VST-GAME: Galaxy Assembly as a function of Mass and Environment with VST

A. Mercurio

and the VST-GAME team*

INAF- OSSERVATORIO ASTRONOMICO DI CAPODIMONTE

Galaxy Assembly as a function of Mass and Environment with VST (VST-GAME)

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Galaxy Assembly as a function of Mass and Environment with VST (VST-GAME)

PI: A. Mercurio (INAF-Osservatorio Astronomico di Capodimonte, OANa)

The main aim of the survey is to disentangle and quantify the relative impacts of mass-quenching (e.g. AGN/SN feedback) and environmental-quenching (e.g. ram-pressure and/or tidal stripping, harassment, group-cluster collisions and "starvation").

One key missing ingredient is a panoramic and homogeneous dataset of high-quality optical imaging of galaxies in a wide and largely unexplored range of cluster environments, down to the dwarf regime (10^9 $M_\odot$), at a redshift when the galaxy population was still rapidly evolving.

Galaxy Assembly as a function of Mass and Environment with VST (VST-GAME)

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300h VST survey of perform a unique wide field coverage (20x20 Mpc^2 at z=0.4) of 12 massive galaxy clusters, at 0.2<z<0.6 (z median ~0.4), in four bands (u', g', r', i'), to explore galaxy evolution from the inner core to well beyond the virial radius (~5 Rvir), following the infall of galaxies along filaments, within groups, or directly from the field, up to 10^9 $M_\odot$, where model predictions are in tension with the data (e.g. too many dwarfs).

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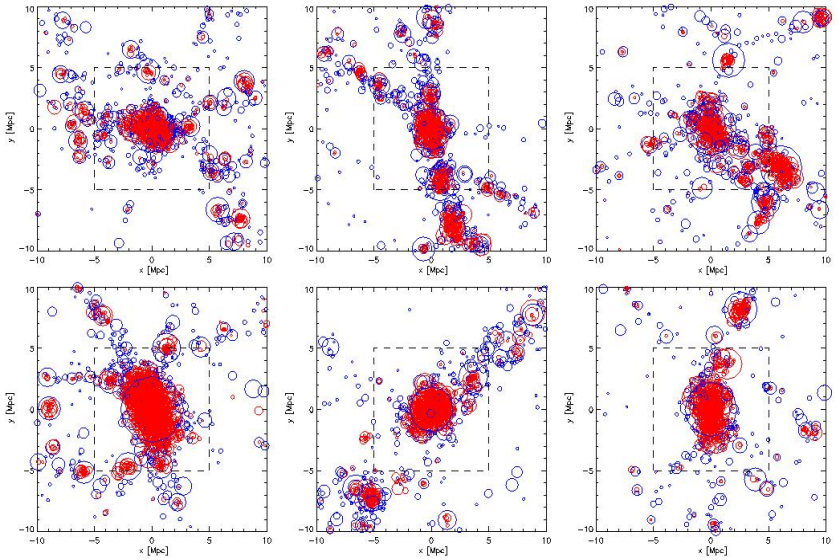


Multi-wavelength approach: from 10 kpc to ~10 Mpc

PI: M. Donahue

Baryon mass distribution
X-ray masses
ICM physics & metallicity

PI: S.Ettori

VLT

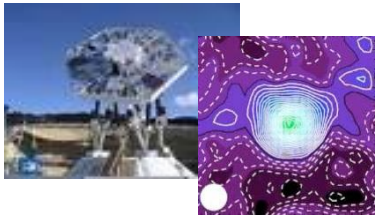
VIMOS Large Prog (230 hr)
~500 members per cluster
+ arcs redshifts

PI: P. Rosati

High-z gals
Dynamical analysis
Stellar masses

Galaxy Formation and evolution

Bolocam, Mustang



PI: K. Umetsu

ICM physics
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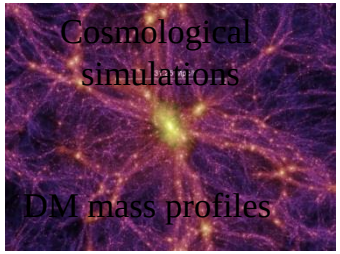
SZ observations



High-z gals

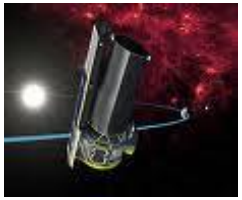
LBT

PI: M. Nonino

WL masses profile
Stellar masses

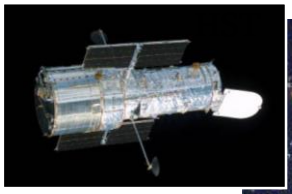
High-z galaxies

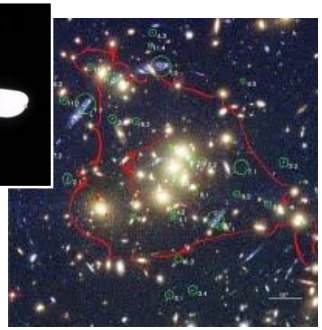
Spitzer



PI: W. Zheng R. Bowuens

Strong Lensing
Mass profile in the core





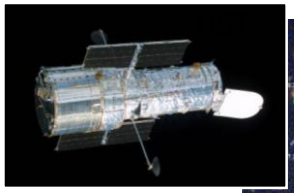
Treasury Program
(530 orbits)
PI: M. Postman

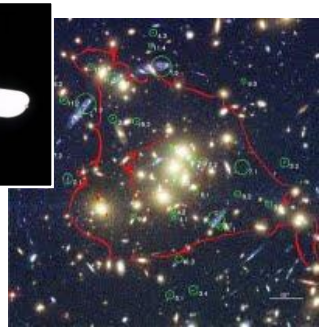
Subaru (+ ESO-WFI)
VISTA+ VST

PI: K. Umetsu
M. Nonino
A. Mercurio

Multi-wavelength approach: from 10 kpc to ~10 Mpc

Strong Lensing
Mass profile





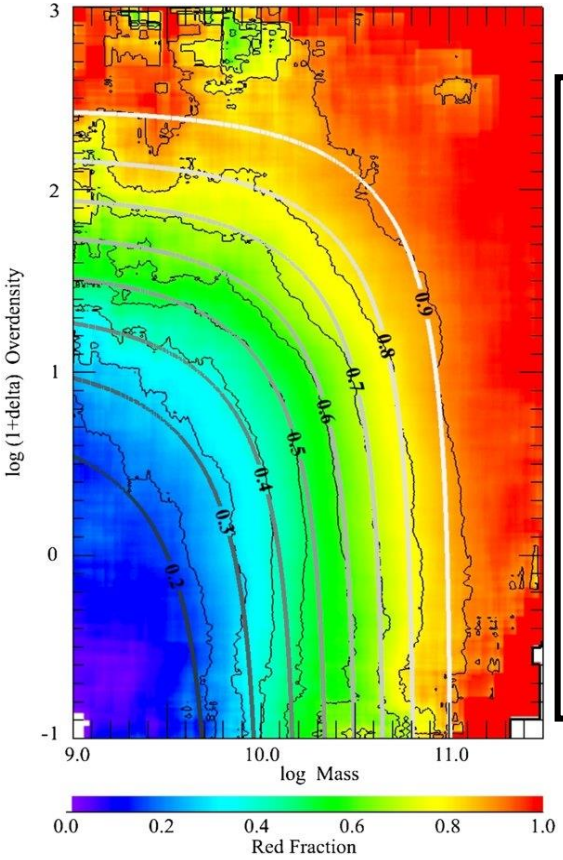
CLASH

Treasury Program
(530 orbits)

PI: M. Postman

From the core

Galaxy formation and evolution



Peng et al. 2010

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~500 members per cluster
+ arcs redshifts

High-z gals
Dynamical analysis
Stellar masses

VLT

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To the outskirts

VST + VISTA

M. Nonino
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WL masses profile
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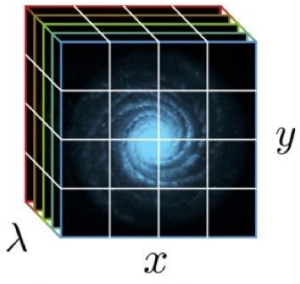
Integral Fied
Spectroscopy



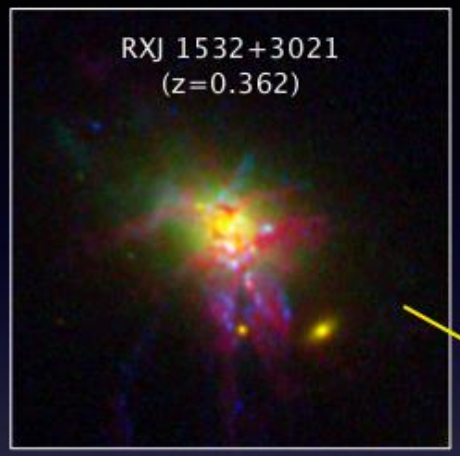
Archive and
Proprietary data
(P.I. C. Grillo)

Environment

Mass

New avenues for galaxy evolution

BCG structure, SF, cooling

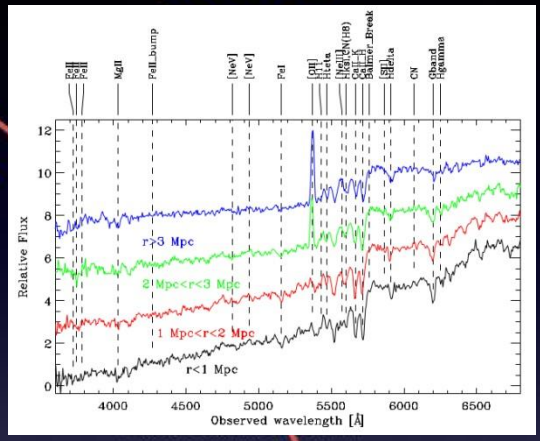


Comparison with Semi-analytic models

Galaxy properties over ~ 10 Mpc:

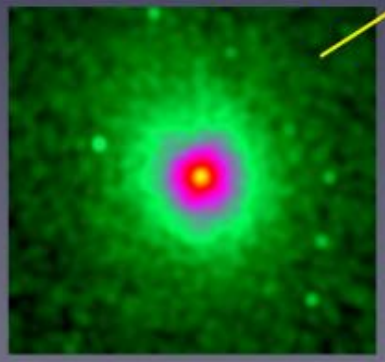
- ✓ Structural parameters
- ✓ Mstar, SFR, sSFR, ages, dust
- ✓ ICM properties

Galaxy transformation processes

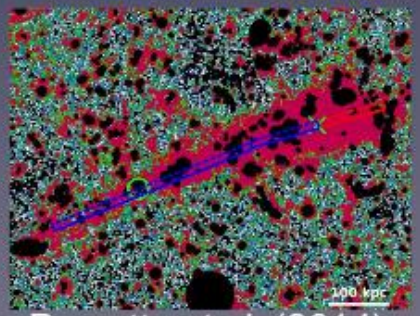


Girardi et al. (2015)

Intra-Cluster Medium (X-ray)

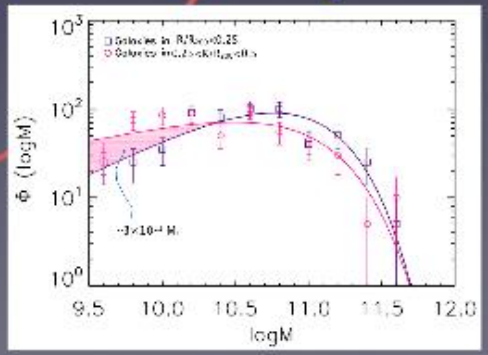


Intra-Cluster light



Presotto et al. (2014)

Stellar mass/luminosity fnct



Annunziatella et al. (2014)

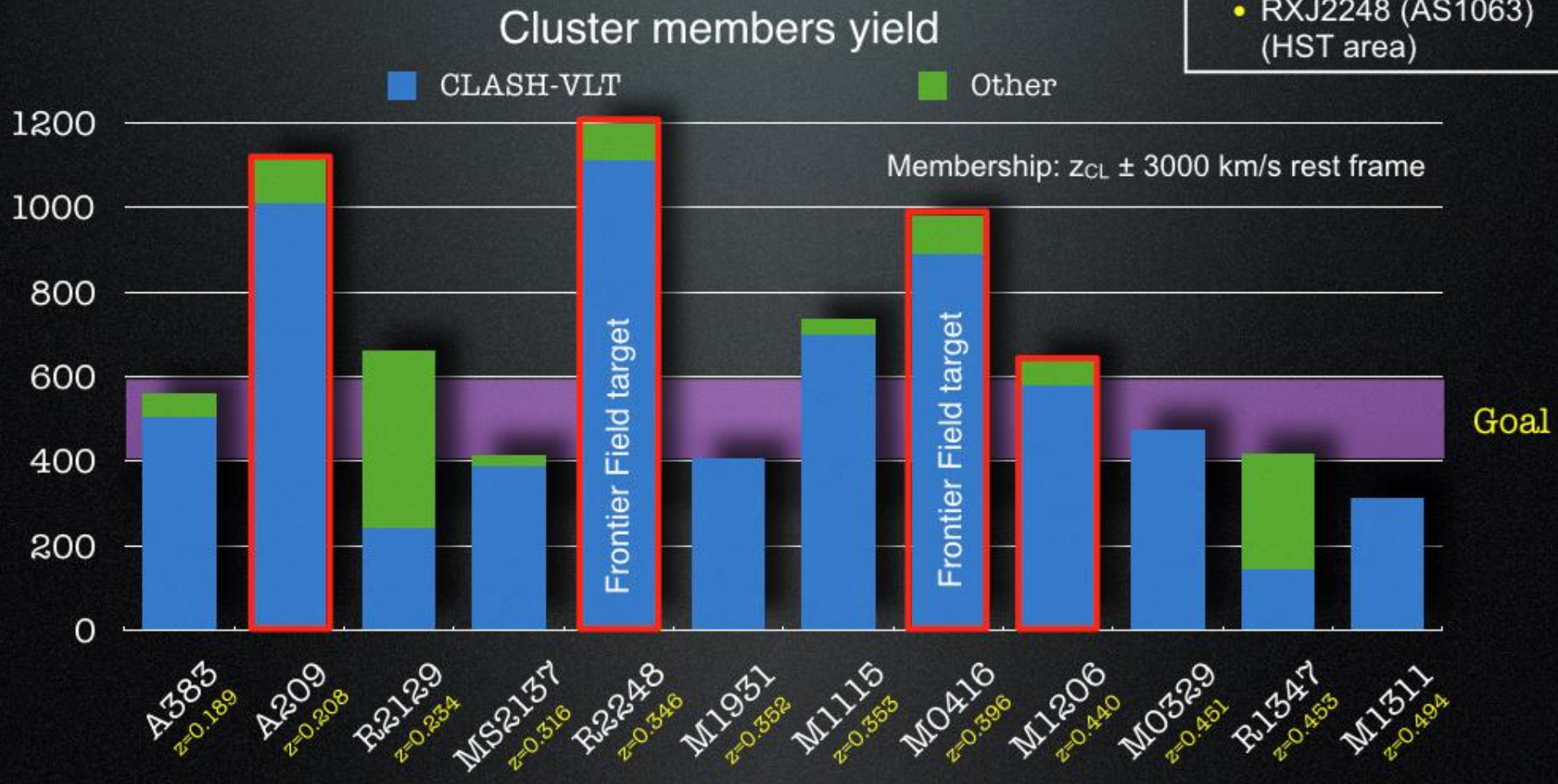
CLASH-VLT LP: completed on 3/2016 (207h)

Final redshift sample (nearly final):

~34500 redshifts (from ~50000 spectra incl. duplicates)
~7300 cluster members
~200 lensed galaxies to z~7 (>300 X-ray Chandra sources)
➡ 19 published papers to date

Redshift catalogs released to date:

- MACS1206
- MACS0416
- MACS2129
- A209
- RXJ2248 (AS1063) (HST area)



https://sites.google.com/site/vltclashpublic

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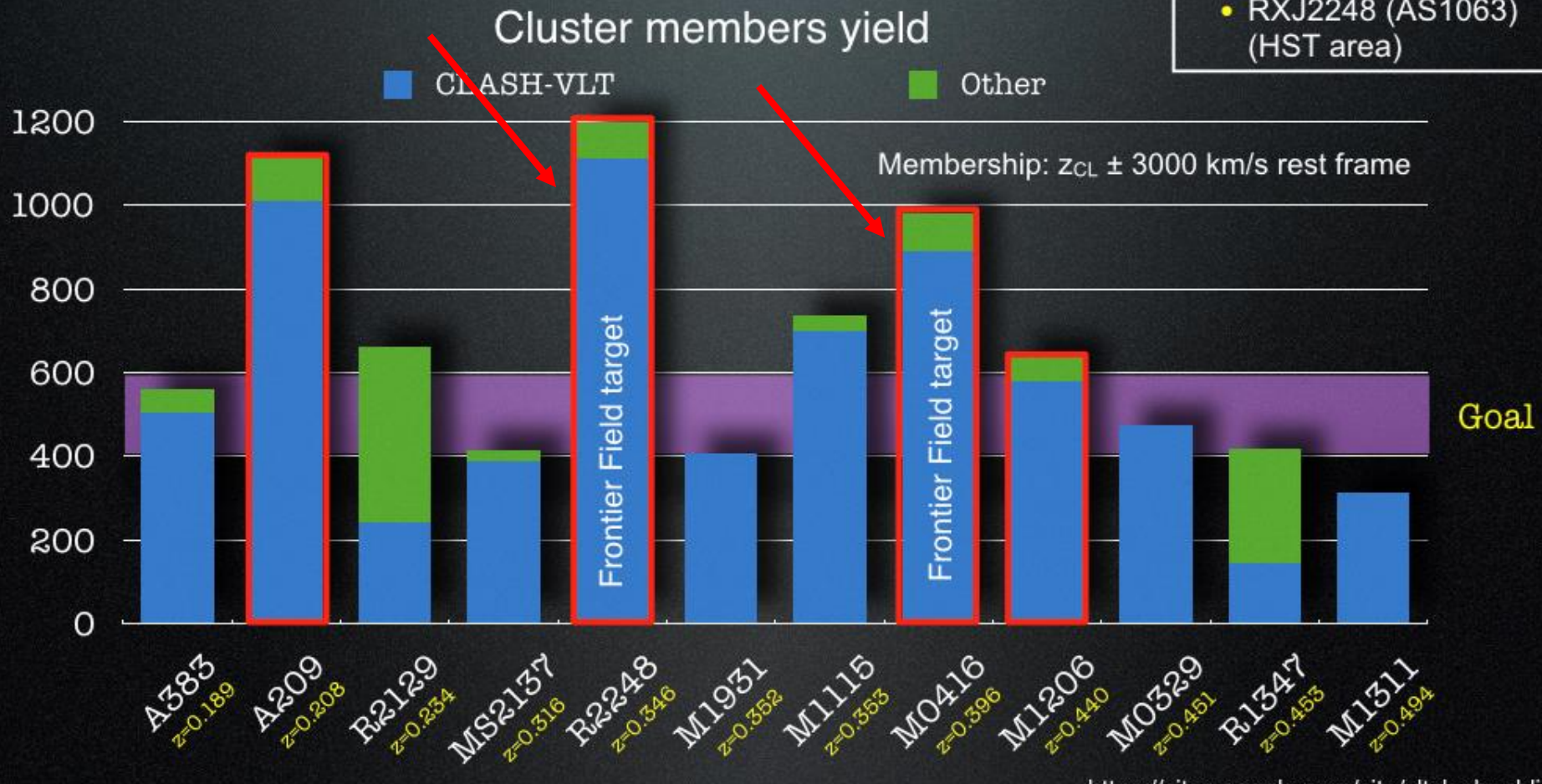

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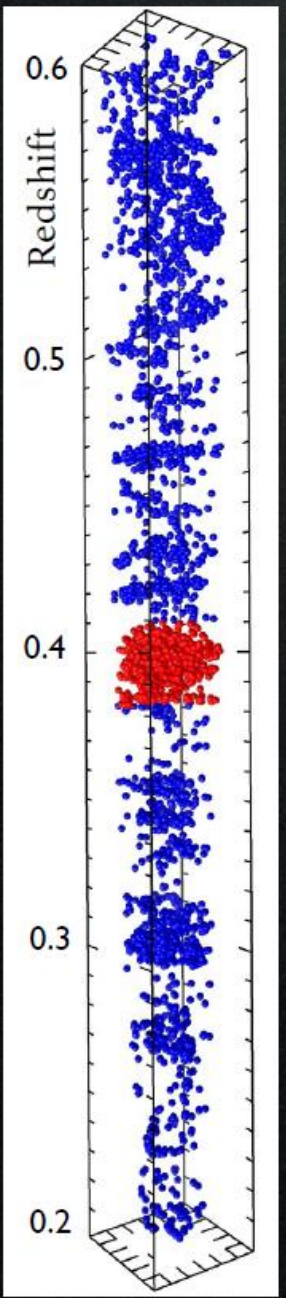
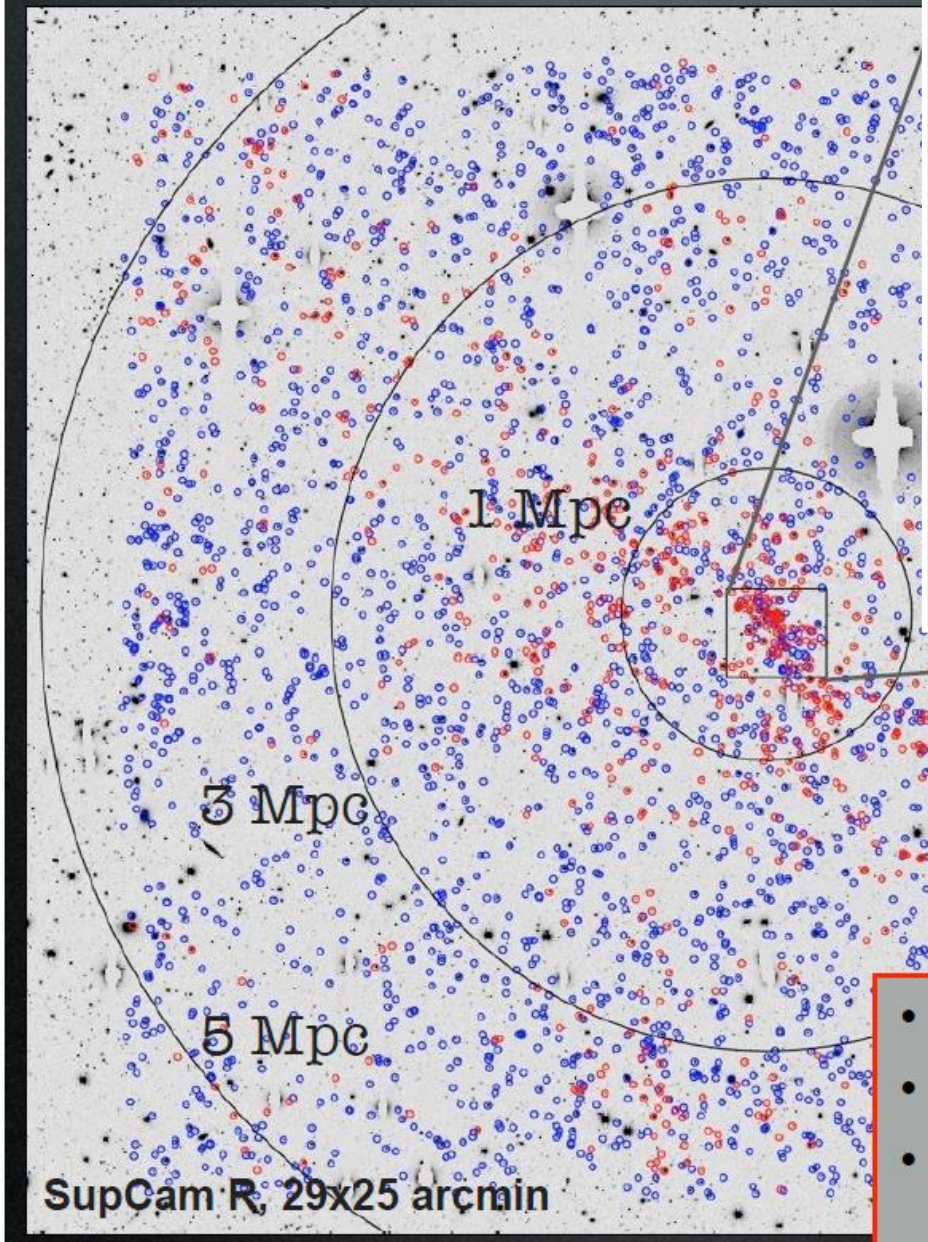
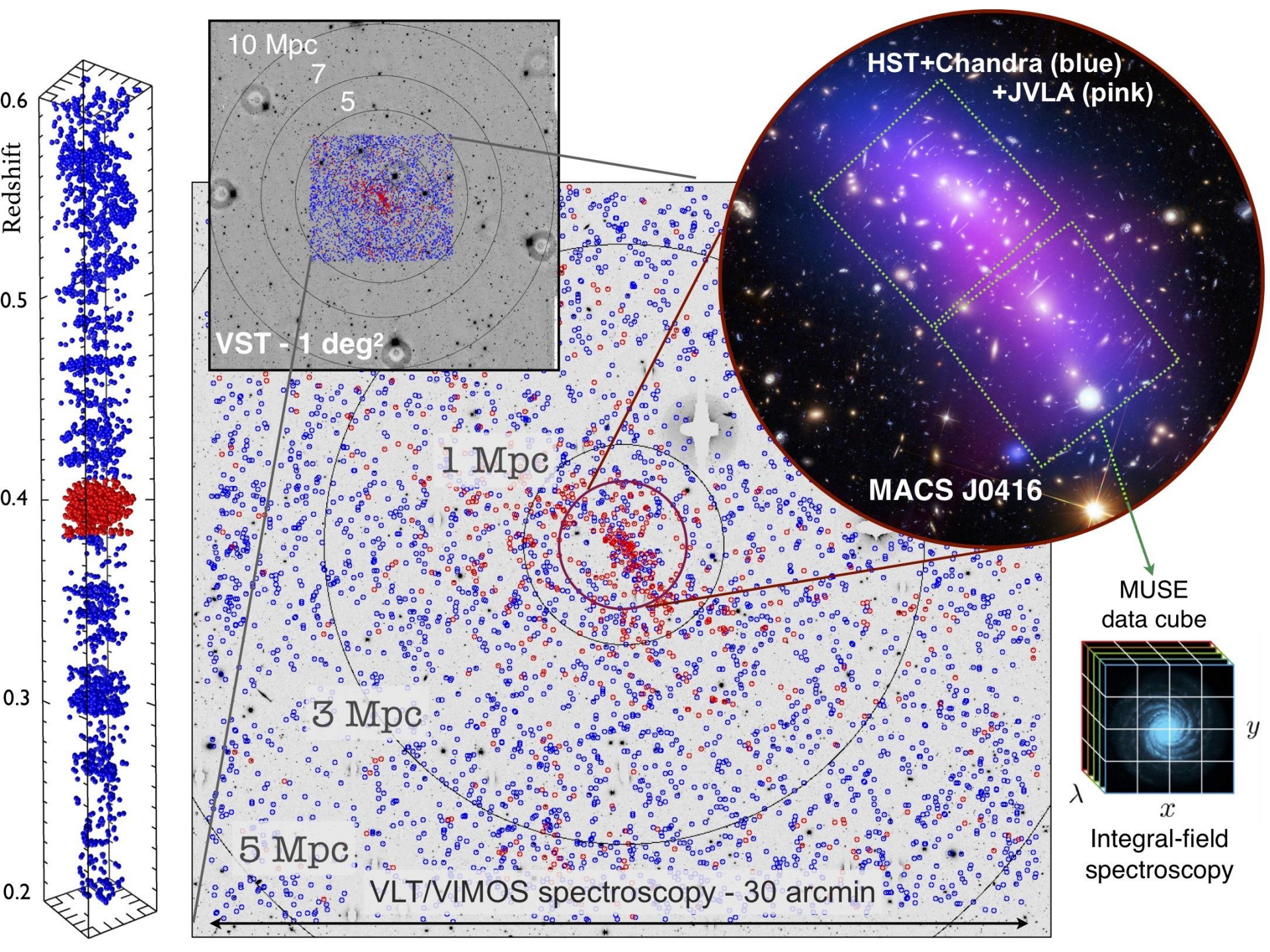
CLASH-VLT spectroscopic campaign of MACS0416

(Grillo+ 2015, Balestra+ 2016 + data release)





- 4200 redshifts in the field
- ~900 spec members
- 30 multiple images at 1.6<z<3.2 (from 10 sources)


Redshift
0.6
0.5
0.4
0.3
0.2
10 Mpc
7
5
VST - 1 deg²
1 Mpc
3 Mpc
5 Mpc
VLT/VIMOS spectroscopy - 30 arcmin
HST+Chandra (blue)
+JVLA (pink)
MACS J0416
MUSE
data cube
λ
x
y
Integral-field
spectroscopy

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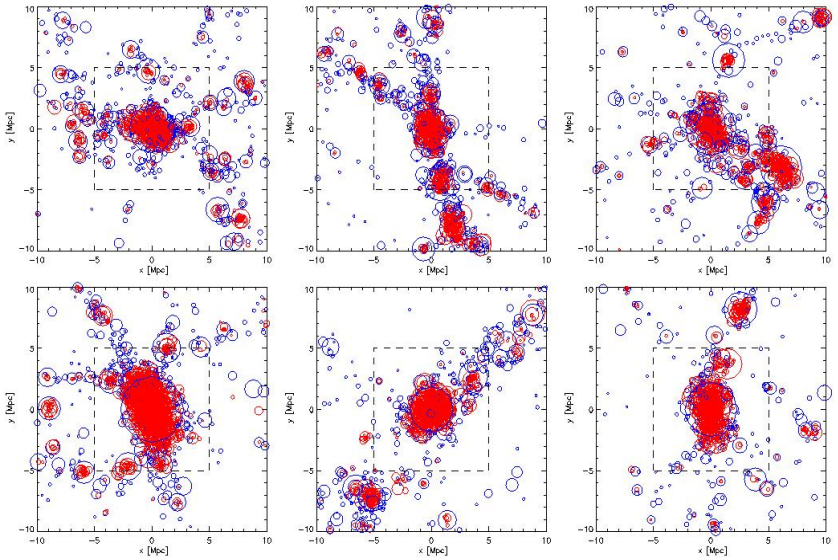
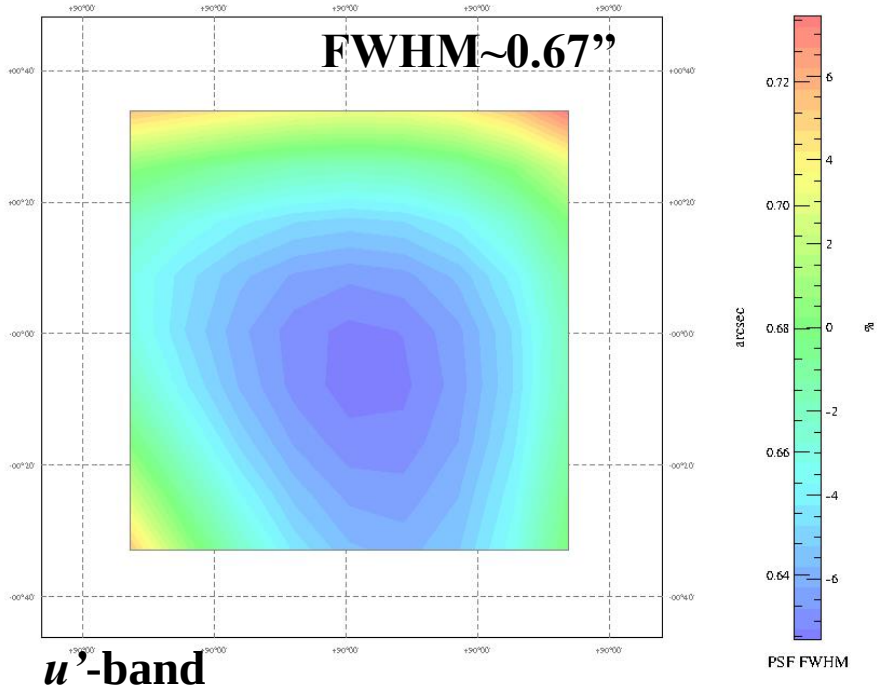
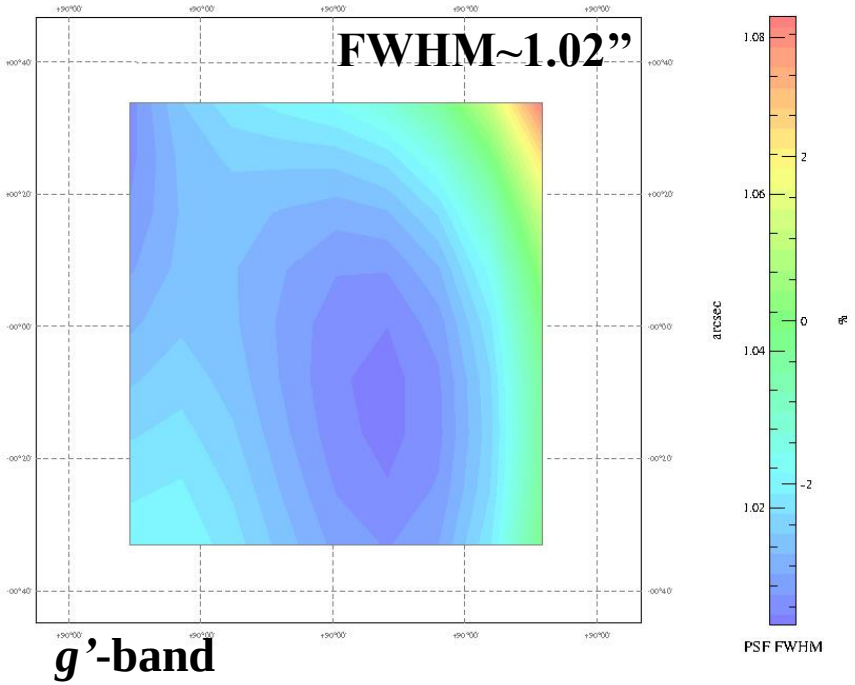


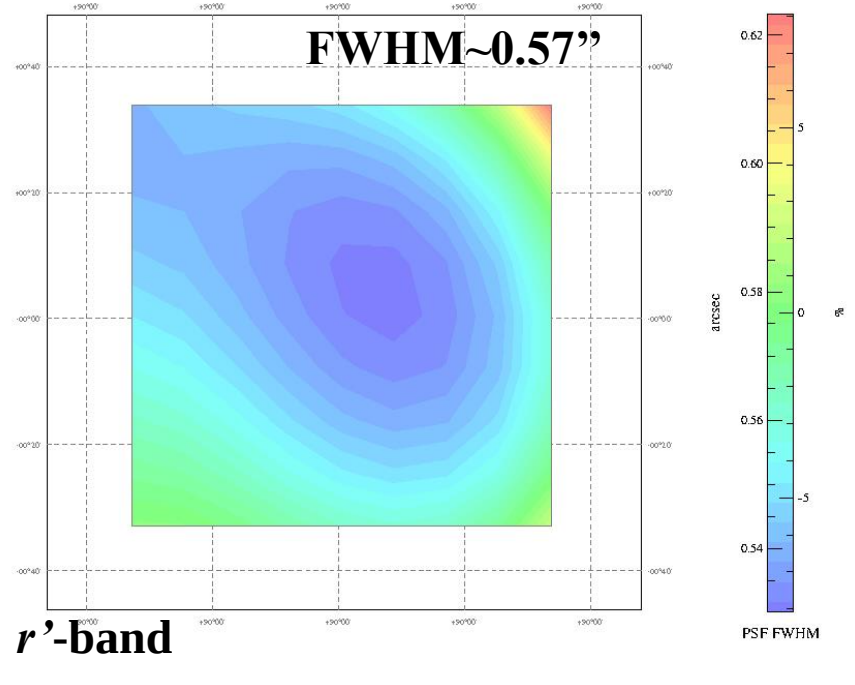
Obs started 04/17



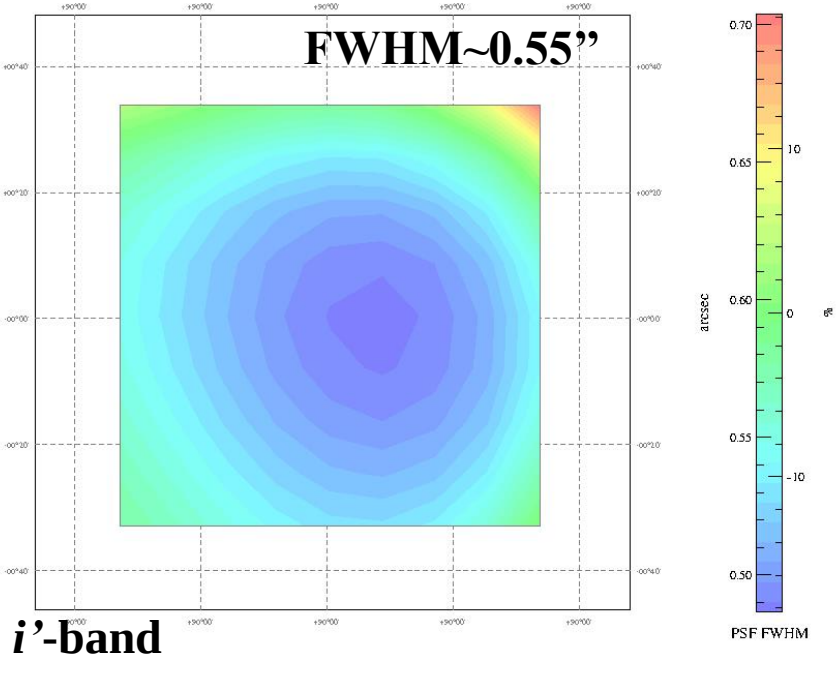
***u’*-band**



***g’*-band**



***r’*-band**



***i’*-band**

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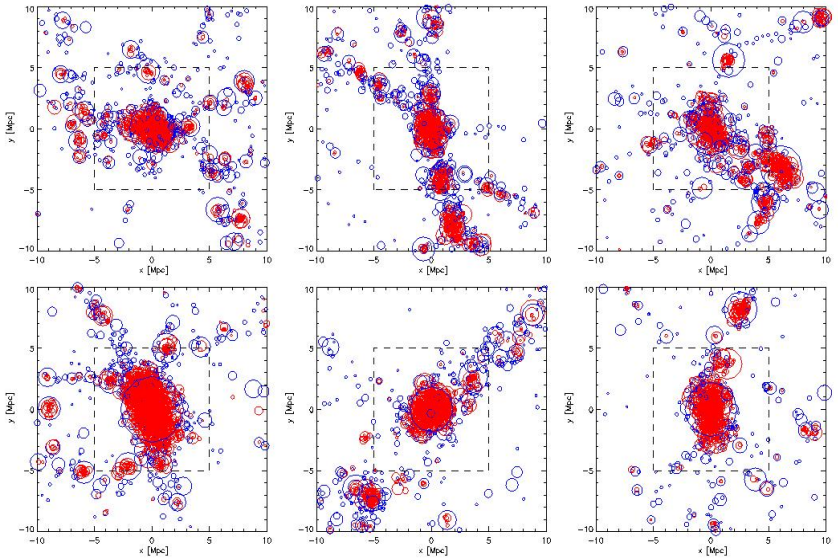

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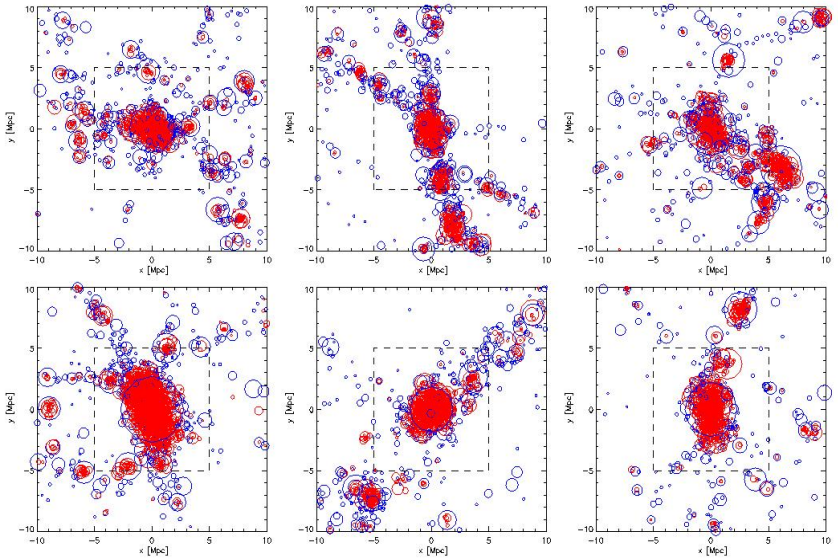

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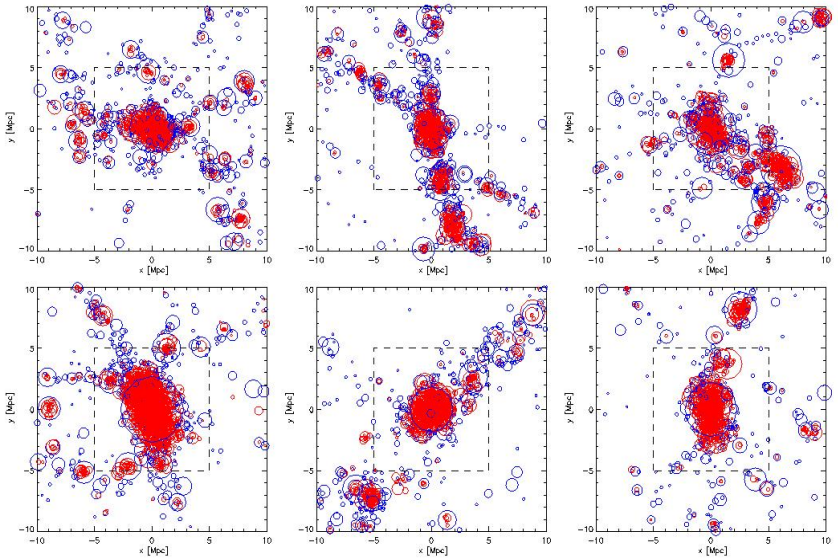
PLCK G004.5-19.5	19:17:05	-33:31:20	0.540	10.5
Abell 1063S	22:48:45	-44:31:50	0.348	22.5



Concerted effort which includes NIR observations of an ongoing VISTA Public Survey (560h, P.I. M. Nonino, Survey manager: A. Mercurio).

The Galaxy Clusters At Vircam (G-CAV, P.I.: M. Nonino)

G-CAV is a infrared Y, J, Ks 560 hrs long survey for a sample of 20 clusters of galaxies, to explore galaxy evolution over a large, and largely unexplored, diversity of cluster environments.

(AB, 5σ)
23.8<Y <24.5
23.2<J<24.3
22.5<Ks<23.3

Cluster z	Y	J	Ks
$z \leq 0.31$ (A)	2×12600	2×10800	2×7200
$0.31 \leq z \leq 0.5$ (B)	2×16200	2×14400	2×10800
$z \geq 0.5$ (C)	2×21600	2×19800	2×16200

Data for 5 clusters already completed:

MACSJ0416 (30h)
RXCJ2248 (30h)
PLCKG287 (26h)
RXCJ1515 (21h)
RXCJ2129 (~19h)

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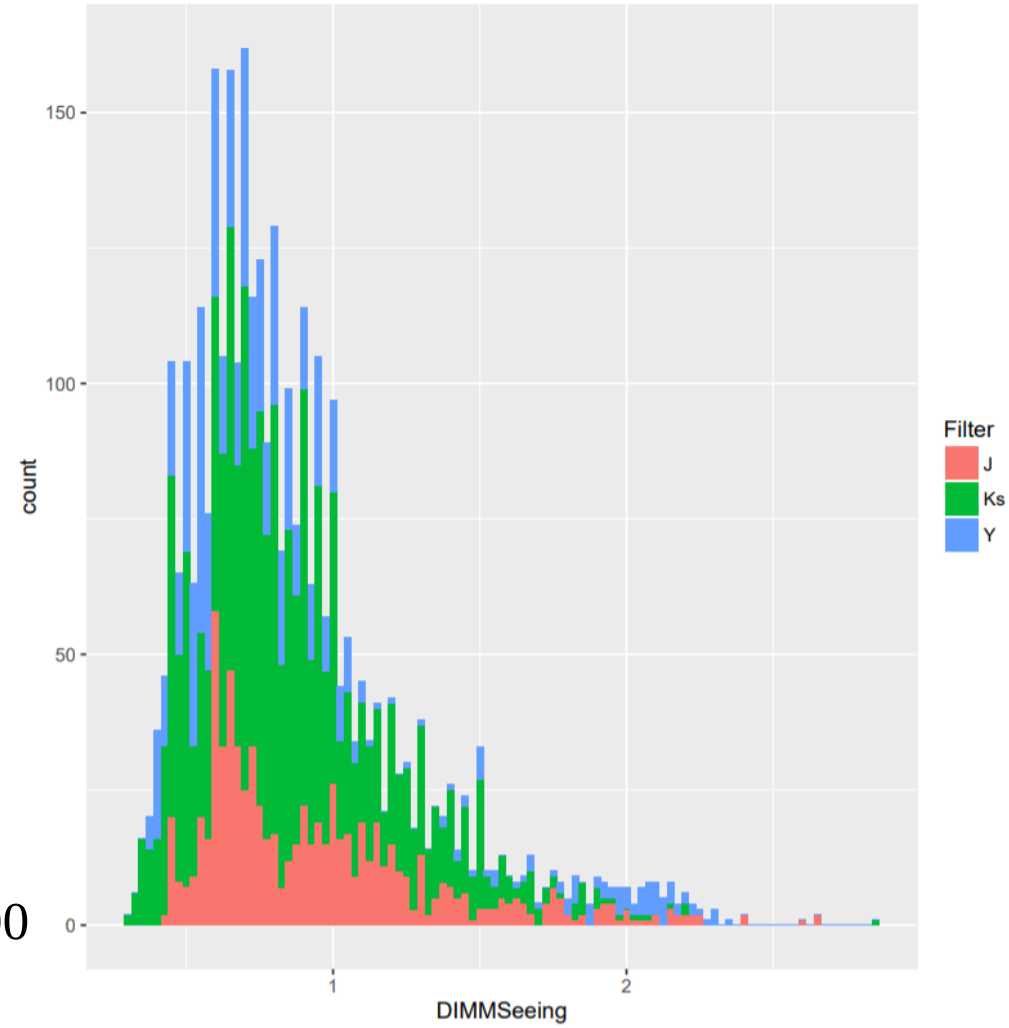
All submitted OBs observed in P98-P100



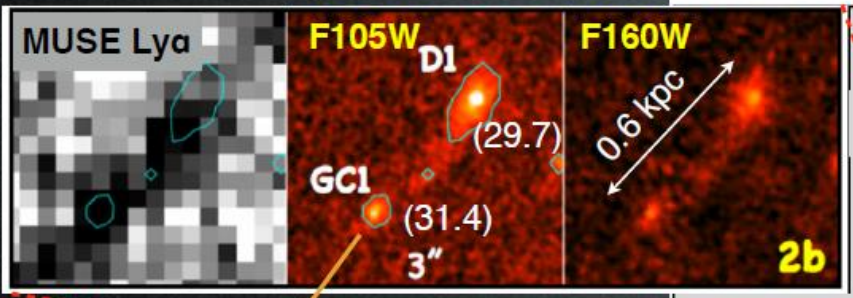
A new window on high-z “galaxies”

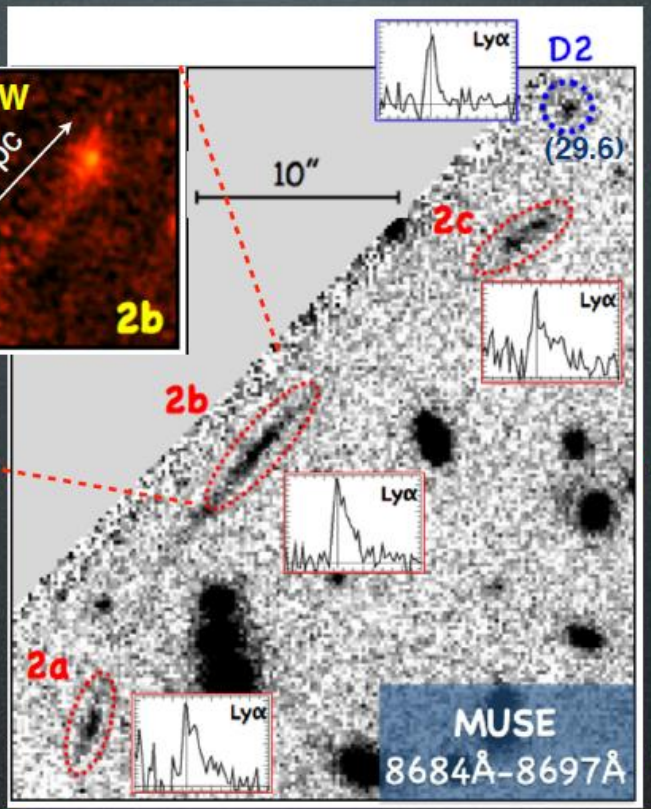
Magnifying "star forming clusters" at z=3-6.4

(Vanzella et al. 2017b)

(T_U = 0.85-2.1 Gyr)

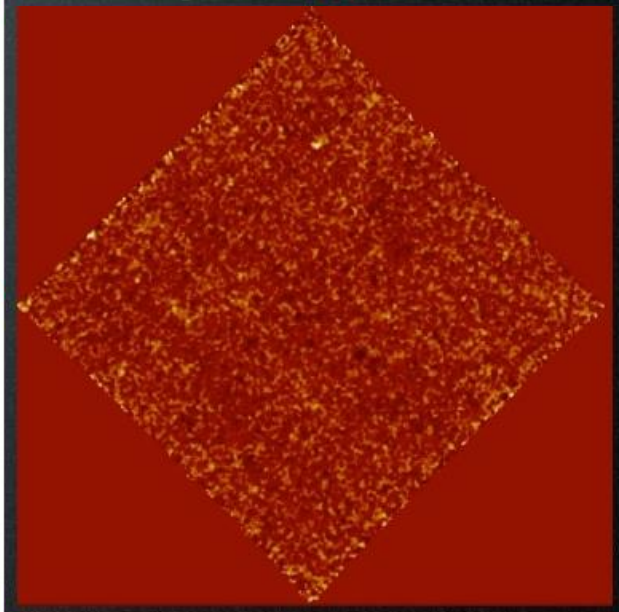
z=6.145



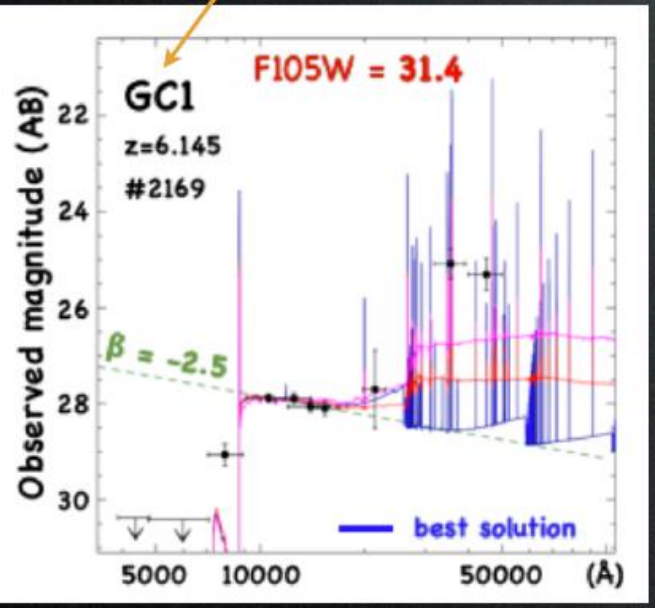


MUSE fly-thru 8690 Å

Ly-α at z=6.145



SED fit



m_{obs} = 27.9 AB, μ = 25 ± 3 ⟹ m_{UV} = 31.4, M_{UV} = −15.3

$M_{stellar}$ ~ 3 × 10^6 $M_\odot$ (10^6 – 10^7), ($M_{stel,D1}$~10x)

R_e = 16 ± 7 pc (D1~140 pc)

Age = 1 – 10 Myr, SFR = 2 – 5 $M_\odot$/yr, high sSFR

Clustering ? GC1–D1 = 0.6 kpc , GC1–D2 = 27 kpc

…consistent with Globular Cluster formation models or physical expectations on GC progenitors (see Renzini 2017; Boylan-Kolchin 2017)

Some numbers (E. Vanzella)….

- z~2.2 [1.7-2.7] ~15000 gals per sq.deg (Reddy&Steidel 2009)
- z~3.0 [2.5-3.5] ~10000 gals per sq.deg (Reddy&Steidel 2009)
- z~4.0 [3.5-4.5] ~9000 gals per sq.deg (Bouwens et al. 2015, tab. A1)

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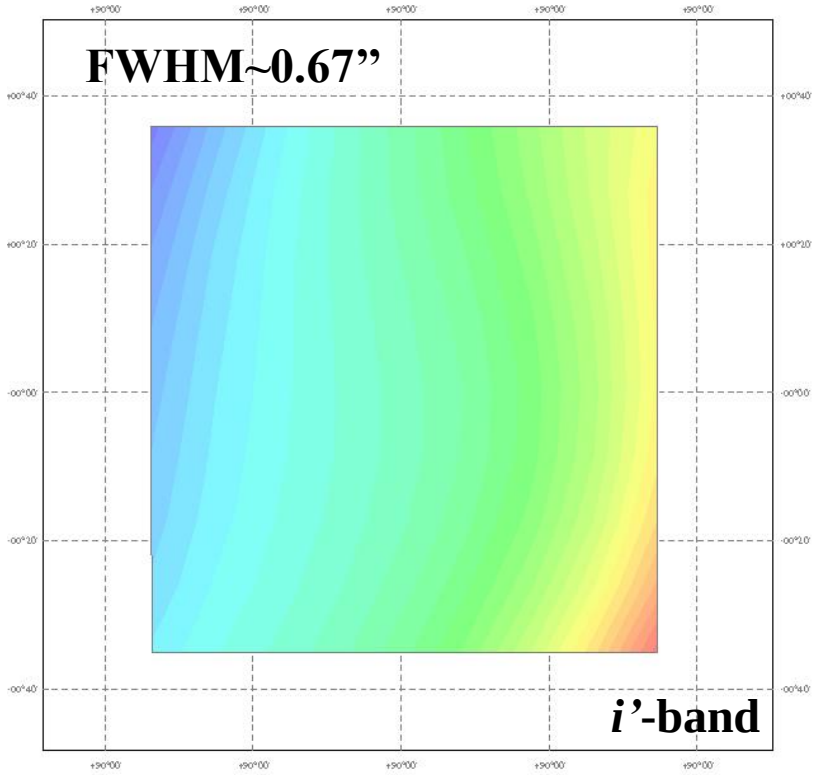

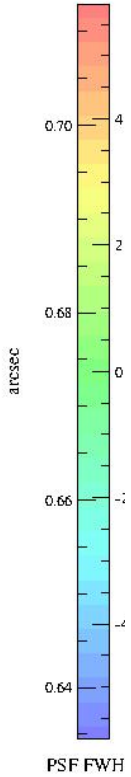

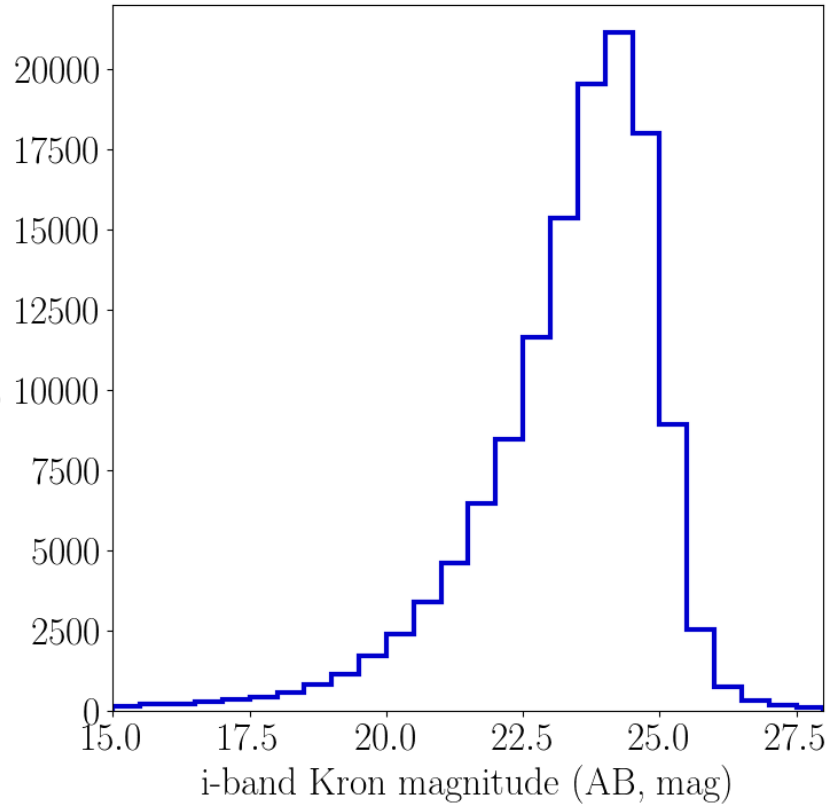

M_{lim}=24.75 (5σ in 3”)

Outlook and legacy

VST/VISTA/HST+VIMOS/MUSE

✓ Goldmine for galaxy evolution studies in different environments:

- Large field of view (20x20 Mpc^2 at z=0.4) to explore a wide range of cluster environment and good data quality to reach the dwarf regime;
- Large spectroscopic members ample critical for the analysis of galaxy properties as a function of mass + environment + dynamical status of the cluster;
- Deep (IFU) spectroscopy to explore low-mass regimes + precise magnification maps for new exploration of (very) low mass/luminosity galaxies at z=3-7 beyond deepest HST fields.
- Large Field photometry: a window on high-redshift galaxies.

The first glimpse to the science era of E-ELT and JWST.

Thanks!!!