LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

PROSPECTIVE X

PROJETS OPTIQUE / IR

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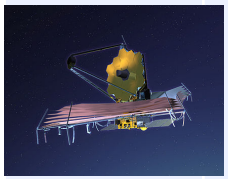
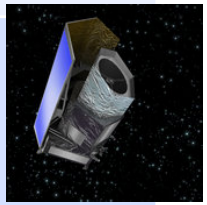
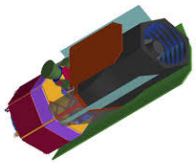
Introduction

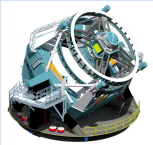
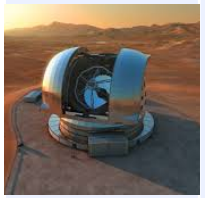
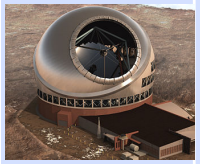
Rapide survol de projets OIR futurs, sol et spatial, au niveau mondial

- **Projets futurs uniquement**
- **Revue non exhaustive**
- **Manques identifiés: GAIA, missions exoplanètes**

Large Scale Projects: space

Project	Country/ Agency	Status	λλ Instruments	Main science objectives
HST	NASA/ESA	Operation	0.1 – 1.6 μm WFC3, COS, ACS	Multi-purpose Observatory 
JWST 	NASA/ESA	2018 launch	0.6 – 24 μm NIRSpec, NIRCam, MIRI	Multi-purpose Observatory • The End of the Dark Ages: First Light and Reionization • Assembly of Galaxies • The Birth of Stars and Protoplanetary Systems • Planetary Systems and the Origins of Life
Euclid	ESA/NASA	2020 launch	0.55 – 2.0 μm VIS, NISP	Dark Energy Dark Energy and Dark Energy 
WFIRST 	NASA	? Post JWST ?	0.60 – 2.0 μm	Dark Energy Exoplanets – Microlensing

Large Scale Projects: ground

Project	Country /Agency	Status	λλ Instruments	Main science objectives
LSST 	USA	Start construction 2014. Operations 2020 ?	0.3 – 1.1 μm	Dark energy, dark matter, time-variable phenomena, supernovas, Kuiper belt and near-Earth objects
E-ELT 	ESO	Contingent upon Brazil joining ESO. Start 2014 ? Operations 2022 ?	0.4– 20 μm CAM, IFU, MOS, MIR, HIRES, XAO	Multi-purpose Observatory Extra-solar planets Resoved Stellar populations The physics of high redshift galaxies Cosmology and fundamental physics
TMT 	USA	Canada / Japan / China / India Start 2014 ? Operations 2022		Multi-purpose Observatory
GMT 	USA	Australia / Korea In construction		Multi-purpose Observatory

Mid Scale Projects: multi-object spectrographs

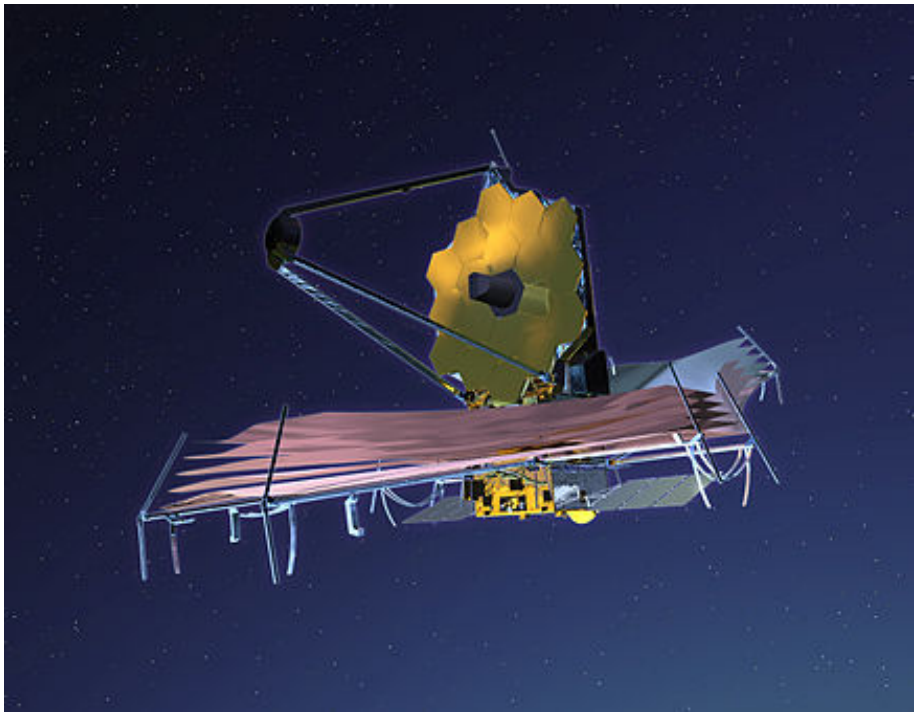
Project	Country/ Agency	Status	λλ Instruments	Main science objectives
SDSS-IV	USA	2014	0.4 – 0.9 μm	Stellar survey of the Milky Way Cosmological survey of quasars and galaxies Survey of 10,000 nearby galaxies
MS-DESI (Mayall)	USA/DOE	CDR 2018	0.4 – 1.0 μm	Dark Energy Stellar populations
PFS (Subaru)	Japan USA France Brazil	2017	0.38 – 1.25 μm	Dark Energy Galaxy evolution Stellar populations (MW, M31)
MOONS	ESO	Approved 2020 ?	0.8 – 1.8 μm	Galactic Archaeology Galaxy evolution Synergy with large-area surveys
4MOST	ESO	To be approved ?	0.4 – 0.9 μm	Suivi GAIA, eROSITA, Euclid
WEAVE	UK, Spain, NL, France	To be approved ?	0.4 – 0.95 μm	Milky Way archaeology: Gaia follow-up Galaxy evolution and cosmology: LOFAR, APERTIF

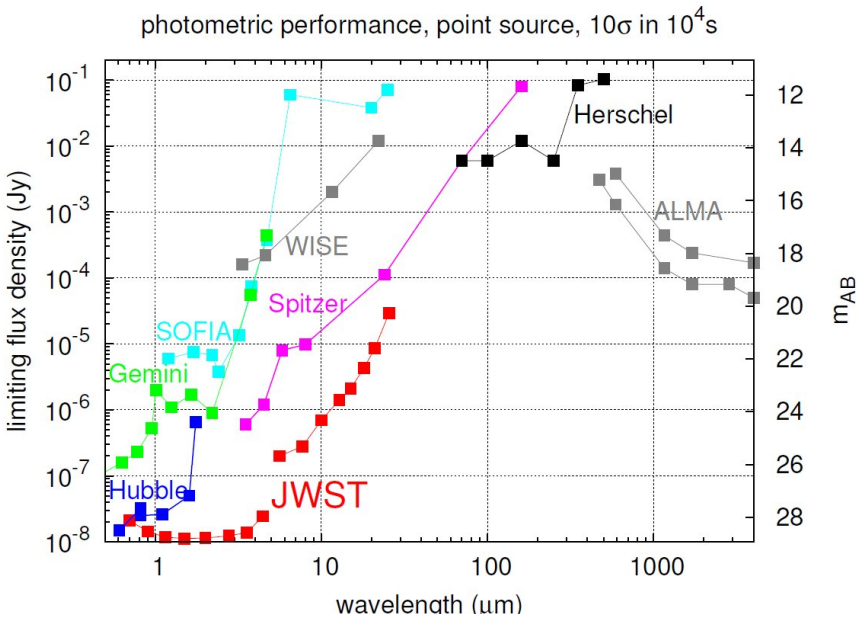
JWST

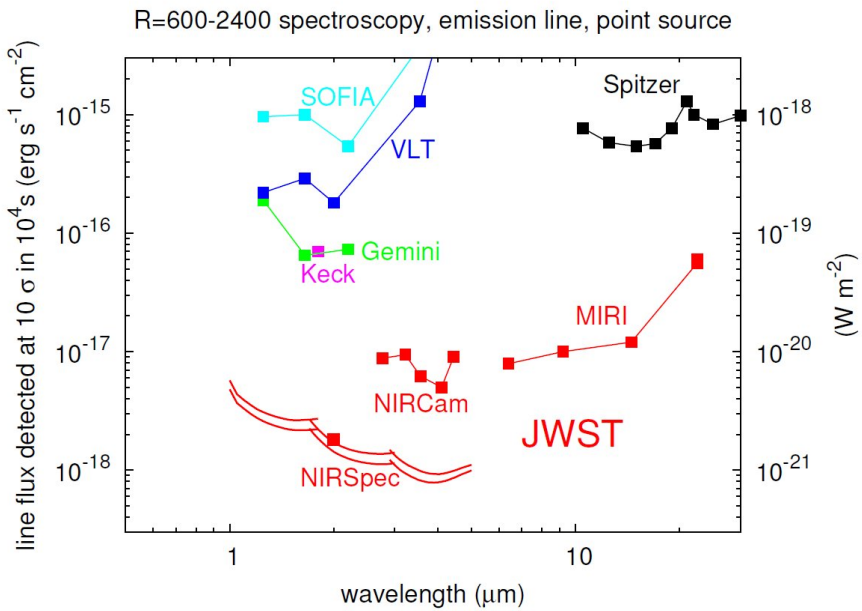
NIRCam, NIRSpec

- **0.6-5 μm**
- **~ 3 x 3 arcmin²**
- **Sub- 100mas**

MIRI (5-28 μm) ~ 1.2 x 2 arcmin²



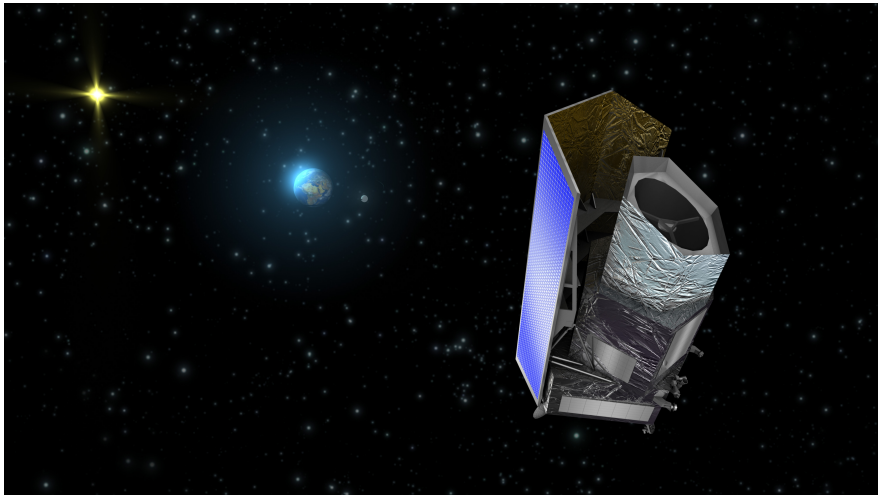


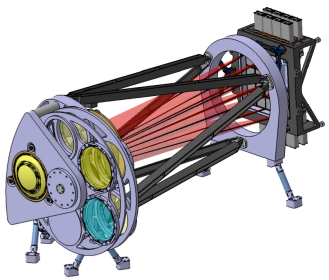


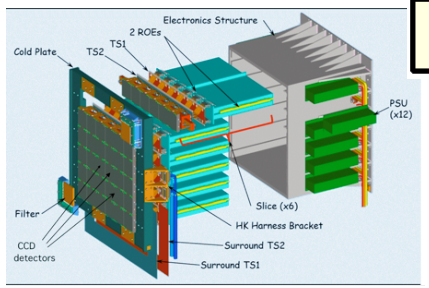
Euclid

1.2m, 0.57 deg²
0.1 arcsec. for VIS; 0.3 arcsec. for NISP
Very broad band (R+I+Z) for VIS
Y, J and H for NISP
Wide Survey: 15,000 deg²
- 1 billion galaxies
- 50 million with spectroscopic identification
- ABVIS=24.5, ABY,J,H=24.0

Deep Survey: 40 deg², location TBD
- ABVIS=26.5, ABY,J,H=26.0

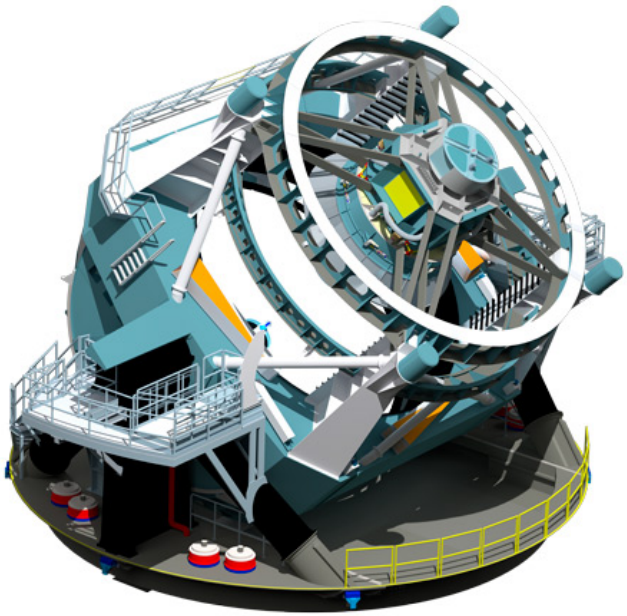




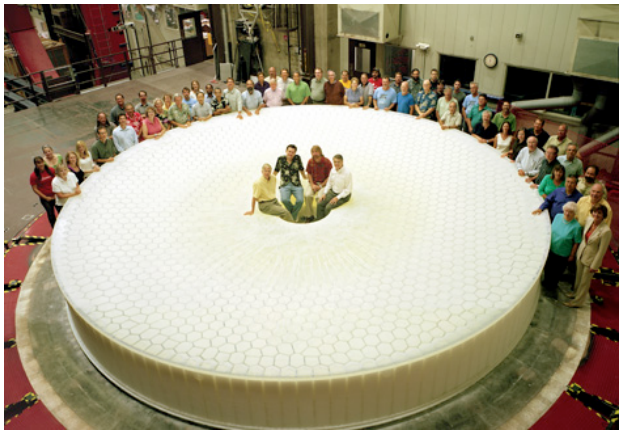


Objects	Euclid	Before Euclid
Galaxies at 1<z<3 with precise mass measurement	~2×10^8	~5×10^6
Massive galaxies (1<z<3))	Few hundreds	Few tenss
Hα Emitters with metal abundance measurements at z~2-3	~$4\times10^7/10^4$	~10^4/~10^2 ?
Galaxies in clusters of galaxies at z>1	~2×10^4	~10^3 ?
Active Galactic Nuclei galaxies (0.7<z<2)	~10^4	<10^3
Dwarf galaxies	~10^5	
T_{eff} ~400K Y dwarfs	~few 10^2	<10
Lensing galaxies with arc and rings	~300,000	~10-100
Quasars at z > 8	~30	None

LSST



8-m
9.6 square degree field of view
3200 Megapixels
6 bands 0.3-1.1 micron
18,000 sq. deg R ~ 26.5
Deep fields r ~ 28
30 Tbytes per night



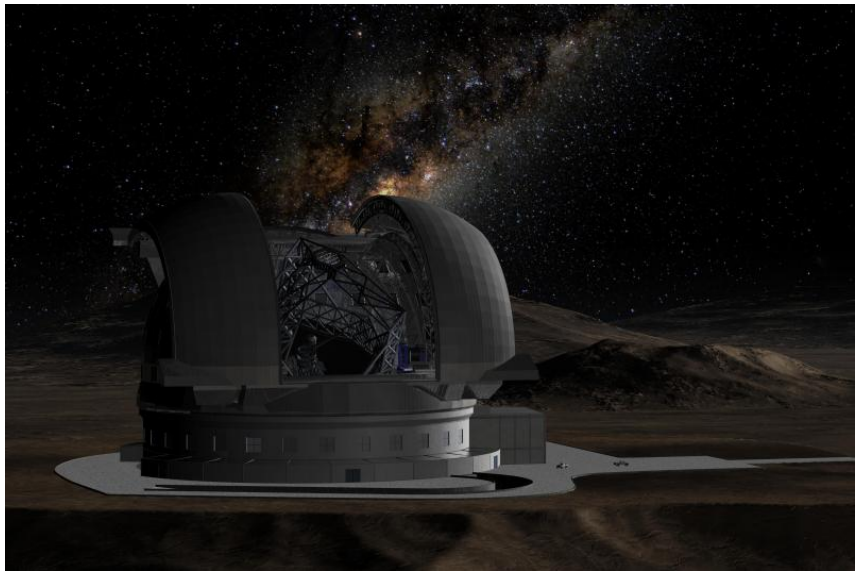
E-ELT

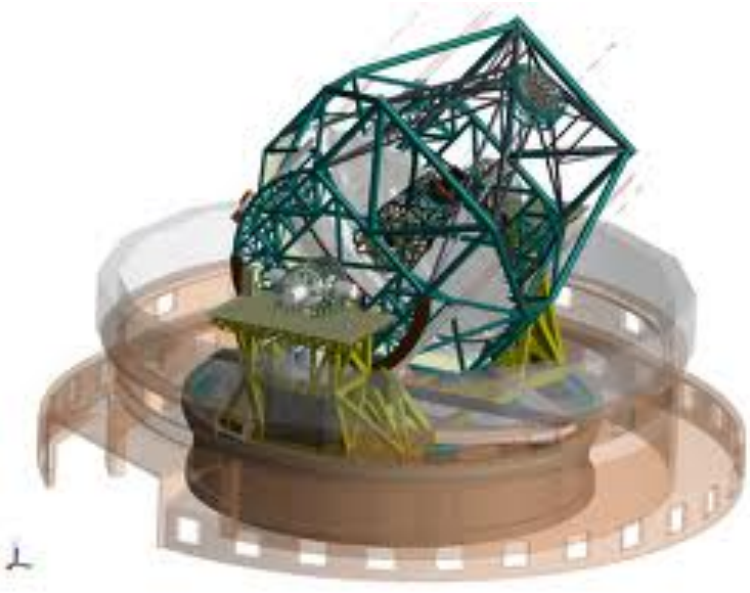
ESO (14 European member states + Brazil)

39-m segmented M1
(1100 m^2), 798 / 931 segments, 1.45 m

Max field of view: 10 arcmin

Adaptive Optics Telescope
A few mas to ~ 0.5 arcsec





E-ELT Instrument Suite

Phase A conceptual studies: eight instruments + 2 Adaptive Optics modules

Two first light instruments selected:

- ELT-CAM (Micado) Diff. limited near-IR imager, 1 arcmin fov.
- ELT-IFU (Harmoni) multi-mode IFU, 5" x 10"
- (this represents ~ 50% of the TMT first light instrument capabilities)

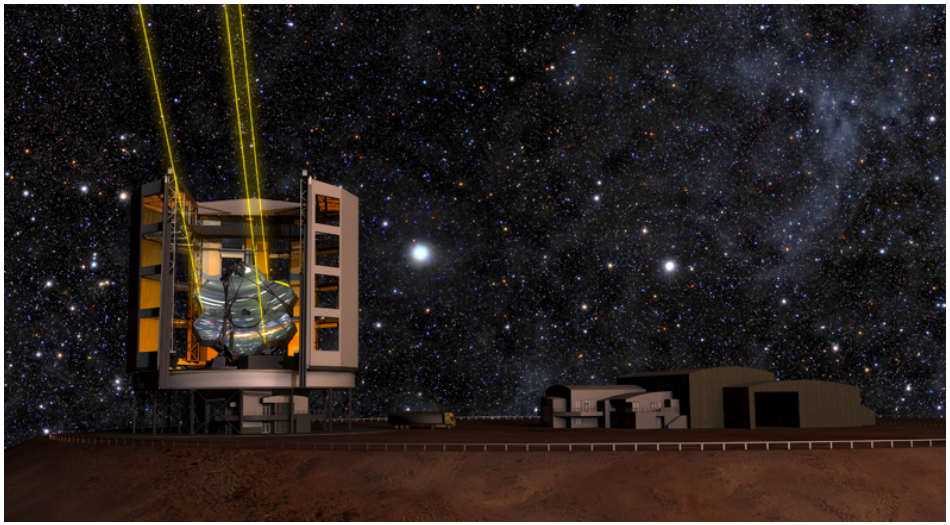
Then ELT-MIR, ELT-MOS and ELT-HIRES (#3, #4 and #5, order TBD)

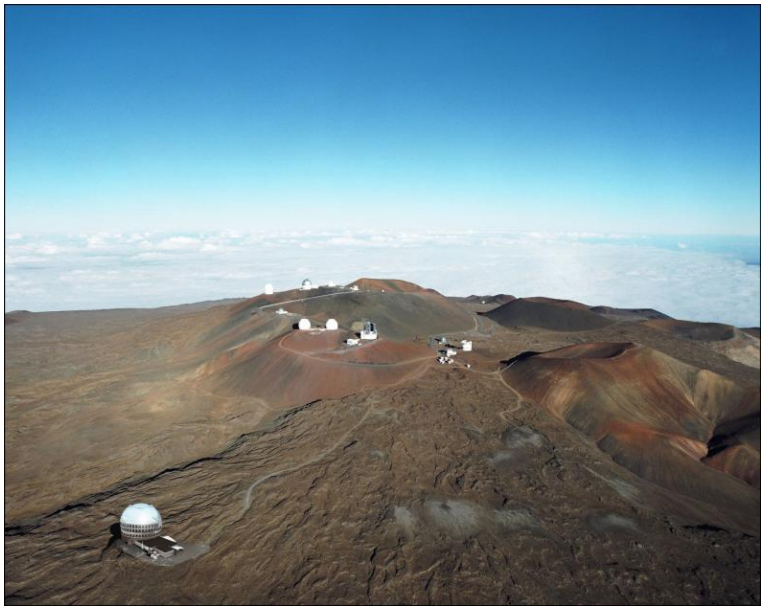
ELT-6 TBD

ELT-PCS (XAO high contrast imager for exoplanets) as technological maturity allows

	ELT-IFU	ELT-CAM	ELT-MIR	ELT-4	ELT-5	ELT-6	ELT-PCS
Commissioning	2022	2022	2023	2024	2026	2028	2025-30

TMT, GMT





Spectro Multi-Objets: DESI, PFS, MOONS, 4MOST, WEAVE

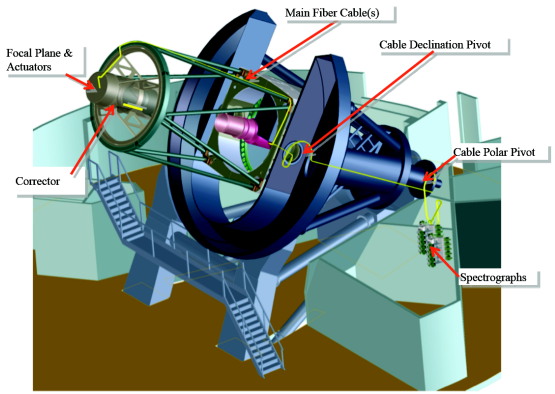
DESI: 4-m, 3 deg. ∅, 5000 fibres. Dédié. 14,000 sq. degrees. 0.5<z<3.5, LRGs, ELGs, QSOs

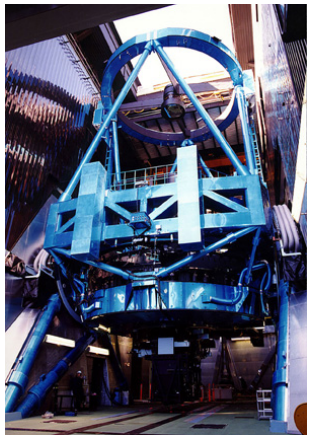
PFS: 8-m, 1.3 deg ∅, 2400 fibres. 16 sq. deg. (cosmo), 65 sq. deg (M31), MW, etc. 300 nights over 5 yrs, starting 2018

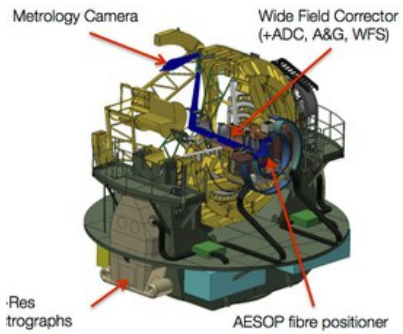
MOONS: 8-m (VLT), 500 sq. arcmin, 1000 fibres, R = 5,000 & 20,000

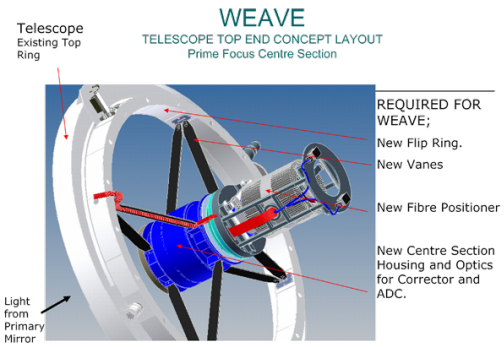
4MOST: 4-m (VISTA), 3 deg^2, 1500 fibres (low-R), 150 (high-R). Dédié. Suivi Gaia et eROSITA (50,000 amas, 100,000 sources X Galactiques), 25 million spectra over ≥15 000 square degrees

WEAVE: 4-m (WHT), 2 deg ∅, 1000 fibres, R = 5,000 & 20,000









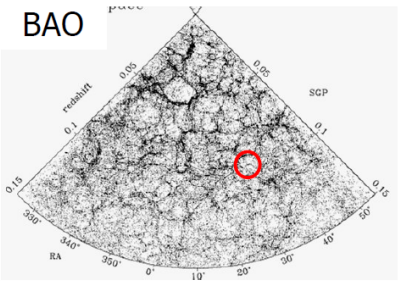
Dark Energy

Euclid (WFIRST)
LSST
DESI, PFS, (WEAVE, 4MOST)

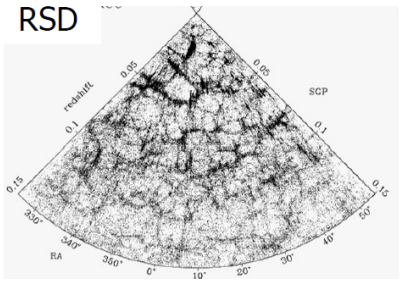
BAO, RSD and WL over 15,000 deg^2

50 million galaxies with redshifts

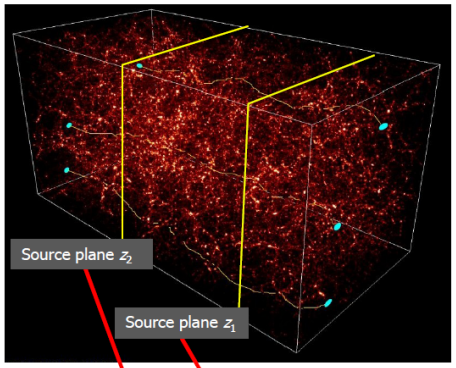
BAO

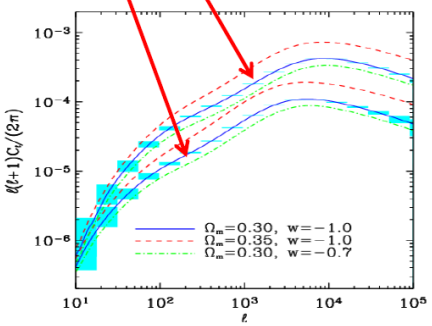


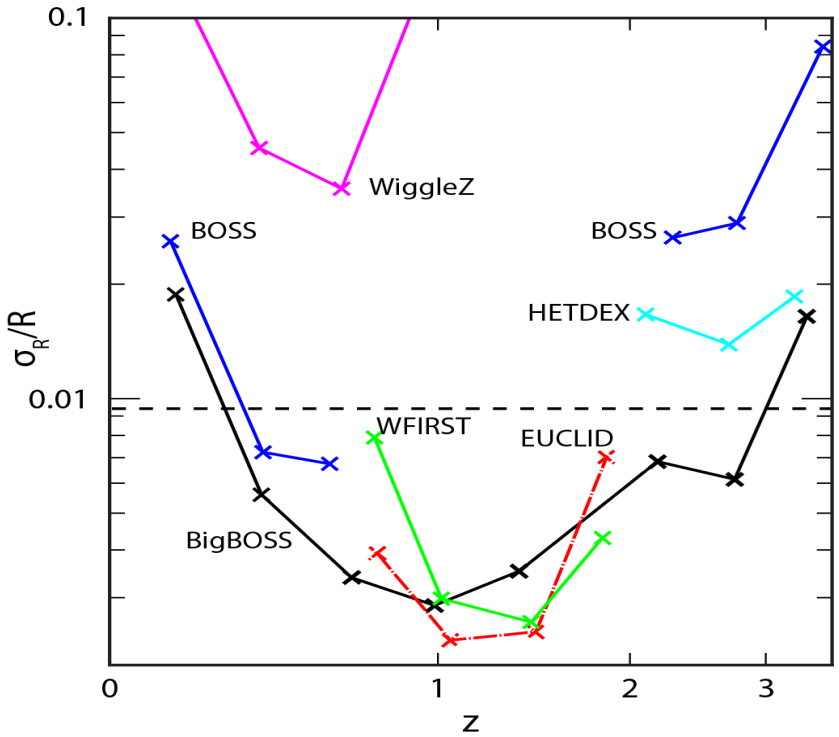
RSD



1.5 billion sources with shapes, 10 slices



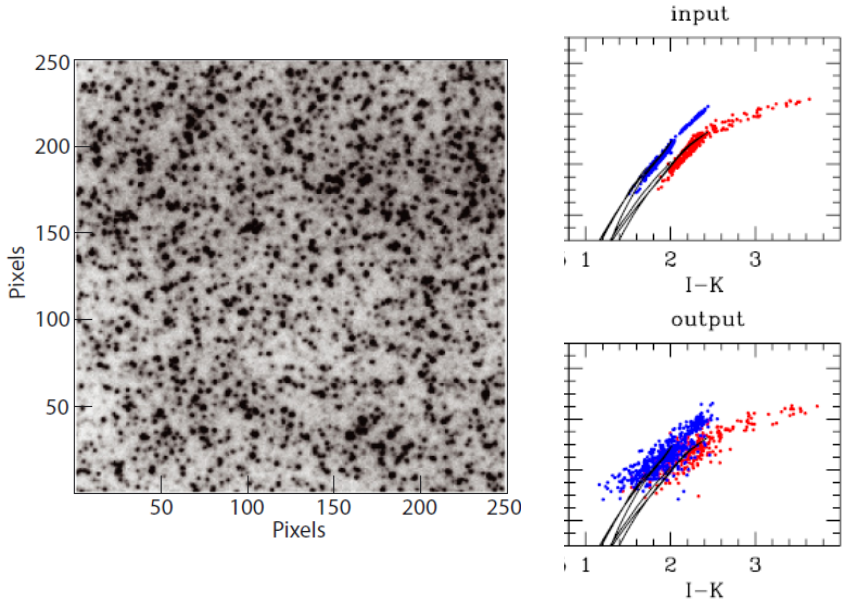




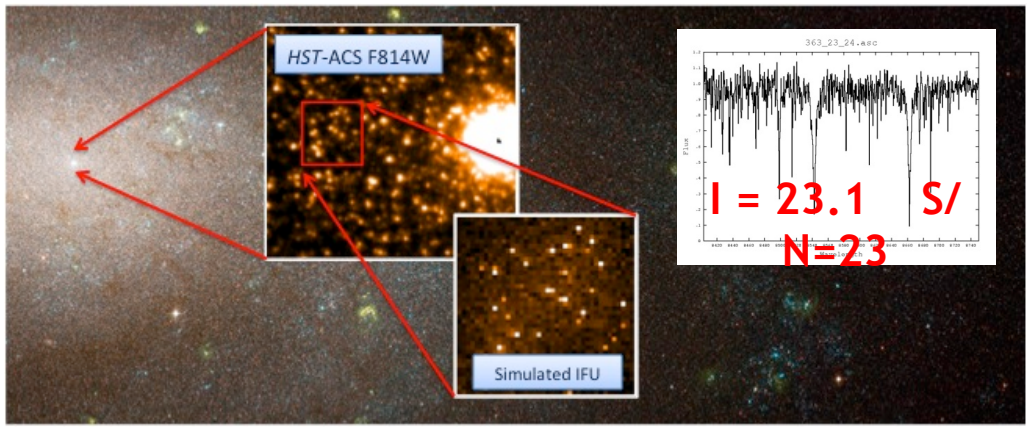
The resolved stellar populations

A bright future with SDSS (IV), Gaia, HERMES (AAO), PFS (Subaru), and several proposed projects and instruments motivated by this science case :

E-ELT, MS-DESI, PFS, MOONS, PFS, 4MOST



E-ELT simulations (imaging): VIRGO (M87)



E-ELT simulations (spectroscopy): a few Mpc

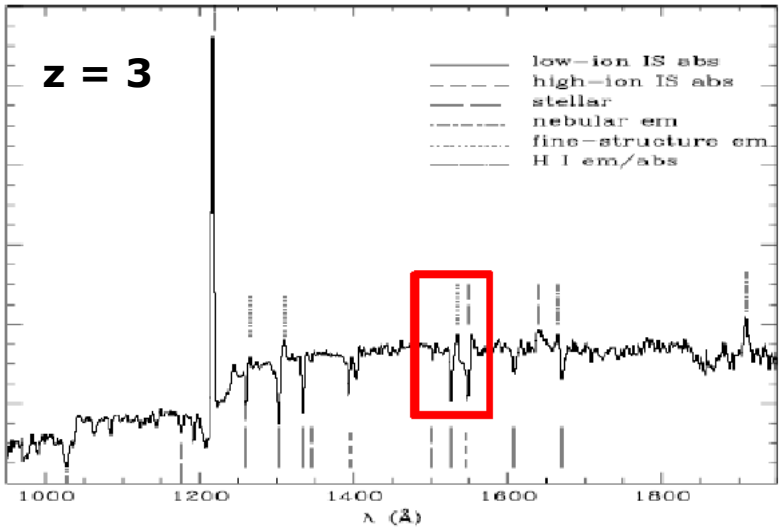
First light - The Highest Redshift Galaxies

JWST will be the main provider of sources (already tens from WFC3)

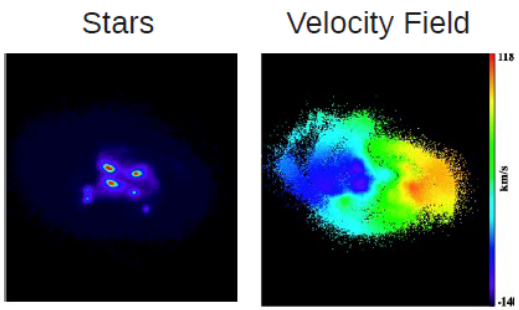
Spectroscopic follow-up from ELTs (UV rest-frame spectroscopy)

Also, high-res spectroscopy (re-ionization) of high-z GRBs and QSOs

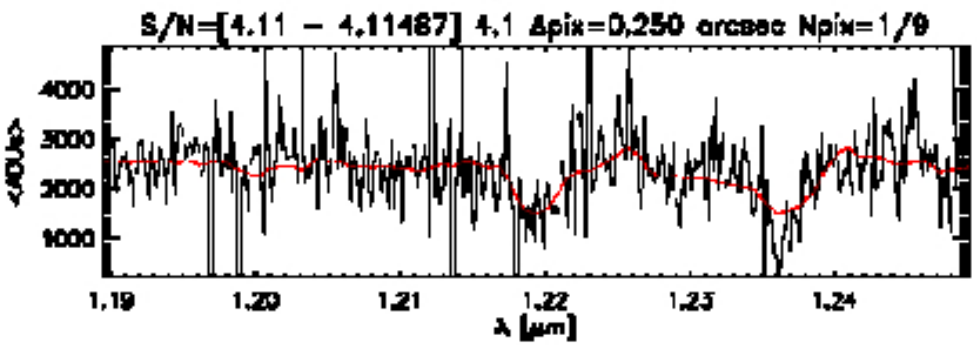
JWST and ELTs



Simulation for an AB=27 galaxy at z ~ 7



z = 0



Summary

Science theme (main, secondary)	Space Imaging *Spectroscopy*	Ground Imaging *Spectroscopy*
Dark Energy (galaxy evolution)	Euclid[1] (WFIRST)	LSST[1], *DESI*[1], *PFS*[1]
First galaxies, re-ionization	JW*ST*	*E-ELT*, *PFS*
Stellar populations	JW*ST*	*E-ELT*, *DESI*[1], *PFS*[1], *4MOST*[1], *MOONS*[1]
Exoplanets	JW*ST*	E-E*LT*

1: dedicated survey instrument