Agenzia Spaziale Italiana

OU-PHZ

Micol Bolzonella

INAF-OAS Bologna

OU-PHZ Tasks and Responsibilities

- OU-PHZ lead: Stéphane Paltani (Geneva)
- OU-PHZ is a very important Euclid task for both main science and legacy science
- About 70 members / 30-40 contributors; important Italian contribution:
  MB, Laura Bisigello, Massimo Brescia, Stefano Cavuoti, Maurizio D'Addona, Lucia Pozzetti, Giuseppe Riccio, Crescenzo Tortora

Main task:

- to determine redshifts for weak-lensing tomography from photometry alone (no spectroscopy)
- to calibrate the tomographic redshift bins or the redshift distribution

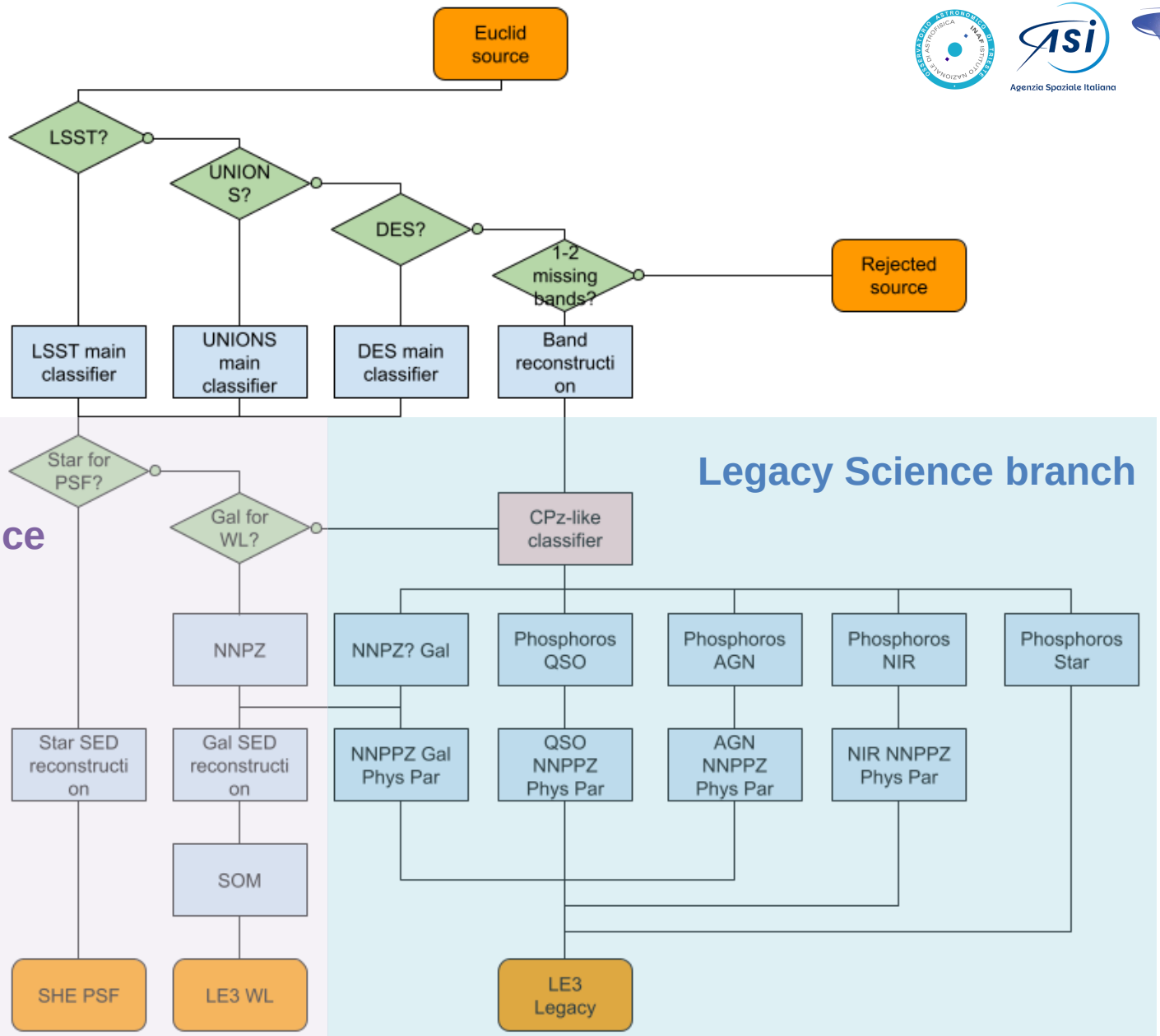
OU-PHZ needs also to

Main science:

- Identify stars for PSF determination, removing contaminants (e.g., QSO)
- Provide unbiased colors of galaxies of stars and galaxies over the VIS band for shape reconstruction

Legacy science:

- **Classify galaxies, stars, AGN and QSOs**
- Compute photometric redshifts for galaxies
- **Compute galaxy physical parameters (Mass, SFR, SFH, reddening,...)**


Euclid source
LSST?
UNION S?
DES?
1-2 missing bands?
Rejected source
LSST main classifier
UNIONS main classifier
DES main classifier
Band reconstructi on
Star for PSF?
Gal for WL?
CPz-like classifier
Legacy Science branch
Main Science branch
NNPZ
NNPZ? Gal
Phosphoros QSO
Phosphoros AGN
Phosphoros NIR
Phosphoros Star
Star SED reconstructi on
Gal SED reconstructi on
NNPPZ Gal Phys Par
QSO NNPPZ Phys Par
AGN NNPPZ Phys Par
NIR NNPPZ Phys Par
SOM
SHE PSF
LE3 WL
LE3 Legacy

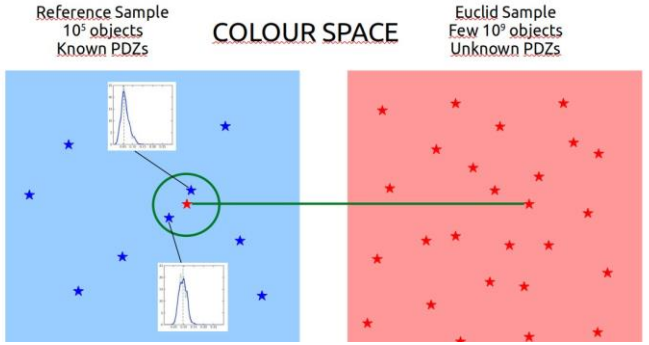
Photometric redshift algorithms

Phosphoros

- Template-fitting code
- Marginalization and sampling on any parameter, including scale factor, so can produce PDFs of any parameter tagged to the templates and arbitrary dimension, like mass, z-mass, etc.
- C++ (fast!) with extensive Python post-processing and plotting tools
- There is a graphical user interface!
- Will be release soon; already available on demand

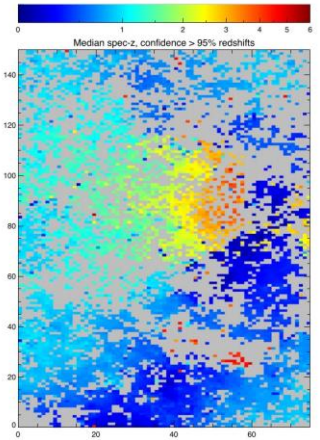
Nearest-Neighbor PDZ (NNPZ)

- Reference sample for a ML algorithm constituted of high-quality photo-z (e.g. COSMOS2015)
- Each Euclid object has its own color space: projection from reference color space to object color space
- NNPZ does not require a training phase



Self-Organizing Map of Galaxy Colors

- Requirement on the knowledge of <z> in tomographic bins: $\sigma_{<z>} < 0.002(1+z)$
- SOM: 1. Place all objects in the SOM; 2. Use <z> from spec-z in each cell; 3. Meets the requirement when averaged over ~1000 cells



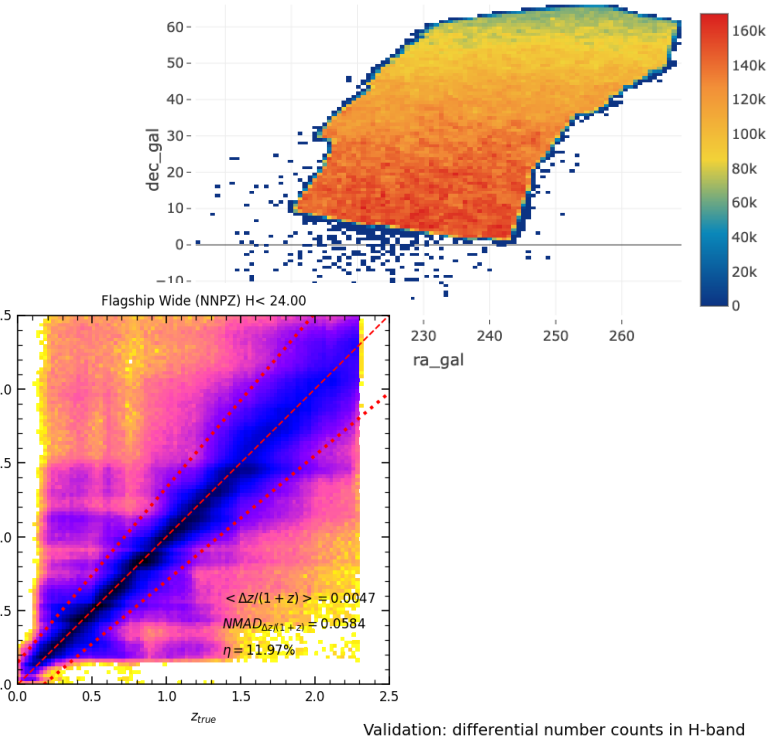
OU-PHZ in simulations

Flagship:

Photometric redshifts complete pipeline in the full SC8 area (simulated photometric noise assuming DR2 depth in the south)

https://cosmohub.pic.es/catalogs/276

Full SC8 table contain 922 296 062 galaxies, “only” 405 912 848 have the photo-z information (the run of NNPZ took about 2 weeks @PIC), adopting a cut at VIS=25.1 (S/N=10) or H=24.25 (S/N=5)

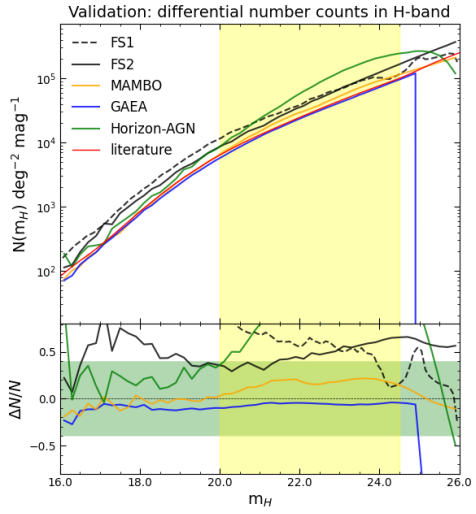


Legacy Science (Olga Cucciati & Gabriella De Lucia):

Phosphoros run on lightcones with photometric noise and limits as in Flagship:

https://euclid.roe.ac.uk/projects/simulation-verification/wiki

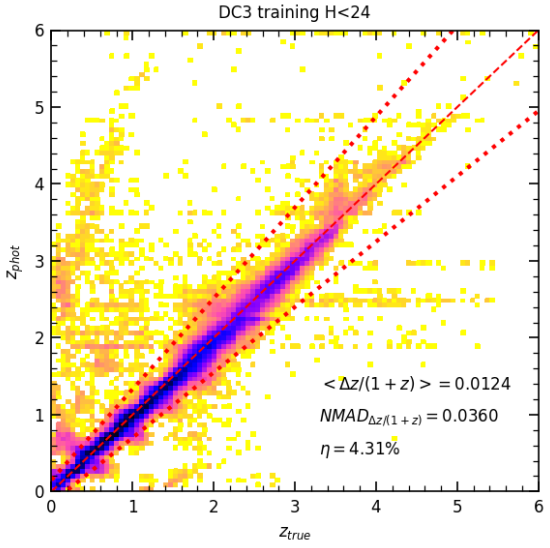
1. **GAEA (Trieste)**
2. **MAMBO (Bologna)**
3. Horizon-AGN

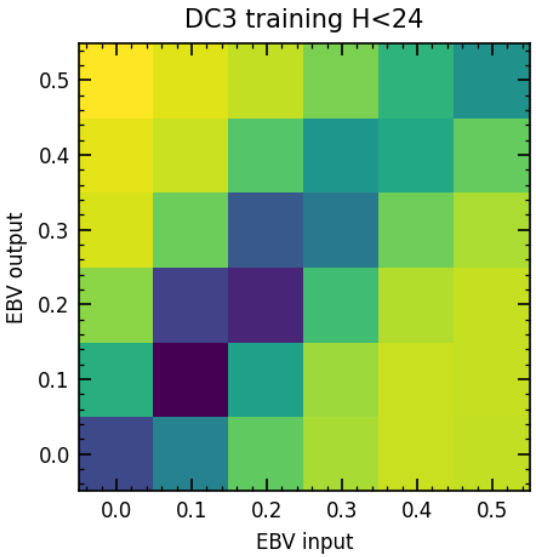


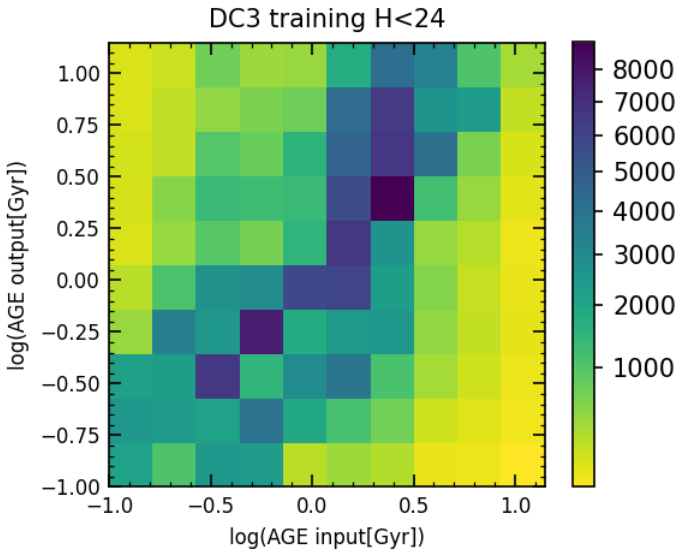
Physical properties

WP leads: **MB**, Claudia Maraston + active Italian participation (Bisigello, Brescia, Cavuoti, Pozzetti, Riccio, Tortora) Monthly telecons

- Definition of the Data Model https://euclid.esac.esa.int/dm/dpdd/latest/phzdpd/dpcards/phz_phzpfoutputcatalog.html#physical-parameters-catalog
- Tests of the pipeline (mirroring the one for photoz: reference sample + nearest neighbours approach) and study of templates for PPs
- Aim: derive simultaneously all the physical properties and the redshift and their multi-dimensional PDFs to take into account the interconnection between PPs.
- Simulations: DC3, GAEA, MAMBO, SPRITZ (L. Bisigello), Horizon-AGN







Physical properties

To do:

- Consider different scenarios considering the deep/aux fields, the Wide Survey, and DR1/2/3 depths
- Need to acquire existing photometry in the first auxiliary fields to build the reference sample
- Continue exploration of different methods (mainly machine learning) besides the baseline pipeline
- Technical KP ongoing

Euclid Data Releases and expected ground depths

Depth metric (for all): point source in 2 arcseconds diameter aperture, 10σ

Euclid (median over the RoI): VIS=25.0, Y=J=H=23.5

DES in Euclid DR1/2/3: *g=24.7, r=24.4, i=23.8, z=23.1*

From J.-C. Cuillandre

UNIONS in Euclid DR1: *u=23.6, g=24.5, r=24.1, i=23.2, z=23.4*

UNIONS in Euclid DR2: *u=23.6, g=24.5, r=24.1, i=23.4, z=23.4*

UNIONS in Euclid DR3: *u=23.6, g=24.5, r=24.1, i=23.6, z=23.4*

Rubin LSST* Y1 in Euclid DR2: *u=23.7, g=24.9, r=25.0, i=24.3, z=23.6*

Rubin LSST* Y1 to Y4 in Euclid DR3: *u=24.4, g=25.6, r=25.7, i=25.0, z=24.3*

*Rubin-LSST DDP main releases depth with point source PSF performance scaled to the 2" diam. metric

Euclid deep and auxiliary fields characteristics

Field	R.A.	Dec	Area [deg^2]	Δm	Completion (semester)	EWS Footprint
Self-Cal	270.000	+66.50	4	2.80	12	in
CDFS	53.117	-27.81	0.5	2.27	2	in
EDF-N	269.737	+66.02	10	2.00	6	in
EDF-F	52.938	-28.10	10	2.00	12	in
EDF-S	61.240	-48.42	23	2.00	12	in
COSMOS-Wide	150.119	+02.21	2	1.75	4	out
SXDS	34.500	-05.00	2	1.75	8	in
VVDS-Deep	36.500	-04.50	0.5	1.75	9	in
CANDELS/AEGIS	214.827	+52.82	1	1.50	1	in
CANDELS/GOODS-N	189.250	+62.25	0.5	1.50	9	in
CPC-N (outer annulus)	269.737	+66.02	10	1.25	2	in

Delta(m) gives the extra depth (source MOCDC_v2.0) versus the Wide survey at that RoI location which can be derived from the previous maps

Classification

WP lead: Sotiria Fotopoulou (active Italian participation: MB, Brescia, Cavuoti, D'Addona, Pozzetti)

Two distinct classifications:

For WL, to create a star sample for PSF determination and to identify WL galaxies

- Purely based on colors (no morphology)
- Binary (for calibration); purity rather than completeness
- Categories: Star, galaxy, everything else
- Meets the requirements on SC8, but AGN may pose a specific challenge

For Legacy

- Can use morphology
- Fuzzy classification
- Categories: Star, galaxy, AGN, QSO

Specific difficulty: validation sample – Under construction

Interfaces (to my knowledge)

OU-LE3 CL:

Test of the output of the Flagship+OU-PHZ: Emiliano Munari, Stefano Andreon

Data Model interface: Emiliano Munari, Erik Romelli, Thomas Vassallo, Samuele Galeotta

OU-LE3 GALEXT-ED:

Implementation of a recipe for MW dereddening: Sandro Bardelli, Ben Granett, Erik Romelli

OU-LE3 VMPZ-ID: Elena Zucca

SWG Clustering: Stefano Camera, Ben Granett, Michele Moresco

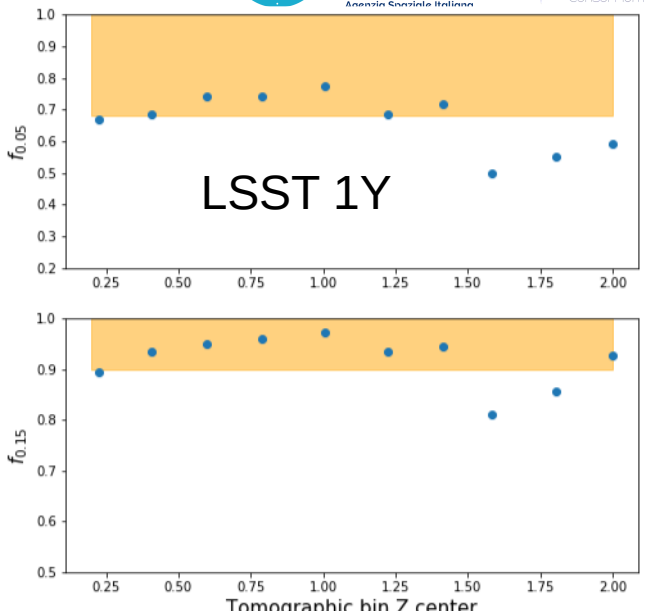
SWG Galaxy & AGN evolution: Lucia Pozzetti, Viola Allevato, Elena Zucca, Giulia Rodighiero

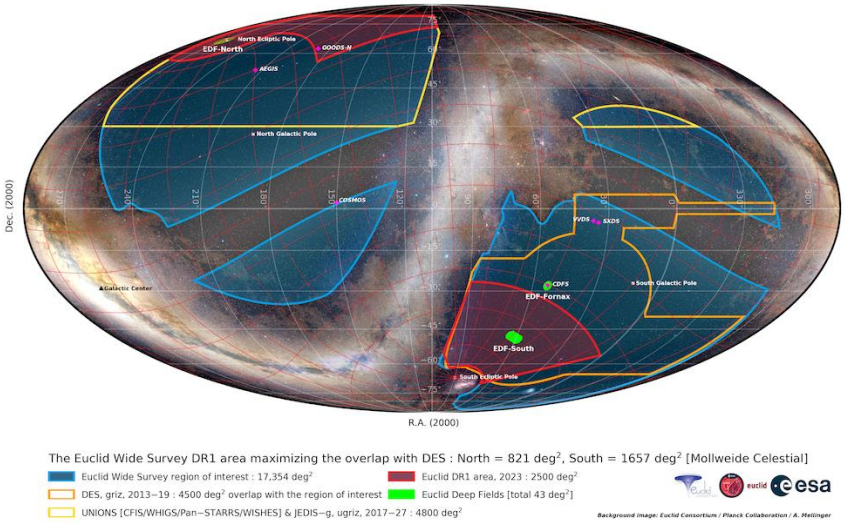
OU-SHE: working on definition of the tomographic redshift bins, binning based on photo-z or SOM

Conclusions

Solid baseline, pipeline is already complete, but some major difficulties remain:

- Current photometry marginally achieves requirements on photo-z precision
- Performance of physical properties and classification still needs to be assessed
- Calibration will remain a major challenge
- Color reconstruction might need more data
- C3R2 survey ongoing + huge validation effort of archival spectra to calibrate SOM





Readiness for first data:

- The pipeline is ready, but **are the users ready**?
- The requirements will not be met with DR1 data (no LSST)
- Tests with the realistic PDZs are ongoing since a while in OU-LE3 CL… what about the others?
- Galaxy evolution should explore what can be done with the first data, either in auxiliary fields (already extensively mined) or in the Wide Survey.