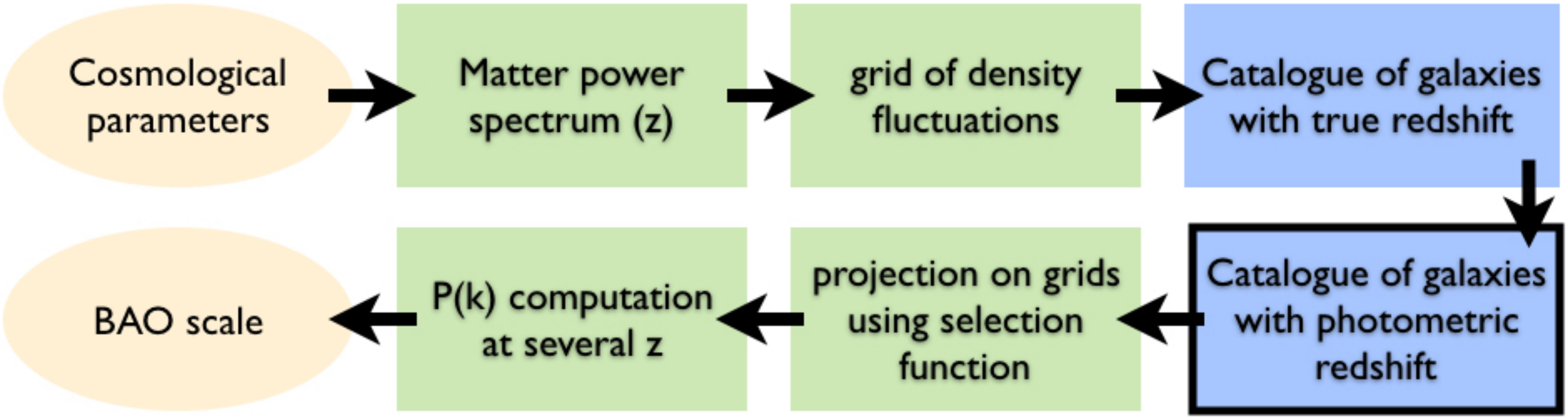
Status of the BAO paper (to be submitted in the following months since one year, but in progress !)

Impact of photometric redshifts on the BAO scale determination in the LSST survey

Adeline Choyer, Cécile Renault, Jean-Stéphane Ricol, Alexandra Abate,
Reza Ansari, Farhang Habibi, Christophe Magneville, Marion Moneuse,
Marc Moniez, and Stéphane Plaszczynski
+ Julien Souchard (M2)

LPSC, LAL, SPP

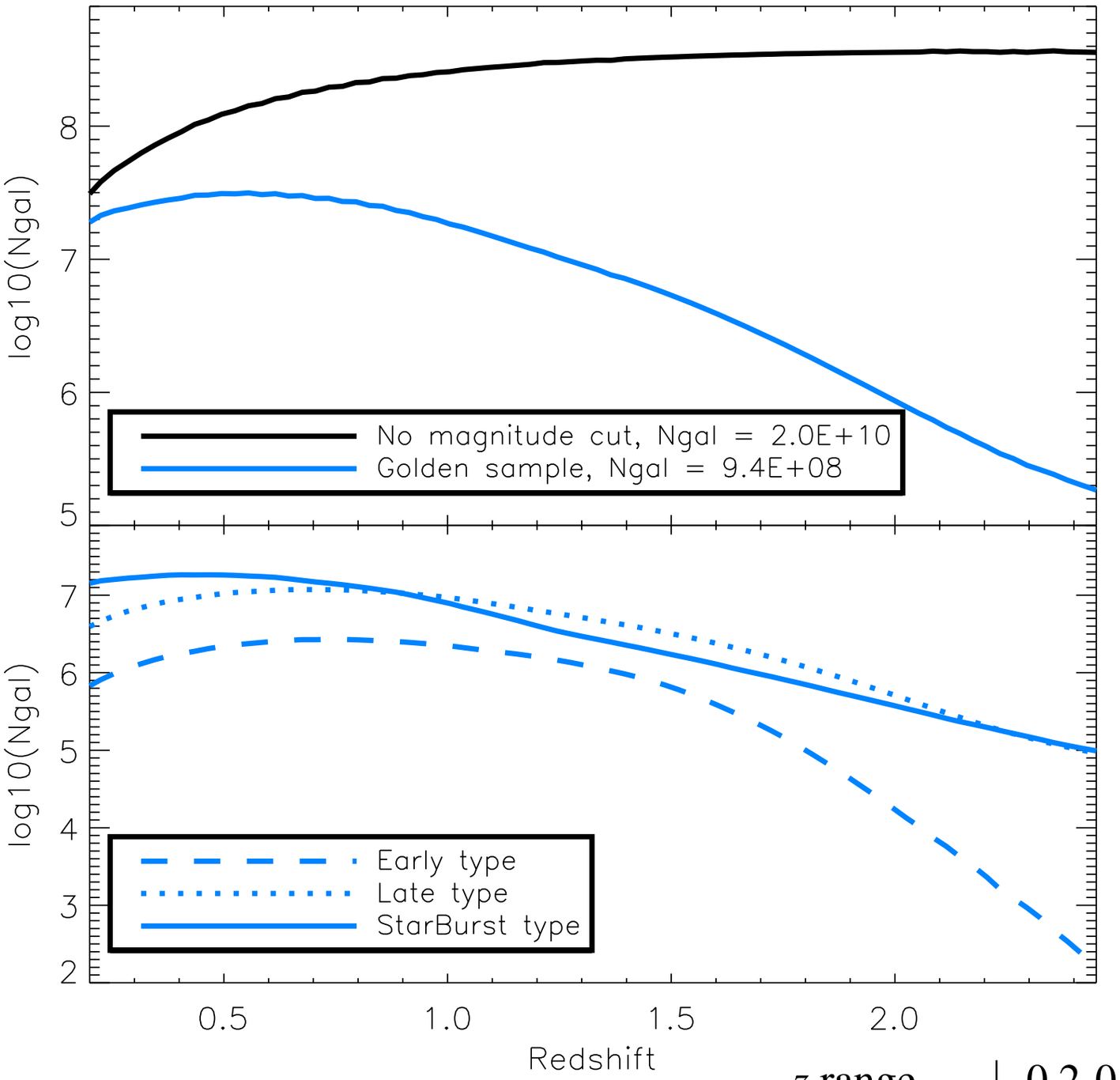
Simulation from cosmological parameters to k_BAO scale throw a catalog of galaxies with photometric redshift



Compared to previous version: not up to cosmological parameters reconstruction (with CAMEL) because simulations are done with more approximations than CLASS computations

—> “incompatibility” at the % level
—> modification to use CLASS from the beginning currently implemented (Julien’s work, M2, LPSC), for the next works

Simulation of a “realistic” catalog of galaxies



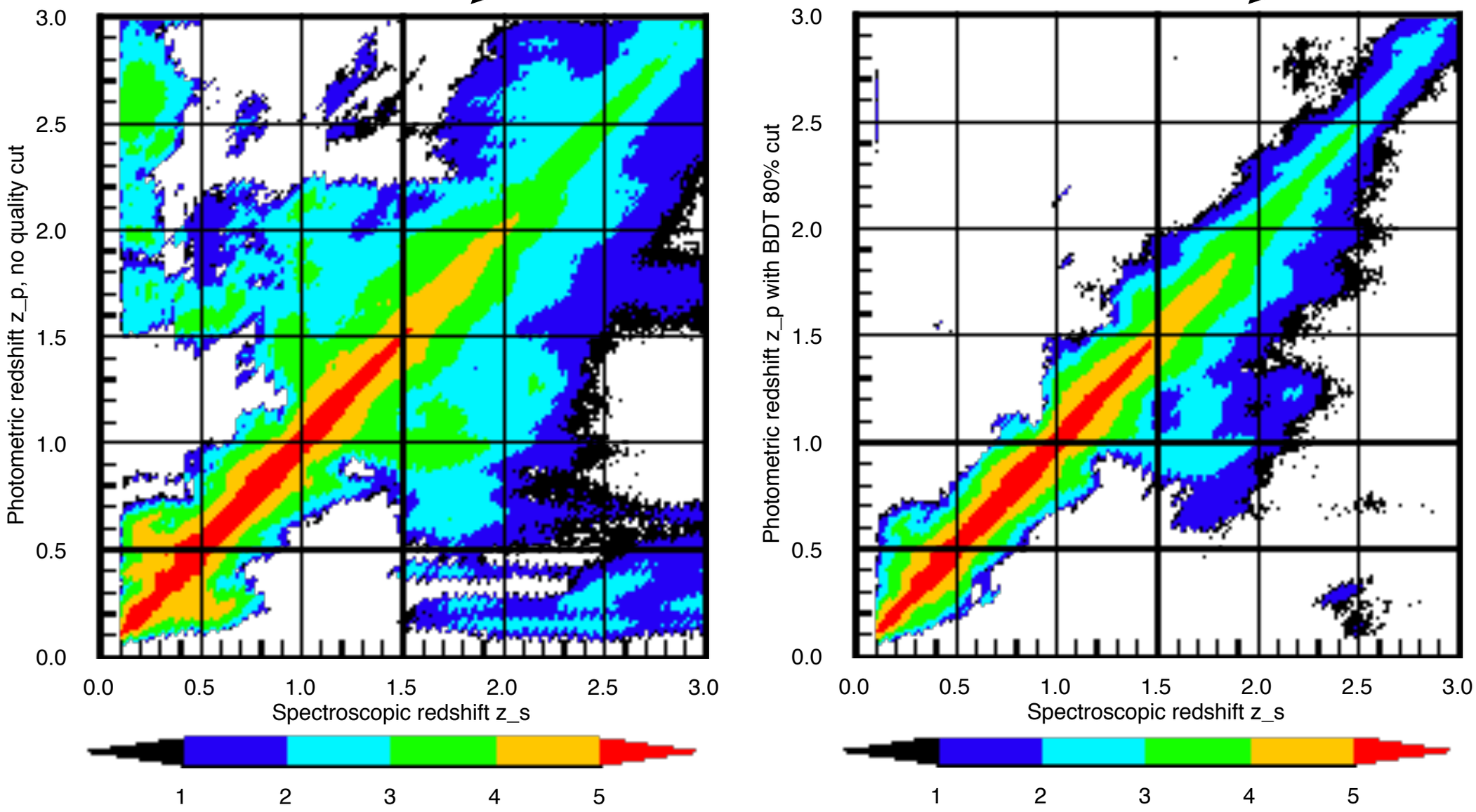
Simulation of a cone of 1/4 of the sky from z=0.2 to z=2.45

“**all**” galaxies to **golden cut** selection (mag_i < 27.3)
—> from **20** to **1** billion of galaxies

Science book : 55 gal/arc-min2
this paper : 25 gal/arc-min2
—> too rough computation in the Science book (55—> 30) (Farhang's work)
—> E(B-V) (~ 11 % effect).
Still some uncertainty: mag_i upper limit with or without atmosphere absorption ?

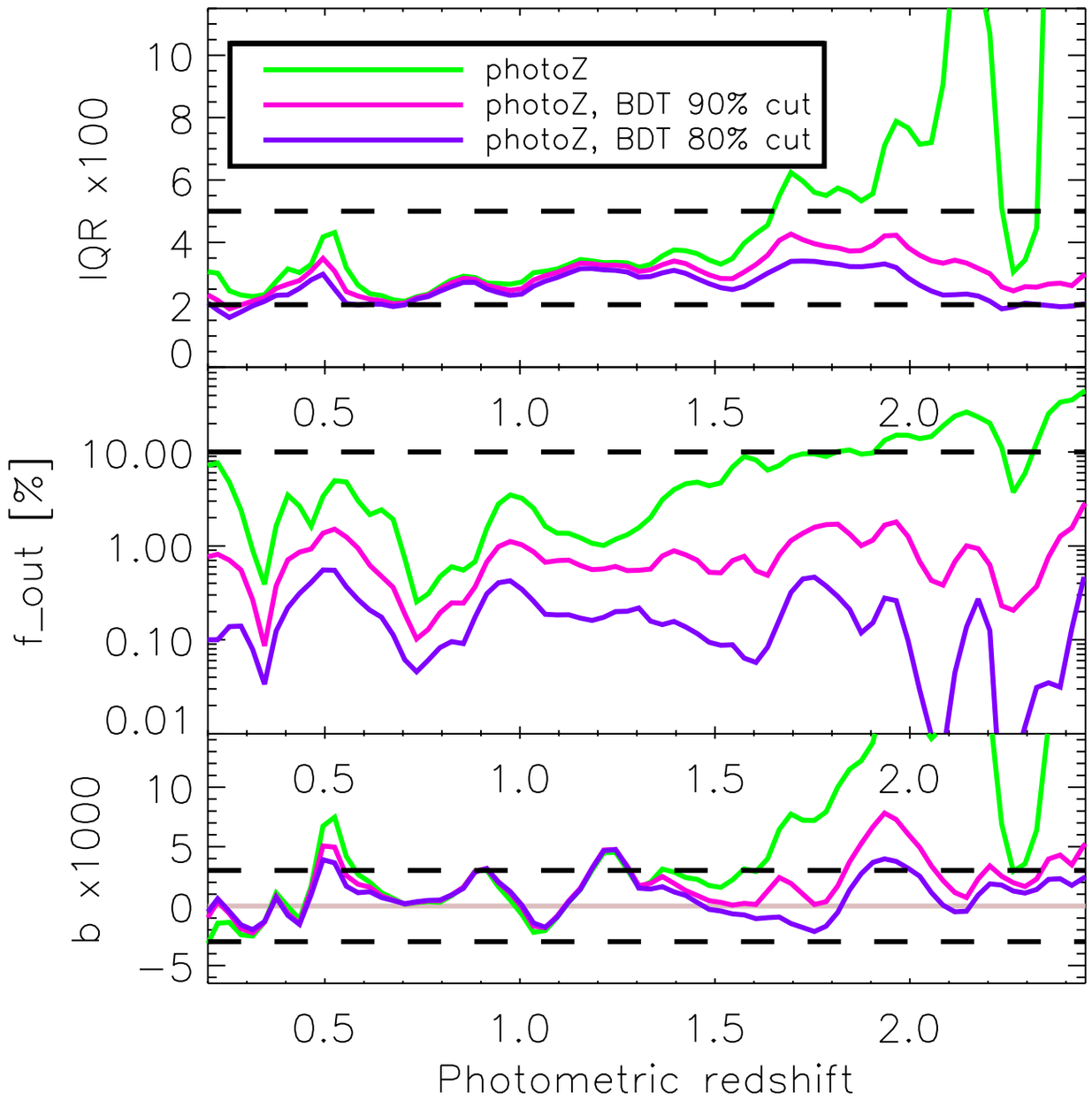
z range	0.2-0.5	0.5-1.0	1.0-1.5	1.5-2.5	0.2-2.5
$z = z_s$	6.9	12.3	5.1	1.4	25.6
$z = z_p$	6.4	12.8	5.1	1.3	25.7
$z = z_{BDT90}$	5.8	11.9	4.7	0.9	23.3
$z = z_{BDT80}$	5.1	10.9	4.1	0.6	20.8

Redshifts: spectroscopic, Gaussian, photometric without or with BDT cut (90 or 80%)

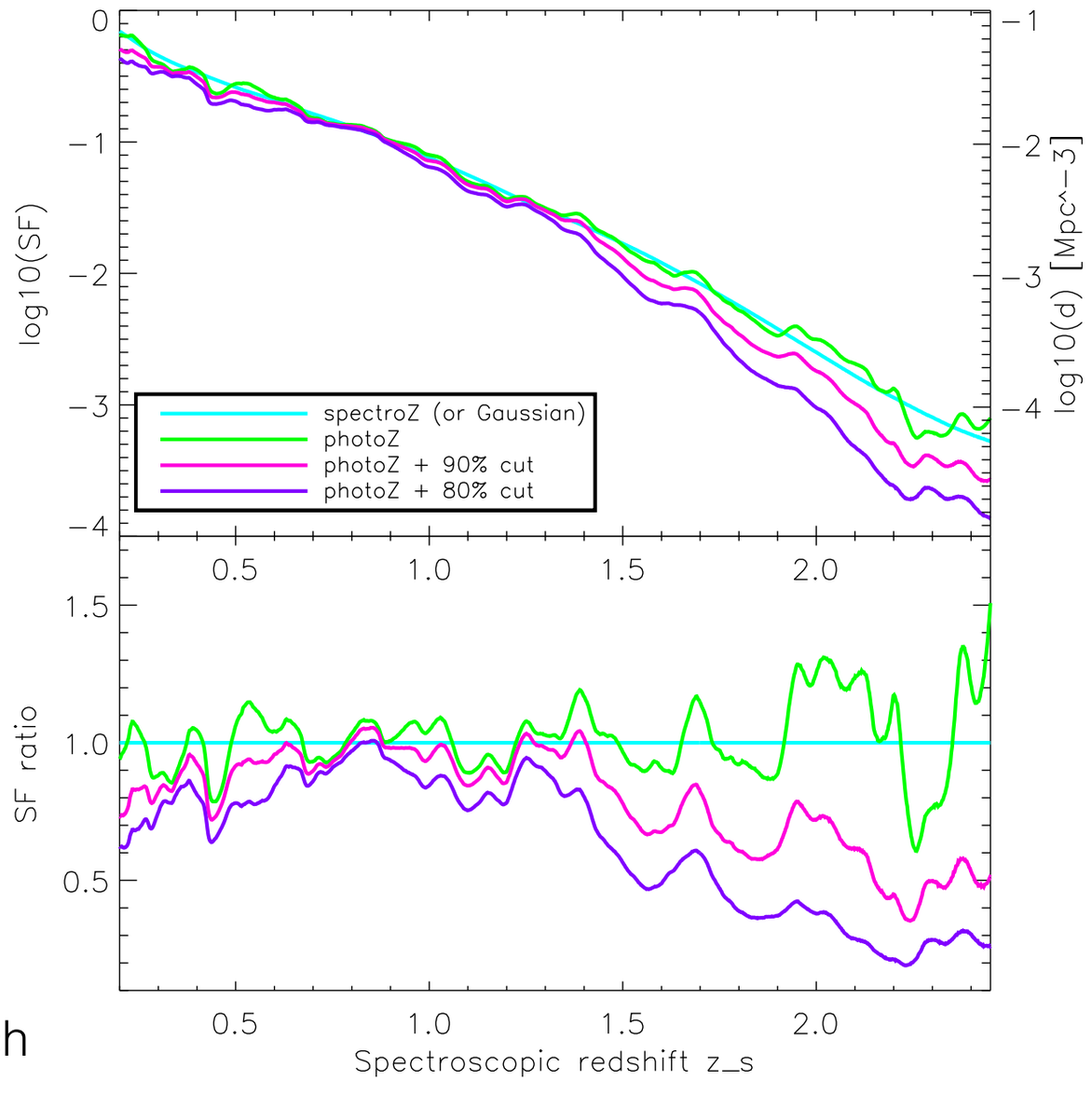


Very efficient cleaning of the outliers, but the cost is a loss of 20% of the galaxies —> what is the most critical for BAO scale ?

LSST requirements on $(z_s-z_p)/(1+z_s)$ & selection function



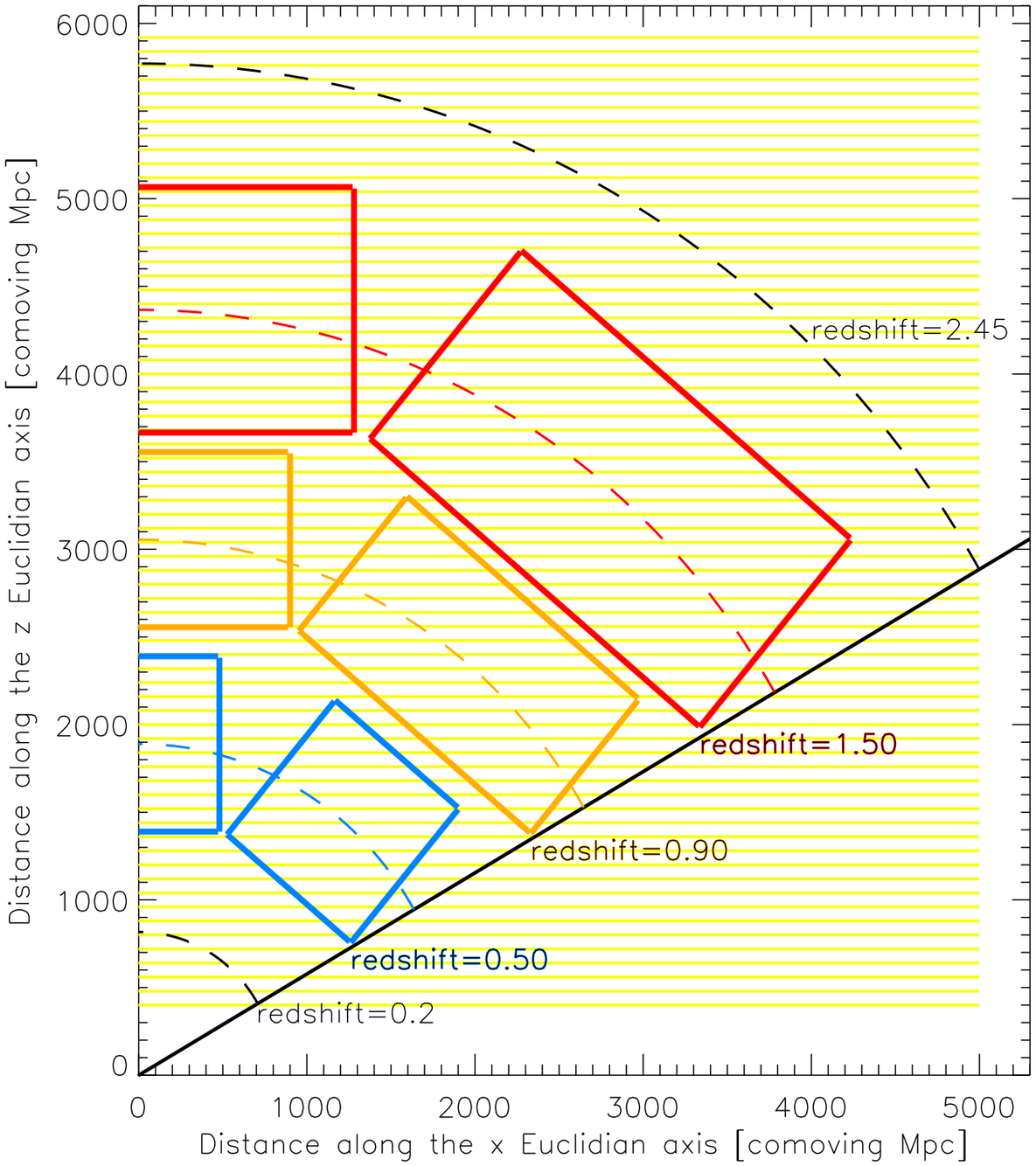
- simple photoZ in the requirements for z< 1.5 (except bias ~ z=0.5)
- BDT cut allows galaxies up to z=2.45 to satisfy the requirements



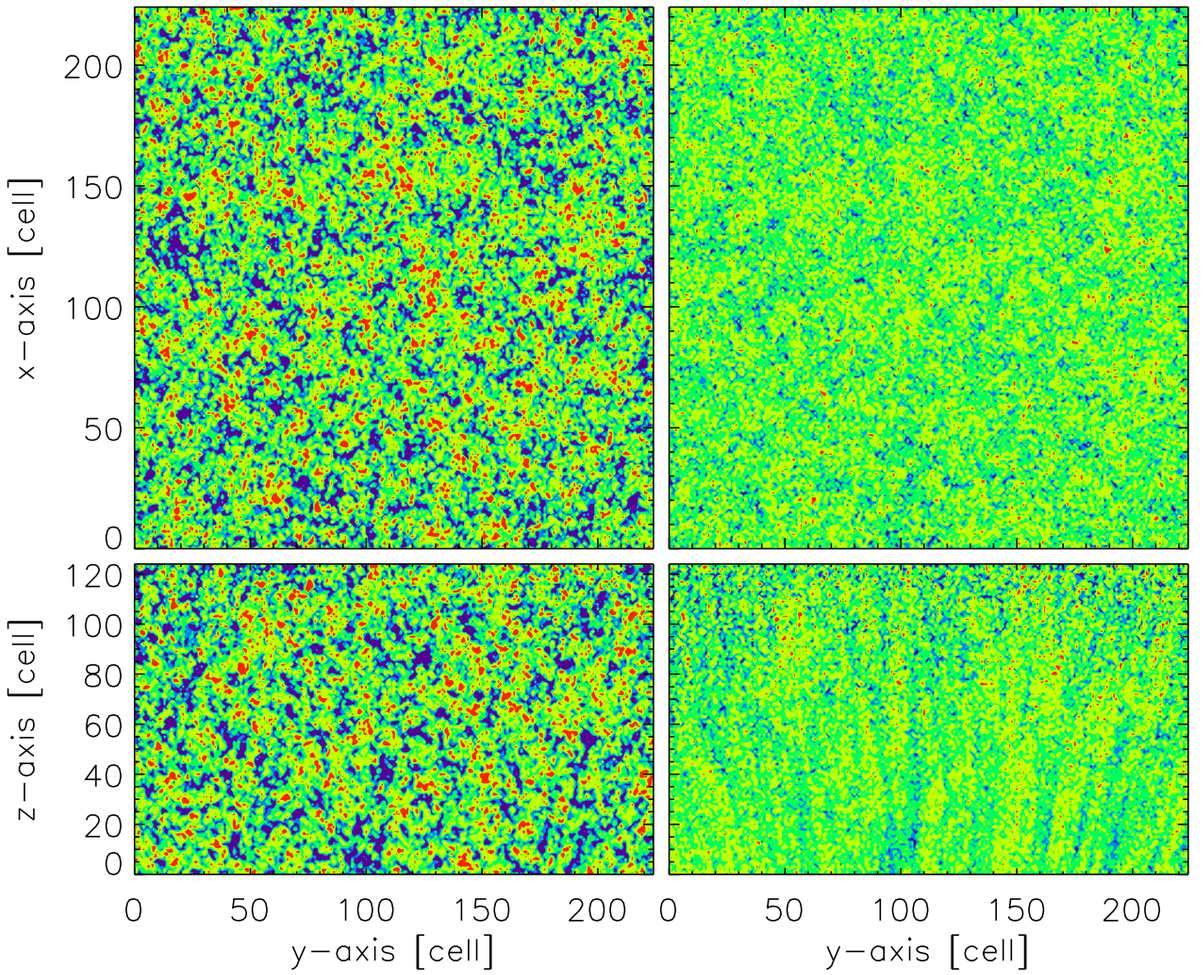
Selection function:

- main shape=golden cut
- photoZ introduce large scale features which MUST be properly taken into account

Comparison with LSST requirements



We try to use galaxy distribution from that …

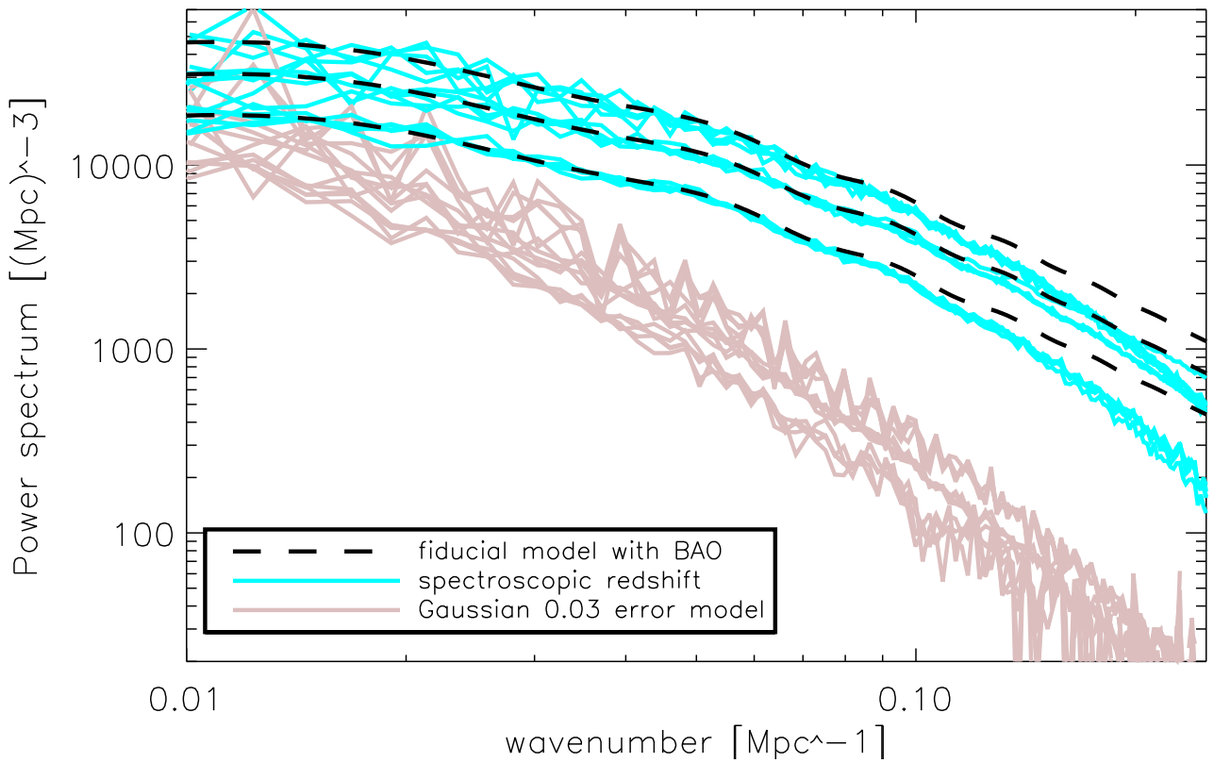


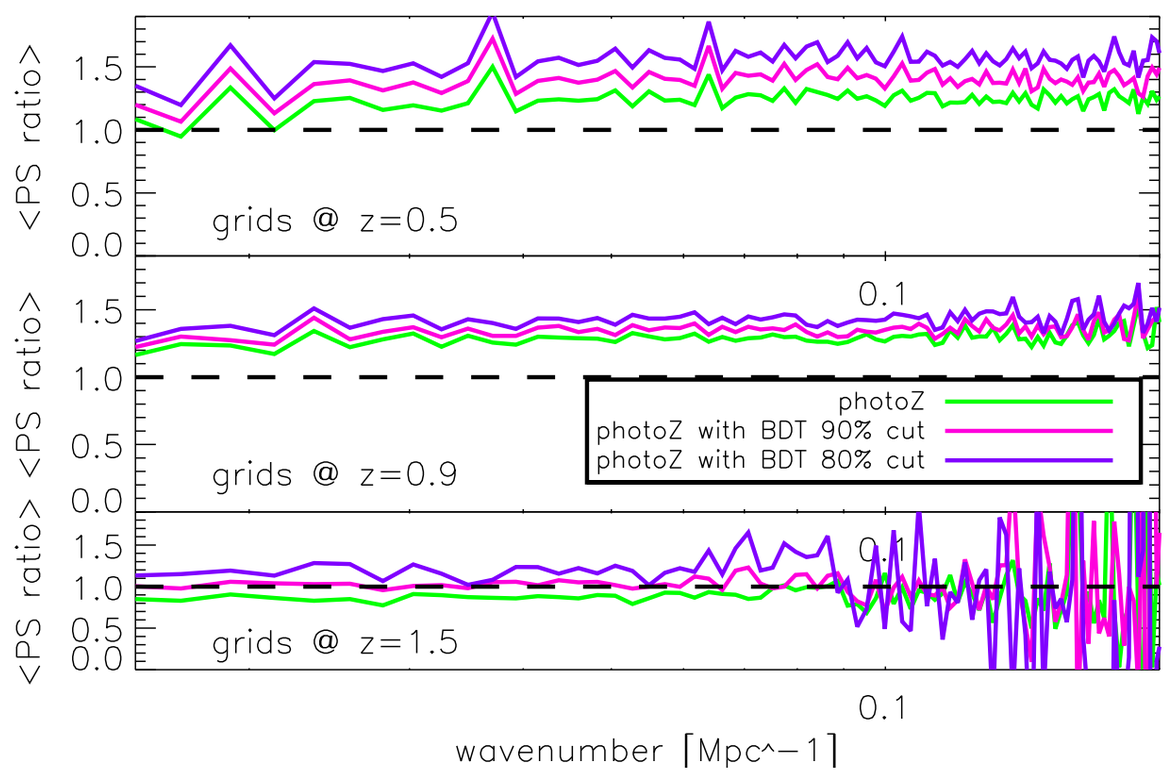
with spectroscopic redshift

with photometric BDT 80% redshift

3 slices in redshift (0.5, 0.9, 1.5)
Each is sampled by 5 grids

Matter power spectra





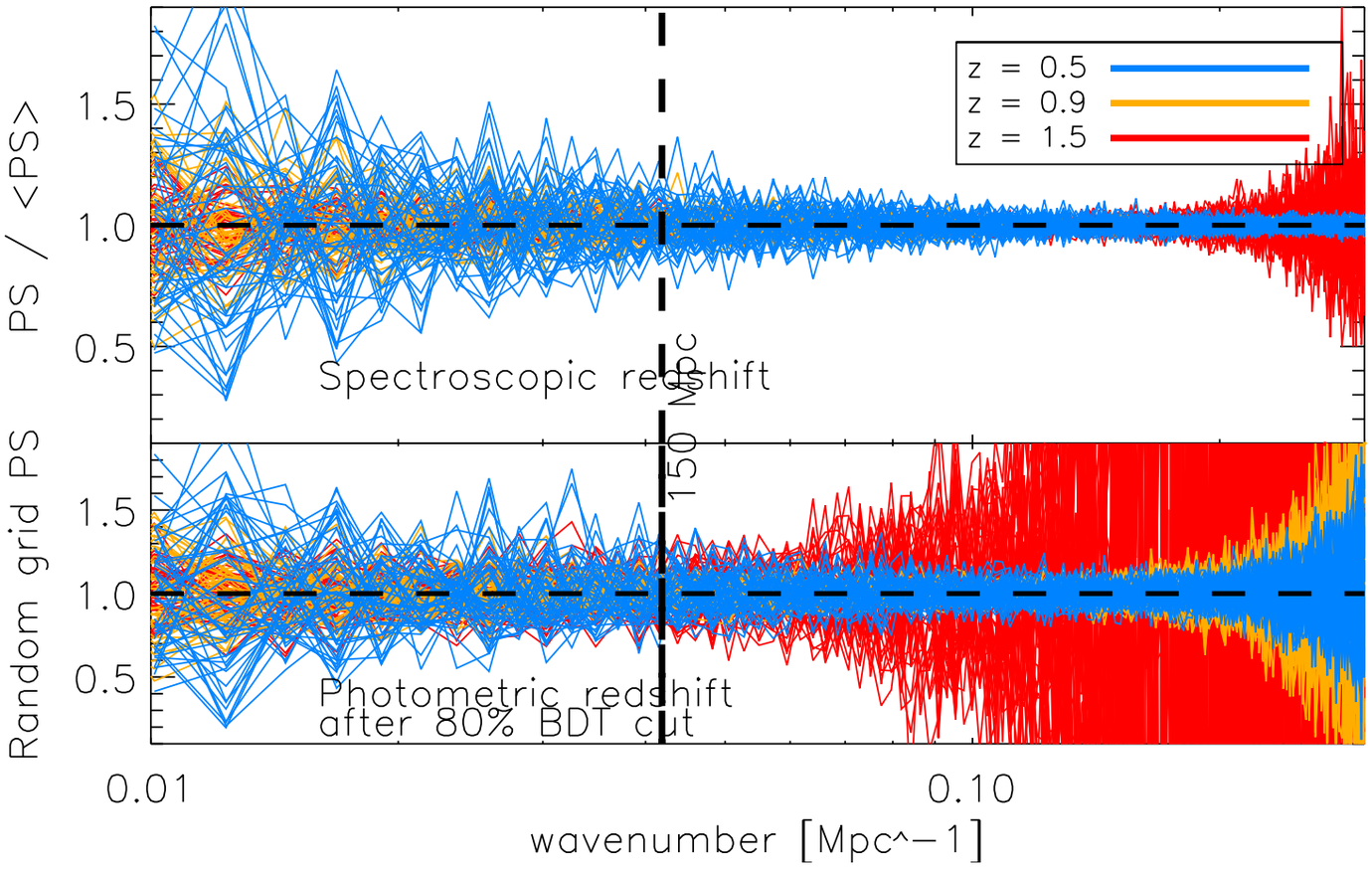
- Individual spectra for the 5 grids/redshift
- SpectroZ well follows theoretical shape
- Gaussian case (sigma=0.03(1+z)): significant damping at scales of interest

- mean ratio (PS photoZ / PS Gaussian)
- if > 1—> equivalent sigma < 0.03

- Cosmic variance at lowest scales (especially @z=0.5)
- Shot-noise at large scales @z=1.5 (too few galaxies)

Reference: simulations without BAO oscillations

Simulation of 10 “universe” without BAO oscillations to properly take into account damping and more subtil impact of the photoZ



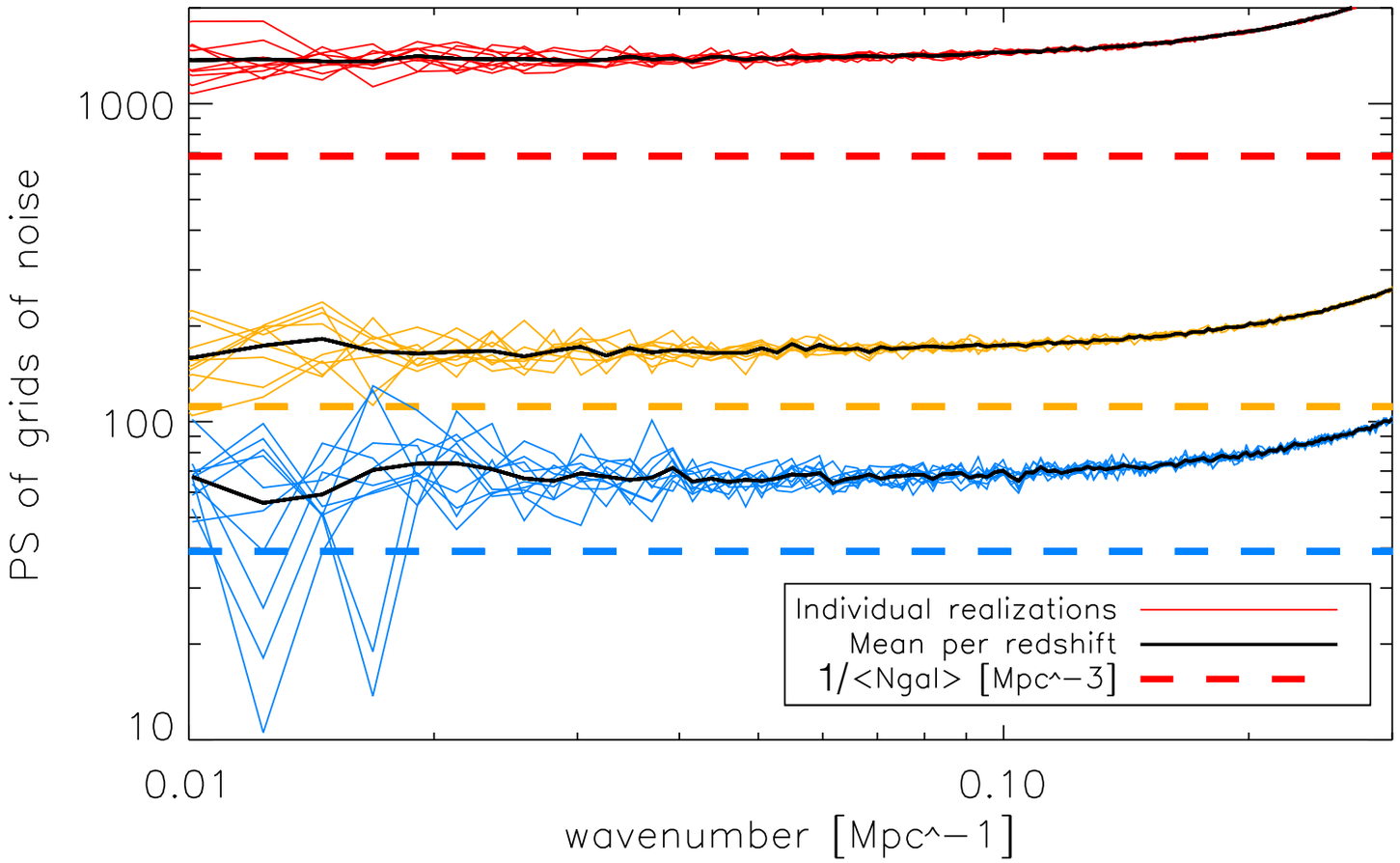
Dispersion of the reference spectra

- 5x10 spectra for reference / redshift
- Cosmic variance not negligible at BAO scale @z=0.5
- Shot-noise starts to dominate juste after the BAO scale @z=1.5

central redshift	mean redshift	redshift range	width, thickness [$n_{\rm cell}$]	volume [Gpc^3] $1 \rightarrow 5$ grids	$N_{\rm gal}$ with spectroZ [10^6]	$< N_{\rm gal} >$ spectroZ [cell^{-1}]	$N_{\rm gal}$ with BDT 90% [10^6]	$< N_{\rm gal} >$ BDT 90% [cell^{-1}]	$N_{\rm gal}$ with BDT 80% [10^6]	$< N_{\rm gal} >$ BDT 80% [cell^{-1}]
0.5	0.51	0.36-0.68	120, 125	$0.9 \rightarrow 4.6$	23.6	13.1	21.1	11.7	18.5	10.3
0.9	0.93	0.72-1.19	225, 125	$3.2 \rightarrow 16.2$	29.1	4.60	28.5	4.50	26.7	4.22
1.5	1.57	1.16-2.12	320, 175	$9.2 \rightarrow 45.9$	13.5	0.75	11.9	0.66	9.7	0.54

BAO scale and errors

Shot-noise: from grids filled by Poisson distribution or theoretical expectation ?



- theoretical value significantly lower the PS of the shot-noise grids
- very noisy at low scales, low z

—> includes cosmic variance
—> rises above k~0.1 (8 Mpc-cell size impact)

==> use of theoretical shot noise

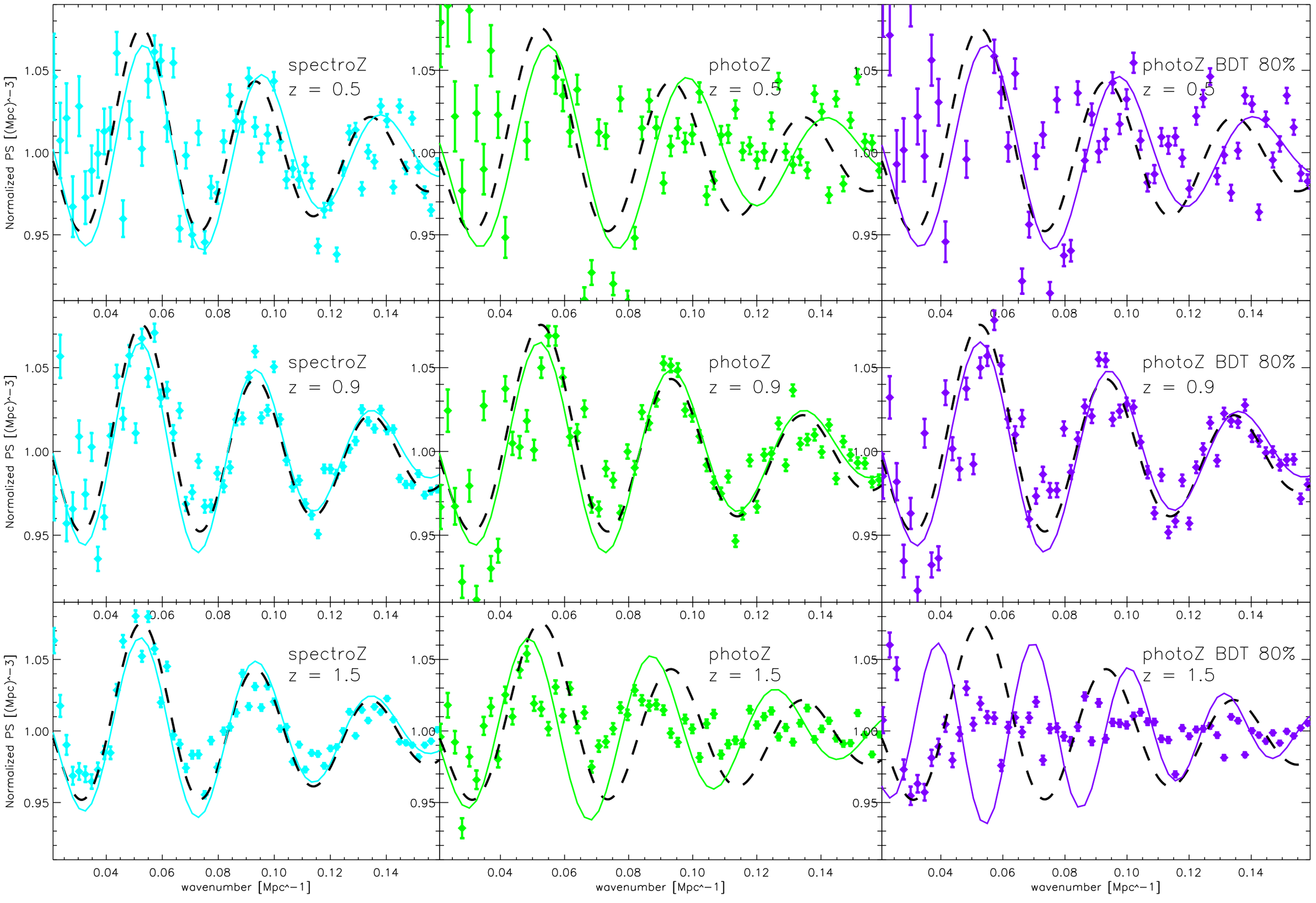
sigma_P(k) = C/k * (($P_{BAO}(k)$ - P_{SN}) + P_{SN}) / ($P_{noBAO}(k)$ - P_{SN}))

P_osc(k) = ($P_{BAO}(k)$ - P_{SN}) / ($P_{noBAO}(k)$ - P_{SN}))

$$C/k = \frac{2\pi \times c}{k\sqrt{V\delta_k}}$$

$$c = d^2 \times P_{\text{raw cells}}/P_{\text{cut cells}}$$ ·—> c ~ 1

Ratio “observation” / mean reference



1-parameter fit: only BAO scale (TBD Stéphane’s improved function)
really nice @ z=0.9 !

Current results

spectroZ

iz = 0.5 s = 147.1 ± 1.5 iz = 0.9 s = 150.6 ± 0.8 iz = 1.5 s = 150.6 ± 1.0

photoZ

iz = 0.5 s = 143.0 ± 2.5 iz = 0.9 s = 150.6 ± 1.4 iz = 1.5 s = 161.6 ± 1.2

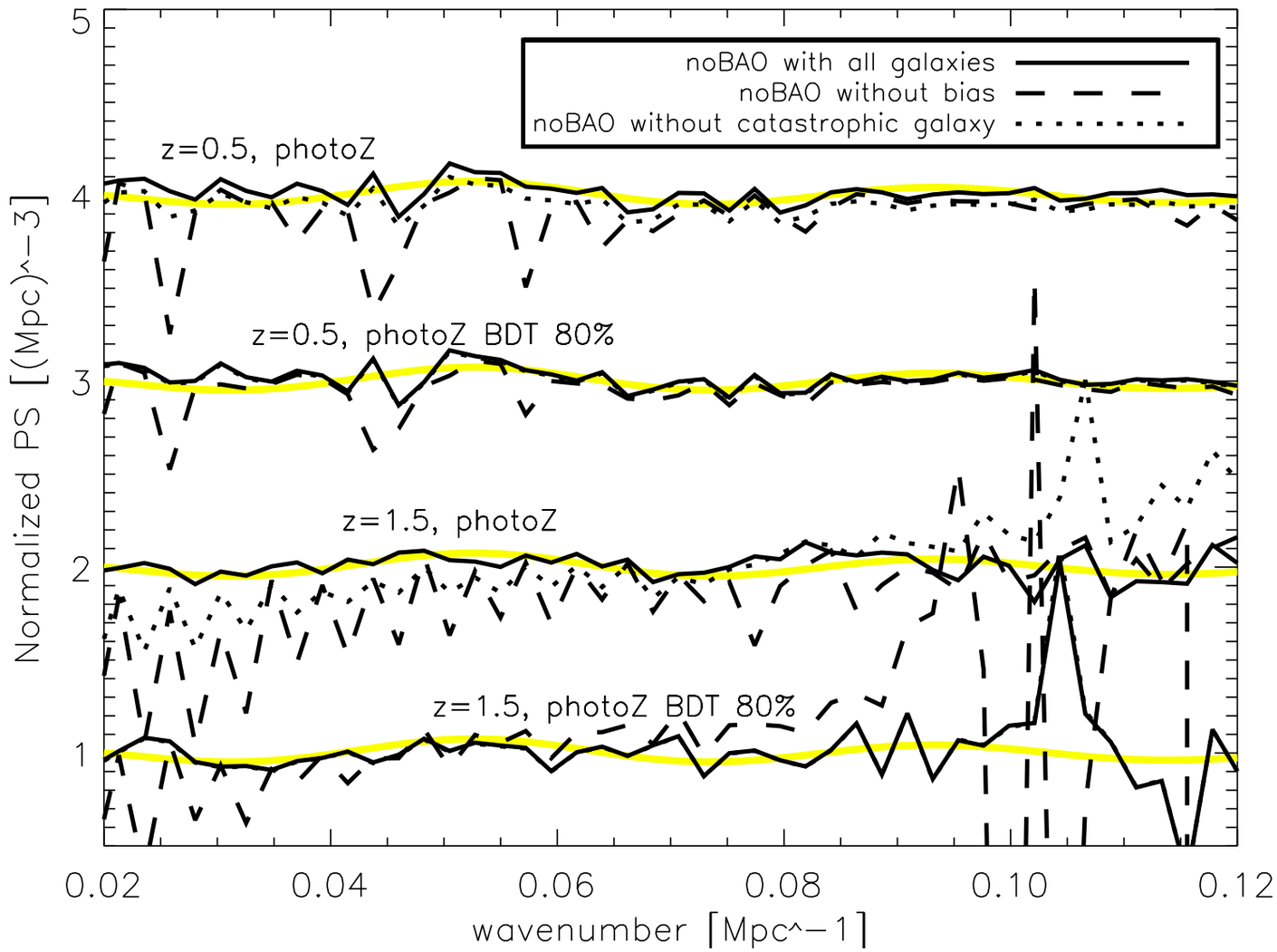
photoZ BDT 80%

iz = 0.5 s = 144.3 ± 2.4 iz = 0.9 s = 149.2 ± 0.8 iz = 1.5 s = 202.6 ± 1.3

Work in progress

- reasonable in spectroZ
- nice @ z=0.9
- still not very good (!) @ z=0.5 & z=1.5 in photoZ

If the reference (without BAO) is computed without taking properly into account bias or catastrophic galaxies, it impacts the results
—> way to check photoZ properties



This paper

- add plot + text to explain the galaxy density wrt the Science book (if we are totally confident)
- try improved fit to better recover BAO scale with photoZ (but spectra noisy …)
- (variance cosmic using simulations: grid shape)
- write the conclusion !

Future

- Improvement of the cosmological simulation (first step) to allow use of CAMEL as last step
- Use of spherical power spectrum to use shell instead of grids —> lower cosmic variance, more galaxies, much better conceptually
- more realistic: masks, stars impact
- use of the “full” spectrum (not only BAO scale)