



euclid
consortium

Euclid Legacy Science prospects

Jenny Sorce

on behalf of the Euclid Consortium - July, 9th 2022



Optical imaging

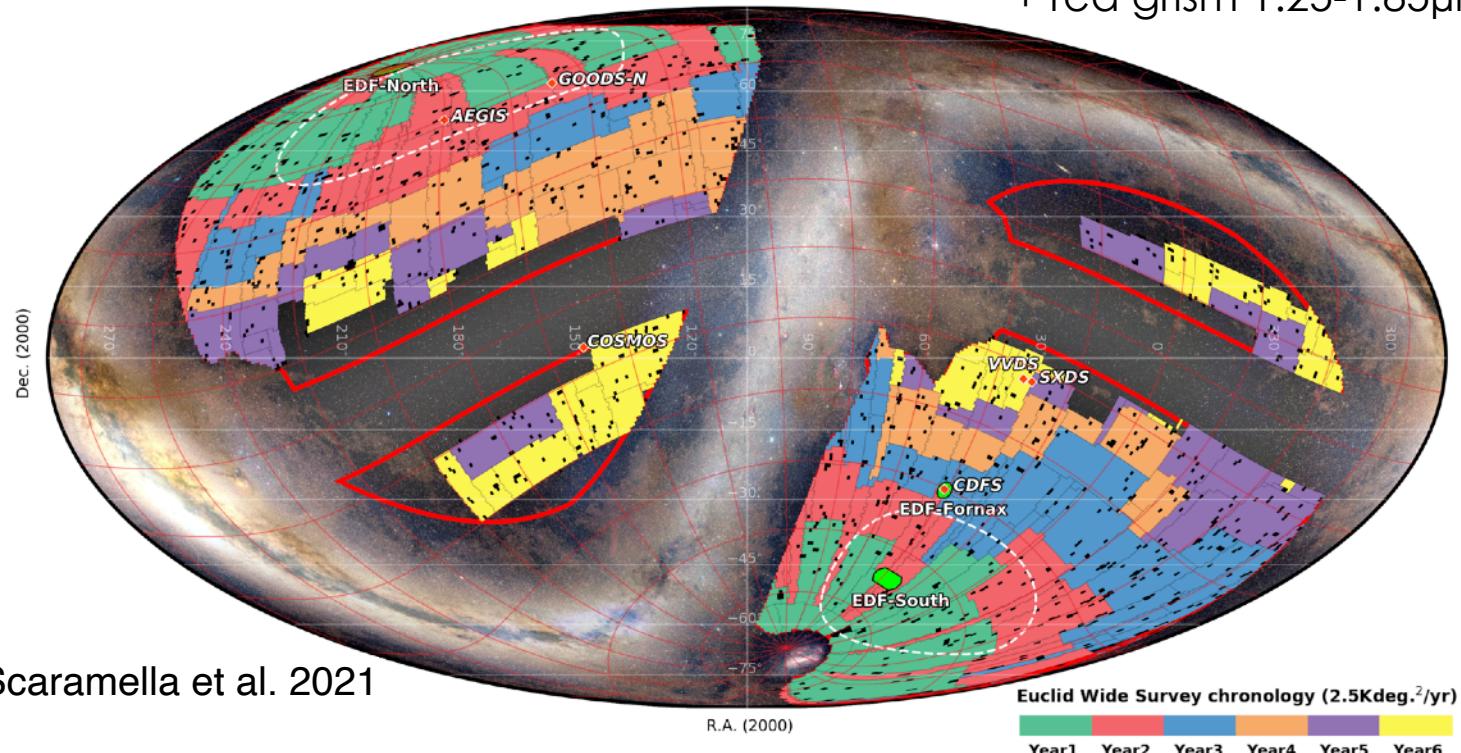
VIS: 0.55-0.9 μ m

NIR imaging

NISP: Y, J, H, 1-1.7 μ m

NIR spectra

NISP: blue grism 0.92-1.3 μ m
+ red grism 1.25-1.85 μ m



see The Euclid mission talk by Antonino Troja

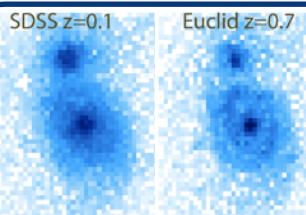
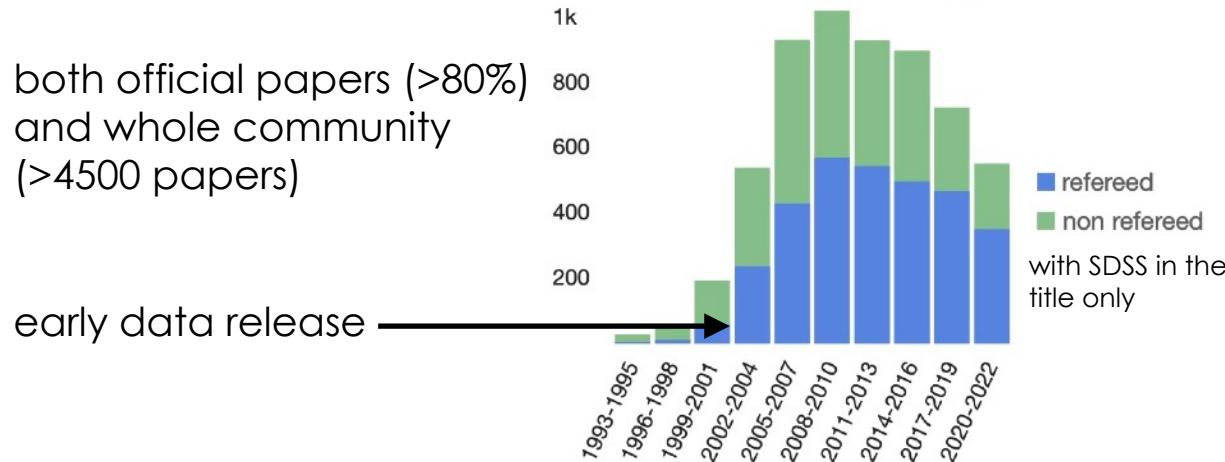
'Legacy Science': kesako and why?

Legacy: not necessarily thought off but do-able with the data.
Can be the most important impact of a given survey afterwards.

+

Science: any goal not at the survey core

Example: SDSS mainly aimed at cosmology but most papers are legacy



Euclid

= An SDSS survey for the $1 < z < 3$ Universe!

$\sim 10^6$ spectra/ $0.1\Delta z$ (+ $> 10^7$ photo-z)
 $\sim 20\text{Gpc}^3$ at $\sim 2 \pm 0.06$

$\sim 10^6$ total
 $\sim 0.3\text{ Gpc}^3$ up to $z \sim 0.2$

Euclid mission goals: Nature of dark energy & matter with weak lensing and BAOs

Cosmology needs → (Some) Gains for legacy science

Very large samples/volumes → distribution functions / scaling relations, rare sources, probing the extremes (cosmic variance reduced)

Exquisite imaging → morphological studies, mergers, strong lensing

Weak lensing → galaxy evolution as a function of halo properties, galaxy alignment (as by-product)

Spectroscopy → metals, star formation at $z>1$

Exoplanets / Extra-solar planets

J.-P. Beaulieu, M.R.Z. Zapatero Osorio, E. Kerins

Milky Way and Resolved Stellar Pops

A. Ferguson, S. Larsen

Local Universe ($z < 0.1$)

C. Conselice, L. Hunt

Galaxy and AGN evolution

A. Cimatti, E. Daddi, J. Brinchmann

Strong lensing

F. Courbin, M. Meneghetti, R. Gavazzi

Primeval Universe

J.-G. Cuby, S. Toft

Supernovae and transients

C. Tao, E. Cappellaro, I. Hook

Solar System

B. Altieri, B. Carry

Clusters of Galaxies

J. Bartlett, J. Weller, L. Moscardini

+ CMB cross-correlations and simulations **see Euclid performance on main cosmological parameter estimates talk by Isaac Tutzus**

Exoplanets / Extra-solar planets

J.-P. Beaulieu, M.R.Z. Zapatero Osorio, E. Kerins

specific cadence required (but for Superluminous & Pair-Instability SN in Deep field)

~~many way and resolved stellar groups~~

A. Ferguson, S. Larsen

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~~Solar system~~

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Milky Way and Resolved Stellar Pops

A. Ferguson, S. Larsen

targets outside ecliptic/galactic plane, still northern & southern sky wrt ground surveys

Local Universe ($z < 0.1$)

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Local Universe ($z < 0.1$)

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better resolution



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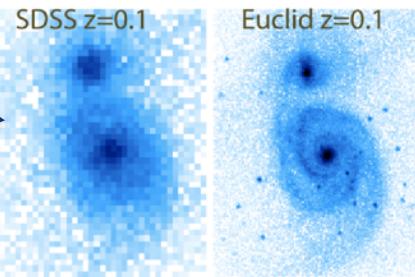
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SDSS $z=0.1$



Euclid $z=0.1$

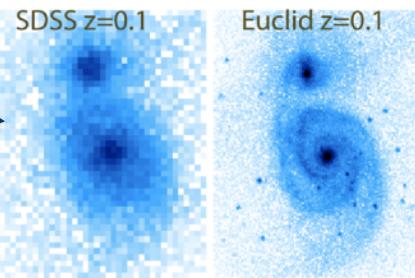
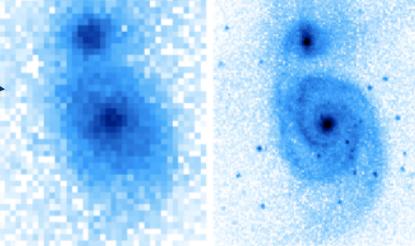
Clusters of Galaxies

J. Bartlett, J. Weller, L. Moscardini

+ CMB cross-correlations and simulations **see Euclid performance on main cosmological parameter estimates talk by Isaac Tutzus**

Exoplanets / Extra-solar planets*J.-P. Beaulieu, M.R.Z. Zapatero Osorio, E. Kerins***Milky Way and Resolved Stellar Pops***A. Ferguson, S. Larsen***Local Universe ($z < 0.1$)***C. Conselice, L. Hunt*

better resolution

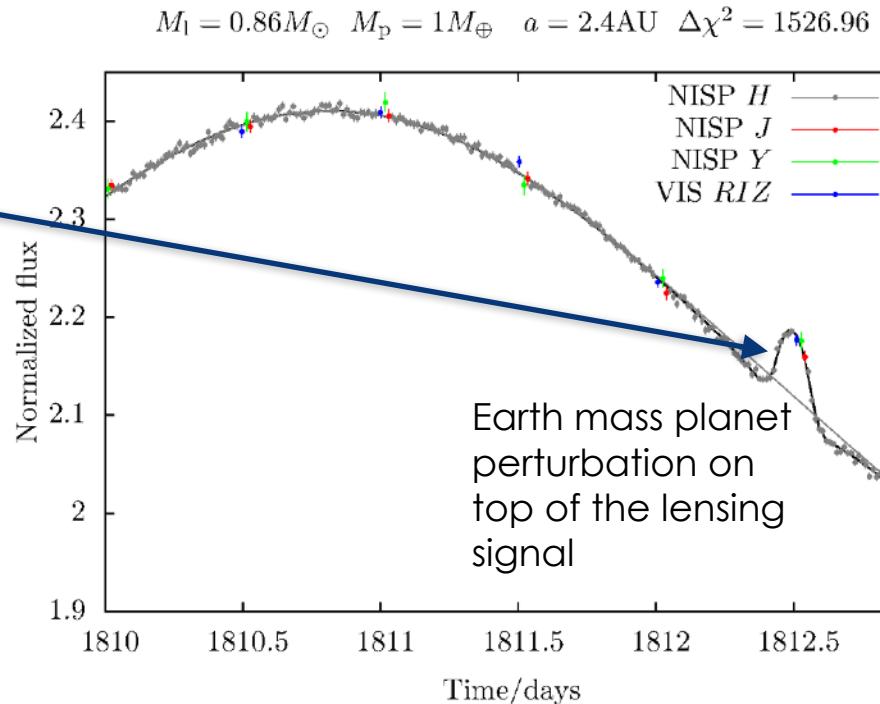
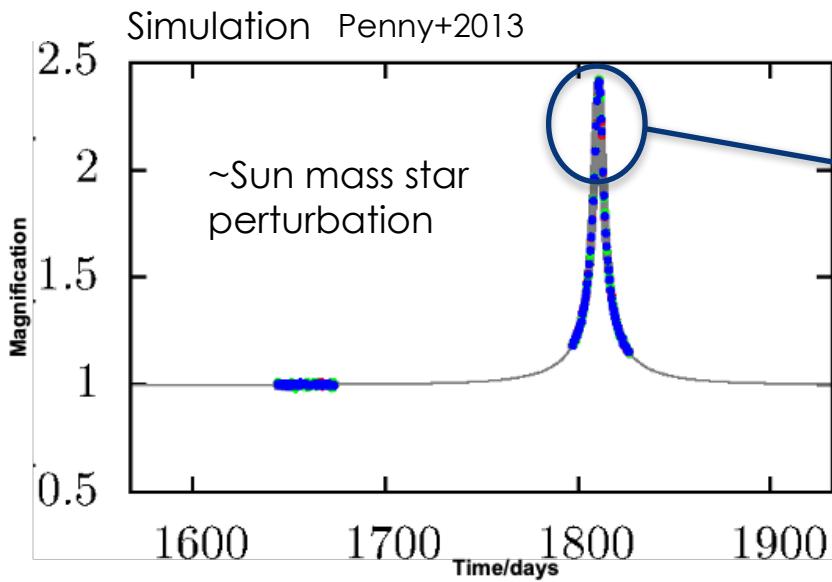
**Galaxy and AGN evolution***A. Cimatti, E. Daddi, J. Brinchmann***Strong lensing***F. Courbin, M. Meneghetti, R. Gavazzi***Primeval Universe***J.-G. Cuby, S. Toft***Supernovae and transients***C. Tao, E. Cappellaro, I. Hook***Solar System***B. Altieri, B. Carry*SDSS $z=0.1$ Euclid $z=0.1$ **Clusters of Galaxies***J. Bartlett, J. Weller, L. Moscardini*

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Exoplanets/Extra-solar planets

J.-P. Beaulieu, M.R.Z. Zapatero Osorio, E. Kerins



Constraining abundance of

- cool exoplanets in habitable zone
- free-floating exoplanets (in particular old population)

Milky-Way and Resolved Stellar Populations

A. Ferguson, S.Larsen

Galaxies out to $\sim 7\text{Mpc}$ can be (partially) resolved into individual stars

Galactic Archaeology

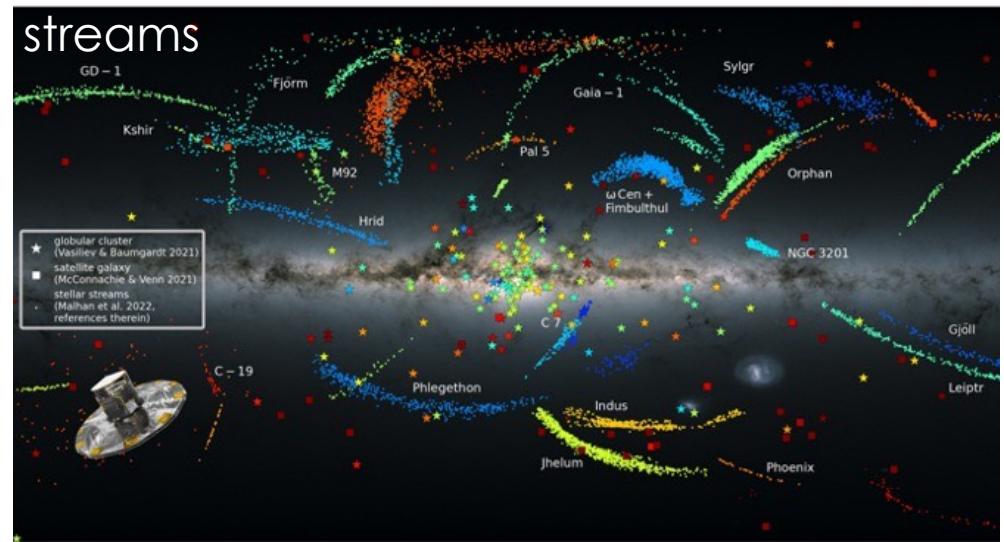
- streams and substructures → accretion histories, DM
- stars and globular clusters → mapping galaxy peripheries
- luminous giant branch stars → SFH and chemical evolution
- new dwarf satellites

Stellar Science (Milky Way)

- low mass objects
(white/brown/ultra-cool dwarfs)
- IMF, sub-dwarf boundary
- stellar exotical/rare objects

Star Clusters (out to $\sim 7\text{Mpc}$)

- GC outskirts → tidal tails, multi-populations,...) with Gaia+HST
- free-floating GCs, young massive clusters





Extragalactic astrophysics:

Local Universe (z<0.1)

Galaxy and AGN evolution

Strong Lensing

Cluster of Galaxies

Primeval Universe

C. Conselice, L. Hunt

A. Cimatti, E. Daddi, J. Brinchmann

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J. Bartlett, J. Weller, L. Moscardini

J.-G. Cuby, S. Toft

Very large samples/volumes

Exquisite imaging

Spectroscopy

Weak lensing

- Strong lensing → Detailed properties of **galaxy halos**
- **Galaxy merger** evolution
- Multi-dimensional distributions of physical parameters, profiles, scaling relations
- **Galaxy cluster** mass function
- **Galaxy evolution** as a function of environment
- Galaxy evolution at fixed halo mass
- **IMF** vs. physical properties of halos and galaxies
- Intrinsic alignments and galaxy properties
- Growth and evolution of **quiescent high-z galaxies**
- **Type II AGN** evolution & relationship to DM halo and galaxy properties
- **QSOs** at $z>8$

Local Universe ($z < 0.1$)

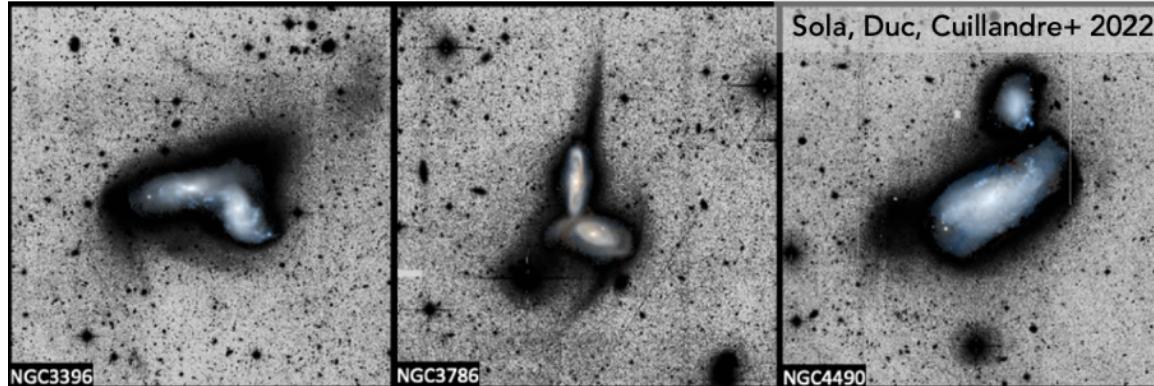
L. Hunt, C. Conselice

Probing low surface brightness limits!

- Dwarfs abundant but undercounted
- streams, shells, tidal filaments → histories



Surprise: UGC1382, a believed elliptical galaxy in shallow optical images is in fact a spiral with deep imaging (Hagen+ 2016)



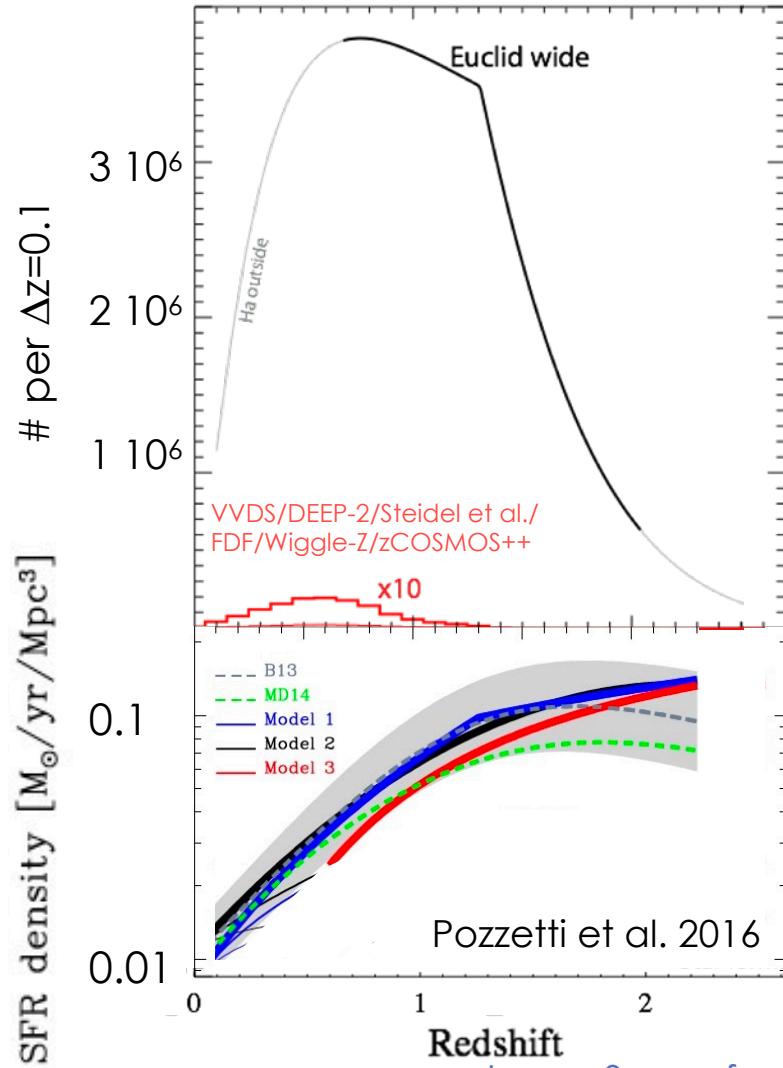
- Distance estimates through SB fluctuations
- Resolved physical properties within galaxies and GCs with unprecedented statistics



Galaxy and AGN evolution

A. Cimatti, E. Daddi, J. Brinchmann

Huge amount of data at a crucial time of the Universe!



Star formation history
of the Universe

Jenny Sorce for the EC

July 9th, 2022

Cluster of Galaxies

J. Bartlett, J. Weller, L. Moscardini

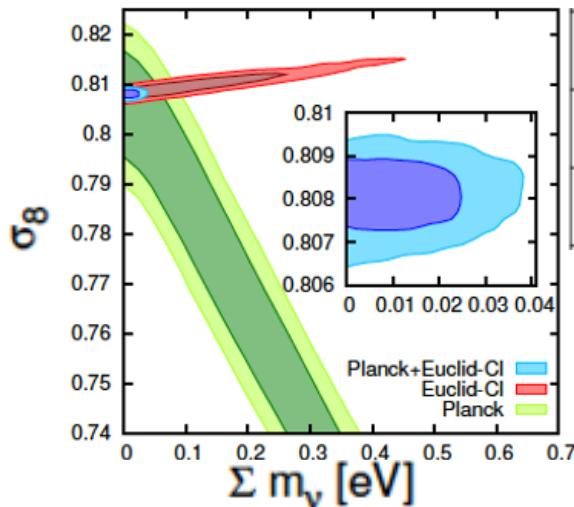
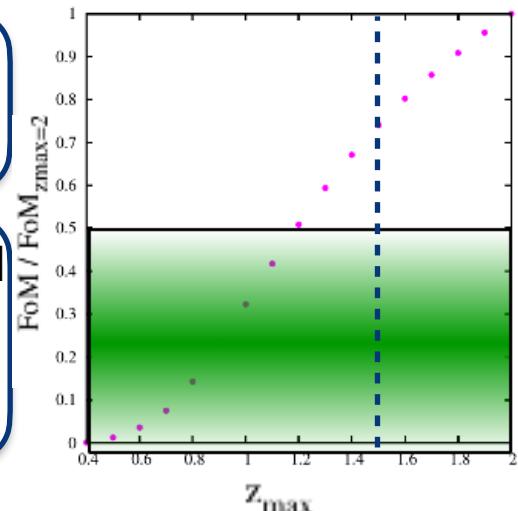


Detection with two algorithms

- AMICO: matched filter (Bellagamba+18)
- PzWav: wavelet-style detection (Gonzalez+14)

Characterization/selection function & Likelihood

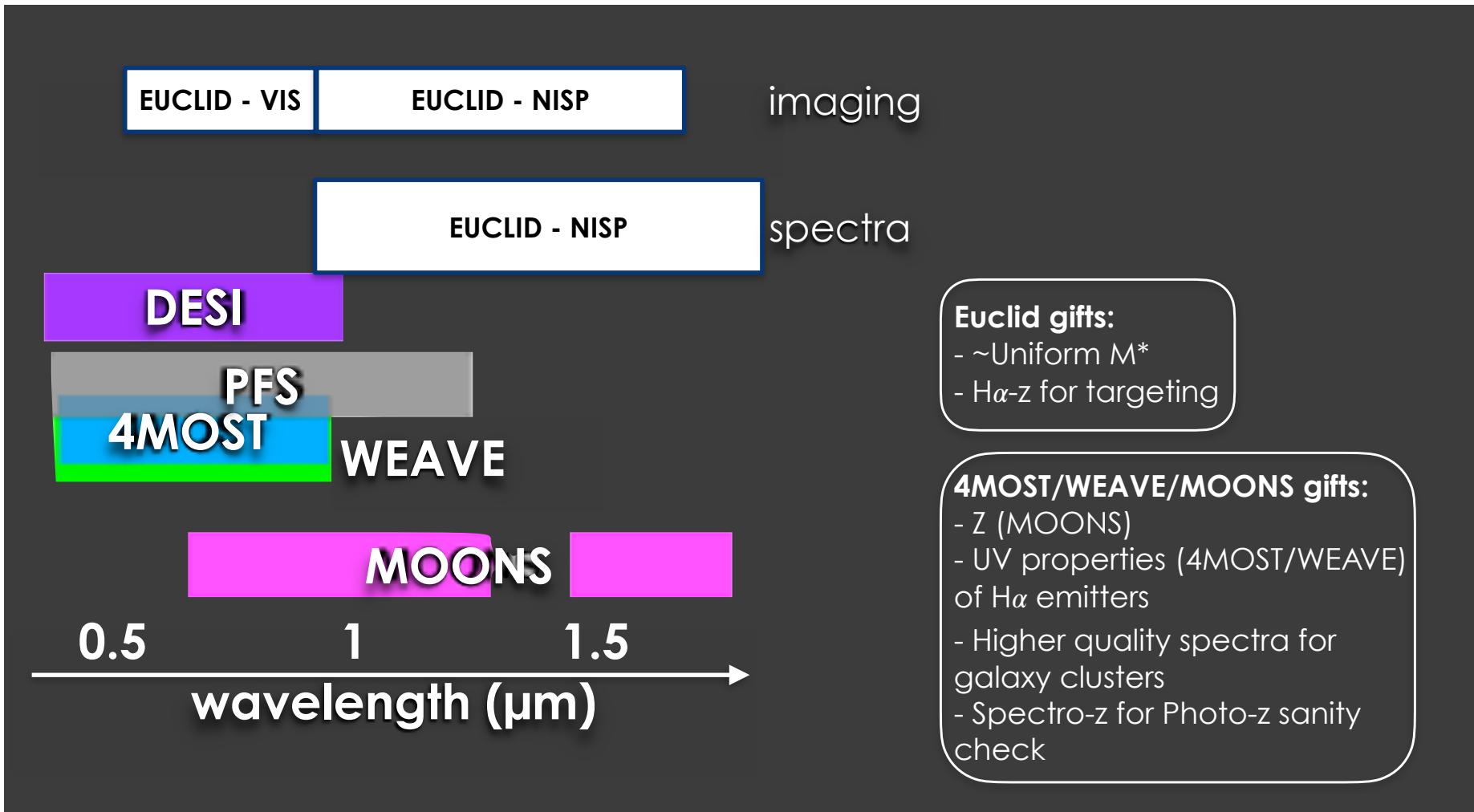
- SinFoniA: mock catalogs directly from data (Maturi+18)
- Covariance matrix for number counts (Fumagalli+21): impact of sample variance, redshift bins, cosmology



Parameter	FoM
Euclid primary (WL+GC)	430
Euclid All Including Clusters	1540

Cosmological Probe

- Observable-mass relation uncertainties → calibration of scaling relations
- $z>1.5$ clusters → doubling the cluster number counts FoM
- Independent probe → tripling cosmological parameter estimate FoM



- Euclid = SDSS for the $1 < z < 3$ Universe !
- Unprecedented **uniformity** of data
- **Exquisite imaging** over 15,000 deg² in optical and NIR
- Large number of scientific questions **from the solar system to high-z galaxies** (e.g. Milky Way: better star/galaxy separation than Gaia at low magnitudes)

BUT

- Euclid spectroscopy **slitless** = crucial to complement it (e.g. WEAVE, 4MOST, MOONS)

Aim is to make Euclid the reference survey of the sky outside the Galactic plane for years to come!



* Missing your 'thanks' spelling? It means I did not get the chance to learn how to say it so far