KiDS-Legacy

Cosmic shear results from the complete Kilo-Degree Survey

Benjamin Stölzner
on behalf of all KiDS members

21st Rencontres du Vietnam on Cosmology

13th August 2025

GCCL GERMAN CENTRE FOR COSMOLOGICAL LENSING
RUHR UNIVERSITÄT BOCHUM
RUB KiDS

KiDS-Legacy

Cosmic shear results from the complete Kilo-Degree Survey

Wright, Stölzner et al. 2025:

"KiDS-Legacy: Cosmological constraints from cosmic shear with the complete Kilo-Degree Survey"

Stölzner, Wright et al. 2025:

"KiDS-Legacy: Consistency of cosmic shear measurements and joint cosmological constraints with external probes"

13th August 2025

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Kilo-Degree Survey

Image credit: ESO

KiDS

Kilo-Degree Survey

Image credit: ESO

- ESO survey, specifically designed for weak lensing science

KiDS

Kilo-Degree Survey

Image credit: ESO

- ESO survey, specifically designed for weak lensing science
- Covering 1347 deg^2 in four photometric bands

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Kilo-Degree Survey

Image credit: ESO

- ESO survey, specifically designed for weak lensing science
- Covering 1347 deg^2 in four photometric bands
- Partner survey VIKING provides five near-infrared bands

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Kilo-Degree Survey

Image credit: ESO

- ESO survey, specifically designed for weak lensing science
- Covering 1347 deg^2 in four photometric bands
- Partner survey VIKING provides five near-infrared bands
- Median r-band 5σ limiting magnitude: 24.8
- Median seeing: 0.7”

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Kilo-Degree Survey

Image credit: KiDS team

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KiDS-Legacy publications

- The fifth data release of the Kilo Degree Survey: Multi-epoch optical/NIR imaging covering wide and legacy-calibration fields (arXiv:2503.19439)
- **KiDS-Legacy: Cosmological constraints from cosmic shear with the complete Kilo-Degree Survey (arXiv:2503.19441)**
- **KiDS-Legacy: Consistency of cosmic shear measurements and joint cosmological constraints with external probes (arXiv:2503.19442)**
- KiDS-Legacy: Covariance validation and the unified OneCovariance framework for projected large-scale structure observables (arXiv:2410.06962)
- KiDS-Legacy: Redshift distributions and their calibration (arXiv:2503.19440)
- KiDS-Legacy calibration: Unifying shear and redshift calibration with the SKiLLS multi-band image simulations (arXiv:2210.07163)
- KiDS-Legacy: Angular galaxy clustering from deep surveys with complex selection effects (arXiv:2410.23141)

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Weak Lensing

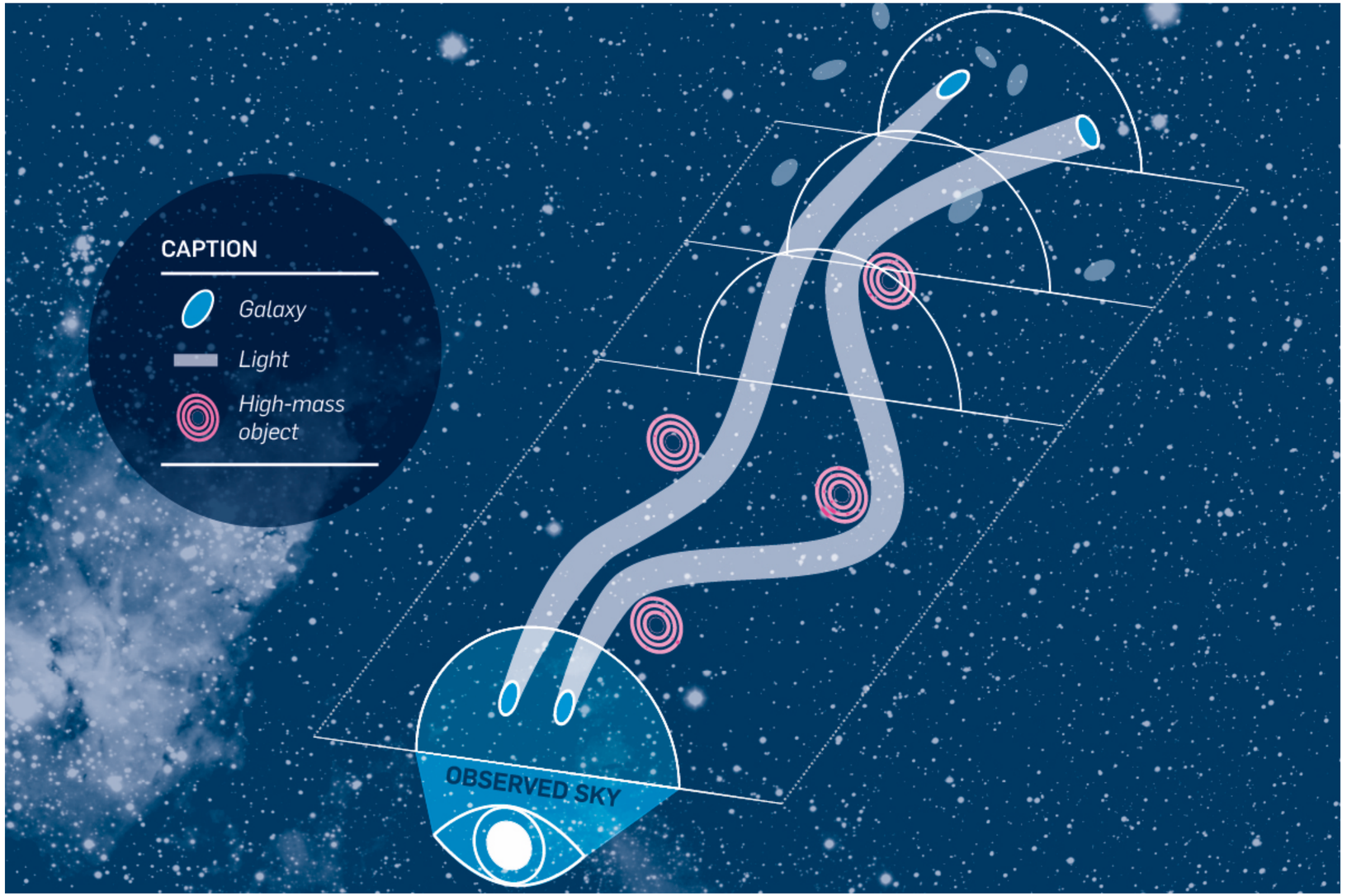

Image credit: RUB

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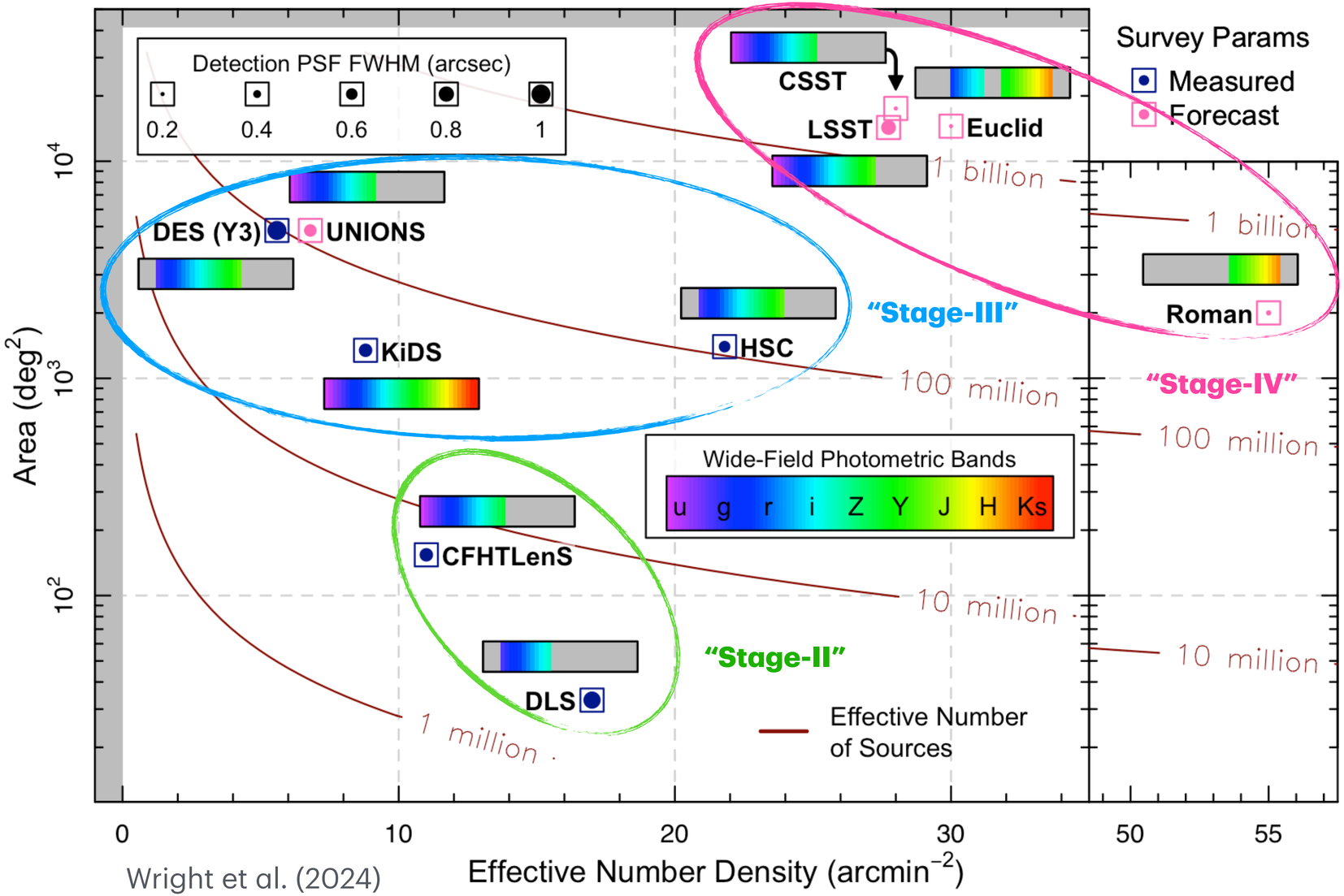
Imaging Surveys for cosmology



Wright et al. (2024)

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Kilo-Degree Survey data release 5

Developments since DR4

Kilo-Degree Survey data release 5

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- More area (**generally useful**)

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- Improved astrometric and photometric calibrations (**better shapes & photo-z**)

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- NIR Imaging releases (**enables more sophisticated photo-z**)

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<u>Particular Focus on Legacy benefits of our data & analysis pipelines</u>

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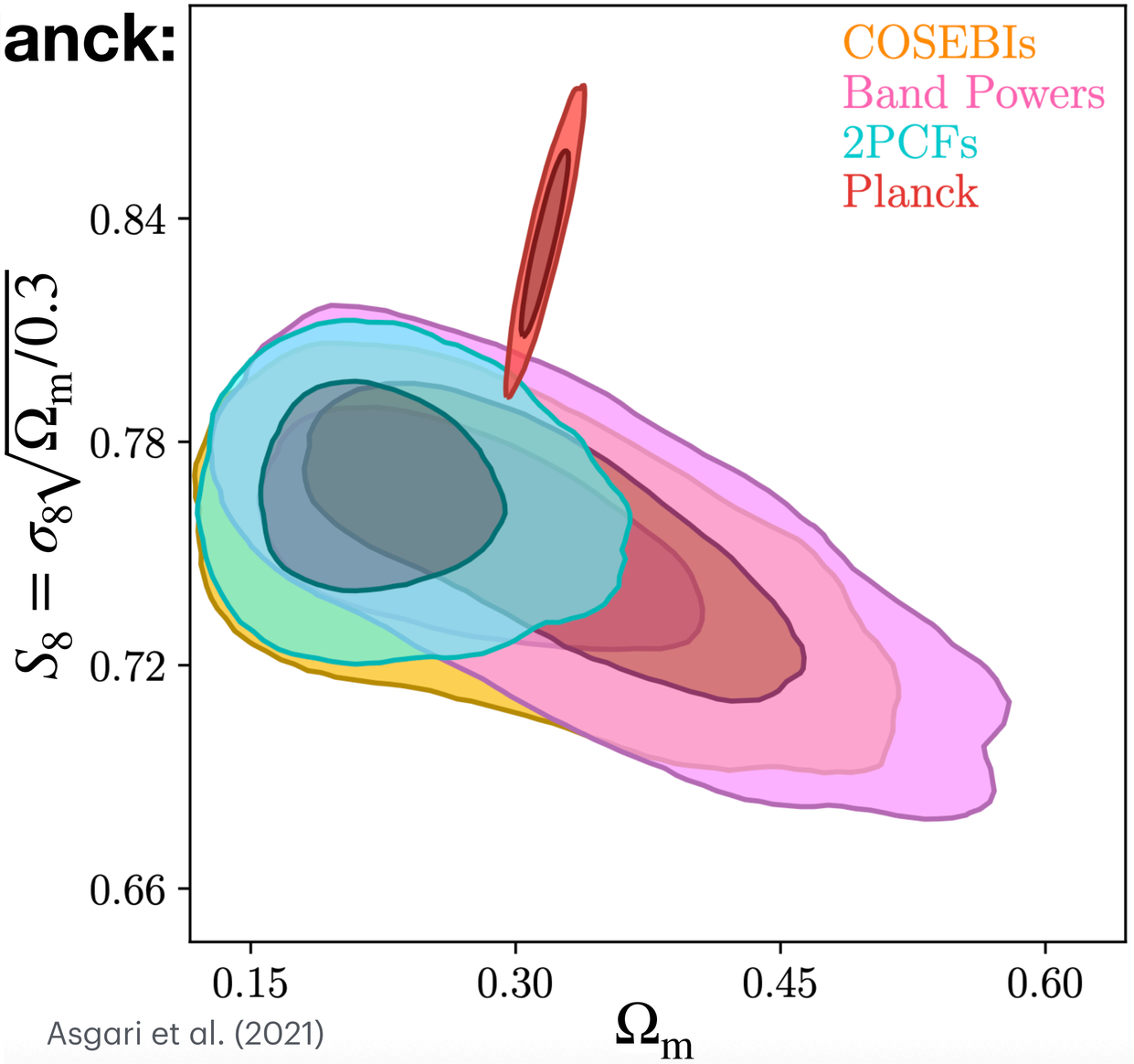
Cosmological constraints

KiDS

KiDS-1000

Tension with Planck:

$N_\sigma \approx 3$



Asgari et al. (2021)

Cosmological constraints

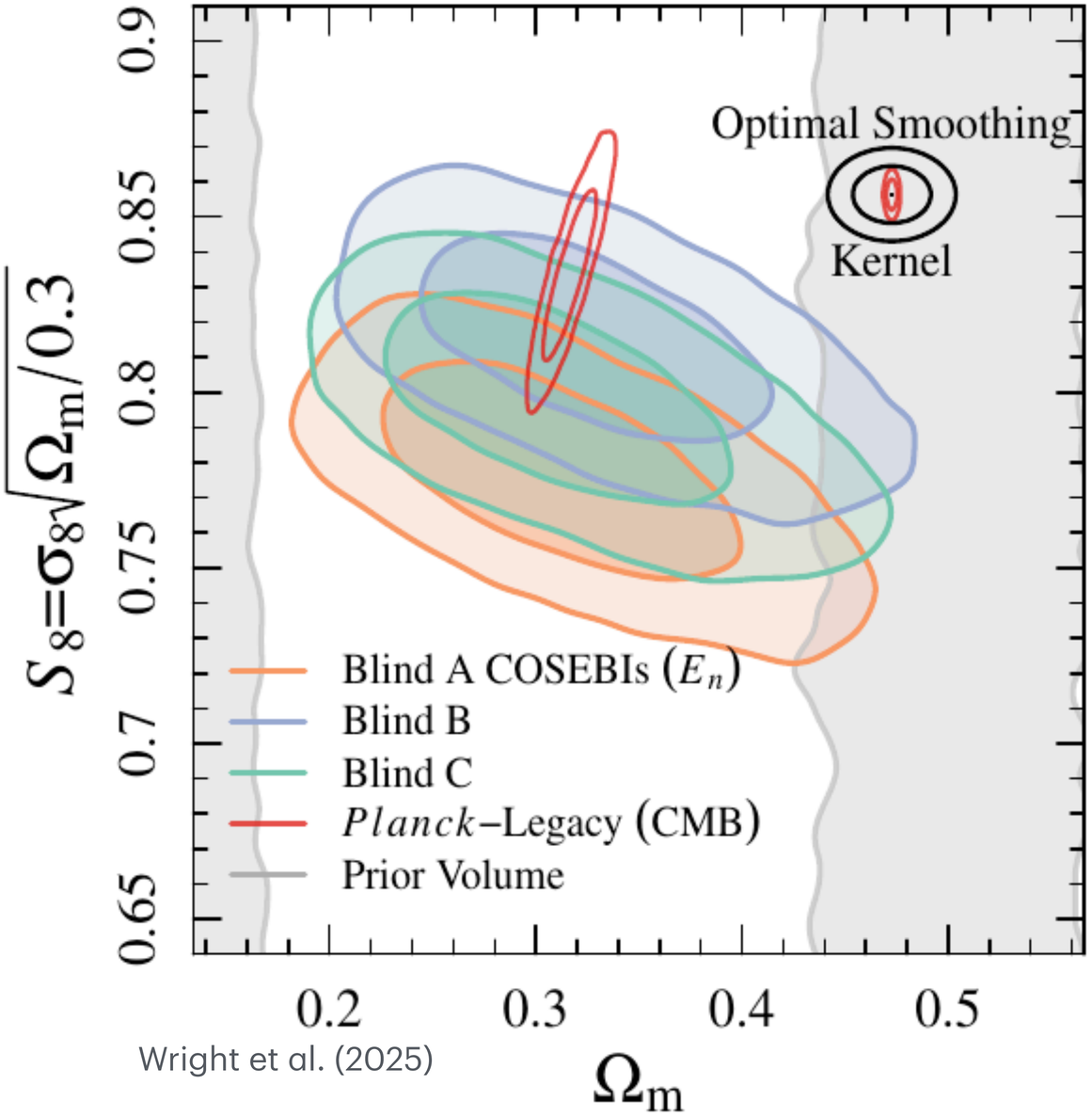
Blinded results

Tension with Planck:

Blind A: $N_\sigma = 2.72$

Blind B: $N_\sigma = 0.73$

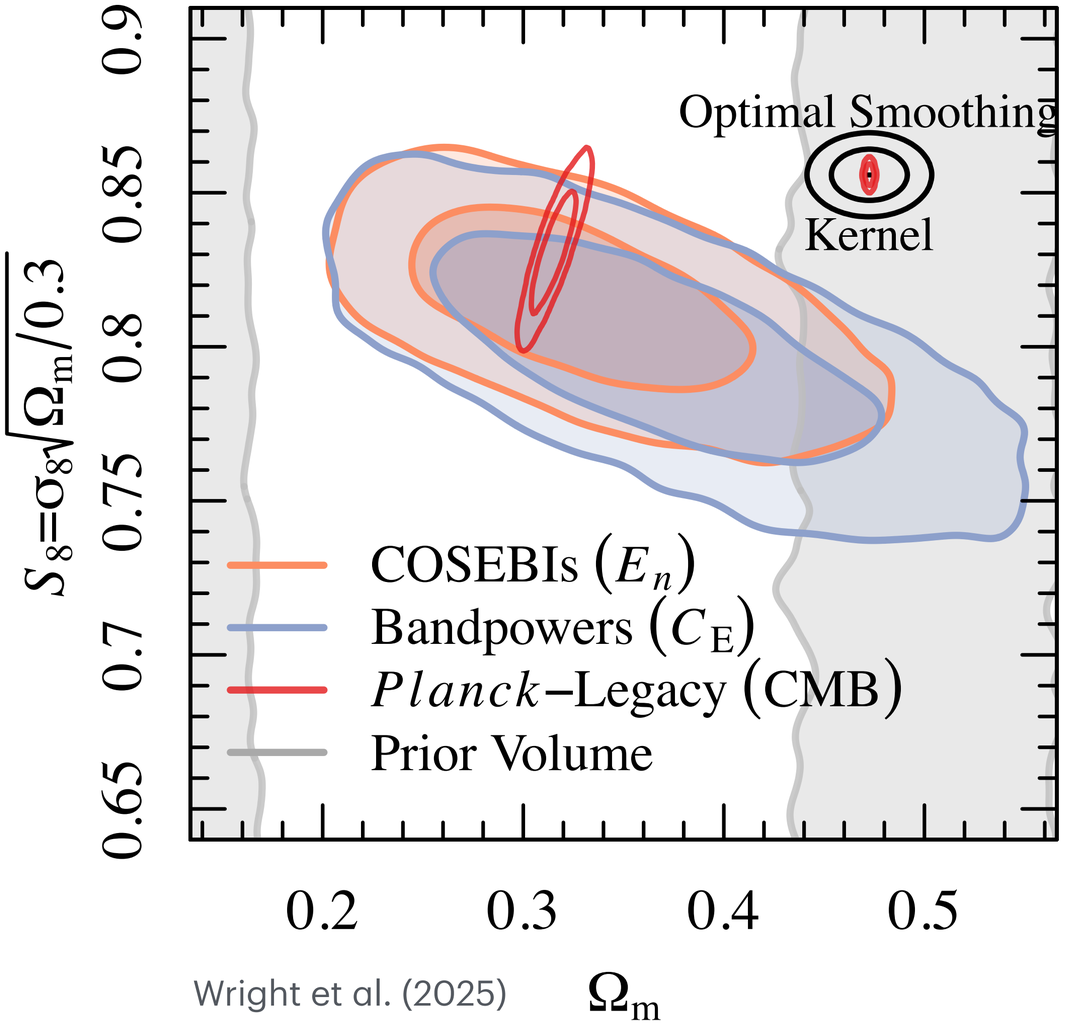
Blind C: $N_\sigma = 1.73$

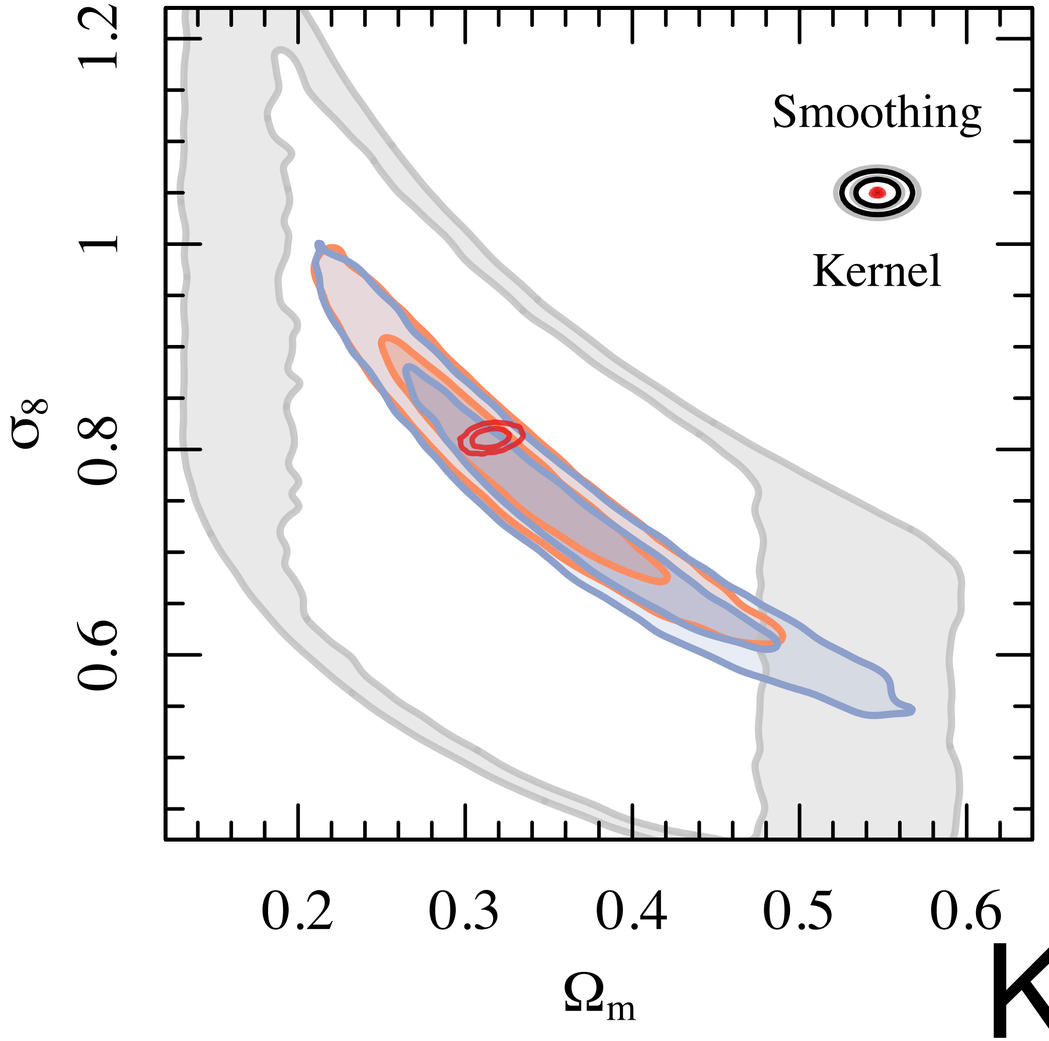


Wright et al. (2025)

Cosmological constraints

Fiducial results

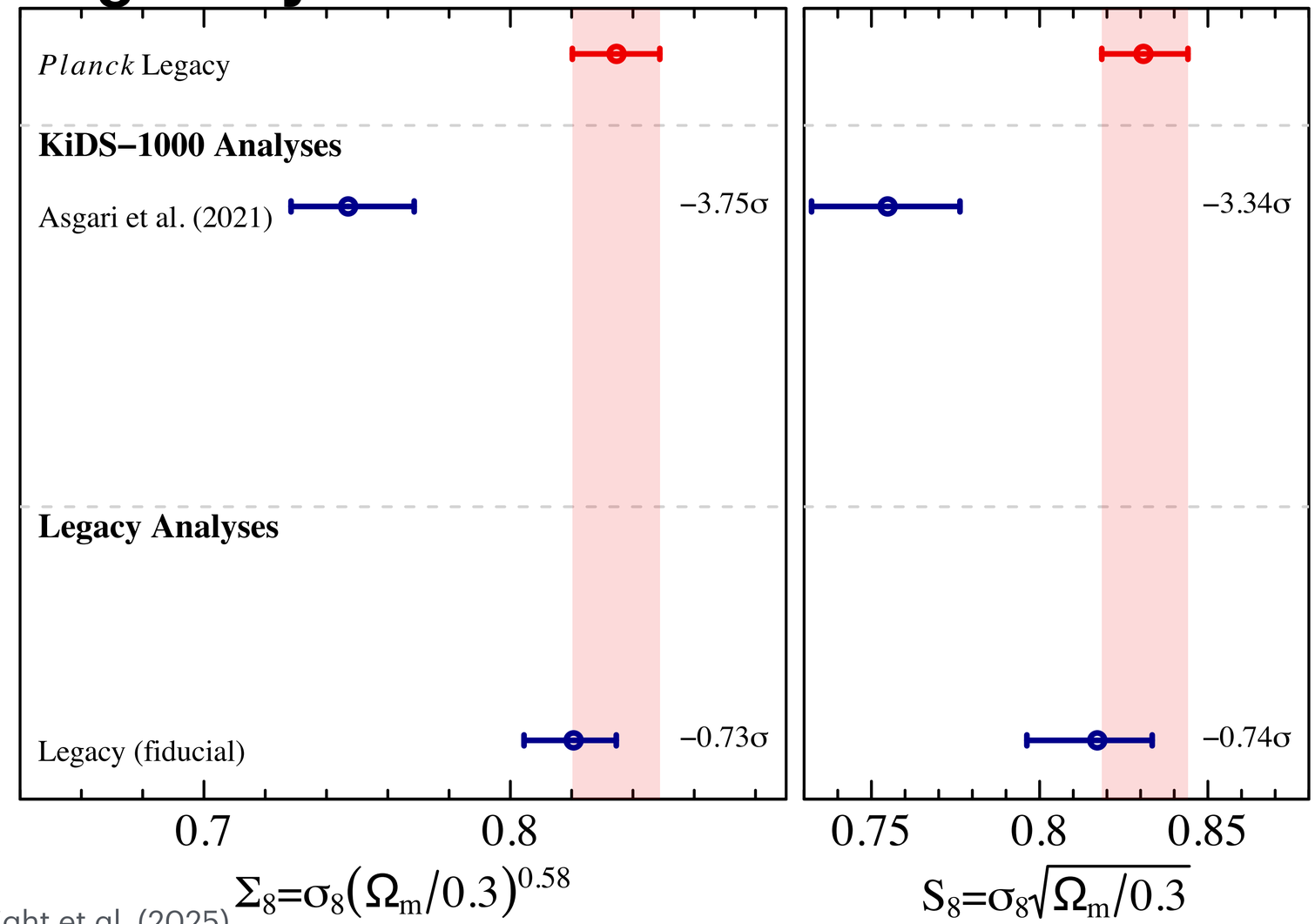




Wright et al. (2025)

S_8 tension

Post unblinding analyses



Wright et al. (2025)

S_8 tension

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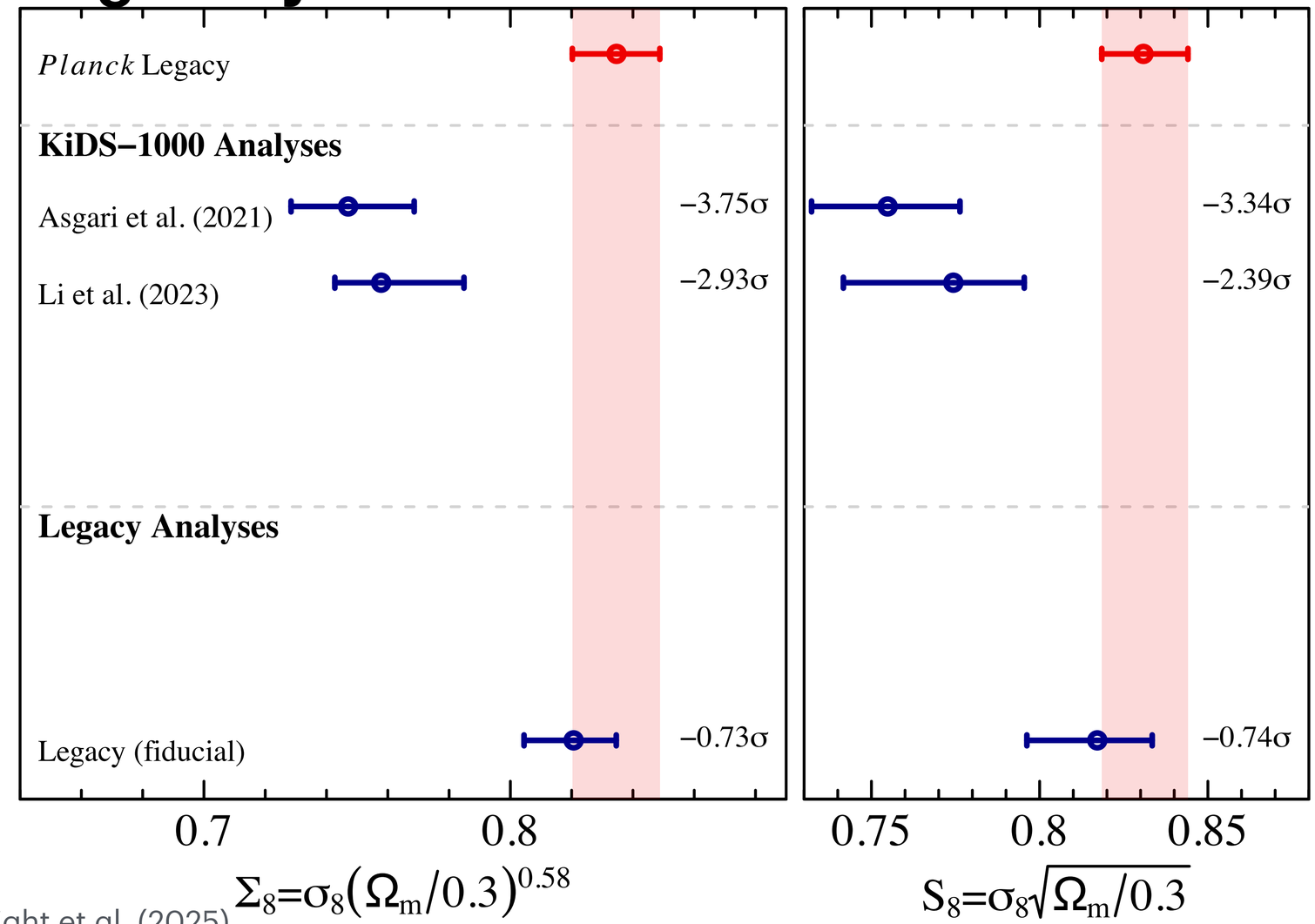

Wright et al. (2025)

S_8 tension

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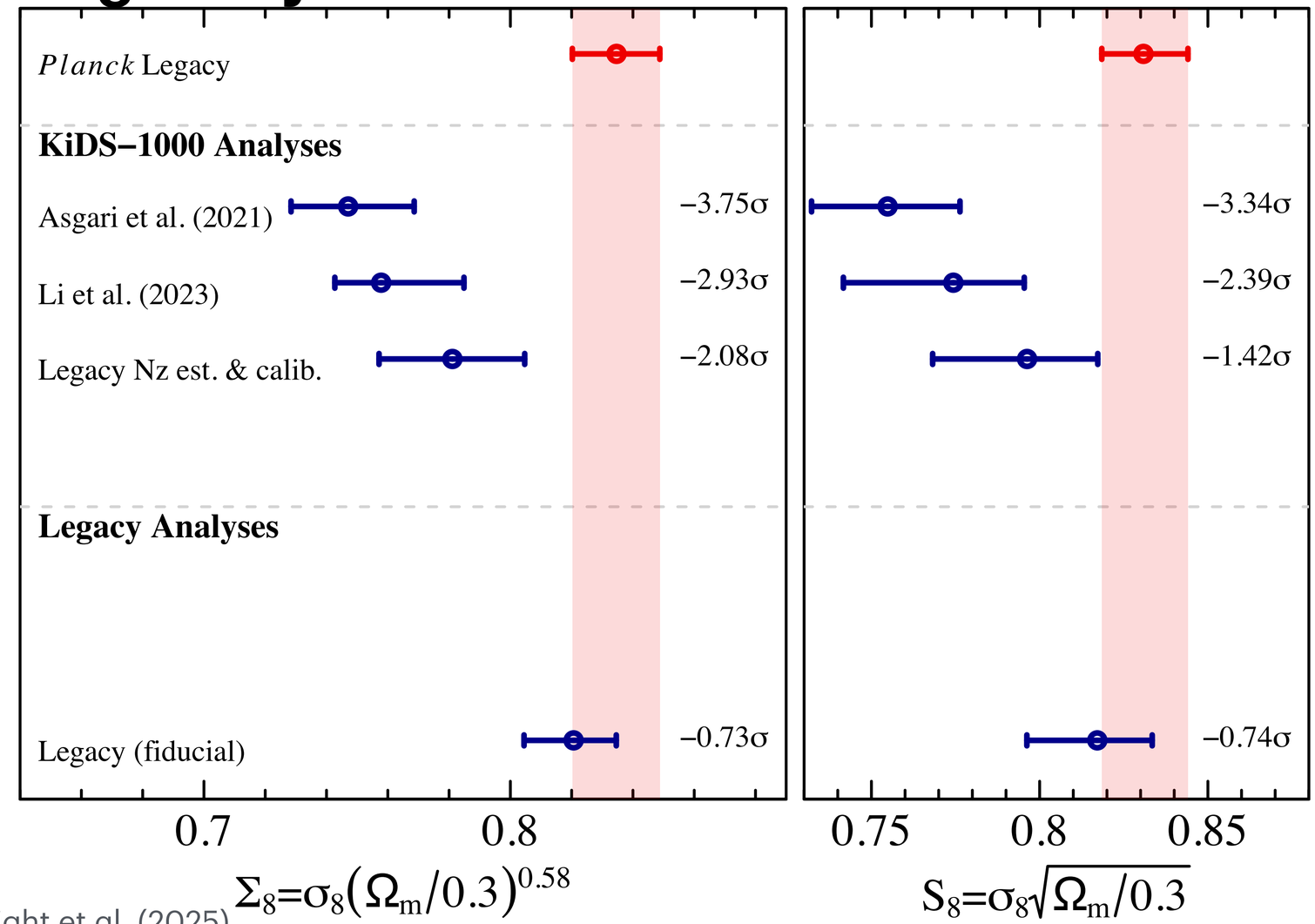

Wright et al. (2025)

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S_8 tension

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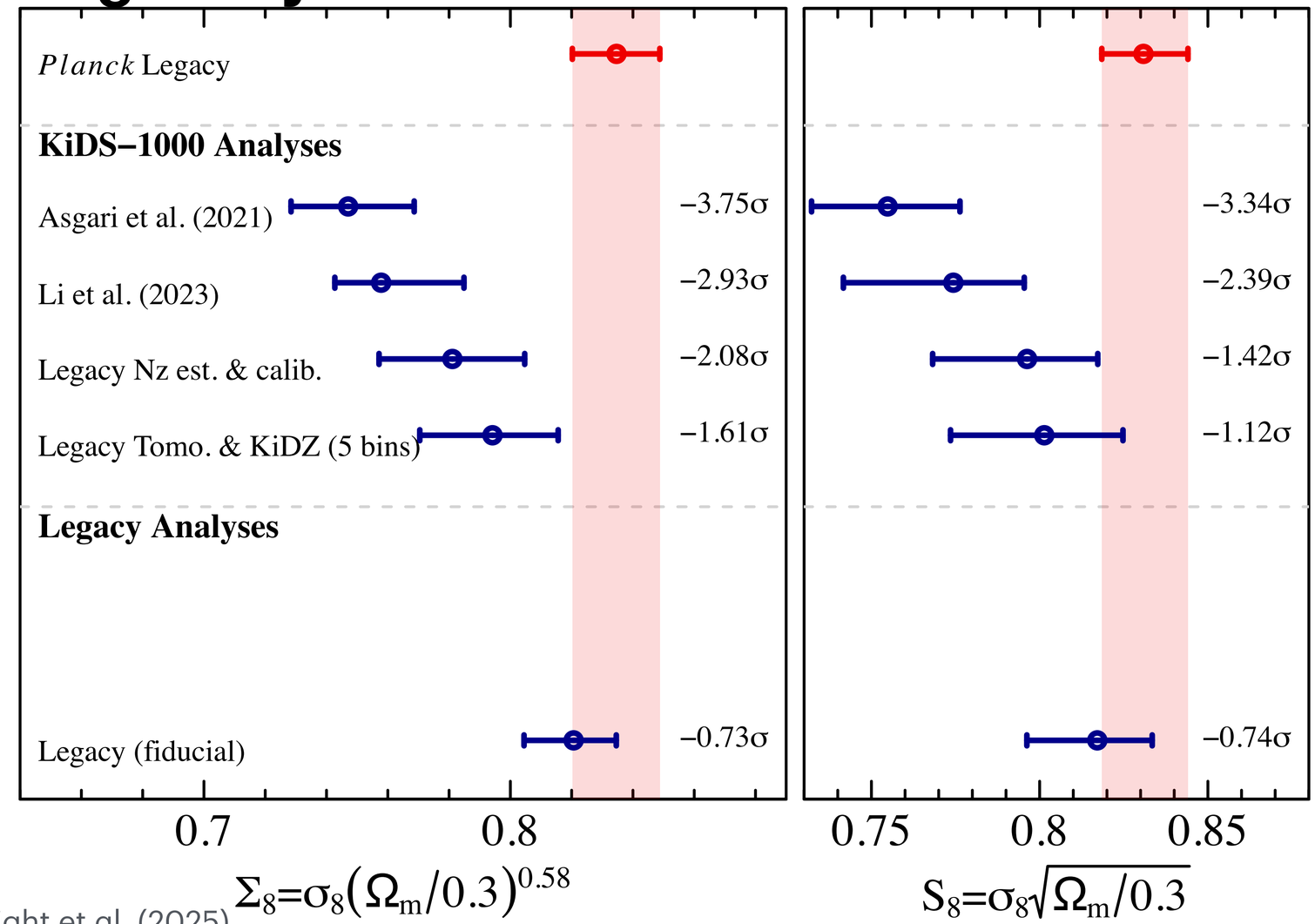

Wright et al. (2025)

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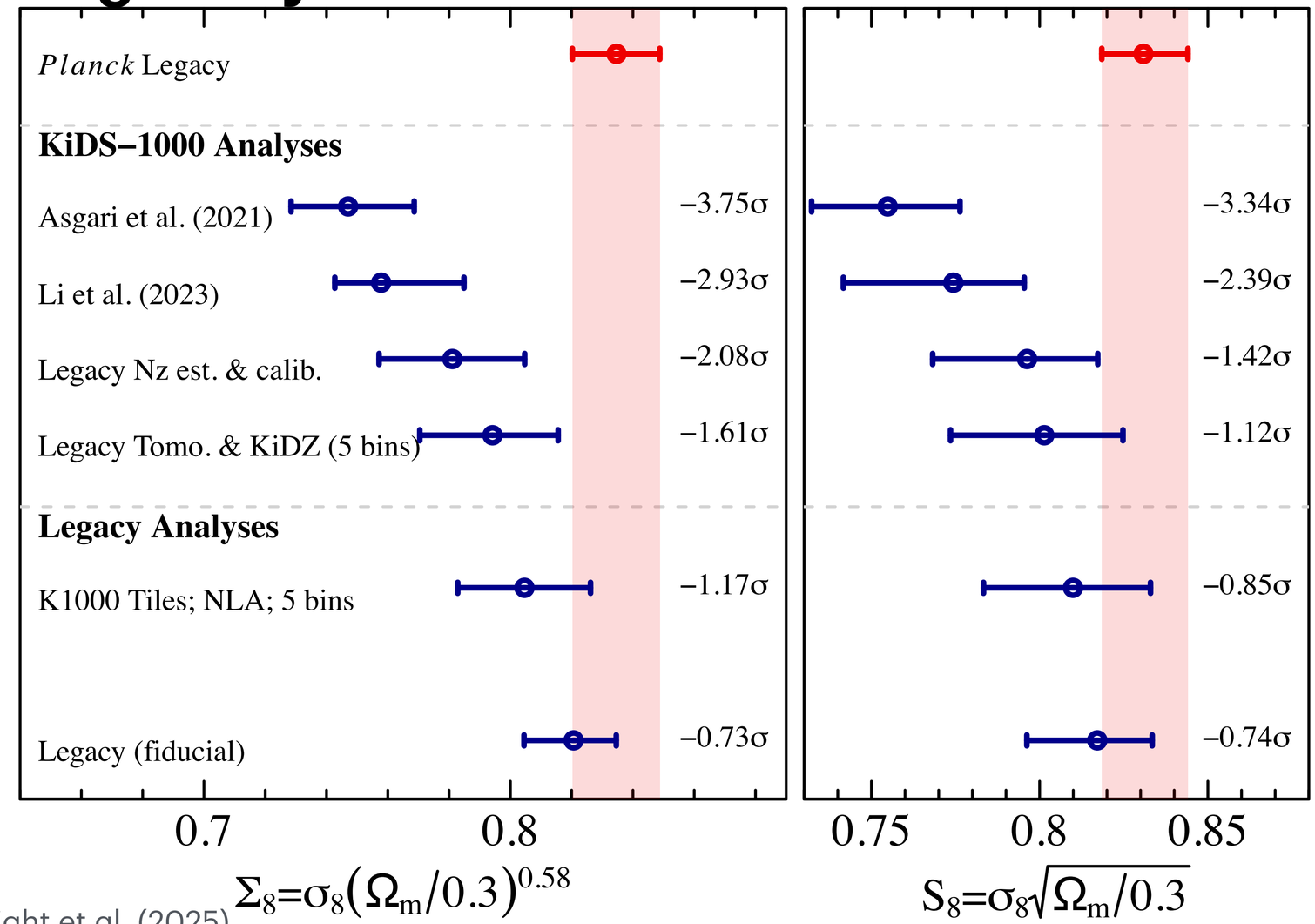

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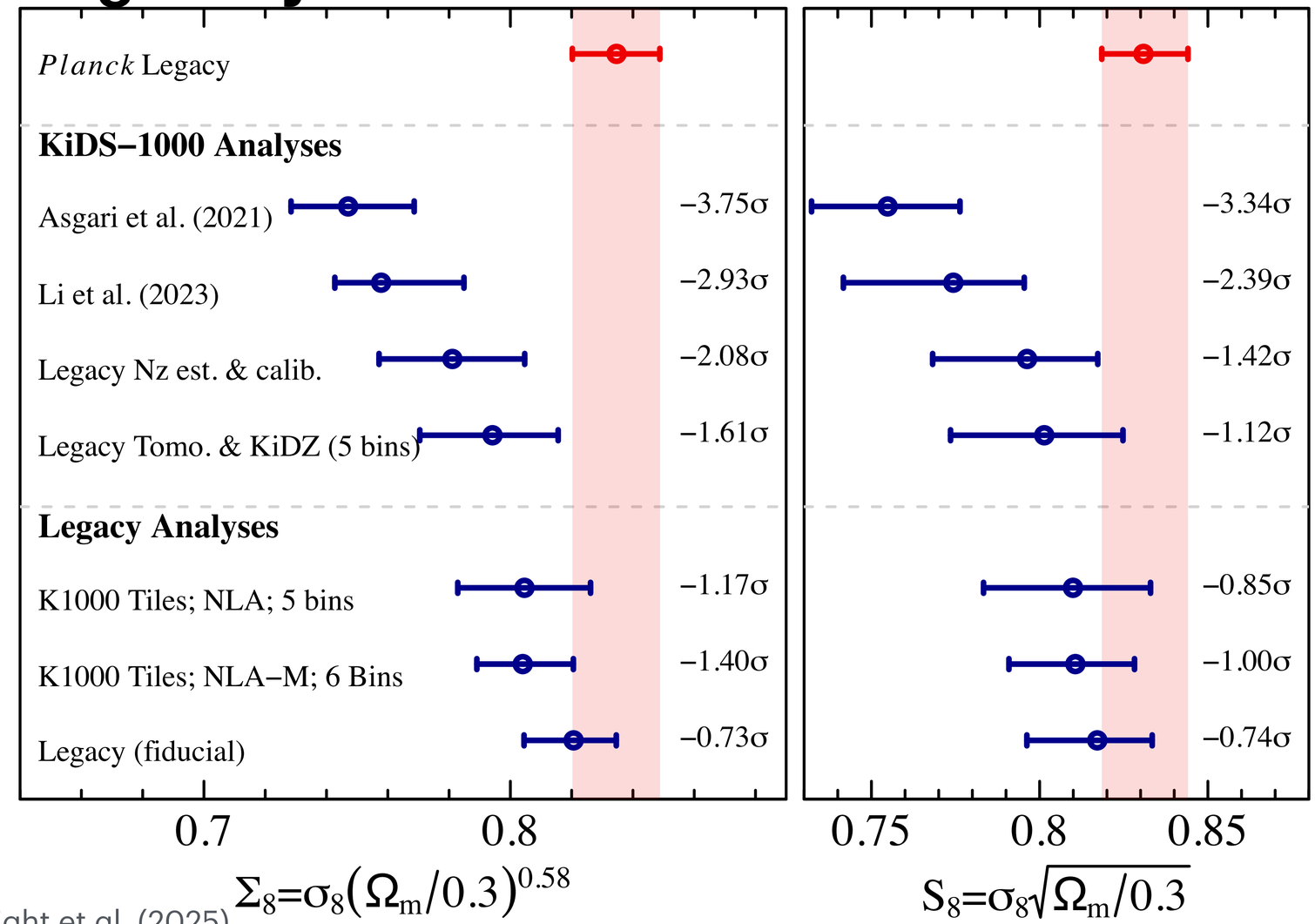
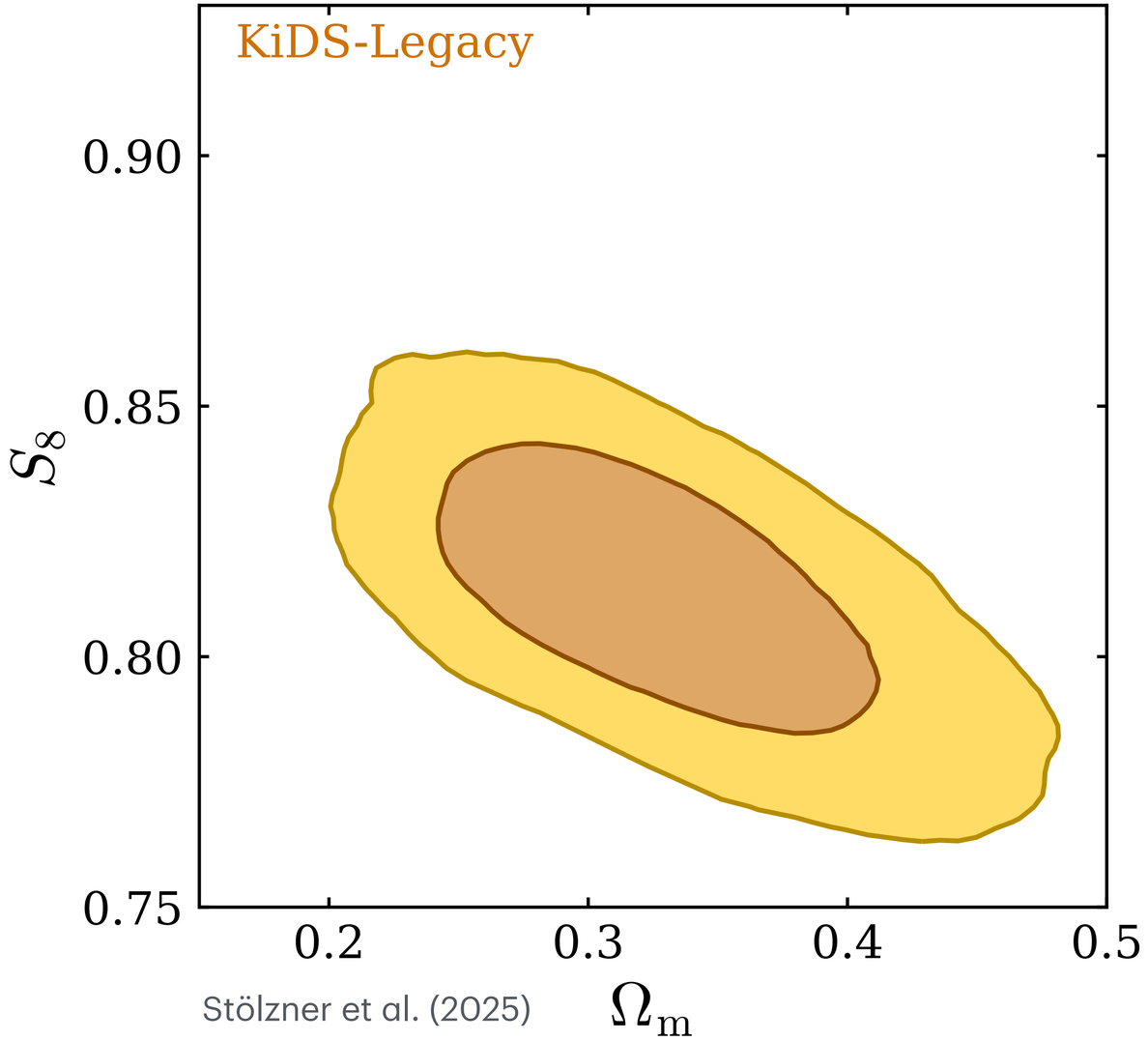


Wright et al. (2025)

KiDS

Cosmological constraints

Combination with external datasets



Stölzner et al. (2025)

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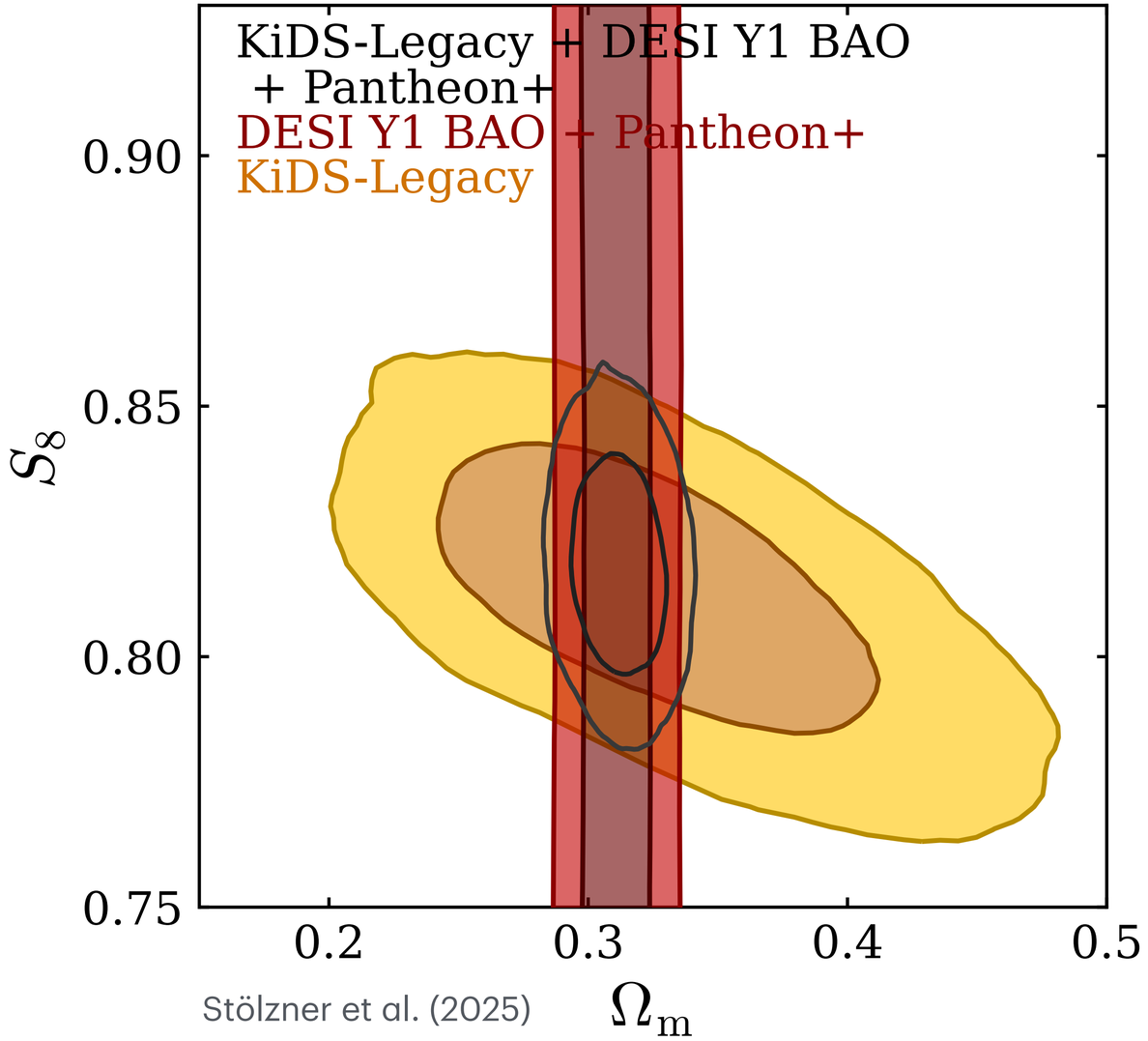

Stölzner et al. (2025)

DESI Y1 BAO: $N_\sigma = 0.44$

(Adame et al. 2025)

Pantheon+: $N_\sigma = 0.23$

(Scolnic et al. 2022; Brout et al. 2022)

KiDS

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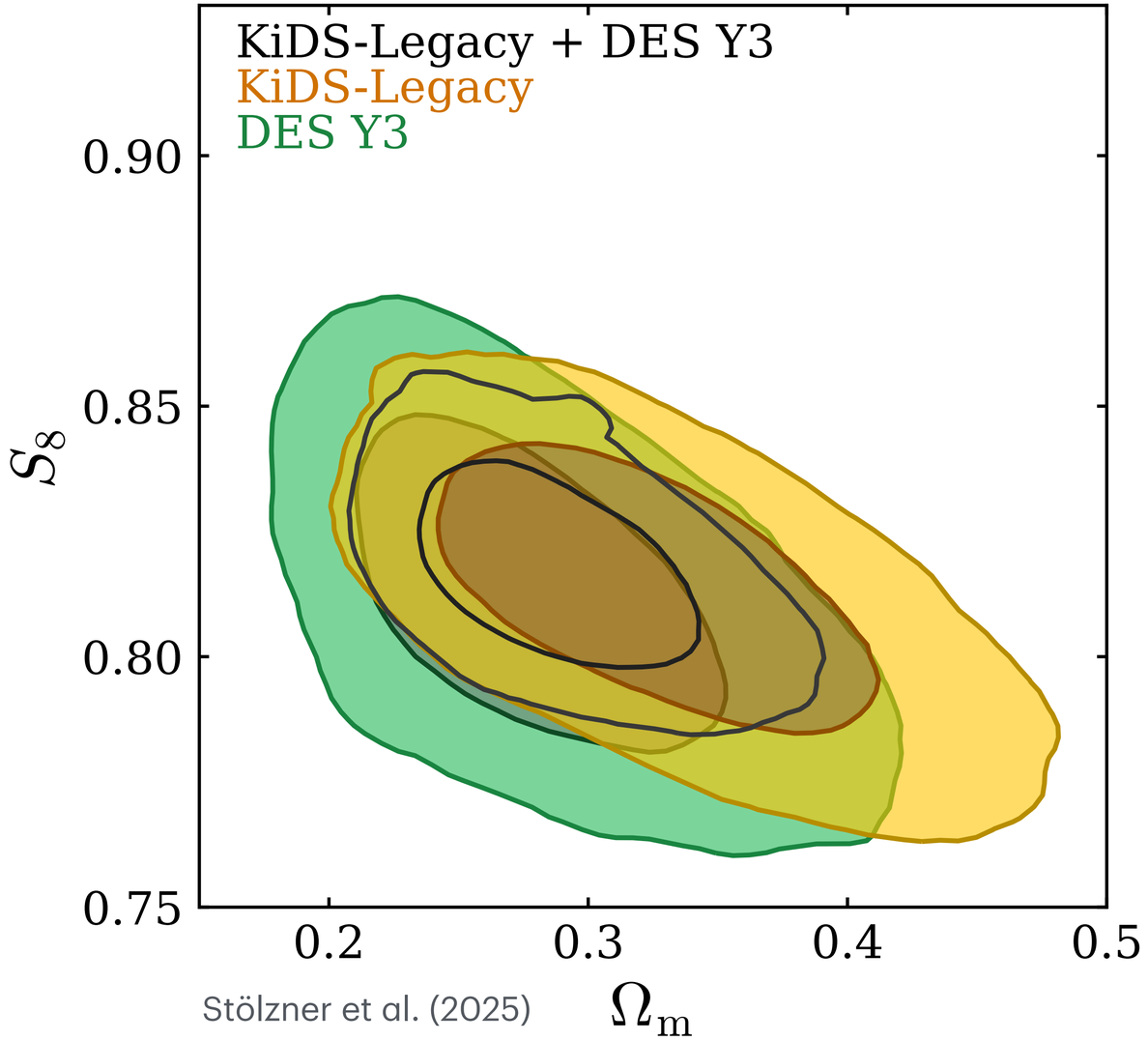

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(Dark Energy Survey and Kilo-Degree Survey Collaboration et al. 2023)

KiDS

Cosmological constraints

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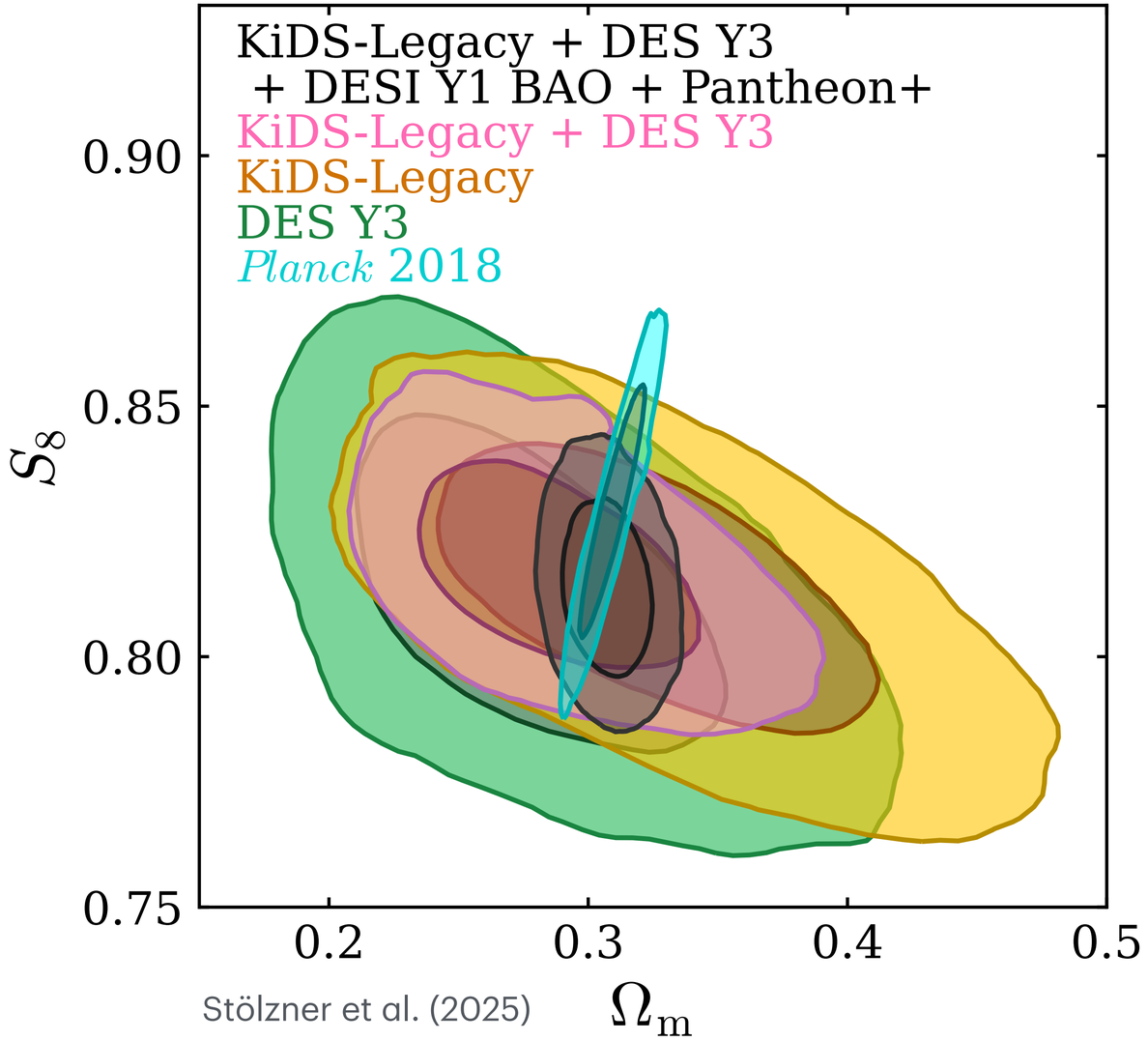

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$$S_8 = 0.814^{+0.011}_{-0.012}$$

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

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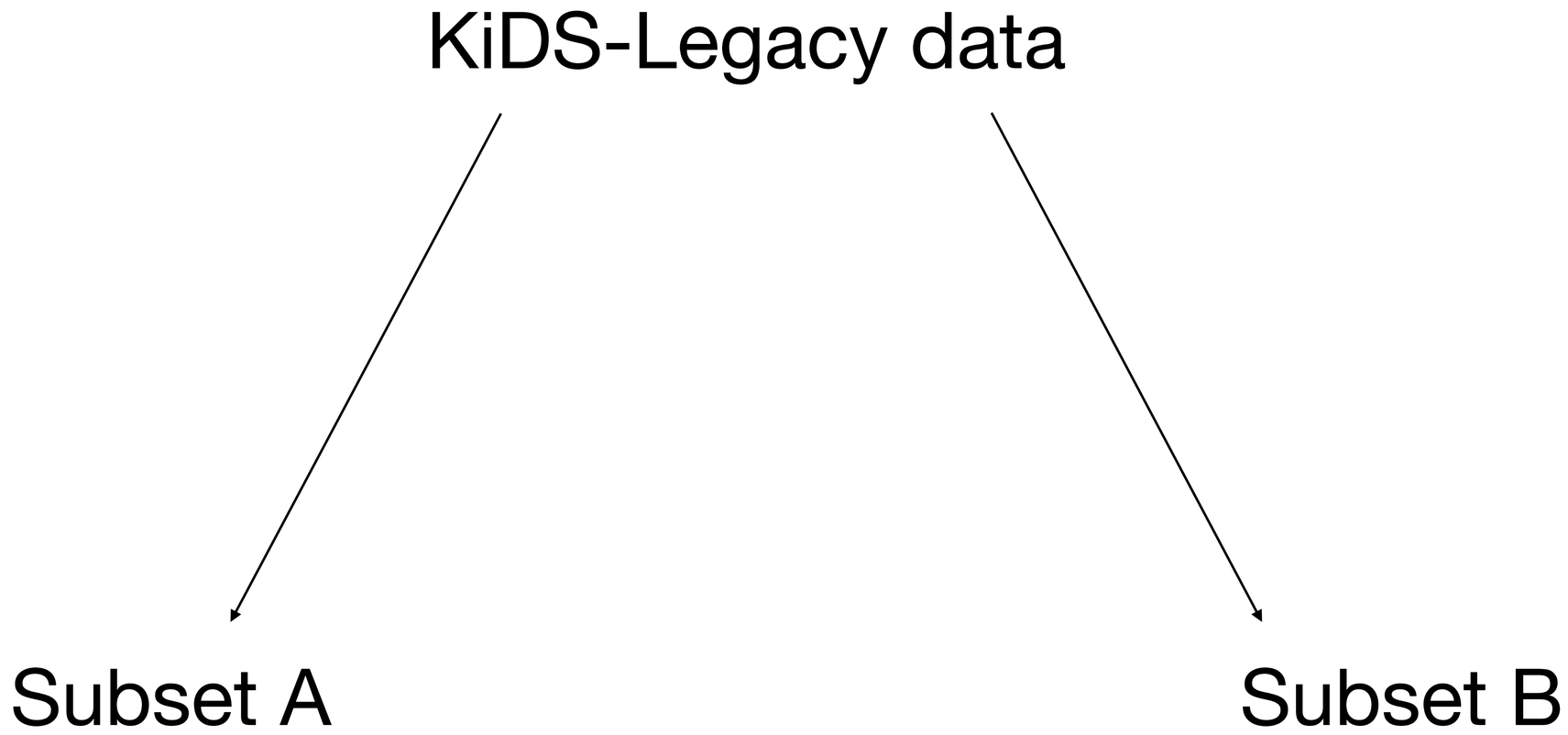
Internal consistency

KiDS

Internal consistency

KiDS-Legacy data

Internal consistency



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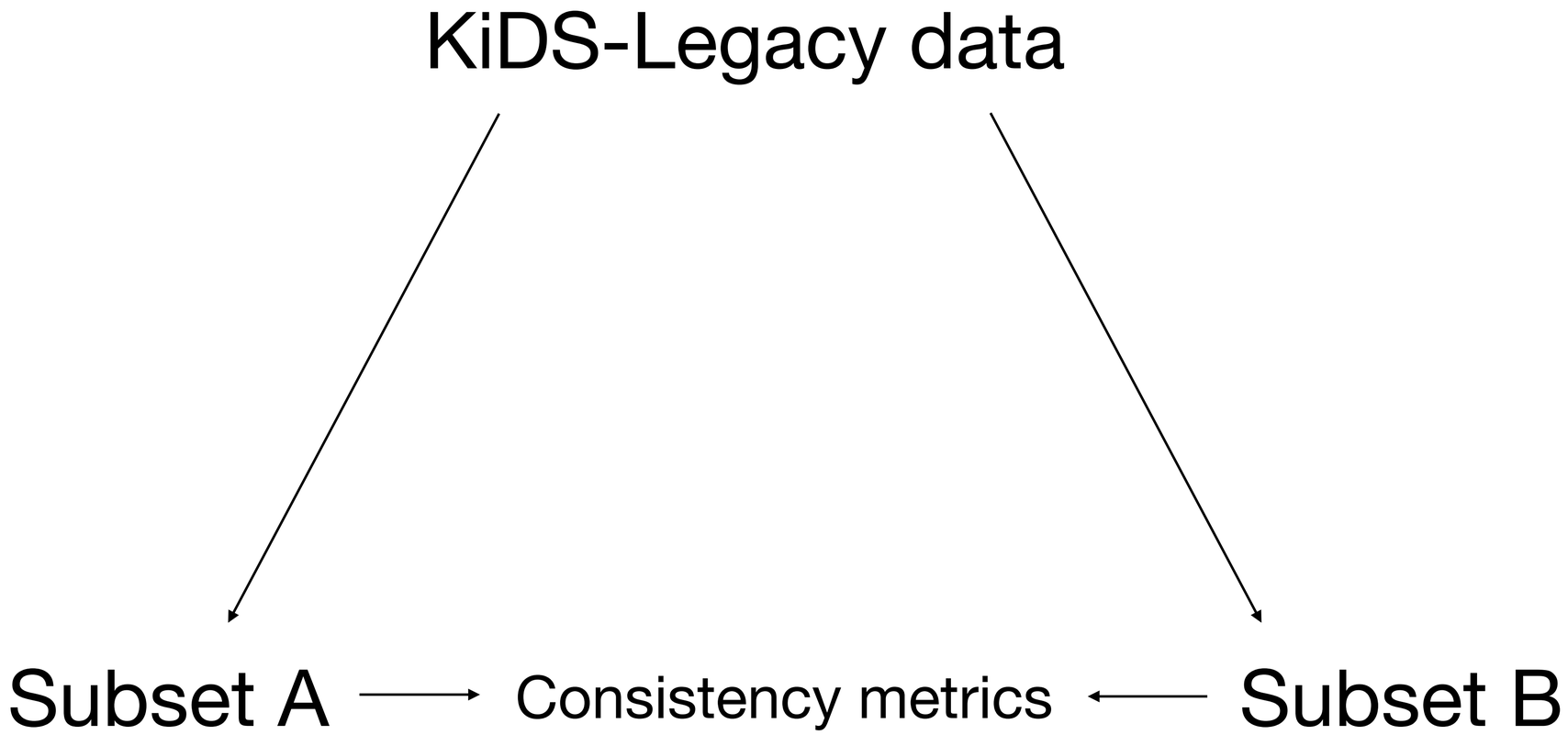
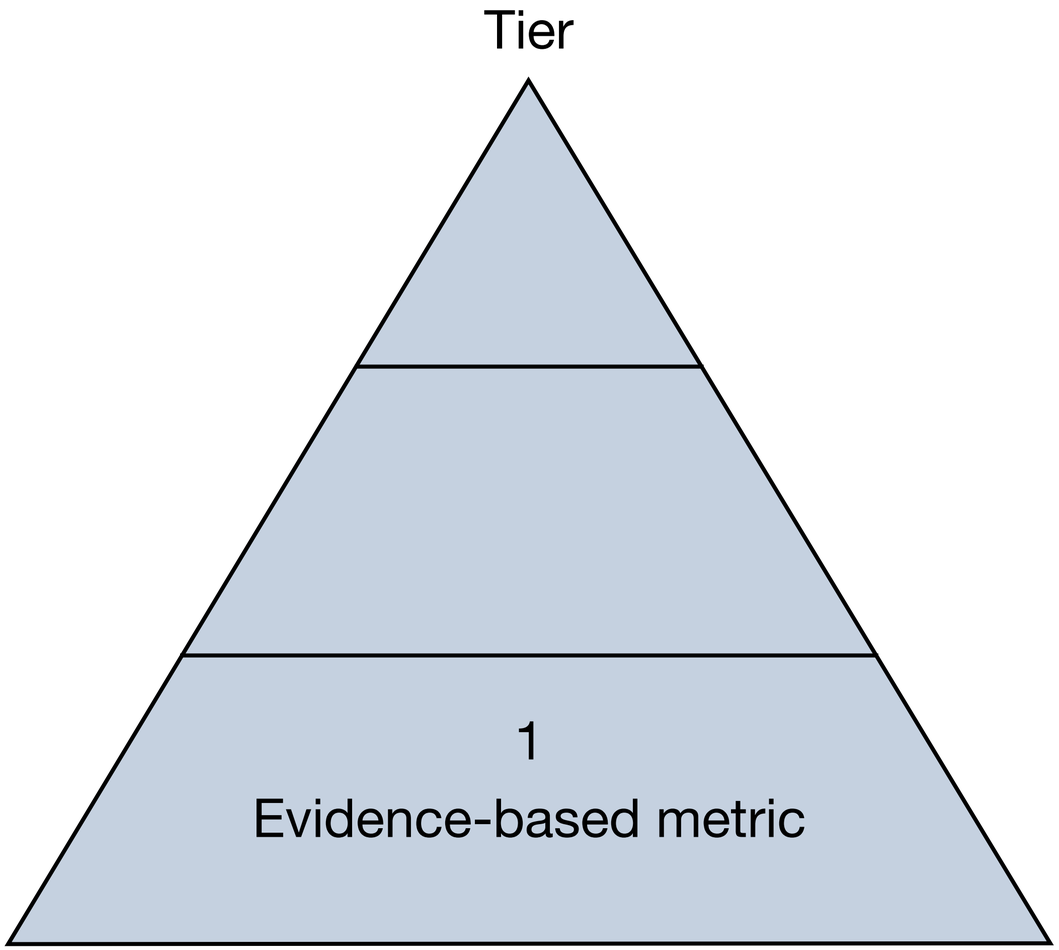


Internal consistency

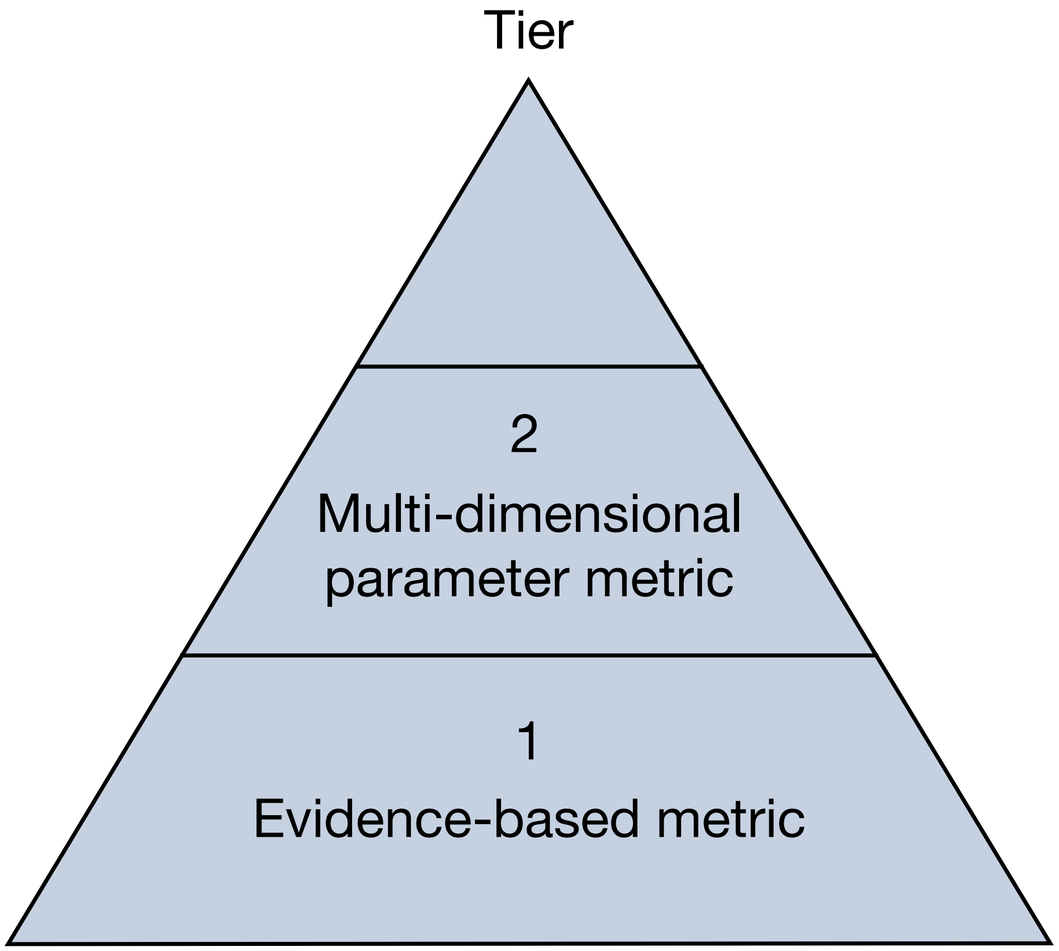
Metrics

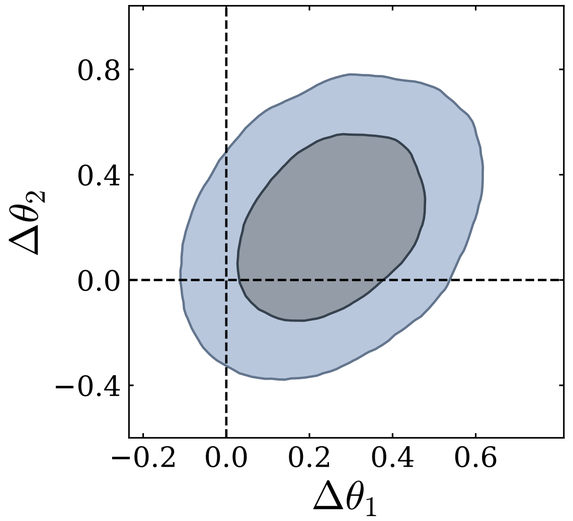


Bayes factor, Suspiciousness

Internal consistency

Metrics





Bayes factor, Suspiciousness

KiDS

Internal consistency

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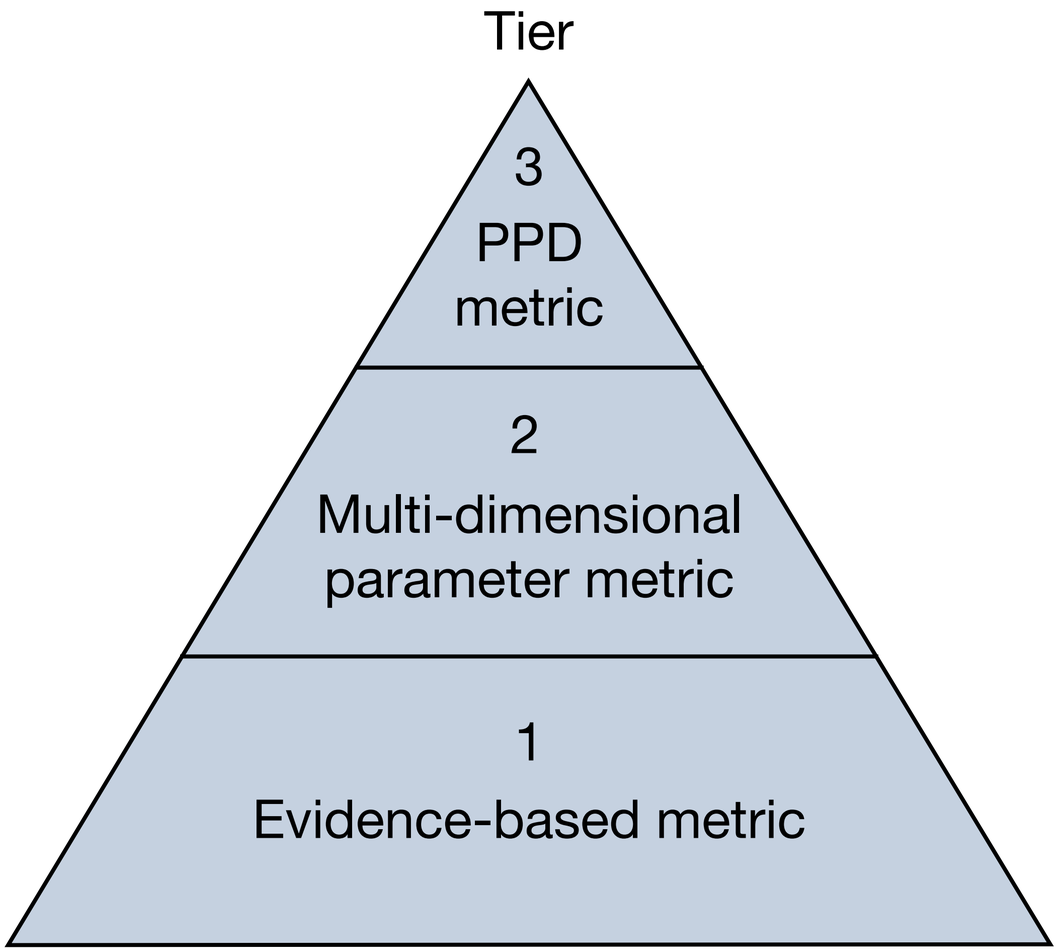
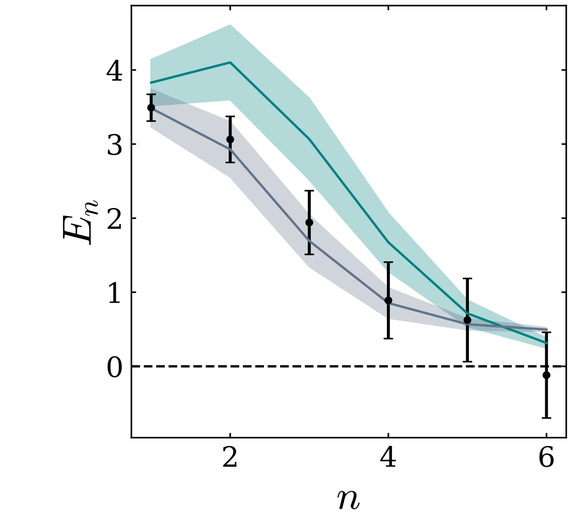
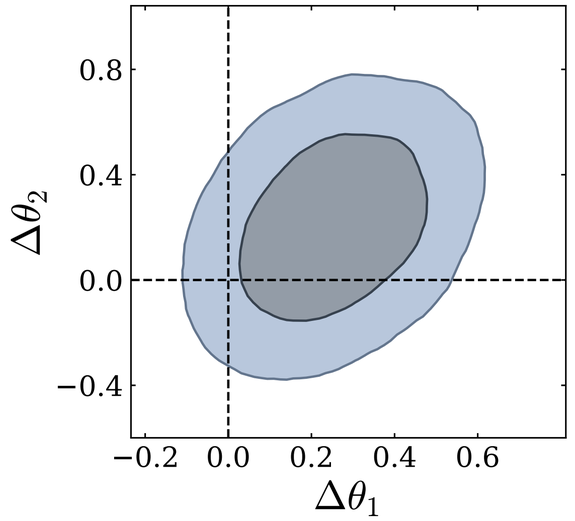






Bayes factor, Suspiciousness

Internal consistency

Data splits

Data vector level:

Stölzner et al. (2025)

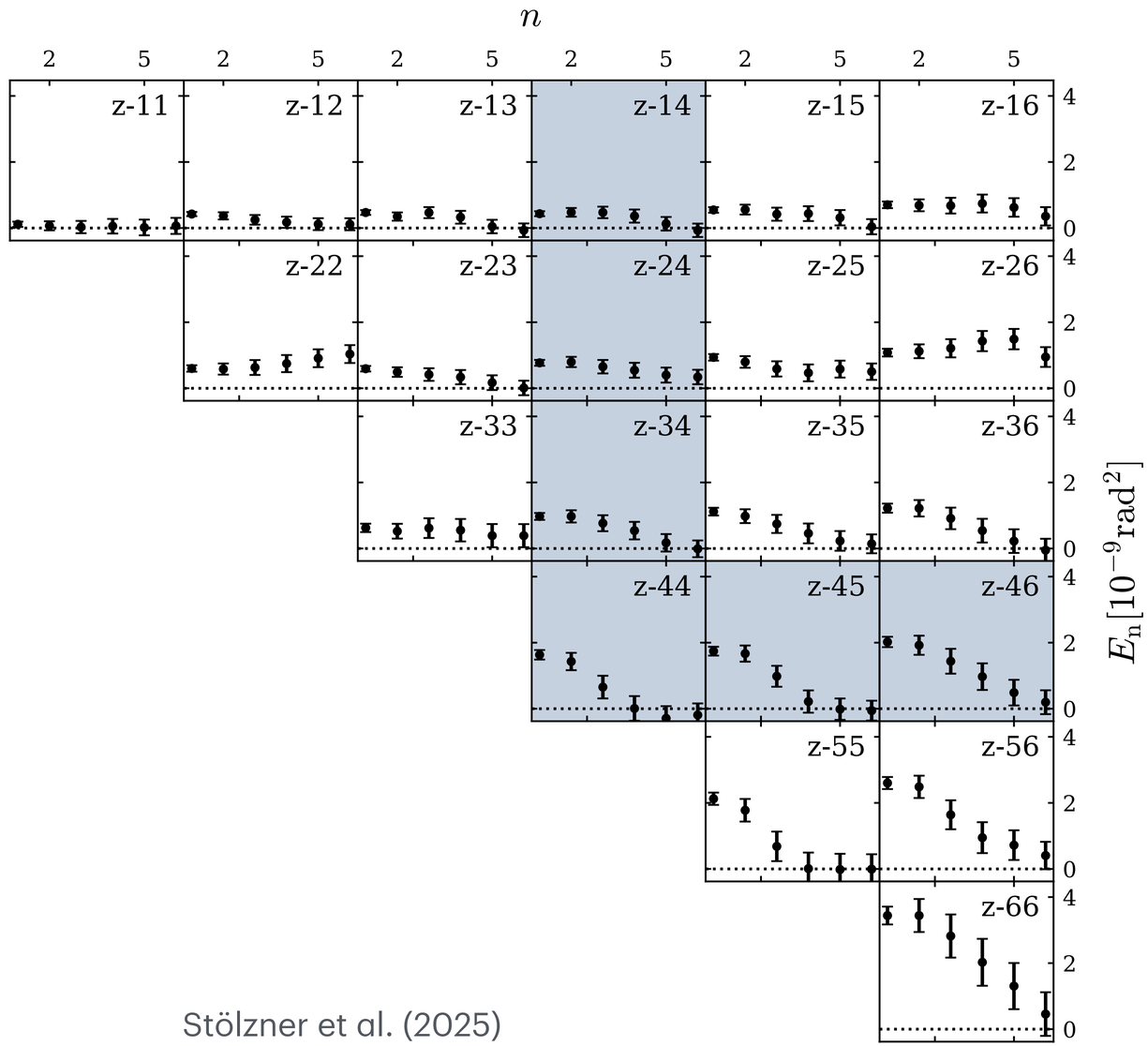
KiDS

Internal consistency

Data splits

Data vector level:

- Redshift bins



Stölzner et al. (2025)

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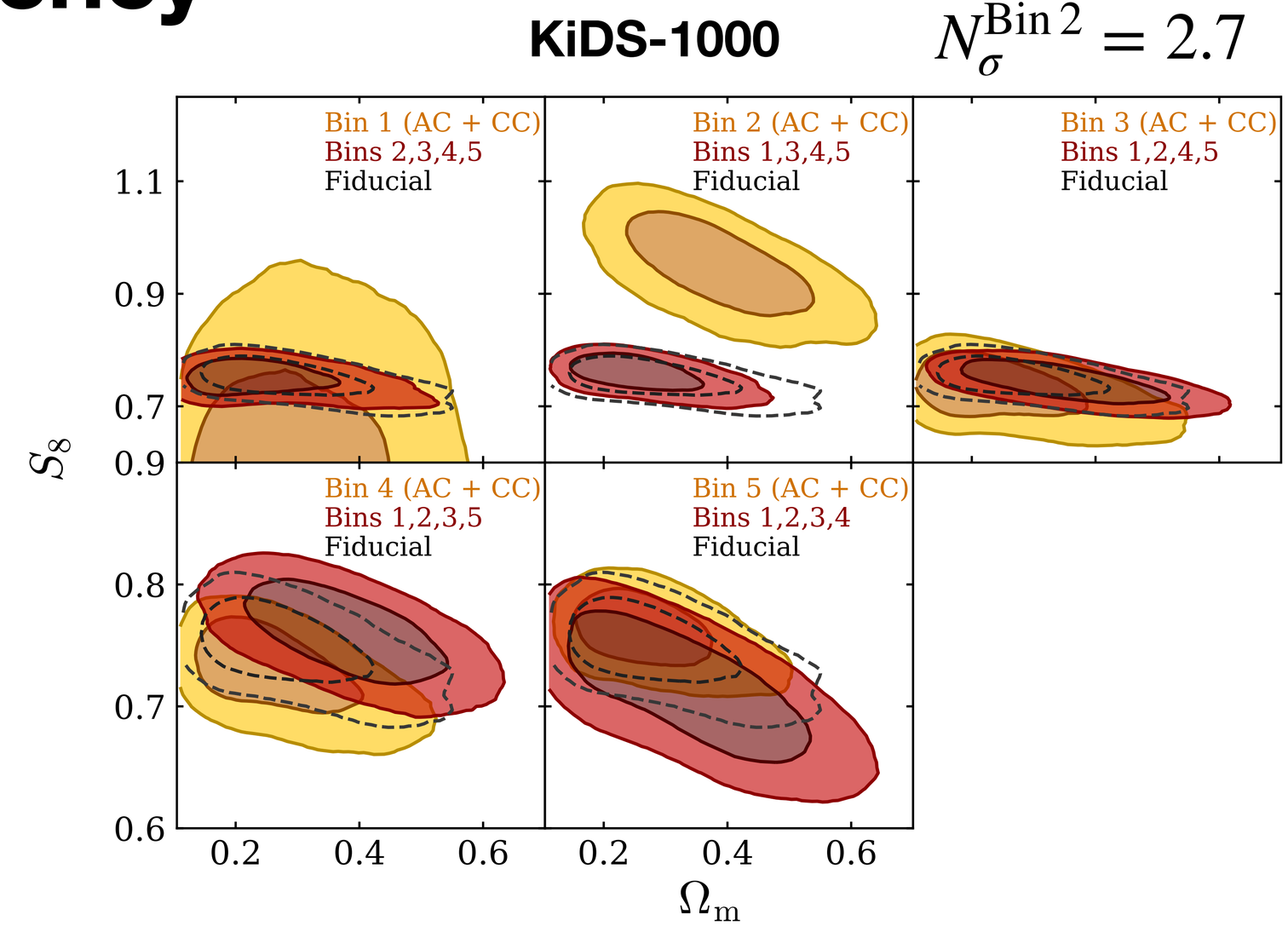

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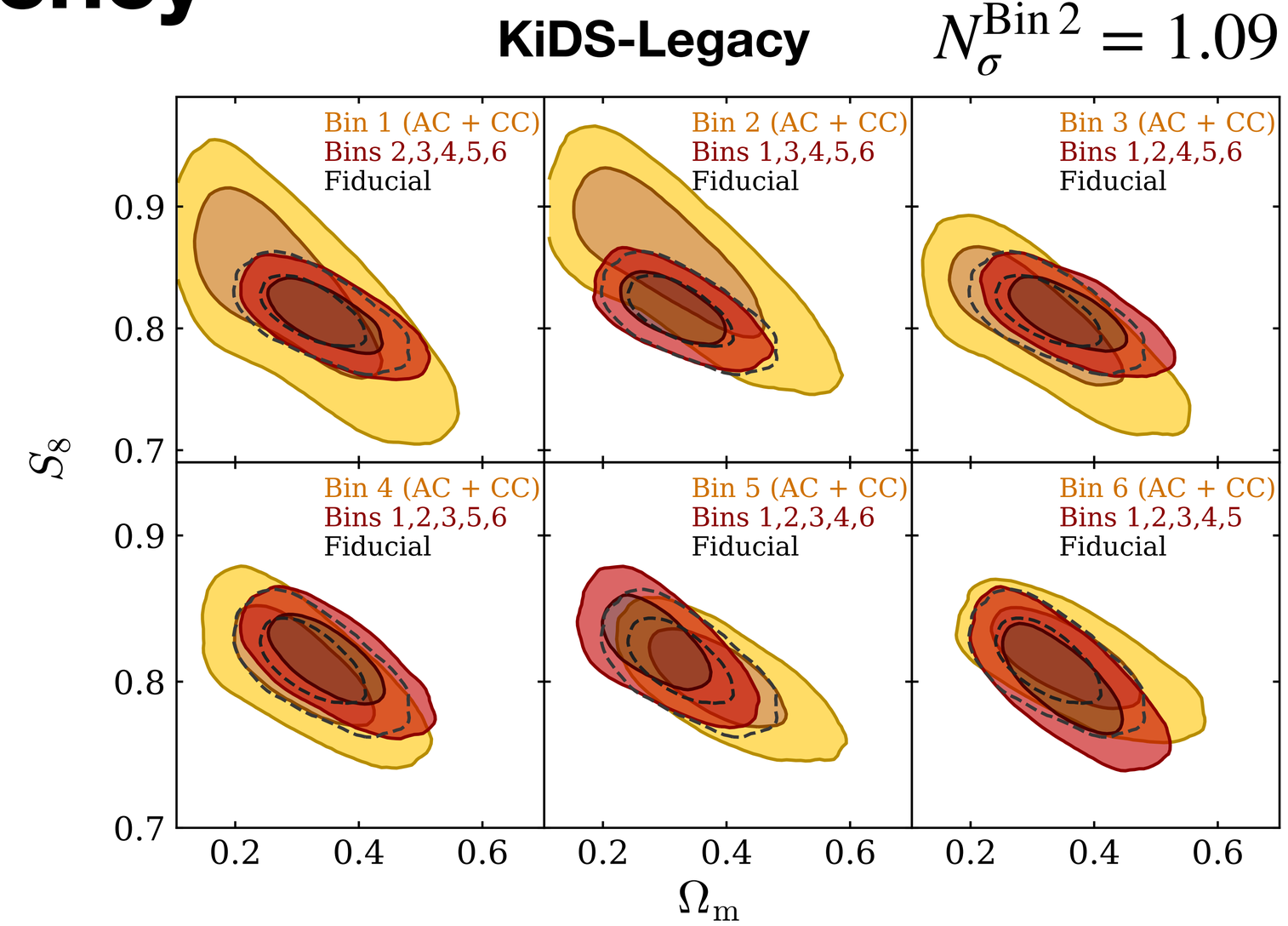


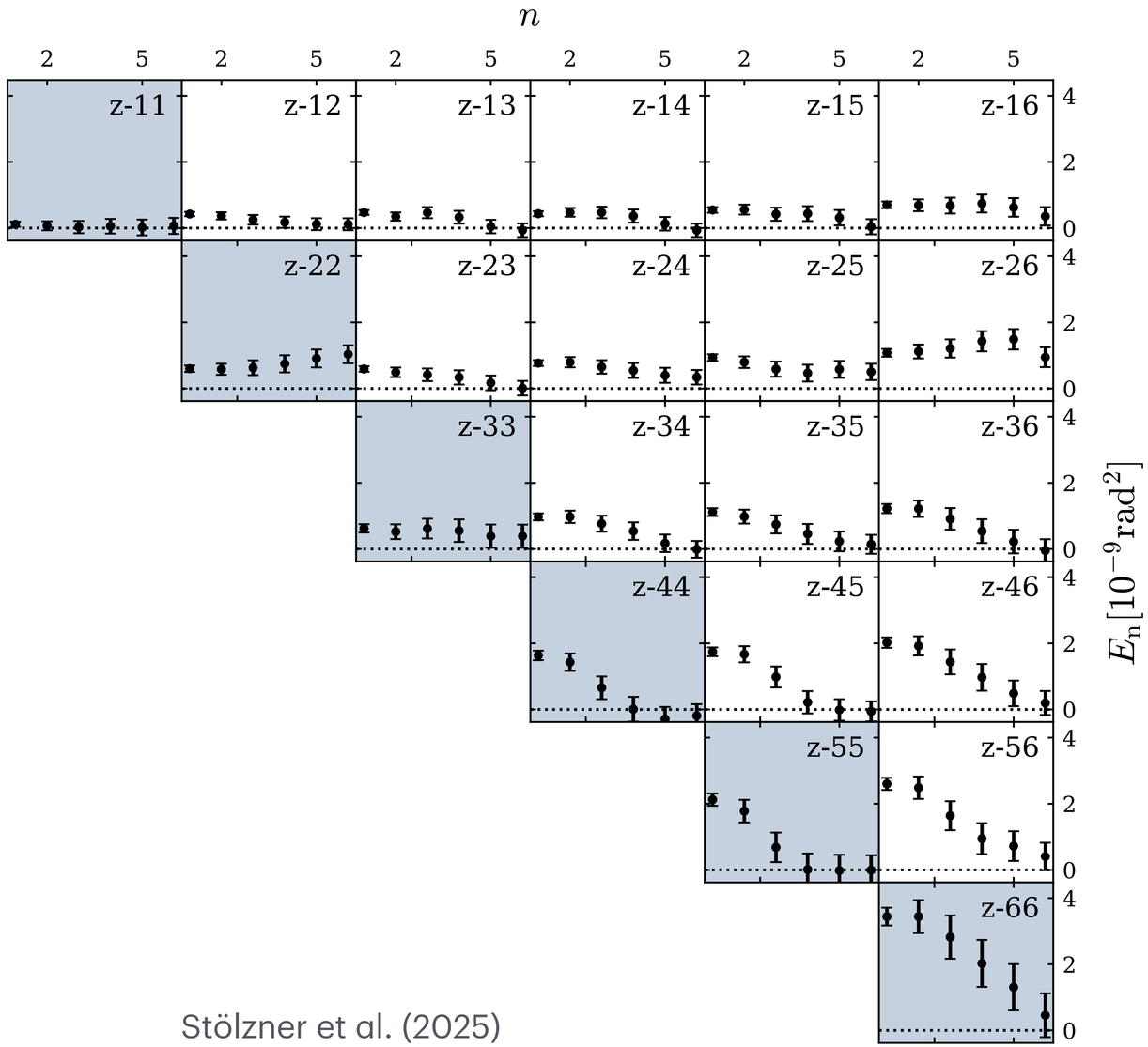
Stölzner et al. (2025)

Internal consistency

Data splits

Data vector level:

- Redshift bins
- Auto- vs cross-correlation



Stölzner et al. (2025)

KiDS

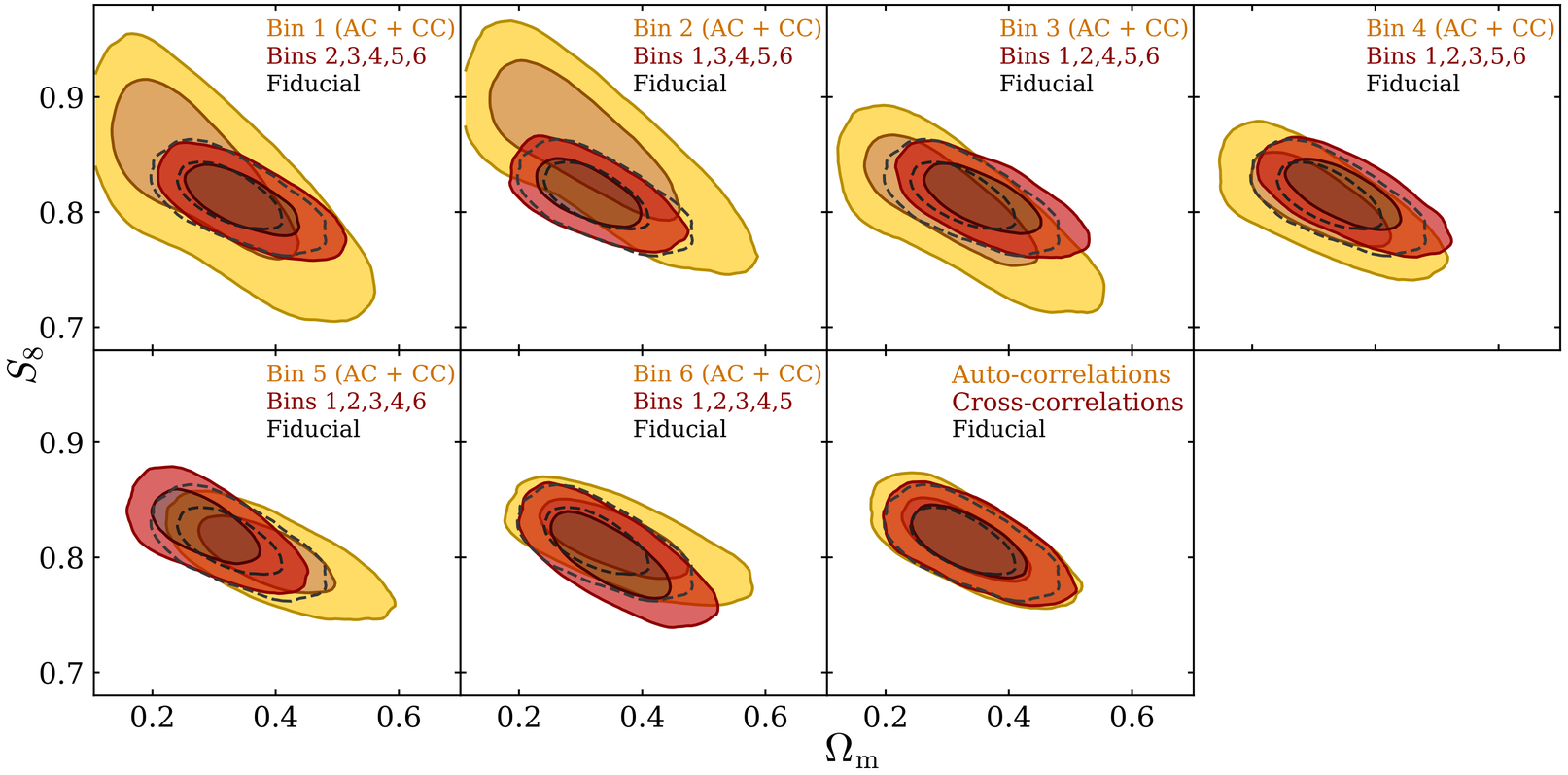
Internal consistency

Data splits

$$N_\sigma^{\mathrm{AC/CC}} = 0.06$$

Data vector level:

- Redshift bins
- Auto- vs cross-correlation



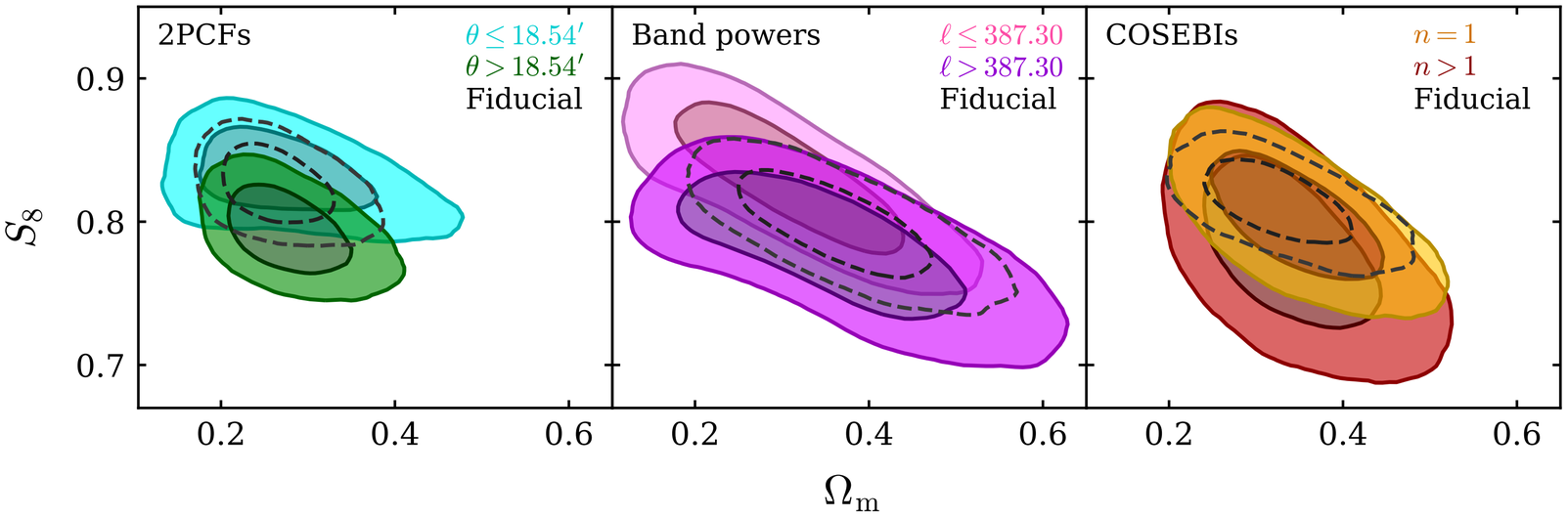
Stölzner et al. (2025)

Internal consistency

Data splits

Data vector level:

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



$N_\sigma = 1.63$ $N_\sigma = 0.84$ $N_\sigma = 0.62$

Stölzner et al. (2025)

Internal consistency

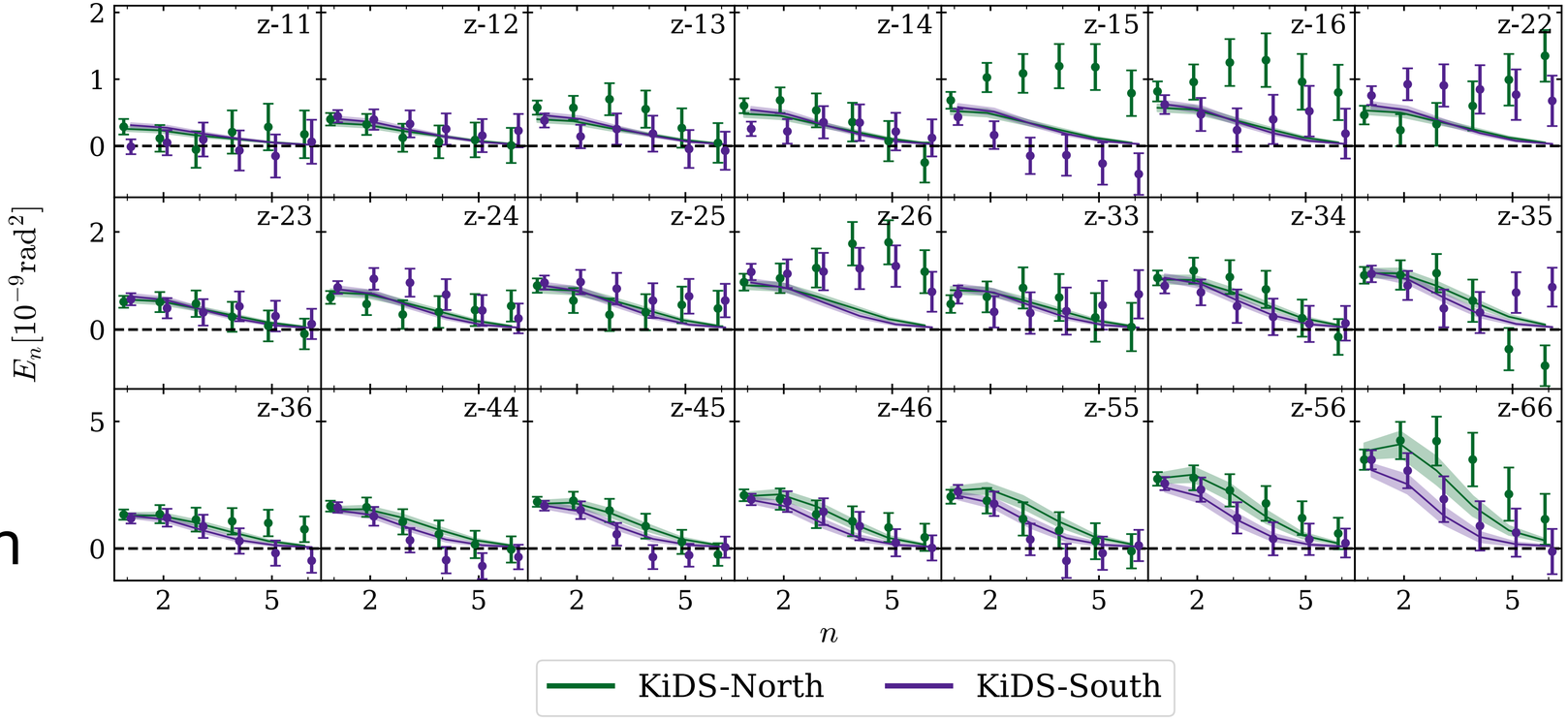
Data splits

Data vector level:

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

Catalogue level:

- KiDS-North vs KiDS-South



Stölzner et al. (2025)

Internal consistency

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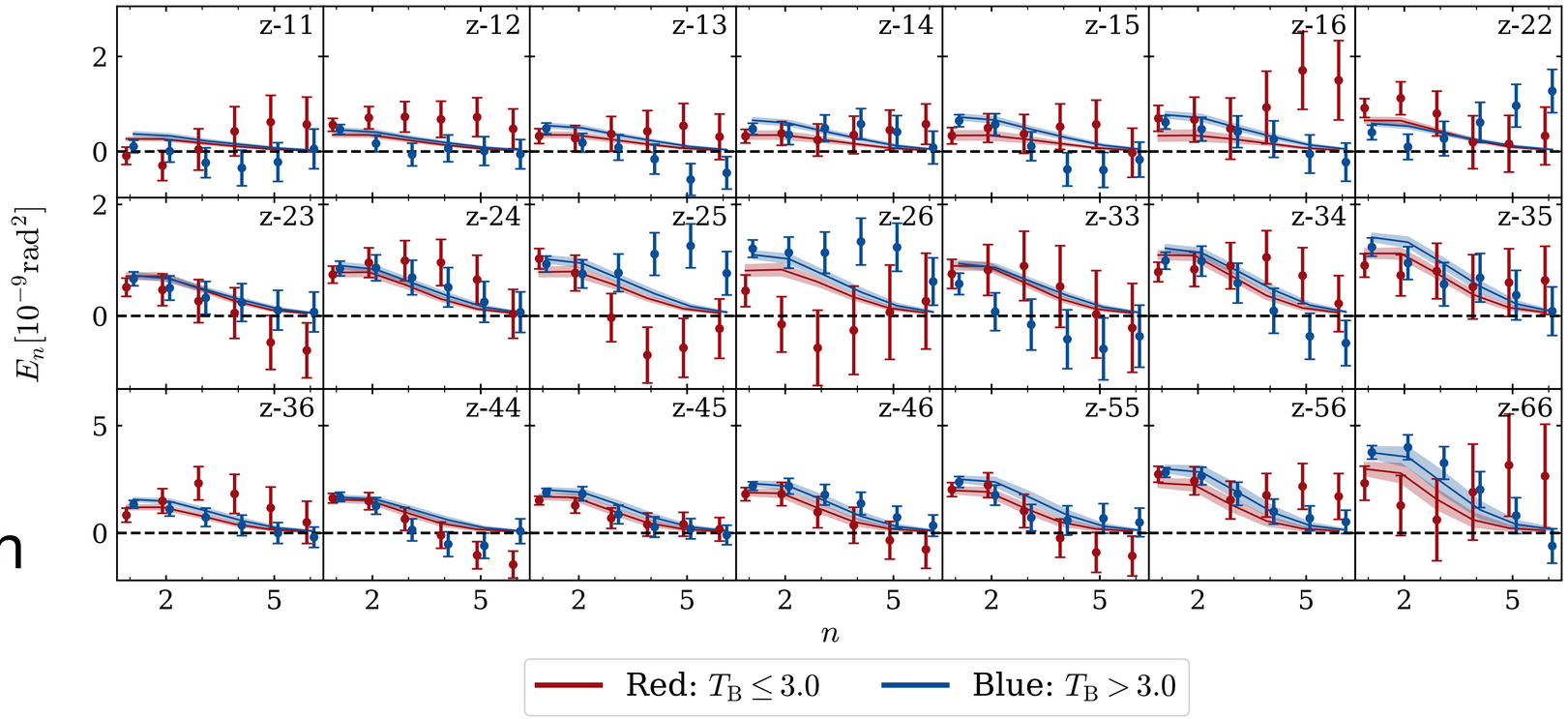
- Scales

Catalogue level:

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



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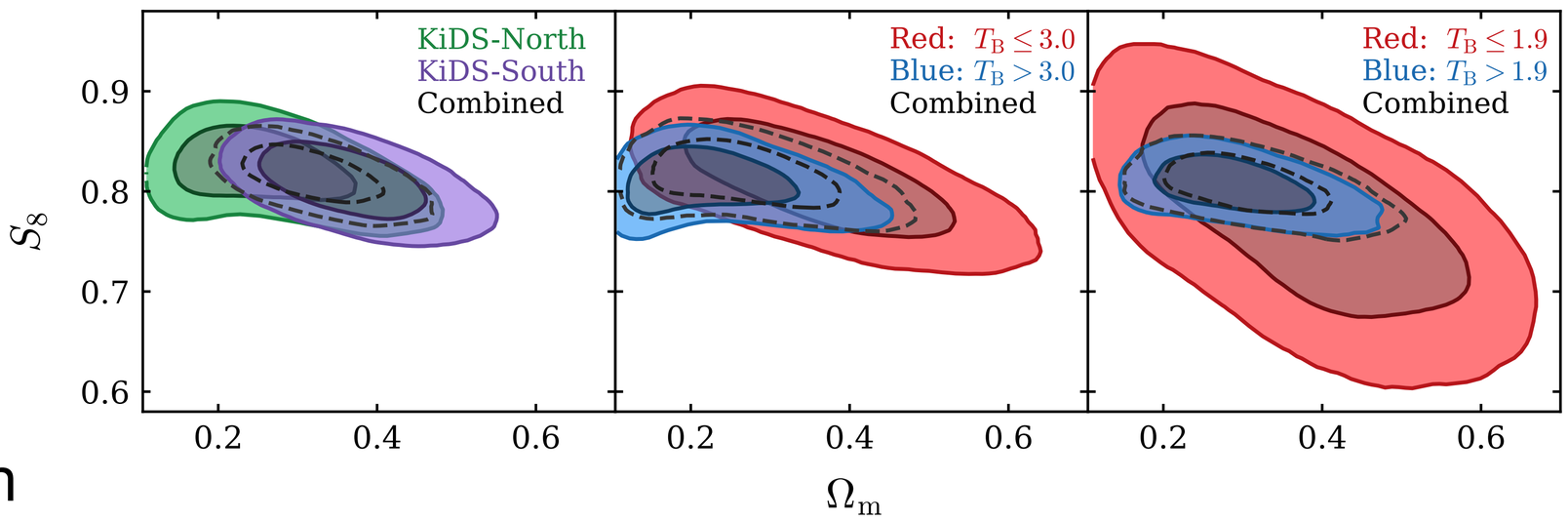

$N_\sigma = 0.60$ $N_\sigma = 0.74$ $N_\sigma = 0.25$

Stölzner et al. (2025)

What’s next?

KiDS-Legacy follow-up analyses

What's next?

KiDS-Legacy follow-up analyses

- Constraints on extended cosmological models beyond ΛCDM
- Constraints on Horndeski gravity
- Cosmic shear with blue galaxies
- 3x2pt: cosmic shear + galaxy clustering + galaxy-galaxy lensing (GGL)
- 6x2pt: cosmic shear + spectroscopic and photometric clustering + spectroscopic and photometric GGL + spectroscopic-photometric cross-clustering
- Constraints from simulation-based inference
- And more!

KiDS

Coming soon

KiDS-Legacy: Constraints on Horndeski gravity from weak lensing combined with galaxy clustering and cosmic microwave background anisotropies (working title)

Benjamin Stölzner[1⋆], Robert Reischke[2], Matteo Grasso[3], Matteo Cataneo[2], Benjamin Joachimi[4], Arthur Loureiro[5,6], Alessio Spurio Mancini[7], and KiDS collaboration[8]

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$$\Phi_{\rm W} = \frac{\Phi + \Psi}{2} = -\frac{3\Omega_{\rm m} H_0^2}{2c^2 k^2 a}\delta_{\rm m}\Sigma(k,a)$$

$$C_{\rm GG}^{ij}(\ell) = \int_0^{\chi_{\rm H}} {\rm d}\chi \, \frac{W_{\rm G}^i(\chi) W_{\rm G}^j(\chi)}{f_{\rm K}^2(\chi)} \Sigma^2\left(\frac{\ell + 1/2}{f_{\rm K}(\chi)}, z(\chi)\right) P_{\rm m,nl}^{\rm MG}\left(\frac{\ell + 1/2}{f_{\rm K}(\chi)}, z(\chi)\right)$$

KiDS

Conclusions

- No S_8 tension
- Fully consistent with CMB constraints from Planck
- Combination of effects moved KiDS from ~3σ to ~0.7σ
- KiDS-Legacy is the most internally and externally consistent KiDS cosmic shear analysis

KiDS

KiDS-Legacy

Road to the stars
Reach New Heights
The Astrophysics welfare committee
ASTRO VETERANS EXPLAINING THE MEME WALL TO THE NEW RECRUITS
IS YOUR CHILD TEXTING ABOUT COSMOLOGY?
ASTRO PEOPLE WATCHING
JOIN US AT ULMC
WE'RE NOT
Dr. Jo Barstow Eberhardt
astrophysics
Lucy Hogarth
Celebrating International Women's Day (March 8th)
Prof. Dorothy Duffy
matterphysics
Here to support you.
Cosmologists
Lambda-CDM
EVERY TIME I USE THE SINK
ONE DOES NOT SIMPLY
"JUST MAKE NEW MEMES"
Marked Safe From Worms Today
ASTRONOMY
MUCH MORE FUN WHEN YOU GIVE IT UP
SCIENTISTS FOR XR
Office 301 people when ___ leaves for a month
4 WEEKS LATER

KiDS-Legacy

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Disclaimer: I do not take responsibility for the creation of this meme

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