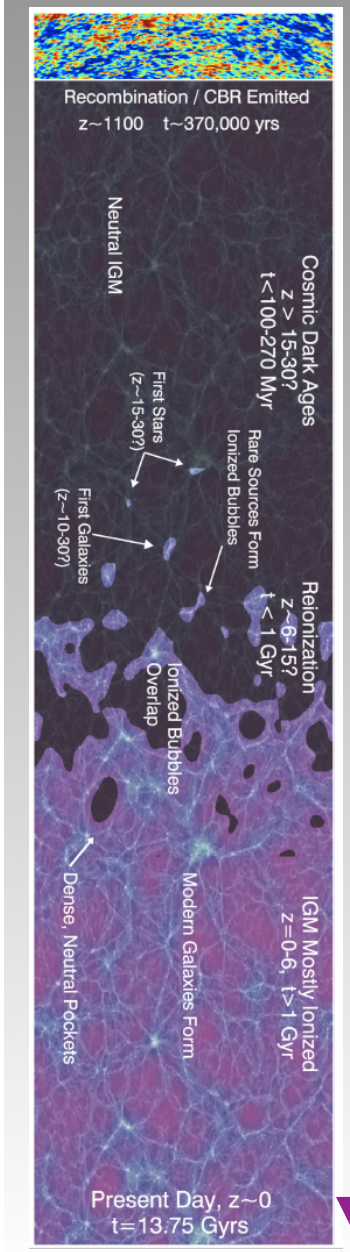
SAGACE

Stellar Mass And GAlaxy CEnsus

in the first two billion years of the Universe

Galaxy assembly in the ΛCDM



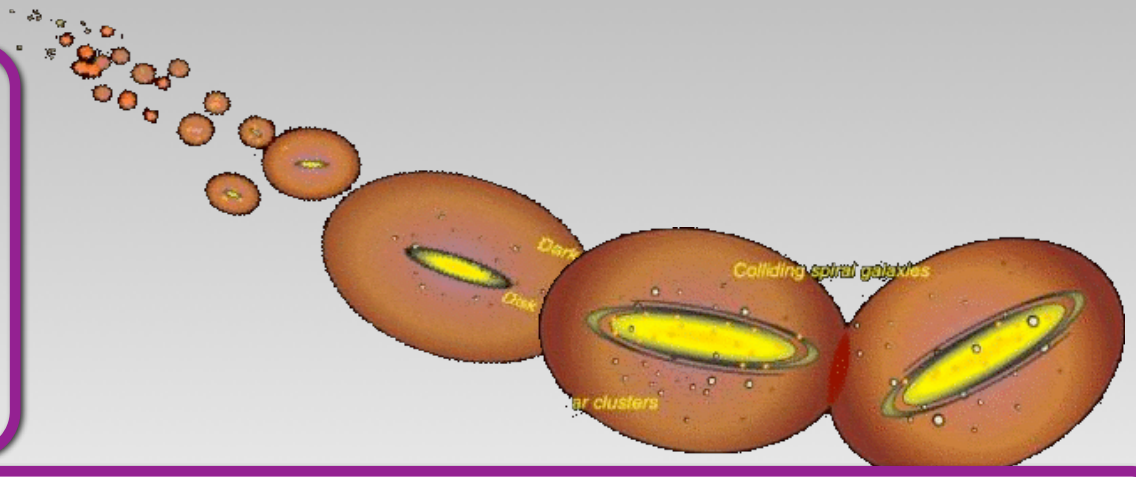
Hierarchical growth of dark matter halos

➢ continuous increase of the baryons available for the galaxy stellar mass assembly:

gas accretion + mergers

T=0.7 Gyr, z=7

T=2 Gyr, z=3



Observational constraints from deep surveys

SAGACE: between z=3 and z>7+

Présentation du projet

ANR « jeune chercheur » only one node at LAM

Starting date: September 2014

End date: September 2017

Name	Position [1]	Laboratory	#PM [2] 2014	#PM 2015	#PM 2016	#PM 2017
Ilbert O.	AA	LAM	4	9	9	5
Tresse L.	A	LAM	1	2	5	4
Arnouts S.	CR	LAM	1	4	4	3
Cattaneo A.	MCF	LAM	1	2	5	4
Le Fèvre O.	A	LAM	0.5	1.5	2	2
Cuby J.G.	A	LAM	0	1	2	2
	postdoc ANR	LAM	0	12	12	0
Capak P. (3)	DR	Caltech				
McCracken H.J. (3)	AA	IAP				

Budget

173k€ over 48 months

The financial support requested for the realization of this project consists in:

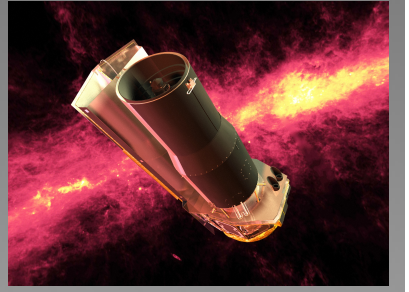
- 24 months of post-doctoral contract: LAM, Marseille: 86.7k€
- Mission/travel expenses: 56k€
- Computing/small expenses: 24k€

Therefore, we request 173k€ in total, and we detail below the total aid requested.

Iary Davidzon started in March 2015 for 2 years.

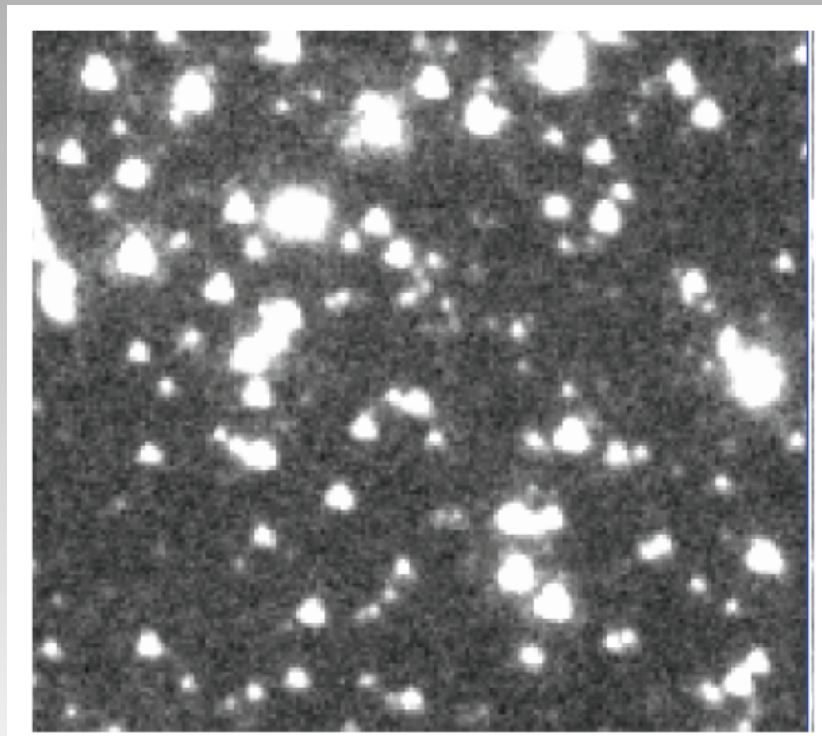
Clotilde Laigle started a PhD in Sep. 2013 with H.J. McCracken and works a lot on this projet too.

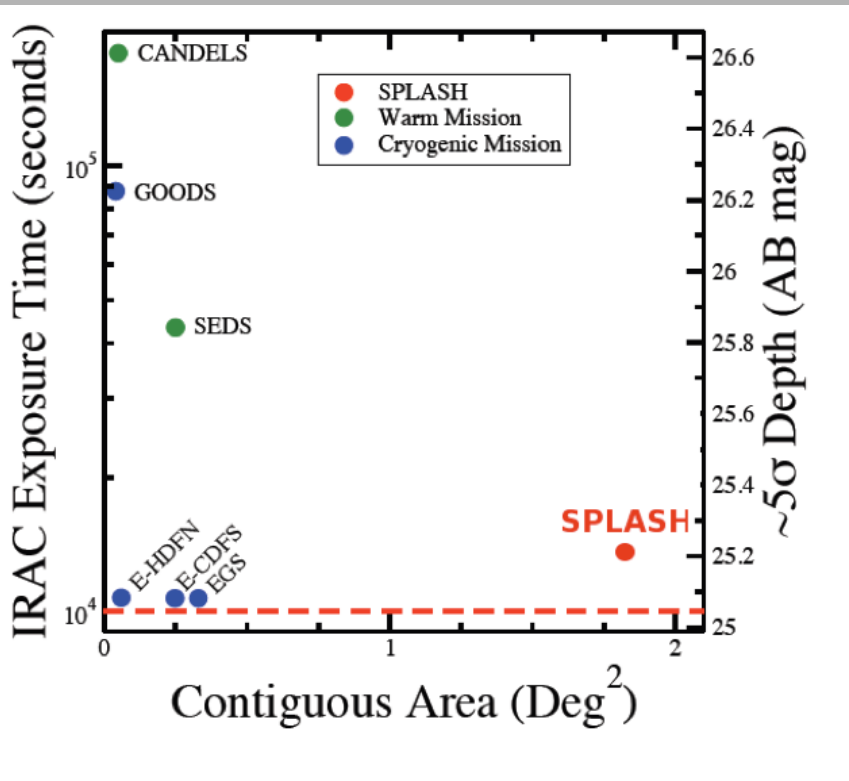
The IRAC-Spitzer surveys



Survey with the Spitzer telescope with IRAC 3.6+4.5μm

- 1800hr over COSMOS (done)+ 1800h avec SMUV (ongoing)
- 1800hr over UDS (done)

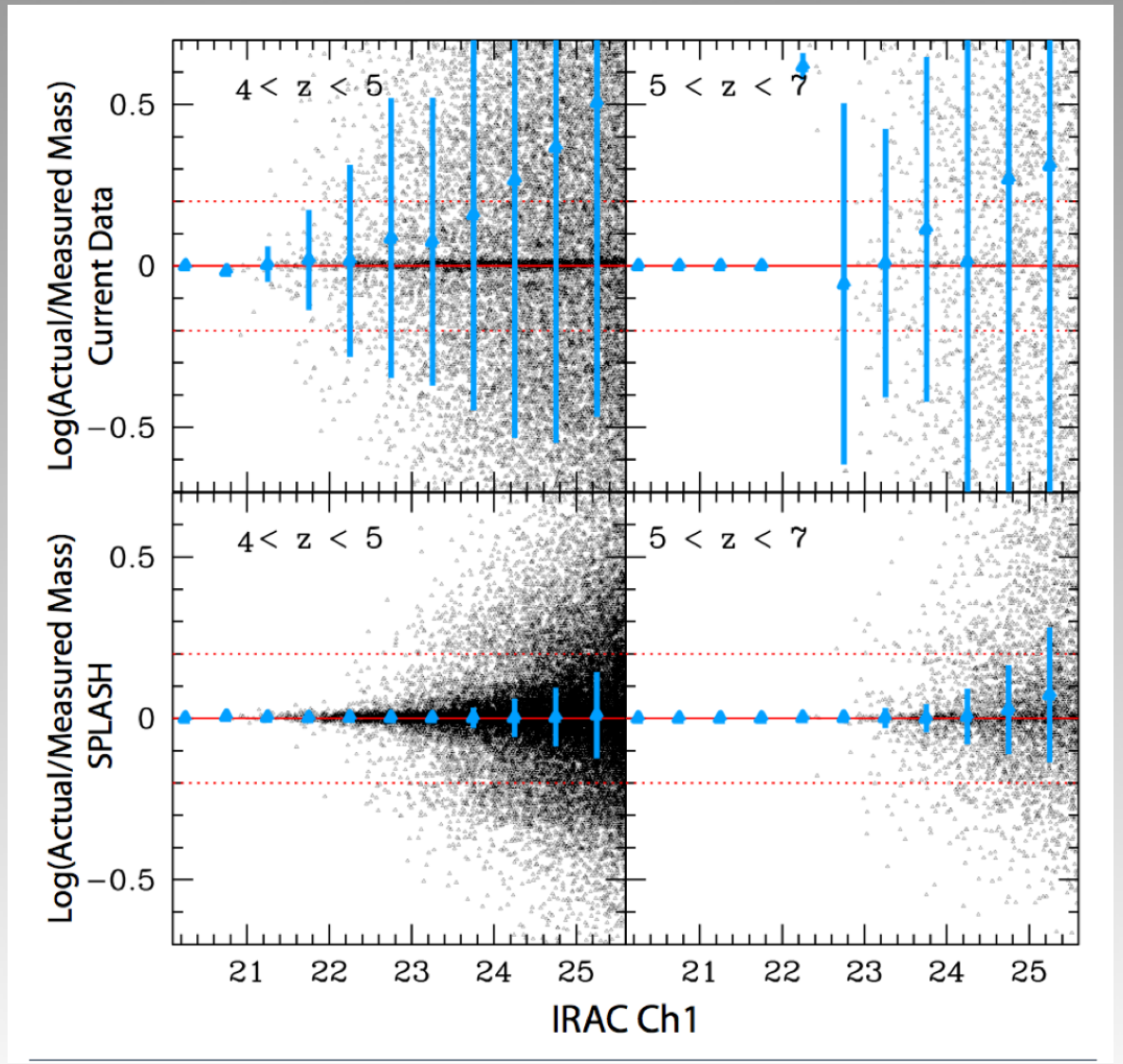




Spitzer-IRAC: the only instrument to get stellar masses at z>4

before SPLASH

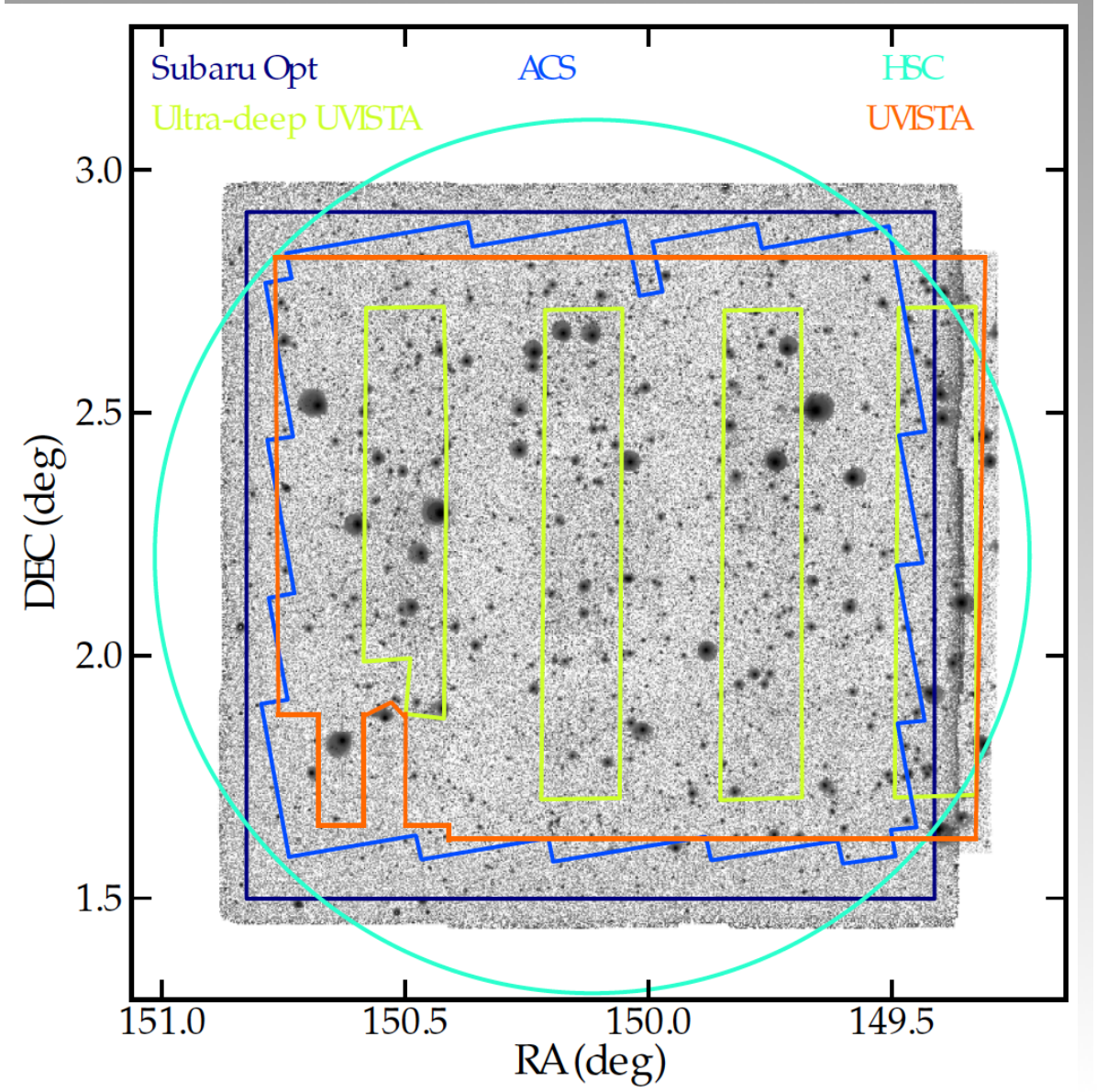
With 1 year of SPLASH



Extend the stellar mass census at 4<z<7 with SPLASH

The COSMOS 2-deg² field

2 deg² UDS field is second priority



Instrument /Telescope (Survey)	Filter	Central λ (Å)	Width (Å)	3σ depth [a] (3″/2″) ±0.1
GALEX	NUV	2313.9	748	25.5 [b]
MegaCam/CFHT	u^*	3823.3	670	26.6/ 27.2
SuprimeCam	B	4458.3	946	27.0/ 27.6
/Subaru	V	5477.8	955	26.2/ 26.9
	r	6288.7	1382	26.5/ 27.0
	i^+	7683.9	1497	26.2/ 26.9
	z^{++}	9105.7	1370	25.9/ 26.4
	$IA427$	4263.4	206.5	25.9/ 26.5
	$IA464$	4635.1	218.0	25.9 / 26.5
	$IA484$	4849.2	228.5	25.9/ 26.5
	$IA505$	5062.5	230.5	25.7/ 26.2
	$IA527$	5261.1	242.0	26.1/ 26.6
	$IA574$	5764.8	271.5	25.5/ 26.0
	$IA624$	6233.1	300.5	25.9/ 26.4
	$IA679$	6781.1	336.0	25.4/ 26.0
	$IA709$	7073.6	315.5	25.7/ 26.2
	$IA738$	7361.6	323.5	25.6/ 26.1
	$IA767$	7684.9	364.0	25.3/ 25.8
	$IA827$	8244.5	343.5	25.2/ 25.8
	$NB711$	7119.9	72.5	25.1/ 25.7
	$NB816$	8149.4	119.5	25.2/ 25.8
HSC/Subaru	Y	9990.0	820	24.4/ 24.9
VIRCAM	$Y^{\rm UD}$	10214.2	970	**25.3**/ 25.8
/VISTA	$Y^{\rm Deep}$			24.8/ 25.3
(UltraVISTA DR2)	$J^{\rm UD}$	12534.6	1720	**24.9**/ 25.4
	$J^{\rm Deep}$			24.7/ 25.2
	$H^{\rm UD}$	16453.4	2900	**24.6**/ 25.0
	$H^{\rm Deep}$			24.3/ 24.9
	$K_{\rm s}^{\rm UD}$	21539.9	3090	**24.7**/25.2
	$K_{\rm s}^{\rm Deep}$			24.0/ 24.5
WIRCam	$K_{\rm s}$	21590.4	3120	23.4/ 23.9
/CFHT	H	16311.4	3000	23.5/ 24.1
IRAC/*Spitzer*	ch1	35634.3	7460	25.5/ o [c]
(SPLASH)	ch2	45110.1	10110	25.5/ o[c]
	ch3	57593.4	14140	23.0/ o[c]
	ch4	79594.9	28760	22.9/ o [c]

[a]

Photometric catalogue, photo-z and physical parameters

TASK WP1 Multi-color catalogue for SPLASH

Responsible: O. Ilbert

Participants: S. Arnouts and several external collaborators (H. McCracken and P. Capak)

Objective: create a multi-color catalogue with >35 bands, despite the PSF variations between the several dataset.

Deliverable: a multi-color catalogue including CFHT/Subaru/VISTA/Spitzer/Herschel data with >2 millions of sources.

TASK WP3 Photometric redshifts

Already done by Laigle, McCracken, Ilbert

paper submitted

Responsible: O. Ilbert

Participants: S. Arnouts, postdoc

Objective: 3-5% accurate photometric redshifts at z>3 for hundred thousands of galaxies for the UltraVISTA and SPLASH surveys, along with associated uncertainties.

Deliverable: a photometric redshift catalogue and their Probability Distribution Functions (PDF) for all sources detected in WP1 (not limited to z>3). We expect one publication in a peer-reviewed journal describing this new catalogue.

TASK WP5 Physical parameters

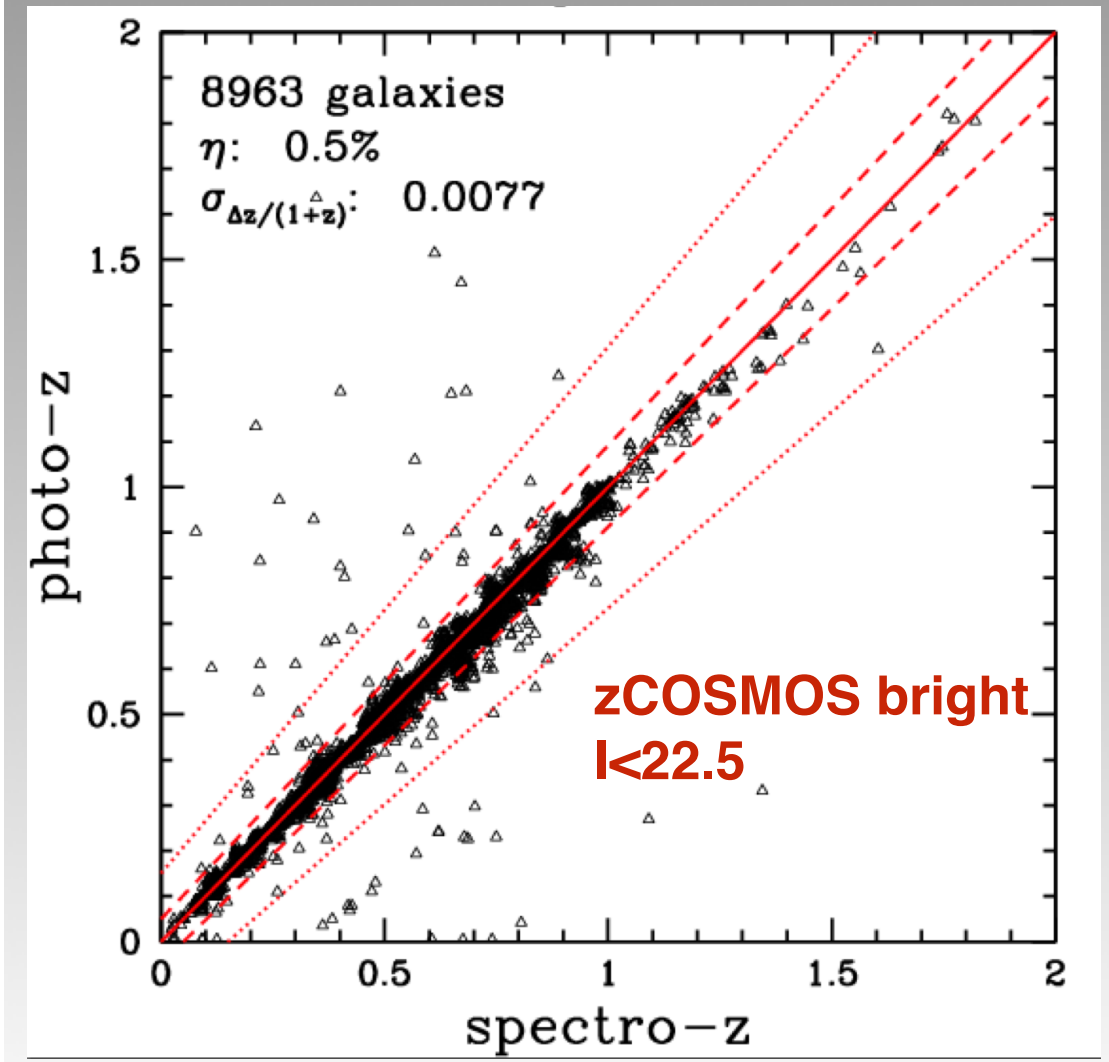
Responsible: S. Arnouts

Participants: O. Ilbert, postdoc

Objective: derive the physical parameters for the full photo-z catalogue, test their accuracy and possible systematic uncertainties for the z>3 populations.

Deliverable: physical parameters (at least stellar masses, SFR, sSFR, absolute magnitudes) for all the sources of the catalogue and associated uncertainties.

Best survey to get and test the photometric redshifts



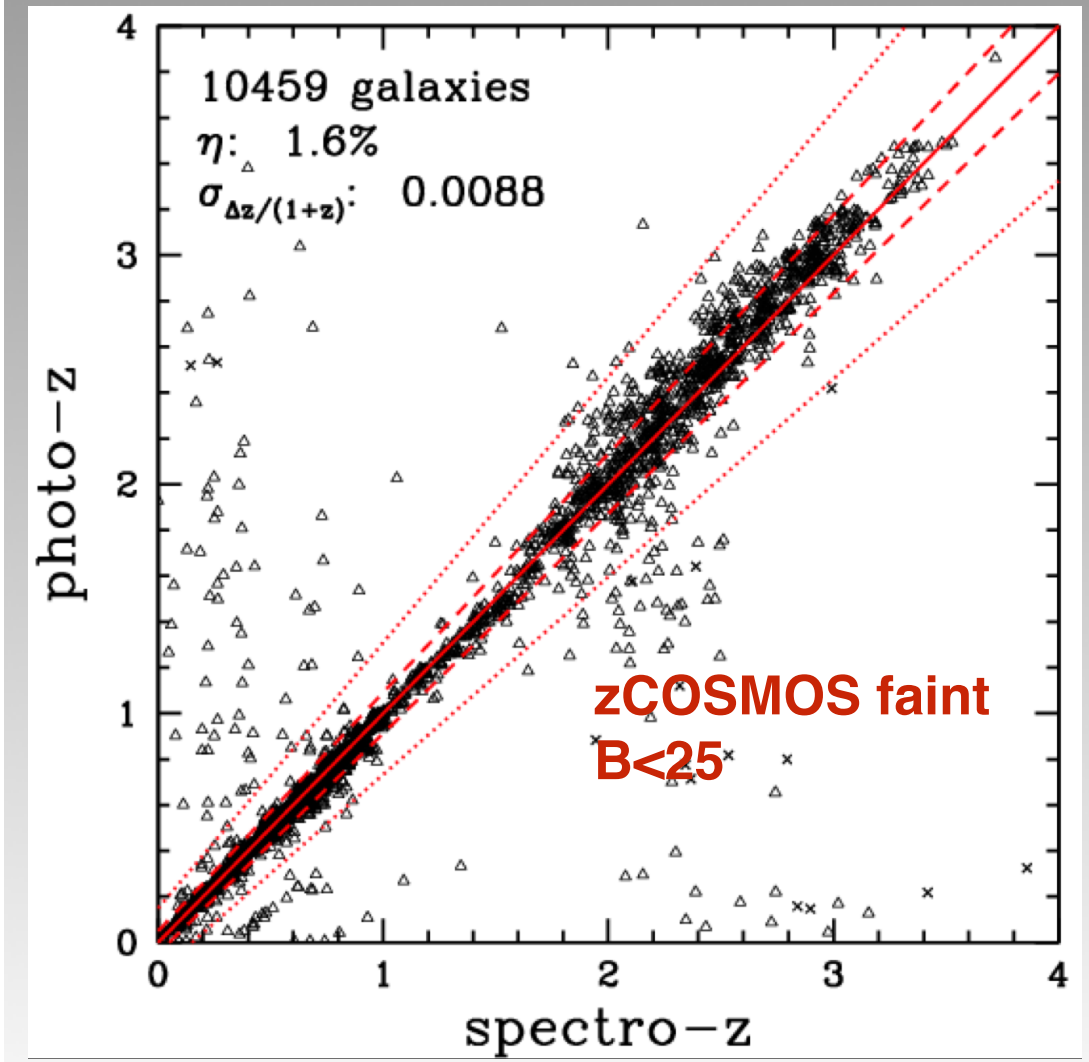
Hyper Suprime Cam >27

UltraVISTA DR2 mag~25.3

SPLASH mag~25.2

spectroscopic redshifts

Best survey to get and test the photometric redshifts



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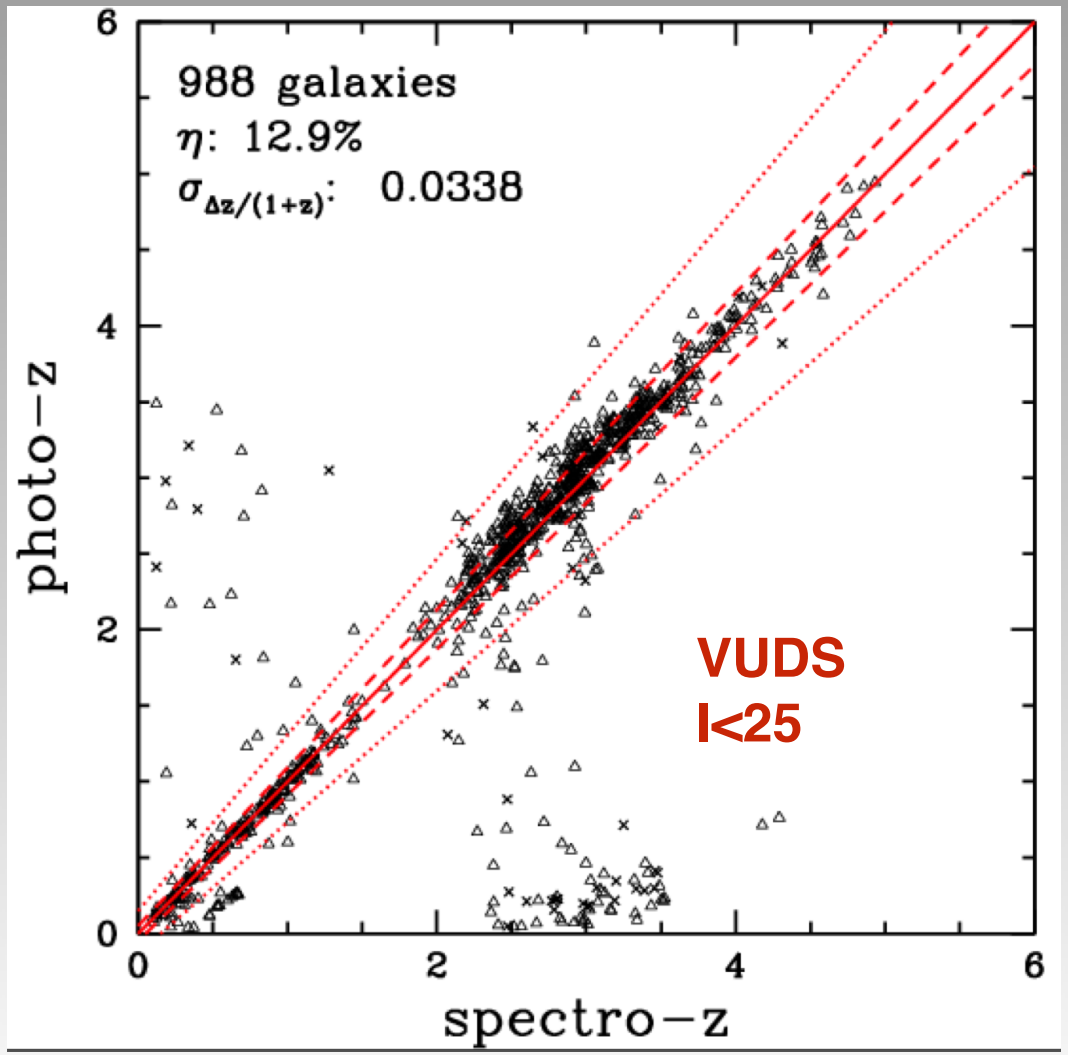
Best survey to get and test the photometric redshifts



Hyper Suprime Cam >27

UltraVISTA DR2 mag~25.3

SPLASH mag~25.2

spectroscopic redshifts

Best survey to get and test the photometric redshifts

Hyper Suprime Cam >27

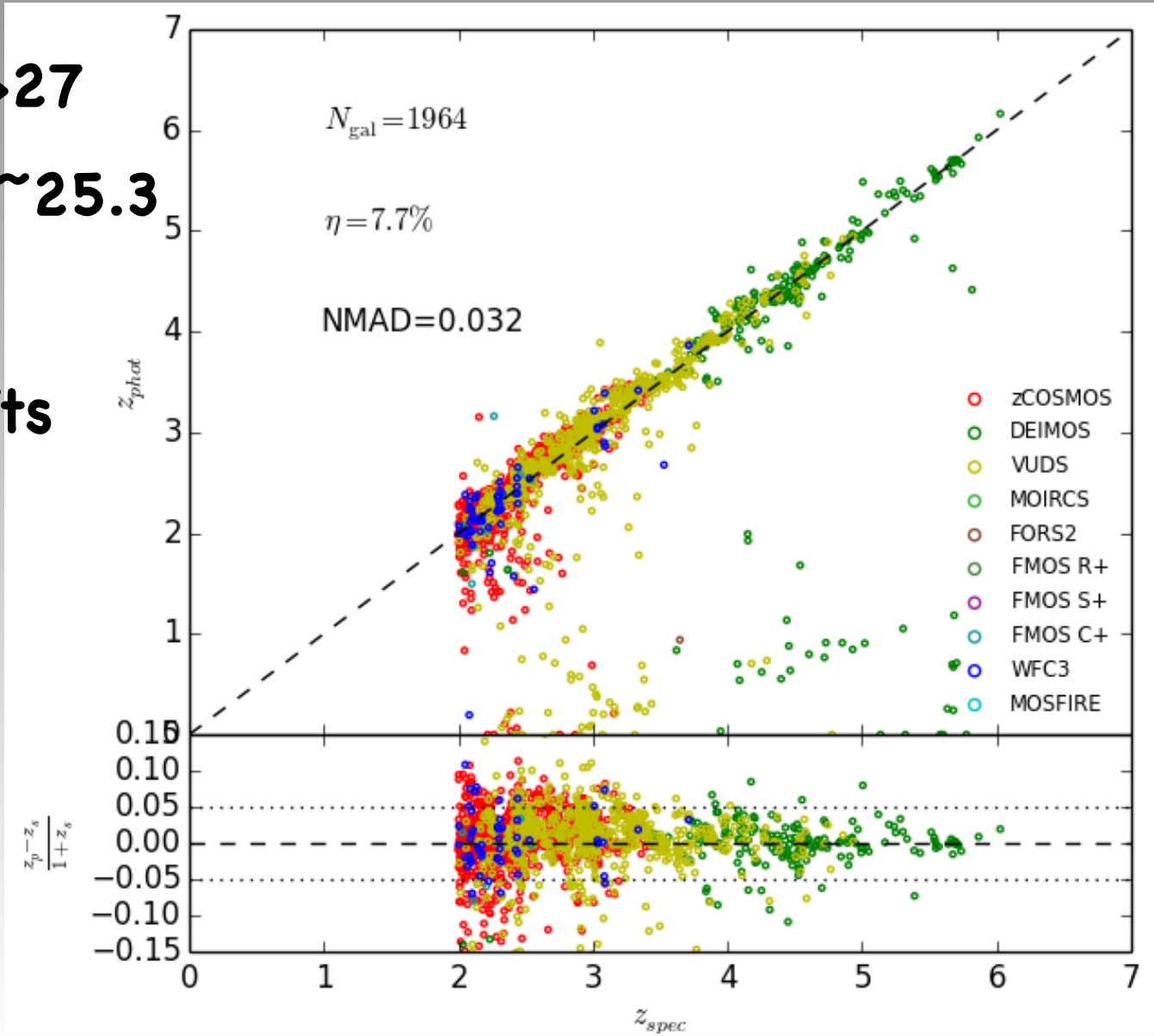
UltraVISTA DR2 mag~25.3

SPLASH mag~25.2

spectroscopic redshifts

➢unique combination for z>4

ongoing work by I. Davidzon



Primordial Universe

TASK WP4 Identify the z>6 galaxies

Thesis of Pin-Wei

Work started by Iary, Laurence, OLF

Responsible: Postdoc

Participants: J.G. Cuby, O. Le Fèvre, O. Ilbert

Objective: define several robust criteria to select the z>6 galaxies and create a catalogue of well checked candidates.

Deliverable: positions of the z>6 candidates and the confidence level in their selection.

TASK WP7 Scientific exploitation: analysis of the z>6 sources

Responsible: Postdoc
Participants: the full team

Objective: analyse the physical properties of z>6 sources, analyse the impact of our estimate on the primordial Universe.

Deliverable: We expect at least one publication in a peer-reviewed journal about the z>6 massive galaxy population.

TASK WP9 spectroscopic follow-up of the massive sources at z>6

Responsible: L. Tresse

Participants: O. Le Fèvre, J.G. Cuby

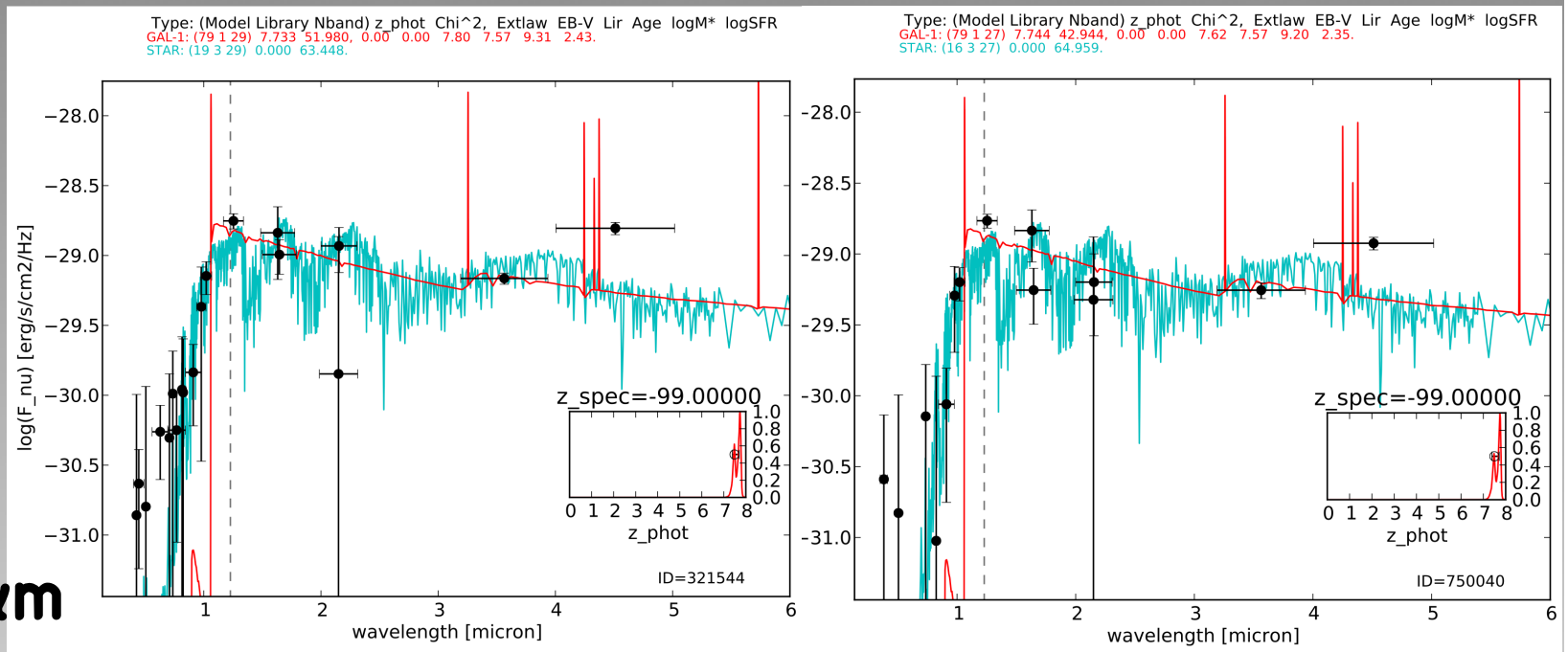
Objective: spectroscopic follow-up of the massive sources at z>6

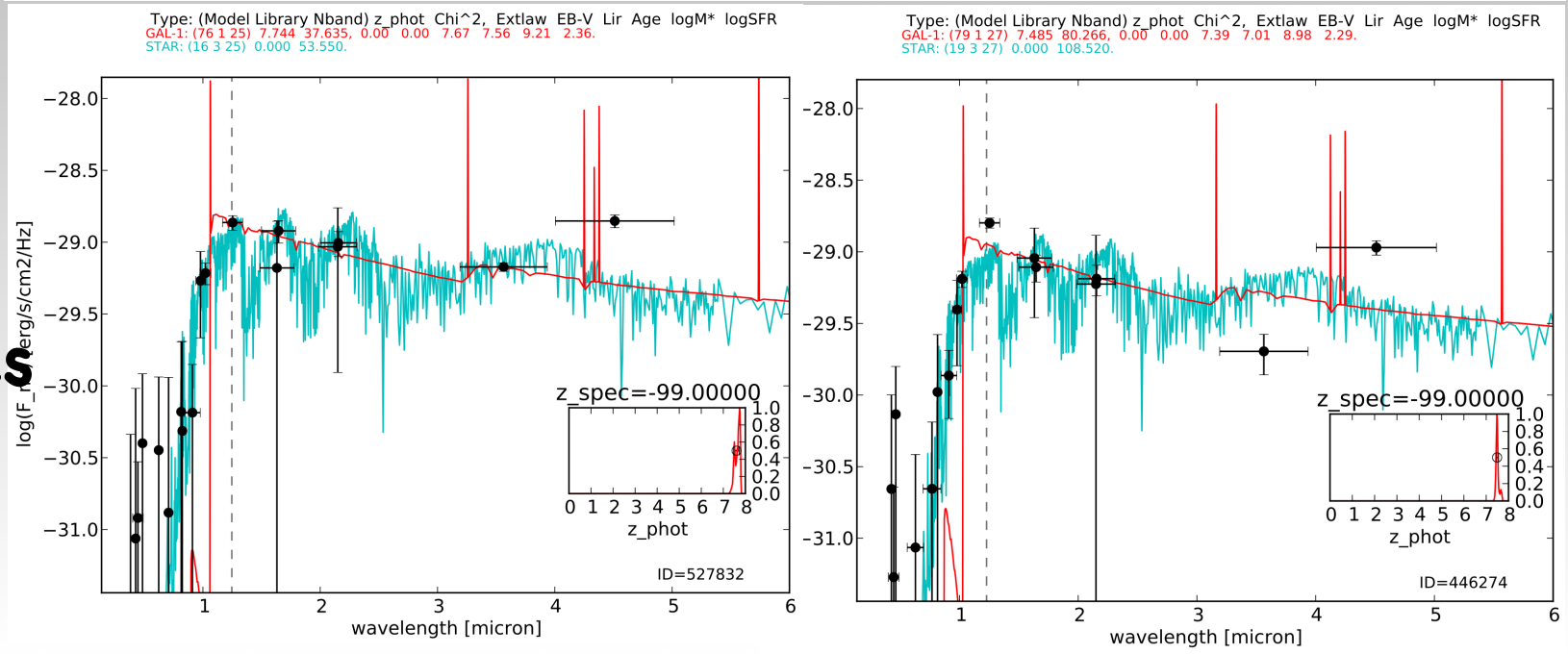
11 good candidates at z>6.5

IRAC 3.6μm

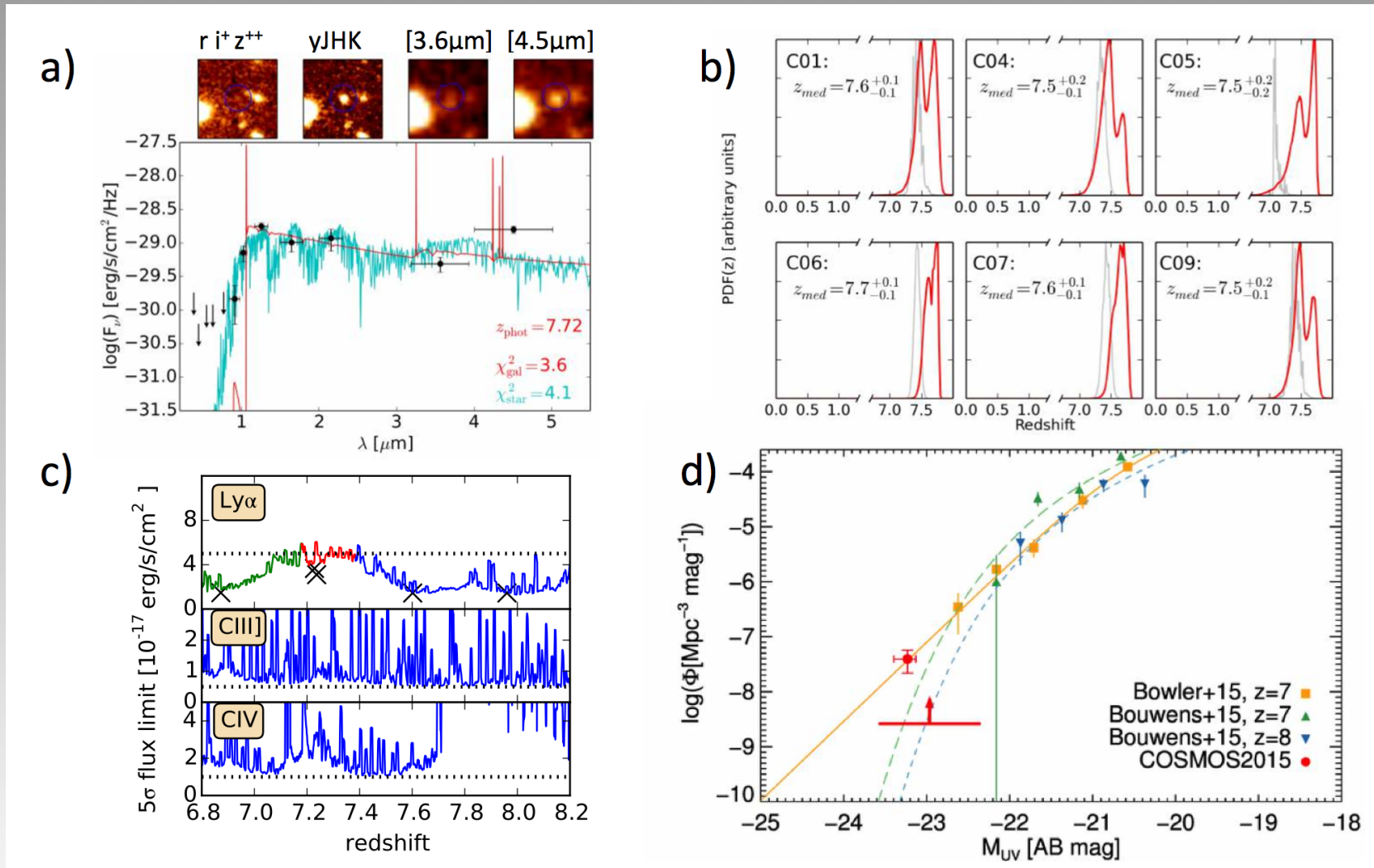
- IRAC 4.5μm

really efficient to get the emission lines





get the spec-z for the z>6.5 galaxies



29h asked with x-shooter this semester

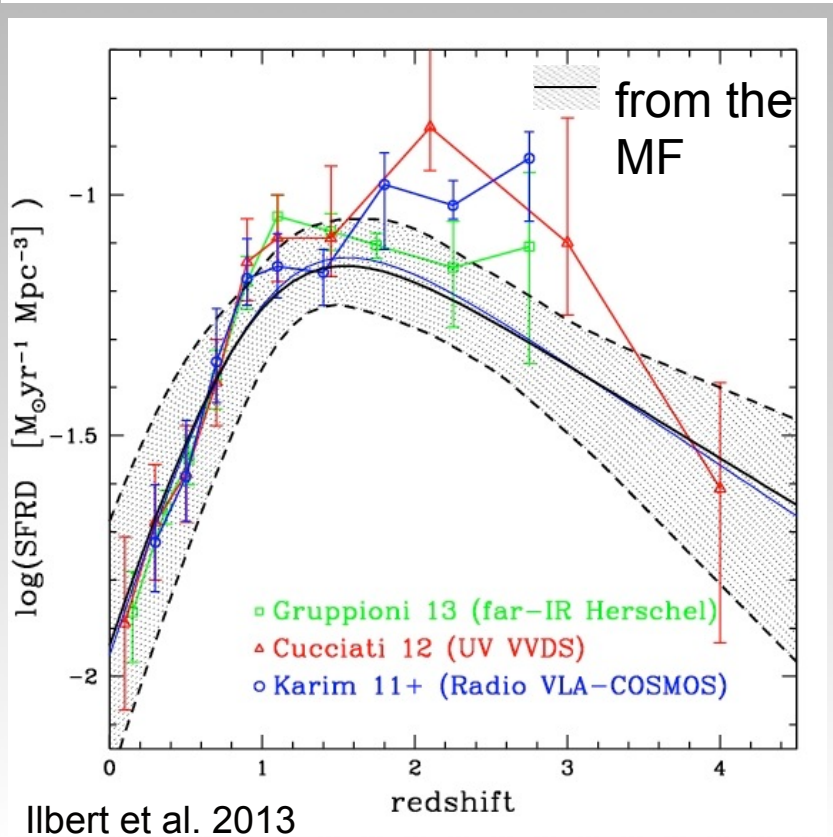
Global star formation history of the galaxies at 4<z<6+

TASK WP6 Scientific exploitation: the star formation history

Responsibles: O. Ilbert, L. Tresse, S. Arnouts
Participants: the full team

Objective: derive the star formation history in the first 2 billion years of galaxy evolution.

Deliverable: We expect several publications in peer-reviewed journals from this WP on the SFH at 3<z<6, using direct tracers of the SFR and complementary methods based on the mass function.



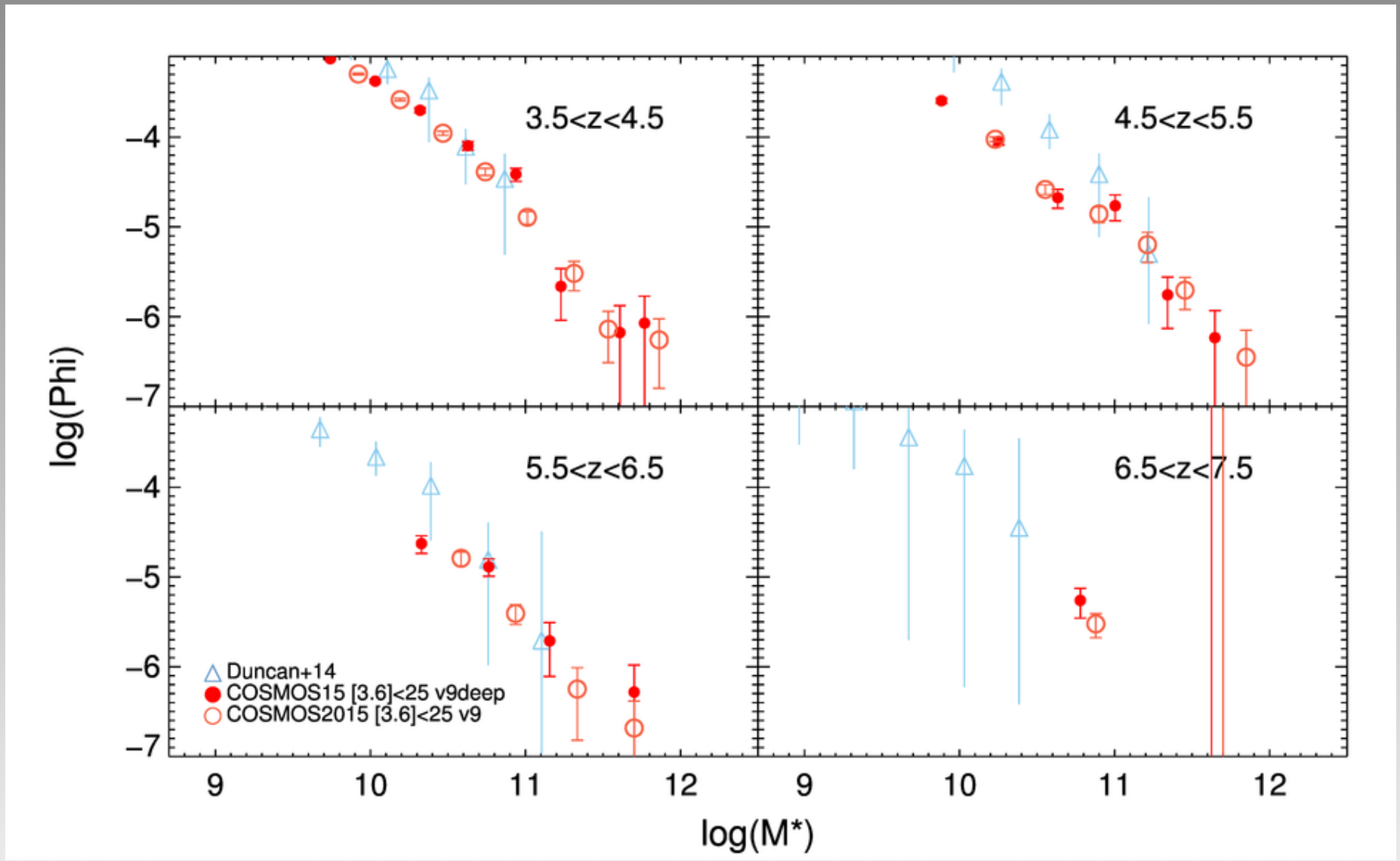
Ilbert et al. 2013

Use the stellar mass cumulated long the galaxy history to derive the SFH

and sSFR

+ direct UV tracers

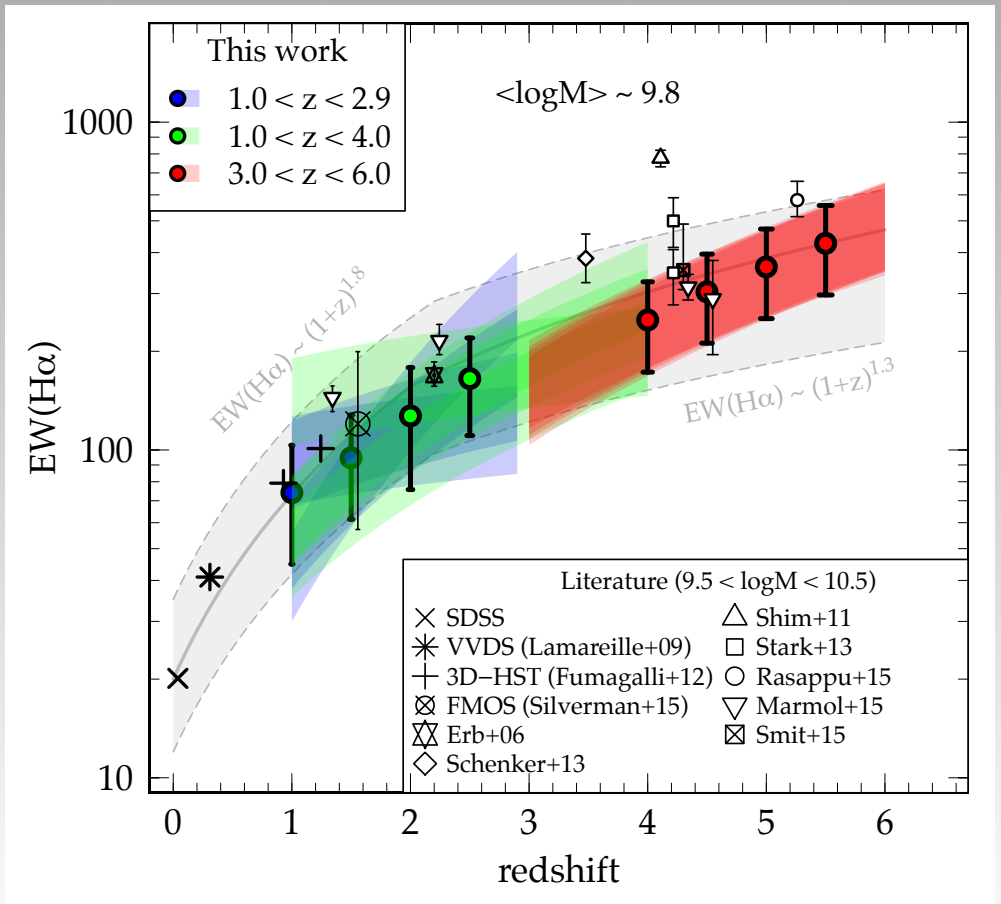
stellar mass function at 3.5<z<7.5

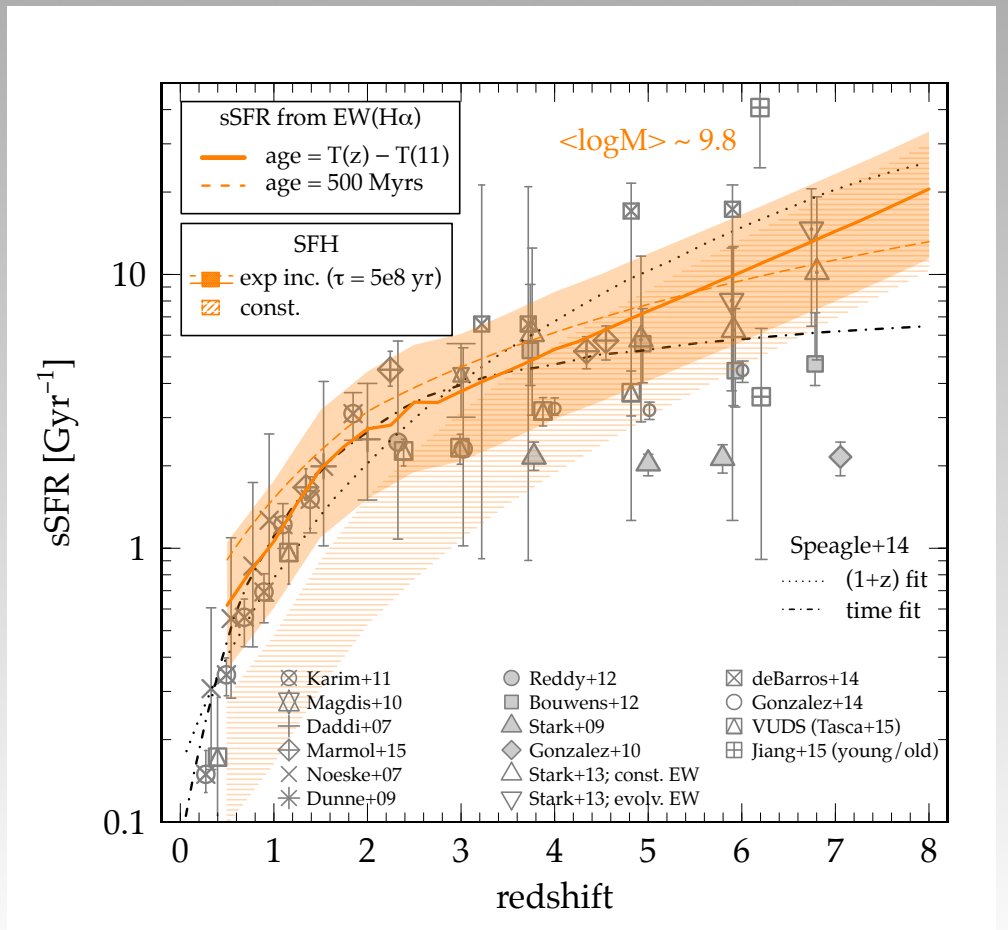


- To be converted into sSFR … next weeks
- Paper to be written by Iary Dadidzon

Evolution of the sSFR with redshift

- Used spec-z and IRAC colors to get the Hα EW at z>1.5
- Paper to be submitted by A. Faisst within 2 weeks

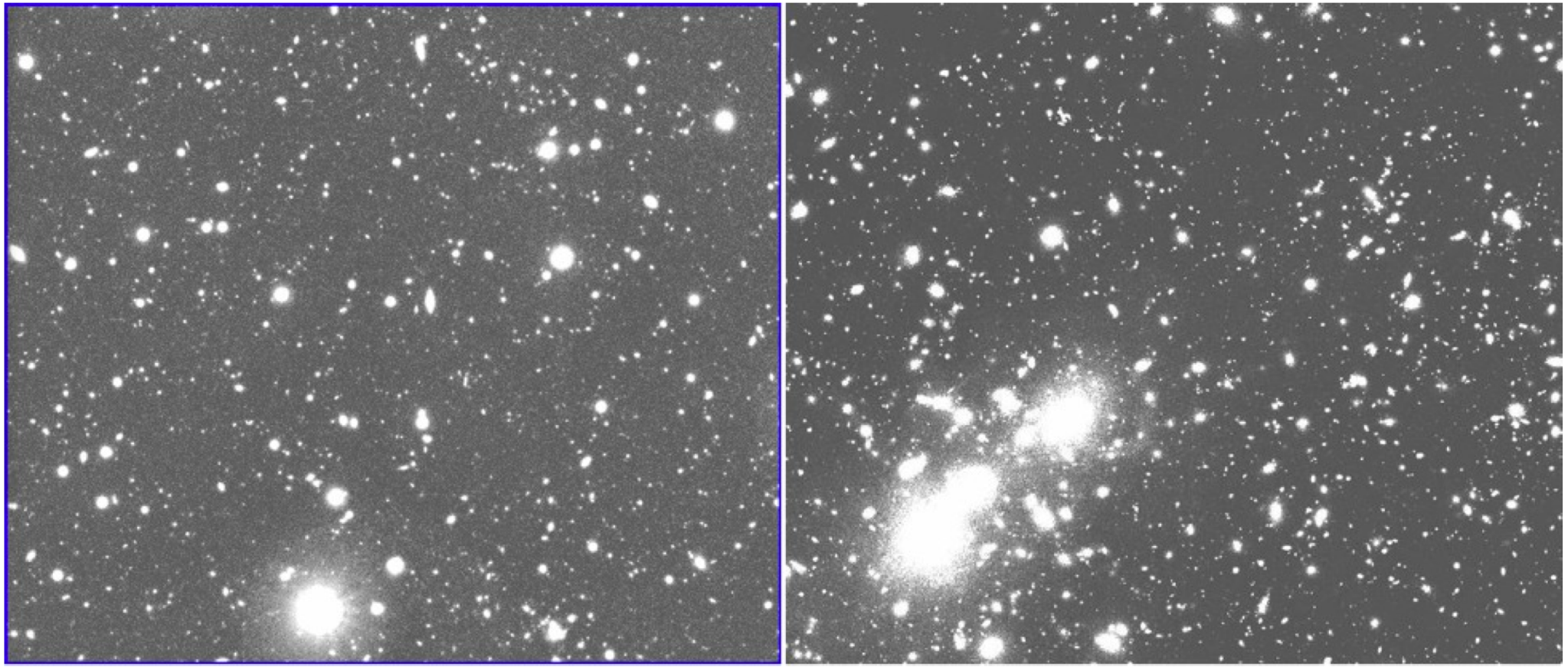


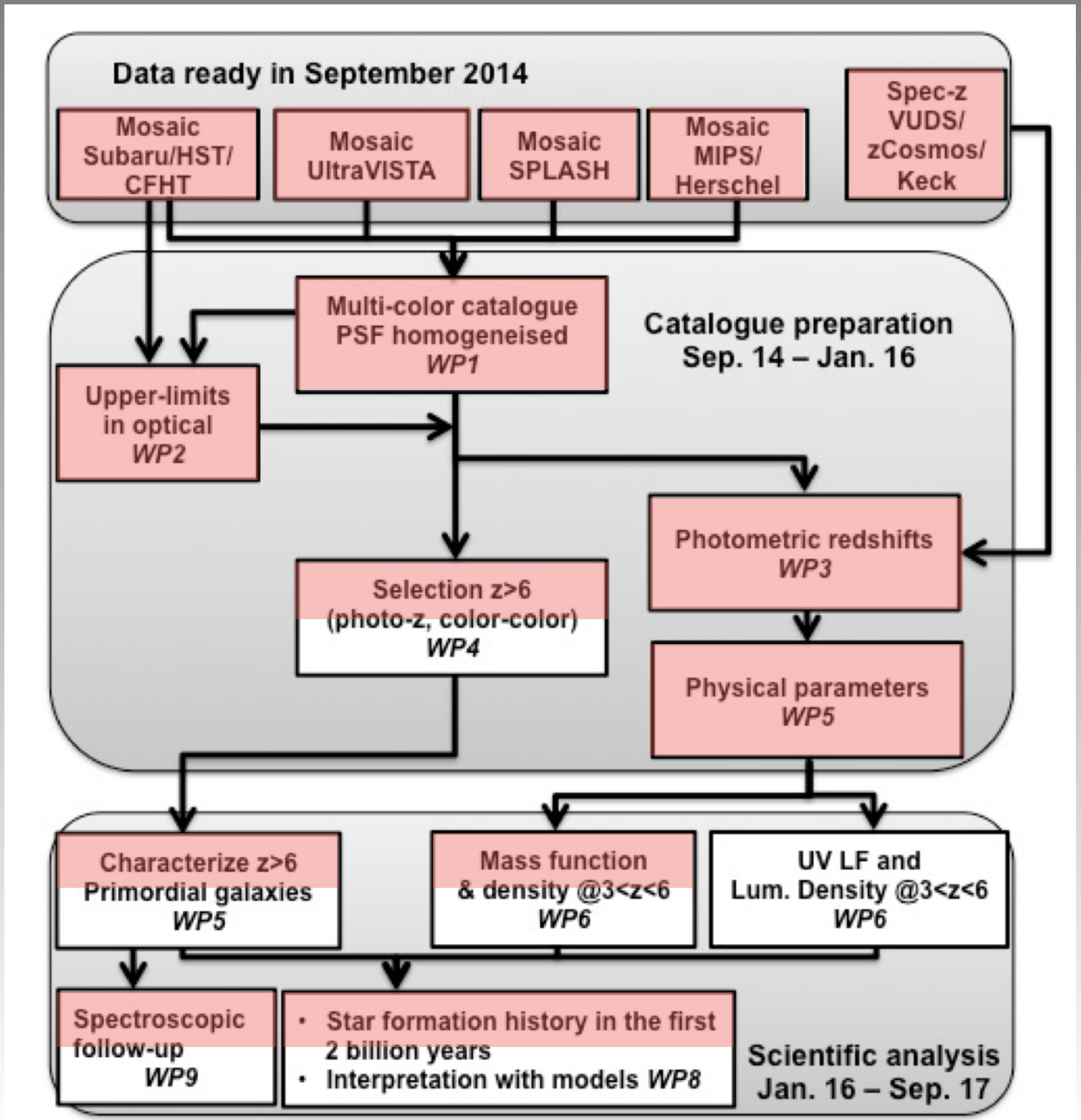


WP8: comparison with the hydro simulation Horizon-AGN

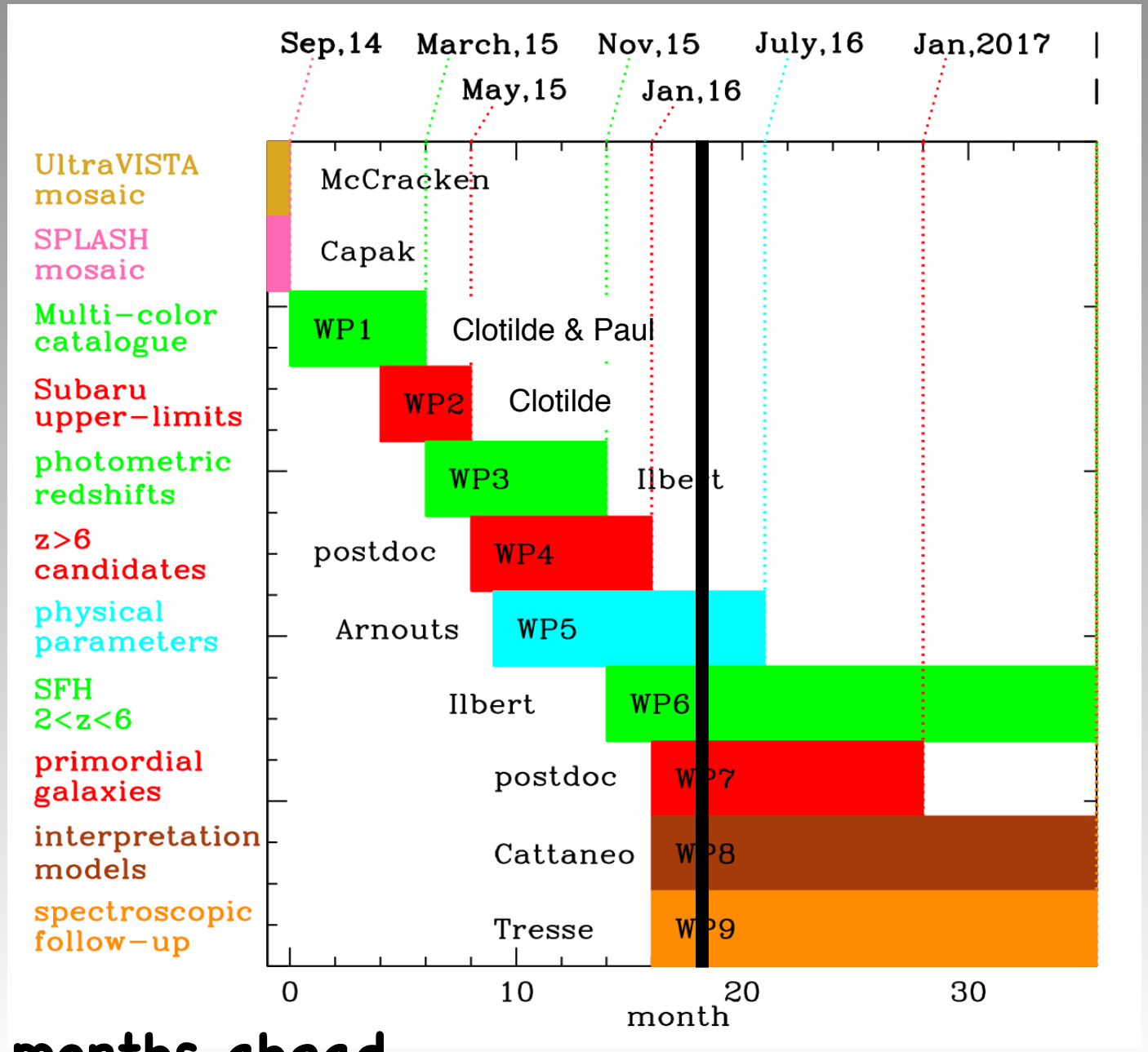
- Clotilde Laigle generates lightcones and mock images
- analyse simulation as done for data, then compare

➢ ongoing work by Clotilde and Iary



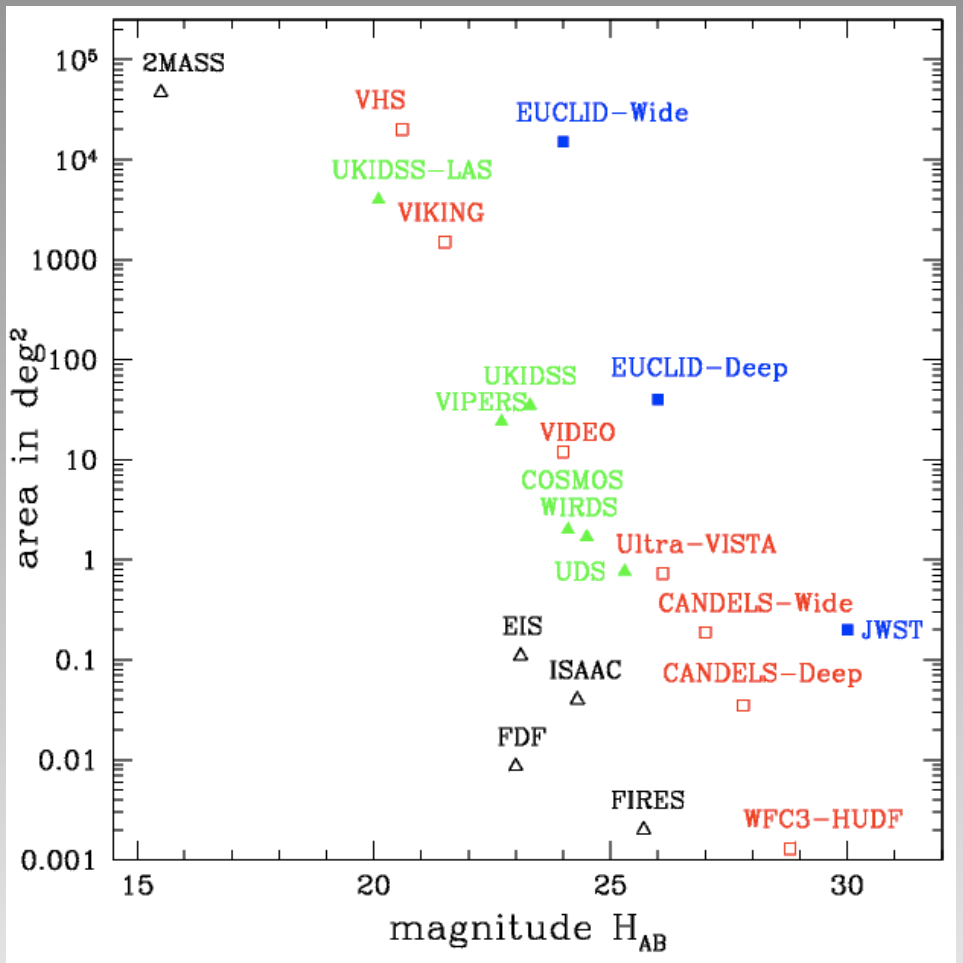

Data ready in September 2014
Mosaic Subaru/HST/ CFHT
Mosaic UltraVISTA
Mosaic SPLASH
Mosaic MIPS/ Herschel
Spec-z VUDS/ zCosmos/ Keck
Multi-color catalogue PSF homogeneised WP1
Catalogue preparation Sep. 14 – Jan. 16
Upper-limits in optical WP2
Photometric redshifts WP3
Selection z>6 (photo-z, color-color) WP4
Physical parameters WP5
Characterize z>6 Primordial galaxies WP5
Mass function & density @3<z<6 WP6
UV LF and Lum. Density @3<z<6 WP6
Spectroscopic follow-up WP9
• Star formation history in the first 2 billion years
• Interpretation with models WP8
Scientific analysis Jan. 16 – Sep. 17

Schedule



➢ 3-4 months ahead

Be prepared to the future



- first quenched galaxies
- z>6+

Follow-up with current spectrograph

Targets for JWST and ELT

Comparison with models

TASK WP8 Scientific exploitation: comparison with theory

Responsible: A. Cattaneo

Participants: full team

Objective: interpret our results with simple phenomenological models but also with more complex physically motivated models as the semi-analytical models.

- SAM (several public ones)
- Hydro Horizon-AGN

- Adaptative Mesh Refinement code (RAMSES)finest cell: 1kpc

Dubois et al. 14, *Dancing in the dark*
http://www.horizon-simulation.org

- standard lambda-CDM cosmology (Ω_Λ=0.728, Ω_m=0.272, H_0= 70.4 km/s/Mpc)

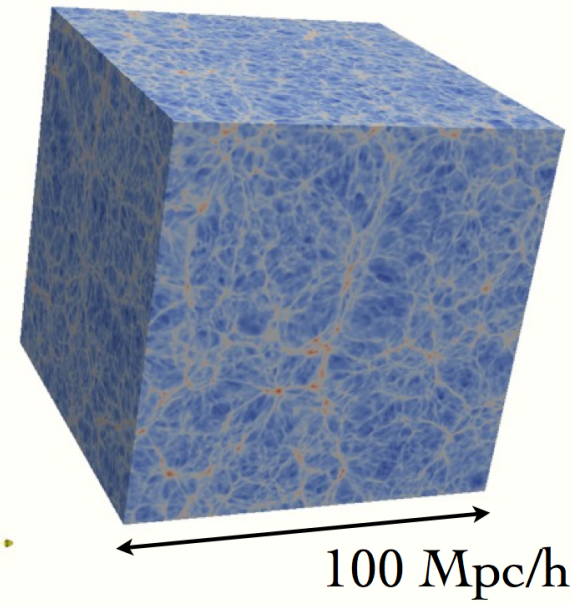
- boxsize = 100 Mpc/h, 1024^3 particles

DM: mass resolution 8x10^7 Msol

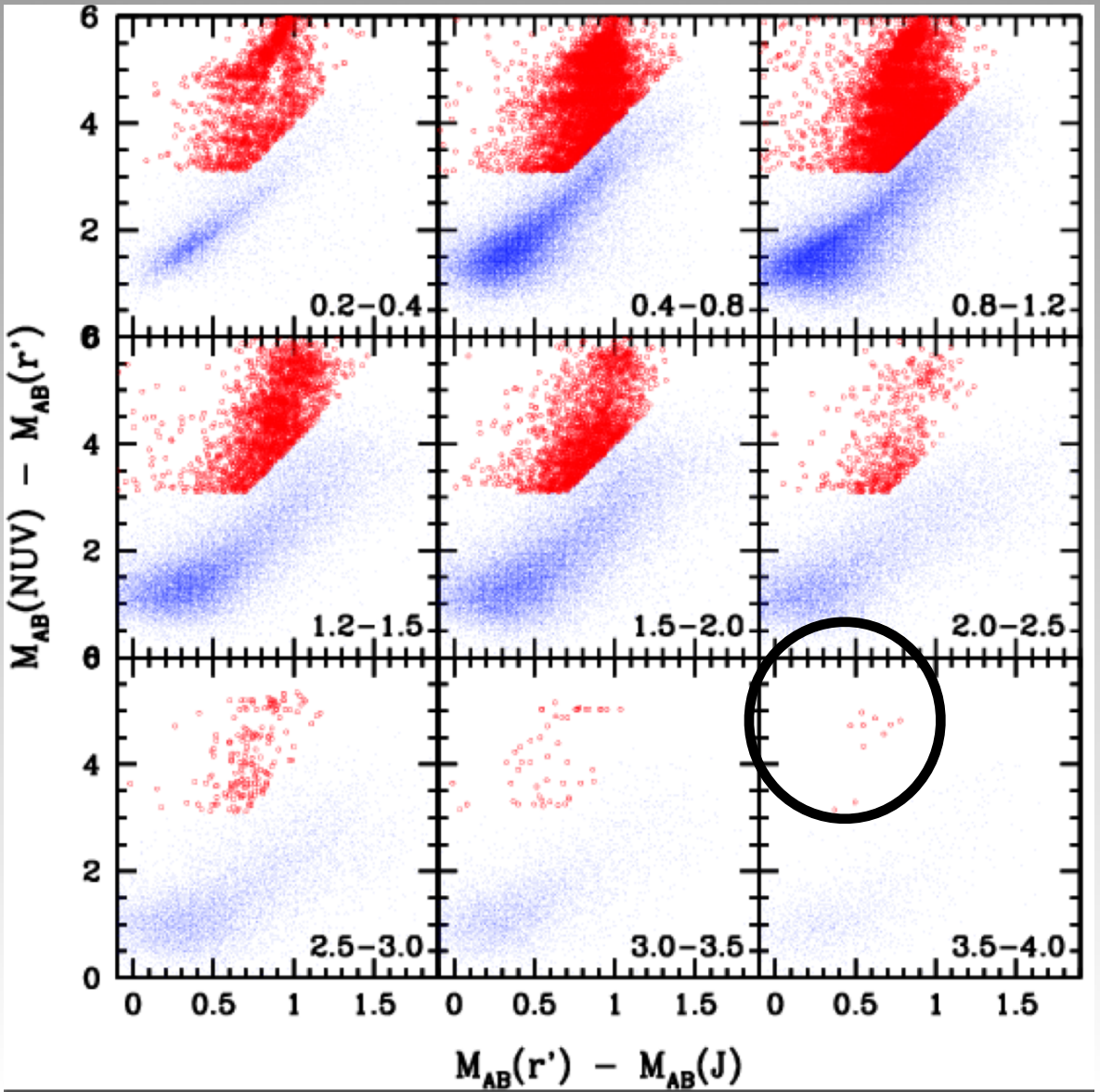
Gas: density, temperature, metallicity (modified by supernovae and stellar winds), chemical elements (O, Fe, C, N, Mg and Si)

Stars: schmidt law, from a certain gas threshold. stellar mass resolution 2x10^6 Msol.

AGN



get the spec-z for the first quenched galaxies



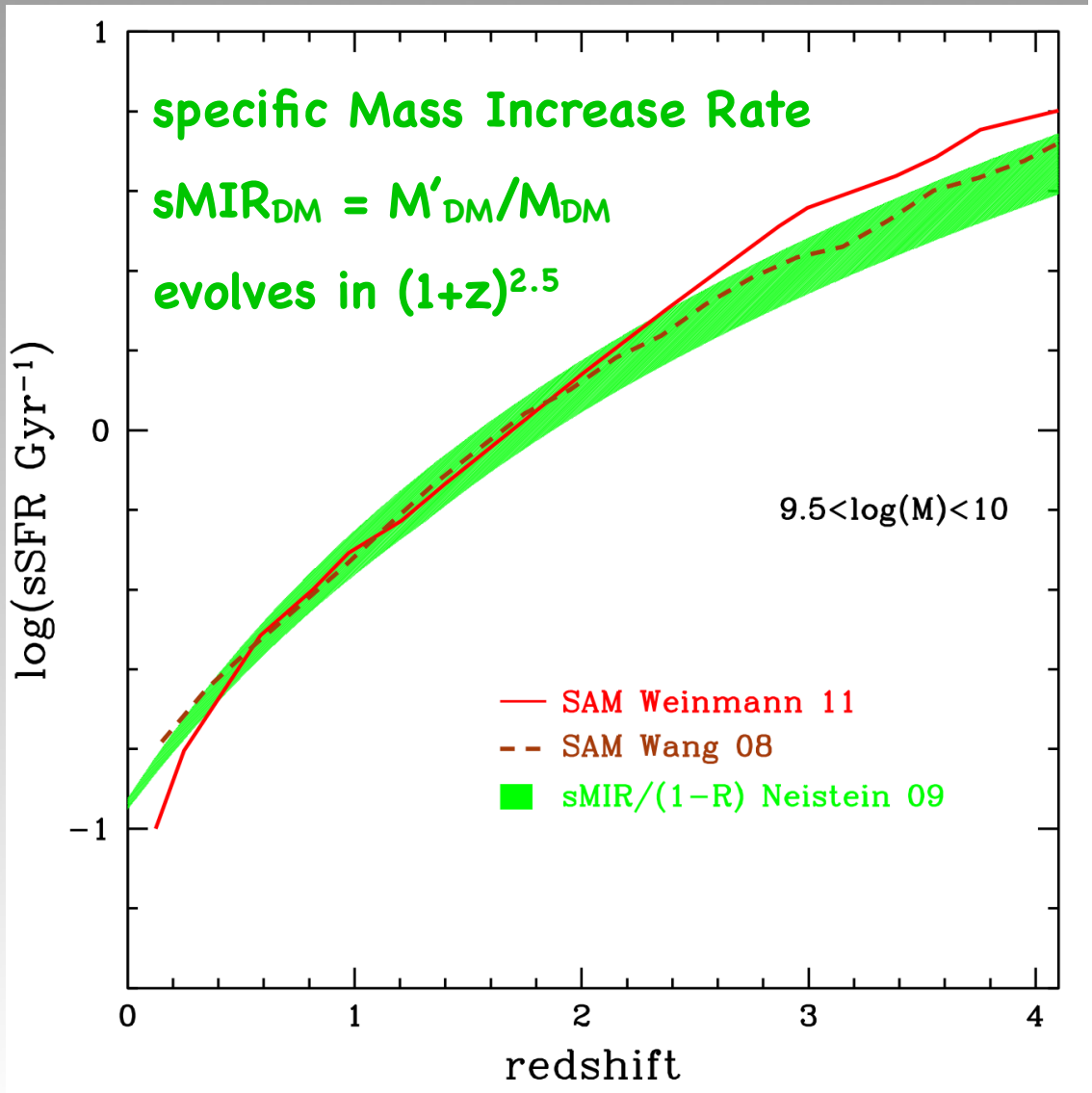
Several interesting candidates that we can ask next semester

Evolution of the sSFR and link with the cosmological accretion rate

If a constant fraction of baryons converted in old ☆

$M'_{DM}/M_{DM} \propto M'_b/M_b \propto SFR/M_\star$

sSFR follows the $sMIR_{DM}$ in most models despite the complexity of the involved processes

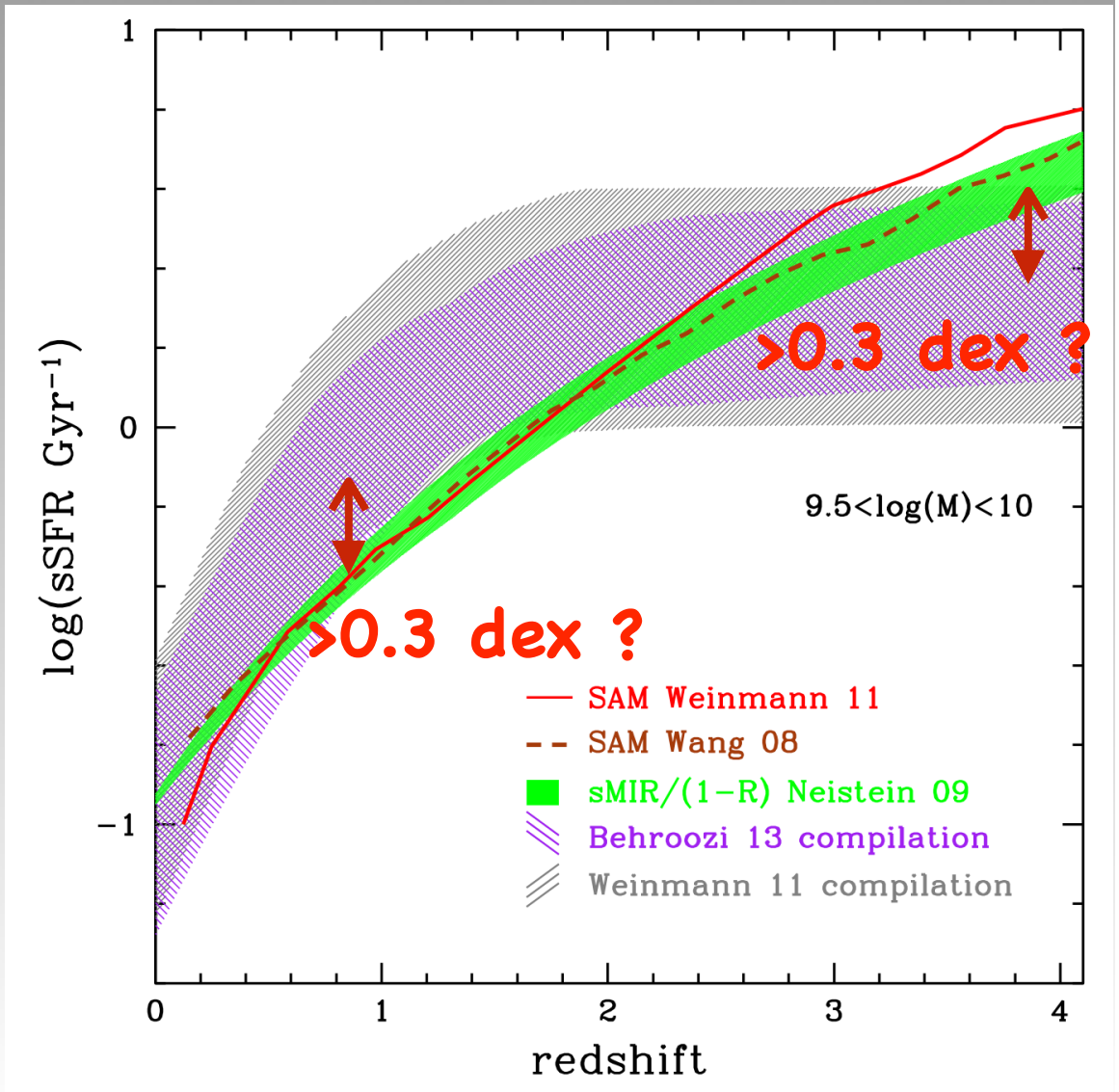


Evolution of the sSFR and link with the cosmological accretion rate

But there is a tension between the observed and predicted sSFR

Even at z<1.5

Missing physical processes or selection effects in the data ?



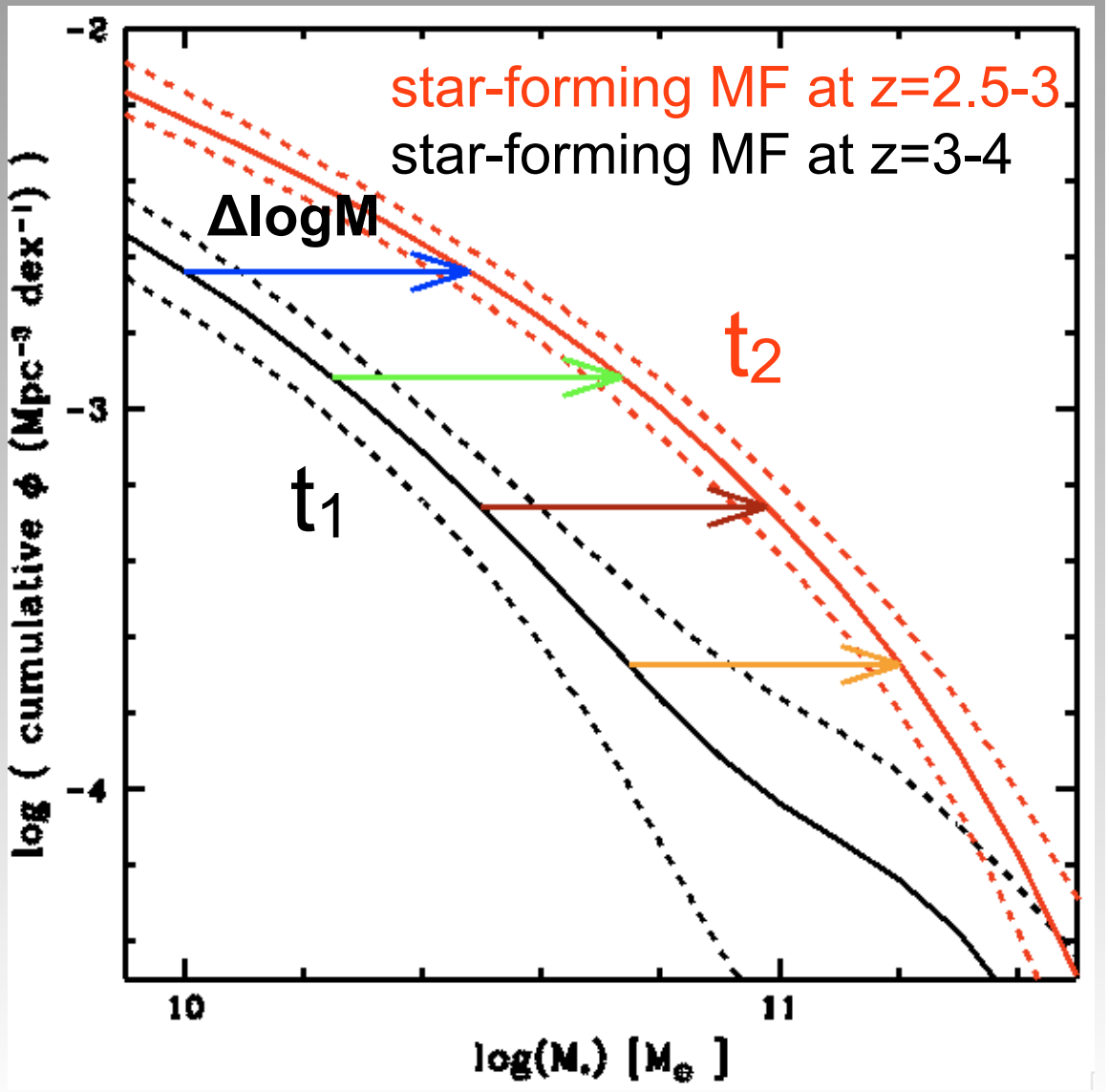
Infer the specific SFR from the star-forming MF evolution

Evolution of the star-forming MF

$\Delta \log M \propto \log(1+sSFR^{*}\delta t)$

$$sSFR(t_1) = \frac{10^{\Delta \log M} - 1}{(t_2 - t_1 - \int_{t_1}^{t_2} f_r(t_2 - t')dt')}$$

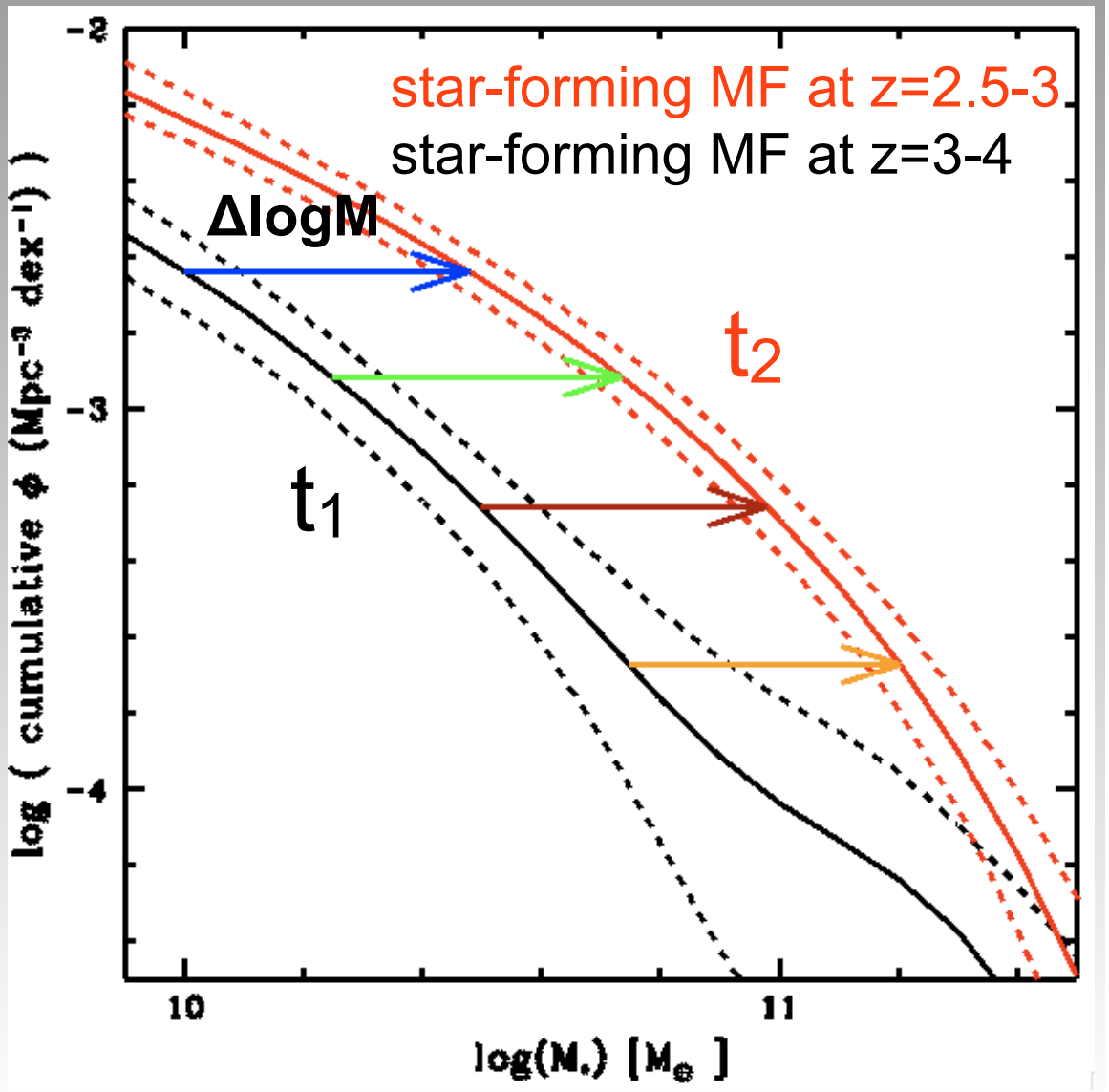
⚠ Need to remove the contribution of galaxies quenched during δt



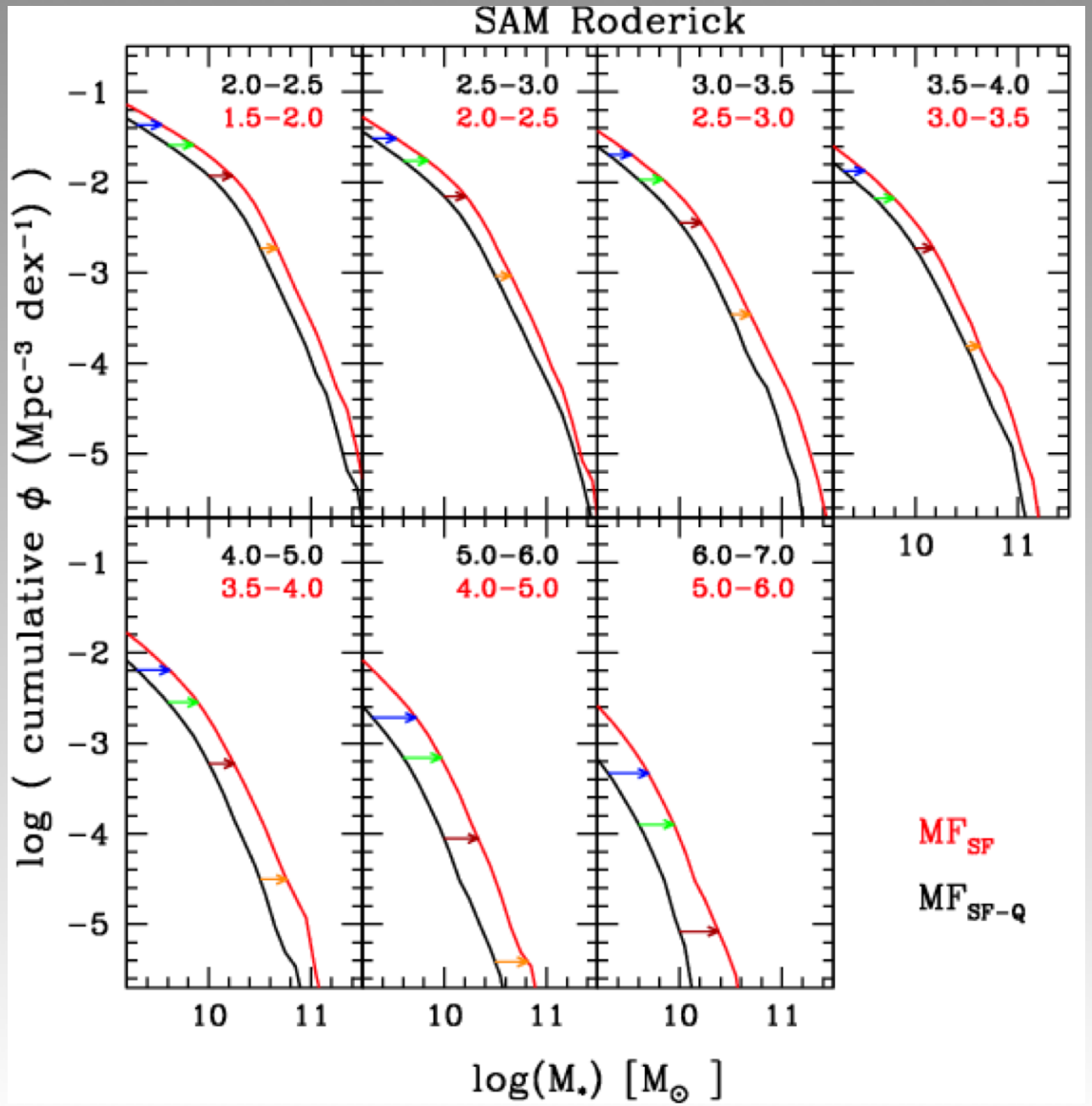
Infer the specific SFR from the star-forming MF evolution

Measure ΔlogM at different redshifts and different masses

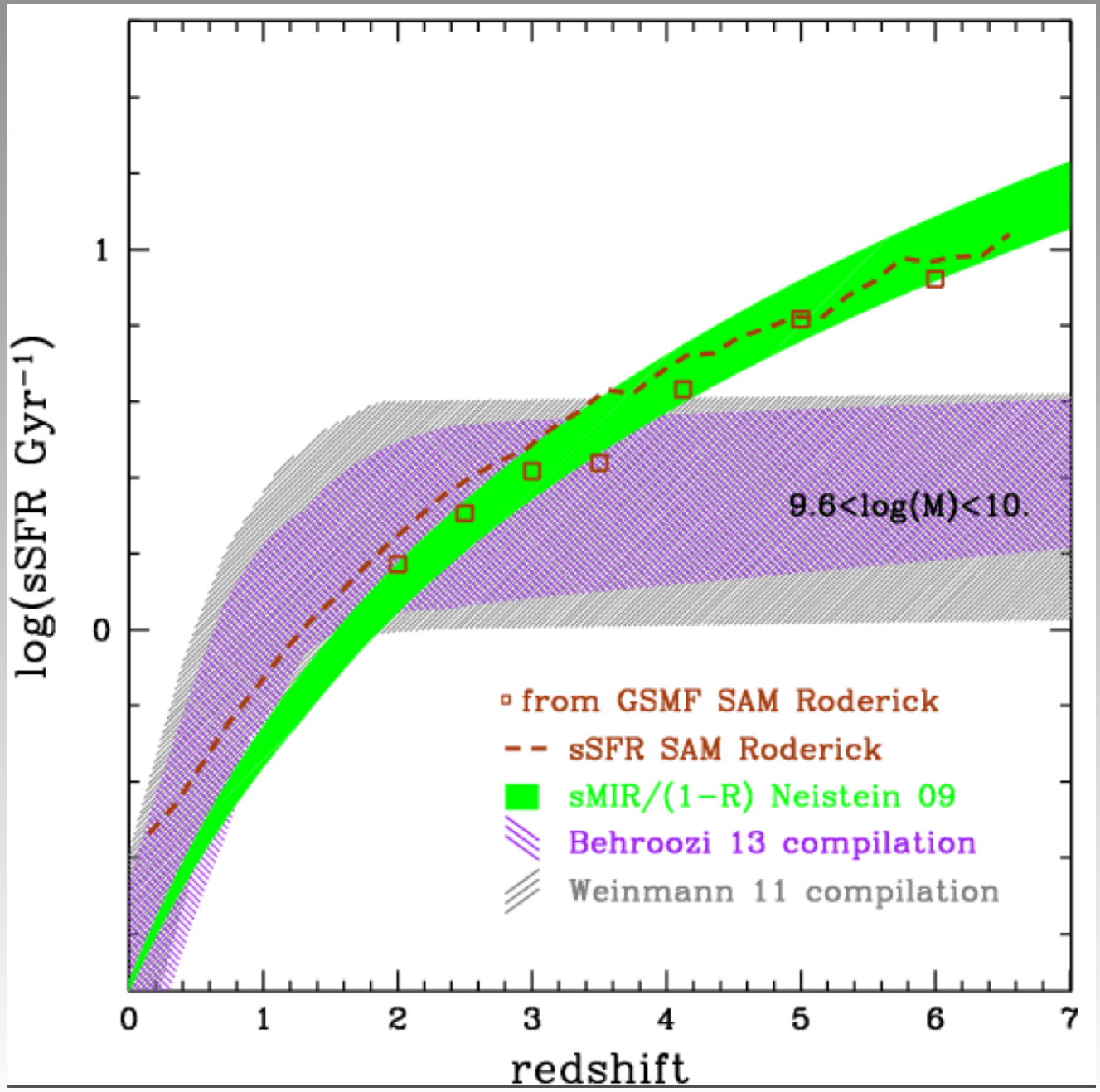
➢ evolution of the sSFR estimated at various masses



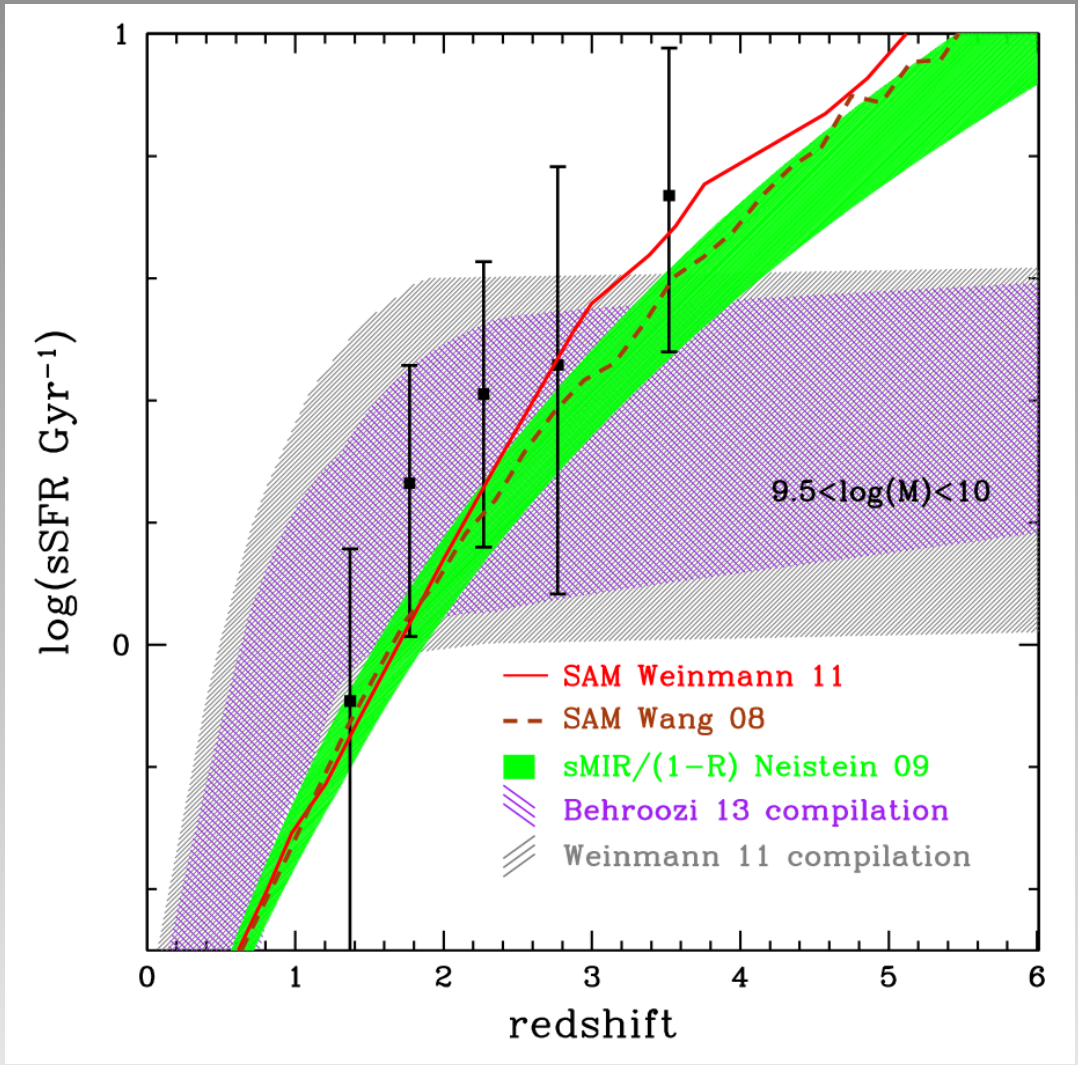
Test the method with a SAM



test the method with a SAM



Evolution of the sSFR with redshift



- Push at 4<z<6
- Improve at 1<z<4