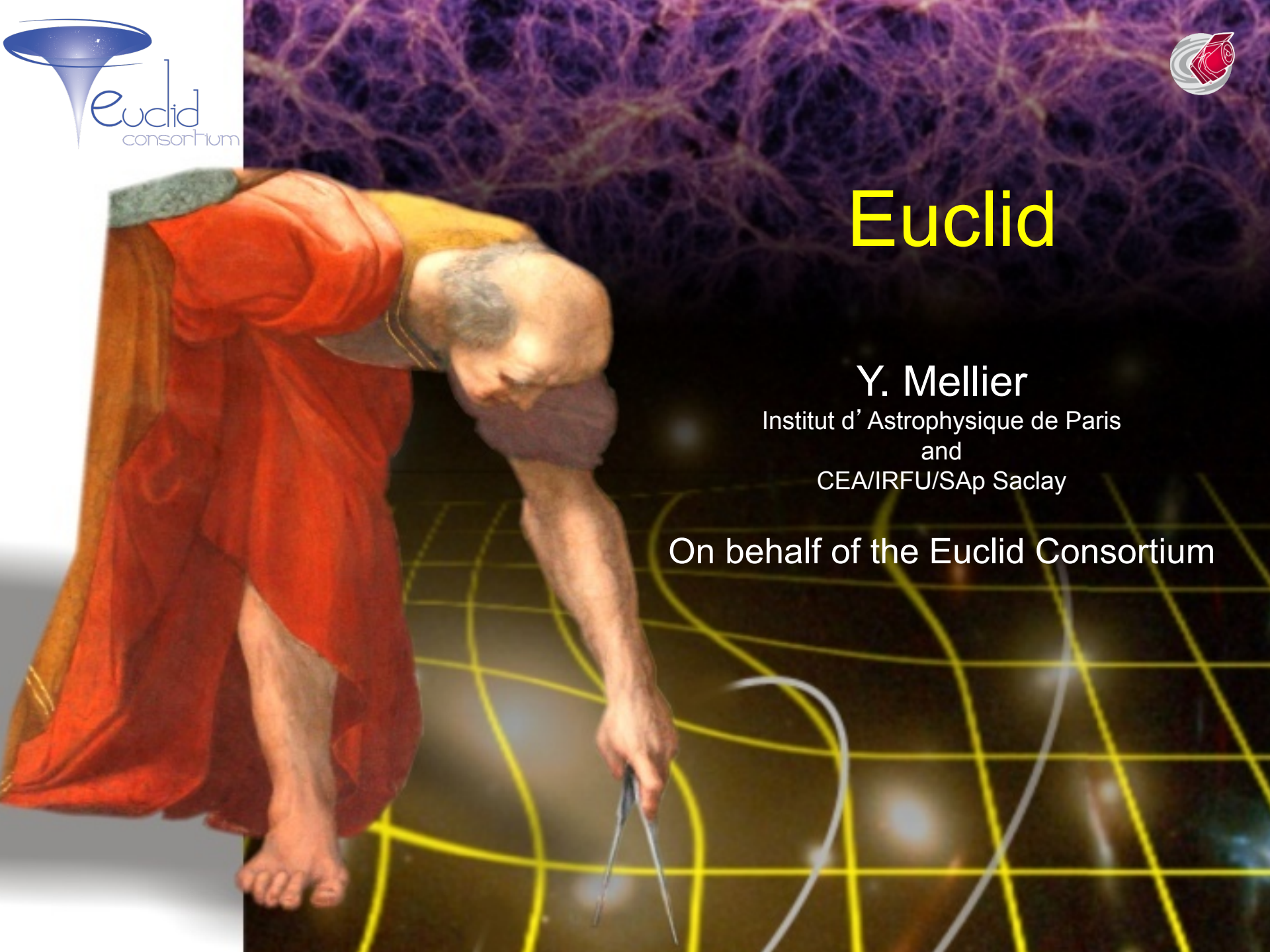
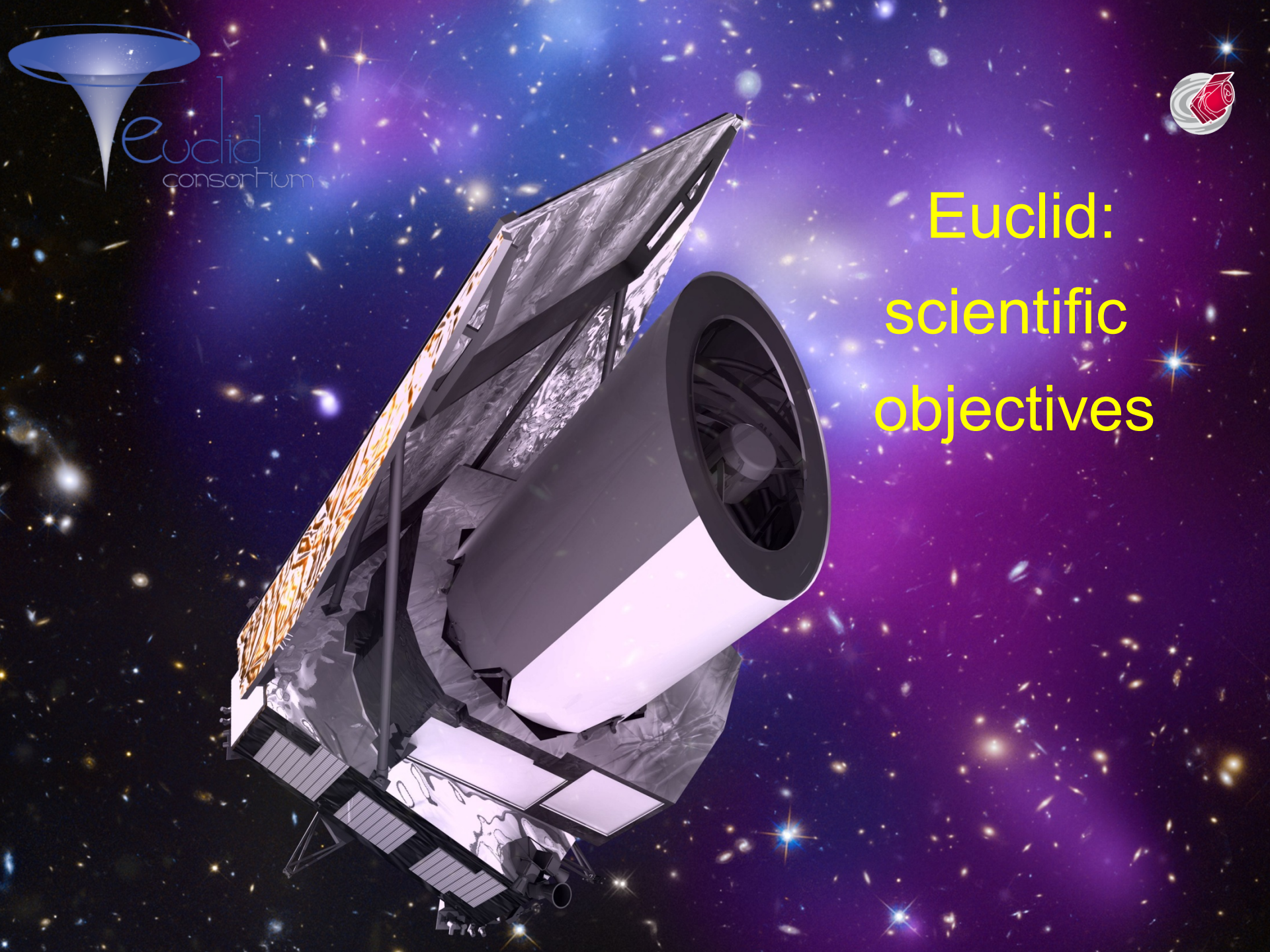


Euclid

Y. Mellier
Institut d'Astrophysique de Paris
and
CEA/IRFU/SAp Saclay

On behalf of the Euclid Consortium

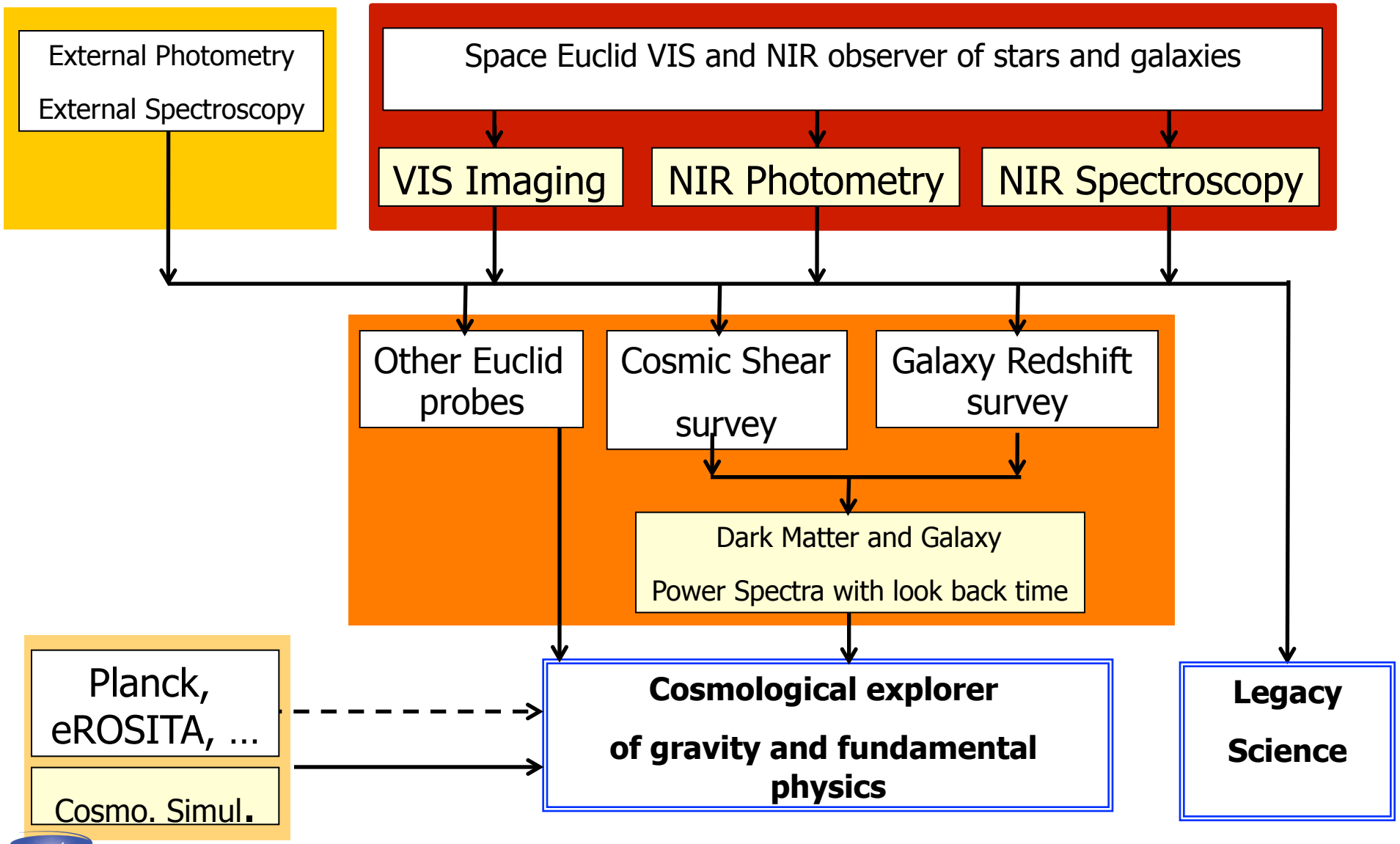

Euclid
consortium
Euclid:
scientific
objectives

Euclid primary objectives

- Understand the origin of the Universe's accelerating expansion
- Probe the properties and nature of Dark Energy and Gravity,

- Distinguish effects of Dark Energy and Gravity by:
  - Using several independent but complementary probes (5 probes)
  - Tracking their observational signatures on the
    - Geometry of the Universe: Weak Lensing (WL), Galaxy Clustering (GC)
    - Cosmic history of structure formation: WL, Redshift-Space Distortion (RSD), Clusters of Galaxies (CL)
  - Controling systematic residuals to an unprecedented level of accuracy.

The *Euclid Machine*




Euclid
consortium
Euclid:
implementation

Euclid mission baseline:

launch in 2020 from Kourou spaceport - L2 orbit

Photo-z, SED: all Euclid sky ground based visible bands photometry and visible + NIR spectroscopic redshifts for photo-z calibrations

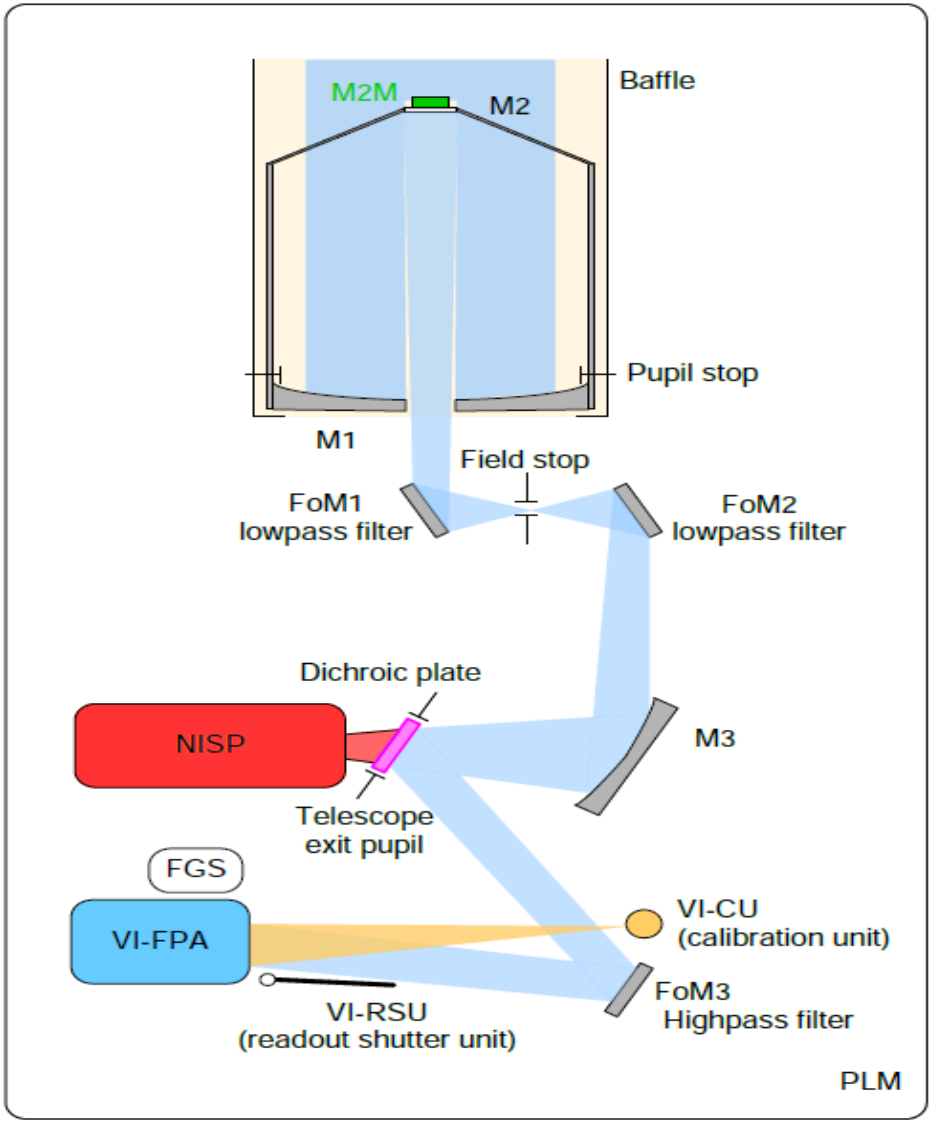
SURVEYS	In ~6 years	
	Area (deg2)	Description
Wide Survey	**15,000 deg²**	Step and stare with 4 dither pointings per step.
Deep Survey	**40 deg²**	In at least 2 patches of > 10 deg² 2 magnitudes deeper than wide survey

PAYLOAD					
Telescope	1.2 m Korsch, 3 mirror anastigmat, f=24.5 m				
Instrument	VIS	NISP			
Field-of-View	0.787×0.709 deg²	0.763×0.722 deg²			
Capability	Visual Imaging	NIR Imaging Photometry			NIR Spectroscopy
Wavelength range	550– 900 nm	Y (920-1146nm),	J (1146-1372 nm)	H (1372-2000nm)	1100-2000 nm
Sensitivity	24.5 mag 10σ extended source	24 mag 5σ point source	24 mag 5σ point source	24 mag 5σ point source	$3\ 10^{-16}$ erg cm-2 s-1 3.5σ unresolved line flux
	Shapes + Photo-z of n = 1.5 x10⁹ galaxies			**z of n=2.5x10⁷ galaxies**	

Possibility other surveys: SN and/or μ-lens surveys, Milky Way (TBC): **after Mission PDR**

Ref: Euclid RB Laureijs et al arXiv:1110.3193

Euclid system overview



PLM:

Airbus DS

Scientific instruments

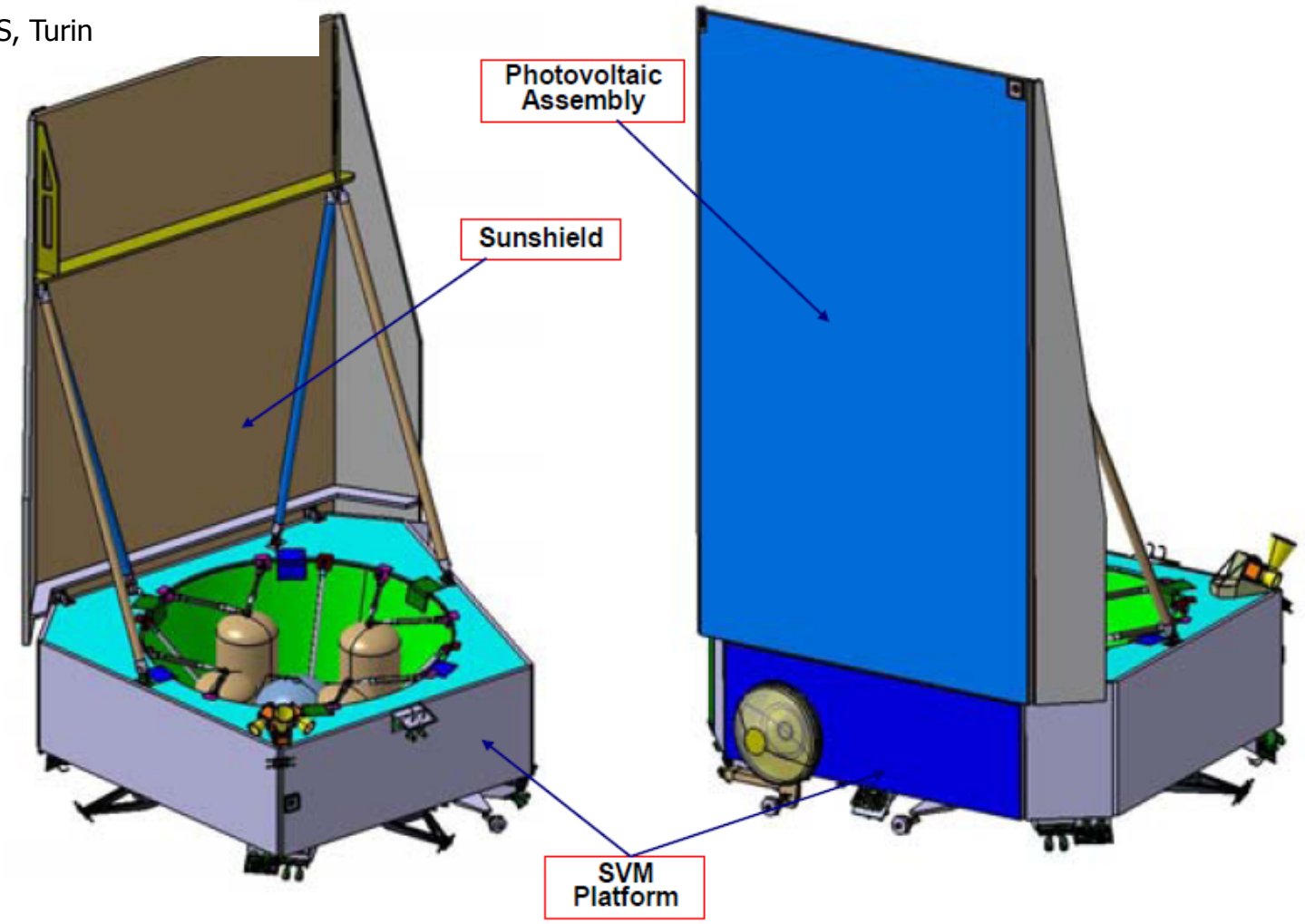
Euclid Consortium

SVM and prime contractor:

Thales Alenia Space

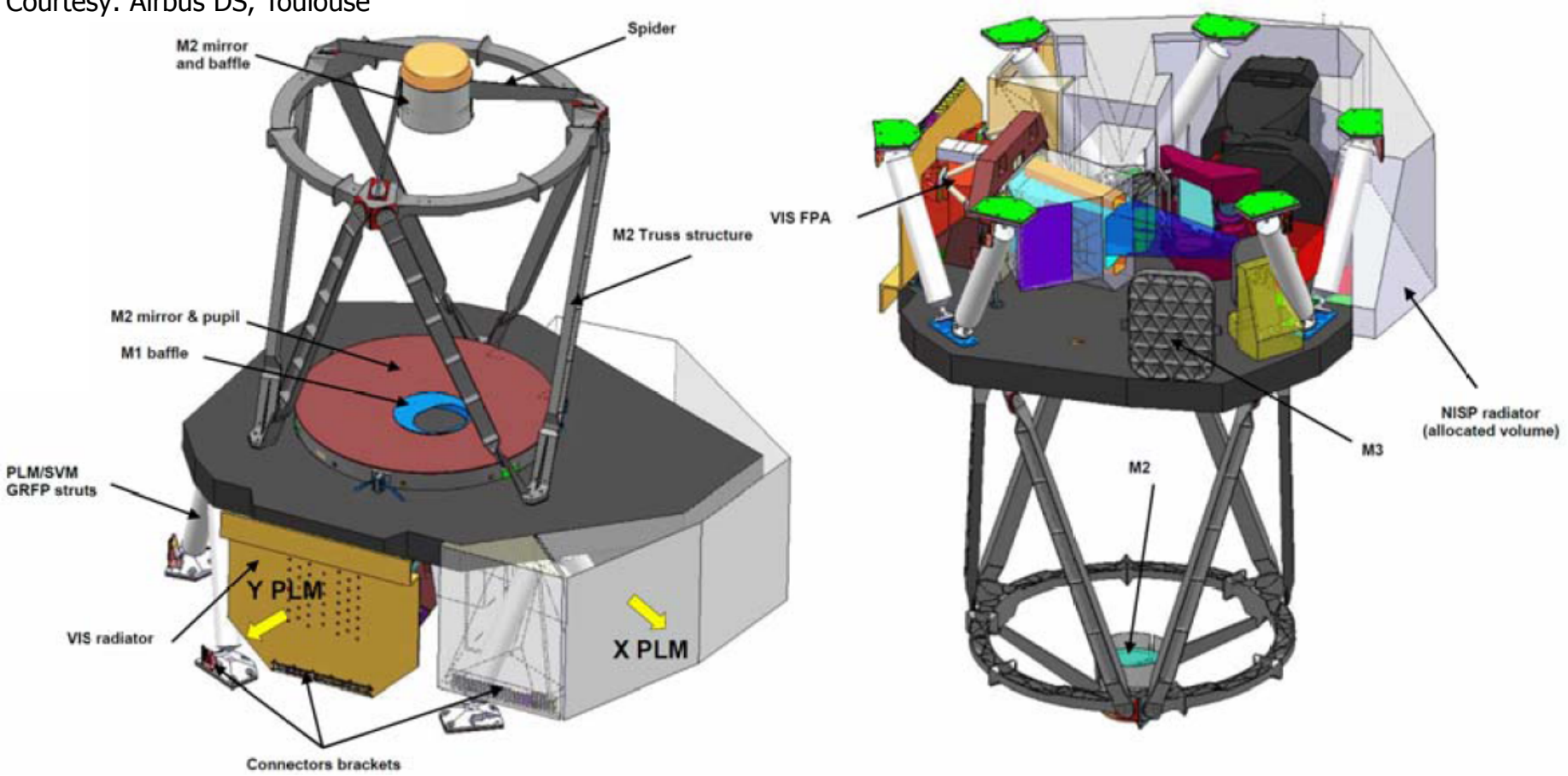
Euclid SVM and sunshield

Courtesy: TAS, Turin



PLM and scientific instruments

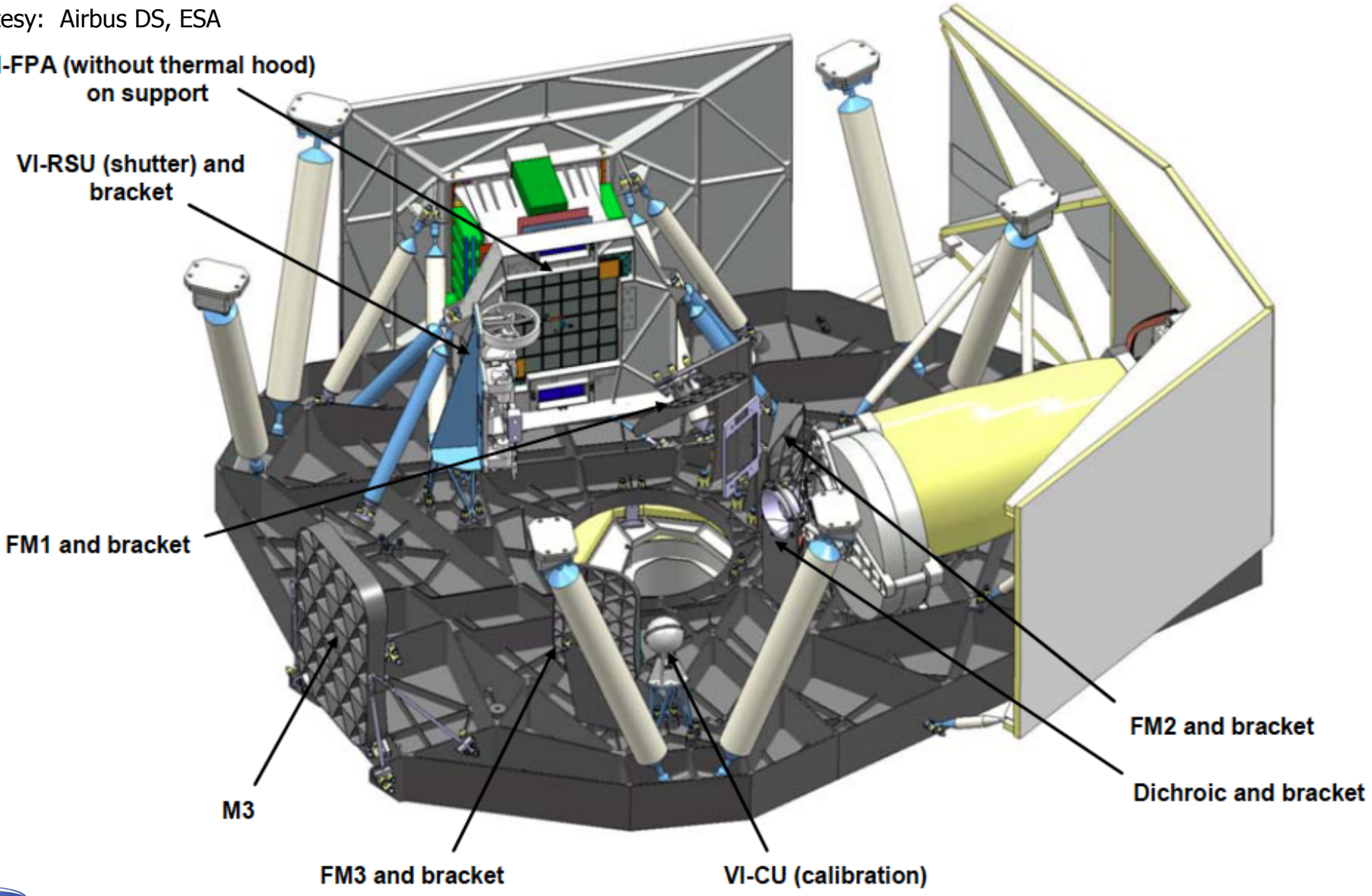
Courtesy: Airbus DS, Toulouse



- **Stabilisation**: Pointing error along the x,y axes= 25mas over a period 700 s.
- **FoV**: Common visible and NIR Fov = 0.54 deg^2

VIS in PLM

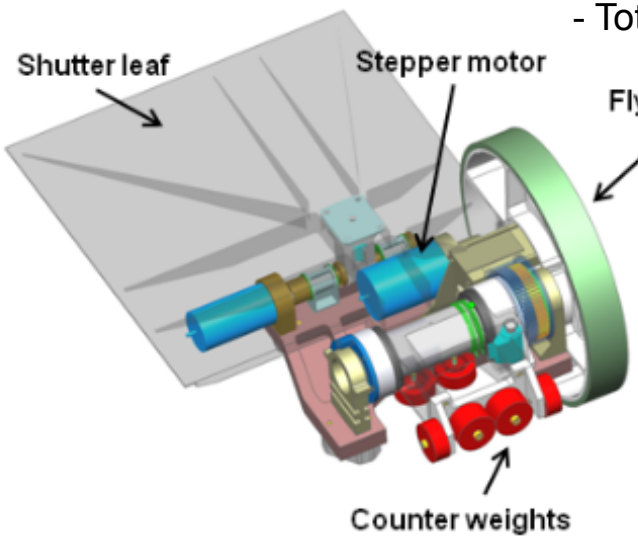
Courtesy: Airbus DS, ESA

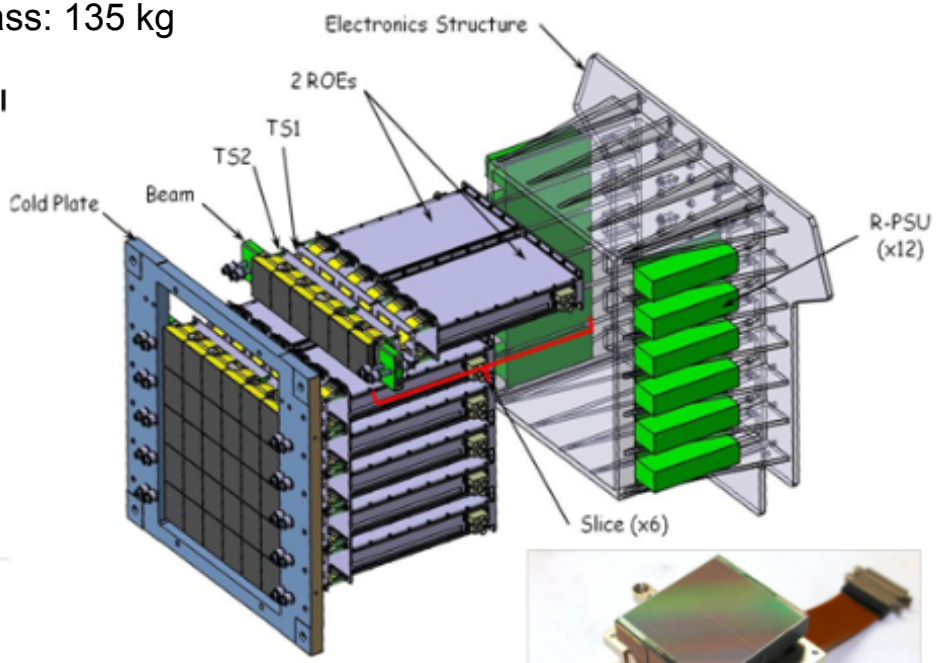


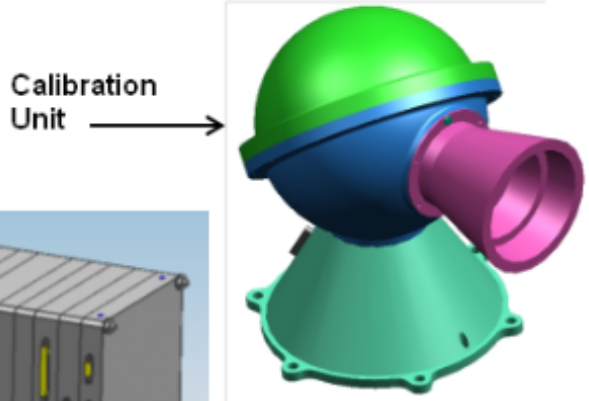
VIS

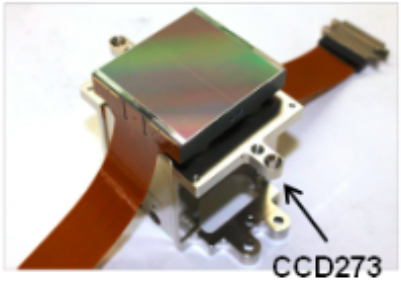
Courtesy: S. Pottinger, M. Cropper and the VIS team

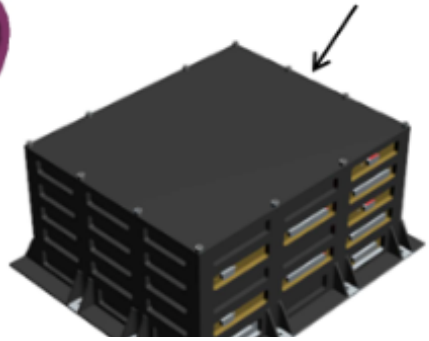
- large area imager – a 'shape measurement machine'
- 36 4kx4k CCDs with 12 micron pixels
- 0.1 arcsec pixels on sky FoV = 0.54 deg^2
- bandpass 550-900 nm – (wide band channel)
- limiting magnitude for wide survey of magAB = 24.5 for 10σ (extended)
- data volume – 520Gbit/day
- Total mass: 135 kg

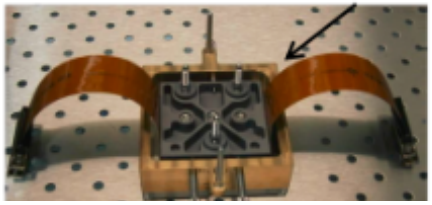












NISP instrument

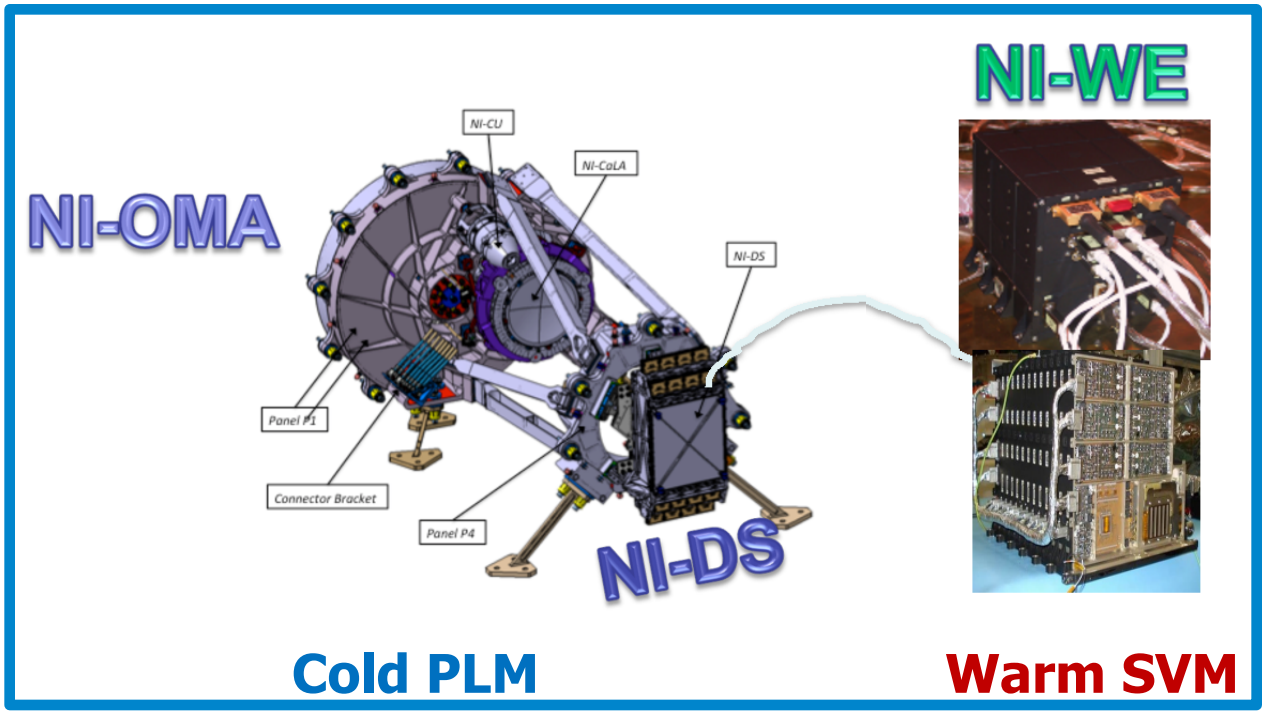
Courtesy: T. Maciaszek and the NISP team

- 3 main assemblies:
  - NI-IOMA: Opto Mechanical Assembly in the satellite Payload Module
  - NI-DS : Detection System mounted in NI-OMA
  - NI-WE: Warm Electronics in the warm satellite Service Module

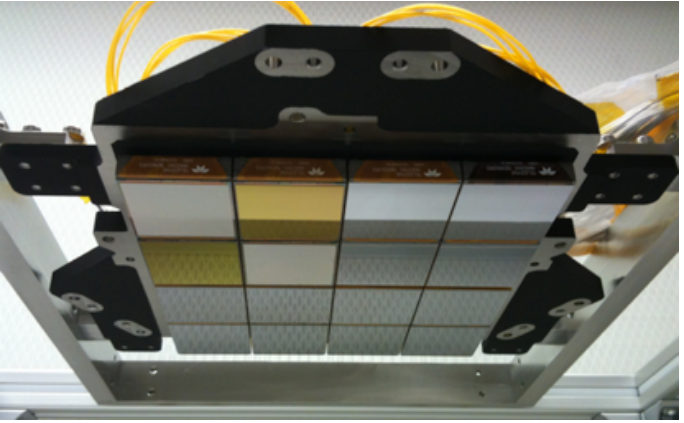
- Fov: 0.55x0.55 deg2
- Mass : 160 kg
- Power < 200 W
- Telemetry: 240 Gbt/day
- Size: 1m x 0.5 m x 0.5 m
- 16 2kx2K H2GR detectors
- 0.3 arcsec pixel on sky

(Wide survey only with R-grism)

- Limiting mag AB: 24 (5 σ)

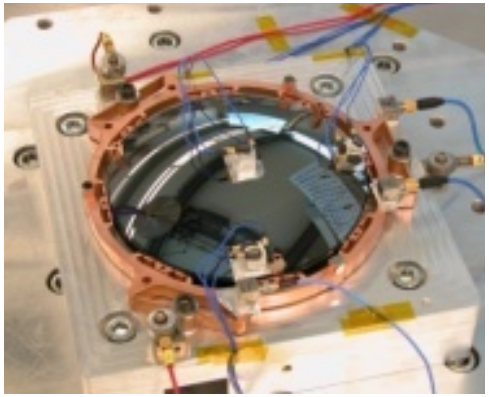


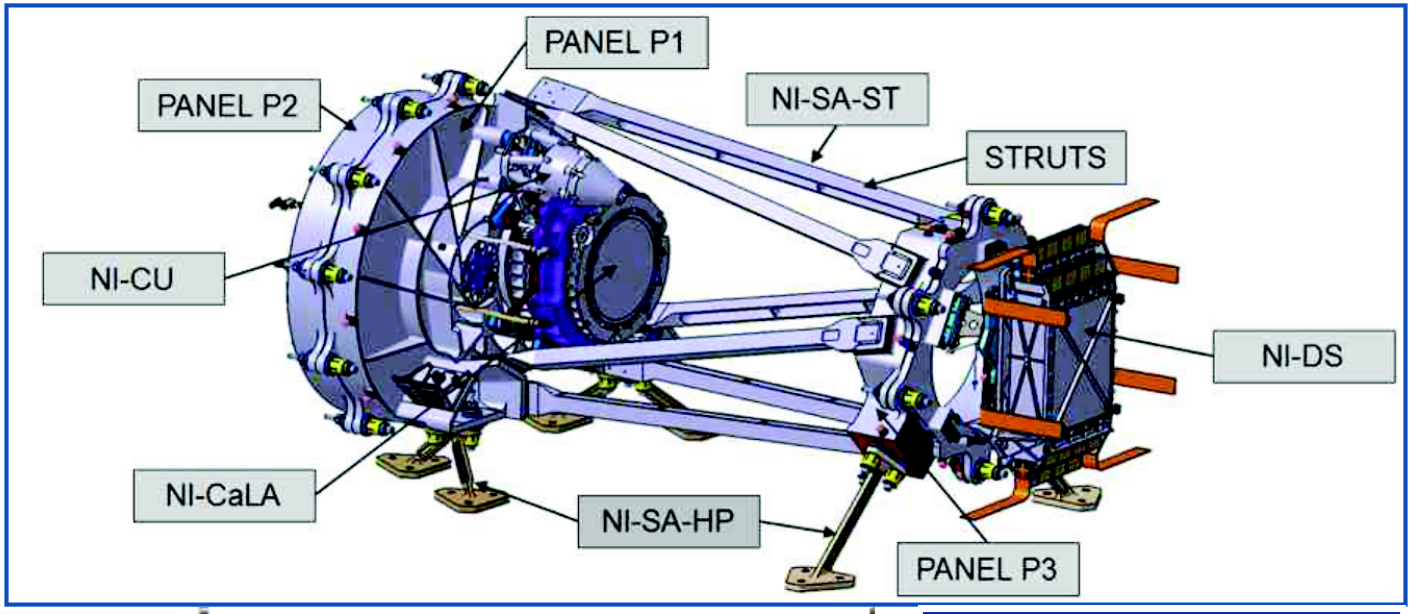
- 3 Filters: Y (920-1146nm), J (1146 – 1372nm), H (1372 – 2000nm)
- 4 grisms: 1B (920 – 1250nm) , 3R (1250 – 1850nm)

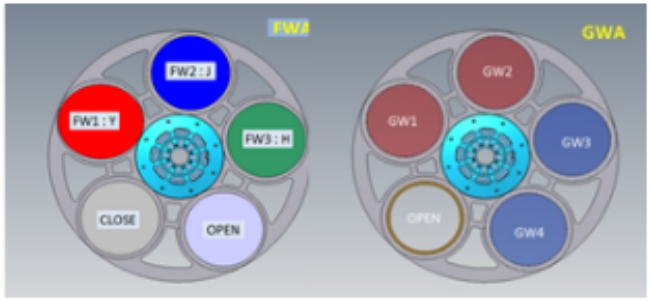


NISP

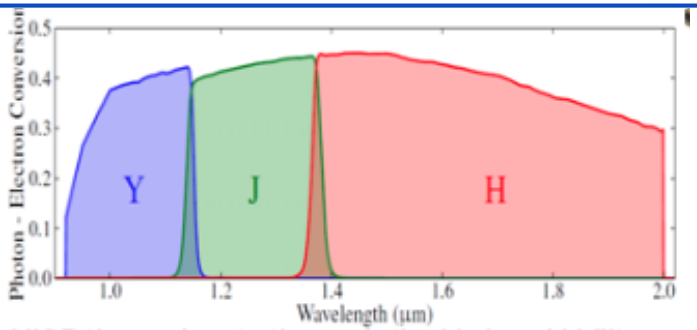
Courtesy: T. Maciaszek
and the NISP team



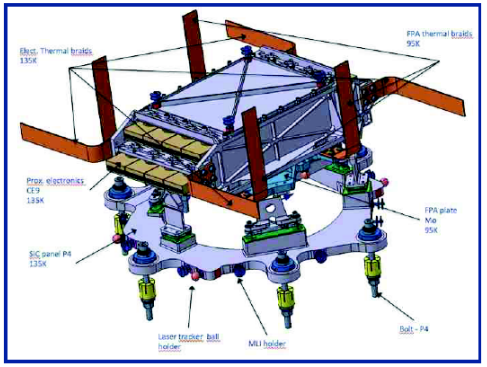




Filters and grisms positions in wheels

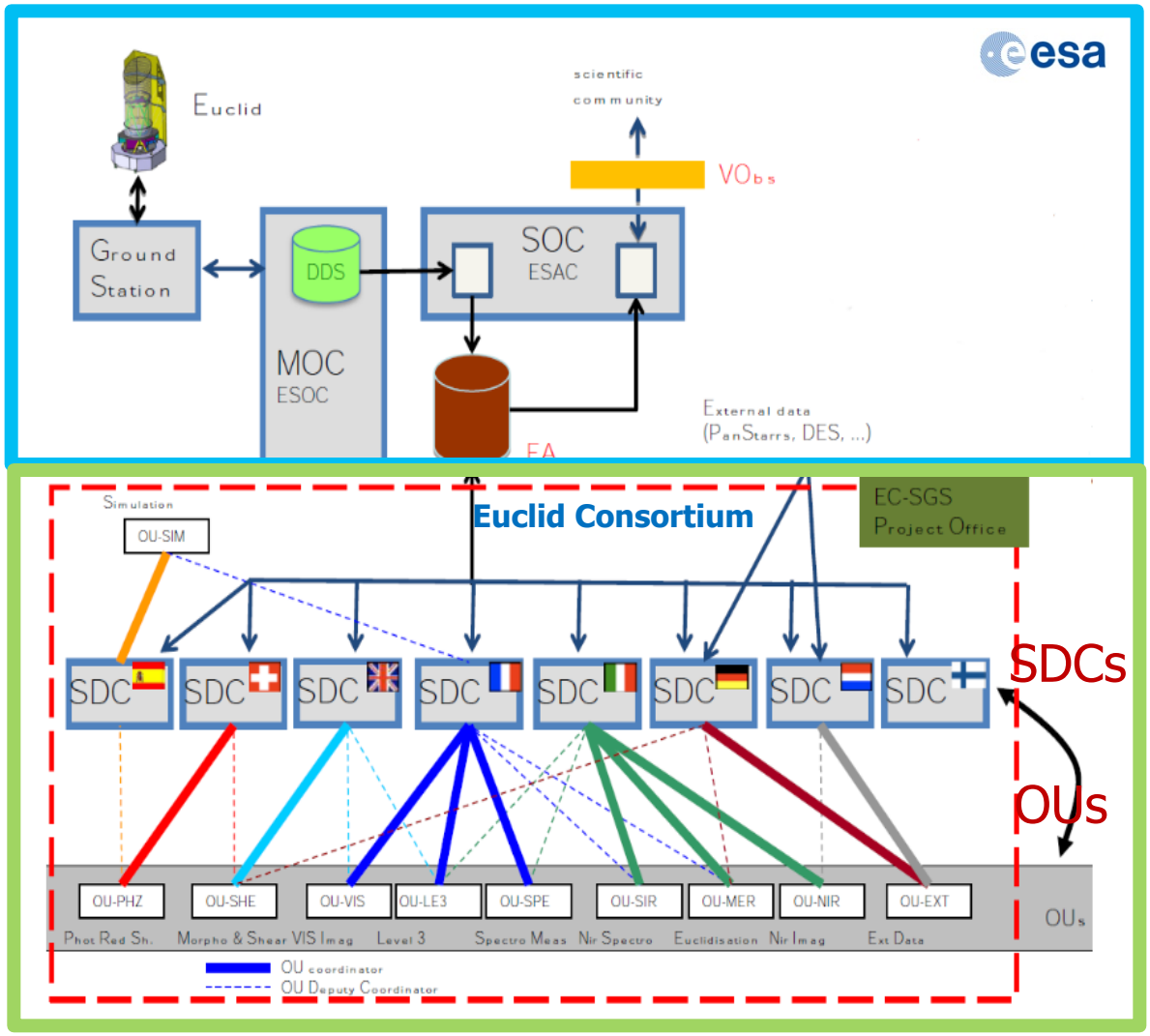


NISP throughputs through the Y, J and H filters



Science Ground Segment: EC, ESAC, ESOC, SDCs

Courtesy: F. Pasian, M. Sauvage, J. Hoar, C. Dabin EC SGS and ESAC



Complex organisation:

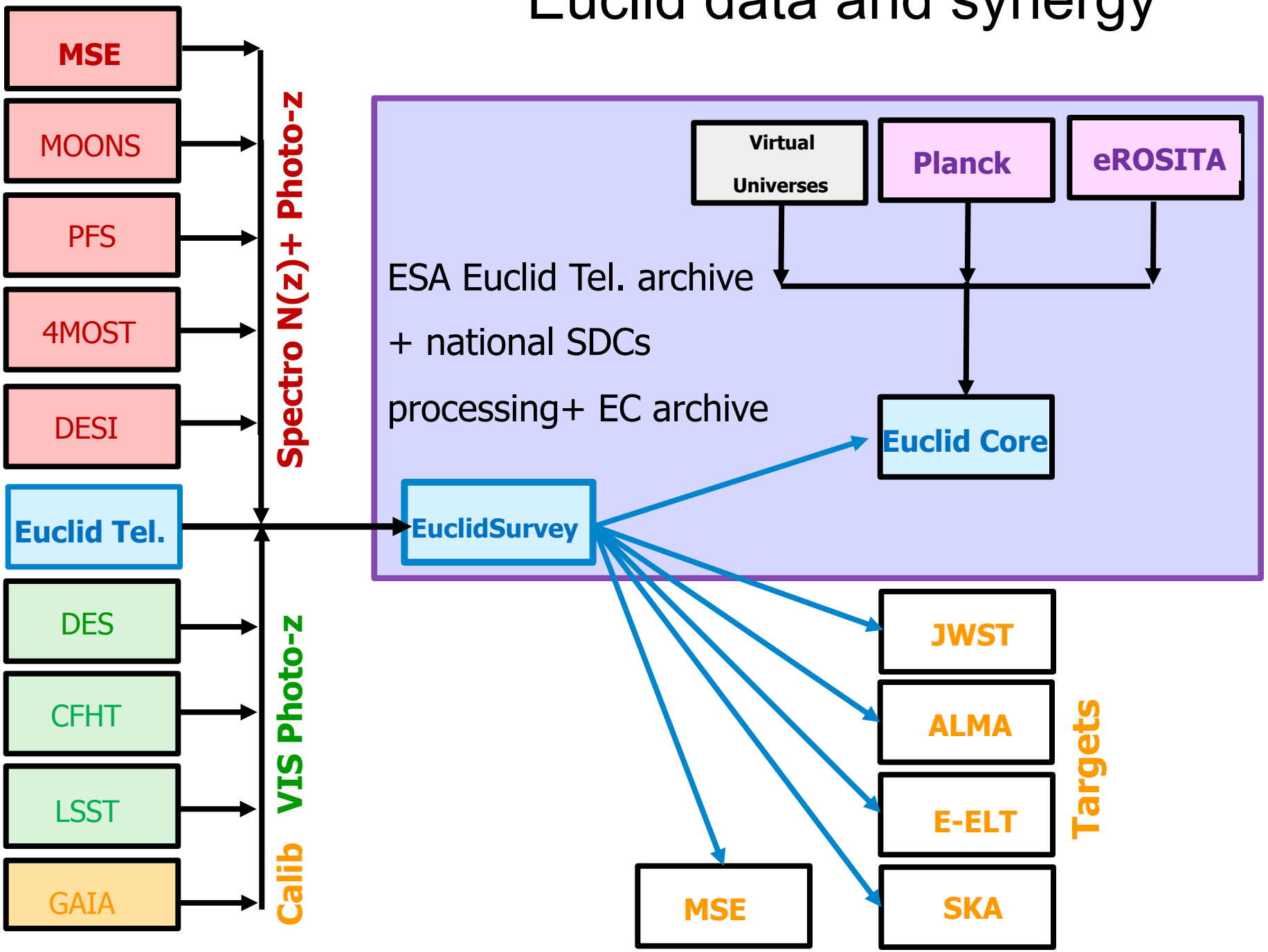
- 10 Organisation Units
- 7 Science Data Centers
- Data centric processing architecture and archive/ distribution

Data: huge volumes, heterogeneous data sets

- VIS+NIR imagery and morphometry, photometry , spectroscopy
- data from ground and space
- >30 Pbytes
- 1+ million big images
- > 10^{10} sources (>3-sigmas)

Cost SGS: 50% of Euclid Consortium contributions.

Euclid data and synergy

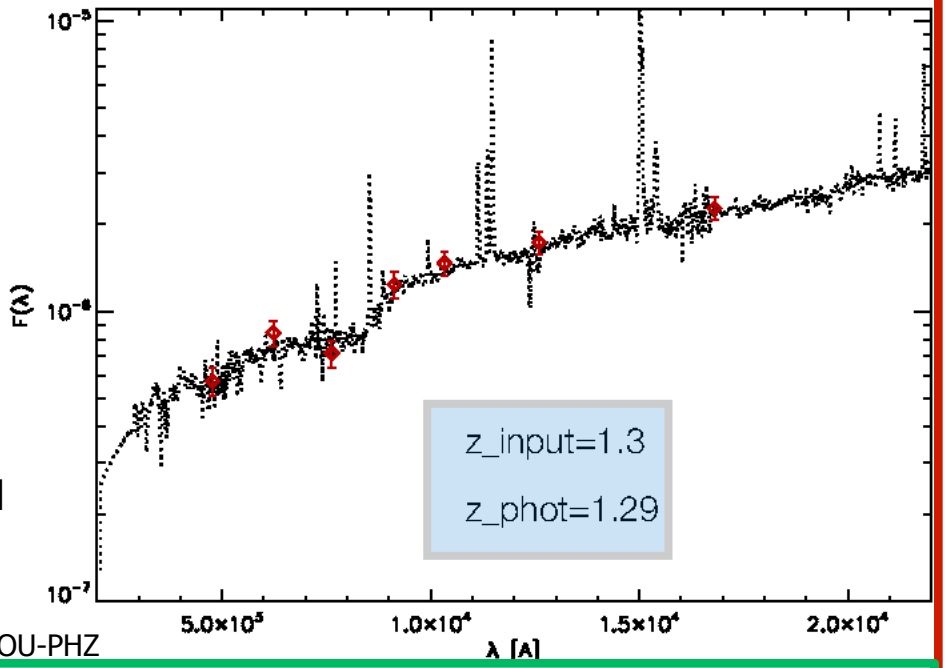


Distances of billion lensed galaxies: photo-z for Euclid

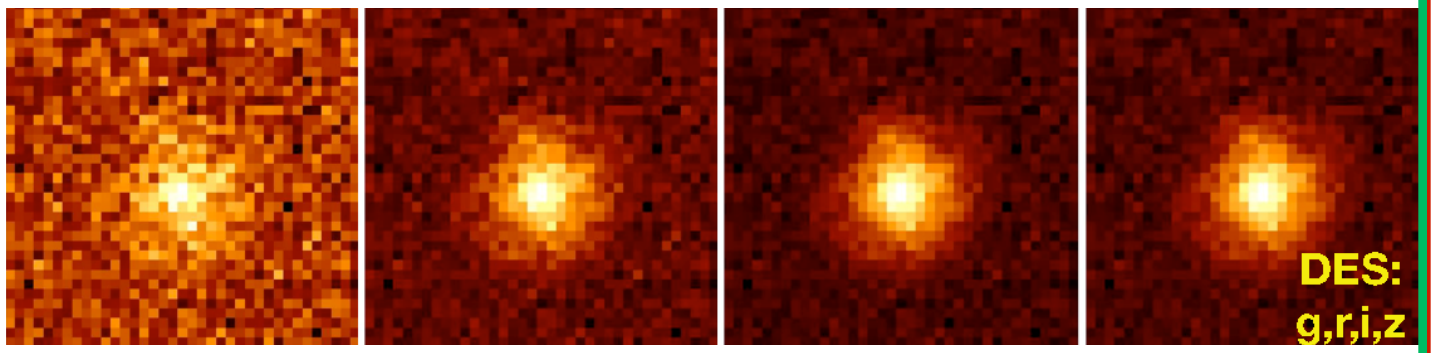
Requirements:

- get photo-z for ~all WL galaxies
- cover the whole Euclid sky (15000 deg^2)
- accuracy = 0.05x(1+z)

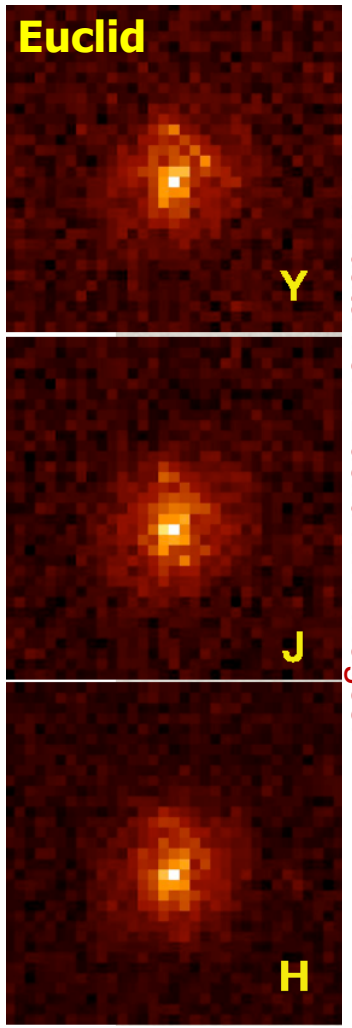
→ 4 optical bands needed



Courtesy Euclid SWG Photo-z and OU-PHZ



Visible data obtained from ground based telescopes



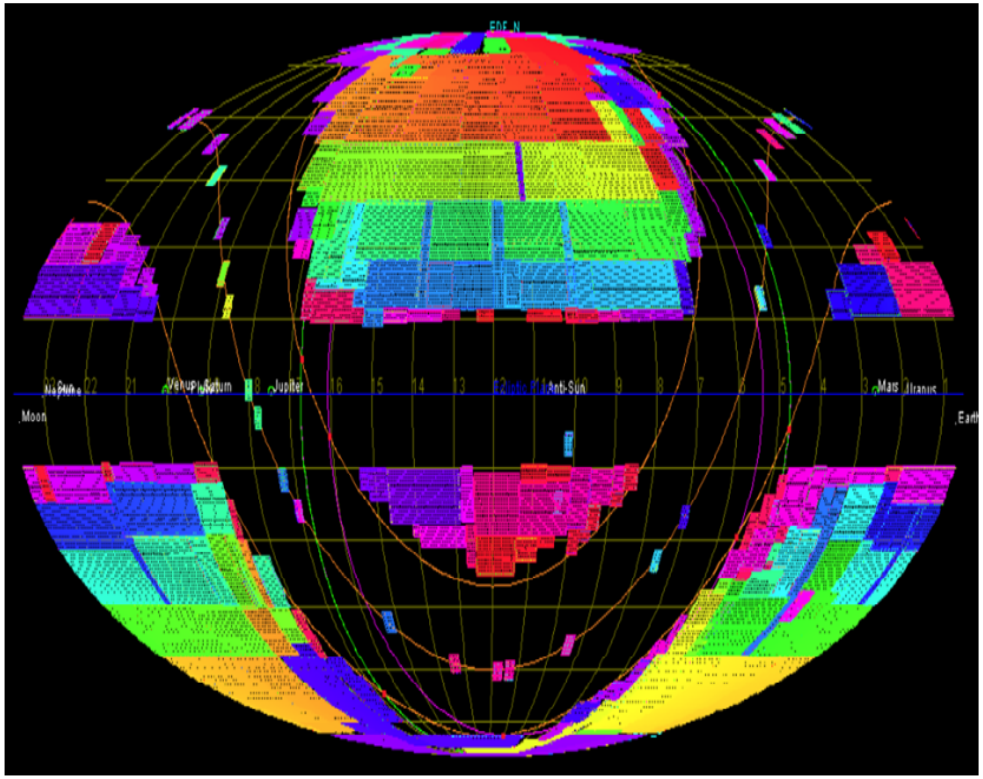
NIR data from Euclid NIR images.

Ground based imaging data for photo-z: under full responsibility of EC

- **South: almost consolidated**
  - DES (5000 deg^2) data deep enough in g,r,i,z . Suits Euclid needs; : consolidated
  - e-KIDS
  - Part of south missing (LSST): if LSST no strong need: I=24.5 and 5000 deg^2: not all LSST data.
- **North: not consolidated urgent**
  - Northernmost: MegaCam at CFHT:proposal: u,g,r,i - best option
  - LSST intermediate south-north: a fraction of sky coverage, and depth

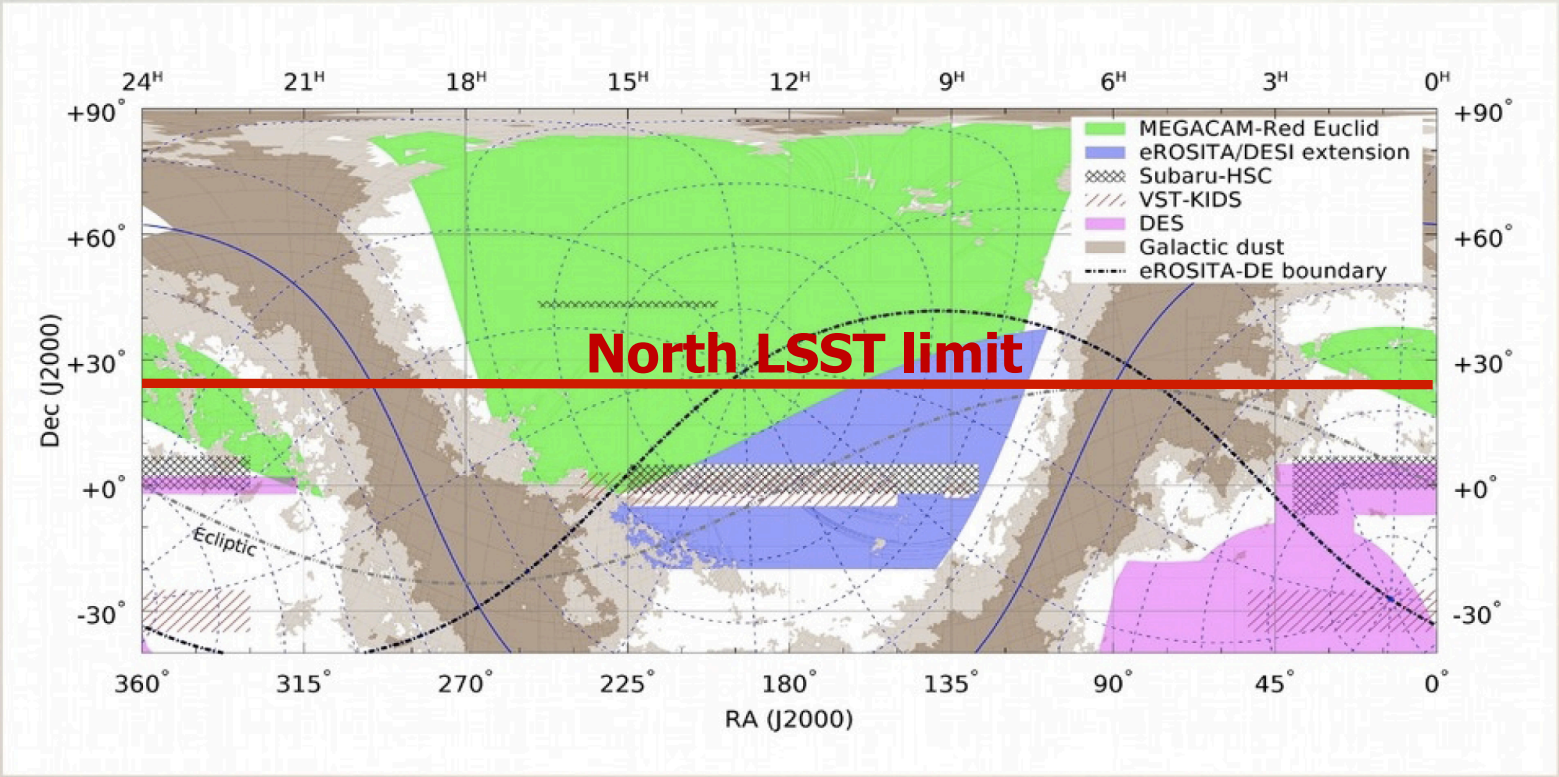
→**LSST + Euclid**: Photo-z, SEDs for PSF and source identification and classification, star/gal separation

→ **Need visible** data before Euclid data



LSST, CFHT/NSLS and Euclid

CFHT Northern Sky Legacy Survey: driven by DESI/Euclid



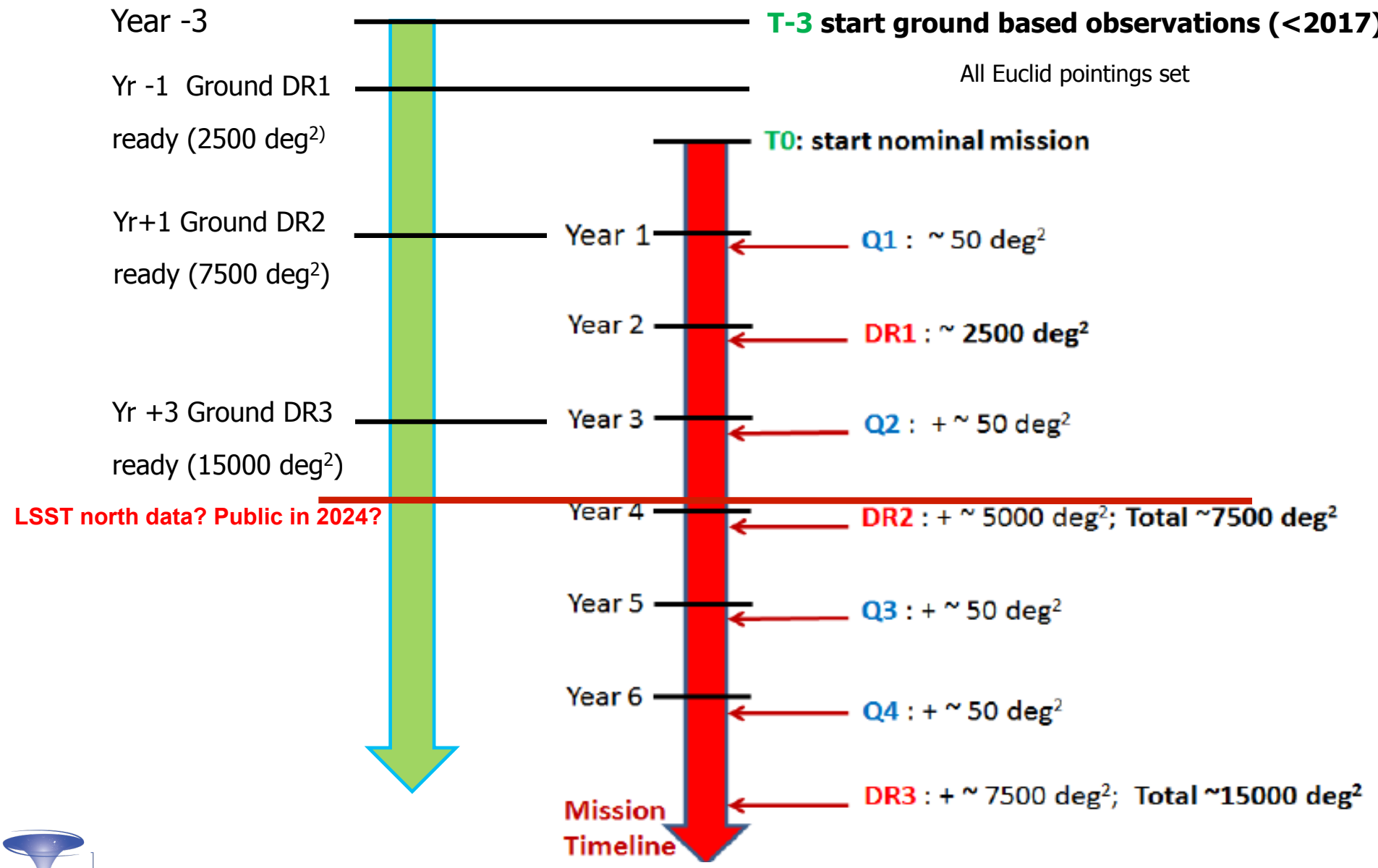
The sky visible from Hawaii

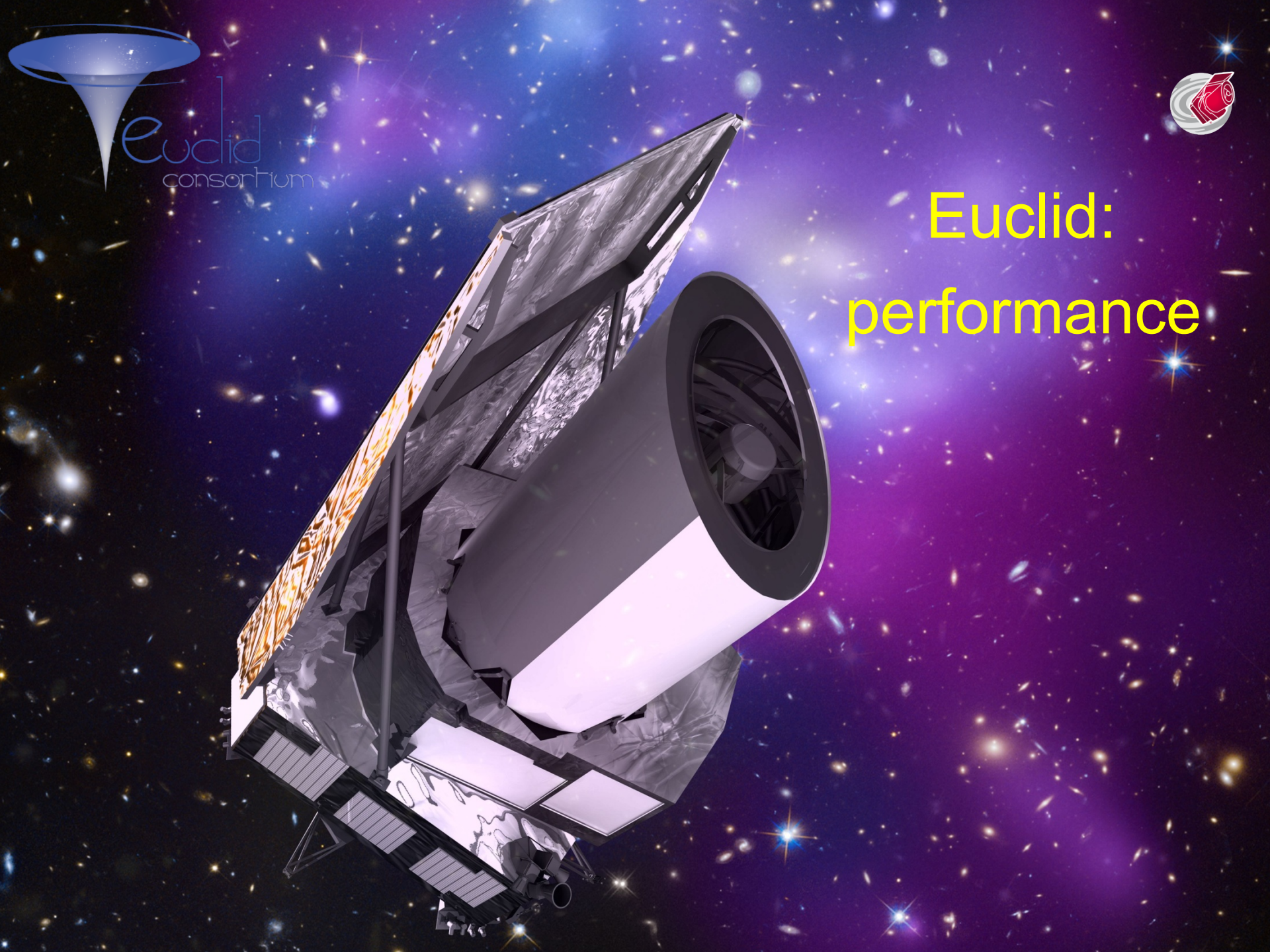
CFHT NSLS (green): 7500 sq.deg. (4 bands), depth driven by Euclid

Other need: DESI/eROSITA (1/3 Euclid depth): 3000 sq.deg. (3 bands)

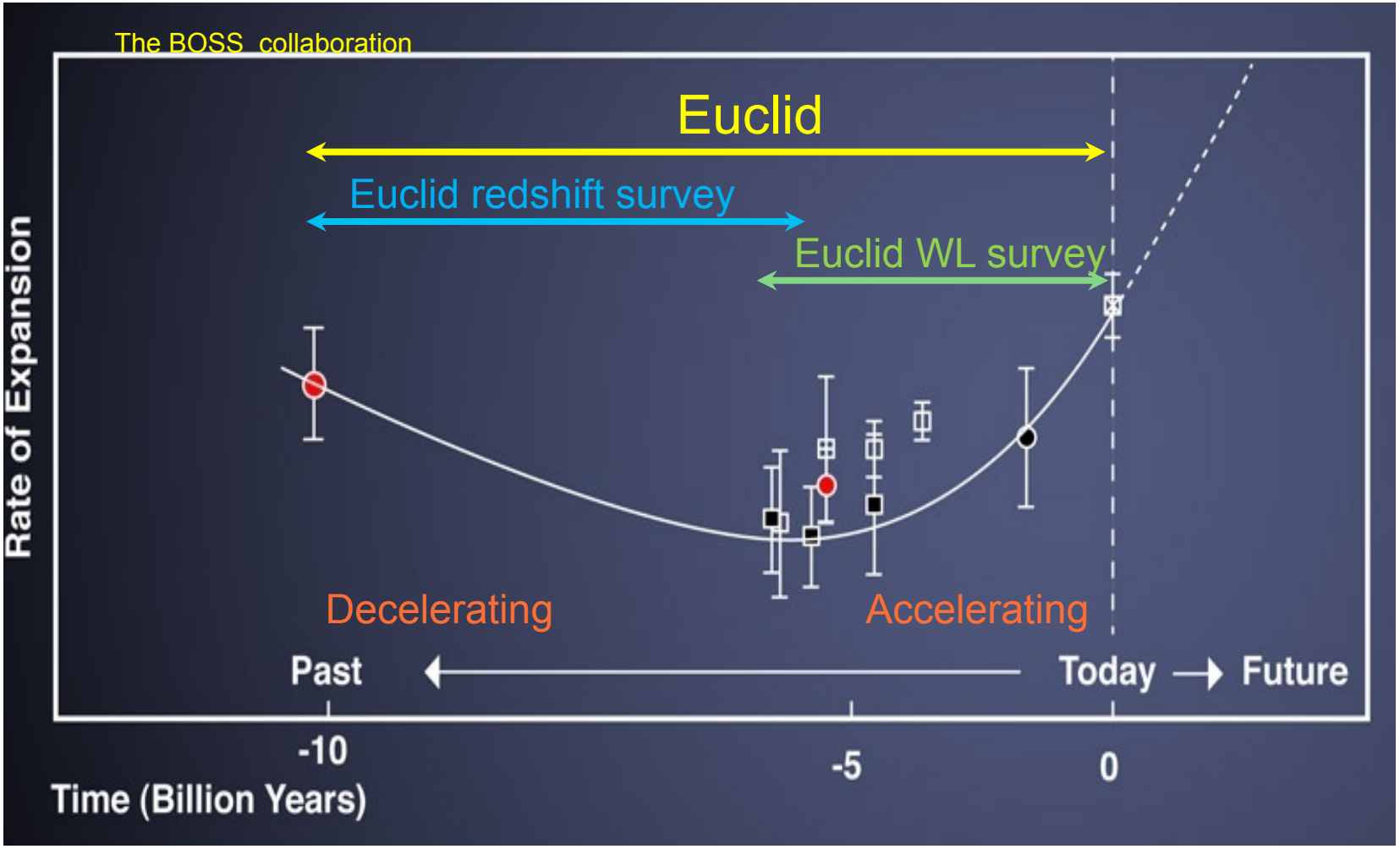
Courtesy JC Cuillandre and the NSLS team

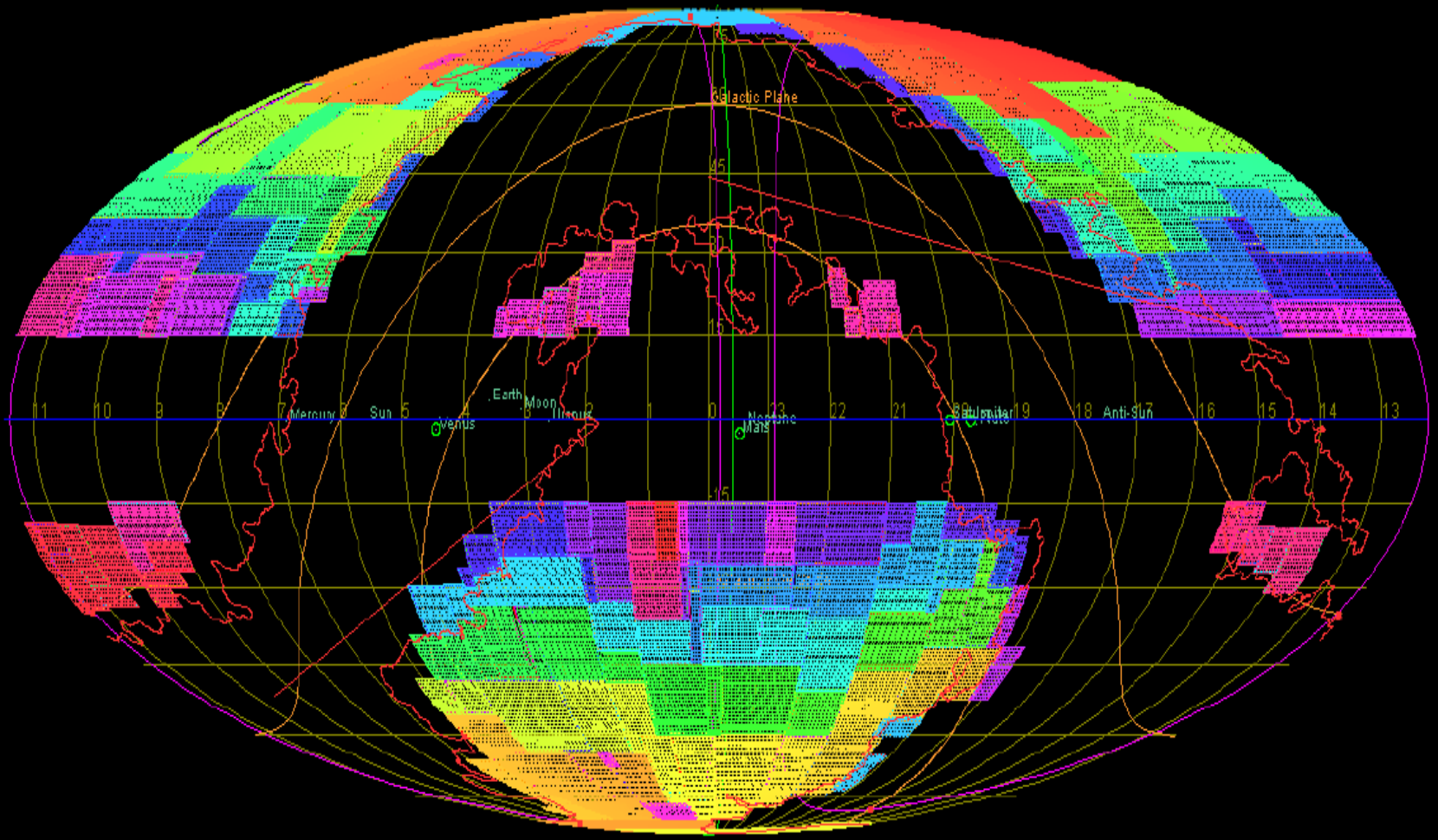
Euclid data release and LSST: compatible?

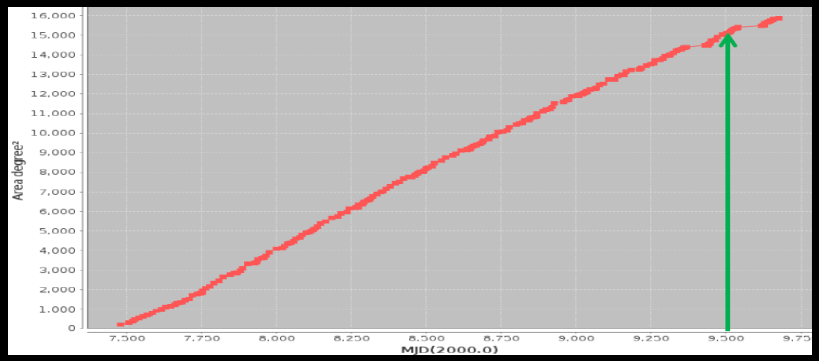



Euclid
consortium
Euclid:
performance

The Universe explored by Euclid probing the DM-DE transition era







Euclid Survey (baseline)

M51 with VIS: shear+legacy science

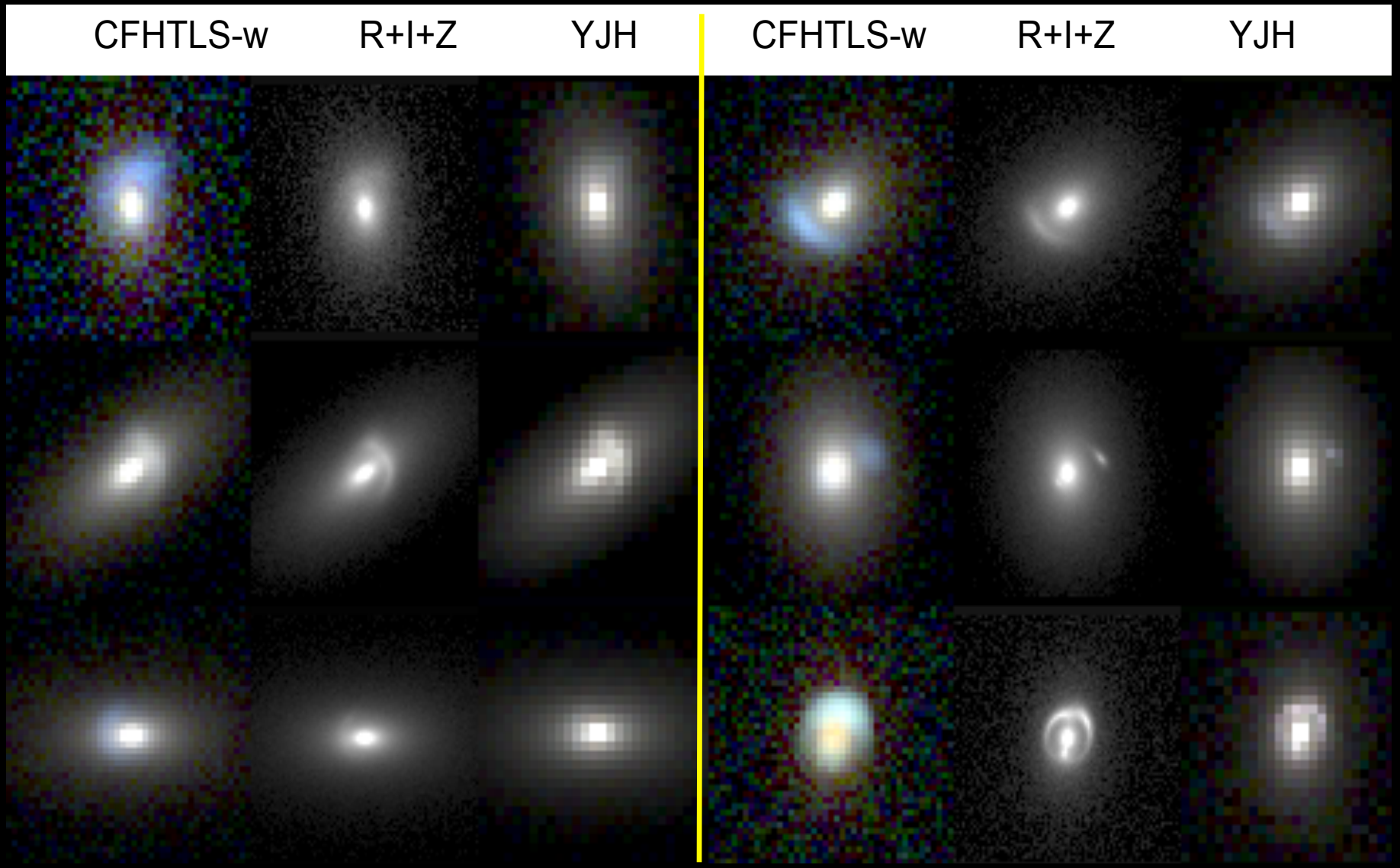
(Courtesy J. Brinchmann and S. Warren)

Messier 51 galaxy at z~0.1 and 0.7:

Euclid will get the resolution of Sloan Digital Sky Survey but at z=1 instead of z=0.05.

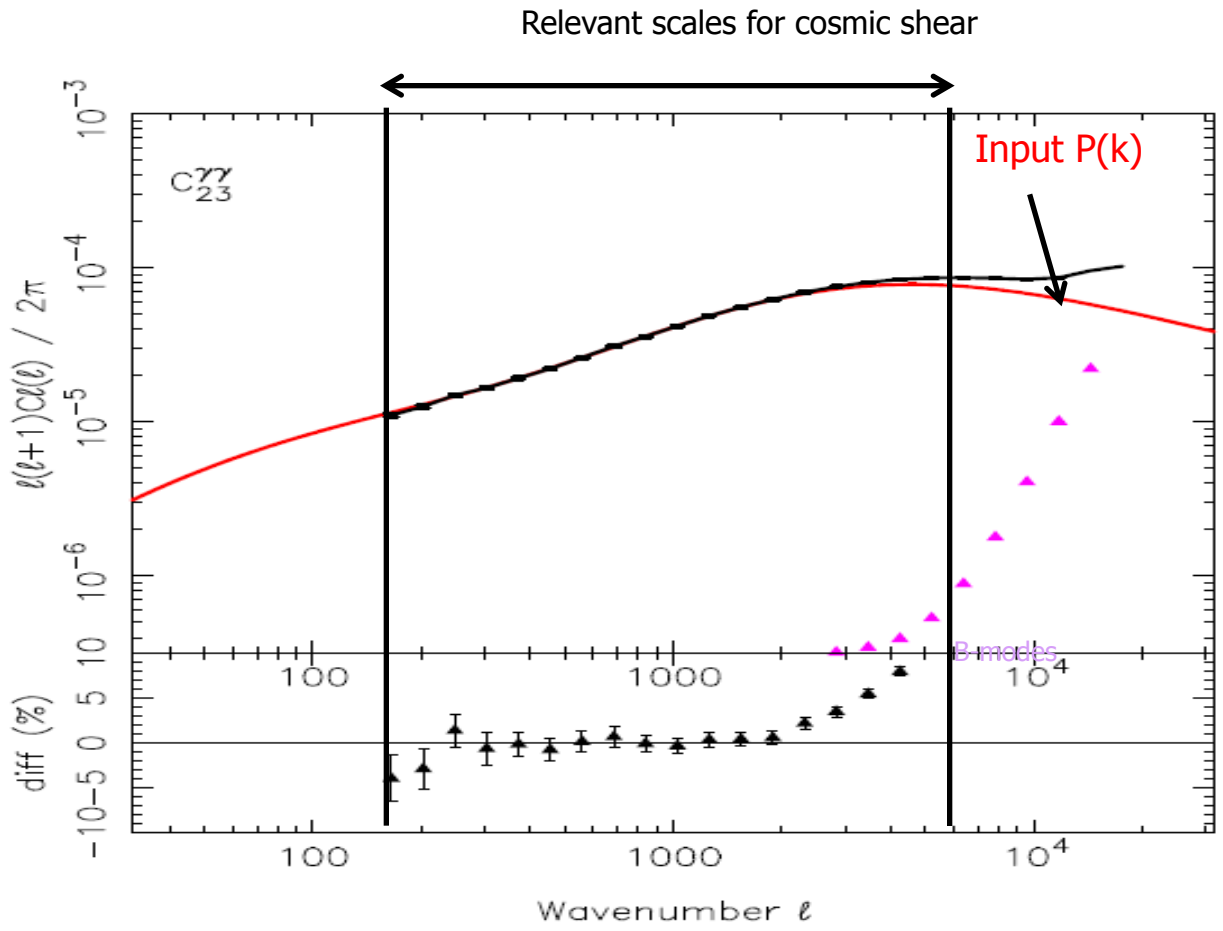
Euclid will be 3 magnitudes deeper → Euclid Legacy = Super-Sloan Survey

Simulations of gravitational arcs and Einstein rings with Euclid



Dark Matter: P(k) from wide survey

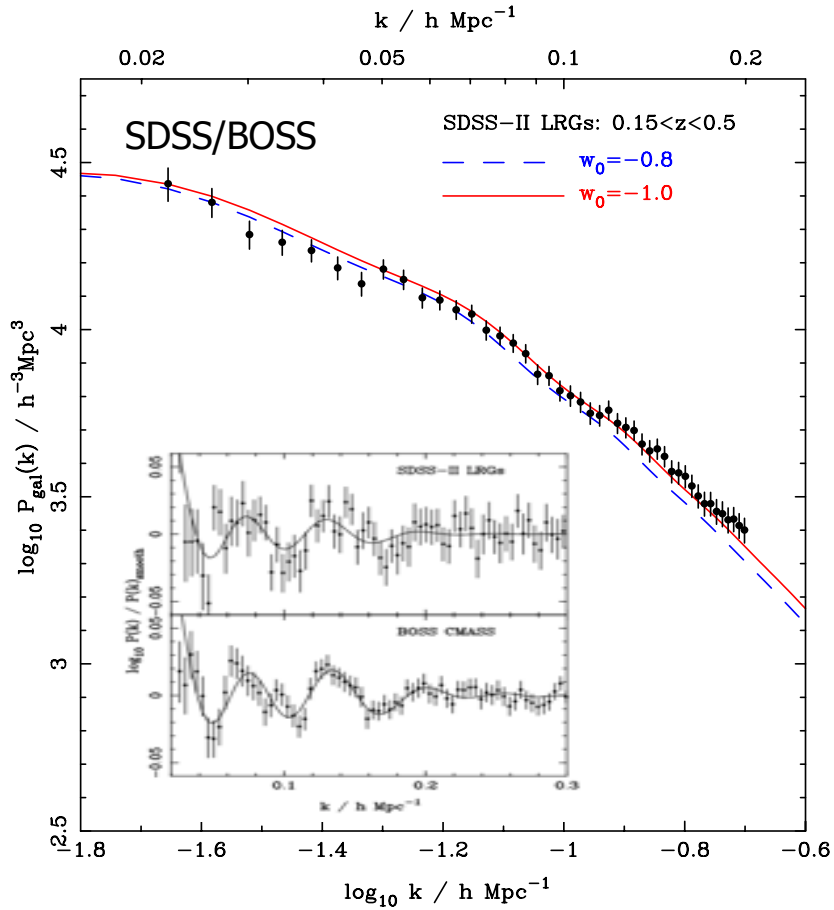
Laureijs et al 2011, Euclid RB arXiv:1110.3193 . Courtesy H. Hoekstra, T. Kitching and the WL SWG



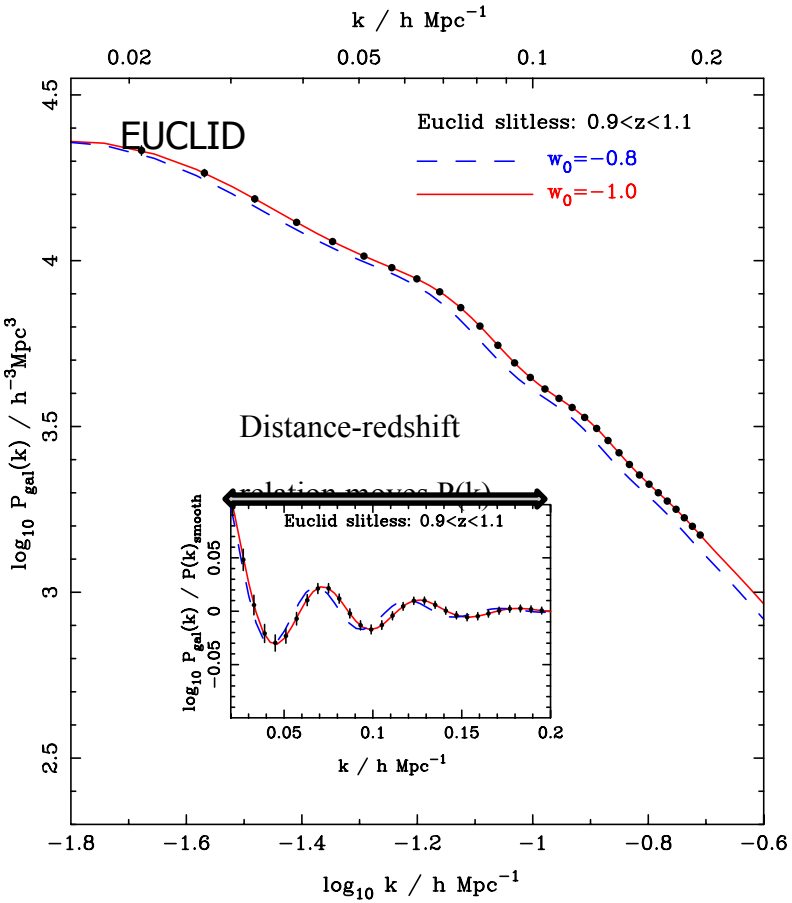
- Tomographic WL shear cross-power spectrum for 0.5 < z < 1.0 and 1.0 < z < 1.5.
- Percentage difference [*expected* – *measured*] power spectrum: recovered to 1% .

BAO : SDSS, BOSS vs Euclid

Courtesy W. Percivall, L. Guzzo and the Euclid GC SWG



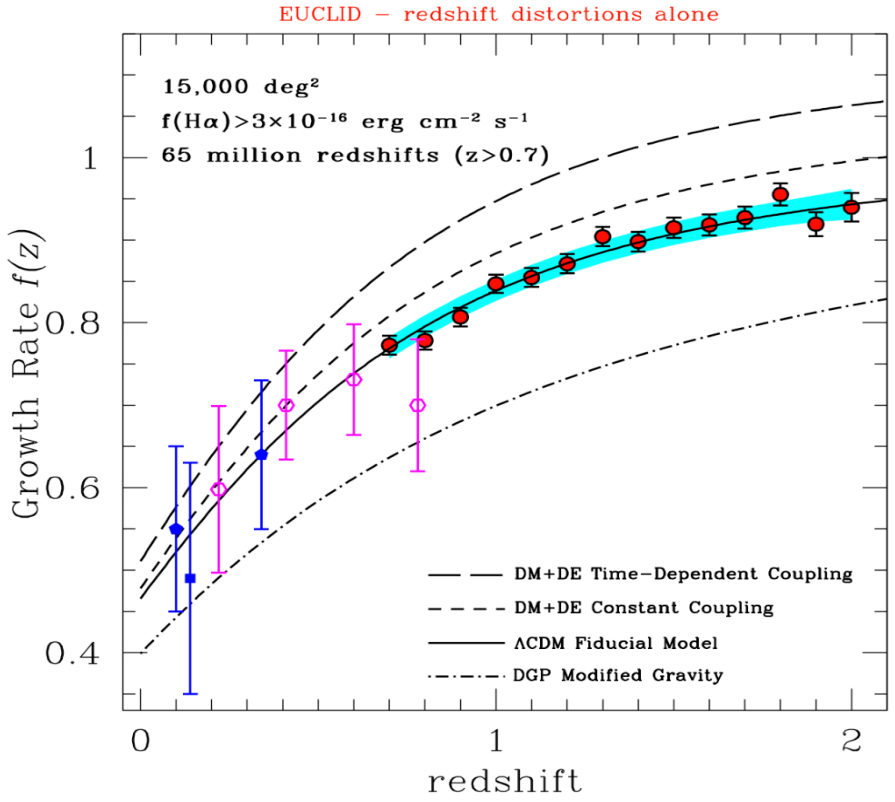
0.15<z<0.5

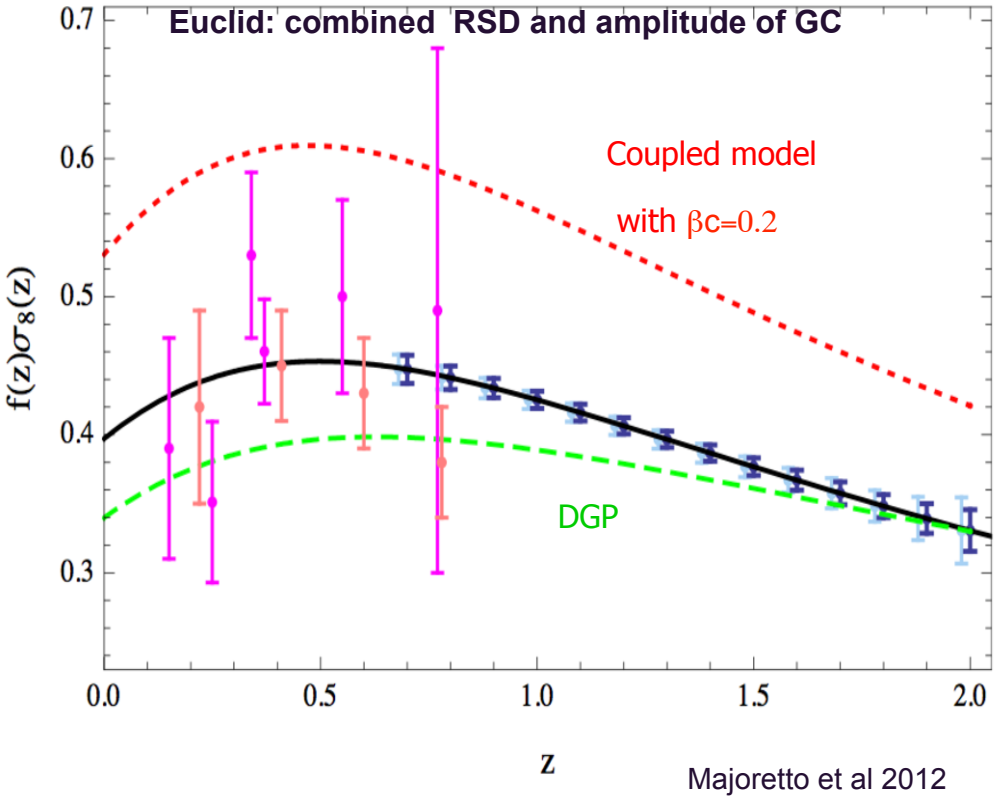


- V_{eff} ≈ 19 h^{-3} Gpc^3 ≈ 75x larger than SDSS

- Percentage difference [*expected* – *measured*] power spectrum: recovered to 1% .

Galaxy Clustering: constraints on dark energy models





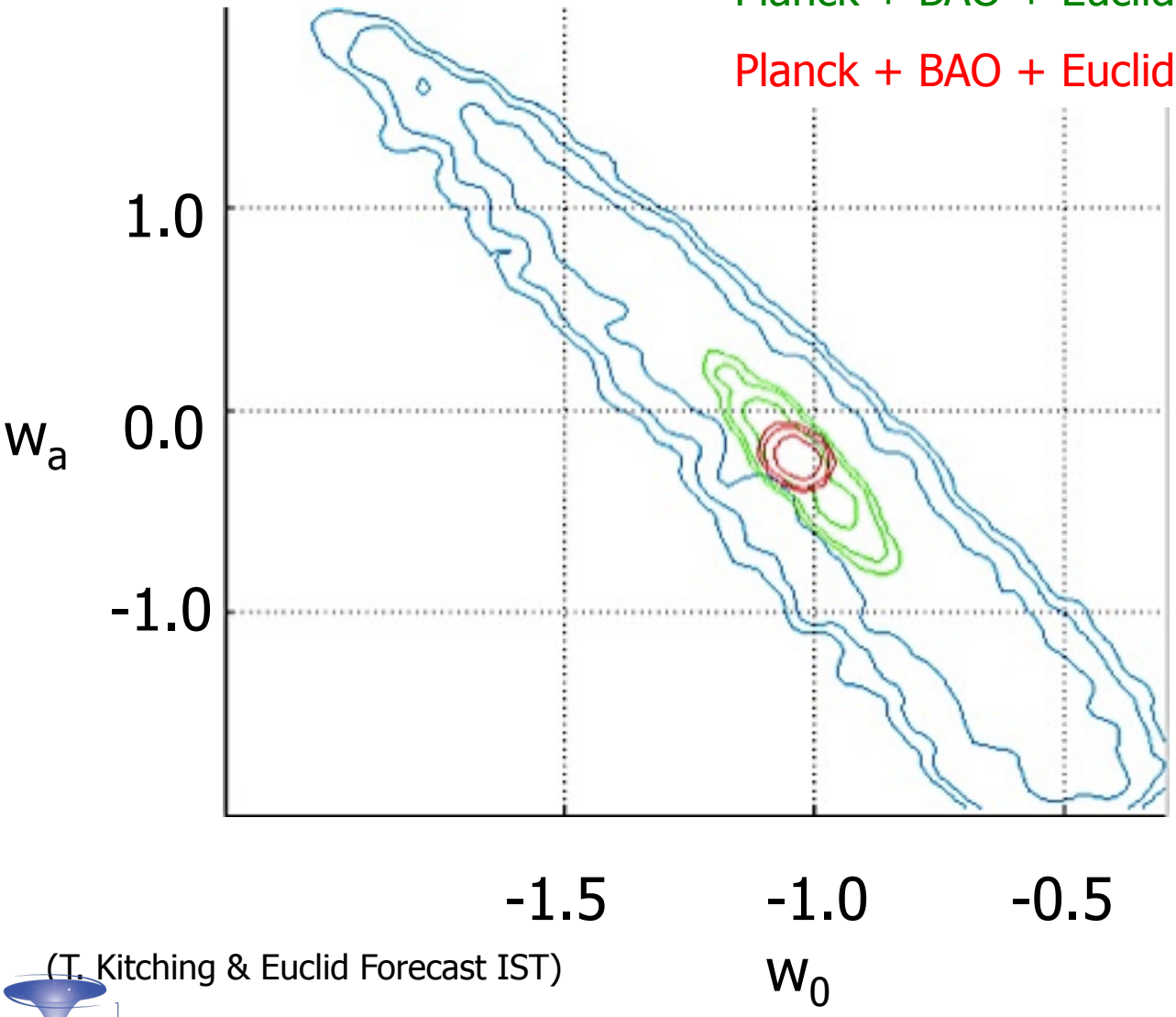
Majoretto et al 2012

Updates to Redbook (VIS+NISP)

Planck + Current BAO MCMC Chains

Planck + BAO + Euclid Weak Lensing

Planck + BAO + Euclid Weak Lensing + Euclid GC



(T. Kitching & Euclid Forecast IST)

- Fisher Matrix (Gaussian Likelihood) predictions
  - Part of "*Inter-SWG Taskforce*" (IST) on forecasts
- For WL
  - including physical IA Model
- For GC
  - Updates from Wang, Chuang, Hirata (2013)
- Combined with *Real* Planck MCMC chains

Forecasts for the primary cosmology programme

	Modified Gravity	Dark Matter	Initial Conditions	Dark Energy		
Parameter	γ	m_ν /eV	f_{NL}	w_p	w_a	**FoM** $= 1/(\Delta w_0 \times \Delta w_a)$
Euclid primary (WL +GC)	0.010	0.027	5.5	0.015	0.150	430
Euclid All	0.009	0.020	2.0	0.013	0.048	1540
Euclid+Planck	0.007	0.019	2.0	0.007	0.035	4020 → **6000**
Current (2009)	0.200	0.580	100	0.100	1.500	~10
Improvement Factor	**30**	**30**	**50**	**>10**	**>40**	**>400**

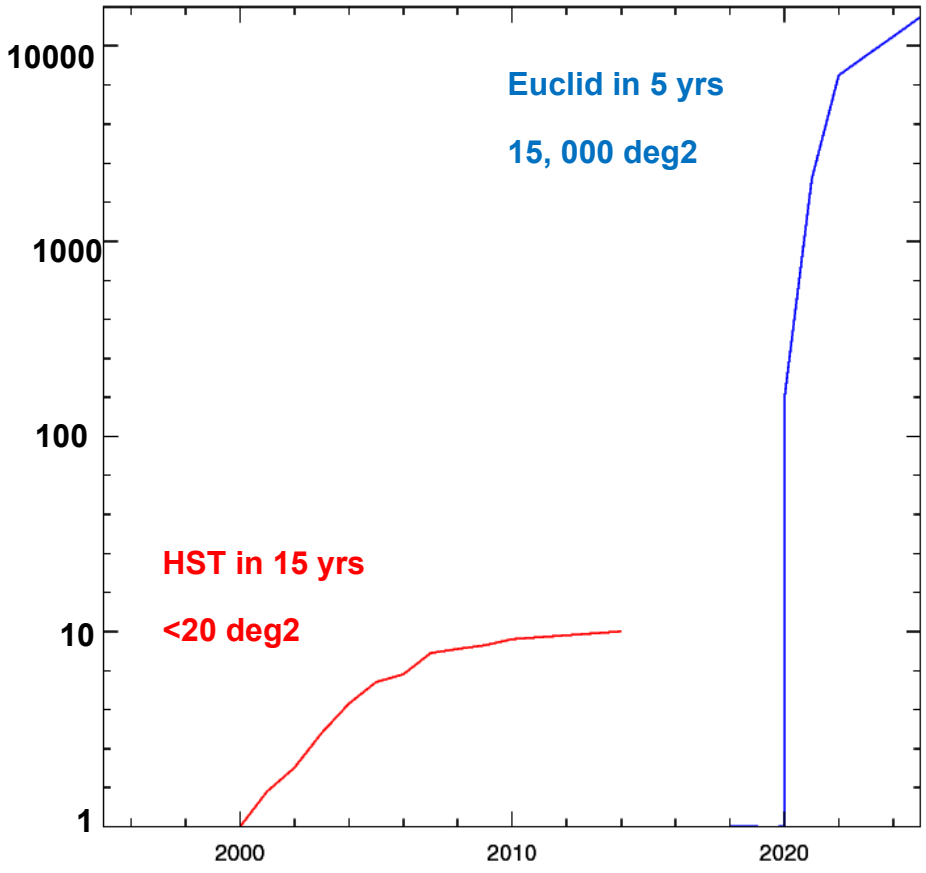
Ref: Euclid RB arXiv:1110.3193

Assume systematic errors are under control

Euclid Legacy:

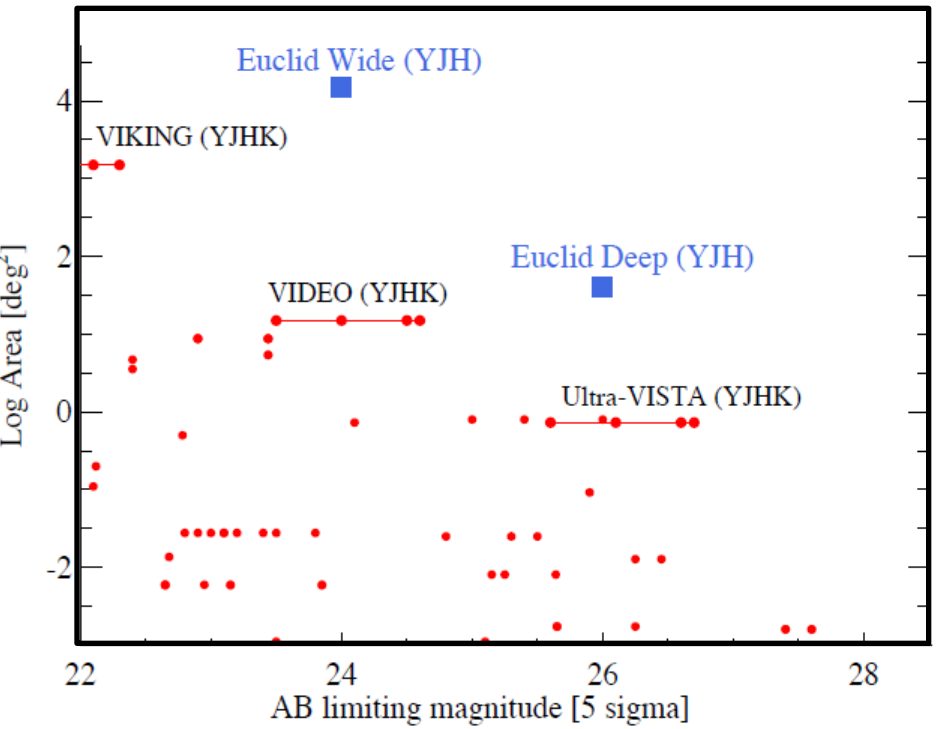
revolution in wide field surveys for the whole scientific community

- Very large samples
  - → diversity of populations
  - → distribution functions
- Exquisite imaging of galaxies
  - → morphological studies, mergers, strong galaxy-scale lenses
- Weak Lensing
  - → Galaxy evolution as function of halo properties
  - → Galaxy alignement
- Huge volumes and numbers
  - → rare sources, probing the extremes
- NIR Spectroscopy
  - → Metals, star formation@ z>1
  - → Cool stars
  - → Very high-z QSOs

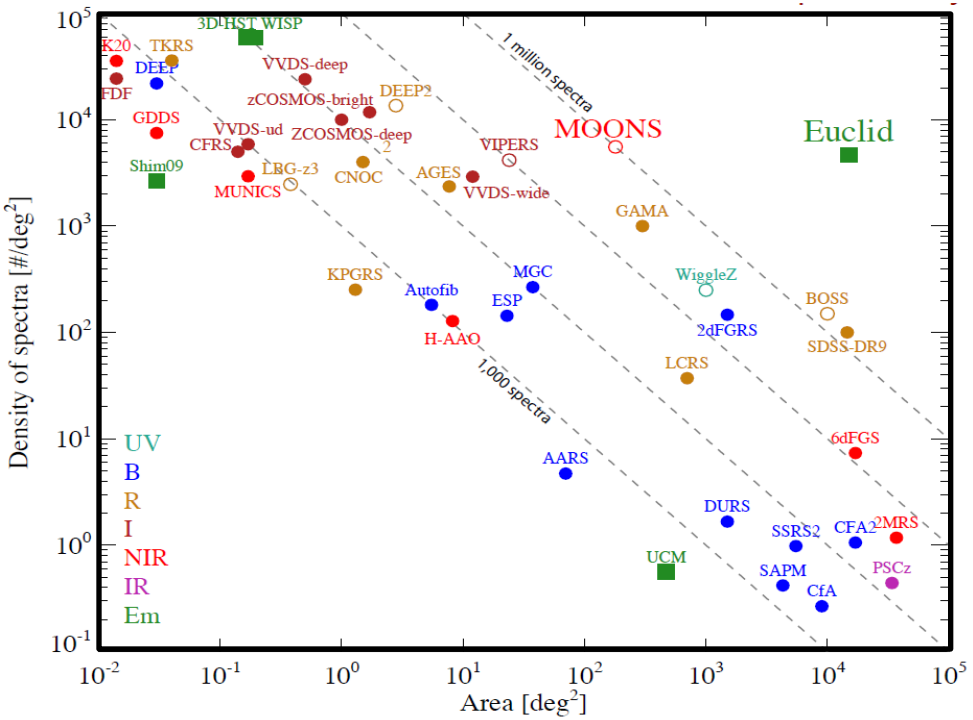


Euclid compared to other surveys

NIR imaging surveys



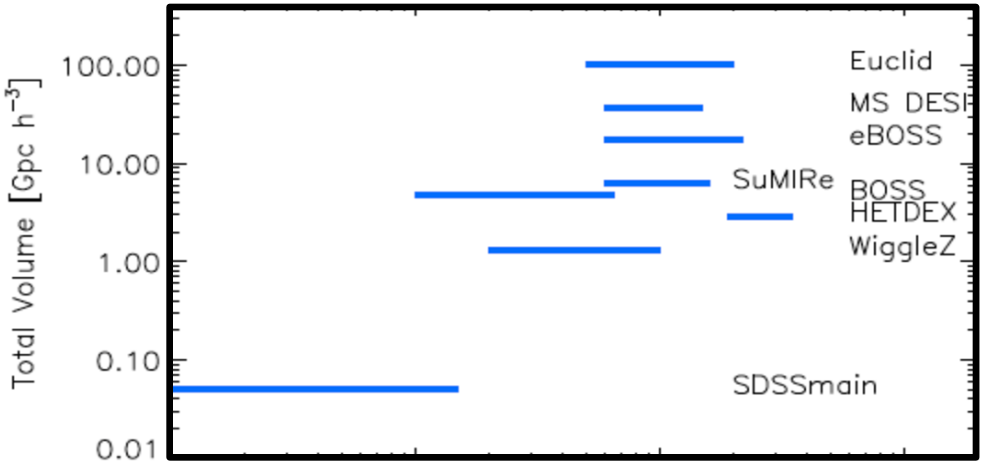
Spectroscopic surveys



NIR imaging depth is similar to the deepest images from the ground.

With ESO/VISTA:

Wide: 680 yrs; Deep: 72 yrs

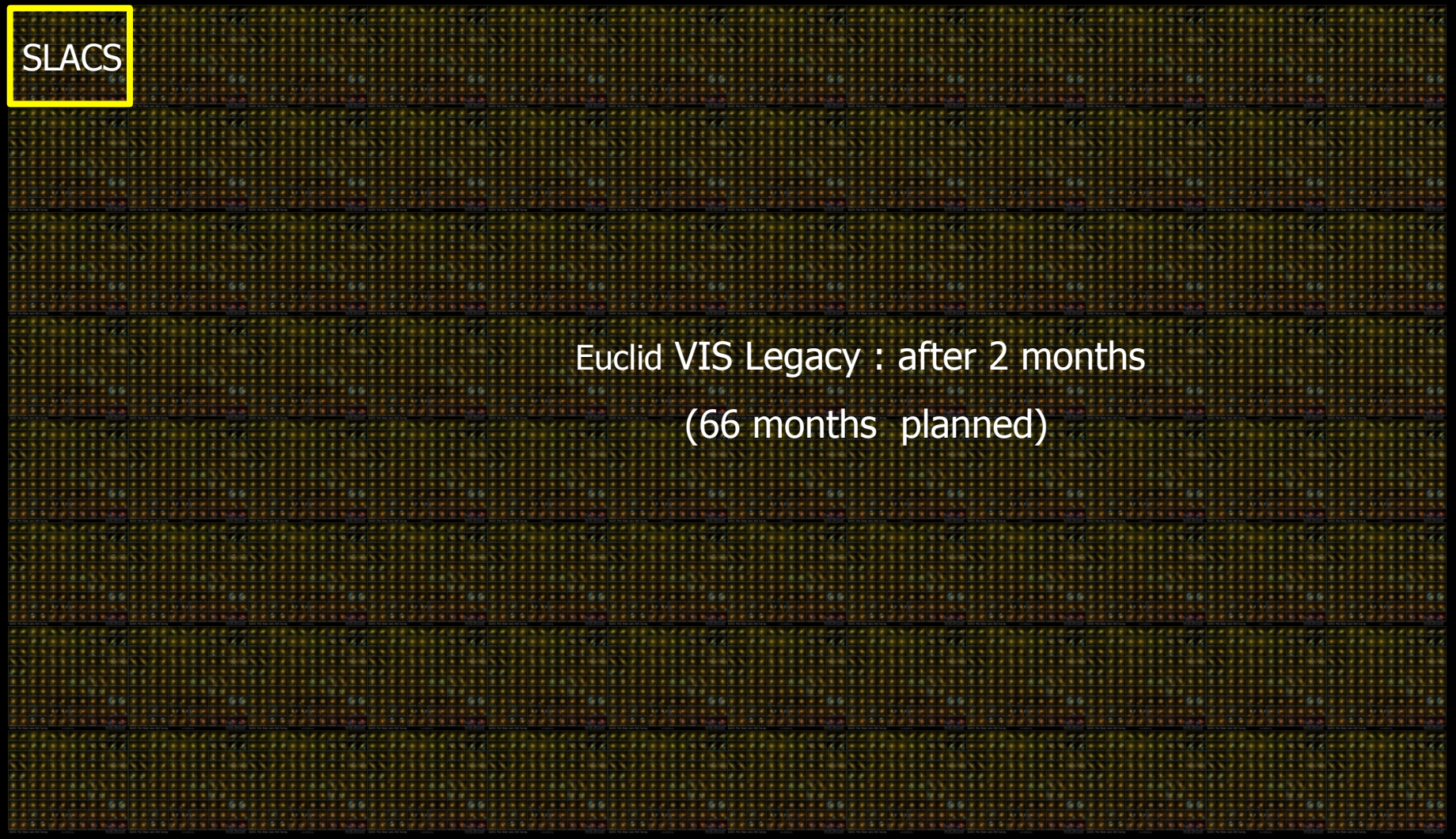


SLACS (~2010 - HST)

SLACS: The Sloan Lens ACS Survey

www.SLACS.org

A. Bolton (U. Hawai'i IfA), L. Koopmans (Kapteyn), T. Treu (UCSB), R. Gavazzi (IAP Paris), L. Moustakas (JPL/Caltech), S. Burles (MIT)


SLACS
Euclid VIS Legacy : after 2 months
(66 months planned)


Euclid
consortium
Euclid:
summary

Summary

- Euclid will
  - Adress the very nature of DE
  - Prepare a revolution for wide field VIS and NIR surveys
  - Prepare the next generation wide field panchromatic all sky surveys: GAIA, LSST, WFIRST, e-ROSITA, SKA
  - Preserve the general philosophy of public worldwide access to all Euclid-space + Euclid-Ground based data
- Euclid Legacy = 12 billion sources, 30-50 million redshifts;
  - A mine of images and spectra for the community for years;
  - A reservoir of targets for JWST, E-ELT, TMT, ALMA, VLT
- LSST and Euclid common sciences cases: clear and strong
- Photo-z of the northern sky is a pressing challenge for Euclid
- LSST+Euclid primary: SEDs, photo-z, source classification


euclid
consortium
Thank you