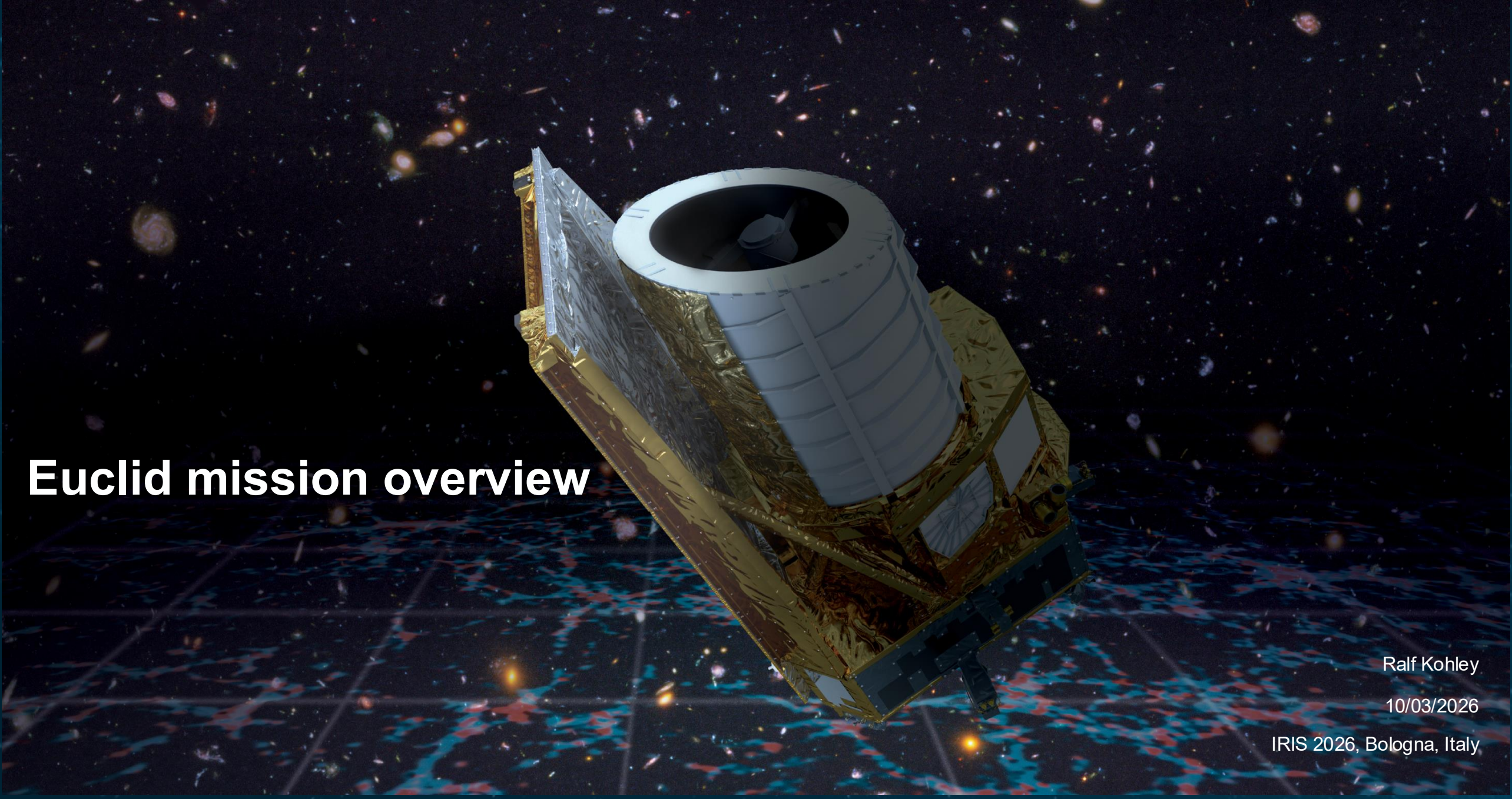


Euclid mission overview

Ralf Kohley

10/03/2026

IRIS 2026, Bologna, Italy

COSMIC OBSERVERS

esa

IN DEVELOPMENT

ACTIVE

LEGACY

ariel (2029)

roman (2026)

arrakihs (2030)

plato (2026)

new athena (~2037)

lisa (~2035)

webb (2021–)

euclid (2023–)

hubble (1990–)

cheops (2019–)

xrism (2023–)

xmm-newton (1999–)

einstein probe (2024–)

- **2007** selection of proposals
- **2012** mission adoption and start of the implementation phase
- Launch 1st July **2023**
- July **2023** – Dec. **2024**
  Commissioning (until 4th August) and Performance verification (until 3rd Dec.)
- Nov **2023**: we released the first images
- 14th Feb **2024**: start of the nominal survey
- May **2024**: Early Release Observations (ERO), image and data release
- 19th March **2025**: first public Quick Data Release (Q1) from survey data

microwaves *sub-millimetre* *infrared*

gravitational waves

lisa pathfinder (2015–2017)

planck (2009-2013)

herschel (2009-2013)

iso (1995-1998)

akari (2006-2011)

hipparcos (1989-1993)

gaia (2013–2025)

corot (2006–2014)

iue (1978-1996)

exosat (1983–1986)

hitomi (2016)

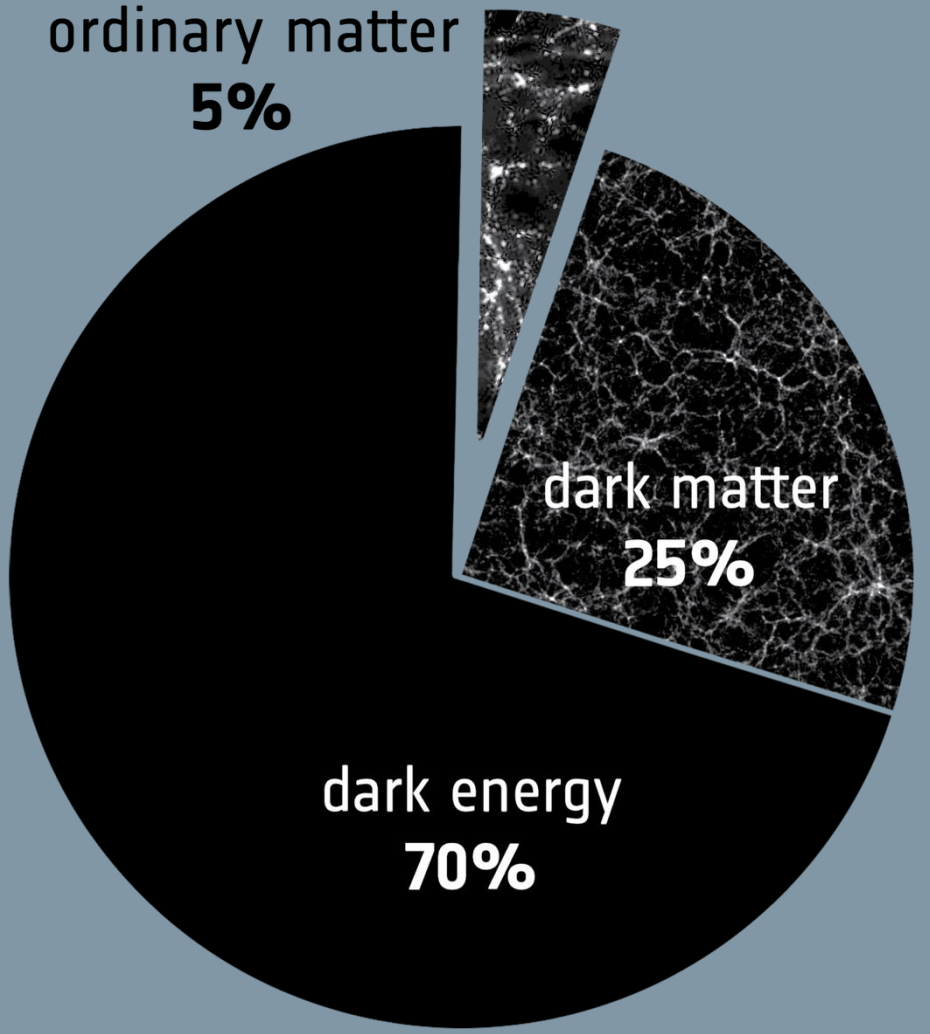
suzaku (2005–2015)

cos-b (1975–1982)

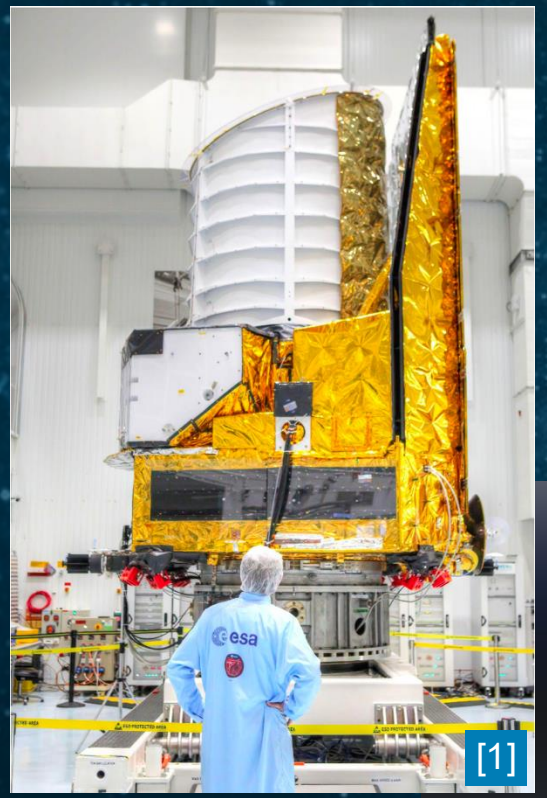
integral (2002–2025)

microscope (2016–2018)

What is the universe made of?



Euclid mission: science, payload and instruments

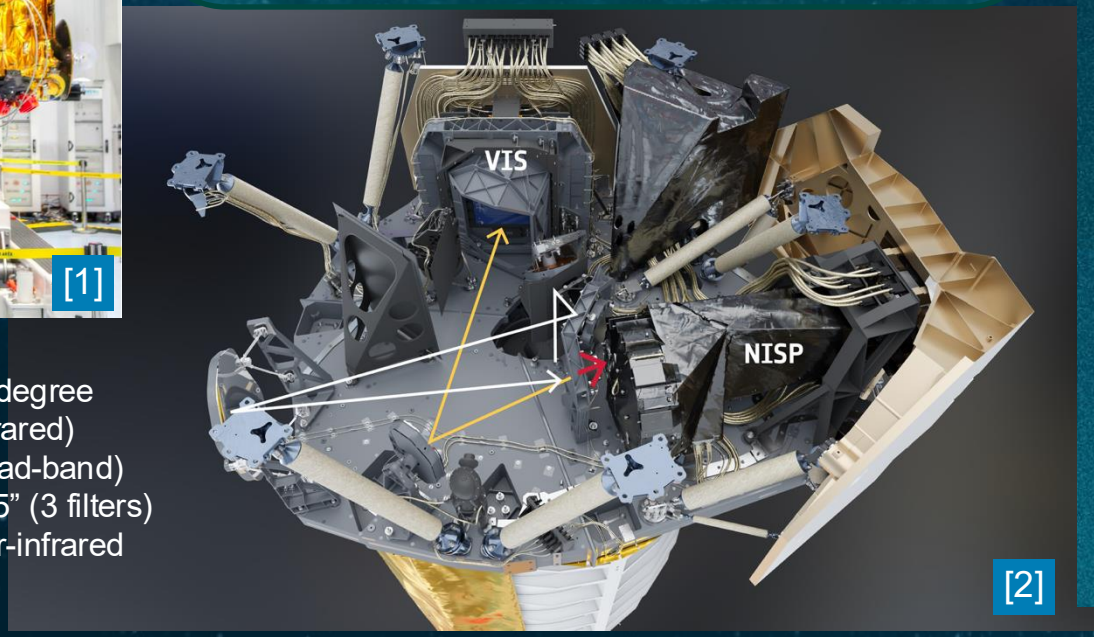


- Primary mirror: 1.2 meter
- Field of view: 0.5 square degree (matched optical/near-infrared)
- FWHM optical: 0.14” (broad-band)
- FWHM near-infrared: 0.45” (3 filters)
- Low-resolution grism near-infrared spectroscopy (R~400)
- 6-year mission at L2

Core science: Cosmology with two complementary dark energy probes

Weak Lensing: → VIS imager + NIR imaging-photometer
Shapes and shear of galaxies with a density of >30 galaxies/arcmin^2

Galaxy clustering: → NIR slitless spectrometer
H_alpha Redshifts for >1800 galaxies/deg^2



VIS

The visible instrument

Measures the shapes of billions of galaxies

550–900 nm wavelength

Mosaic of 36 CCDs, 4k x 4k pixels each

Special feature

very sharp images of galaxies

NISP

Near-infrared spectrometer and photometer

Measures brightness and intensity of light from galaxies

Used to calculate redshift/distance

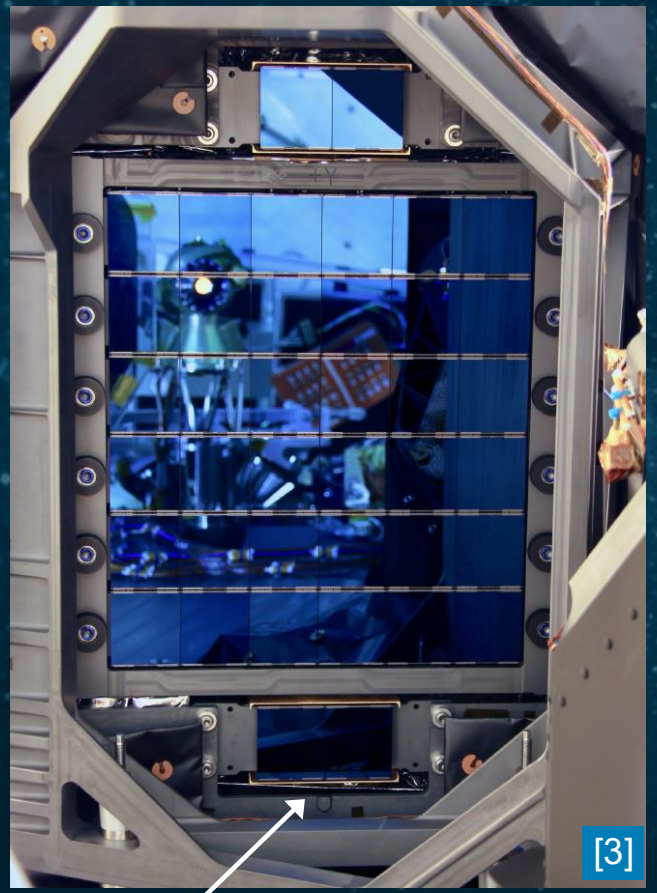
900–2000 nm wavelength

Mosaic of 16 detectors, 2k x 2k pixels each

Special feature

largest infrared field-of-view from space

Euclid mission: focal planes


[3]

2 additional CCD273 on each side of the VIS FPA used as Fine Guide Sensors (FGS) with own high-speed controller.

VIS

36 (6x6 mosaic) Te2v CCD273 4kx4k, 12µm pixels, 4 outputs, deep depleted, red enhanced AR coating.

12 custom readout electronics (ROE) build by MSSL, UK, leading institute of the VIS instrument.

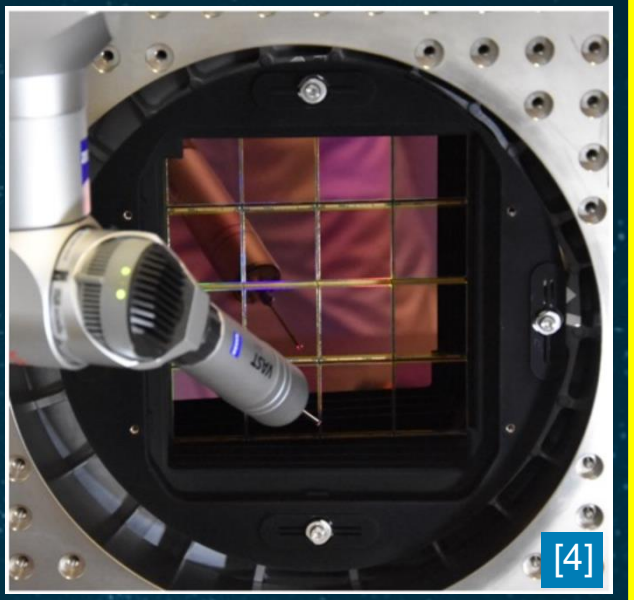
- → 609 Mpixels
- → 0.1 arcsec/pixel plate scale
- → Closely butted FPA with nearly 0.1 m^2 of silicon real estate
- → 72 s FPA readout time with ~3.4 e- RON

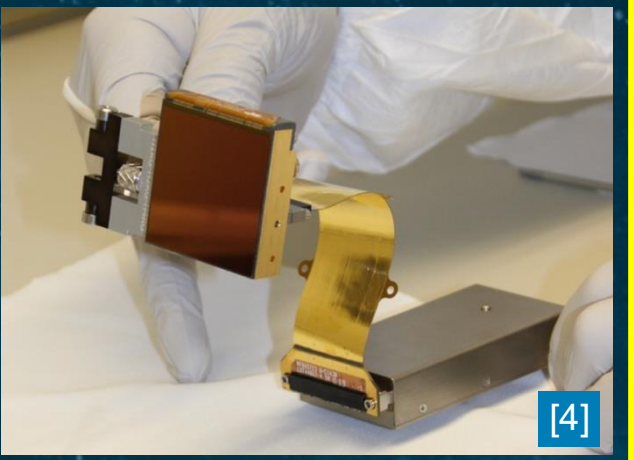
NISP

16 (4x4 mosaic) TIS SWIR H2RGs 2kx2k, 18µm pixels, 32 outputs, 2.3µm cut-off (SCA).

16 TIS SIDECAR front-end (SCE; JPL packaging), which together with the H2RGs were a NASA contribution to Euclid.

- → 67 Mpixels
- → 0.3 arcsec/pixel plate scale
- → Largest infrared FPA flown so far with 0.02 m^2 of MCT real estate
- → 1.45 s frame time operated in MACC mode

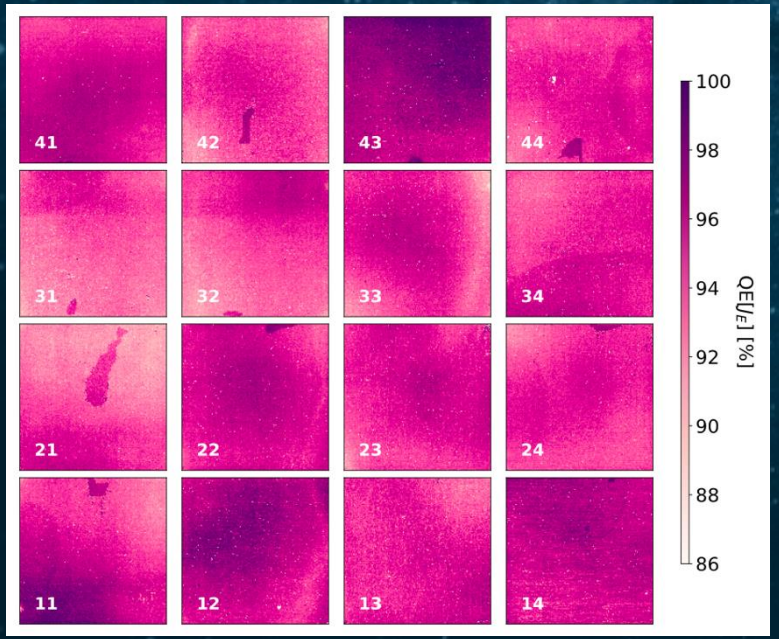

[4]

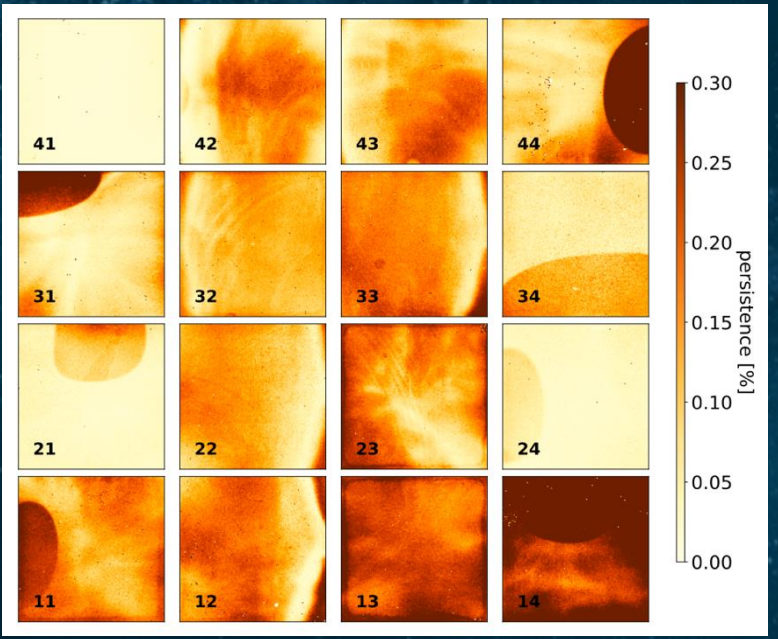

[4]

NISP detector system performances

Mosaic	Position	11	12	13	14	21	22	23	24	31	32	33	34	41	42	43	44
	SCA 18XXX	453	272	632	267	268	285	548	452	280	284	278	269	458	249	221	628
QE [%]	Y_E-band	93	96	88	95	92	94	94	93	91	92	94	94	92	93	96	92
	J_E-band	95	97	95	96	93	96	95	95	93	94	95	95	96	94	98	95
	H_E-band	96	98	95	97	94	96	96	95	93	94	95	96	95	94	99	95
Noise [e^-]	Spectro	8.2	9.0	7.8	9.2	8.2	8.9	8.3	8.4	8.1	7.9	8.0	8.7	7.7	7.9	8.1	8.7
	Photo	6.0	6.2	5.9	6.4	6.3	6.7	6.4	6.4	5.9	5.8	5.6	6.4	5.7	5.6	6.1	6.1
Disconnected pixels [#]		135	3223	589	252	313	2580	1512	146	1420	269	262	970	198	334	222	255

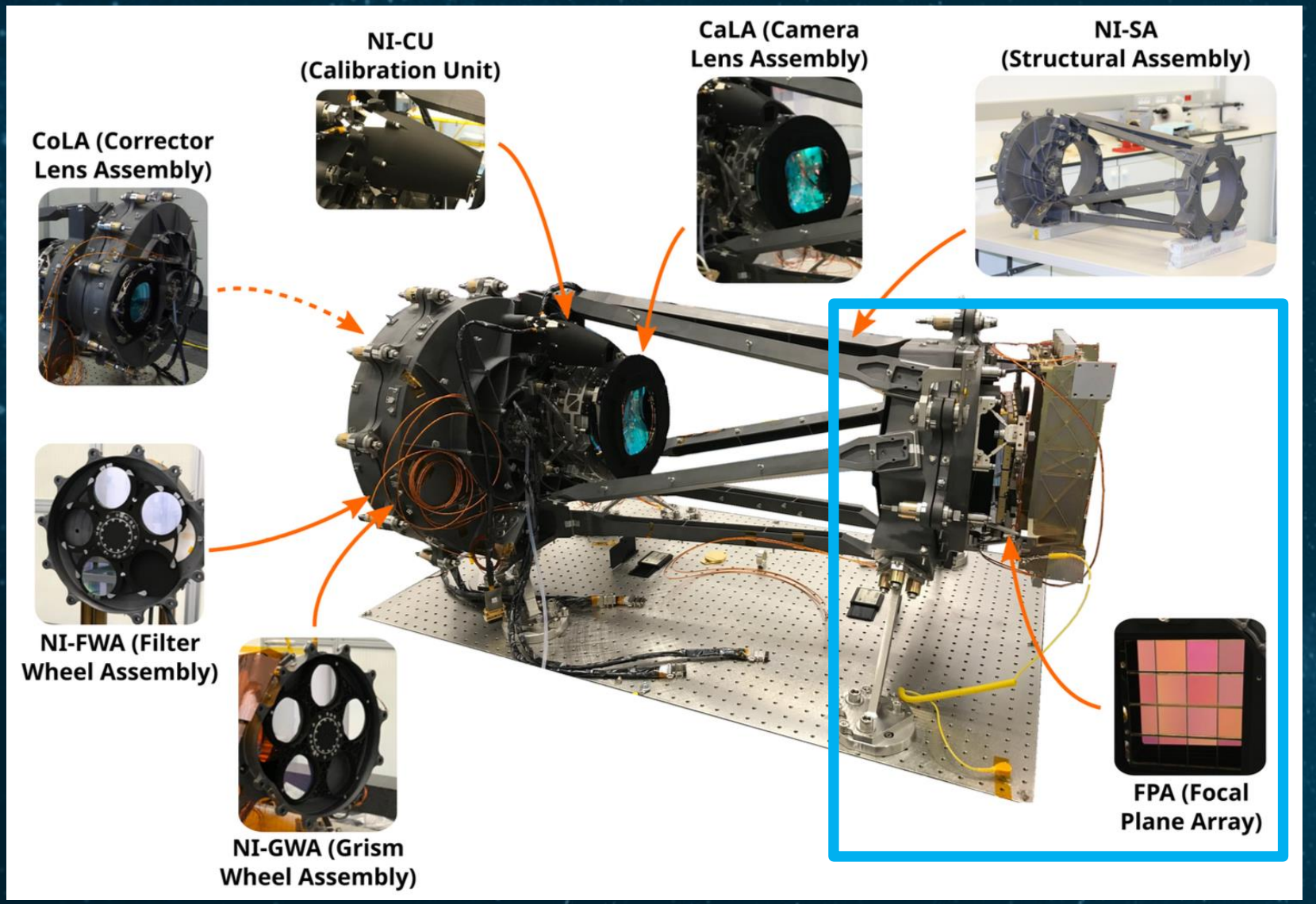
From [4]: Detector chain performance of the 16 NISP detector systems.
'*Position*' refers to position in the 4×4 array as defined in the FPA assignment matrix;
'*QE*' is the quantum efficiency in the respective photometry passbands, with an absolute accuracy of 5% (Waczynski et al. 2016);
'*Noise*' is the signal estimator noise in the standard survey MACC modes for photometry and spectroscopy (Single frame readout noise is between 11e- and 14e-);
'*Disconnected pixels*' gives the number of pixels per detector that do not produce a signal due to a missing or faulty indium bump;
If not specified, then values given are medians over the array.





From [5]:
(Left)
Map of the average QE in the NISP J_E band (1168–1567 nm)
(Right)
Persistence amplitudes in percentage of the previous flat-field illumination below saturation.

NISP instrument

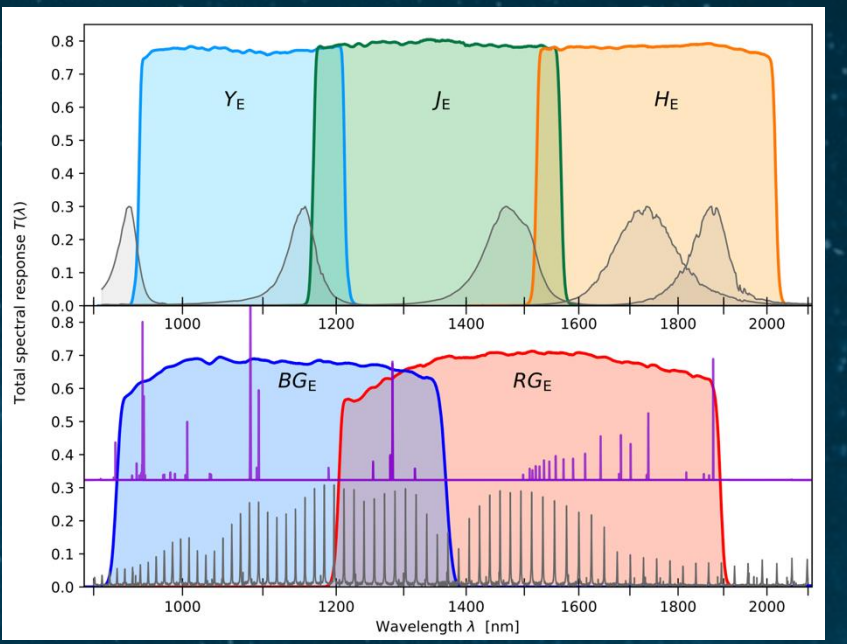


NISP

Photometer: 3 filters Y, J and H

Spectrometer: 2 grism types: Blue and Red slitless, R ~ 400

FF calibration: 5 LEDs outside optical path matched to cover full spectral bandwidth of NISP



[4]

NISP acquisition system and observing sequence

Cold part:

- 16 H2RGs @ ~95K
- 16 SIDECAR @ ~135K

Warm part:

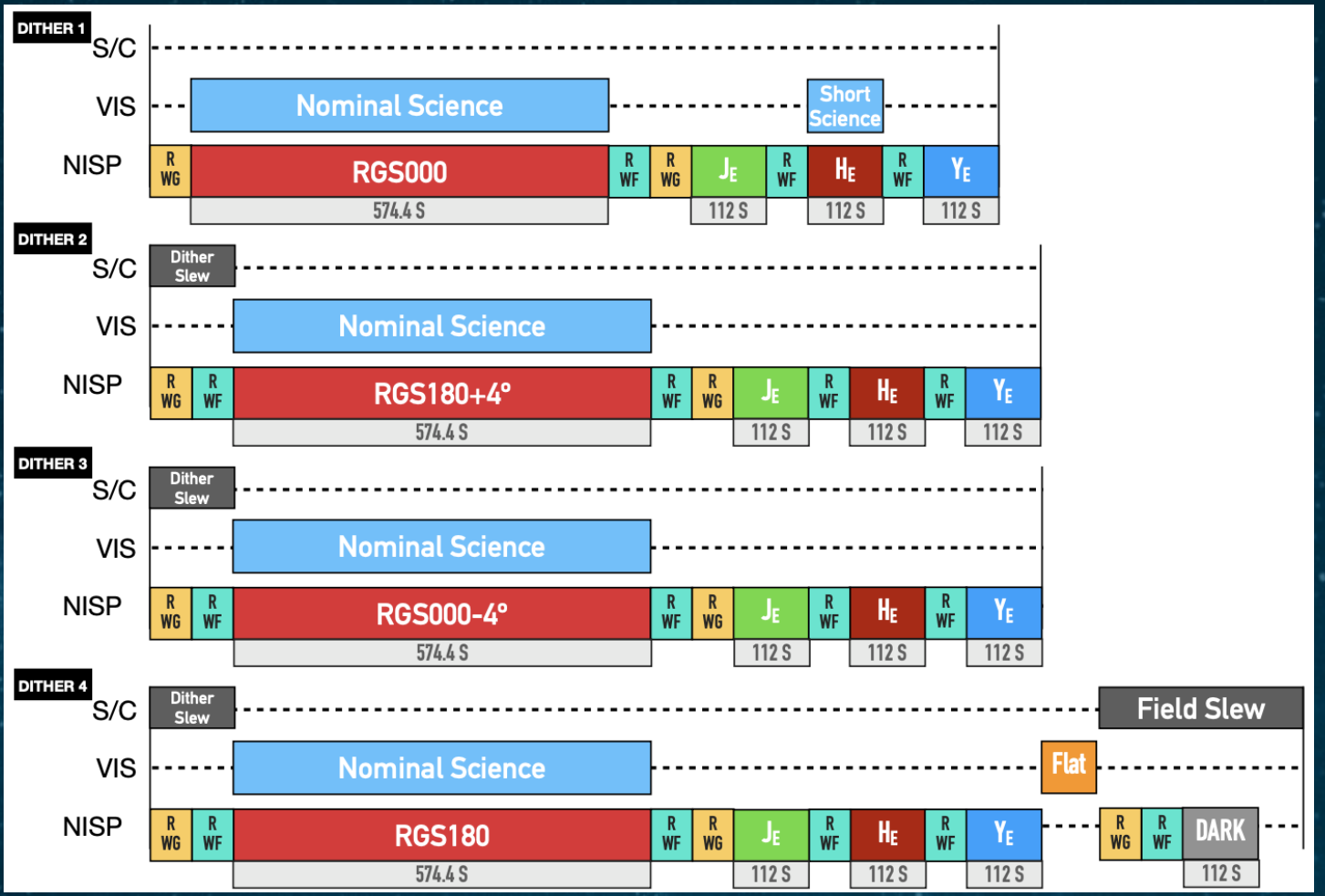
- 16 Detector Control Units (DCU)
- 2 Data Processing Units (DPU), one for 8 H2RGs each (half of FPA)
- 1 DPU & 8 DCUs in same electronics box
- Dual buffer memory to allow for processing of former image while taking the next

Data link (SIDECAR-DCU):

- Synchronous LVDS, 8-bit parallel, 11.8 Mbytes/s

Fundamental observing sequence during survey:

- 4 small dithers (~ 100 arcsec) to cover detector gaps) before moving to next field
- Spectro observation for one of the red grism (positions) or blue grism
- Followed by sequence of the three photometric filters and a slew dark for the last dither



[6]

NISP acquisition modes

General:

- Rolling shutter mode
- Reset (pixel-to-pixel reset) frame time = image frame time = 1.45408 s
- SIDECAR 16-bit ADCs (100 kHz), 32 channel mode
- 500 mV SCA reverse bias and 15 dB SCE gain setting
  → ~1.92 e-/ADU conversion gain
- Buffered mode

Spectro:

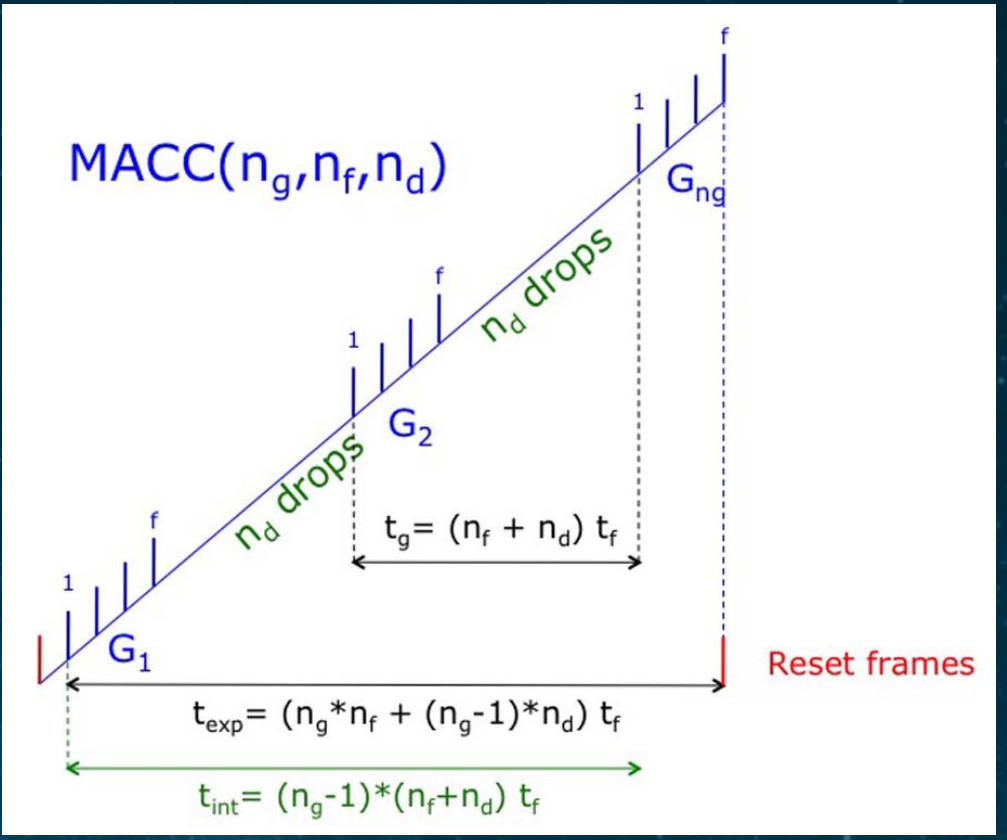
- MACC(15,16,11)
- t_{exp} = 572.9 s
- t_{int} = 549.6 s

Photo and Dark:

- MACC(4,16,4)
- t_{exp} = 110.5 s
- t_{int} = 87.2 s

On-board processing:

- Top-bottom and left-right reference pixel subtraction per co-added group
- Linear fit to group differences as signal estimator
- Chi2 calculation as ramp fitting quality factor
  (8-bit for Spectro and 1-bit discriminator based on settable threshold for Photo)
- Raw data for 5 programmable lines for all frames per co-added group



[7]

Legend:
n_g = number of groups
n_f = number of frames per group
n_d = number of drop frames (actually drop lines)
t_{exp} = exposure time
t_{int} = integration time

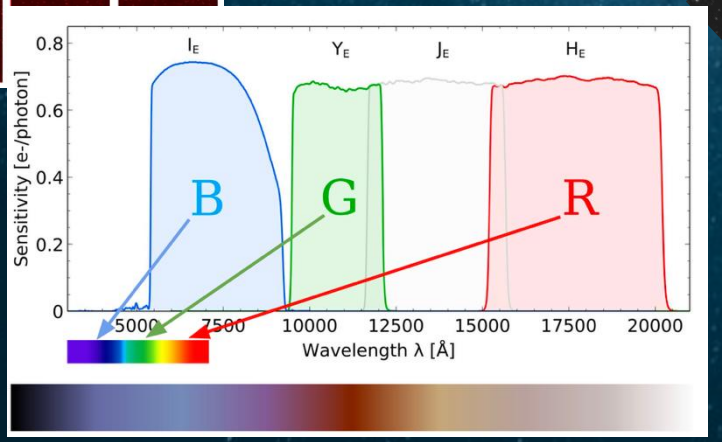
Early Release Observations processing

VIS
raw frames

NISP-Y
raw frames

NISP-H
raw frames

Data processing
with dedicated
pipeline

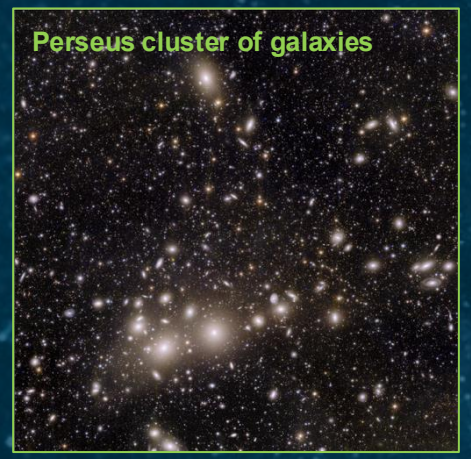


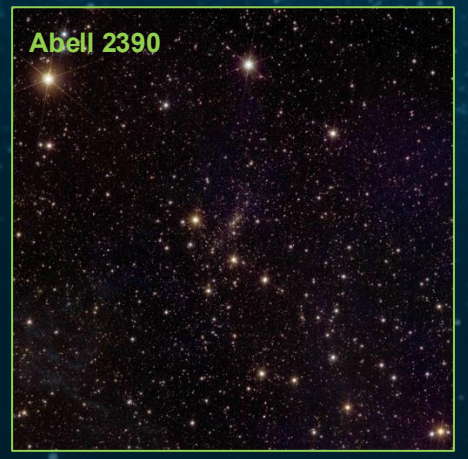
ERO science-ready
product: image stacks
for VIS and NISP.

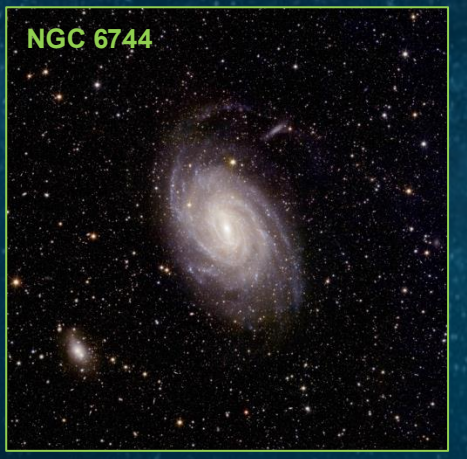
Published false colour image:

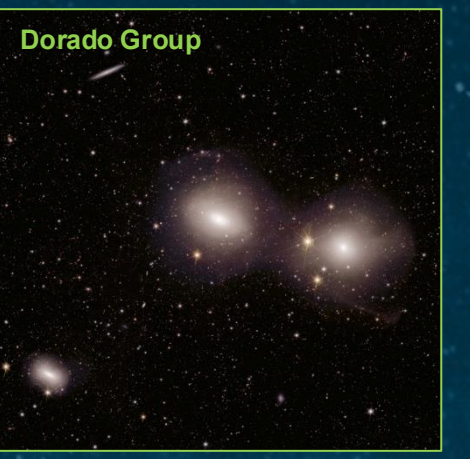
RGB image production by J.-C. Cuillandre
and RGB optimization through Photoshop
by G. Anselmi

Early Release Observations public releases



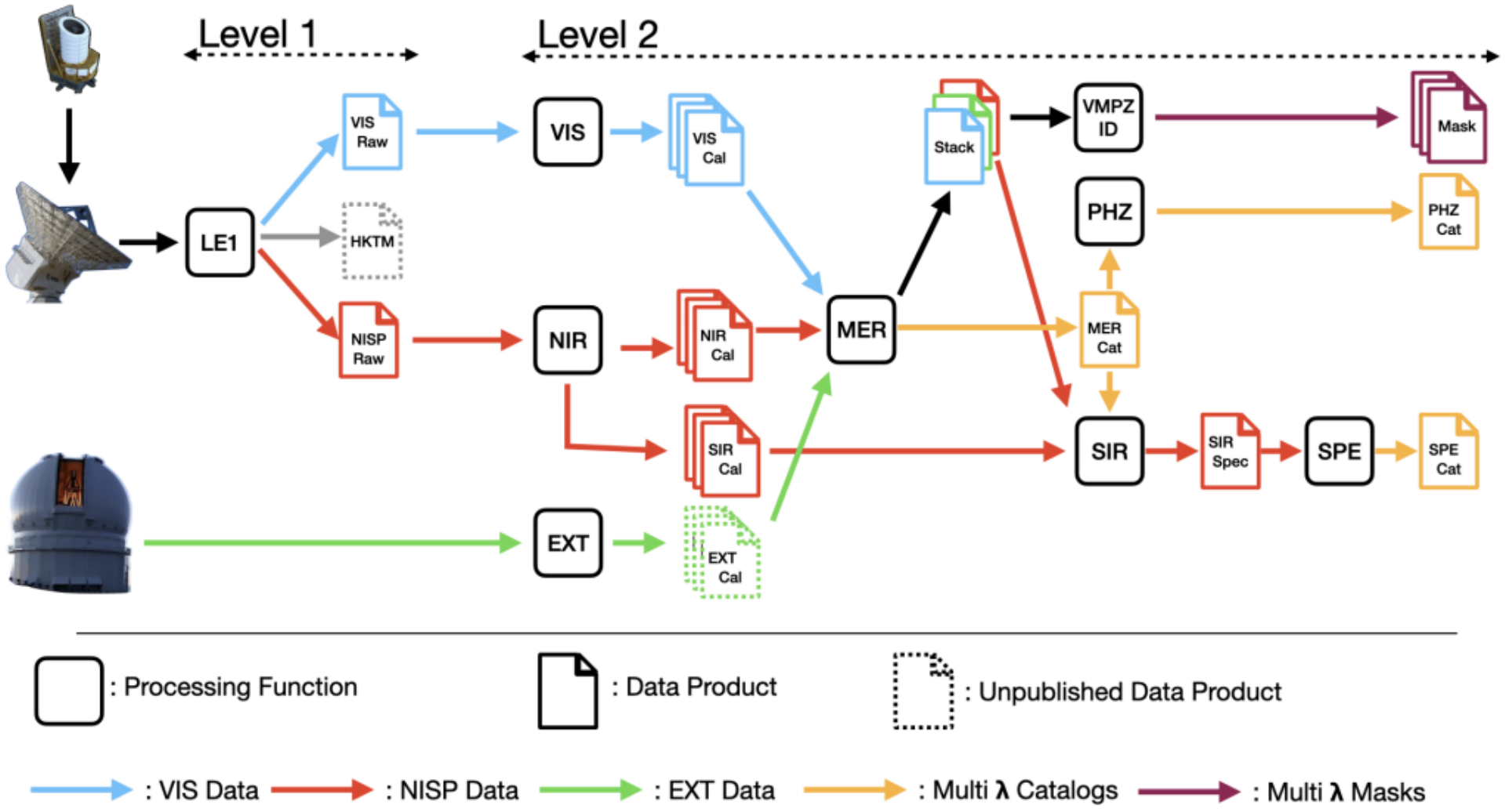






[8]

Euclid Science Ground Segment Processing



Q1 processing flow:

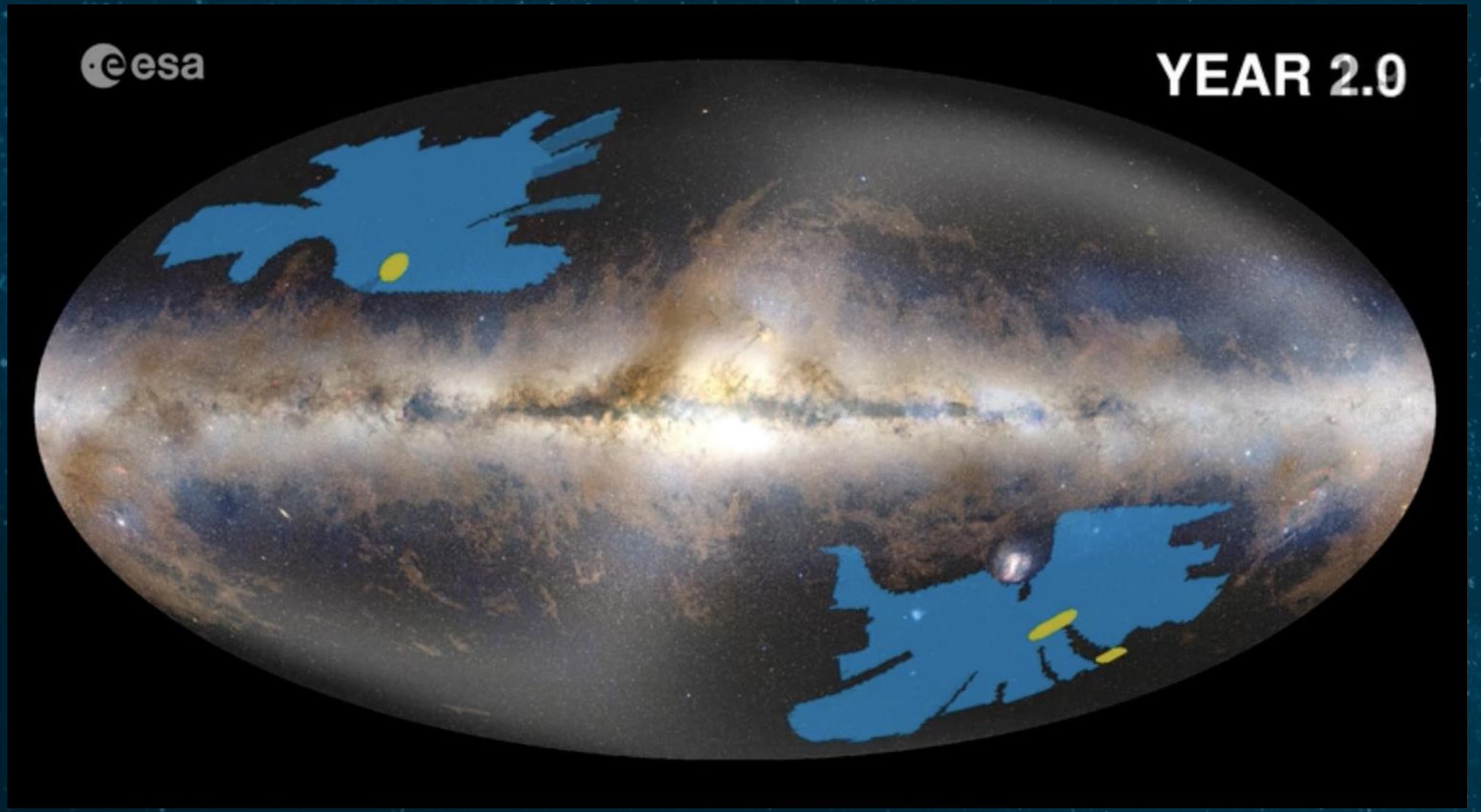
LE1:
Level-1 processing (decompression of raw files and generation of FITS files)

NIR:
NISP photometry image processing

SIR:
NISP spectroscopy image processing

[9]

Survey progress



Survey year 2.0:

- 14% of the sky observed (~4500 deg^2)
- 1 year of observations (~1900 deg^2) will be released as DR1

3 Deep Fields (yellow) published as Q1 data release:

- EDF-North
- EDF- South
- EDF-Fornax
- 28 million galaxies in 1 week of observations

[10]

Data releases

What comes next?

[Please note: data release dates are tentative and will have to be confirmed.]

- 24th June 2026 Quick Data Release 2 (Q2): Euclid Galactic Bulge Survey (EGBS)
- 21st October 2026 Data Release 1 (DR1)
- March 2029 Data Release 2 (DR2)
- October 2031 Data Release 3 (DR3)

[12]

[11]

Acknowledgements

Euclid is a European mission, built and operated by ESA, with contributions from NASA. The Euclid Consortium - consisting of more than 2000 scientists from 300 institutes in 15 European countries, the US, Canada and Japan – was responsible for providing the scientific instruments and will provide the scientific data analysis. ESA selected Thales Alenia Space as prime contractor for the construction of the satellite and its service module, with Airbus Defence and Space chosen to develop the payload module, including the telescope. NASA provided the detectors of the Near-Infrared Spectrometer and Photometer, NISP. Euclid is a medium-class mission in ESA's Cosmic Vision programme.

All ERO images are acknowledged with the following credits:
"ESA/Euclid/Euclid Consortium/NASA, image processing by J.-C. Cuillandre (CEA Paris-Saclay), G. Anselmi."

Dark cloud image [11] credit:
"ESA/Euclid/Euclid Consortium/NASA, image processing by M. Schirmer (MPIA, Heidelberg)"

Galaxy collage [12] credit:
"ESA/Euclid/Euclid Consortium/NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi"

References

[1] Image credit: Thales Alenia Space

[2] Image credit: Airbus

[3] Euclid Collaboration, M.S. Cropper et al., 2025, “Euclid II. The VIS instrument”, A&A Volume 697

[4] Euclid Collaboration, K. Jahnke et al., 2025, “Euclid III. The NISP Instrument”, A&A Volume 697

[5] Euclid Collaboration, B. Kubik et al., 2025, “Overview of Euclid infrared detector performance from ground tests”, A&A

[6] Euclid Collaboration, W. Gillard et al., 2024, “Euclid Near Infrared Spectrometer and Photometer instrument NISP in space”, SPIE

[7] B. Kubik et al., 2016, “A New Signal Estimator from the NIR Detectors of the Euclid Mission”, PASP Volume 128

[8] https://www.esa.int/Science_Exploration/Space_Science/Euclid/ESA_s_Euclid_celebrates_first_science_with_sparkling_cosmic_views

[9] Euclid Collaboration, H. Aussel et al., 2025, “Euclid Quick Data Release (Q1). Data release overview”, A&A

[10] https://www.esa.int/Science_Exploration/Space_Science/Euclid/Euclid_opens_data_treasure_trove_offers_glimpse_of_deep_fields

[11] https://www.esa.int/ESA_Multimedia/Images/2025/11/Euclid_peers_through_a_dark_cloud_s_dusty_veil

[12] https://www.cosmos.esa.int/web/euclid/euclid-nearby-galaxies-collage