l'Observatoire de Paris | GEPI

Galaxies Étoiles Physique et Instrumentation

MOSAIC

Galaxy kinematics the requirements for an E-ELT (multi)-IFU

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(multi)-IFU: Kinematics of distant galaxies

Large number of IFU instruments in 4 and 8 m class telescopes.

Multi-IFU at ESO: FLAMES/GIRAFFE and a new one KMOS

FLAMES/GIRAFFE	Galaxy evolution TF relation
KMOS	The masses and growth of galaxies High-redshift galaxies and re-ionisation

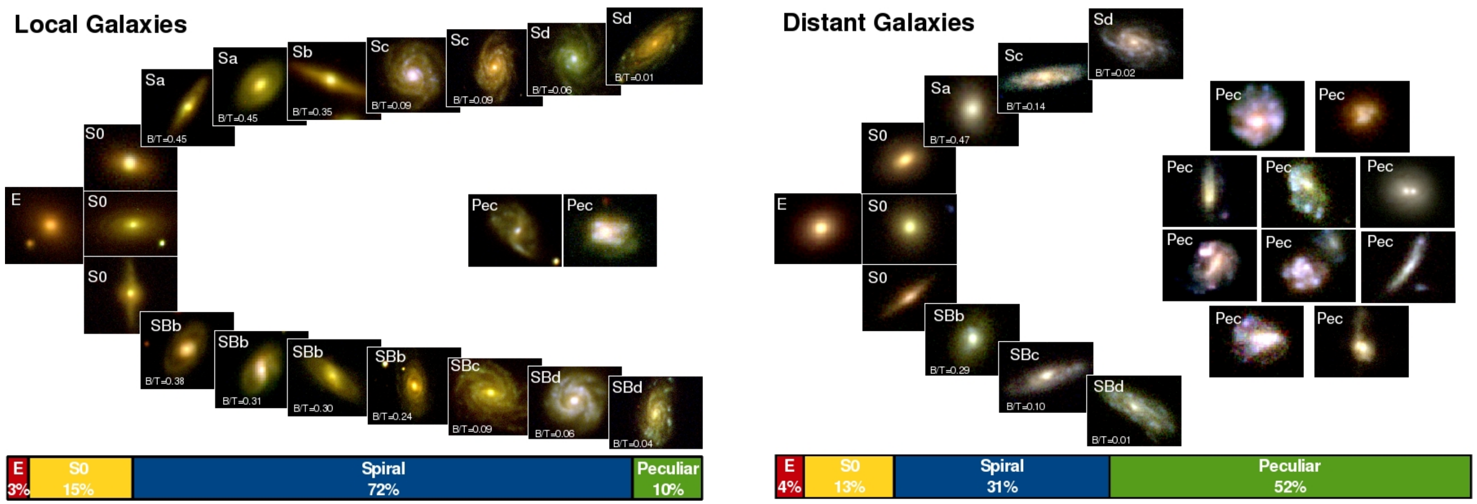
For the future E-ELT instrument : Mass assembly and first galaxies

Why IFUs

Spiral in the past and in the present:

link to the hubble sequence

Delgado-Serrano et al 2008

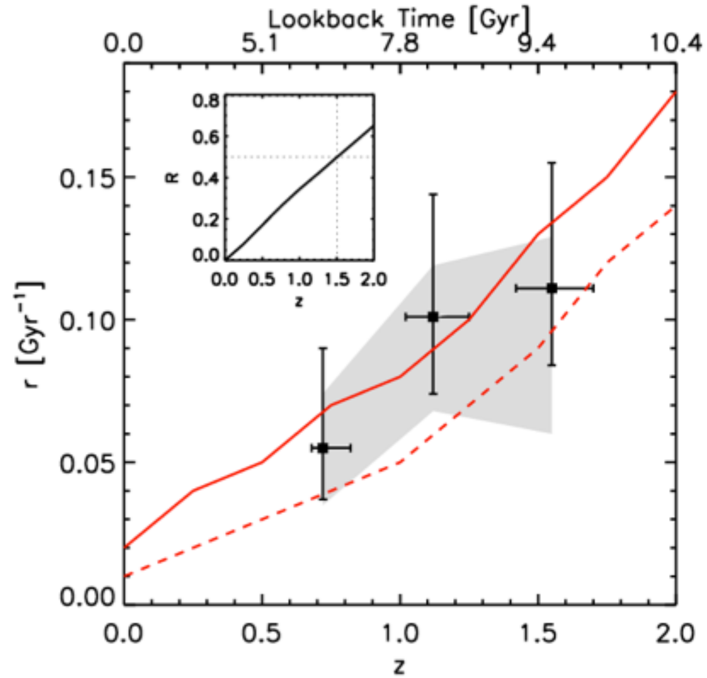


Local z=0.6 high-z

Combining SDSS survey, HST/ACS & three VLT instruments (FORS2 VIMOS & FLAMES)

Why IFUs

Formation of galaxy:
link to evolution of differents quantities and fundamental relation



Puech et al 2012

Combining HST & VLT observations and hydro dynamical models:
cumulative merger rate R match Λ-CDM semi-empirical models

Methology to answer a question ←→ Link to instruments

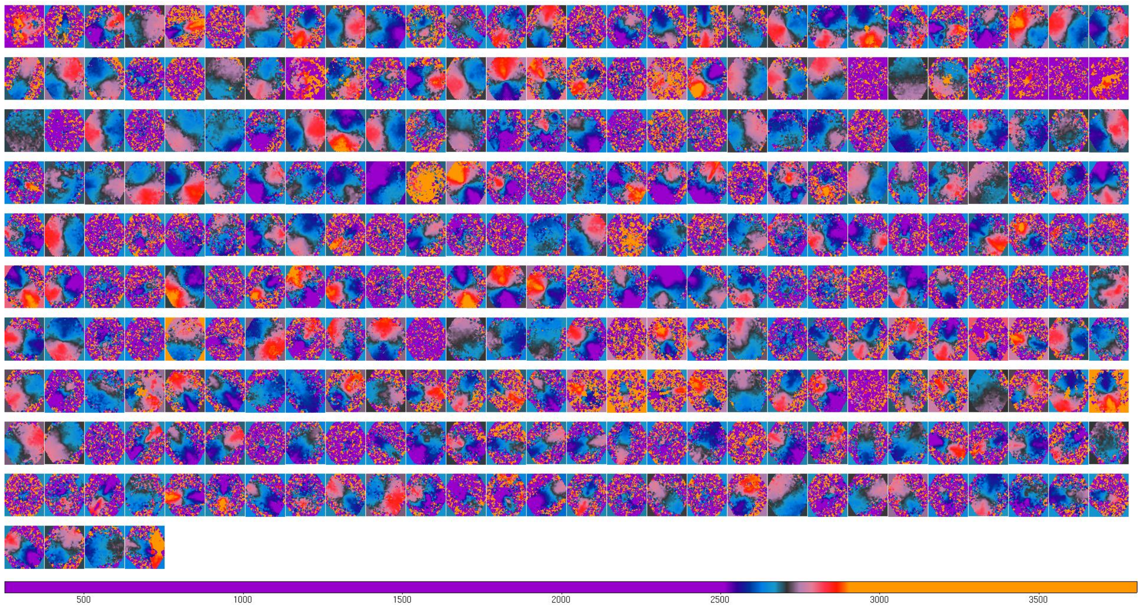
Local universe: From SDSS to CALIFA

Sample are under construction, can be used as comparison for distant studies

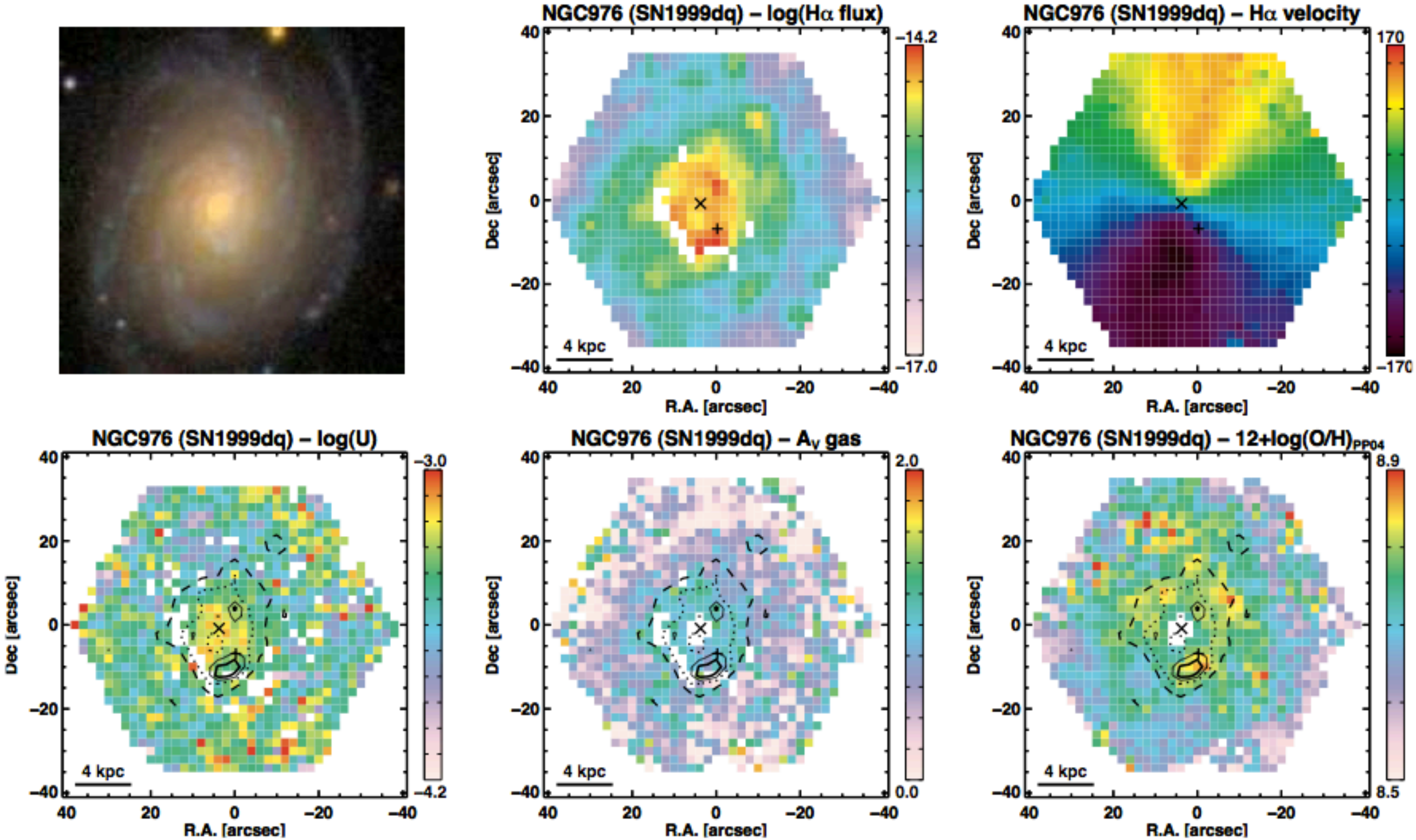
CALIFA survey (Sanchez et al., 2012)

more than 600 galaxies selected on the SDSS survey

IFU: PMAS/PPAK at calar alto. 2D maps of :
(a) stellar populations: ages and metallicities;
(b) ionized gas: distribution, excitation mechanism and chemical abundances; and
(c) kinematic properties: stellar and ionized gas.



284 velocity field



Observed at Calar Alto, PMAS/PPAK instrument

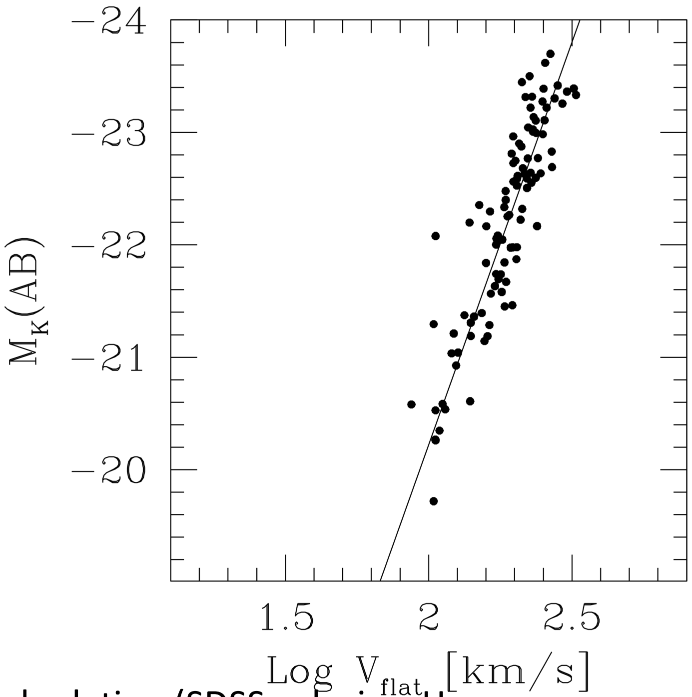
Intermediate z: FROM MOS to MOS-IFU

IMAGES & MASSIV survey

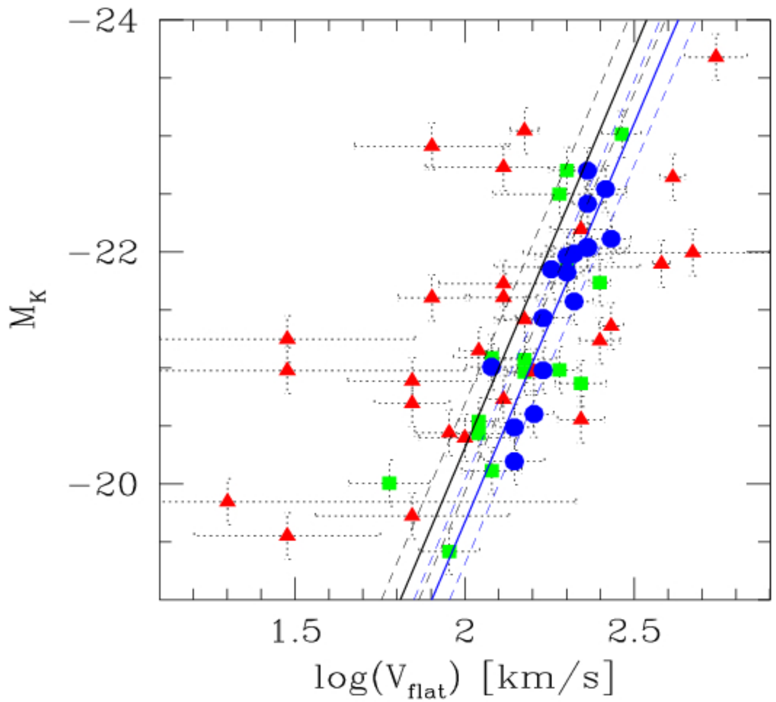
IMAGES survey: Galaxies selected from mass limited sample (GOODS field)

FORS2 and VIMOS observations (2 VLT telescopes) and then IFU

Observed using FLAMES/GIRAFFE multi-IFU



Local relation (SDSS galaxies; Hammer et al. 2007)

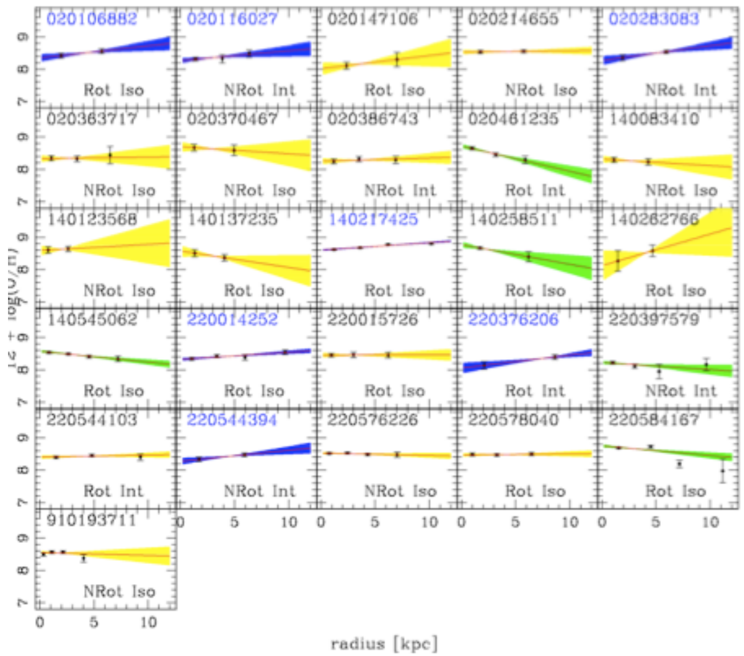


FROM high multiplex survey to mono IFU

MASSIV survey (0.9<z< 1.5)

Sample selected in the optical VVDS survey (VIMOS instrument)

SINFONI IFU



High fraction with **positive gradients**

Queyrel et al 2012

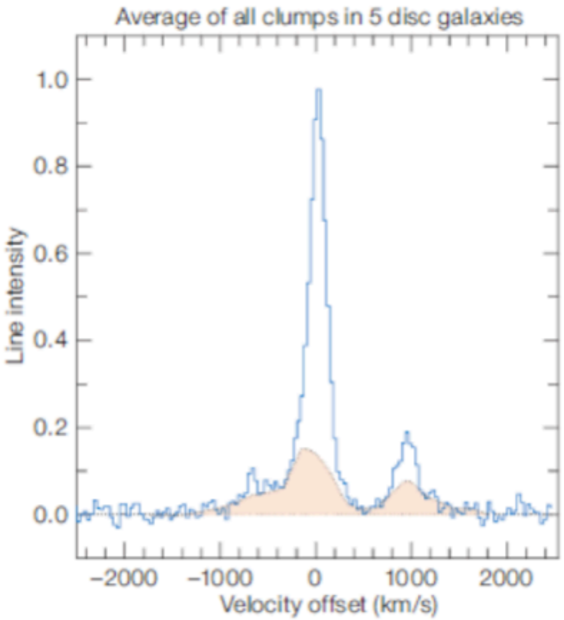
At higher z SINS survey

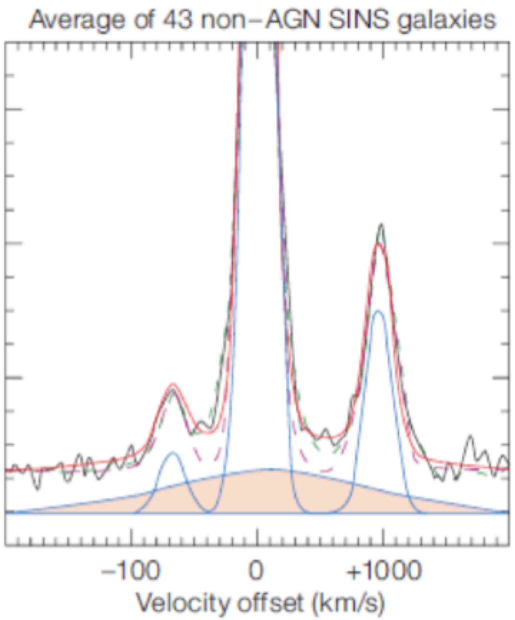
Challenging survey: (z>1.5) 3D samples are drawn
using various selection criteria which makes their representativeness more uncertain.

Major issue no dedicated survey to select galaxies to observe with the IFU….

They found a important fraction of galaxies with perturbed velocity maps

SINS/zC-SINF (Newman et al 2012)
Clumps lifetime is only 100-200 Myr (Forster-Schreiber et al, 2011; Wuyts et al. 2012)





Broad spectral features below emission lines in *z~2 clumps*

At higher z

If we want to construct an unbiased sample till z=2, a near IR survey is needed

Proper evaluation of the relative contribution of
the different galaxy populations to:
-- the star formation
-- stellar mass densities

Unbiased way the evolution of these
fundamental quantities over the past ten billion years.

Every goes in this sense,
we need a spectroscopic survey before to use the IFU

MOSAIC instrument will have a high multiplex mode !!!! >>after the survey, which kind of IFU

IFU definition

Keeping in mind that when we talk about the VLT (They are 4 telescopes)

→ More than 12 instruments

The E-ELT will be unique with few instruments

We must maximize the scientific return

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Among the observational modes proposed by MOSAIC

We have defined a multi-IFU

Science cases for E-ELT/ MOSAIC instrument:
Two science cases used to scale the IFU

Mass assembly

Multiplex

Spatial size and resolution

Spectral resolution

Goals:

- Mass assembly history (gas, stars, etc)
- Chemical enrichment history (age, metallicity, SFH)

Context:

- Hierarchical structure formation
- Internal dynamical evolution

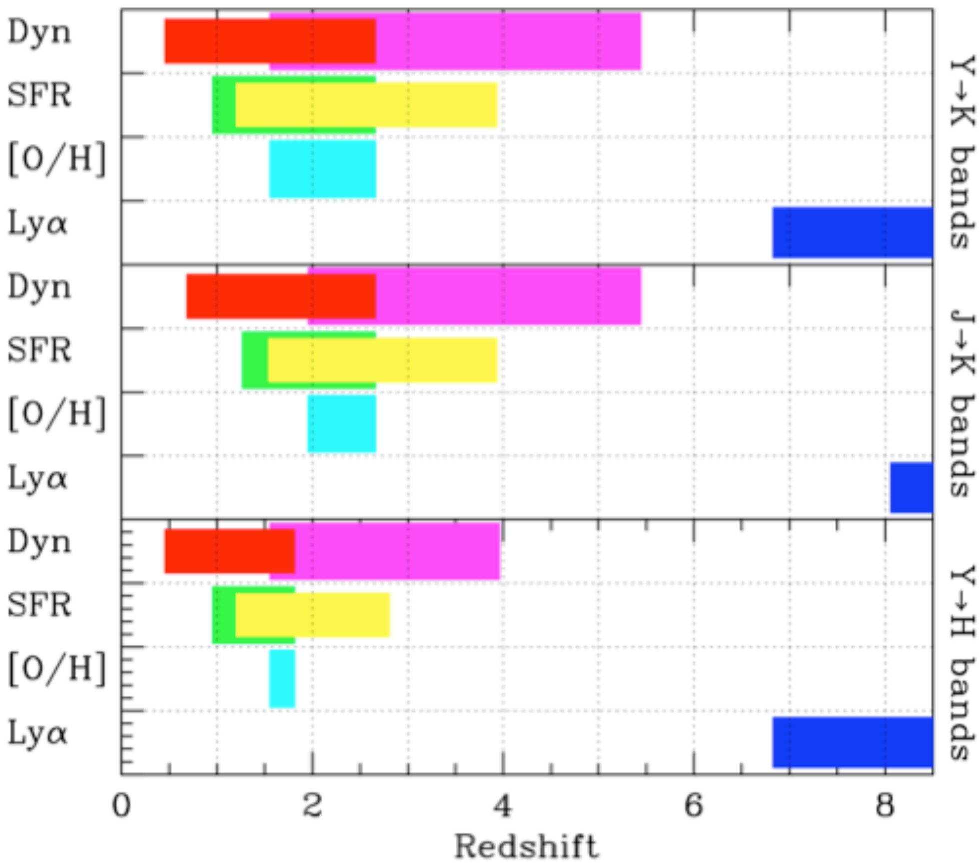
Mass assembly science case

Observing modes and wavelength coverage:

Target the rest-frame optical emission lines redshifted into the near-IR

YJ- and H-bands (not simultaneously) but one band per observation

K-band as optimal/desirable



Spatially-resolving properties:

- Kinematics
- metallicity
- SFR

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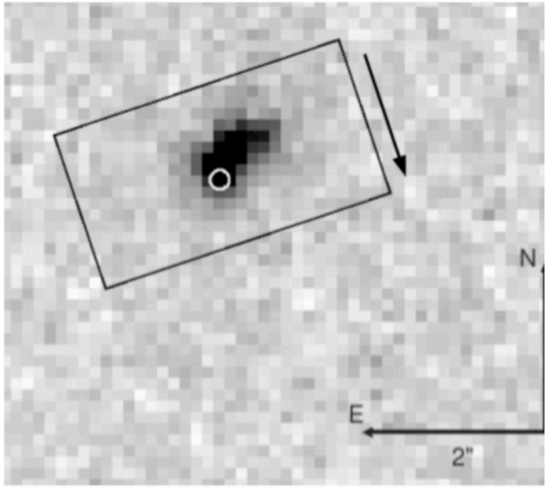
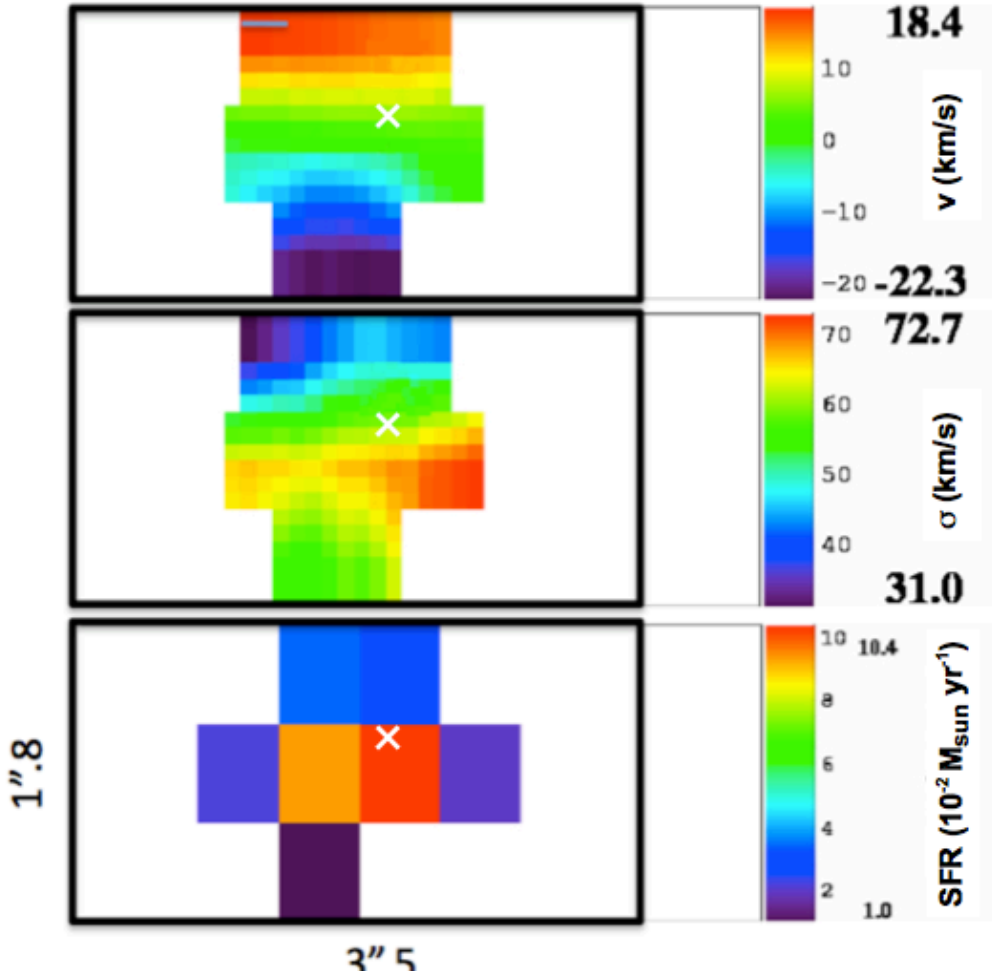
GRB 091127/SN 2009nz and the VLT/X-shooter spectroscopy (SLT & IFU)

(Vergani et al., 2011)





They show that the host galaxy has a perturbed rotation kinematics with evidence of a SFR enhancement consistent with the afterglow position

Mass assembly science case

Multiplex:

FoV of the E-ELT from tens to hundreds of targets from $2 \leq z \leq 5.6$
Multiplex of 10-20 is required

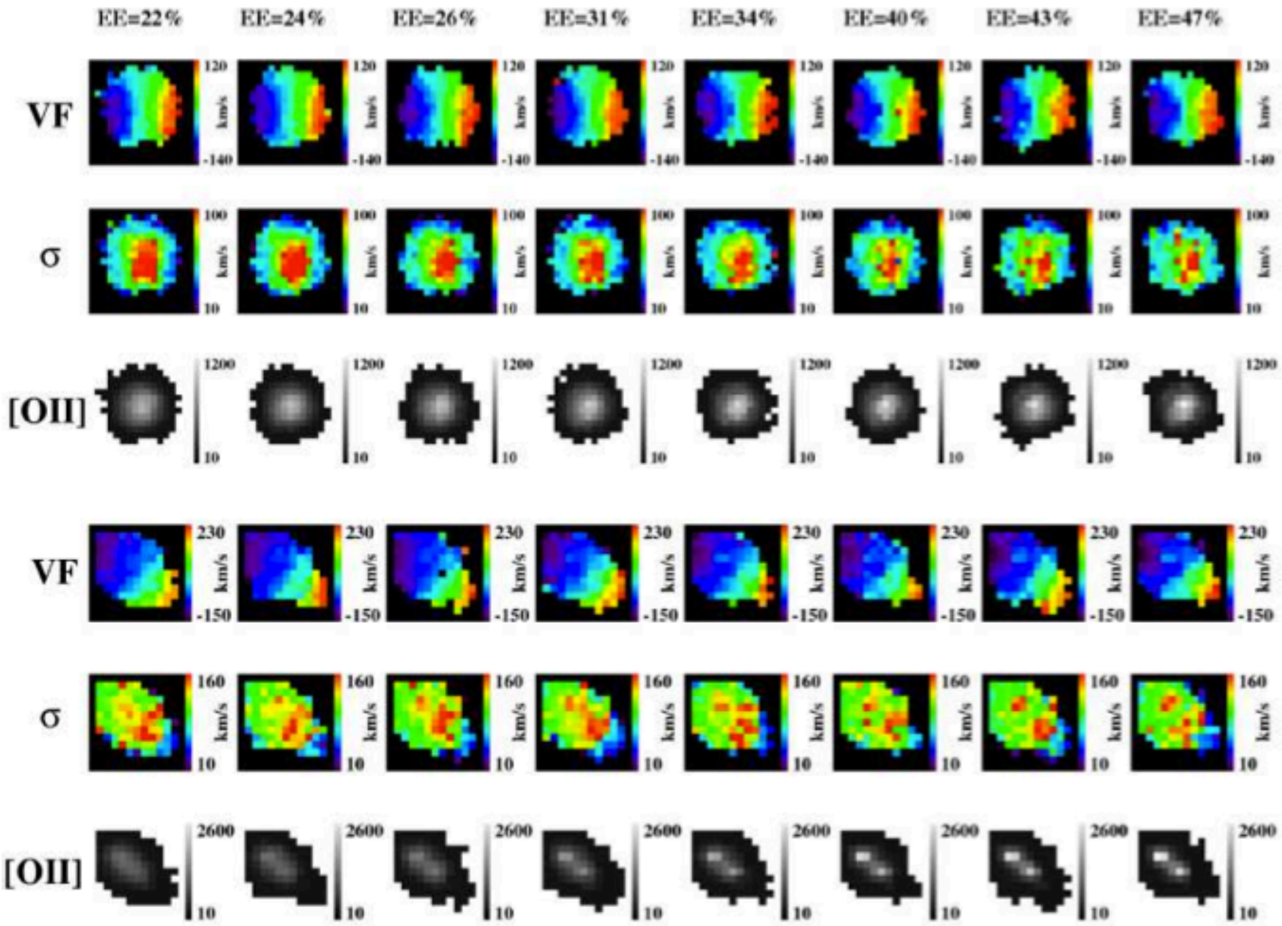
Spatial resolution/image quality:

z>1 sources reveal clumpy morphologies , but they not play a major role on the bulge formation (Genel et al. 2011; Hopkins et al. 2012)

Size of high-*z galaxies* → *spatial sampling in the range 50-75 mas*

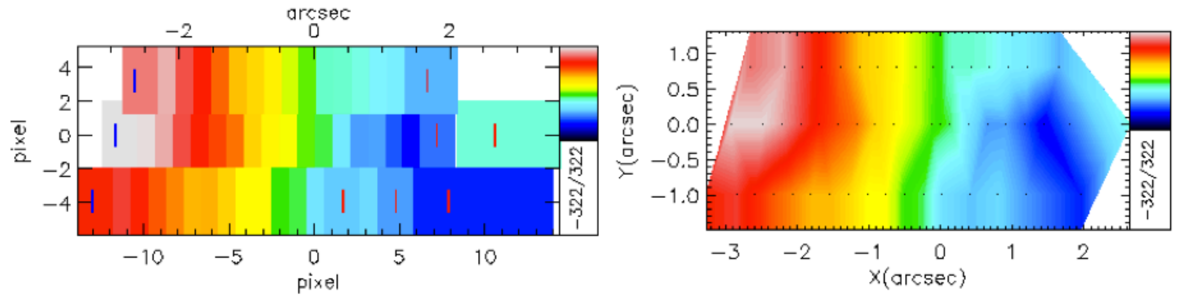
Large-scale motions:
Spatial sampling in the range 50-75 mas (Puech et al, 2008)

~75 mas pixel resolve sub-M* galaxies at *z~4*

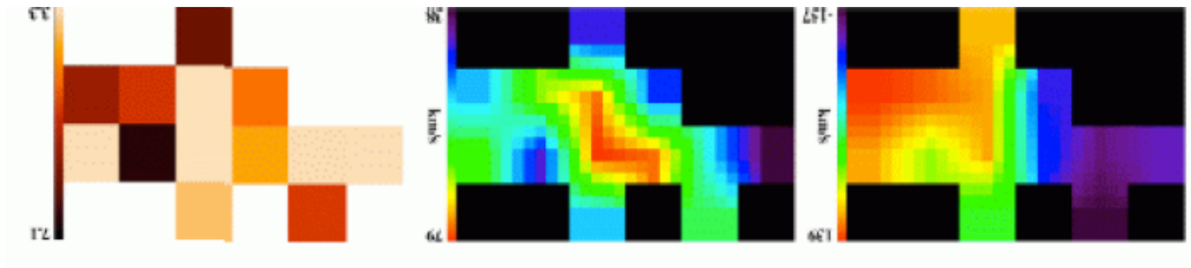


(Puech et al 2008, 2010 and conference poster)

Large scales motion:



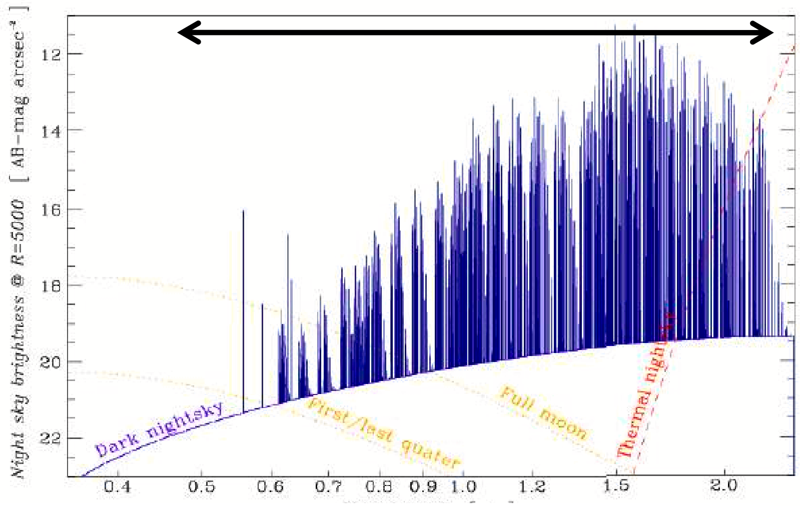
FORS2
Kutdemir et al 2008



FLAMES GIRAFFE

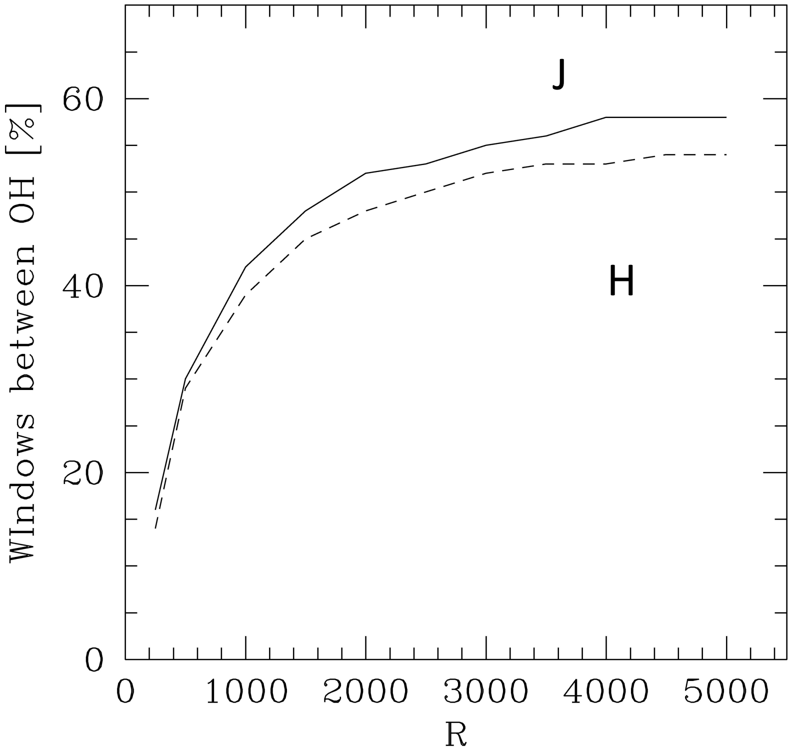
<u>Spatial extent of each IFU</u>:
Size of the galaxies on the sky and the need for good sky subtraction (dithers within the IFU)
A size of 2’’x2’’ is required

Spectral resolution



- R≥ 3000 to target emission lines between the OH sky lines to warrant to be background limited for λ > 720 nm, to properly resolve the OII doublet for kinematics,

- to optimise detection of faint Lyα lines with observed FWHM down to 150 km/s;



At least *R=4,000-5,000*

Better to resolve the brightest OH sky lines and identify emission lines between them

Conclusion

All the successful IFU survey always preceded by a larger survey

MOSAIC fulfill the first condition to be a successful instrument by definition:

High multiplex mode can be used to construct a representative sample to be observed

And then MOSAIC / multi IFU mode

This mode will be used to study the kinematics and maps of physical properties of the galaxies (see Puech et al poster)

And also detect the first galaxies (SC1 white paper)

First galaxies

Mass assembly

Table 3: Summary of top-level requirements from each Science Case

Case	Target densities	FoV/target	Spatial resolution	λ-coverage (μm)	*R*
SC1	1-2 arcmin^{-2}	2" × 2"[3]	40-90 mas	1.0-1.8 *1.0-2.45*	5,000
	10s arcmin^{-2}	–	(GLAO)	1.0-1.8 *1.0-2.45*	>3,000
SC2	1-2 arcmin^{-2}	2" × 2"	50-80 mas	1.0-1.8 *1.0-2.45*	5,000
	10s arcmin^{-2}	–	(GLAO)	1.0-1.8 *1.0-2.45*	> 3,000

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