COSMOLOGY FROM HOME 2020
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ROBUST ESTIMATION OF TOMOGRAPHIC REDSHIFT DISTRIBUTIONS FOR KIDS

ANGUS H WRIGHT
RESEARCH FELLOW

GERMAN CENTRE FOR COSMOLOGICAL LENSING (GCCL)

RUHR-UNIVERSITÄT BOCHUM, GERMANY

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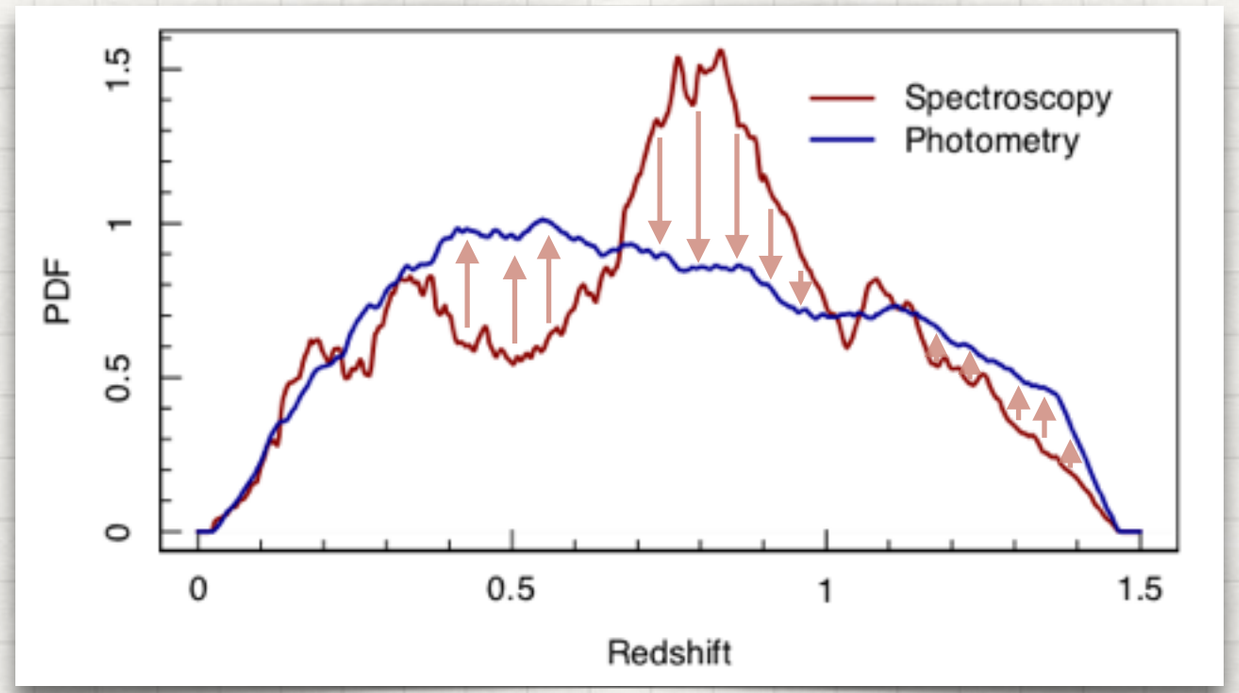
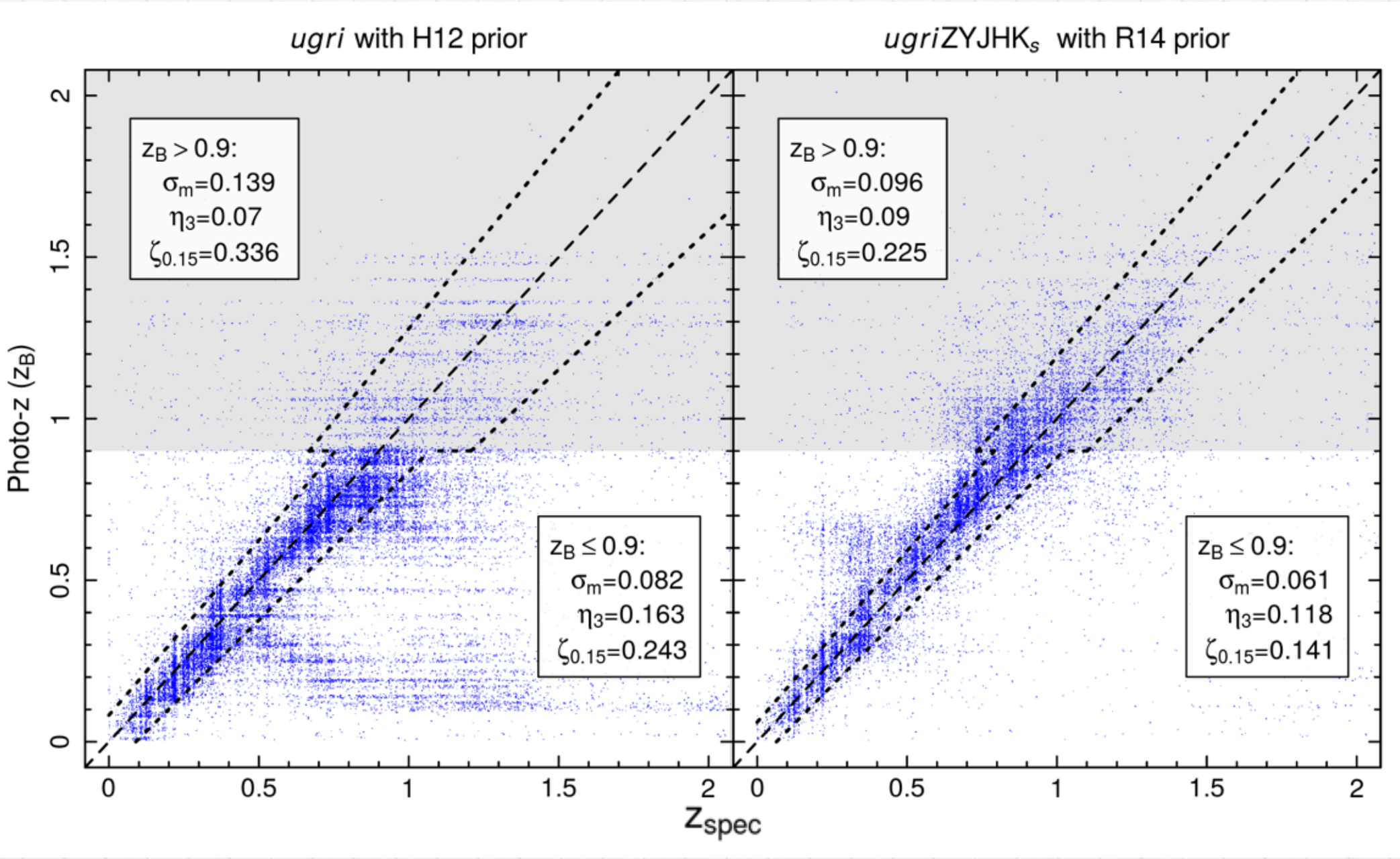


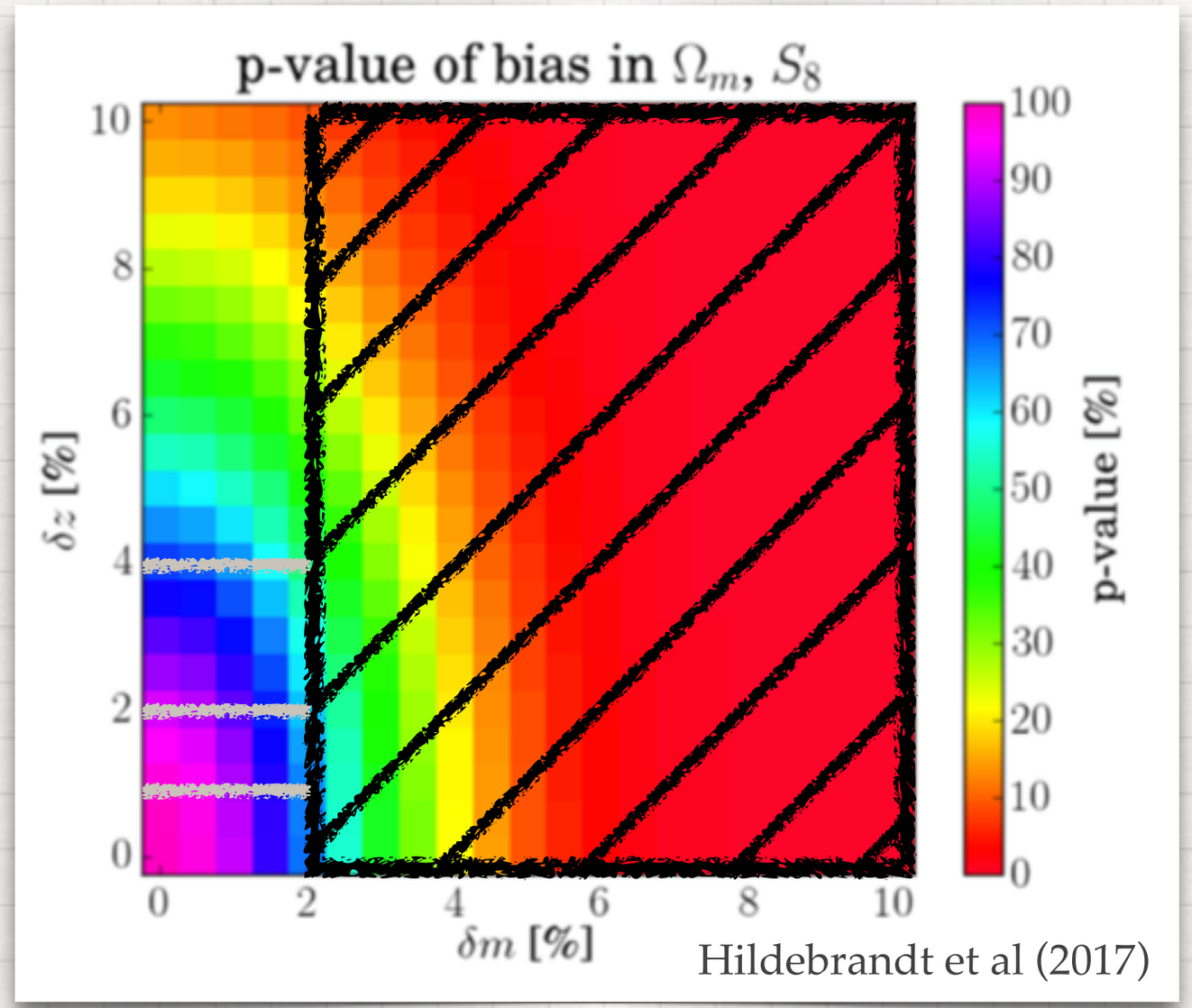
REDSHIFT CALIBRATION FOR COSMIC SHEAR

PHOTOMETRIC REDSHIFTS



Wright et al (2019)

HOW ACCURATELY MUST WE CALIBRATE REDSHIFT DISTRIBUTIONS



Hildebrandt et al (2017)

For stage-III cosmic shear surveys like KiDS, redshift calibration accuracy must be:

$$|dz| \sim 0.01$$

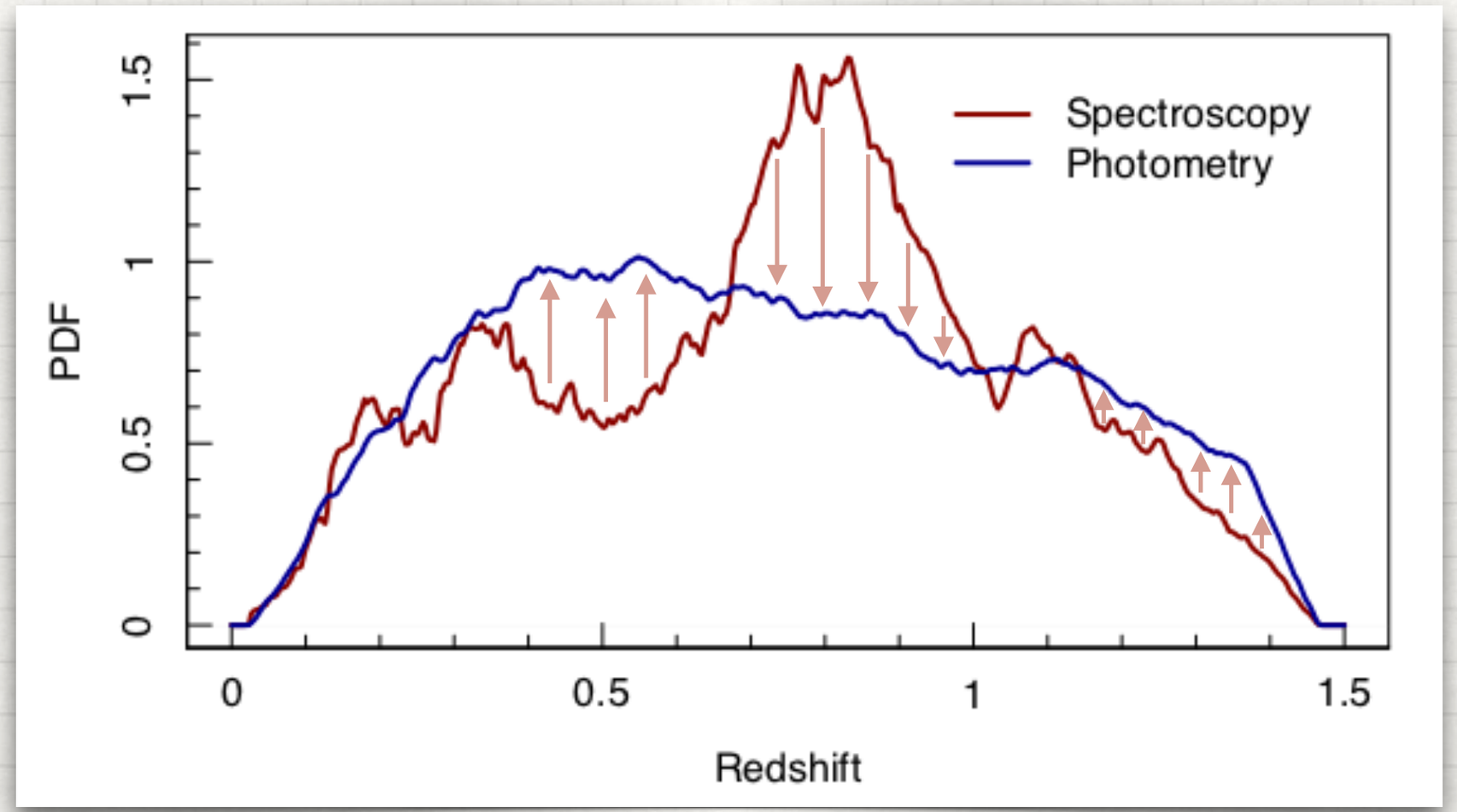
in order to be sub-dominant to (e.g.) shear-measurement uncertainty

DIRECT REDSHIFT CALIBRATION FOR COSMIC SHEAR

SPECTROSCOPIC CALIBRATION

One option is to use spectroscopic redshifts to calibrate cosmic-shear galaxies.

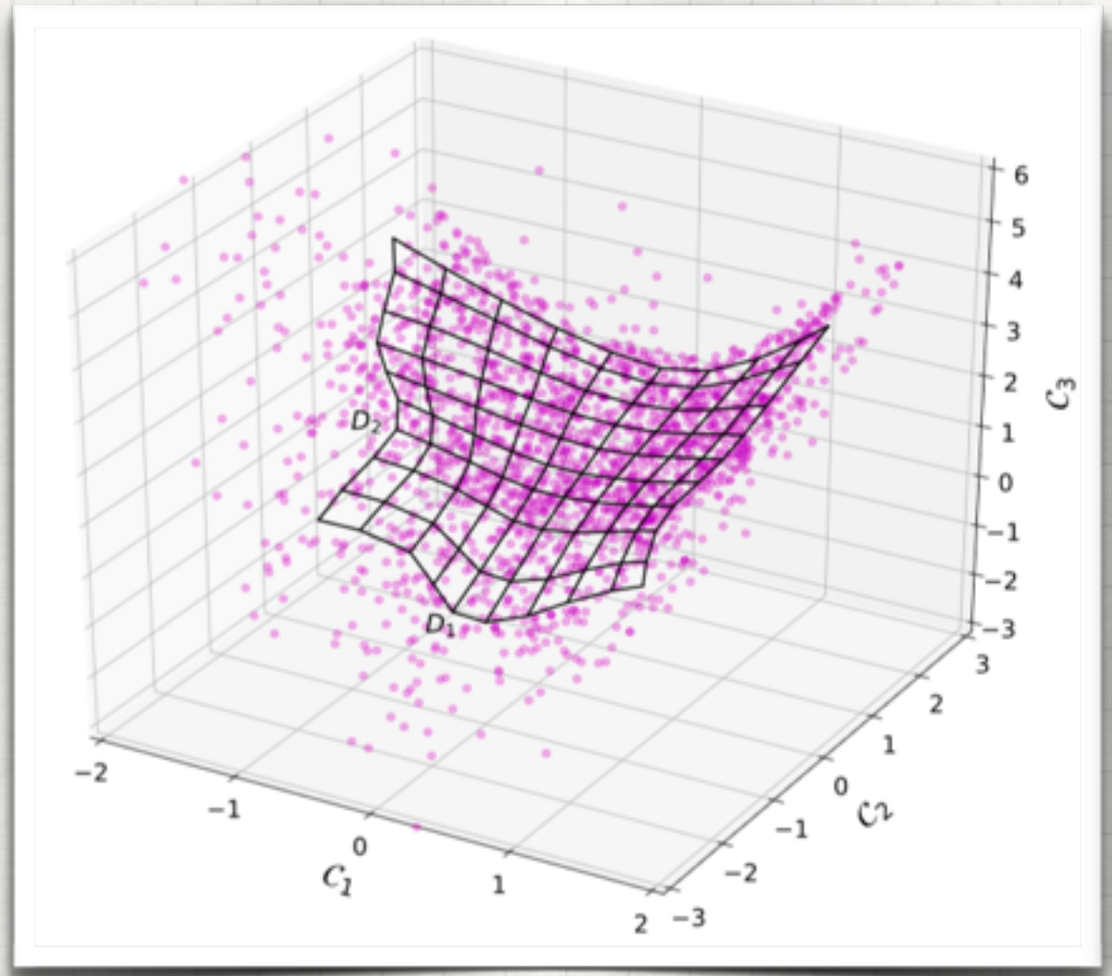
- ↳ Requires a method of mapping spectra onto wide-field galaxies
- ↳ Requires a representative spec-z sample *or* a method for determining which photometric sources are matched



THE SELF-ORGANISING MAP (SOM)

A NOVEL APPROACH TO DIRECT CALIBRATION

The SOM is a 2D representation of an n-dimensional surface, in our case the galaxy colour^n-space



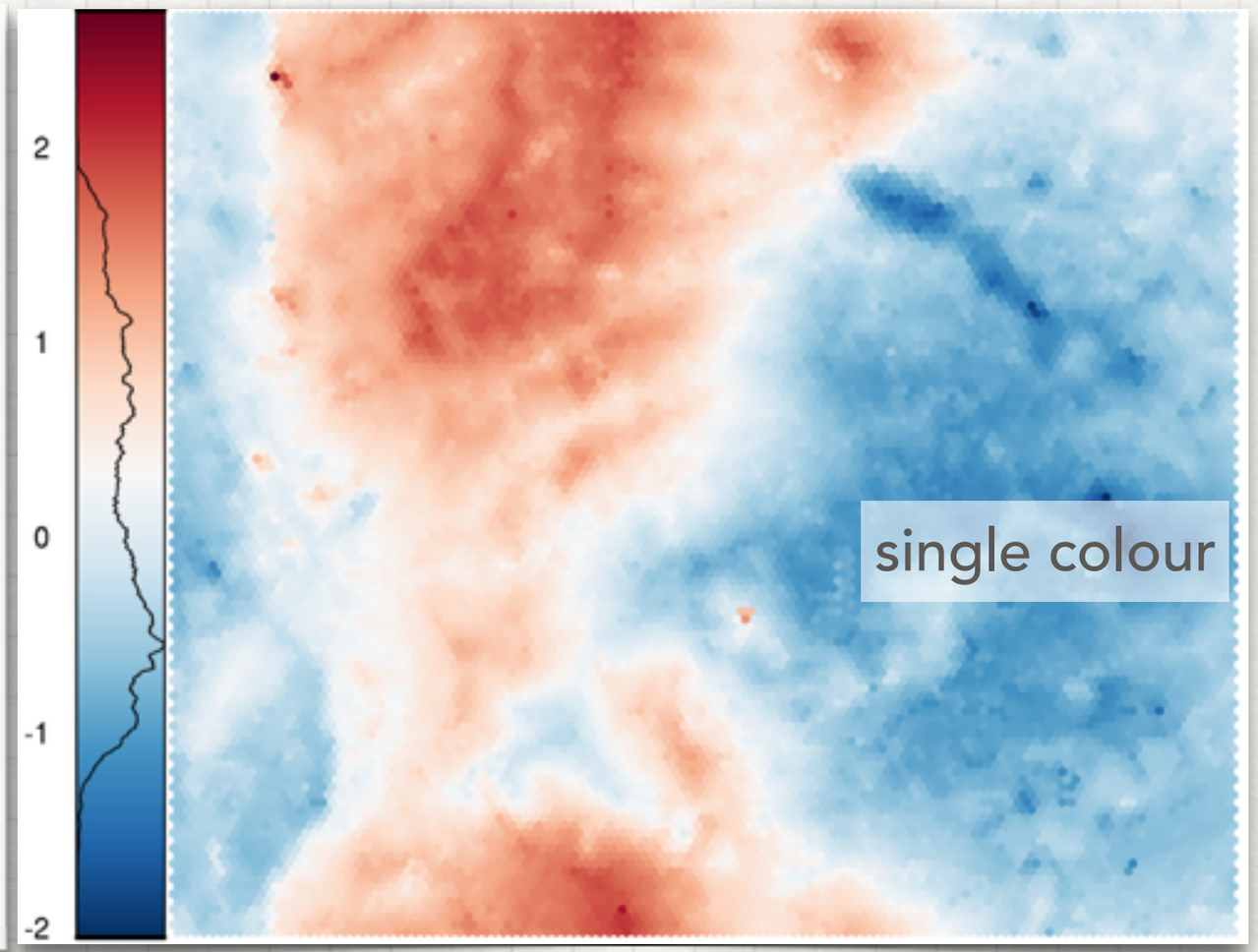
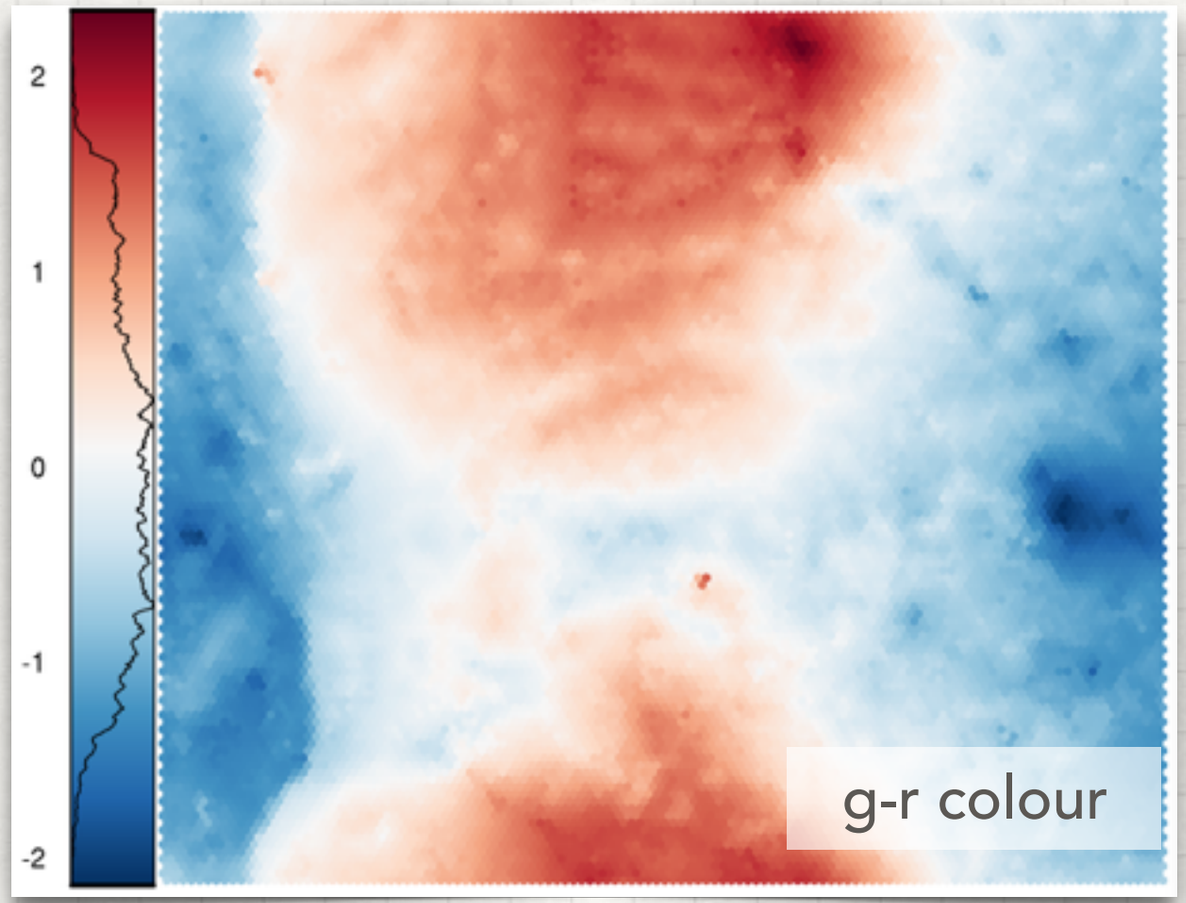
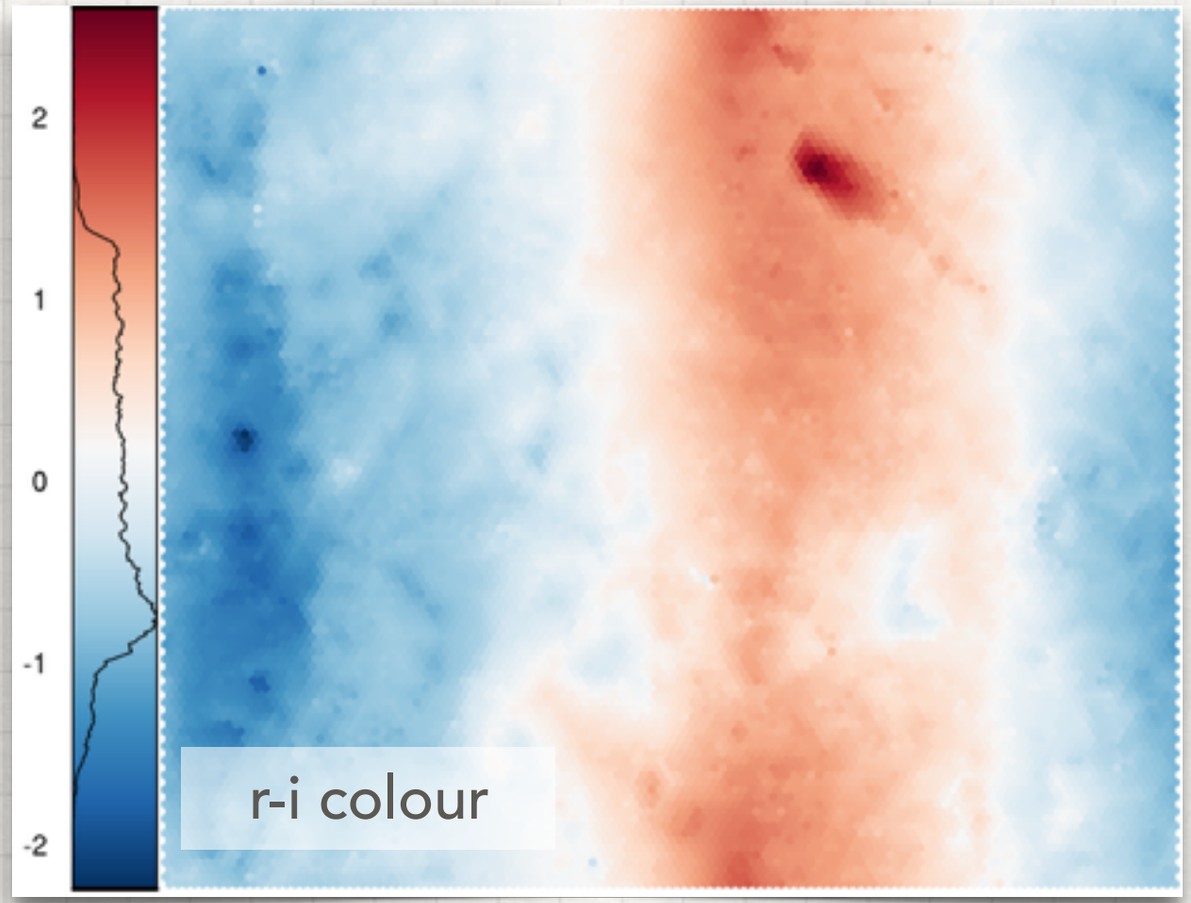


Image credit: Davidzon et al (2019)

EXAMPLE SOM

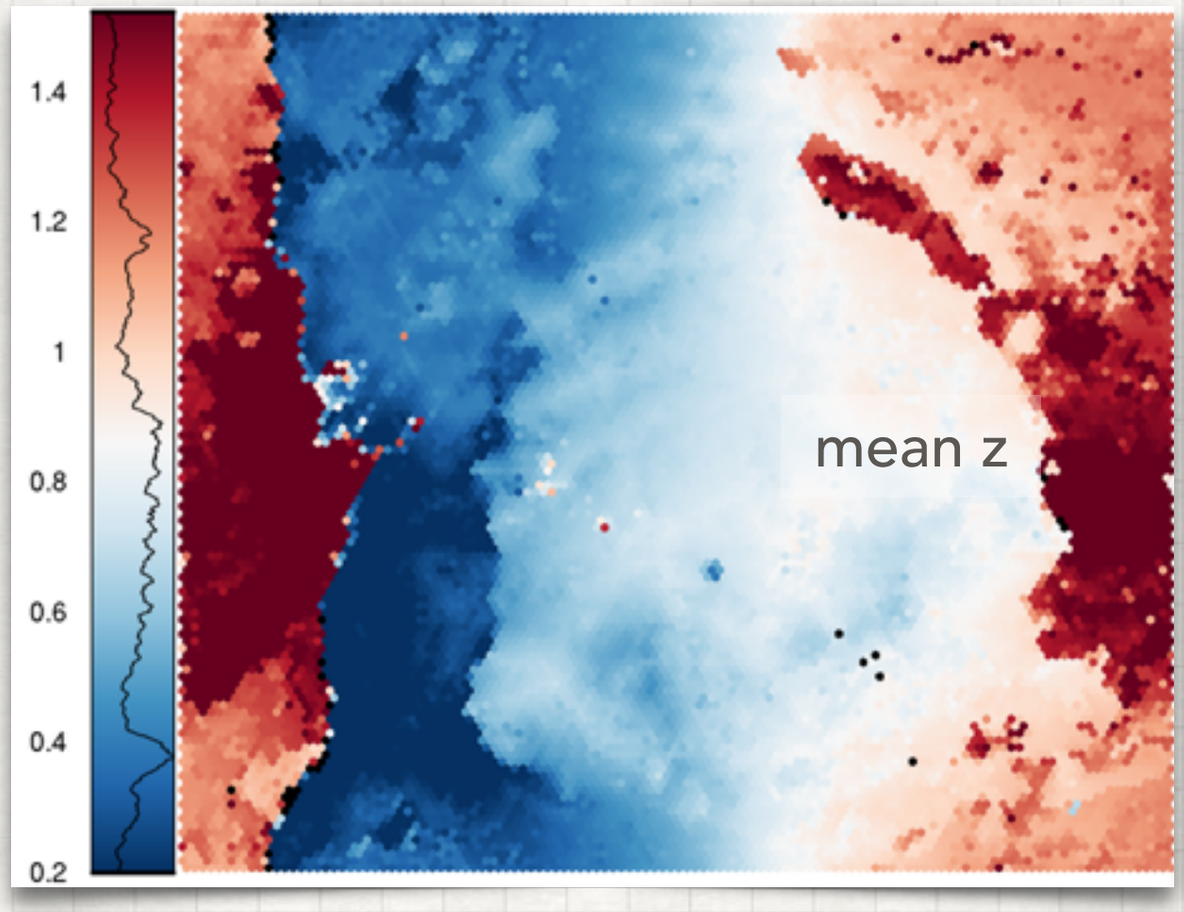
MAPPING OF INPUT PROPERTIES

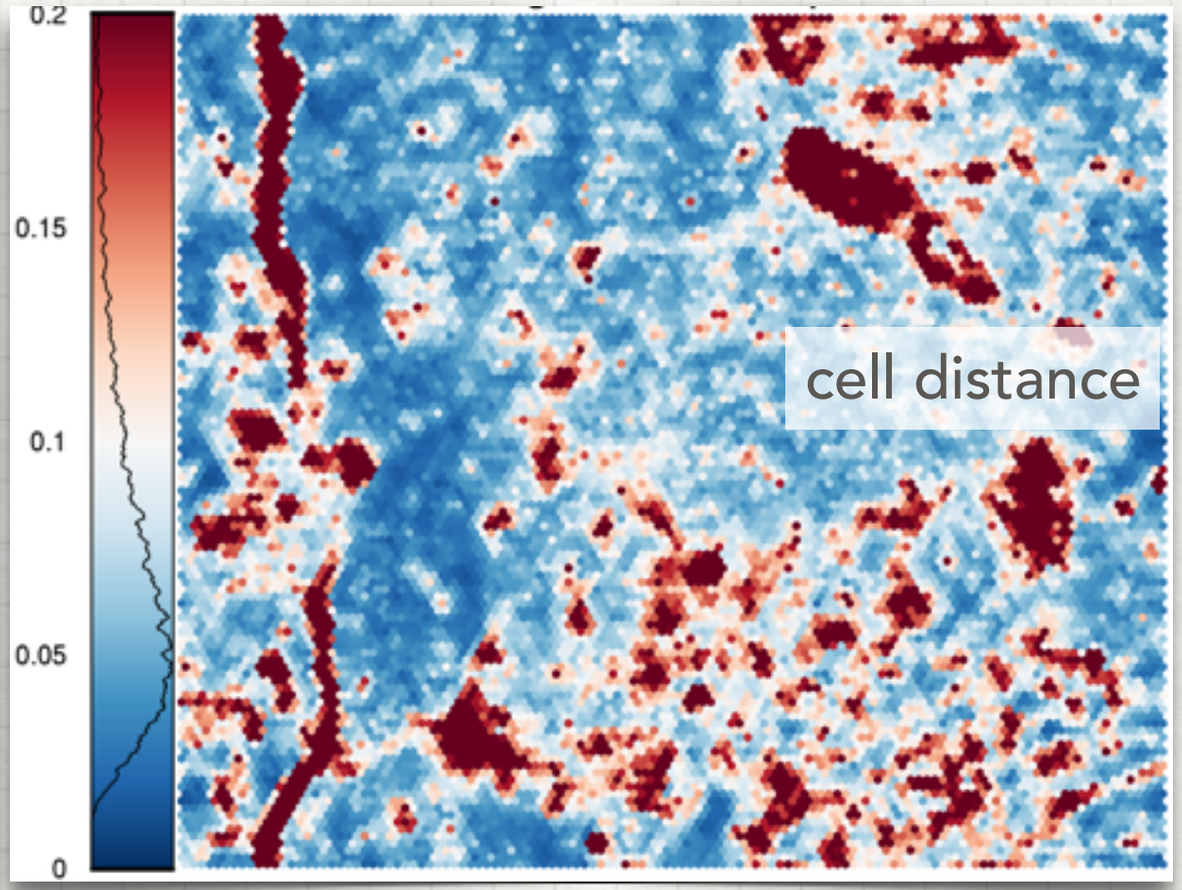




EXAMPLE SOM

MAPPING OF DERIVED PROPERTIES



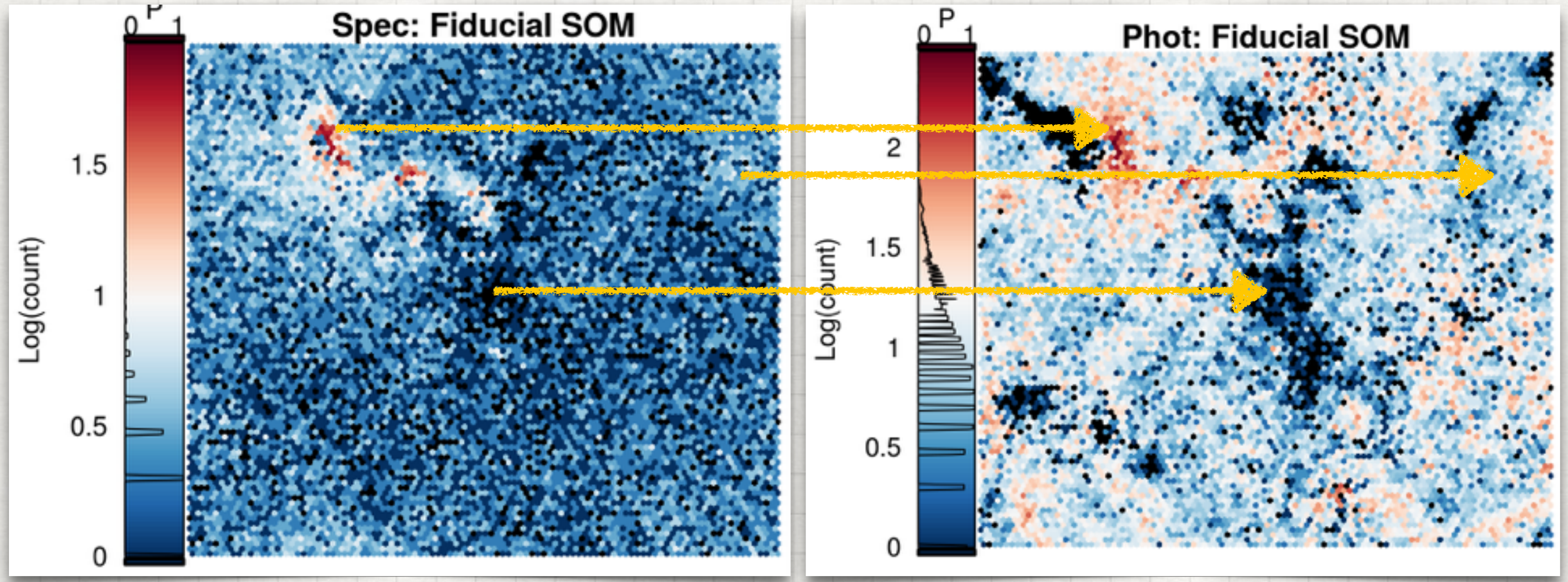


REDSHIFT CALIBRATION USING SELF-ORGANISING MAPS

Wright et al (2020a)

Associations are based on the self-similarity between the sources in respect to the colour-colour manifold.

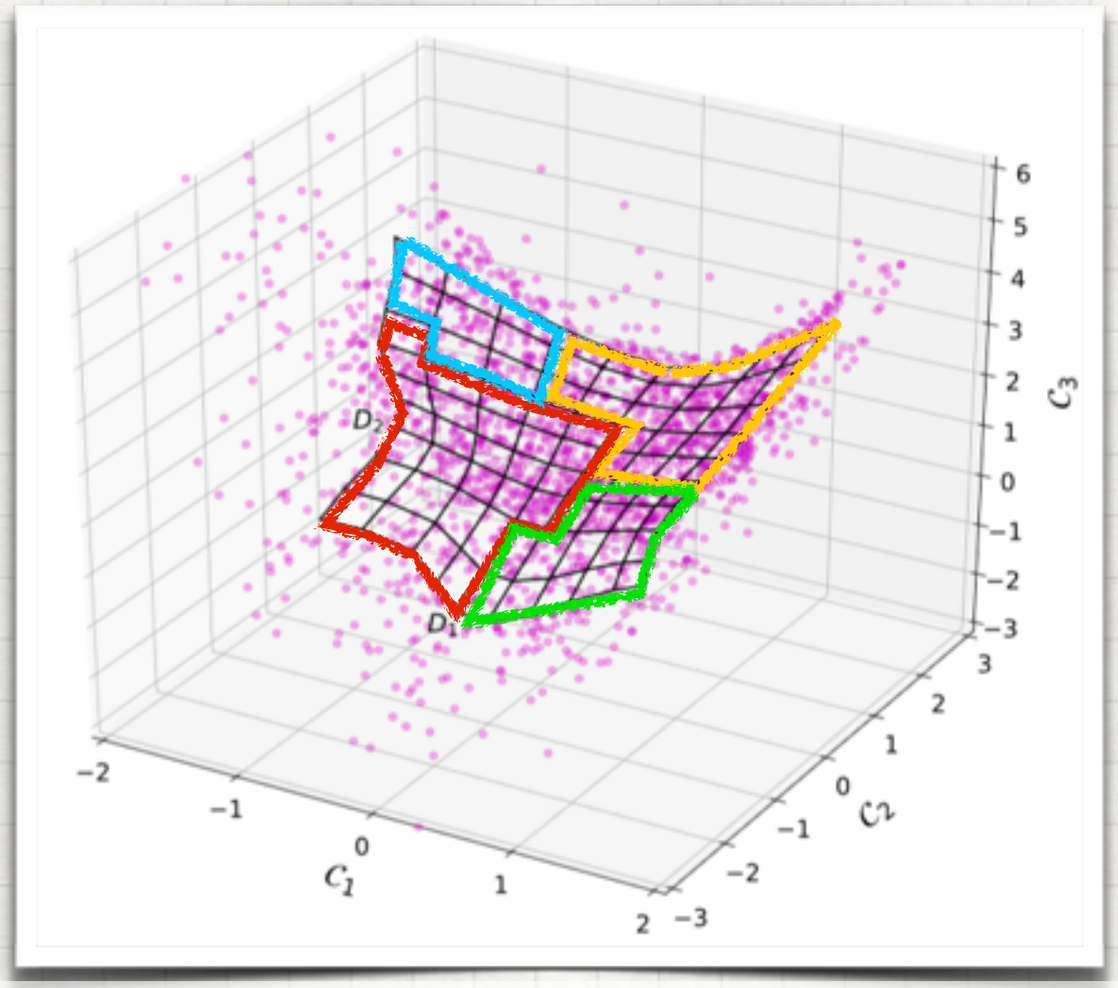
Requires us to choose a discrete number of associations.

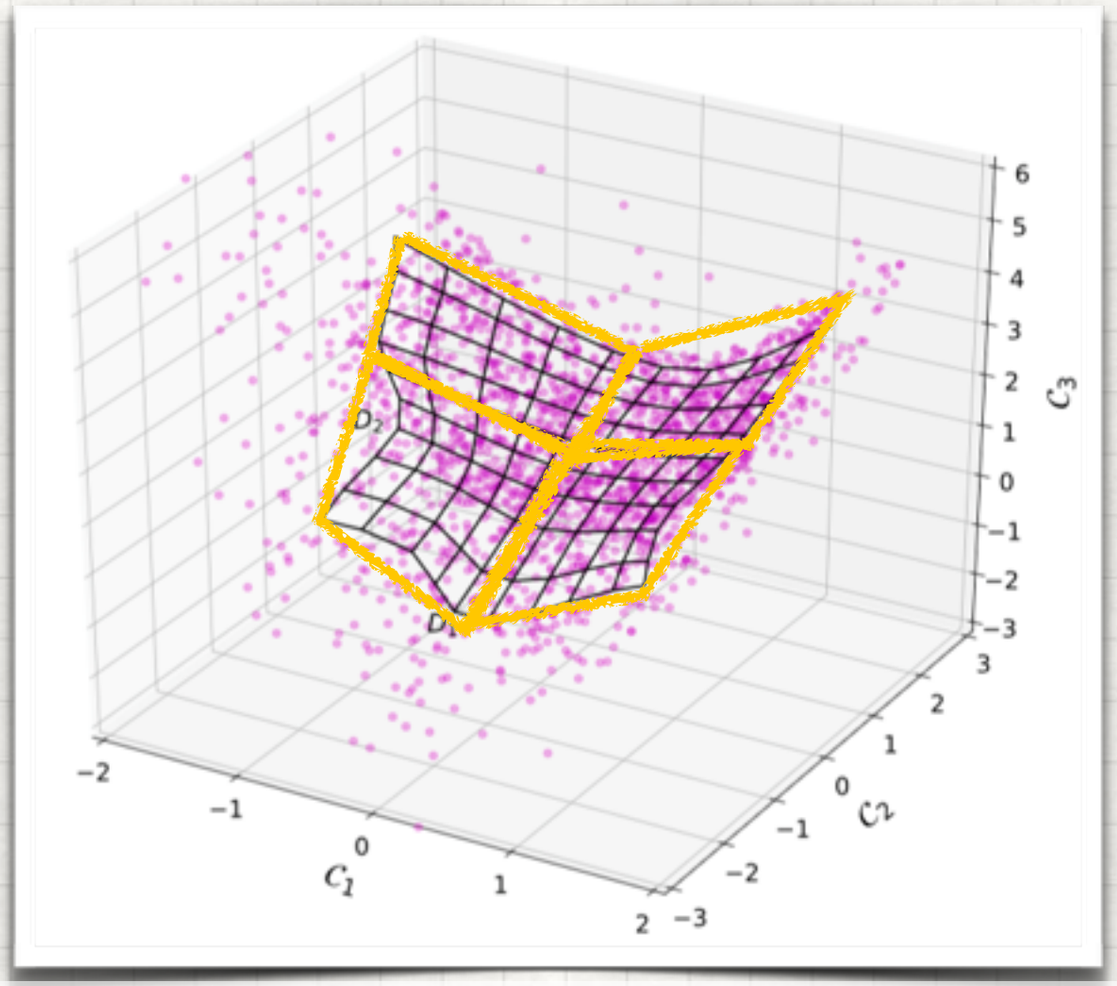


Directly shows which shear sources are not calibrated by spec-z

COMMON MISCONCEPTION

"THE NUMBER OF ASSOCIATIONS IS DETERMINED BY THE NUMBER OF CELLS"





In the literature authors will frequently sacrifice SOM resolution because of other constraints (e.g. number of sources required per association).
But merging of cells achieves the same result without sacrificing the map's flexibility (and so with minimal information loss).

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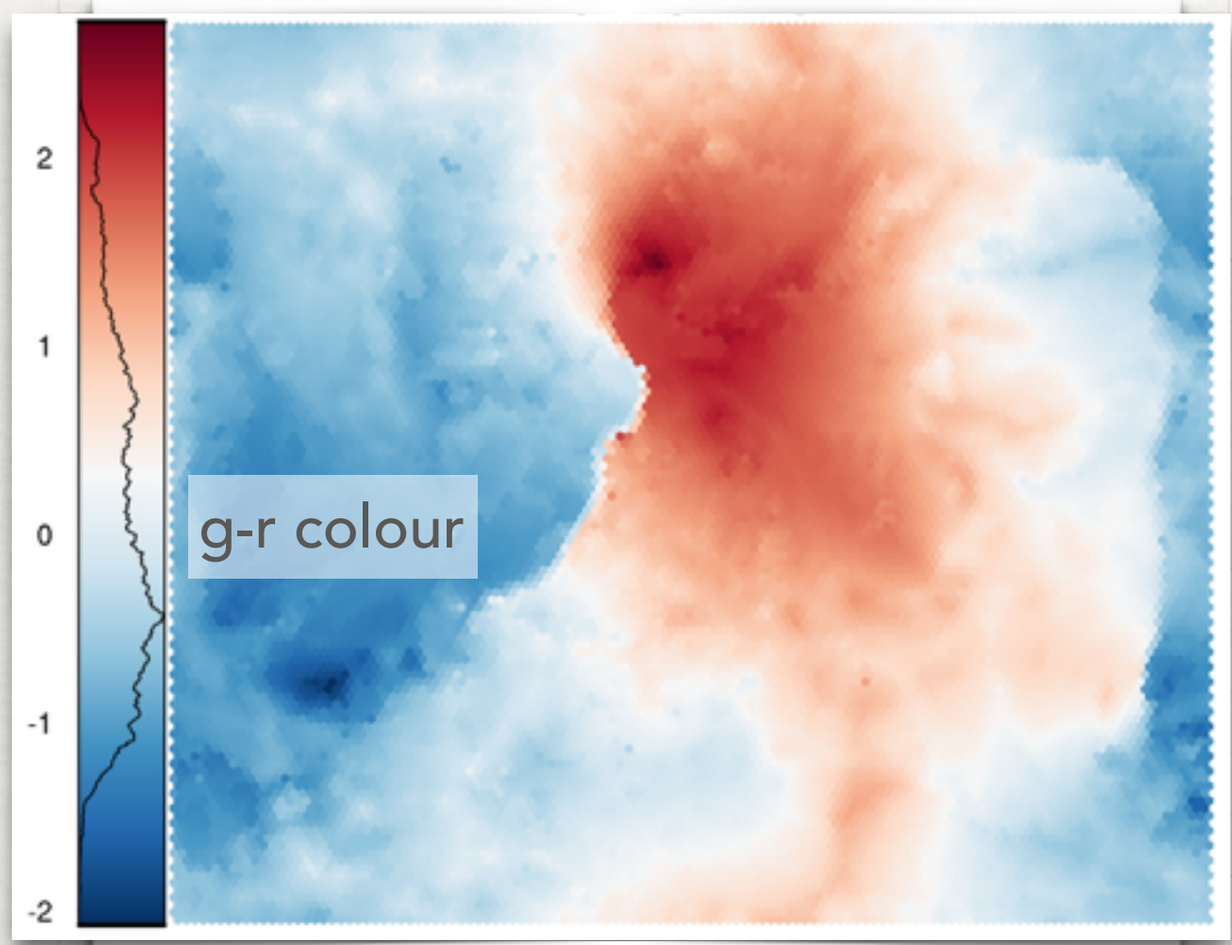

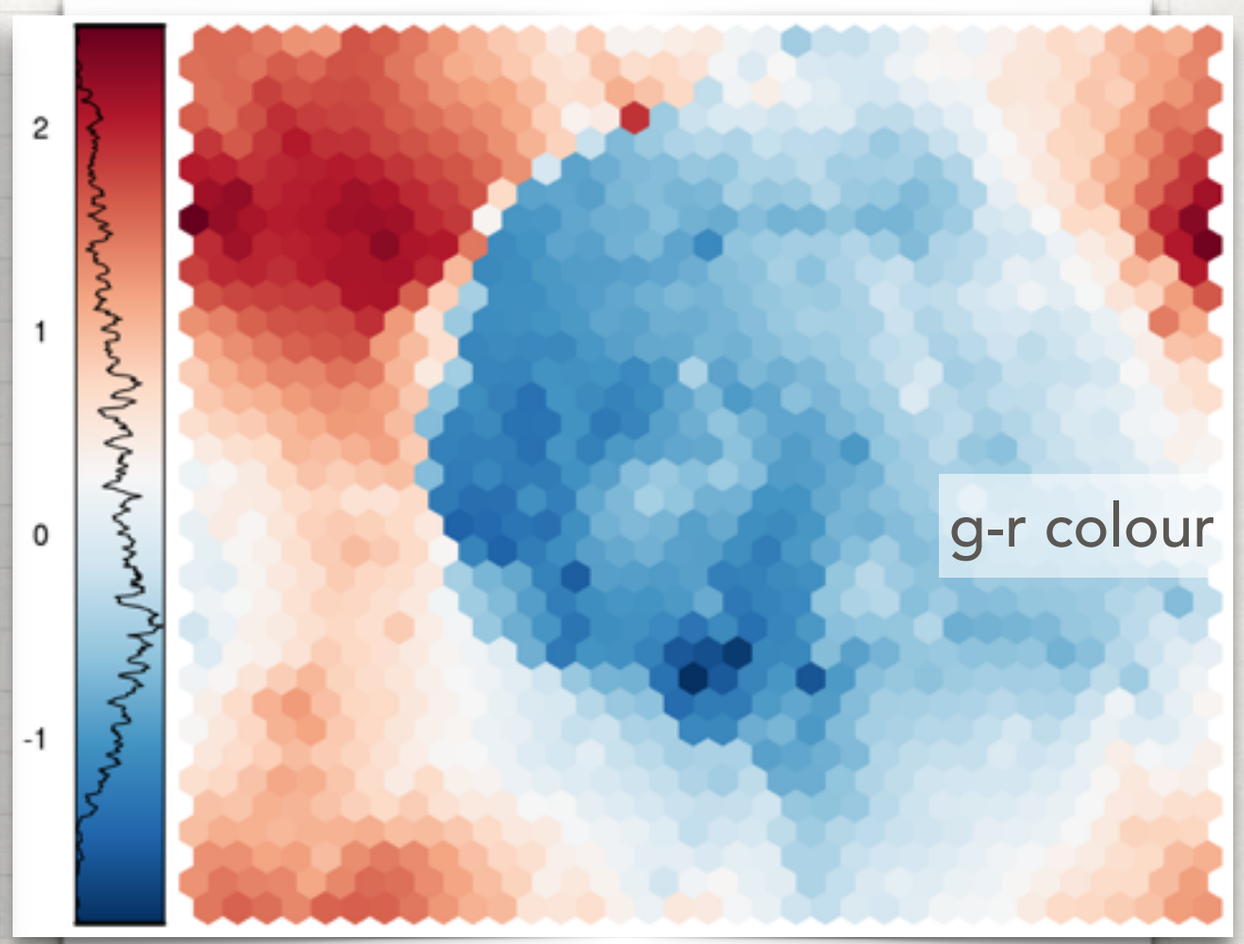

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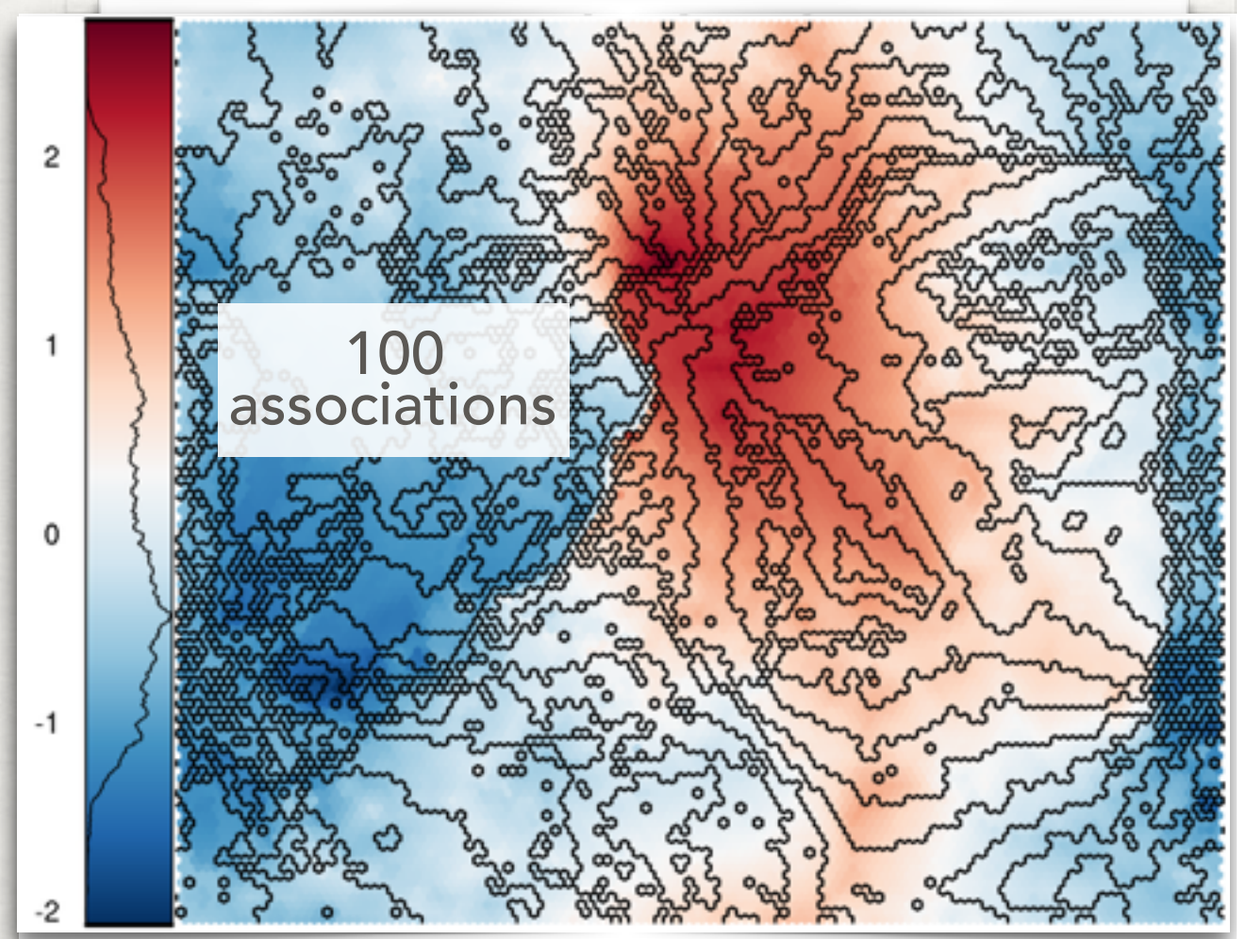

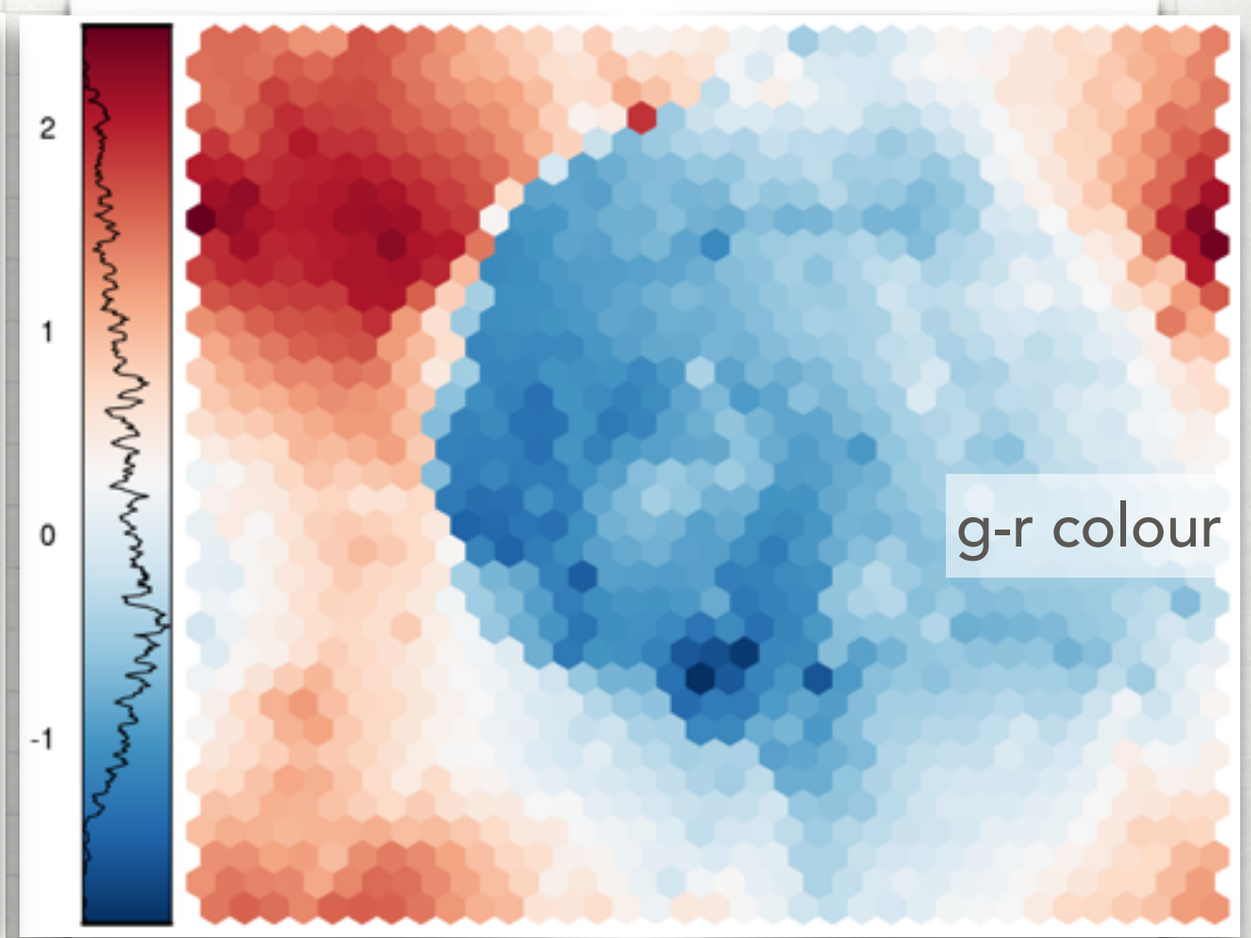

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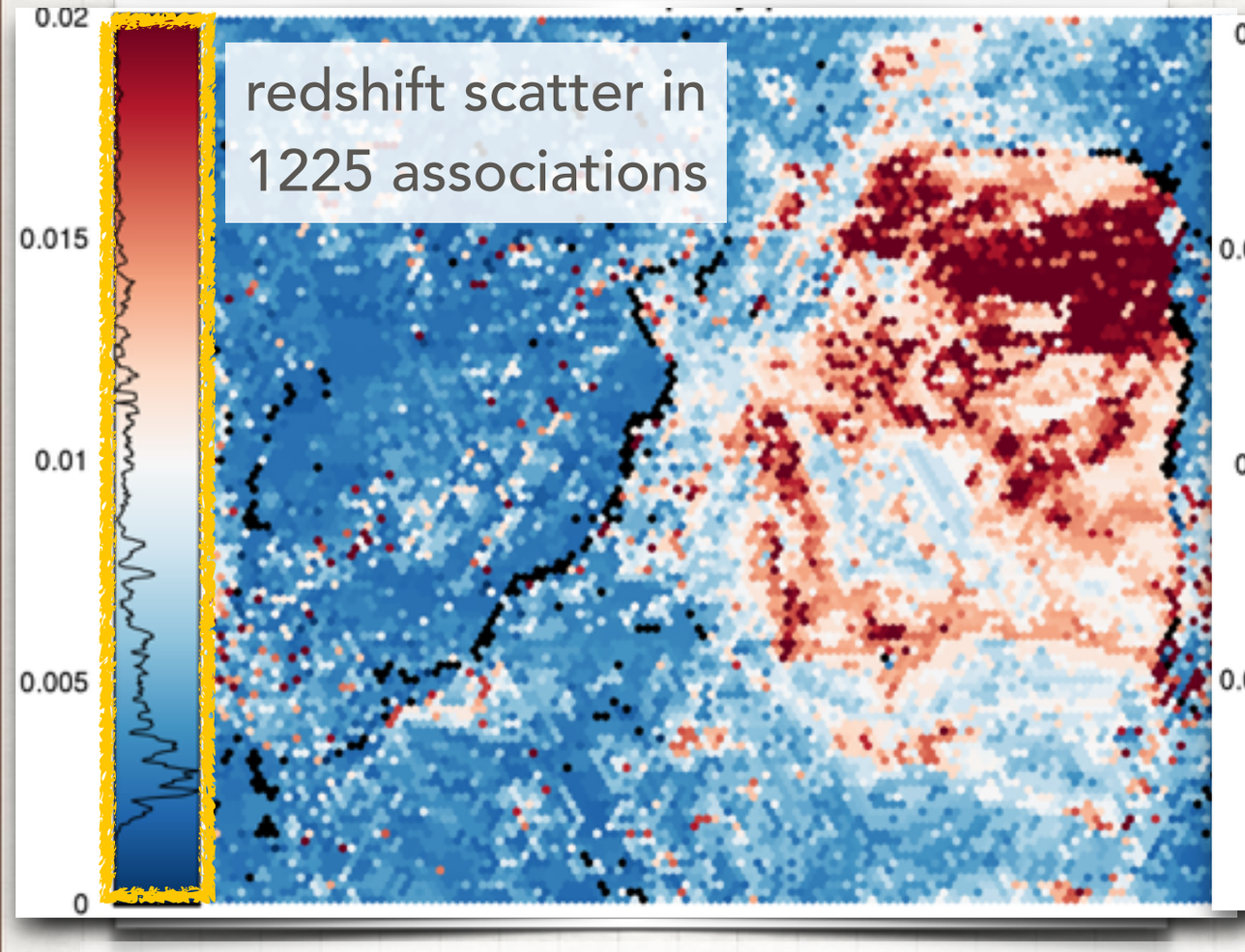

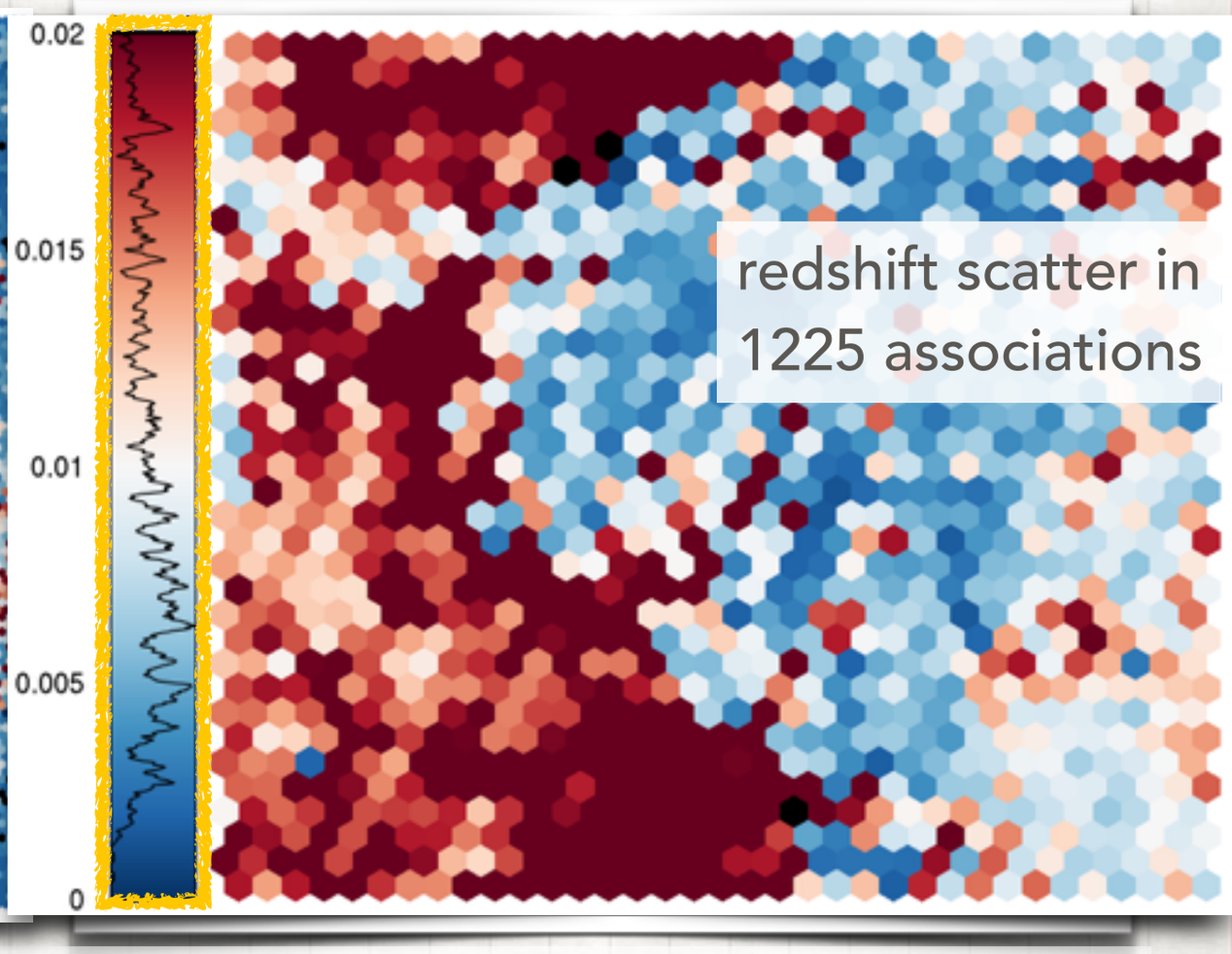

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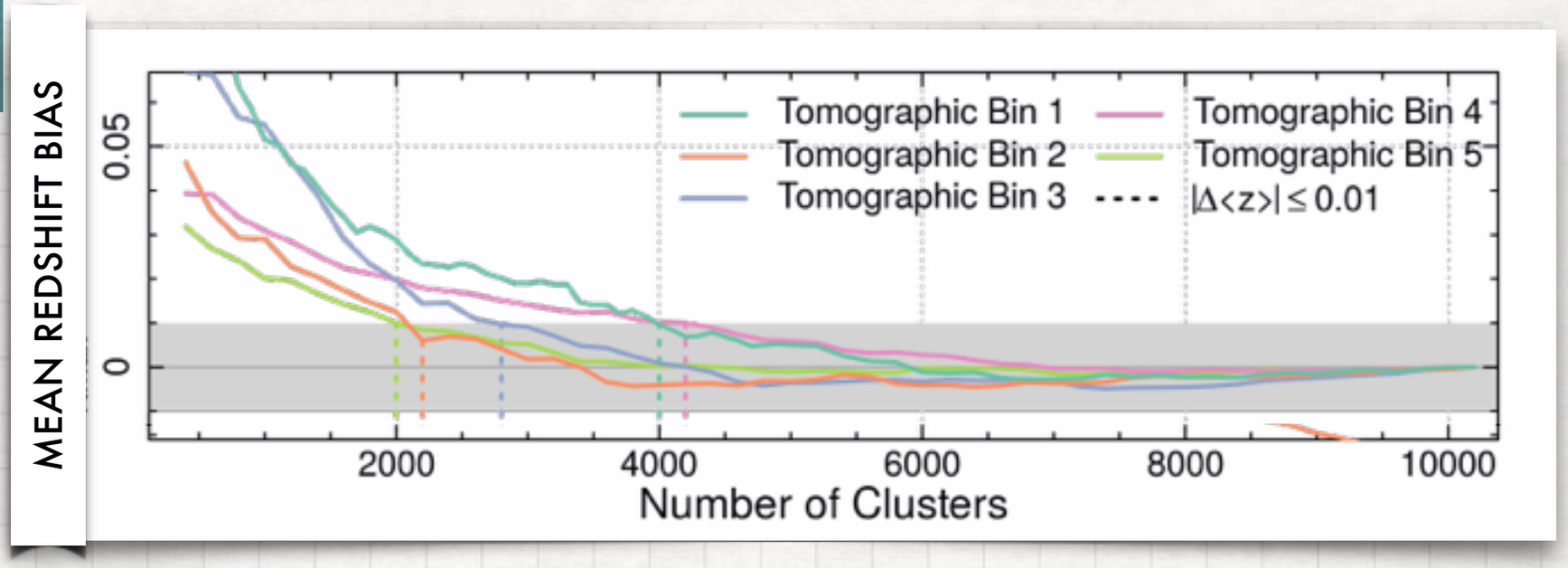
SOM CELL CLUSTERING

IMPROVED NUMBER DENSITY WITHOUT LOSS OF ACCURACY



A SOM trained with ~10,000 cells can then be arbitrarily clustered into N smaller associations.

We can ask the question

“How does the calibration accuracy change a.f.o N associations?”

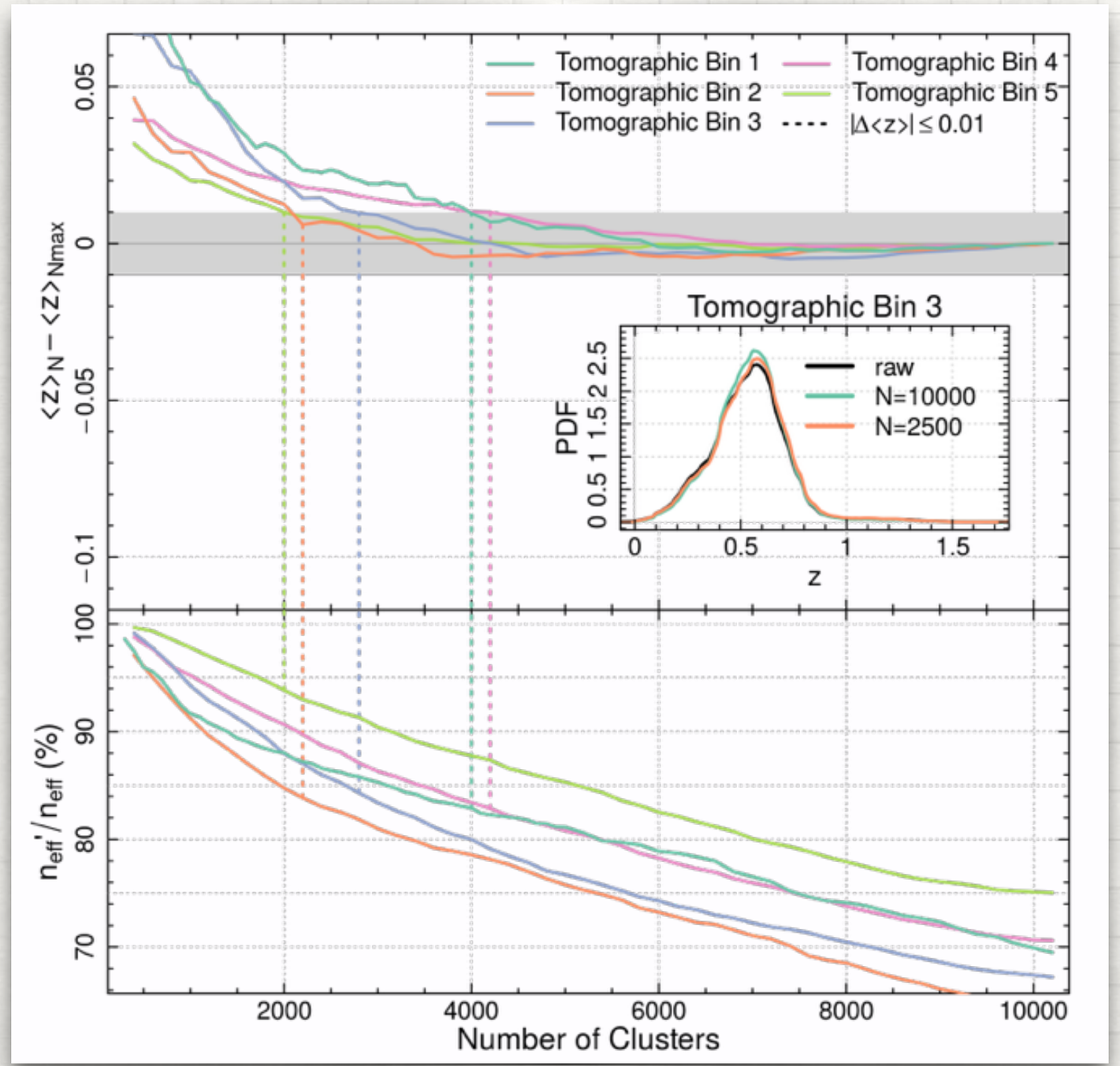
↳ it’s very stable

↳we can make a principled decision where to draw the line

Wright et al (2020a)

SOM CELL CLUSTERING

IMPROVED NUMBER DENSITY WITHOUT LOSS OF ACCURACY



We set the clustering using our $|dz| \sim 0.01$ requirement at the hierarchical clustering level, and thereby define the number of associations.

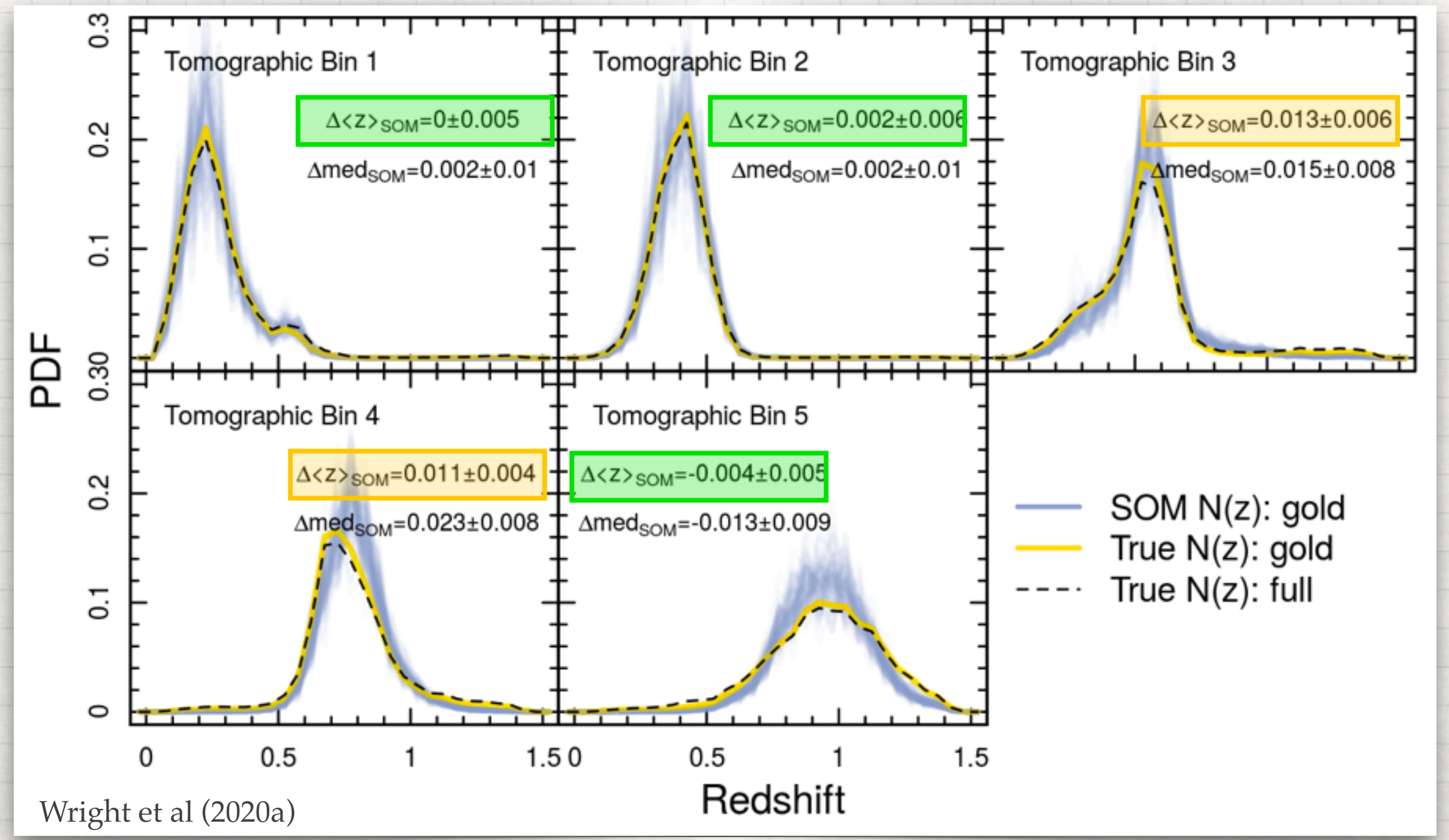
↳ no arbitrary decision

↳ Improved source number density

Wright et al (2020a)

SOM PHOTOMETRIC REDSHIFT CALIBRATION

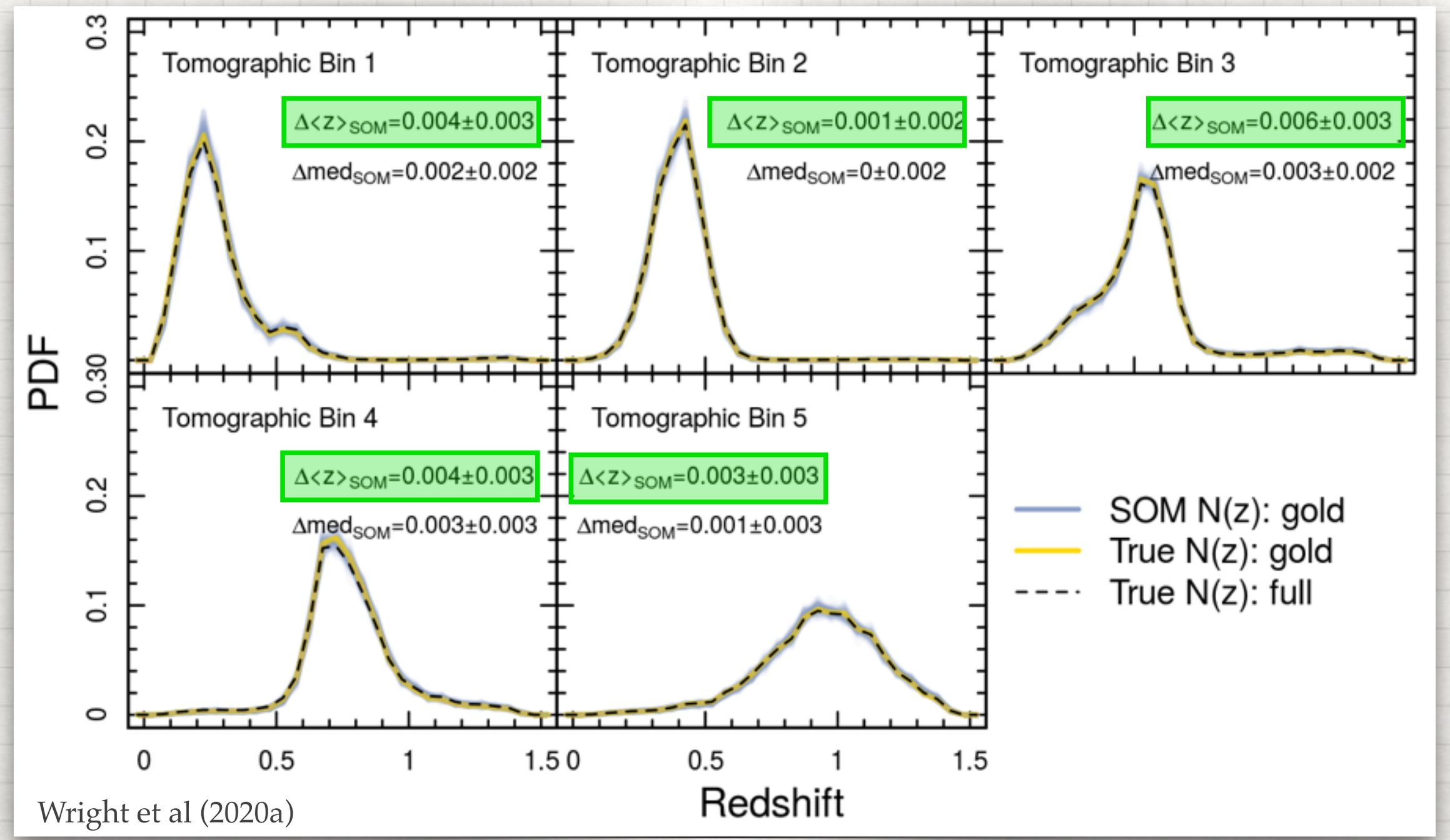
KIDS-LIKE SIMULATIONS FROM MICE2



Wright et al (2020a)

SOM PHOTOMETRIC REDSHIFT CALIBRATION

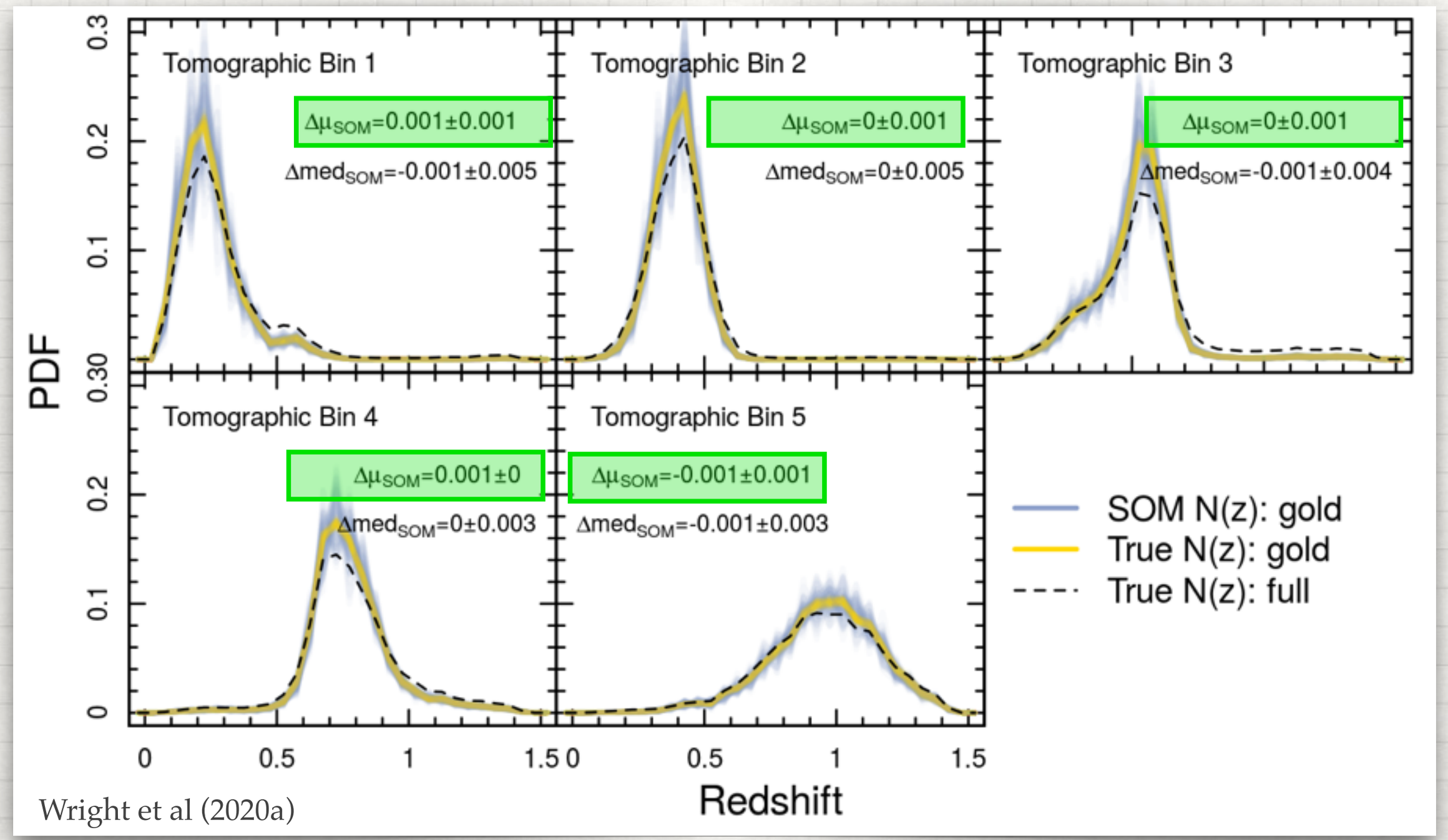
PERFECT SPECTROSCOPY, NOISY PHOTOMETRY



Wright et al (2020a)

SOM PHOTOMETRIC REDSHIFT CALIBRATION

BIASED SPECTROSCOPY, NOISELESS PHOTOMETRY



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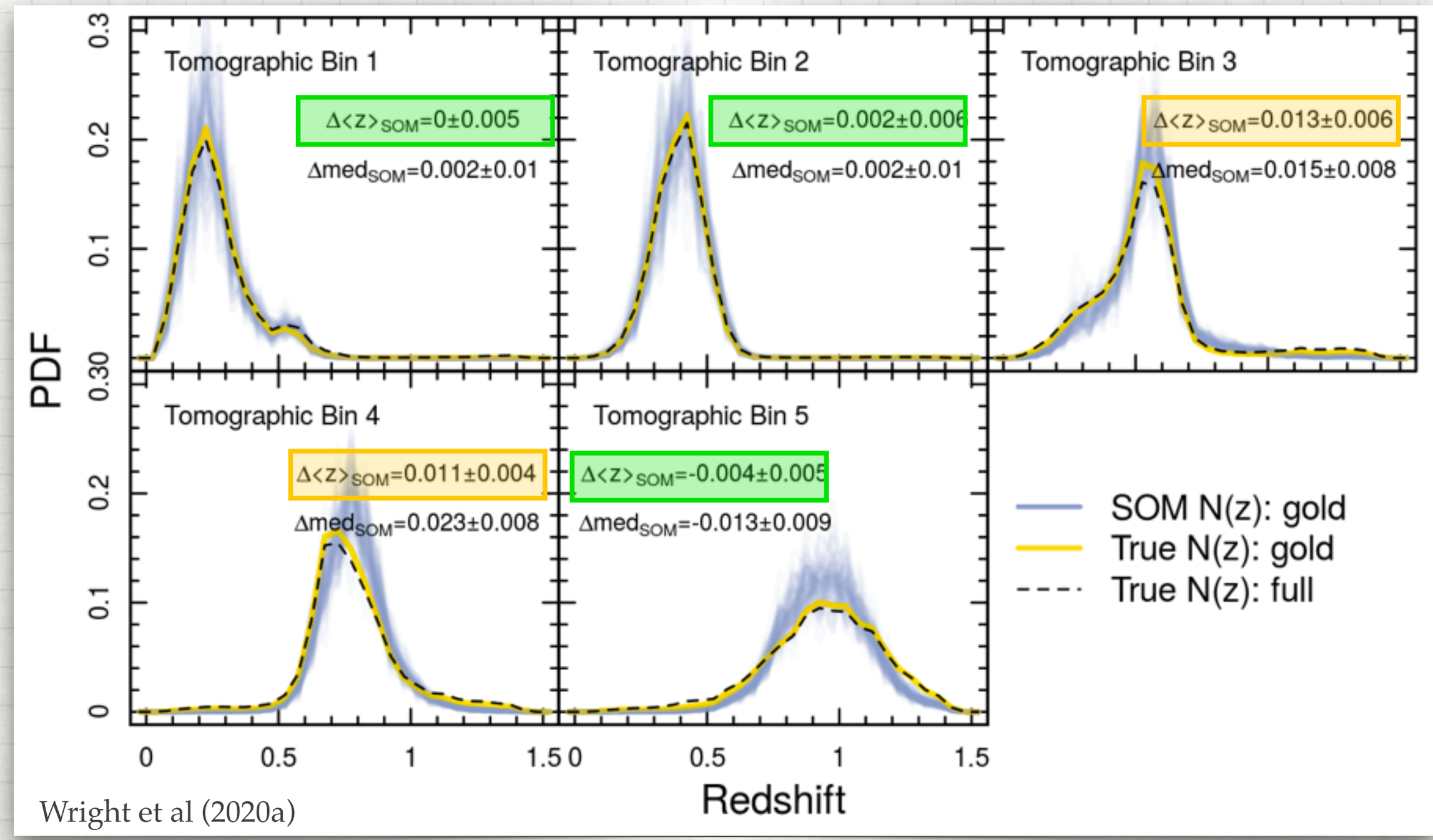
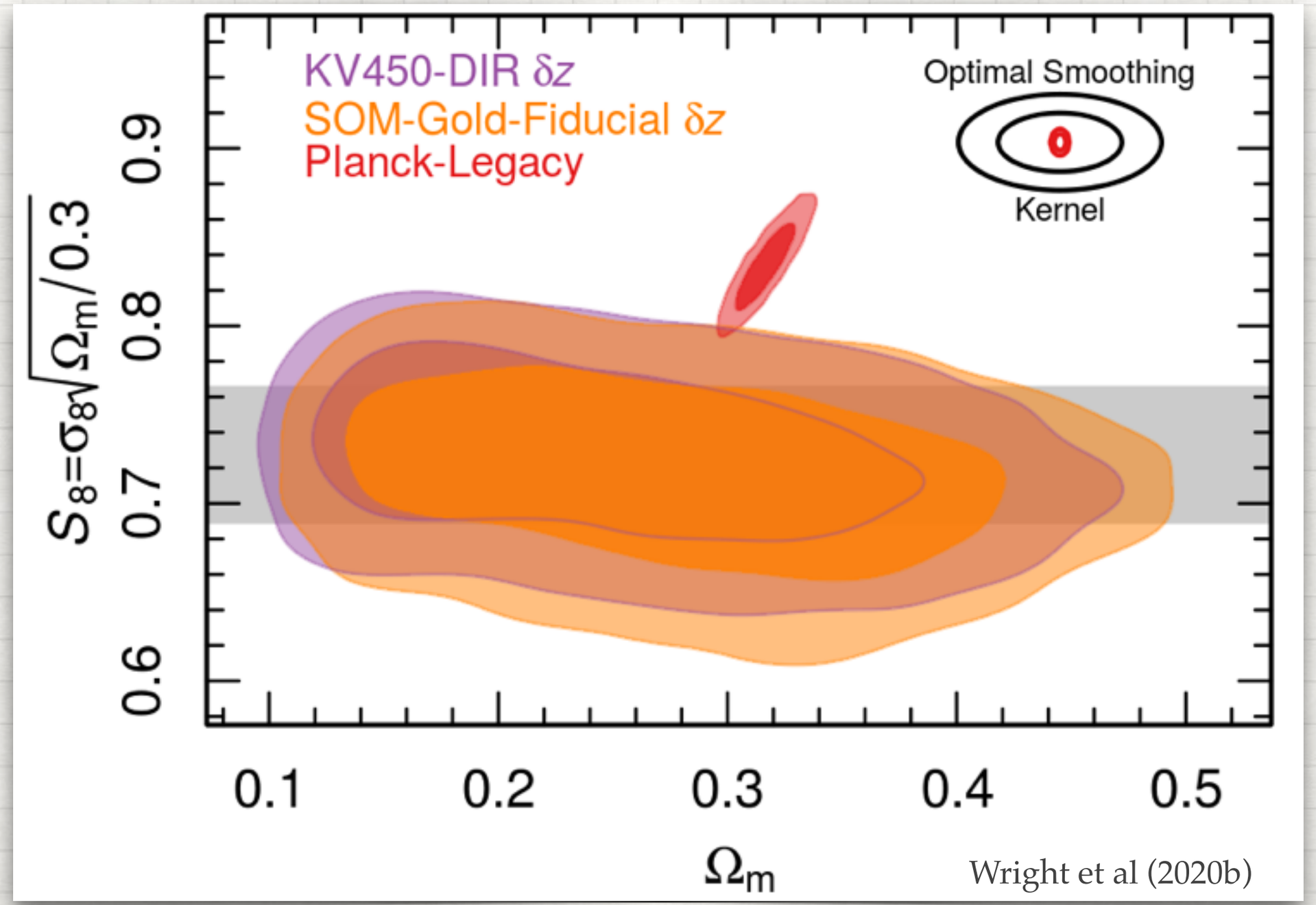


Wright et al (2020a)

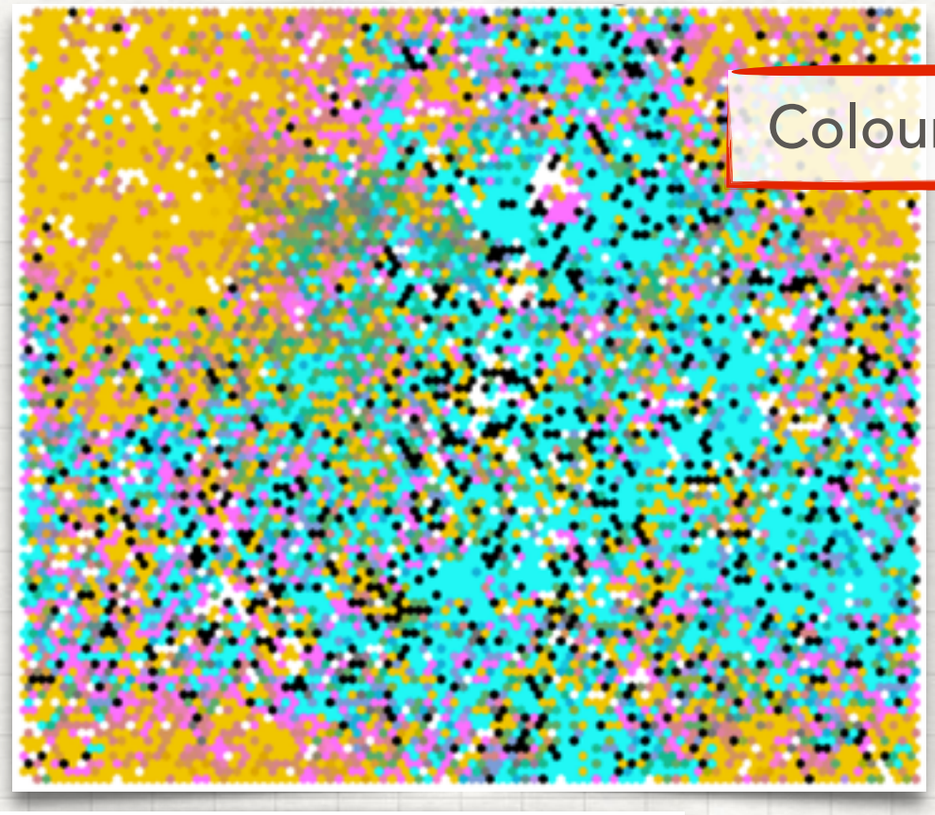
NEW COSMOLOGICAL PARAMETER ESTIMATES

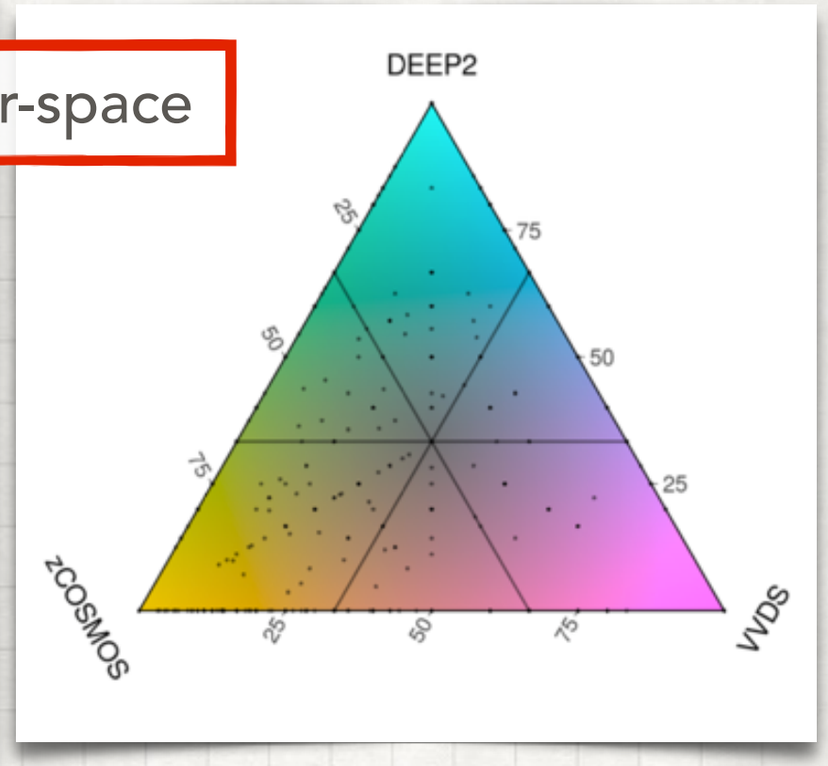
KV450 DIR & GOLD SAMPLES

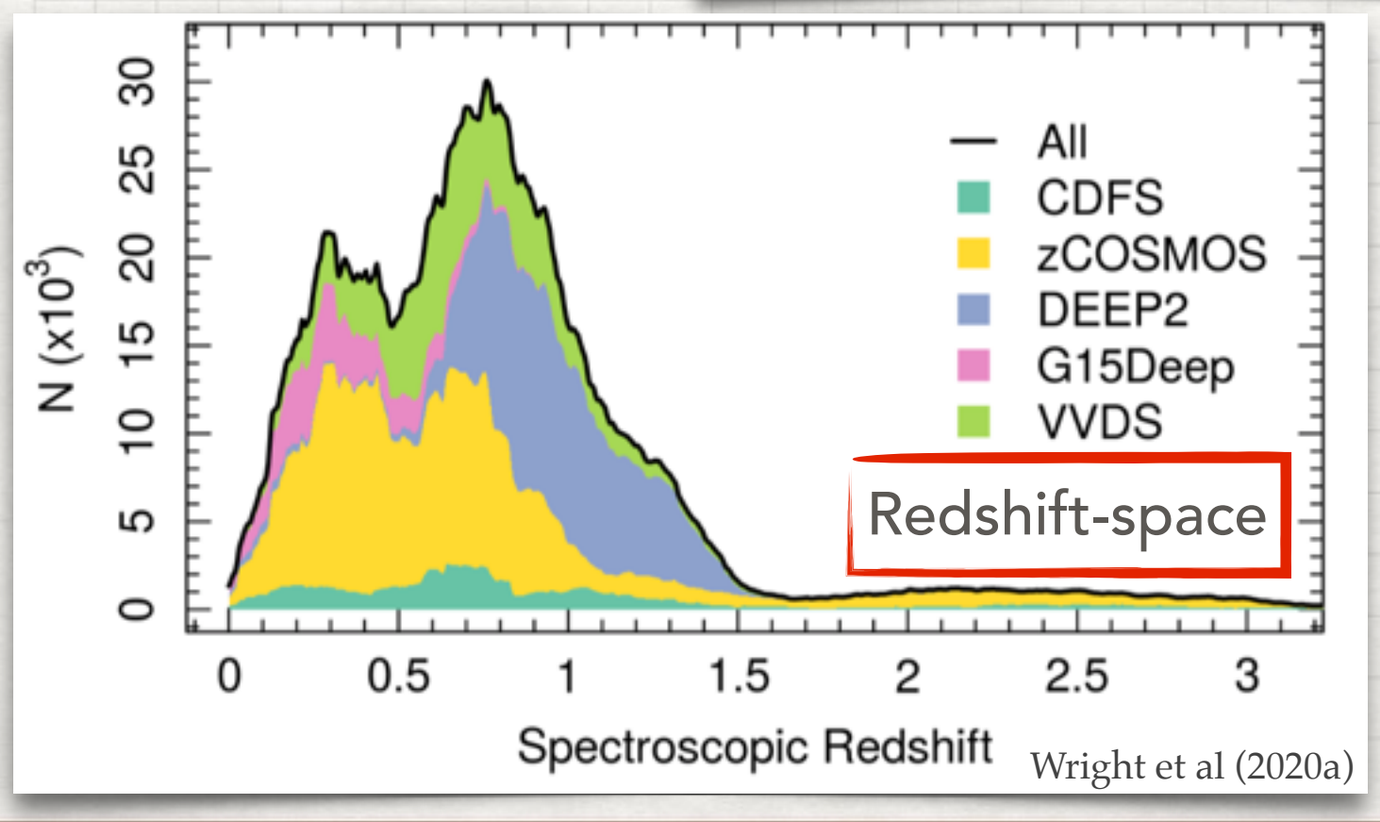


Wright et al (2020b)

THE INFLUENCE OF SPEC-Z MISREPRESENTATION







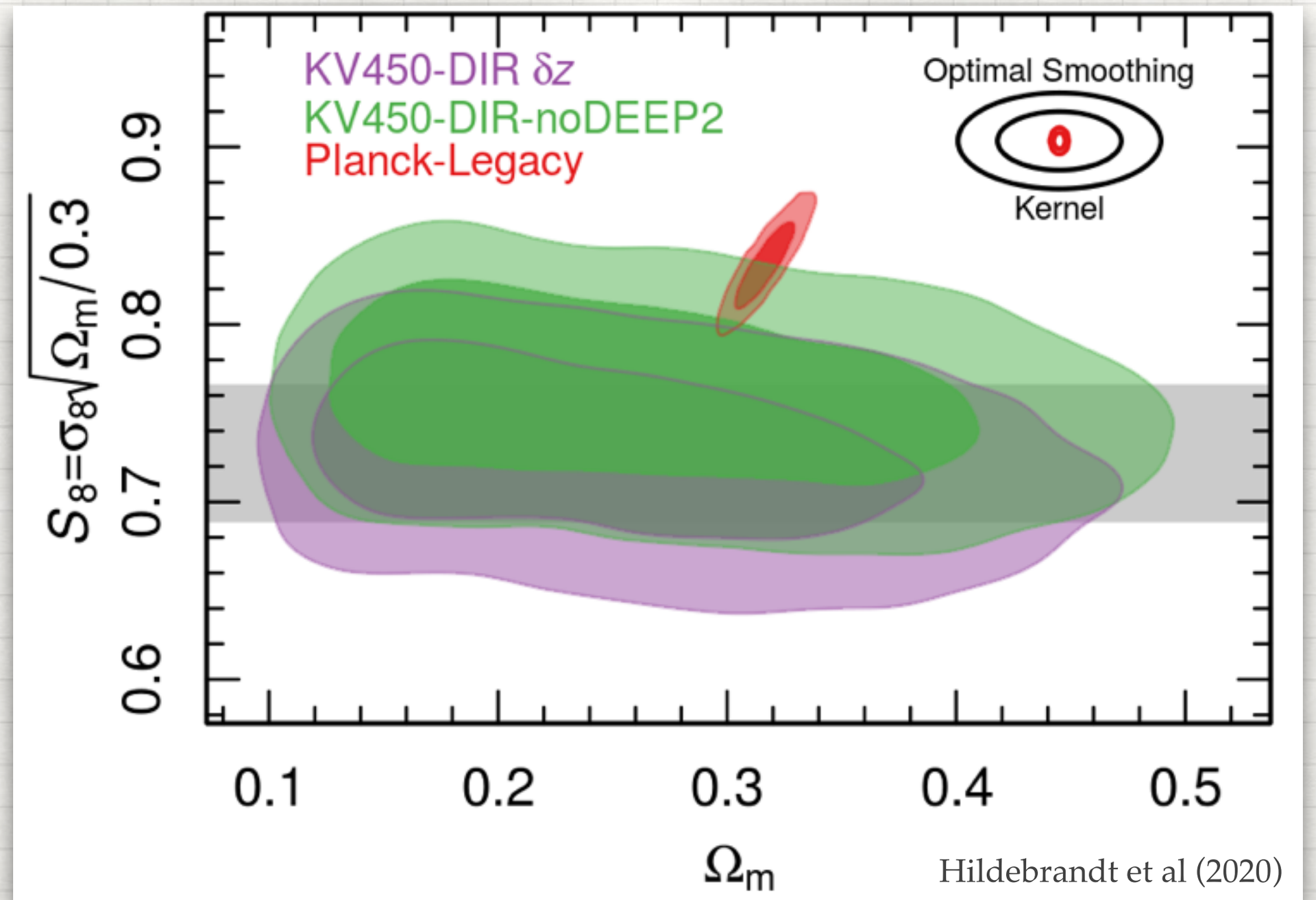
Wright et al (2020a)

Subsets of the spectroscopic data preferentially probe different redshifts/colours:

1. DEEP2: $0.7<z<1.5$ universe
2. zCOSMOS: $0.0<z<0.7$ universe
3. VVDS: $0.3<z<1.0$ universe

THE INFLUENCE OF SPEC-Z MISREPRESENTATION

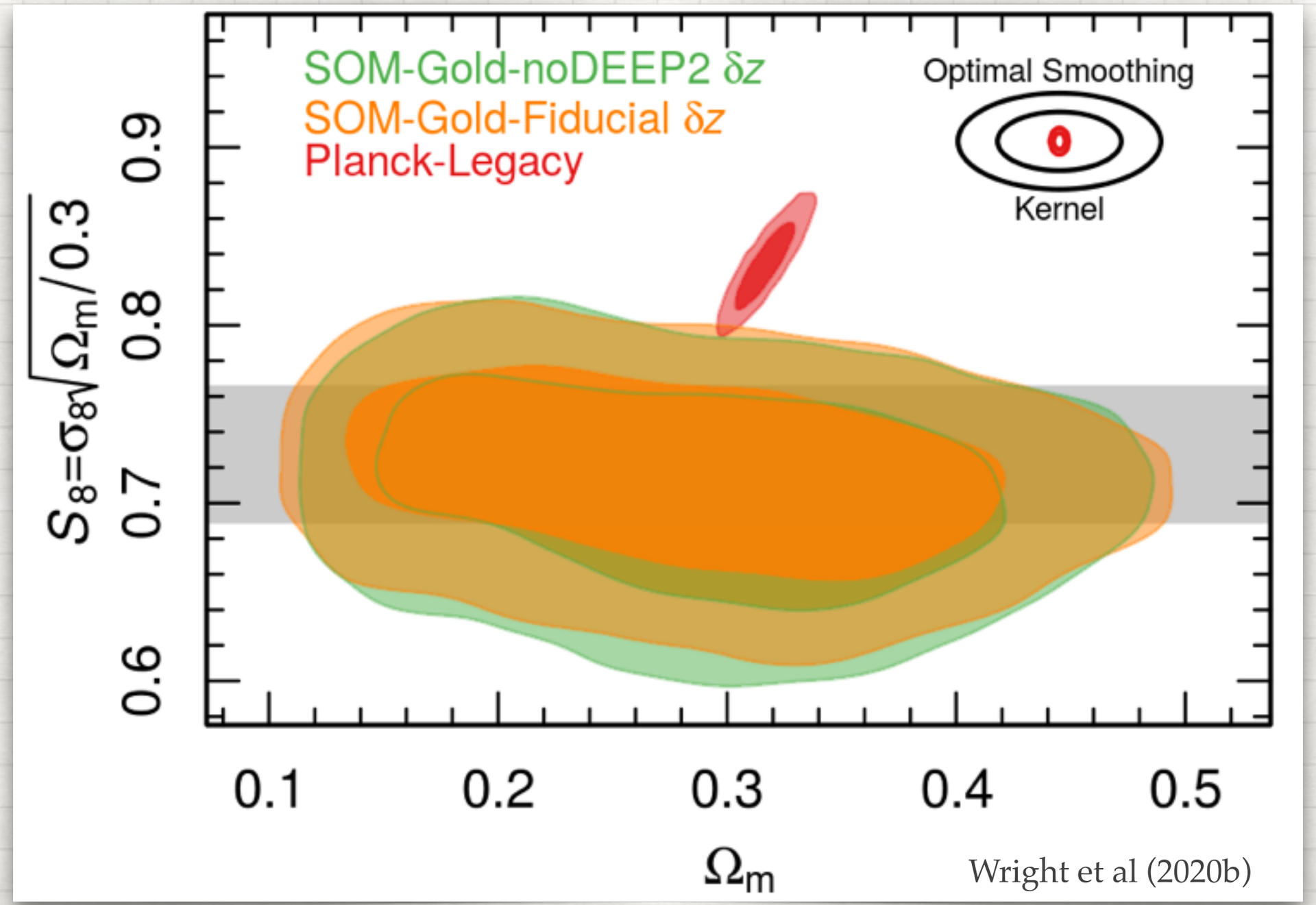
PREVIOUS KIDS CALIBRATION METHOD



Hildebrandt et al (2020)

THE INFLUENCE OF SPEC-Z MISREPRESENTATION

SOM REDSHIFT CALIBRATION



Wright et al (2020b)

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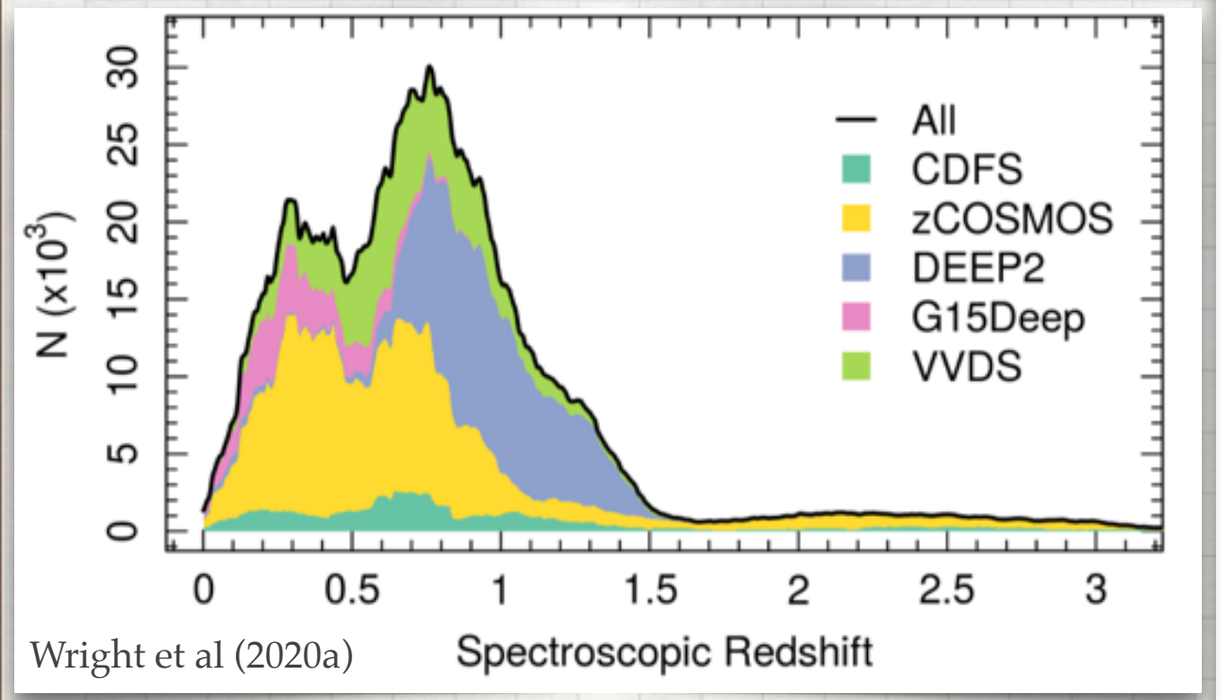
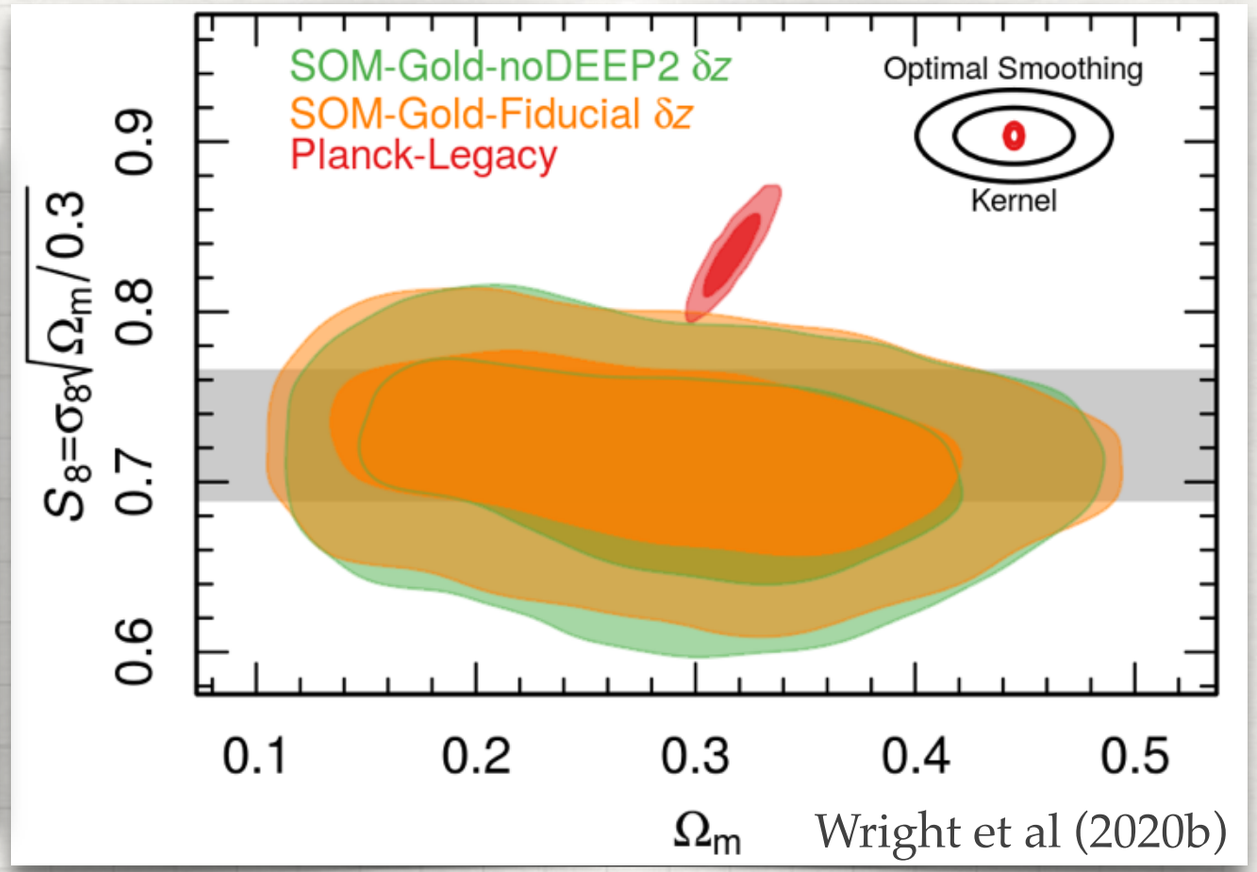


Wright et al (2020a)



Wright et al (2020b)

Removing the primary calibration dataset for the z>0.7 cosmic-shear data now causes no systematic change in the recovered cosmological parameter estimates.

↳ Increase in constraint uncertainties due to the ~40% reduction in source number for the highest-z tomographic bins.

SUMMARY & CONCLUSIONS

WHERE THE SUMMARY AND CONCLUSIONS ARE WRITTEN

- For KiDS-1000 and beyond, we utilise a self-organising map (SOM) strategy for calibration of redshift distributions
- In the noiseless and/or perfectly representative cases, the SOM redshift calibration is unbiased.
- The dominant factors in the accuracy of the redshift calibration are photometric & Poisson noise in the spectroscopic compilation.
- SOM Nz are robust to systematic biases in the spectroscopic colour-space
- Cosmology estimated with SOM Nz are much more robust to selection effects in the spectroscopic compilation than previous direct calibration implementations.