

SSA22-HIT project report

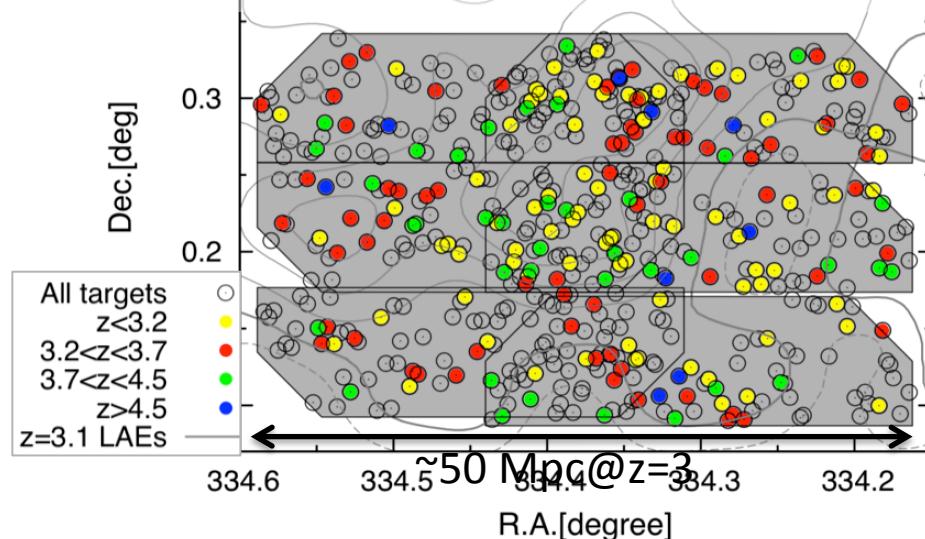
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Summary

(1) DEIMOS survey of $2.5 < z < 5.5$ LBGs (HIT)

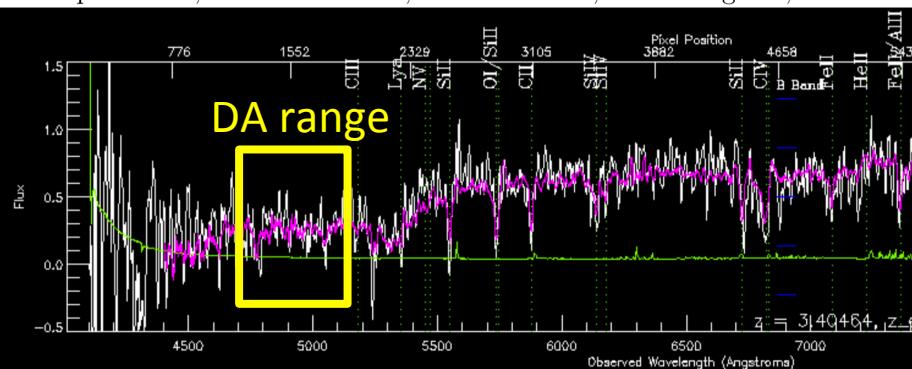
~ 200 LBGs are confirmed, $5\sigma \sim 24$ mag



(2) HI absorption analysis in DA range

~ 100 LBGs have $S/N > 2$ after smoothing

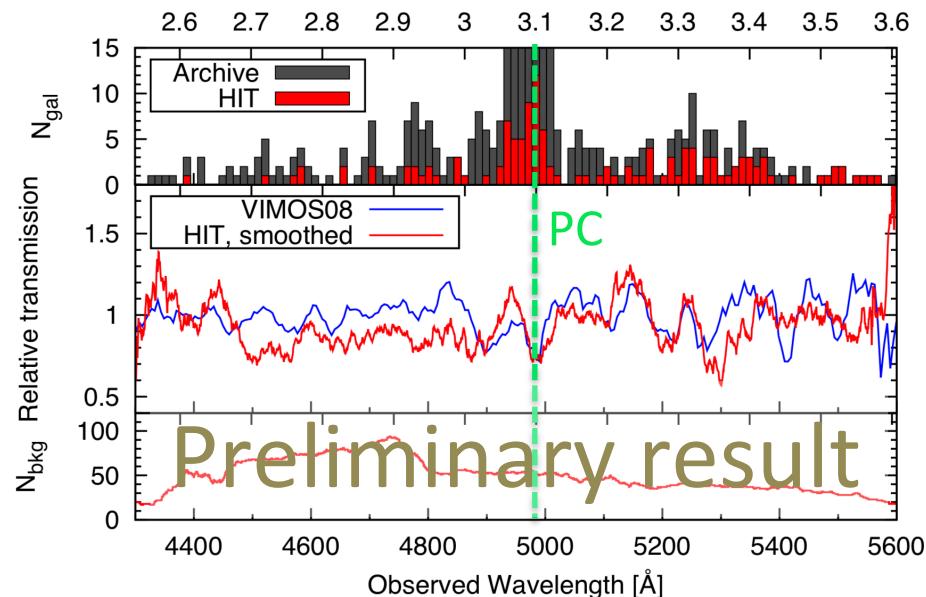
($\Delta\lambda \sim 25 \text{ \AA}$)
05098: specz=8971, RA=334.341375, Dec=0.298864, 24.044mag in i, z=3.4040.



(3) Composite DA spectrum (quick check)

Significant absorption in the proto-cluster

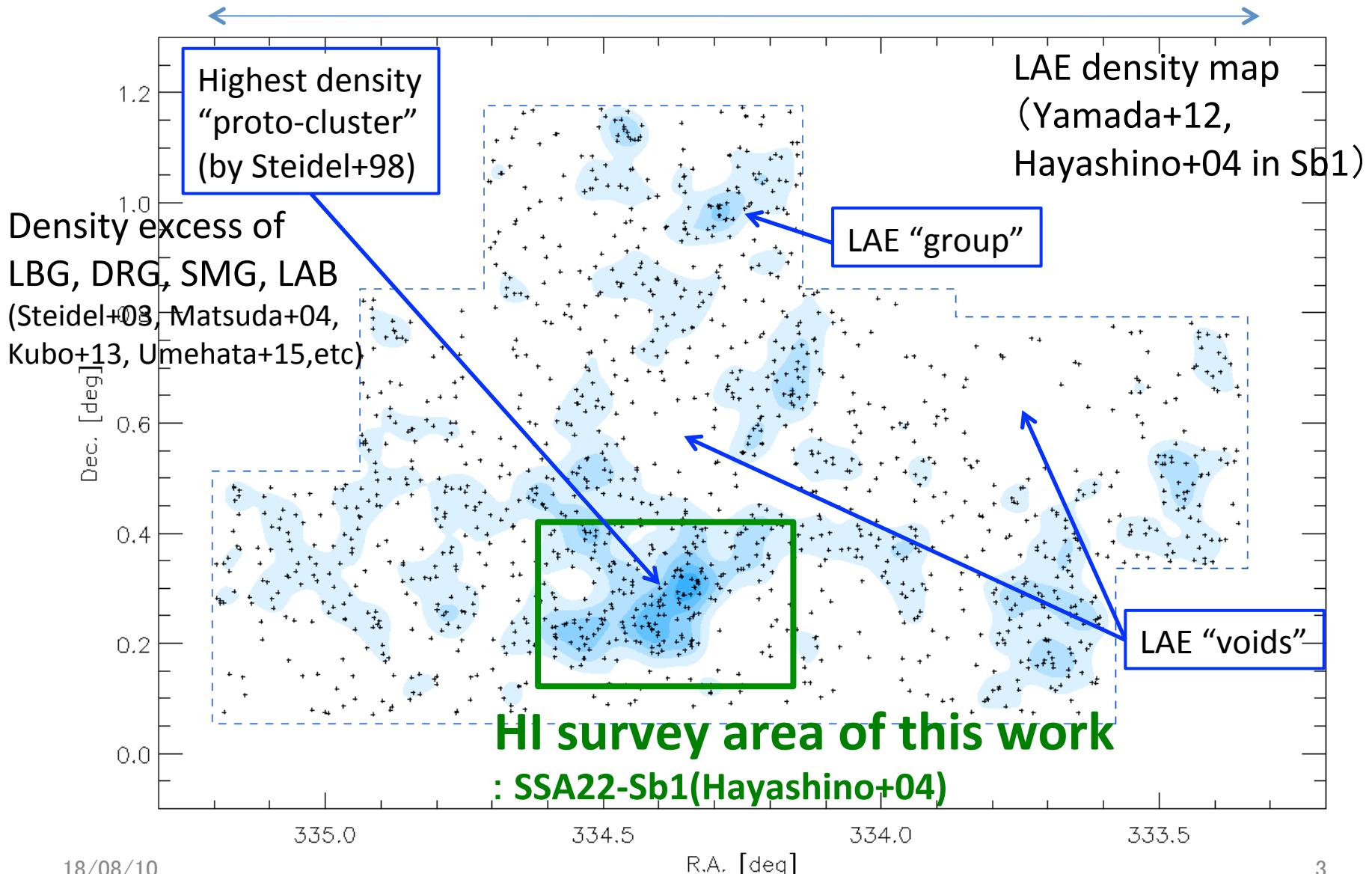
Ly α redshift



- Current status: spec-z catalog is nearly completed.
- Science plan: (1) IGM tomography
(2) CGM of LAEs/SMGs/DRGs
(3) galaxy LSS survey
- We'll combine the HIT data with our previous VIMOS data.

The SSA22 field

200Mpc (comoving)



HI Tomography (HIT) survey with Keck/DEIMOS

Panoramic survey of both HI and galaxies at $z = 2.5 - 5.5$

In total 9 nights in S15B – S16B were awarded for this project.

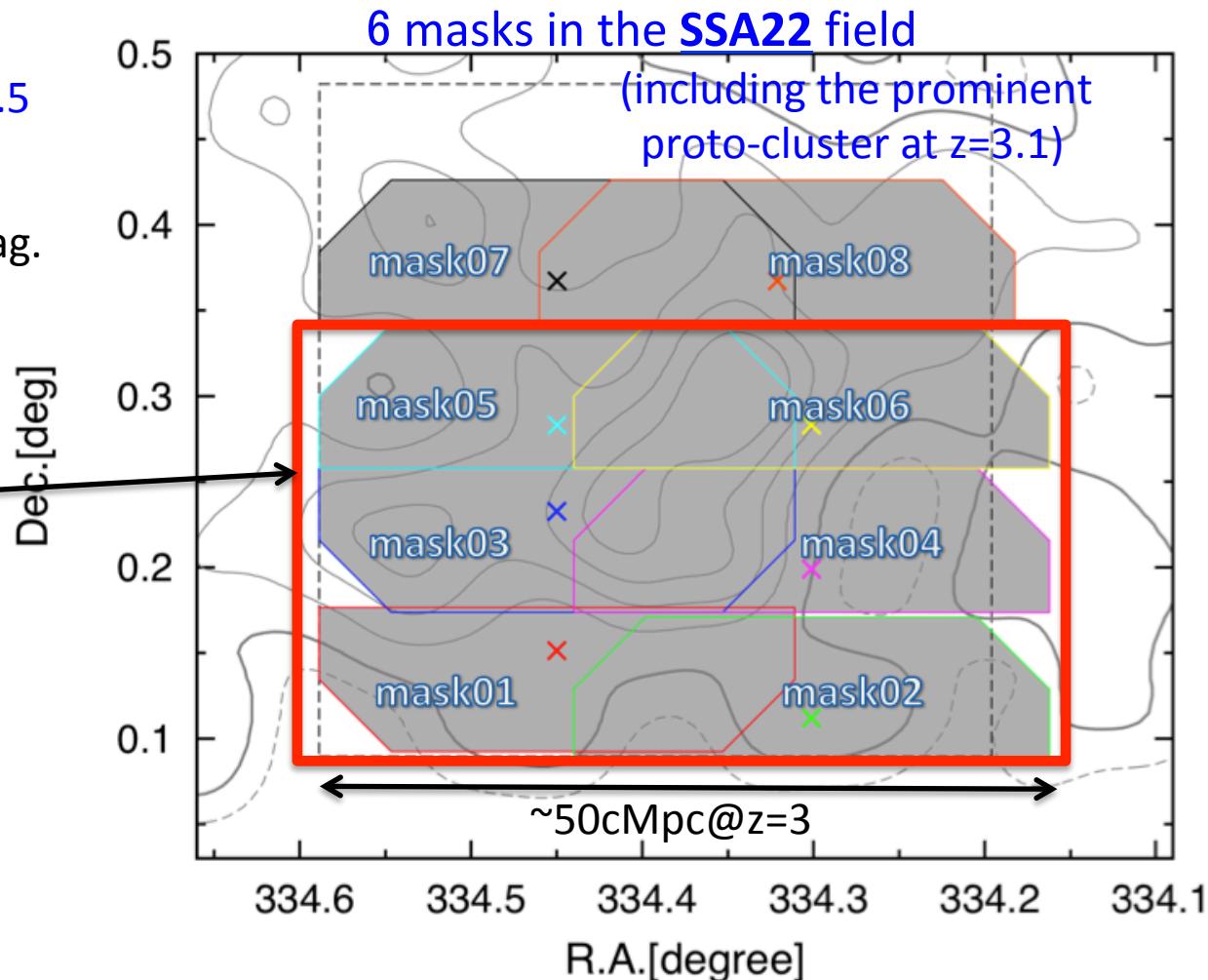
(6 nights in Subaru-Keck time exchange program,
and 3 nights in UC time)

Practically, observing nights ~ 5.5

Targets are
 ~ 500 LBGs with $i' = 24-25.5$ mag.

Data were taken for the 6
masks so far.

- 600ZD ($R \sim 1500$)
- $\lambda = 4000 - 9000\text{\AA}$



Data reduction and results

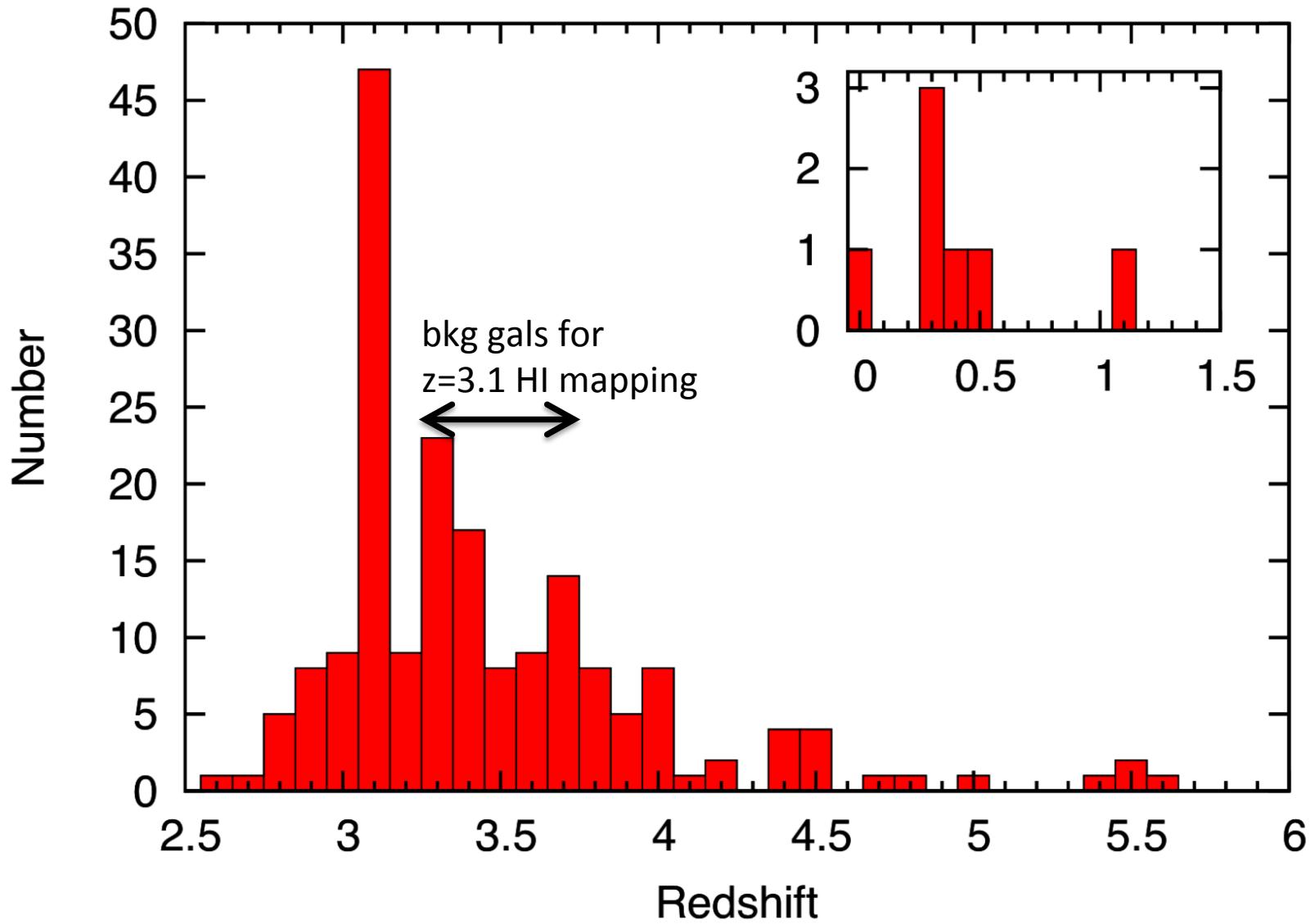
- Wavelength calibration accuracy = $0.1 \sim 0.3\text{\AA}$ << resolution (3.5\AA)
- Special attention was paid in flux calib to remove 2nd order light contamination.
- We determined the redshifts with the auto-correlation scheme (“specpro” software).

	Integration time [hour] in total	2 σ depth @5000 \AA per resolution [AB]	Goal depth: ETC 2 σ per resolution in 4 h	Nspecz / Nobj
mask01	2	24.5	25.8	22/86
mask02	2	24.7	25.8	28/78
mask03	7.8	25.4	25.8	36/84
mask04	8	25.3	25.8	42/86
mask05	7.9	25.2	25.8	30/93
mask06	13.5	25.5	25.8	39/86
Total				197/513

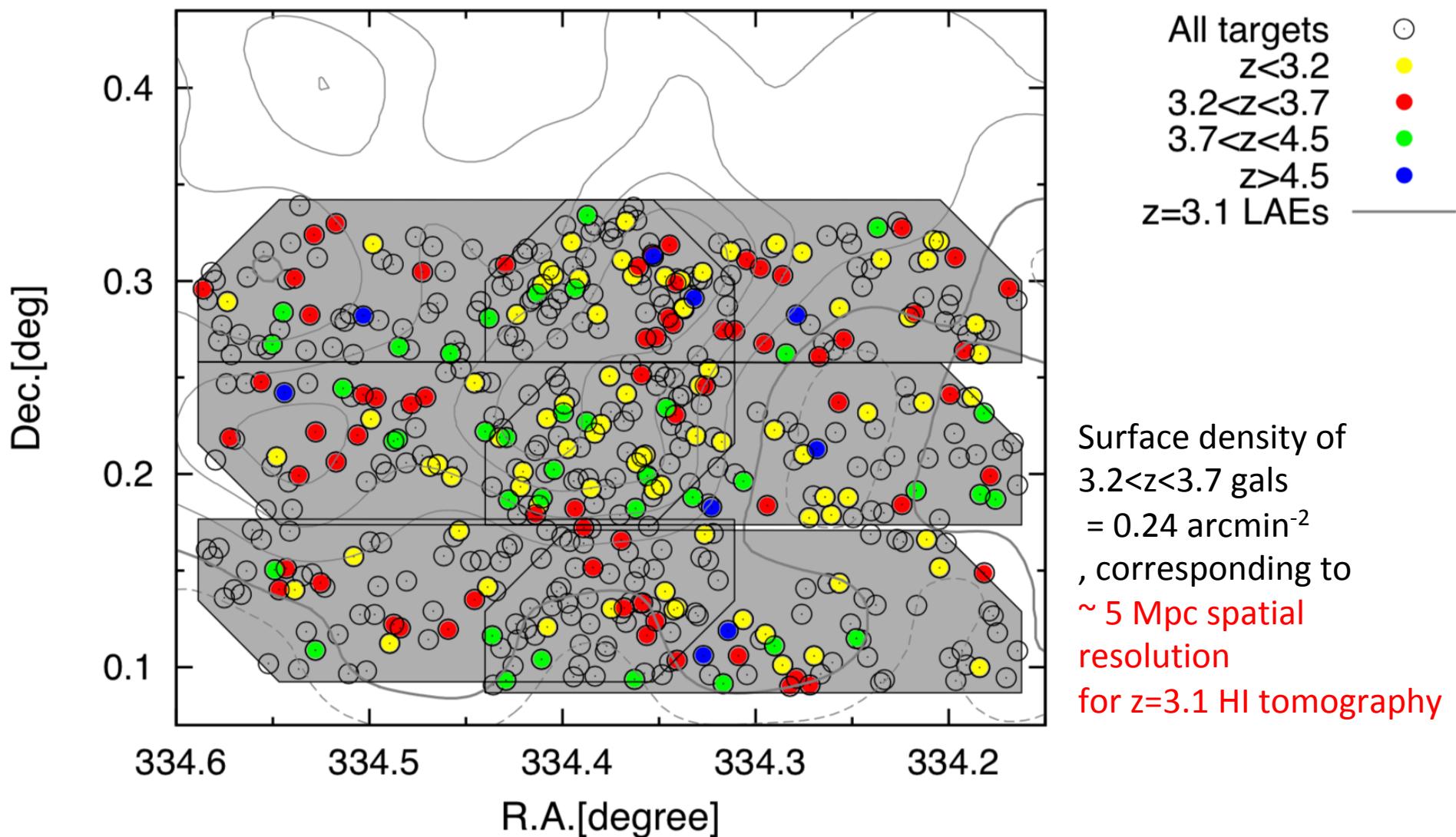
shallow than expected....

165 are newly determined

specz distribution

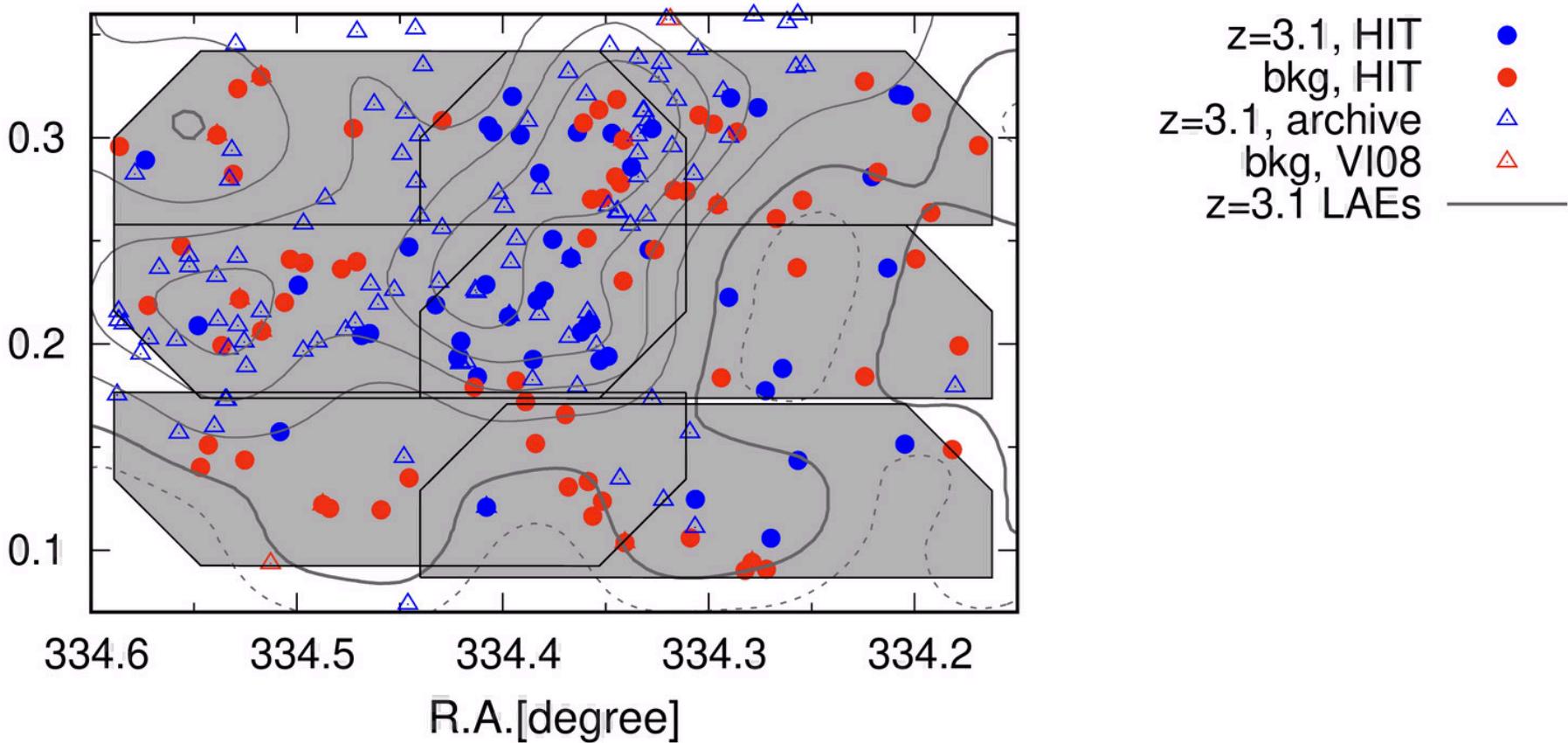


Sky distribution of specz objects



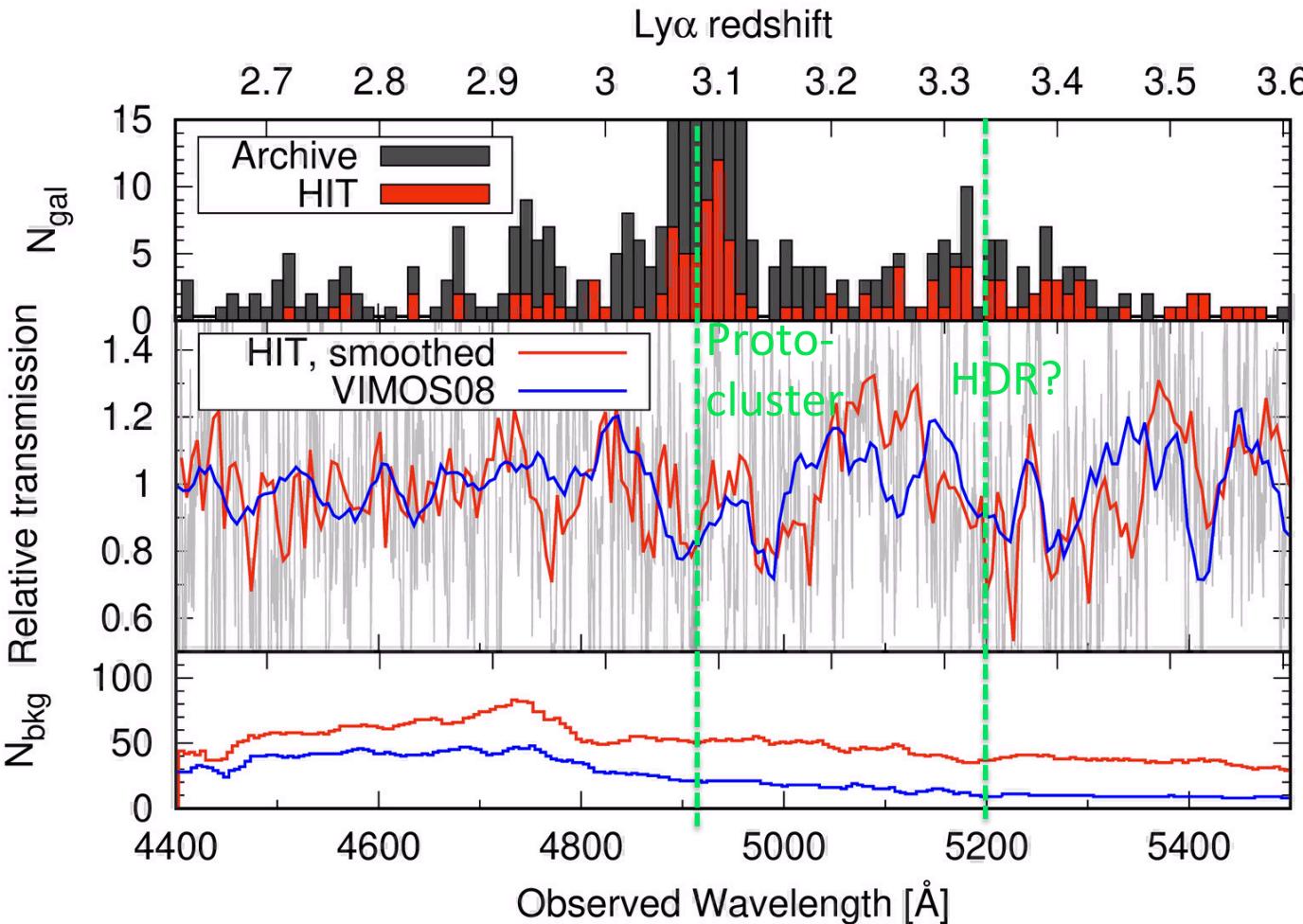
Sky distribution of specz objects

Focus on $z=3.1$ proto-cluster.



Quick check for HI tomography

Observer-frame composite spectrum \Leftrightarrow HI absorption distribution along redshift

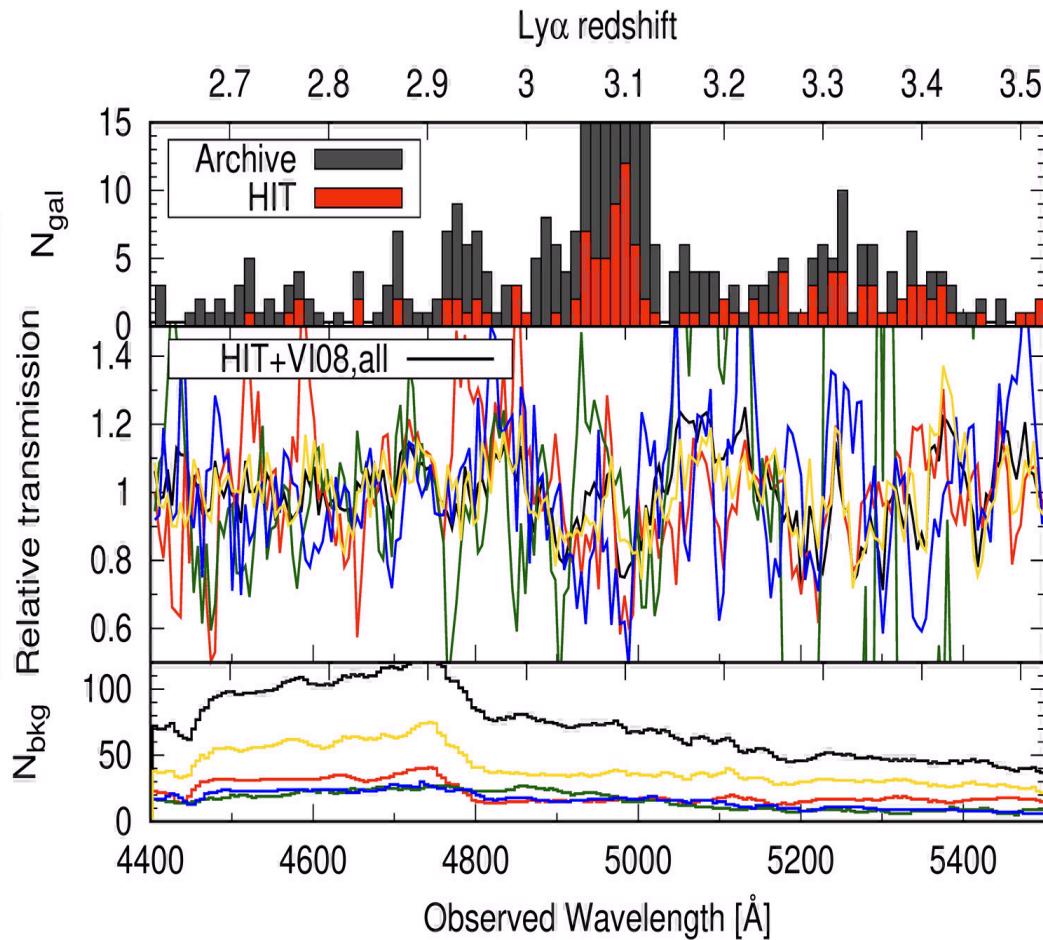
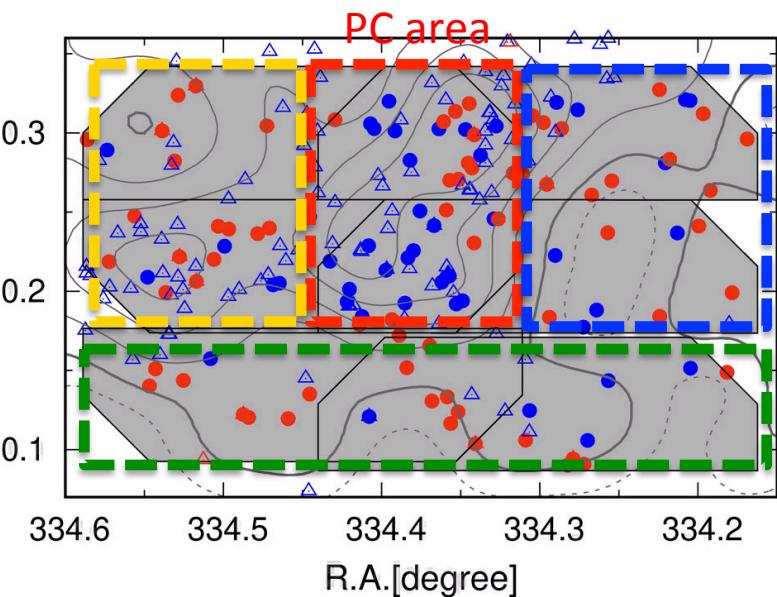


N of Gals at
 $3.2 < \text{spec}z < 3.7$
 $\Rightarrow 61$
But, among them,
 $S/N > 2$
 $\Rightarrow 28$
 $\Rightarrow \sim 7\text{cMpc}$
resolution for
 $z=3.1$ HI

- S/N of individual sight-line spectra are typically lower than 2 without smoothing.
- We plan to merge our own VIMOS data to perform 3D tomography.

Quick check for HI tomography

Observer-frame composite spectrum \Leftrightarrow HI absorption distribution along redshift

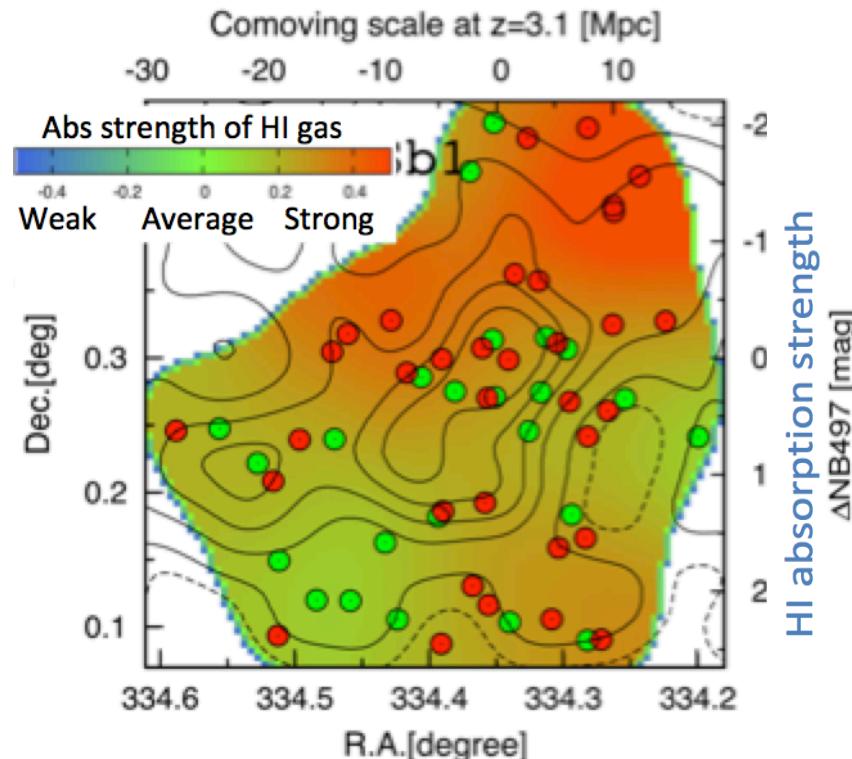


No clear field variation of HI absorption.

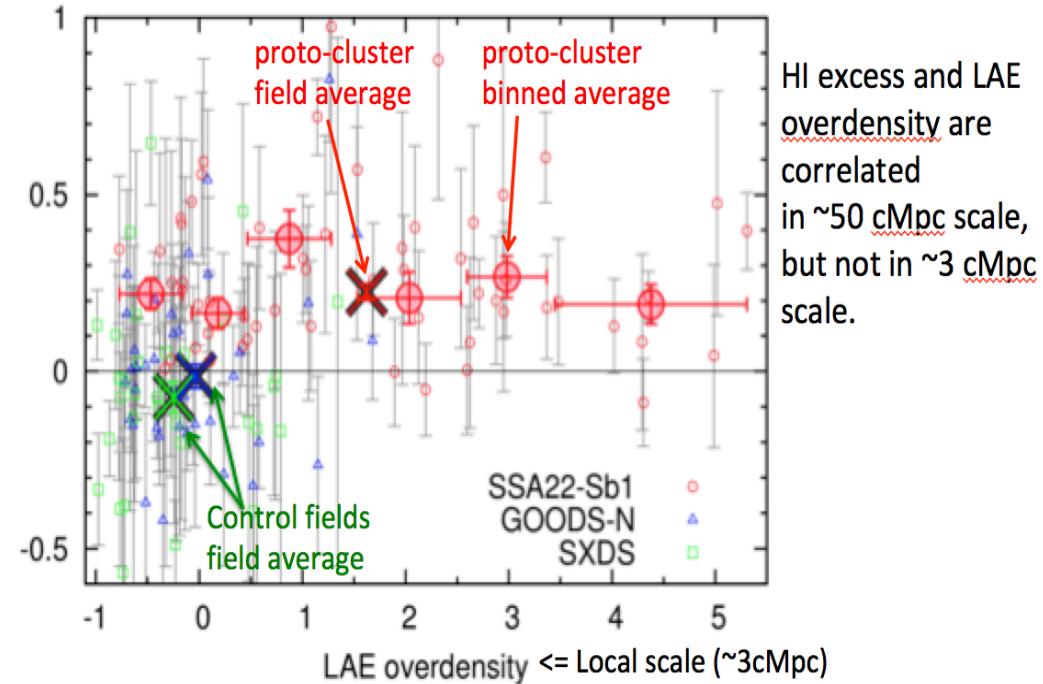
Diffuse HI absorption structure spreads out over $\sim 50\text{Mpc}$?! (same conclusion as Mawatari+17)

NB mapping (Mawatari+17)

Reconstruction of the $z=3.1$ HI spatial dist Δ_{NB}



Only the SSA22 shows significant Δ_{NB} excess.
(No excess in the SXDS and GOODS-N)



HI excess and LAE overdensity are correlated in ~ 50 cMpc scale, but not in ~ 3 cMpc scale.

Extended HI gas, which is different from CGM, distributes only in/around the proto-cluster.

Summary

- We spent 9 Keck/DEIMOS nights to survey a $\sim 50 \times 30 \text{ Mpc}^2$ area in the $z \sim 3$ Universe.
- We determined spec-z for ~ 200 among ~ 500 observed galaxies. Their spectral S/Ns at wavelength shorter than Ly α , however, are very low (< 2).
- After smoothing spectra as coarse as $\Delta \lambda = 25\text{\AA}$, we could make composite DA spectrum (i.e., HI absorption pattern along redshift). This is consistent with our previous VIMOS result (Hayashino+submitted).
- We plan to perform HI tomography using merged sample of DEIMOS and previous VIMOS data, which will achieve tomographic resolution of $\sim 10\text{cMpc}$.
- HI absorption strength seems to be independent of LAEs' density in/ around the SSA22 protocluster.