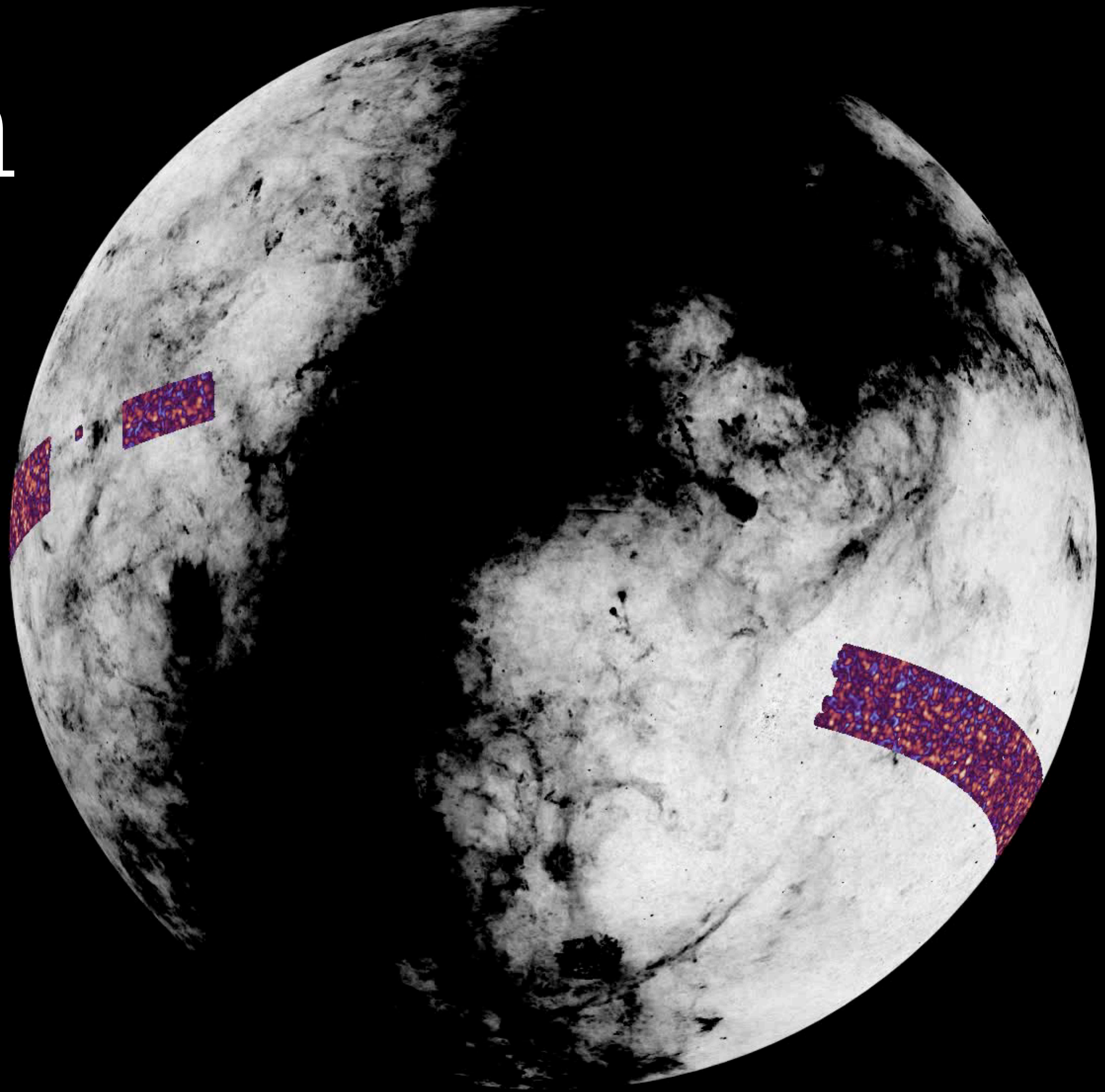
Cosmology with KiDS-Legacy

Angus H Wright
On behalf of the KiDS Collaboration

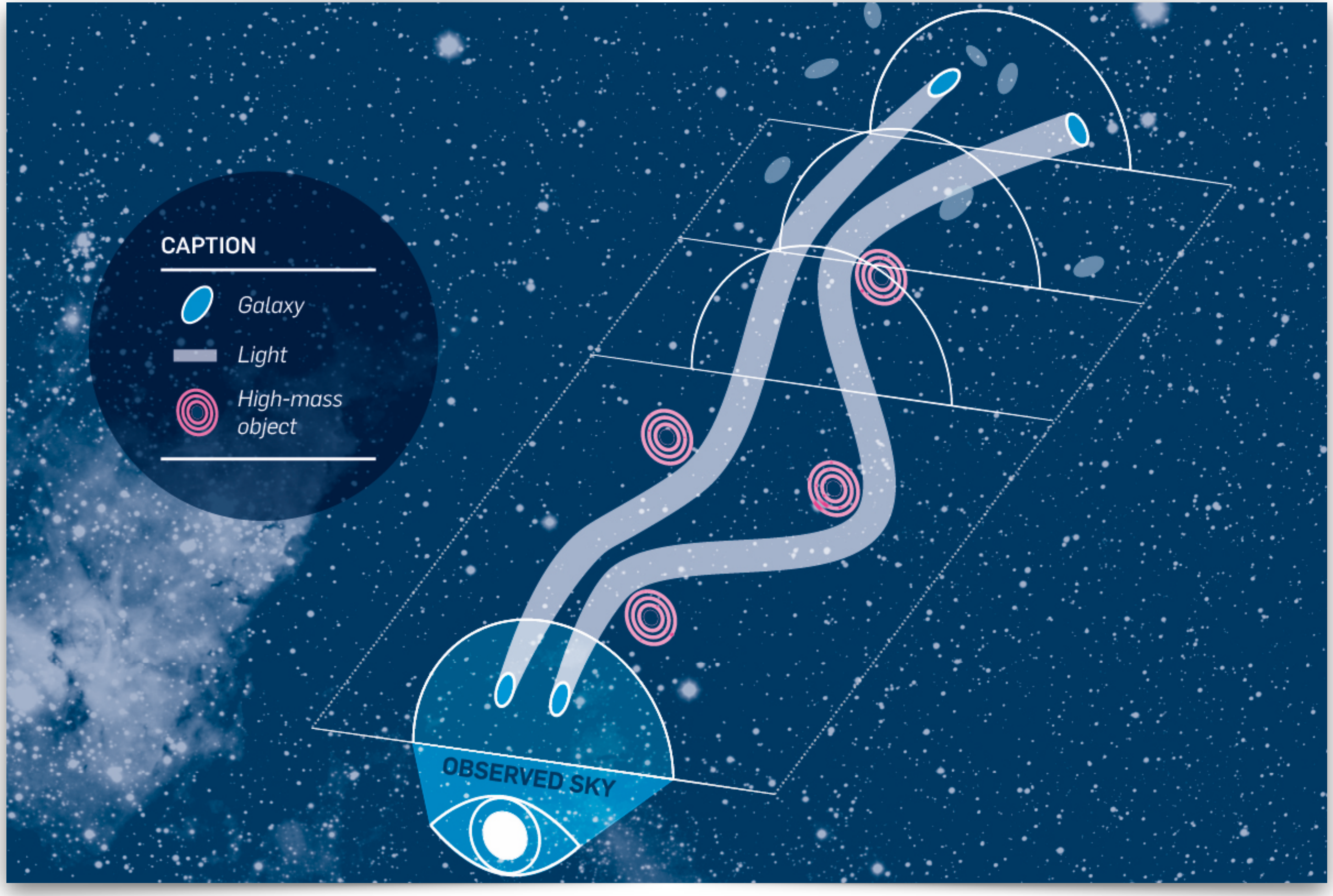
Colloque Action Dark Energy
Université de Montpellier
06.11.25



RUHR UNIVERSITÄT BOCHUM RUB GCCL GERMAN CENTRE FOR COSMOLOGICAL LENSING

Fundamentals of Cosmic Shear

Lensing by large-scale structures



Galaxies in the distant universe have (mostly) randomly distributed shapes

Light is distorted along the line-of-sight by massive structures

Propagation through similar structures imprints coherent distortions on galaxy shapes

Image Credit: Ruhr-University Bochum

Fundamentals of Cosmic Shear

The Shear-Shear Correlation Function

Observed & Theory

- Observed shear-shear correlation function relates observed tangential- and cross-shears
- Shear correlations directly relate to the matter power-spectrum
- Requires knowledge of the source redshift distribution

$$\xi_{\pm}(\theta) = \langle \gamma_{\mathrm{t}} \gamma_{\mathrm{t}} \rangle (\theta) \pm \langle \gamma_{\times} \gamma_{\times} \rangle (\theta)$$

$$\xi_{+}(\theta) = \int_0^\infty \frac{\mathrm{d}\ell\, \ell}{2\pi} \mathrm{J}_0(\ell\theta)\, P_\kappa(\ell)$$

$$\xi_{-}(\theta) = \int_0^\infty \frac{\mathrm{d}\ell\, \ell}{2\pi} \mathrm{J}_4(\ell\theta)\, P_\kappa(\ell)$$

$$P_\kappa(\ell) = \frac{9 H_0^4 \Omega_{\mathrm{m}}^2}{4 c^4} \int_0^{\chi_{\mathrm{h}}} \mathrm{d}\chi\, \frac{g^2(\chi)}{a^2(\chi)}\, P_\delta\left(\frac{\ell}{f_K(\chi)}, \chi\right)$$

$$g(\chi) = \int_\chi^{\chi_{\mathrm{h}}} \mathrm{d}\chi'\, p_\chi(\chi') \frac{f_K(\chi' - \chi)}{f_K(\chi')}$$

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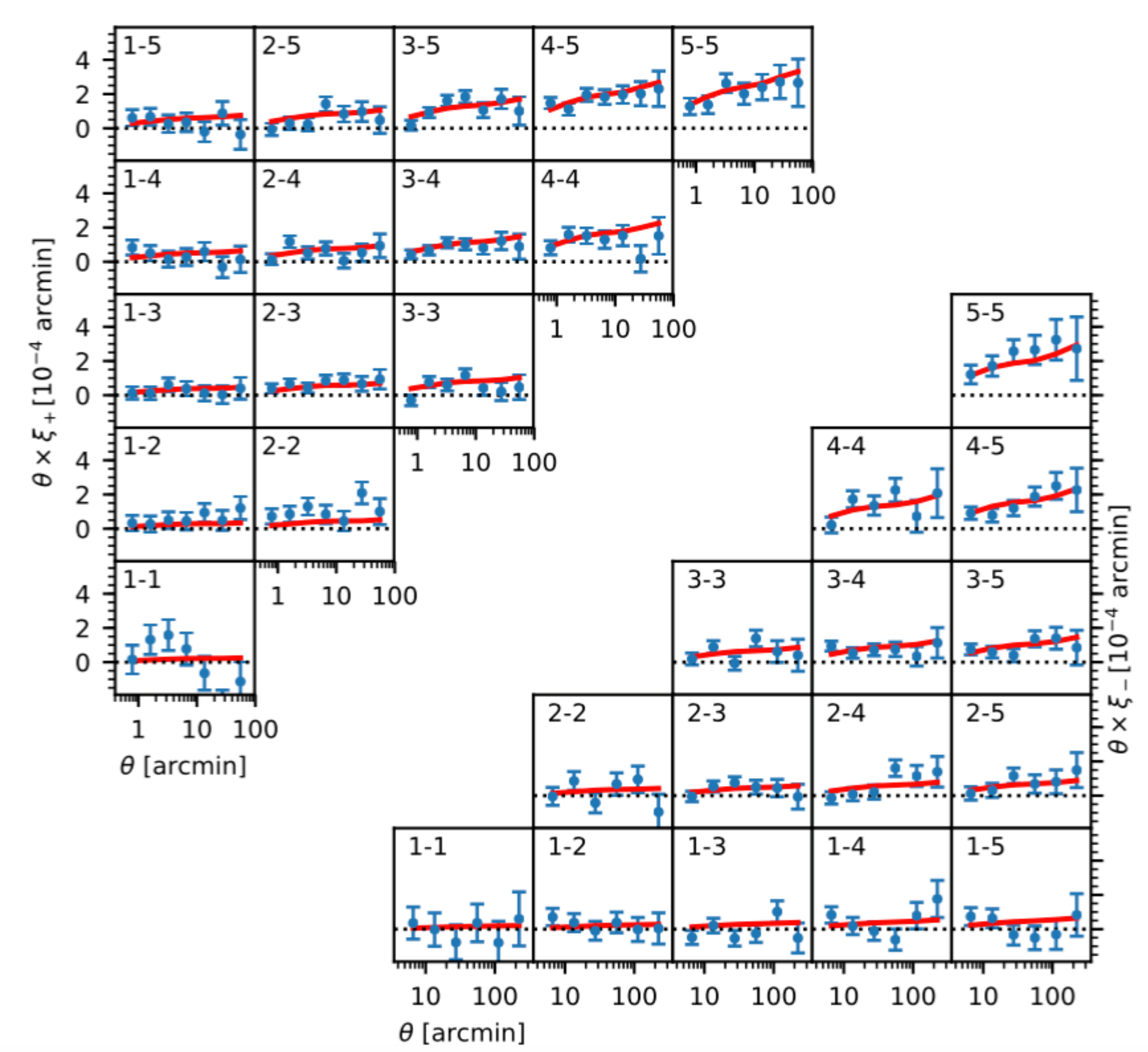
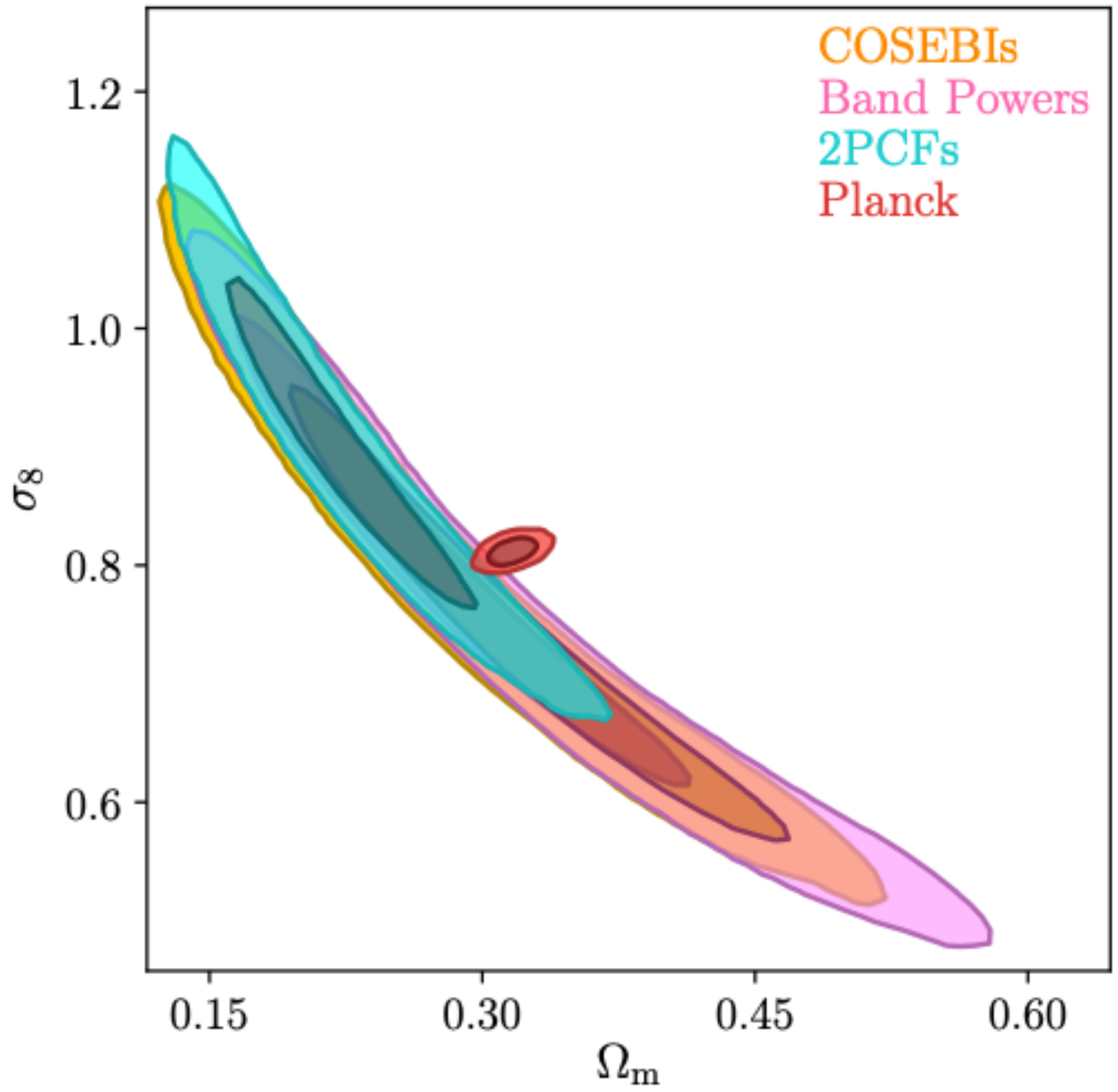


Fundamentals of Cosmic Shear

Measuring Cosmological Parameters



Asgari et al. (2021)

Degeneracy between amount of matter and strength of clustering

So we discuss cosmic shear in terms of the degeneracy:

$$S8 = \sigma_8\sqrt{\Omega_m/0.3}$$

or more generally:

$$\Sigma_8 = \sigma_8(\Omega_m/0.3)^\alpha$$

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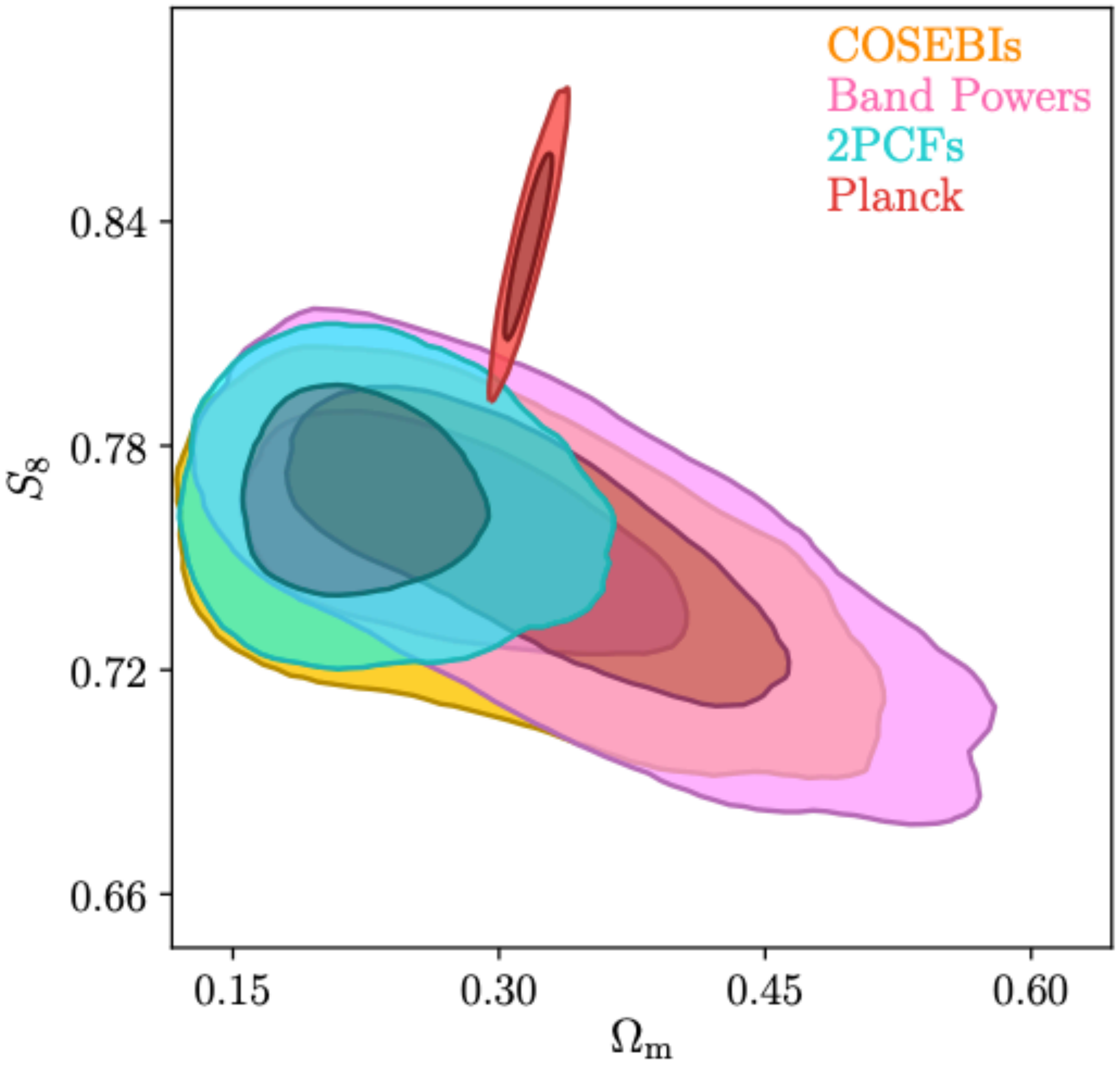

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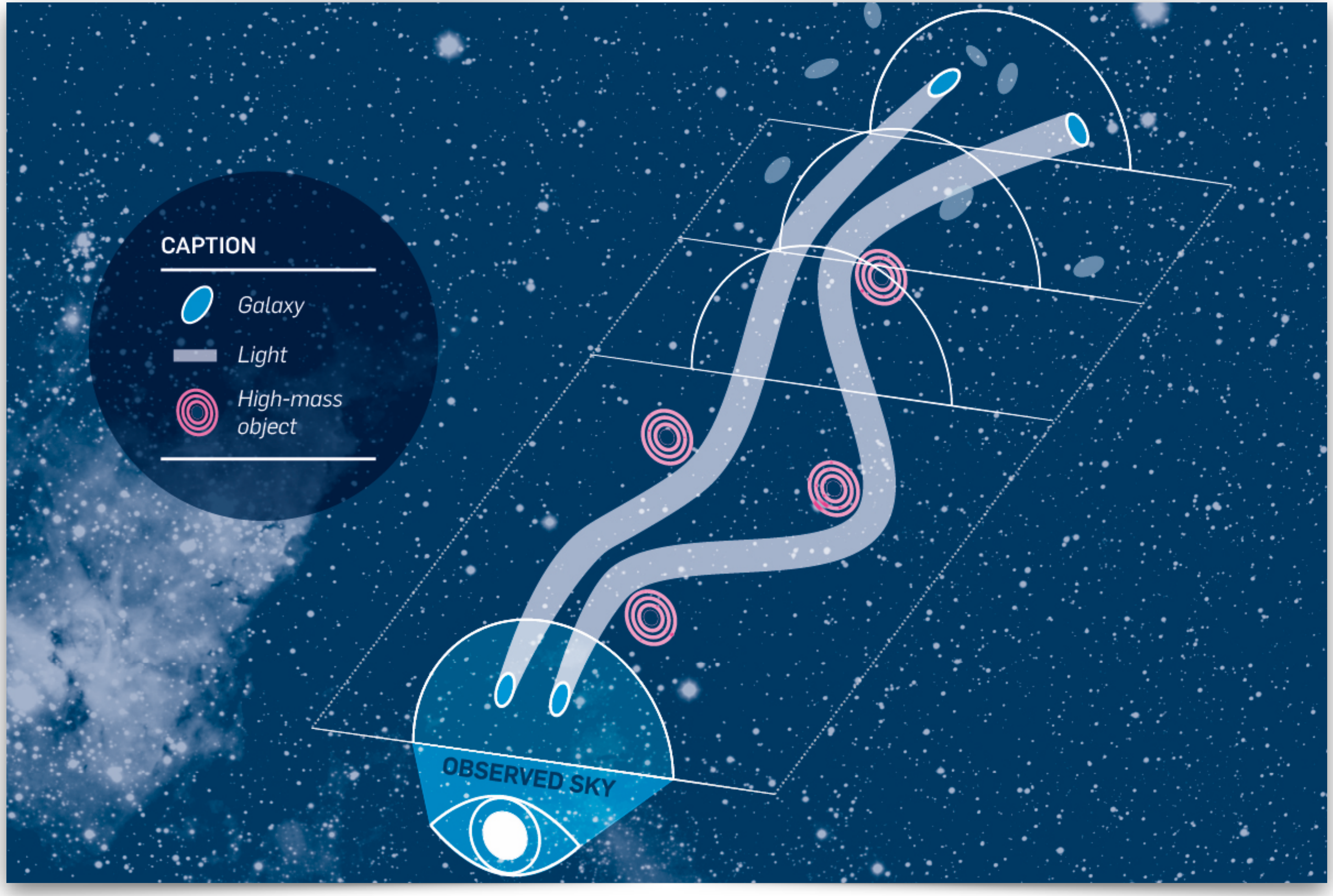
Robust Cosmic Shear Requirements

What do you need to get right?



Shape Measurements

Source Redshift Distributions

Modelling of the Source galaxy population

Modelling of baryonic effects

Image Credit: Ruhr-University Bochum

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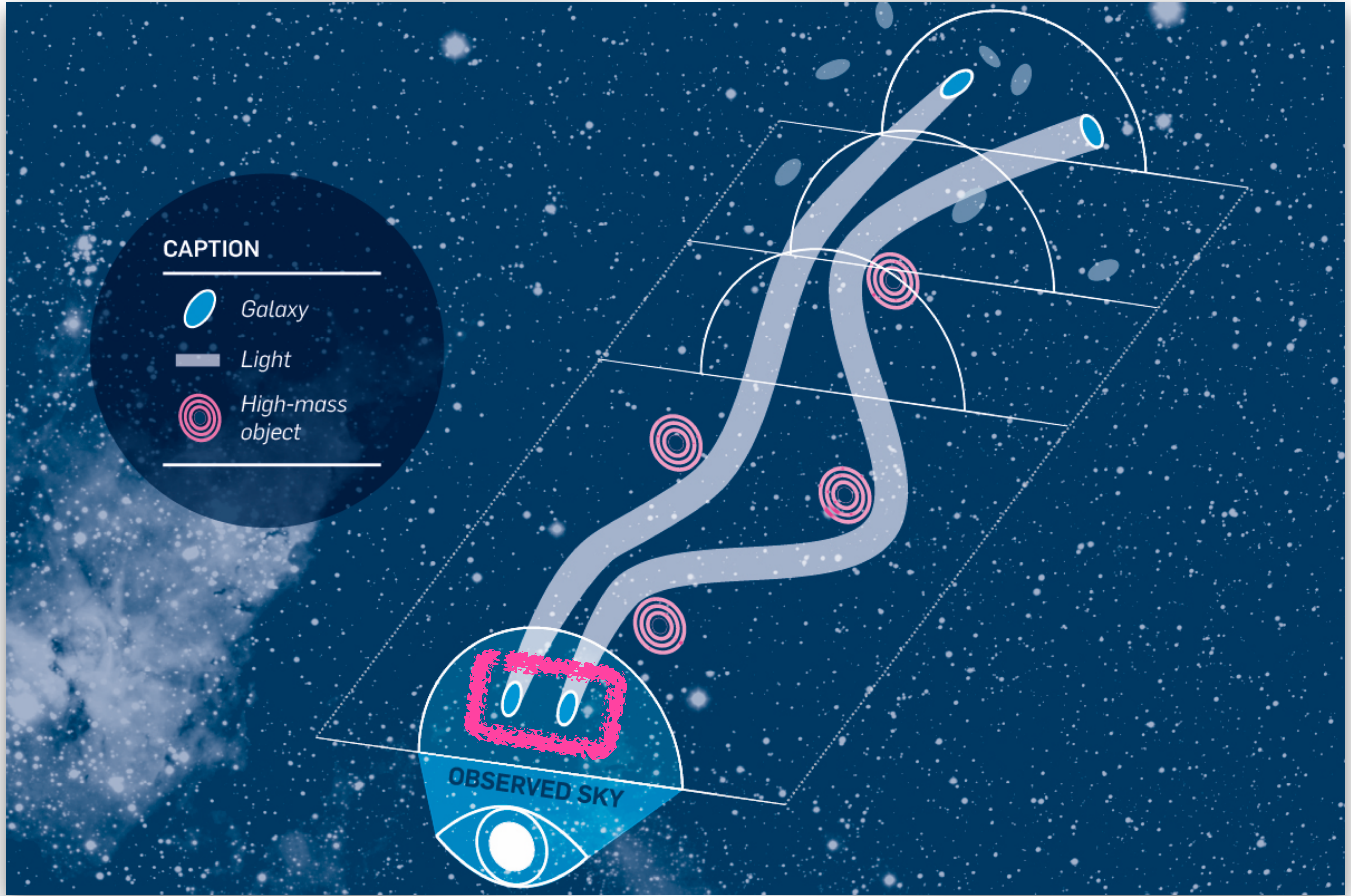

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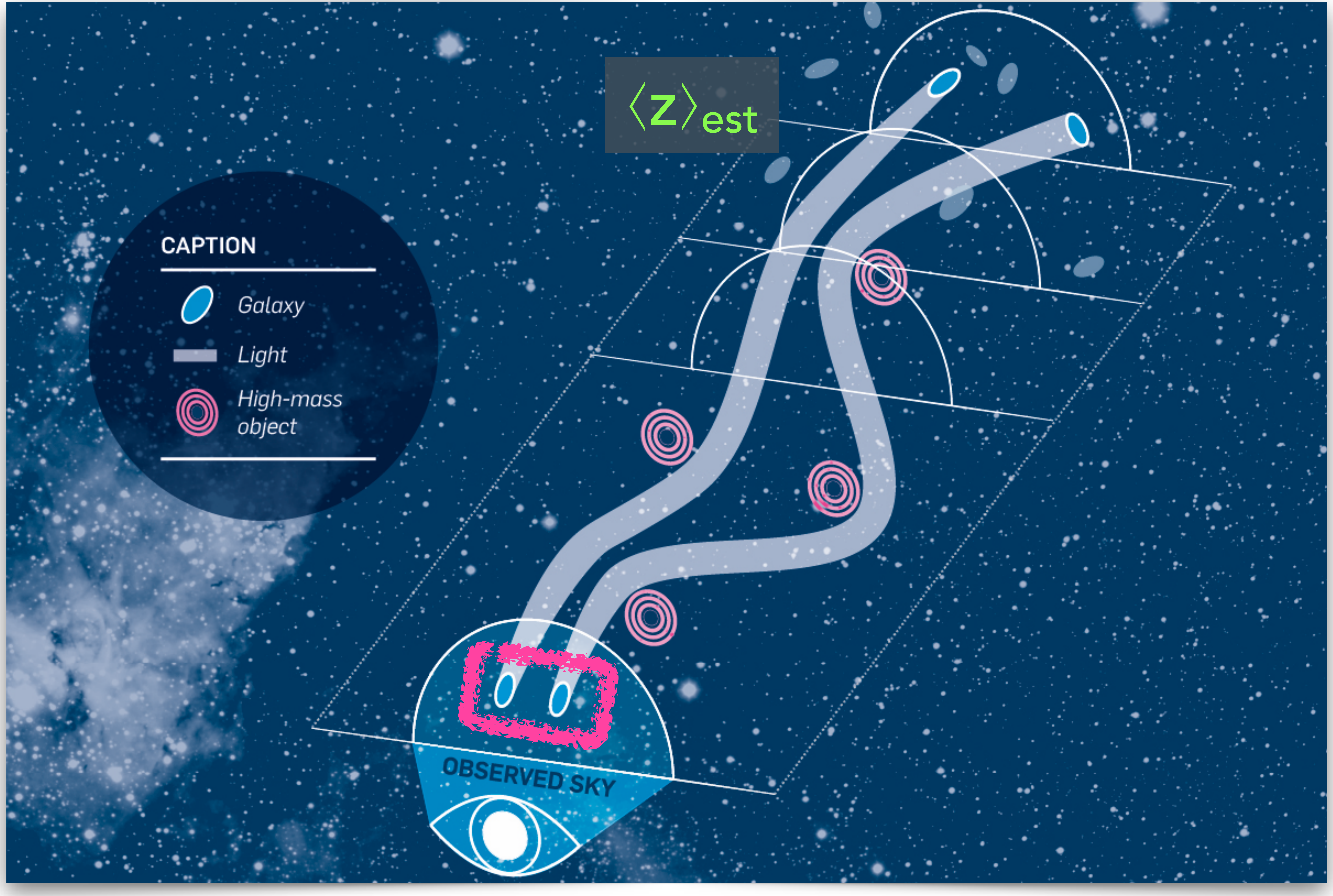

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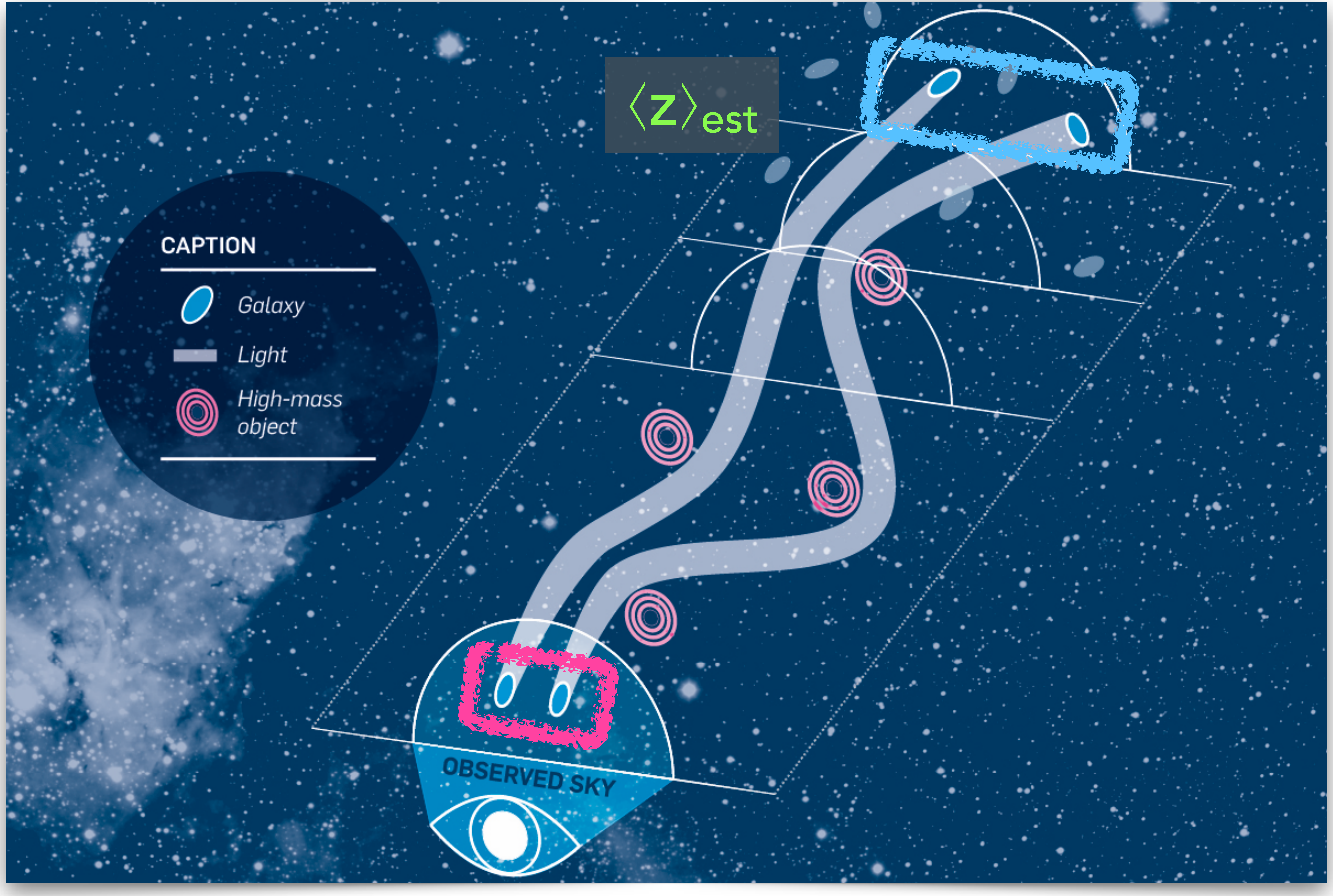

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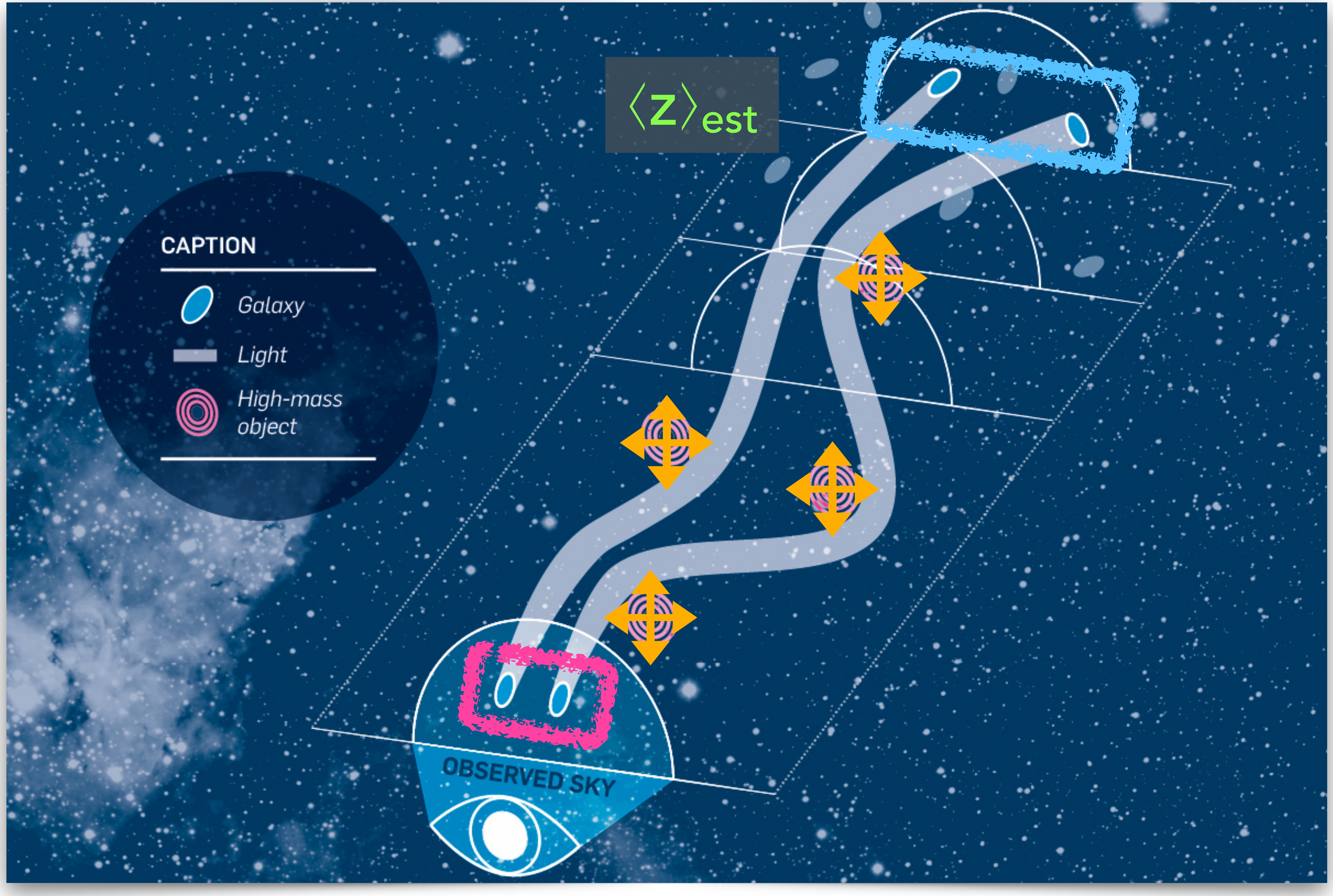

Shape Measurements

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Why is line-of-sight localisation (i.e. *redshift distribution calibration*) important for cosmic shear?

Robust Cosmic Shear Requirements

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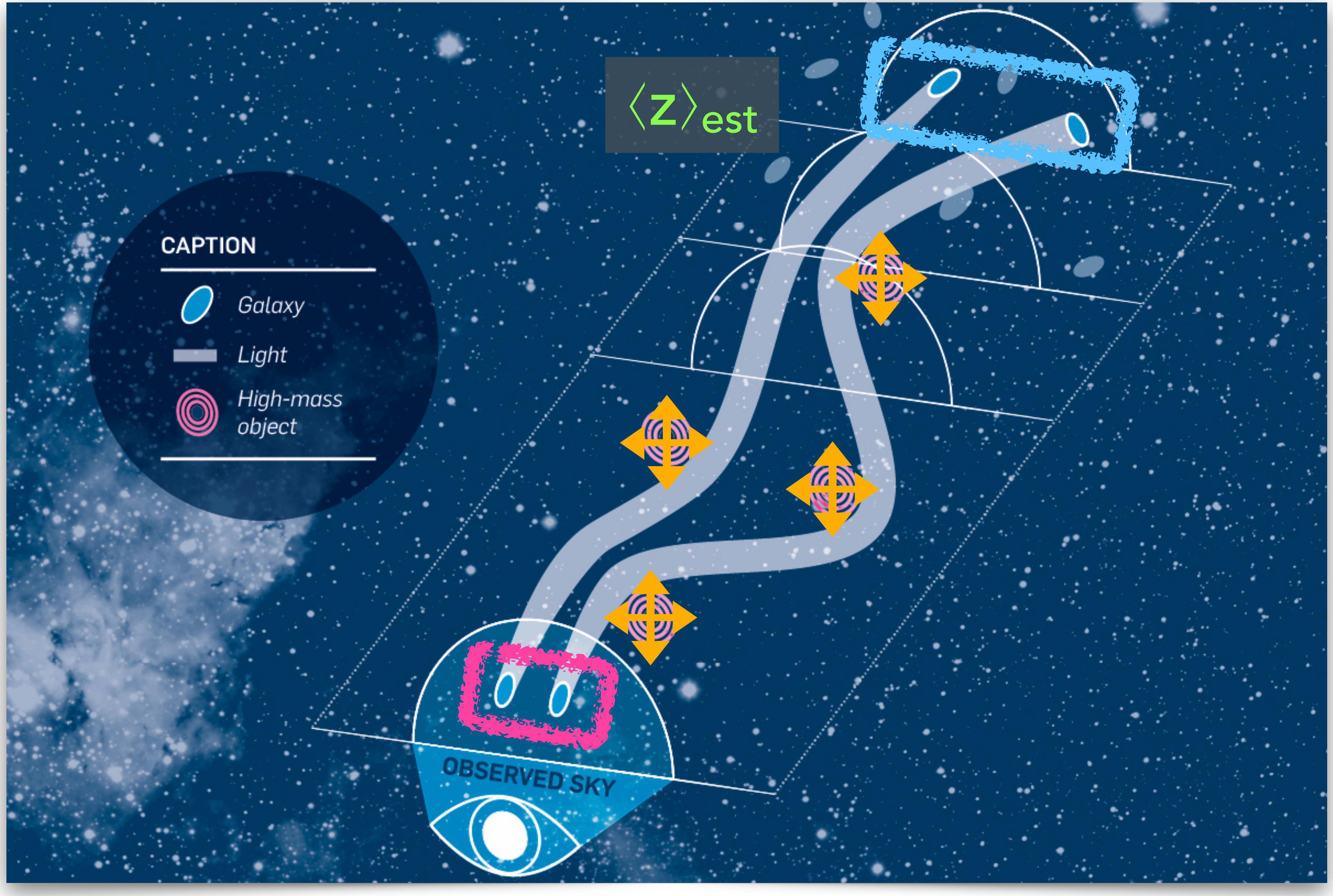

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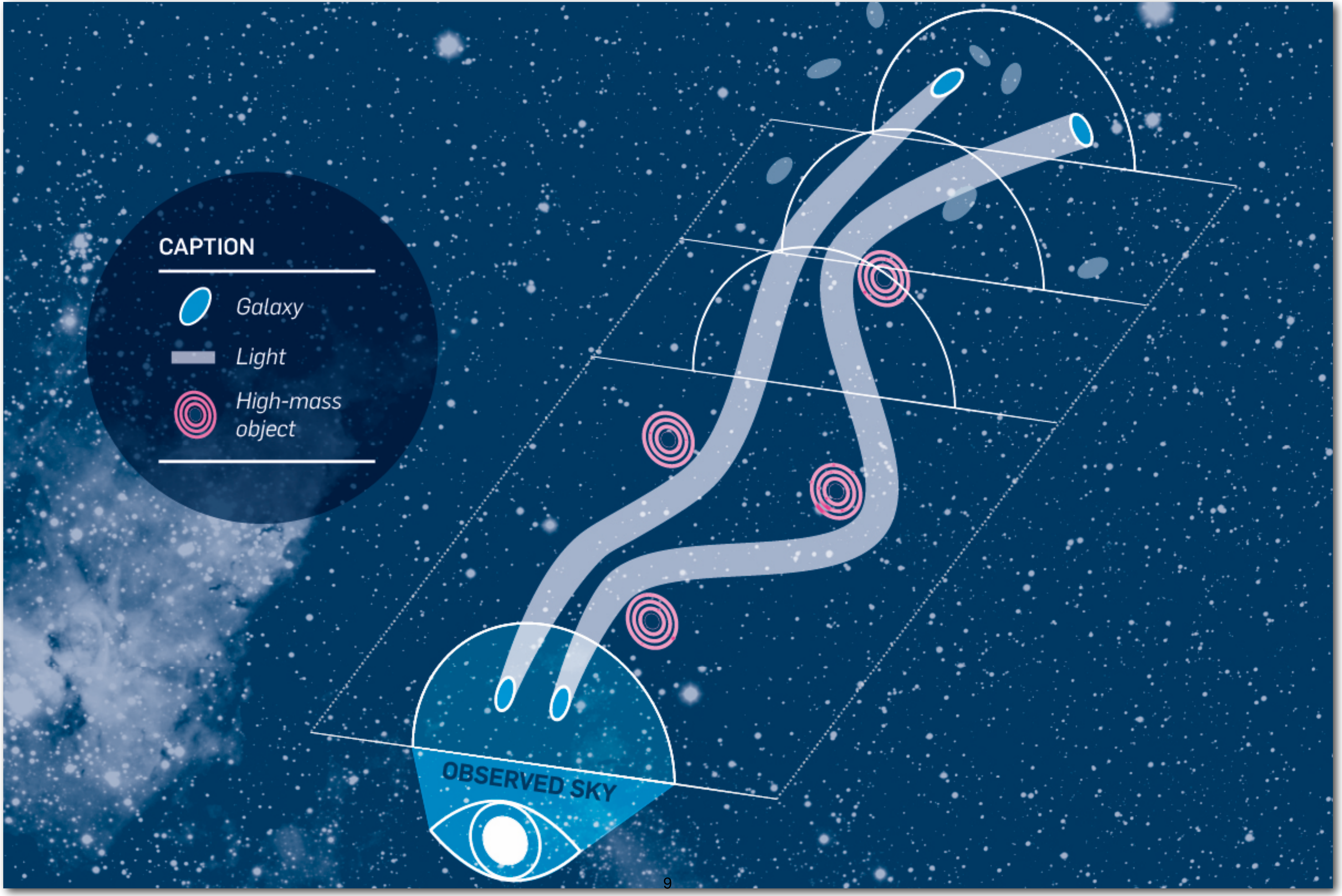
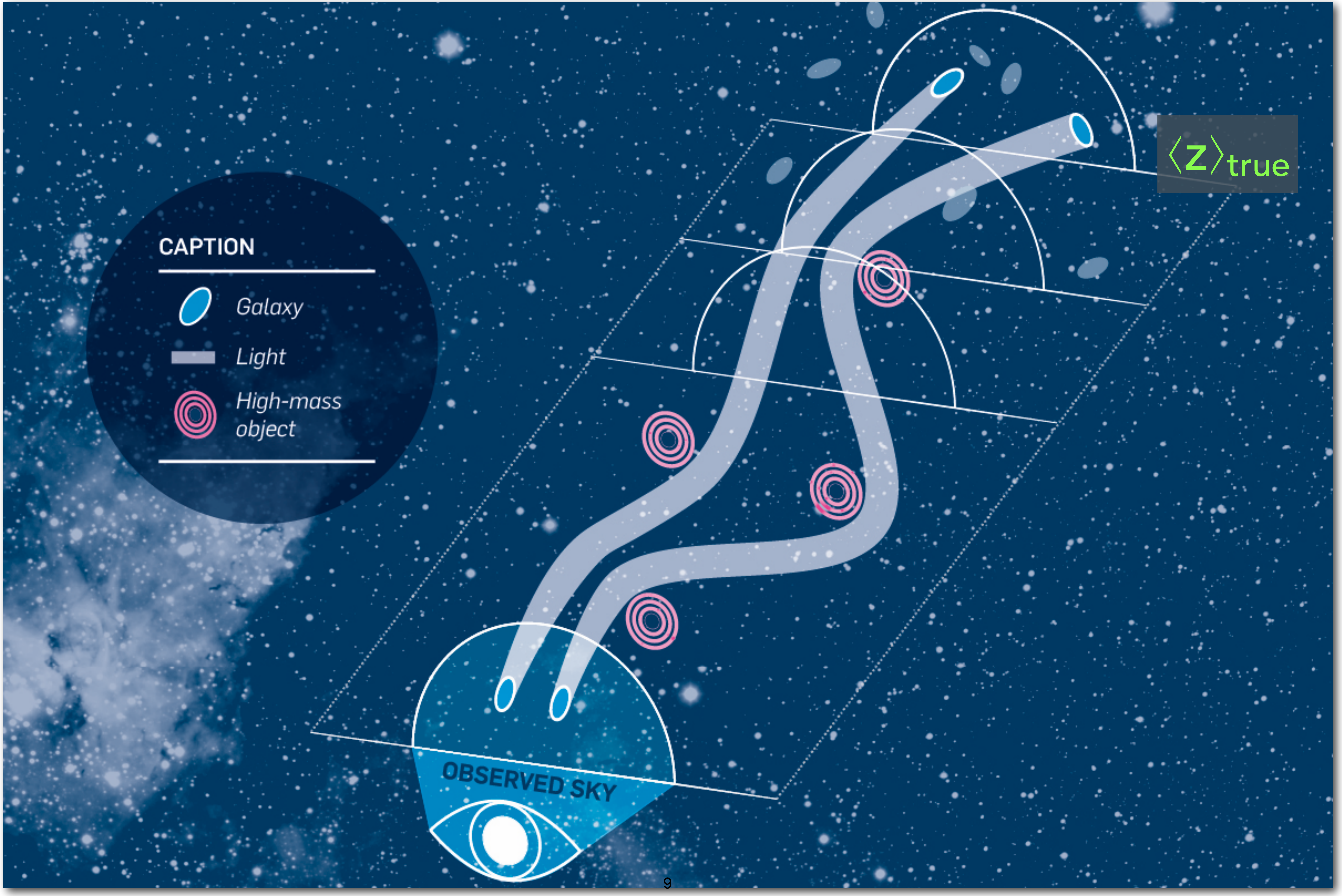

CAPTION
Galaxy
Light
High-mass object
OBSERVED SKY


CAPTION
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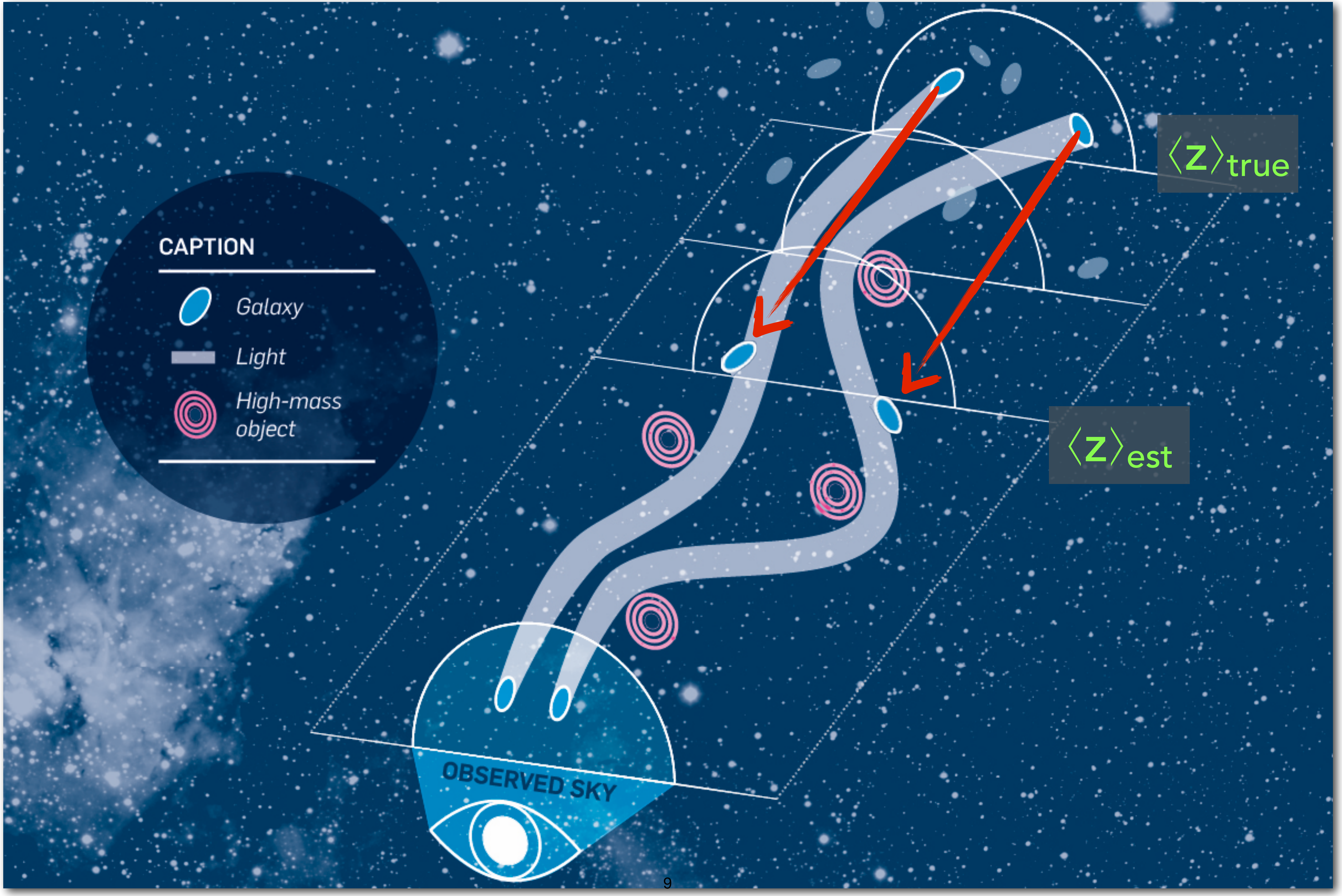
⟨z⟩true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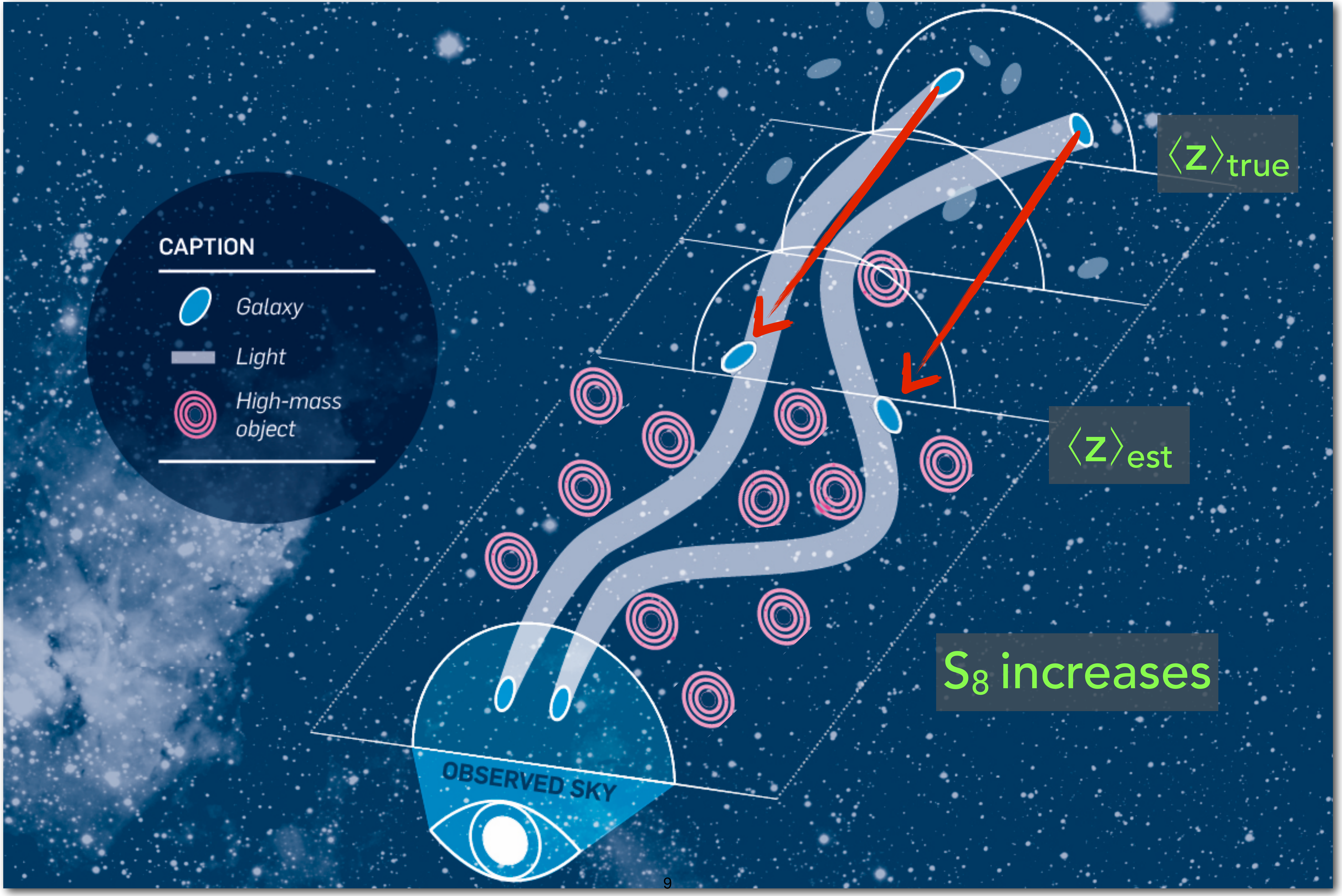
CAPTION
Galaxy
Light
High-mass object
OBSERVED SKY
⟨z⟩true
⟨z⟩est
S8 increases

Stage-III Cosmic Shear
with
the final release of KiDS

The path to KiDS-Legacy

	KiDS-450
Publication	H+17
Footprint [sqdeg]	450
Filters	***ugri***
Tomographic Bins	4
photo-z range	$(0.1, 0.9]$
2pt statistic(s)	$\xi_\pm$
Scale cuts [arcmin]	$[0.5, 300.0]$
Shear calibration	SCHOol
$N(z)$ calibration	DIR
Calibration sample	~ 25k
Sample Selection	-
Covariance	simple geom.
PNL	HMCode 2016
Feedback model	**1 par. *m*-*c* relation [2, 4]**
IA model	NLA

The path to KiDS-Legacy

	KiDS-450	KV450	KV450+	KiDS-1000	K1000+	K1000++	KiDS-Legacy
Publication	H+17	H+20	W+20b	A+21	vdB+22	Li+23	This work
Footprint [sqdeg]	450	450	450	**1000**	1000	1000	**1350**
Filters	$\boldsymbol{ugri}$	$\boldsymbol{ugri}$ $\boldsymbol{ZYJHK_s}$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$\boldsymbol{ugri_1i_2}$ $\boldsymbol{ZYJHK_s}$
Tomographic Bins	4	**5**	5	5	5	5	**6**
photo-z range	$(0.1, 0.9]$	$(\mathbf{0.1}, \mathbf{1.2}]$	$(0.1, 1.2]$	$(0.1, 1.2]$	$(0.1, 1.2]$	$(0.1, 1.2]$	$(\mathbf{0.1}, \mathbf{2.0}]$
2pt statistic(s)	$\xi_\pm$	$\xi_\pm$	$\xi_\pm$	$\xi_\pm$, $\mathbf{C}_{\mathrm{EE/BB}}$, $\mathbf{E_n/B_n}$	E_n/B_n	E_n/B_n	$\xi_\pm$, $C_{\mathrm{EE/BB}}$, E_n/B_n
Scale cuts [arcmin]	$[0.5, 300.0]$	$[0.5, 300.0]$	$[0.5, 300.0]$	$[0.5, 300.0]$	$[0.5, 300.0]$	$[\mathbf{2.0}, \mathbf{300.0}]$	$[2.0, 300.0]$
Shear calibration	SCHOol	SCHOol	SCHOol	**COllege**	COllege	**SKiLLS**	SKiLLS
$N(z)$ calibration	DIR	DIR	**SOM**	SOM	SOM	SOM	**tomo SOM**
Calibration sample	~ 25k	~ 25k	~ 25k	~ 25k	~ **50k**	~ 50k	~ **125k**
Sample Selection	-	-	**Gold flag**	Gold flag	Gold flag	Gold flag	**Gold weight**
Covariance	simple geom.	**pair counts**	pair counts	pc & **var. depth**	pc & var. depth	pc & var. depth	**the One Covariance**
PNL	HMCode 2016	HMCode 2016	HMCode 2016	HMCode 2016	HMCode 2016	**HMCode 2020**	HMCode 2020
Feedback model	**1 par.** ***m-c*** **relation** $[\mathbf{2}, \mathbf{4}]$	1 par. *m-c* relation $[\mathbf{2}, \mathbf{3.13}]$	1 par. *m-c* relation $[2, 3.13]$	1 par. *m-c* relation $[2, 3.13]$	1 par. *m-c* relation $[2, 3.13]$	$\log \boldsymbol{T}_{\mathbf{AGN}}$ $[\mathbf{7.3}, \mathbf{8}]$	$\log T_{\mathrm{AGN}}$ $[7.3, 8]$
IA model	NLA	NLA	NLA	NLA	NLA	**NLA+F21**	**NLA-M**

The path to KiDS-Legacy

Intermediate changes

Used by Legacy

	KiDS-450	KV450	KV450+	KiDS-1000	K1000+	K1000++	KiDS-Legacy
Publication	H+17	H+20	W+20b	A+21	vdB+22	Li+23	This work
Footprint [sqdeg]	450	450	450	**1000**	1000	1000	**1350**
Filters	$\boldsymbol{ugri}$	$\boldsymbol{ugri}$ $\boldsymbol{ZYJHK_s}$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$ugri$ $ZYJHK_s$	$\boldsymbol{ugri_1i_2}$ $\boldsymbol{ZYJHK_s}$
Tomographic Bins	4	**5**	5	5	5	5	**6**
photo-z range	(0.1, 0.9]	**(0.1, 1.2]**	(0.1, 1.2]	(0.1, 1.2]	(0.1, 1.2]	(0.1, 1.2]	**(0.1, 2.0]**
2pt statistic(s)	$\xi_\pm$	$\xi_\pm$	$\xi_\pm$	$\xi_\pm$, $C_{\mathrm{EE/BB}}$, $\mathbf{E_n/B_n}$	E_n/B_n	E_n/B_n	$\xi_\pm$, $C_{\mathrm{EE/BB}}$, E_n/B_n
Scale cuts [arcmin]	[0.5, 300.0]	[0.5, 300.0]	[0.5, 300.0]	[0.5, 300.0]	[0.5, 300.0]	**[2.0, 300.0]**	[2.0, 300.0]
Shear calibration	SCHOol	SCHOol	SCHOol	**COllege**	COllege	**SKiLLS**	SKiLLS
$N(z)$ calibration	DIR	DIR	**SOM**	SOM	SOM	SOM	**tomo SOM**
Calibration sample	~ 25k	~ 25k	~ 25k	~ 25k	~ **50k**	~ 50k	~ **125k**
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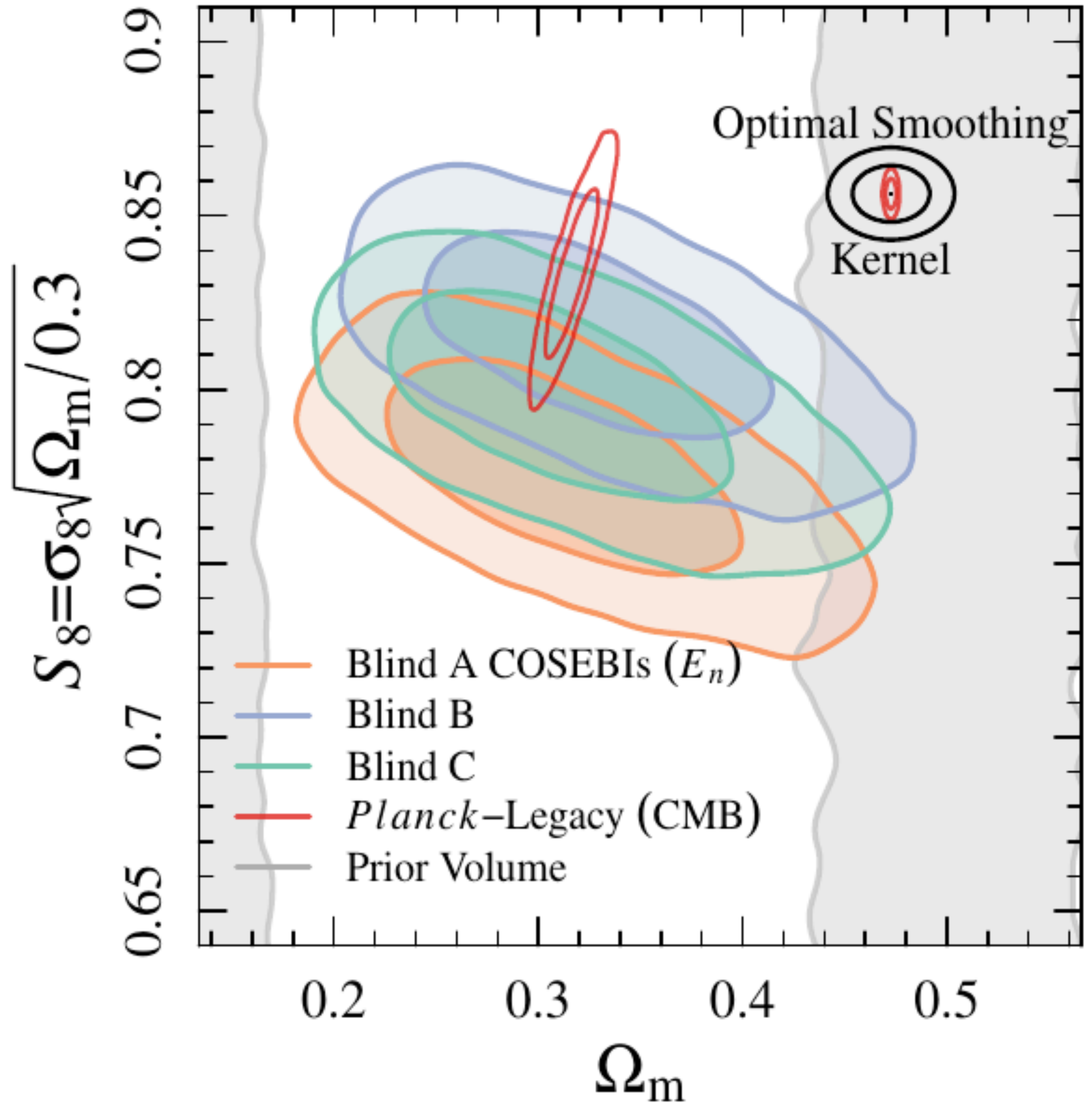
Covariance	simple geom.	**pair counts**	pair counts	pc & **var. depth**	pc & var. depth	pc & var. depth	**the One Covariance**
PNL	HMCode 2016	HMCode 2016	HMCode 2016	HMCode 2016	HMCode 2016	**HMCode 2020**	HMCode 2020
Feedback model	**1 par.** ***m-c* relation** **[2, 4]**	1 par. *m-c* relation **[2, 3.13]**	1 par. *m-c* relation [2, 3.13]	1 par. *m-c* relation [2, 3.13]	1 par. *m-c* relation [2, 3.13]	$\log \boldsymbol{T_{\mathrm{AGN}}}$ **[7.3, 8]**	$\log T_{\mathrm{AGN}}$ [7.3, 8]
IA model	NLA	NLA	NLA	NLA	NLA	**NLA+F21**	**NLA-M**

DR5 & KiDS-Legacy Analysis

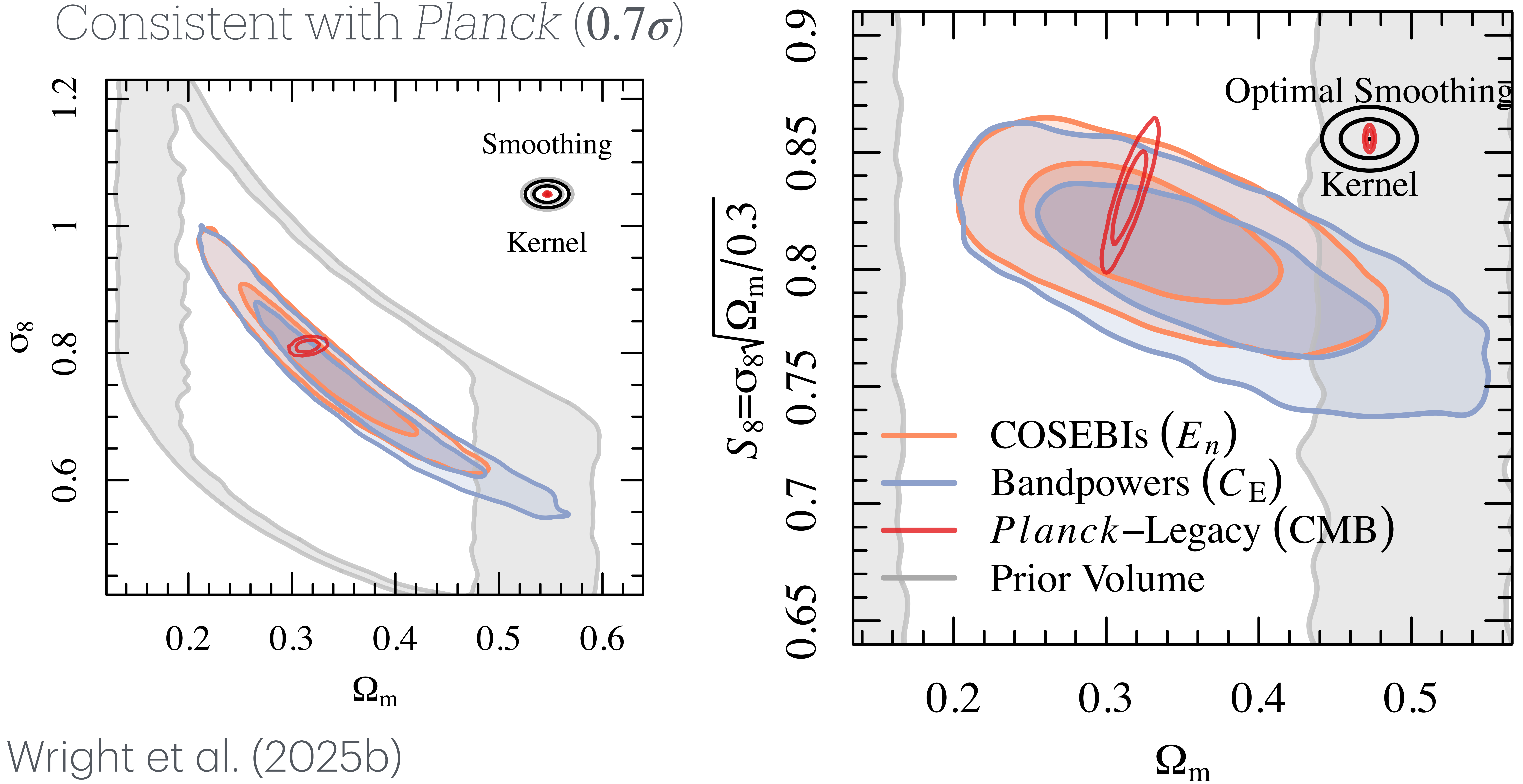
Photons to Blinded Cosmology

- 1347 sqdeg of optical & NIR data
- Complete re-reduction, including added depth
- Six bin tomographic analysis ($0.1 < z_B \leq 2.0$)
- Multiple $N(z)$ estimates and calibrations
- Joint $N(z)$ and shear calibration simulations
- Updated covariance & IA modelling (NLA-M)
- New analysis infrastructure (*CosmoPipe*)
- Papers written with Blinded results



KiDS-Legacy cosmological constraints

Consistent with *Planck* ($\mathbf{0.7\sigma}$)



Wright et al. (2025b)

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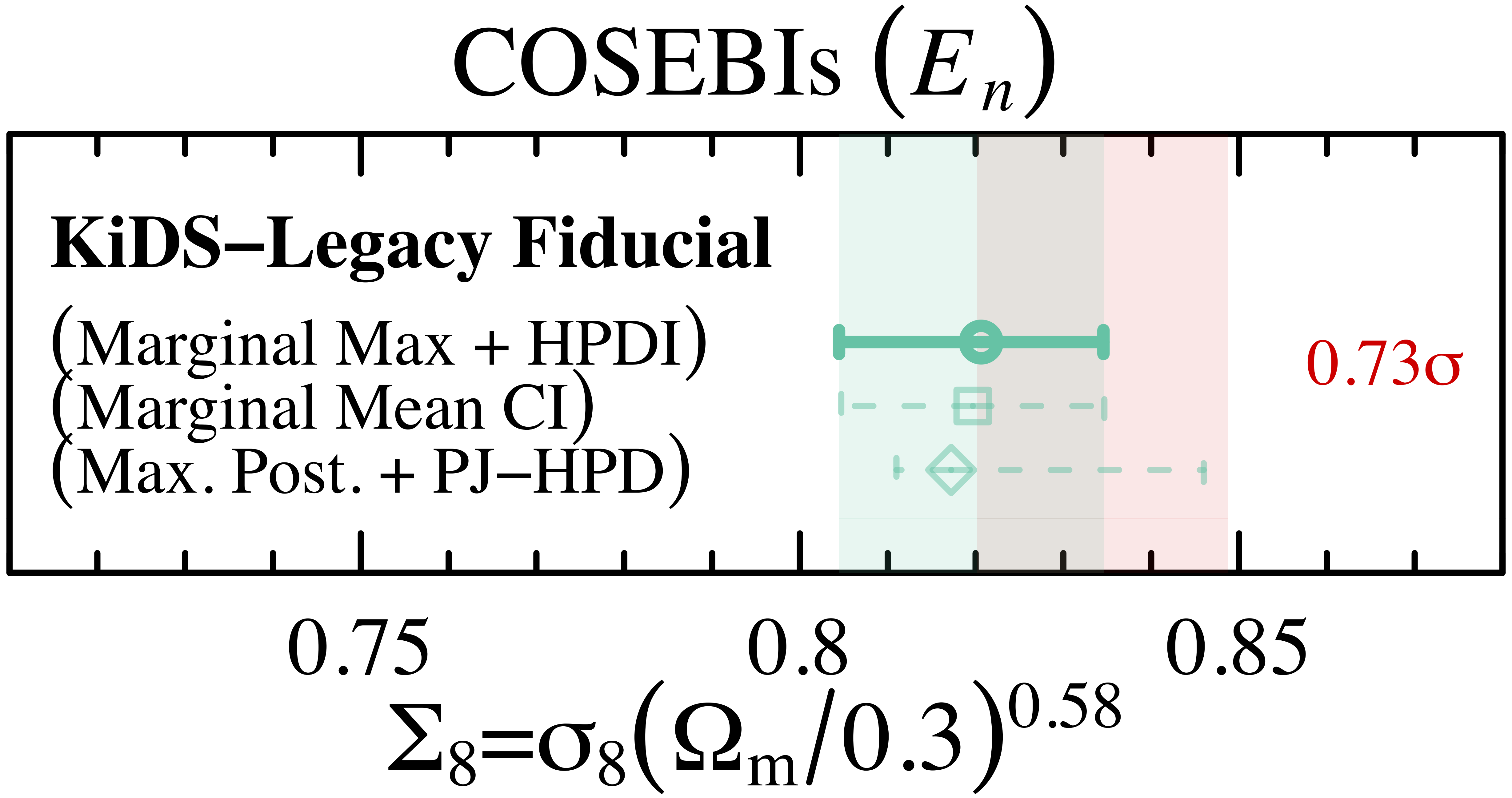

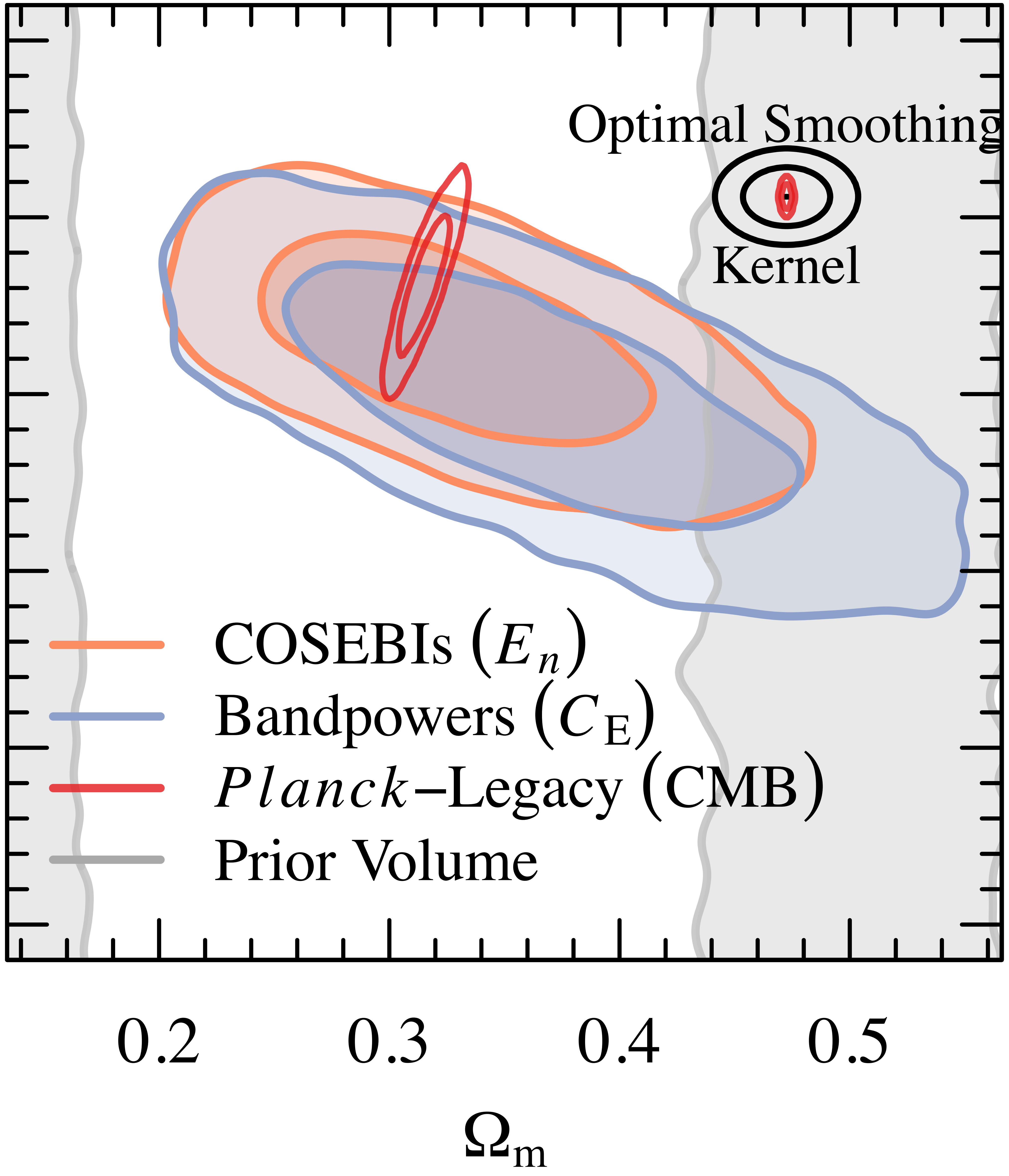

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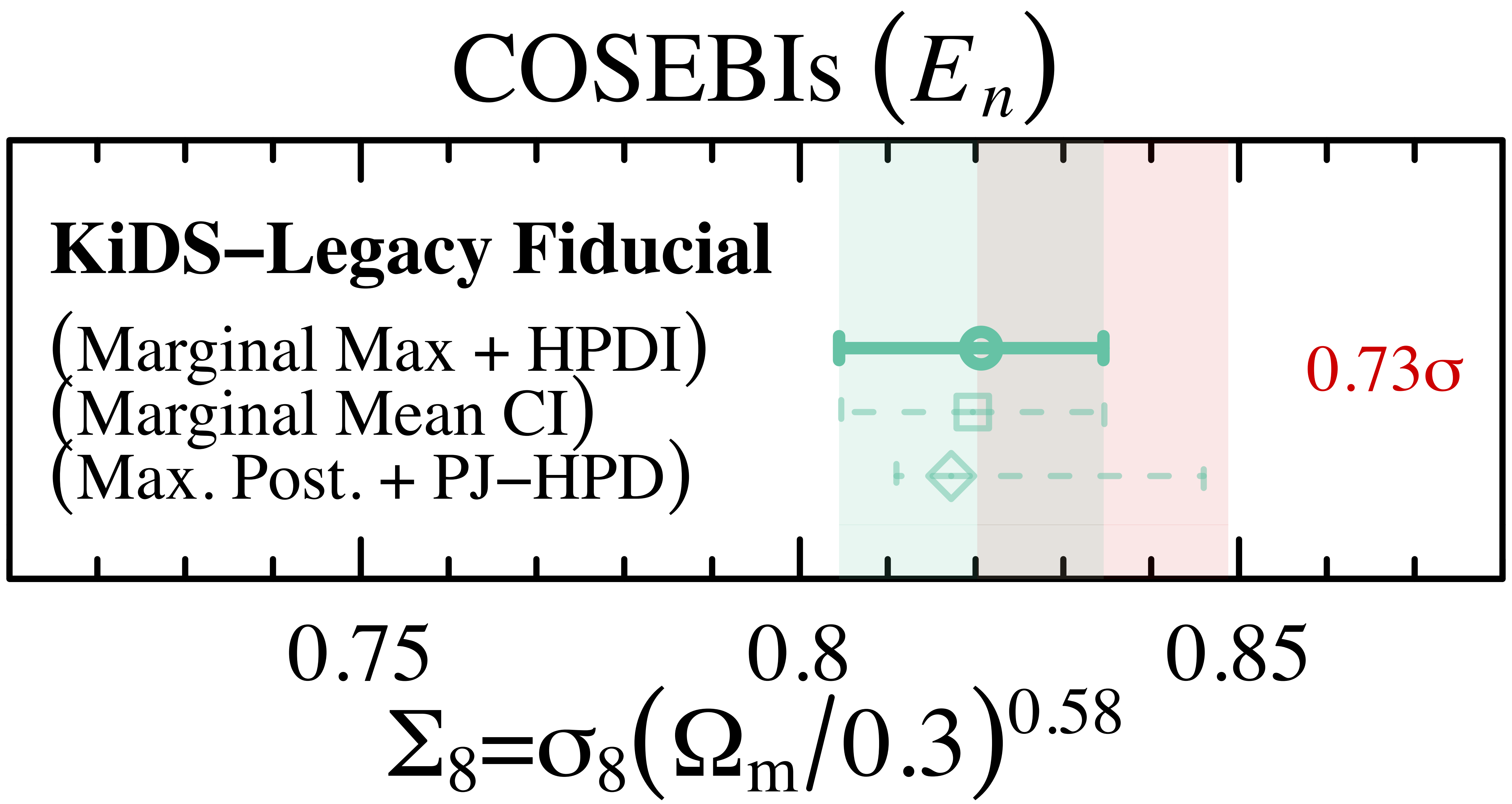
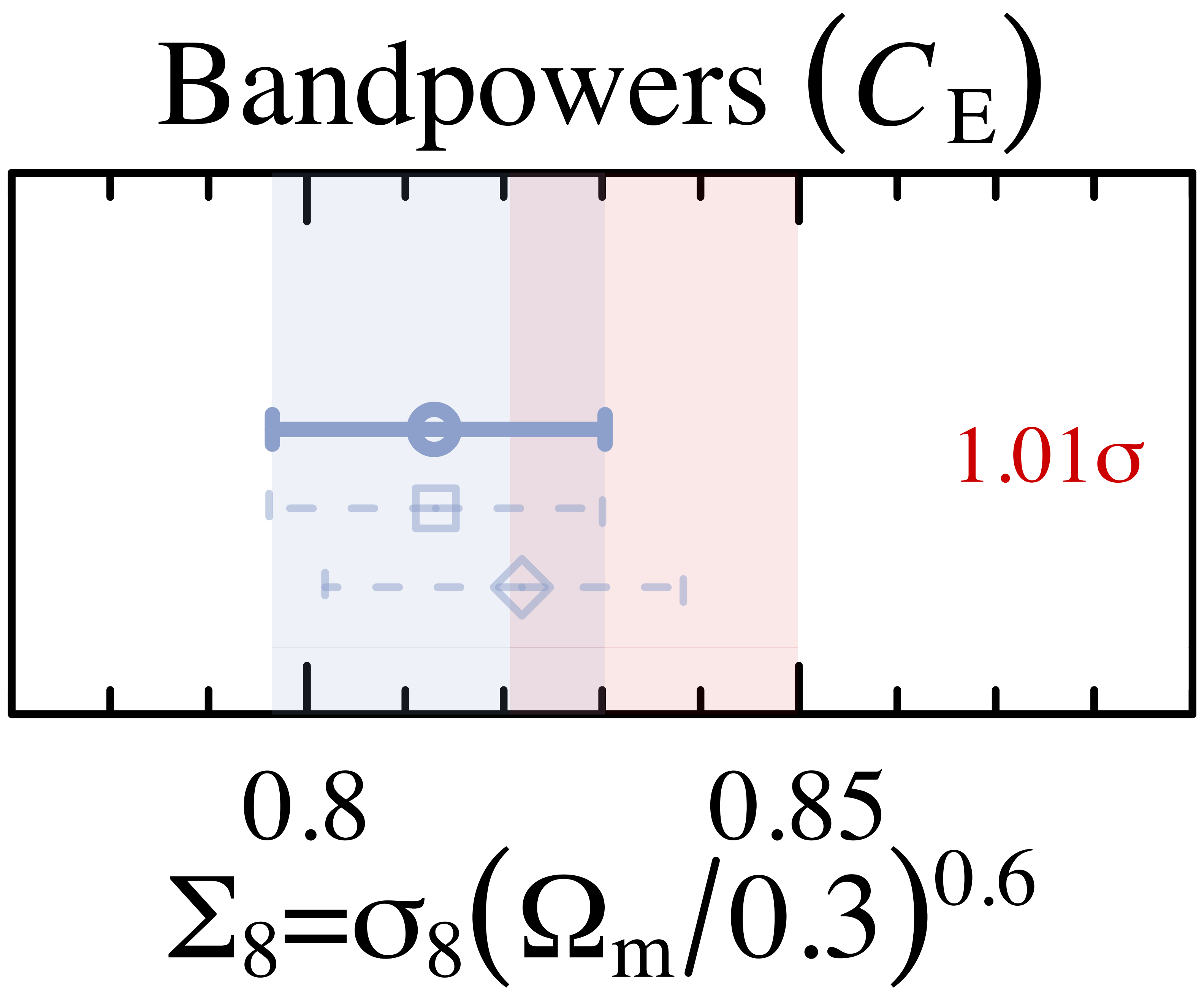
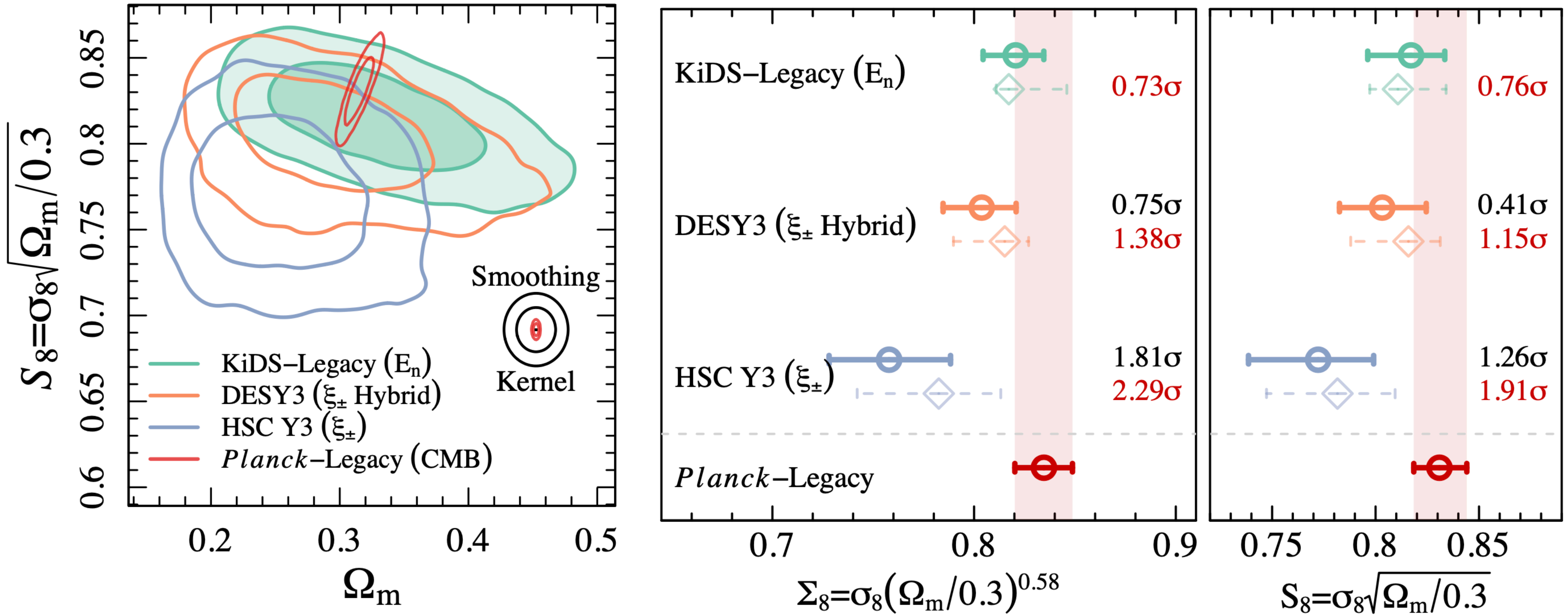




Wright et al. (2025b)

KiDS-Legacy cosmological constraints

Consistent with DES-Y3 Hybrid (**0.8σ**) & HSC Y3 (**1.8σ**)



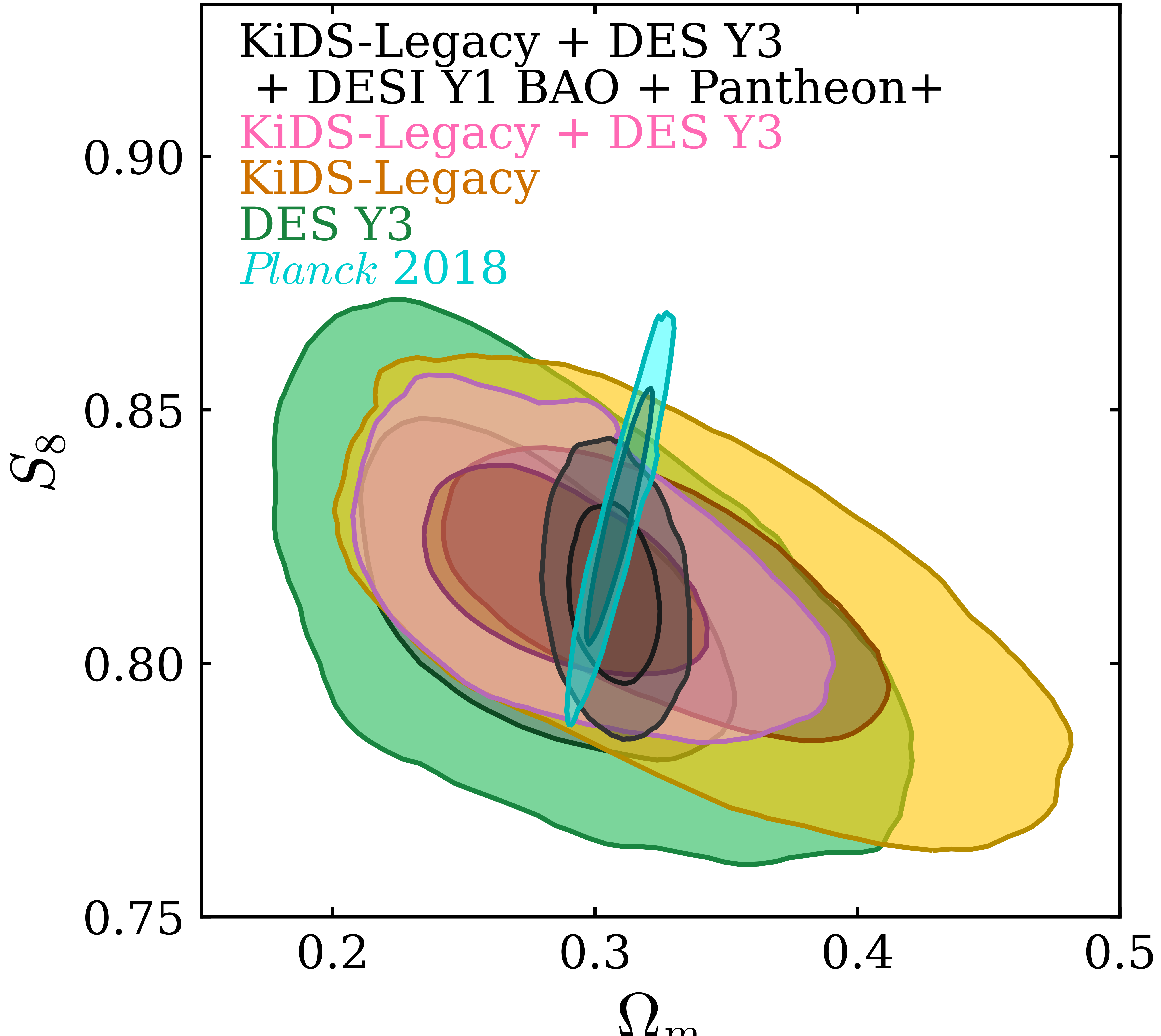
Wright et al. (2025b)

Joint constraint with DES/DESI/Pantheon+

Combined constraint is the most precise measurement of S_8 to date

$$S_8 = 0.814^{+0.011}_{-0.012}$$

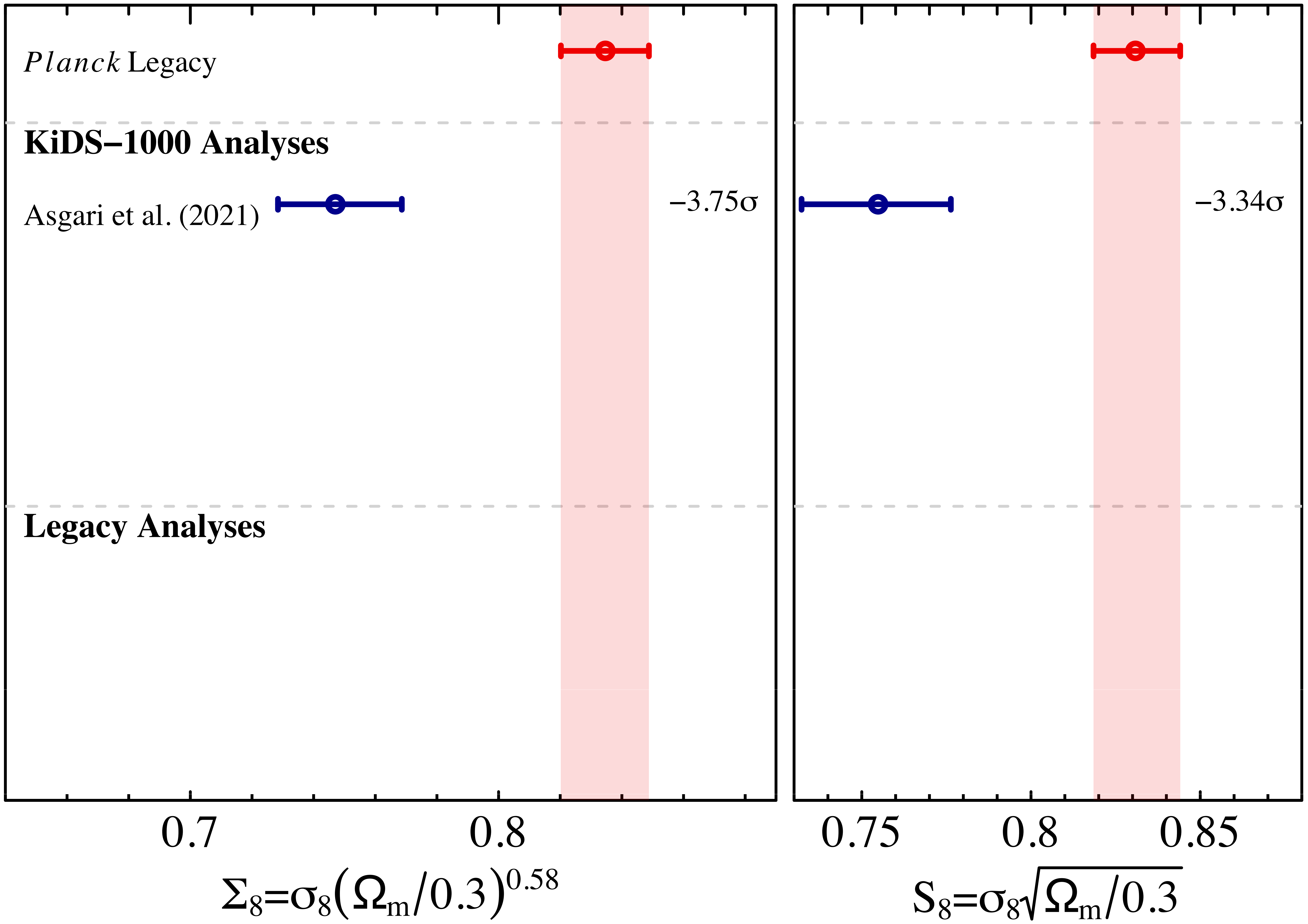
$$\Omega_m = 0.307^{+0.011}_{-0.011}$$



Stölzner et al. (2025)

From KiDS-1000 to KiDS-Legacy

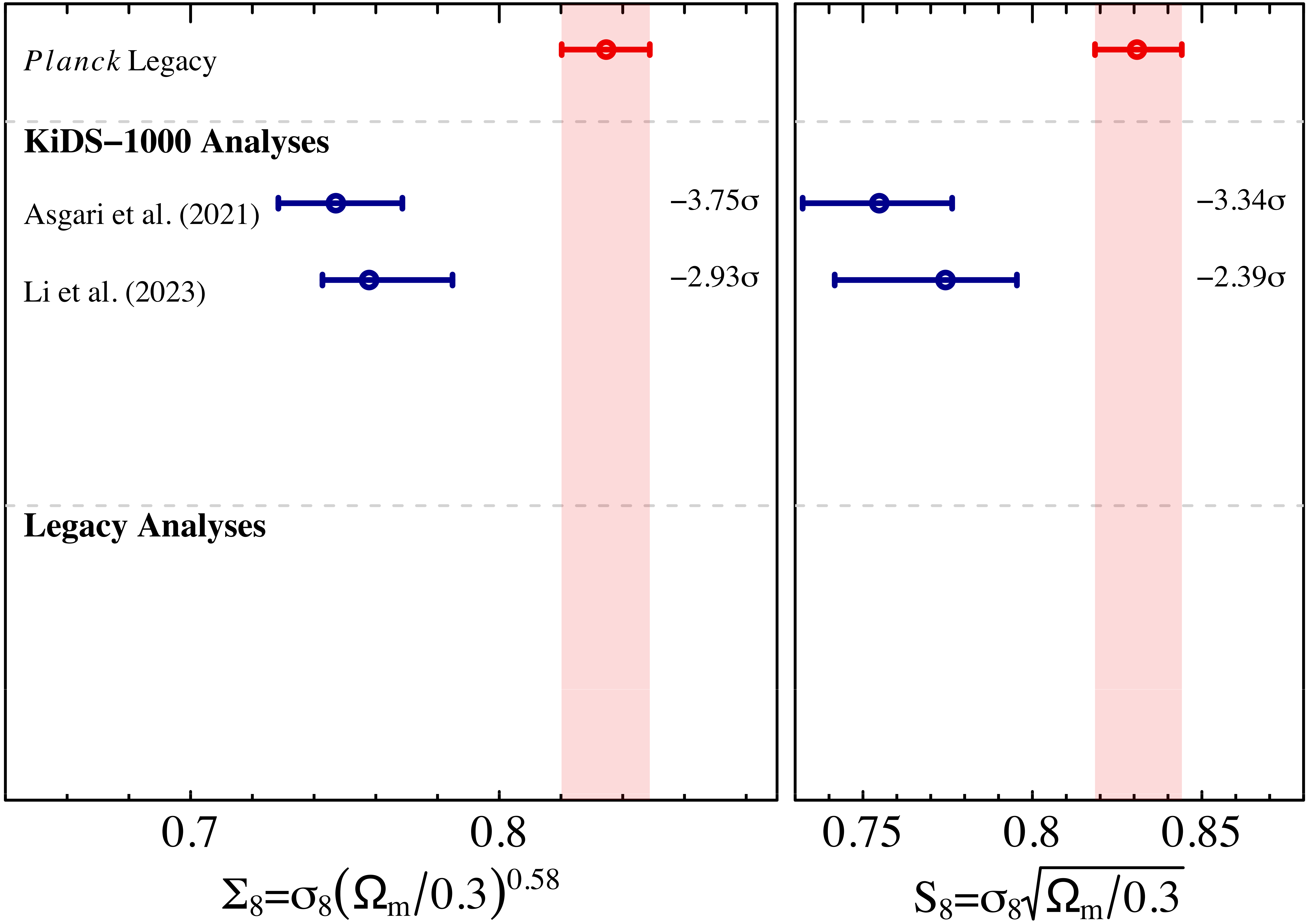
What changed since 2021?



Wright et al. (2025b)

What changed since 2021?

Updated Scale Cuts



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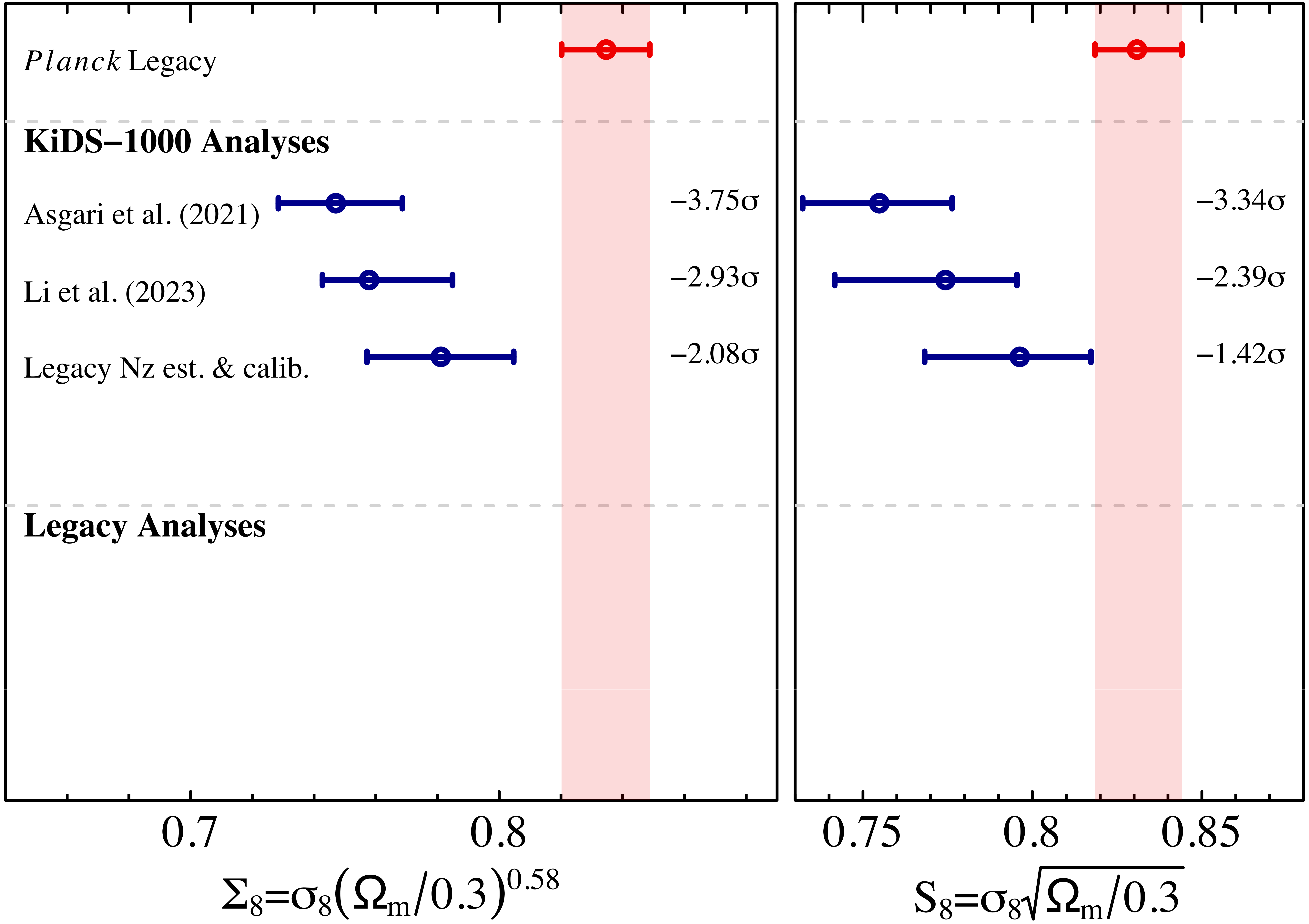
What changed since 2021?

Updated Scale Cuts
New $N(z)$ methods



Wright et al. (2025b)

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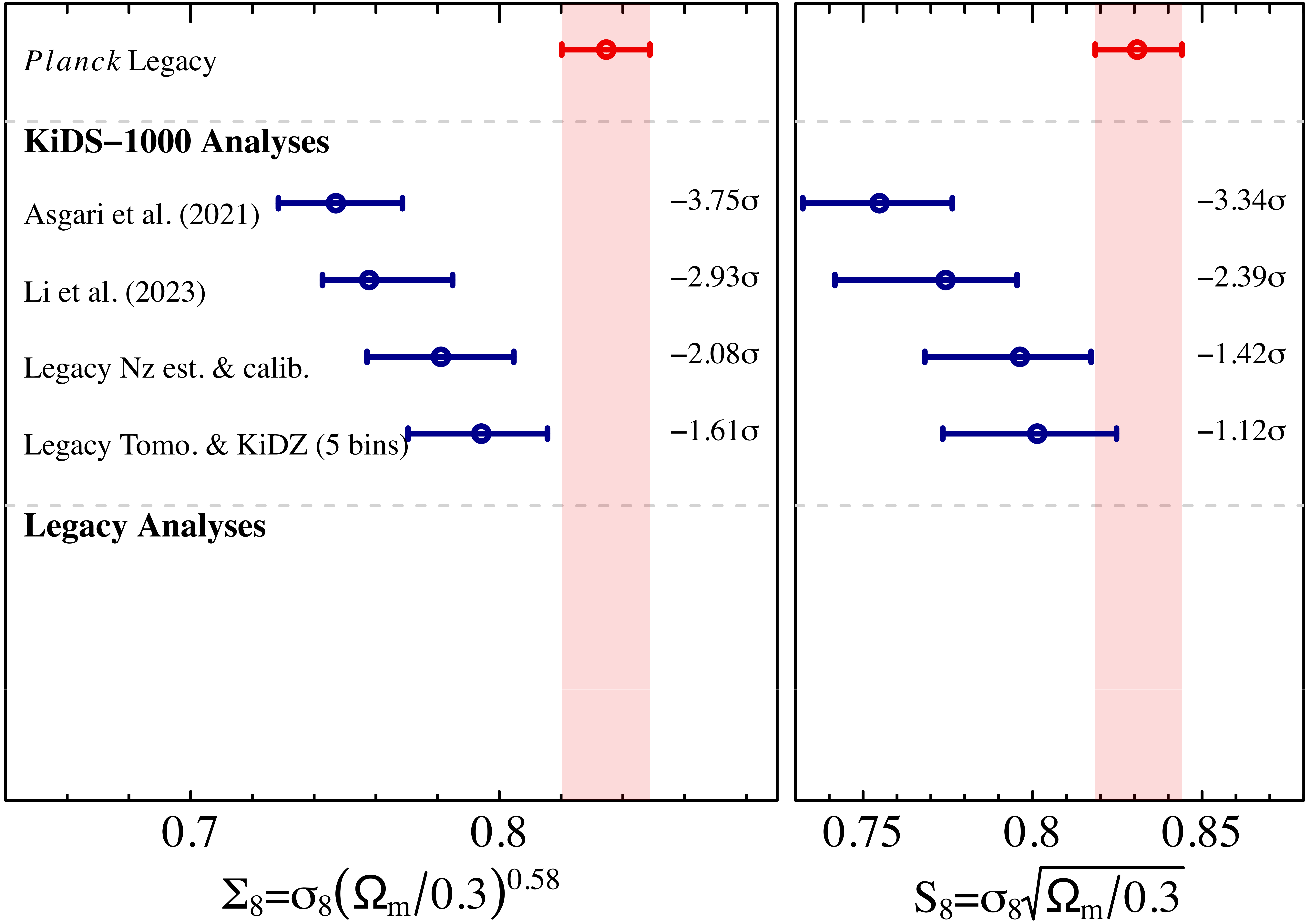
New $N(z)$ methods

New calib. sample

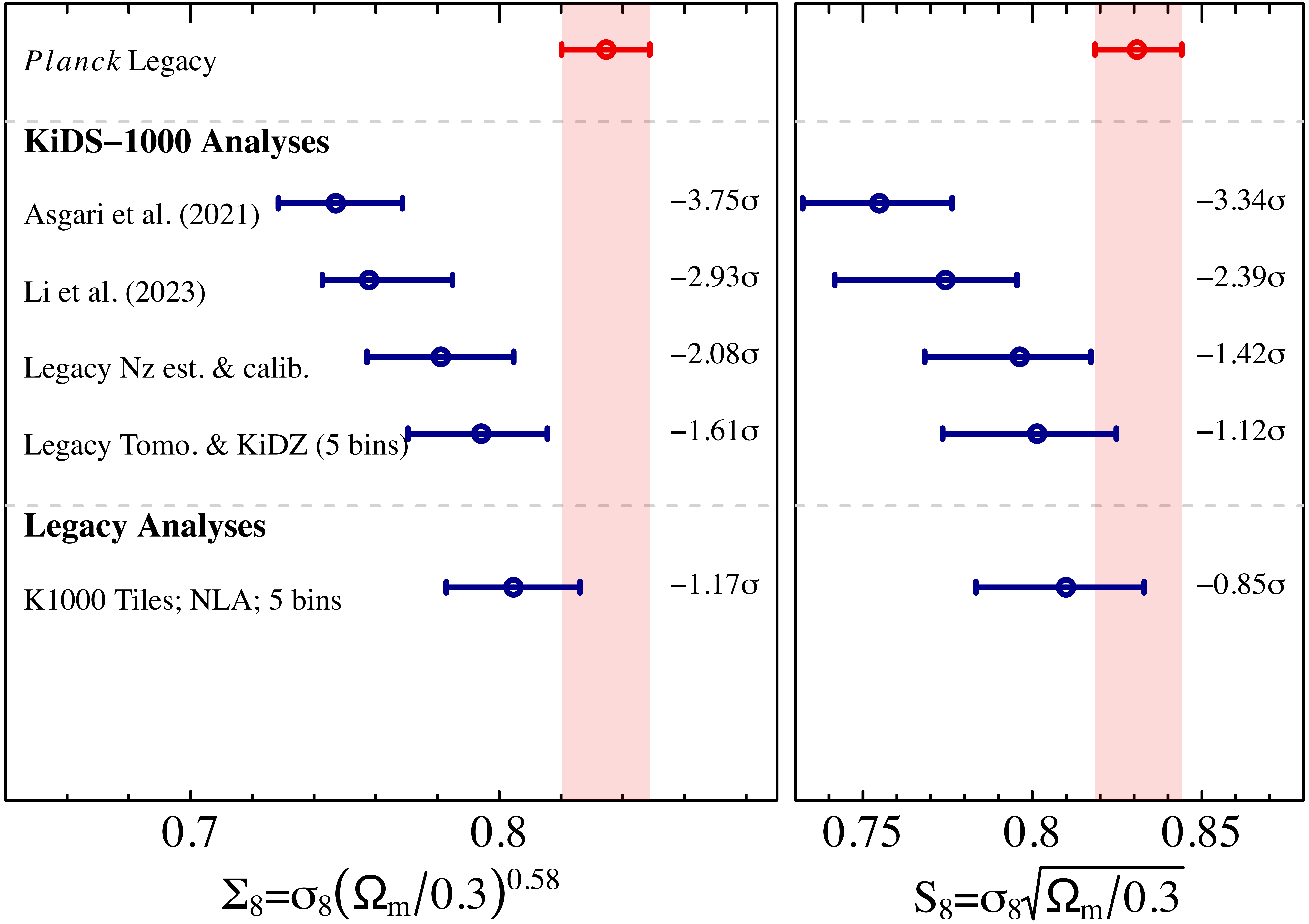


Wright et al. (2025b)

What changed since 2021?

Updated Scale Cuts
New $N(z)$ methods
New calib. sample

New images/photo-z



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What changed since 2021?

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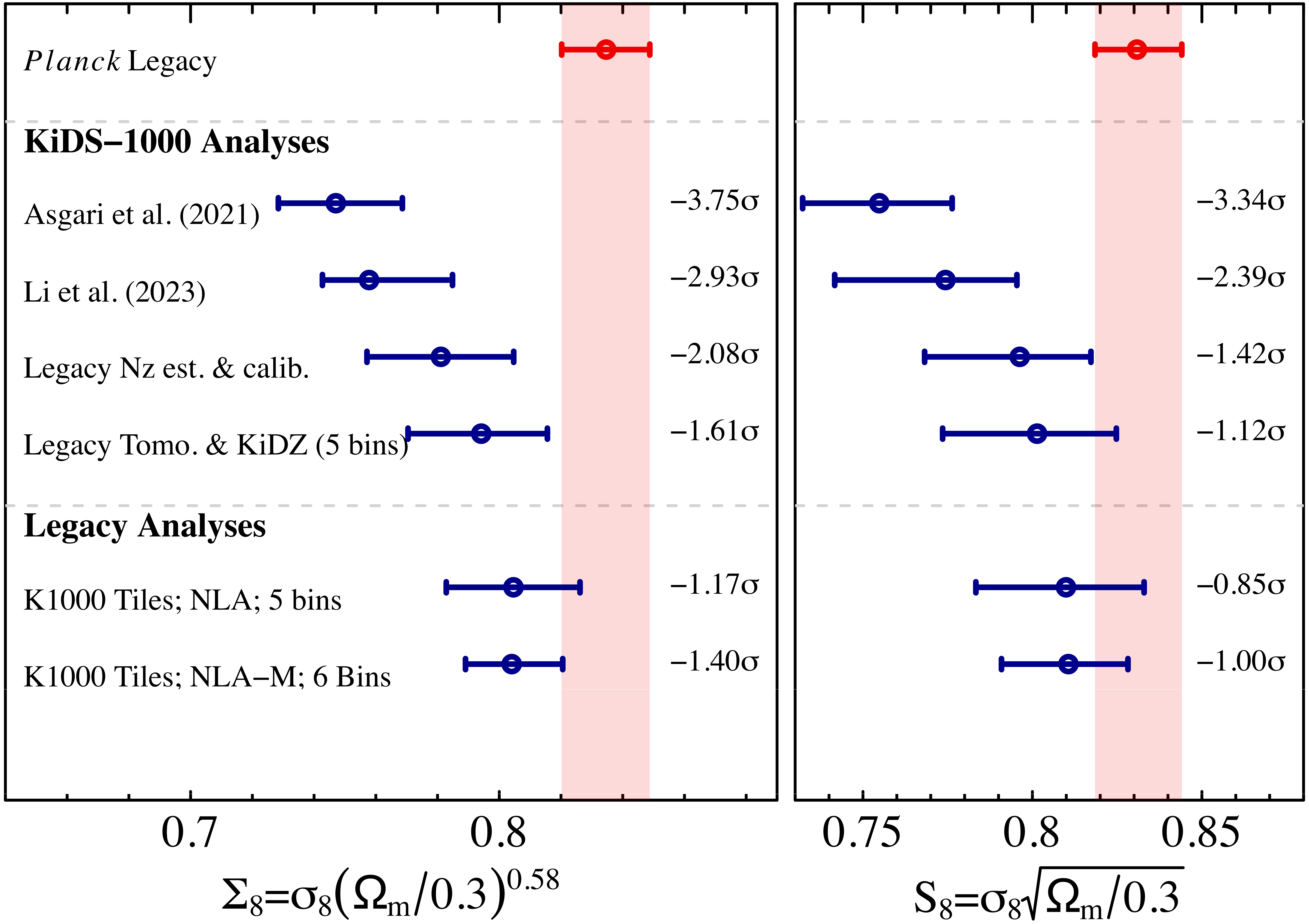
New $N(z)$ methods
New calib. sample

New images/photo-z
Additional bin, new IA



Wright et al. (2025b)

What changed since 2021?

Updated Scale Cuts

New $N(z)$ methods

New calib. sample

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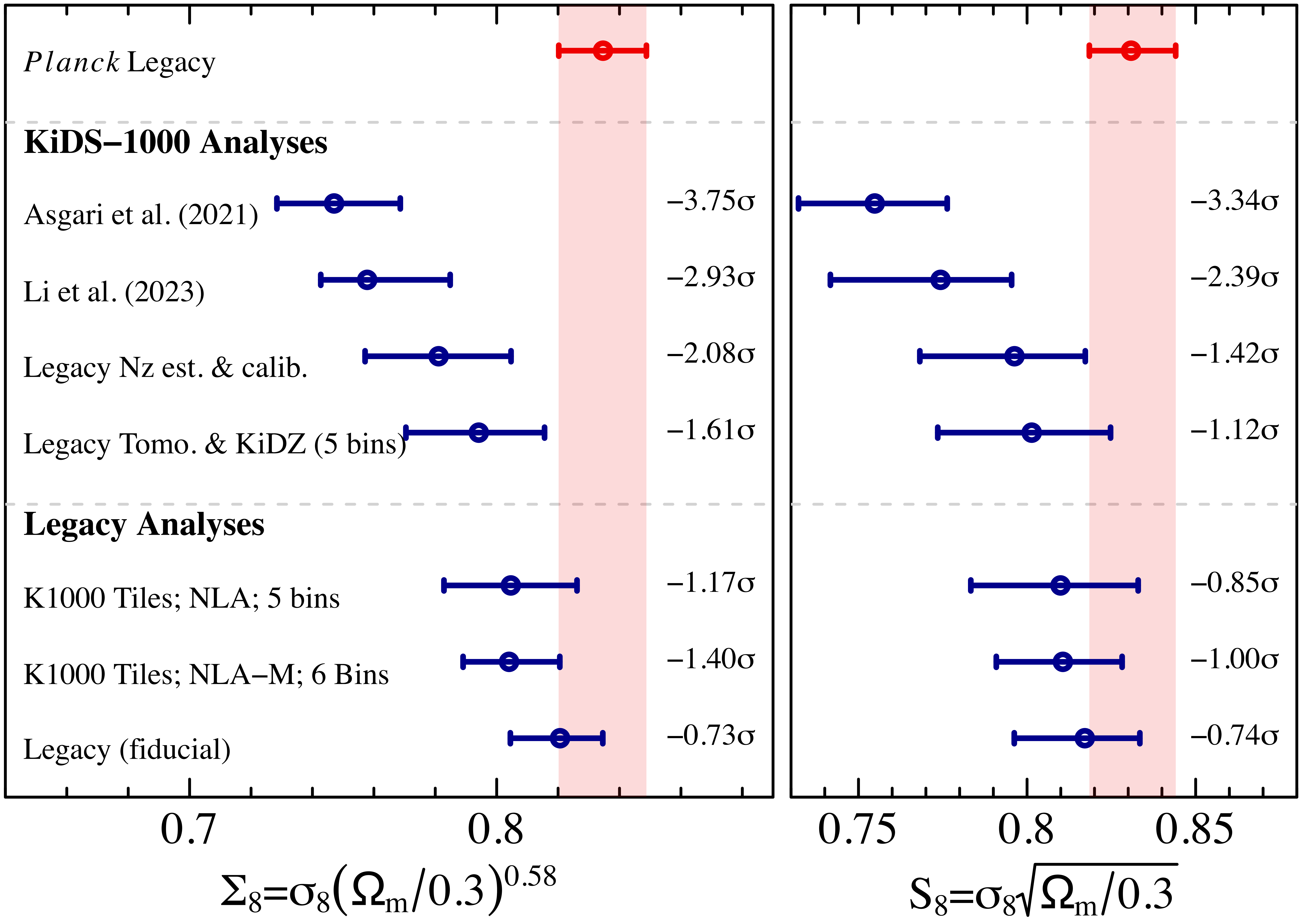
Additional bin, new IA

Additional area



Wright et al. (2025b)

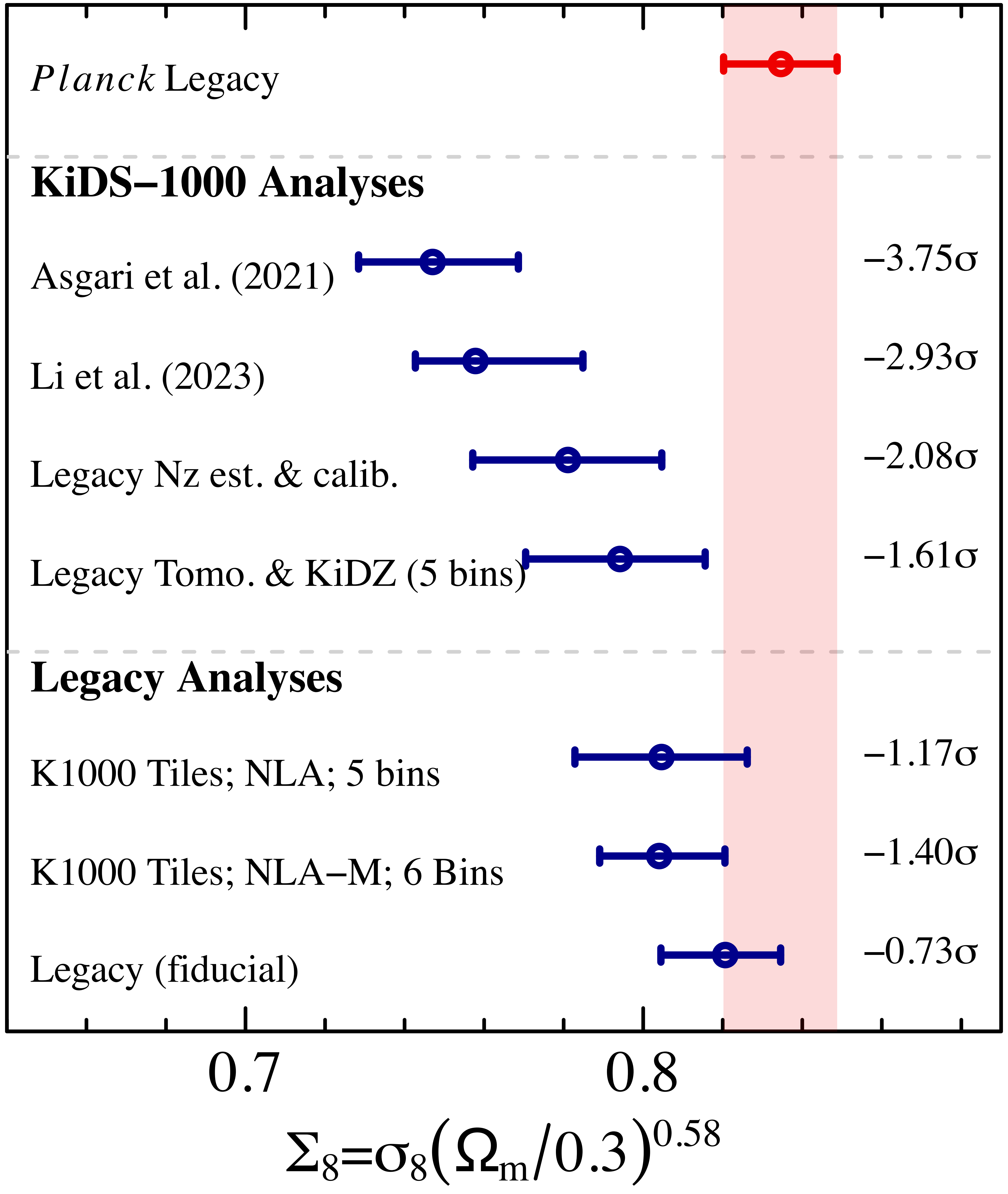
What changed since 2021?

Driving Factors

- New spectroscopic sample for $N(z)$ estimation
- Updated $N(z)$ calibration and estimation methods
- New imaging, new area

Further changes

- Revised scale cut
- New IA modelling
- New tomography
- New $P(k)$ emulation
- New sampler
- New analysis pipelines



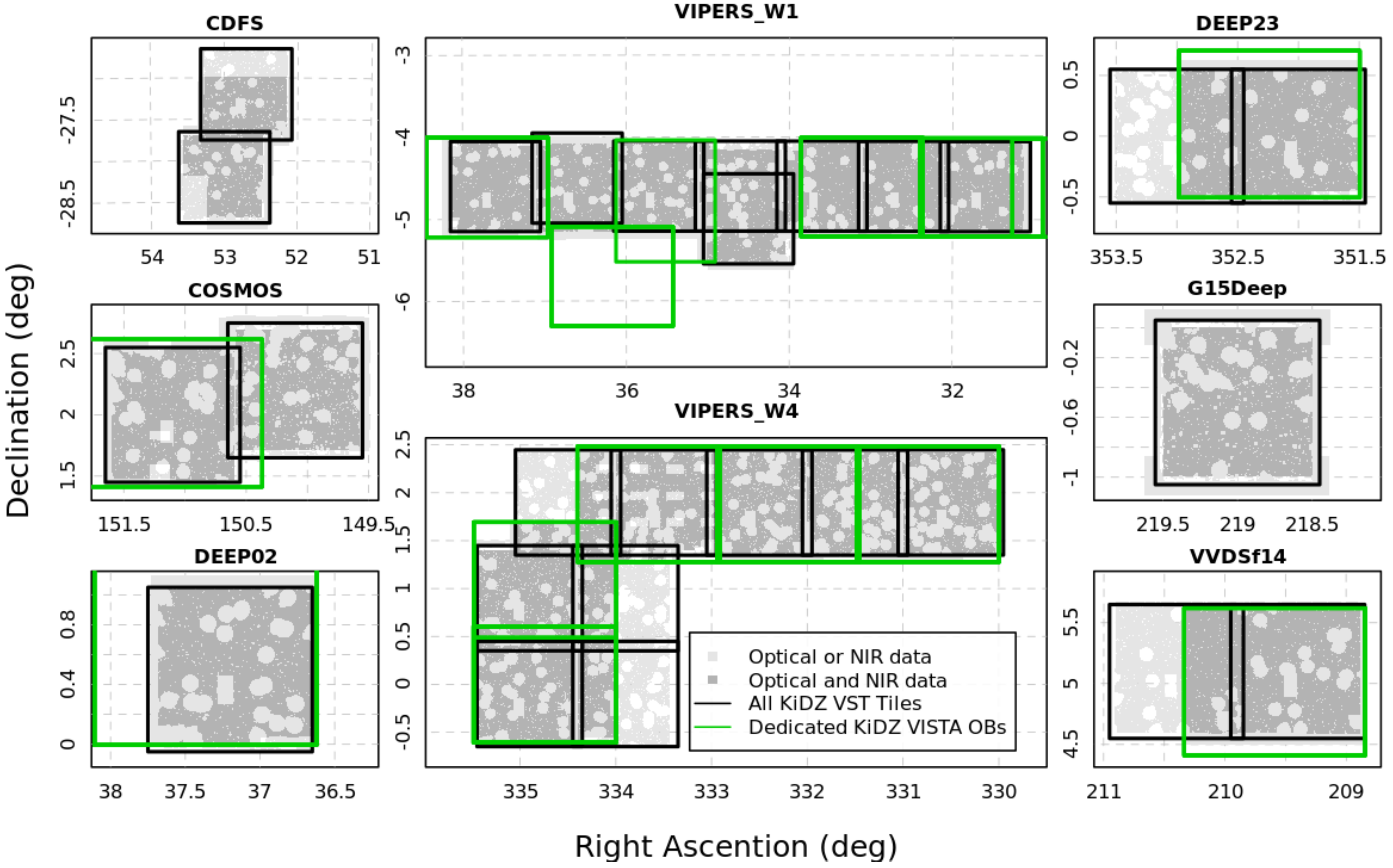
Wright et al. (2025b)

Calibration Improvements in KiDS-Legacy

KiDZ Redshift Calibration Sample

KiDS

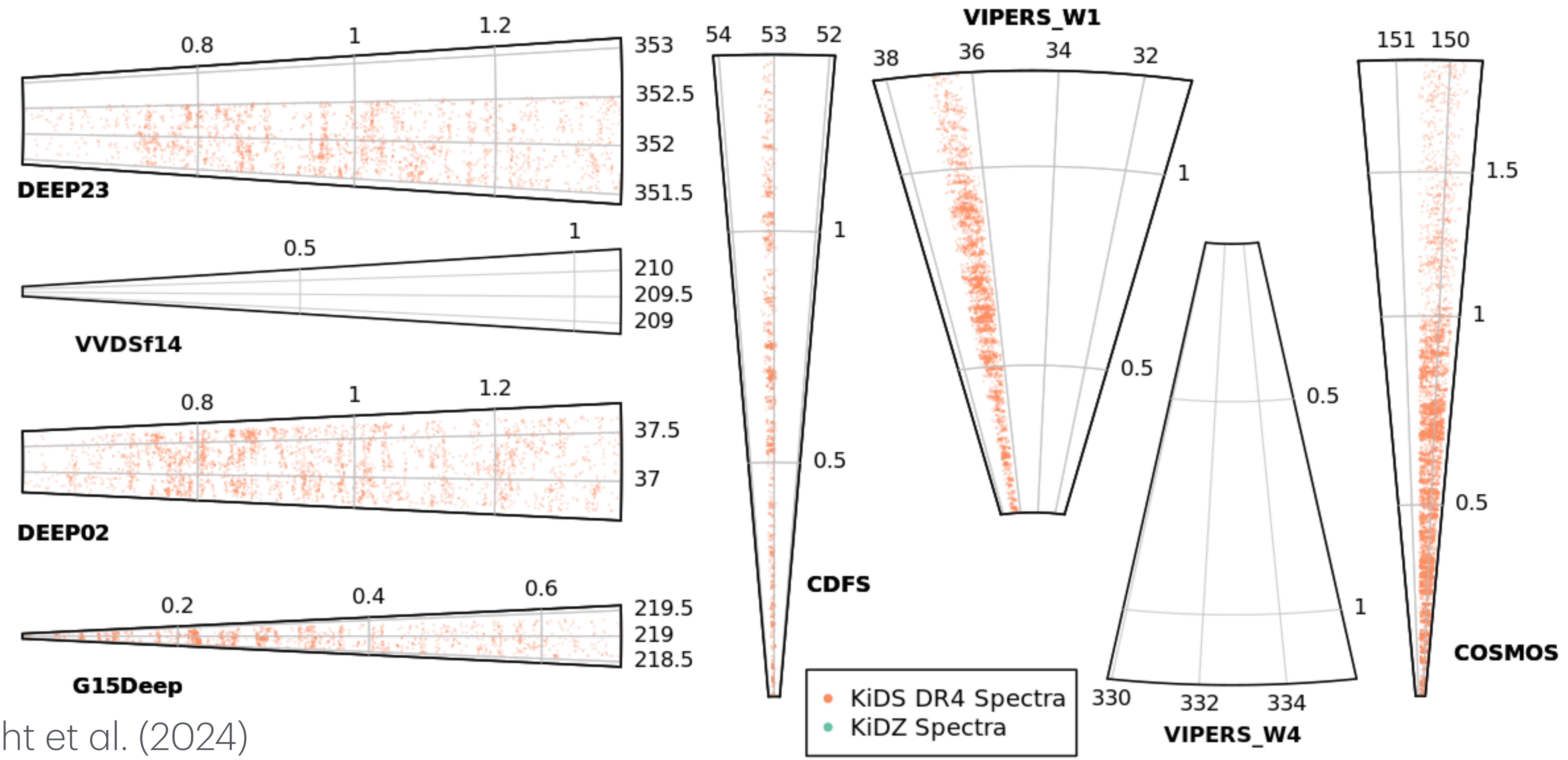
New data, new simulations, new methods, better results



Wright et al. (2024)

KiDZ Redshift Calibration Sample

More spectra means more robust corrections

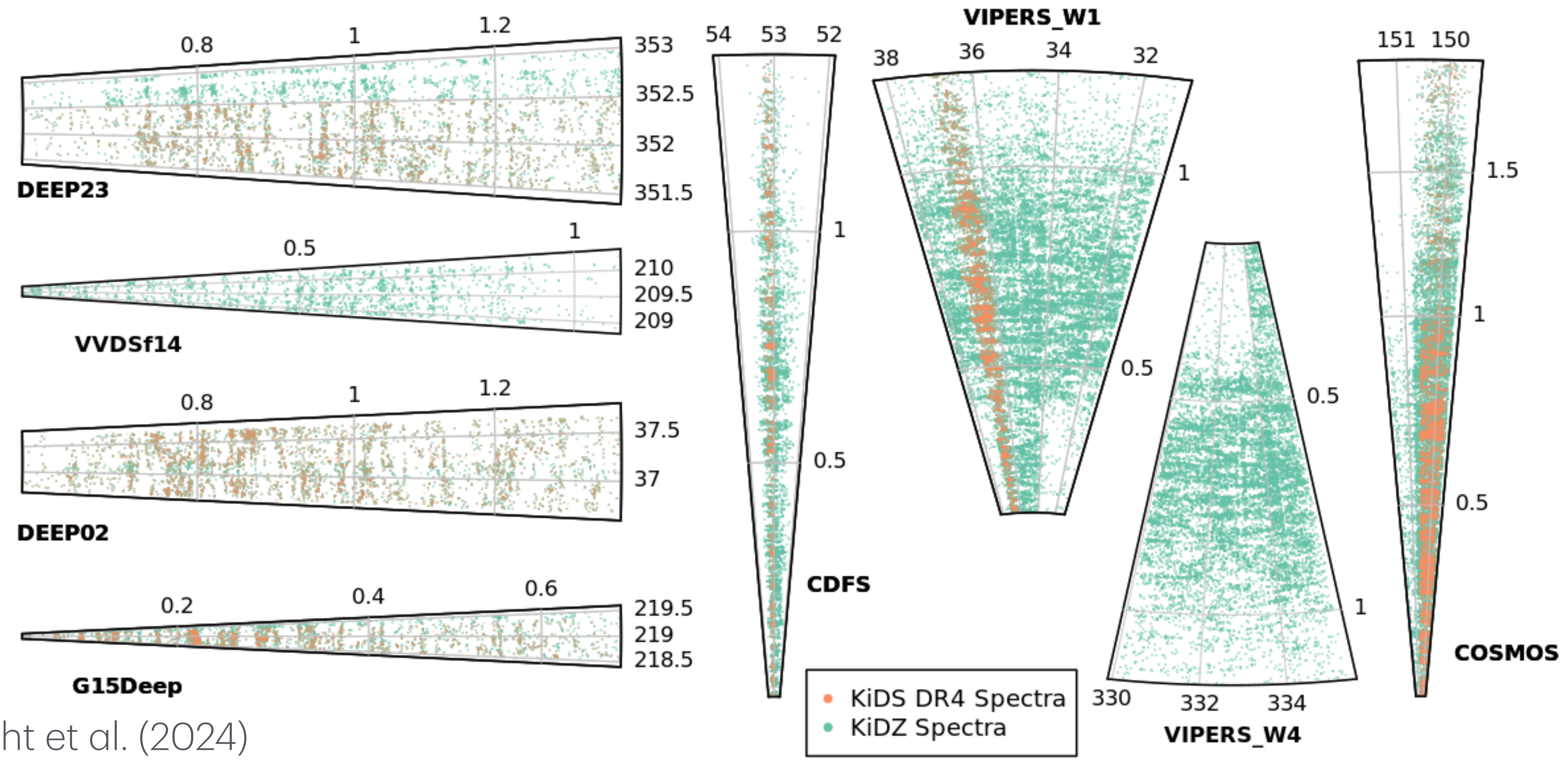


Wright et al. (2024)

KiDZ Redshift Calibration Sample

KiDS

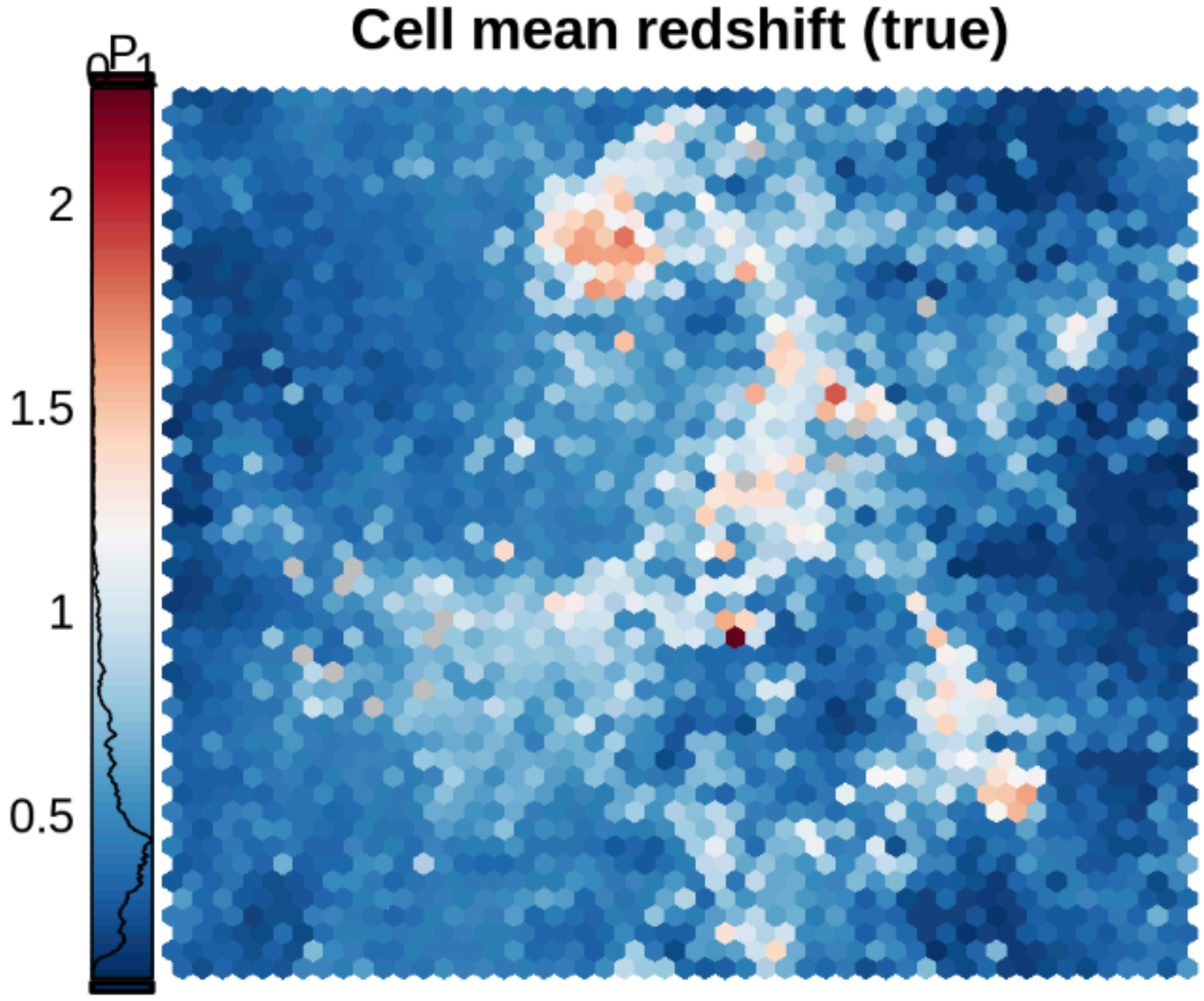
More spectra means more robust corrections

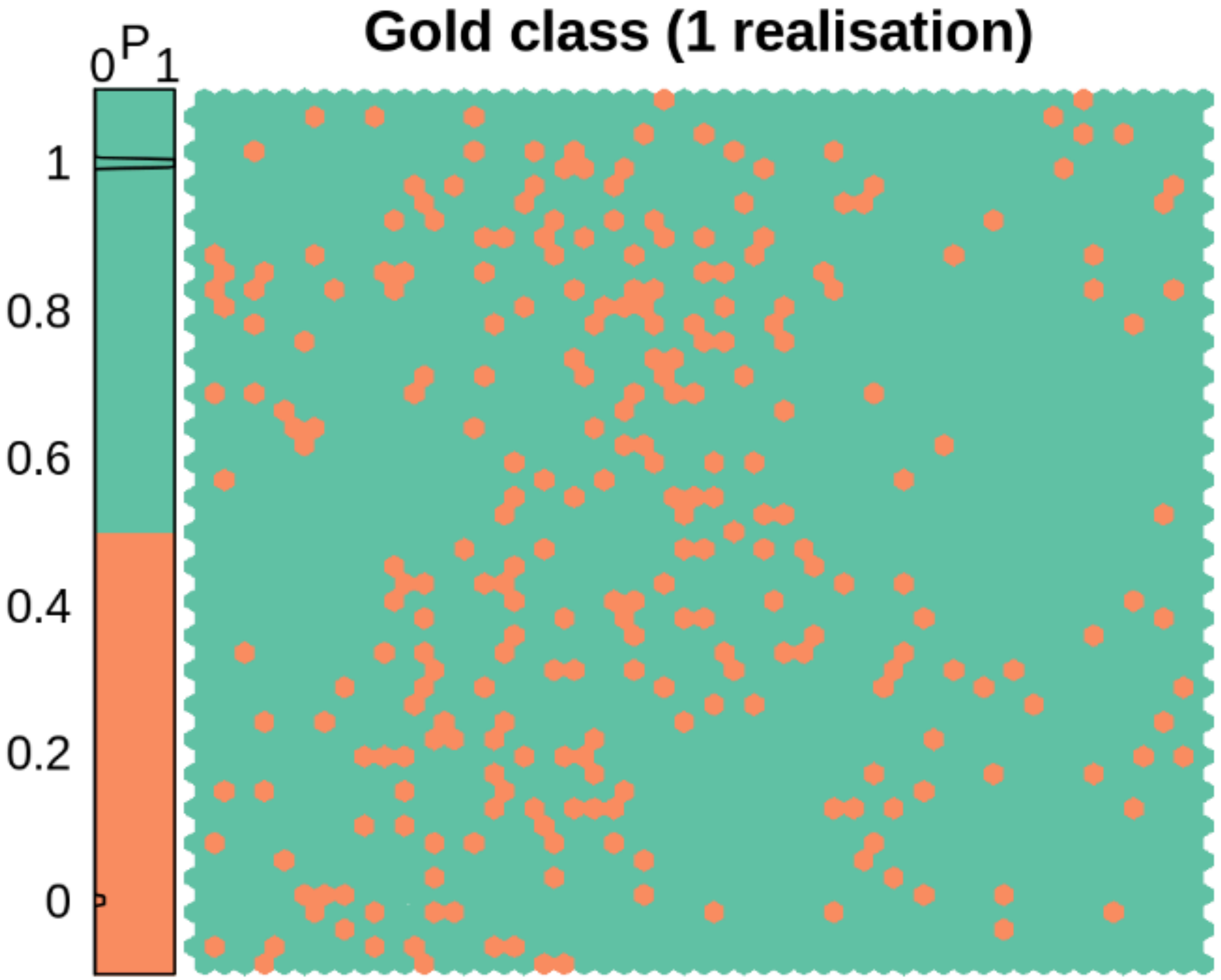


Wright et al. (2024)

Improved $N(z)$ calibration methods

Gold-weight replaces Gold-class

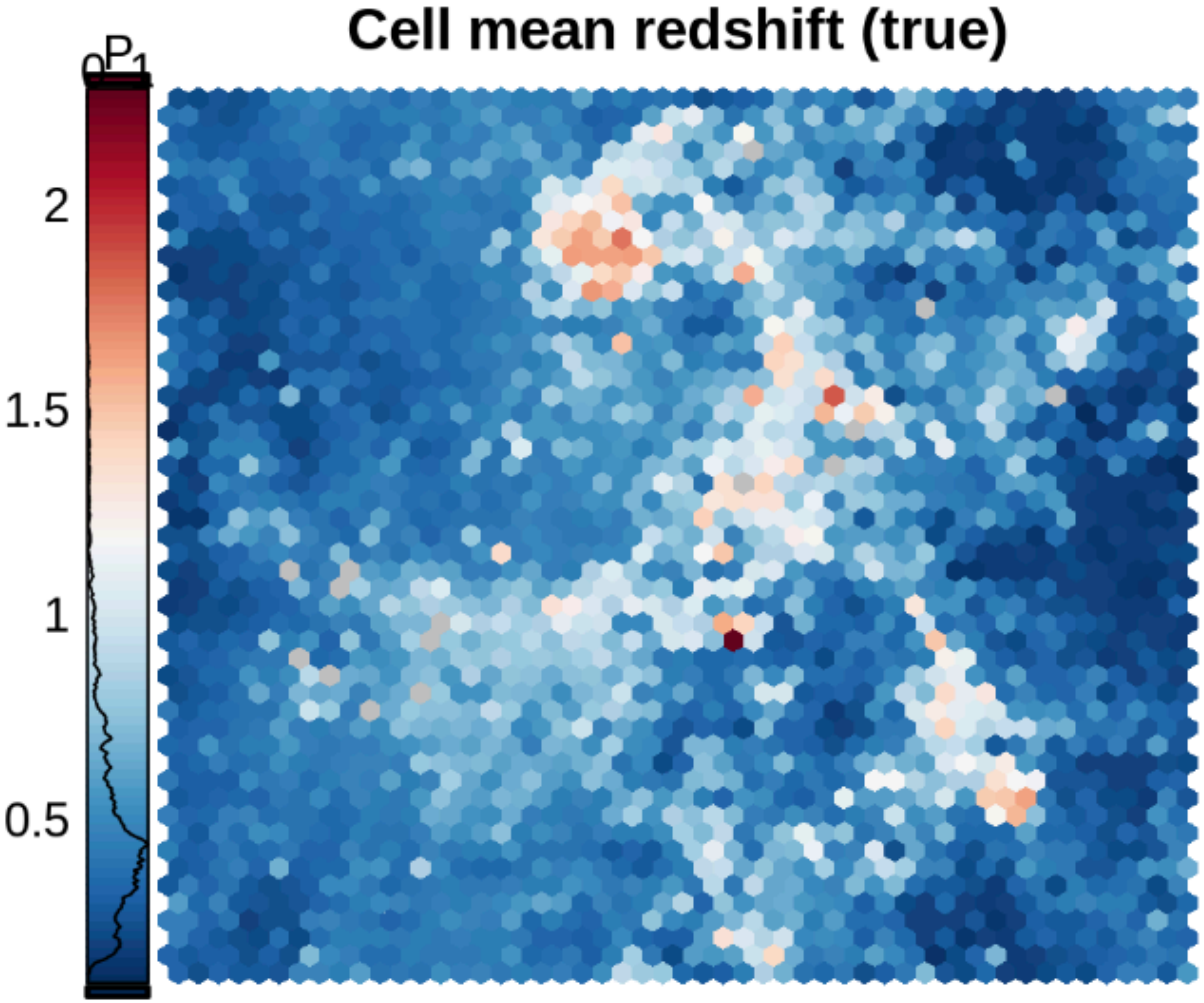


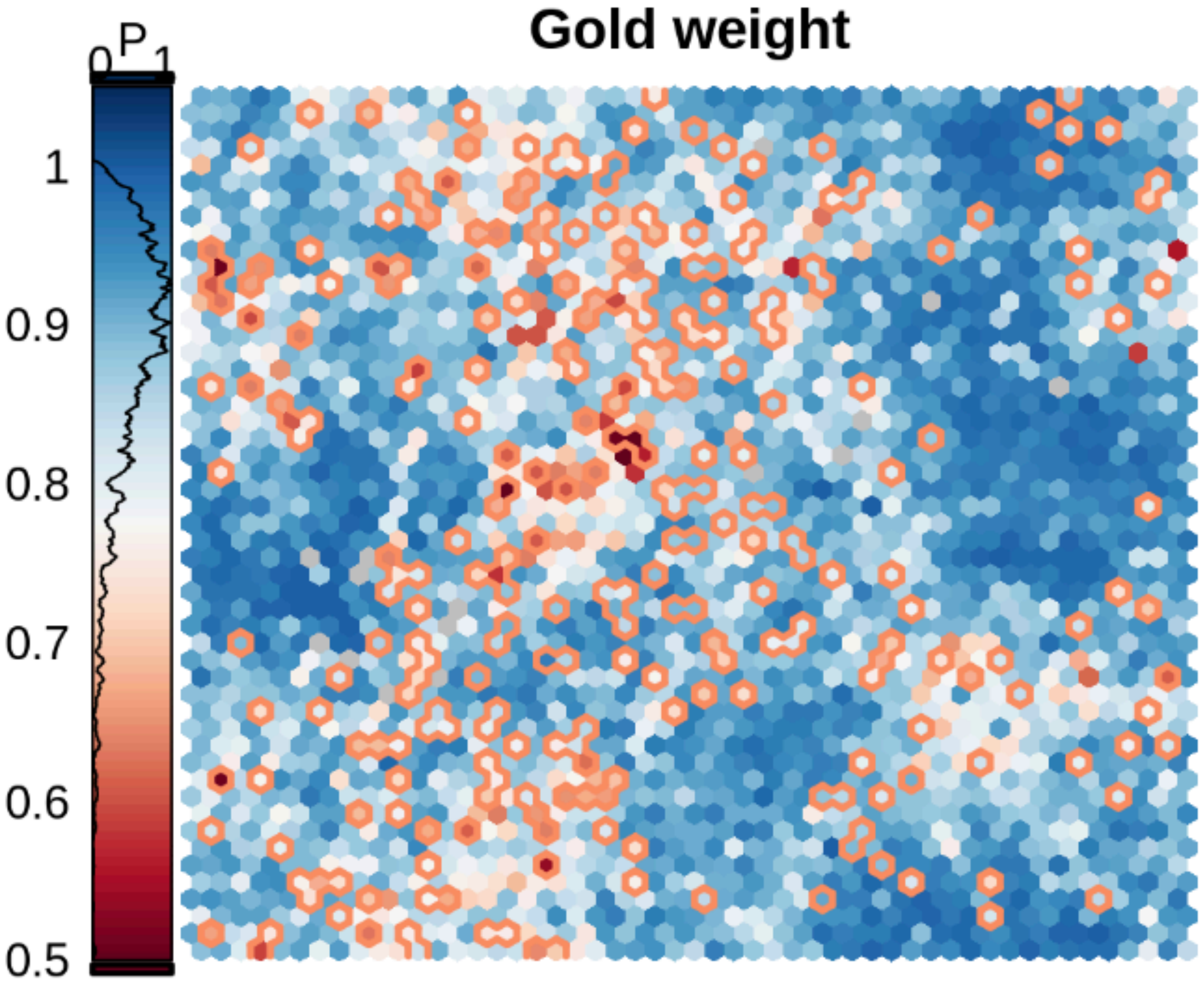


Wright et al. (2025a)

Improved $N(z)$ calibration methods

Gold-weight replaces Gold-class





Wright et al. (2025a)

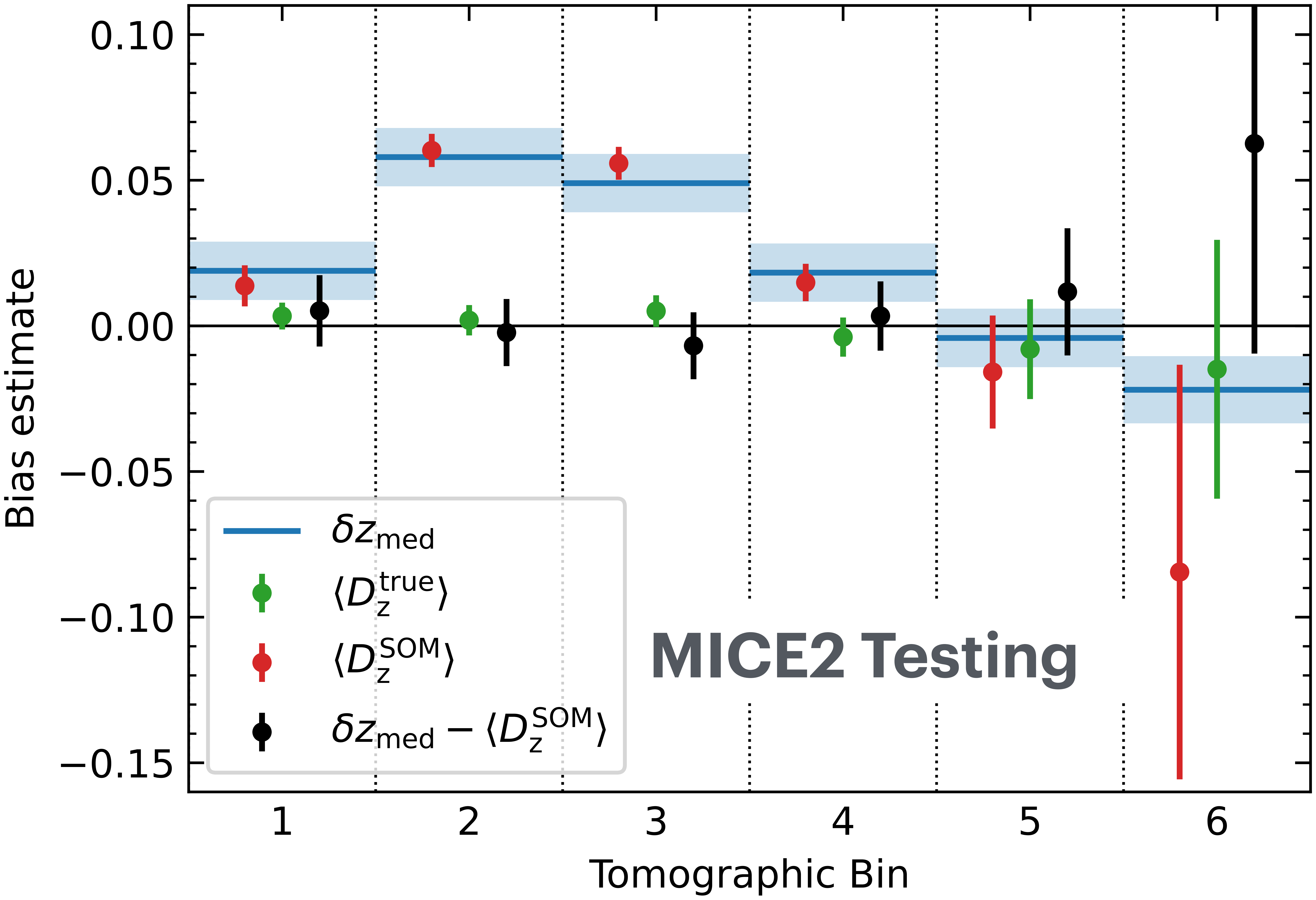
Complementary $N(z)$ calibration methods

Validated with multiple simulations, incl. new simulated samples

SOM $N(z)$ Bias

CC $N(z)$ Bias

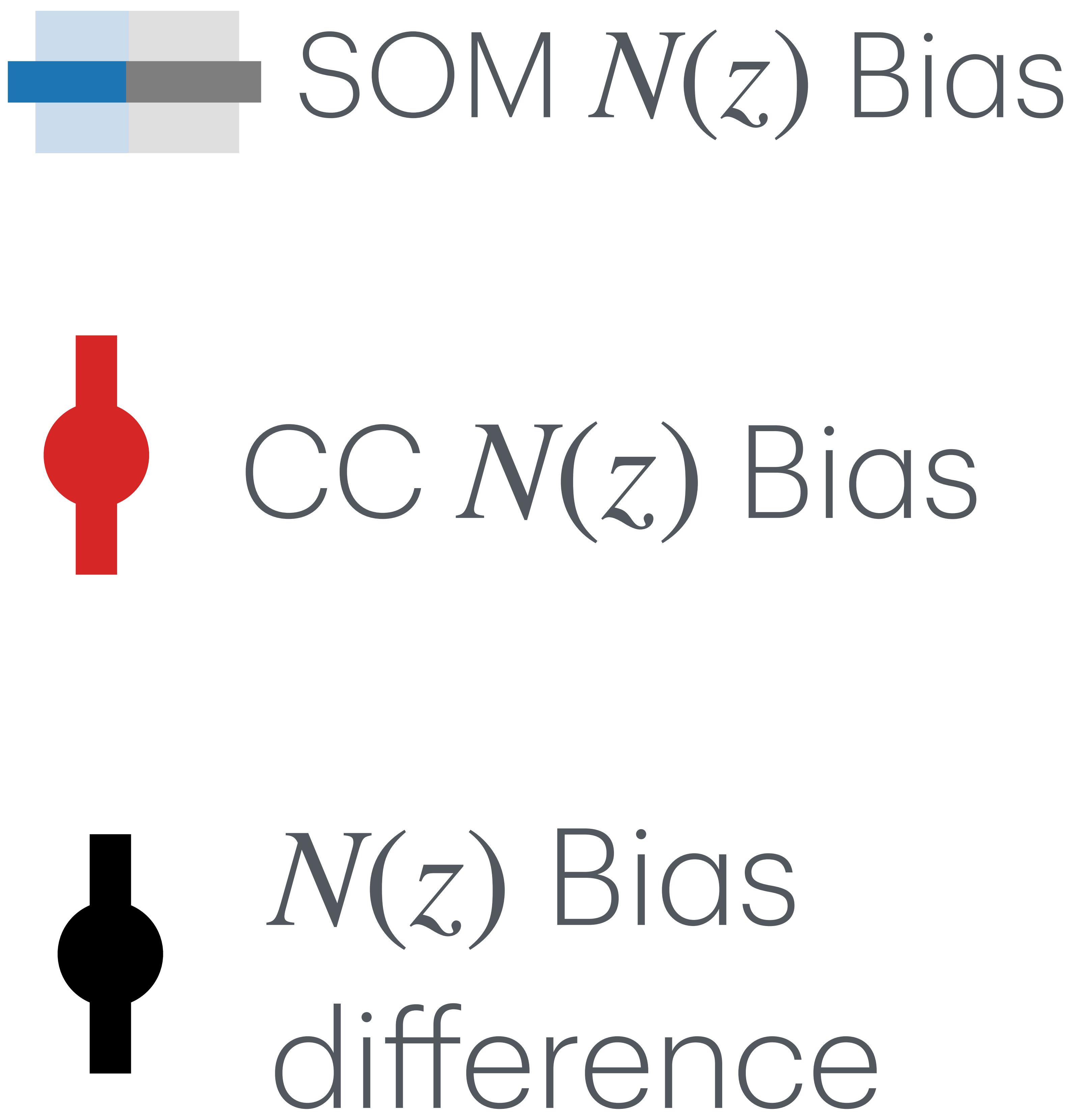
$N(z)$ Bias difference

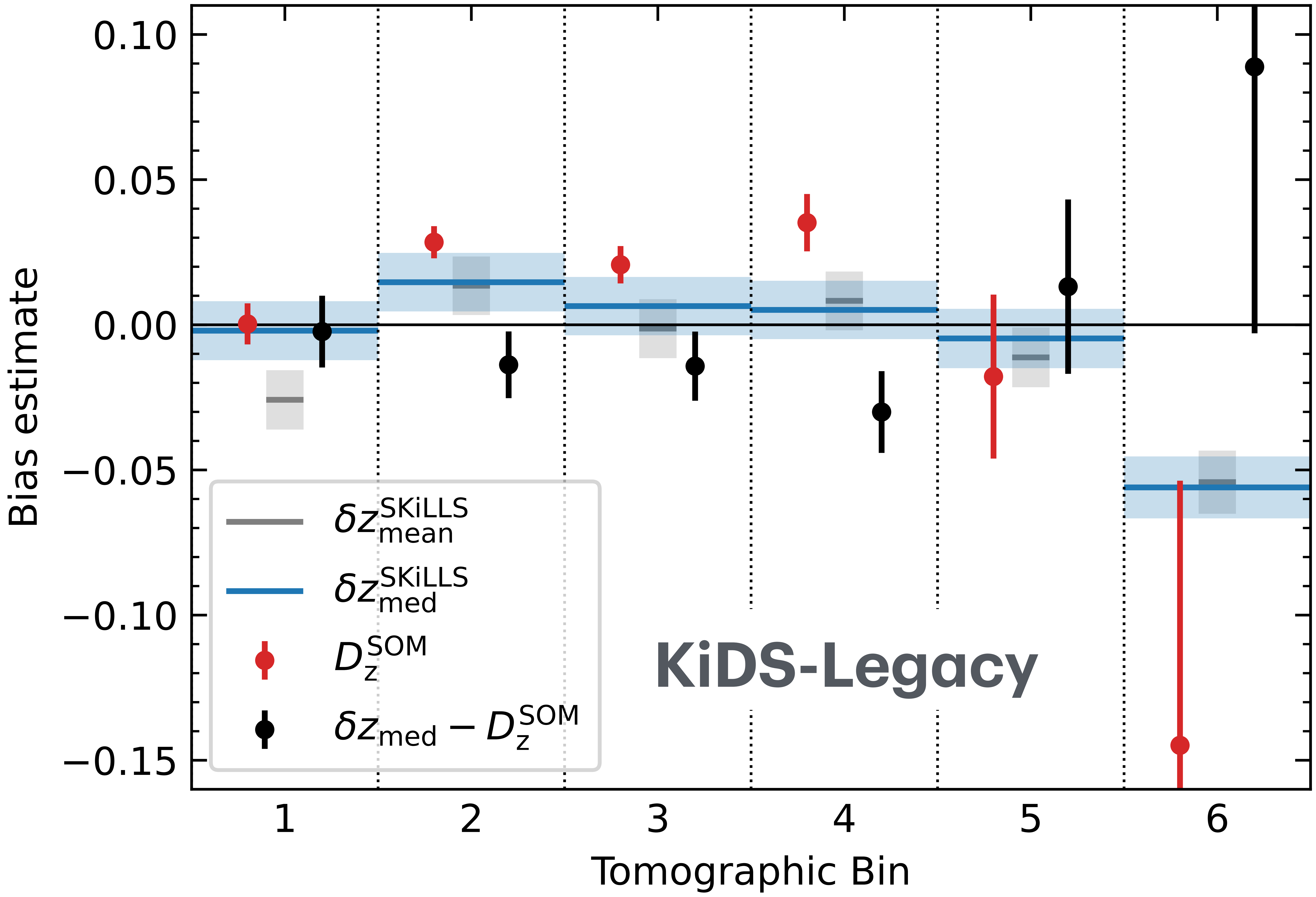


Wright et al. (2025a)

Complementary $N(z)$ calibration methods

Data $N(z)$ biases are consistent; most different in bin 4, but...

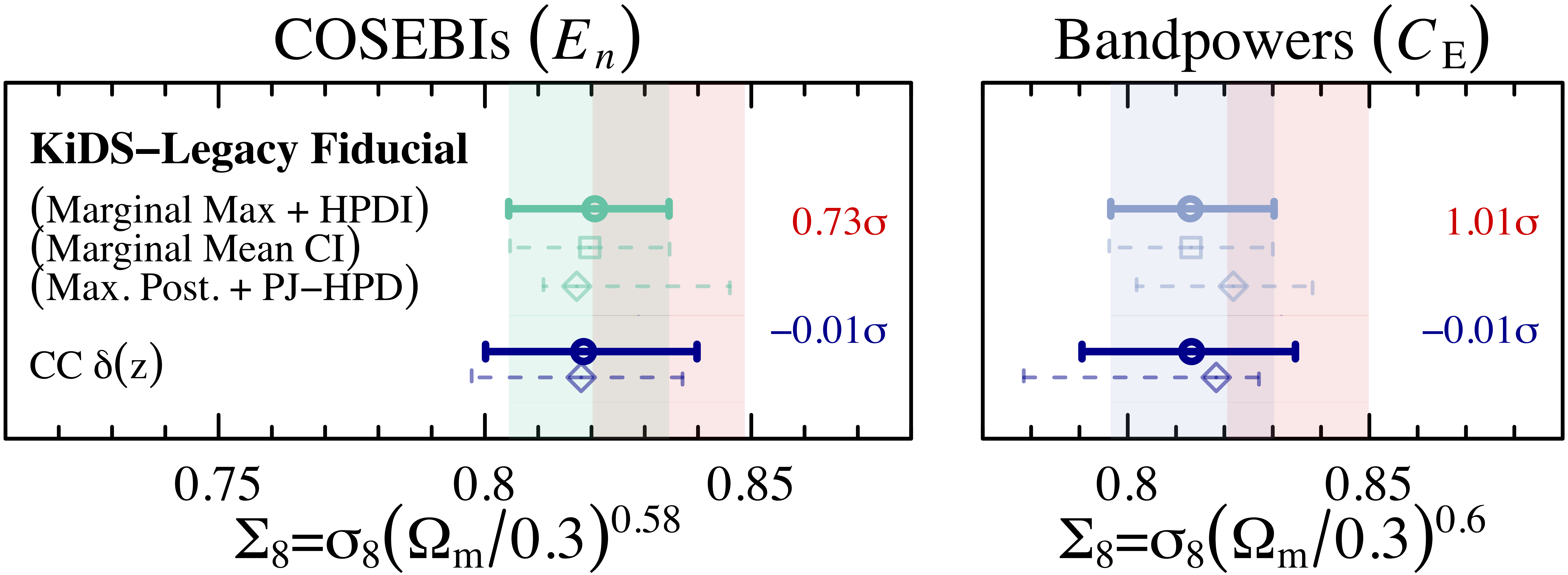




Wright et al. (2025a)

Complementary *N(z)* calibration methods

... our independent *N(z)* bias estimation gives identical cosmology

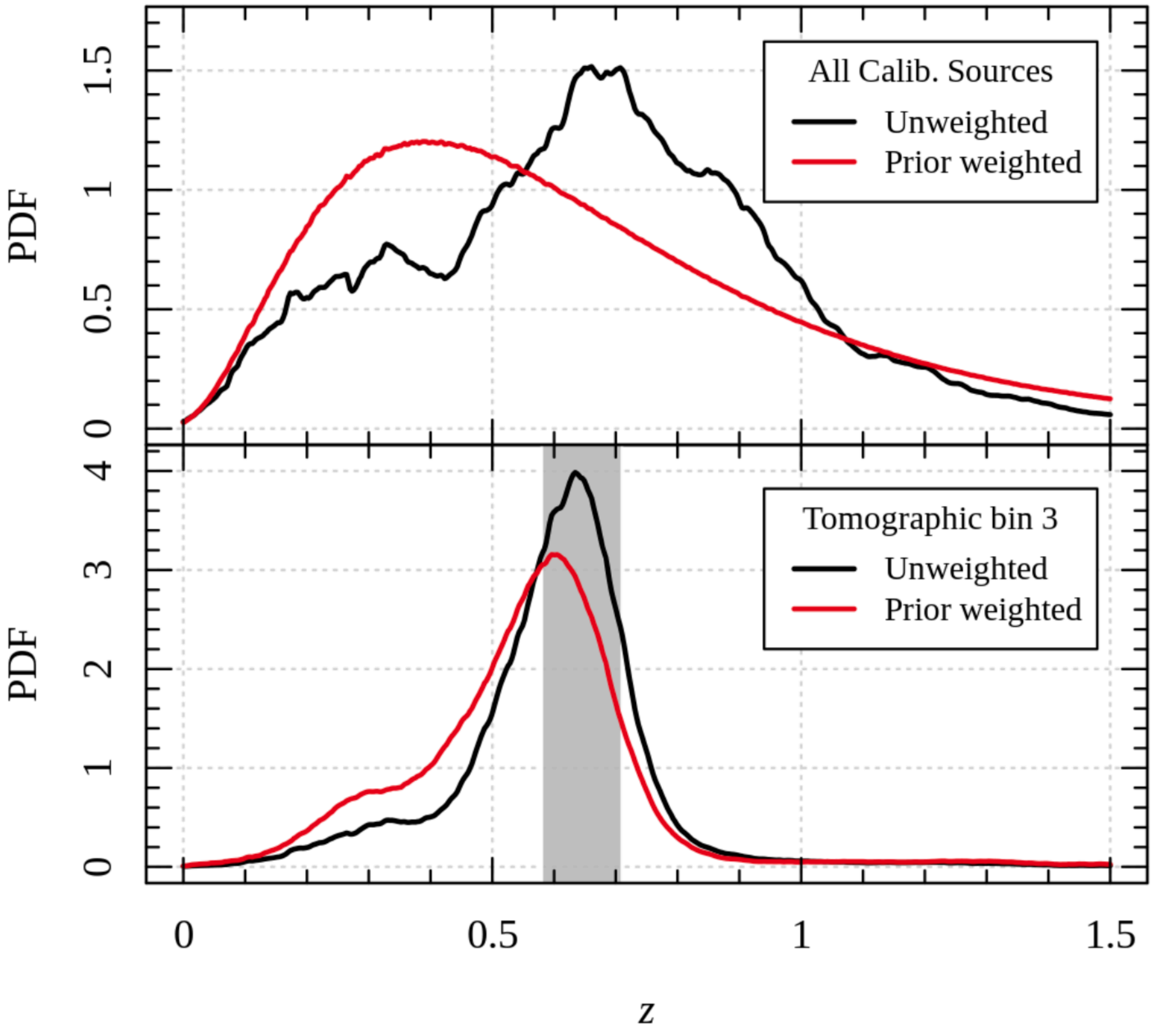


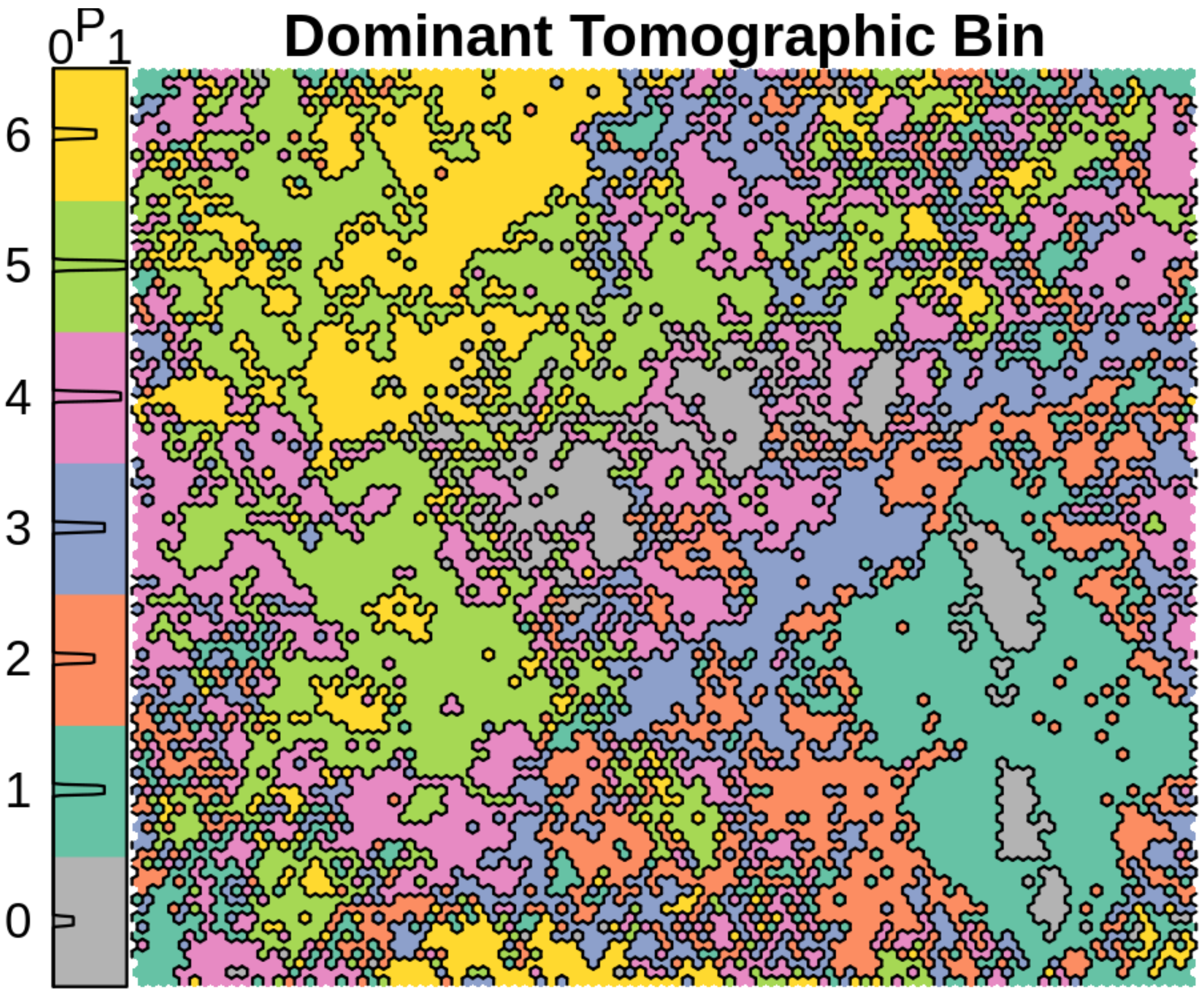
Wright et al. (2025b)

KiDS

Other $N(z)$ calibration method updates

Prior Calibration Weights

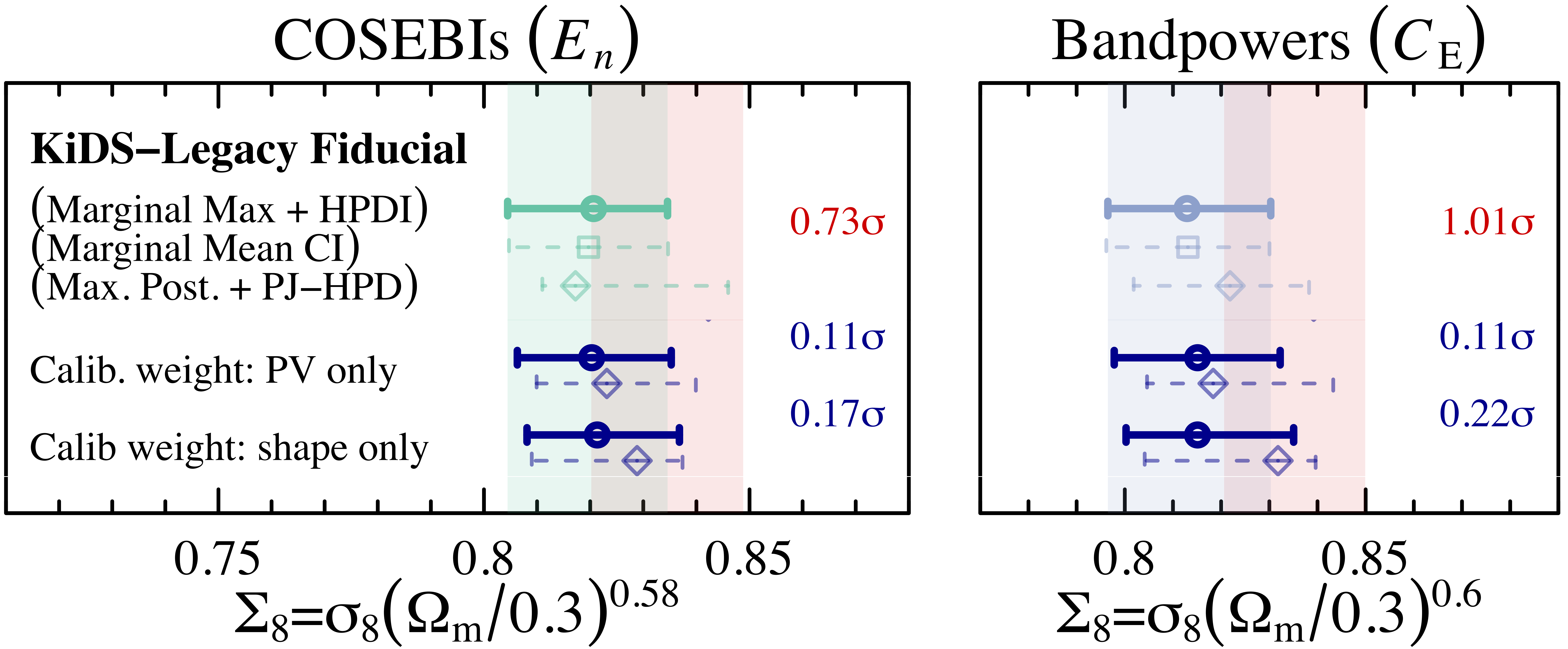




Per-Bin Tomography

Wright et al. (2025a)

Robustness to $N(z)$ calibration variations



Wright et al. (2025a)

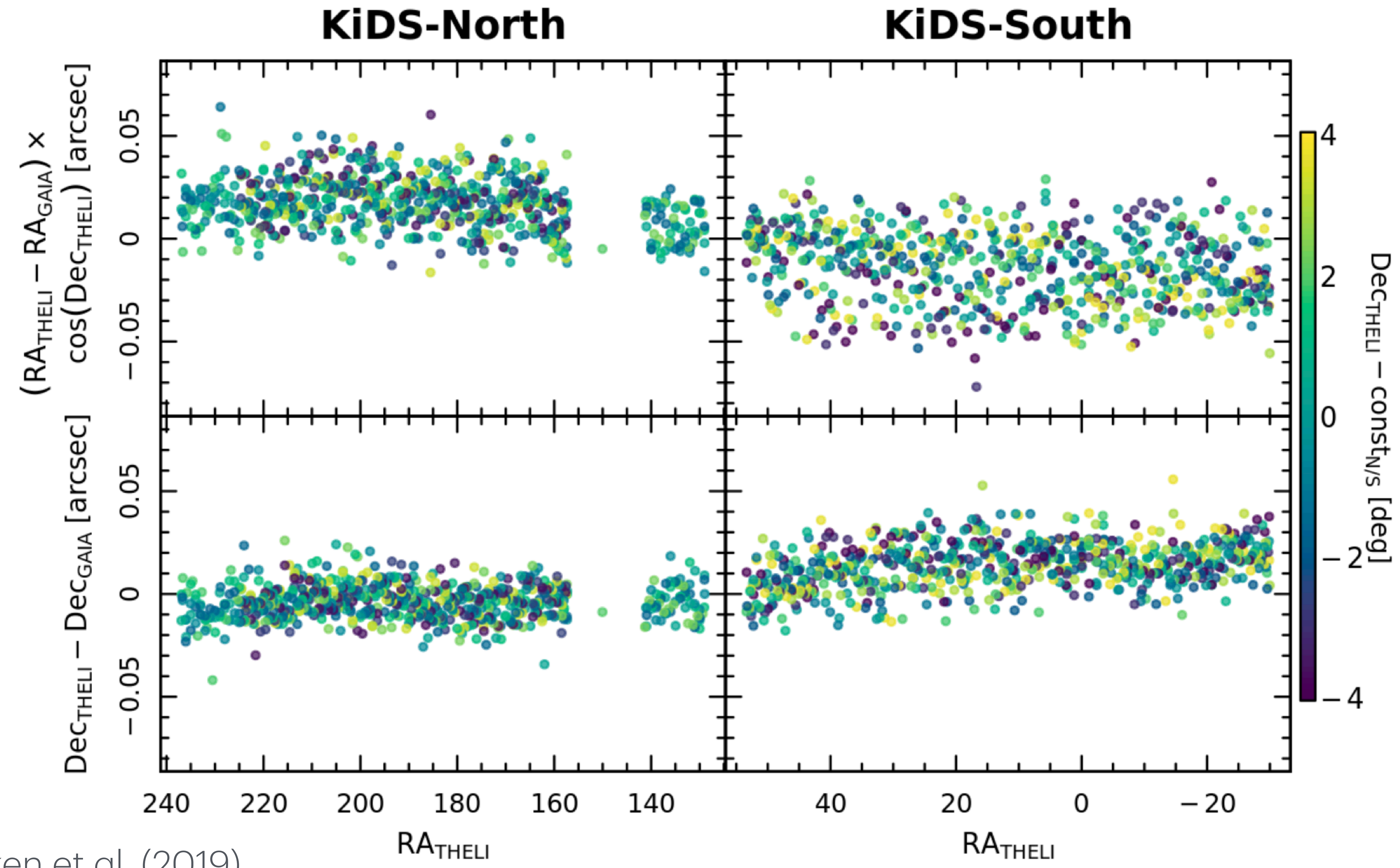
KiDS

Other changes in KiDS-Legacy

New imaging: updated astrometric calibration

Improved astrometric solutions bring higher quality images

● **KiDS-Legacy**



Wright et al. (2024); Kuijken et al. (2019)

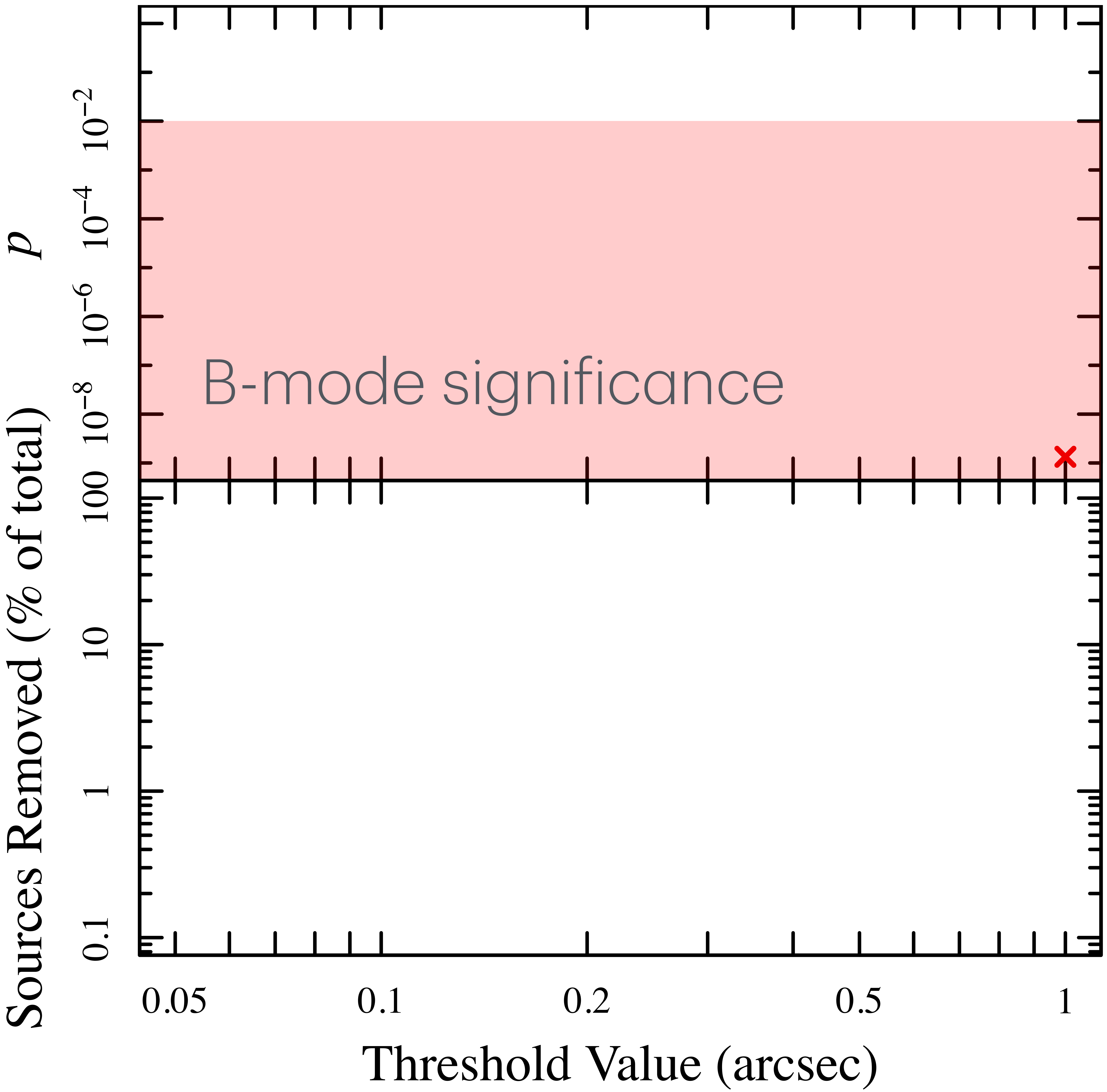
New imaging: updated astrometric calibration

Improved astrometric solutions bring higher quality images

Wright et al. (2024); Kuijken et al. (2019)

B-modes

Improved astrometric solutions can also trigger new failure modes

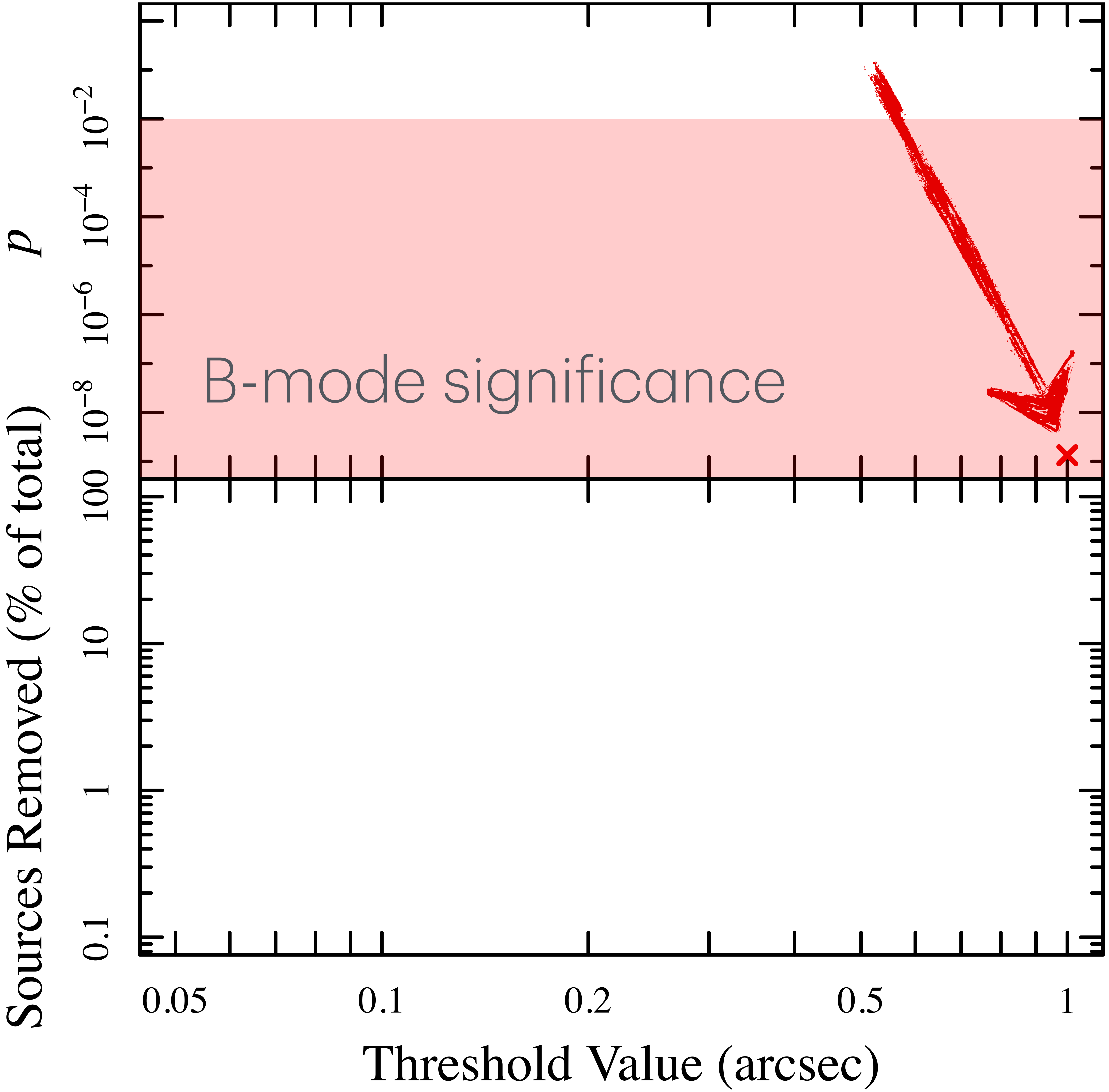


Wright et al. (2025b)

B-modes

Improved astrometric solutions can also trigger new failure modes

✓ Detected by our null tests



Wright et al. (2025b)

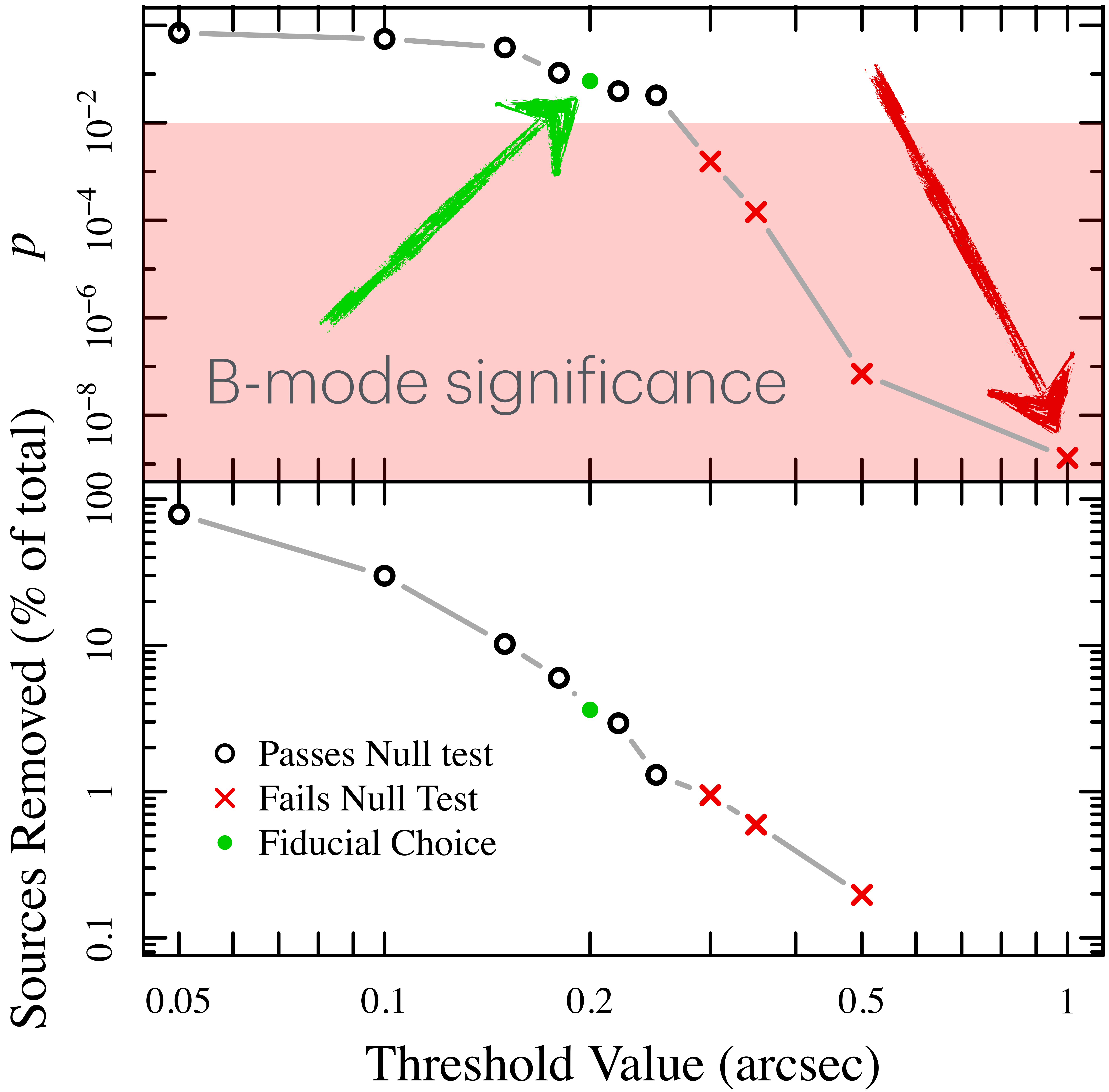
B-modes

Improved astrometric solutions can also trigger new failure modes

✓ Detected by our null tests

✓ Cause identified

✓ Systematic removed

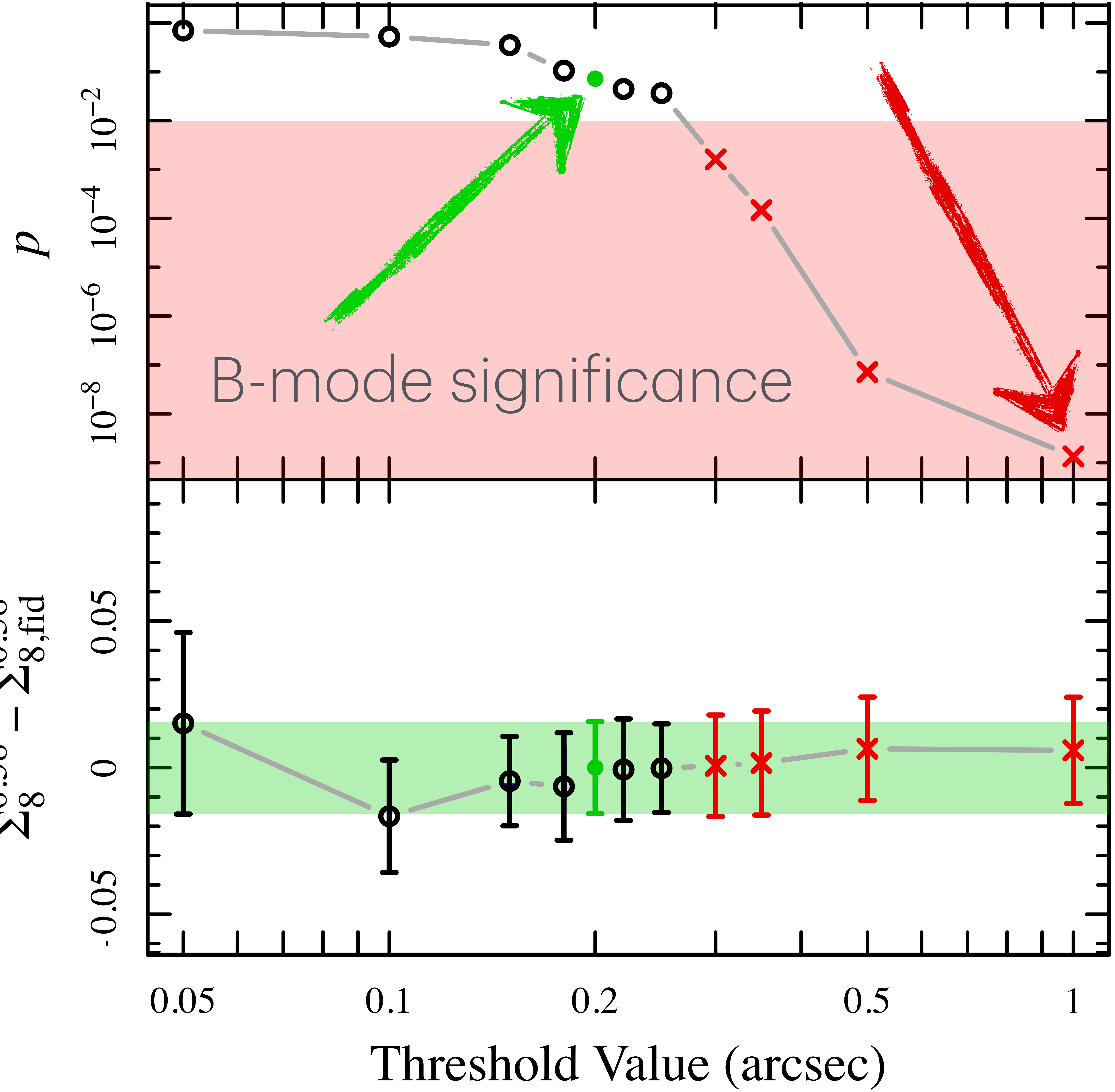


Wright et al. (2025b)

B-modes

Improved astrometric solutions can also trigger new failure modes

- ✓ Detected by our null tests
- ✓ Cause identified
- ✓ Systematic removed
- ✓ Does not impact cosmology

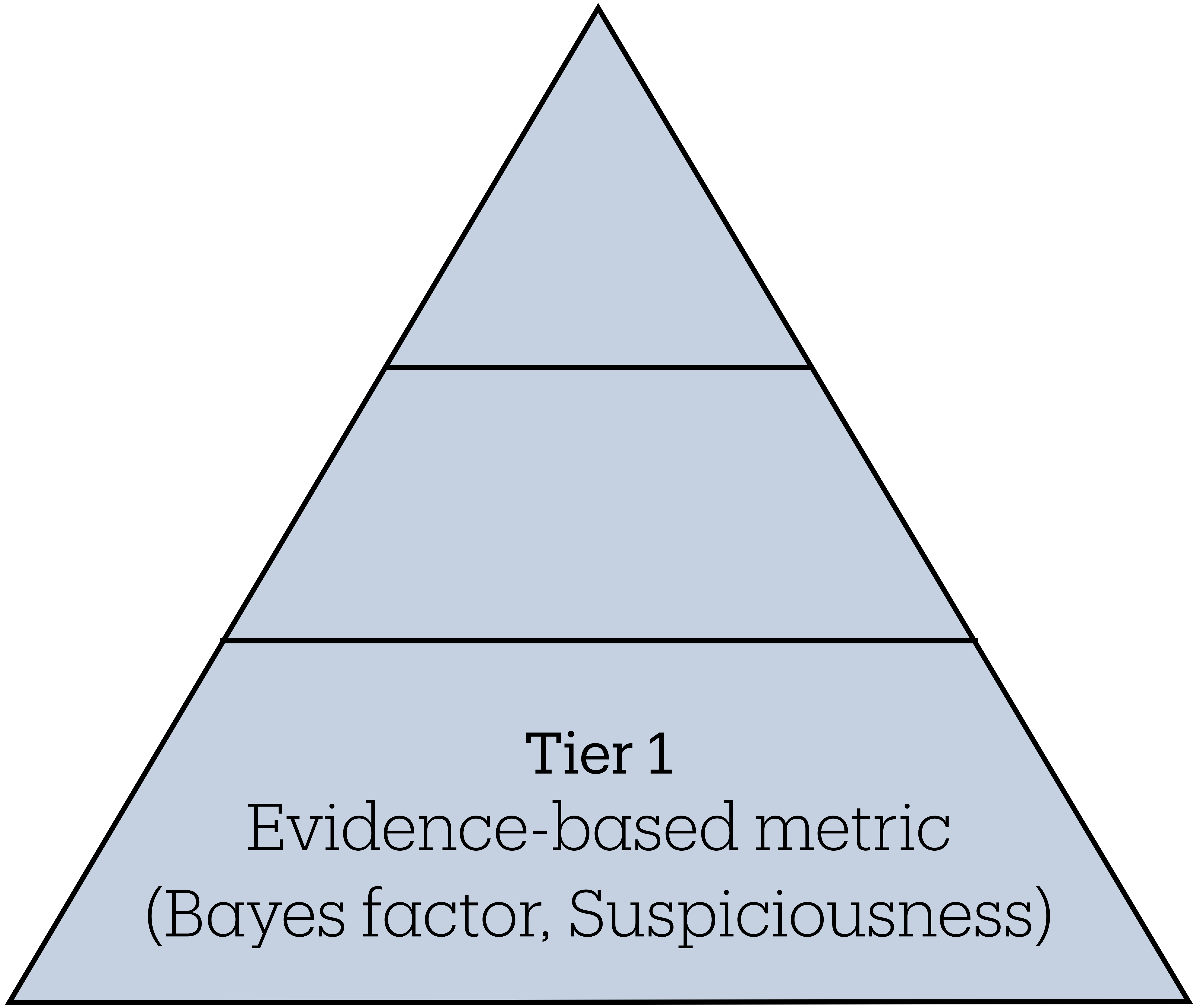


Wright et al. (2025b)

How do we know KiDS-Legacy is more robust?

Testing Internal Consistency

Greatly expanded suite of tests all indicate full consistency



Stölzner et al. (2025)

Testing Internal Consistency

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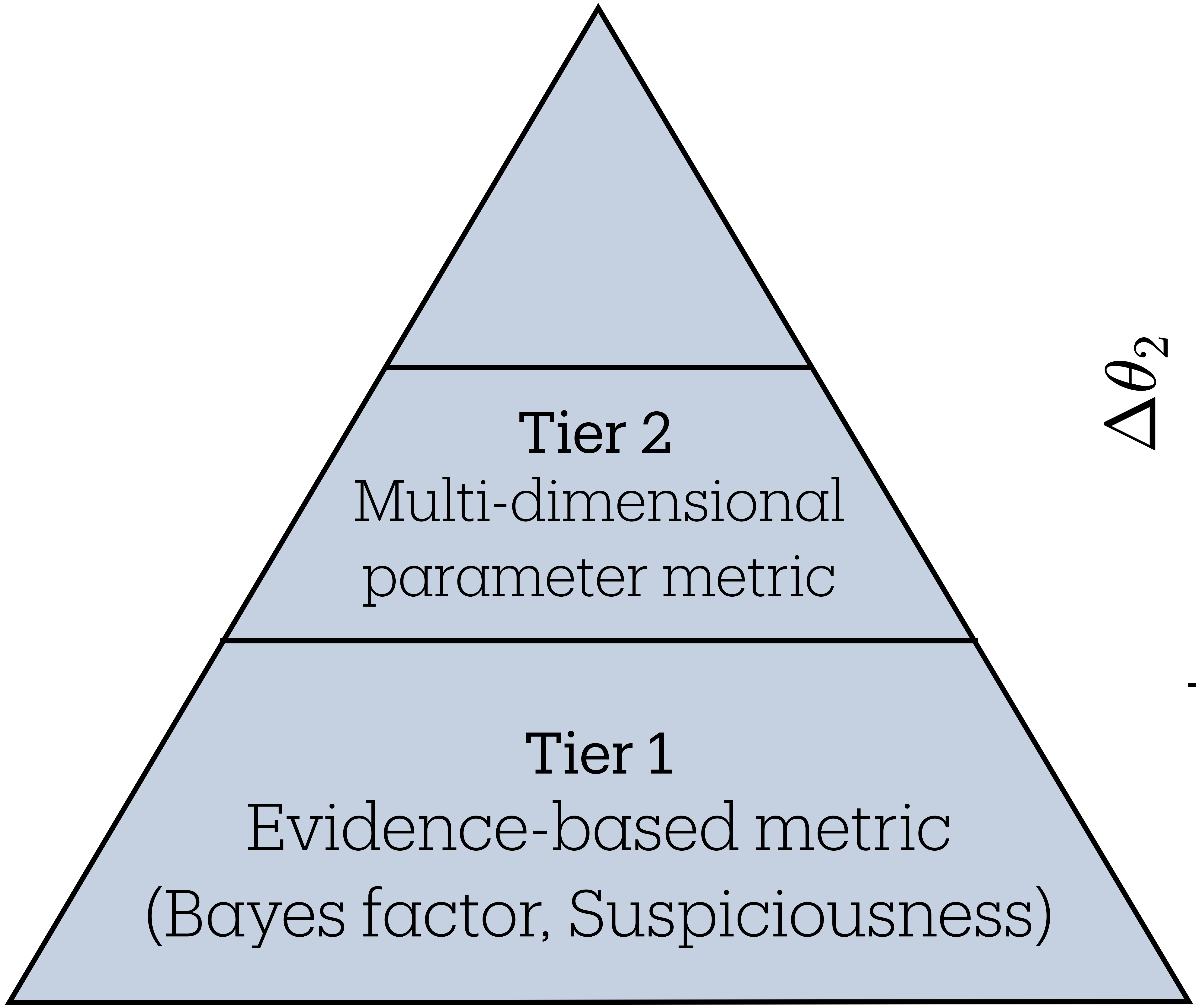

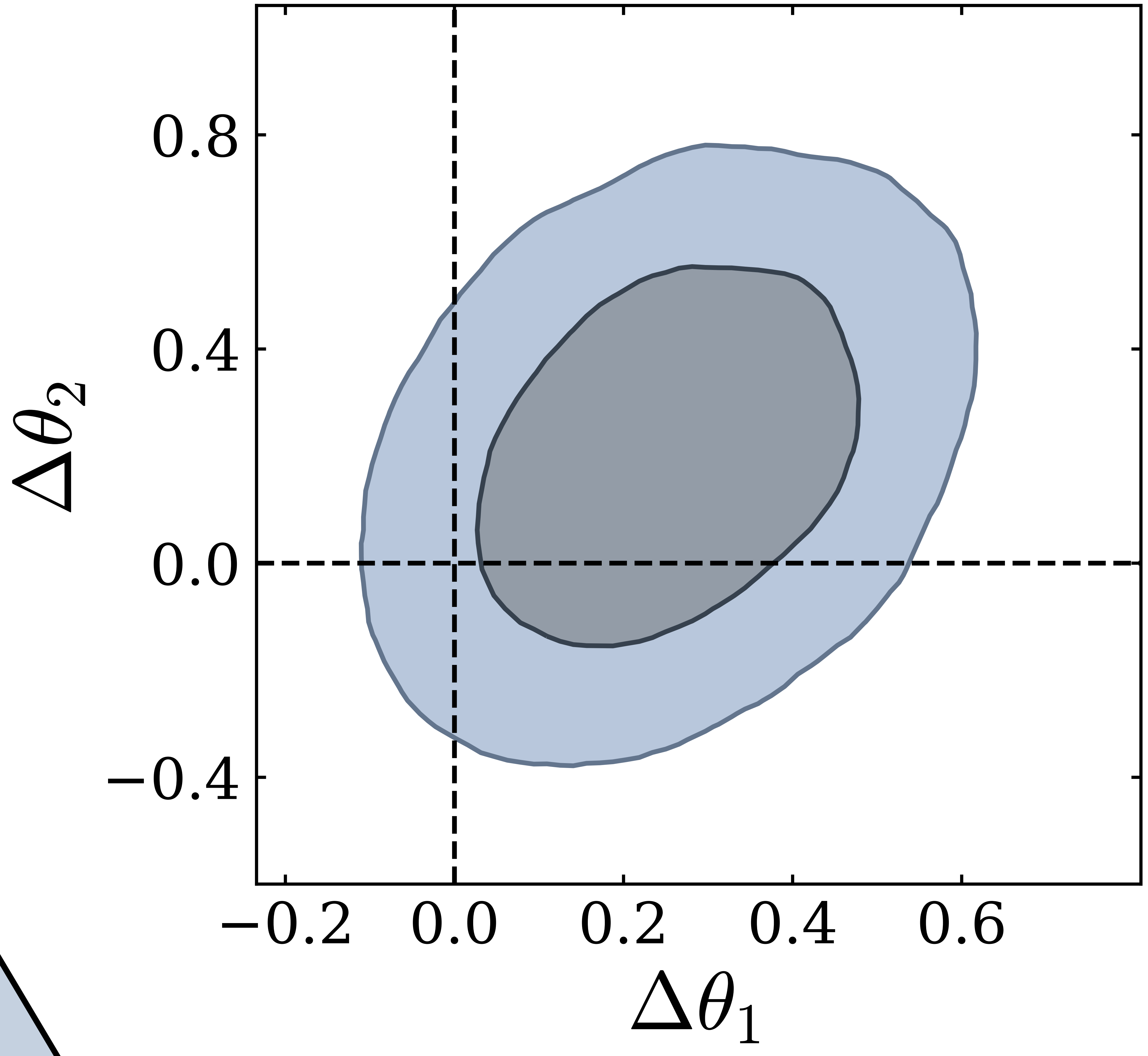

Stölzner et al. (2025)

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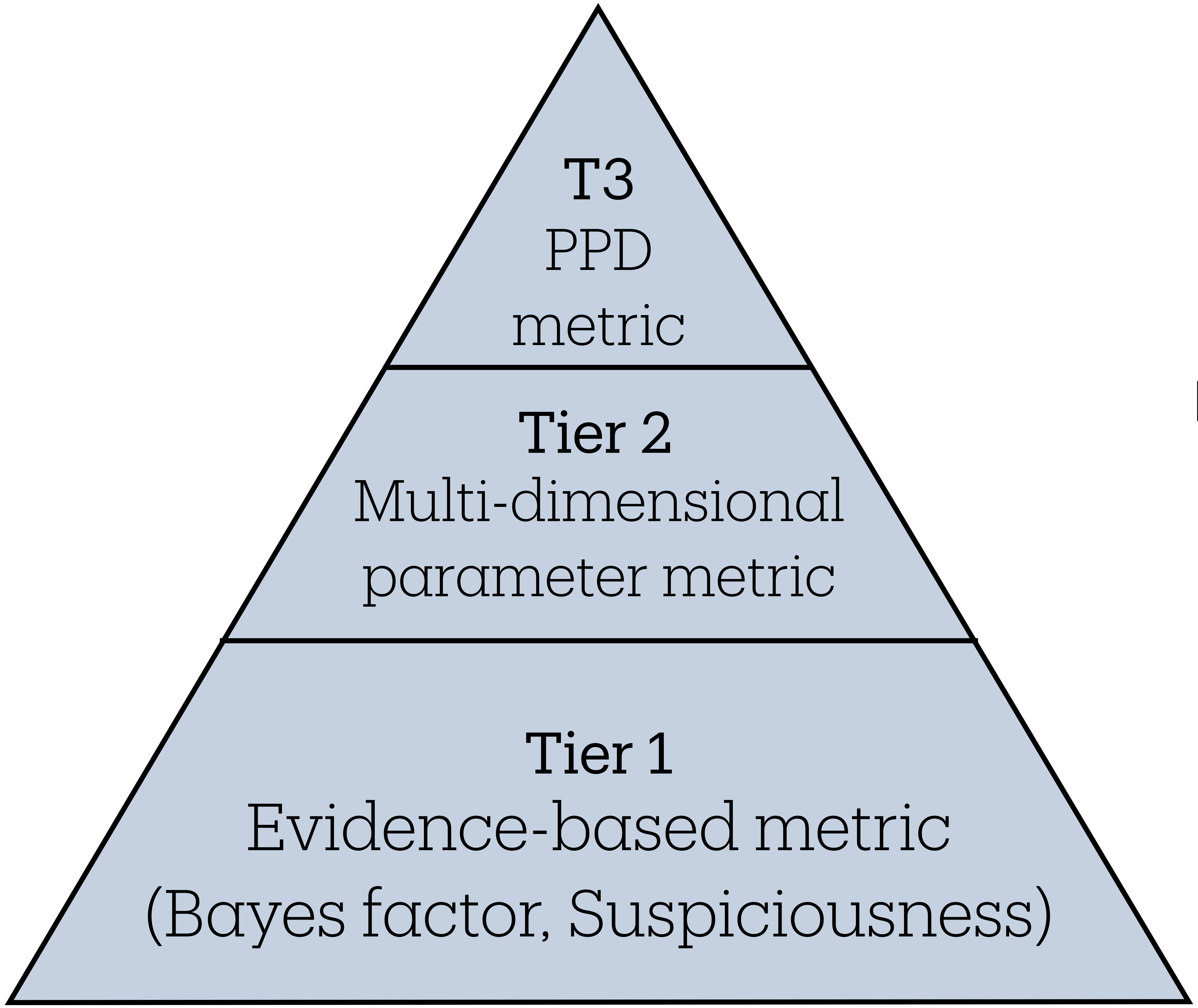
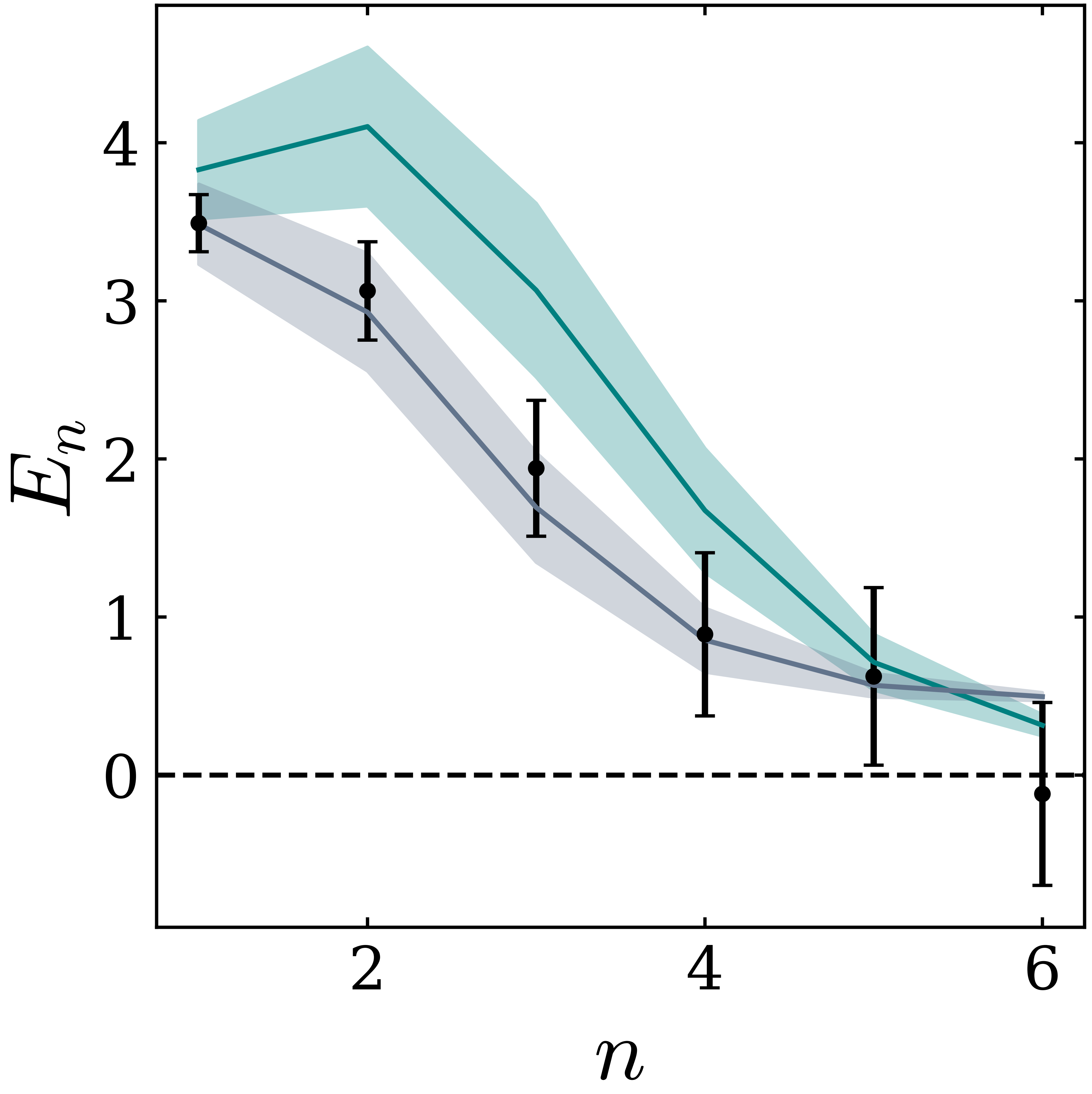




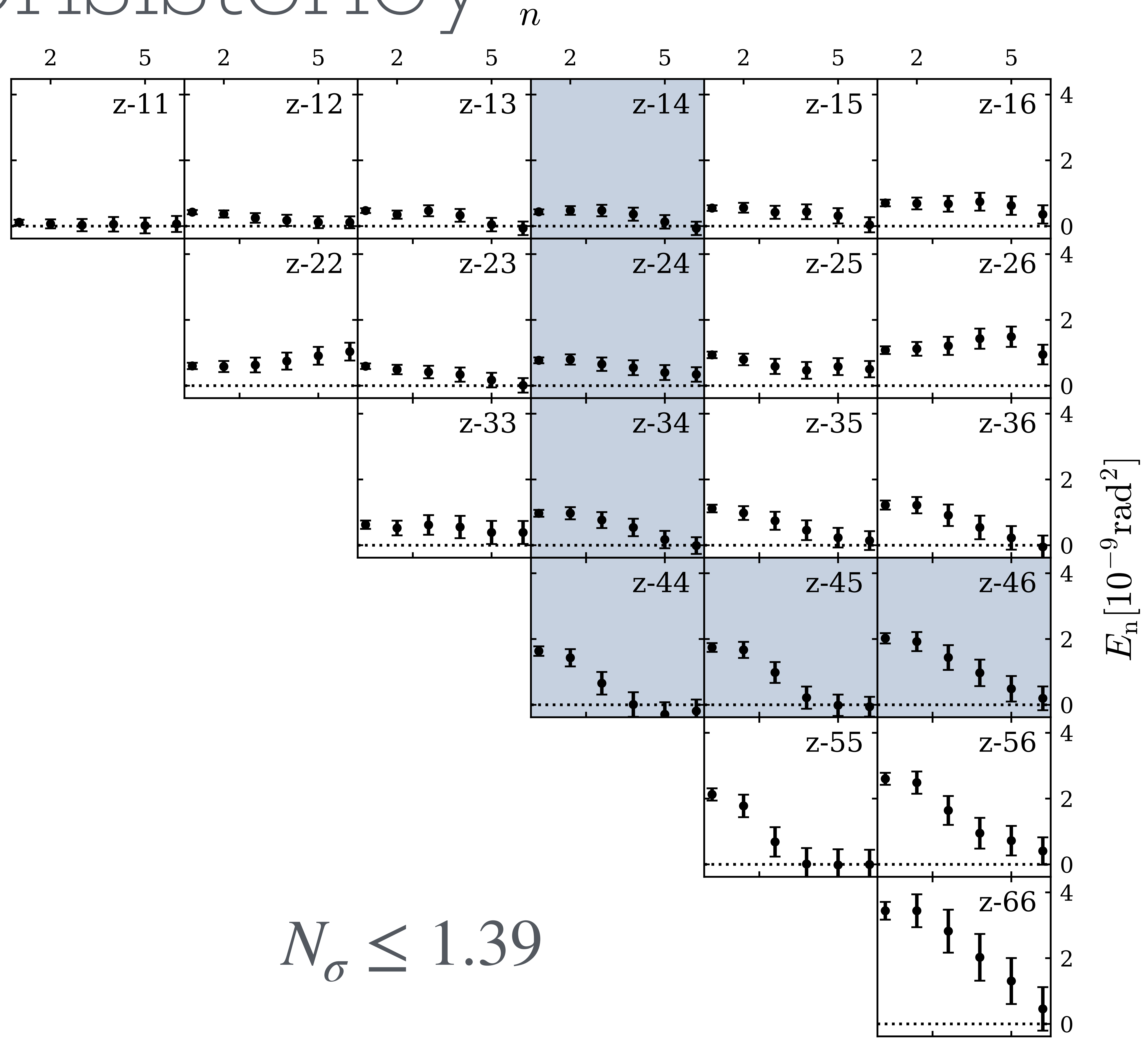
Stölzner et al. (2025)

Testing Internal Consistency

Wider range of internal splits

Data vector level:

- Redshift bins



$N_\sigma \leq 1.39$

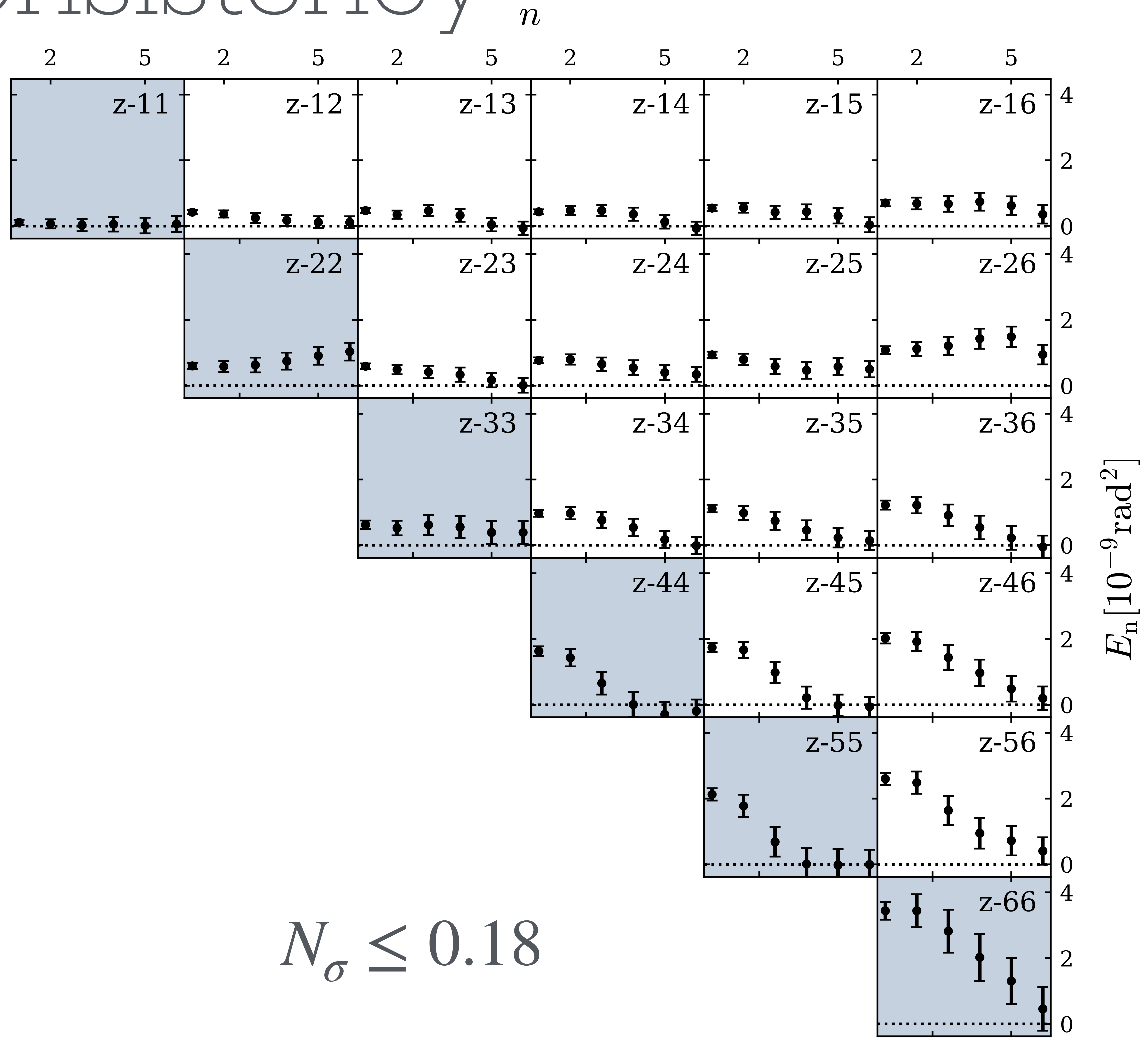
Stölzner et al. (2025)

Testing Internal Consistency

Wider range of internal splits

Data vector level:

- Redshift bins
- Auto- vs cross-correlation



$N_\sigma \leq 0.18$

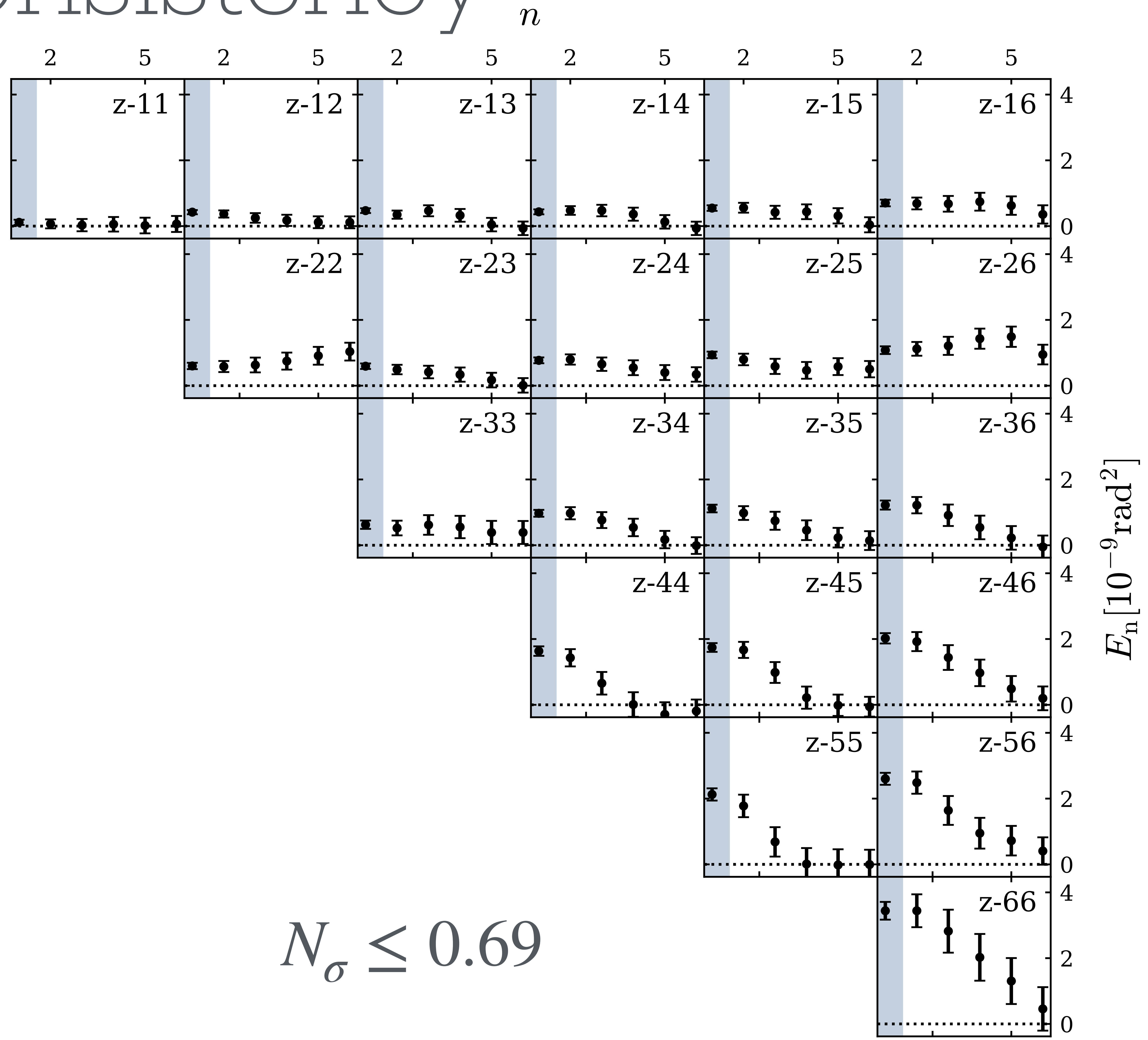
Stölzner et al. (2025)

Testing Internal Consistency

Wider range of internal splits

Data vector level:

- Redshift bins
- Auto- vs cross-correlation
- Scales/modes



$N_\sigma \leq 0.69$

Stölzner et al. (2025)

Testing Internal Consistency

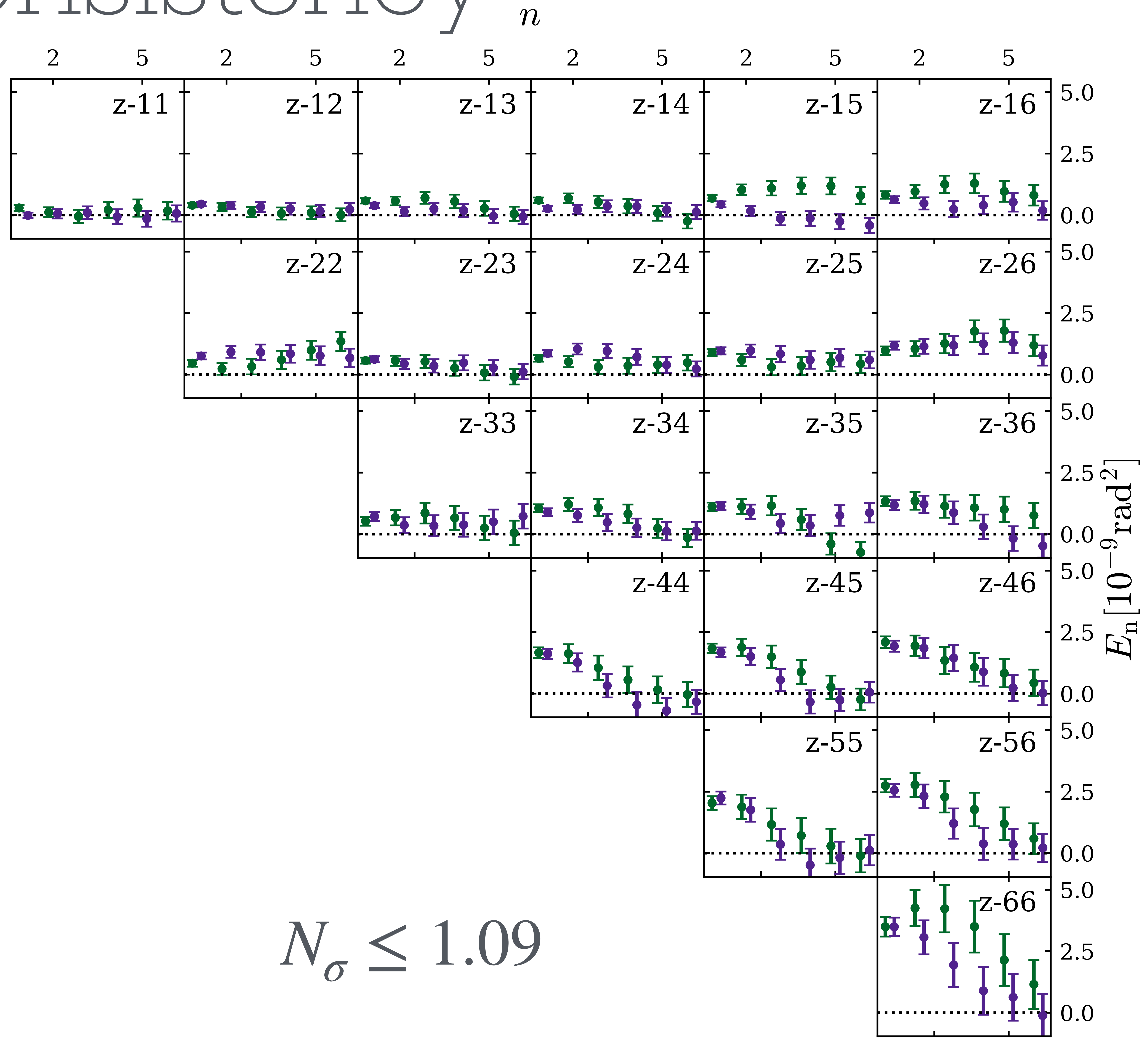
Wider range of internal splits

Data vector level:

- Redshift bins
- Auto- vs cross-correlation
- Scales/modes

Catalogue level:

- KiDS-North vs KiDS-South



$N_\sigma \leq 1.09$

Stölzner et al. (2025)

Testing Internal Consistency

Wider range of internal splits

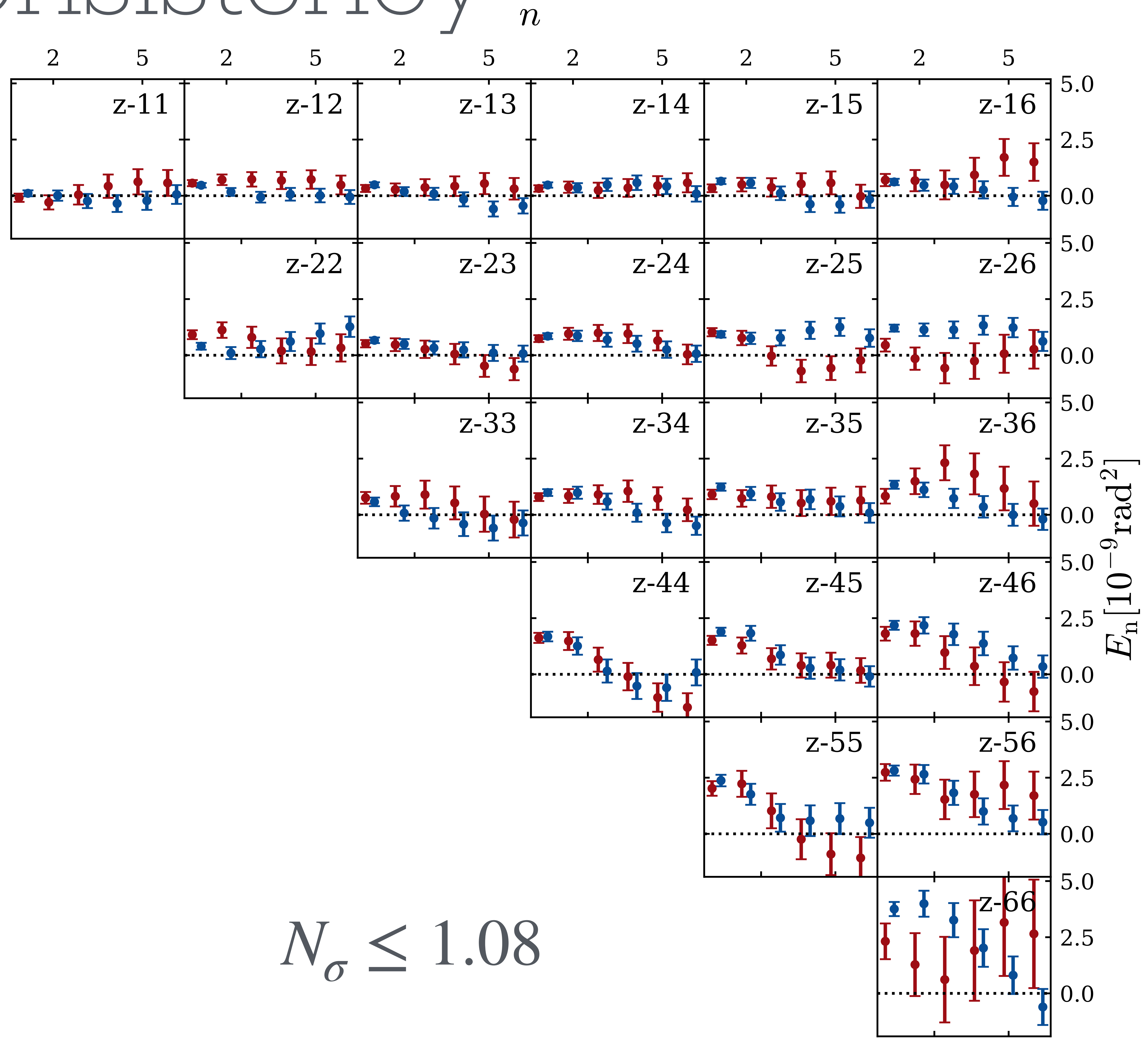
Data vector level:

- Redshift bins
- Auto- vs cross-correlation
- Scales/modes

Catalogue level:

- KiDS-North vs KiDS-South
- Red vs Blue

Stölzner et al. (2025)

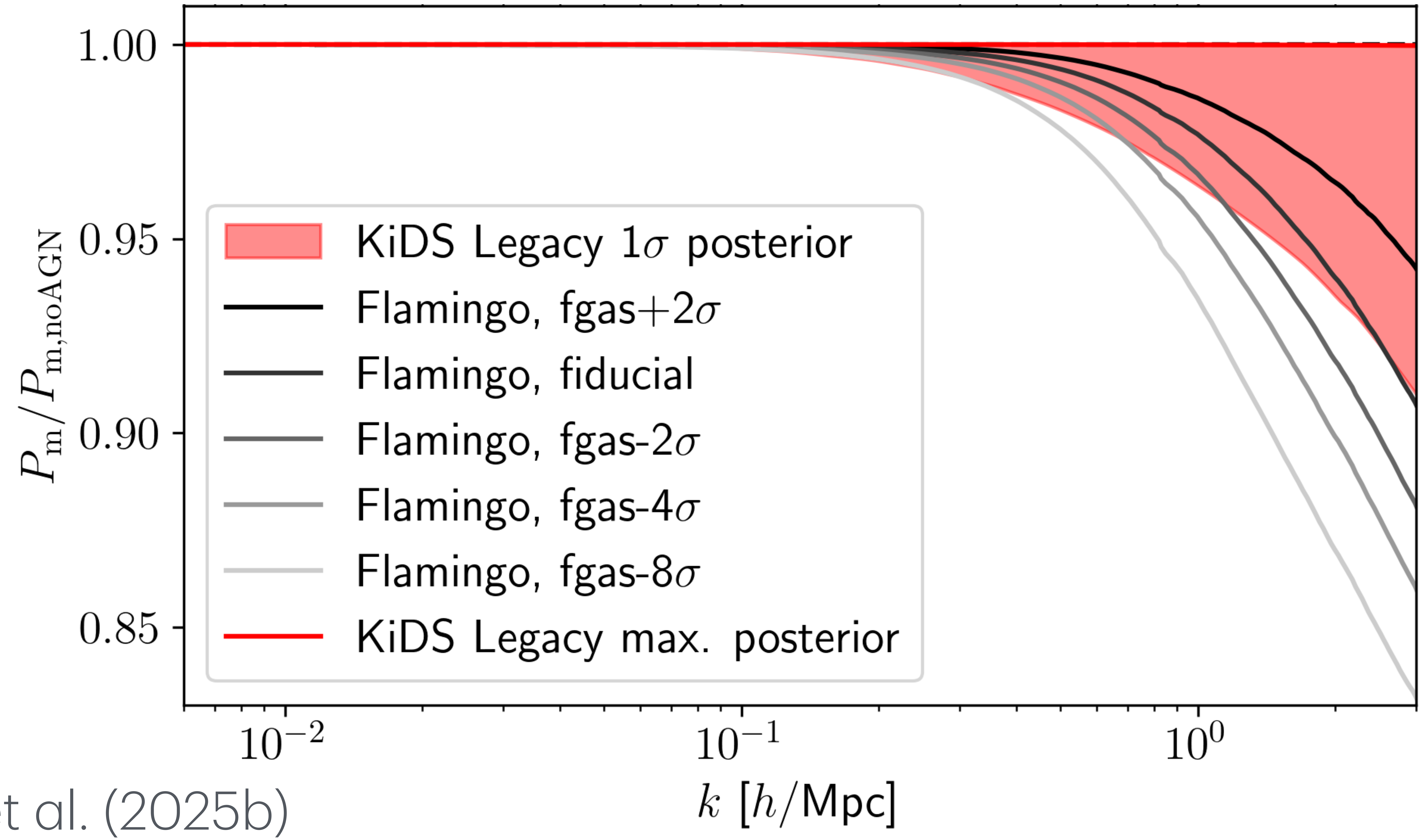


$N_\sigma \leq 1.08$

Other Results from KiDS-Legacy Cosmic Shear

Baryonic Feedback Constraints

No evidence for significant feedback amplitudes from fiducial COSEBIs

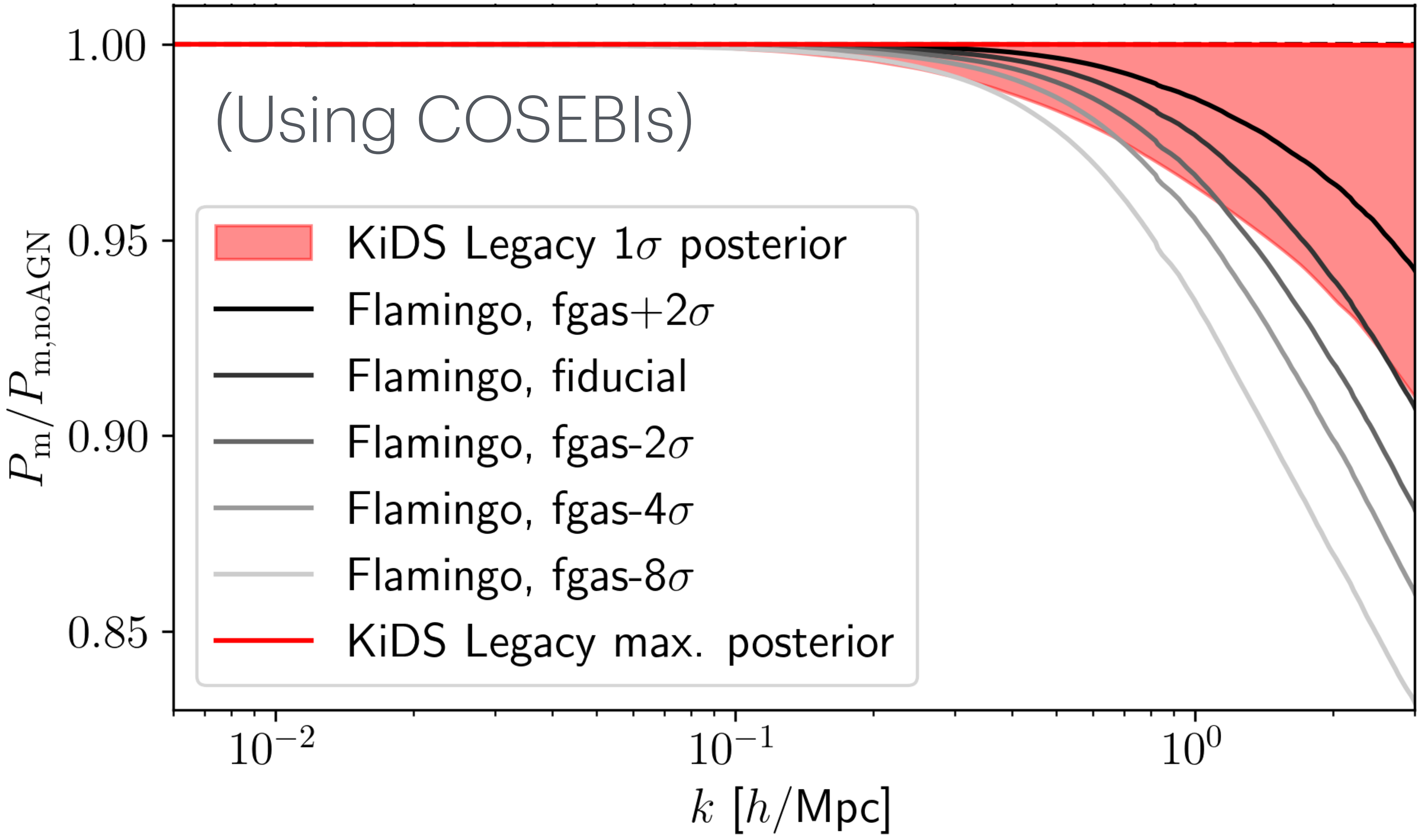


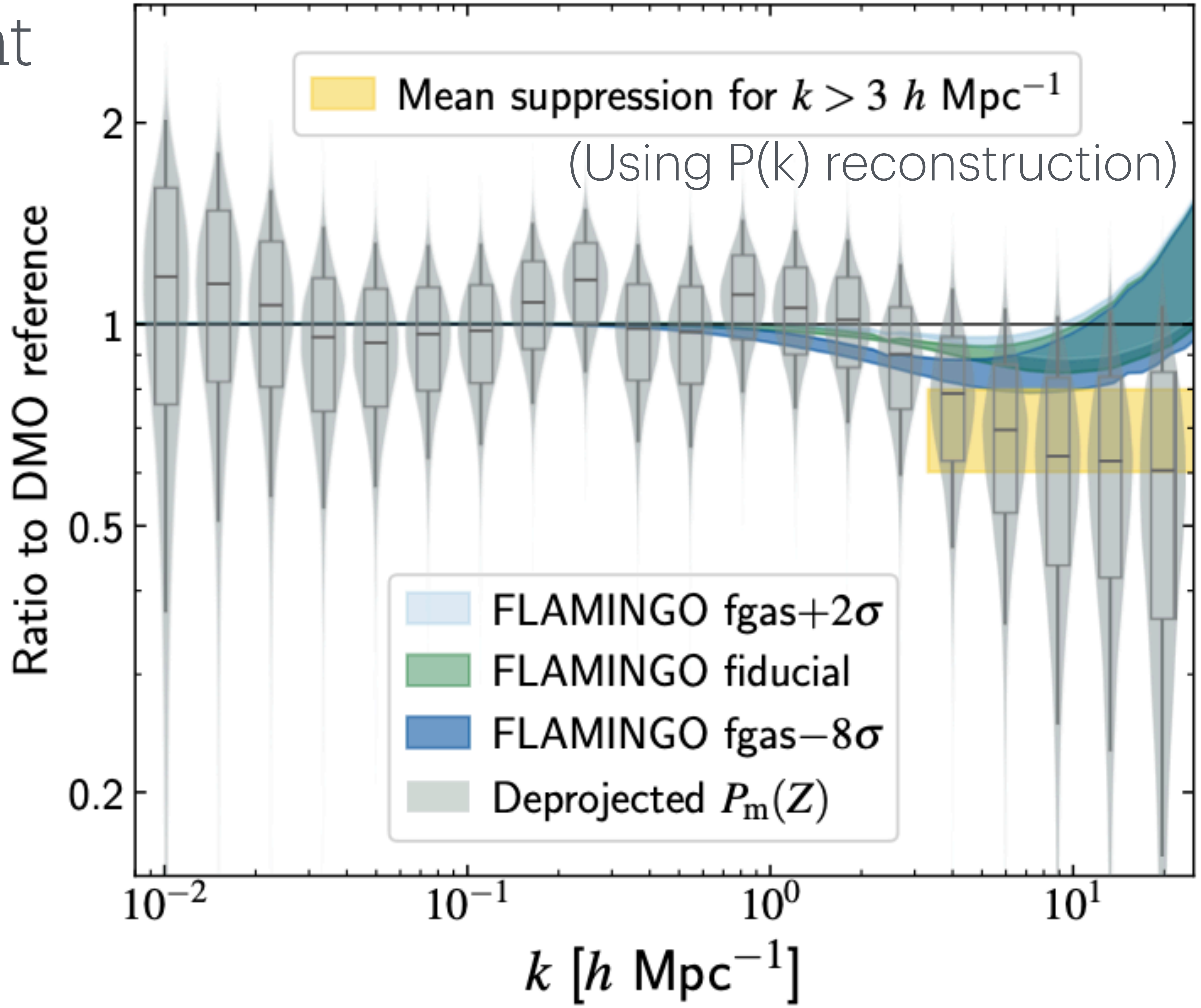
Wright et al. (2025b)

Baryonic Feedback Constraints

Using correlation functions at small scales & P(k) reconstruction:

more extreme feedback is evident



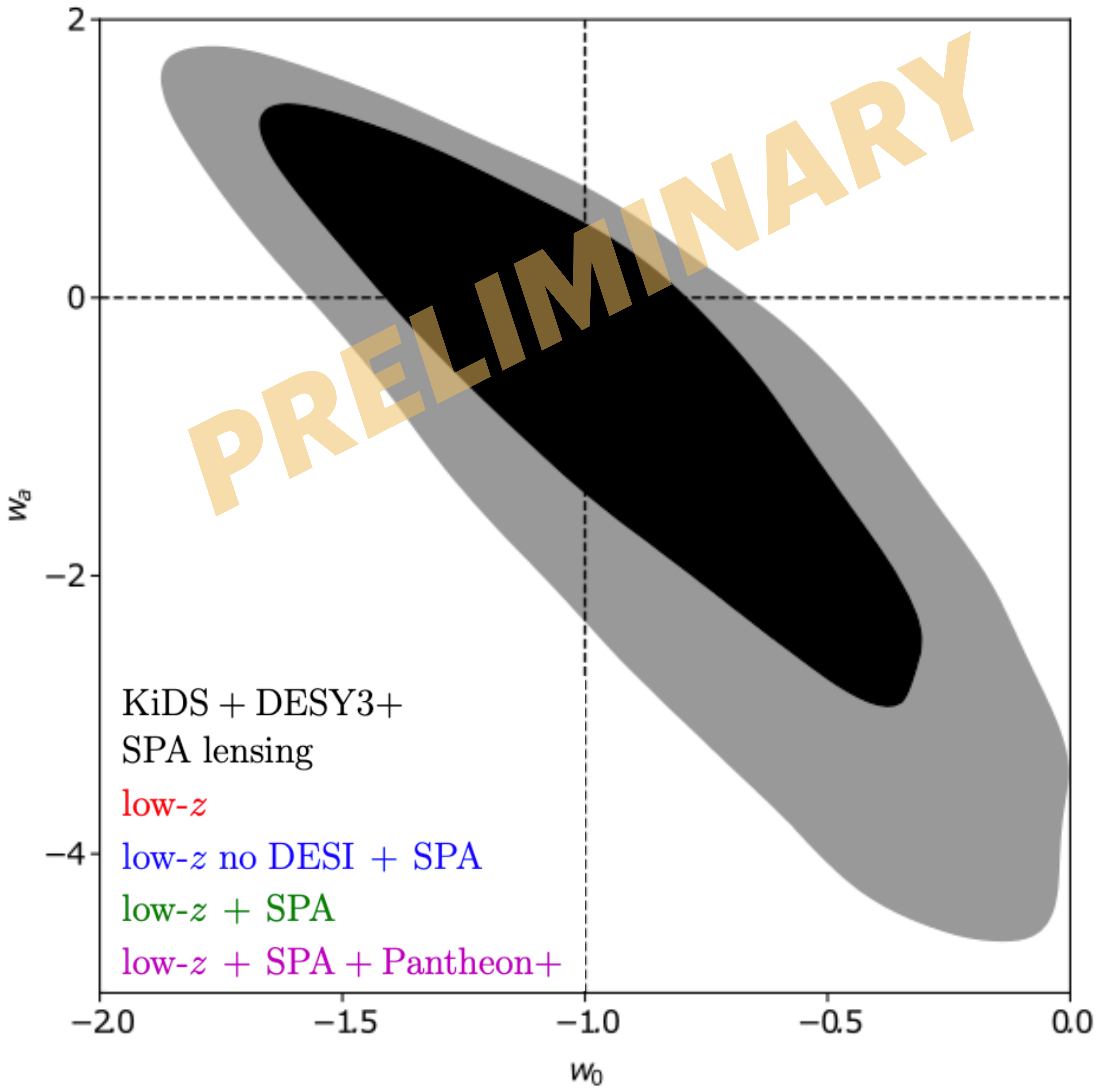


Broxterman et al. (2025)

Extended Cosmologies from Joint Analyses

name	data set
KiDS	KiDS DR5 cosmic shear catalogue
SPA	SPT 3G D1 + ACT DR6 + Planck 2018 lensing and primary
lensing	KiDS + DESY3 + SPA lensing
low-z	KiDS + DESY3 + DESIY2 BAO + eBOSS RSD

Reischke et al. (in prep)



Extended Cosmologies from Joint Analyses

Lensing strongly prefers ΛCDM over extensions

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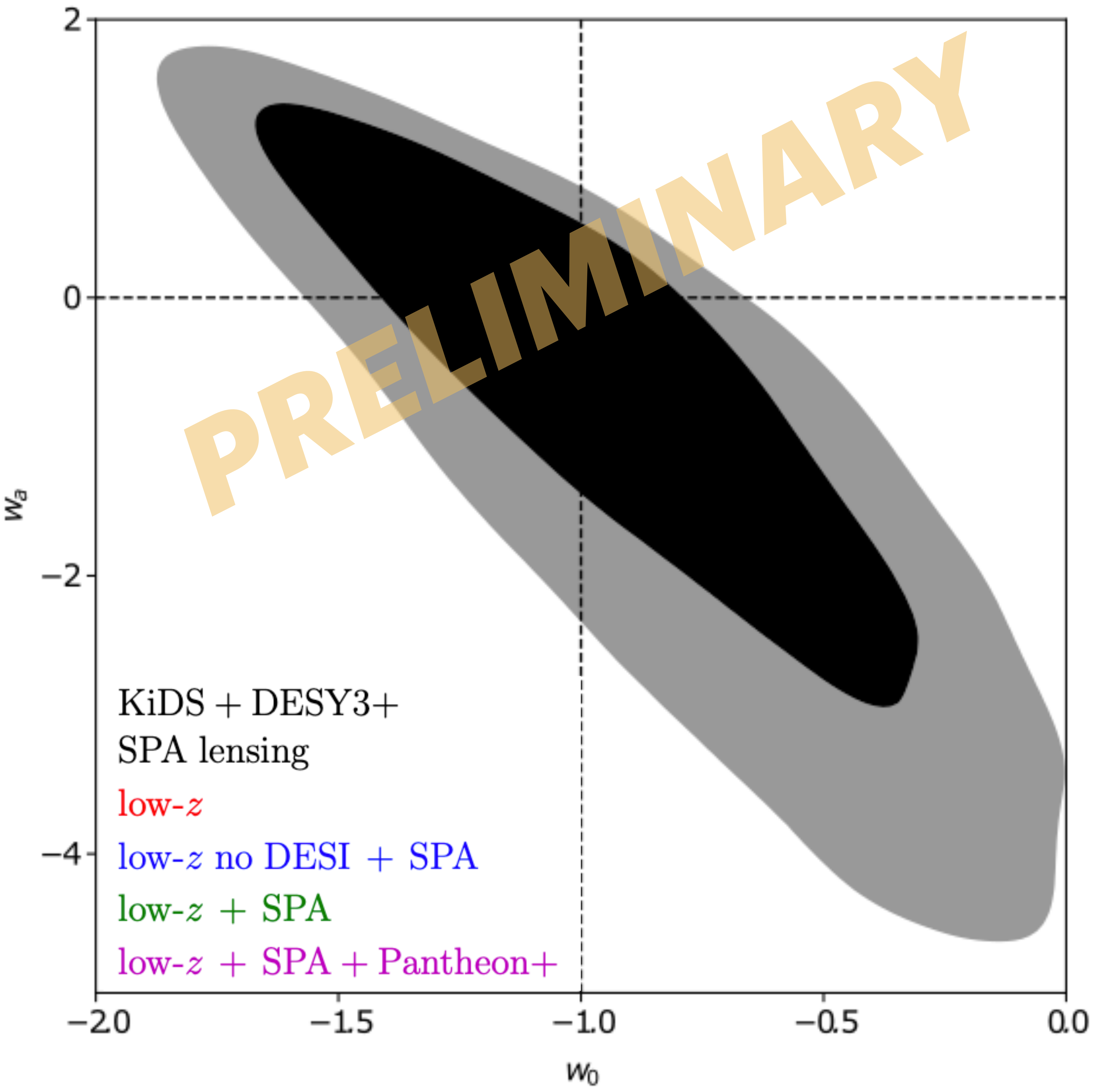

Reischke et al. (in prep)

Extended Cosmologies from Joint Analyses

Lensing strongly prefers ΛCDM over extensions

Low-z data strongly prefer ΛCDM over extensions

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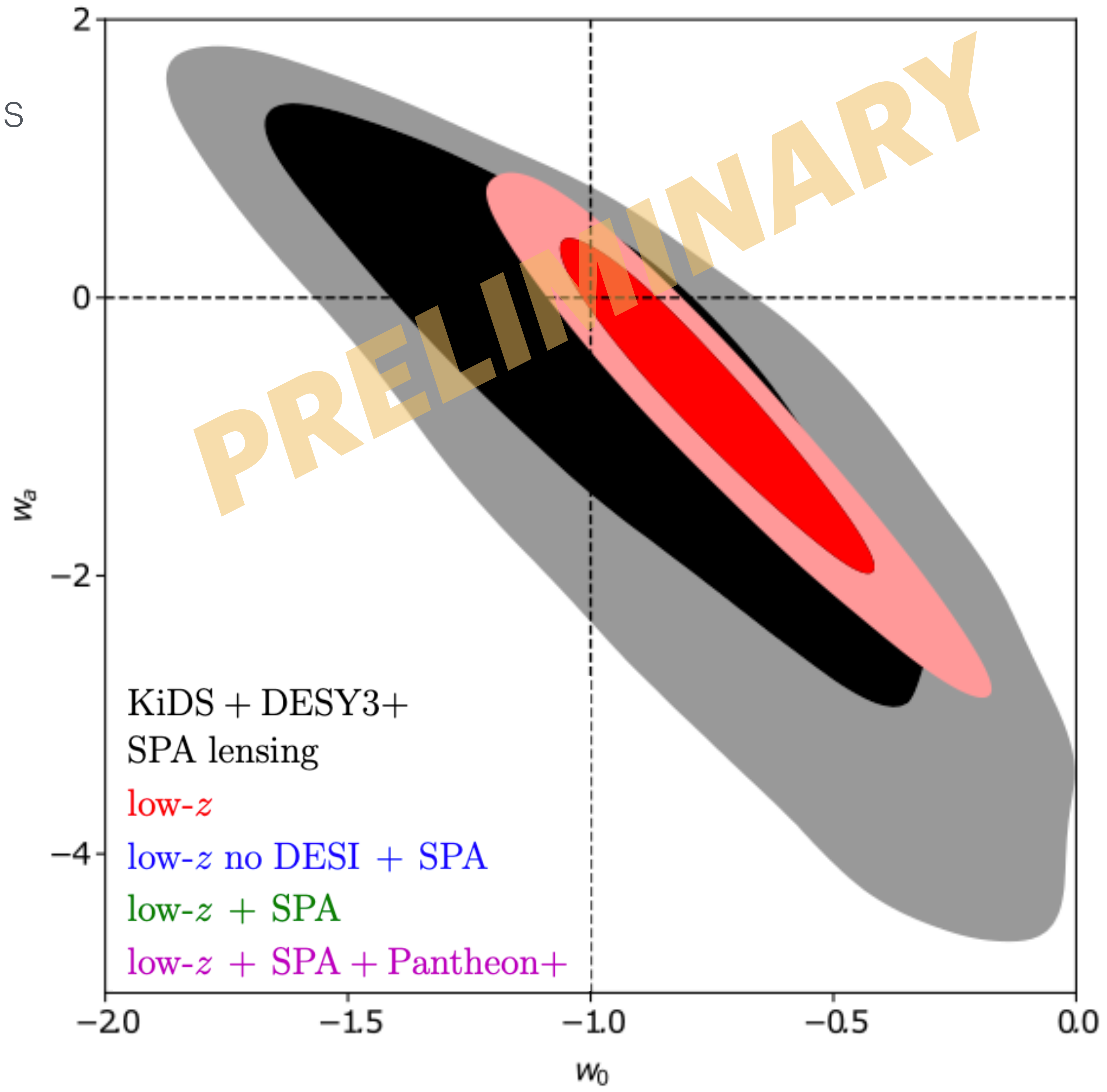
Reischke et al. (in prep)



Extended Cosmologies from Joint Analyses

Lensing strongly prefers ΛCDM over extensions

Low-z data strongly prefer ΛCDM over extensions

Excluding DESI:

- combination of low-z & CMB data prefer ΛCDM

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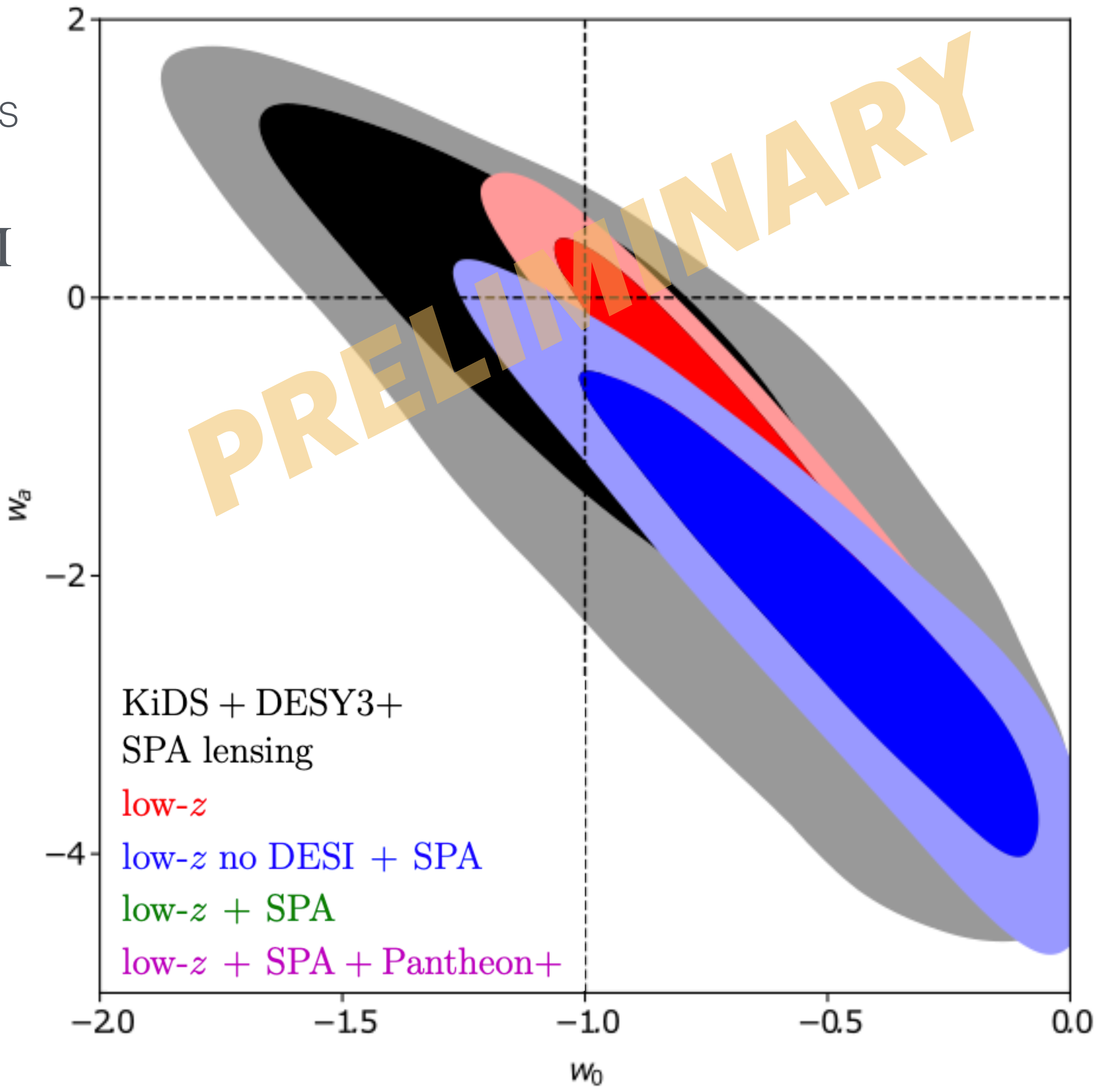
Reischke et al. (in prep)



Extended Cosmologies from Joint Analyses

Lensing strongly prefers ΛCDM over extensions

Low-z data strongly prefer ΛCDM over extensions

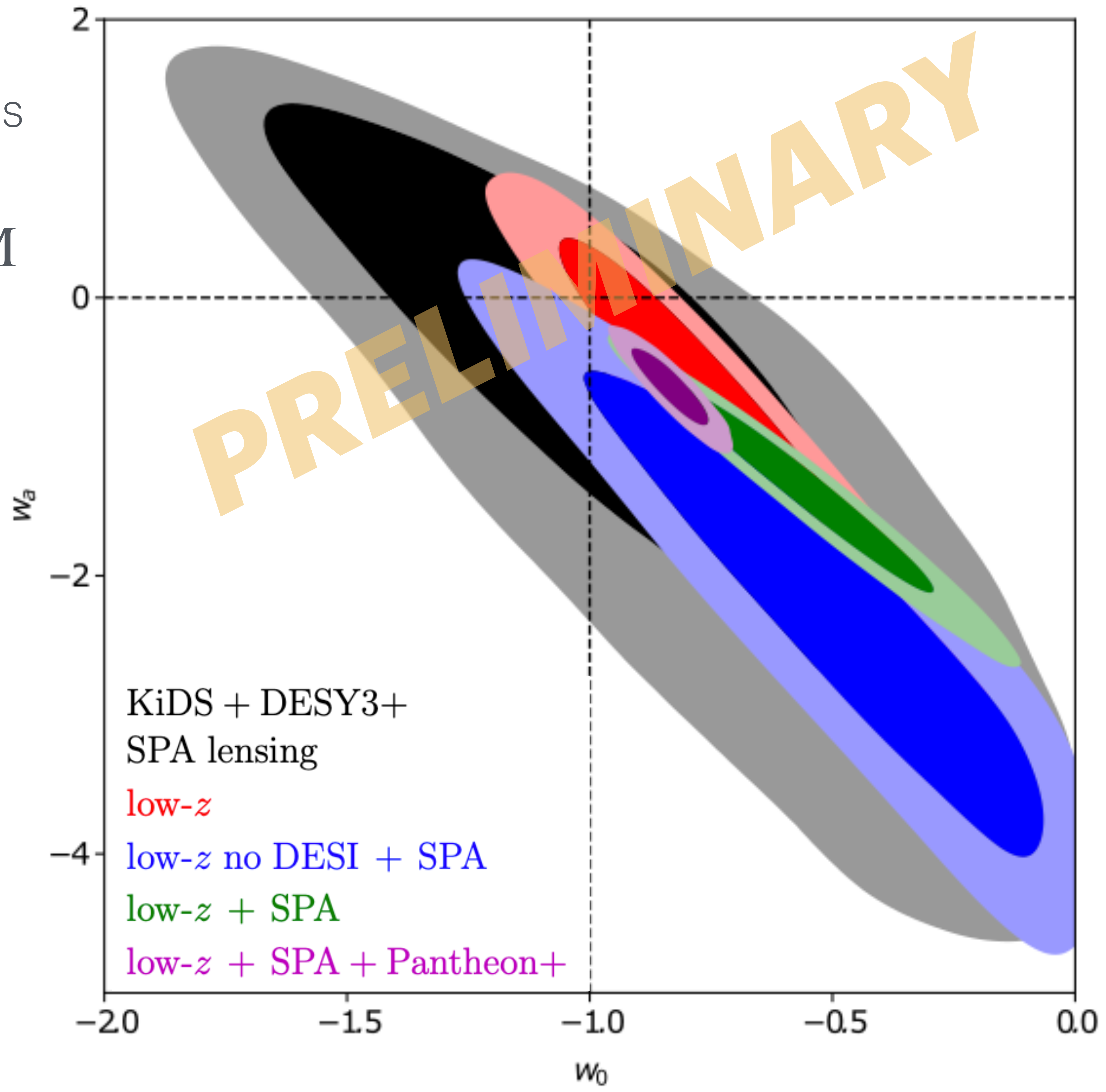
Excluding DESI:

- combination of low-z & CMB data prefer ΛCDM

Including **DESI** or **DESI & SN**:

- w0-wa is preferred over ΛCDM

name	data set
KiDS	KiDS DR5 cosmic shear catalogue
SPA	SPT 3G D1 + ACT DR6 + Planck 2018 lensing and primary
lensing	KiDS + DESY3 + SPA lensing
low-z	KiDS + DESY3 + DESIY2 BAO + eBOSS RSD



Reischke et al. (in prep)

Modified Gravity from Joint Analyses

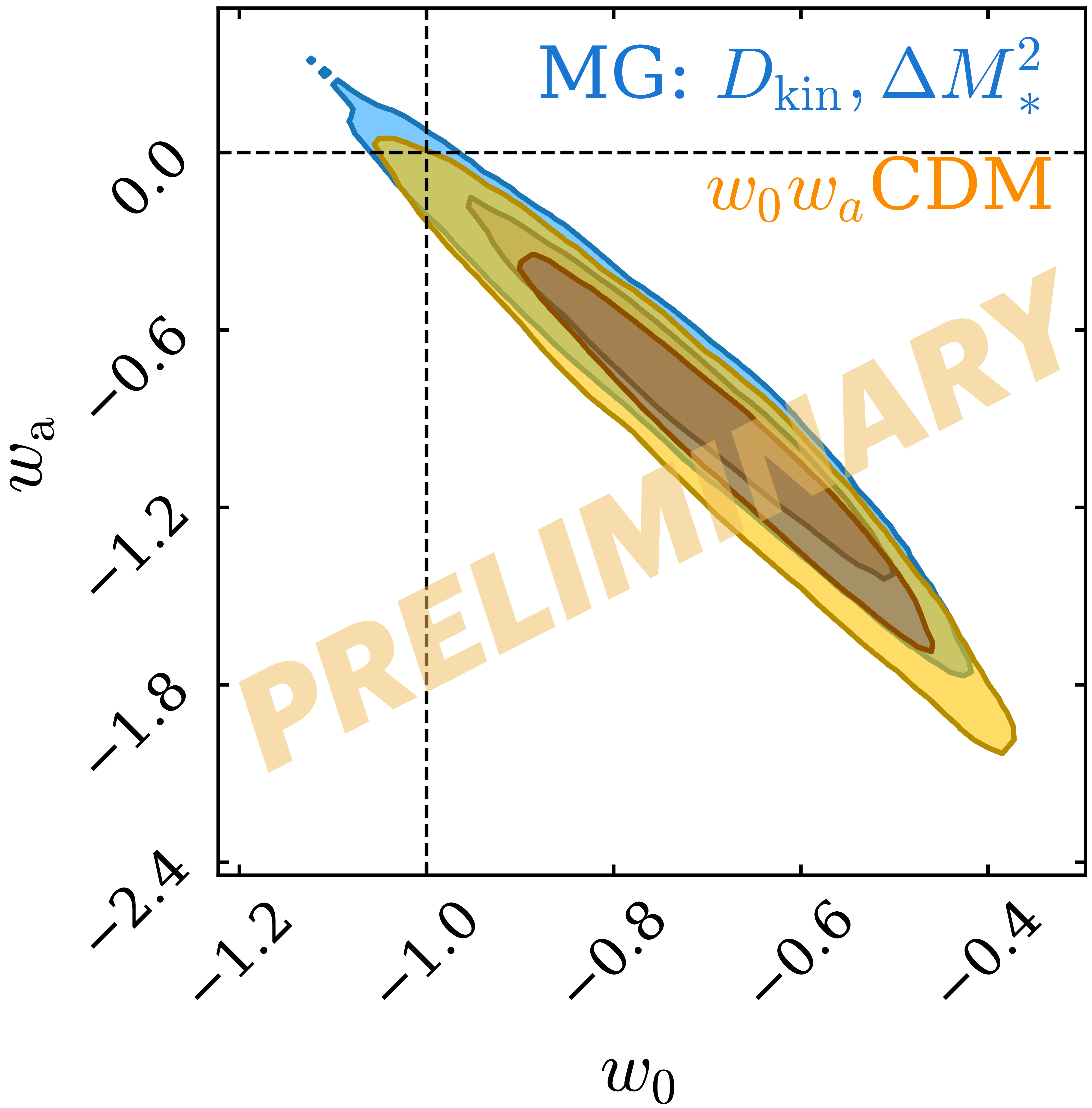
Combination of:
KiDS-Legacy, DESI BAO, eBOSS, & Planck

Models MG perturbations to a background ΛCDM or **w0wa** cosmology

Includes sampling of lensing anomaly parameter

Weak preference for a **w0wa** over a ΛCDM in a MG analysis, but not statistically significant (1.57σ)

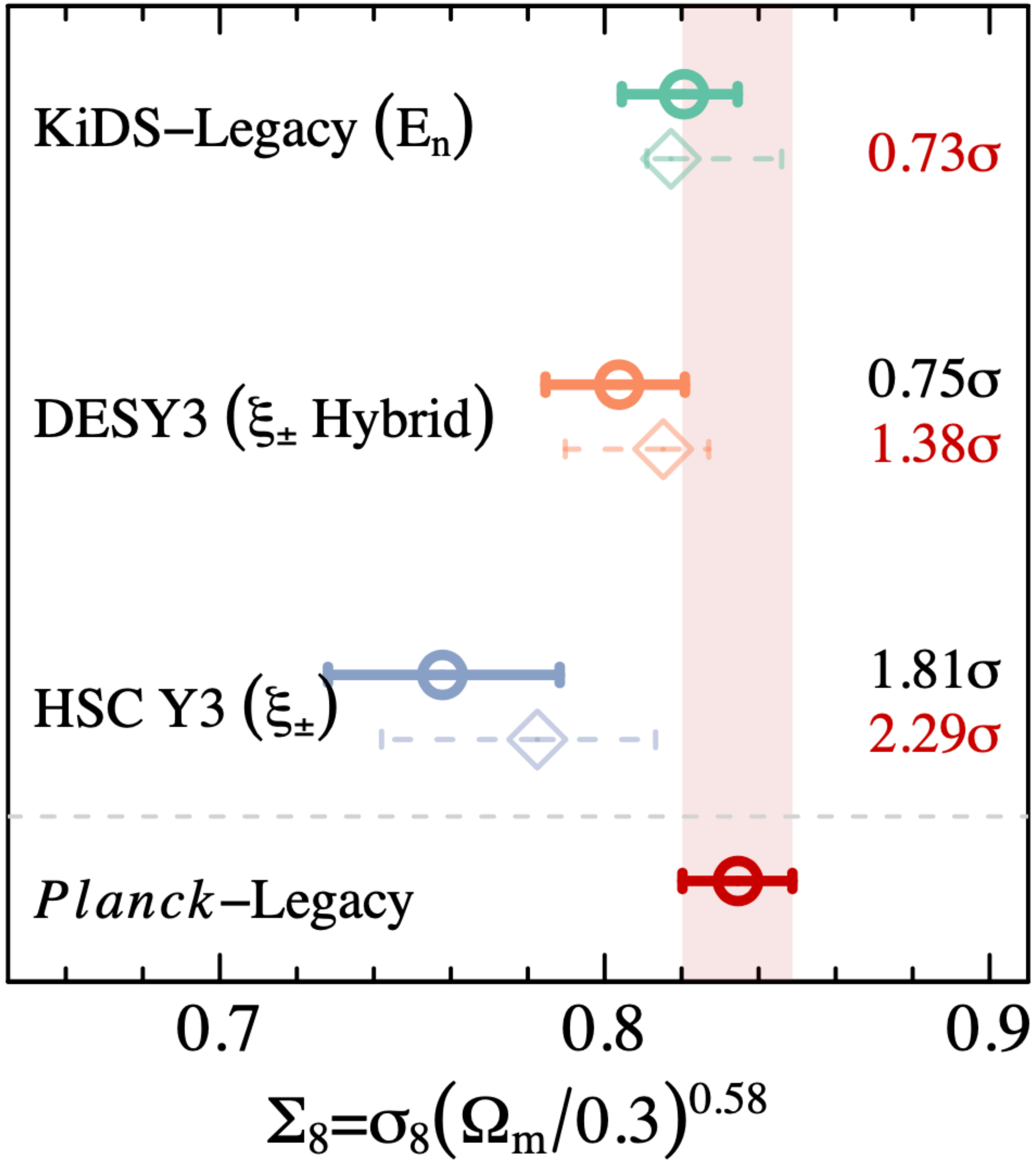
MG parameters consistent with their ΛCDM expectations, and stable with **w0wa** background



Stölzner et al. (in prep)

Conclusions from KiDS-Legacy

- Data from the complete KiDS survey
  [Wright et al. (2024)]
- Improved calibration samples and methods **[Wright et al. (2025a)]**
- Consistent with *CMB*
  [Wright et al. (2025b)]
- No evidence for significant feedback
  [Wright et al. (2025b)]
- Most robust KiDS analysis to date
  [Stölzner et al. (2025)]



Conclusions from KiDS-Legacy + External Probes

- Combined analysis with DES, DESI, and Pantheon+

  [Stölzner et al. (2025)]

- Additional analyses with CMB

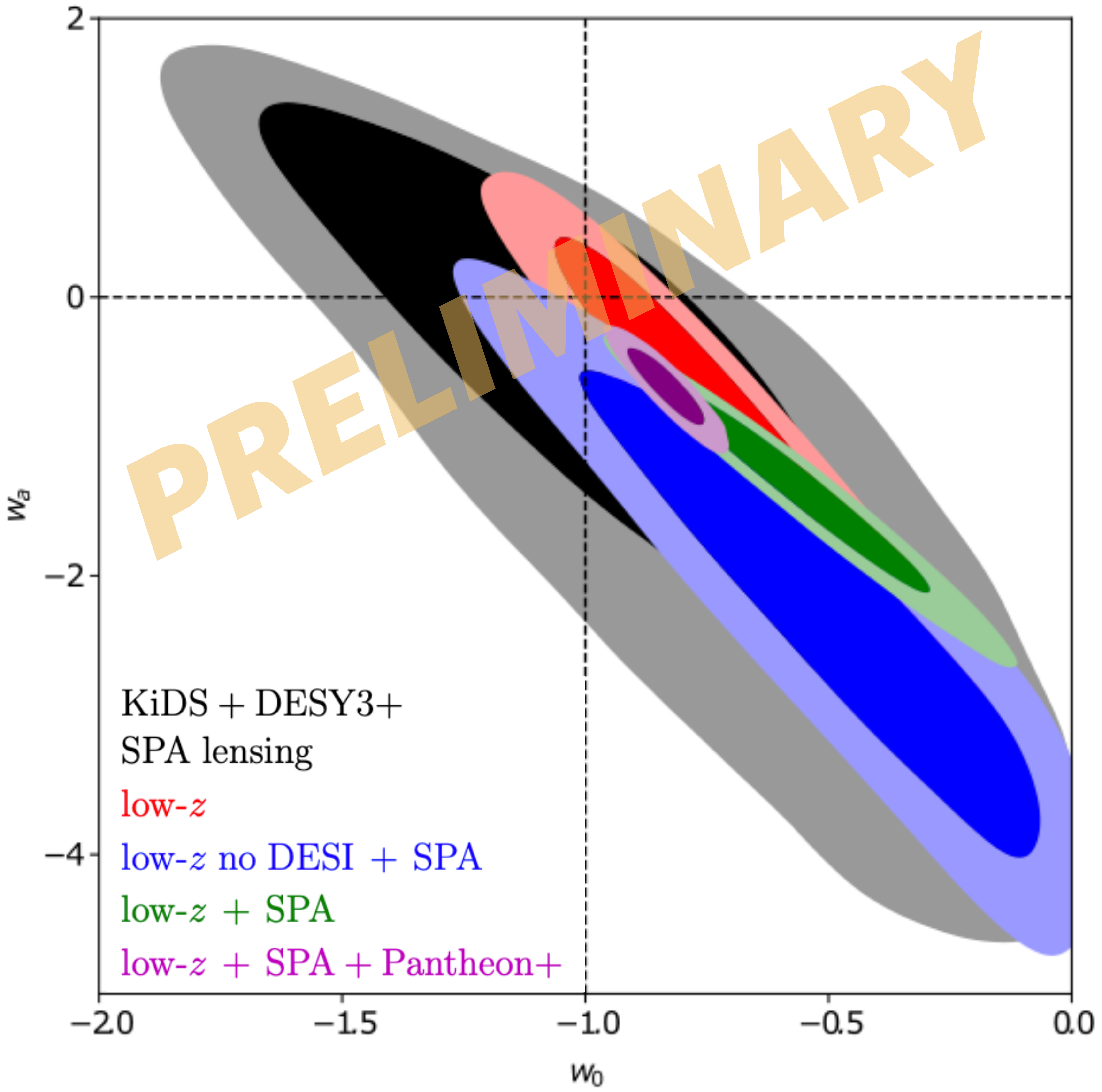
  [Reischke et al. (in prep)]

- ΛCDM preferred over extended models, except when including DESI

  [Reischke et al. (in prep)]

- Modified gravity consistent with ΛCDM expectation

  [Stölzner et al. (in prep)]



Additional Slides

Gravitational Lensing

Galaxy images are distorted by the presence of matter

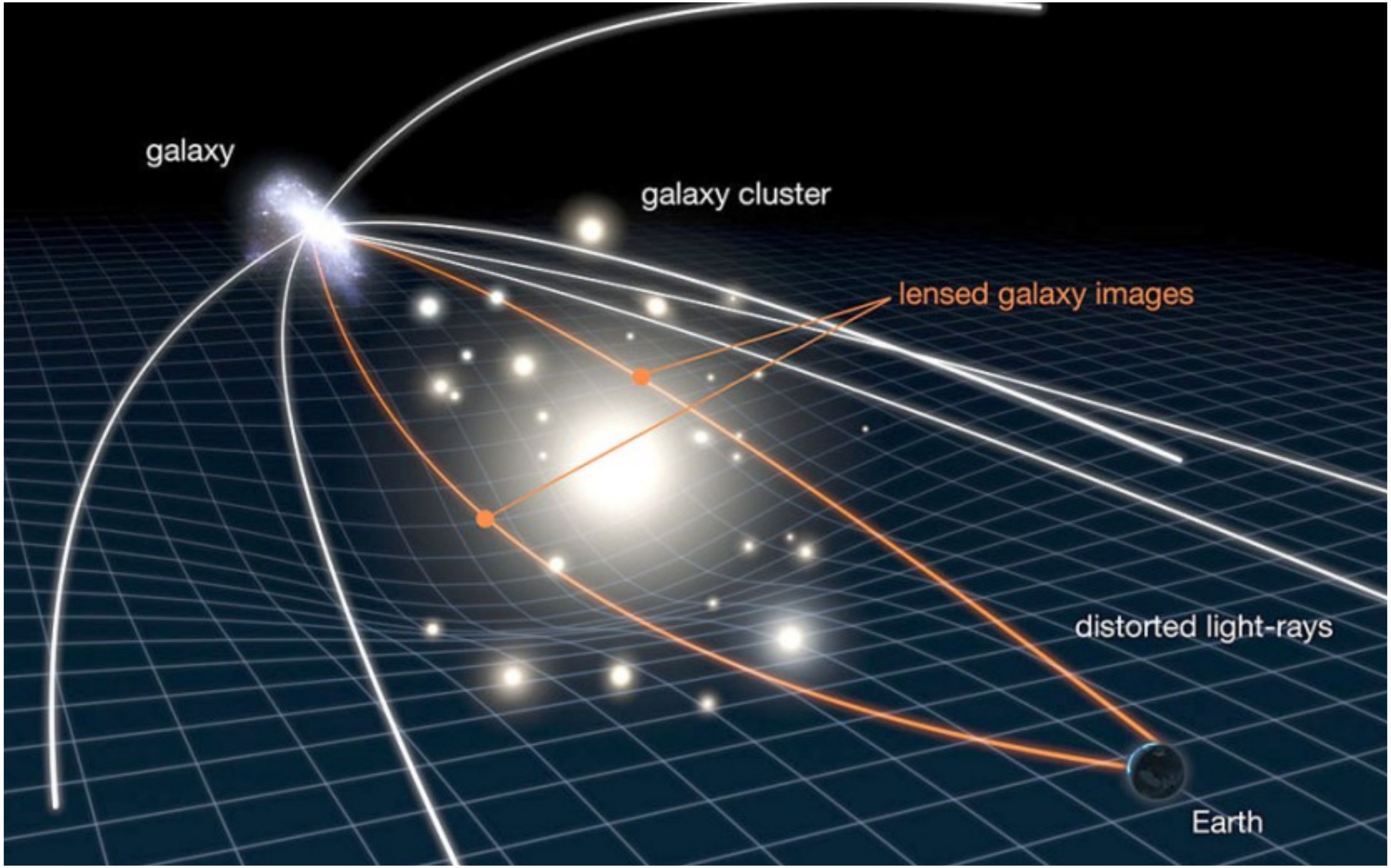


Image credit:
NASA/ESA

Gravitational Lensing

Galaxy images are distorted by the presence of matter

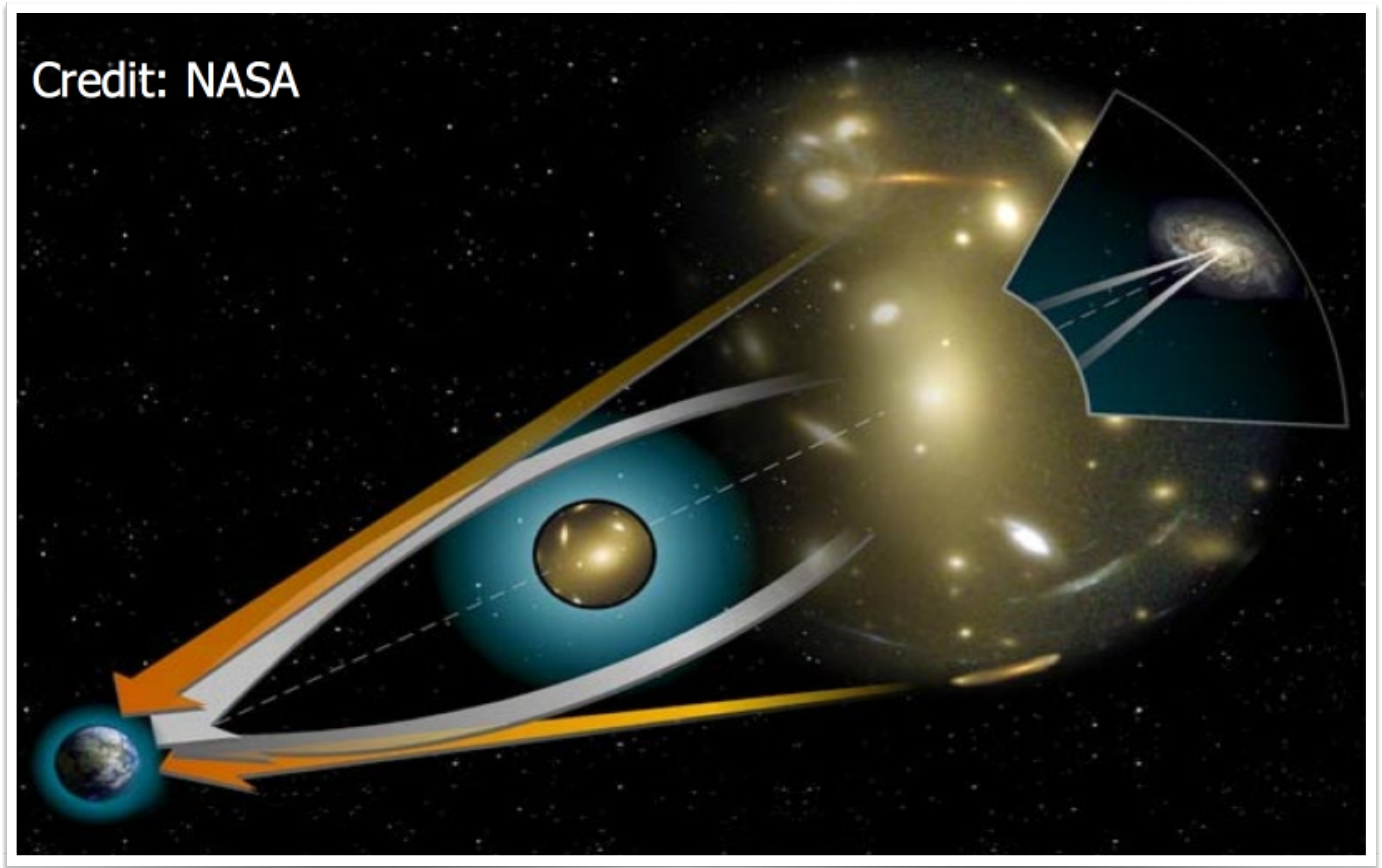


Image credit: NASA/ESA

Gravitational Lensing

Galaxy images are distorted by the presence of matter

Image credit: NASA/ESA

Strong and Weak Gravitational Lensing

Different implications for galaxy images

Strong lensing creates visibly distorted galaxy images, multiple images, arcs, etc.

Weak lensing is typically only measurable using ensembles of galaxies

The true shear of the potential is measurable from the mean ellipticity of the galaxies

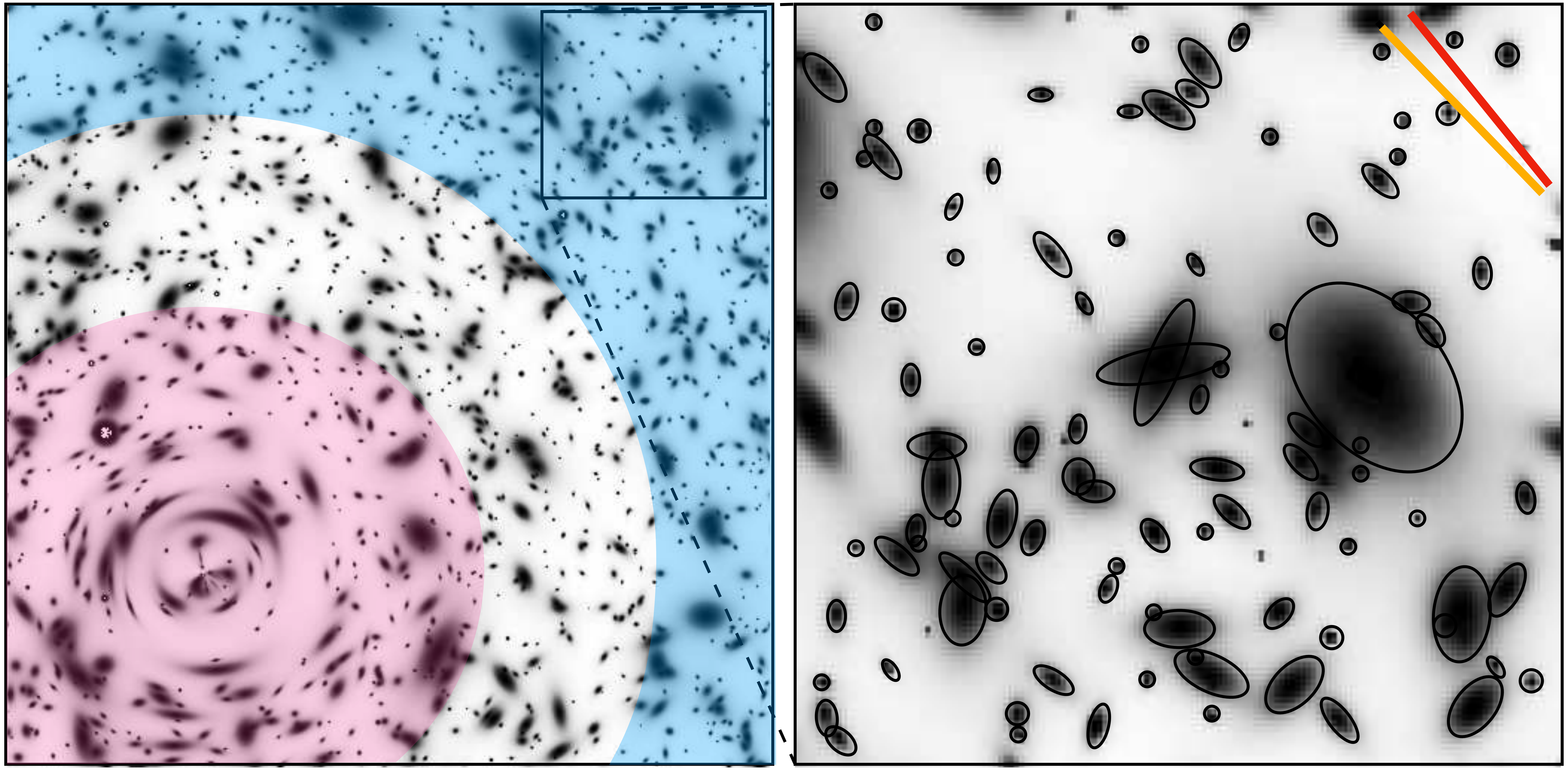


Image credit: Mellier (1999)

Weak Gravitational Lensing

Shear is estimated from average ellipticity

Weak gravitational lensing modifies the observed ellipticities of galaxies:

$$\epsilon = \epsilon^{(s)} + g$$

Per galaxy, the shear g is small. However we can approximate the average shear as being the average ellipticity:

$$\langle \epsilon \rangle = \left\langle \epsilon^{(s)} \right\rangle + \langle g \rangle = \langle g \rangle$$

The assumption of zero average source ellipticity can be violated by, e.g., galaxy intrinsic alignments. In practice this is modelled (more on this later).

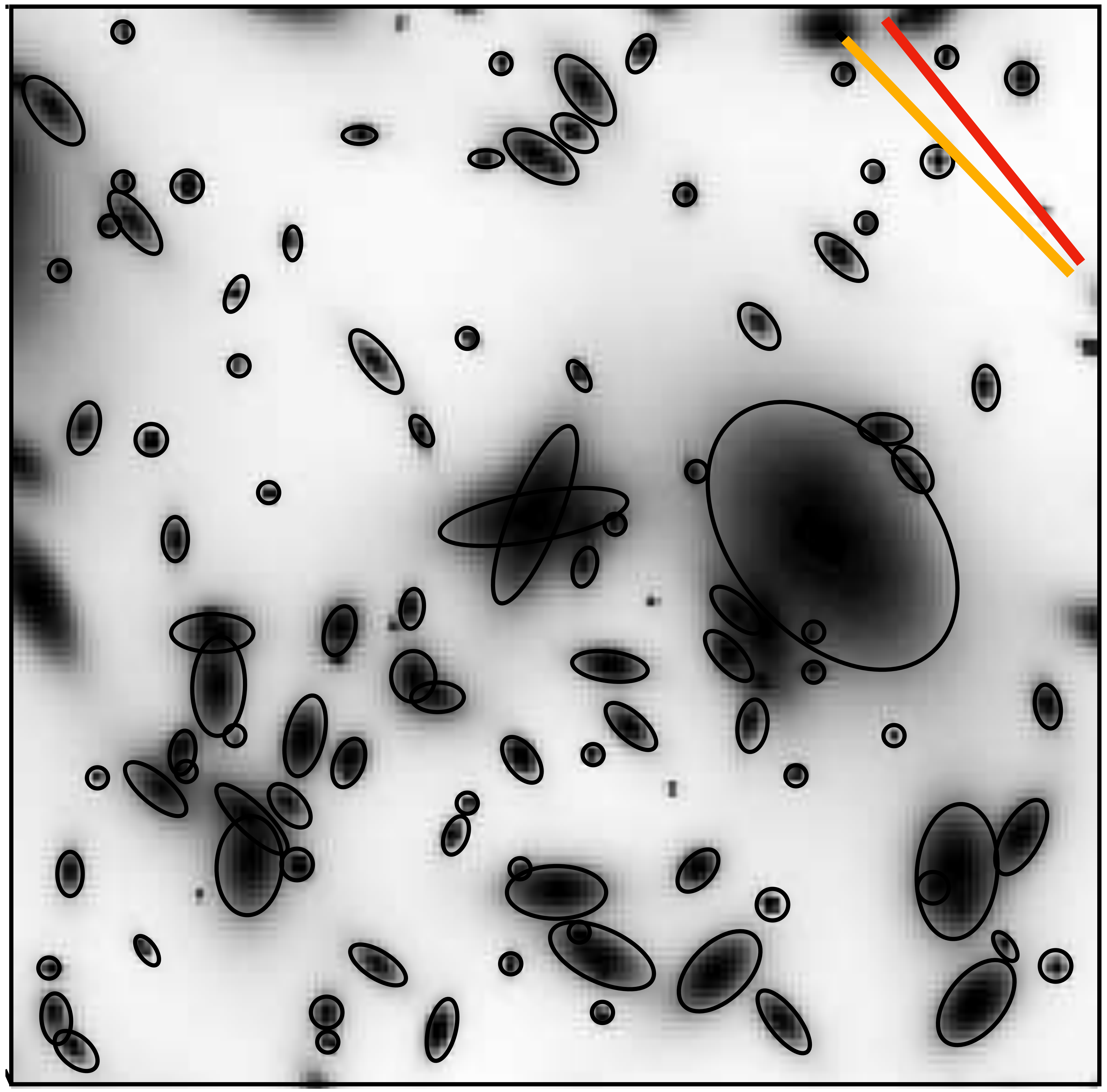
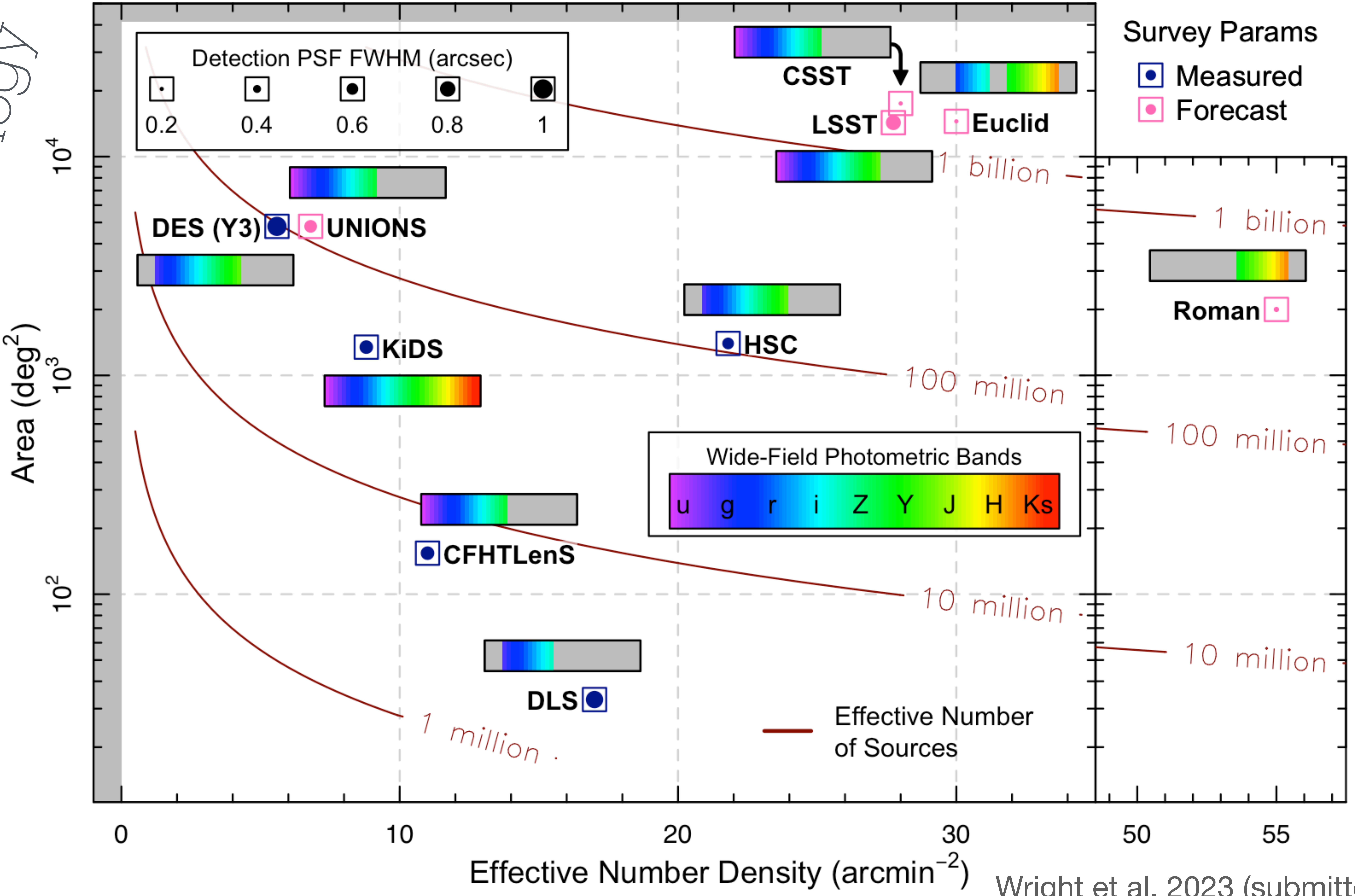


Image credit: Mellier (1999)

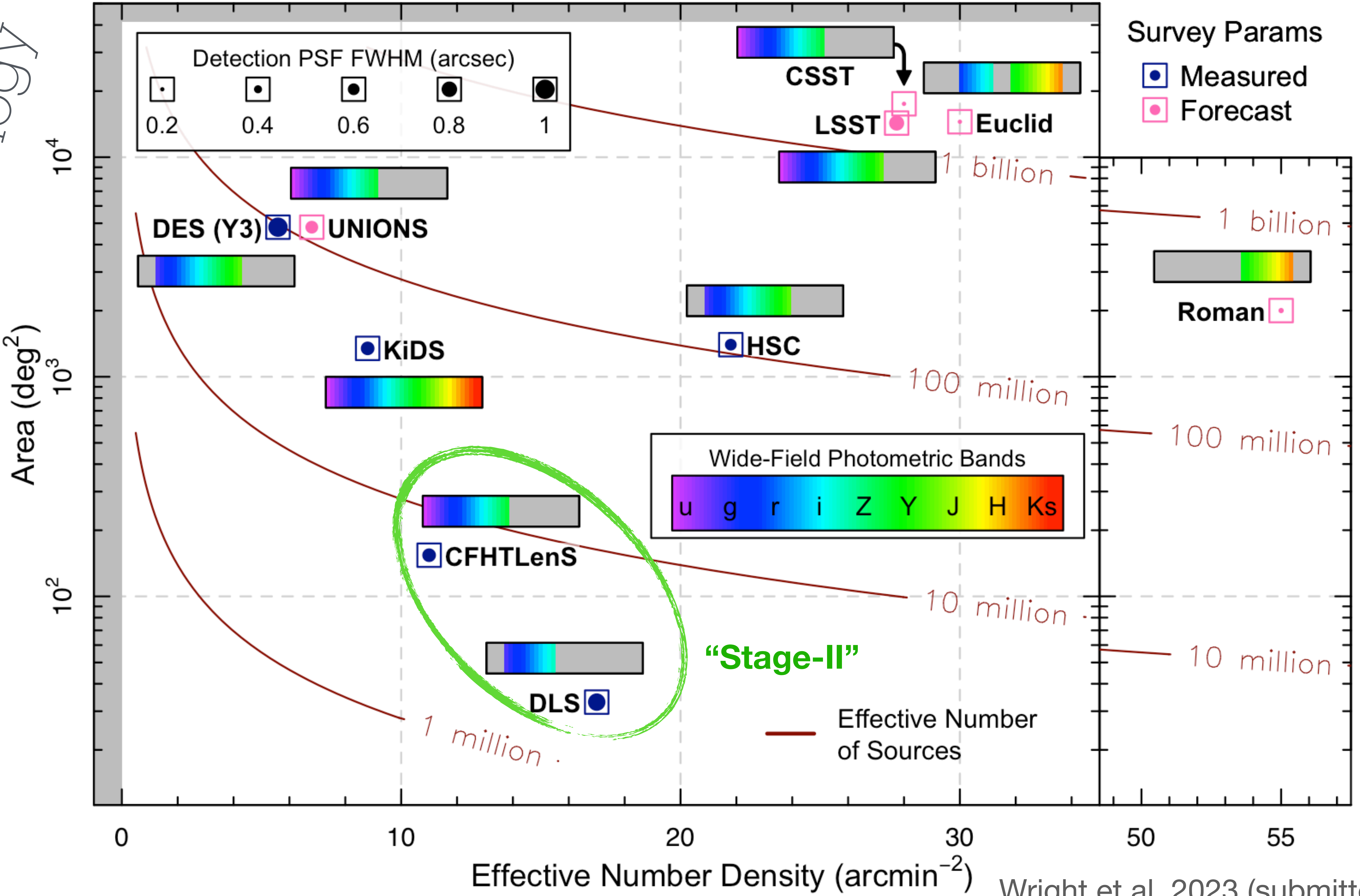
Imaging Surveys for Cosmology

Imaging Surveys for Cosmology



Wright et al. 2023 (submitted)

Imaging Surveys for Cosmology



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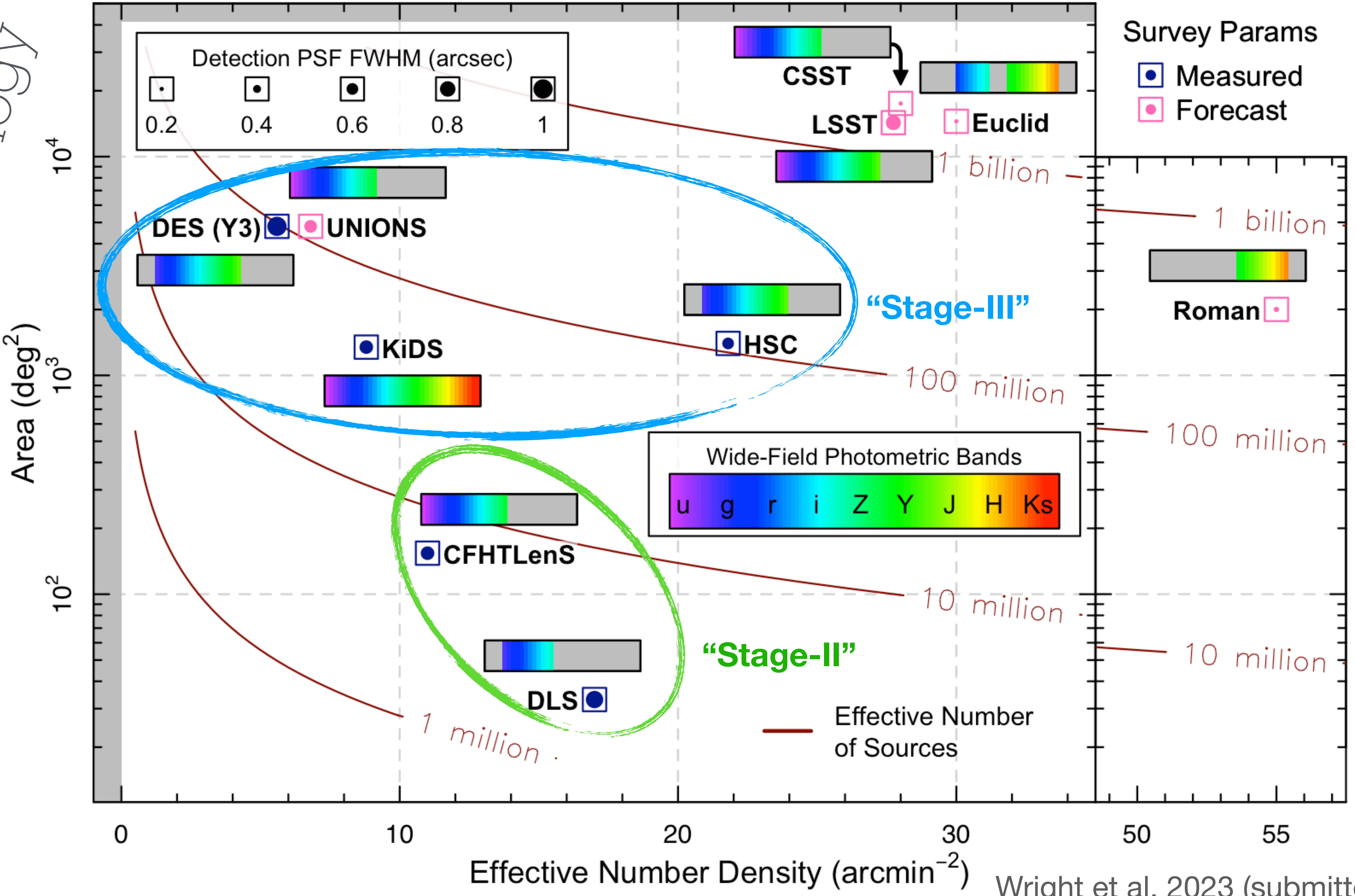
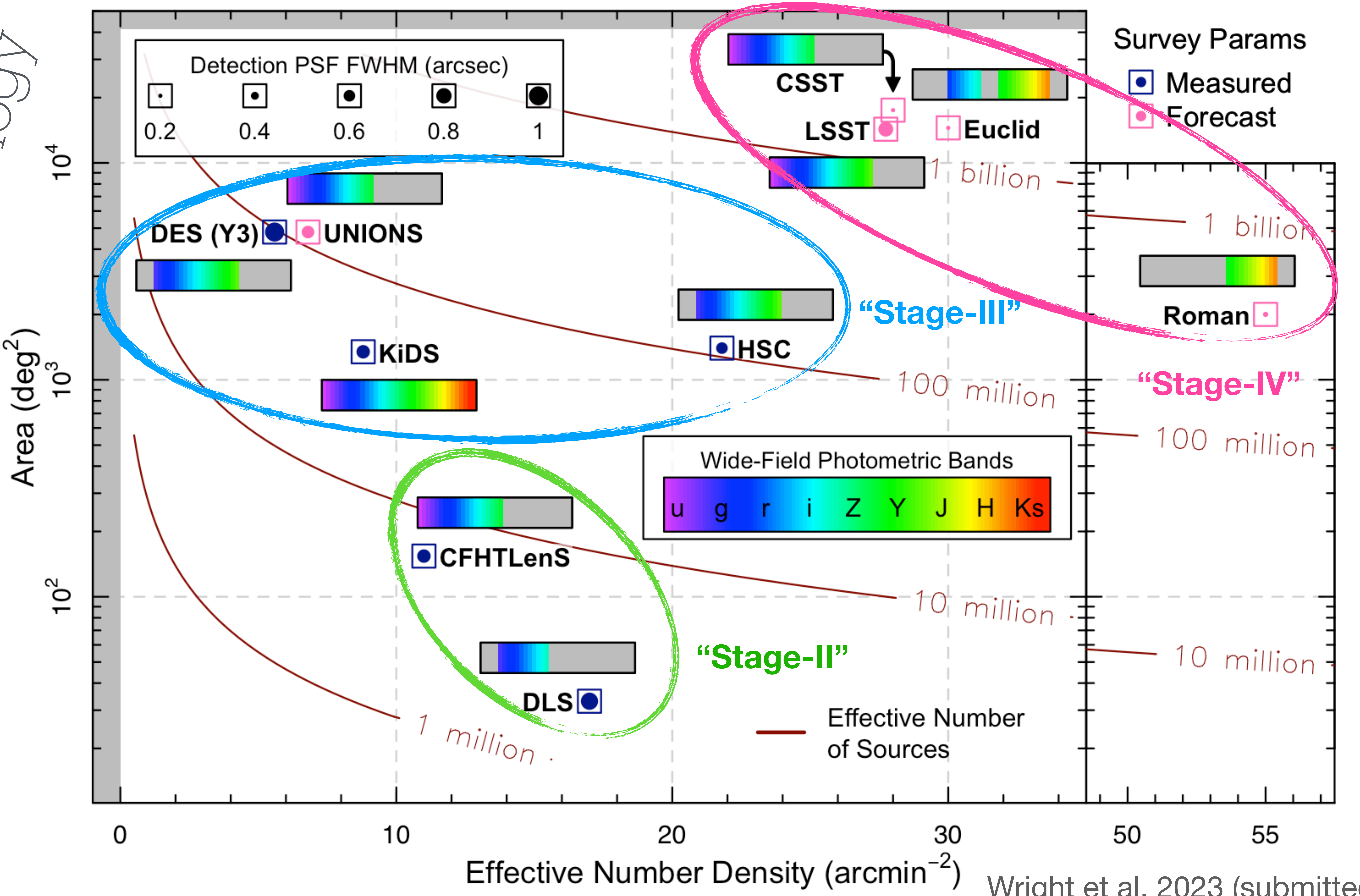
Imaging Surveys for Cosmology



Wright et al. 2023 (submitted)

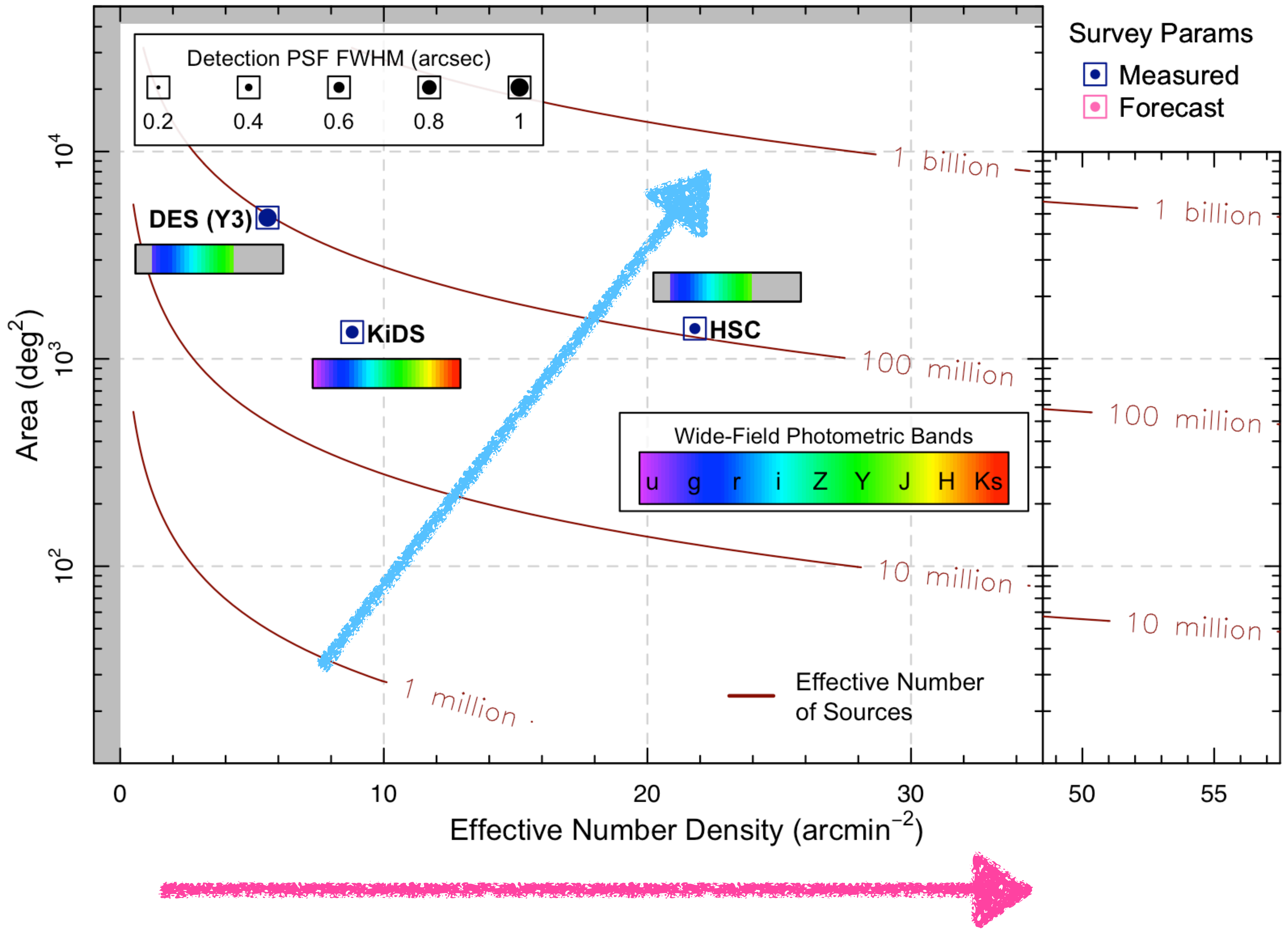
Imaging Surveys for Cosmology



Wright et al. 2023 (submitted)

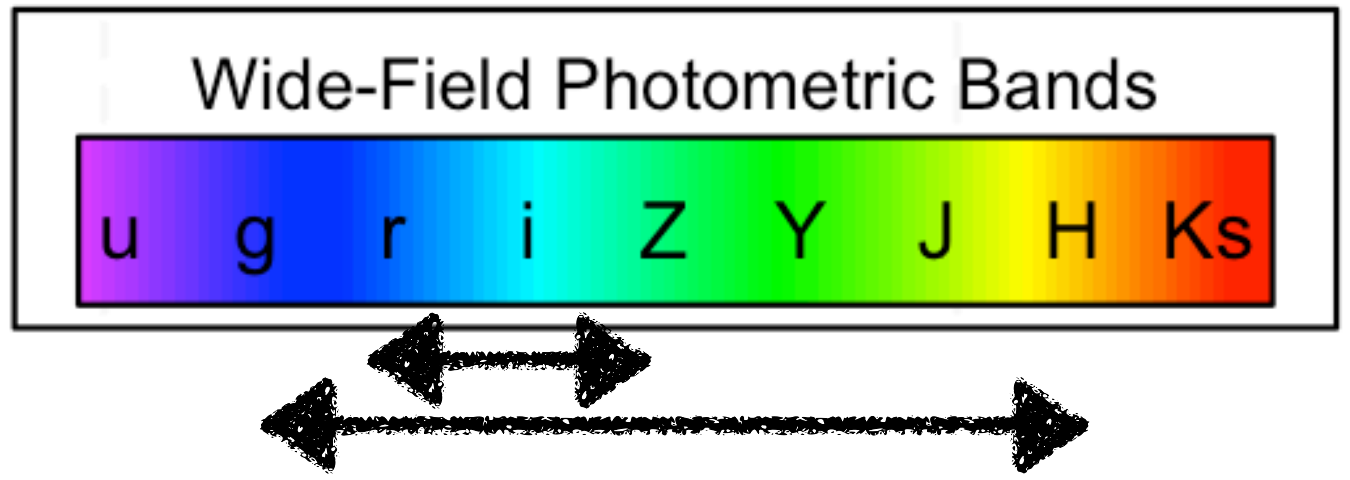
Drivers of cosmological sensitivity

Four main observational considerations

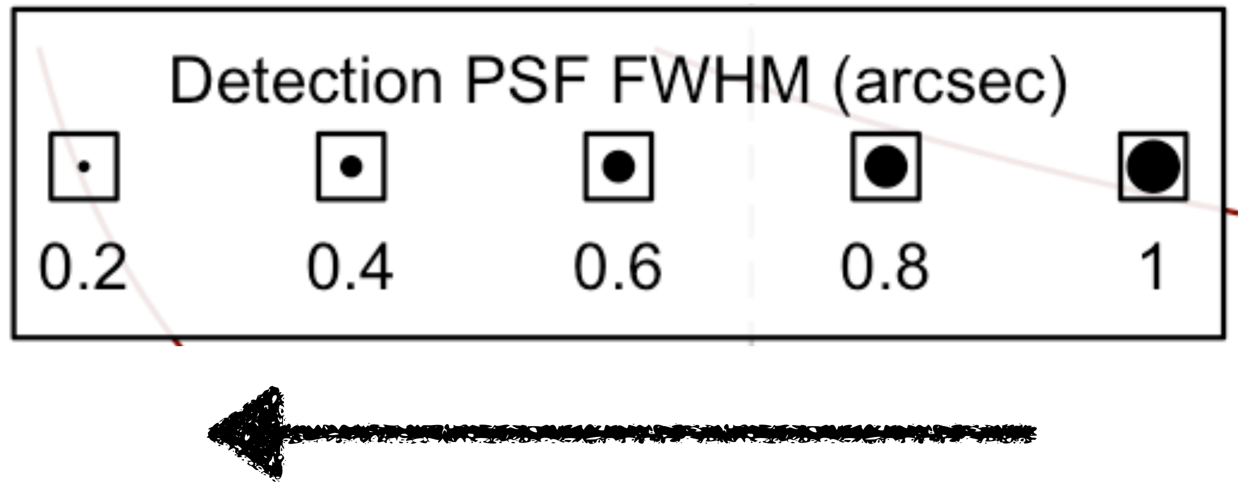


Higher lensing SNR per unit area
Access to higher redshift samples

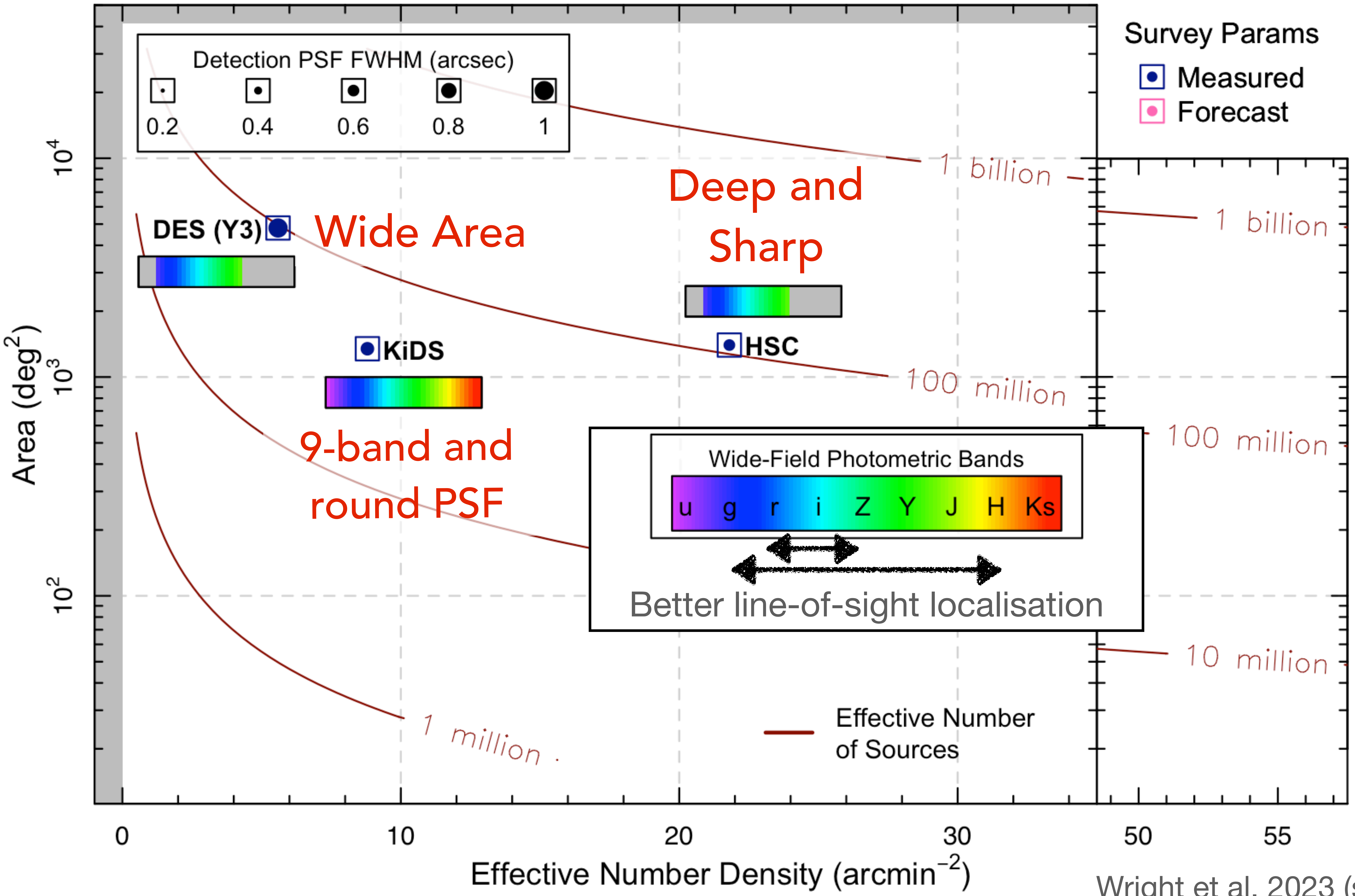
Lower statistical noise



Better line-of-sight localisation

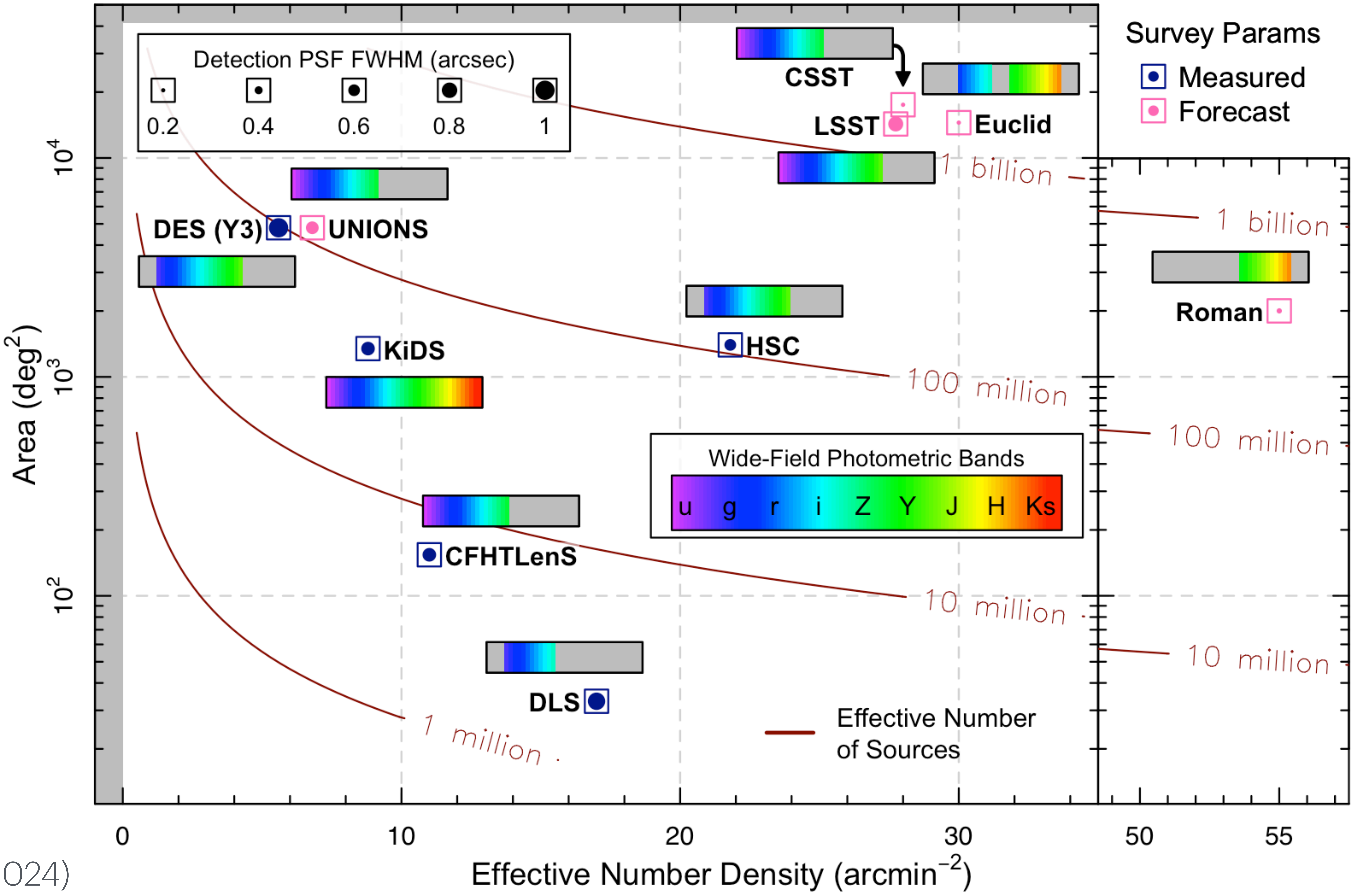


Better shape measurement



Wright et al. 2023 (submitted)

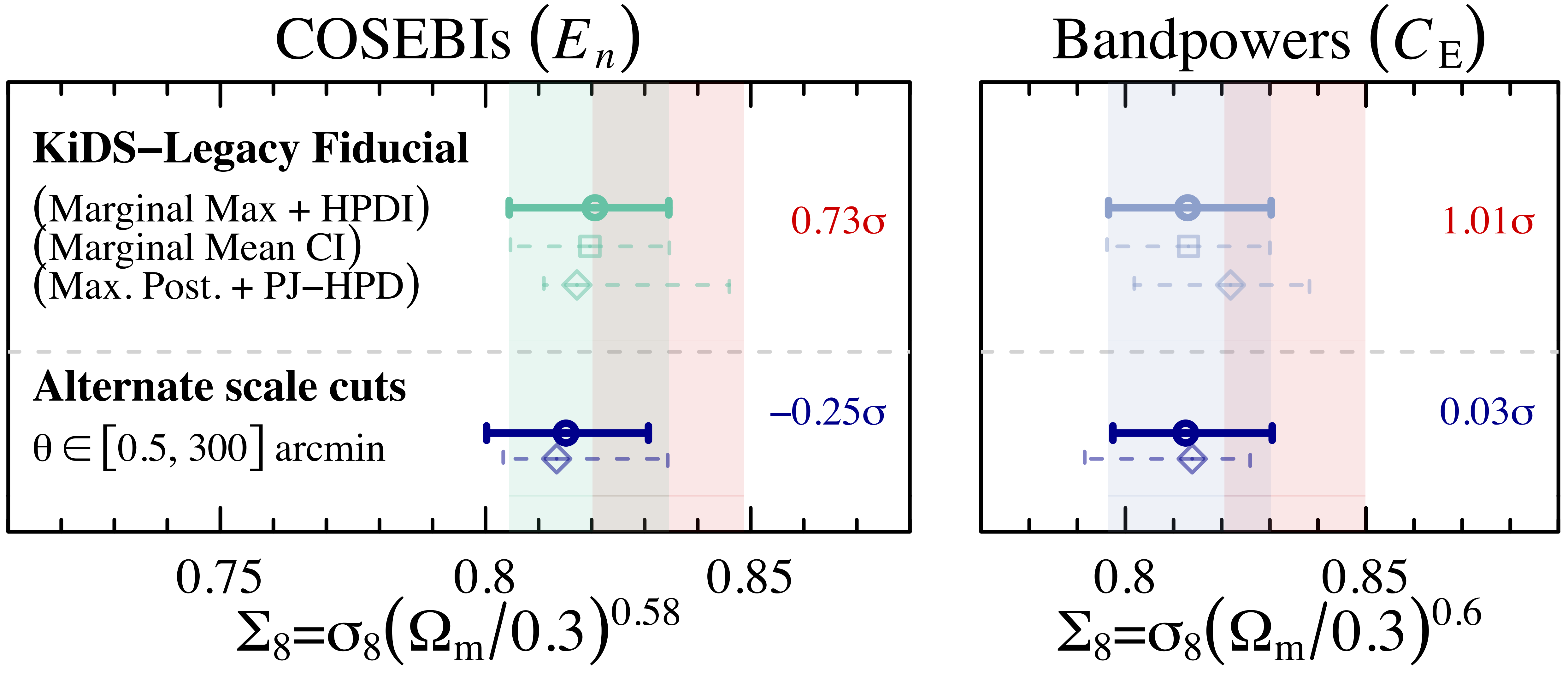
Weak Lensing Surveys

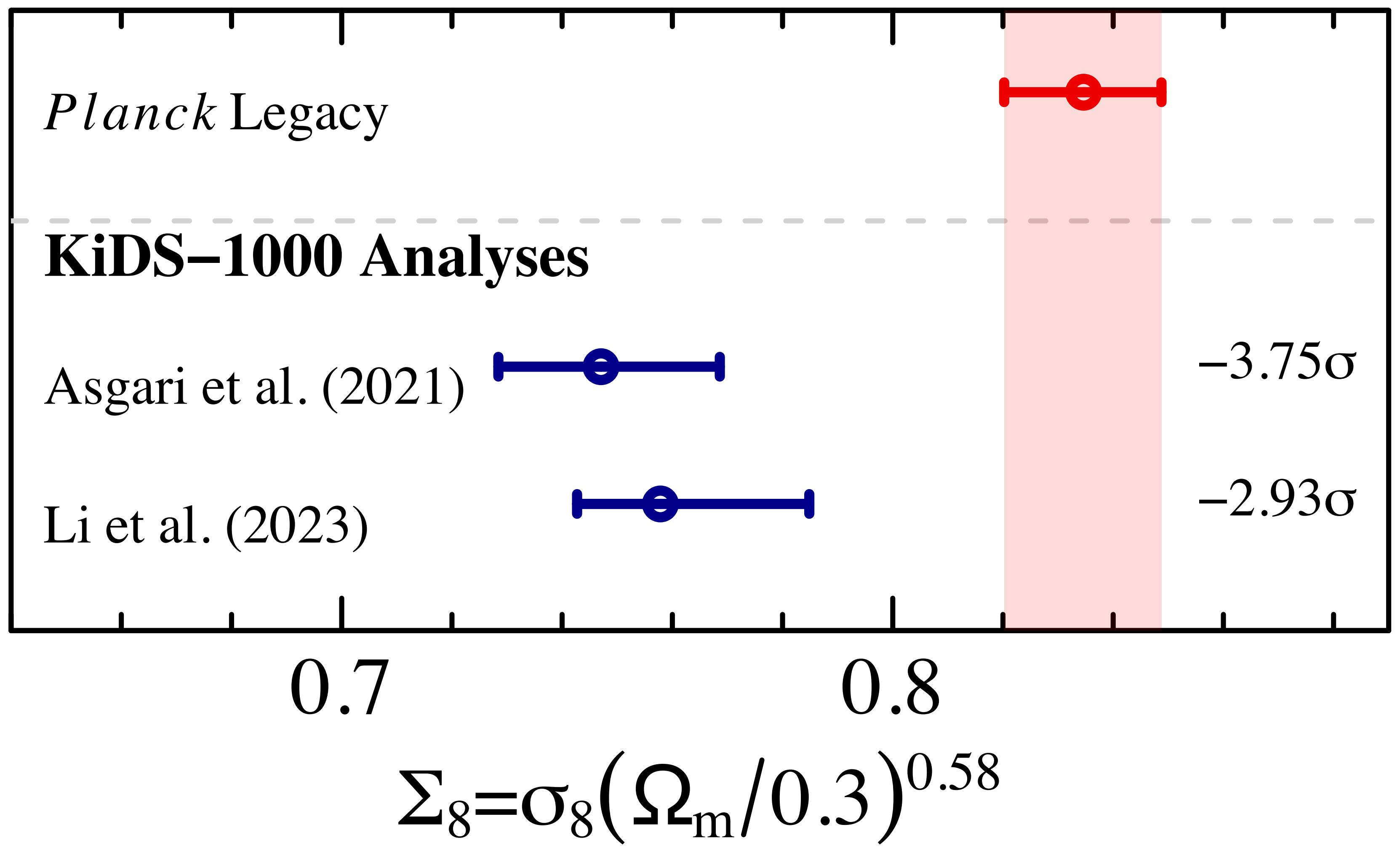


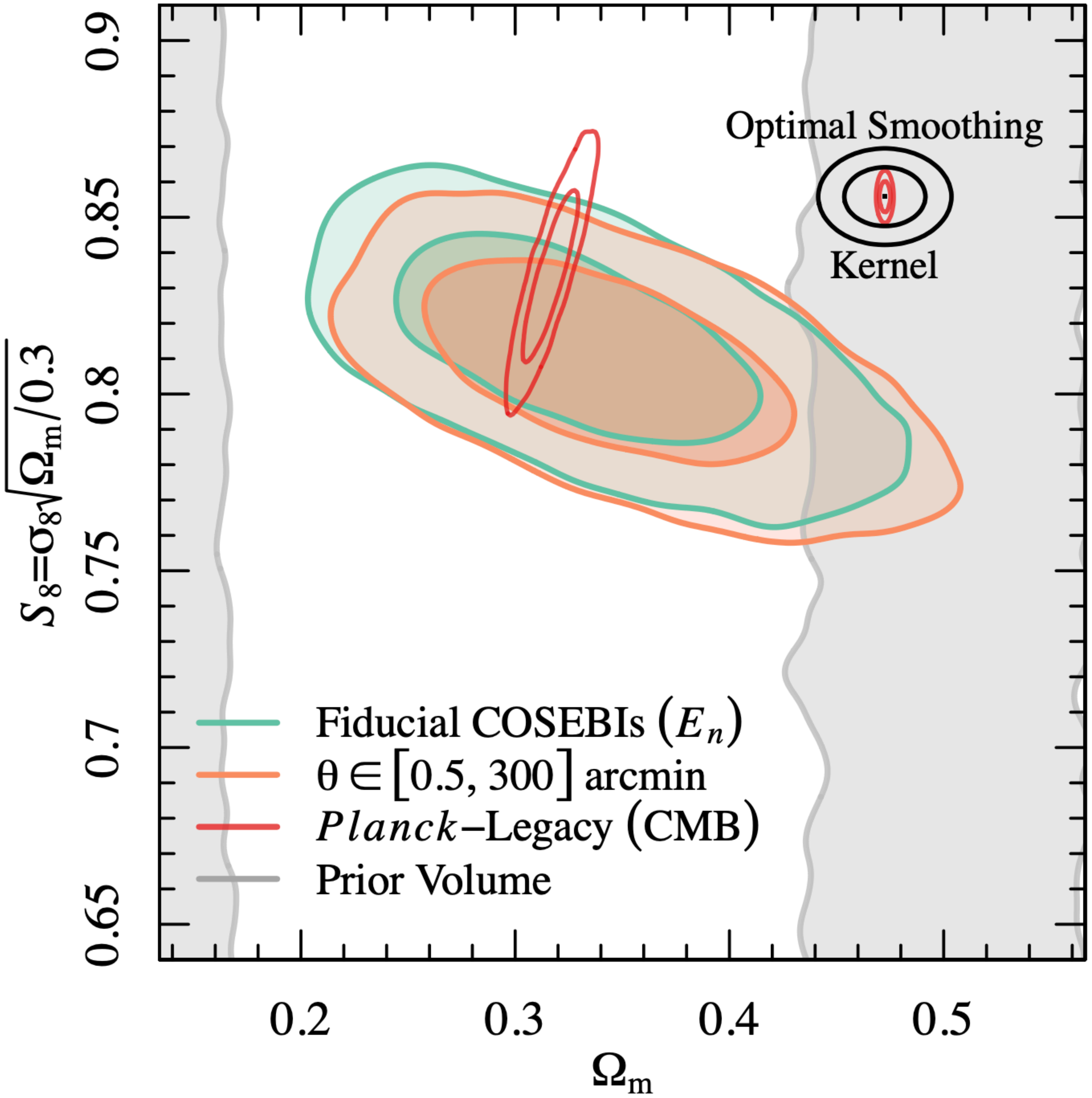
Wright et al. (2024)

KiDS-Legacy cosmological constraints

Impact of scale-cuts







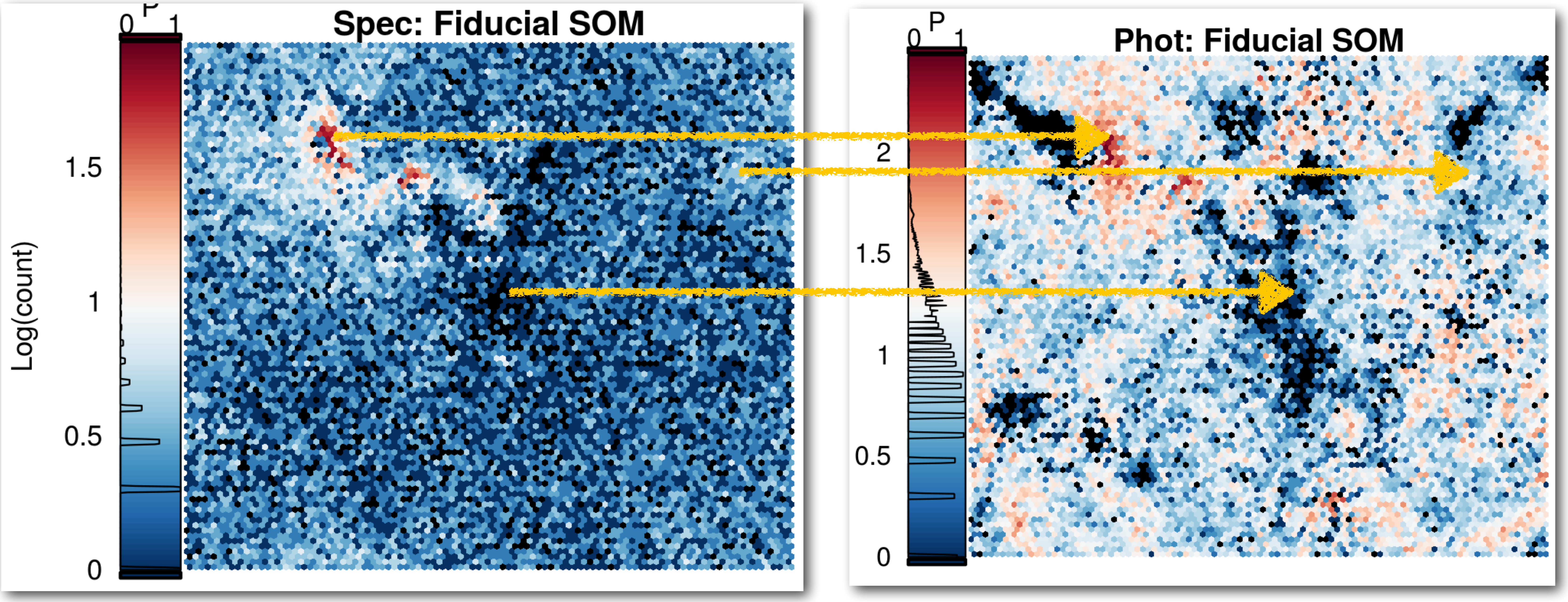
Redshift Distribution Estimation & Calibration

ML Redshift Distribution Calibration

Early work used k-nearest-neighbours. But for the last few years, the cosmic shear community has been caught firmly in the grip of the Self-Organising Map (SOM). This is because SOM gives us both:

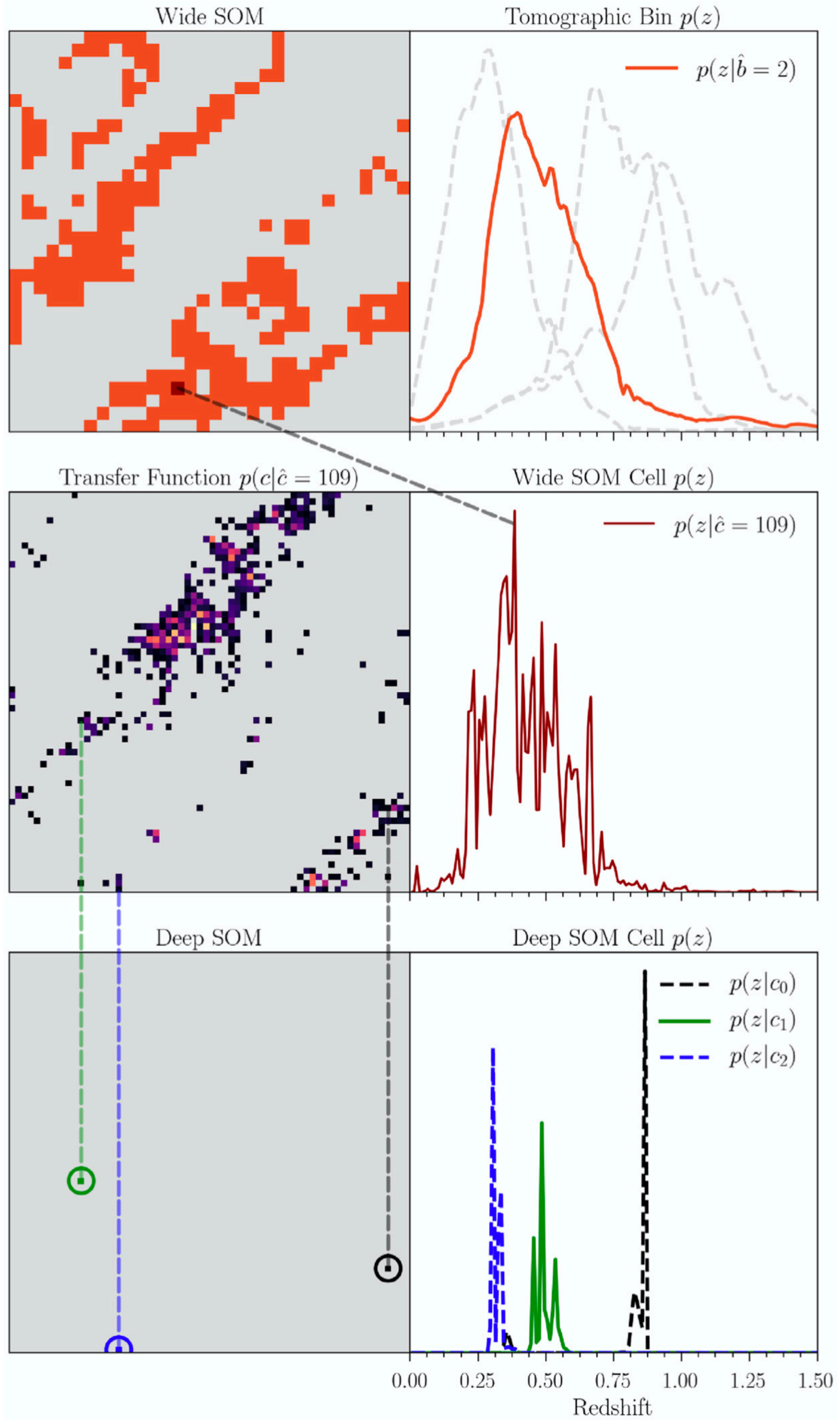
(1) Unsupervised classification &

(2) human-interpretable representations of $\mathbb{R}^n$-spaces



KiDS1000

Wright et at (2020a)



DESY3

Myles et al (2021)

Ways that your ML analysis can fail

There are three classic failure modes in ML regression/classification problems:

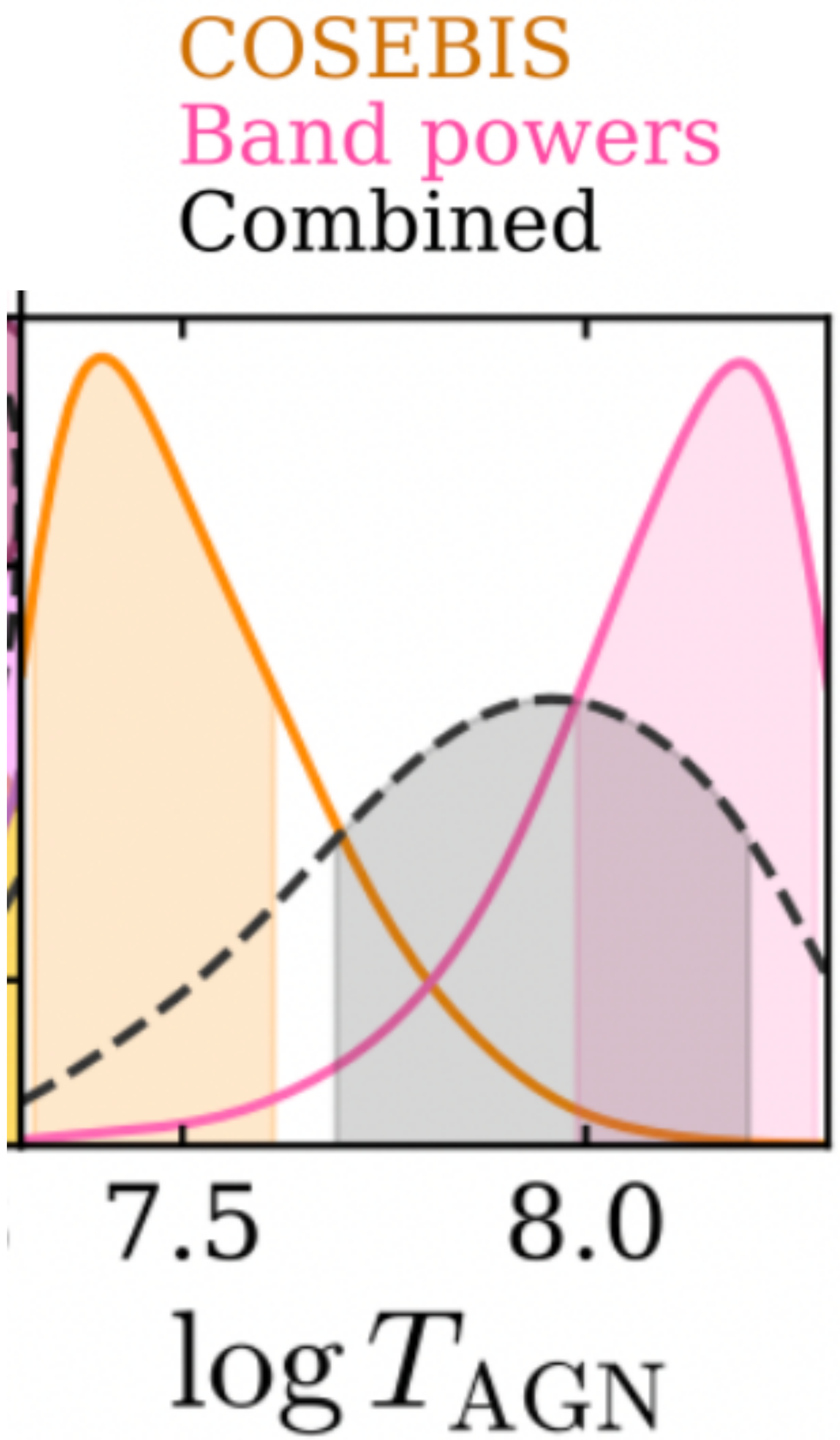
1. **Covariate shift**: $p_{\mathrm{tr}}(z\,|\,c) = p_{\mathrm{tg}}(z\,|\,c)$ & $p_{\mathrm{tr}}(c) \neq p_{\mathrm{tg}}(c)$
2. **Prior Probability shift**: $p_{\mathrm{tr}}(c\,|\,z) = p_{\mathrm{tg}}(c\,|\,z)$ & $p_{\mathrm{tr}}(z) \neq p_{\mathrm{tg}}(z)$
3. **Concept drift**: $p_{\mathrm{tr}}(z\,|\,c) \neq p_{\mathrm{tg}}(z\,|\,c)$

These all affect redshift calibration datasets:

1. Targeting in spectroscopy differs from photometry
2. Redshift success and confidence is systematic
3. SOM cells have non-zero size

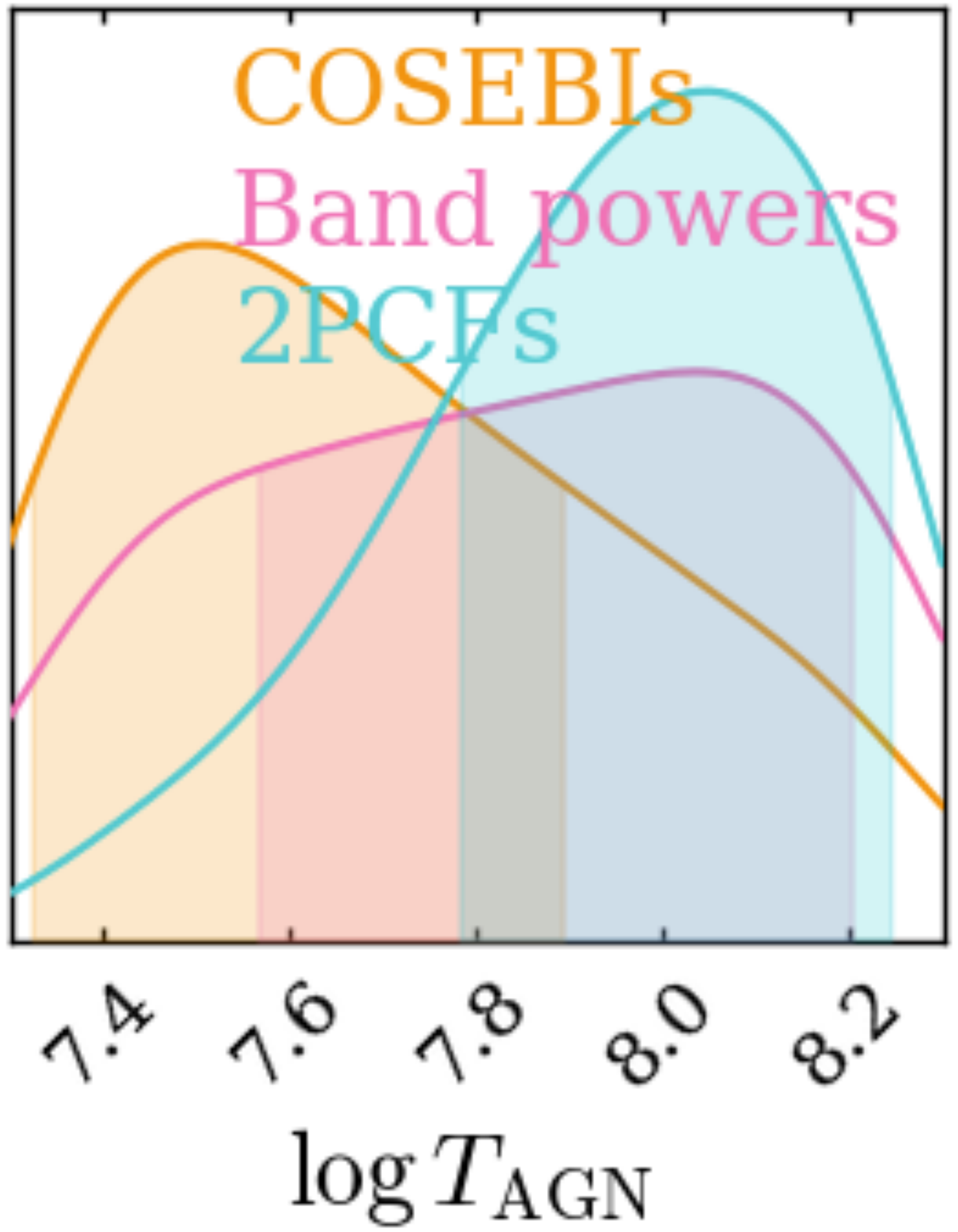
➡ the above effects persist below the cell level

Constraints on $\log T_{\mathrm{AGN}}$ in joint analyses



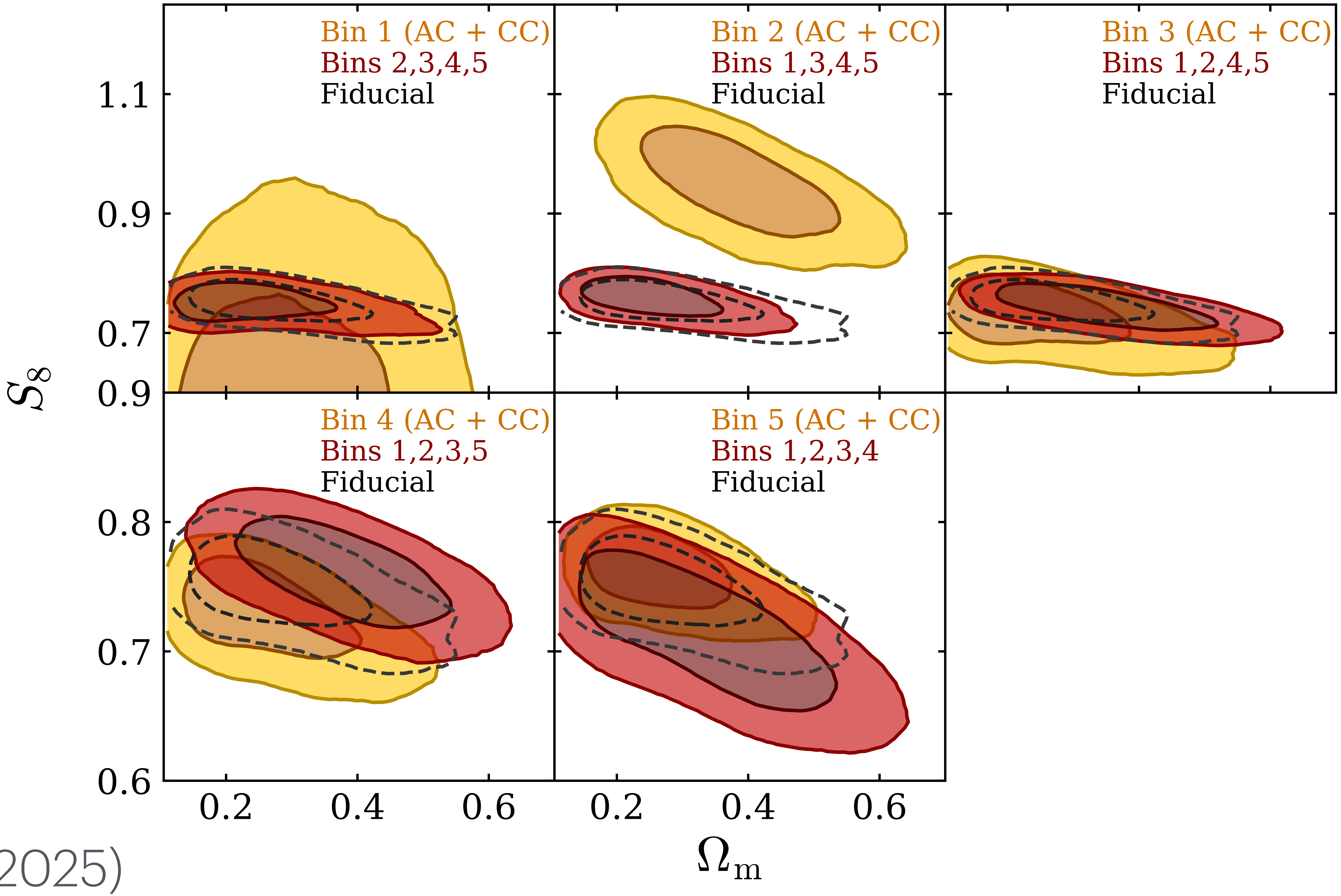
Combined analysis

Individual analyses



Example: Consistency of KiDS-Legacy $N(z)$ Bins

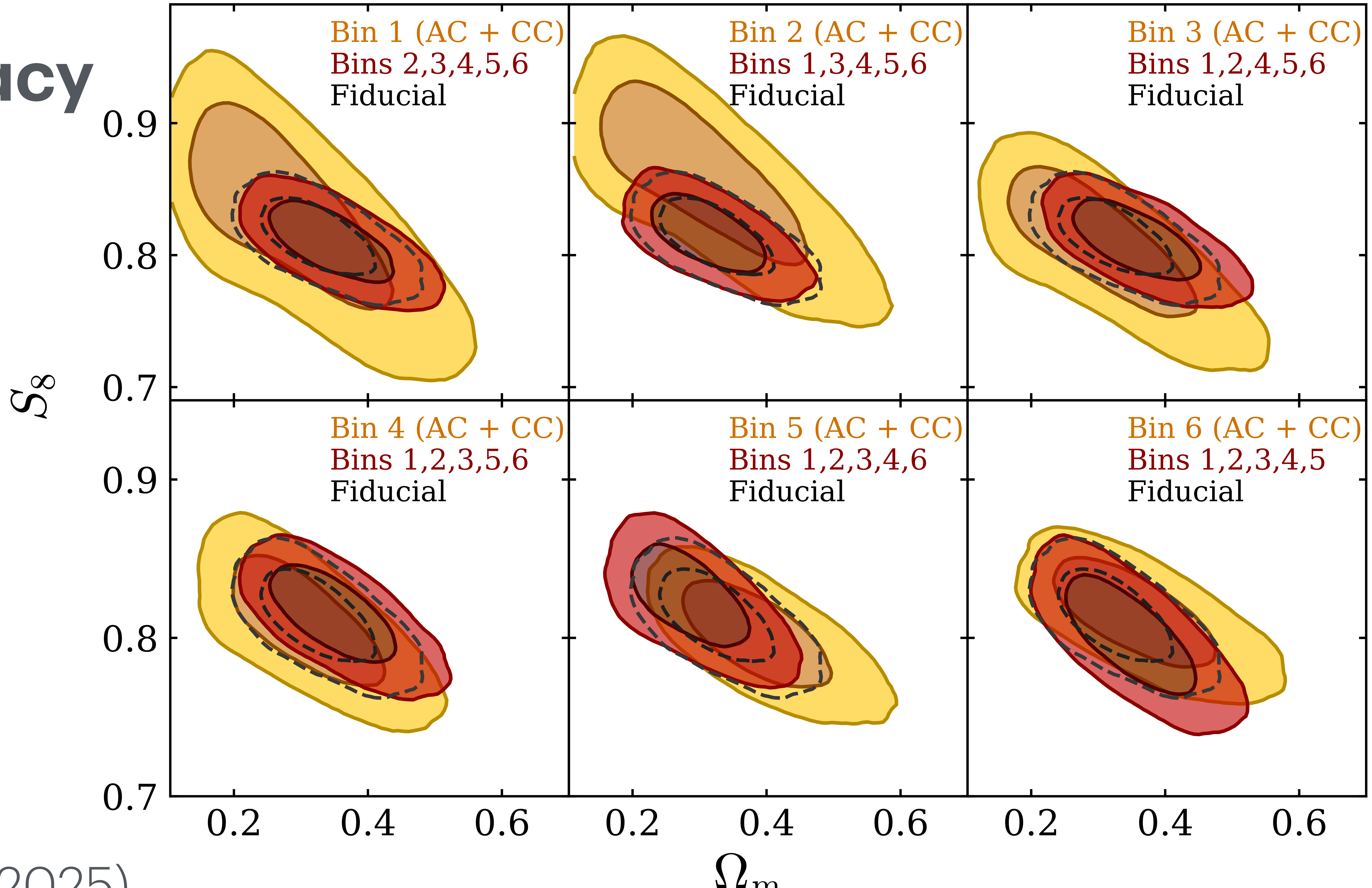
KiDS-1000



Stölzner et al. (2025)

Example: Consistency of KiDS-Legacy $N(z)$ Bins

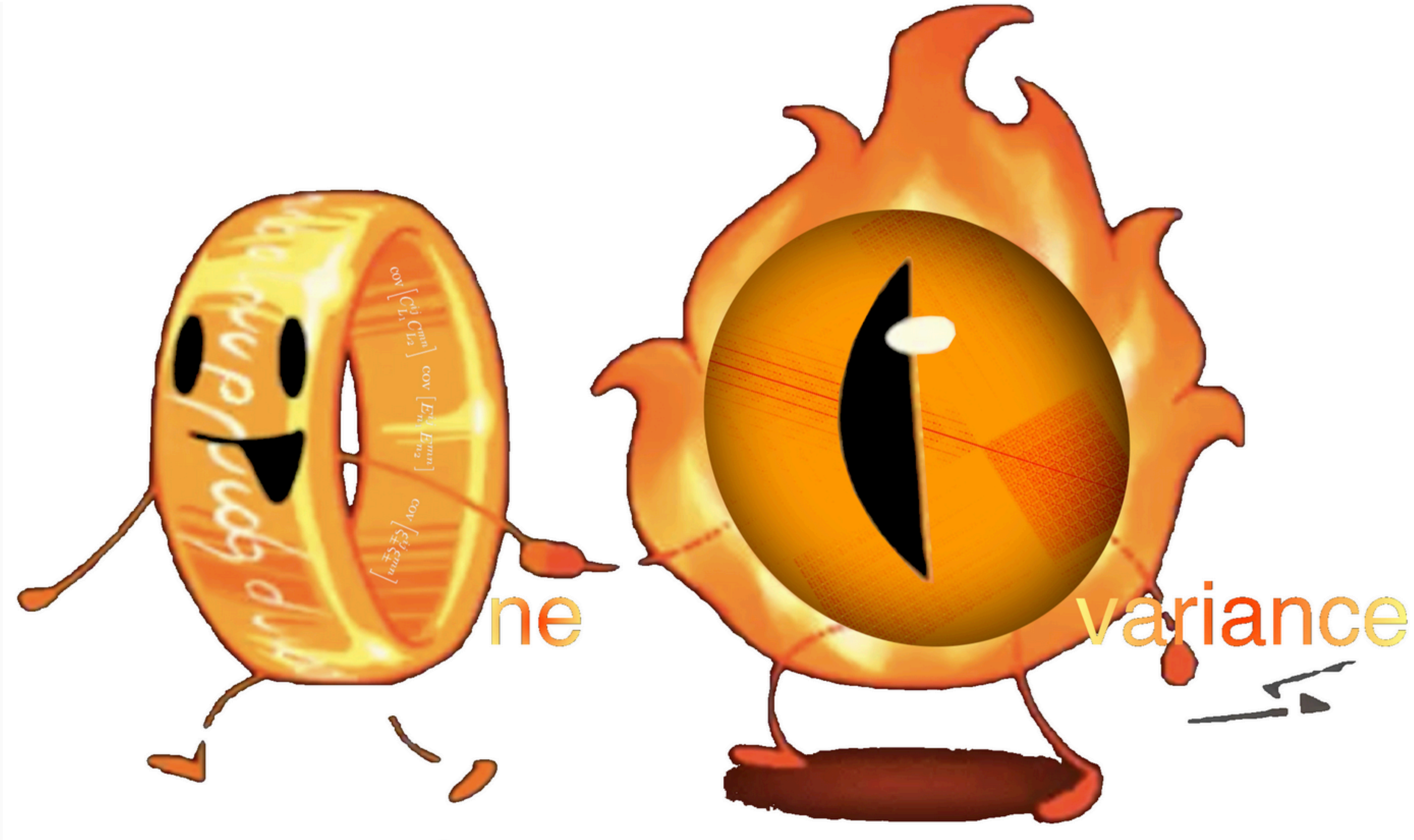
KiDS-Legacy



Stölzner et al. (2025)

Covariance and modelling

Framework for photometric LSS covariances



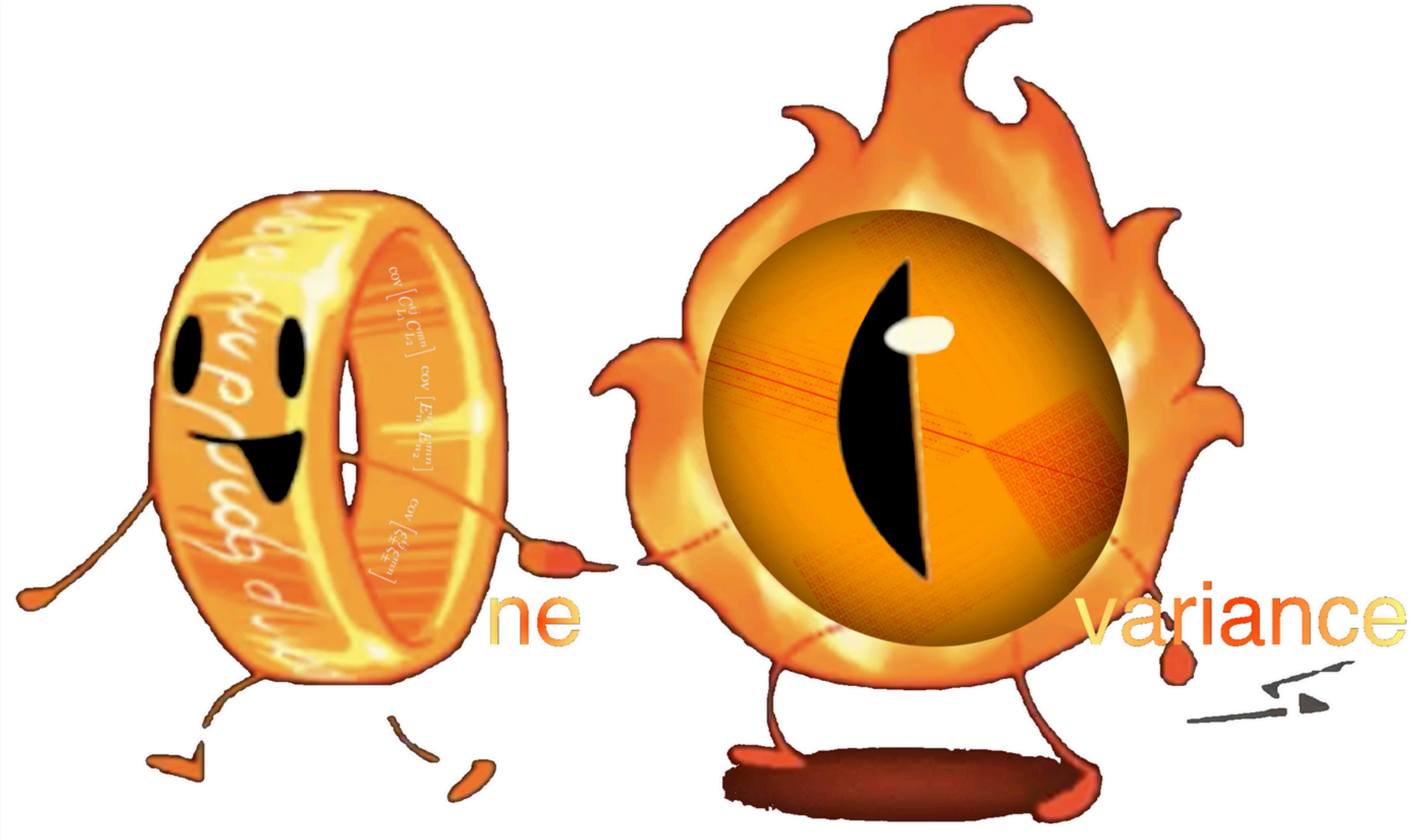
OneCovariance code by KiDS for kids and adults

Reischke et al. (2025)

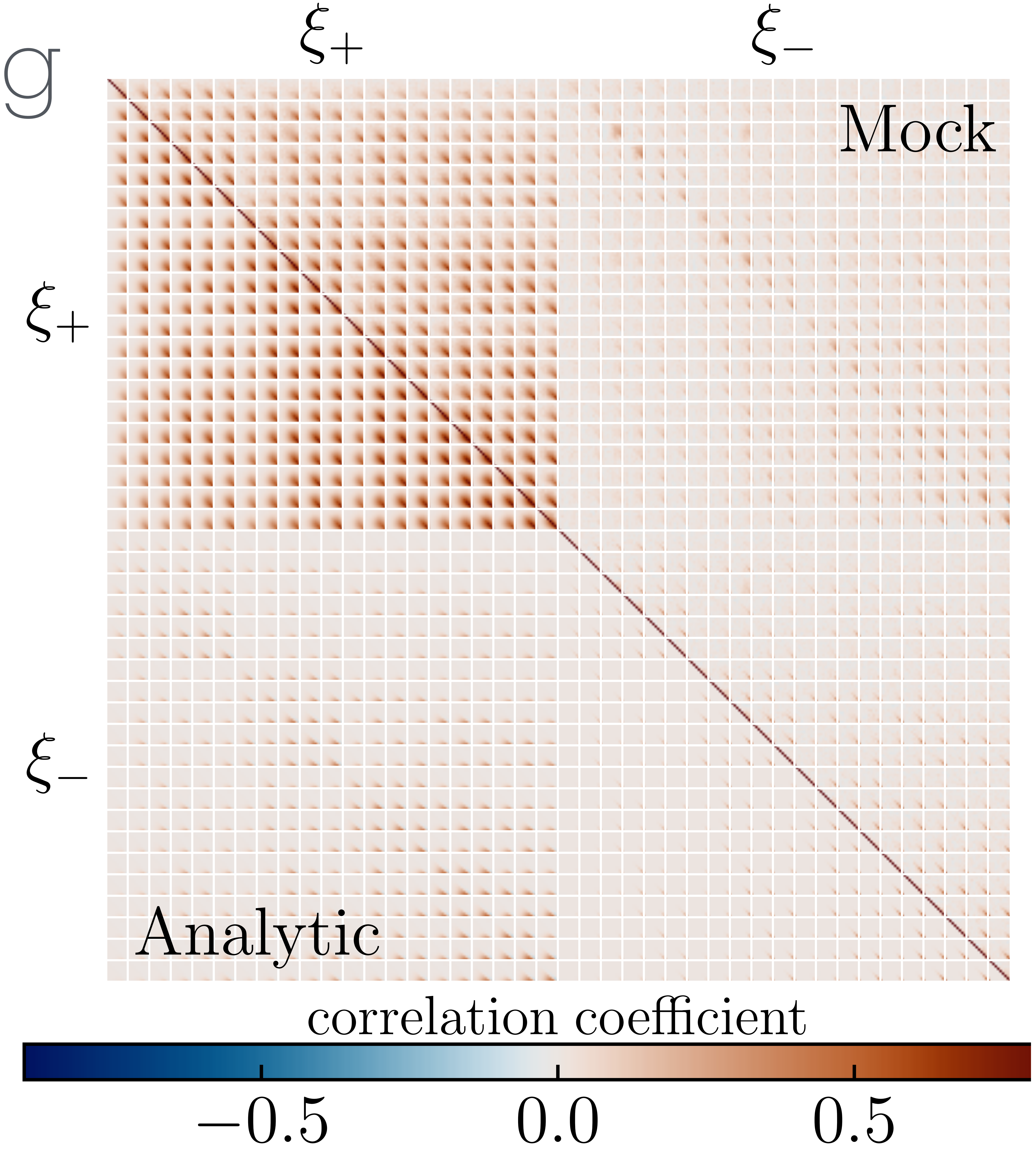
https://github.com/rreischke/OneCovariance

Covariance and modelling

Framework for photometric
LSS covariances



OneCovariance code by KiDS for kids and adults

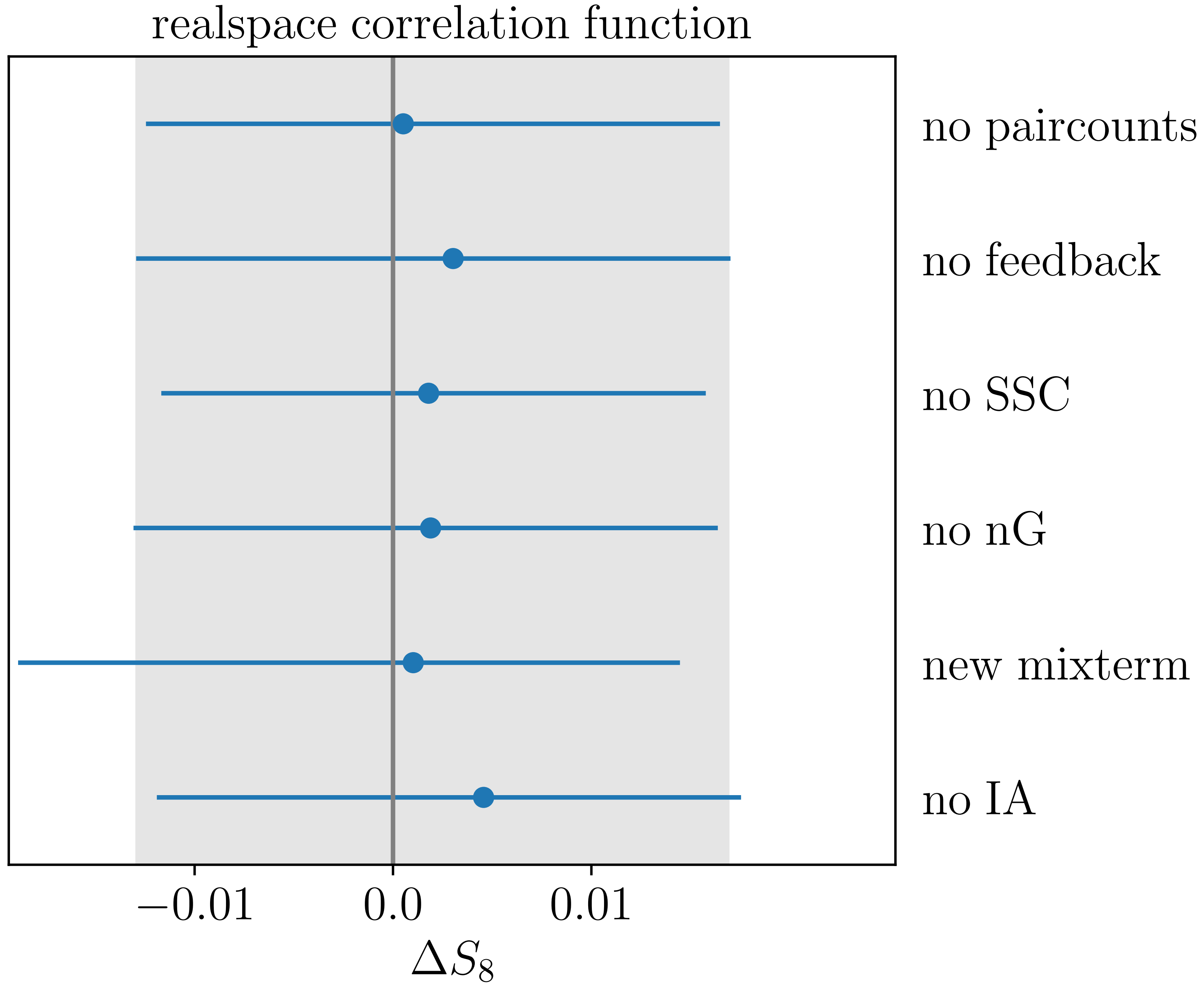


Reischke et al. (2025)

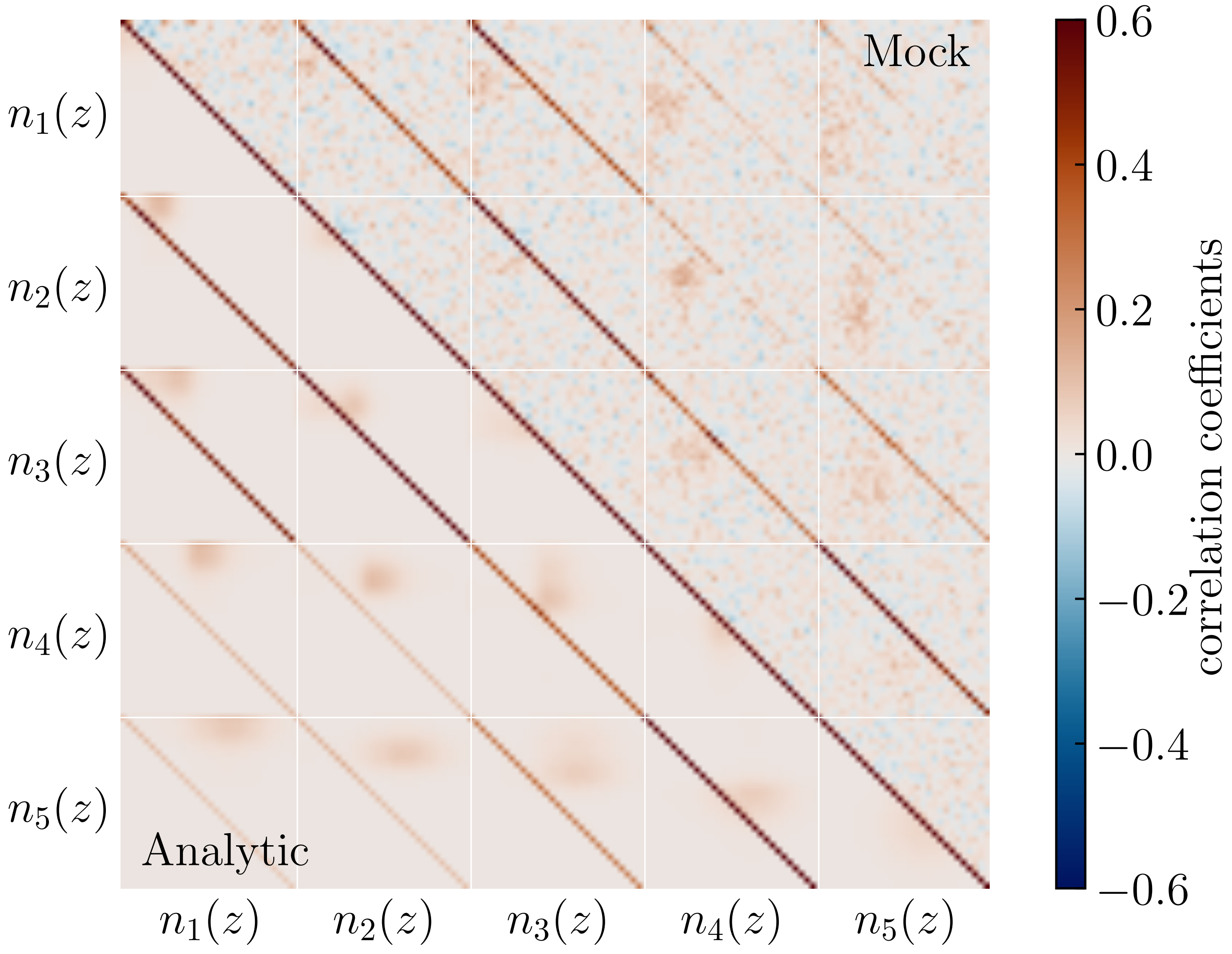
https://github.com/rreischke/OneCovariance

Covariance and modelling

Analytic covariances are good enough for Stage-III



Impact on S_8

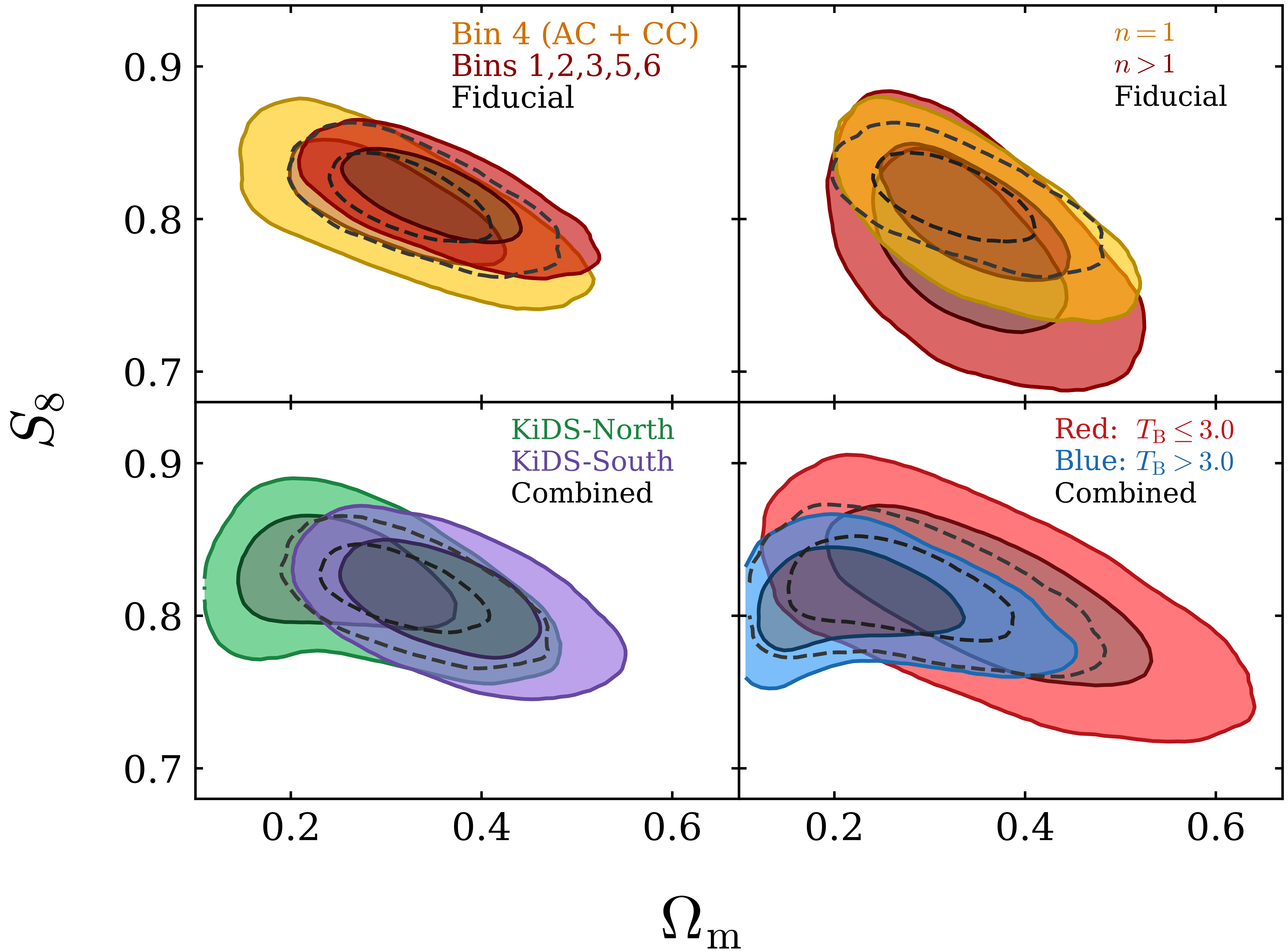


Clustering redshift covariance

Reischke et al. 2025, (2410.06962)
https://github.com/rreischke/OneCovariance

Internal Consistency Constraints

Most robust KiDS analysis to date



Stölzner et al. (2025)

KiDS

P(k) Constraints

Modelling bias of **P(k)** is less than $\mathbf{0.1\sigma}$ of our posterior constraint