

IAP UNIVERSE WEBINAR

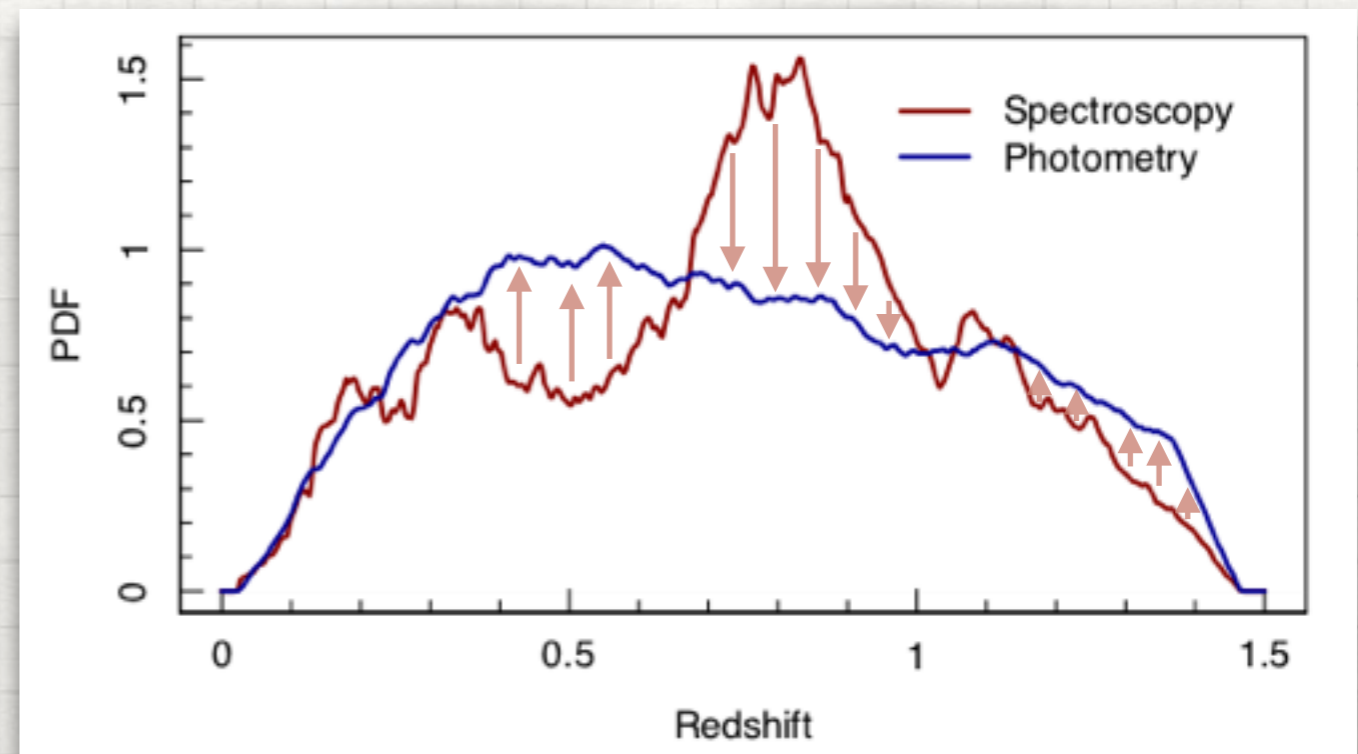
03-11-2020

TRANSLATING PIXELS INTO COSMOLOGY FOR KIDS-1000

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RESEARCH FELLOW

GERMAN CENTRE FOR
COSMOLOGICAL LENSING (GCCL)

RUHR-UNIVERSITÄT BOCHUM,
GERMANY



KiDS-1000 Core Cosmology Team

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Survey Production: Kuijken, Heymans, **Dvornik**, Hildebrandt, **Wright** et al.

Photometric Redshifts: Hildebrandt, **van den Busch**, **Wright** et al.

Shear Measurements: **Giblin**, Heymans, **Asgari** et al.

Methodology: Joachimi, **Lin**, **Asgari**, **Tröster**, Heymans et al.

Cosmic Shear Cosmology: **Asgari**, **Lin**, Joachimi et al.

3x2pt Cosmology: Heymans, **Tröster** et al.

Cosmology Beyond Λ CDM: **Tröster** et al.



**Benjamin
Giblin**



Marika Asgari



Tilman Tröster



**Konrad
Kuijken**



**Hendrik
Hildebrandt**



**Catherine
Heymans**



Andrej Dvornik



**Jan Luca
van den Busch**



**Benjamin
Joachimi**

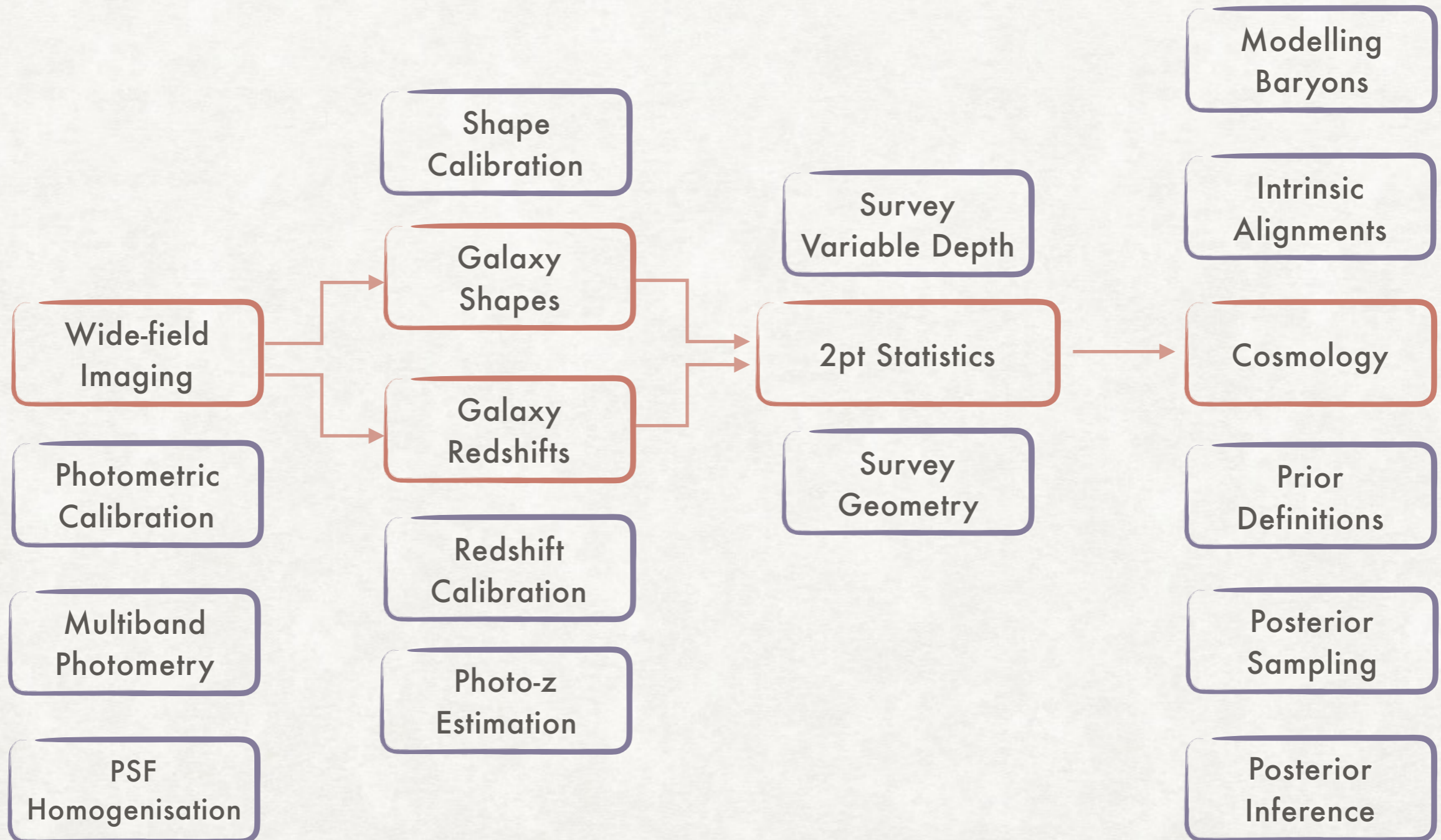


Chieh-An Lin

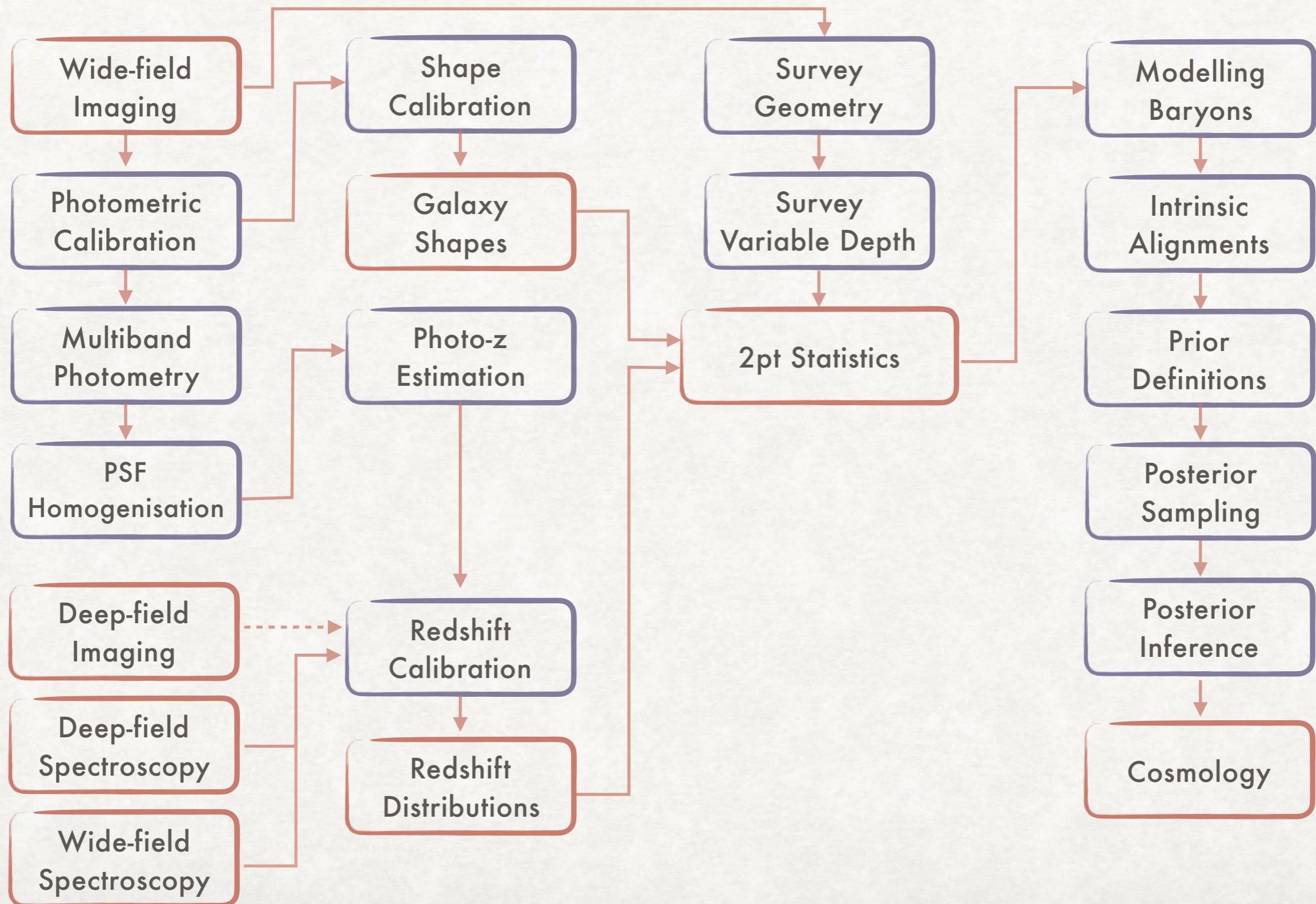


Angus H Wright

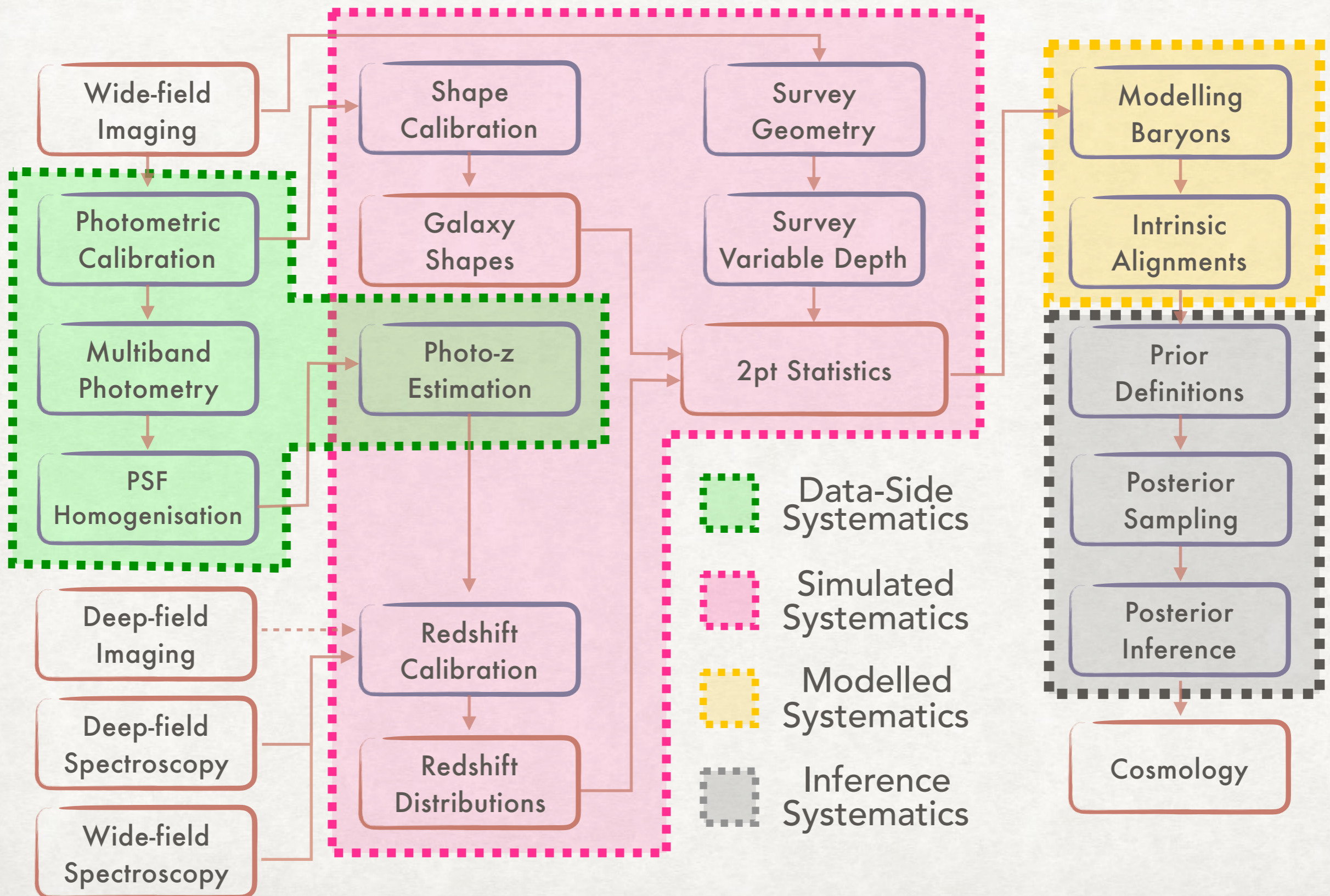
COSMIC SHEAR WEAK LENSING



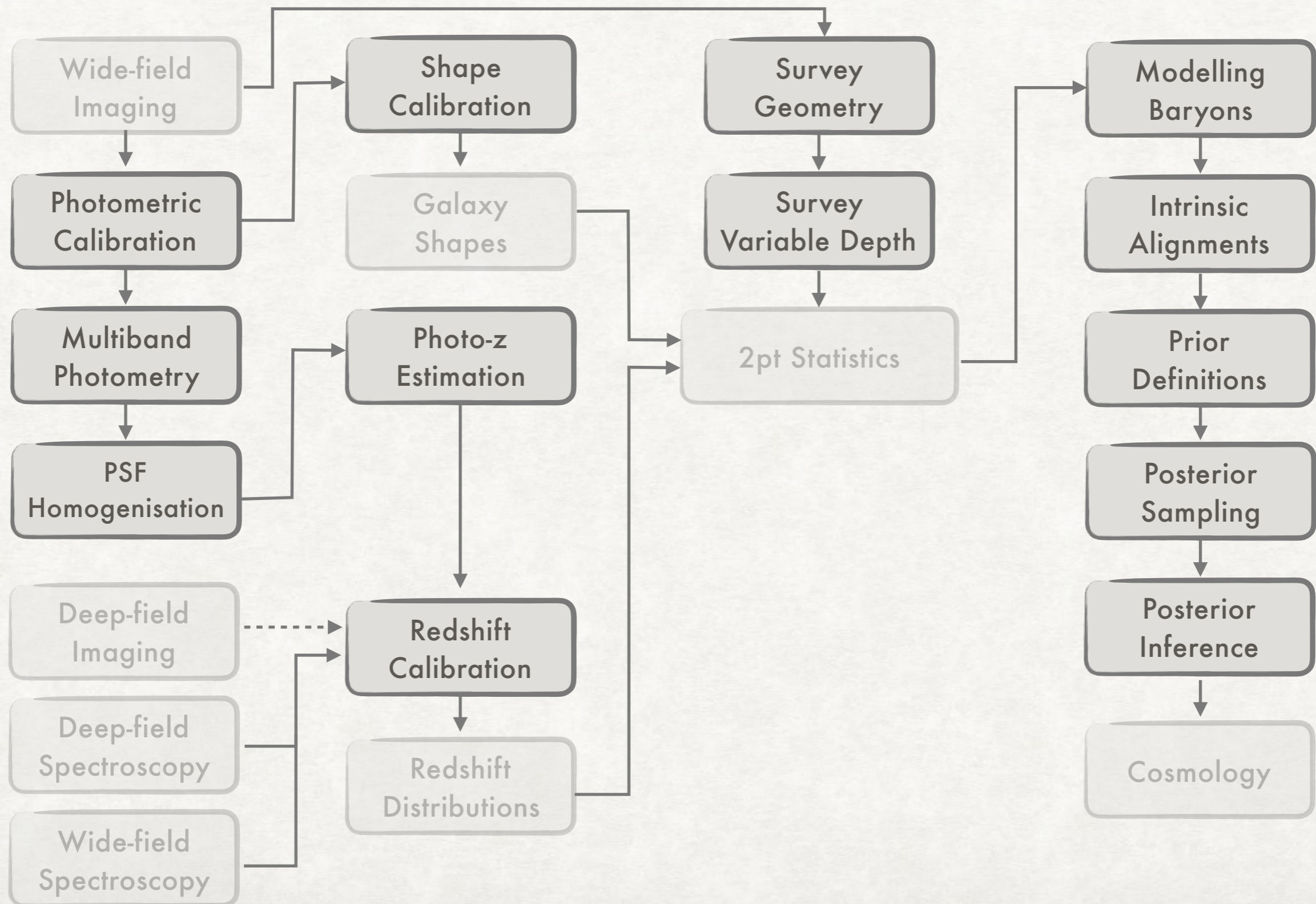
COSMIC SHEAR WEAK LENSING



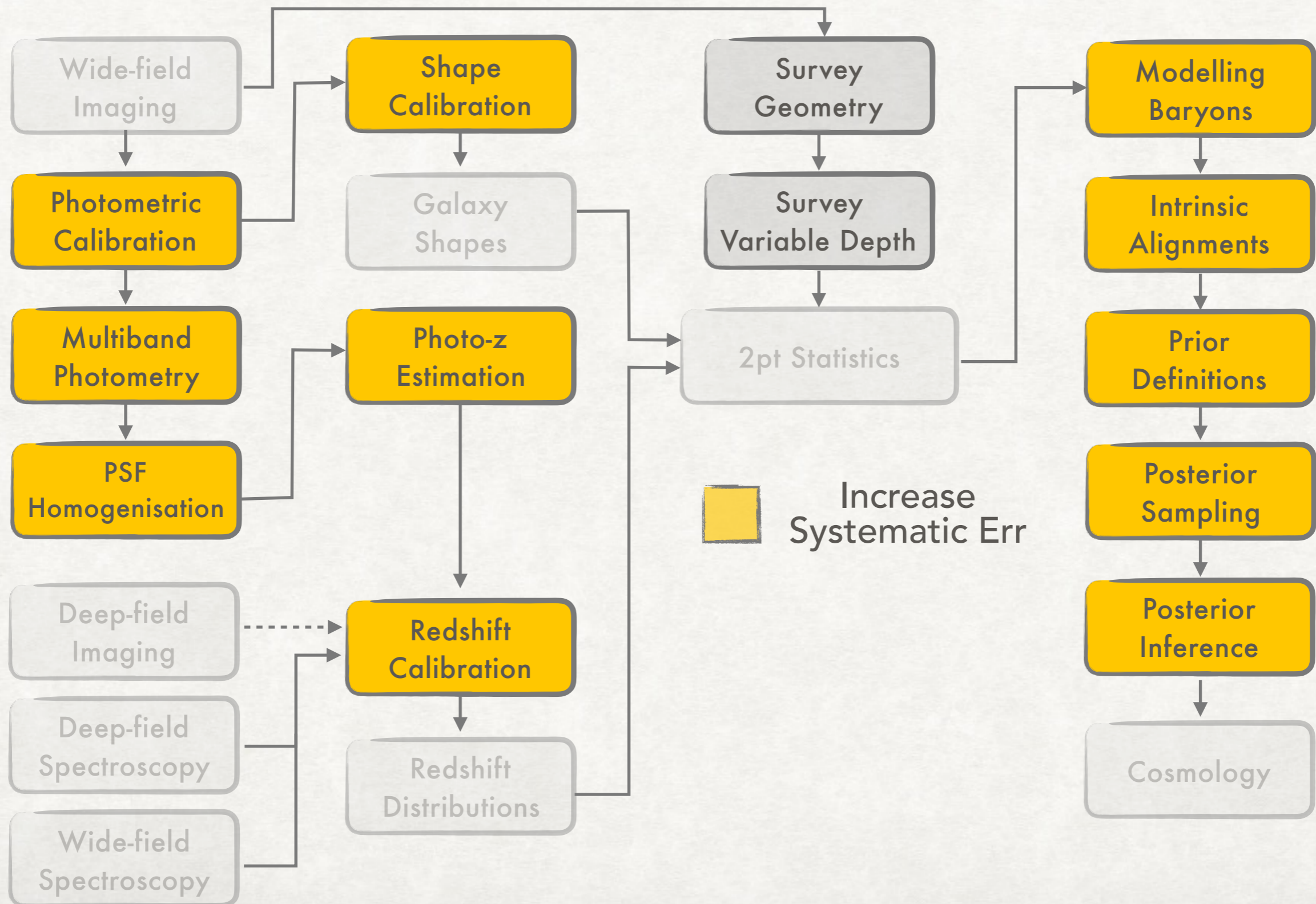
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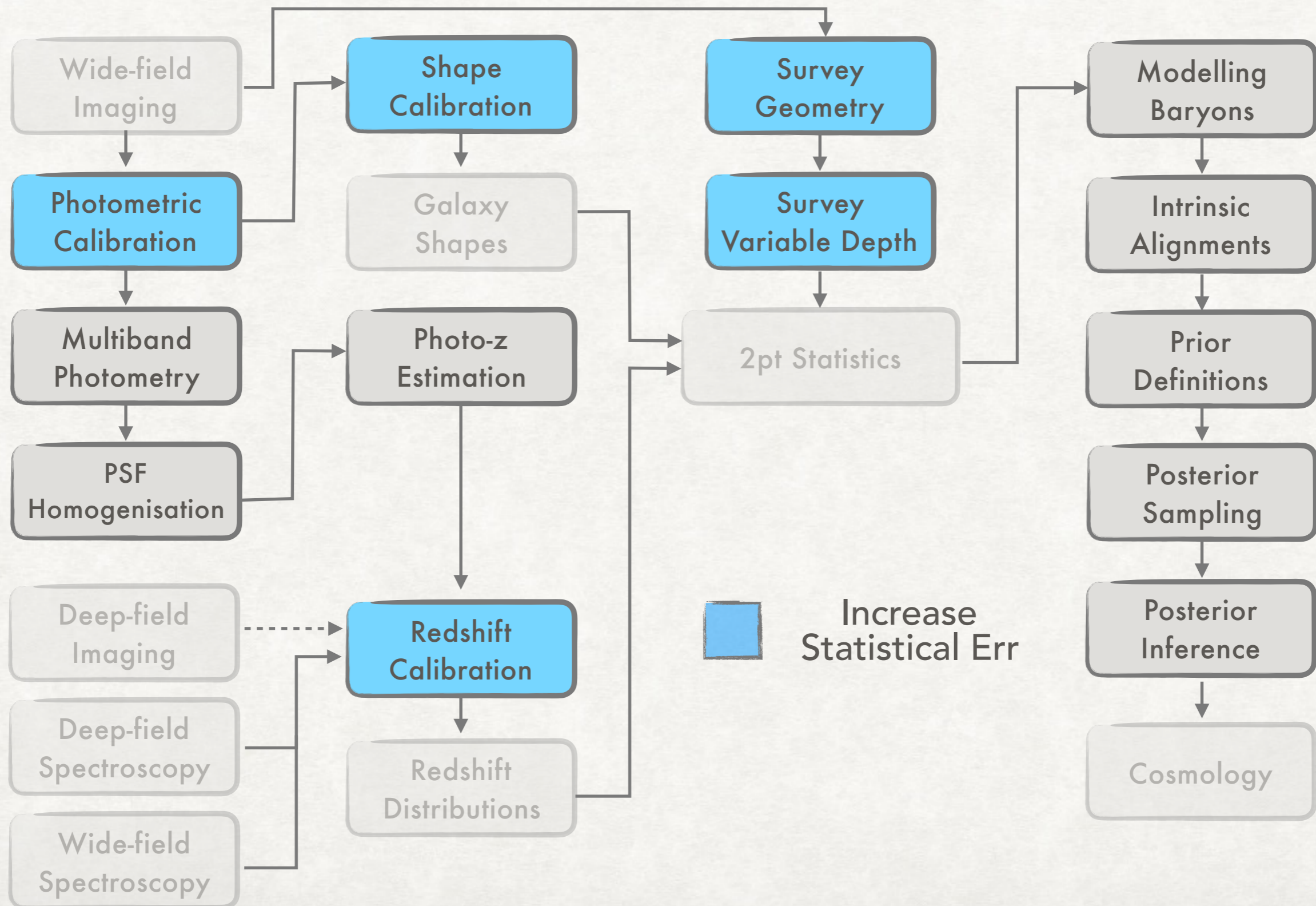
COSMIC SHEAR SYSTEMATICS



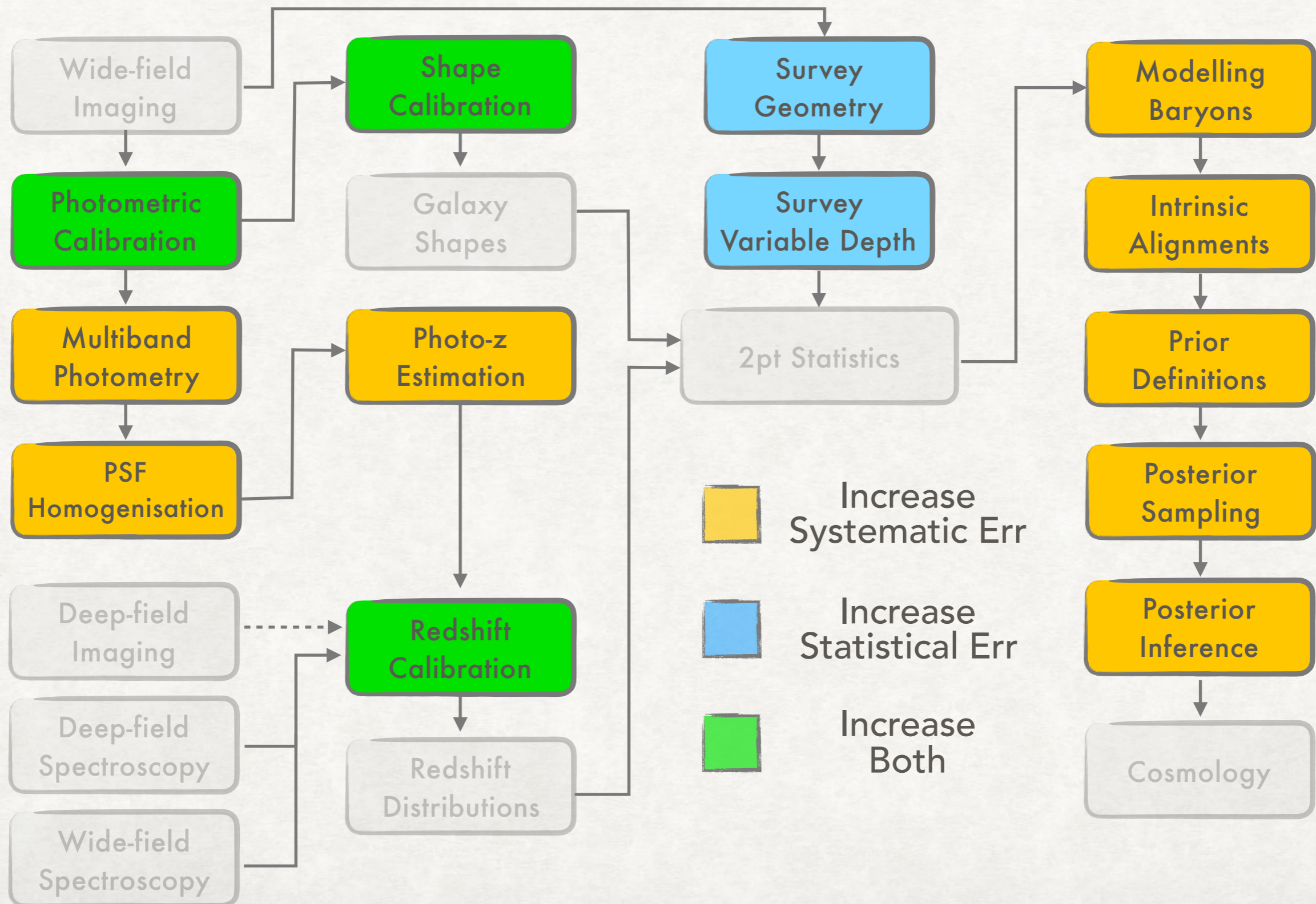
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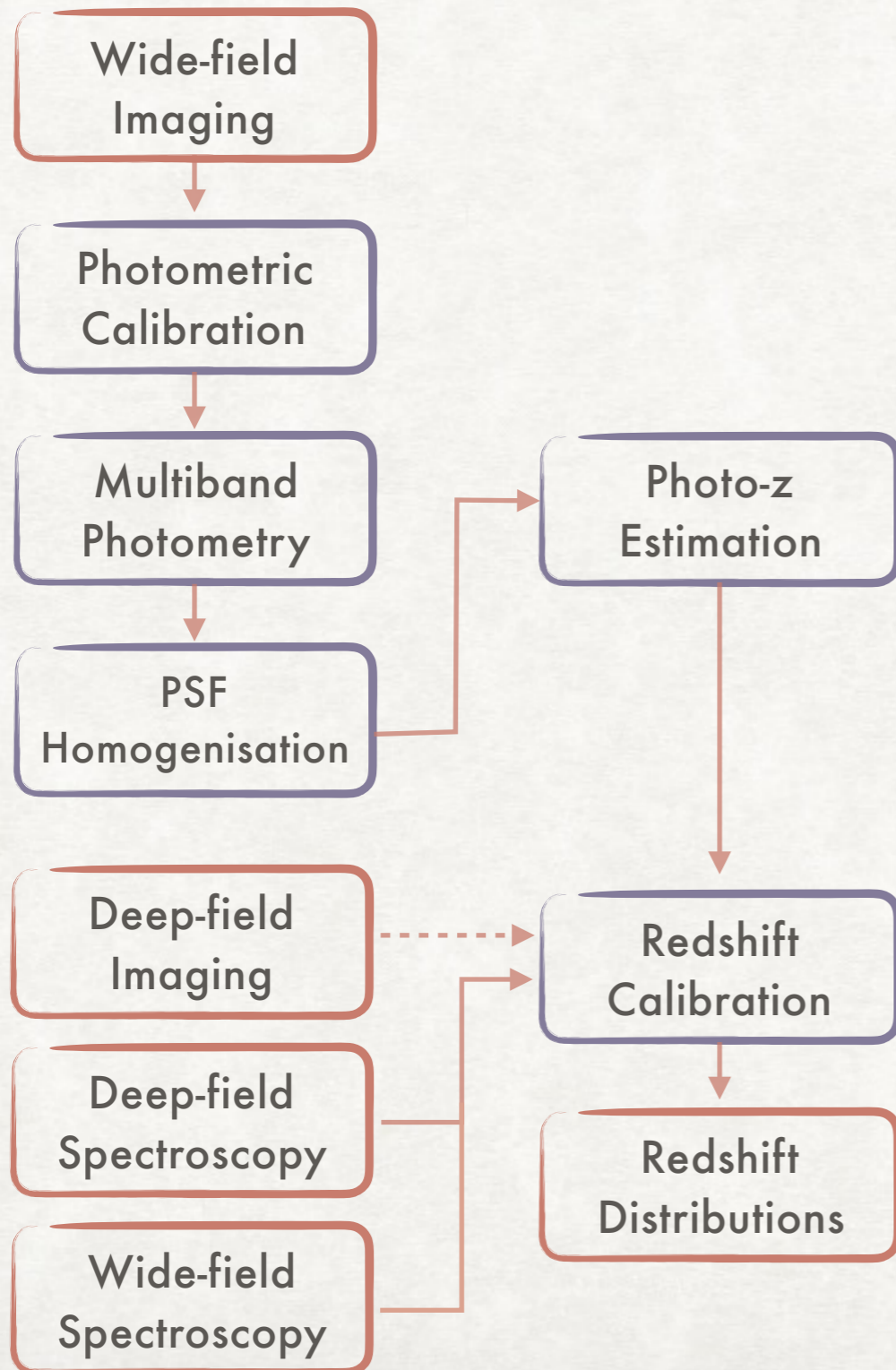
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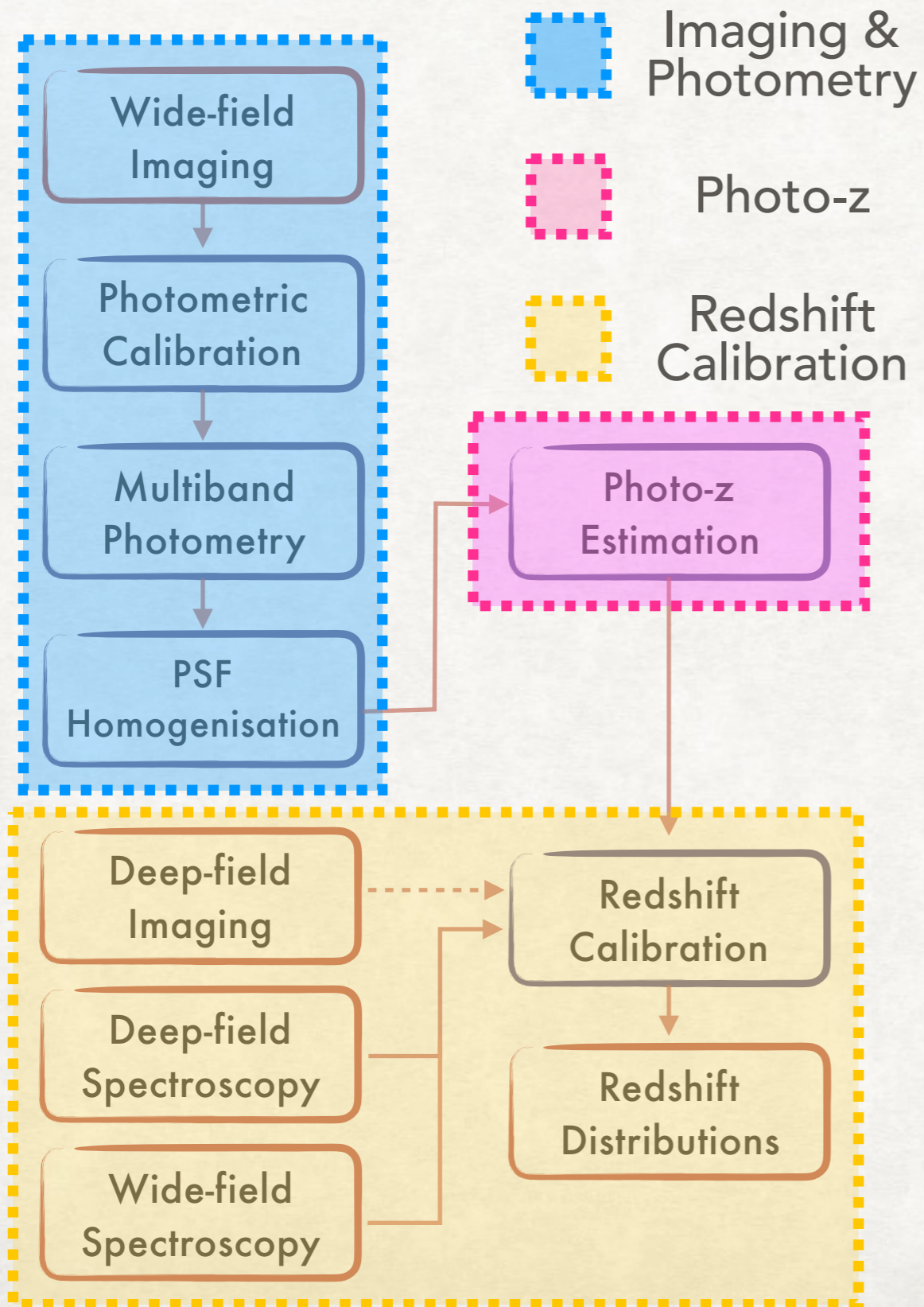
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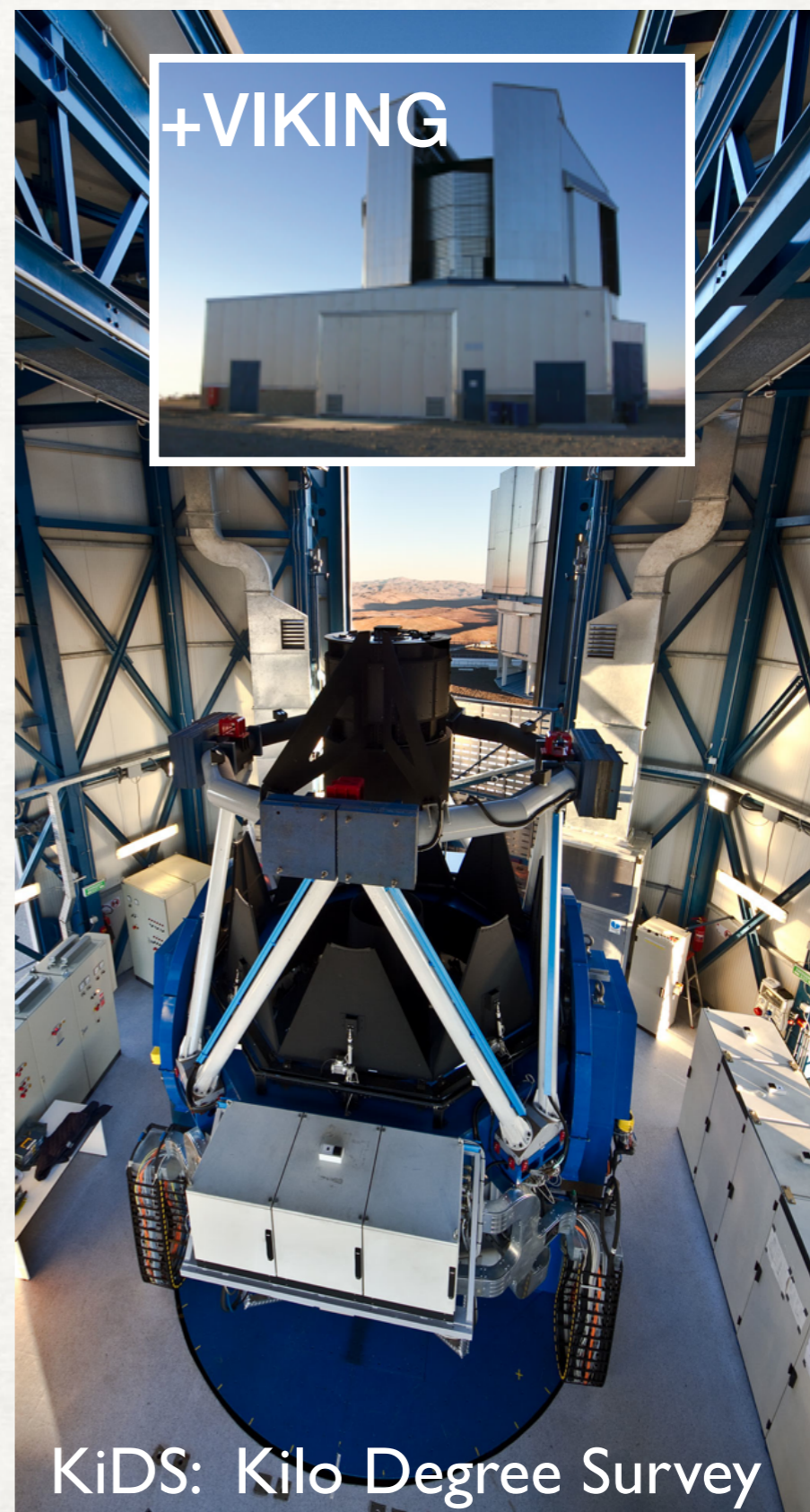
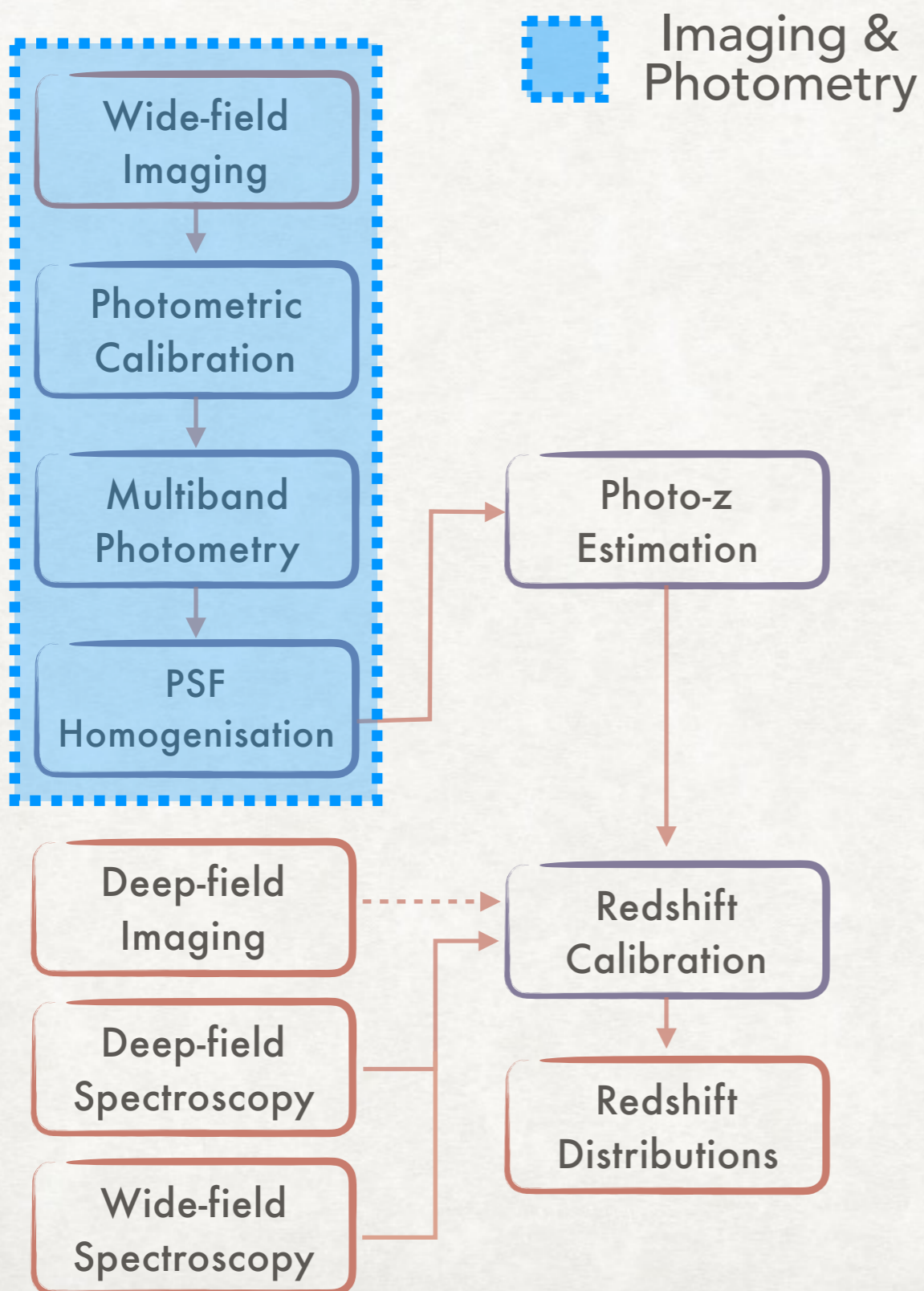
COSMIC SHEAR REDSHIFT CALIBRATION



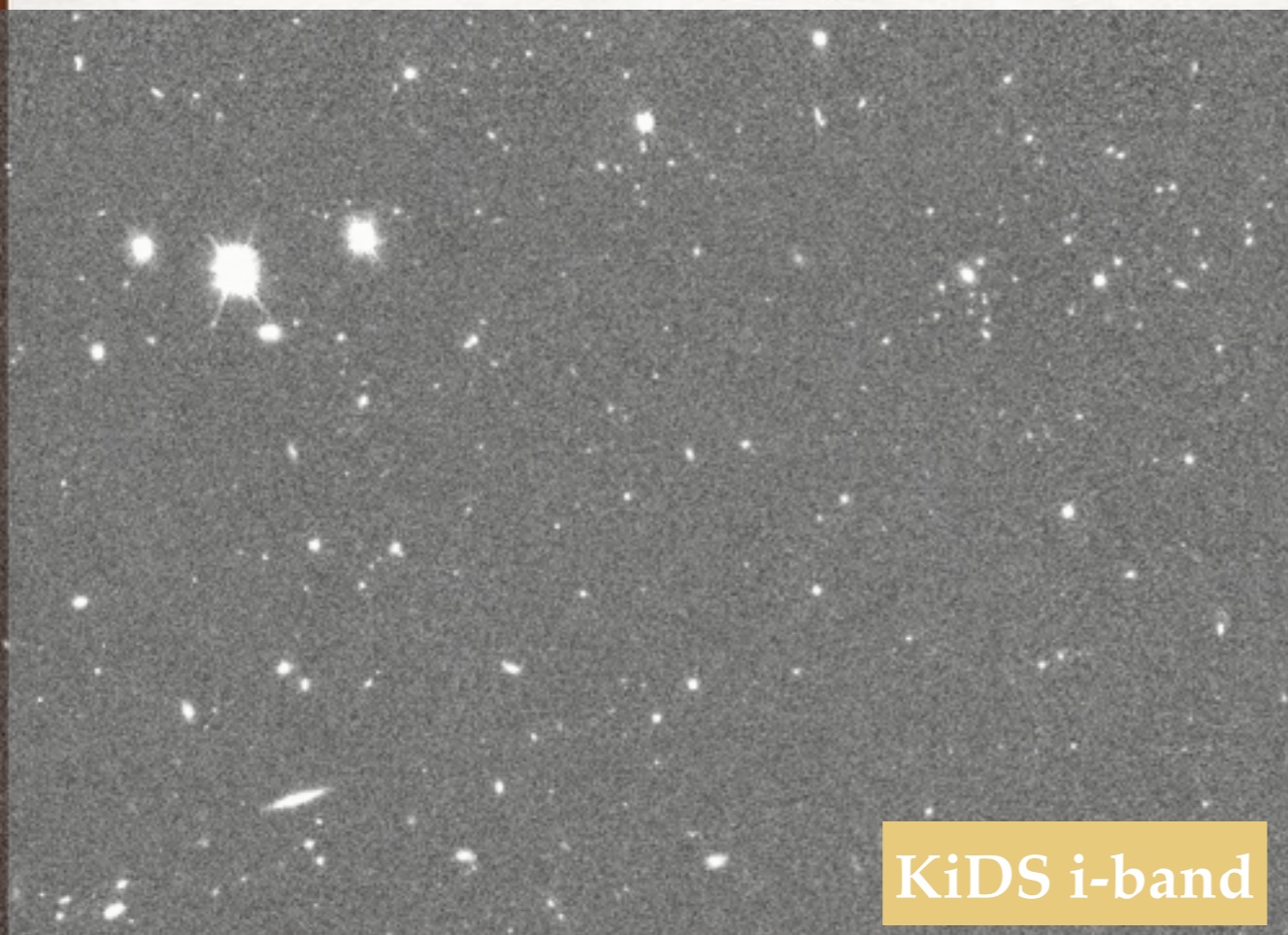
COSMIC SHEAR REDSHIFT CALIBRATION



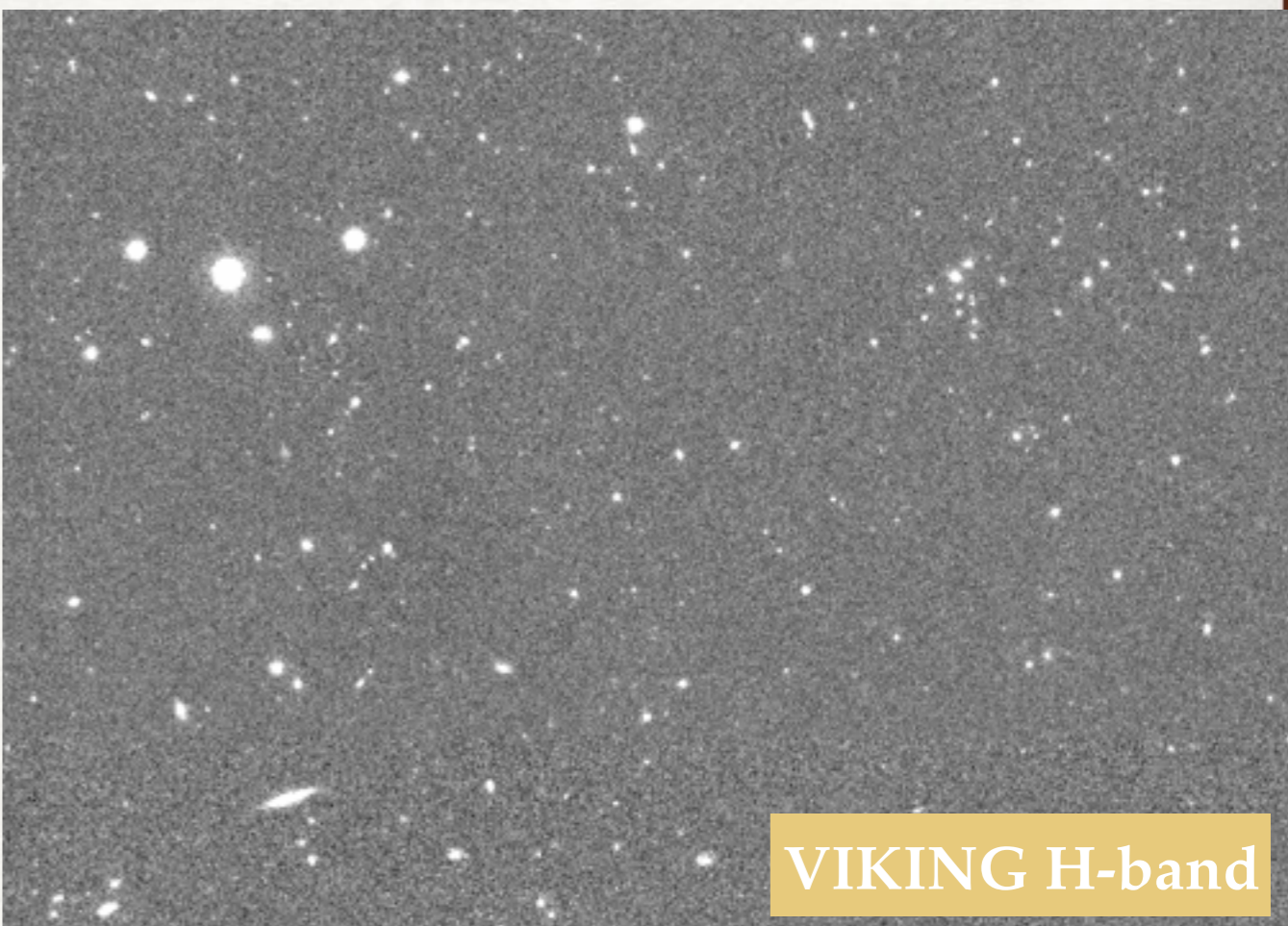
KIDS-1000 IMAGING & PHOTOMETRY



KIDS-1000 IMAGING & PHOTOMETRY

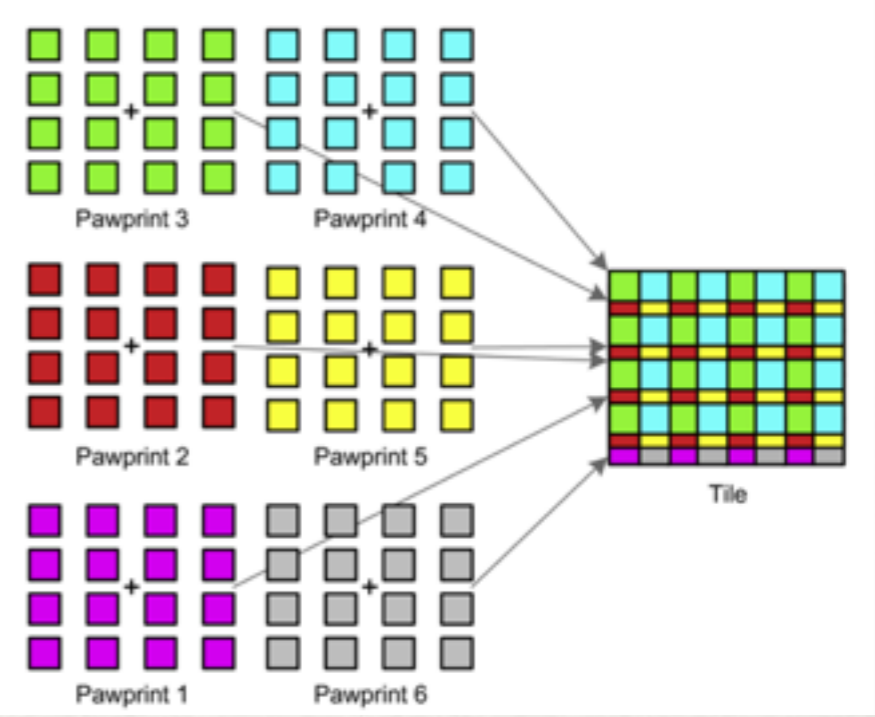
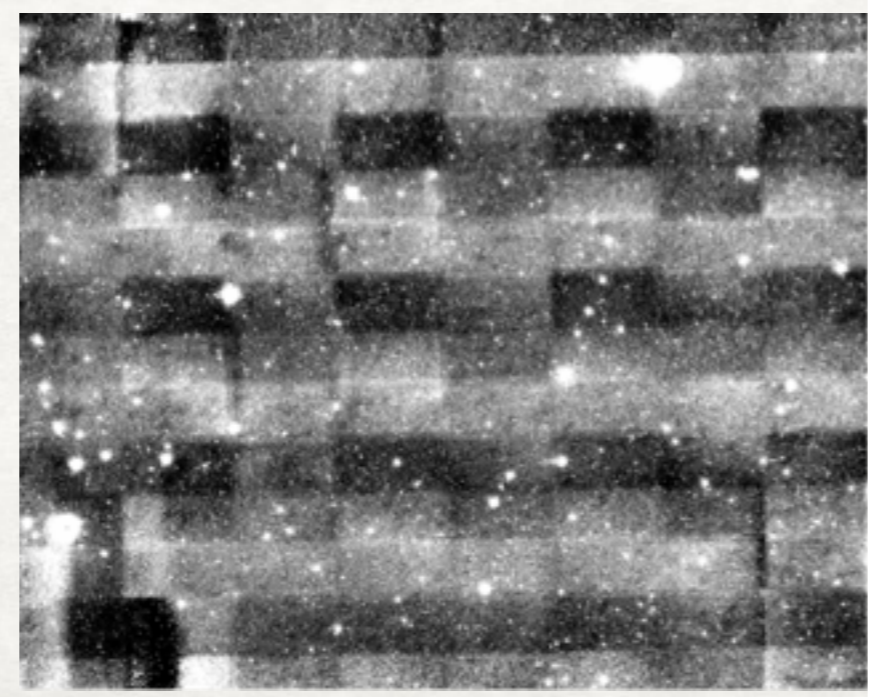


KiDS i-band

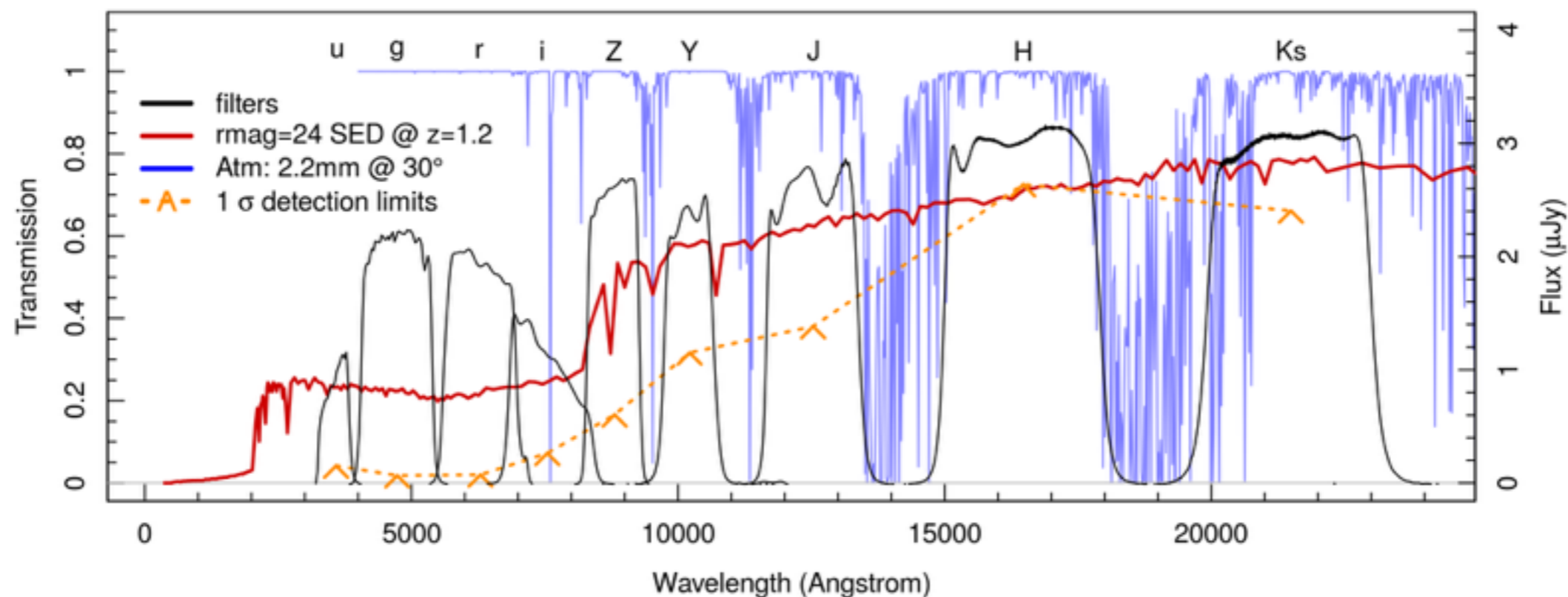


VIKING H-band

Band(s)	f_{good}	f_{meas}
<i>u</i>	0.998	0.791
<i>g</i>	1.000	0.990
<i>r</i>	1.000	1.000
<i>i</i>	1.000	0.950
<i>Z</i>	0.991	0.982
<i>Y</i>	0.990	0.963
<i>J</i>	0.999	0.990
<i>H</i>	0.988	0.930
<i>K_s</i>	0.992	0.941

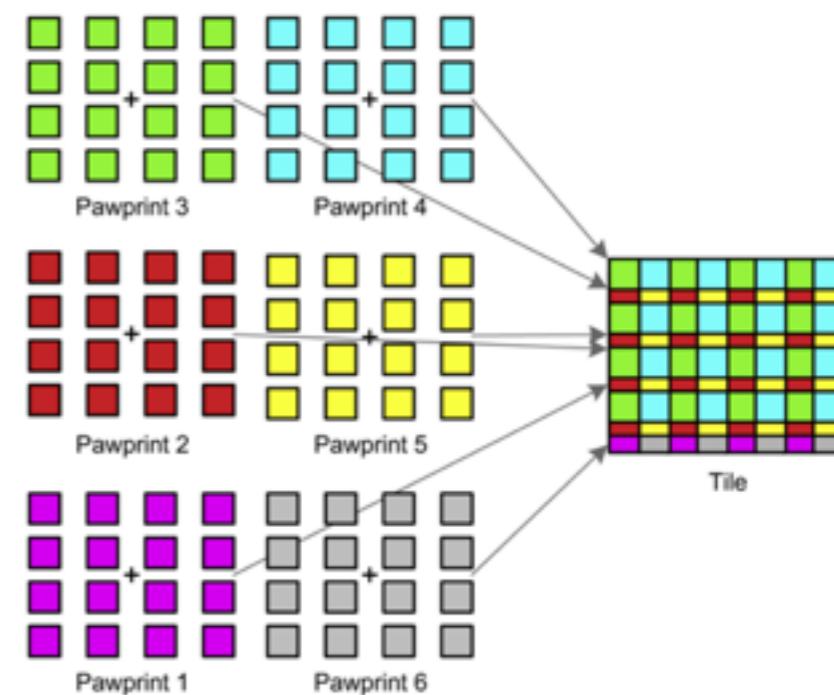
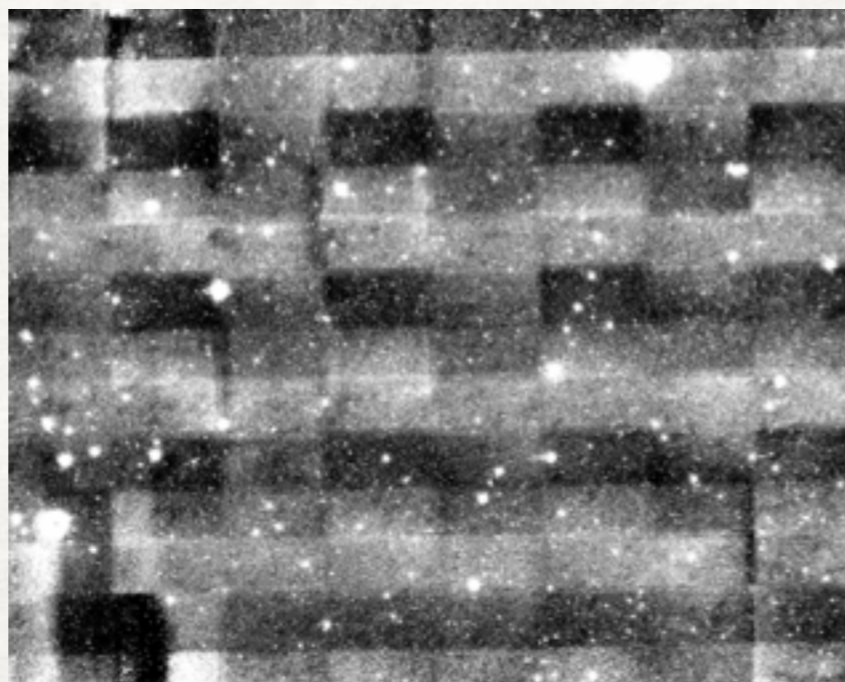


KIDS-1000 IMAGING & PHOTOMETRY

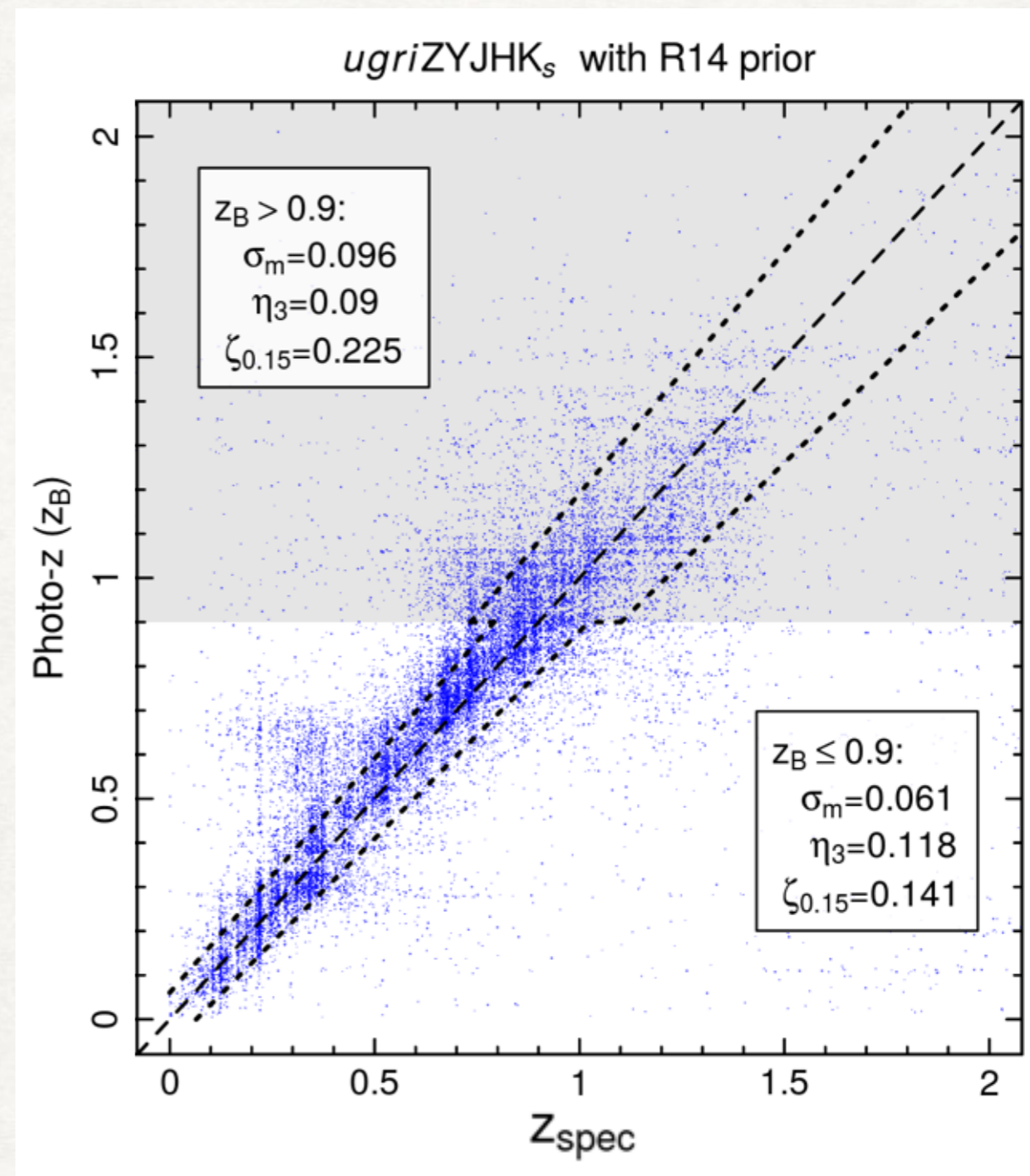
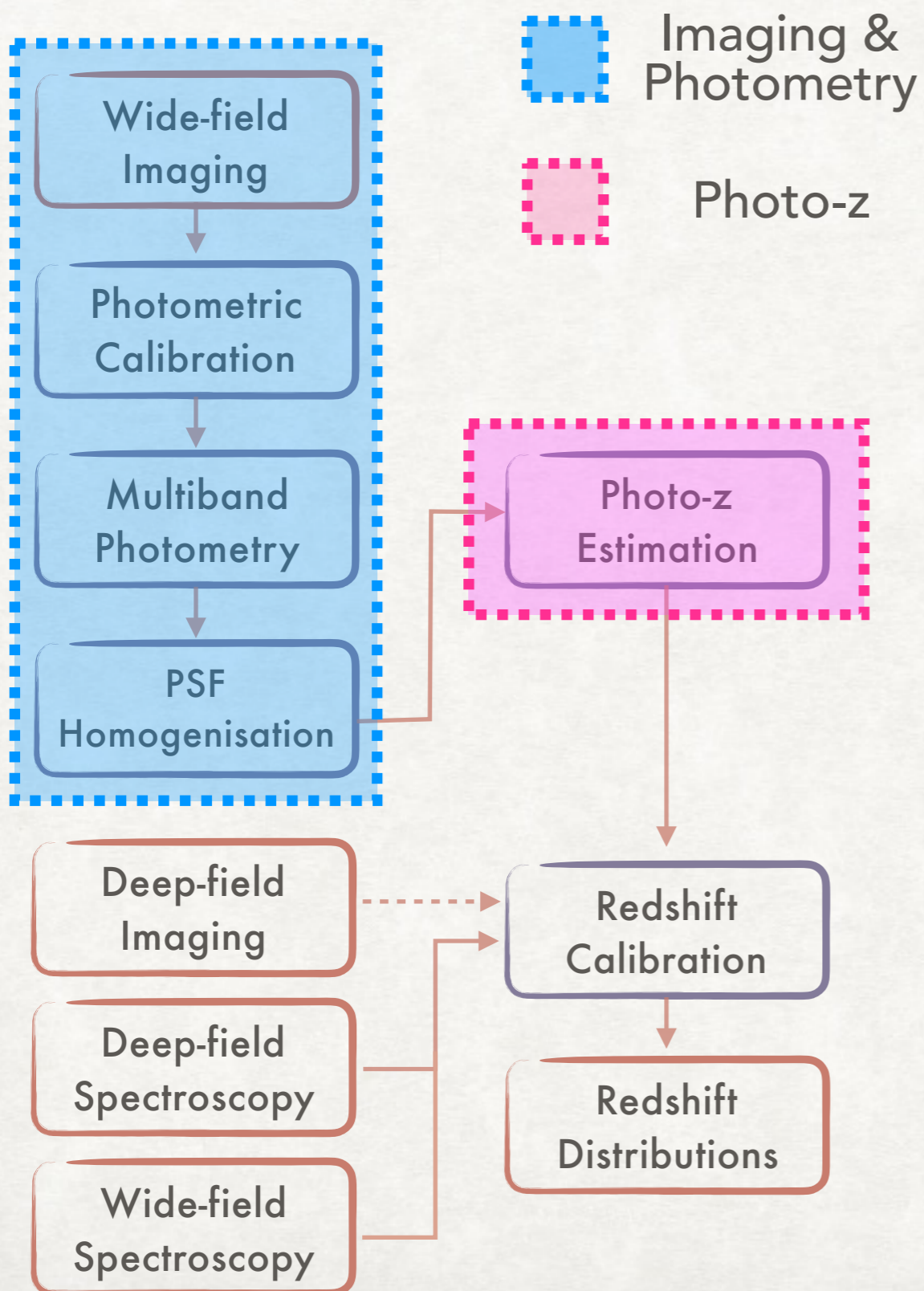


H-band

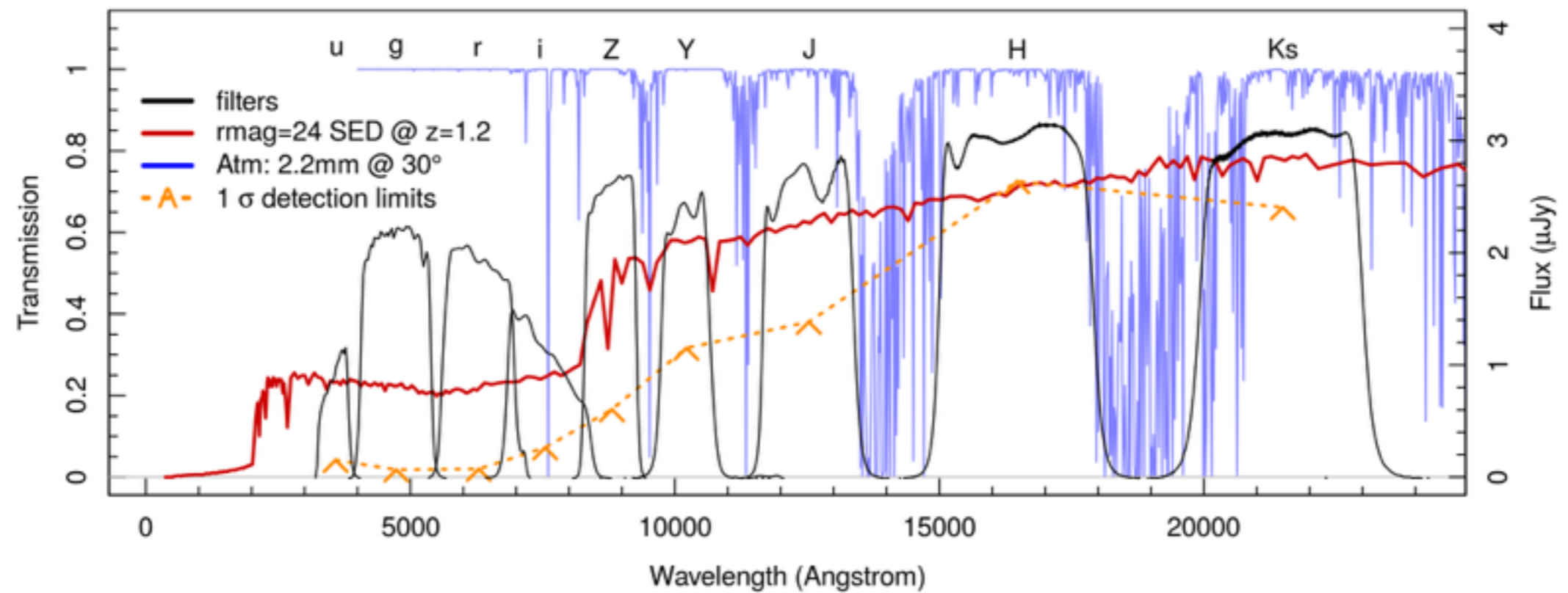
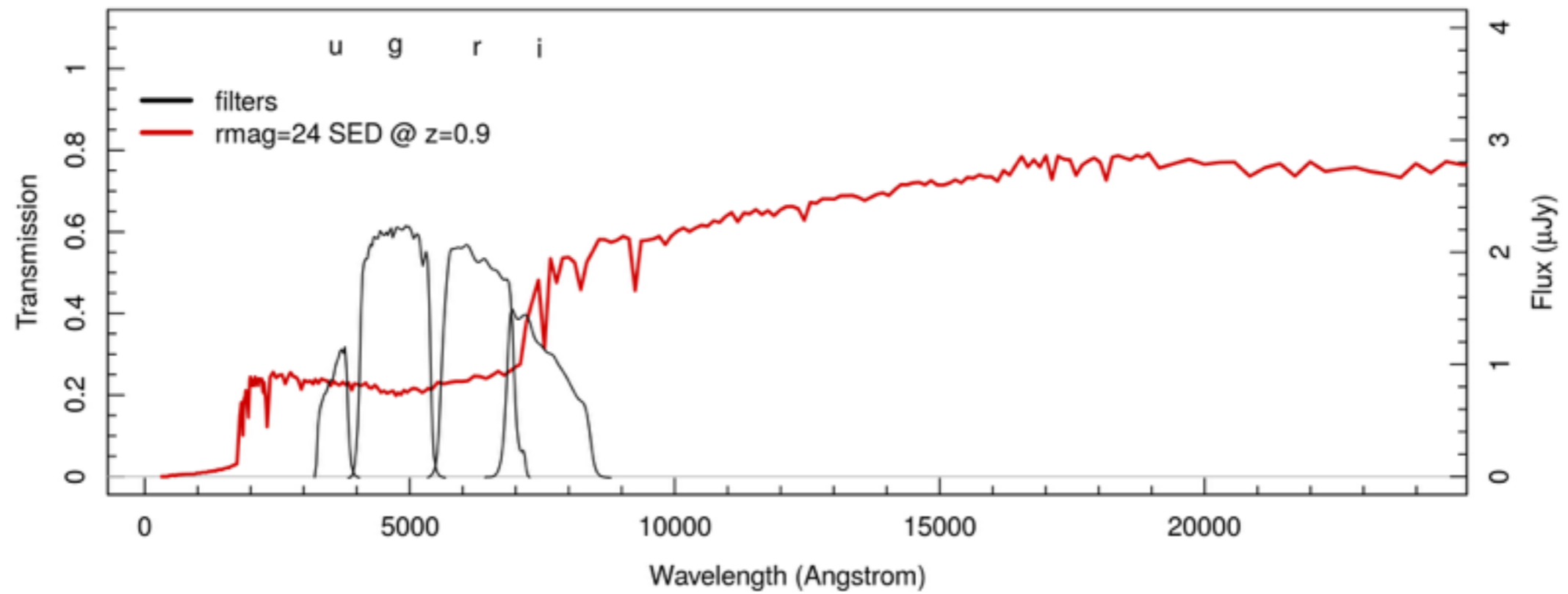
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KIDS-1000 PHOTO-Z



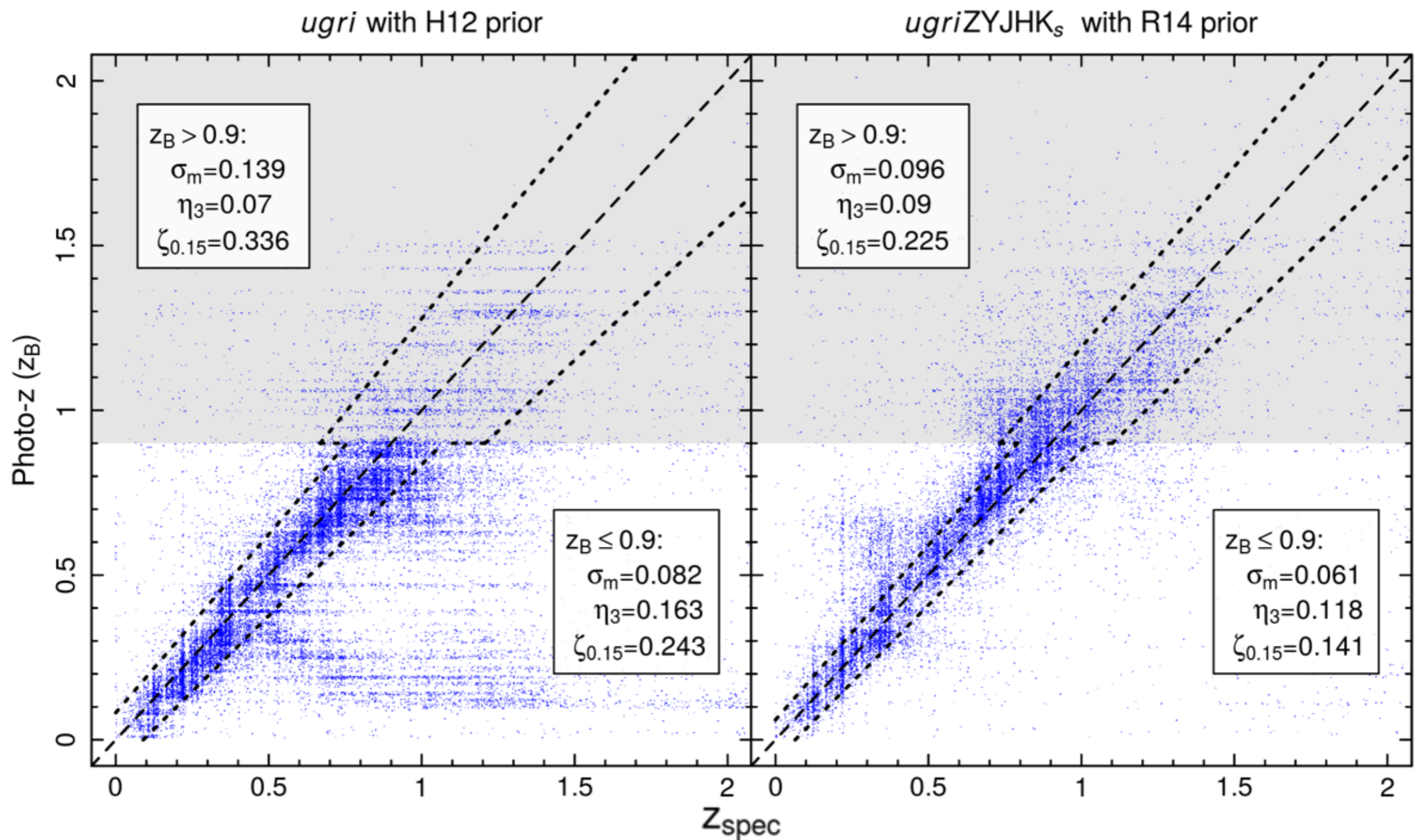
KIDS-1000 PHOTO-Z ESTIMATION



KIDS-1000 PHOTO-Z ESTIMATION

KiDS-450

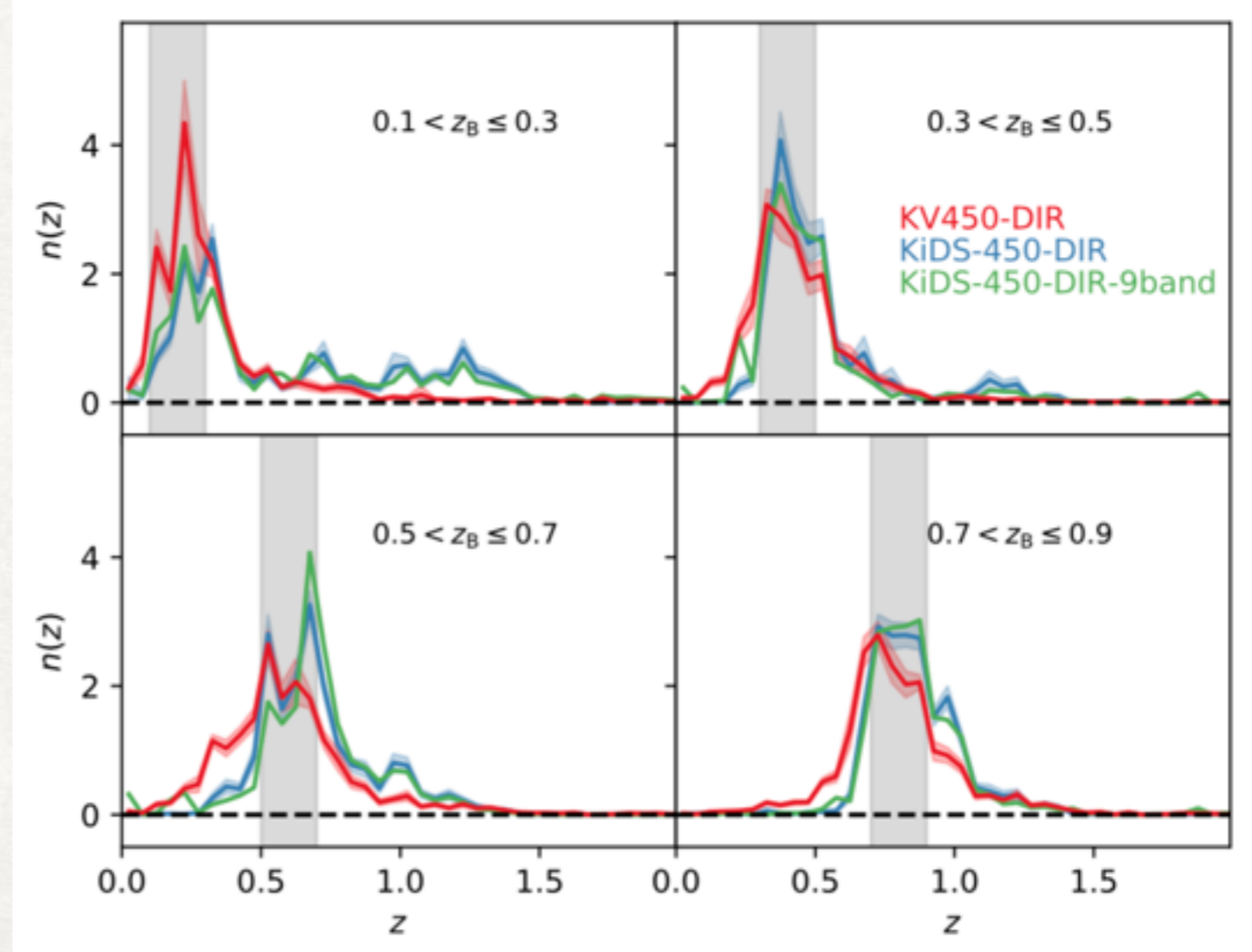
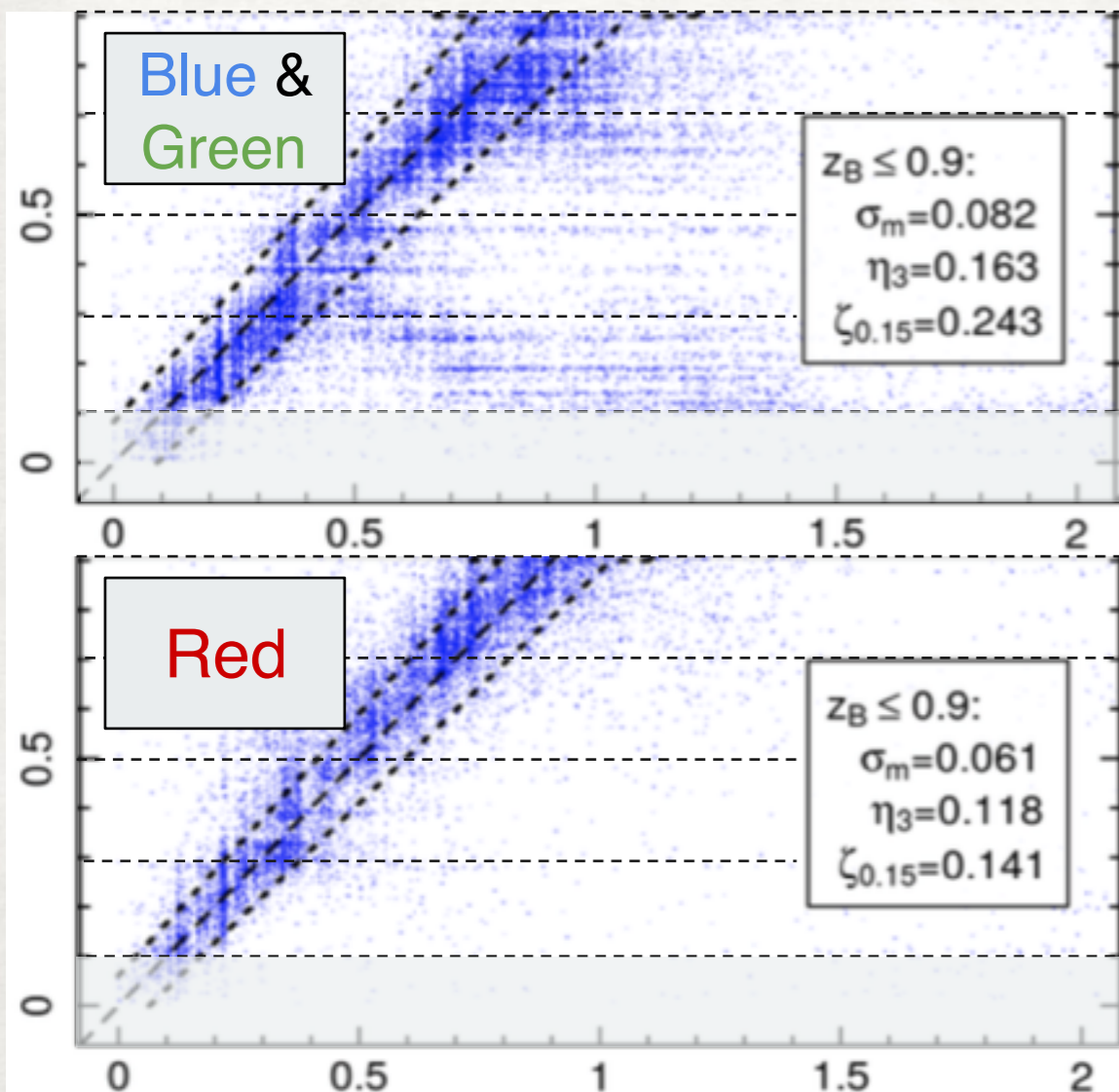
KiDS+VIKING-450



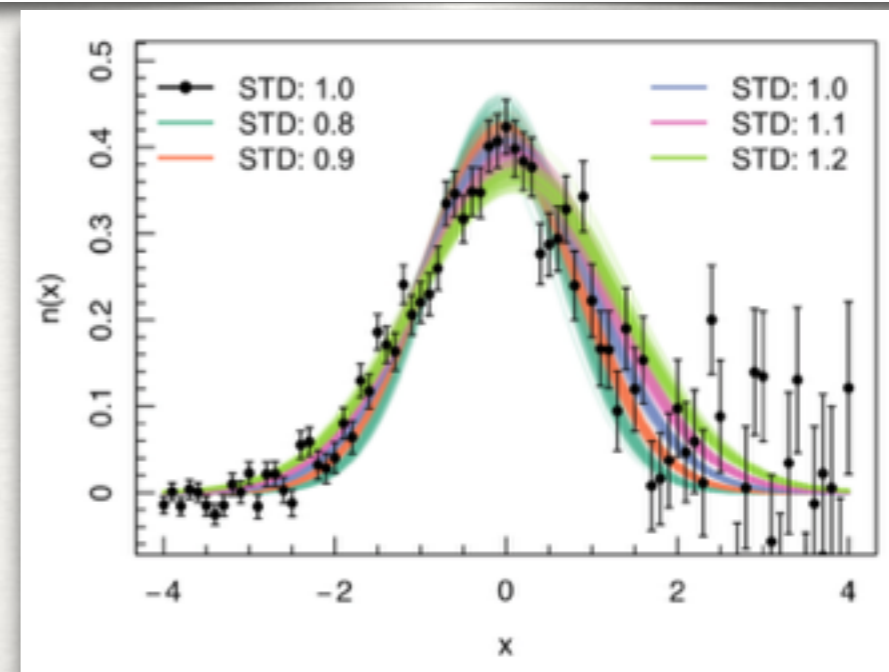
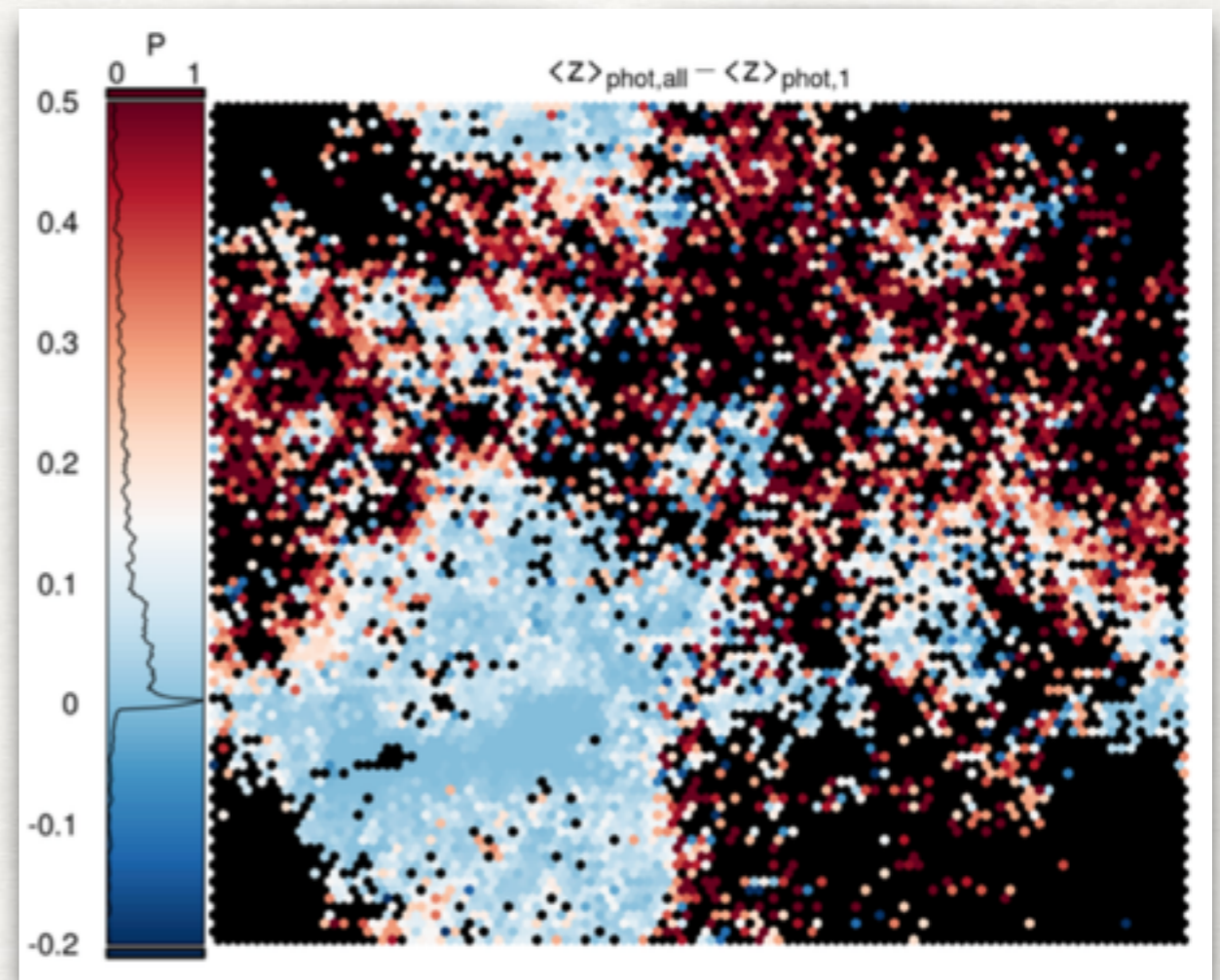
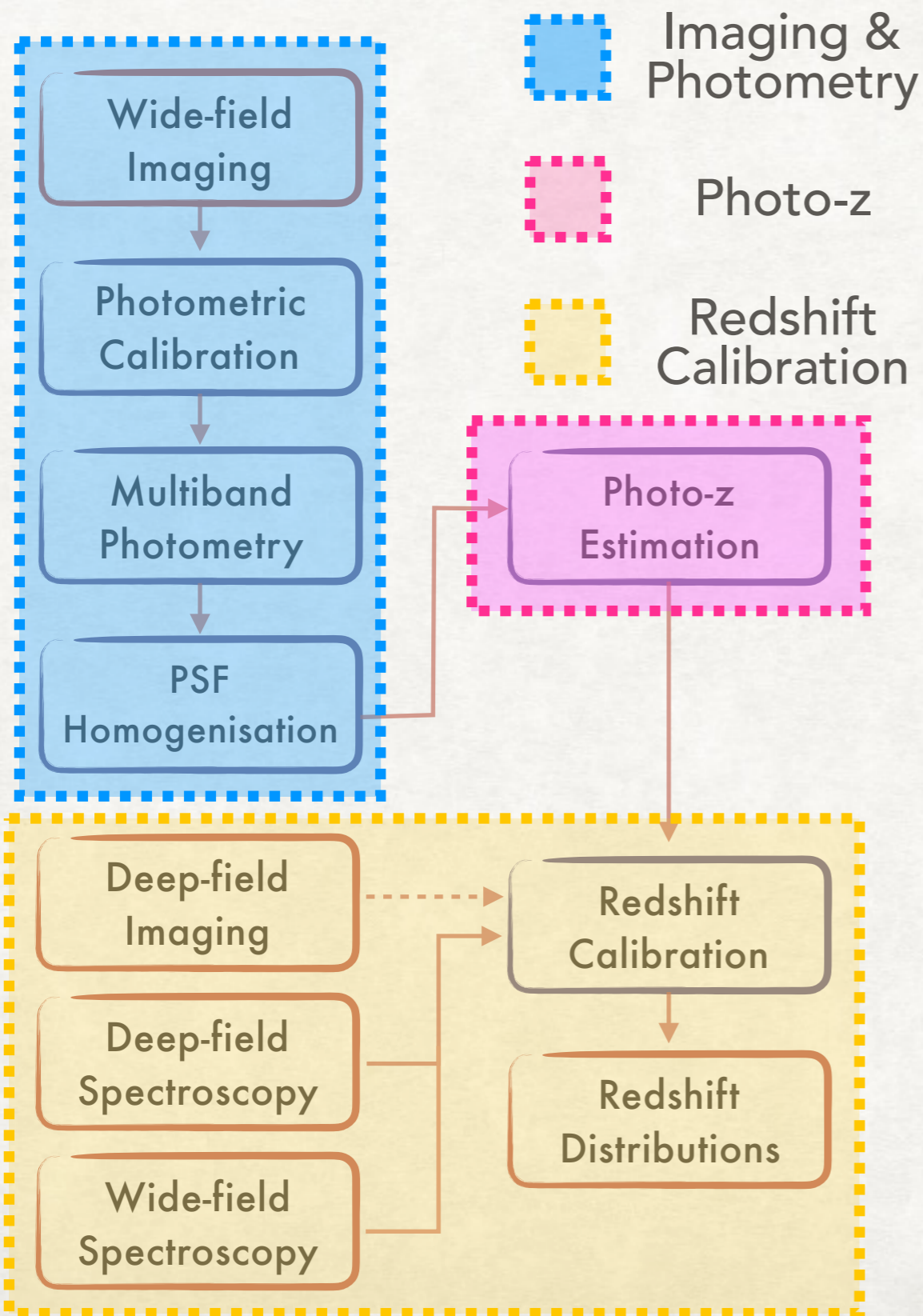
KIDS-1000 PHOTO-Z ESTIMATION

Tomographic redshift calibration systematics Lesson 1:

If you start out with complex N_z , they are more difficult to calibrate
Regardless of how much additional photometric information you have.

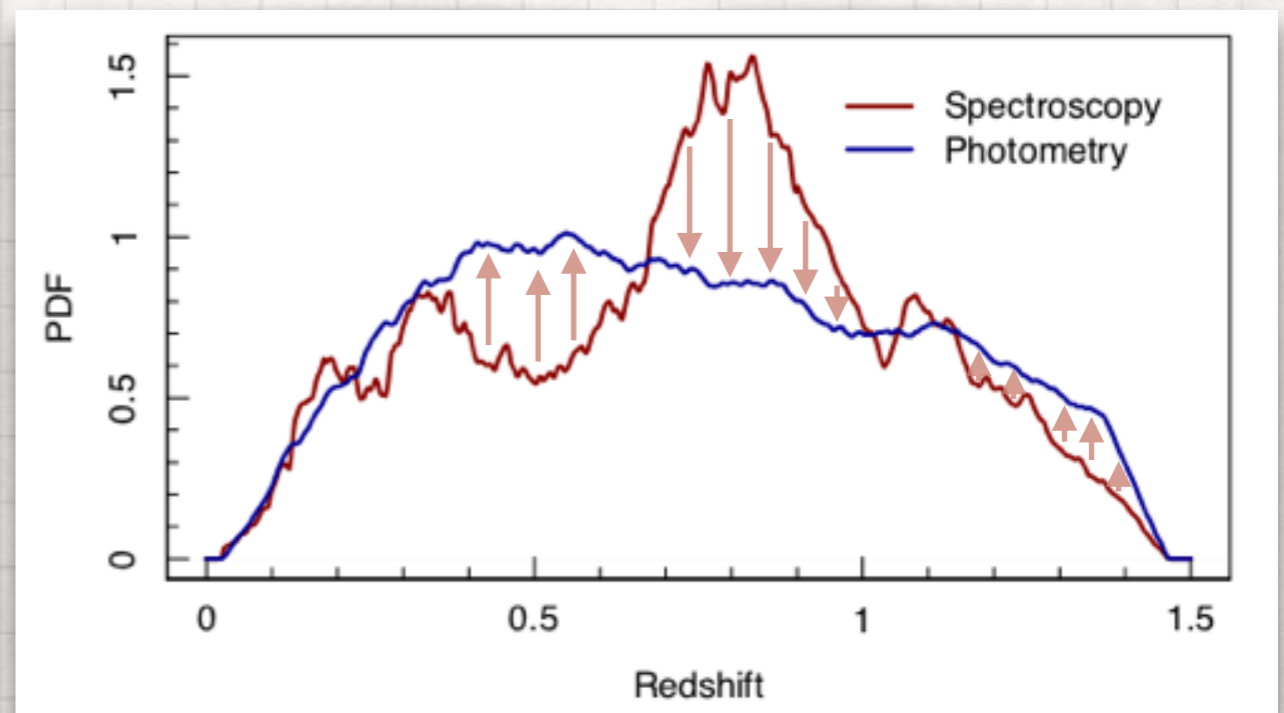
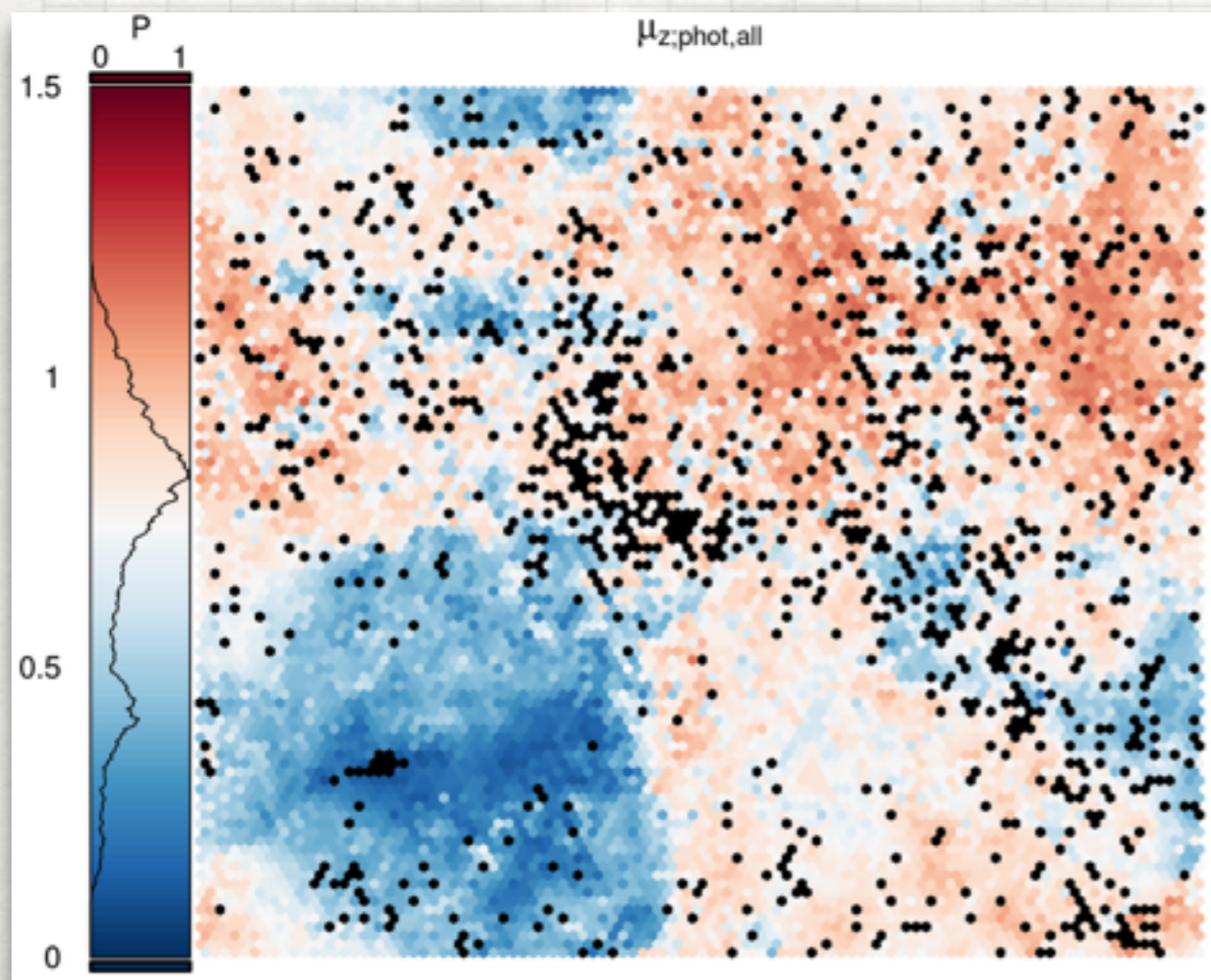


KIDS-1000 REDSHIFT CALIBRATION



KIDS SOM REDSHIFT CALIBRATION (SOM)

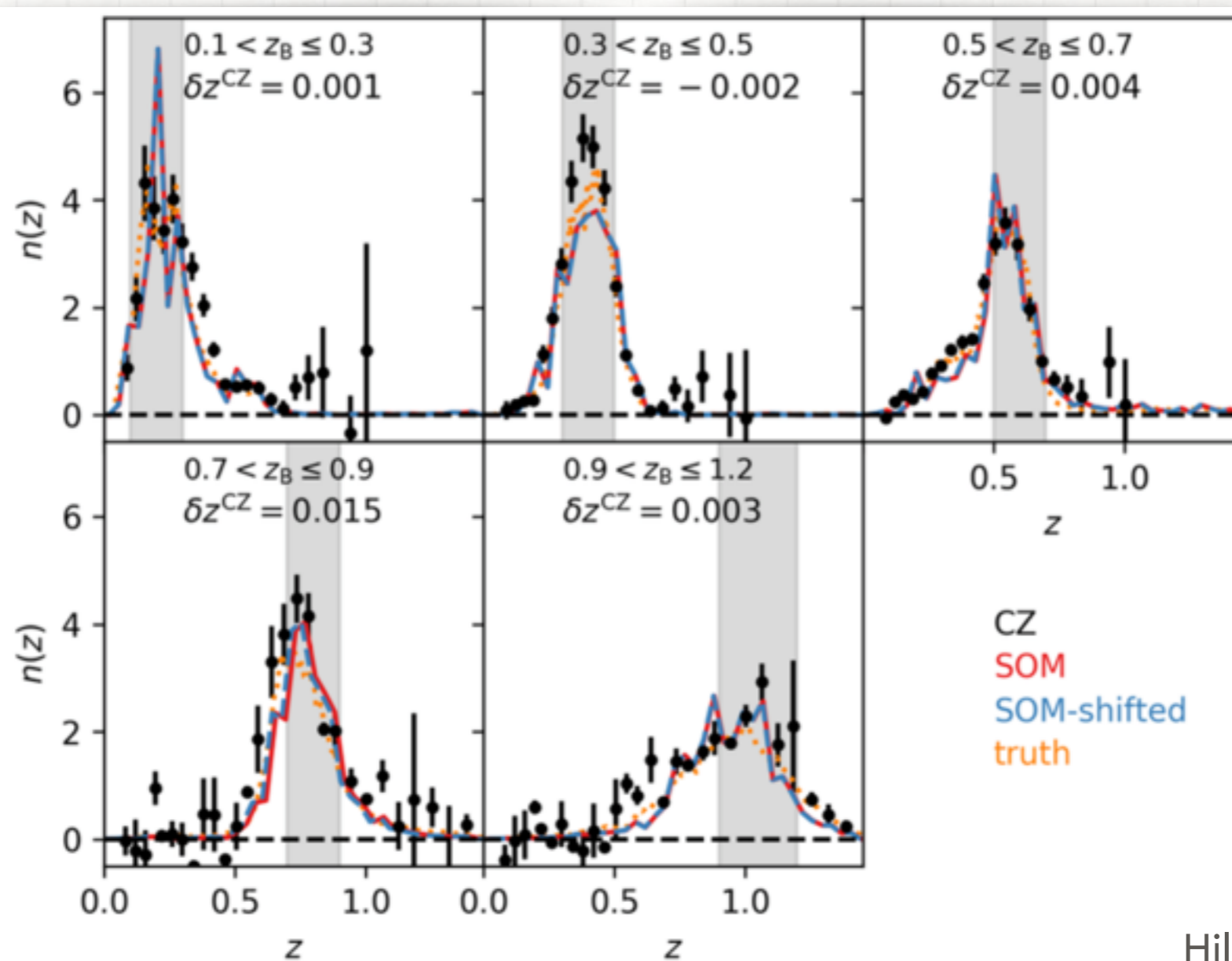
Colour-based Redshift calibration involves re-weighting spectroscopic data to represent the wide-field photometric sources. Requires matching photometry in the spectroscopic- and wide-fields



KIDS CLUSTERING REDSHIFT CALIBRATION (CC)

Cross-Correlation based Redshift calibration involves using deep- and wide-field spectroscopic data to cross-correlate photometric galaxy positions to spectroscopic sources.

Independent of colour information

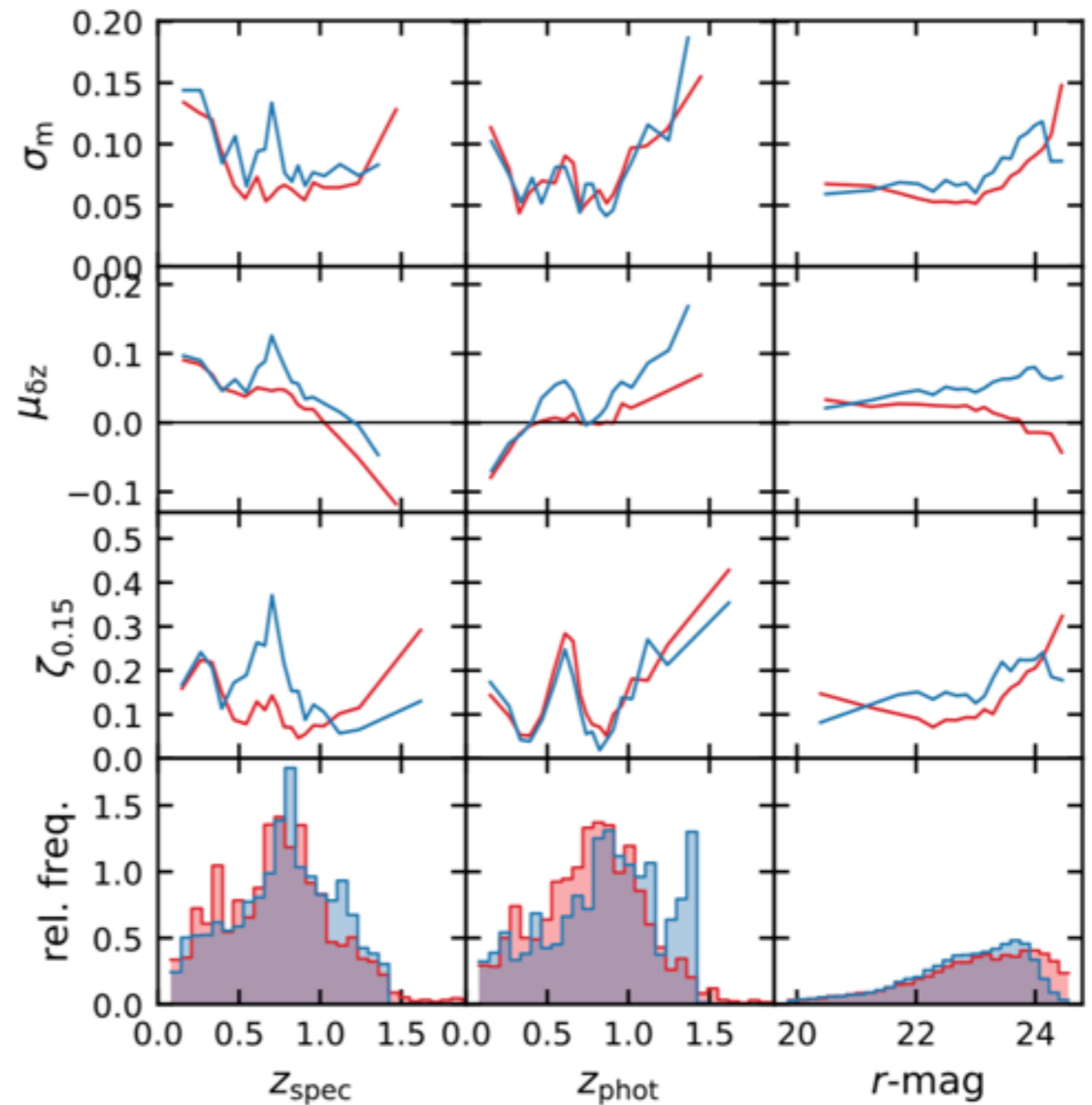
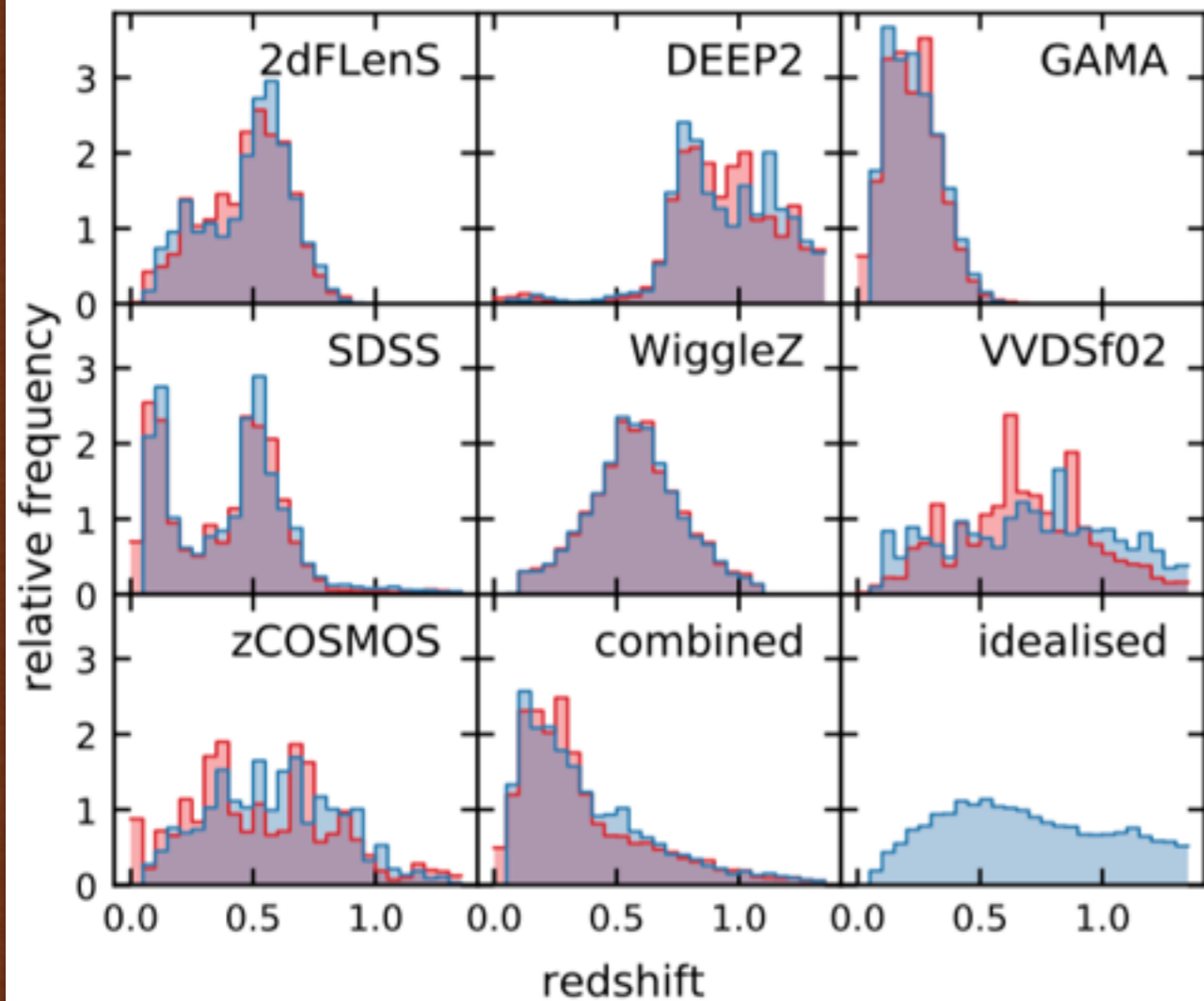


SIMULATIONS IN KIDS-1000

Redshift Calibration Cosmological Simulations

- Based on MICE Grand Challenge Galaxy Catalog 2
- Nbody, HOD/HAM assignment
- Halo resolution $\sim 1E11$ Msol
 - ▶ sub-resolved halo filling gives $i\sim 25$ apparent mag limited galaxy sample
- Used for calibration testing
- Slow: 1 simulation, covering an Octant and spanning $0.1 < z < 1.4$
- Tailored to match SDSS at low- z
- Requires meticulous tailoring of available products to match the observables from data

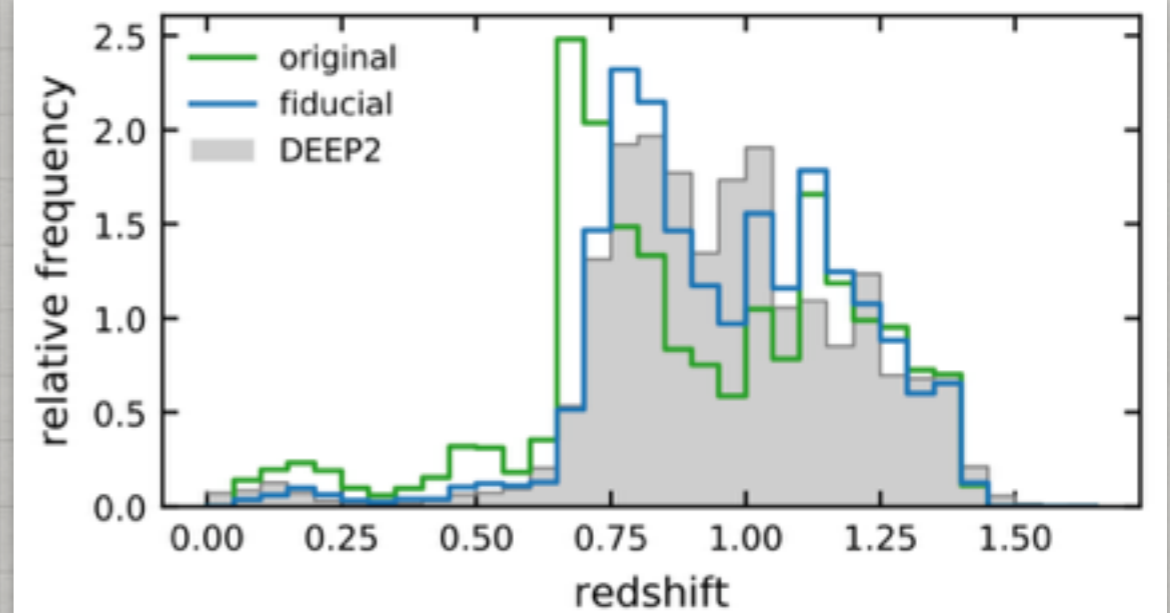
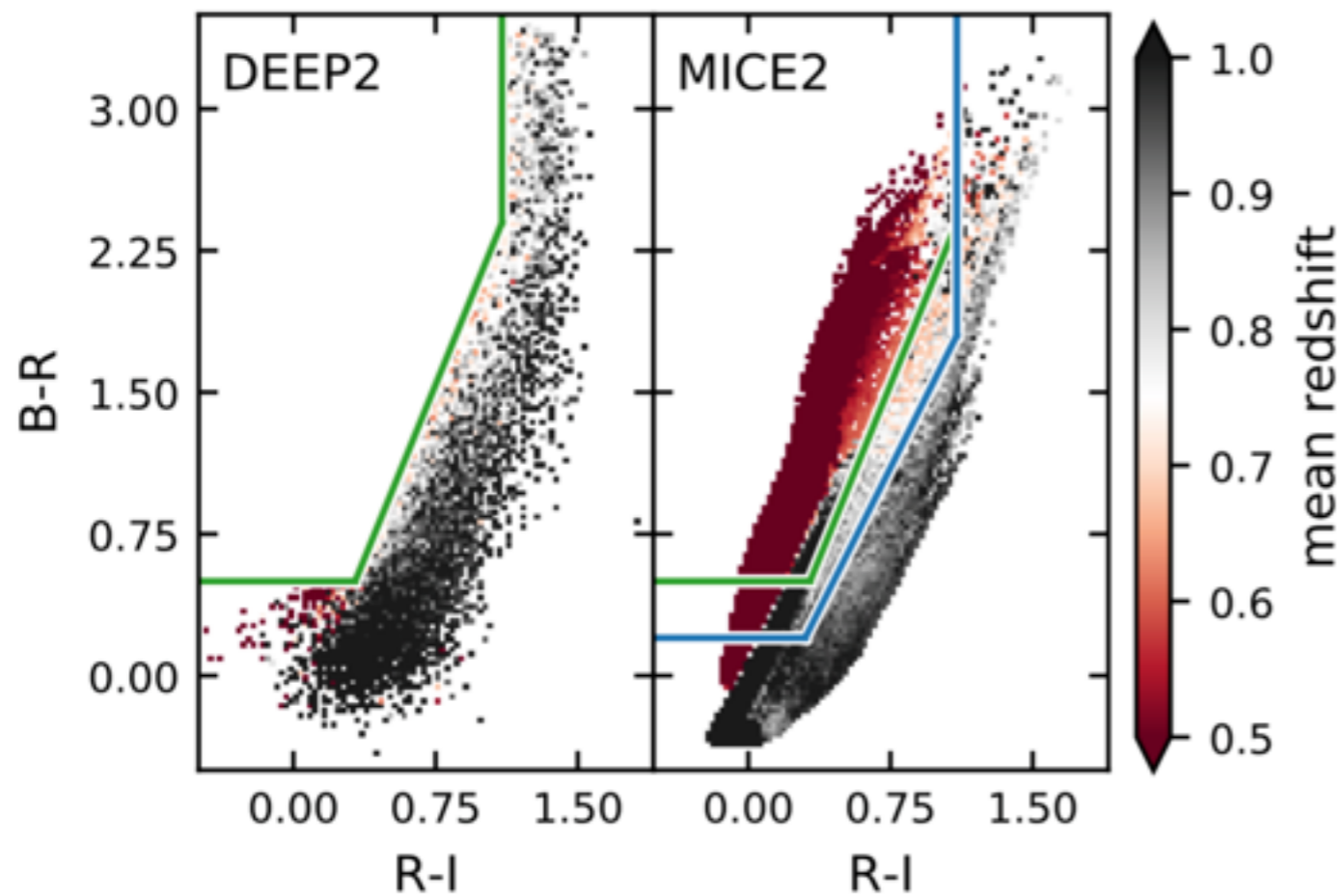
SIMULATIONS IN KIDS-1000



In short:
Complexity is paramount

WHERE ARE THE COMPLICATIONS?

SAMPLE DEFINITION



Samples defined in the mocks will always need tweaks to better reproduce the empirical distributions of subsets of the data.

Selection Type	WiggleZ Selection	MICE2 Object Selection	Comments
Exclusion	$g < 22.5$	$g < 22.5$	WiggleZ
	$i < 21.5$	$i < 21.5$	
	$r - i < g - r - 0.1$	$r - i < g - r - 0.1$	
	$r - i < 0.4$	$r - i < 0.4$	
	$g - r > 0.6$	$g - r > 0.6$	
	$r - z < 0.7(g - r)$	$r - z < 0.7(g - r)$	
Inclusion	NUV < 22.8	—	UV selection is mimicked by weighted sampling to match the $n(z)$'s.
	$20.0 < r < 22.5$	$20.0 < r < 22.5$	
	FUV - NUV > 1 or no FUV	—	
	$-0.5 < \text{NUV} - r < 2.0$	—	
	$S/N_{\text{NUV}} > 3.0$	—	
	Match within 2.5"	—	

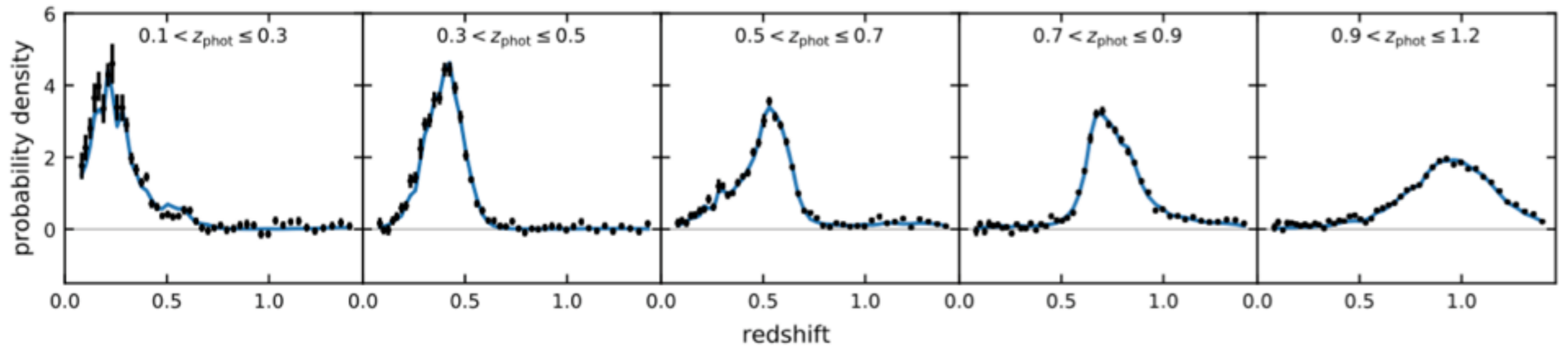
Selection Type	DEEP2 Selection	MICE2 Object Selection	Comments
Magnitude	$18.5 < R < 24.0$	$18.5 < R < 24.0$	DEEP2
Colour	$B - R < 2.45 (R - I) - 0.2976$	$B - R < 2.0 (R - I) - 0.4$	
	$R - I > 1.1$	$R - I > 1.1$	
	$B - R < 0.5$	$B - R < 0.2$	magnitudes references, see Fig. 7.

Sub-sample	SDSS Selection	MICE2 Object Selection	Comments
Main	$r_{\text{pet}} < 17.77$	$r < 17.7$	SDSS
LOWZ	$16.0 < r < 19.6$	$16.0 < r < 20.0$	
	$ c_{\perp} < 0.2$	$ c_{\perp} < 0.2$	
	$r < 13.5 + c_{\parallel}/0.3$	$r < 13.35 + c_{\parallel}/0.3$	
CMASS	$17.5 < i < 19.9$	$17.5 < i < 20.1$	
	$d_{\perp} > 0.55$	$d_{\perp} > 0.55$	
	$i < 19.86 + 1.6(d_{\perp} - 0.8)$	$i < 19.98 + 1.6(d_{\perp} - 0.7)$	
QSO	—	$\text{flag_central} == 1$	Substitute selection to compensate that MICE2 does not contain quasars.
	—	$\log_{10}(M_{\text{halo}}) > 13.3$	
	—	$\log_{10}(M_{\star}) > 11.2$	

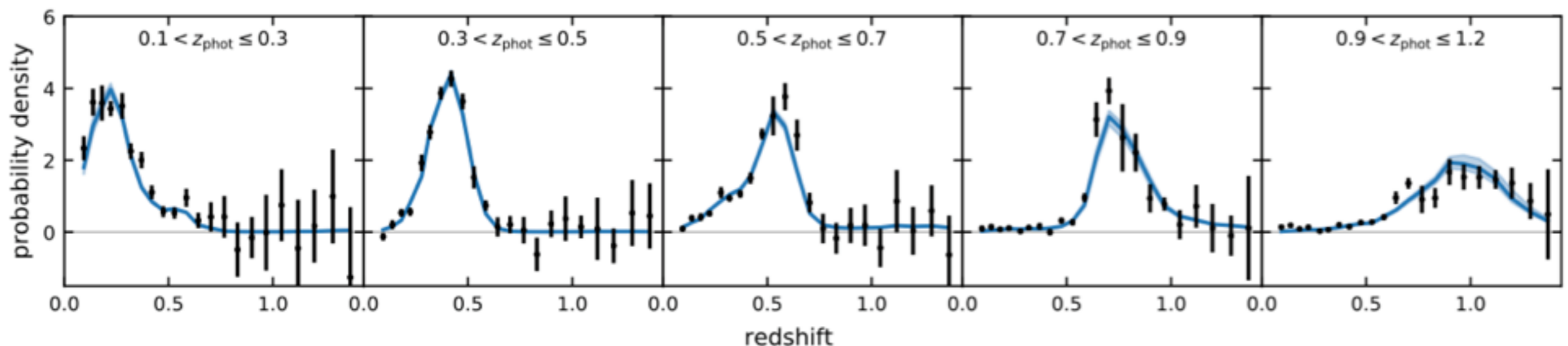
WHY CAN'T WE TRUST THE SIMPLE CASE?

CLUSTERING REDSHIFT ESTIMATES

Idealised Reference Sample

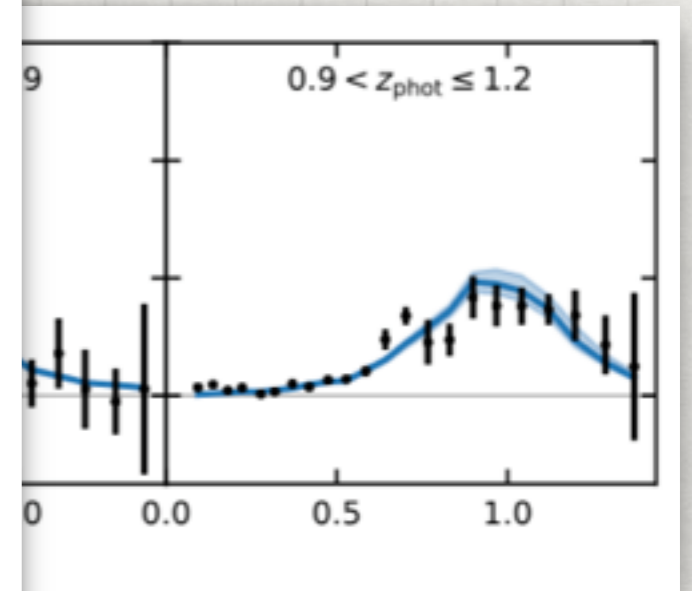
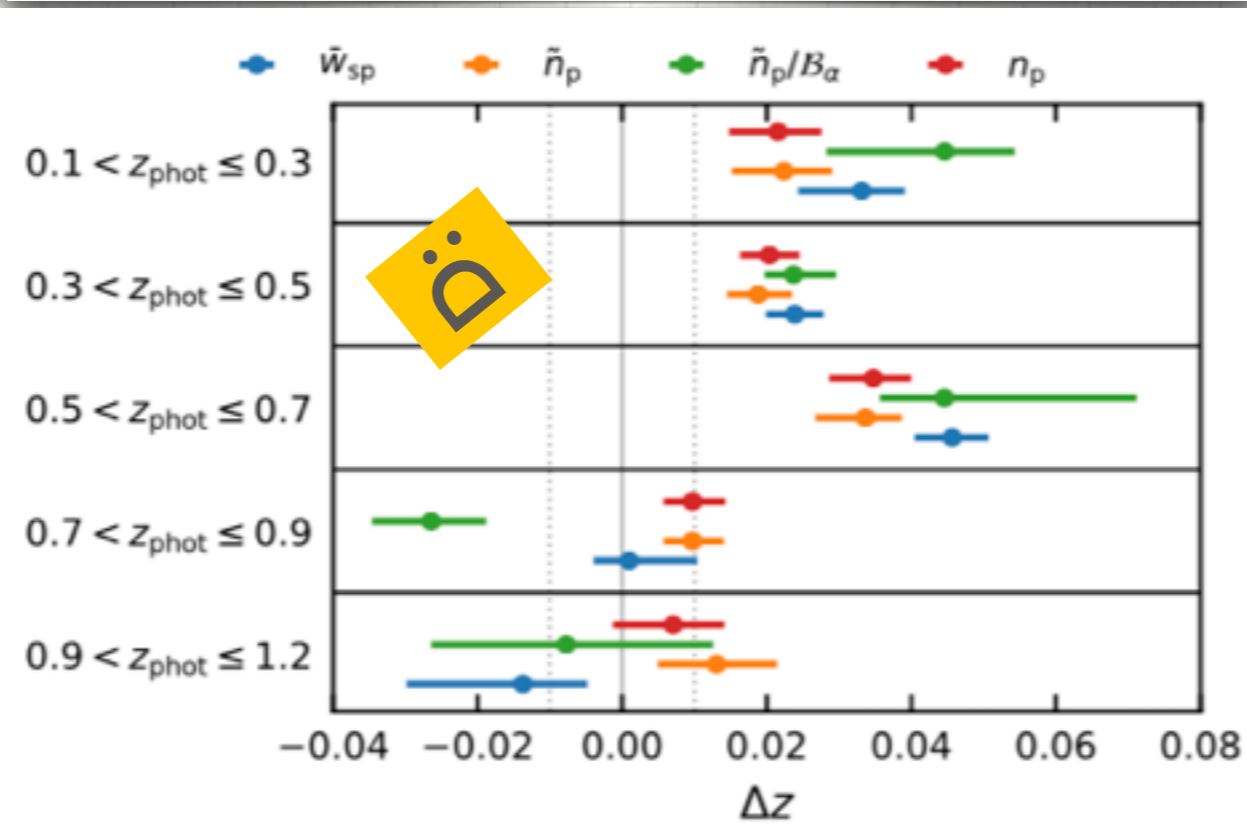
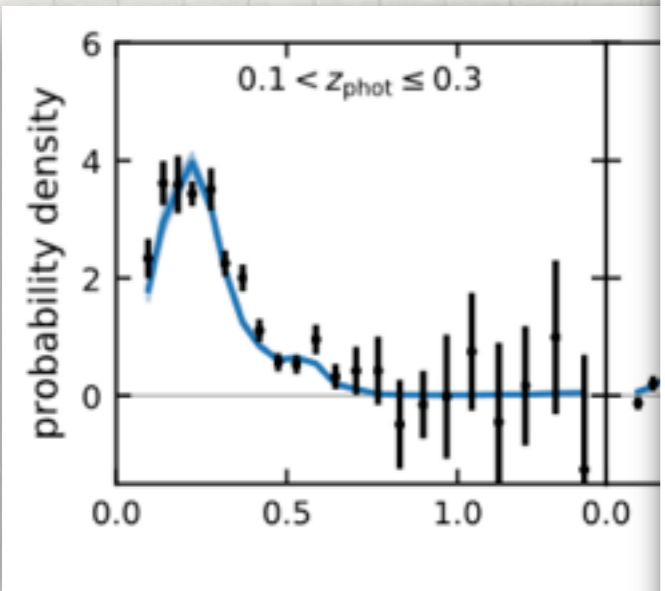
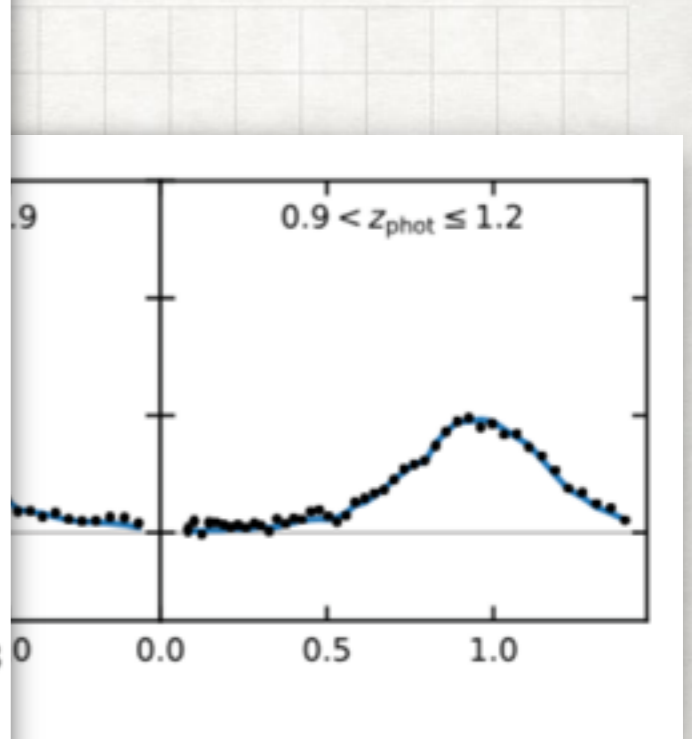
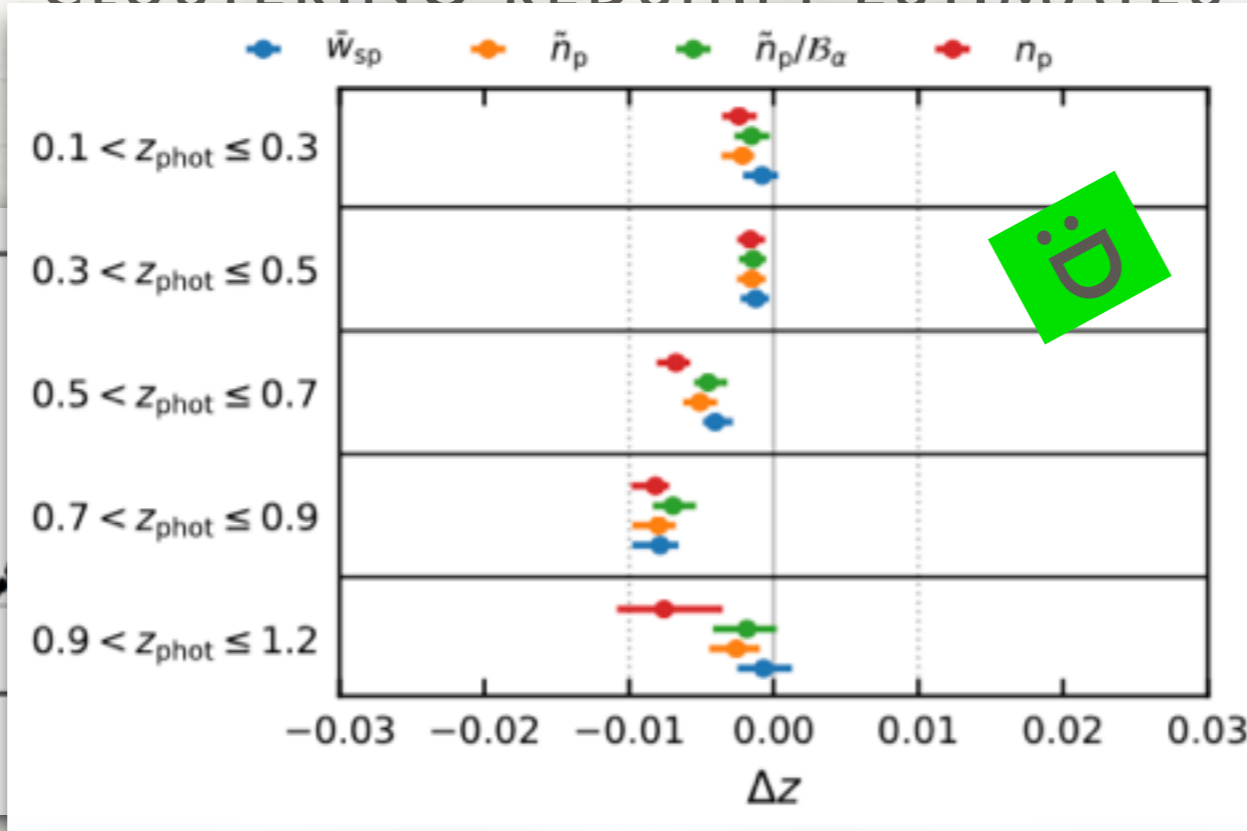
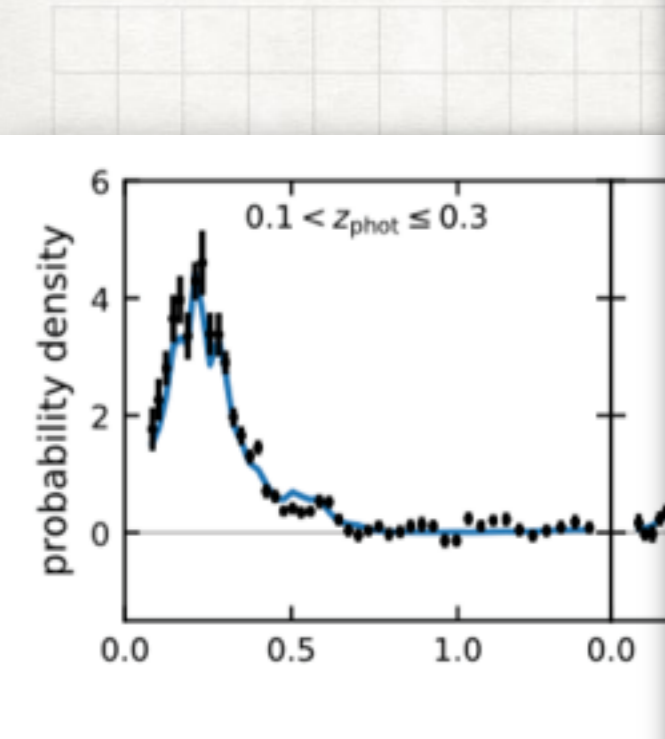


Realistic Reference Sample



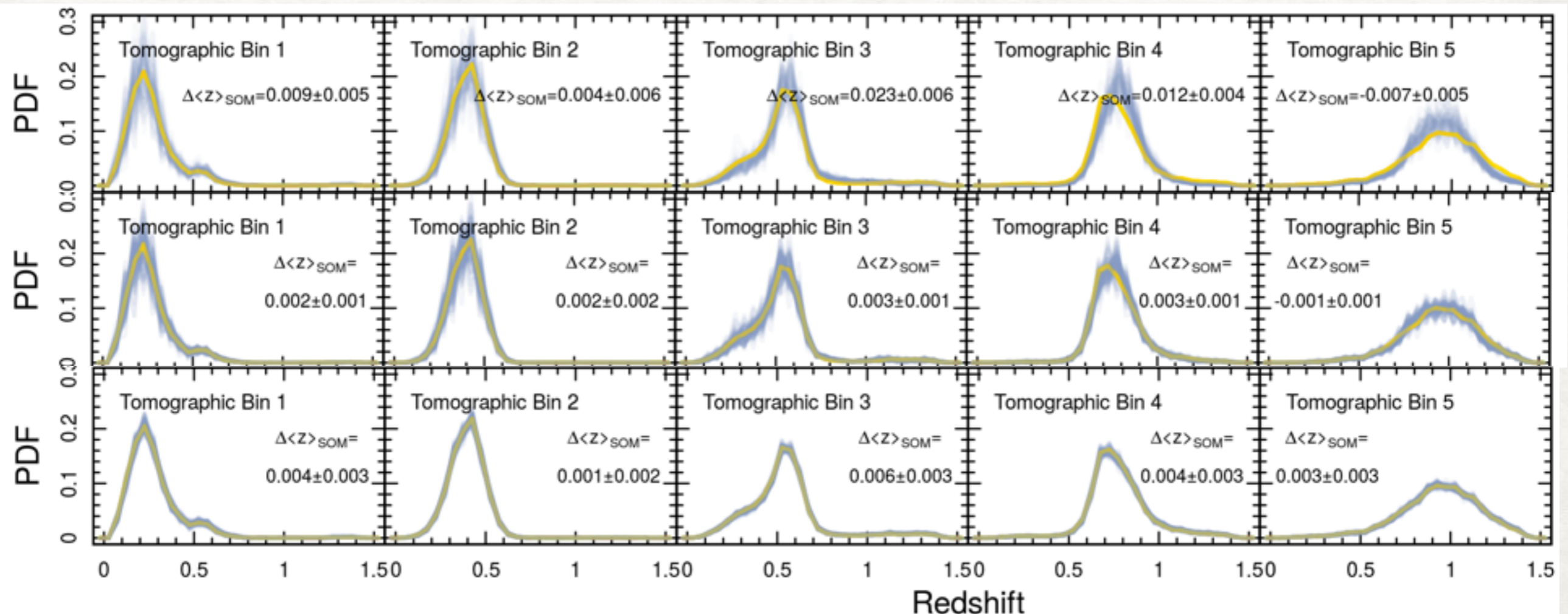
WHY CAN'T WE TRUST THE SIMPLE CASE?

CLUSTERING REDSHIFT ESTIMATES



WHY CAN'T WE TRUST THE SIMPLE CASE?

COLOUR-CALIBRATION



Top: Realistic Spec-z Samples & Realistic Photometric Noise

Middle: Realistic Spec-z Samples & Perfect Photometric Information

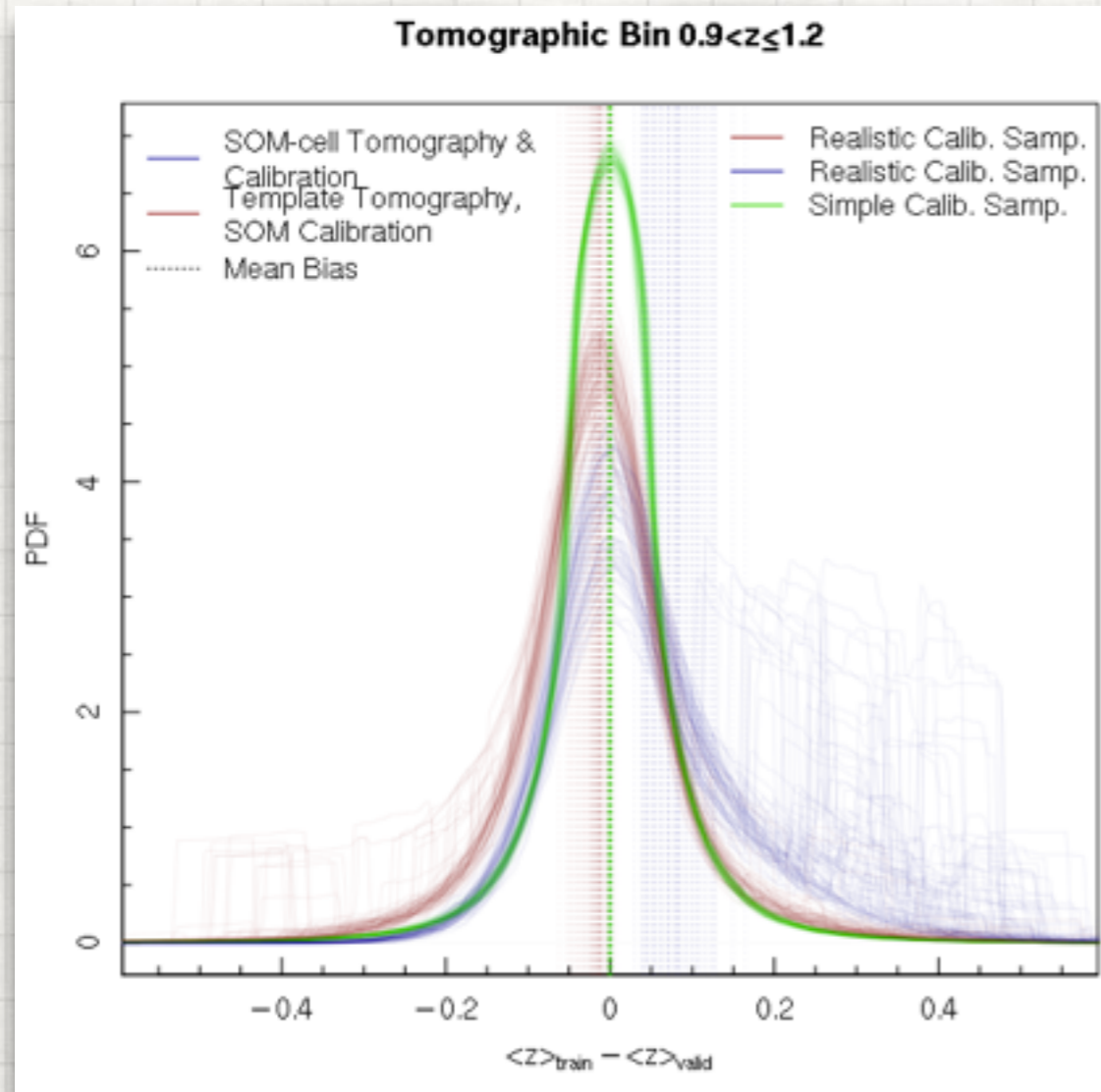
Bottom: Representative Spec-z Sample & Realistic Photometric Noise

It is *insufficient* to test our methods w.r.t. individual systematics

DISCOVERING THE UNEXPECTED

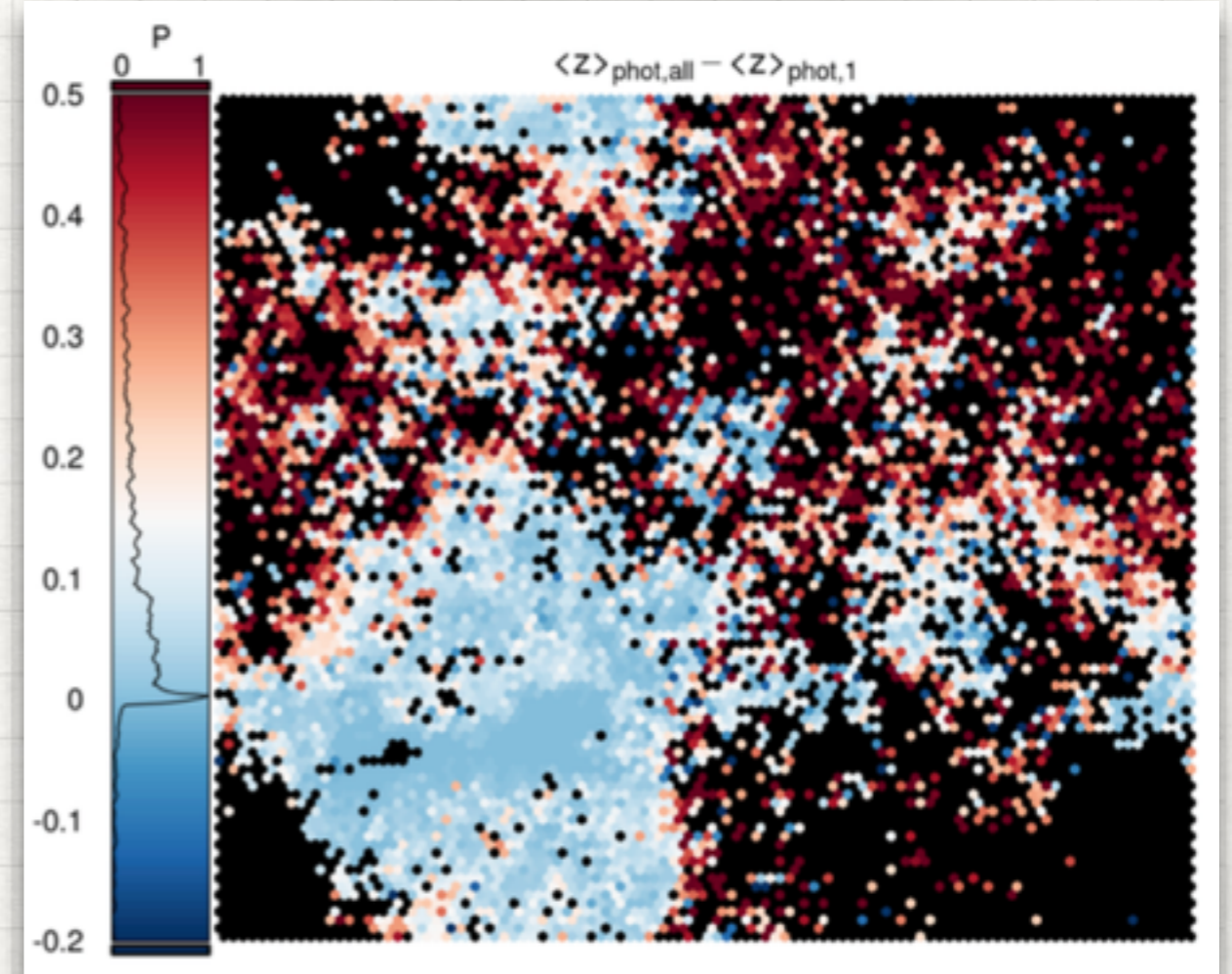
COLOUR-CALIBRATION

Methodological Biases



Realistic Spec-z compilations allowed us to diagnose pathological biases in methods of tomographic binning.

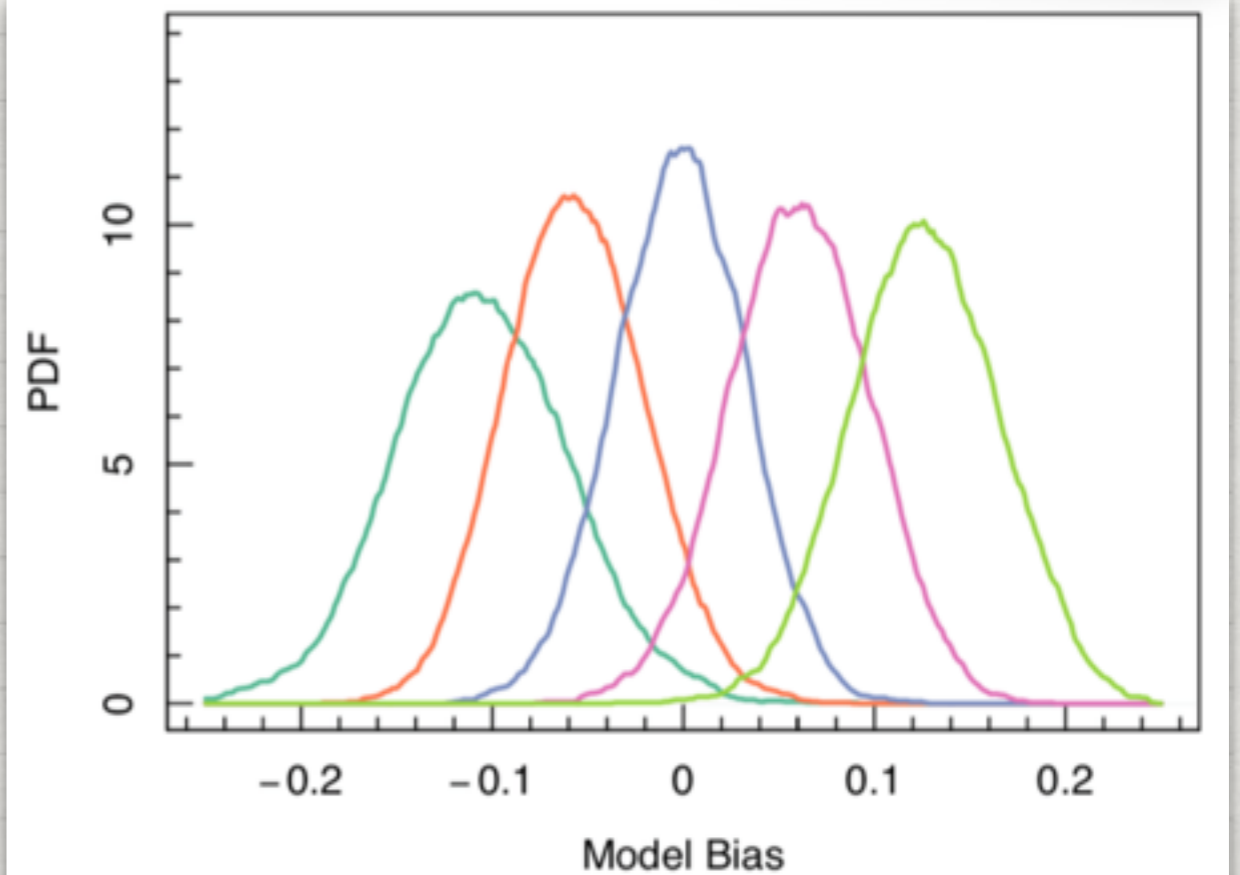
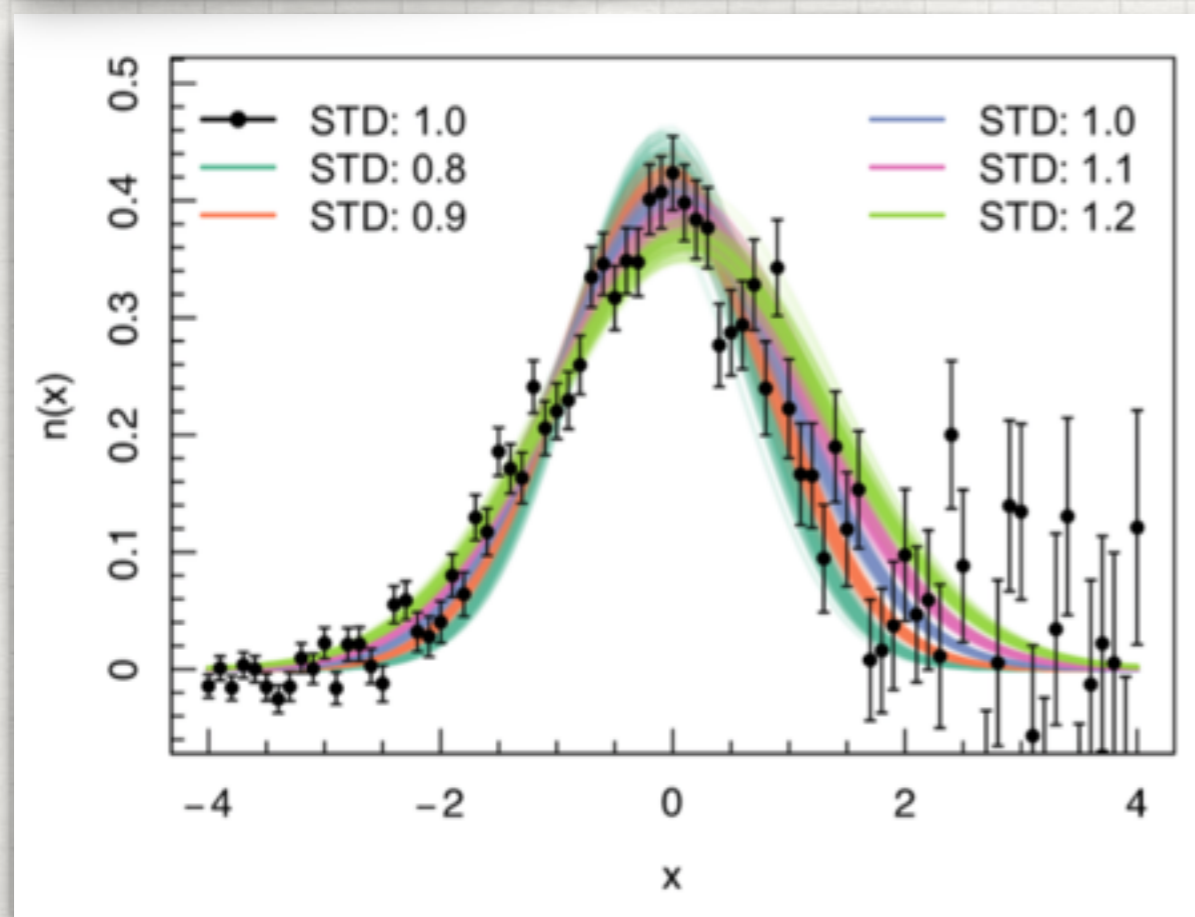
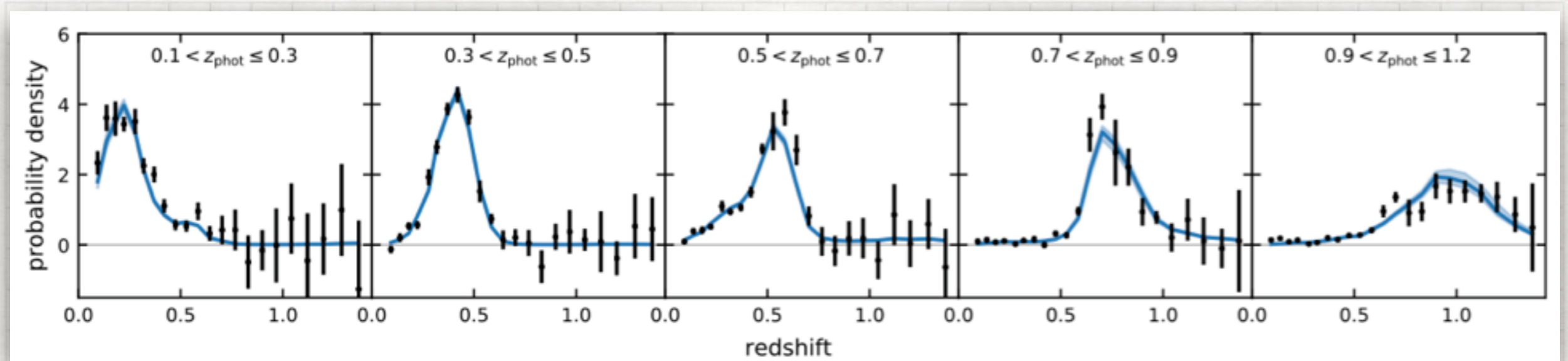
"Normal" Systematic Biases



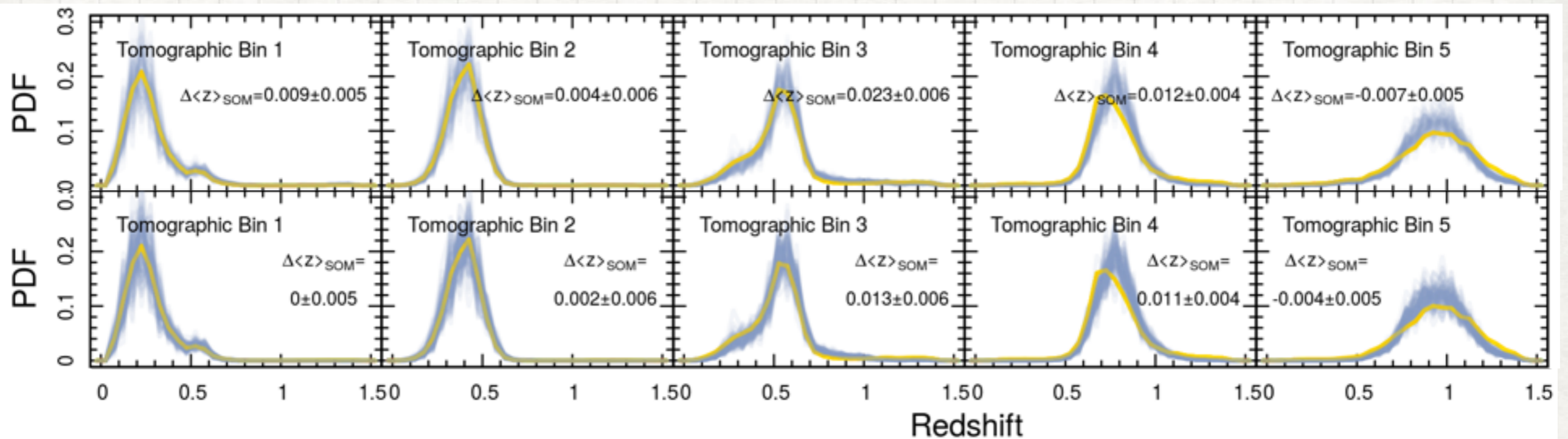
Realistic Spec-z compilations also allowed us to construct quality control metrics in the mocks which improve our calibration considerably.

DISCOVERING THE UNEXPECTED

CLUSTERING REDSHIFT ESTIMATES



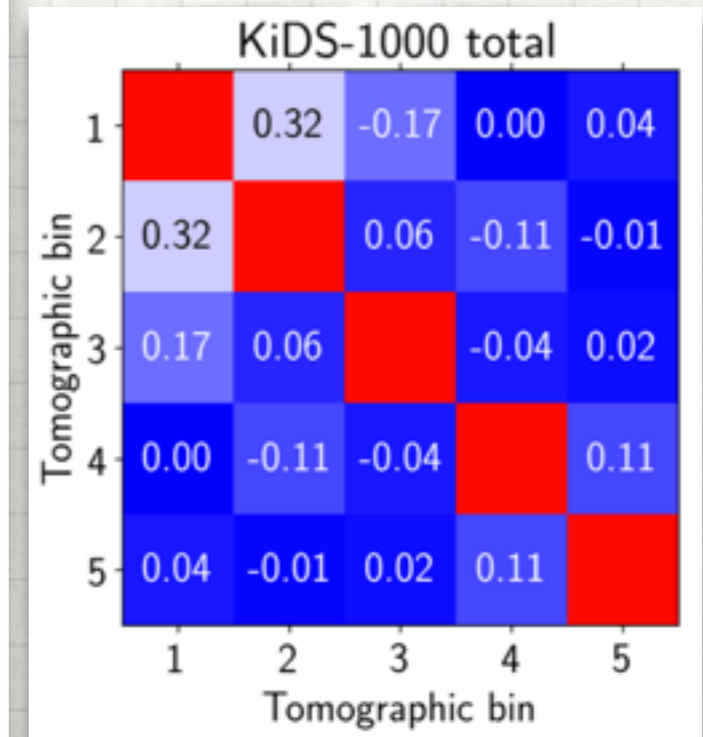
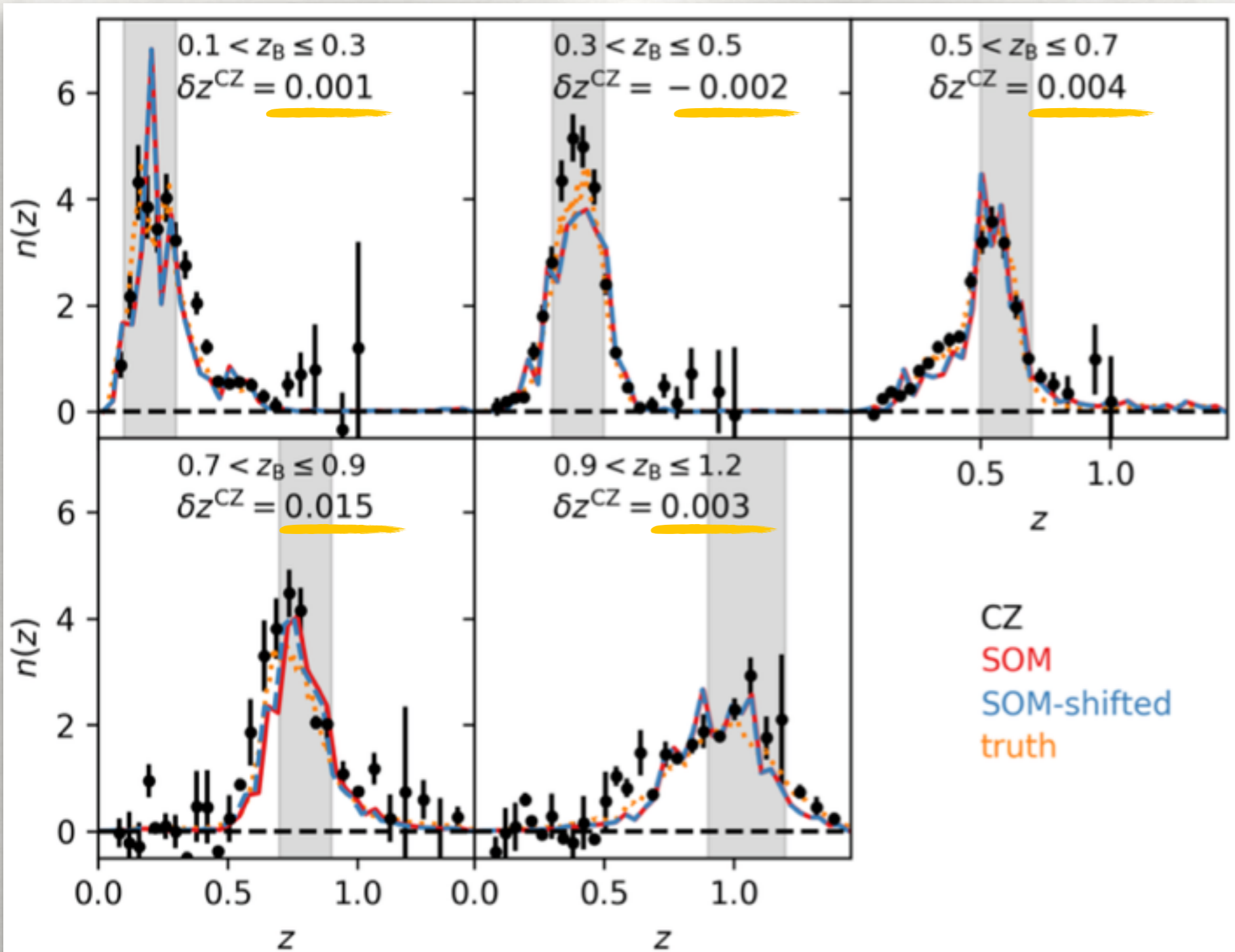
OVERALL REDSHIFT CALIBRATION ACCURACY



We can use the simulations to verify our method and calibrate biases

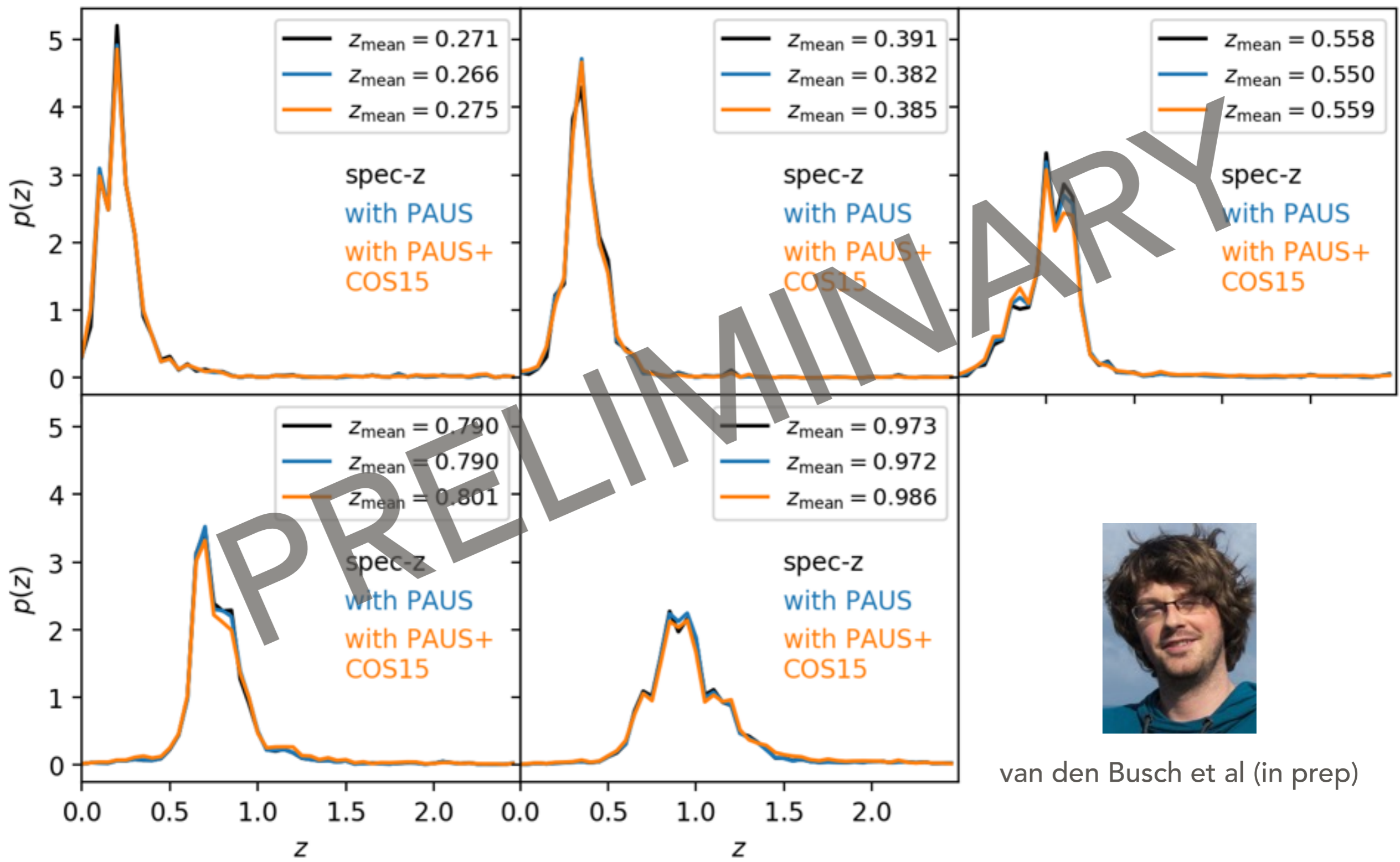
Best estimates now suggest: $|\Delta z| \leq \sim 0.01$ using SOM Calibration

OVERALL REDSHIFT CALIBRATION ACCURACY



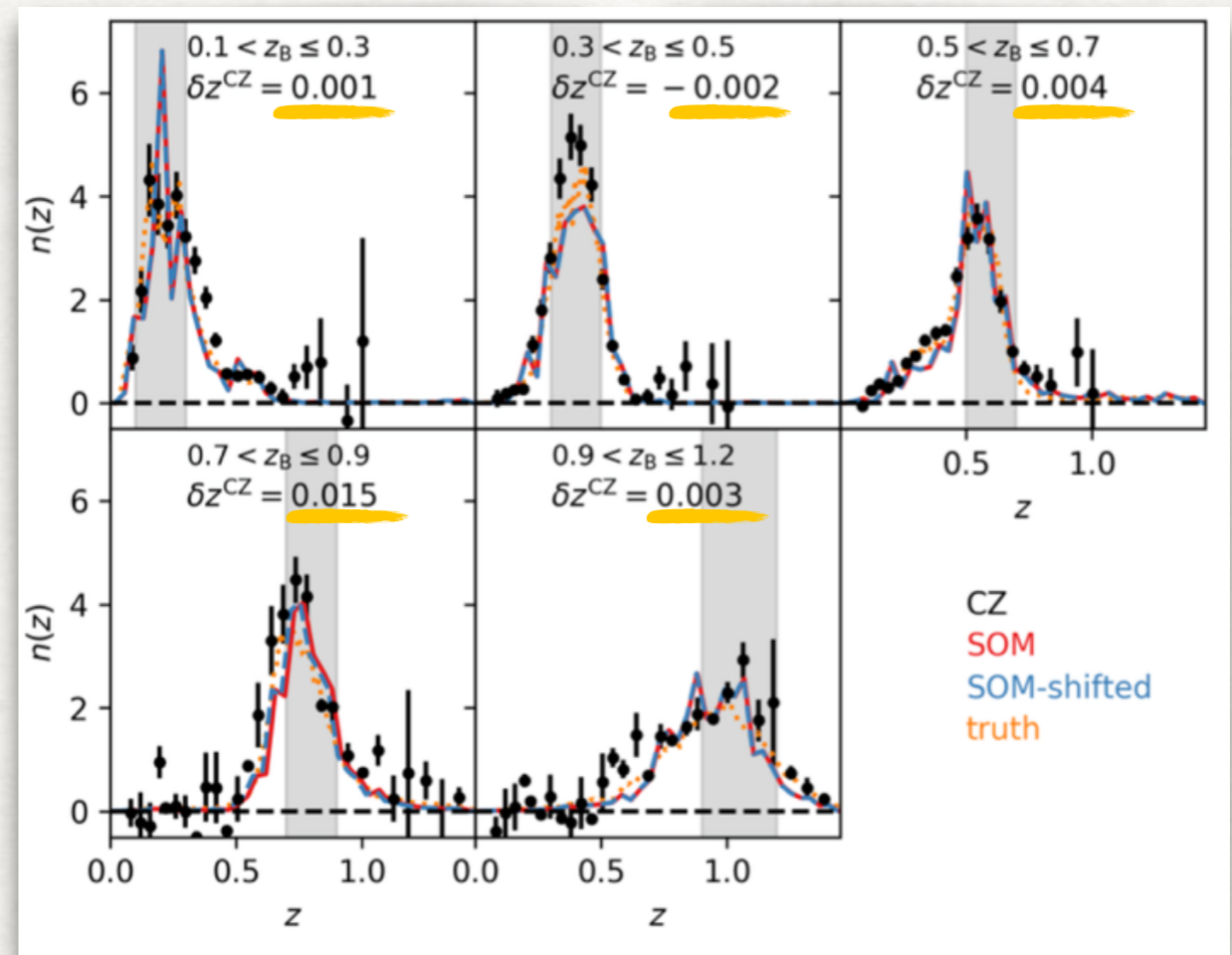
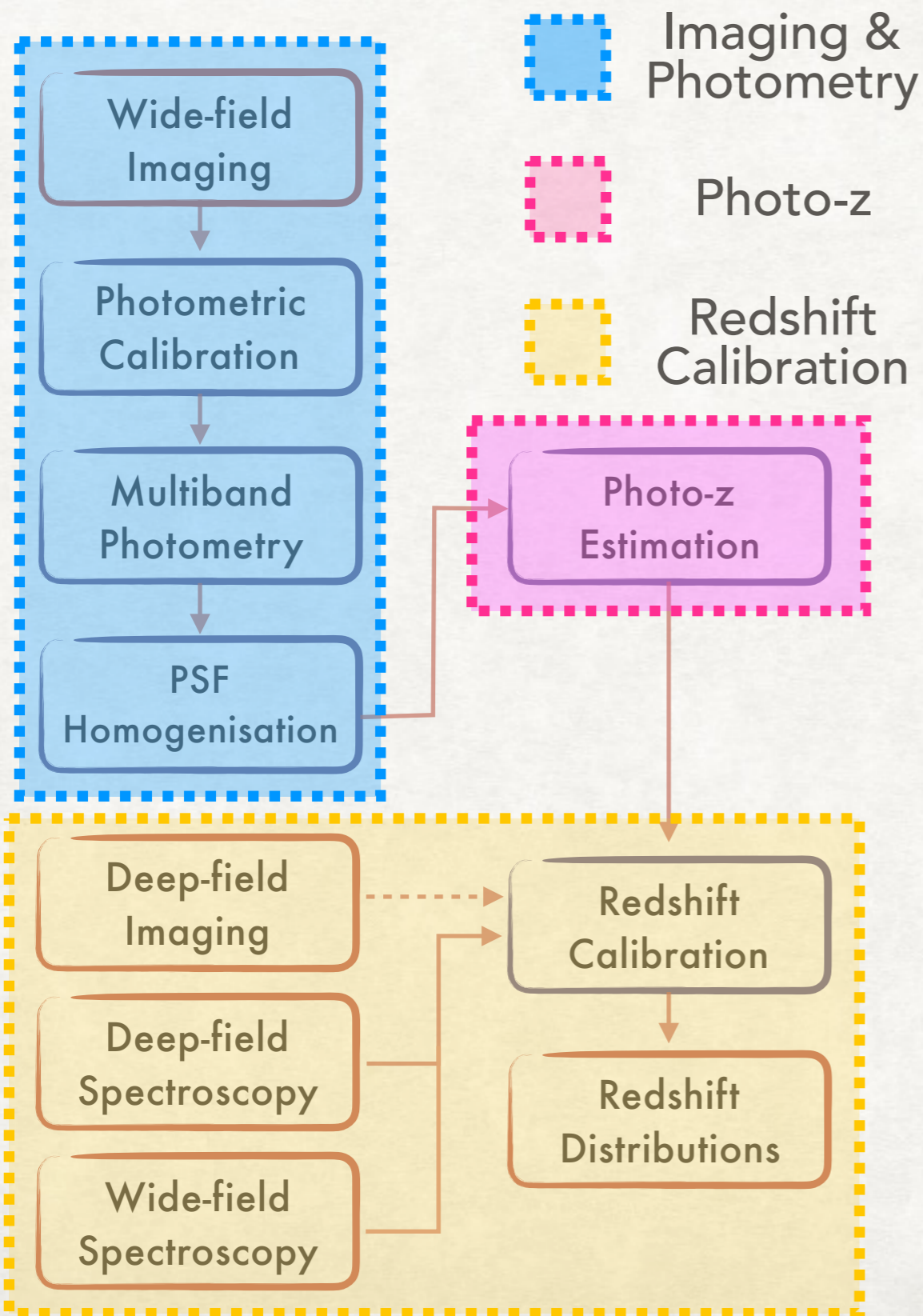
$|\Delta z| \leq \sim 0.01$

REDSHIFT CALIBRATION WITH MORE SPECTRA



van den Busch et al (in prep)

COSMIC SHEAR REDSHIFT CALIBRATION



$|\Delta z| \leq \sim 0.01$

More work to come for KiDS-Legacy

COSMIC SHEAR WEAK LENSING

