Testing AGN impact on SF: a single source and a statistical sample.

Vincenzo Mainieri

G. Cresci, M. Brusa, A. Marconi
M. Bonzini, J. Silverman, M. Perna
F. Fiore, C. Feruglio, R. Maiolino

Motivations/goals

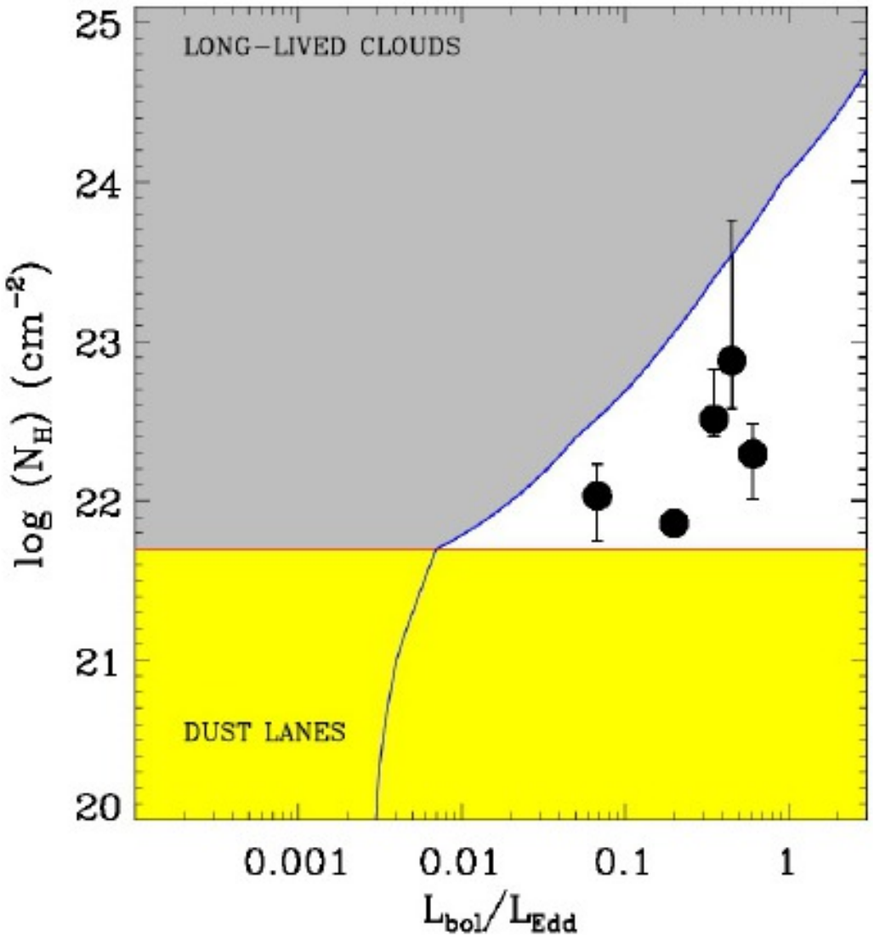
- ✧ Study how radio-quiet AGNs can affect their host galaxies (e.g. quenching/triggering SF).
- ✧ In the redshift range 1<z<3 (e.g. peak of the AGN activity, peak of the SFRD)

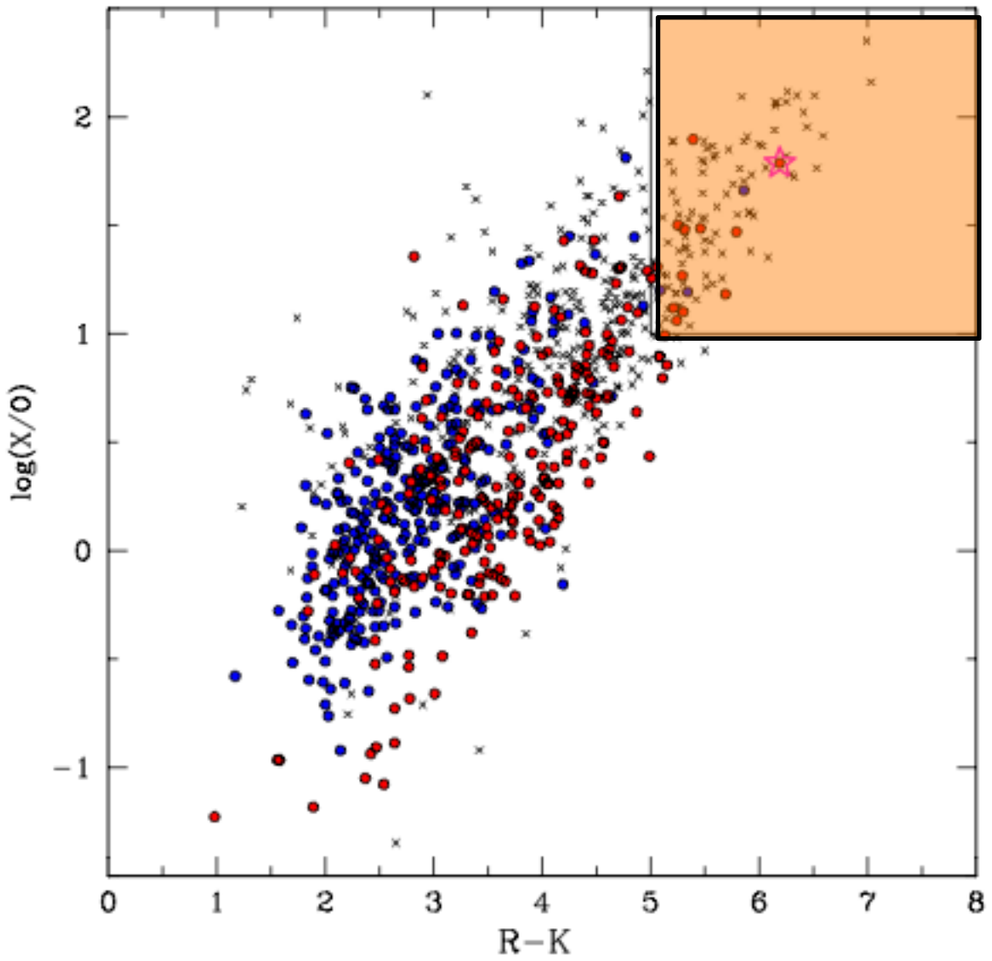
A single source in great details (IFU)

A statistical sample (stacking of opt spectra)

A single source in great details

Catching an AGN where the gas is being expelled

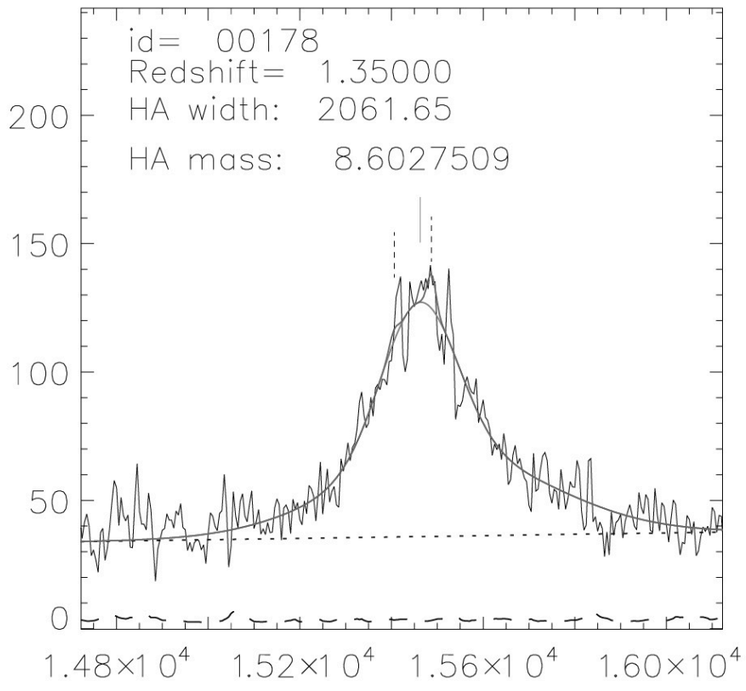




SINFONI noAO J-band observations (Feb-Mar 2014, PI Mainieri)

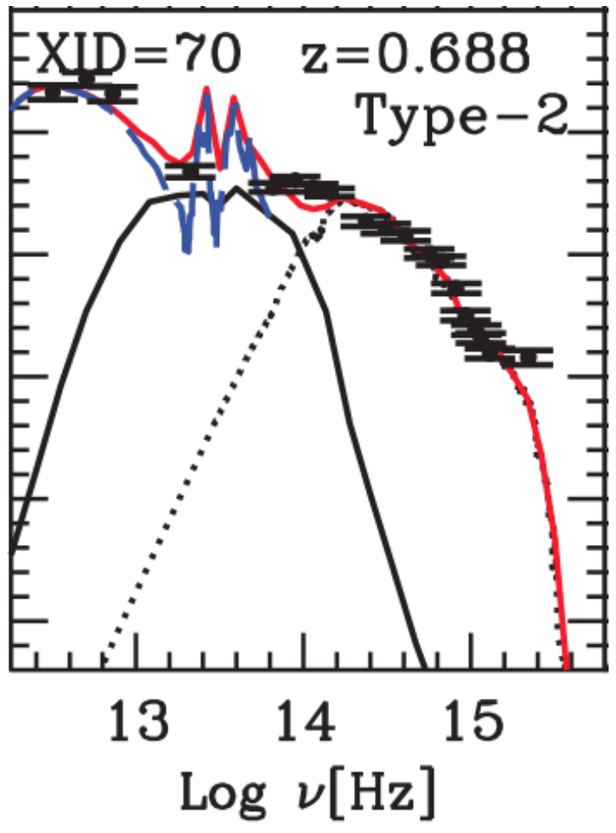
Ingredients

M_{BH}



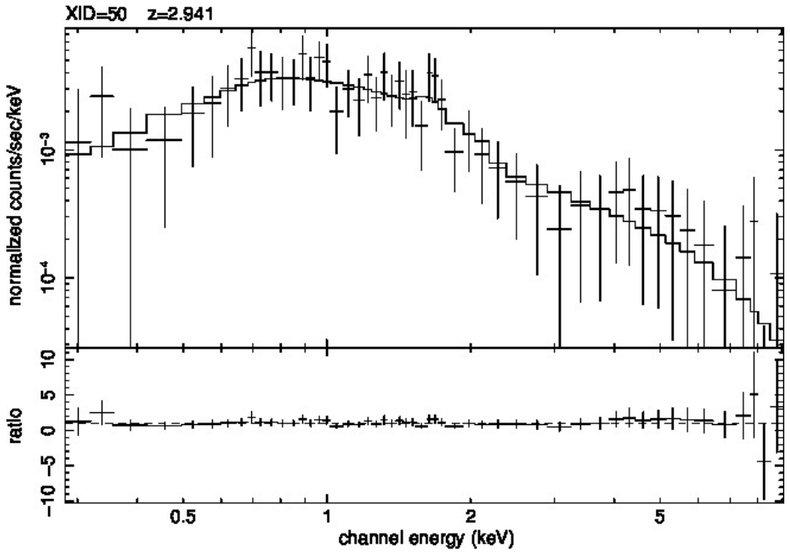
Silverman+13
Matsuoka+13

L_{bol}



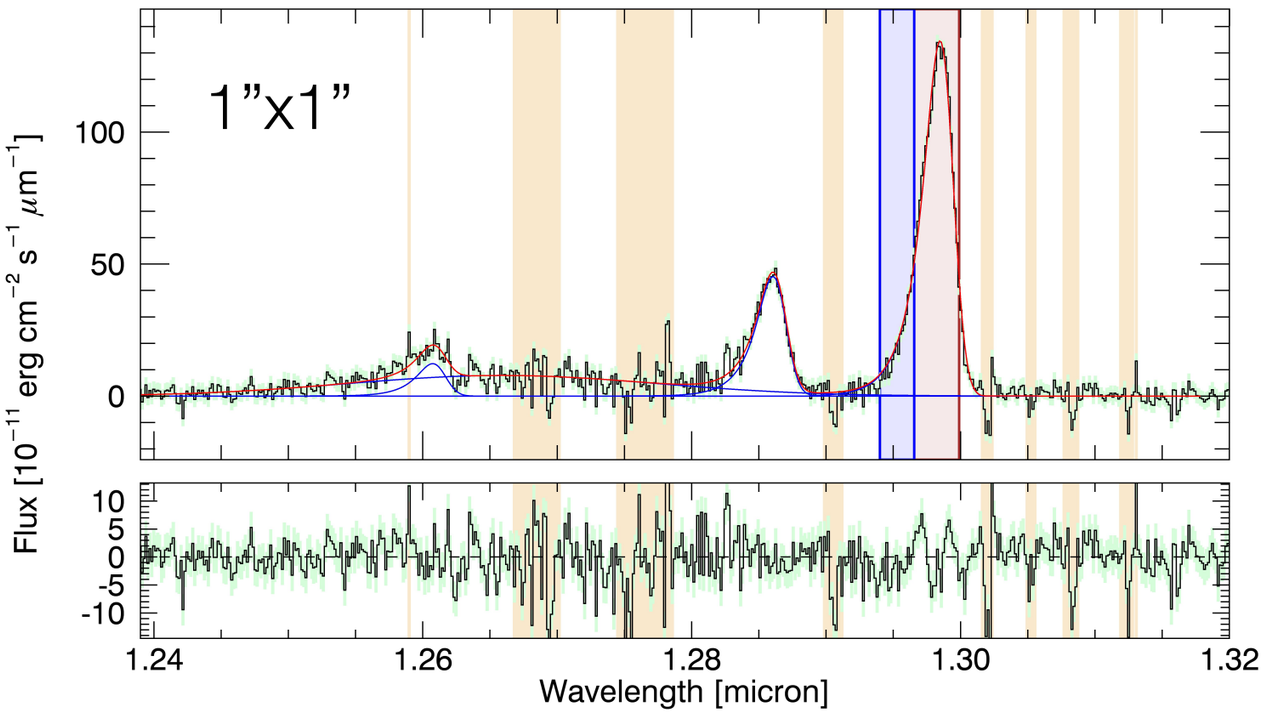
Lusso+12

N_H



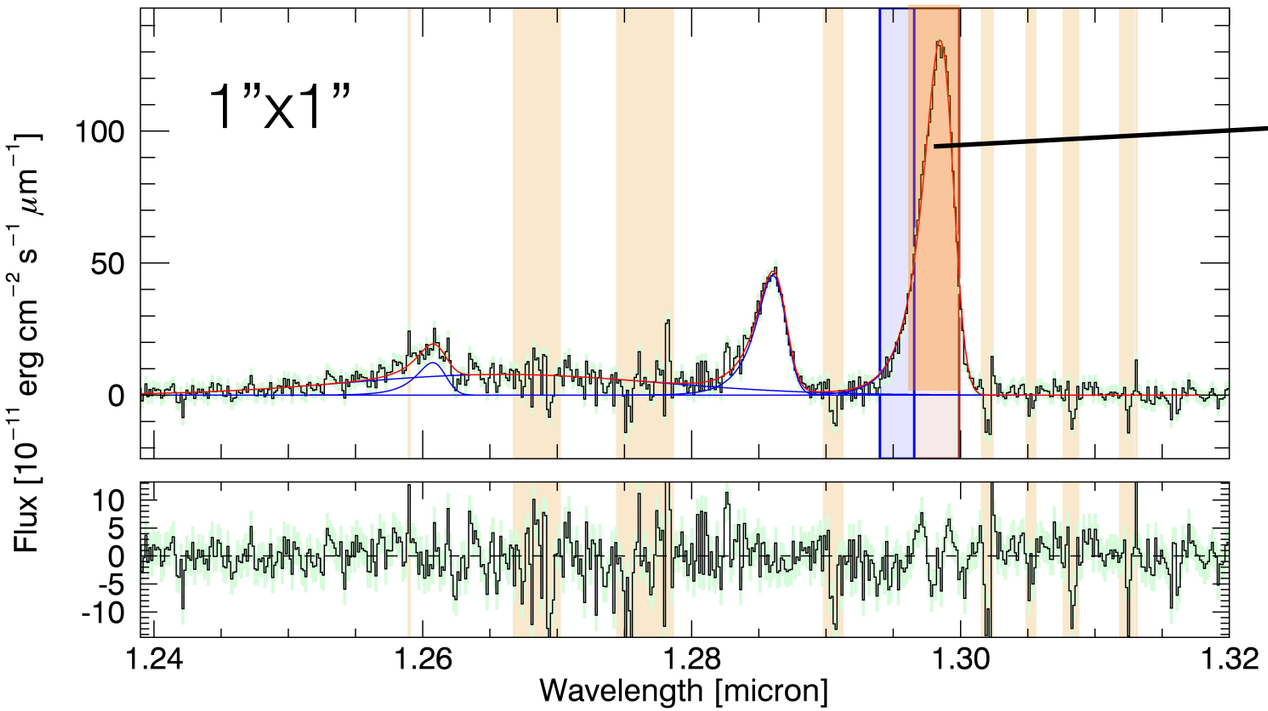
Mainieri+07
Lanzuisi+12

SINFONI/VLT J-band

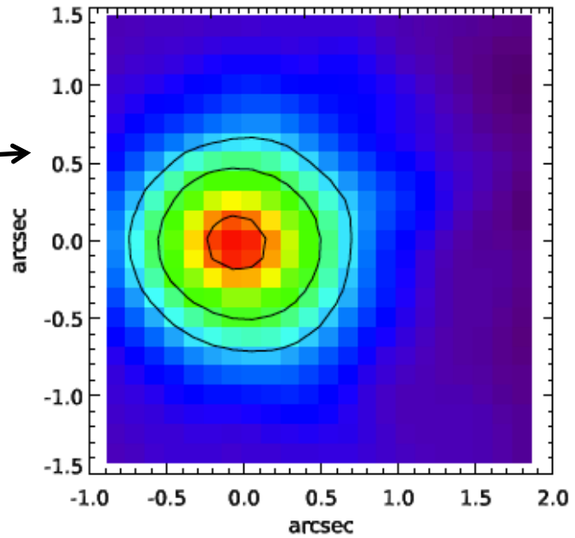


Scale 250x125 mas, noAO
6 hours on target
z=1.594
L(AGN)~2 x 10^46 erg/s
q_{24}=1.36
$M_{BH}(H\alpha)$~2.7 x 10^9 $M_\odot$

SINFONI/VLT J-band



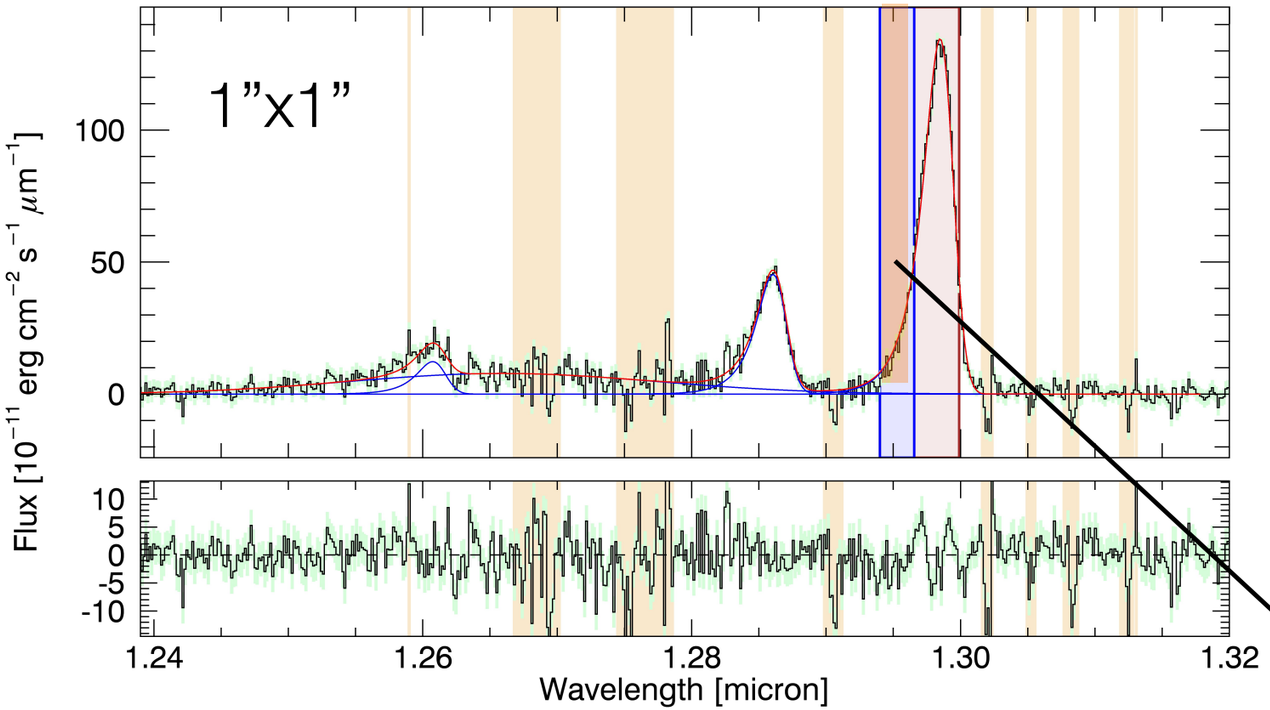
[OIII] core



1.296<λ<1.300 μm

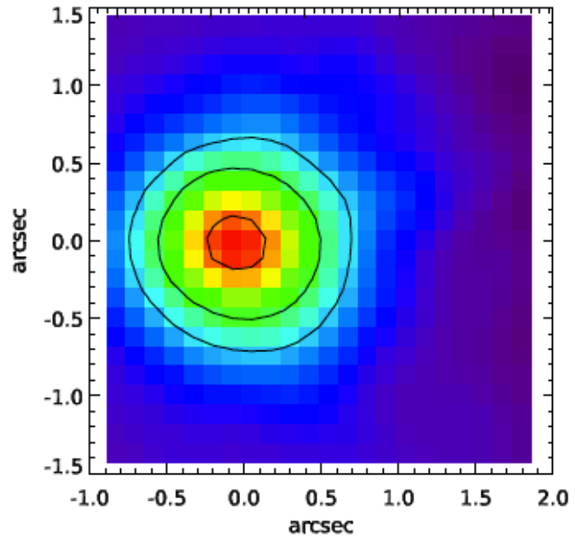
Scale 250x125 mas, noAO
6 hours on target
z=1.594
L(AGN)~2 x 10^46 erg/s
q_{24}=1.36
M_{BH}(Hα)~2.7 x 10^9 $M_\odot$

SINFONI/VLT J-band



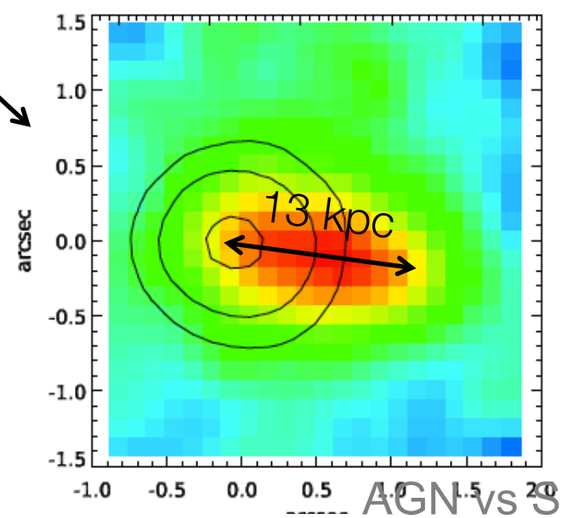
Scale 250x125 mas, noAO
6 hours on target
z=1.594
L(AGN)~2 x 10^46 erg/s
q_{24}=1.36
$M_{BH}(H\alpha)$~2.7 x 10^9 $M_\odot$

[OIII] core



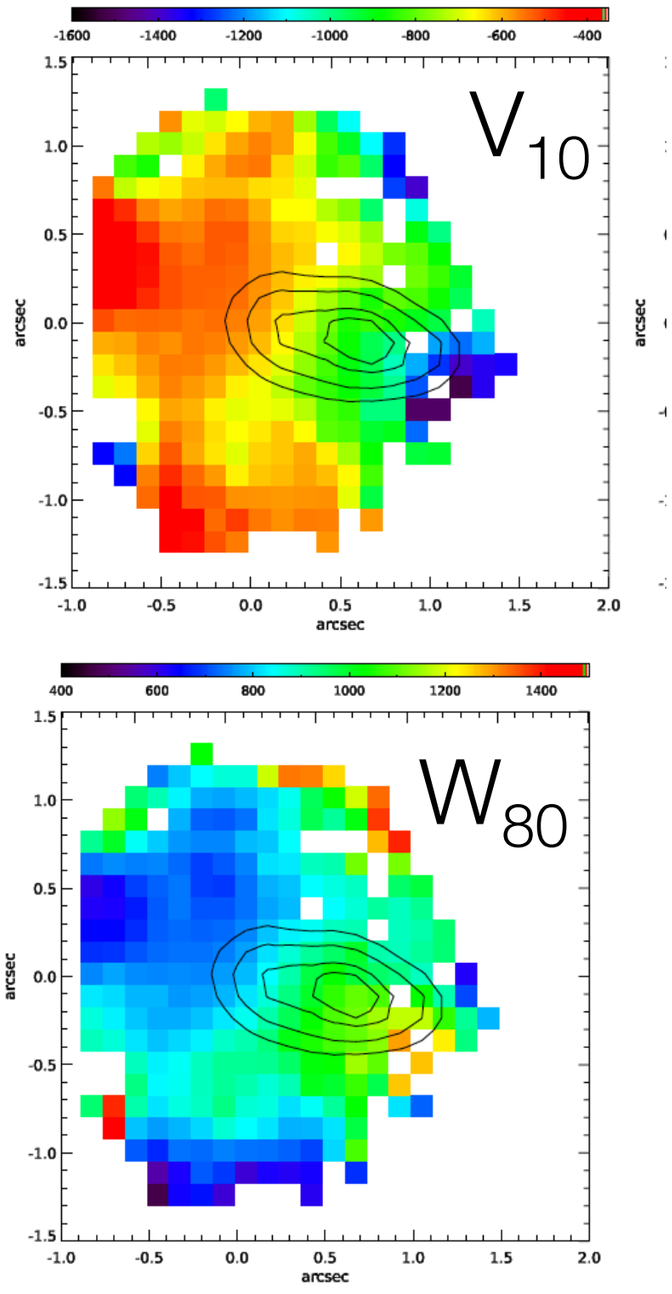
1.296<λ<1.300 μm

[OIII] blue wing



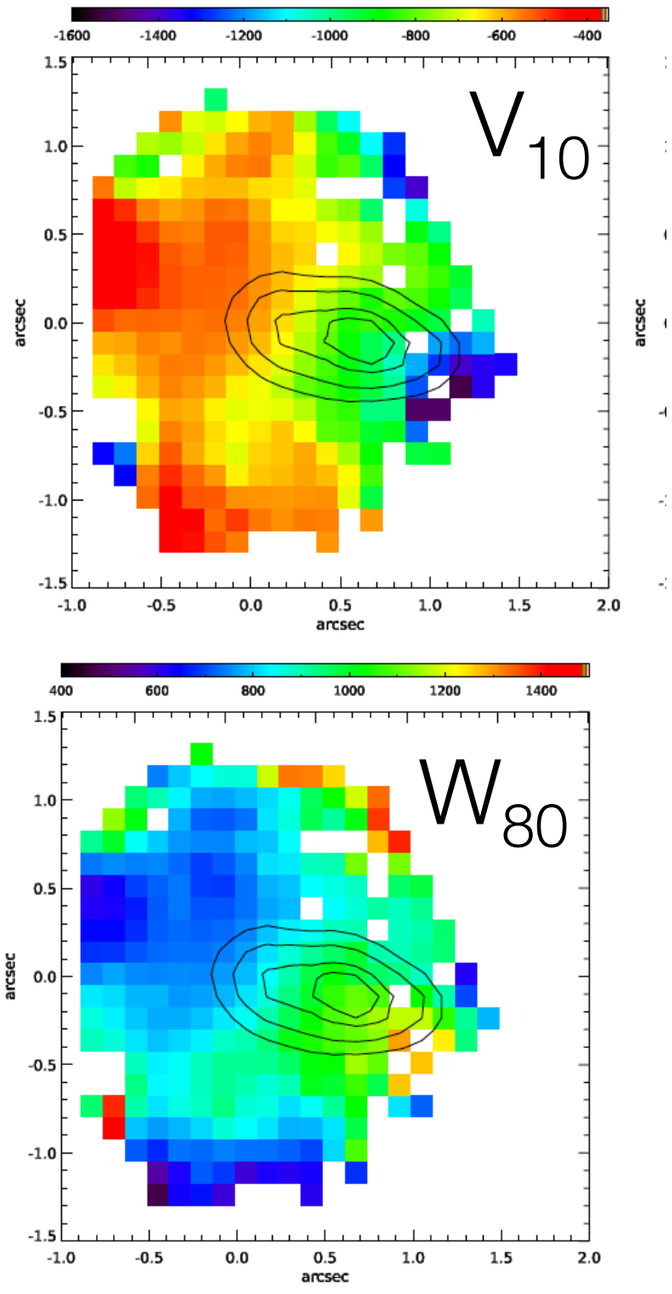
1.294<λ<1.296 μm

SINFONI/VLT J-band: outflow properties



- V_{10} ~ -1500 km/s

SINFONI/VLT J-band: outflow properties



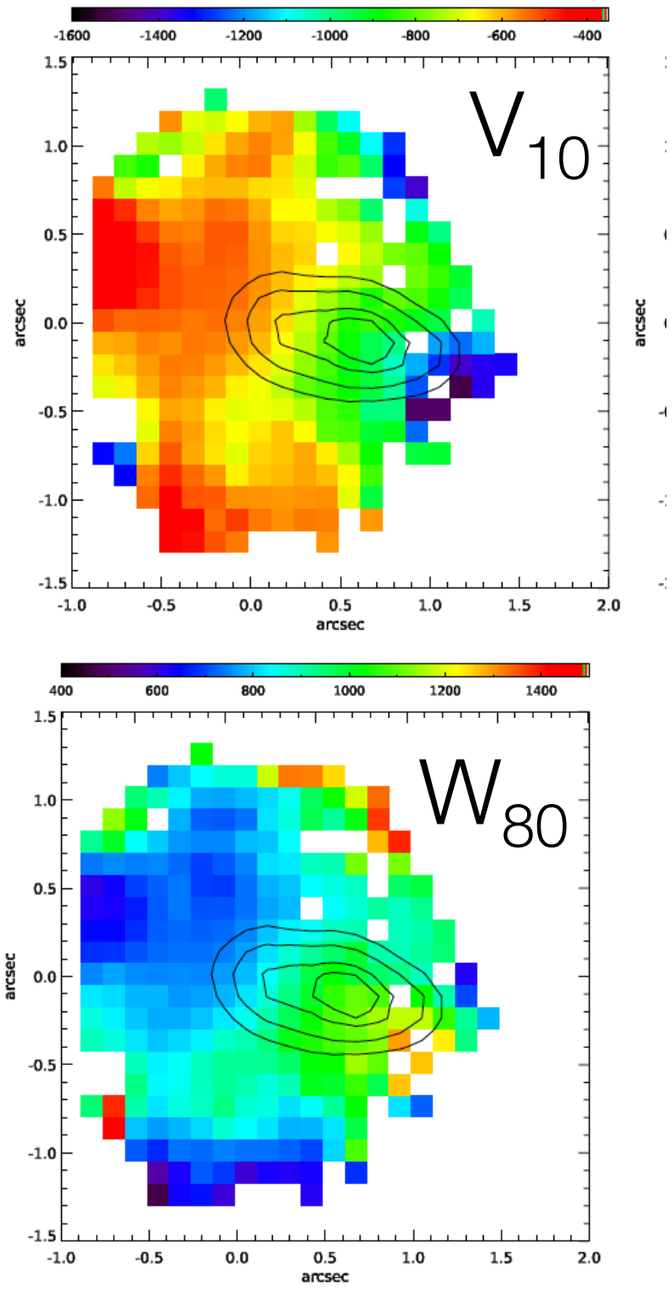
- V_{10} ~ -1500 km/s
- $M_{ion} > 8.5 \times 10^8 M_\odot$

$$M_{ion} = 2.82 \bullet 10^9 \left(\frac{L_{H\beta}}{10^{43} ergs^{-1}} \right) \left(\frac{n_e}{100 cm^{-3}} \right)^{-1}$$

[Osterbrock & Ferland 2006]

Assuming n_e =100 cm^{-3}

SINFONI/VLT J-band: outflow properties

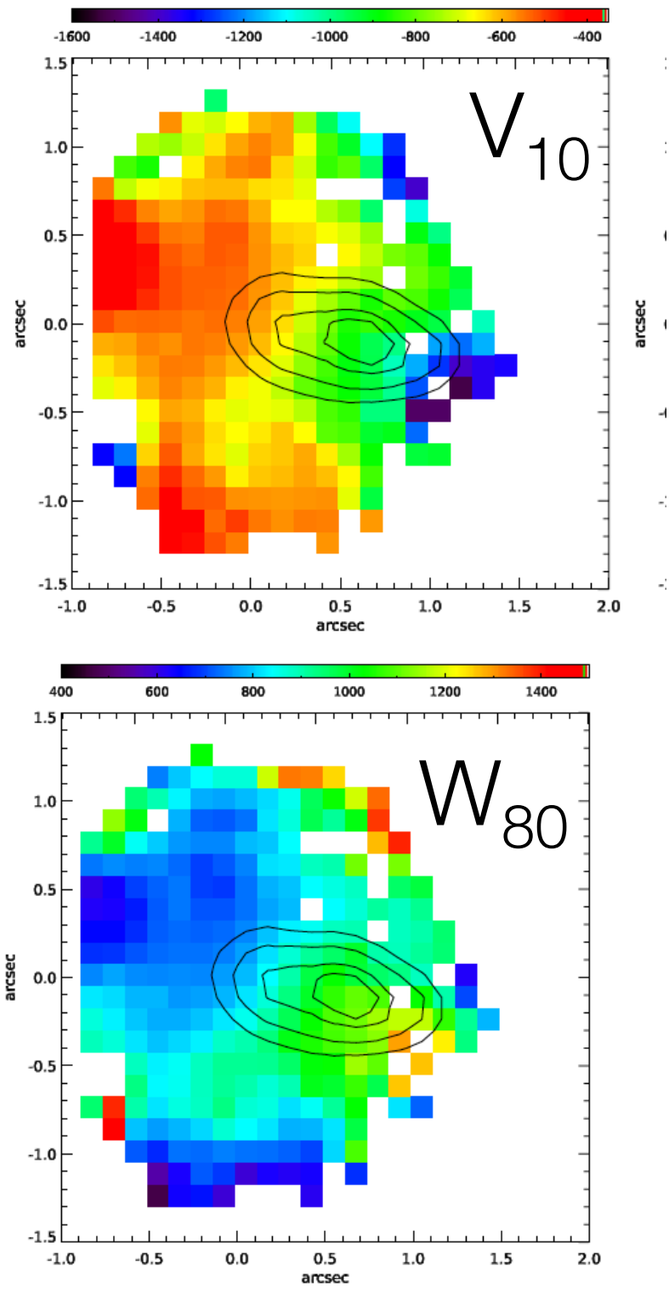


- V_{10} ~ -1500 km/s
- $M_{ion} > 8.5 \times 10^8 M_\odot$
- $T_d \approx R_{out} / v_{out} \sim 8.5$ Myr
- $M_{out,ion} > 300 M_\odot$/yr

$$\dot{M} \approx \langle \rho_{out} \rangle_V \bullet \Omega R_{out}^2 \bullet v_{out} = 3 \bullet v_{out} \bullet \frac{M_{out}}{R_{out}}$$

Bi-conical outflow uniformly filled with outflowing clouds

SINFONI/VLT J-band: outflow properties



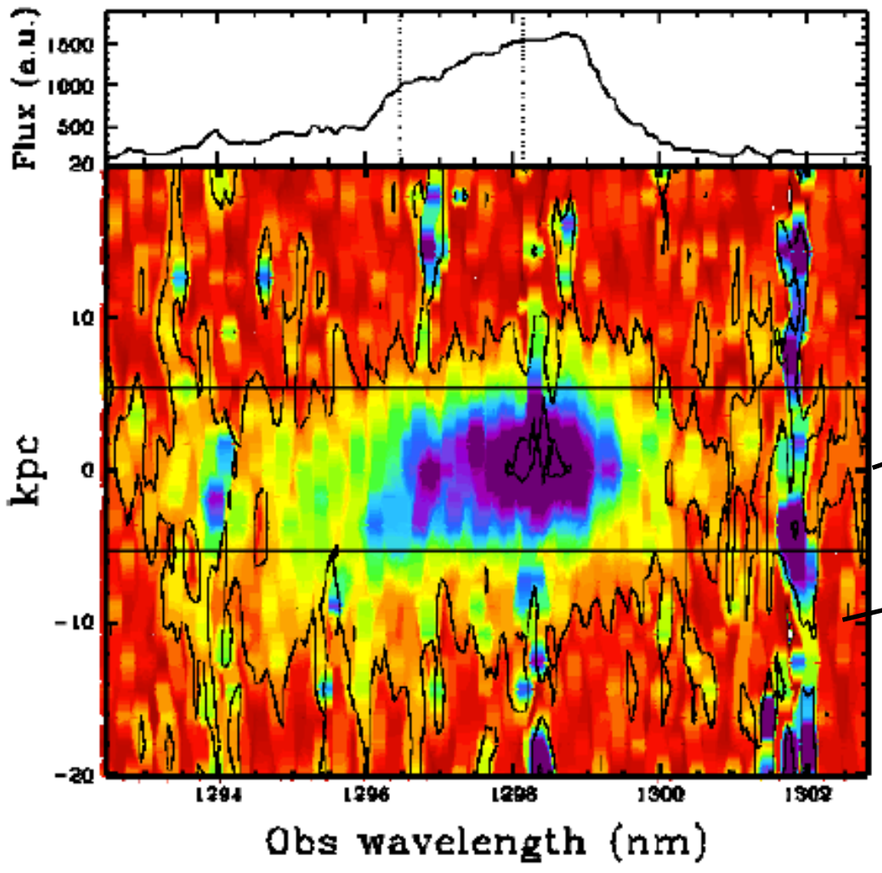
- V_{10} ~ -1500 km/s
- $M_{ion} > 8.5 \times 10^8 M_\odot$
- $T_d \approx R_{out} / v_{out} \sim 8.5$ Myr
- $M_{out,ion} > 300 M_\odot$/yr
- $P_{kin,tot} > 0.5 M_{out} v_{out}^2 = 5.3 \times 10^{44}$ erg s^{-1}

What powers the outflow?

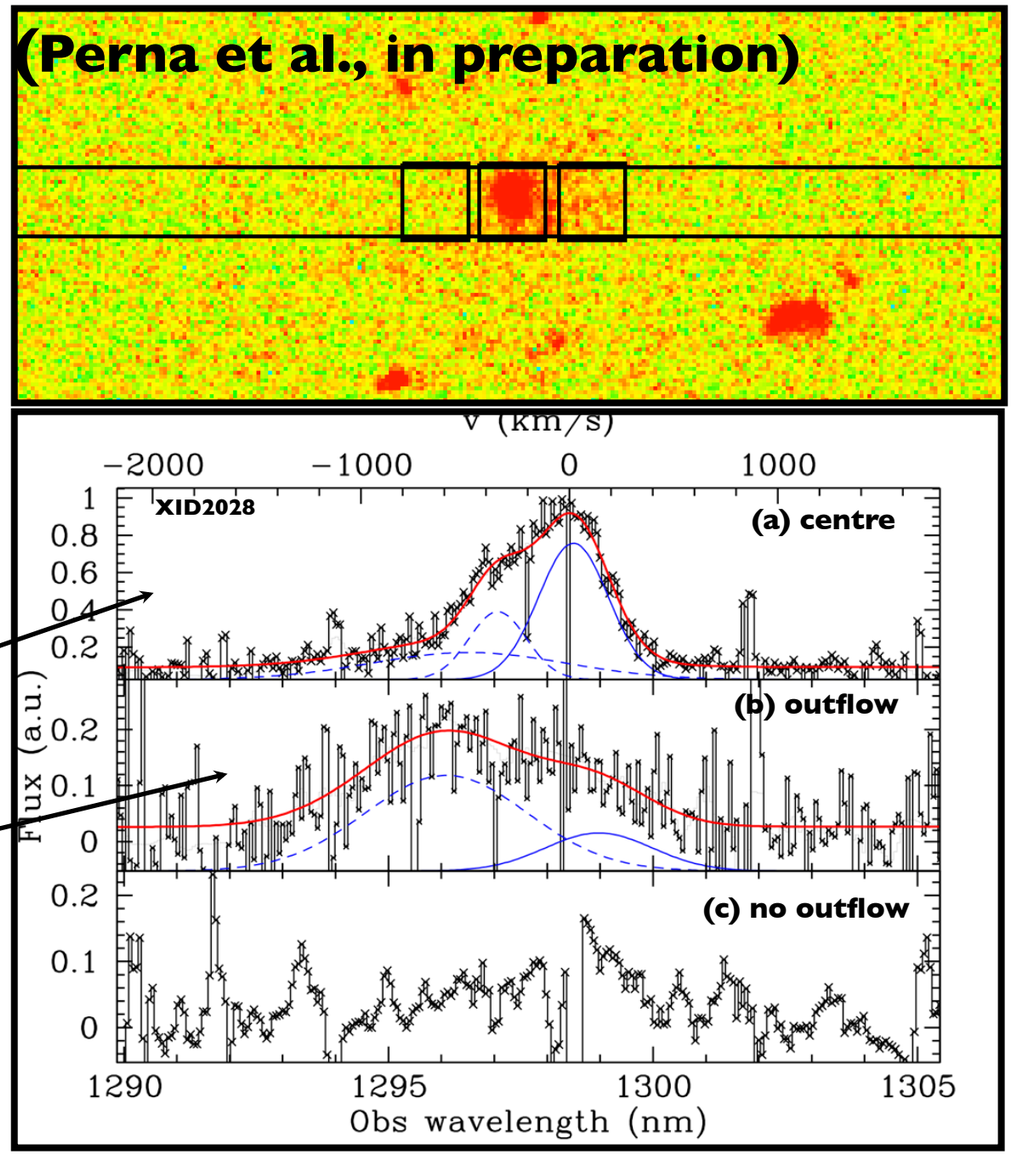
$P(SF) \sim 7 \times 10^{41} \times SFR(M_\odot/yr)$ [Veilleux+05]

$P_{kin,tot} / P(SF) \sim 2.5$

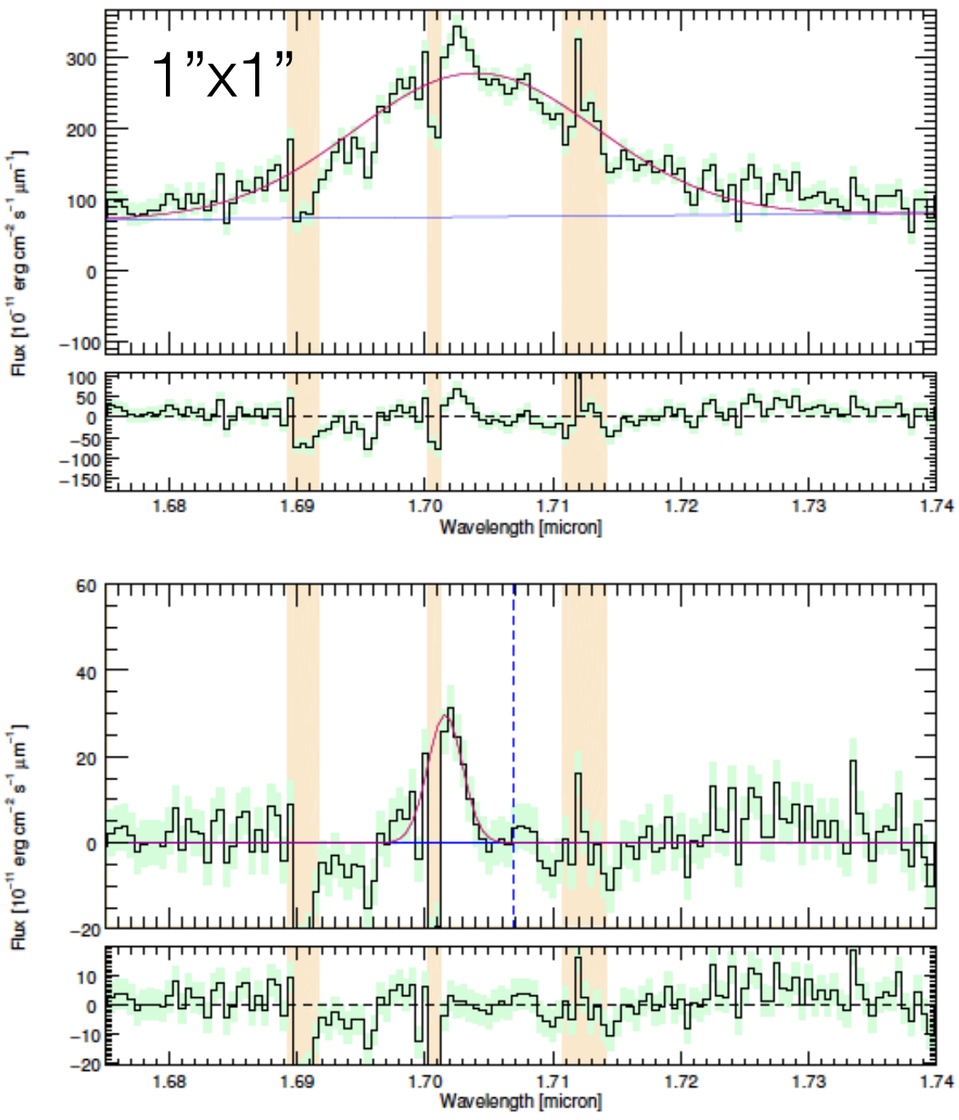
X-shooter/VLT spectroscopy (PI Brusa)



Brusa+14



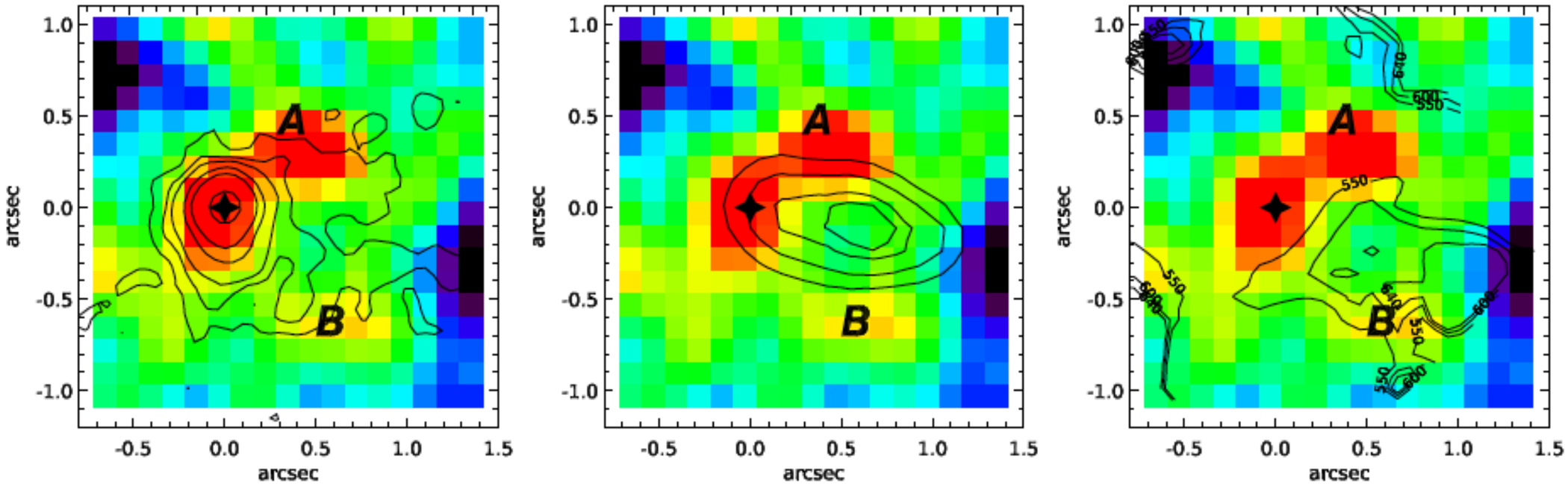
SINFONI/VLT H-band



H+K archival observations
Scale 250x125 mas, noAO
20 min on target
SFR (narrow Ha) ~ 230 $M_\odot$/yr
SFR (PACS Herschel) ~ 275 $M_\odot$/yr

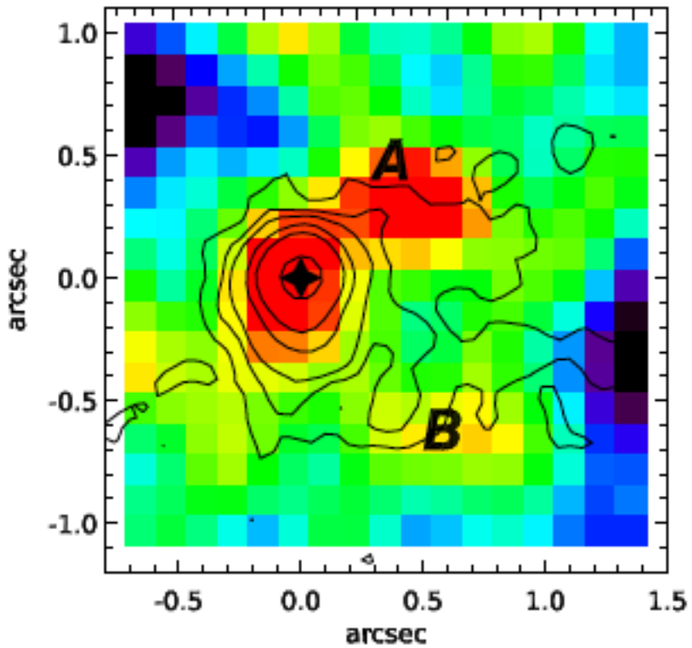
SINFONI/VLT H-band: positive and negative feedback

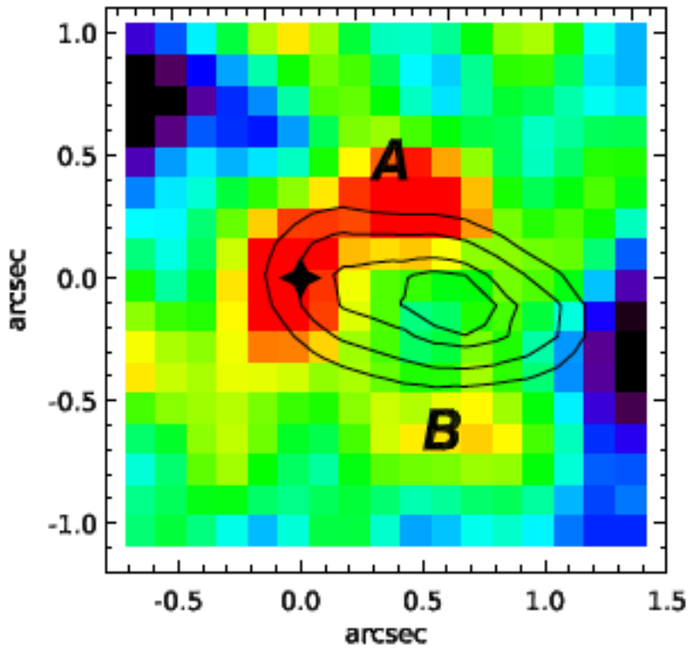
Cresci, VM, et al., submitted

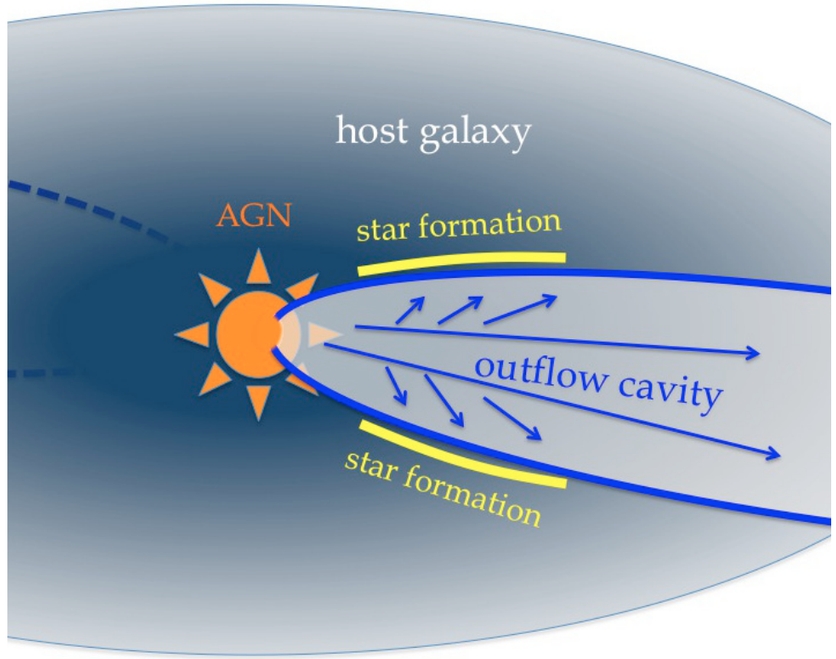


SINFONI/VLT H-band: positive and negative feedback

Cresci, VM, et al., submitted

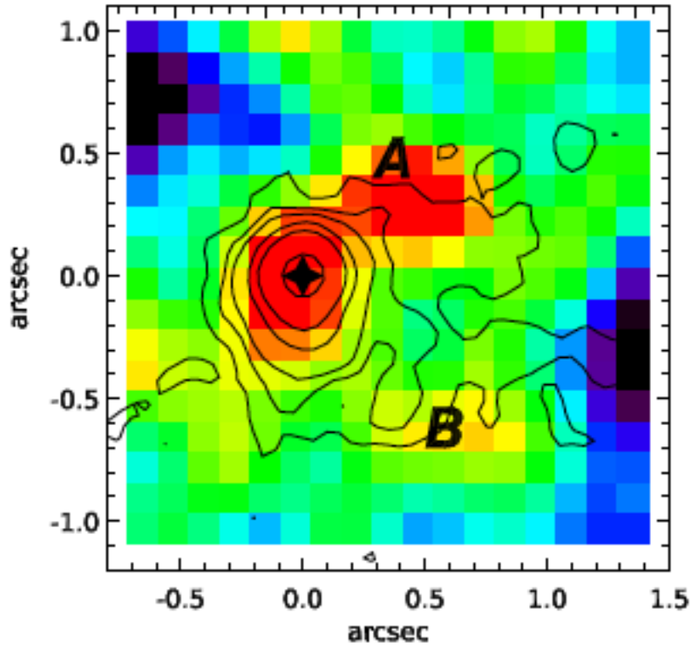


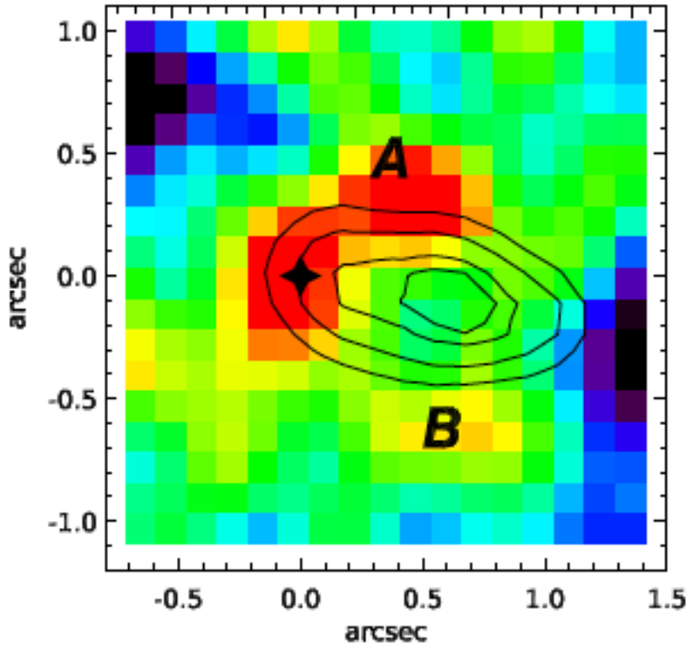


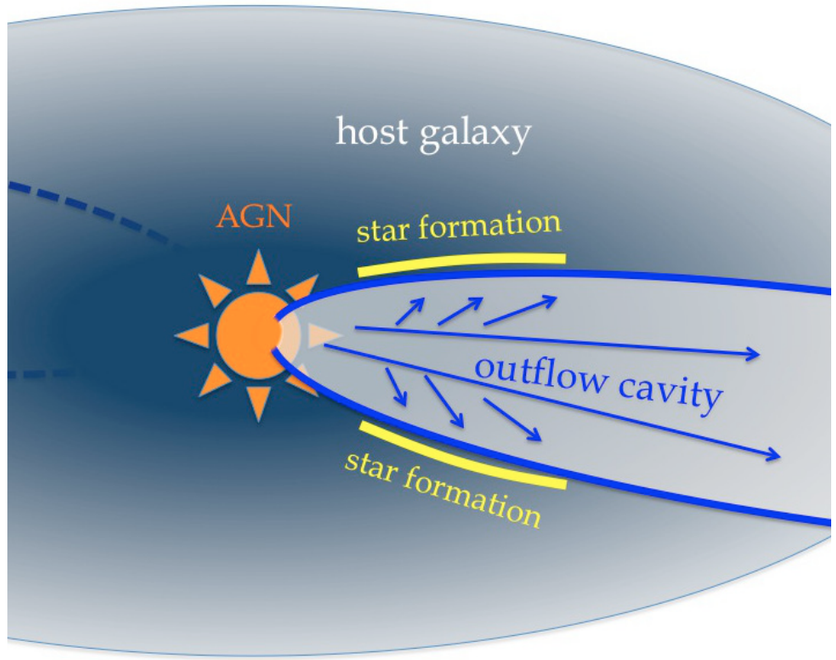


SINFONI/VLT H-band: positive and negative feedback

Cresci, VM, et al., submitted







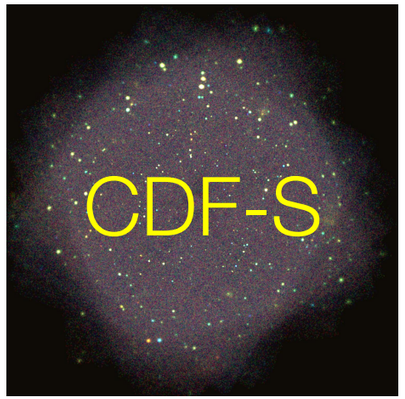
- SF in blobs A&B: log([NII]/Hα)<-1.1
- Casual connection outflow-SF: highly asymmetric shape of the SF regions

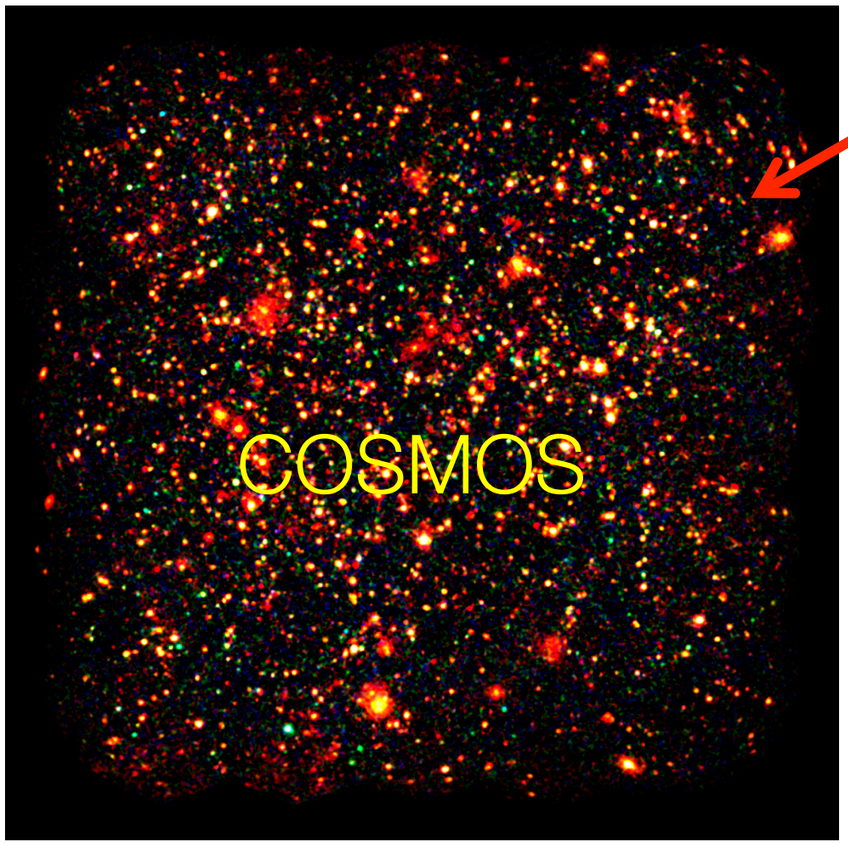
A statistical sample: stacking

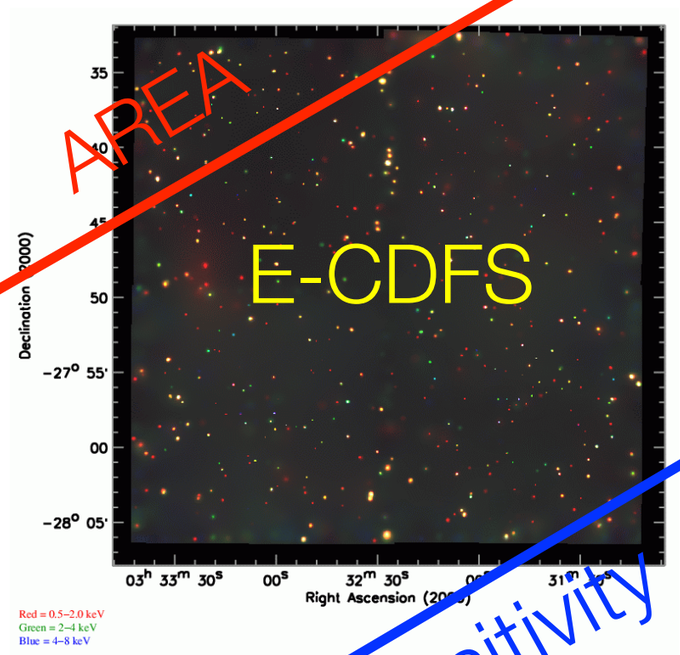
Testing AGN impact on SF: the SFR vs M_* plane

Testing AGN impact on SF: the SFR vs M_* plane

- X-ray selected sample of AGN: $L_X(2\text{-}10keV) > 10^{42}$ erg s^{-1}





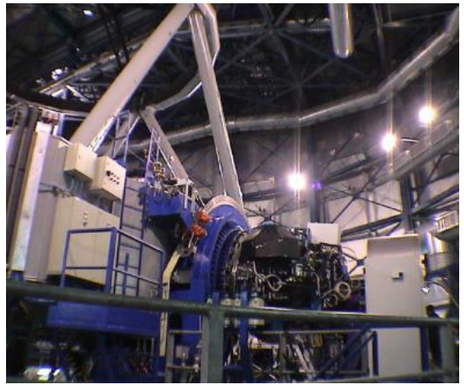


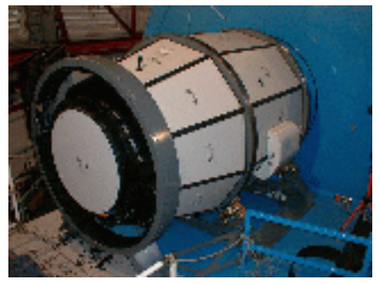
AREA

Sensitivity

Testing AGN impact on SF: the SFR vs M_* plane

- X-ray selected sample of AGN: $L_X(2\text{-}10keV) > 10^{42}$ erg s^{-1}
- High quality optical spectra: VIMOS, FORS1-2, IMACS

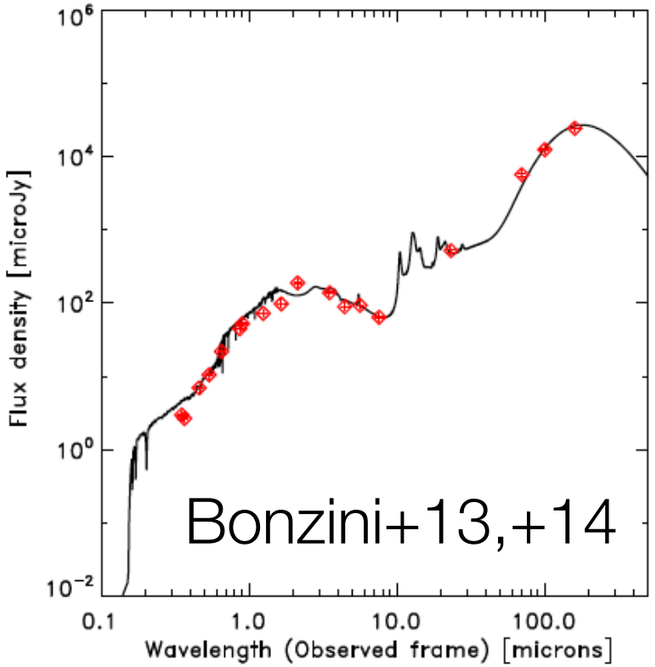


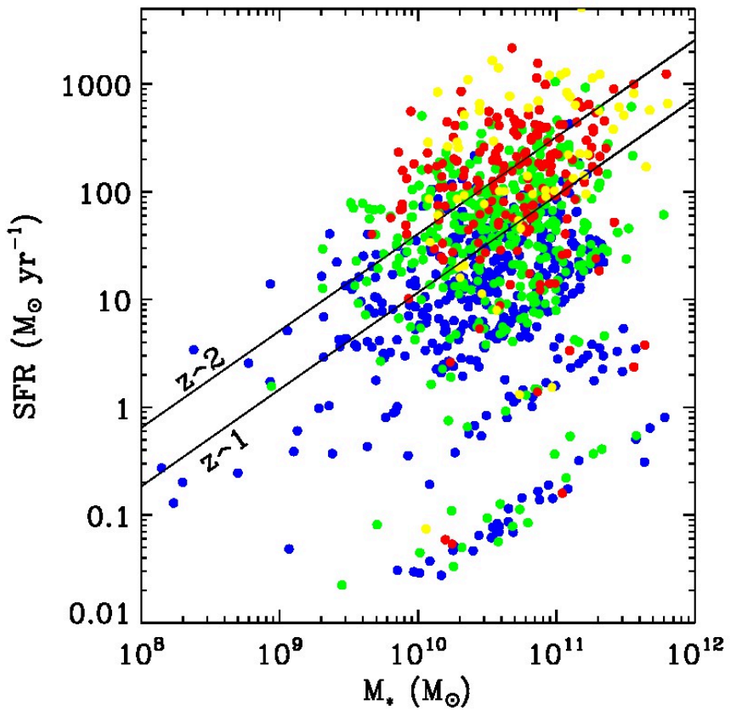


Testing AGN impact on SF: the SFR vs M_* plane

- X-ray selected sample of AGN: $L_X(2\text{-}10keV) > 10^{42}$ erg s^{-1}
- High quality optical spectra: VIMOS, FORS1-2, IMACS
- PACS/Herschel detection or PACS ul and 24μm detection

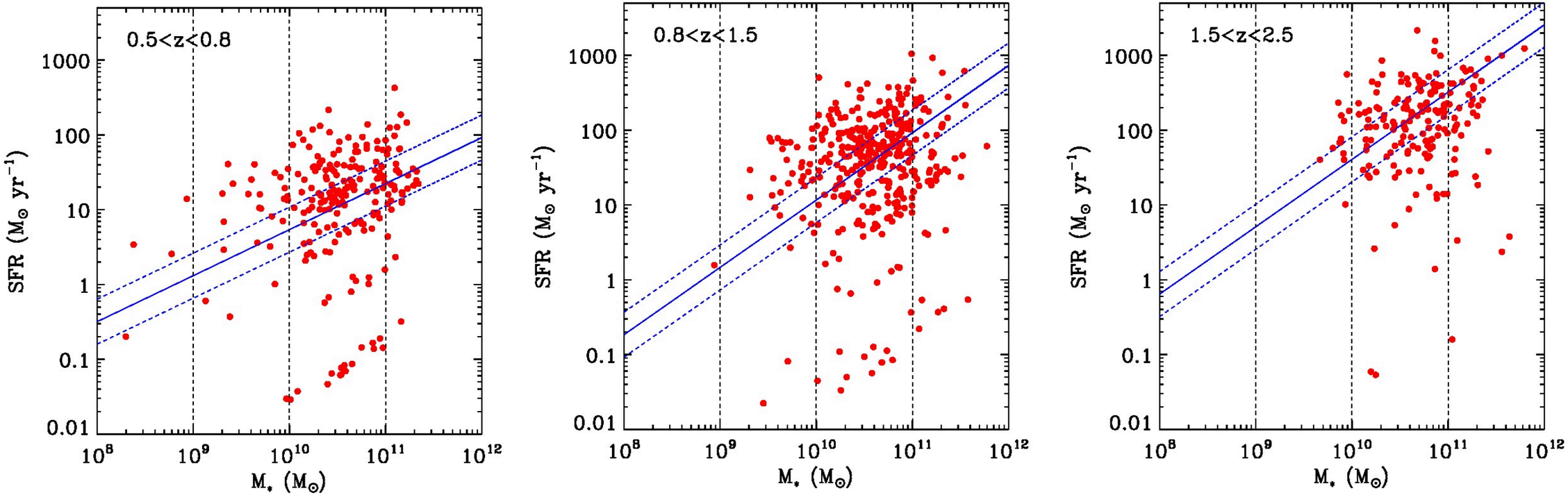
2361 AGNs



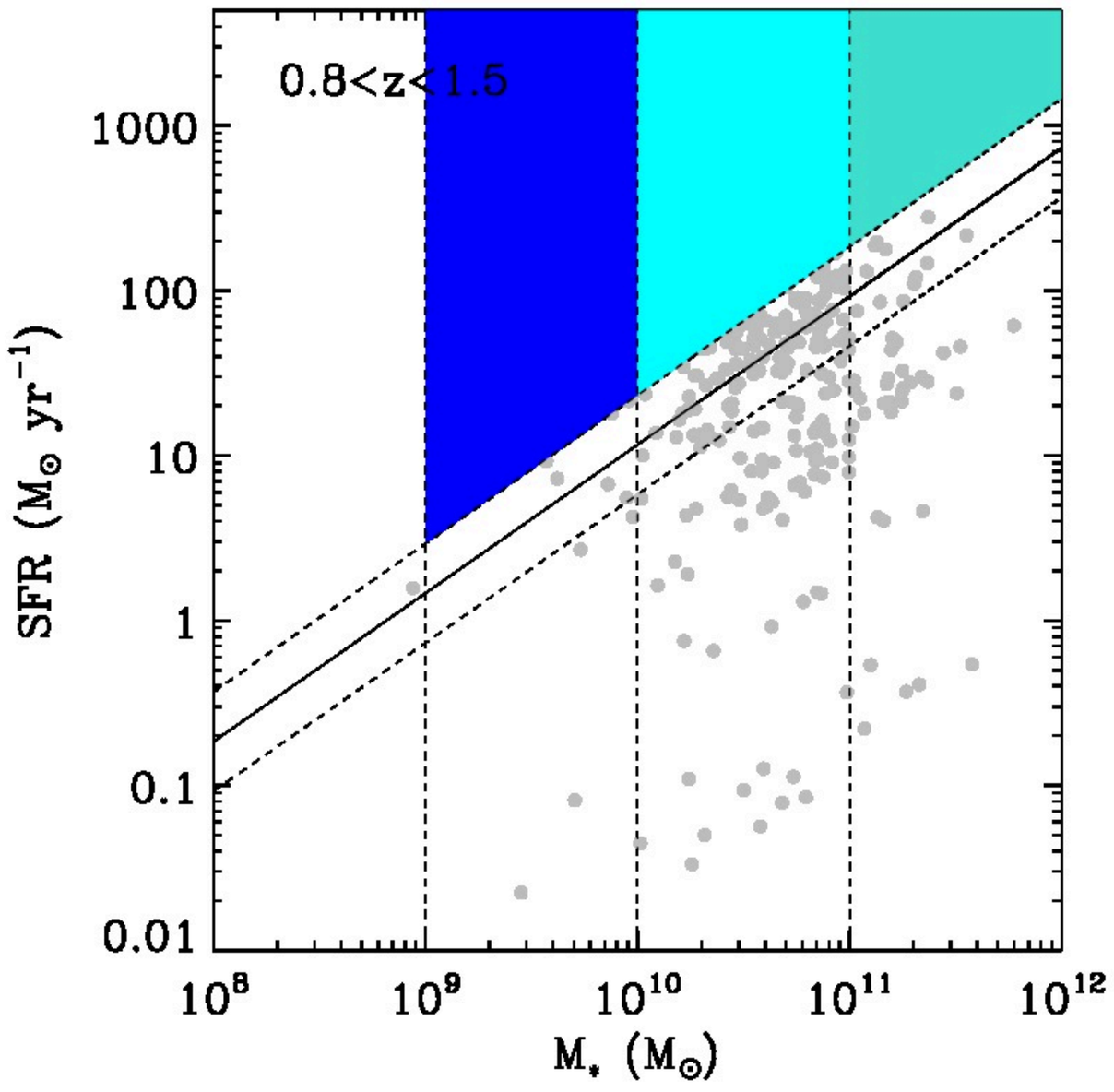


Testing AGN impact on SF: the SFR vs M_* plane

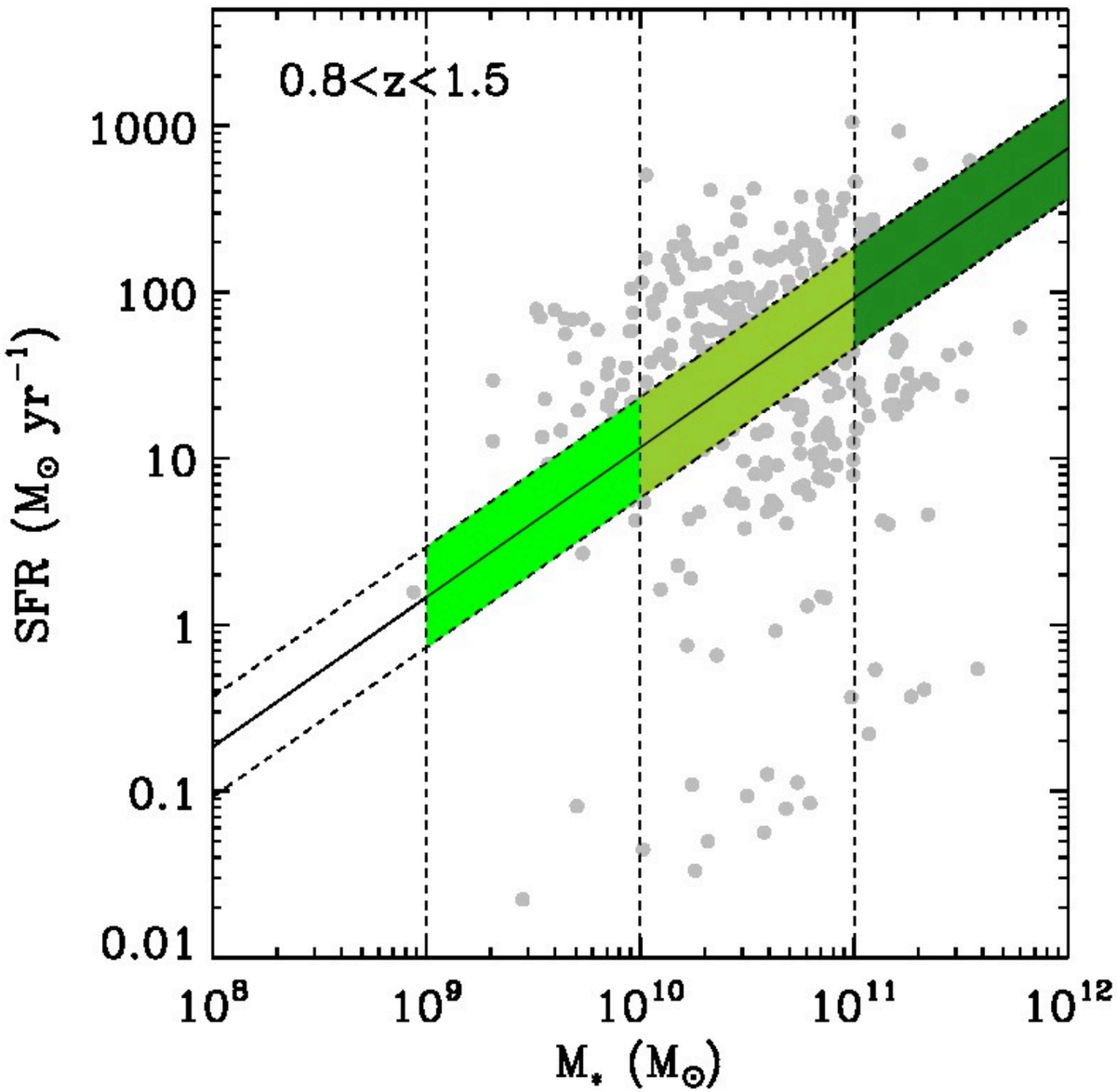
- X-ray selected sample of AGN: $L_X(2\text{-}10keV) > 10^{42}$ erg s^{-1}
- High quality optical spectra: VIMOS, FORS1-2, IMACS
- PACS/Herschel detection or PACS ul and 24μm detection



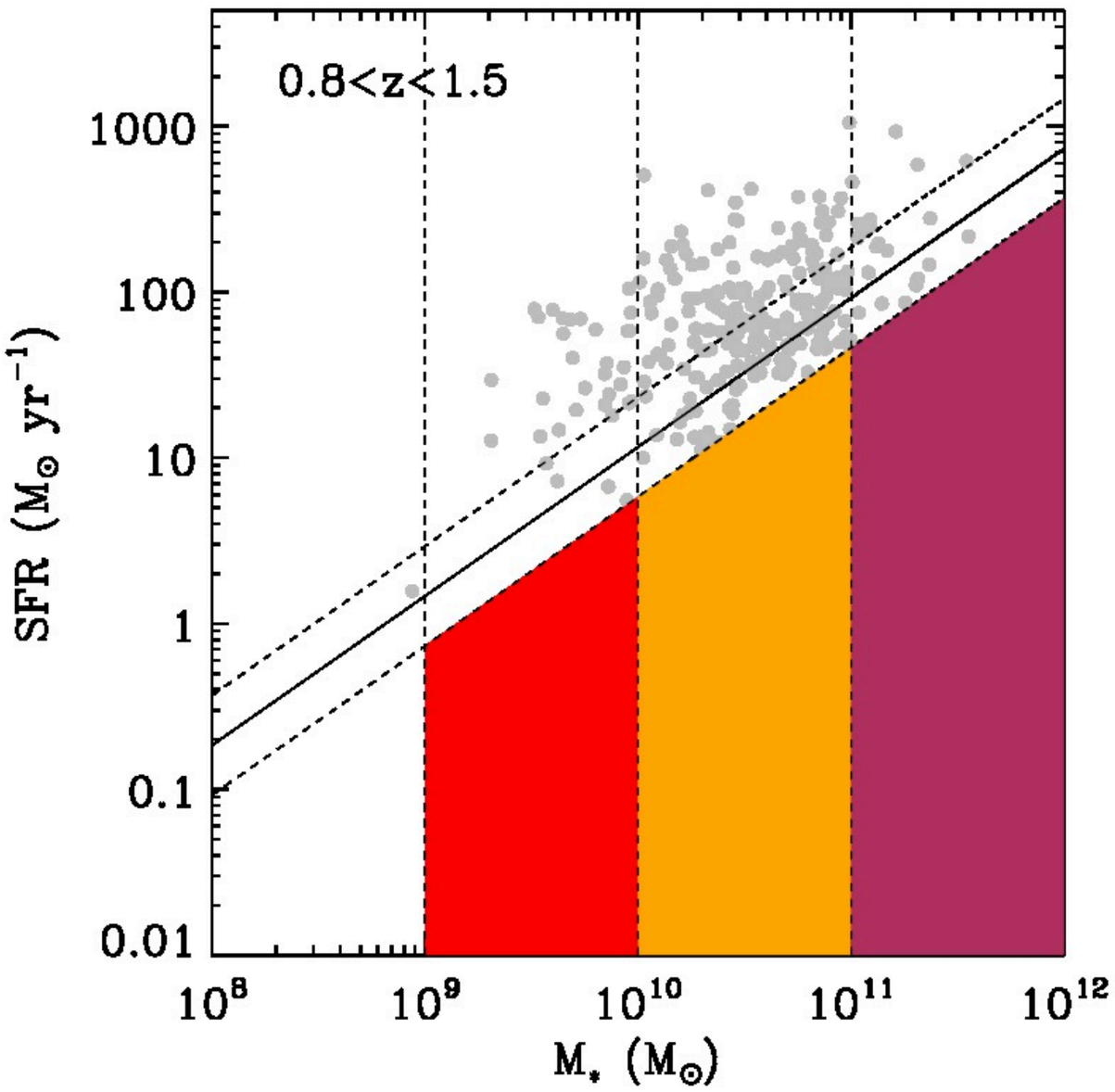
SFR vs Mstar



SFR vs Mstar

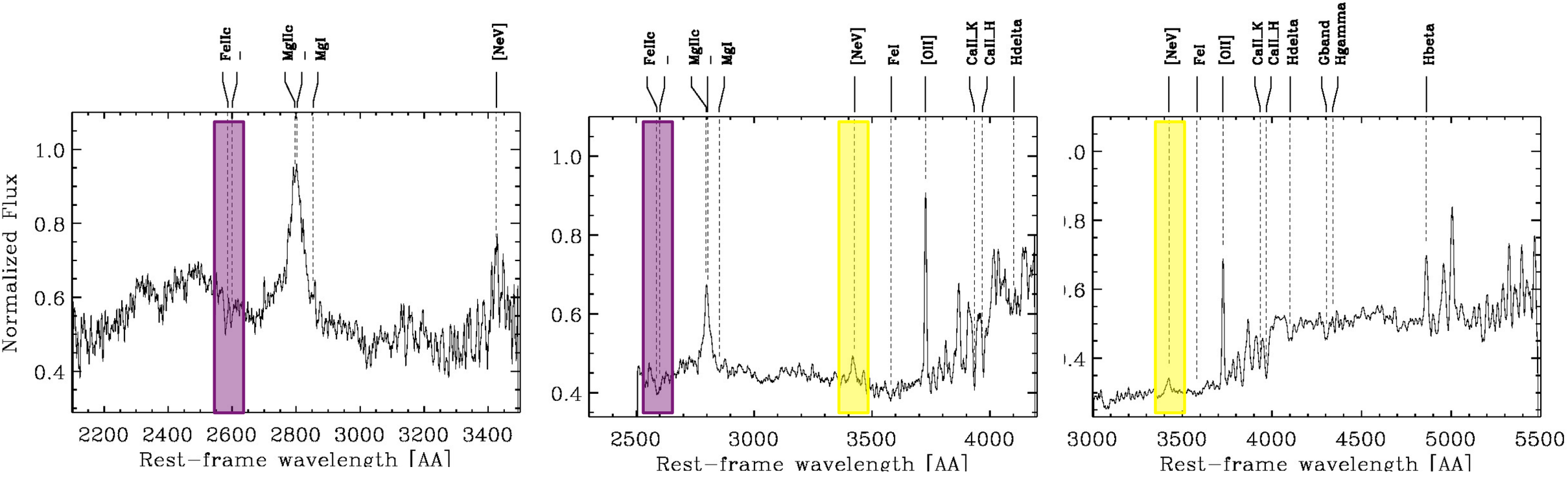


SFR vs Mstar



Average spectra

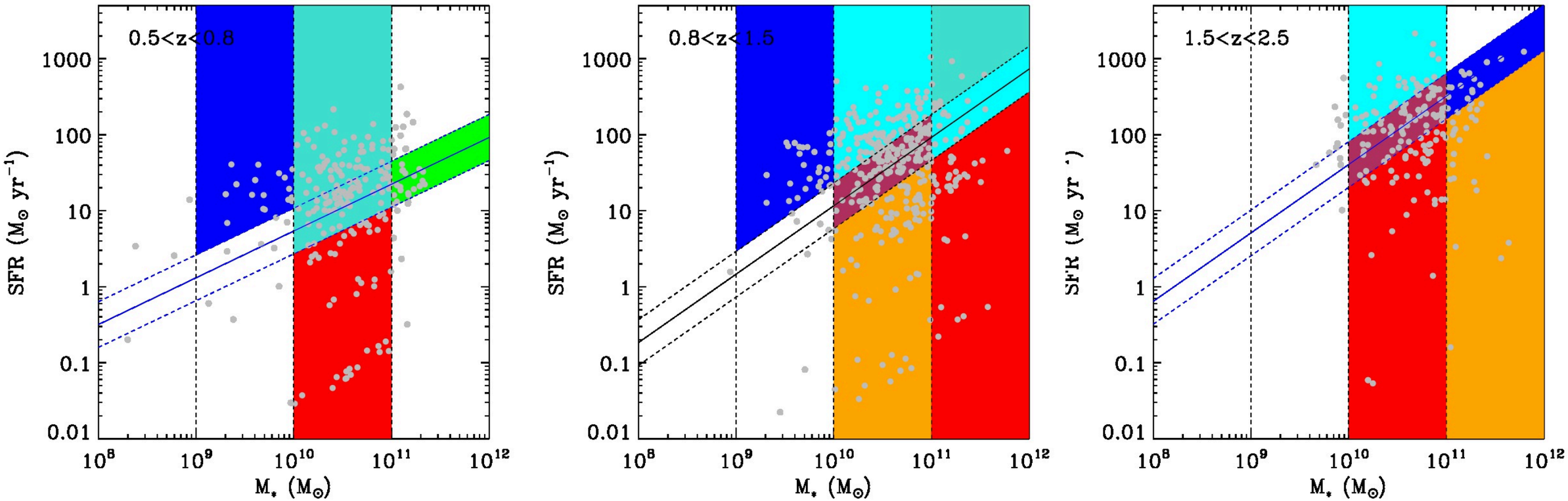
2.5 redshift 0.5

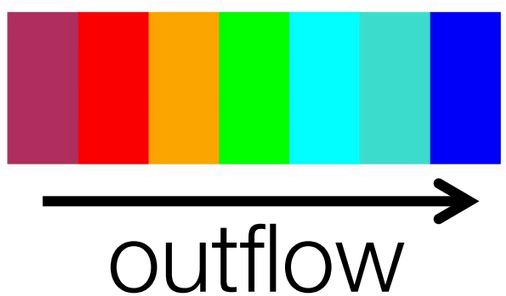


2200 wavelength 5500

Velocity offsets: [NeV]λ3346 and FeIIλ2586-2600

0.5 redshift 2.5





VM, Bonzini in prep

Summary and outlook

- ✧ An AGN driven outflow on kpc scale is quenching SF along its way and triggering new SF at its edges.

- ✧ AGN hosts show blue shifted ISM lines mostly above the MS. AGN or SF? → comparison sample of inactive galaxies

Single source

- Molecular outflow: PdBI (PI Brusa)
- High resolution map of the SF: VLT/SINFONI AO H band (PI Cresci)

Statistical samples

- Gas content in MS AGN hosts: ALMA band 3 in Cycle-2 (PI Mainieri)