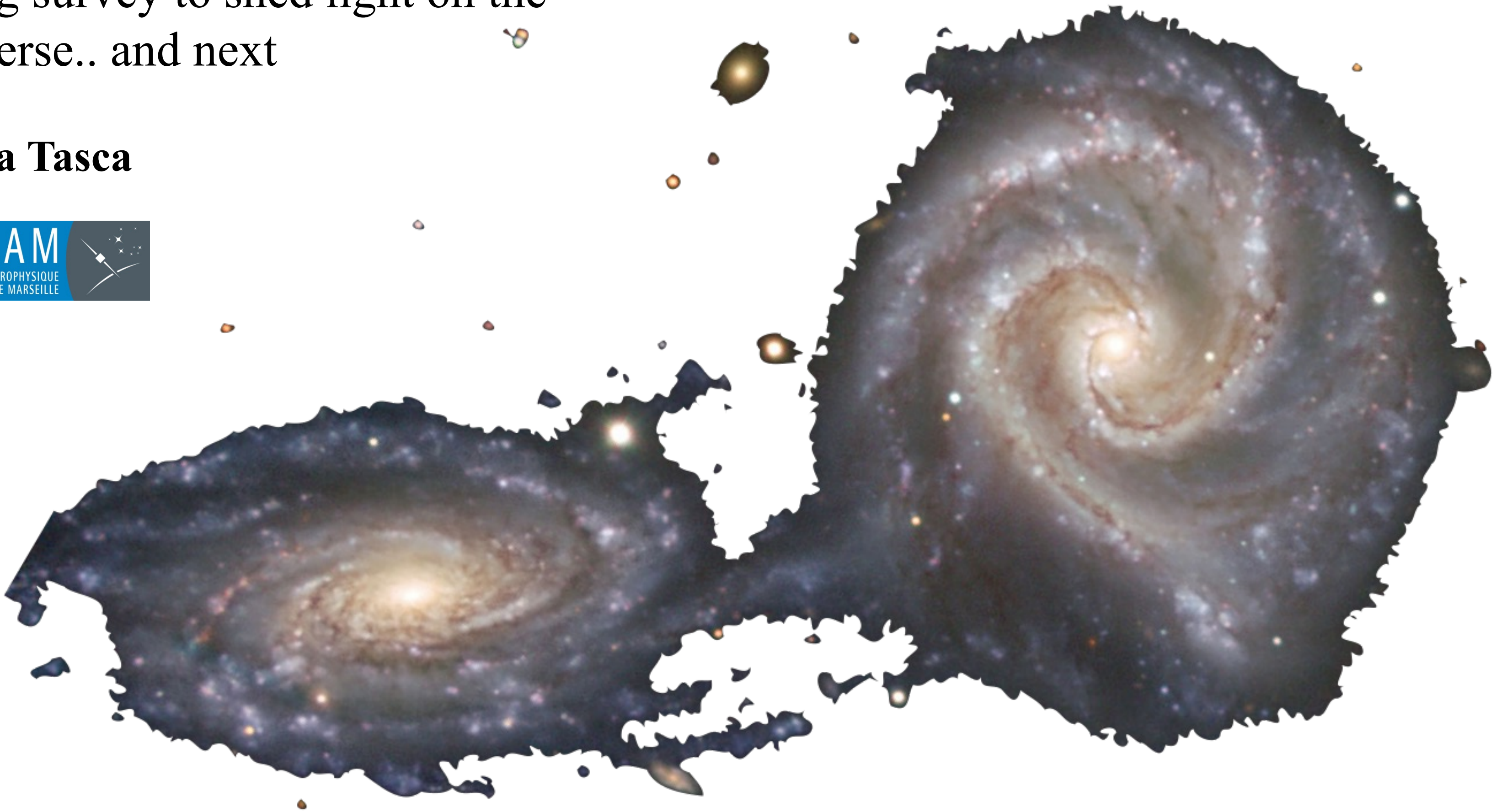
From galaxies to cosmology with deep spectroscopic surveys
A tribute to Olivier Le Fevre

VUDS: a ground-breaking survey to shed light on the high-z universe.. and next

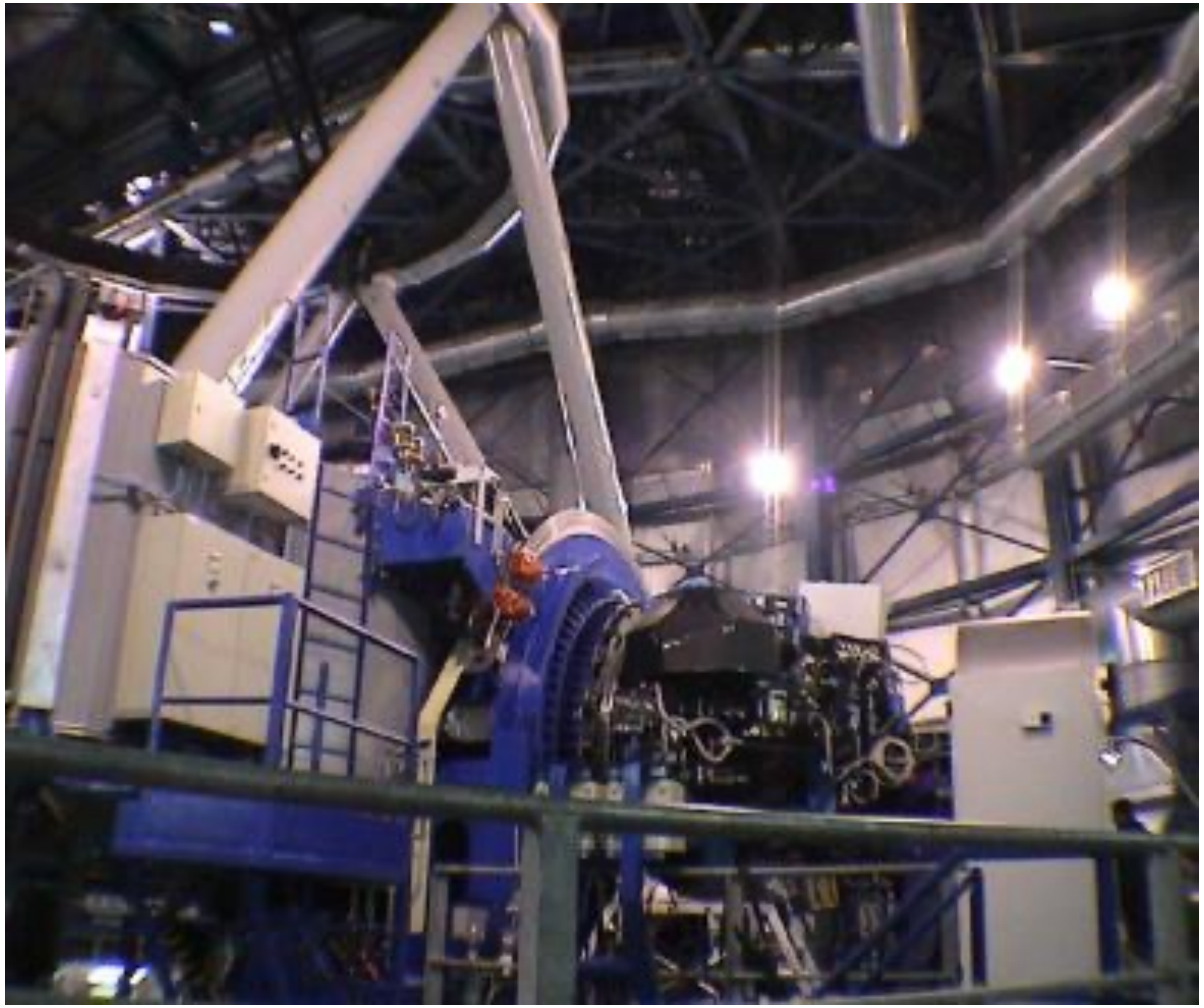
Lidia Tasca

LAM
LABORATOIRE D'ASTROPHYSIQUE
DE MARSEILLE



VUDS | VIMOS Ultra Deep Survey

A strange family…



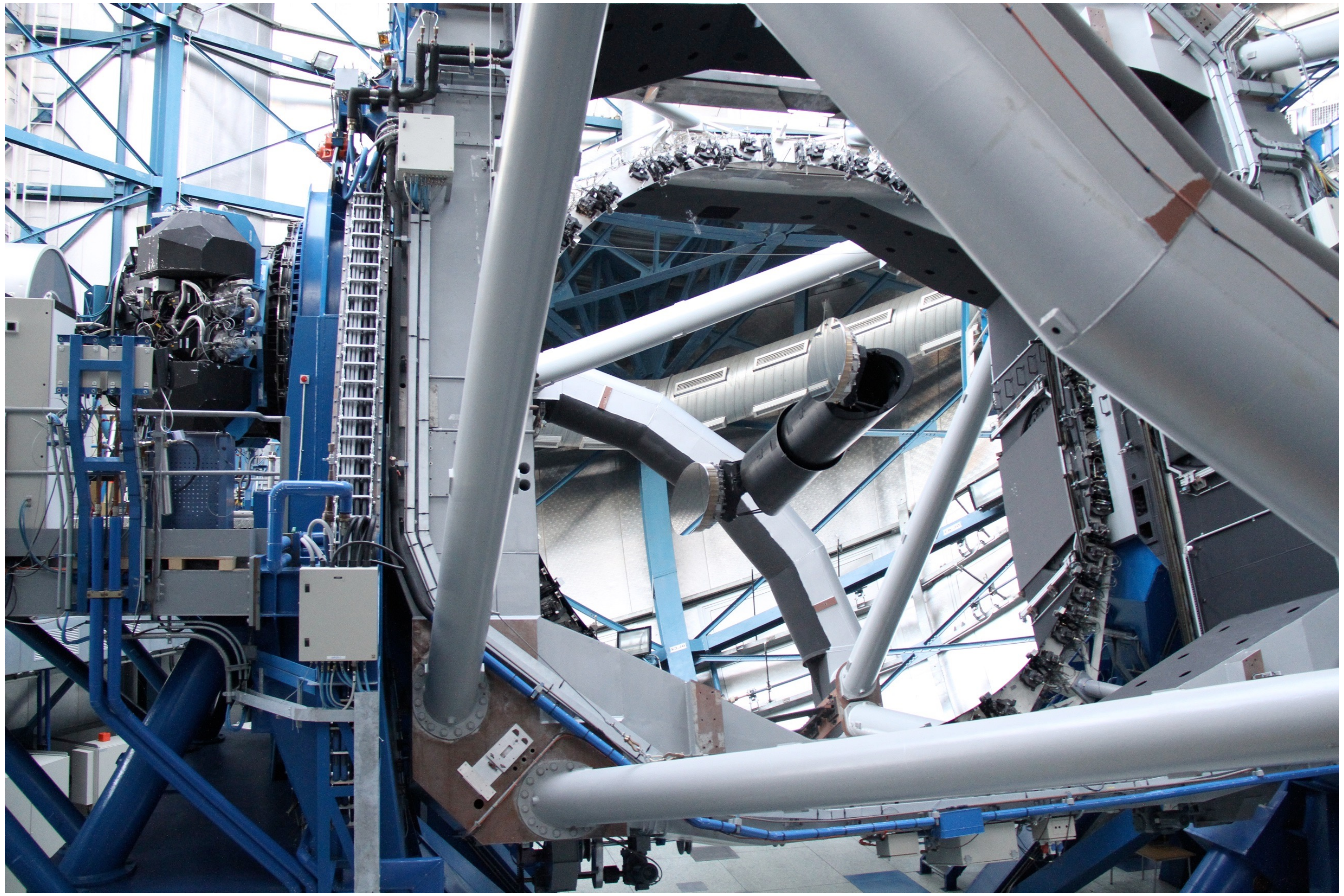

KM
12

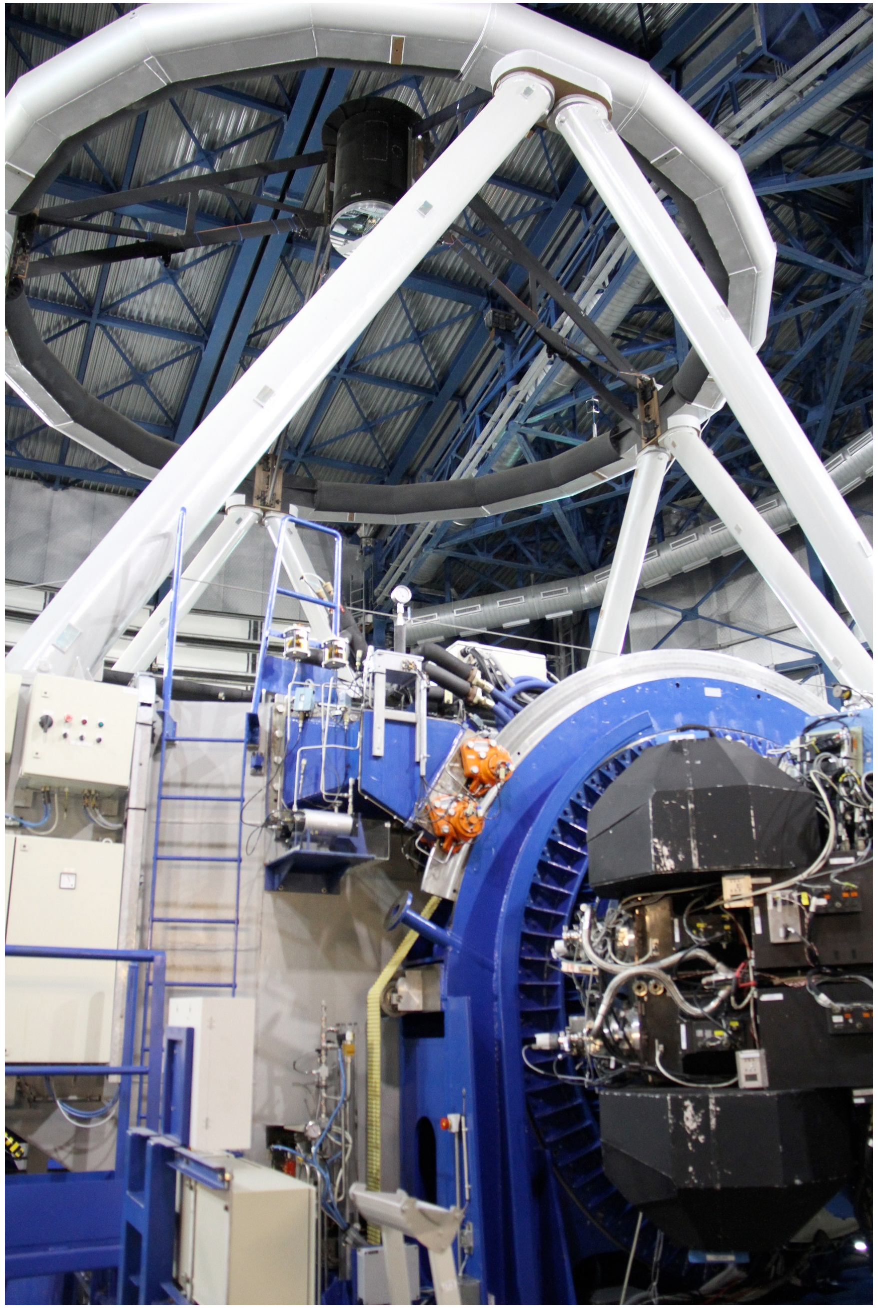


CELESTRON


DISCOVER
Maunakea And TMT
Quechua

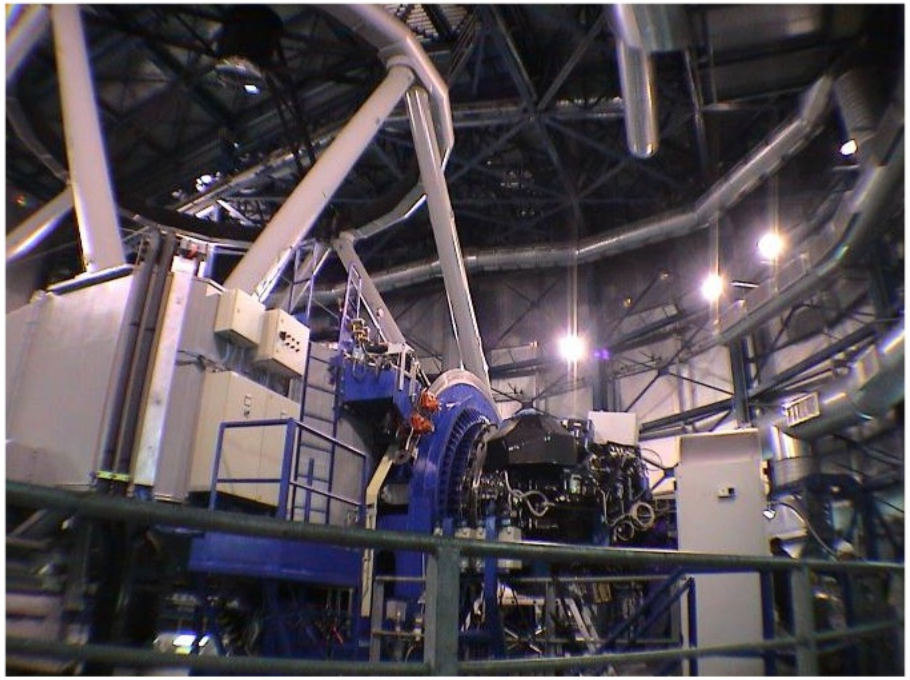
The VIMOS team in the MELIPAL control room, moments after "First Light" on February 26, 2002. From left to right: Oreste Caputi, Marco Scodeggio, Giovanni Sciarretta, Olivier Le Fevre, Sylvie Brau-Nogue, Christian Lucuix, Bianca Garilli, Markus Kissler-Patig, Xavier Reyes, Michel Saisse, Luc Arnold and Guido Mancini
Credit:ESO





Credit: Olivier Le Fevre. VANDELS observing run August 2017

VUDS: spectroscopic survey of the first phases of galaxies assembly



ESO Large Program, PI: Olivier Le Fèvre
640h allocated (~80 nights, clear)

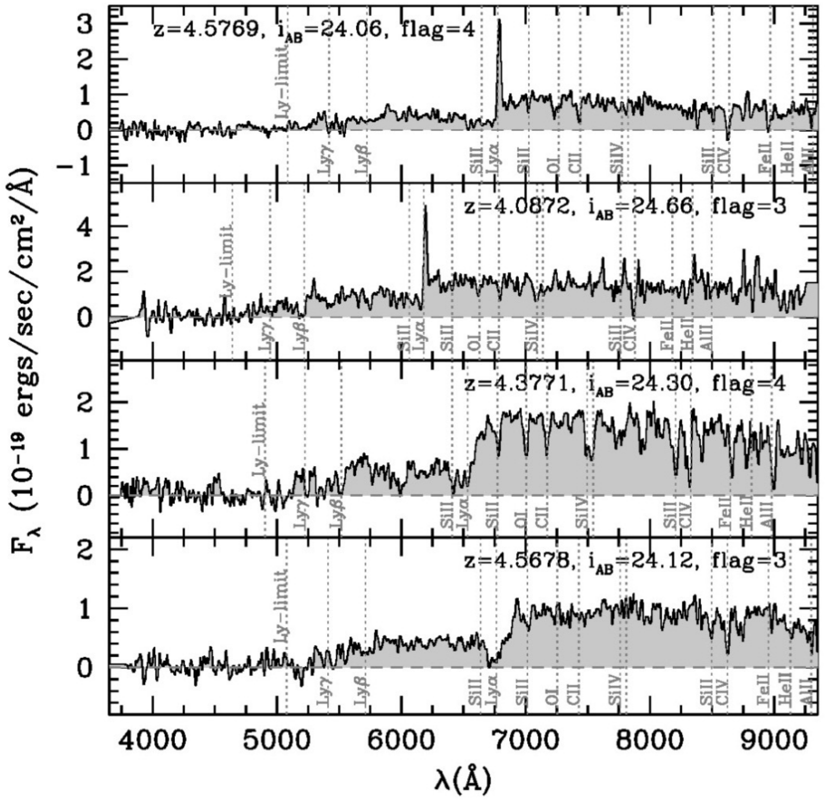
Understanding early galaxy assembly :

- 14h exp.time, 3600-9300Å
- 1 deg² in3 fields: COSMOS, ECDFS, VVDS2h
- Multi-wavelength imaging from u to IR bands
- Smart selection: photo-z and SED
- Largest spectroscopic survey in 2<z<6+

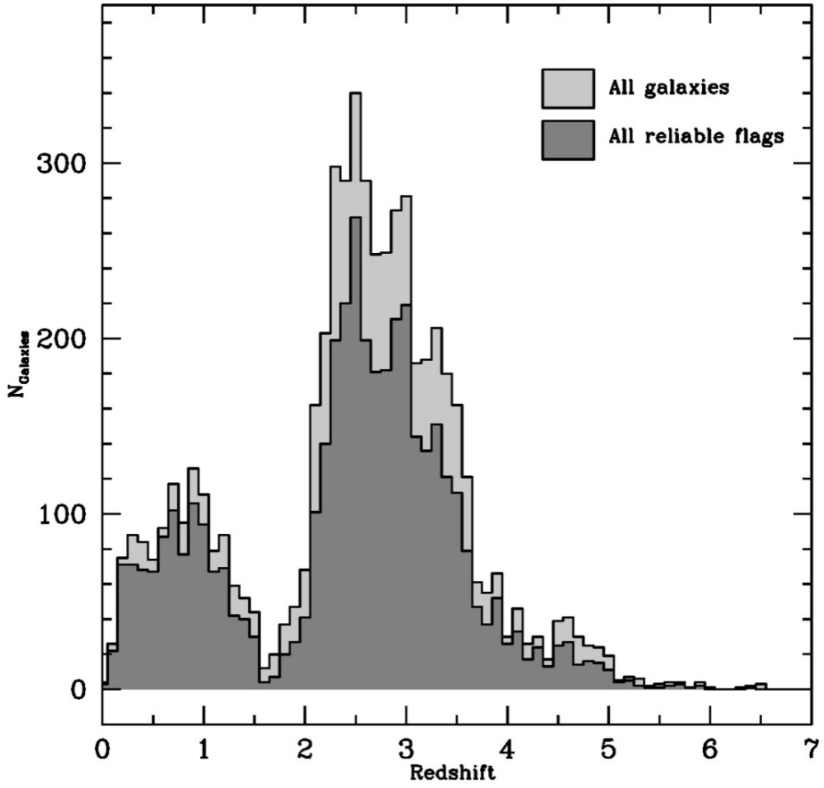
FIELD	VIMOS pointings	Area arcmin²
COSMOS	8	1800
ECDFS	2+1	675
VVDS-02	5	1125
TOTAL	**15+1**	**3600**

VUDS: spectroscopic survey of the first phases of galaxies assembly

Individual spectra $i_{AB} \leq 25$, a very faint sample



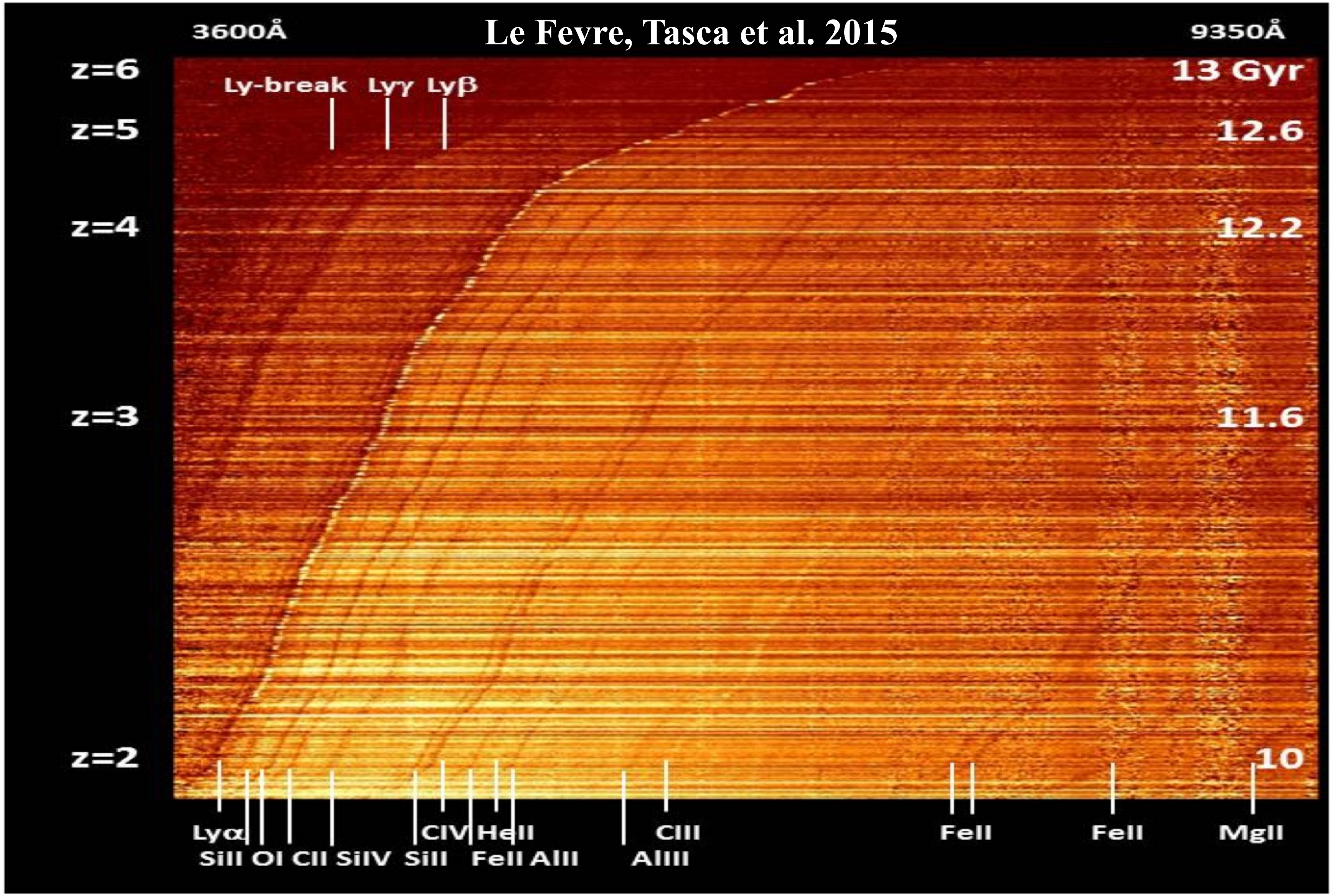
Le Fèvre, Tasca et al. 2015



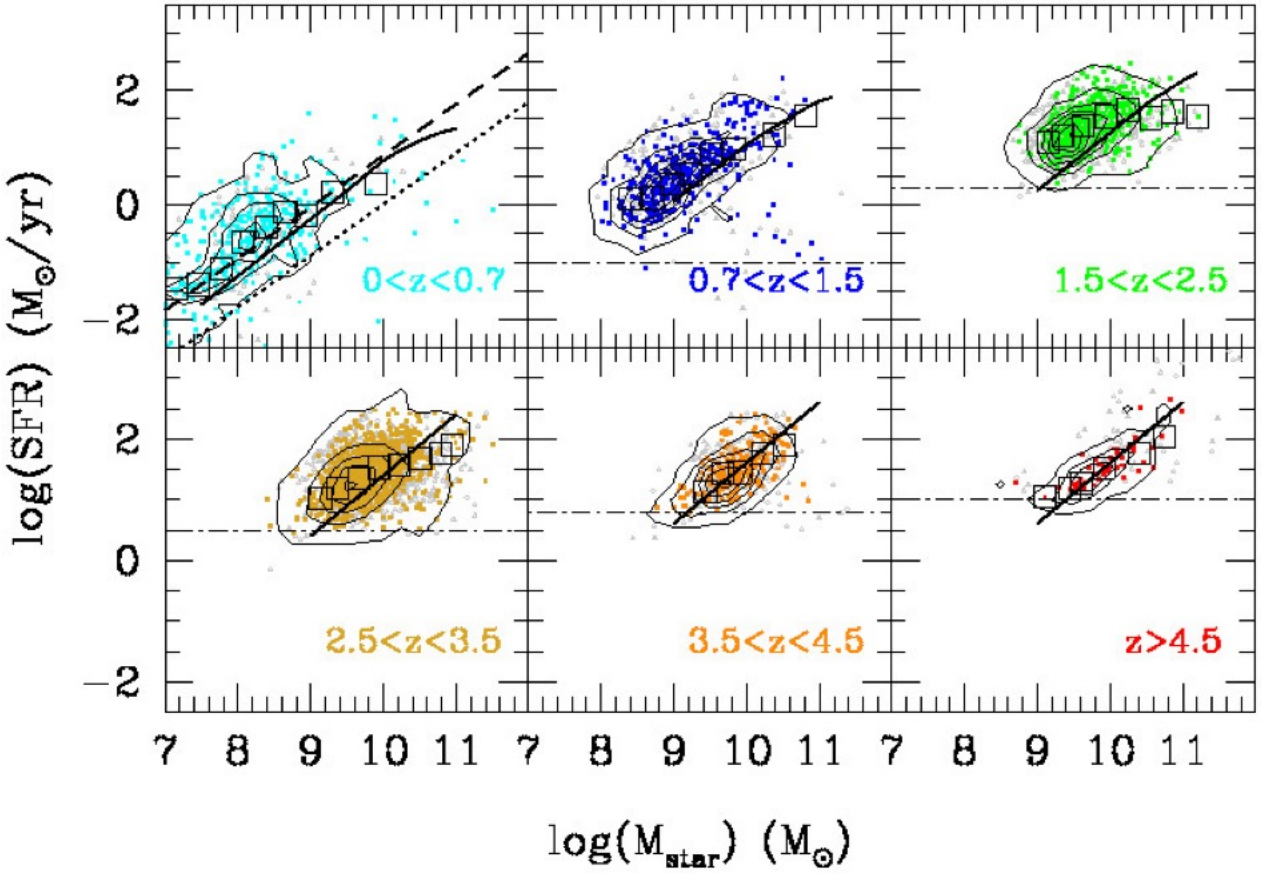
~10000 spectra to map the Universe 10-13 Gyr ago

The largest sample of UV-rest selected star-forming galaxies

VUDS ~7500 spectra of galaxies at z>2:~3Gyr of evolution in one glance



“Main Sequence” of SF galaxies up to z~5

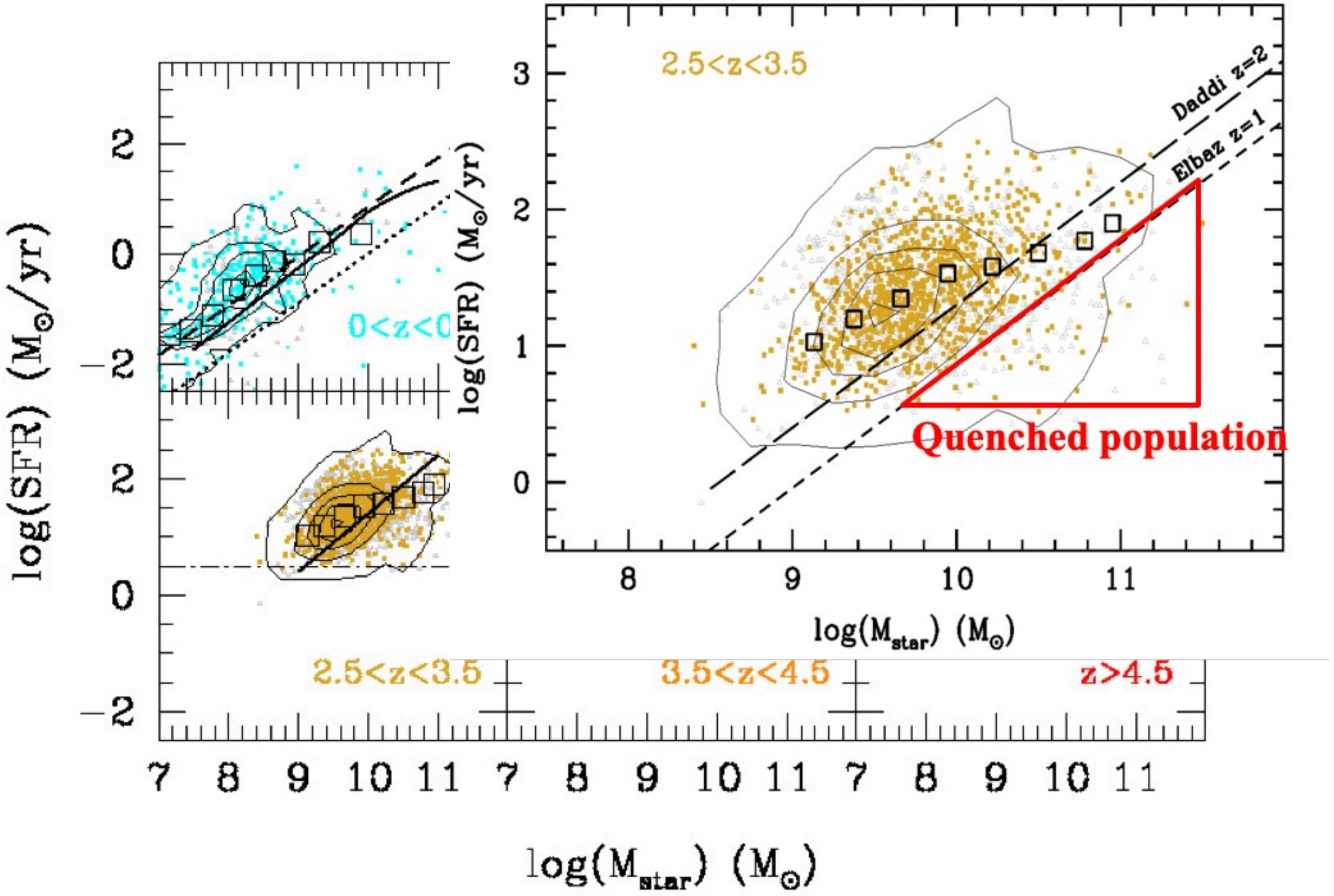


High-M turn-off at z<3.5.
→ effect of SF quenching in a downsizing pattern

Quenching processes not fully active at z>3.5

Tasca et al. 2015

"Main Sequence" of SF galaxies up to z~5



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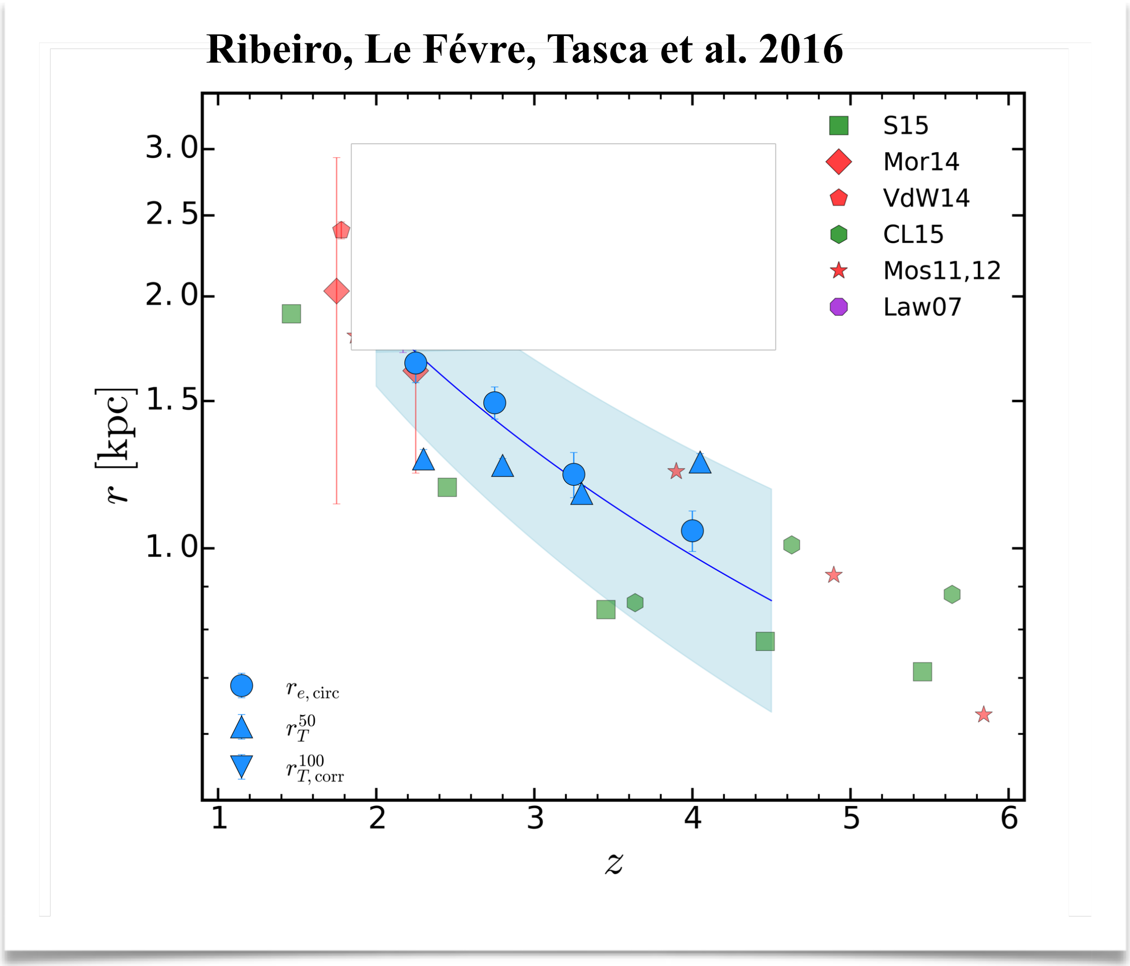
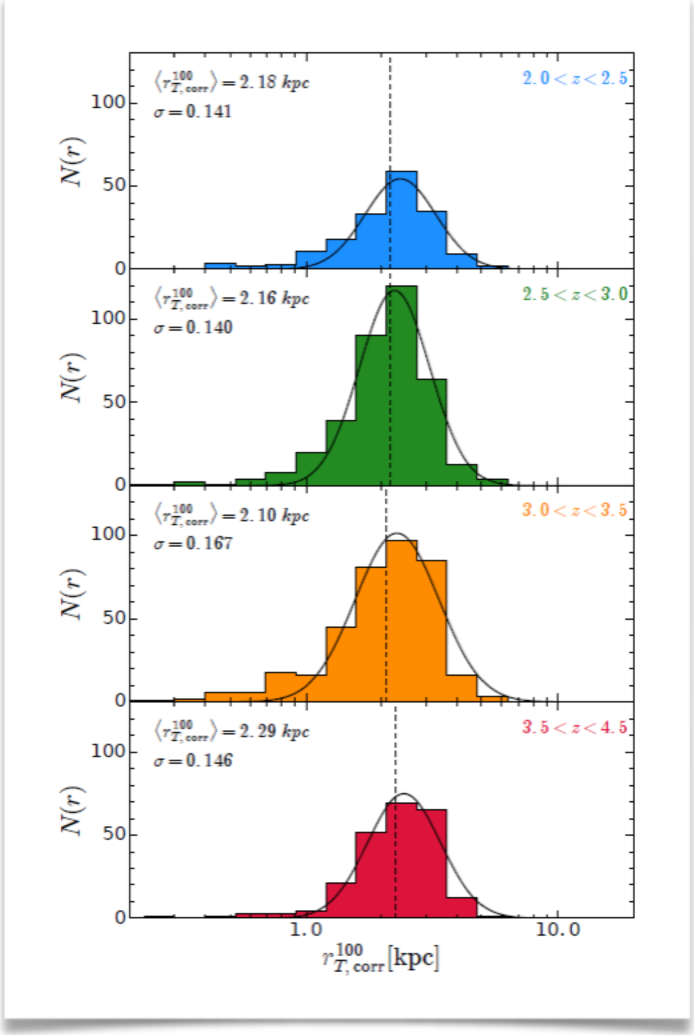
Tasca et al. 2015

Galaxies size evolution since z~4.5

Galaxies have roughly the same sizes across two billion years of active formation

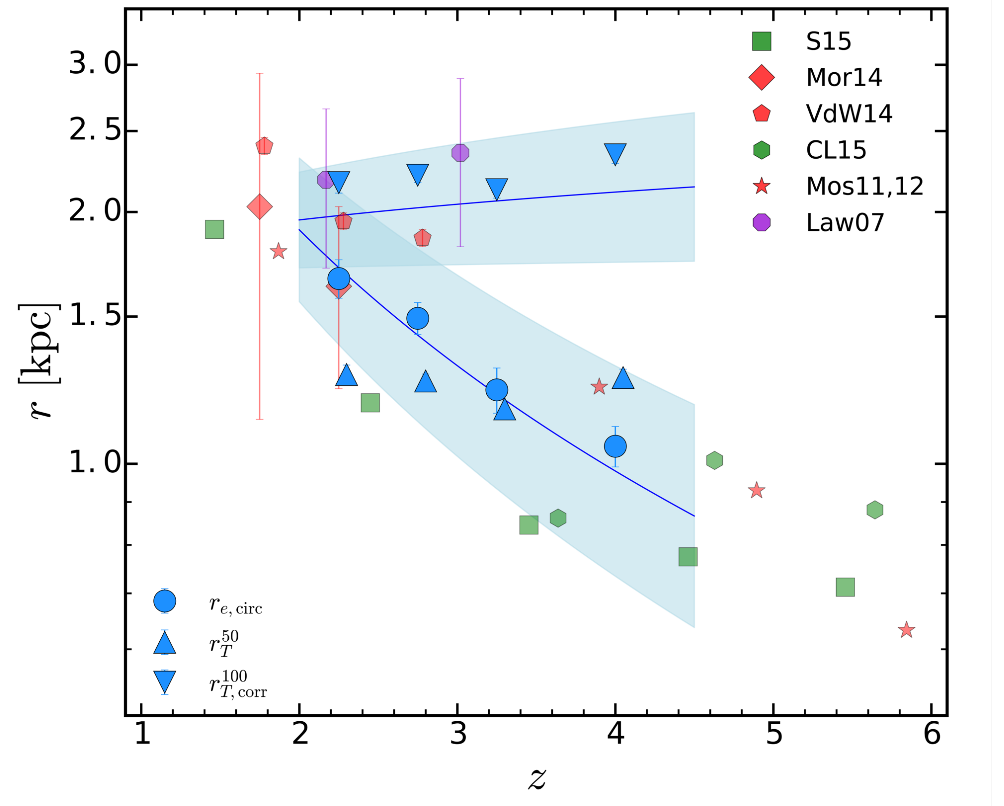


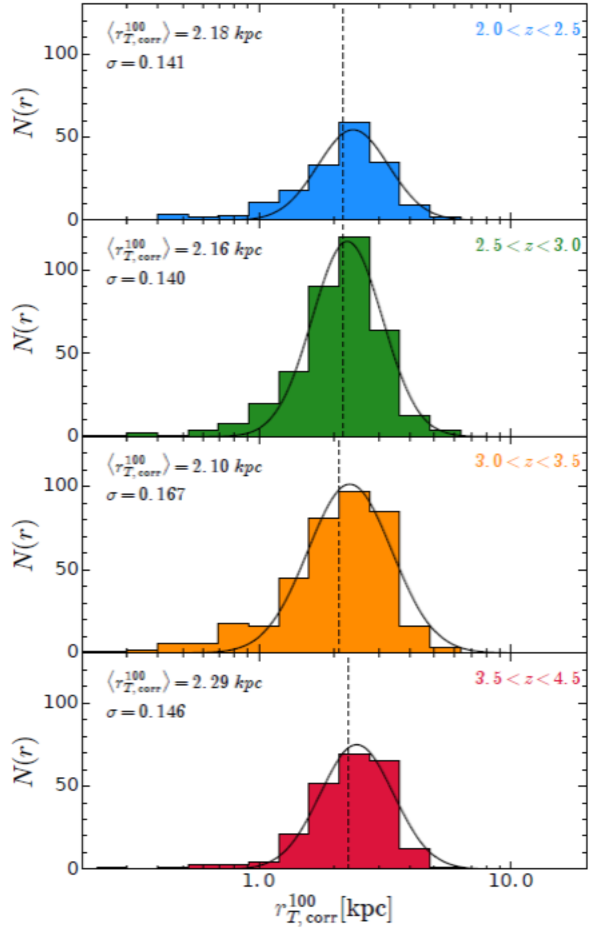


Galaxies size evolution since z~4.5

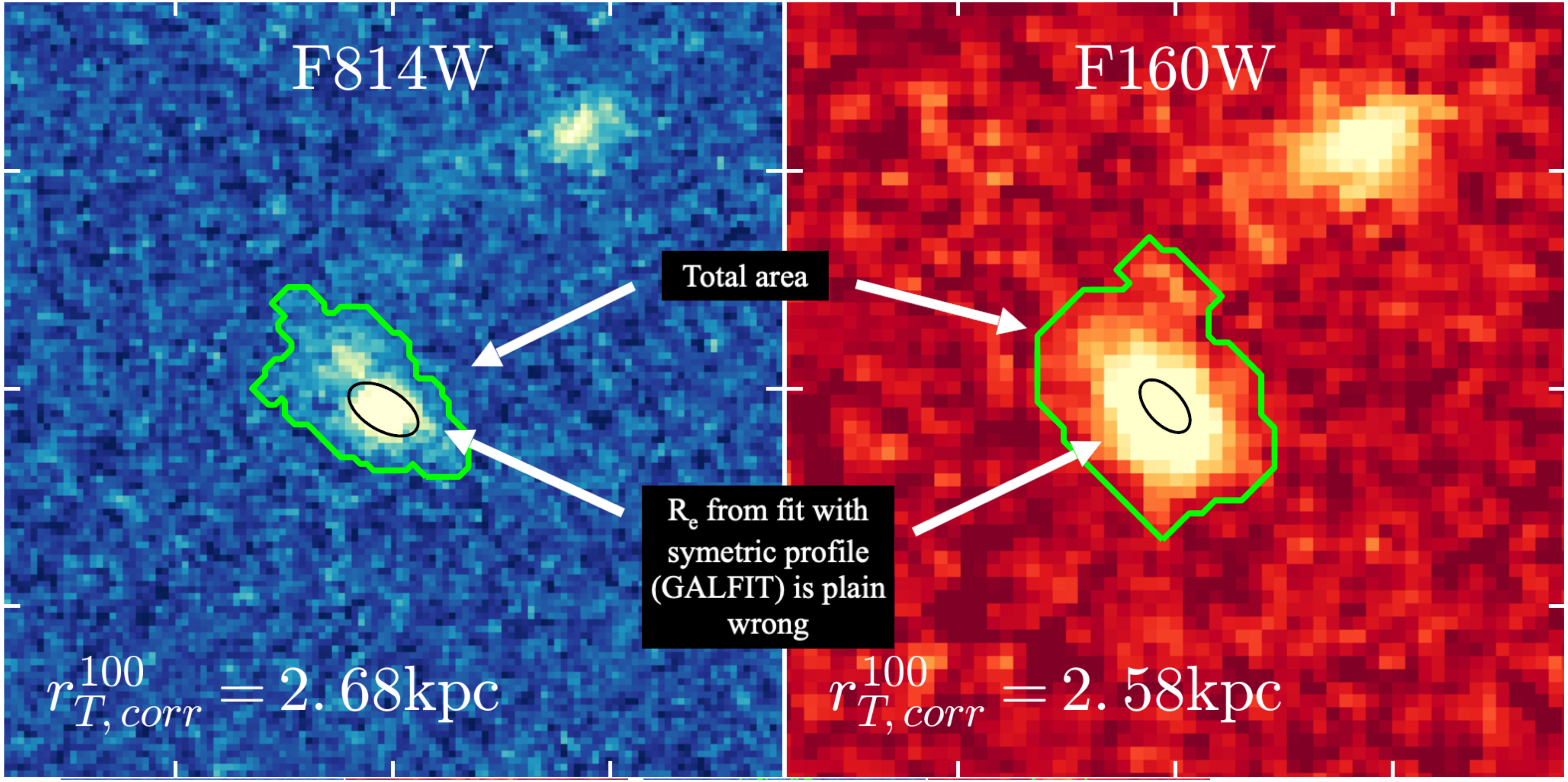
Galaxies have roughly the same sizes across two billion years of active formation

Ribeiro, Le Févre, Tasca et al. 2016





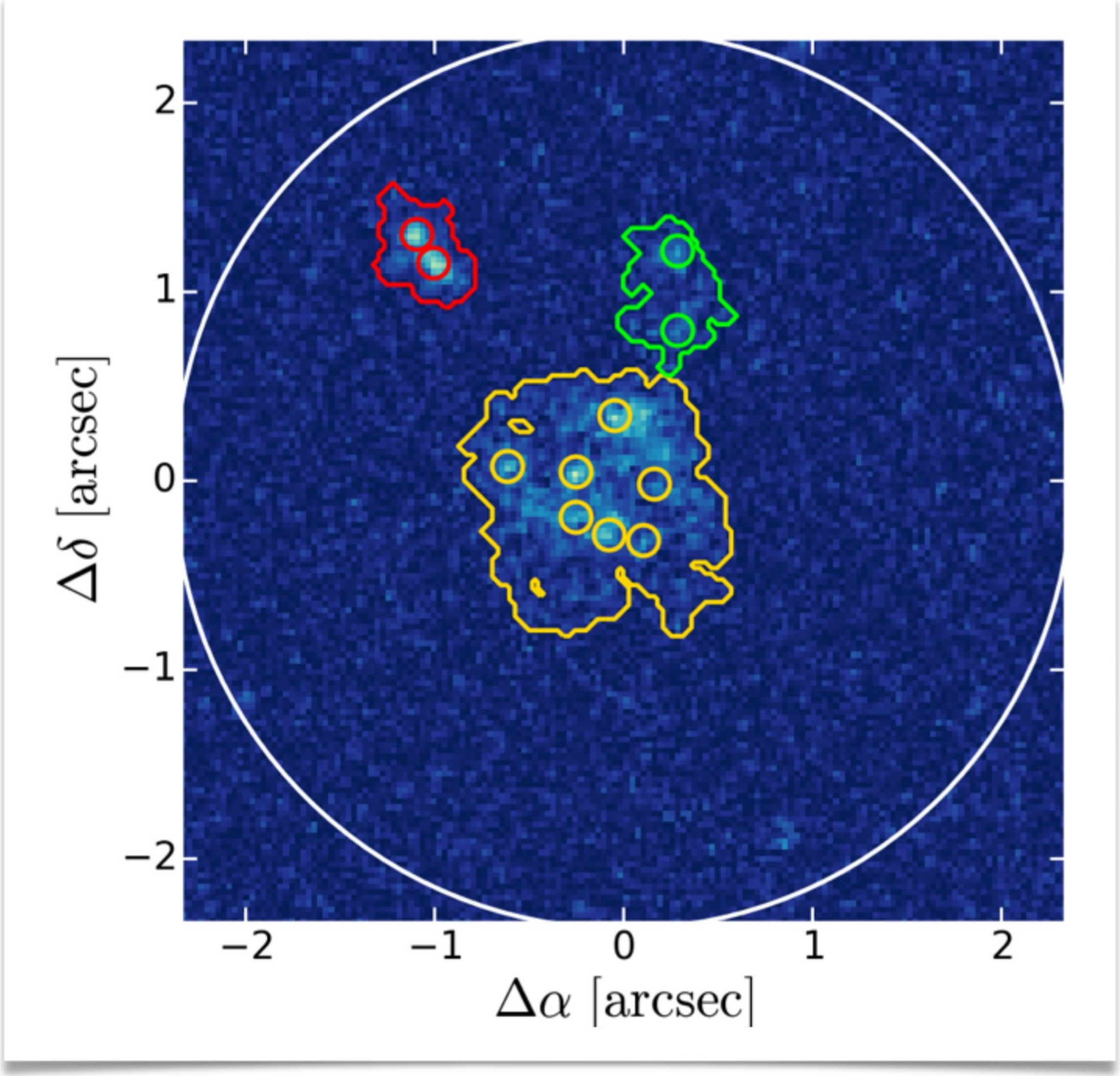
Size measurements



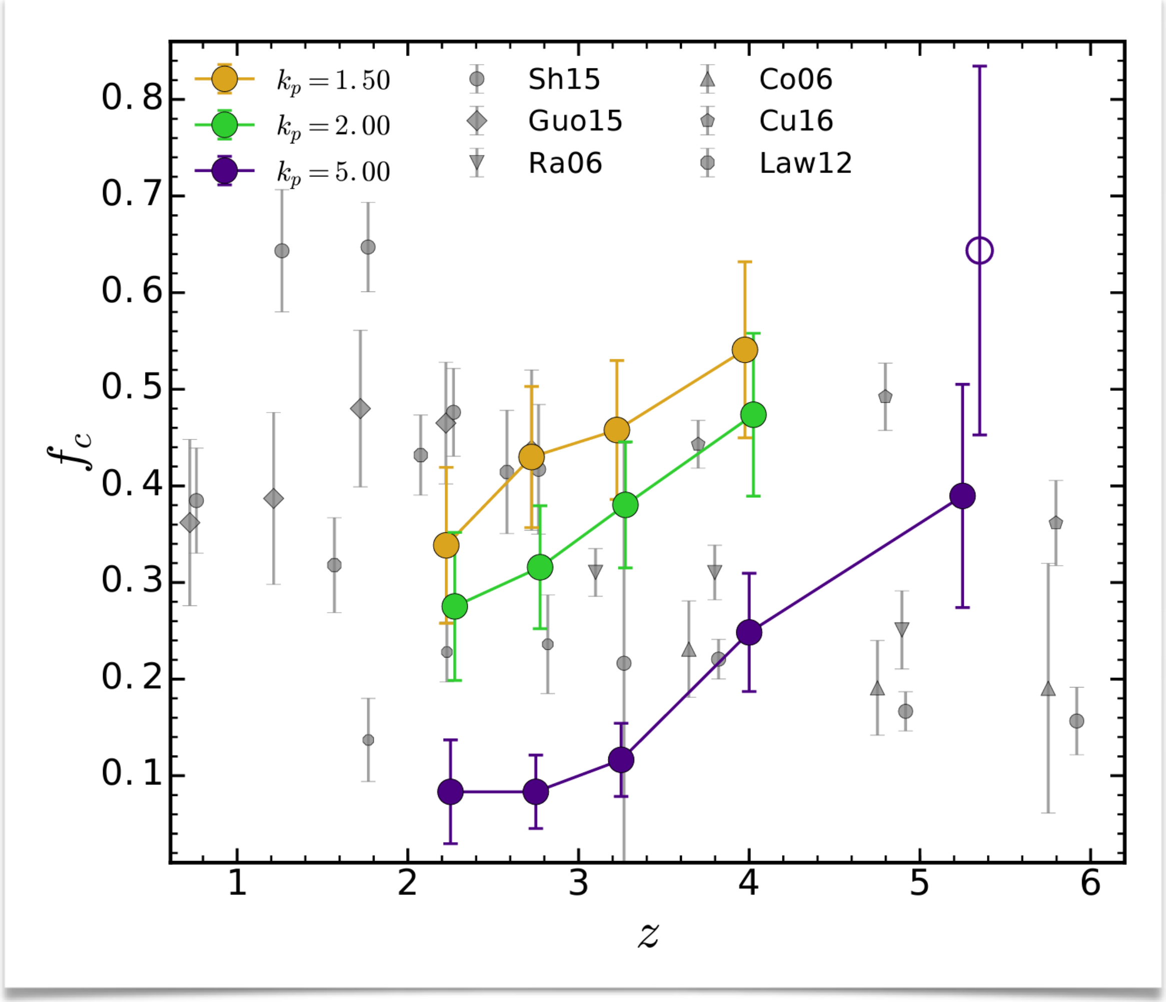
Clump detection

New method to detect clumps

Based on total extent
for search area



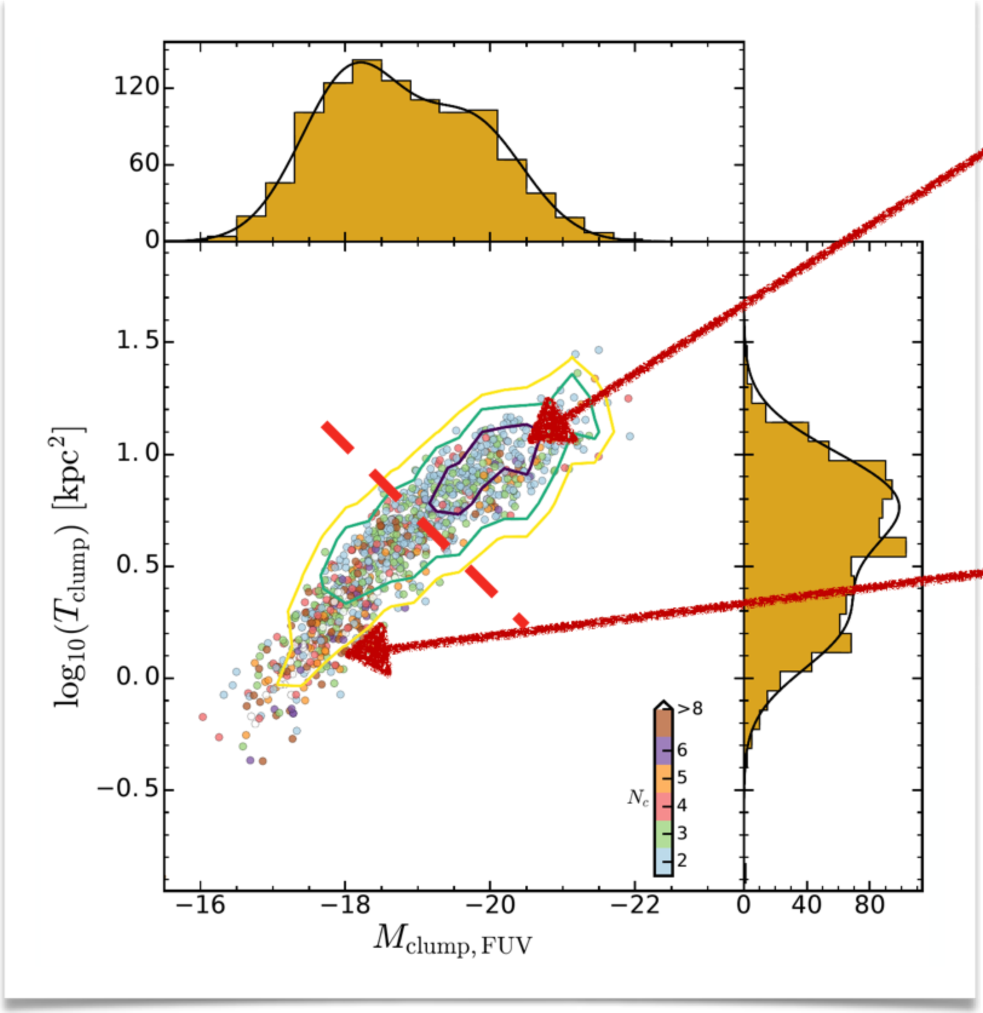
Clumpy fraction



Clumpy fraction rises with redshift

Ribeiro, Le Févre, et al. 2017

Clumps in galaxies: clues on the galaxy formation processes



Bright &large clumps are typically found in 2-clump systems

Major merger

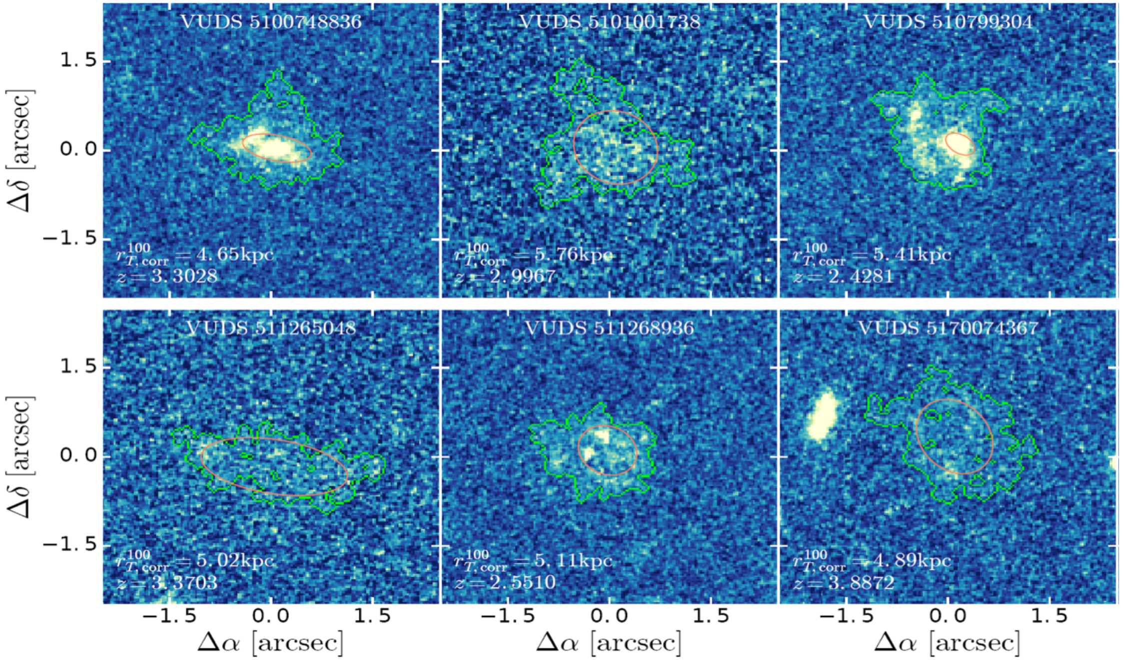
Small & faint clumps in higher multiplicity systems

Disk instability/ Minor merger

Ribeiro, Le Févre, et al. 2017

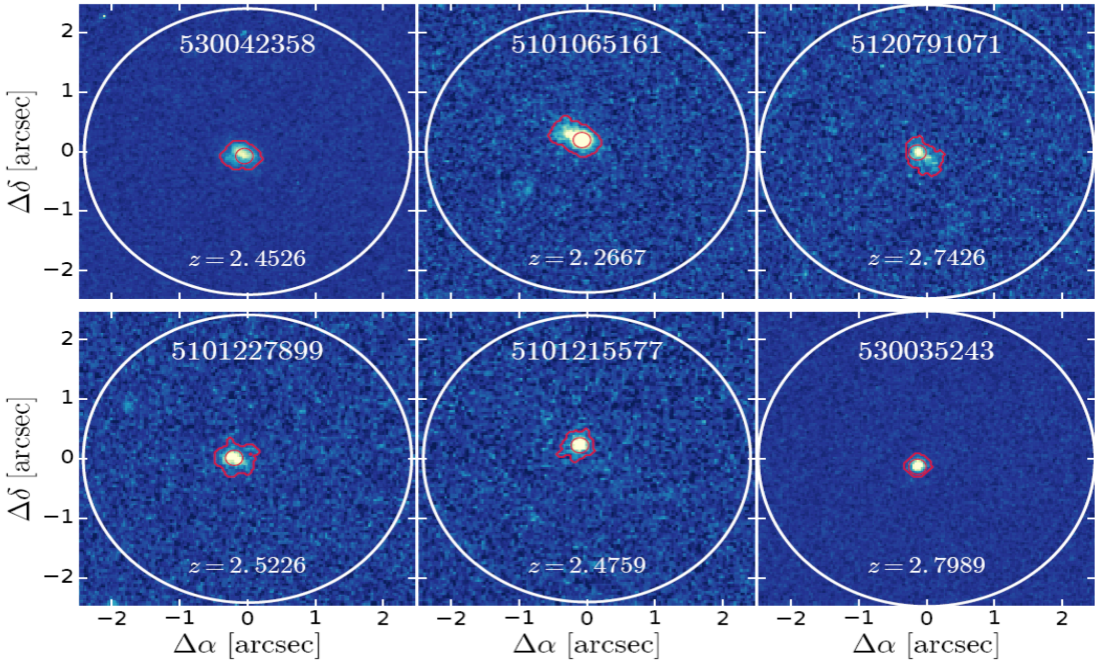
Galaxy's shapes at 2<z<5

Similar SFR & masses



Examples of the largest galaxies
Proto disks ?

Same formation process !?

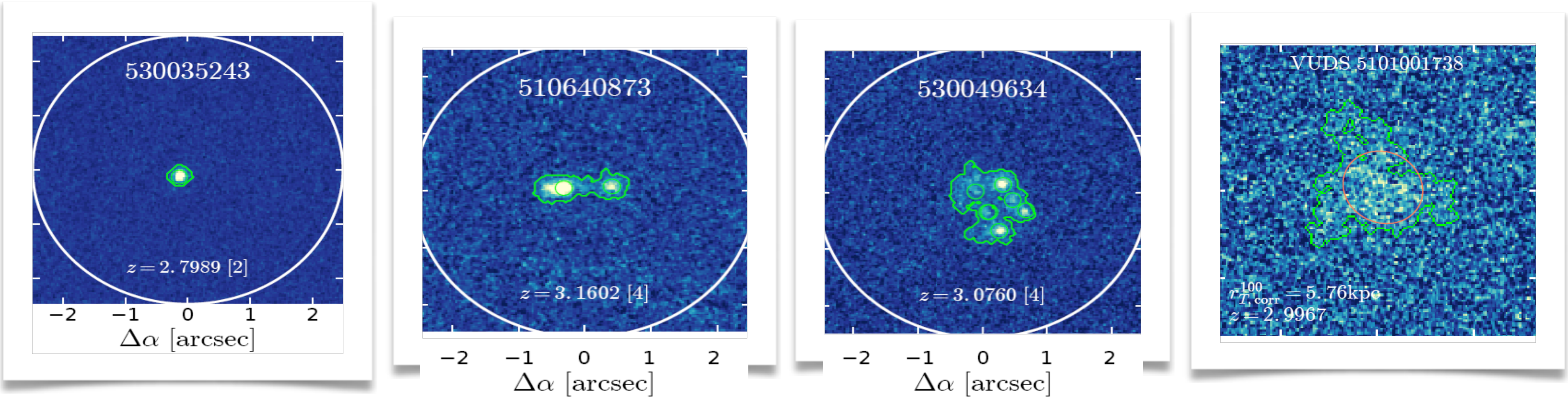


Examples of the smallest galaxies
Proto spheroids ?

Courtesy: O. Le Fevre

Elements for a galaxy formation scenario

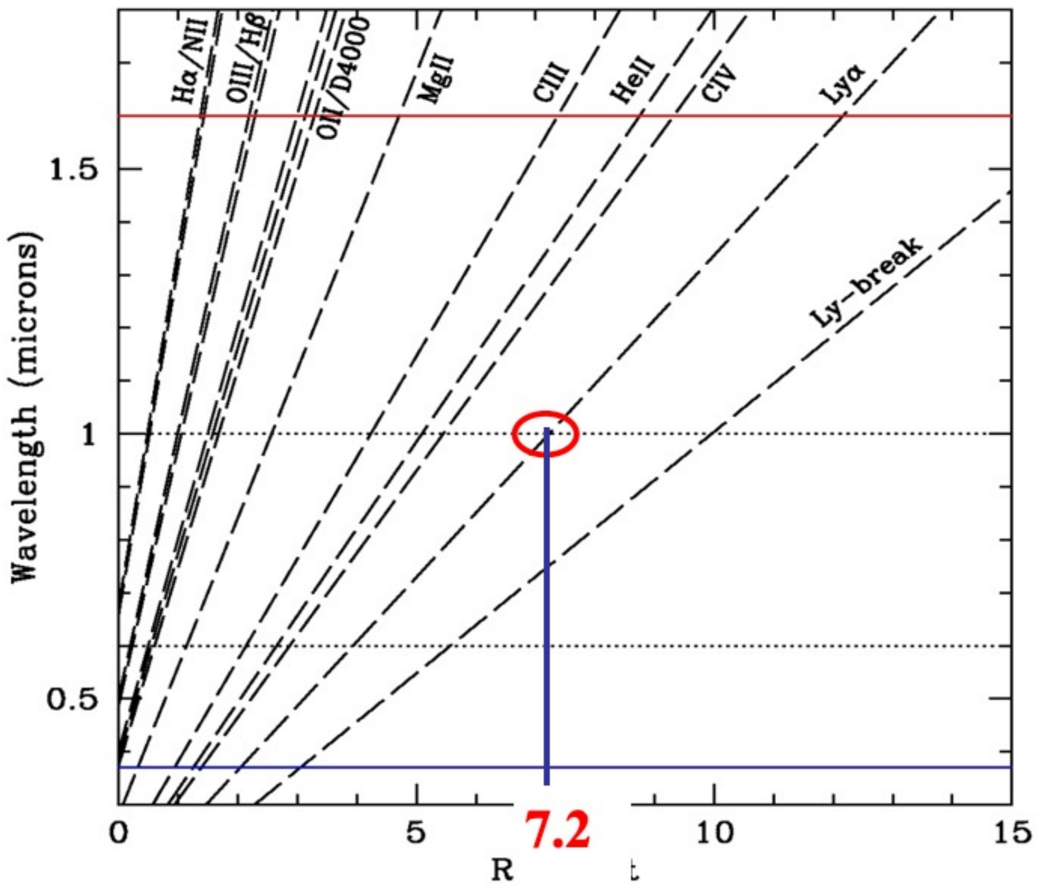
- The diversity of galaxy properties 0.2-2Gyr after the reionisation is striking
- There must be several different channels for forming galaxies
  - Track the progenitors of disks and spheroids
- Not simply a “Cold accretion along the cosmic web” picture with secular evolution
  - Catastrophic events: merging, quenching,…
  - Continuous processes: environment,…



Ultra-compact ≠ **major mergers** ≠ **disc formation** ≠ **massive LSB**

Courtesy: O. Le Fevre

NEXT: Breaking the z-frontier: with efficient NIR imaging and MOS



- Finally efficient MOS in NIR
  - ✓ MOSFIRE-Keck, KMOS-VLT, EMIR-GTC
  - ✓ Massive multiplex: PFS, MOONS
- Space missions: a quantum leap forward !
  - ✓ NIRSPEC-JWST: 2018 2021
  - ✓ EUCLID: 2020 2023
- EELT
  - ✓ Case for MOS in NIR: MOSAIC

Credit: Olivier Le Fevre. Bariloche, December 2017

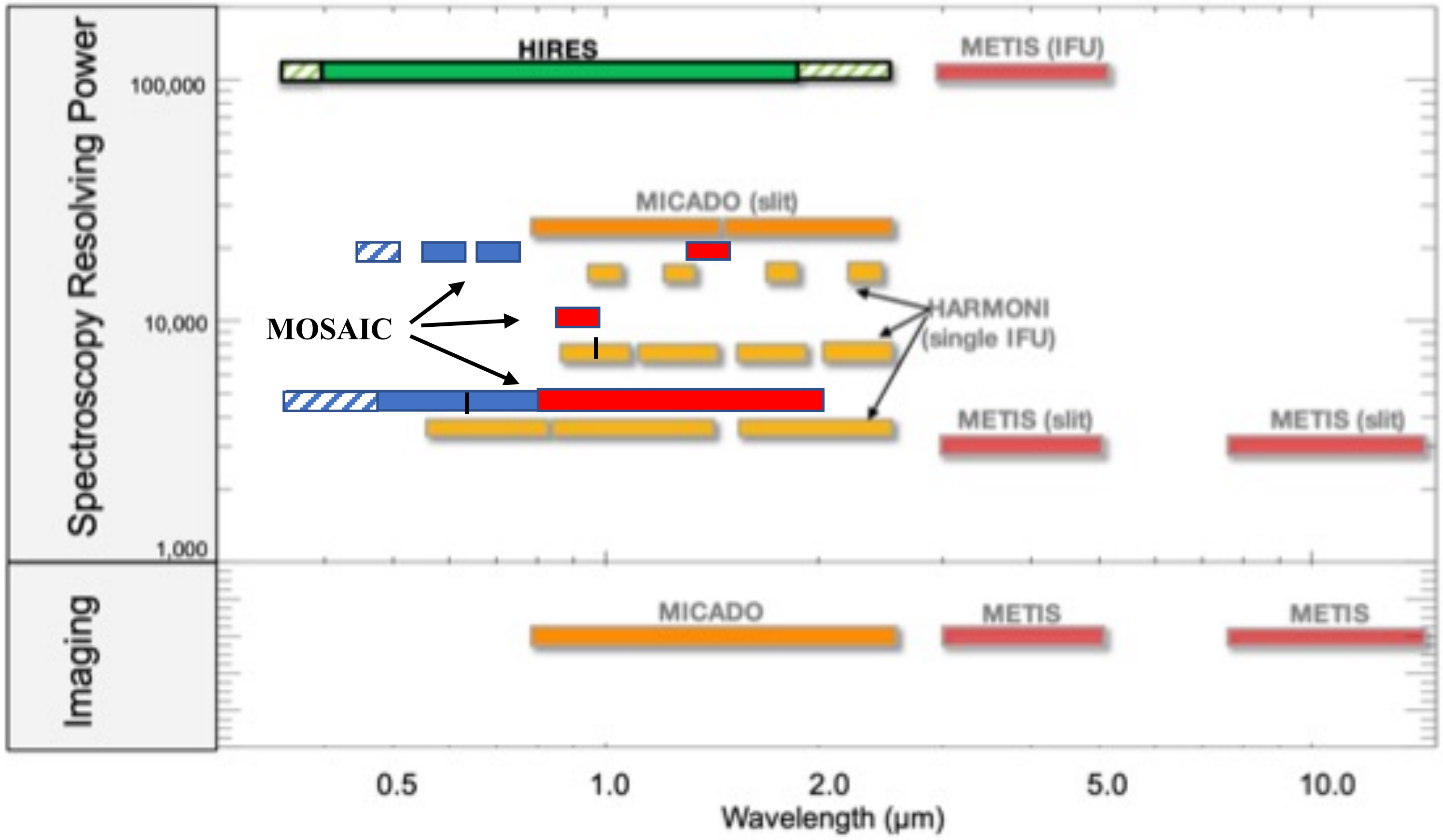
A new era

The ELT

Technical first light planned in 2027

Why a MOS on the ELT?

- Many key science cases for ELT require a significant multiplex in optical and near-IR
- MOSAIC provides spectroscopy at optical wavelengths



ESO programmatic / strategic requirements:

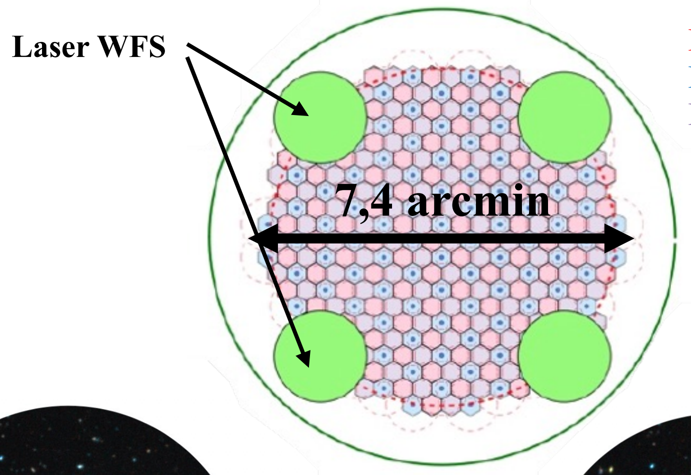
- Survey speed: high multiplex & wavelength coverage
- VIS coverage at range of R
- Operational in all seeing conditions

MOSAIC

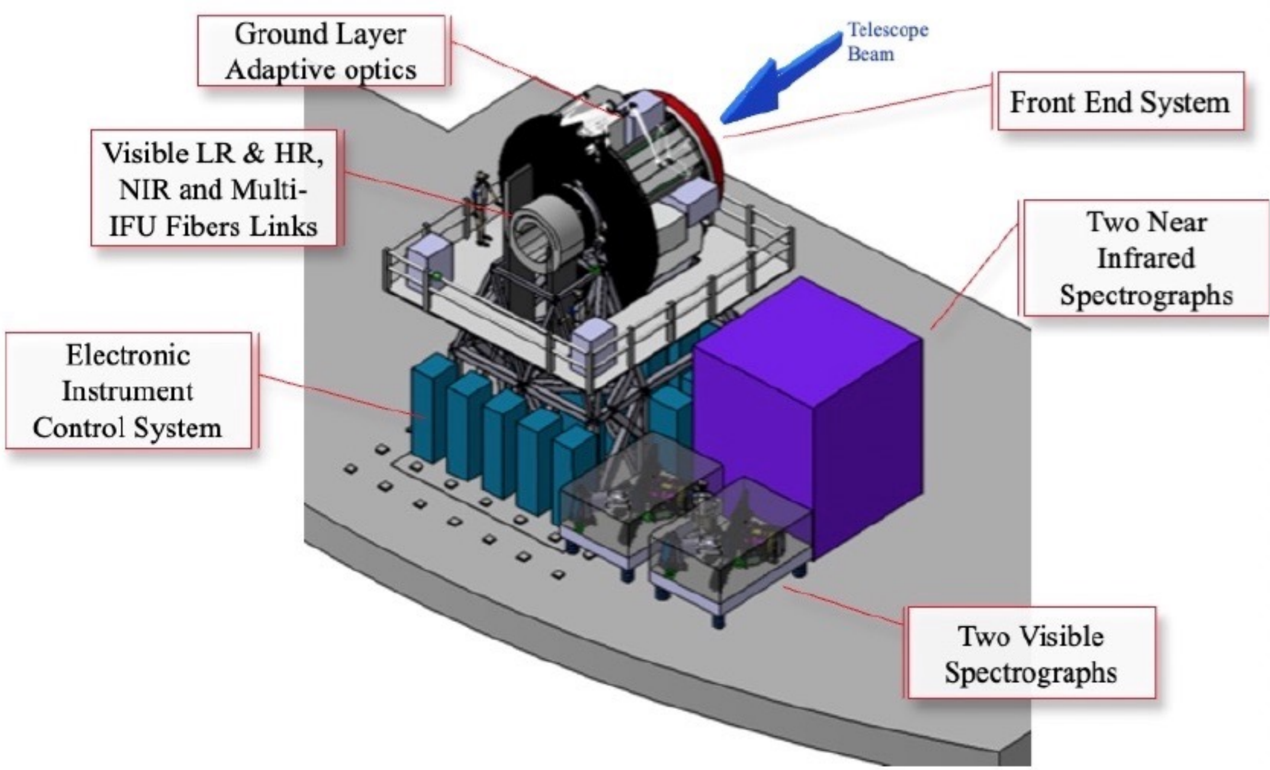
Objective

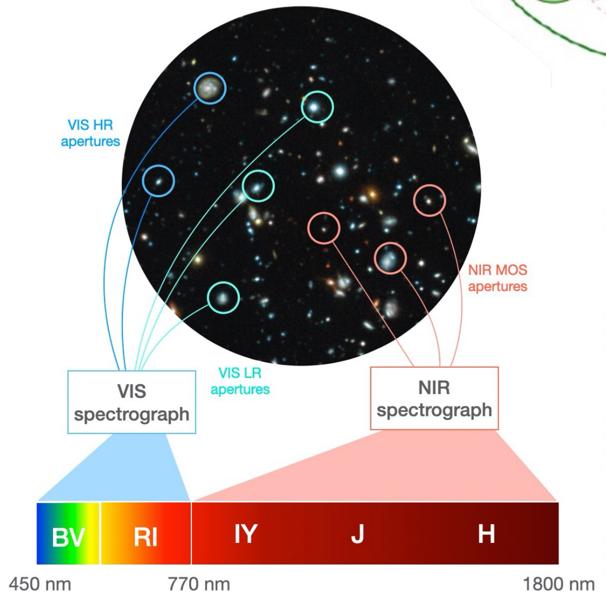
To provide the scientific community with a workhorse instrument providing comprehensive follow-up of ground-based and space-borne imaging data & allowing to tackle some of the key scientific drivers of the ELT project, ranging from studies of stellar populations out to the highest-redshift galaxies.

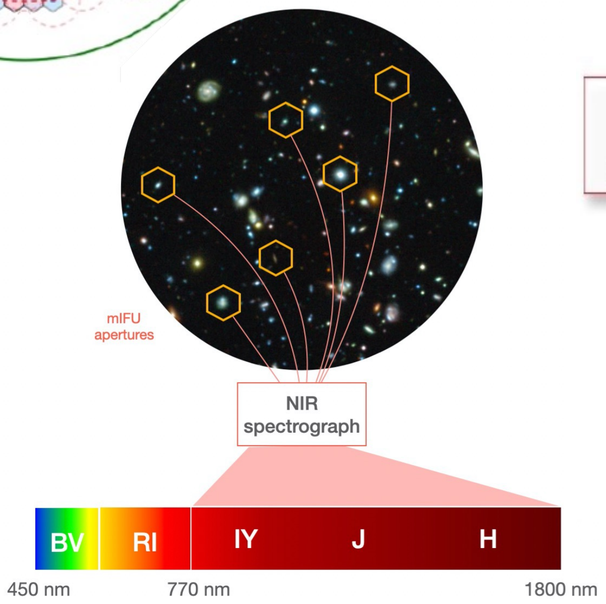
MOSAIC



Red tiles: ≈ 100 NIR
Blue-dotted tiles: ≈ 100 VIS + VIS_HR
Purples tiles: ≈ 100 VIS + NIR

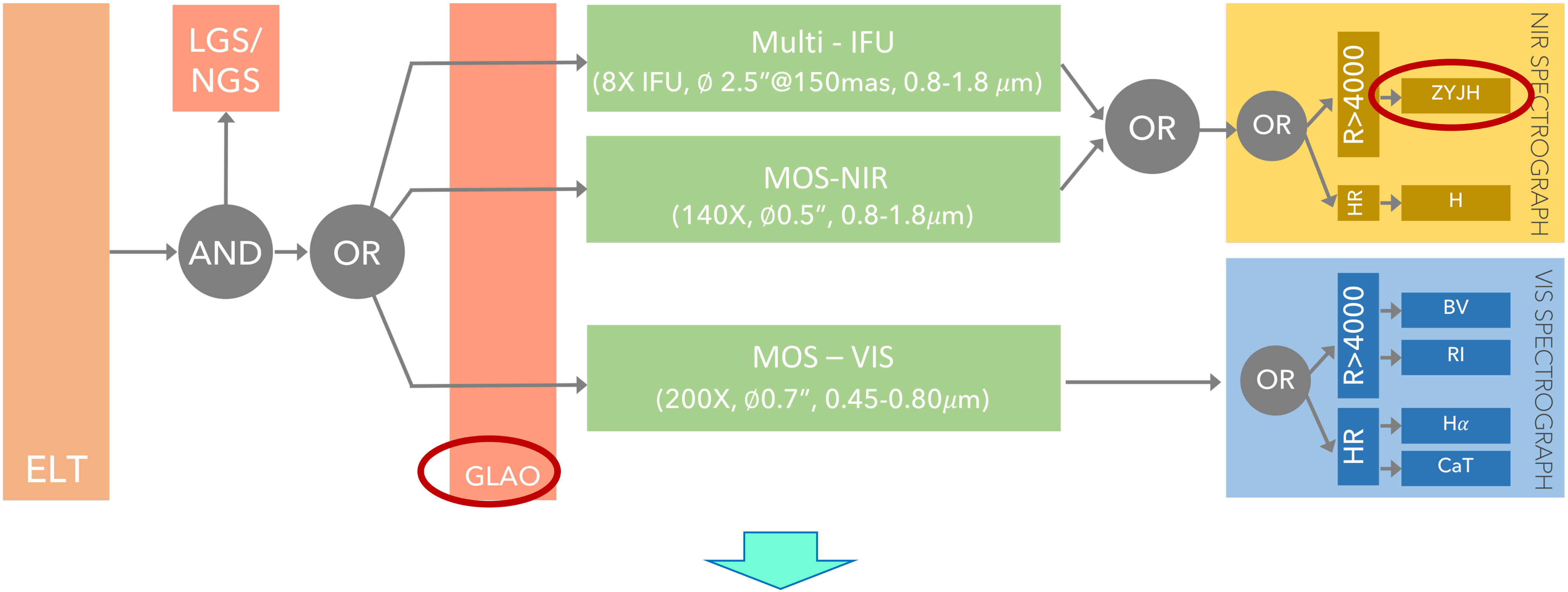






Parallel observations between VIS and NIR

Extremely modular architecture



Reached consensus about the MOSAIC concept
3 different observing modes (MOS_NIR, MOS-VIS, IFU-NIR)

Observing capabilities

MOSAIC

REQUIREMENTS

PARAMETER	MOS-VIS		MOS-NIR		mIFU	
	LR	HR	LR	HR	LR	HR
Multiplex	200	70	140	140	8	8
Wavelength coverage	0.45-0.77μm	0.51-0.57μm 0.61-0.67μm	0.77-1.80μm	0.77-0.89μm 1.52-1.62μm	0.77-1.80μm	0.77-0.89μm 1.52-1.62μm
Resolution	4000	18,000 18,000	4000	9000 18,000	4000	9000 18,000
Aperture	0.7″	0.7″	0.6″	0.6″	2.5″	2.5″
Spaxel	N/A	N/A	N/A	N/A	0.150″	0.150″

NOTE: In the VIS the full wavelength range is covered in 2 exposures (cf 1 exposure in the NIR).

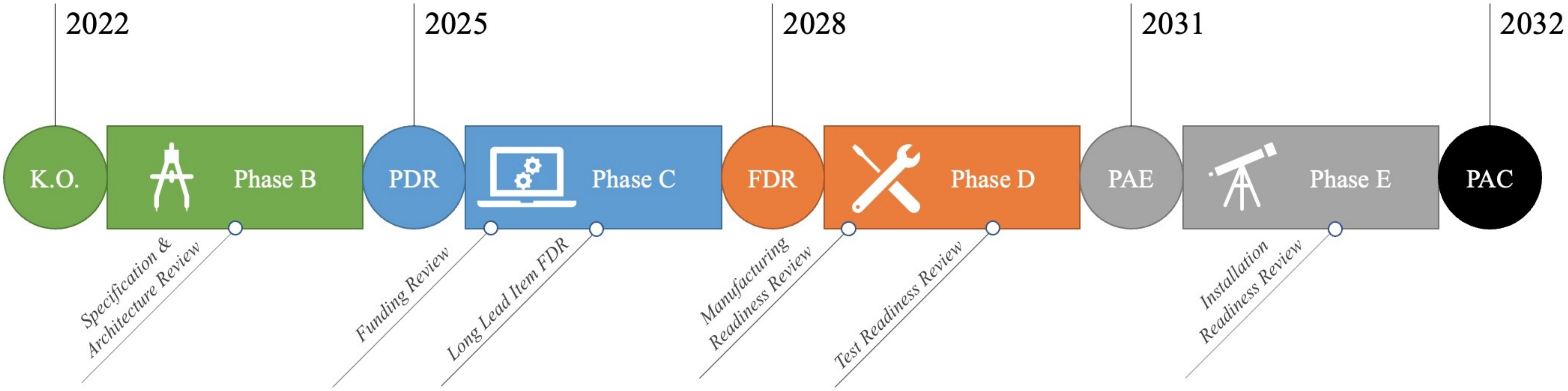
Observing capabilities

GOALS

PARAMETER	MOS-VIS		MOS-NIR		mIFU	
	LR	HR	LR	HR	LR	HR
Multiplex	200	100	200	200	10	10
Wavelength coverage	0.39-0.87μm	0.39-0.44μm 0.51-0.57μm 0.61-0.67μm 0.83-0.87μm	0.77-1.80μm	0.76-0.90μm 1.52-1.63μm	0.77-1.80μm	0.76-0.90μm 1.52-1.63μm
Resolution	5000	20,000 20,000	5000	10,000 23,000	5000	10,000 23,000
Aperture	0.9″	0.9″	0.6″	0.6″	4″	4″
Spaxel	N/A	N/A	N/A	N/A	0.120″	0.120″

NOTE: In the VIS the full wavelength range is covered in 3 exposures (cf 1 exposure in the NIR).

MOSAIC Timeline



MOSAIC Consortium

mosaic.all@lam.fr

The Consortium is made of 14 Partners countries responsible for the hardware development &/or contributing with funds:

- 12 countries: France, UK, Netherlands, Germany, Austria, Brazil, Finland, Italy, Portugal, Spain, Switzerland & Sweden
- University of Michigan
- Space Telescope Science Institute

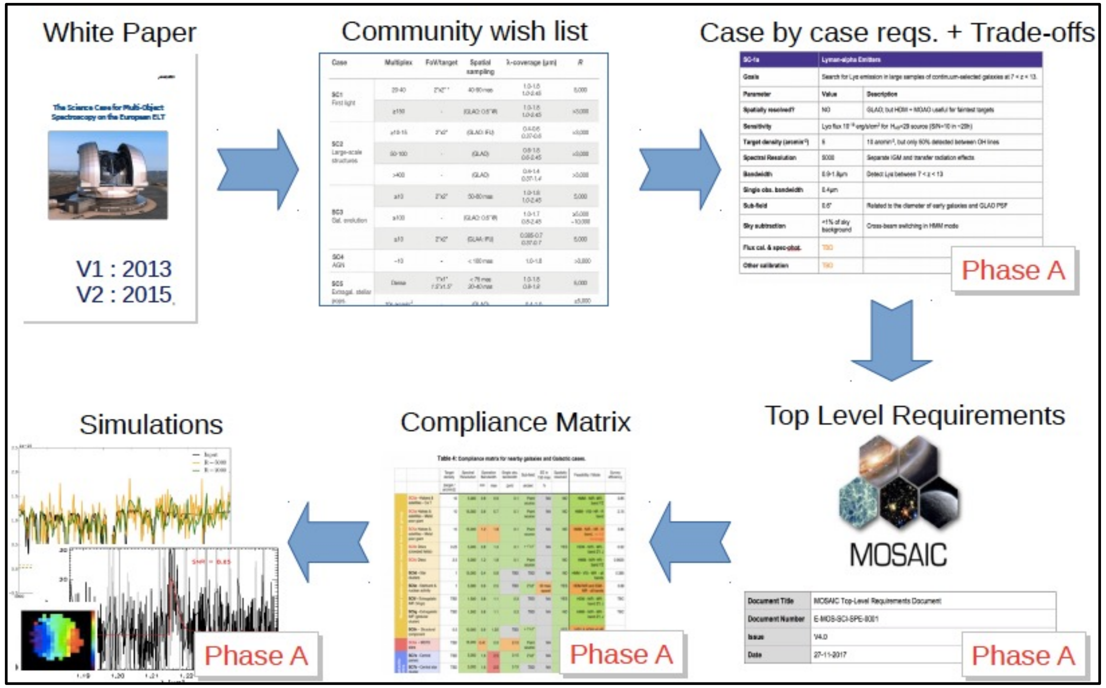
- The consortium is responsible for raising the complete construction and commissioning funding of the instrument, including contingencies and functioning costs

- 65 nights of GTO for FTEs
- TBD nights of GTO for HW

MOSAIC science drivers

Six dimensioning science cases:

- ✾ **SC1**. First light galaxies & reionisation
- ✾ **SC2**. Inventory of matter
- ✾ **SC3**. Mass assembly of galaxies through cosmic time
- ✾ **SC4**. Resolved stellar population beyond the Local Group
- ✾ **SC5**. Galaxy archeology
- ✾ **SC6. Transients (NEW)**



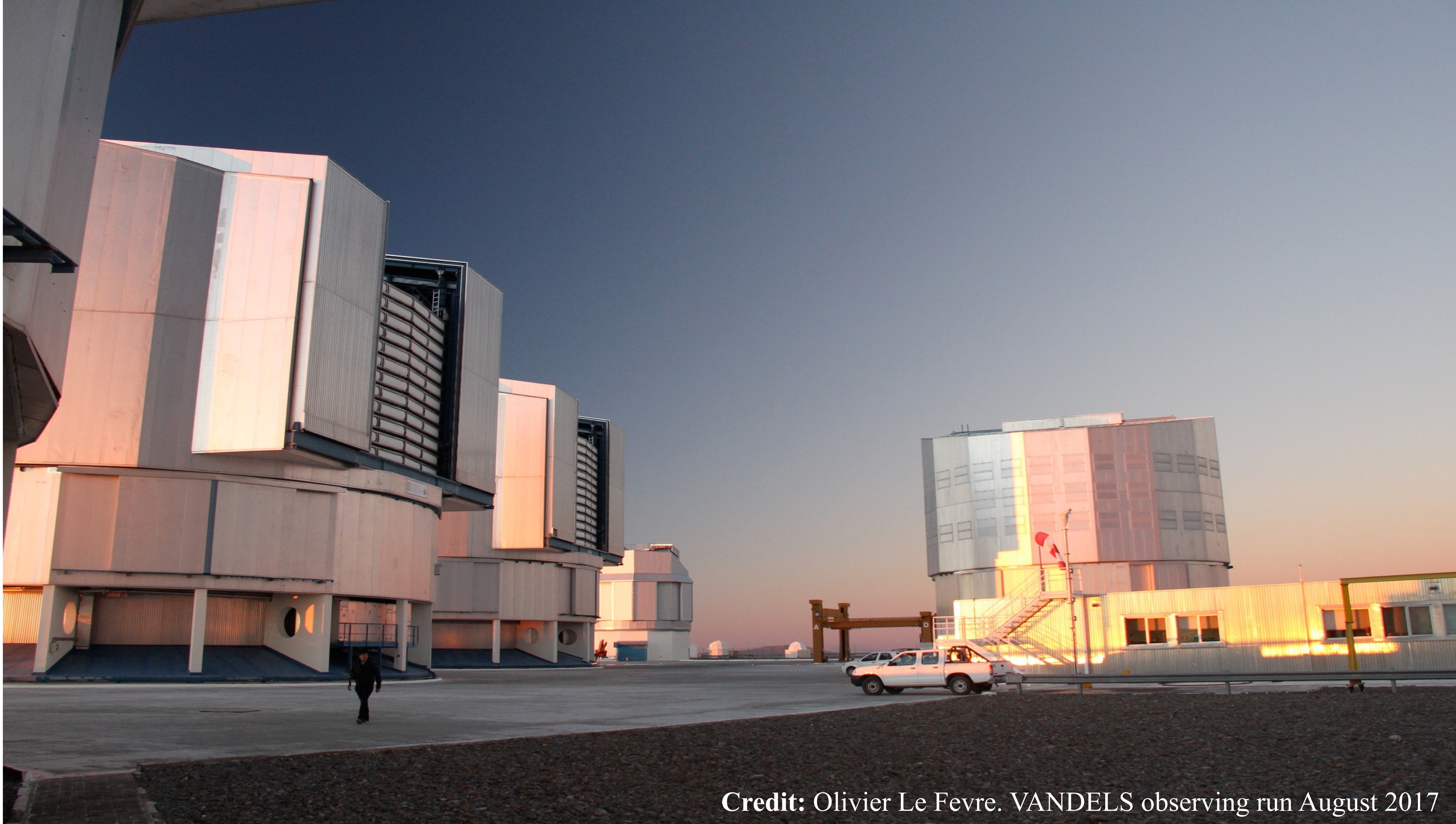
Individual SC: 2 white papers (Evans & Puech Eds.13, 15)
Potential Surveys: SPIE papers (incl. Puech+18)

Take home message

- The new MOSAIC concept defines an unique MOS with competitive performances.

- Compared to other instruments on the ELTs, MOSAIC stands out as an efficient spectrograph, providing **highly competitive survey speeds & unique observing modes** (MOS, multi-IFU).
- **Highly complementary** to other ELT instruments
- **Combination of JWST and MOSAIC** is the ultimate tool for studies of high redshift galaxies and of the history of cosmic reionisation.

- Opens large discovery space for any SC where **statistics** play a key role.



Credit: Olivier Le Fevre. VANDELS observing run August 2017

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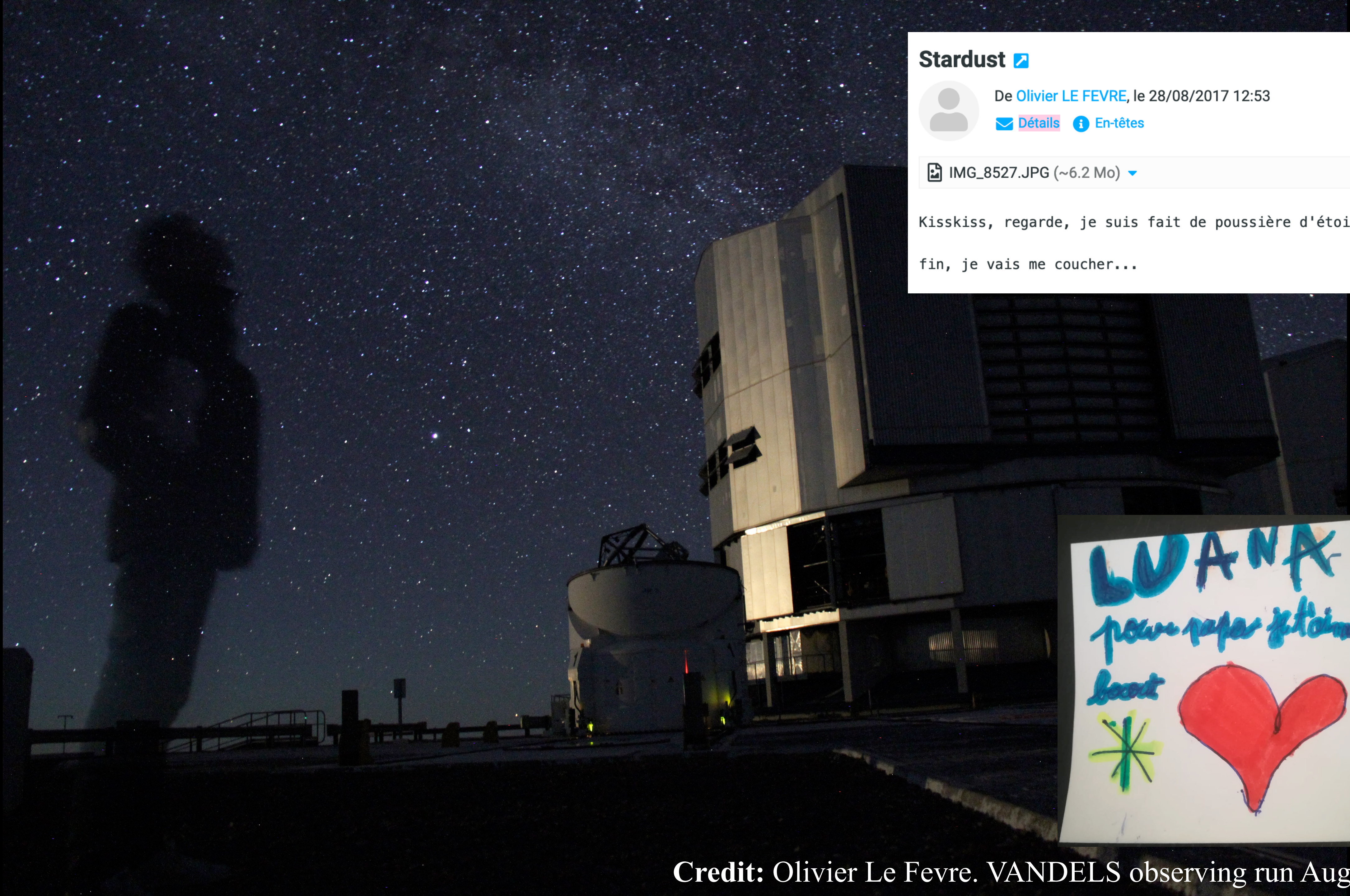

Stardust

De Olivier LE FEVRE, le 28/08/2017 12:53

Détails   En-têtes

IMG_8527.JPG (~6.2 Mo)

Kisskiss, regarde, je suis fait de poussière d'étoiles :-)

fin, je vais me coucher...

Credit: Olivier Le Fevre. VANDELS observing run August 2017

Thank you All…

Thank you Olivier..

..for everything. Your heritage will Stay with us