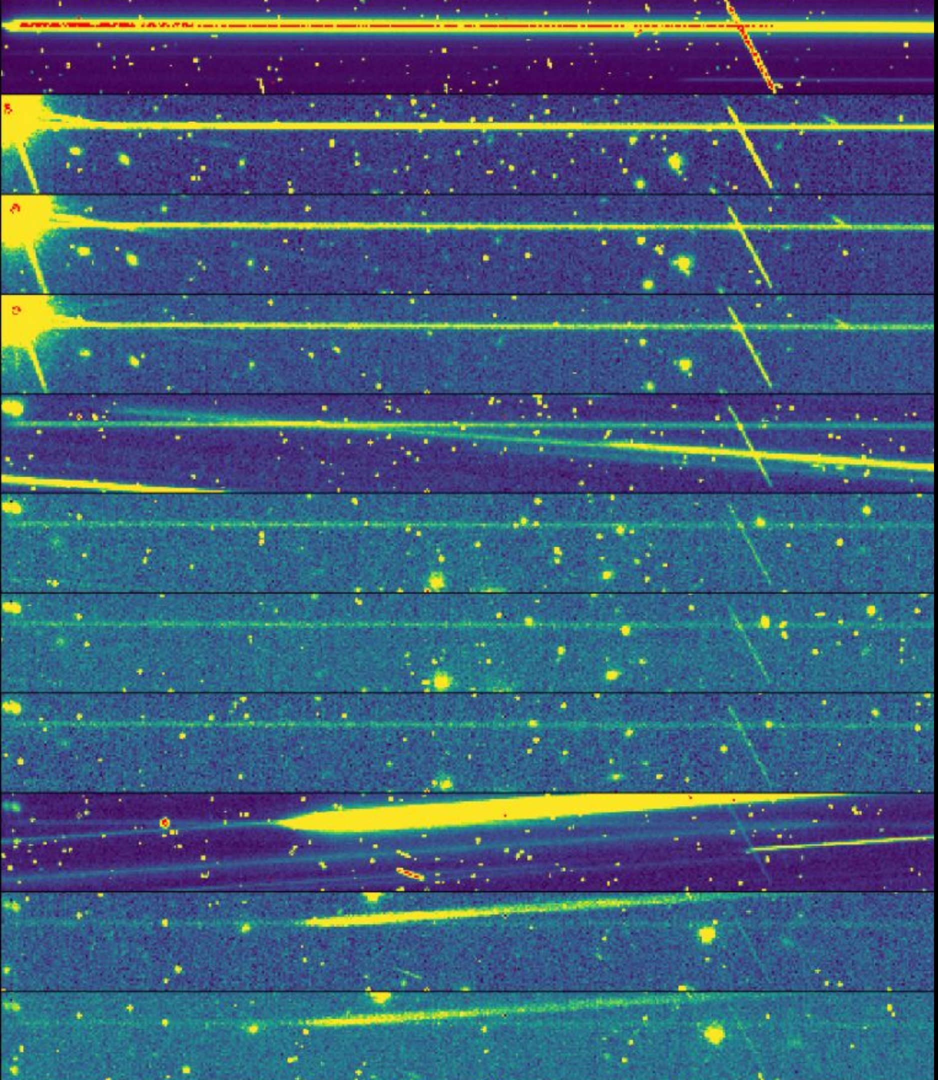

Euclid - Persistence In-flight calibration

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on behalf of the *Euclid* Collaboration

InfraRed detectors In Space (IRIS 2026) Workshop

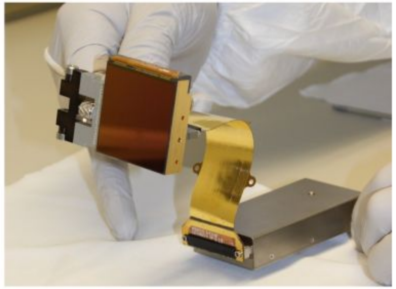
euclid consortium

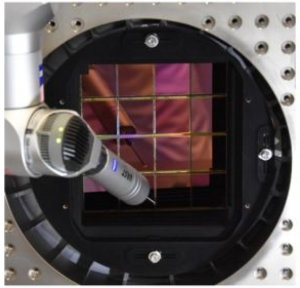
iP2i LES 2 INFINIS LYON

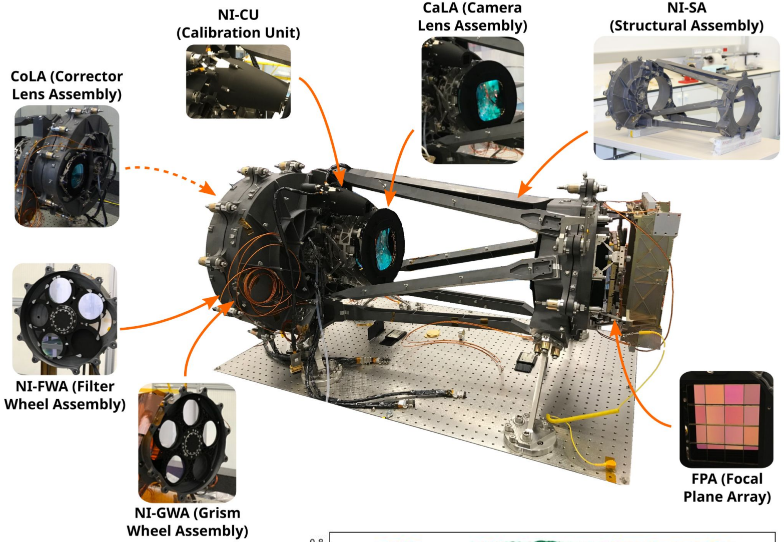
Near-Infrared Spectrometer & Photometer (NISP)

- Large field of view (~0.5 deg^2)
- Mosaic of 16 2k x 2k H2RG detectors
- Operating at ~95K
- 900-2000 nm, 2 modes:
  - spectrometric (red and blue grisms)
  - photometric (Y_E, J_E, and H_E)

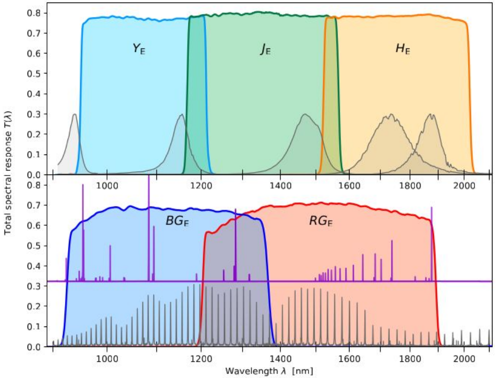
- **Detector ground characterisation:** ***Kubik et al. 2025*** [arXiv:2507.11326]





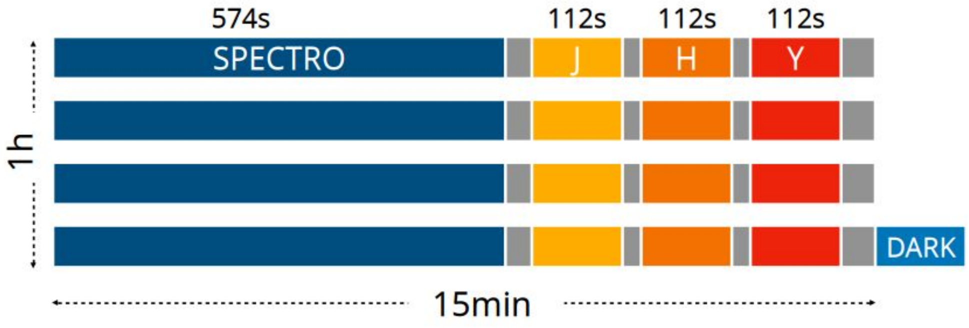


Credit: Jahnke et al. (2024)
The NISP Instrument

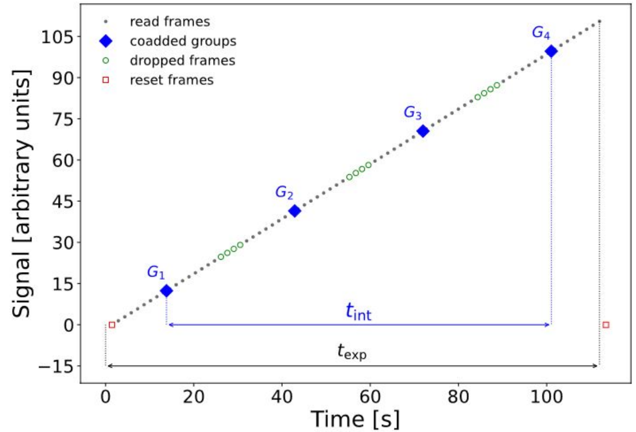


Euclid Wide Survey

- ~14’000 deg^2 in 6 years (>40’000 observations)
- Avoiding stars brighter than $m_{AB} < 4$
- **Reference Observation Sequence (ROS):**
  1 Observation = 4 dithers (SP, J, H, Y) ~1h

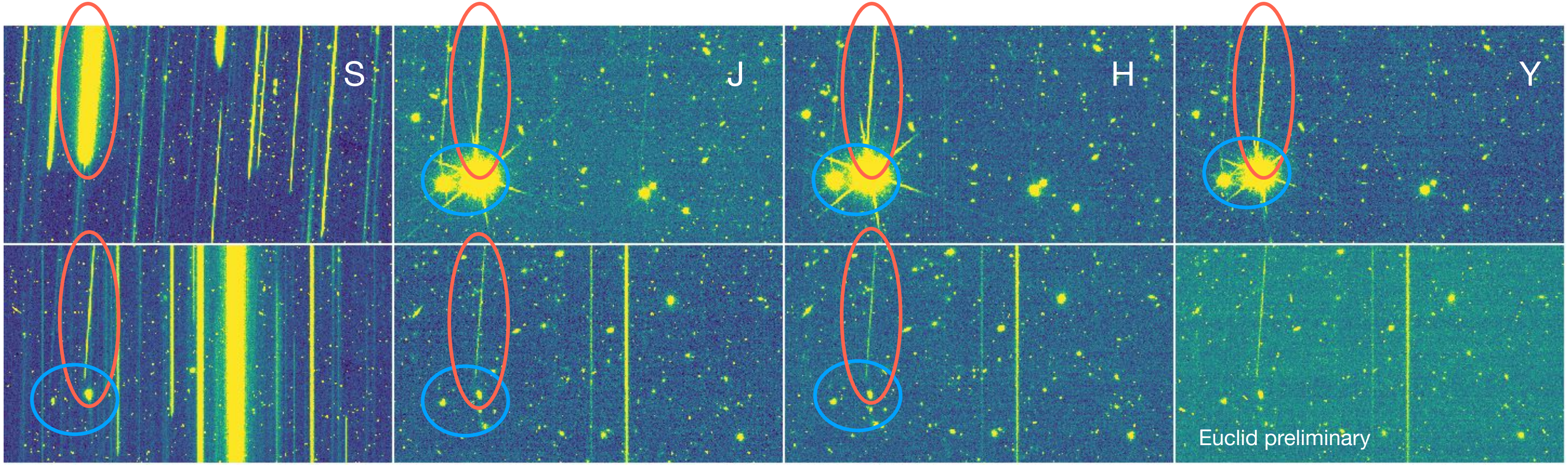


- **On-board ramp fit** (see *Kubik et al 2016* and Fabrizio’s talk)
- Spectro: MACC(15,16,11) ~574s
- Photo: MACC(4,16,4) ~112s



Credit: Euclid collaboration: Kubik et al. (2025)

Persistence impact



- Spectro-to-photo: spectral traces seen in photometric exposures
- Photo-to-photo (self-persistence)
- Spectro-to-spectro
- Photo-to-spectro
- Large scale background persistence

In-flight calibrations

- **Performance Verification phase (PV-016):**
  - Flat fields and darks with multiple fluxes

- **Monthly calibrations (F-018):**
  - Flat fields and darks, one flux (30kADU)

- Average persistence is <1% of stimulus
- Strong variations between detectors
- Strong spatial variations

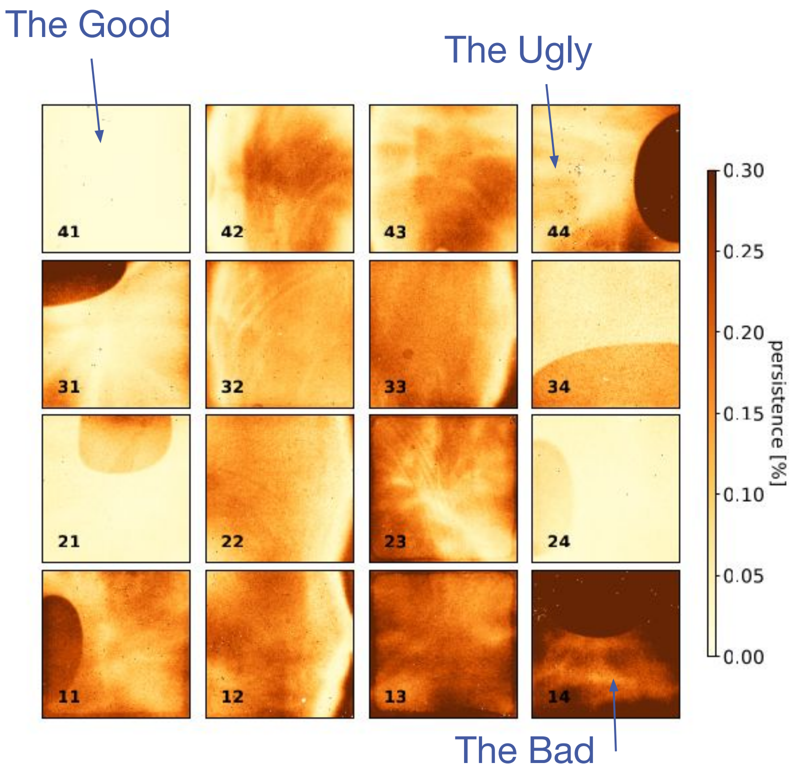
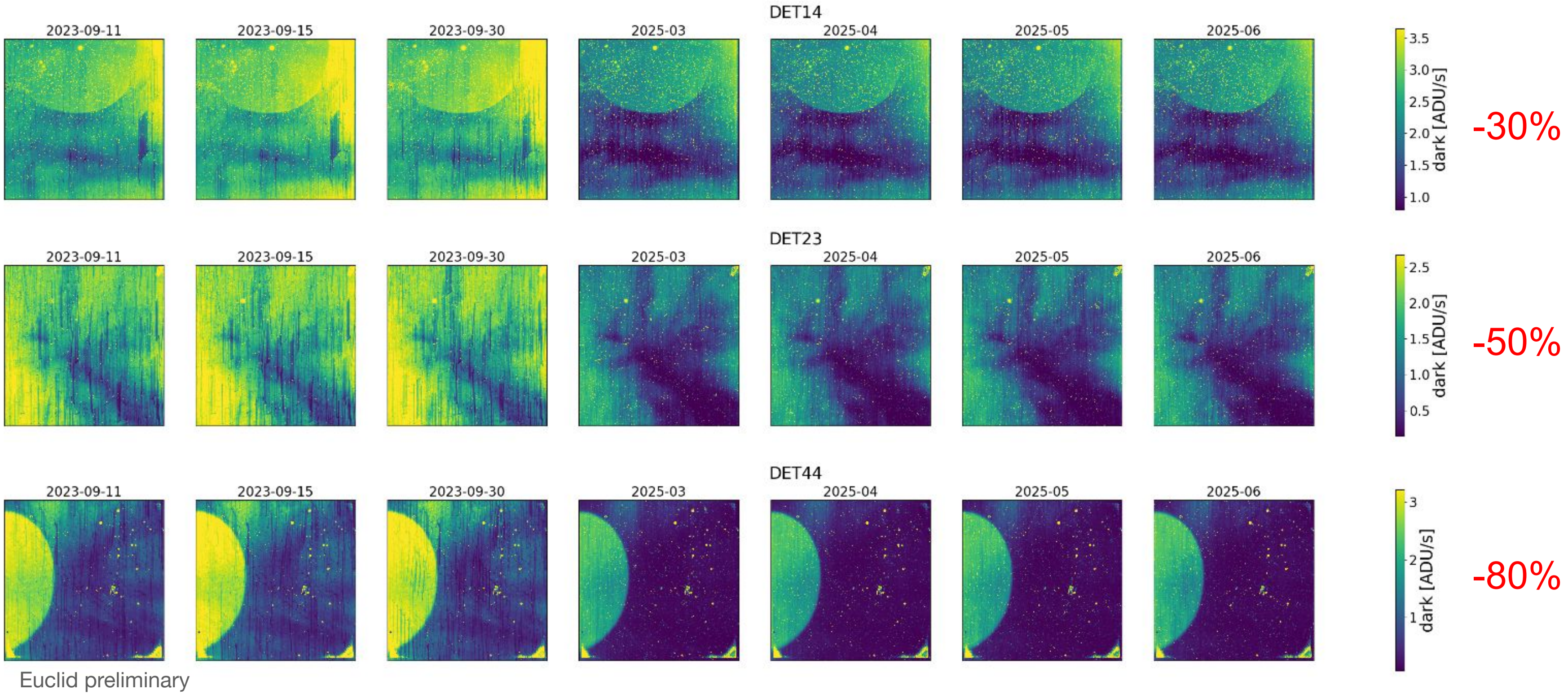


Fig. 19. Persistence amplitudes in percentage of the previous flat-field illumination below saturation.

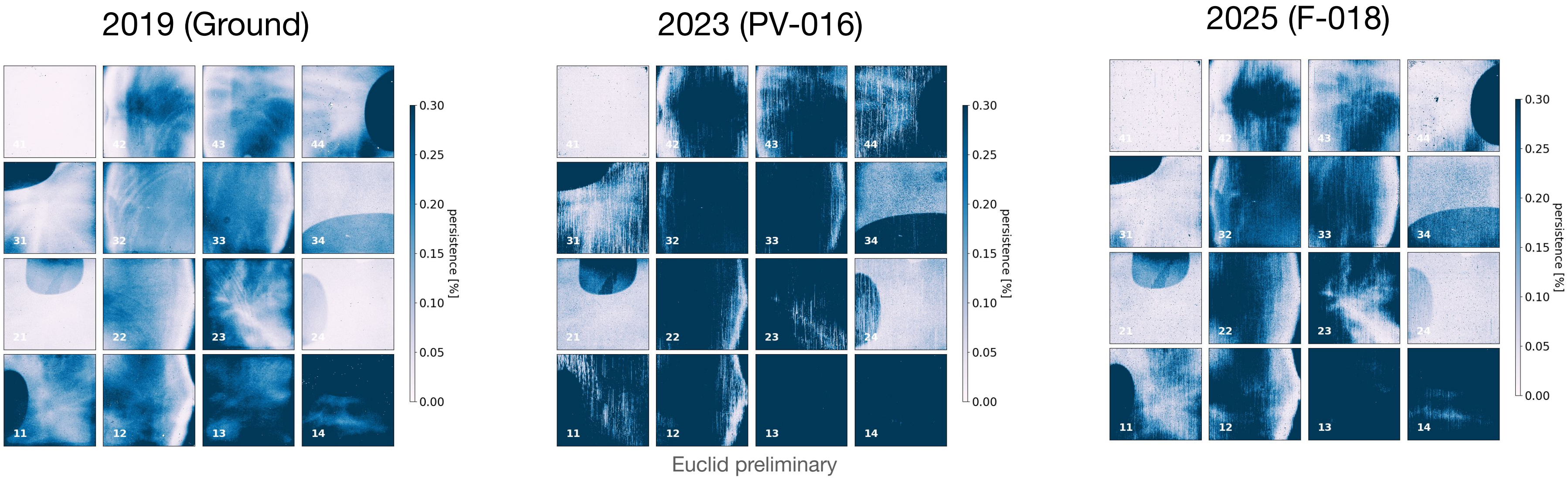
Credit: Euclid collaboration: Kubik et al. (2025)

Persistence evolution over time

First dark after 30 kADU flat, PV-016 (2023), F-018 (monthly since March 2025)



Relative persistence 30kADU

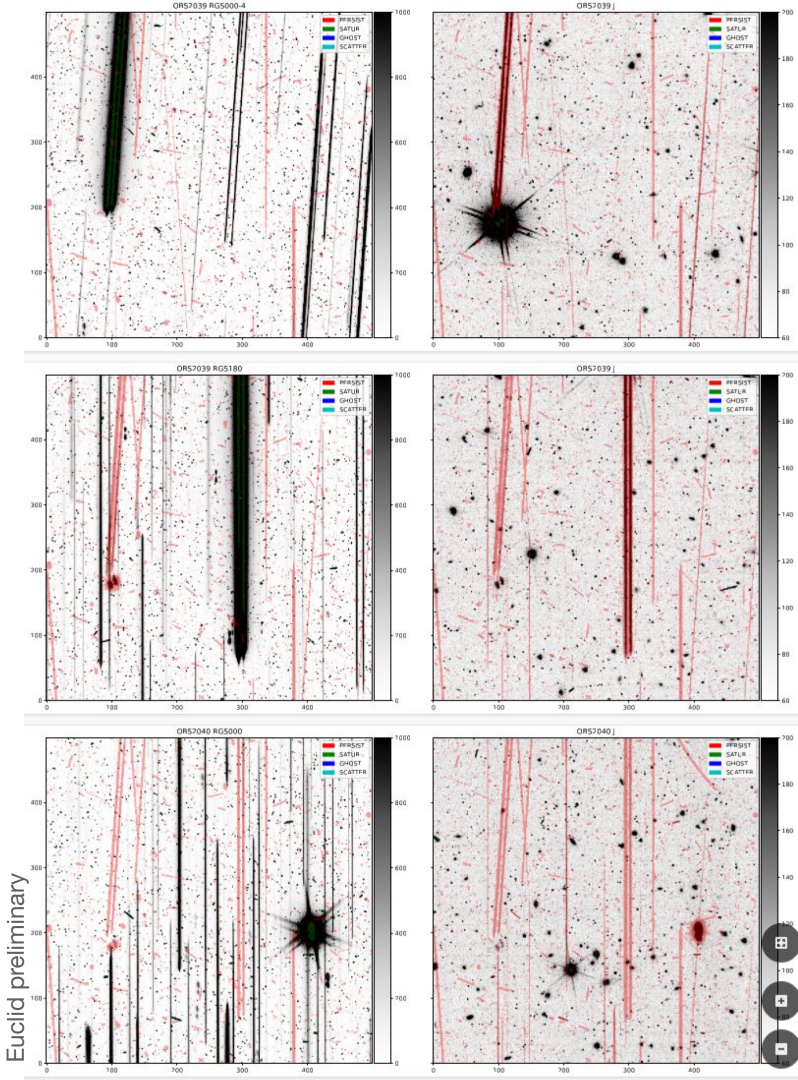


Persistence masking in the pipeline

DR1 (public release, end of 2026):

- Power law model (pixel based), fitted on PV-016 data (30kADU).
- Persistence image = accumulation of predicted persistence from images in the last **5 hours**
- **Persistence mask** with
  - **threshold = 2e$^-$ (spectro→photo)**
  - **threshold = 30e$^-$ (spectro+photo→spectro)**
- **Saturated pixels** are masked for 5 hours

- Masking parameters are very conservative, masking pixels for too long
- Masking ~5-8% of the pixels, and more when solar activity is important
- Huge improvement with respect to Q1

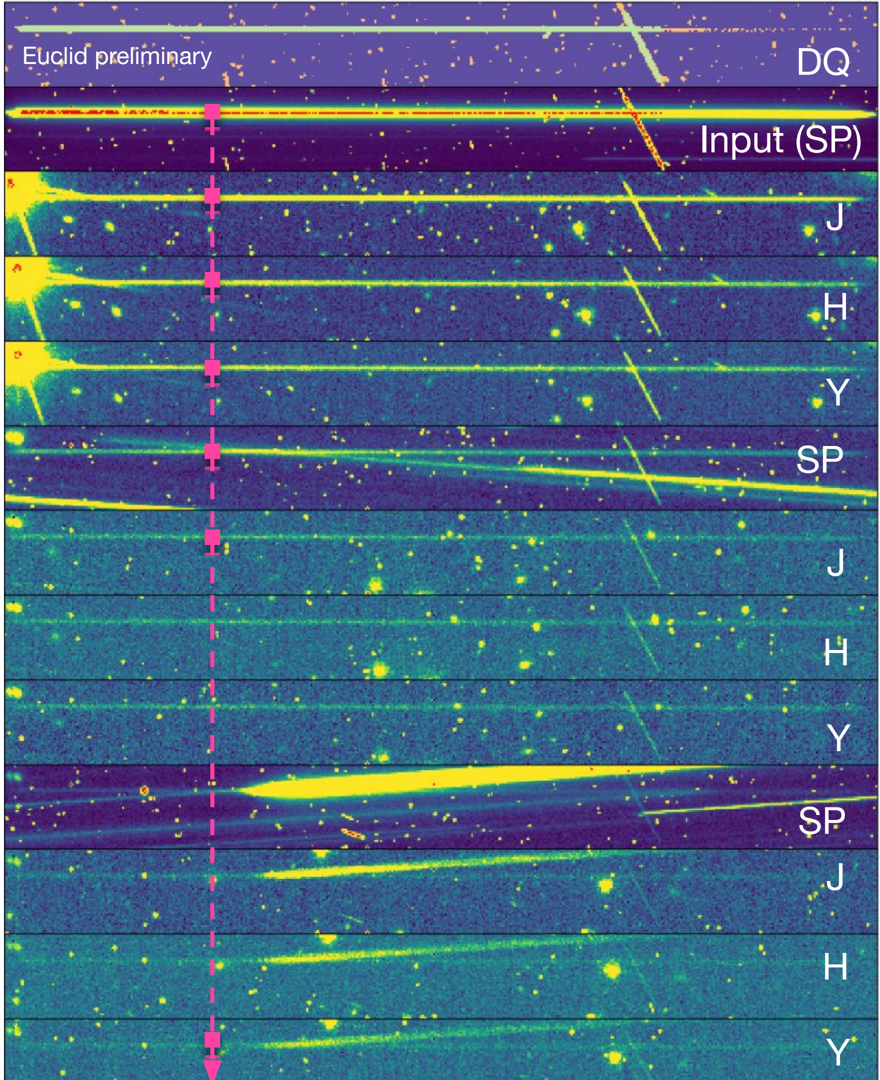


Fitting persistence on science data

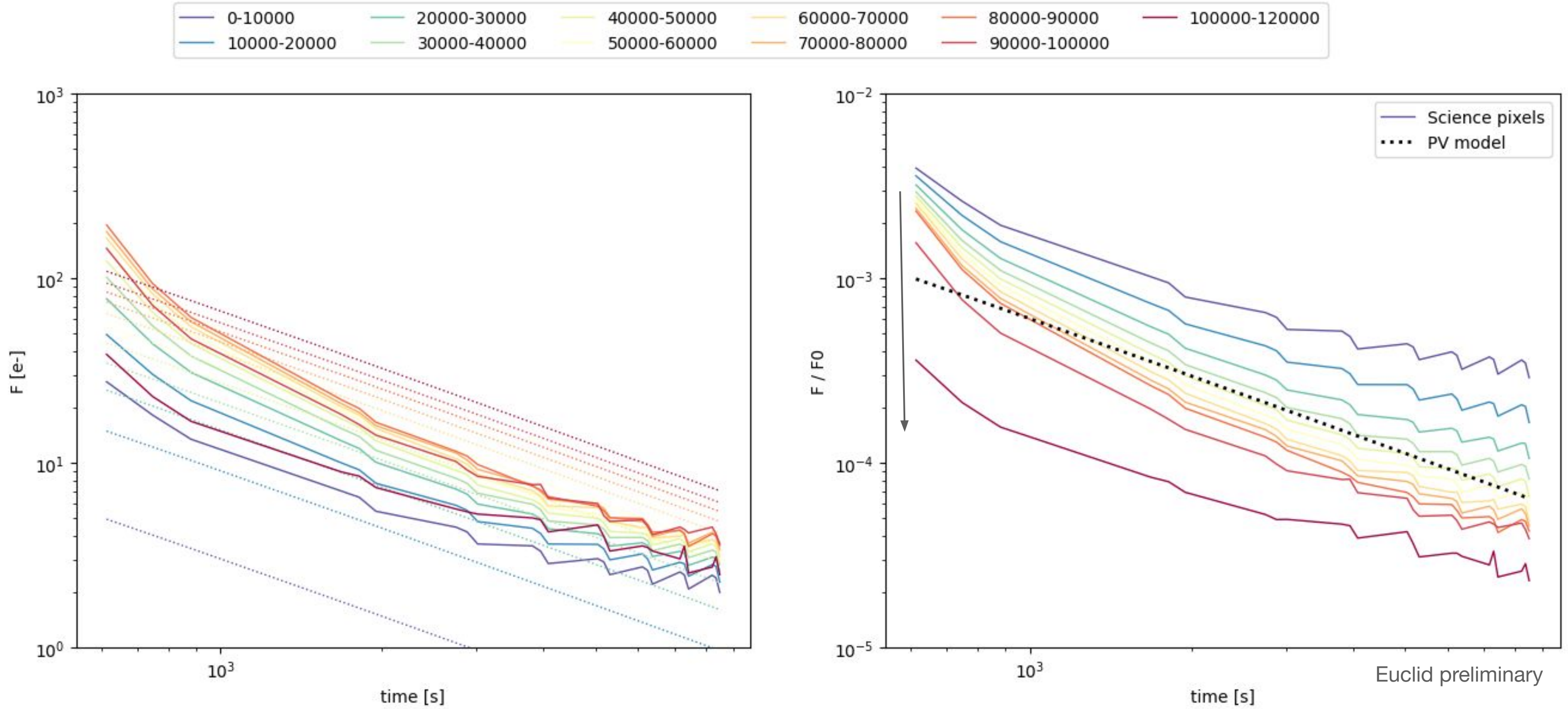
- **Patch 38:**
  - **43 observations**
  - **172 exposures per grism/filter**
  - **High solar activity**

- Extract time series
  - for pixels > 5’000 e^-
  - history = 32 exps
- Average time series per bin of flux (from the input image)

- Science: ~5e6 pixels (55%)
- Cosmic: ~3.4e6 pixels (37%)
- Saturated: ~0.7e6 pixels (8%)



Comparison with PV model (DET13)

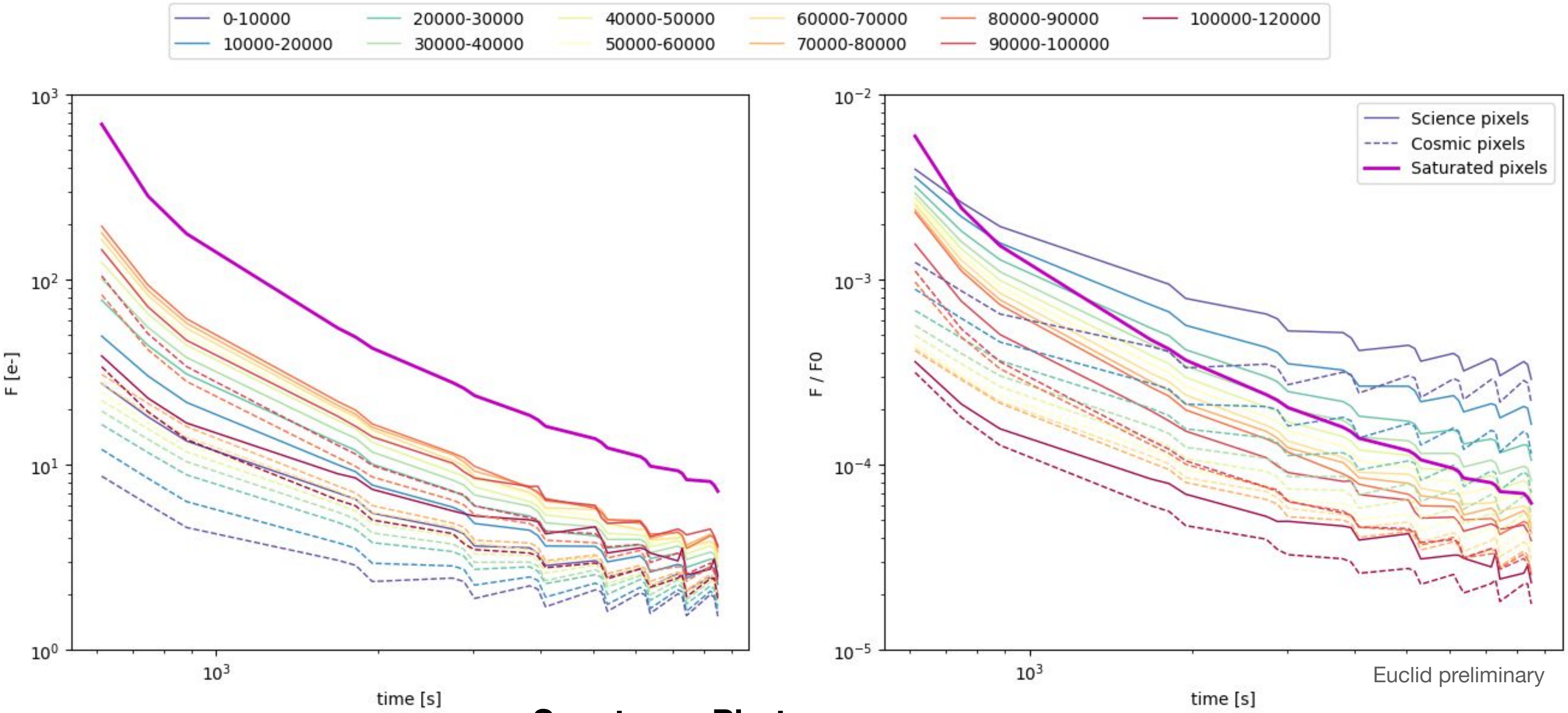


Absolute values in e⁻

Spectro → Photo

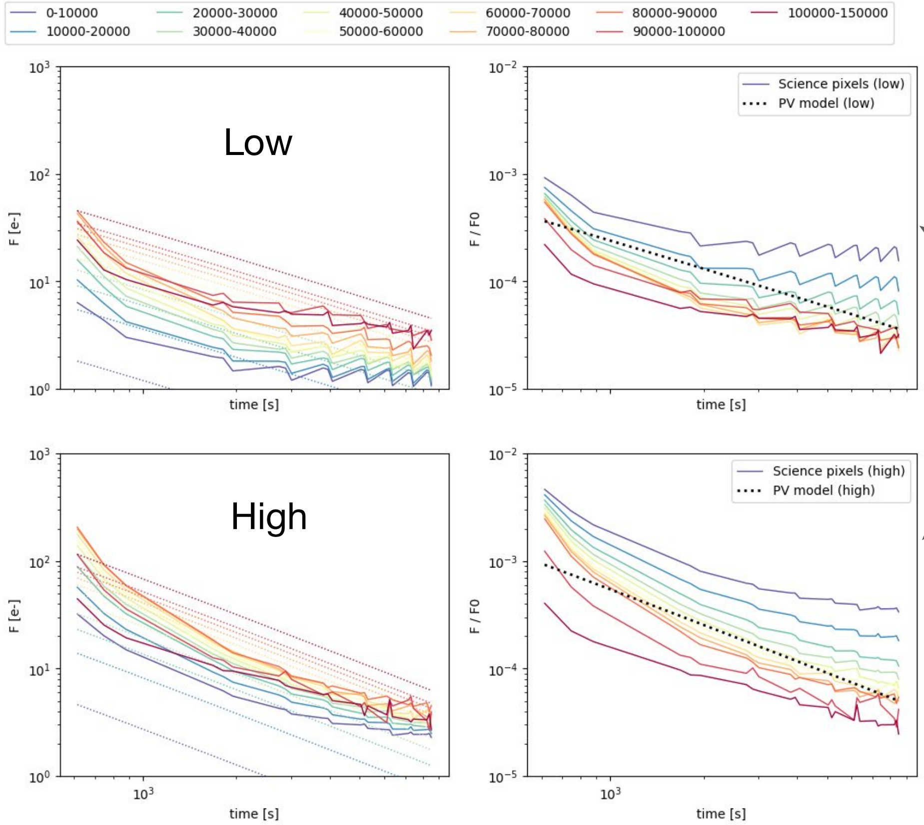
Relative values (divided by input flux)

Cosmics & saturated pixels (DET13)

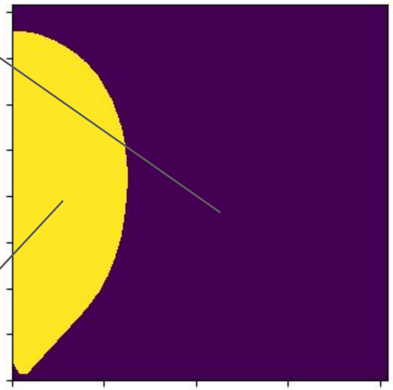


Absolute values in e⁻ **Spectro → Photo** Relative values (divided by input flux)

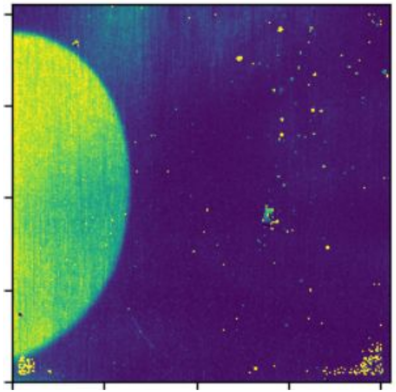
Low/high persistence regions (DET44)



High trap density regions in some detectors



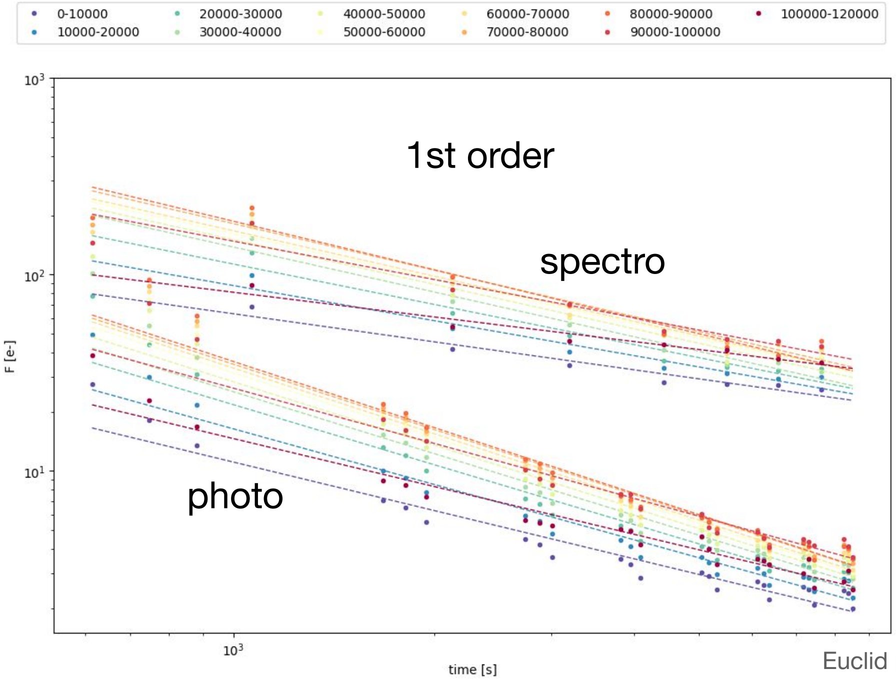
Euclid preliminary

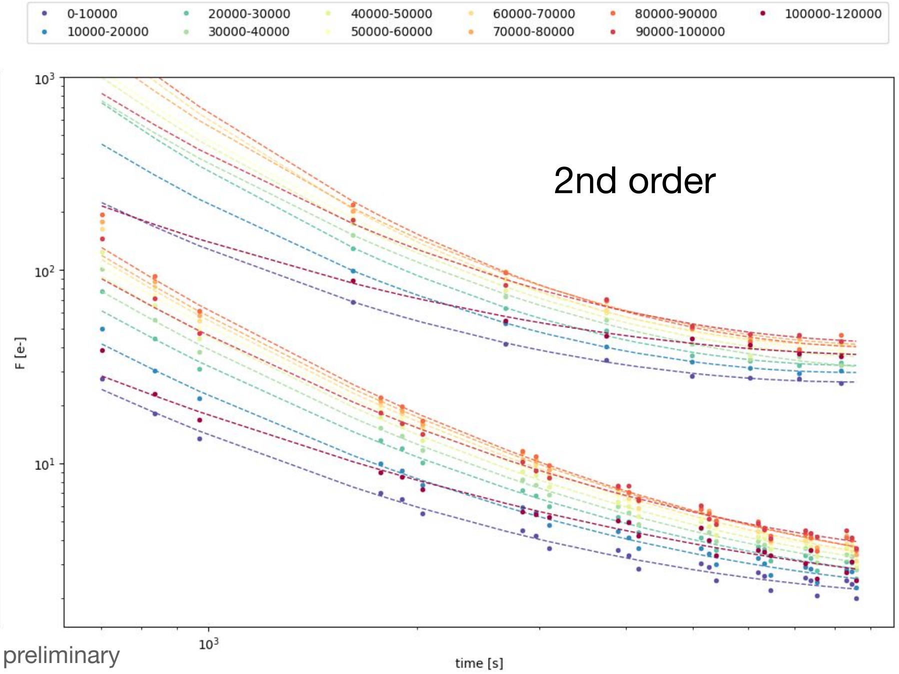


1st dark after flat

Fit spectro⇒photo/spectro (DET13)

Simple power law (straight line fit in log(F) vs log(t)) does not describe well the short-term persistence. Higher order? Broken law? Splines?
Correction with those models is difficult.



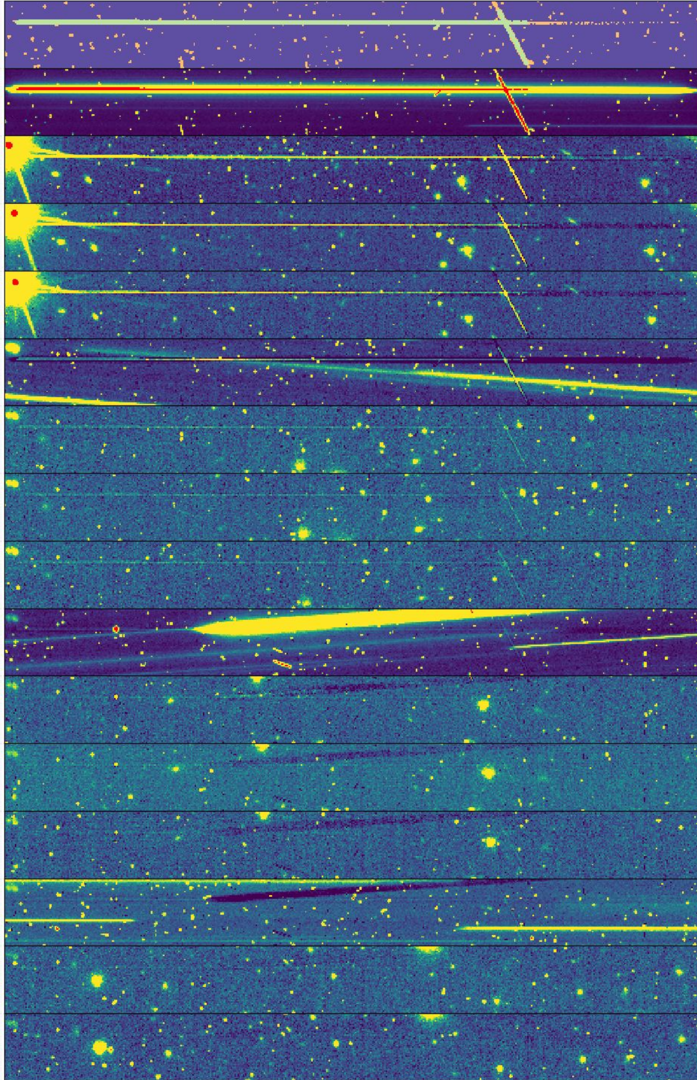


Euclid preliminary

Persistence correction ?

Various efforts to correct persistence but…

- Pixel based calibration model (with flats and darks) not precise enough
- Spatial variations vs flux dependency
- Some efforts to rescale the model based on the science data, on specific datasets, but hard to generalize
- Difficult to assess the performance of correction methods



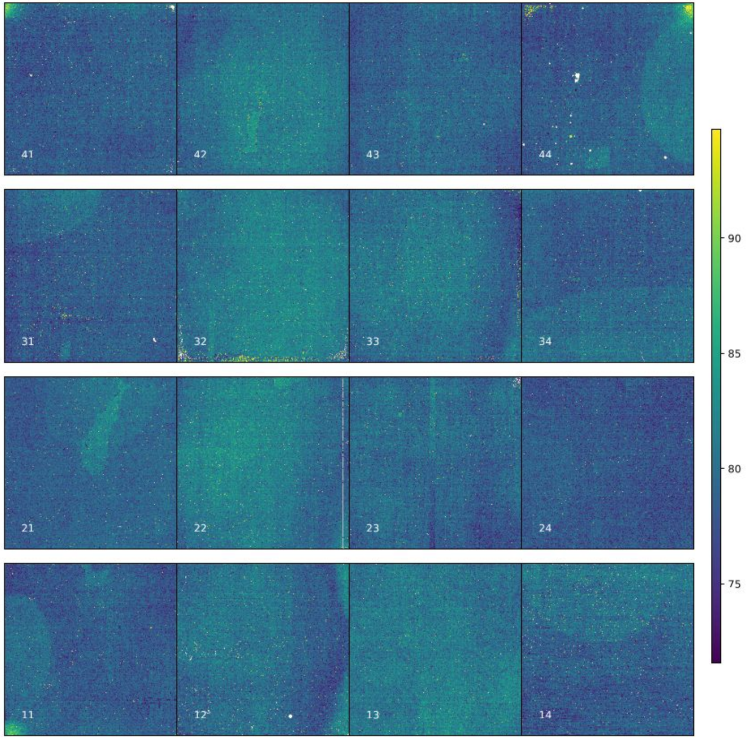
Conclusions

- Persistence is decreasing with time

- Masking works well but needs some optimization to avoid masking too much
- Correction is difficult, various experiments on specific datasets but hard to generalize to the full survey
- Persistence decreases faster than what the PV model predicts, esp. at high flux
- Faster decrease for cosmics

- Persistence also has an impact on background, flats, etc.

“Superflat” computed on raw science exposures (172, J band)



Euclid preliminary