



Euclid-INFN@TO Activity Report

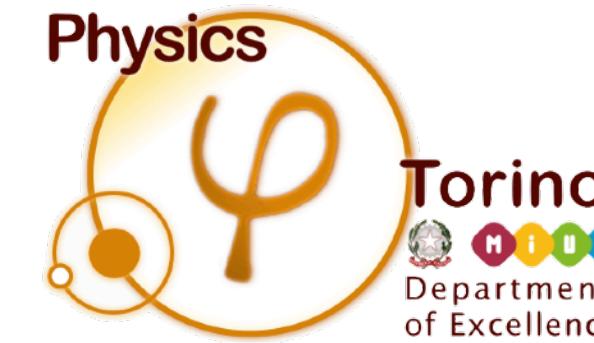
2024

Stepano Camera



Funded by
the European Union
NextGenerationEU

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Dipartimento di Fisica, Università degli Studi di Torino, Italy

Euclid-INFN@TO Group



Stefano Camera
[Associate Professor]

Interface between theoretical and observational cosmology; multi-wavelength synergies

Euclid Builder, ECPG-S member, DR1 KP-JC-1 Coordinator



Francesco Pace
[Researcher]

Theoretical tools for linear and non-linear perturbations; comparison of theory vs data vs N-body simulations

SWG-Theory WP7 Lead



Nicolao Fornengo
[Full Professor]

Particle dark matter modelling and indirect detection; multi-wavelength synergies

Cross-correlation of Euclid's clustering/lensing and gamma ray maps



Lorenzo Fatibene
[Full Professor]

General relativity and extended theories of gravity

Covariant metrologic conventions to fill the gap between theory and experiments



Matteo Luca Ruggiero
[Researcher]

General relativity and extended theories of gravity

Congruence of light like geodesic trajectories



Benedict Bahr Kalus
[Postdoctoral Researcher]

Cosmology w/ Euclid and SKAO pathfinders/ precursors in auto- and cross-correlations



Giulia Piccirilli
[Postdoctoral Researcher]

Cosmology w/ Euclid and SKAO pathfinders/ precursors in auto- and cross-correlations



Sam Rossiter
[3rd-yr PhD Student]

Modelling of relativistic corrections to galaxy clustering bispectrum



Federico Montano
[1st-yr PhD Student]

Detection of relativistic effects in power spectrum (cross-correlations, multi-tracer, flux-tomography)



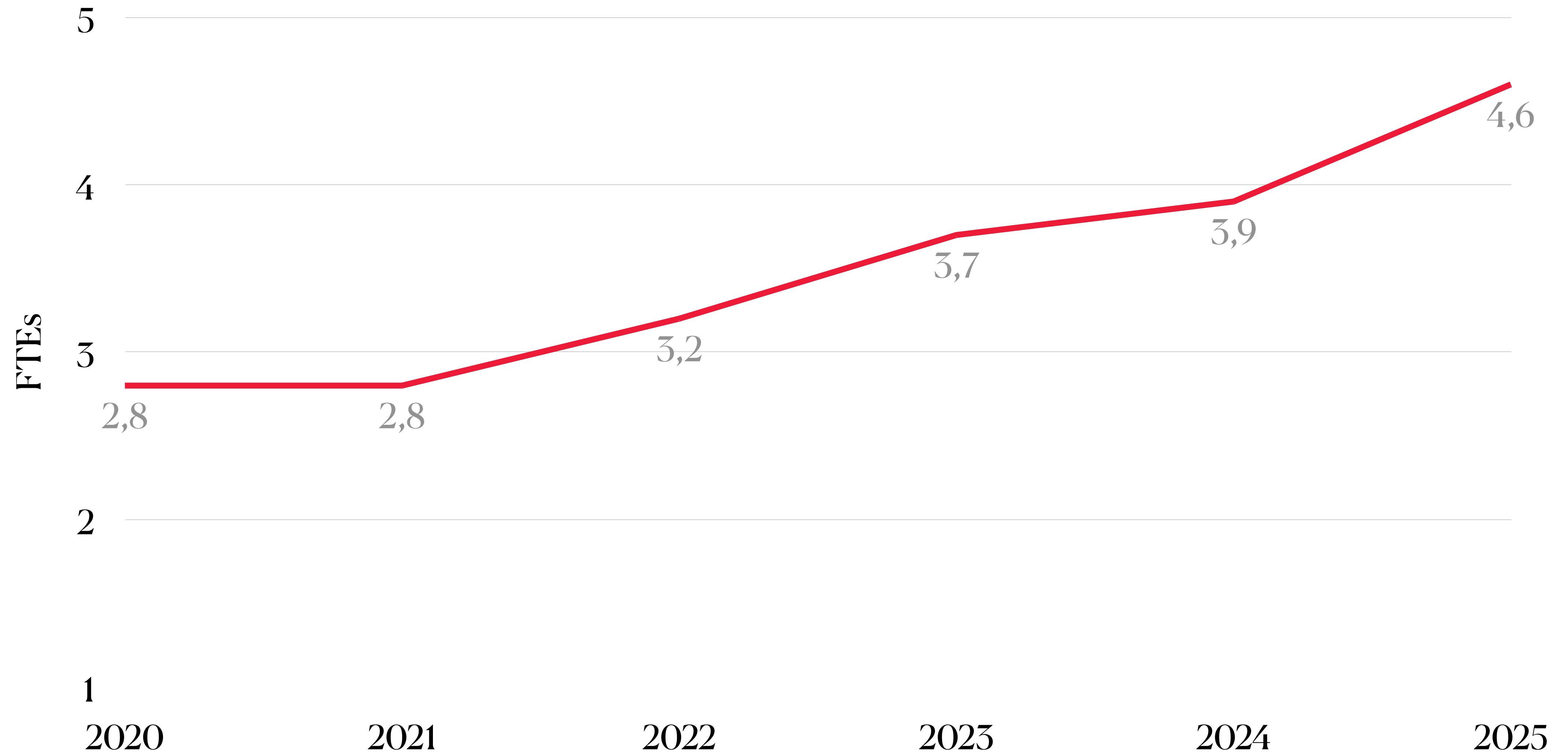
Jiakang (Jack) Han
[1st-yr PhD Student]

Forecasts for CIB-clustering/lensing cross-correlations



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- Who are we?
 - Active and proactive group; built up momentum over the years; diverse set of skills, building bridges between theory and observations; good balance between senior and junior members (~30% w/ management roles and ~70% working on projects)

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- Proficiencies and know-how
 - Large-scale structure of the Universe; cosmological perturbations (linear and non-linear regimes); extended models of gravity for dark matter and dark energy; modelling of power spectra in Fourier and harmonic space; novel observables and multi-wavelength synergies; development of techniques to detect of yet-unobserved effects

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- Involvement in the Euclid Consortium
 - Galaxy Clustering, Weak Lensing, Theory, and CMBX Science Working Groups (SWGs)
 - Inter SWG Taskforces (ISTs) for Forecasts, Likelihood, and Non-linearities
 - Diversity Committee, Publication Group, pre-launch and DR1 Key Project (KP) coordination

Research activities in 2024

- Milestone
 - Submission to the Euclid Consortium Editorial Board of KP-GC-7 Paper 11 (Euclid Collaboration: Turin et al.) [see later]

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- Other deliverables
 1. Euclid Collaboration: Tanidis et al. A&A, 683, A17 (2024)
 2. Euclid Collaboration: Jelic-Cizmek et al. A&A, 685, A167 (2024)
 3. Submission of Euclid Collaboration: Koyama et al. arXiv:2409.03524
 4. Submission of Euclid Collaboration: Lesgourgues et al. arXiv:2406.18274
 5. Submission of Euclid Collaboration: Archidiacono et al. arXiv:2405.06047 [see later]
 6. Submission of Euclid Collaboration: Mellier et al. arXiv:2405.13491
 7. Development of new technique to detect relativistic effects in power spectrum [see later]



Milestone

Euclid preparation

**TBD. Harmonic-space measurements of clustering, growth, and magnification
with *Euclid*'s spectroscopic and photometric galaxy samples**

Euclid Collaboration: S. Camera,^{1, 2, 3*} K. Tanidis,^{4, 5} B.R. Granett,⁶ I. Tutusaus,⁷ N. Dalmasso,¹

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- Observed fluctuation in galaxy number counts

$$\Delta = b \delta - \frac{\partial_{\parallel}^2 V}{\mathcal{H}} - (2 - 5 s) \kappa + \Delta^{(\text{loc})} + \Delta^{(\text{int})}$$



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- Template fitting

$$P_{\Delta\Delta}(k, \mu; \bar{z}) \simeq [b(\bar{z}) + f(\bar{z}) \mu^2]^2 D^2(\bar{z}) P_{\text{lin}}(k)$$

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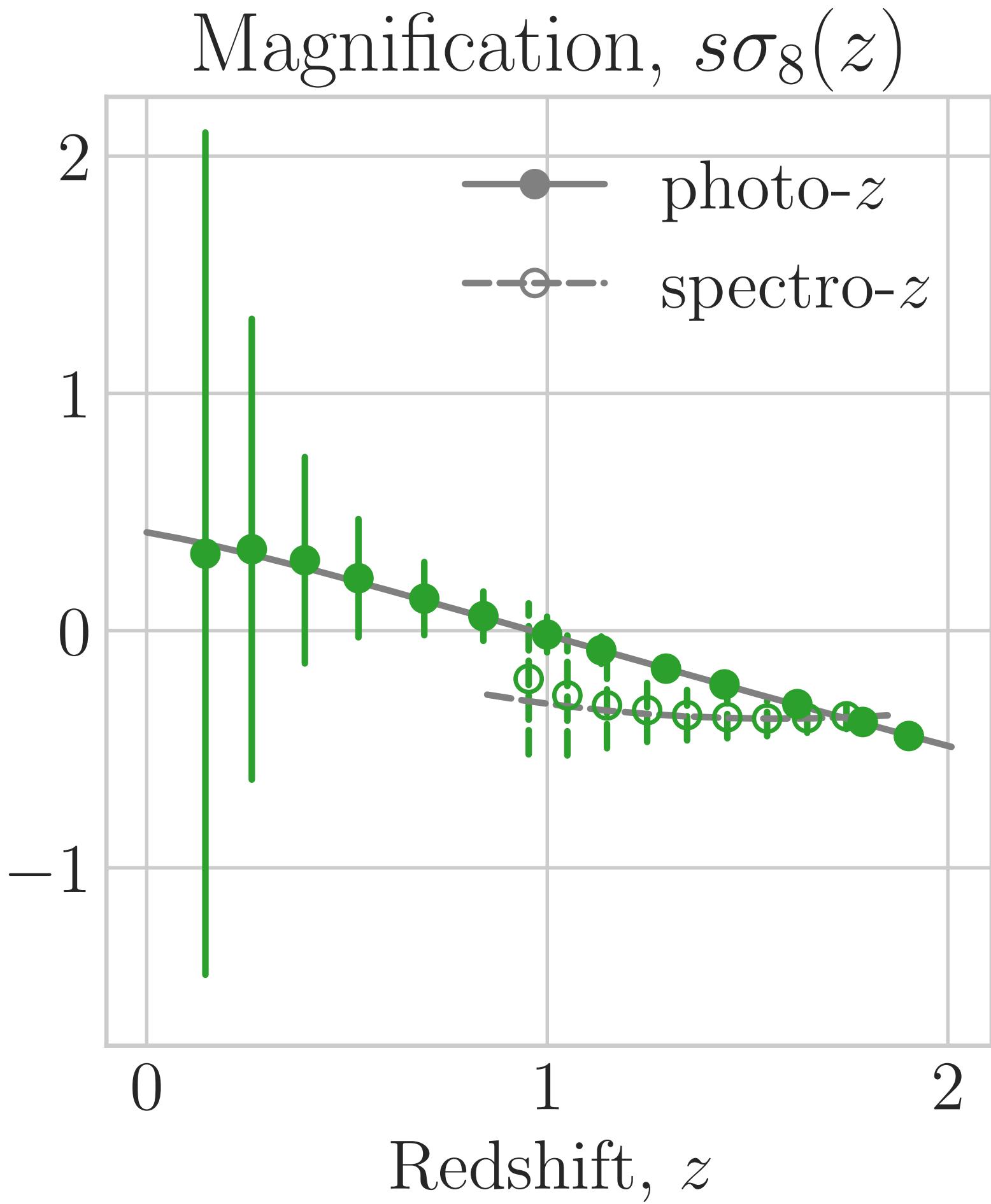
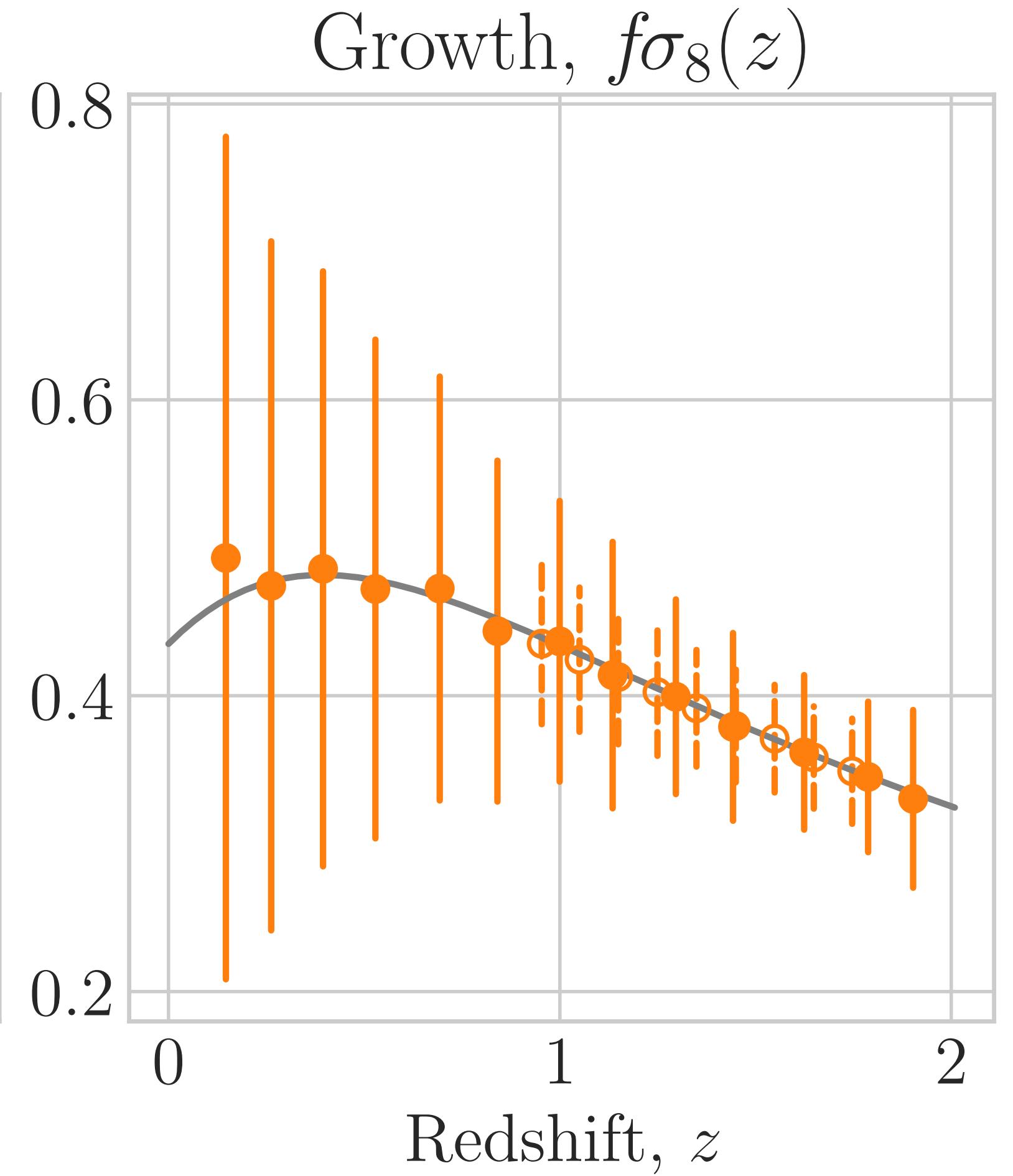
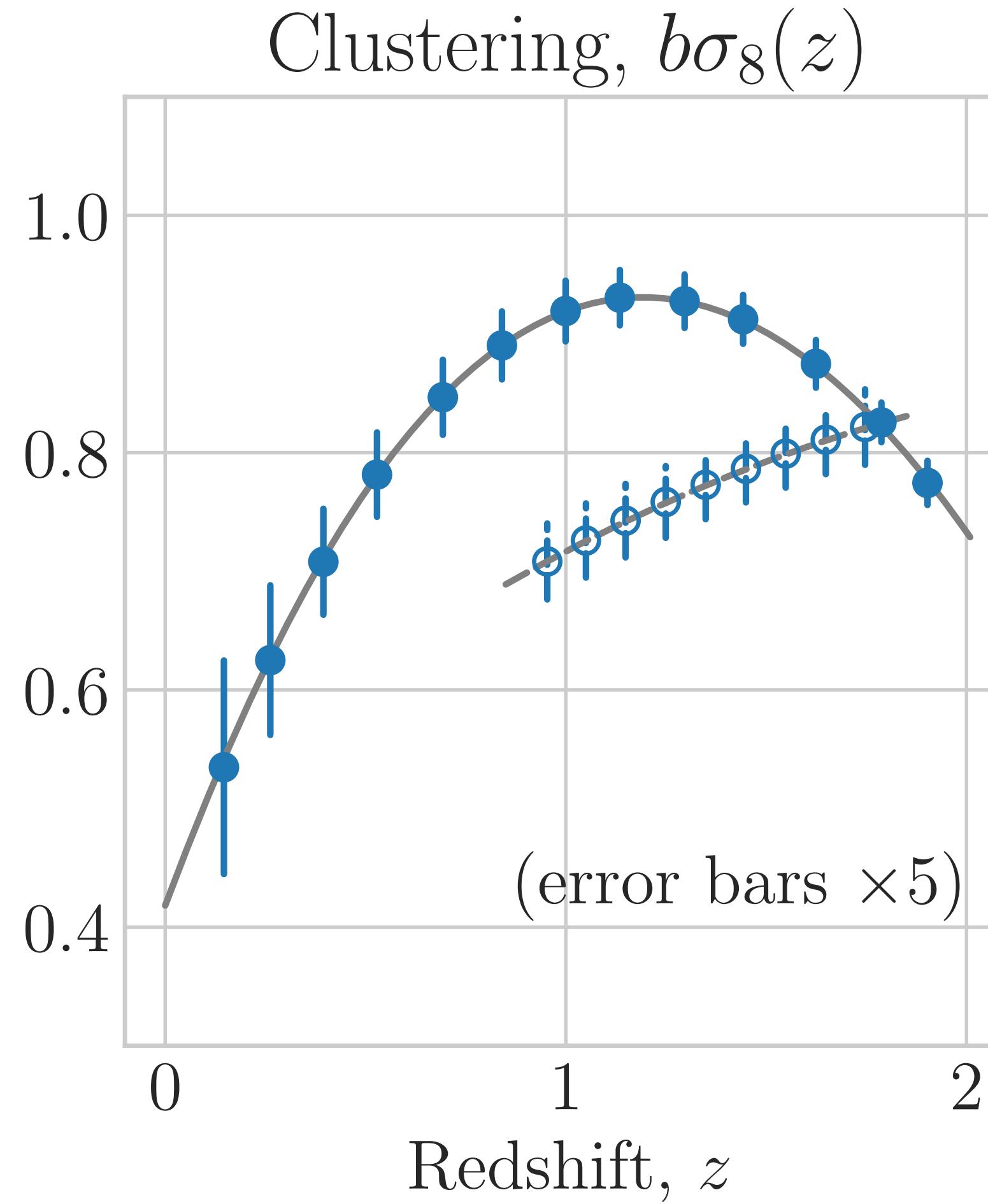


- Template fitting

$$S_{ij,\ell}^{\Delta\Delta} \simeq \underbrace{b\sigma_{8,i} b\sigma_{8,j} T_{ij,\ell}^{\delta\delta}}_{S_{ij,\ell}^{\text{den den}}} + \underbrace{f\sigma_{8,i} f\sigma_{8,j} T_{ij,\ell}^{\theta\theta}}_{S_{ij,\ell}^{\text{RSD RSD}}} + \underbrace{s\sigma_{8,i} s\sigma_{8,j} T_{ij,\ell}^{\kappa\kappa}}_{S_{ij,\ell}^{\text{len len}}} - 2 \underbrace{\left(b\sigma_8 f\sigma_8^T \circ \mathsf{T}_\ell^{\delta\theta} \right)_{(ij)}}_{S_{ij,\ell}^{\text{den RSD}}} - 2 \underbrace{\left(b\sigma_8 s\sigma_8^T \circ \mathsf{T}_\ell^{\delta\kappa} \right)_{(ij)}}_{S_{ij,\ell}^{\text{den len}}} + 2 \underbrace{\left(f\sigma_8 s\sigma_8^T \circ \mathsf{T}_\ell^{\theta\kappa} \right)_{(ij)}}_{S_{ij,\ell}^{\text{RSD len}}}$$

[EC KPP Camera et al. (TBS)]

Milestone

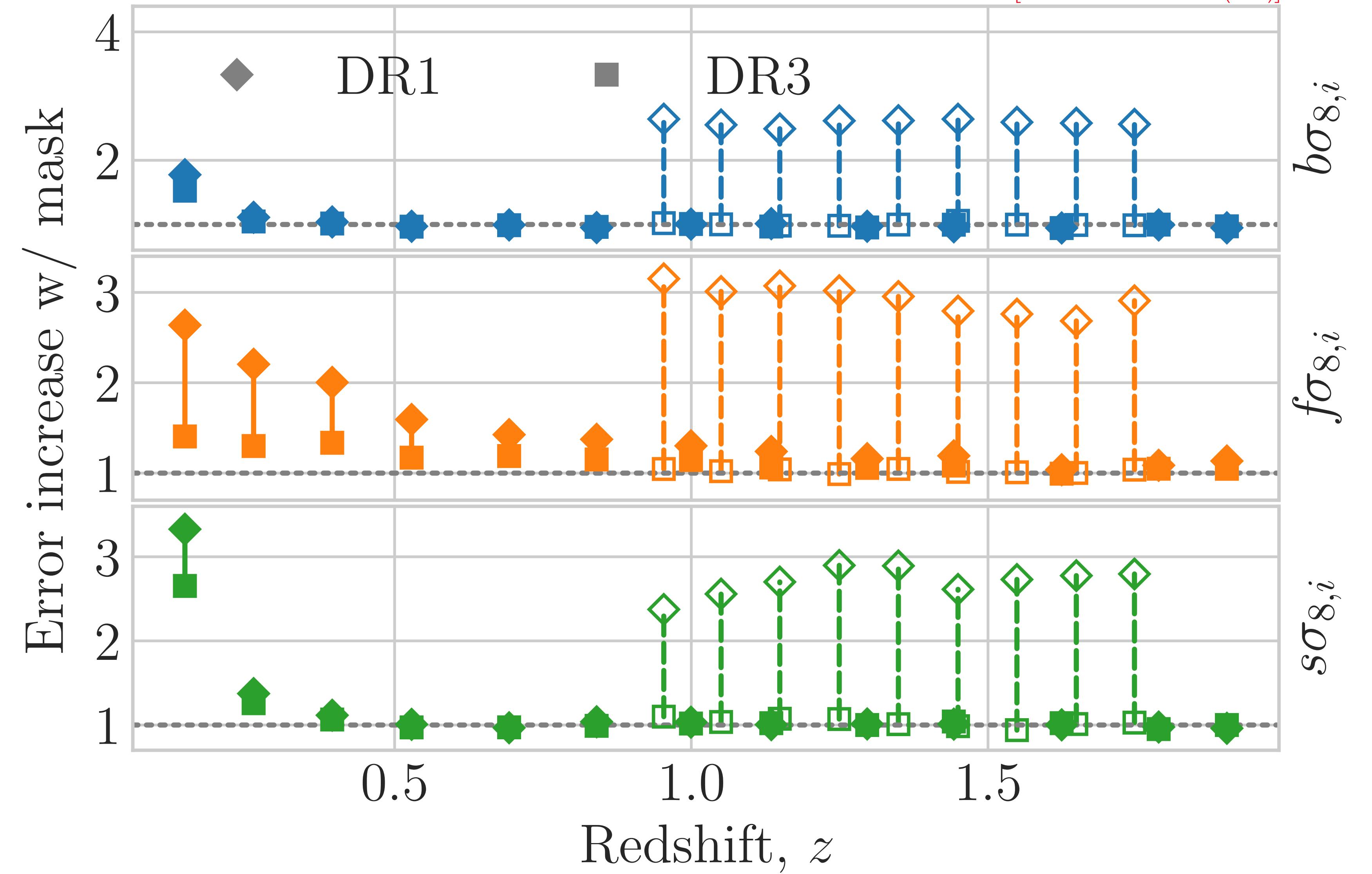


Milestone



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[EC KPP Camera et al. (TBS)]



Other deliverables no. 2

Euclid preparation

Sensitivity to neutrino parameters

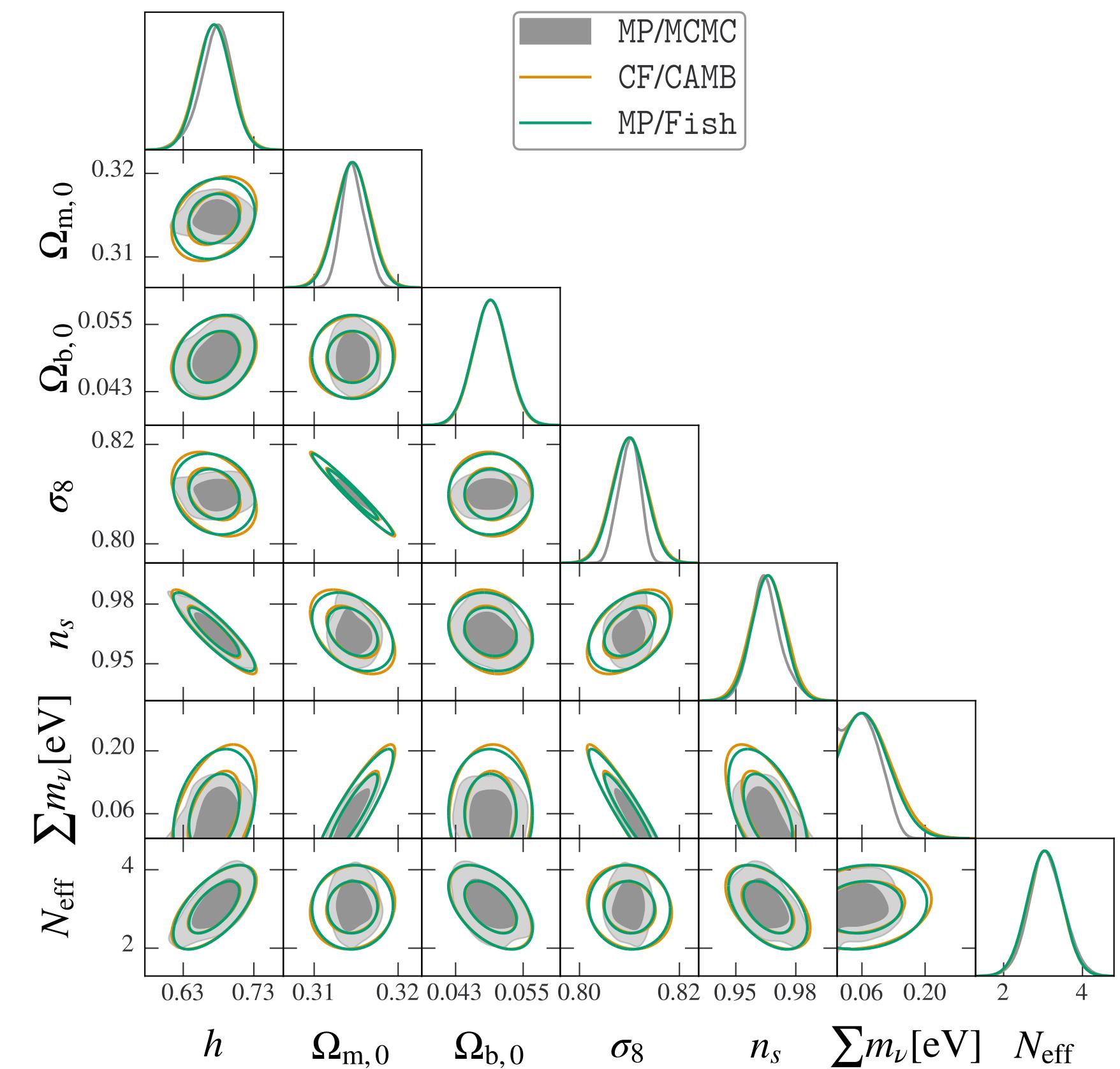
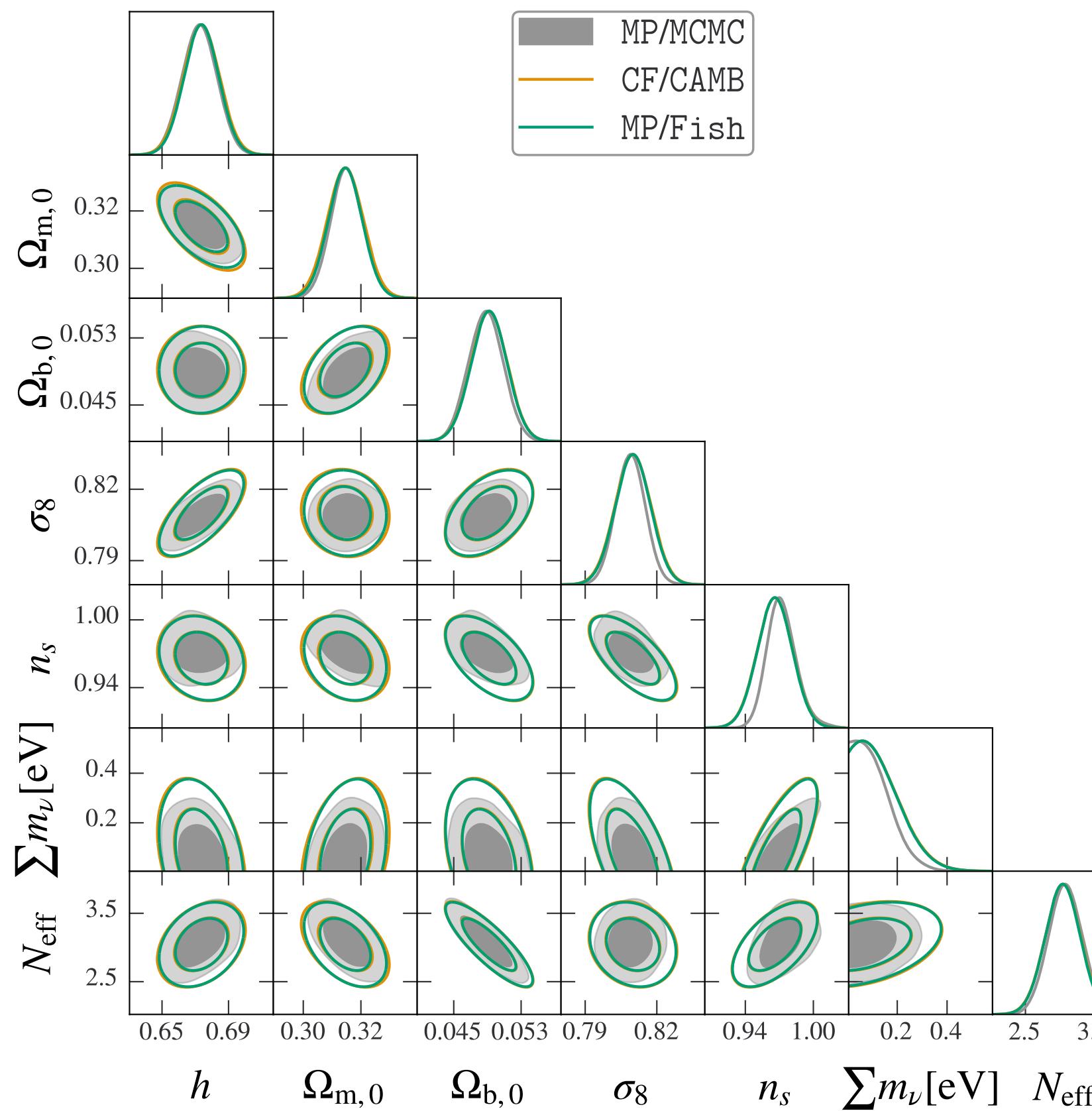
Euclid Collaboration: M. Archidiacono^{✉^{1,2}}, J. Lesgourgues^{✉³}, S. Casas^{✉³}, S. Pamuk^{✉³}, N. Schöneberg^{✉⁴}, Z. Sakr^{✉^{5,6,7}}, G. Parimbelli^{✉^{8,9,10}}, A. Schneider^{✉¹¹}, F. Hervas Peters^{✉^{12,11}}, F. Pace^{✉^{13,14,15}},

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	$\Lambda\text{CDM} + \sum m_\nu + \Delta N_{\text{eff}}$						
	$\Omega_{\text{m},0}$	$100\Omega_{\text{b},0}$	h	n_s	σ_8	$\sum m_\nu [\text{meV}]$	ΔN_{eff}
<i>Euclid</i> -only							
WL+GC _{ph} +XC _{ph} +GC _{sp}	0.0026	0.19	0.023	0.012	0.0039	< 220	< 0.746
<i>Euclid</i> +CMB							
<i>Euclid</i> + <i>Planck</i>	0.0022	0.037	0.0028	0.0021	0.0031	25	< 0.144
<i>Euclid</i> +CMB-S4+LiteBIRD	0.0019	0.025	0.0018	0.0016	0.0025	16	< 0.063

Other achievement no. 7

- Development of new technique to detect relativistic effects in power spectrum

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Auto- and cross-correlation measurements

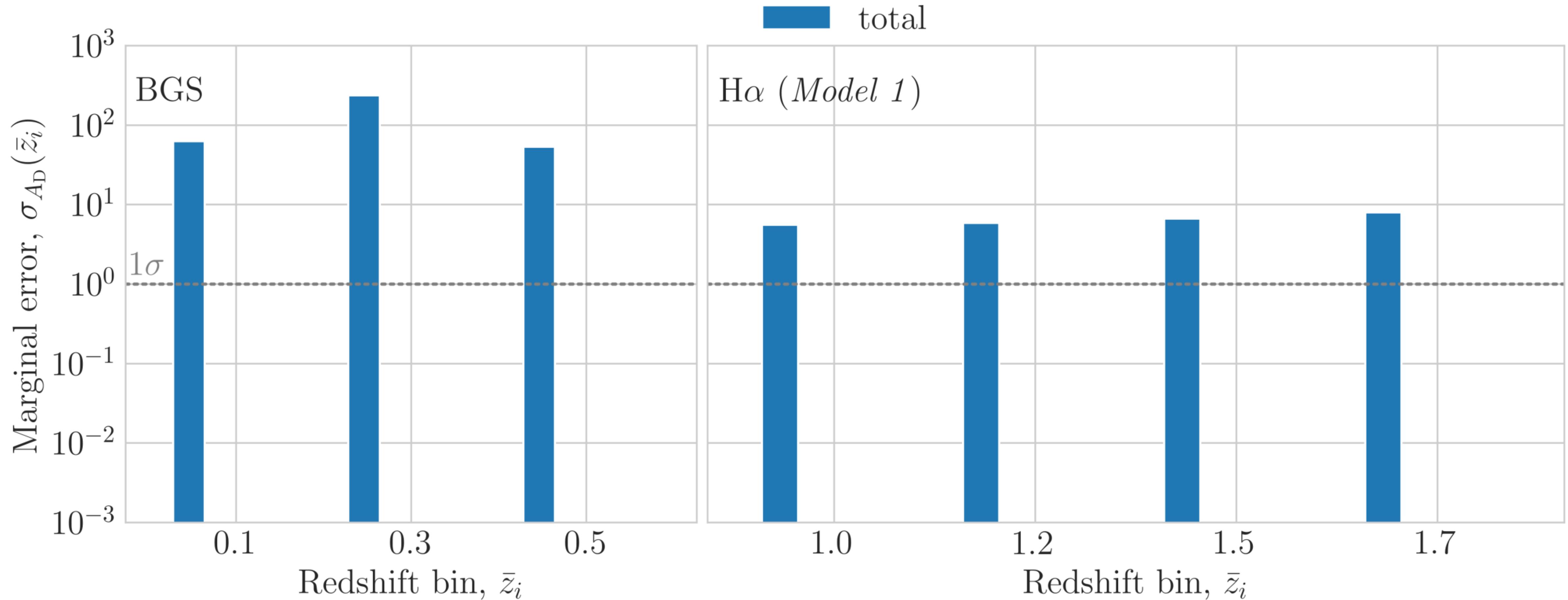
$$\begin{aligned} \bullet <\delta_X(\vec{k})\delta_Y(\vec{k}')> &\propto \delta^D(\vec{k} + \vec{k}') P_{XY}(k) \\ P_{XY}(z, k, \mu) = & \\ &= \left[(b_X + f\mu^2)(b_Y + f\mu^2) + \left(\frac{\mathcal{H}f\mu}{k}\right)^2 \alpha_X \alpha_Y \right. \\ &\quad \left. + i \frac{\mathcal{H}f\mu}{k} (\alpha_X(b_Y + f\mu^2) - \alpha_Y(b_X + f\mu^2)) \right] P_m(k) \end{aligned}$$

- $X = Y \rightarrow$ auto-correlation
- $X \neq Y \rightarrow$ cross-correlation

[Courtesy of F. Montano]

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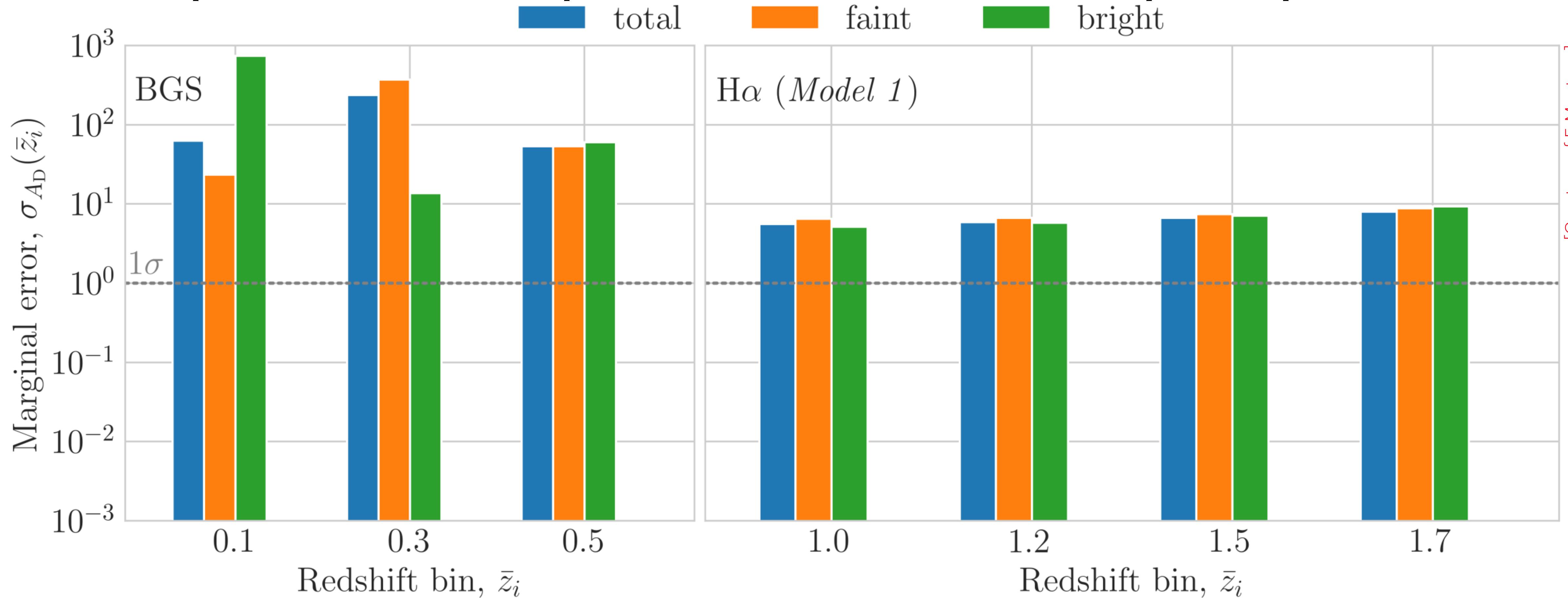


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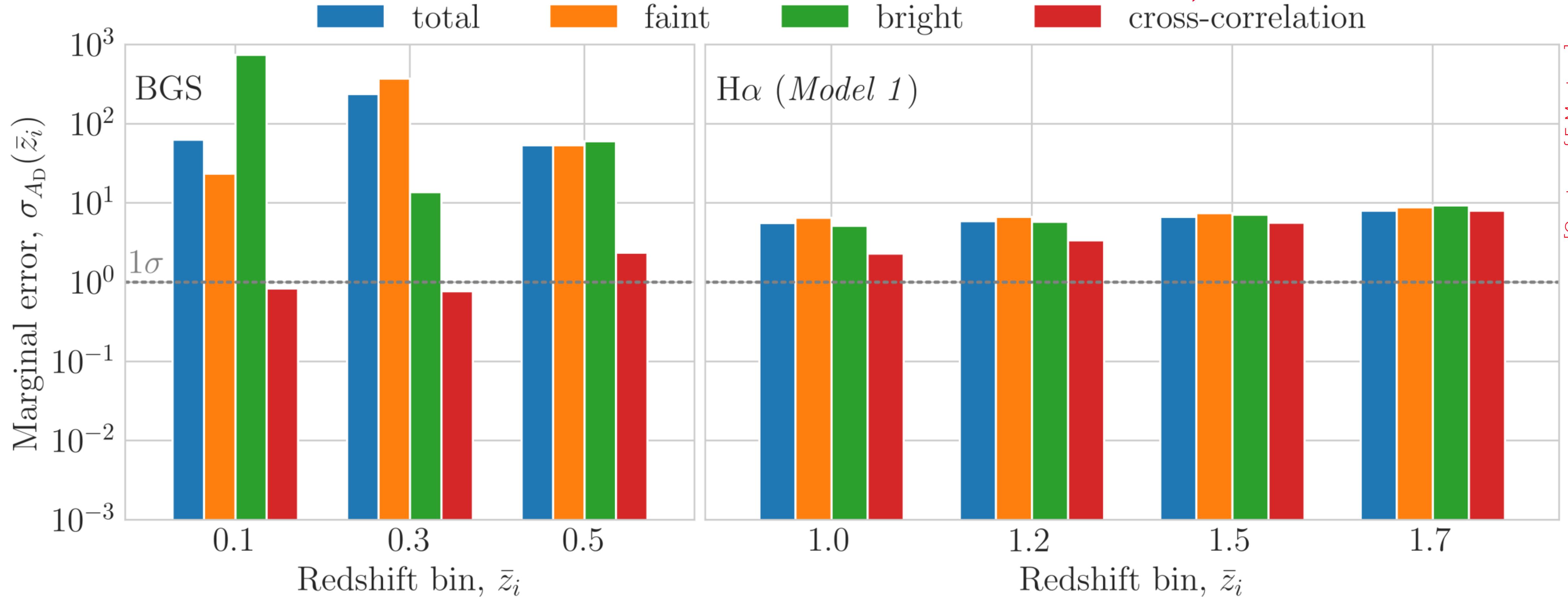
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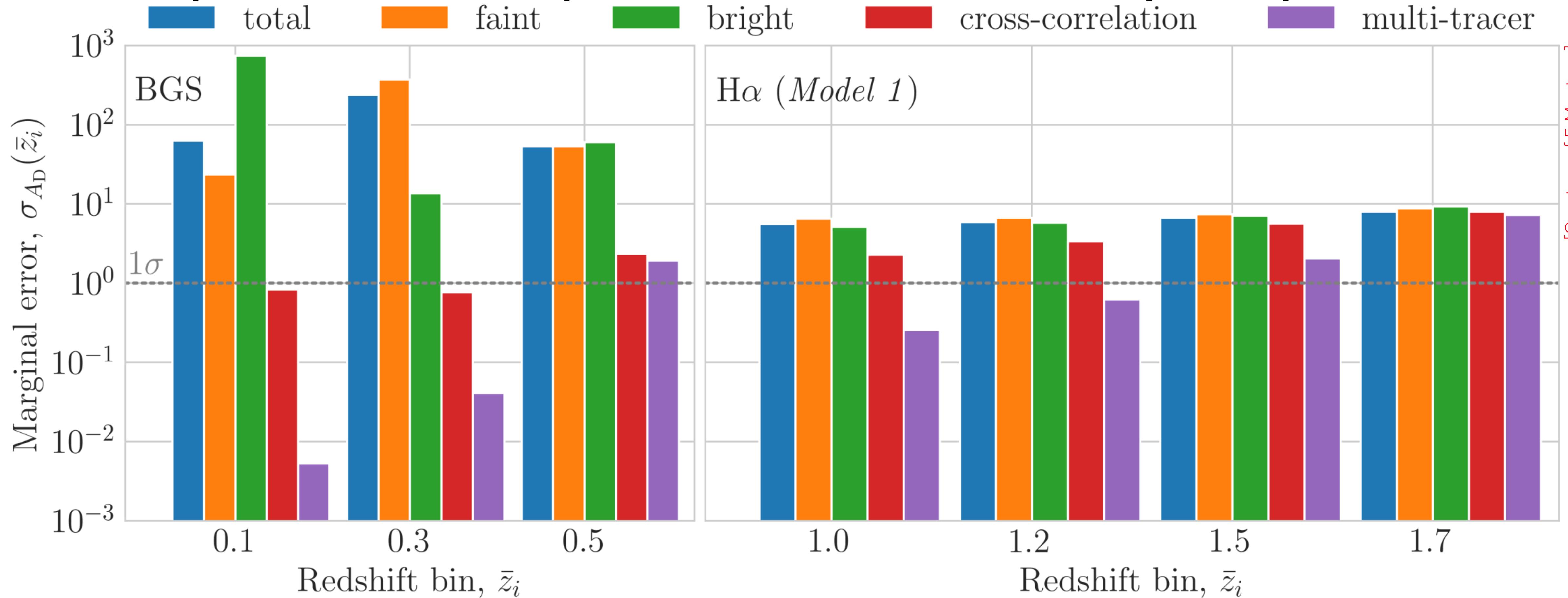
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Plan for 2025

- Work on DR1 KPs
 - Coordination of the Joint Cosmology KP no. 2 (cosmology with photometric observables)