CosmoGold

University of Edinburgh

Impacts of variable depth on weak-lensing covariance

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June 28th, 2019

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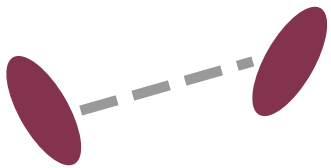
3×2pt analysis

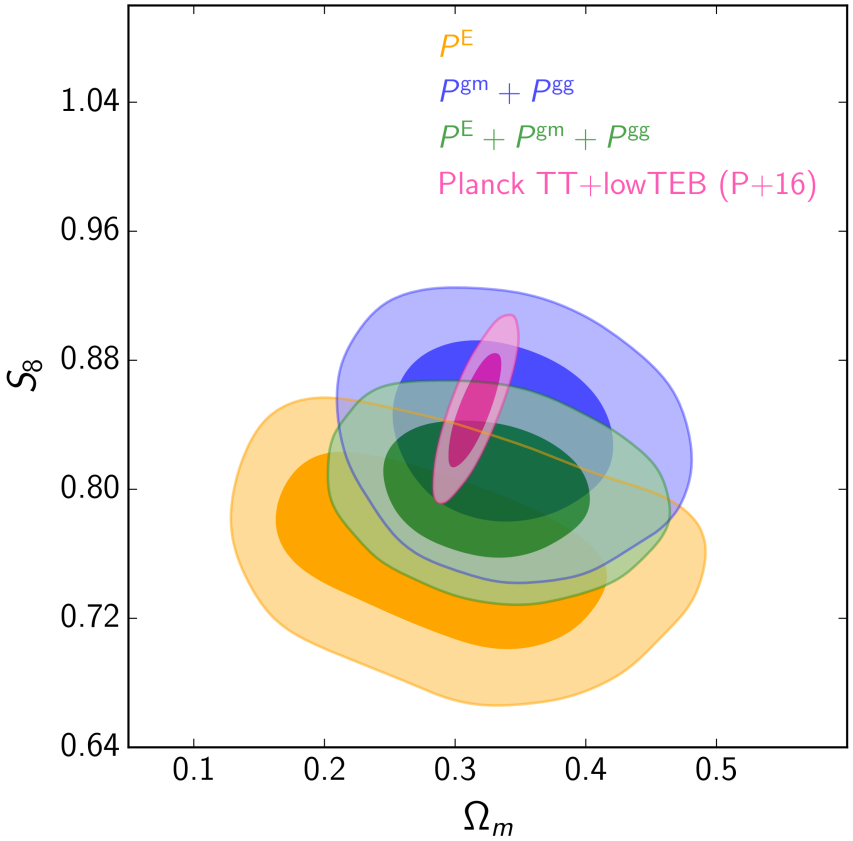
- Galaxy position: biased tracer of matter
- Galaxy shape: noisy tracer of projected matter

⟨ position position ⟩ galaxy clustering w

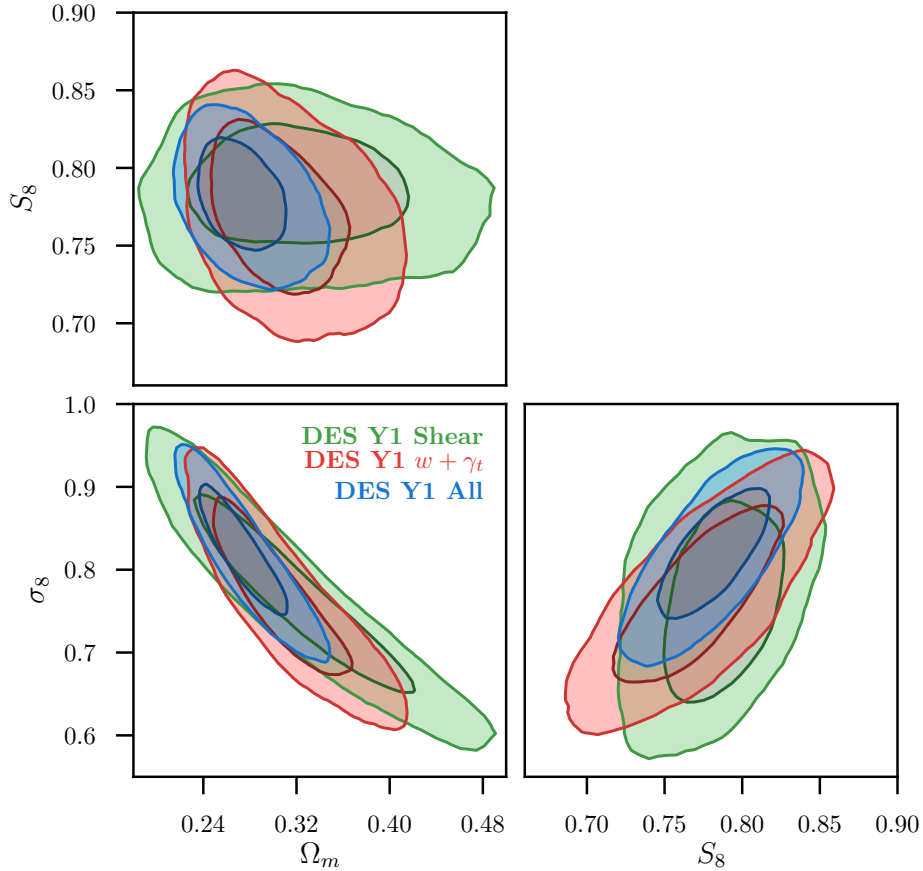
⟨ position shape ⟩ galaxy-galaxy lensing γ_+

⟨ shape shape ⟩  cosmic shear $\xi_\pm$

State of the art

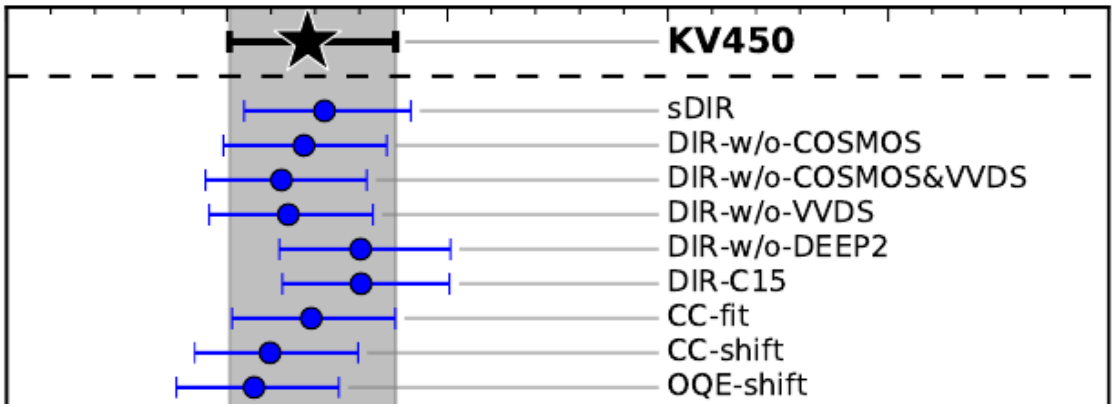


KiDS Collaboration
(van Uitert et al. 2018)



DES Collaboration (2018)

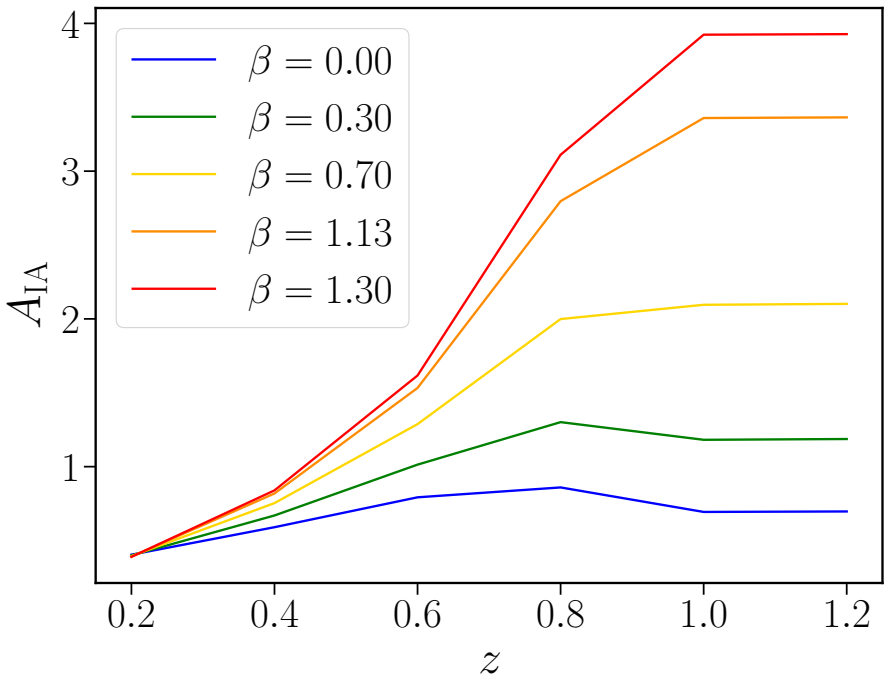
3x2pt: better constraints



Hildebrandt et al. (2019), Hendrik's talk

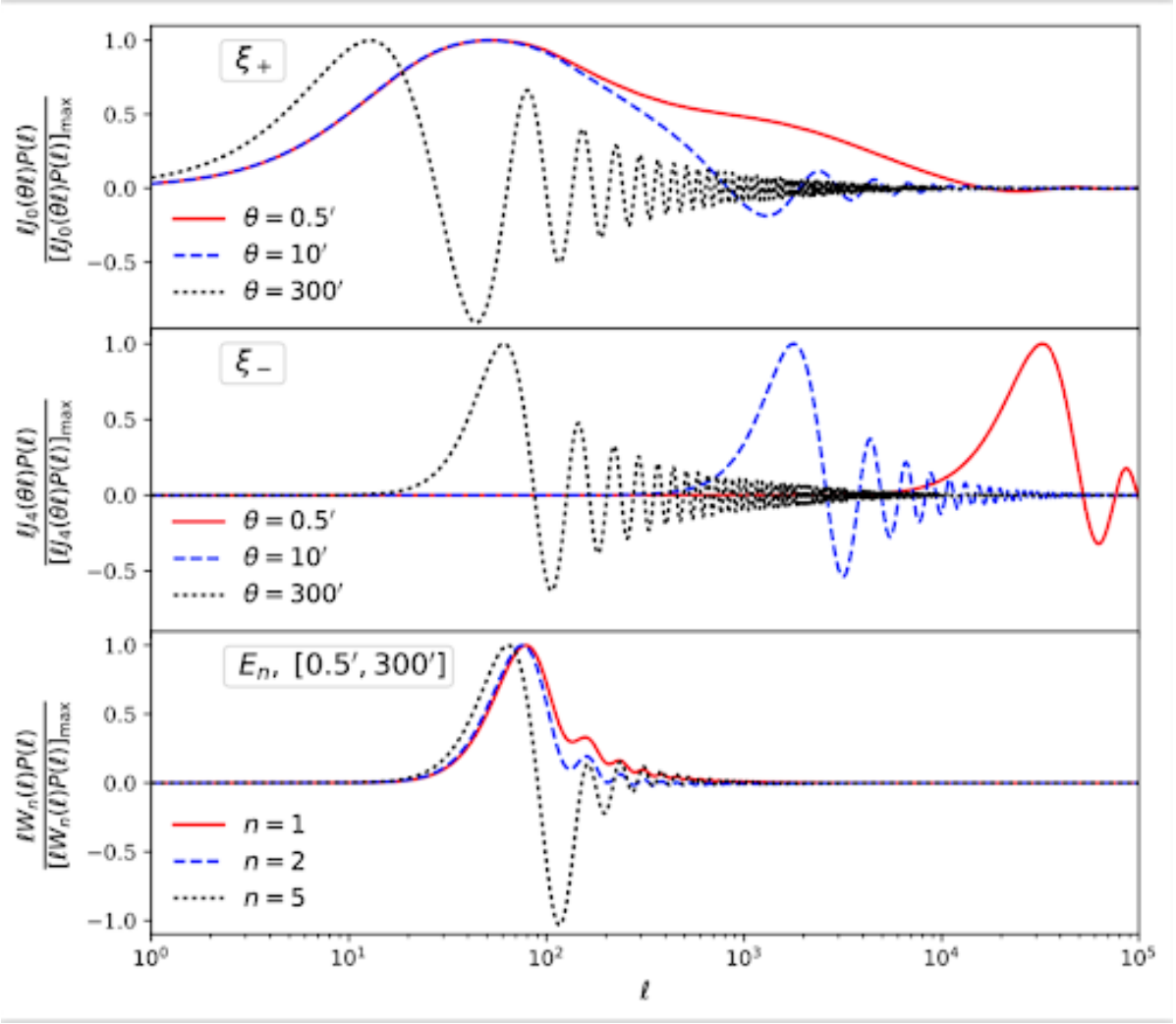
Systematics

(a reminder for Elisabeth's talk)



Maria Cristina's talk

- Redshift distributions
- Intrinsic alignment
- Shape measurement
- Galaxy bias



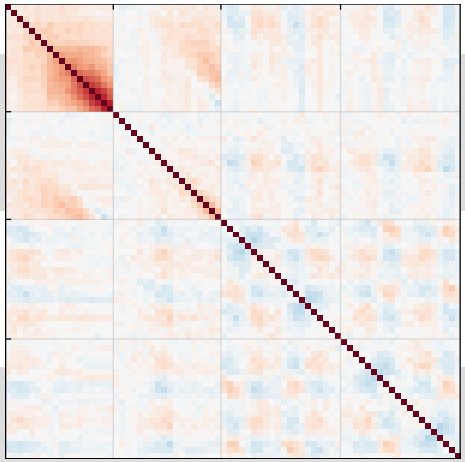
Asgari et al. in prep., Marika's talk

Systematics

- Baryon feedbacks or scale cuts
- Survey effects (this talk)
- etc.

Covariance is (one of) the key(s)

Estimation from data



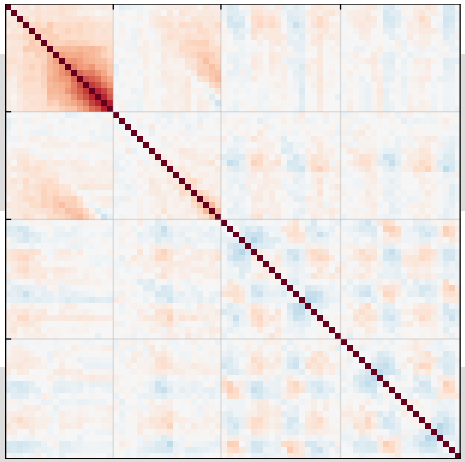
Analytical formalism

N-body simulations

Covariance is (one of) the key(s)

Estimation from data

- Risky if subsamples are correlated



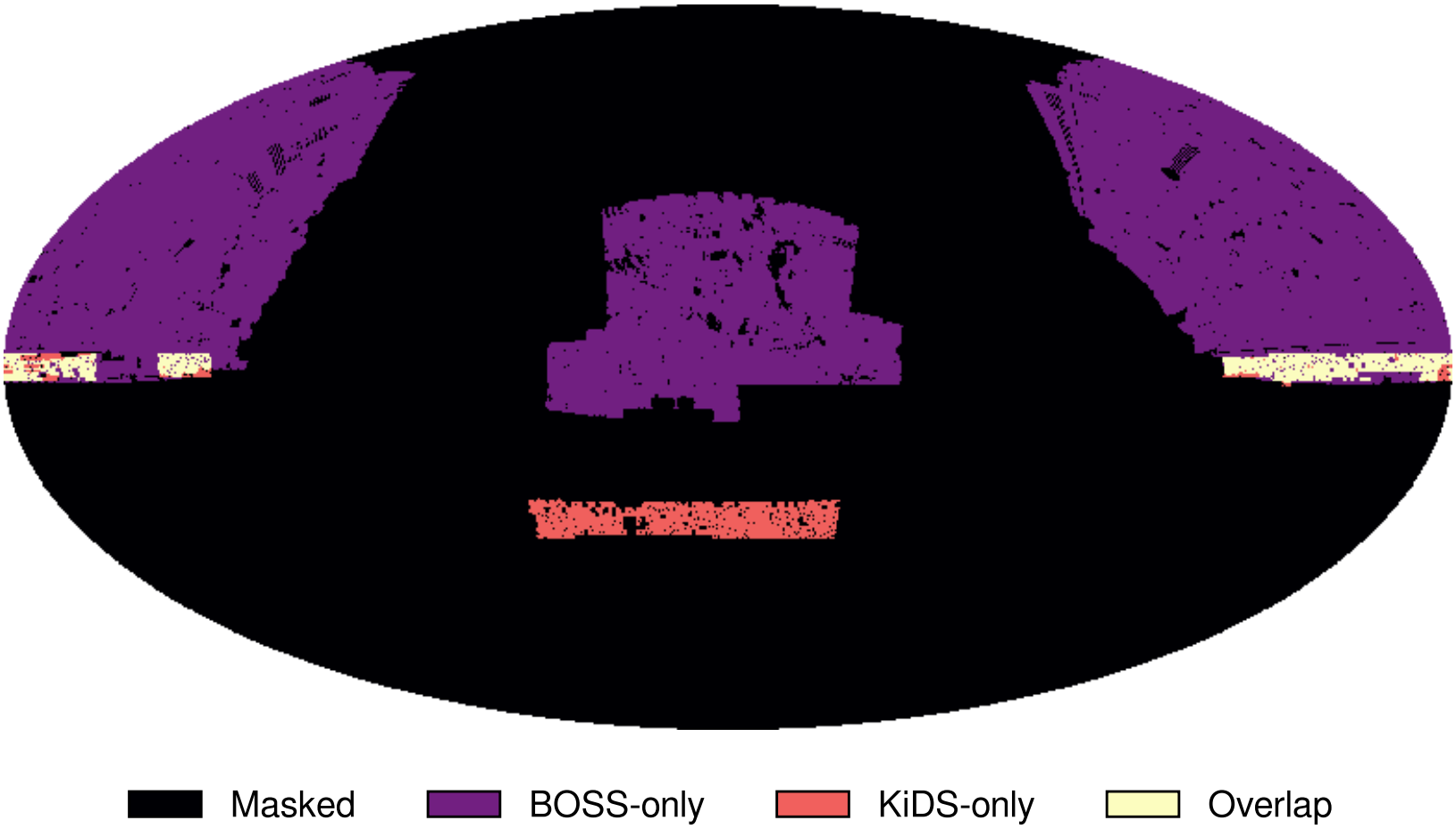
Analytical formalism

- Challenging to include survey effects

N-body simulations

- Missing large modes: box size
- Missing small modes: particle mass
- Time consuming

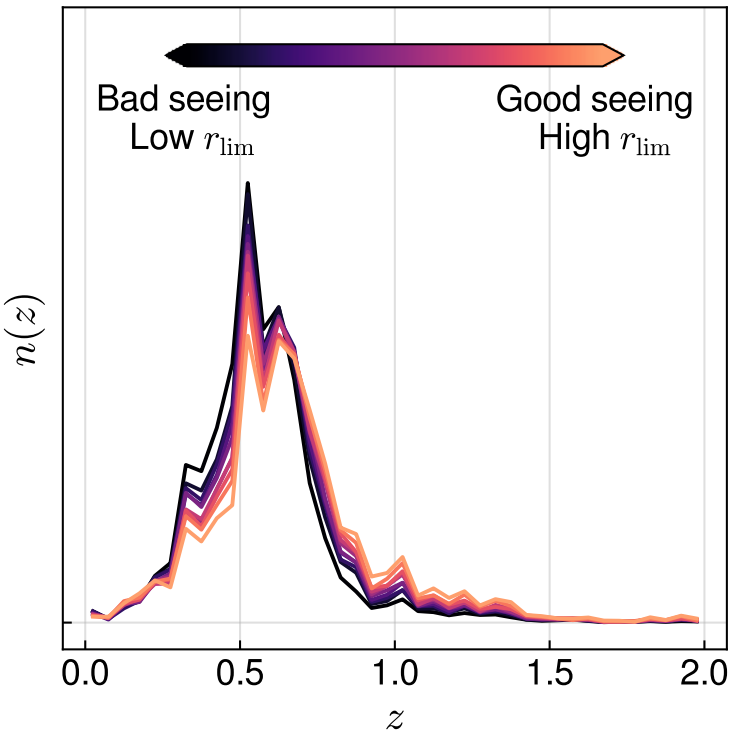
Survey effect 1: mask geometry

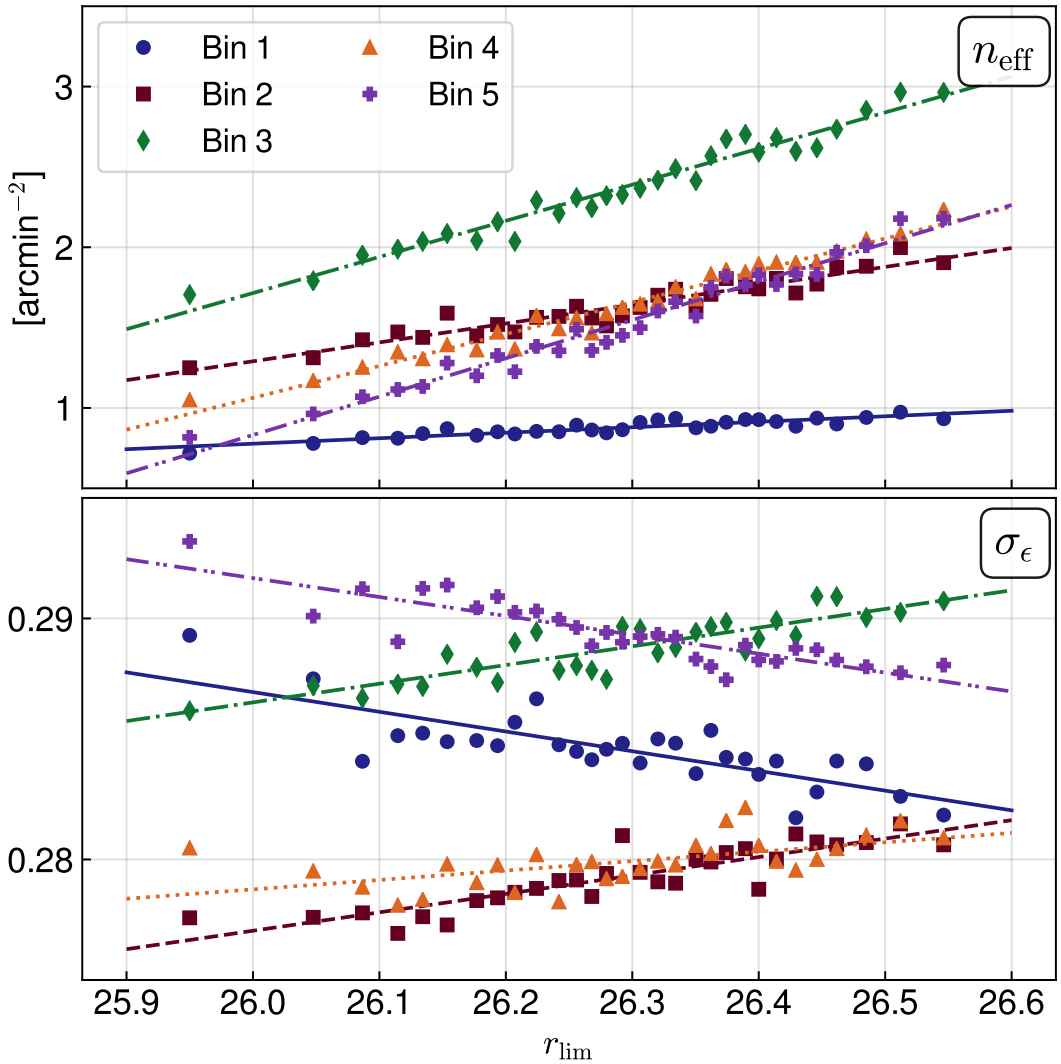


(KiDS-1000 data, preliminary)

Survey effect 2: variable depth

Redshift distributions $n(z)$,
source density $n_{\rm eff}$,
and shape noise σ_ϵ
vary with r-band
magnitude limit $r_{\rm lim}$.





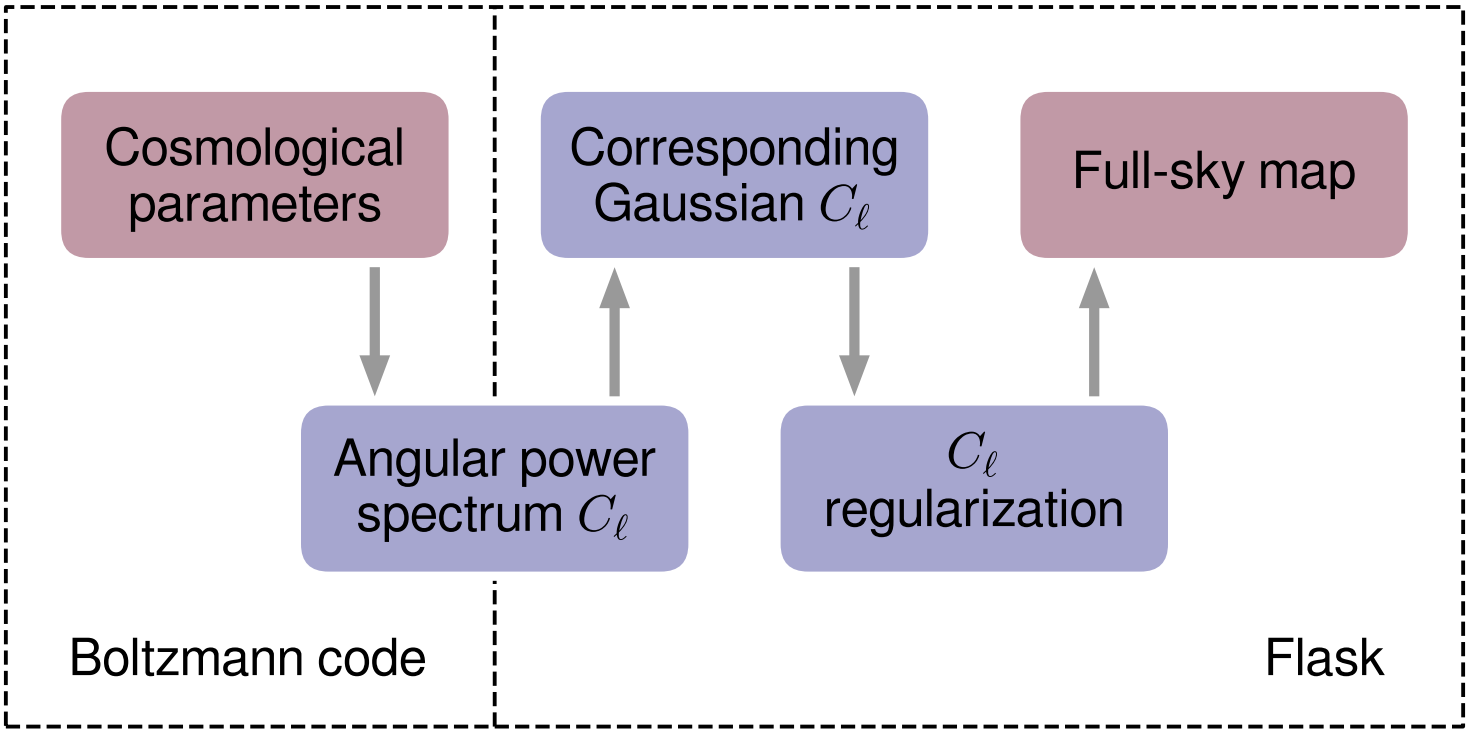
Challenges

What is the impact of survey footprints on the weak-lensing covariance?

Methodology

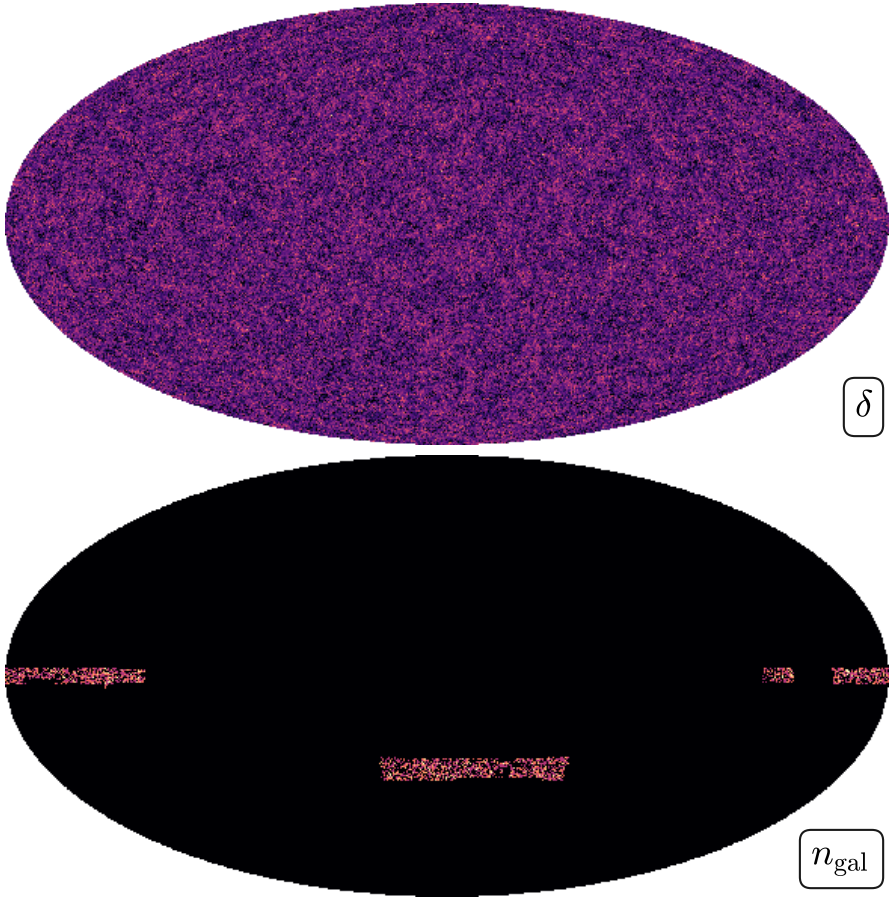
FLASK (Xavier et al. 2016)

Fast Gaussian/lognormal simulations



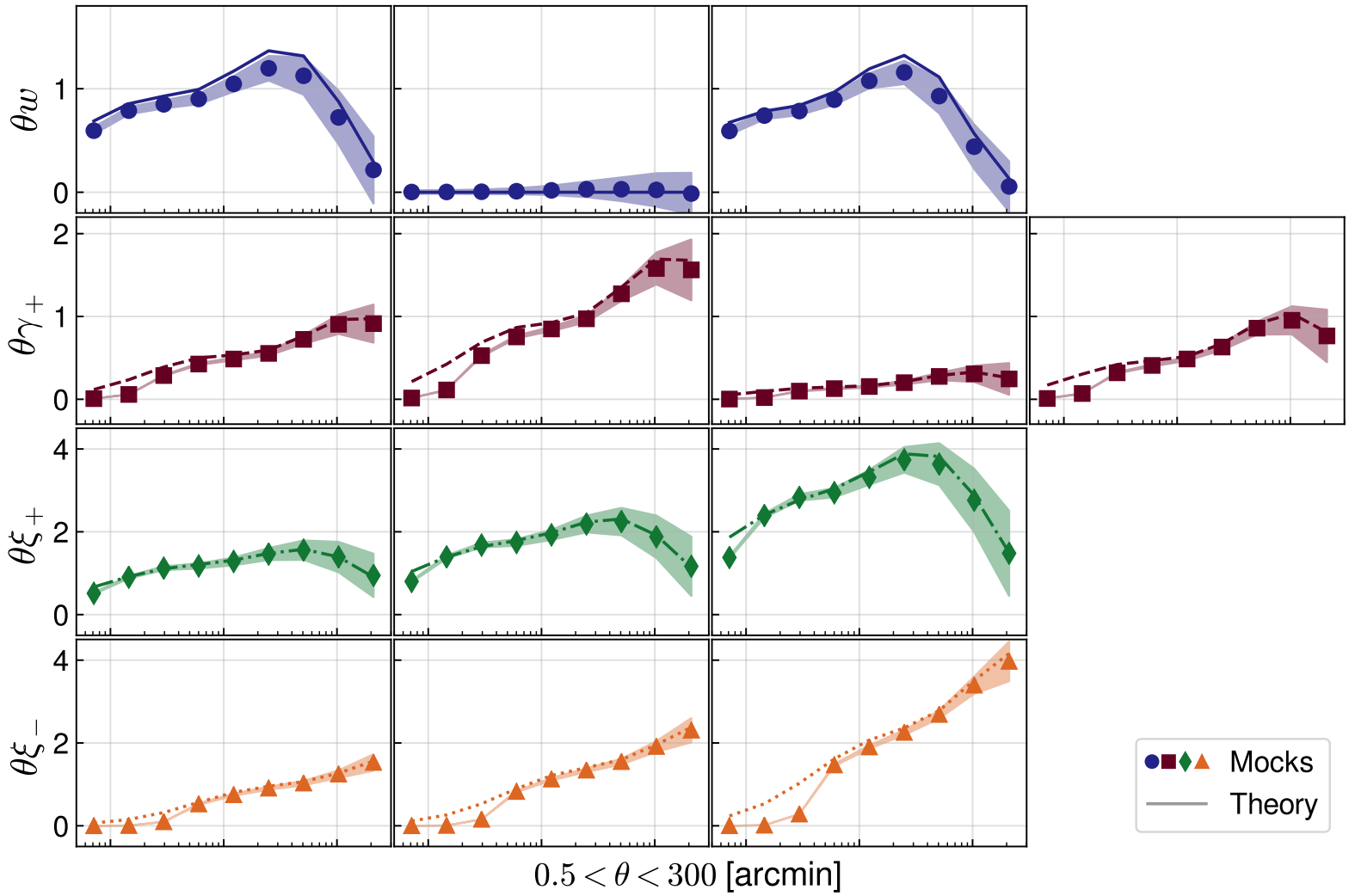
Methodology

- Compute C_ℓ from input parameters
- Generate density & lensing maps
- Apply survey effects
- Sample galaxies
- Compute correlation functions



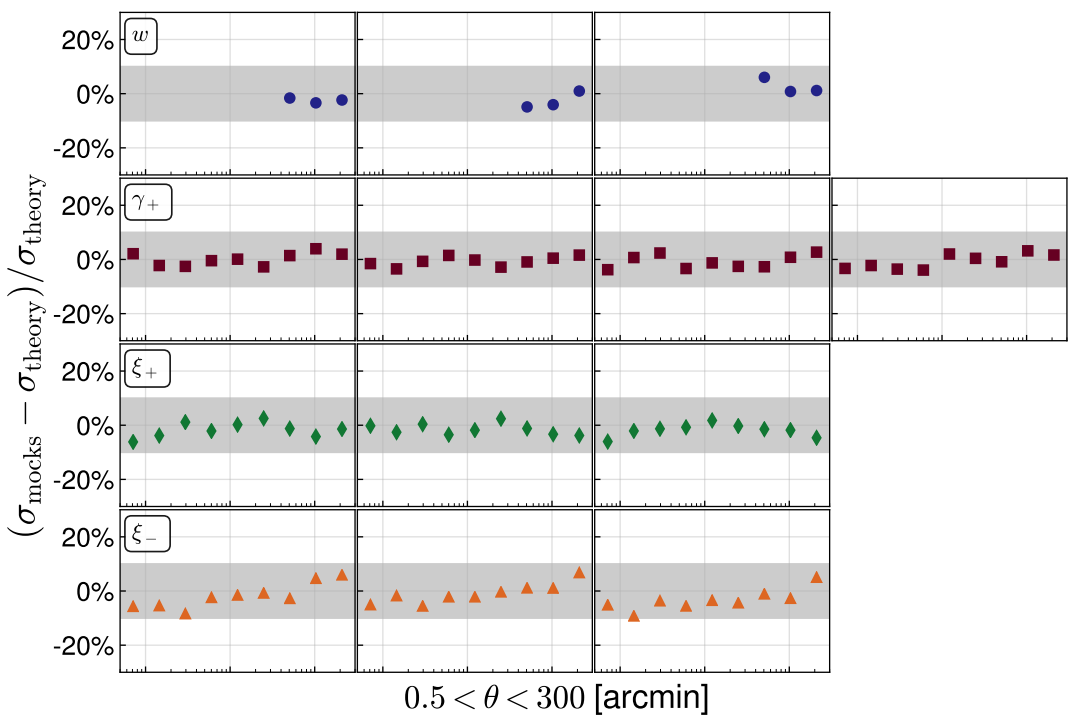
Test case with 2 lens bins
& 2 source bins

Comparisons with theory

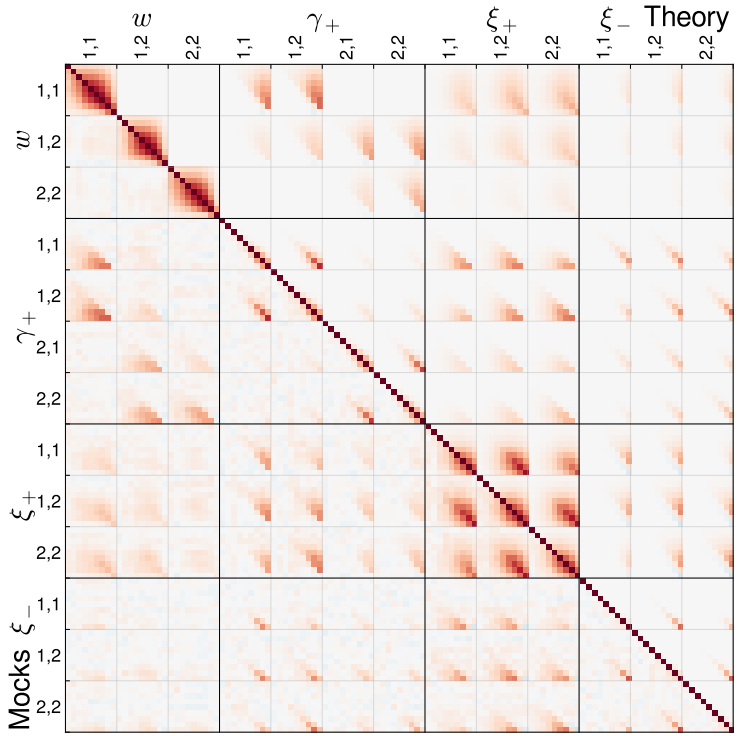


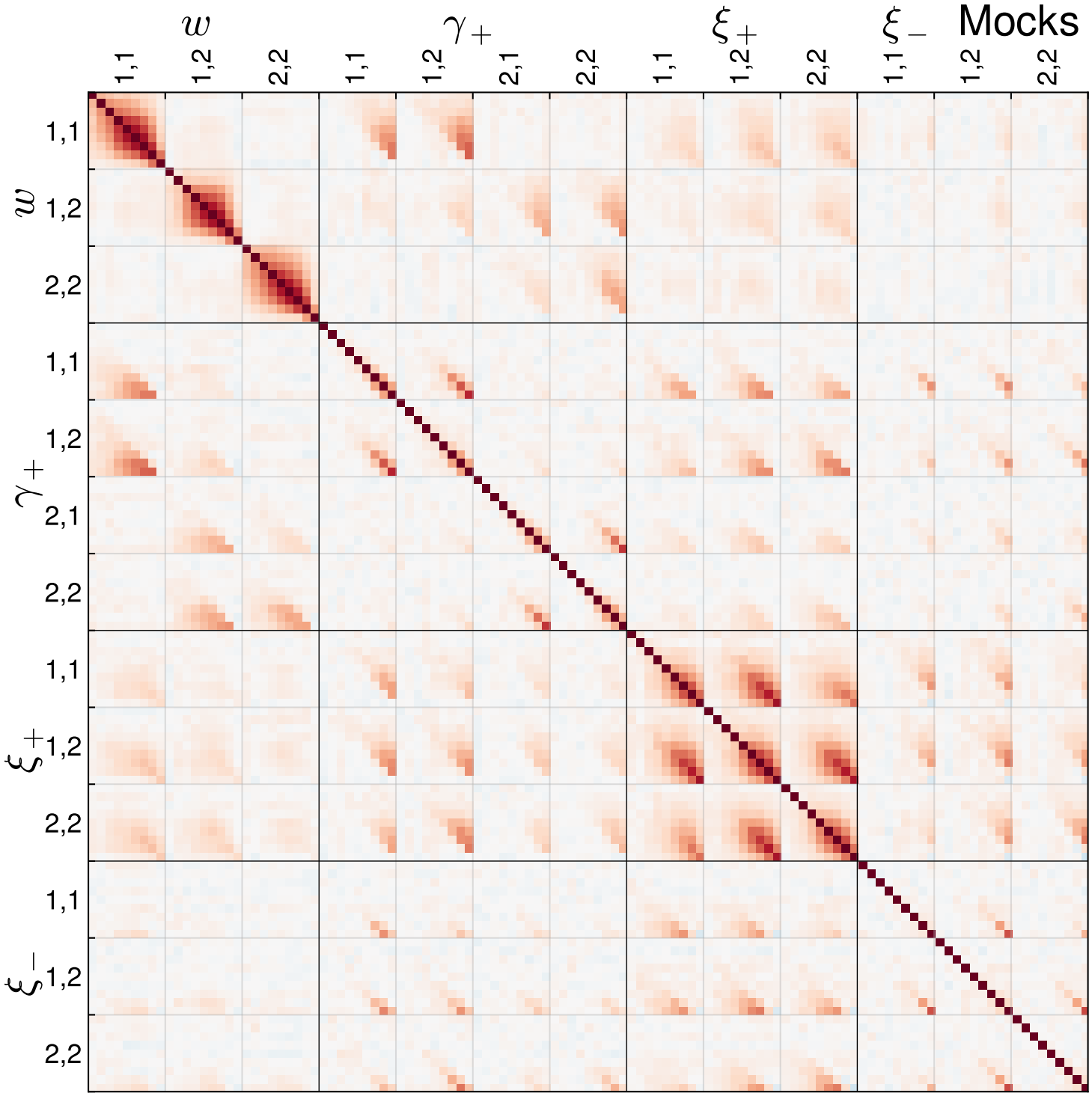
Comparisons with theory

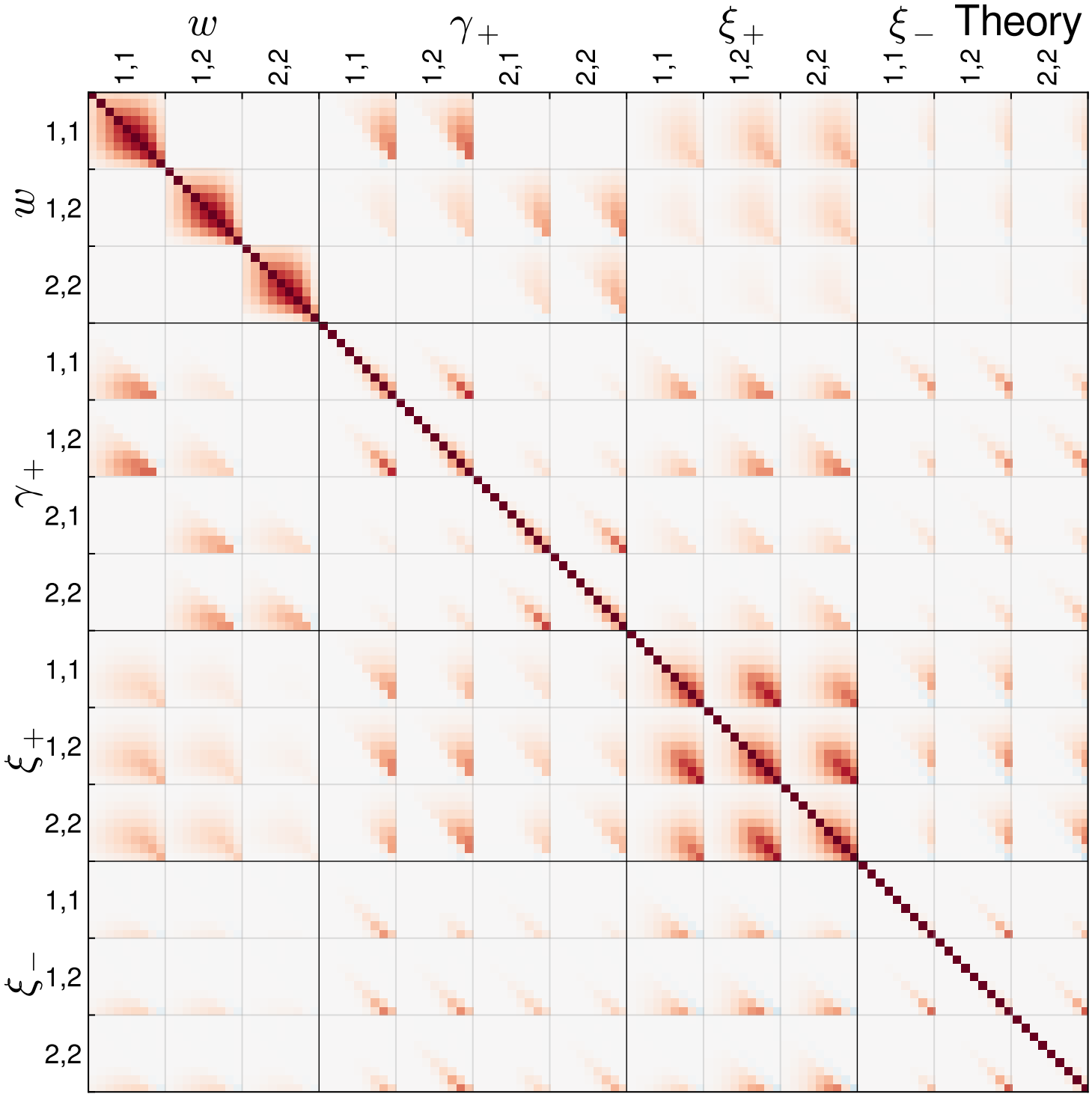
Diagonal (std)

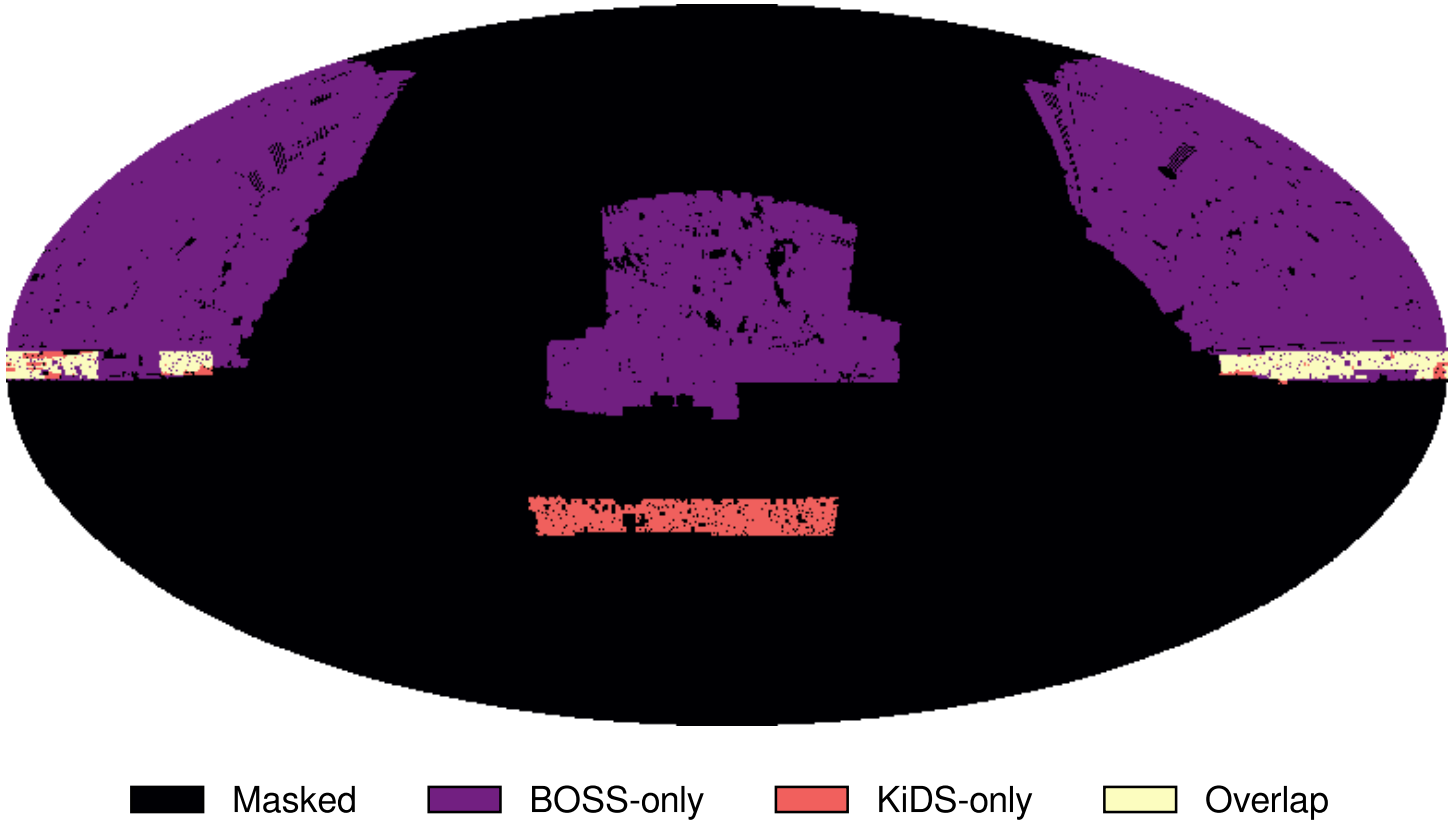


Off-diagonal (correlations)



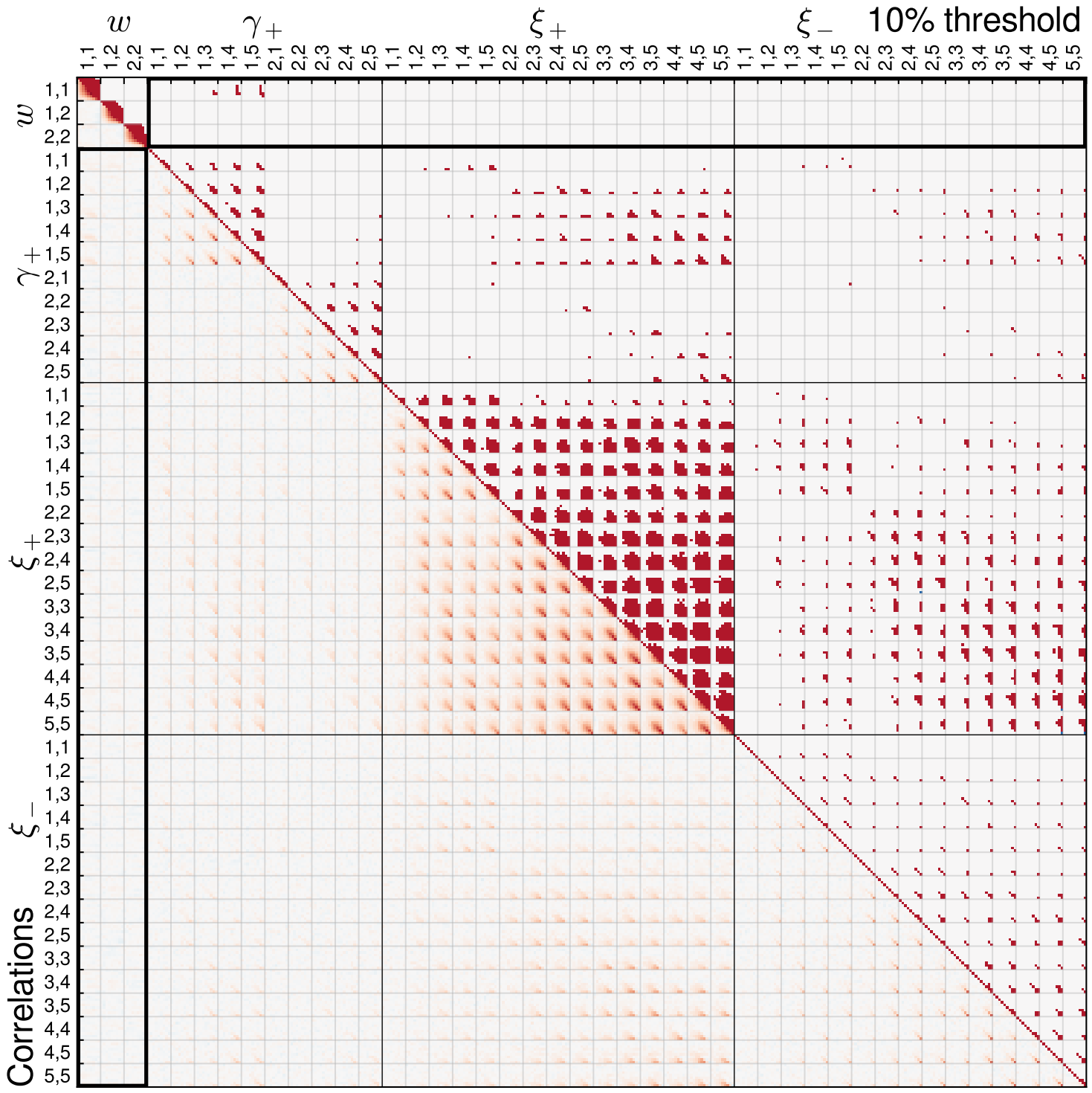

Mocks
w
γ_+
ξ_+
ξ_-
1,1
1,2
2,1
2,2


Theory
w
γ_+
ξ_+
ξ_-
1,1
1,2
2,1
2,2



Preliminary results

Are cross-correlations negligible?



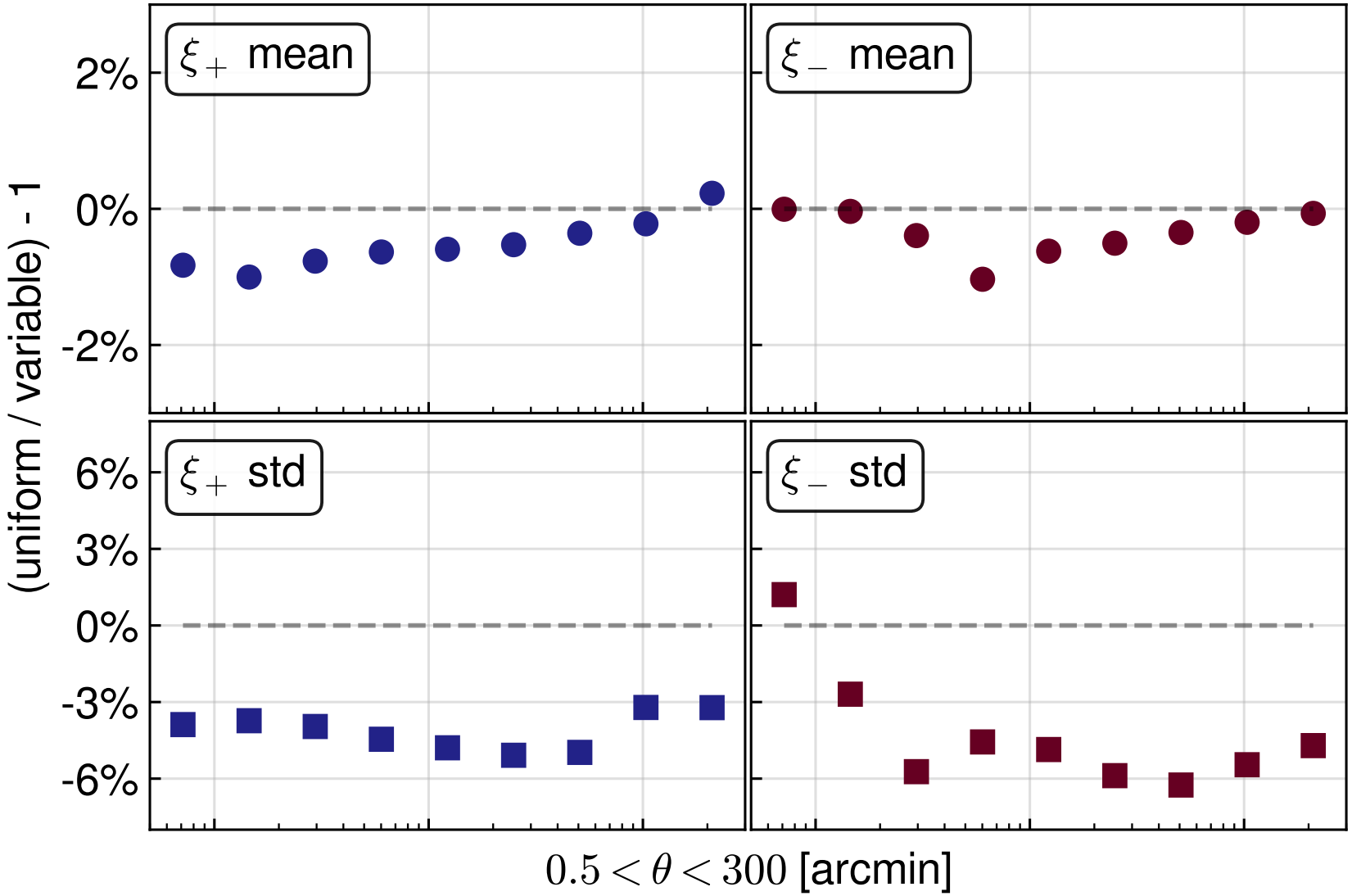
Preliminary results

Are cross-correlations negligible?

Yes

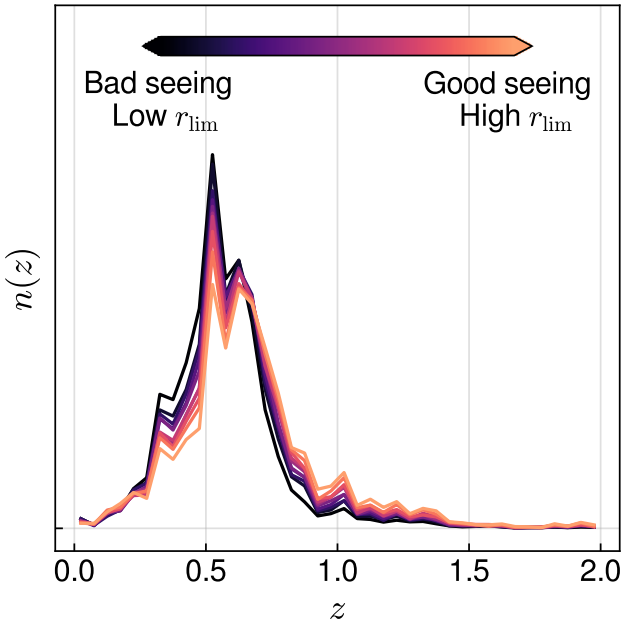
~1% effect on mean
~5% effect on covariance

Preliminary results



Summary

- Variable depth of weak-lensing sources affects the likelihood analysis.
- KiDS-like survey: $\sim$1% bias on mean and $\sim$5% on covariance.
- Will be significant as statistical errors decrease for future surveys.



THE UNIVERSITY of EDINBURGH

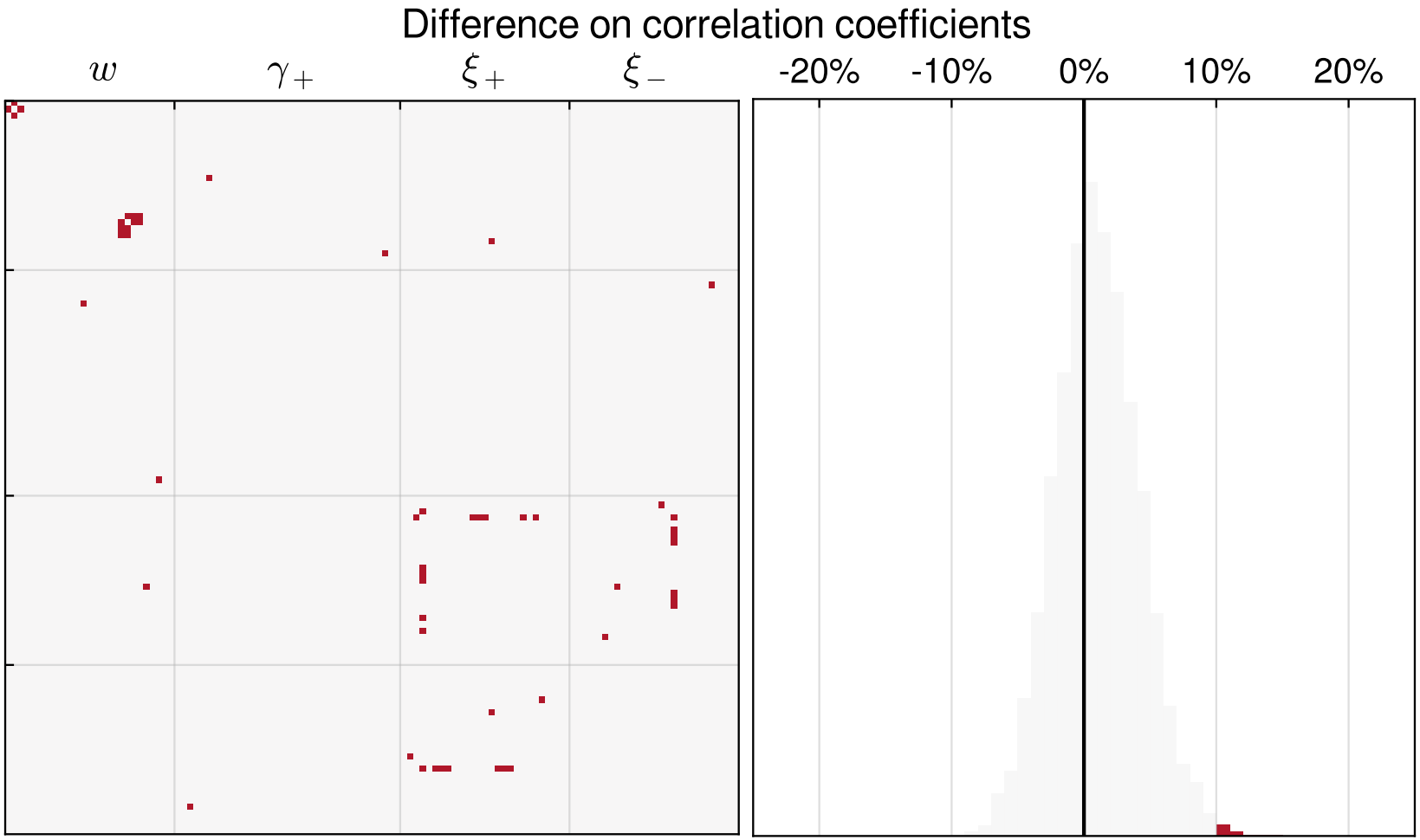
European Research Council
Established by the European Commission

KiDS

Benjamin Joachimi
Marika Asgari
Catherine Heymans
Tilman Tröster
among others

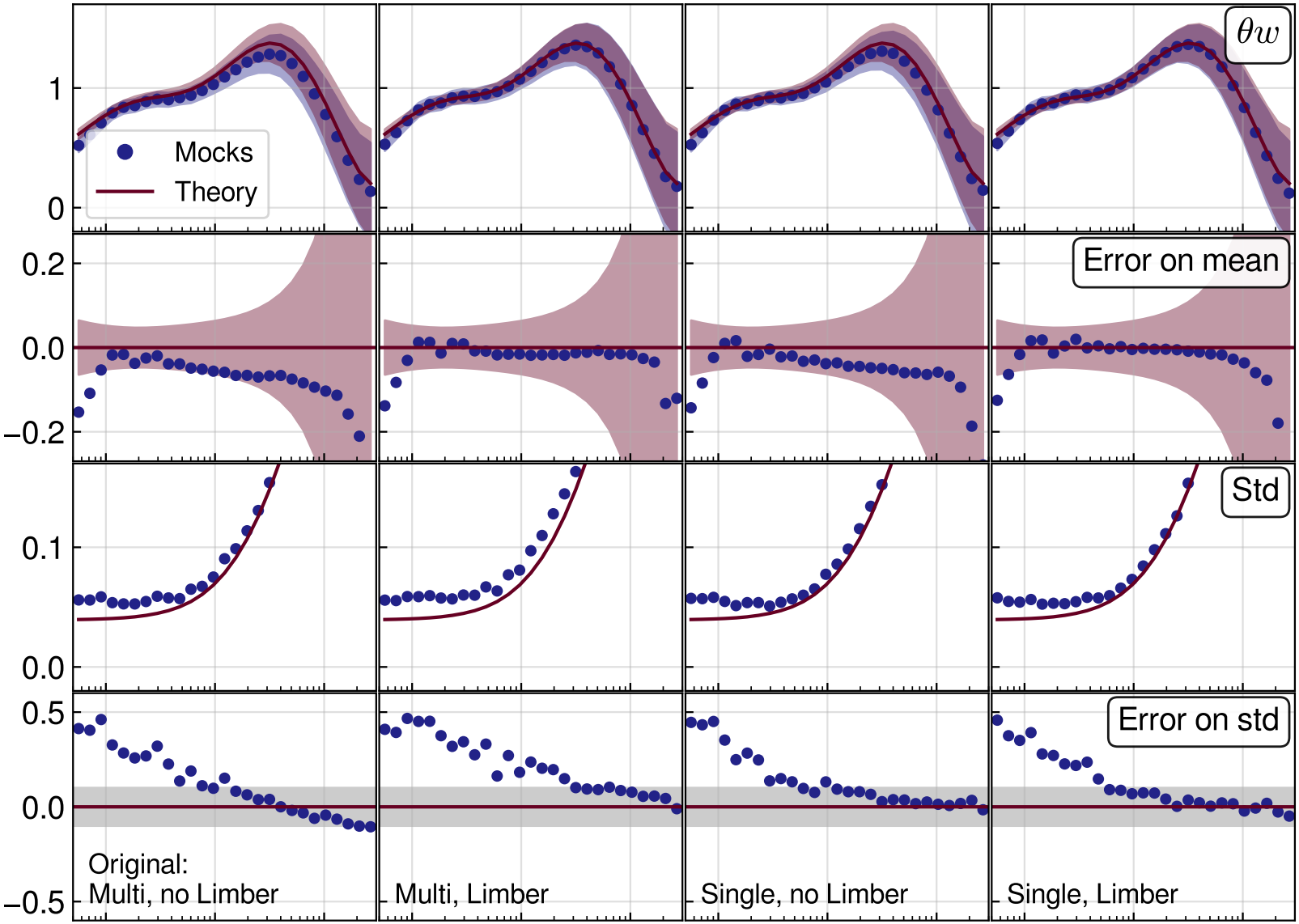
Backup slides

Comparisons with theory



Covariance

$$C_{\rm tot} = \underbrace{\langle SS \rangle}_{\text{cosmic term}} + \underbrace{\langle SN \rangle}_{\text{mixed term}} + \underbrace{\langle NN \rangle}_{\text{noise term}}$$

$$\langle SS \rangle = \underbrace{C_{\rm G}}_{\substack{\text{Gaussian} \\ \text{term}}} + \underbrace{C_{\rm NG}}_{\substack{\text{non-Gaussian} \\ \text{term}}} + \underbrace{C_{\rm SS}}_{\substack{\text{super-sample} \\ \text{term}}}$$

Clustering: impacts from Limber & slicing