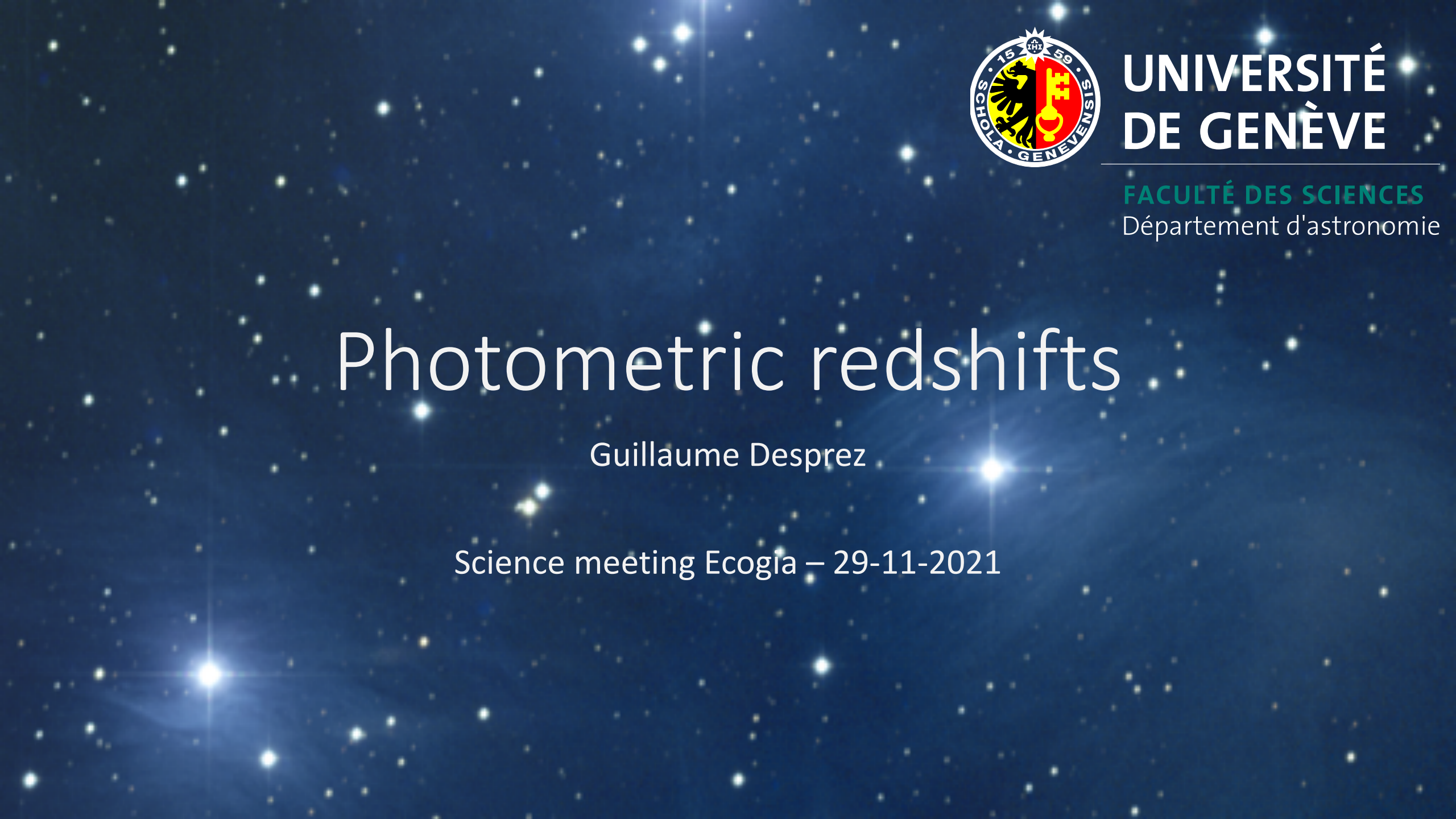


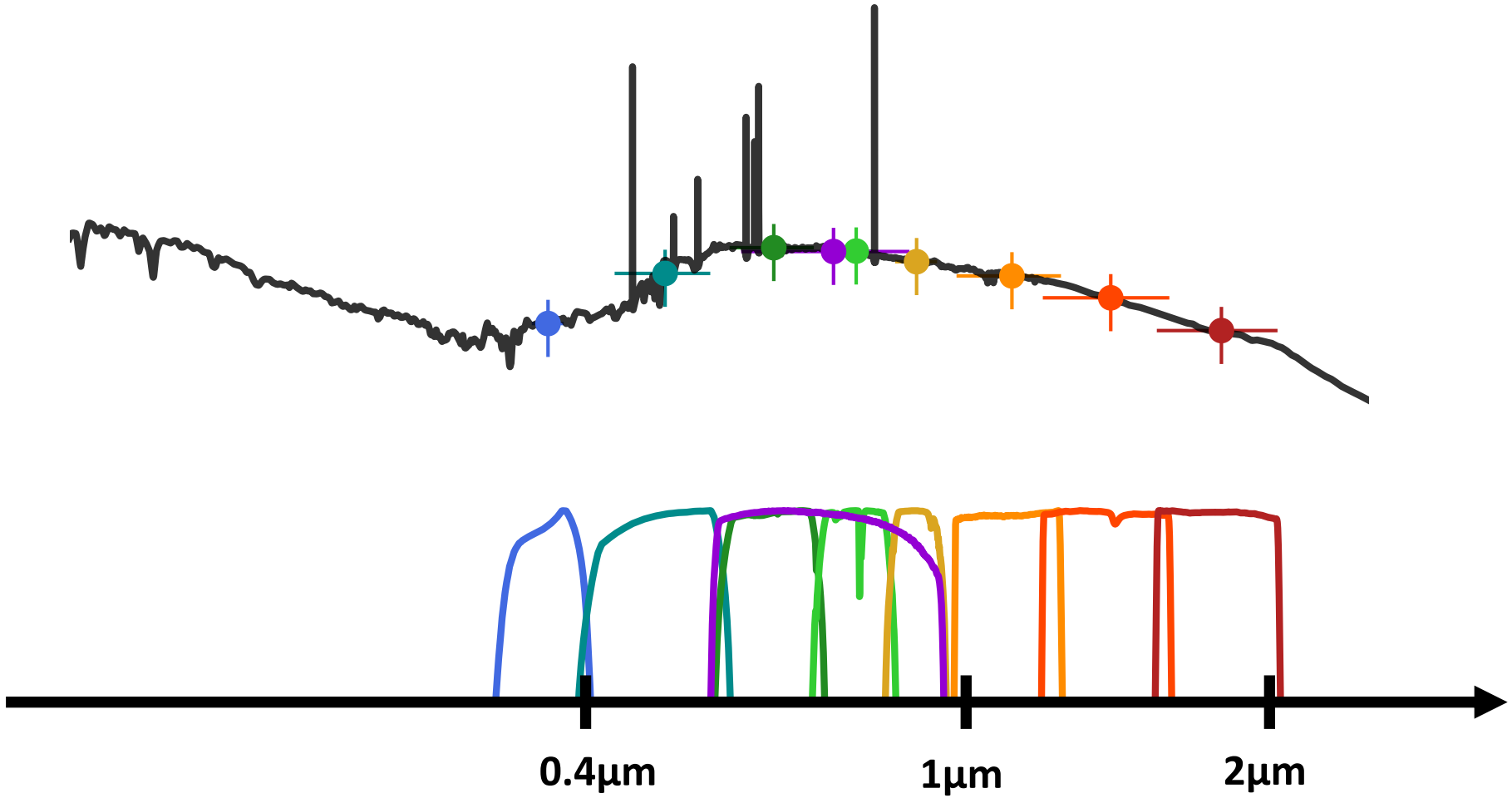
UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département d'astronomie

Photometric redshifts

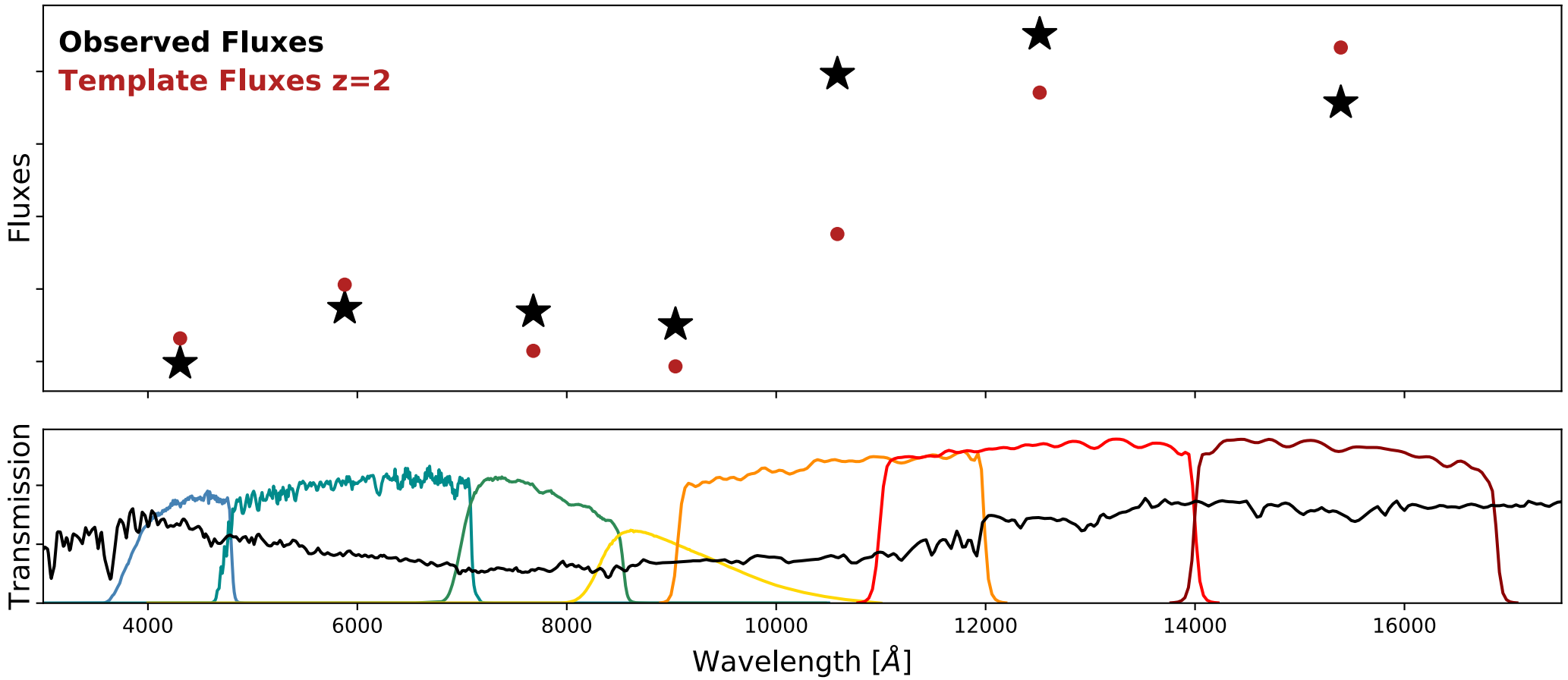
Guillaume Desprez

Science meeting Ecogia – 29-11-2021

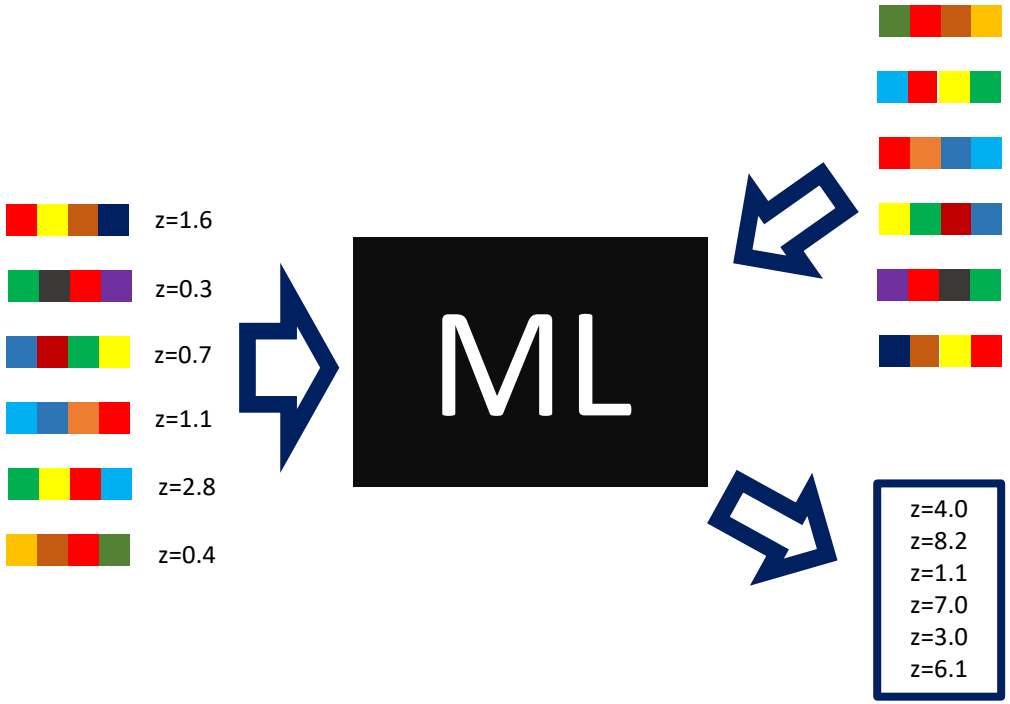
Principle of photo-z’s

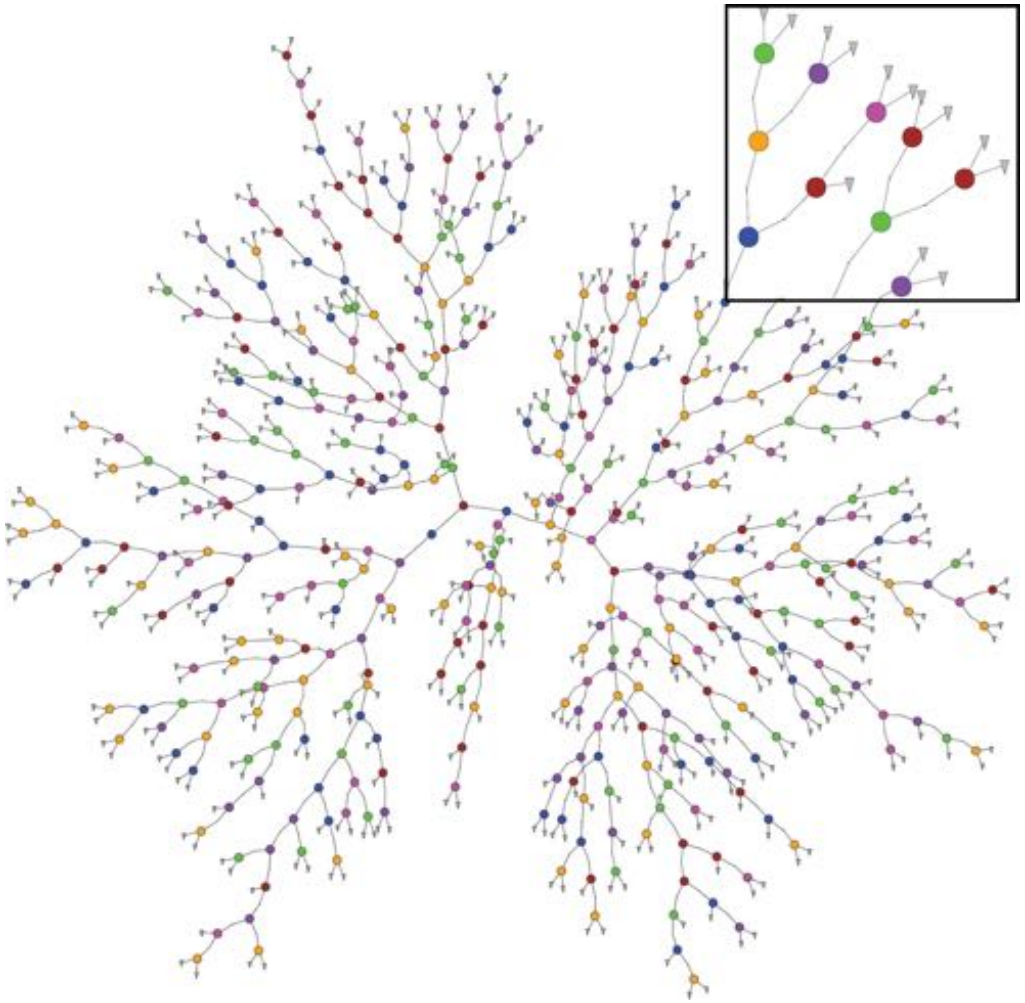


Template fitting



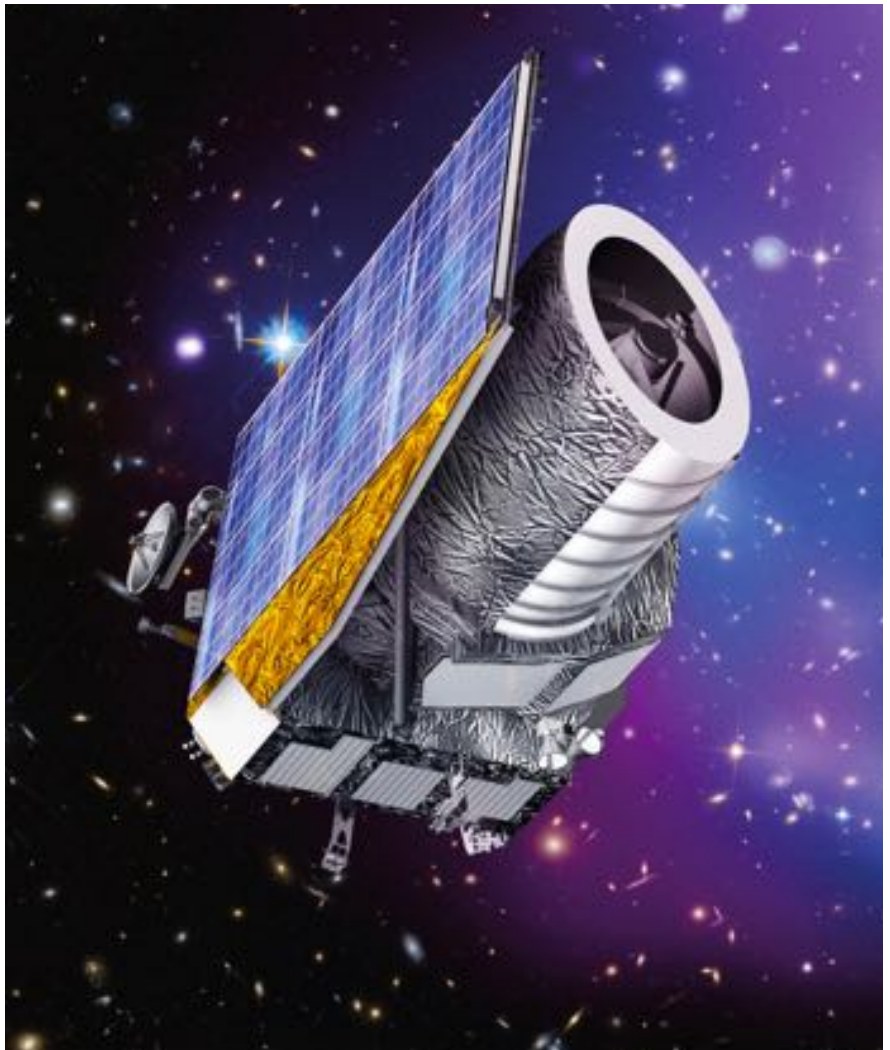
Machine Learning





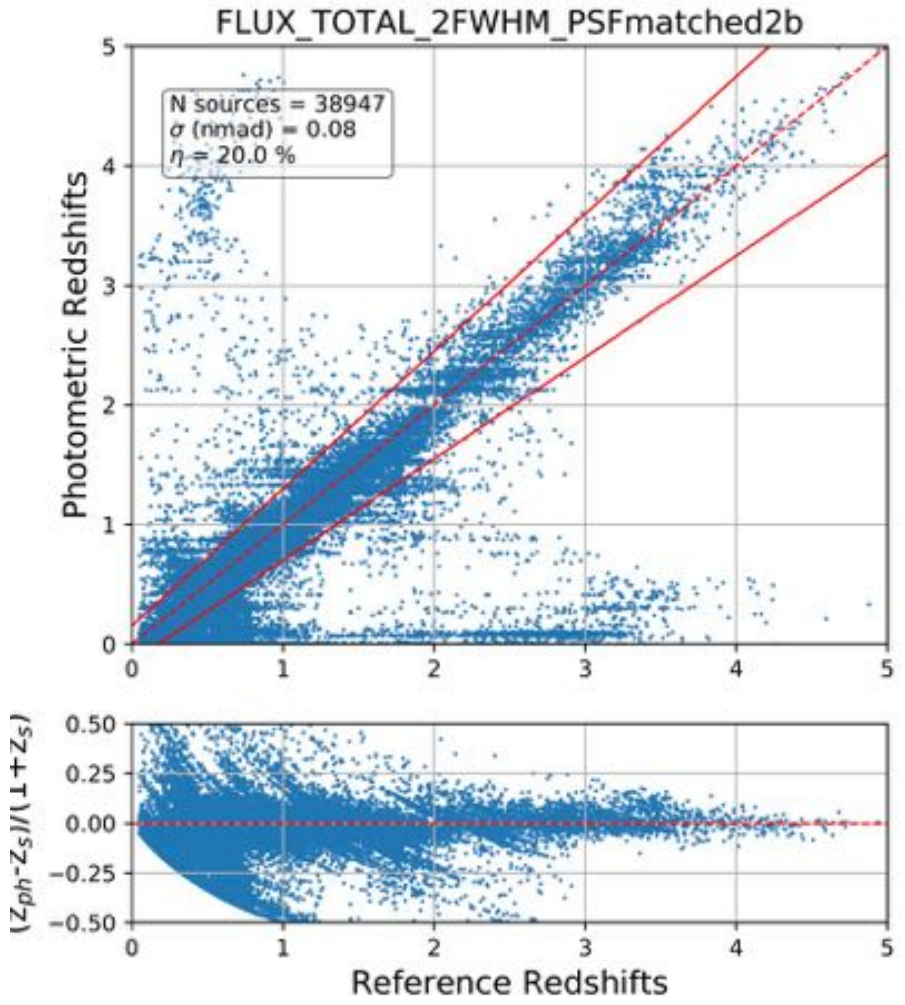
Euclid

- Launch early 2023
- Mission to observe all the extra-galactic sky: ~ 10 billions galaxies over 15’000 deg^2
- Optical and Near infra-red observation from space + Optical from the ground
- Science goals:
  - BAO
  - cosmic shear

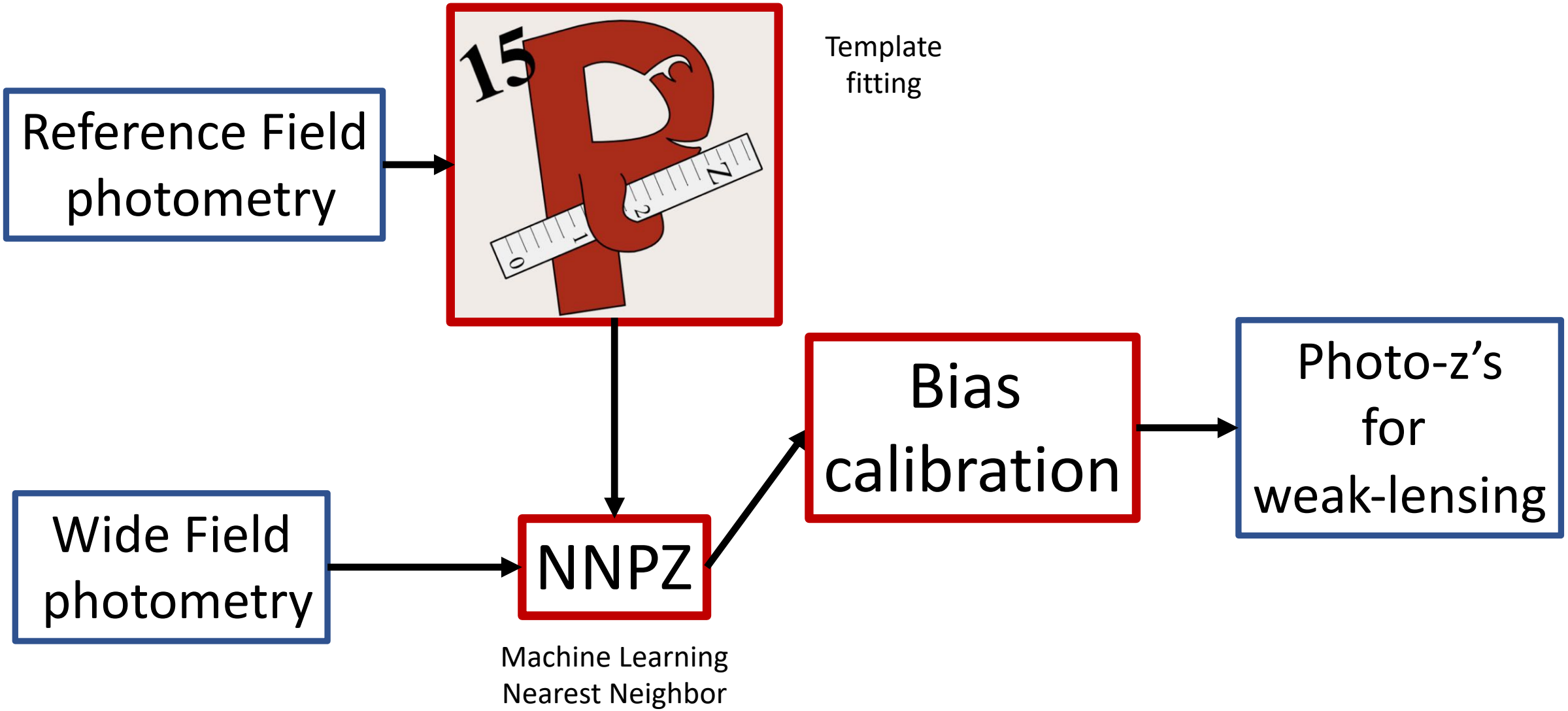


Requirements for cosmic shear

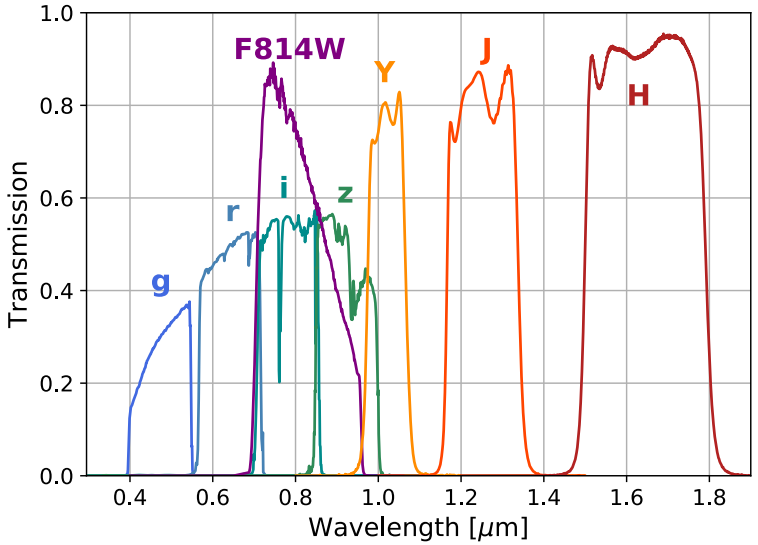
- 30 galaxies arcmin^{-2}
- 12 tomographic bins from 0.2 to 2.6
- σ (<$\mathbf{\Delta}$z>) < 0.002(1+z)
- σ_z < 0.05(1+z)
- $\boldsymbol{\eta}$ < 10%

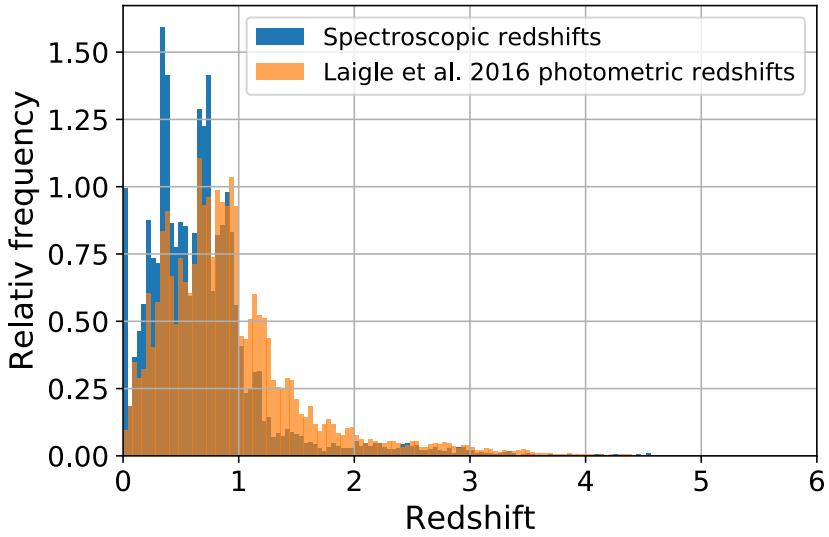


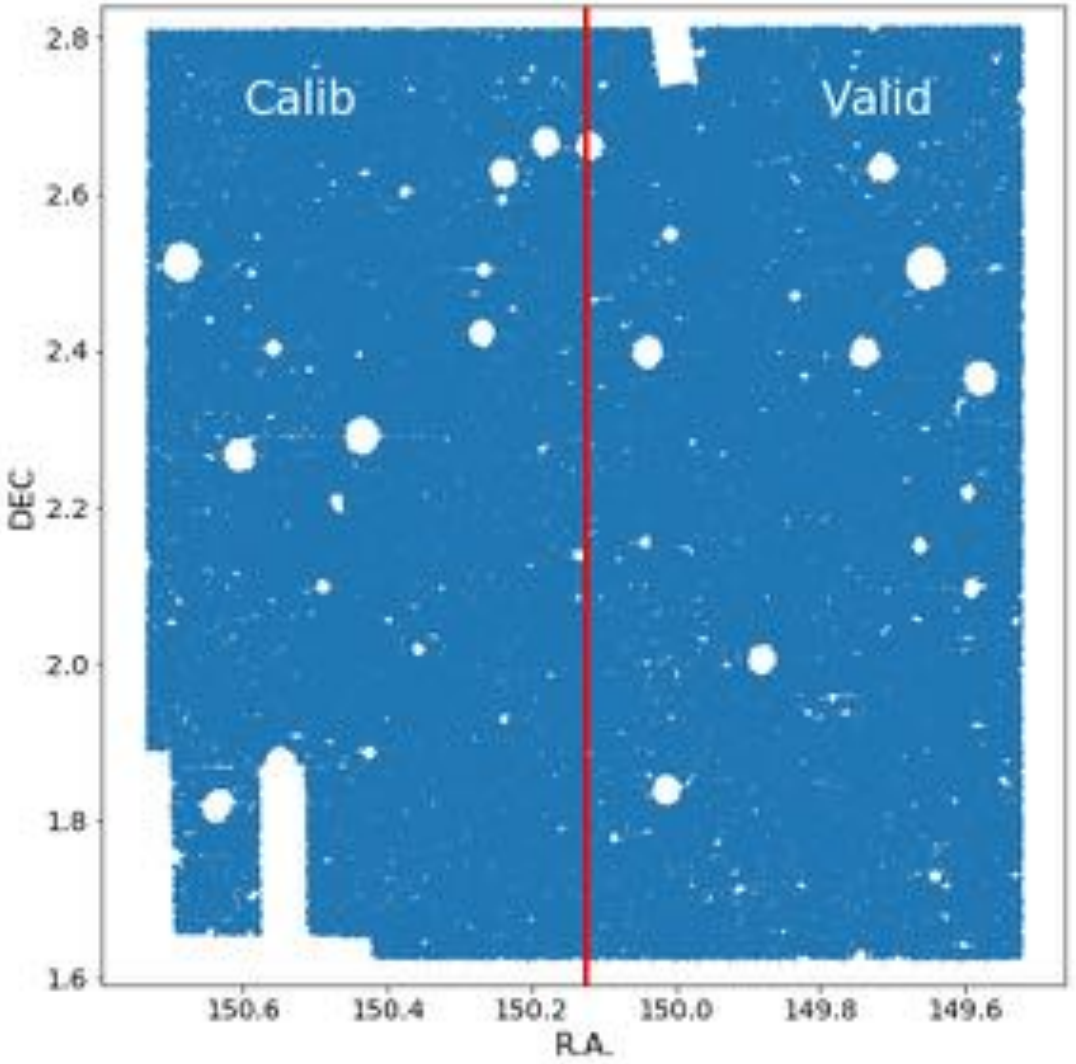
Euclid photo-z pipepline baseline (simplified)



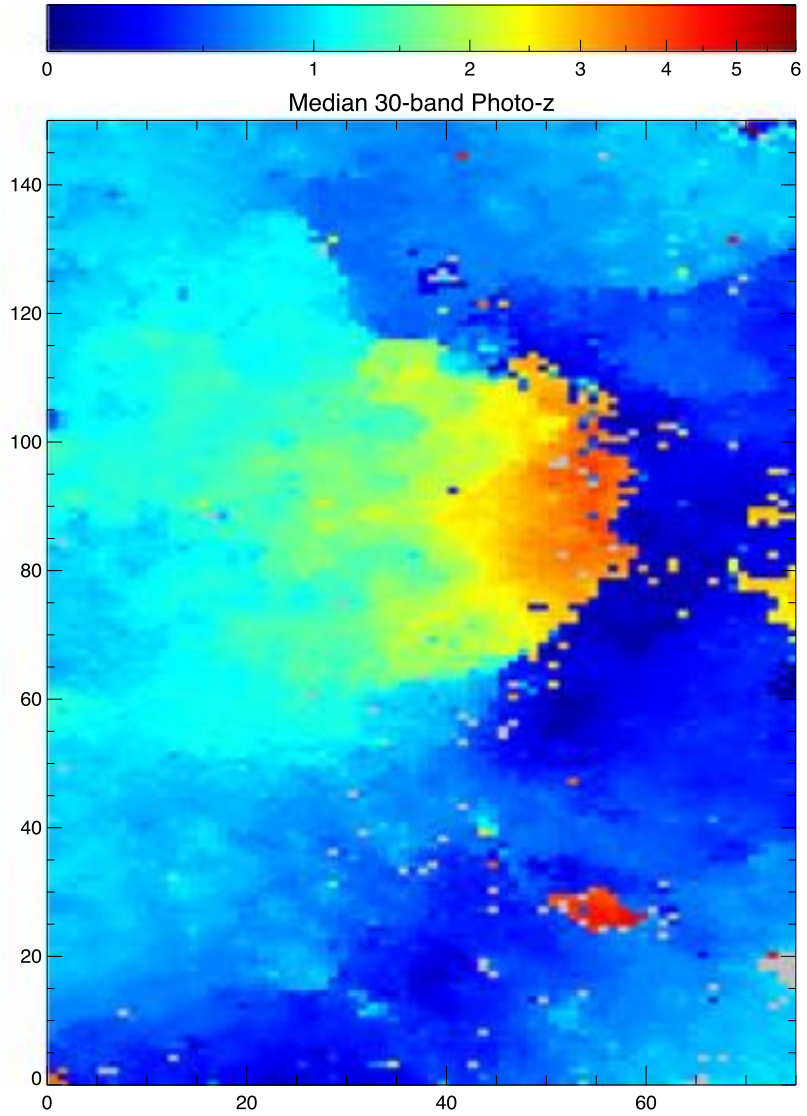
Euclid photo-z challenge

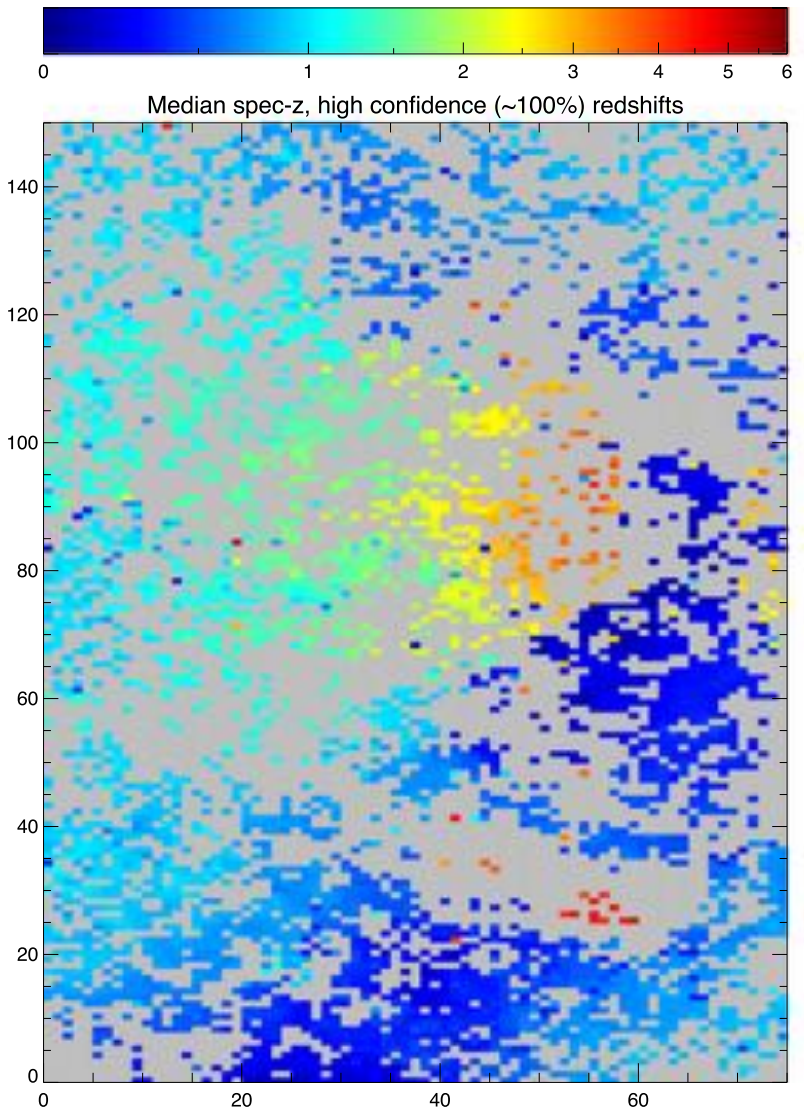




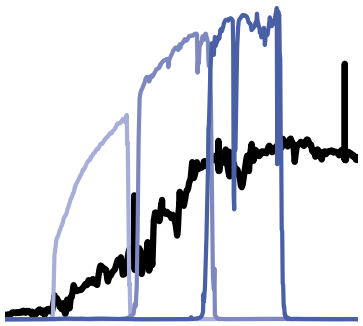


Bias calibration through SOM



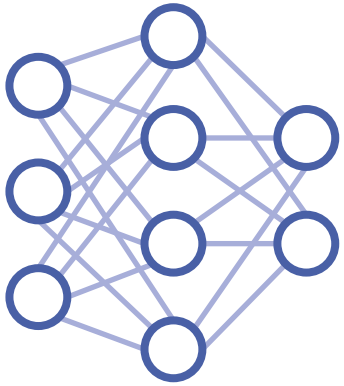


The methods



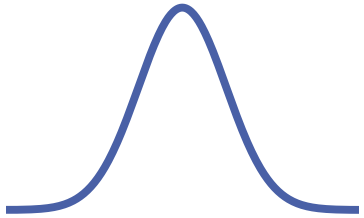
Template fitting

Le Phare
CPz
Phosphoros
EAzY



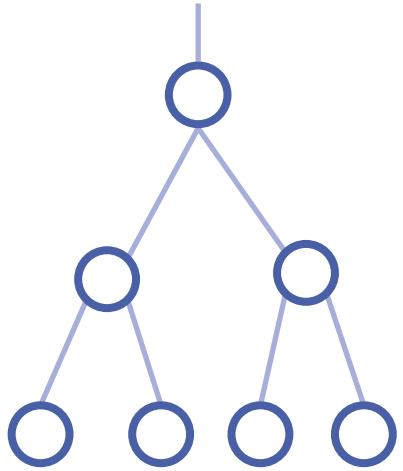
Neural Network

METAPHOR
ANNz



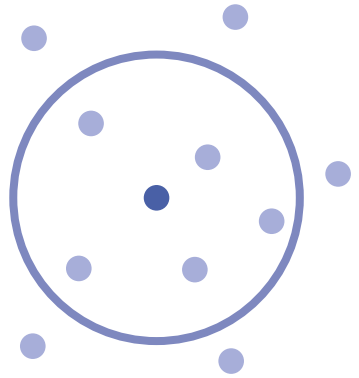
Gaussian Processes

GPz



Decision trees

GBRT
Random Forest
Adaboost

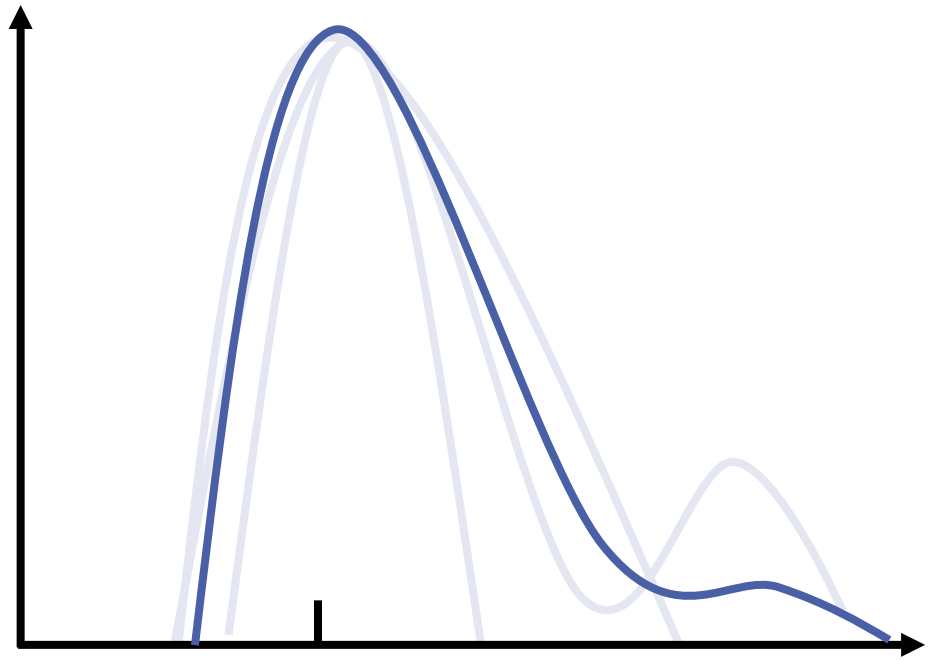


Nearest Neighbor

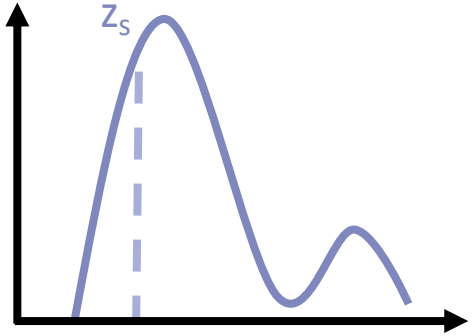
DNF
frankenz
NNPZ

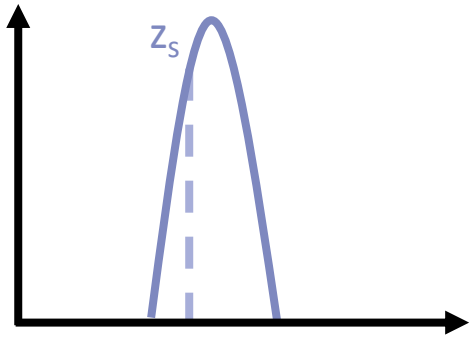
Have to provide for each source : z probability distribution function (PDZ) + quality flag

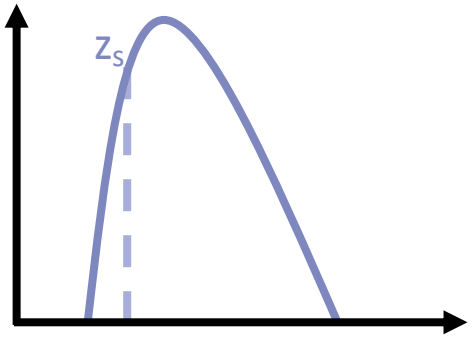
PDZ metrics



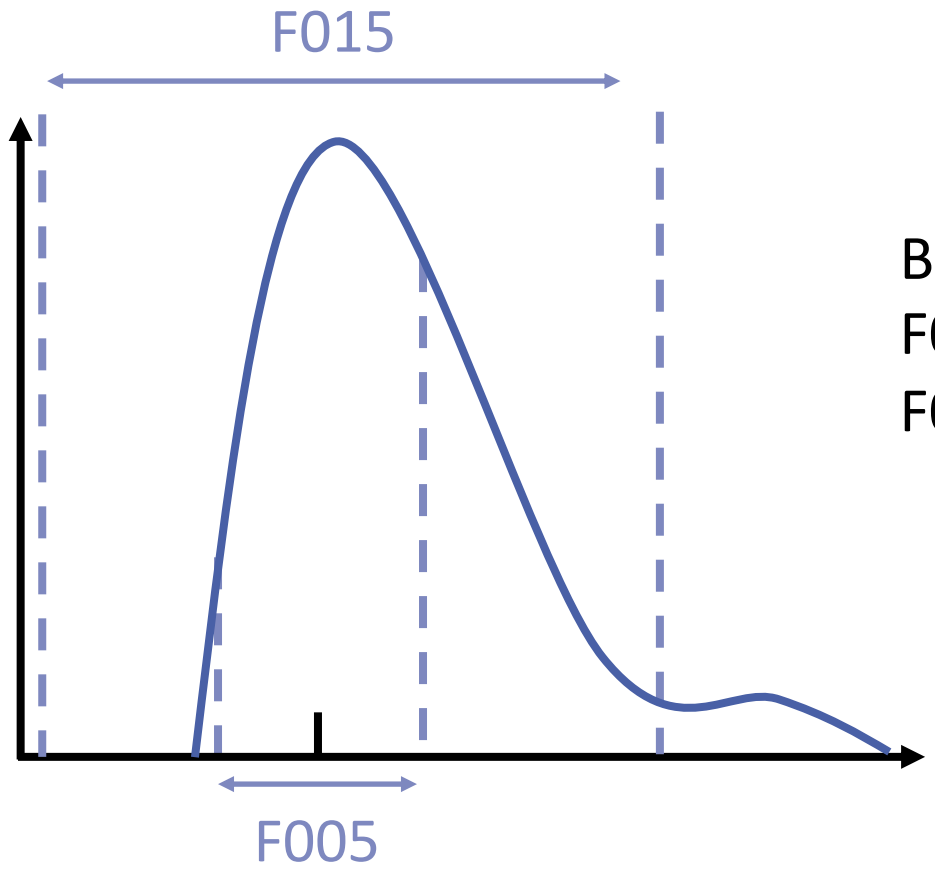
PDZs shifted by the spec-z values and stacked







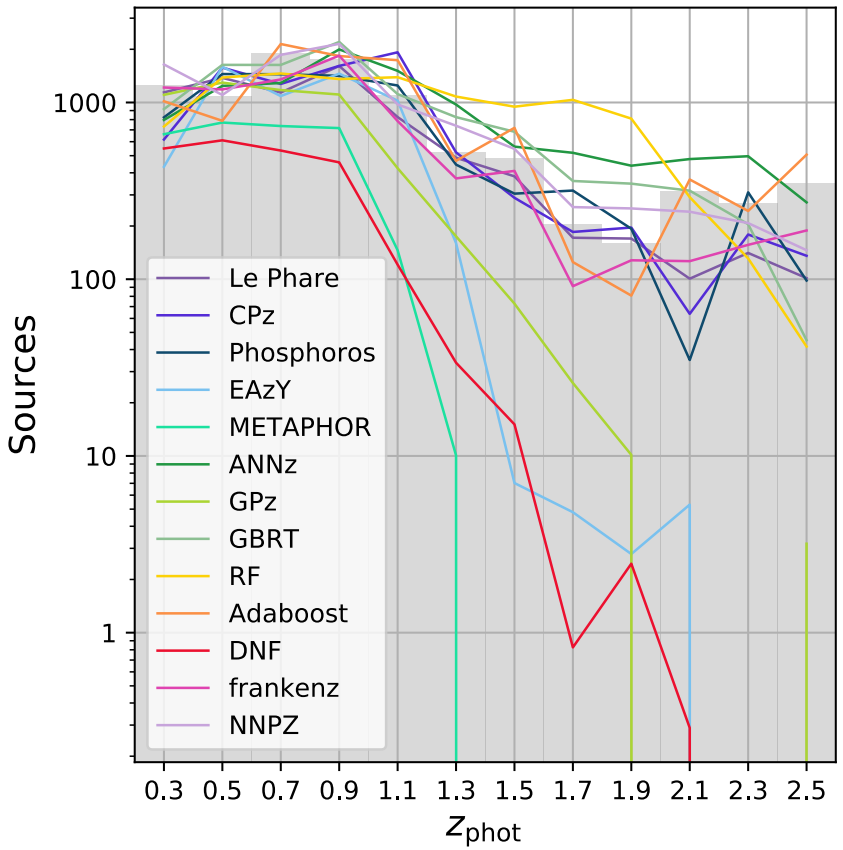
PDZ metrics

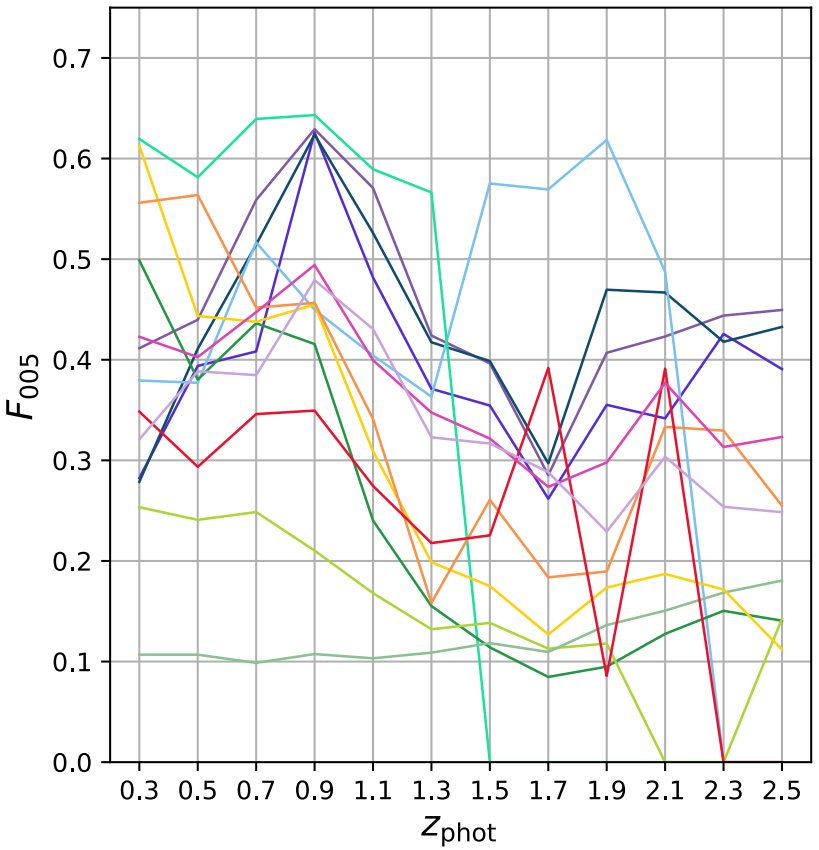


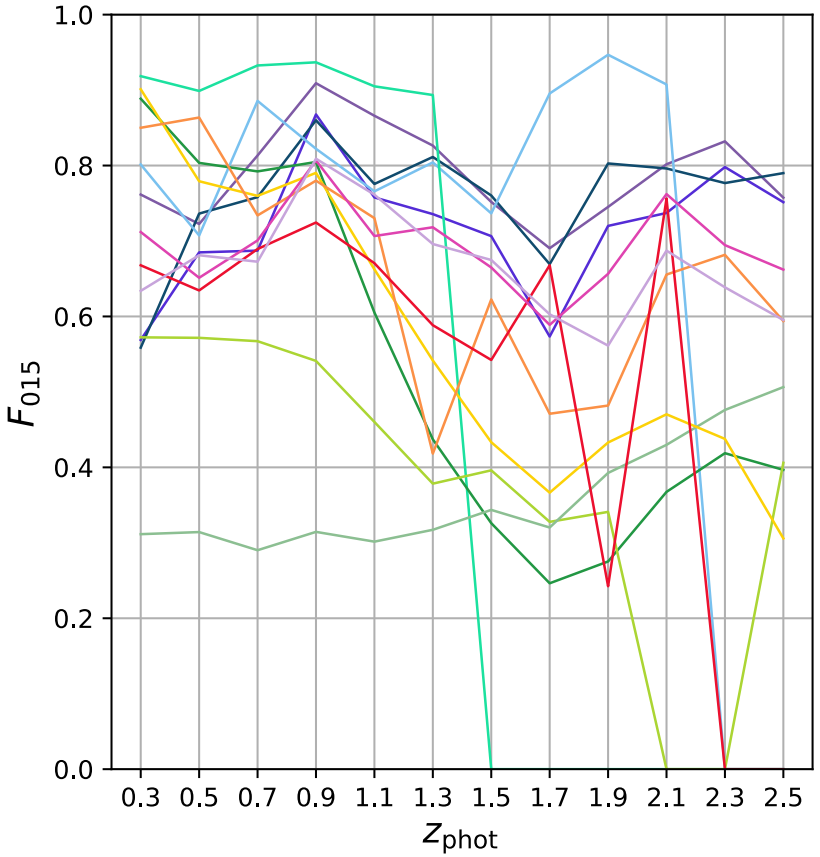
Bias : Δ mean z - origin
F005 : fraction of PDZs in 0.05(1+z) around origin → σ
F015 : fraction of PDZs in 0.15(1+z) around origin → η

Requirements in tomographic bins:
F005 > 0.68
F015 > 0.90

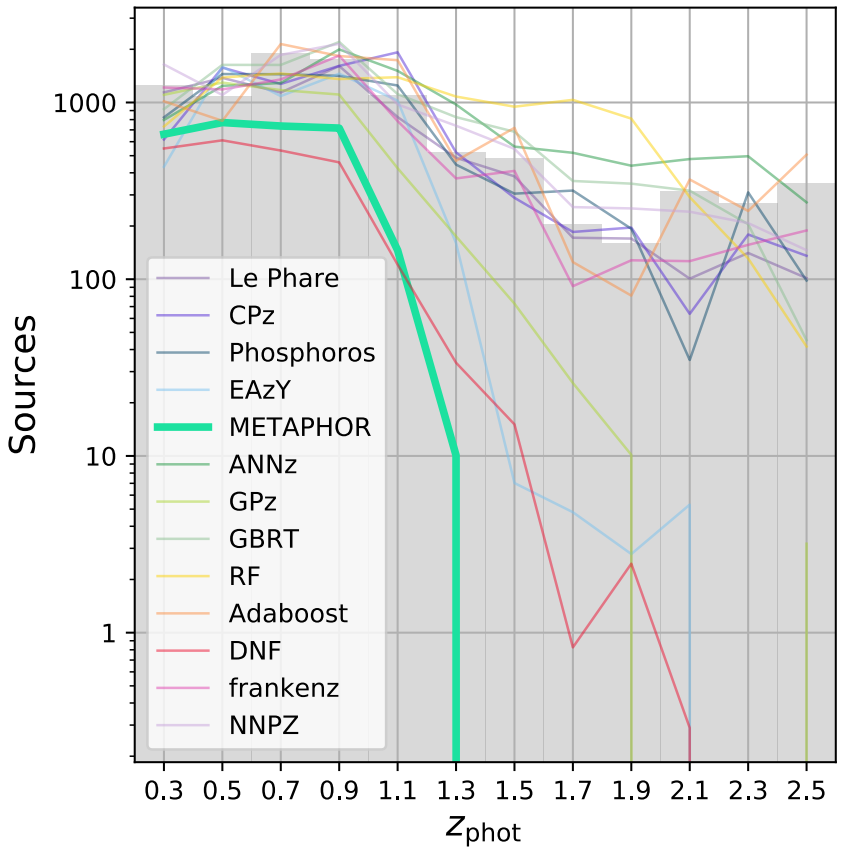
PDZ fractions

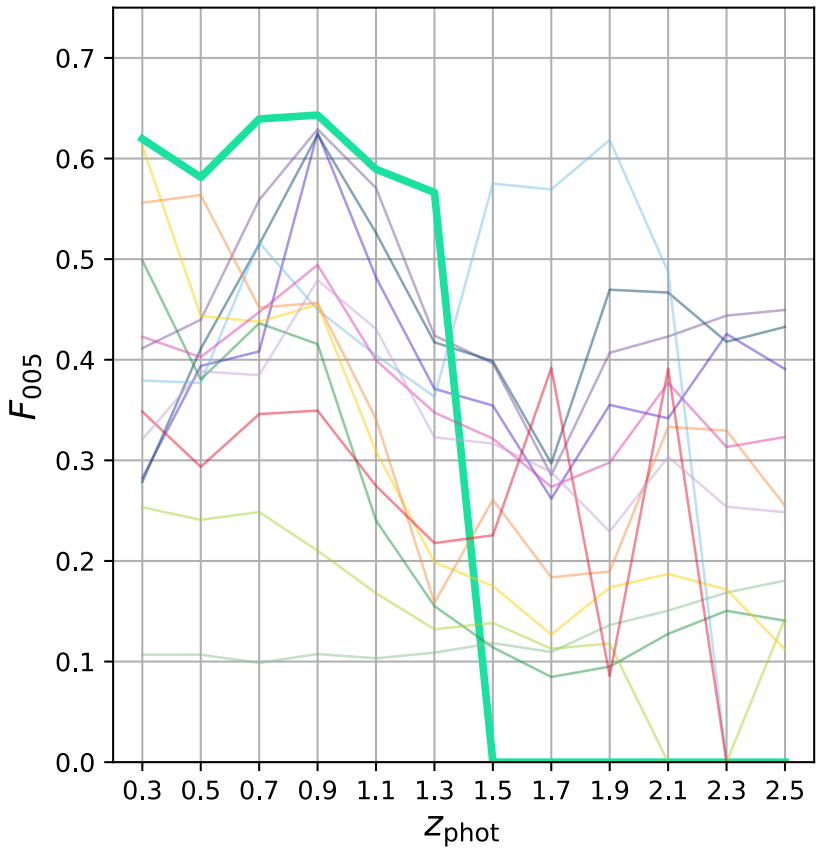


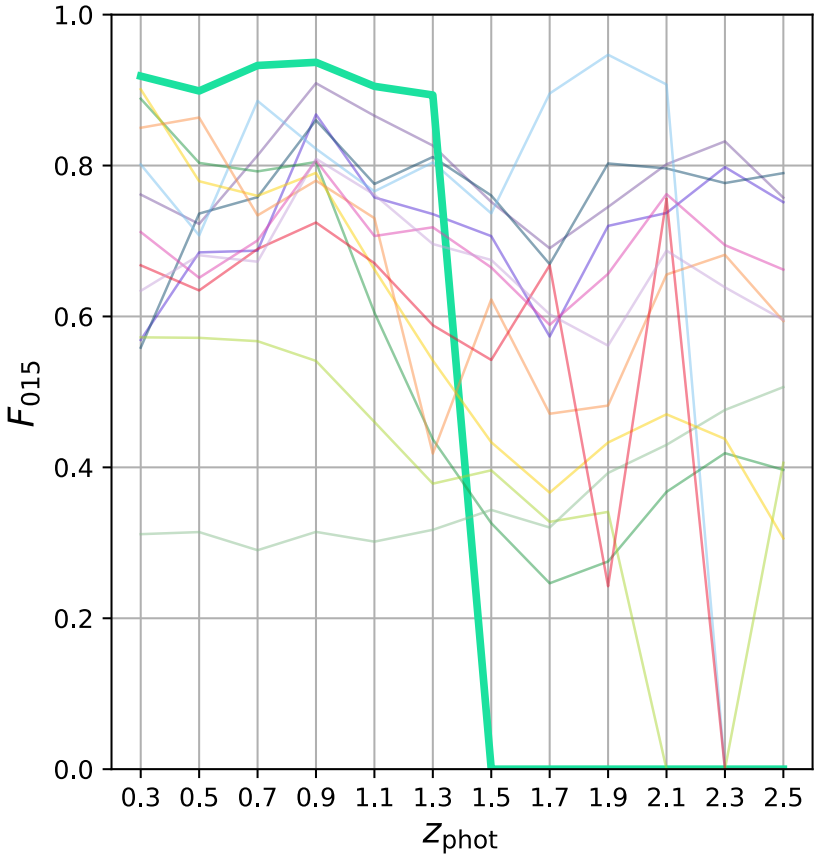




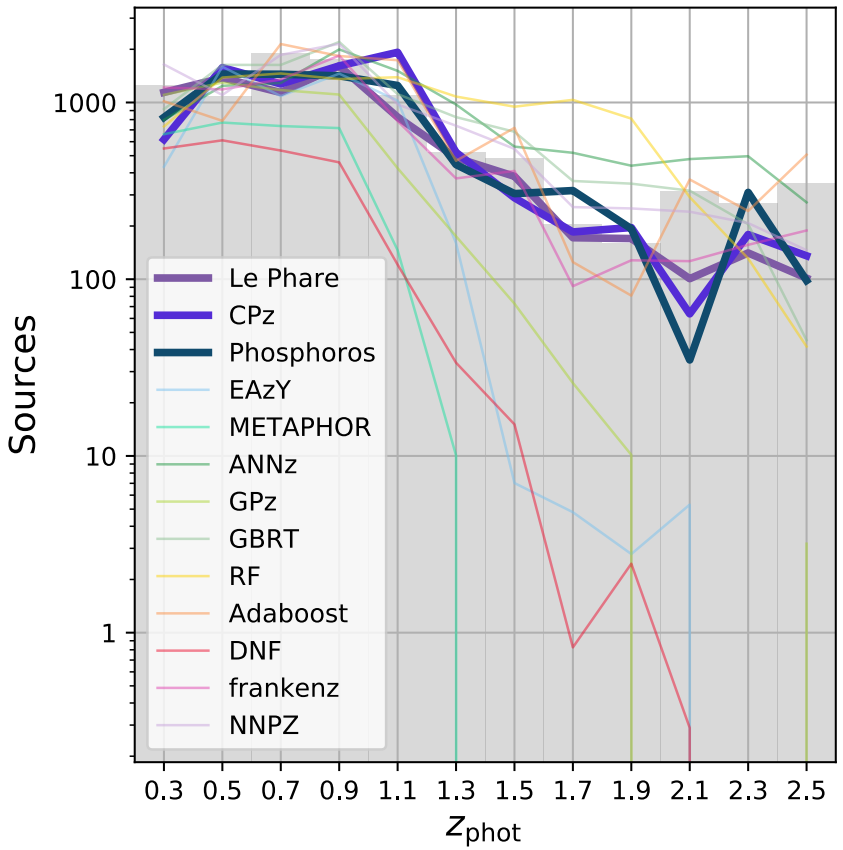
PDZ fractions

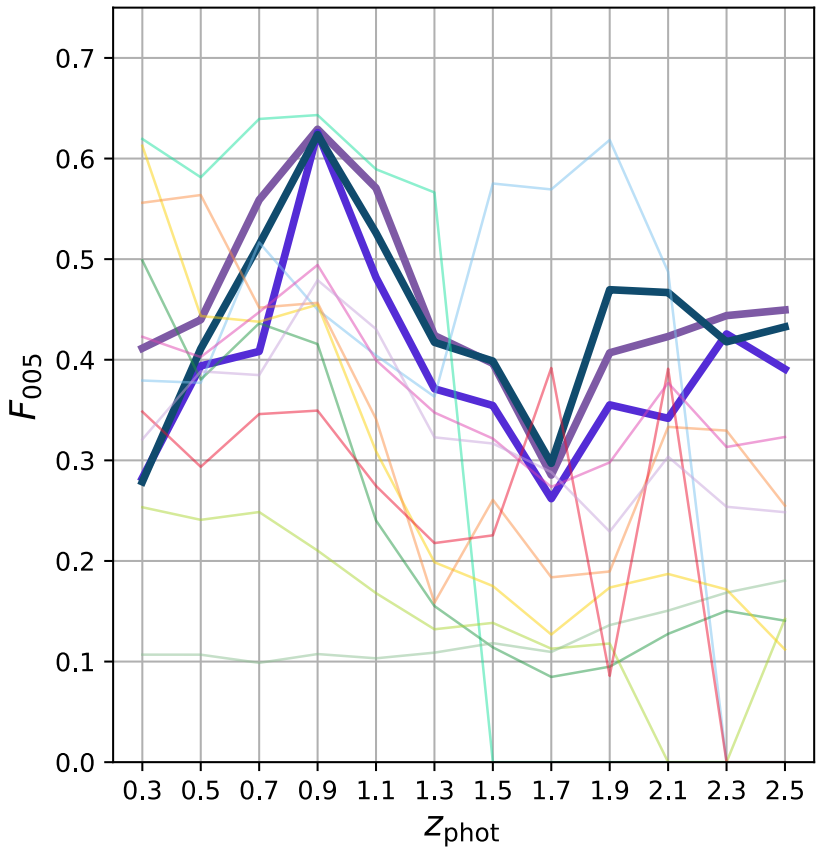


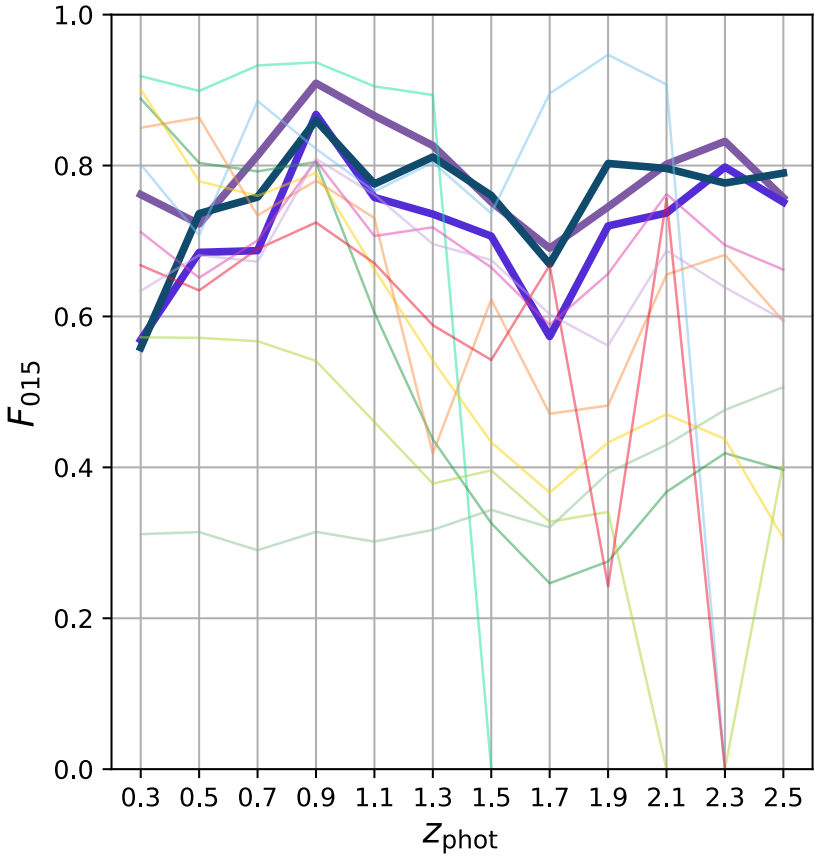




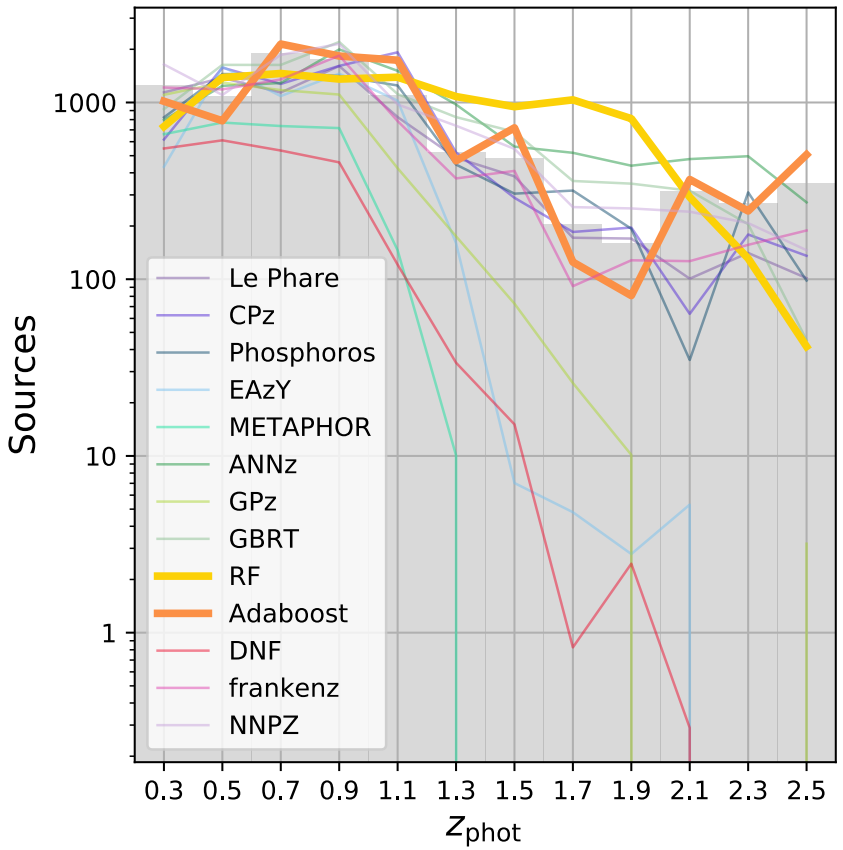
PDZ fractions

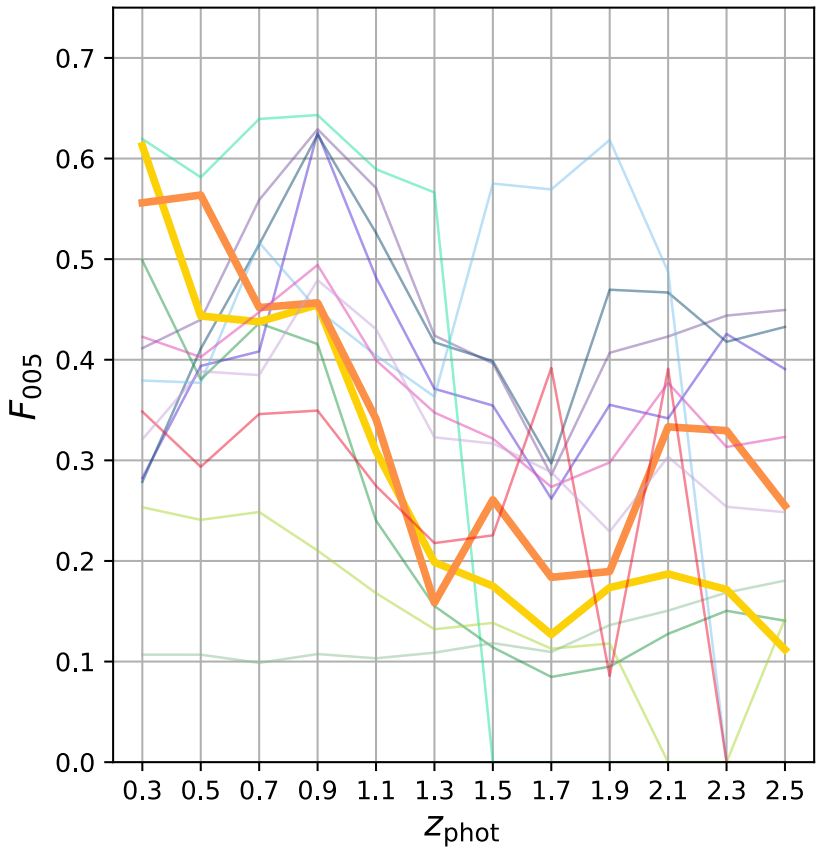


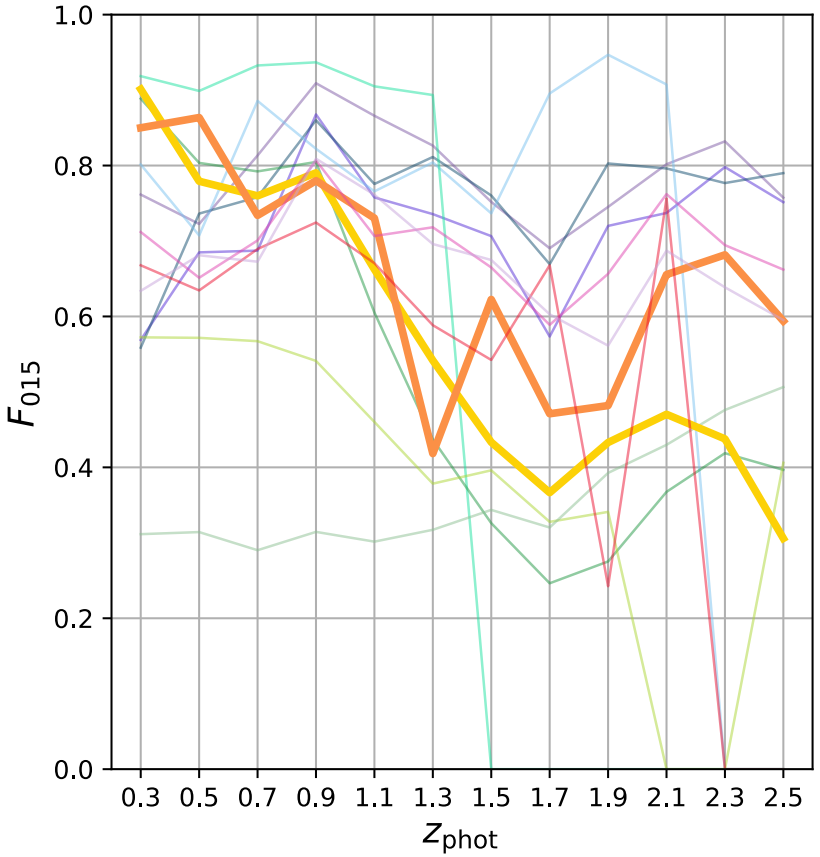




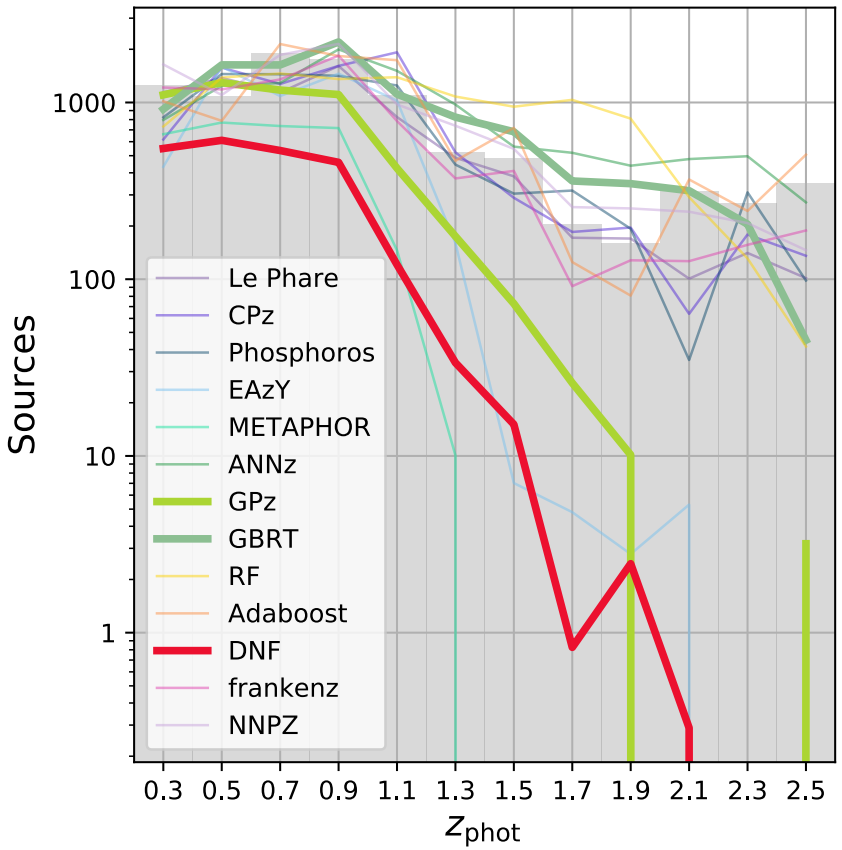
PDZ fractions

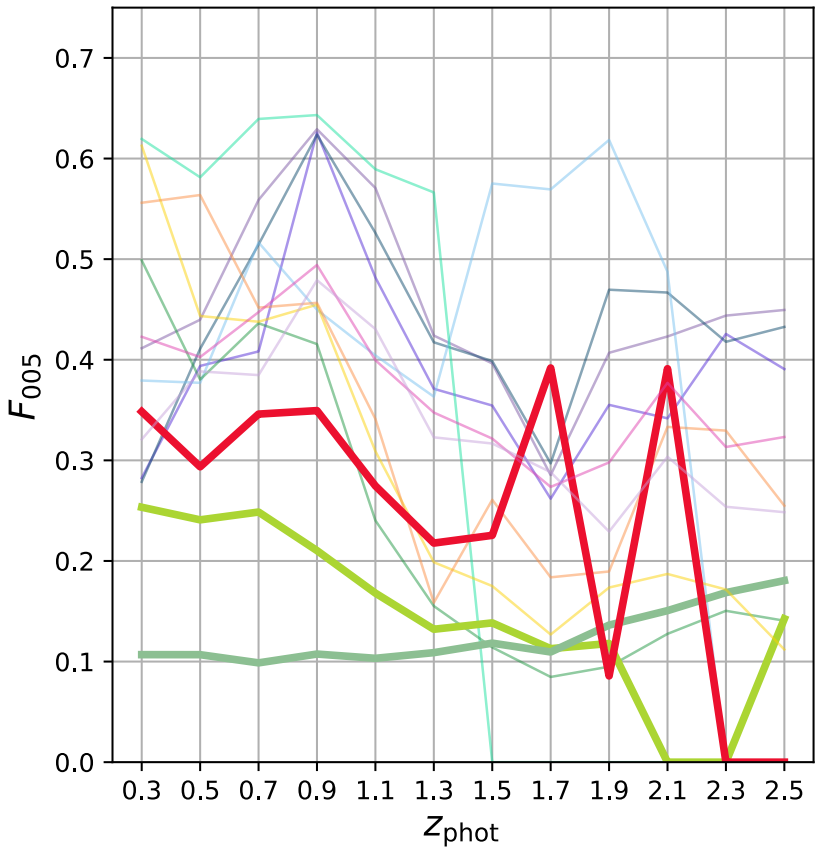


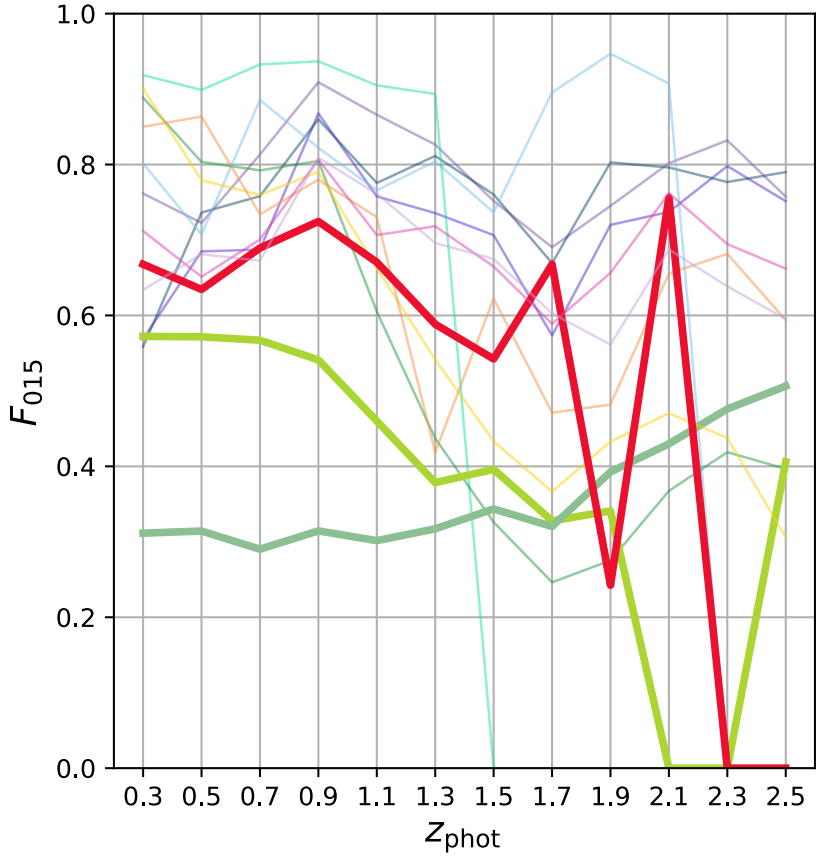




PDZ fractions

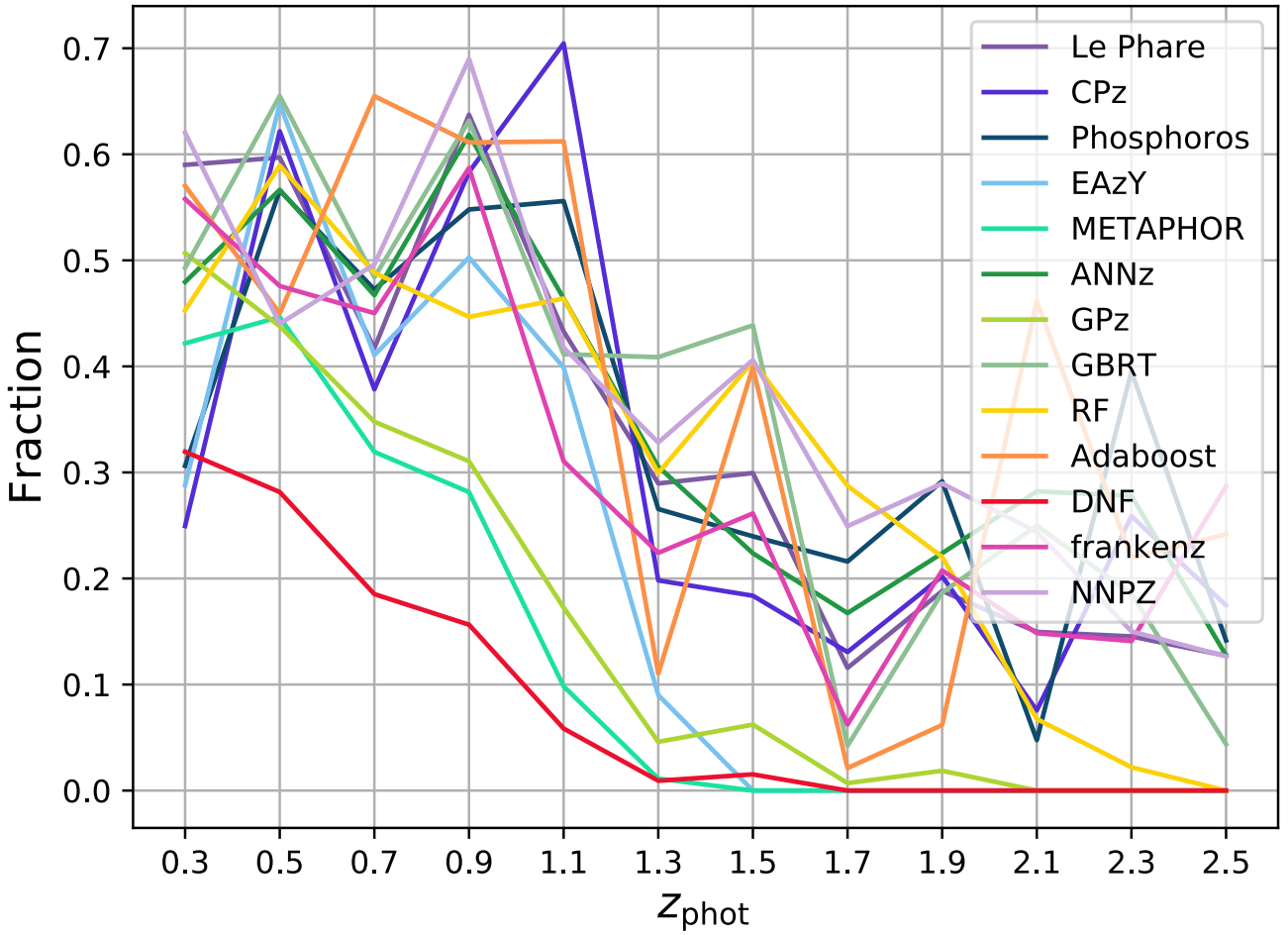




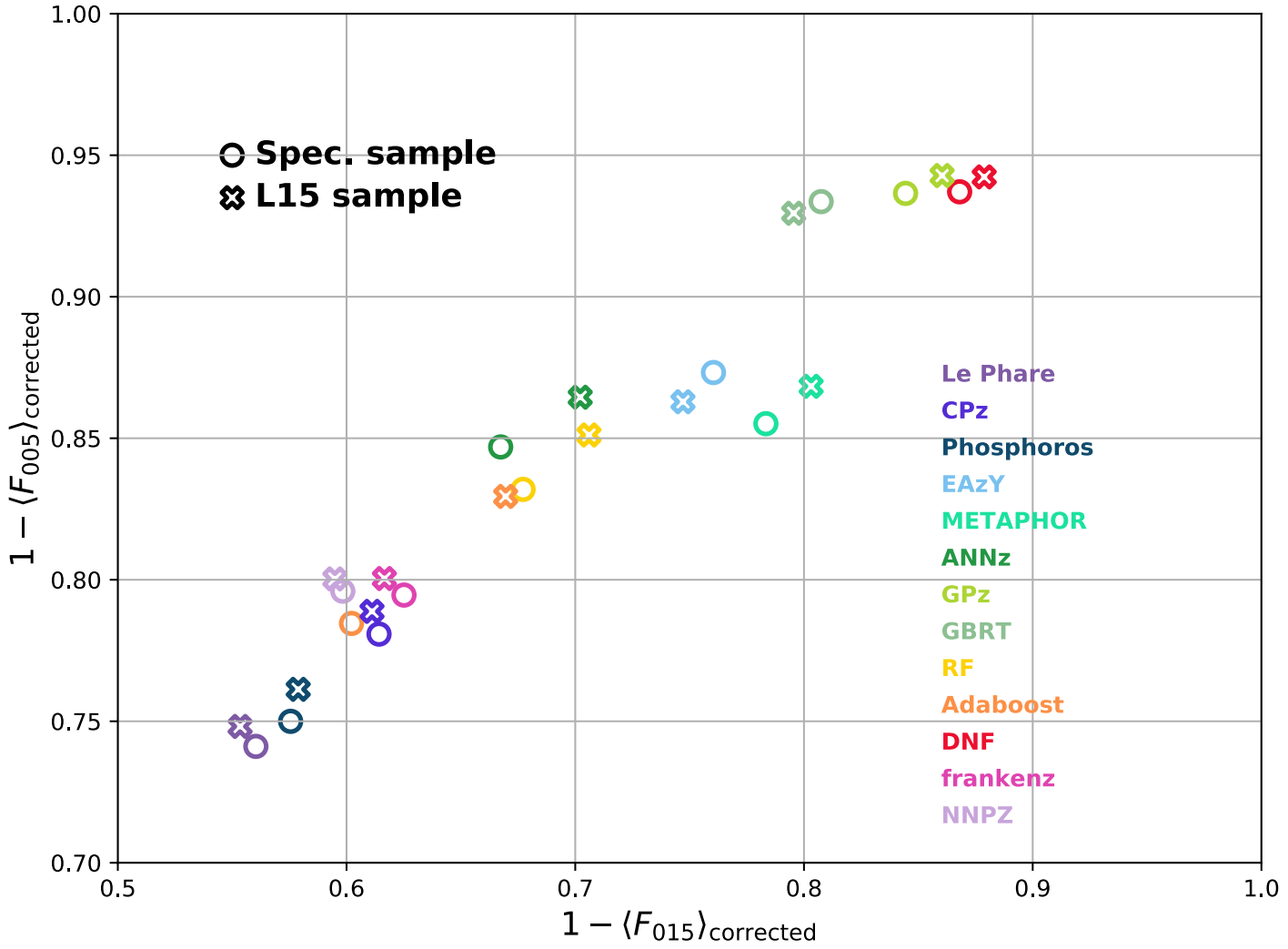


Requirement on galaxy density

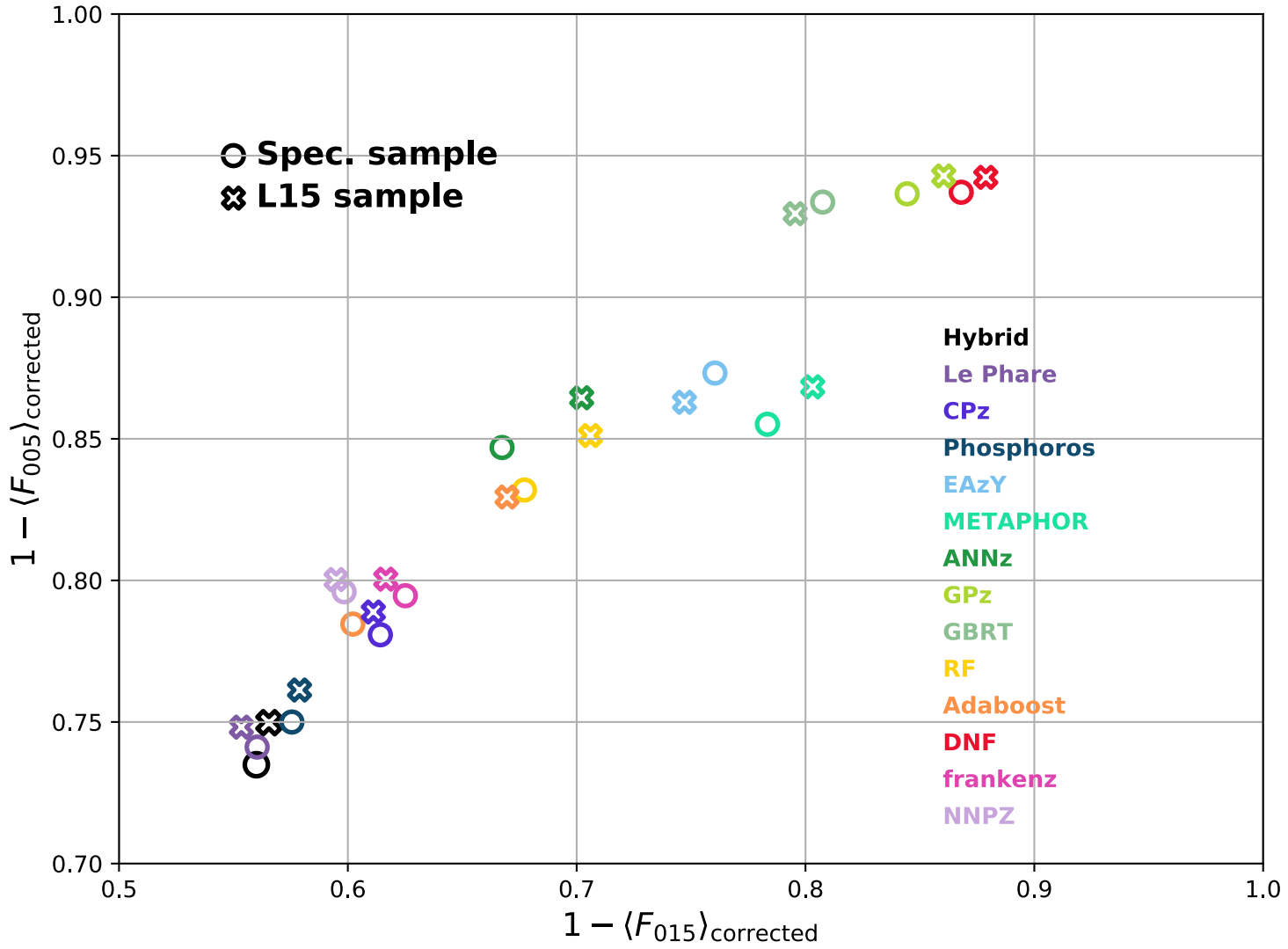
$$\langle F \rangle_{corr} = \frac{1}{N_{bin}} \sum_{i}^{bins} F_i \sqrt{\frac{N_{good,i}}{N_{true,i}}}$$



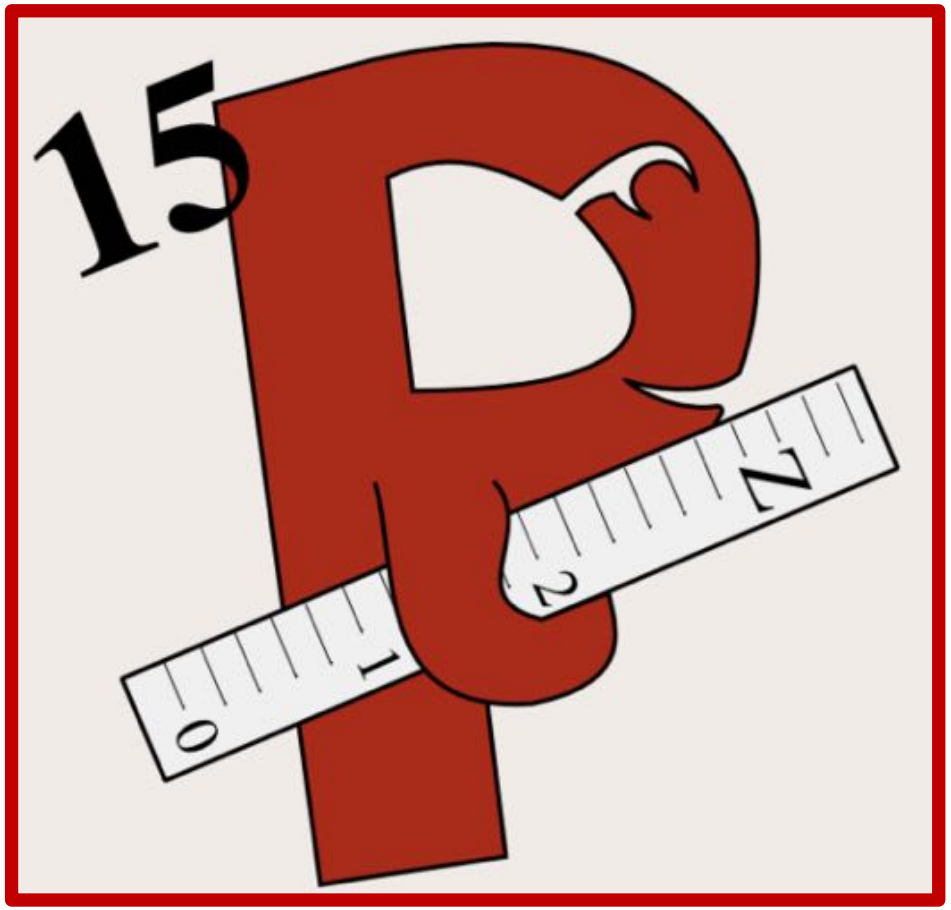
Corrected metrics



Corrected metrics

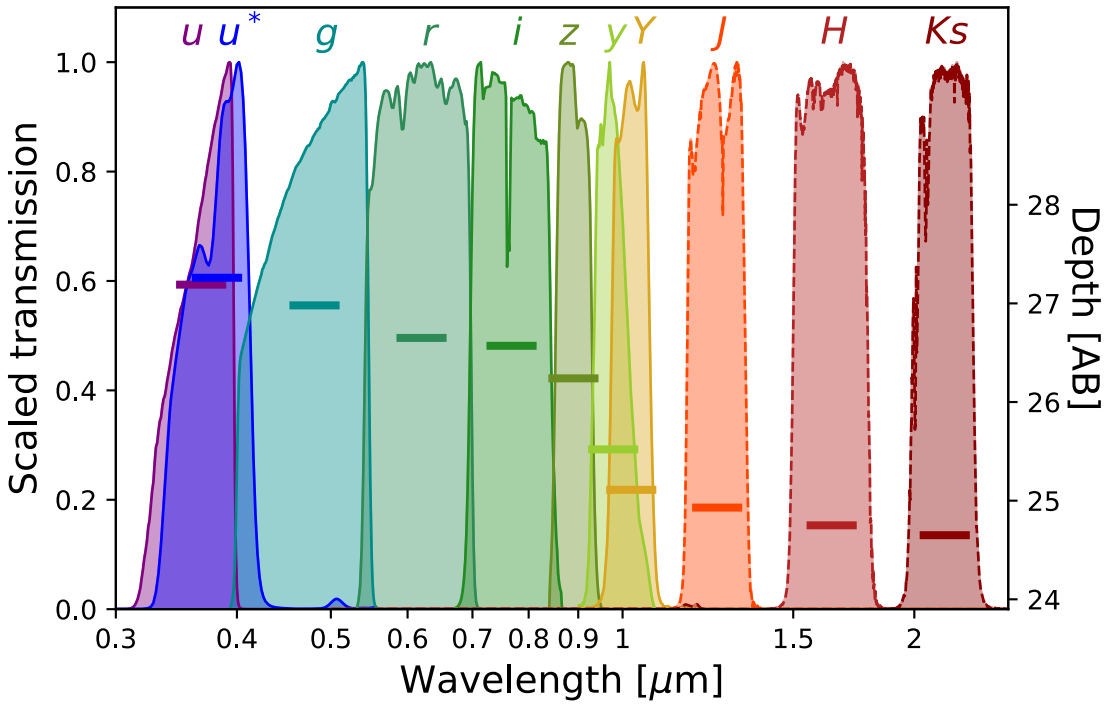


Validation of Phosphoros



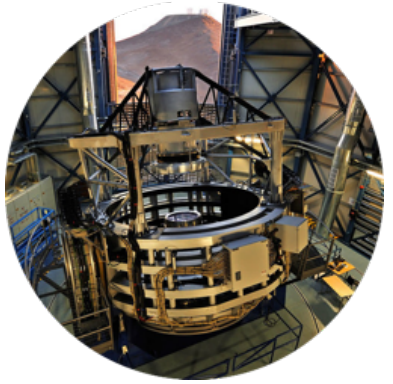
- Since Euclid challenge:
  - Changes of templates
  - Changes on Prior
    - Priors on SEDs
    - Priors on sources luminosity

CLAUDS+HSC-SSP

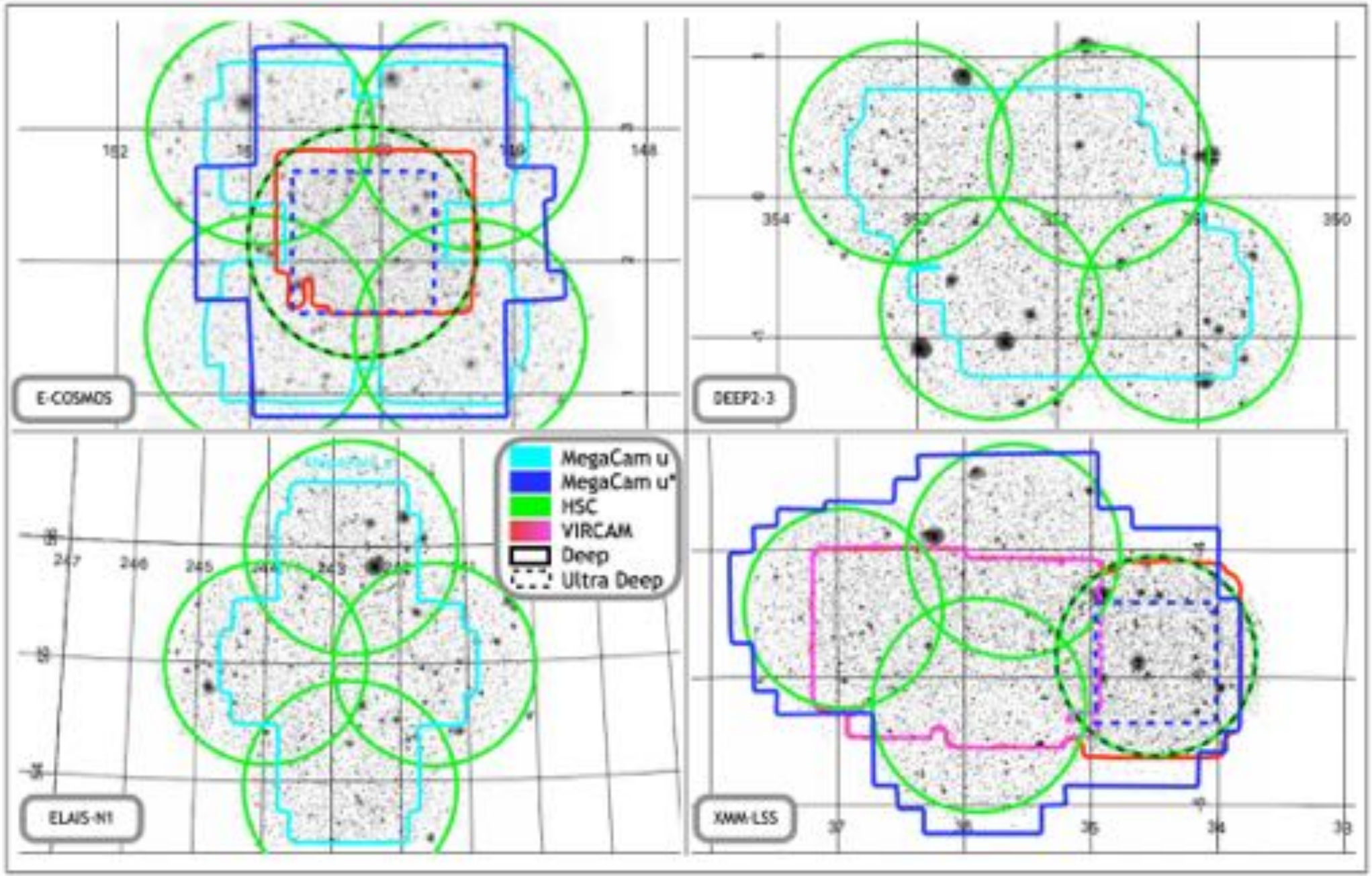


CFHT : u, u*

Subaru : g, r, i, z, y

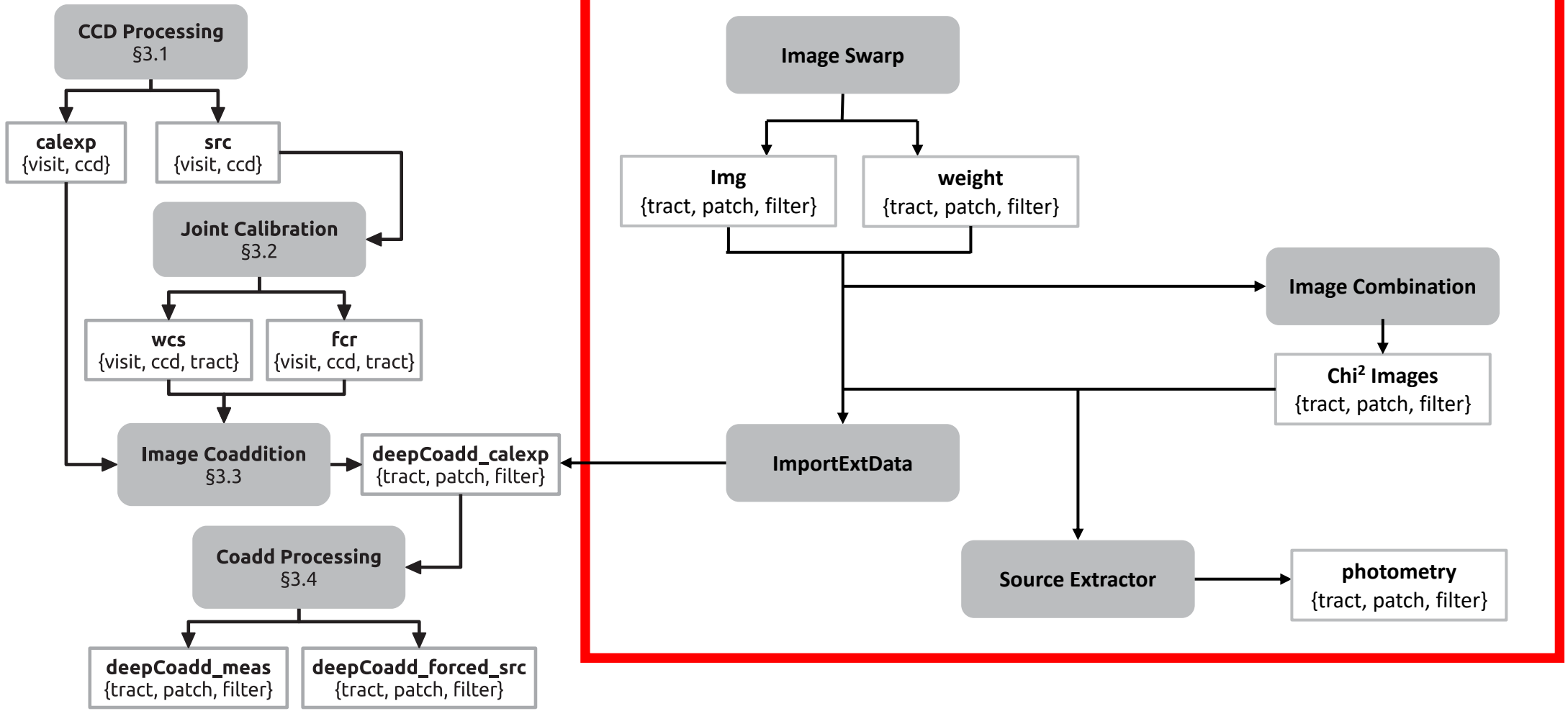


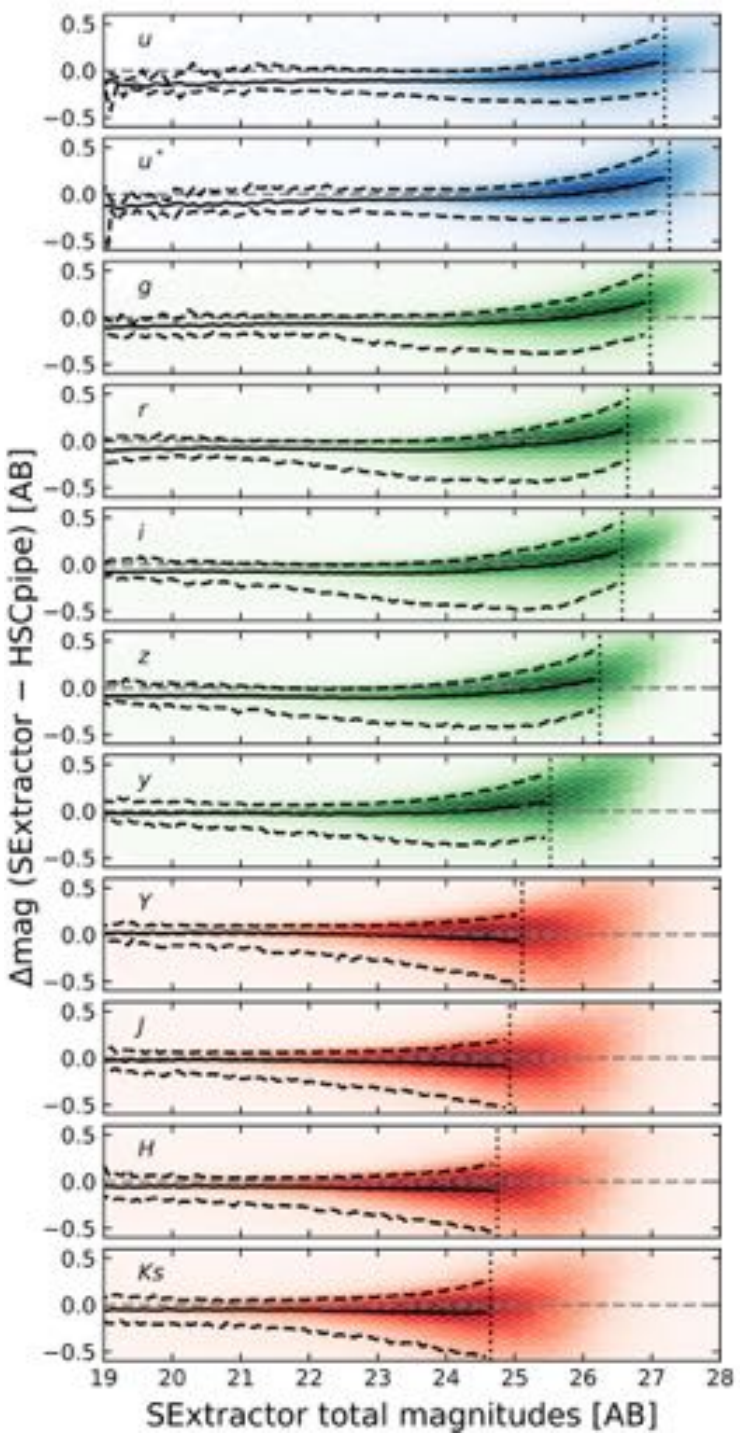
VISTA : Y, J, H, Ks


E-COSMOS
DEEP2-3
ELAIS-N1
XMM-LSS
MegaCam u
MegaCam u*
HSC
VIRCAM
Deep
Ultra Deep

Data processing and photometry extraction

Pipeline HSC/LSST – Bosch et al 2018




u
u*
g
r
i
z
y
Y
J
H
Ks
Δmag (SExtractor − HSCpipe) [AB]
SExtractor total magnitudes [AB]

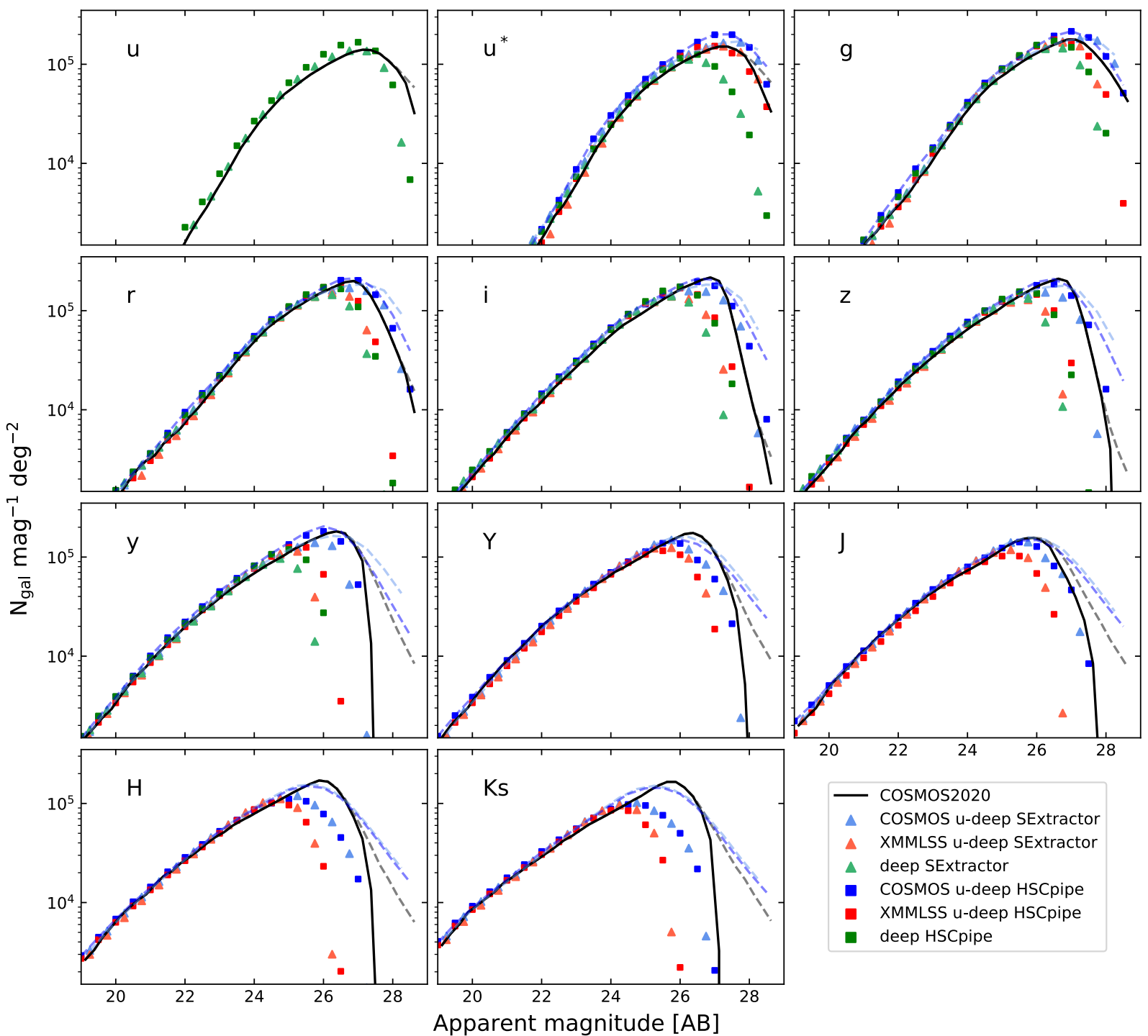

u
u*
g
r
i
z
y
Y
J
H
Ks
N_{gal} mag^{-1} deg^{-2}
Apparent magnitude [AB]
COSMOS2020
COSMOS u-deep SExtractor
XMMLSS u-deep SExtractor
deep SExtractor
COSMOS u-deep HSCpipe
XMMLSS u-deep HSCpipe
deep HSCpipe

Photo-z's

Two methods:

- Phosphoros
- Le Phare

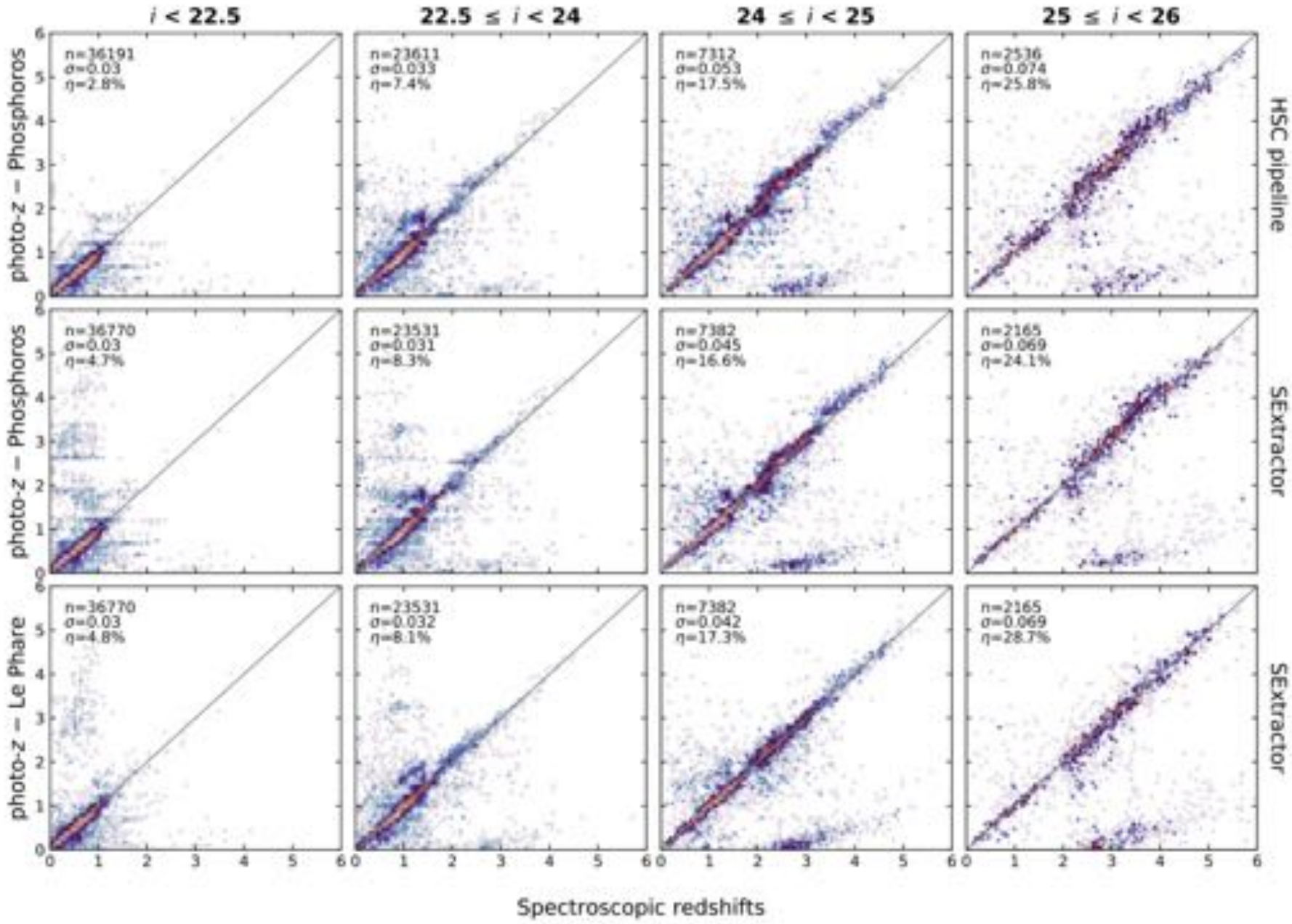
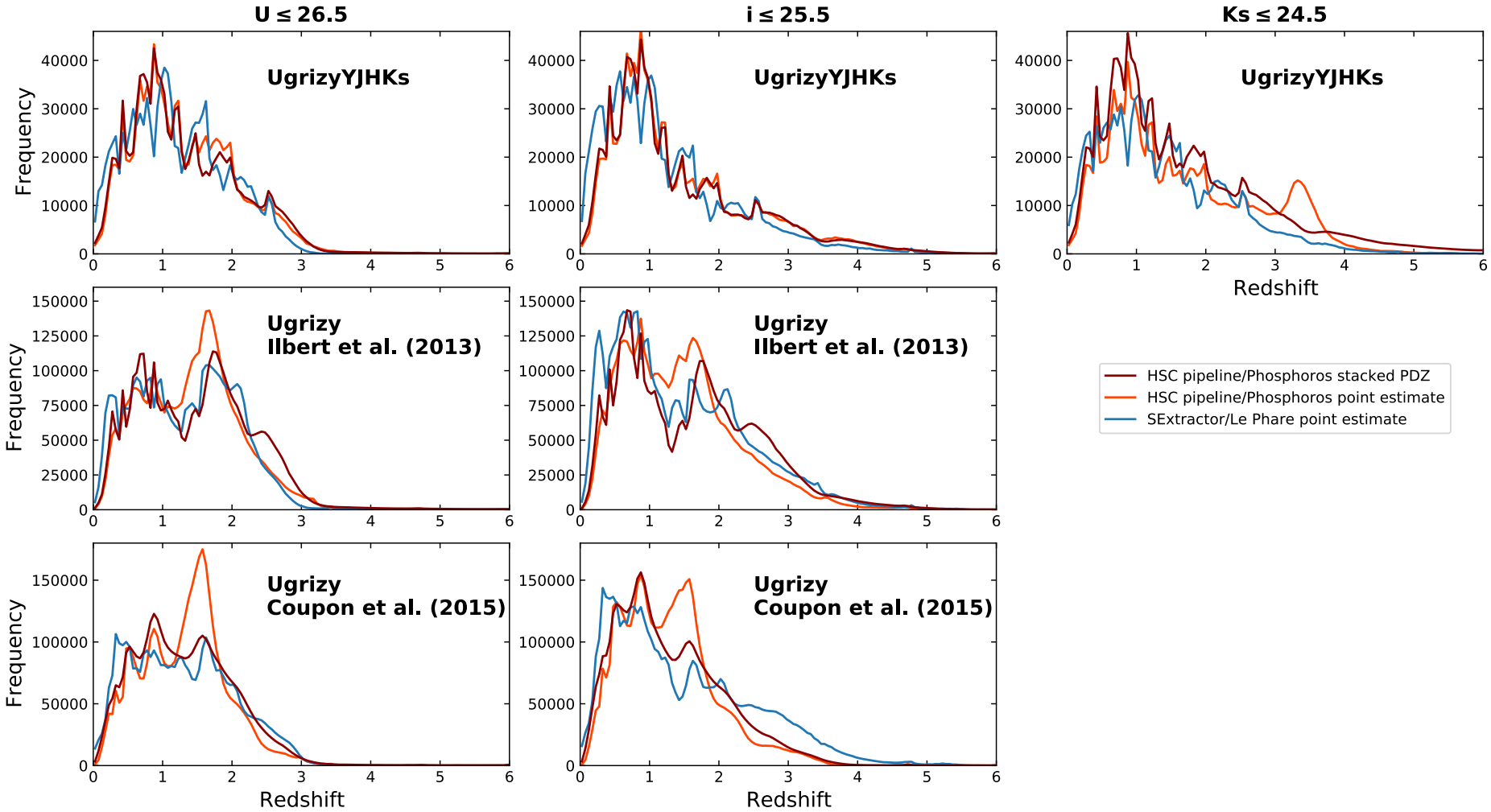
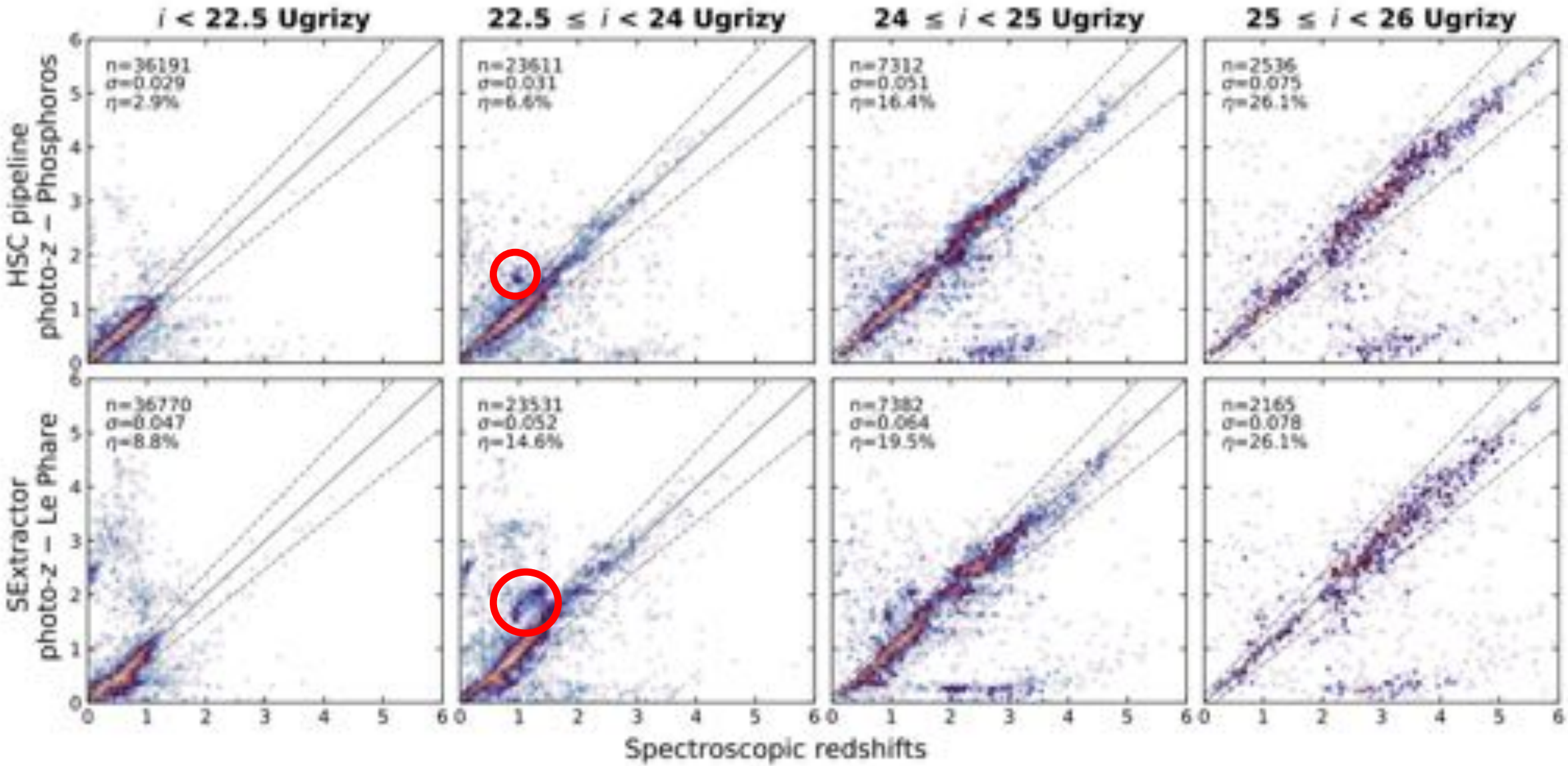
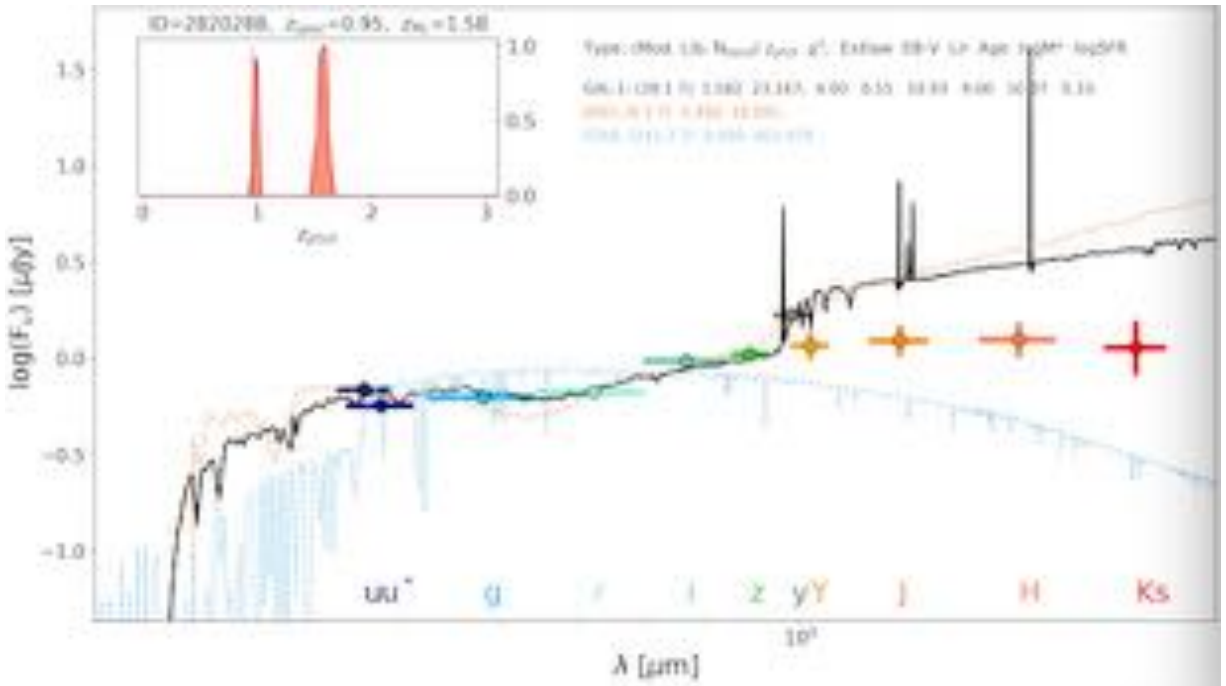
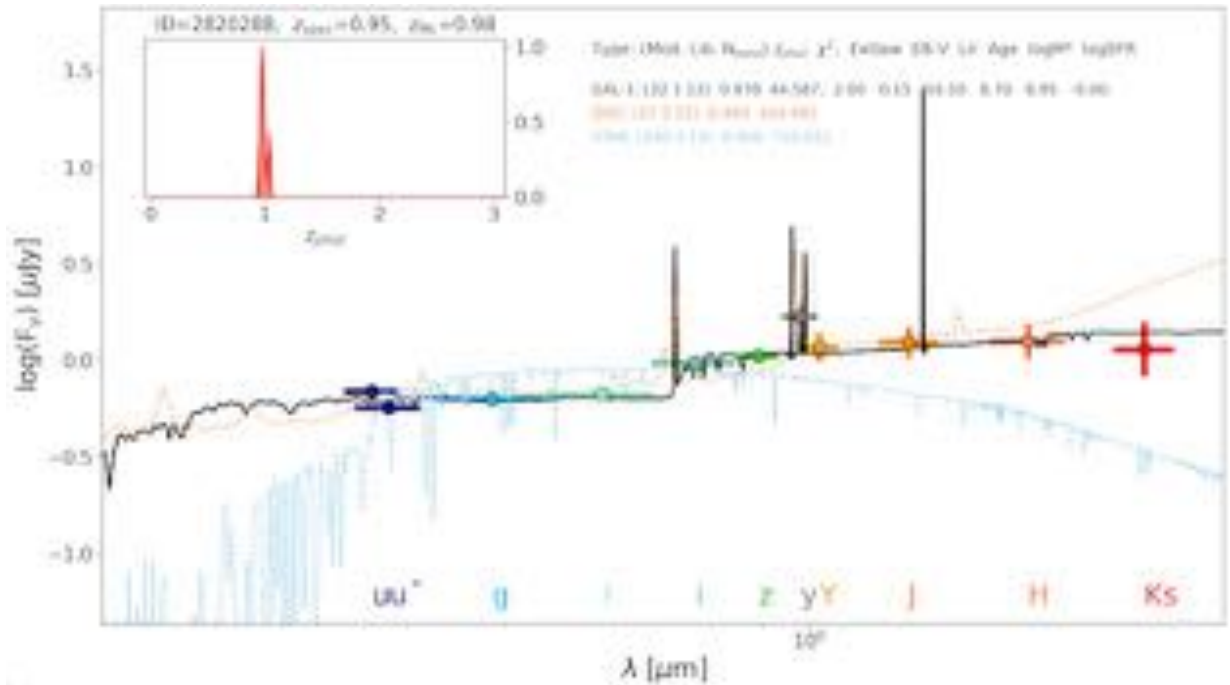


Photo-z distribution




i < 22.5 Ugrizy
22.5 ≤ i < 24 Ugrizy
24 ≤ i < 25 Ugrizy
25 ≤ i < 26 Ugrizy
HSC pipeline
photo-z – Phosphoros
n=36191
σ=0.029
η=2.9%
n=23611
σ=0.031
η=6.6%
n=7312
σ=0.051
η=16.4%
n=2536
σ=0.075
η=26.1%
SExtractor
photo-z – Le Phare
n=36770
σ=0.047
η=8.8%
n=23531
σ=0.052
η=14.6%
n=7382
σ=0.064
η=19.5%
n=2165
σ=0.078
η=26.1%
Spectroscopic redshifts


ID=2820288,
log(F_ν) [μJy]
λ [μm]
uu*
g
r
i
z
yY
J
H
Ks


ID=2820288,
log(F_ν) [μJy]
λ [μm]
uu*
g
r
i
z
yY
J
H
Ks

Summary

- Euclid Photo-z challenge:
  - Machine learning can have some diffulty to produce sensible PDZs
  - Template-fitting and machine-learning approach work best on different regime → a combination is possible
  - There is room for improvements

- Validation of Phosphoros
  - Phosphoros provides the same results as Le Phare
  - Ready for release