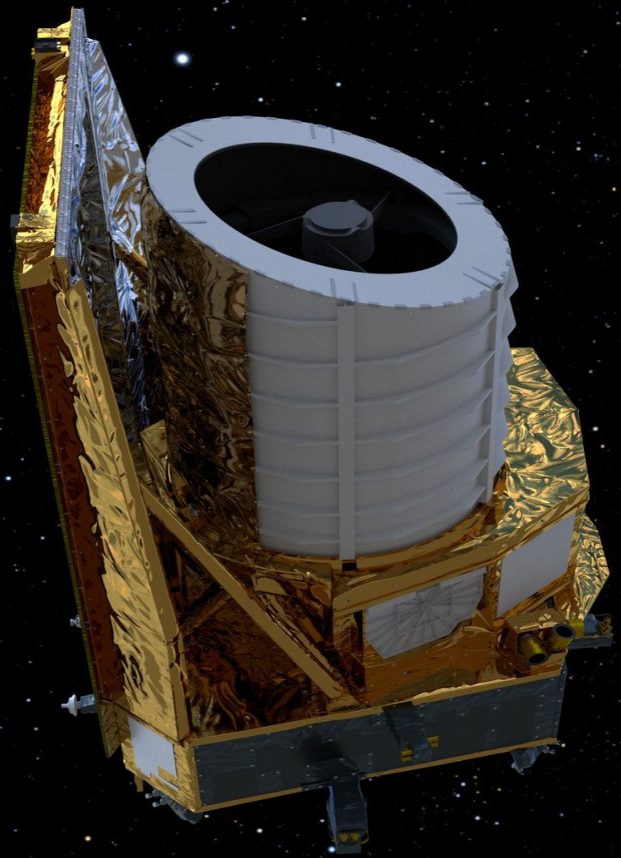


The Euclid mission

Elizabeth J. Gonzalez (on behalf of the Euclid Consortium) - EPS HEP 8th July 2025

https://arxiv.org/abs/2405.13491

IFAE Institut de Física d'Altes Energies

EXCELENCIA SEVERO OCHOA

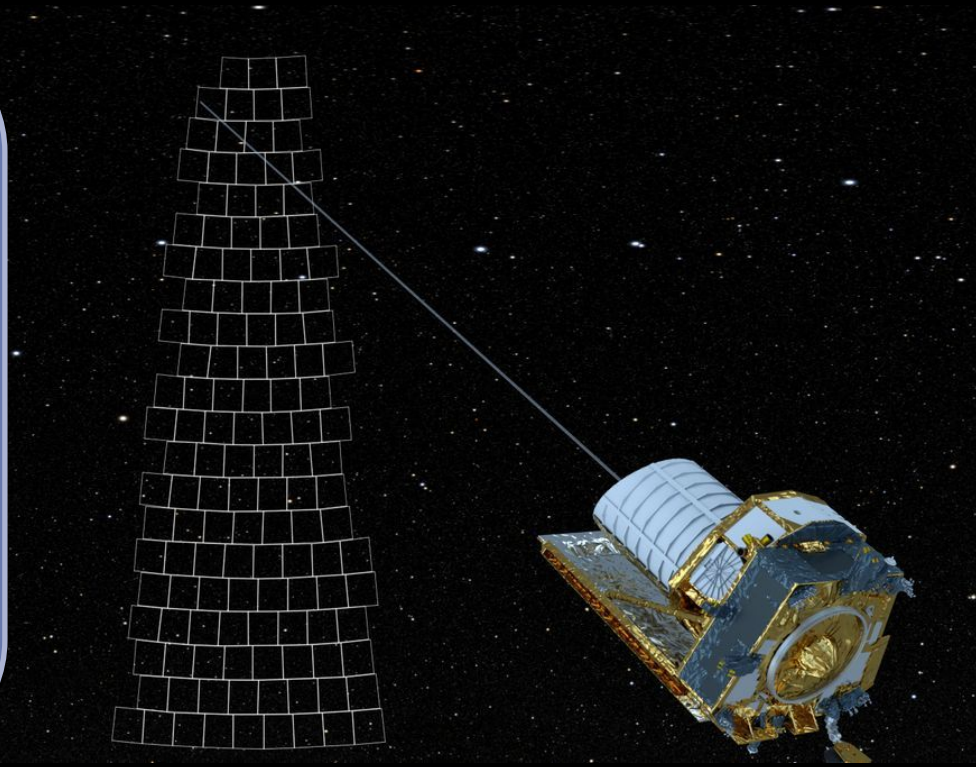
PIC port d'informació científica

Euclid consortium

IATE CONICET UNC

Outline

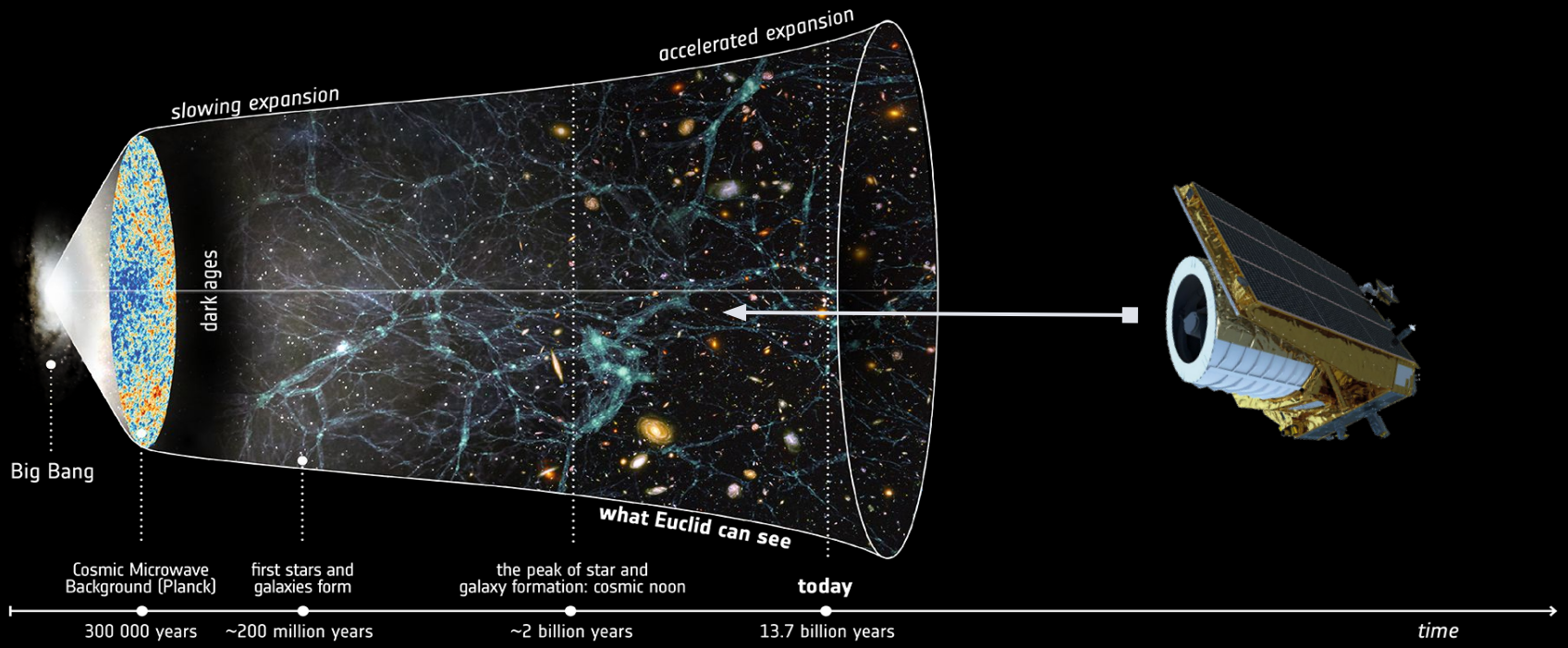
- Primary Science
- Spacecraft & Instruments
- Simulated data
- Survey and releases
- First data (Q1)
- Summary



Credit: ESA

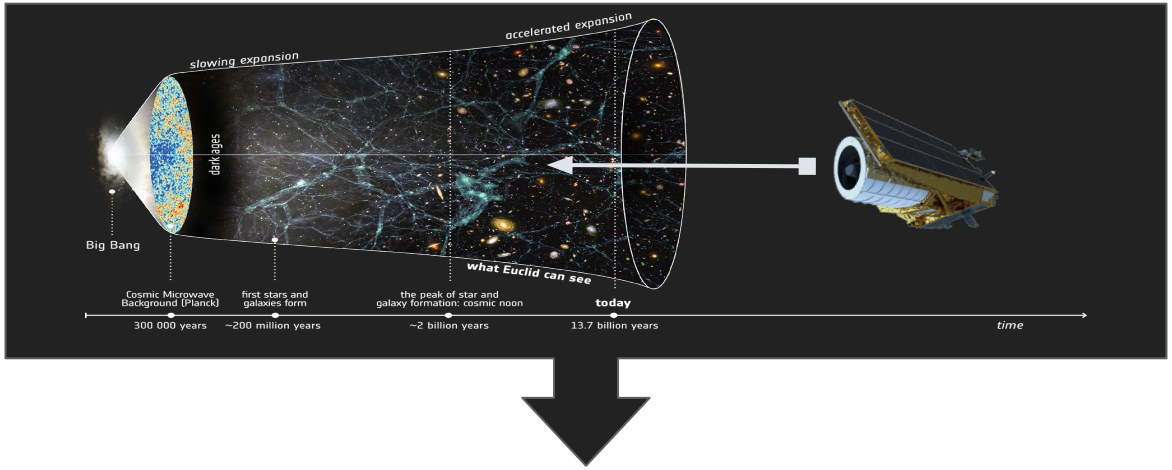
Primary Science

Timeline of the Universe



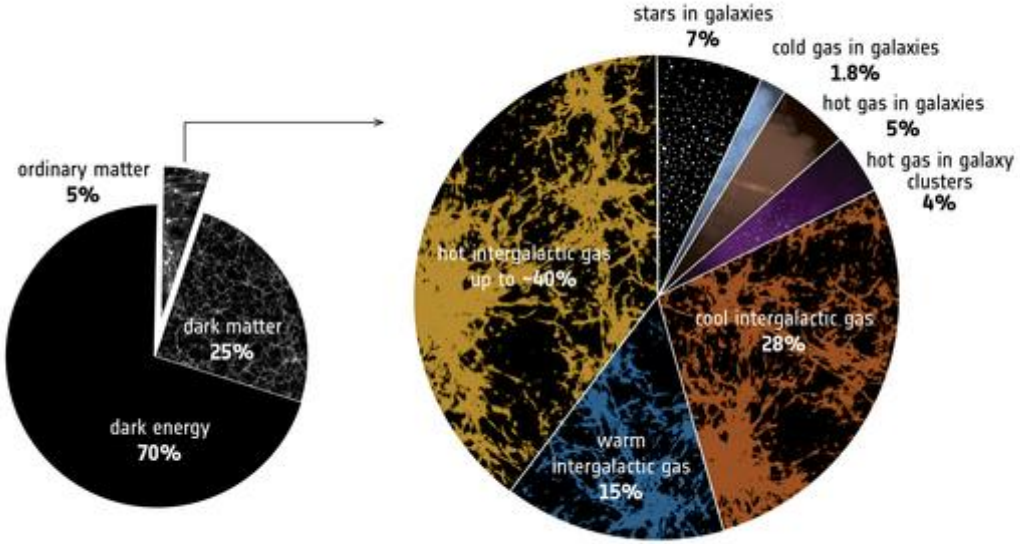
Credit: ESA/ATG

ΛCDM model - parameters



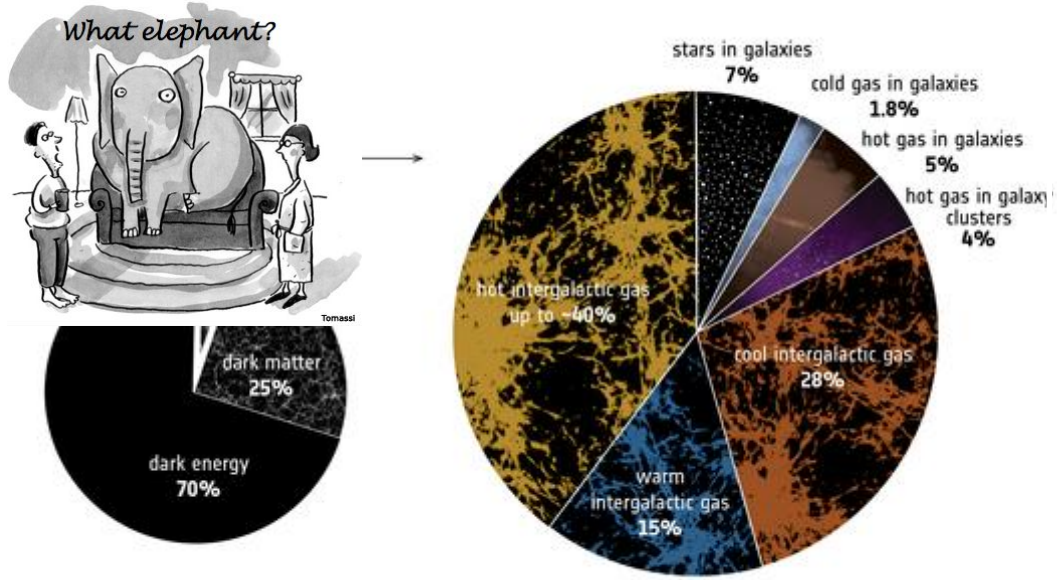
H_0	Ω_m	Ω_b	Ω_m	σ_8	n_s
Current expansion rate	Matter density	Baryon density	Dark Energy density	“Clumpiness”	Scale index of initial density fluctuations

ΛCDM model - composition



Credit: ESA

ΛCDM model - composition



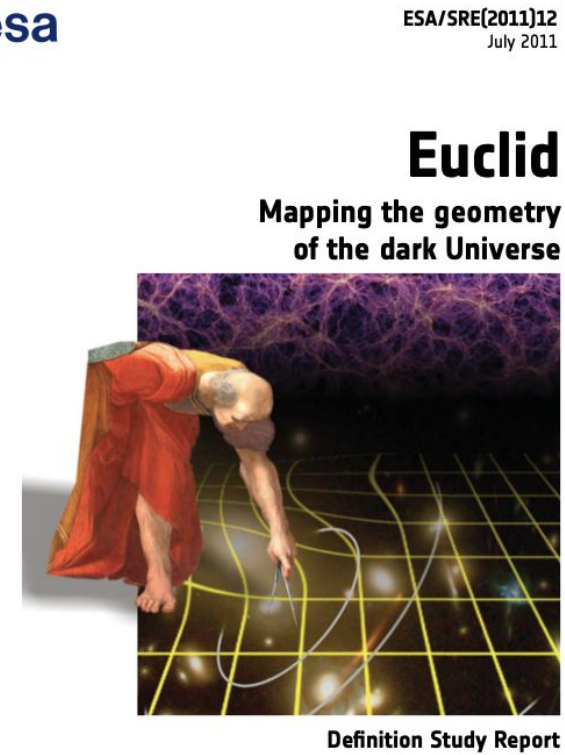
Credit: ESA

The nature of the main ingredients remain great mysteries

Our theories of **particle physics** and/or **gravity** are either **incomplete or incorrect**

Strategy: **Improve the precision** of the measurements to distinguish between different theoretical models

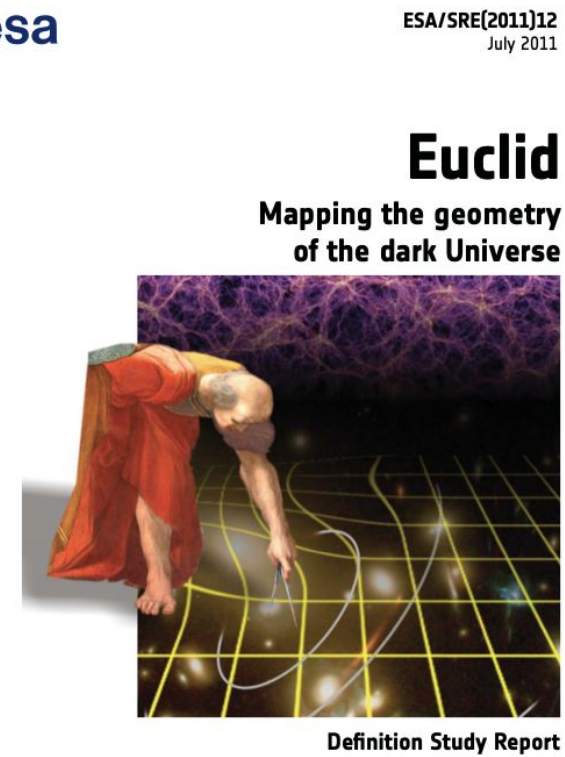
Main objectives



Credit: ESA Euclid Definition Study report

- Dynamical nature of dark energy
- Test gravity models
- Explore the nature of the dark matter particle
- Constraint the seeds of cosmic structure

Main objectives



Credit: ESA Euclid Definition Study report

Reach a dark energy FoM > 400 using only *Euclid* primary probes

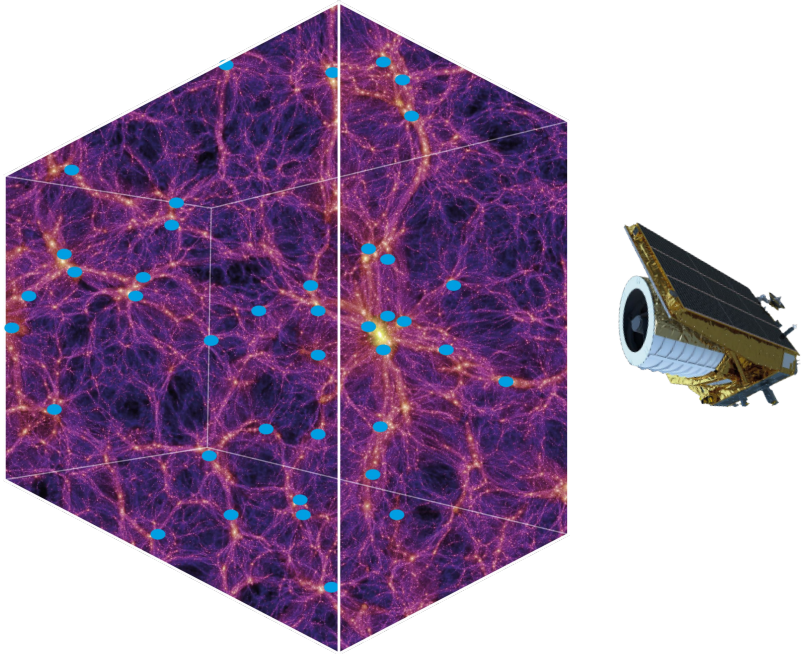
Measure the exponent of the growth factor with 1σ precision < 0.02

Measure the sum of the neutrino masses with 1σ precision < 0.03 eV

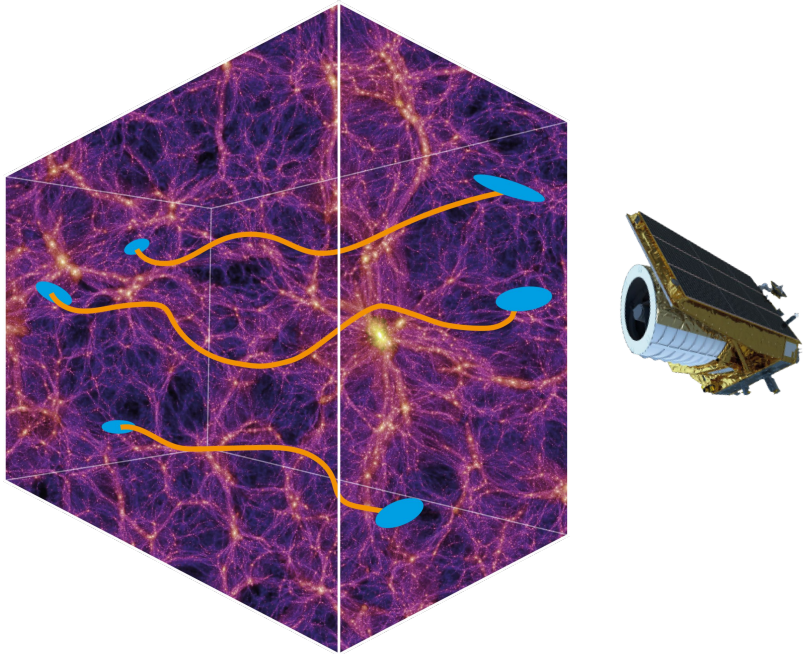
Constrain the spectral index and measure non-Gaussianity of the initial conditions

Two primary probes of the large scale structure

Galaxy clustering



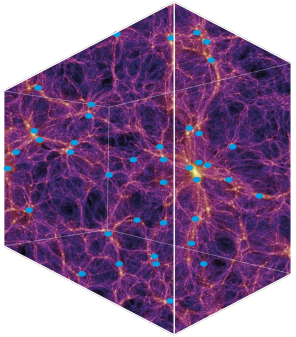
Cosmic shear

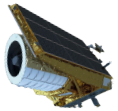


Credit: Springel+ (2005) (Background) ESA/ATG medialab (spacecraft)

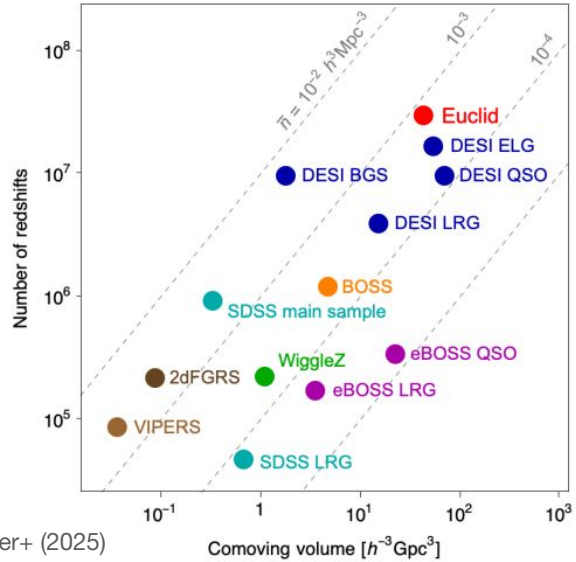
Two primary probes of the large scale structure

Galaxy clustering



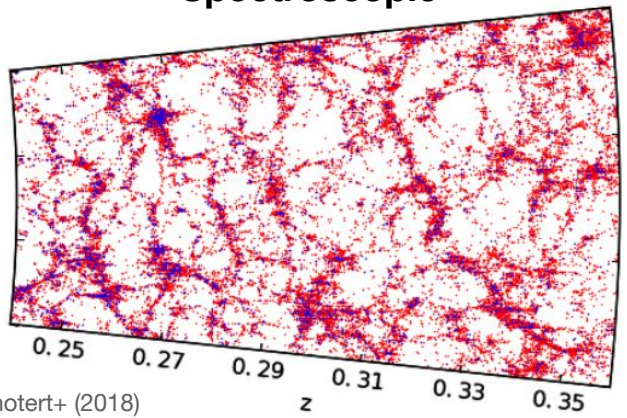


$\sigma(z) < 0.001\ (1 + z)$



Credit: Mellier+ (2025)

Spectroscopic



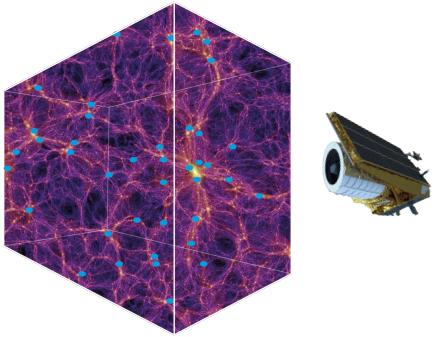
Sthotert+ (2018)

BAOs → expansion history→ H_0 and $w(z)$

RSD → growth of structure→$f_g(z)$

Two primary probes of the large scale structure

Galaxy clustering

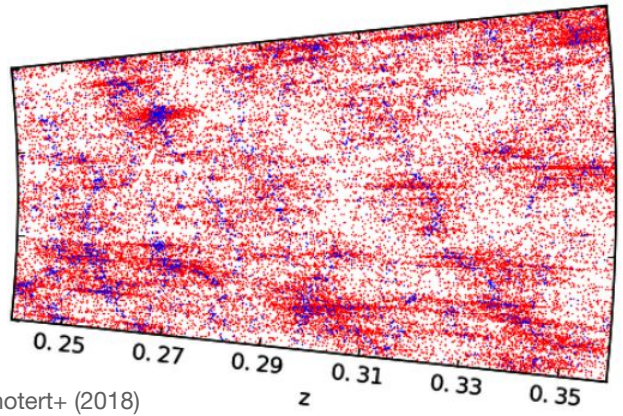


Credit: Springel+ (2005) (Background) ESA/ATG medialab (spacecraft)

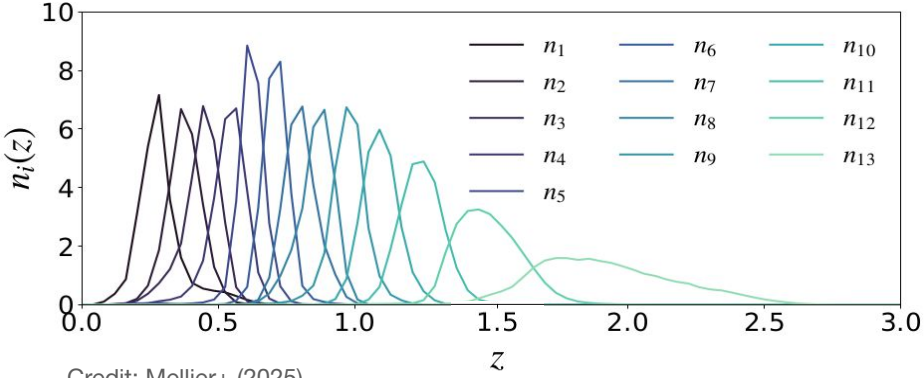
2D angular distribution in tomographic bins

Photometric

$\sigma(z) < 0.05\,(1+z)$



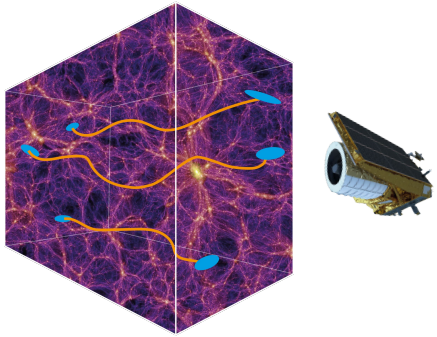
Sthotert+ (2018)

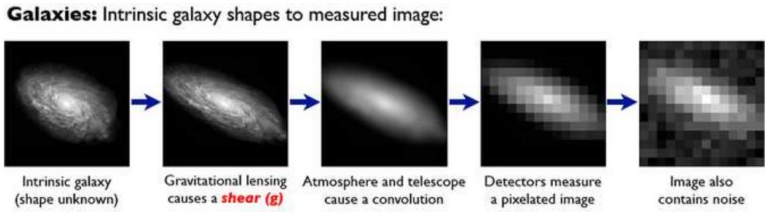


Credit: Mellier+ (2025)

Two primary probes of the large scale structure

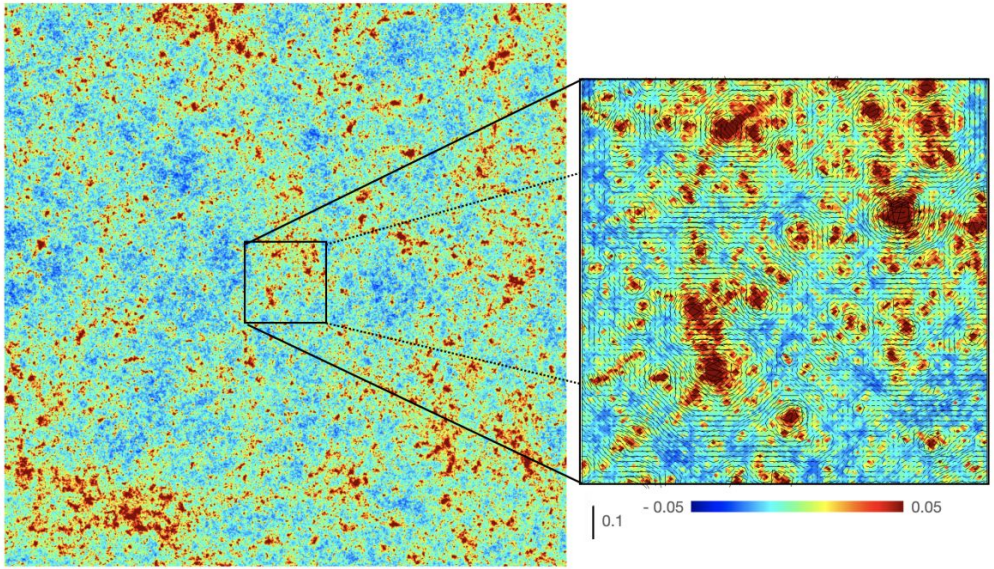
Cosmic shear





Credit: Bridley+ (2009)

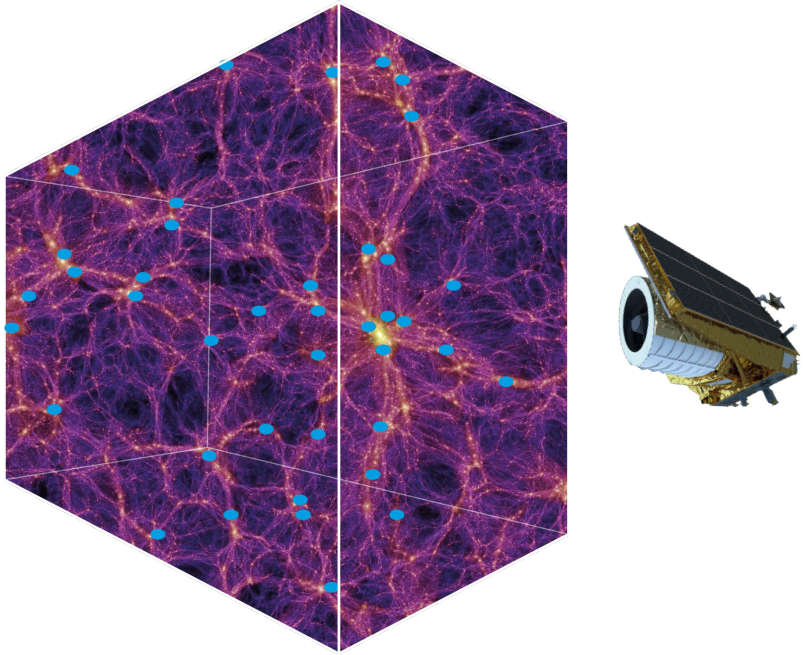
Galaxy shapes trace the L.O.S. mass distribution



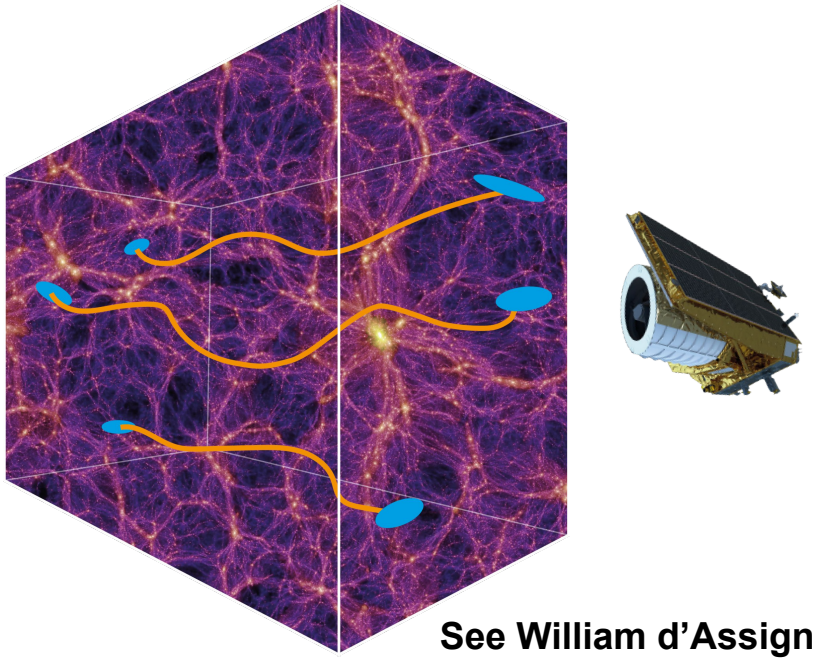
Credit: Castander, Fosalba+ (2025)

Two primary probes of the large scale structure

Measure galaxy positions



Measure galaxy shapes



Credit: Springel+ (2005) (Background) ESA/ATG medialab (spacecraft)

See William d'Assignies talk for further details!

Spacecraft & Instruments

Spacecraft

4.7m tall
3.7m total diameter
1.2m diameter main mirror
2 tonnes

Sunshield

Solar panels

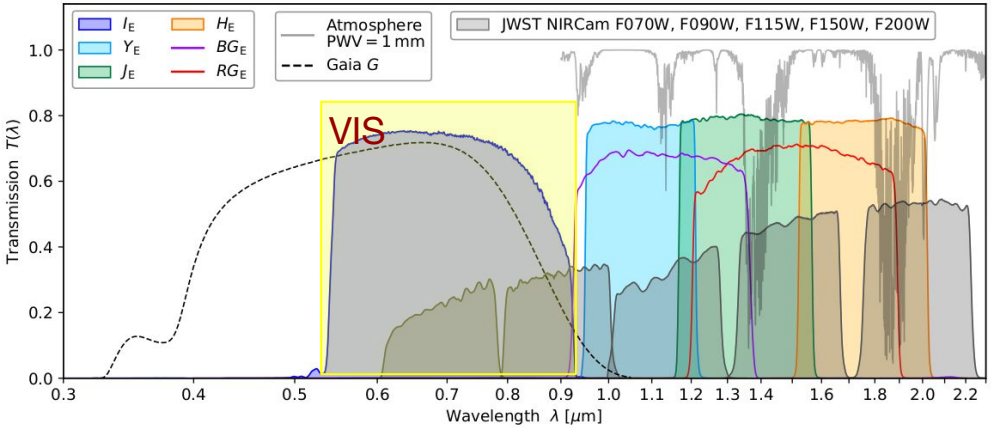
Service module

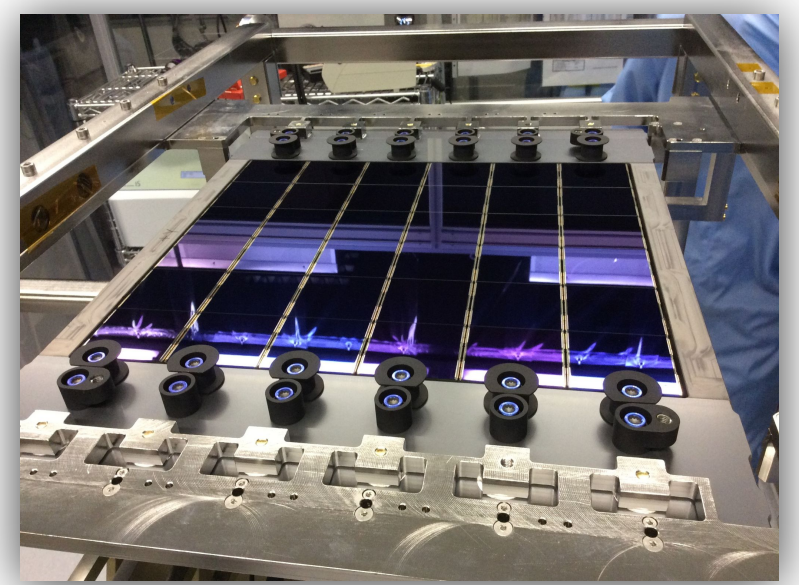
VIS and NISP

VIS

Design to measure galaxy shapes with high precision

- No moving parts
- One bandpass filter (covering r+i+z)
- 0.57 deg^2 and pixel size 0.1 arcsec



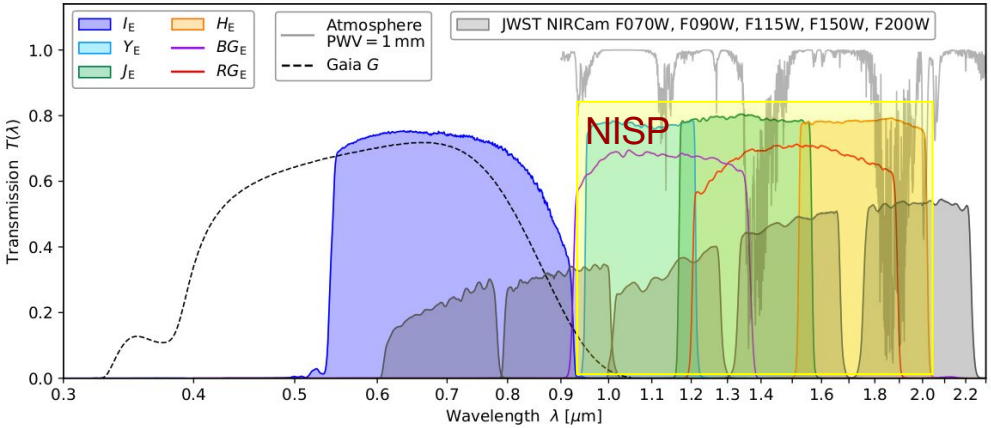


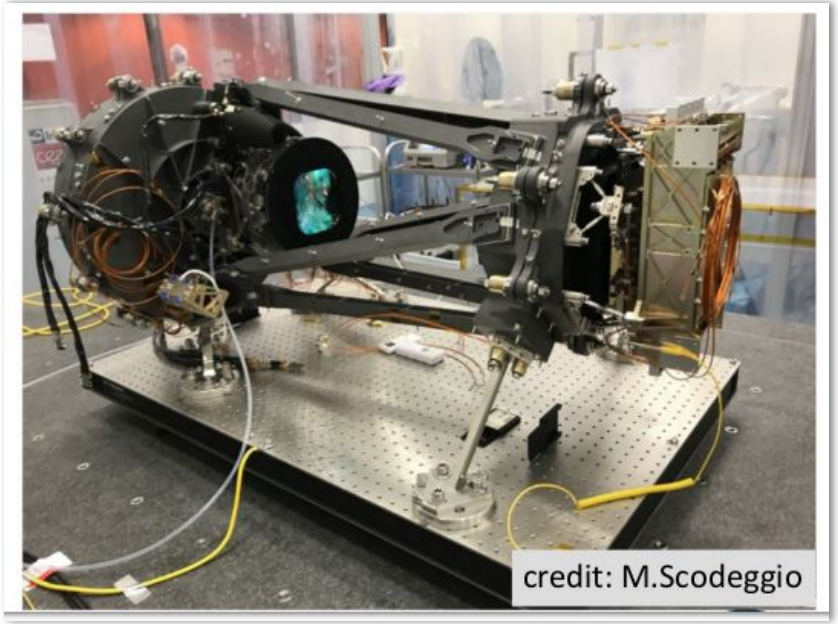
VIS focal plane array

NISP (Near Infrared Spectrometer and Photometer)

Design to measure galaxy LOS distances and velocities

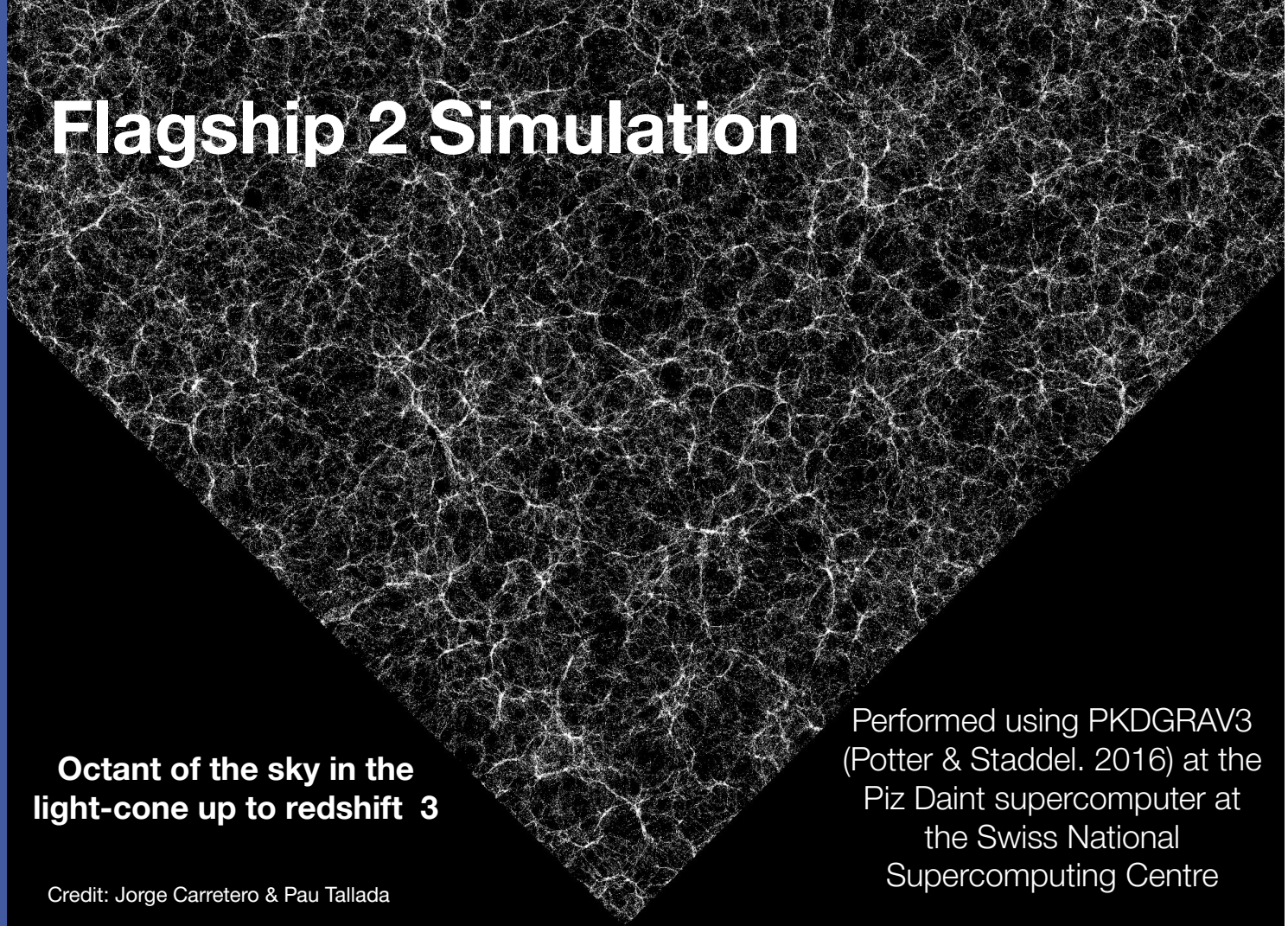
- Imaging + Slitless spectroscopy
- 3 imaging bands (YJH) and 2 grism bandpasses
- 0.57 deg^2 and pixel size 0.3 arcsec





Simulated data

Flagship 2 Simulation



Octant of the sky in the light-cone up to redshift 3

Credit: Jorge Carretero & Pau Tallada

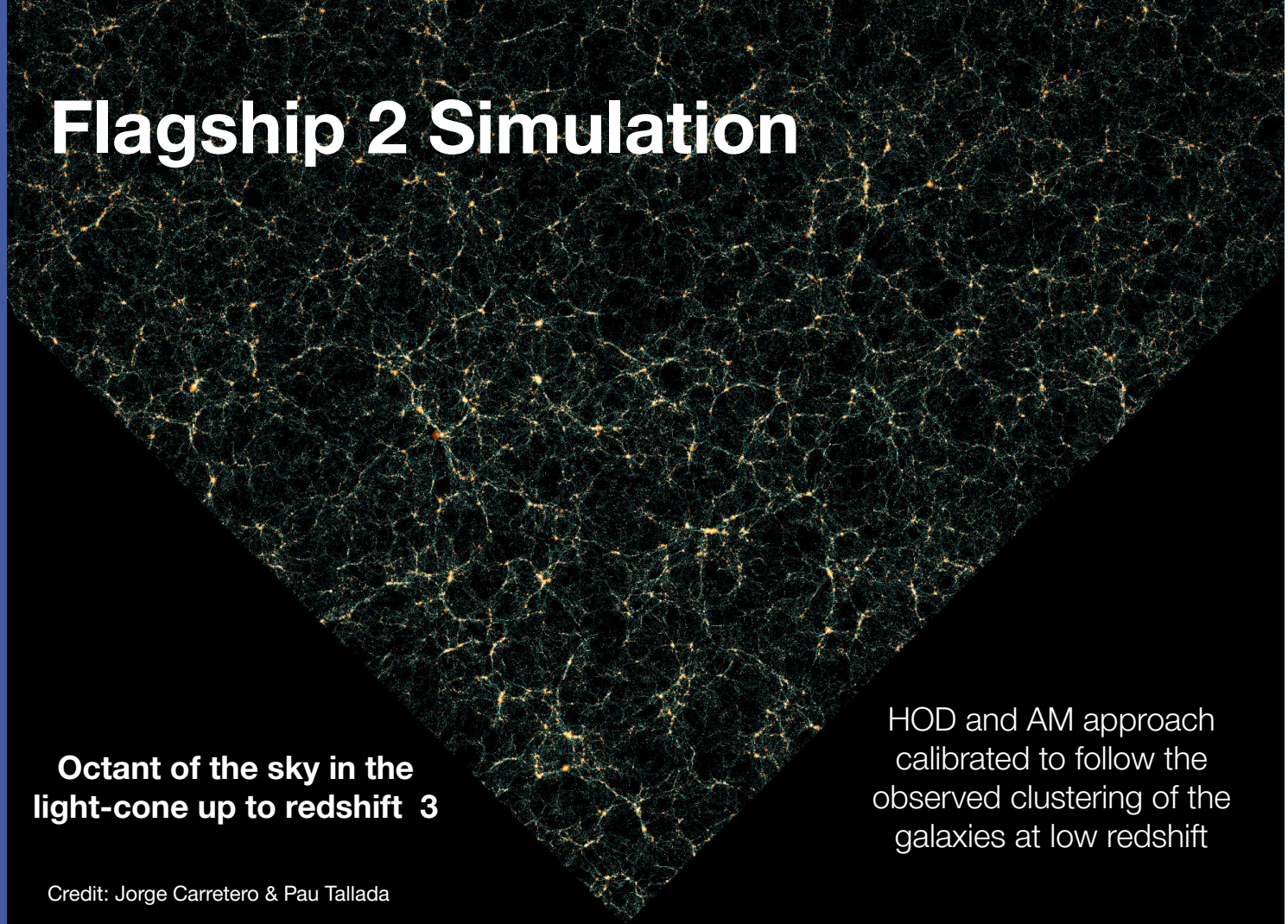
Performed using PKDGRAV3 (Potter & Staddel. 2016) at the Piz Daint supercomputer at the Swiss National Supercomputing Centre

Simulation box: 3600 Mpc/h.
Particle mass = 10^9 $M_\odot/h$

$\Omega_m = 0.319$
$\Omega_b = 0.049$
$\Omega_\Lambda + \Omega_\gamma = 0.681$
$A_s = 2.1 \times 10^{-9}$
$n_s = 0.96$, $h = 0.67$

1.5×10^9 haloes

Flagship 2 Simulation



Octant of the sky in the light-cone up to redshift 3

Credit: Jorge Carretero & Pau Tallada

HOD and AM approach calibrated to follow the observed clustering of the galaxies at low redshift

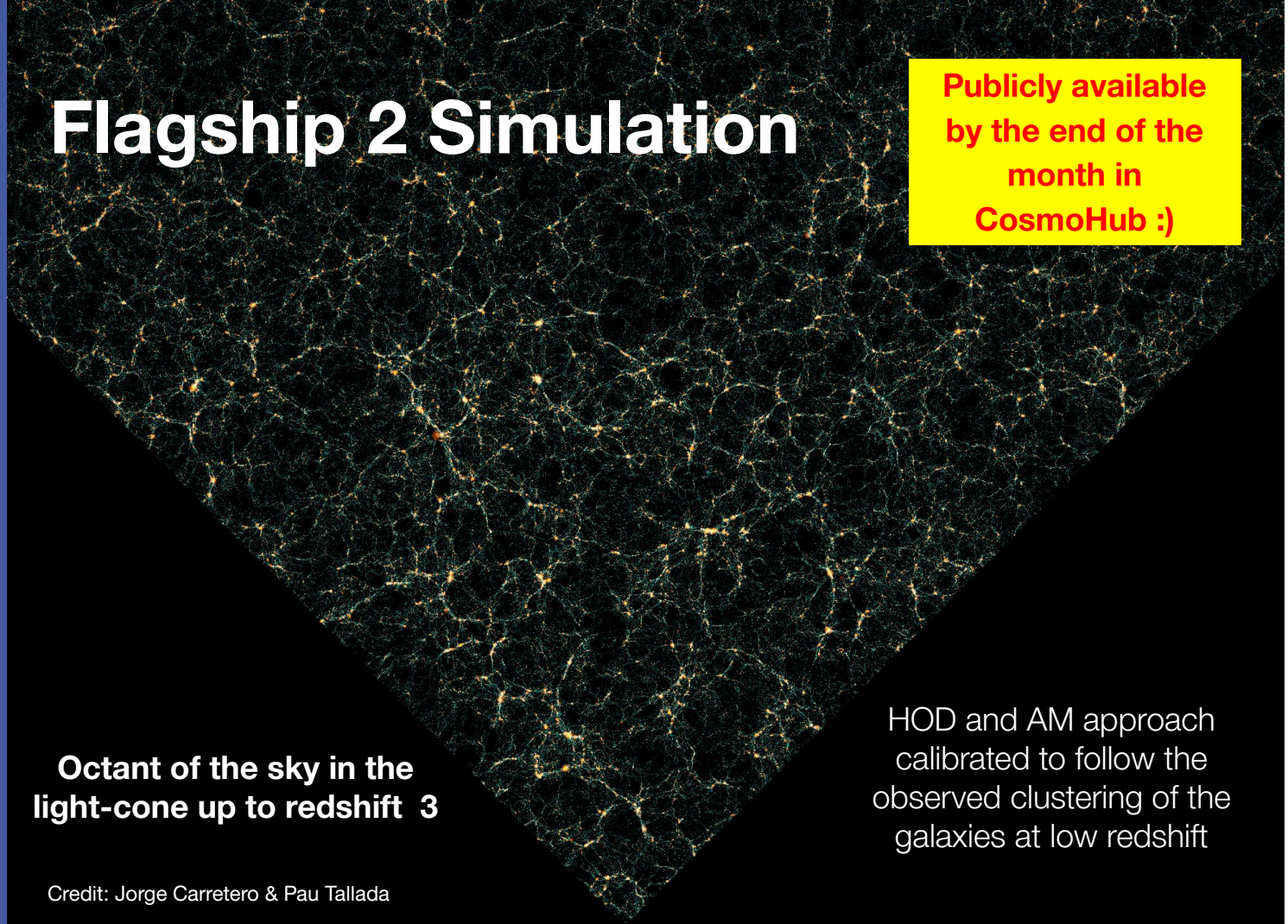
3.4×10^9 galaxies

Includes several properties: position, velocities, fluxes, intrinsic shapes, morphological parameters, stellar properties, lensing effects, photometric redshifts and more…

Euclid Collaboration: Castander & Fosalba et al. (2024)

Flagship 2 Simulation

Publicly available by the end of the month in CosmoHub :)



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3.4×10^9 galaxies

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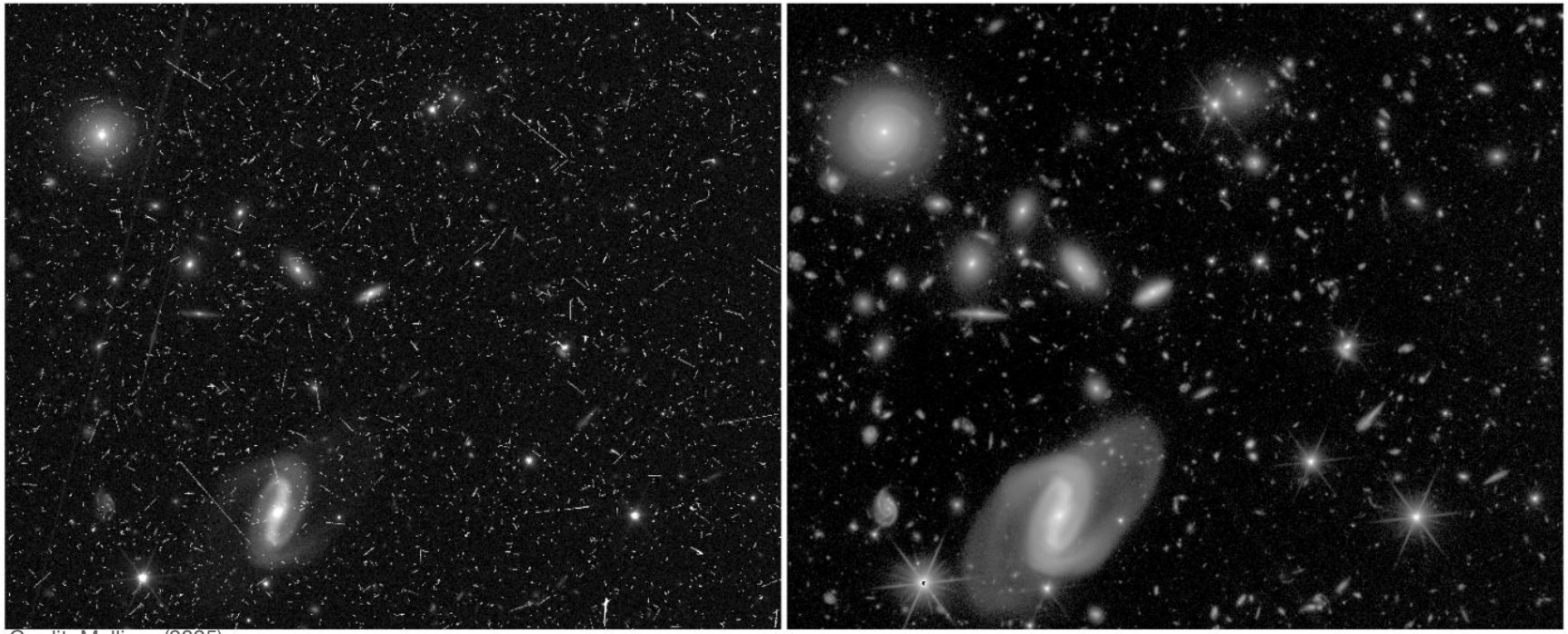
Euclid Collaboration: Castander & Fosalba et al. (2024)

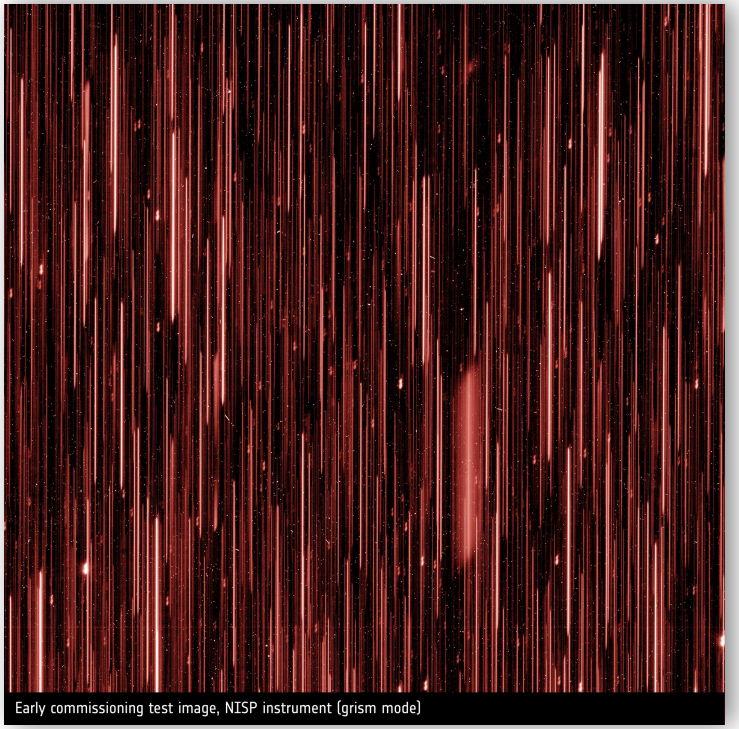
VIS simulated view



Credit: Mellier+ (2025)

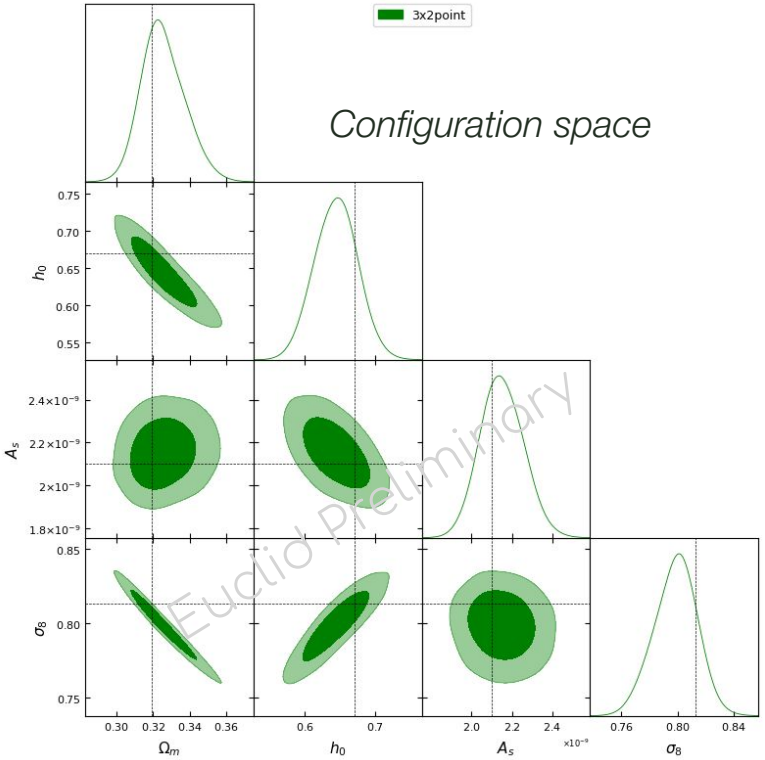
NISP simulated images

Credit: Mellier+ (2025)

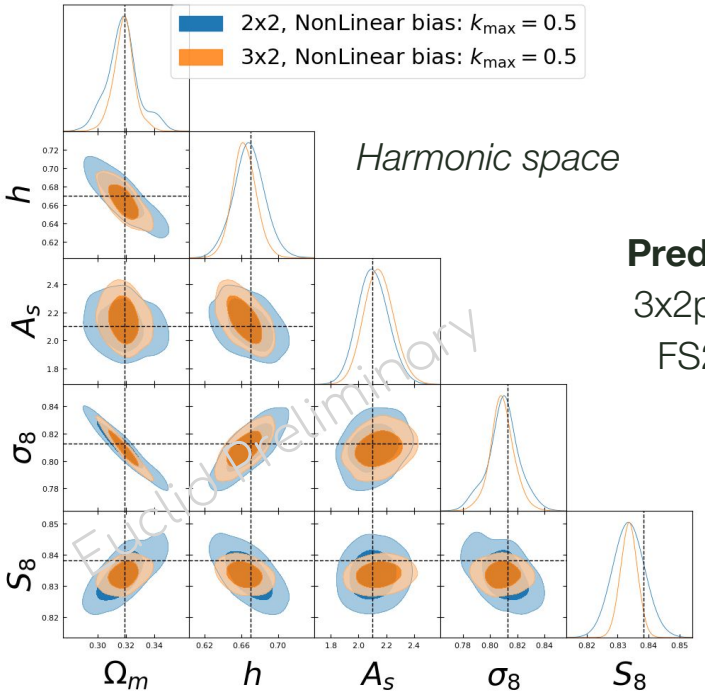


Early commissioning test image, NISP instrument (grism mode)

FS2 cosmological constraints



Credit: Zahra Baghkhani+ (in preparation)



Credit: Sylvain Gouyou-Beauchamps+ (in preparation)

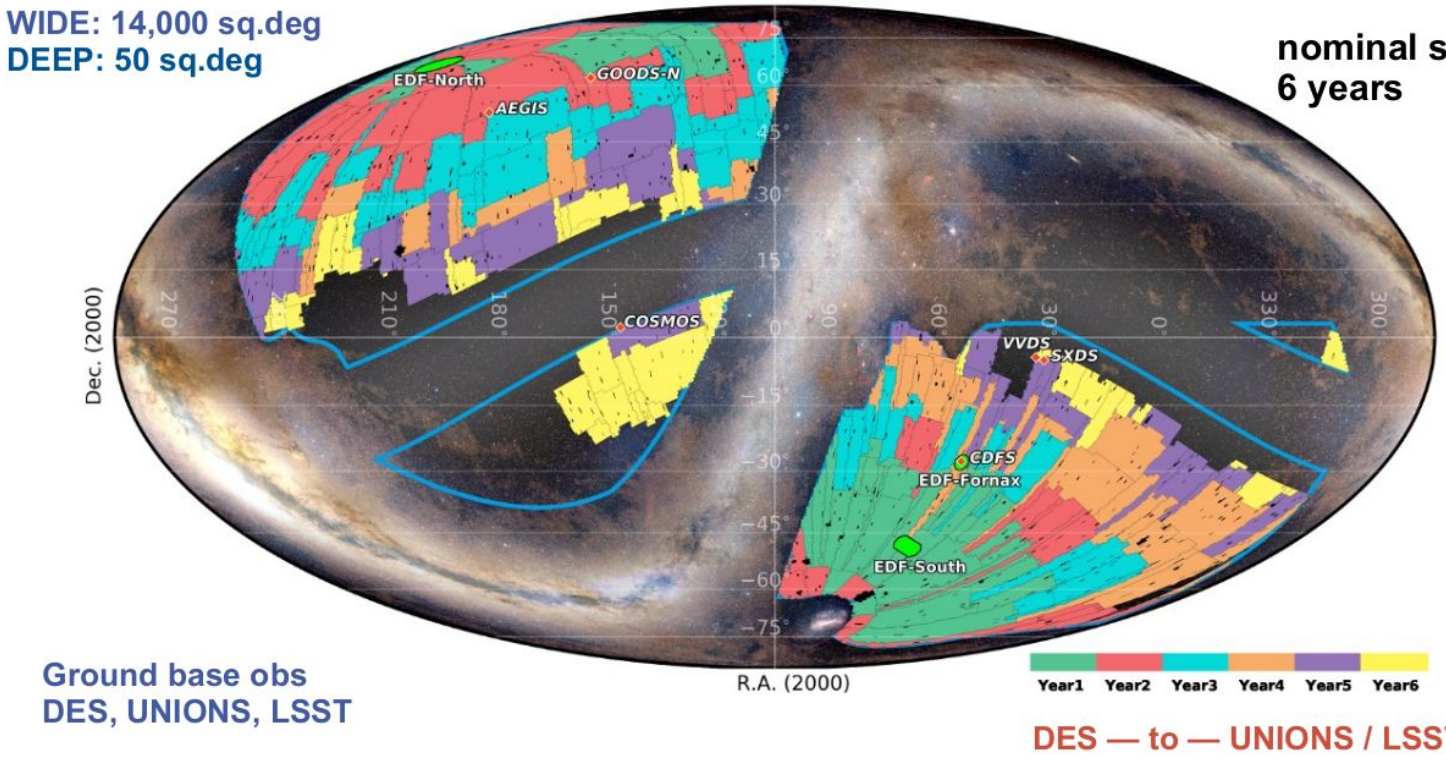
Prediction for DR1:
3x2pt analysis using FS2 galaxy mock catalogue

Survey and releases

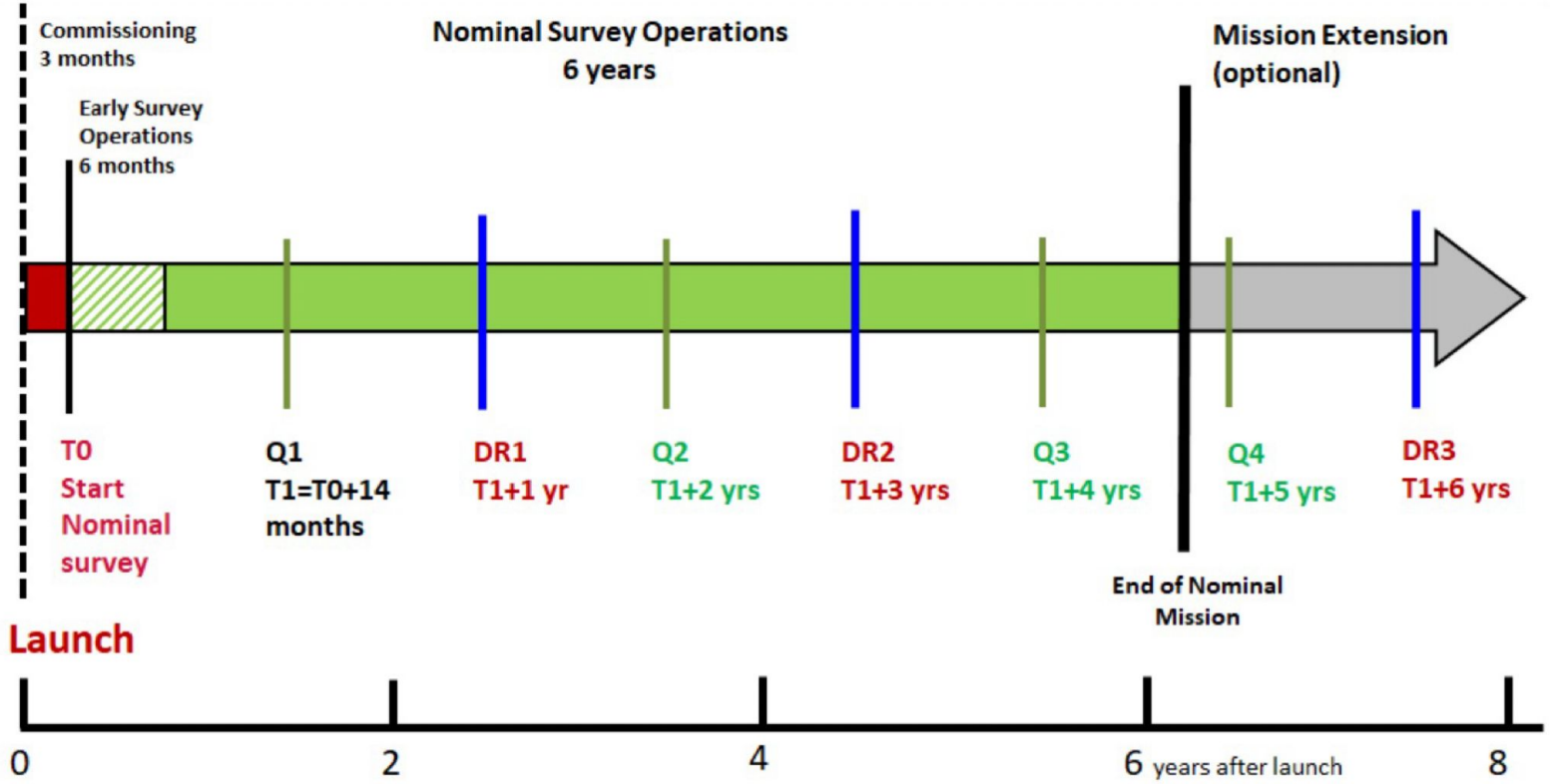
Launch

Euclid launched on a Falcon 9, SpaceX, on 1st July 2023, from Cape Canaveral. Credit: ESA

Euclid Survey

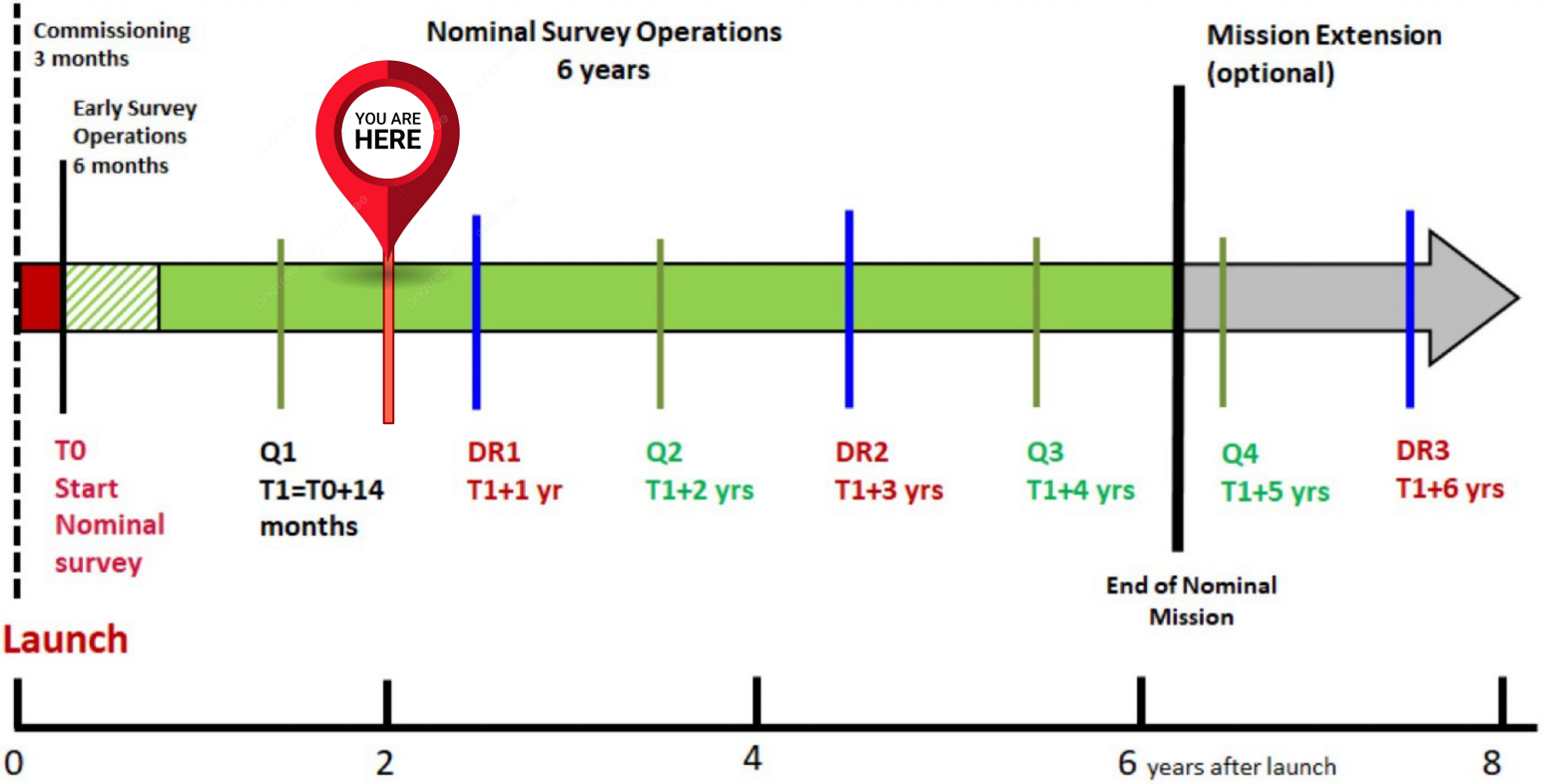


Data releases



Credit: ESA

Data releases



Credit: ESA

First data (Q1)

Teaser images released in November 2023

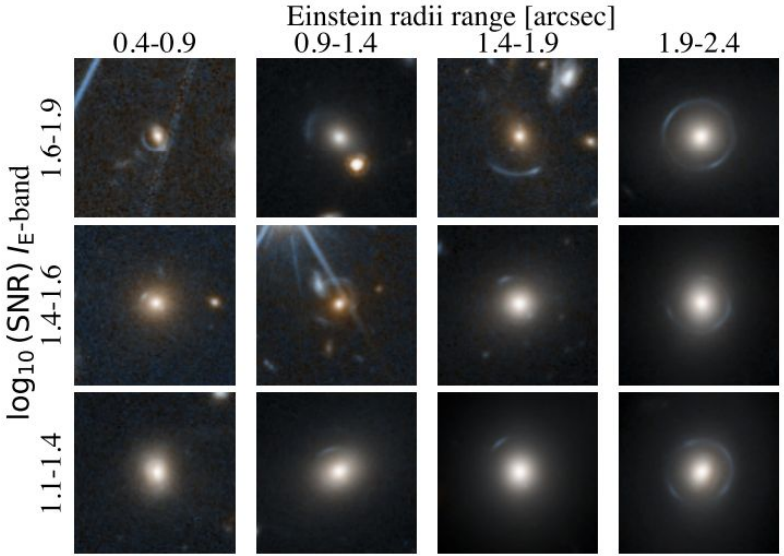
Chris Pattison

This is a single Hubble pointing at the same scale.

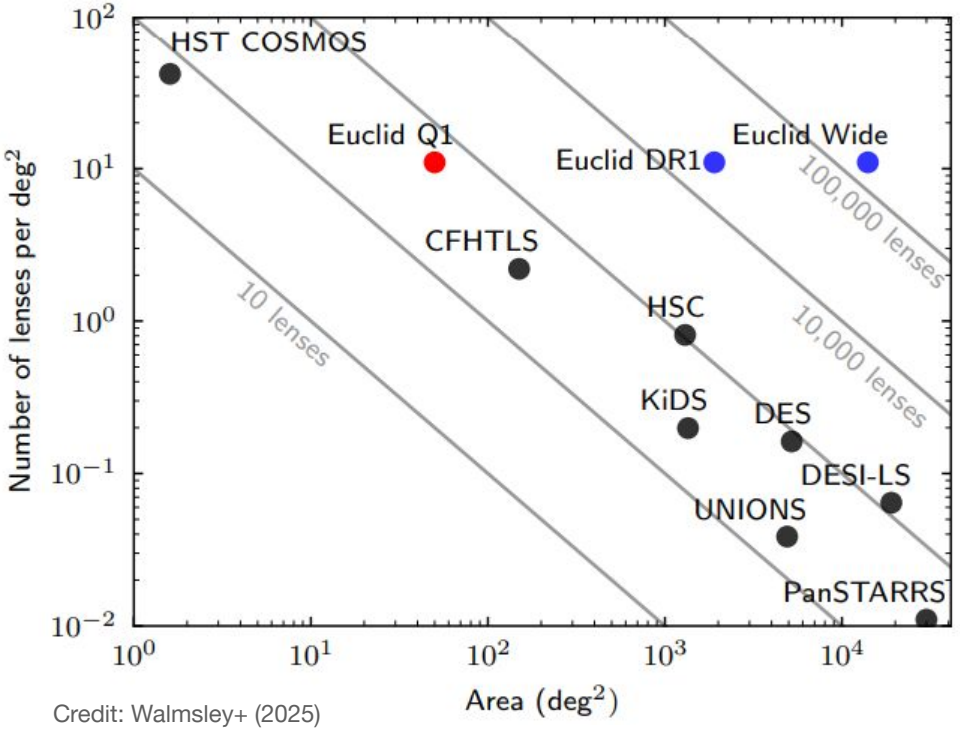
Euclid's individual images are big!

Strong lenses in Q1

497 galaxy-galaxy strong lenses catalogue

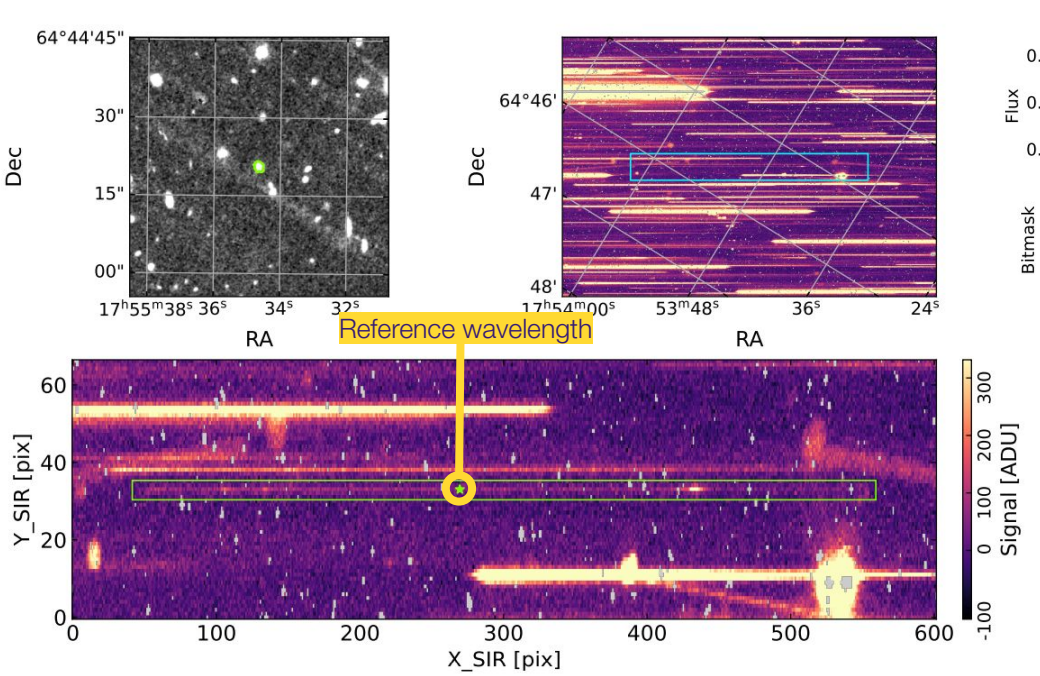


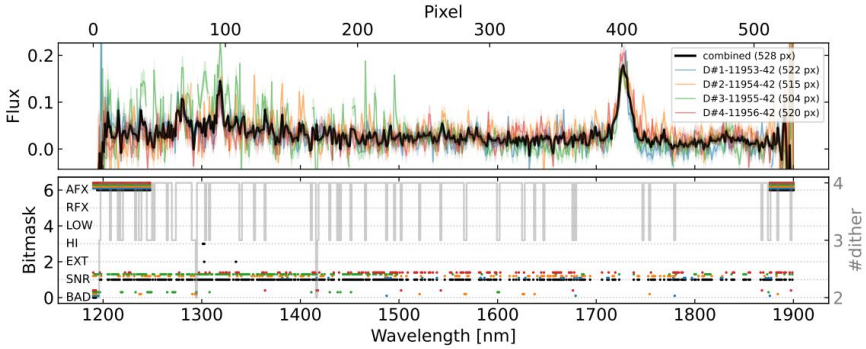
Credit: Rojas+ (2025)



Credit: Walmsley+ (2025)

Spectroscopic from Q1





Galaxy at z = 1.63

Spectra obtained by the combination of four single-dither extracted spectra

Credit: Copin+ (2025)

Summary

Thanks on behalf of the Euclid consortium

More than 3120 registered scientists

15 European countries + USA + Canada + Japon

Euclid Consortium meeting in Leiden, March 2025

Summary

Euclid launched on July 1st 2023, operates from L2, and is currently surveying 10 deg^2 per day

Euclid aims to unveil the nature of Dark Matter and Dark Energy by using weak gravitational lensing and galaxy clustering

The goal is to map one third of the sky (14000 deg^2), first data release after one year of operations (2000 deg^2, end 2026)

By designing a space-based instrument for probing the dark Universe, Euclid is offering amazing new insights into the bright Universe