Forecasting lensing-clustering analyses with DESI

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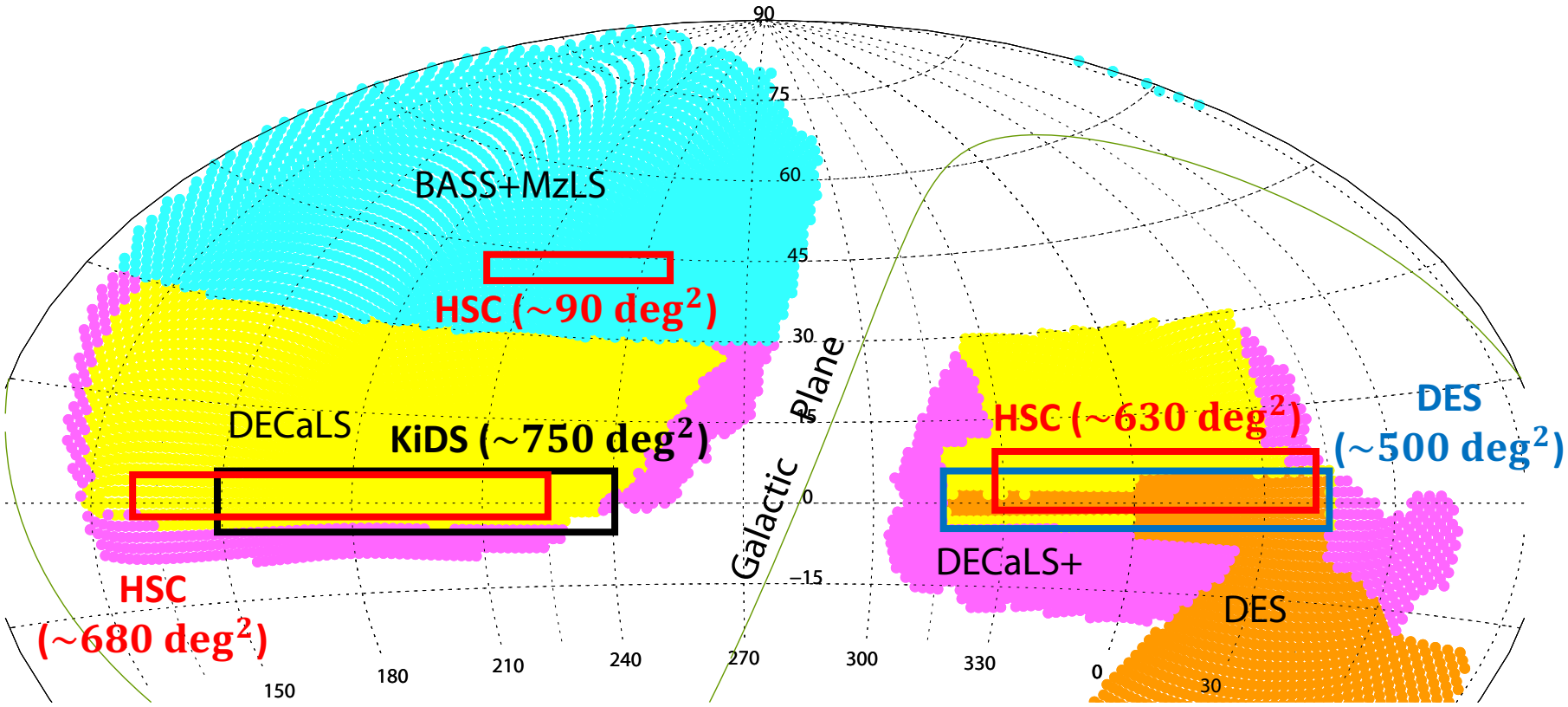
Goals

Investigate potential and practicality of joint lensing and clustering analyses in DESI

- **How accurately can such analyses constrain cosmology, what do they add to clustering alone?** *(Science cases: testing gravity, photo-z by cross-correlation, halo studies…)*
- **What weights should be applied to reduce systematic bias or optimize statistical error?** *(Examples: FKP weights, fibre collision, completeness, redshift kernels/weights?)*
- What are the **key systematics** to address?

Methods

- DESI will overlap with several current weak lensing surveys (**KiDS**, **DES**, **HSC**) and future surveys (e.g. **CFIS**, **LSST**)



Methods

We use **two approaches** for forecasts / tests:

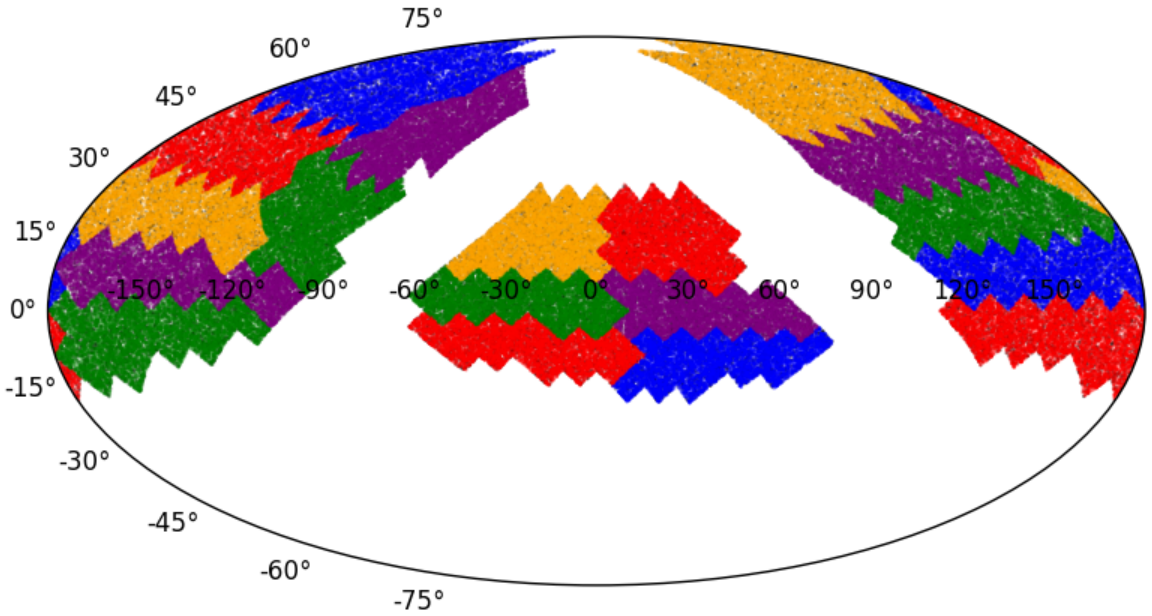
- **Combined-probe mocks** from Buzzard simulations
- **Analytic covariance** for lensing statistics

We measure various **combined-probe correlations**:

- **Cosmic shear**, $\xi_+(\theta)$ and $\xi_-(\theta)$
- **Galaxy-galaxy lensing**, $\gamma_t(\theta)$ or $\Delta\Sigma(R)$
- **Galaxy clustering**, $w(\theta)$ or $w_p(R)$

DESI-HSC mocks

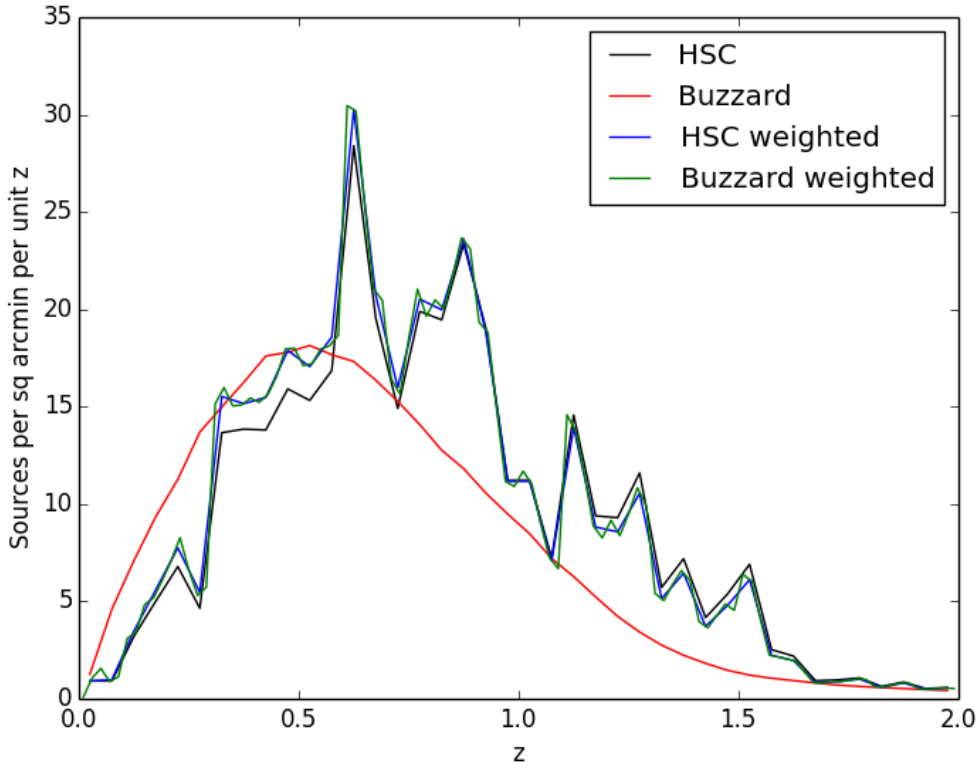
- Use **Buzzard mocks** on NERSC to construct 18 "HSC-like" simulations (each with area $\sim 1000\ \mathrm{deg}^2$)



- Each mock consists of **sources with shapes**, and **DESI lenses** (I will show here, LRGs $0.4 < z < 0.6$)

DESI-HSC mocks

- Modulate the shape noise applied to the Buzzard sources to match the “effective number density” of the HSC source redshift distribution



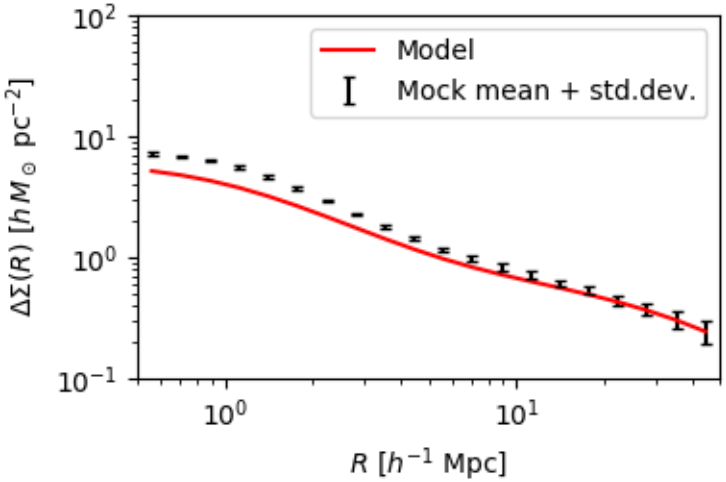
Mock correlations (1000 deg^2)

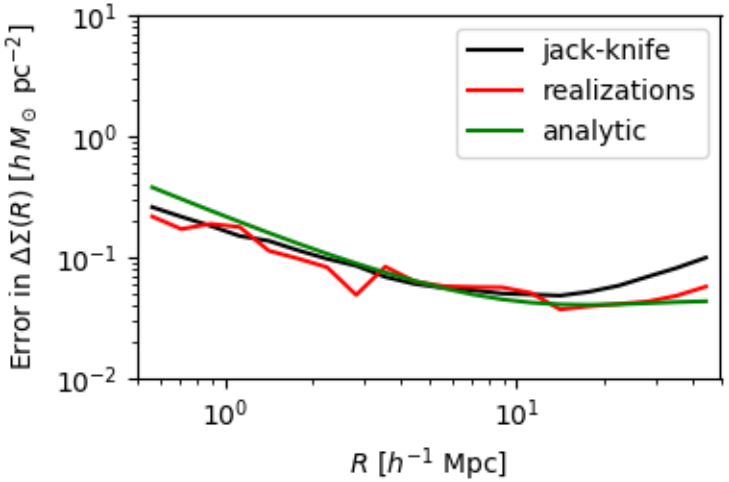
Galaxy-galaxy lensing $\Delta\Sigma$

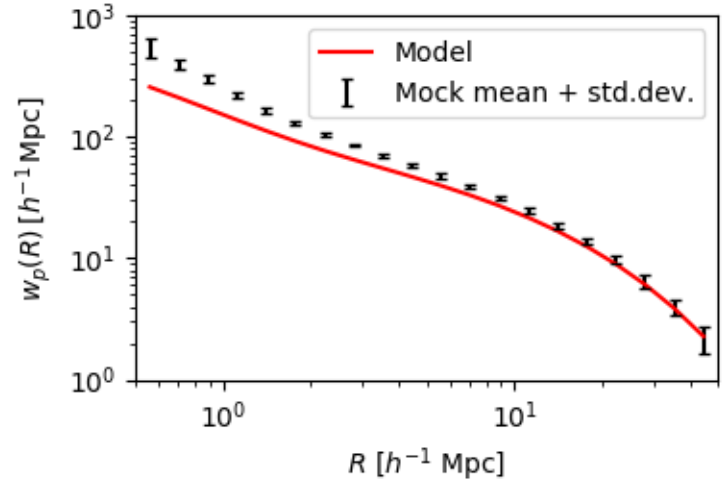
Projected clustering w_p

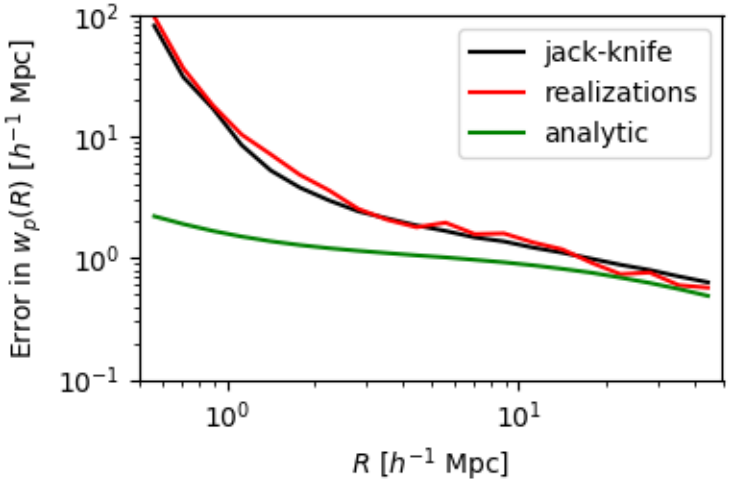
Mock mean and (halofit) model

Errors (JK vs mock vs analytic)





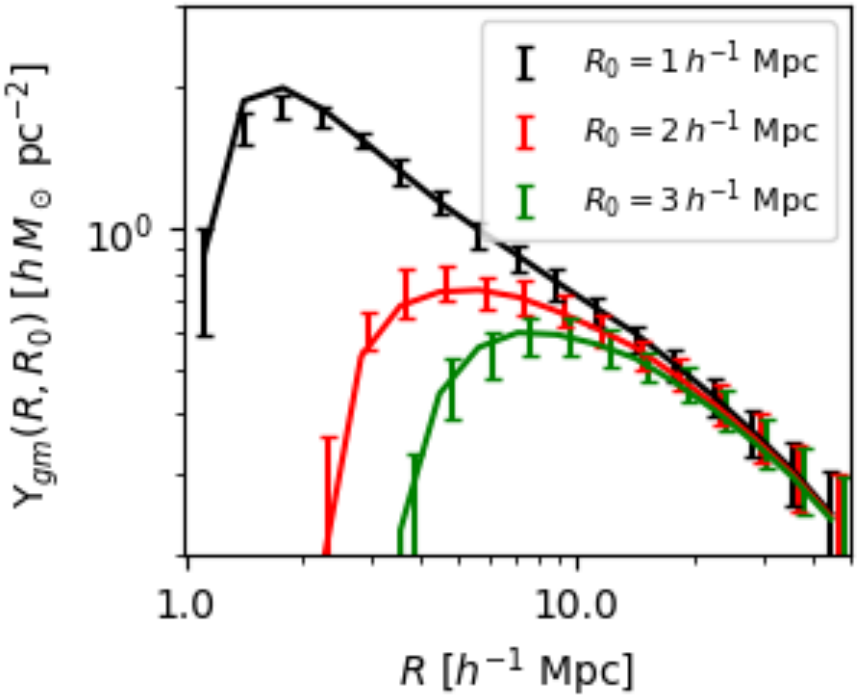


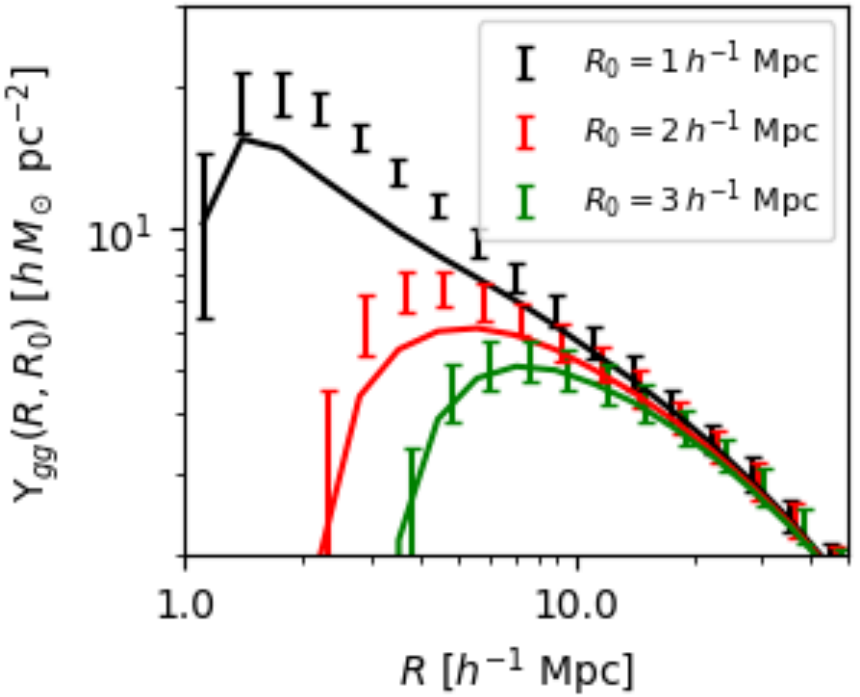


Mock correlations (1000 deg^2)

- **Annular differential surface density** statistics (suppress information at $R < R_0$):

$$\Upsilon_{gm}(R, R_0) = \Delta\Sigma(R) - \frac{{R_0}^2}{R^2}\,\Delta\Sigma(R_0)$$

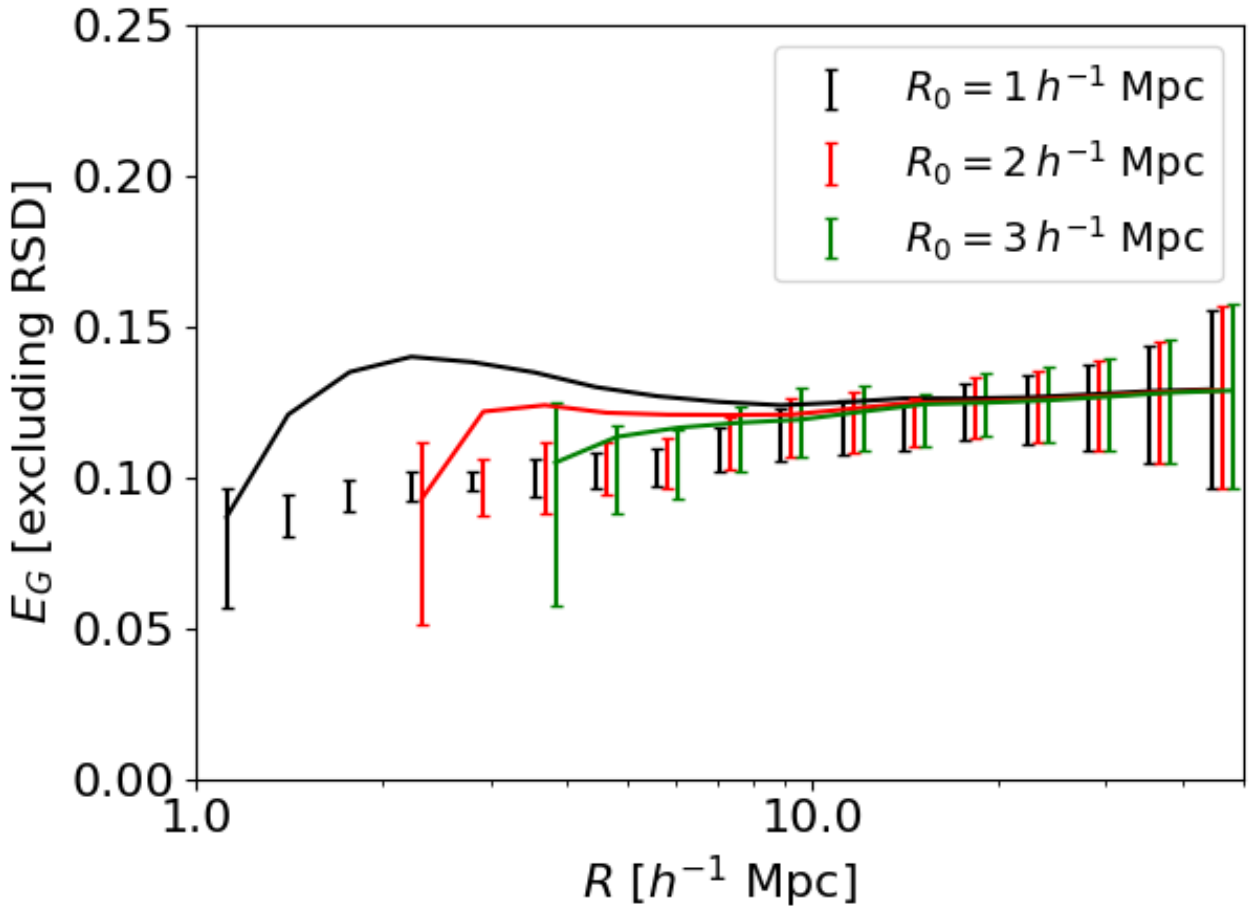




Mock correlations (1000 deg^2)

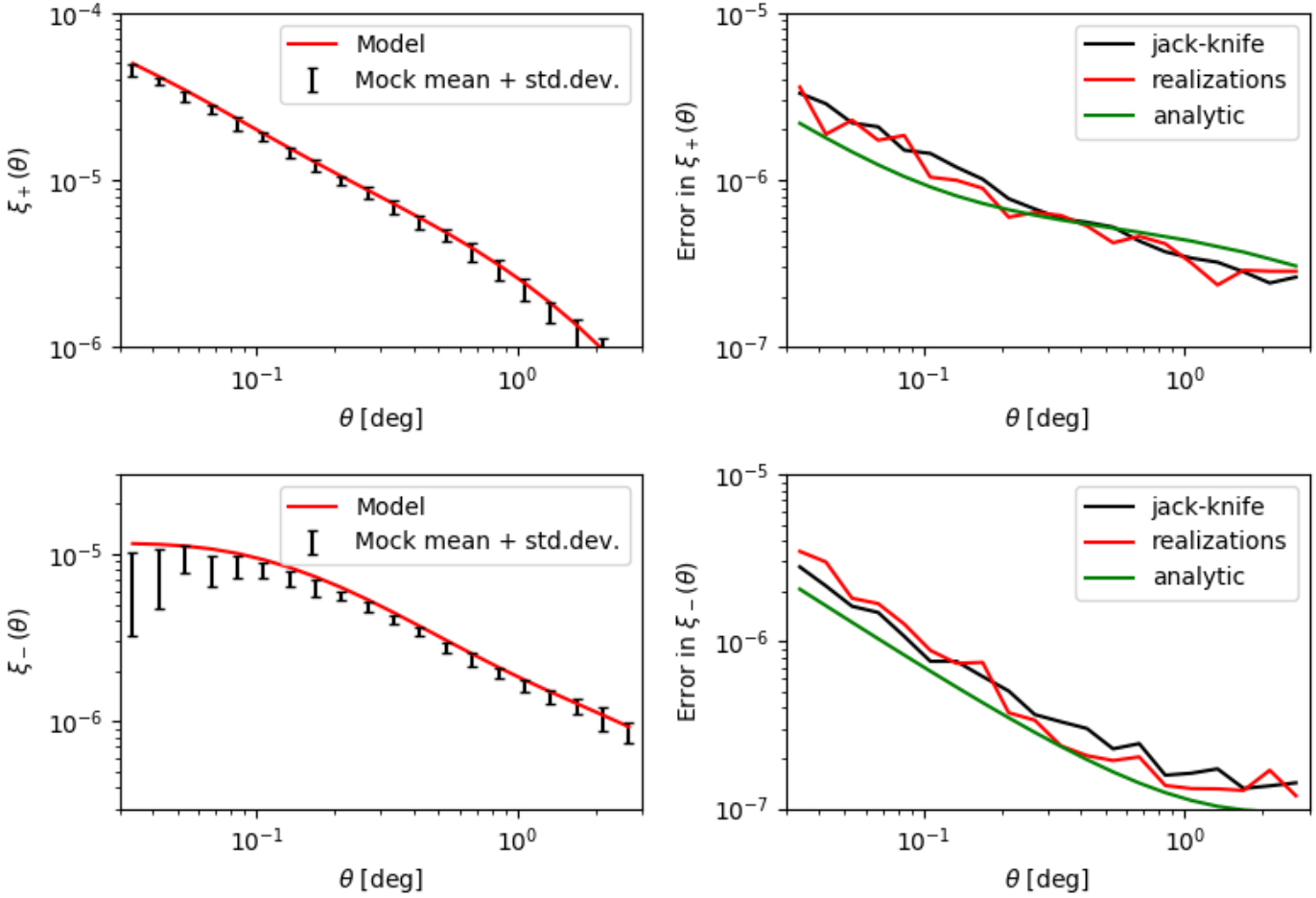
- **Gravitational slip** statistic:

$$E_G(R) = \frac{1}{\beta}\frac{\Upsilon_{gm}(R,R_0)}{\Upsilon_{gg}(R,R_0)} \approx \frac{\Omega_m}{f}$$



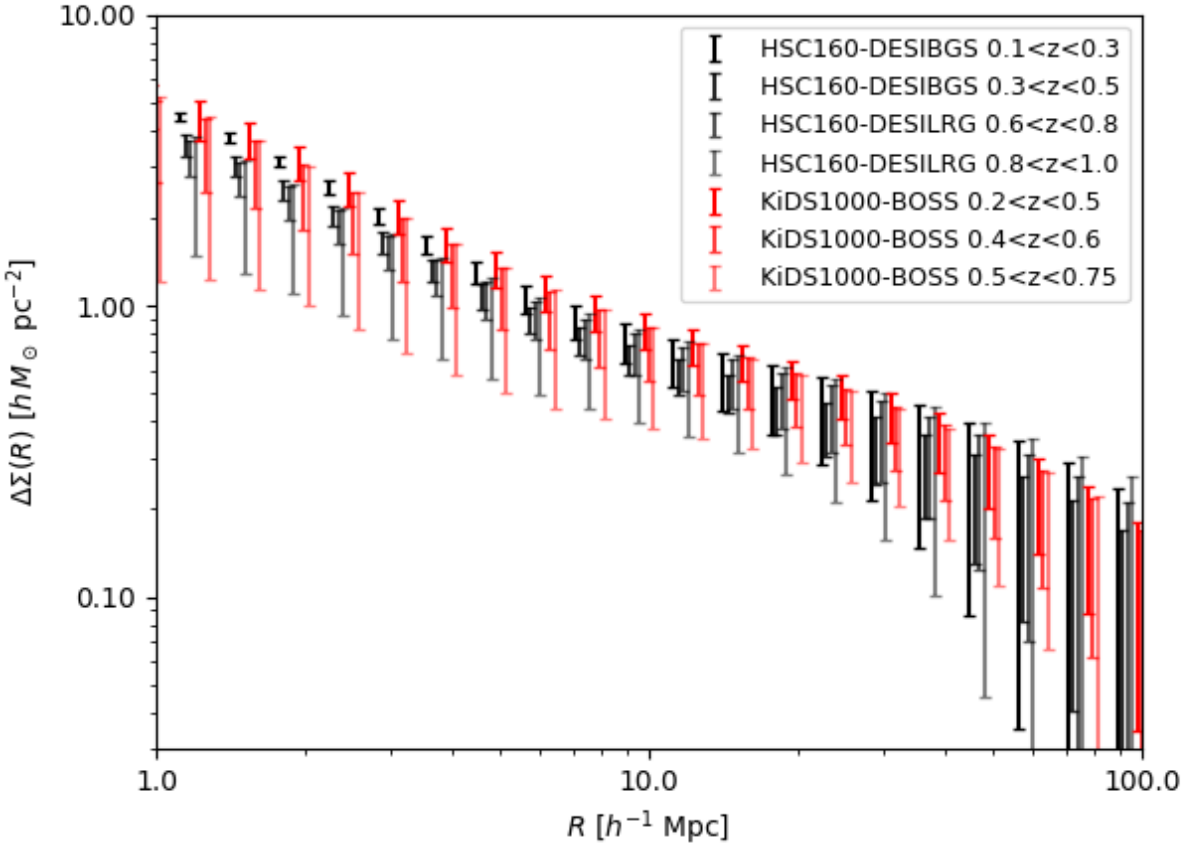
Mock correlations (1000 deg^2)

- **Cosmic shear** statistics (just one bin for now, in practice would split into tomographic bins)



DESI-HSC Y1 forecast ($160\ \mathrm{deg}^2$)

- Here is a $\Delta\Sigma(R)$ forecast for a putative $160\ \mathrm{deg}^2$ Y1 DESI-HSC overlap area using analytic covariance:



Note: this dataset would not be competitive on large scales with current KiDS/DES datasets

Rossana and I are working on …

- Optimal weighting for combined probe analyses
- Differing effective bias values for $\Delta\Sigma(R)$ and $w_p(R)$
- Fibre collision corrections for lensing analyses
- Source redshift distributions by cross-correlation
- **I look forward to further discussions at this meeting!**