

Euclid transient search

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on behalf of the Supernovae and Transient WG

Why do transient search with Euclid?

**Euclid optical and NIR survey
is a unique opportunity for a transient search**

- simultaneous transient detections (and follow-up) with VIS and NIR images
- high resolution and deep limiting magnitude of optical images
- simultaneous analysis of photometric and spectroscopic data
- photometric redshifts of host galaxies
- high-redshift transients

Why do transient search with Euclid?

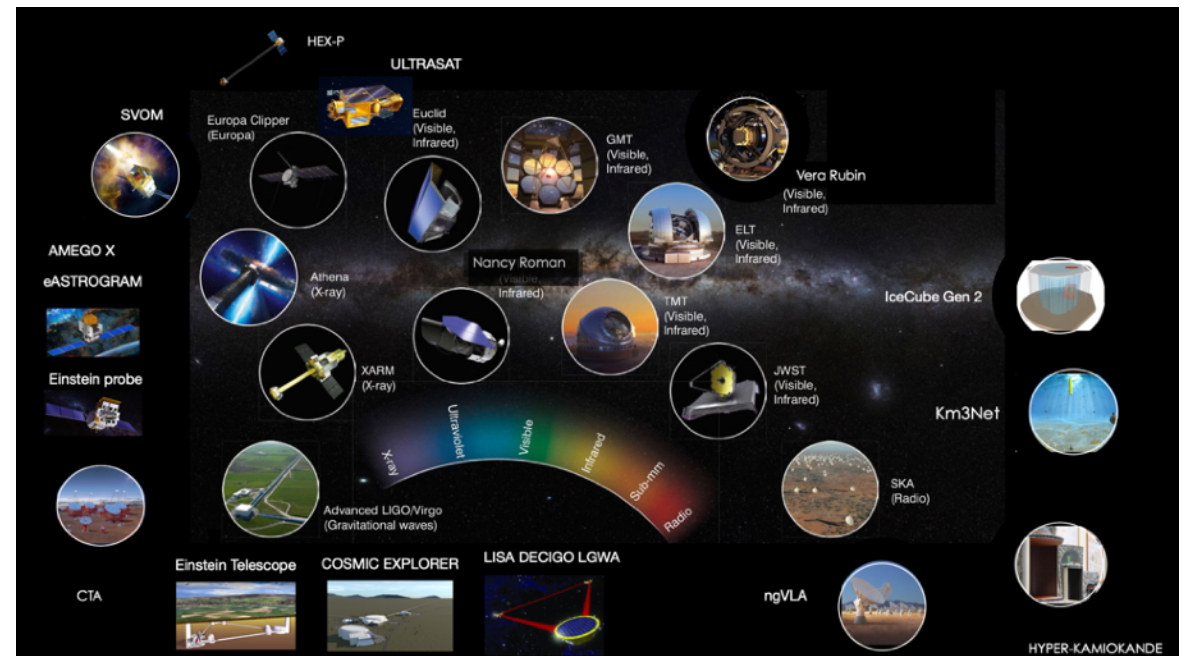
Science cases

- Supernova Ia cosmology with NIR data & high-redshift
- Supernova rates in dusty environments and at high-redshift
- Very high- z and/or long-lasting transients (e.g. SLSNe, PISNe)
- Nearby Universe: progenitor studies & intrinsically-faint red transients (LRNe, ILRT)
- Lensed Supernovae
- Host galaxies of distant transients & GW events (bright/dark sirens)

SNT-WG activities

Several standard projects - started activities for DR1

- Host galaxy studies
- SLSNe & PISNe at high redshifts
- Lensed transients
- SN Ia cosmology with LSST and LS4
- Dust obscured transients
- Photometric classification
- SN statistics and rates
- Synergies with other transient surveys

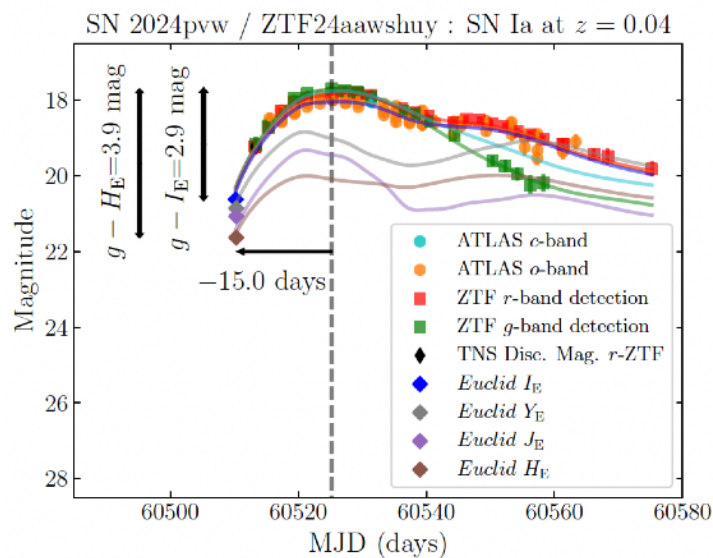


Photometric studies of known transients with Q1

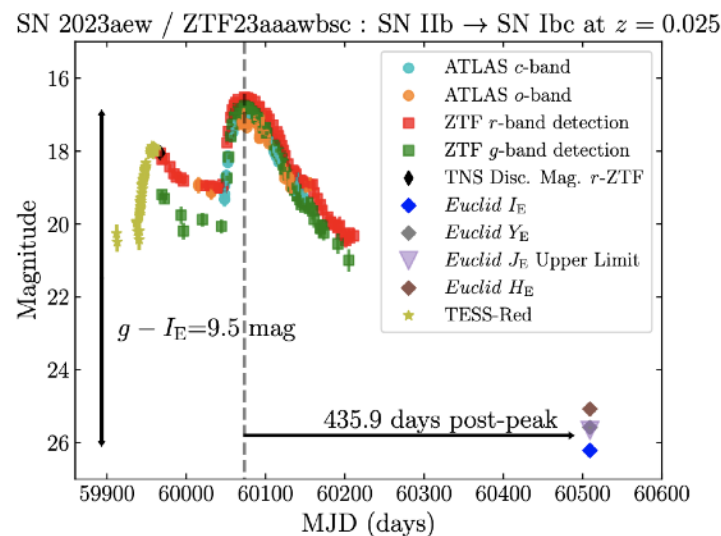
(Duffy et al 2025)

161 known transients in Q1 images

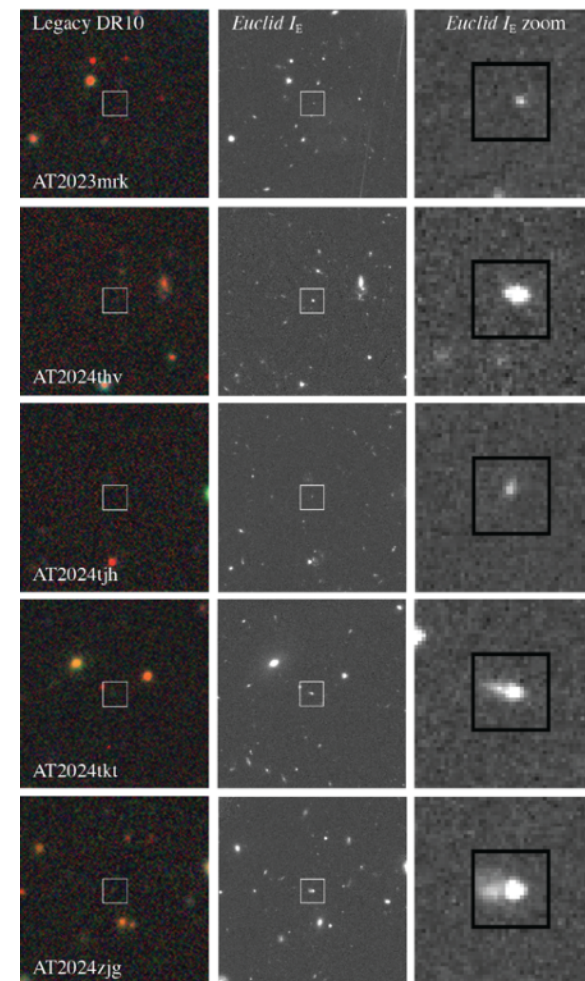
Early NIR detections



Late optical detections



Orphans host galaxies



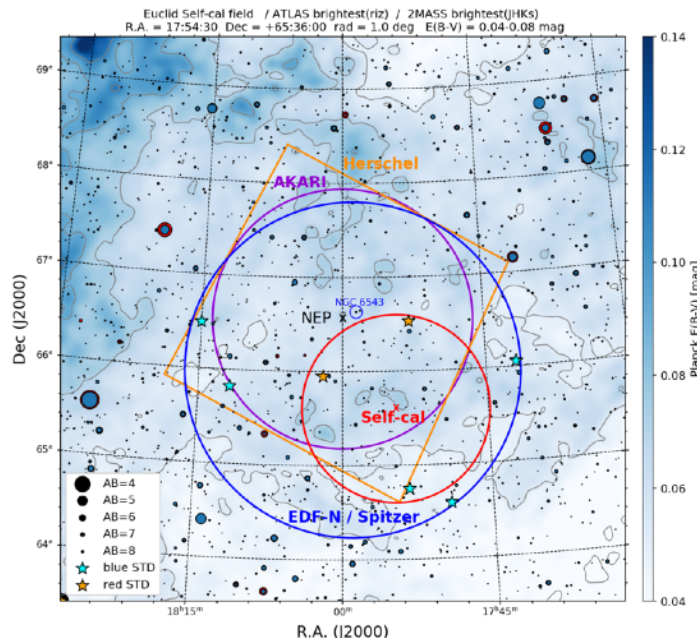
Similar project for DR1

KP: Euclid transient search in the Self-Cal field

(Cappellaro et al in prep)

DR1-KP-SNT-1

SelfCal field



~3 deg² field with multi-epoch observations

9 epochs during PV phase

1 epoch per month during nominal mission

Aims

Demonstration of Euclid capabilities to detect transients on both NISP and VIS images

Optimization of Difference Image Analysis tools for Euclid

Development of a transient database tools for cross matching catalogues, classifying transients...

Requirement

Early access to raw data

Fast data reduction and analysis

KP: Euclid transient search in the Self-Cal field

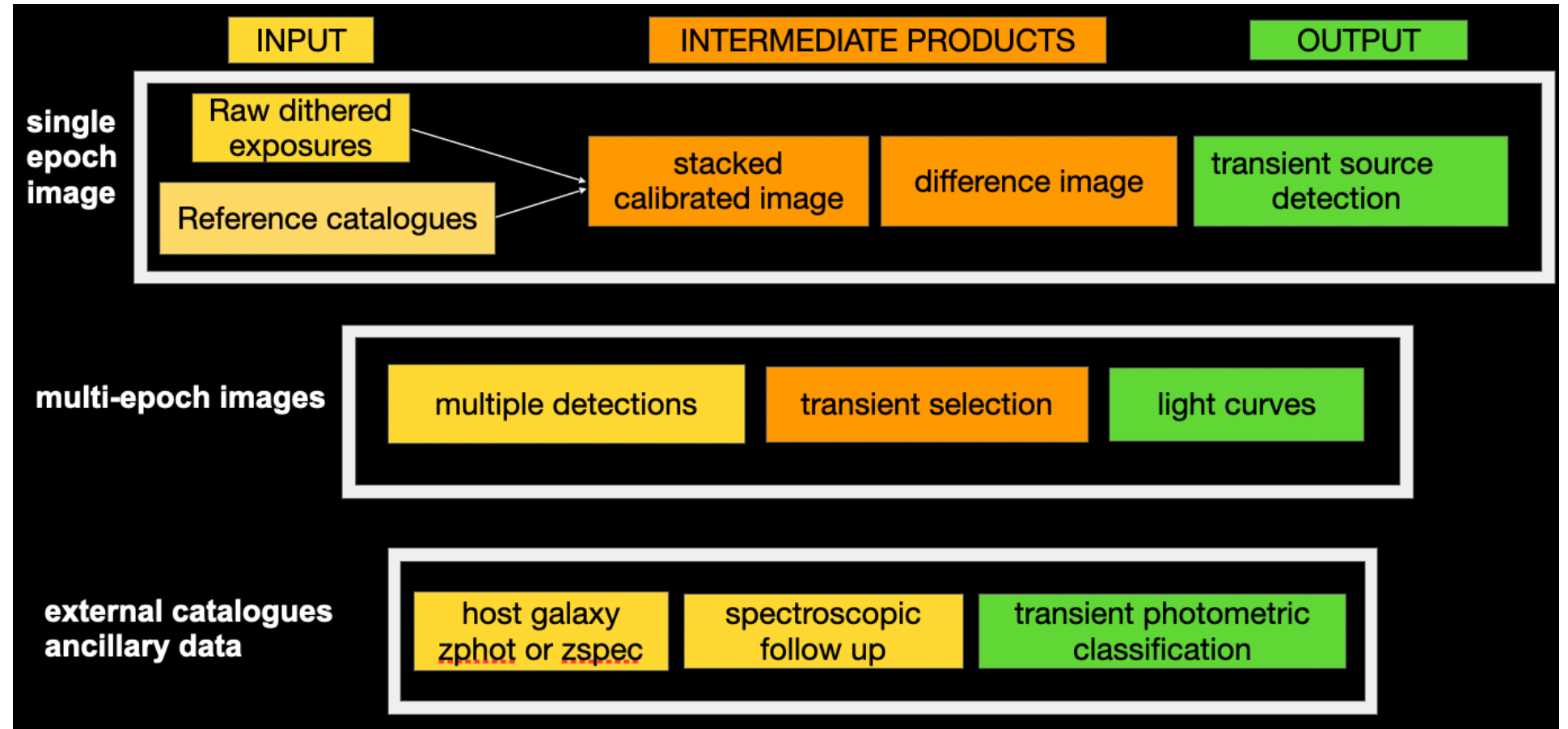
(Cappellaro et al in prep)

DR1-KP-SNT-1

Transient Pipeline
working on Datalab
(EC-Spritz)

Work on LE1 data

astrometrically &
photometrically
calibrated stacked
frames



KP: Euclid transient search in the Self-Cal field

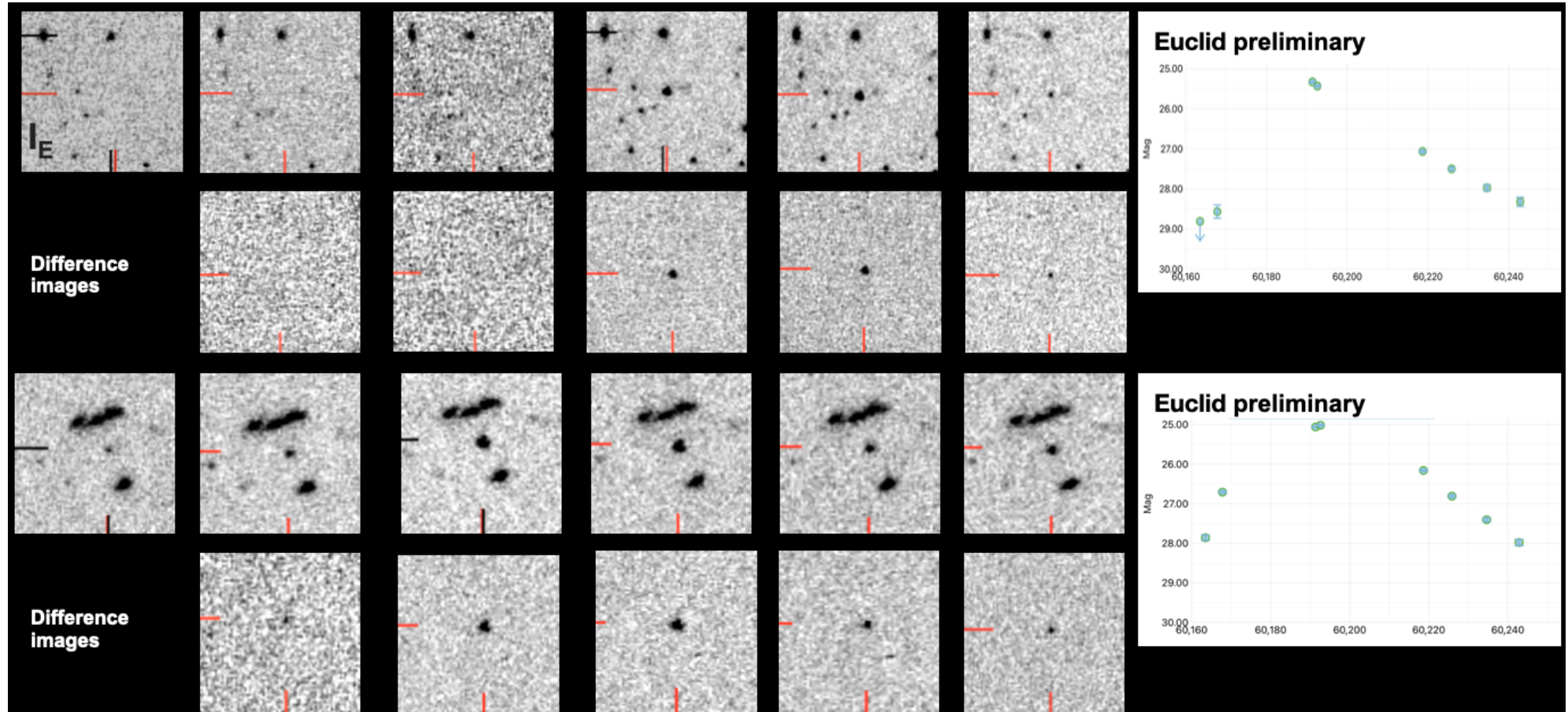
(Cappellaro et al in prep)

DR1-KP-SNT-1

Multi-epoch
Image analysis

Detailed optical
light curves

Faint
magnitude limits



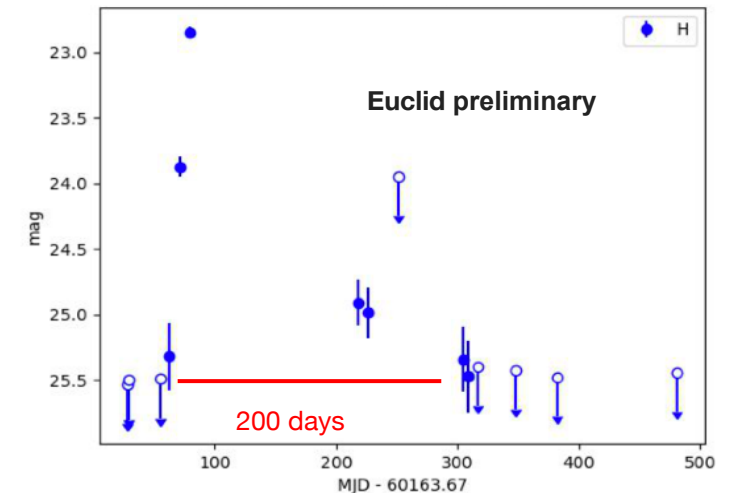
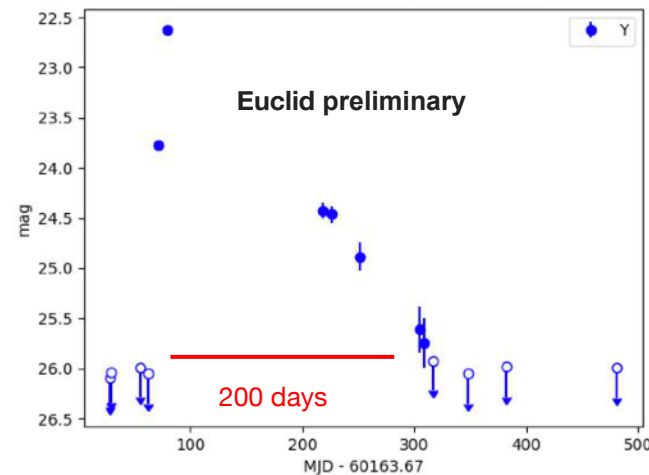
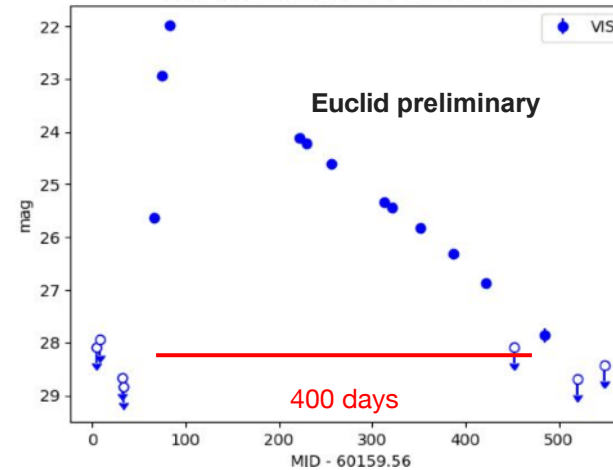
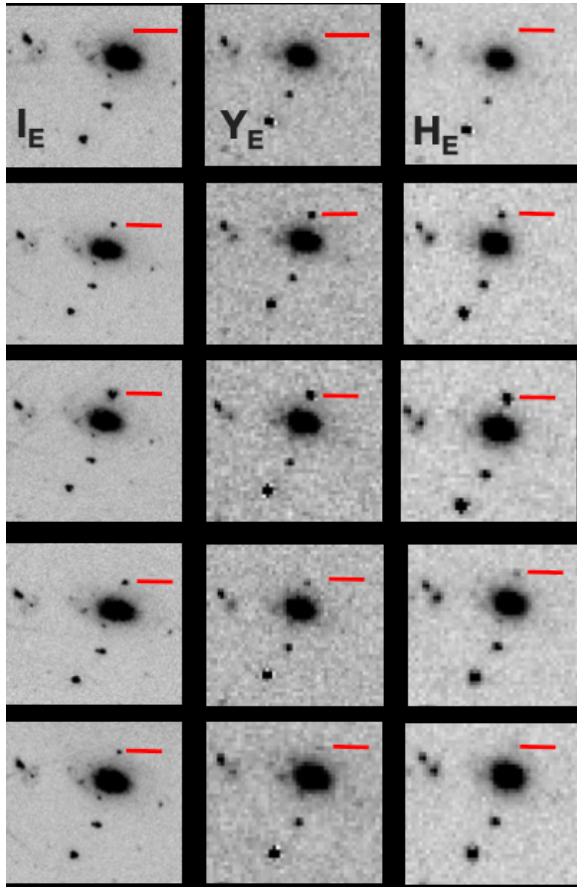
KP: Euclid transient search in the Self-Cal field

(Cappellaro et al in prep)

DR1-KP-SNT-1

Combined optical-NIR
Image analysis

Building a precious dataset
for further studies (on-going)



KP: Euclid transient search in the Self-Cal field

(Cappellaro et al in prep)

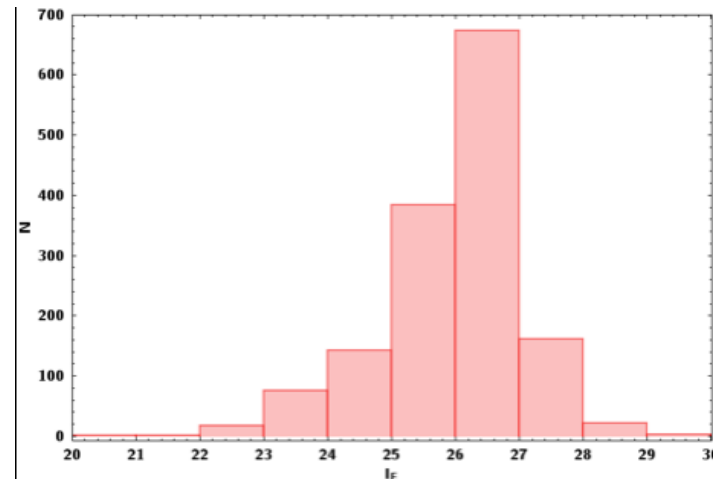
First results

1.5 years - 1300 candidates

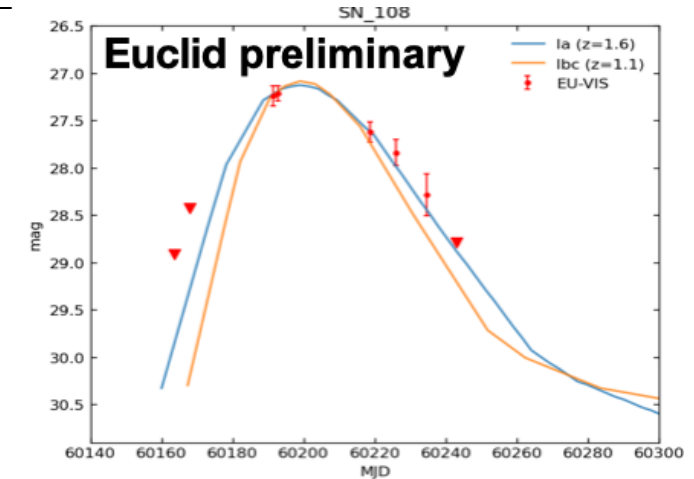
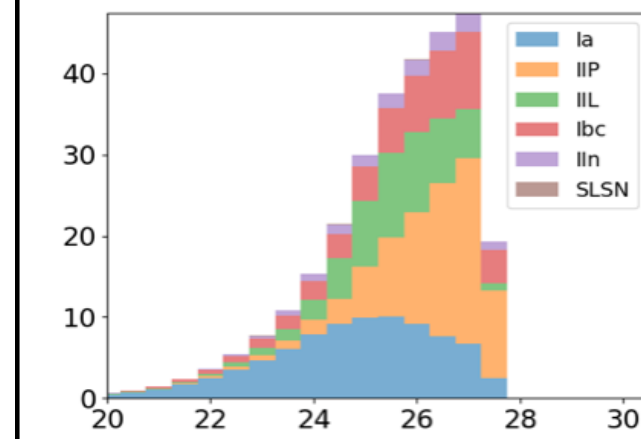
$I_E \sim 27$ mag

Type-Ia SNe up to $z \sim 1.5$

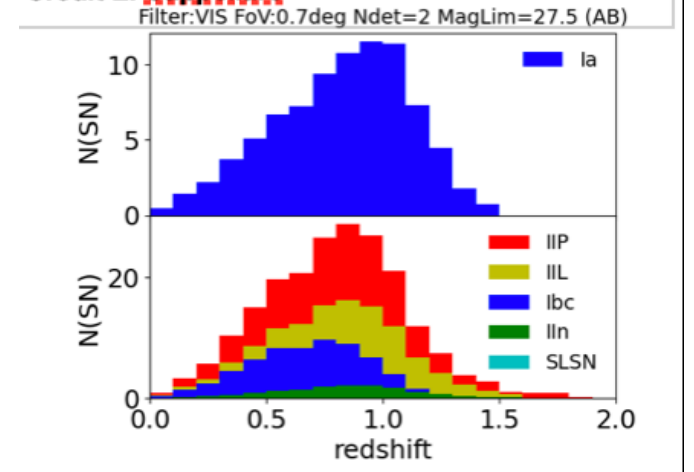
In agreement with
simulations performed
pre-launch



Credit E. Cappellaro



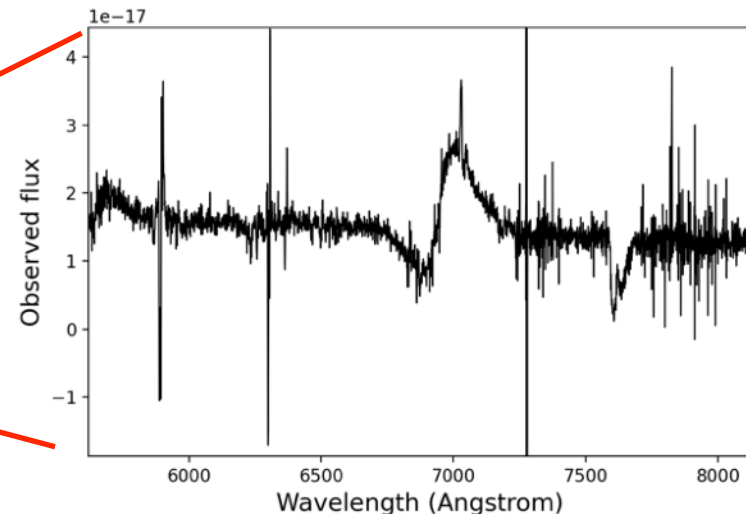
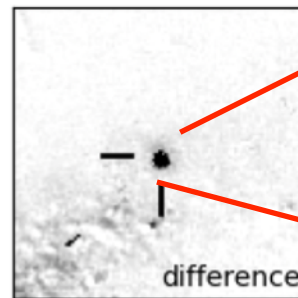
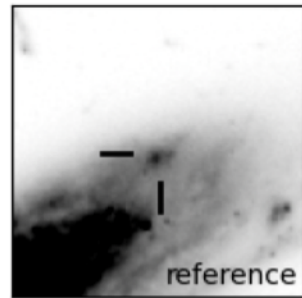
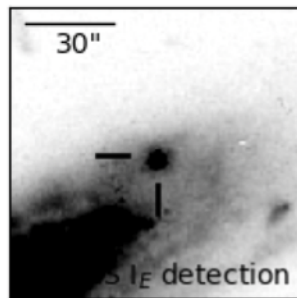
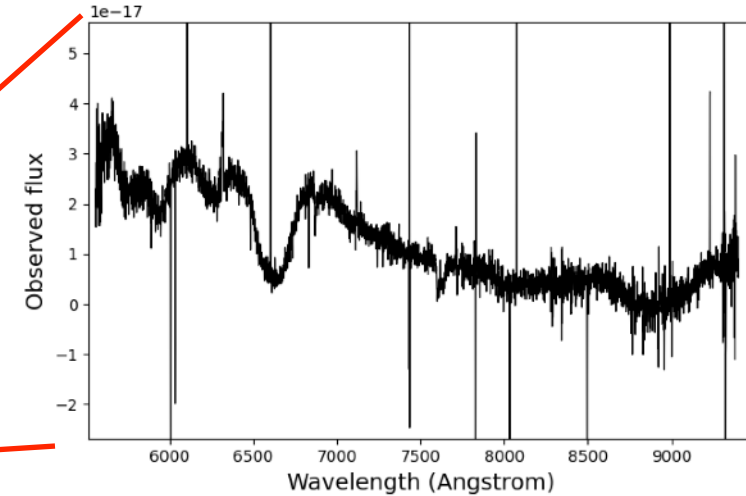
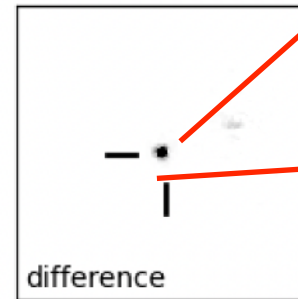
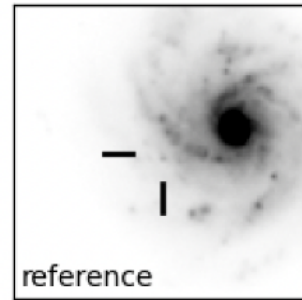
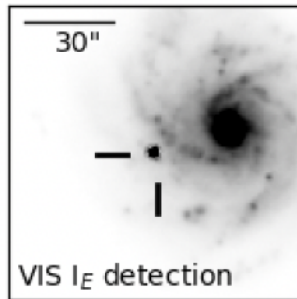
Credit E. Cappellaro



KP: Euclid transient search in the Self-Cal field

(Cappellaro et al in prep)

Spectroscopic follow-up



Towards DR1: Rubin-Euclid and more

(Petrecca et al in prep)

Photometric follow-up

VESTA: VST-Euclid Synergies for Time-domain Astronomy

Wide-field camera (1 square degree FoV)

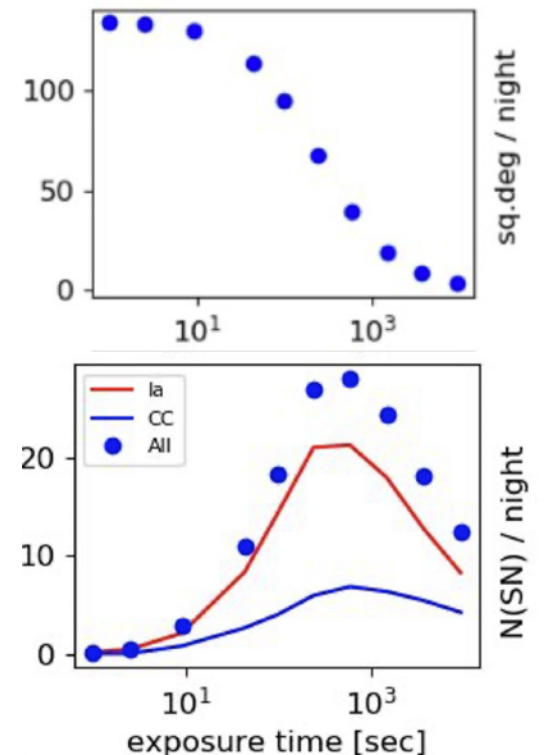
Excellent image quality and depth

Same pixel scale of LSST (0.2 arcseconds)

Very similar photometric system of LSST

Location (Cerro Paranal) close to LSST (Cerro Pachón)

Great experience with transient surveys (SUDARE)

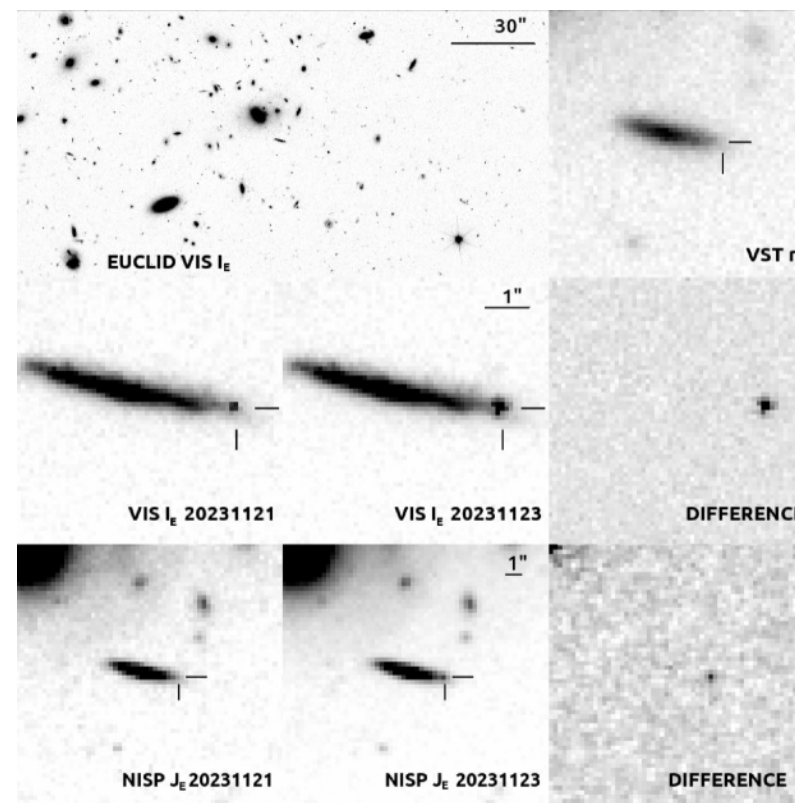
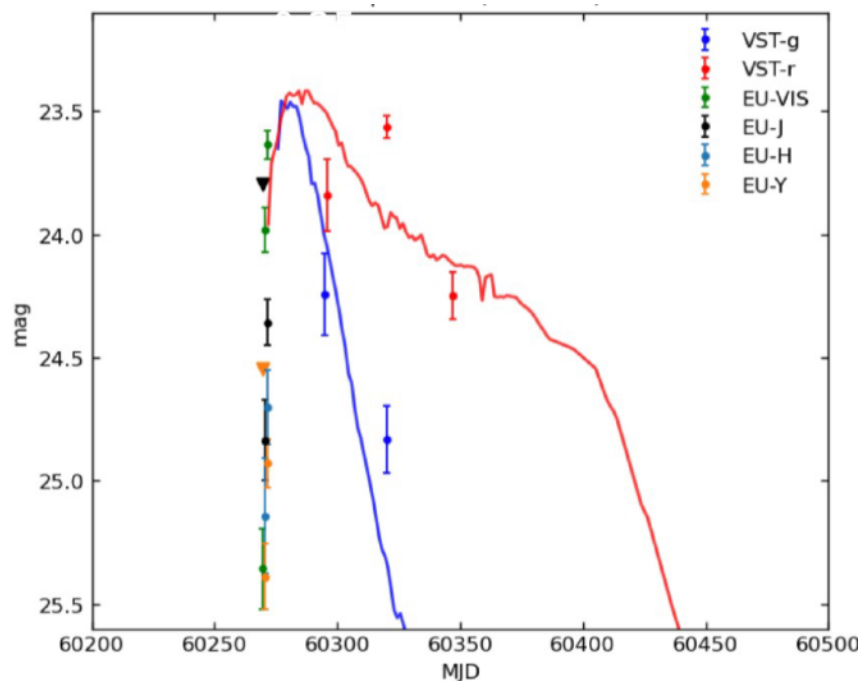


Towards DR1: Rubin-Euclid and more

(Petrecca et al in prep)

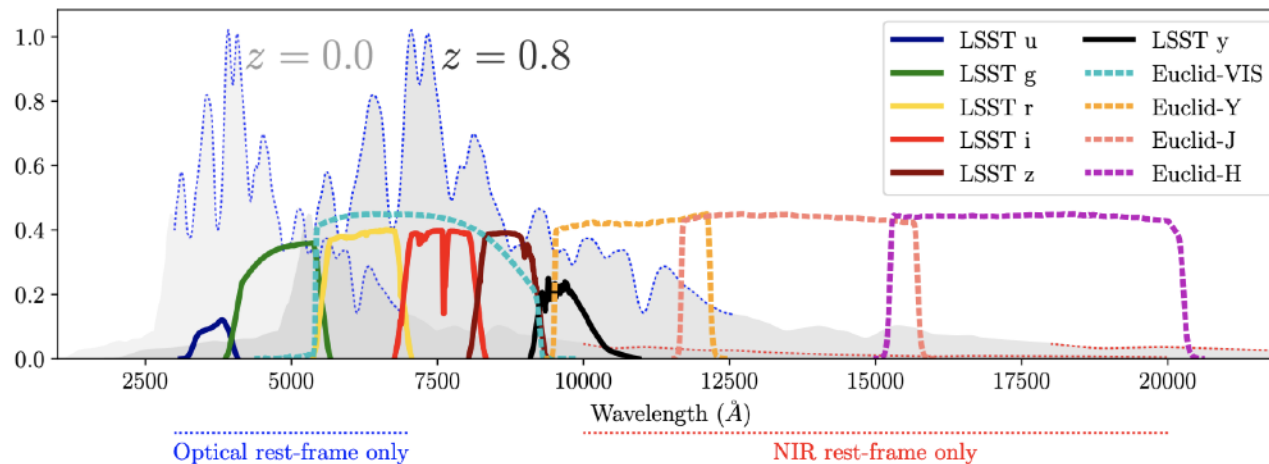
Photometric follow-up

VESTA: VST-Euclid Synergies for Time-domain Astronomy



Towards DR1: Rubin-Euclid and more

Transient science can be enabled by coupling Rubin-LSST and Euclid survey



- SN rate evolution as a function of redshift, galaxy mass, SFR
- SN Ia cosmology in the NIR range
- Nuclear Transients
- Gravitationally lensed transients
- High redshift long-lasting transients (SLSNe, PISNe...)
- Dust extinction bias for transient search

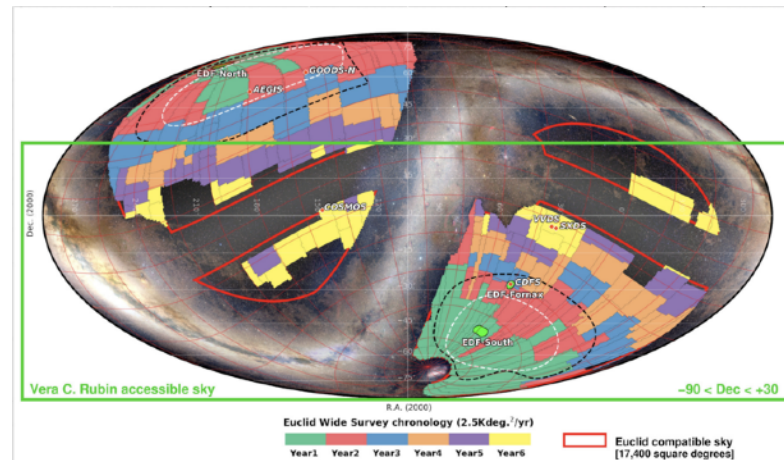
Complementing low- and medium- z transient Universe

Towards DR1: Rubin-Euclid and more

Pave the way for simultaneous Rubin-Euclid observations - DR2 and DR3

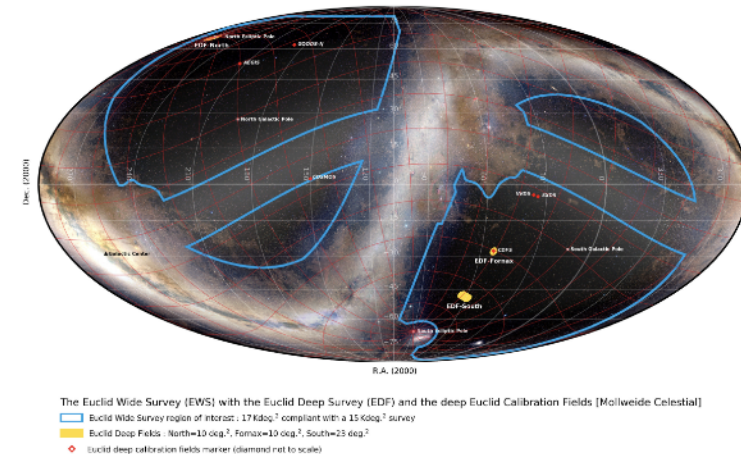
2 main projects

Euclid-Rubin joint light curves and cutouts



exploiting the spatial overlap of the two wide surveys
~9400 deg²

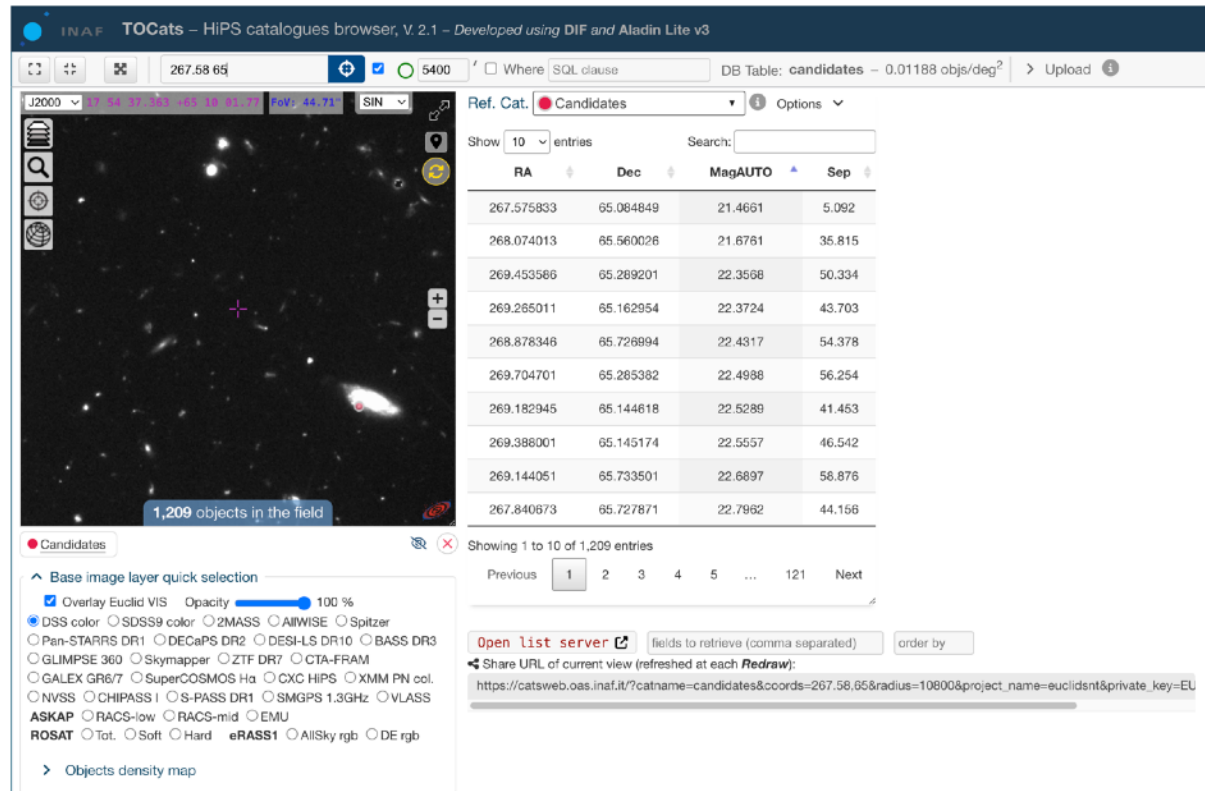
Euclid-Rubin simultaneous transient search



exploiting the temporal overlap on deep fields
for several seasons ~30 deg²

Coming soon

Bright candidate release to the TNS & web tools for Euclid members



Immediate visualization
of SelfCal candidates

Interactive check of TNS sources
and Euclid DF data

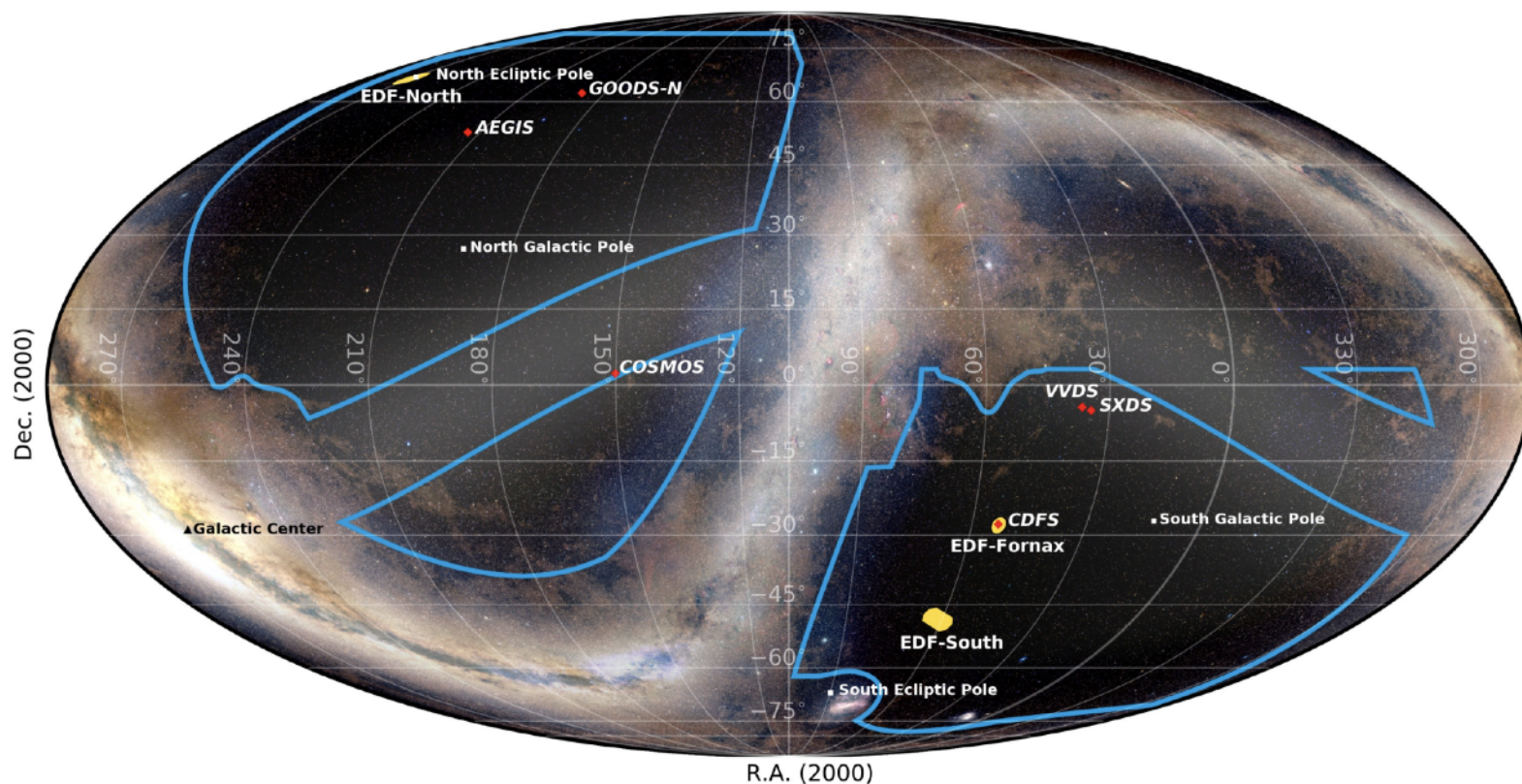
Check with other (many) catalogs

Thank you for the attention



<https://euclid.roe.ac.uk/projects/stswg>

Euclid surveys



(Mellier et al 2024)

Wide Survey:

14,000 deg²

VIS: 24.5 mag (10σ)

Y/J/H: 24.0 mag (5σ)

Deep Survey:

53 deg²

VIS: 26.5 mag (10σ)

Y/J/H: 26.0 mag (5σ)

Auxiliary fields

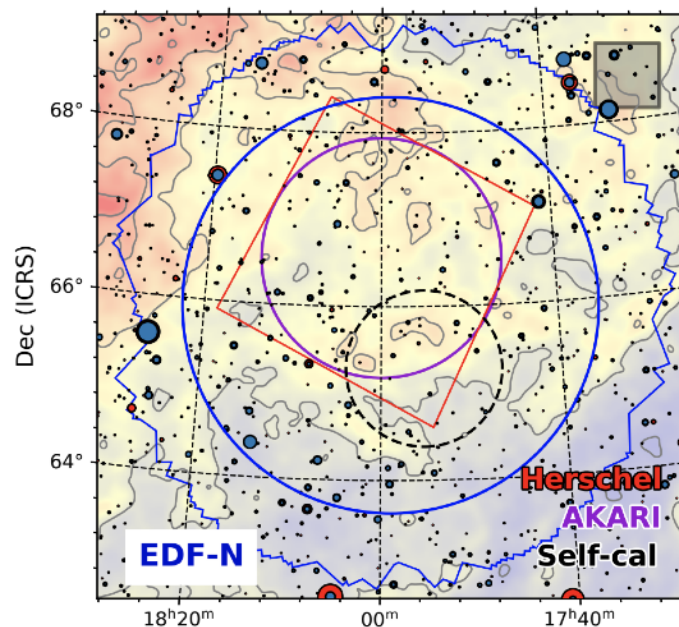
NIR self-calibration field

Photo-z calibration field

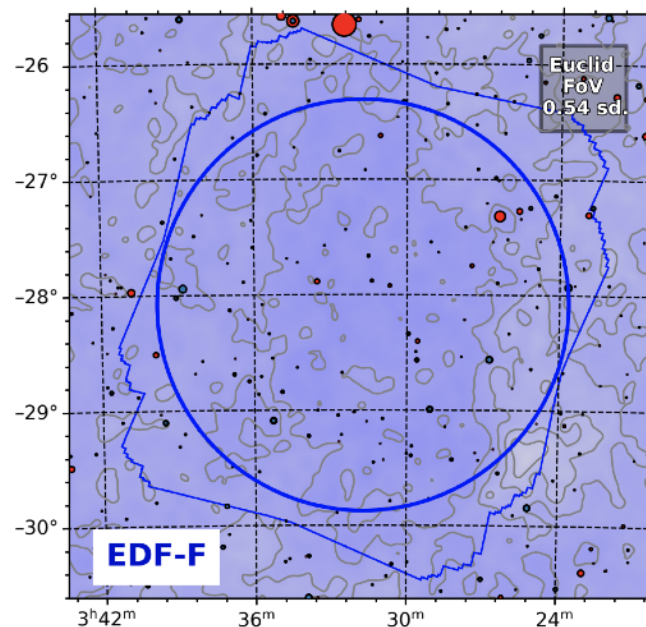
Euclid Deep Fields

- Deep Fields take up 12% of the total survey time
- Visits at regular intervals during the mission with different observation angles
- Two magnitudes deeper than the Wide Survey

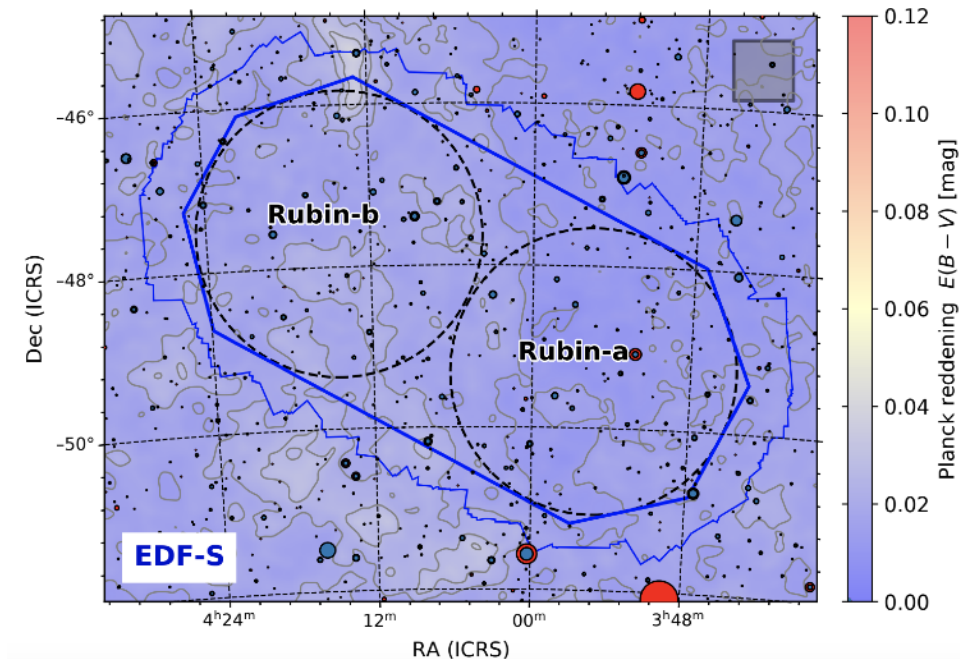
(Mellier et al 2024)



Overlap with *Spitzer* deep fields
SelfCal field



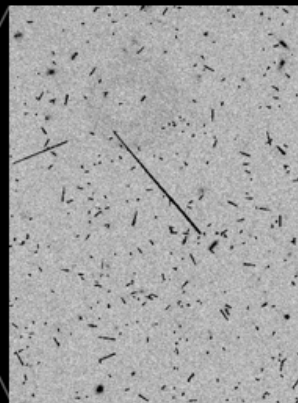
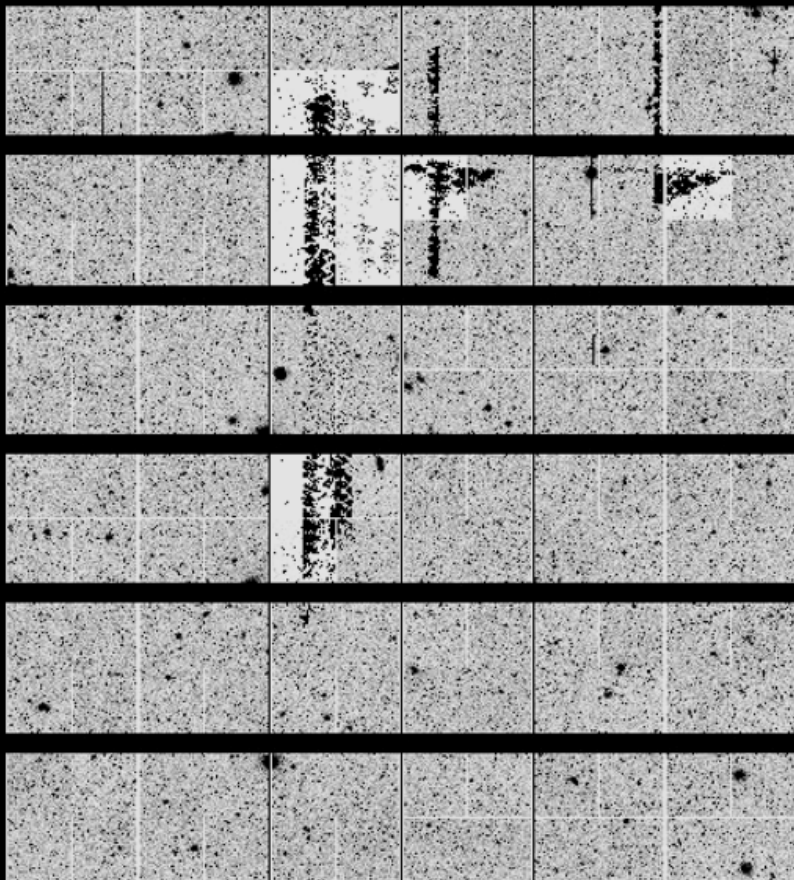
Includes Chandra Deep Field South



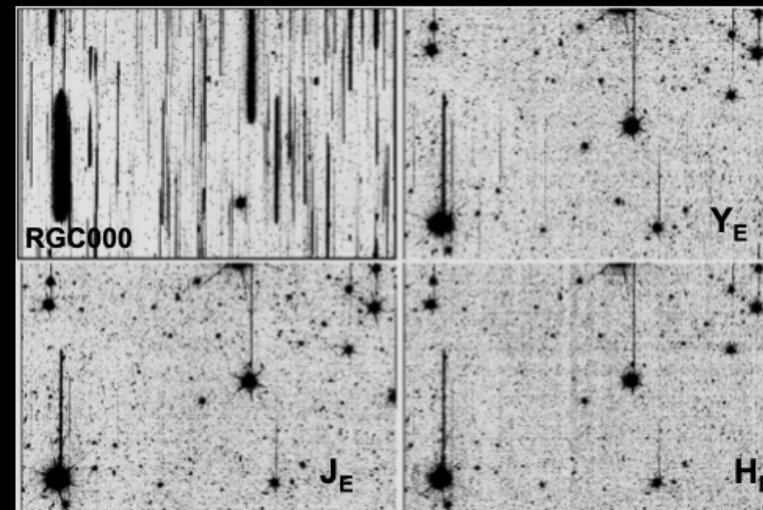
Important spatial and temporal overlap with
Vera Rubin LSST (including partial ComCam)

single epoch image analysis

cosmic ray removal

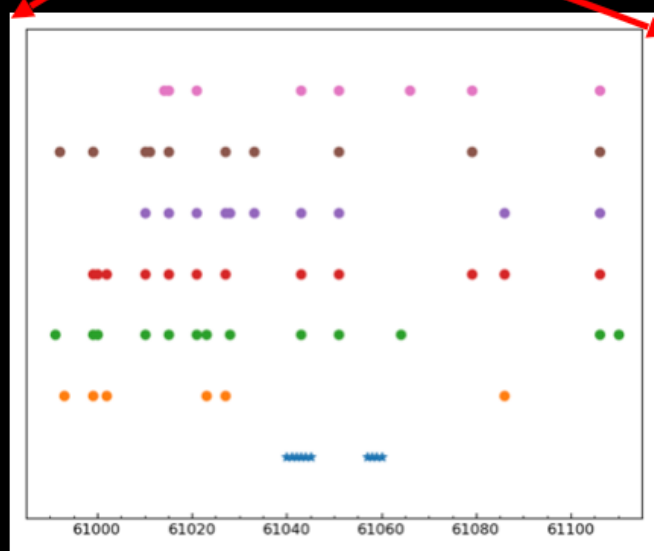
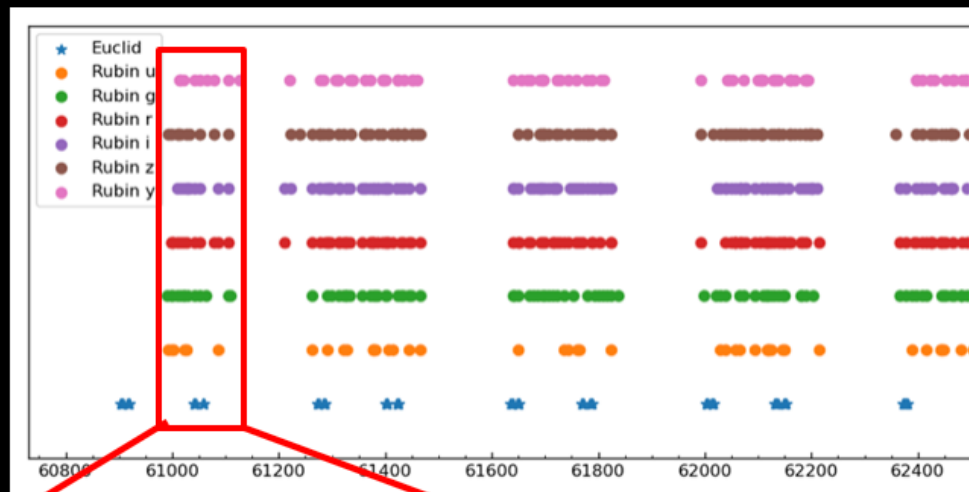


persistence correction for NISP data



astrometric calibration

photometric calibration



EDFS
1st overlap
Jan 2026

Rubin and Euclid images:

cross-match transient detections

forced photometry on transient positions

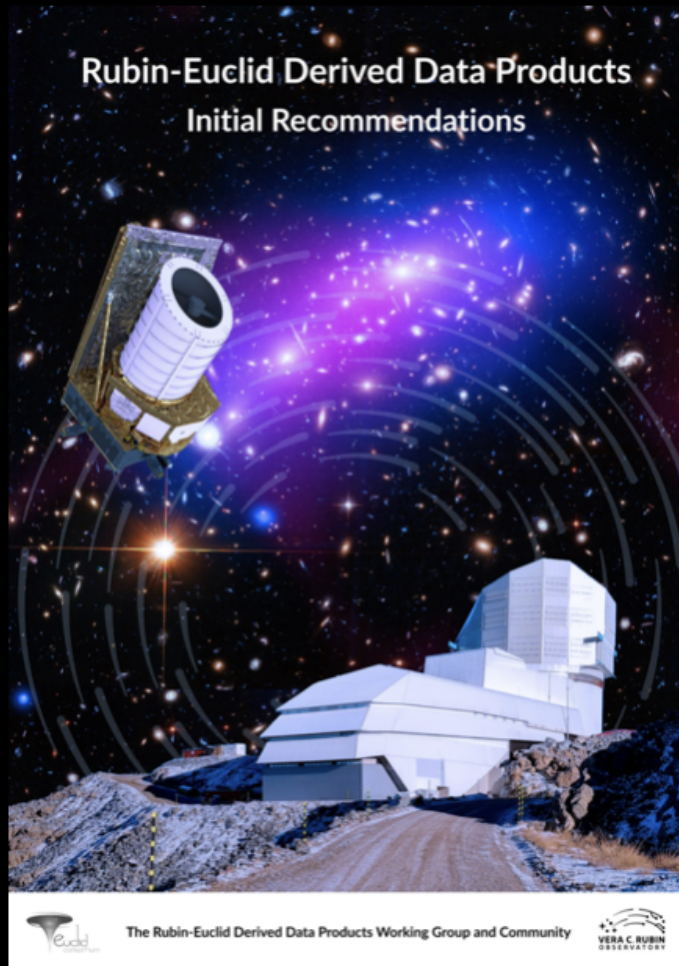
Rubin and Euclid catalogues:

joint optical + NIR light curves

transient photometric classification

host galaxy zphot with optical+NIR

Euclid - Rubin joint transient science with DR2 and DR3 data



<https://arxiv.org/abs/2201.03862>

Broad scientific impact of

joint transient light curves in the optical and NIR
high quality photometry
photometric redshift of host galaxies

Transients (TR)

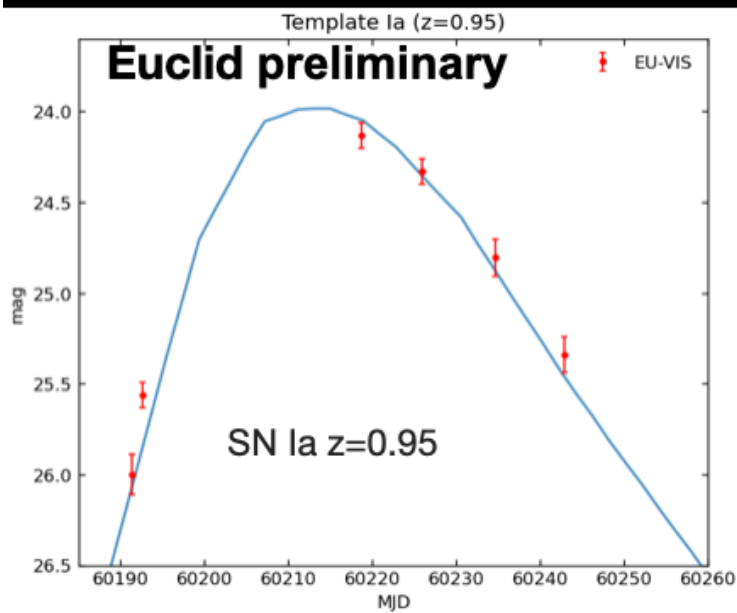
DDPs for transients

DDP-25-TR	B P1+U1+RT	T0	Transient object light-curves
DDP-26-TR	B P1+U1+RT	T0	Transient object cutouts
DDP-27-TR	B P2+U1+RT	T0	Transient astrometry
DDP-28-TR	B P1+U1+YR	T1	Transient host galaxy photometry
DDP-29-TR	B P1+U1+RT	T0	Transient host galaxy redshifts
DDP-30-TR	B P2+U2+YR	T2	Transient host spectral parameters
DDP-31-TR	B P1+U1+RT	T0	Joint transient lightcurve parameters
DDP-32-TR	B P1+U1+RT	T0	Transient redshifts
DDP-33-TR	B P1+U1+YR	T1	Joint transient host parameters
DDP-34-TR	B P1+U1+RT	T0	Joint transient database and interface
DDP-35-TR	B P1+U1+DR	T2	Transient detection efficiencies

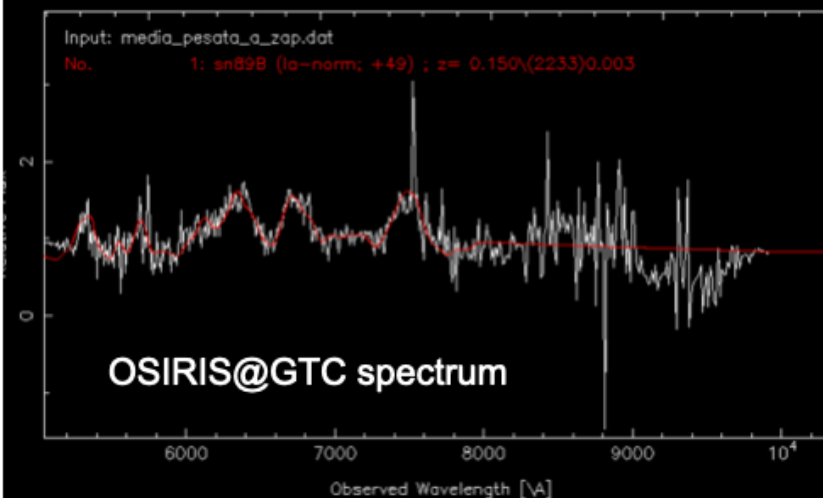


Rubin-Euclid Derived Data Products Forum

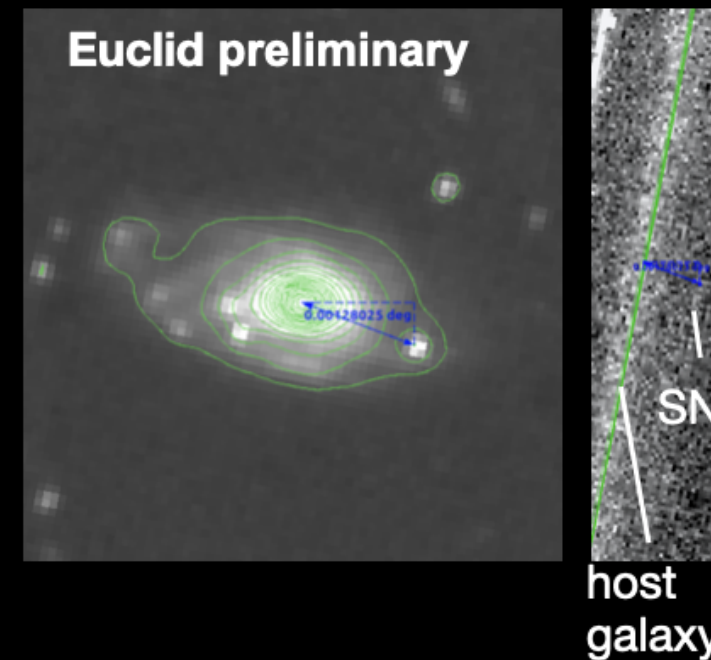




photometric classification
by fitting light curves



spectroscopic follow up
for brightest transients
LBT, Subaru, GCT, ESO-VLT, TNG



zphot from MER catalogues
zspec from NISP spectrum
for brightest galaxies

INAF TOCats – HiPS catalogues browser, V. 2.1 – Developed using DIF and Aladin Lite v3

267.58 65 5400 Where SQL clause DB Table: candidates – 0.01188 objs/deg² Upload

J2000 12 54 32.774 65 12 51.63 Fov: 58.33 SIN

1,209 objects in the field

Ref. Cat. Candidates Options

Show 10 entries Search:

RA	Dec	MagAUTO	Sep
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268.074013	65.560026	21.6761	35.815
269.453586	65.289201	22.3568	50.334
269.265011	65.162954	22.3724	43.703
268.878346	65.726994	22.4317	54.378
269.704701	65.285382	22.4988	56.254
269.182945	65.144618	22.5289	41.453
269.388001	65.145174	22.5557	46.542
269.144051	65.733501	22.6897	58.876
267.840673	65.727871	22.7962	44.156

Showing 1 to 10 of 1,209 entries

Previous 1 2 3 4 5 ... 121 Next

Candidates

Base image layer quick selection

Overlay Euclid VIS Opacity 100 %