

# 3D density field reconstruction

(O. Cucciati, A. Iovino, C. Marinoni et al. 2006, A&A, 458, 39)

# Data: The First-Epoch VVDS redshift sample (2h-field)

- Flux limited sample:  $17.5 \leq I_{AB} \leq 24$
- Sky area of **0.7 x 0.7 deg**
- **6582** galaxies with secure spectroscopic redshift out of  $\sim 36000$  in the photometric catalog (BVRI bands)
- Median depth:  $z \sim \mathbf{0.76}$  (up to  $z \sim 5$ )
- Transversal dimensions  $\sim \mathbf{37 \times 37 h^{-1} Mpc}$  at  $z=1.5$
- Radial extension:  $\sim \mathbf{4300 h^{-1} Mpc}$  up to  $z=1.5$

# Environment of galaxies

## 3D overdensity field

as indicator of the galaxy space distribution

$$\delta_g(r) = \frac{\rho_g(r) - \overline{\rho_g}}{\overline{\rho_g}}$$

$\rho_g(r)$   $\longrightarrow$  Dimensionless **density contrast** at the comoving position  $\mathbf{r}$ , smoothed over a typical dimension  $R$

$\overline{\rho_g}$   $\longrightarrow$  Average galaxy number density in survey slices  $r \pm D$ , where  $D=400 h^{-1}\text{Mpc}$

# Environment estimator: the 3D galaxy density contrast

$$\rho(r, R, <M^C) = \frac{\sum \delta^D(r-r_i) F(|r-r_i|/R)}{S(r, M^C) \Phi(m) \zeta(z, m) \psi(\alpha, \delta)}$$

$F(R)$

→ gaussian filter

$S(r, M^C)$

→ radial selection function

$\Phi(m)$

→ target sampling rate

$\zeta(z, m)$

→ spectroscopic success rate

$\psi(\alpha, \delta)$

→ angular sampling rate

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**F(R)**

S(r, M<sup>C</sup>)

Φ(m)

ζ(z, m)

ψ(α, δ)

→ **gaussian filter**

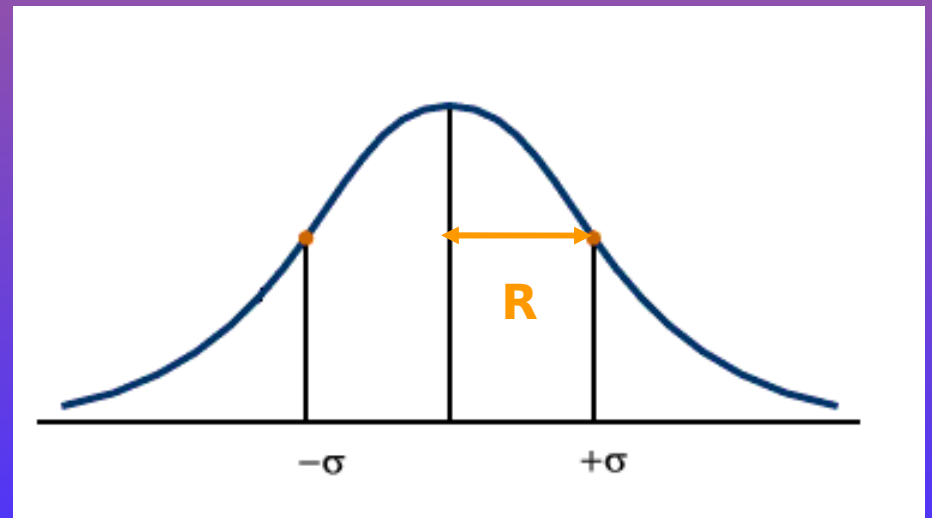
→ radial selection function

→ target sampling rate

→ spectroscopic success rate

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$$F\left(\frac{|r_i - r|}{R}\right) = \frac{3}{(2\pi R)^{3/2}} \exp\left(-\frac{|r_i - r|^2}{2R^2}\right)$$



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$F(R)$

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**$S(r, M^C)$**

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$$S(r, M^C) = \frac{\int_{M_b(r)}^{M_f(r)} \varphi(M) dM}{\int_{-\infty}^{M^C} \varphi(M) dM}$$

**$M_b(r)$**  and  **$M_f(r)$**  are the B-band absolute magnitudes corresponding , at distance  **$r$** , to the I-band survey limits (I=17.5 and I=24 respectively)

It takes into account survey flux limits

# Environment estimator: the 3D galaxy density contrast

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$$\Phi(m) = \frac{dN(spec)}{dm} \bigg/ \frac{dN(phot)}{dm}$$

It takes into account bias against bright objects  
introduced by the slit positioning tool

# Environment estimator: the 3D galaxy density contrast

$$\rho(r, R, <M^C) = \frac{\sum \delta^D(r-r_i) F(|r-r_i|/R)}{S(r, M^C) \Phi(m) \zeta(z, m) \psi(\alpha, \delta)}$$

|                        |                                     |
|------------------------|-------------------------------------|
| $F(R)$                 | → gaussian filter                   |
| $S(r, M^C)$            | → radial selection function         |
| $\Phi(m)$              | → target sampling rate              |
| $\zeta(z, m)$          | → <b>spectroscopic success rate</b> |
| $\psi(\alpha, \delta)$ | → angular sampling rate             |

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Comparison between :

- **z\_phot** distribution of **all targets**
- **z\_spec** distribution of **flag ≥ 2**

It takes into account:

- increasing difficulty in measuring  $z$  at faint magnitudes
- scarce/no presence of spectral features in given  $z$  ranges



# Environment estimator: the 3D galaxy density contrast

$$\rho(r, R, <M^C) = \frac{\sum \delta^D(r-r_i) F(|r-r_i|/R)}{S(r, M^C) \Phi(m) \zeta(z, m) \psi(\alpha, \delta)}$$

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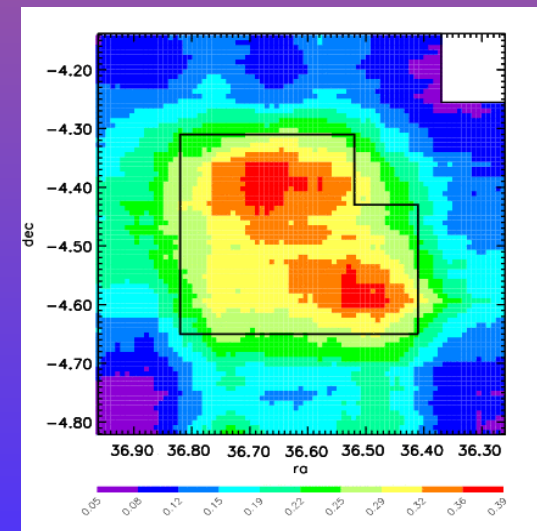
$\psi(\alpha, \delta)$

→ **angular sampling rate**

$$\Psi(\alpha, \delta) = \frac{d^2 N(\text{spec})}{d\alpha d\delta} \bigg/ \frac{d^2 N(\text{phot})}{d\alpha d\delta}$$

(its mean value is normalized to unity)

It takes into account the number of  
VIMOS passes



# Environment estimator: the 3D galaxy density contrast

We also have to take into account **boundary effects**:

- 3) We **normalize** density measured around each galaxy **by the fraction  $F$  of the volume** of the gaussian filter contained within survey borders
- 4) We in any case **exclude** from any further analysis all **galaxies with  $F < 0.5$**

# Testing the environment reconstruction

- TEST 1: Kinematical effects
  - No reconstruction bias from real space to redshift space
- TEST 2: Survey design effects
  - No reconstruction bias from 100% sampling rate to VVDS-like observation strategy

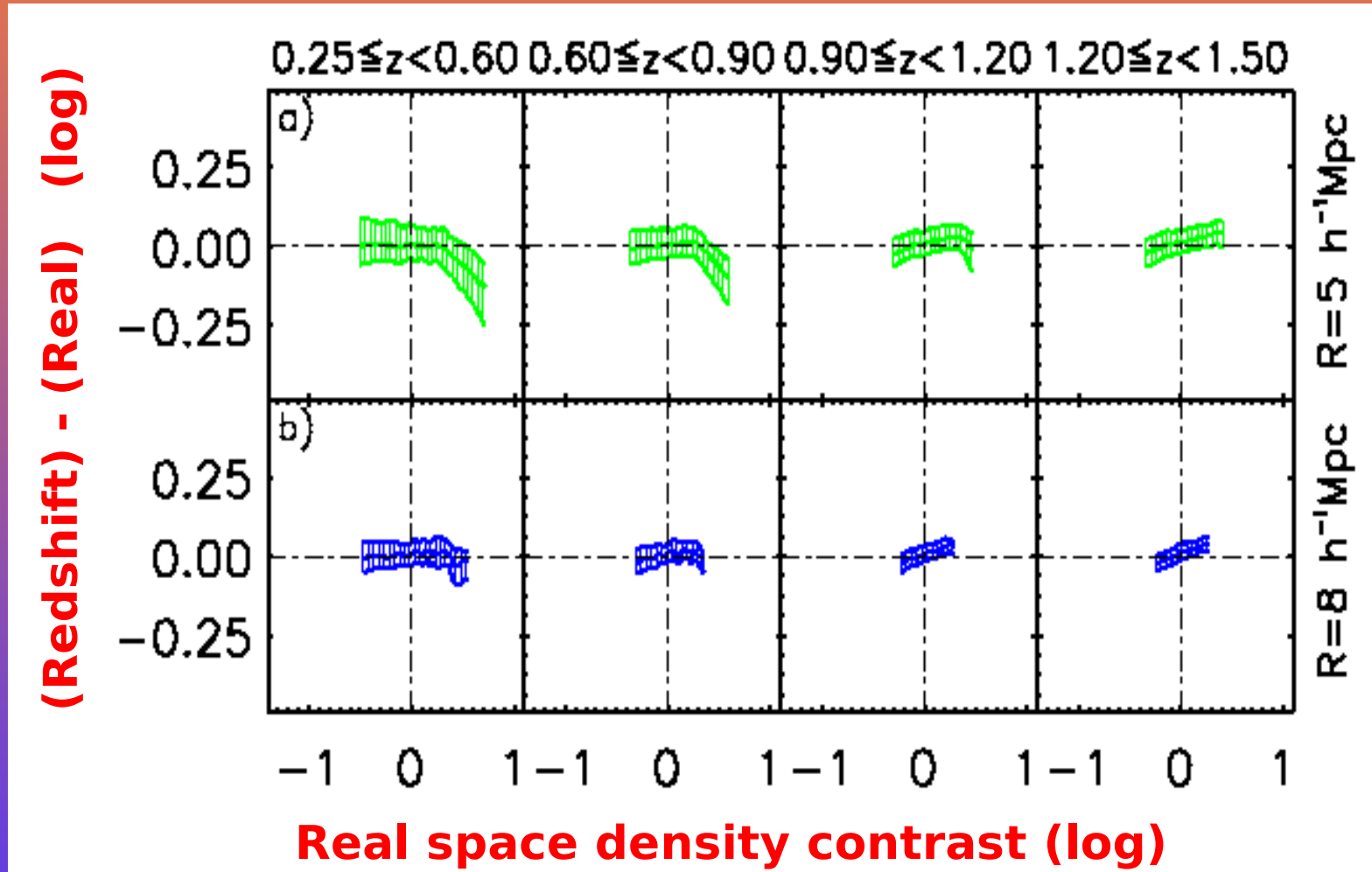
No reconstruction bias for

$$R \geq 5 h^{-1} \text{ Mpc}$$

$$0.25 \leq z \leq 1.5$$

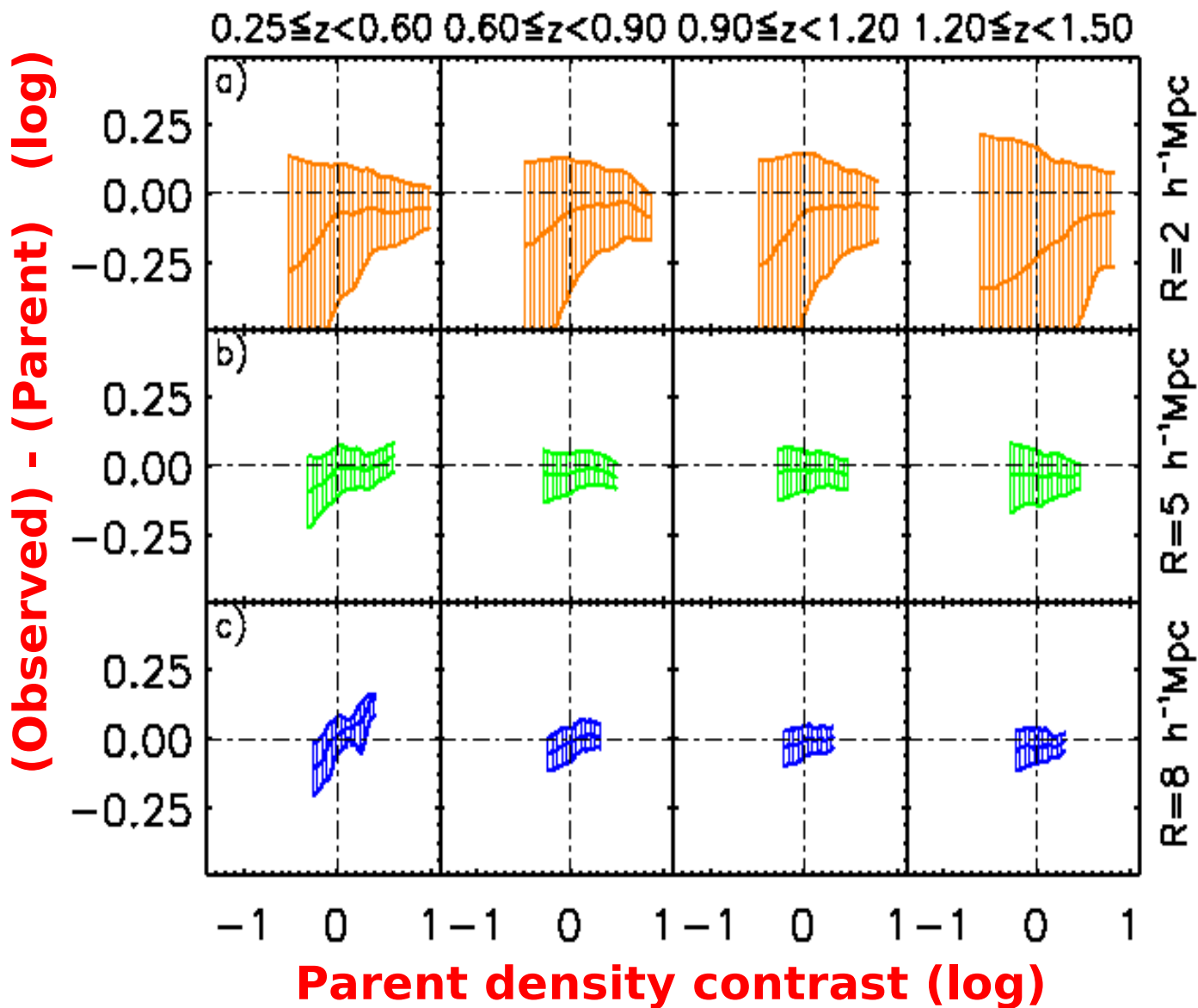
# TEST 1: Kinematical effects

SIMULATIONS (GALICS, Hatton et al. 2003)



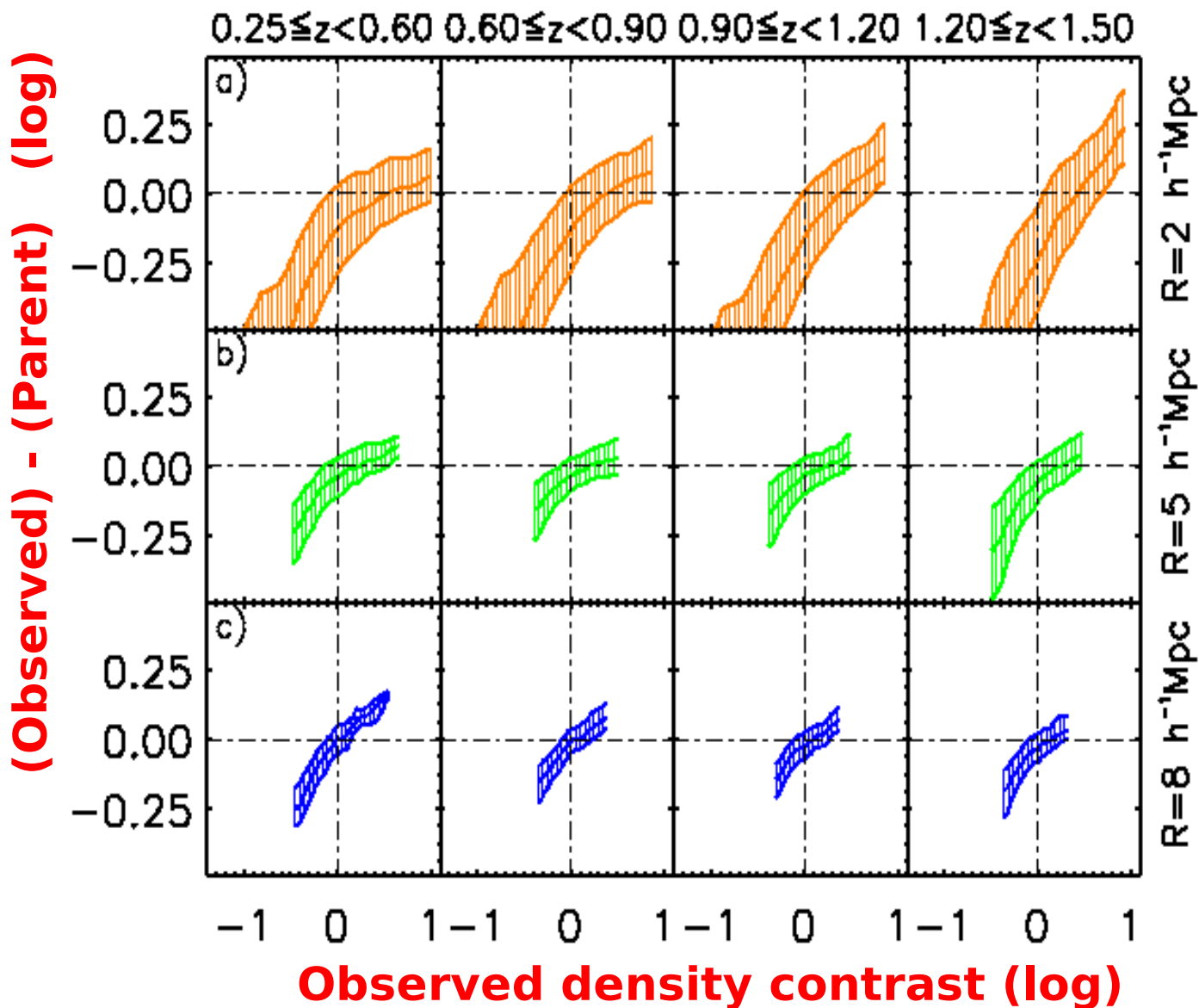
**No reconstruction bias from real space to redshift space**

# TEST 2: Survey design effects



**No reconstruction bias for  $R \geq 5 \text{ h}^{-1} \text{ Mpc}$  up to  $z = 1.5$**

# TEST 2: Survey design effects



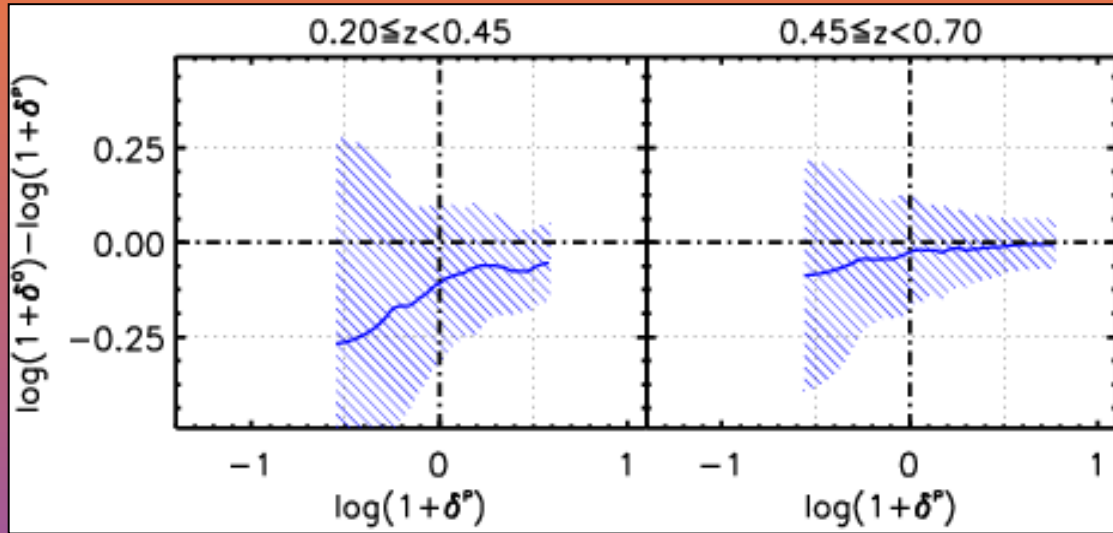
**No reconstruction bias for  $R \geq 5 \text{ h}^{-1} \text{ Mpc}$  up to  $z = 1.5$**

# Applying the algorithm to zCOSMOS mocks

- **10K** and **20K** mocks + **parent** 100% sampling catalogs (from MILLENNIUM simulations)
- **Simplified local density estimator:**
  - Density computed with a volume limited subsample ( $M_B \leq -20$ ): no need to use selection function
  - PLEASE NOTE: the limit  $M_B \leq -20$  implies that we have to limit the computation at  $z \leq 0.7$
  - Mock catalogs obtained with no implementation of dependences from observed I magnitude and redshift range: no need to use target sampling rate and spectroscopic success rate
  - only angular sampling rate (not normalized) is used in this preliminary test

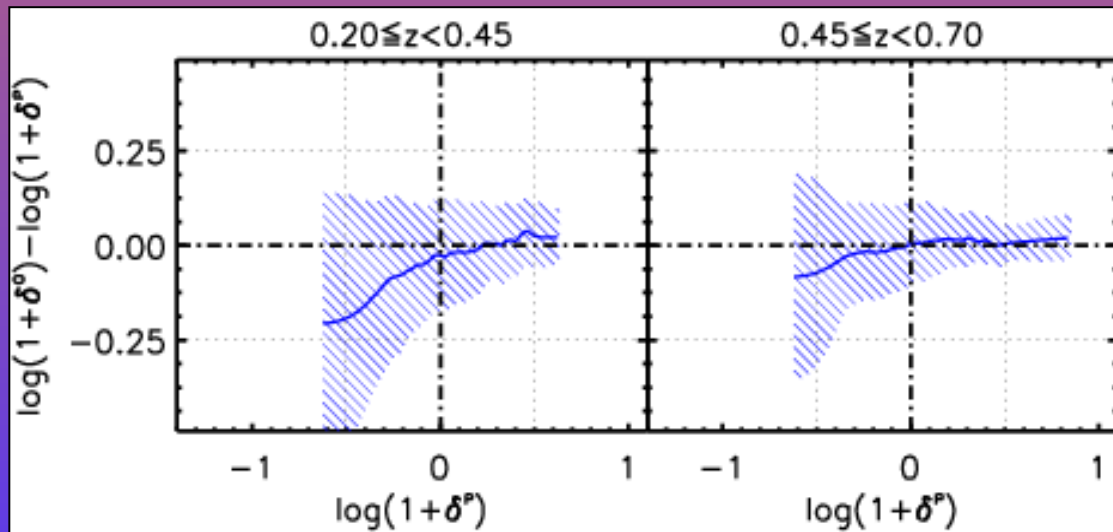
# TEST: Survey design effects

**(Observed) - (Parent) (log)**



**10K mocks**

$R = 5 h^{-1} \text{ Mpc}$



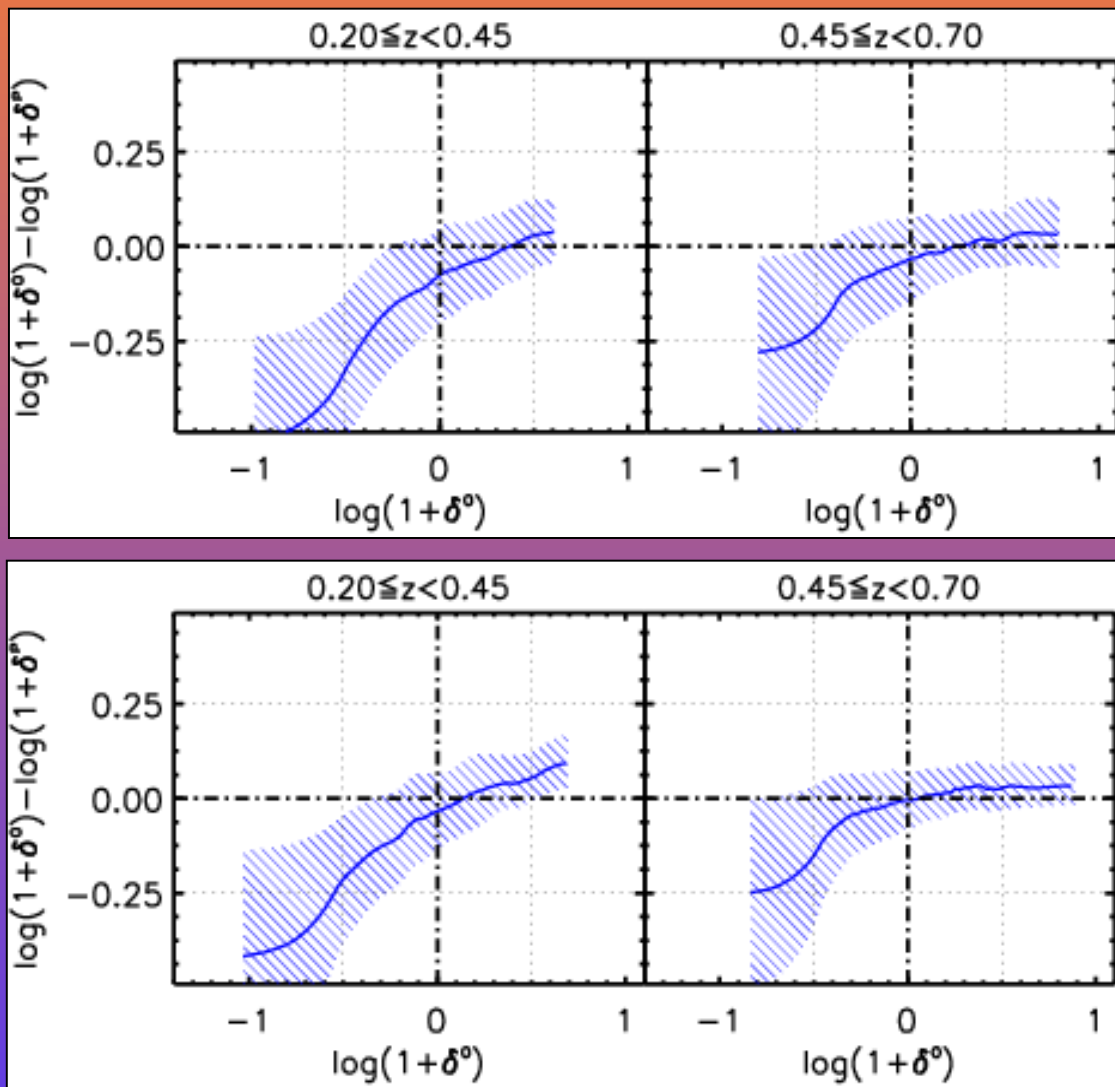
**20K mocks**

**Parent density contrast (log)**



# TEST: Survey design effects

**(Observed) - (Parent) (log)**



**10K mocks**

$R = 5 h^{-1} \text{ Mpc}$

**20K mocks**

**Observed density contrast (log)**