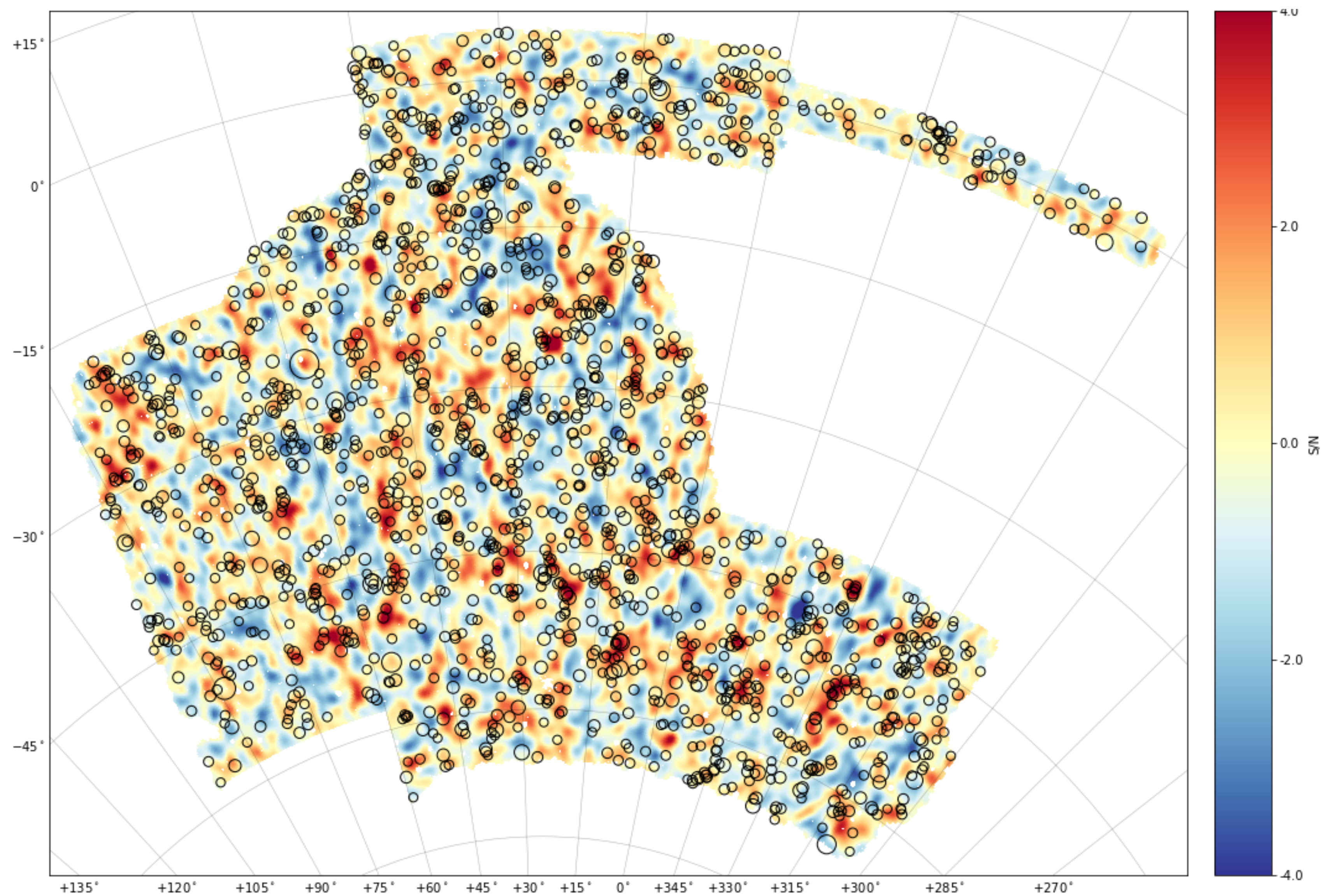
SCLSS @Oxford 18-20 April 2018

Curved-Sky Weak Lensing Mass Maps with the Dark Energy Survey Y3 data

simulated DES Y3 mass map



Marco Gatti (IFAE Barcelona)

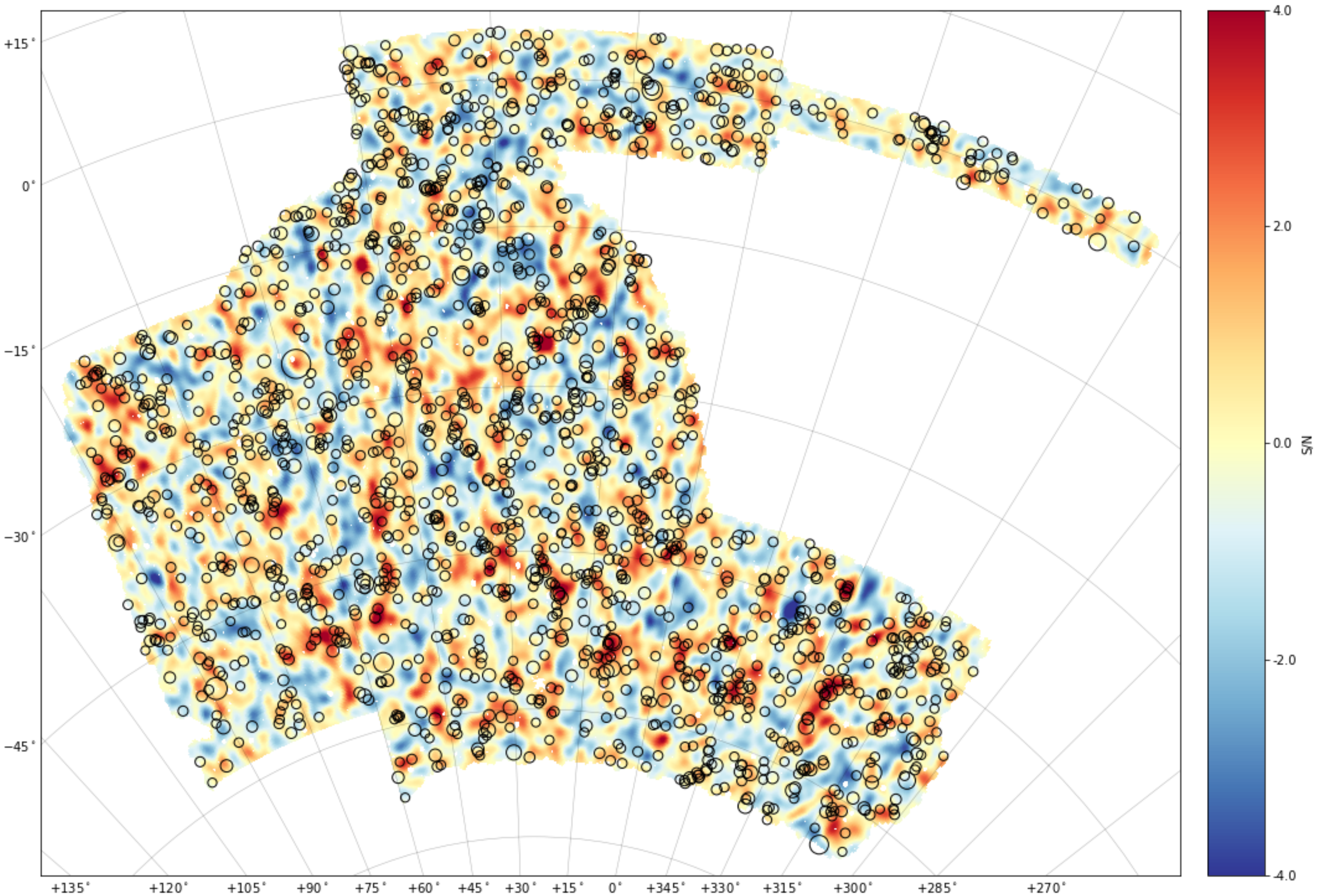
for the DES collaboration

What is a mass map?

convergence field = integrated 3D density contrast along the line-of-sight smoothed by a lensing kernel

$$\kappa_{\theta_0}(\boldsymbol{\theta}) = \frac{3}{2}\Omega_0 \int \mathrm{d}\boldsymbol{\theta}' \int_0^{w_H} \mathrm{d}w \frac{g(w)}{a(w)} \times \delta(f_K(w)(\boldsymbol{\theta} - \boldsymbol{\theta}'), w) W_{\theta_0}(\boldsymbol{\theta}'),$$

simulated DES Y3 mass map



- with DES Y3, largest mass map to date! (5000sq degree)
- mass maps have intuitive physical interpretation, easy to handle
- preserve non-gaussian information
- useful to identify features (clusters,voids..)

sources: 40 milions, 0.6 <z <1.2
open circles: RM clusters with richness > 50 , 0.2 <z<0.5

How to obtain a mass-map?

full-sky Kaiser-Squires formalism allows to obtain convergence from galaxy shapes

$$
\begin{aligned}
\hat{\gamma}_{\ell m} &= \hat{\gamma}_{E,\ell m} + i\hat{\gamma}_{B,\ell m} \\
&= \frac{1}{4}[\ell(\ell+1)(\ell-1)(\ell+2)]^{\frac{1}{2}}\psi_{\ell m} \\
&= \frac{1}{2}\sqrt{\frac{(\ell+2)(\ell-1)}{\ell(\ell+1)}}(\hat{\kappa}_{E,\ell m} + i\hat{\kappa}_{B,\ell m}).
\end{aligned}
$$

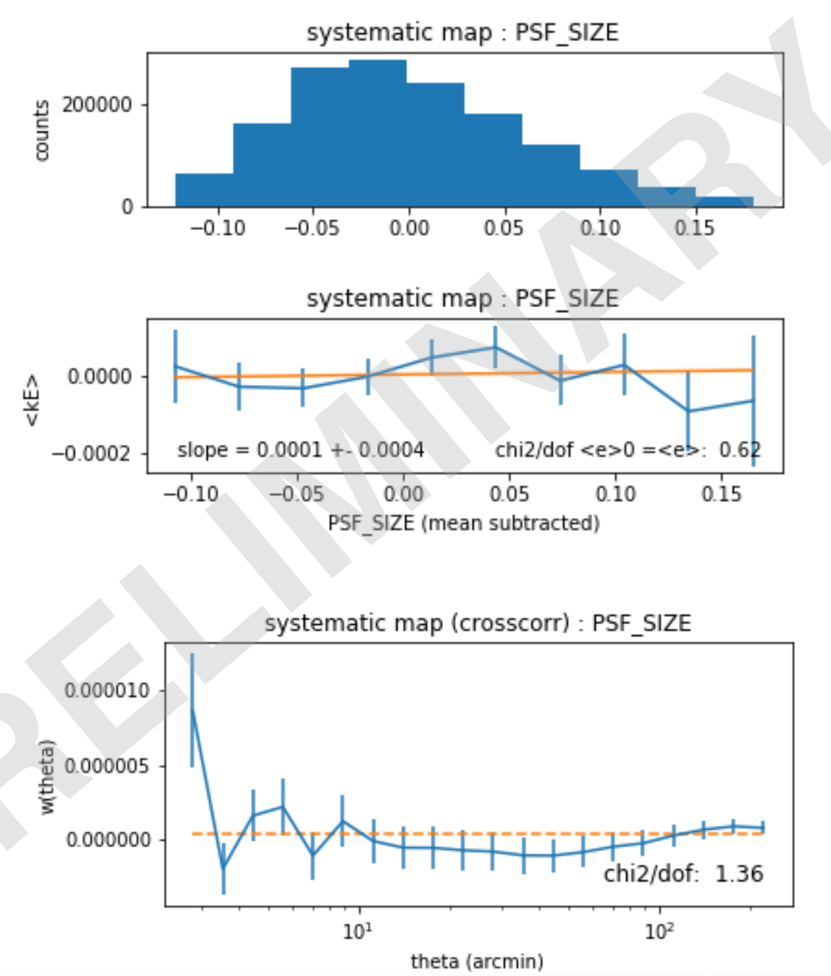
noise, systematics (mask effects)

signal

Systematic tests on the maps

1: dependence between <kE> maps and systematics maps

2: two-point angular cross correlation between kE and the systematics maps

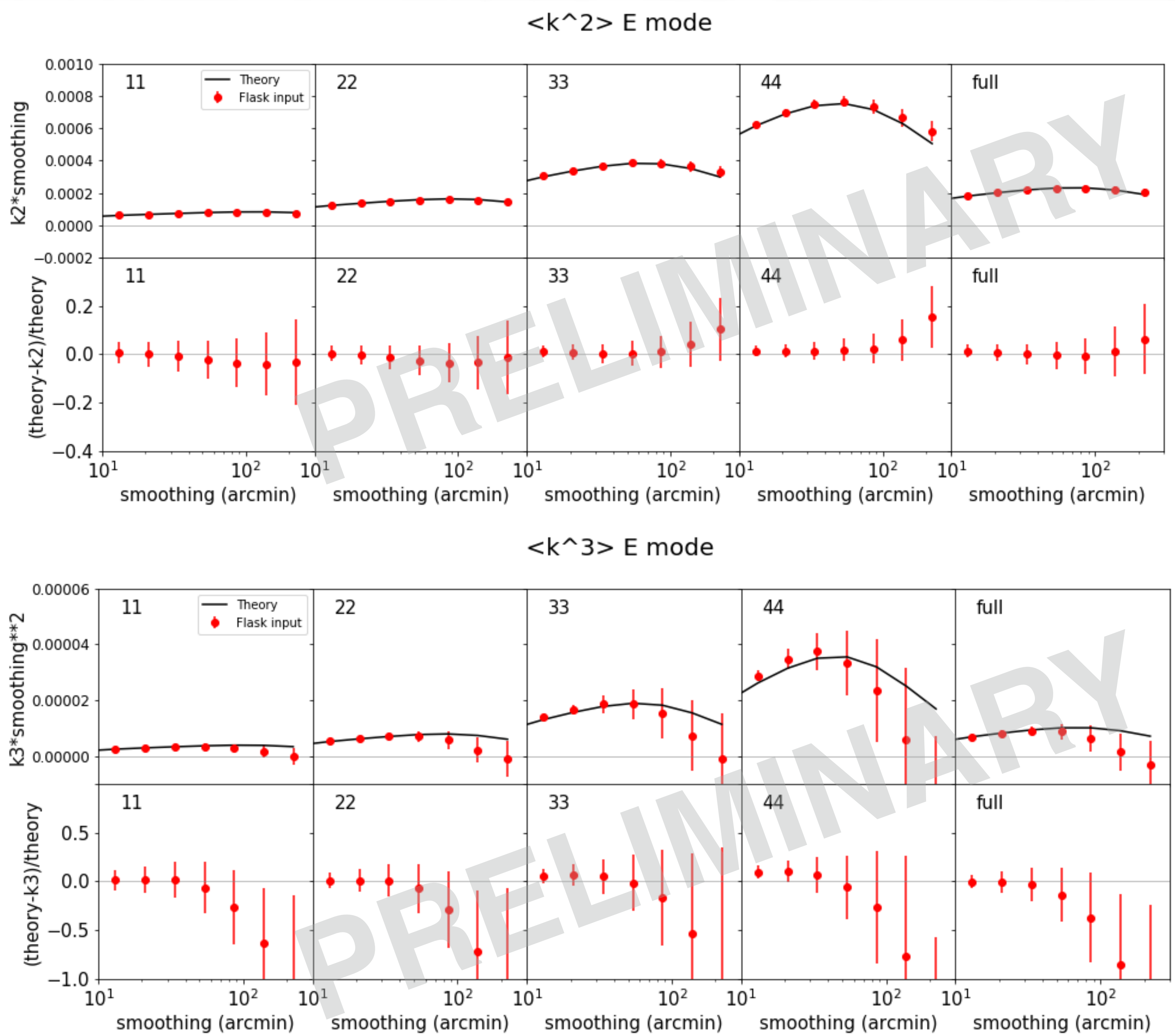


Convergence moments - basic ingredients

$$\langle \kappa^2 \rangle_{\theta_0} = \frac{1}{4\pi} \sum_l (2l+1) C_l^{\kappa} F_l^2 W_l^2(\theta_0)$$

$$\langle \kappa^3 \rangle_{\theta_0} \approx S_3 \langle \kappa^2 \rangle_{\theta_0}^2$$

- W_l :smoothing window function
- F_l pixel window function
- S3 from perturbation theory

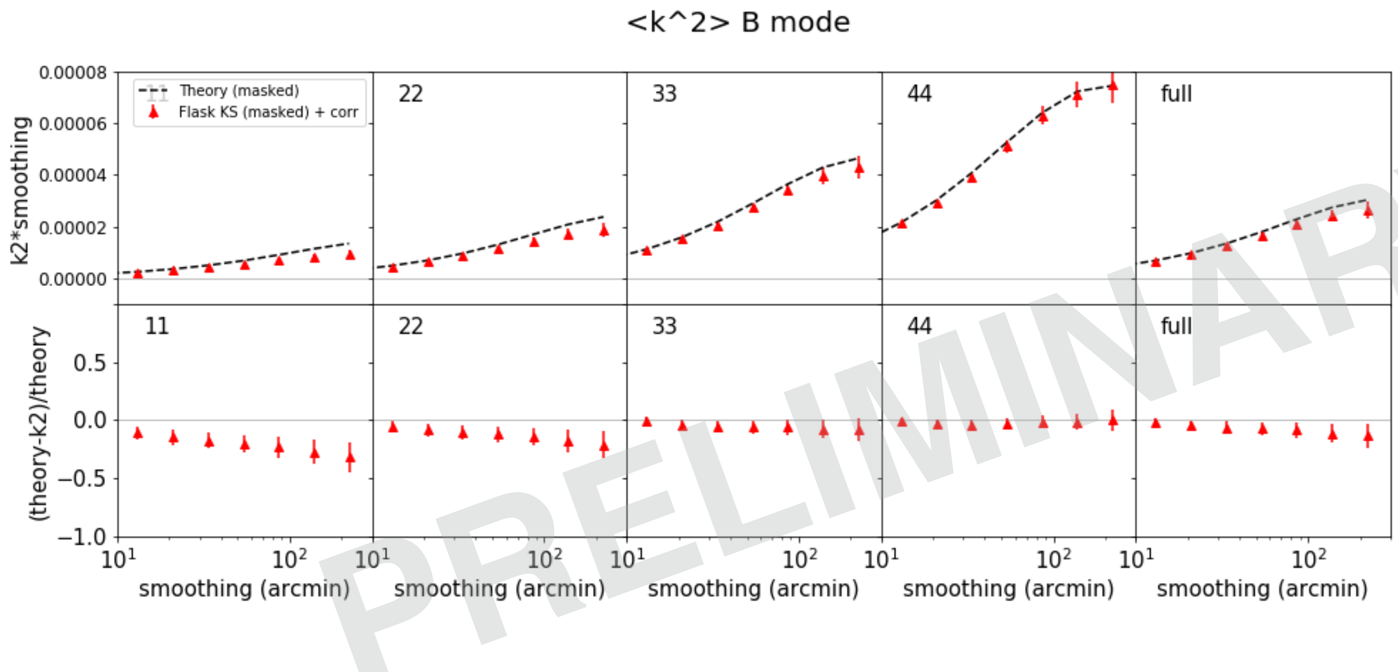


Adding masking effects:

$$\langle\kappa^2_{E/B}\rangle_{\theta_0} = \frac{1}{4\pi}\sum_l (2l+1)W_l^2(\theta_0)\sum_{l'} M_{ll'}^{E/B} C_{l'}^{\kappa} F_{l'}^2$$

$$\langle\kappa^3_{E/B}\rangle_{\theta_0} \approx S_3\langle\kappa^2_{E/B}\rangle^2_{\theta_0}$$

- W_l :smoothing window function
- F_l pixel window function
- S3 from perturbation theory
- **M_ll' : mixing matrix**

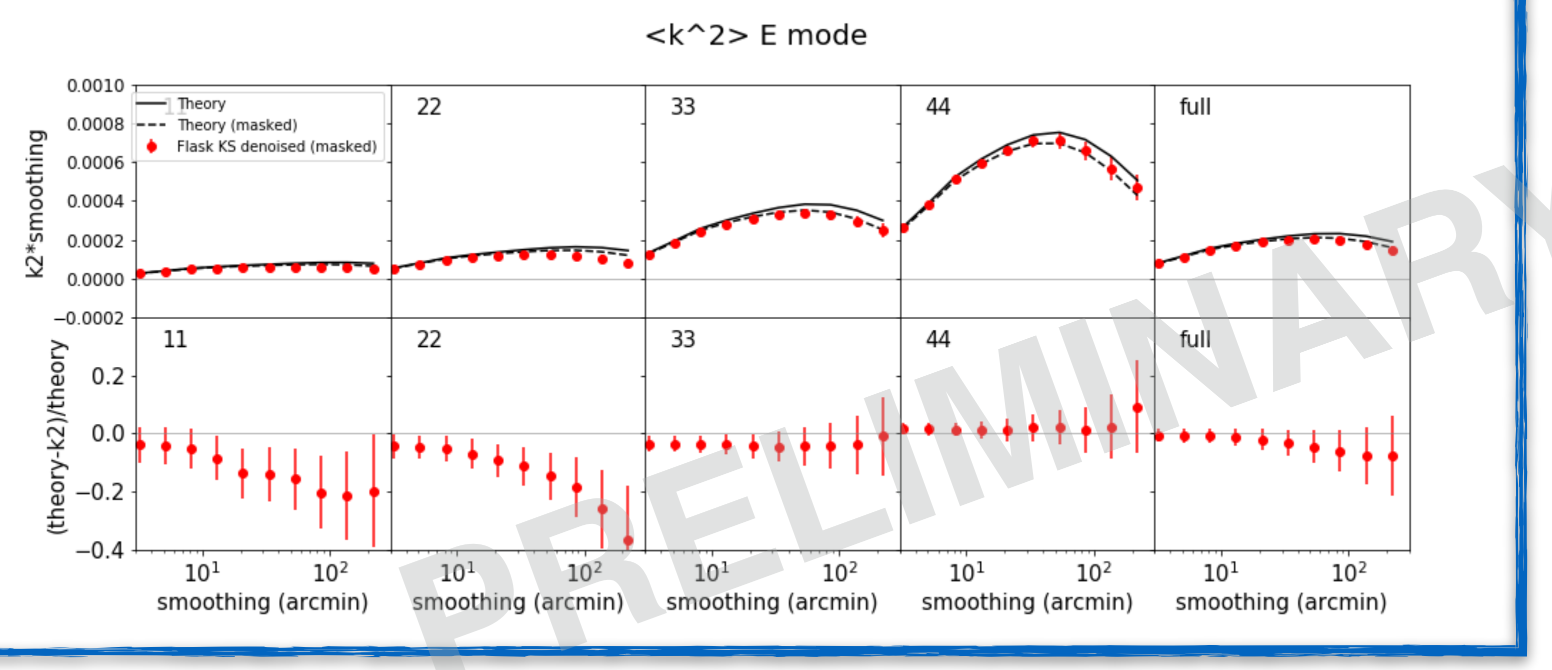


mask introduces B modes!

Adding noise:

$$\langle\hat{\kappa}_{shear}\rangle^2_{\theta_0} = \langle\hat{\kappa}_{shape}\rangle^2_{\theta_0} - \langle\hat{\kappa}_{noise}\rangle^2_{\theta_0}$$

$$\langle\hat{\kappa}_{shear}\rangle^3_{\theta_0} = \langle\hat{\kappa}_{shape}\rangle^3_{\theta_0}$$

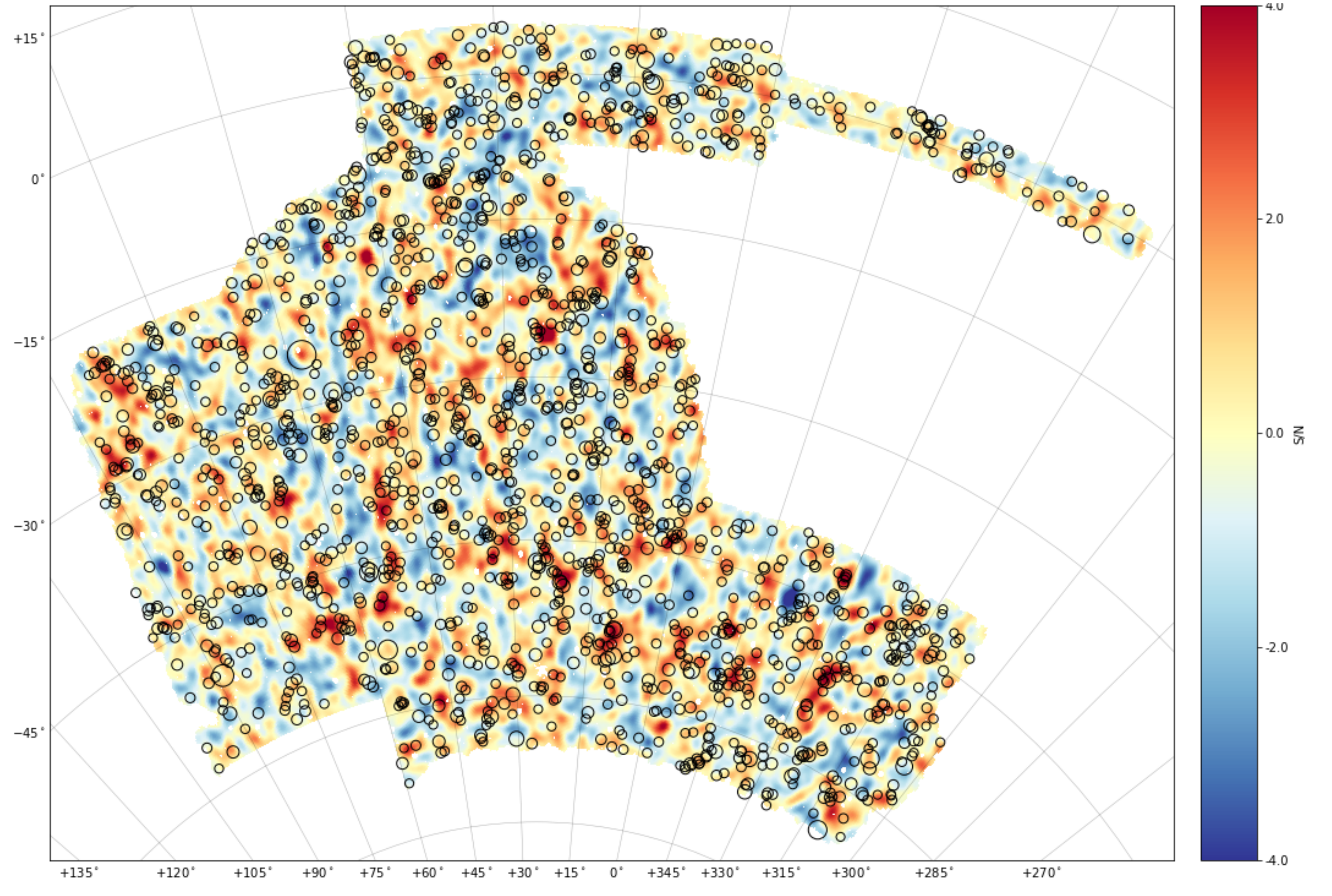


Summary

WL mass maps provide complementary information with respect to 2pt functions

DES Y3 will provide the largest mass maps up-to-date!

simulated DES Y3 mass map



Thanks!

(for questions & doubts mgatti@ifae.es)