Importance of the spectroscopic follow-up to achieve high-quality photo-z

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Why do we need spectroscopic z ?

I. Training sample for empirical methods as neural network
II. Optimize template-fitting methods
III. Characterize the photo-z performance
IV. Determine the mean redshift of the weak lensing sample

The required follow-up could be really specific,
highly time consuming (telescope and human ressources)

➢ need to be prepared well in advance

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Empirical methods

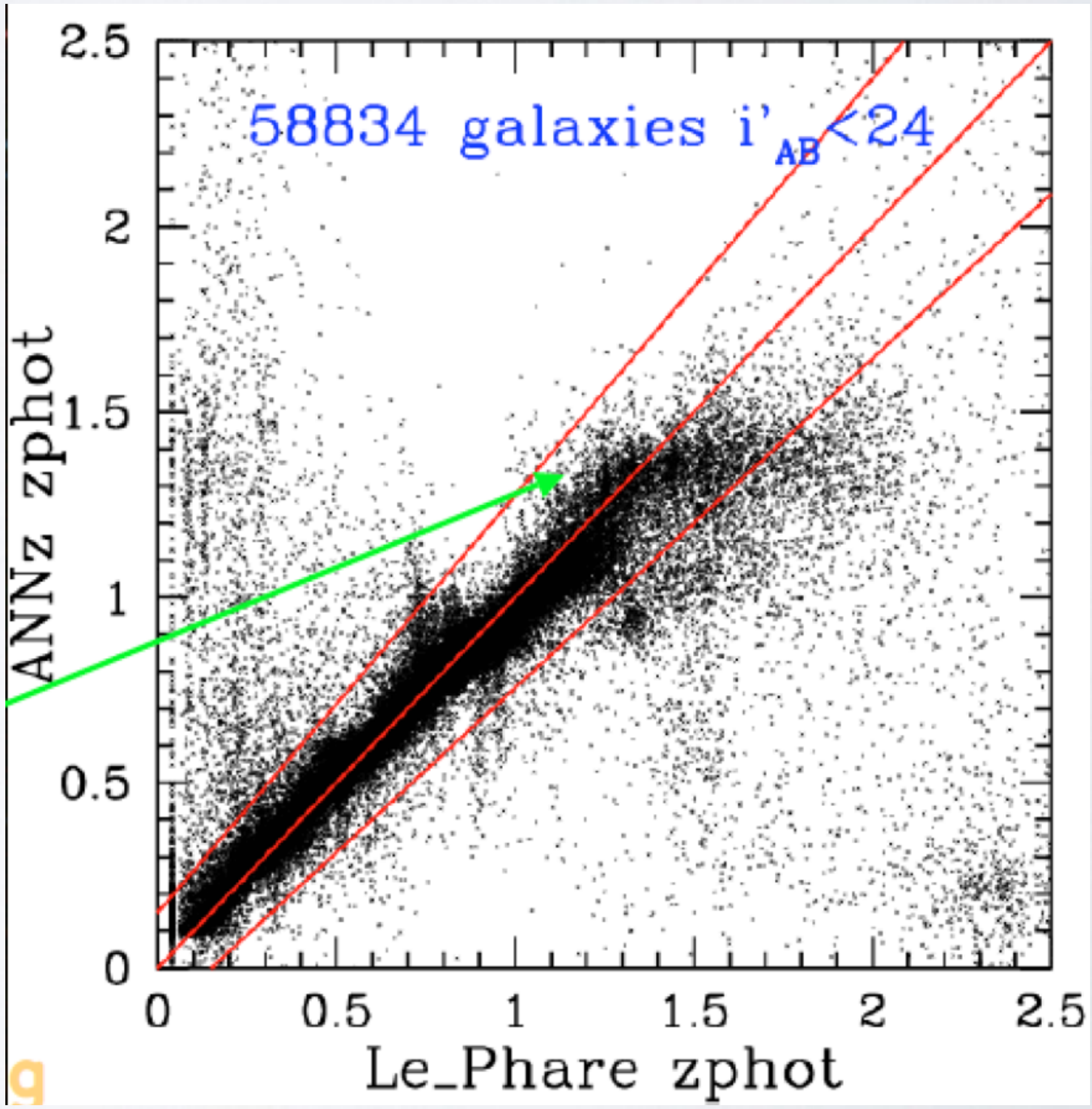
Need

➢ a representative spec-z sample

➢ to keep a spec-z sample for the validation

Potential problem if your sample is not representative

Works well with the SDSS



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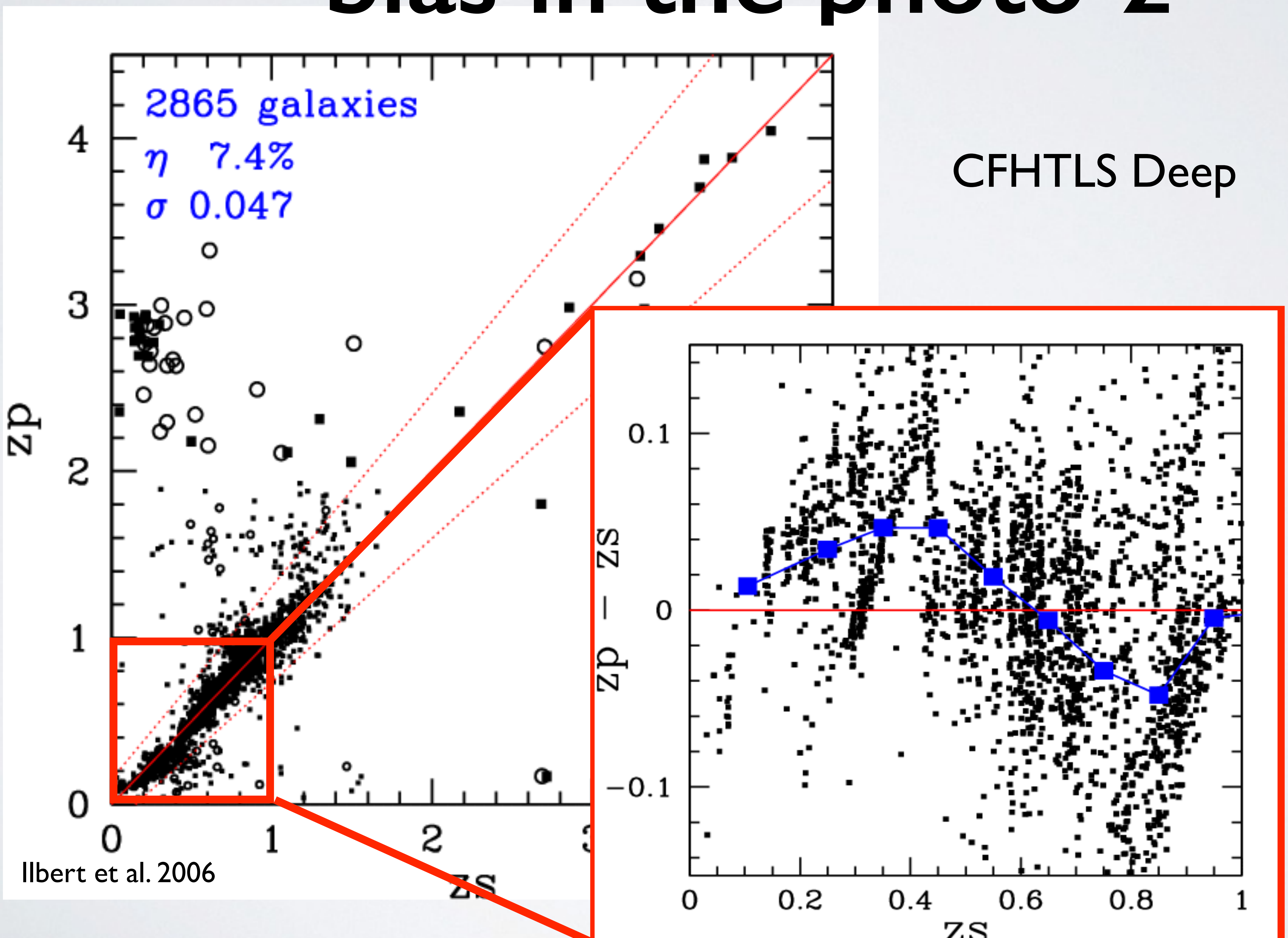
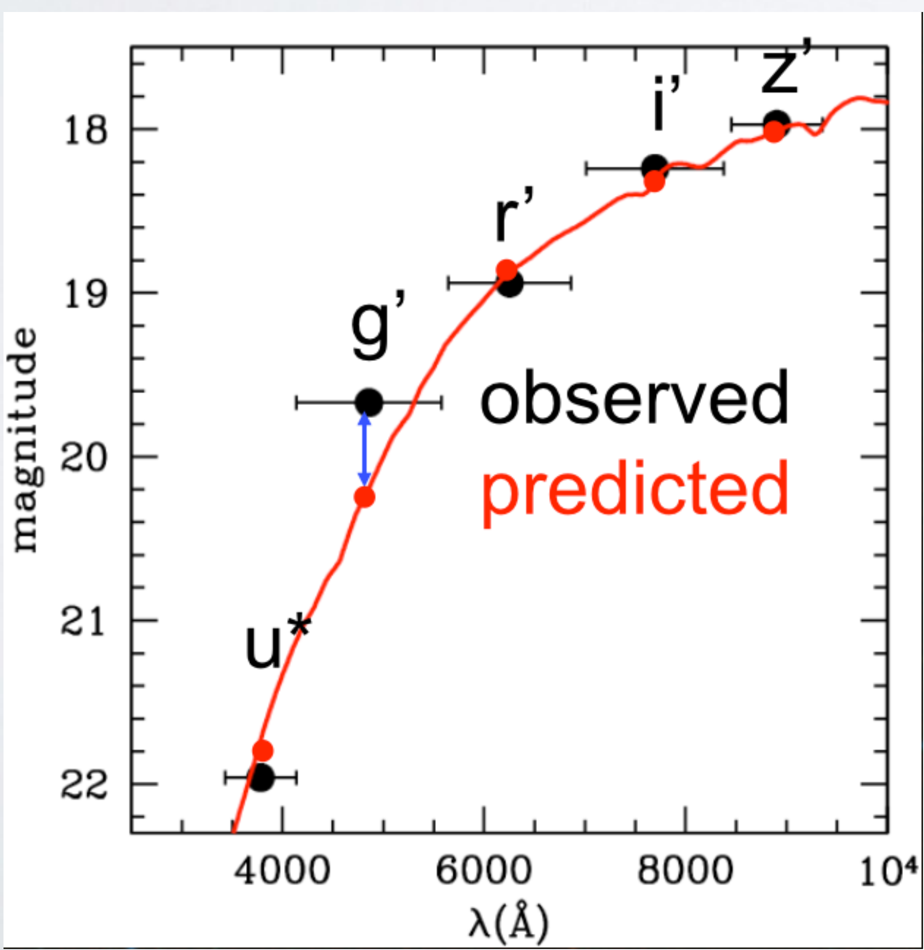
The standard χ^2 method - bias in the photo-z



CFHTLS Deep

Readjust the zero-points

1. Redshift fixed for a limited spec-z sample
2. Best-fit templates
3. Measure the average difference between predicted and observed magnitudes in each band
4. Readjust the zero-points
5. Do the step 1 to 4 iteratively



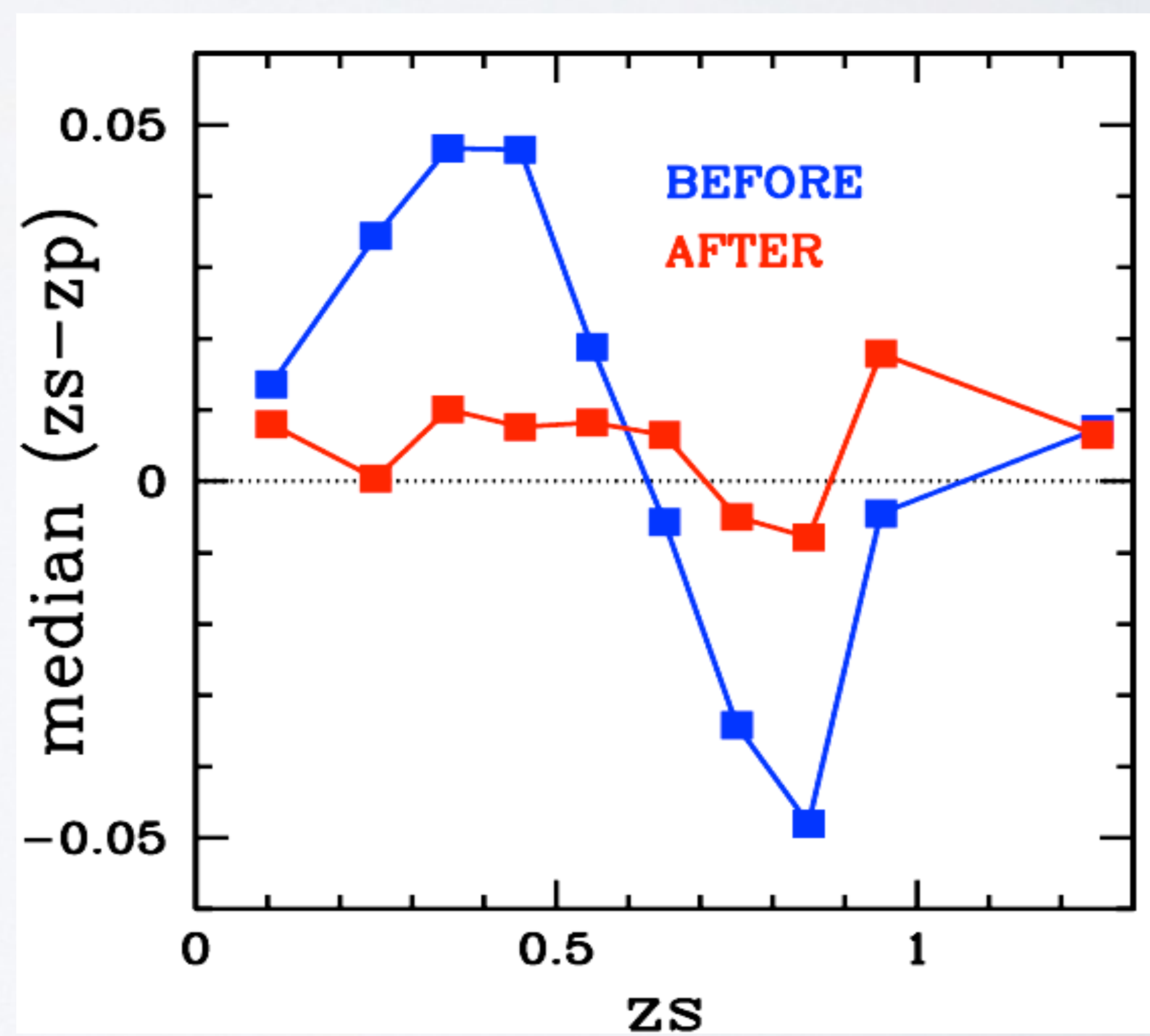
u* +0.019

g' -0.079

r' -0.002

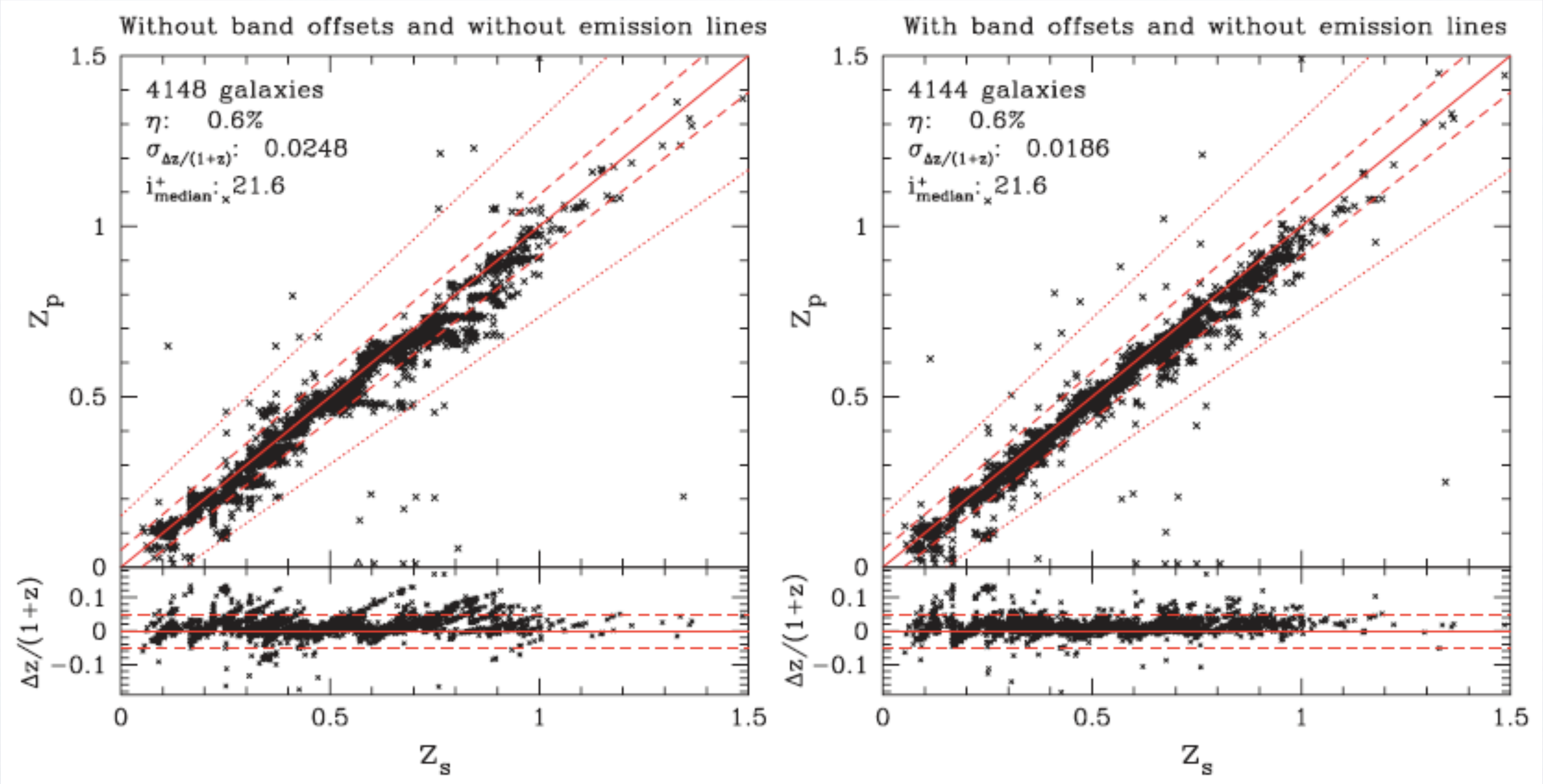
i' 0

z' -0.008



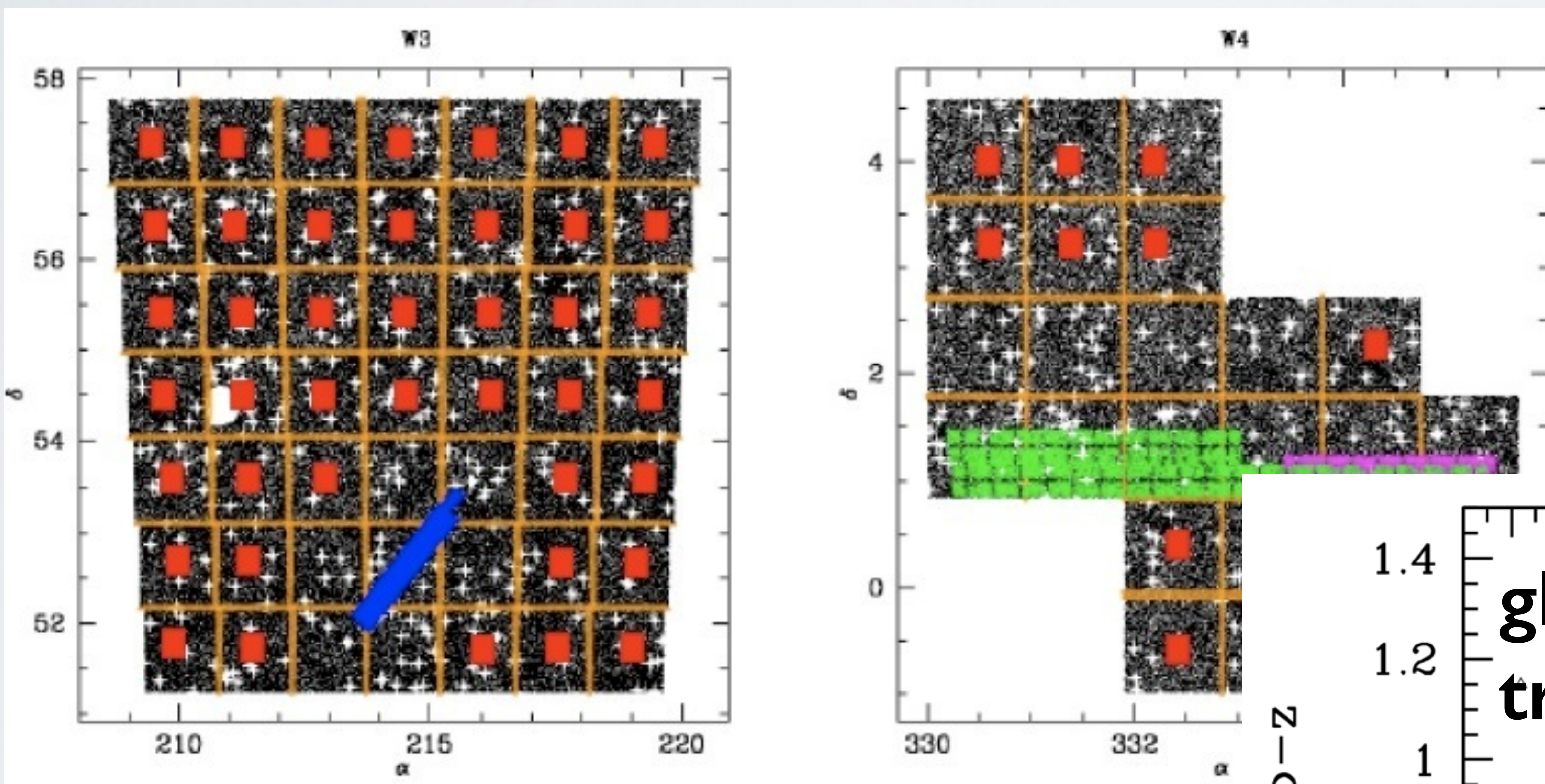
Readjust the zero-points

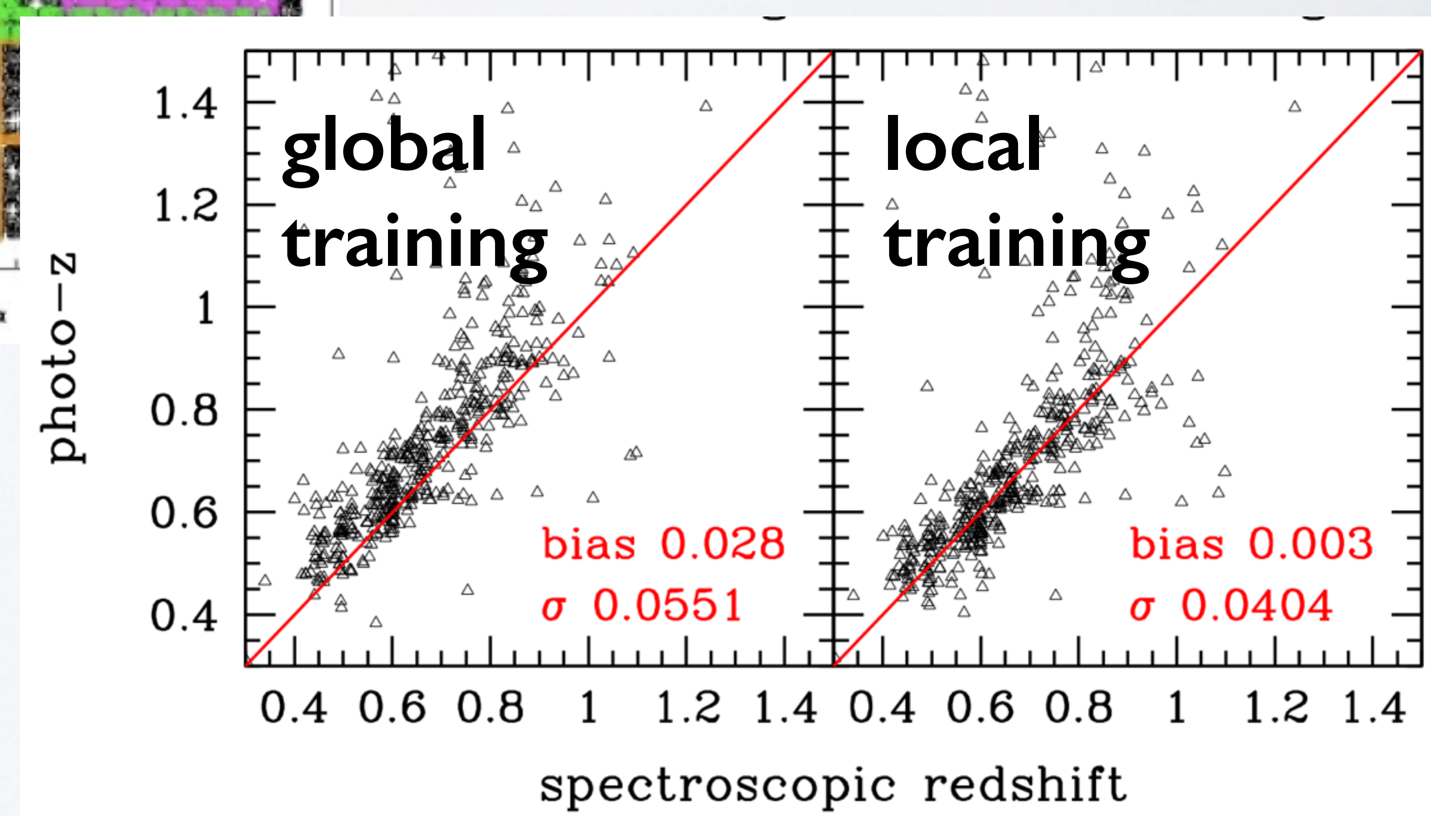
Crucial to remove biases, even with PSF homogenized images and 30 bands



Homogeneity over a large field

Variation of the relative photometric calibration tile to tile
➢ importance of maintaining a high degree of homogeneity
➢ a spec-z sample could be needed for each tile





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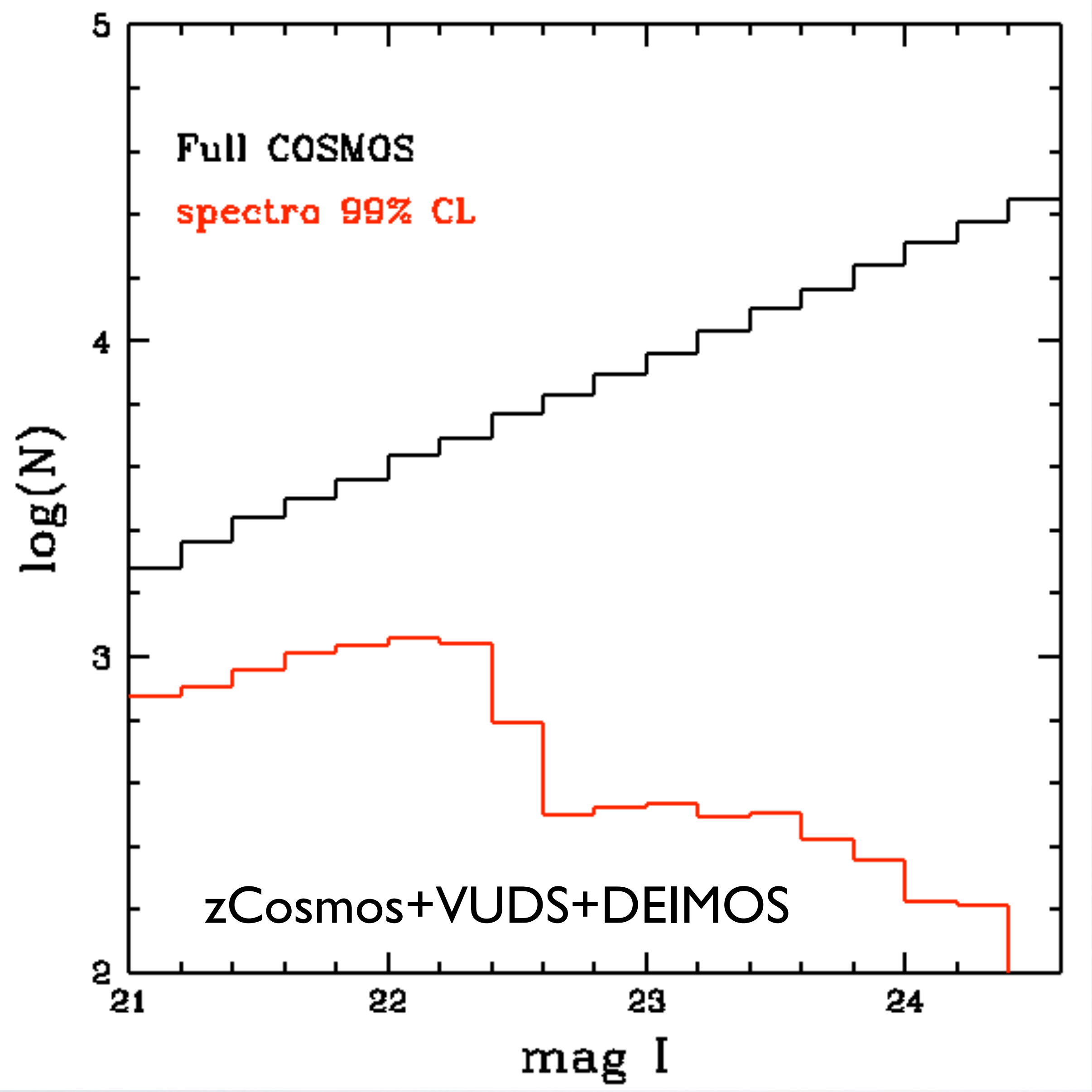
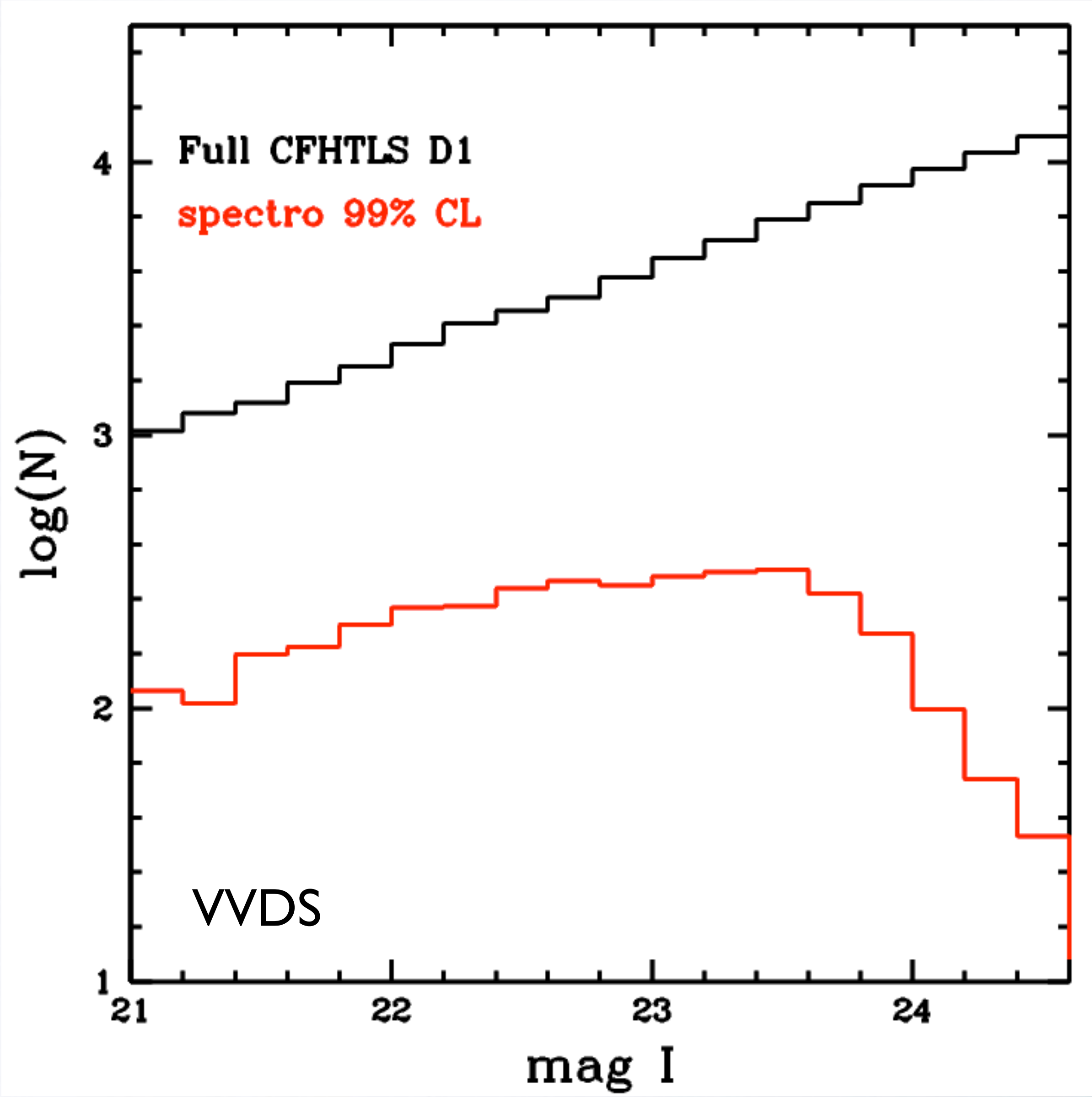
Spec-z sample to validate the quality of the photo-z

Not a random selection of the photometric catalogue

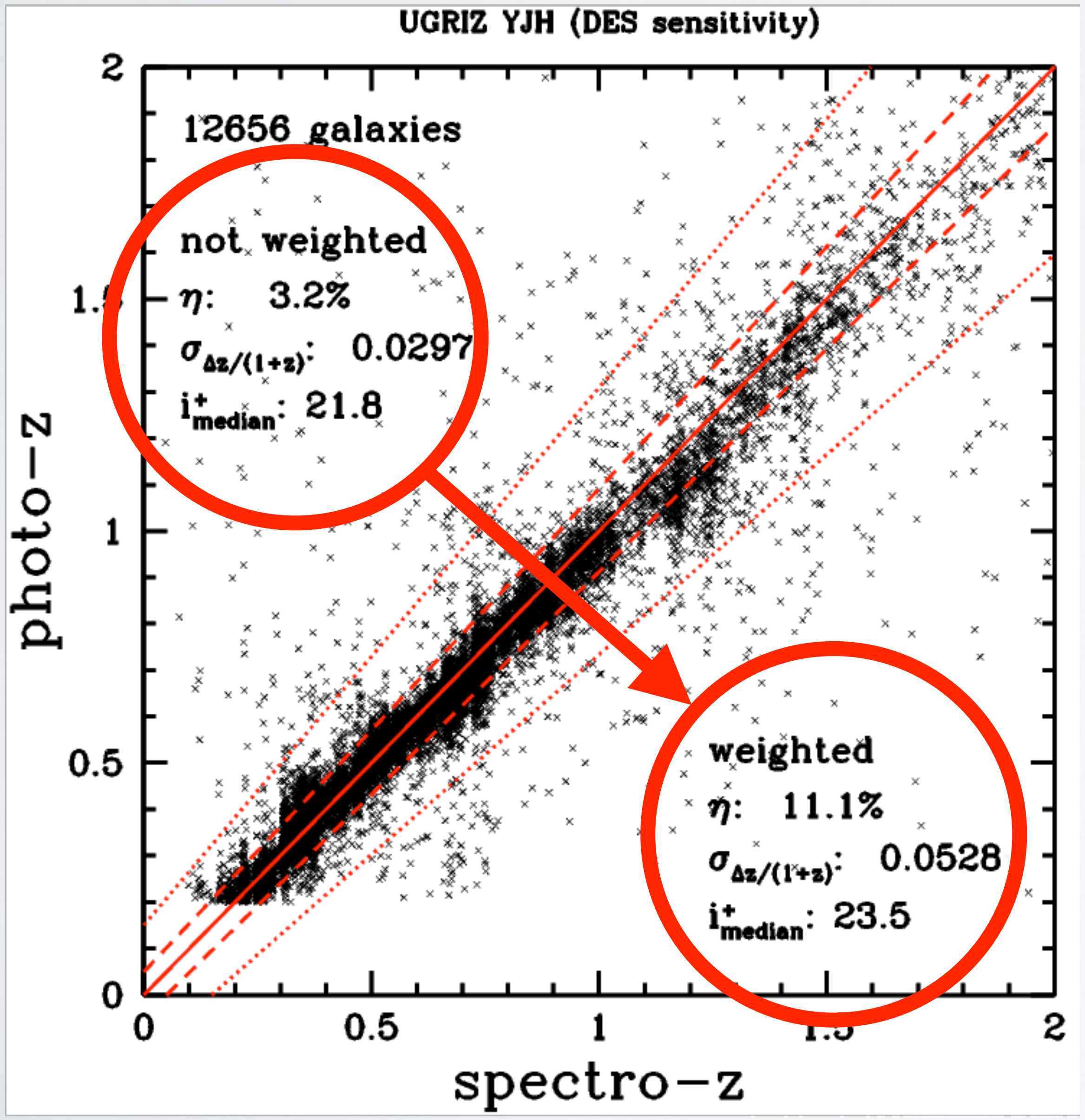
➢usually brighter, not representative

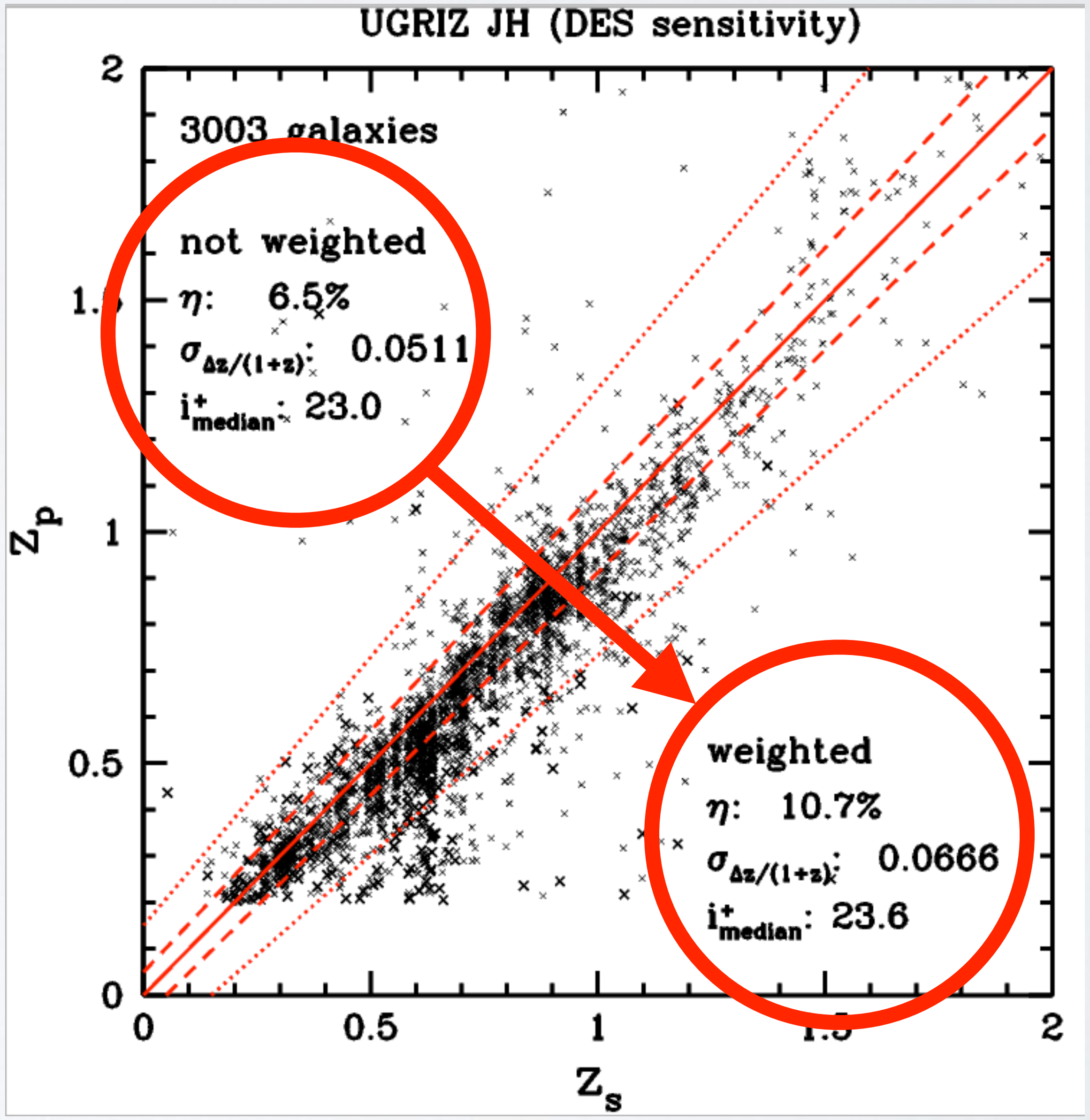




Spec-z sample to validate the quality of the photo-z

Apply a weight to the spec-z

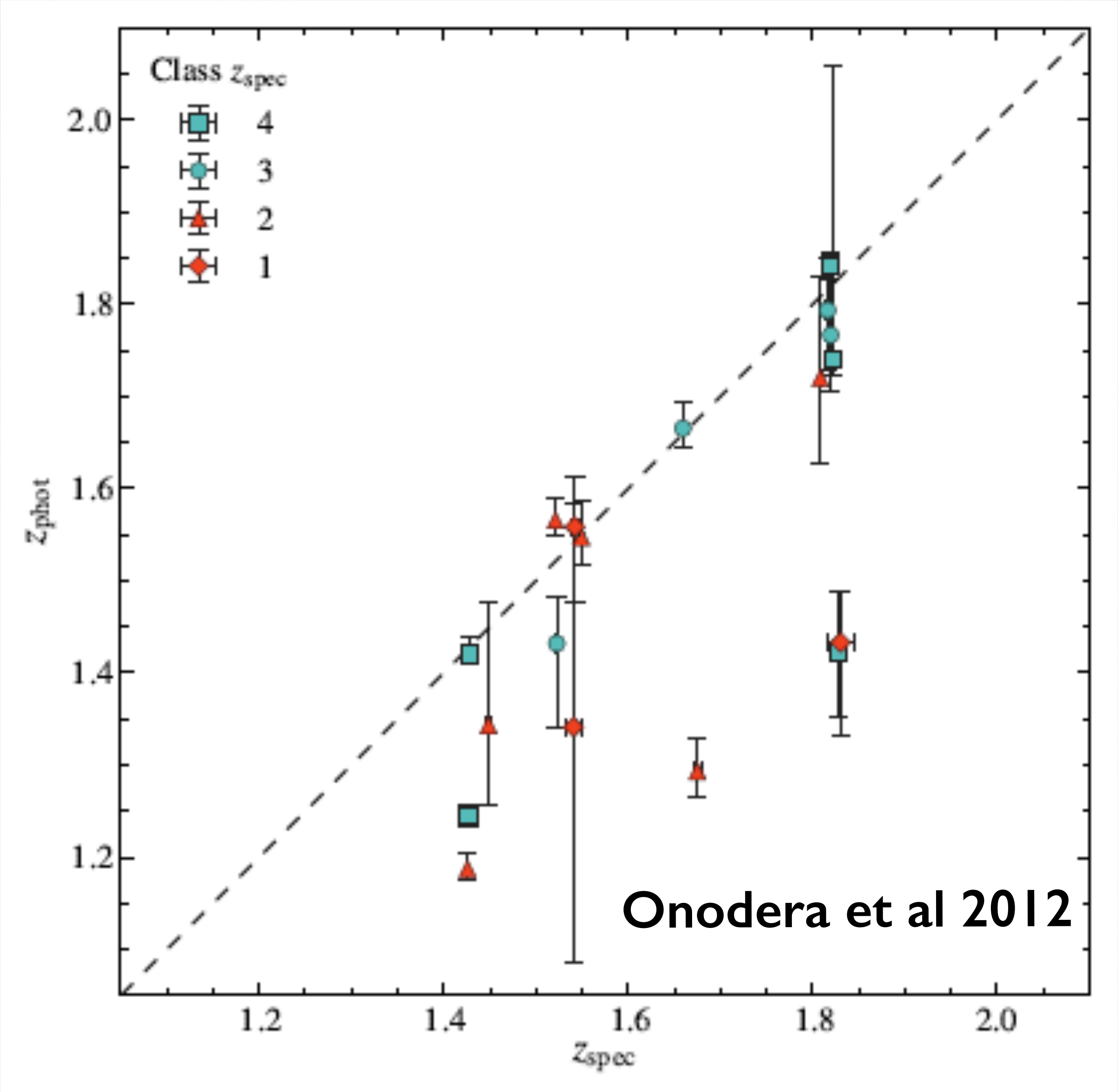




Need a deep spec-z sample as representative as possible

What you don't want to discover:
e.g. biases for a specific population as quiescent

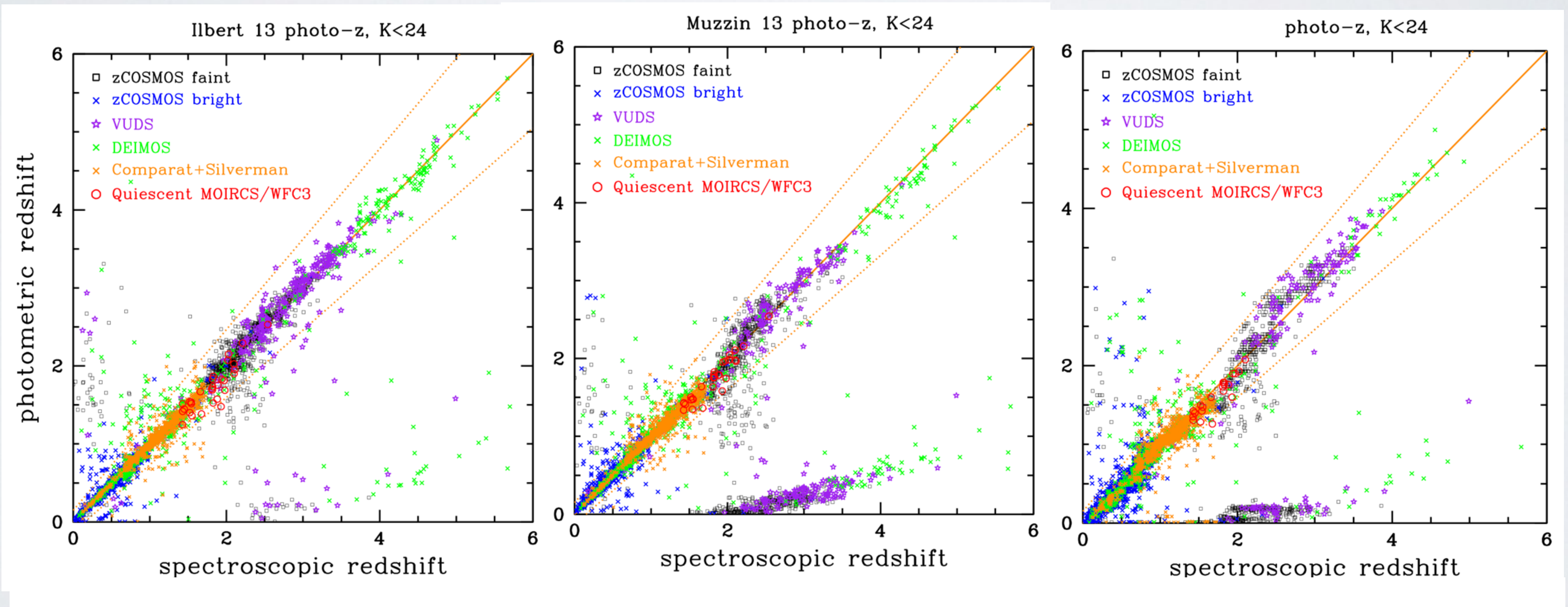
Probably unavoidable ...
➢ use photo-z in the mag/redshift/type range in which you can check your work



Need a deep spec-z sample as representative as possible

Same imaging data COSMOS+UltraVISTA

Spec-z at z>1.5 available only for the COSMOS team (left)

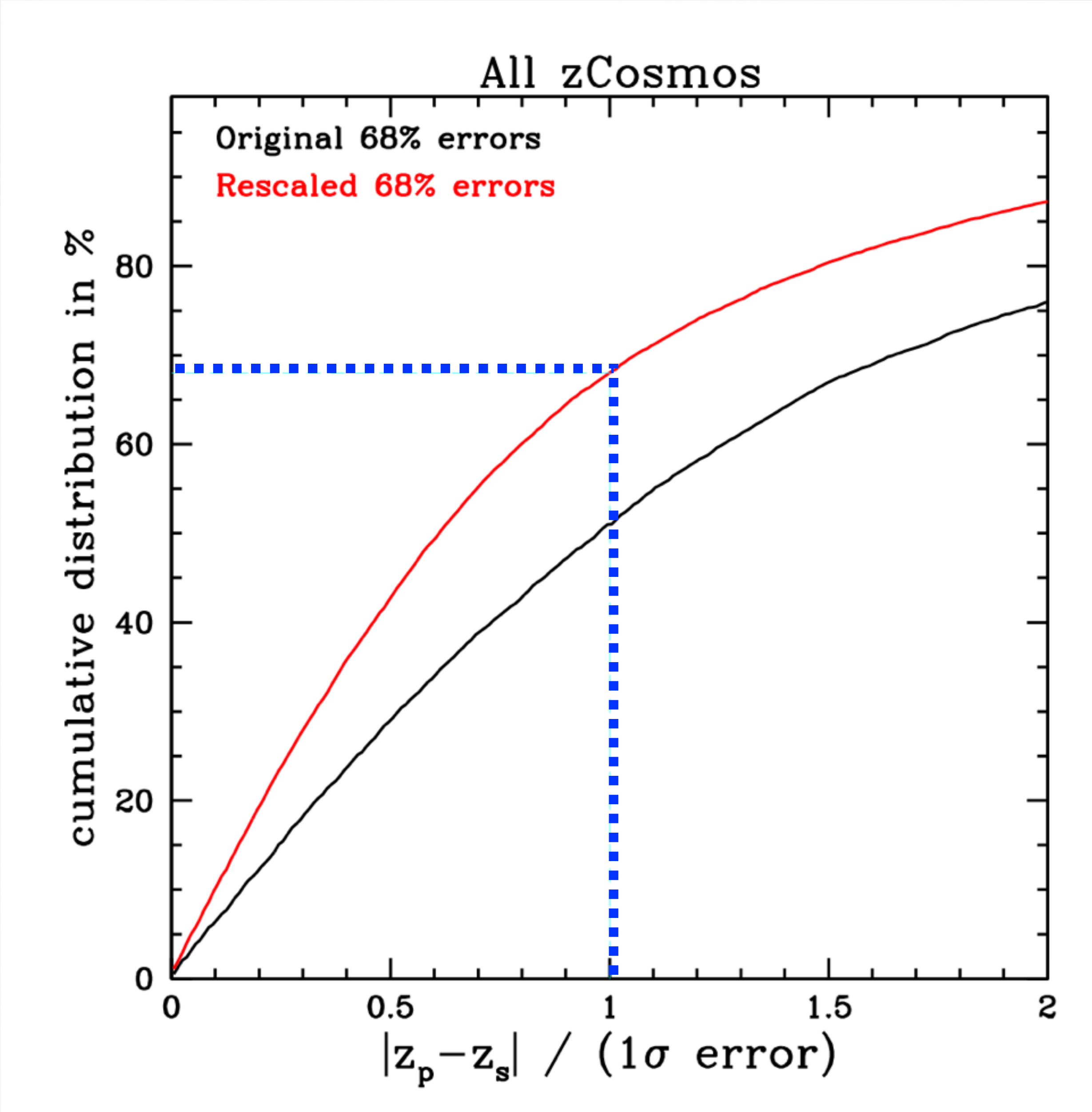


Risk of tuning a code to improve the comparison with an unrepresentative spec-z sample

Validation of the PDF and photo-z errors

Need to work as much as possible with PDF

Not easy to get the right ones (lack of representativity of the templates, uncertainties on the fluxes, …)



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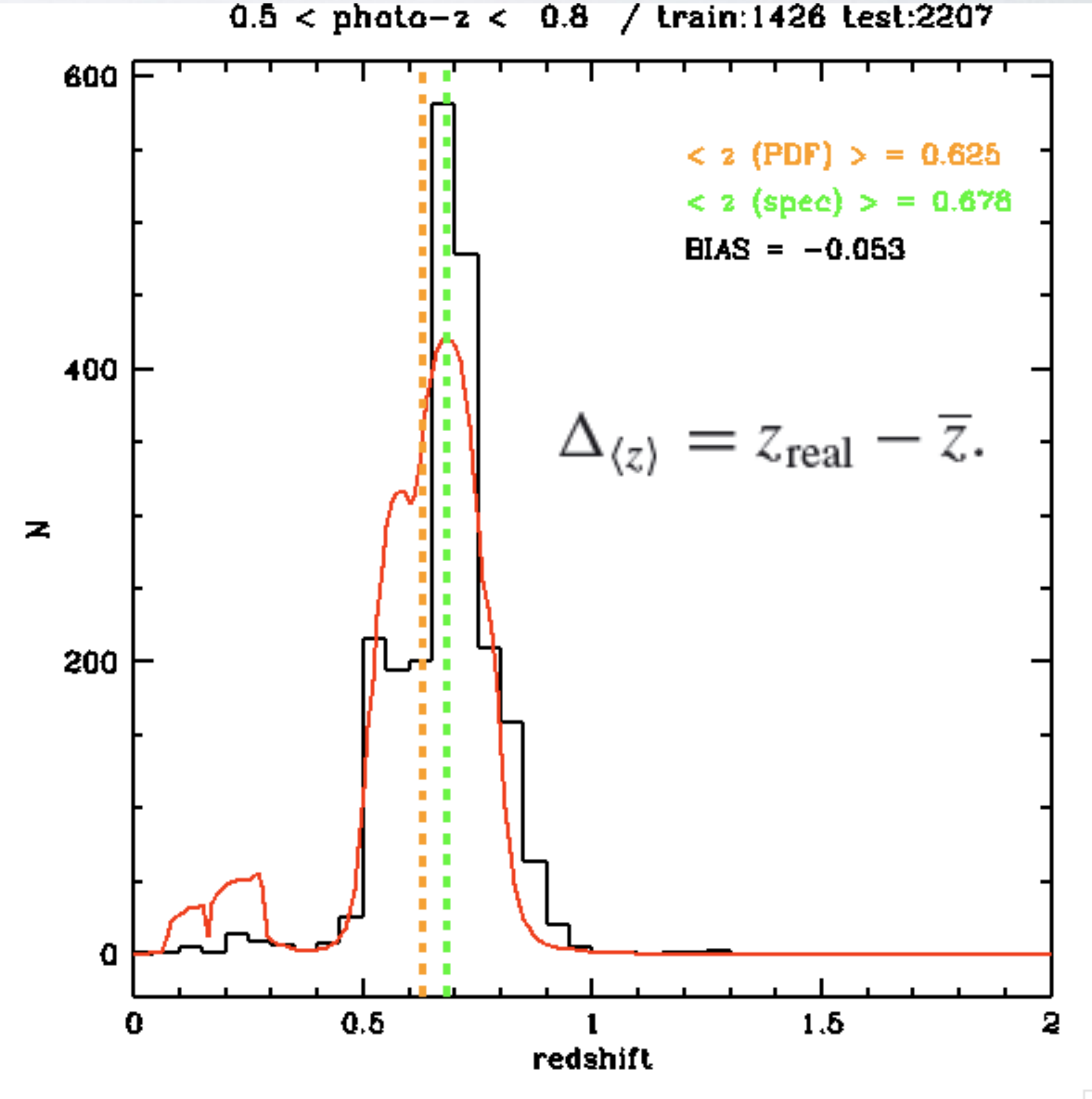
From the shear analysis to the cosmological parameters

➢ need the mean redshift

Euclid requirement:

Req. ID	Parameter	Requirement
WL.1-5	Redshifts error ($\sigma(z)/(1+z)$)	≤ 0.05
WL.1-6	Catastrophic failures	10%
WL.1-7	Error in mean redshift in bin	<0.002

Real challenge, broad-band photo-z not able to reach 0.2% on the bias directly



How to get the mean redshift

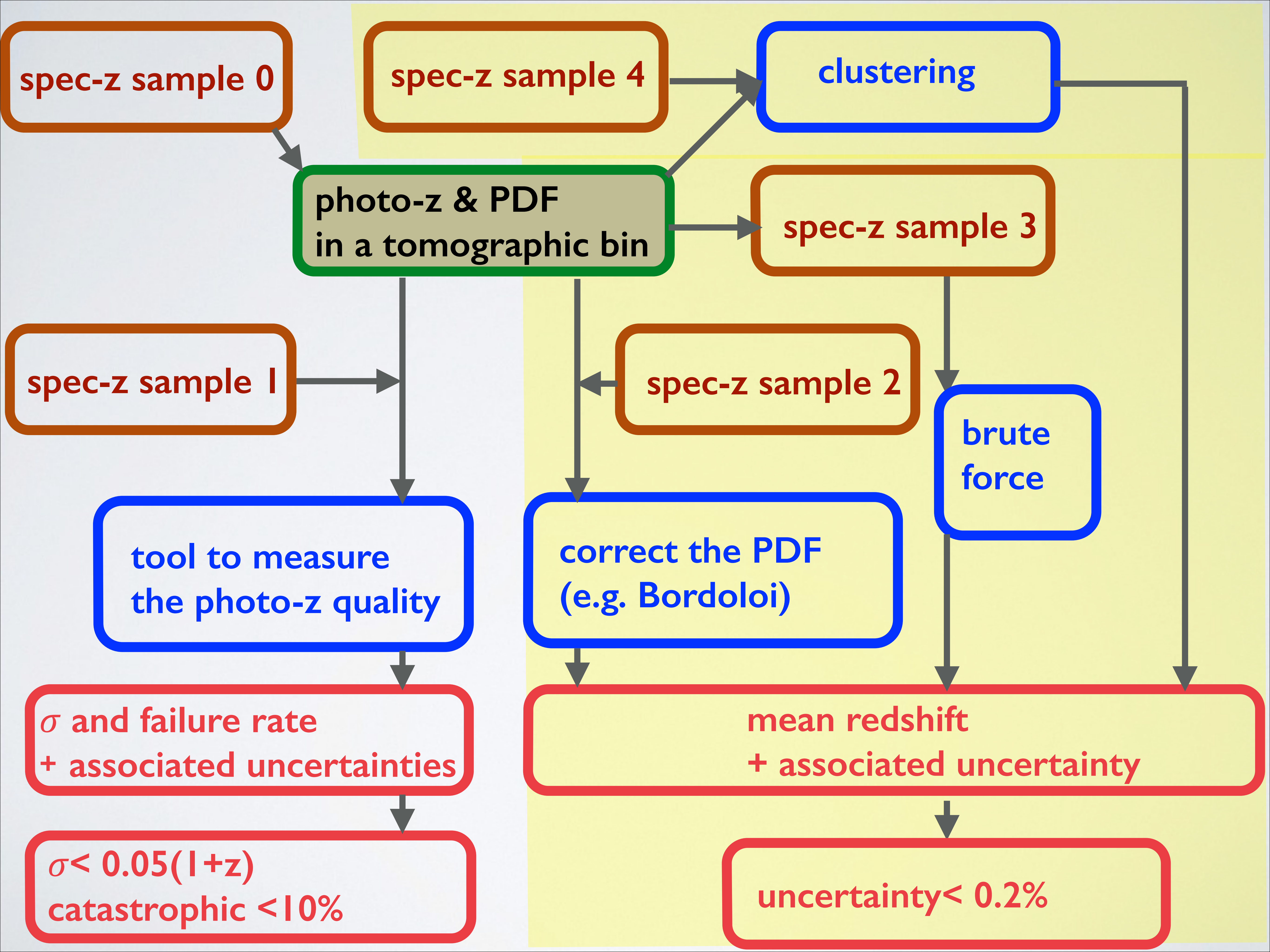
1) Brute force: organize a spectroscopic follow-up of a representative I<24.5 sample to get the exact redshift distribution. Need to beat the cosmic variance.

2) Use a spec-z sample to define the bias and correct the photo-z or the PDF(z).

- ➢ Bordoloi method 2010 and 2012

3) Use the spatial information (Newman et al. 2008, Menard et al. 2011)

- ➢ promising but not proved to work on real data yet


spec-z sample 0
spec-z sample 4
clustering
photo-z & PDF
in a tomographic bin
spec-z sample 3
spec-z sample 1
spec-z sample 2
brute
force
tool to measure
the photo-z quality
correct the PDF
(e.g. Bordoloi)
σ and failure rate
+ associated uncertainties
mean redshift
+ associated uncertainty
σ< 0.05(1+z)
catastrophic <10%
uncertainty< 0.2%

Summary

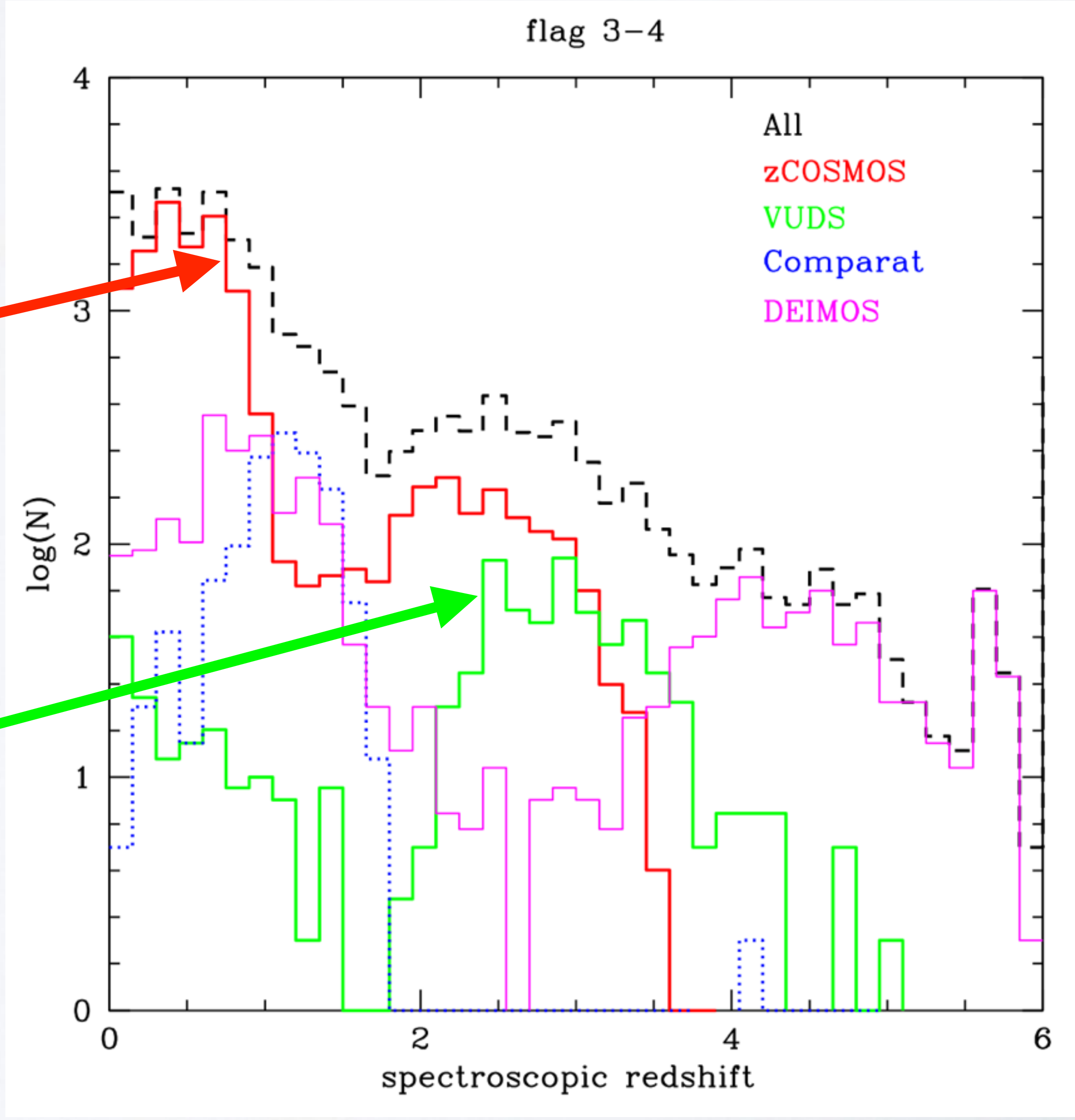
The spectroscopic follow-up is crucial

Different spec-z samples needed depending on the goal
➢ depth, area covered, redshift range …

Huge amount of telescope time and work

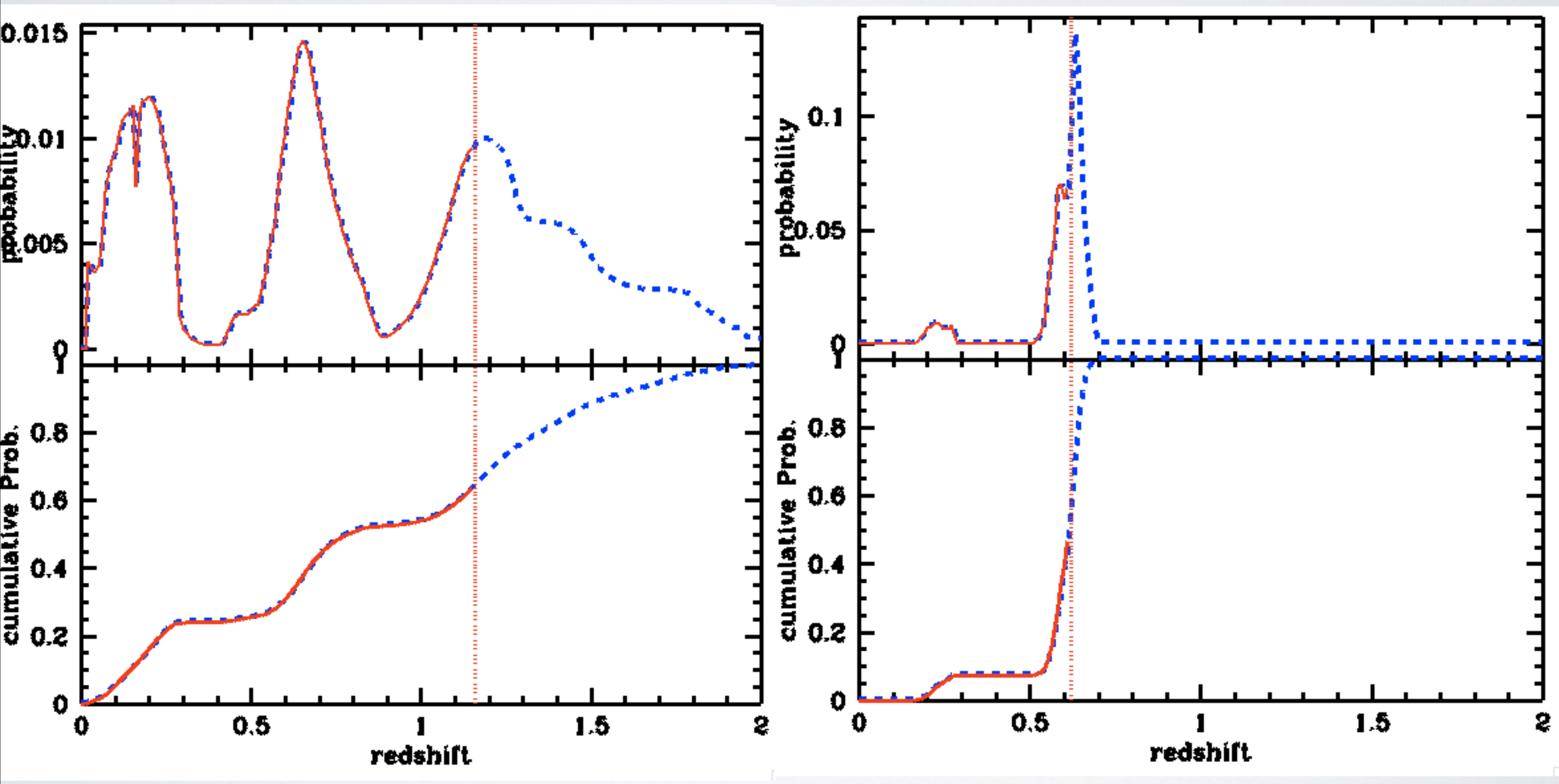
zComos (Lilly + 50 persons)
20000 spectra I<22.5
10000 spectra B<25
600h at VLT with VIMOS

VUDS (Le Fèvre + 50 persons)
10000 spectra I<25
600h at VLT with VIMOS
Blue and red grism,
40h exposure per spectra



PDF(z) examples

Standard output of the photo-z codes

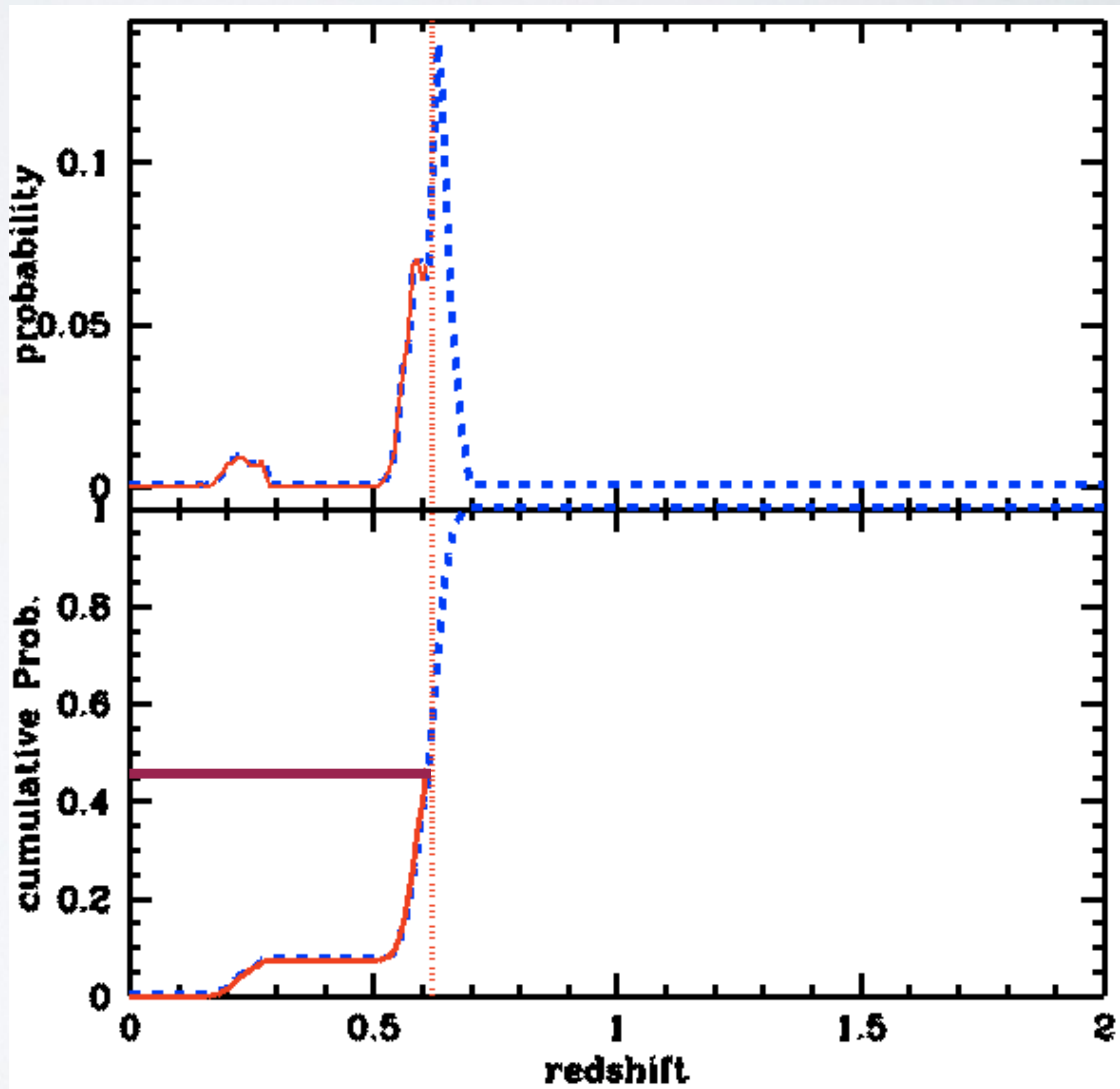


Principle of BORDOLoi 2010

The distribution of the PDF cumulated from z=0 to zs should be flat

$$P_{real} = \int_0^{zs} L(z')\mathrm{d}z'$$

Preal



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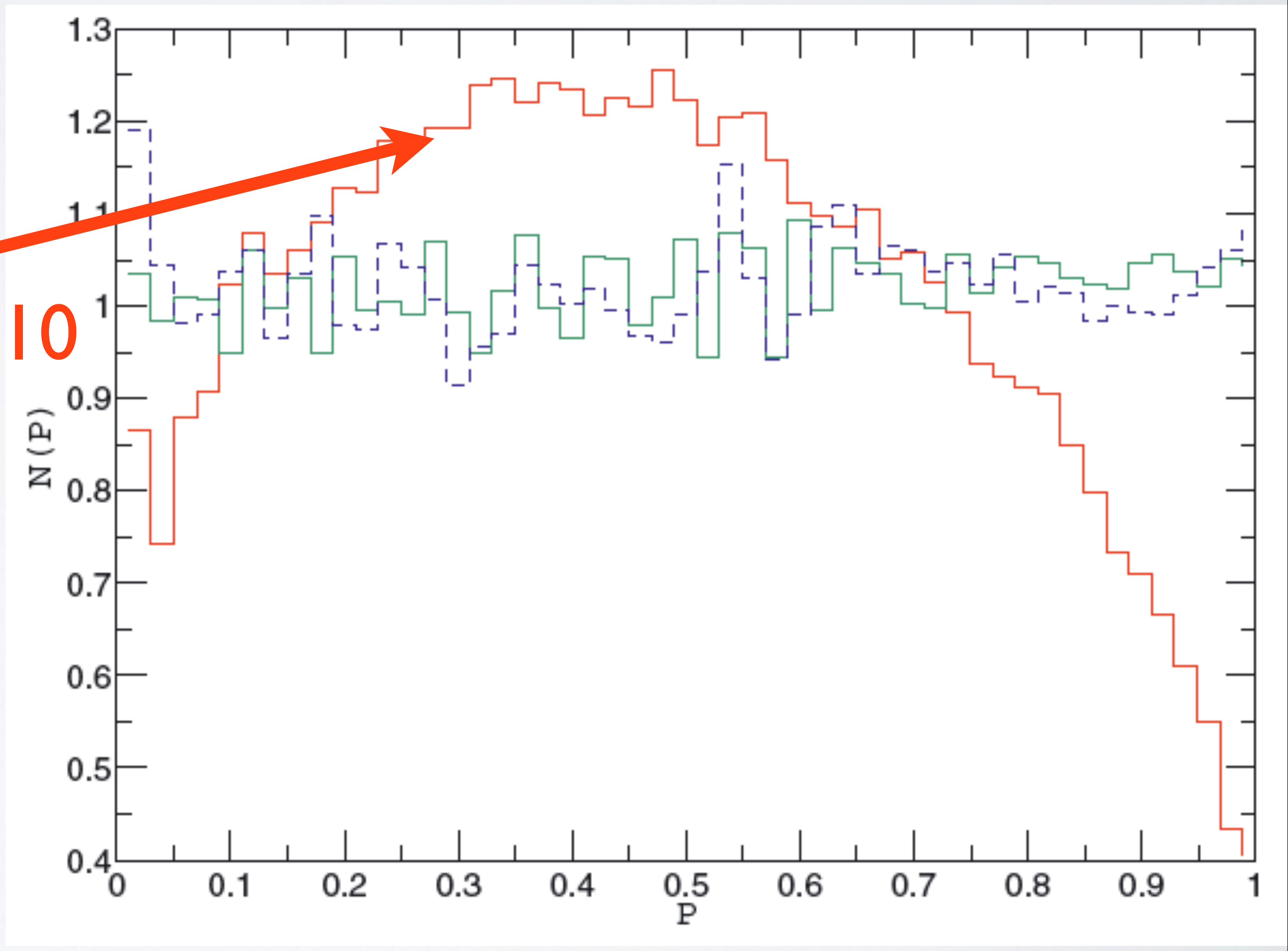
Simulation by Bordoloi 2010

➢ distribution not flat



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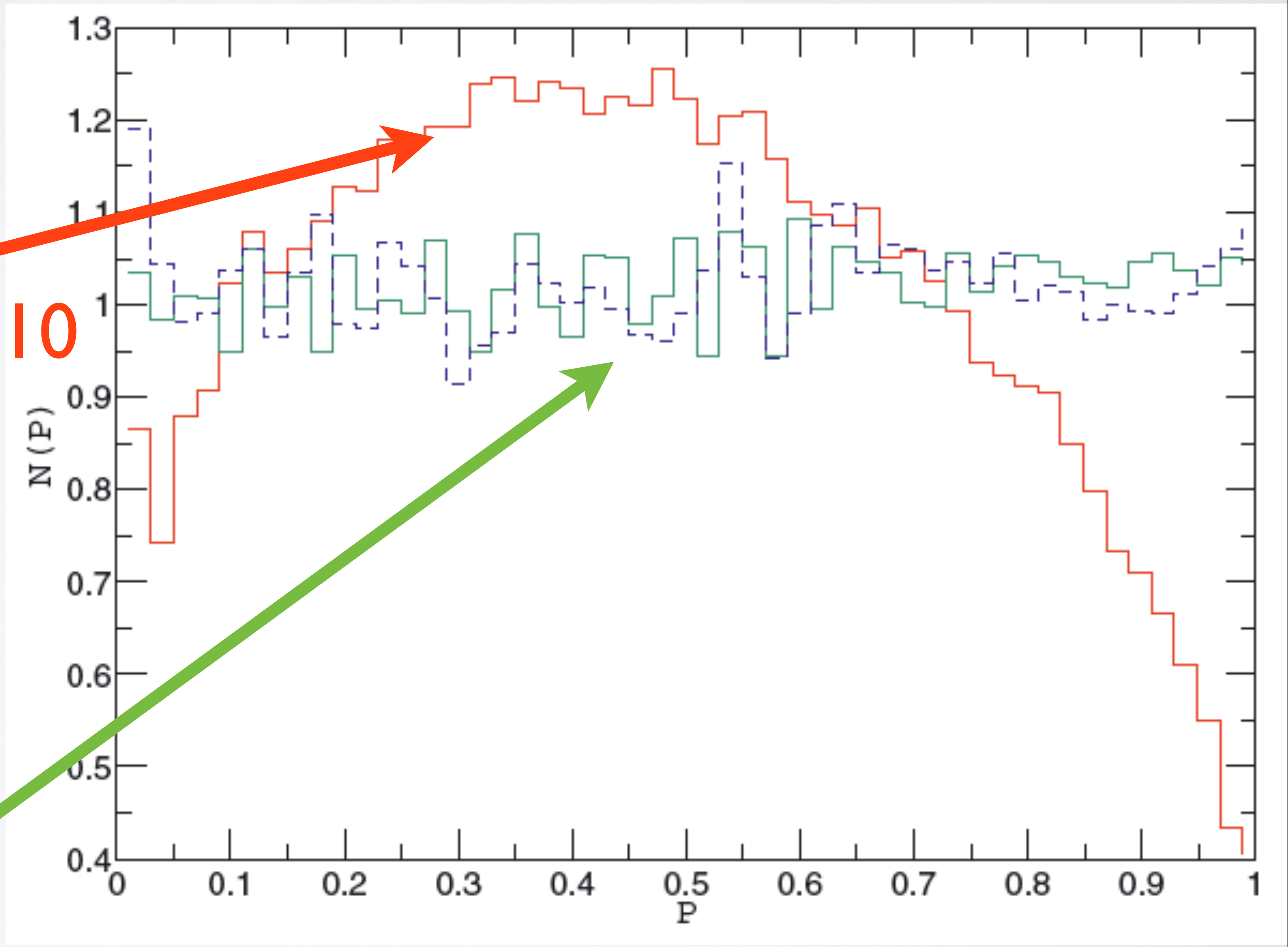
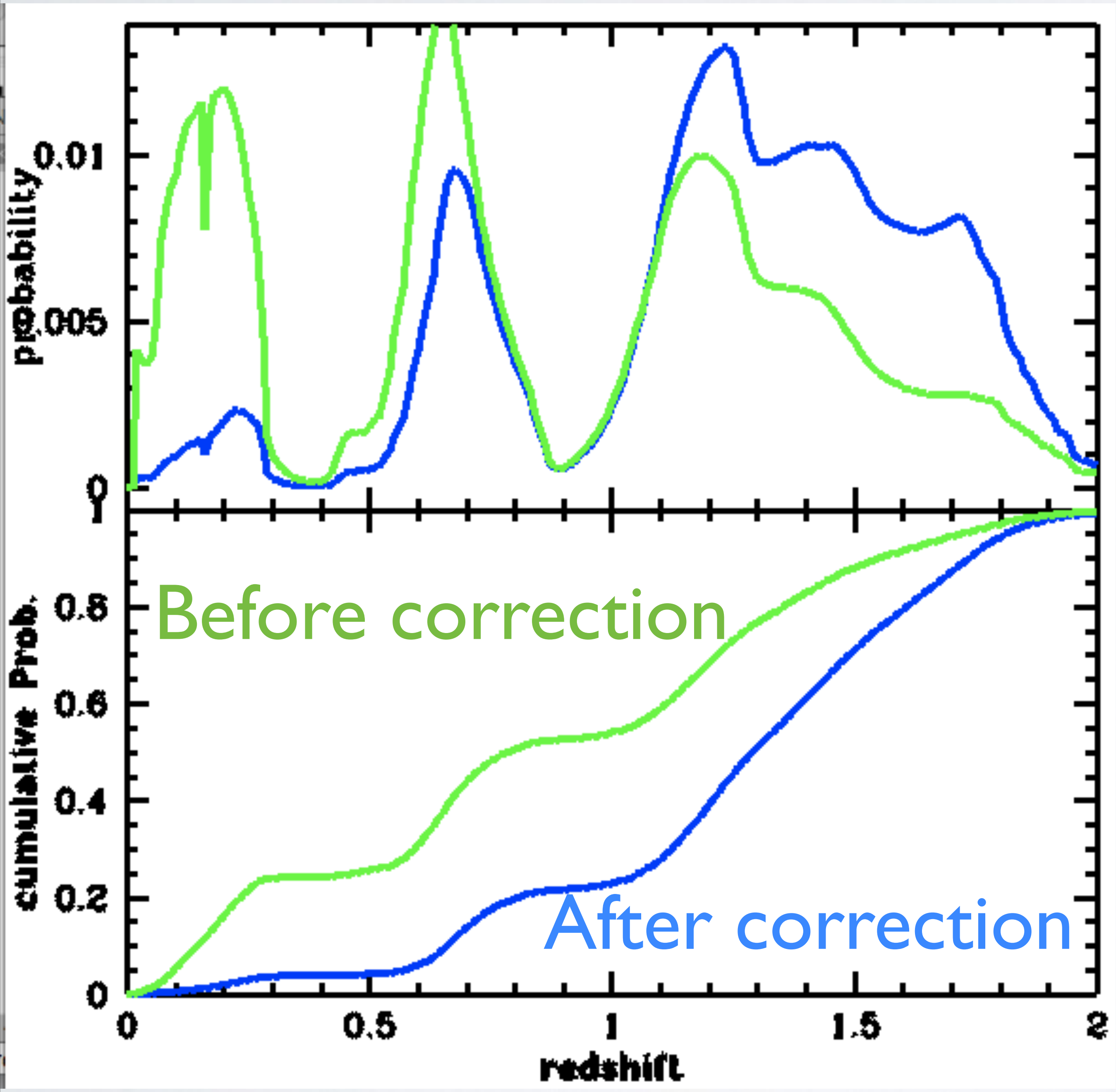
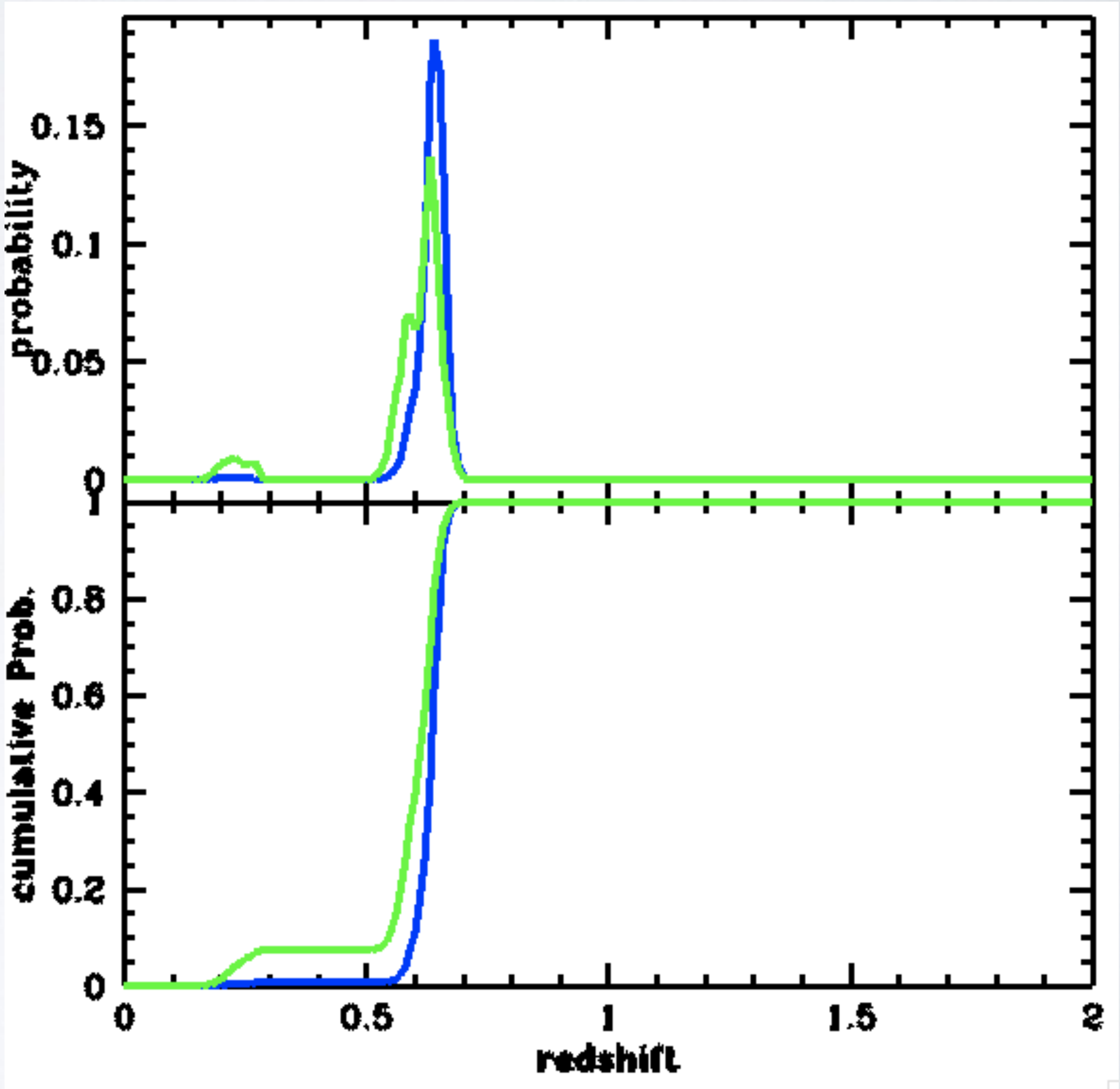


Use this distribution to correct the PDF

$$\mathcal{L}'(z) = L(z)\,N(P(z))$$

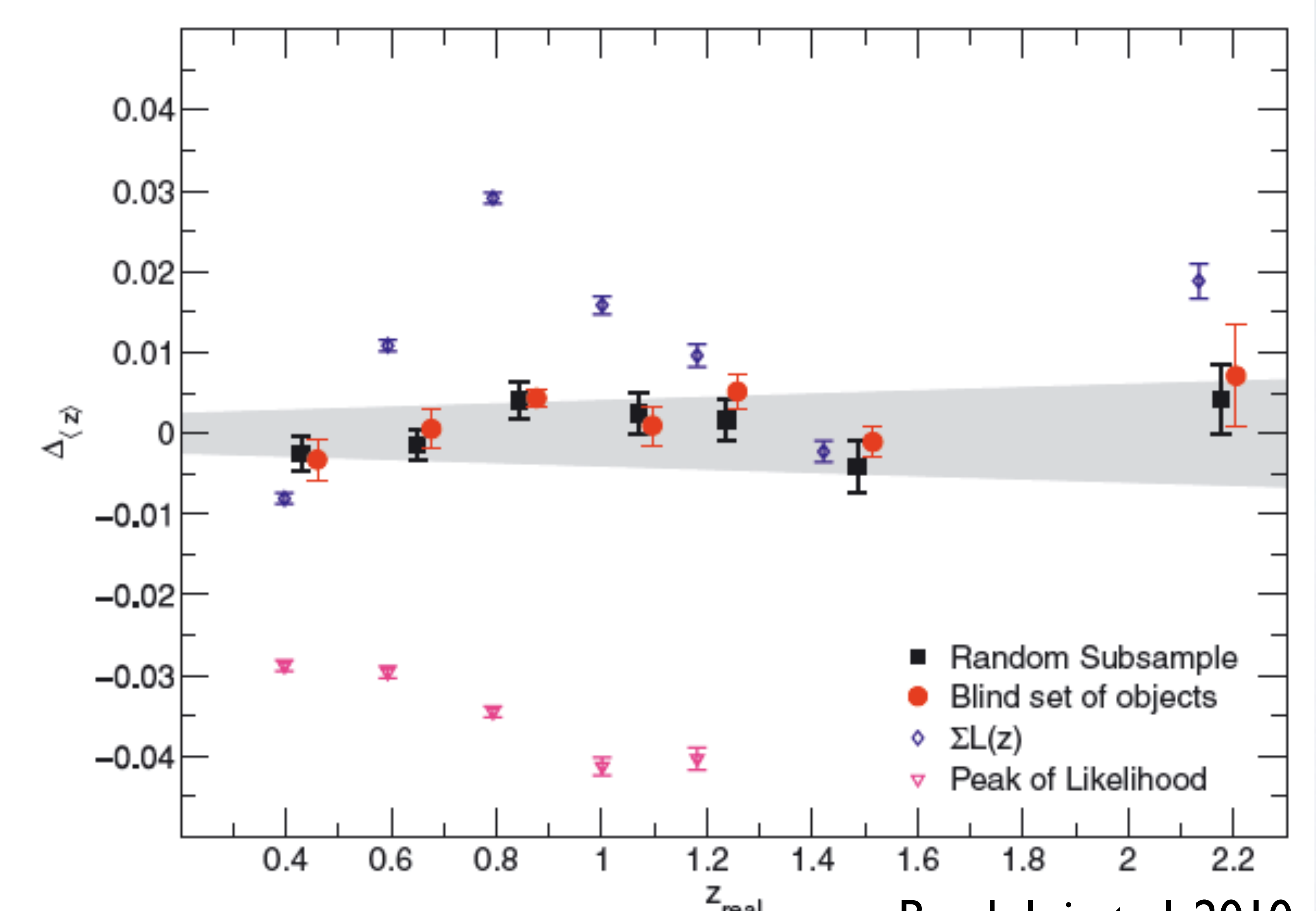
PDF(z) corrected examples





Test on simulations

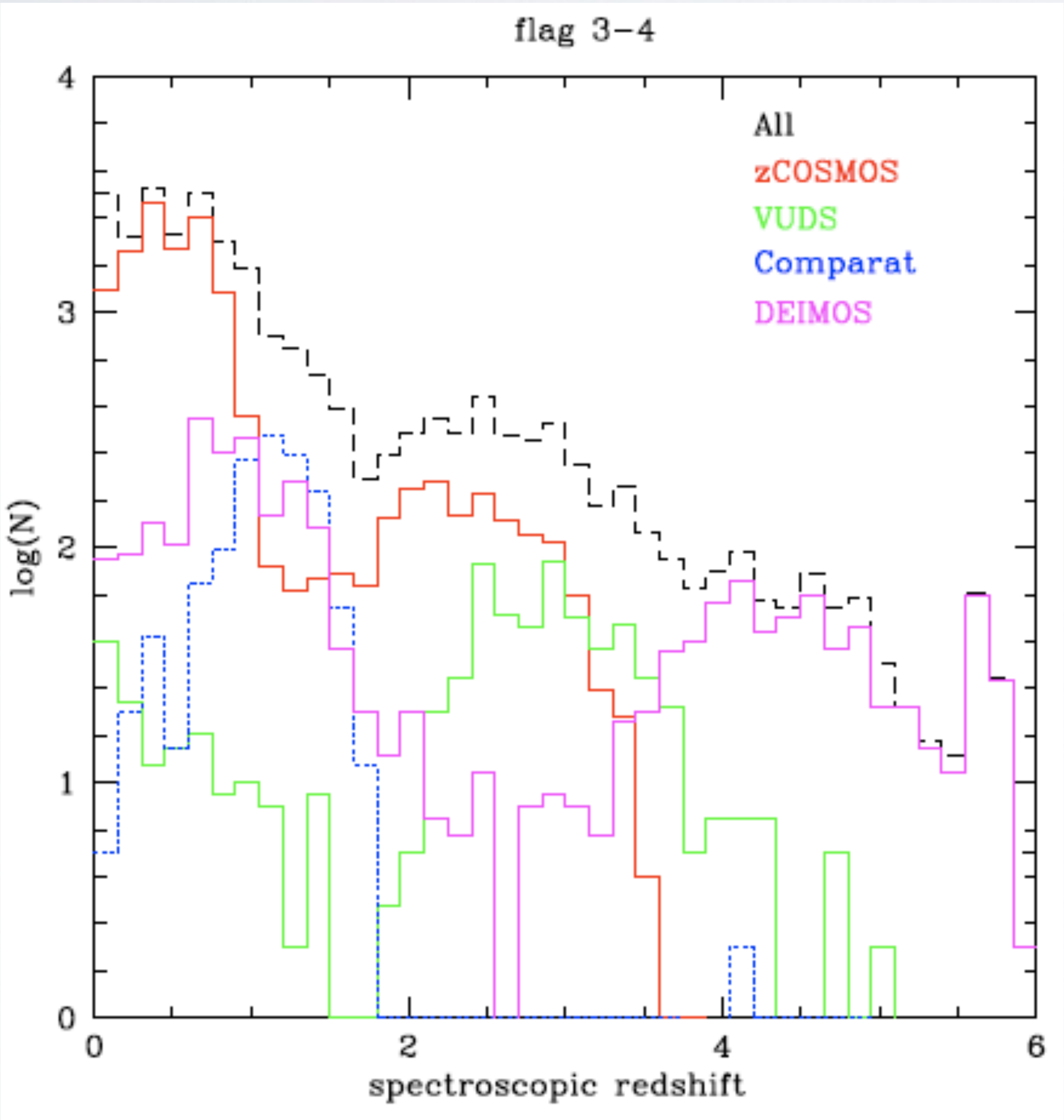
Within the EUCLID requirement



Bordoloi et al. 2010

TRY WITH COSMOS

Advantage of the large and deep spec-z samples, reaching I<25



spectroscopic survey	Nb spec-z $i^+ < 25$	z_{med}	I_{med}
zCOSMOS bright	8616	0.52	21.5
Kartaltepe 2013	526	0.74	22.2
Comparat 2013	1160	1.16	22.8
Capak 2013	922	1.25	23.9
Onodera 2012	15	1.65	24.5
Silverman 2013	97	1.58	23.2
Krogager 2013	11	1.98	25.0
zCOSMOS faint	1522	2.15	23.8
VUDS	459	2.75	24.5

PHOTo-z versus spec-z

adding the U band
adding the J band

U (Megacam)
GRIZ (suprime-cam)
Y (HSC)
J (VISTA)

J band selected catalogue

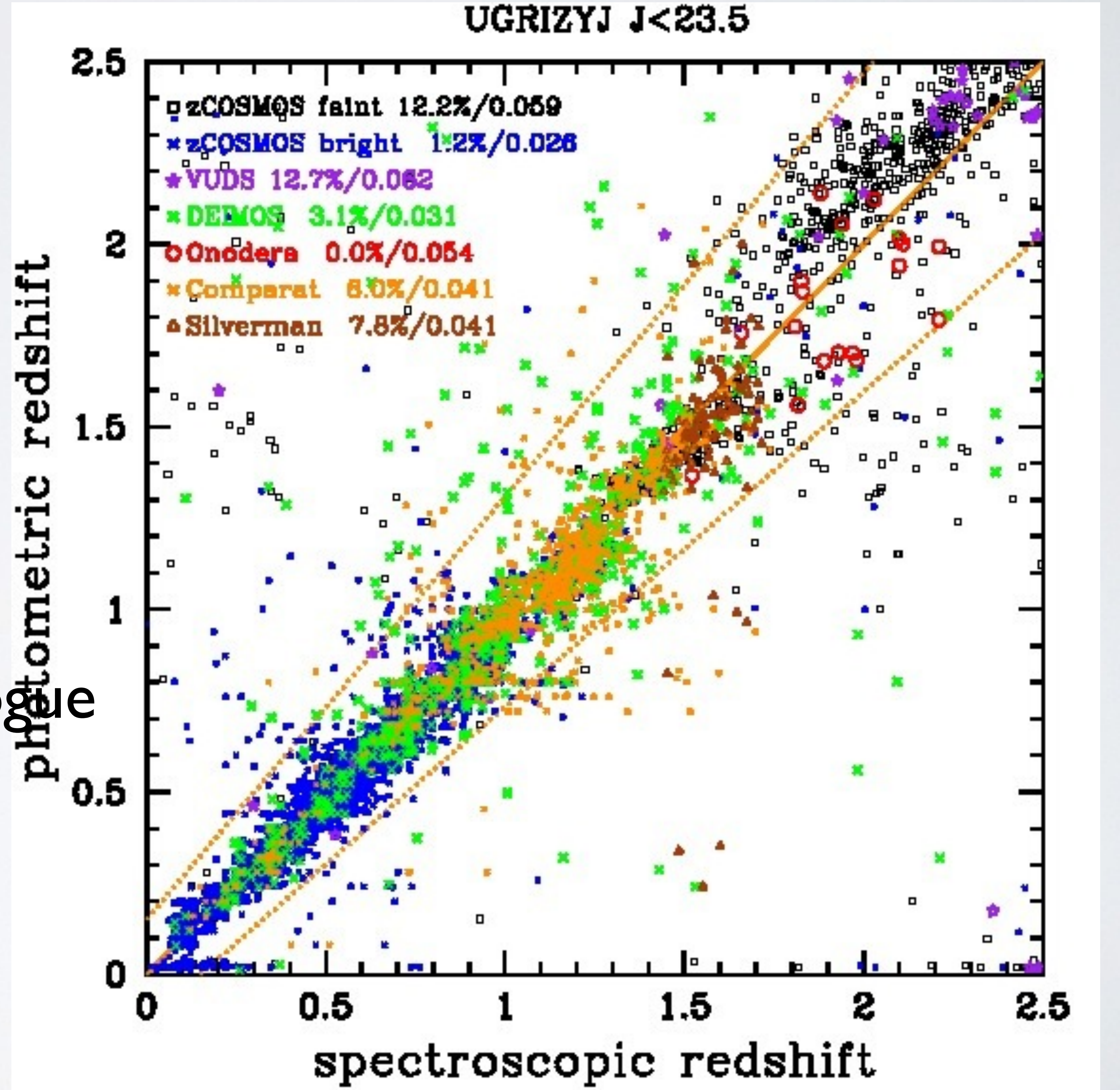
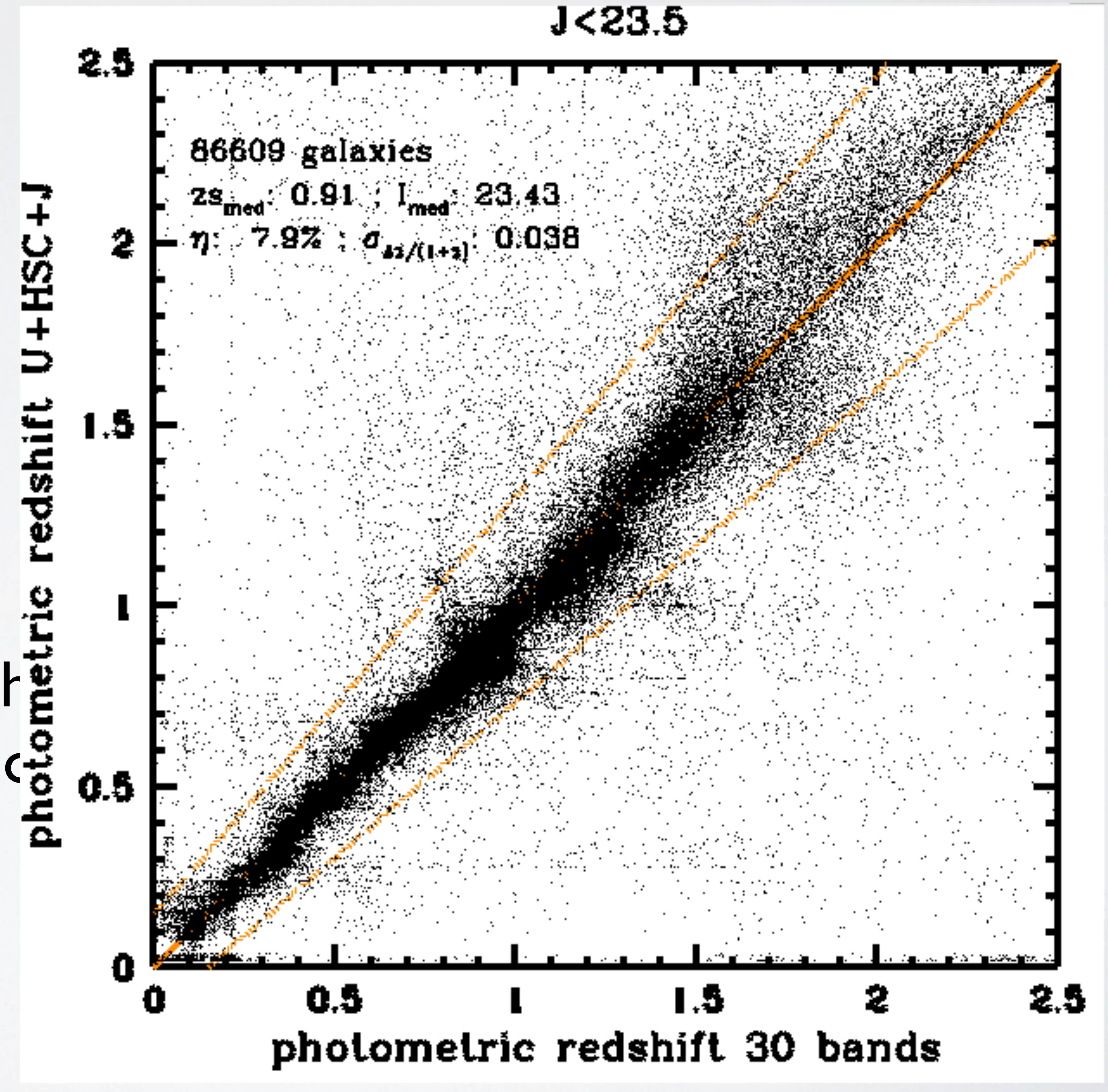


PHOTo-z PFS versus

Photo-z PFS:
U (Megacam)
GRIZ (suprime-cam)
Y (HSC)

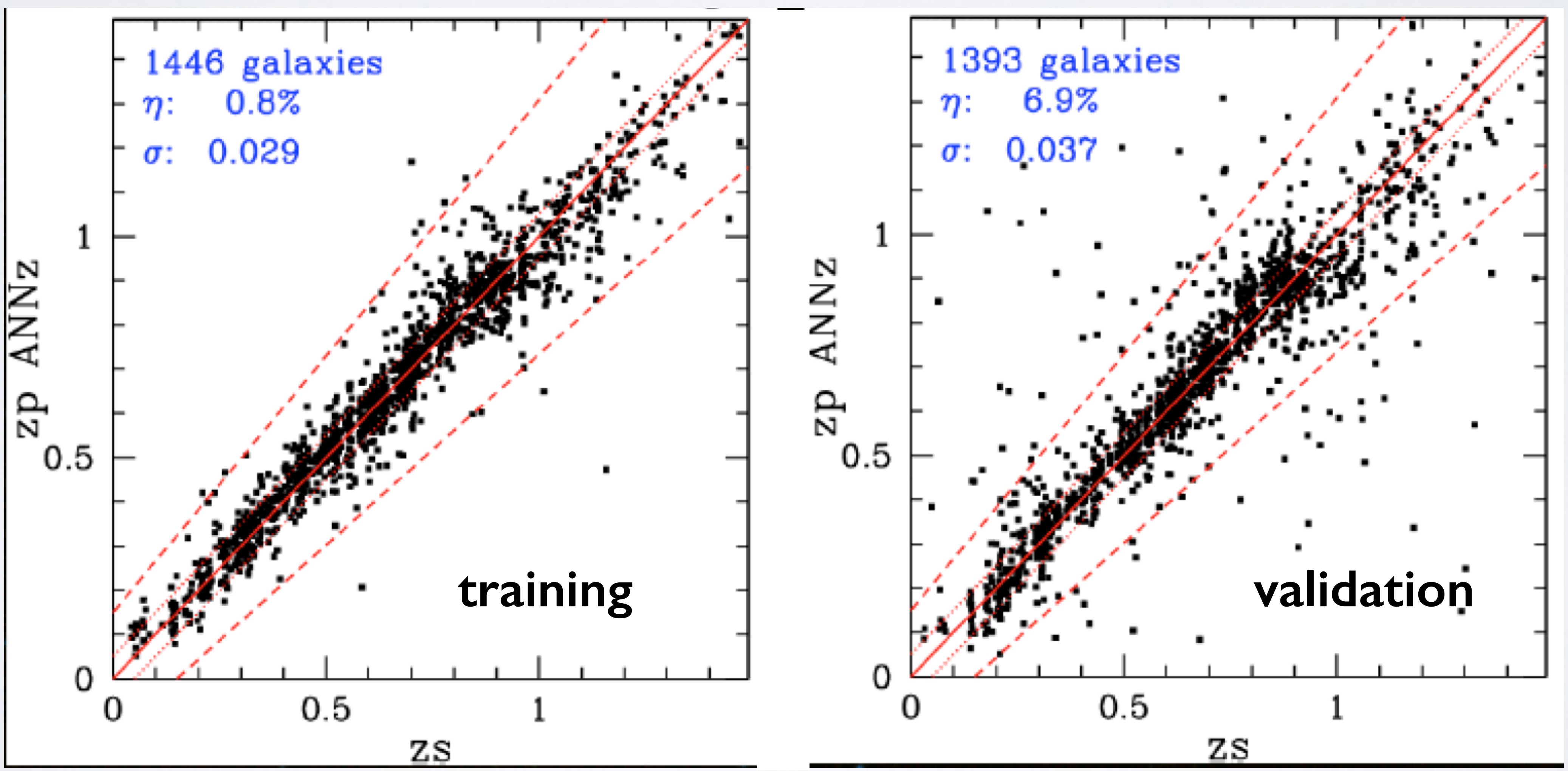
Photo-z COSMOS
30 bands

Even with 30 bands, th
which contributes also



Neural Network

Use only a fraction of the sample for the training
ANNz from Collister & Lahav 2004



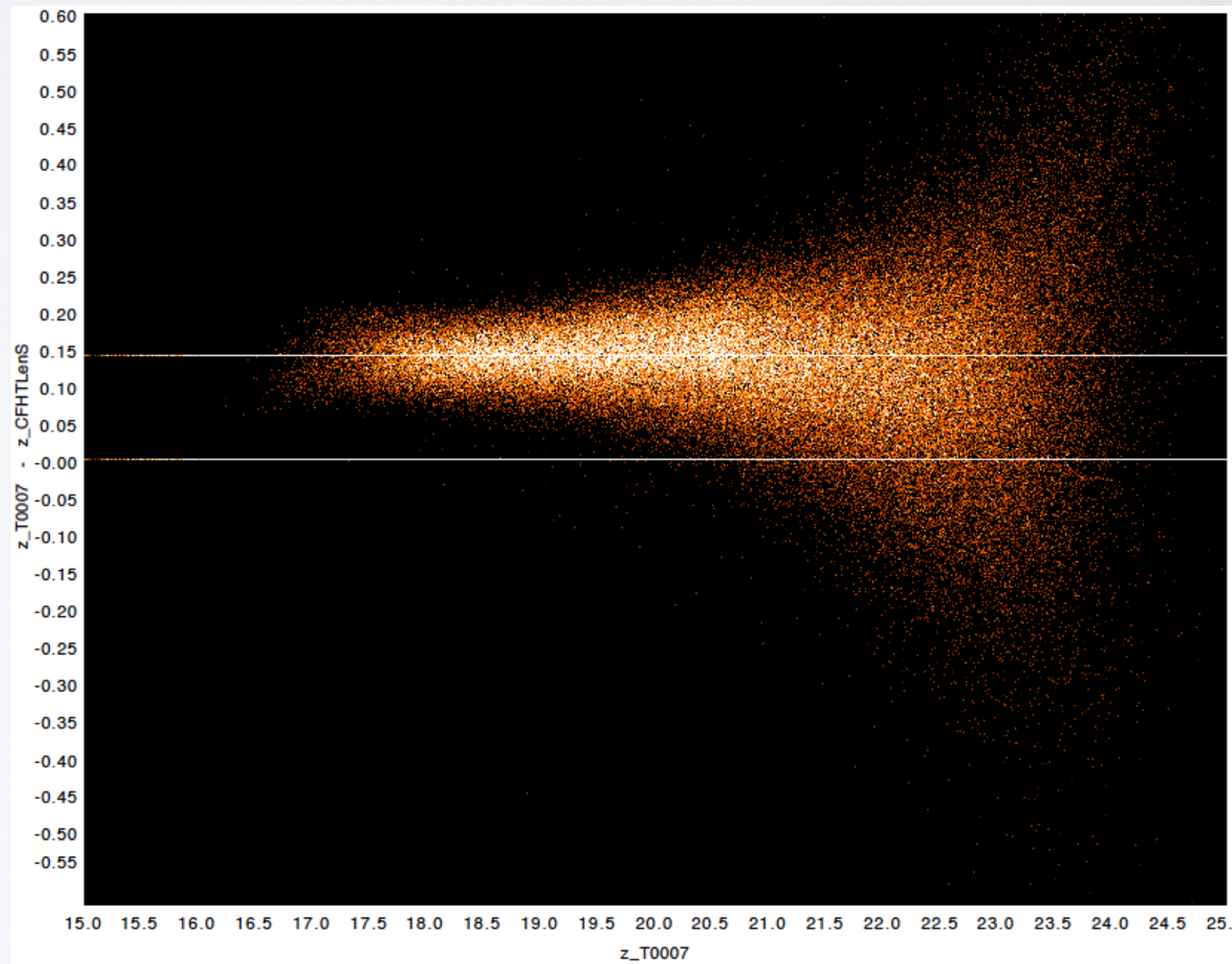
Difficulty of the absolute calibration

Even between two CFHTLS releases T006/T007

➢ differences >0.1 mag

		K_S RELATIVE OFFSETS	
Filter	Δmag^*	T0007	CFHTLenS
FUV	—	0.102 ± *0.070*	0.084 ± *0.079*
NUV	—	0.054 ± *0.055*	0.022 ± *0.065*
u	-0.013 ± *0.052*	0.075 ± *0.031*	0.087 ± *0.042*
g	0.071 ± *0.053*	0.028 ± *0.019*	-0.053 ± *0.016*
r	0.038 ± *0.052*	0.022 ± *0.019*	-0.024 ± *0.005*
i	0.066 ± *0.045*	0.013 ± *0.015*	-0.055 ± *0.009*
y	0.048 ± *0.051*	0.008 ± *0.009*	-0.042 ± *0.013*
z	0.148 ± *0.054*	0.087 ± *0.027*	-0.063 ± *0.015*
Ks	—	0.0 ± *0.016*	0.0 ± *0.019*

$^* m_{T07} - m_{LenS}$



Moutard et al., in prep