

Université

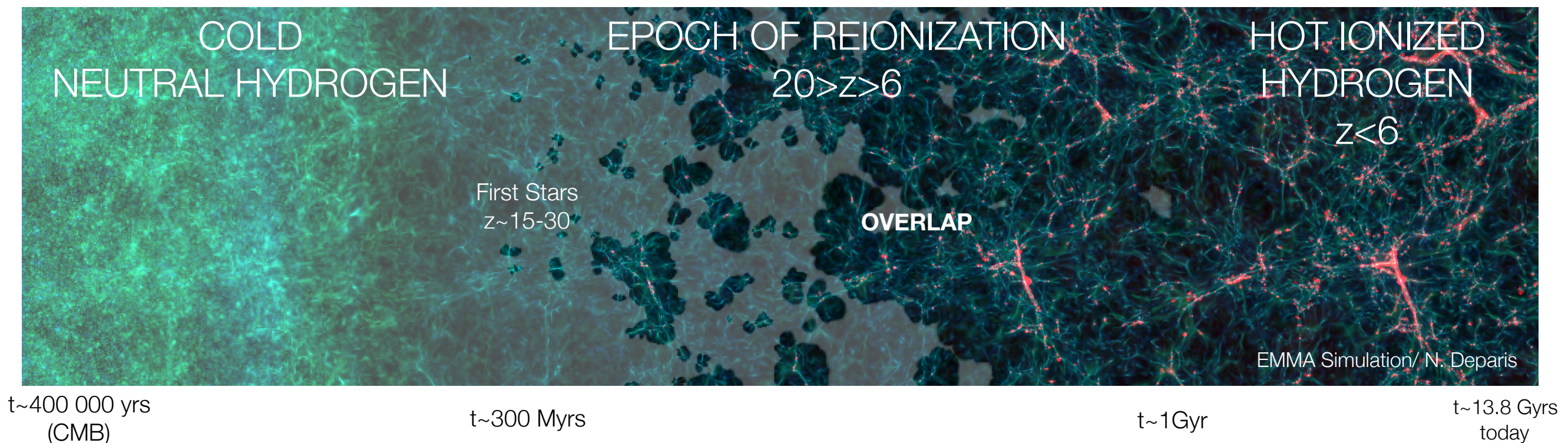
de Strasbourg

The Reionization epoch of $z=0$ halos

Dominique Aubert

very first results of the CODA I-AMR simulation

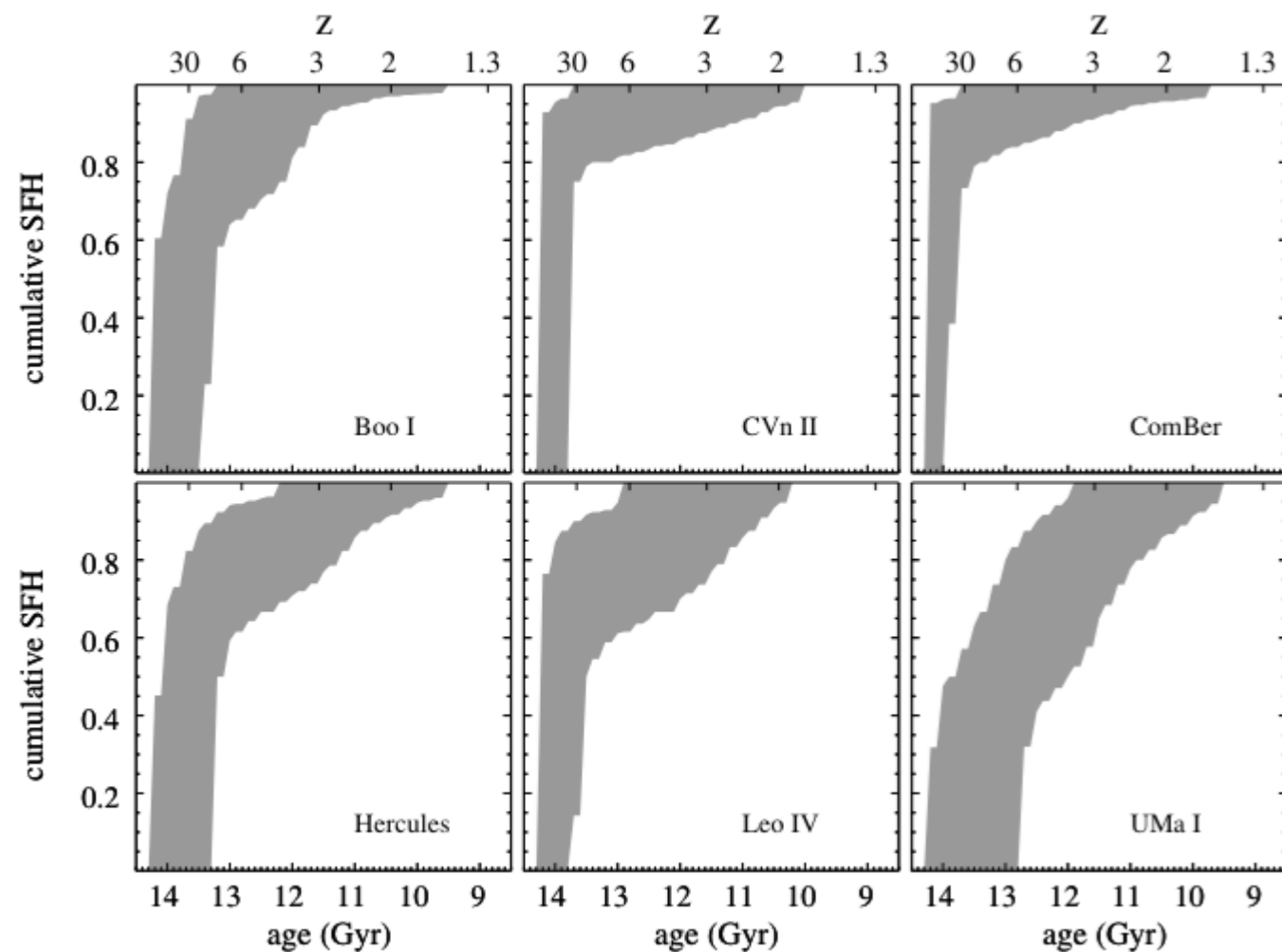
Collaborators : Deparis, Ocvirk (Strasbourg) + CODA (Shapiro, Iliev) + CLUES (Gottlober, Hoffman, Yepes)



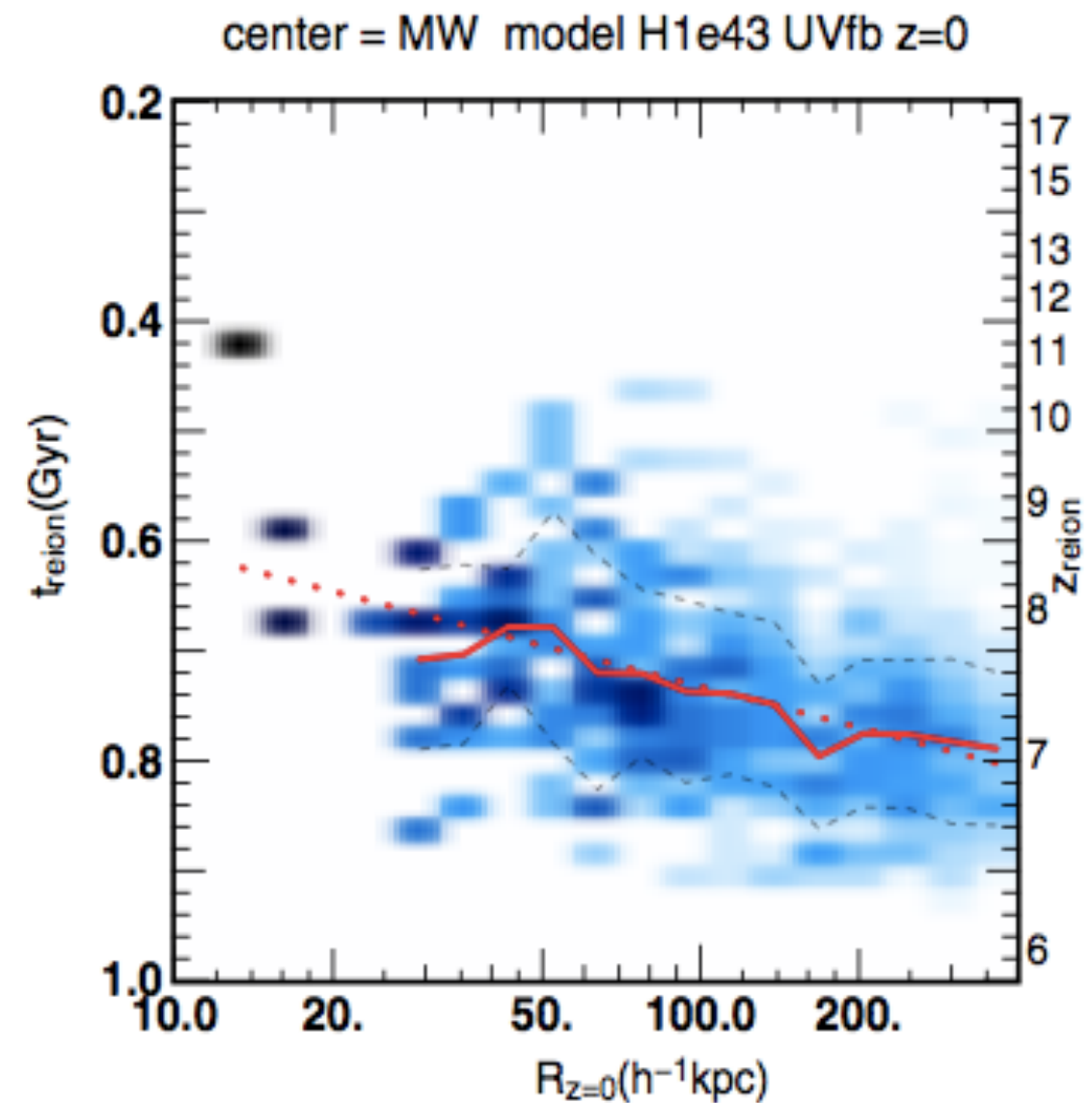
The Reionization is an heterogeneous process.
 The perception of Reionization from the point of view of galaxies is biased.

When did a $z=0$ galaxy/halo see the UV field rise ?

Important for e.g photo-suppression of stellar population in first galaxies.
 $Z=0$ Imprint in LG satellites stellar populations ?



Brown et al. 2014

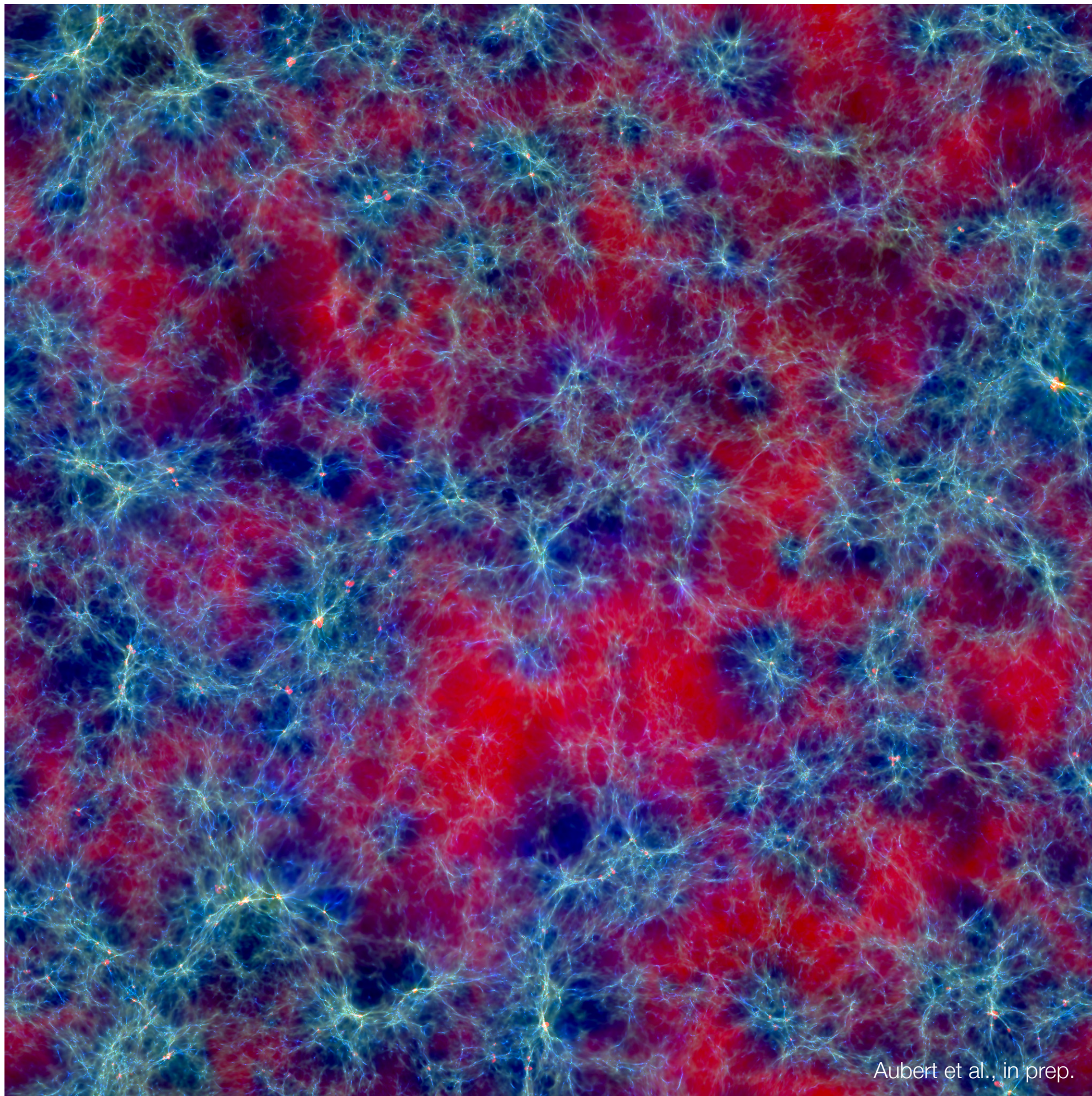


Ocvirk et al. 2014

Reionization @ z=0

- The buildup of stellar population could be influenced by the rise of the UV field
- The imprint of this buildup could still be present at low-z

How did z=0 galaxies experience the Reionization ?



CODA I-AMR

64 h⁻¹ Mpc/2048³

16 billions

resolution elements

with AMR

@ z=6

32768 cores +

4096 GPUs on

Titan(DOE/ORNL)

using EMMA

20+ millions

cpu hours

Jan.-Mar 2017

INCITE CODA

(PI : Shapiro)

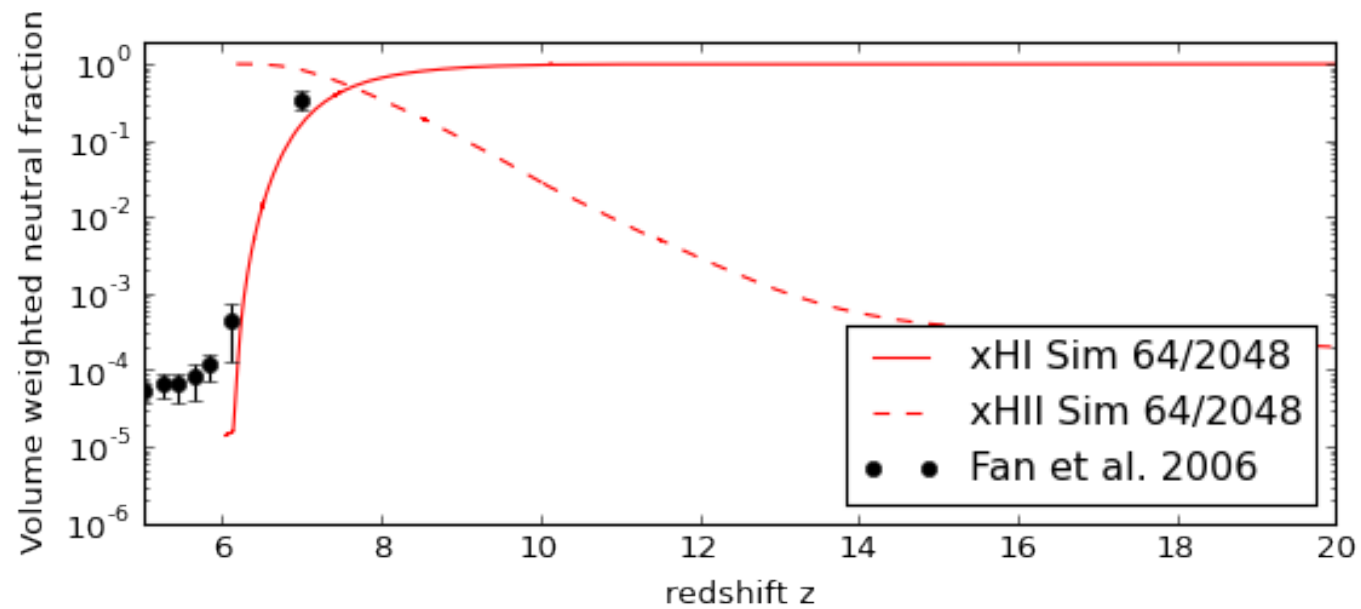
WMAP5-CLUES ICs

spatial res.=500 pc

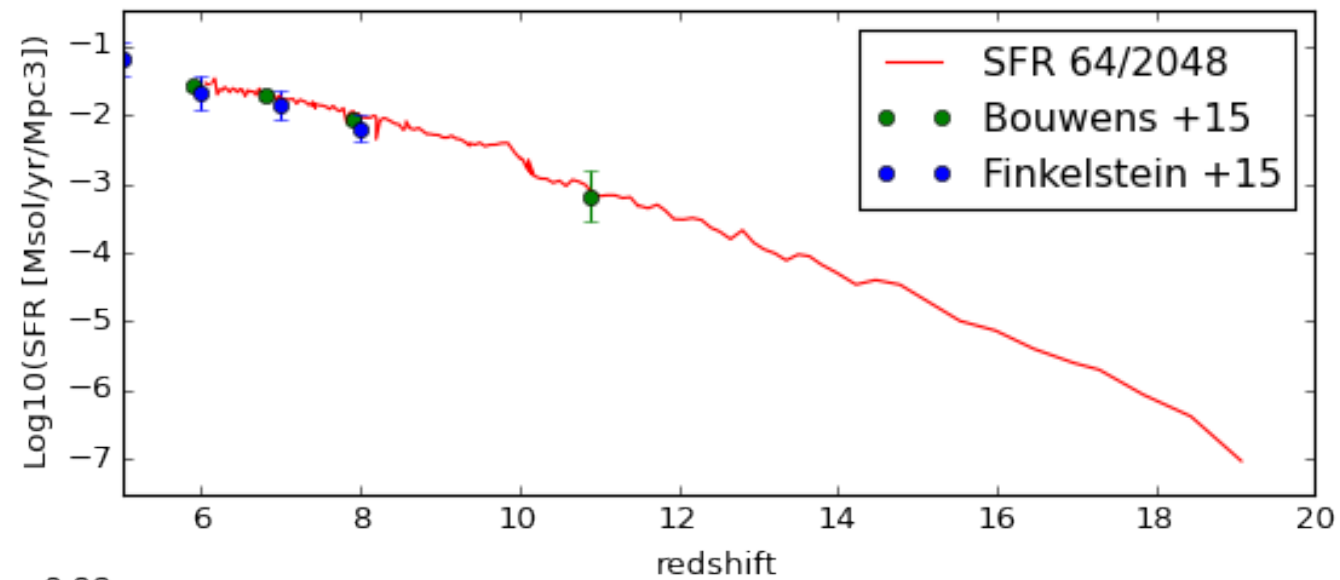
mass res~2e6 Msol

stellar res ~70 000 Msol

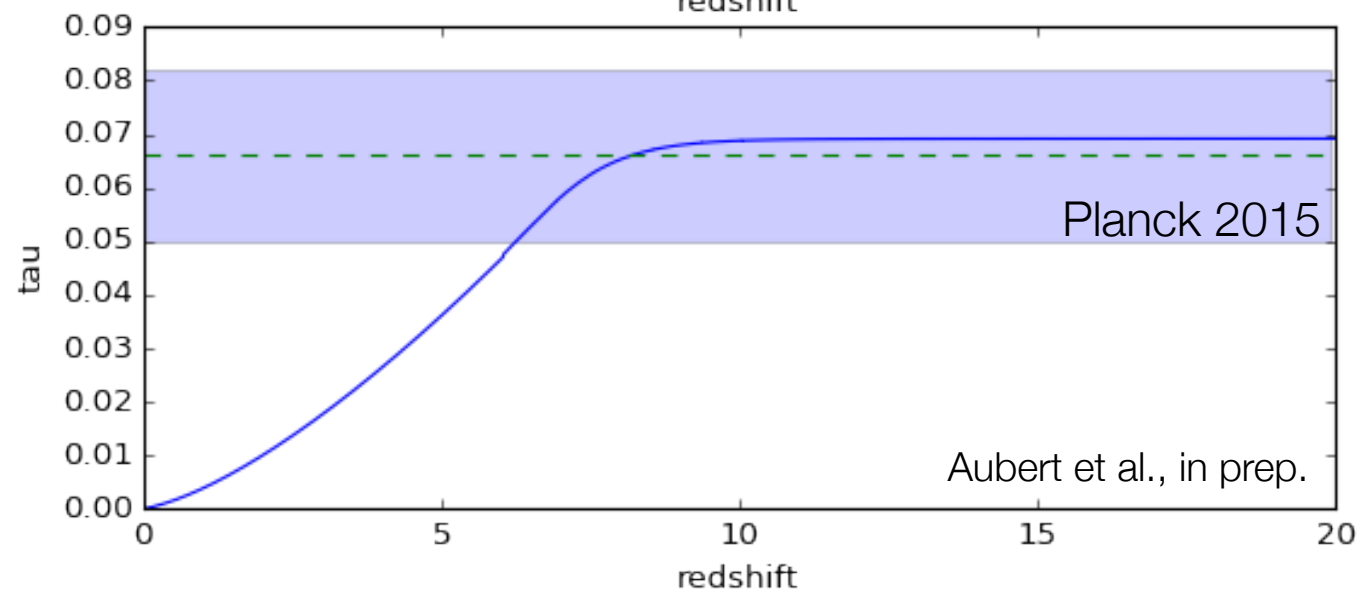
Aubert et al., in prep.



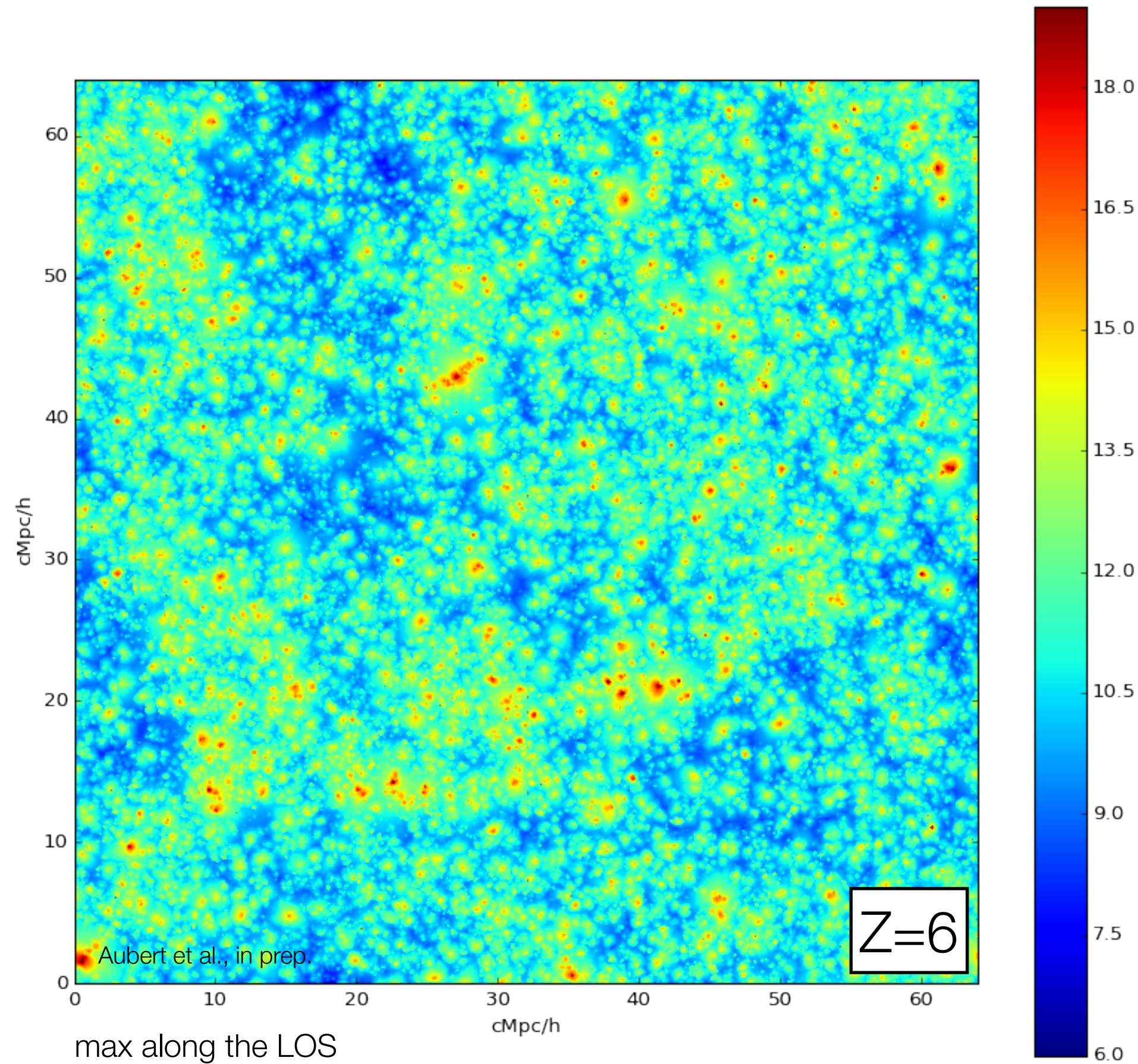
Ionized fraction Vs Z



SFR Vs Z



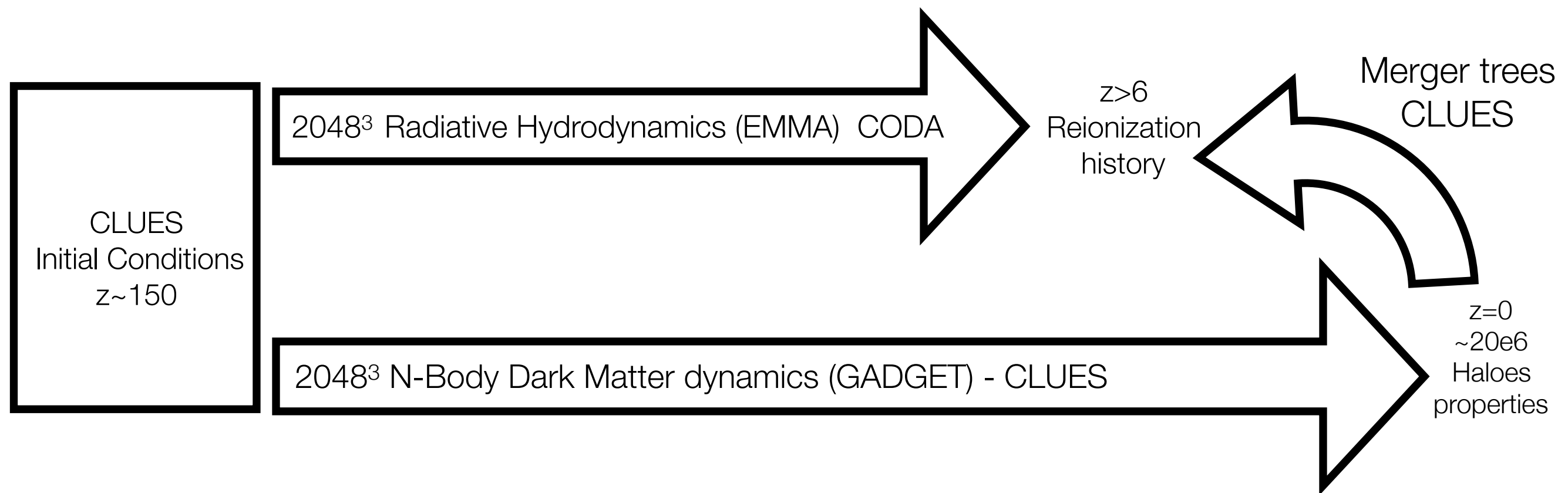
CMB Optical Depth Vs Z



Map of
first ionizations
redshifts
($x_{\text{HII}} > 0.5$)

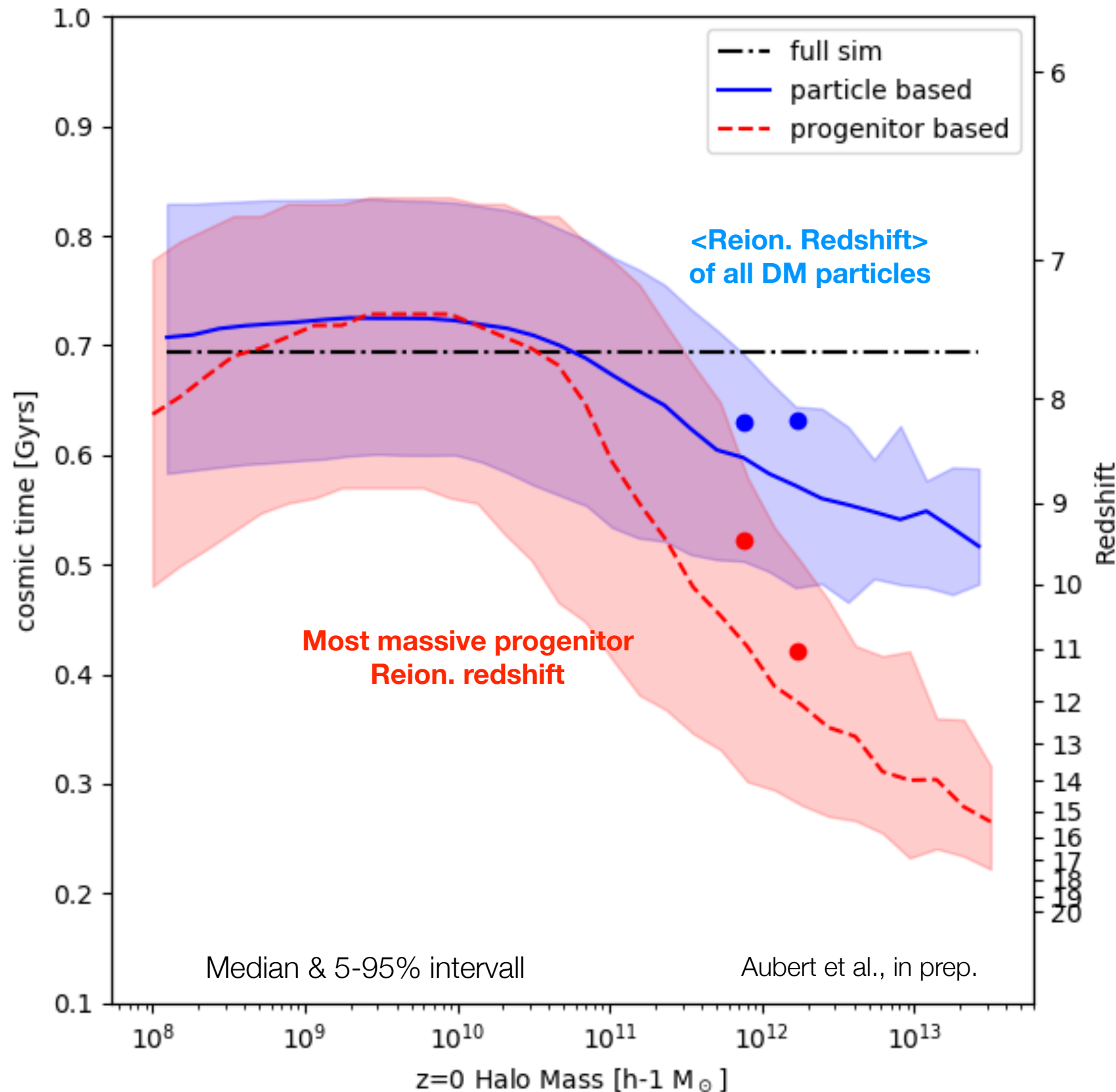
Reionization
epoch
depends on
location

Connecting $Z=0$ to the EoR



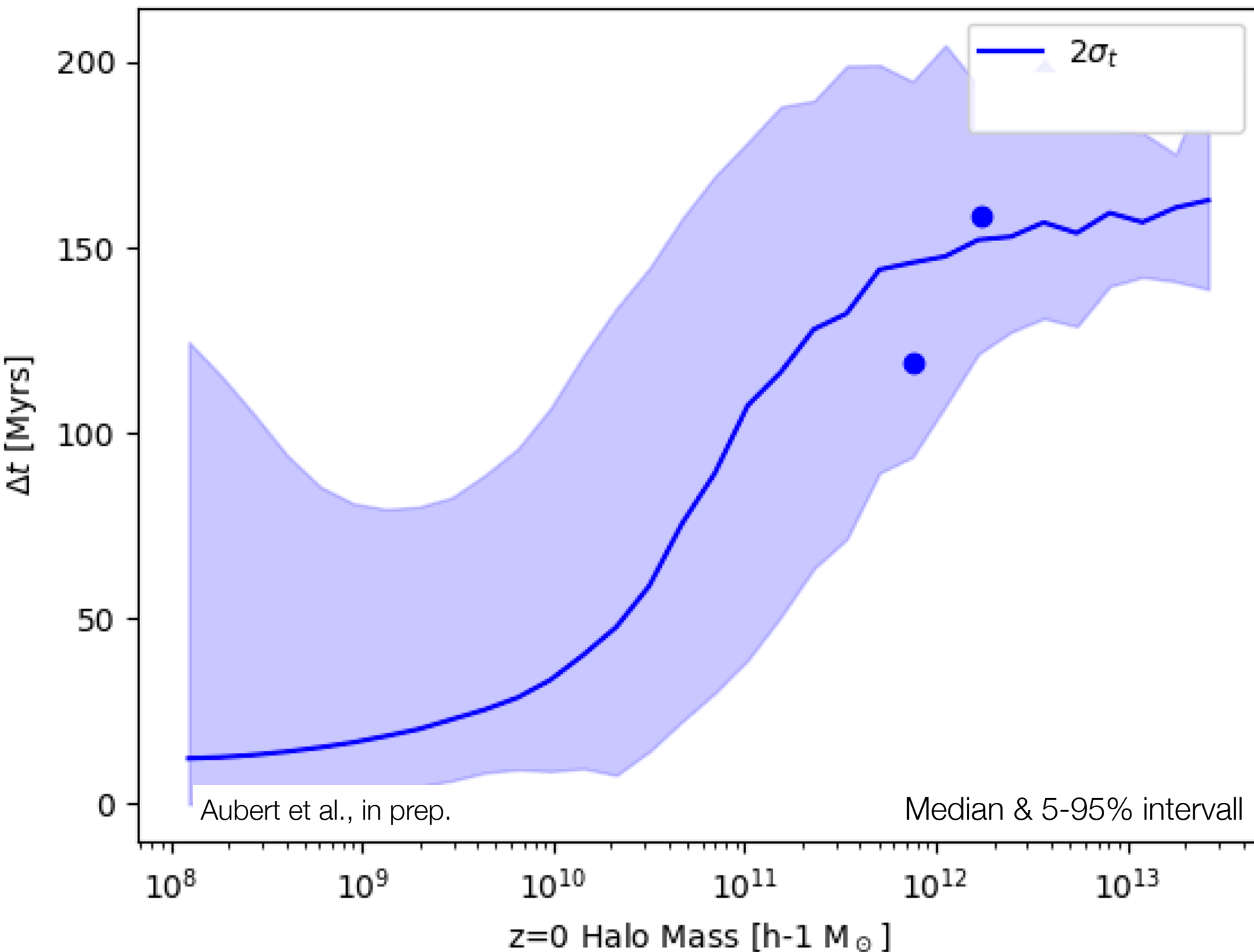
Similar to e.g. Weinmann et al. 2007, Alvarez et al. 09 or Li et al. 14
here we deal with 'galactic haloes' (instead of clusters)
and we use actual radiative hydrodynamics (instead of semi-analytical models)

Reionization times of $z=0$ haloes



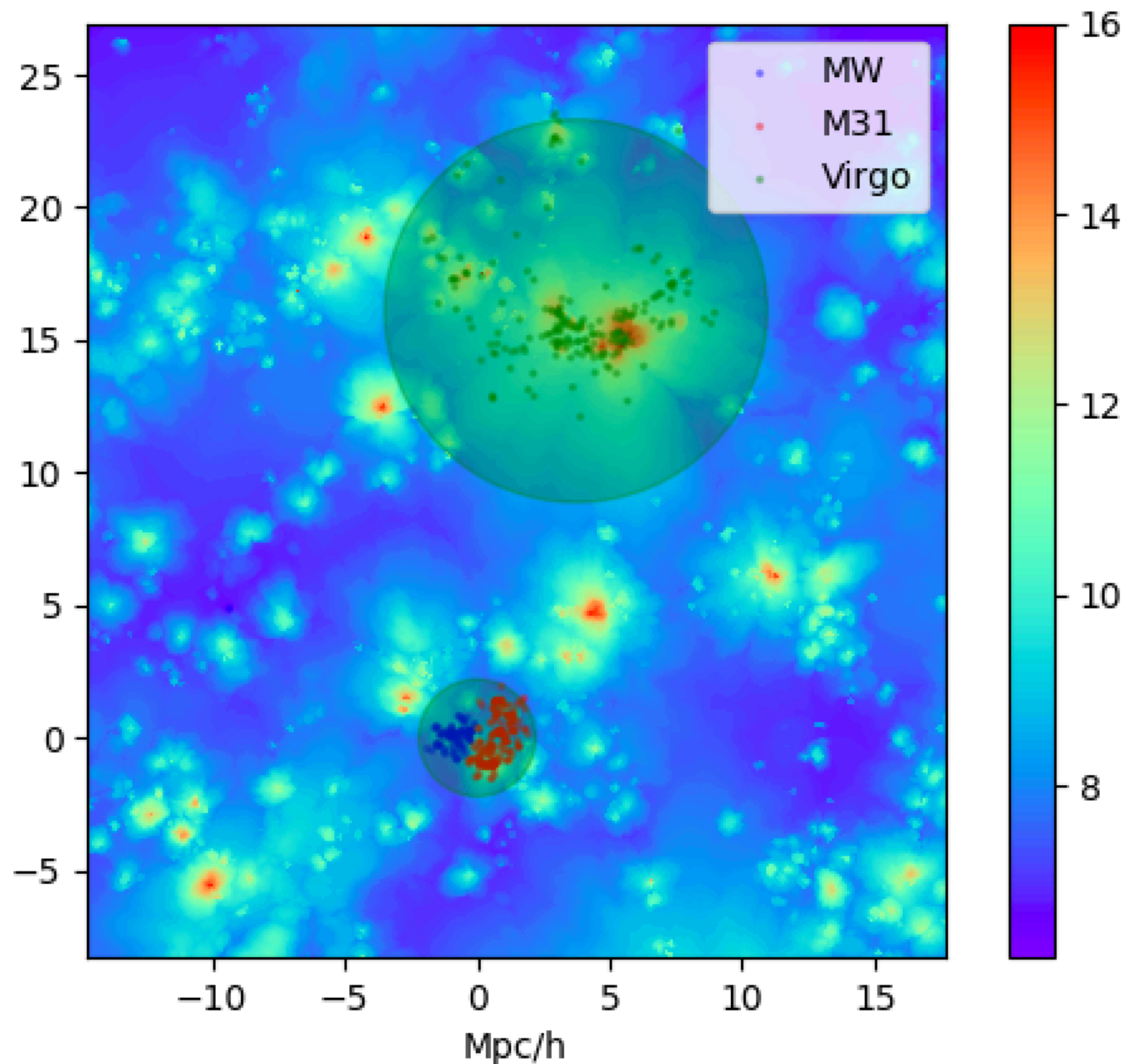
- Massive objects reionize early on
- First sources in most massive $z=0$ halos
- Light Objects reionize like the full volume
- The scatter is significant (~ 200 Myrs)
- Light Objects have median reionization times at later times than the full box (late reionization of faint objects ?)
- At low-mass, progenitor-based predictions are biased (reionization times consistent with heavier objects)
- Particle-based predictions tend to predict later reionization times (sensitive to the full reionization history of the object, even diffuse matter)

Reionization durations of $z=0$ haloes

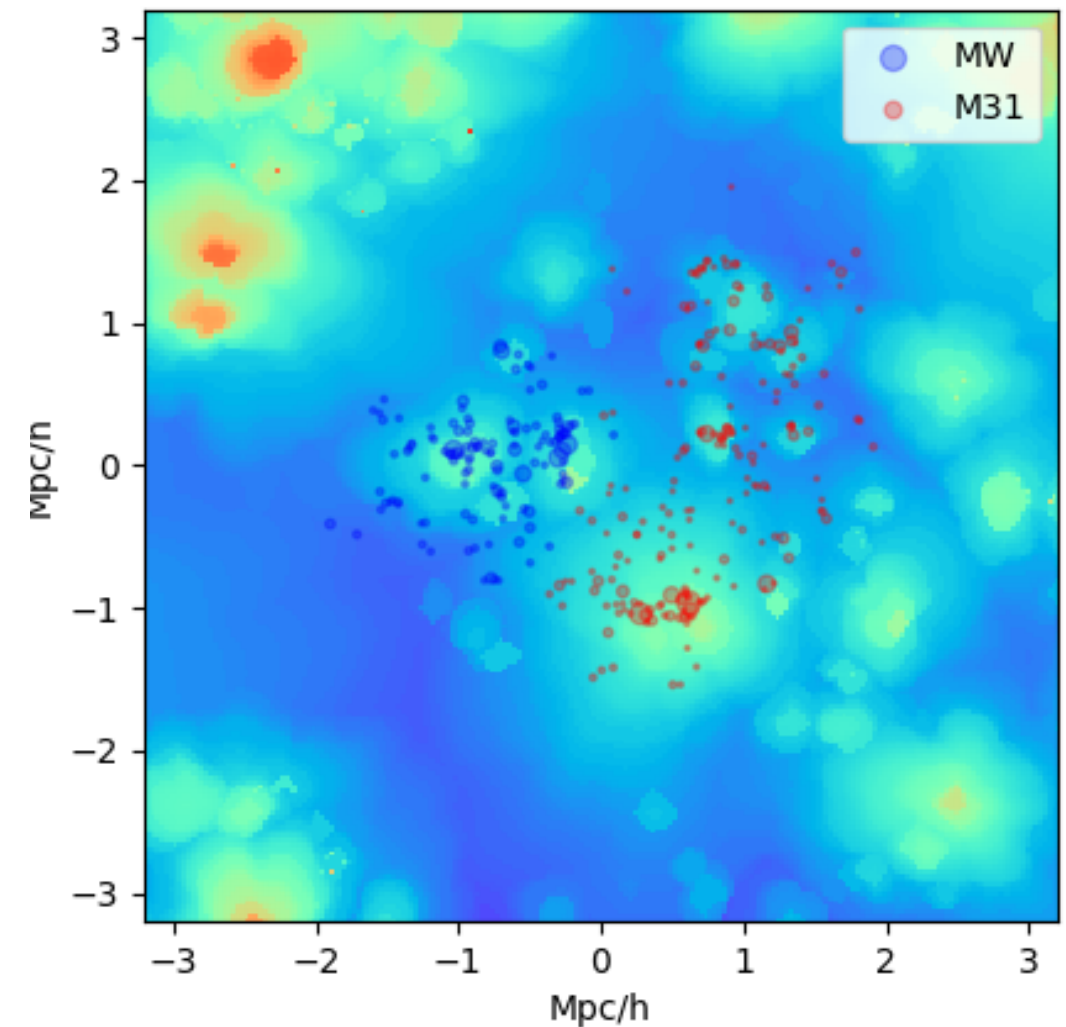


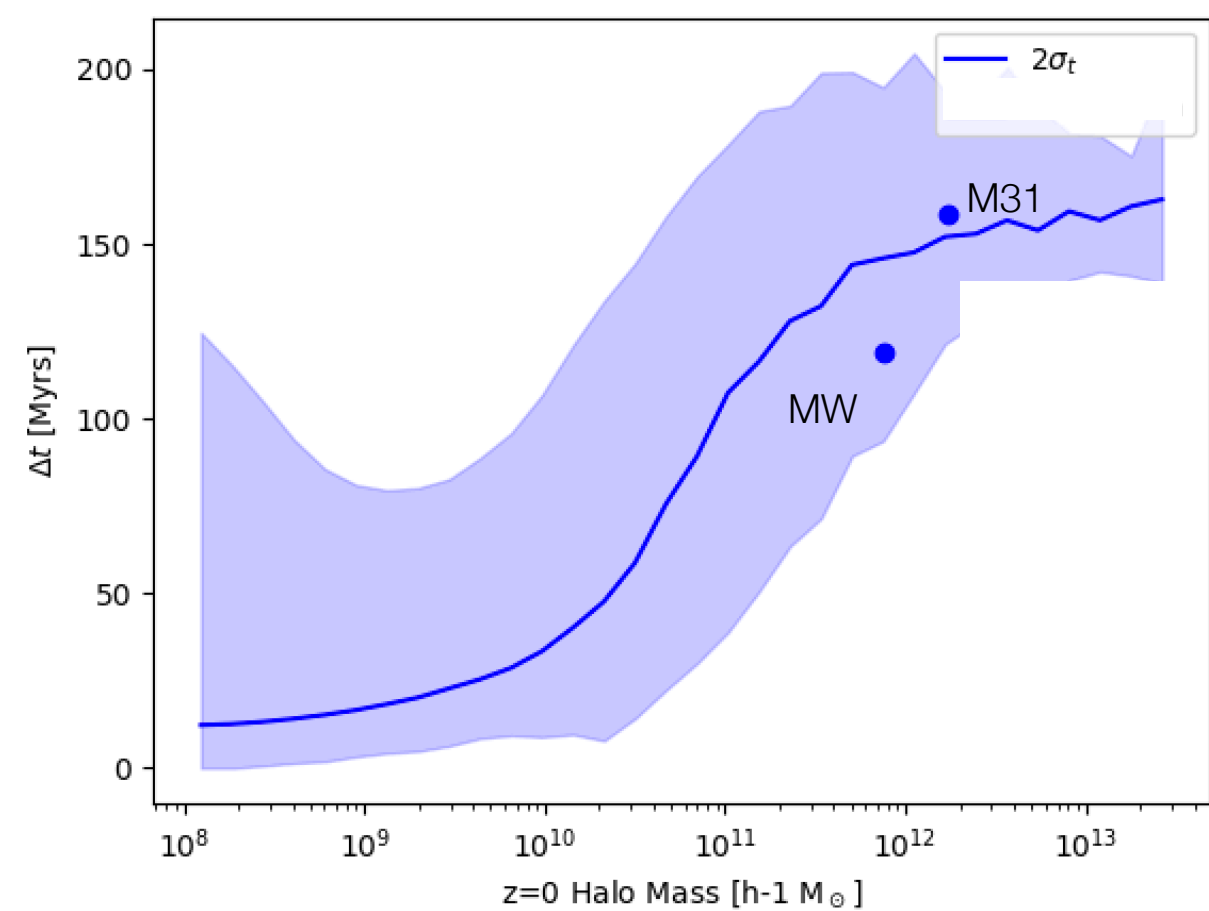
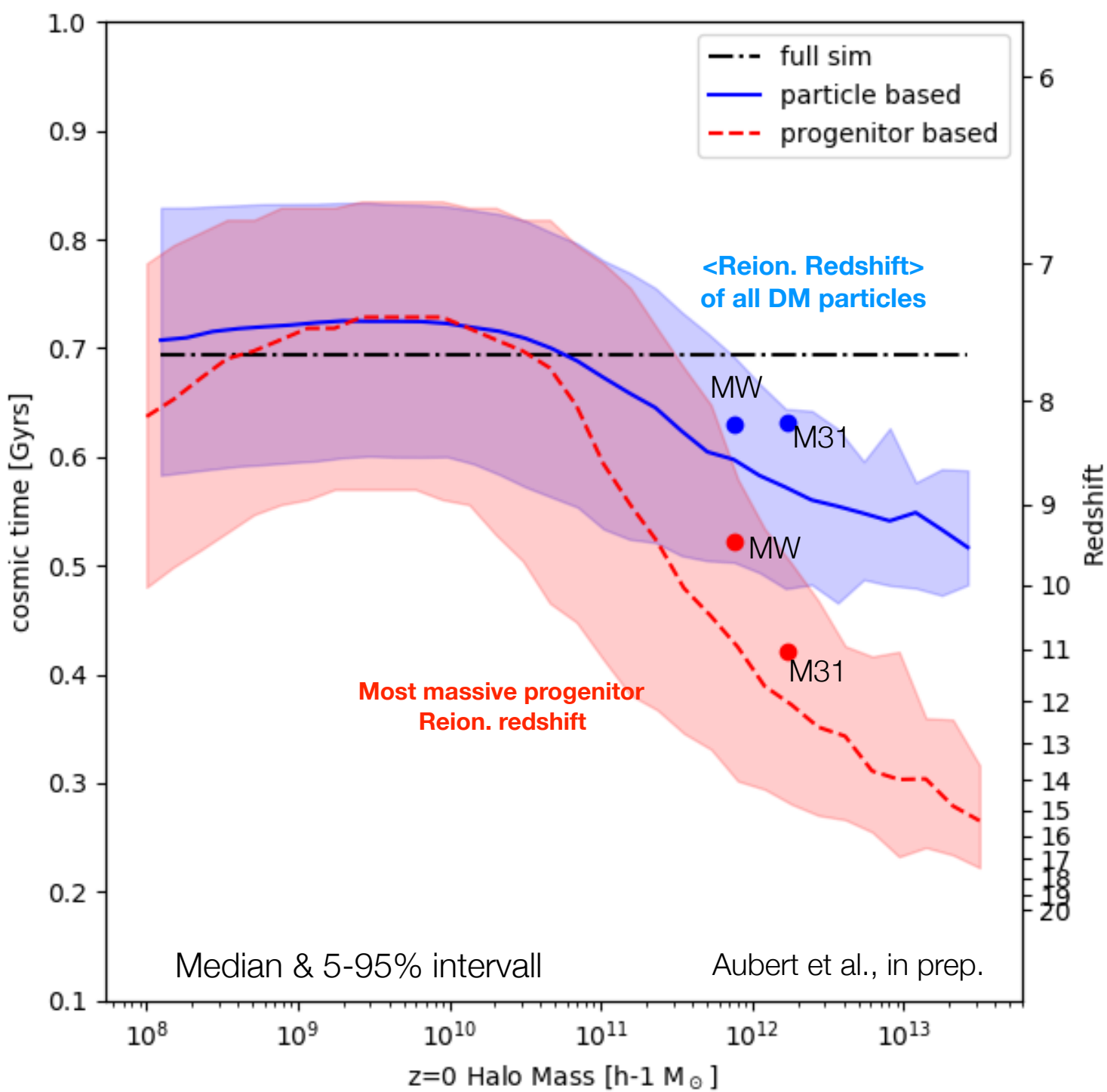
- Using particle-based prediction, we have access to the full distribution of reionization times *within* haloes
- duration = 2 sigma within a halo
- for massive haloes, durations are comparable to halo-to-halo scatter, reionization (as seen by galactic material) is not instantaneous
- for light haloes, reionization can be extremely short

The case of the Local Group (I)



CLUES Initial Conditions
produces
a MW and M31 pair
in proper cluster environment
(Virgo & Fornax)





Progenitors early reionization @ $z \sim 11$ (M31)
 $z \sim 9.8$ (MW)

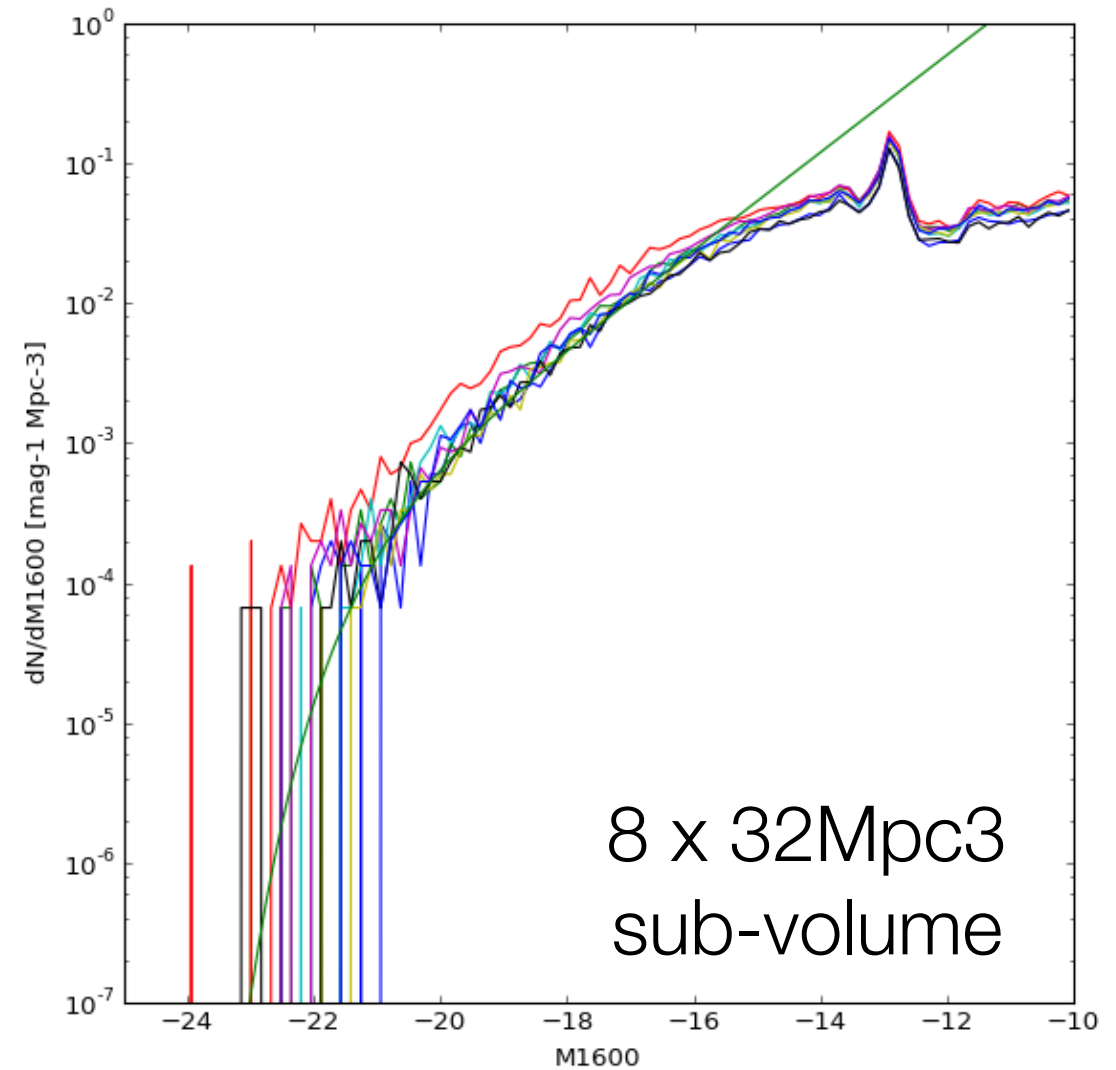
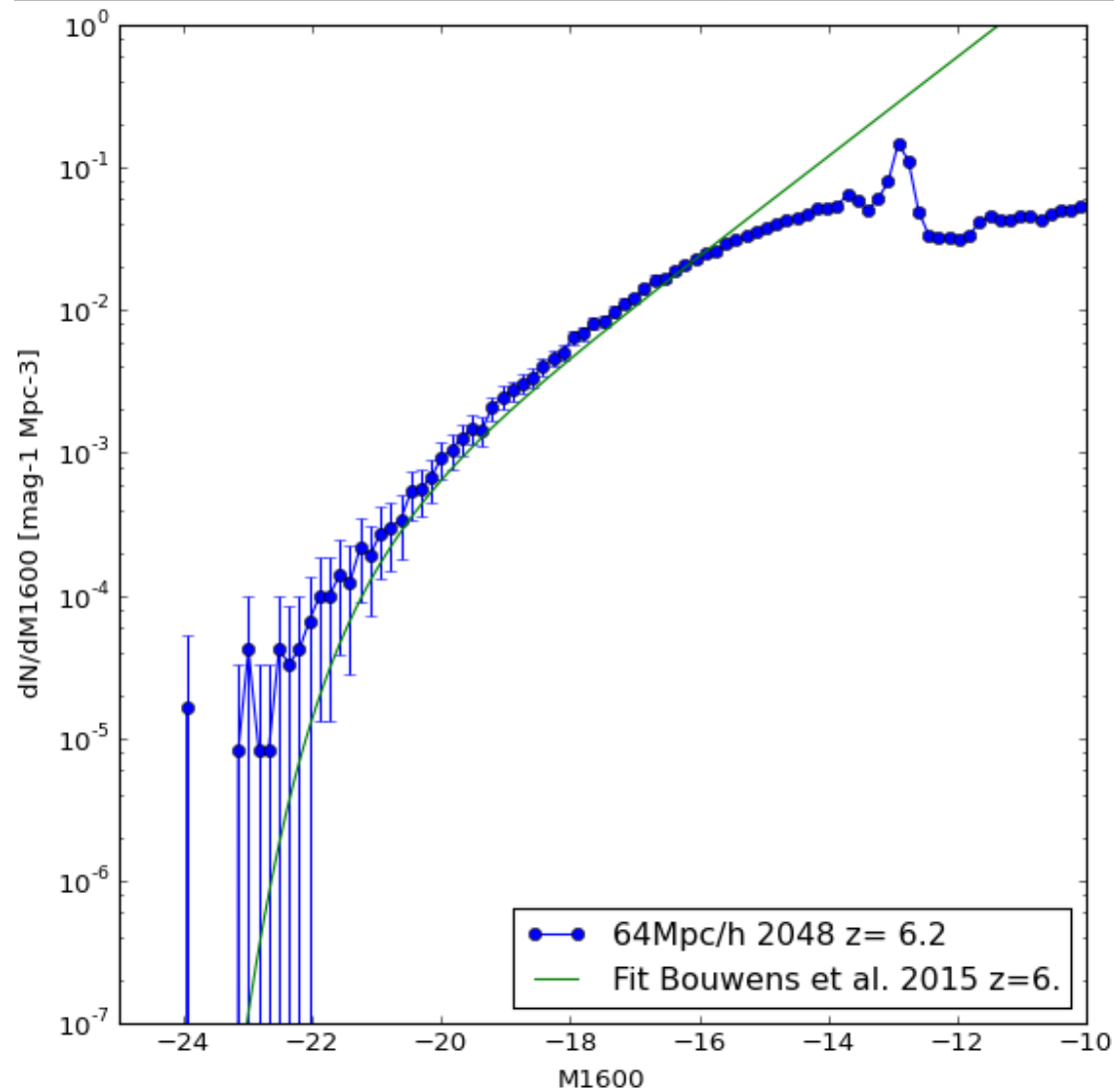
Similar Lagrangian reionization @ $z = 8.2$

2 sigma duration ~ 120 -150 Myrs

Conclusions

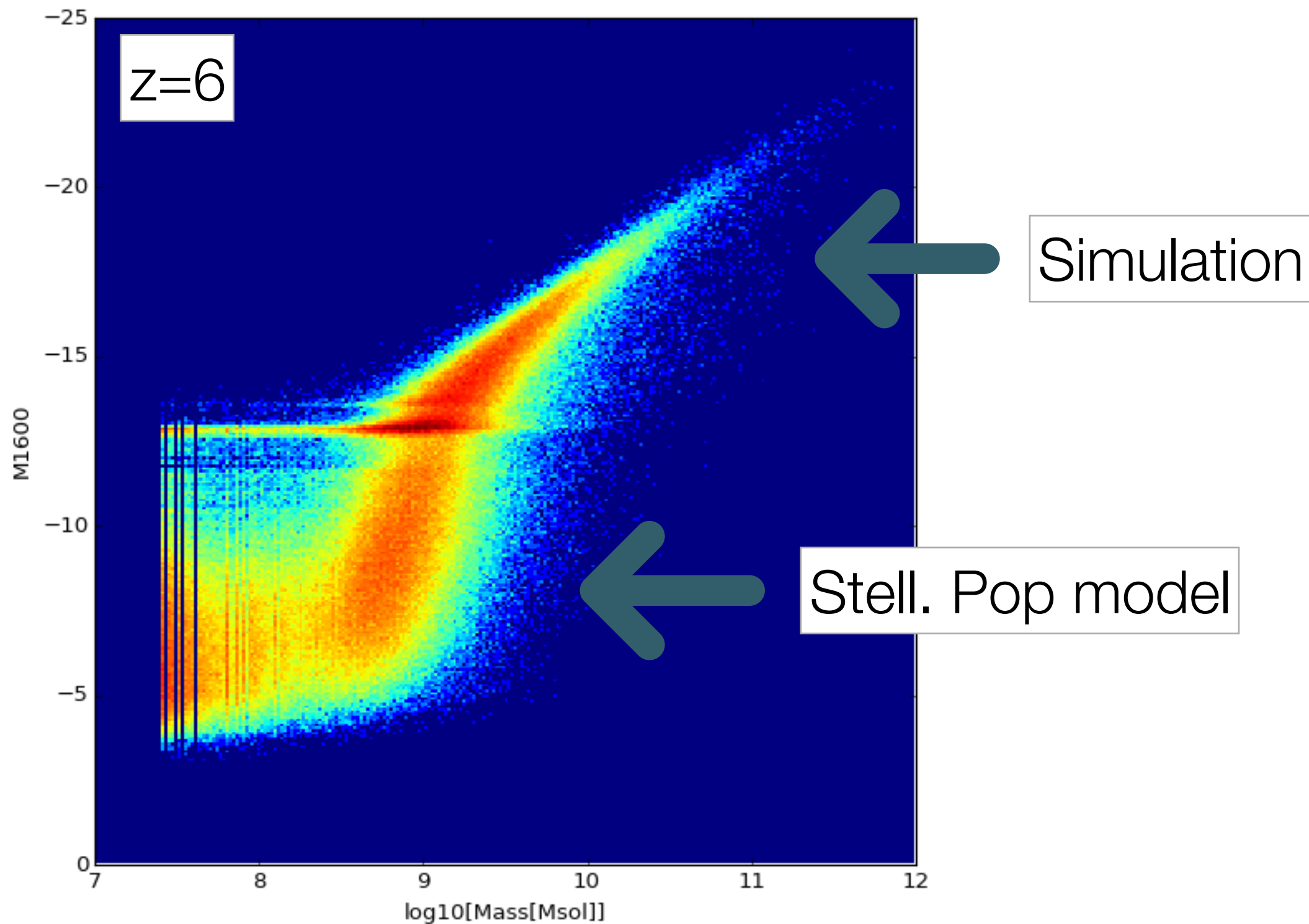
- We combined Reionization maps from EMMA to $z=0$ halos and merger trees from DM GADGET simulation
- $Z=0$ Massive halos ($>10^{11}$ Msol) are reionized earlier than the full volume : $z_{\text{reion}} \sim 11$ for MW-like halo
- The more massive a halo is today, the earliest it has been reionized
- Scatter of reionization times is quite large (~ 200 Myrs)
- Durations of reionizations are comparable to the halo to halo scatter : Reionization takes time
- The LG reionized in isolation
- MW & M31 do not significantly influence each other
- $Z_{\text{reion}}(\text{M31}) \sim 11$ $z_{\text{reion}}(\text{MW}) \sim 9.8$, with 2sigma duration $\sim 120\text{-}150$ Myrs

Z=6 LF



Slight Overshoot of the LF for bright objects
Seems biased by one sub-volume

Mass- UV Magnitude relation



Fraction of bright objects at $z=6$

