Cosmic Re-ionization History Probed With Lyα Luminosity Function of LAEs at z=7.3

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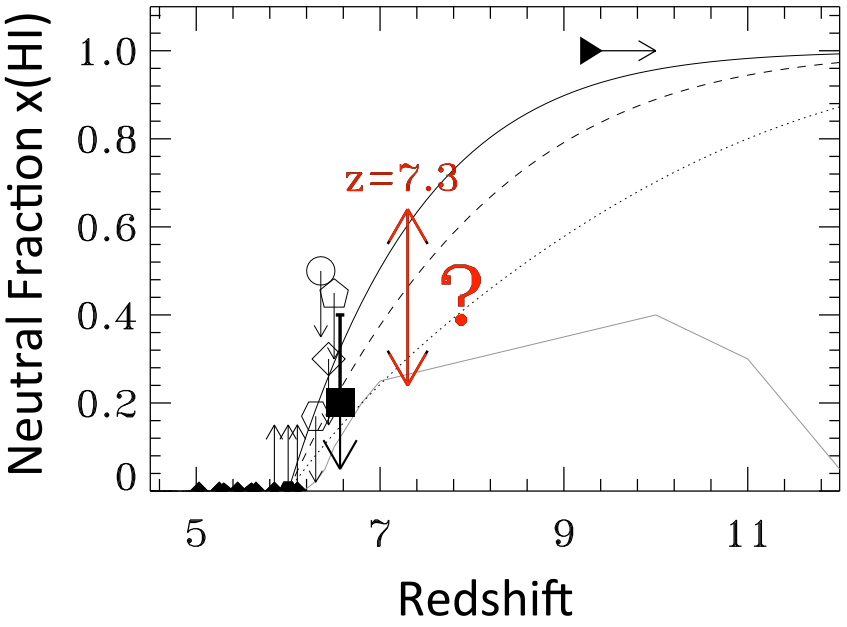
Outline

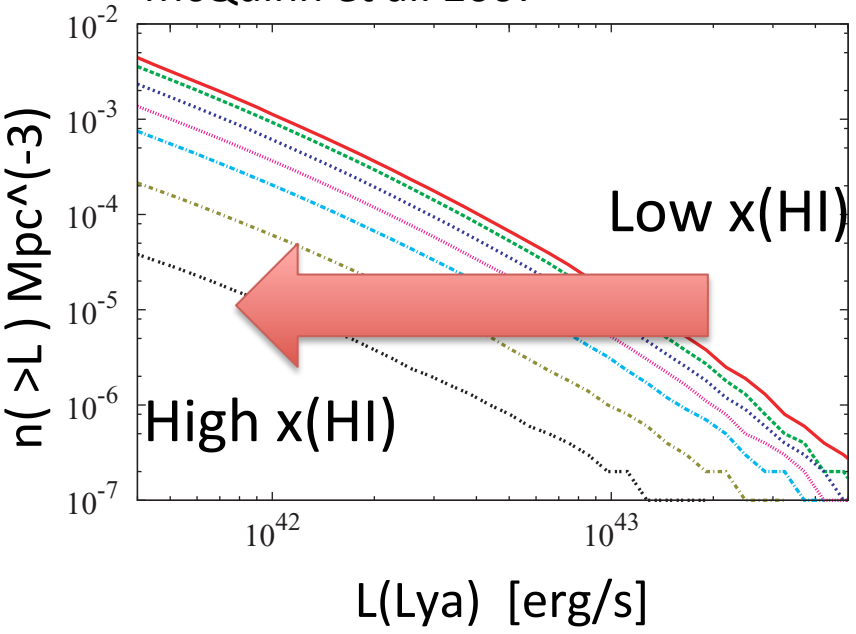
- Significance and previous study of z=7.3 LAE survey
- Results of LAE survey, Lyα LF of z=7.3 LAEs and x(HI) at z=7.3
- Future work : HSC survey

Introduction :
x(HI) can be estimated using Lyα LF.

Ouchi et al.



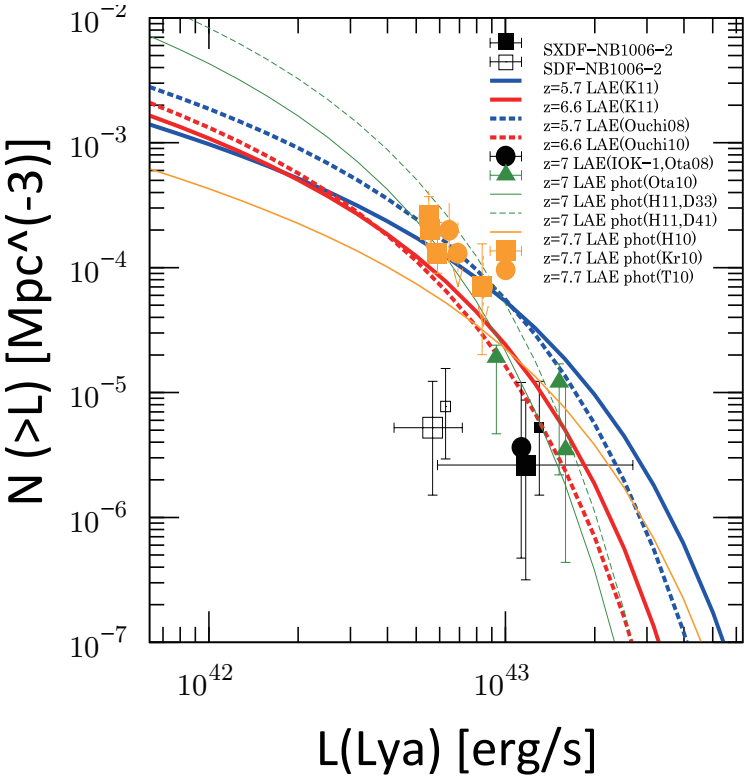
McQuinn et al. 2007



- z=7.3 LAEs study can constrain the time evolution of neutral hydrogen fraction, x(HI).
- Lyα LF will change because of Lyα damping wing of neutral hydrogen in IGM.

Previous Study of z=7.3 LAEs

- The first result of z=7.3 LAEs : Shibuya+ 2012
  - L(Lya) >~ 10^43 [erg/s]
- Only the bright-end of Lya LF and a few sources
- Large uncertainties of foreground contaminations and statistics
- Measure the faint end of LF to check the luminosity evolution

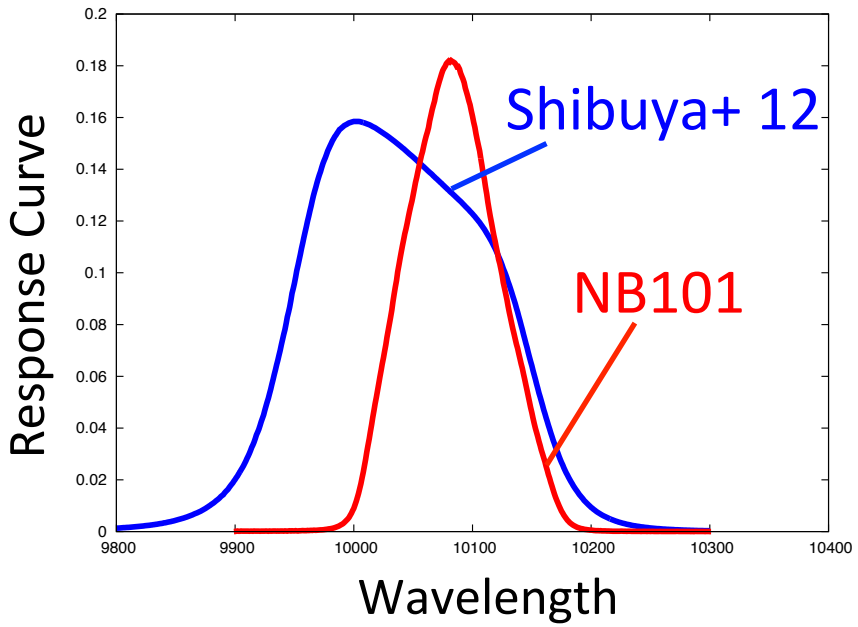


Shibuya et al. 2012

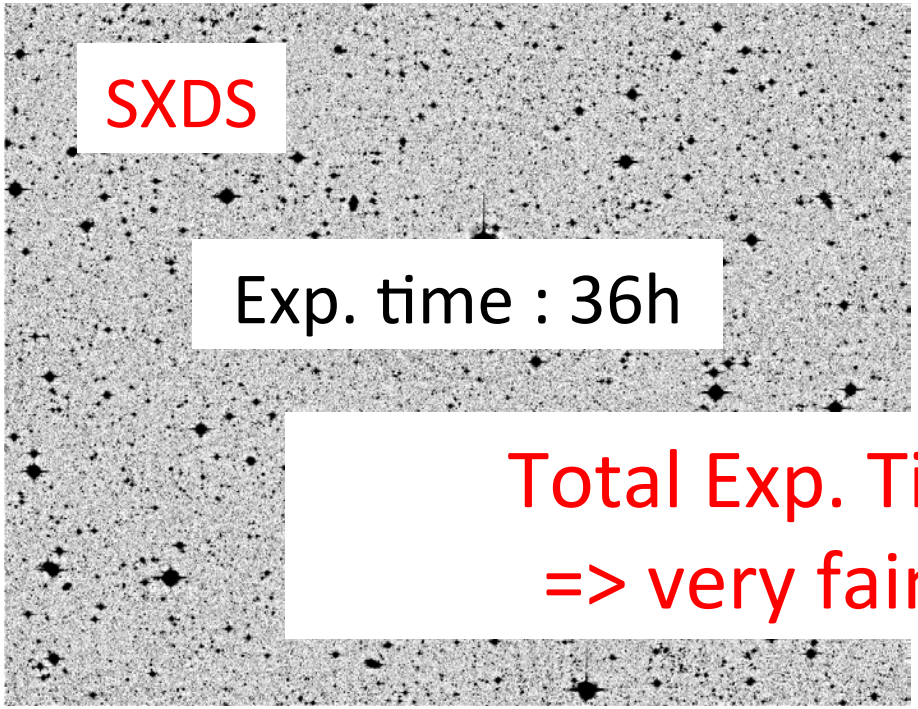
A Custom Narrowband : NB101

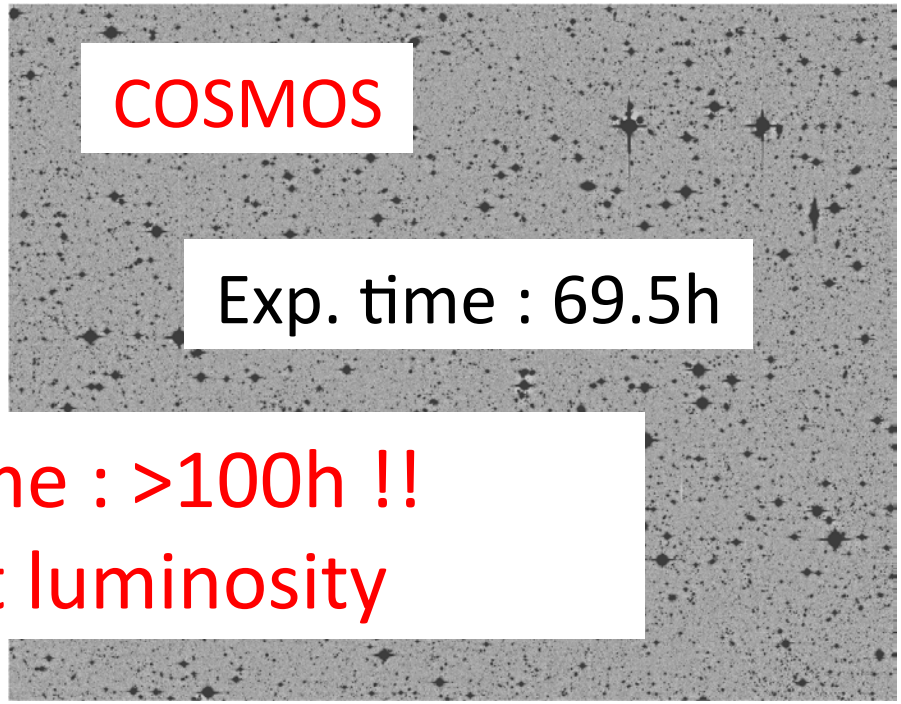
- We developed a custom narrowband : NB101
- FWHM(NB101) ~ 9 nm
  - present technological limit !
- high S/N ratio and fast survey speed w 160%

=> detect very faint LAEs



Observation : Imaging





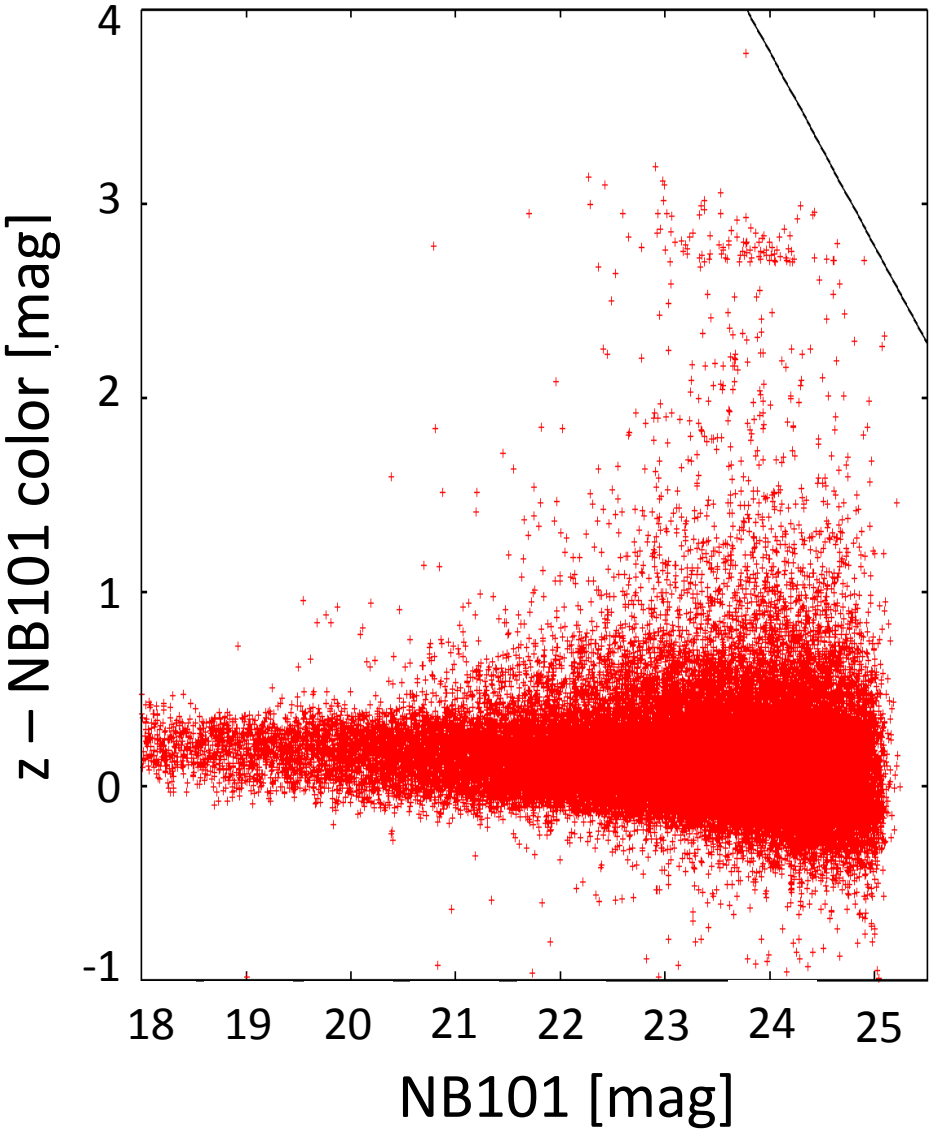
Total Exp. Time : >100h !!
=> very faint luminosity

in total ~1600 arcmin^2

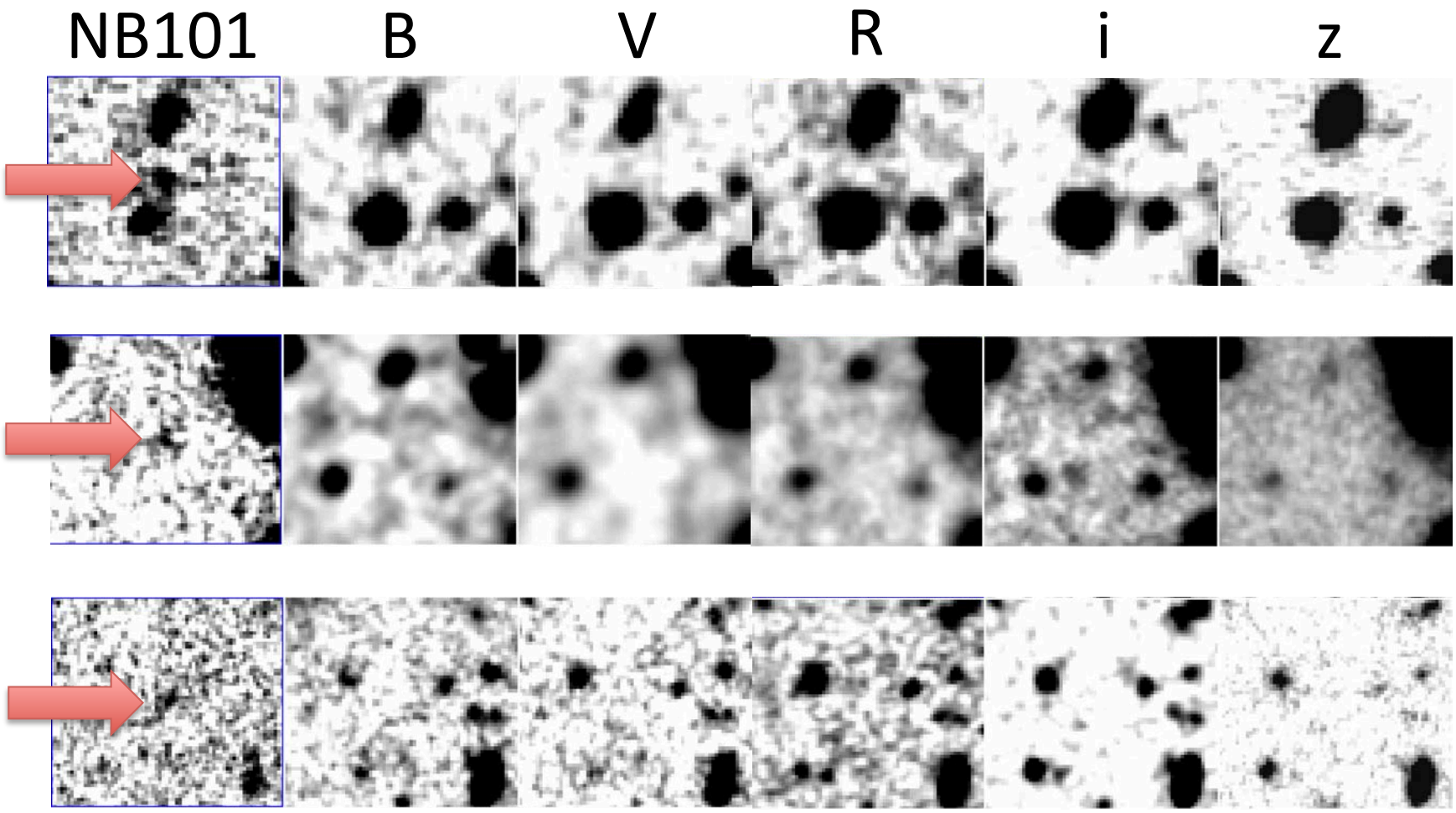
5 sigma = 4*10^42[erg/s] 5 sigma = 2*10^42 [erg/s]

Selection of z=7.3 LAE

- selection criteria :
  z – NB > 3, B,V,R,i < 3σ
  NB > 5σ, B,V,R,i,z < 3σ
- z=7.3 photo. candidate :
  SXDS … 3 COSMOS … 4
  Total … 7
- down to ~3*10^42 erg/s
  ~0.5L*_{z=6.6}
- cf) previous Subaru NB surveys ~1*10^43 erg/s (Shibuya+ 12) … 4 photo. candidates
  -> 2 spec.

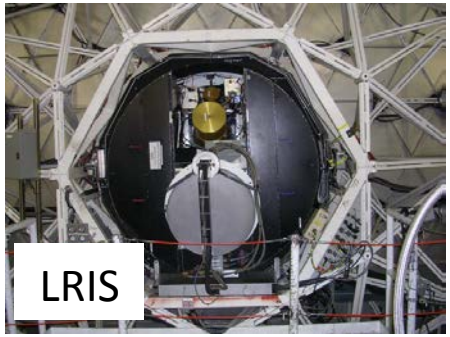


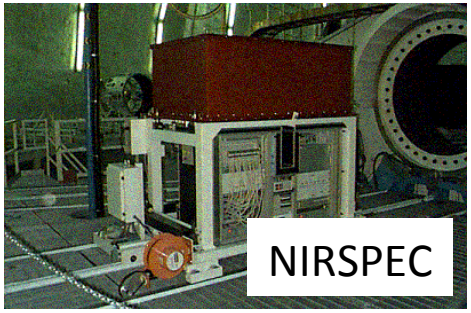
Snapshots of z=7.3 LAEs

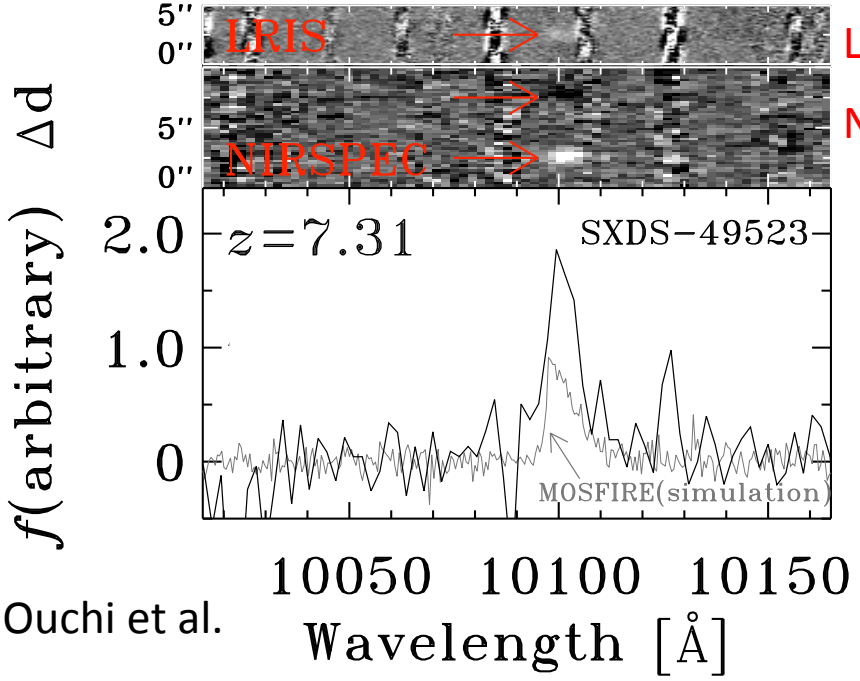


Observation : Spectroscopy

- Follow-up spectroscopy for z=7.3 LAE candidates
- PI : Ouchi / Nakajima et al.
- Keck / MOSFIRE observation in Oct. & Jan.

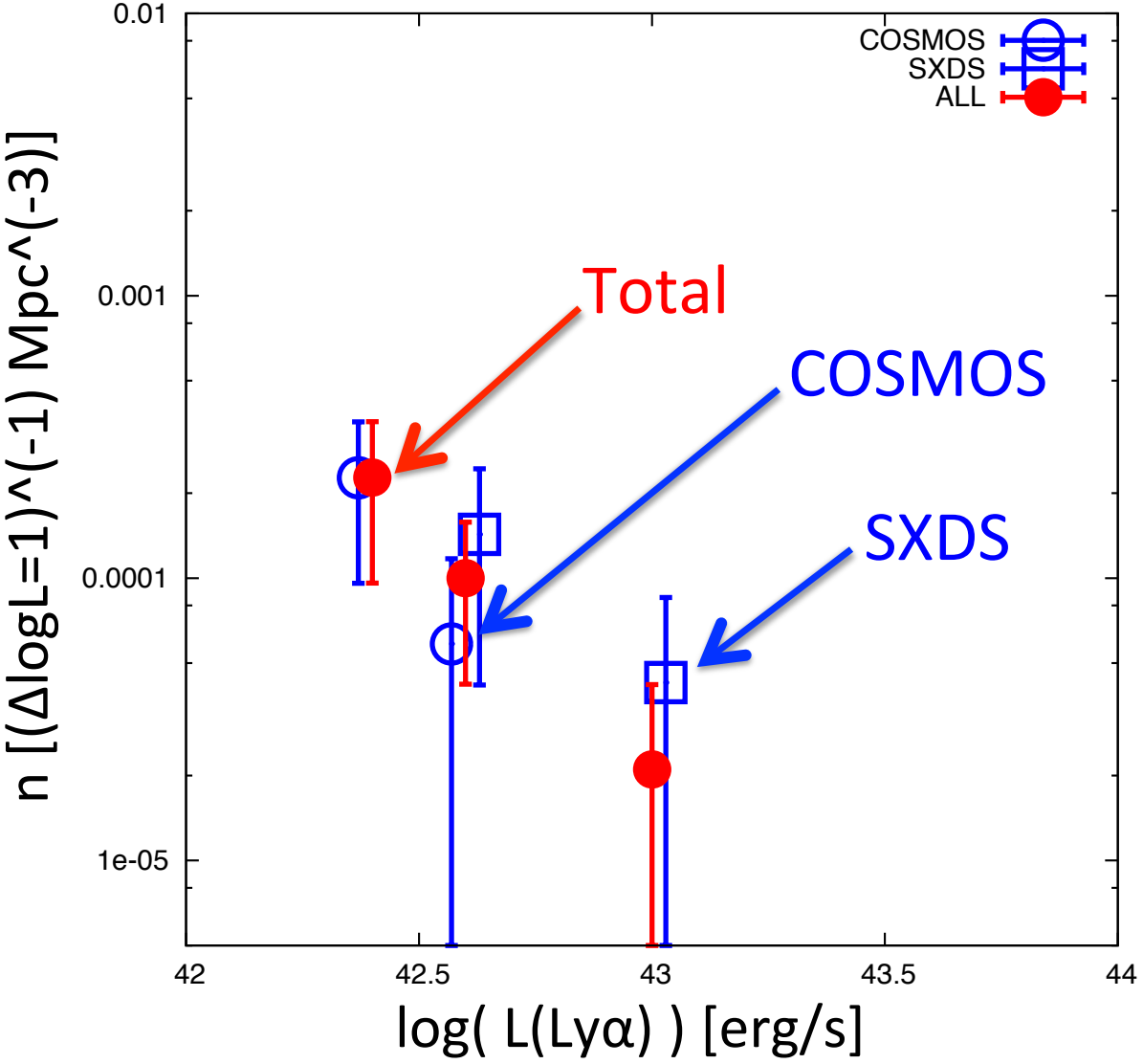




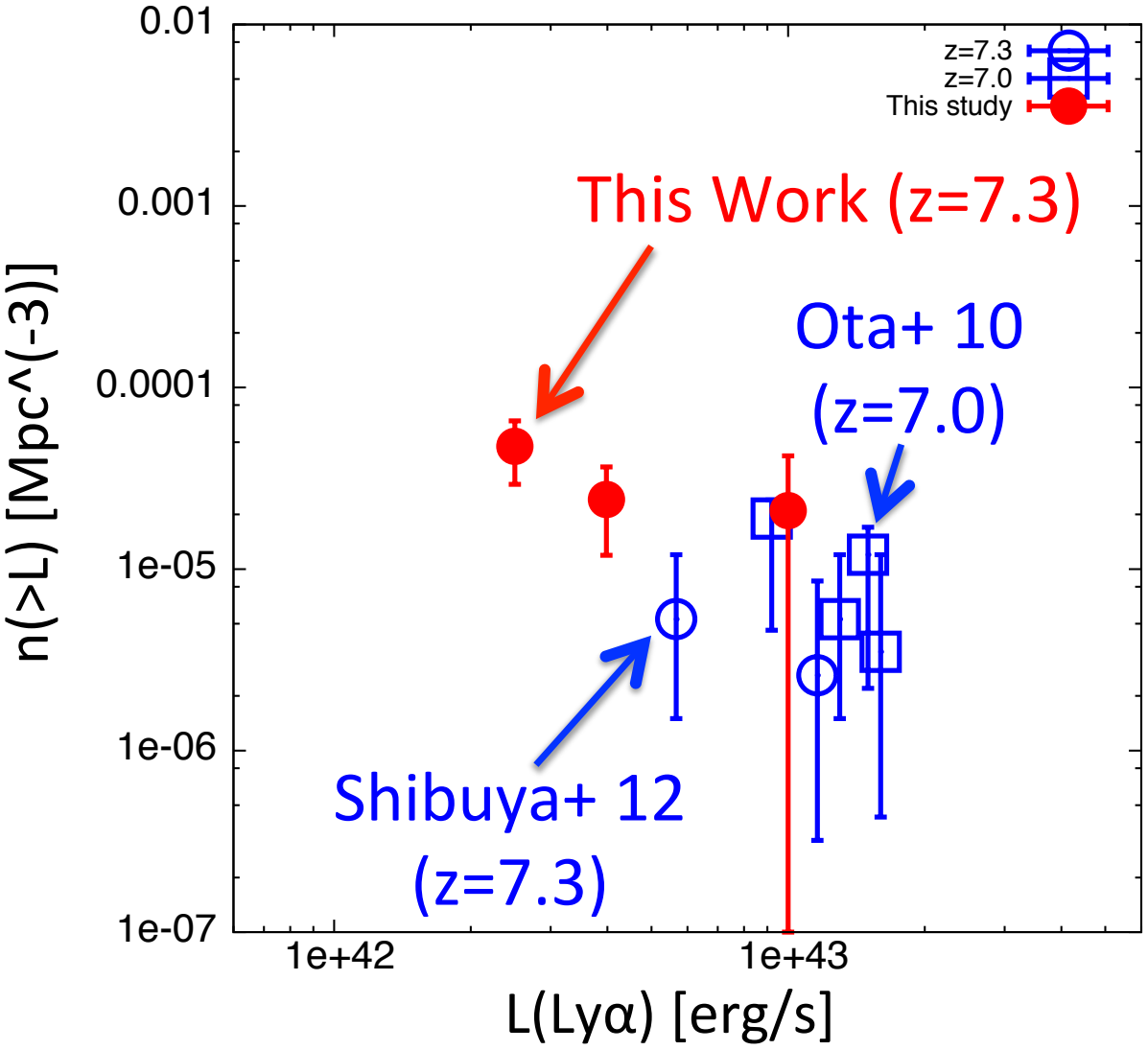


Ouchi et al.

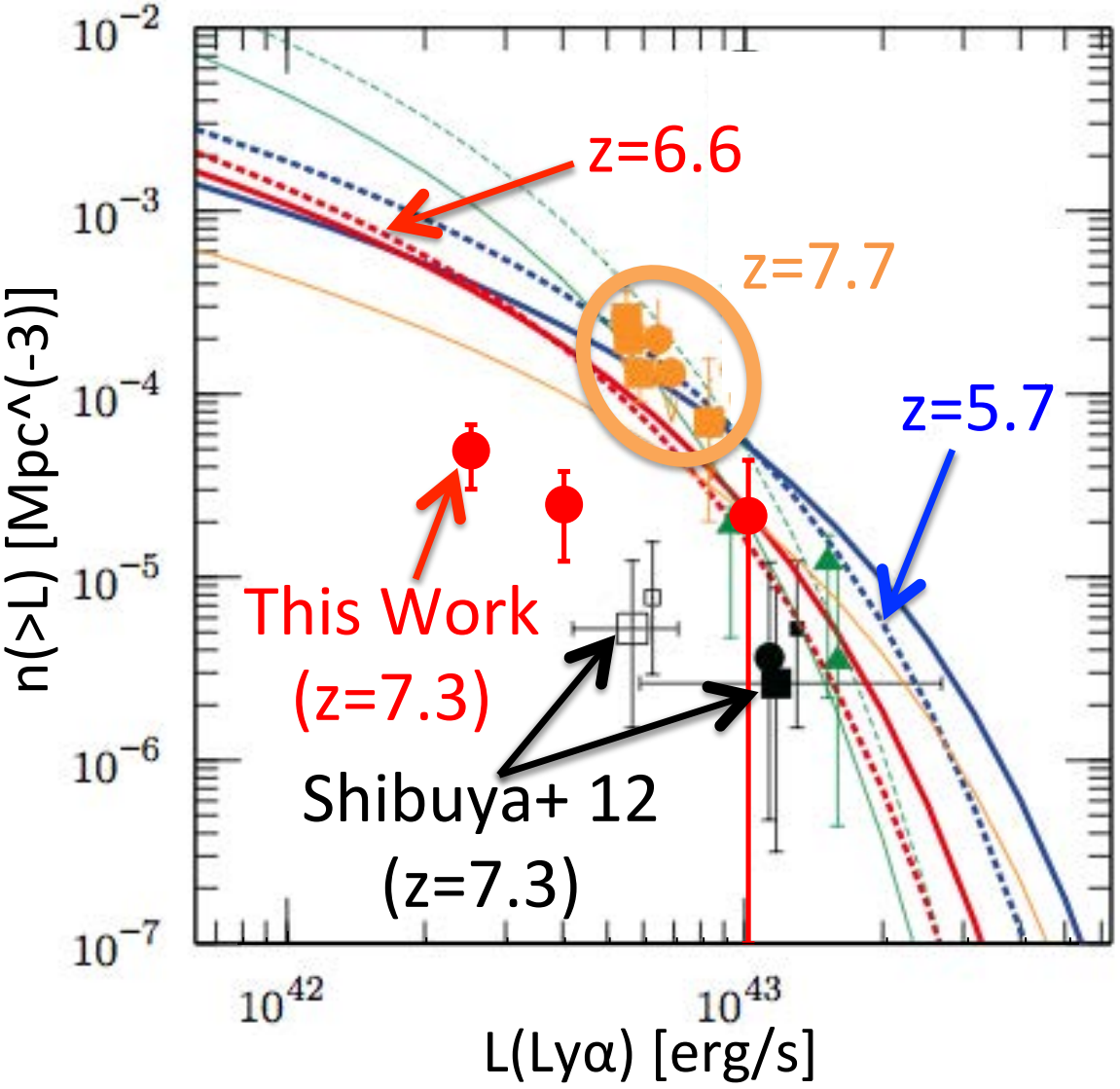
Results :
Lya LF



Results :
Lya LF compared with z~7



Results :
Lya LF compared with different redshifts



- z=7.7 results : photo only (Hibon+ 10, Tilvi+ 10, Krug+ 12)
- z=7.3 previous Subaru results : photo + spec (3/4; Shibuya+12)
- z=7.3 Udeep Subaru results : photo + spec (3/7; This Study)

Discussion

- We used the equation : $\rho^{Ly\alpha} = \kappa T_{IGM}^{Lya} f_{esc}^{Ly\alpha} \rho^{UV}$
- The decrease of ρ(Lyα) is ~25% from z=5.7 to z=7.3.
- The decrease of ρ(UV) is ~70% from z=5.7 to z=7.3.
- If we assume that κ & f(Lyα, esc) are constant,

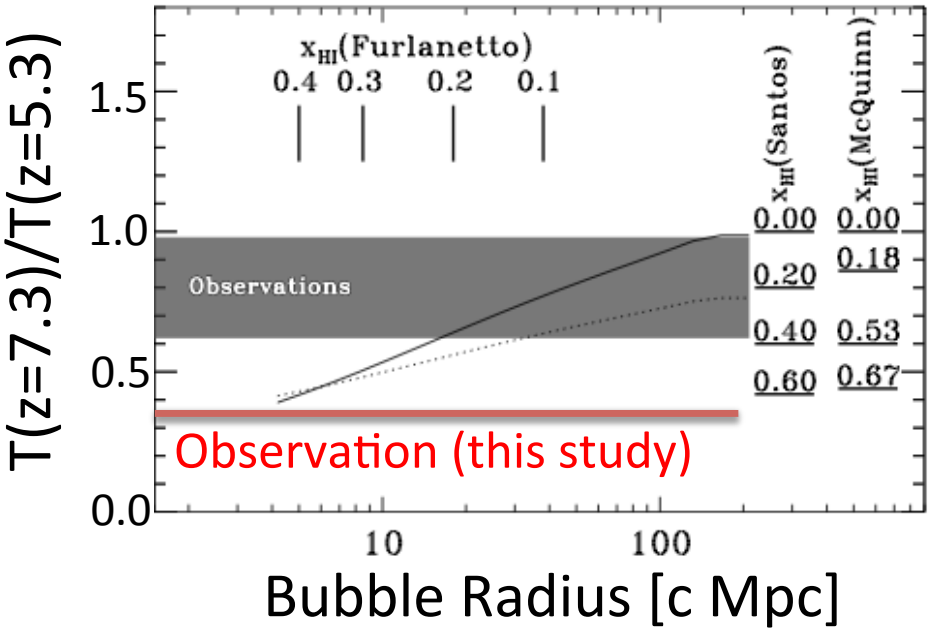
$$\frac{T_{IGM,z=7.3}^{Ly\alpha}}{T_{IGM,z=5.7}^{Ly\alpha}} = \frac{\rho_{z=7.3}^{Ly\alpha} / \rho_{z=5.7}^{Ly\alpha}}{\rho_{z=7.3}^{UV} / \rho_{z=5.7}^{UV}} = 0.36$$

- The estimated x(HI) :

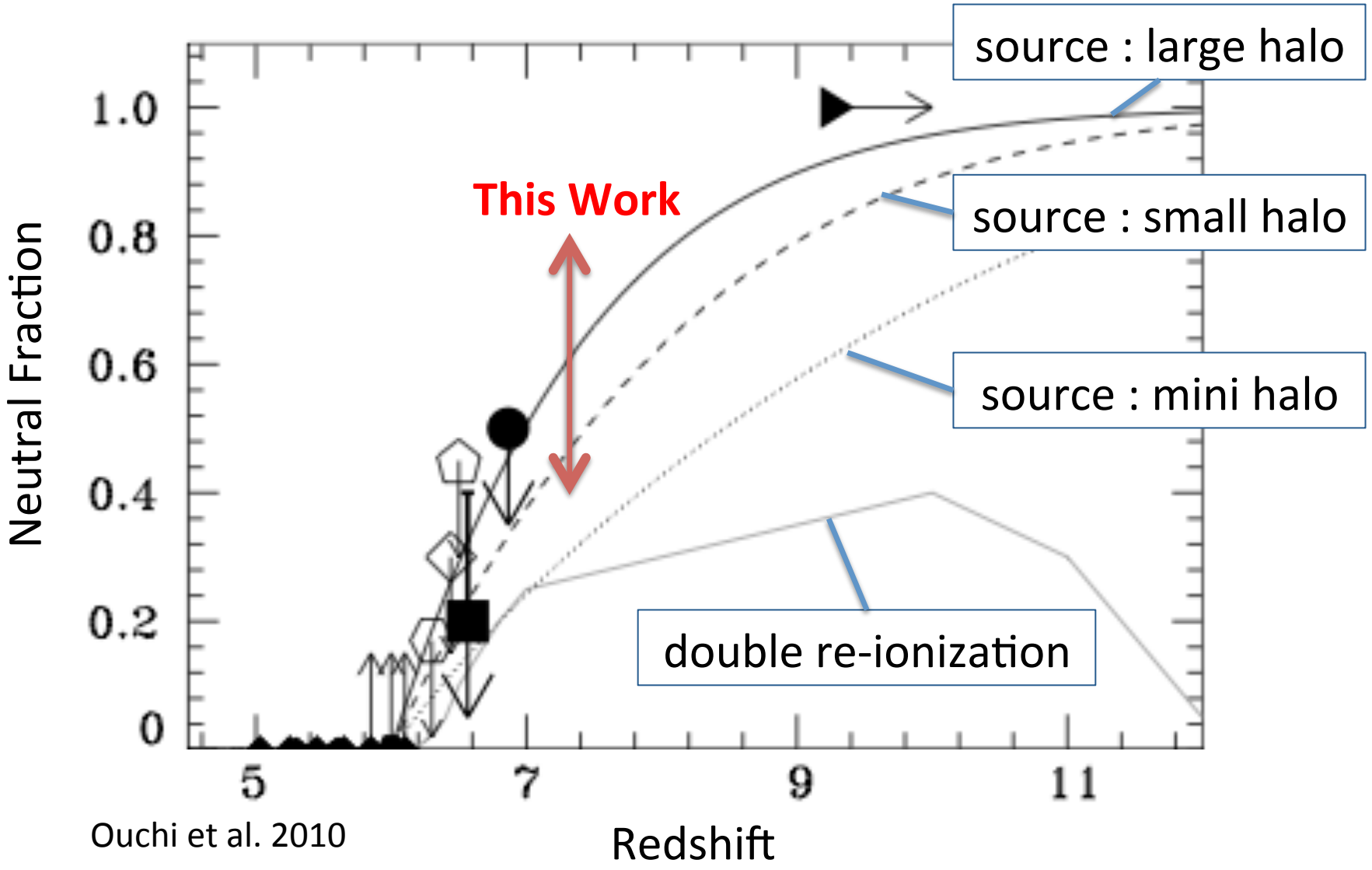
  ~0.4-0.8

  – too large x(HI)

  =>Haehnelt & Mesinger's talk



Discussion

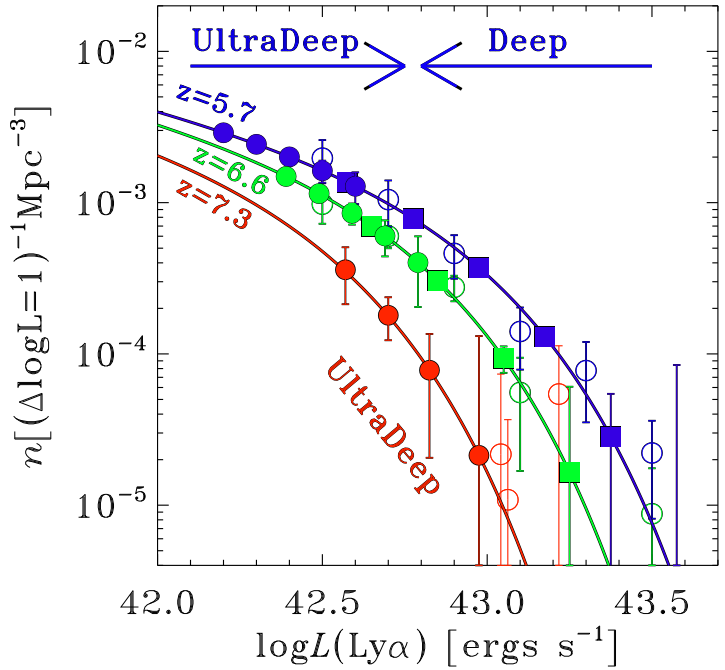


Ouchi et al. 2010

Future Work : HSC Survey

- Subaru/Hyper-Suprime-Cam (HSC) will be running in 2014.
- The FoV of HSC is ~7 times wider than that of Suprime-Cam.

  ⇒ Overcoming the statistical uncertainties
- Our goals :
  - Estimate x(HI) within the error of 0.1
  - Constrain cosmic re-ionization history and the re-ionization sources



From HSC SSP proposal

Summary

- We have completed ultra-deep(100h!) z=7.3 LAEs survey with an ultimate narrowband filter, NB101.
- We found 7 LAEs in SXDS & COSMOS field and Lya LF decrease from z=5.7 & 6.6 to z=7.3.
- We estimated x(HI) ~ 0.4-0.8 at z=7.3
- We will constrain cosmic re-ionization history and re-ionization sources with HSC survey.