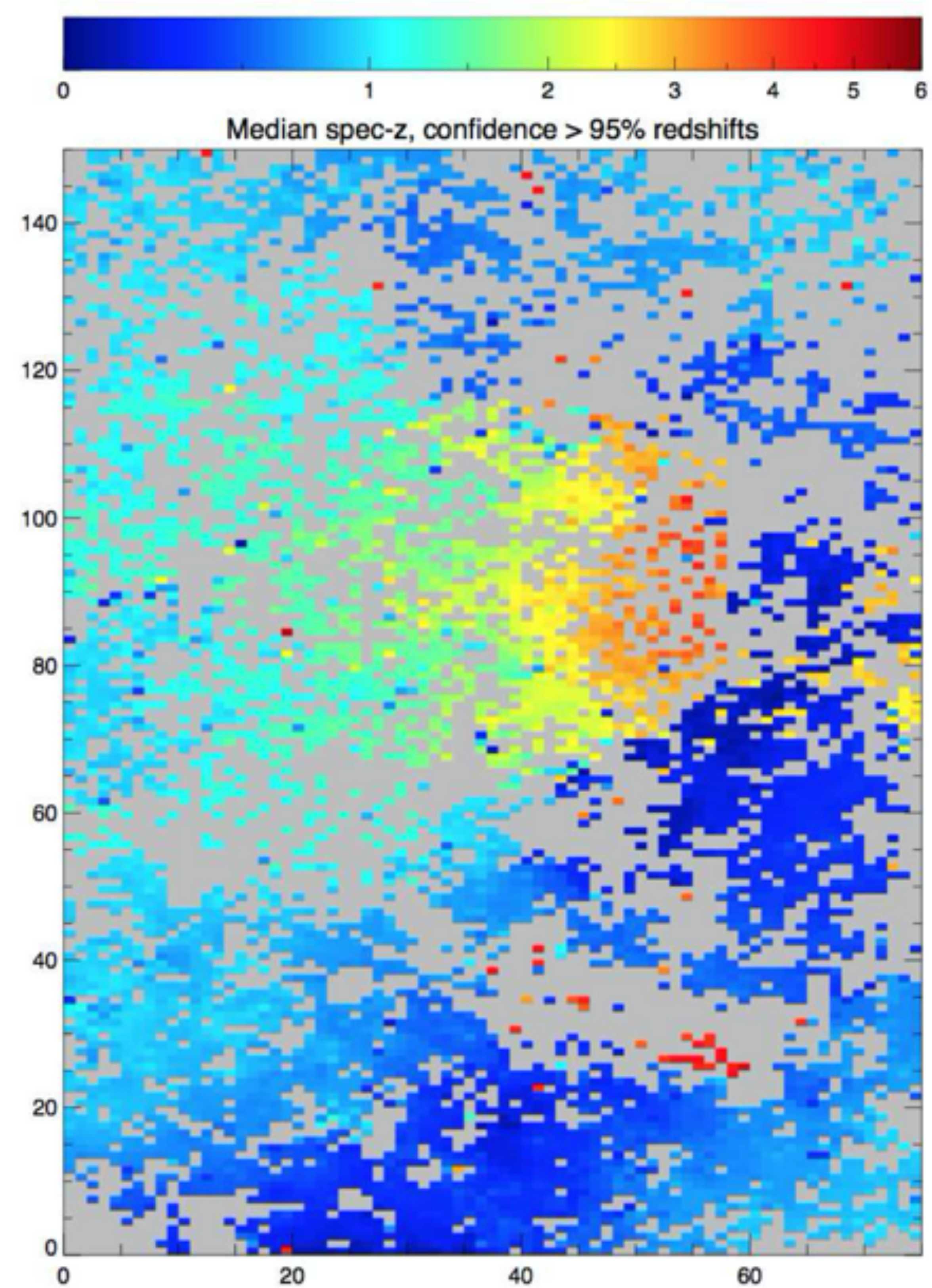




~99% coverage of 9D mag space in KV450.

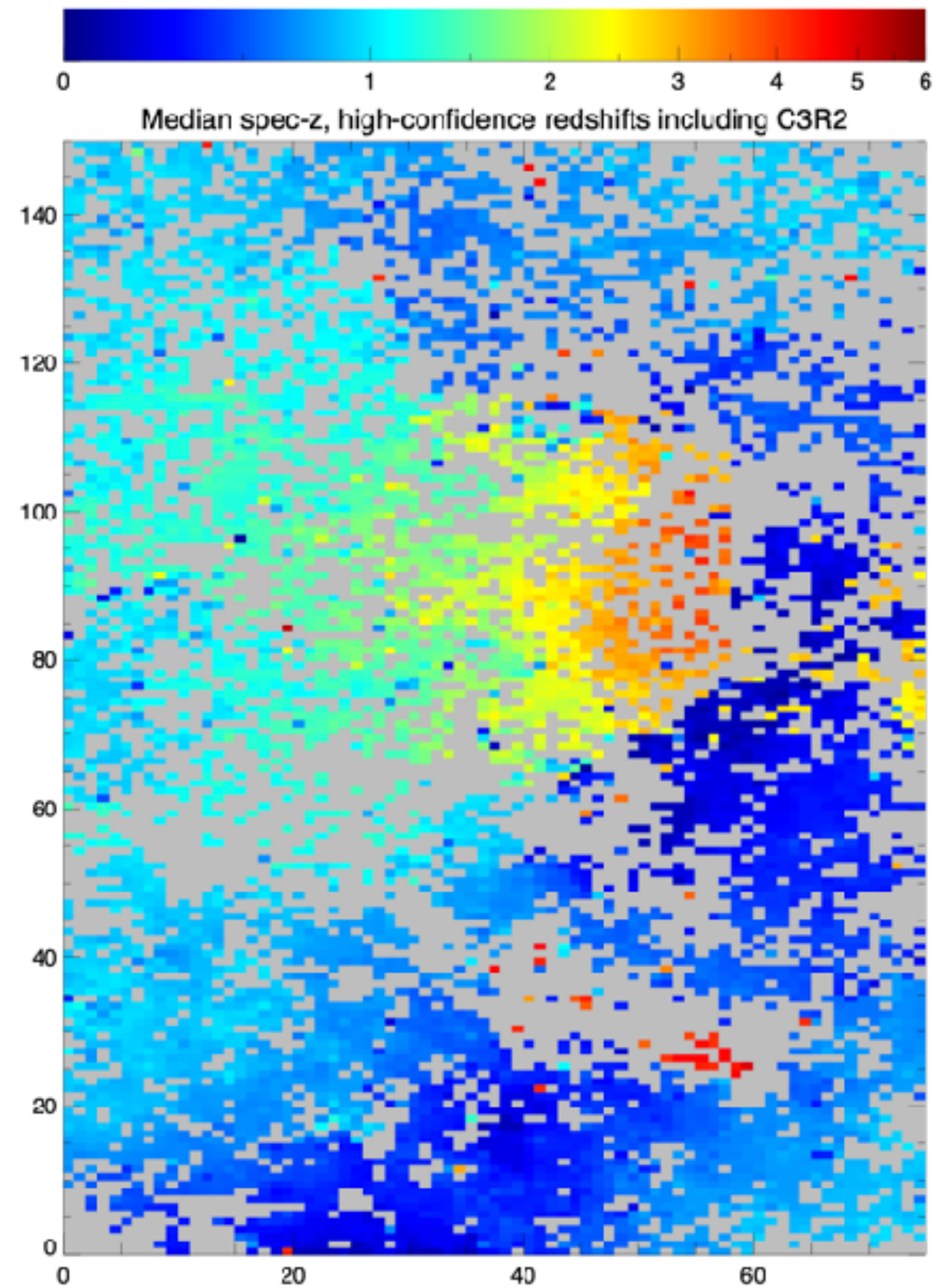
Wright et al. in (2019)

SOM for Euclid



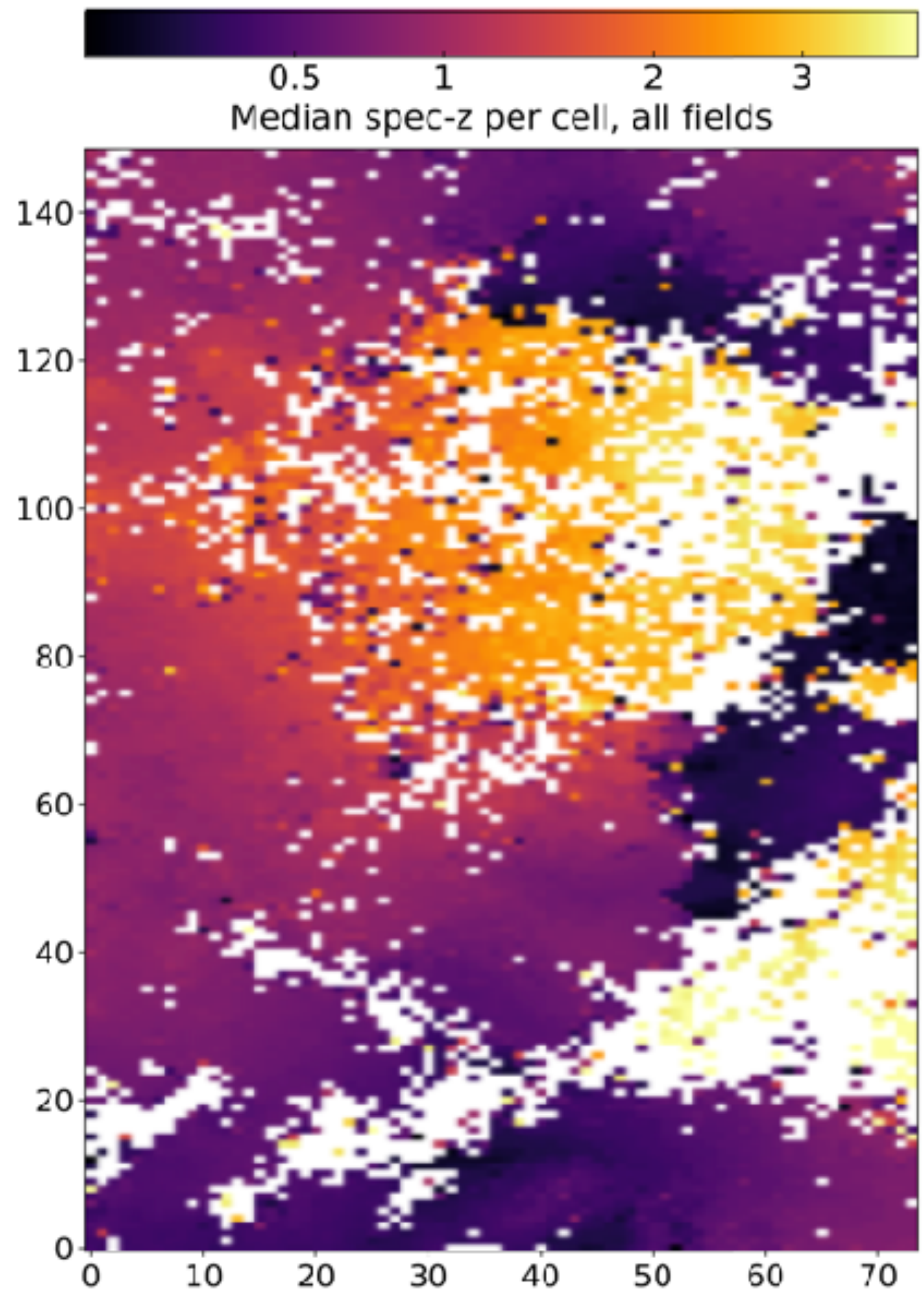
Masters et al. (2015)

SOM for Euclid



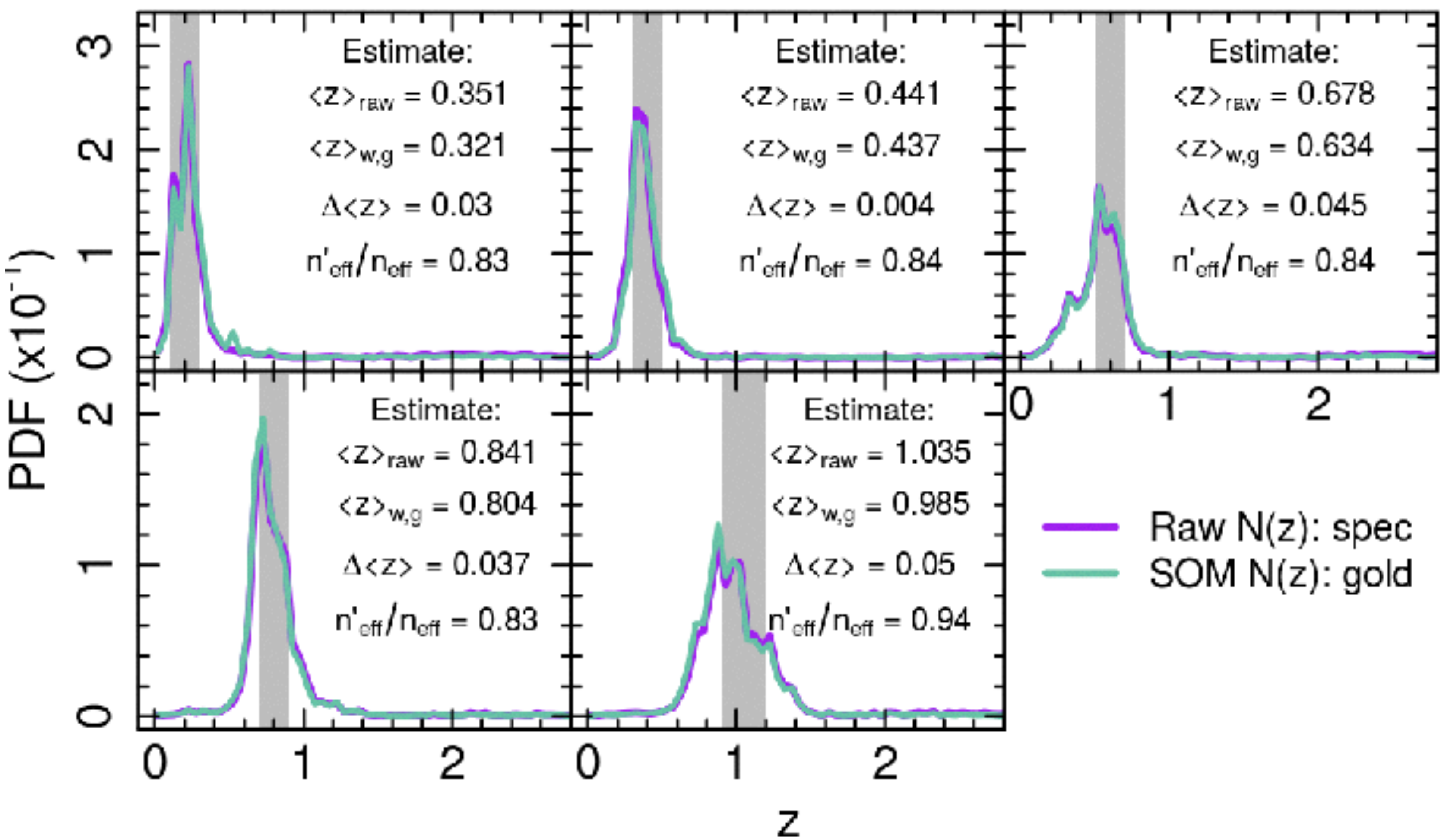
Masters et al. (2017)

SOM for Euclid



Masters et al. (2019)

KV450 “gold” sample

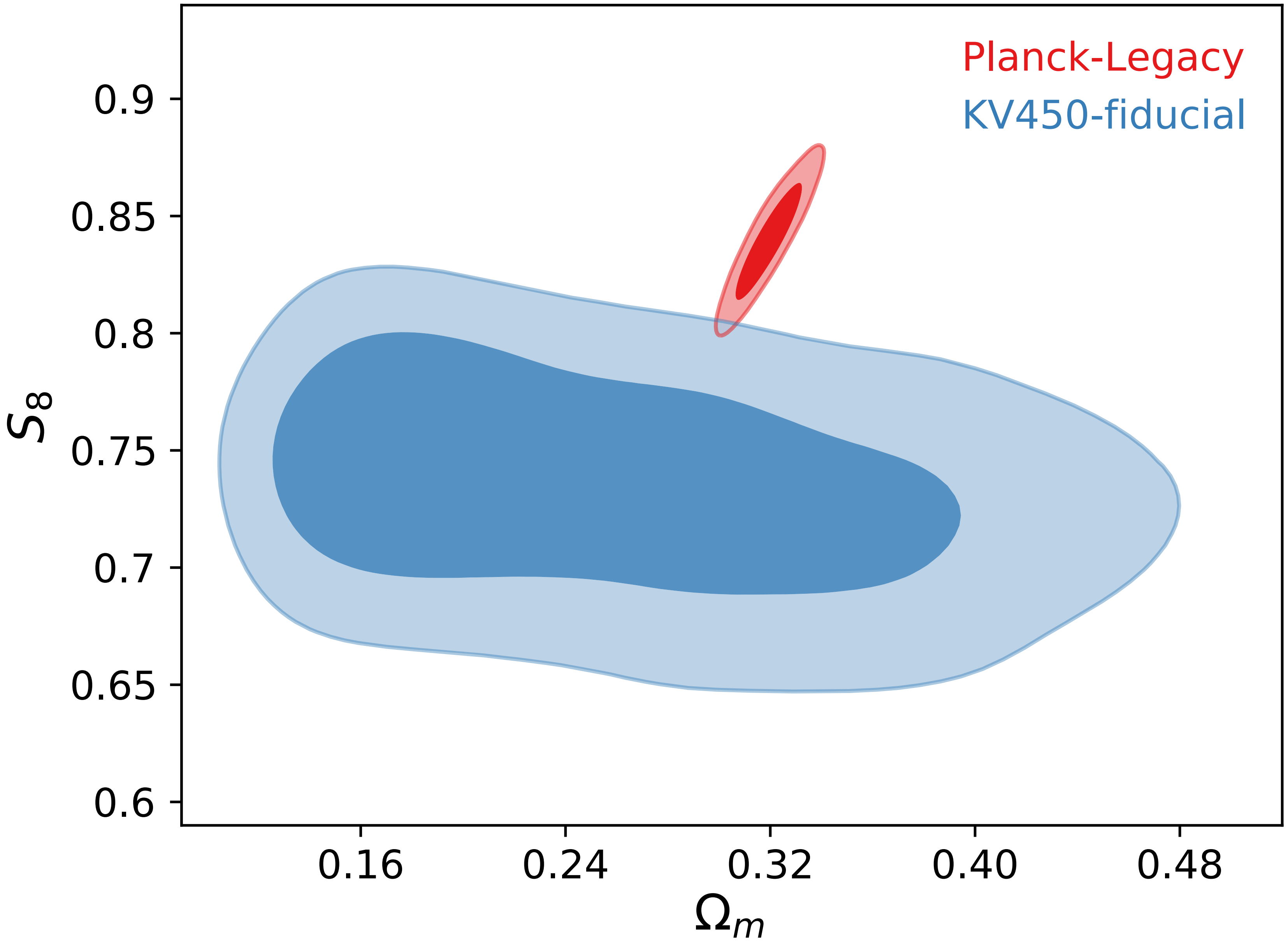


~85% of the sources.

Mean redshifts good to $\sigma_{<z>}$<~0.007.

Wright et al. in (2019)

KV450 full sample

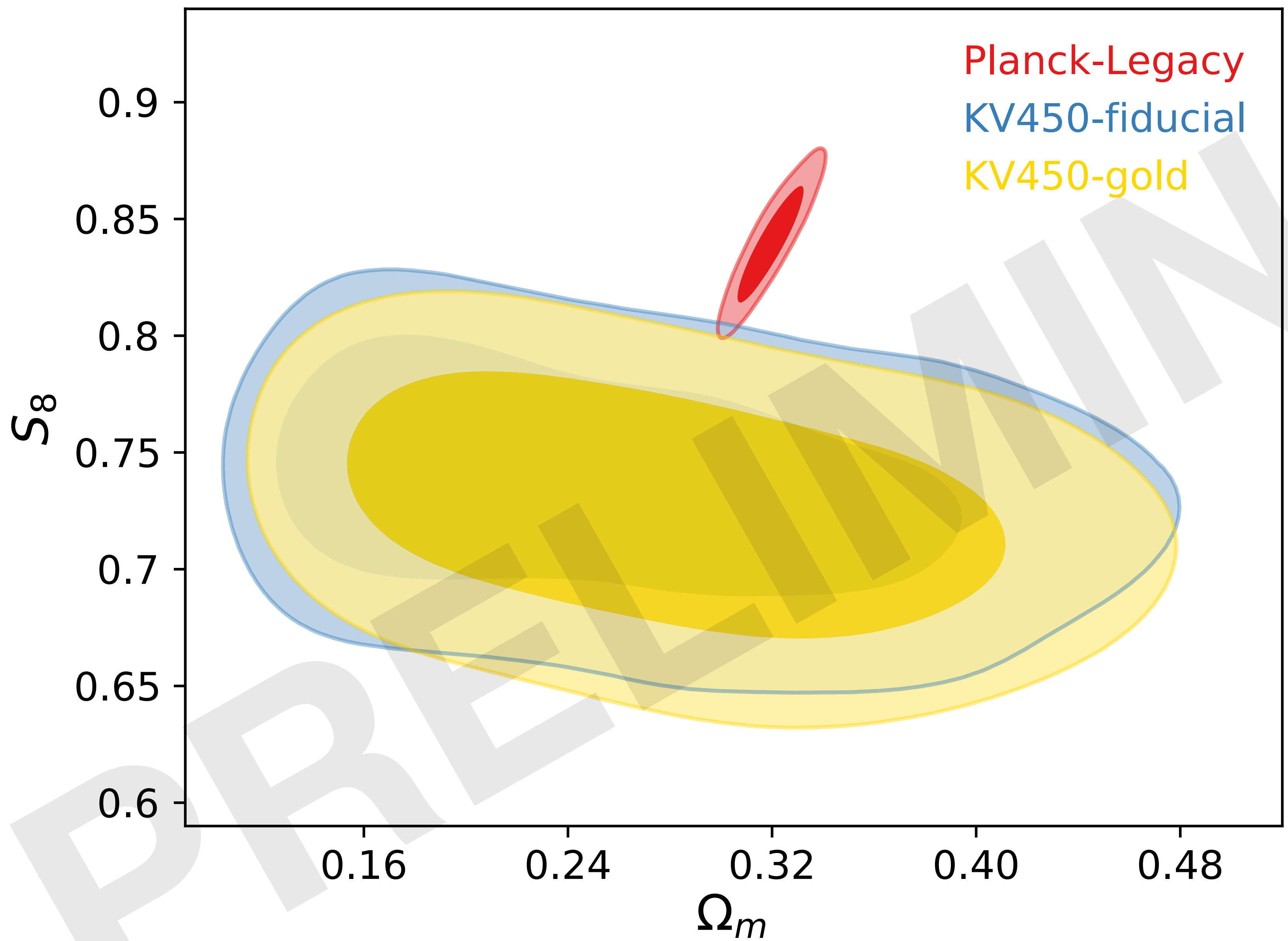


$S_8 = 0.737_{-0.036}^{+0.040}$

2.3σ tension

Wright et al. in prep.

KV450 “gold” sample



$S_8 = 0.737_{-0.036}^{+0.040}$

2.3σ tension

$S_8 = 0.724_{-0.039}^{+0.044}$

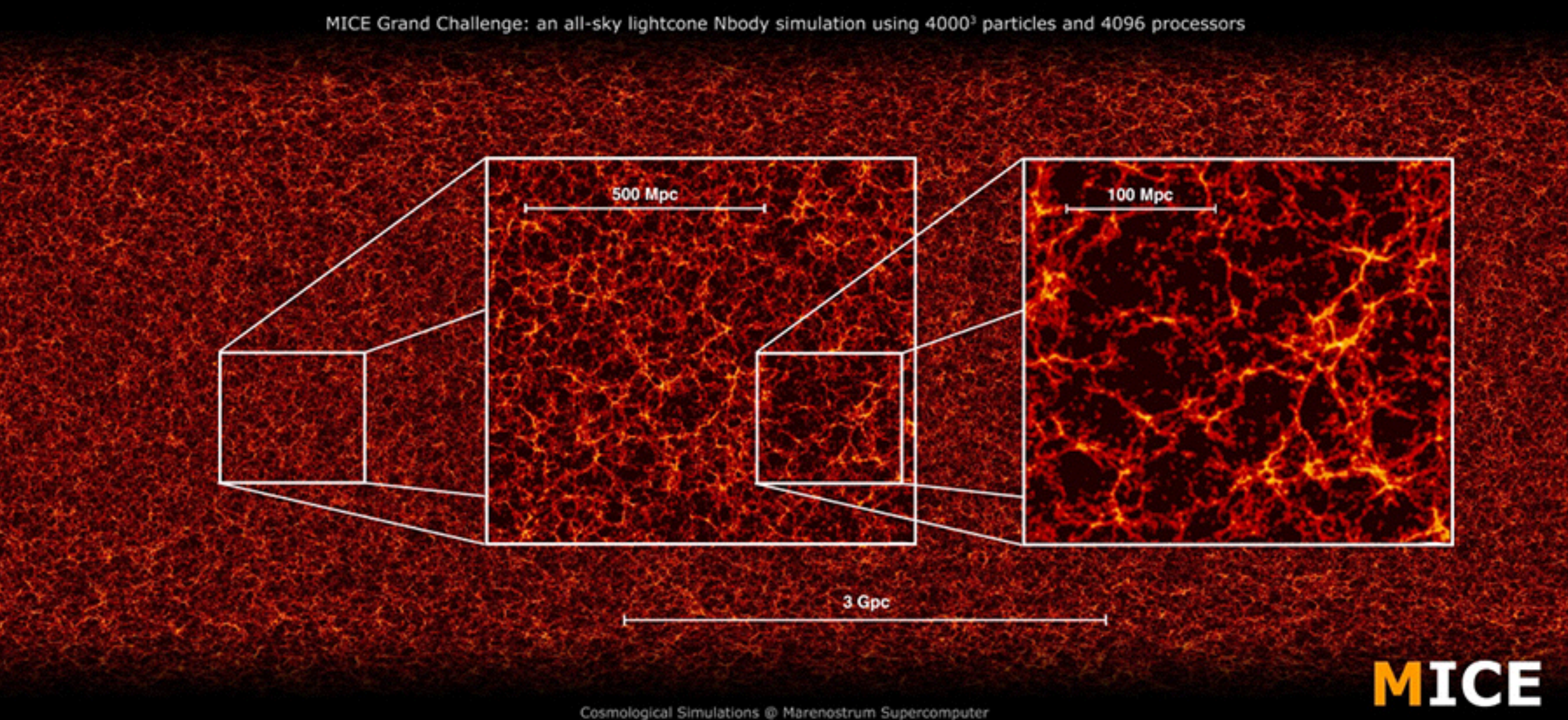
2.3σ tension

Wright et al. in prep.

Ground-based calibration

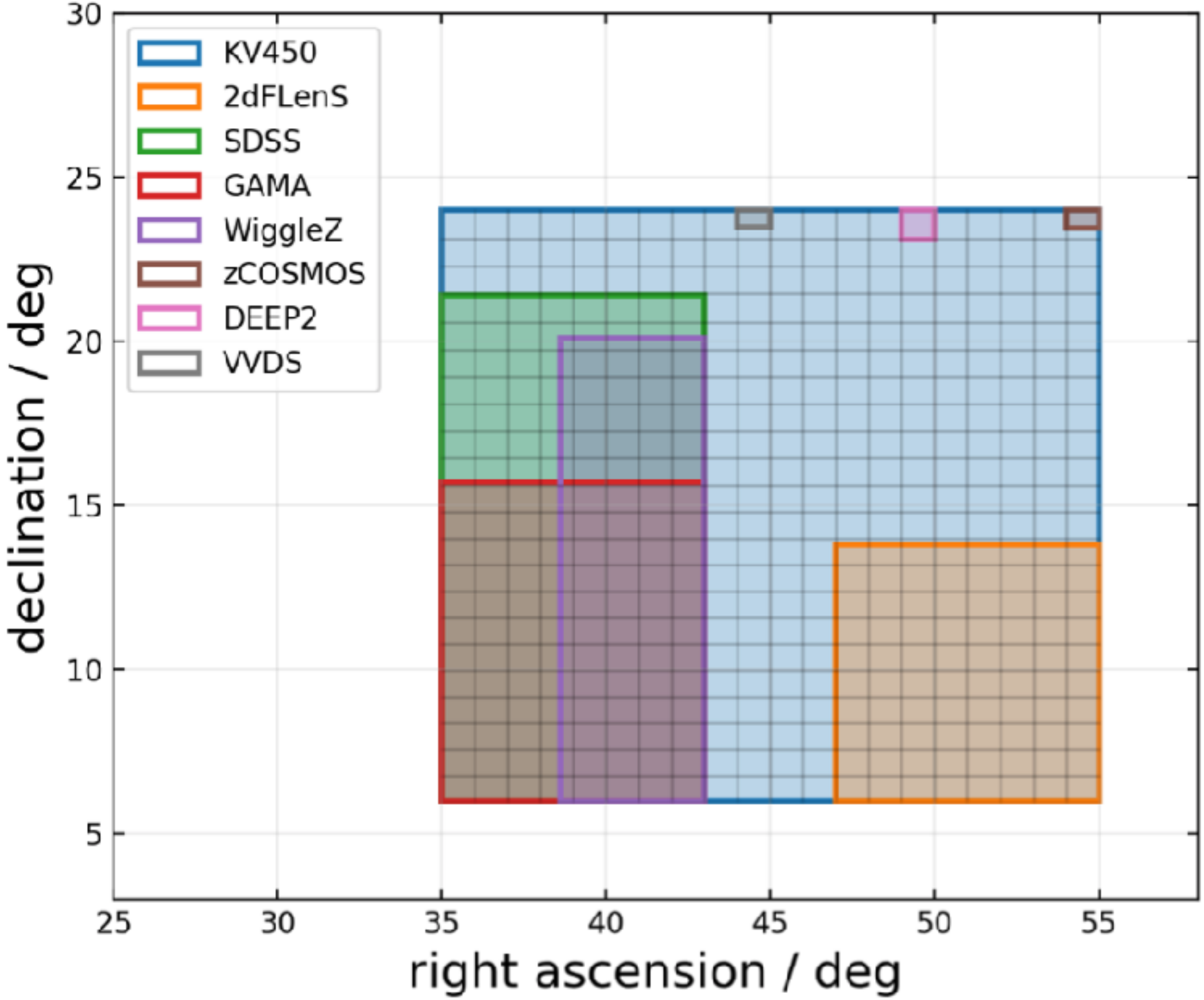
- KiDS-450 and DES-y1 reach 1-2% error on <z>.
- Cross-correlation catching up by using wide-area spec-z surveys.
- Better photometry (e.g. KiDS+VIKING) and more spec-z will push this below 1% soon.
- Need to look into limitations of techniques:
  - Discreteness of SOM.
  - Negative amplitudes in cross-correlations.
  - Sample variance.

Testing KiDS-VIKING photo-*z* on MICE

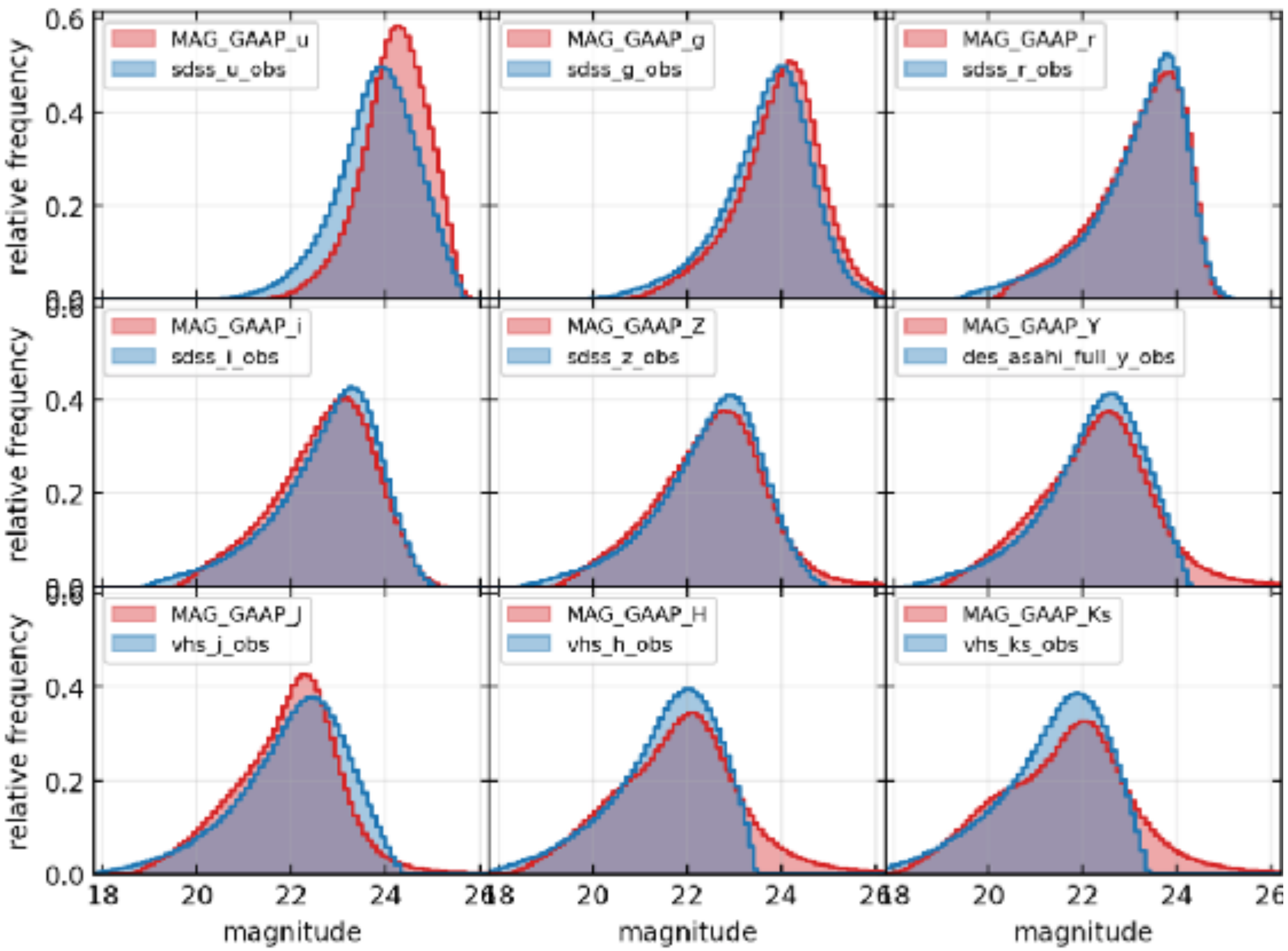


~200 million galaxies over 5000 sq.deg and up to a redshift z=1.4
Not the same as the data but similarly **complex** as the data.

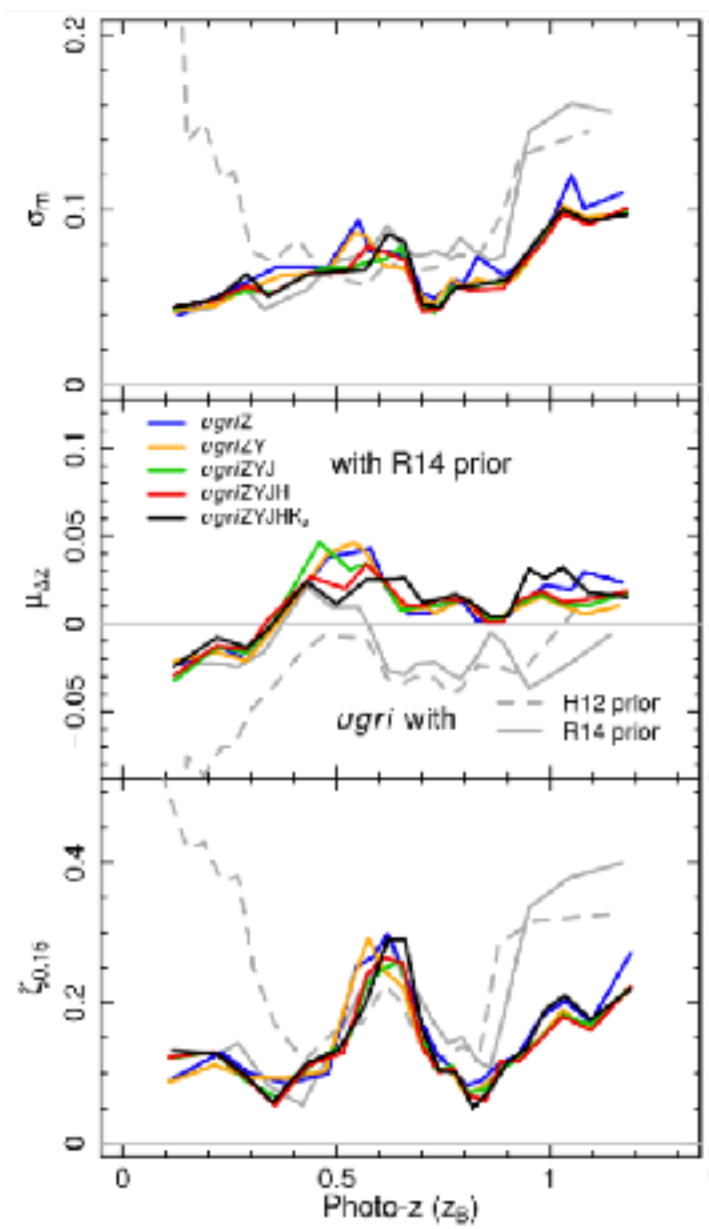
MICE2 - KV450 mocks



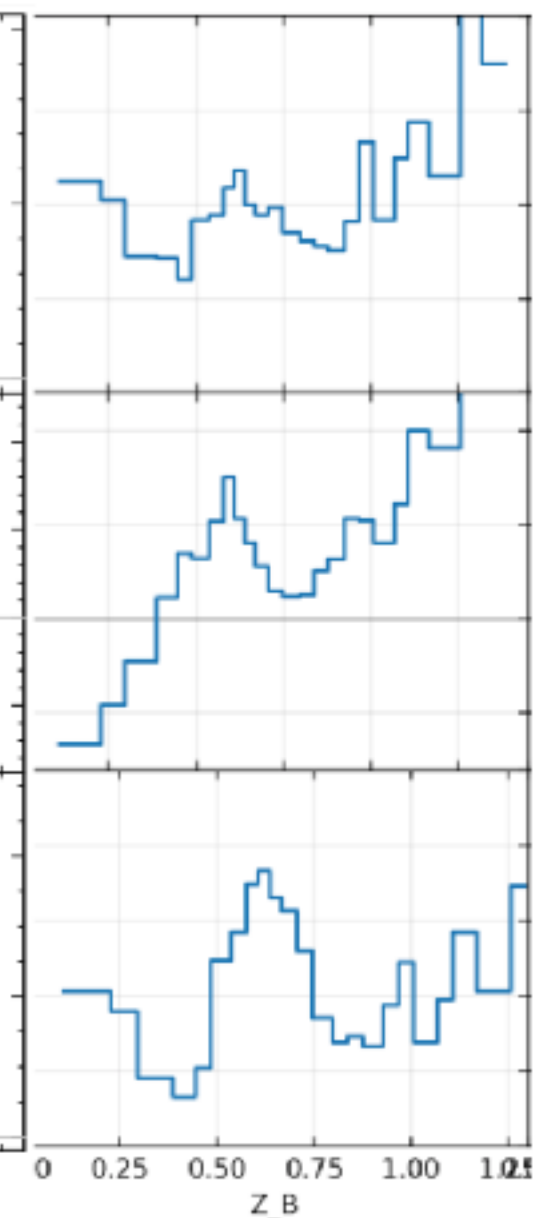
MICE2 - KV450 mocks



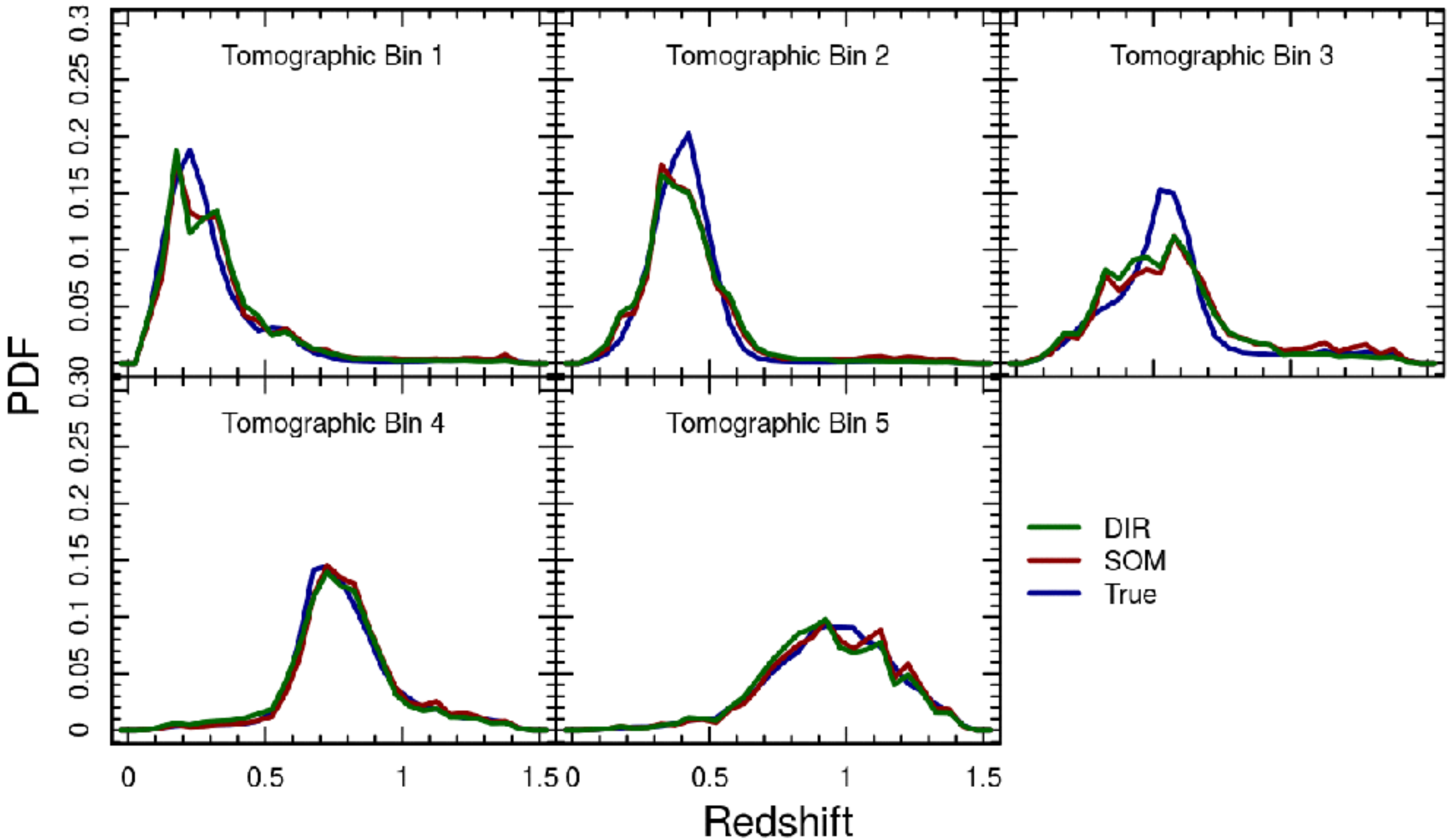
KV450 data paper



MICE2

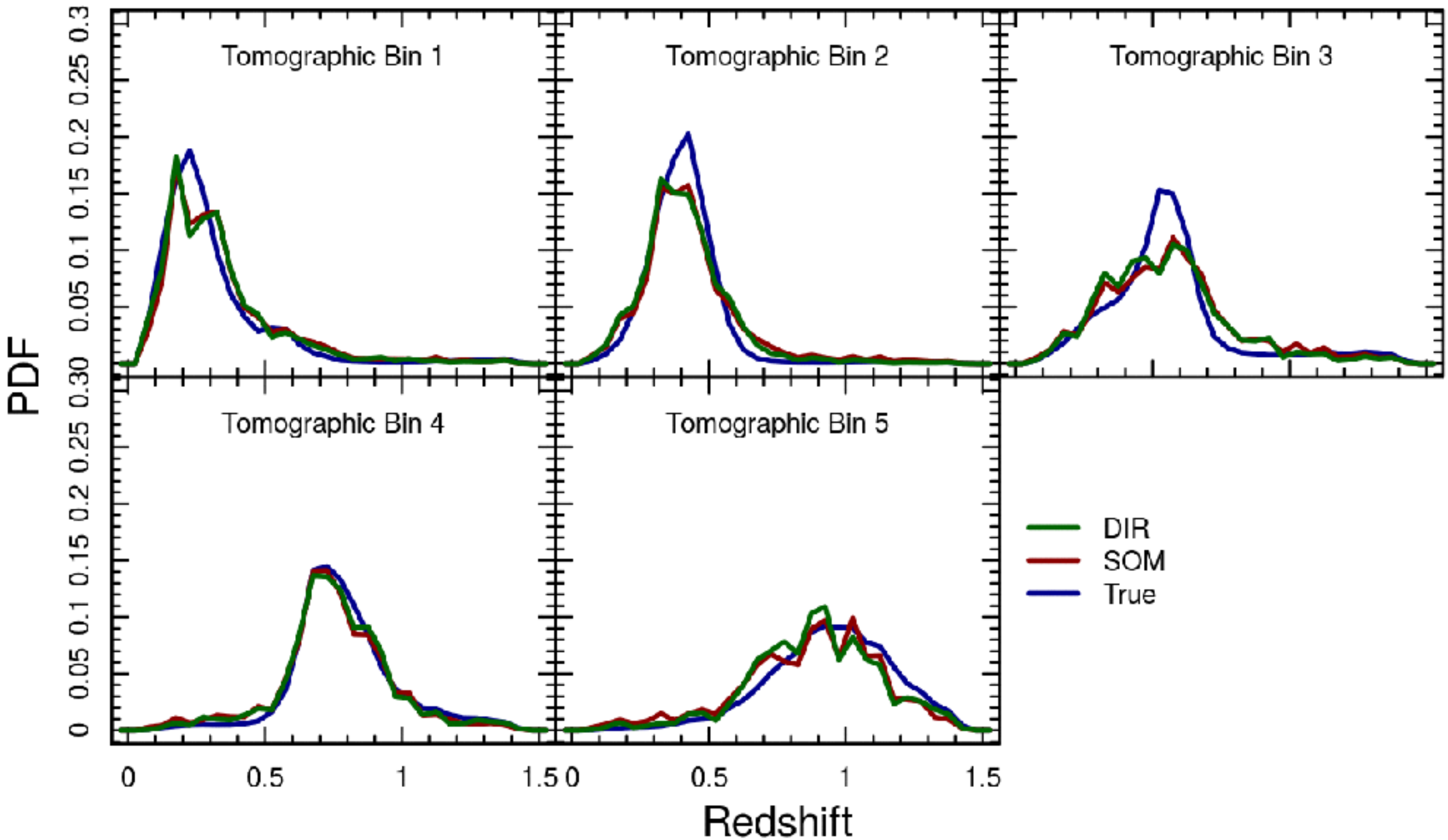


MICE2 - DIR calibration



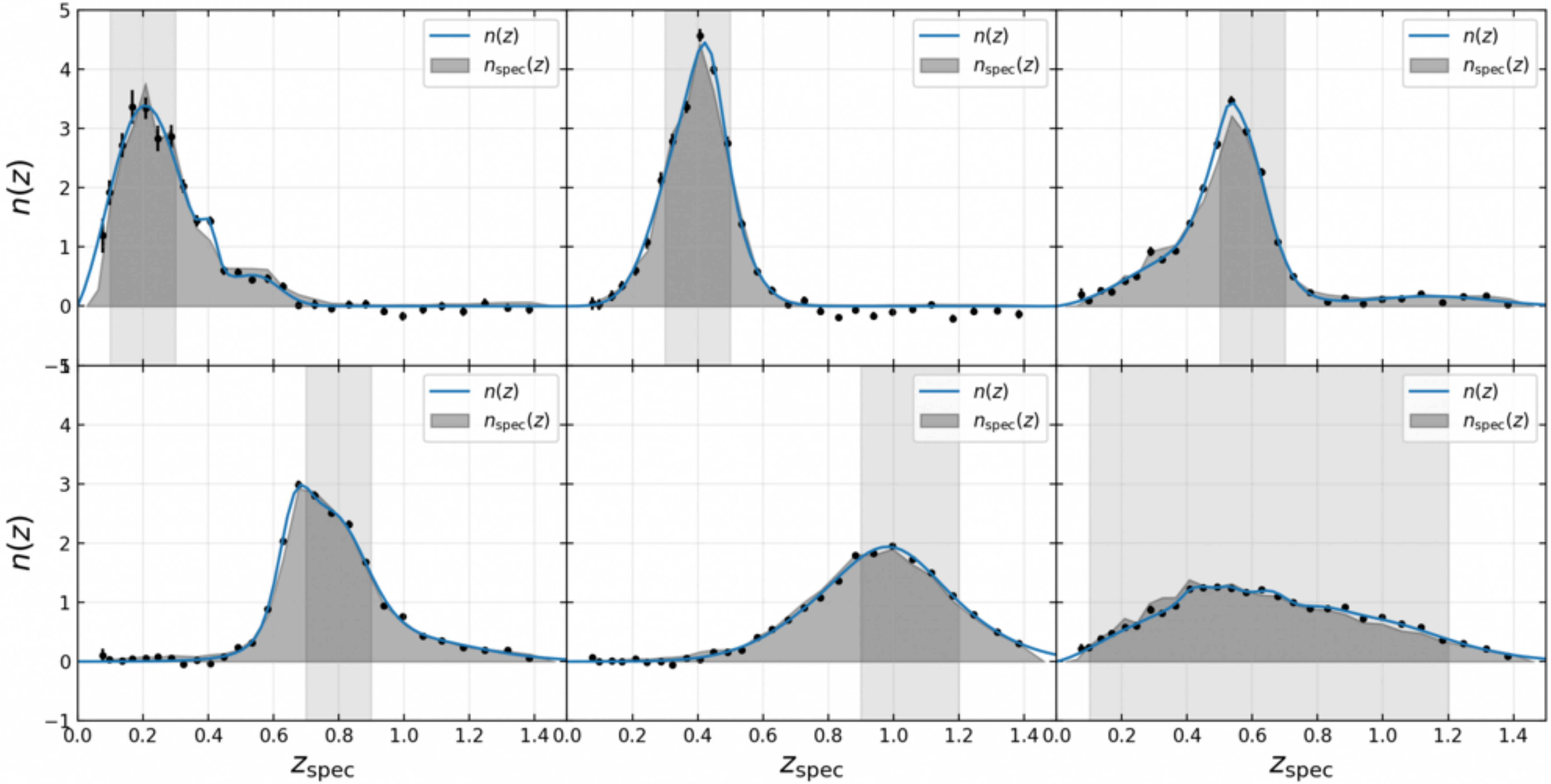
KV450-like spectroscopic sample (very similar to ideal sample)

MICE2 - DIR calibration



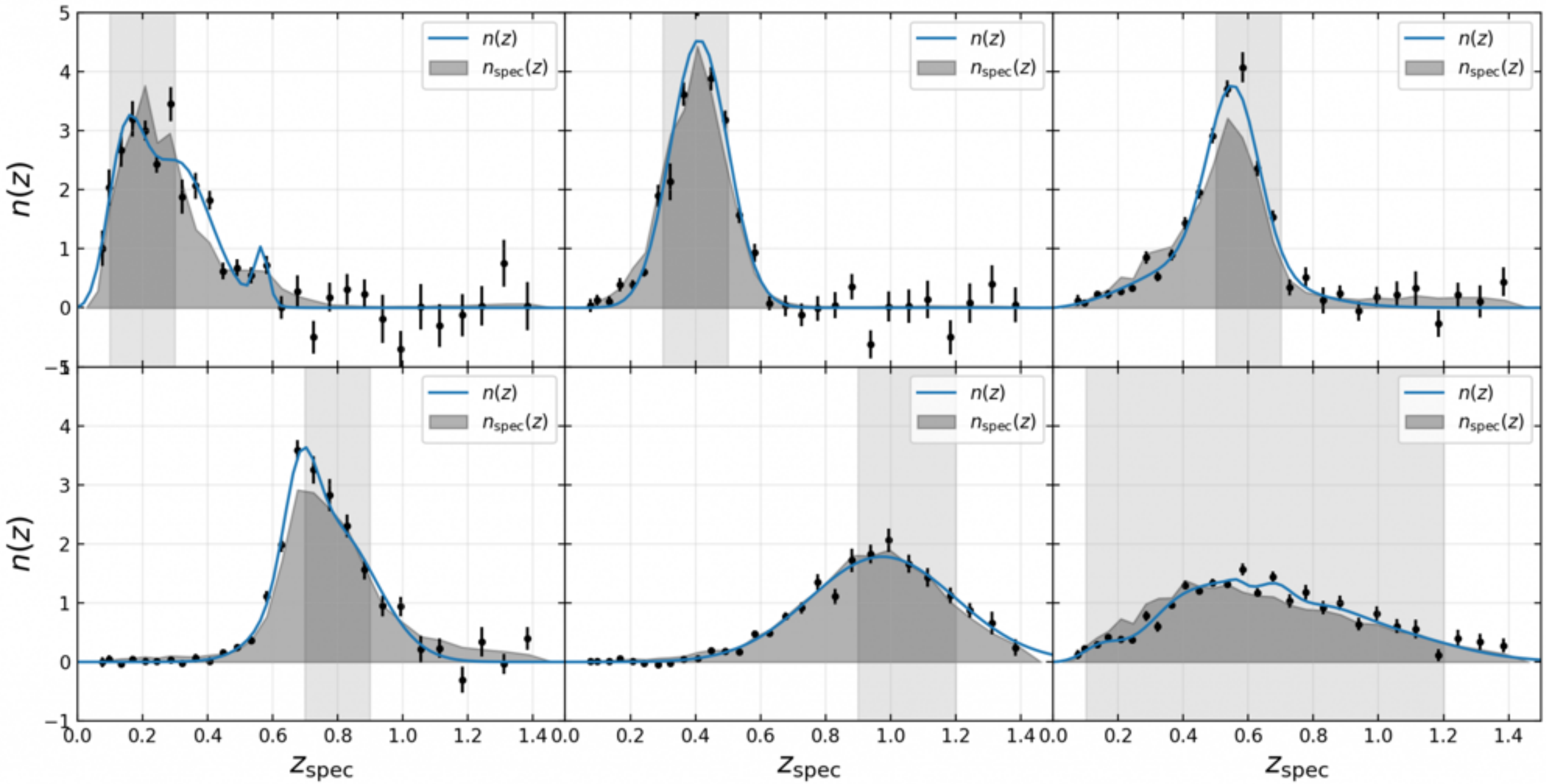
KV450-like spectroscopic sample without DEEP2

MICE2 - Clustering-z



Ideal spectroscopic sample

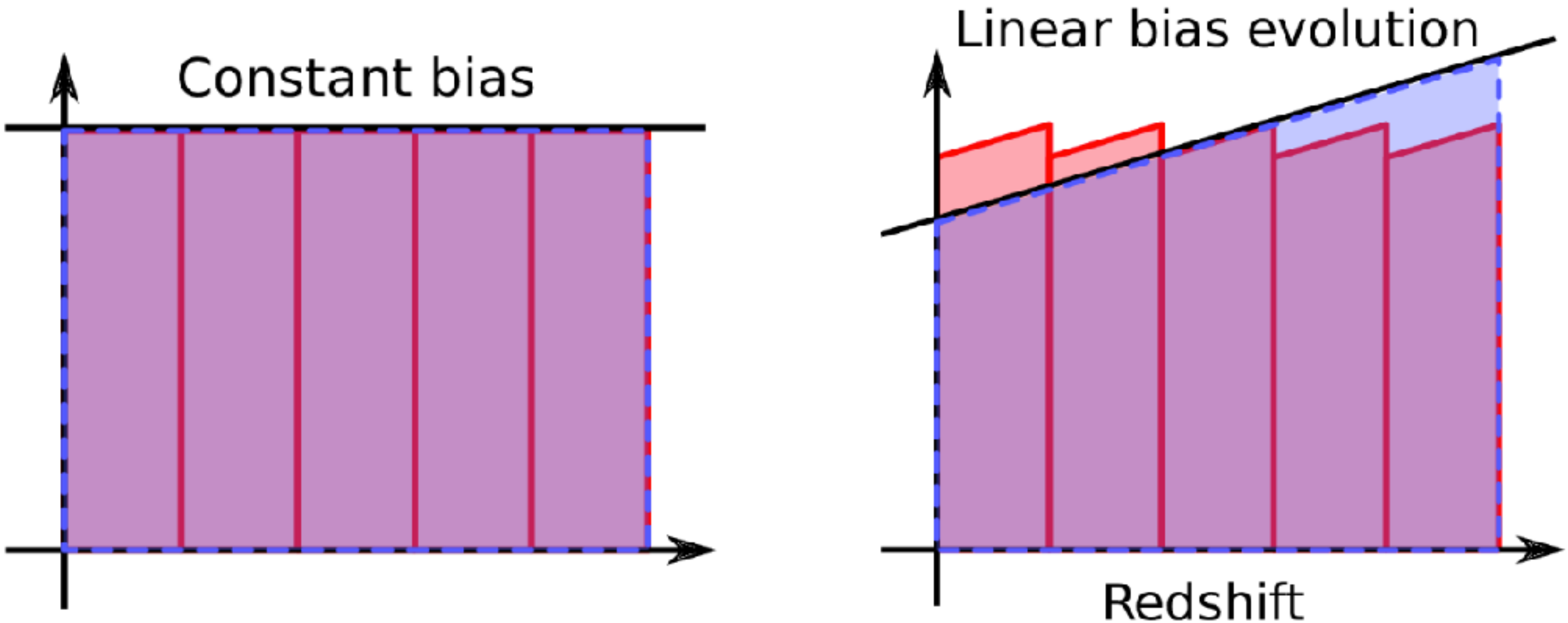
MICE2 - Clustering-z



KV450-like spectroscopic sample

Summary

- Uncertainty in <z> of <0.002*(1+z) is one of the hardest requirements for Euclid.
- Calibration plan:
  - Colour-based calibration with e.g. SOM.
  - Clustering-z to validate.
- Testing this plan on KiDS+VIKING and simulations.


Constant bias
Linear bias evolution
Redshift