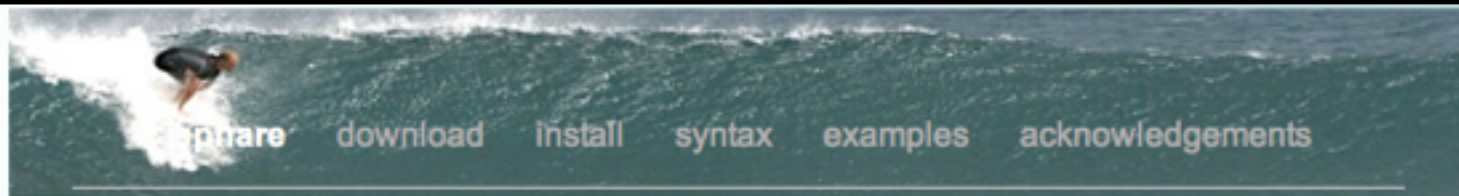


Photometric redshifts for LSST

Stephane Arnouts et Olivier Ilbert



LE PHARE

PHotometric Analysis for Redshift Estimations
Stephane ARNOUITS & Olivier ILBERT

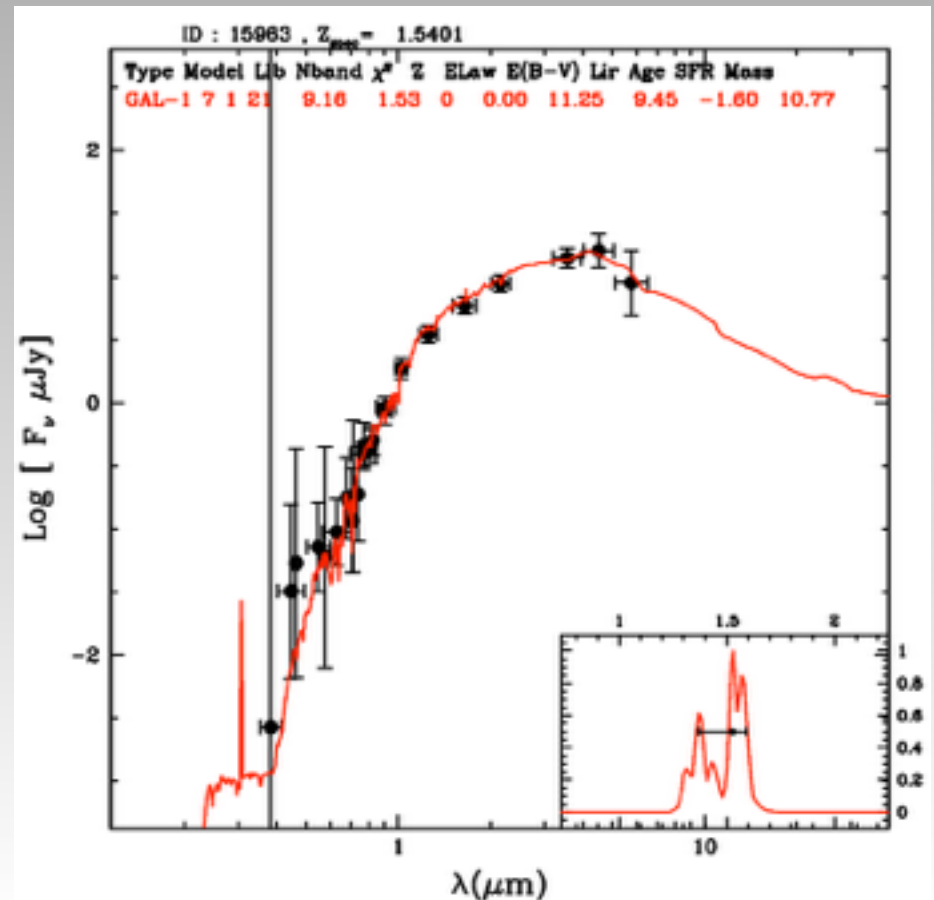
<http://www.cfht.hawaii.edu/~arnouts/LEPHARE/>

Public code in fortran

Template-fitting algorithm

Continuously evolved in the last 10 years

New version in c++
in development. Testing phase.



Basic concept

SED
(Galaxies/Stars/AGN)
+
Dust attenuation
+
IGM
+
redshift
+
Telescope/instrument/
Filters

Theoretical flux

observed flux
and error

$$\chi^2(z, T, A) = \sum_{f=1}^{N_f} \left(\frac{F_{\text{obs}}^f - A \times F_{\text{pred}}^f(z, T)}{\sigma_{\text{obs}}^f} \right)^2$$

Outputs

Redshift and physical parameters:
values and associated uncertainties + PDF

Important aspects of the method

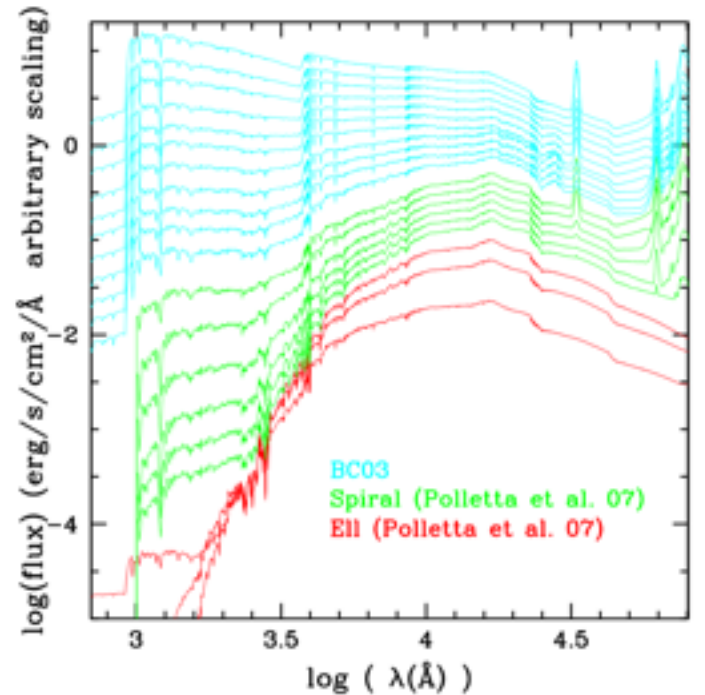
- Adapt the absolute photometric calibration based on a spec-z sample

$$\psi^2 = \sum_{i=1}^{i=N_{gal}} \left(\sum_{f=1}^{N_f} \left(\frac{A_i \times F_{pred,i}^f \times 10^{-0.4s^f} - F_{obs,i}^f}{\sigma_{obs,i}^f} \right)^2 \right)$$

Important aspects of the method

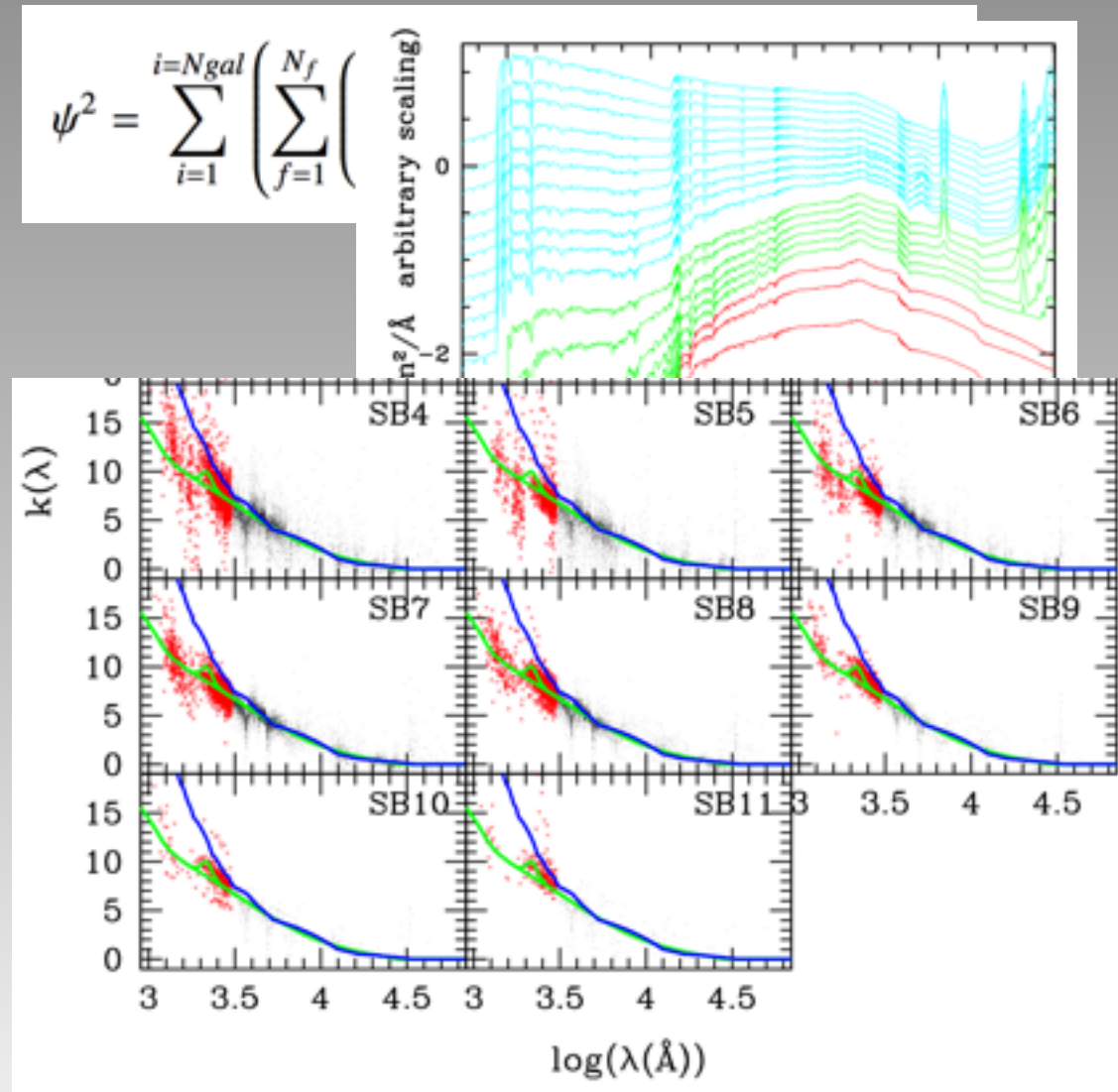
- Adapt the absolute photometric calibration based on a spec-z sample
- Several SED libraries available (synthetic as BC03 or Pegase, empirical as tuned CWW)

$$\psi^2 = \sum_{i=1}^{i=N_{gal}} \left(\sum_{f=1}^{N_f} \left(\right. \right.$$



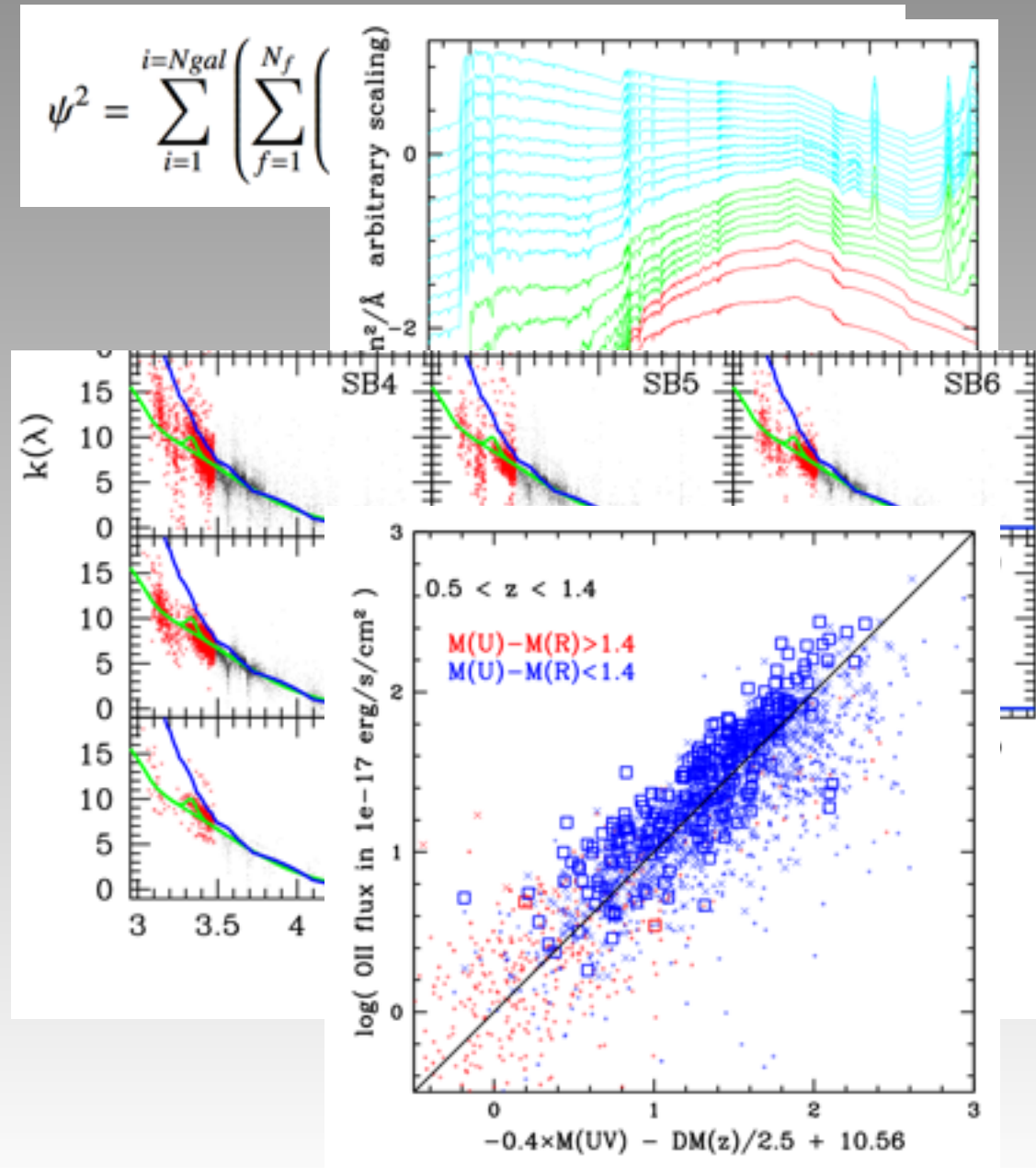
Important aspects of the method

- Adapt the absolute photometric calibration based on a spec-z sample
- Several SED libraries available (synthetic as BC03 or Pegase, empirical as tuned CWW)
- Work on dust attenuation curves including several slopes and the bump at 2175Å



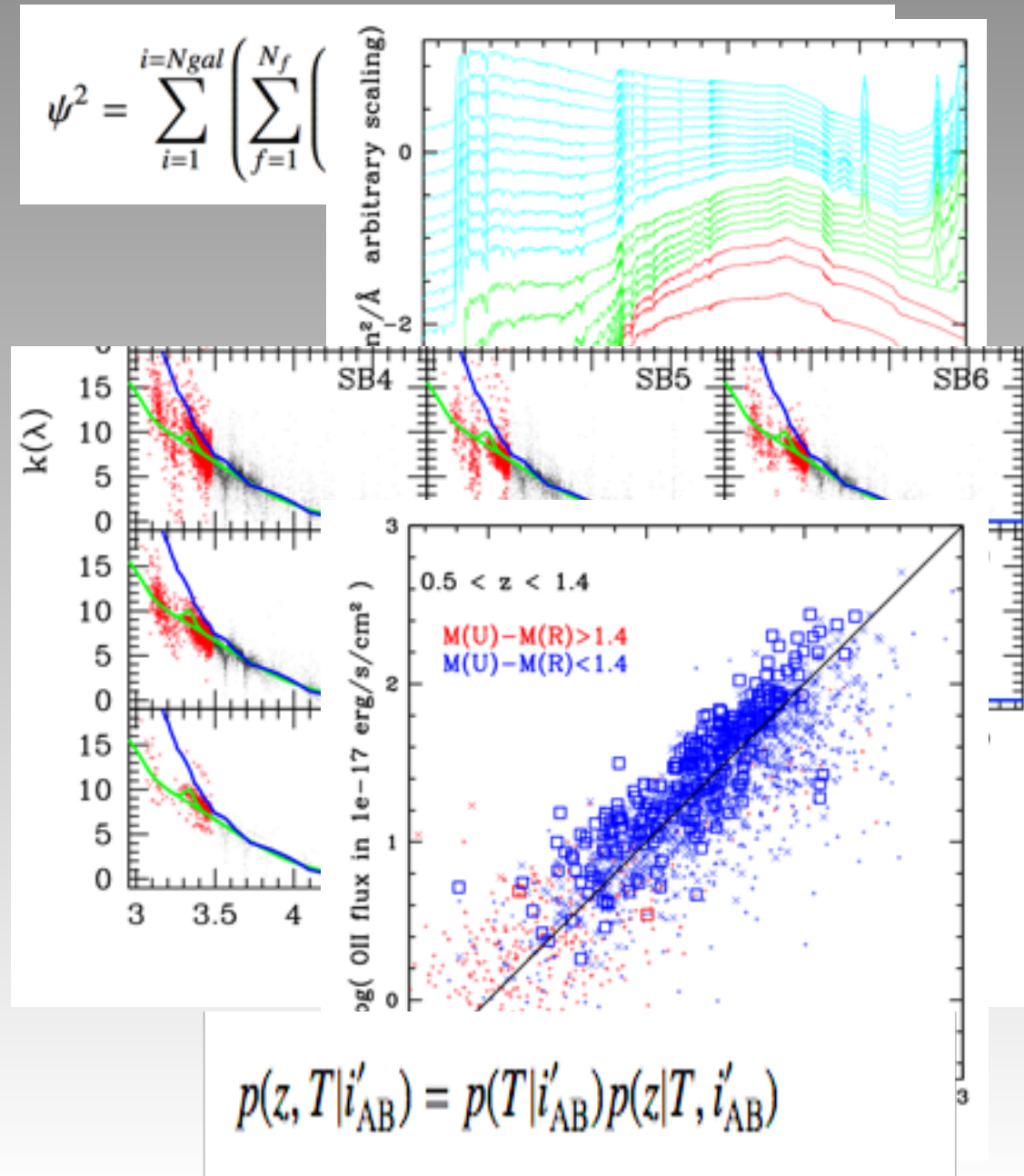
Important aspects of the method

- Adapt the absolute photometric calibration based on a spec-z sample
- Several SED libraries available (synthetic as BC03 or Pegase, empirical as tuned CWW)
- Work on dust attenuation curves including several slopes and the bump at 2175Å
- Work on emission lines based on Kennicutt empirical relations

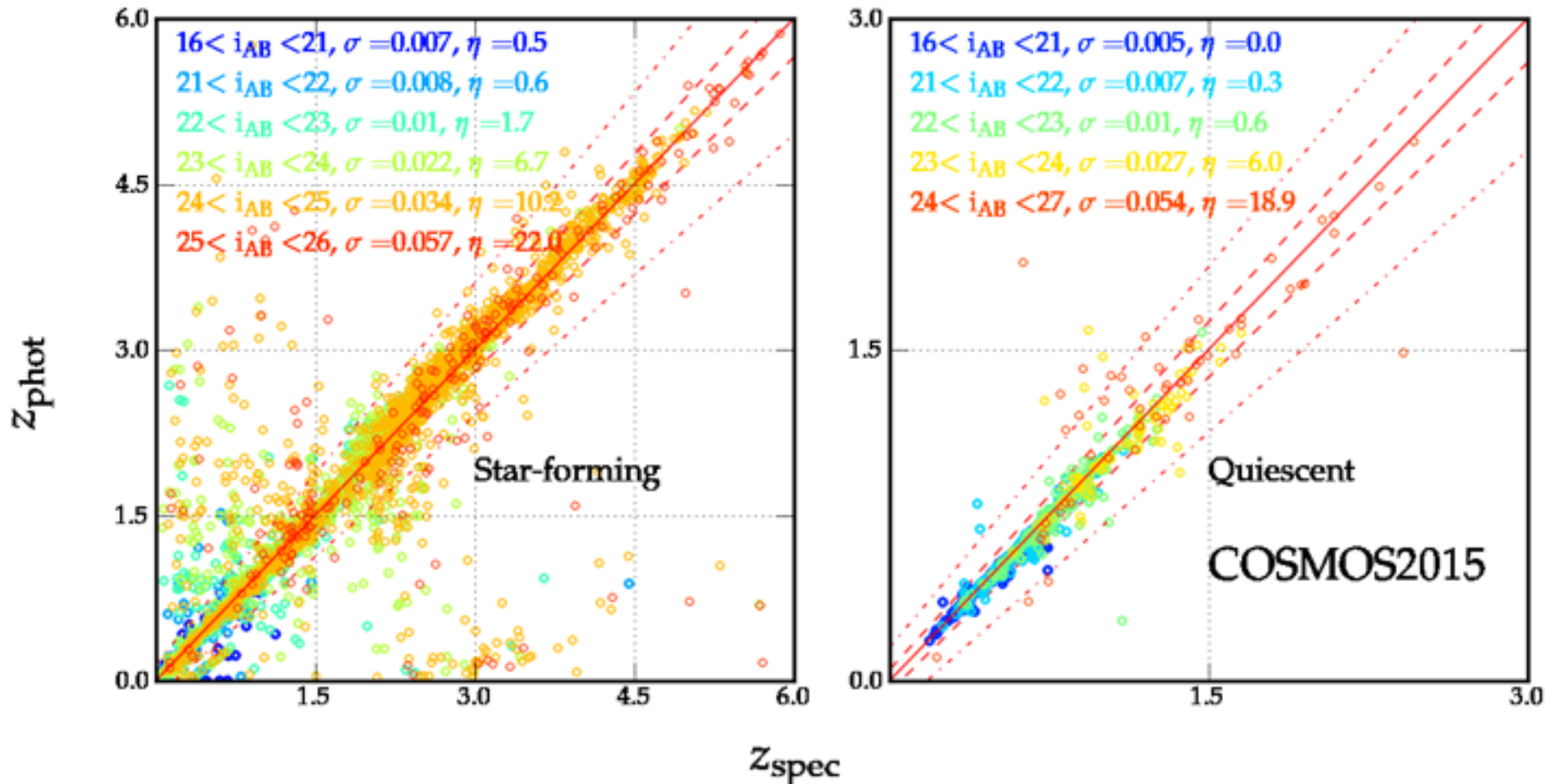


Important aspects of the method

- Adapt the absolute photometric calibration based on a spec-z sample
- Several SED libraries available (synthetic as BC03 or Pegase, empirical as tuned CWW)
- Work on dust attenuation curves including several slopes and the bump at 2175Å
- Work on emission lines based on Kennicutt empirical relations
- Prior based on the VVDS redshift distribution



Example of application: the COSMOS field



Current version COSMOS2015, >30 bands

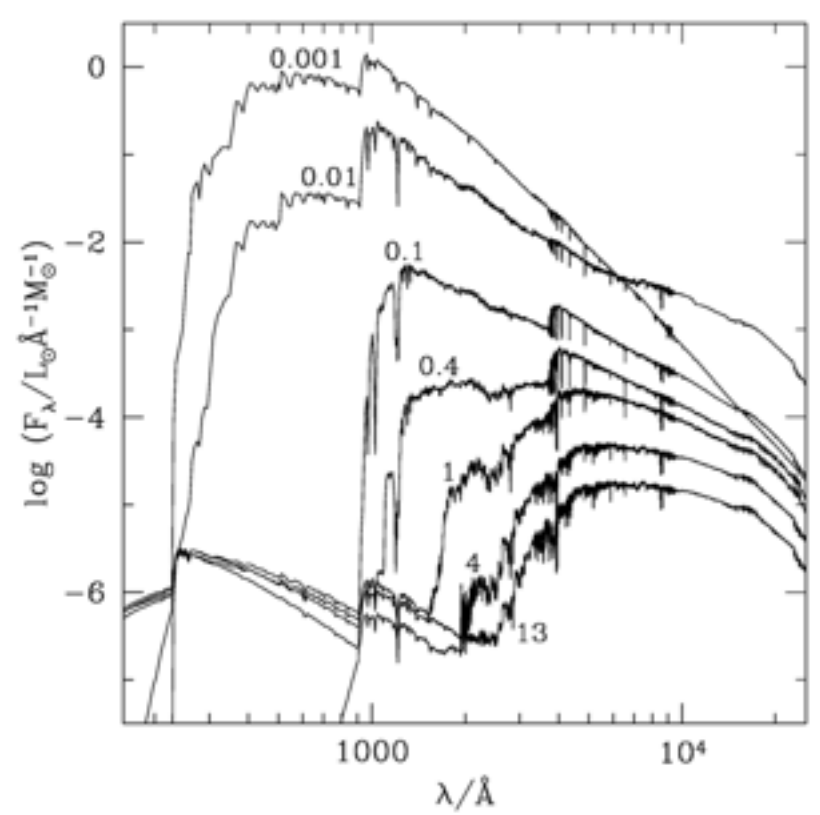
Laigle, McCracken, Ilbert et al. 2016

From 1% accuracy at $i < 23$ to 6% at $i < 26$

Physical parameters associated to the photo-z

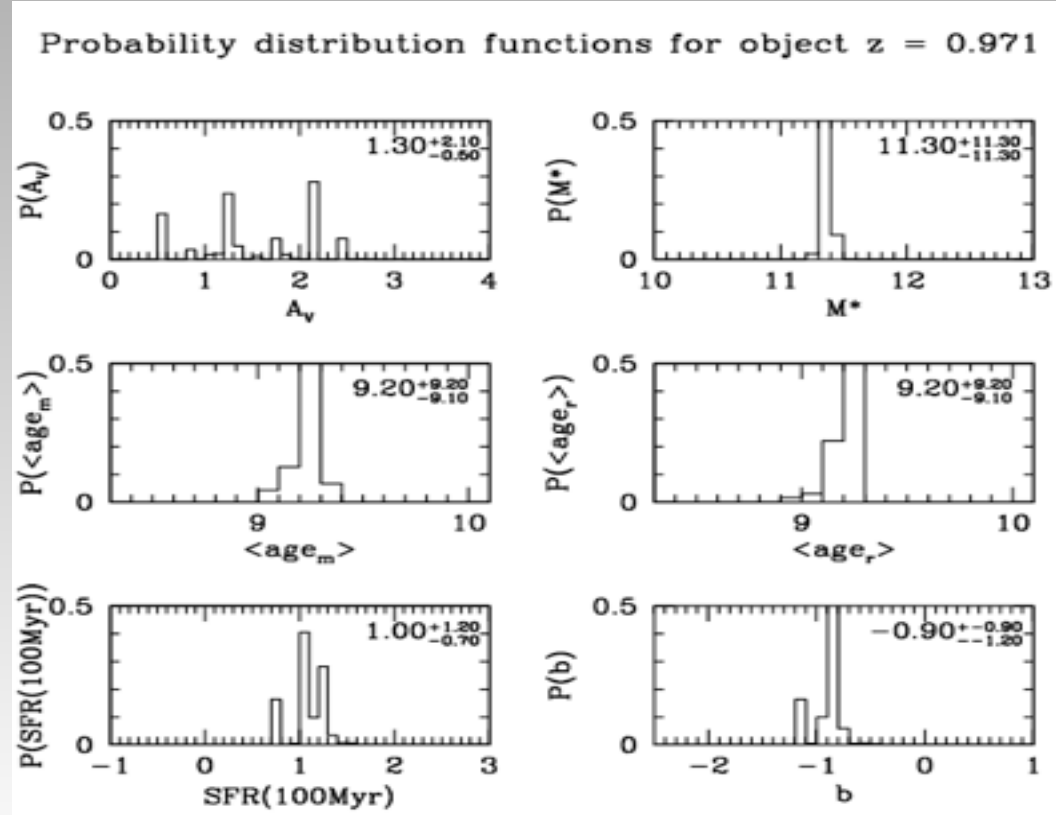
Simulated galaxy spectra with Stellar Population Synthesis codes at different ages (assuming various SFH, metallicities, dust attenuation)

Fit to the multi-color data to get stellar masses, SFRs, rest-frame colors, dust extinction, etc and associated uncertainties



Bruzual & Charlot 2003

Walcher+07



LSST: an incredible machine for photo-z

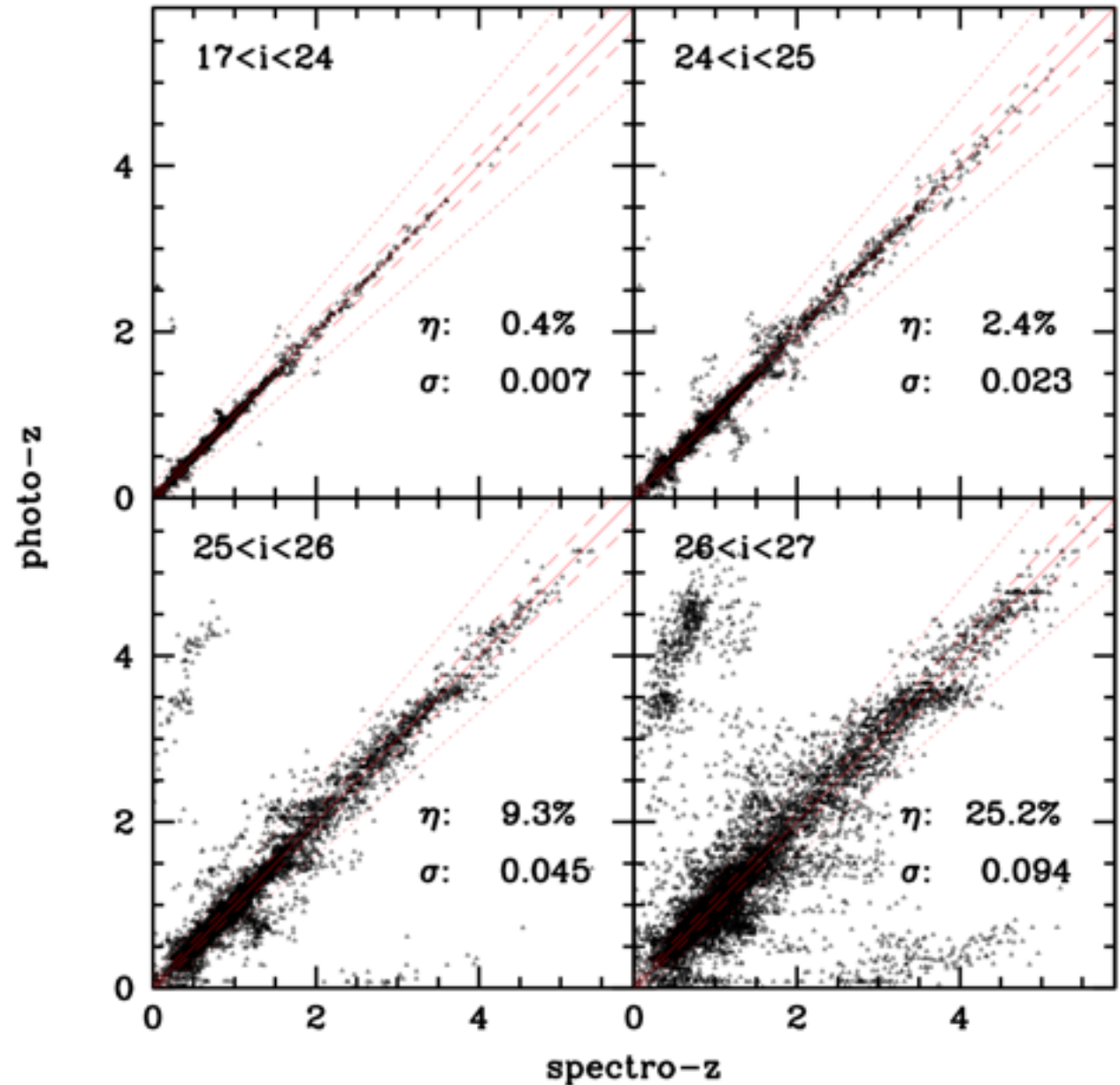
2-3% accurate
photo-z at $i < 25$

Better than CFHTLS
Deep

over 20000 deg^2 ...

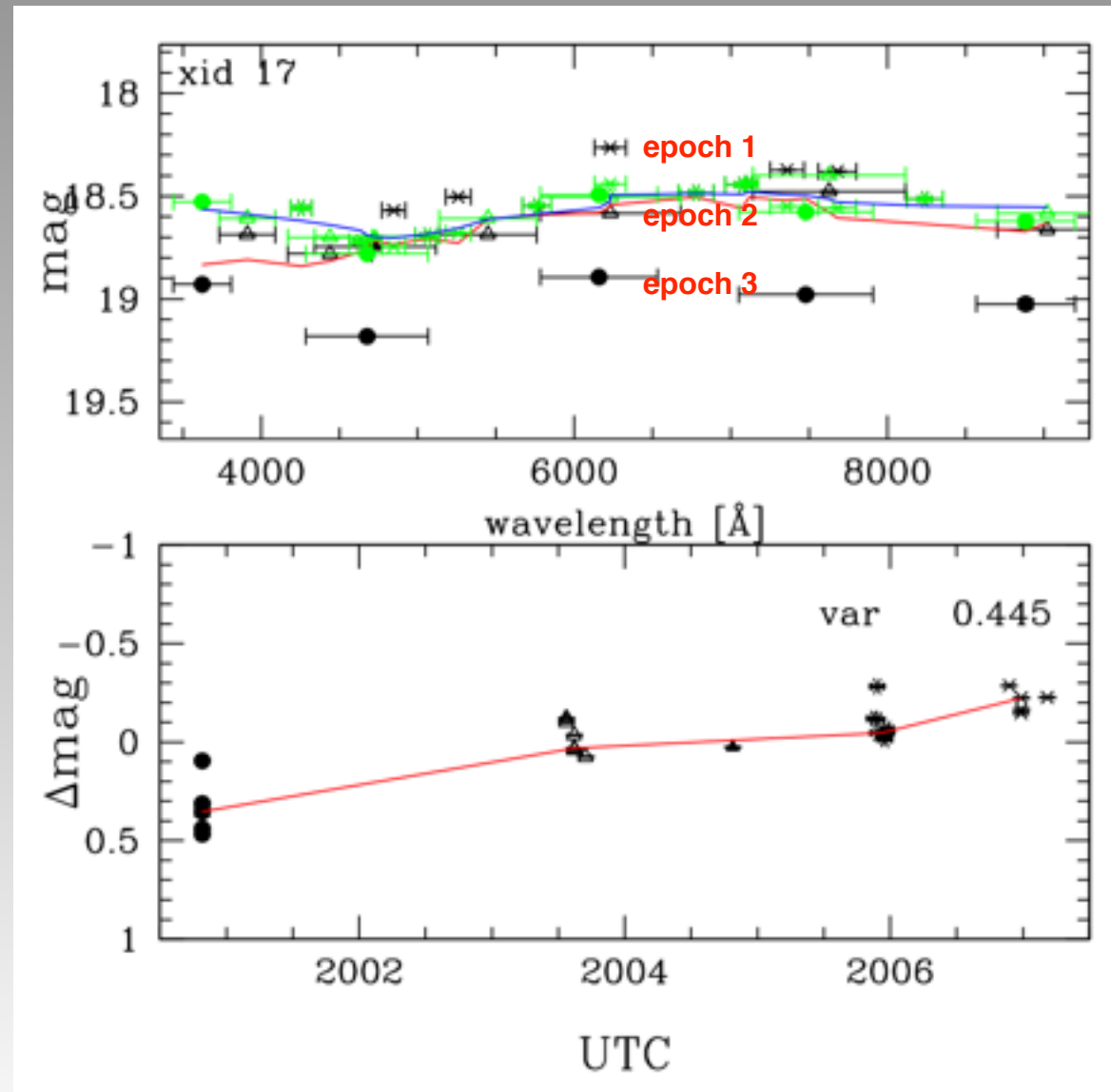
Idealized simulation

LSST



Photometric redshifts for AGNs

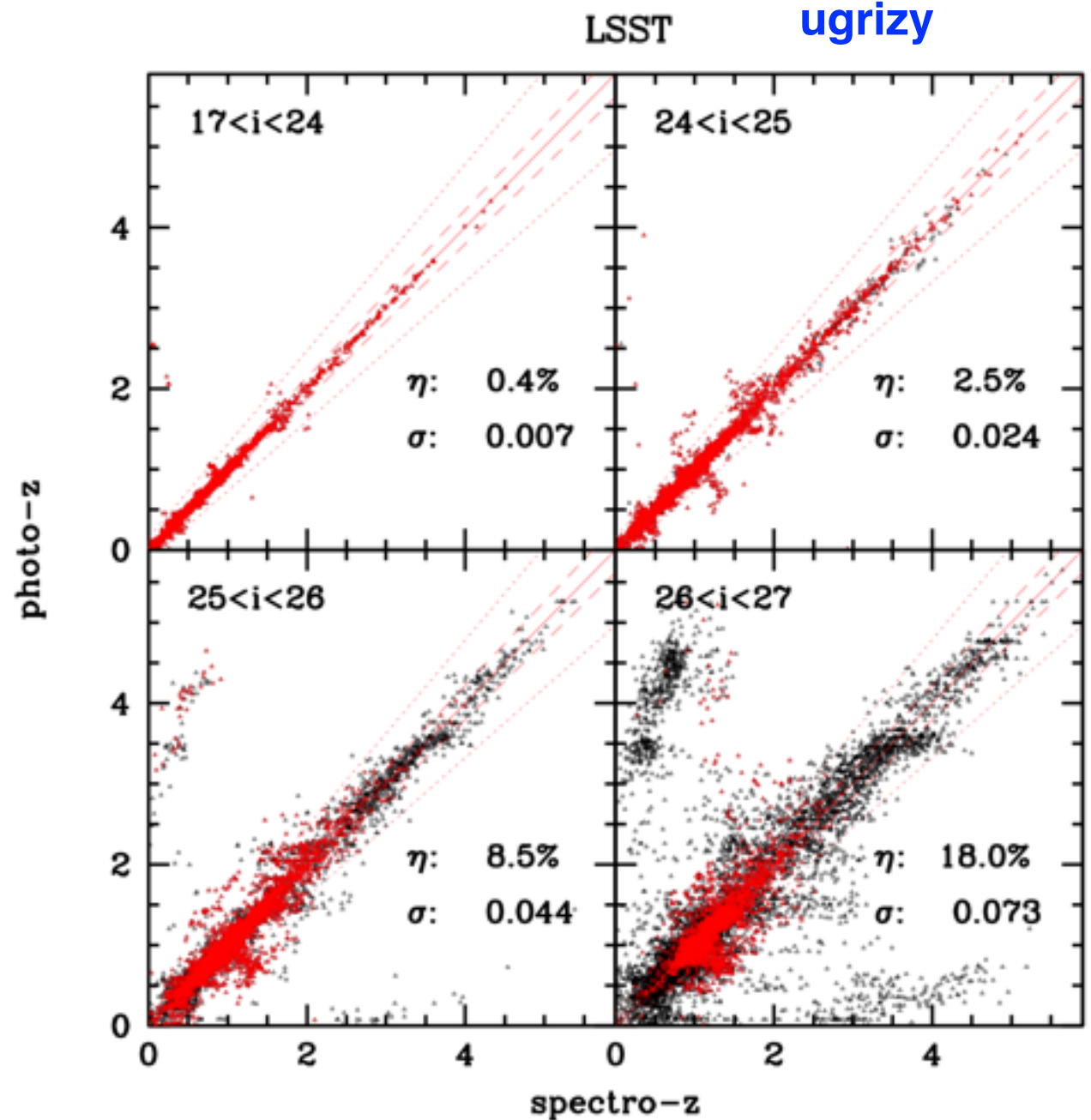
- Correct the photometry for the AGN variability
- It has been crucial in COSMOS
- photometry every 30 days for 10 millions of AGN
- Characterize the galaxy properties hosting an AGN ➤ feedback



combine visible+NIR

Idealized simulation

Red points:
sources detected in
Euclid J band at 3σ

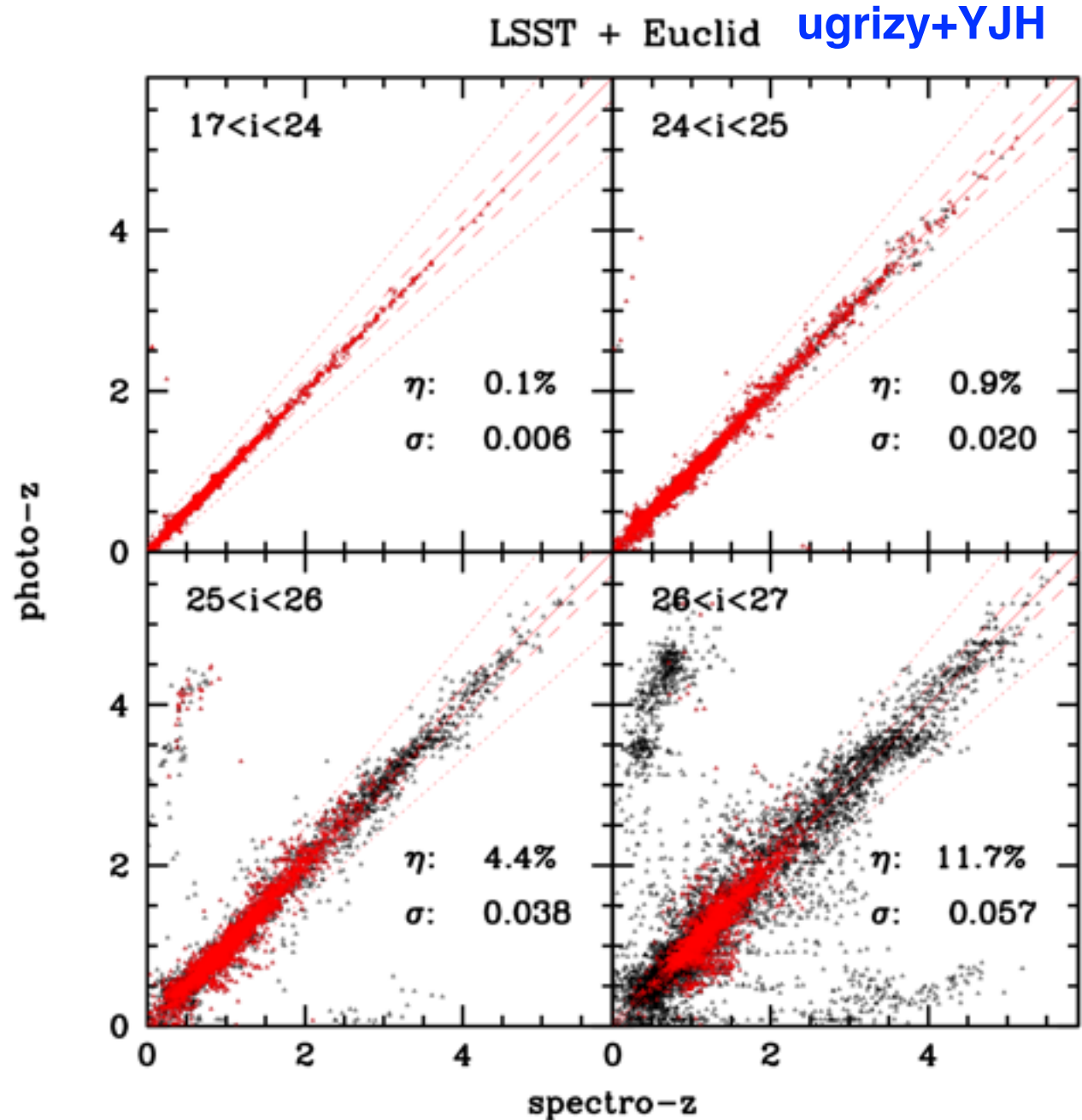


combine visible+NIR

Idealized simulation

Red points:
sources detected in
Euclid J band at 3σ

➤ improve the
accuracy for a sub-
sample detected in
NIR



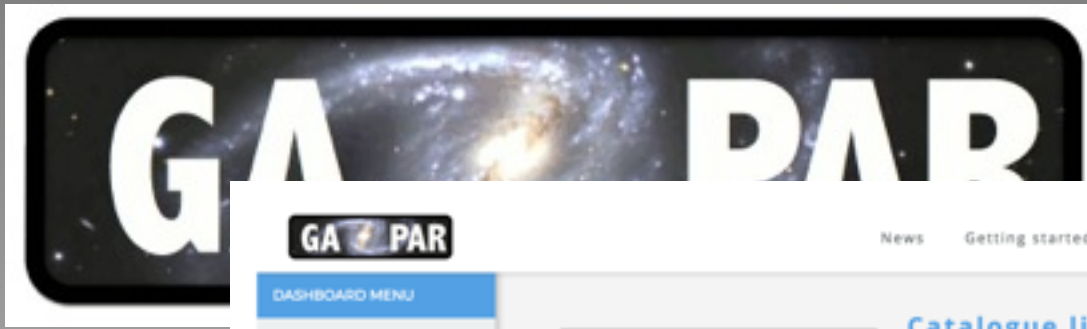
Work for LSST

- **Improve the c++ version**
 - to be tested
 - to be optimized
- **Improve the model**
 - Empirical templates using large spectroscopic surveys
 - $N(z|T,i)$ prior at fainter magnitude
- **Make use of the multi-epoch dataset**
 - variability
 - use multiple-epoch dataset to check the photo-z stability



<https://gazpar.lam.fr/>

- **Service National d'Observation (SNO)**
- **Template fitting codes to measure photometric redshifts and physical parameters:**
 - **Le Phare**
 - **CIGALE**
 - **BEAGLE (coming soon)**
 - **Hyperz (coming soon)**
- **Web interface to upload your catalogue**
 - **The SNO run the code for you**



Catalogue list

Upload your multi-color catalogues and associate each pair of column (mag/flux and associated error) to a passband. Each new catalogue uploaded is checked and we confirm that it is valid for the creation of a new request. All the previous catalogues are stored and you can find them later if you want.

⚠ The catalogue columns require specific order : [id] | ([filter] [filter_en] ...) | [redshift] | [V] | [ra] | [dec] | [mask]

Add catalogue

Label	Unit	Valid	Lines	Flux	Redshift	Actions
catalogue chri	magAB	✔	10304	4	true	⊞
test unit	milliy	✔	3	2.5	true	⊞
test unit	microy	✔	12286	9	true	⊞

Add new request

Enter a request label :

Select your catalogue :

Select the request job :

- Le Phare photometric redshifts ⓘ
- Le Phare physical parameters ⓘ
- Cigale physical parameters ⓘ
- Beagle ⓘ

What is the future use of your catalogue ?

Explain what is the population the most relevant for you (redshift range, spectral type, ...)

- Service National d'Observation
- Template fitting codes and physical parameters:
 - Le Phare
 - CIGALE
 - BEAGLE (coming soon)
 - Hyperz (coming soon)
- Web interface to upload catalogues
 - The SNO run the code