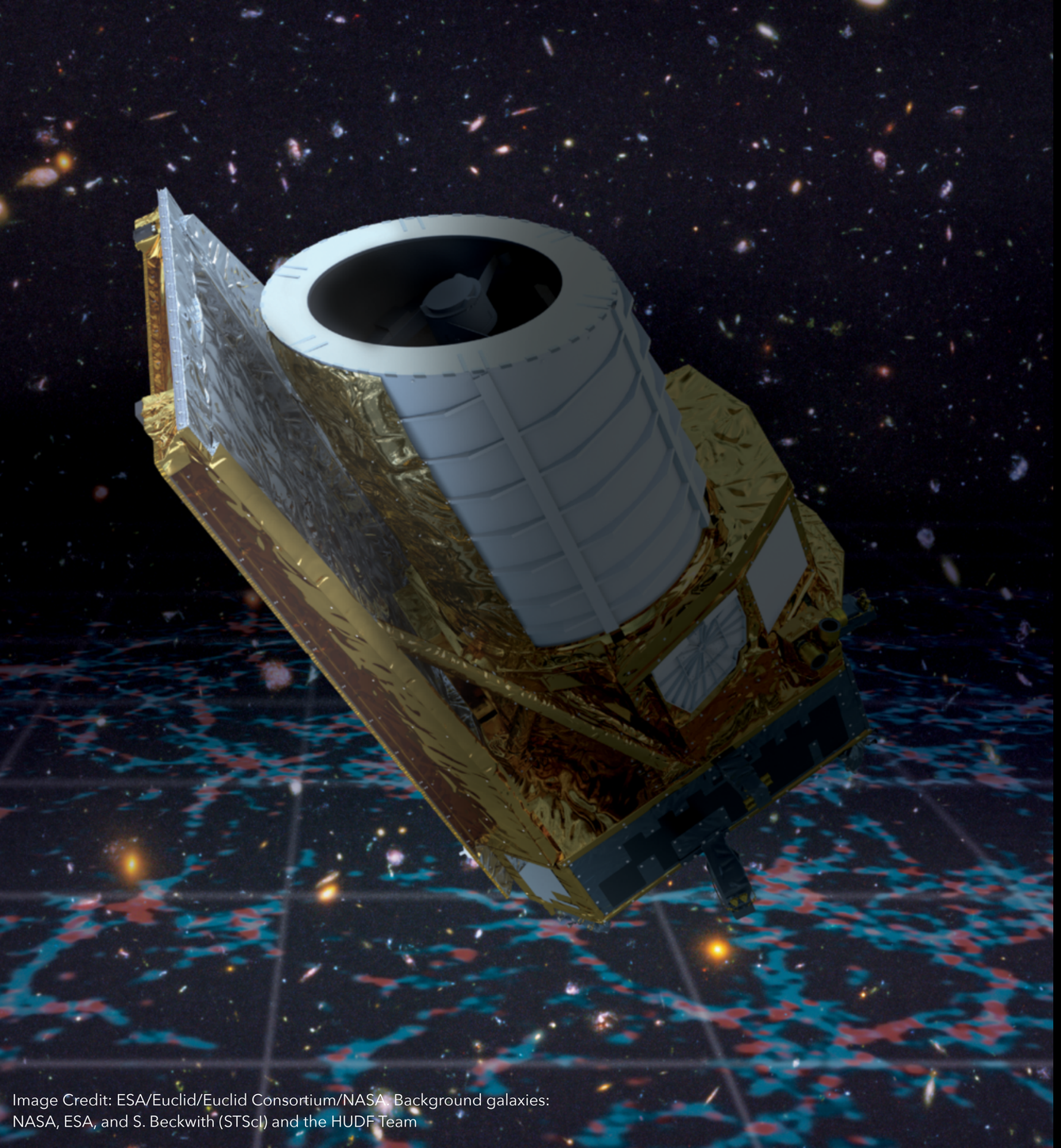


Image Credit: ESA/Euclid/Euclid Consortium/NASA. Background galaxies: NASA, ESA, and S. Beckwith (STScI) and the HUDF Team

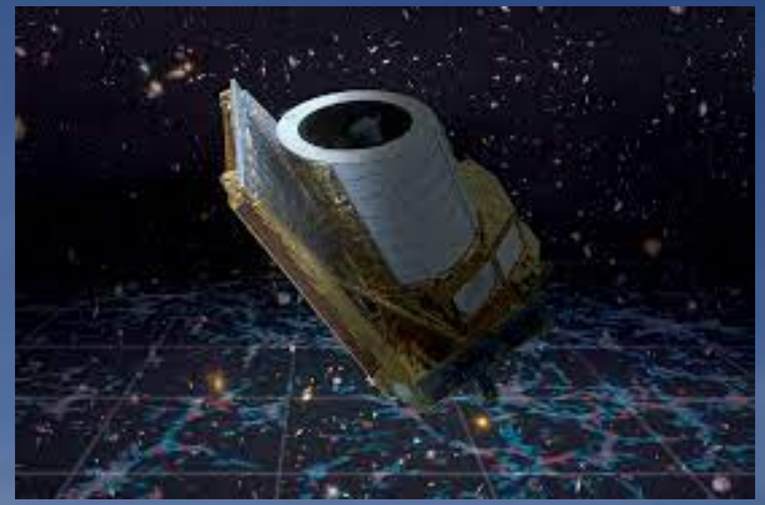
Status Report on Euclid Survey

GOPIRA Symposium 2025; 2025/11/06

大里 健 (千葉大学)

on behalf of Japanese Euclid Consortium

Euclid launch @ Cape Canaveral on July 1st, 2023



esa

esa euclid

SPEED 74 KM/H

ALTITUDE 0.0 KM

STAGE 1 TELEMETRY

LIFTOFF

STARTUP

MAX-Q

MECO

FAIRING

T+ 00:00:08

EUCLID

LIFTOFF

THE HOLDDOWN CLAMPS HAVE RELEASED FALCON 9 AND WE HAVE BEGUN OUR FLIGHT

Subscribe

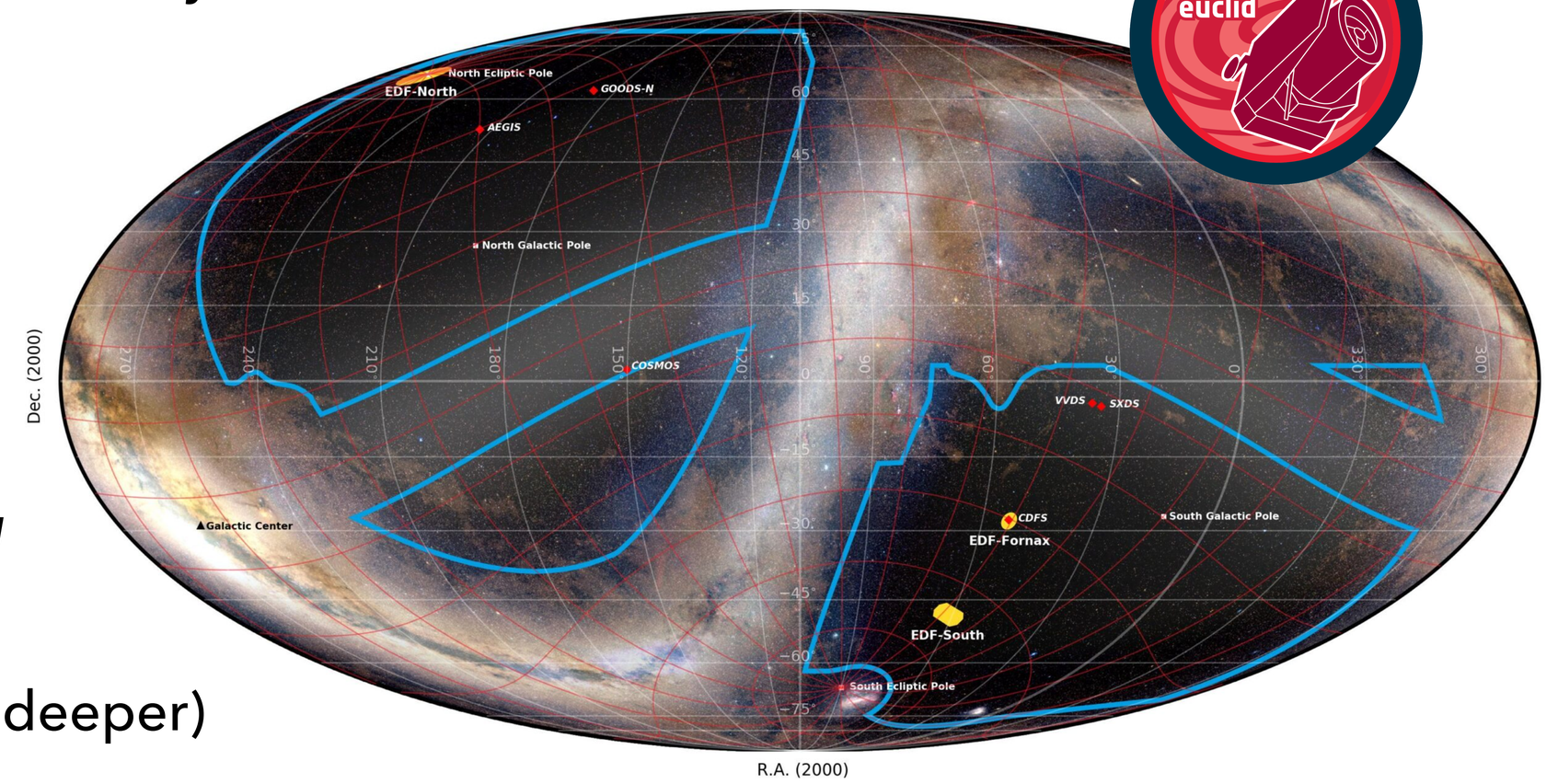
Euclid Survey in a nutshell

✦ *Euclid* satellite was launched on July 1st, 2023
and began 6-year wide field survey from Feb. 2024.

- **Wide Imaging Survey**
  (14,000 deg², optical+NIR)
  Core science: Weak lensing

- **Wide Spec. Survey**
  (14,000 deg², grism)
  Core science: Galaxy clustering

- **Deep Survey**
  (3 patches, 53 deg², 2 mag deeper)



The 15,000 deg.² Euclid Wide Survey, the 53 deg.² Euclid Deep Survey, and the 6 deep auxiliary fields (6.5 deg.²) [Mollweide Celestial]

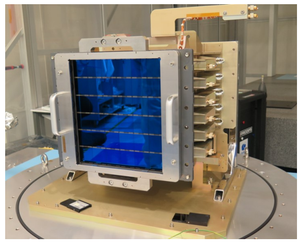
Euclid Wide Survey region of interest : 16 Kdeg.² compliant with a 15 Kdeg.² survey

Euclid Deep Fields : North=20 deg.², Fornax=10 deg.², South=23 deg.²

Euclid deep auxiliary fields (GOODSN=0.5, AEGIS=1, COSMOS=2, VVDS=0.5, SXDX=2, CDFS=0.5 deg.²)

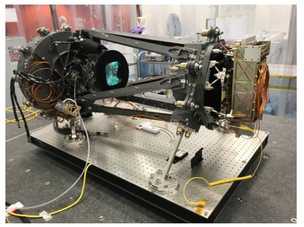
Background image: Euclid Consortium / Planck Collaboration / A. Mellinger

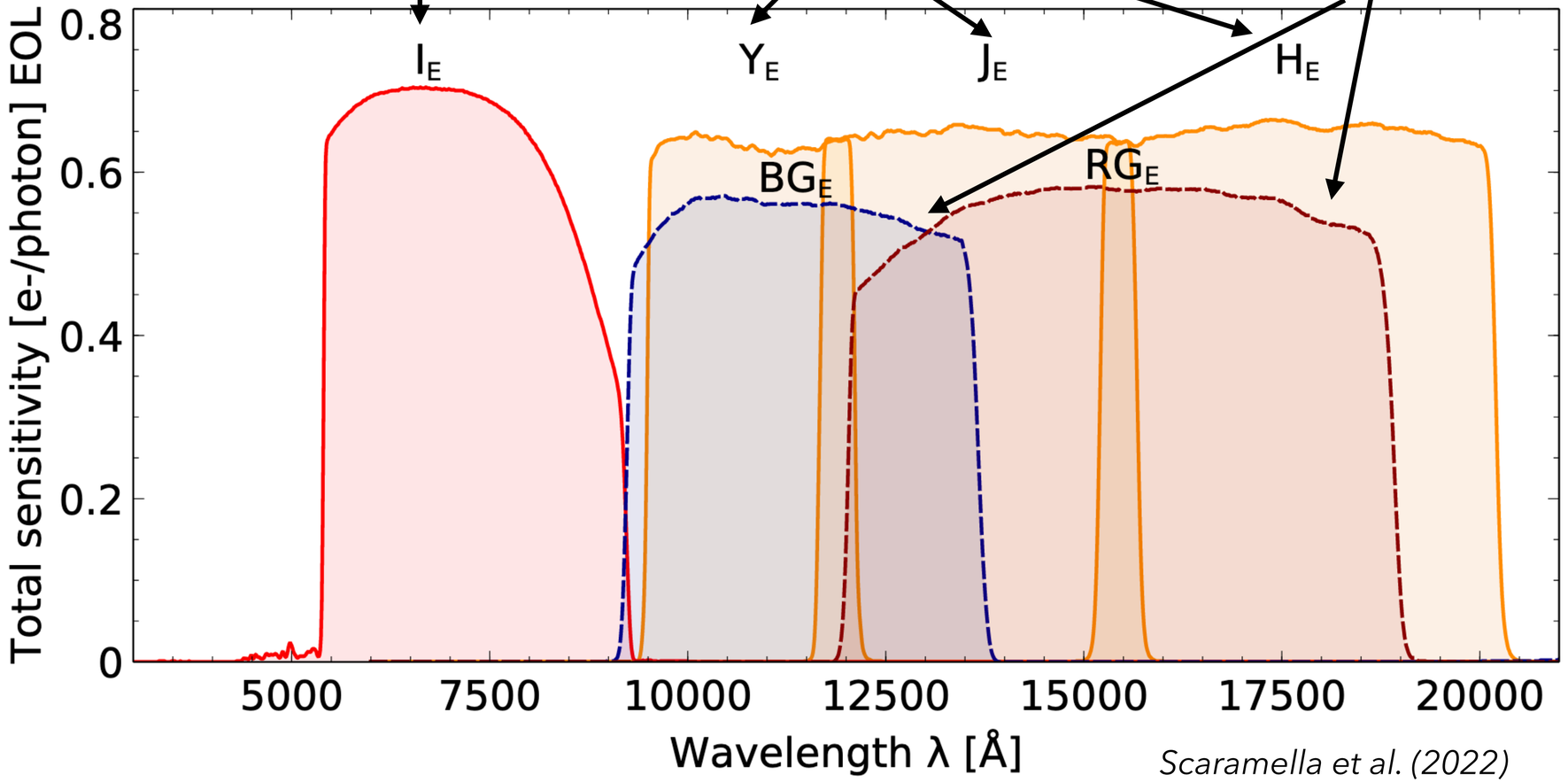
Instruments on *Euclid*



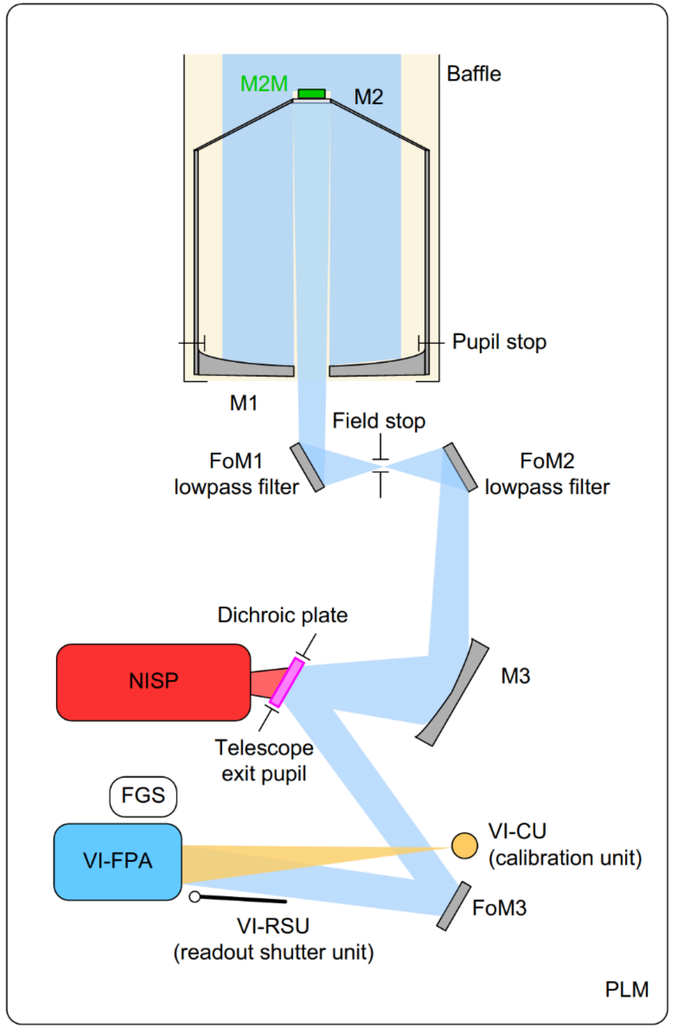
- Field of View: 0.57 deg²

VIS (imaging) **NISP (imaging)** **NISP (grism spec.)**





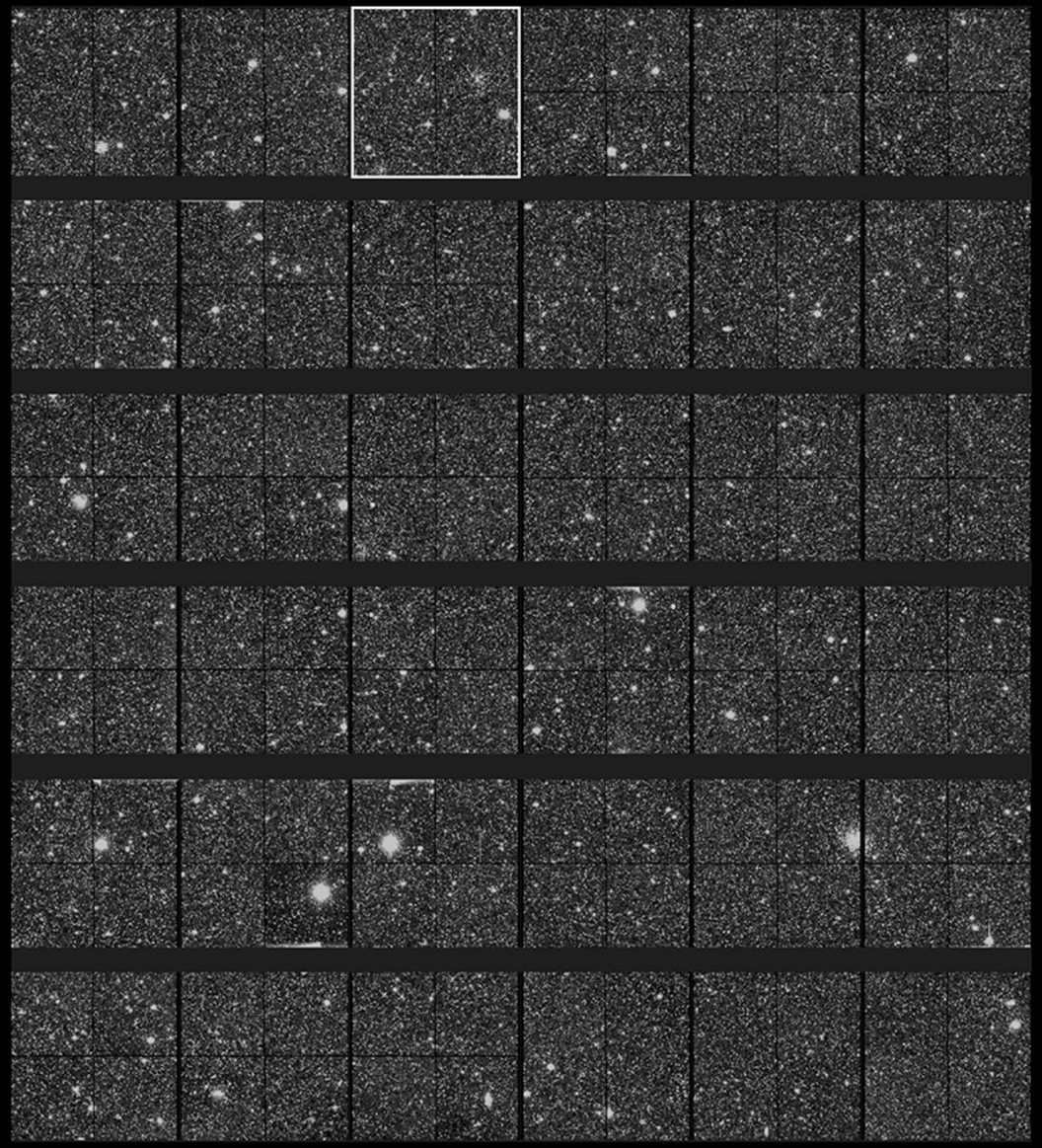
Scaramella et al. (2022)



Mellier et al. (2025)

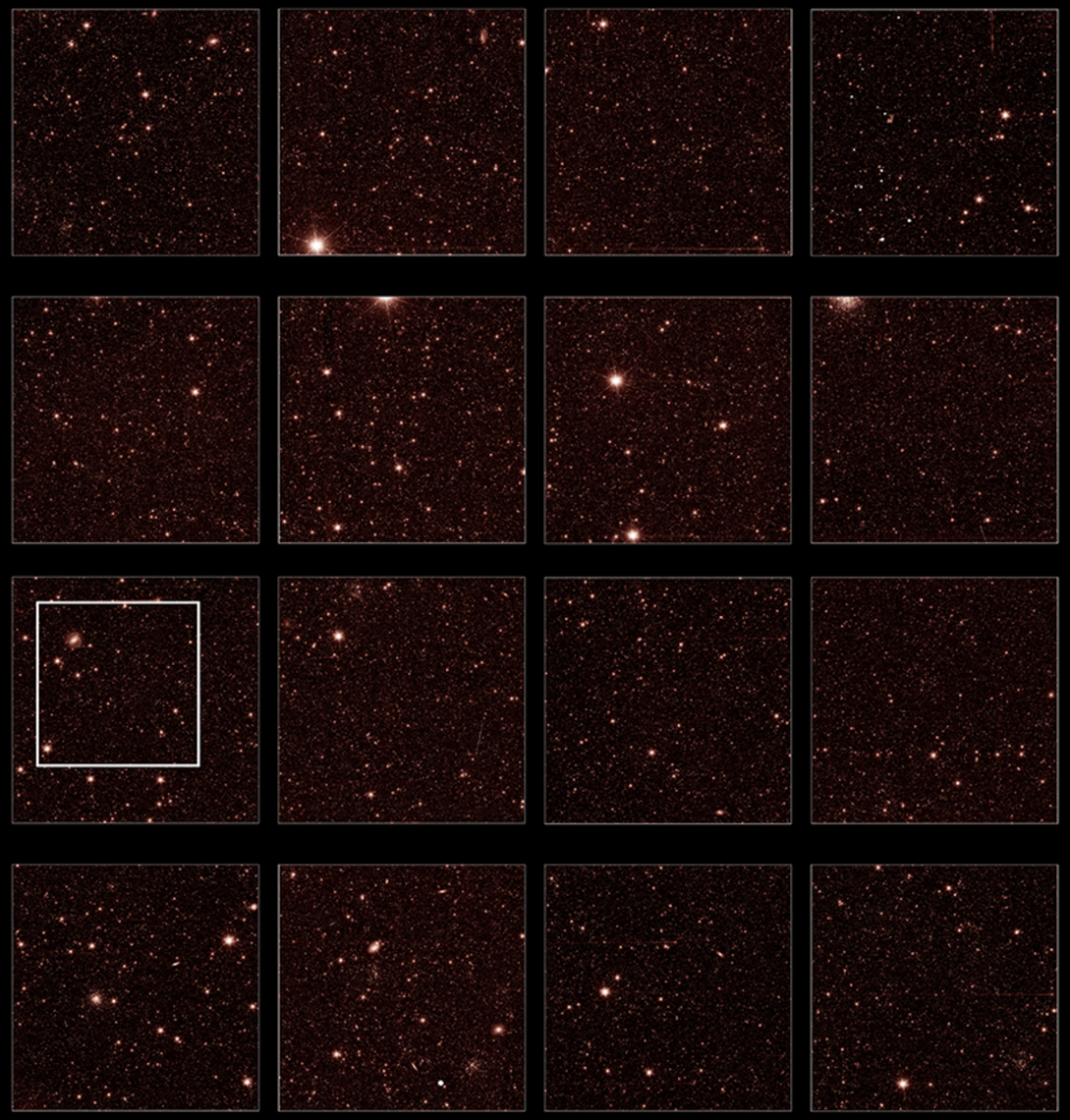
Credit: ESA/Euclid/Euclid Consortium/NASA

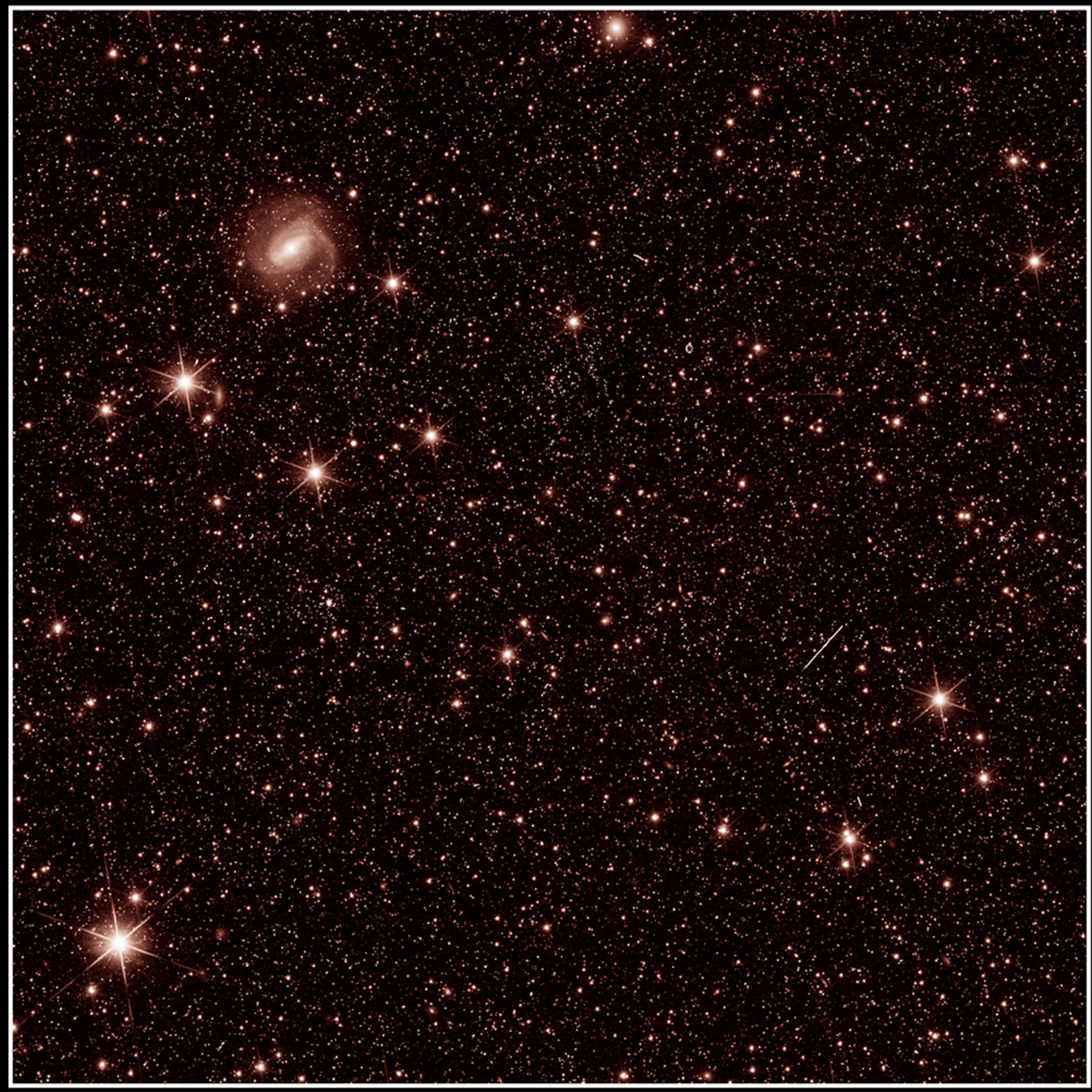
EARLY COMMISSIONING TEST IMAGE, VIS INSTRUMENT



Credit: ESA/Euclid/Euclid Consortium/NASA

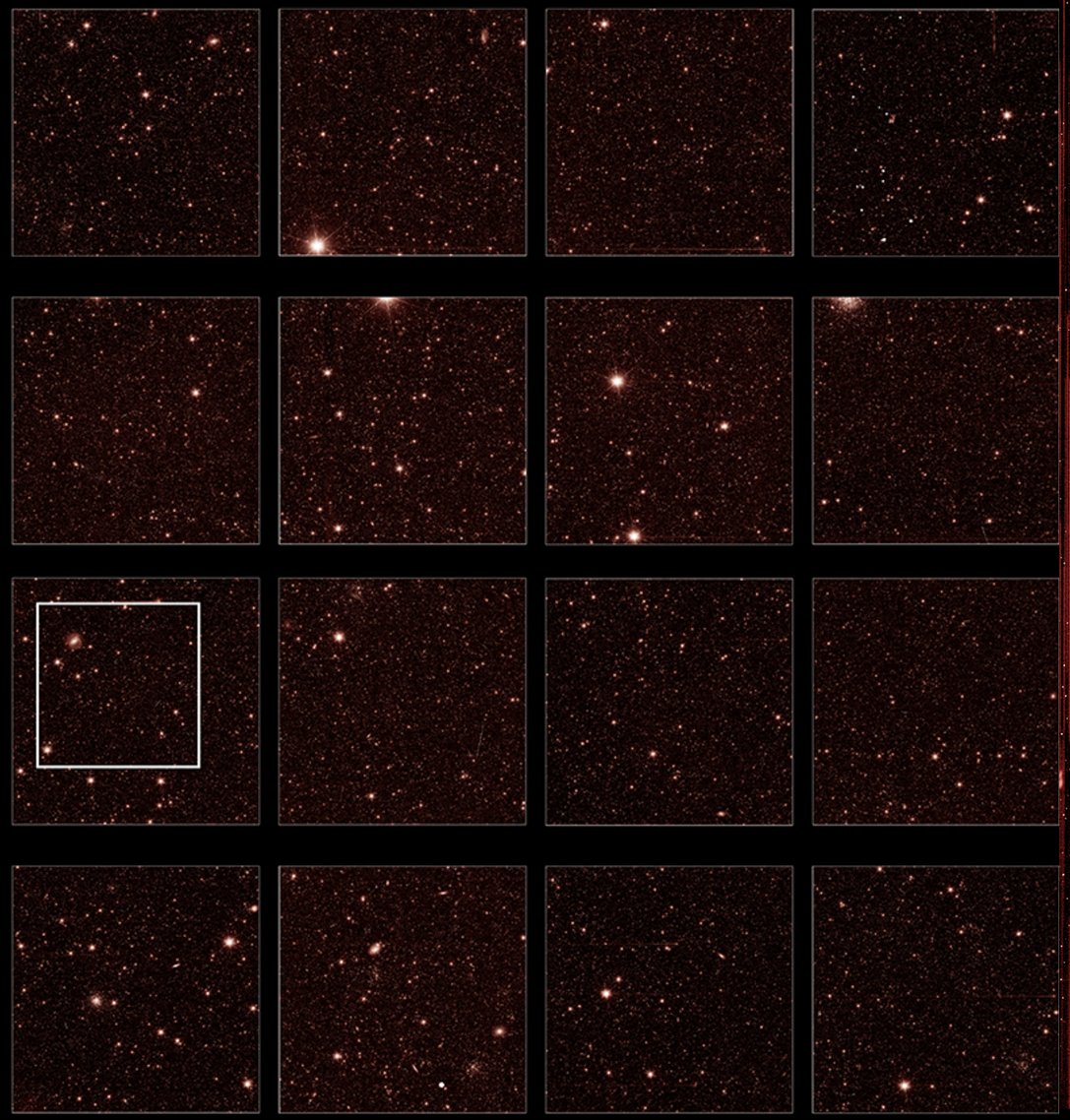
EARLY COMMISSIONING TEST IMAGE, NISP INSTRUMENT





Credit: ESA/Euclid/Euclid Consortium/NASA

EARLY COMMISSIONING TEST IMAGE, NISP INSTRUMENT



Dispersed image with slitless spectroscopy

Early commissioning test image, NISP instrument (grism mode)

Image credit: ESA

Euclid Early Release Observations

- **17 fields are observed in a single day prior to the nominal survey.**
  11 papers and data are released on 24th May, 2024.

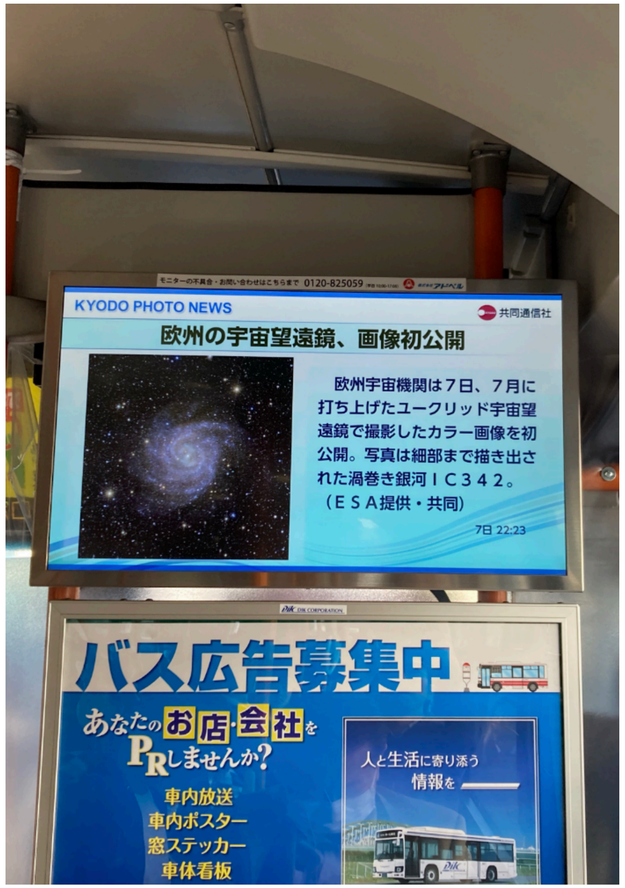
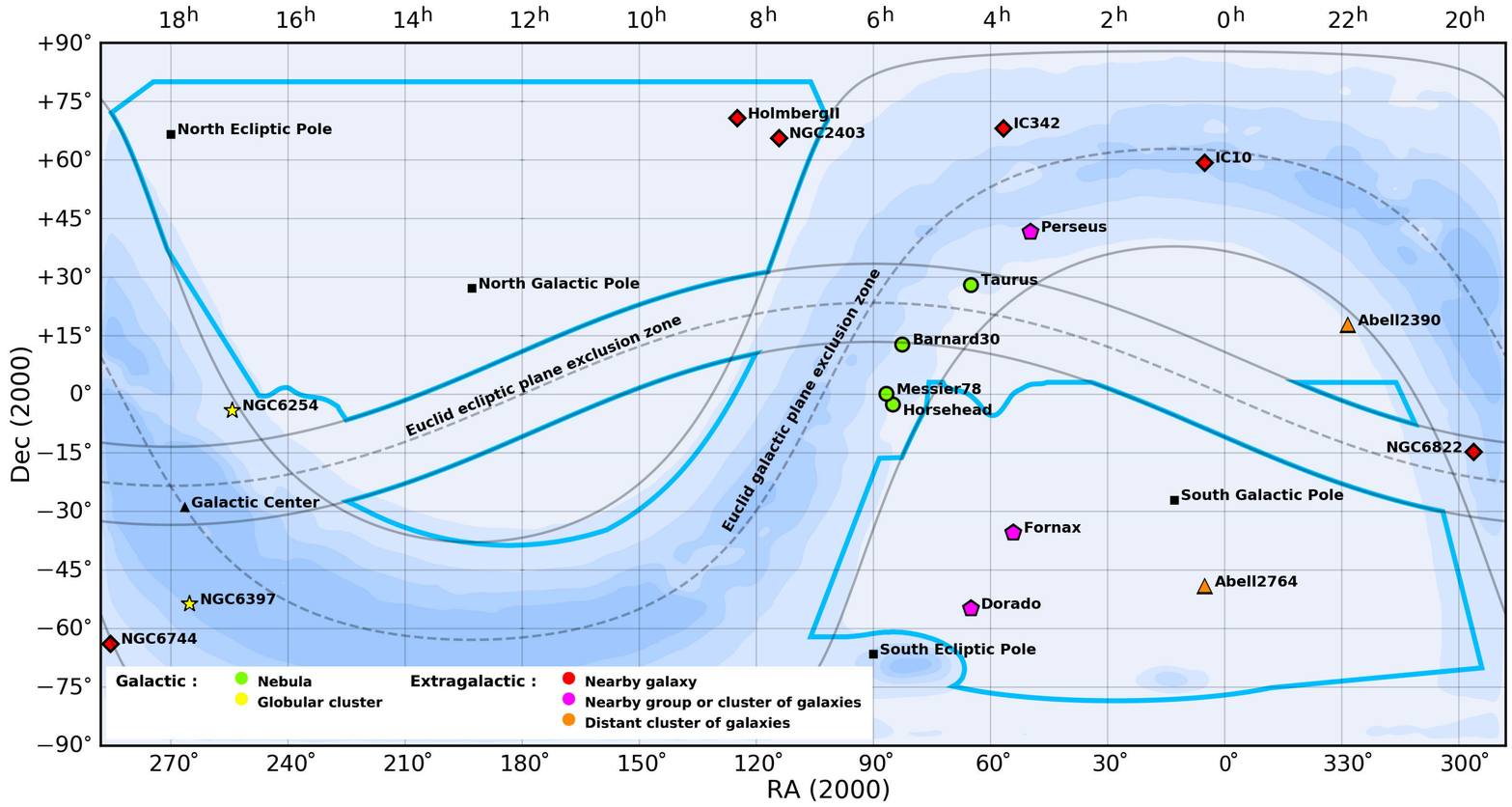
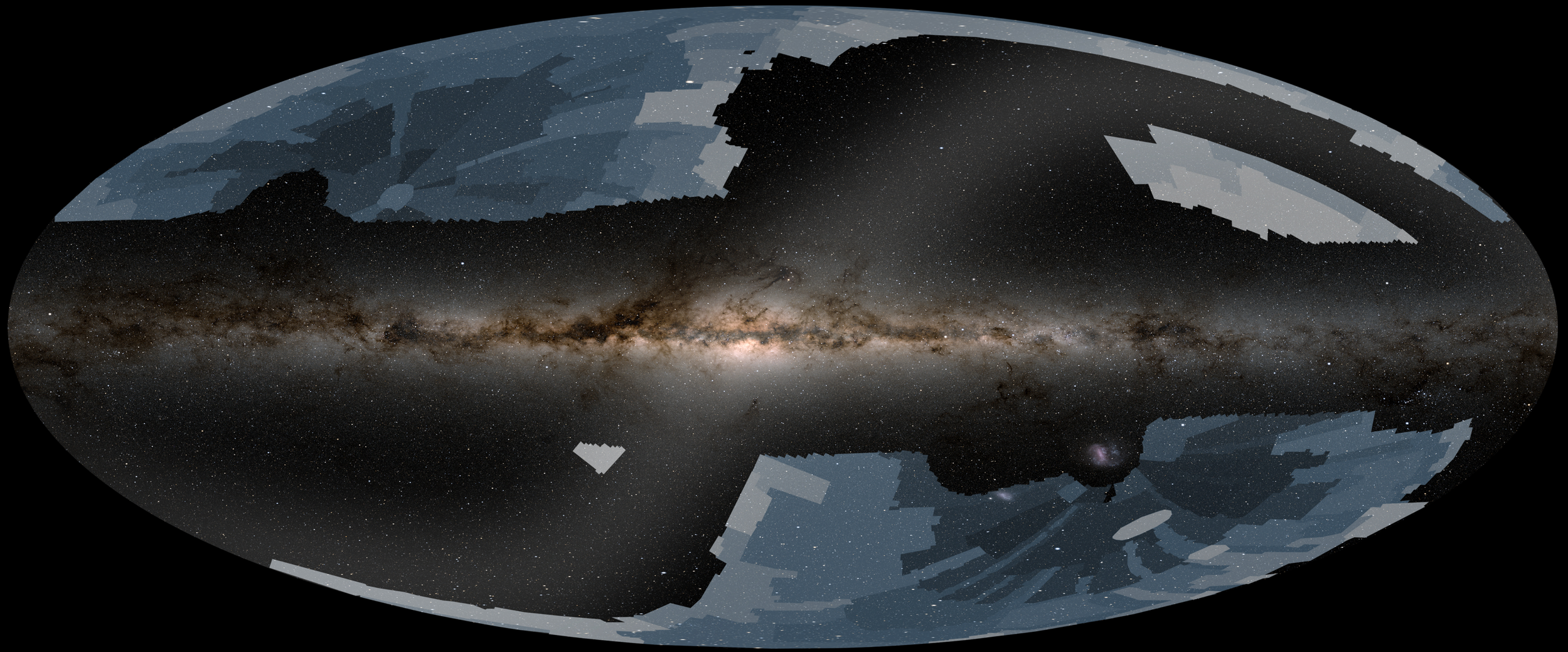


Image credit: Takashi Moriya

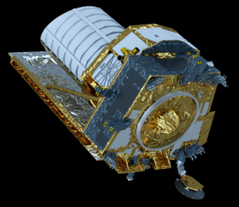




Time (years)

1 2 3 4 5 6

***Euclid* will observe 14,000 deg² in 6 years.**



Survey Plan

▸ Euclid Wide Survey

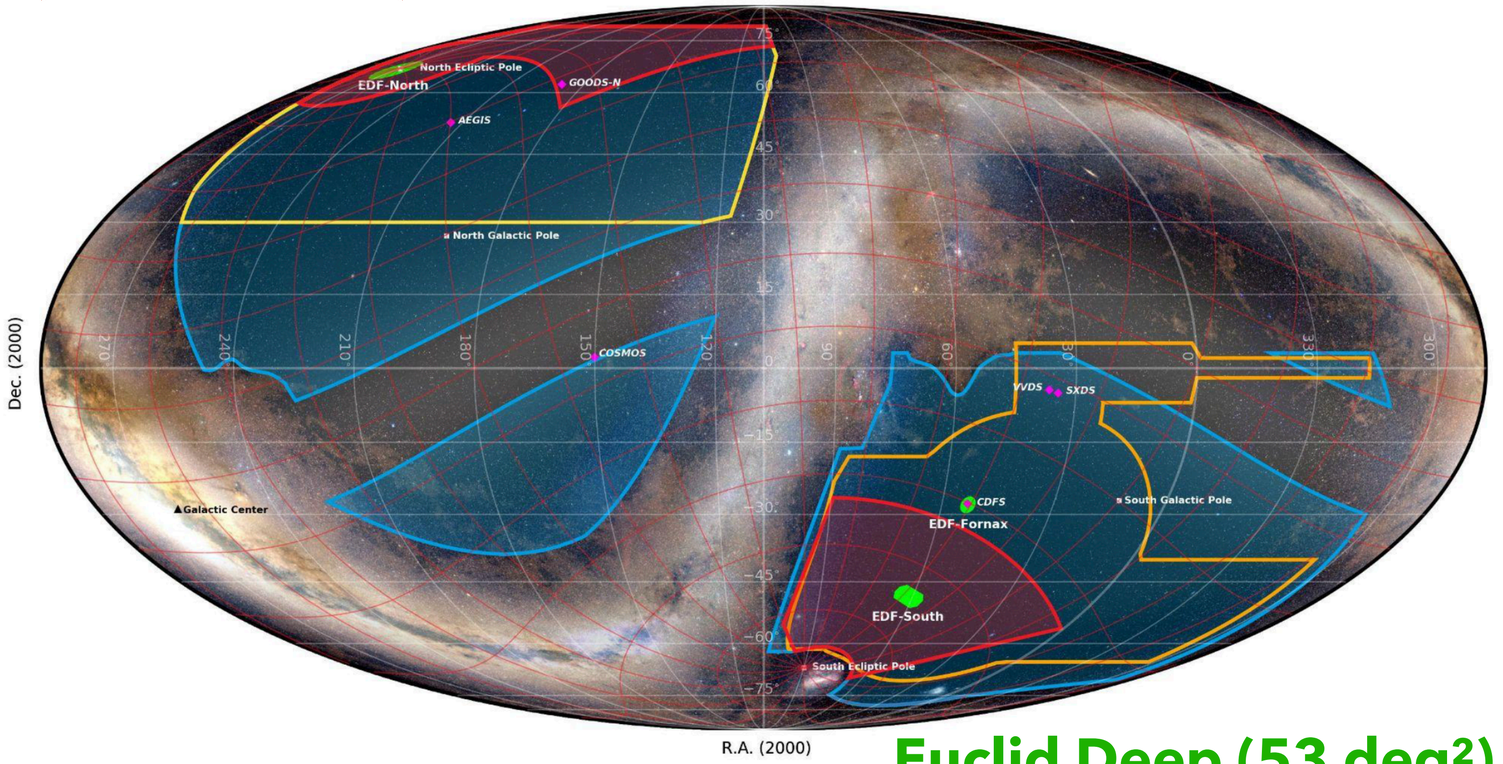
- ~14,000 deg^2
- VIS imaging down to AB magnitude 24.5 (10 σ, extended source)
- NISP photometry in the Y, J and H NIR bands reaching AB magnitude 24 (5σ, point source)
- NISP slitless spectroscopy (red grism) Hα line flux limit: 2 × 10^{-16} erg cm^{-2} s^{-1}

▸ Euclid Deep Survey

- ~50 deg^2
- Both blue and red grisms

- EDFN (North): 20 deg^2 x 40 visits
- EDFS (South): 23 deg^2 x 45 visits
- EDFF (Fornax): 10 deg^2 x 52 visits

Euclid Wide (14,000 deg²)
(DR1 in 2026)



Euclid Deep (53 deg²)

The Euclid Wide Survey DR1 area maximizing the overlap with DES : North = 821 deg^2, South = 1657 deg^2 [Mollweide Celestial]

Euclid Wide Survey region of interest : 16,217 deg^2
DES, griz, 2013−19 : 4500 deg^2 overlap with the region of interest
UNIONS, ugriz, 2017−24 : 4500 deg^2 overlap with the region of interest
Euclid DR1 area, 2024 : 2500 deg^2
Euclid Deep Fields [total 53 deg^2]

Background image: Euclid Consortium / Planck Collaboration / A. Mellinger

Euclid Wide Survey

✦**The survey observation started on Feb. 2024 and is ongoing.**
The first image of mosaic (132 deg^2, ~1% of the full area) was released on Nov. 2024.

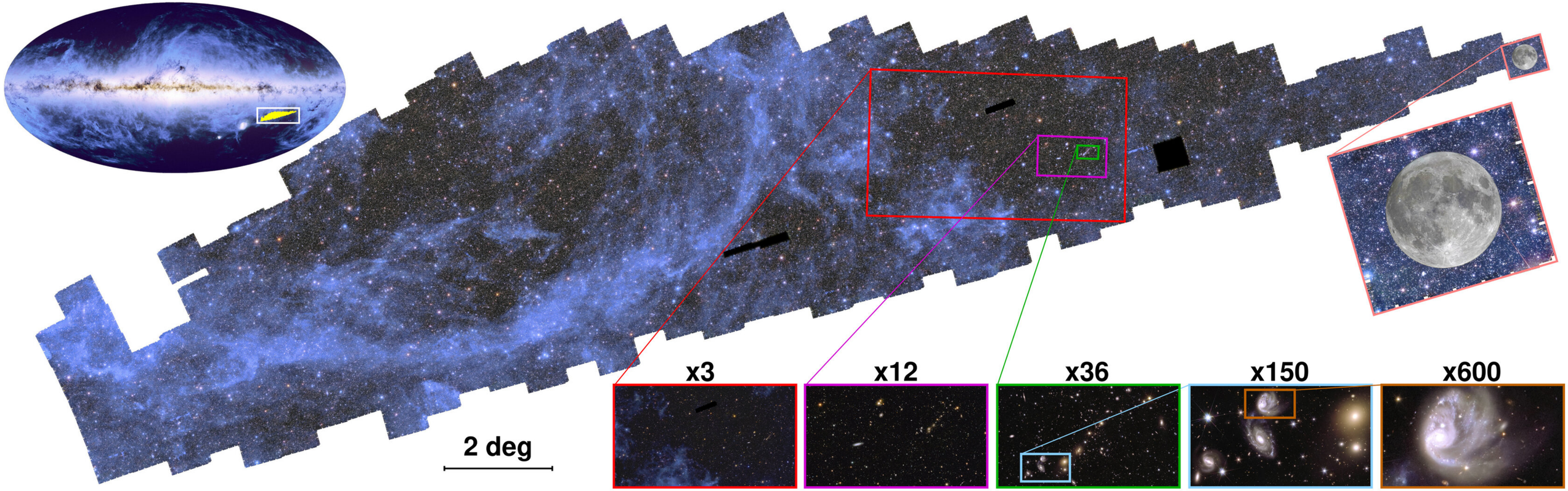
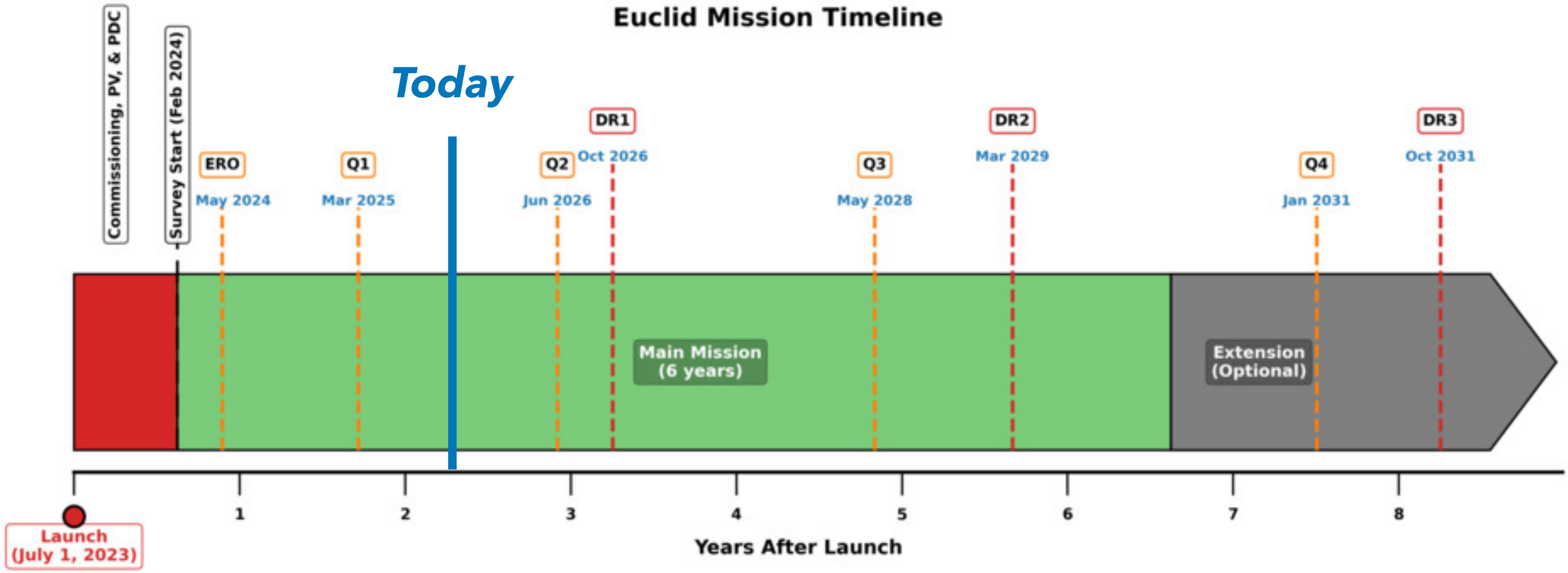


Image credit: ESA

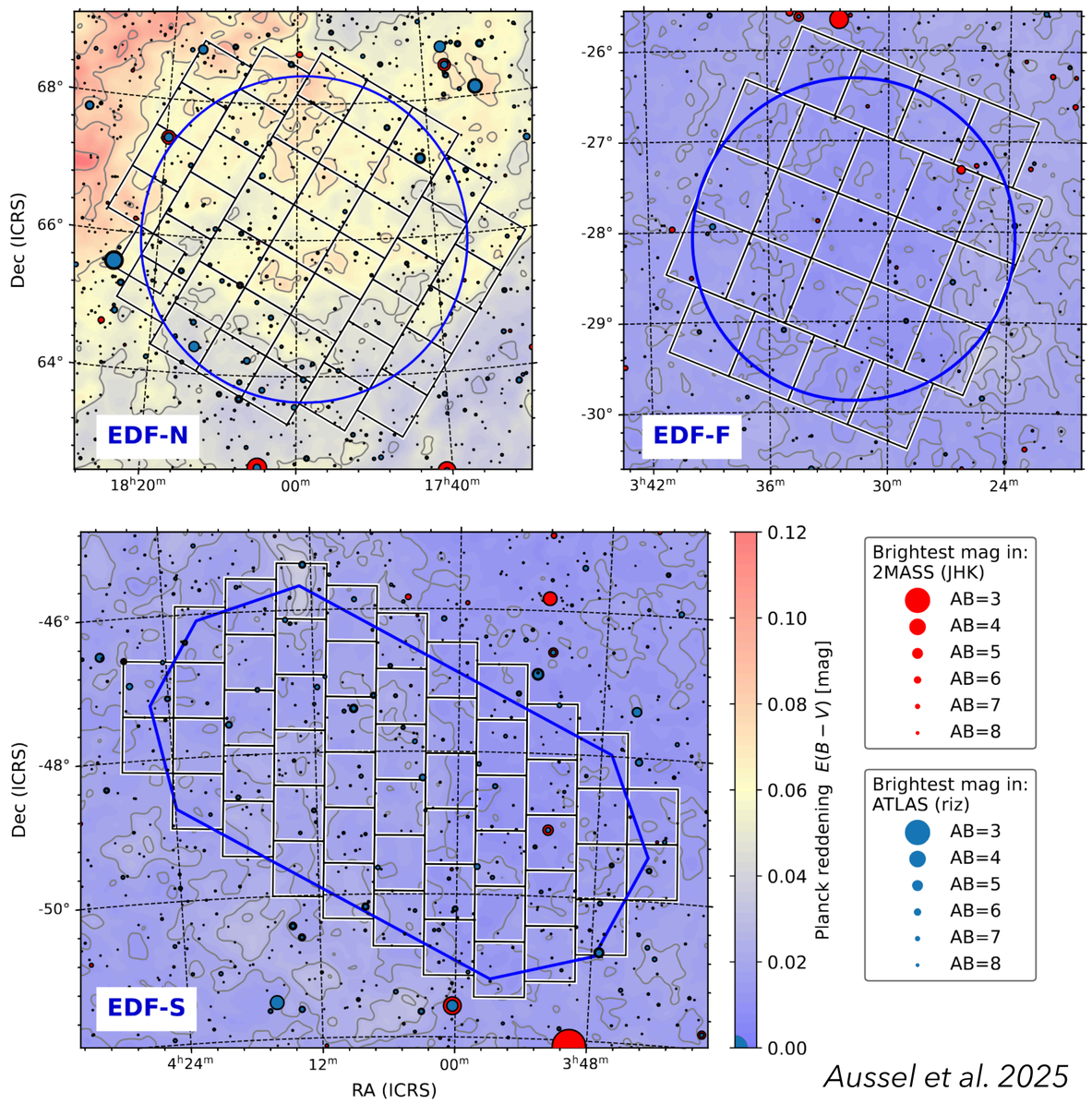
Euclid Survey Timeline

- Public data release of Q1 (Quick release; 53 deg^2): Mar. 19th, 2025
- Public data release of DR1 (~1,900 deg^2): Oct. 21th, 2026



Euclid Q1 Data Release

- **Q1 Data Release happened on March 19, 2025**
- ▸ **Single visits of EDF fields**
  Total area: 63.1 deg²
  - 28.1 deg² of the EDF South
  - 12.1 deg² of EDF Fornax
  - 22.9 deg² of the EDF North
- ▸ **Data product**
  - VIS and NISP image and 2d spectra frames
  - Merged mosaics
  - Ground-based images in *g*, *r*, *i*, *z*
  - NISP 1d spectra and redshift catalogues
  - Catalogues based on VIS
  - Masks



Aussel et al. 2025

Euclid Deep Field South (16x Zoom)

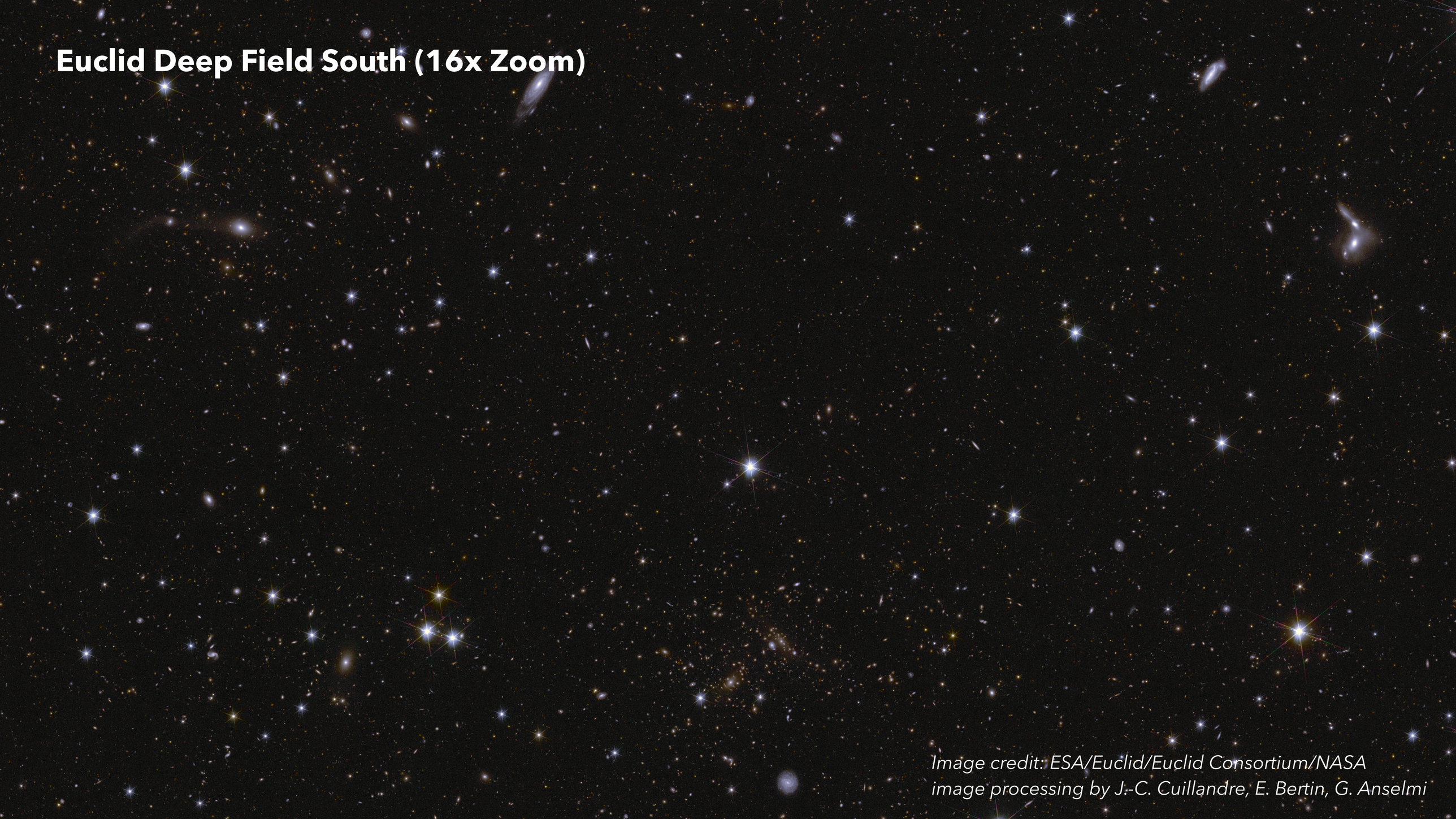


Image credit: ESA/Euclid/Euclid Consortium/NASA
image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi

A&A Special Issue: *Euclid* on Sky

A&A, 697, A1 (2025)
https://doi.org/10.1051/0004-6361/202450810

Astronomy & Astrophysics

Special issue

Euclid on Sky

1139 authors!

Euclid

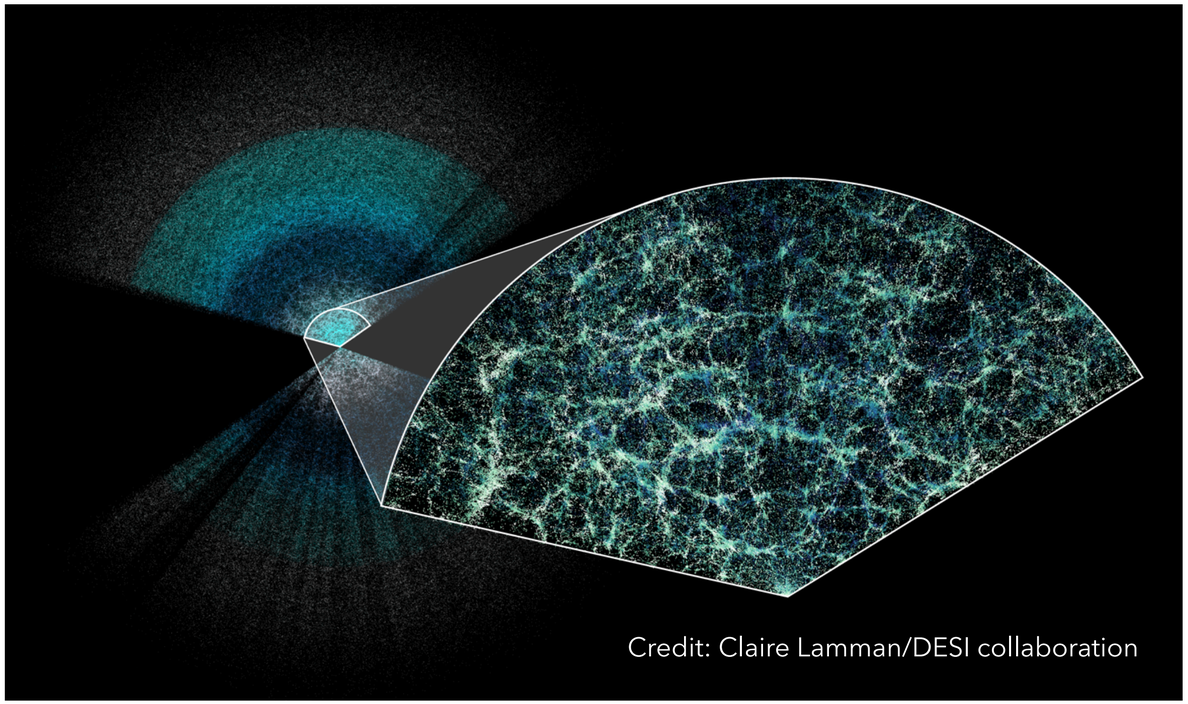
I. Overview of the *Euclid* mission★

Euclid Collaboration: Y. Mellier[1,2,★★], Abdurro'uf[3], J. A. Acevedo Barroso[4], A. Achúcarro[5,6], J. Adamek[7], R. Adam[8], G. E. Addison[3], N. Aghanim[9], M. Aguena[10], V. Ajani[11,12,13], Y. Akrami[14,15], A. Al-Bahlawan[16], A. Alavi[17], I. S. Albuquerque[18], G. Alestas[14], G. Alguero[19], A. Allaoui[20], S. W. Allen[21,22,23], V. Allevato[24], A. V. Alonso-Tetilla[25], B. Altieri[26], A. Alvarez-Candal[27,28], S. Alvi[29], A. Amara[30], L. Amendola[31], J. Amiaux[11], I. T. Andika[32,33], S. Andreon[34], A. Andrews[35], G. Angora[24,29], R. E. Angulo[36,37], F. Annibali[35], A. Anselmi[38], S. Anselmi[39,40,41], S. Arcari[29,42], M. Archidiacono[43,44], G. Aricò[7], M. Arnaud[45,46], S. Arnouts[20], M. Asgari[47], J. Asorey[48], L. Atayde[18], H. Atek[2], F. Atrio-Barandela[49], M. Aubert[50,51], E. Aubourg[10,45], T. Auphan[52], N. Auricchio[35], B. Aussel[53], H. Aussel[11], P. P. Avelino[54,55], A. Avgoustidis[56], S. Avila[57], S. Awan[16], R. Azzollini[16], C. Baccigalupi[58,59,60,61], E. Bachelet[62], D. Bacon[63], M. Baes[64], M. B. Bagley[65], B. Bahr-Kalus[51,66], A. Balaguera-Antolinez[67,68], E. Balbinot[69,70], M. Balcells[67,68,71],

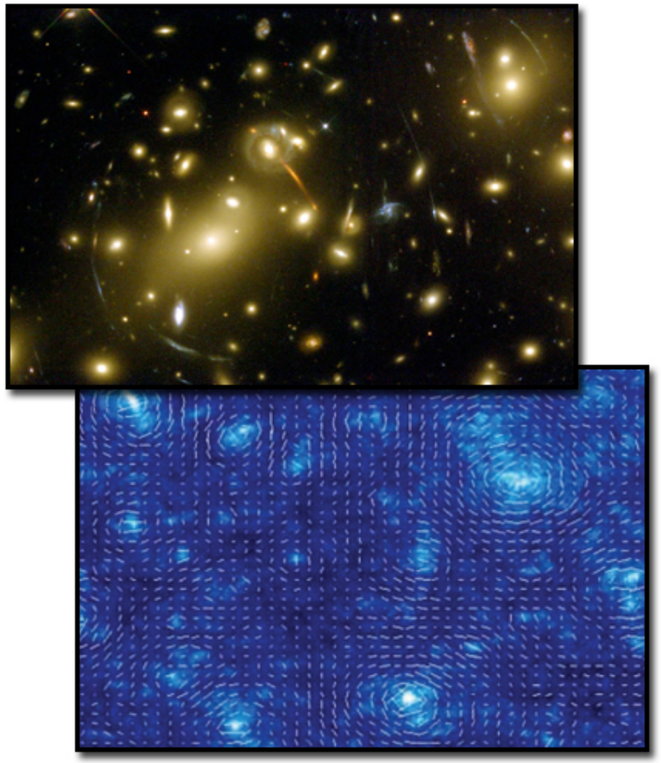
5 Flagship papers + 11 Early Release Observation science papers

Large-Scale Structures: Galaxy Clustering and Weak Lensing

✦ Galaxy clustering (BAO, RSD)
- Spectroscopy (*Euclid*, Subaru PFS, *Roman*)
➡ Geometry of the Universe, growth of structures


Credit: Claire Lamman/DESI collaboration

✦ Weak Lensing
- Imaging (*Euclid*, LSST, *Roman*)
➡ Structure formation, galaxy clusters



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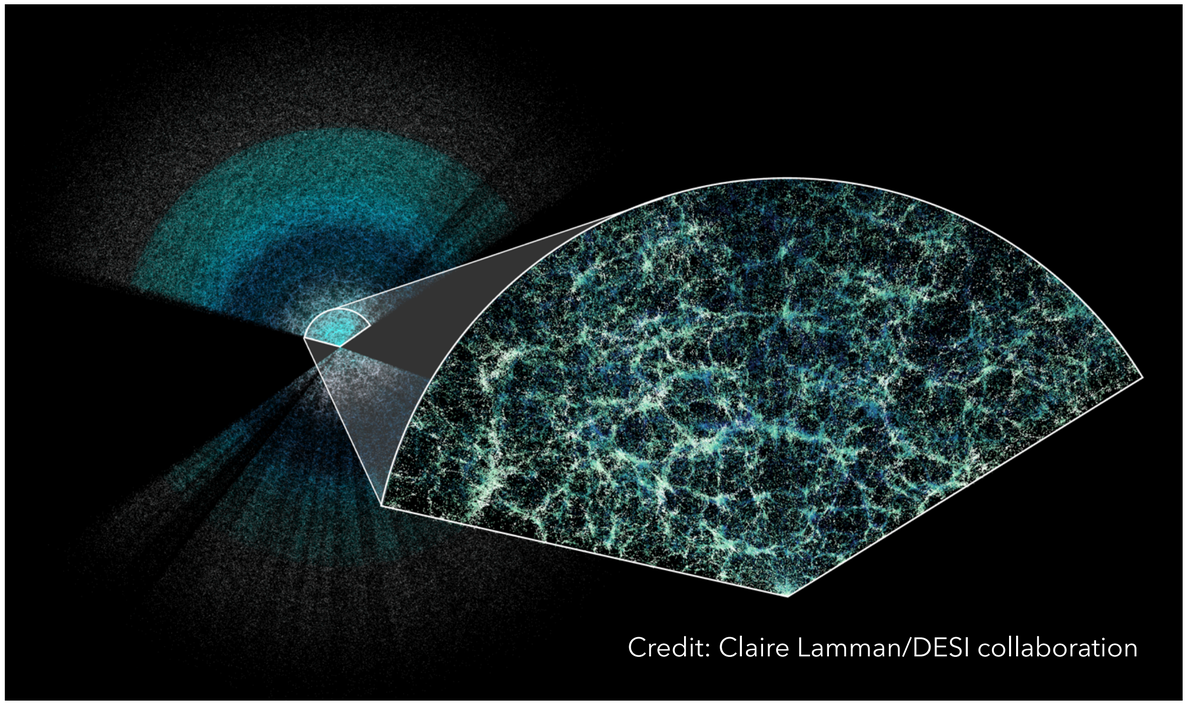

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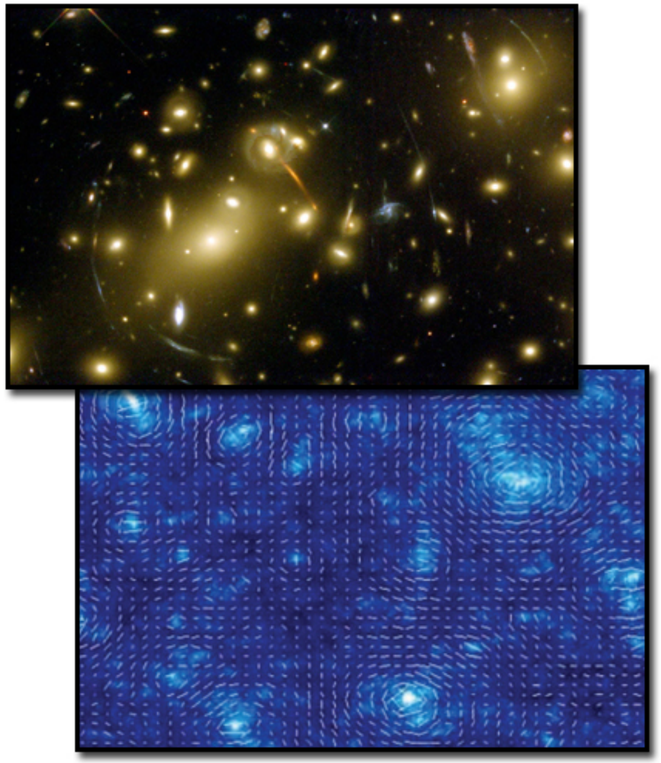


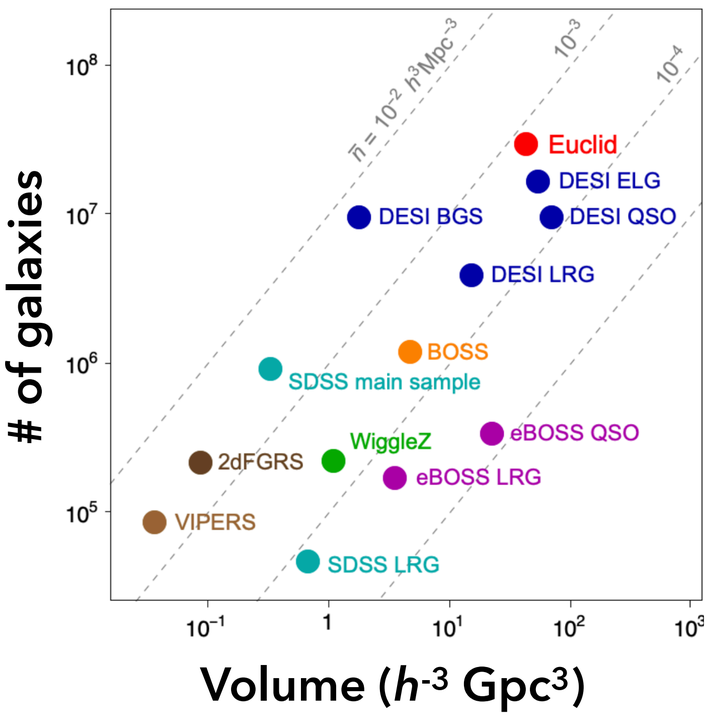
✦ Galaxy-galaxy lensing (cross-correlation)

➡ Adding more information to break parameter degeneracy

✦ 3x2pt analysis = *gg* + *γγ* + *gγ*

Large-Scale Structures: Galaxy Clustering and Weak Lensing

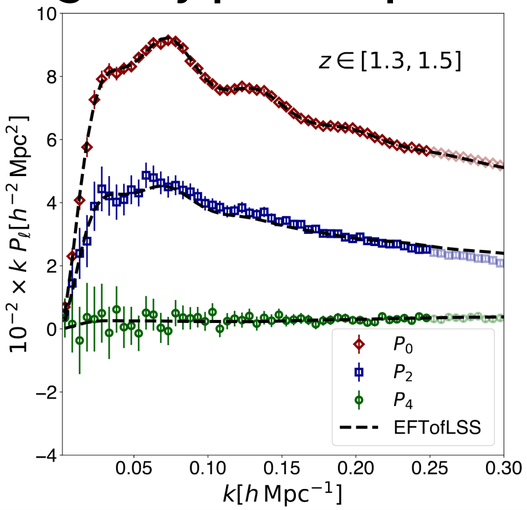
✦ Galaxy clustering



35 millions of galaxies
with 3D positions
$0.84 < z < 1.88$
$\delta z < 0.001\ (1+z)$

Castander et al. (2025)

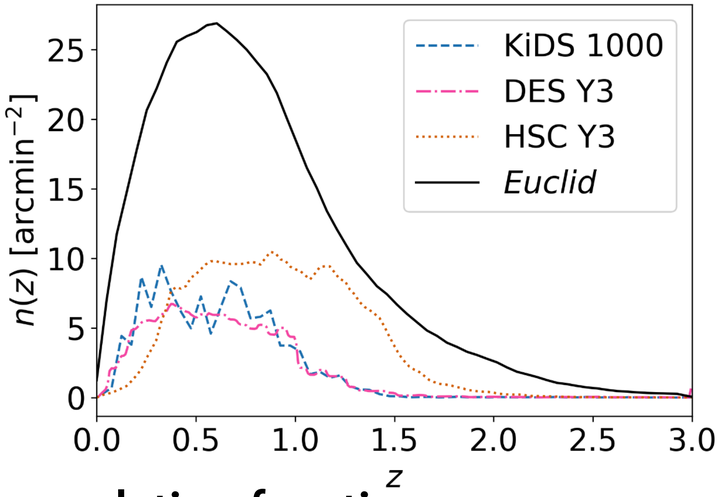
Redshift space galaxy power spectra



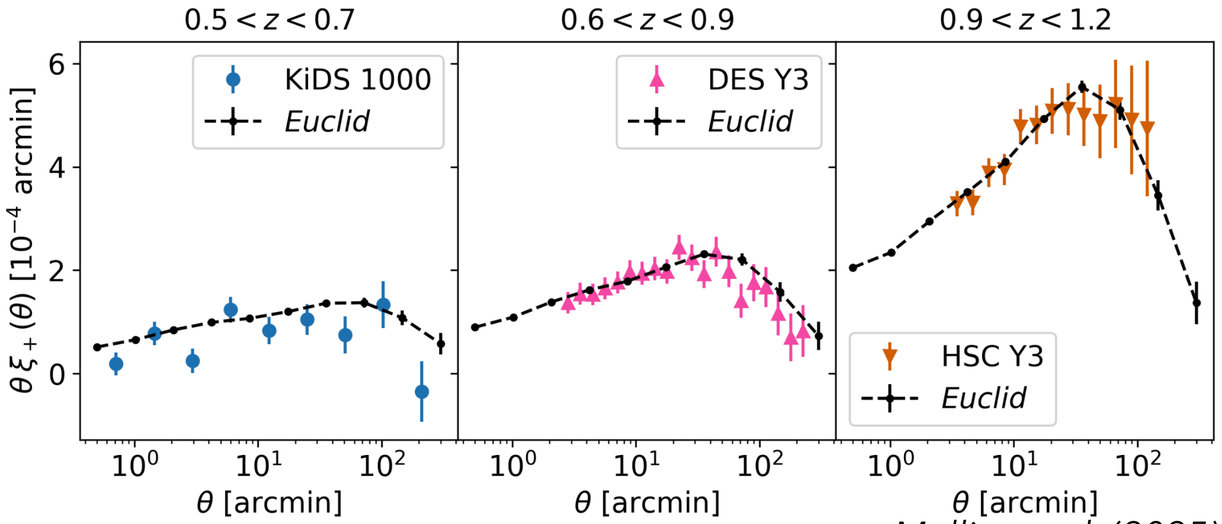
✦ Weak Lensing

1.5 billion shapes
$0 < z < 2$
$\delta z < 0.05\ (1+z)$

Source redshift distribution



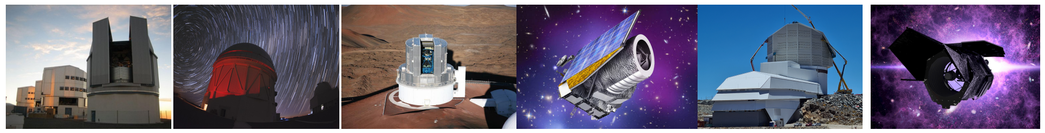
Shape correlation functions



Mellier et al. (2025)

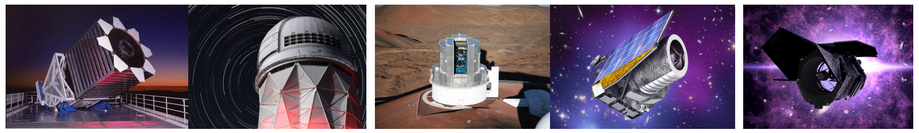
Stage-III/IV Imaging/Spectroscopic Surveys

- **Imaging surveys**



	KiDS	DES	HSC	*Euclid*	LSST	*Roman*
Mirror diameter [m]	2.6	4.0	8.2	**1.2**	8.4	2.4
Galaxy density [arcmin^{-2}]	11	25	25	**30**	30	50
Survey area [deg^2]	1,500	5,000	1,400	**14,000**	18,000	2,000

- **Spectroscopic surveys**



	eBOSS	DESI	PFS	*Euclid*	*Roman*
Instrument	1000 fibers	5000 fibers	2400 fibers	**Slitless**	Slitless
Redshift	0.7-1.1	1.1-1.6	0.8-2.4	**0.7-2.1**	1.0-2.8
Survey area [deg^2]	9,000	14,000	1,200	**14,000**	2,000

Forecasts on Cosmological Parameter Constraints

- **Dark Energy EoS parameter**

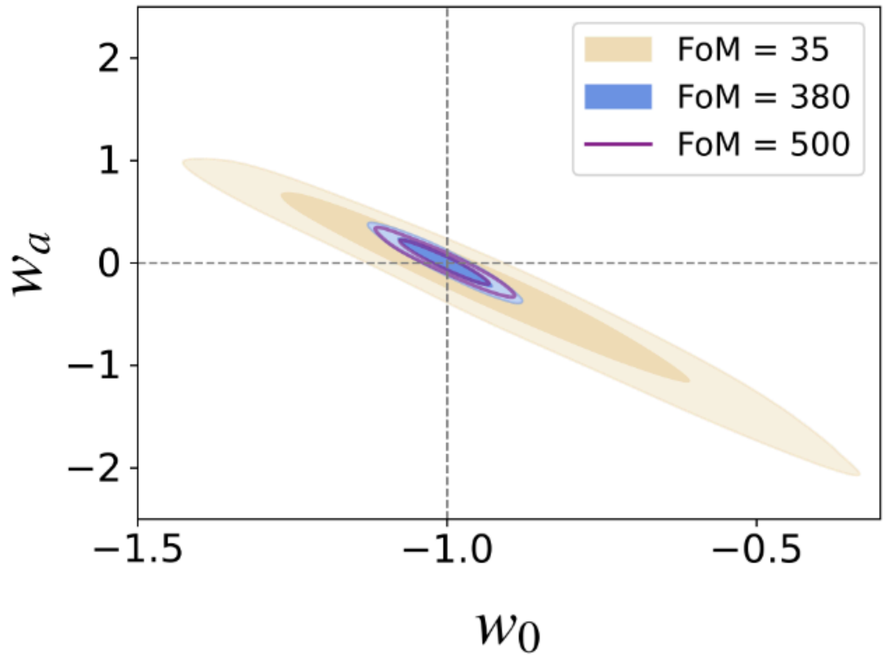
$$w = w_0 + (1 - a)w_a$$

$w_a \neq 0$ → break of cosmo. constant!

w_0w_aCDM (GCsp) **Spec. GC**

w_0w_aCDM (3x2pt) **WL + Photo. GC**

w_0w_aCDM (3x2pt + GCsp)



$$\mathrm{FoM} = \frac{1}{\sqrt{\det \mathrm{Cov}(w_0, w_a)}},$$

N.B.: other cosmo. params. are marginalized.

- **Growth rate**

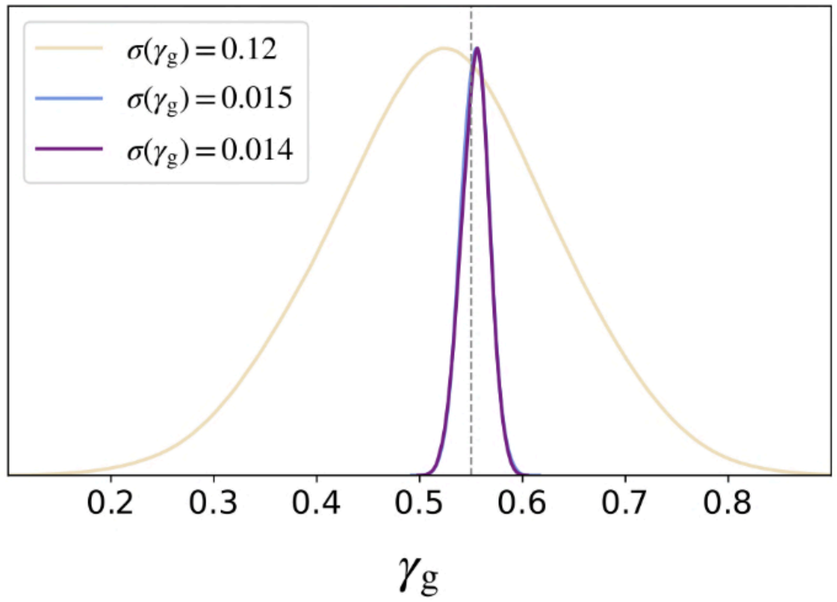
$$f_{\rm g}(z) \equiv \frac{d\ln g_+(z)}{d\ln a} \simeq [\Omega_{\rm m}(z)]^{\gamma_{\rm g}}$$

$\gamma_{\rm g} \neq 0.55$ → break of GR!

ΛCDM + $\gamma_{\rm g}$ (GCsp) **Spec. GC**

ΛCDM + $\gamma_{\rm g}$ (3x2pt) **WL + Photo. GC**

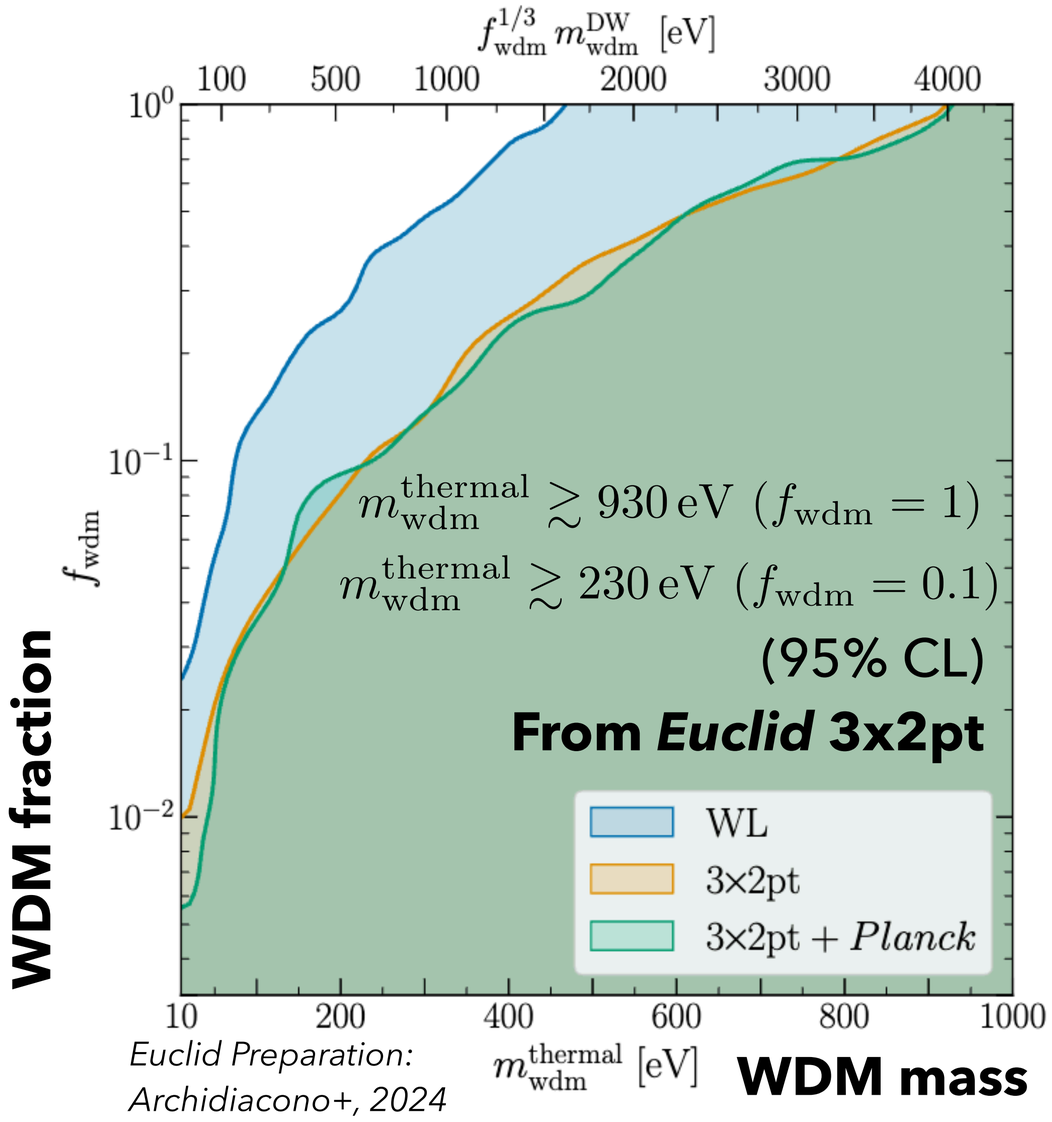
ΛCDM + $\gamma_{\rm g}$ (3x2pt + GCsp)



Mellier+ (2025)

Forecasts on Dark Matter and Neutrinos

- **Cold + Warm MDM model**

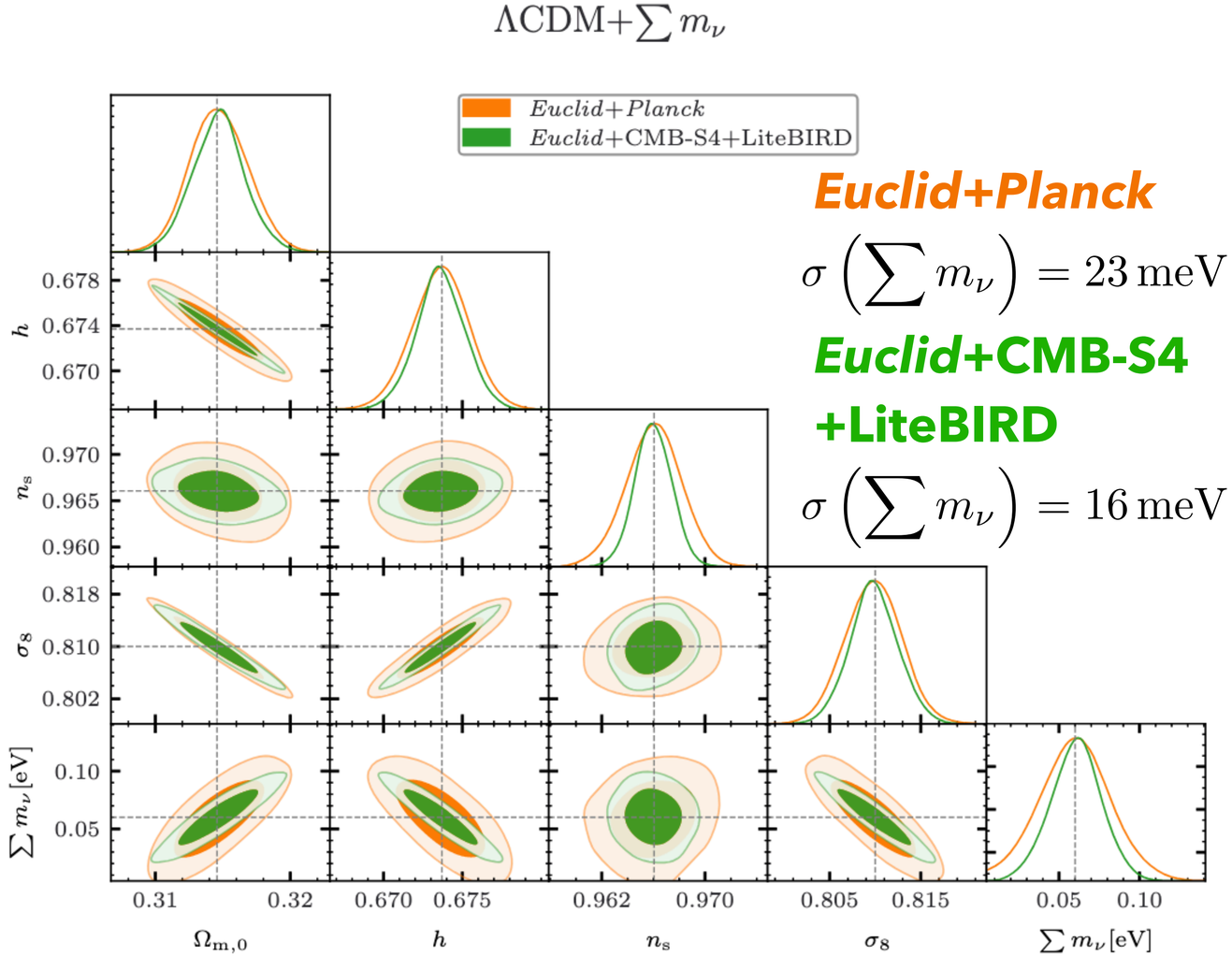


WDM fraction

WDM mass

Euclid Preparation: Archidiacono+, 2024

- **Massive neutrinos in ΛCDM**



Euclid Preparation: Archidiacono+, 2024

UNIONS and WISHES

UNIONS

The Ultraviolet Near Infrared Optical Northern Survey is a collaboration of 4 scientific projects:

Hawaiian Islands

Pan-STARRS
2 x 1.8m

CFHT
3.6m

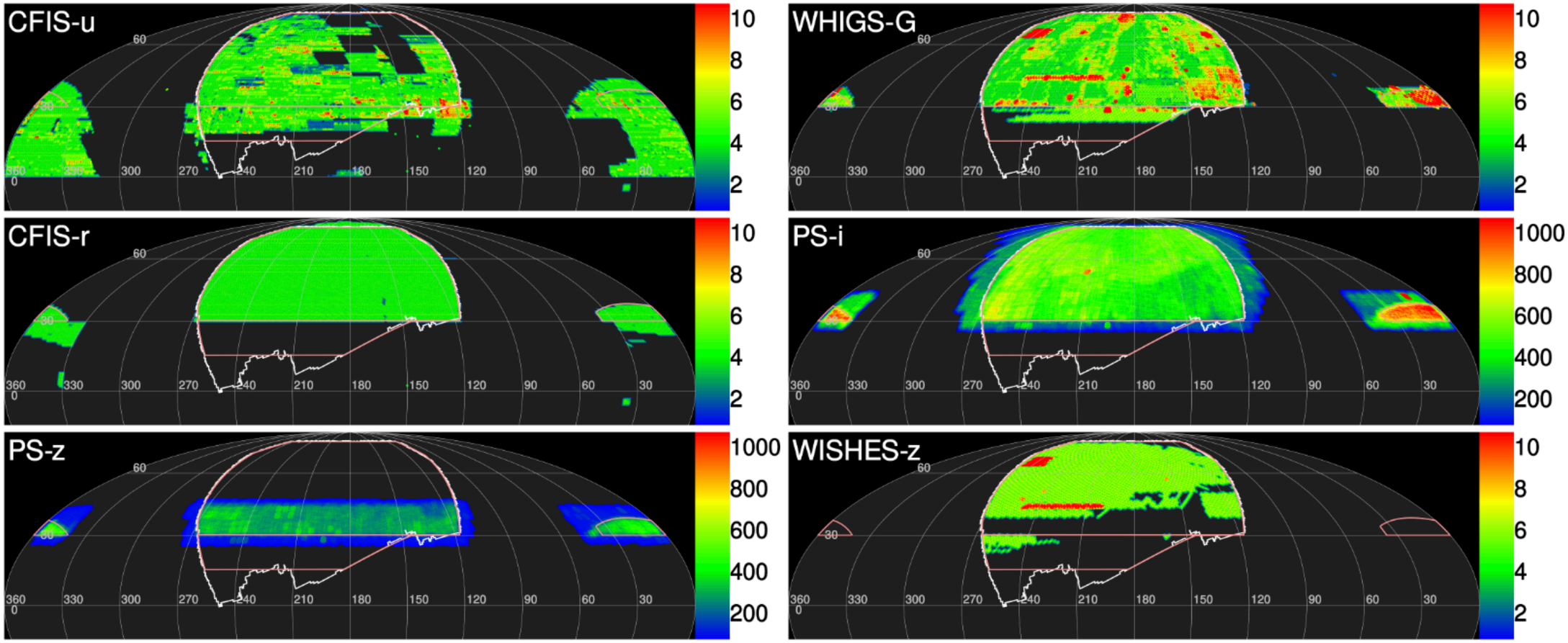
Subaru
Telescope
8.2m

UNIONS

Hawaiian Alliance of ground-based telescopes:

CFHT/CFIS(++) (*u*, *r*), Subaru/WISHES(+) (*z*), Subaru/WHIGS (Extension) (*g*), Pan-STARRS (*i*, *z*)

Goal: complement Euclid's data with multi-band observations

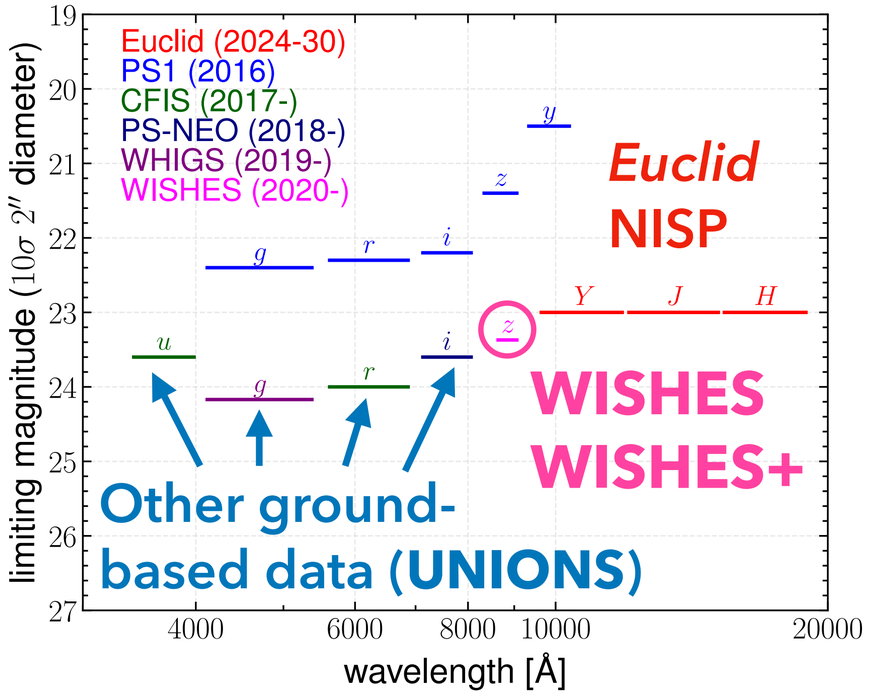


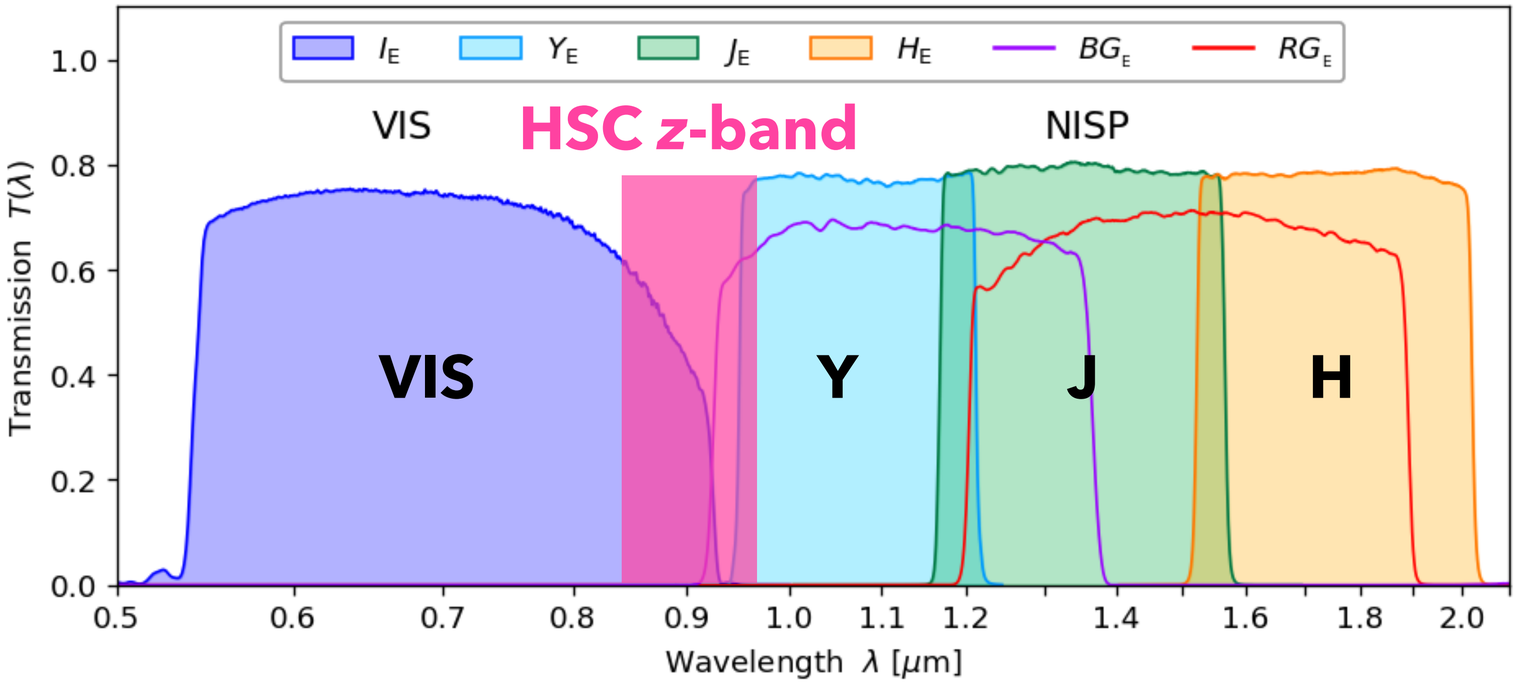
UNIONS Overview Paper (Gwyn+, 2025)

WISHES and WISHES+: *z*-band Survey for Euclid

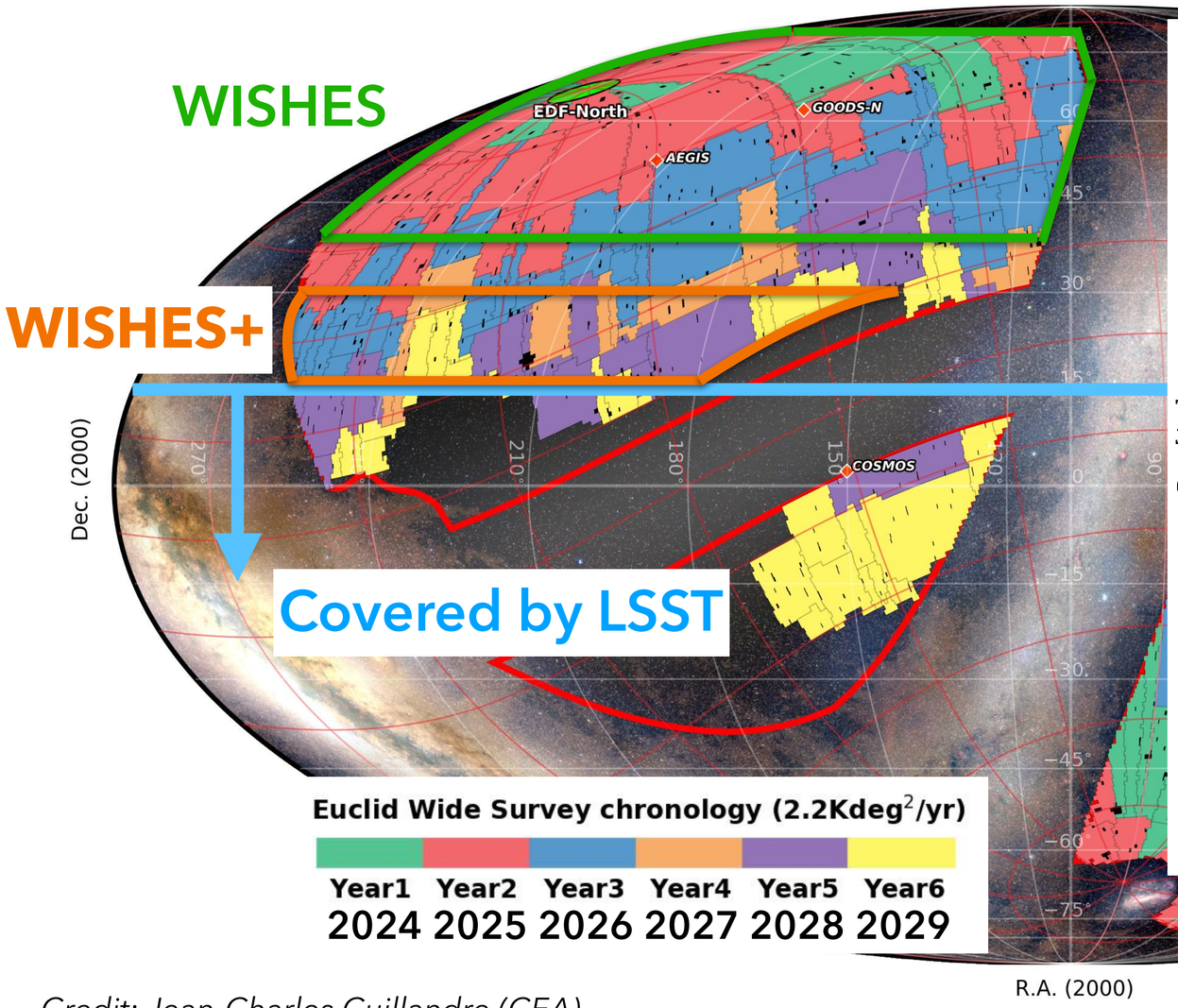
✦**Wide Imaging with Subaru HSC of the Euclid Sky (WISHES): S20B-S24A (PI: M. Oguri)**
Provide HSC *z*-band imaging data covering the northern footprint of Euclid Survey
(i) improve photo-*z* of source galaxies for **cosmic shear science**
(ii) search for rare objects such as **high-*z* quasars**

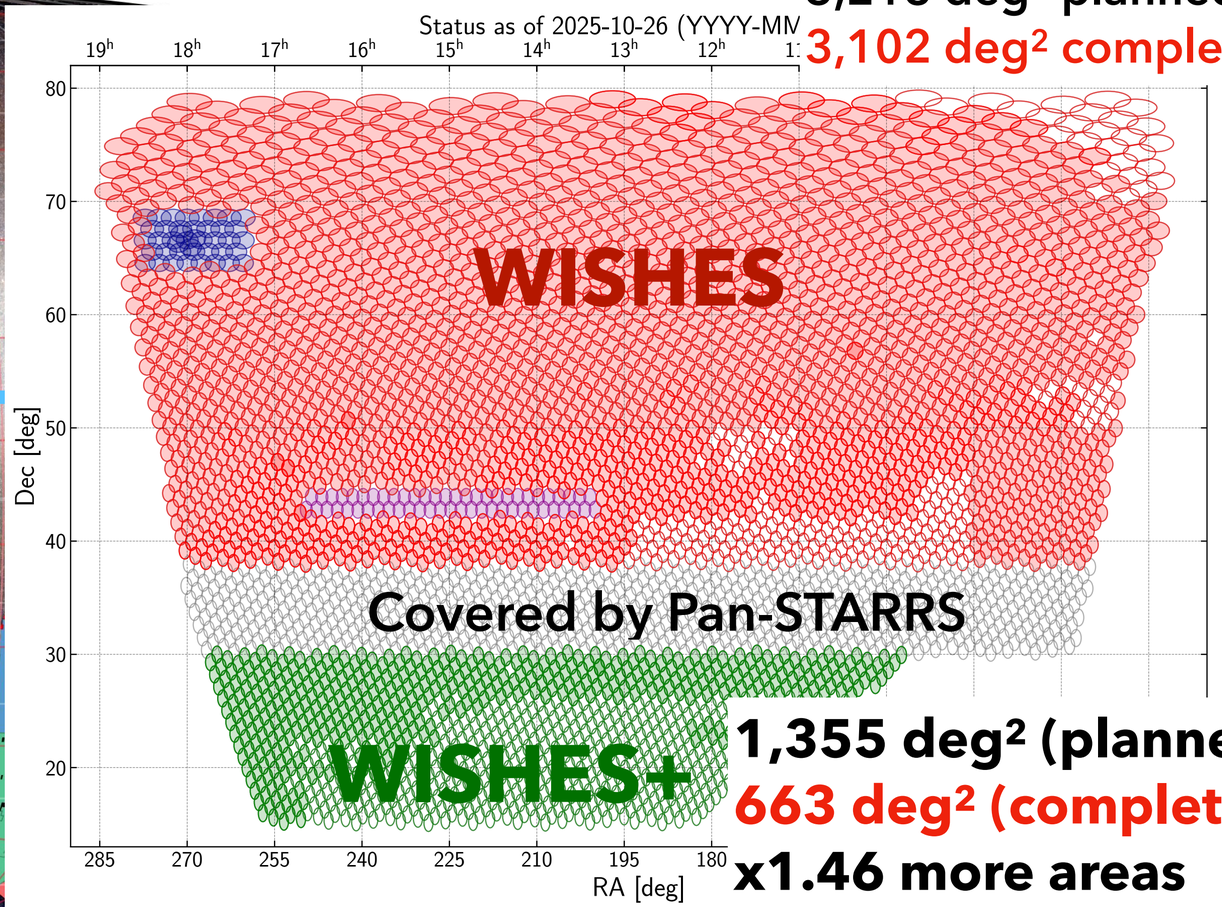
➡The regions at +15 deg < Dec. < +30 deg will not be observed by LSST nor WISHES.
WISHES+ (S24B-S27A; PI: K. Osato) will cover the missing sky.





Survey Footprints of Euclid and WISHES/WISHES+





3,218 deg² planned

3,102 deg² completed

1,355 deg² (planned)

663 deg² (completed)

x1.46 more areas

✦ WISHES+ region will be observed by Euclid from 2026 (Year 3).

Credit: Jean-Charles Cuillandre (CEA)

Recent Activities of Japanese Euclid Consortium

- **Japanese Euclid Consortium (JEC)**
  The contribution from WISHES/WISHES+ grants access to Euclid's data for 35 PIs.
  Each PI can assign two junior members (students or PDs), who also can get access.

JEC Meeting 2024
KMI, Nagoya University; Nov. 25-26, 2024

Summary

- *Euclid* as one of Stage-IV cosmological surveys has started 6-yr wide field survey. The primary science goal is to verify or even exclude the standard cosmological models through weak lensing and galaxy clustering.

- Q1 data release has already happened and the first data release (DR1) is planned in Oct., 2026. By then, many scientific results are expected to appear.

- To complement *Euclid*'s data, UNIONS will provide multi-wavelength observations. Subaru HSC is also contributing to UNIONS for *z*- and *g*-band observations.