Rubin/*Euclid* Synergy

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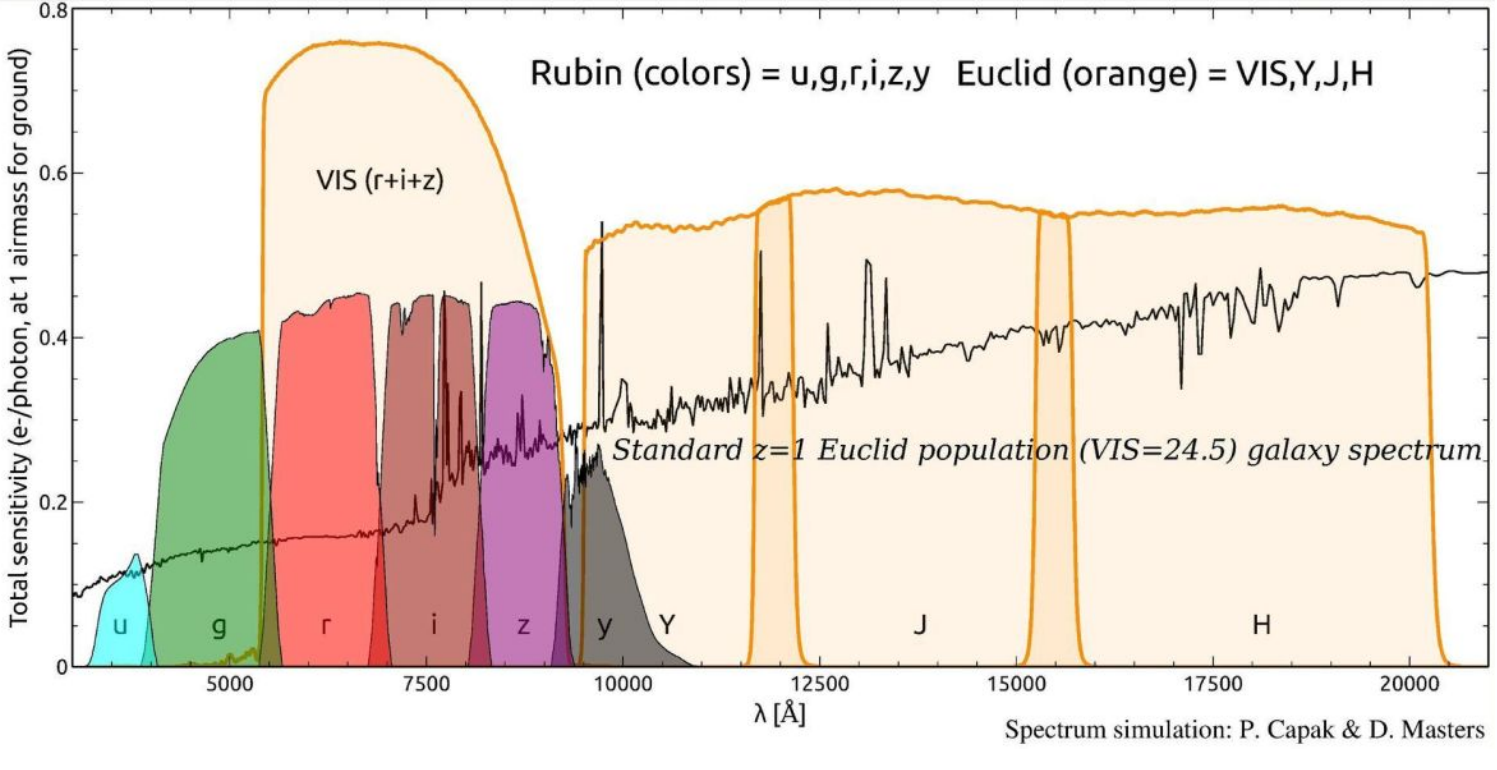
for the IN2P3 Rubin & *Euclid* Teams

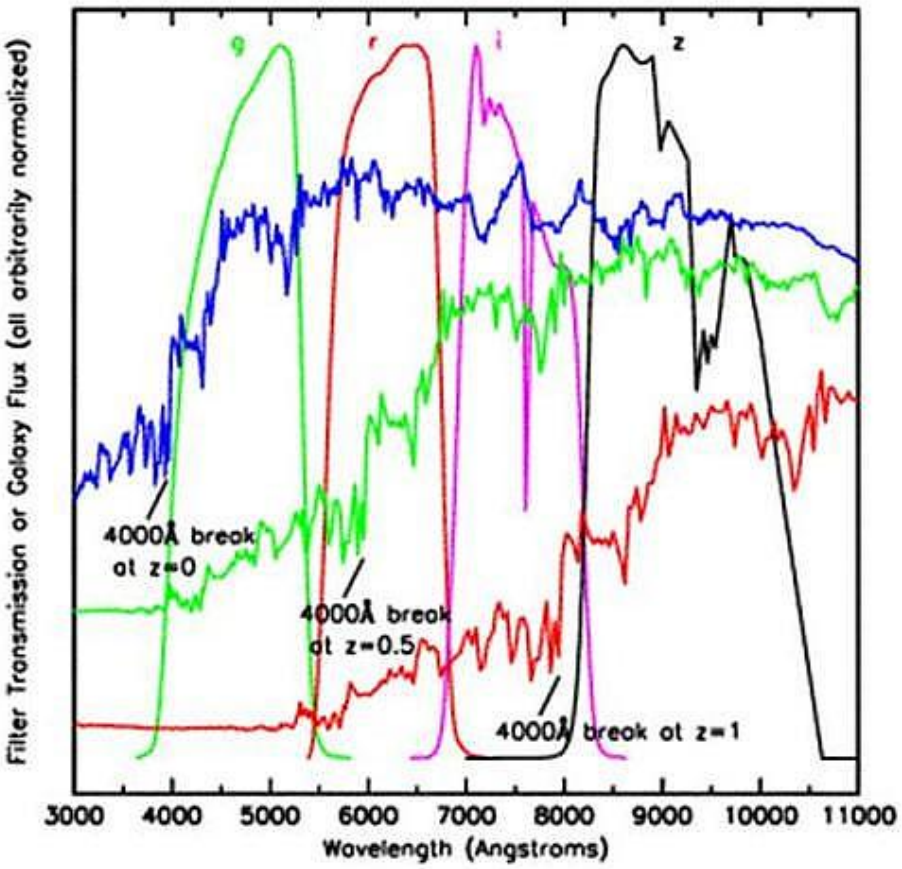
(Photometric) Wavelength Coverage



Euclid has one wide optical band and three infrared bands

Rubin has multiple optical bands

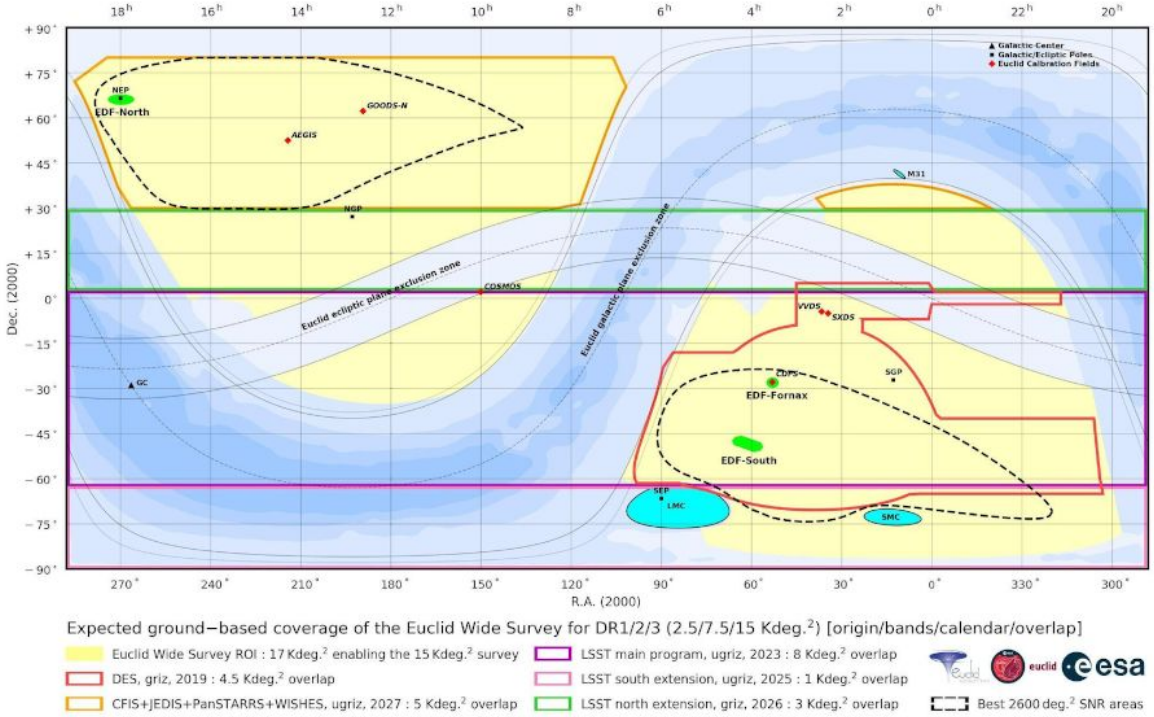
Photometric Redshifts



This example from the Dark Energy Survey illustrates how the redshift of a given object can be extracted even without high-resolution spectroscopy.

As an object is redshifted, its spectrum is shifted, changing the broad-band photometry measured.

Sky Coverage

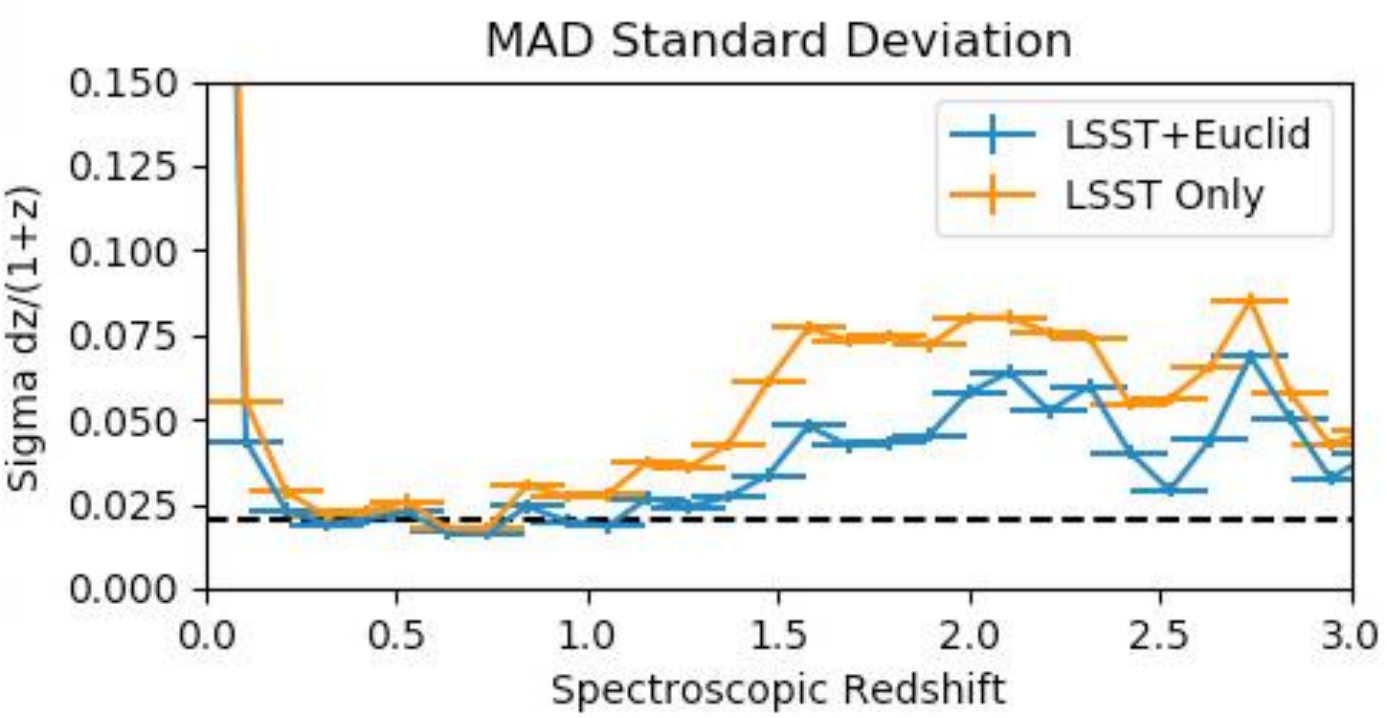


Euclid requires photometry from a number of ground-based telescopes such as Rubin to get photometric redshifts for all its sources.

The agreements and timing is an important issue even now.

The Rubin “Wide-Fast-Deep” survey will cover 18,000 square degrees of sky.
The *Euclid* Survey mission requirement is to cover 15,000 square degrees of sky

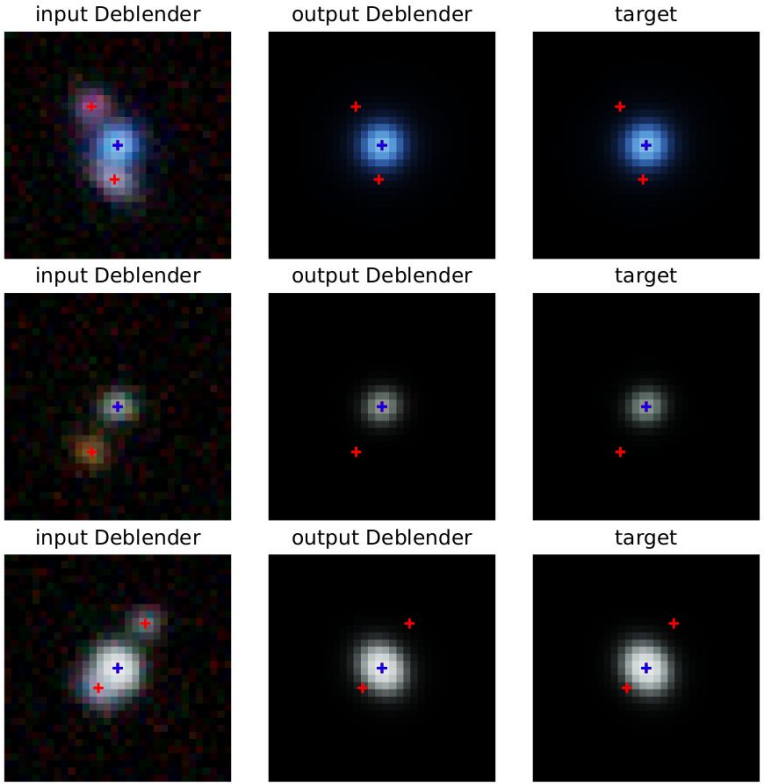
Photometric Redshift Improvements



Adding *Euclid* bands to those from Rubin can improve redshifts by a factor of 2 in some cases

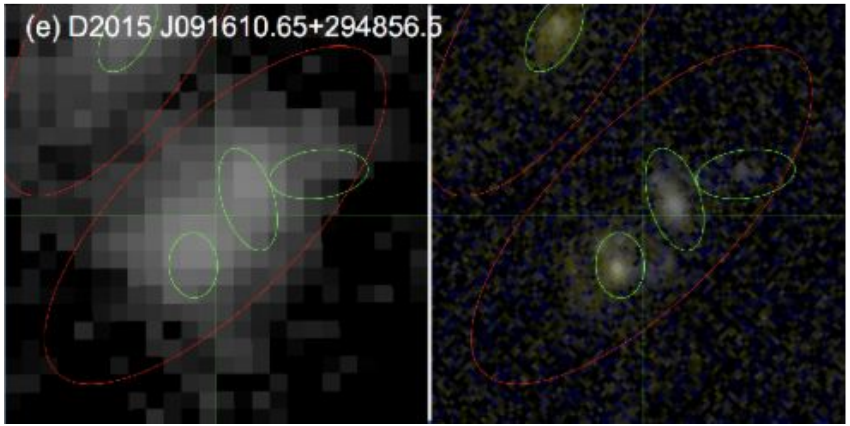
(and essentially enable photo-z's for *Euclid* over the southern sky)

Multi-color/multi-instrument deblending, color and PSF



Arcelin et al. 2020

Dawson 2016



Formal Collaborations are being negotiated now

15 scientists from each experiment, with initial scientific recommendations by Summer 2021

- Design initial DDPs
- Outline scientific justification
- Issue initial recommendations
- Define rhythm for future work together
- Gather input from communities
- Focus on the products needed, not how they'll be made, who will make them, etc.

Computing Synergies

The CC is the production environment for the entire French *Euclid* Data Center (SDC-Fr). It is also, with the US Data Facility (at SLAC), part of the Rubin computing team making the Rubin catalogs.

No agreement exists between Rubin and *Euclid* at the moment. If/when an agreement arrives, however, the IN2P3 should be able to benefit in terms of computing resources, as both data sets will be housed at the CC.

Rubin/*Euclid* Scientific & Analysis Method Synergies

- Combined photo-z is essential for *Euclid* and will benefit Rubin
- *Euclid* Clustering Redshifts methods can be used by Rubin
- Common simulations are required
- Rubin High-throughput processing innovations can be used in *Euclid*
- Deblending is helped by the complementarity in depth/resolution and in colors
- Some shear systematics can be reduced by a combined analysis, or estimated by analysis comparison
- Supernovae in Rubin can benefit from host galaxy Euclid imaging/spectro
  - Supernovae magnification in Rubin x weak shear
- Cluster science benefits from improved lensing, better z's for z>1
- ...

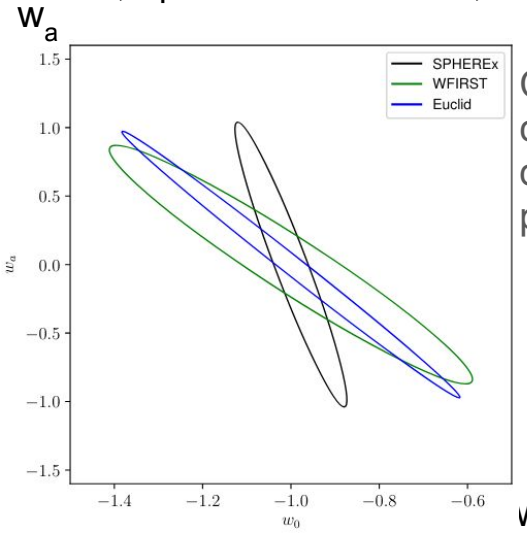
There are *MANY* OTHER synergies to anticipate...

- DESI
  - Spectroscopic survey, BAO, RSD...
- *Roman* (*WFIRST*)
  - Space telescope, IR imaging and spectro
  - WL, BAO, SNe (smaller and deeper than Euclid, IR)
- *SPHEREx*
  - 0.75-to-5 μm full-sky spectro-photo, z<1.
  - Euclid foreground understanding, incl photo-z and g(S)xg(E/R) lensing
- Simons Observatory / CMB Stage 4
  - CMB structure x *Euclid* / Rubin
- Gravitational Waves
  - Optical counterparts
- *⇒ Should we create a LSS/Dark Universe/? GdR ?*

SPHEREx (Spectro-Photometer for the History of the Universe, Epoch of Reionization, and Ices Explorer)

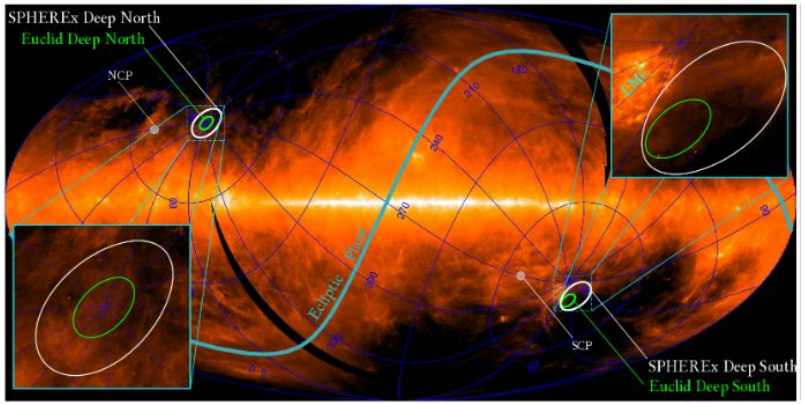
A NASA MIDEX mission, scheduled for launch in 2023, with a baseline two-year mission. It will make 0.75-to-5 μm spectra of every 6.2”×6.2” pixel on the sky. As it will measure structure of the entire sky at redshifts less than 1, it allows for complementary science (from comets through cosmology with Rubin) as well as improving *Euclid* “foreground” understanding:

- Photometric redshifts improvements in certain cases
- Galaxy (*SPHEREx*)-Galaxy(*Euclid*) lensing improvements
- Intrinsic alignment estimate improvements

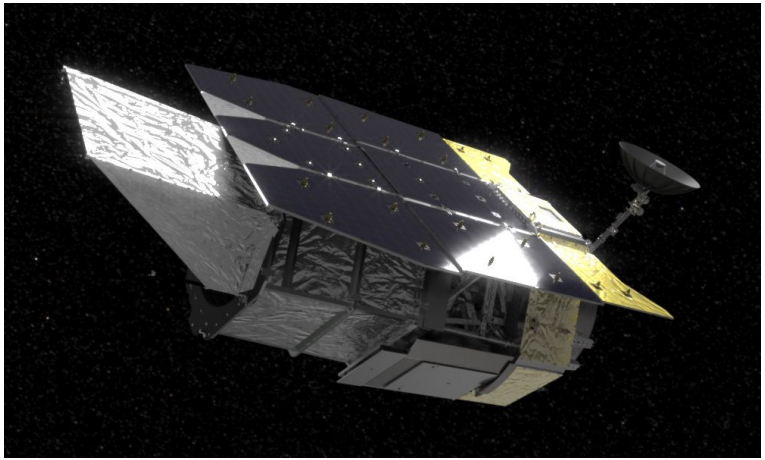


Complementary cosmology using different populations.

Overlapping Deep Fields



Roman Space Telescope (*WFIRST*)



- Grandson of *SNAP*/*JDEM*
- NASA IR 2.4m telescope @L2 (*Euclid*=1.2m)
- Approved in 2010, to be launched in 2026 (at best -- *Euclid* ~2022)
- 2 instruments
  - *High contrast Coronographic Instrument*
  - Wide Field Instrument: 300 Mpx, 0.28 sq.° (*Euclid* ~ 67 Mpx, 0.53 sq.°)
    - Includes a Grism (spectro-z) **and** a Prism (spectro-photometry) slitless modes
- Cosmology science case complementary to *Euclid*: smaller/deeper survey
  - BAO, WL and **SNe Ia**, the exact definition of the survey shares still to be defined
- France (CNES & INSU-LAM now) participating in Corono. HW and Slitless SW
  - Broader community (IN2P3 & CEA) to be involved in slitless and SN activities
  - IN2P3 expertise: SN cosmology (ZTF/Rubin), slitless spectro (*Euclid*), CC