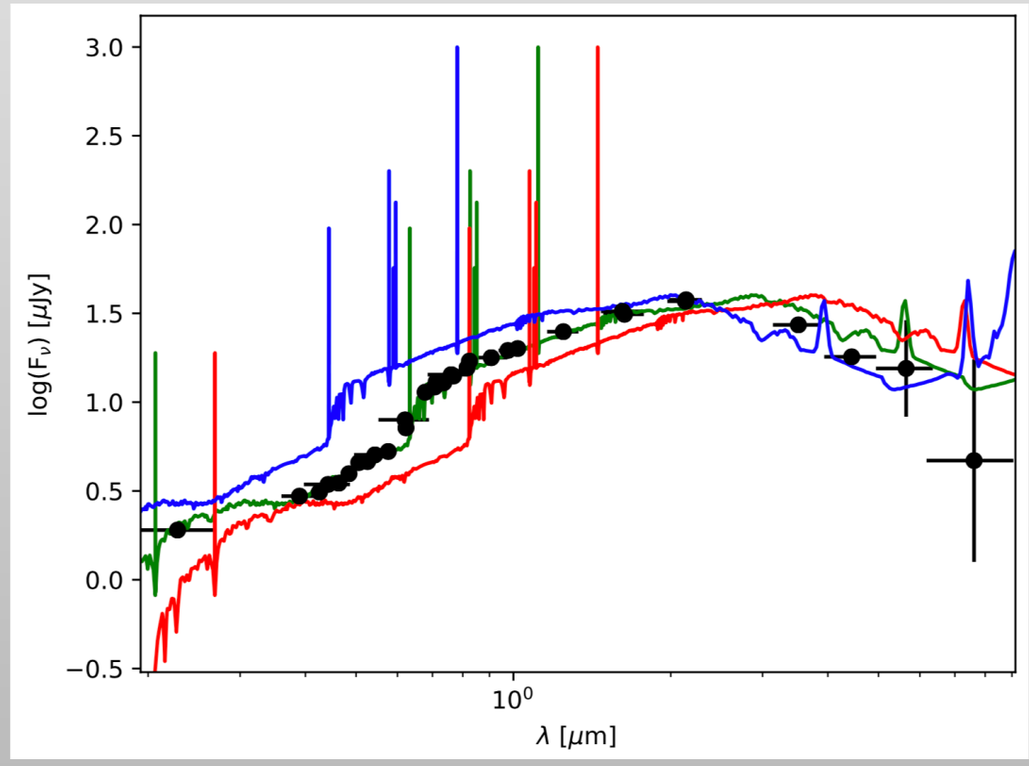
LePHARE and recent developments for LSST

Olivier Ilbert, Johann Cohen-Tanugi, Raphael Shirley,
Mara Salvato, Stephane Arnouts

Template-fitting code based on a χ^2 minimisation

- **several set of templates, dust attenuations, emission lines recipes, …**
- **Stars, galaxies, and AGN fit seperately**
- **Possible priors**
- **Photo-z and physical parameters in output, as well as associated PDF**
- **…**

Originally a fortran code



New c++ version

Olivier Ilbert, Johann Cohen-Tanugi
with the help of several others

Completely re-writen in c++

https://gitlab.lam.fr/Galaxies/LEPHARE

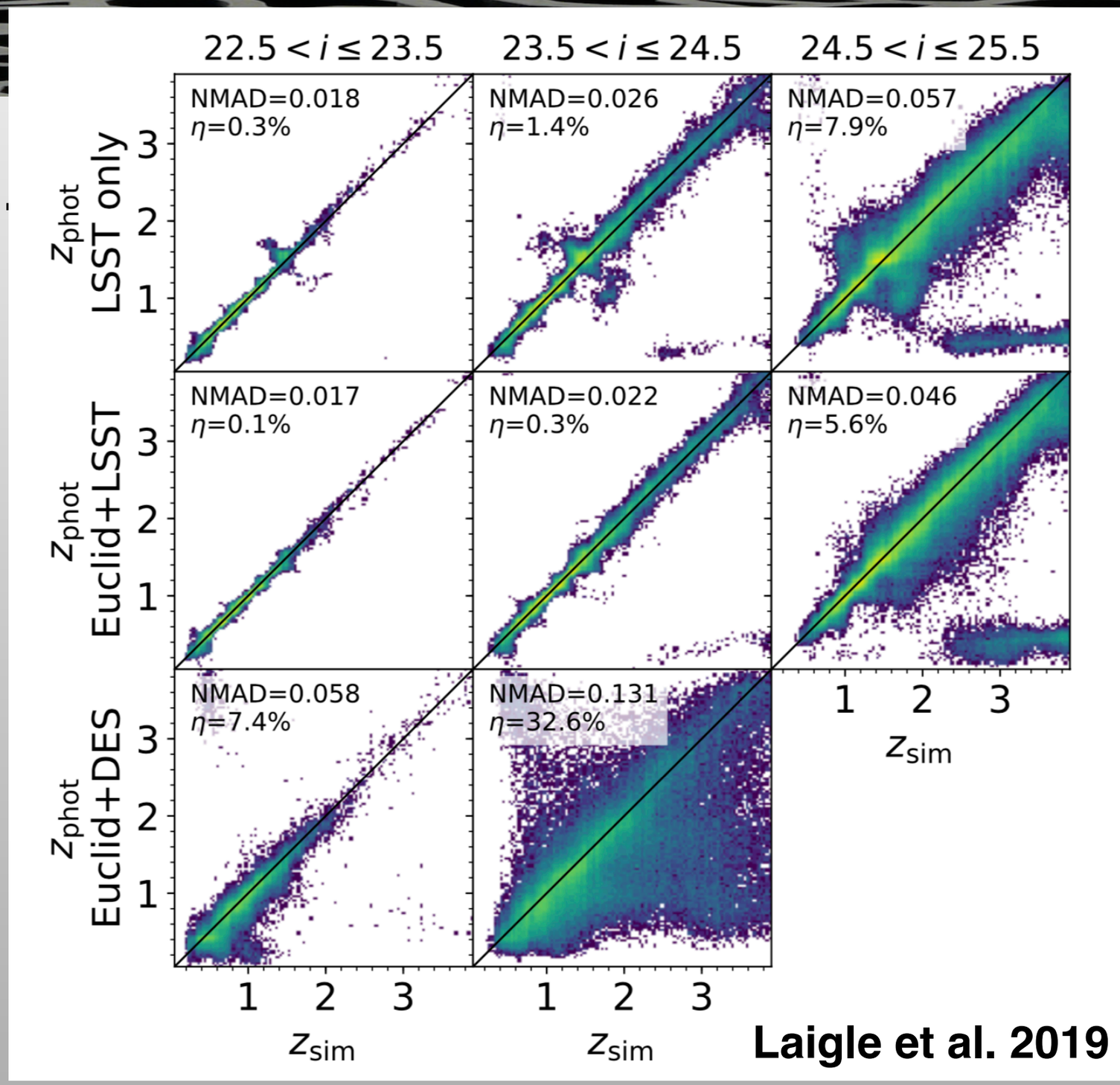
- **Parallelized**
- **Better optimized (hopfully…)**
- **Python interface using pybind**
  - ☆ **C++ classes can be used as library**
  - ☆ **The code can be fully run through notebooks**
  - ☆ **Allow to manipulate any input/output format available in python**
  - ☆ **Legacy way to run the code still available**

Template-fitting code used/tested intensively in the last >20 years

Applied on many simulations

Horizon-AGN cosmological simulation

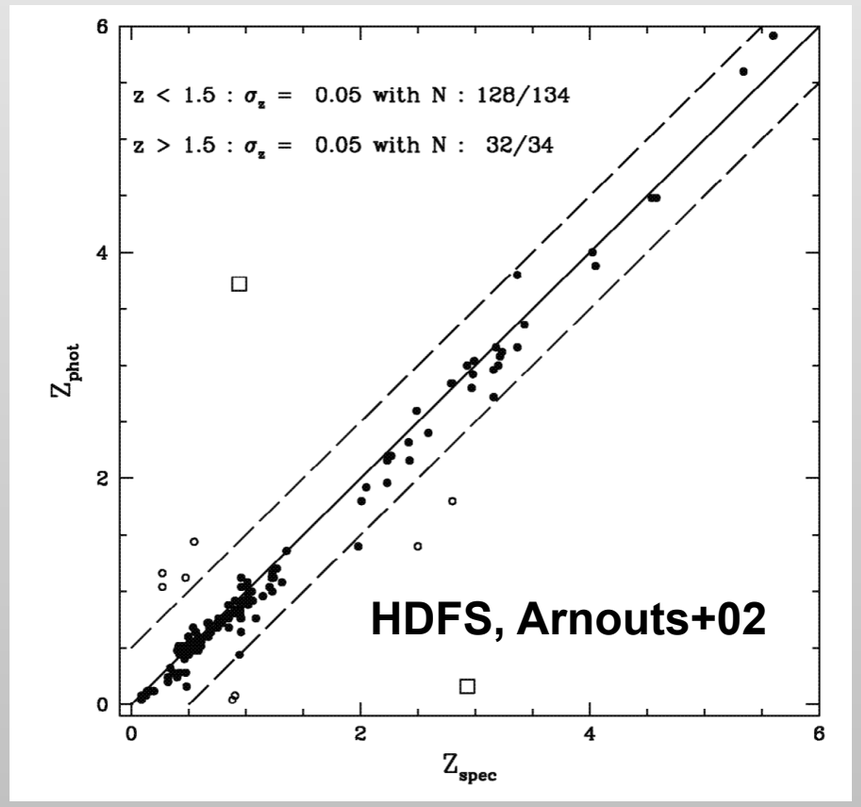
➢ complex histories and diversity of galaxies

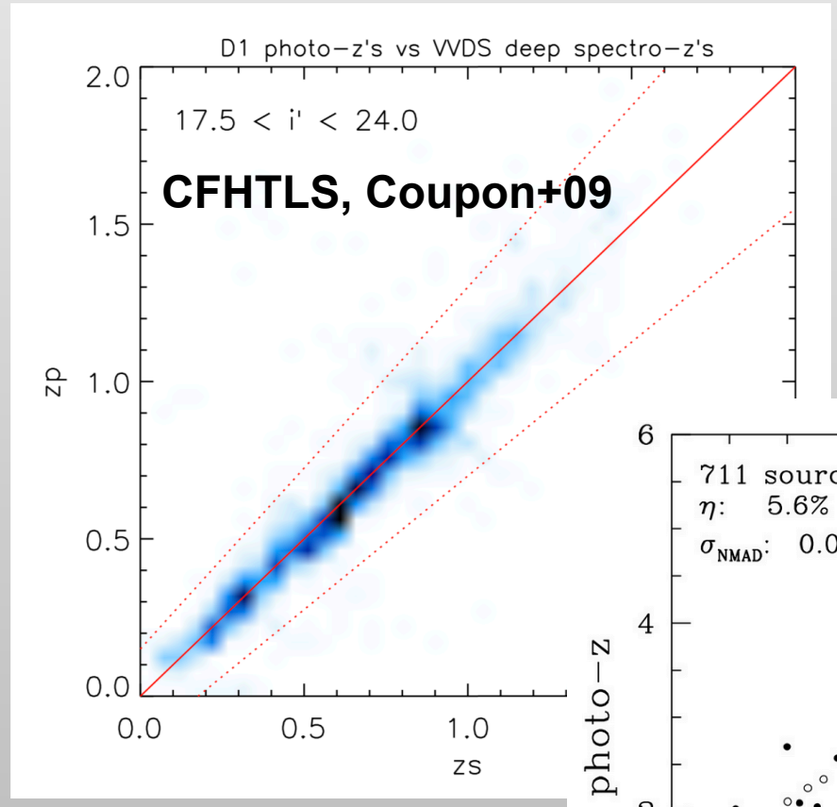


Laigle et al. 2019

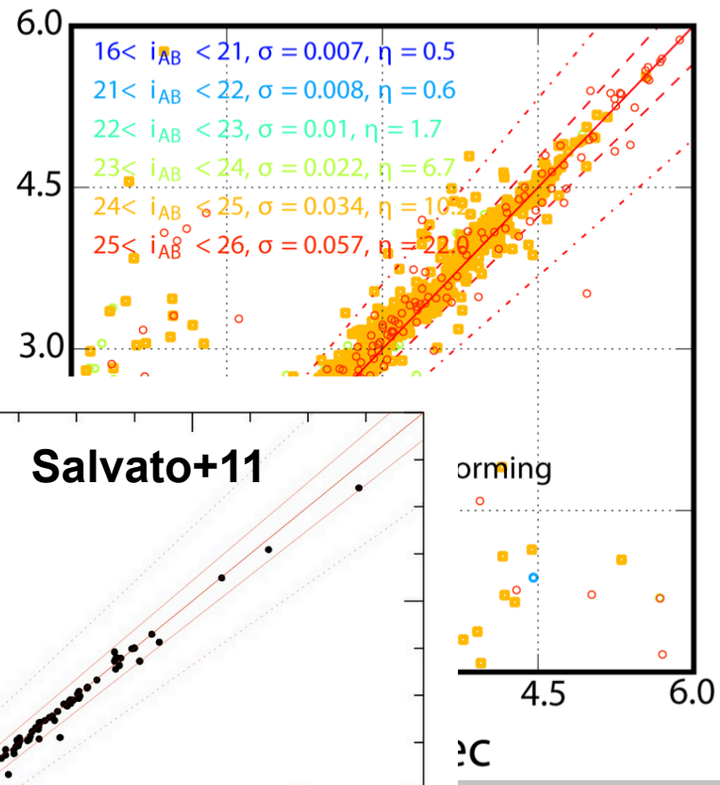
Template-fitting code used/tested intensively in the last >20 years

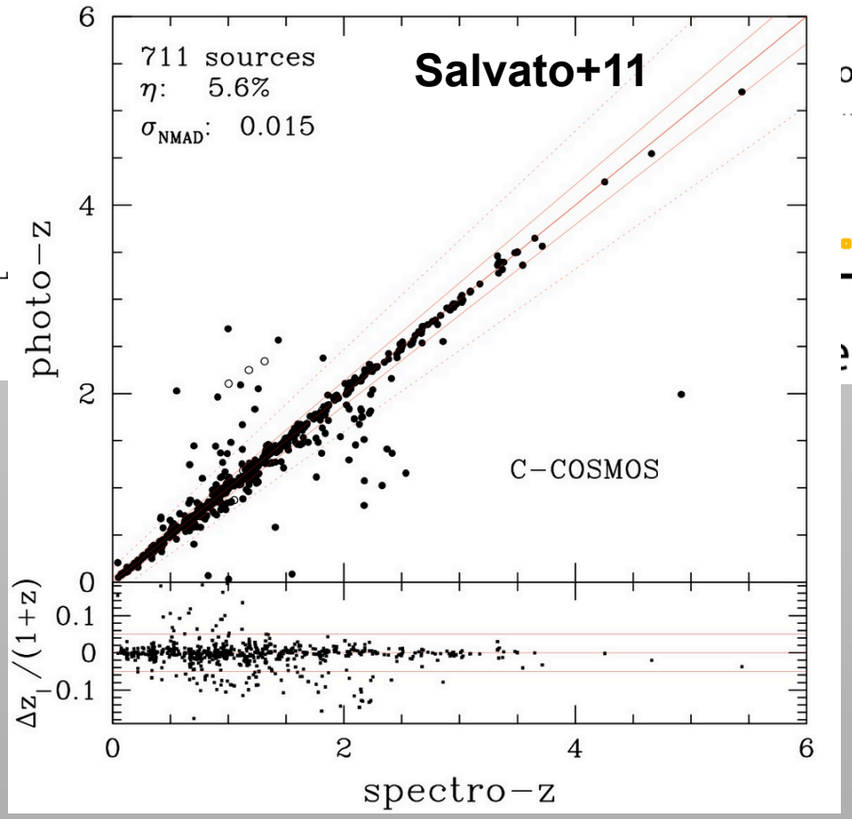
Applied to many surveys





COSMOS, Laigle+2016





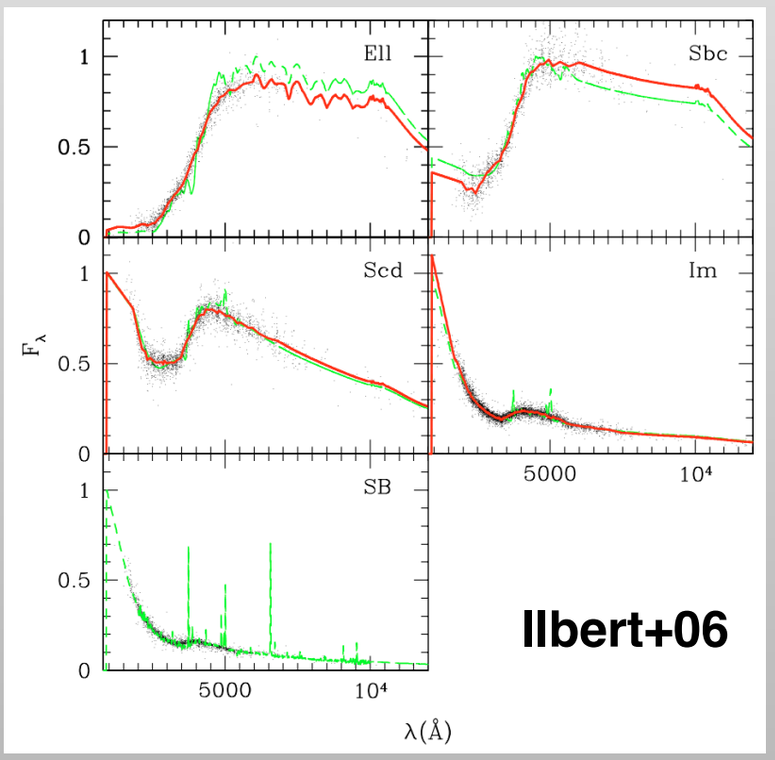
including AGN

Method

The set of galaxy templates

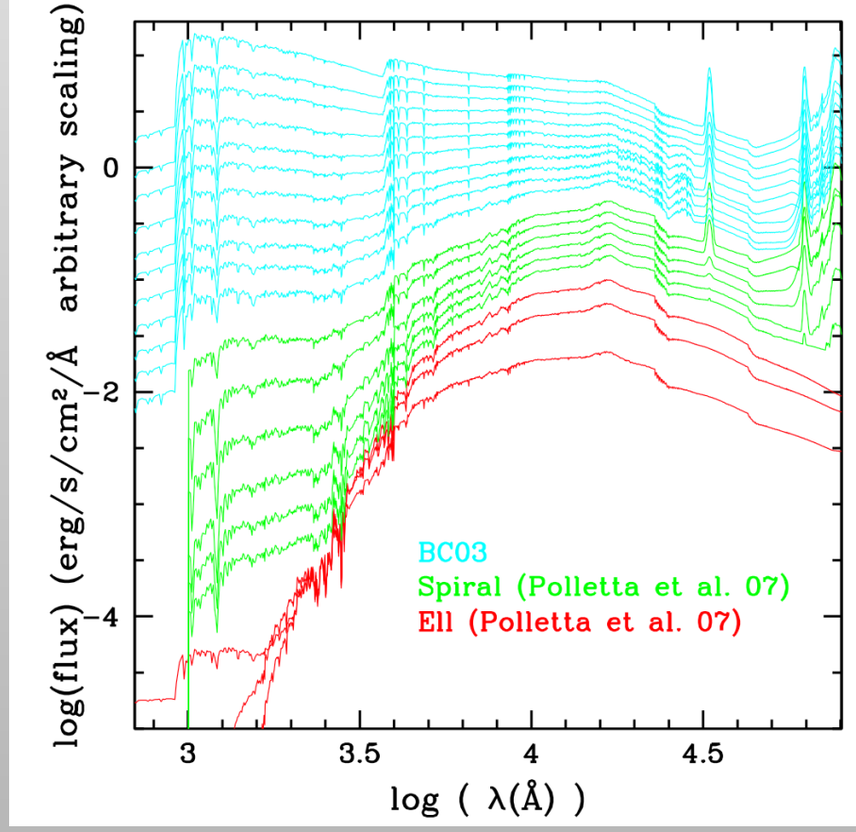
Various set of templates depending on the information contained in the multi-wavelength data

Bruzual & Charlot 2003

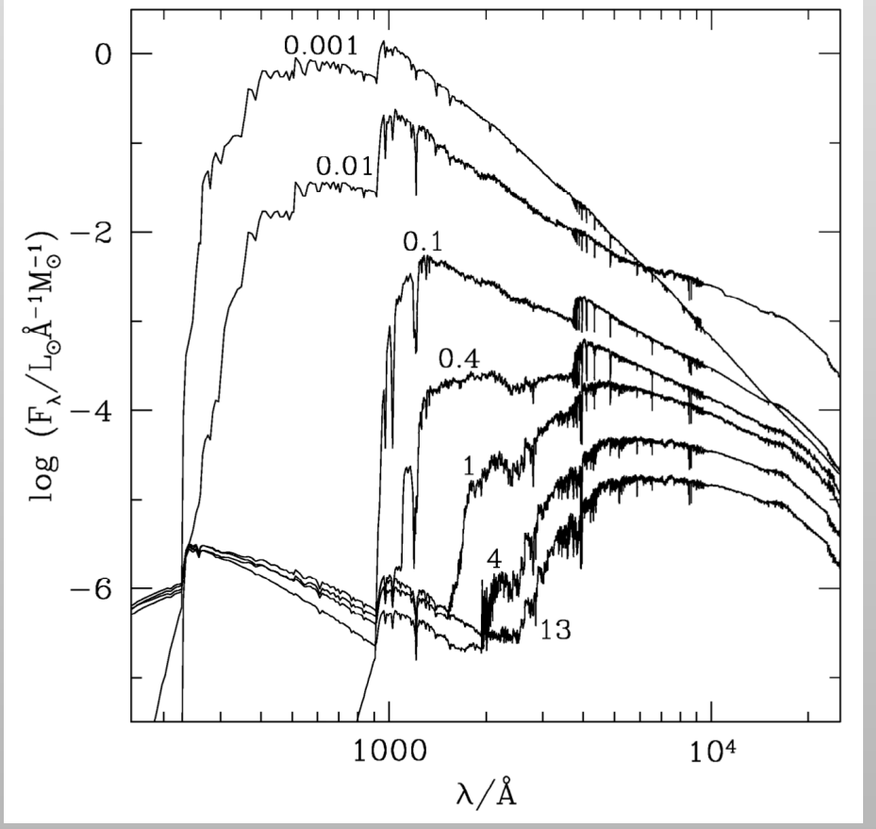


Ilbert+06

Simple empirical templates as CWW+Kinney



Limited set of models (GRASIL + BC03) Ilbert+09

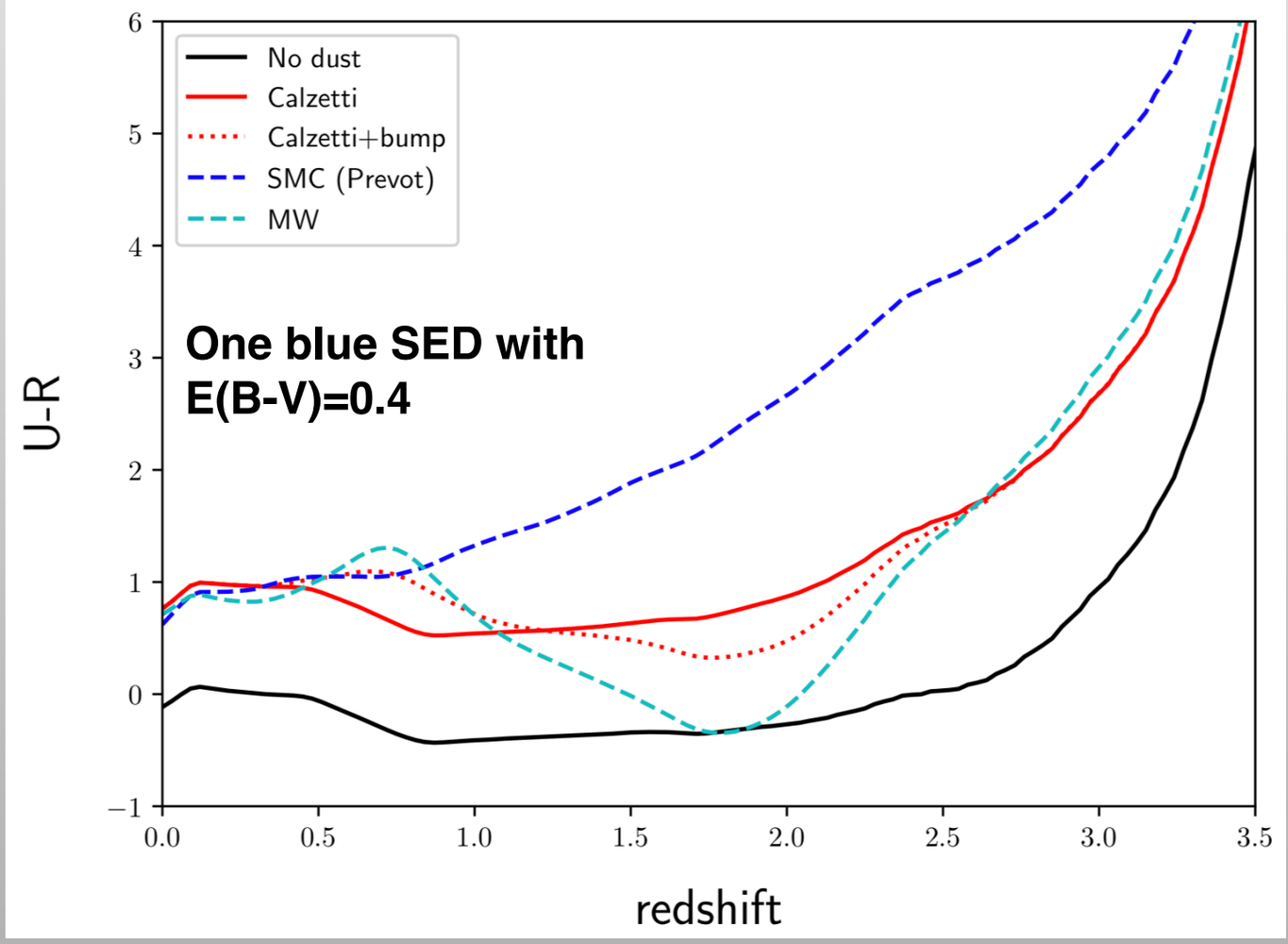


Physical models
➢ Complex Stellar Populations
Large library

Method

Dust attenuation

Several dust attenuation laws could be considered simultaneously

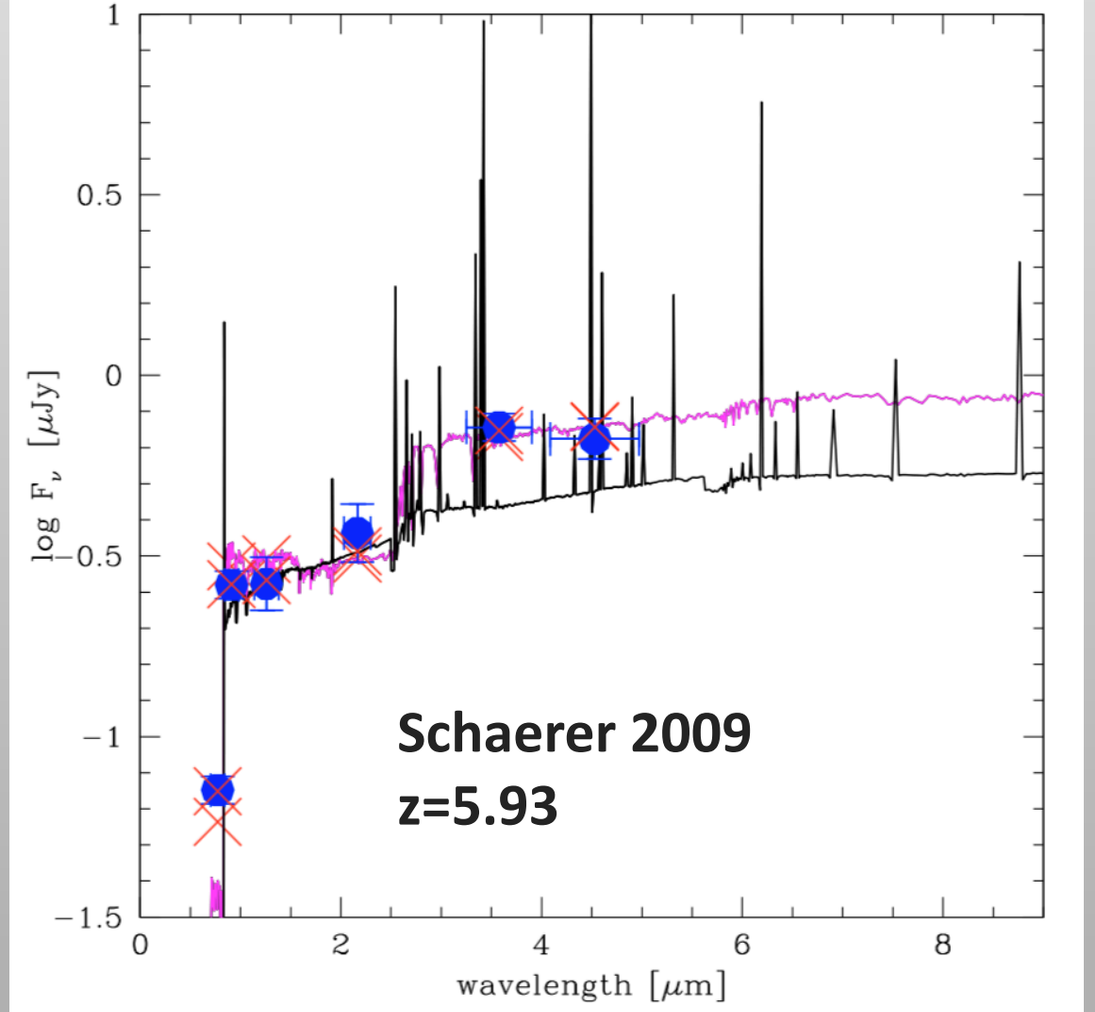


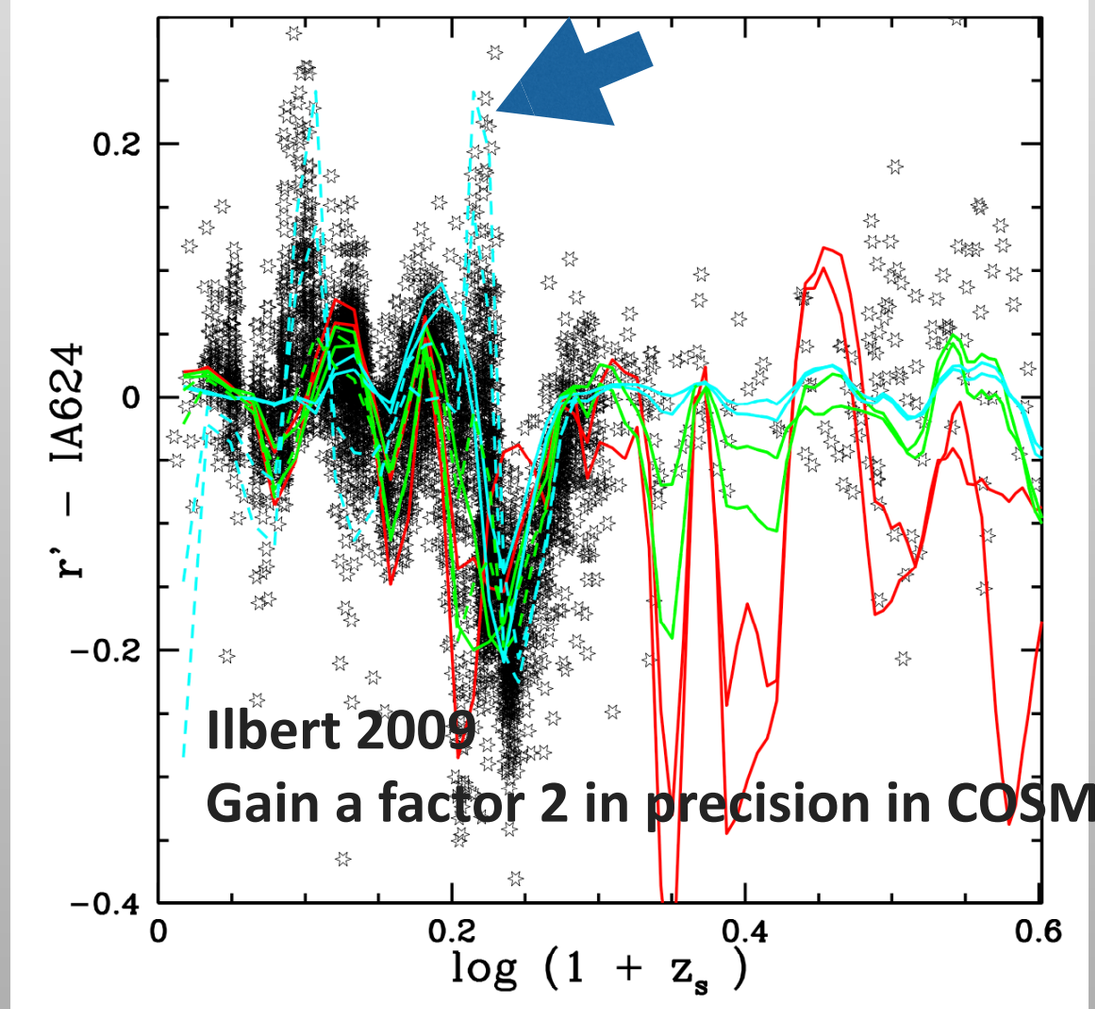
Method

Emission lines

Absolutely necessary, even with broad bands

Two possible recipes



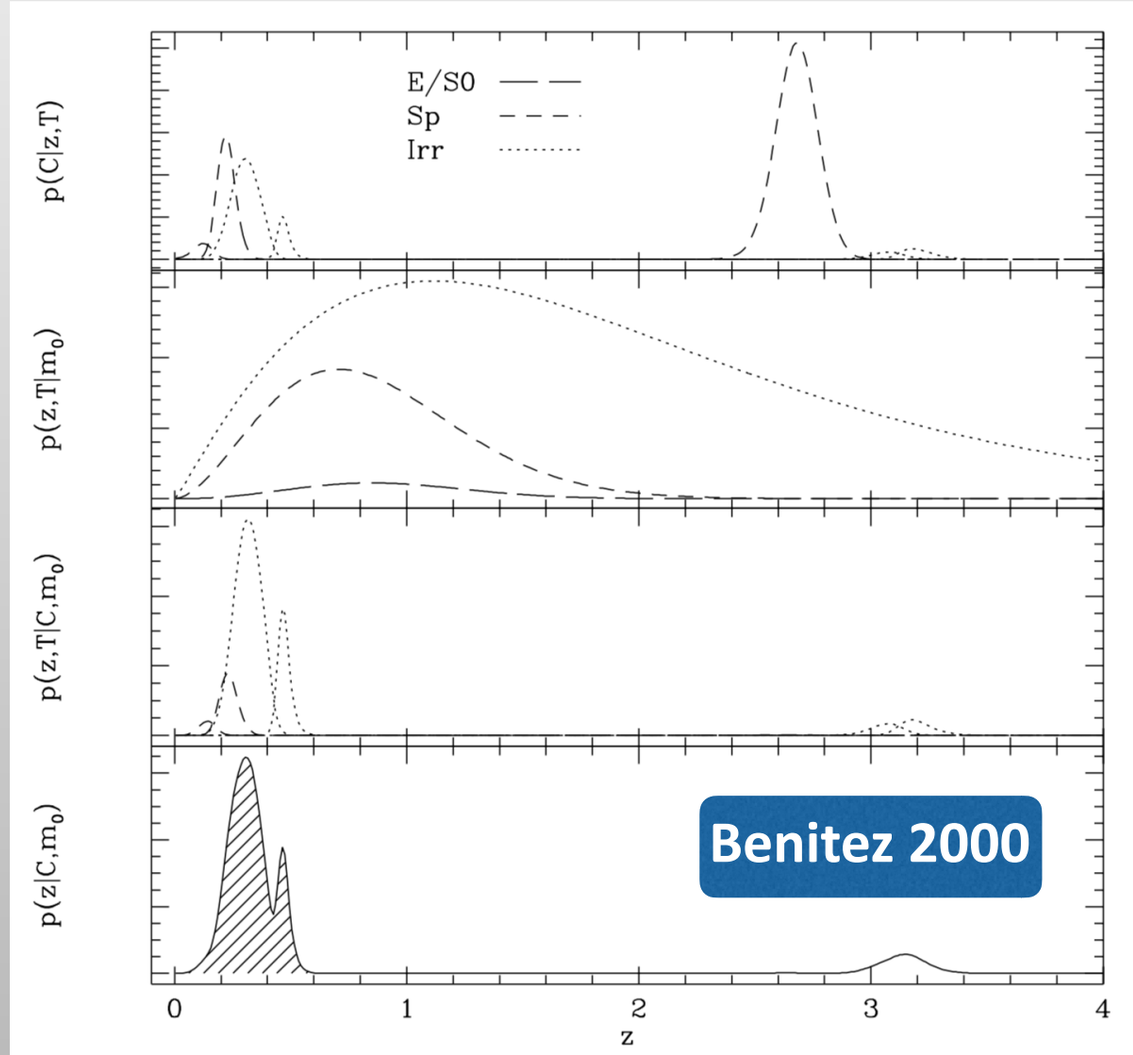


Method

Priors

Bayesian approach could be chosen to derive the PDF and then the photo-z

the plausibility of the corresponding values of z or T. On the contrary, Bayesian probability averages over all the likelihoods after weighting them by their prior probabilities, $p(z, T \mid m_0)$. In this way, the estimation is not affected by spurious likelihood peaks caused by noise (Fig. 2; see also



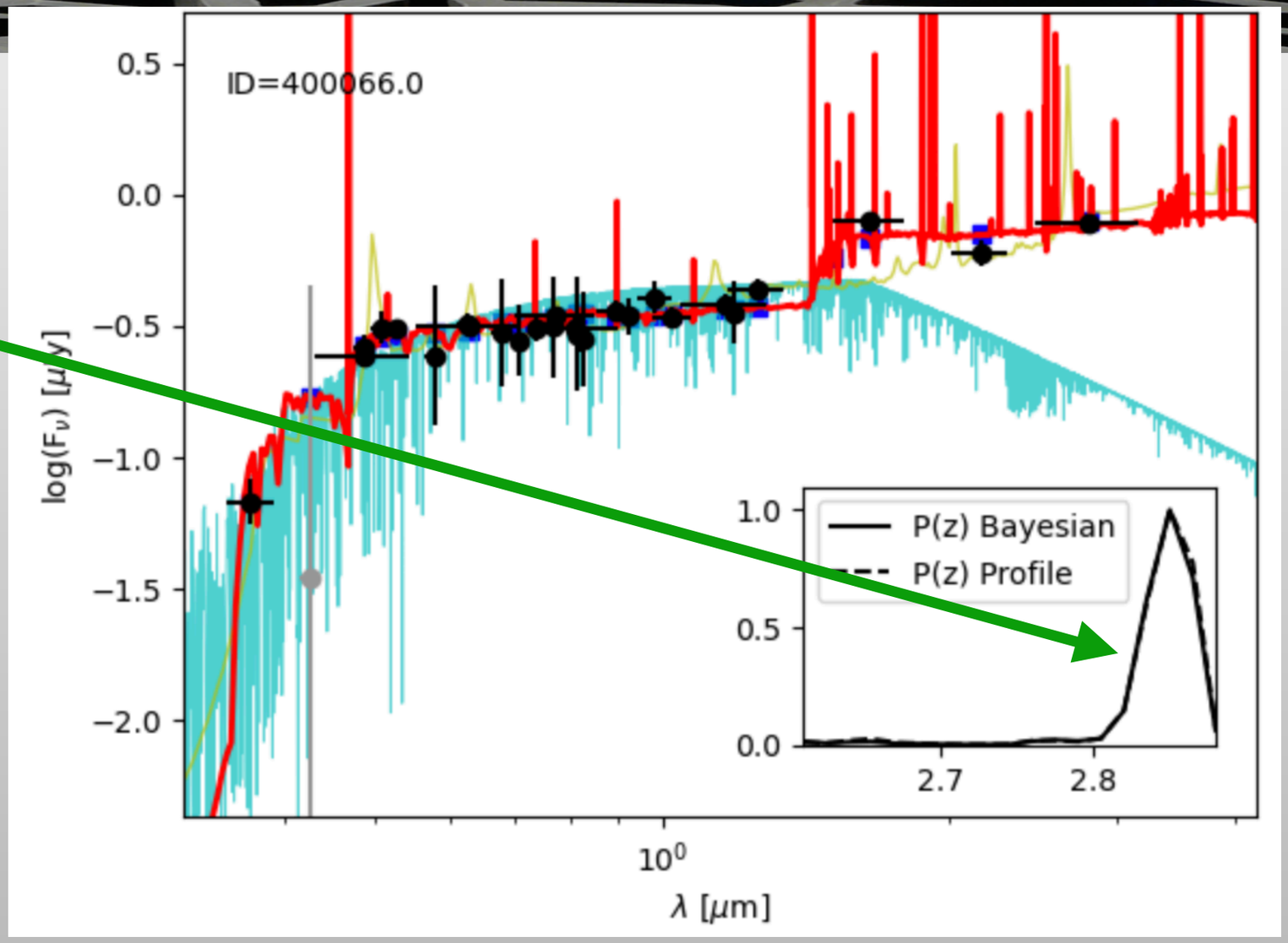
N(z) prior and simple priors on the absolute magnitude range

N(z) prior from Benitez 2000 but improved in Ilbert+2006

The output

Probability Distribution Function

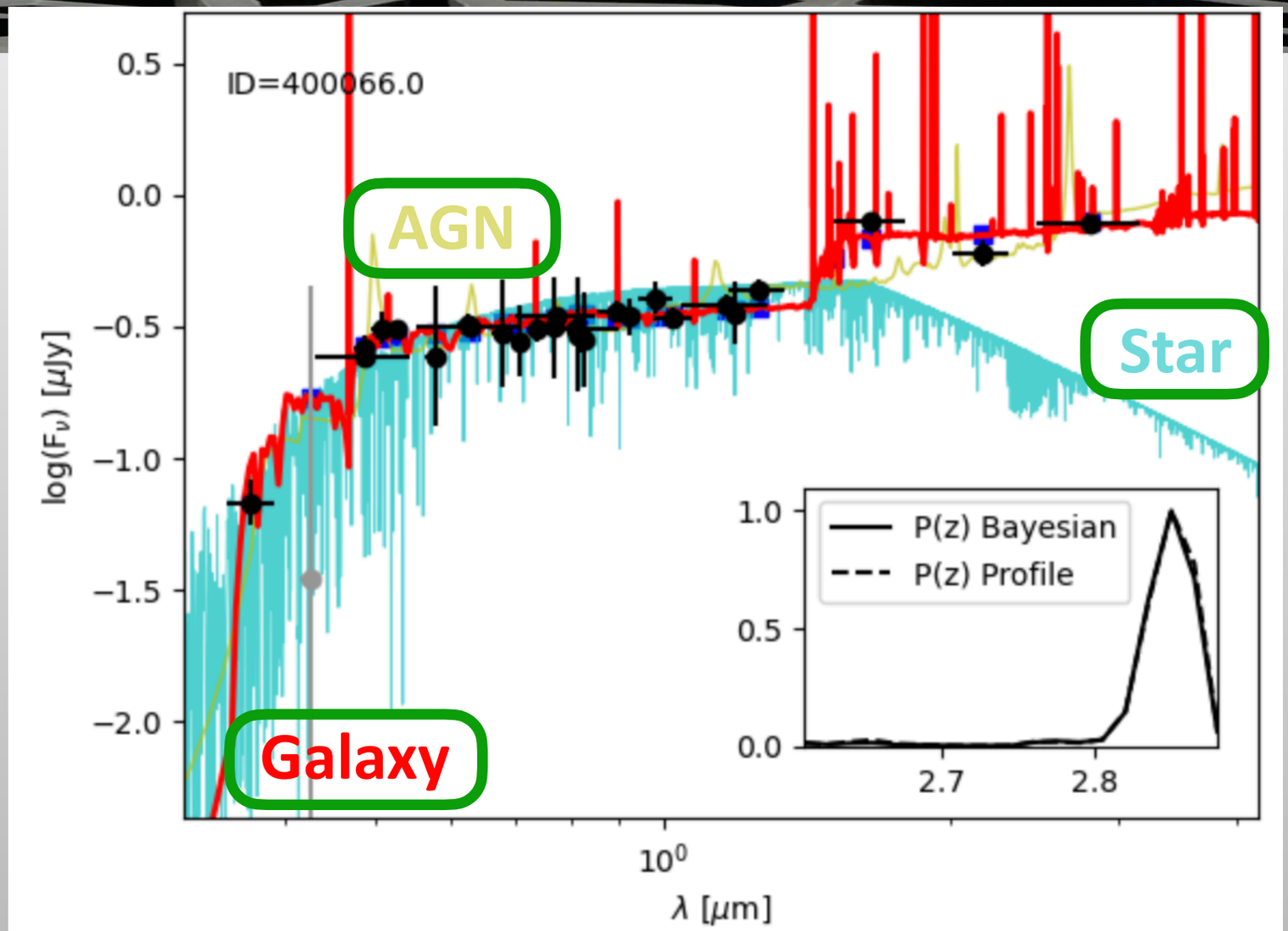
PDF and associated quantities as point estimates and 68% uncertainties



The output
Classification

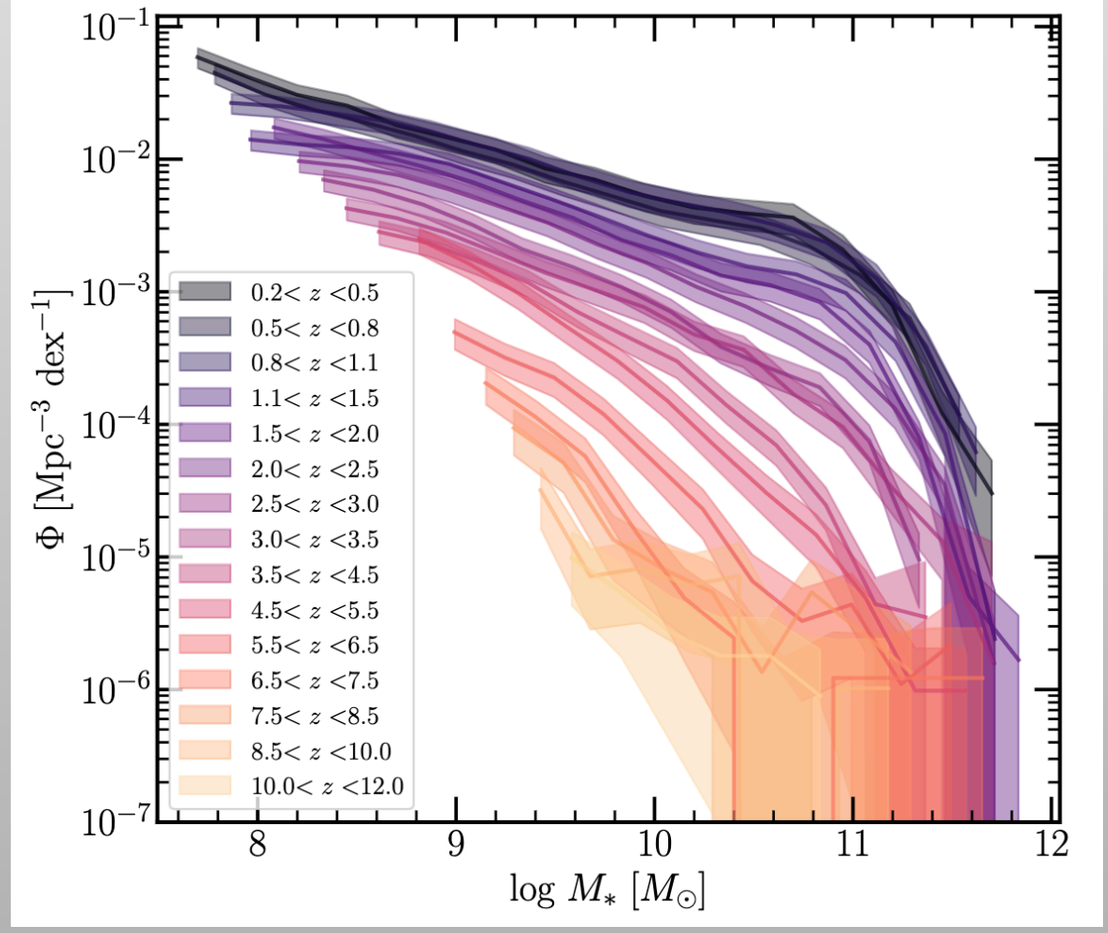
Run the galaxies/stars/AGN libraries separately

➢ minimum χ^2 associated to each library

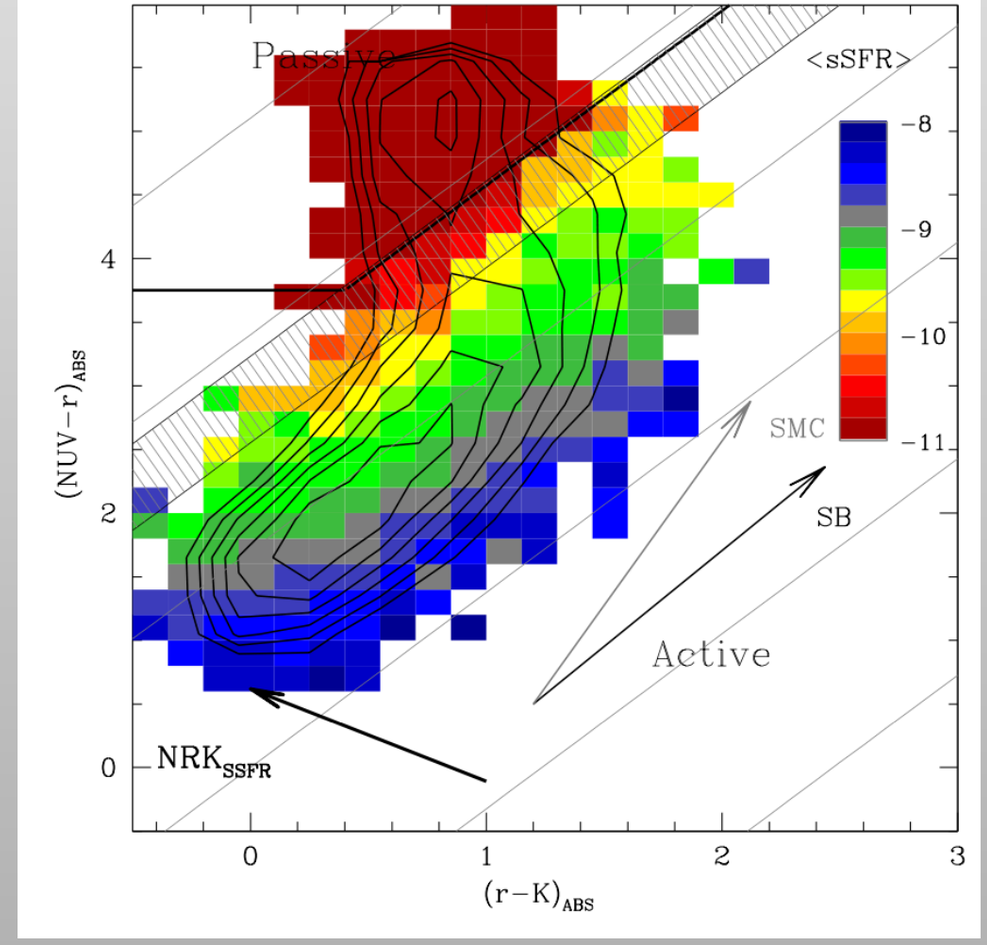


The output
Physical parameters

Extract of the physical properties and associated PDF
For instance: stellar masses, rest-frame colors, SFR, specific SFR, E(B-V), …



Shuntov+24



Arnouts+13

Recent evolution

work lead by Raphael Shirley

LSST Interdisciplinary Network for Collaborattion and Computing

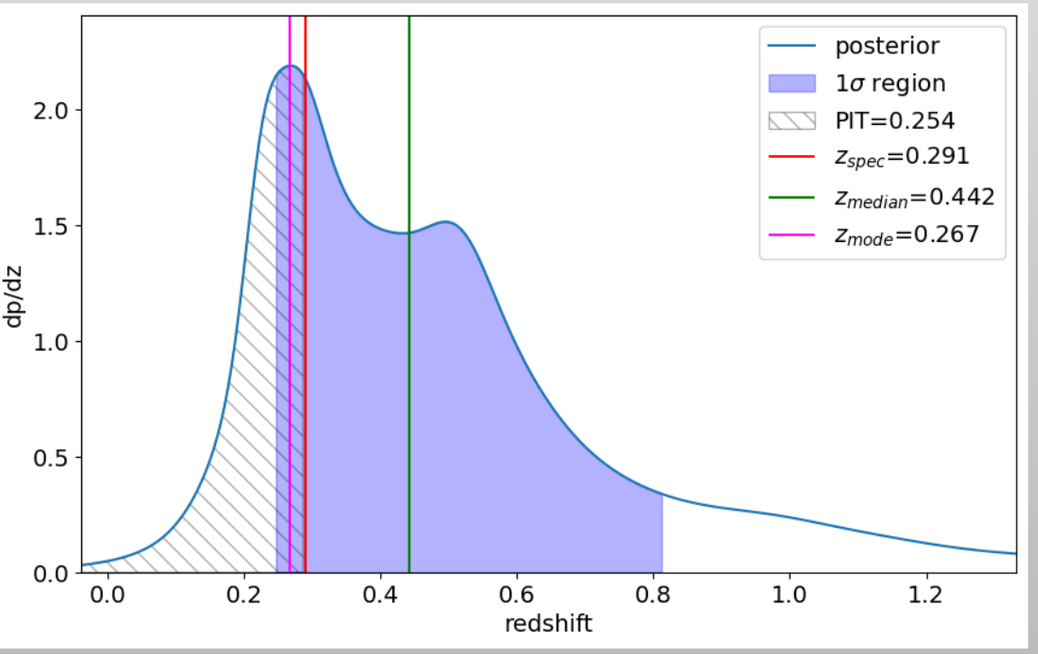
- **$22k**
- **3 months with software developers, Drew Oldag (UW), Olivia Lynn (CM), Jeremy Kubica (CM), in addition to Raphael Shirley and Johann Cohen-Tanugi**
- **Feb 17 to May 17**
- **Moving from GitLab to GitHub**
- **CI/CD with mac deployment**
- **RAIL interface via Python**
- **pip install lephare – experimental stage**

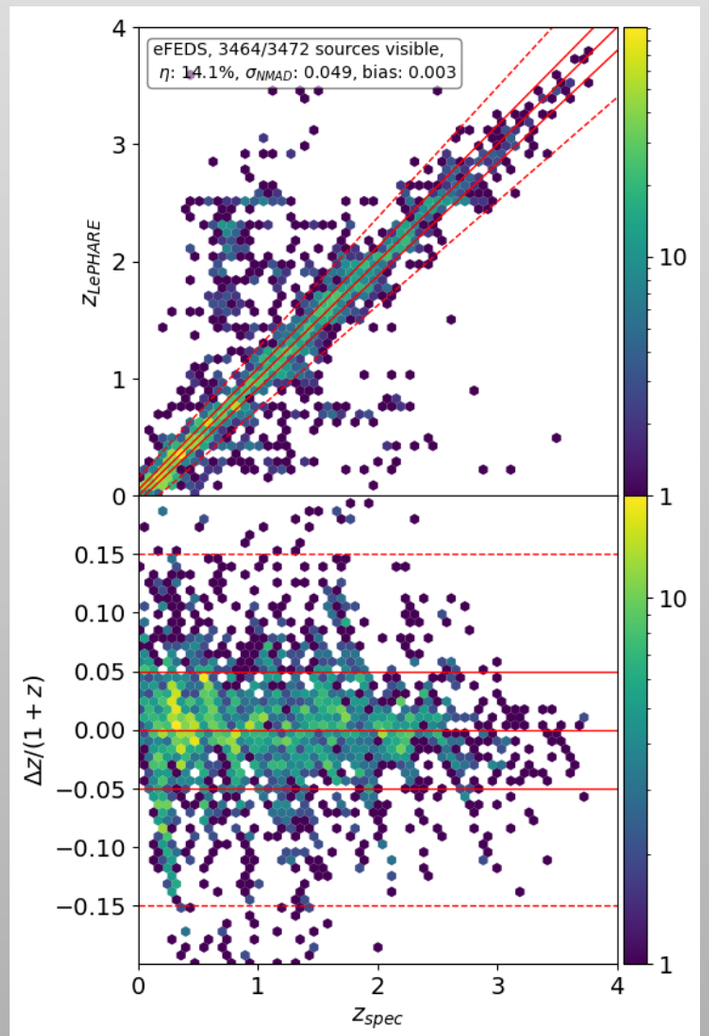
RAIL

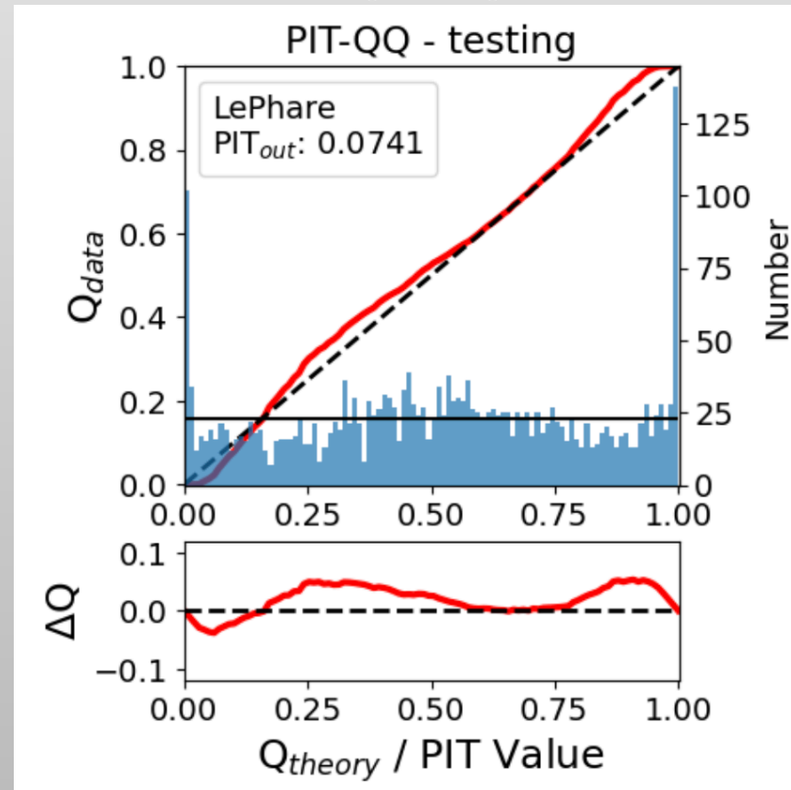
Redshift Assessment and Infrastructure Layers

Visualisation of various metrics

Point estimate performance and Probability Integral Transform (PIT) distributions.







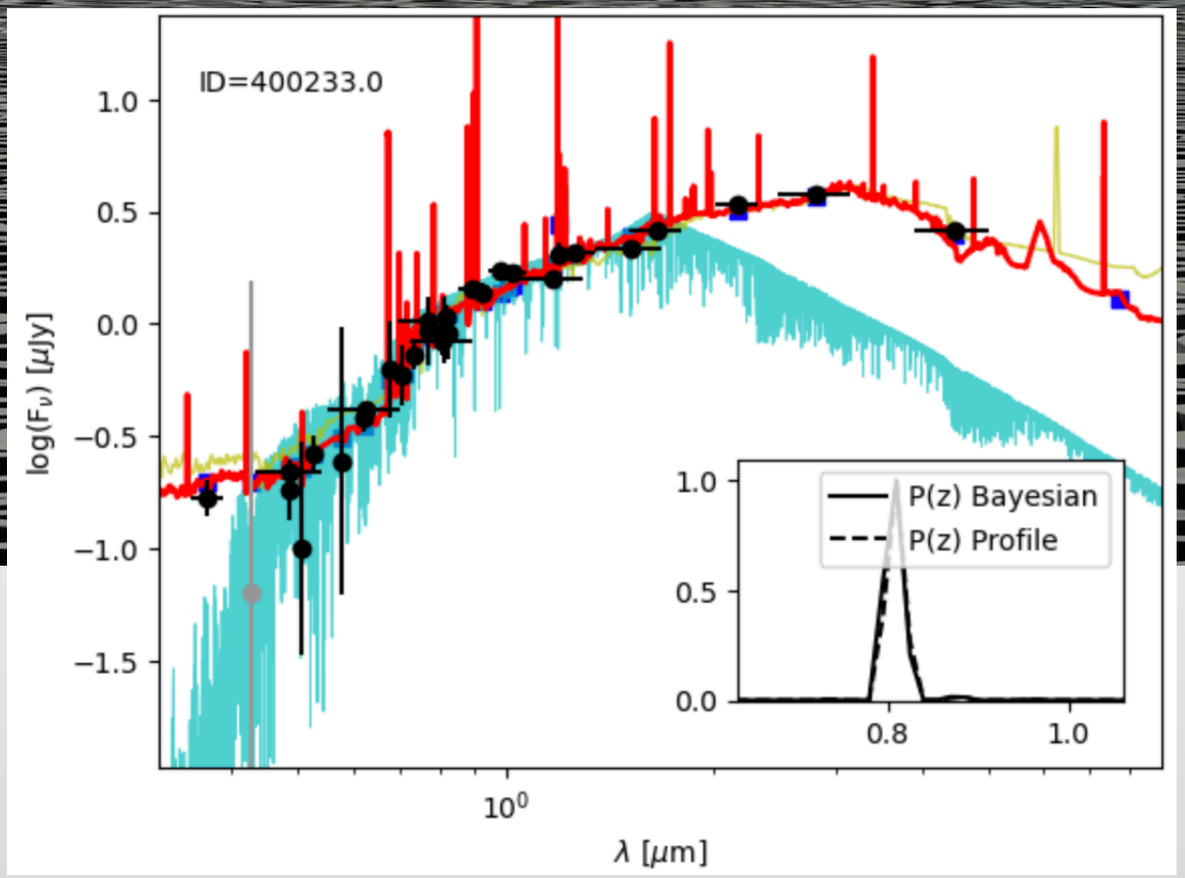
Schmidt et al. 2020

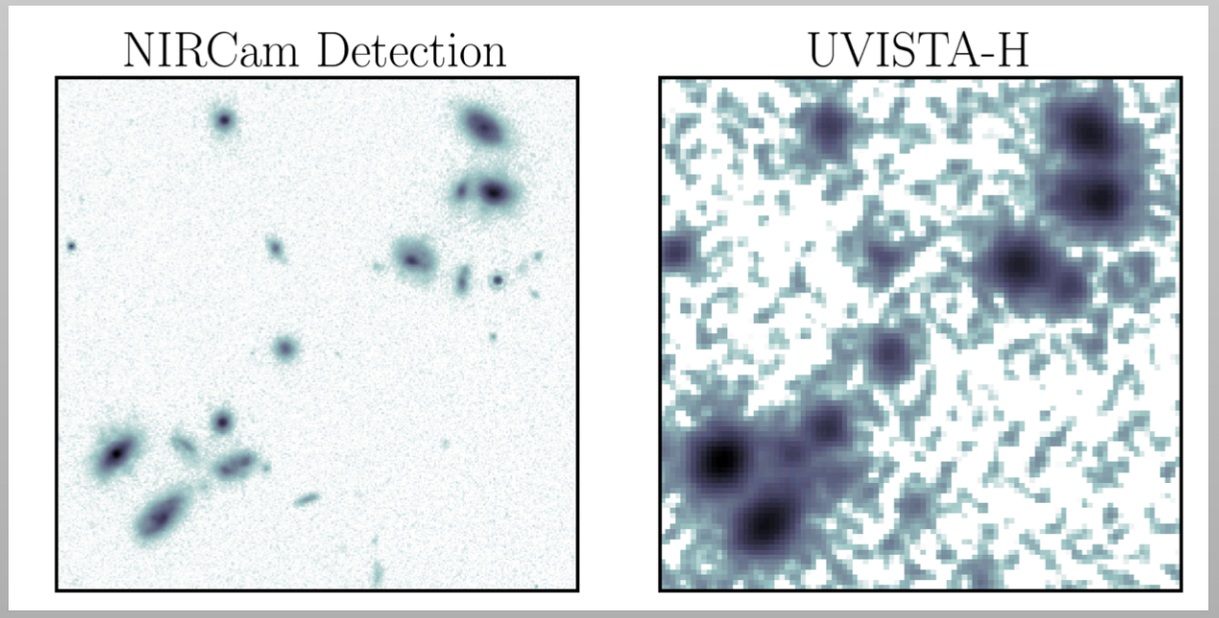
LePHARE
Ongoing and future steps

- **Documentation for the github and RAIL version**
- **Include CLAUDS/HSC as test in RAIL**
- **Optimize the configuration for LSST**

- **German inkind contribution led by M. Salvato and Raphaël Shirley**
  - **Developing LePHARE AGN capacities targeted towards LSST but for general multiwavelength surveys**
  - **Add new prior functionalities**

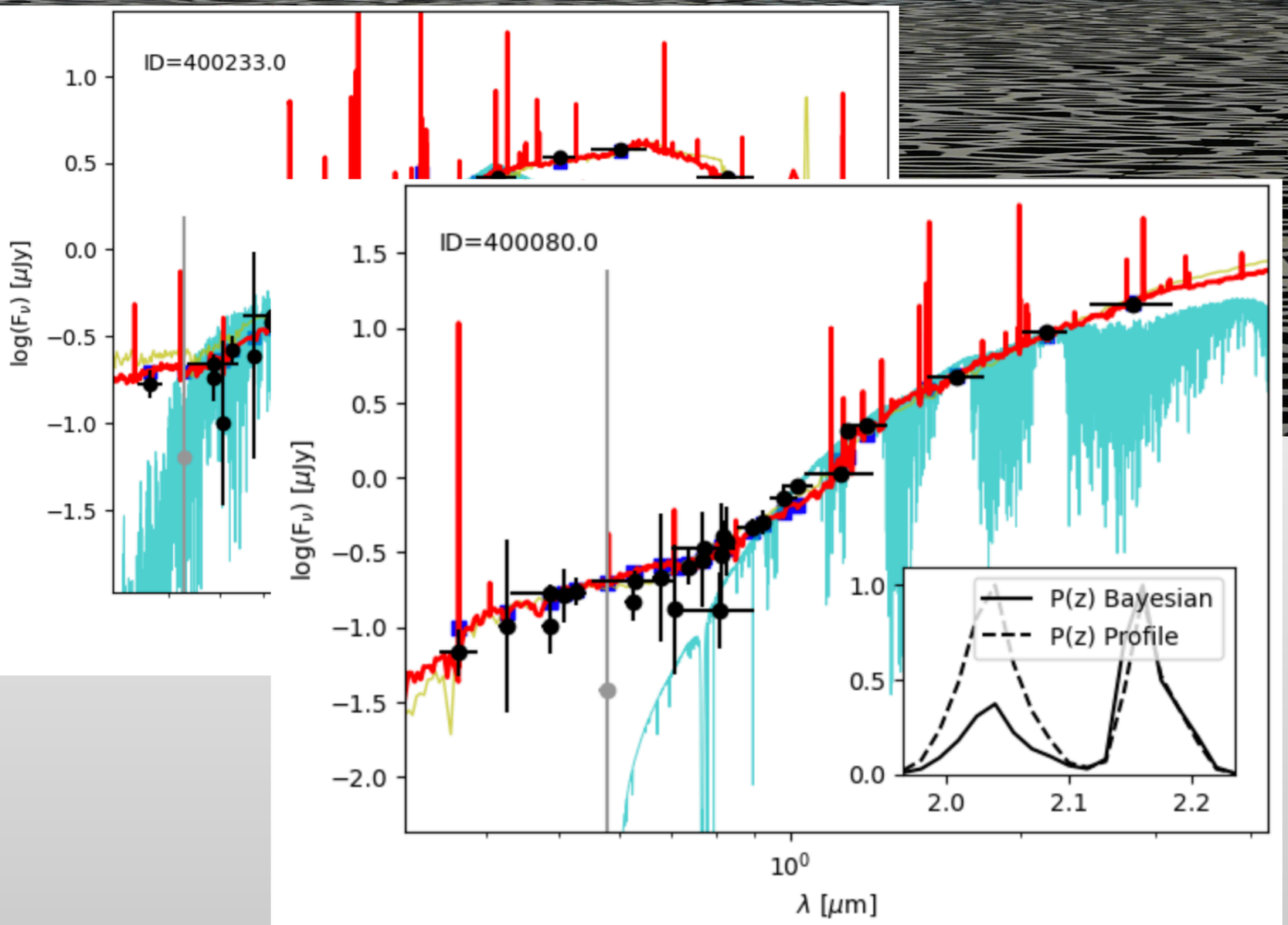
- **Always improve the physics/codes based on our current work, specially COSMOS-Web**

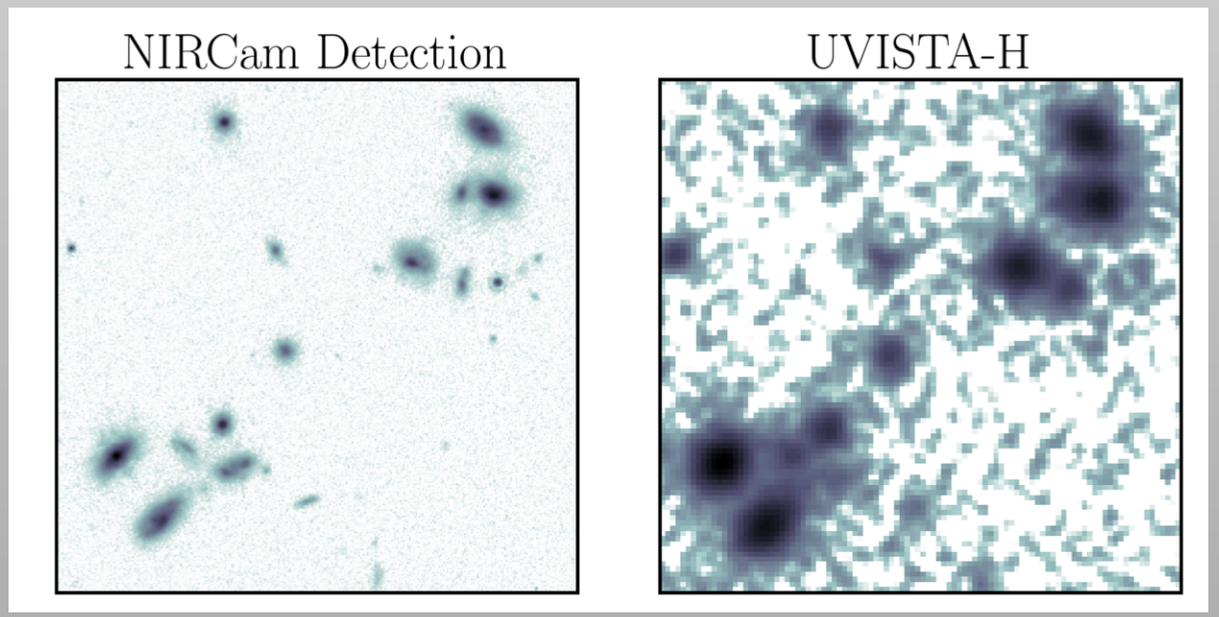




Ground based + JWST data on COSMOS

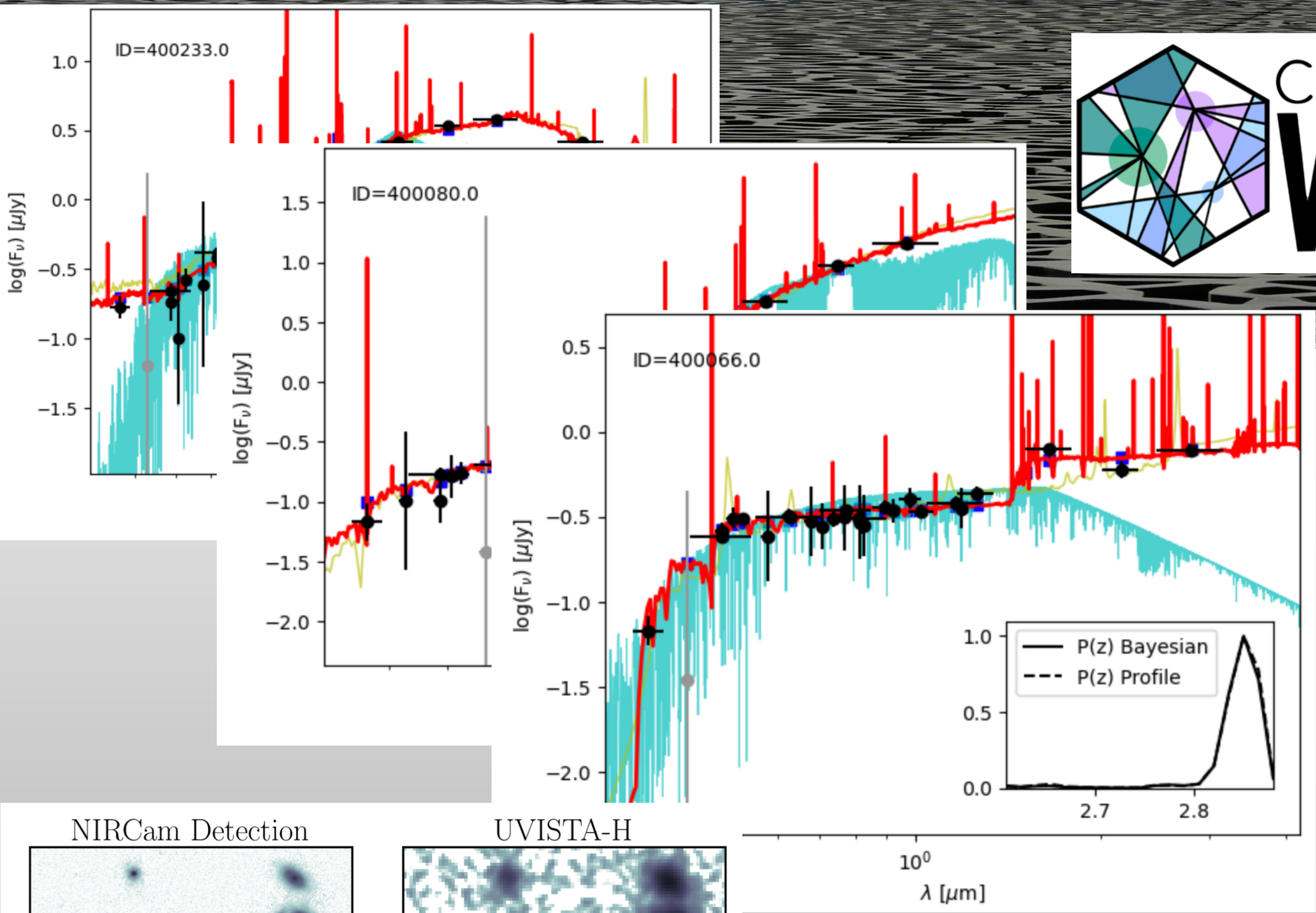
Shuntov, Paquereau et al., in prep

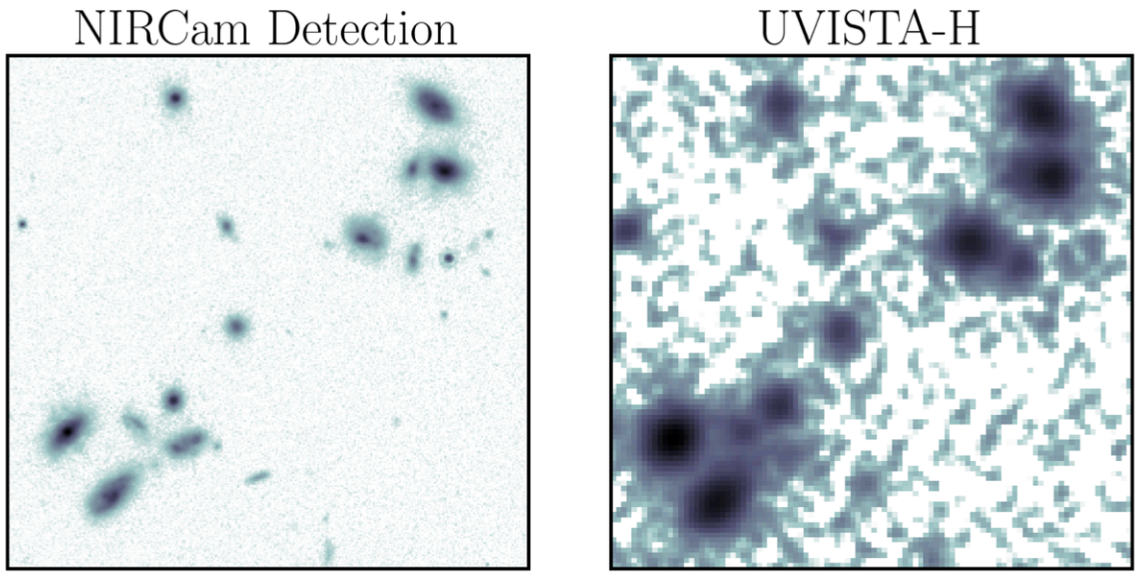




Ground based + JWST data on COSMOS

Shuntov, Paquereau et al., in prep

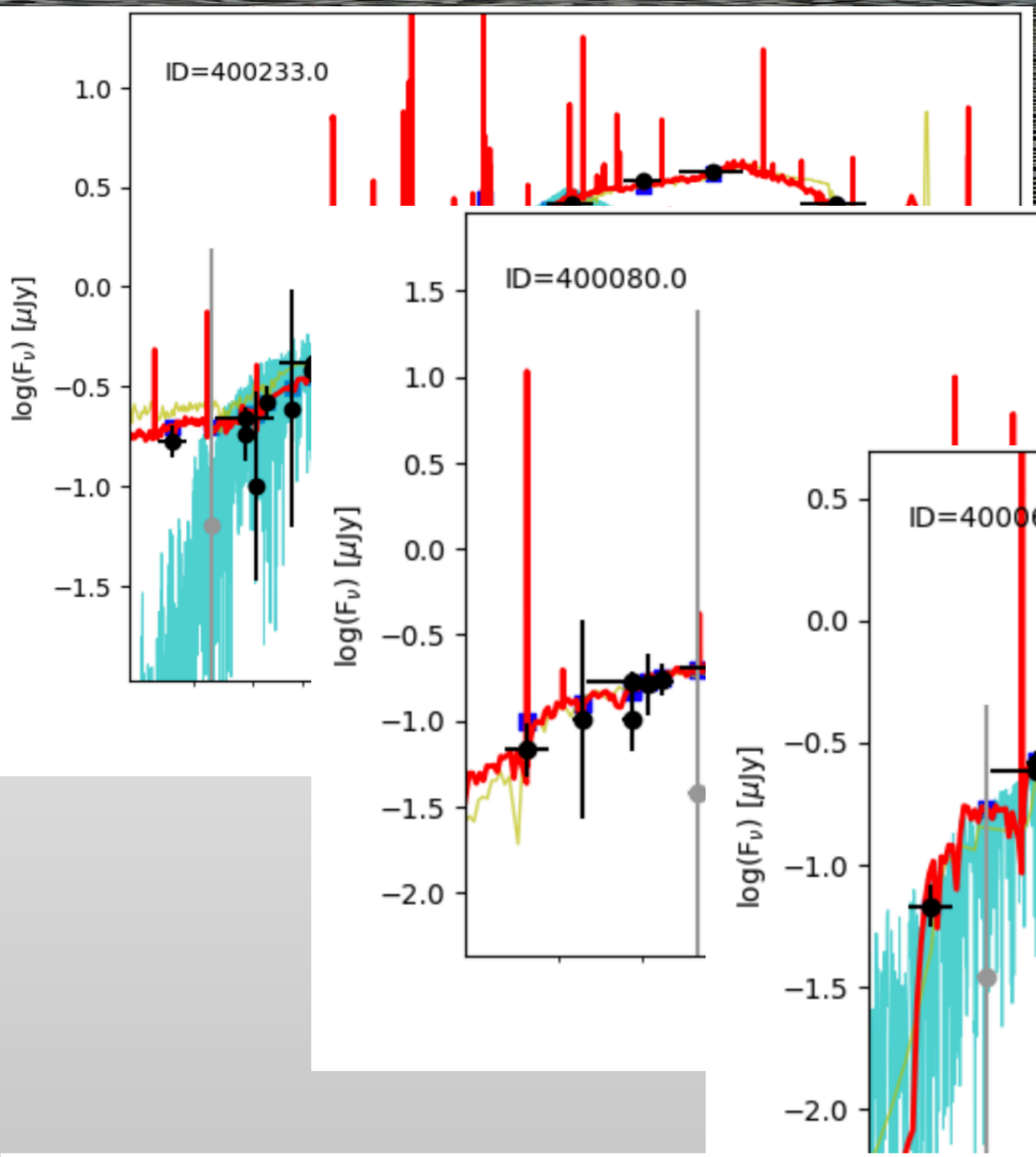


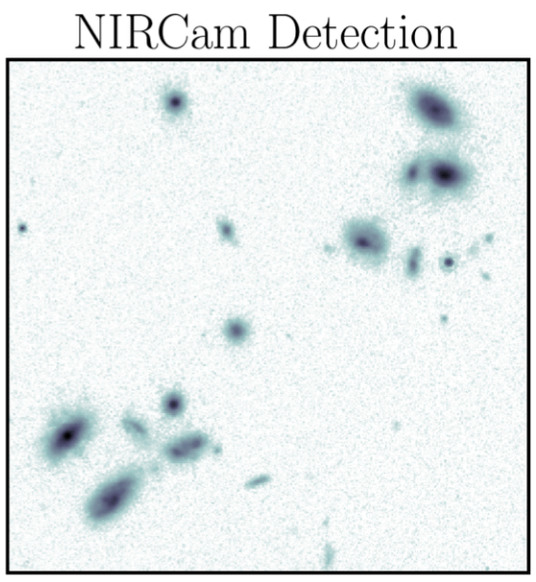


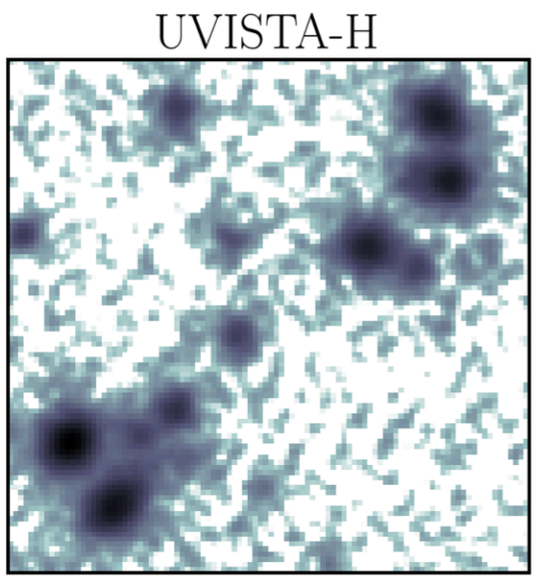
Ground based + JWST data on COSMOS

Shuntov, Paquereau et al., in prep

COSMOS WEB







Ground based + JWST data on COSMOS

Shuntov, Paquereau et al., in prep