Redshifts measurements by on-sky cross-correlations

How to extract redshifts distributions
from
the angular clustering of objects ?

Vivien Scottez

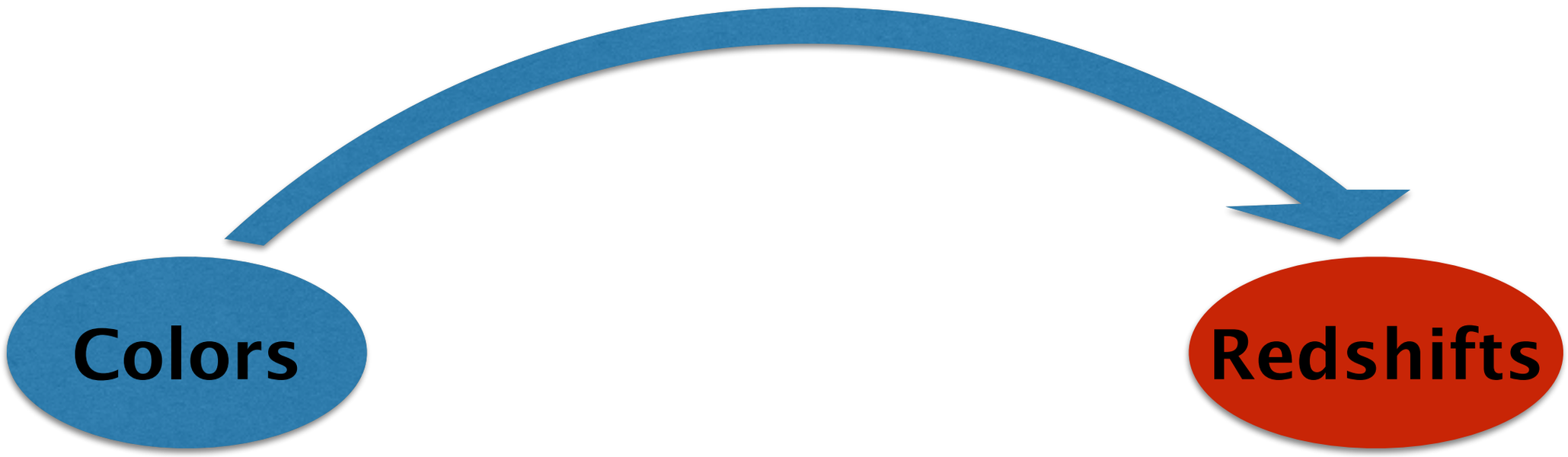
In collaboration with:

B. Ménard & Y. Mellier

What are Photo-z ?

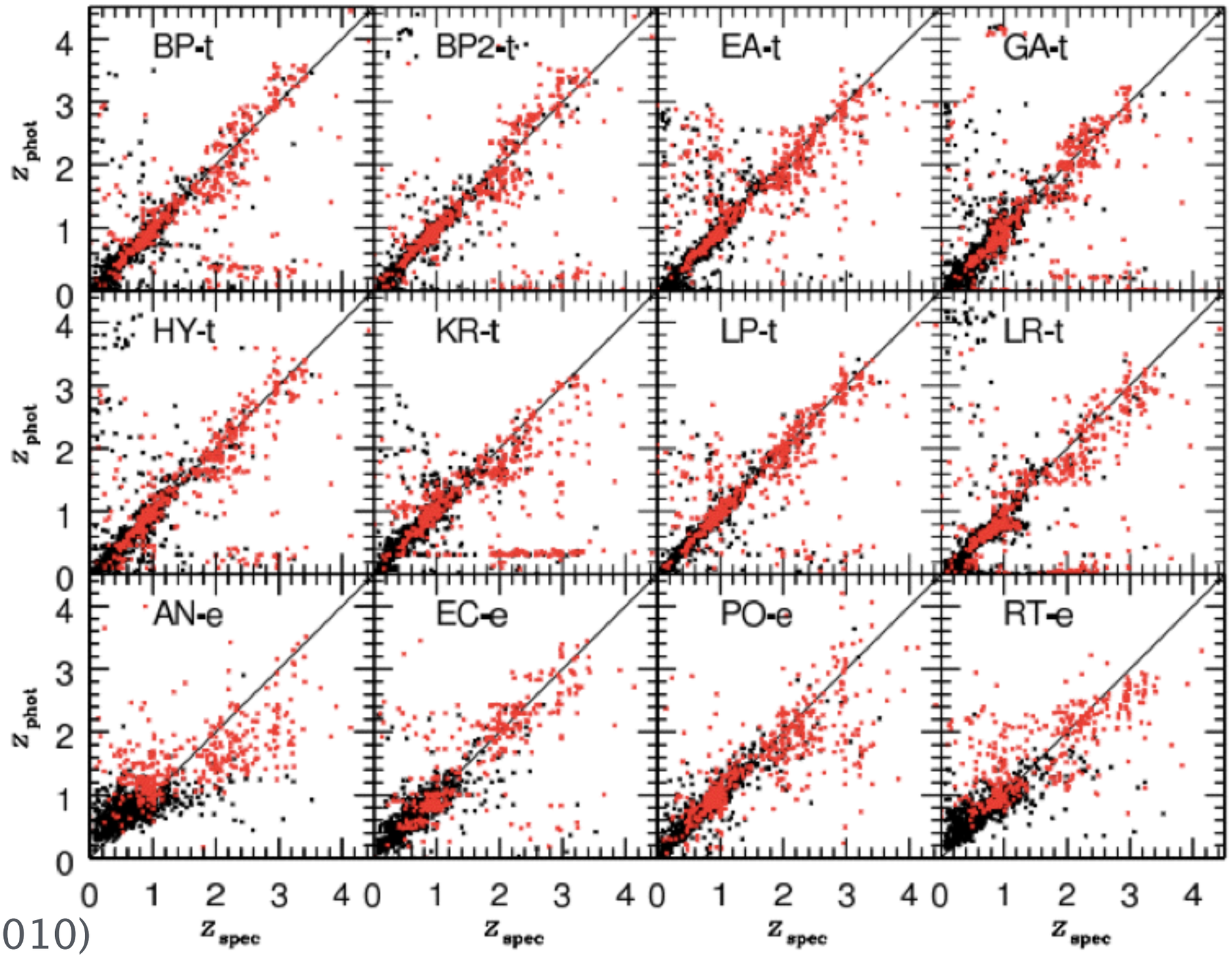
Photometric Redshifts

SEDs or Training Sets



Photometric redshifts

- They rely on templates (theoretical or observed)
- They require training sets.
- The answer is not unique.



Hildebrandt et al. (2010)

Photometric redshifts

- They rely on templates (theoretical or observed)
- The answer is not unique.
- They are affected by dust extinction/reddening effects
- They suffer from catastrophic failures

Clustering based redshifts

Seldner & Peebles (1979) !!

Phillips & Shanks (1987), Landy, Szalay & Koo (1996)

Newman (2008), Matthews & Newman (2010, 2012)
McQuinn & White (2013)

[global approaches]

Schmidt et al. (2012), Ménard et al. (2013), Rahman et al. (2014)

Scottez et al. (in prep)

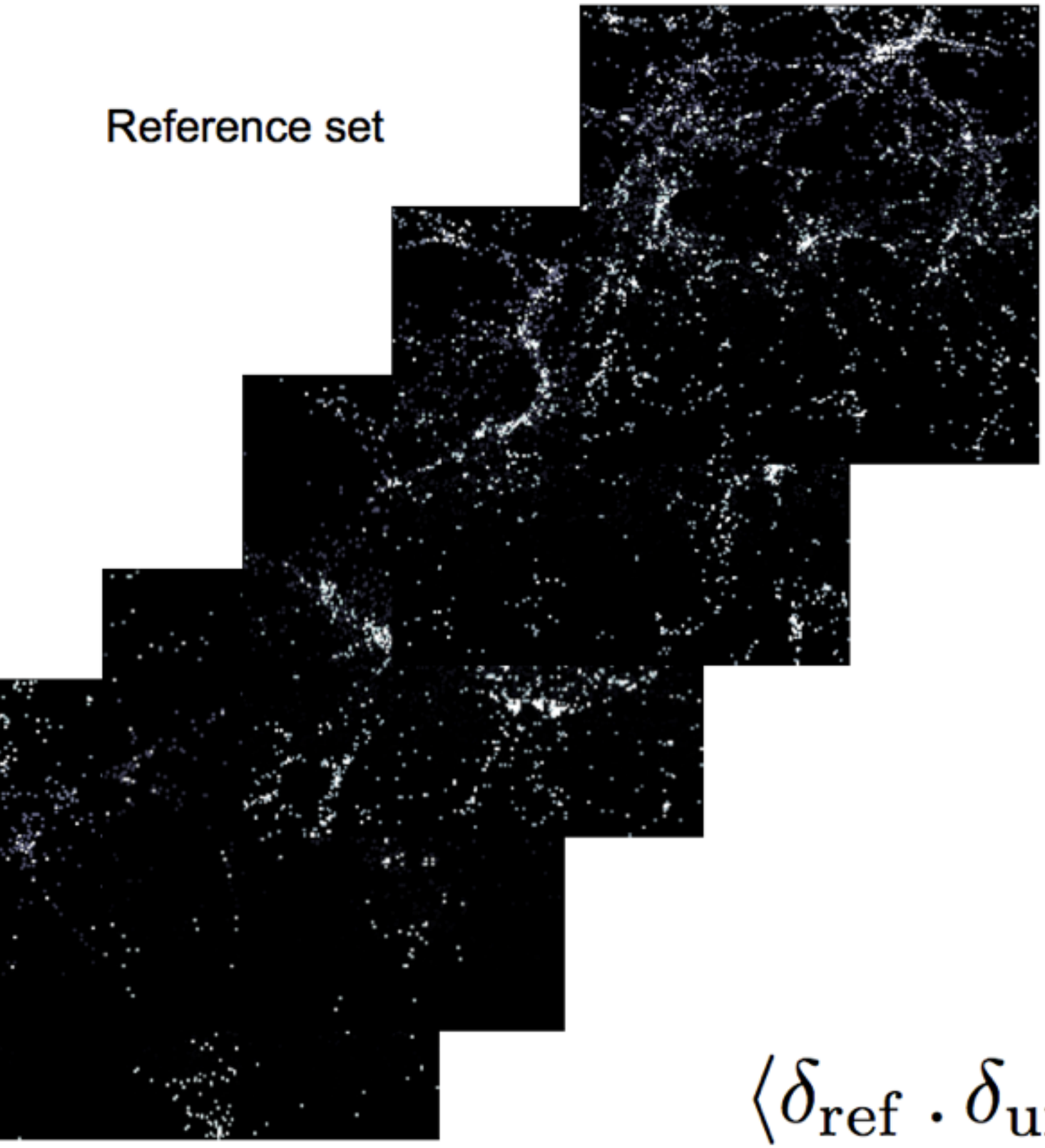
[local approach]

Clustering Redshifts

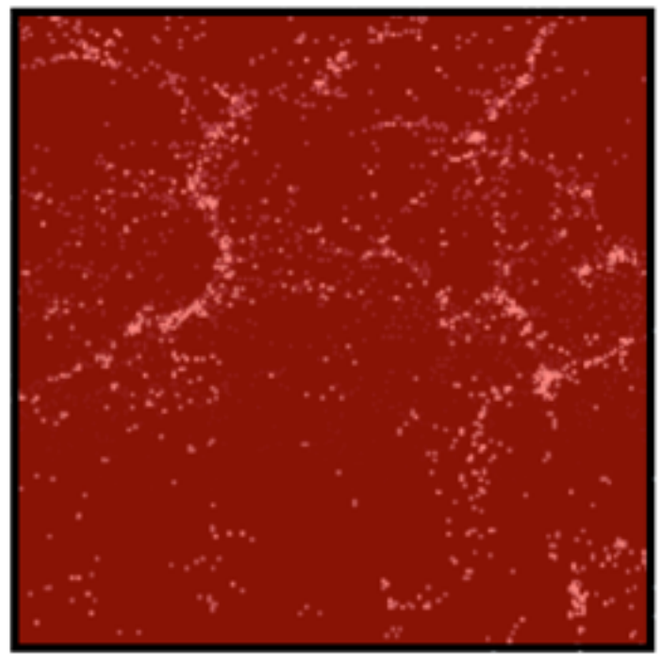
Spatial correlation with reference set

Clustering based redshifts

Reference set



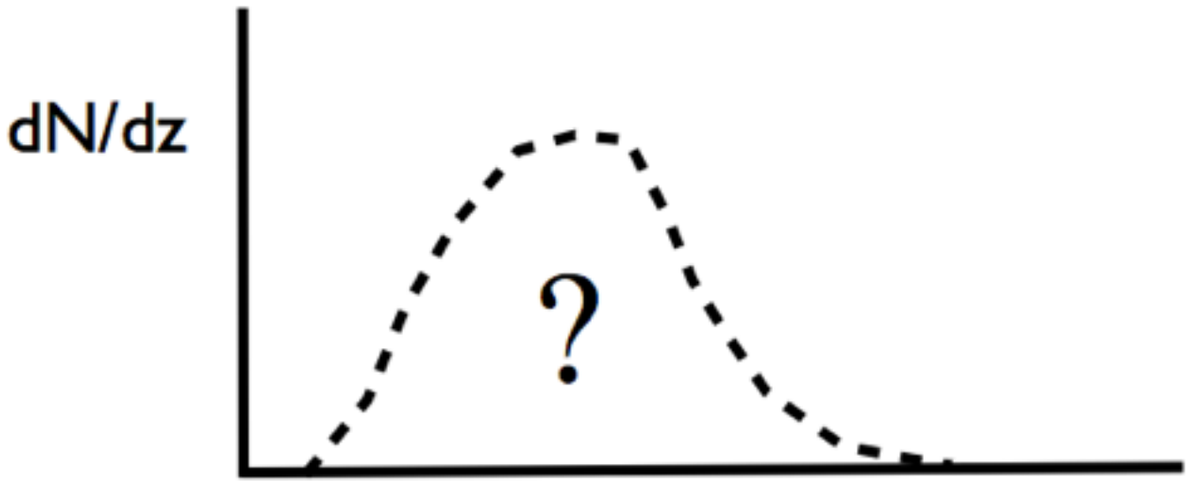
Sample at unknown redshift

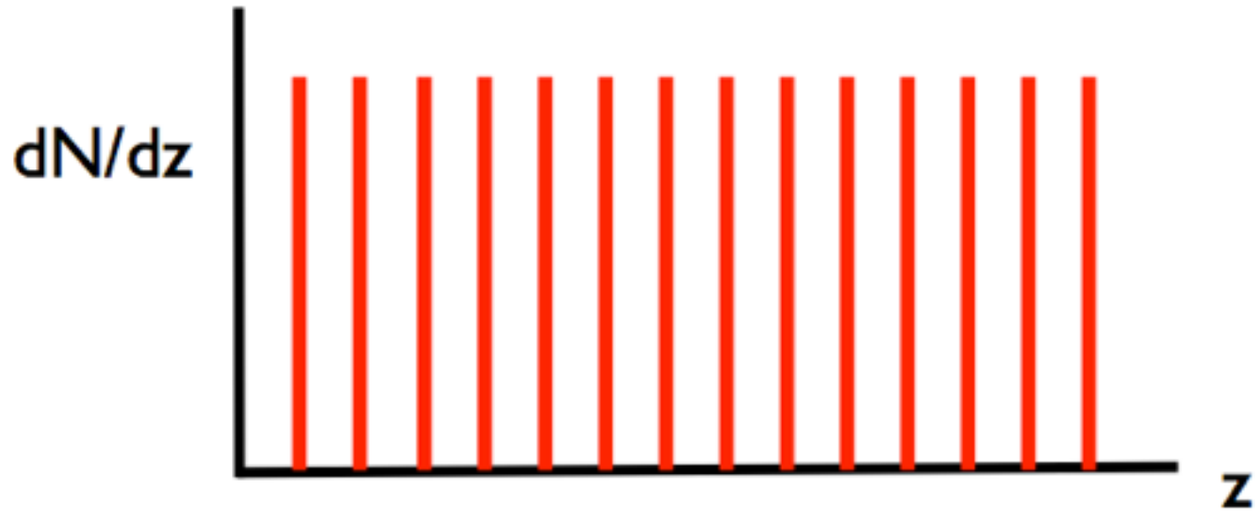


$$\langle \delta_{\rm ref} \cdot \delta_{\rm unknown} \rangle$$

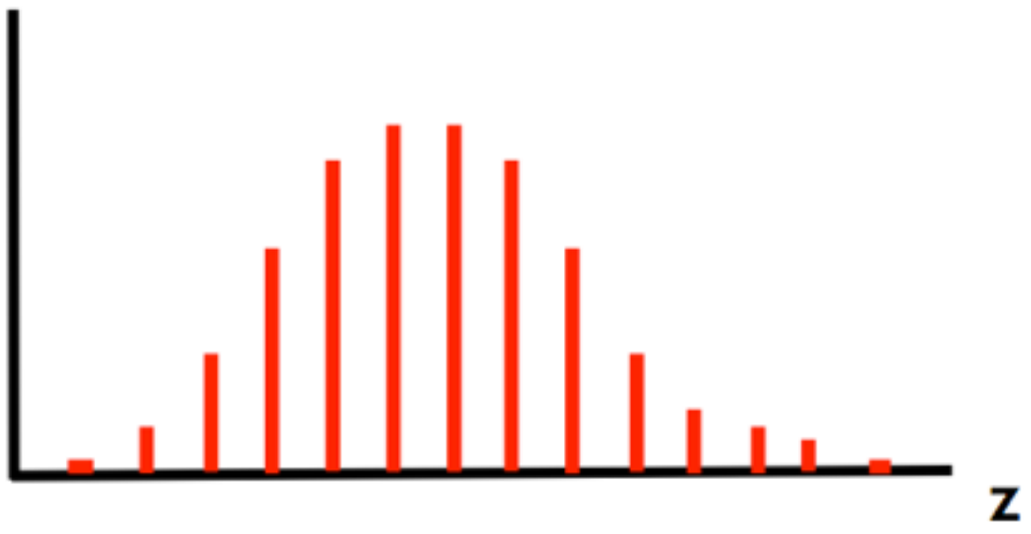
Metric: 2-point correlation function

Clustering based redshifts



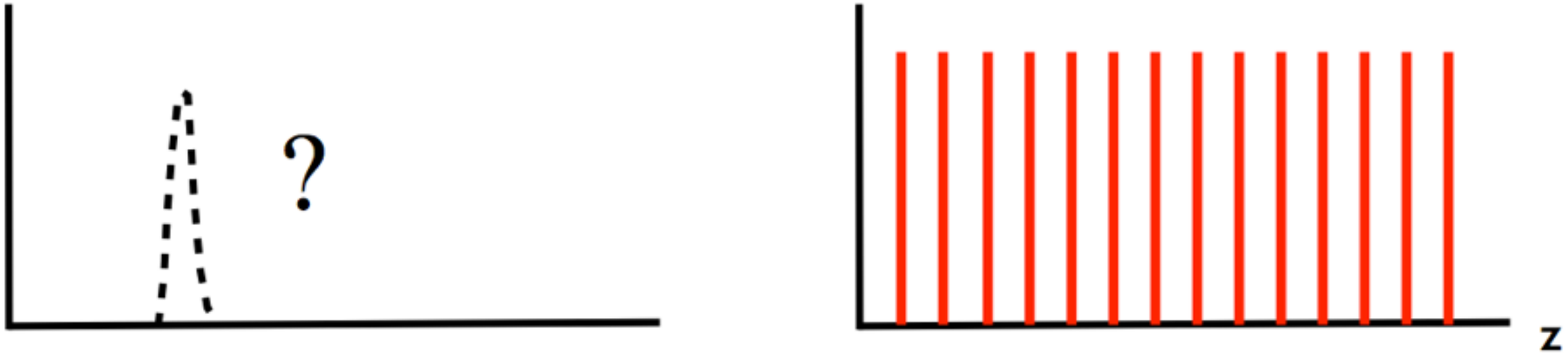


$$< \partial_{\text{unknown}} \cdot \partial_{\text{reference}} >$$



$$\bar{w}_{ur}(z) \sim \int \mathrm{d}z' \, \frac{\mathrm{dN_u}}{\mathrm{d}z'} \frac{\mathrm{dN_r}}{\mathrm{d}z'} \, \bar{b}_u(z') \bar{b}_r(z') \, \bar{w}(z')$$

$< \partial_{\text{unknown}} \cdot \partial_{\text{reference}} >$



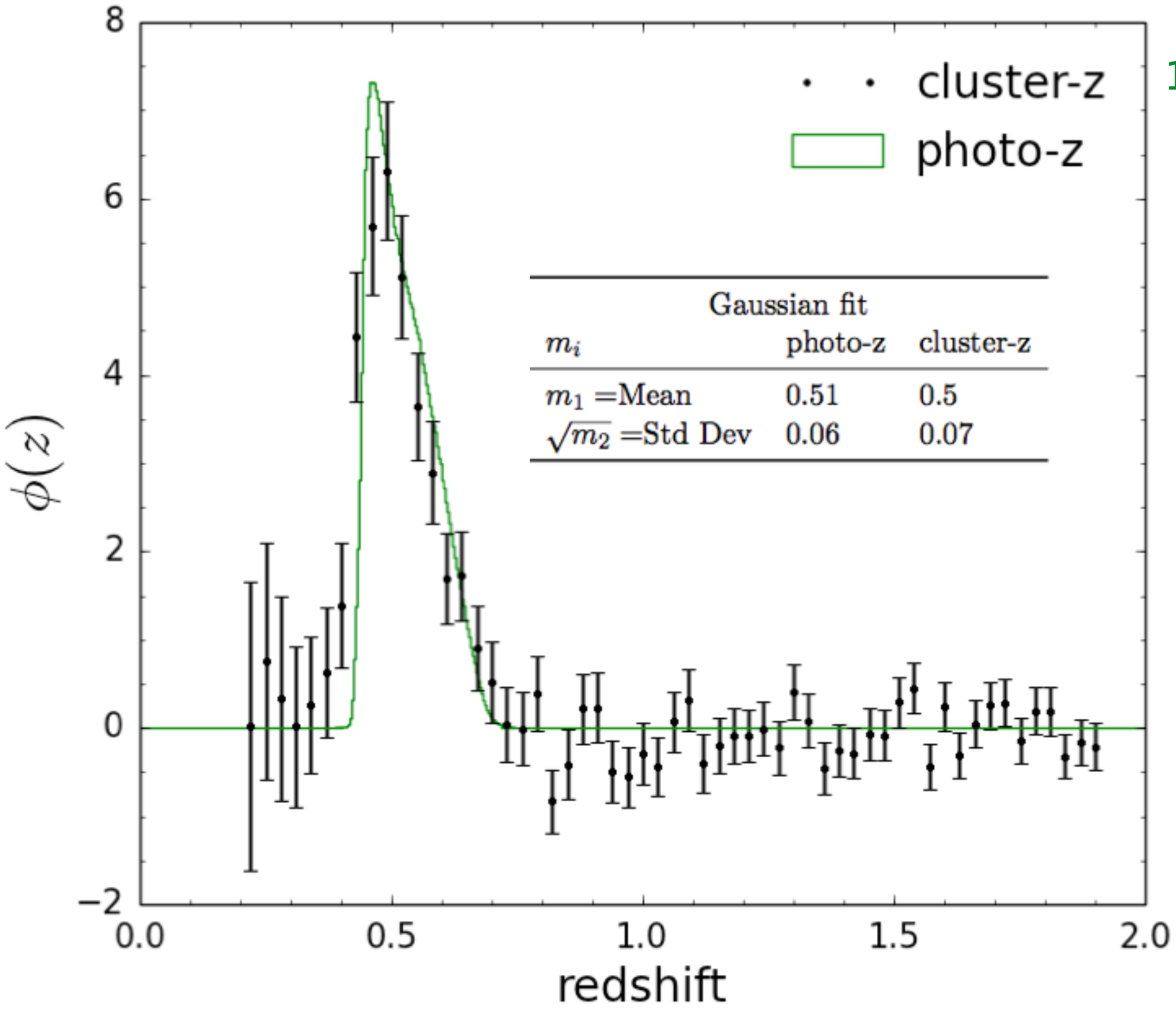
The key point here is to have a local approach

if $\dfrac{\mathrm{d}\log \mathrm{dN}/\mathrm{d}z}{\mathrm{d}z} \gg \dfrac{\mathrm{d}\log \mathrm{b_u}(z)}{\mathrm{d}z}$

then $\mathrm{dN}/\mathrm{d}z \propto \bar{w}_{ur}(z) \left(\dfrac{1}{\bar{b}_r(z)\,\bar{w}(z)} \right)$

and the redshift distribution is simply normalized by $\int \mathrm{d}z\, \mathrm{dN}/\mathrm{d}z = N_{\mathrm{tot}}$

Clustering based redshifts



Unknown sample:
1M LRGs from SDSS (with photo-z)

Reference sample:
100k QSOs from SDSS (spectro-z)

Reconstruction is in agreement with photo-z !

Cluster-z VS Spectro-z

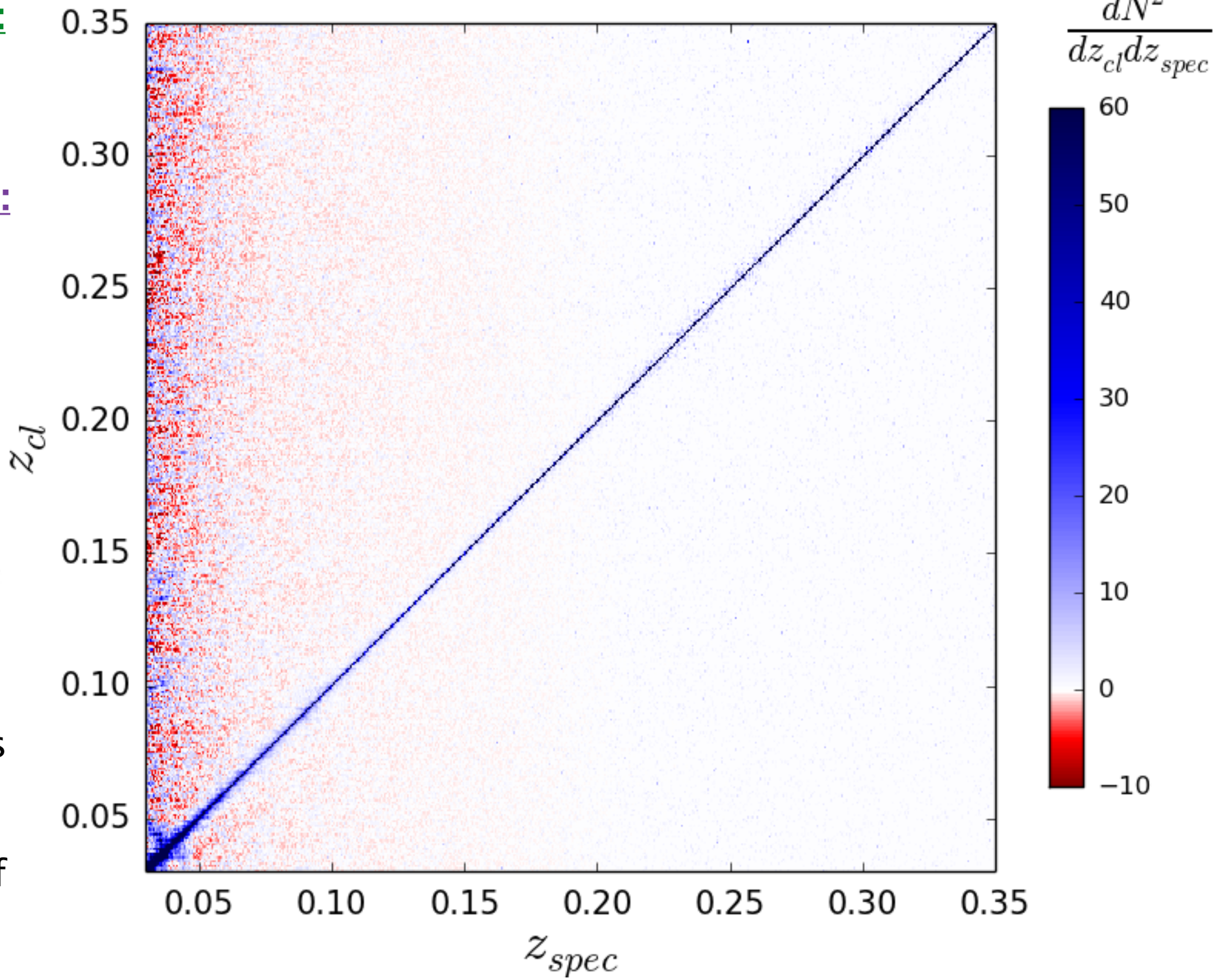
No catastrophic failures !

Unknown sample:
100k Galaxies from SDSS

Reference sample:
700k Galaxies from SDSS

Noises:

- Over sampling in reference sample
- Cosmic variance
- Peculiar velocities
- Unlikely overlap along the ligne of sight



Cluster-z VS Spectro-z

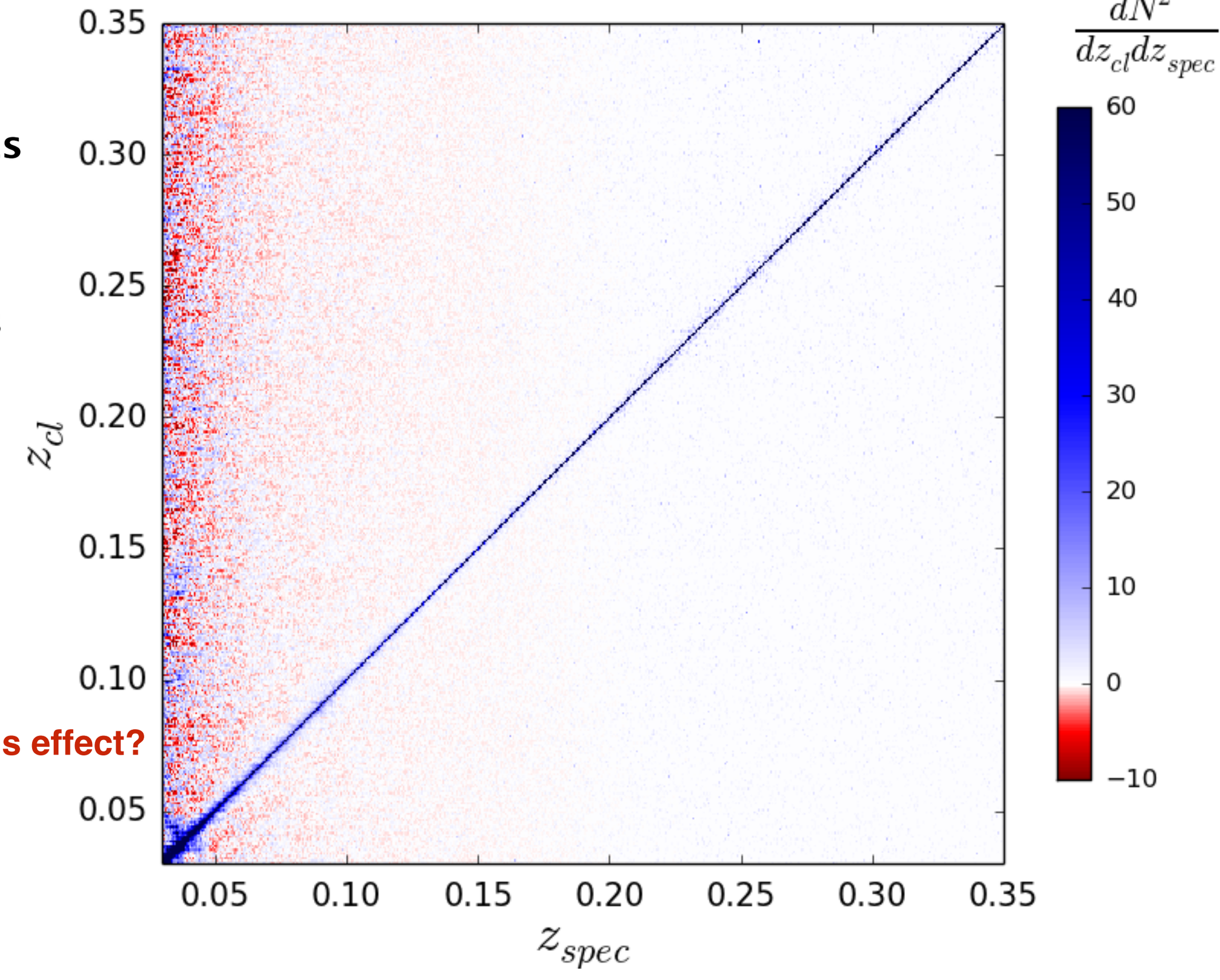
Ideal case:

use spectro-z

to reduce effects

of the

unknown biais



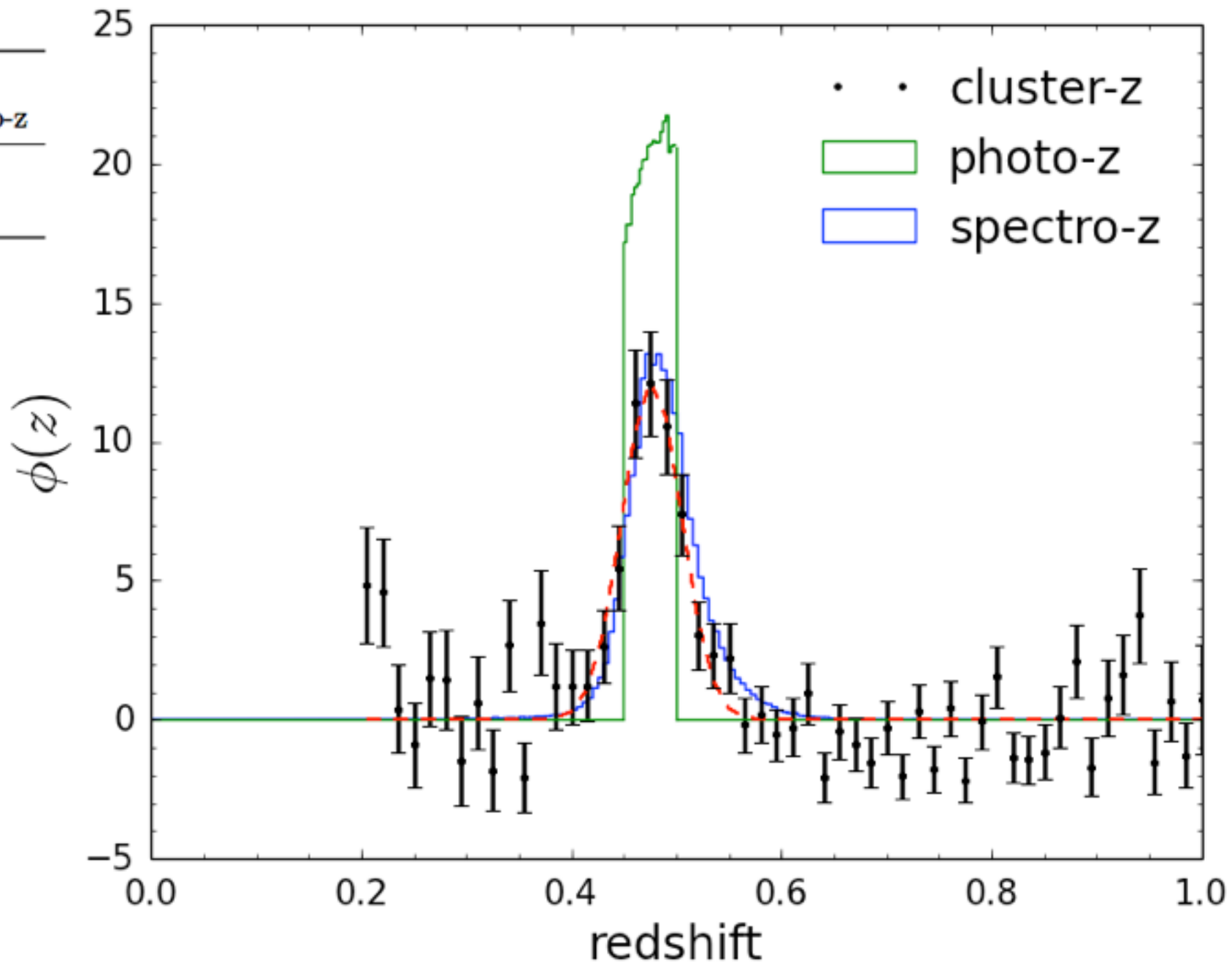
How to minimize this effect?

Cluster-z in real life

Two ways to reduce the width of the redshift distribution of the unknown sample:

- **<u>Use photo-z:</u>**

	Gaussian fit		
m_i	photo-z	cluster-z	spectro-z
m_1 =Mean	0.48	0.48	0.48
$\sqrt{m_2}$ =StDev	0.02	0.03	0.04

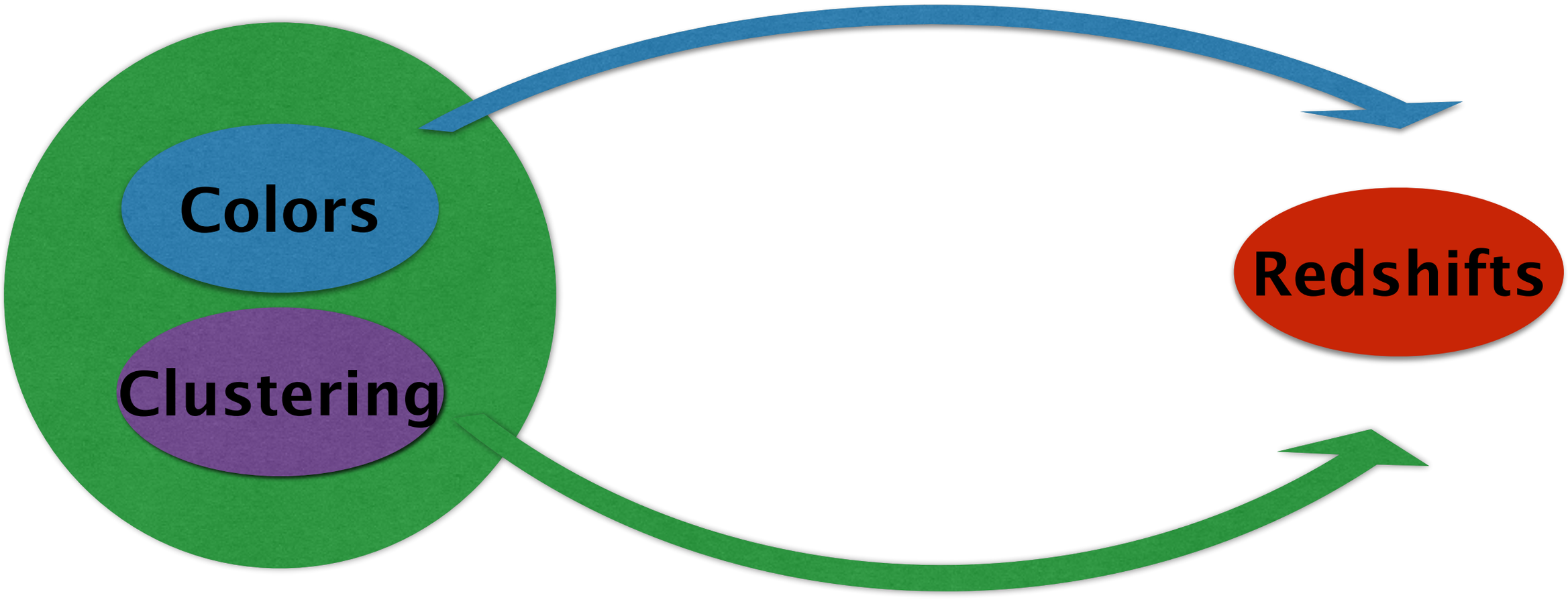


Cluster-z in real life

- **apply colors cuts:**

Photometric Redshifts

SEDs or Training Sets



Clustering Redshifts

Spatial correlation with reference set

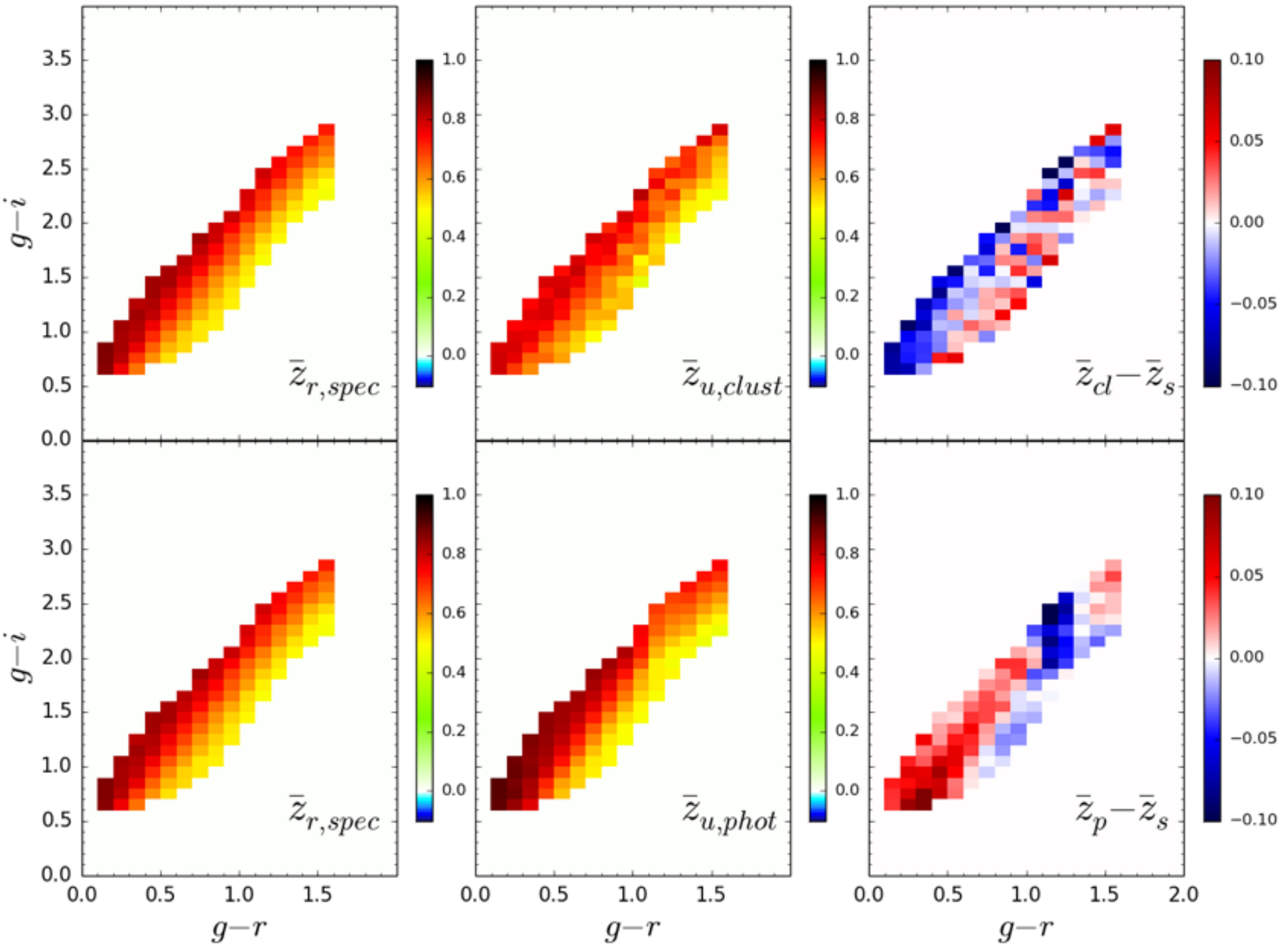
&

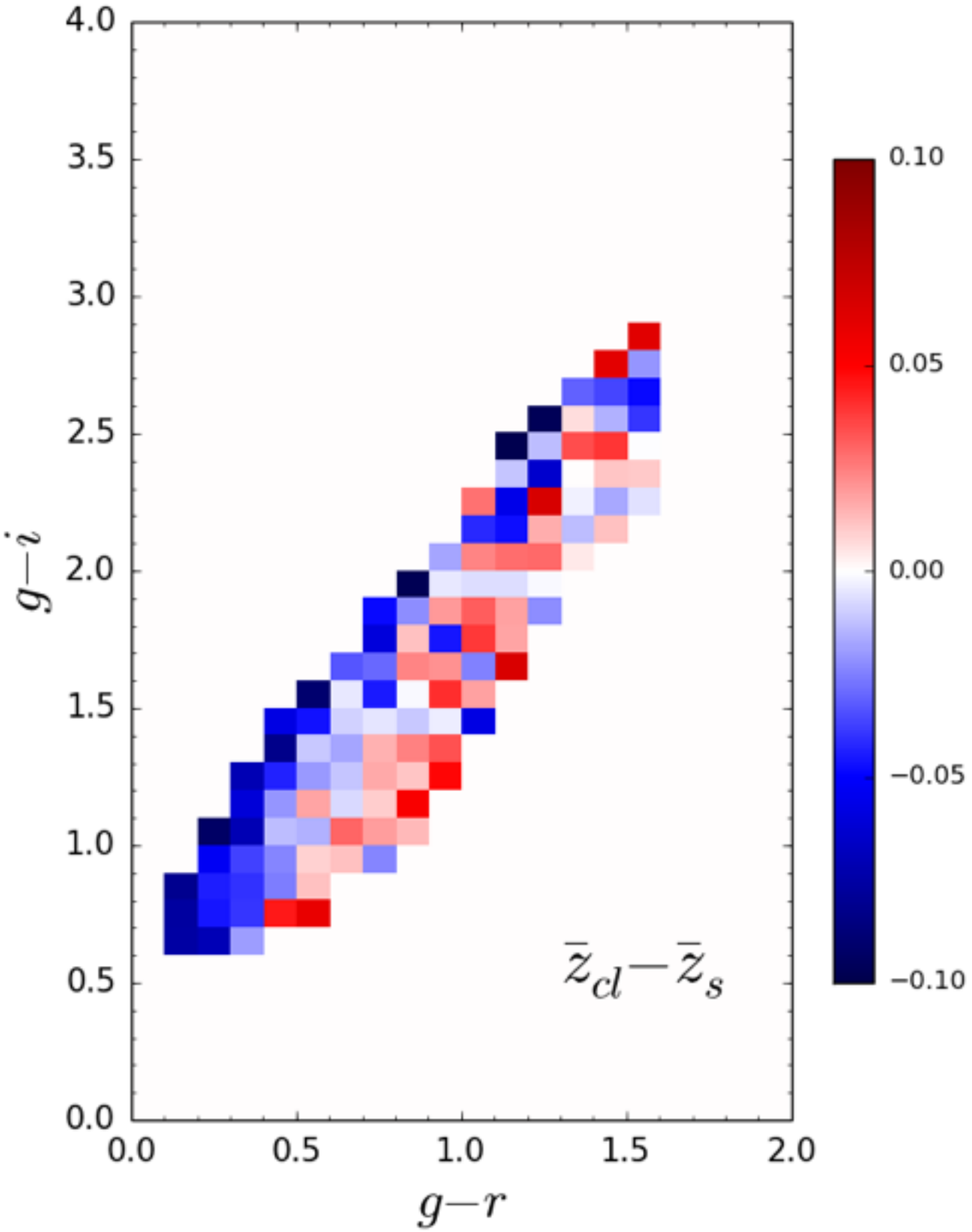
pre-selection on colors space

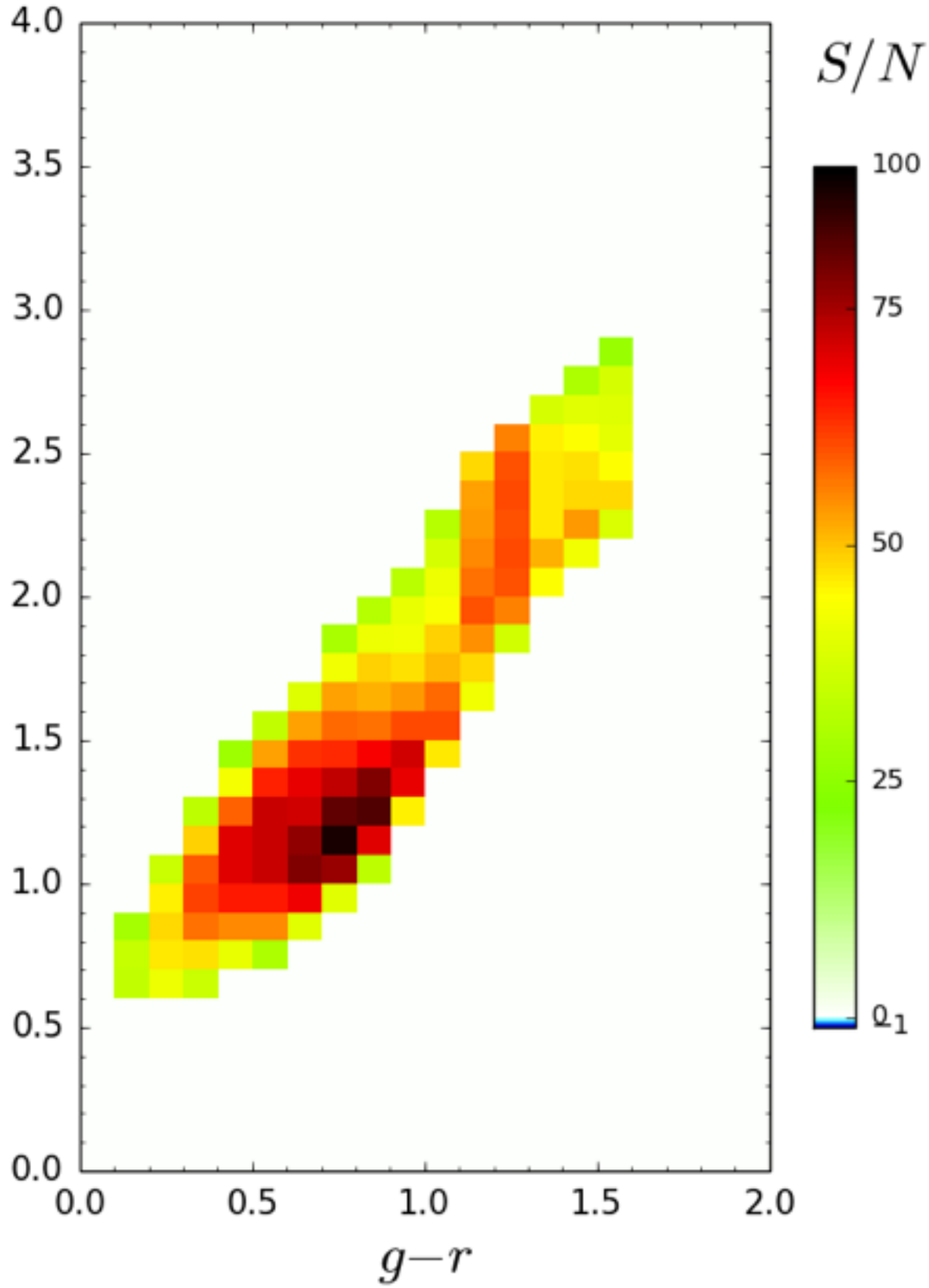
Cluster-z in real life

U sample:
200k gal
(CFHTLS)

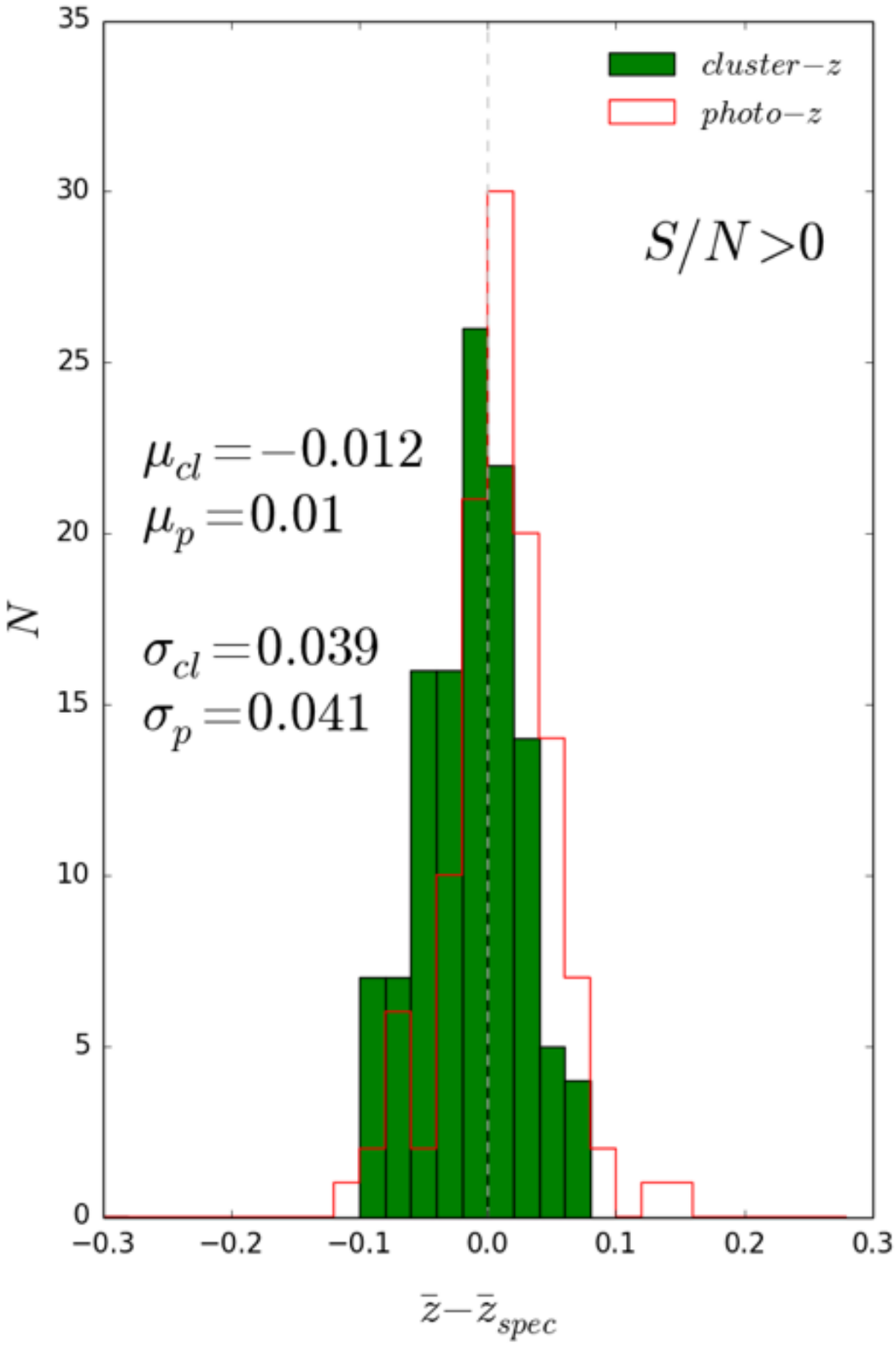
R sample:
20k gal
(VIPERS)

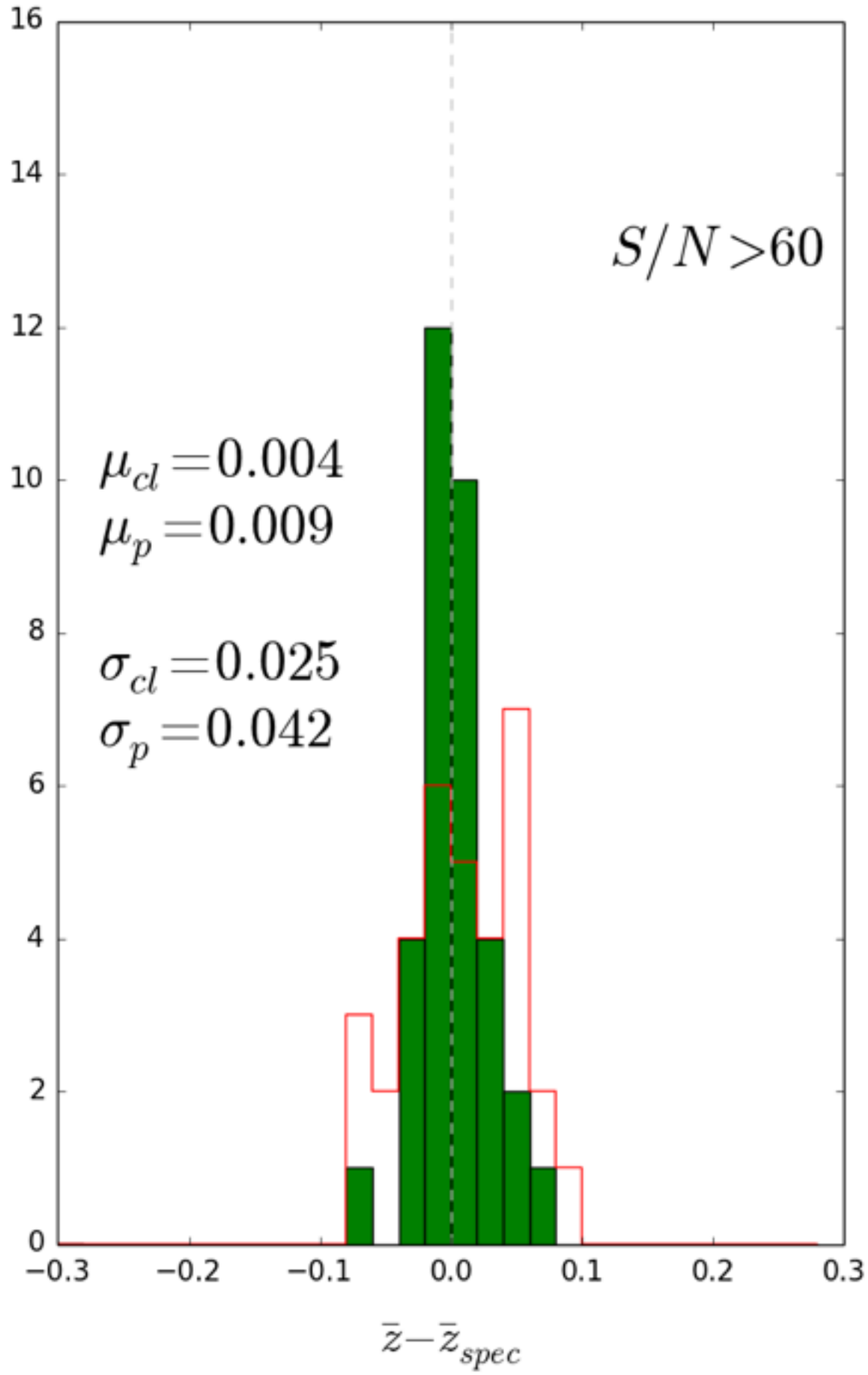



4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
$g-i$
$g-r$
$\bar{z}_{cl}-\bar{z}_s$
0.10
0.05
0.00
−0.05
−0.10

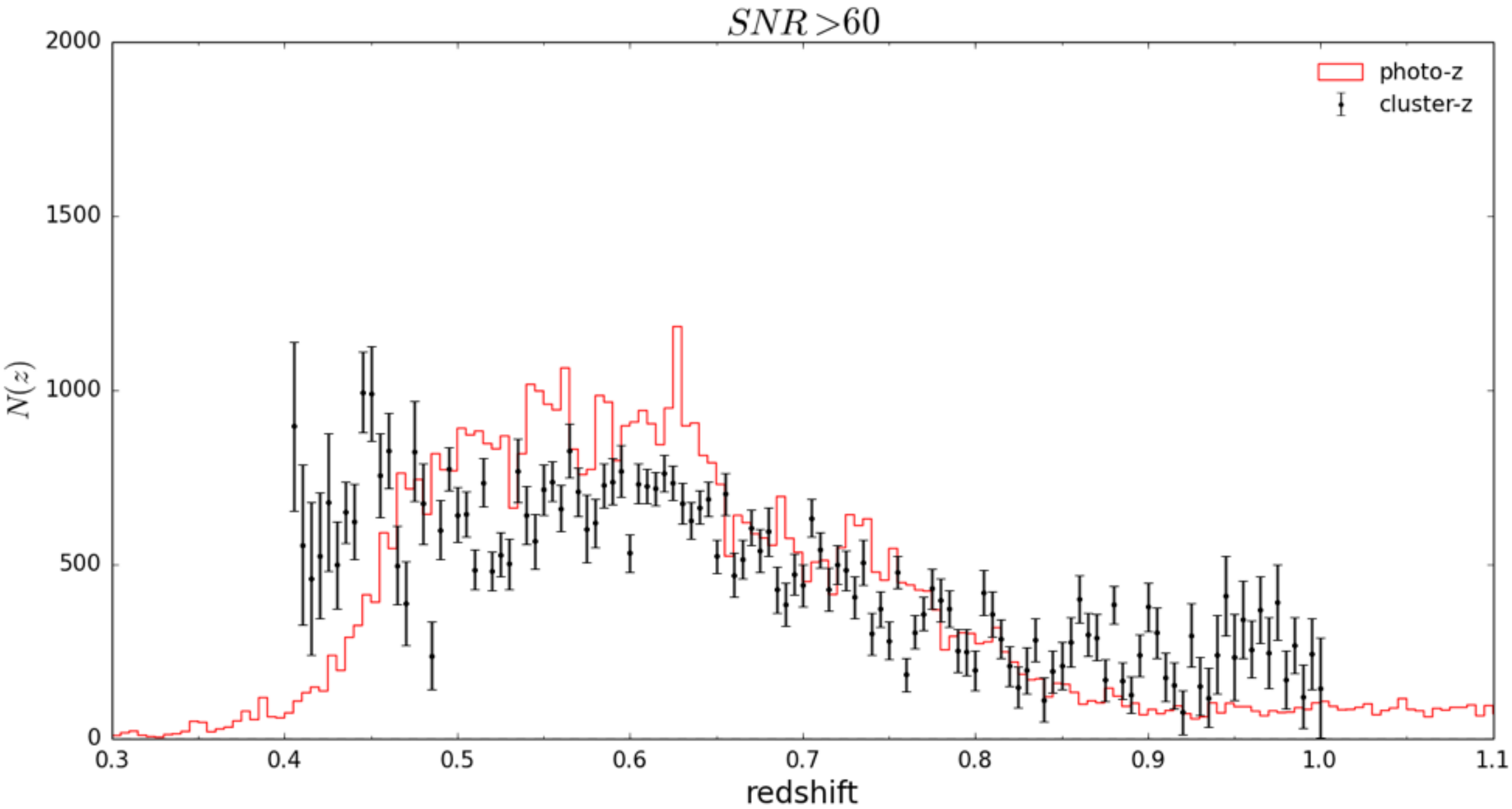

4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
$g-r$
S/N
100
75
50
25
0

Cluster-z in real life





Cluster-z in real life



And now ?

We have a new tool to look on data in a completely new way.

- Go to fainter magnitude

- Check photo-z

- Combined with photo-z against catastrophic redshift => WL tomography

- Give redshift in bad region of the EM spectra

- Measure luminosity functions

- BAO ?

- RSD ?

- ??? (feel free to propose)