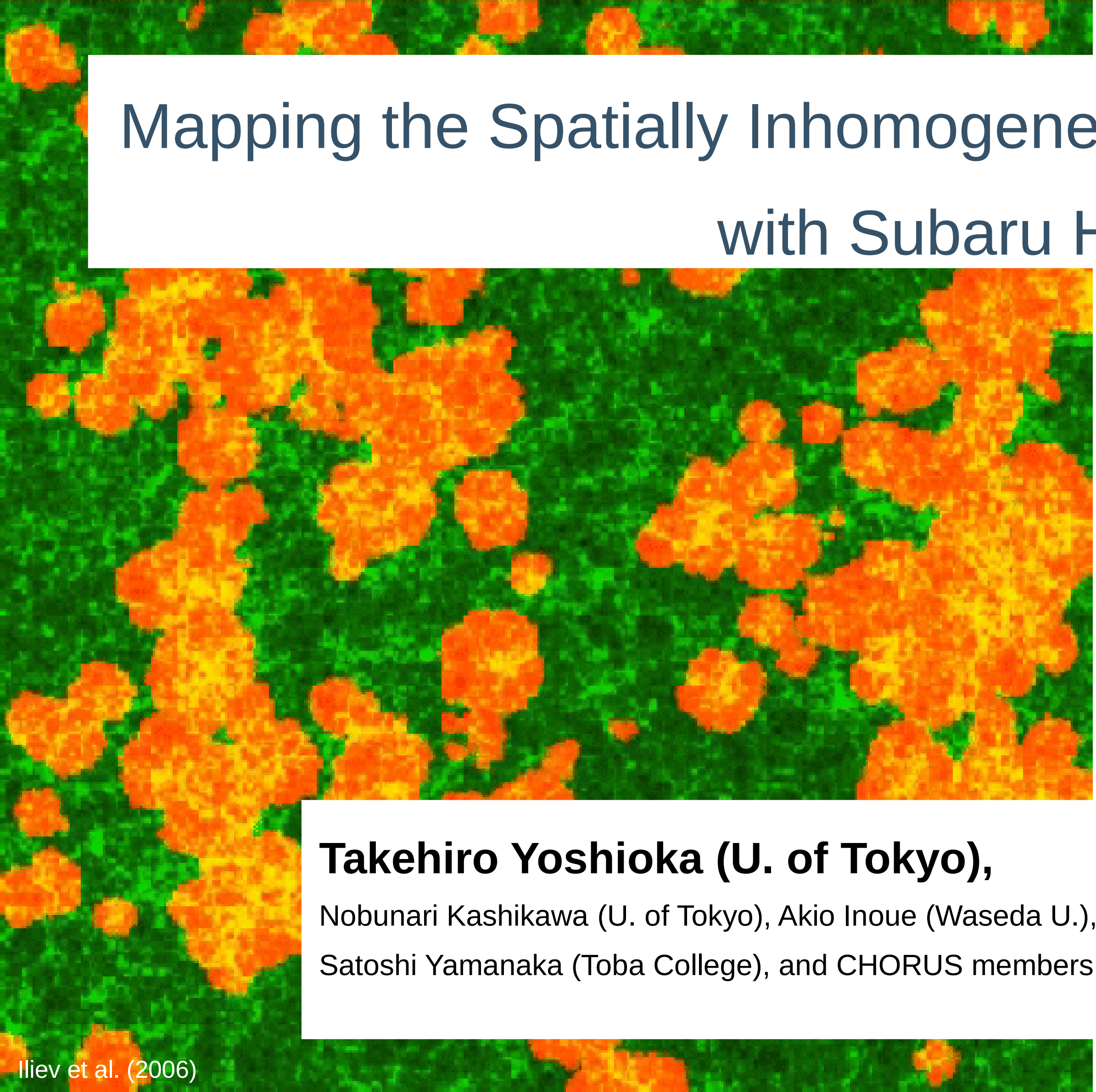
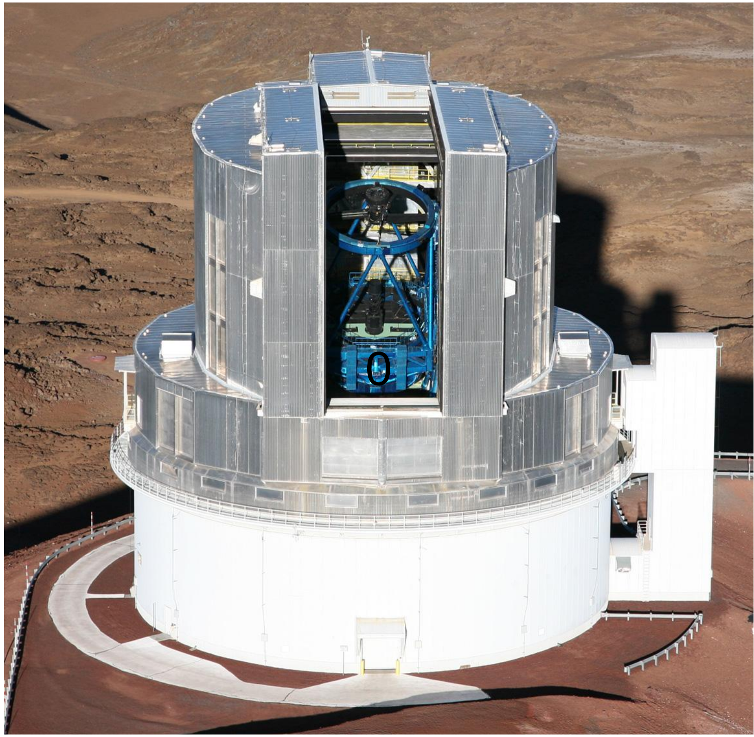


Iliev et al. (2006)

Mapping the Spatially Inhomogeneous Cosmic Reionization with Subaru HSC



Takehiro Yoshioka (U. of Tokyo),

Nobunari Kashikawa (U. of Tokyo), Akio Inoue (Waseda U.),
Satoshi Yamanaka (Toba College), and CHORUS members

SCHOOL OF SCIENCE
THE UNIVERSITY OF TOKYO

Spatially inhomogeneous reionization

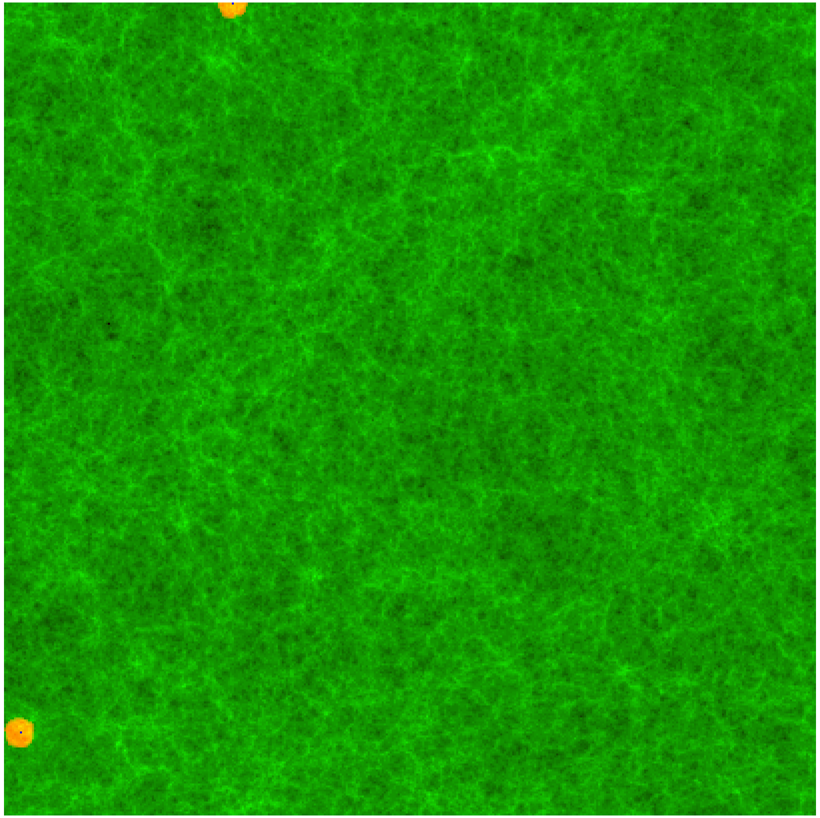
Reionization topology

Ionizing source

f_{esc}

IGM

Investigation of reionization topology is important for studying these parameters.

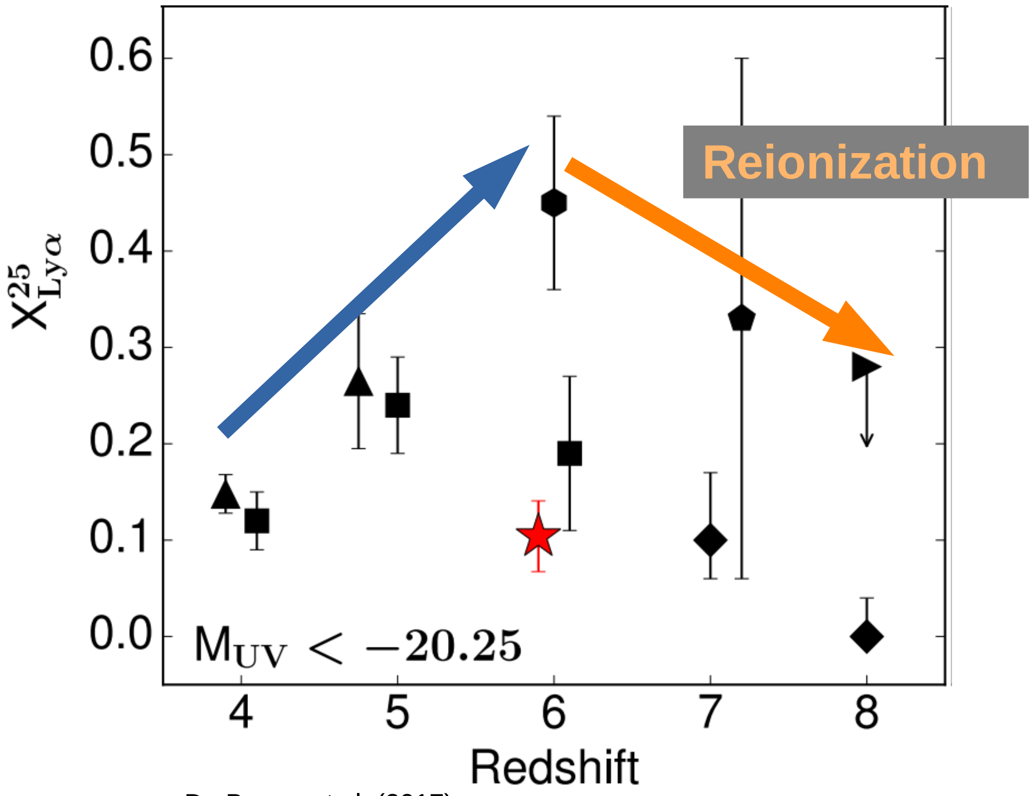


Iliev et al. (2006)

Lyα fraction as a probe of reionization

- Lyα fraction
  - the fraction of LBGs that show Lyα emission lines.

- Lyα fraction measurements require spectroscopic observations.
  - Difficult to obtain large sample.
  - **Unable to investigate spatially inhomogeneous reionization.**



De Barros et al. (2017)
Data points are taken from Stark et al (2011); Schenker et al. (2014); Tilvi et al. (2014); Ono et al. (2012); Curtis-Lake et al. (2012); Cassata et al.(2015).

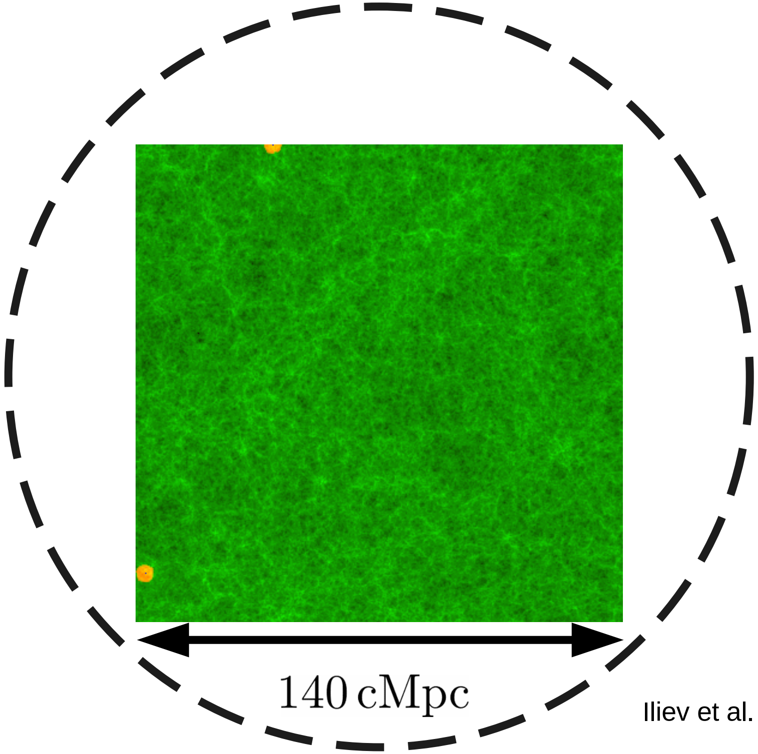
Motivation

Subaru/Hyper Suprime-Cam (HSC)

- Wide field of view (FoV) ~ 1.5 deg^2.
    - Efficiently detect LAEs and LBGs.

Observe spatially inhomogeneous reionization by efficient survey of LAEs and LBGs at z = 6.6.

HSC FoV at z=6.6

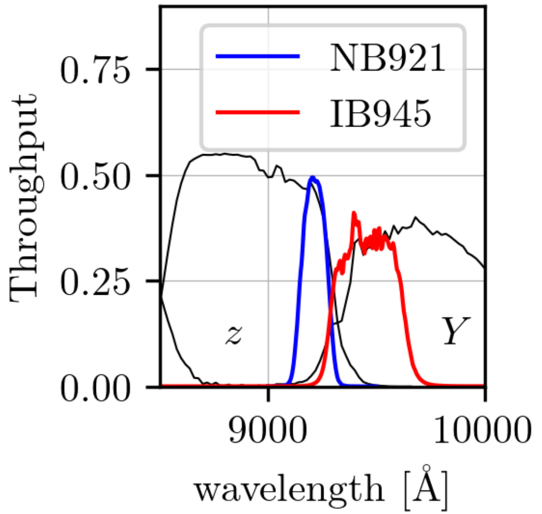


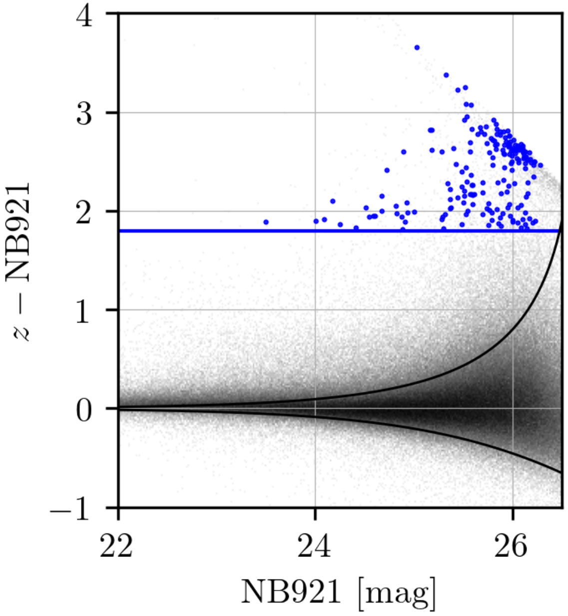
Iliev et al. (2006)

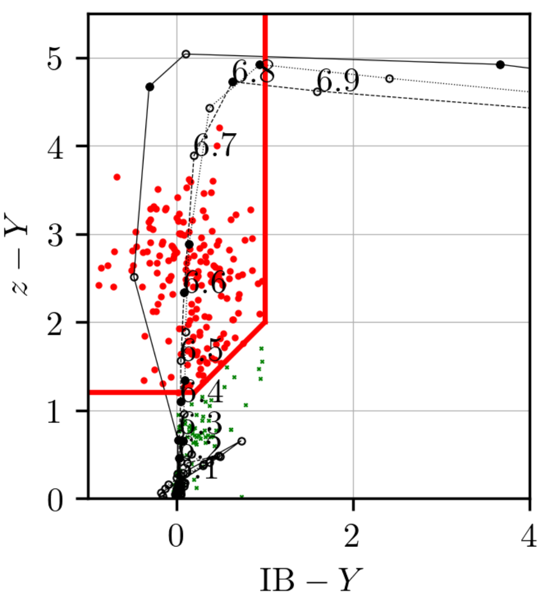
LAE, LBG selections at z = 6.6

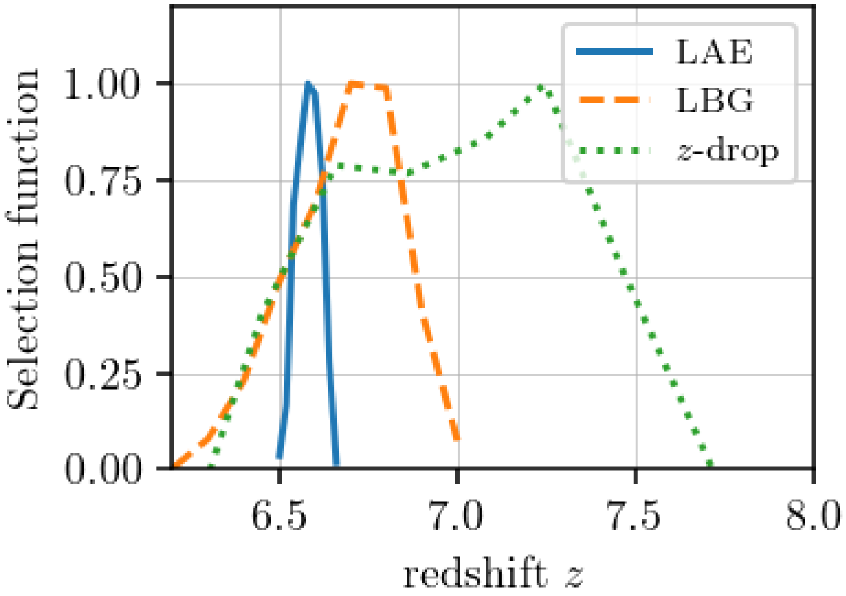
- HSC-SSP UD-COSMOS ~1.5 deg^2 field.
- NB excess — 189 LAEs
- Lyman break — 179 LBGs

- Brand new filter, **IB945**.
  - Detect LAEs and LBGs **simultaneously at the same redshift z=6.6.**





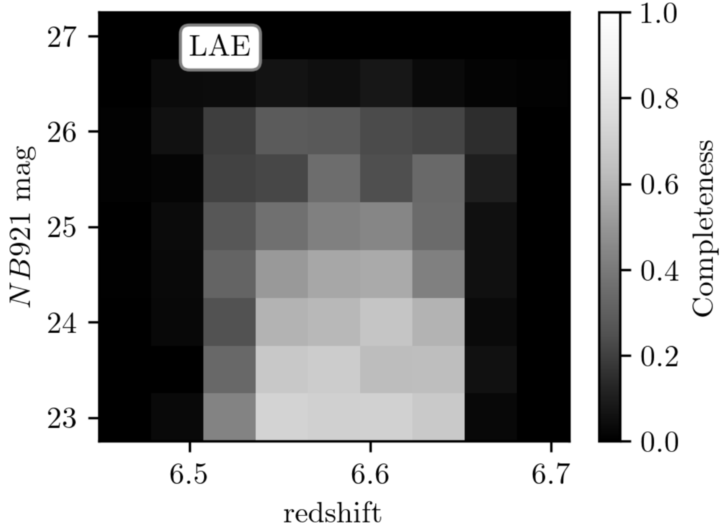


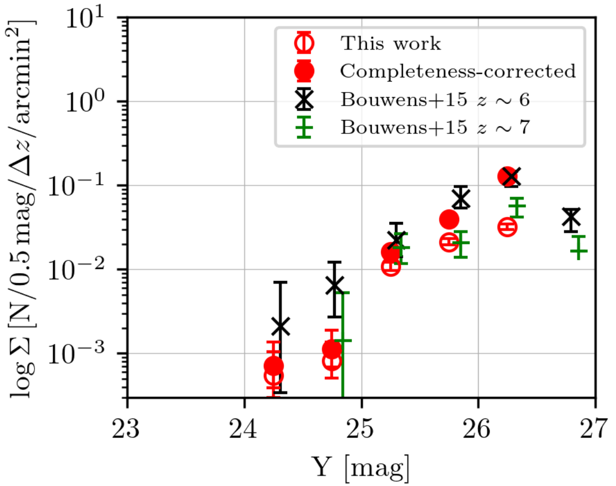


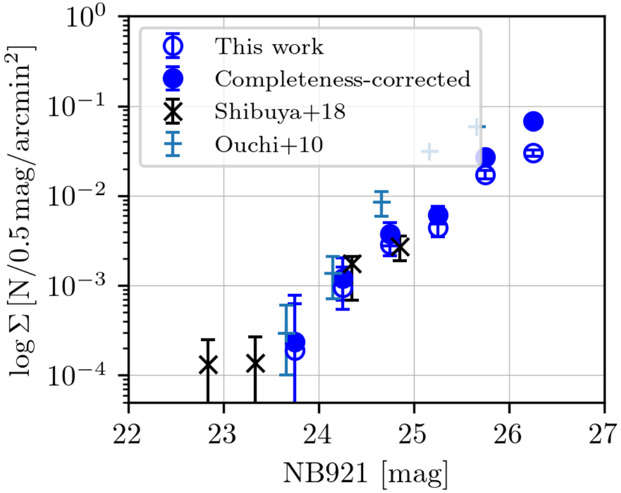
Completeness

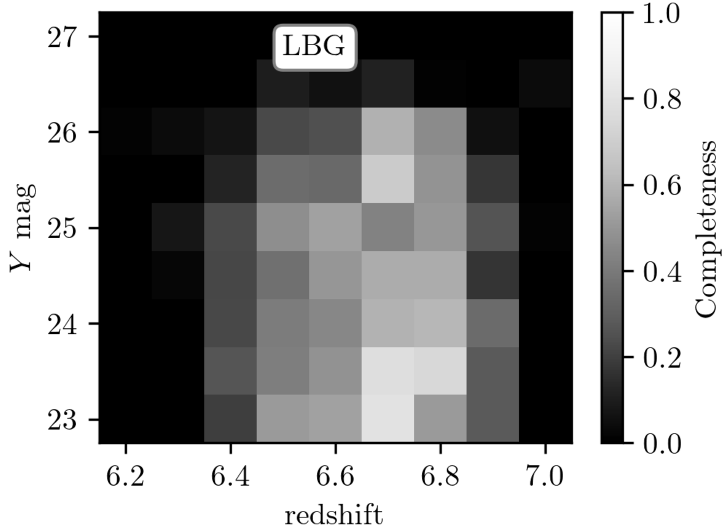
- Calculate selection completeness by mock galaxy simulations applying the selection criteria.

- Surface densities of LAEs and LBGs are consistent with previous studies.



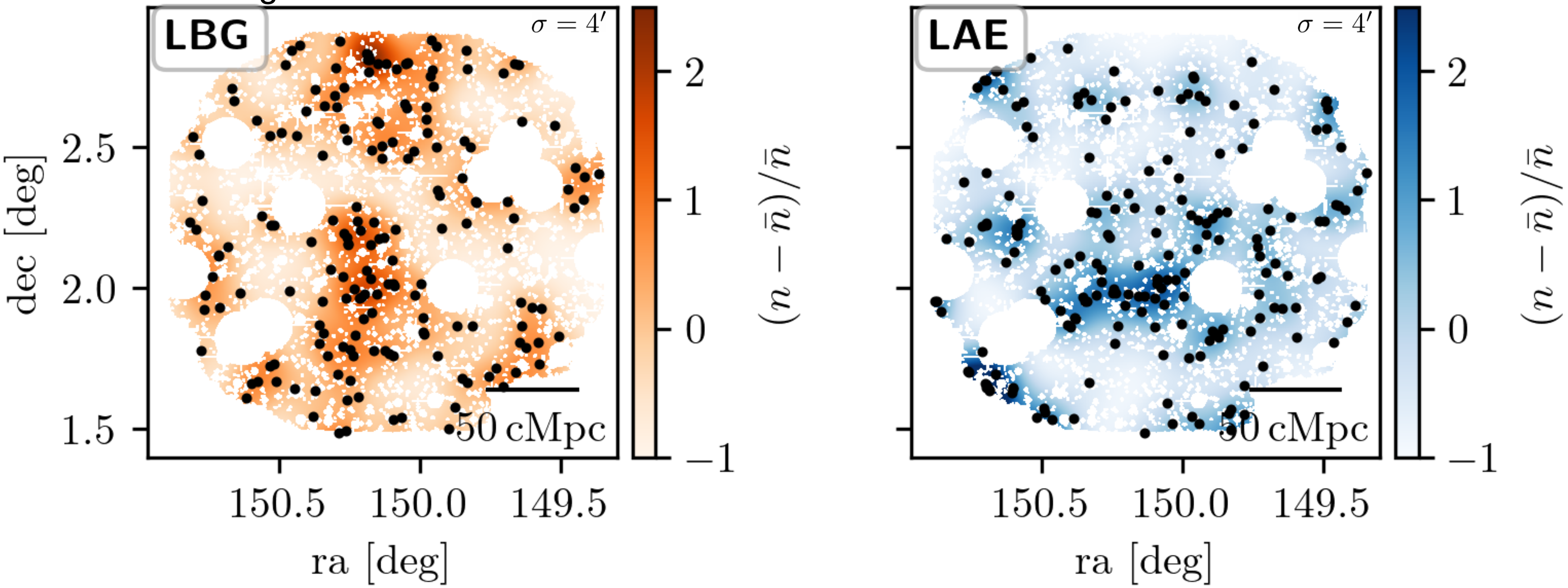






Distribution

- Color maps show the density distribution of the objects.
- Their values indicate the overdensity (n - mean(n)) / mean(n).
- Mask regions are shown in white.



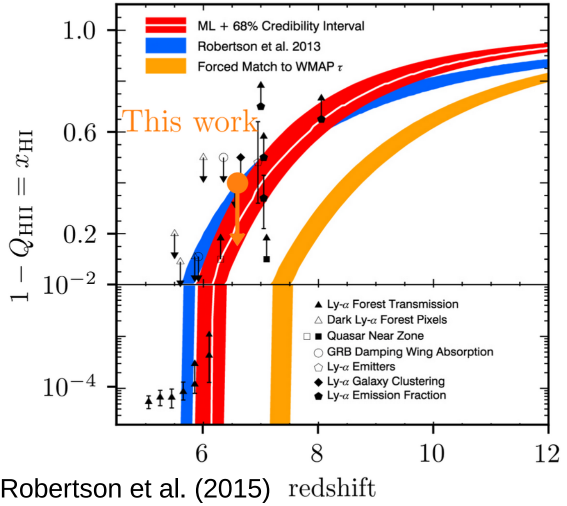
Neutral fraction

- LAE/LBG number ratio averaged in the entire FoV is

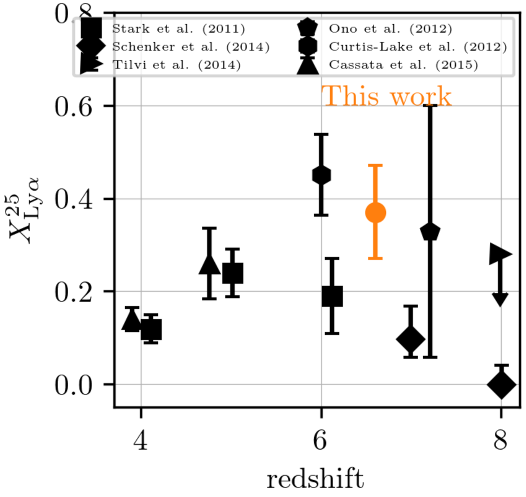
$$n(\mathrm{LAE})/n(\mathrm{LBG}) = 0.84^{+0.23}_{-0.27}.$$

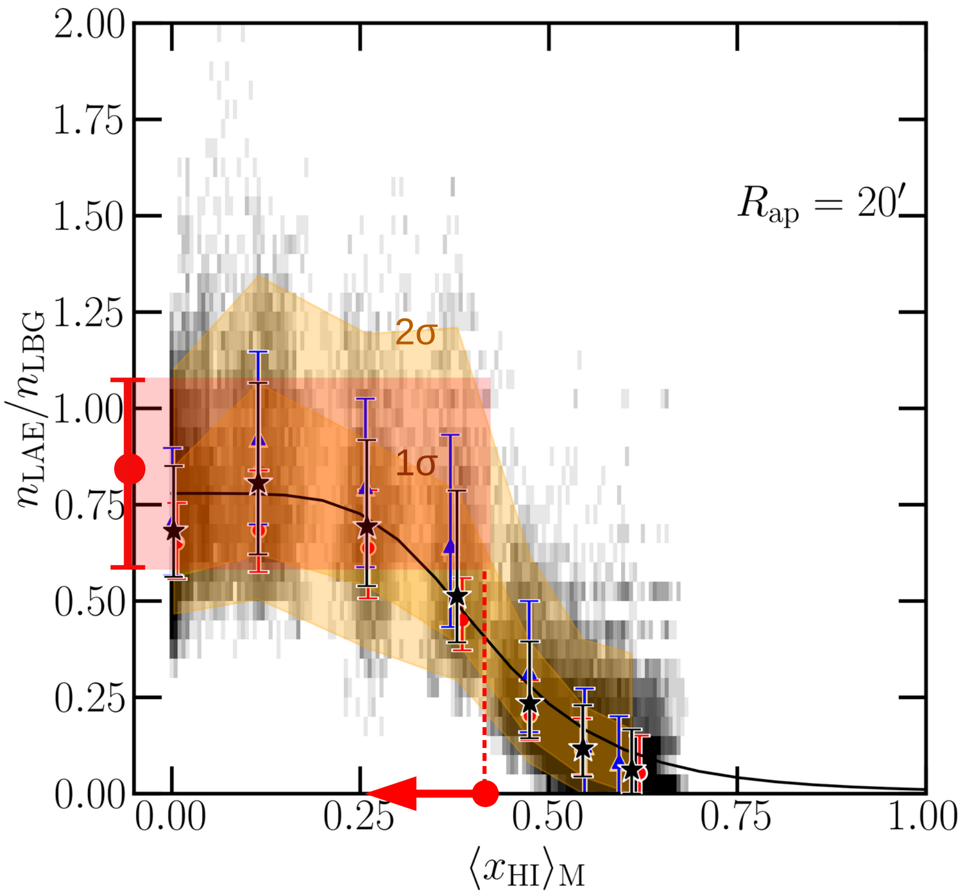
- Averaged neutral fraction in the entire FoV is

$$x_{\mathrm{HI}} < 0.4.$$



Robertson et al. (2015)





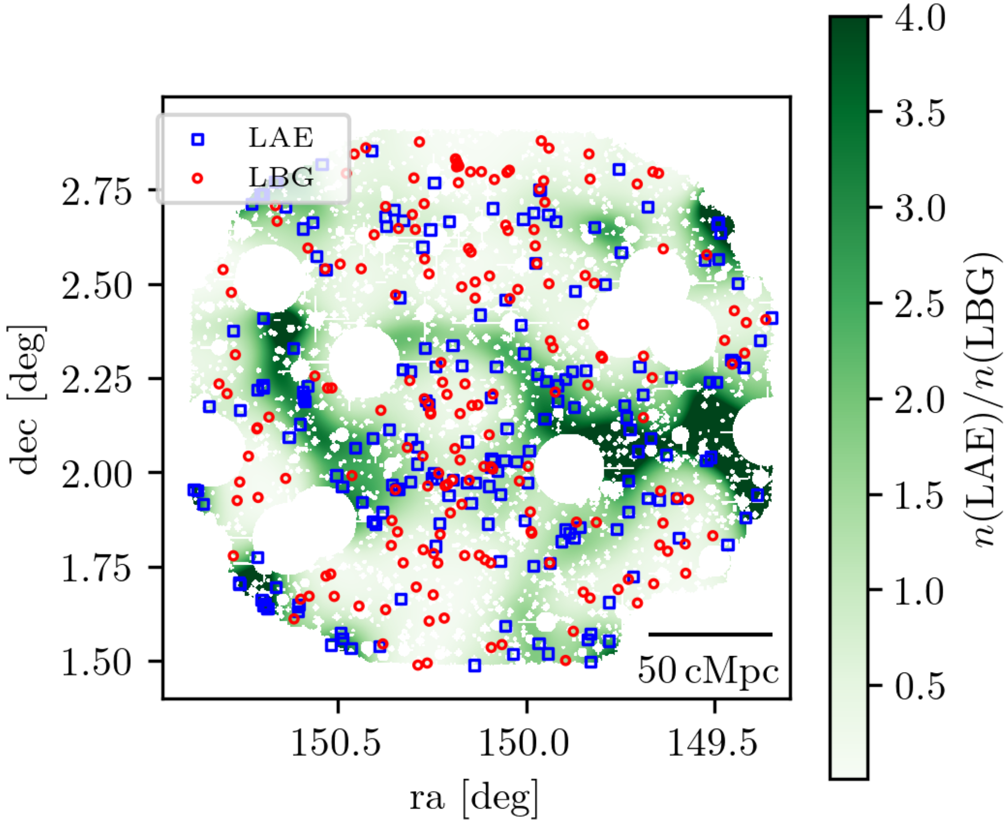
Inoue et al. (in prep.)

LAE/LBG ratio map

- Spatial variation of LAE/LBG is a factor of three.

Imply inhomogeneous reionization

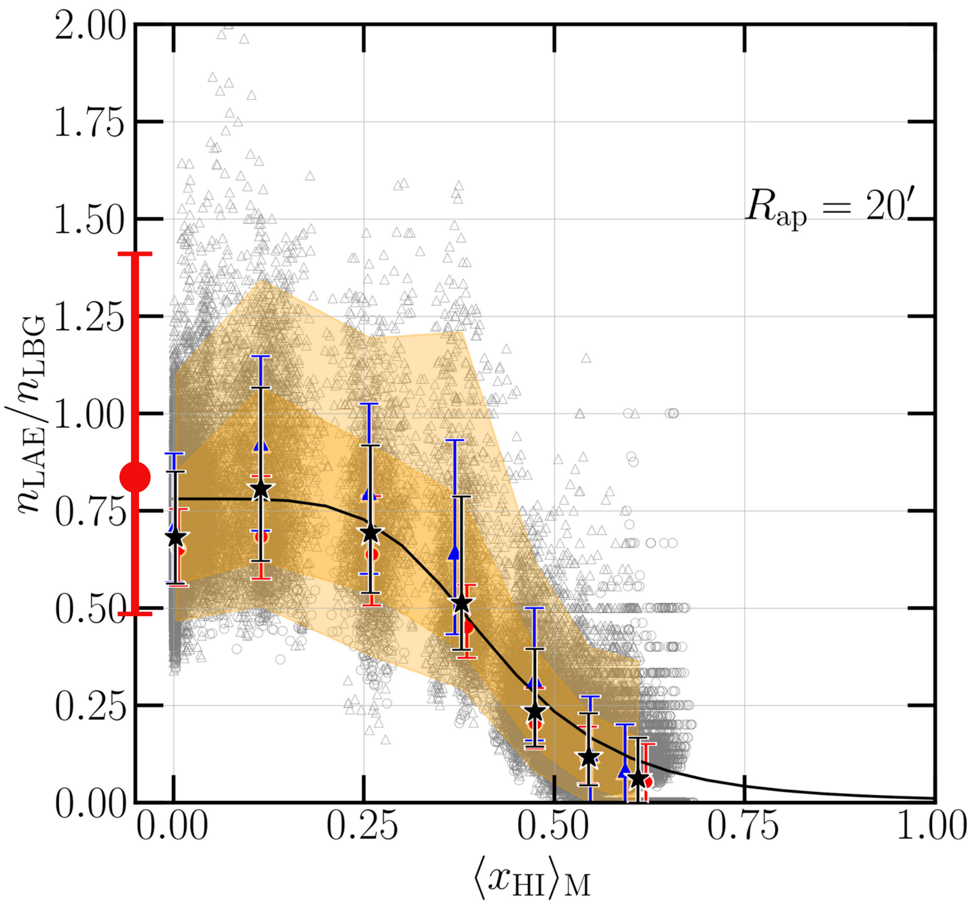
- High LAE density region:
  - Reionization is in progress.
- Low LAE density region:
  - Reionization is delayed.



Neutral fraction

- Spatial variation of LAE/LBG is a factor of three.

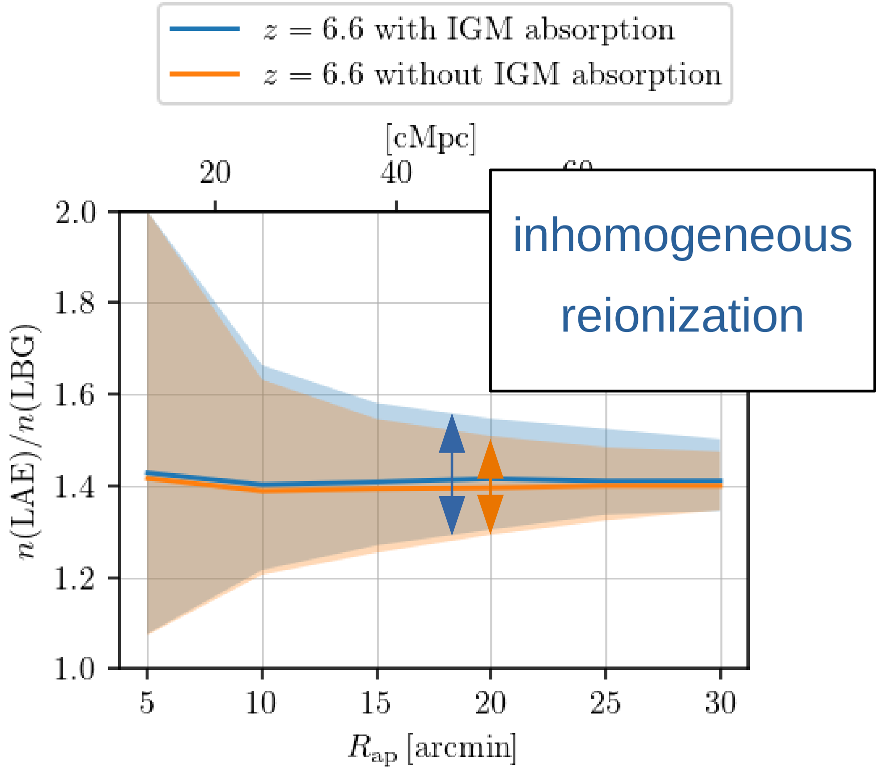
- Difficult to quantify the spatial variation of neutral fraction.



Inoue et al. (in prep.)

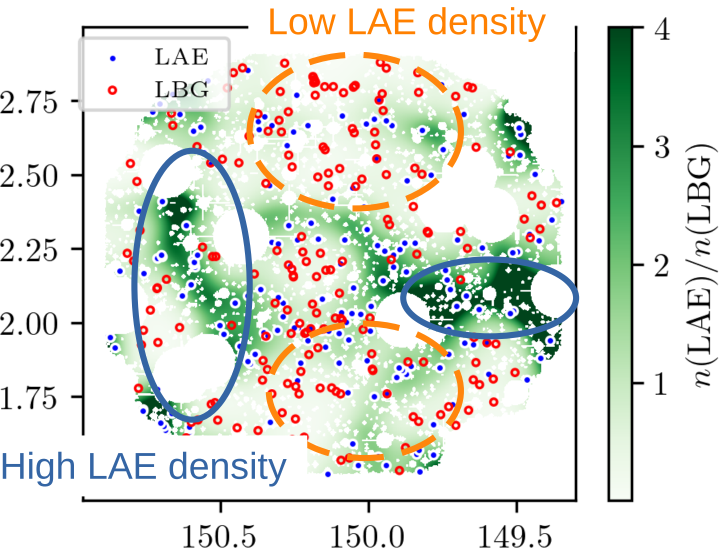
Distinguish the reionization topology from the intrinsic large scale structure

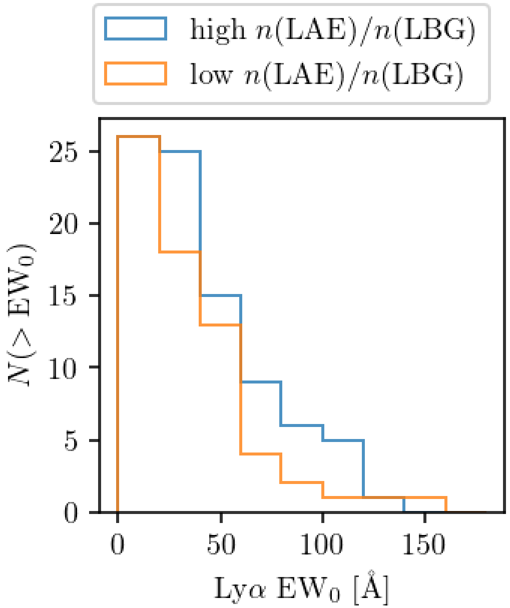
- **Large aperture is necessary for this aim.**
- Observed large variation in LAE/LBG may be due to intrinsic LSS without IGM absorption.
- Compare the scatter of LAE/LBG ratio between with and without IGM absorption in the simulation data.
- **Hard to distinguish them even with ~ 2 mag deeper observations.**

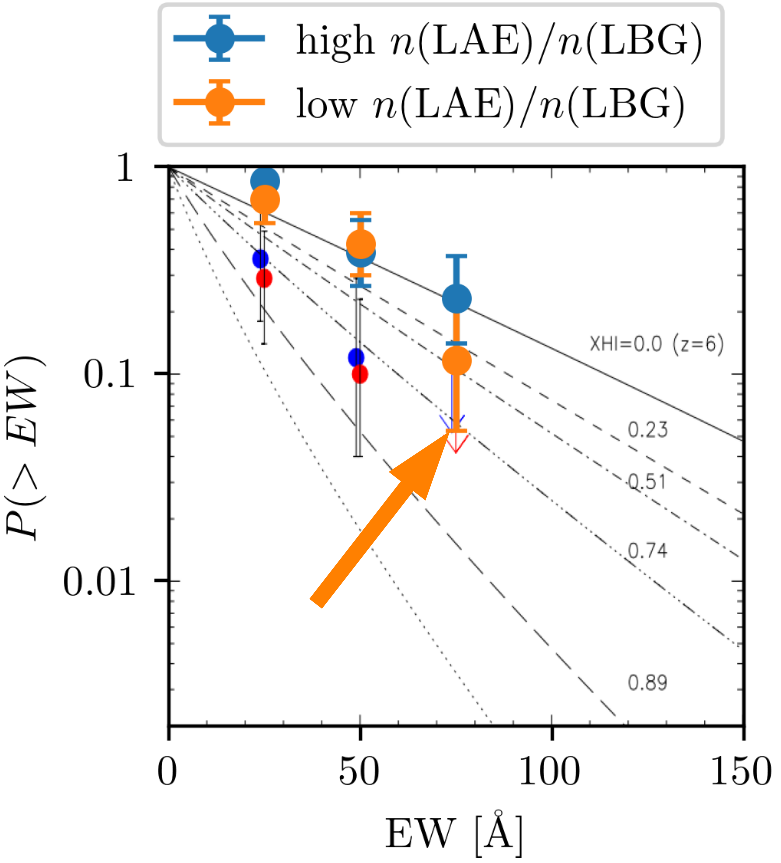


Lyα EW distribution

- Compare Lyα EW distribution between high and low LAE density regions.
- **Although the statistical significance is low, Low LAE density region implies higher neutral fraction.**







Pentericci et al. (2014)

Summary

- We **simoultaneously detect LAEs and LBGs at z ~ 6.6** in the large FoV of the HSC observations with the new filter IB945.
- From the efficient survey, we attempt to **investigate the spatially inhomogeneous reionization for the first time**.
- From observed LAE/LBG ratio and reionization simulations, we derived **the averaged neutral fraction in the FoV** $x_{\rm HI} < 0.4$.
- Mapping the spatial inhomogeneity of reionization requires much deeper imagings.
- It is **difficult to distinguish the reionization topology from the LSS** even with ~ 2 deeper observations.