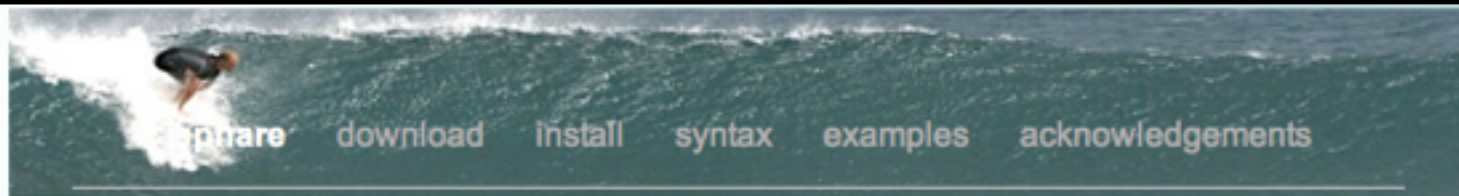# Photometric redshifts for LSST

## Stephane Arnouts et Olivier Ilbert

## LE PHARE

PHotometric Analysis for Redshift Estimations
Stephane ARNOUTS & Olivier ILBERT
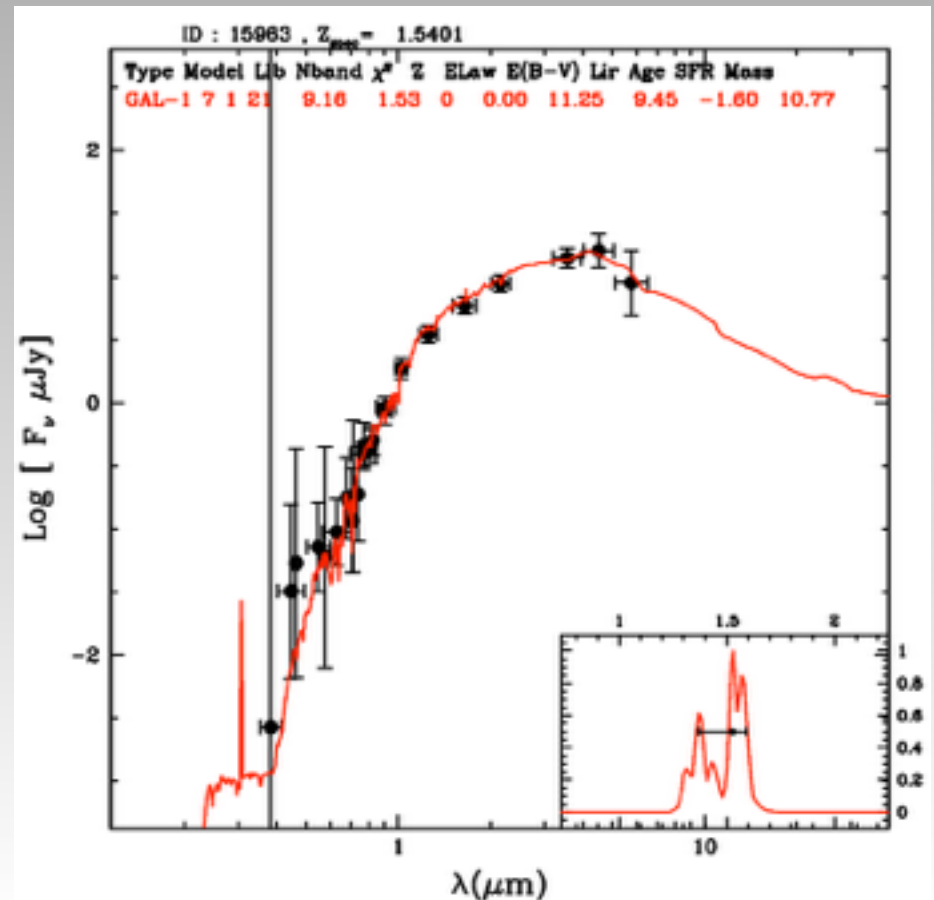
http://www.cfht.hawaii.edu/~arnouts/LEPHARE/

**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

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

**Outputs**
Redshift and physical parameters:
values and associated uncertainties + PDF
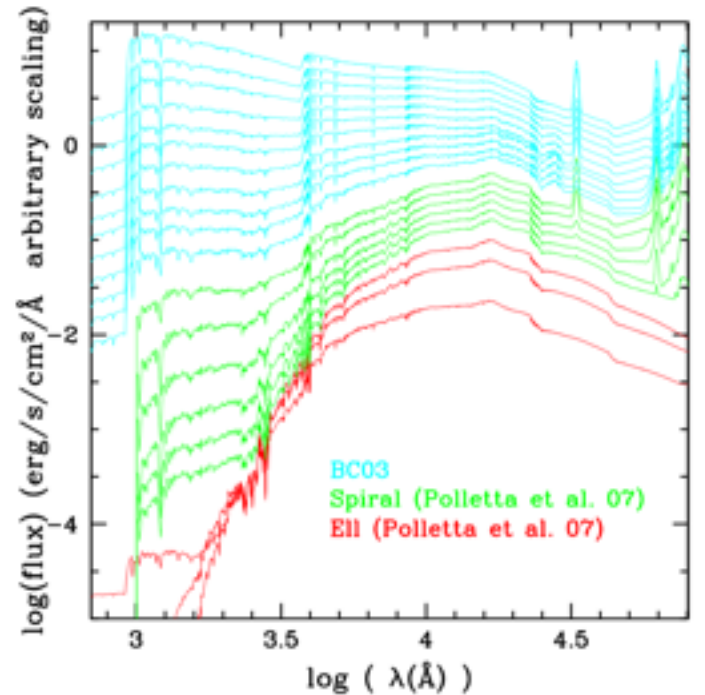
# Important aspects of the method

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

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

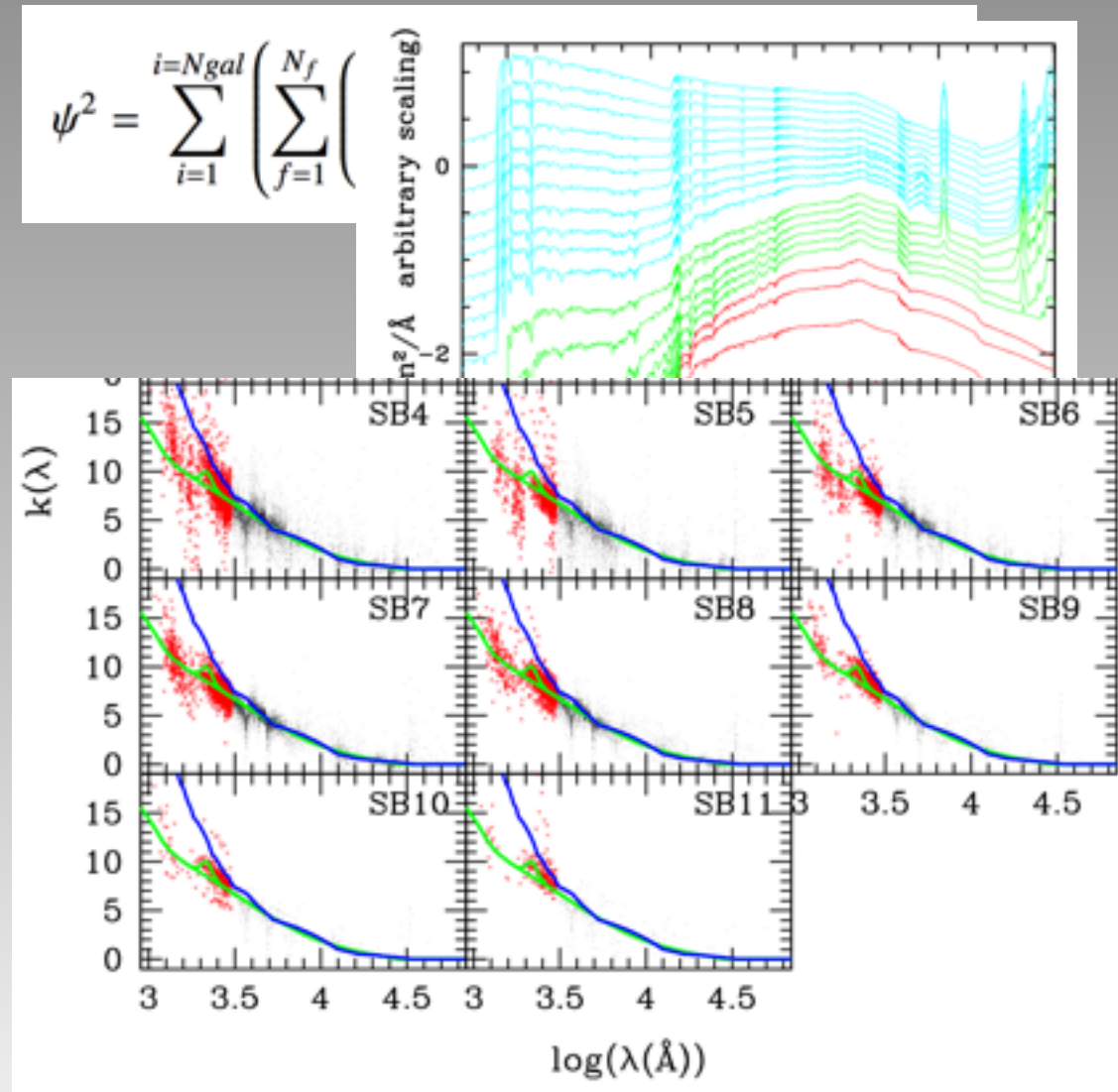# Important aspects of the method

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

- **Several SED libraries available (synthetic as BC03 or Pegase, empirical as tuned CWW)**

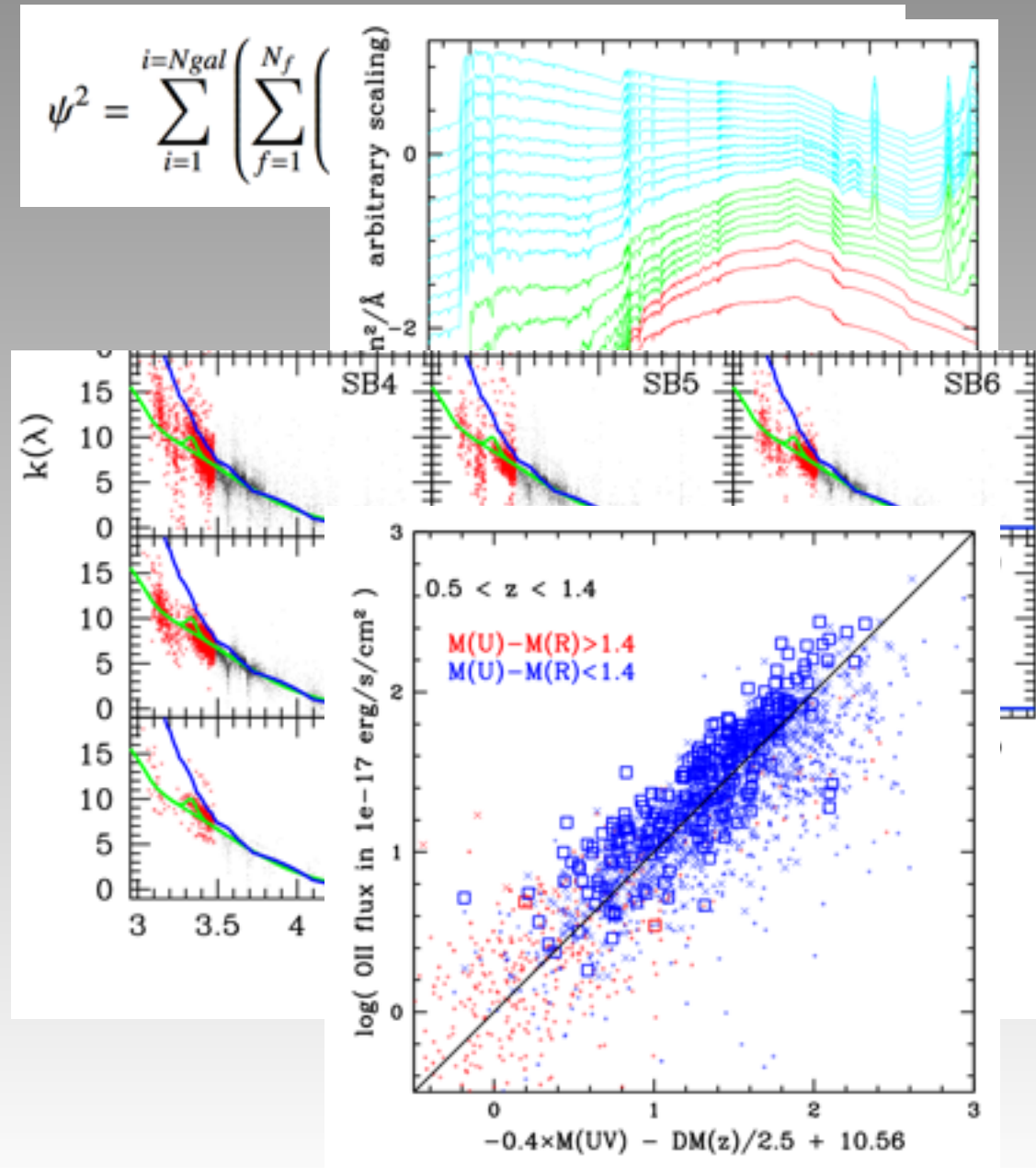$$\psi^2 = \sum_{i=1}^{i=Ngal} \left( \sum_{f=1}^{N_f} \left( \right. \right.$$

# 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 2175A**

# 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 2175A**

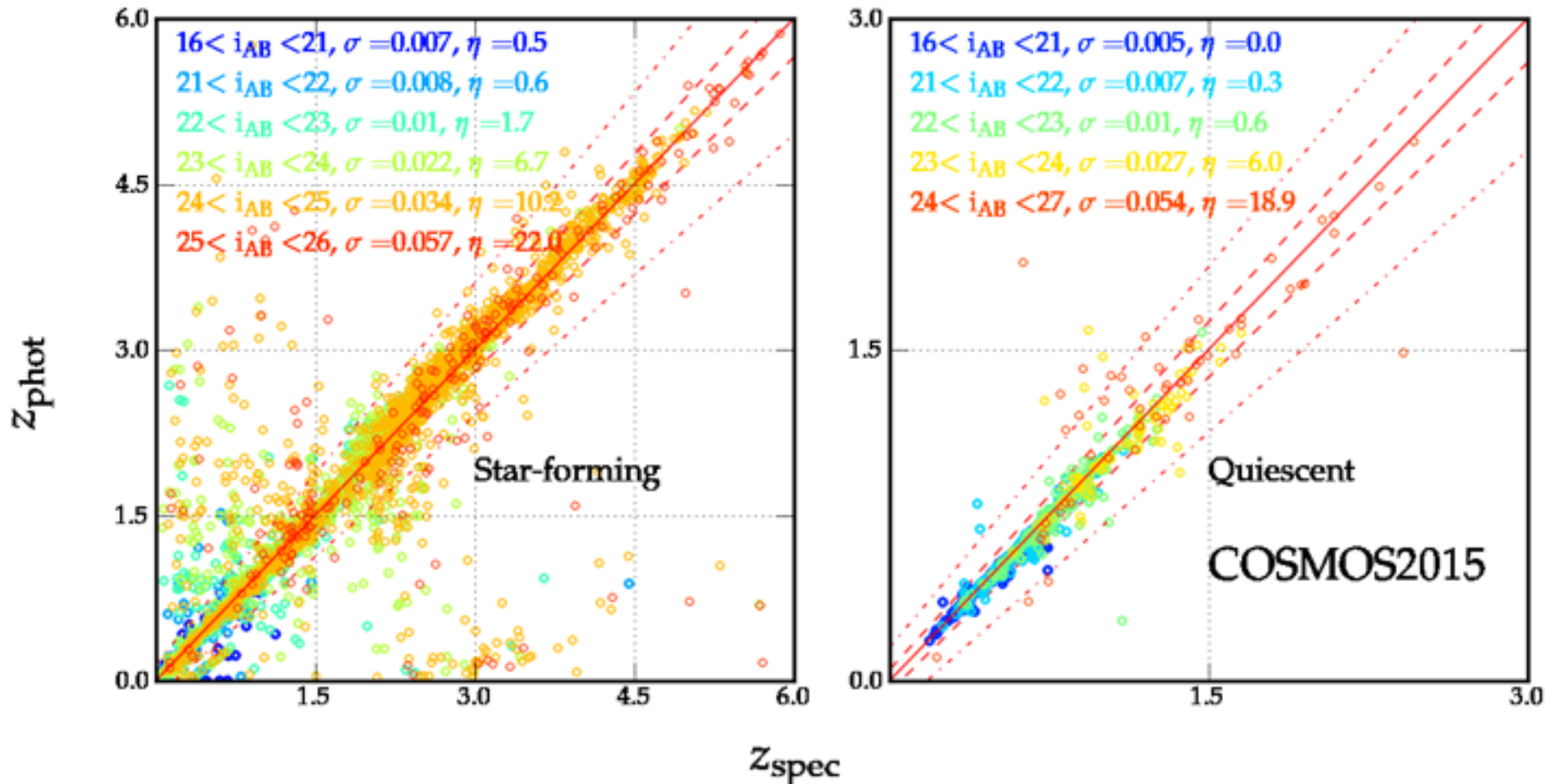- **Work on emission lines based on Kennicutt empirical relations**

# 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 2175A**

- **Work on emission lines based on Kennicutt empirical relations**

- **Prior based on the VVDS redshift distribution**



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

$$p(z, T | i'_{AB}) = p(T | i'_{AB}) p(z | T, i'_{AB})$$
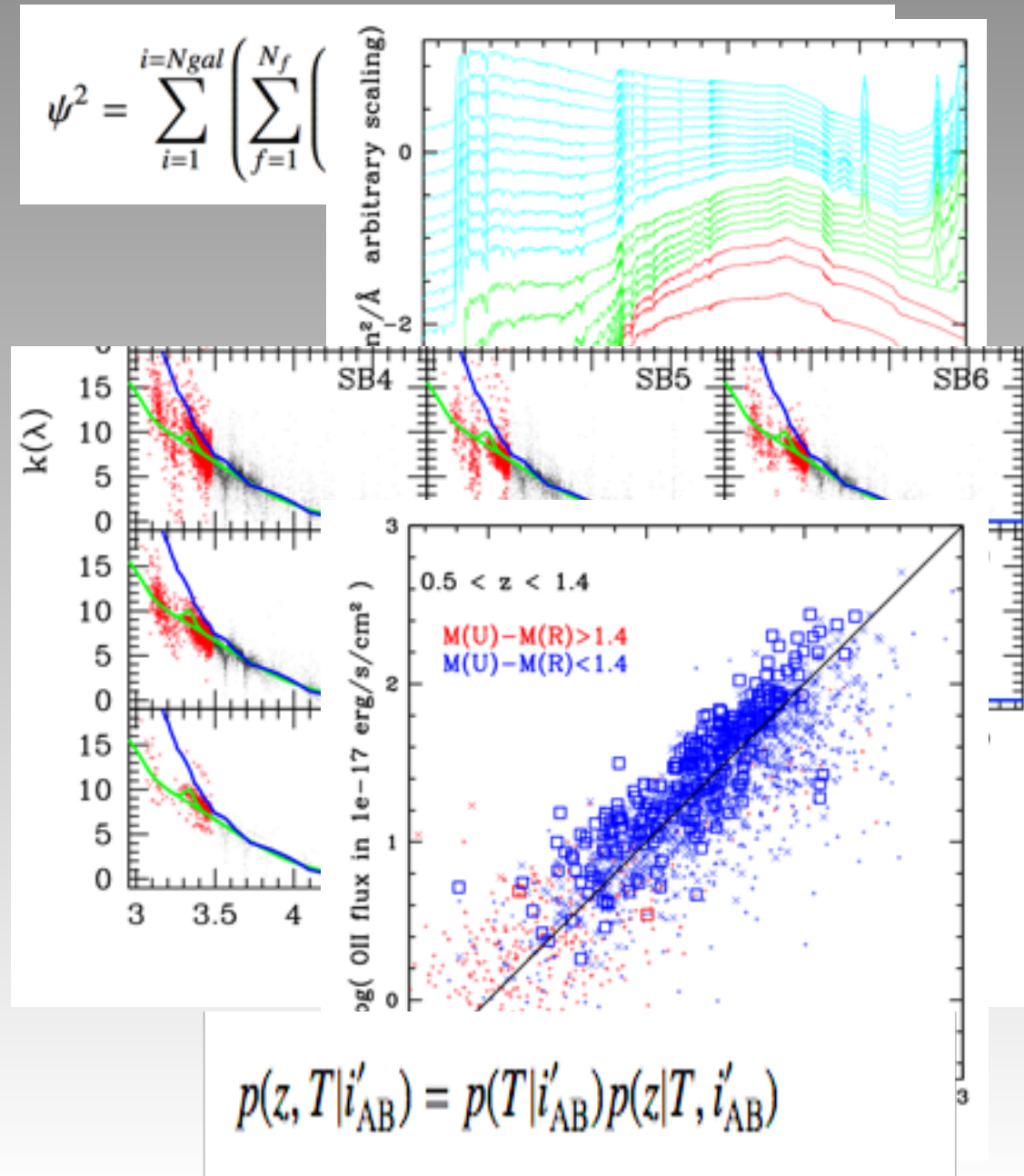
# Example of application: the COSMOS field



Current version COSMOS2015, >30 bands

Laigle,McCracken, Ilbert et al. 2016

From 1% accuracy at i<23 to 6% at i<26
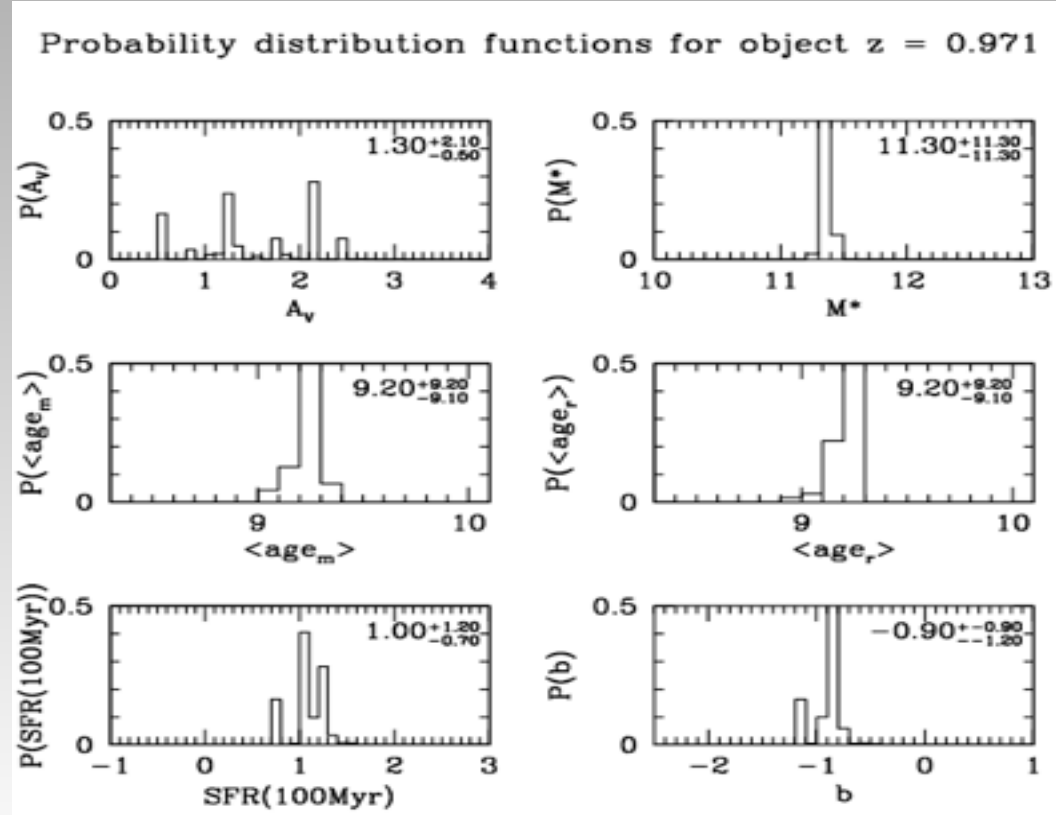
# Physical parameters associated to the photo-z

**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**
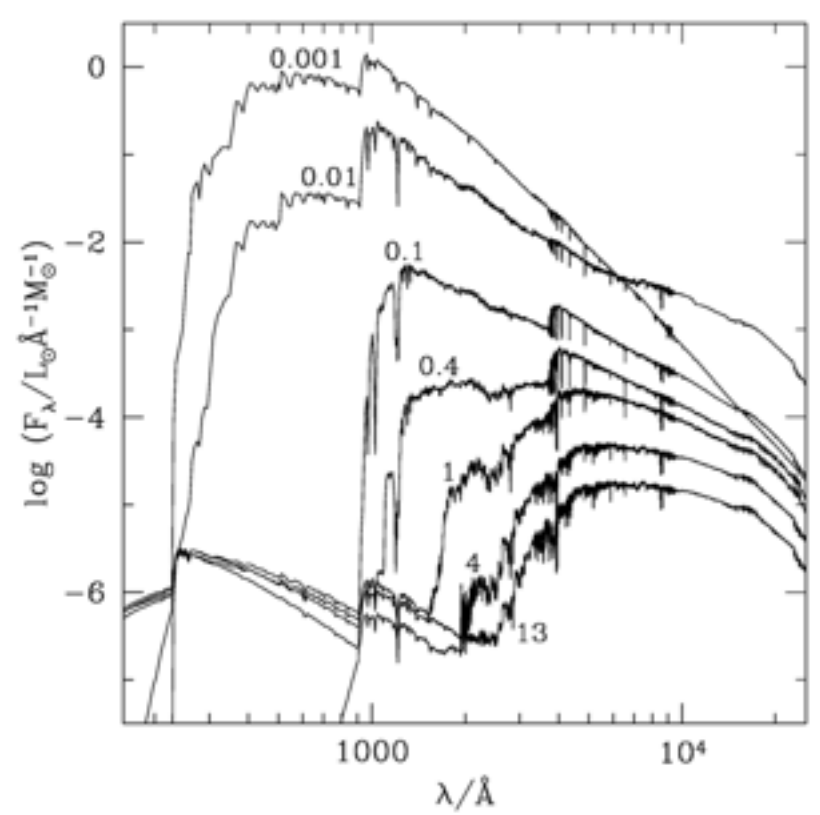


**Bruzual & Charlot 2003**
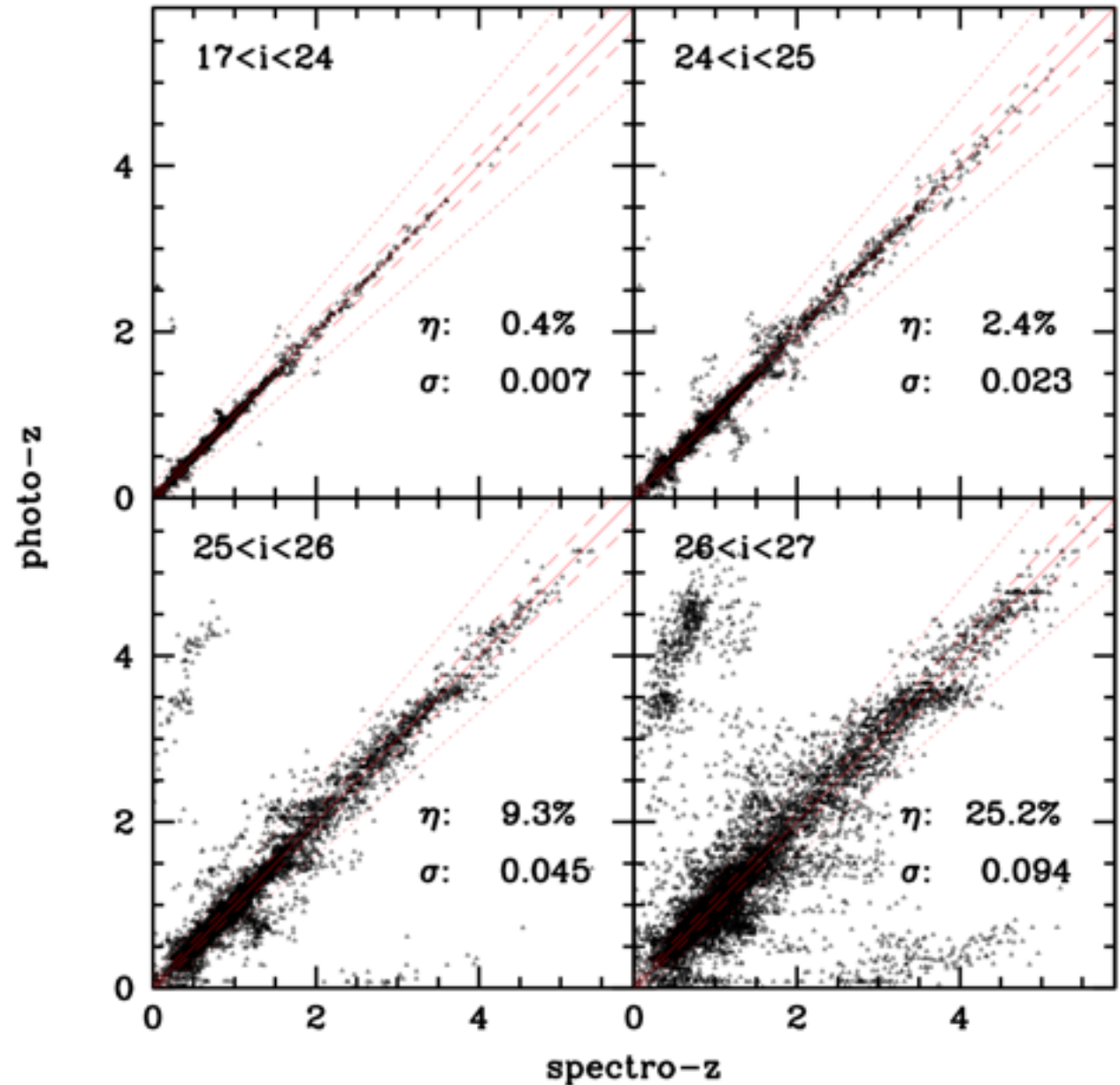


Walcher+07

# LSST: an incredible machine for photo-z

**2-3% accurate photo-z at i<25**
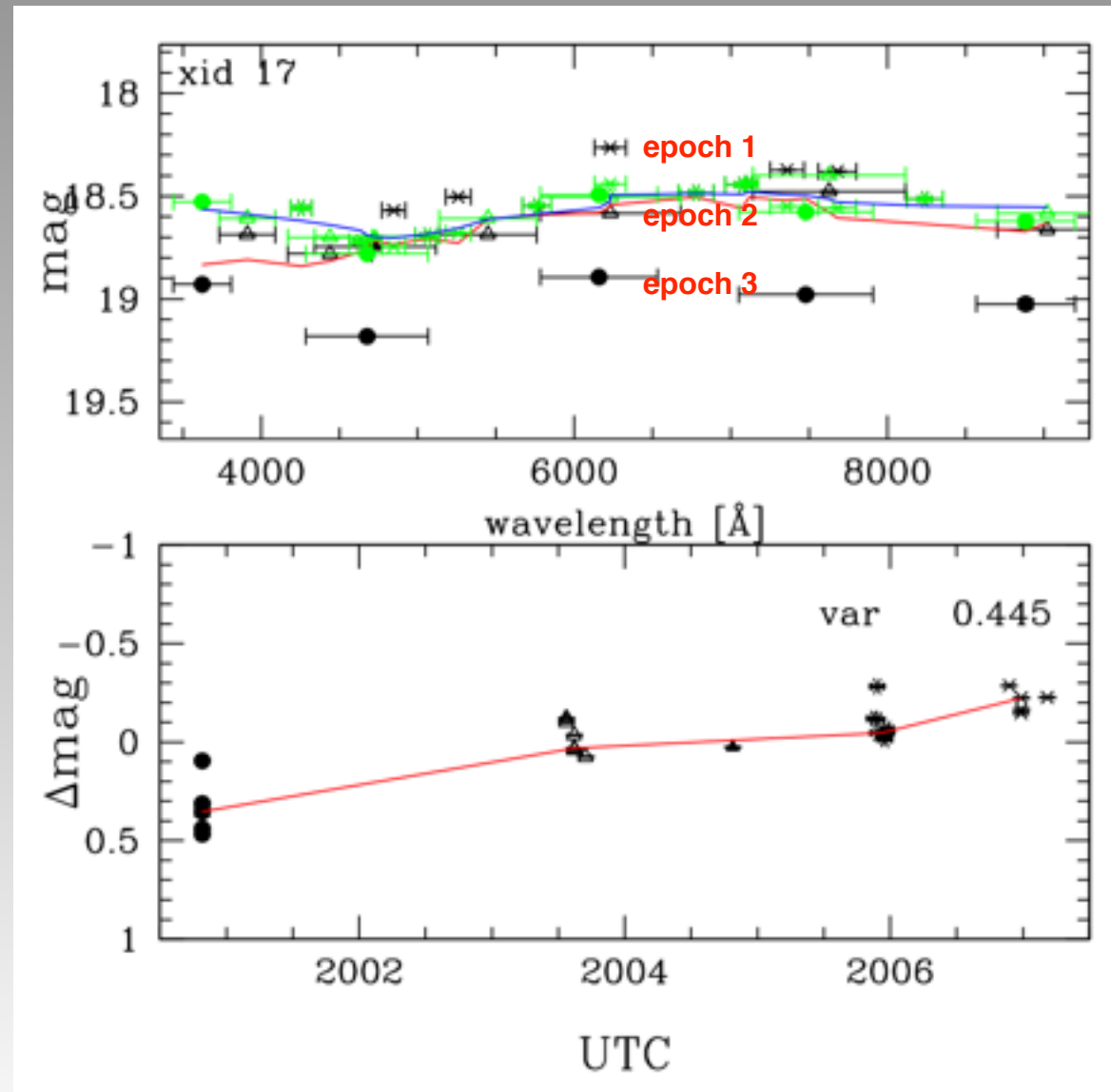
**Better than CFHTLS Deep**

**over 20000 deg² …**

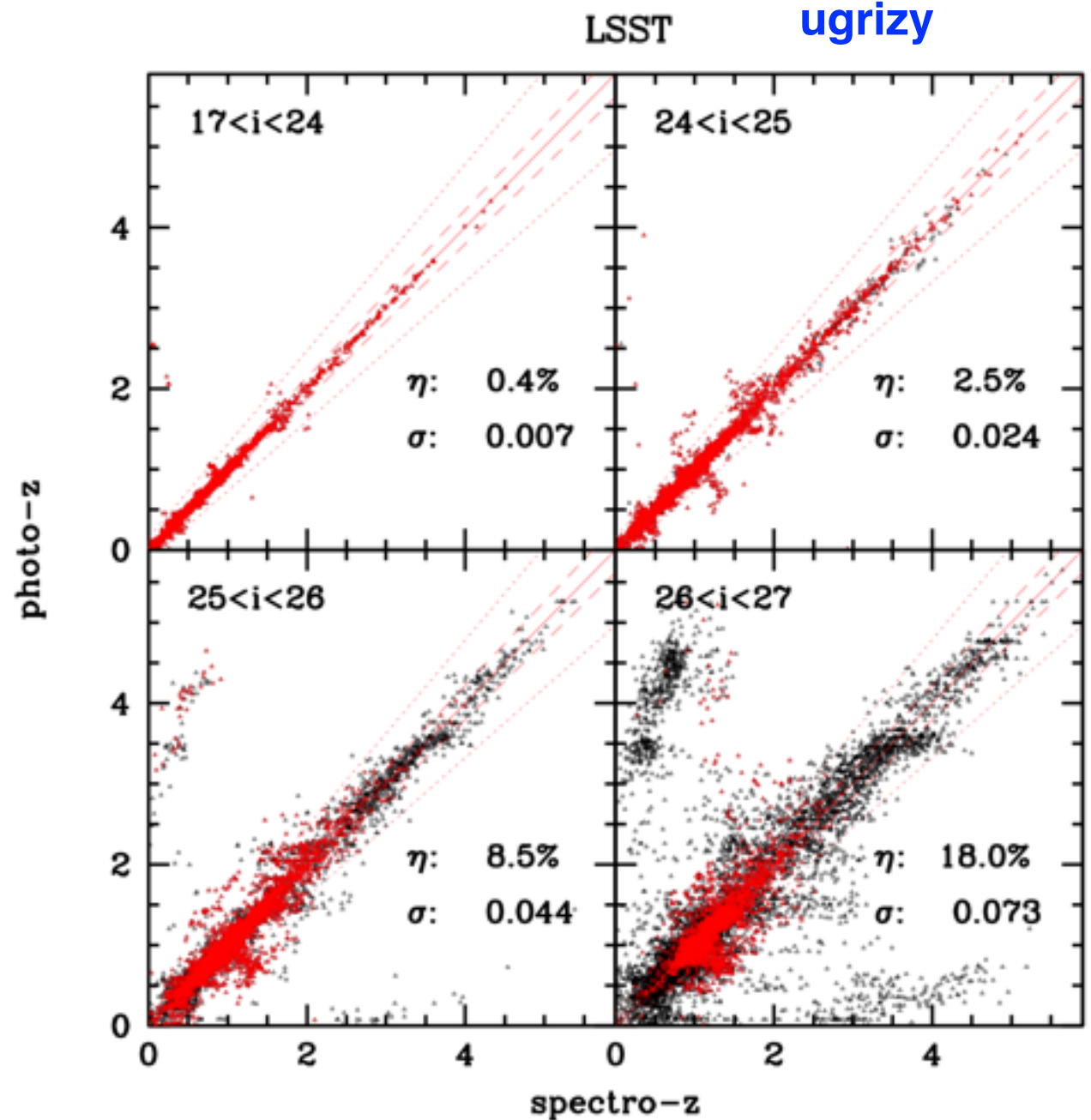# Photometric redshifts for AGNs

- **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**



**Salvato et al. 2009**

# combine visible+NIR

**Idealized simulation**

**Red points:**

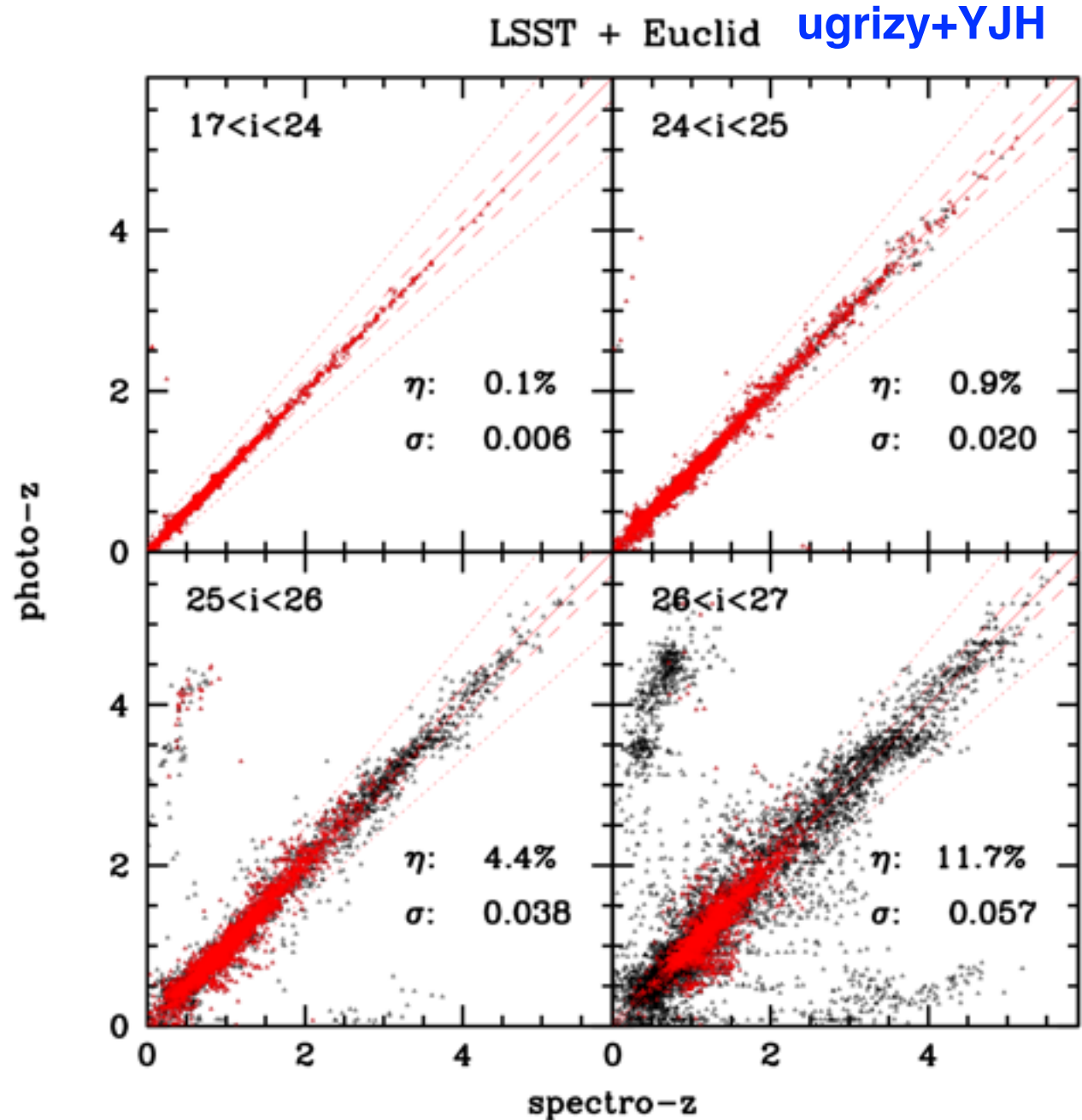**sources detected in Euclid J band at 3$\sigma$**

# combine visible+NIR

**Idealized simulation**

**Red points:**

**sources detected in Euclid J band at 3$\sigma$**

➢ **improve the accuracy for a sub-sample detected in NIR**
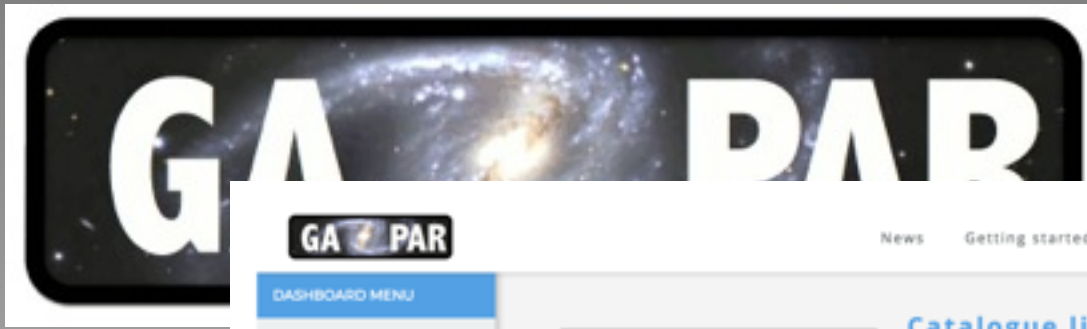


LSST + Euclid  ugrizy+YJH

# 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**

**GA★PAR**

**h...**

- **Service National d'Ob...**
- **Template fitting codes... physical parameters:**
  - **Le Phare**
  - **CIGALE**
  - **BEAGLE (coming s...**
  - **Hyperz (coming so...**
- **Web interface to uploa...**
- ➢ **The SNO run the cod...**