A panoramic look at ram pressure stripping in the Virgo cluster with CFHT and MUSE

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GEE5 - Florence - 16 November 2017

Why do we care about environment?
Open questions

What do we know/learn about the detailed physics of various environmental mechanisms?

What number (or fraction) of galaxies become passive as a direct result of their surrounding environments?

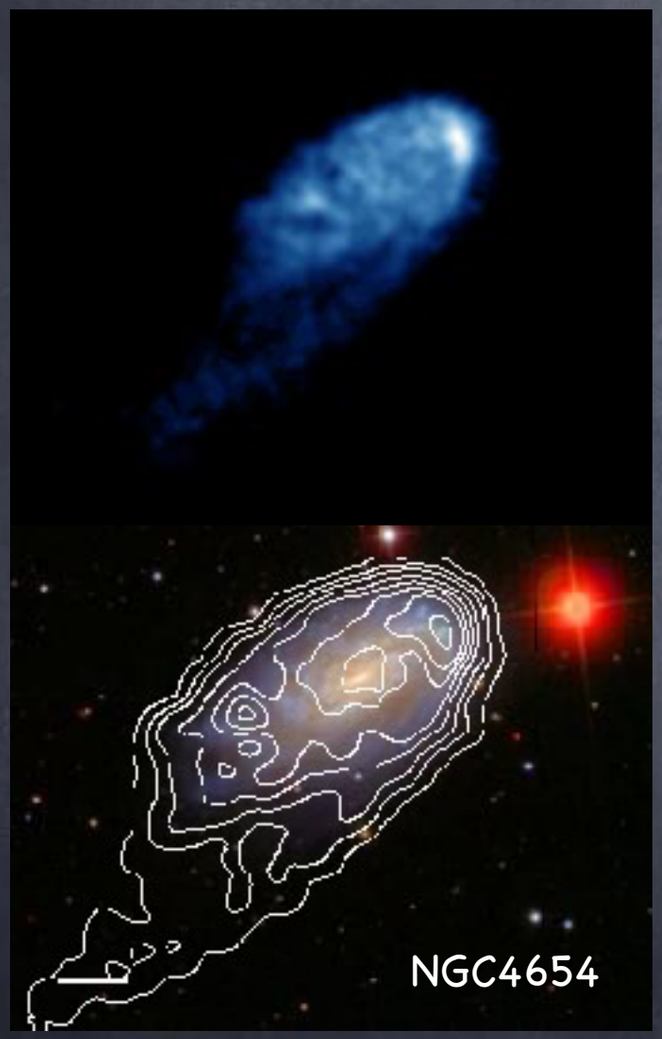
What is the main quenching mechanism? How long does it take for a satellite to be quenched?

Evolution of the above with cosmic time?

Signatures of ram-pressure stripping

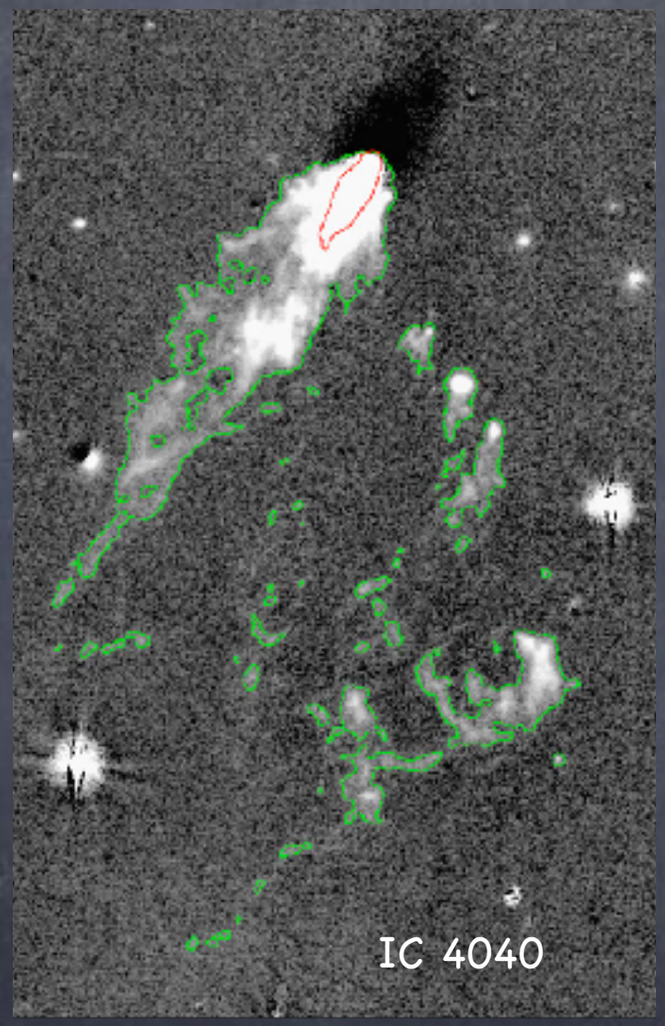
Multi-wavelength tails

HI (neutral hydrogen)



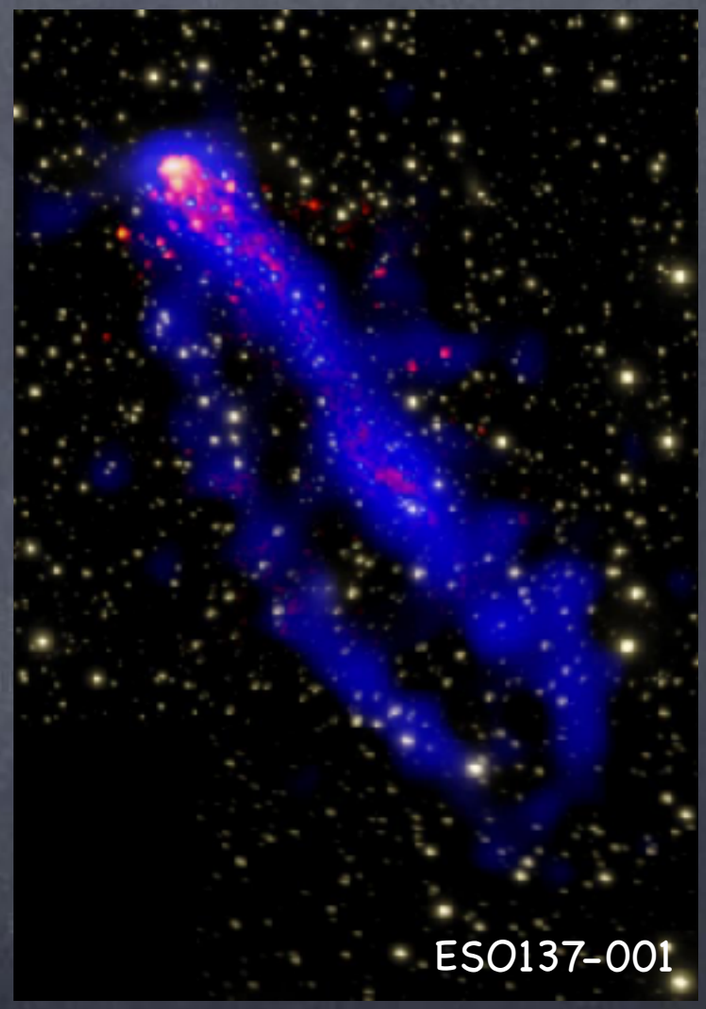
Chung et al. 2007

Halpha



Yagi et al. 2010

X-Ray



Sun et al. 2010

Halpha is ideal when hunting
for tails in large scale surveys

VESTIGE

A Virgo Environmental Survey Tracing Ionized Gas Emission

P.I. A. Boselli

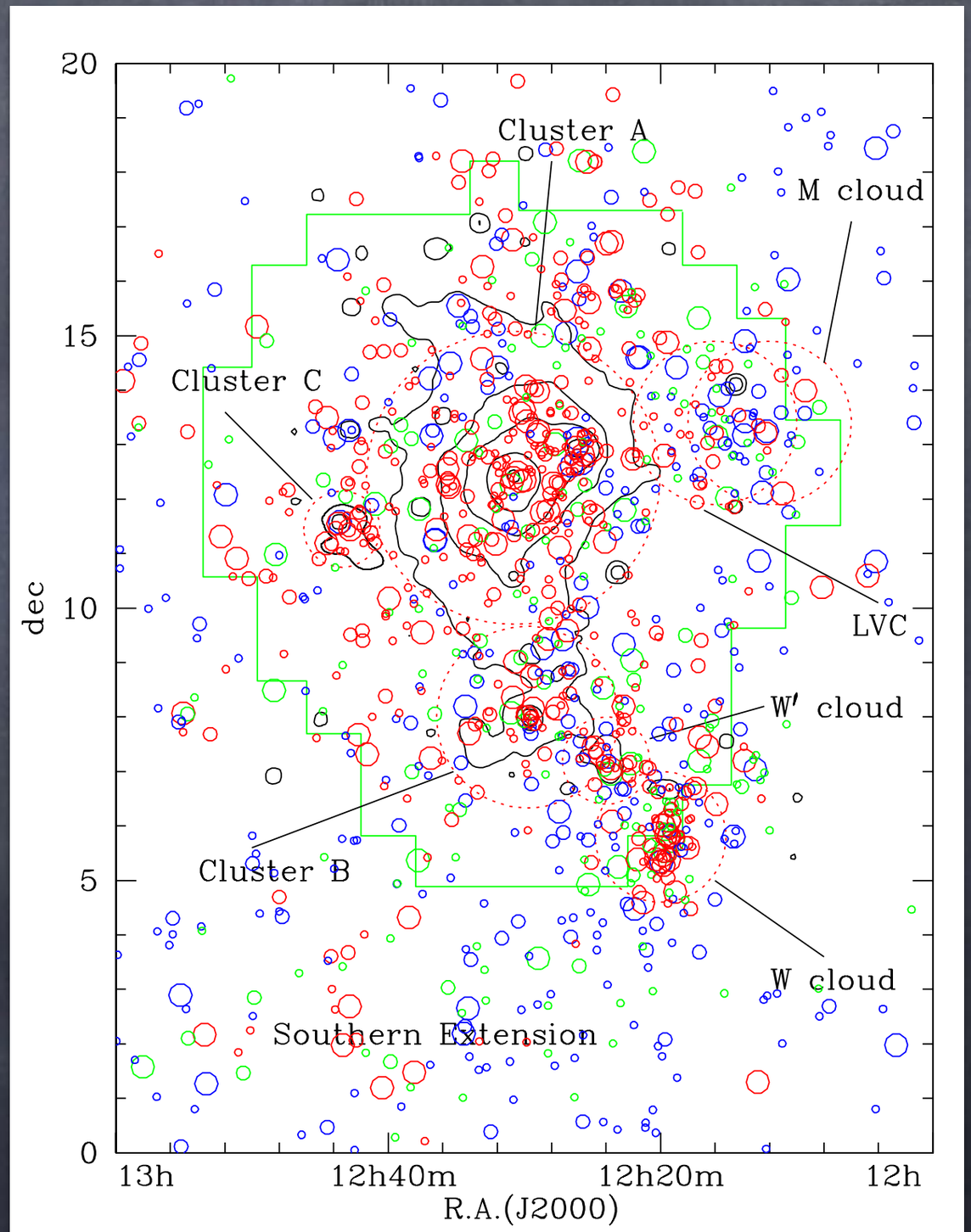
50 allocated night with MegaCam (1^ox1^o) to cover the Virgo cluster within 1 virial radius (~ 104^{o2})

Integration time: 2 h in the Hα filter (λ = 6563 Å, $\Delta\lambda$ = 106 Å; T = 93%), 12 min in r (for the stellar continuum subtraction)

Sensitivity:

f(Hα) ~ 4×10^{-17} erg sec^{-1} cm^{-2} (5σ) for point sources

Σ(Hα) ~ 2×10^{-18} erg sec^{-1} cm^{-2} $arcsec^{-2}$ (1σ) for ext. sources at 3″ res

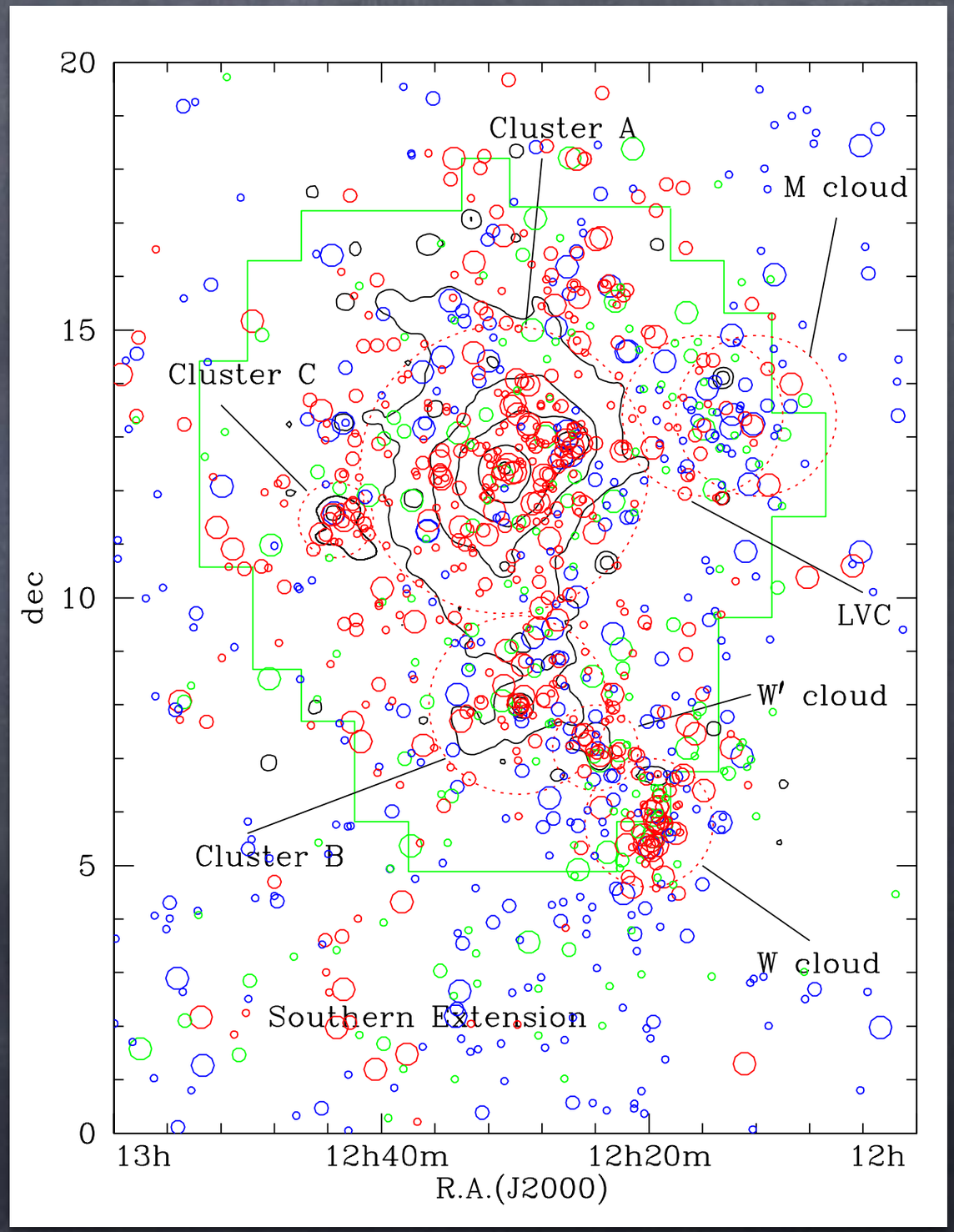


VESTIGE

A Virgo Environmental Survey Tracing Ionized Gas Emission

Why Virgo?

The closest cluster of galaxies
Dist = 16.5 Mpc;
M_{200} = 1.4-4.2x10^{14} Mo
High angular resolution (1 arcsec = 80 pc)
Access to the dwarfs (M_{star} ~ 10^{6-7} Mo)
Spiral rich cluster in formation
Multifrequency data available:
GUViCS (UV), NGVS (optical),
HeViCs (FIR), ALFALFA+VIVA (HI)



VESTIGE

A Virgo Environmental Survey Tracing Ionized Gas Emission

1) VIRGO SCIENCE

The effects of the environment on galaxy evolution (quenching)
The fate of the stripped gas in cluster galaxies
The star forming process in nearby galaxies
The ionised gas emission in early-type galaxies
The Hα luminosity function of galaxies
The Hα scaling relation in galaxies
The nature of dark galaxies
The dynamical structure of the Virgo cluster
The HII luminosity function of cluster galaxies
Planetary nebulae and the origin of the intracluster light

2) FOREGROUND SCIENCE

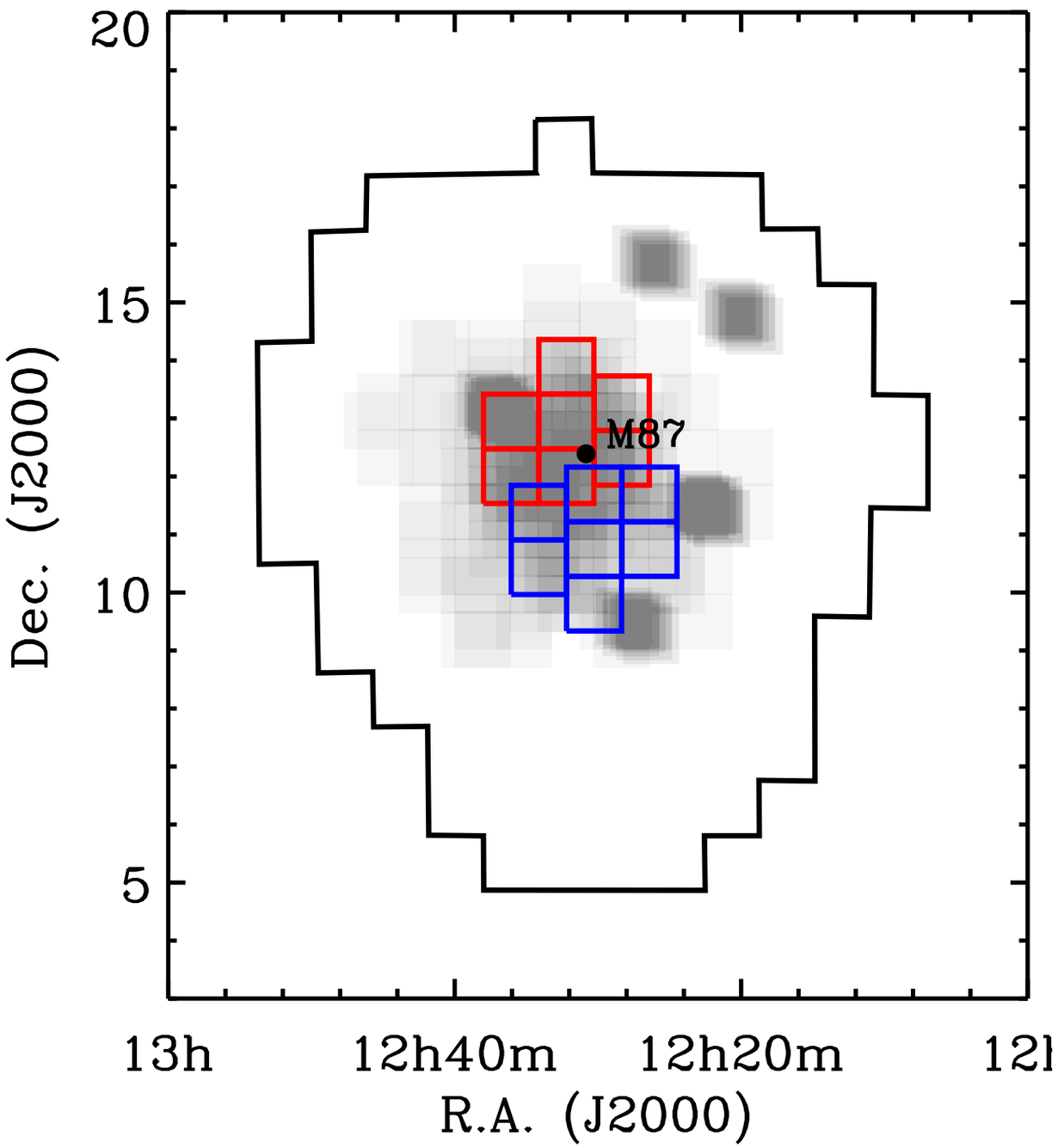
The diffuse ionised emission of the Milky Way
High velocity clouds, compact sources and Galactic fountains

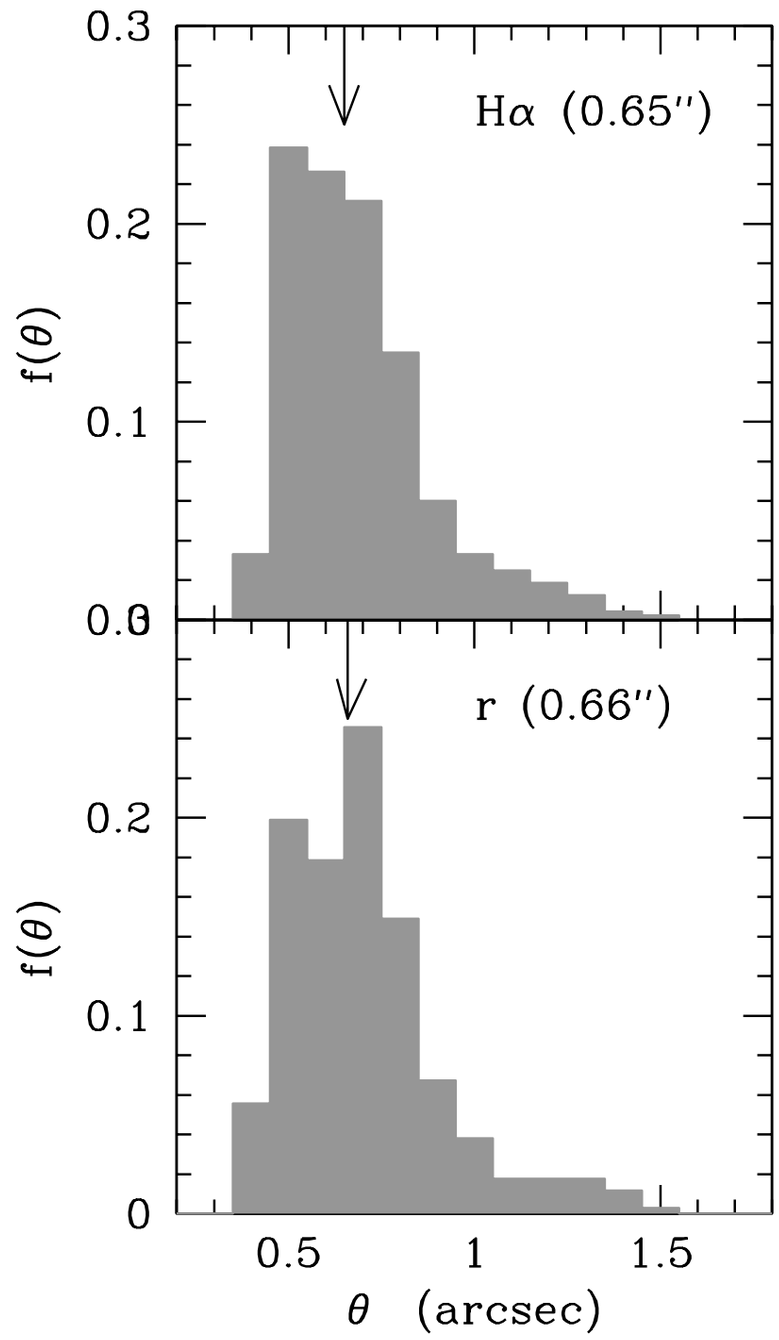
3) BACKGROUND SCIENCE

High redshift emission line galaxies (Lyα , [OII], [OIII])

VESTIGE

A Virgo Environmental Survey Tracing Ionized Gas Emission

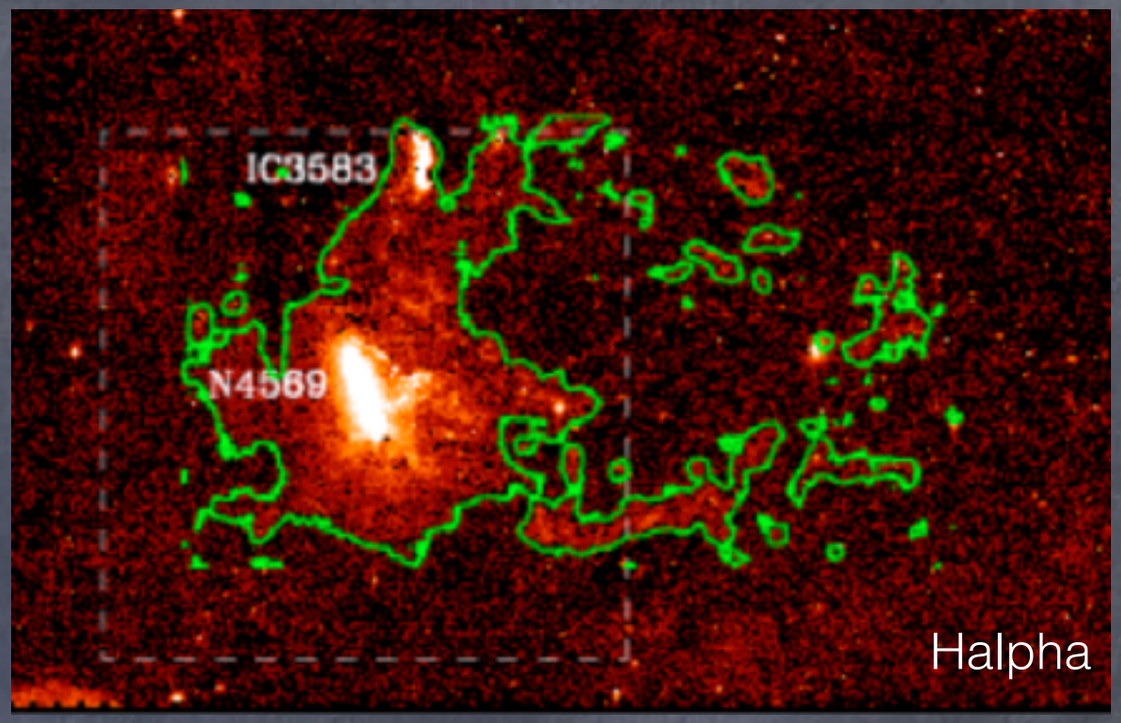


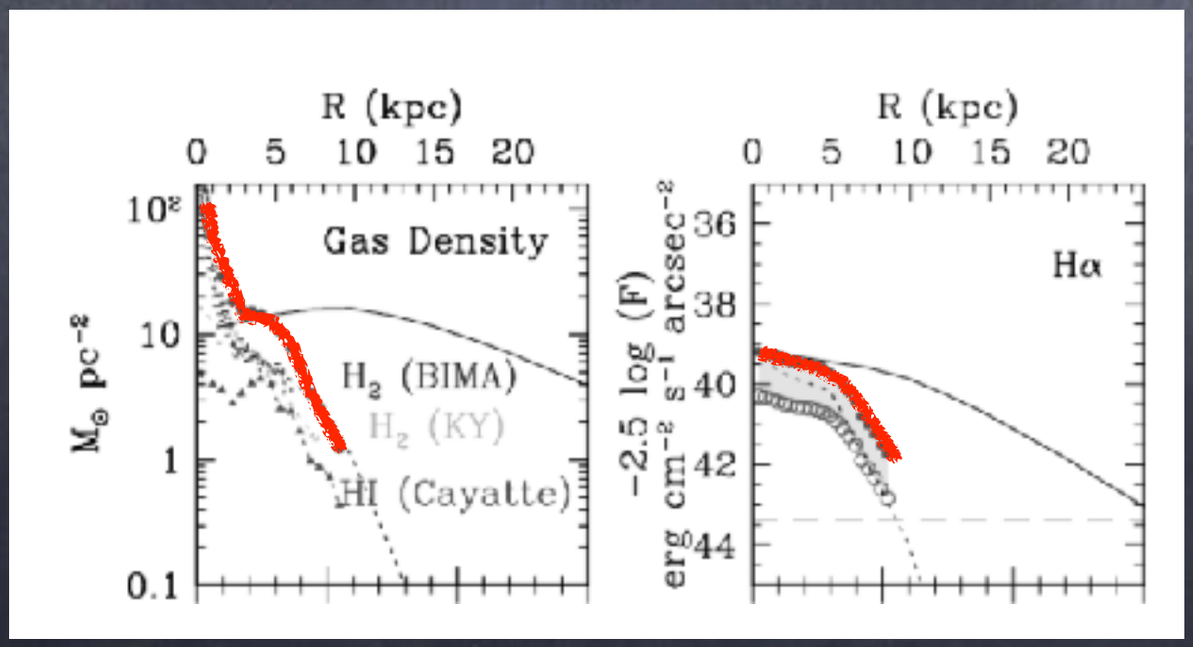


Status after 2017A (12 nights)

VESTIGE-pilot NGC4569

RPS tail detection and truncation of radial profiles



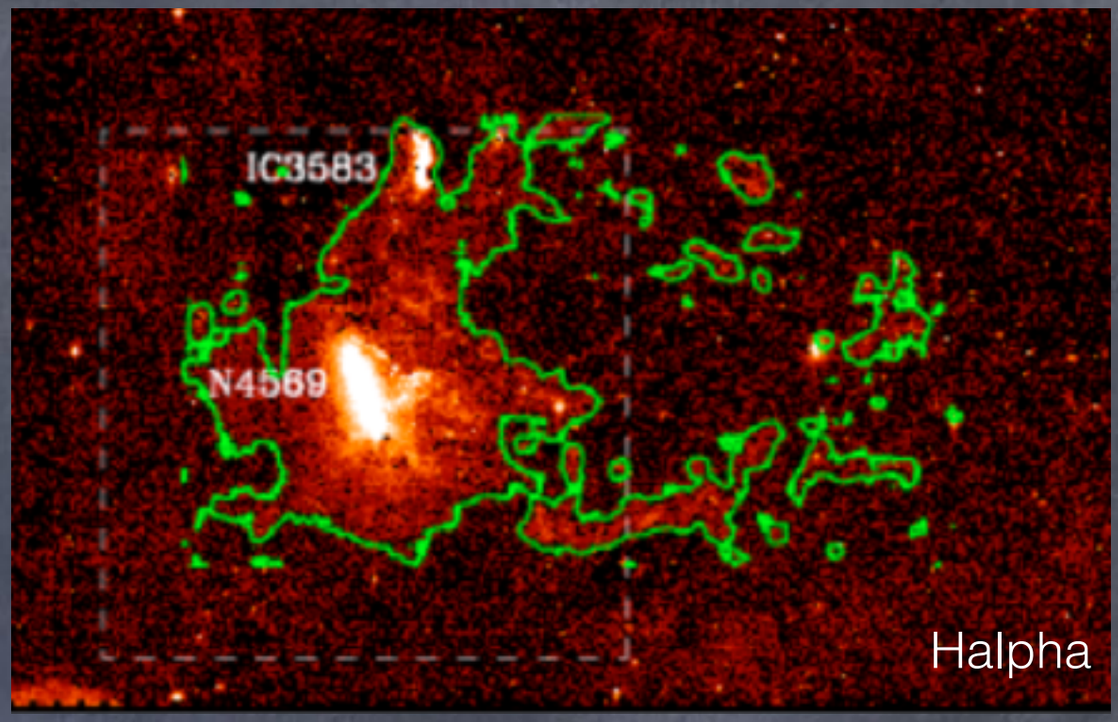


Disk truncation due to Ram pressure stripping

Boselli et al. 2006,2016

VESTIGE-pilot NGC4569

RPS tail detection and truncation of radial profiles



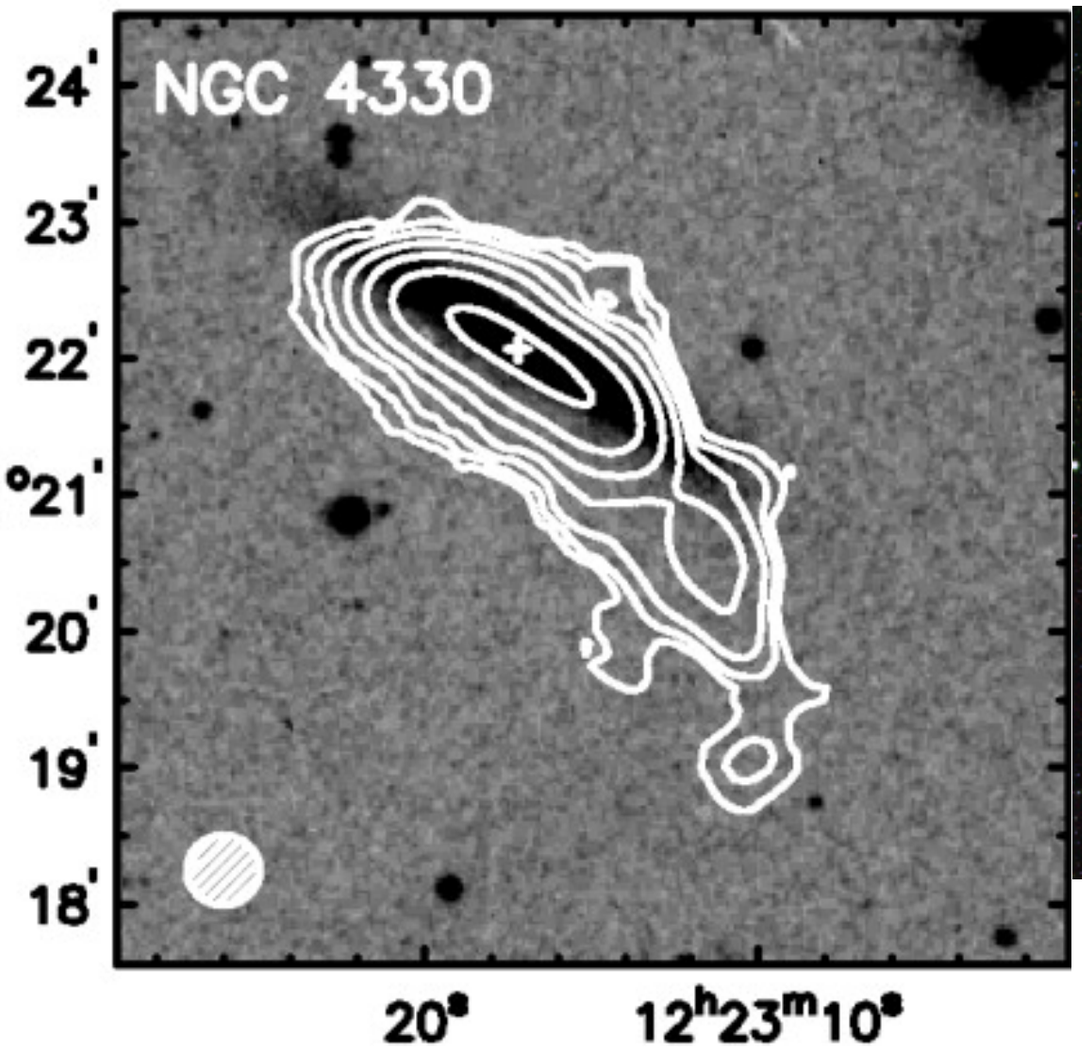
- The mass of the ionised gas in the tail is a large fraction of the stripped HI
- The ionization of the gas in the tail is supported by shocks and turbulence
- The mass of the gas expelled by the nuclear outflow is estimated to be 1-3% of the total stripped mass due to RPS

Boselli et al. 2006,2016

VESTIGE-pilot NGC4330

Accurate reconstruction of the RPS quenching times

VIVA (HI)



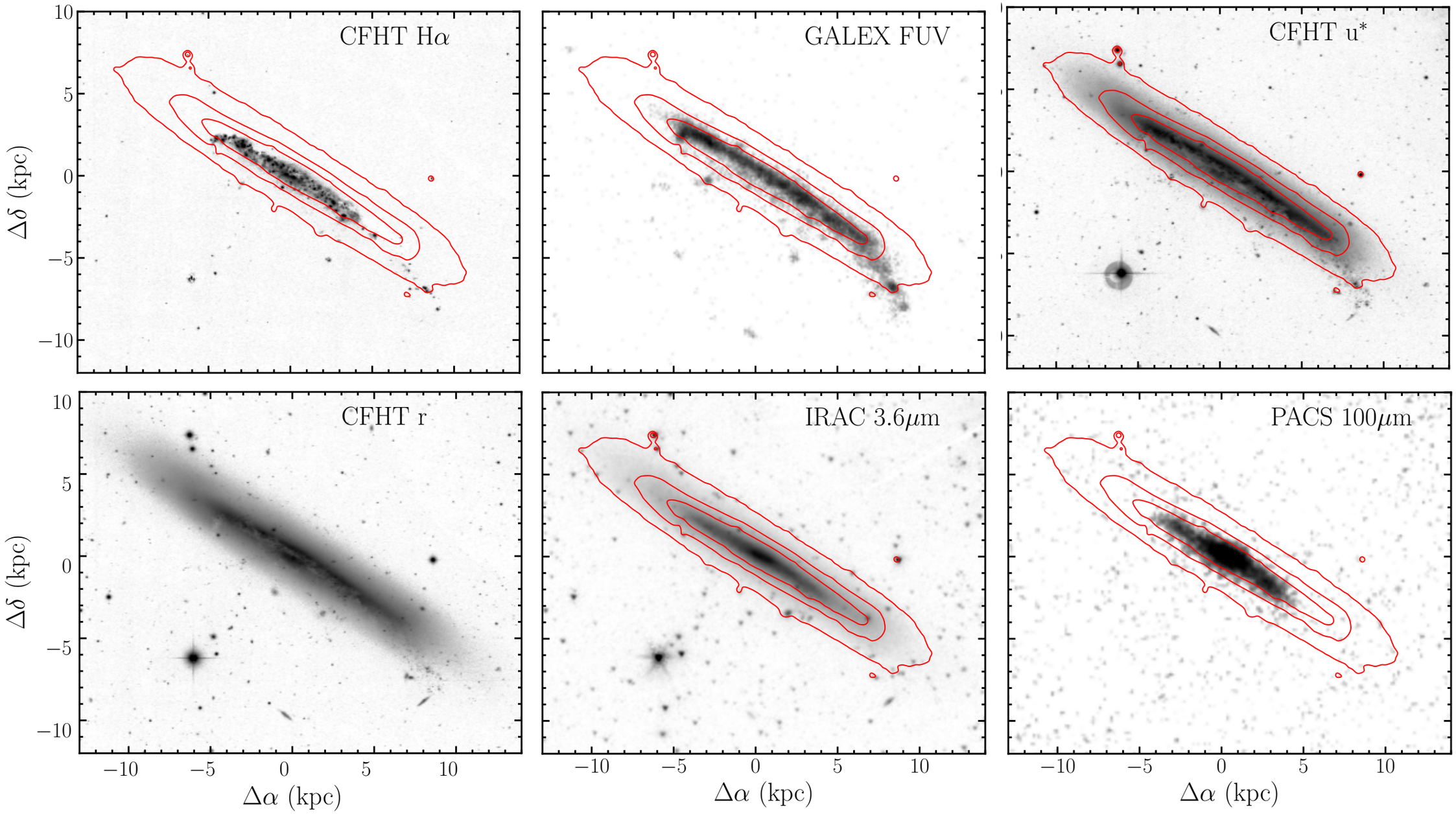
Chung et al. 2007

NGVS (optical)

Fossati et al. submitted

VESTIGE-pilot NGC4330

Accurate reconstruction of the RPS quenching times



Fossati et al. submitted

VESTIGE-pilot NGC4330

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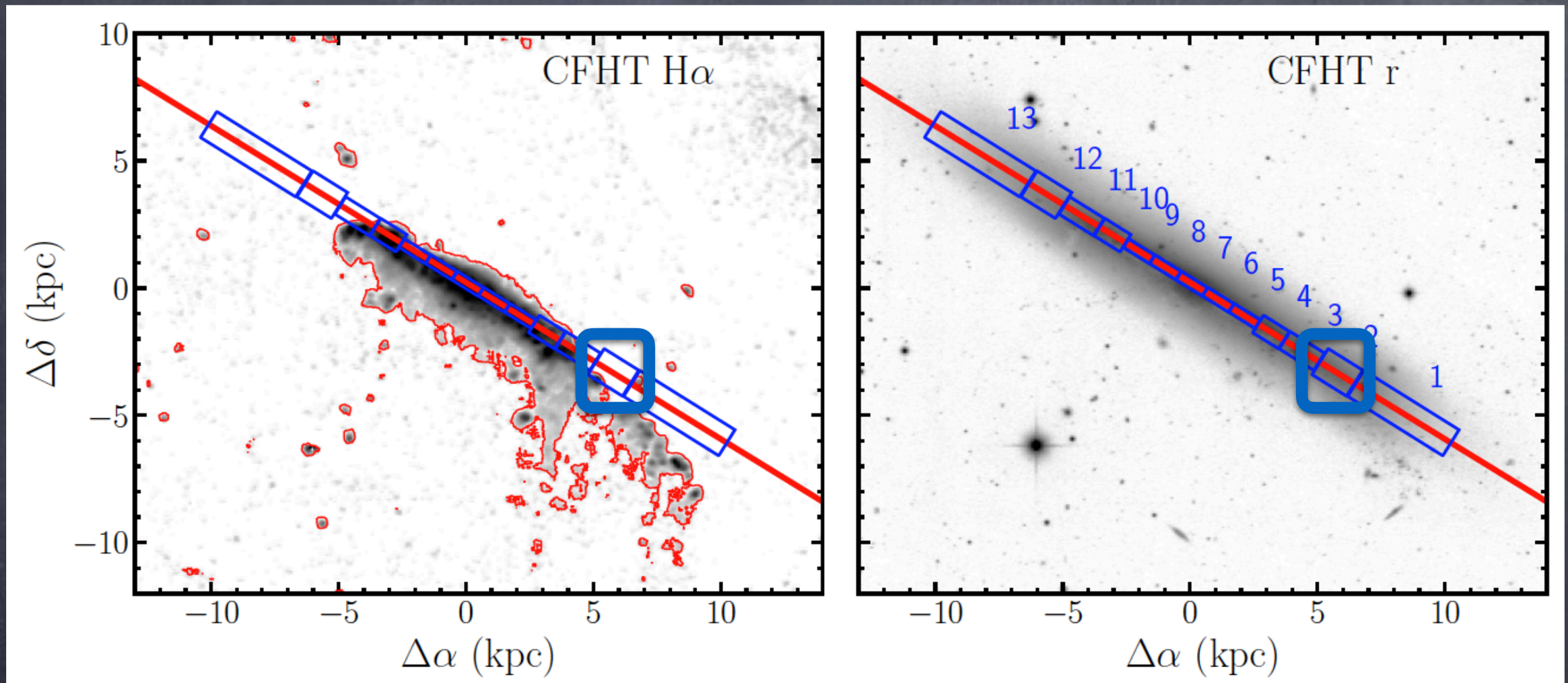


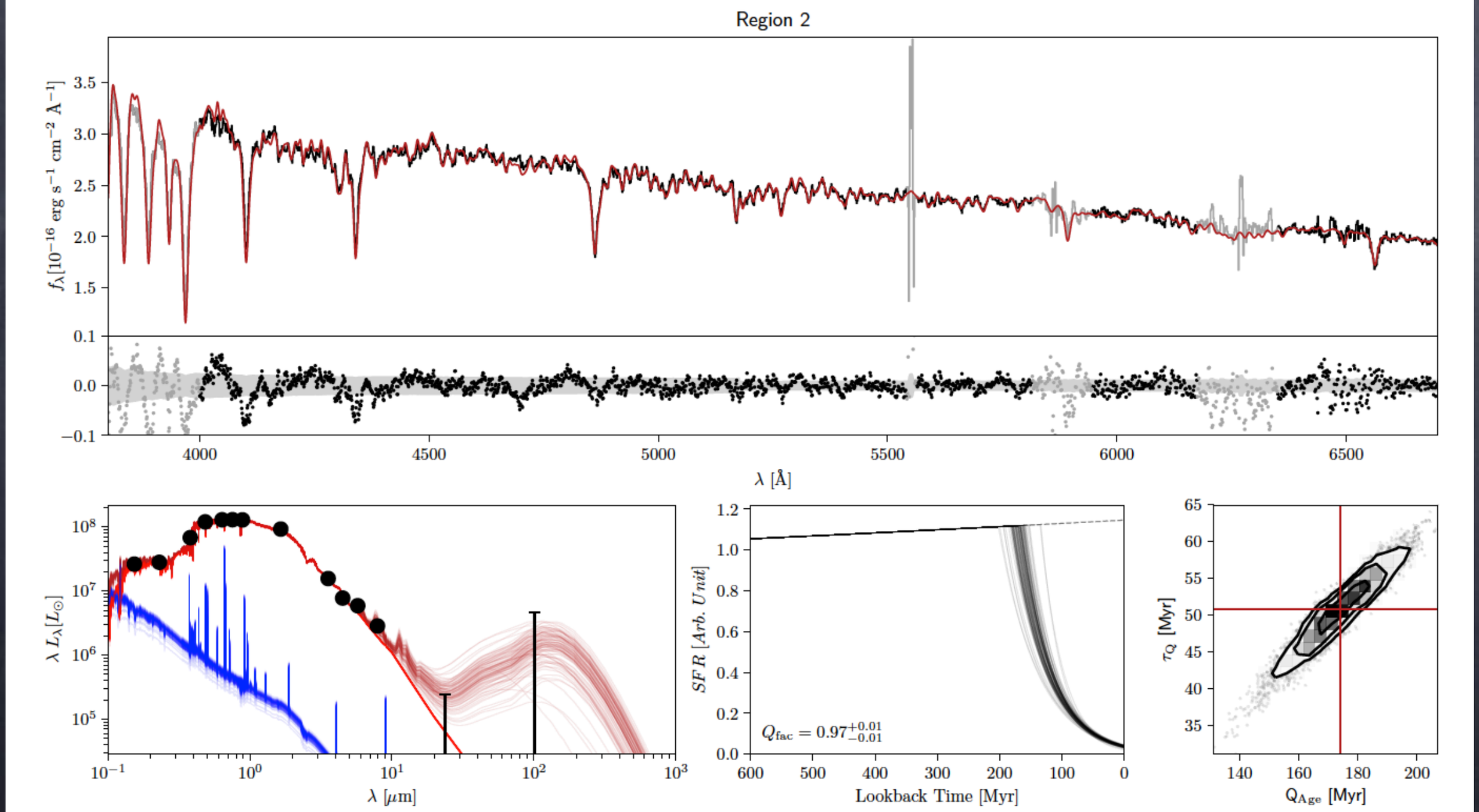
Jointly fit FORS2 spectroscopy (DDT) and 15 band photometry using MonteCarlo code (thanks to J.T.Mendel)

Radial SFH from Boissier & Prantzos (2000) models plus exponential truncation (2 free parameters: lookback time of the start of the quenching event and exponential timescale)

Fossati et al. submitted

VESTIGE-pilot NGC4330

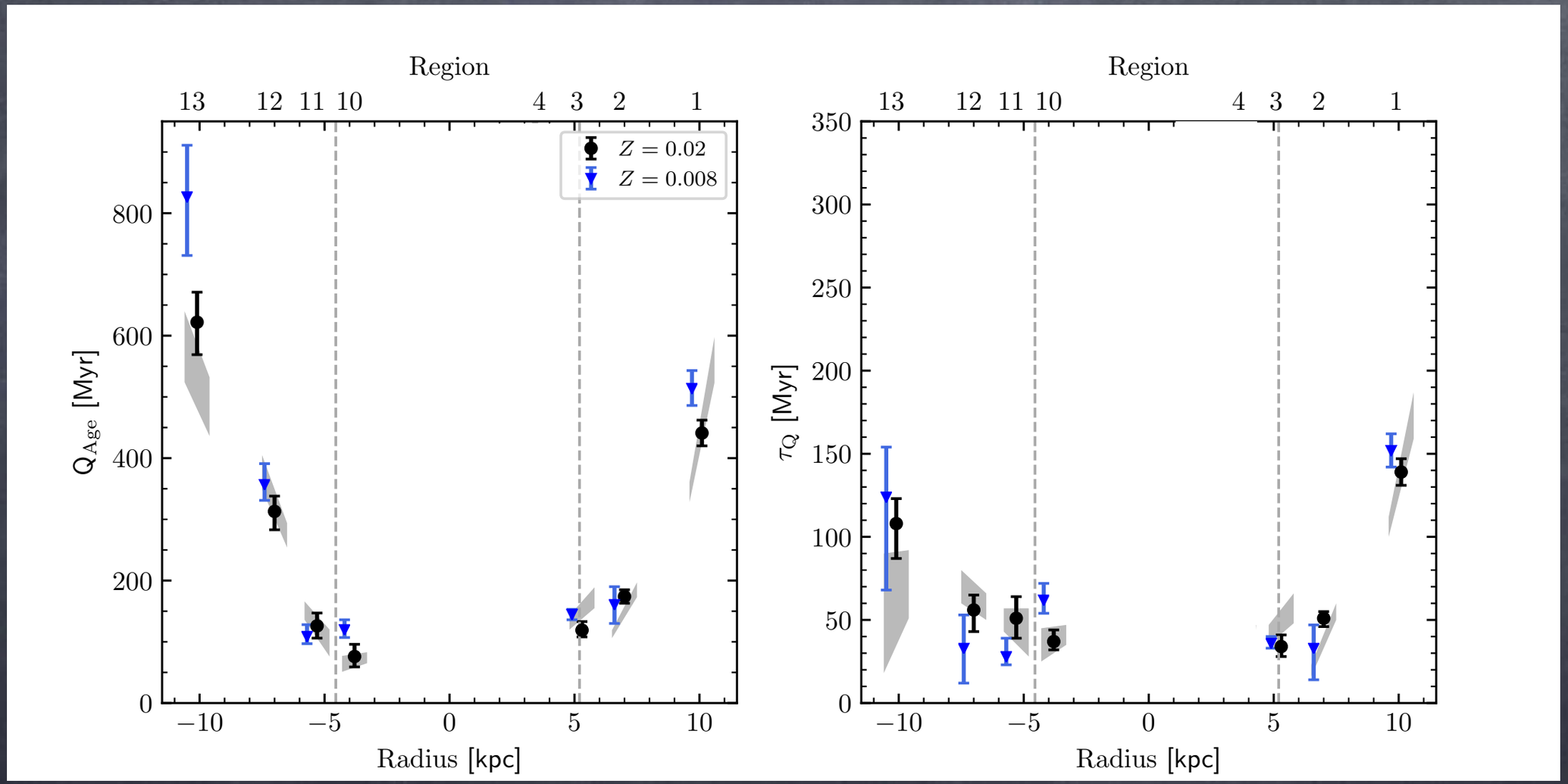
Accurate reconstruction of the RPS quenching times



Fossati et al. submitted

VESTIGE-pilot NGC4330

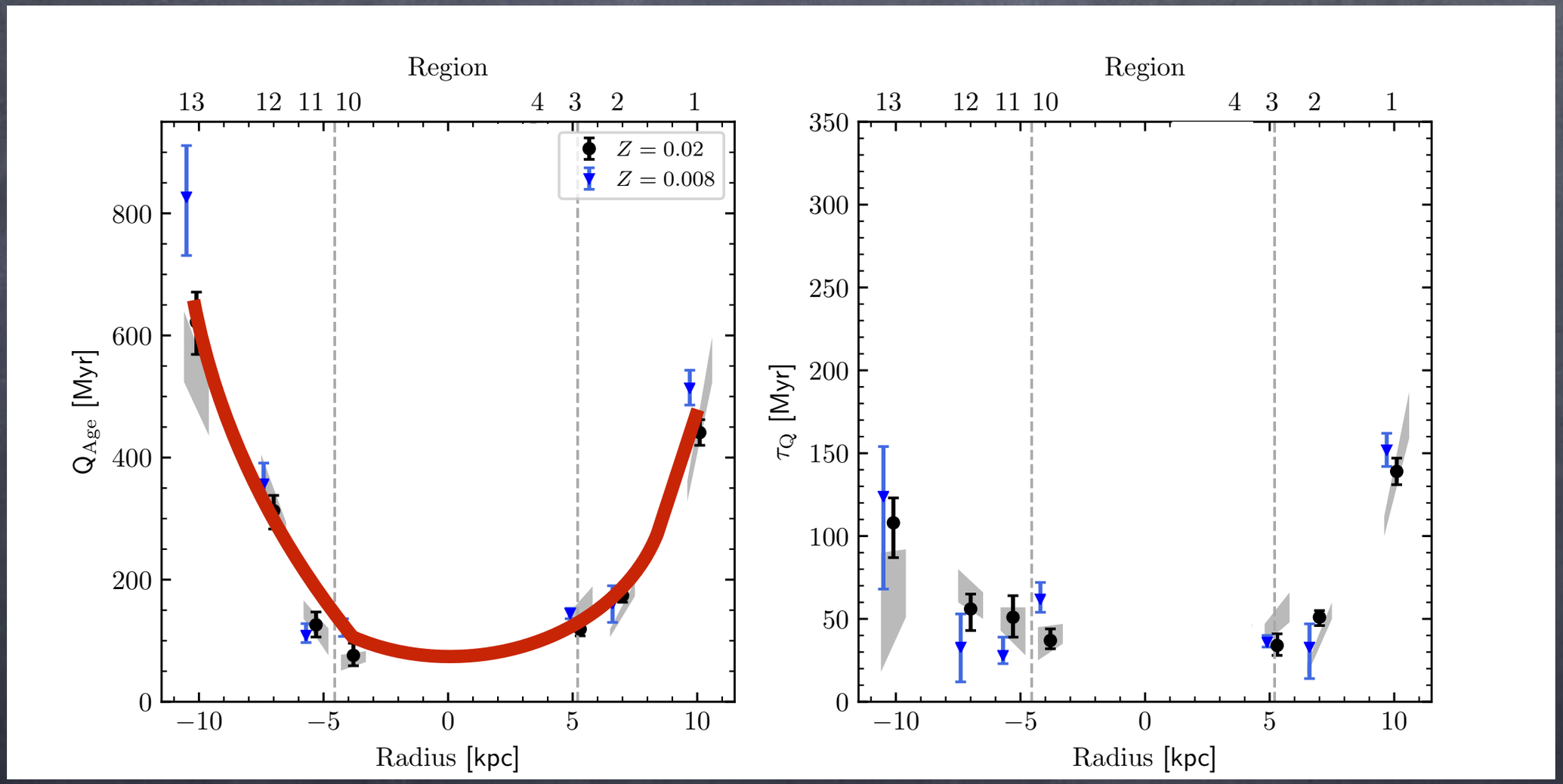
Accurate reconstruction of the RPS quenching times



Fossati et al. submitted

VESTIGE-pilot NGC4330

Accurate reconstruction of the RPS quenching times



- Outside-in quenching event, outskirts stripped first
- Short timescales, RPS event started 500 Myr ago, from simulations we estimate it will last another <1 Gyr before the SF activity is completely suppressed

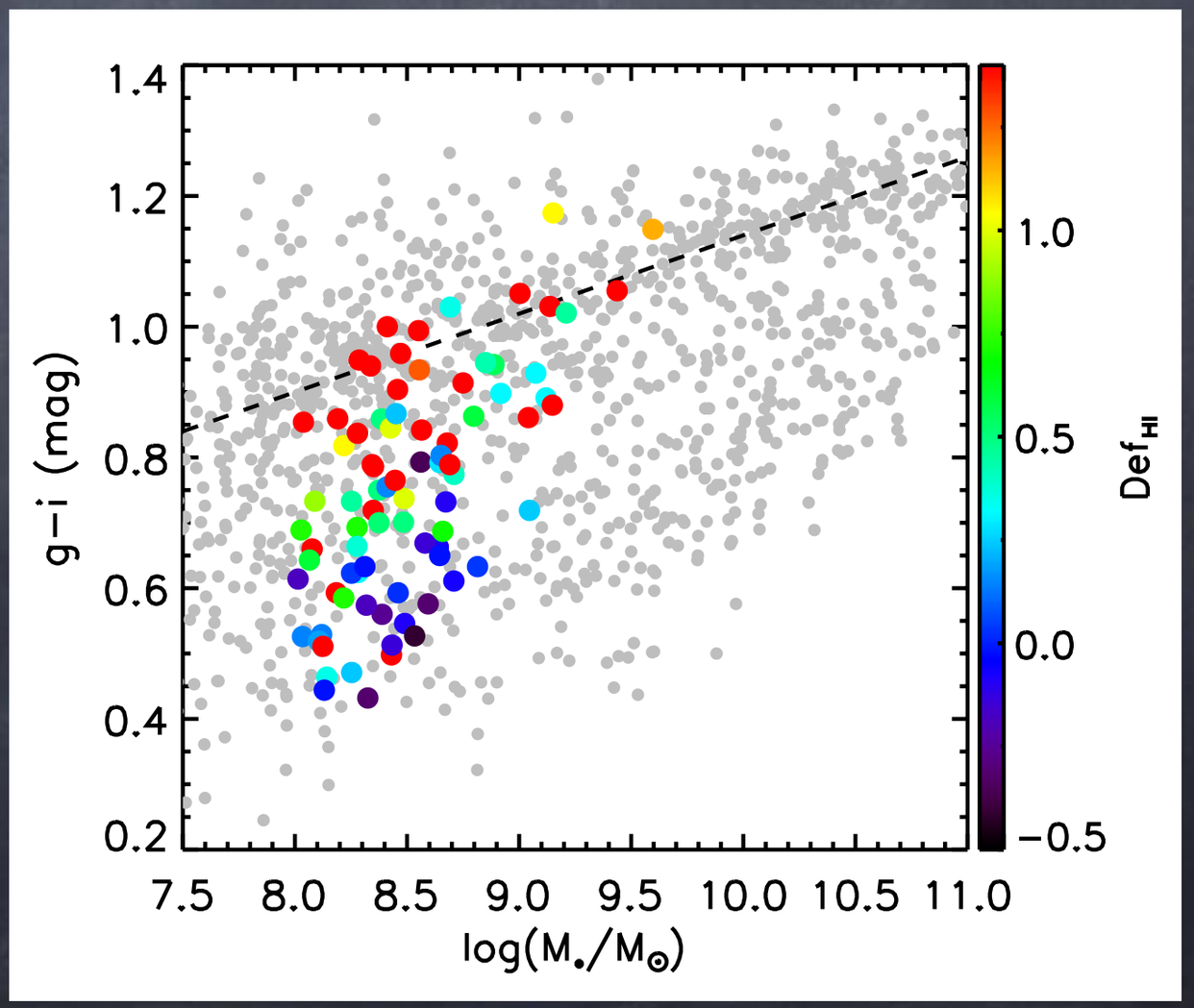
Fossati et al. submitted

A complete MUSE survey of low mass galaxies in the VIRGO cluster

- PI M. Fossati, 85 targets each one to be observed for 1h.

- Main goal: build a statistical sample of low mass galaxies (8 < logM*<9.5) and observe their path from activity to quiescence as a function of clustercentric distance, stellar mass. Strong synergies with imaging surveys in VIRGO (e.g. Galex, NGVS, VESTIGE, Herschel)
  - Detect RPS tails and characterise their ionization properties in a relatively large sample.
  - Reconstruct SF histories of galaxies which are being transformed by the environment

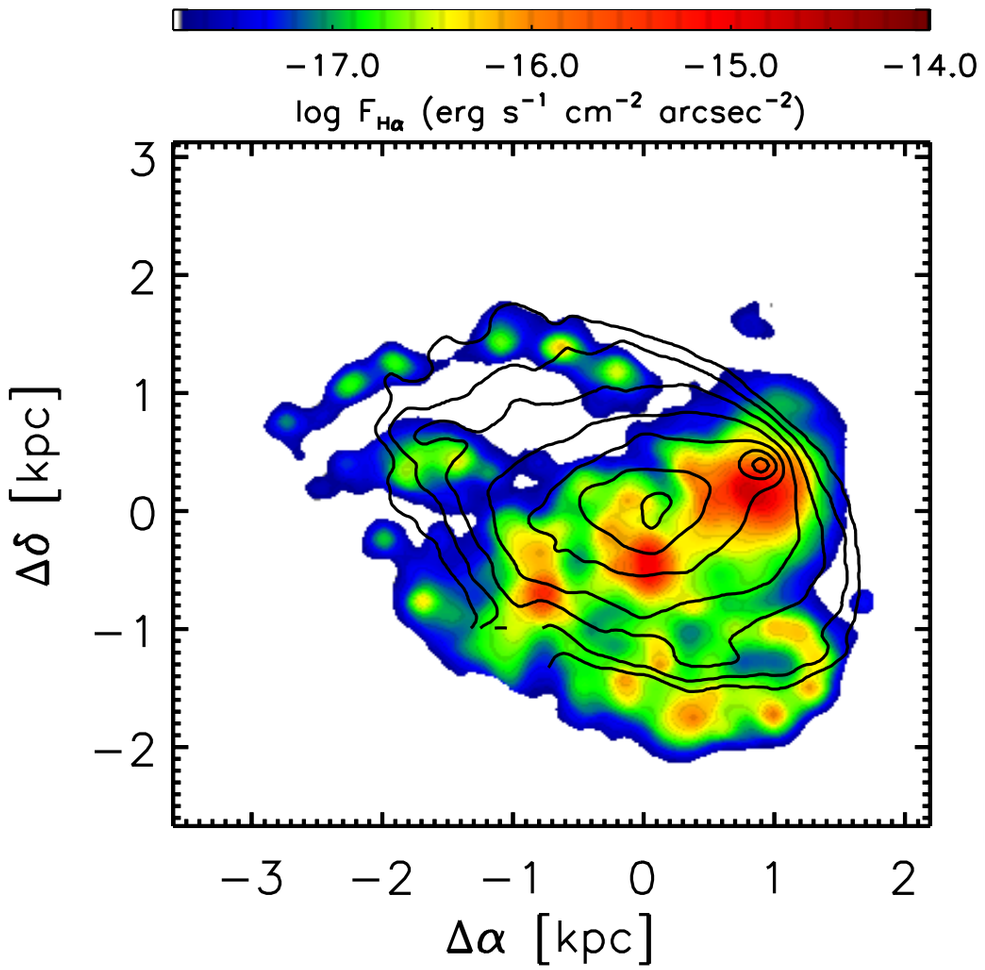
Time allocated in P98 (7 galaxies observed) and in P99, proposed again for the following periods



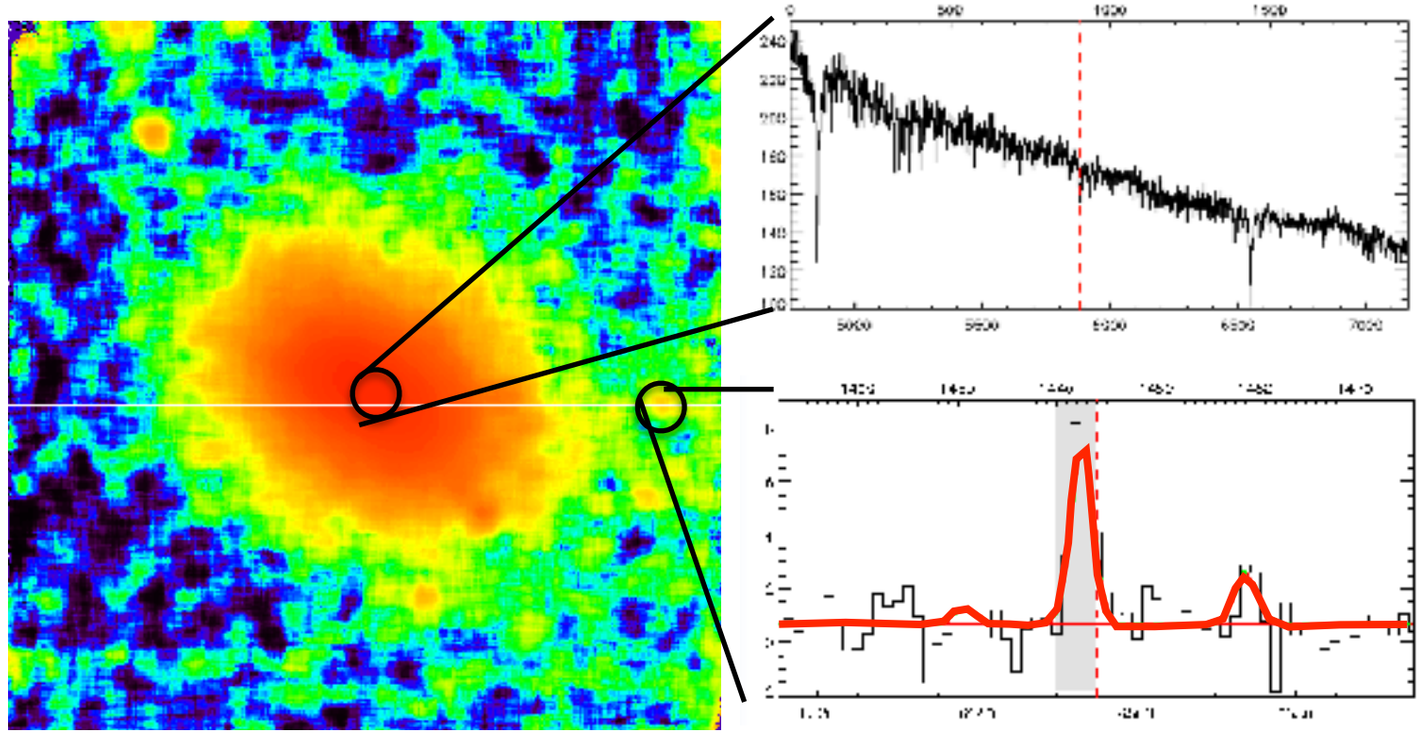
A complete MUSE survey of low mass galaxies in the VIRGO cluster

- P98 observations

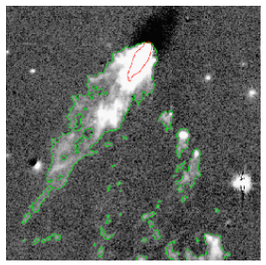
VCC415



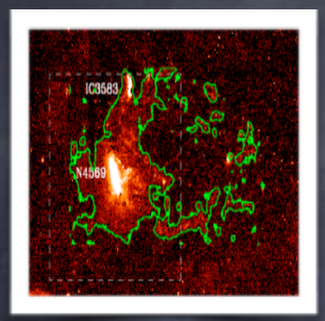
VCC1499



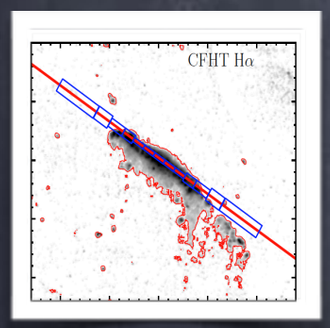
Conclusions



Signatures of gas stripping phenomena are ubiquitous in local massive clusters (e.g. detection of ionised gas tails, truncated radial profiles, short quenching times).



VESTIGE is probing the Virgo cluster with unprecedented area and depth



Monte Carlo methods coupled with state of the art models can robustly derive the age since the quenching event in case of RPS

Full statistical picture in the next two years with full VESTIGE survey and follow-up spectroscopic observations