Photo-z

R. Ansari, S. Arnouts, G. Blanc, V. Bonillo, A. Choyer, J. Cohen Tanugi, S. Dagoret-Campagne, E. Giraud, O. Ilbert, E. Nuss, M. Moniez, F. Habibi, C. Renault, C. Roucelle, JSR

LSST-France June 2016

Photo-z is the key to LSST Science Goals

Strong specs : bias < 0.003, RMS < 0.05

Bring the community together

Topics : requirements, DESC/DES, spectroscopy, simulations, emission lines / SEDs, methods

Many experts : new interactions started

DESC RoadMap

- PZ1: Photo-z Testbed p(z) and Incompleteness
- PZ2: Tests of photo-z cross-correlation calibration
- PZ3: Photometric redshift infrastructure development
- PZ4: Develop infrastructure for spectroscopic redshift training sets

PZ1 to be delivered in 2016, PZ2-PZ4 -> 2017-2018

PZ1 = simulated catalog with incompleteness

SEDs + Sim (cosmo+errors) -> catalog -> PZ

- Generate parameterized form of continuous SEDs
- Assign SEDs to galaxies in input Sims catalog
- Finalize creation of dataset PZColor (with LSS group)
- Generate parameterized em. line model, add to SEDs.
  Generate new galaxy colors and errors for photo-z code tests
- Create training, validation, and test datasets
- Compare / combine different pz codes

1) Sandbox (DC1) to improve PZ codes
2) Study the impact (correction) of incompleteness
- in colors (SEDs, extinction, em-lines, mis-calibration …)
- in training (zs)

PZ3 ≡ PZ infrastructure development

Improved photo-z catalog for DC2 (DC3)

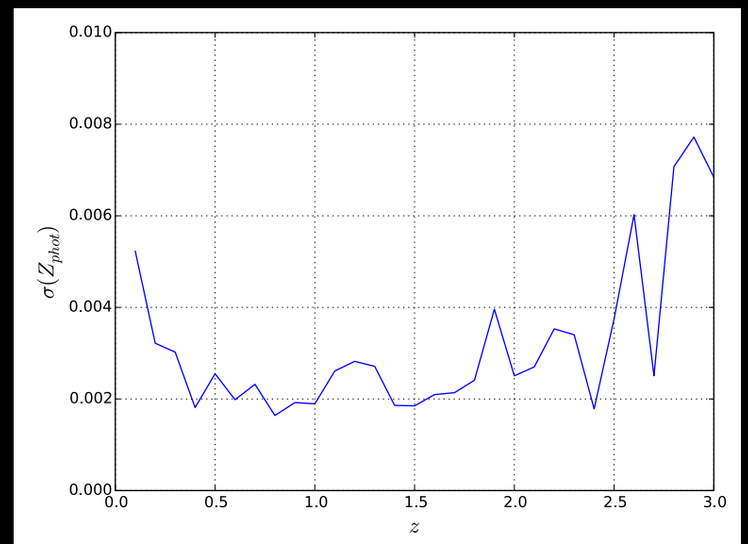
- DC2 Mock Lightcone for photo-z computation
- Provide training, validation, and test data sets for use with multiple photo-z codes
- Determine storage format for p(z)
- Develop catastrophic outlier id/rejection algorithms
- Provide p(z) estimates (including combinations of multiple algorithms) for DC2 catalog

French activities

- Simulation : LAL LPSC -> LSST-like galaxies catalog (DC0)

- Home made TF PZ code developed in LPSC
  —> intended to disappear since LePhare has been recoded in C++

- Photo-z and calibration : LPSC - LPNHE
  see A. Choyer thesis concerning the impact
  of LSST (mis)calibration on pz performances
  + megacam calibration parameters covariance
  => requirements on calibration (PC1)



- Catalogs : APC reprocessing of CFHTLens x spectra surveys to
  obtain large spectro-photo catalog for pz tests

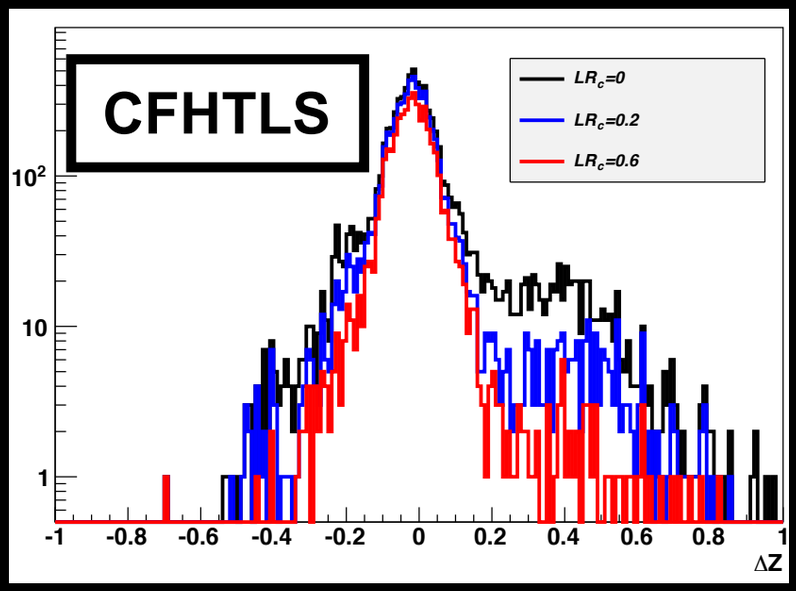
- Galaxy / Star separation : LAL see Farhang's talk

- Extinction laws : LPSC see Vincent's talk

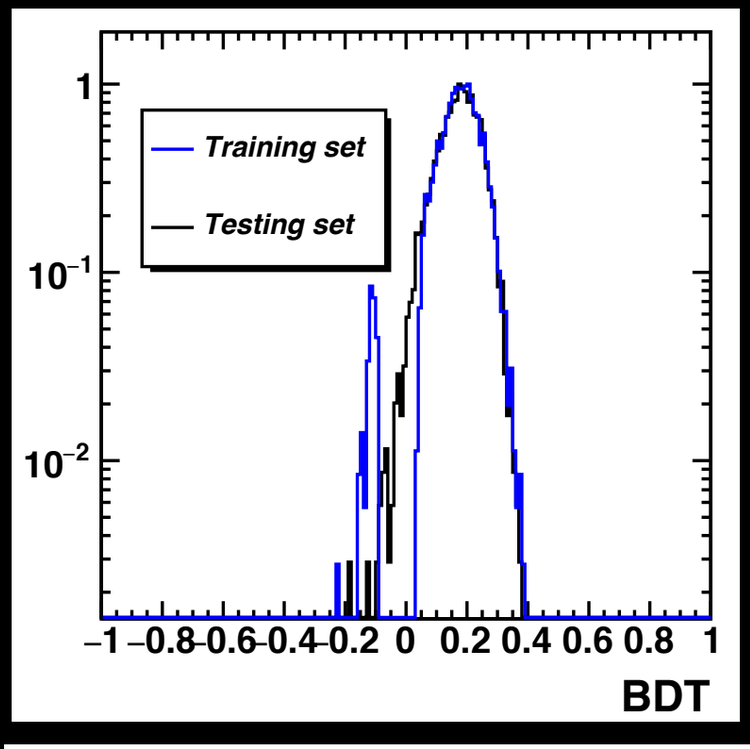
French activities

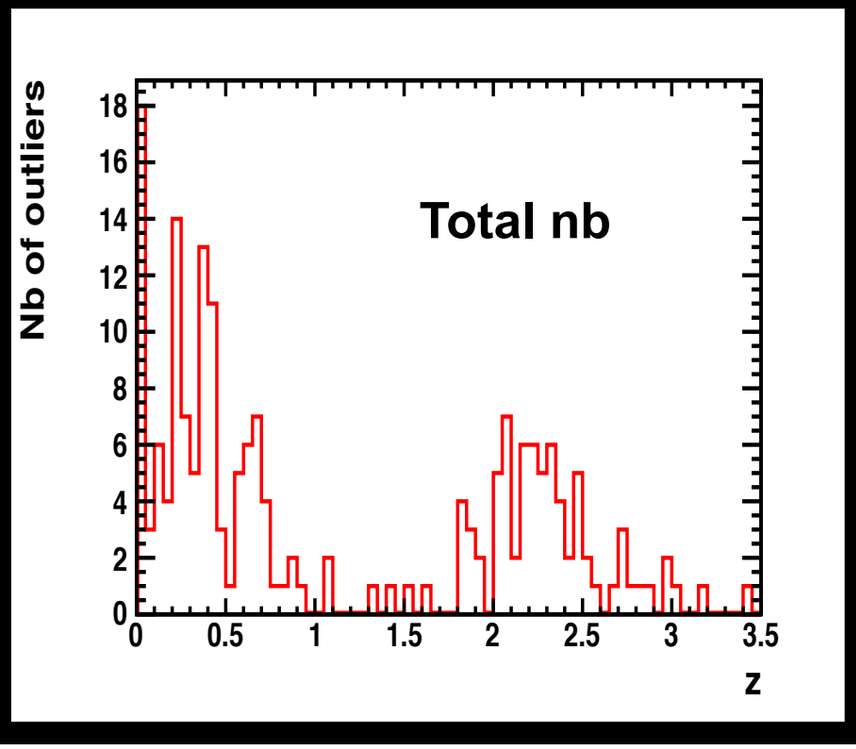
- ★ Outliers rejection : LPSC LR/BDT quality tool

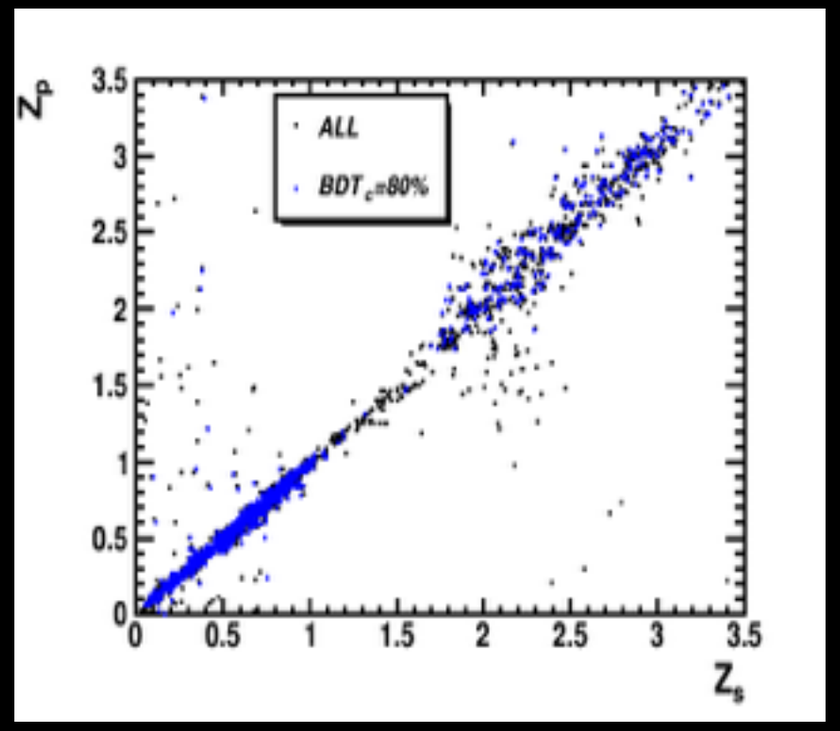
Gorecki et al 2013



Tested on COSMOS - Lephare PDF(z)
(marginalized PDF only for z, no PDF(T), PDF(ebv))







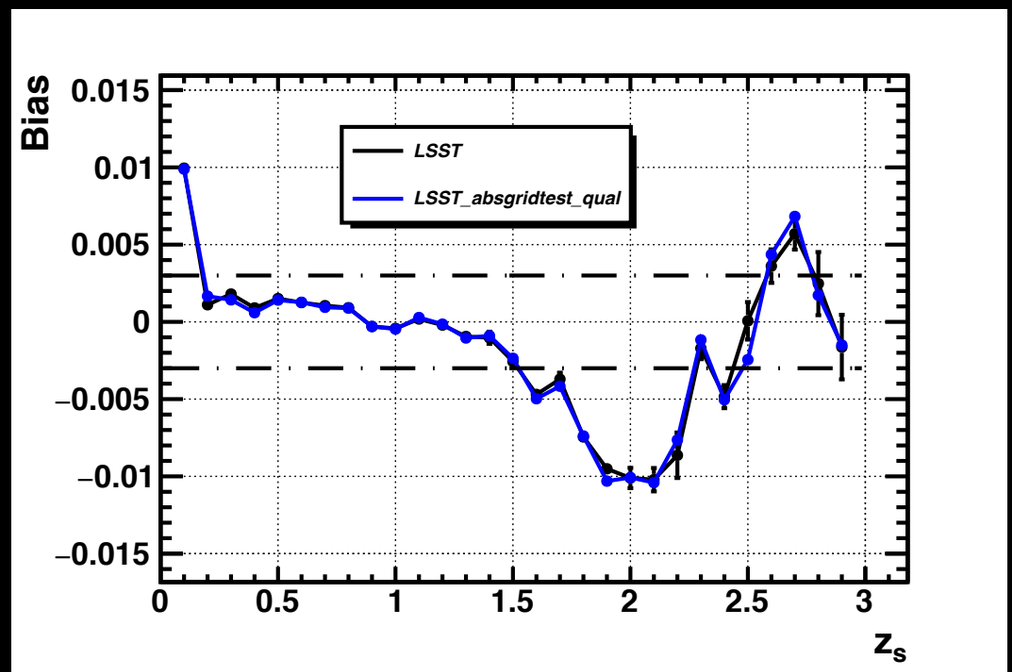
Not enough stats -> we may train it with simulations (see Gorecki et al)

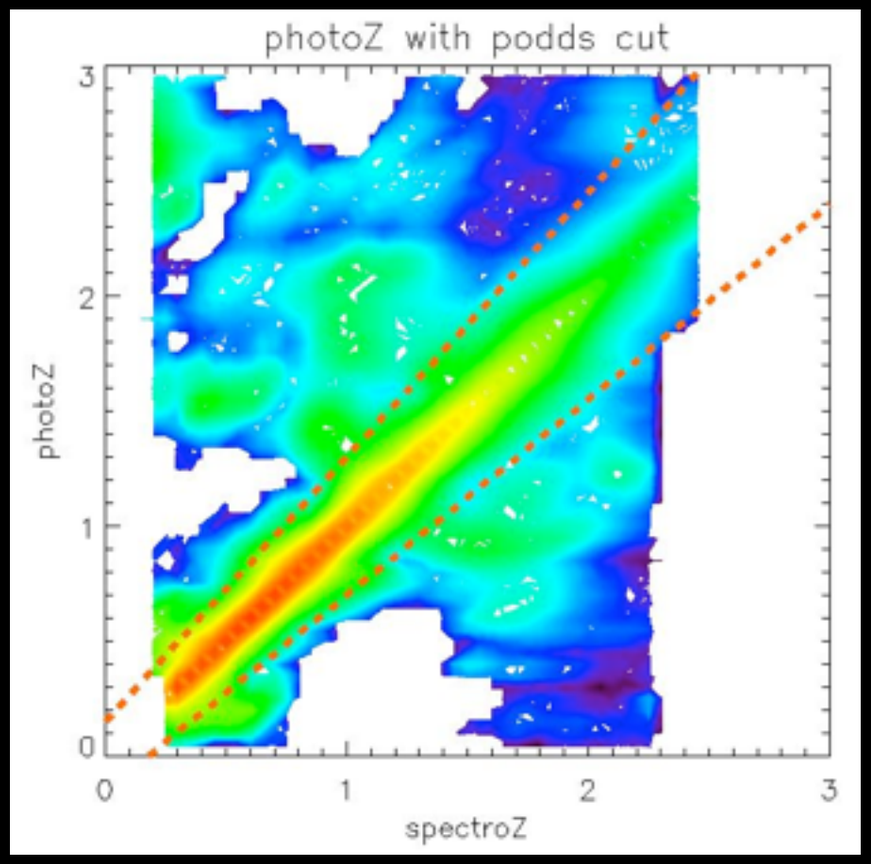
French activities

- Fast PZ tool : LPSC - LUPM development of a python tool that can QUICKLY compute random pz from PDF(pz I z, t, mag)
  (method) Already used in BAO analysis chain

CPU for 10^7 galaxies :
- true PZ ~ 1 day x 200 jobs
- fast PZ ~ 1 sec

Performances are unchanged





pz in BAO analysis

Already under test by Anze Slosar (LSS)
Stats issues in some bins -> reprocessing
To be shared / maintained in DESC WG

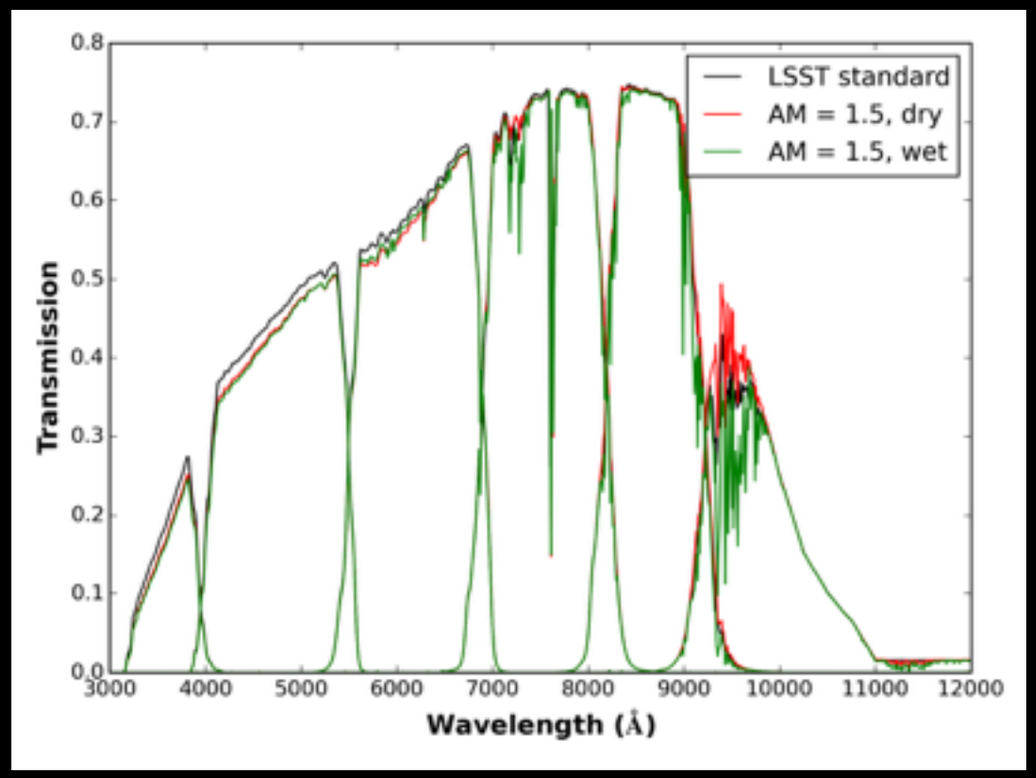
French activities

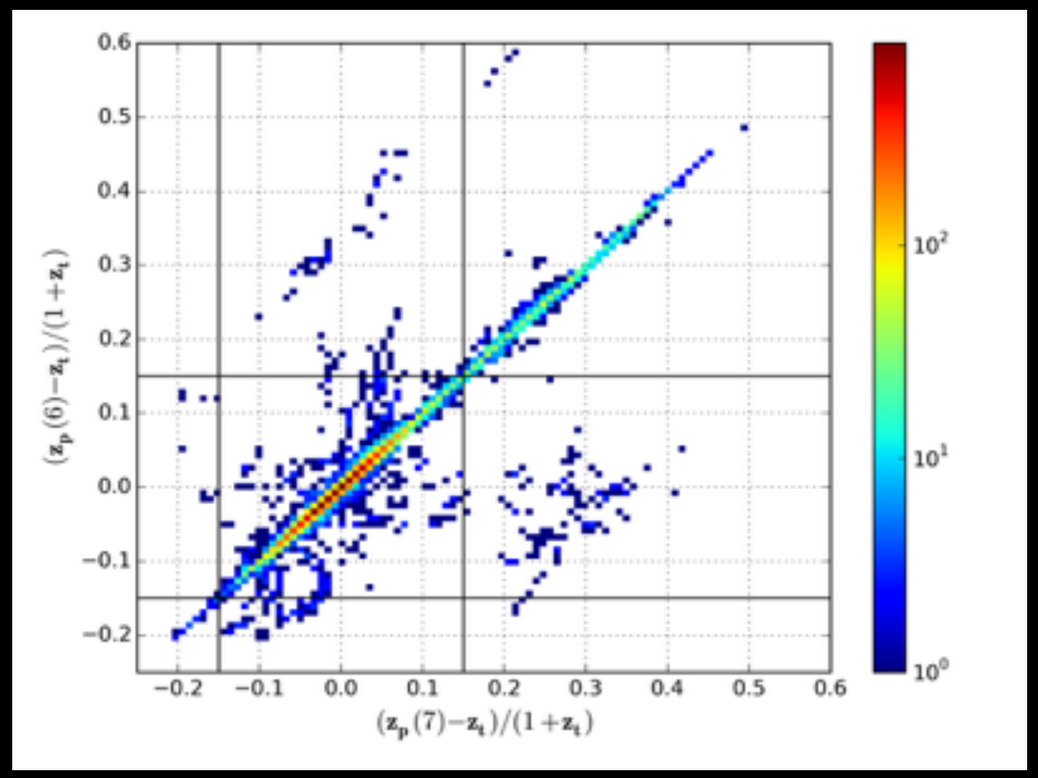
- Atmosphere : LAL impact of atmosphere on photo-z

Simulated catalog with Brown SEDs for $z = 0.3$ to 1.5

Two sets of filters: *ugrizy* with a standard US atmosphere and *ugrizy*^{wet}*y*^{dry}
Nvis(*y*^{wet}) = Nivis(*y*^{dry}) *= 0.5 Nvis(y)*

PZ computed with Lephare





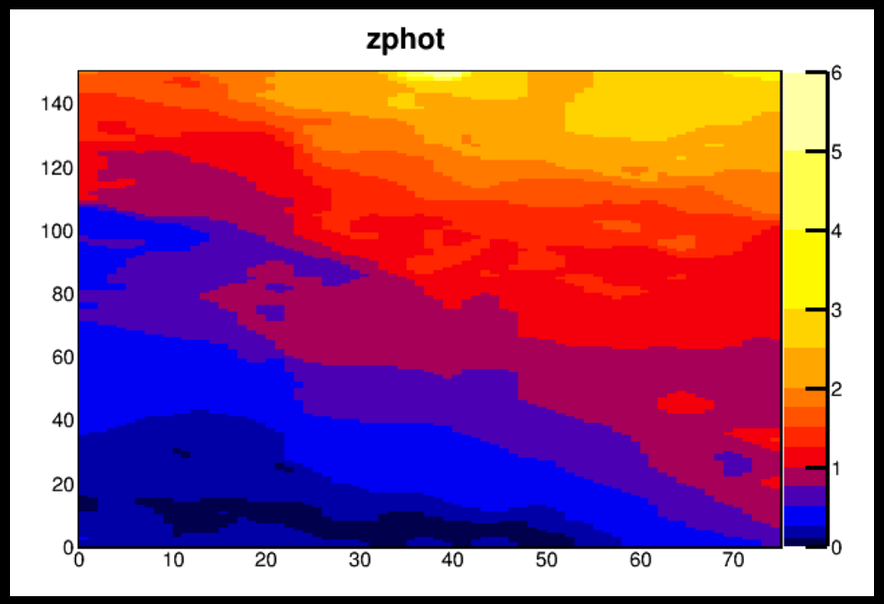
~ 10% of outliers have different photo-z in both filter sets
-> they could be tagged

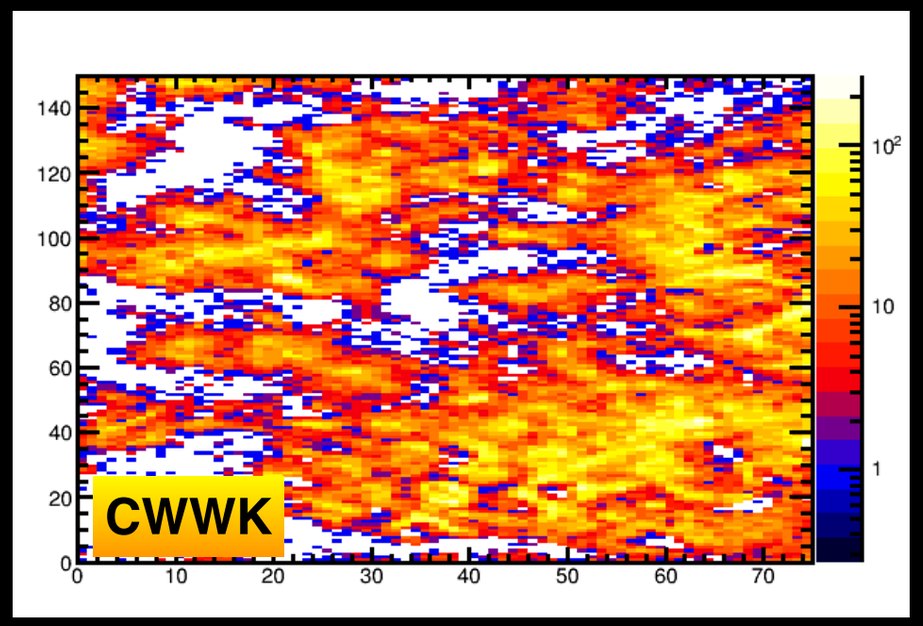
Next step: have a look on the u-side with the aerosols

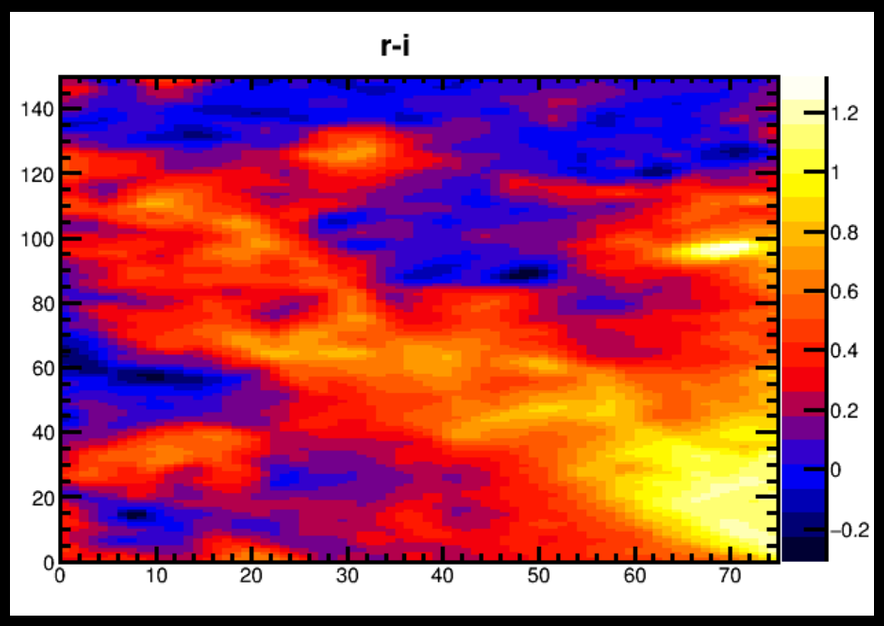
French activities

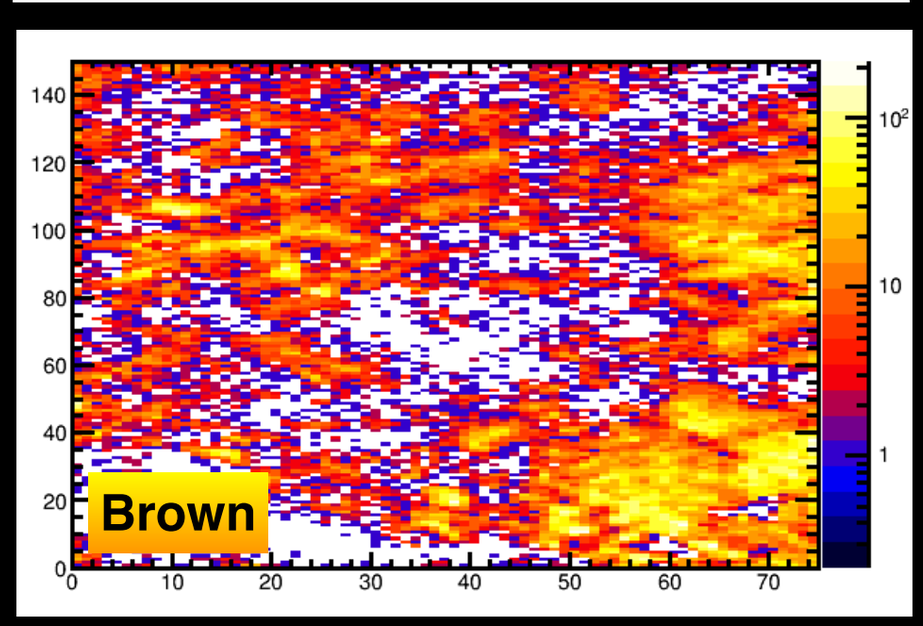
- SEDs : LPSC using SOMs to (un)validate a given SED library on a particular data set, first tentative on COSMOS-LSST data (lephare pz templates extrapolated in LSST ugrizy)

SOM **BMU**









Preliminary study

Helpful to point a lack of SEDs

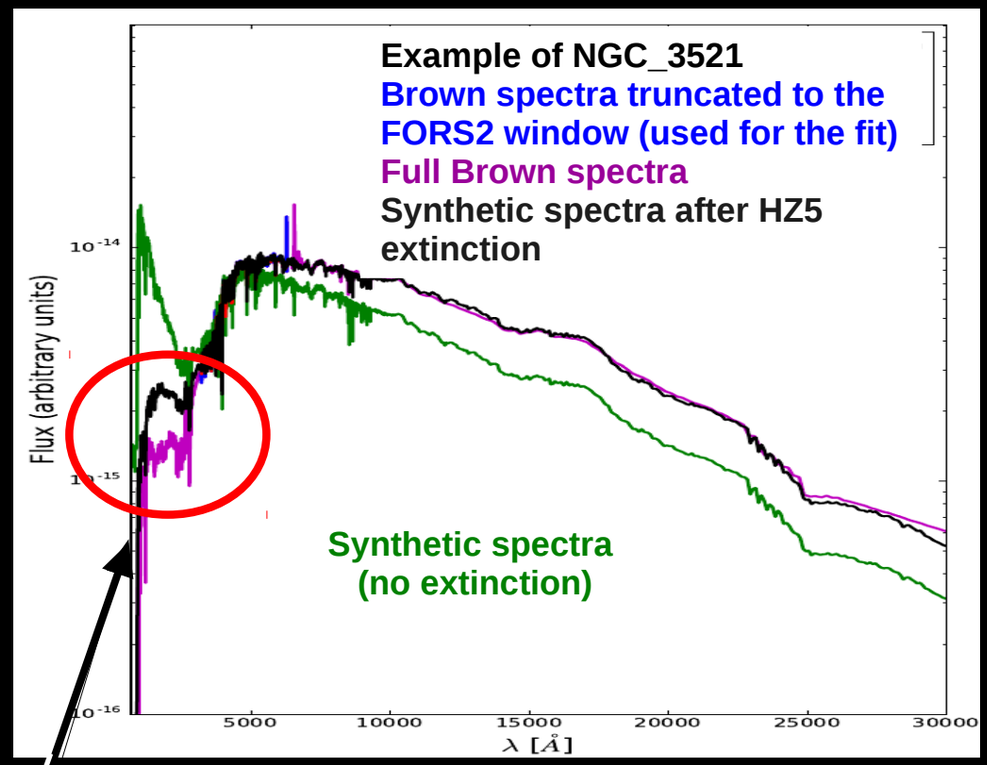
French activities

- SEDs : LUPM development of Fors2 based SED library

1/ Methodology :

Stellar mixing and synthetic spectra derived from fit on physical spectra using evolutionary stellar population models

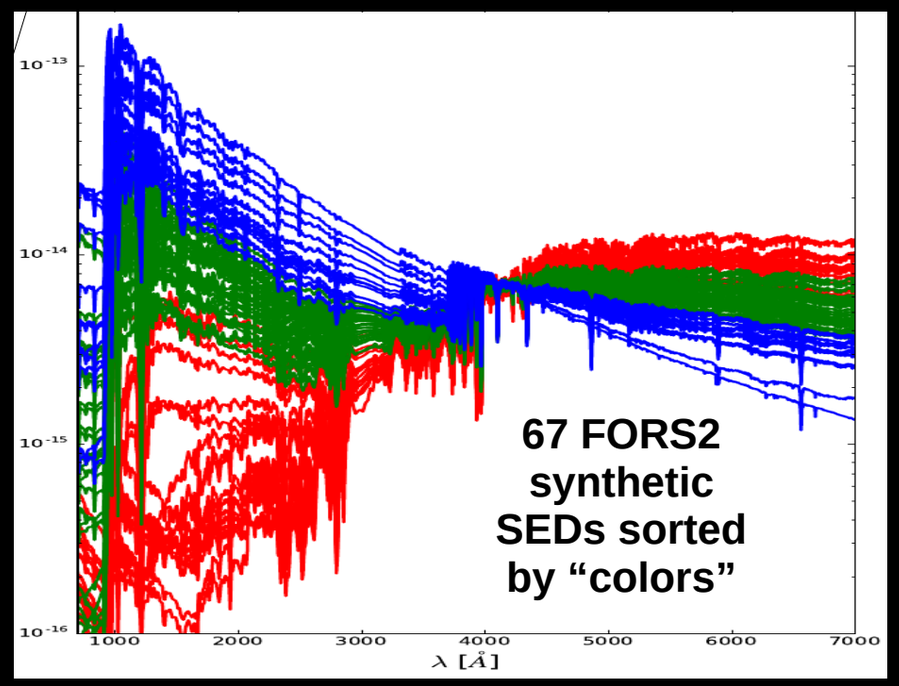
Resulting spectra extrapolated to 700 Å < lambda < 100000 Å



2/ Proof of concept using Brown (physical) spectra :

Restricting the fit to the FORS2 rest frame window (3000Å< lambda <6000Å)

→ most of the 129 Brown spectra are well reconstructed, UV contribution is overestimated for some spectra (still under study)



3/ Same procedure applied to FOR2 dataset :

→ 67 averaged spectra used as new SED templates

Fors2 PZ performances

SED libraries :

- 66 “CWW” SED
- 129 Brown SEDs (z<0.05)
- 67 FORS2 SEDs (0.275<z<1.05)

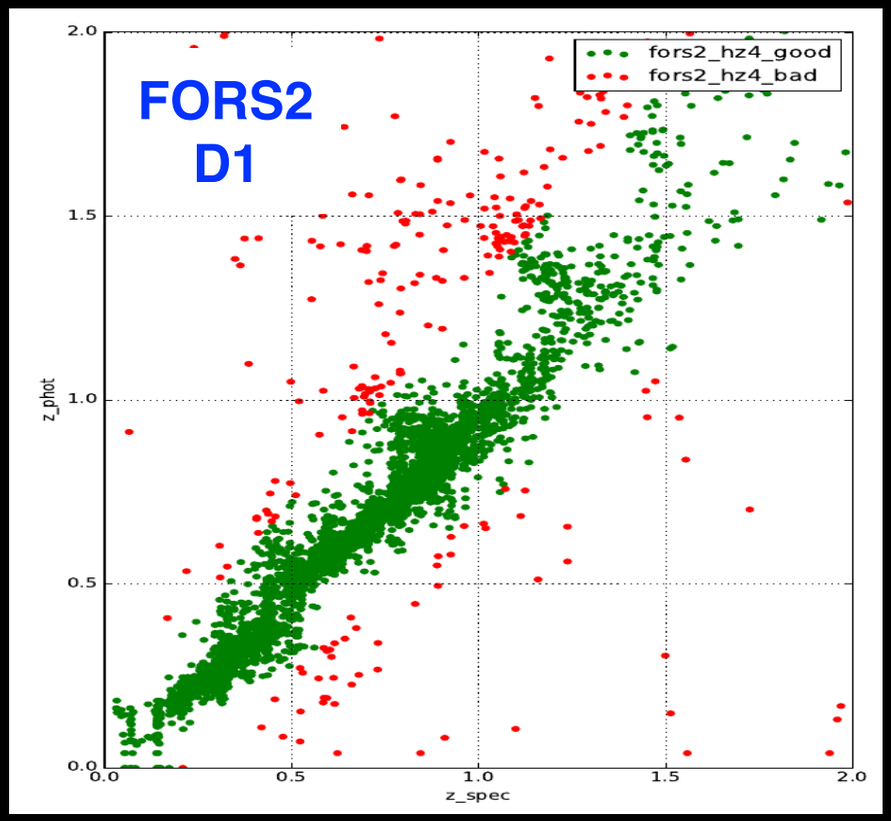
Code PZ : Lephare

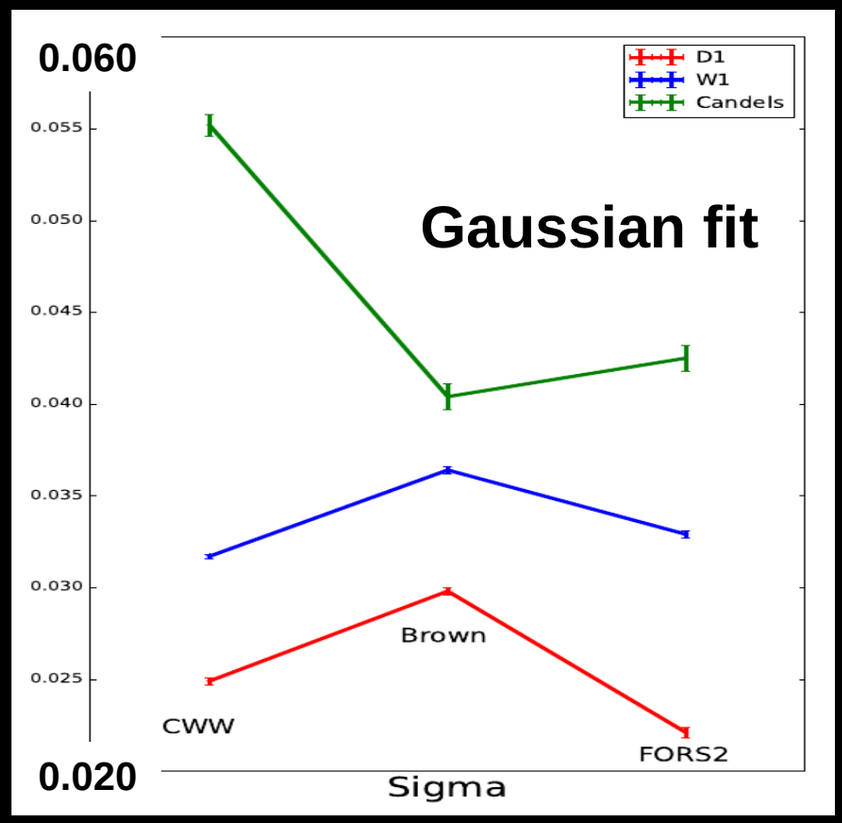
Catalogs

CFHTLS (U,G,R,I,Z)

- D1 0<z<6 4663 objects
- W1 0<z<2 19594 objects
- W4, 8933 objects

Candels GOODS (HST)
U, f435w, f606w, f775w, f850lp, f125w, f160w, Ks
0<z<5 1068 objects





FORS2 library is very competitive, though not yet optimized

Short term priorities

- PZ - calibration requirements (PC1)
- Finalize / maintain fast pz code
- Atmospheric effect (u-y bands) on pz
- Star - galaxy separation
- Fors2 SEDs library

Discussion

French contributions

DESC SRM

- SEDs library & extinction treatment
- Calibration impact on pz
- BDT outliers removal
- Combination ML/TF

- **PZ1 : Development of a simulated catalog to test photo-z - DC1**
- **PZ2: Tests of photo-z cross-correlation calibration**
- **PZ3: P(z) combination / outliers removal - DC2 DC3**
- **PZ4: Develop infrastructure for spectroscopic redshift training sets**

Additional contributions

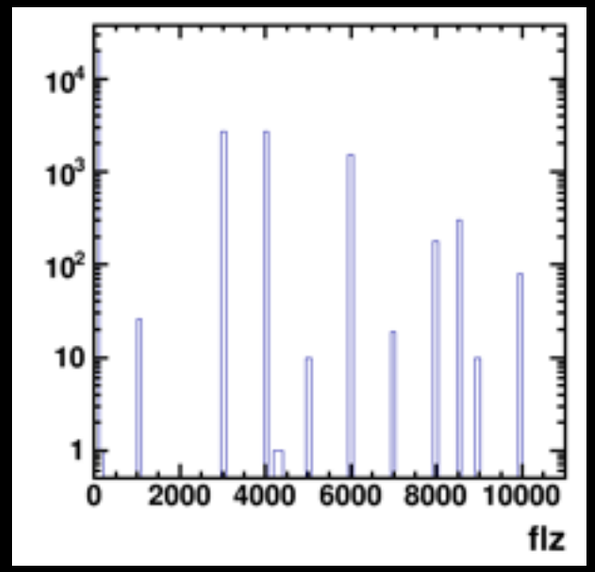
Clusters pz
* Weighing the f_gas clusters (CFHT)
* CFHTLS reprocessing

back-up slides

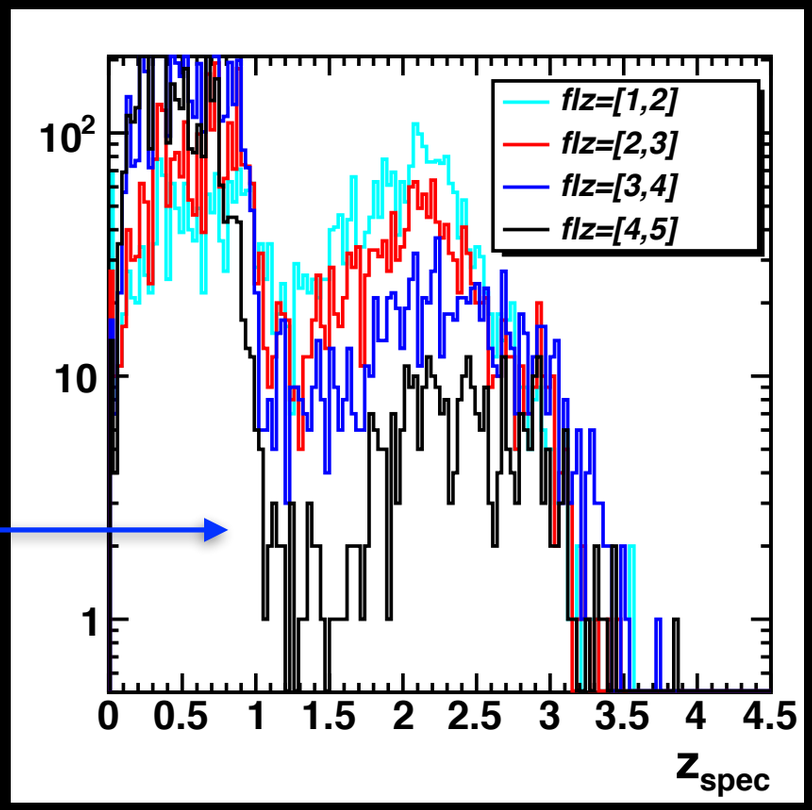
COSMOS spectroscopic catalog

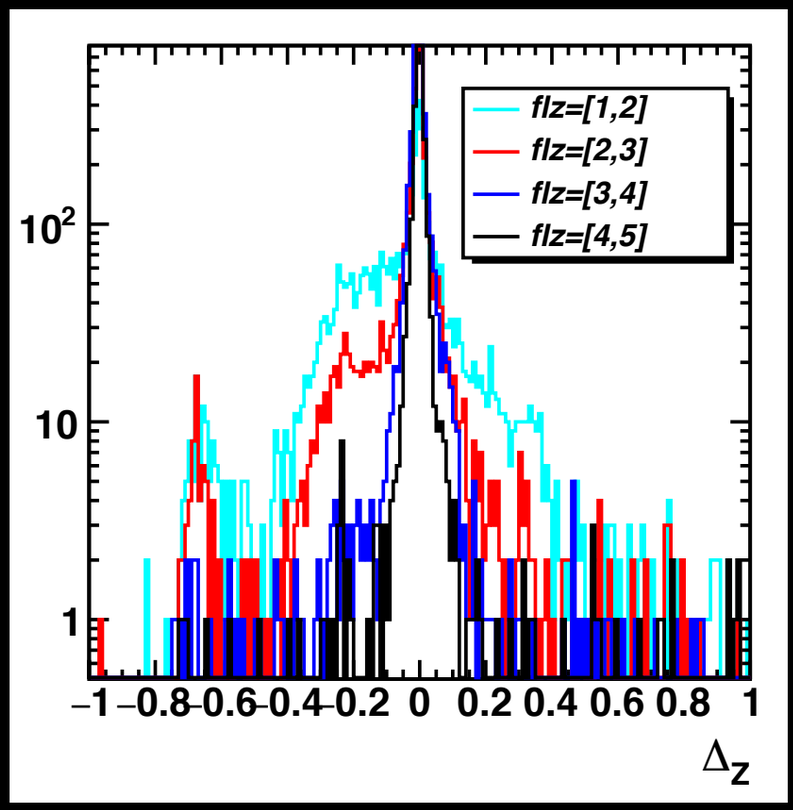
zflag	Objets	Outliers
All	27419	3536
flz=[1,2[	3931	1368
flz=[2,3[	4077	509
flz=[3, 4[	6364	115
flz=[4,5[	4115	60
flz=[3,5[	10479	175

Good zspec for flz=[3,5]

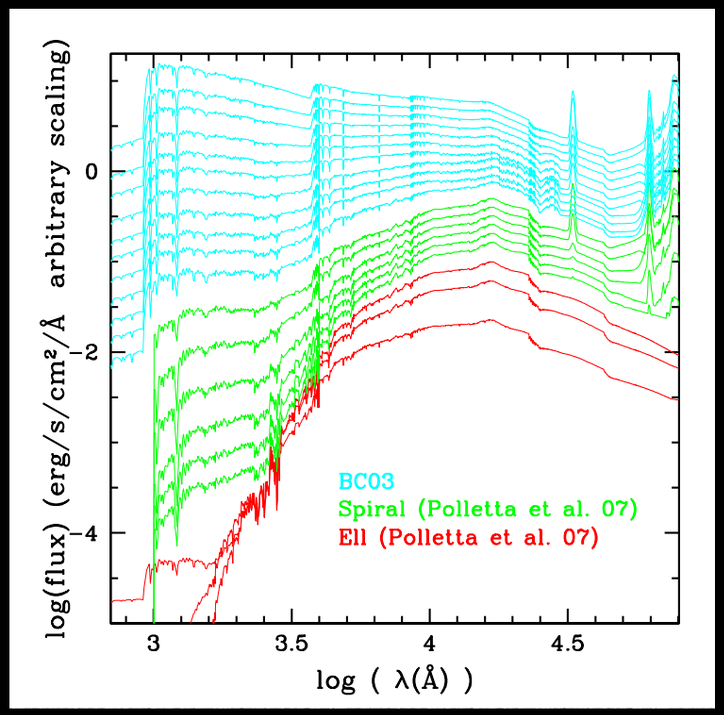


Very low stats
for z=[1,1.8]





LePhare



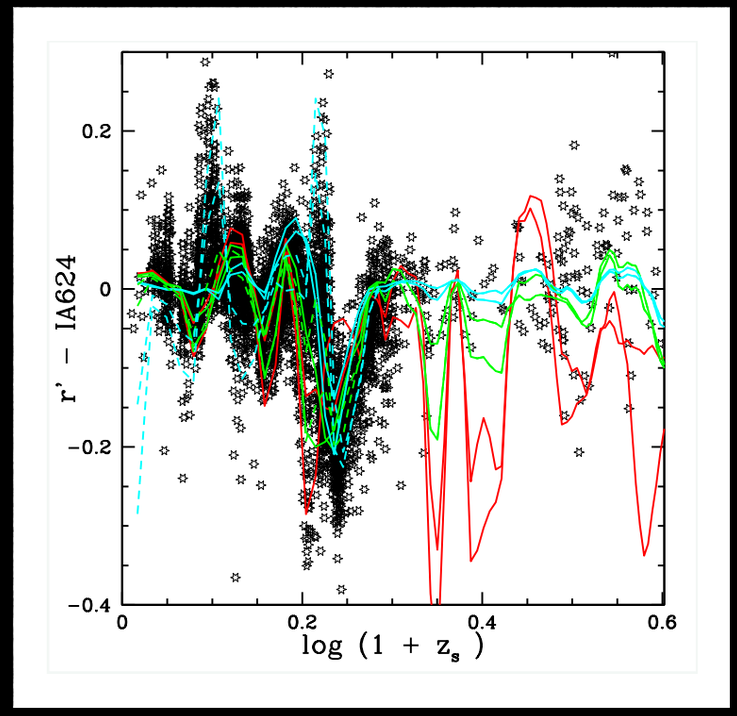
21 SEDs

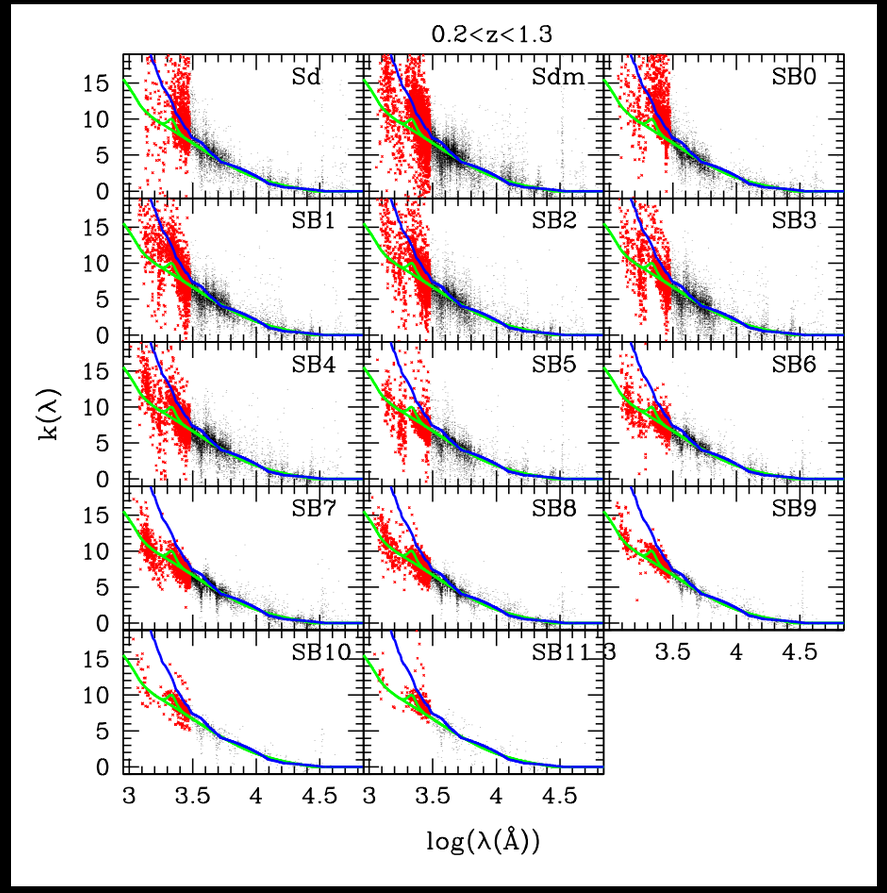
Emission lines

Kennicut 1998

$$log(F_{[\mathrm{OII}]}) = -0.4 \times M_{\mathrm{UV}} + 10.65 - \frac{DM(z)}{2.5}$$

OIII, Hb, Ha, Lya from OII

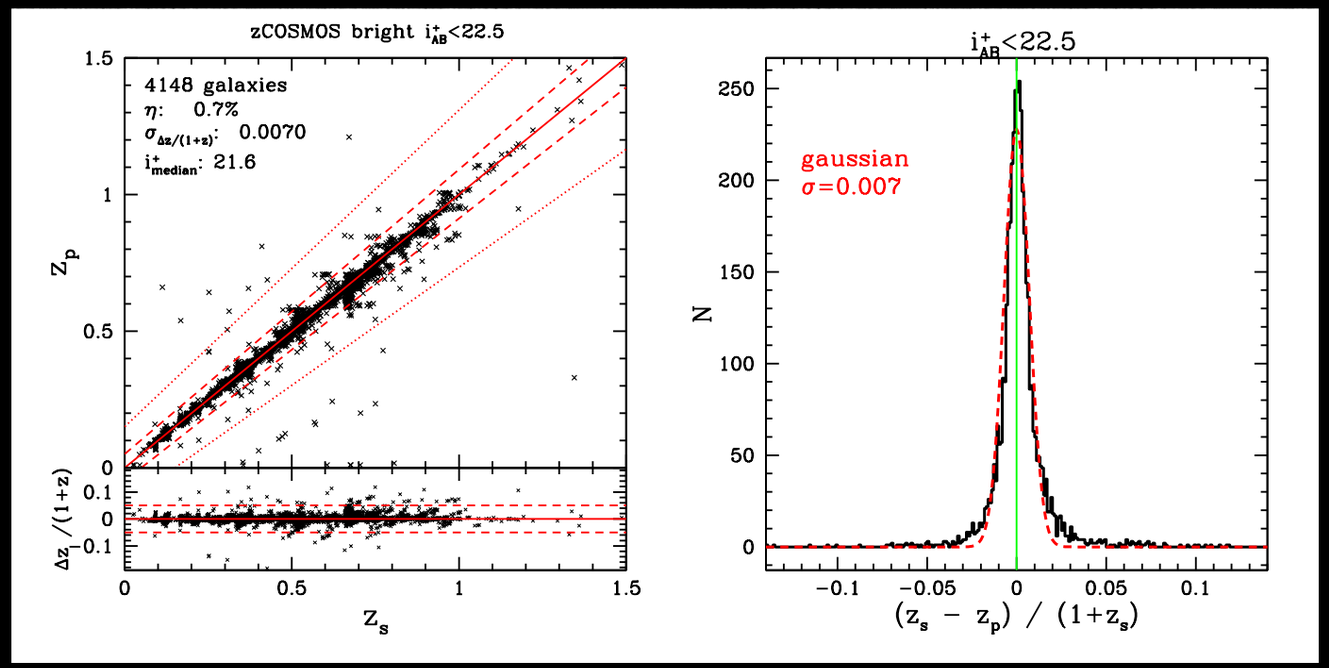


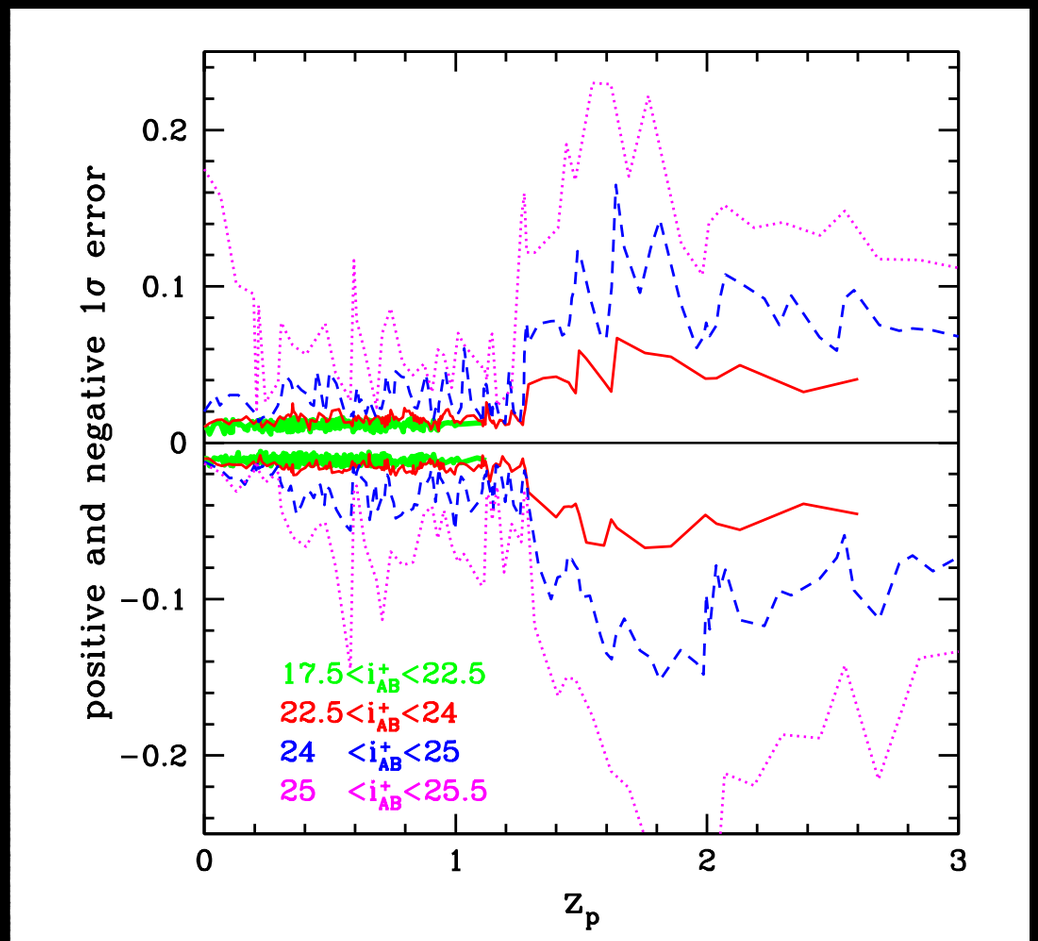


3 extinction models :

- LePrevot et al if redder than SB3
- Calzetti et al (+ 2175A° UV bump) if bluer

LePhare performances on COSMOS





PZ1 short term tasks (2016) in DESC Roadmap

SEDs + Sim (cosmo+calib) -> catalog -> PZ

- Generate parameterized form of continuous SEDs
- Assign SEDs to galaxies in input Sims catalog
- Finalize creation of dataset PZColor (with SS group)
- Generate parameterized em. line model, add to SEDs.
  Generate new galaxy colors and errors for photo-z code tests
- Solicit updated photo-z requirements from WGs
- Create training, validation, and test datasets
- Select codes to be used in photo-z tests
- Assess how the output p(z) from each code relates to the true distribution of galaxy redshifts (pz uncertainties)
- Determine storage format for p(z)
- Compile best p(z) estimates and deliver summary p(z) statistics