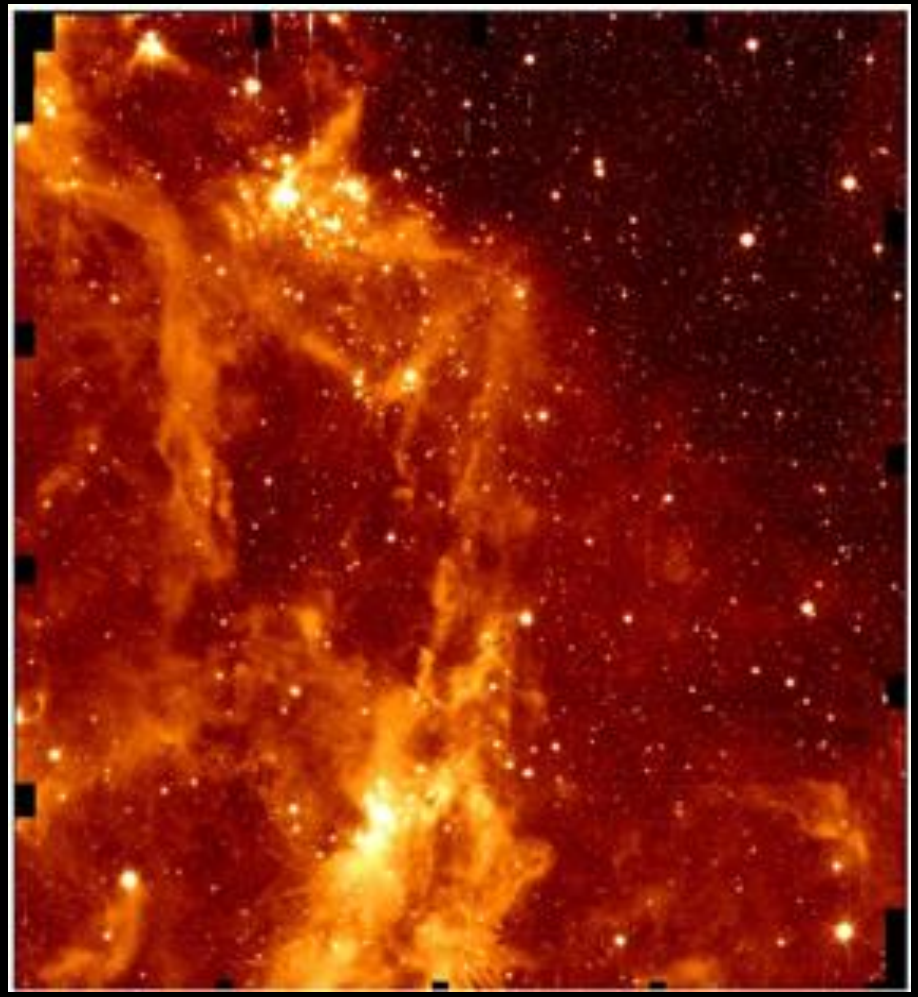


Lynd's Dark Nebula LDN1641 – credit: Euclid Consortium

Impact of detector effects on *Euclid* NISP photometric data processing

Gianluca Polenta
Italian Space Agency

on behalf of the *Euclid* Collaboration

Euclid@IRIS 2026

- R. Kohley: *Euclid* mission
- F. Cogato: NISP signal estimator
- L. Gabarra: snowball detection
- A. Secroun: IPC and Persistence
- W. Gillard: spectroscopic data
- S. Conseil: persistence
- E. Balbi's poster on CRs and snowballs
- N. De Araujo's on anti-persistence
- + this talk on photometric data

EC in Leiden 2025

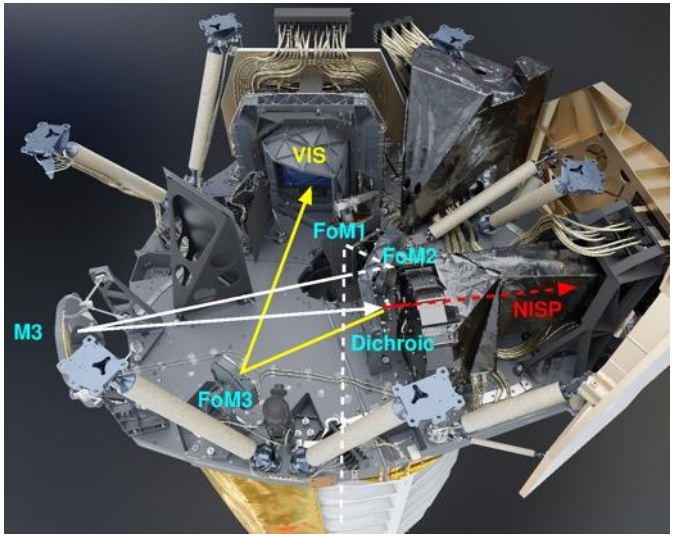
The *Euclid* Instruments

EC: Mellier et al., 2025, A&A, 697, A1

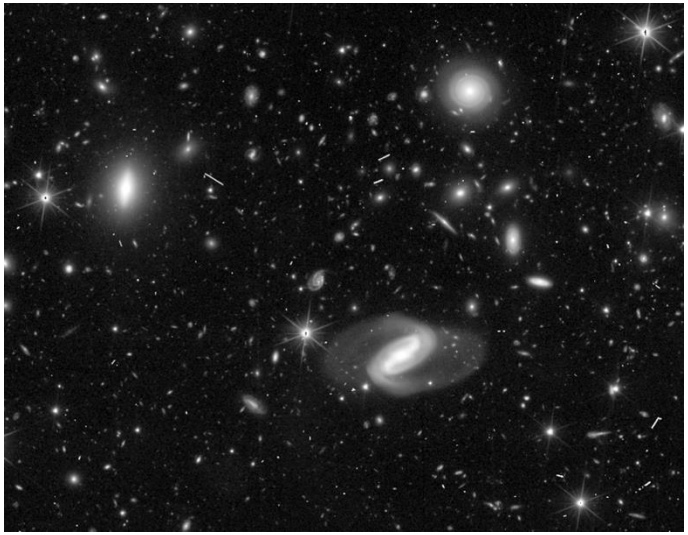
During 6 years of observations, *Euclid* will observe a few bilion galaxies over 1/3 of the sky.

VIS – Visible Instrument: high-res camera to measure *weak lensing* - 36 4k x 4k CCDs, 0.1" / pixel, 550-900 nm

Credit: Airbus / ESA



Credit: CEA, e2v, Airbus, IAS, APCO



EC: Cropper et al., 2025, A&A, 697, A2

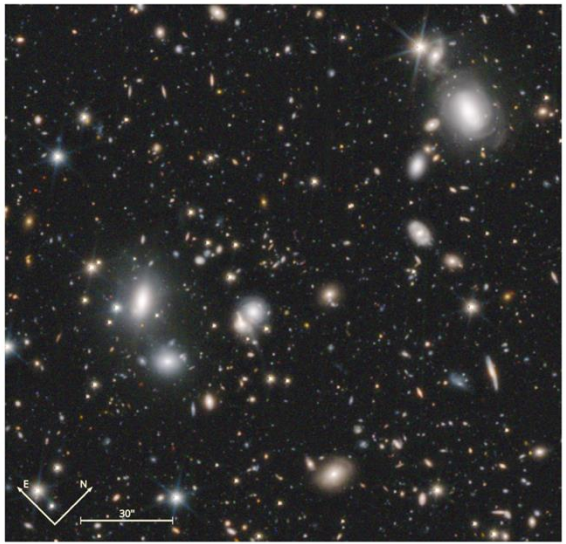
The *Euclid* Instruments

EC: Mellier et al., 2025, A&A, 697, A1

During 6 years of observations, *Euclid* will observe a few bilion galaxies over 1/3 of the sky.

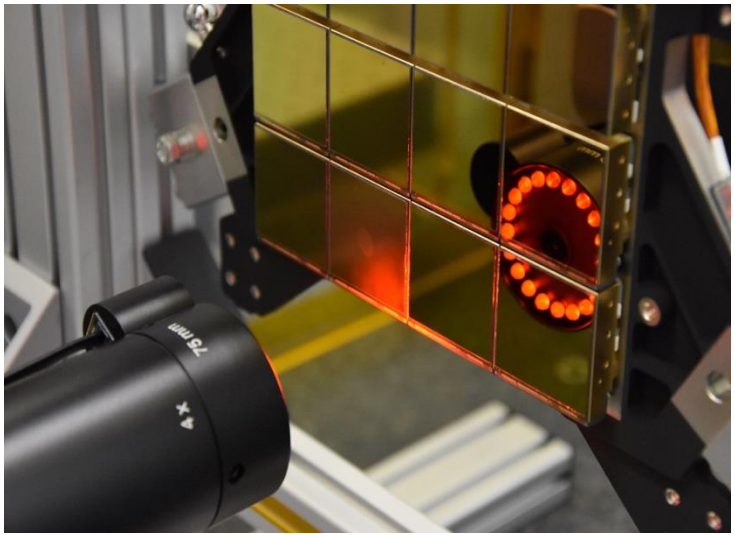
VIS – Visible Instrument: high-res camera to measure *weak lensing* - 36 4k x 4k CCDs, 0.1" / pixel, 550-900 nm

NISP – Near Infrared Spectrometer and Photometer to measure photometric and spectroscopic redshift –
16 2k x 2k H2RG detectors, 0.3 " / pixel, 3 photometric bands: Y_E, J_E, and H_E from 900 to 1900 nm;
2 grisms: blue from 900 to 1400 nm, and red from 1200 to 1900 nm

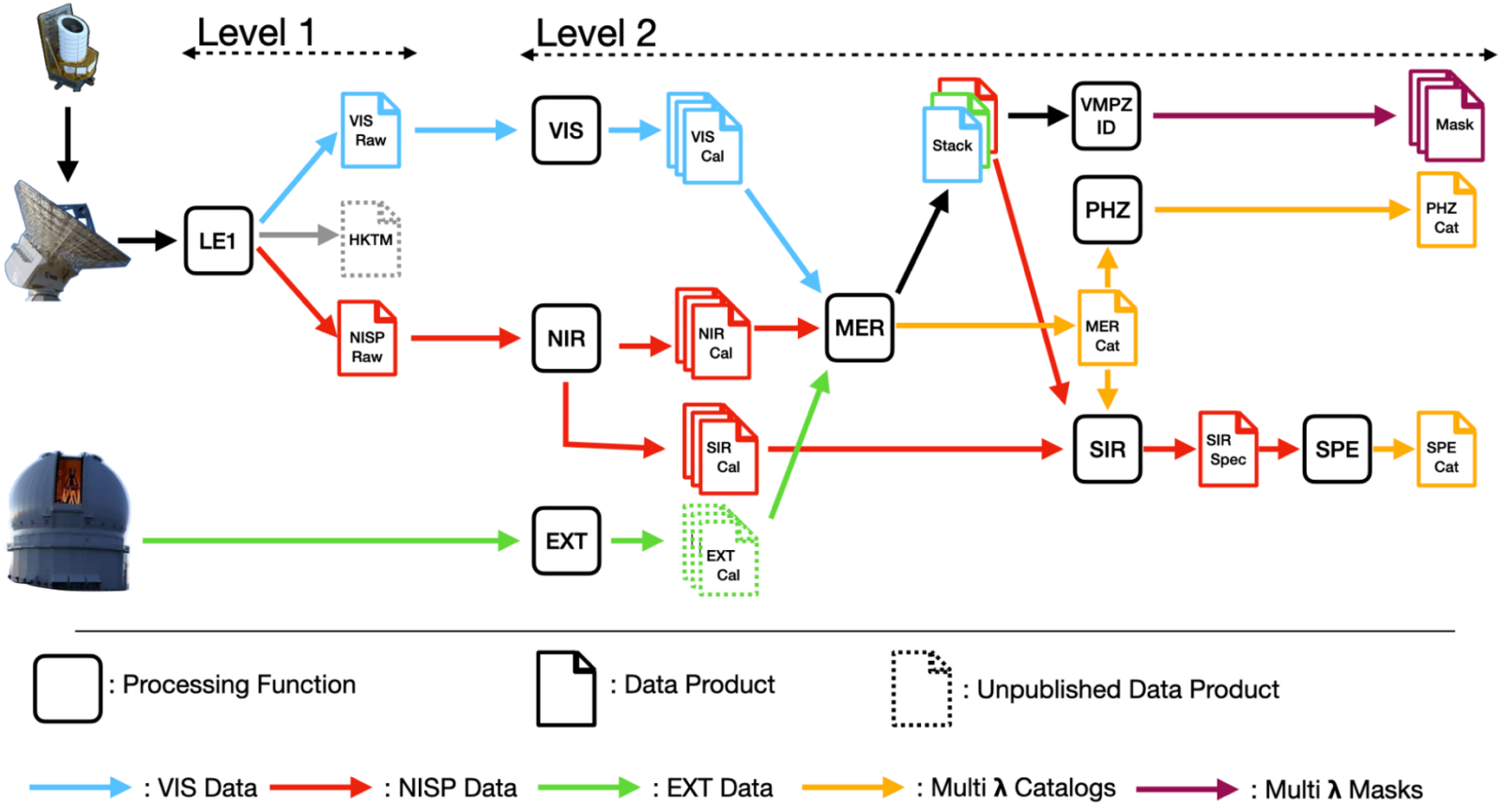


EC: Jahnke et al., 2025, A&A, 697, A3

Credit: Euclid Consortium / NISP IDT

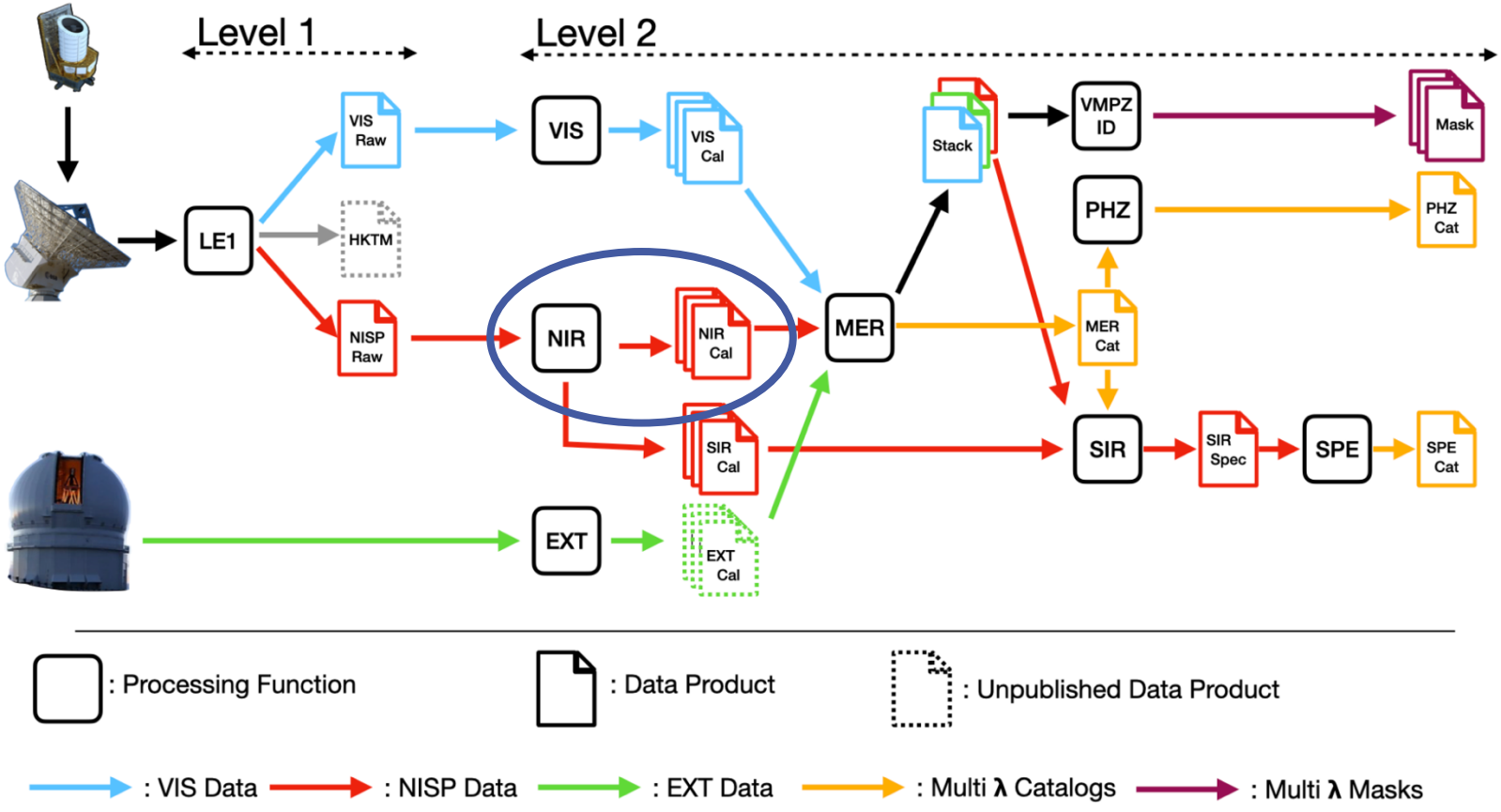


The *Euclid* Science Ground Segment



EC: Aussel et al., 2025, arXiv:2503.15302

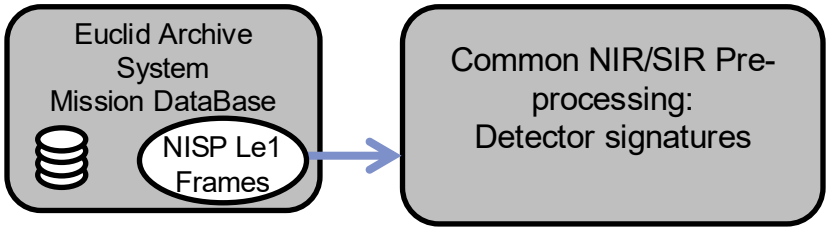
The *Euclid* Science Ground Segment

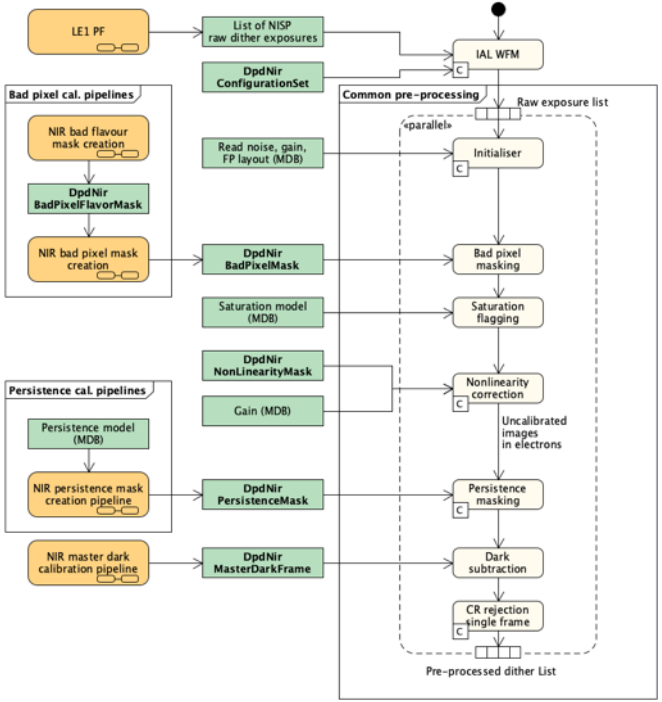


EC: Aussel et al., 2025, arXiv:2503.15302

The NIR processing function

EC: Polenta et al., 2025, arXiv:2503.15304





The NIR processing function

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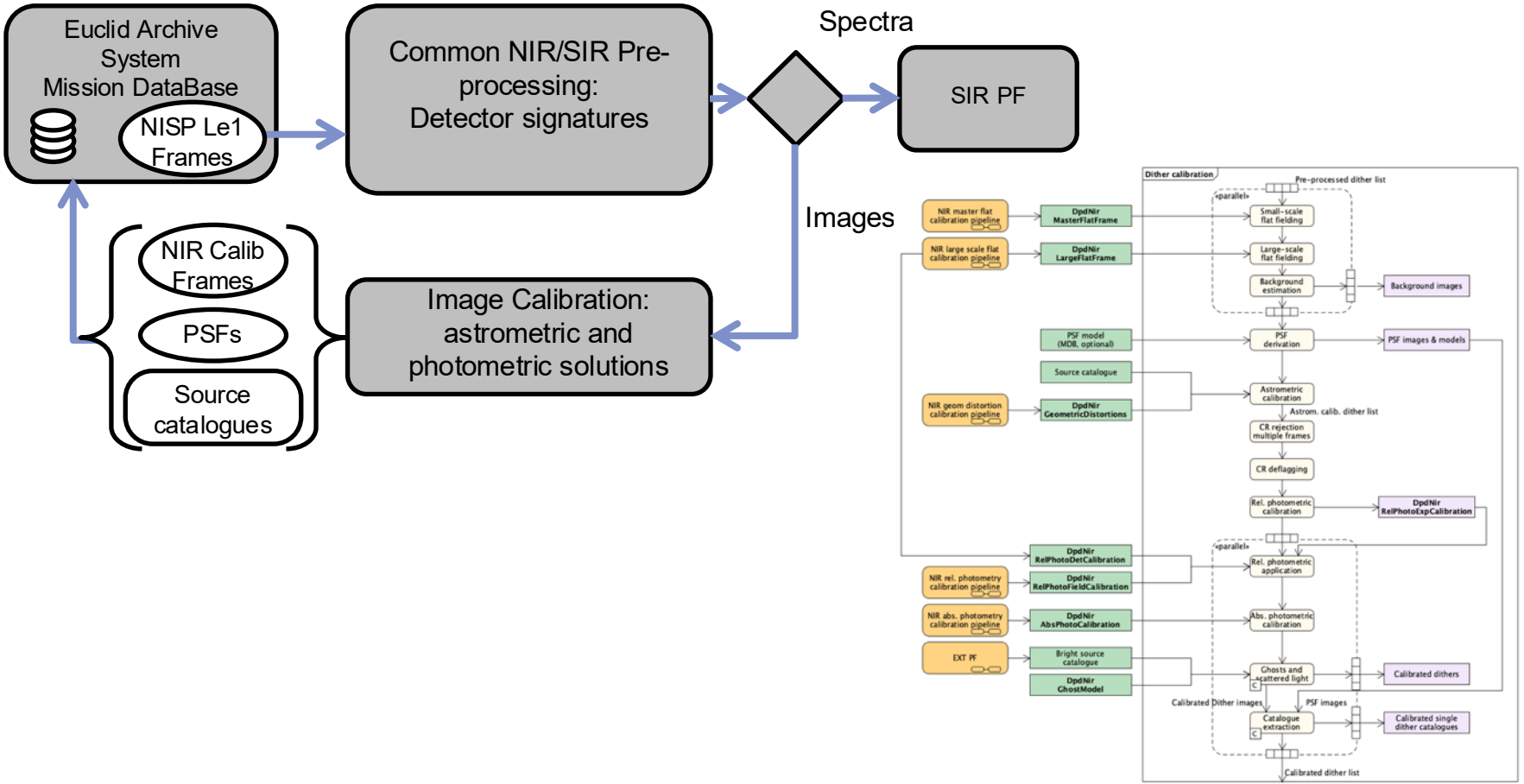

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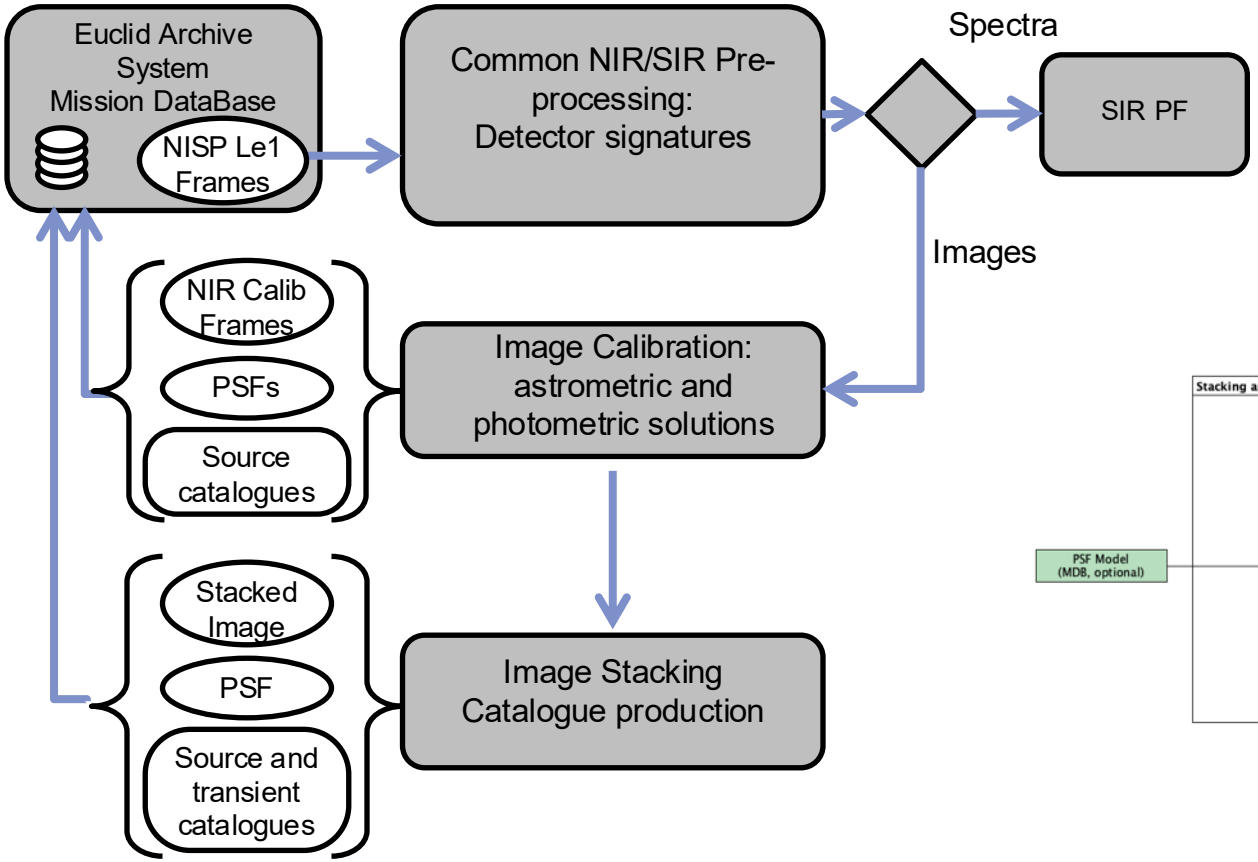

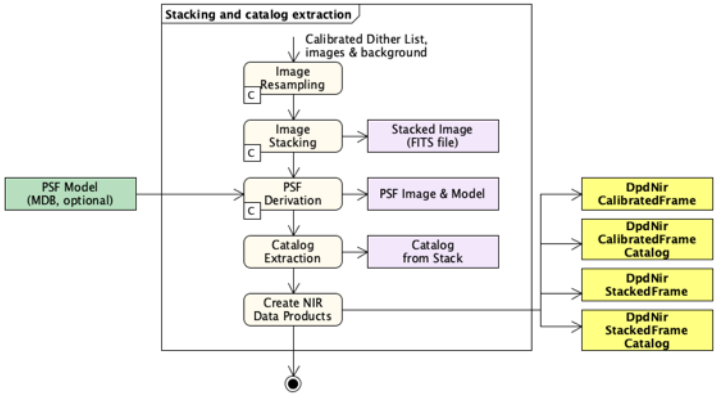

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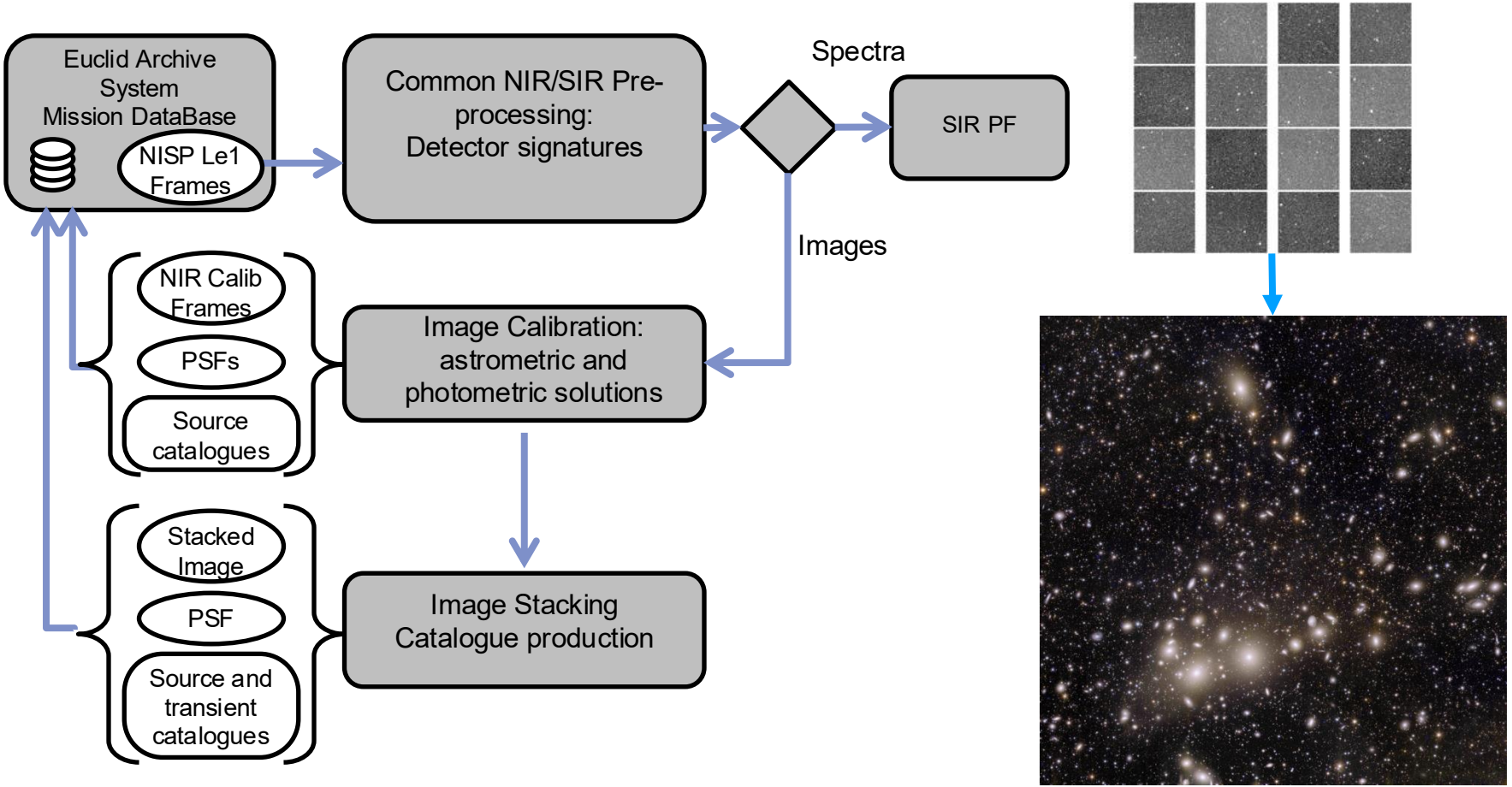
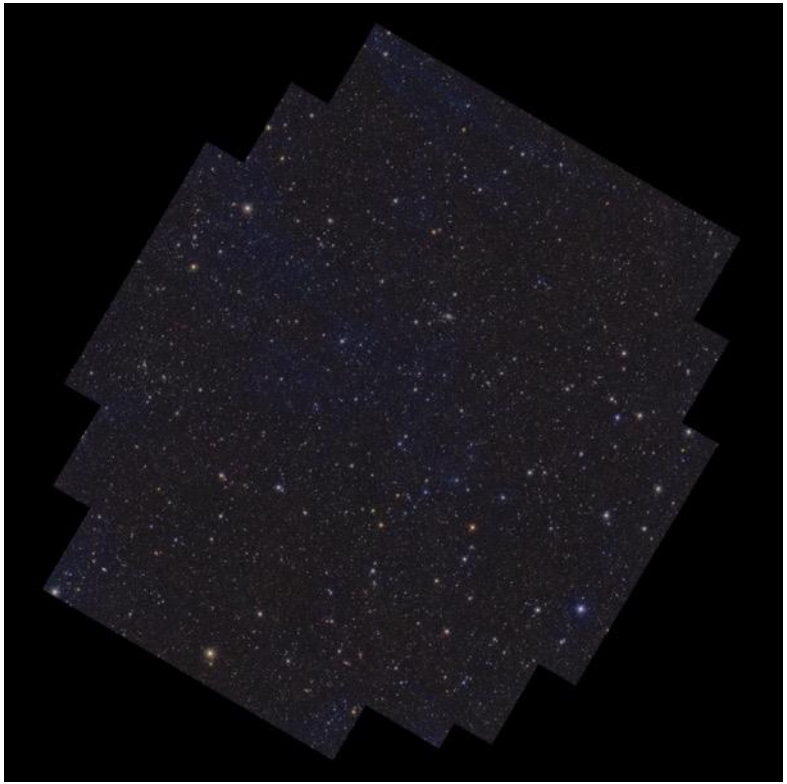


The *Euclid* Quick Data Release 1 – Q1

EC: Aussel et al., 2025, arXiv:2503.15302
Q1 data: https://doi.org/10.57780/esa-2853f3b

Observations to single-visit depth of the three *Euclid* Deep Fields: North, South, and Fornax



EDF-N Preview. Credit:ESA/Euclid/Euclid Consortium/NASA

EDF-S – 70x zoom. Credit:ESA/Euclid/Euclid Consortium/NASA

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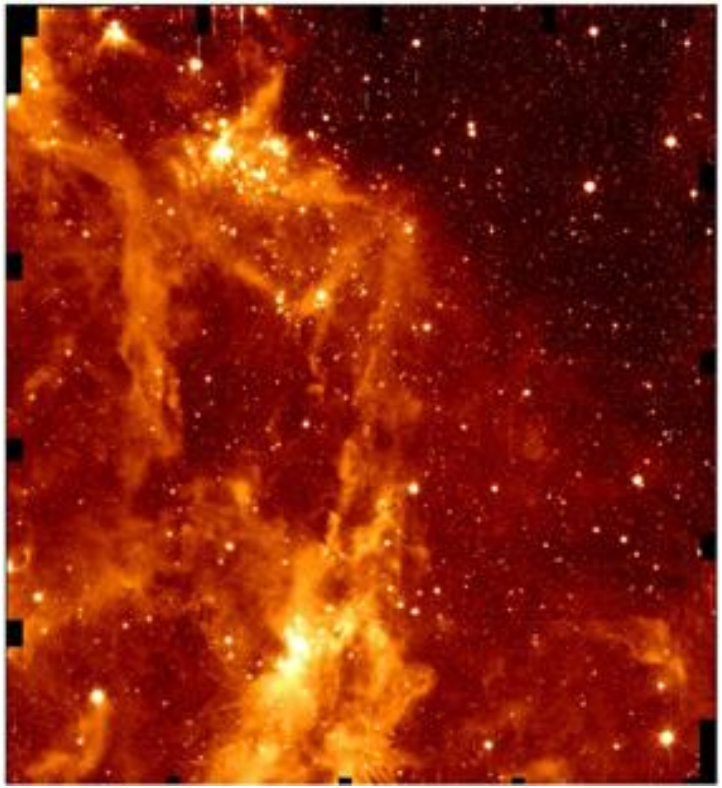
Observations to single-visit depth of the three *Euclid* Deep Fields: North, South, and Fornax

Observations of the Lynd's Dark Nebula LDN1641, an extended dust-obscured part of the Orion A Cloud

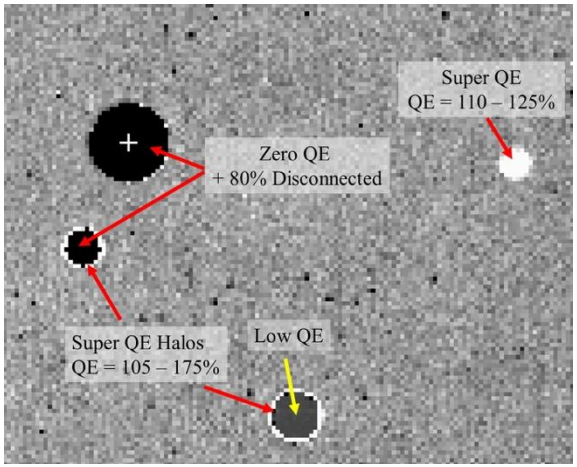


Shopping cart

Detector effects seen on NISP detectors and accounted for in the NIR PF:

- baseline and DNL outliers
- read noise
- unstable channels
- bad pixels & cosmetic defects
- gain
- non-linearity and saturation
- persistence
- dark current
- QE
- IPC
- + unaccounted (snowballs, 1/f, IPS, …)
- + known unknowns
- + unknowns
- …

Bad pixels and cosmetic defects



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1	OBMASK	On-board flags	
2	DISCONNECTED	Disconnected	Yes
3	ZEROQE	Zero QE	Yes
4	BADBASE	High or Low Baseline	Yes
5	LOWQE	QE < 74% at $1120 \leq \lambda/\mathrm{nm} \leq 2020$ QE < $(64 + (\lambda/\mathrm{nm} - 920)/20)\%$ at $920 \leq \lambda/\mathrm{nm} \leq 1120$.	
6	SUPERQE	Pixel QE > 110%	Yes
7	HOT	Pixels with dark current signal falling 3 σ above the detector median	
8	RTN	Random Telegraph Noise	Yes
9	SNOWBALL	Very energetic internal deposit of signal in pixels	Yes
10	SATUR	Saturated Pixel	Yes
11	NLINEAR	Pixels whose signal in electrons are below or above the applicable signal limits	
12	NLMODFAIL	Pixels whose linear correction model failed	Yes
13	PERSIST	Pixels affected by persistence charge from previous sources	Yes
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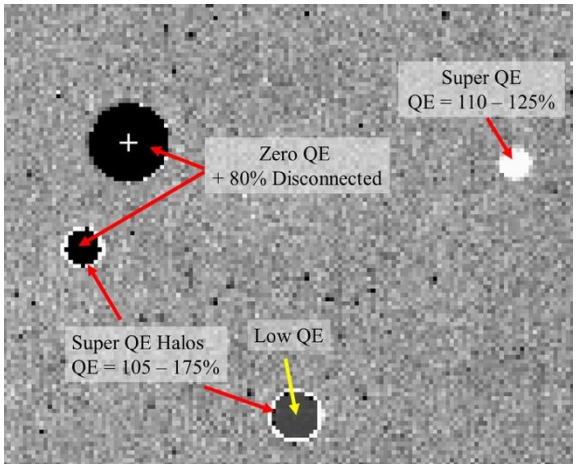
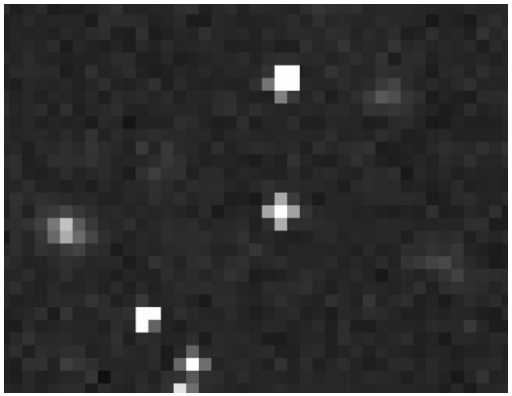
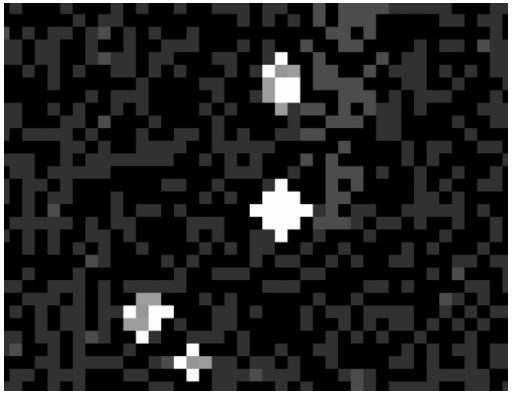
EC: Polenta et al., 2025, arXiv:2503.15304

Bad pixels and cosmetic defects







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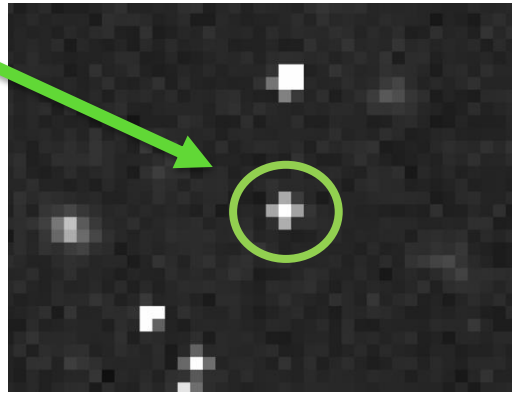
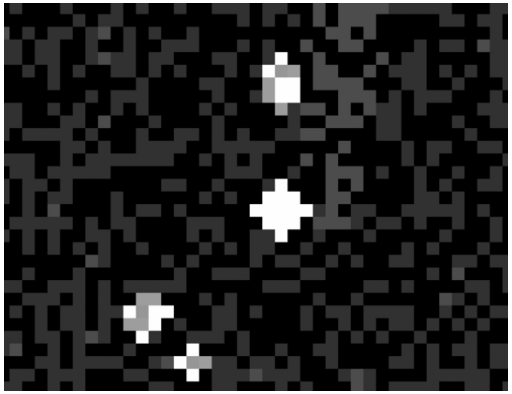
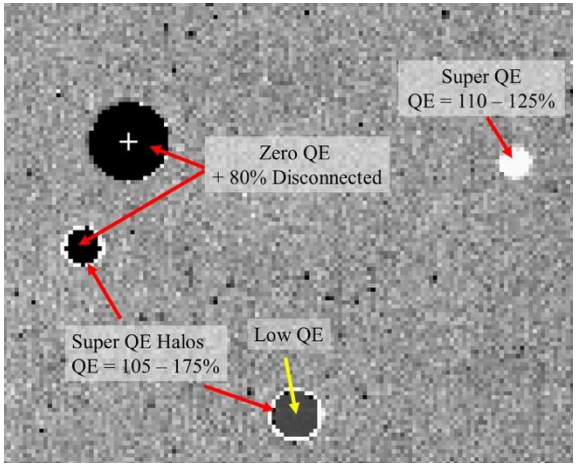
Bad pixels and cosmetic defects

CR event + IPC







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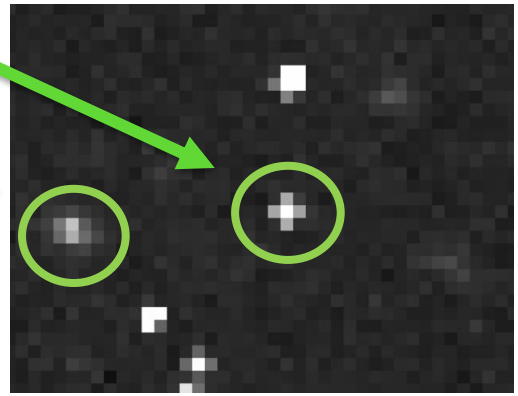
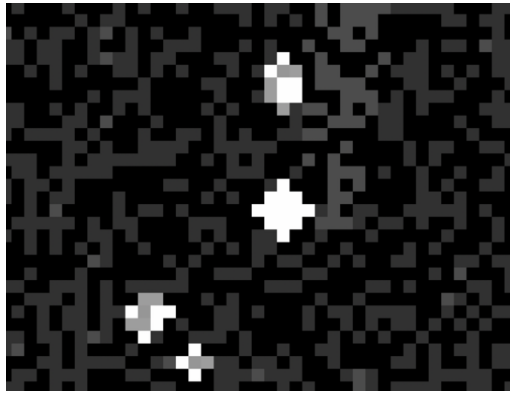
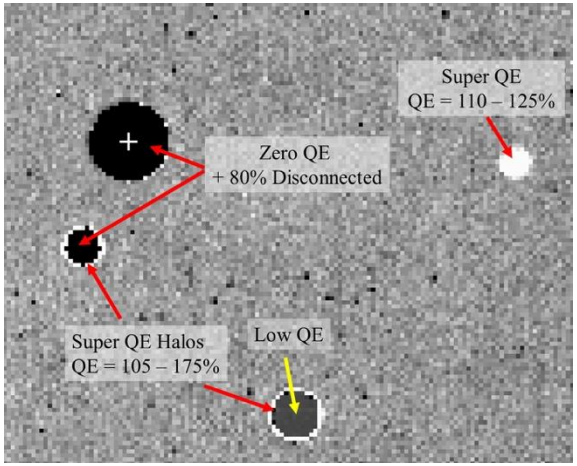
Bad pixels and cosmetic defects

CR event + IPC

Real point source
undersampled PSF
size ~ CR+IPC







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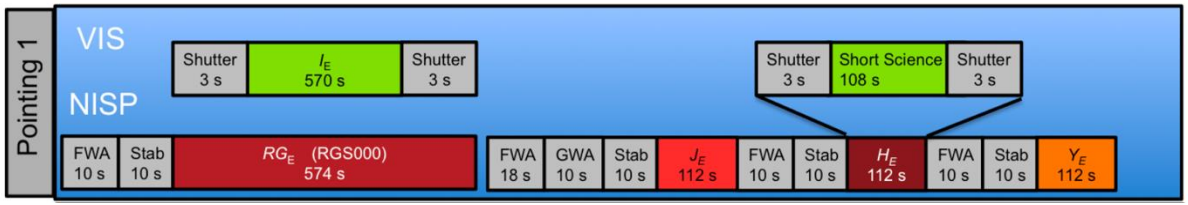
Persistence Masking



Euclid NISP obs sequence:

Spectro -> J_E -> H_E -> Y_E

EC: Scaramella et al., 2022, A&A, 662, A112

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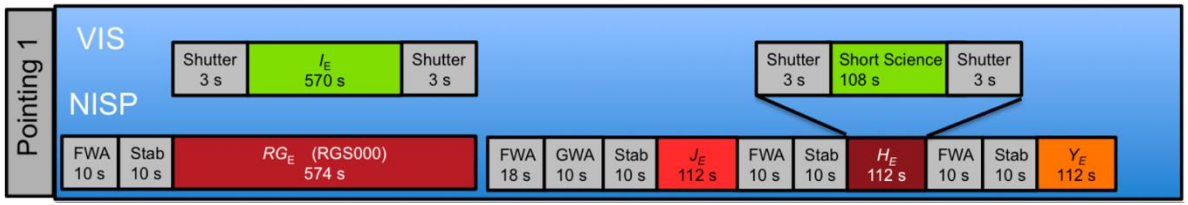

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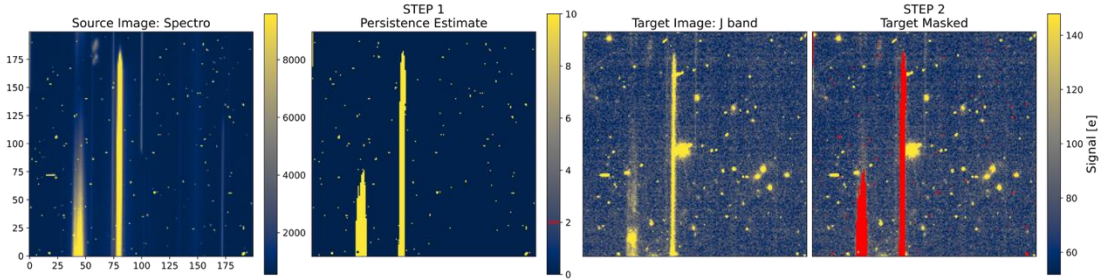
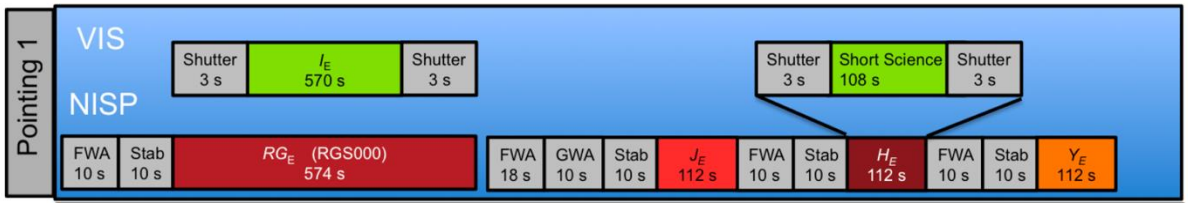


Q1

Effective model from ground calibration

Single spectroscopic observation

Persistence Masking



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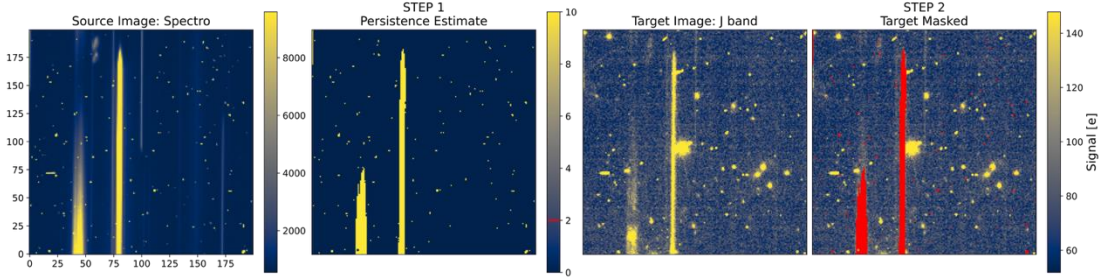

Q1

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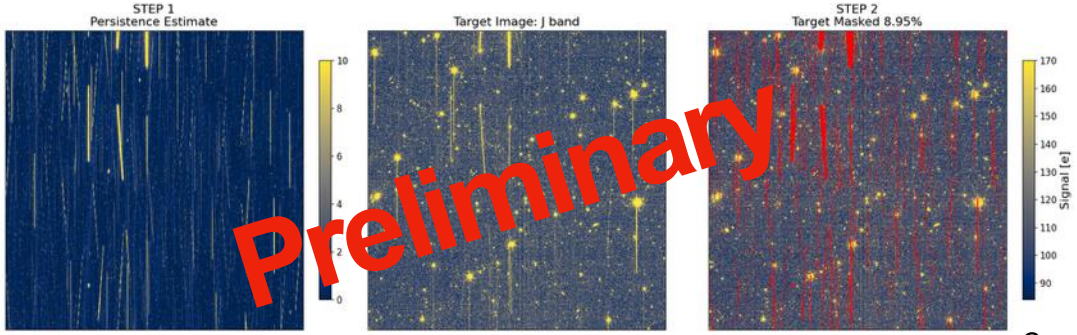
Single spectroscopic observation



DR1

Power law model based on PV flight data

5 hours history of spectroscopic observations

Hough transform

Courtesy of B. Kubik

Persistence Masking: Q1 vs DR1

old persistence masking (Q1)

New persistence masking (DR1)

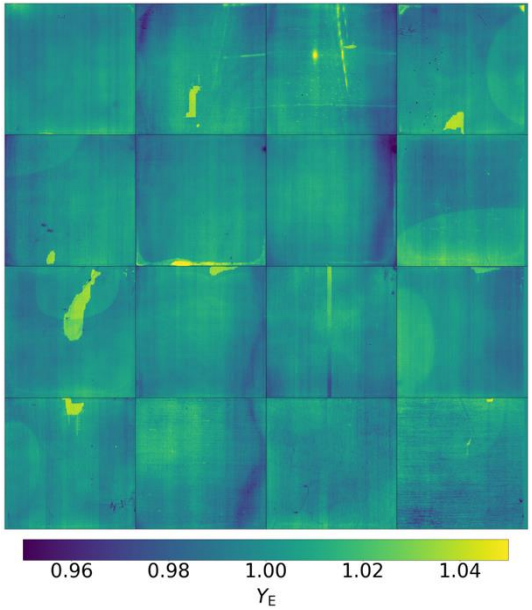
Persistence masking vs correction

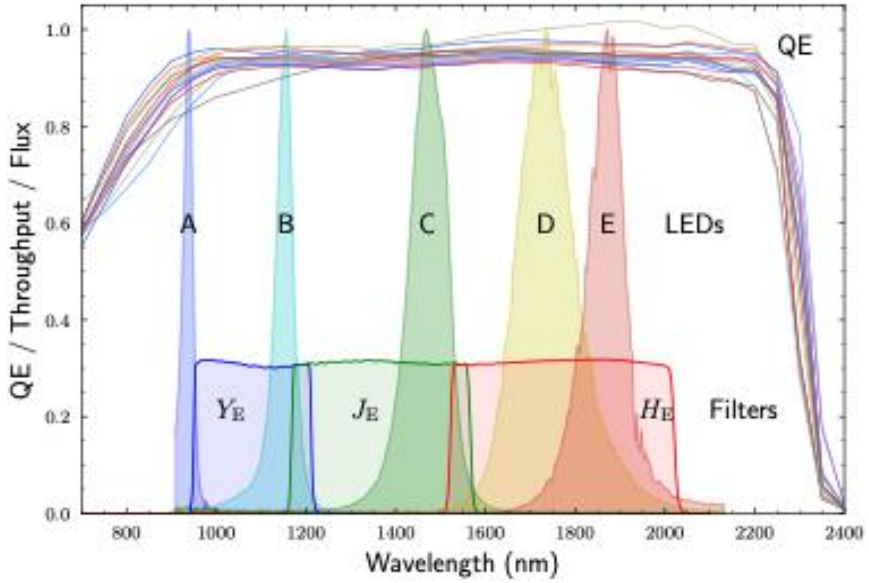
Power law model derived from dedicated calibration observations – LED flat + darks:

- good masking using 5hrs history + Hough transform
- accuracy not enough to correct for persistence:
  - temporal stability
  - dependence from counts/incoming signal
- very long time scale, issue for CR showers possibly leading to flagging a high fraction of the focal plane for few hrs:
  - persistence for CRs vs persistence from photons
- coupling with other detector effects, e.g. NL & saturation, QE, etc.

PRNU correction from LED flats

Master PRNU flats computed from NI-CU LED frames





EC: Polenta et al., 2025, arXiv:2503.15304
EC: Hormuth et al., 2025, A&A, 697, A4

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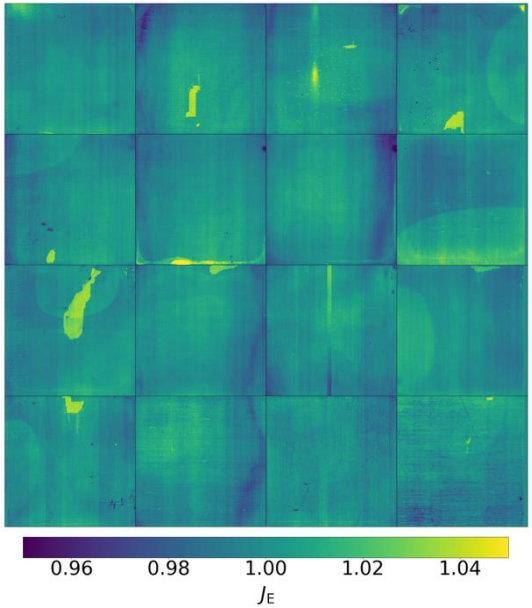

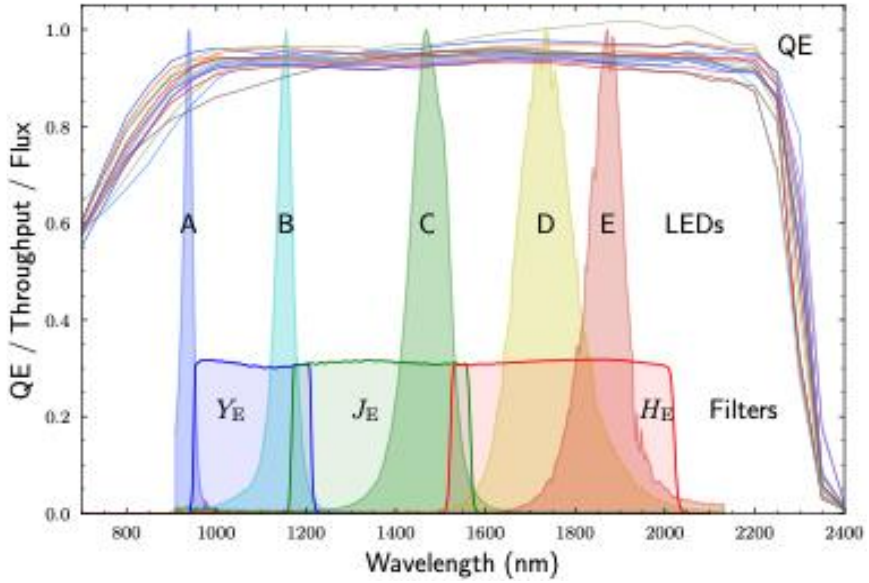

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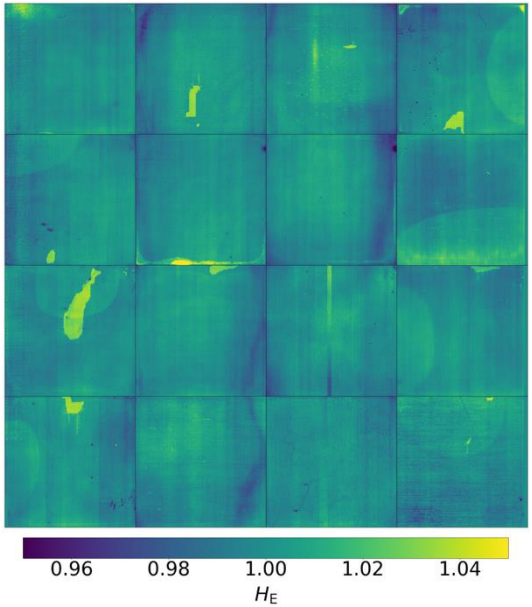
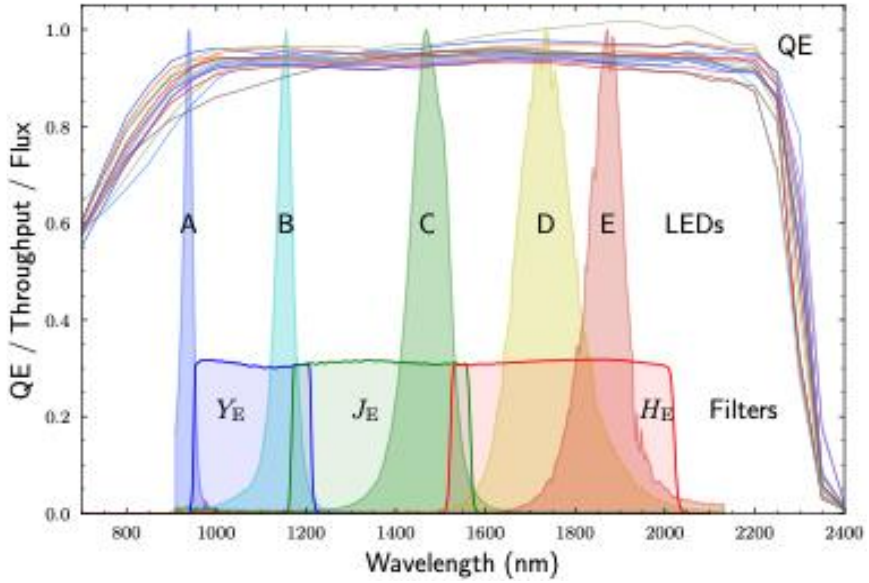
PRNU correction from LED flats

Master PRNU flats computed from NI-CU LED frames

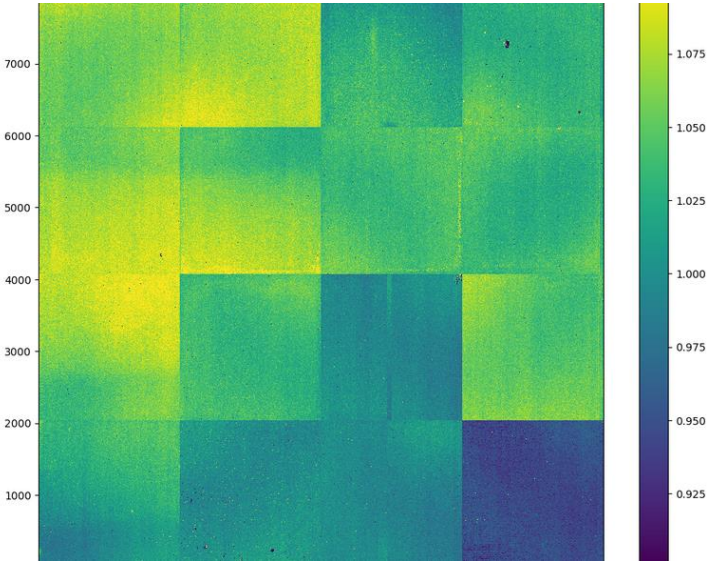




EC: Polenta et al., 2025, arXiv:2503.15304
EC: Hormuth et al., 2025, A&A, 697, A4

PRNU correction from LED flats

Good performance in flattening QE features but…



PRNU correction from LED flats

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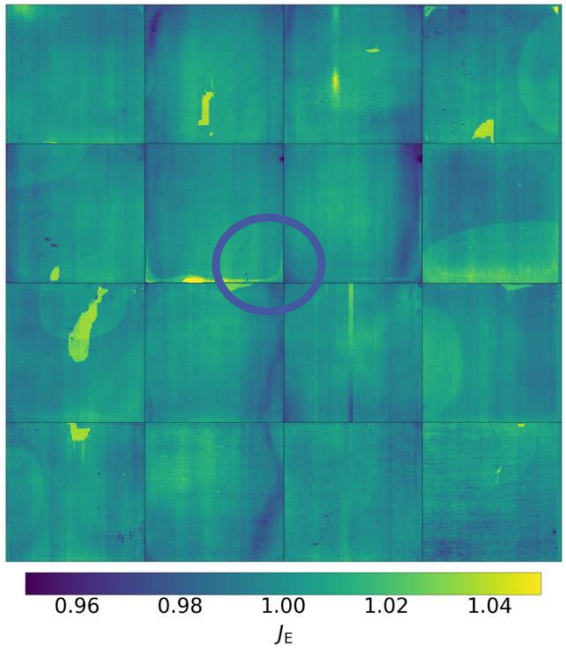
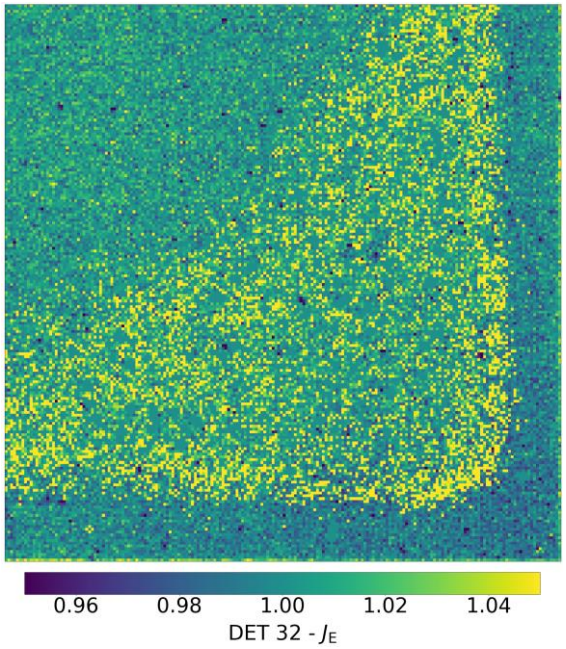


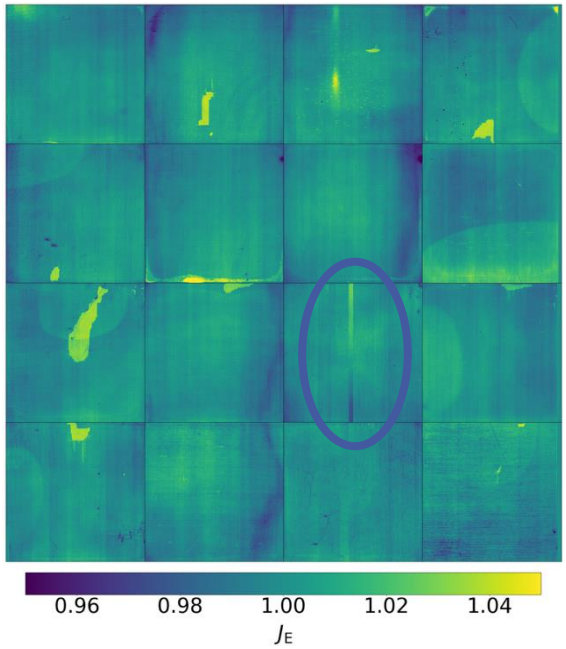


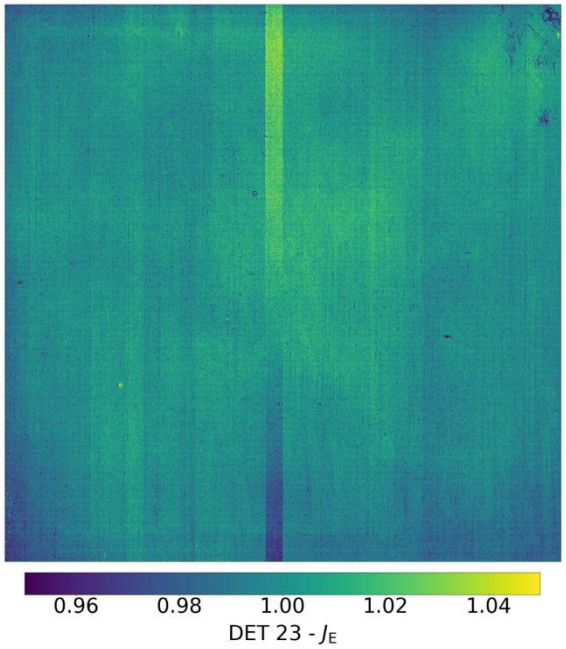
Preliminary

Flowers

PRNU correction from LED flats

Good performance in flattening QE features but…



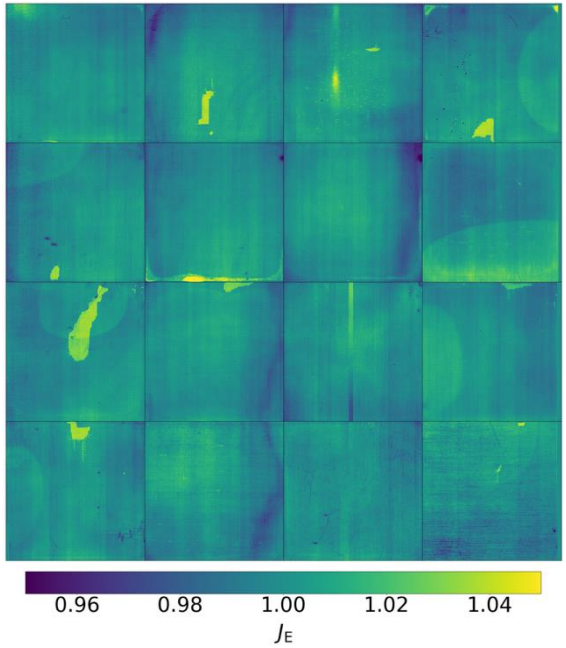


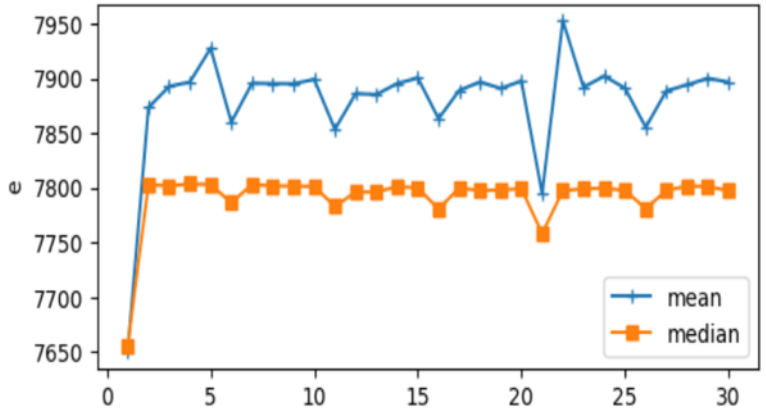
Preliminary

Unstable channels

PRNU correction from LED flats

Good performance in flattening QE features but…





Courtesy of Y. Fu

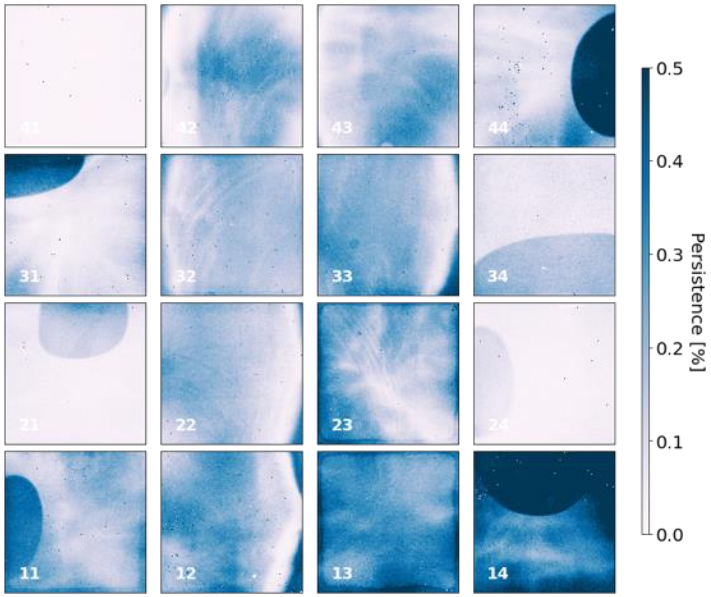
Preliminary

Persistence

Large scale flat and persistence

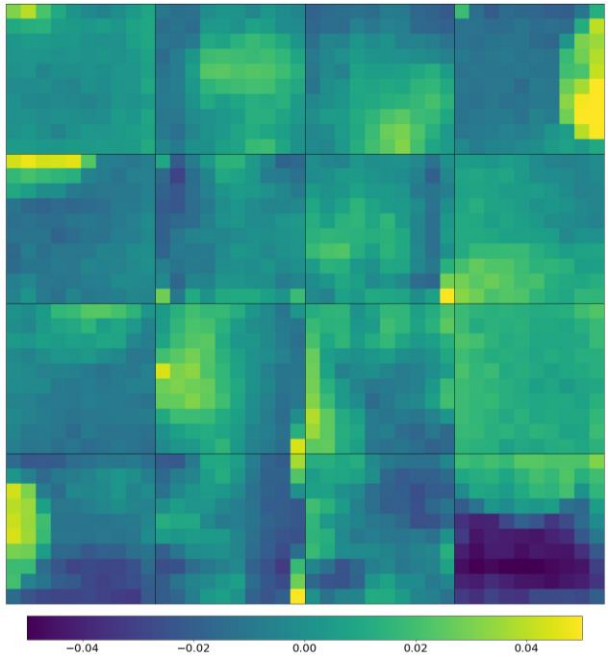
EC: Polenta et al., 2025, arXiv:2503.15304

LSF computed from self-cal field observations



Persistence template

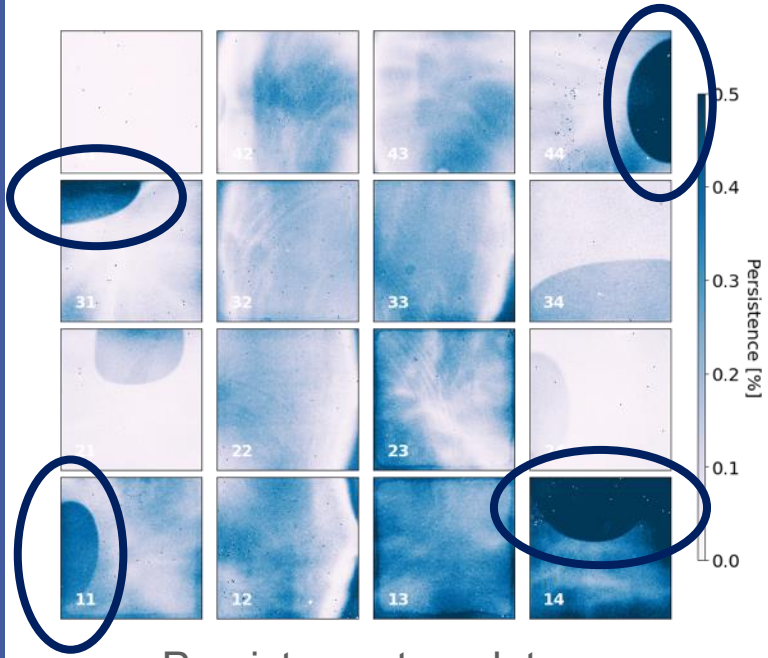
H_E band LSF



Large scale flat and persistence

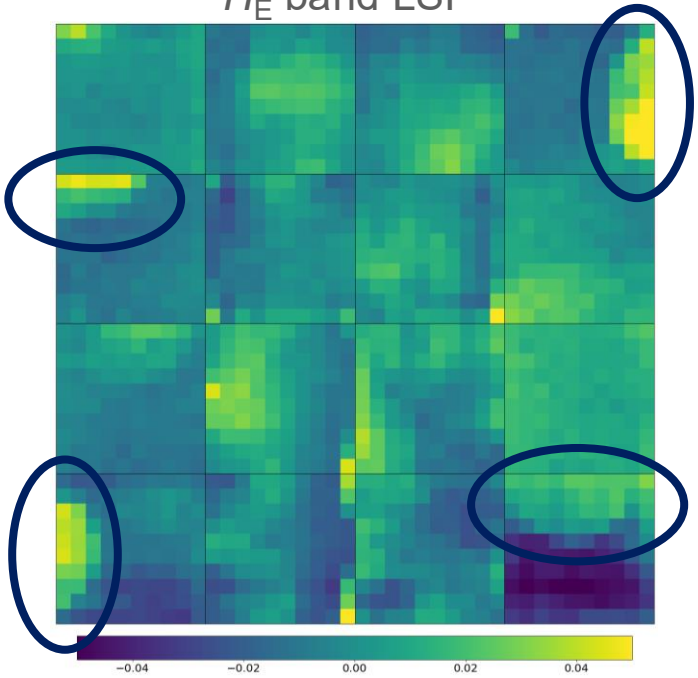
EC: Polenta et al., 2025, arXiv:2503.15304

LSF computed from self-cal field observations



Persistence template

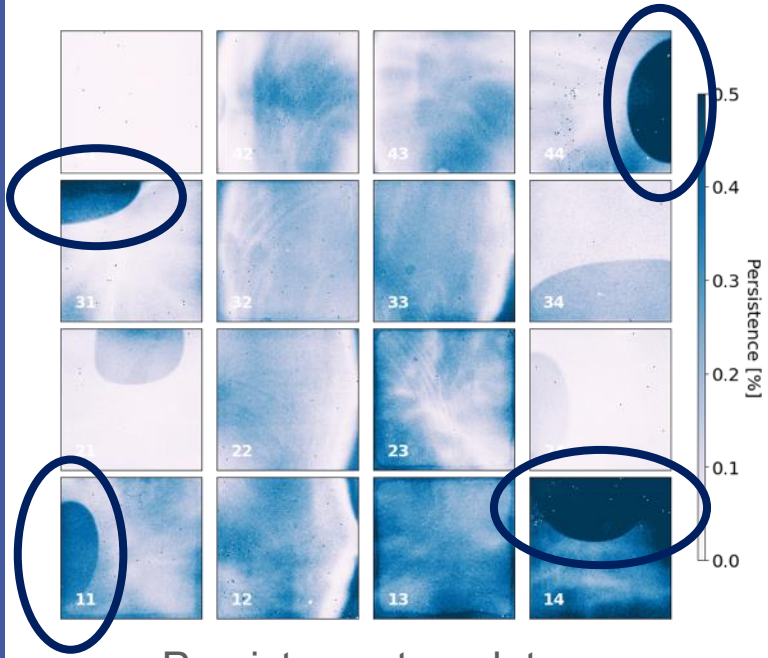
H_E band LSF



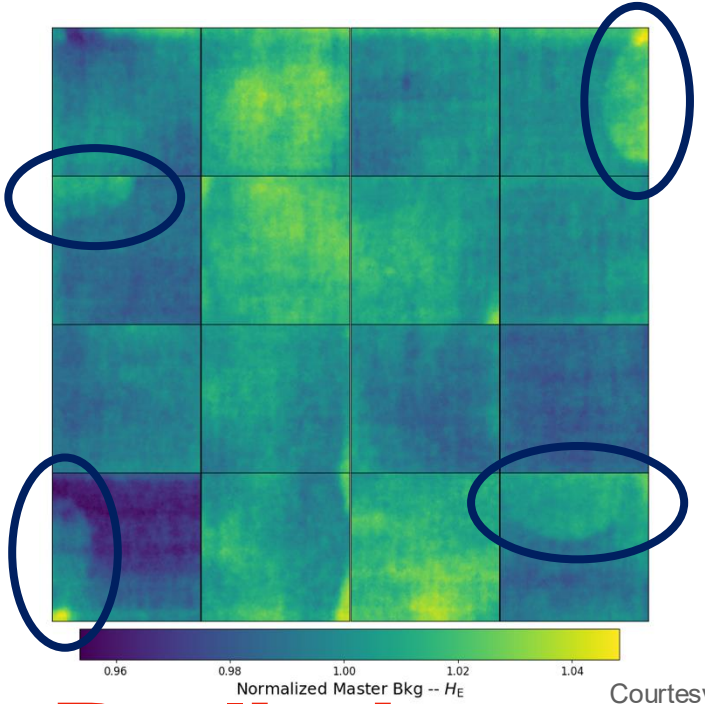
Large scale flat and persistence

EC: Polenta et al., 2025, arXiv:2503.15304

Superflat computed from stacking background observations



Persistence template

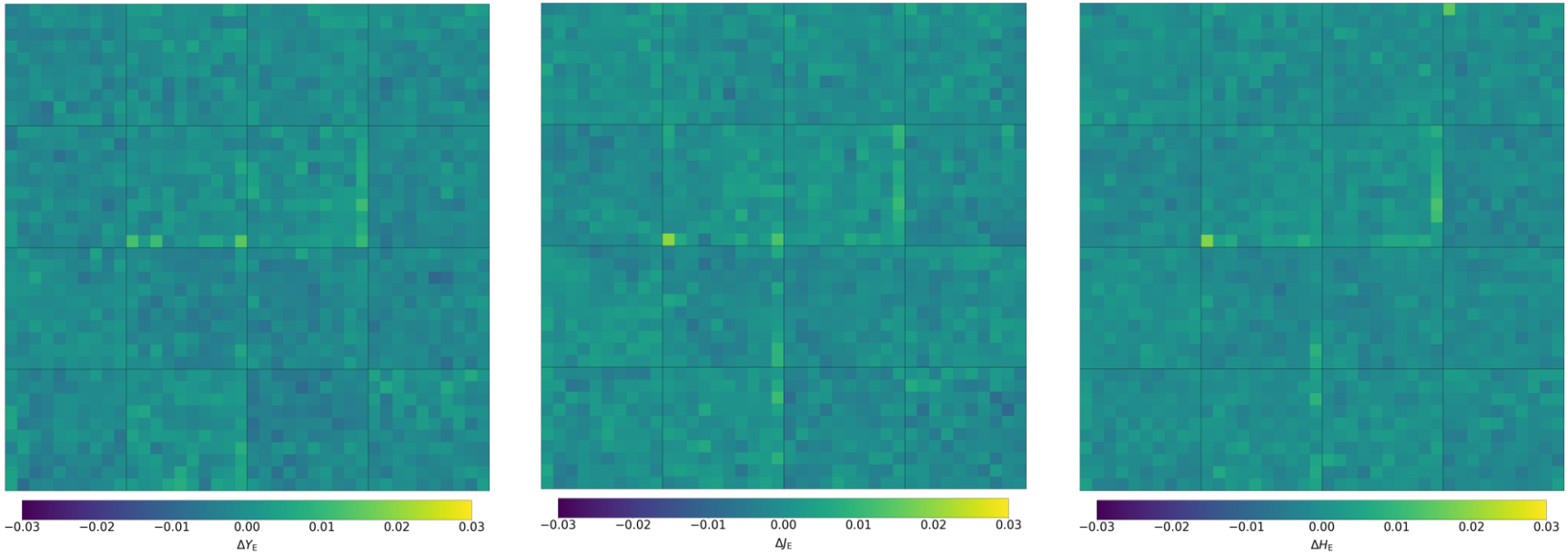


Courtesy of M. Correnti

Preliminary

Quality of the NIR Q1 images: photometric calibration

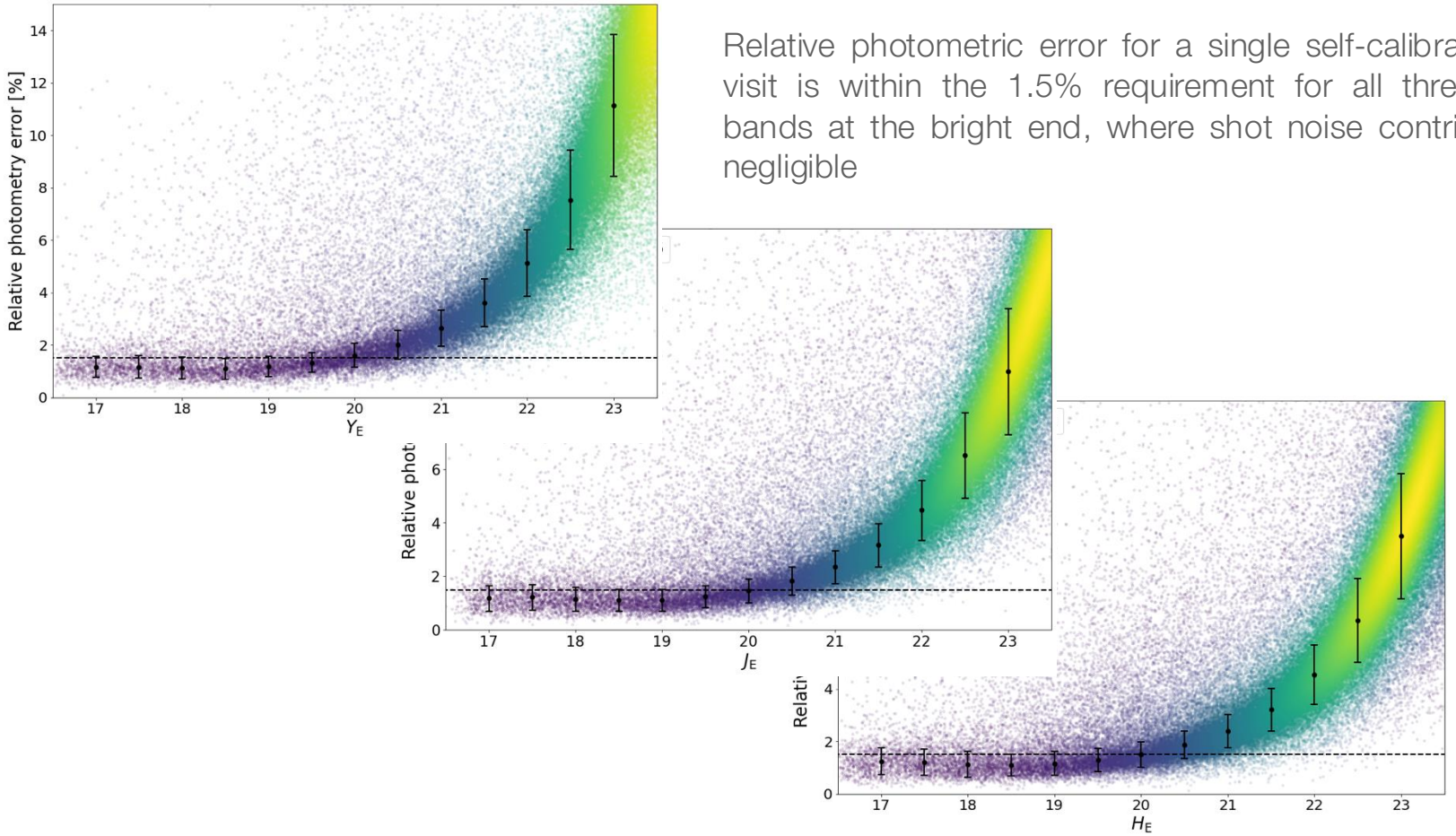
Self-calibration field



Euclid internal analysis averaging residual magnitudes for all sources in the self-cal field as function of focal plane position

No major spatial dependencies at the level of ~0.01mag

Quality of the NIR Q1 images: photometric calibration



Relative photometric error for a single self-calibration field visit is within the 1.5% requirement for all three *Euclid* bands at the bright end, where shot noise contribution is negligible

Discussion and conclusions

- *Euclid* 6-year nominal operations started on Feb 2024
- Q1 release showed the *Euclid* potential: 63.1deg^2, EDF-N, EDF-S, and EDF-F to single-visit depth, Lynd's Dark Nebula LDN1641
- The NIR PF provides calibrated images for Q1 compliant with astrometric and photometric requirements
- Main known limitations have been addressed for the *Euclid* Data Release 1
  - Improved persistence masking, bad pixels, non-linearity (+background, PSF, ice and throughput changes, …)
  - some more features being implemented in preparation for DR2
- DR1: ~1.500 deg^2 public release at the end of 2026

Stay tuned!