Lyα Tomography Mapping with BOSS QSOs at z = 2.5 : HII Bubble Candidate in FALL Field

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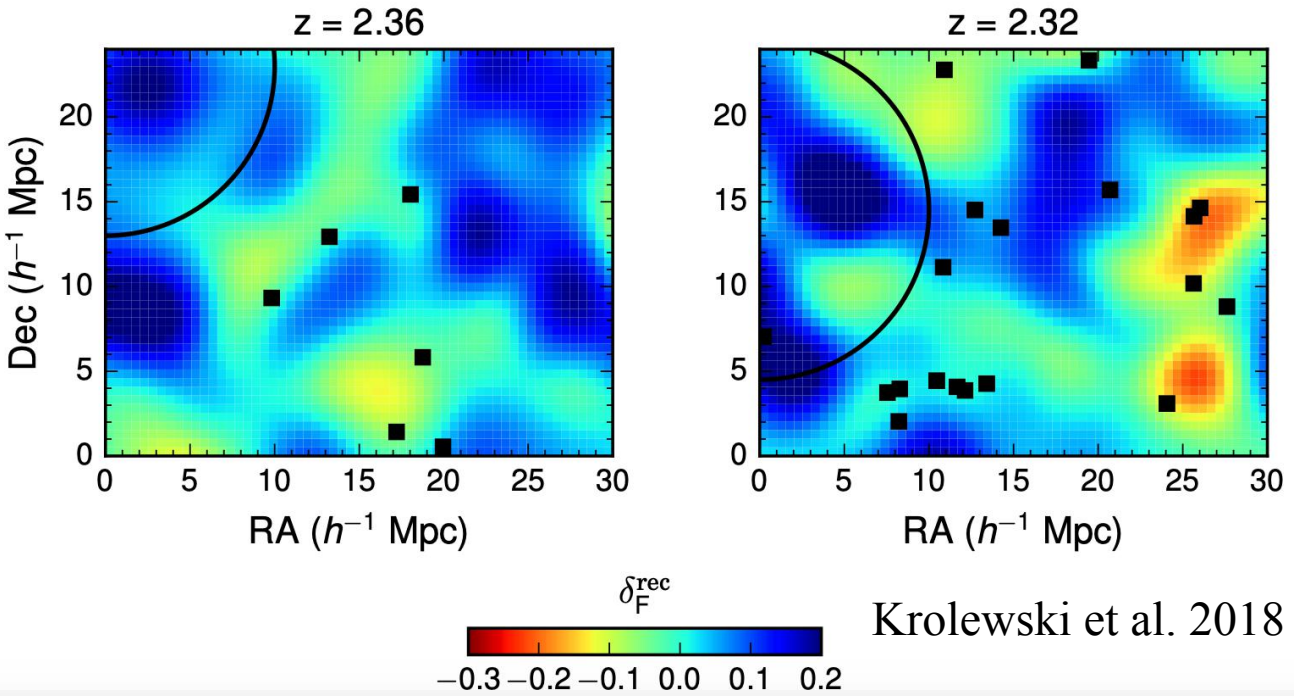
Introduction

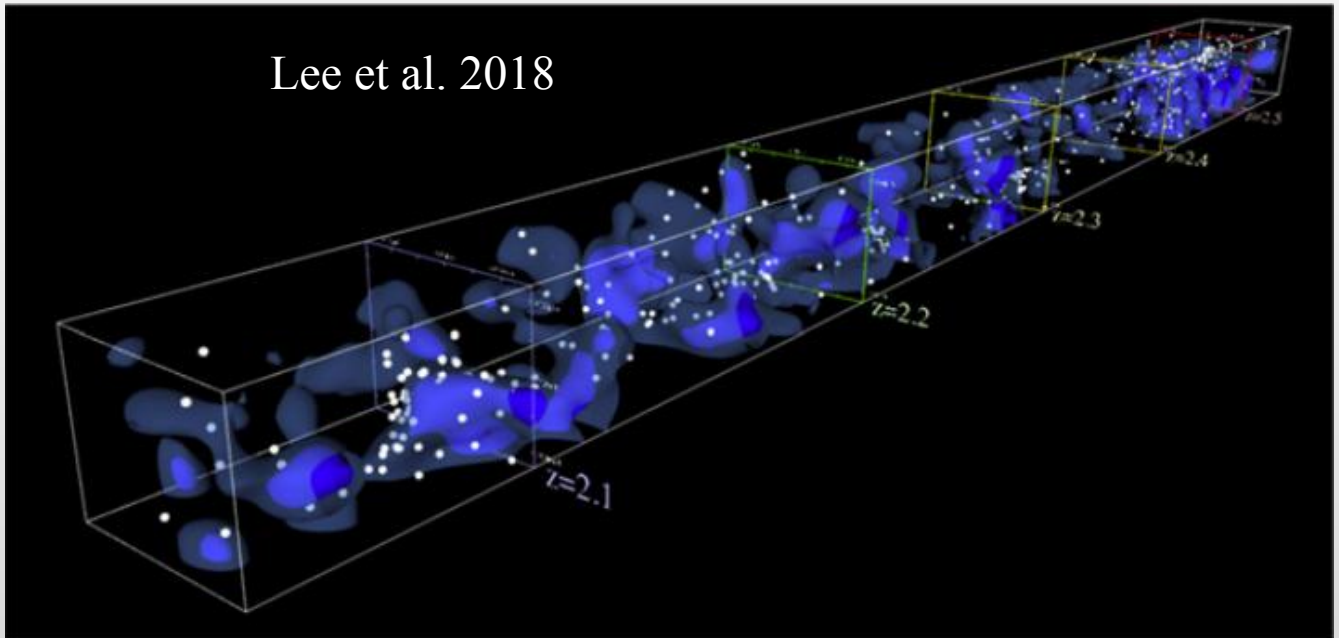
Void in HI underdensity
(Krolewski et al. 2018)
Void : Area with relatively low matter density

Lyα Tomography Mapping
(Lee et al. 2018) :
Lyα Forest of Background QSO
To trace Foregound HI gas distribution in IGM

But some HI underdensity areas can not be explianed by void
(associated with high matter density)

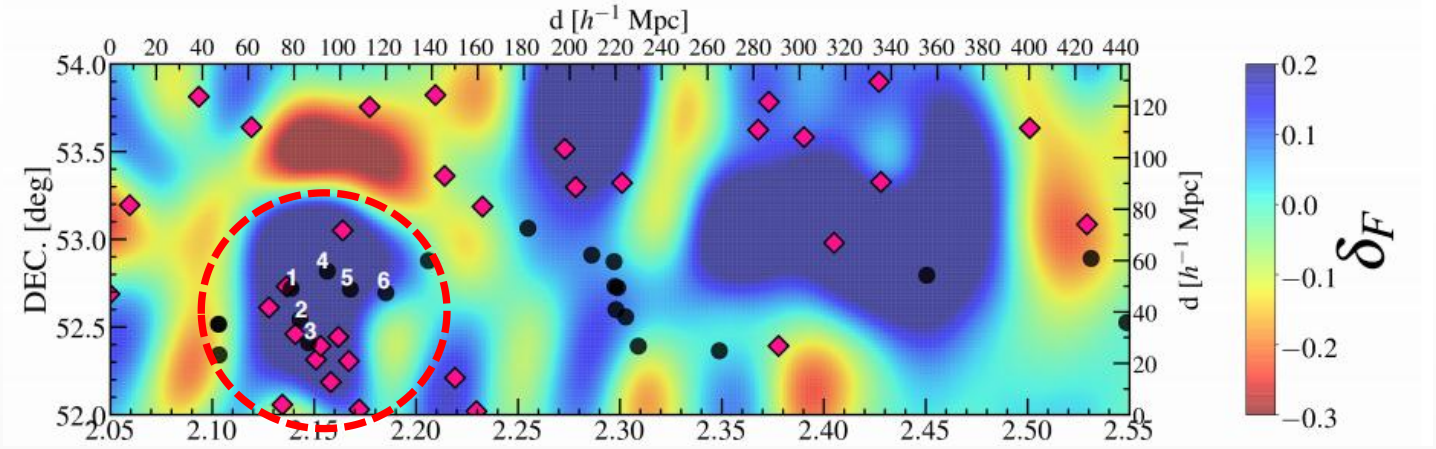


Krolewski et al. 2018



Introduction

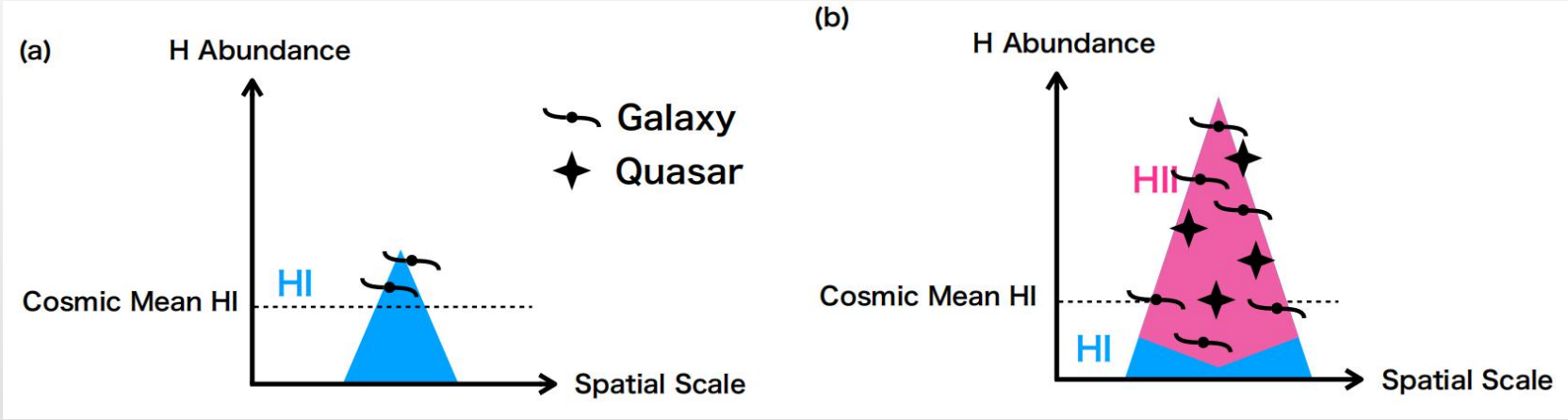
HII Bubble (Mukae et al. 2020) :
HI gas Highly ionized by radition of QSOs overdensity



Mukae et al. 2020

Evolution :
HI gas overdensity → Galaxy overdensity
→ Quasar overdensity→ HII Bubble

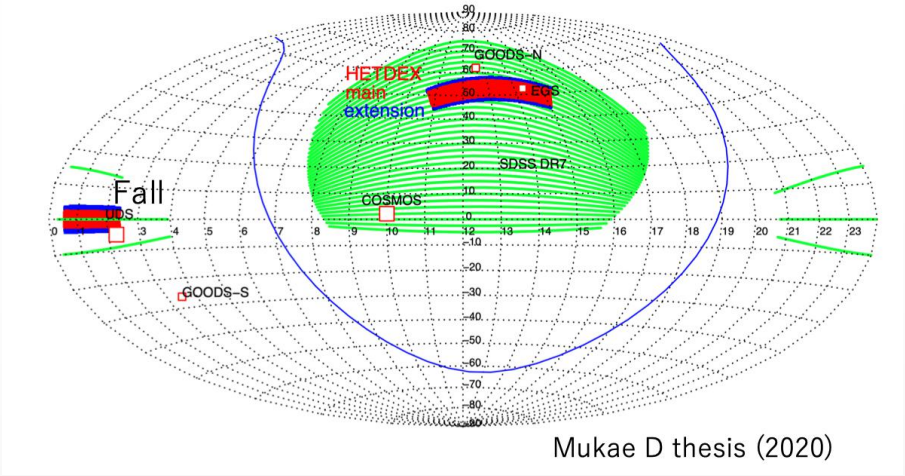
To confirm this Evolution :
More QSO overdensity suround by HI underdensity



Mukae et al. 2020

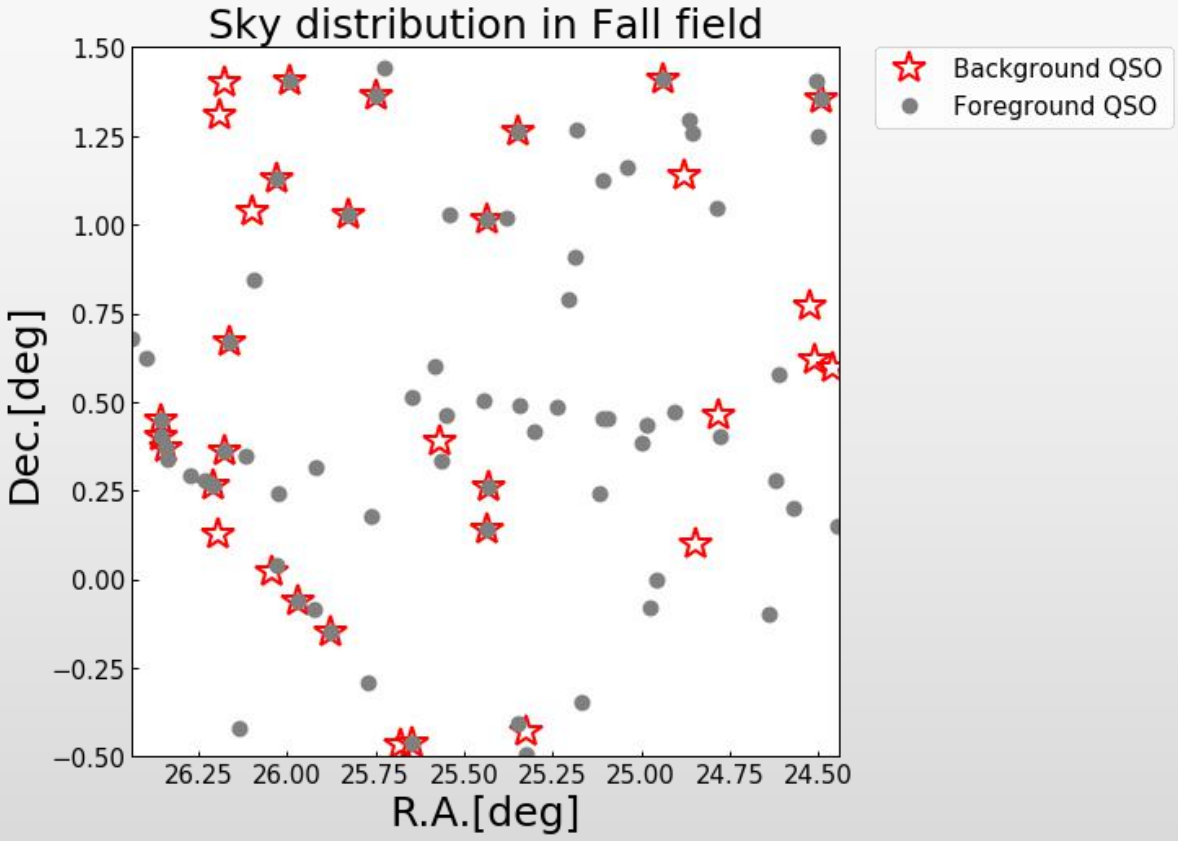
DATA

Background spectra ： SDSS DR14 QSOs (Paris+18)
Field : Fall (R.A.[deg] 5.3~37.7
Dec[deg] -1.5~1.8)



Mukae D thesis (2020)

Selection of QSO overdensity
Foreground QSOs :
R.A.[deg]: 24.44 ~ 26.44
Dec[deg]: -0.5 ~ 1.5
Red shift z : 2.489 ~ 2.689
70 QSOs in 4 deg^2



Background QSOs for tomography
Selection :
Red shift z : 2.3 ~ 3.5
Restframe 1040 Å to 1185 Å
Median SN > 2 ; remove DLA
33 Background QSOs Used

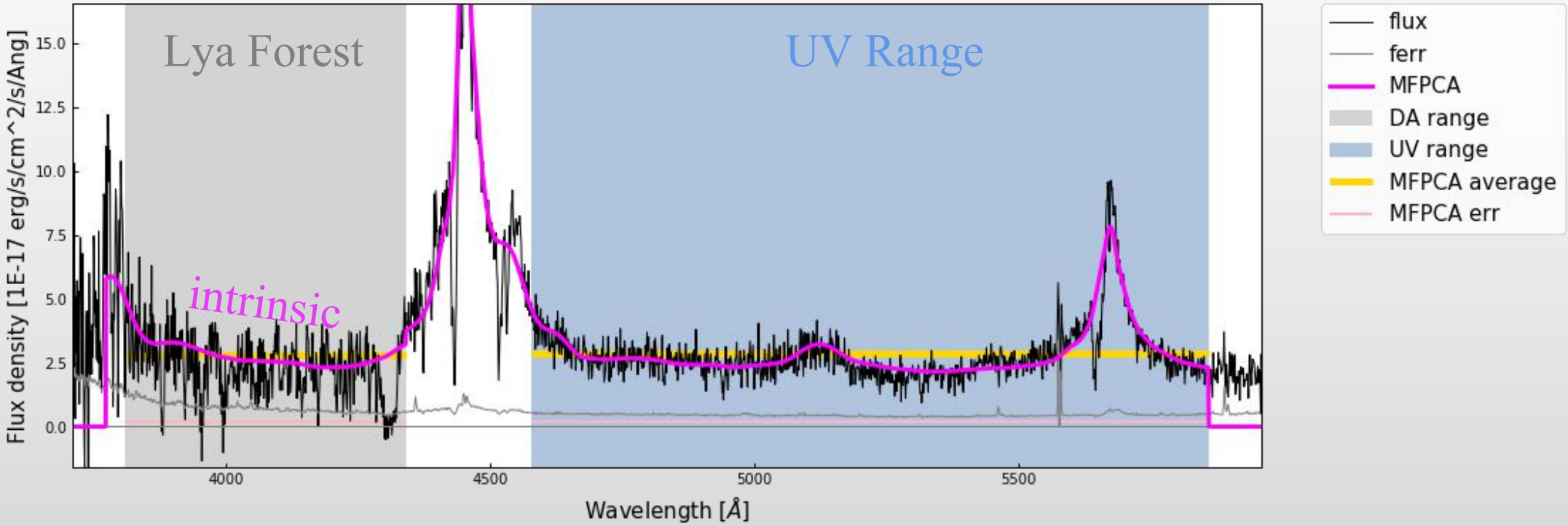
Analysis : Tomography map construction

MF-PCA fitting (Lee et al. 2012,2013,2014) : To get Intrinsic Flux of Background QSOs

PCA : Principal Component Analysis , Correlations between the unabsorbed flux
(UV continum and Lya Forest)

MF : Mean Flux regulation , Lya forest transmission have a redshift evolution
(z incaease Lya forest Transmission decrease, Faucher-Giguere+08)

MF-PCA fitting in an example Background QSO spectrum :



Analysis : Tomography map construction

HI overdensity δ_F : Relative HI Absorption excess from cosmic average

δ_F + : HI Underdensity

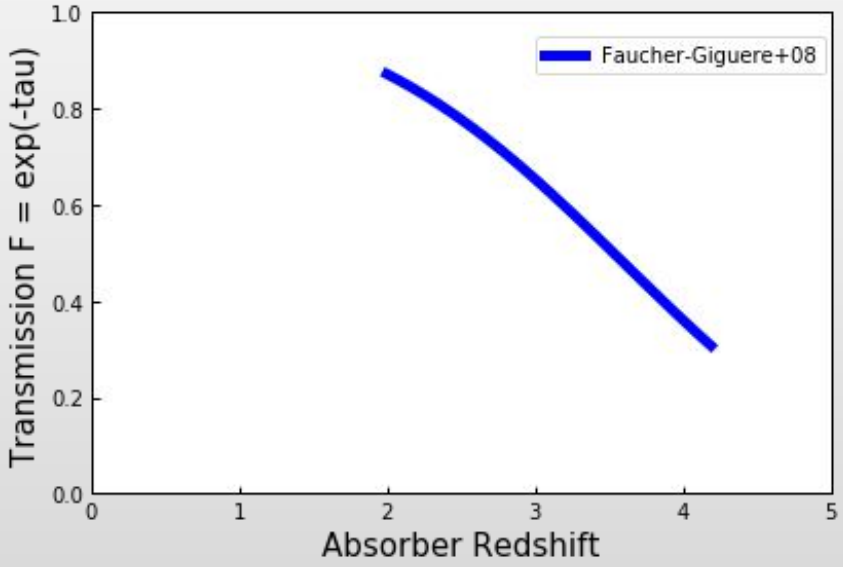
δ_F - : HI Overdensity

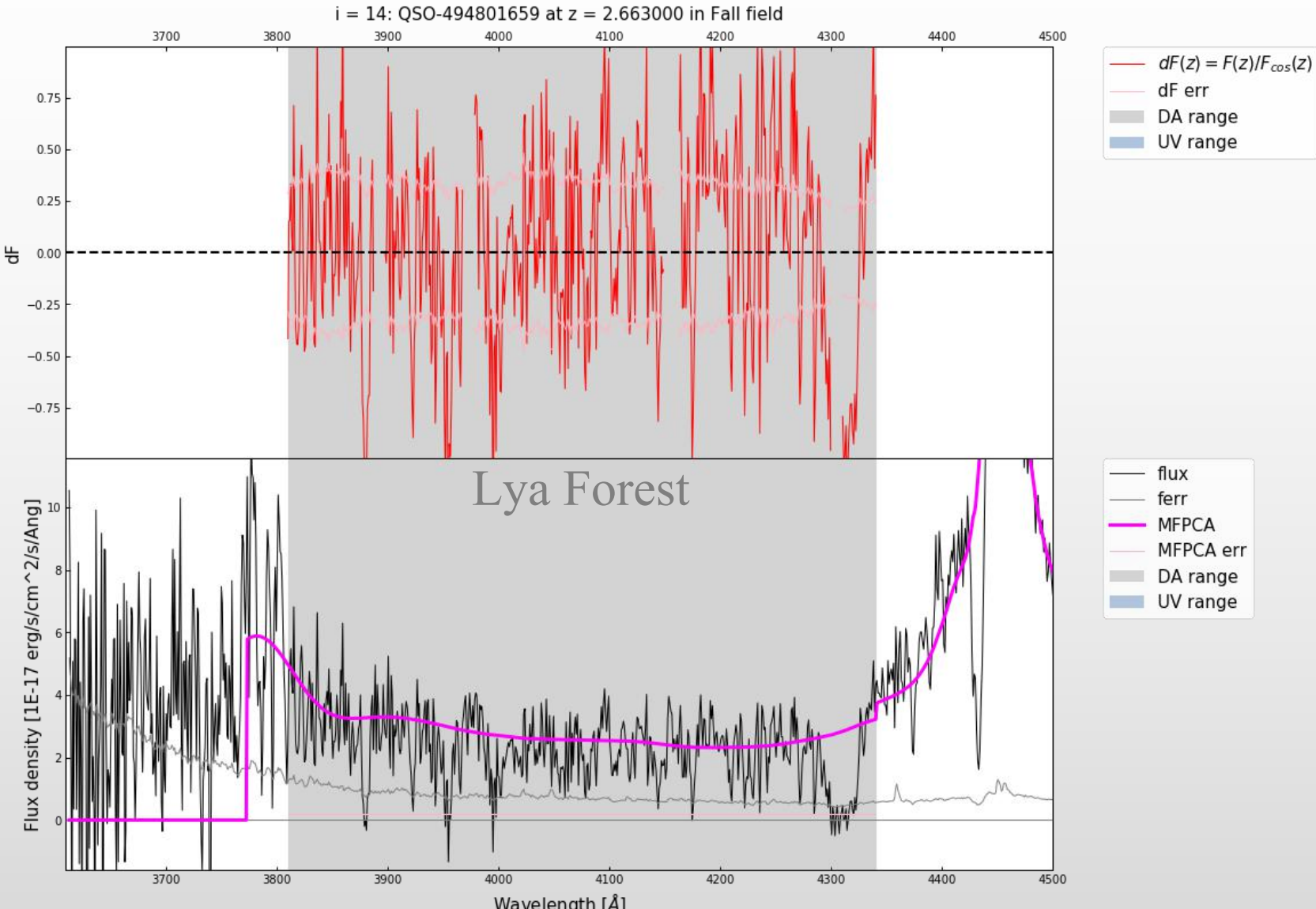
Observed Spectrum

$$\delta_F = \frac{F_{obs}}{F_{cont} \times F_{cos}(z)} - 1$$

Intrinsic Spectrum

Cosmic Average Transmission

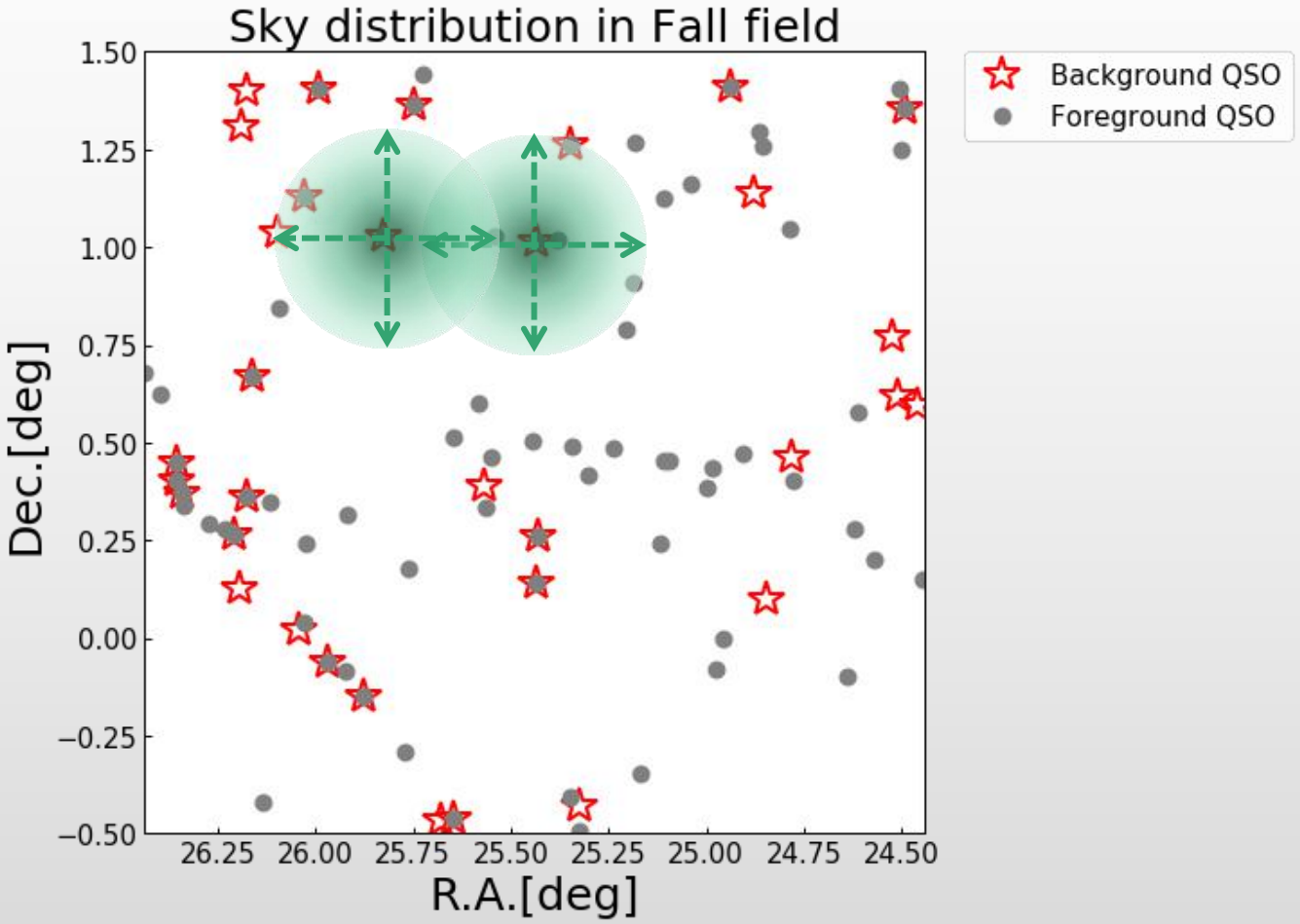




Analysis : Tomography map construction

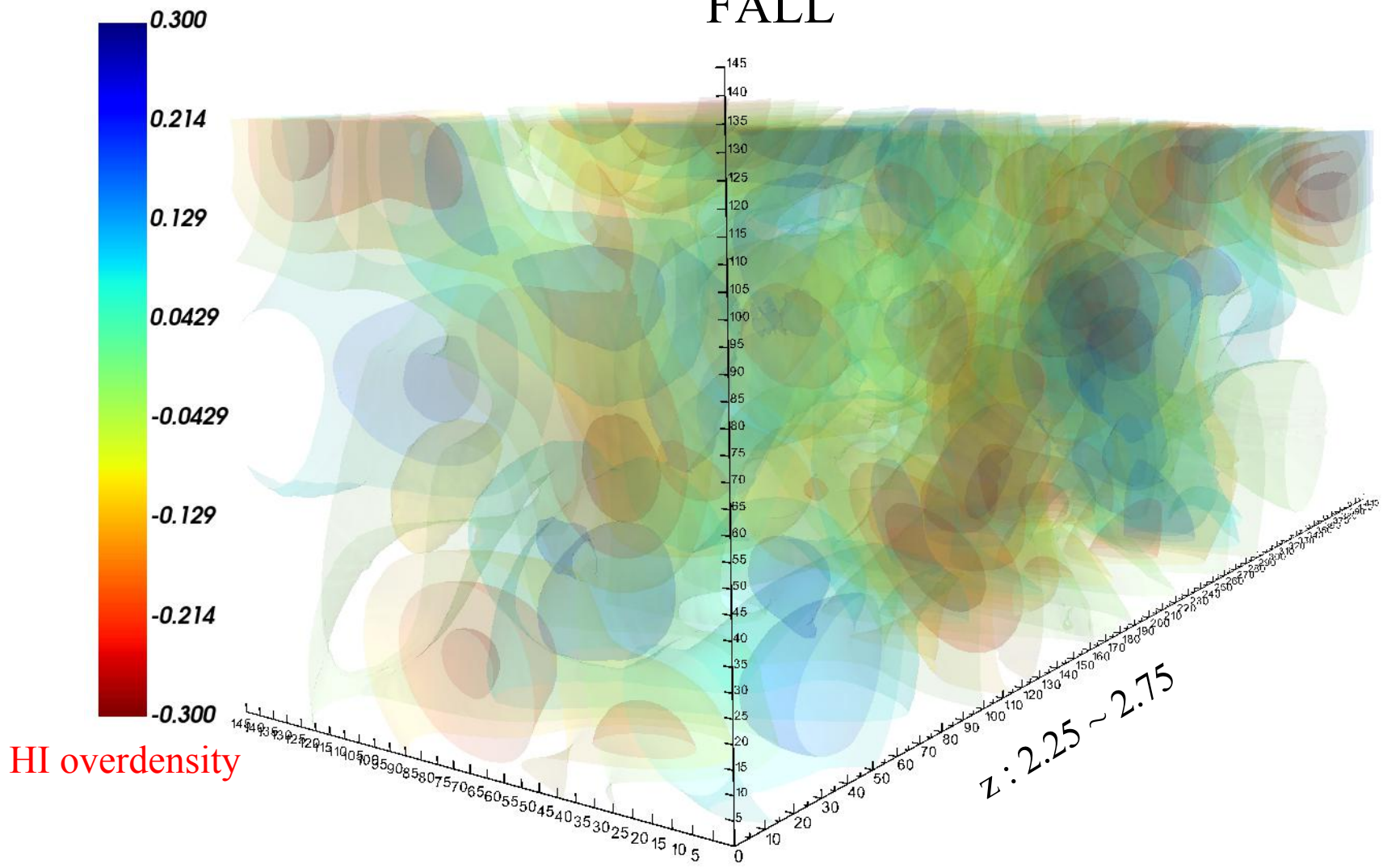
Wiener filtering : A Smoothing technique , Reasonable Estimation in region without background QSO

1. 2D Gaussian Smoothing (RA and Dec ; smoothing scale = 20 h^{-1}Mpc)
2. Weighting factor depends on SN



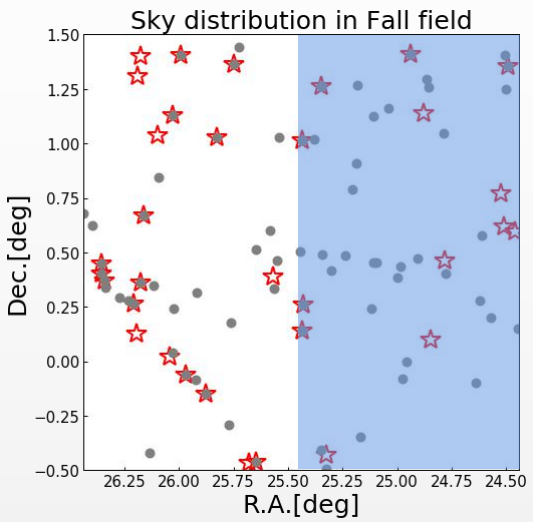
Result : HI Tomography map

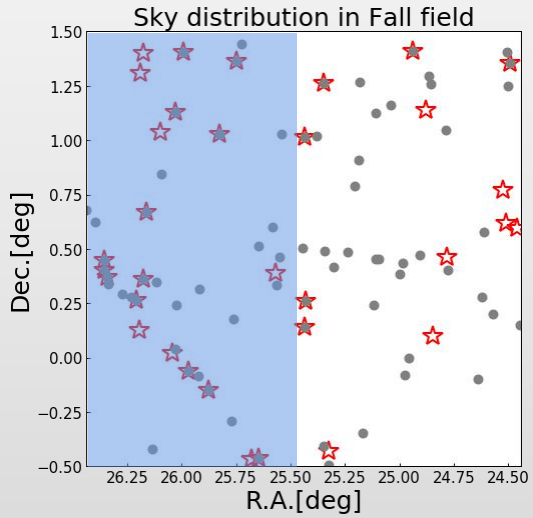
HI underdensity



HI overdensity

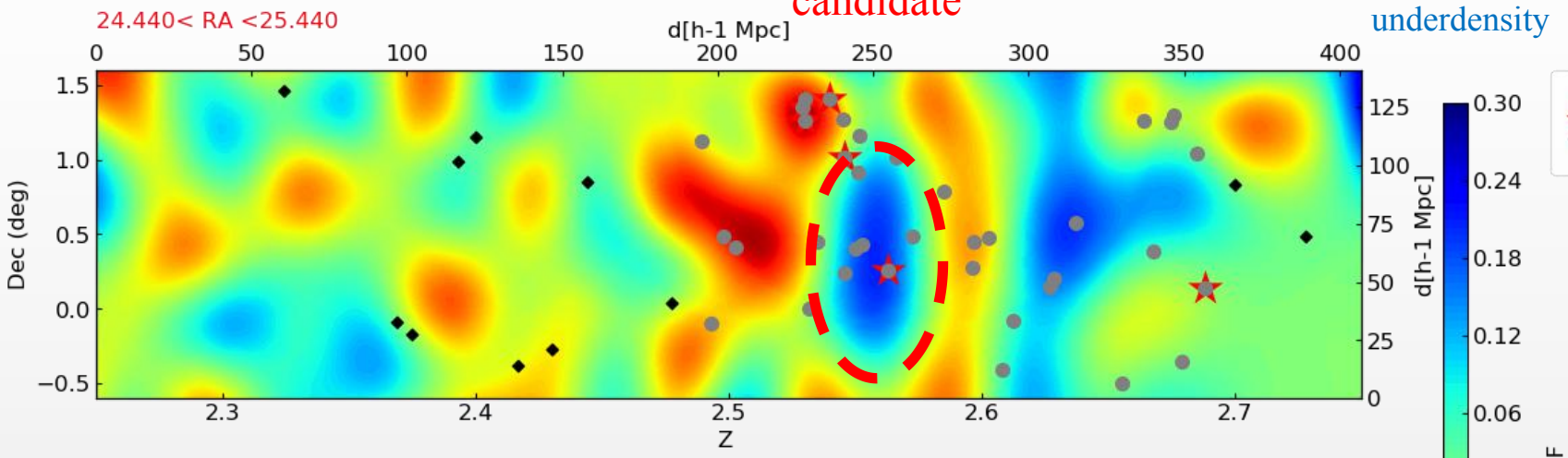
Result : FALL Slice

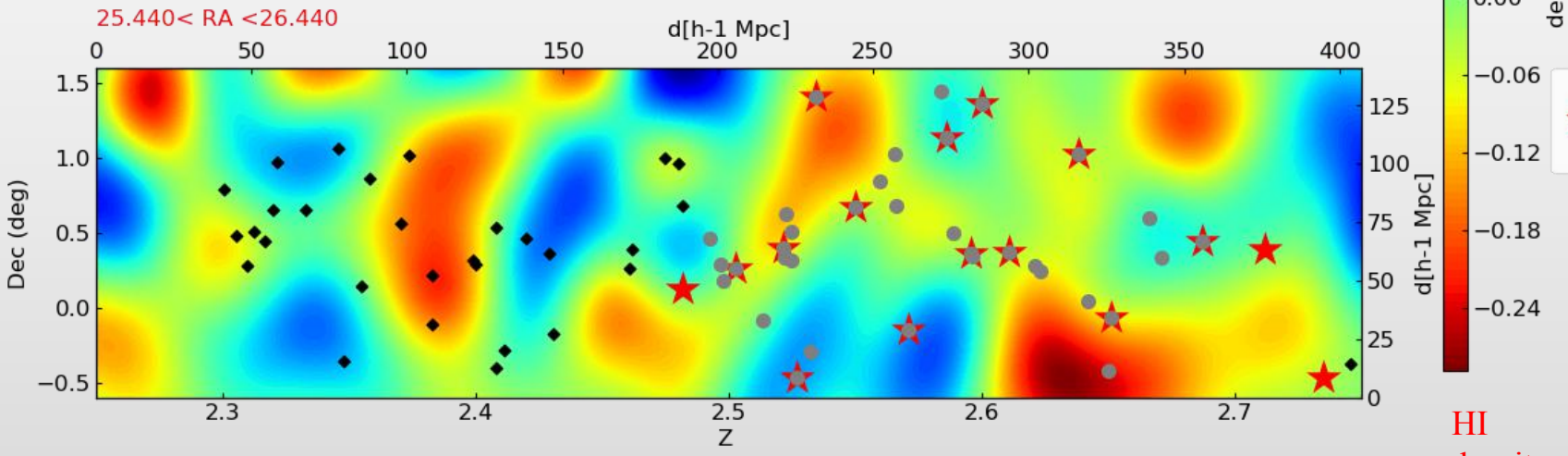




HII Bubble candidate

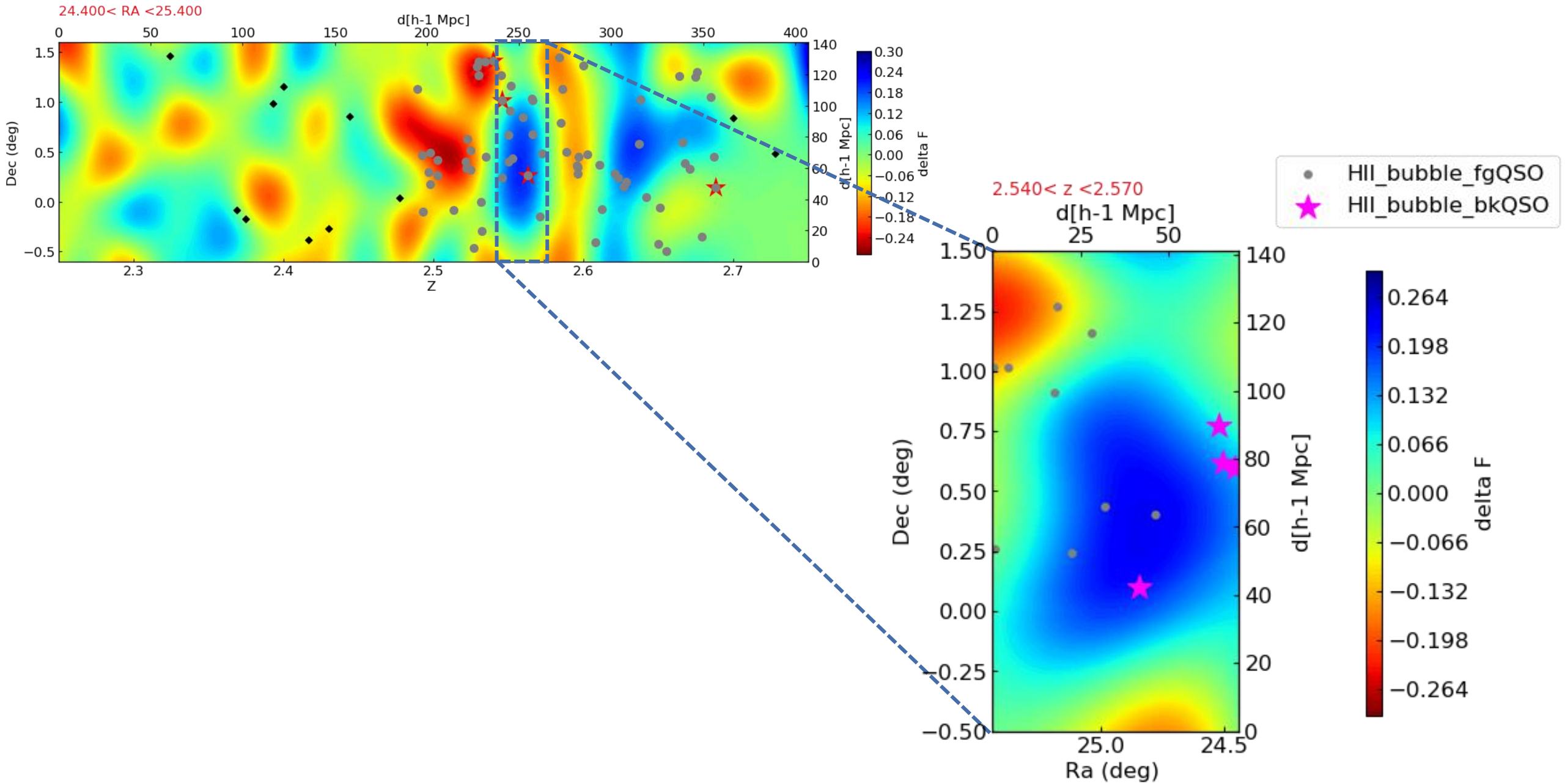
HI underdensity





HI overdensity

Confrimation



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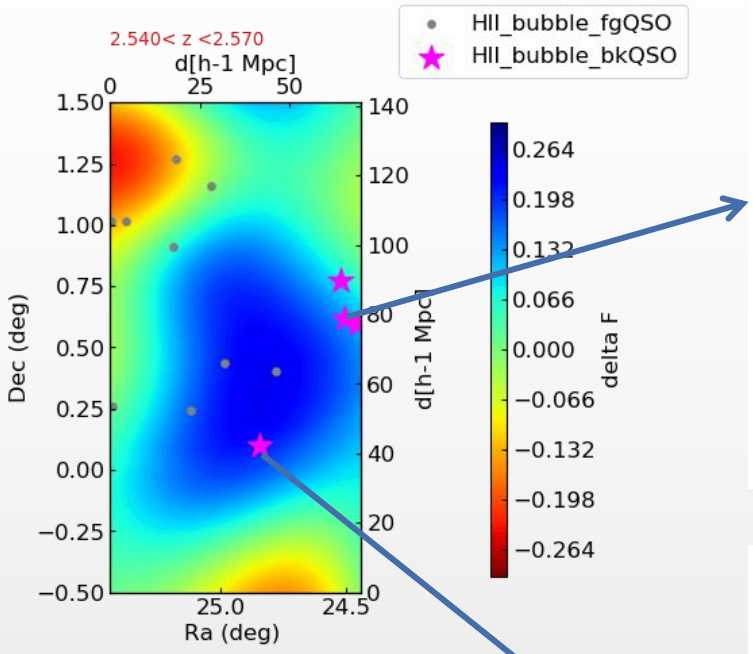

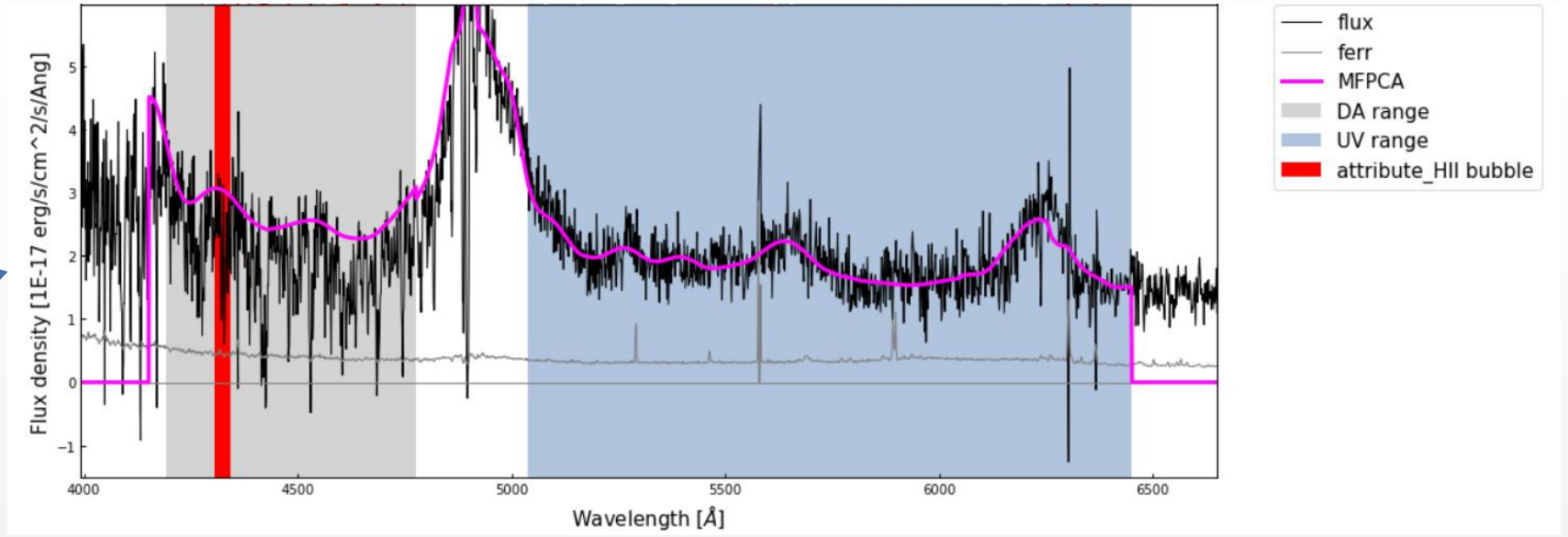

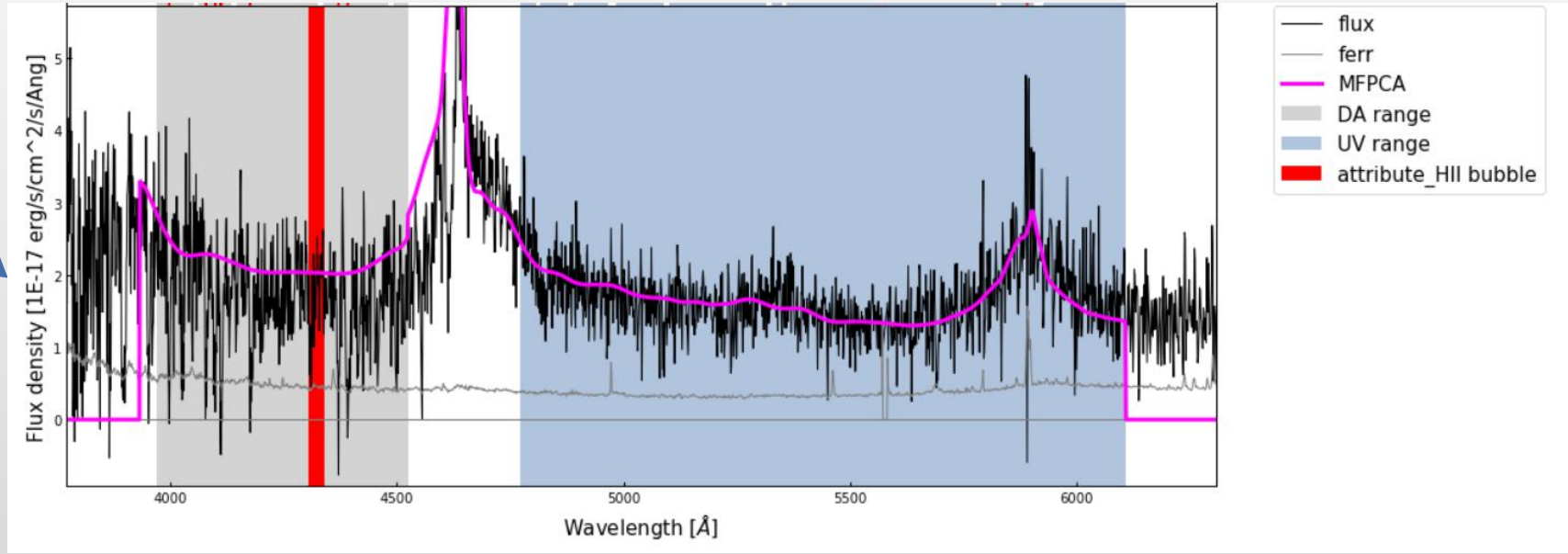

Conclusion

- HII Bubble candidate have been found by using Tomography mapping in QSOs overdensity of FALL field

Future

- Increase Accuracy

  More Sightline

- Confrim Mukae et al. 2020 hypothesis

  More HII Bubble

  LAEs&QSOs overdensity