Euclid status

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CPPM

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Overview

- Scientific objectives of the mission
- The Euclid design and its instrument
- In-flight status

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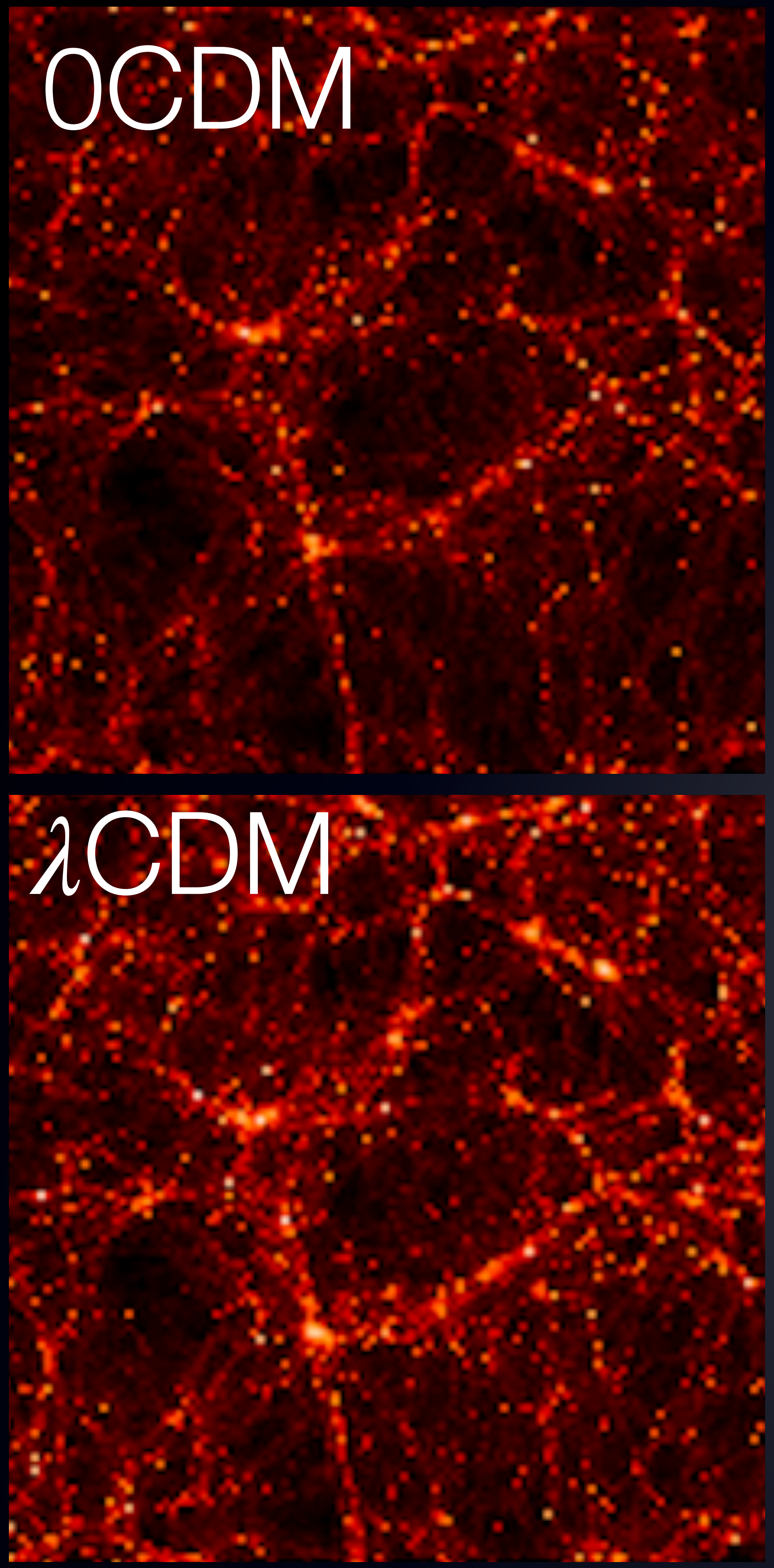
Perseus Cluster

Scientific objectives of the Euclid mission

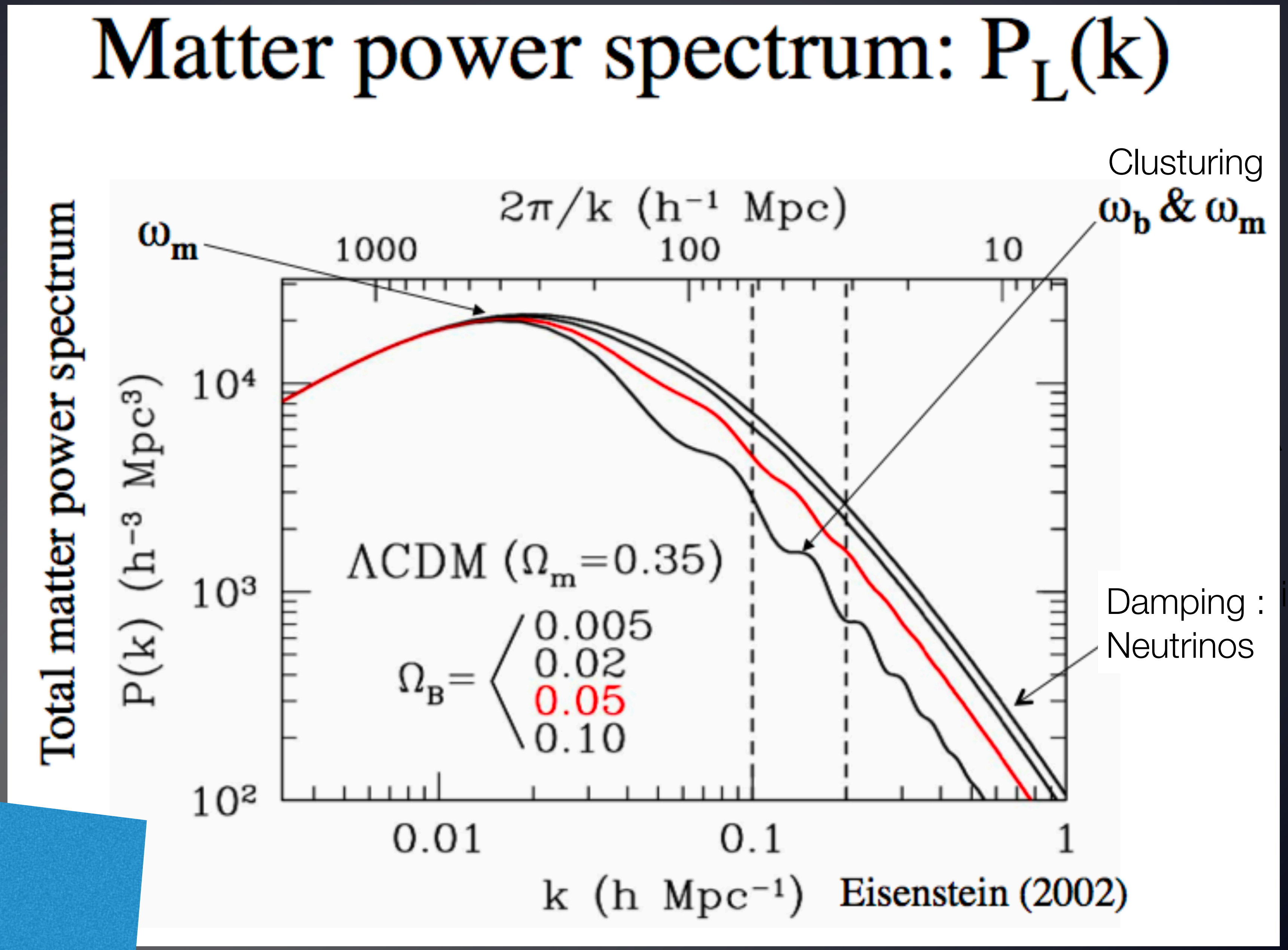
Unraveling the nature of the dark sides of the Univers

How Euclid will probe the dark side of the Univers

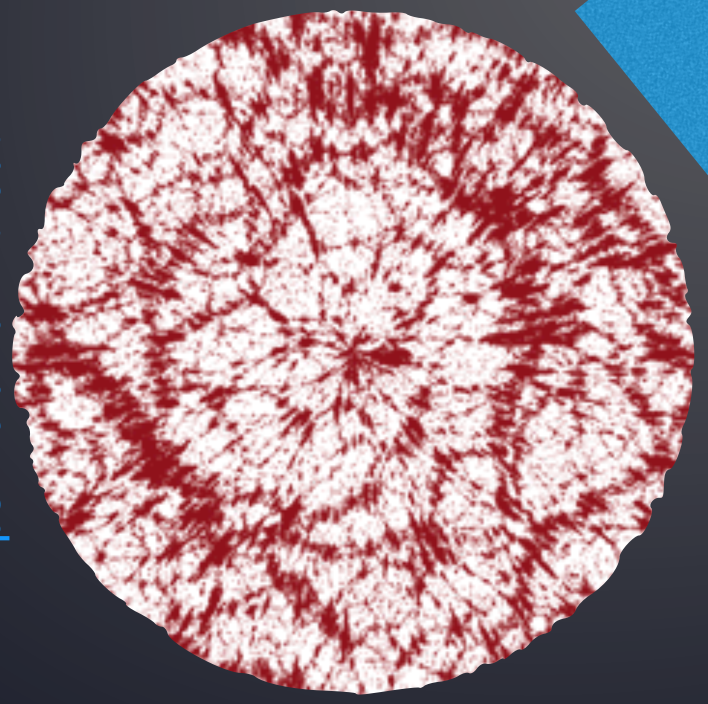
Galaxy Clustering → Mapping the observable Univers



VIRGO consortium
Jenkins et al. 1998



H. A. Feldman
https://feldman.ku.edu/



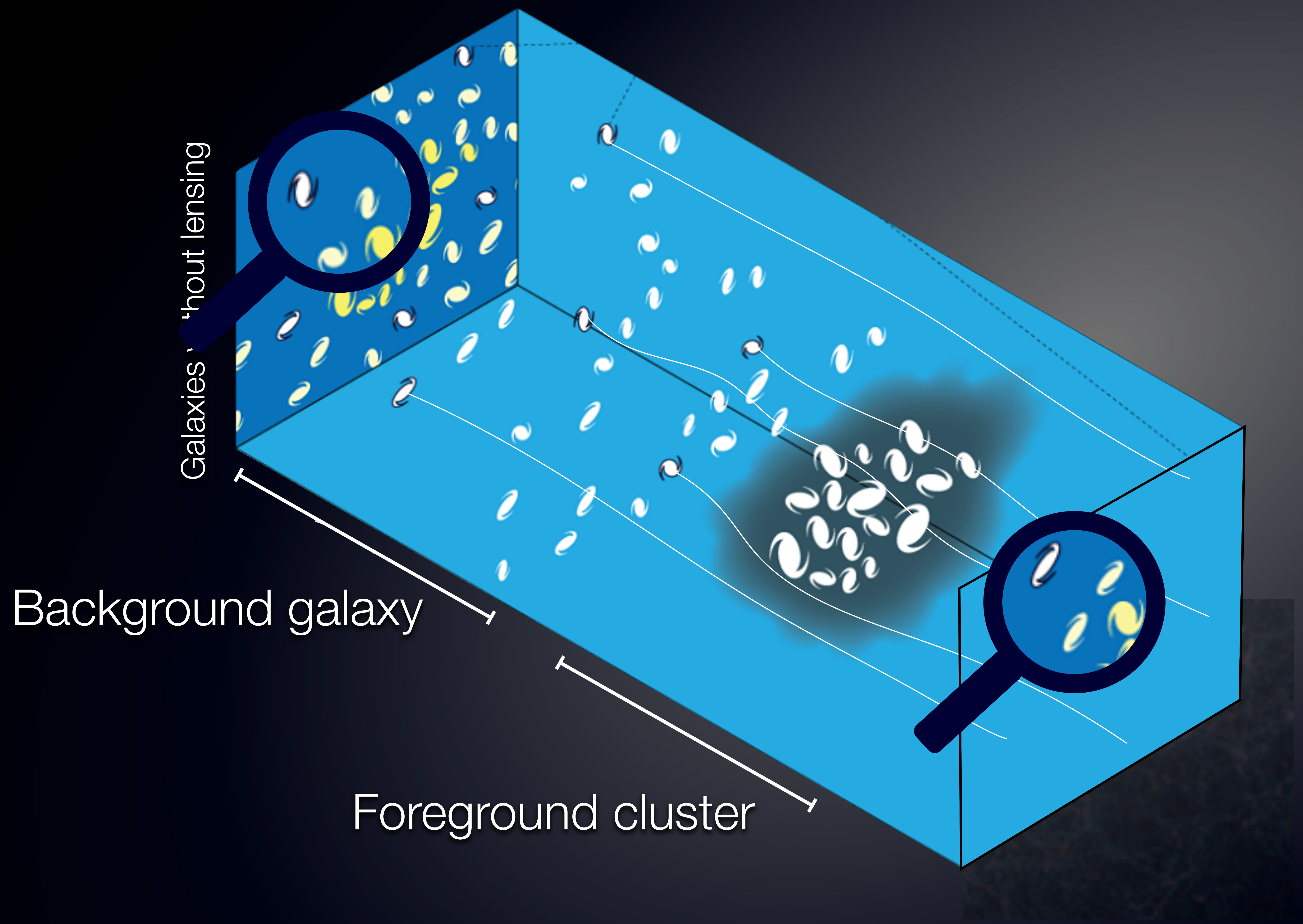
Redshift space distribution

Sensitive to the

- **content** of the Univers ($\Omega_{CDM}, \Omega_b, \Omega_\Lambda, \nu, \ldots$)
- **growth rate** of structure
- **density-velocity relation** → **Test beyond general relativity**

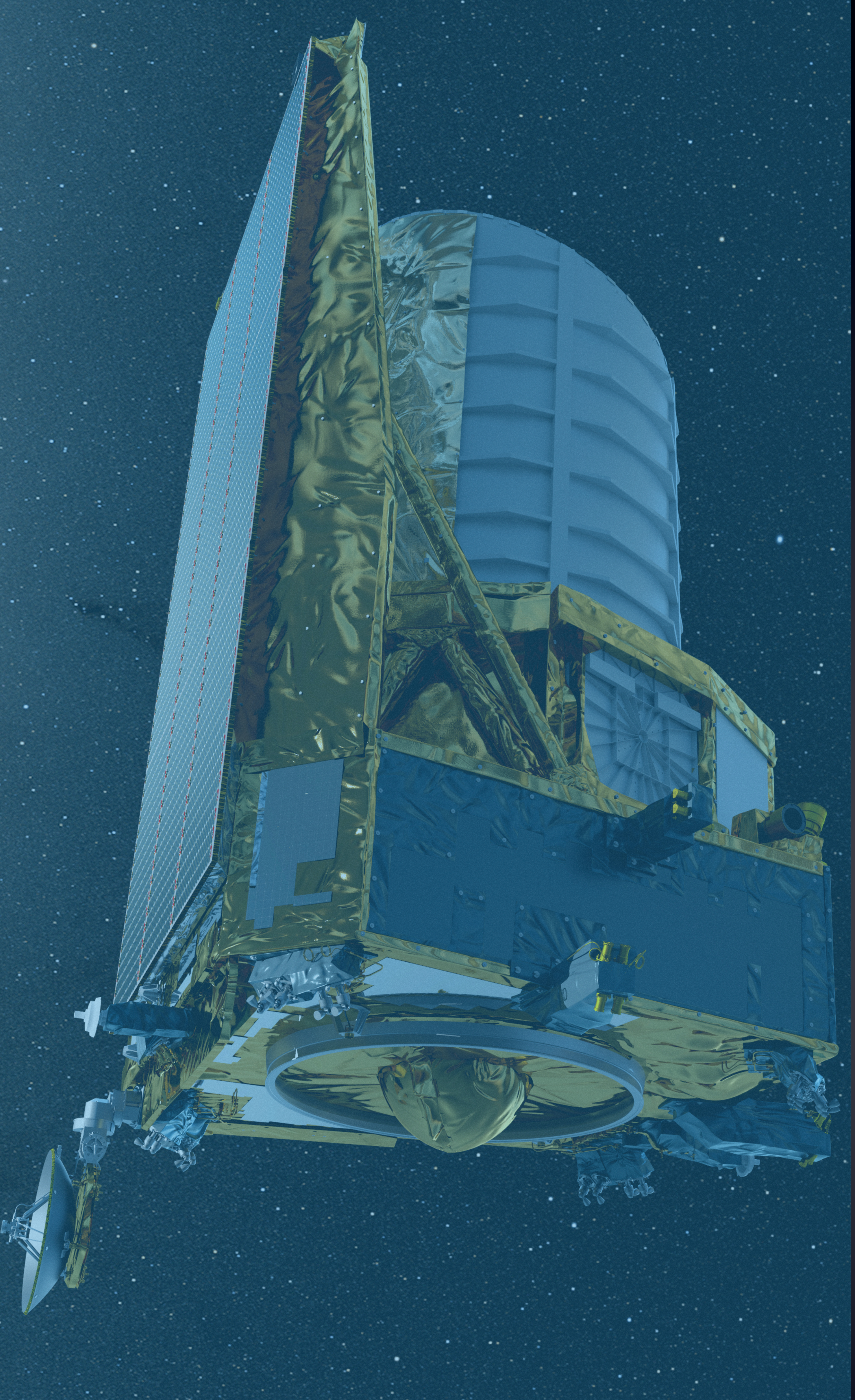
How Euclid will probe the dark side of the Univers

Weak lensing → weighting the Univers



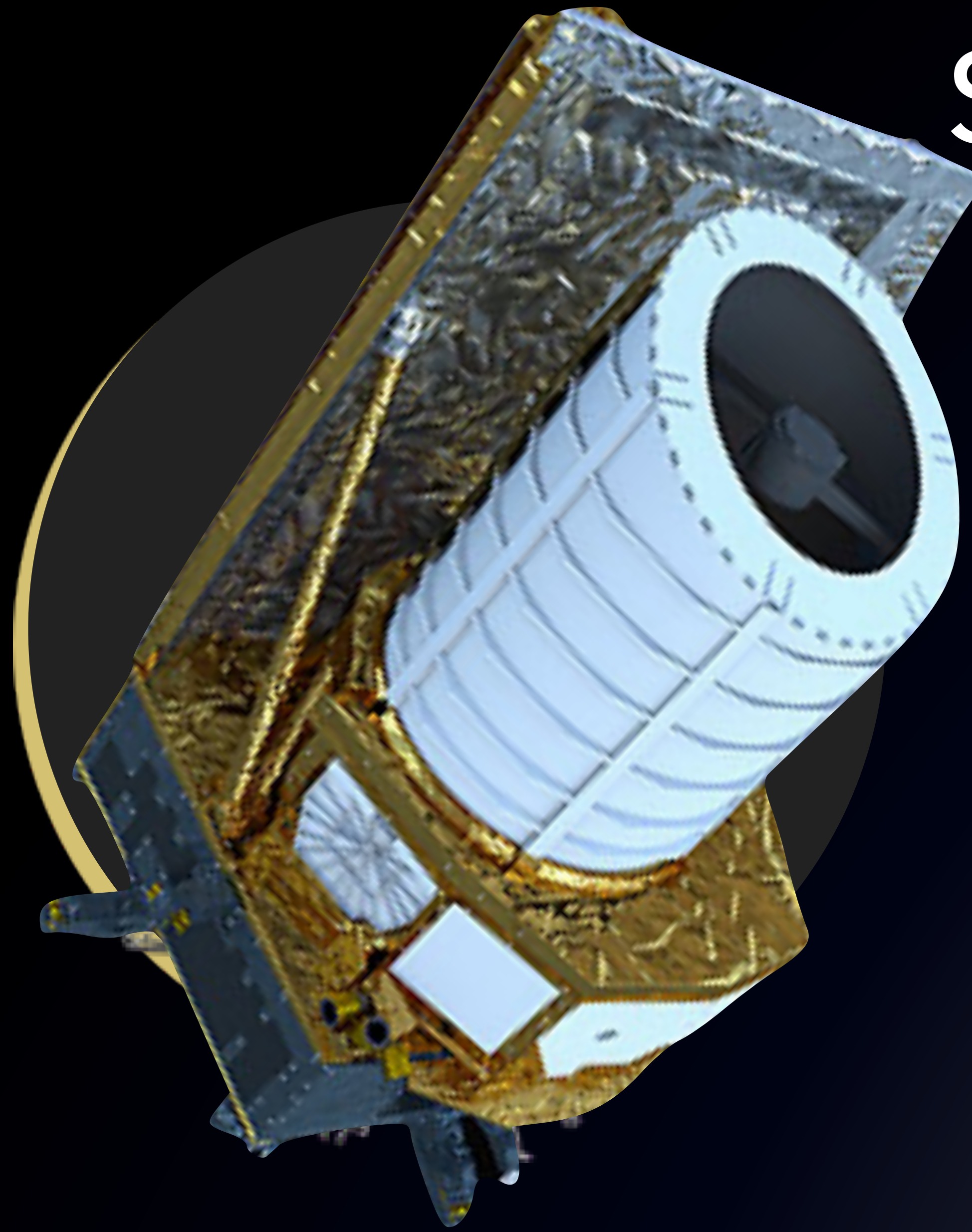
Large-scale structure bend light from background galaxy, resulting in a coherent deformation at few arcmin scale at few percent level

- Direct measurement of gravitational potential along the line of sight
- Redshift mass map
- **Sensitivity to growth rate**
- **Sensitivity to expansion history**



The Euclid design & its instruments

Euclid in numbers

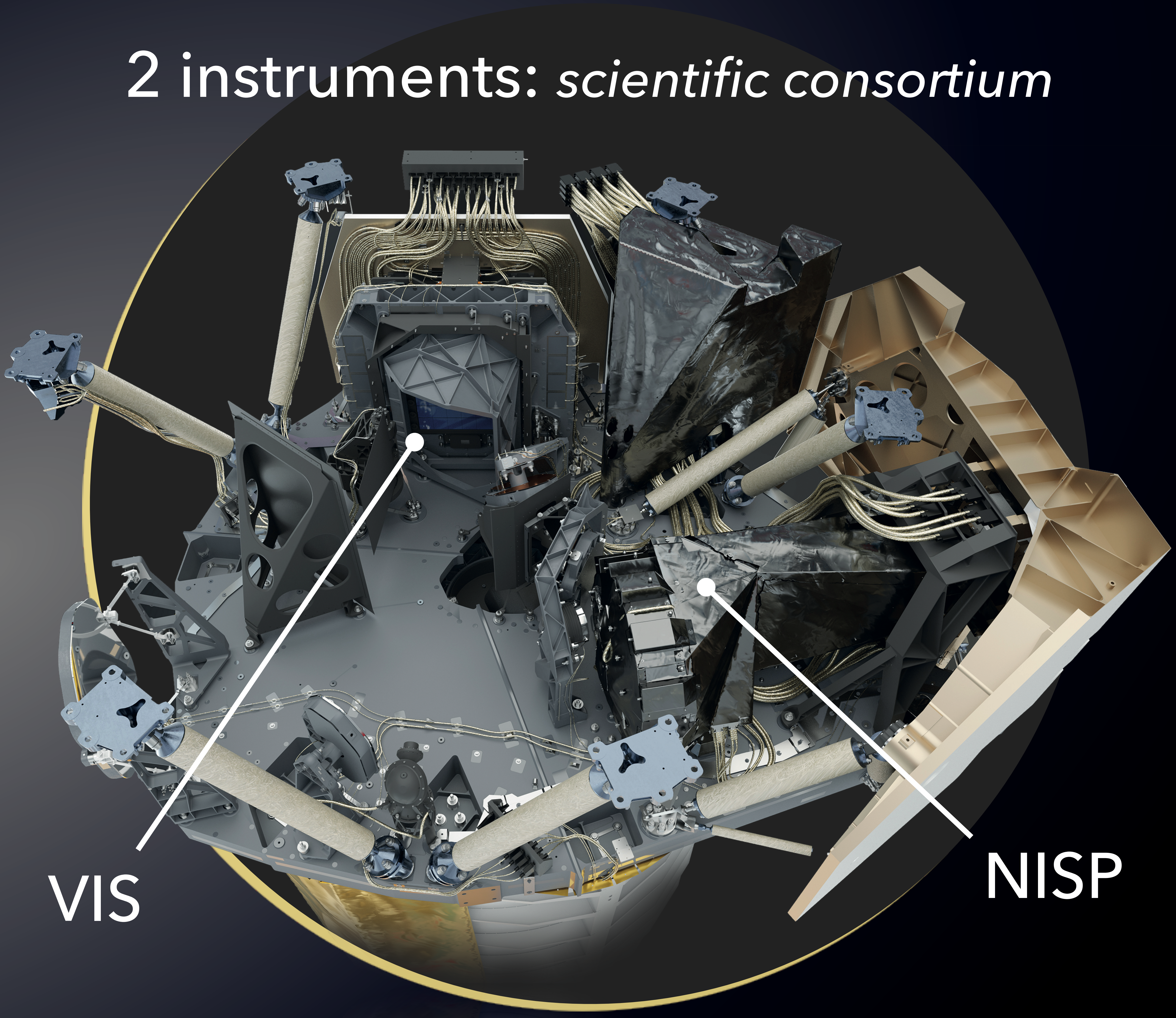


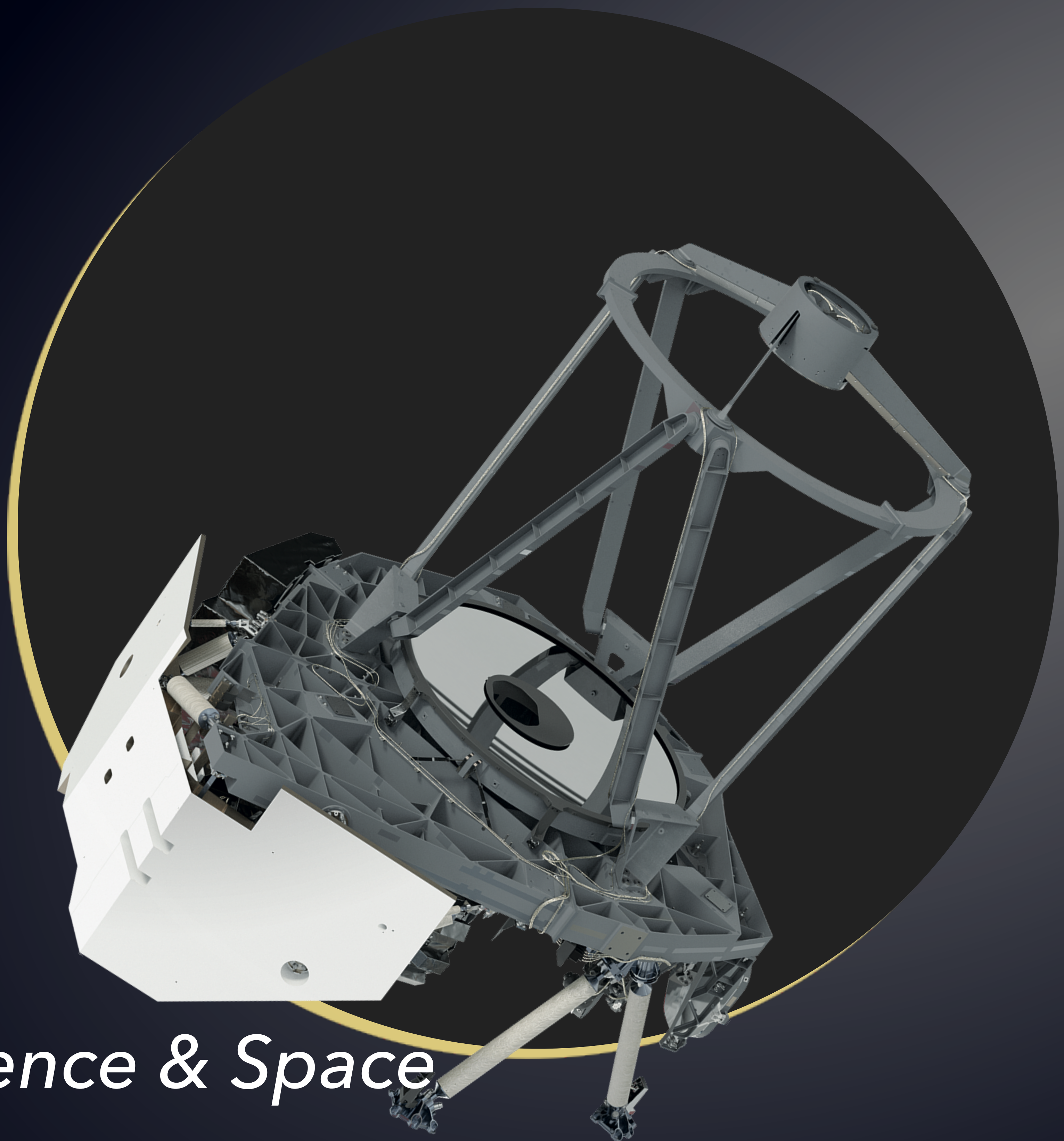
Satellite: *Thales Alenia Space*

2200 kg

4,7m × 3.7m × 3.7m

2 instruments: *scientific consortium*



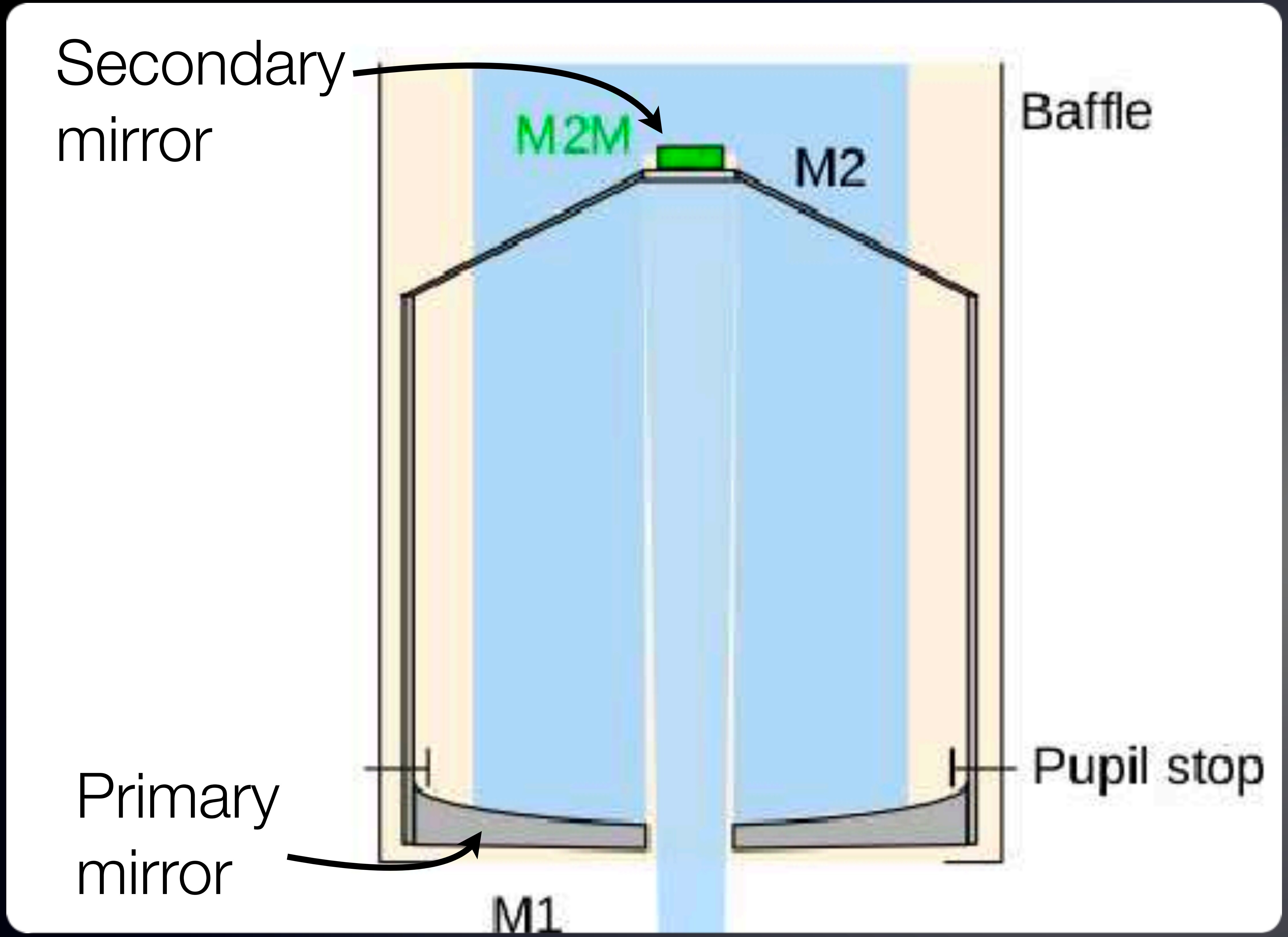


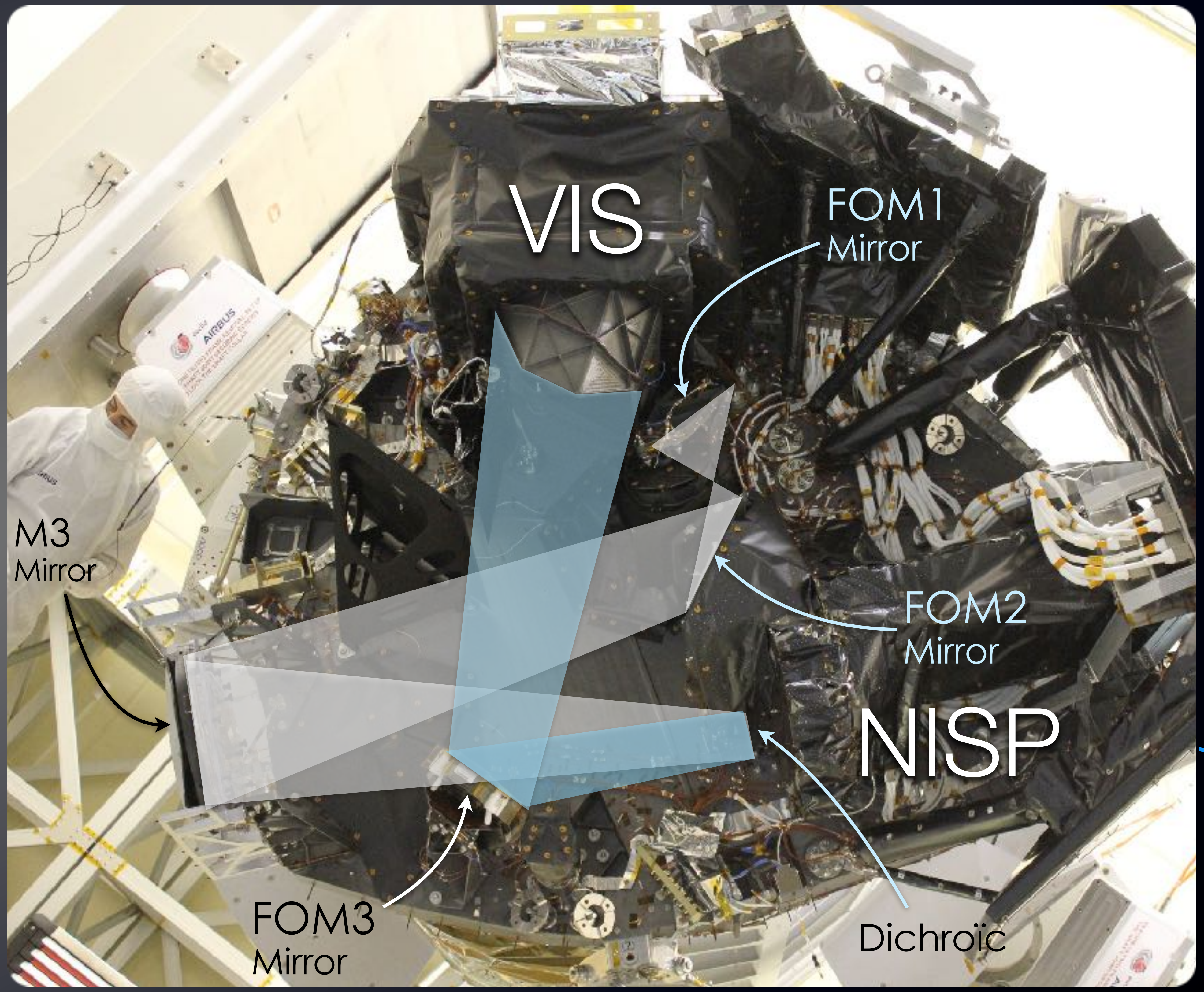
Miroirs: *Airbus Defence & Space*

Korsch design of 1.2 m in diameters

Optical design

Euclid is based on a Korsch 3-mirrors design





Euclid PLM base plate and its instrument
Airbus Defence and Space - Toulouse

The folding 3-mirrors design corrects for **spherical aberration**, **coma**, **astigmatism**, and **field curvature.**

Baffle ensures minimize out of filed stray-light.

The VIS instrument

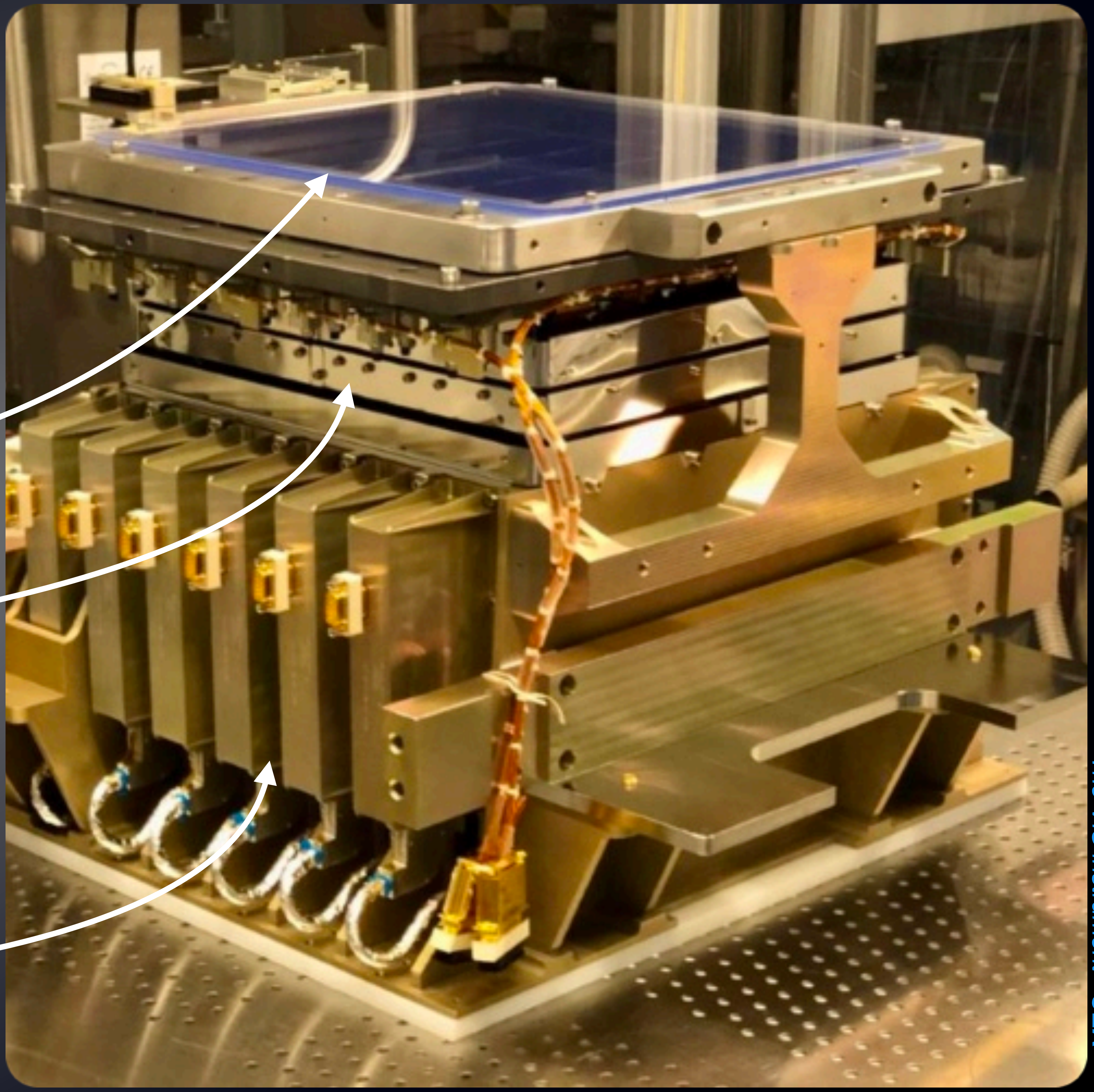
Wide band visible imaging camera

36 e2V CCD camera ⇒ 609 Mpx
Angular resolution : 0.1 arcs/px
Spectral range : 530 - 920 nm

Active area
877 cm^2

Thermal isolation layer
Different operational temperatures:
CCD → ≃ 153 K
Read Out Electronic (ROE) → ≃ 270 K

ROE
Signal amplifier + Analog to Digital converter
FPGA for CCD operation

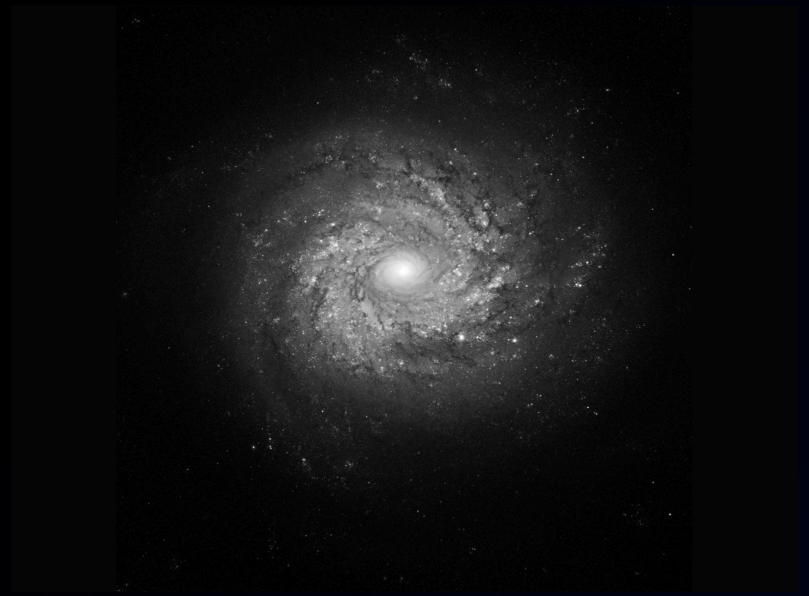


The VIS instrument - **CEA**

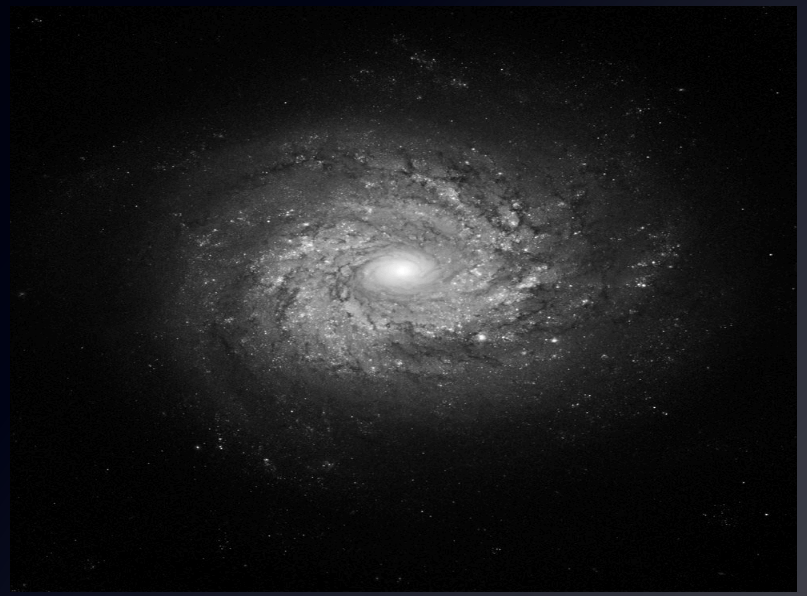
Calibration unit
& Shutter not represent on this picture

The VIS instrument

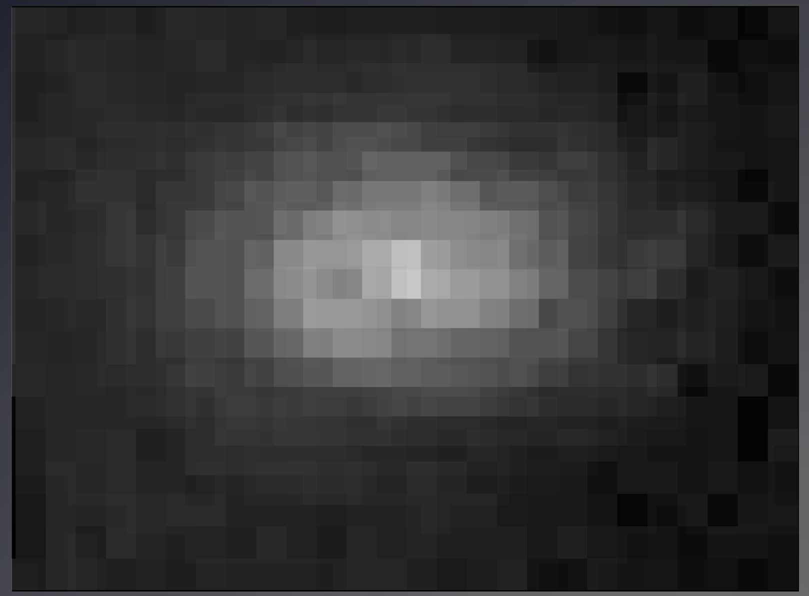
Wide band visible imaging camera



Intrinsic shape
(unknown)

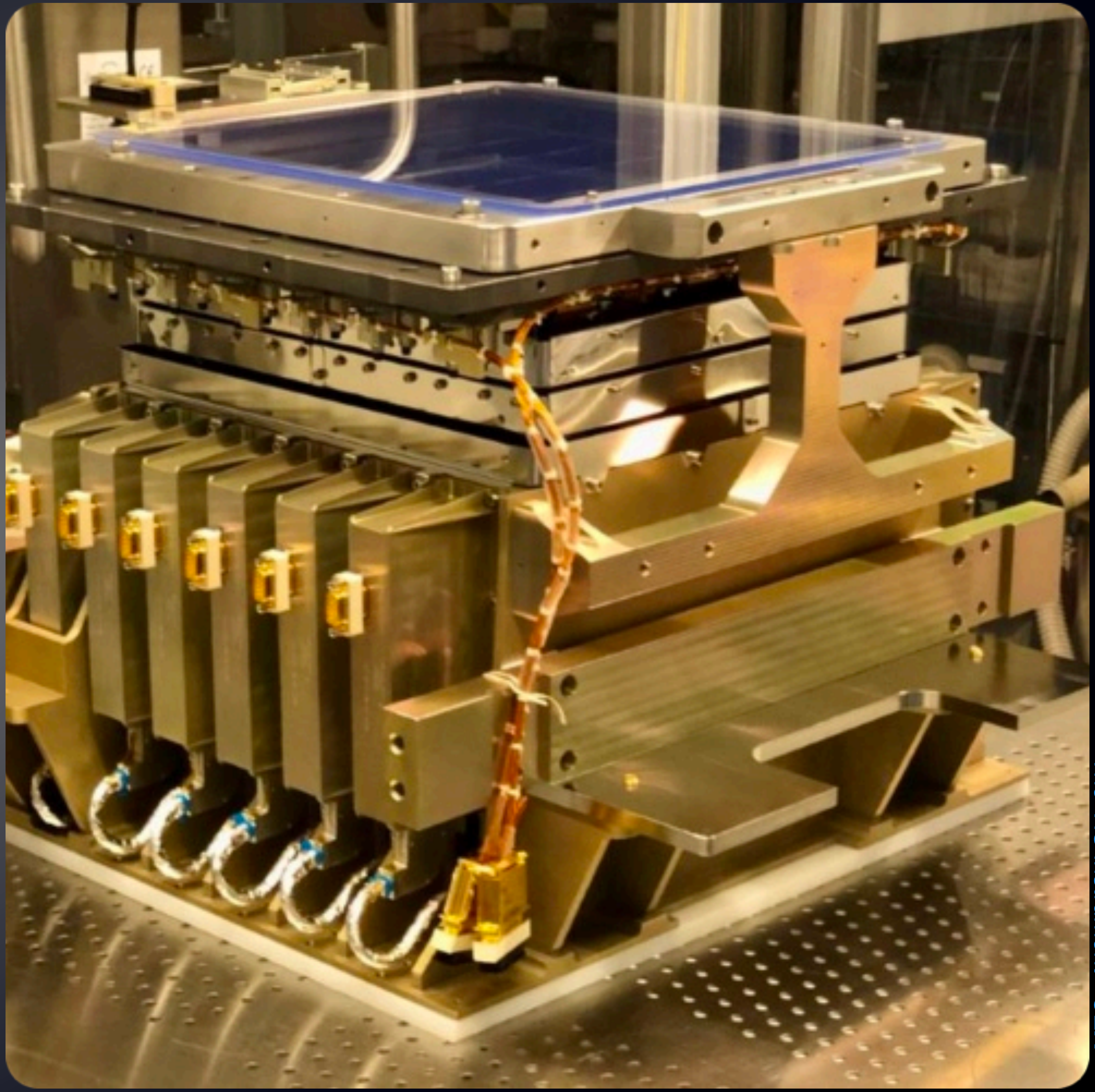


Cosmic shear



Pixel images

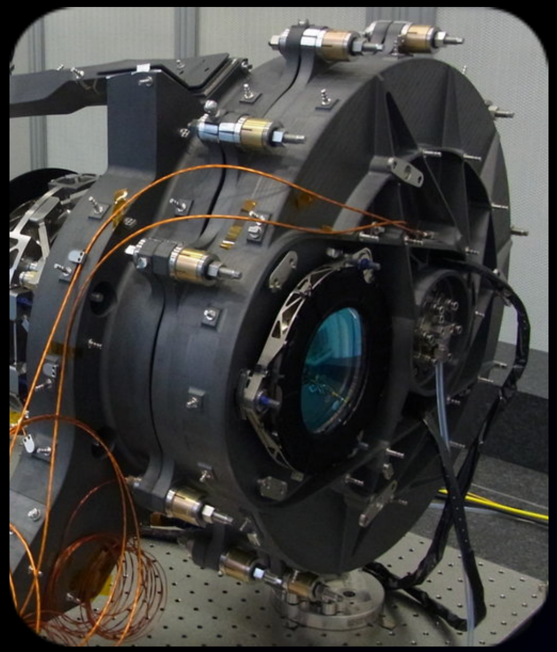
The VIS is a camera designed to **measure galaxy ellipticities** with **accurate control on systematics** (optical, instrumental, astrophysical, …)



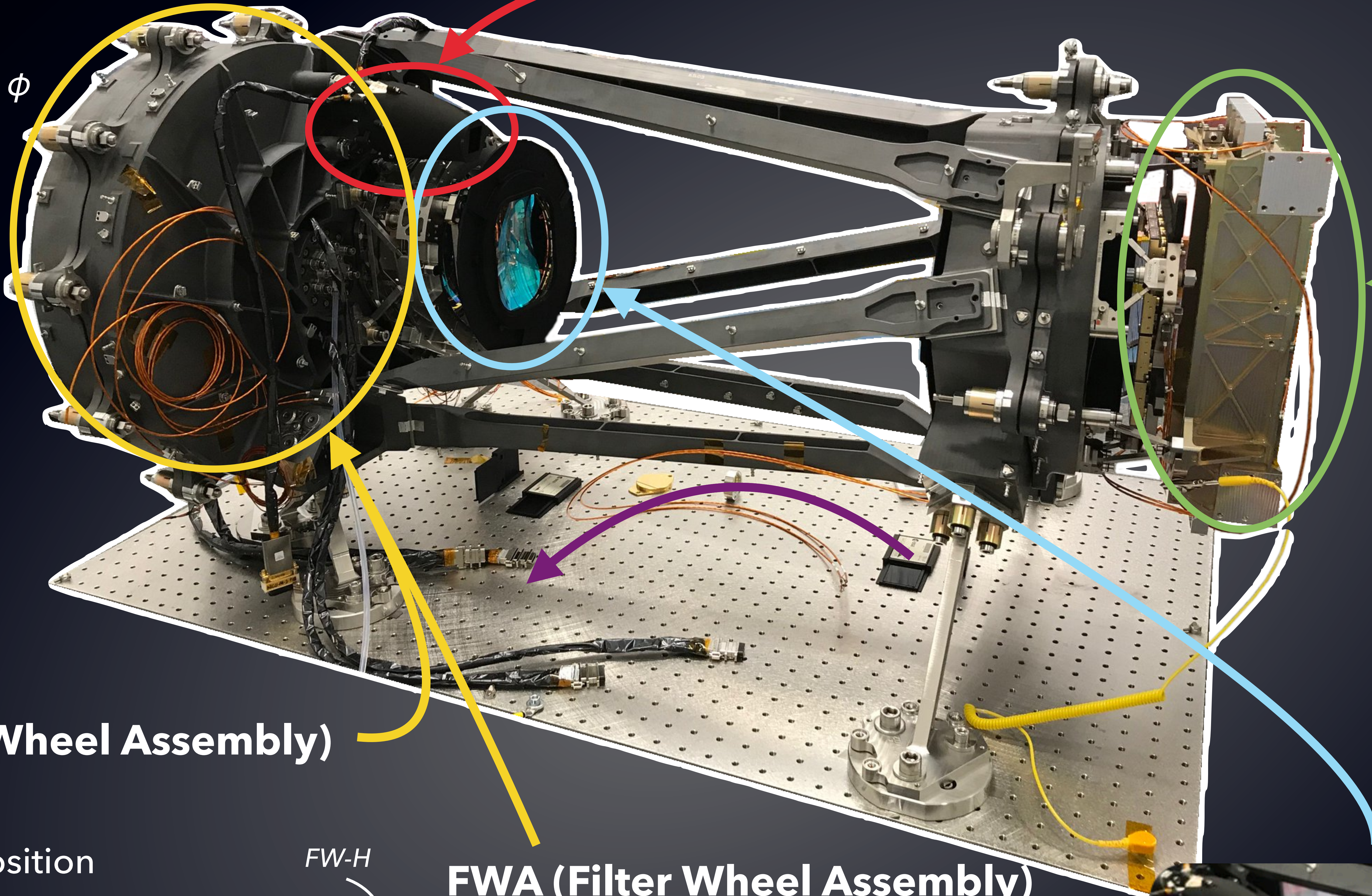
The VIS instrument - **CEA**

The NISP instrument

Corrector lense:



- Wave front correction
- Lense ≃ 20 cm ϕ



The NISP calibration unit:

- 2×5 LED → 5λ
- Used for flat field and detector calibration

The NISP focal plane:

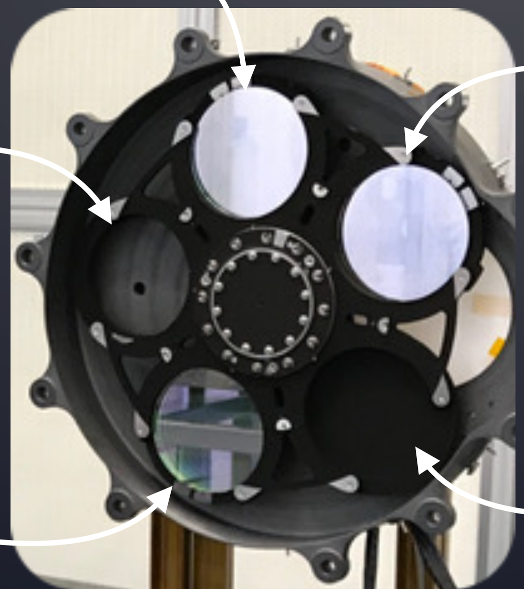
- 16 Near IR detectors
- 2k×2k pixels/detectors
- Passively cooled down to T≃ 95 K
- 0.3"/px resolution

The largest Near Infrared focal plane in space

GWA (Grism Wheel Assembly)

- 4 Grism
- 1 Open position

FWA (Filter Wheel Assembly)



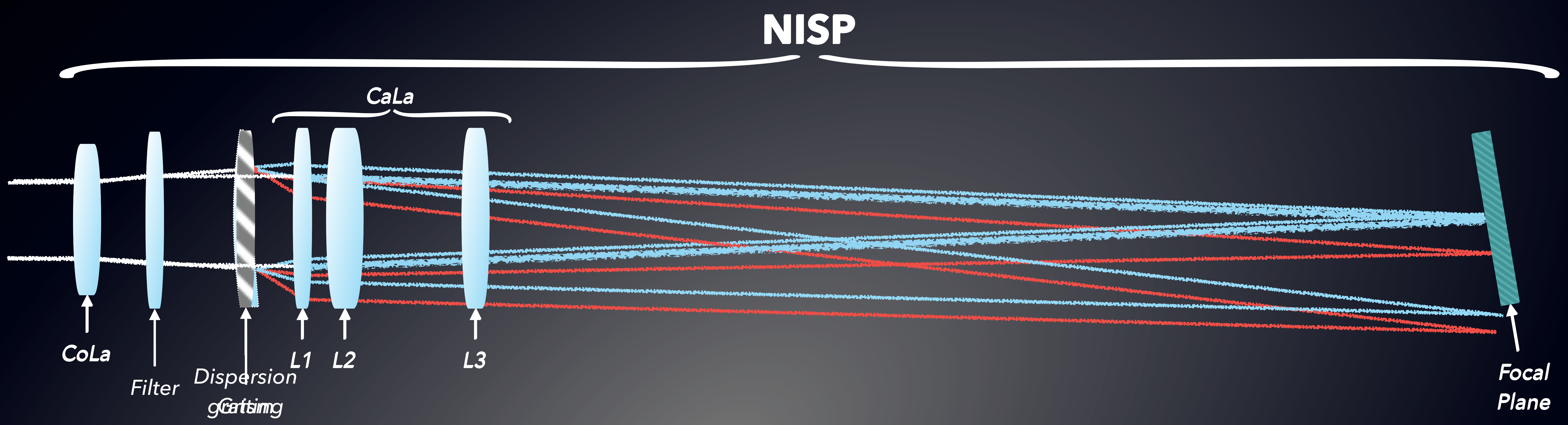
- 3 Filters
- 1 Open position
- 1 Close position

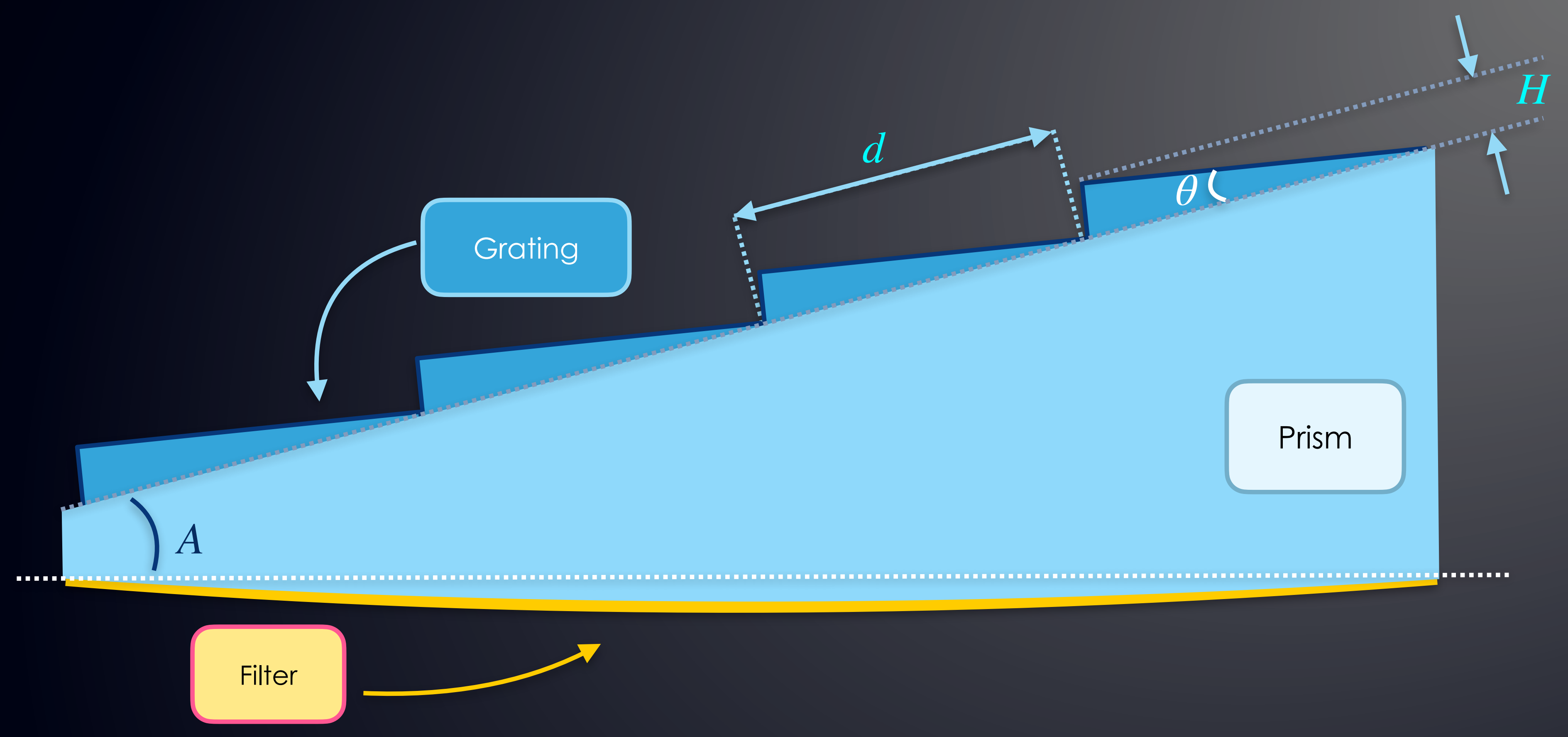
Camera lense:

- Collimate light onto focal plane array
- Combination of 4 lenses
- Lense ≃ 20 cm in diameter
- Heaviest lense = 1.5 kg

Among the largest and heaviest lenses ever sent to space.

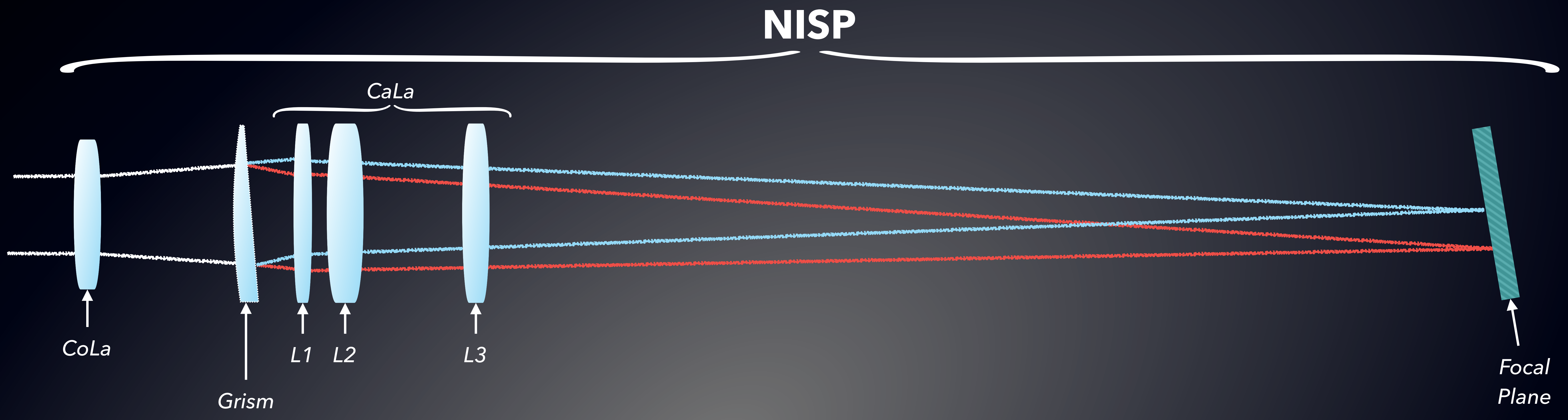
The NISP grisms

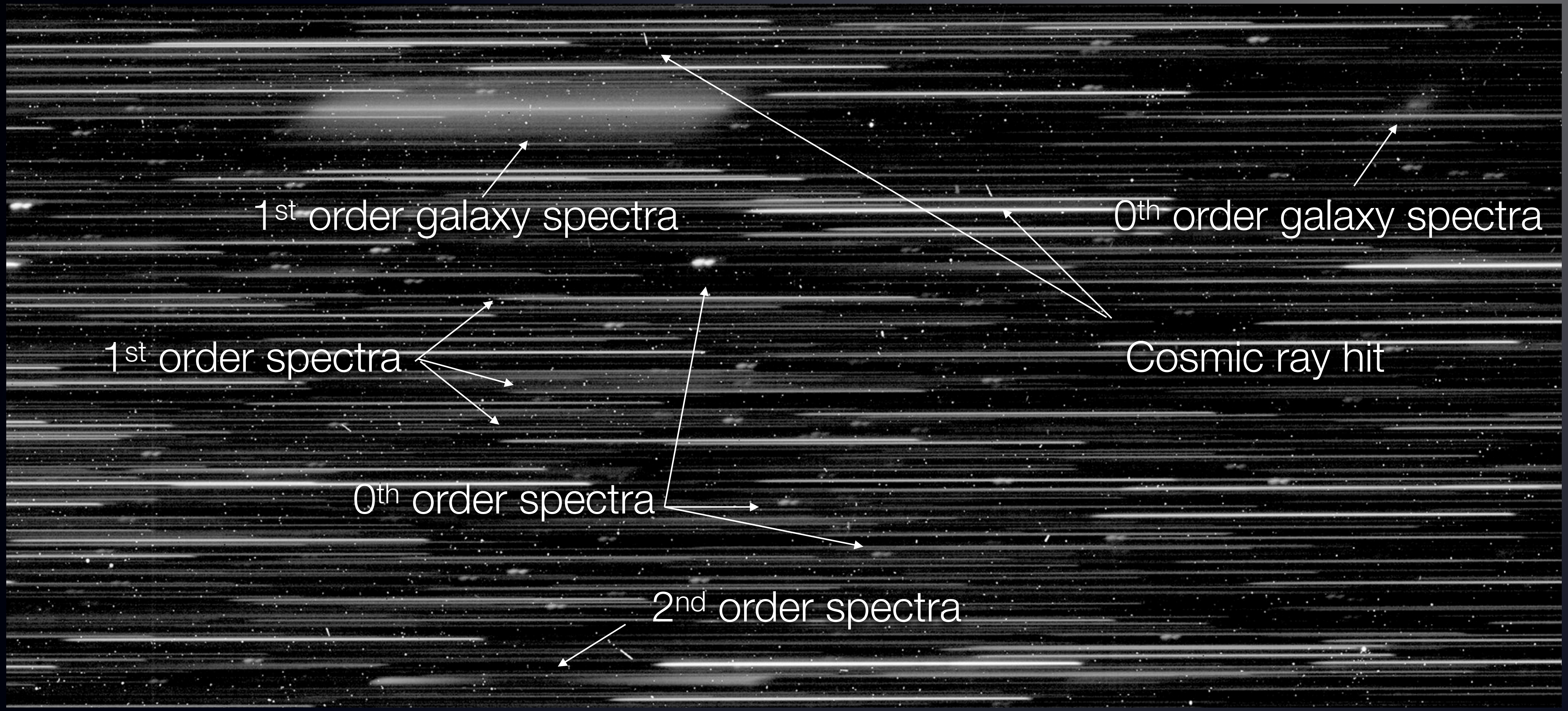




- The **Grating** : disperse light and provide image spectra
- The **Prism** : compensate for the light deviation induced by the grating allowing to images spectrum onto the NISP focal plane.
- The **Filter** : select bandpass → **convex surface to focalise light onto the detectors**

The NISP grisms





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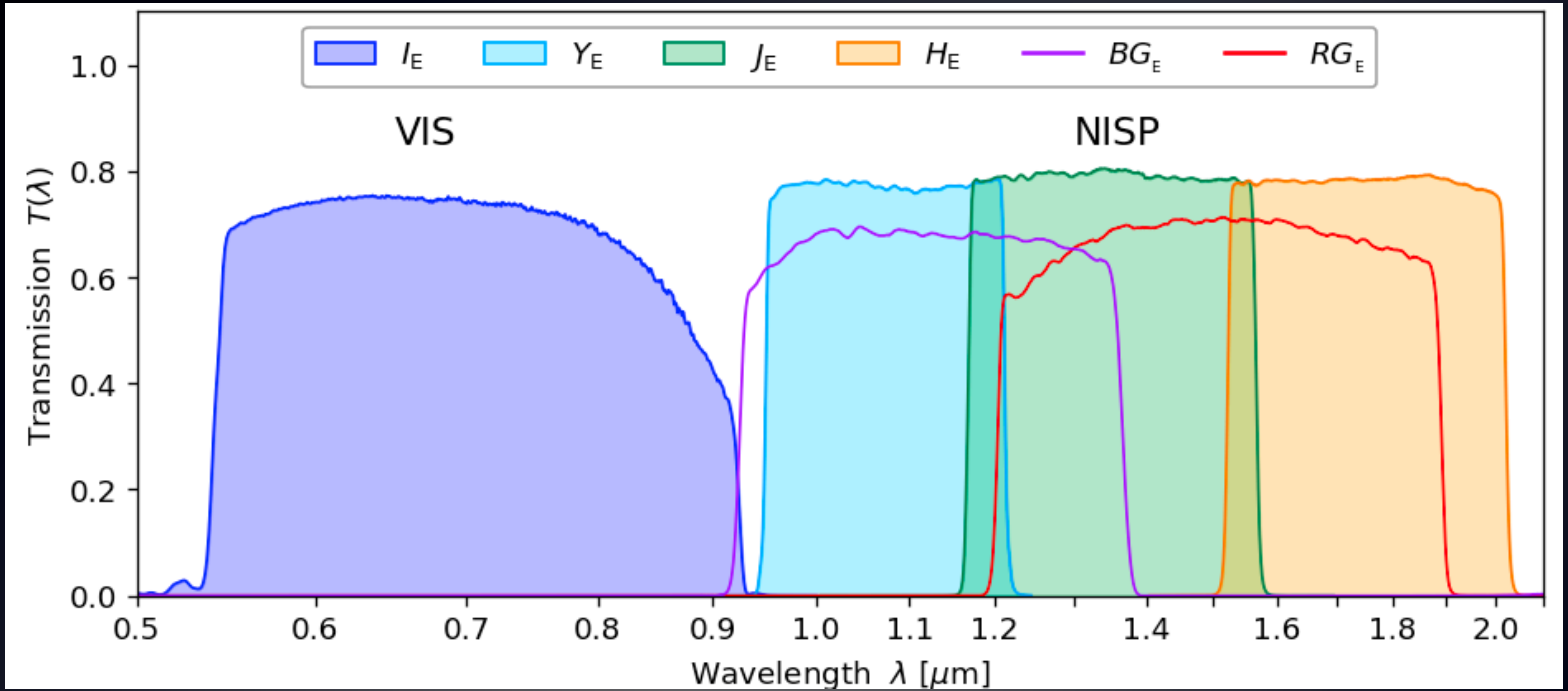
Slit-less Spectrometer :

Spectroscopic redshift for thousand of spectra per exposure with $\sigma_z < 0.001(1+z)$.

Resolving power $\lambda/\Delta\lambda > 400$

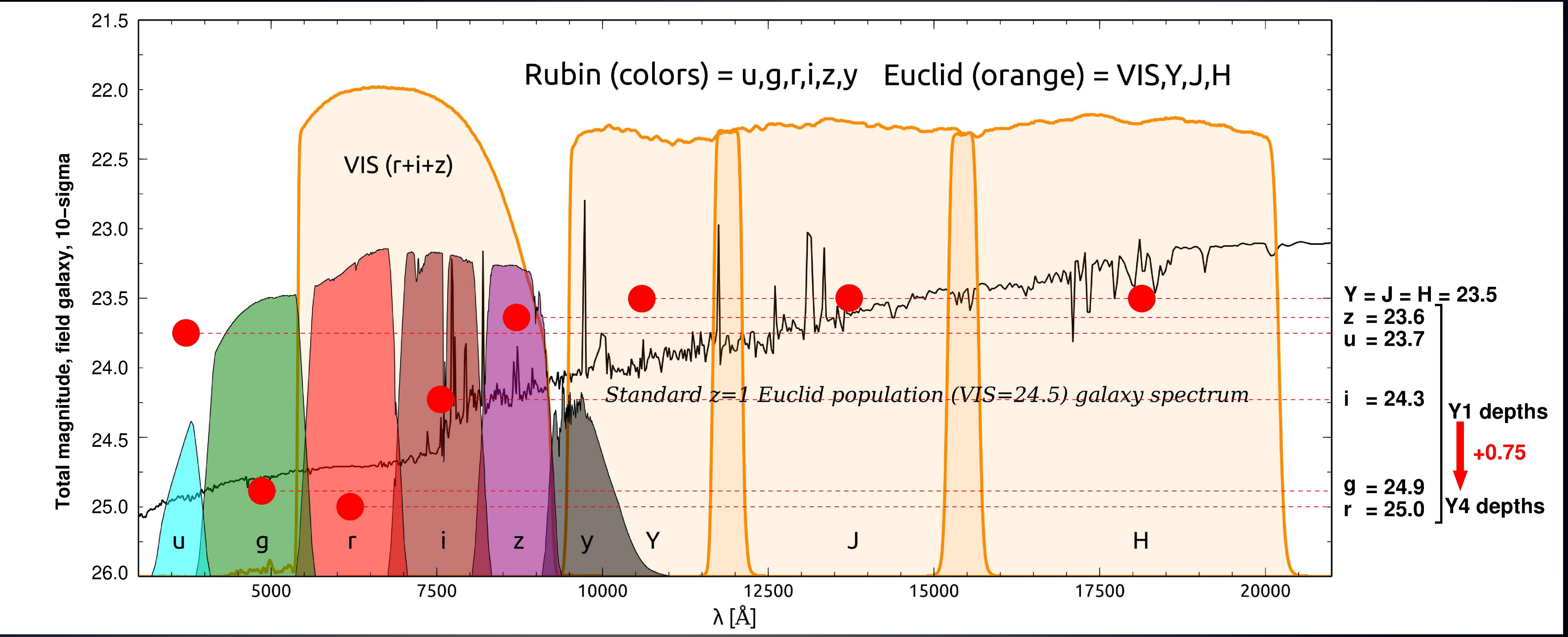
- 3 red grisms → different dispersion orientation for decontamination purpose
- 1 blue grism used in deep field

Euclid Spectral response



- 4 photometric band (1 in the visible, three at Near Infrared wavelength) with total throughput > 70 % in transmission
- 3 spectroscopic channel in the Near Infrared wavelength domain with total throughput > 60 % in transmission

Euclid Spectral response



- 4 photometric band (1 in the visible, three at Near Infrared wavelength) with total throughput > 70 % in transmission
- 3 spectroscopic channel in the Near Infrared wavelength domain with total throughput > 60 % in transmission

→ Complementary to LSST for photometric redshift

Large field of view

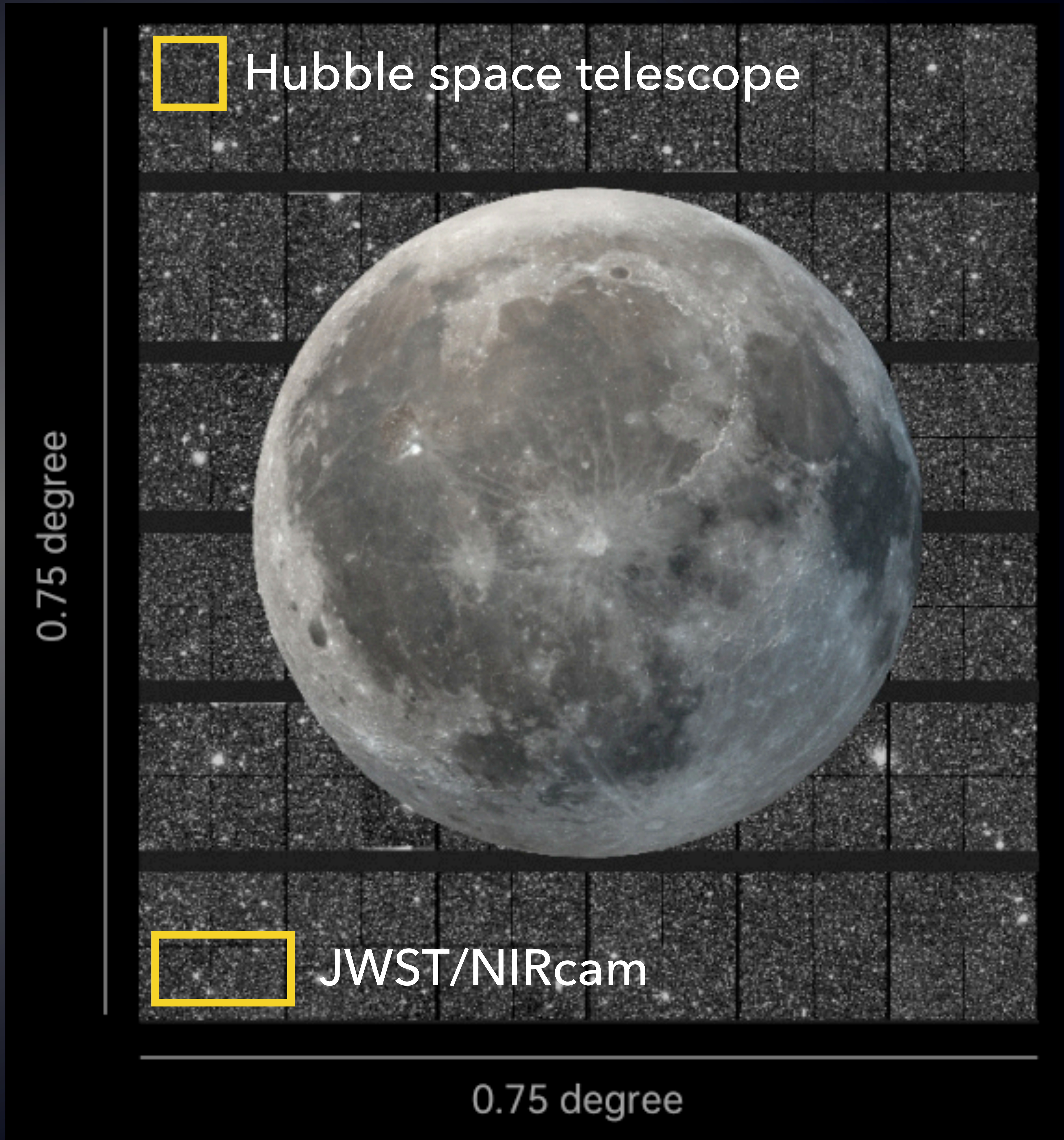
Two larges cameras for a large field of view

VIS & NISP share the same field of view of 0.53 deg^2

➡ 100 × Hubble fields of view

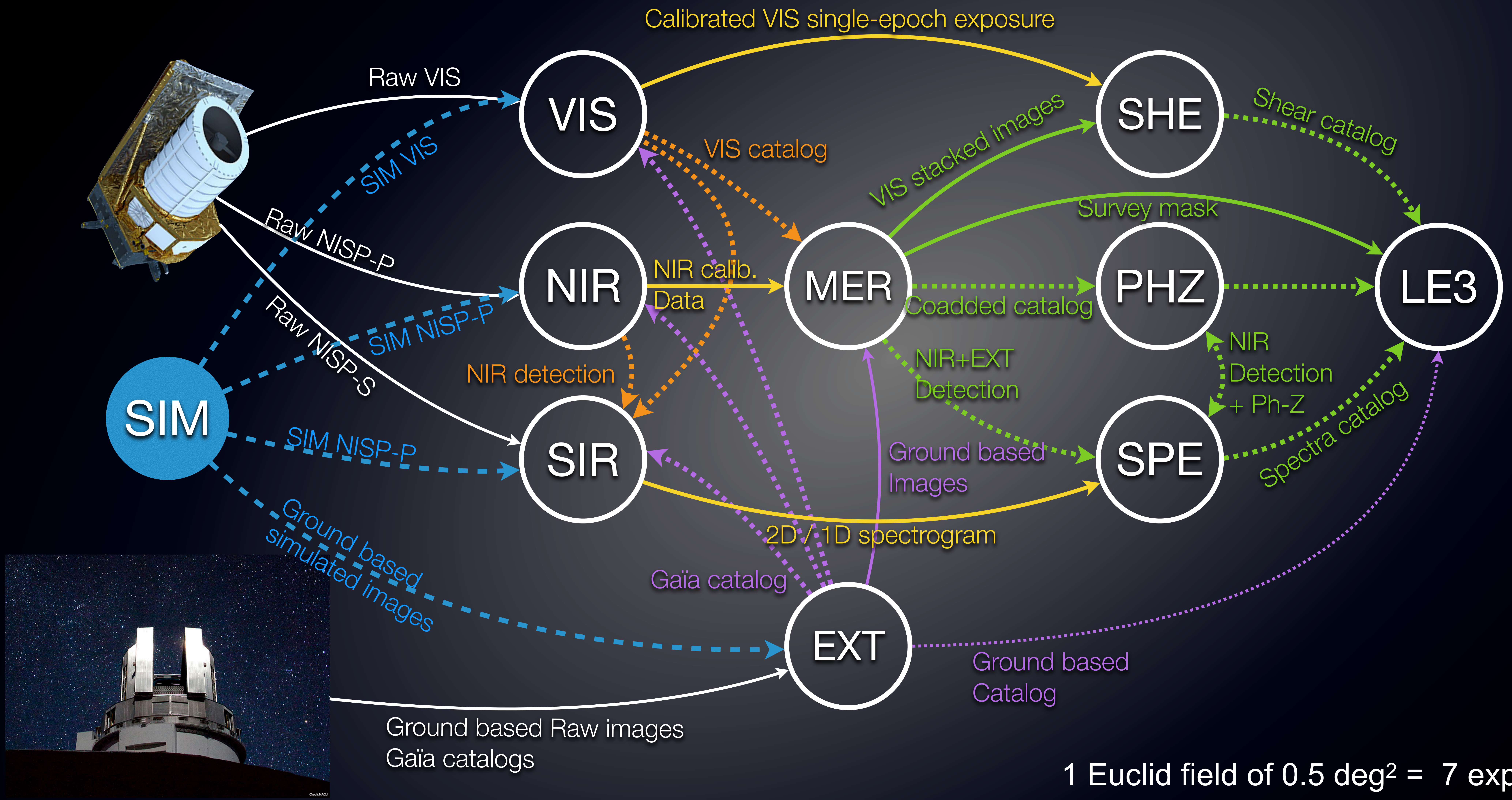
➡ > 100 000 Galaxies every square degree

➡ > 1700 redshift measurement every square degree



The Ground segment

The third instrument of Euclid mission … to process, analyses and interpret data

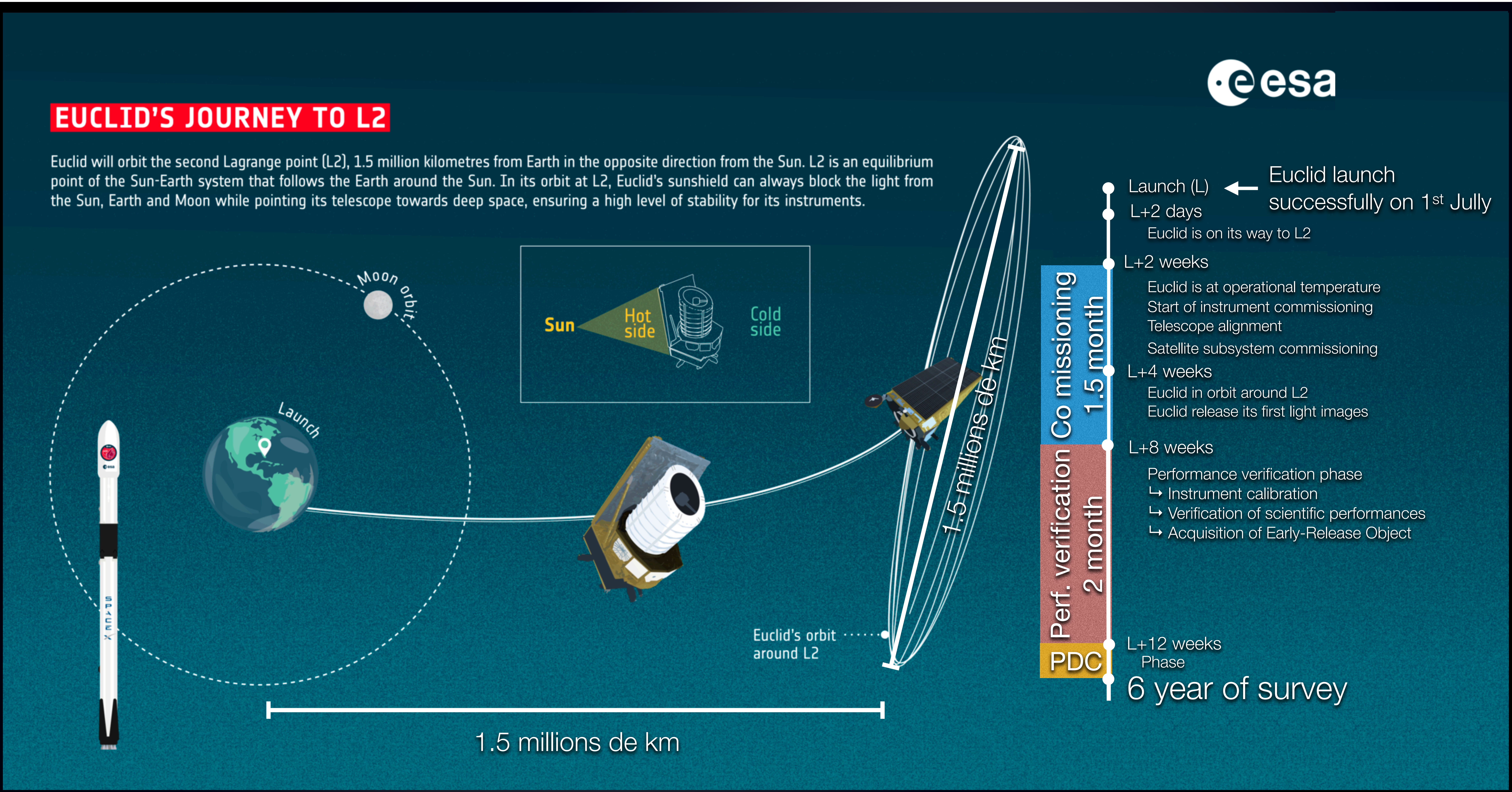


1 Euclid field of 0.5 deg^2 = 7 exposures = 144 images
850 Gbit data transmitted to ground every day

Space X

Euclid status after launch

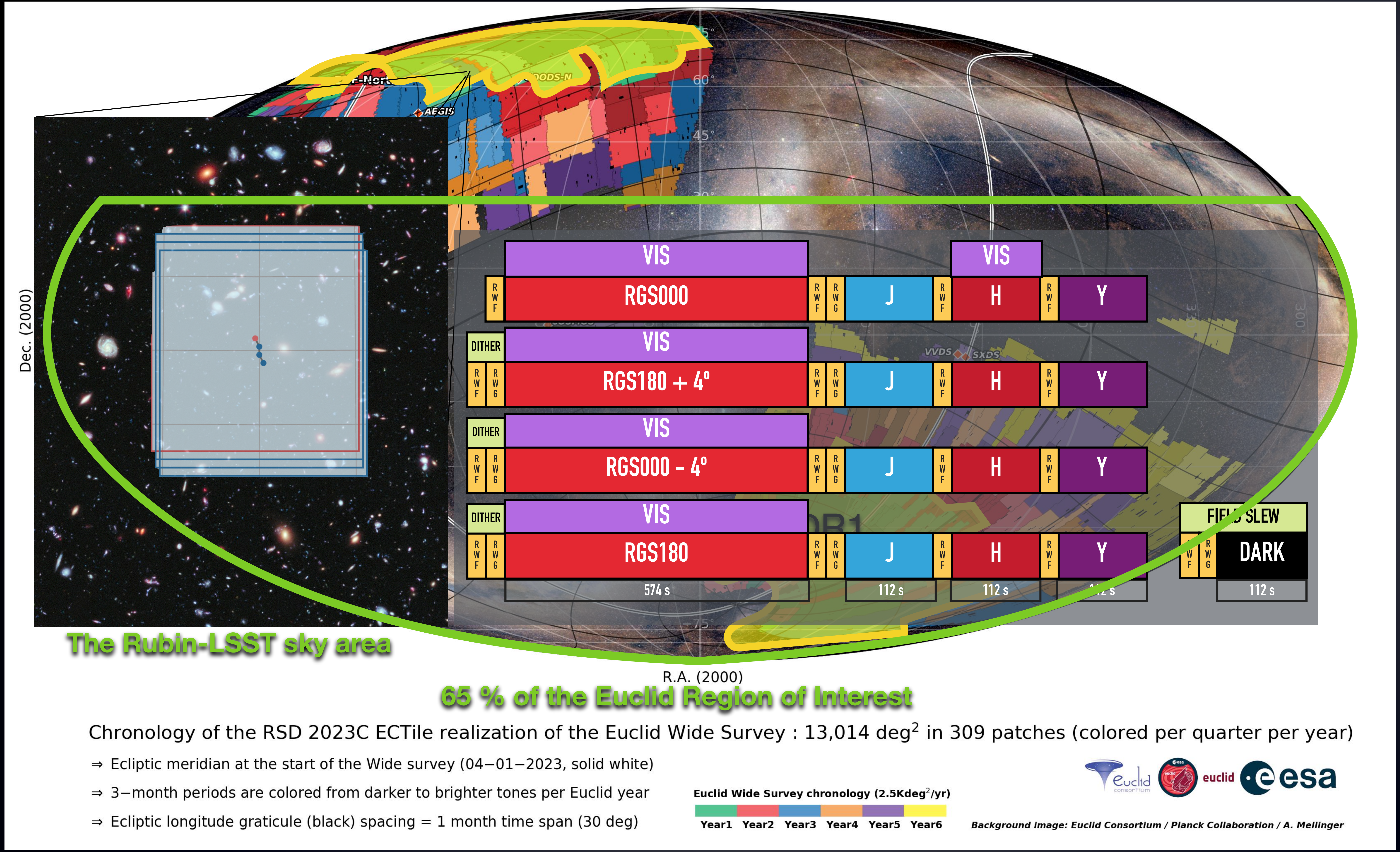
The early moments of Euclid's flight

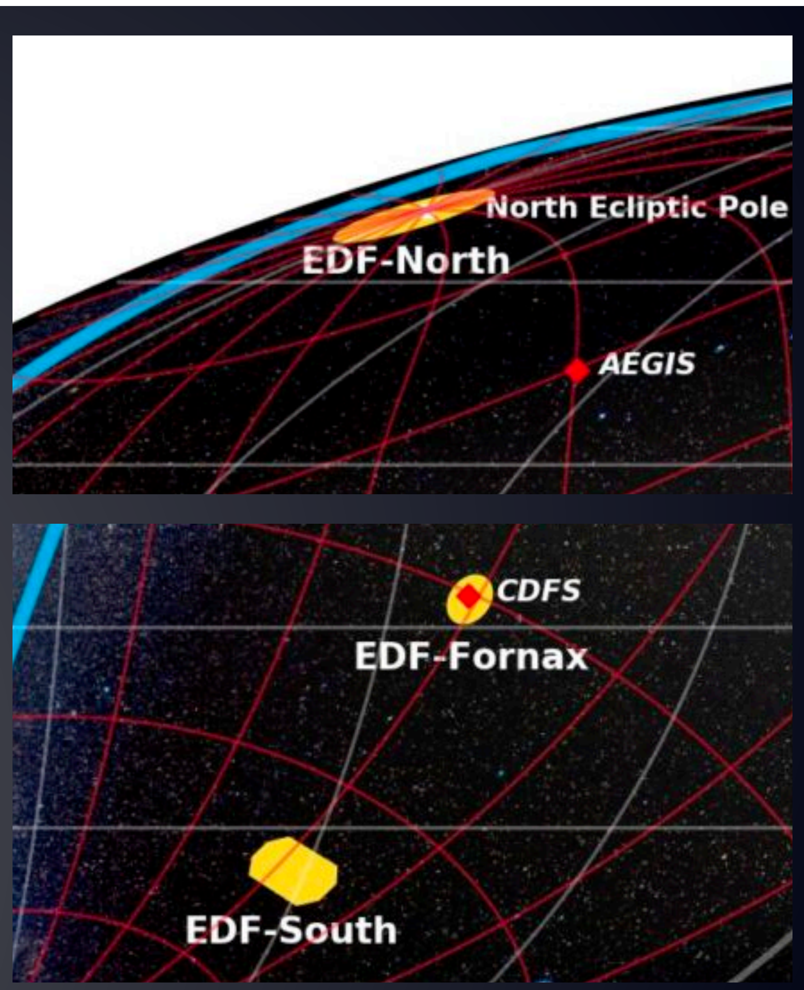


Euclid survey

6 year of sky survey

Euclid survey





Deep survey:

1×10 deg^2 North

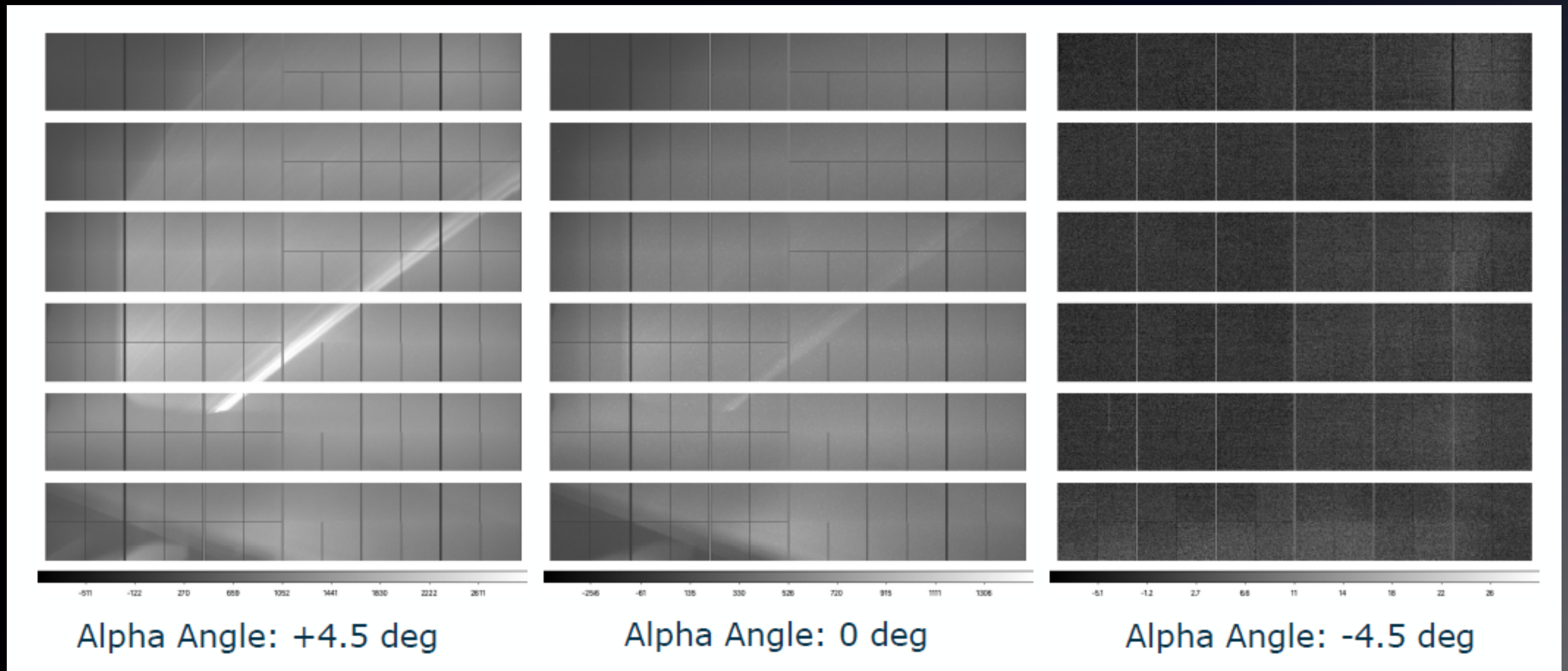
1×20 deg^2 South

1×10 deg^2 CDFS

Wide survey:

15 000 deg^2

Nasty surprises

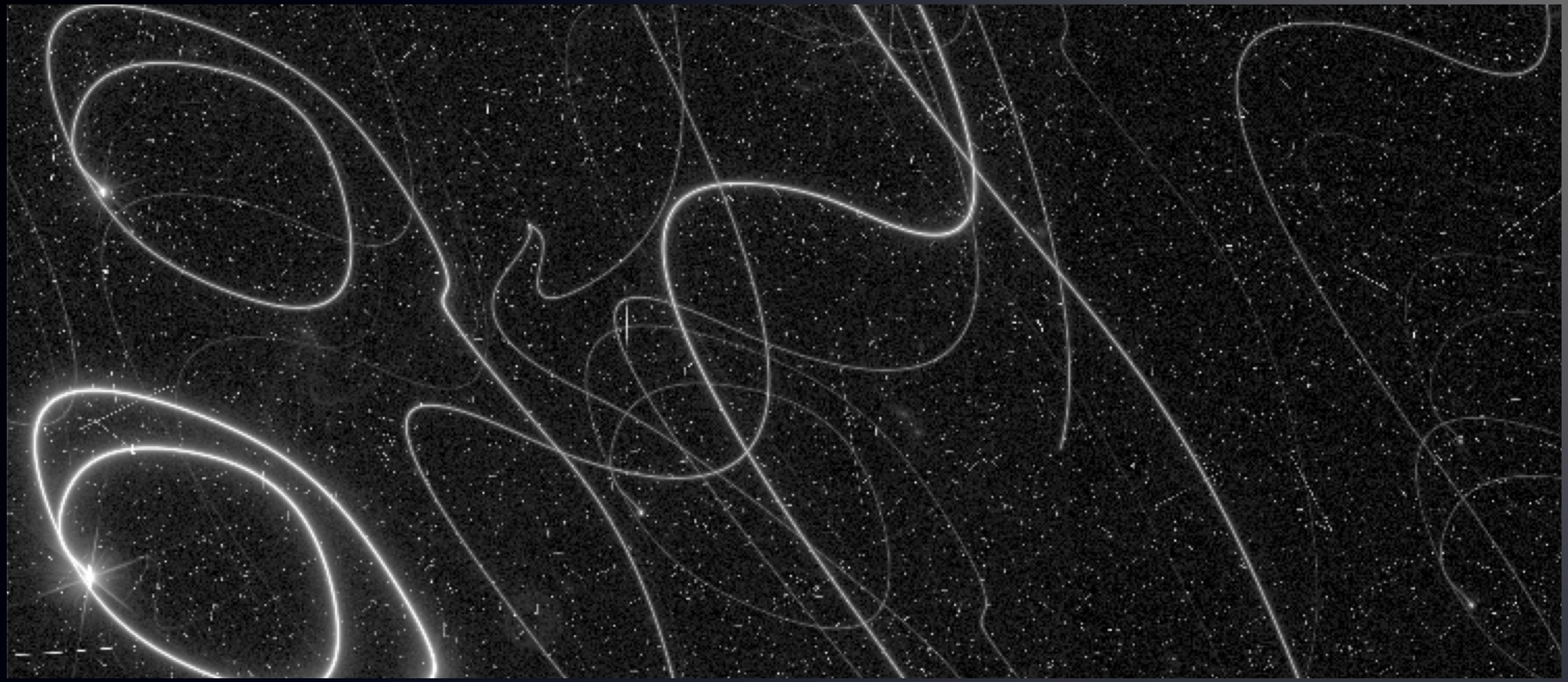


ESA

Sun's straylight

Sun light is entering PLM cavity at certain solar and solar aspect angle

→ redesign of the survey strategy to avoid those nasty angles



ESA / Euclid Consortium / TAS-I,

Fine guiding sensor issue (FGS)

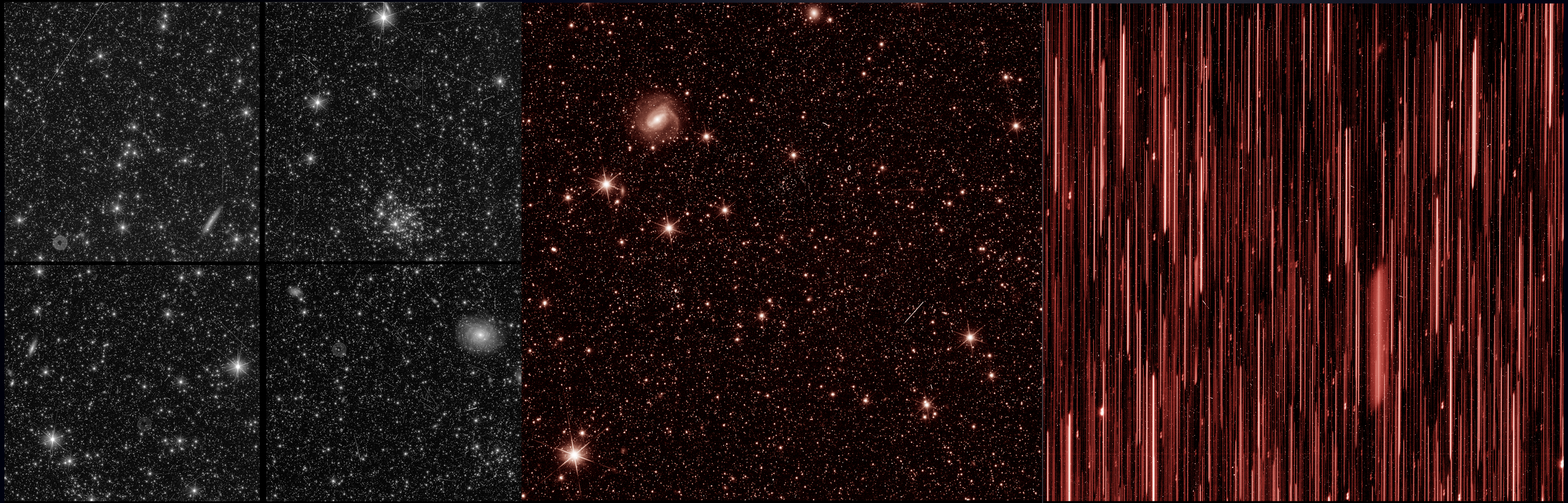
In early operation the FGS was loosing its tracking stars signal because of cosmic ray hit

→ on board software update with more robust cosmic ray rejection algorithm

→ delay in start of scientific performance validation

Euclid Milestone

ESA/Euclid/Euclid Consortium/NASA,



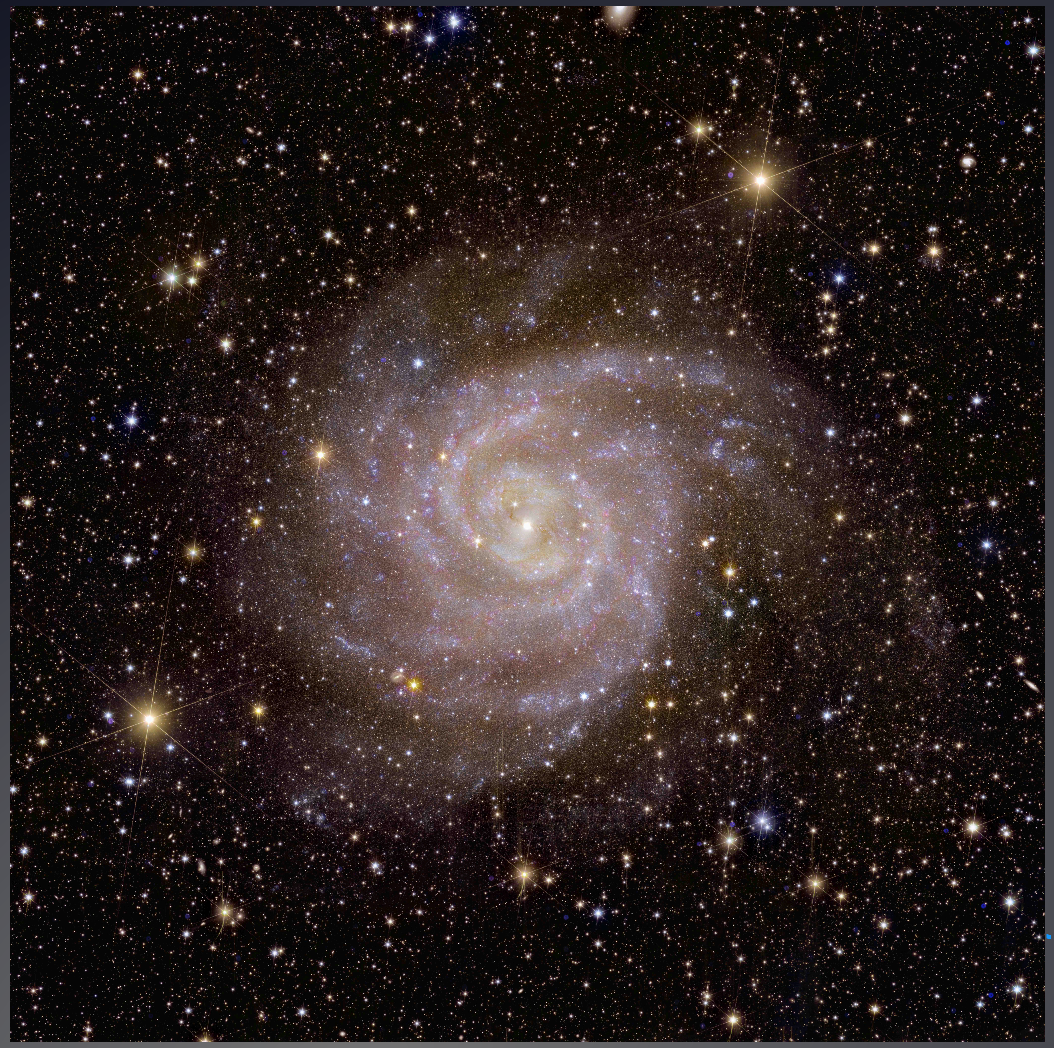
Early commissioning test image, VIS instrument
Early commissioning test image, NISP instrument
Early commissioning test image, NISP instrument (grism mode)

Euclid 1st light *(31st July 2023)*

One of the early engineering sky image taken with a telescope not yet perfectly align. Image quality already showed us the great capability of Euclid

Euclid Milestone



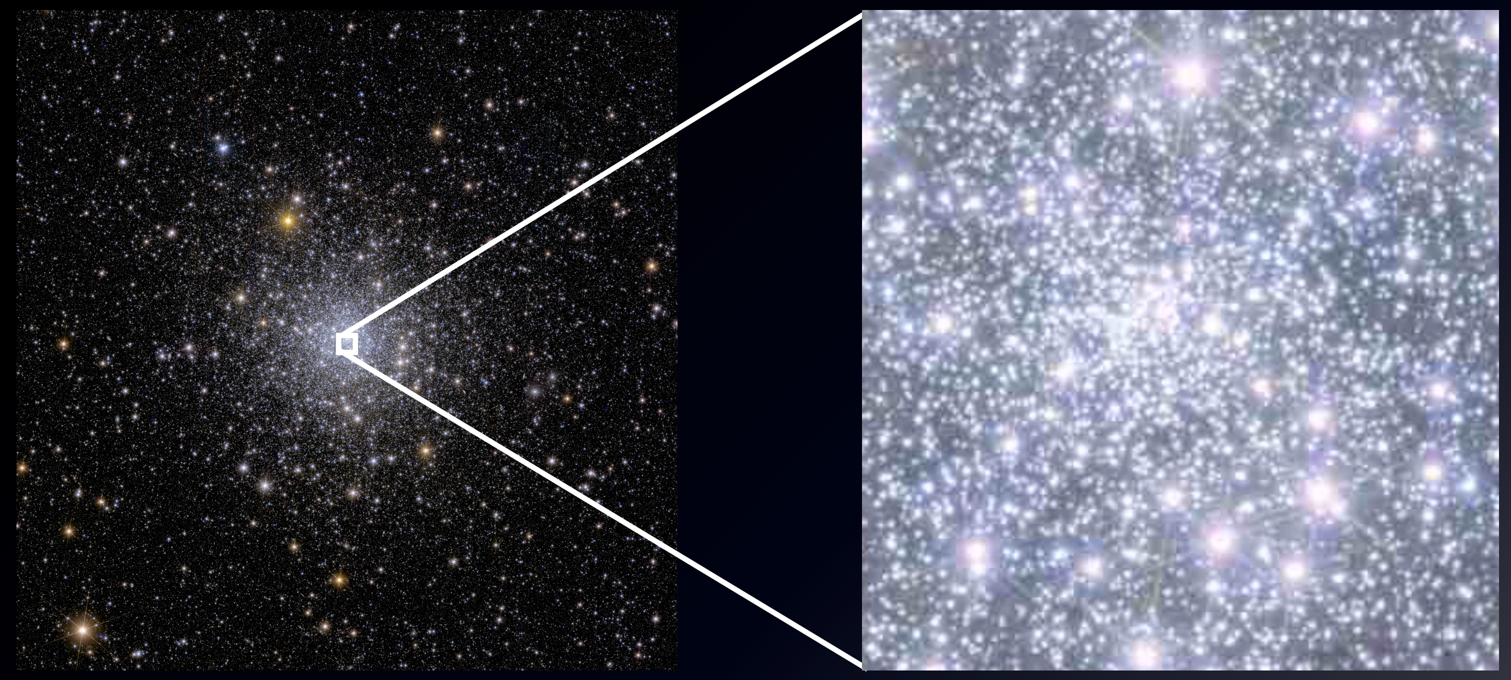


Euclid outreach with Early Release Object

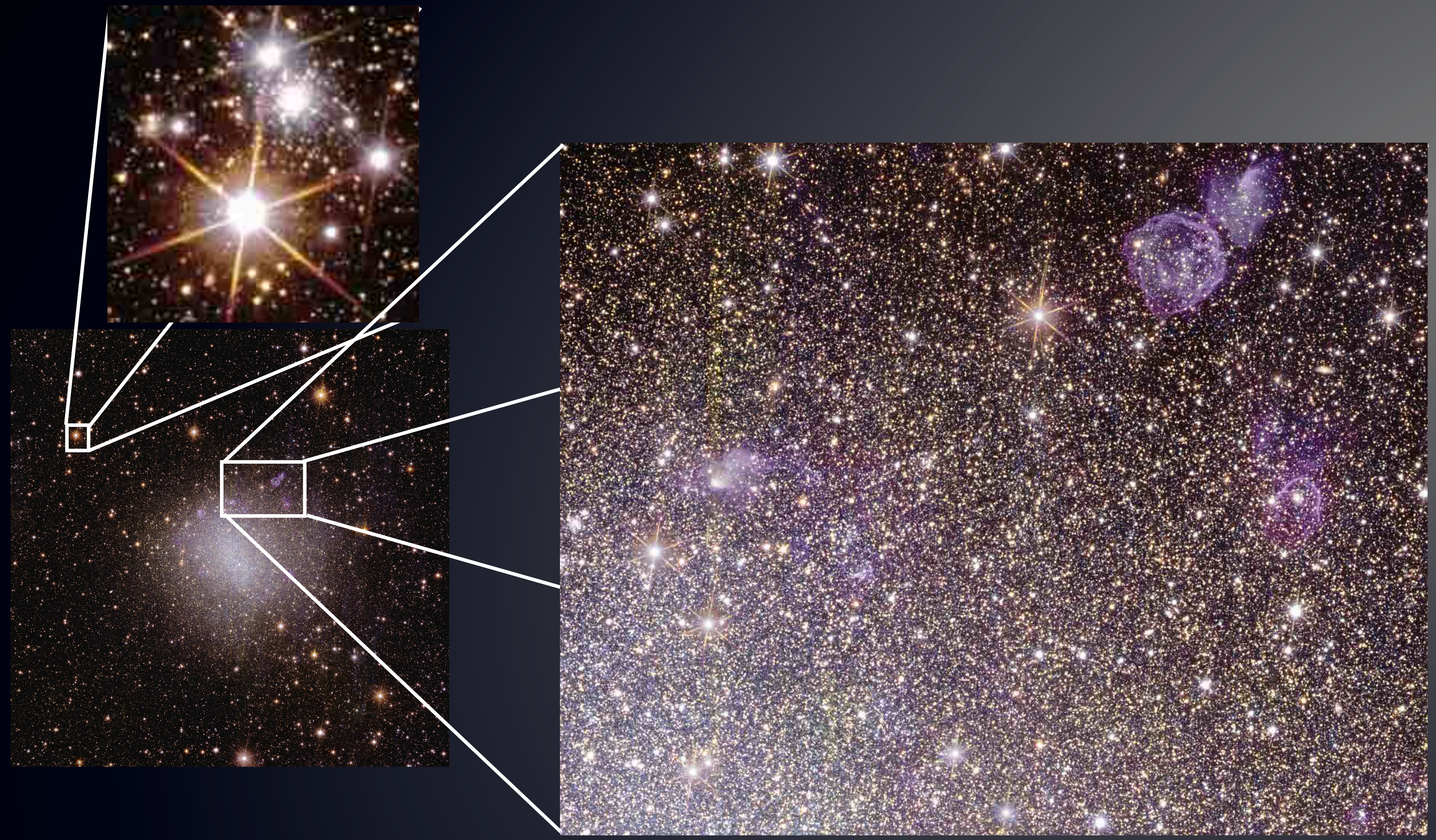
1 day of observation time dedicated on legacy science to showcase Euclid capabilities.

5 of the ERO' target release to the public in November

Euclid Milestone

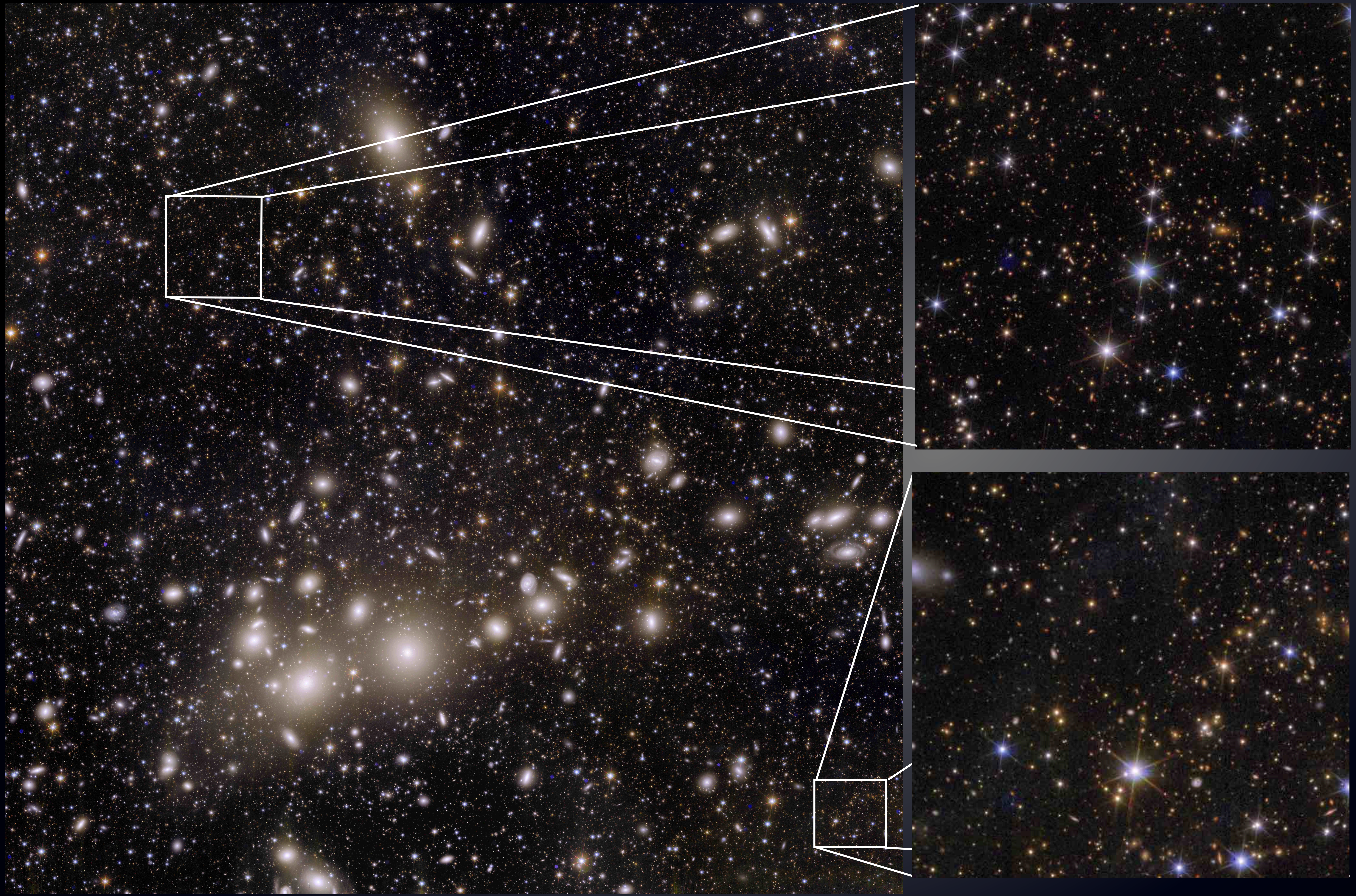


NGC6397 stacked at the VIS resolving power :
Resolving of the stellar population into the core of the globular cluster demonstrate the resolving power of Euclid and its capability to accurately measure galaxy's shear.



NGC6822 first time imaged with such resolution in its integrity in less than 1 hour :
→ Many star cluster discovered,
→ Euclid photometry provide metallicity information which, together with the many discovered stellar cluster, gives hint to the Star formation history of this galaxy.

Euclid Milestone



Perseus Galaxy cluster

- Particularity of this exposure : twice as long as previous EROS
- Hundred thousand of background galaxies never seen before demonstrate the capability of Euclid for its core science : cosmology

Conclusion

Euclid in numbers

EUCLID: AN ESA-LED GLOBAL COLLABORATION

Through developing and implementing the Euclid mission, ESA is leading a global collaboration that is already bringing socio-economic benefits to Europe and the rest of the world. These benefits are set to continue once the mission has launched.

>300 institutions

21 countries

80 companies

140 industry contracts

>3500 people

~1.4 billion euros (mission cost)

Euclid status

Euclid successfully launch on the 1st of July 2023 and reaches L2 in the end of July 2023

Euclid Commissioning → Summer 2023
Both Instruments are operational, providing high quality images. Team on duty has to overcome unforeseen event as FGS tracking issue and unexpected straylight

Euclid Performance verification phase → falls 2023
Instrument fine tuning, calibration and scientific performance verification ⇒ **Making Euclid ready for Science !!!**

High image quality
High capability
Very exciting time for Cosmology and science

What next

- Start of survey operation January 2024 for the next 6 years