KiDS-1000 and DES-Y1 combined: Cosmology from peak count statistics [http://arXiv.org/abs/2405.10312]

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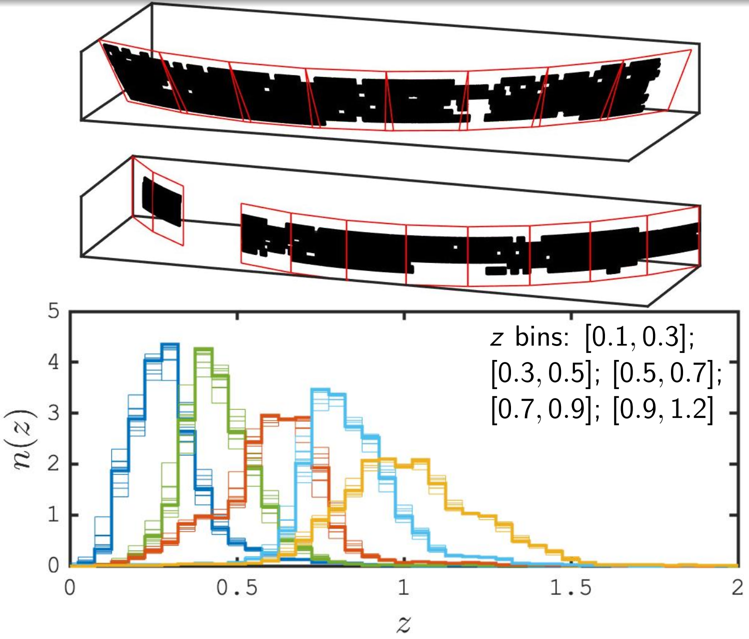
June 5, 2024

The KiDS-1000 Survey

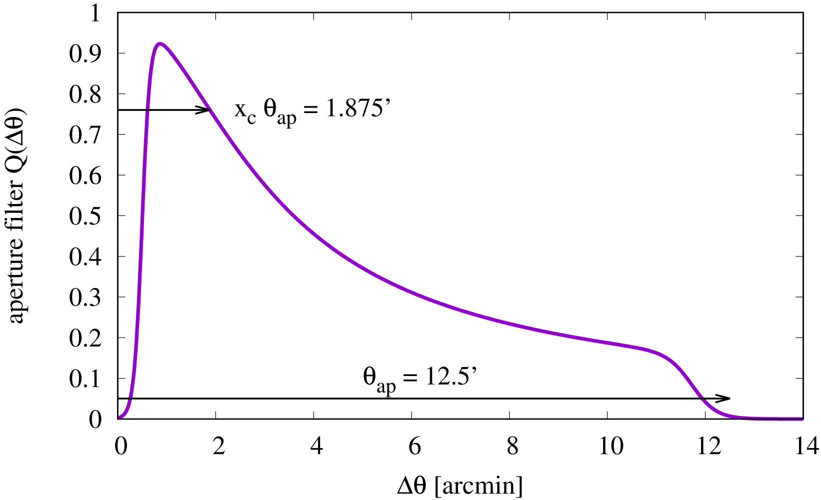


Aperture mass

$$M_{\rm ap}(\vec{\theta}) = \frac{\sum_a W_a \epsilon_{a,t}(\vec{\theta},\vec{\theta}_a) Q(\left|\vec{\theta}-\vec{\theta}_a\right|,\theta_{\rm ap},x_c)}{n_{\rm gal}(\vec{\theta}) \sum_a W_a(1+m_a)}$$

where $\theta_{\rm ap} = 12.5$ arcmin, $x_c = 0.15$

- a runs over galaxies
- $\epsilon_{a,t}$ is tangential ellipticity
- Q optimized for NFW haloes



Aperture mass peaks

Aperture mass and its variance:

$$M_{\rm ap}(\vec{\theta}) = \frac{1}{n_{\rm gal}(\vec{\theta})\sum_a W_a(1+m_a)} \sum_a W_a \epsilon_{a,t}(\vec{\theta}, \vec{\theta}_a) Q\left(\left|\vec{\theta} - \vec{\theta}_a\right|, \theta_{\rm ap}, x_c\right)$$

$$\sigma^2_{\rm ap}(\vec{\theta}) = \frac{1}{2n_{\rm gal}(\vec{\theta})^2(\sum_a W_a)^2} \sum_a W_a^2 \left|\epsilon_a\right|^2 \left|Q\left(|\vec{\theta} - \vec{\theta}_a|, \theta_{\rm ap}, x_c\right)\right|^2$$

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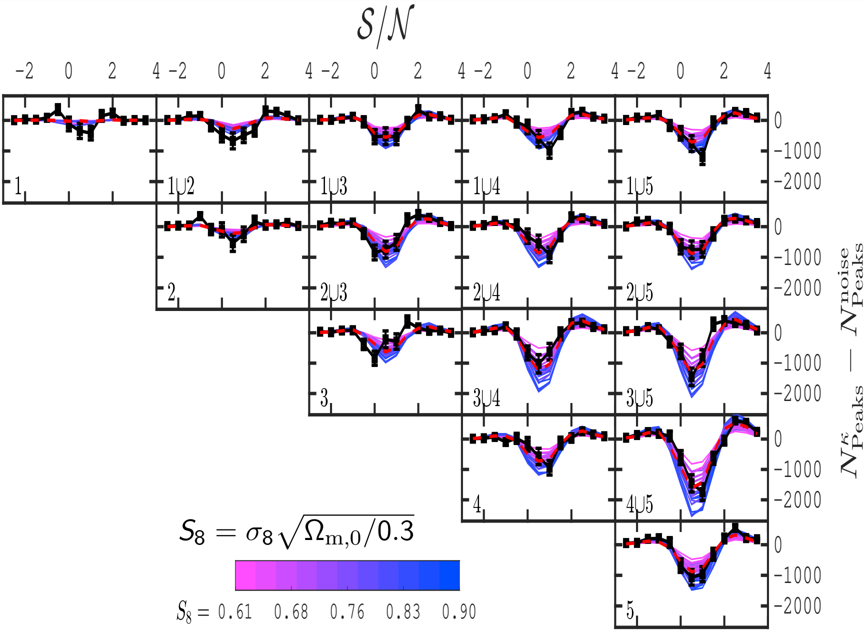
Peaks are local maxima in the signal-to-noise

$$\mathcal{S}/N = M_{\rm ap}(\vec{\theta})/\sigma_{\rm ap}(\vec{\theta}).$$

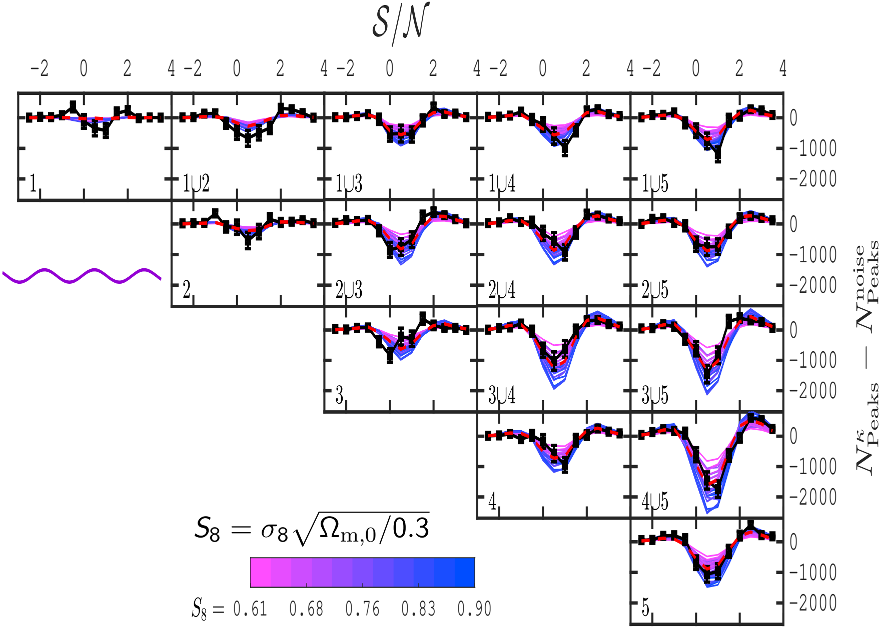
We count the number of such peaks binned by $\mathcal{S}/N$, a quantity which depends upon the cosmological parameters.

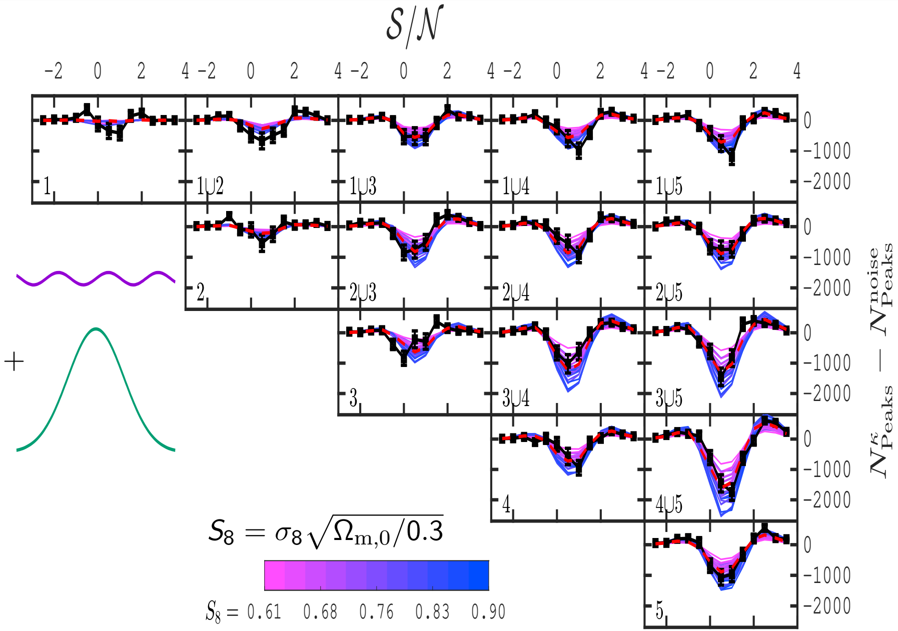
$M_{\rm ap}(\vec{\theta})$ vs. $\kappa(\vec{\theta})$: $M_{\rm ap}$ better for complicated survey geometries.

Observed peaks (black) vs. S_8-dependent predictions



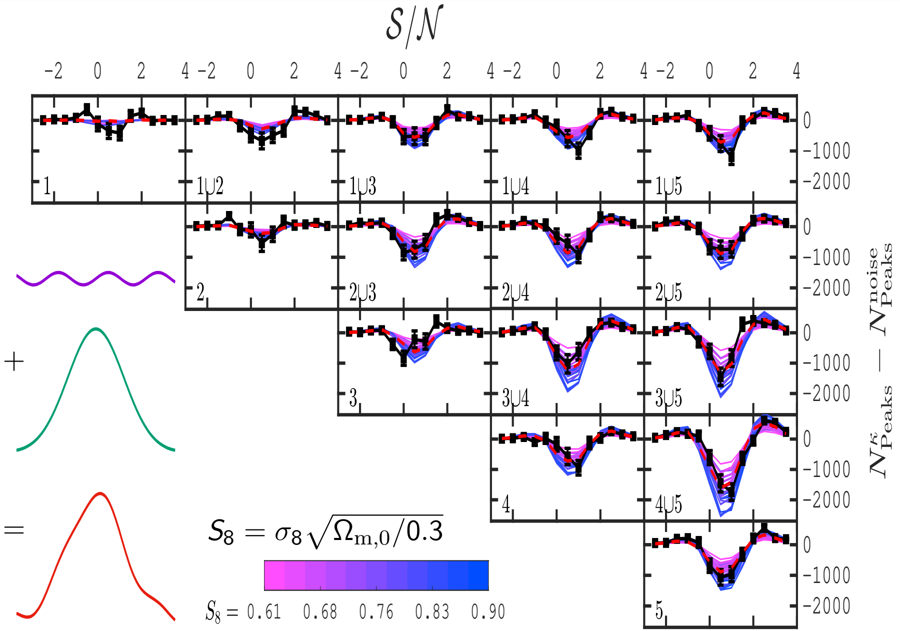
Observed peaks (black) vs. S_8-dependent predictions



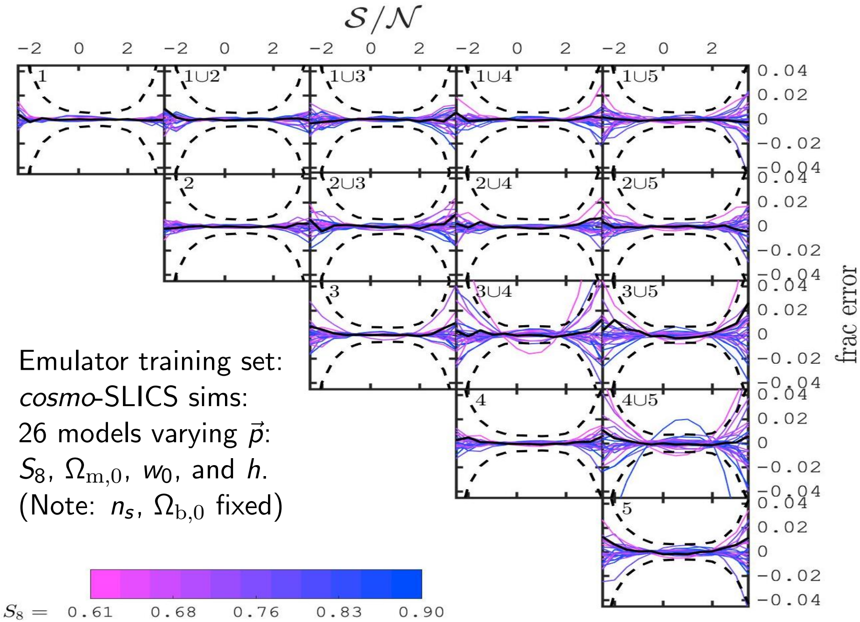


$$S_8 = \sigma_8 \sqrt{\Omega_{\mathrm{m},0}/0.3}$$

Observed peaks (black) vs. S_8-dependent predictions



Emulator holdout tests



Emulator training set:
cosmo-SLICS sims:
26 models varying $\vec{p}$:
S_8, $\Omega_{\mathrm{m},0}$, w_0, and h.
(Note: n_s, $\Omega_{\mathrm{b},0}$ fixed)

Modeling of systematic uncertainties

$$N_{\rm peaks}^{\rm syst}(\vec{p}, \Delta m_b, \Delta z_b, A_{\rm IA}, b_{\rm bary})$$

$$= N_{\rm peaks}^{\rm emu}(\vec{p})$$
- emulator prediction

$$+\frac{\partial N_{\rm peaks}}{\partial \Delta m_b}\Delta m_b$$
- multiplicative calibration in z bin b

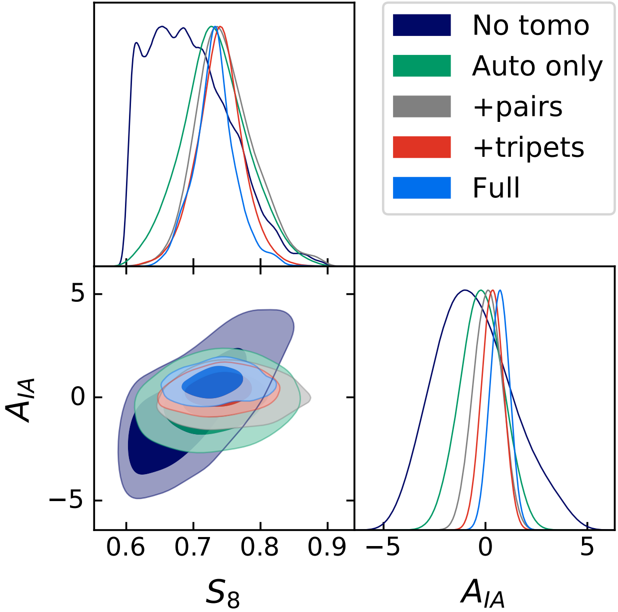
$$+\frac{\partial N_{\rm peaks}}{\partial \Delta z_b}\Delta z_b$$
- photo-z bias in bin b

$$+\frac{\partial N_{\rm peaks}}{\partial A_{\rm IA}}A_{\rm IA}$$
- intrinsic alignment (IA)

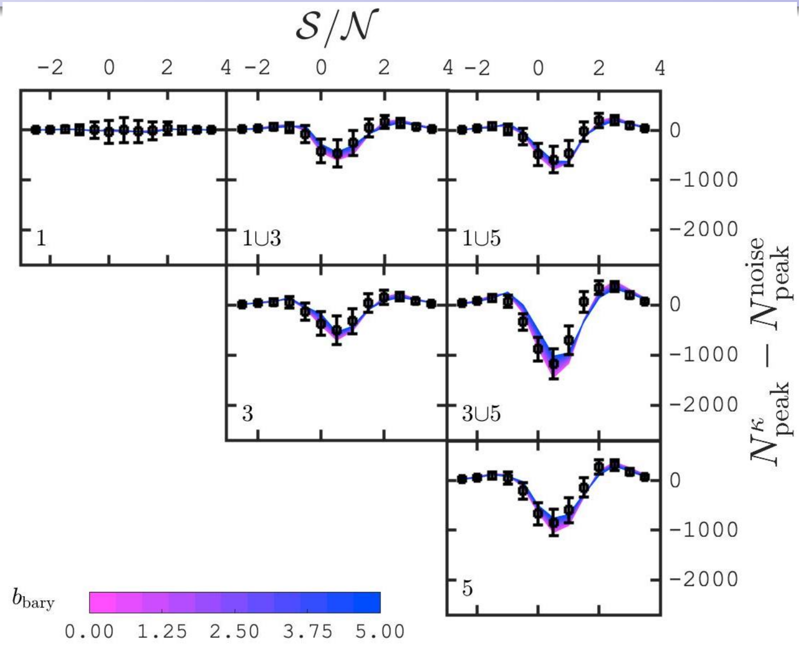
$$+\frac{\partial N_{\rm peaks}}{\partial b_{\rm bary}}b_{\rm bary}$$
- baryonic correction

subdominant:
- N-body resolution; • ray-tracing approximation;
- covariance matrix estimation; • source-lens coupling;
- priors and $\mathcal{L}$ sampling; • $M_\times$ (B) mode contamination

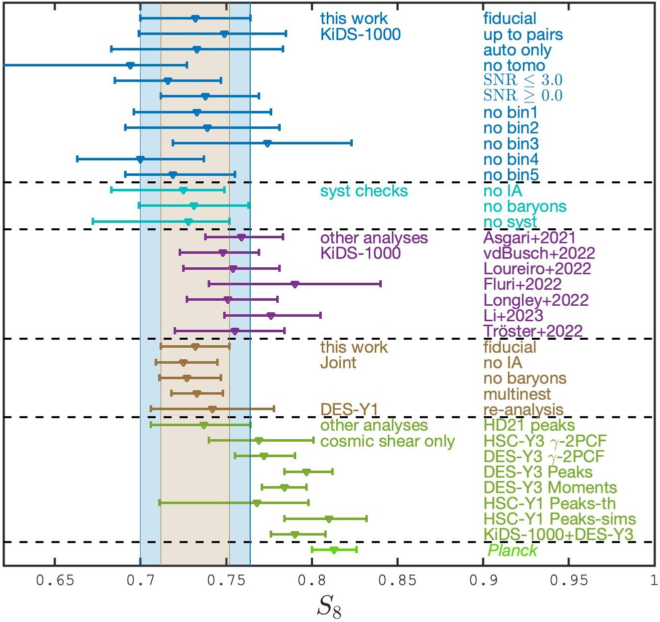
Intrinsic Alignments



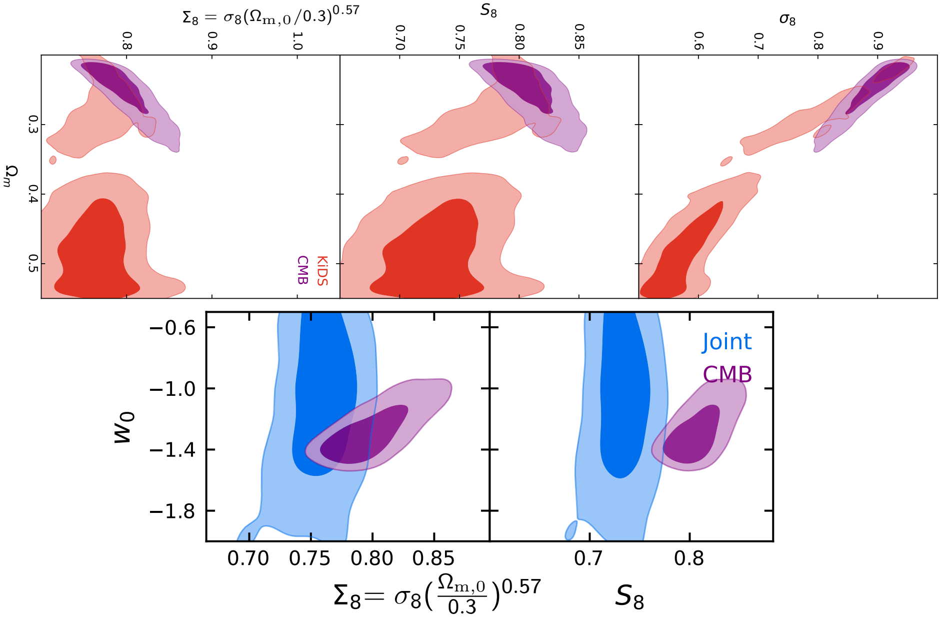
Baryonic effects



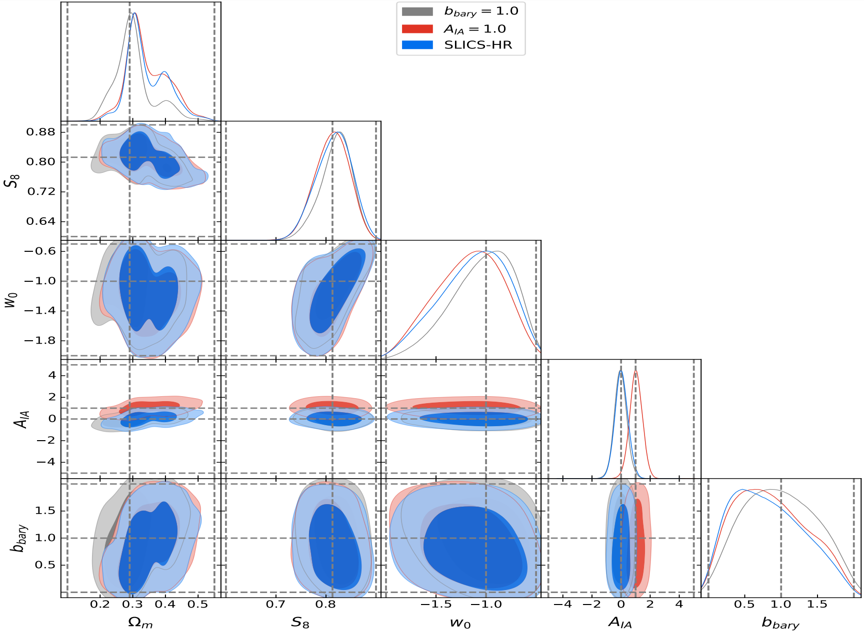
Constraints: S_8



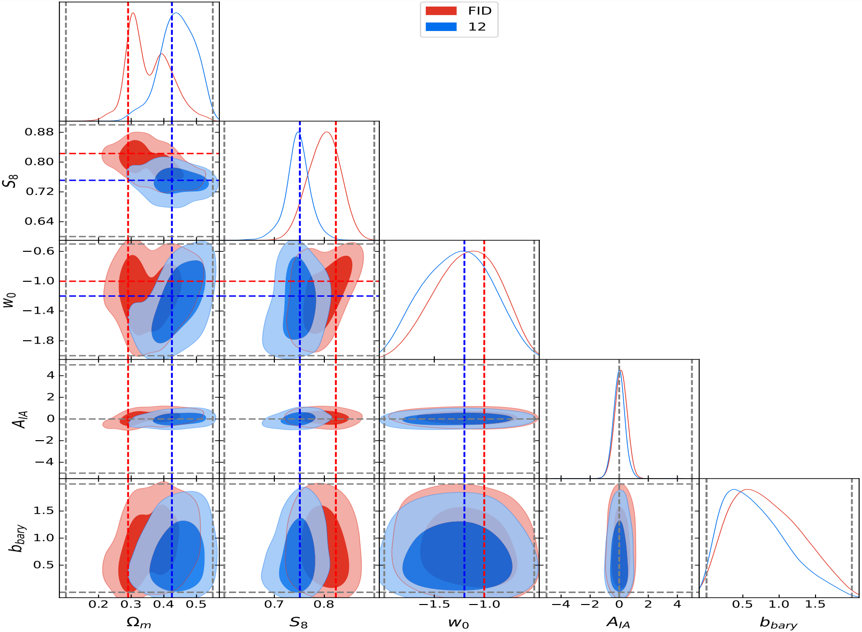
Constraints vs. Planck



Validation: Resolution, IA, and baryons



Validation: Cosmology-dependence of emulator



Validation: Joint KiDS+DES analysis