Euclid and UVEX

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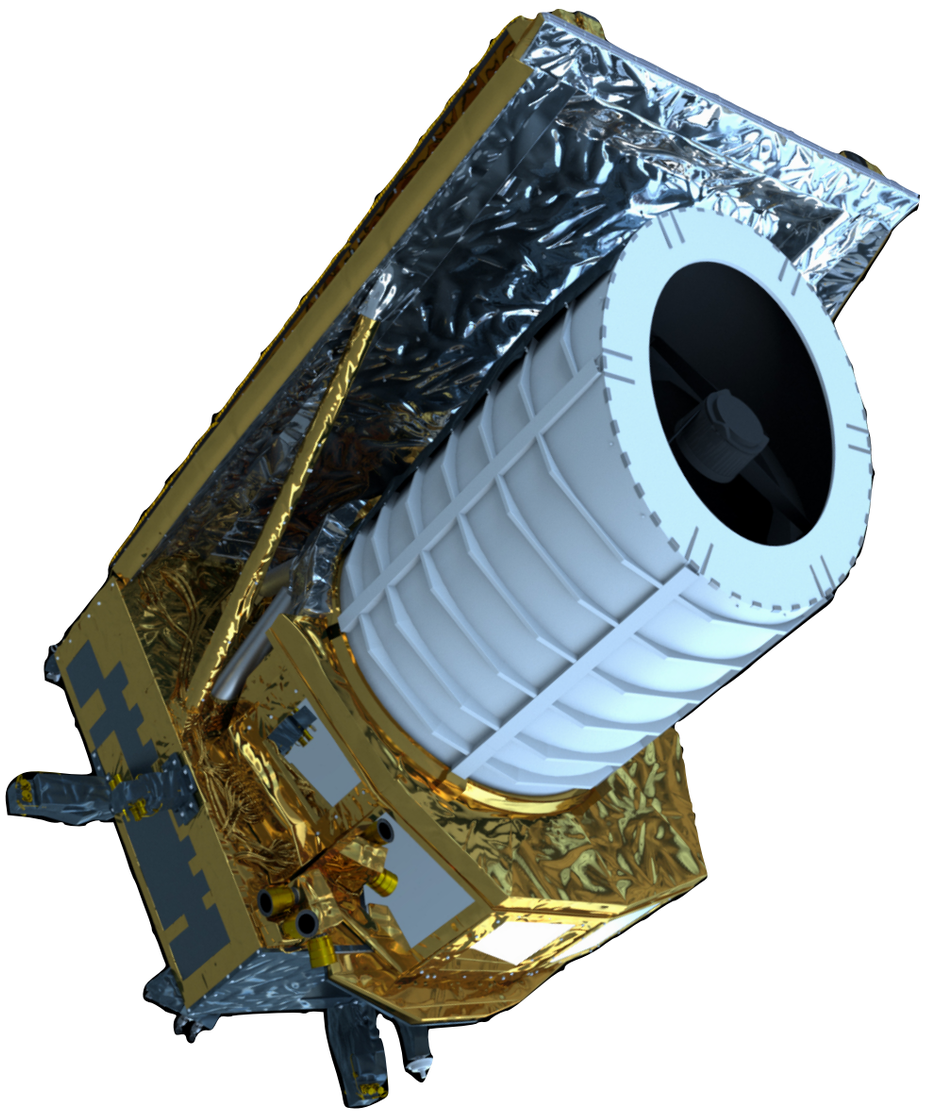
euclid consortium

Euclid mission



ESA+NASA space mission with launch in July 2023 and a nominal length of 6 years.

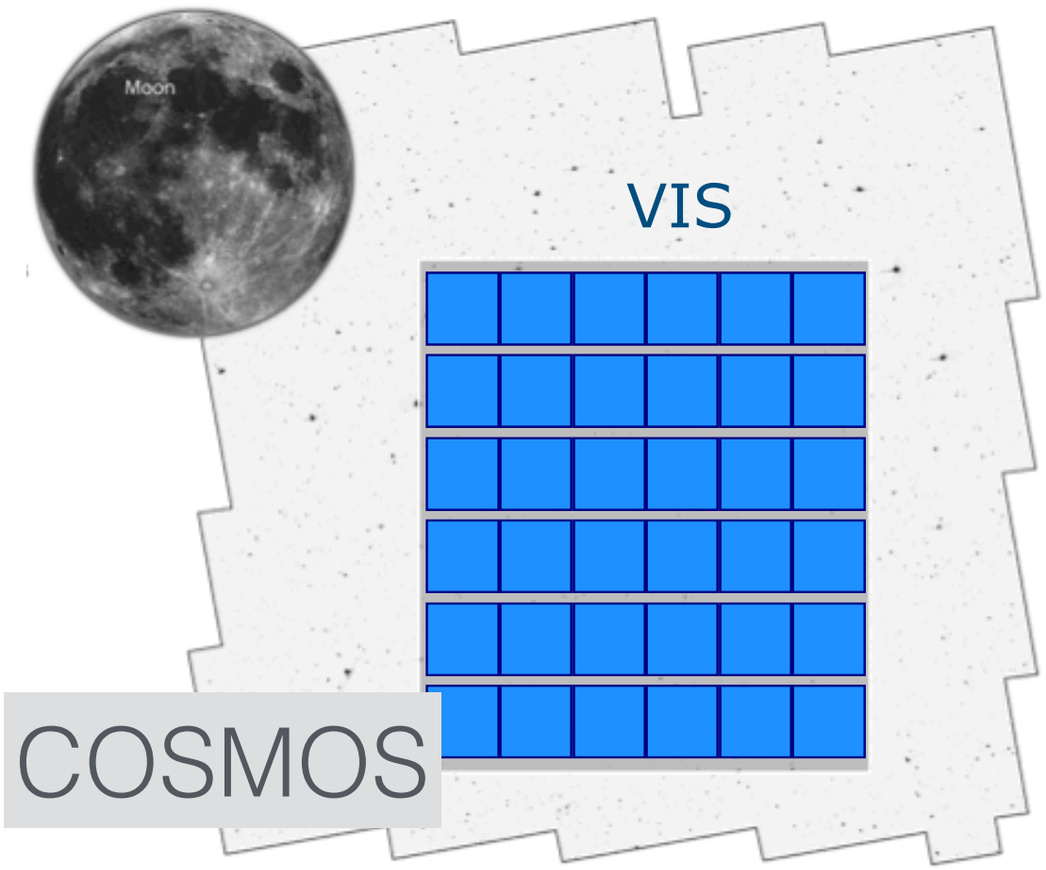
Scientific goal: understanding the nature of darks matter and dark energy.

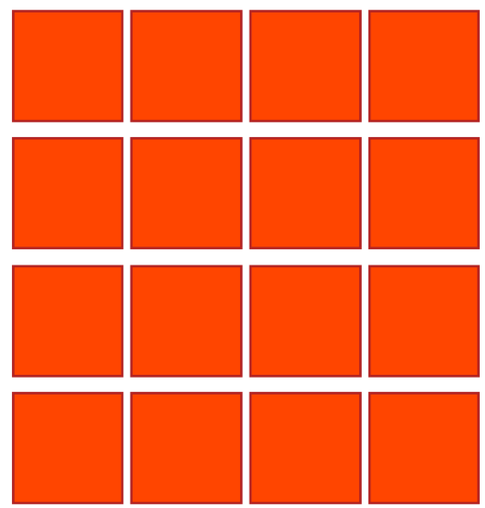
Euclid will use two cosmological probes: galaxy clustering (BAOs and RSD) and Weak Lensing (WL).

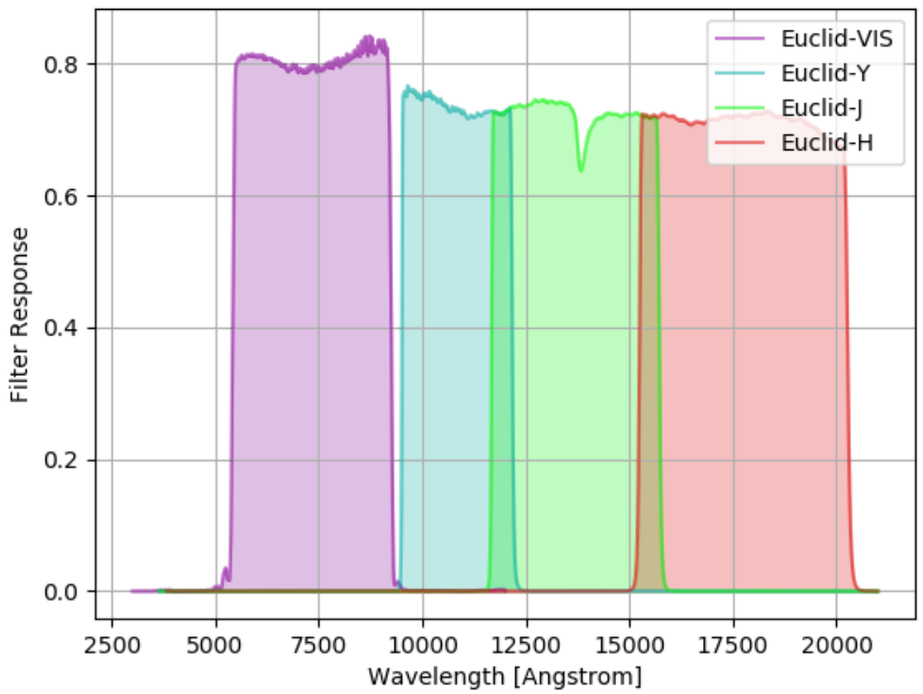
Clustering requires measurements of galaxy positions and redshifts.
WL requires galaxy shapes and photometric redshifts.
Both require very large samples of galaxies.

Euclid mission : high resolution imaging

Euclid will achieve its science goals with a 1.2 meter mirror telescope, at L2, and two instruments operating in parallel.



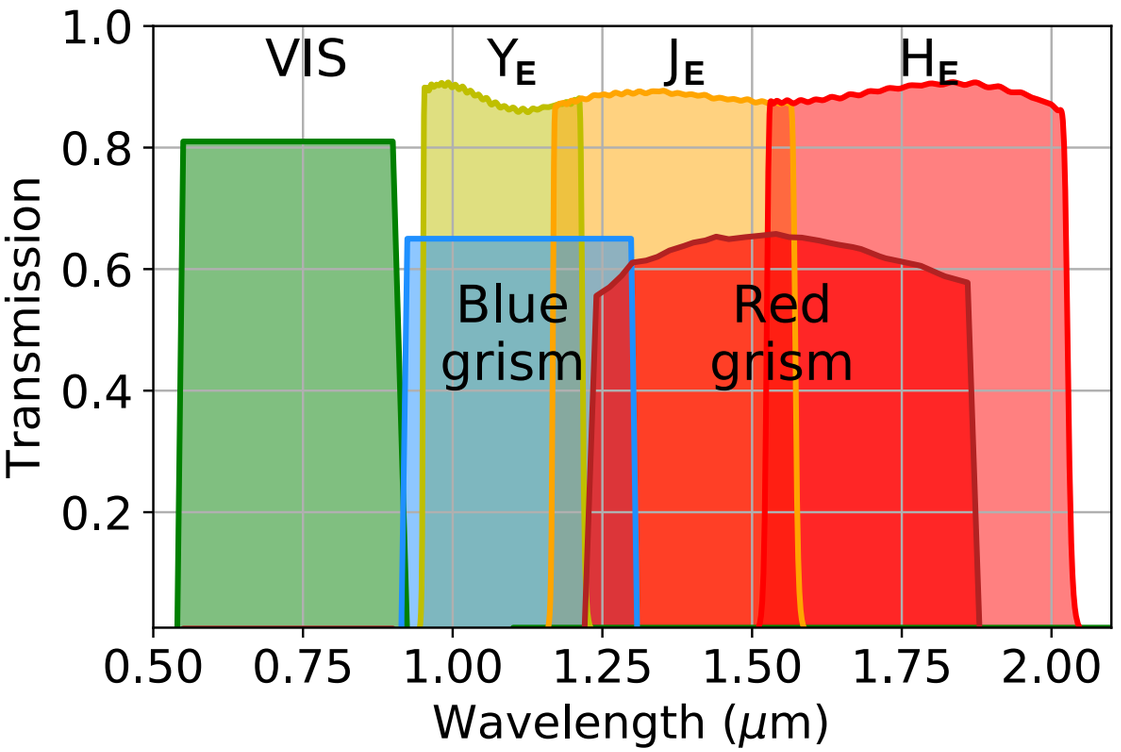




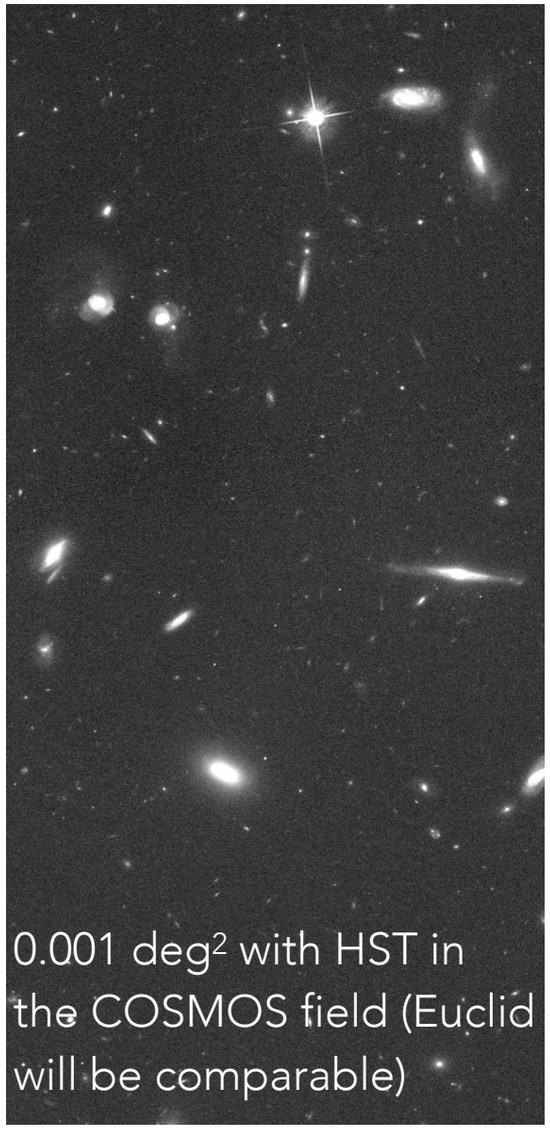
- **FoV**: 0.787 x 0.709 deg²
- **Plate scale**: 0.1 arcsec/pix
- **Spectral range**: 550–920nm

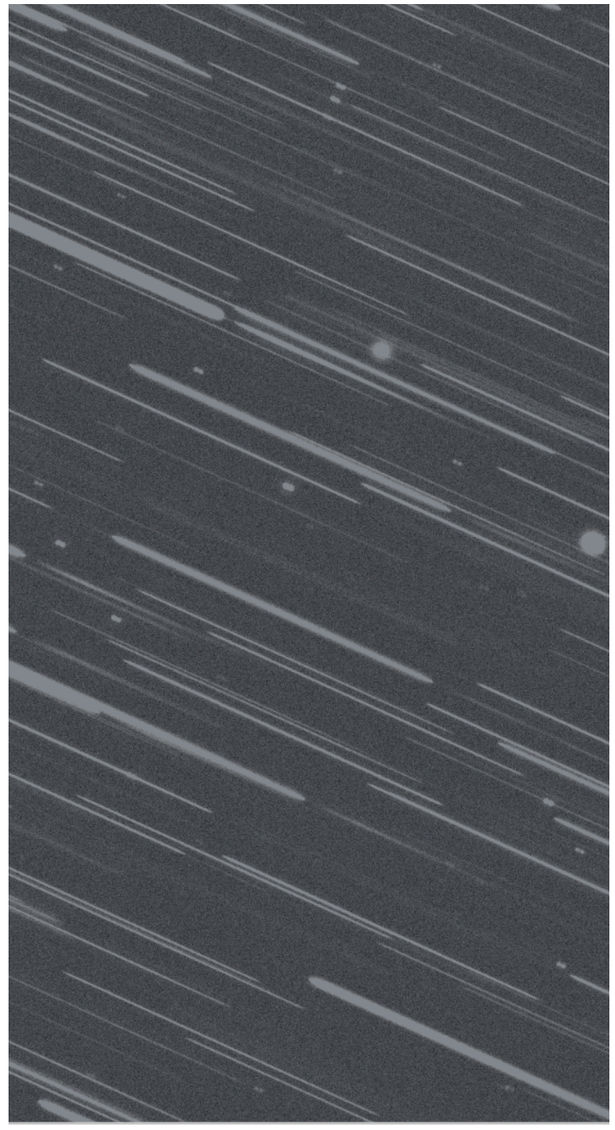
- **FoV**: 0.74 x 0.74 deg²
- **Plate scale**: 0.3 arcsec/pix
- **Spectral range**: 950–2000nm

Euclid mission : IR spectroscopy



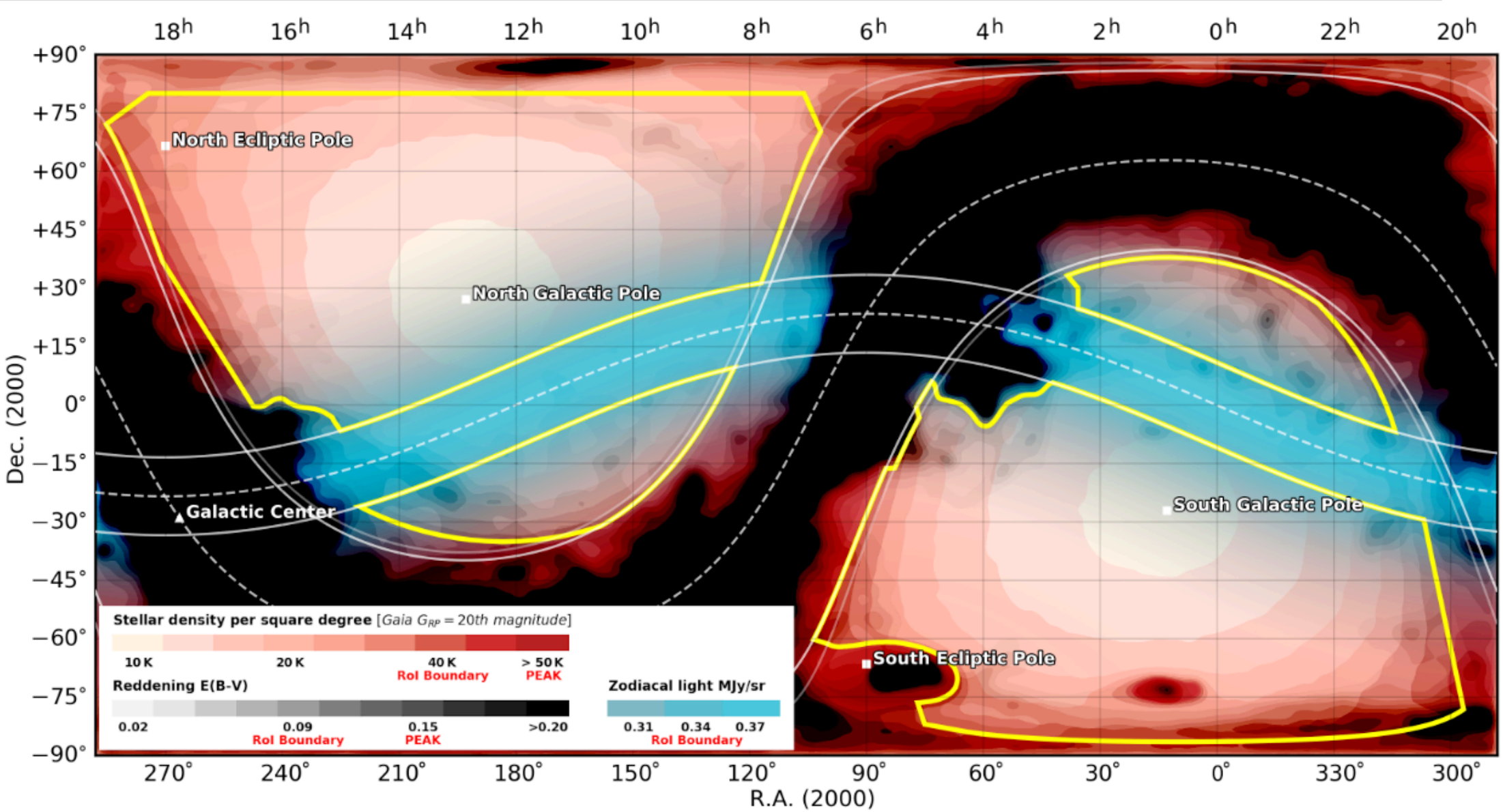
Slitless spectroscopy at R = 250 between 1.25μm < λ < 1.85μm





Euclid also has a Blue grism (0.9μm < λ < 1.3μm) that will be used for calibration of the the main cosmological probes and legacy science in the deep fields.

Euclid mission: Wide survey



Wide survey: **15,000 deg²**

Avoiding high stellar density, bright Zodiacal light and bright (mAB < 4) stars

$f_{line} > 2x10^{-16}$ erg/s/cm² (3.5σ 0.5”)

Band	VIS	Y_E	J_E	H_E
Wide survey	25.2	24	24	24

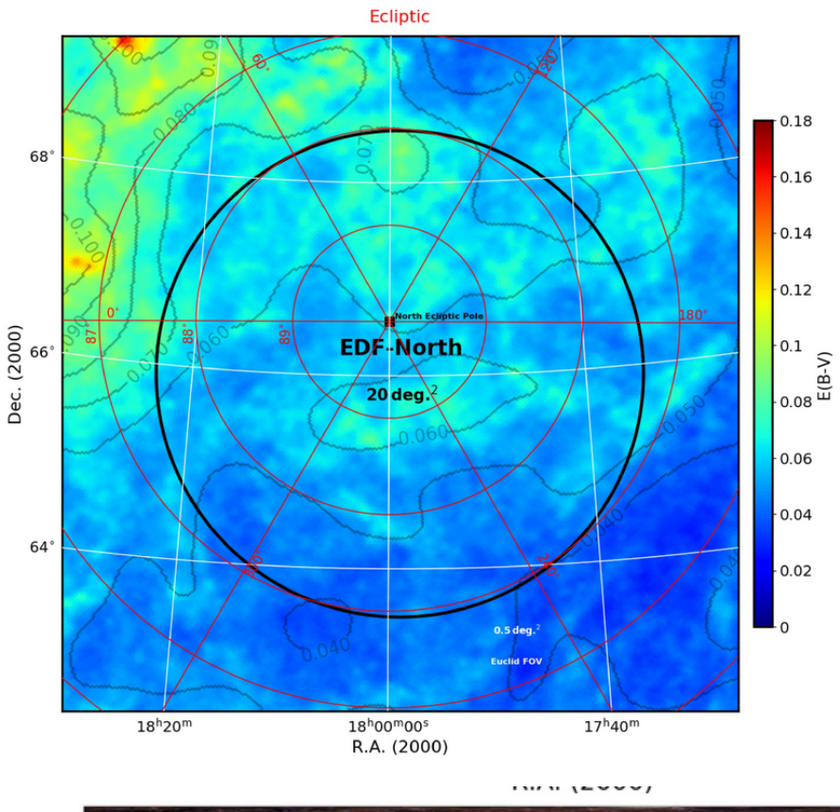
euclid consortium

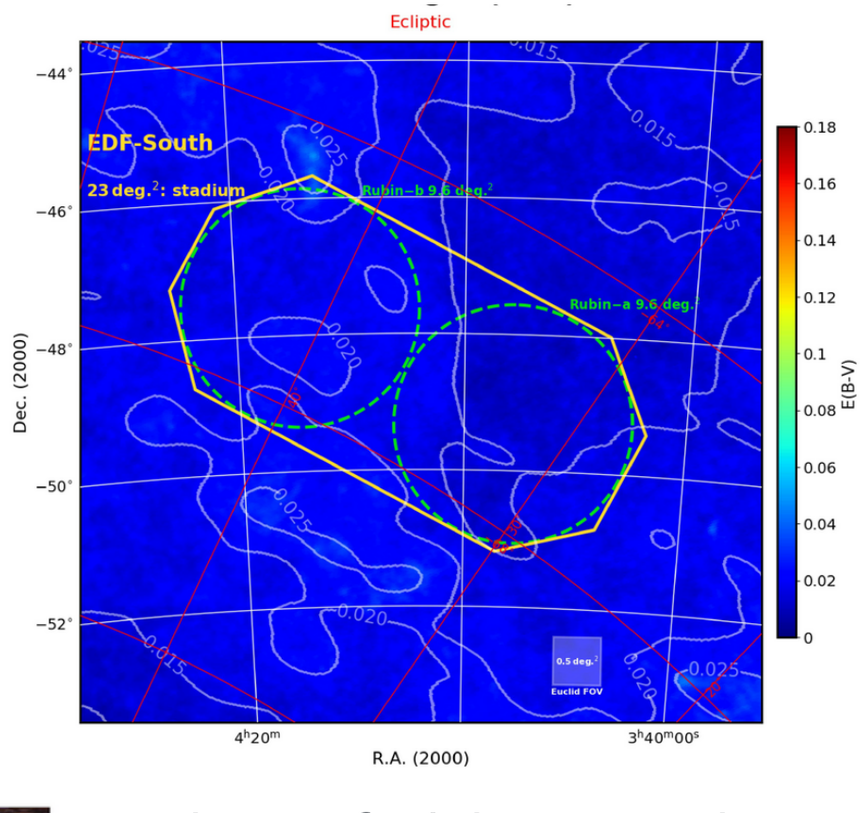
Euclid mission: main samples

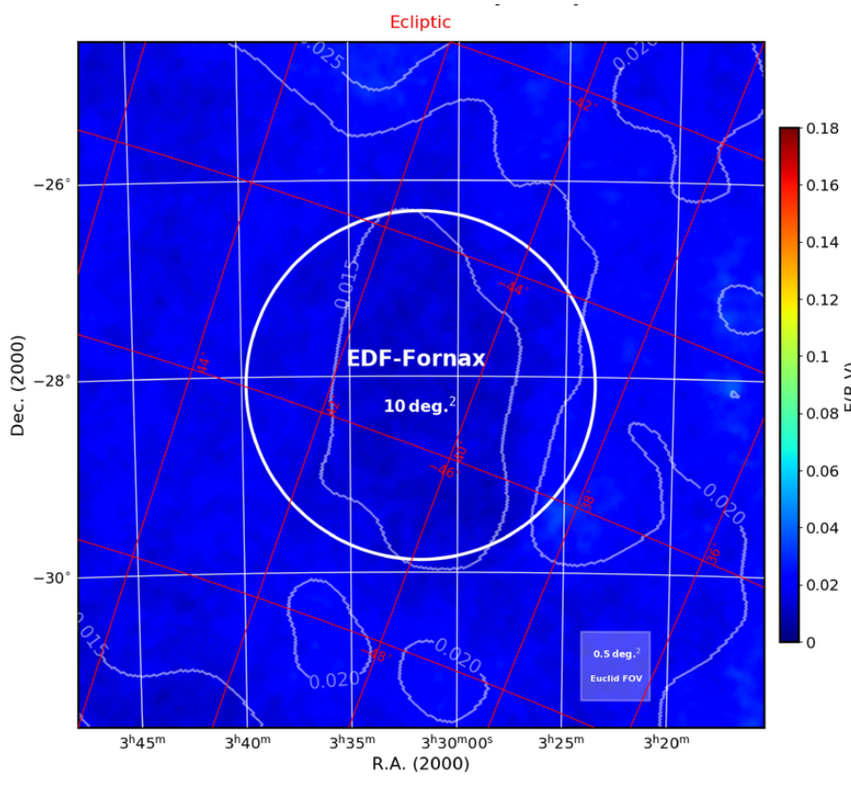
- For WL, Euclid measures the shapes of 30 resolved galaxies per sq. arc minute down to VIS=24.5 AB [10sigma]. The photometric redshifts for these galaxies reaches a precision of $\sigma_z/(1+z) < 0.05$, with the combination of Euclid and ground based survey data. To measure the shear from galaxy ellipticities, strict requirements on the knowledge and stability of the PSF.
- For clustering: Euclid will measure spectroscopic redshifts with a redshift accuracy of $\sigma_z/(1+z) \leq 0.001$ using the Hα+[NII] emission line. The survey will identify ~3000 galaxies/sq.deg. with $0.9< z <1.8$, yielding a sample of 45 million galaxies.

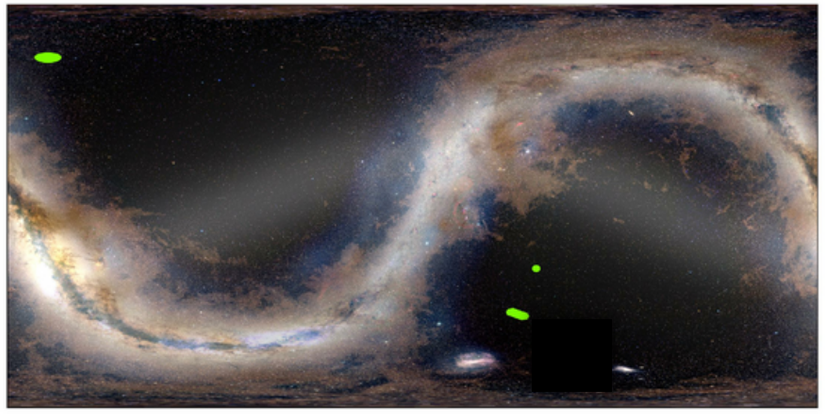
- The Deep fields are two magnitudes deeper than the wide survey. Needed for calibration of the slitless spectroscopy and WL-PSF. The deep survey monitors the stability of the spacecraft and payload through repeated visits of the same regions.

Euclid mission: Deep survey









Three fields, 2 at the Ecliptic poles + Fornax. Visited 40x to observe multiple angles and ensure decontamination.

Deep survey: 50 deg²

$f_{line} > 6x10^{-17}$ erg/s/cm² (3.5σ 0.5")

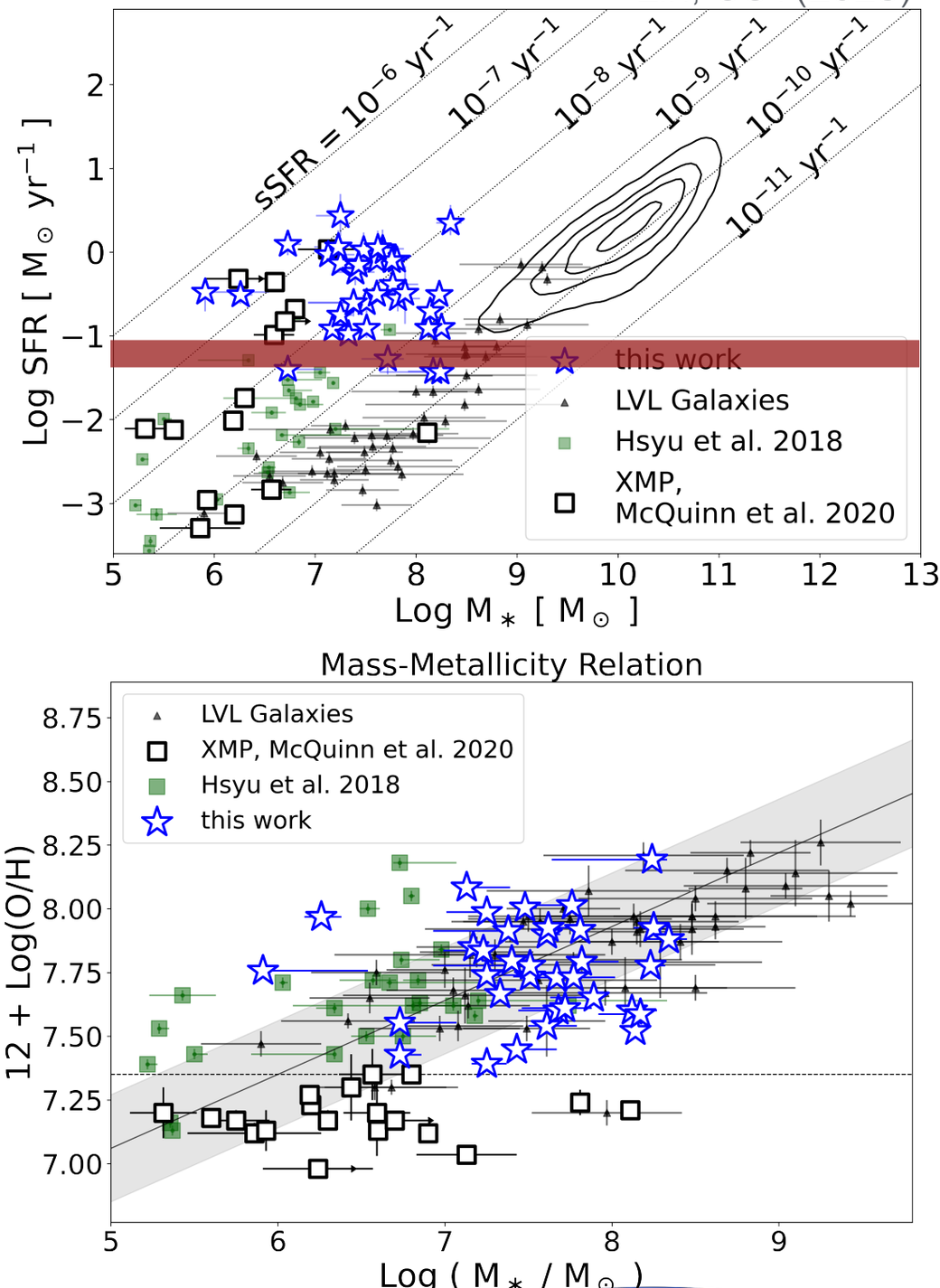
Band	VIS	Y_E	J_E	H_E
Wide survey	27.2	26	26	26

Synergies between Euclid and UVEX: Pillar I

- **Low-Z Low-Mass galaxies (z<0.03):**

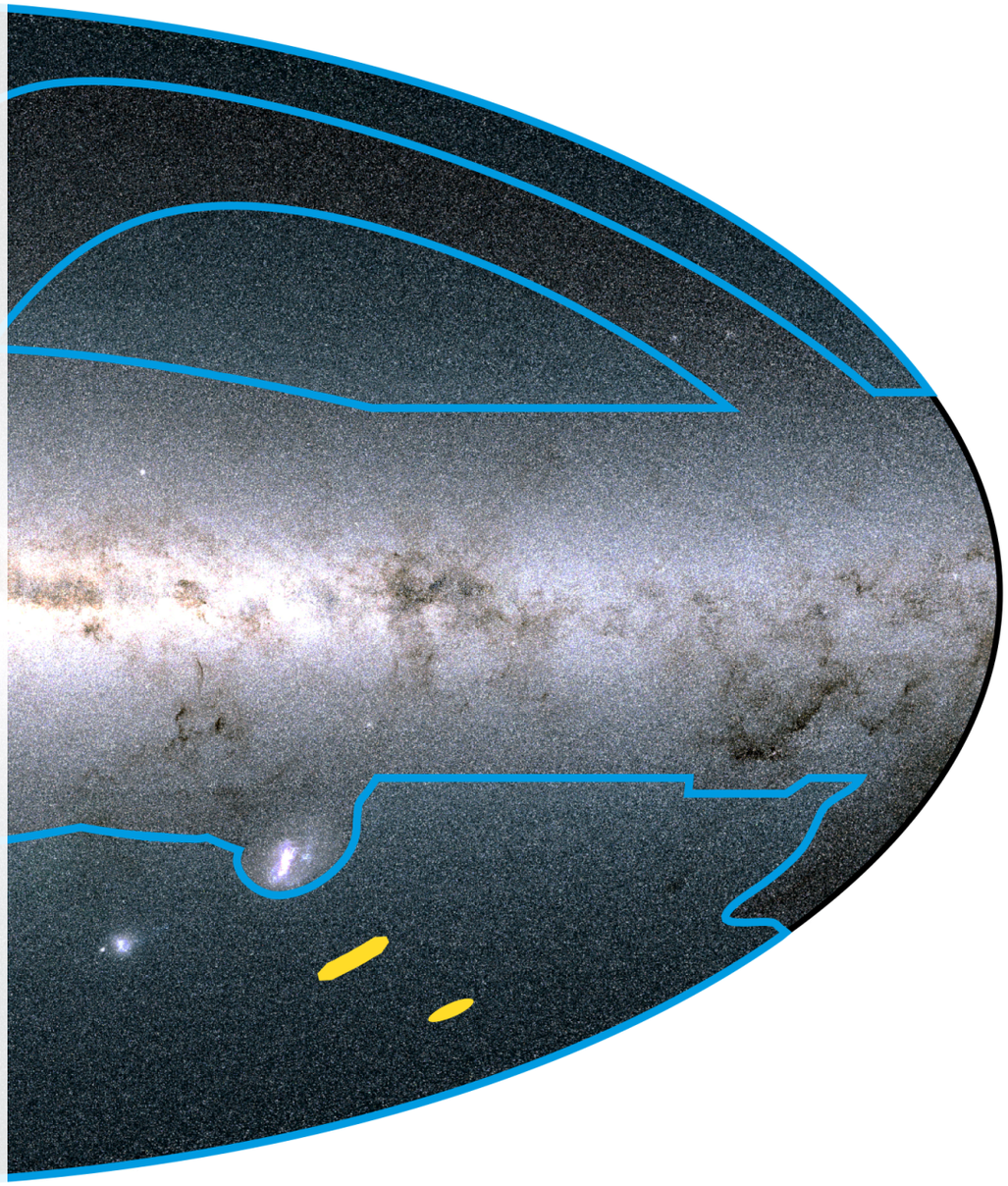
- Photometry in VIS, Y_E, J_E, H_E [wide: M>10^7 M_*, deep: M>10^6 M_*] ➡ **constrain redshifts, identify new targets for spectroscopic followup**
- High resolution images with resolution of from 100pc to 300pc (VIS to NISP) ➡ **effective radii, galaxy morphology, SFR surface density**
- Paschen-β in star-forming galaxies down to SFR~0.01Msun/yr and stellar masses as low as M>10^6 M_* ➡ **~10^5 galaxies with spec-z and unobscured SFR**
- Deep fields will add depth and coverage down to 0.9nm ➡ **[SIII] lines useful for Z preselection for UVEX spectroscopy**
- Redshifts of massive galaxies ➡ **environmental information**

Lin, CS+(2023)



Synergies between Euclid and UVEX: Pillar I

- **Local Volume:**
  - Individual stars and globular clusters will be detected out to D~5Mpc*
    - ➡ Accretion history of the **Milky Way via tidal streams and substructure**
    - ➡ Identification of Ultra Cool Dwarfs to study IMF
    - ➡ Resolved map of the SMC, adding complementary information given by older stars as well as a less dust-affected view of the SMC
    - ➡ Pick reddened sight lines for spectroscopic studies of dust
    - ➡ Low background, large area and depth make it easy to identify ultra-diffuse galaxies. SB fluctuations can then be used for distances out to 20Mpc.



Transient sky: Pillar II

- **Transient sky:**

  - Euclid will provide a deep all sky image that can provide vital background information to interpret UVEX-detected transients
    - (for example: progenitor properties, redshifts and physical properties of host galaxy)

  - Redshifts (photometric or spectroscopic) for the majority of galaxies in the sky ➡ Euclid will provide maps of the “association probability” between possible counterparts and future gravitational wave detections in O5 and O6.

  - …

A legacy of synoptic all sky surveys: Pillar III

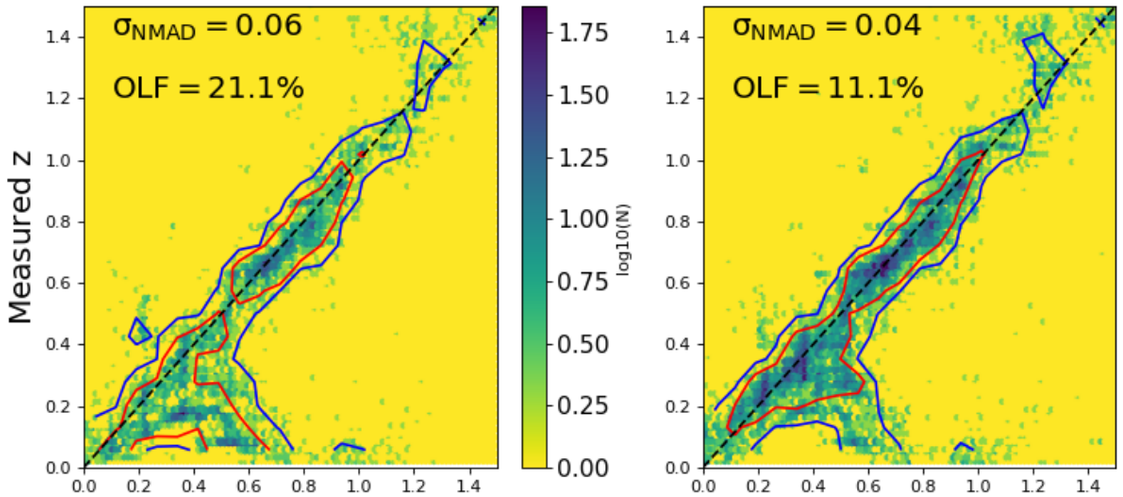
Here is where most of the synergies can be found, and where the two telescopes can really help each other. Some (biassed) examples:

What	Euclid
Galaxies at 1<z<3 with good mass estimates and morph.	~$2x10^8$
Massive [inc. passive] galaxies (1<z<3) w/spectra	~few x 10^3
Hα emitters/metal abundance in z~1-2	~$4x10^7/10^5$
Galaxies in massive clusters at z>1	~$(2\text{-}4)x10^4$
Type 2 AGN (0.7<z<2)	~10^4
Galaxy mergers	~10^5-few x 10^6
Strongly lensed galaxy/cluster-scale lenses	~200,000

- Duty cycle time scale for bursts as a function of mass, environment, redshift (out to z~0.6)
- Dust properties from UV colors and optical lines
- Recent rejuvenation in elliptical
- Lyα Luminosity function, Lyα EW distribution out to z~1.2, average Lyα escape fraction
- LyC escape fraction at z>1.1 in both galaxies and AGN

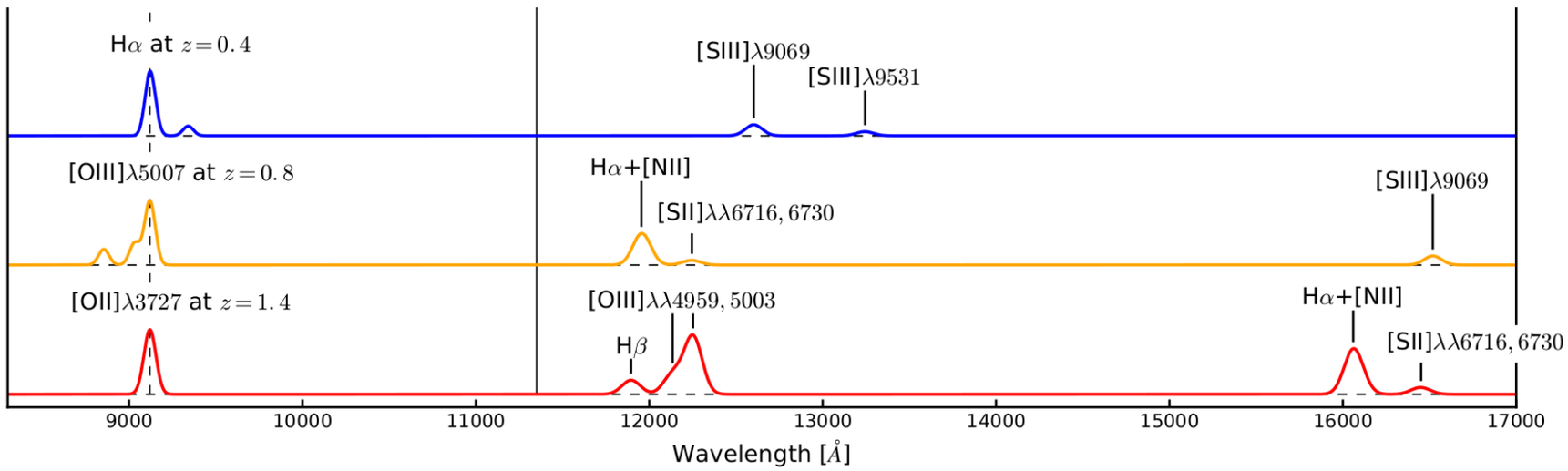
A legacy of synoptic all sky surveys: Pillar III

UV data will improve Euclid photometric redshifts (needed for the WL probe).



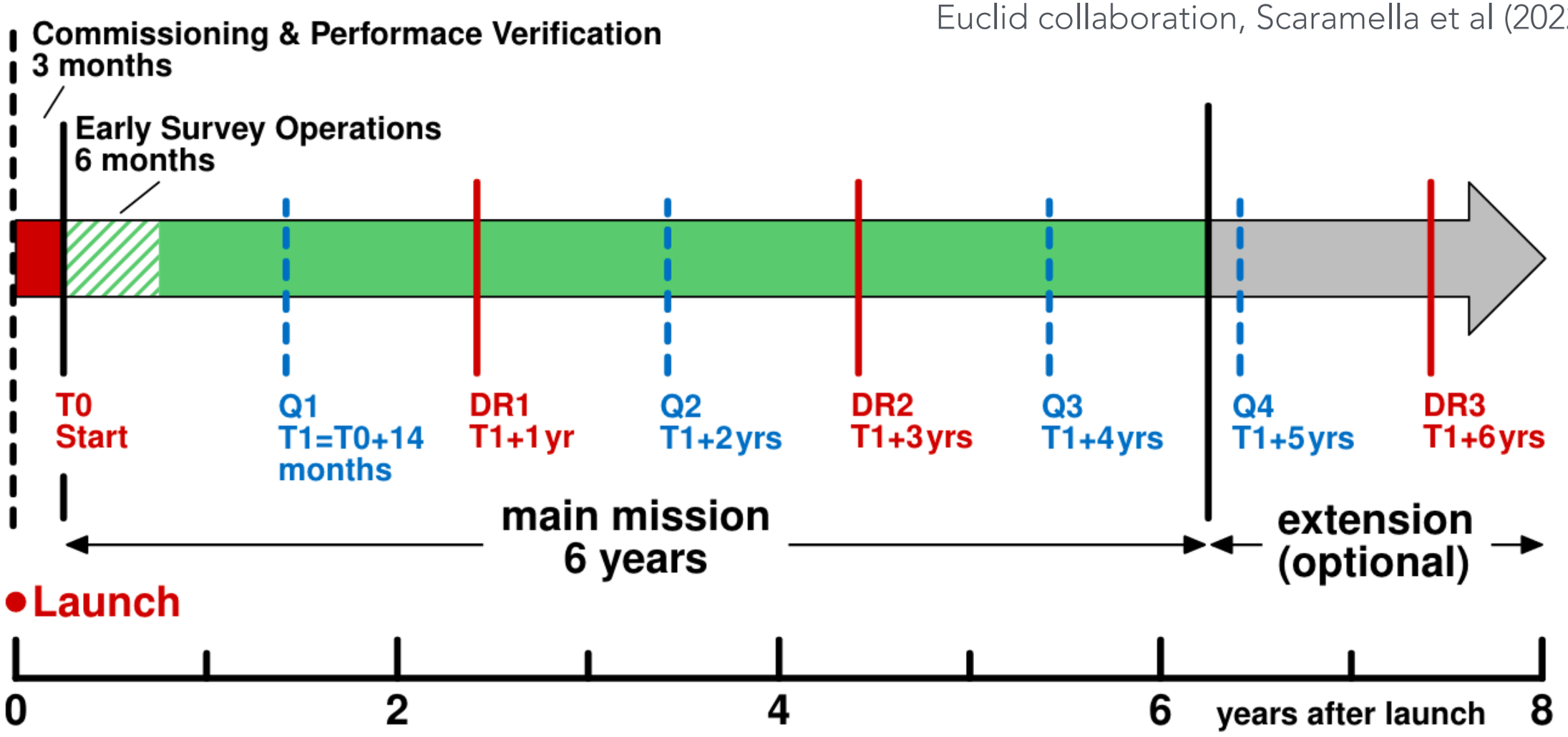
Addition of UV data to the full sky can reduce the average scatter between input and recovered redshifts by 30%, and the outlier fraction by almost a factor of two.

UV data will break redshift degeneracies in single-line emitters (clustering).



Euclid mission: timeline

Euclid collaboration, Scaramella et al (2022)



Launch: July 2023.

Q1: 50 deg^2

DR1: 2500 deg^2

Conclusions

- **Euclid data will come soon. First substantial public release in about 2yrs**
  - Cover 15,000 deg^2 with deep optical IR imaging.
  - Slitless spectra for all sources to H=24.
  - 50sq. degs. 2mags deeper.

    - The synergy between Euclid and UVEX goes both ways

      - Euclid to provide targets for followup studies, characterize properties of UVEX detected objects, provide a static reference sky for UVEX transits …

UVEX can support both cosmological probes (WL and clustering) improving photometric redshift and single-line identification. Provide unobscured SFR, Lya and LyC for most of the galaxy populations identified by Euclid.

Feel free to contact me mscarlat@umn.edu

Some synergies with UVEX

Gabarra et al. (2023)

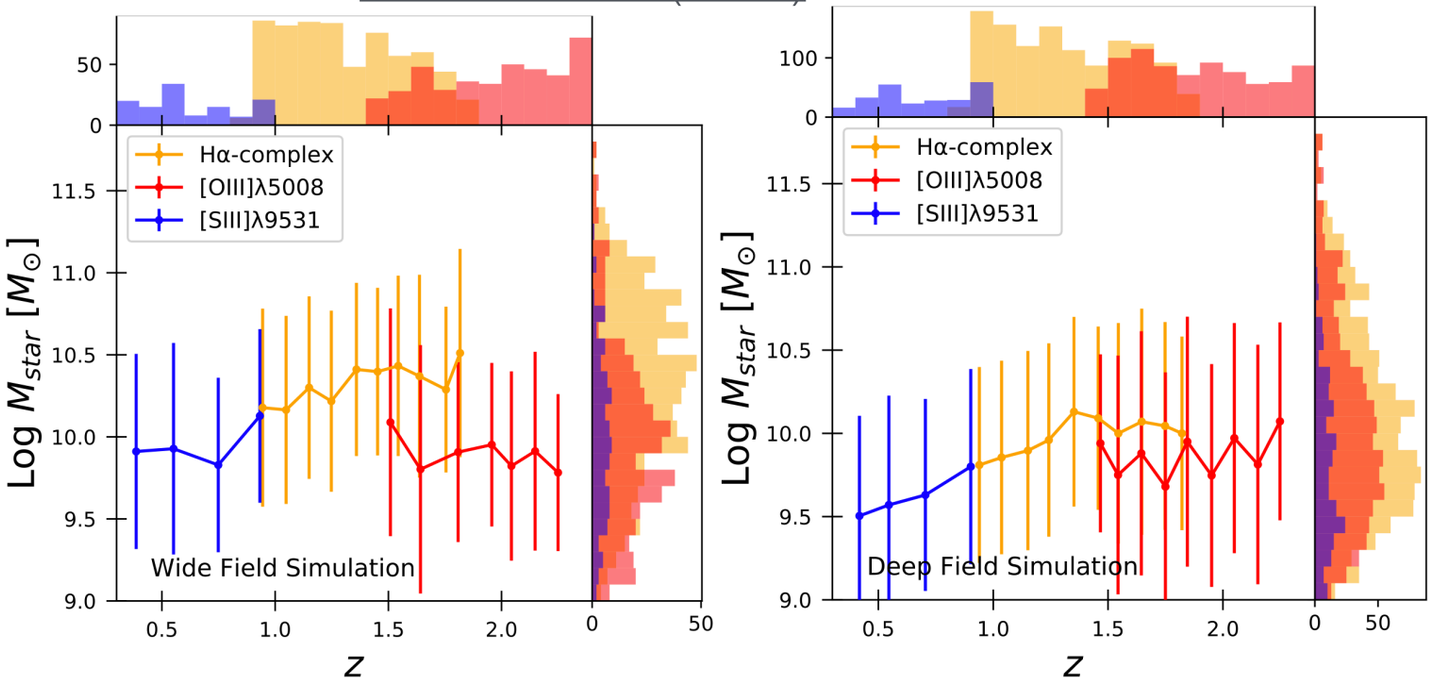


Fig. 17. Distribution of the sources with an emission line measurement at SNR ≥ 3.5, in the stellar mass versus redshift plane. Results are indicated for the EWS (*left*) and for the EDS (*right*) simulations and for the Hα-complex (orange), [O III]λ5008 (blue) and [S III]λ9531 (red) emission lines. The lines and error bars show the median SNR and MAD values calculated in redshift bins including a fixed number of 50 sources.