Institut de Ciències del Cosmos
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Blind Observers of the Sky

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Blinding in a Nutshell

Why should we go blind?

- Avoid confirmation bias

What do we want to blind?

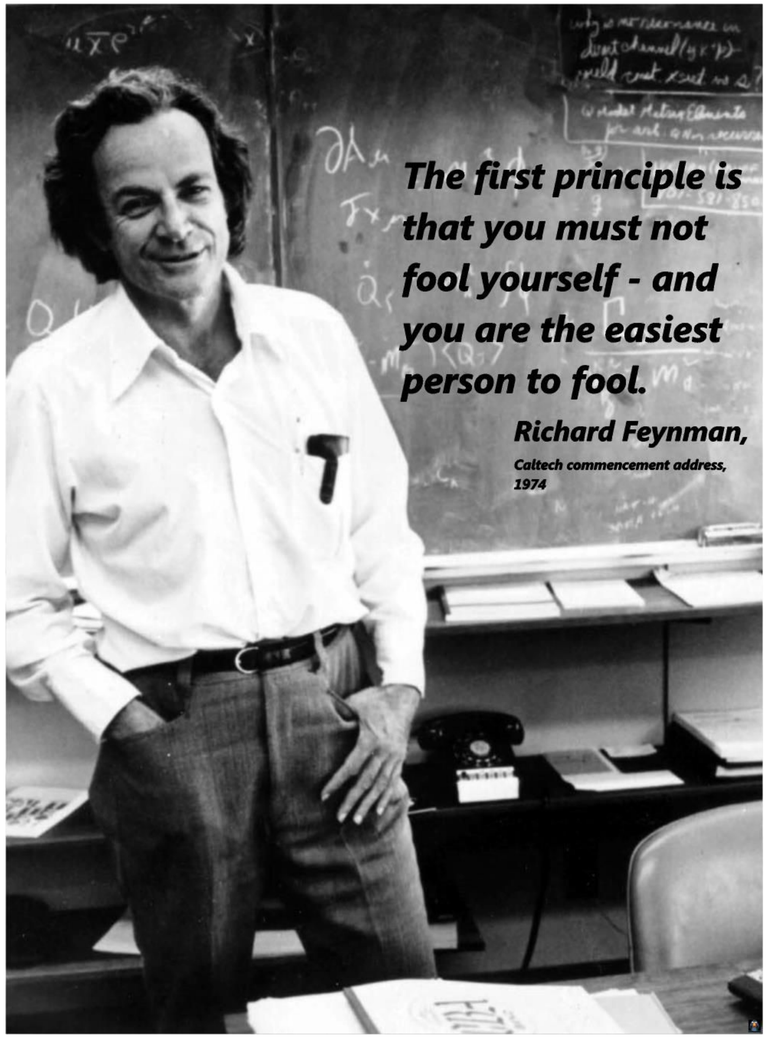
- We blind the redshifts, not angular positions. Blind for cosmology not for systematics

BAO blinding

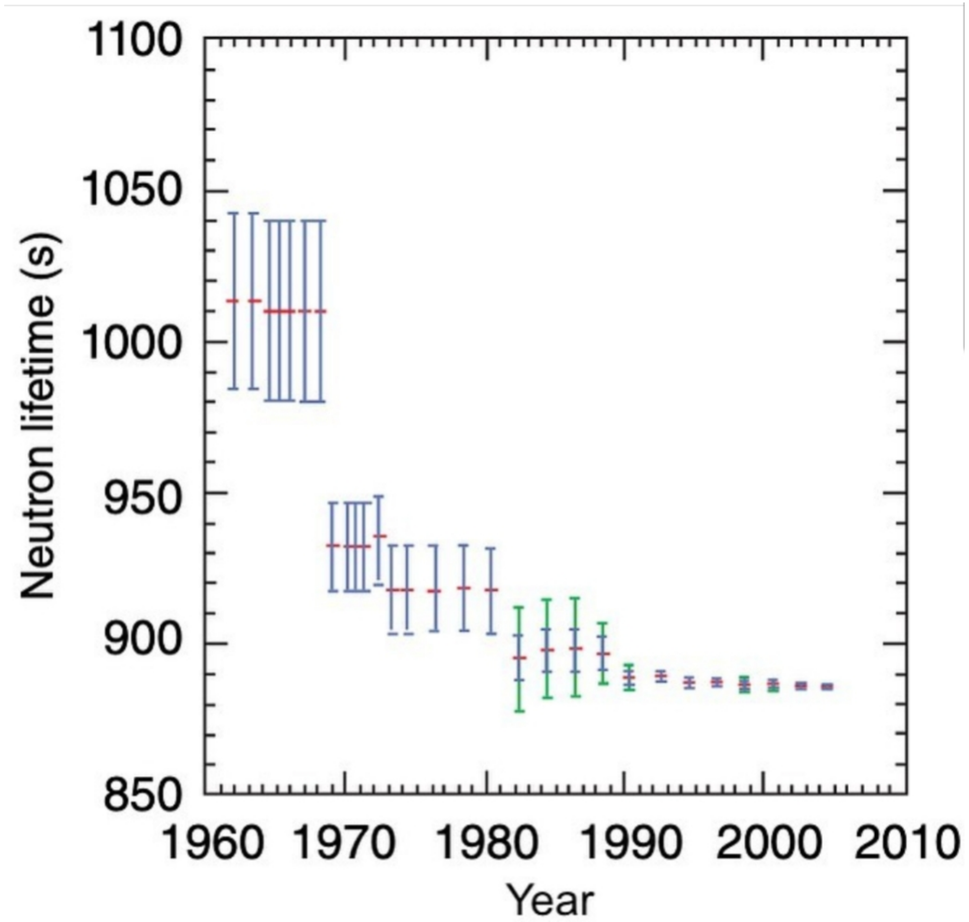
- Aim to blind the AP geometrical distortions along the LOS

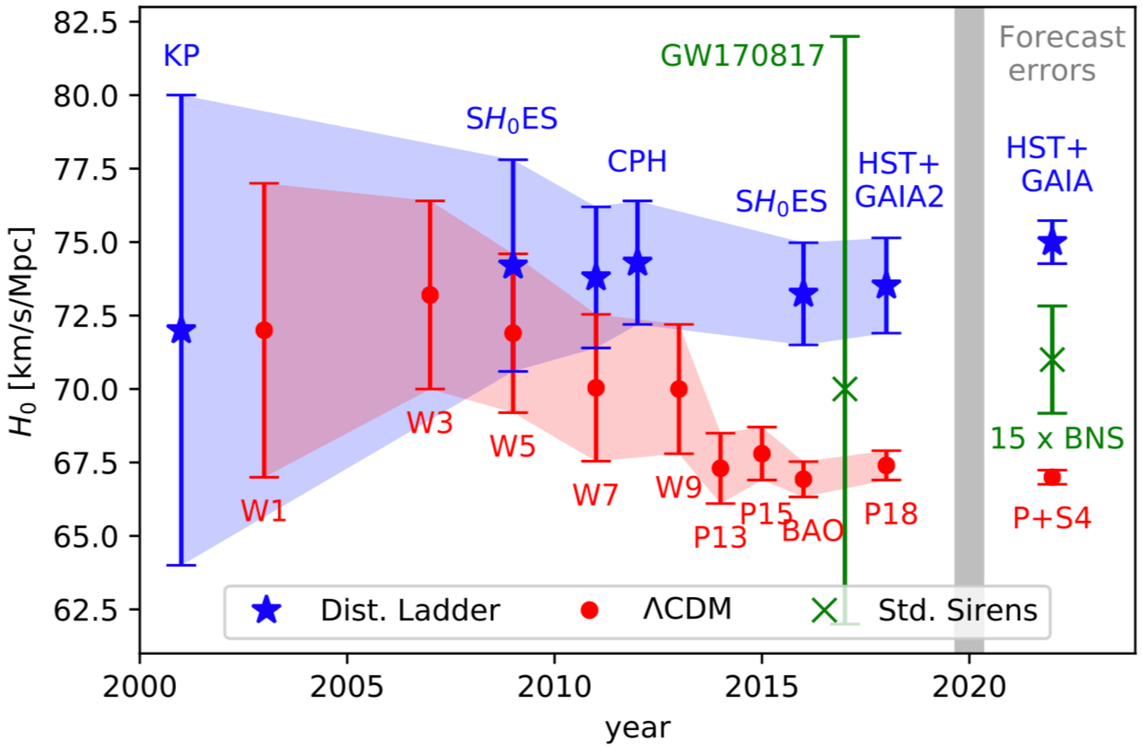
RSD blinding

- Aim to blind the the growth factor, f (along LOS)



Avoid confirmation bias: historical examples





Levels of Blinding

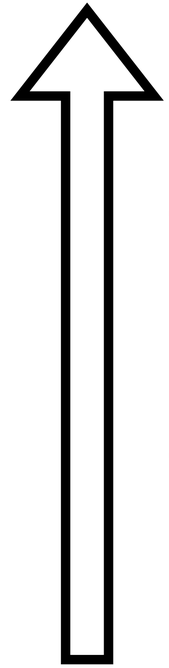
Blinding on galaxy spectroscopic surveys

1. **Catalogue Level:** Modify galaxy (over-density field) positions

2. **Summary Statistics Level:** Modify P(k), ξ(r), B(k), ξ_3(r), void, ….

   2.5. Posterior level: via modification of the covariance $\chi^2 = (D_{\rm data} - D_{\rm theory})^T C^{-1} (D_{\rm data} - D_{\rm theory})$

3. **Posterior Level:** Shift the inferred posterior



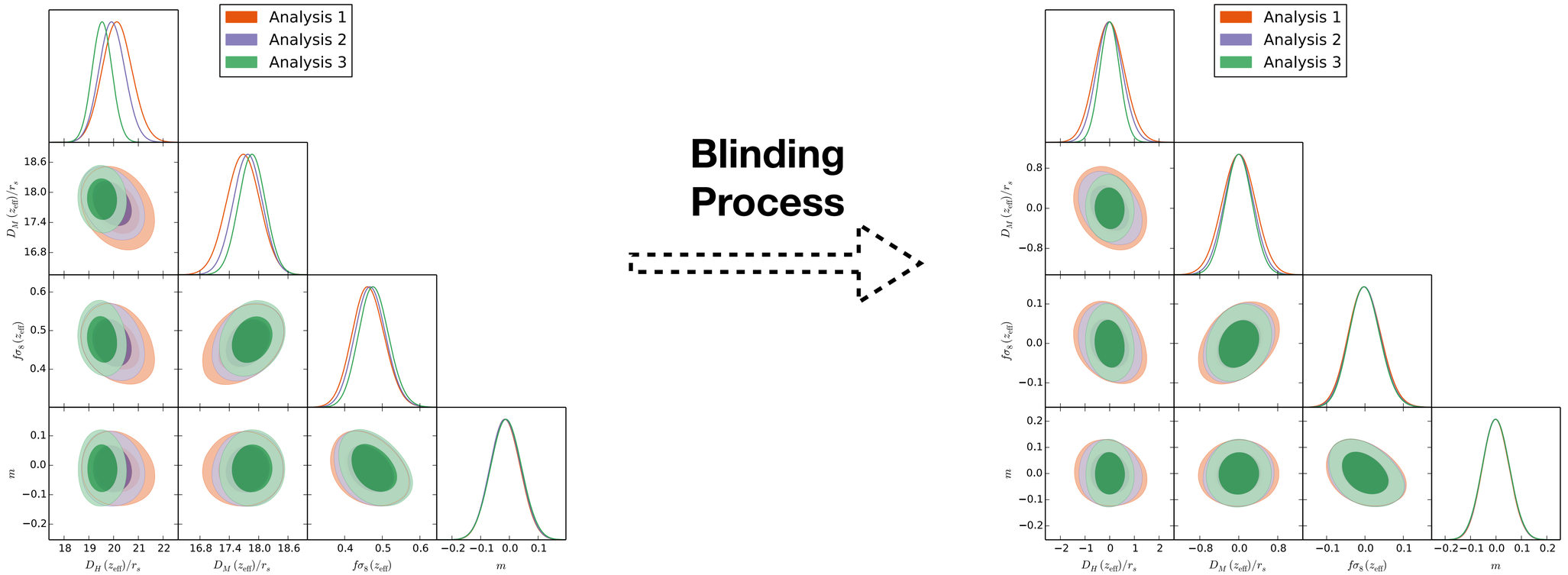
Complexity

Robustness

Credibility

Levels of Blinding

3. Posterior Level

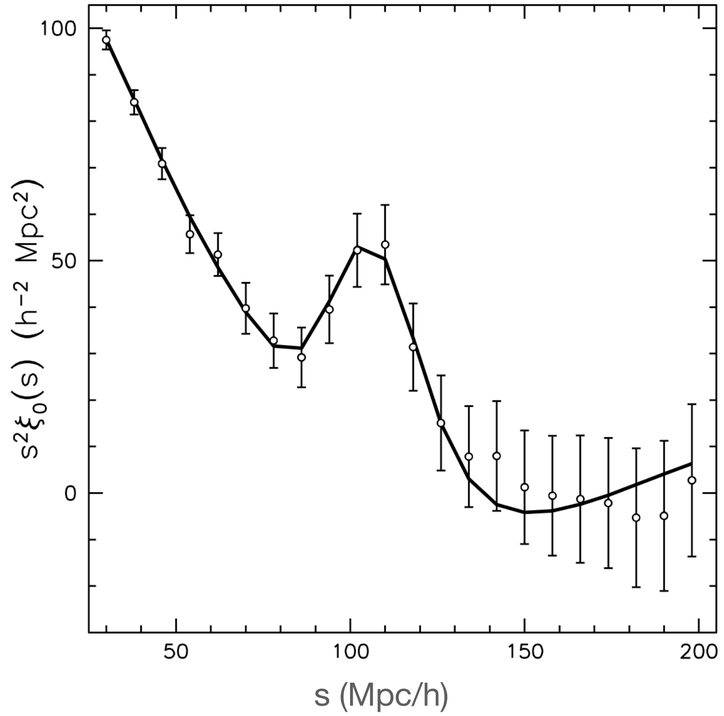


Blinding Process

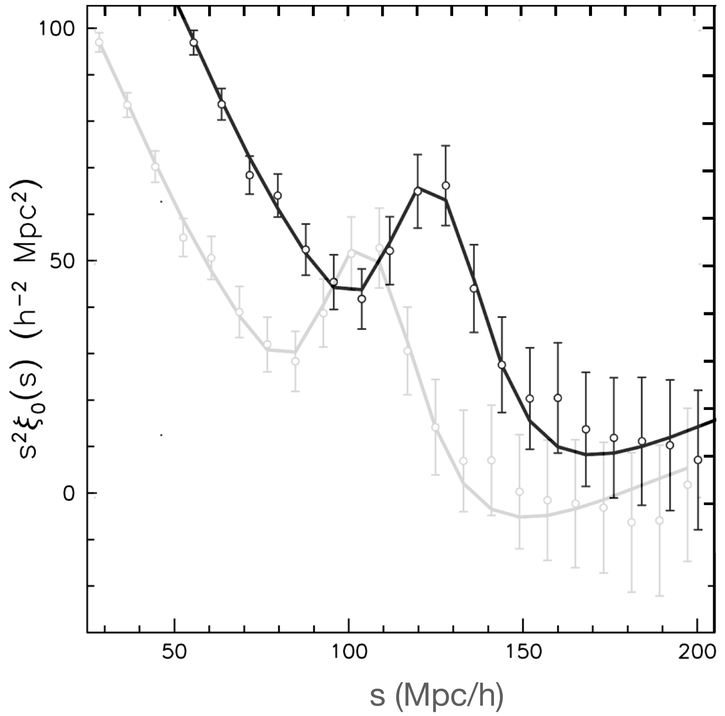
- Pros: Easy to implement
- Cons: Easy to accidentally unblind, blind at the last step of the analysis

Levels of Blinding

2. Summary Statistics Level



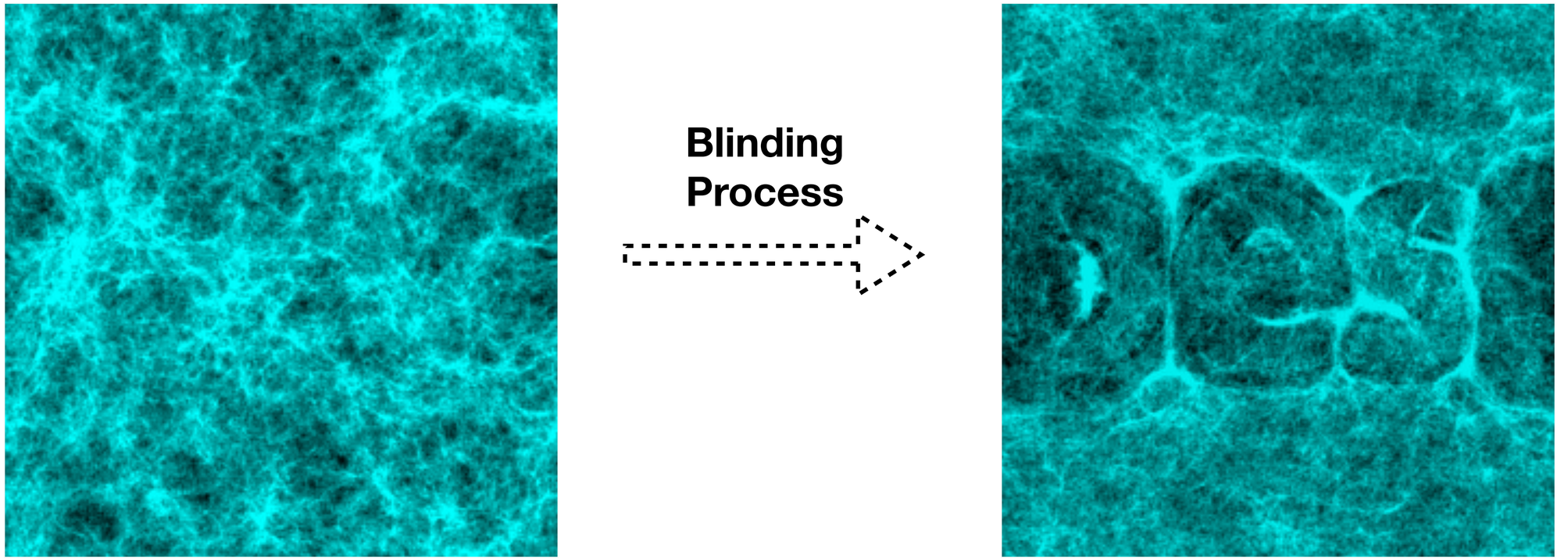
Blinding Process



- Pros: Relatively easy, more robust
- Cons: Different for each summary statistic; need to account for each physical effect

Levels of Blinding

1. Catalogue level



- Pros: Robustness, Consistently blind for all statistics at once (eg. P(k) and ξ(r)).
- Cons: more complex process than just blind on summary statistics or posteriors

Blinding Strategy

Target of the blinding

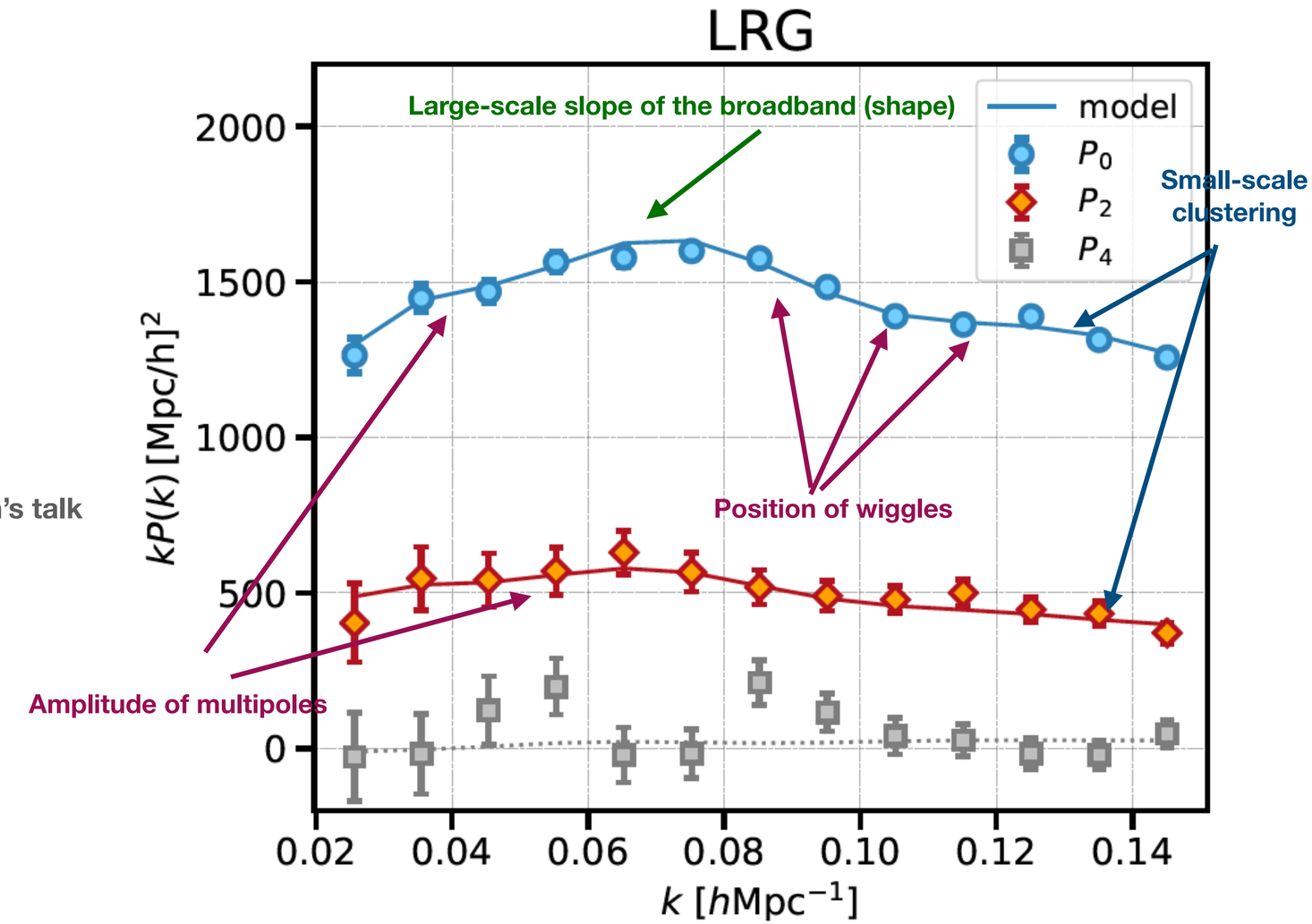
Position of wiggles

Amplitude of multipoles

Shape of the broadband → See Sam Brieden's talk

Small-scale clustering

Amplitude/Shape of wiggles



Blinding Strategy

Target of the blinding

Position of wiggles

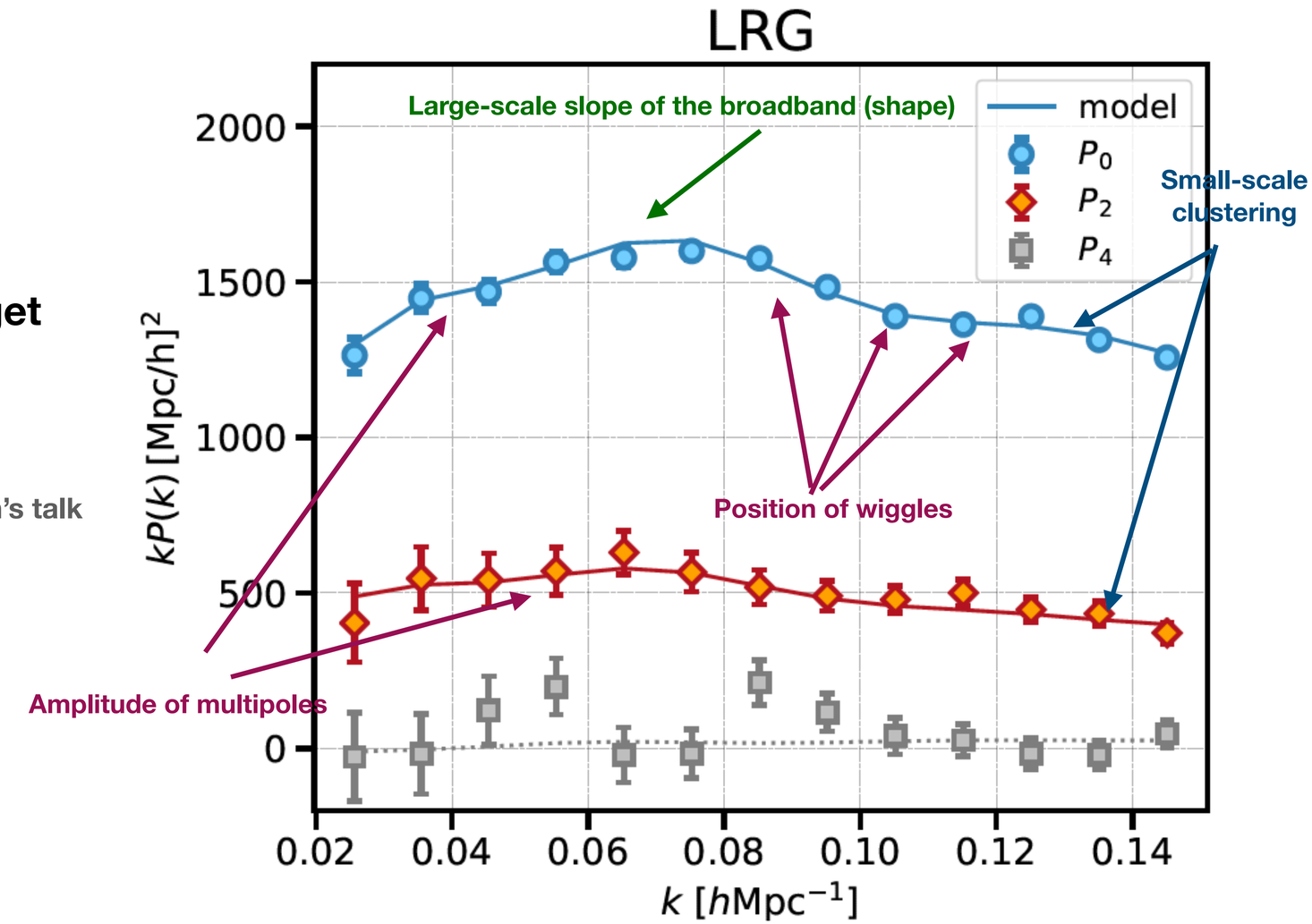
Amplitude of multipoles

Our Blinding Target

Shape of the broadband → See Sam Brieden's talk

Small-scale clustering

Amplitude/Shape of wiggles

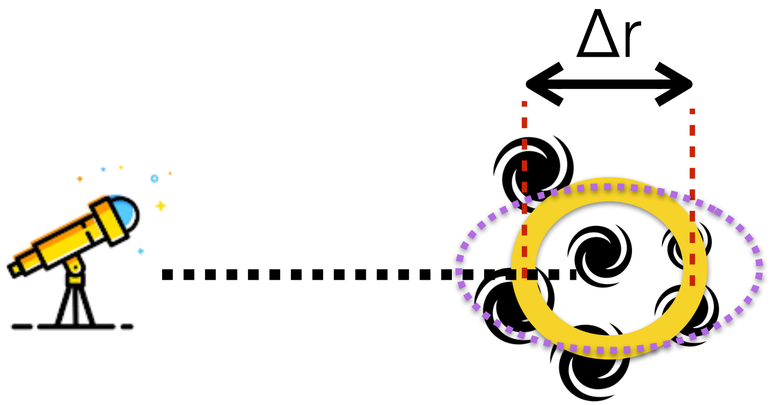


Blinding Strategy

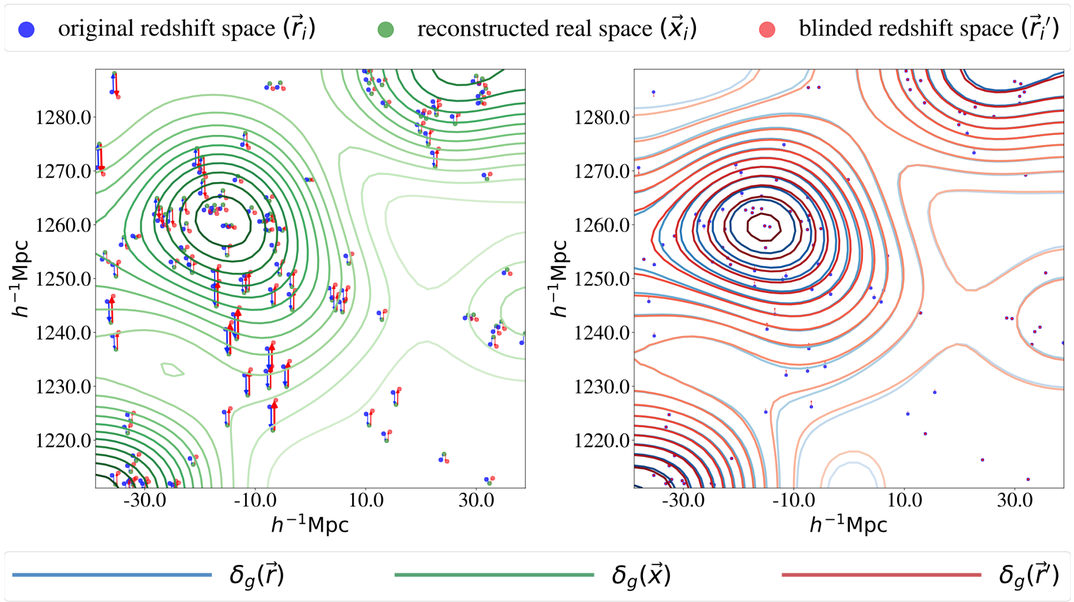
Blind along the line-of-sight

- Avoid modifying angular positions (imaging clustering is not blind anyway)
- Blind for BAO & RSD signal at the catalogue level through two redshift shifts,

1. geometrical AP-like shift



2. density-dependent RSD-like shift



Blinding Strategy

Blinding the background (BAO)

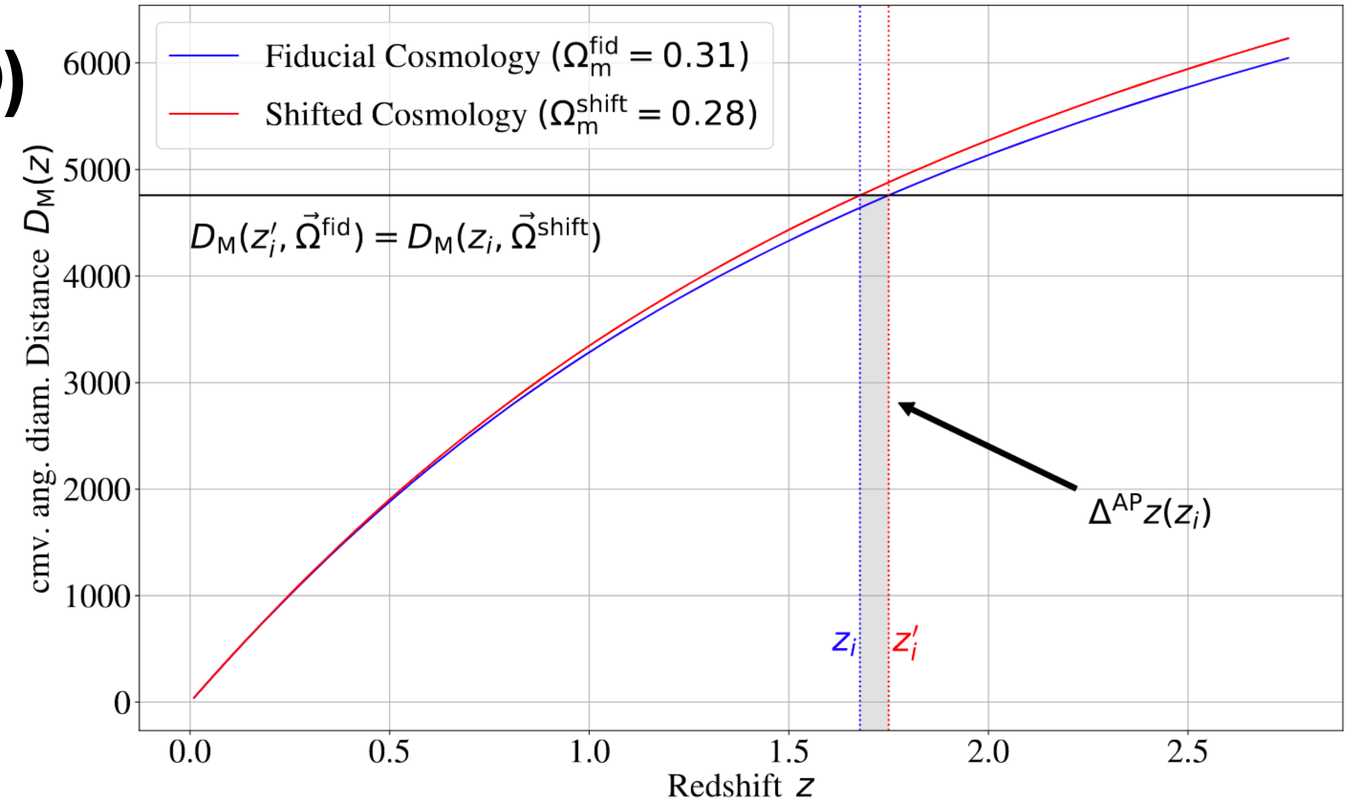
$\Omega^{\rm fid} = \{\Omega_m, h, \dots\}$ Arbitrary fiducial cosmology

$\Omega^{\rm shift} = \Omega^{\rm fid} + \Delta\Omega$

$$z_i \xrightarrow{\Omega^{\rm fid}} D_{M,i} \xrightarrow{\Omega^{\rm shift}} z_i' \xrightarrow{\Omega^{\rm fid}} D'_{M,i}$$

(blinded distances or blinded redshifts)

$z_i' = z_i + \Delta z$



Fiducial

$$\alpha_{\parallel,\perp} = \frac{D_x r_d^{\rm fid}}{D_x^{\rm fid} r_d};$$

Blinded

$$\alpha'_{\parallel,\perp} = \frac{D_x r_d^{\rm fid}}{D_x^{\rm shift} r_d};$$

$$\alpha_{\parallel,\perp} = \alpha'_{\parallel,\perp} \frac{D_x^{shift}}{D_x^{\rm fid}}$$

Correction after unblinding before re-analysing

Blinding Strategy

Blinding the perturbations (RSD)

- Use reconstruction to imprint a new logarithmic growth rate along the LOS

Smooth the density field to solve for Ψ

$$\nabla \cdot \Psi + \frac{f}{b} \nabla \cdot (\Psi \cdot \hat{r}) \hat{r} = -\frac{\delta_g}{b};$$

Shift galaxies back by the total displacement field ψ, only using Δf=f-f'

$$r \longrightarrow r' + (f - f')(\Psi \cdot \hat{r}) \hat{r};$$

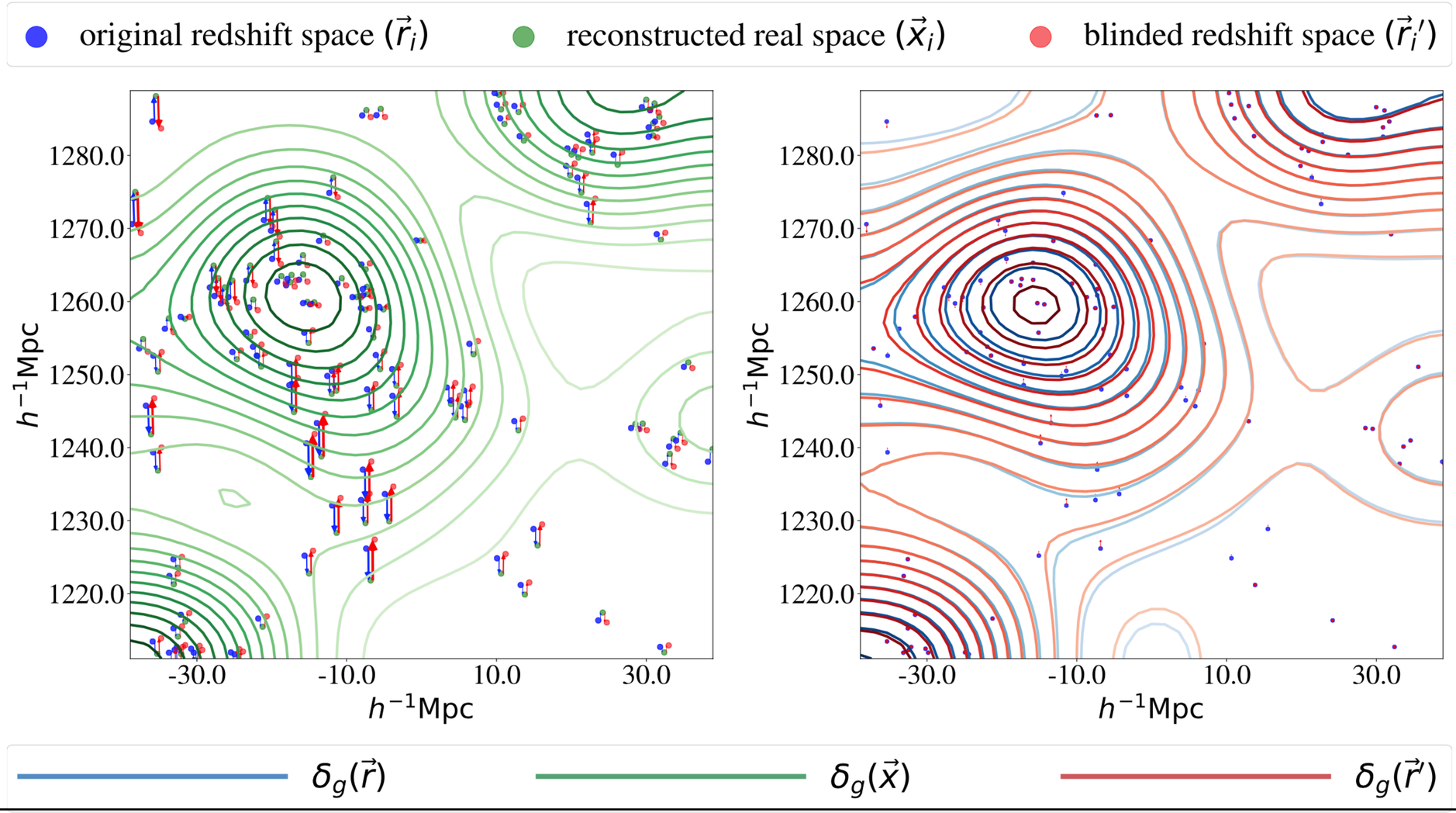
- This effectively imprint a new growth factor f' at large scales.
- Scales below smoothing scale unmodified

where

$$f(z) = \Omega(z)^{\gamma^{GR}};$$

$$f'(z) = \Omega(z)^{\gamma'};$$

Blinding the perturbations (RSD)



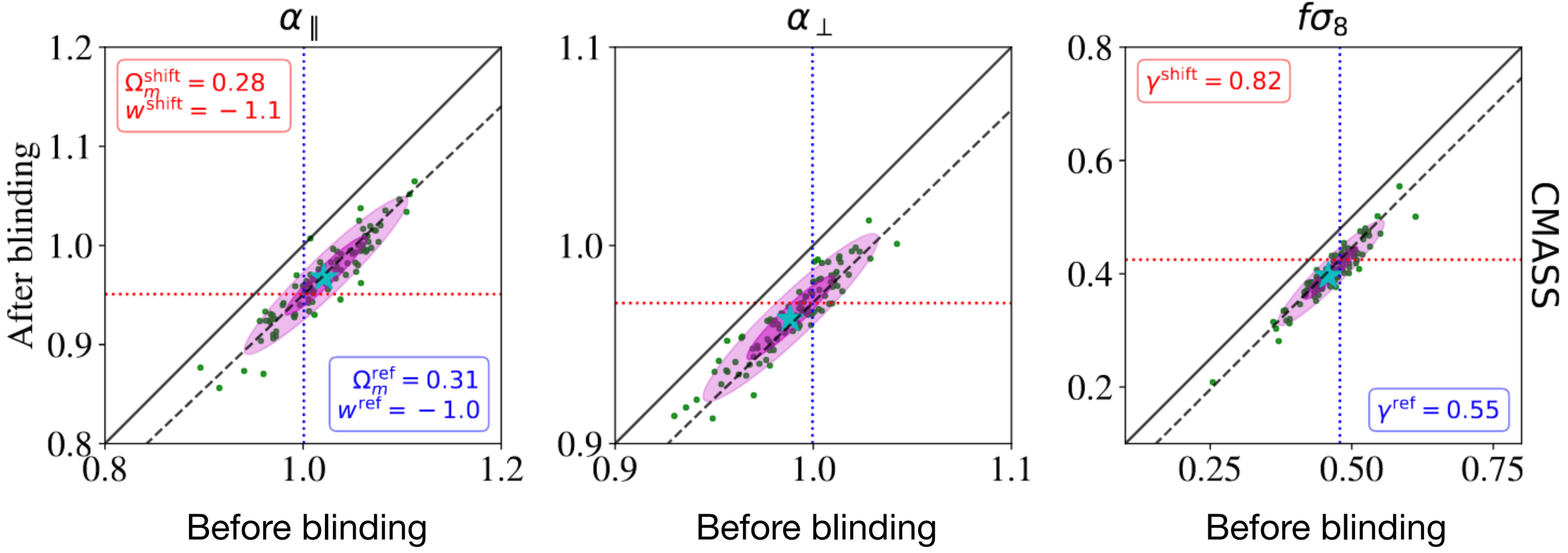
Blinding Tests

Battery of tests,

- Goodness of best-fit not affected,
- Size of retrieved error-bars not affected,
- Assumed values for reconstruction not affected
- Effect of evolving DE also tested via AP, f(z) modifications
- Smoothing scales on reconstruction for RSD-blinding

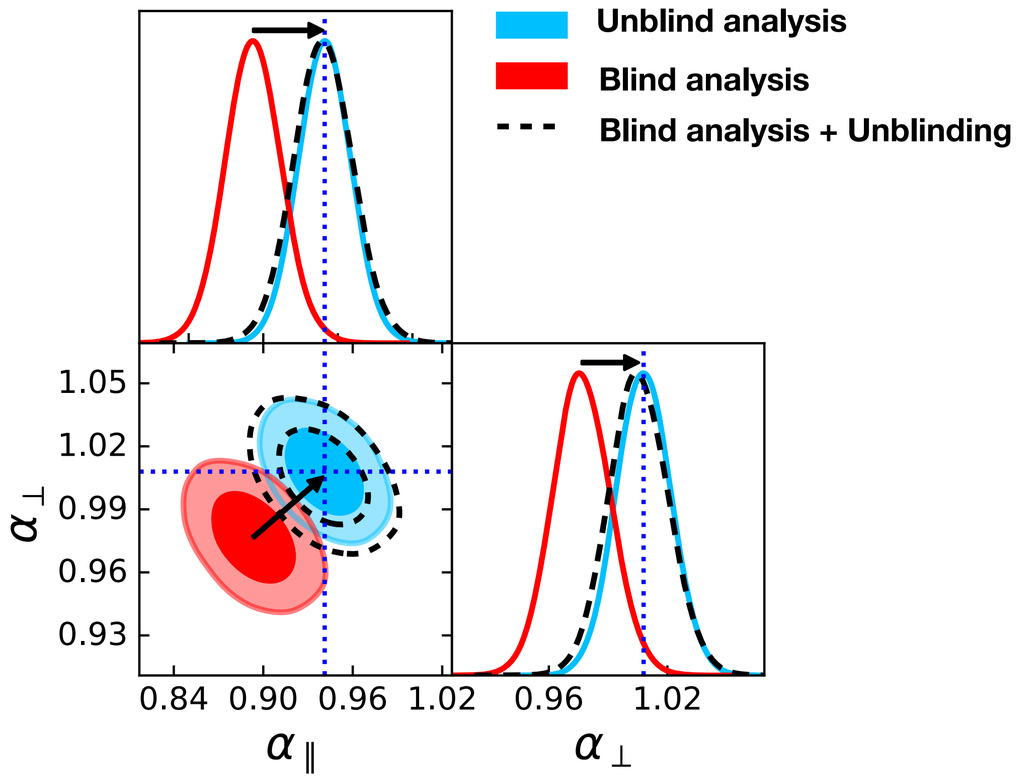
Blinding Tests

Proof of concept with BOSS mocks

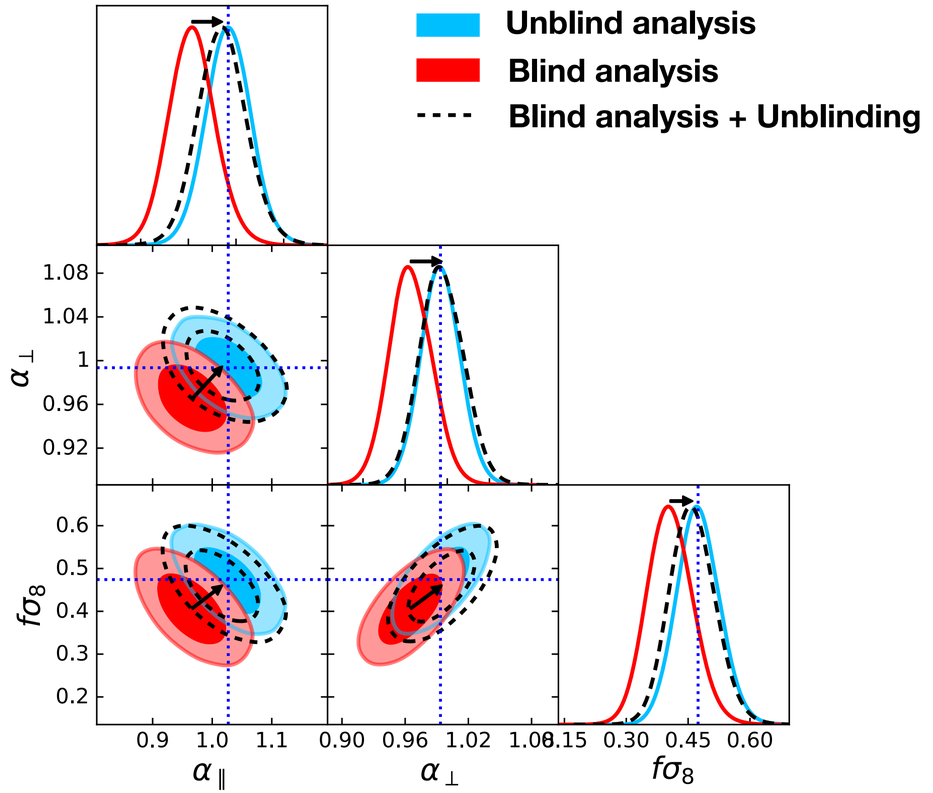


Proof of concept with BOSS data

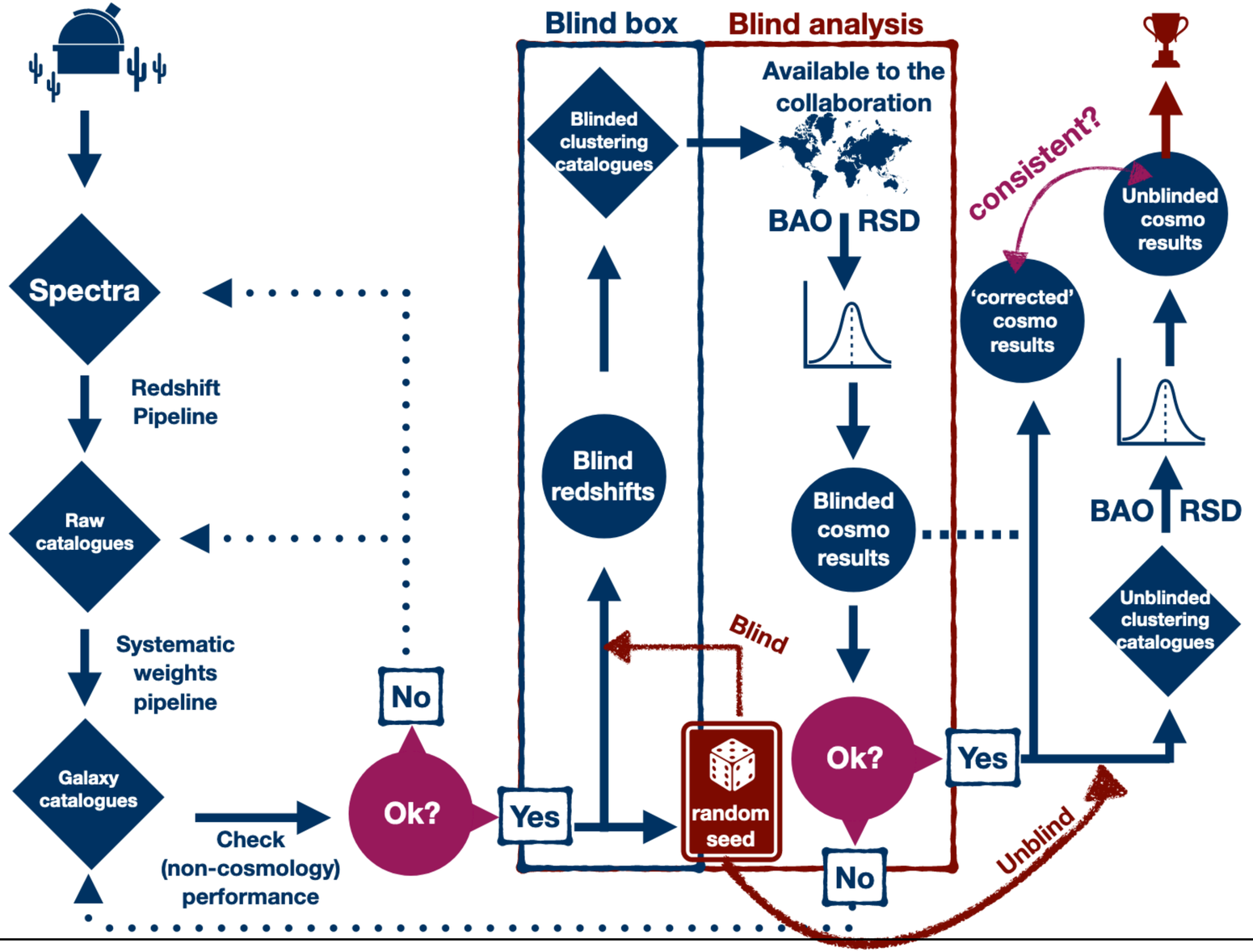
BAO post-recon



Full Shape



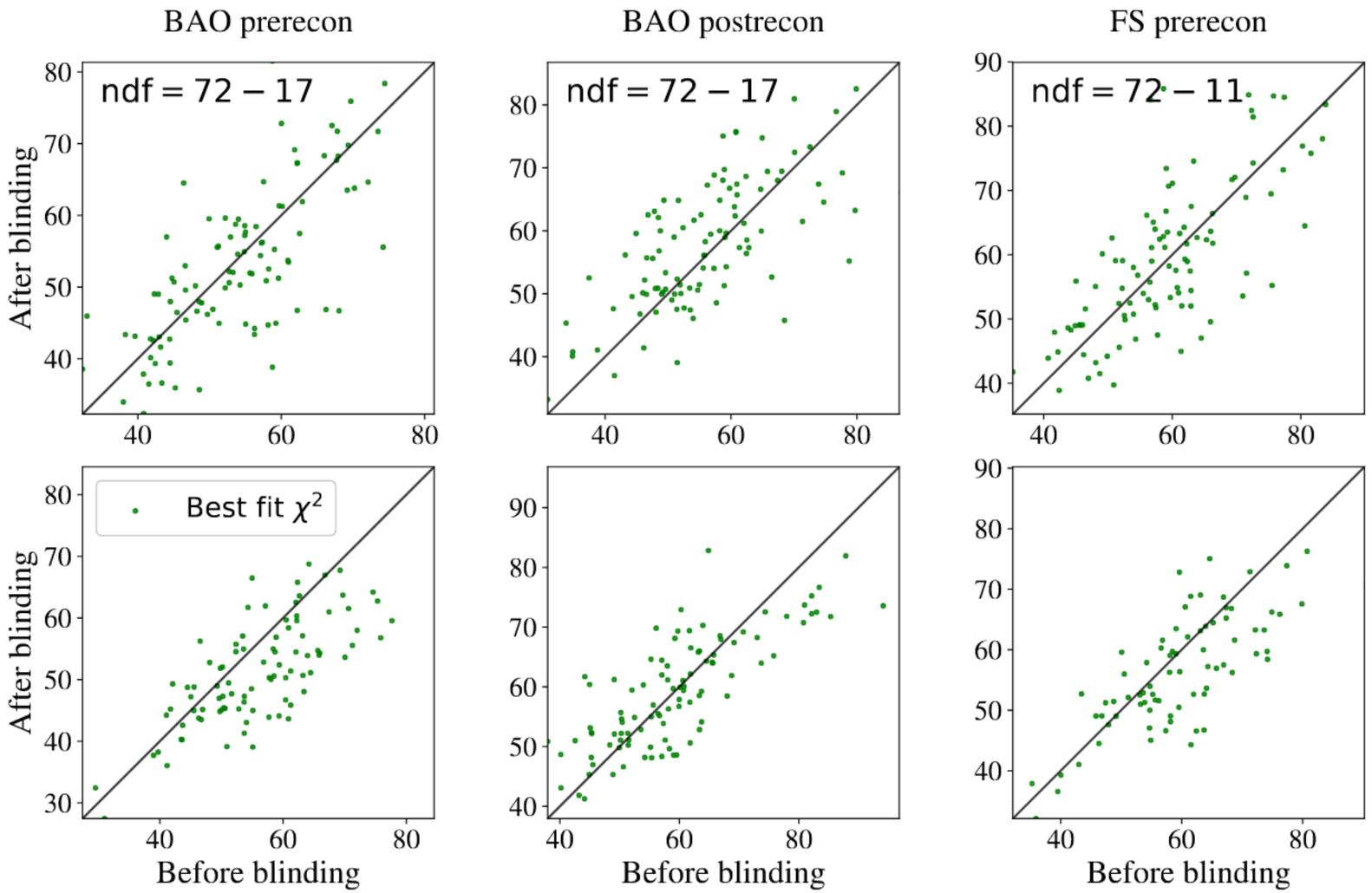
DESI Application



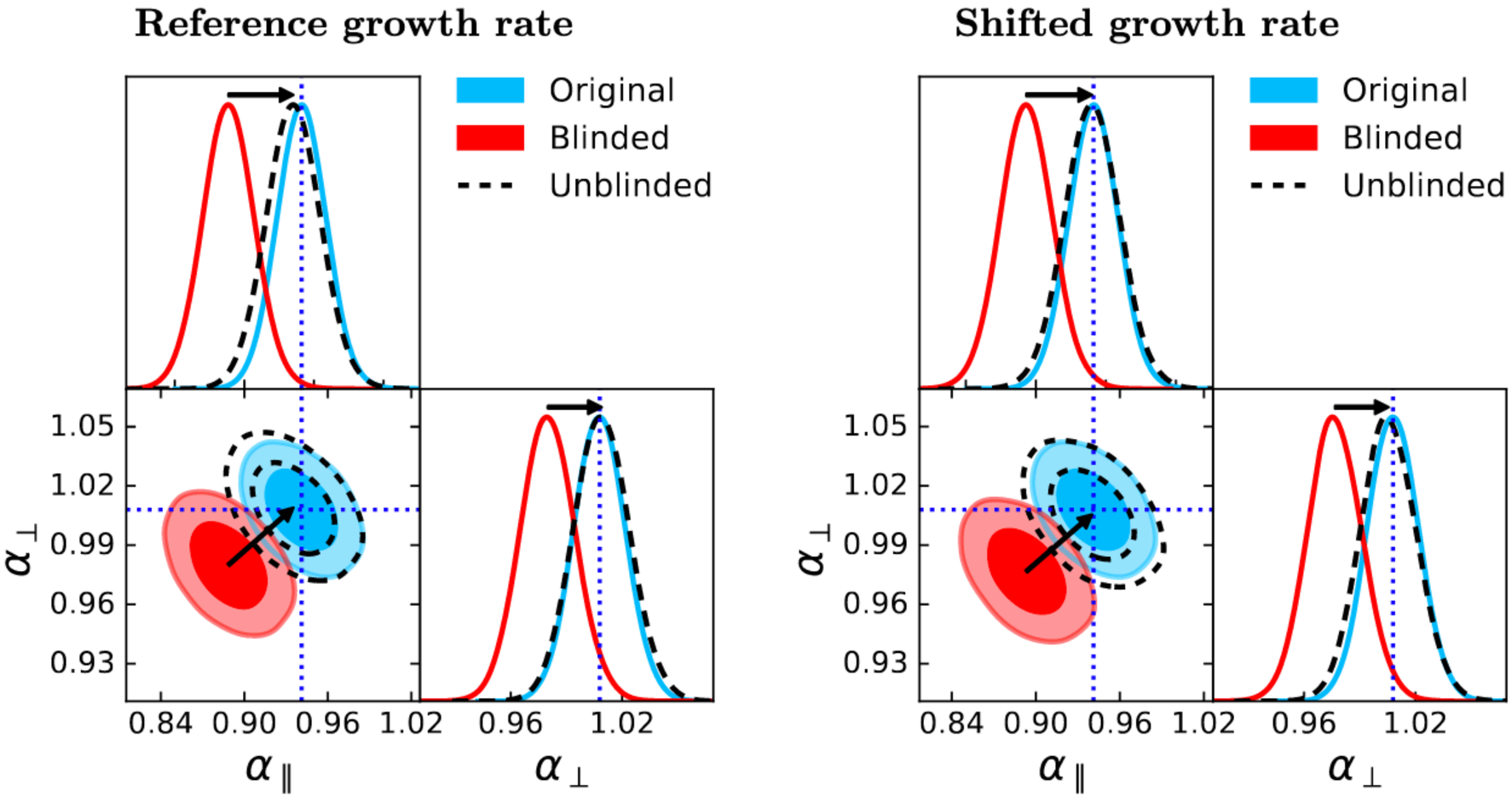
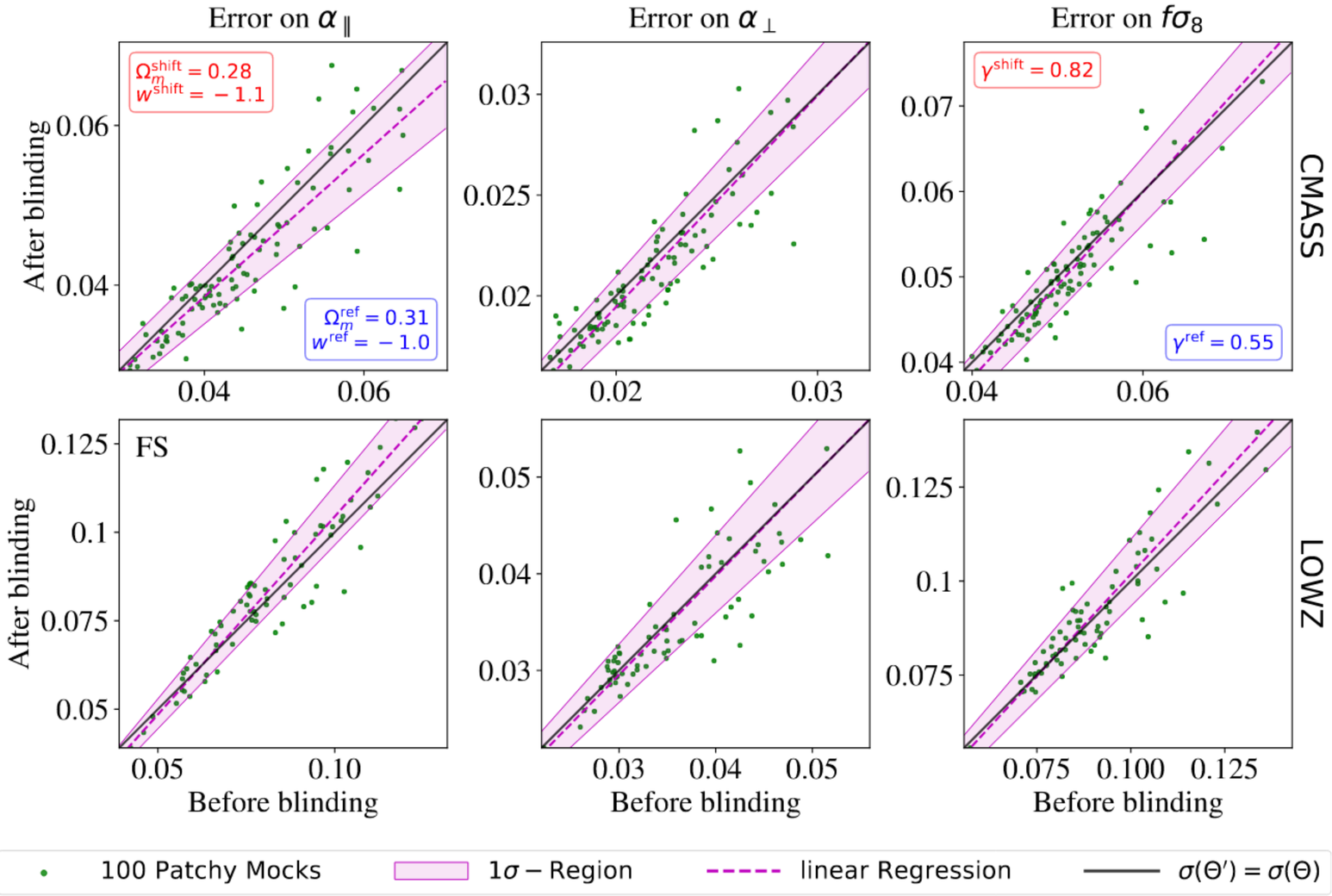
Conclusions

- We have presented the first catalogue-level blinding technique for spectroscopic galaxy surveys
- This technique allows to consistently blind for the BAO and RSD signals for all summary statistics derived from the catalogues at once.
- This approach has been tested on BOSS data with successful results.
- This has been accepted for blinding the upcoming year-1 DESI release.

Extra: χ^2 best-fit



Extra: Reconstruction



Extra: blinded errors