3D HI Tomography Map of the HETDEX Fall field at $z = 2.0 \sim 3.0$: Connection between IGM HI and QSO&LAE

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Introduction

Trace HI gas :

3D HI Tomography mapping (KG.Lee et al.2014)

Special EGS-QO1 (R ~ 20 h^{-1}Mpc) :

6 QSOs in a void : HII region (Mukae et al. 2020)

Mukae+20 scenario :

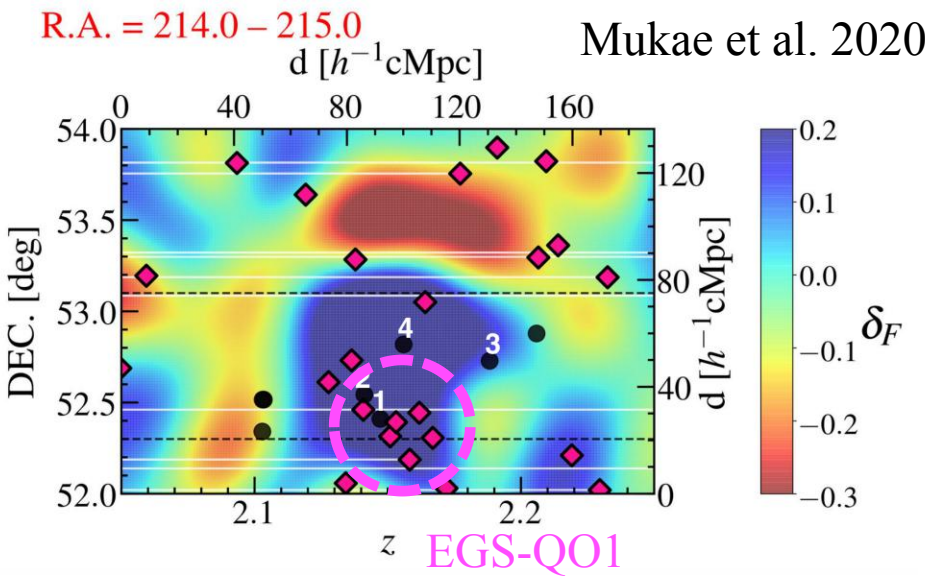
Stage 1 : HI overdensity

Stage 2 : Galaxy overdenstiy

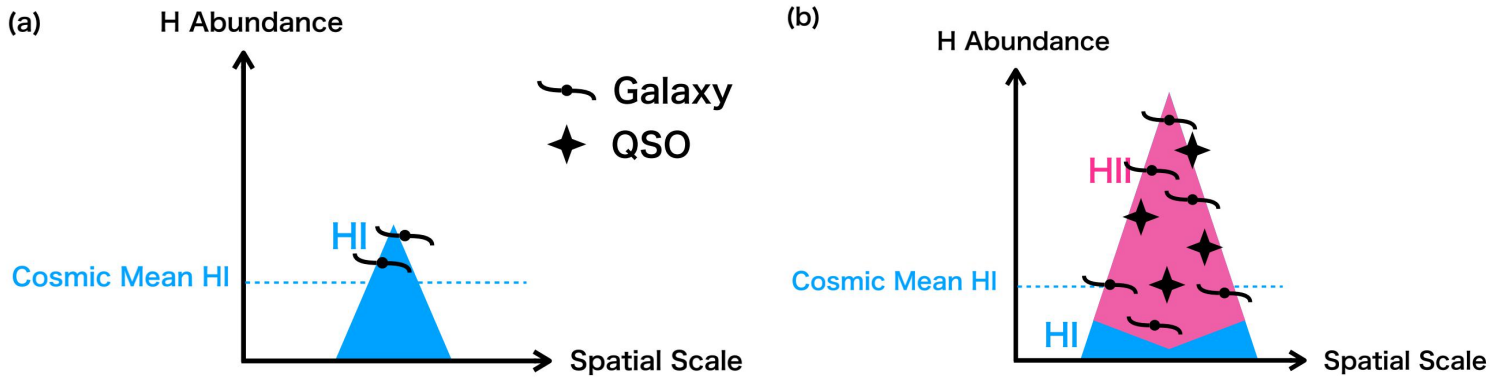
Stage 3 : QSO overdensity

Stage 4 : HII region (EGS-QO1)

This study : To confrim Mukae+20 scenario



Mukae et al. 2020



Mukae et al. 2020

Data

Field : HETDEX Fall

RA [deg] : 6.3 - 36.3, Dec [deg] : - 1.5 ~ 1.8

z = 2.0 - 3.0

LAEs : HETDEX HDR2.1

Blind integral field spectroscopic (IFS) survey

Narrow line LAE : 3436

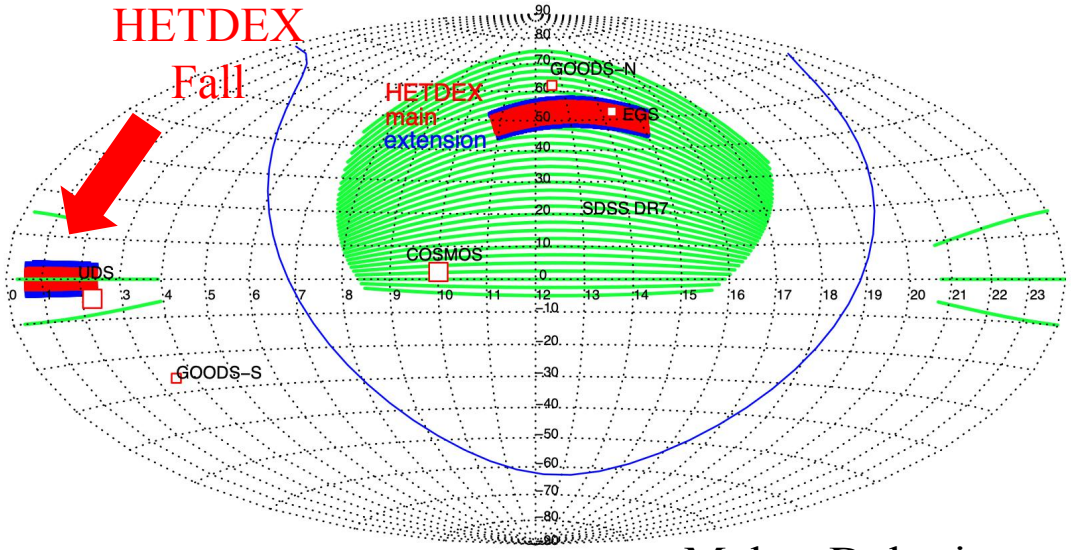
Broad line LAE (Type 1 AGN) : 459

QSOs : SDSS DR14

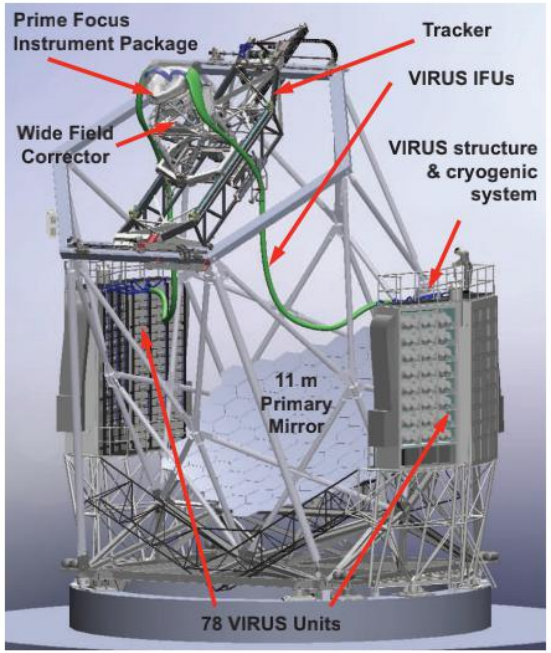
Background QSO spectra : 1706 (z = 2.0 - 3.7)

Foregound QSO : 4158 (Paris+18, Rakshit+20)

Unbias LAEs and QSOs for comparison is rare.



Mukae D thesis

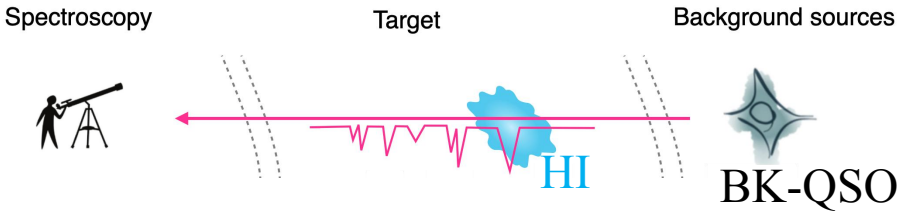


11m HET (Hobby-Eberly Telescope)

3D HI Tomography map construction

Mukae Kashiwa meeting

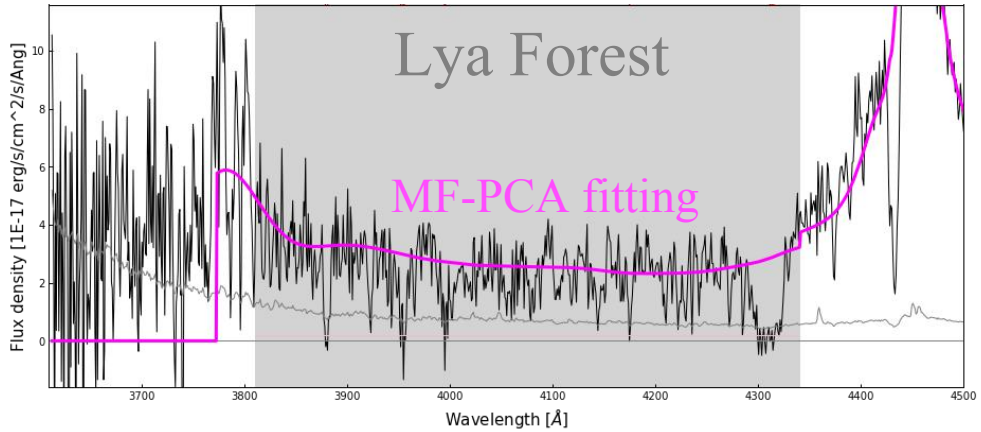
Background sources probe foreground IGM HI : Lya forest



Intrinsic continuum :

MF-PCA (Mean Flux reglation - Principal Component Analysis) fitting

(KG.Lee et al. 2013)



HI overdensity (δ_F) :

Observed absorption

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

Average absorption

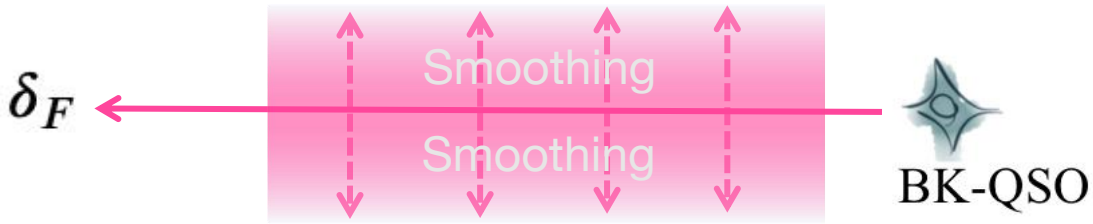
(Faucher-Giguere et al. 2008)

$\delta_F > 0$: Weak HI abs

$\delta_F < 0$: Strong HI abs

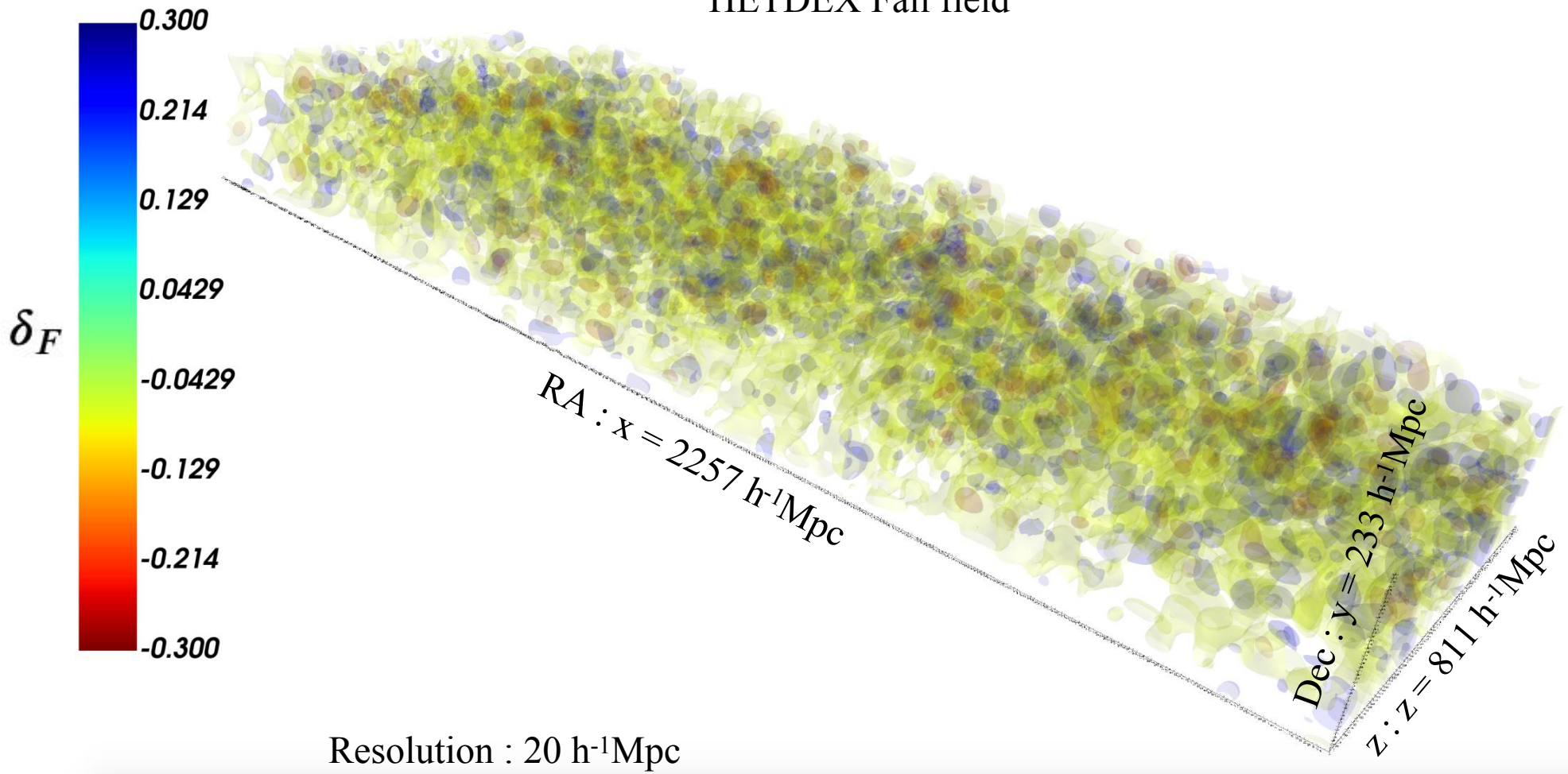
Wiener filtering : 3D gaussian smoothing

Weighting factor



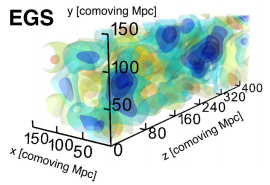
Tomography construction of the HETDEX Fall field

HETDEX Fall field



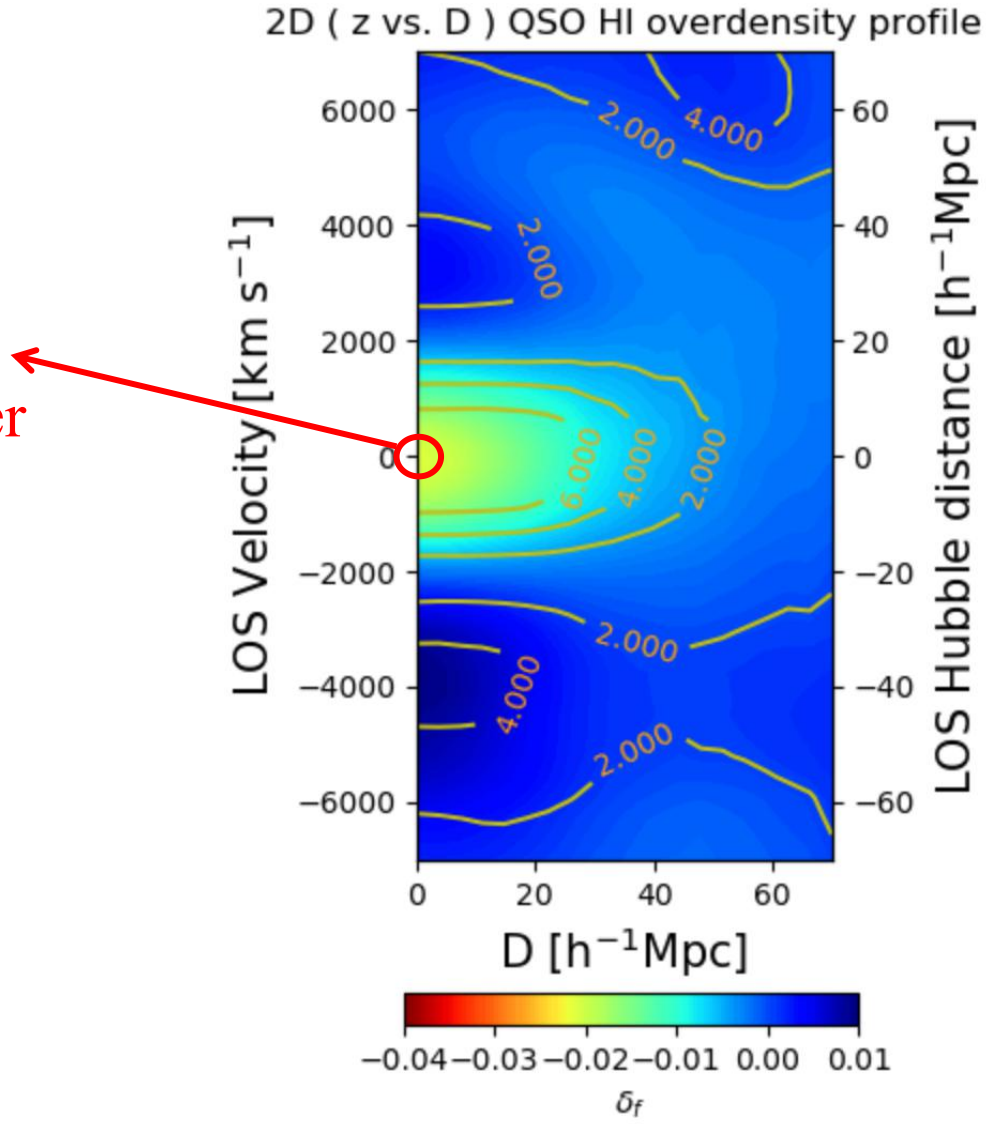
Resolution : 20 h^{-1}Mpc

56 times larger than Mukae+20 EGS HI tomography map



Mukae et al. 2020

QSO HI overdensity profile



Stacking QSO center

Contour : 2σ, 4σ, 6σ signal excess

Agree with Ravoux+20

HI richest at the stacking center

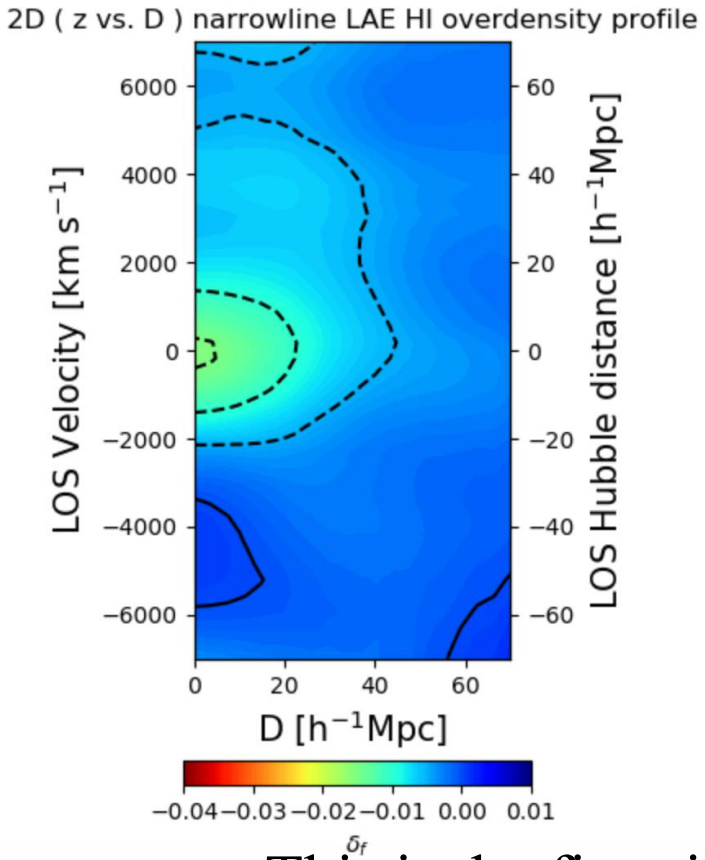
⟶ Good quality

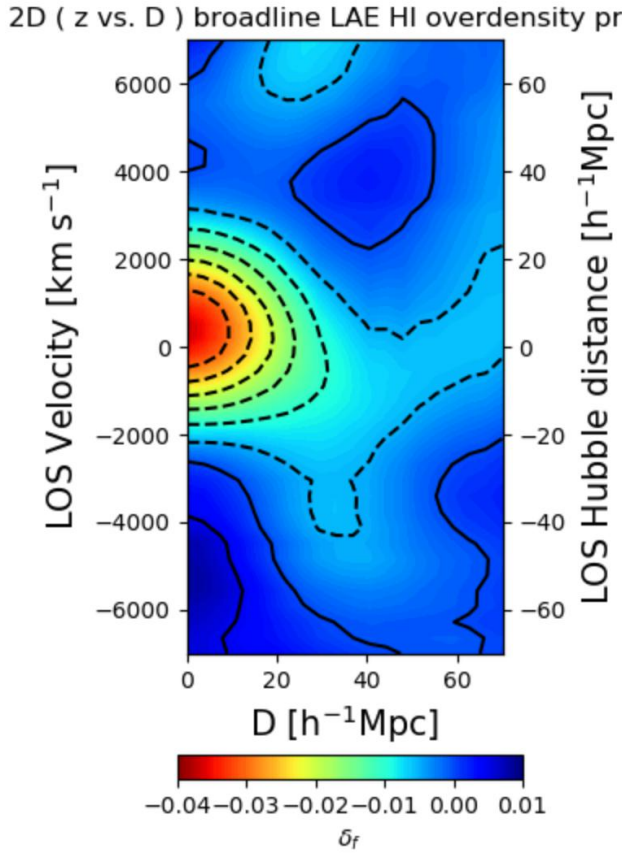
In average, QSO can not fully ionize IGM HI

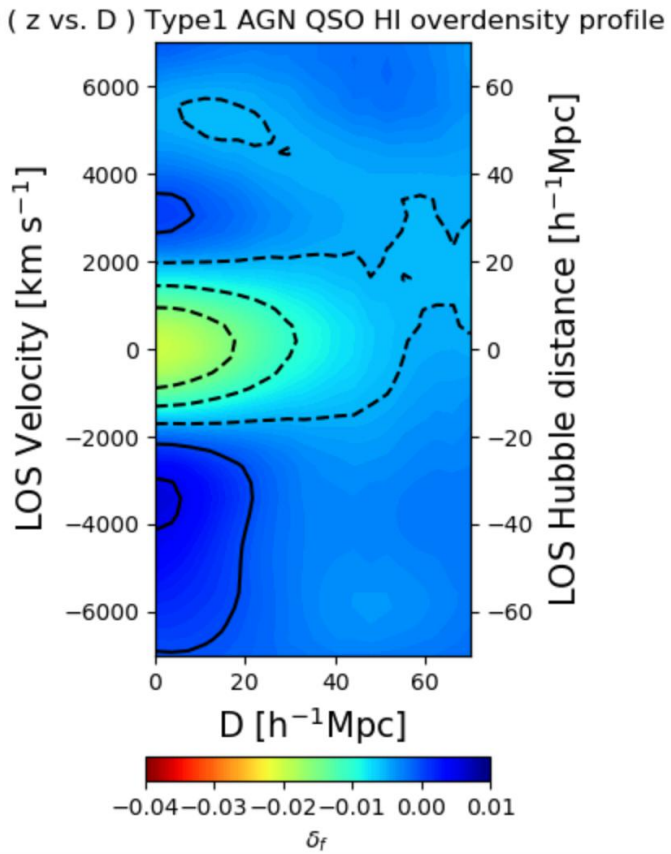
LAE&QSO HI profile

—— : $\delta_F \geq 0$

----- : $\delta_F < 0$







This is the first time that we compare HI profile in the same HI tomography map with such large sample size.

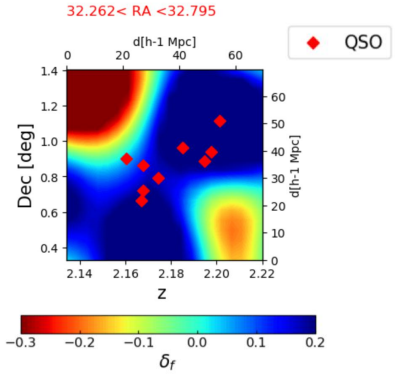
HI gas close to the center is partially ionized

High QSO numberdensity system in the HETDEX Fall field

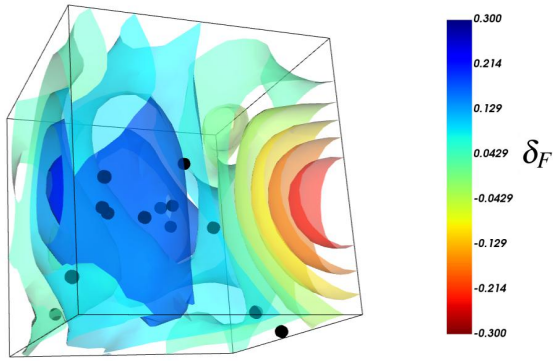
Stage 4 (HII region) : 5 systems, QSO numberdensity close to EGS-QO1

Example 1

2D slice :

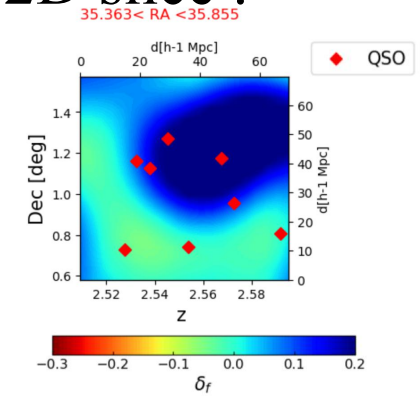


3D snap shot :



Example 2

2D slice :



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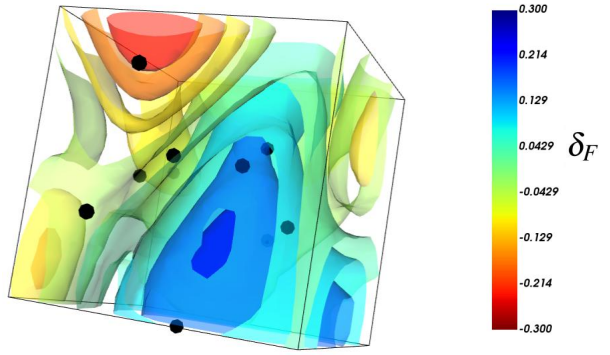
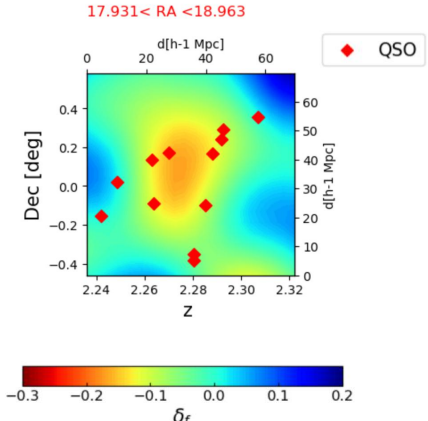


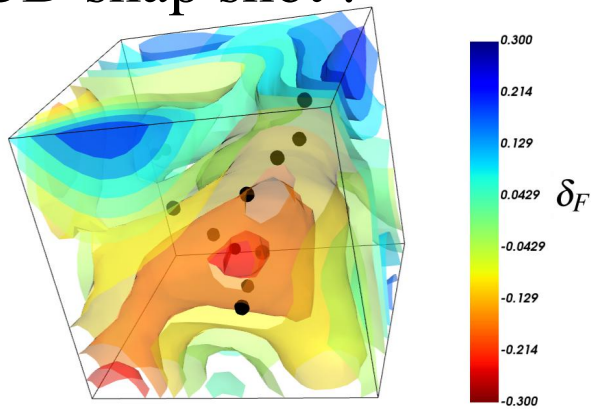
Stage 3 (QSO overdensity) : 7 systems, QSO numberdensity close to EGS-QO1

Example 1

2D slice :

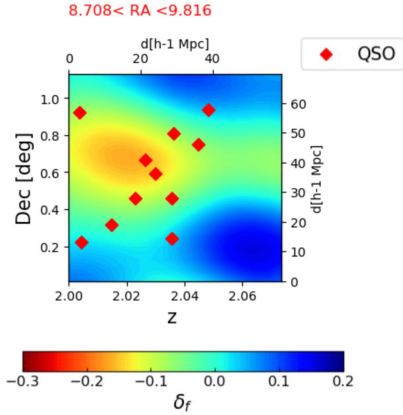


3D snap shot :

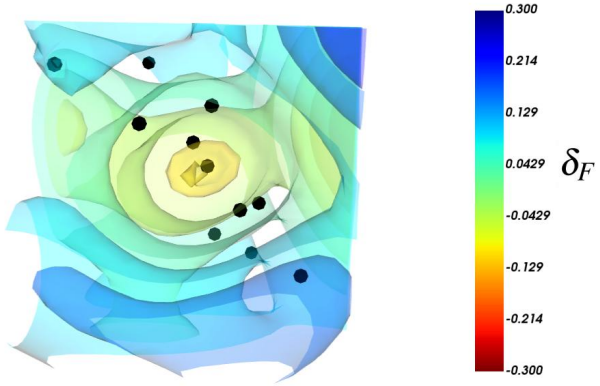


Example 2

2D slice :



3D snap shot :



Summary

- HI tomography map construction of the HETDEX Fall field, area 99 deg^2, $z = 2 - 3$

- HI overdensity profile of QSO
- HI overdensity profile comparison : Narrow line LAE, Broad line LAE (HI rich), Type 1 AGN QSO (Partially ionized)

  Largest sample size of LAEs/QSOs for HI profile

- Identification 5 systems at stage 4 of Mukae+20 scenario, 7 systems at stage 3 in the HETDEX Fall field.

  Mukae+20 scenario may works.