

Euclid

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- Medium-size mission (1 B€)
- 1.2m wide-field telescope
- Location: 2nd Lagrangian point
- Mission duration: 6-7 years
- Two payload instruments:
 - VIS
 - NISP

Euclid launched on July 1st, 2023!



Euclid main science goals

- Equation of state of dark energy: $w_0 = 1 \pm 0.016 ?$ $w_a = 0 \pm 0.16 ?$

$$p = w\rho c^2$$

$$w(z) = w_0 + \left(\frac{z}{1+z} \right) w_a$$

- Growth rate of density fluctuations: $\gamma = 0.55 \pm 0.02 ?$

$$f(z) = \Omega_m^\gamma$$

Euclid main probes

- Galaxy clustering
 - Low resolution spectroscopy
 - High multiplexing
 - Evolution over 90% of the life of the Universe → near-infrared ($z \sim 2$)
 - Large area
- Weak-lensing tomography
 - High-resolution imaging
 - Multi-band photometry
 - Evolution over 90% of the life of the Universe → near-infrared ($z \sim 2$)
 - Large area
- 3x2pt

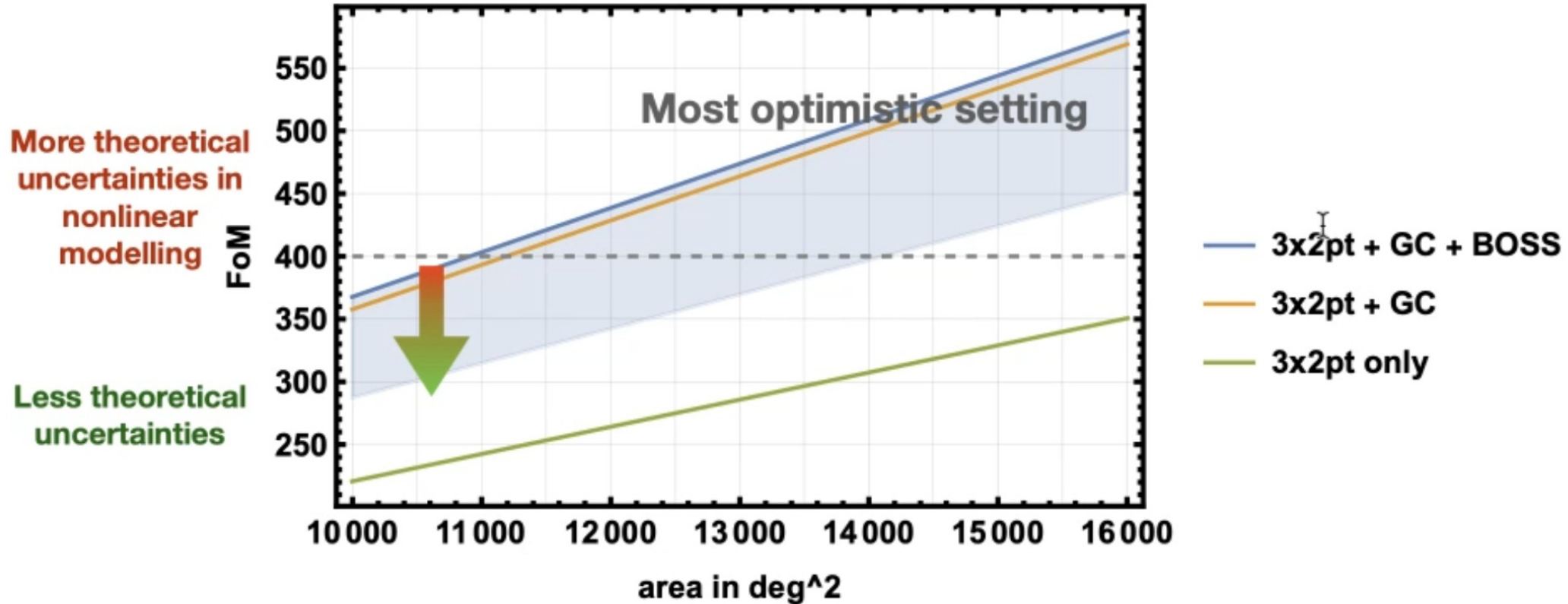
Figure of merit

- Equation of state of dark energy: $w_0 = 1 \pm 0.016 ?$ $w_r = 0 \pm 0.16 ?$

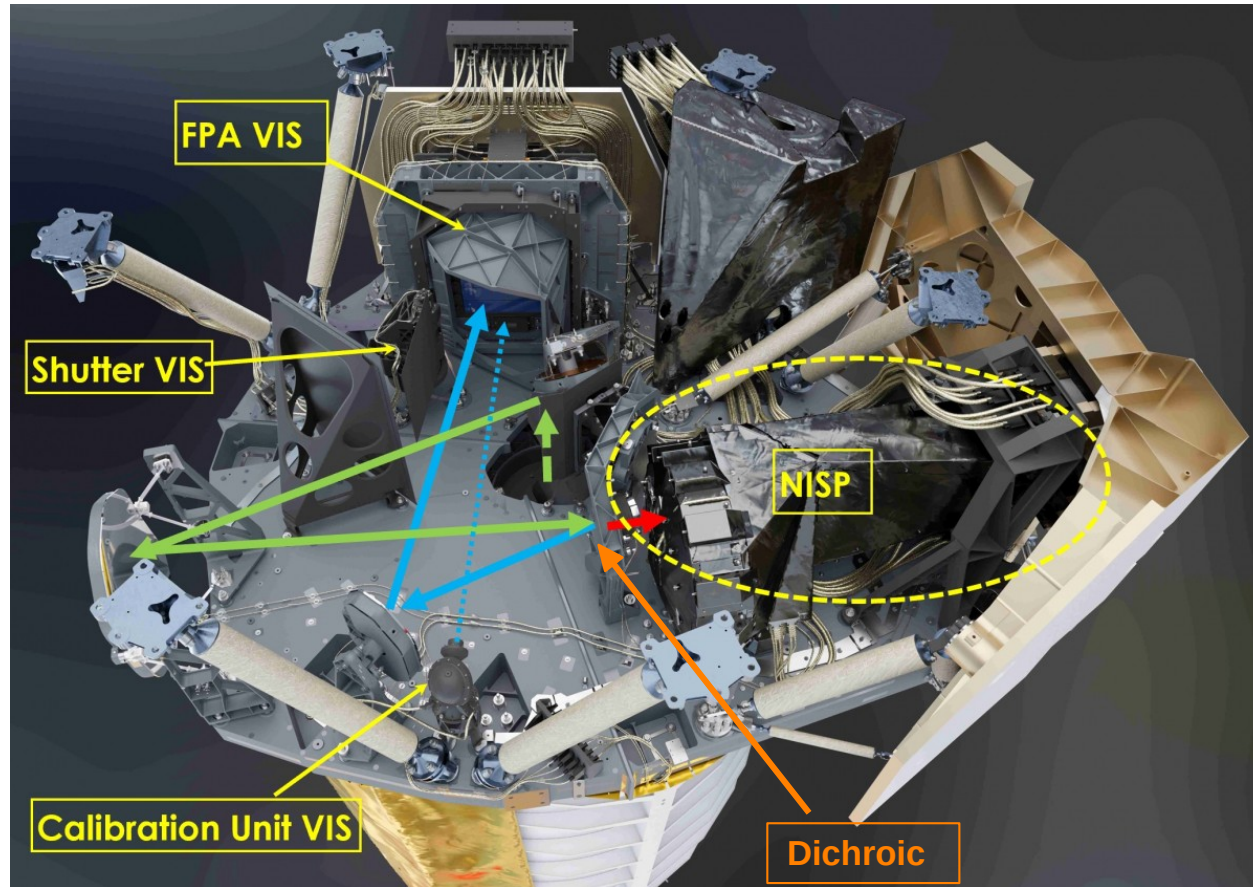
$$\text{FOM} = \frac{1}{\sqrt{\det \text{Cov}(w_0, w_a)}}$$

- Euclid requirement: $\text{FOM} \geq 400$

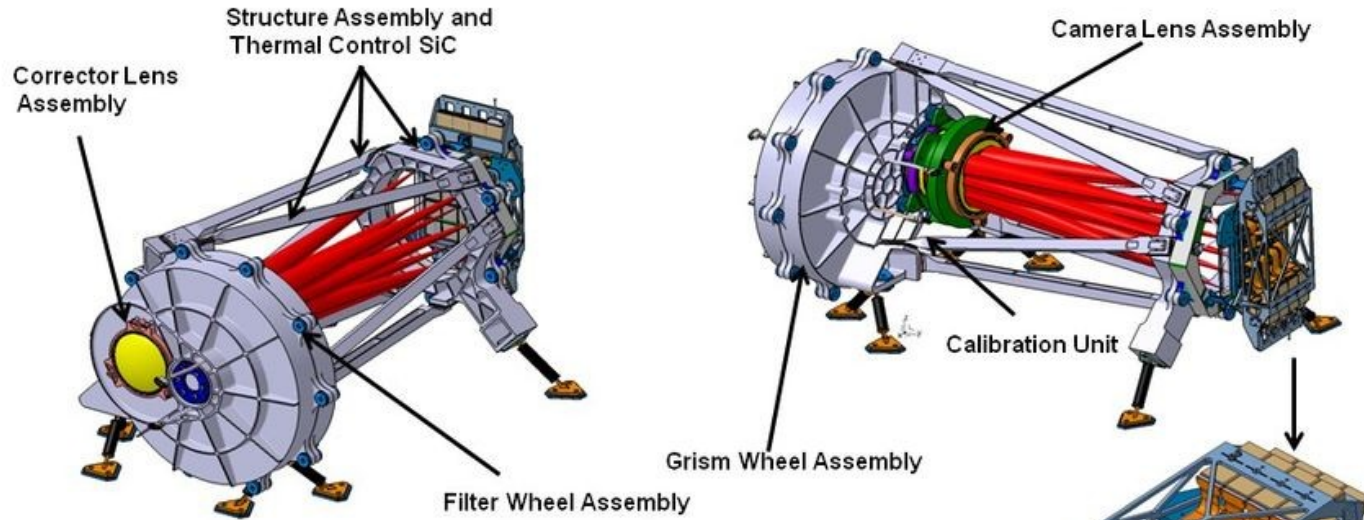
Figure of merit



Euclid Payload Module



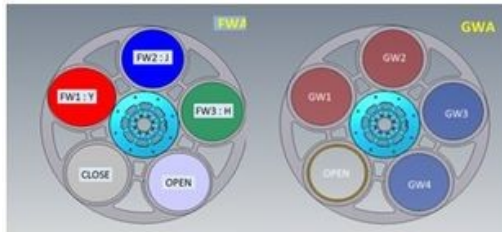
NISP: Near-Infrared Photometer and Spectrometer



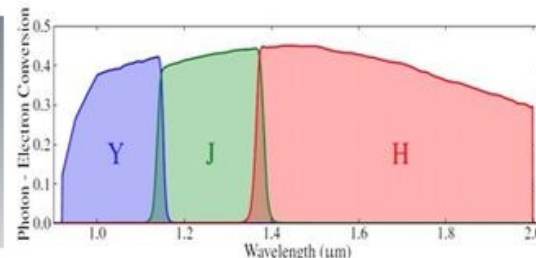
4x4 matrix of 2kx2k HgCdTe detectors

Imaging photometry in three bands Y, J, H

Low-resolution spectra
1.25-1.85 μm
(+0.9-1.25 μm)



Filters and grisms positions in wheels

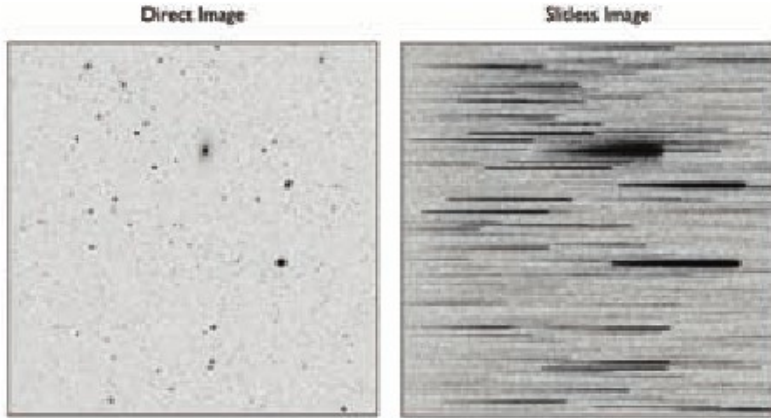


NISP throughputs through the Y, J and H filters



16 H2GR detectors

Slitless spectroscopy

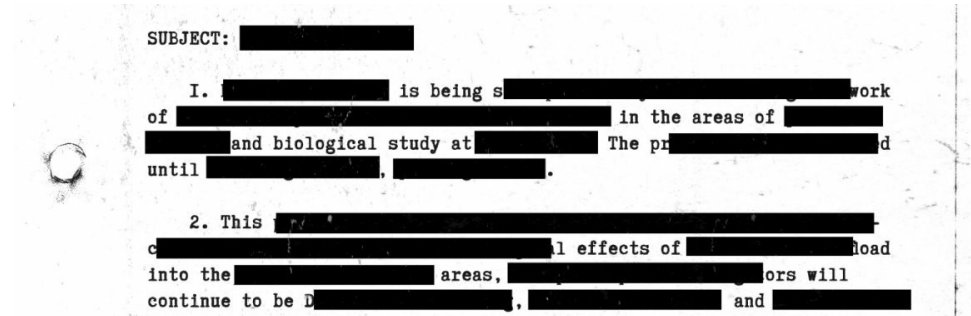


Advantages:

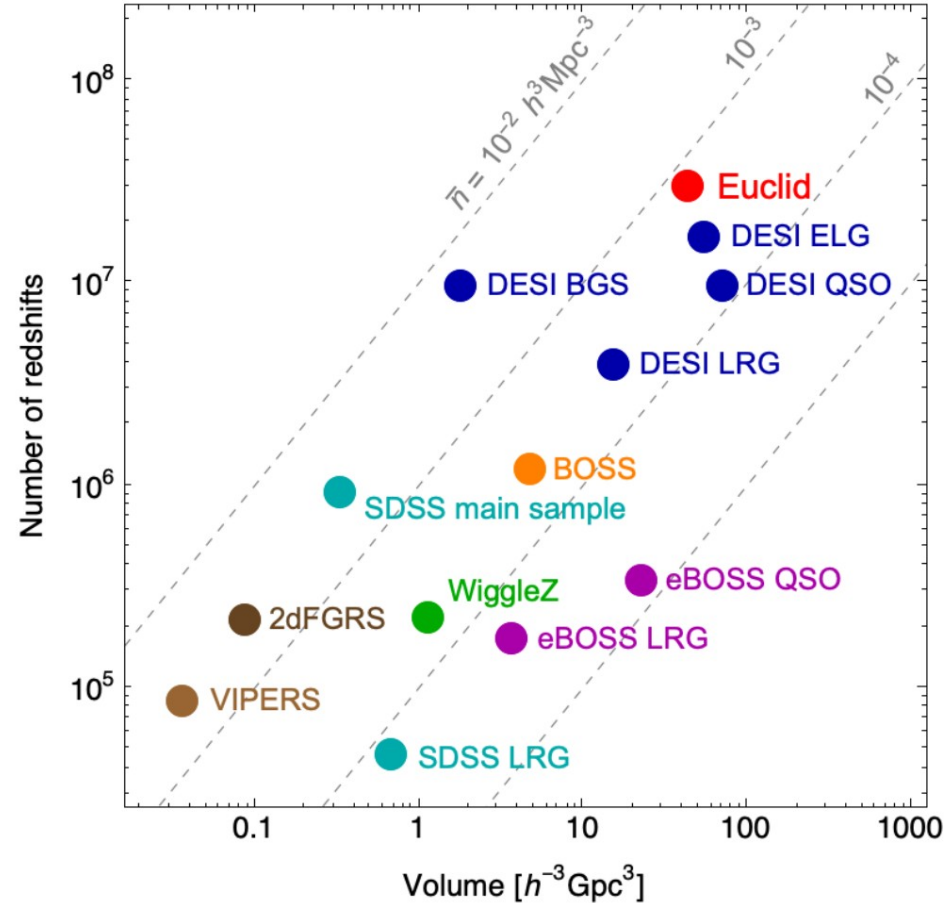
- Simplicity
- No source preselection

Disadvantages:

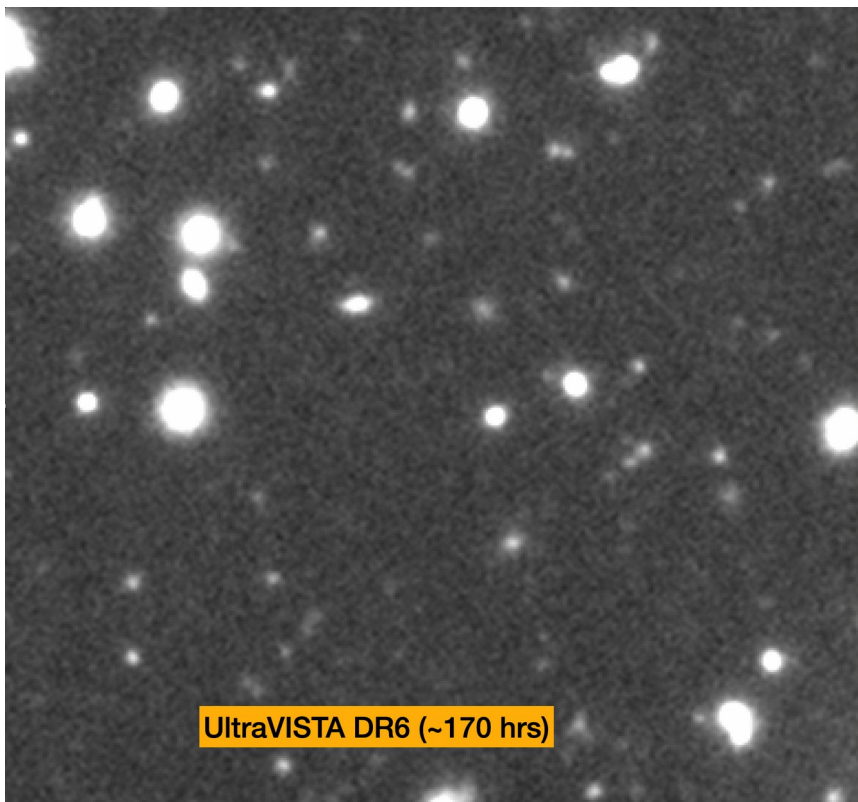
- Source overlap
- Complex sky background



Euclid spectroscopic survey



NISP imaging



SUBJECT: [REDACTED]

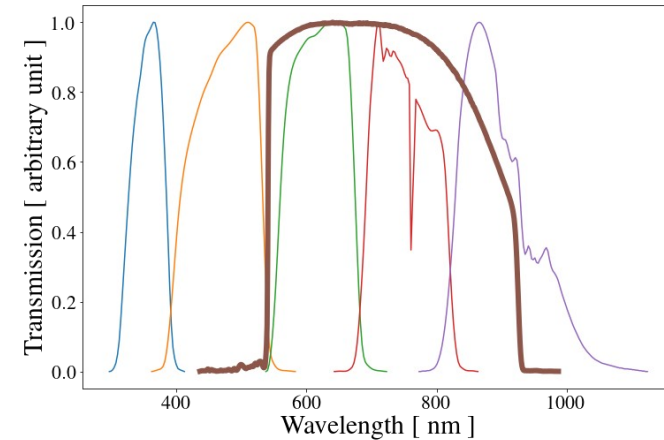
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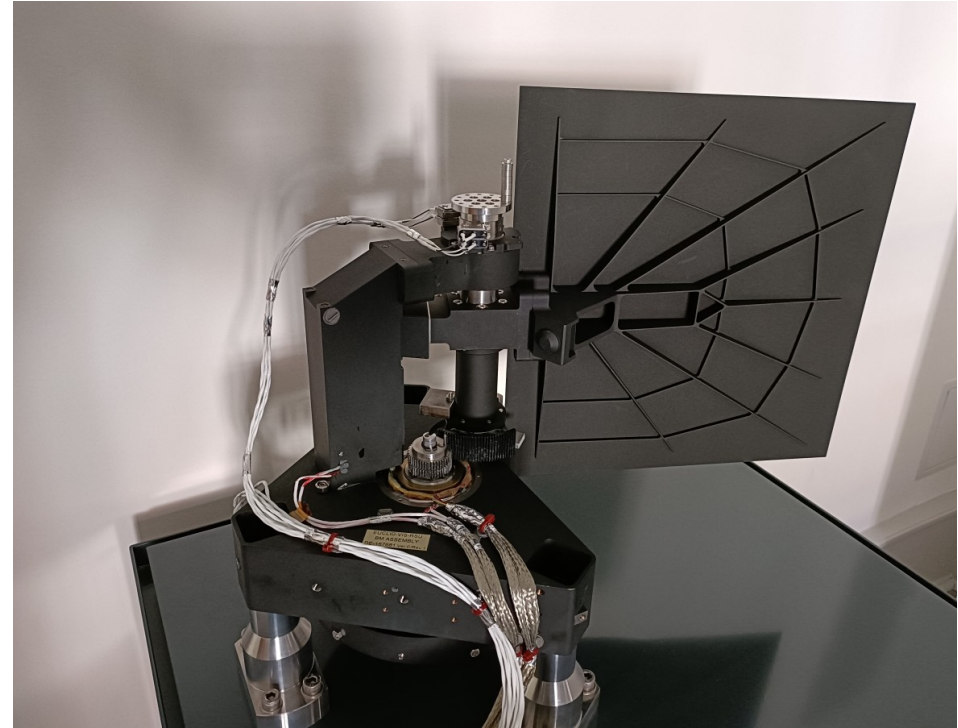
The VIS imager



- 6x6 matrix of 4kx4k CCDs
- One broad-band filter
- 0.15 arcsec resolution



The Readout Shutter unit for VIS

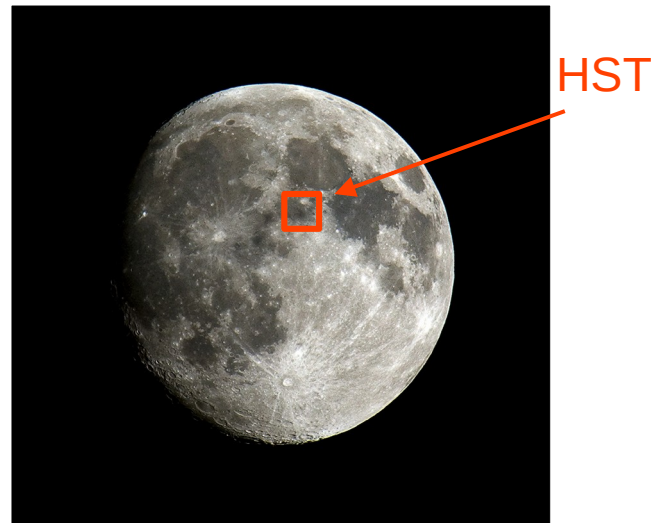
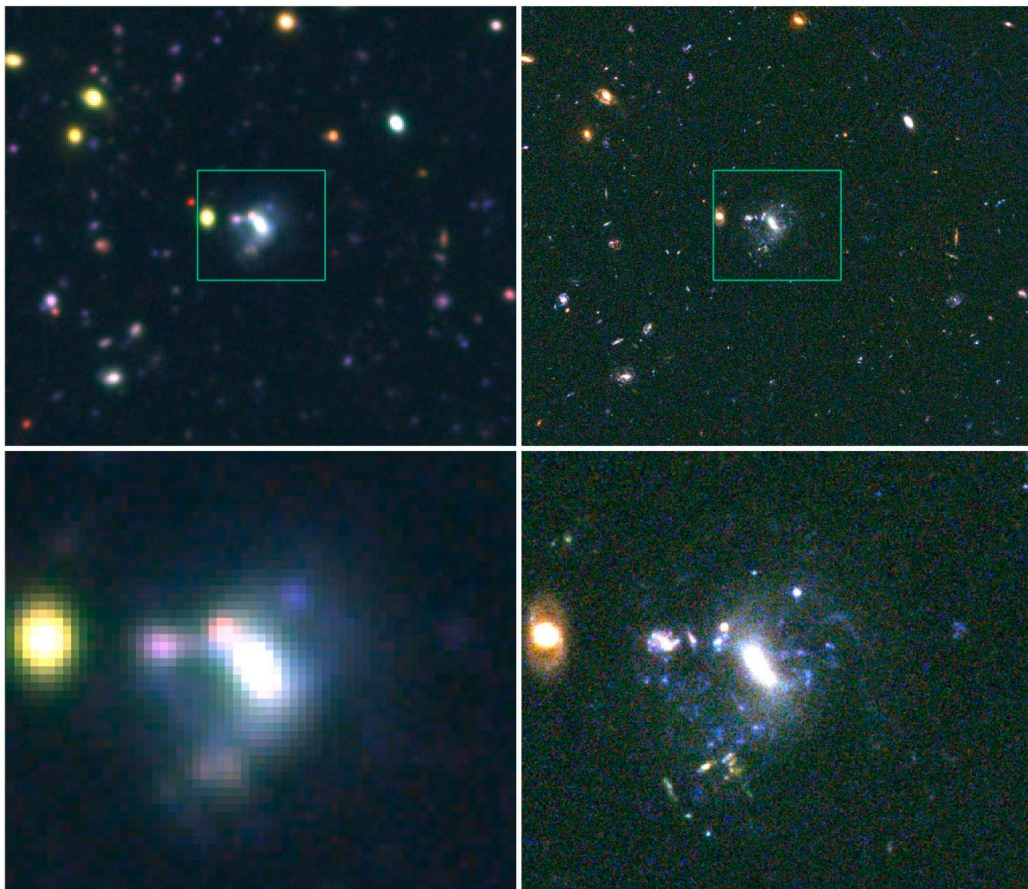


- Cold (170 K)
- 14 kg
- Highly reliable (500'000 operations)
- No exported momentum and torque
- No microvibrations

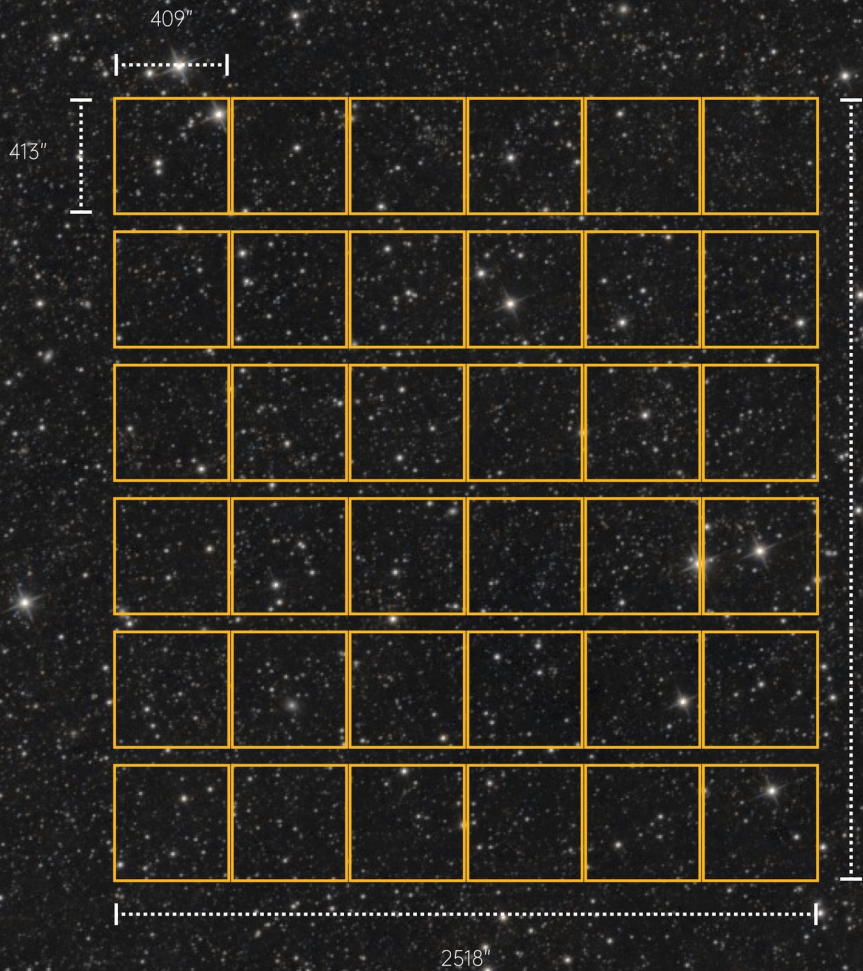
Euclid VIS images

Ground: Subaru (8m)

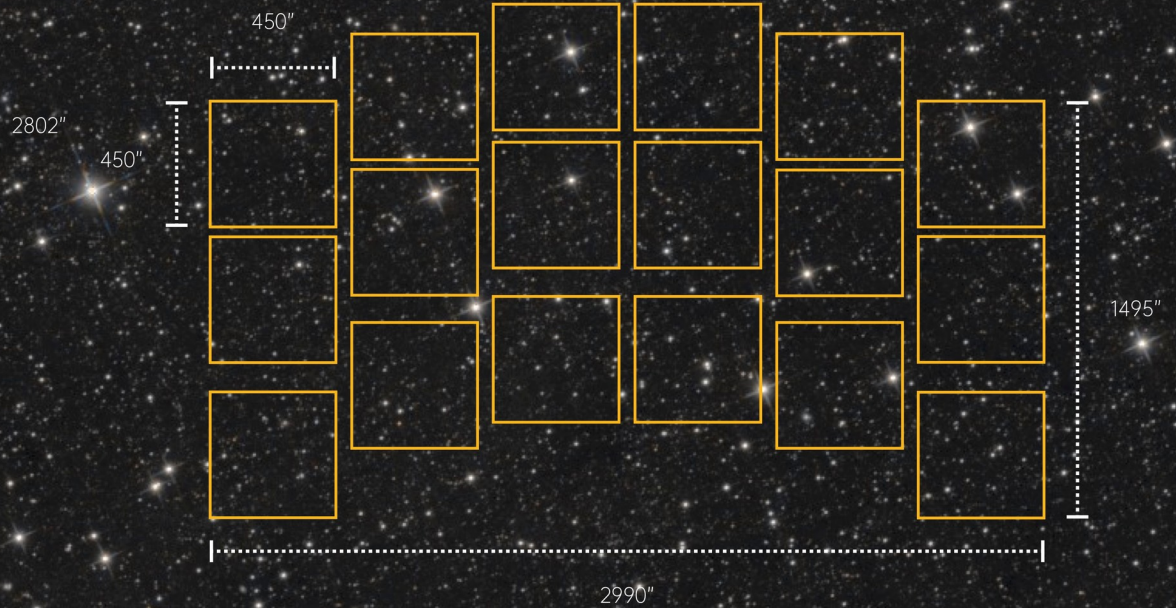
Space: *HST* (2.4m)



Euclid

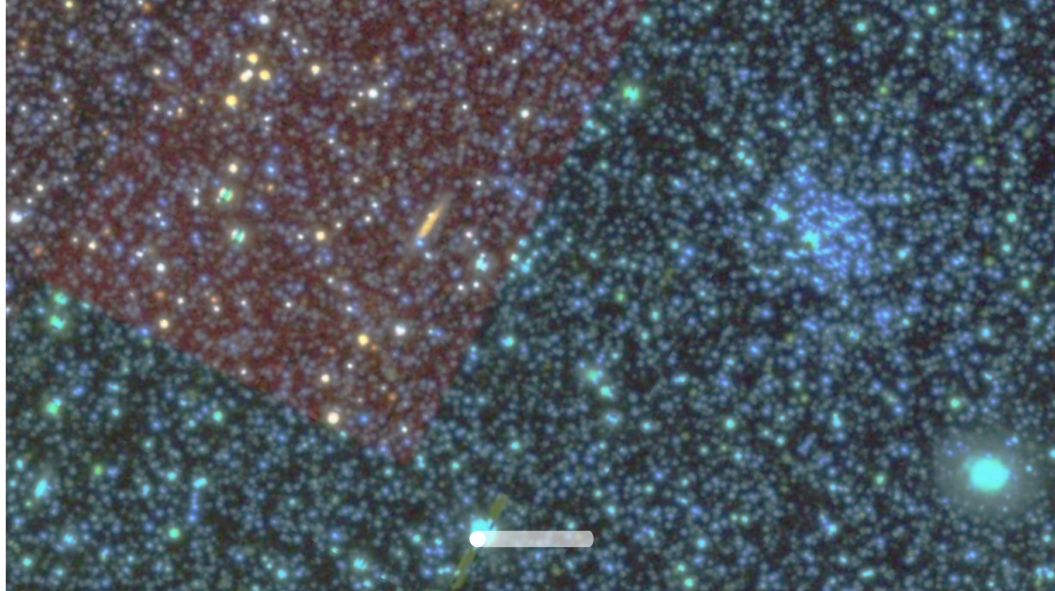


EUCLID VIS

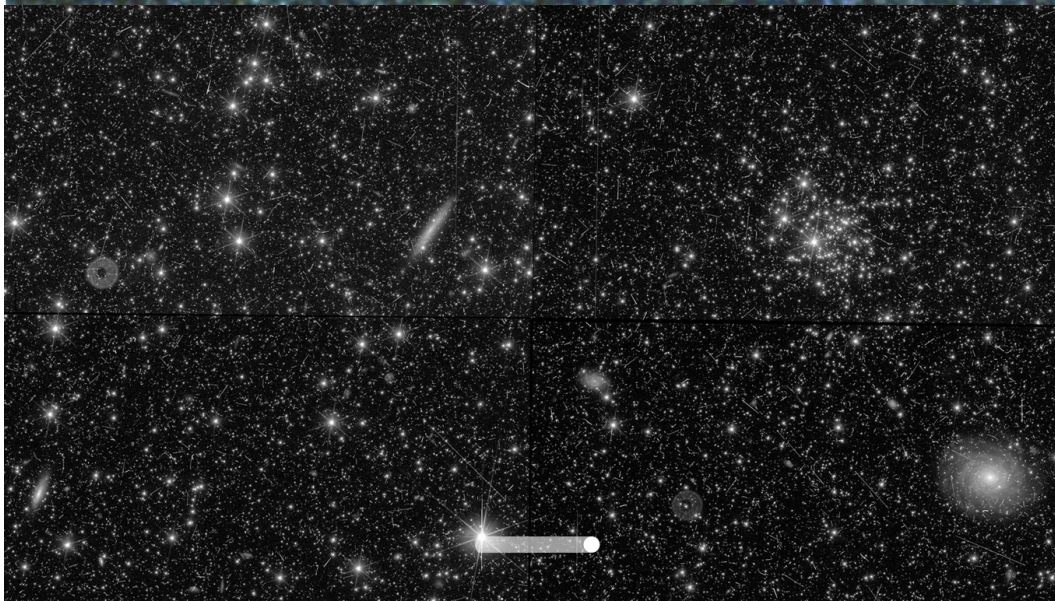


ROMAN WFI (planned 2027)

DESI



VIS



SUBJECT: [REDACTED]

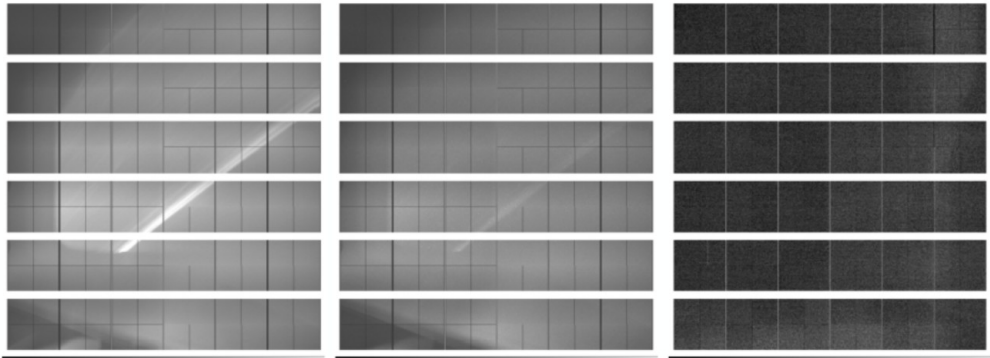
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Alpha Angle: +4.5 deg

Alpha Angle: 0 deg

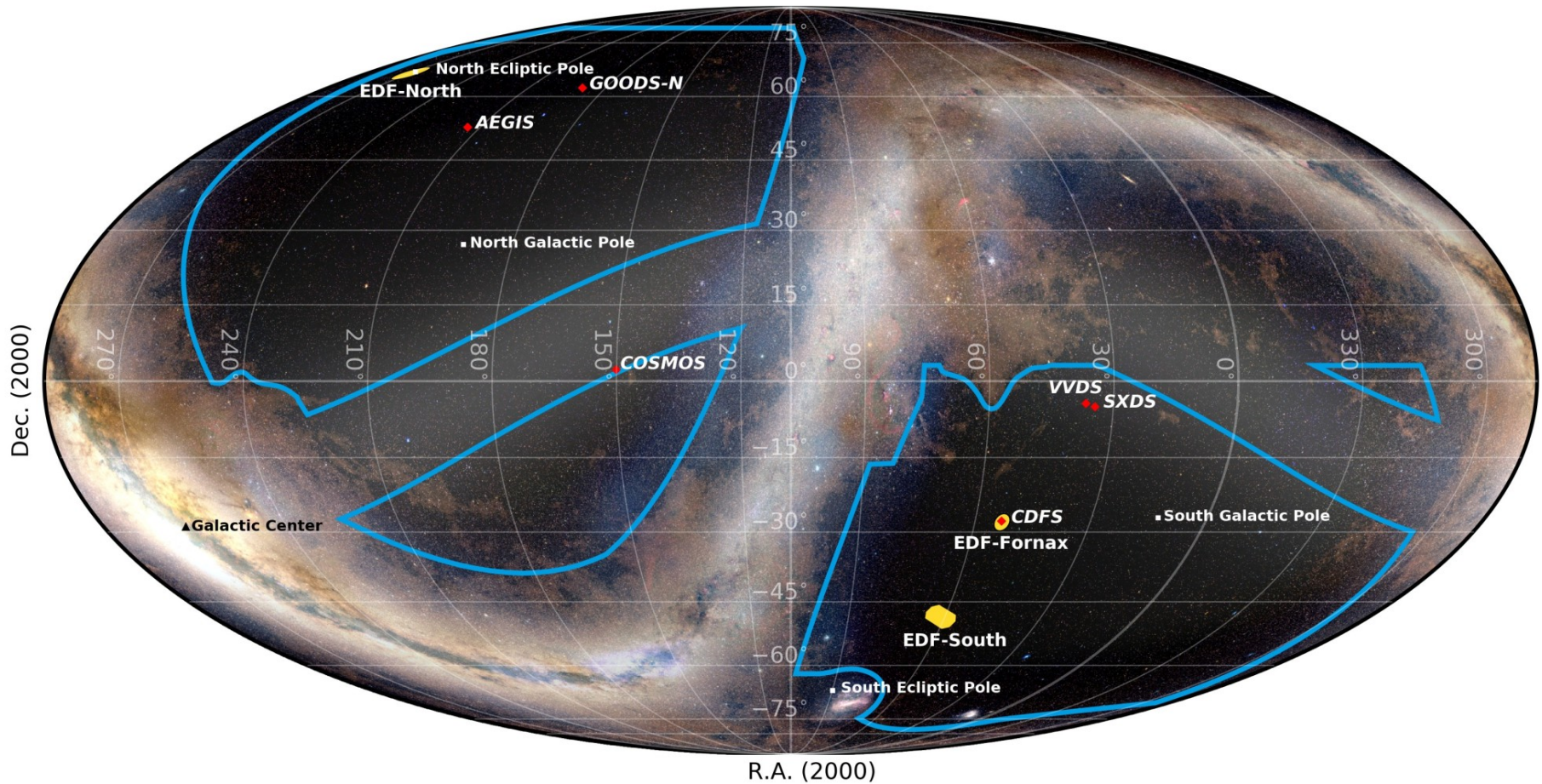
Alpha Angle: -4.5 deg



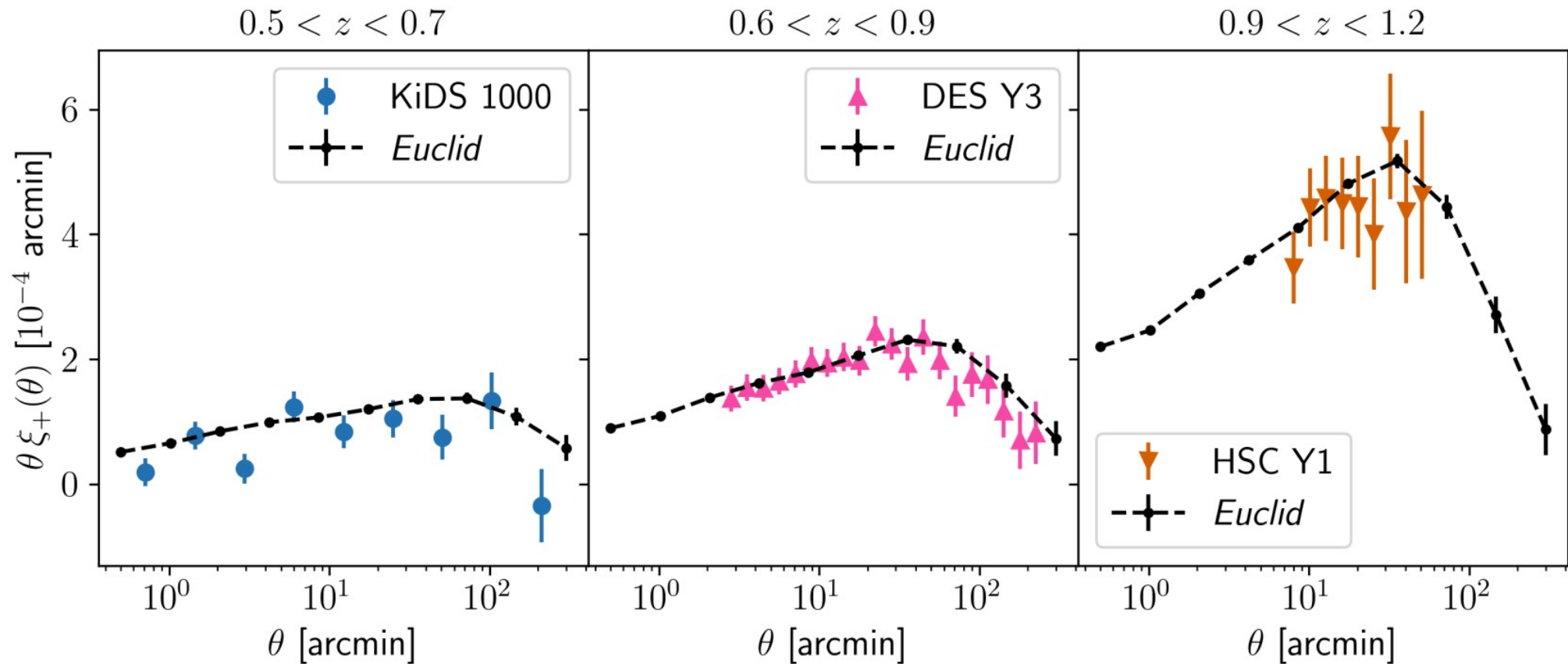
What Euclid will provide

- Sky area: 15'000 deg² (x4-10)
 - A few billion galaxies for weak lensing
 - 30 million galaxies with spectroscopy
- Image resolution: 0.15 arcsec (x5)
- Near-infrared:
 - $z \rightarrow 2$ (x2-3)
 - Tomography: clustering over 80% of the age of the Universe

The Euclid Survey



Shear correlation function

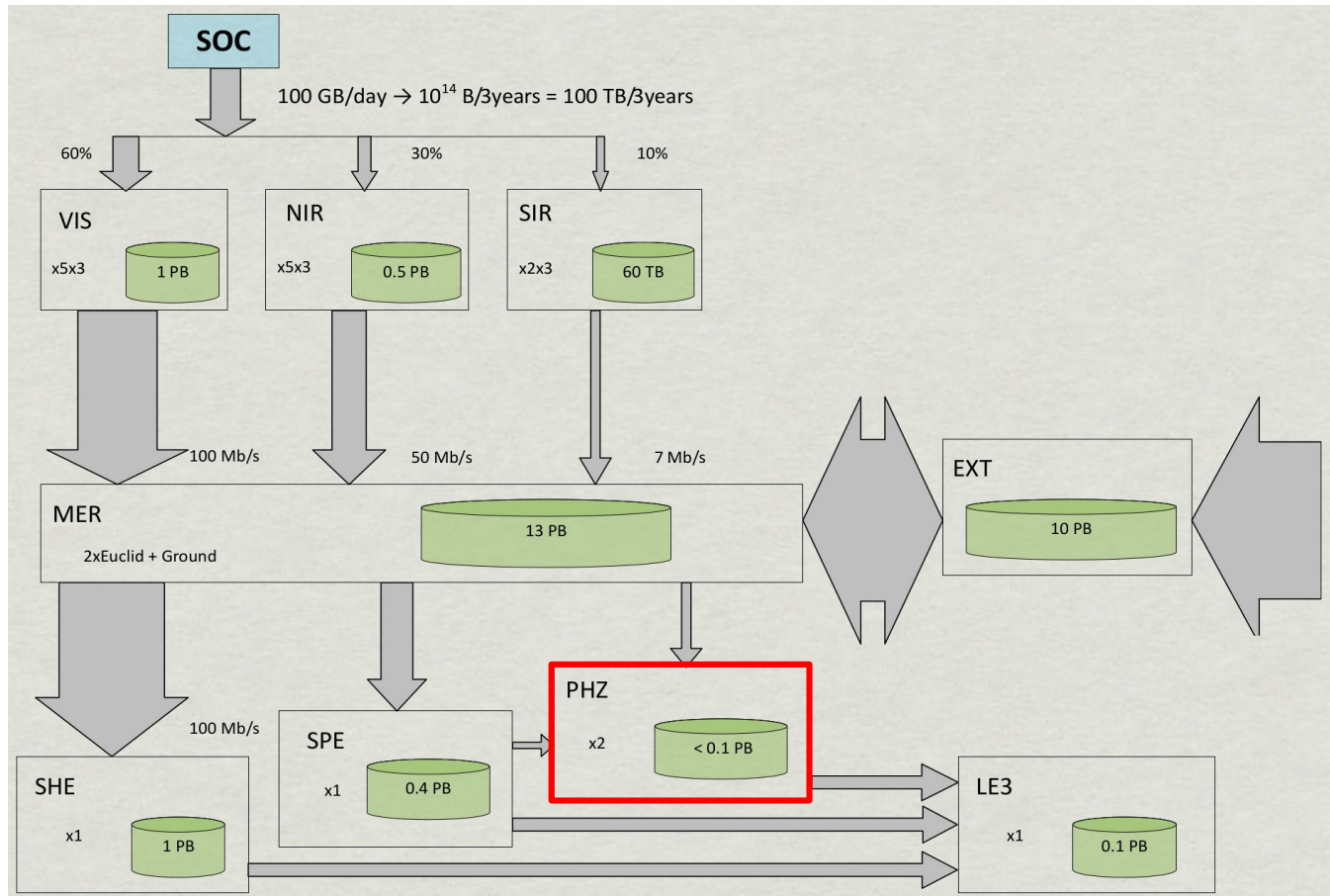


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The Euclid pipeline



- 10 data centers
 - All SDC process all data
 - SDC-CH @ UNIGE
- PHZ is the Swiss (UNIGE) main responsibility

Photometric redshifts

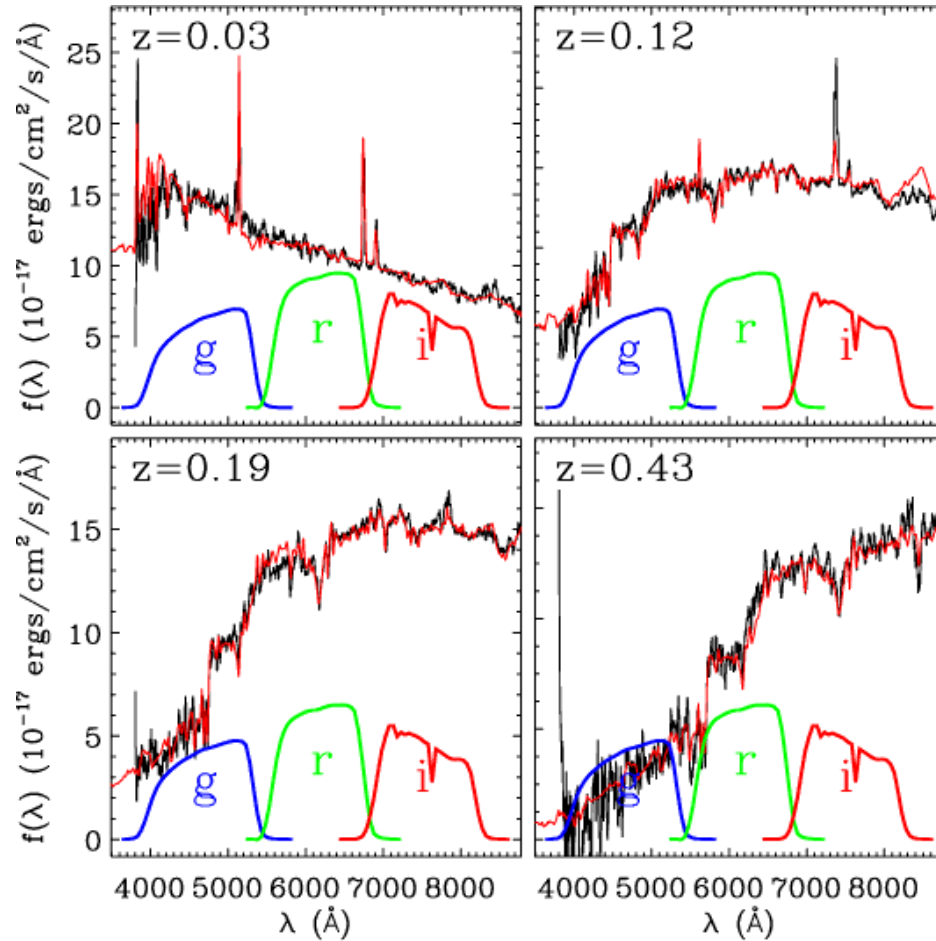
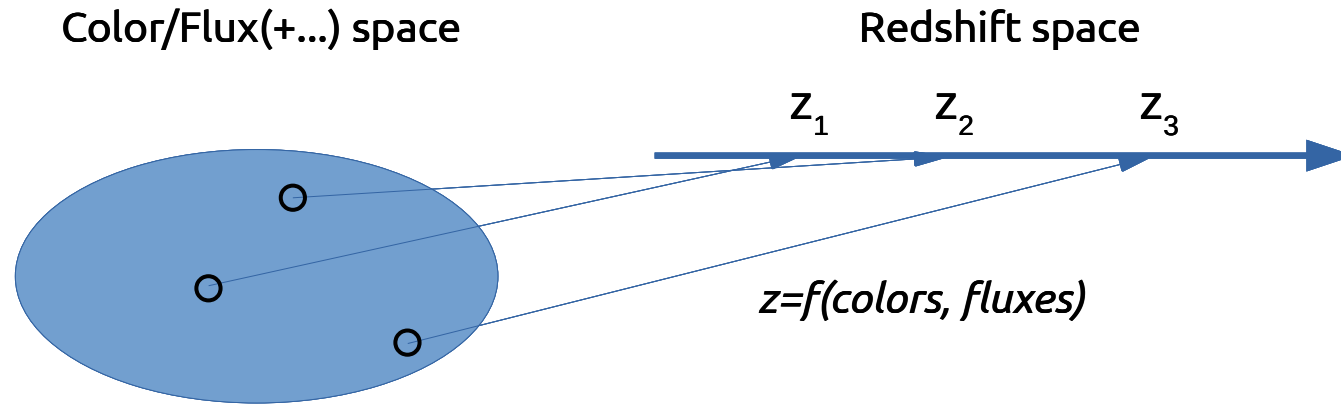


Photo-z as a mapping problem



Mapping f can be constructed based on **prior astrophysical knowledge** :

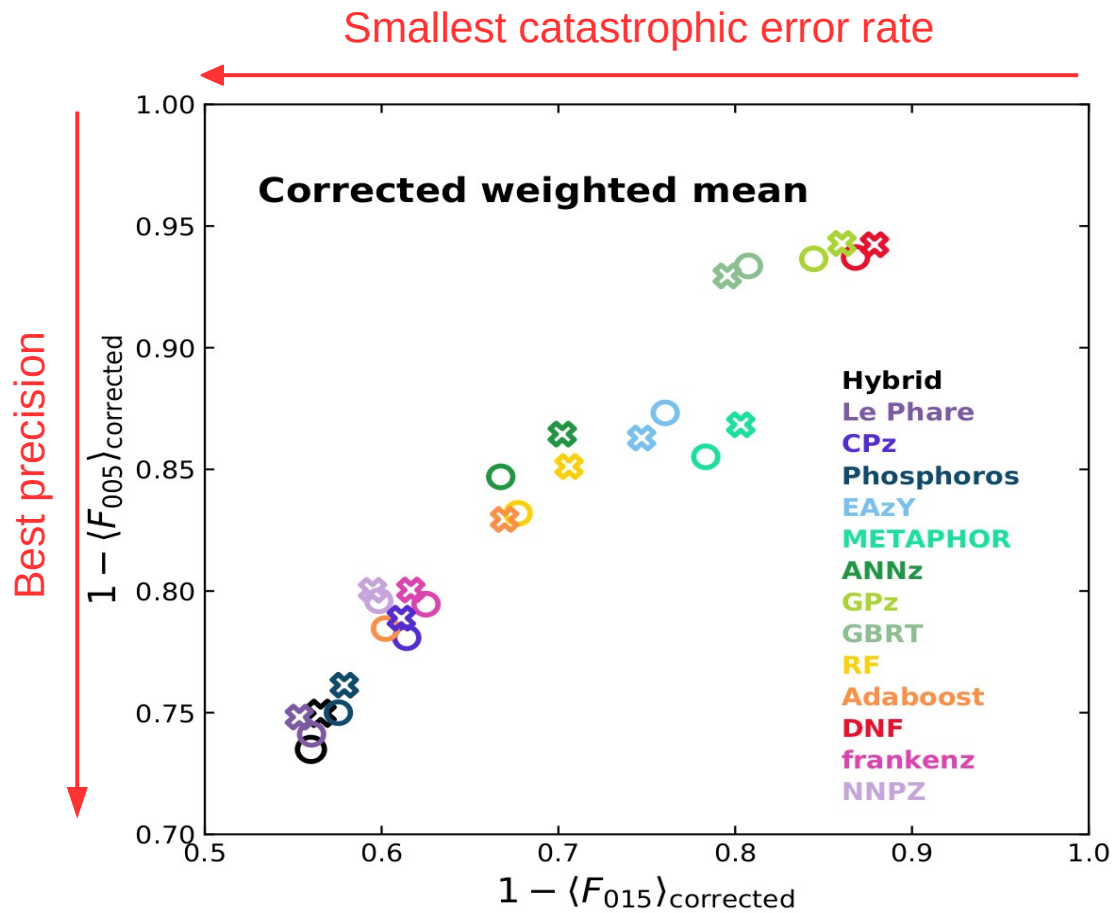
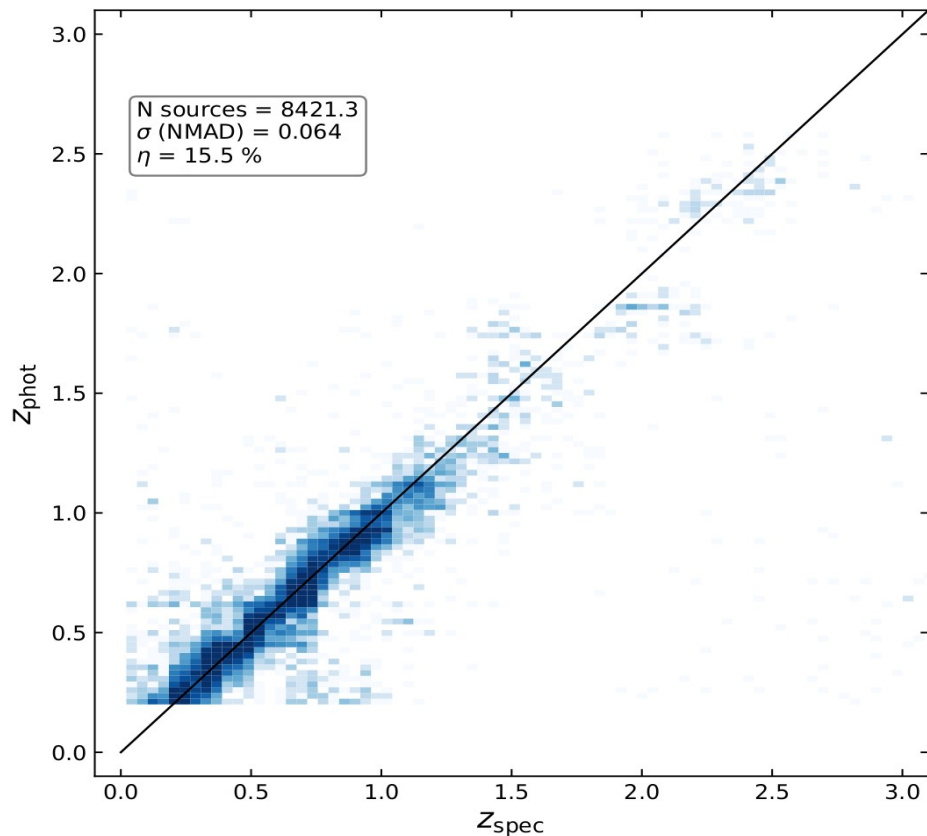
- Template-fitting: Hyper-Z, Le Phare, BpZ, **Phosphoros**,...

Or it can be **discovered** using known (spectroscopic) redshifts:

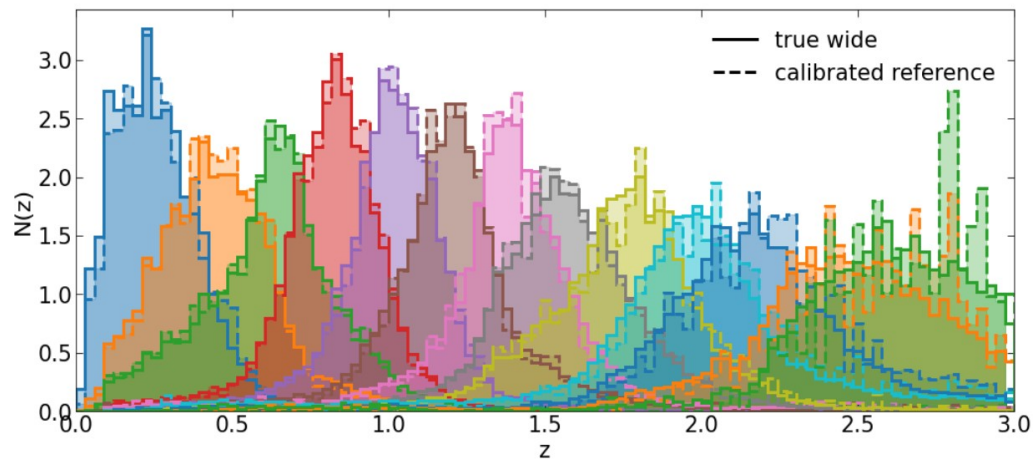
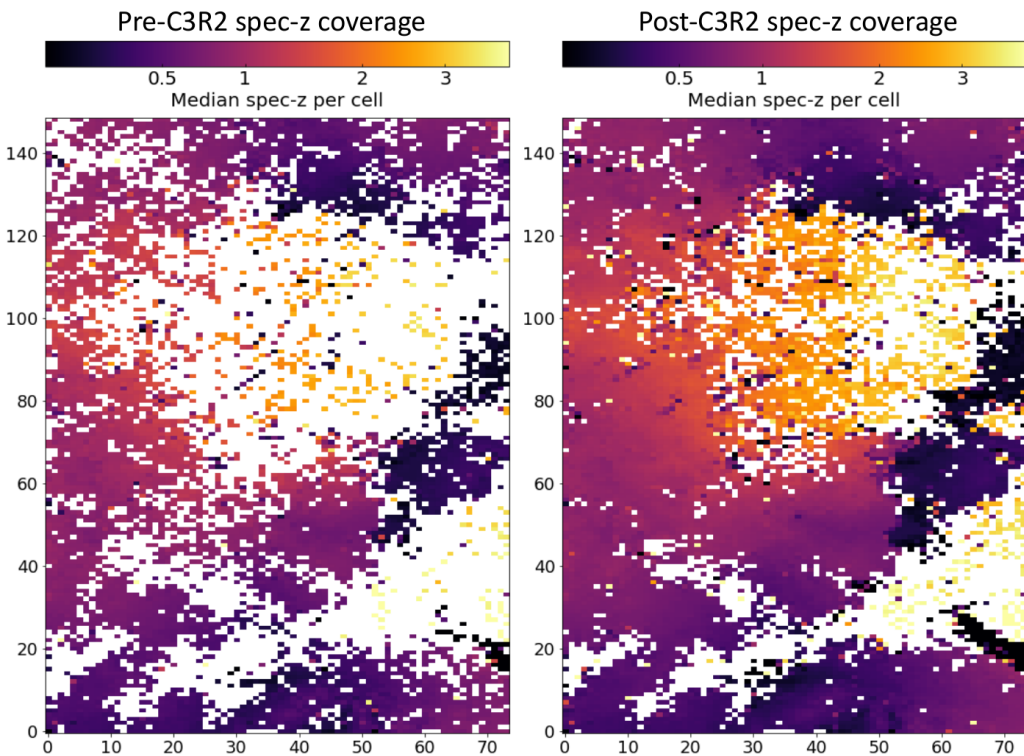
- Machine-learning: Nearest neighbours, Perceptron, Support vector regression, Random Forest, Adaboost, Gaussian Processes, ...

Data Challenge

EC, Desprez et al. 2020

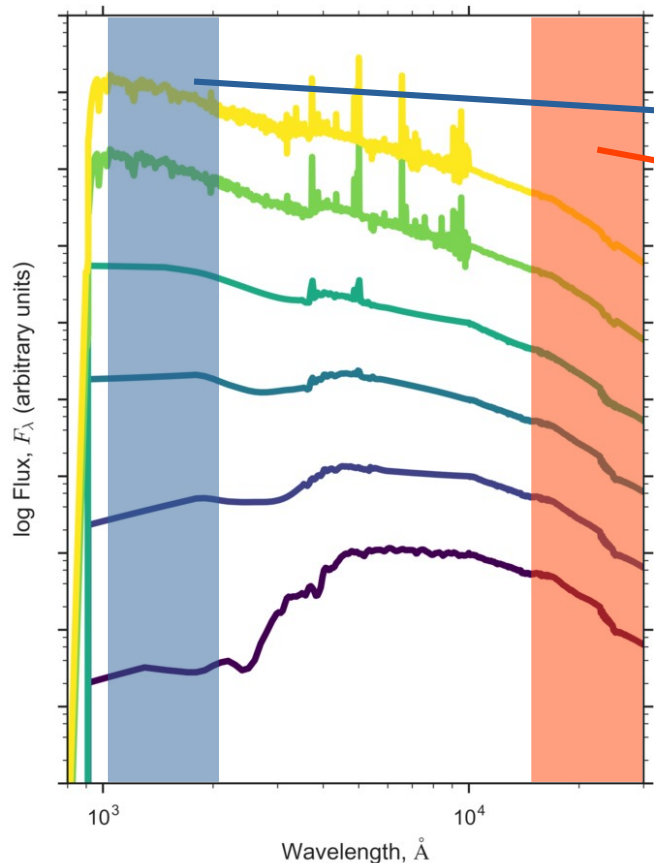


$N(z)$ determination



EC, Kang et al. in prep.

Legacy science



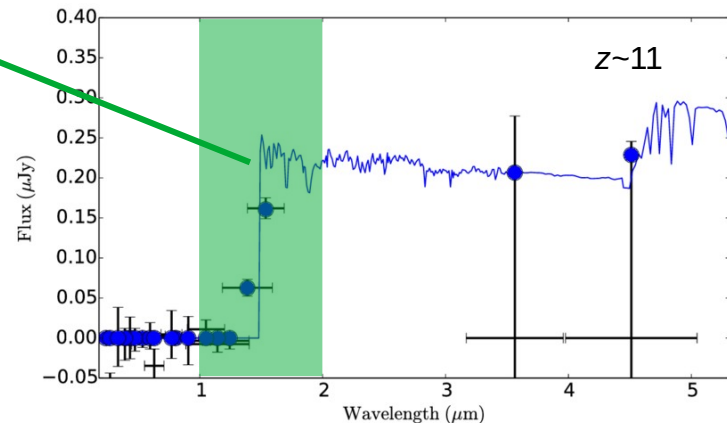
Primordial universe

Star formation rate

Stellar mass

Also:

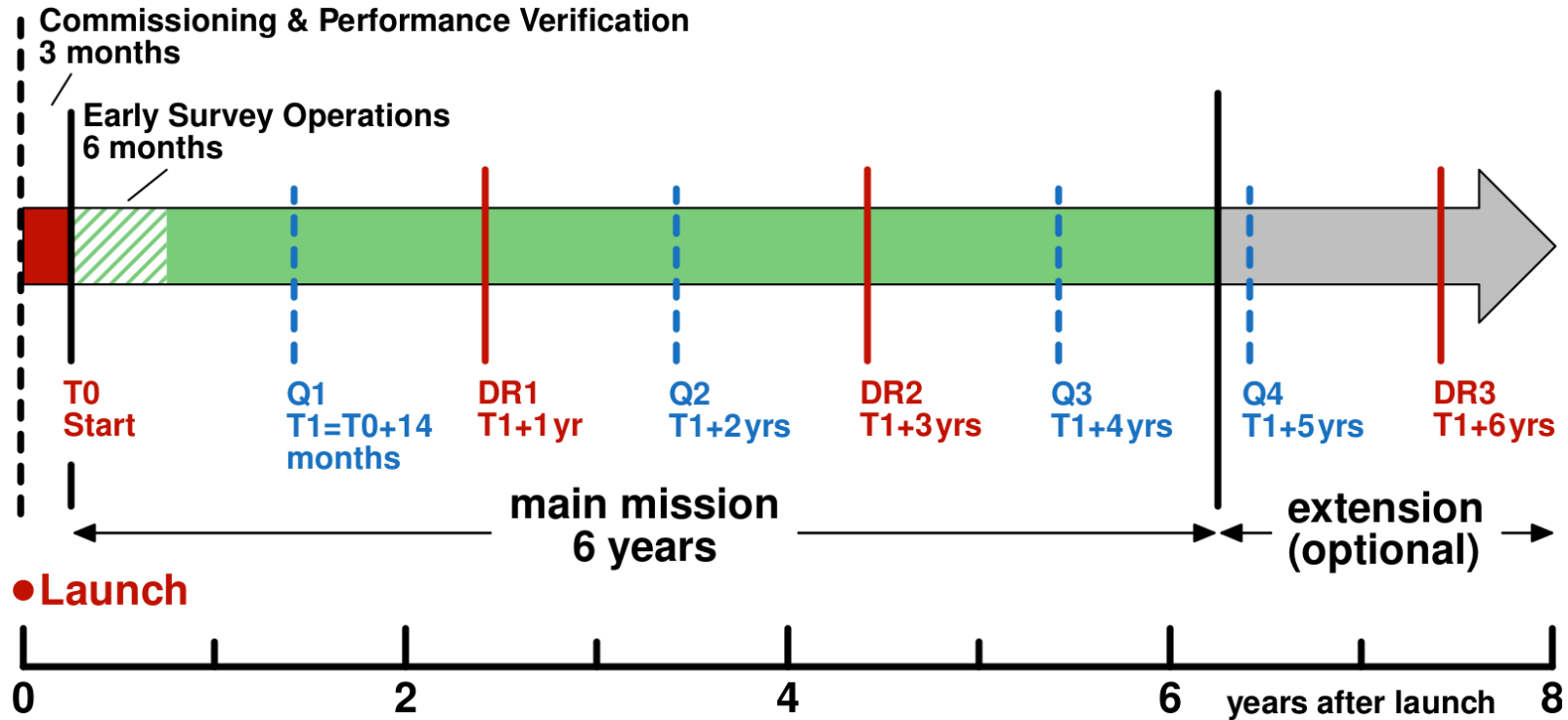
- Luminosity
- Extinction
- Metallicity
- Nuclear activity



Physical parameters of billions of galaxies:

- Galaxy formation
- Galaxy evolution
- Growth of supermassive black holes
- ...
- ...
- ...

Data Release Schedule



Conclusions

- Euclid shall answer some of the most fundamental questions in physics:
 - Nature of dark energy
 - Nature of gravity
- Data analysis is extremely challenging, fully in the bias regime
 - What if we get $w = -1.05 \pm 0.016$?
- Legacy science will largely dominate the science of Euclid in terms of number of papers!
 - But not in term of Nobel Prizes!
- Survey start is imminent!