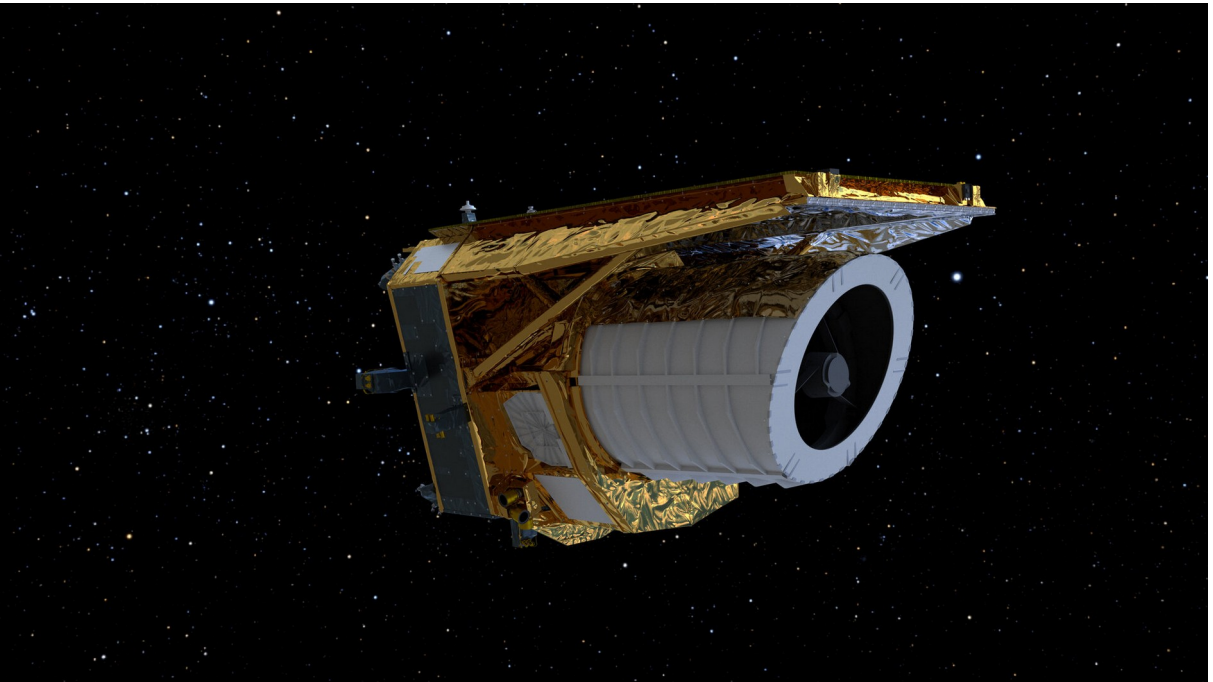
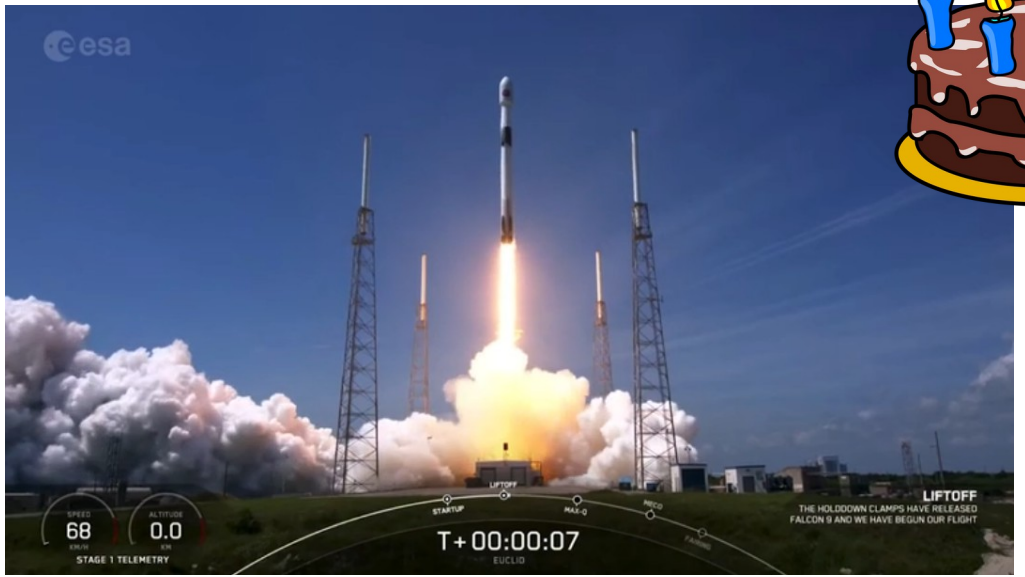
Euclid in its infancy



Will Hartley

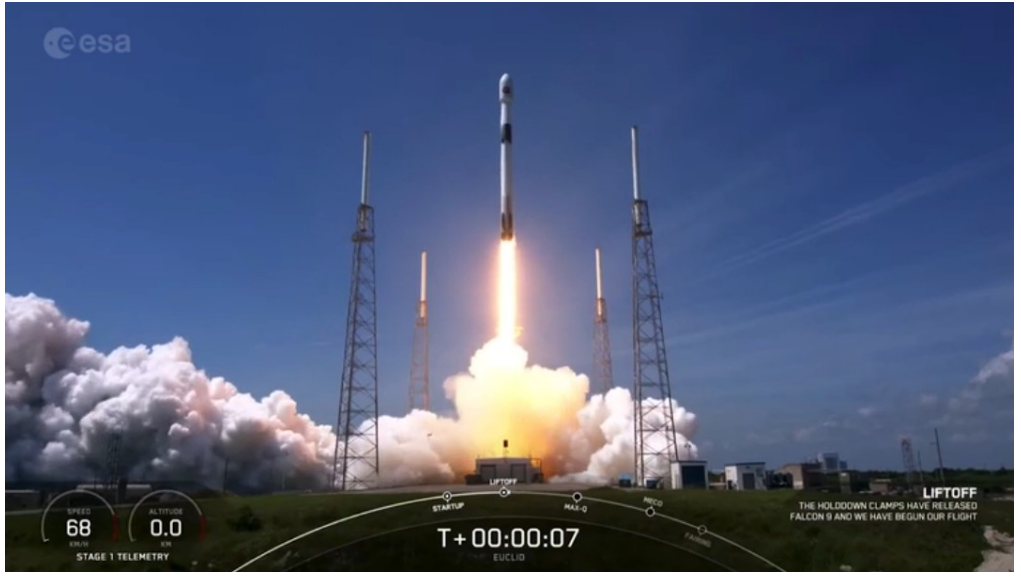
Science seminar 23rd Oct 2023

July 1st 2023

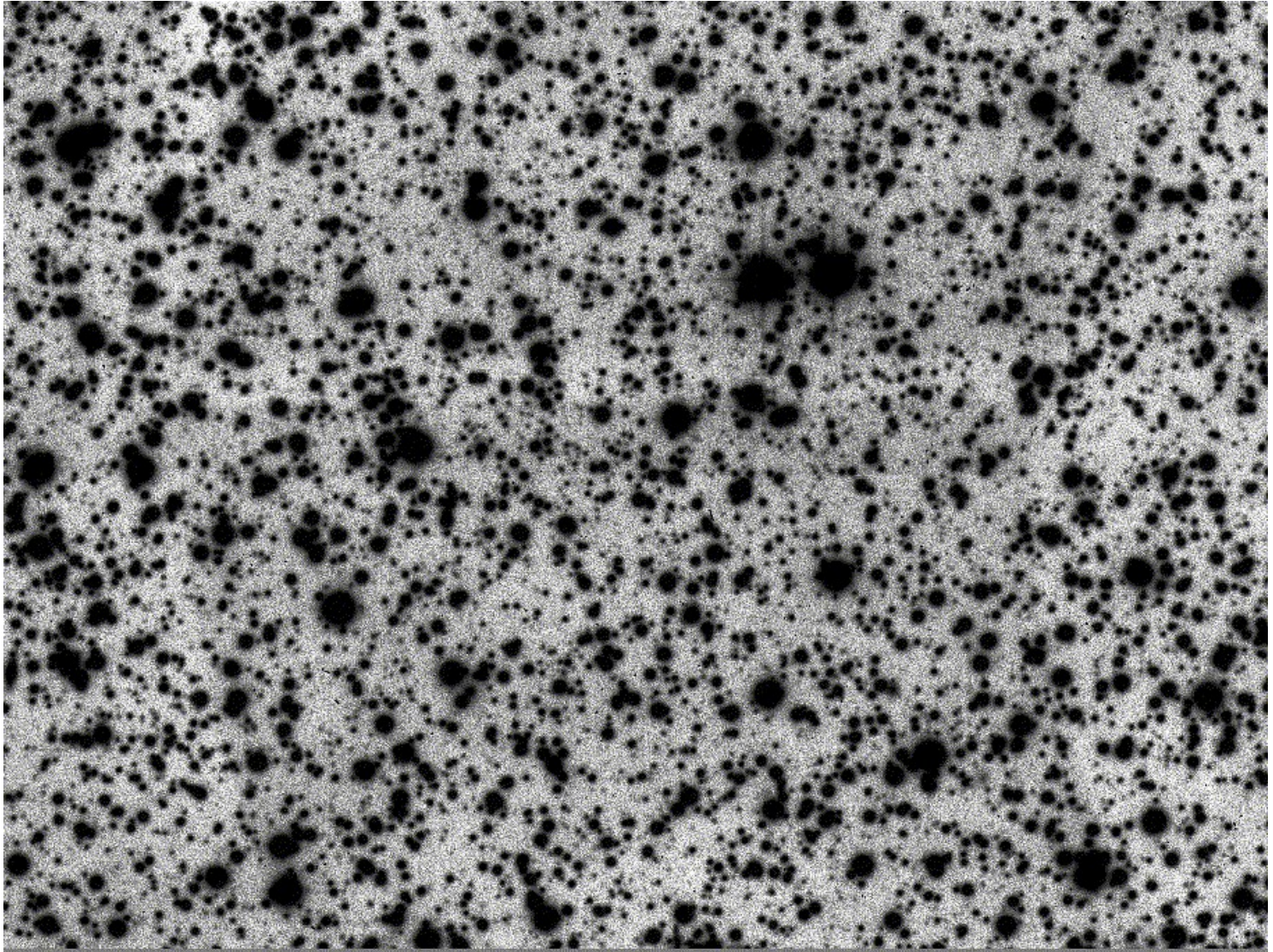


Then: “I think we’re more or less ready, we’re just waiting for the data now.”

July 1st 2023

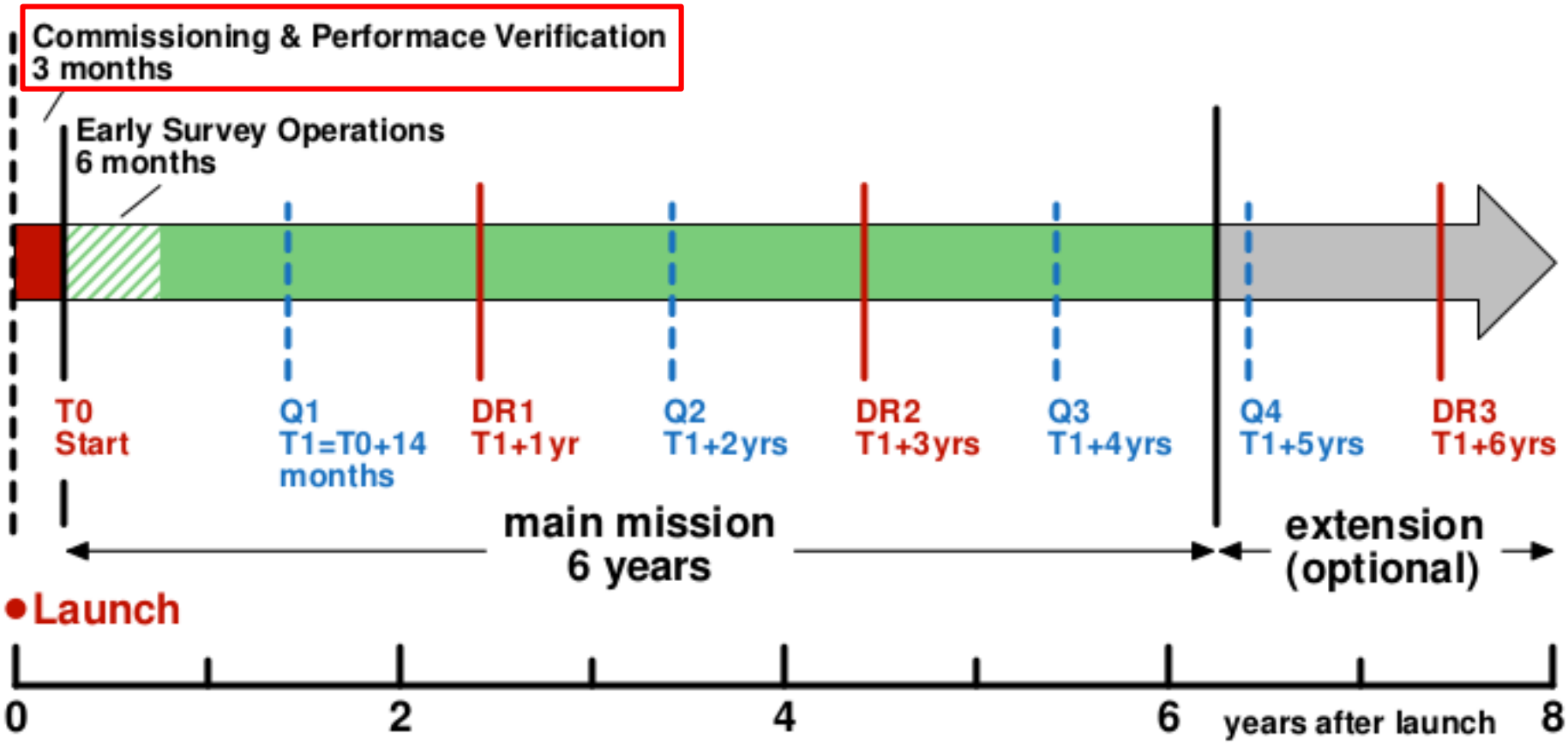


Now: “I think we can stop [taking data], we’ve got enough data now!”



Euclid moving to L2 by CFHT-MegaCam / 12-07-2023

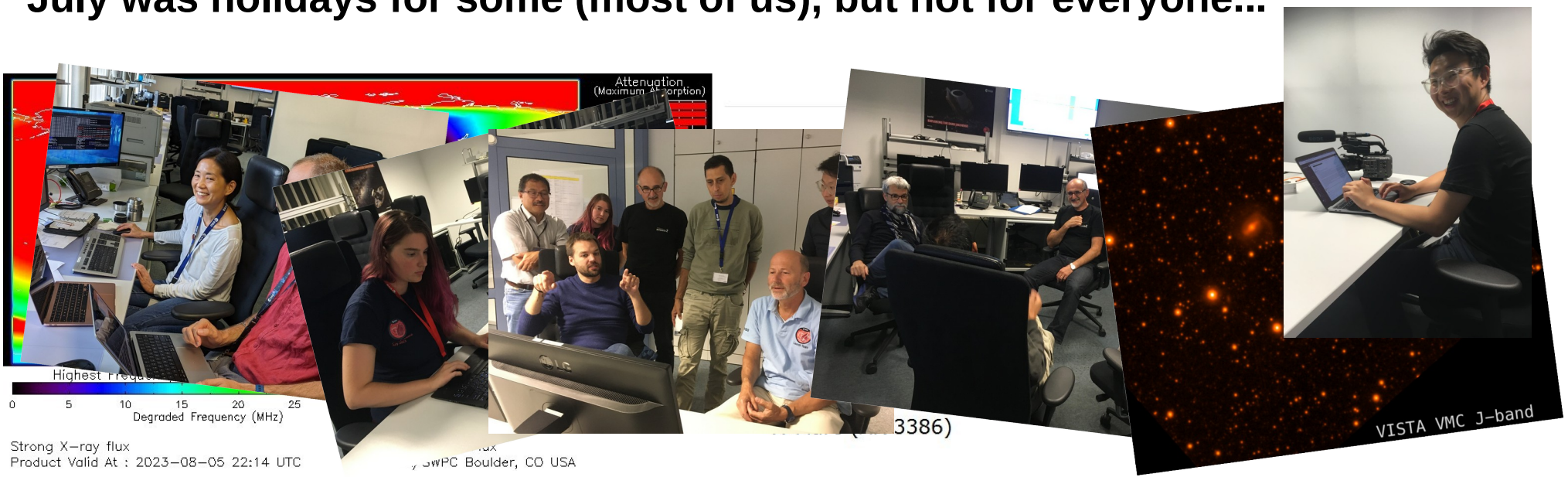
Euclid mission timescale



Disclaimers

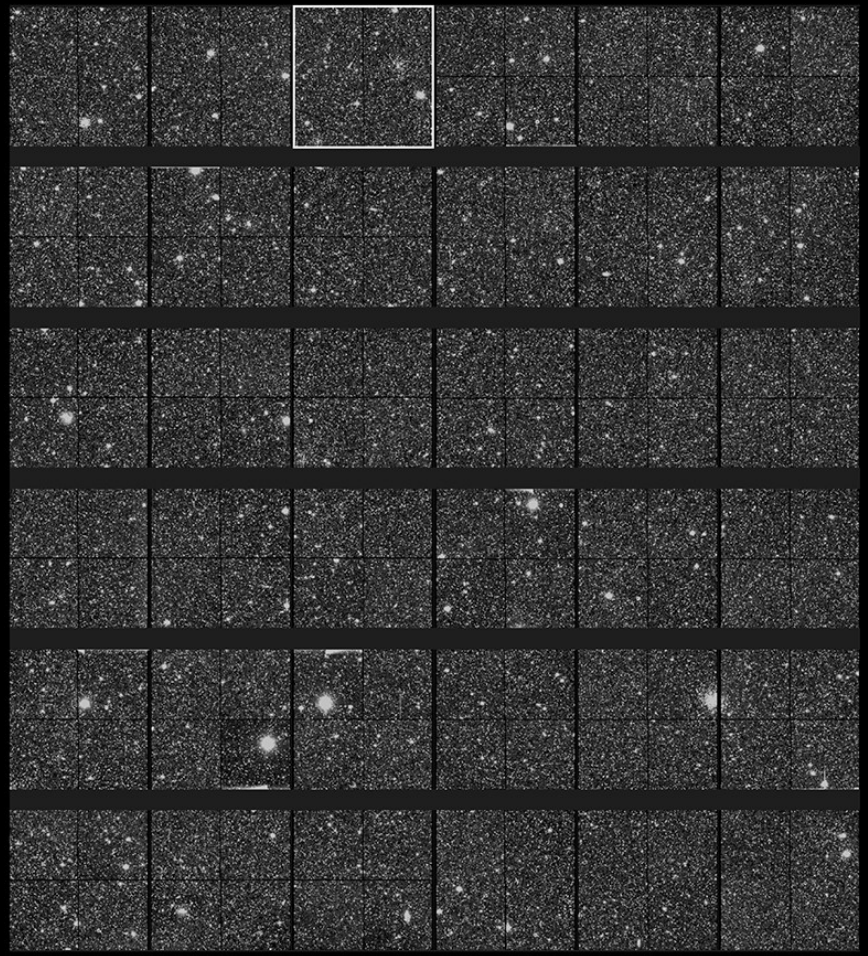
- No-one truly believed we were fully ready.
- We’re still in a sort of information quarantine, so I can’t show the work that we’re elbows-deep in.
- I’m pretty sure everything I’ll show is public / not sensitive, but please don’t put on social media.

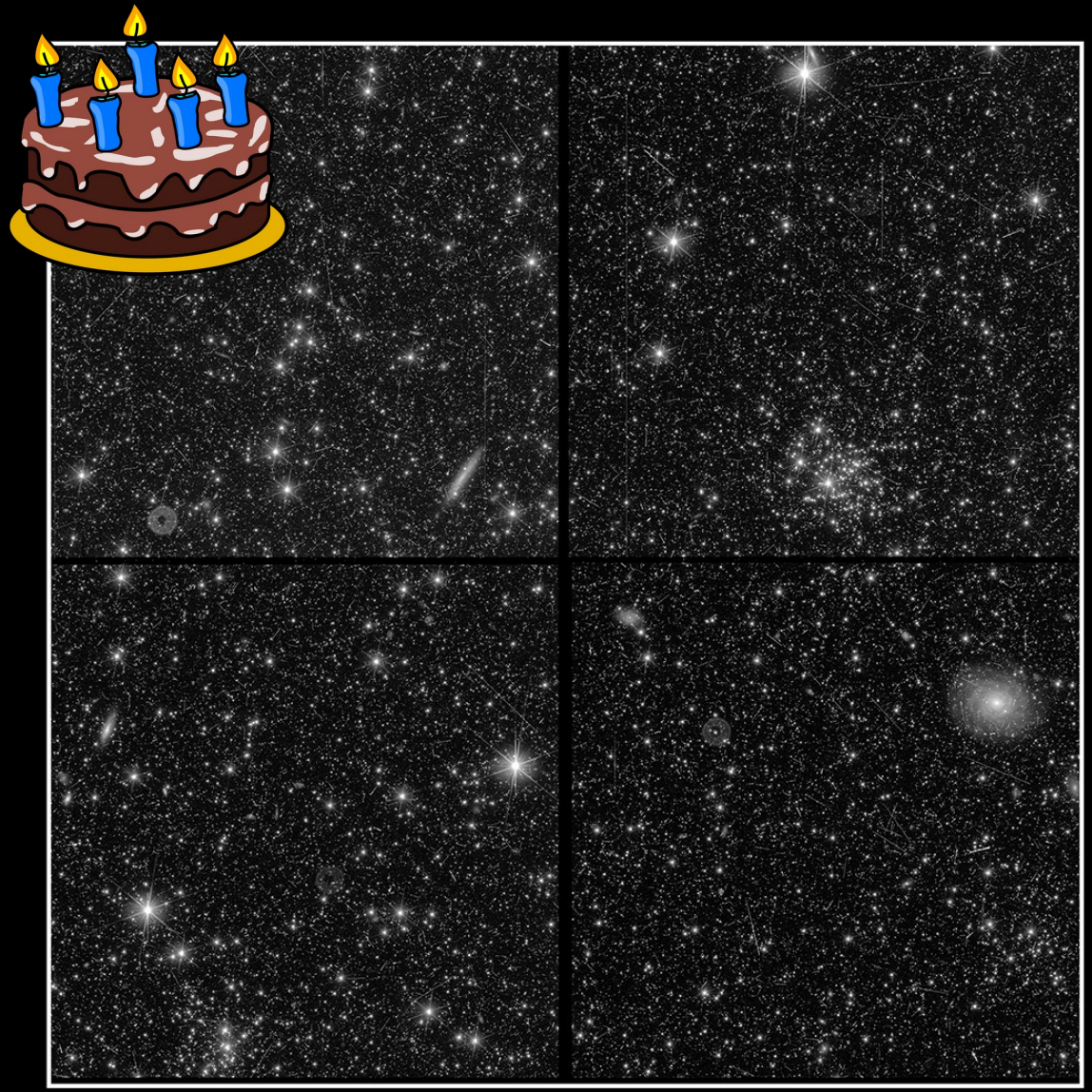
July was holidays for some (most of us), but not for everyone...



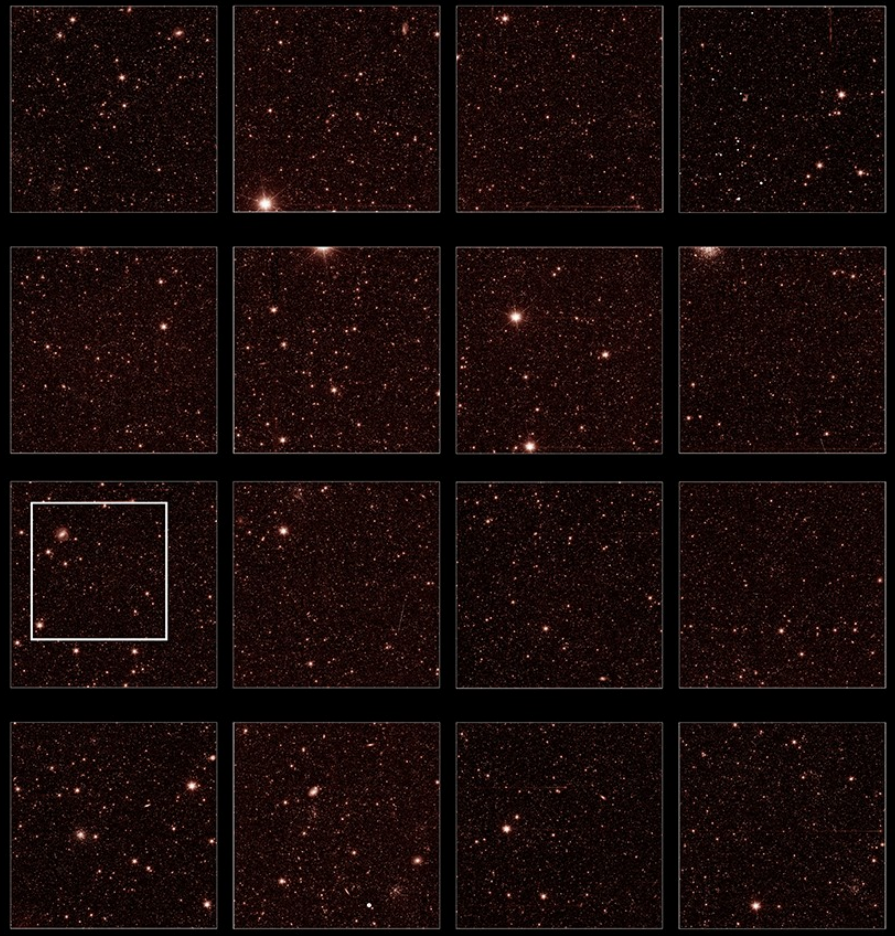
July 31st 2023

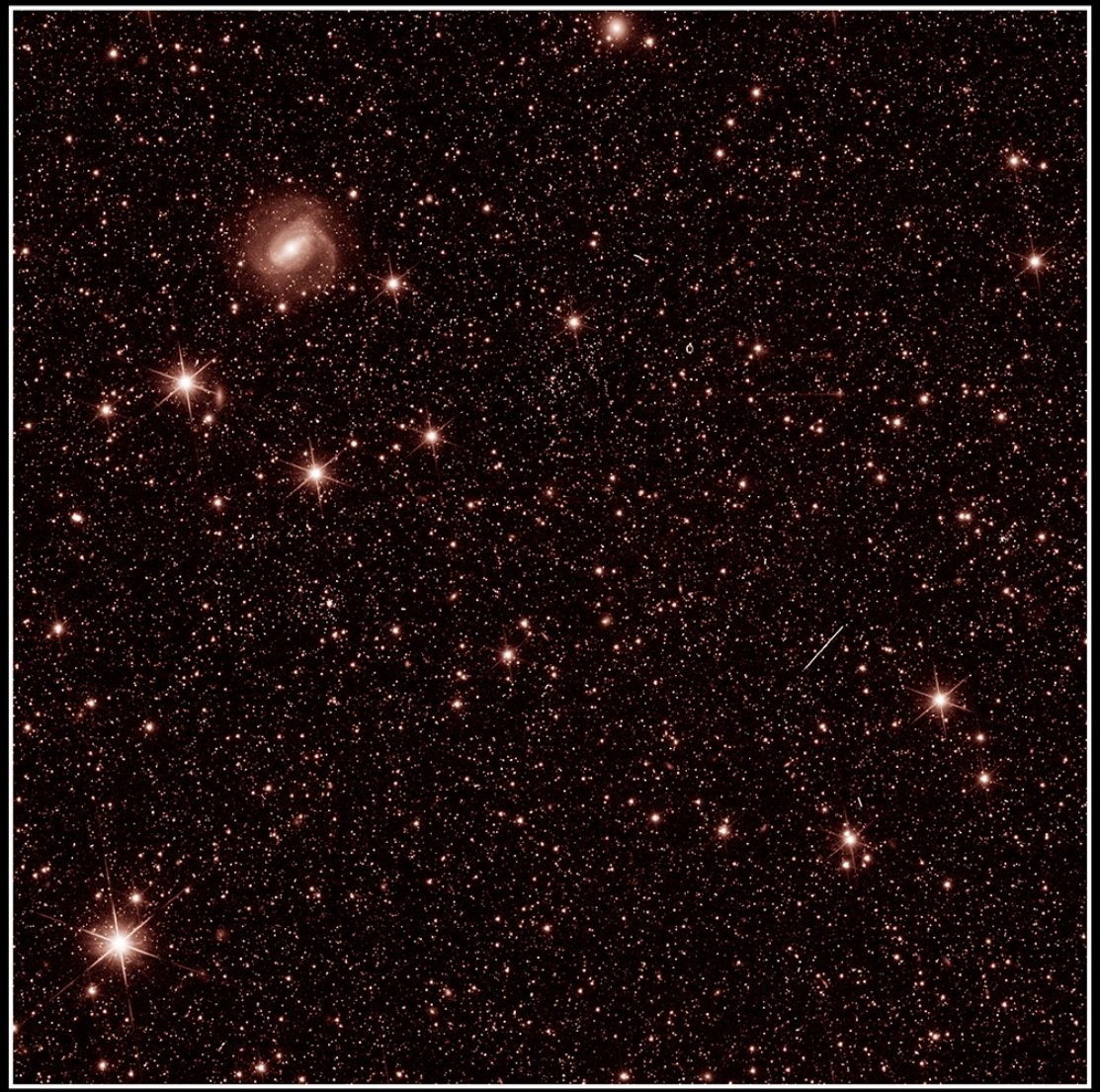
EARLY COMMISSIONING TEST IMAGE, VIS INSTRUMENT



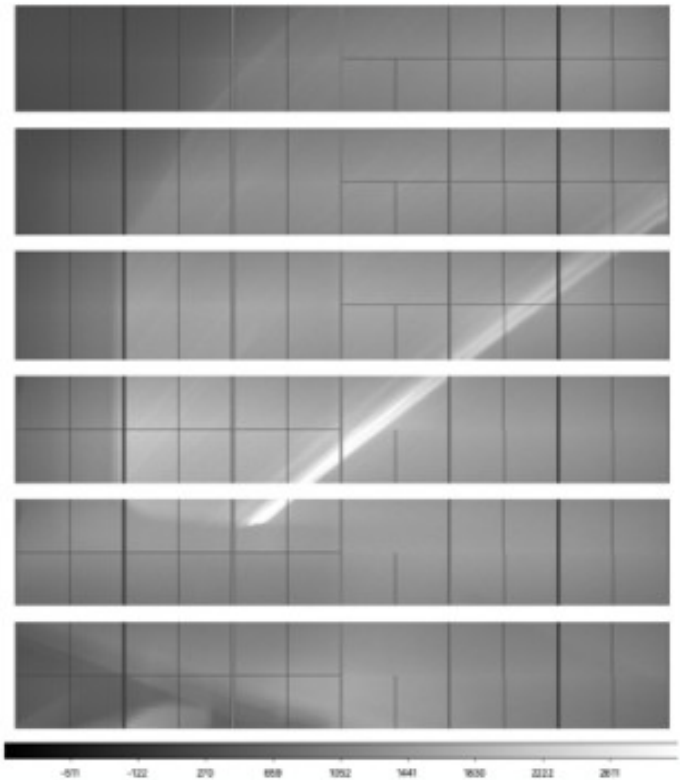


EARLY COMMISSIONING TEST IMAGE, NISP INSTRUMENT

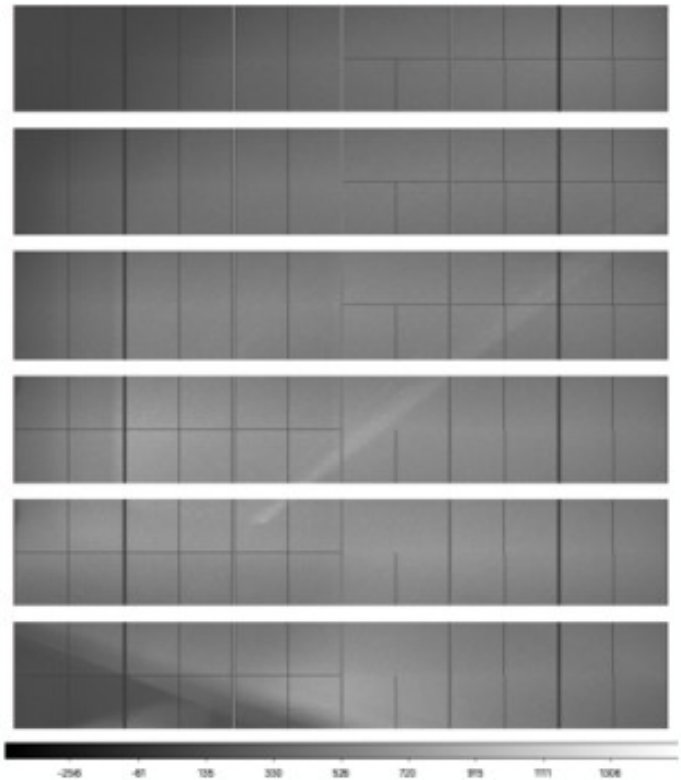




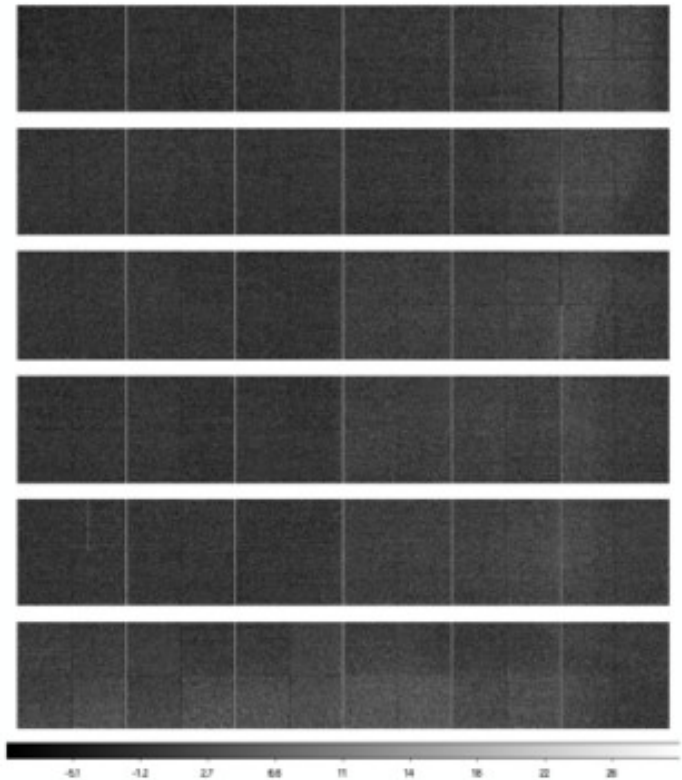
Early woes: stray light



Alpha Angle: +4.5 deg

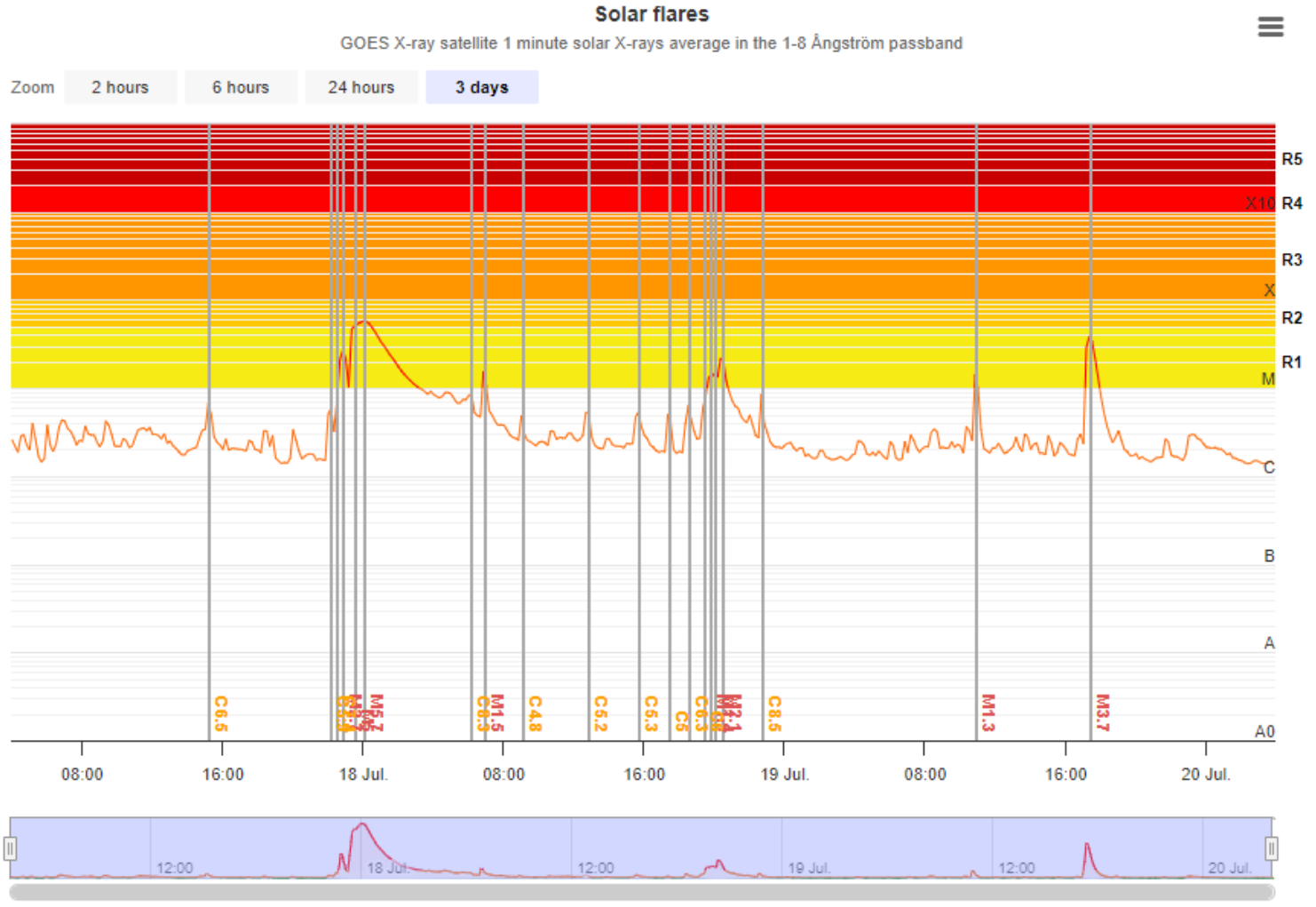


Alpha Angle: 0 deg

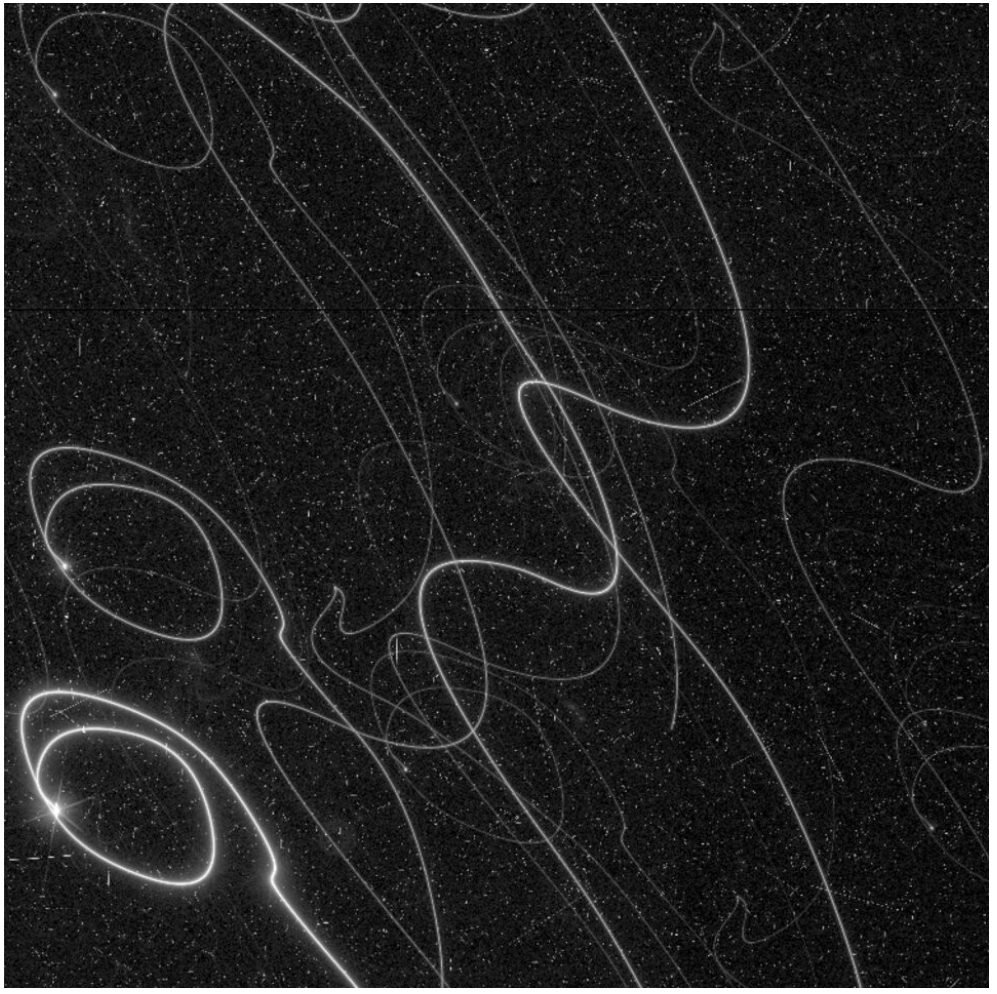


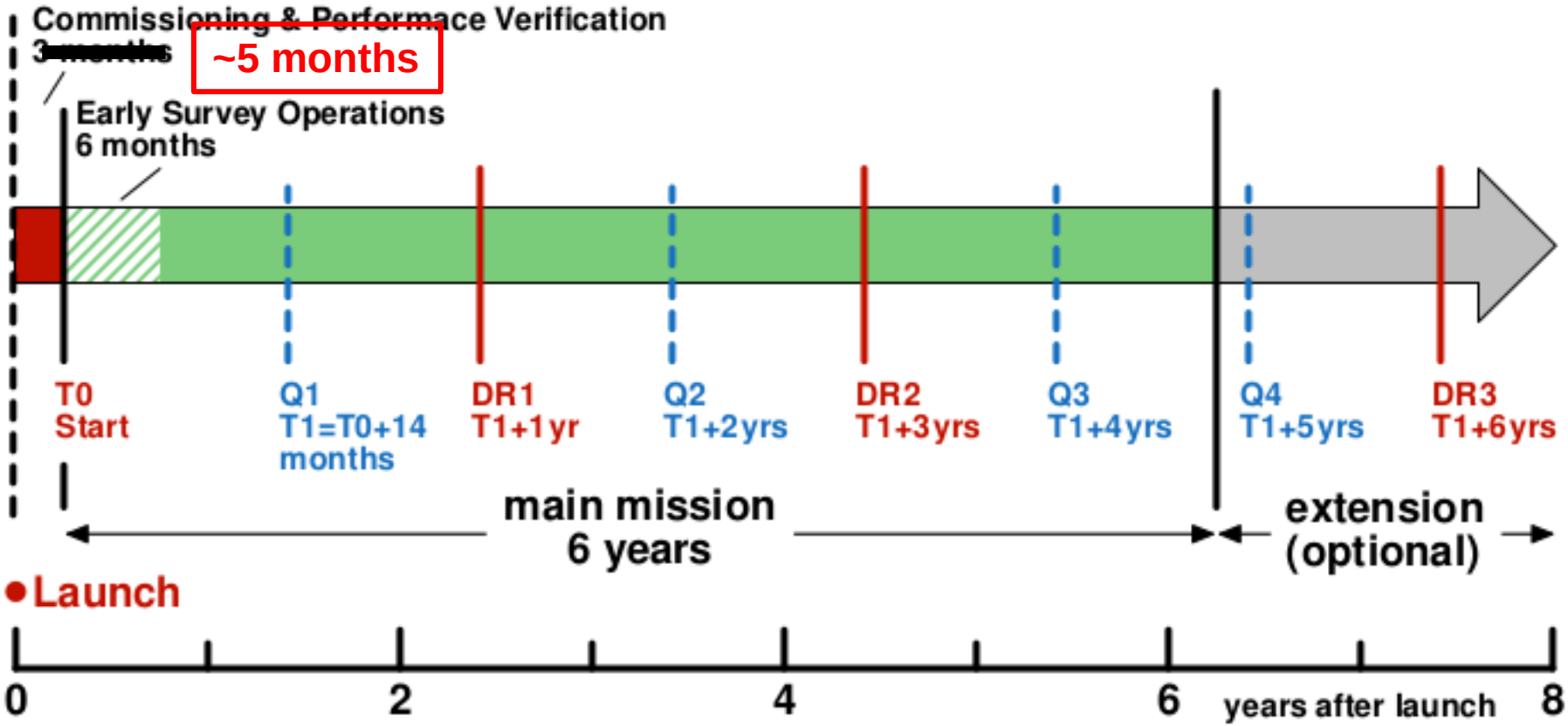
Alpha Angle: -4.5 deg

Early woes: solar X-rays

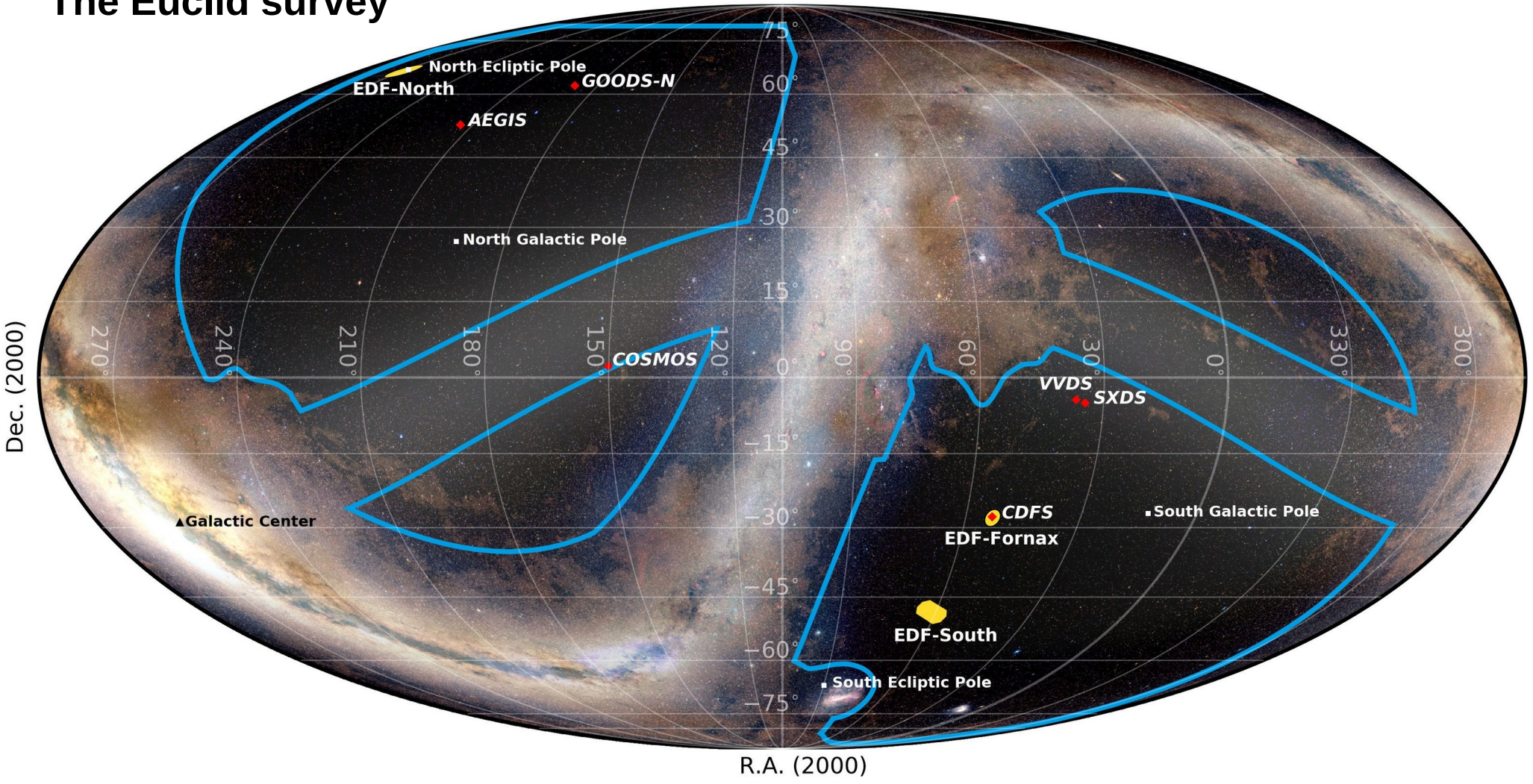


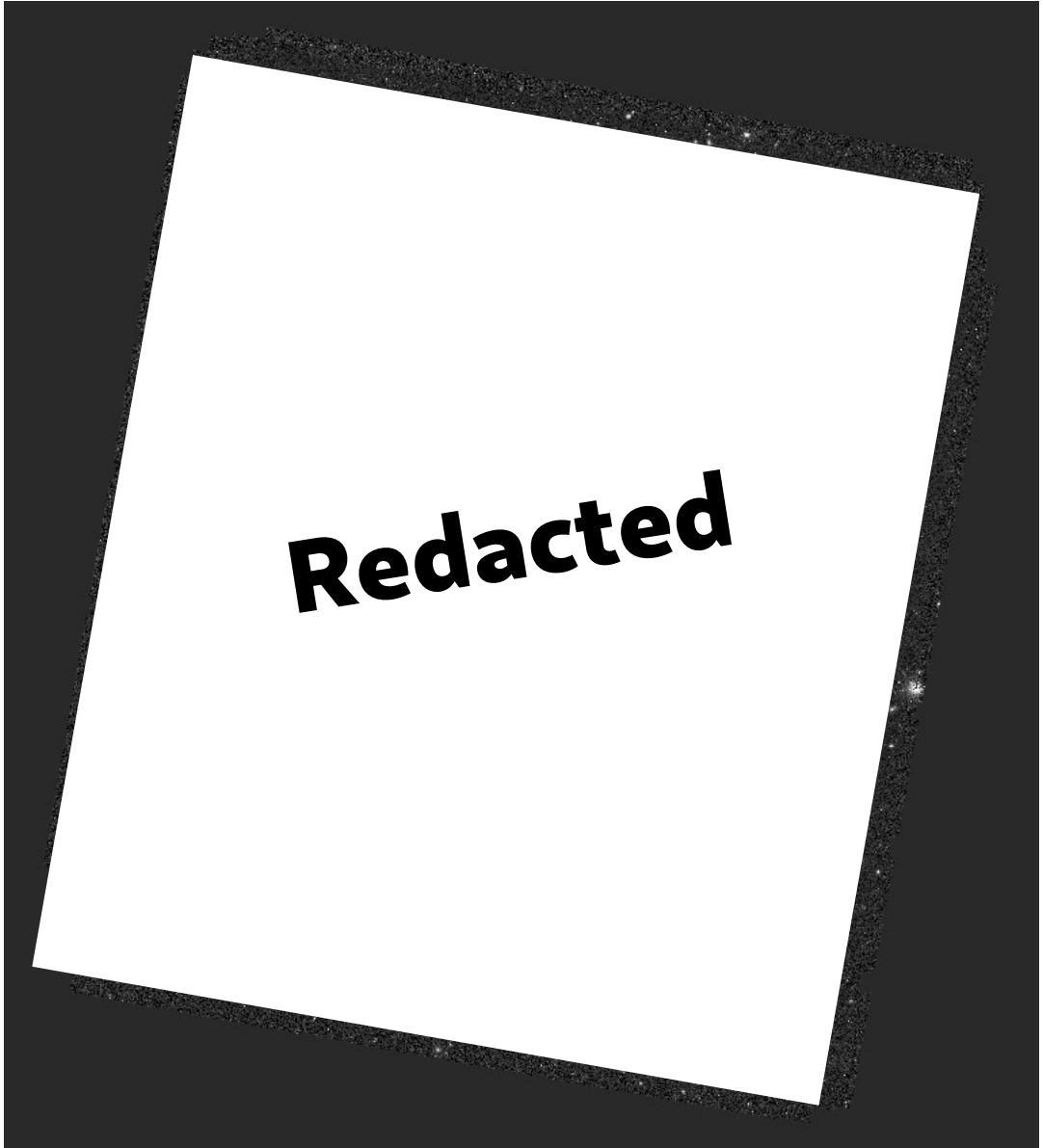
Early woes: guiding



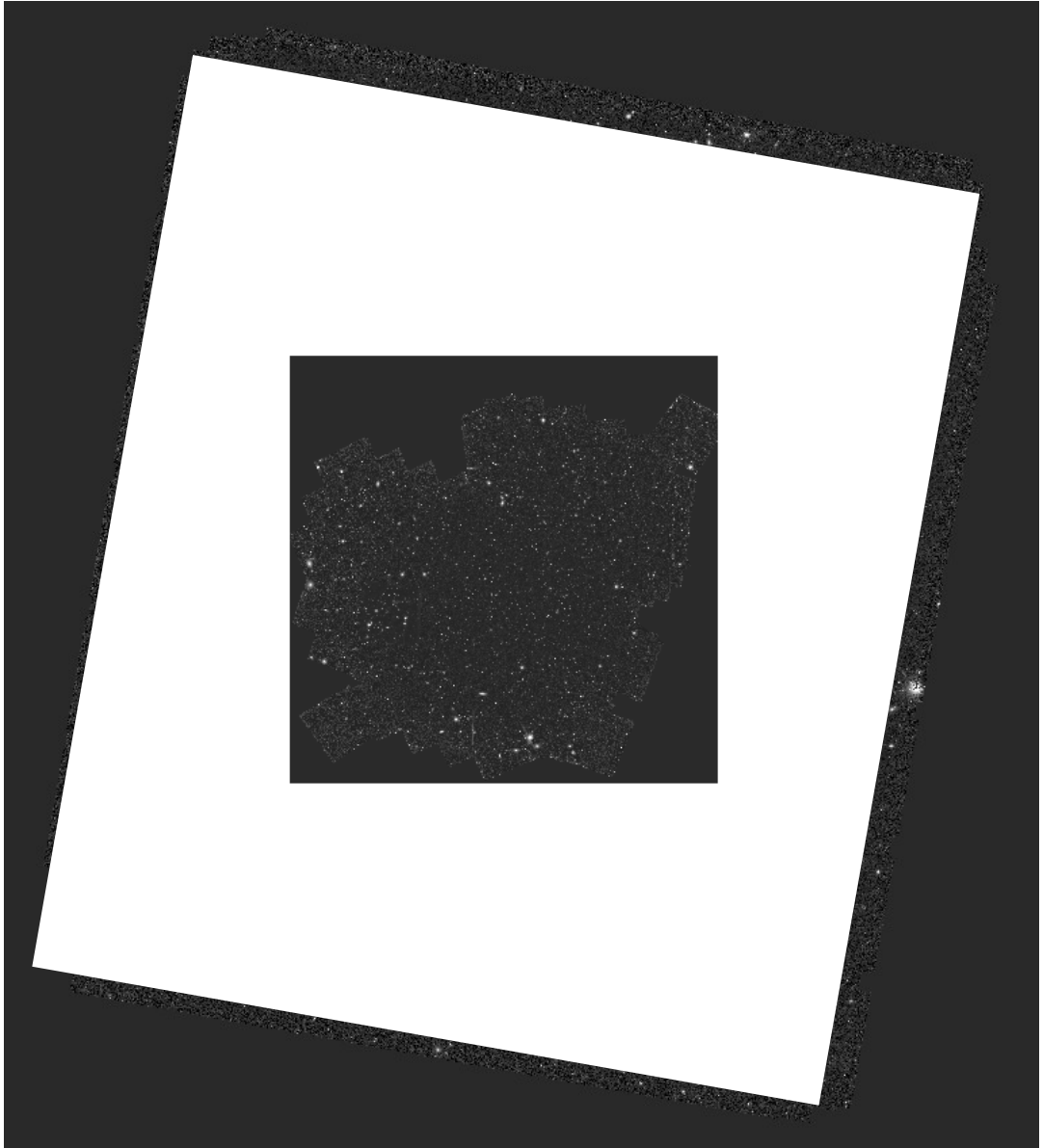

Commissioning & Performace Verification
~5 months
Early Survey Operations
6 months
T0
Start
Q1
T1=T0+14
months
DR1
T1+1yr
Q2
T1+2yrs
DR2
T1+3yrs
Q3
T1+4yrs
Q4
T1+5yrs
DR3
T1+6yrs
main mission
6 years
extension
(optional)
Launch
0
2
4
6
years after launch
8

The Euclid survey



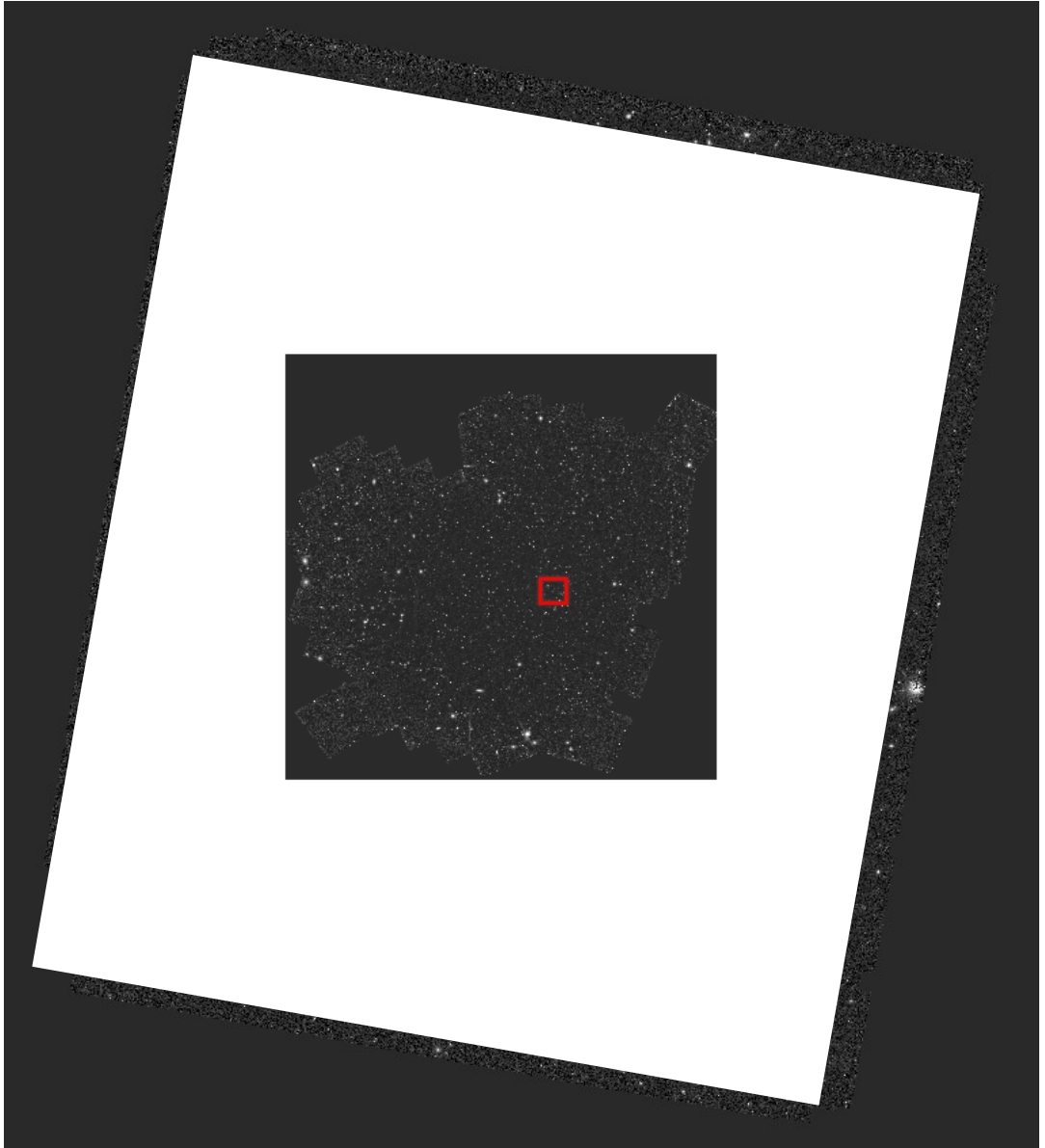


CDFS – testing Euclid’s deep field readiness

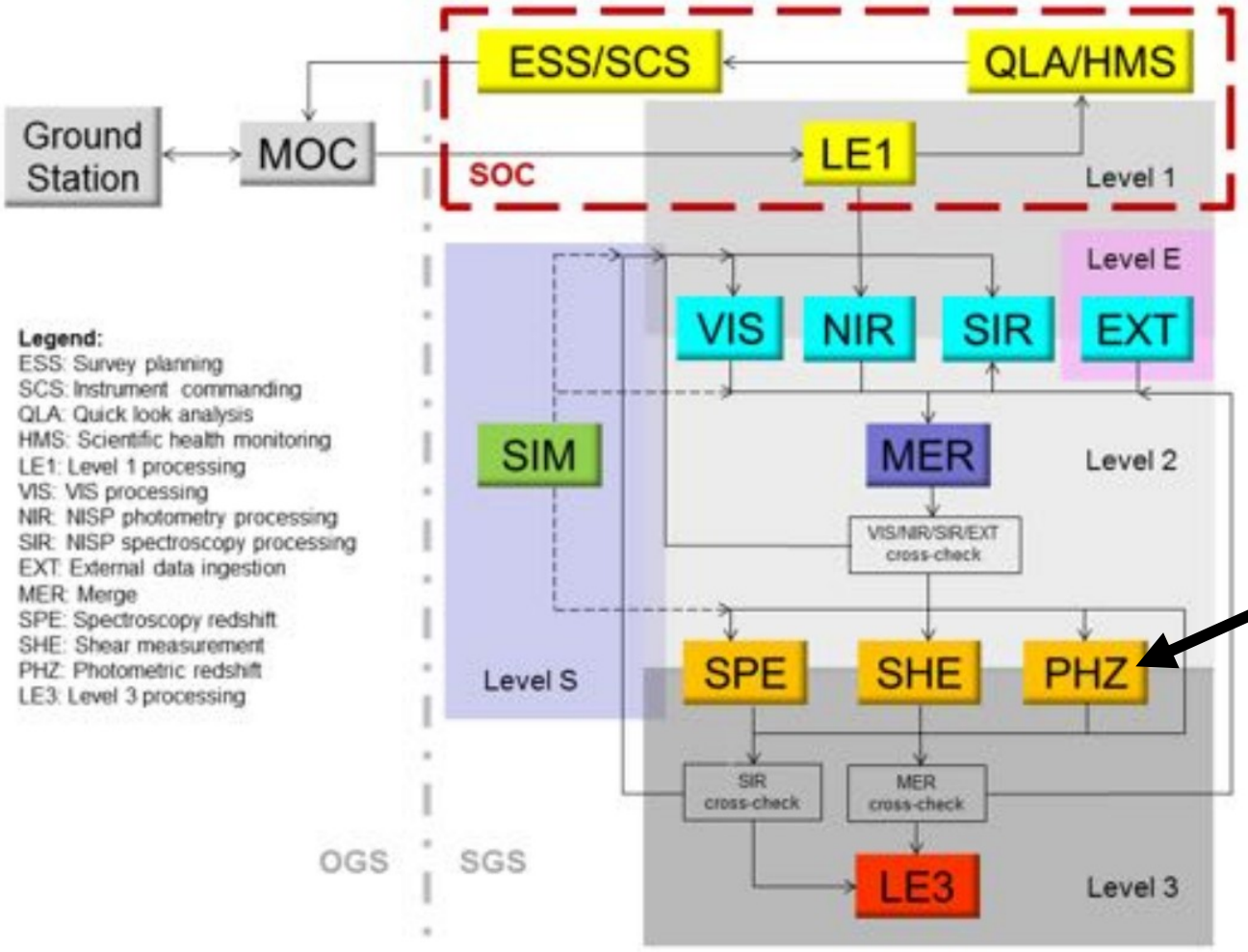


CDFS – testing Euclid’s deep field readiness

CDFS – testing Euclid’s deep field readiness



Euclid science ground segment

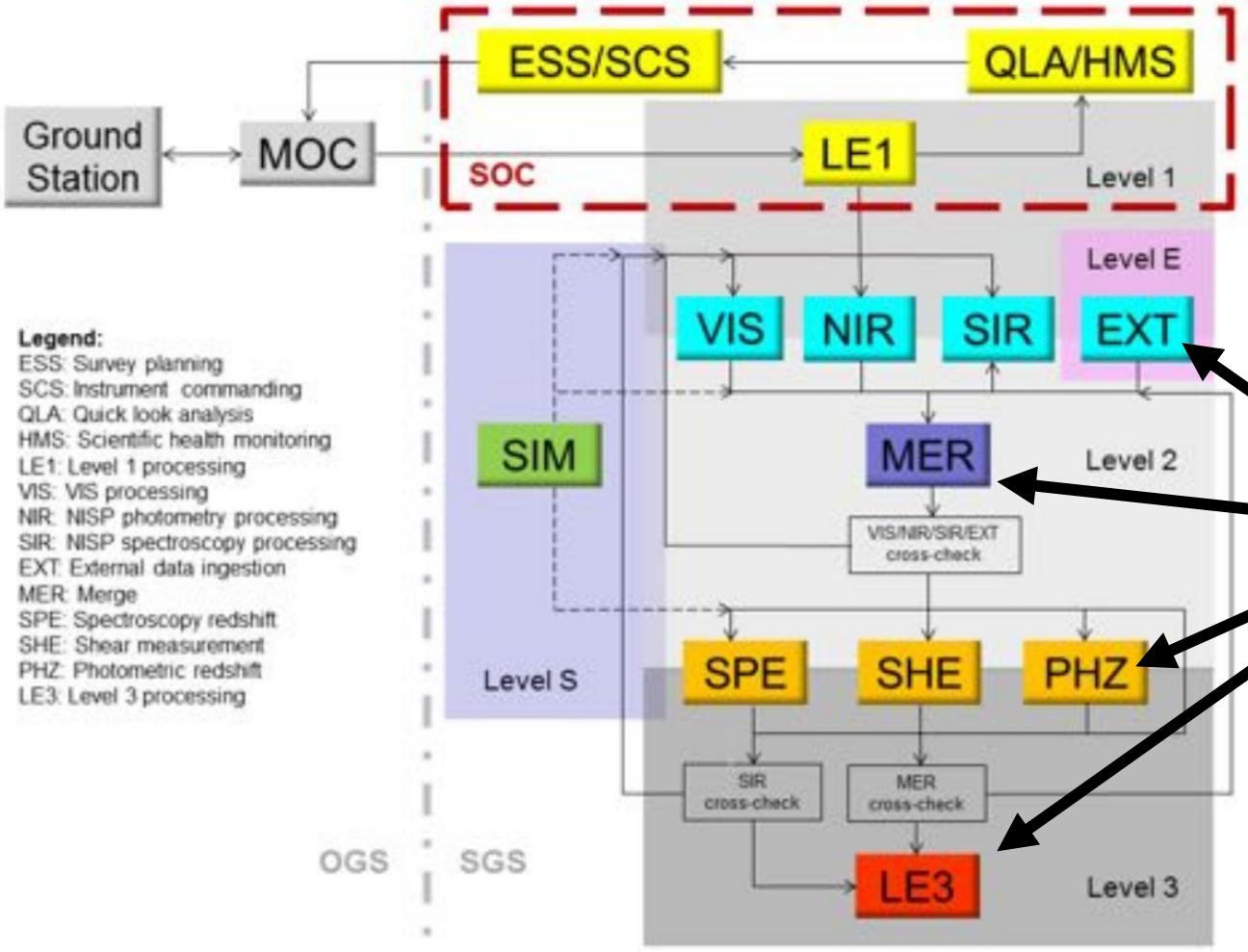


We are here

UNIVERSITÉ DE GENÈVE

- **Florian**
- **Nicolas**
- **Alejandro**
- **++**

Euclid science ground segment



We are here

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- **Marc (SX++)**
- **Hubert (Elements)**
- **Andrea (Asterism)**
- **Yuzheng**
- **++**

OU-PHZ main pipeline

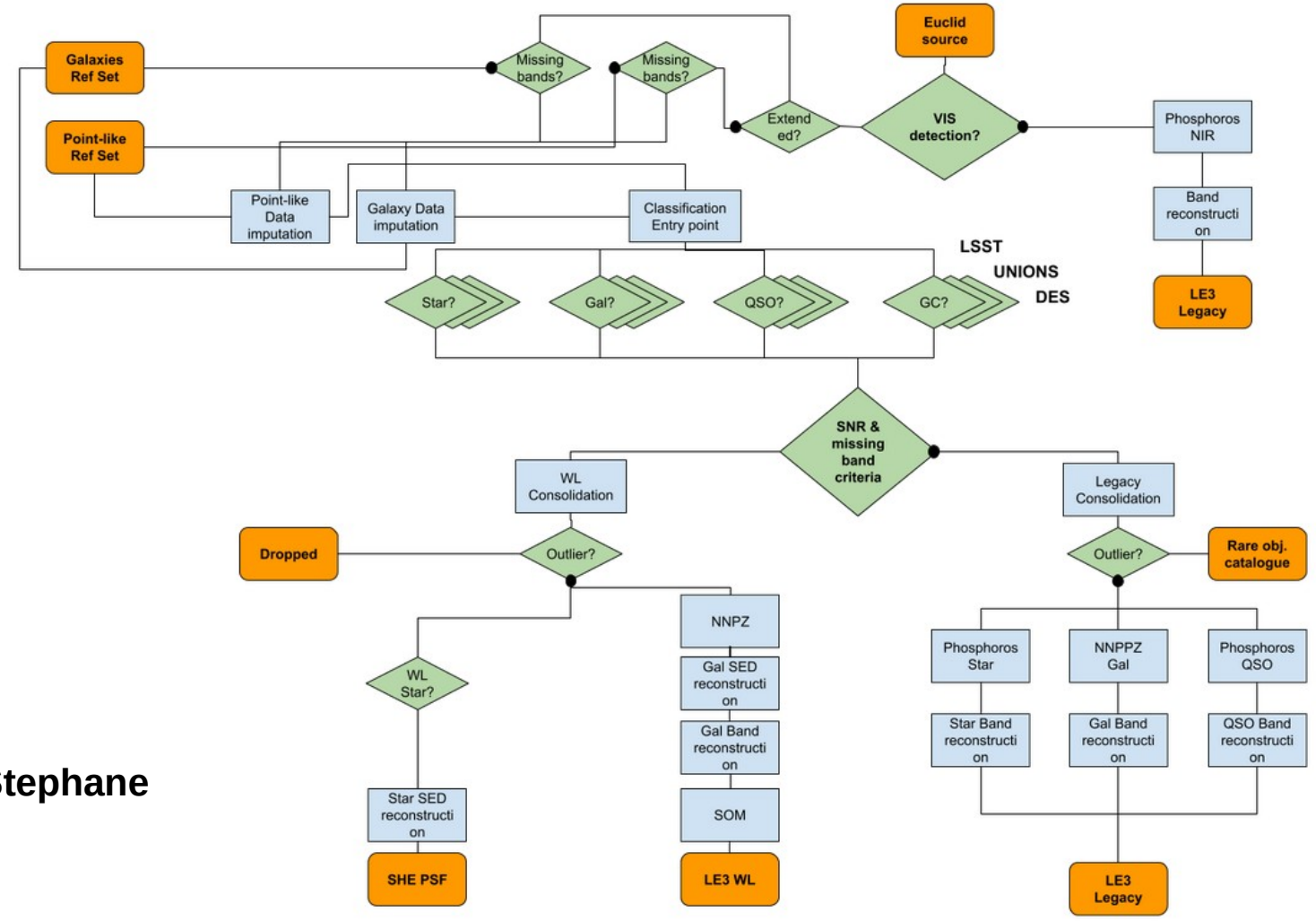
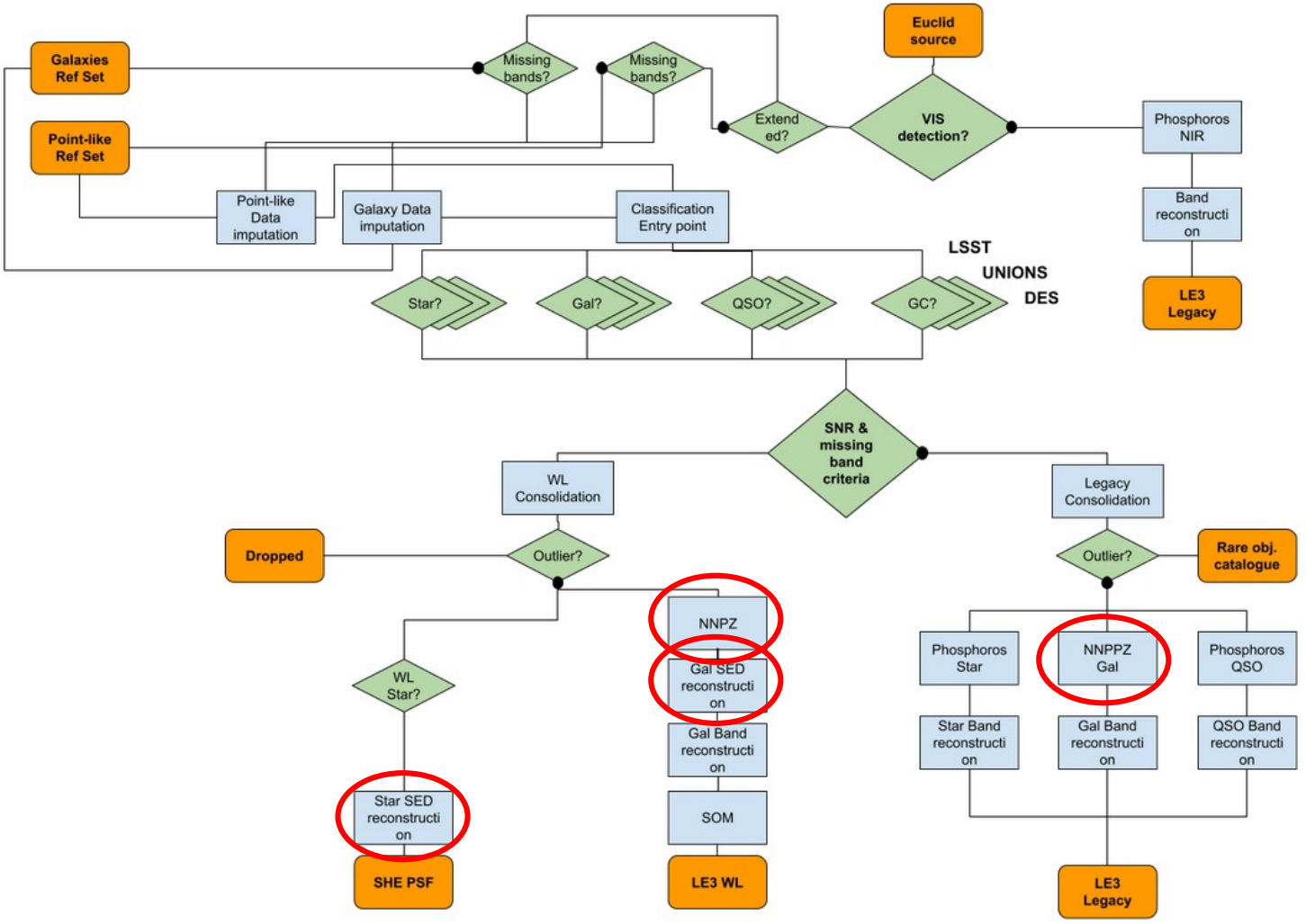


Figure from **Stephane**

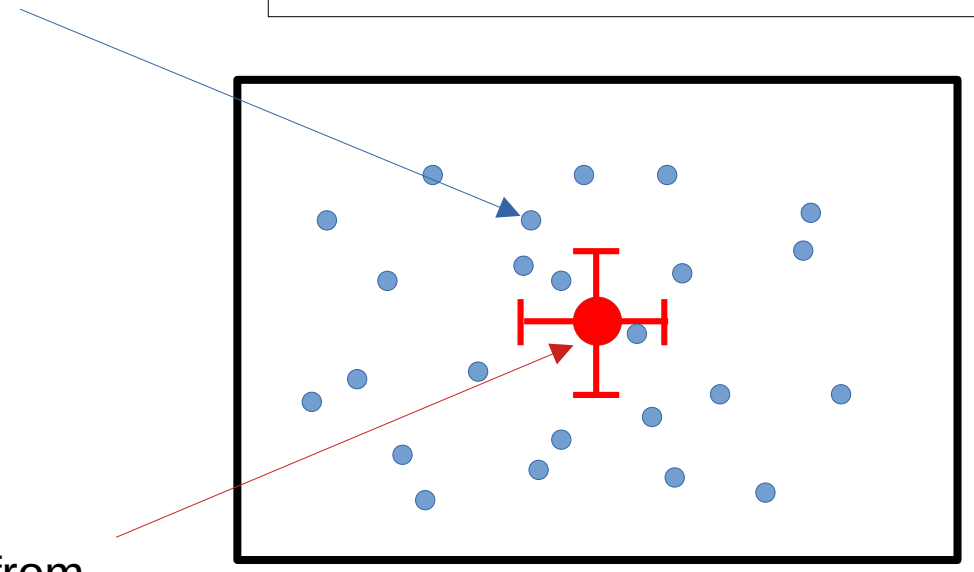
OU-PHZ main pipeline



NNPZ – OU-PHZ's workhorse

PHZ Reference objects:
- Drawn from key deep surveys (COSMOS/UltraVISTA, SXDS/UDS, CDFS)
- Have effectively noiseless photometry (w.r.t. wide survey)
- Accurate and precise measurements of galaxy properties, e.g. photo-z

Reference objects



Object from Euclid wide survey

NNPZ – nearest neighbours in Euclid photometric space (VIS $\mathbf{I_E}$, NISP **YJH**, EXT – e.g. DES **griz**)
→ chi-squared distance metric

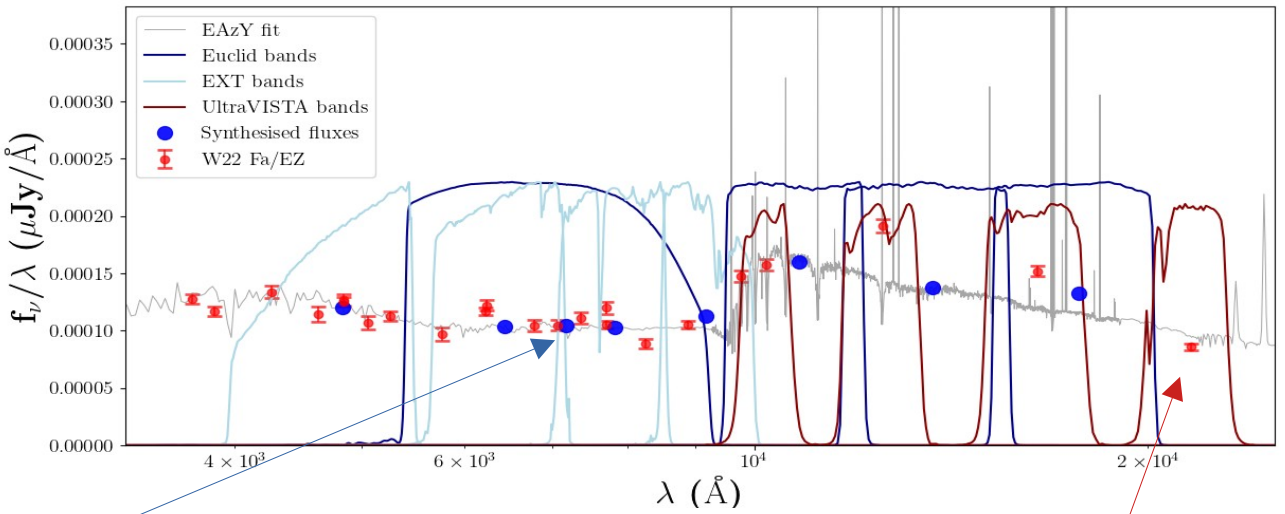
Output per Euclid wide survey object

- Photometric redshift, **p(z)**
- Galaxy physical properties (e.g. **stellar mass**)
- **Galaxy SED**, for PSF modelling
- **Star SED**, also for PSF modelling

inherited from reference objects

Early survey operations NNPZ reference data

1. **Photometric redshifts**
2. Galaxy physical properties
3. Galaxy SEDs
4. Star SEDs



SED fits to the COSMOS-UltraVISTA photometry are used to construct synthetic Euclid photometry and the detailed SED through the VIS passband.

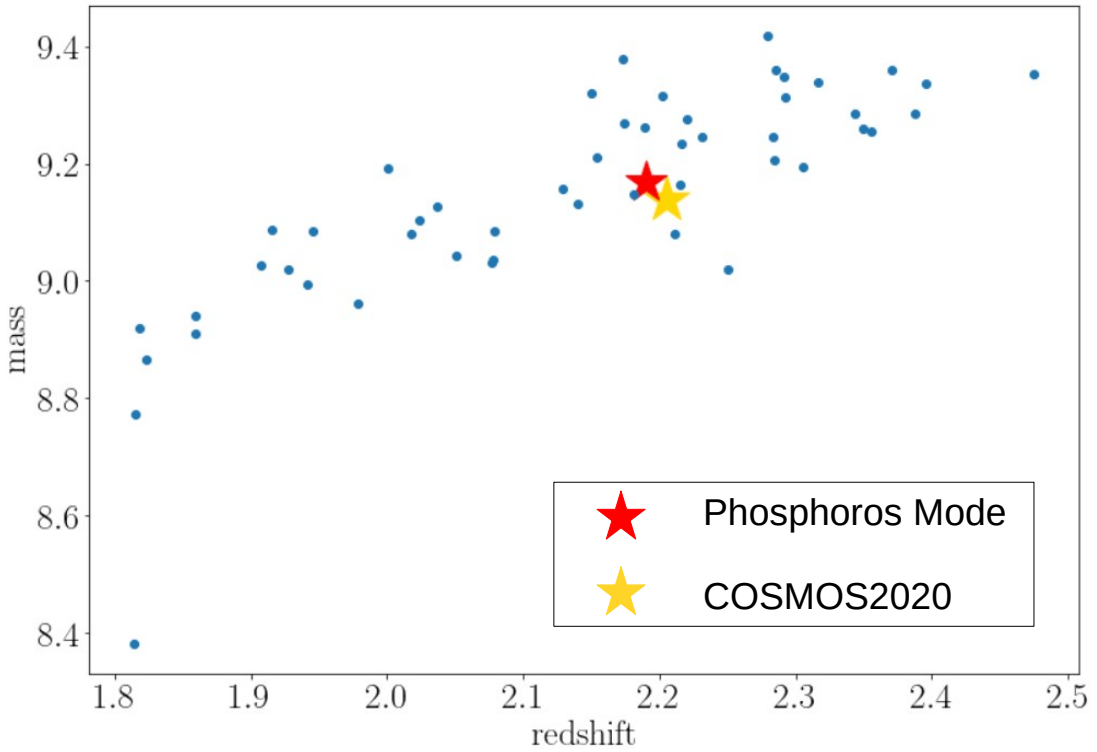
UltraVISTA bands extend the Euclid wavelength range and are narrower filters than NISP, which adds information in photo-z.

Early survey operations NNPZ reference data

1. Photometric redshifts
2. **Galaxy physical properties**
3. Galaxy SEDs
4. Star SEDs

Galaxy physical properties are measured with Phosphoros, again using the COSMOS catalogue.

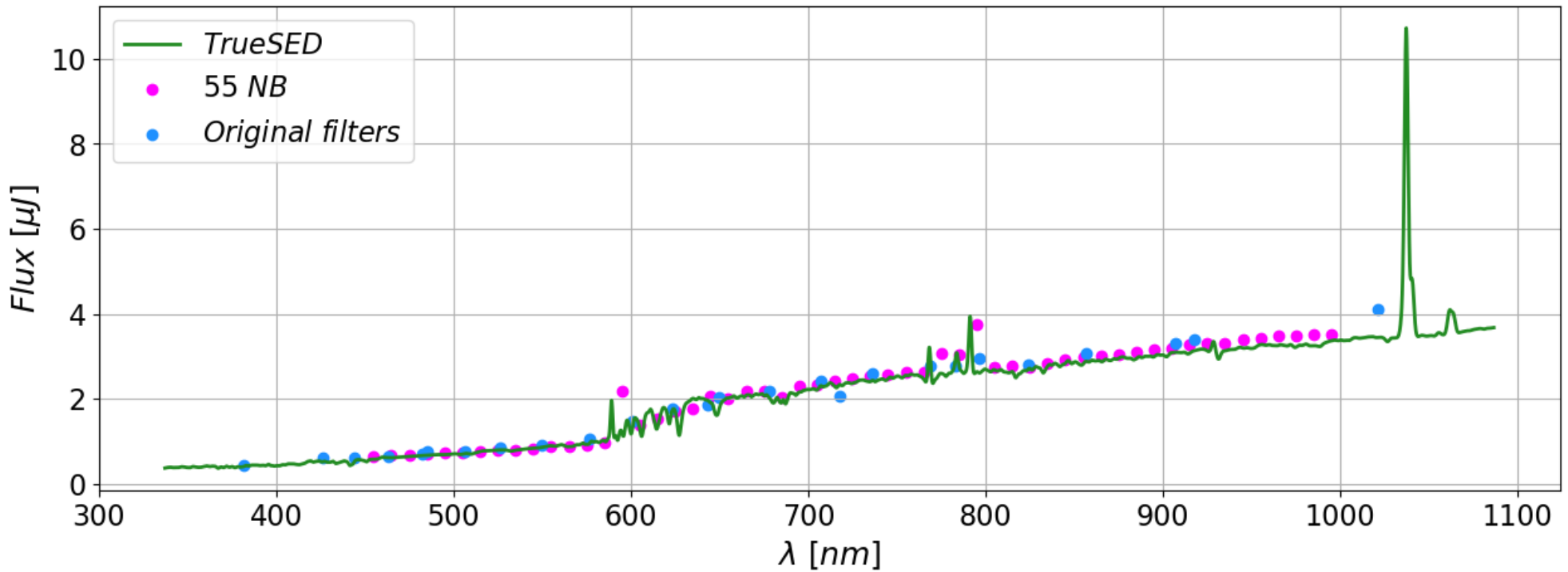
Posterior distributions are stored as a set of samples from the posterior.



Early survey operations NNPZ reference data

1. Photometric redshifts
2. Galaxy physical properties
3. **Galaxy SEDs**
4. Star SEDs

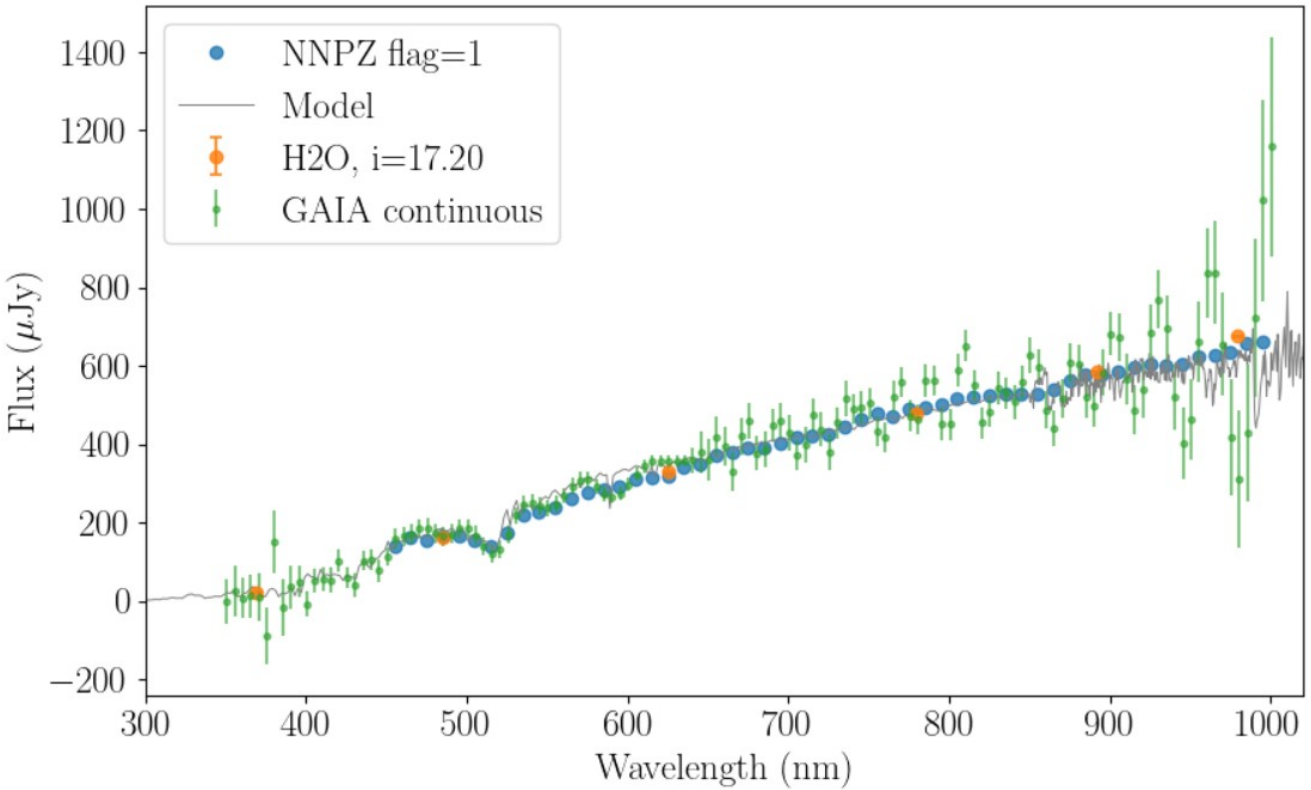
Galaxy SEDs are reconstructed from the bets data we have available: Broad + Medium bands in the COSMOS field. **Federica**'s solution for this task is already close to beating our final-year requirement on shear multiplicative bias.



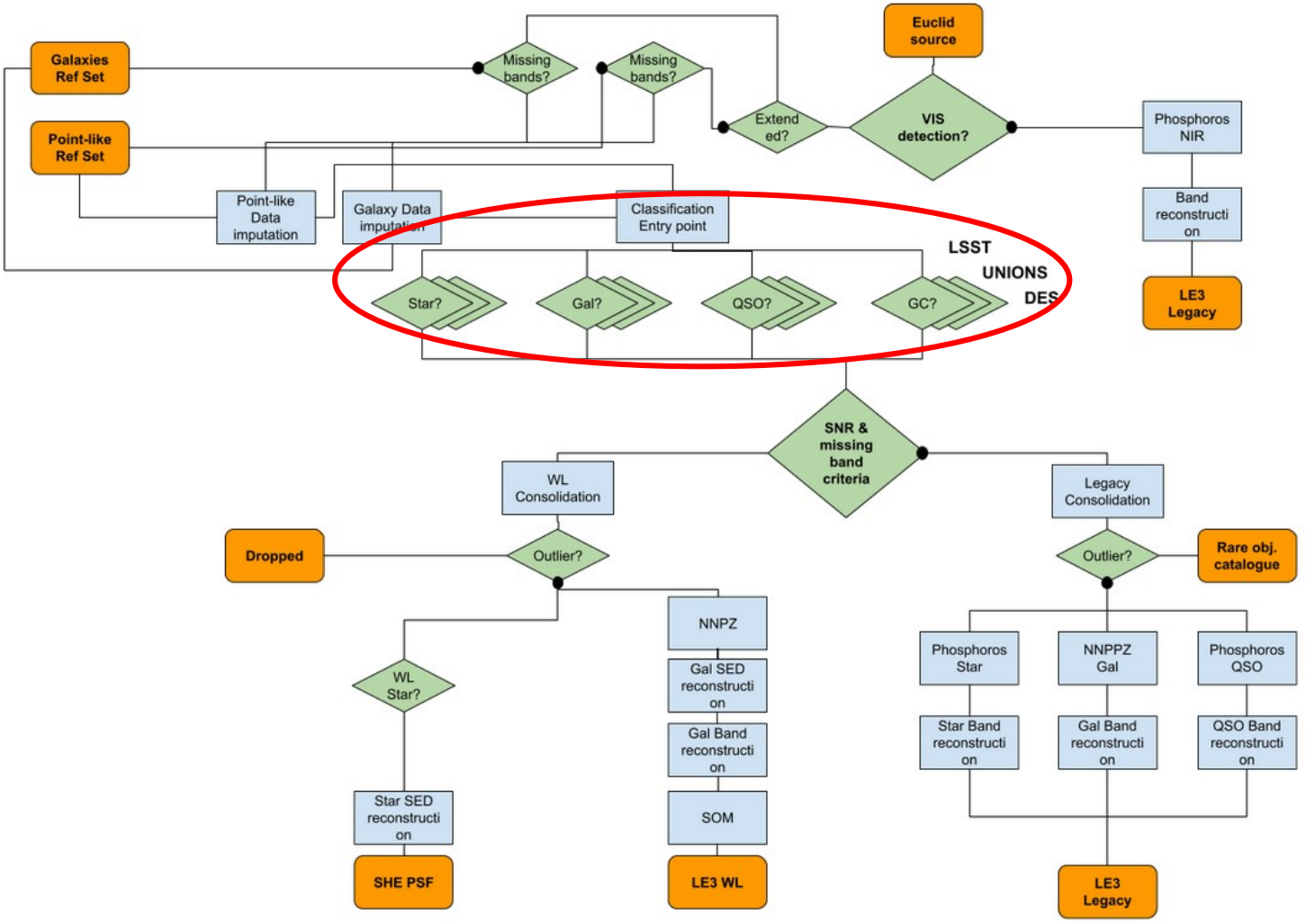
Early survey operations NNPZ reference data

1. Photometric redshifts
2. Galaxy physical properties
3. Galaxy SEDs
4. **Star SEDs**

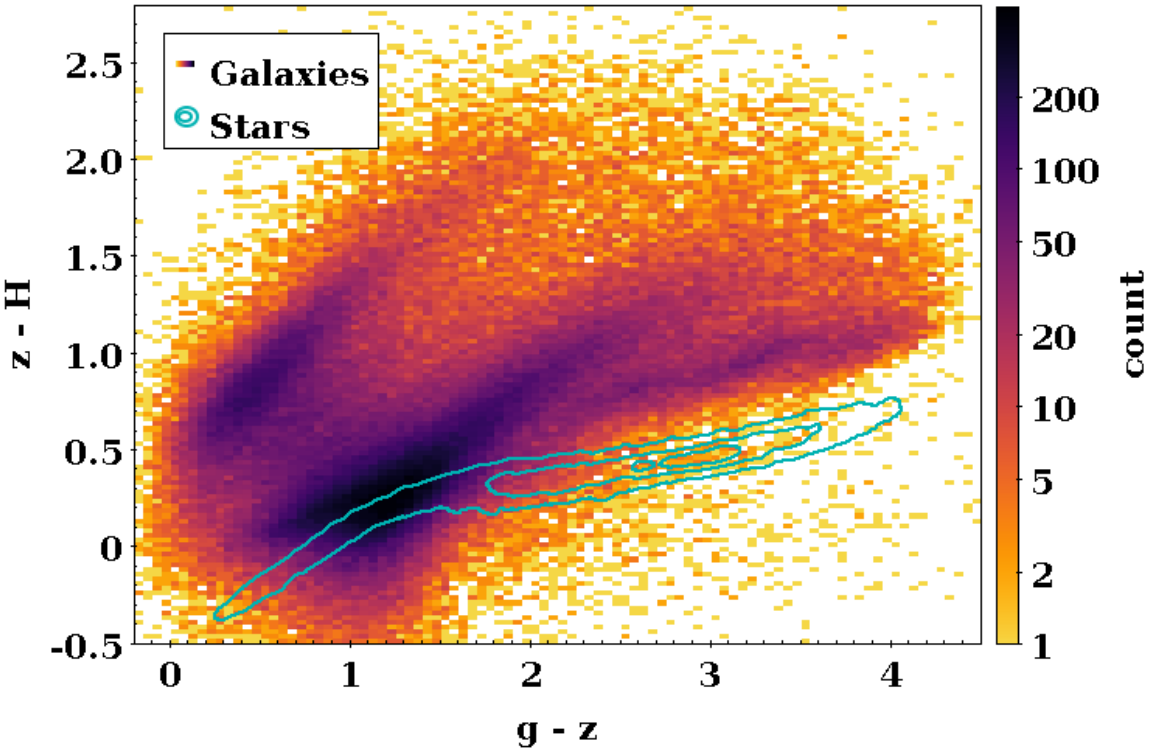
GAIA stars are used as our truth for star SEDs and matched with free amplitude.



OU-PHZ main pipeline

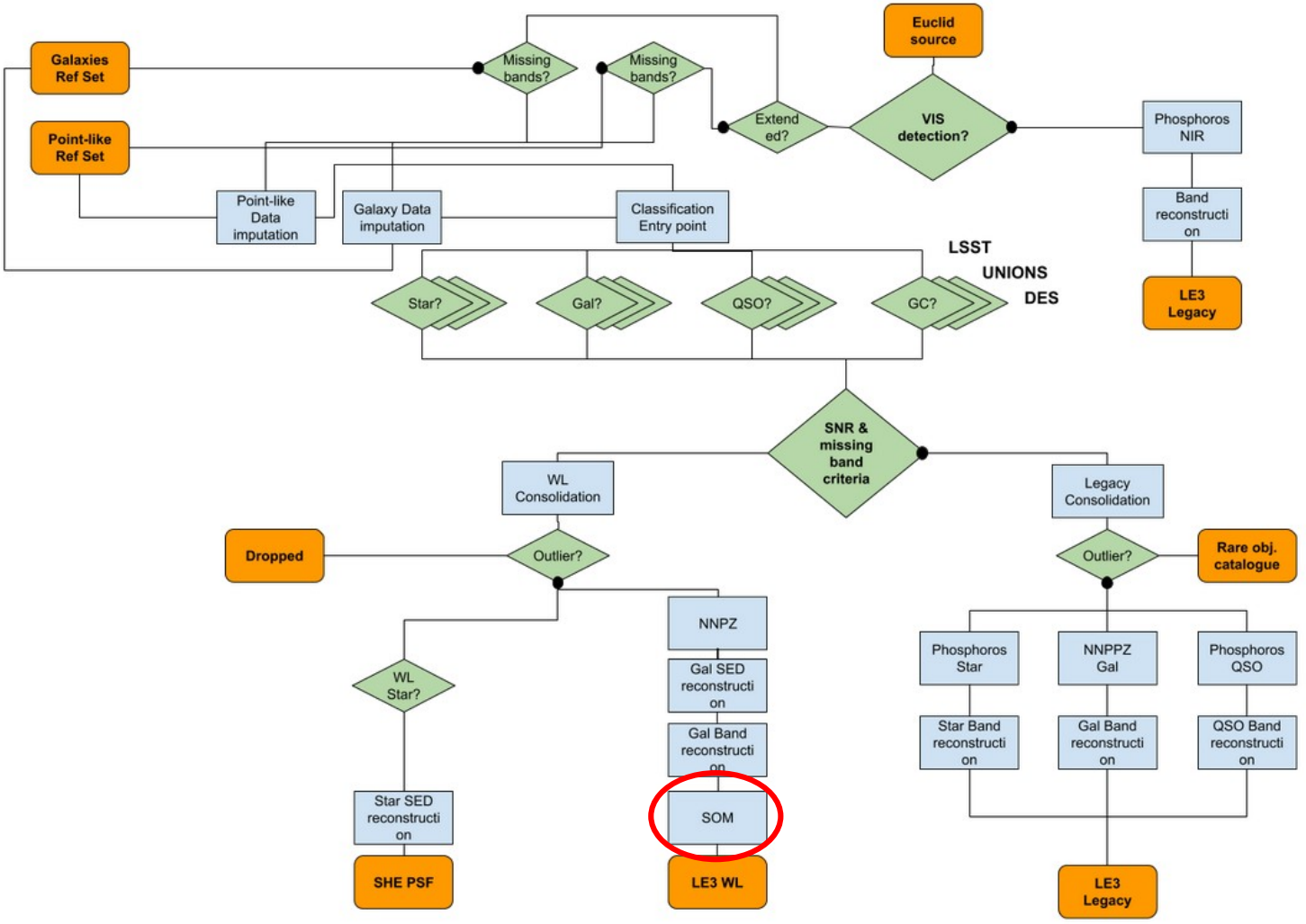


Early survey operations classification training data



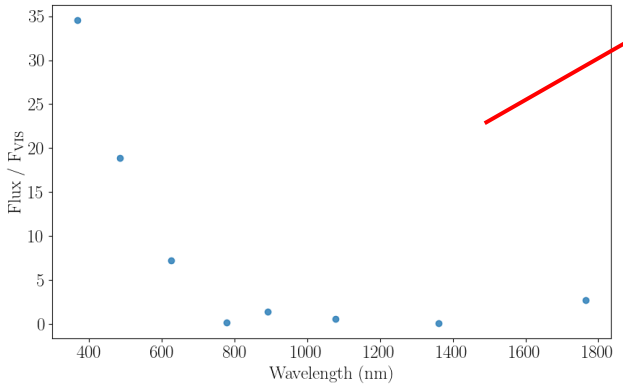
Stars and galaxies are quite well separated in the Euclid colour space (QSOs less so), but our classifier needs careful tuning to reach required level in purity – for this, **Marco** has used True Universe simulated catalogues.

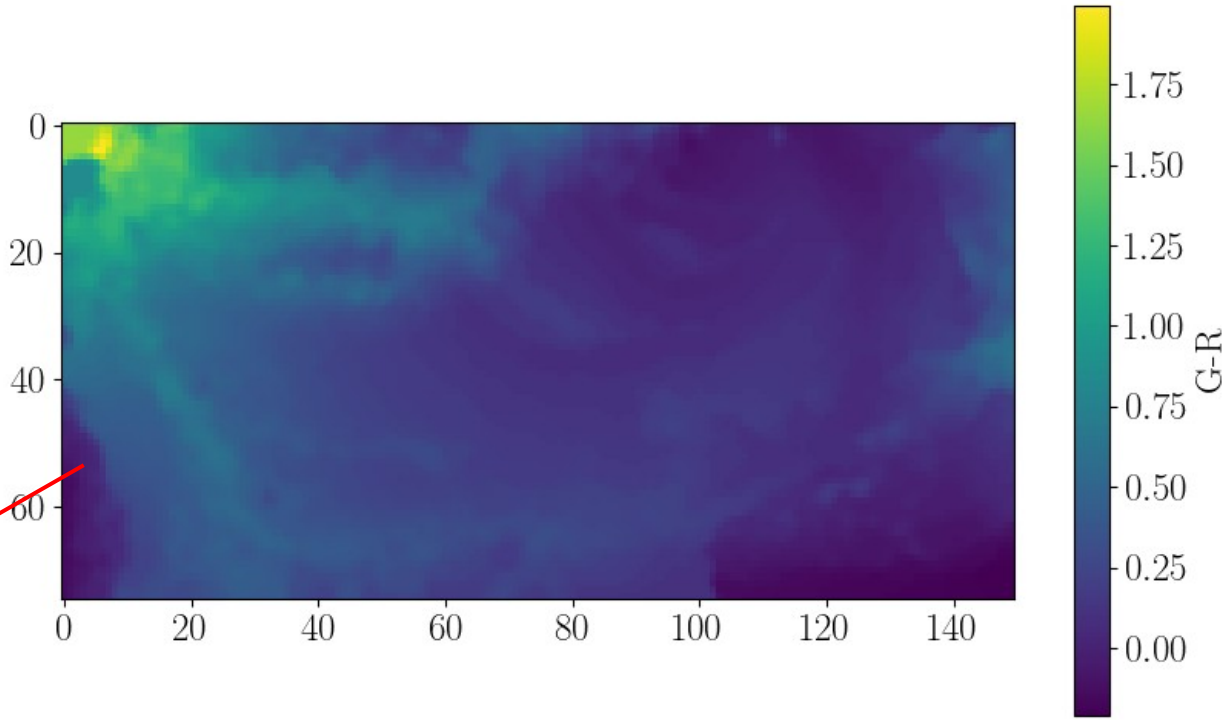
OU-PHZ main pipeline



Early survey operations Self-Organising Map (SOM)

- Self-Organising Map is a dimensionality reduction algorithm that preserves locality in the original space.
- Each pixel (“cell”) of the map represents an SED and is trained with the COSMOS data.
- The map is used quantise the photometric space which can also be filled by galaxies with spec-z, and thereby calibrate our photo-z distributions (**Yuzheng**’s work)





Summary

- The Euclid launch went very well, and we were soon blessed with fantastic, but raw, images of the Universe.
- Unsurprisingly, there have been some hiccups and difficulties that we need to mitigate.
- As a result, the early phase of commissioning and performance validation will be longer than initially planned, but overall things are looking very good!
- Data processing has reached us (OU-PHZ), and we are having to be adaptable to the data as it comes in.
- We’re more or less ready for main tranche of survey validation! (maybe)

COSMOS-UltraVISTA in the Euclid Science Ground Segment

- COSMOS-UltraVISTA is the only field with the combination of area, depth and wavelength sampling that we can use to build reference data for the early stages of Euclid operations.
- We will rely on the COSMOS2020 catalogue for the first ~6 months of operations, until we can re-build the reference samples from real in-flight Euclid data.
- UltraVISTA will continue to be important throughout the mission due to the complementary Ks-band data – for stellar masses etc., and improved redshifts.
- Euclid WL will use galaxies up to z=2.6, so Ks-band in the reference sample is required.
- UltraVISTA will likely also be used to help calibrate and understand the Euclid survey at faint NIR magnitudes.
- The medium-band data in the field are almost our only current resource for measuring galaxy SEDs through the VIS band wavelength range, for PSF modelling.
- The collection of vast amounts of spectroscopic and multi-wavelength data in the field is also critical for the star / galaxy / QSO classification task.
- Plus many more uses in science working groups.

OU-PHZ main pipeline