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Z Equal Nine (ZEN): a deep VLT near-IR narrow-band survey for z~9 Lyα emitters

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In collaboration with

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Why z~9 ?

- Most studies so far concentrate on z~6
- Going beyond gradually is hard due to poor sensitivity in the z-band
- detecting only one ZEN object would constrain strongly the re-ionisation epoch (z~6-7 from quasar absorption lines; z~11 from WMAP).
- The extent and surface brightness of ZENs constrain the ionization processes in the high-z universe (AGN, quasars ? Intense star formation ?)
- Caveat: we won't detect anything if the IGM is opaque !


GRUYÈRE

Technical aspects

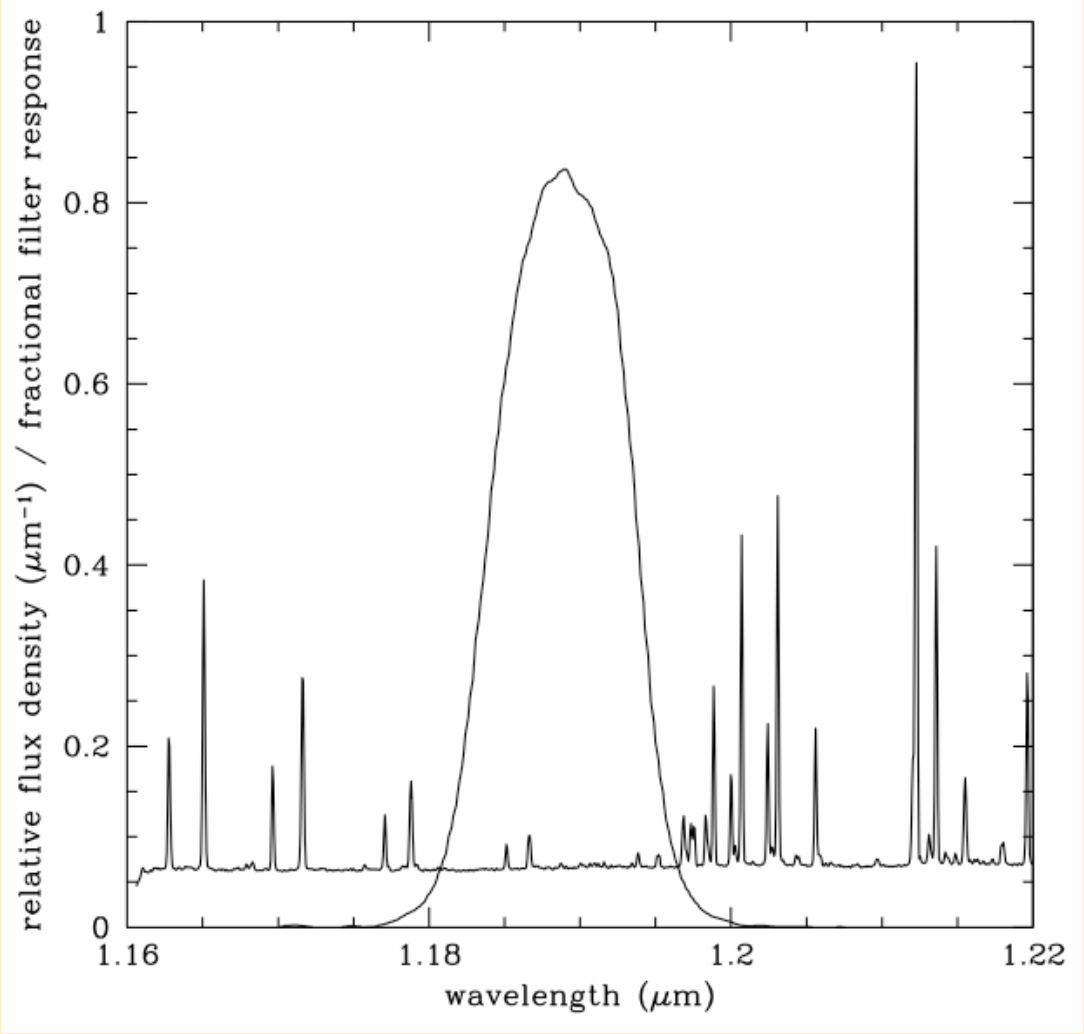
Two **near-IR narrow-band** filters available at the VLT on ISAAC with decent throughput:

1.06 μ (z~7.71)
1.19 μ (z~8.78)

No strong sky lines

Single exposures of 300s

Slightly better sky stability at 1.19 μ



The ZEN1+2 surveys

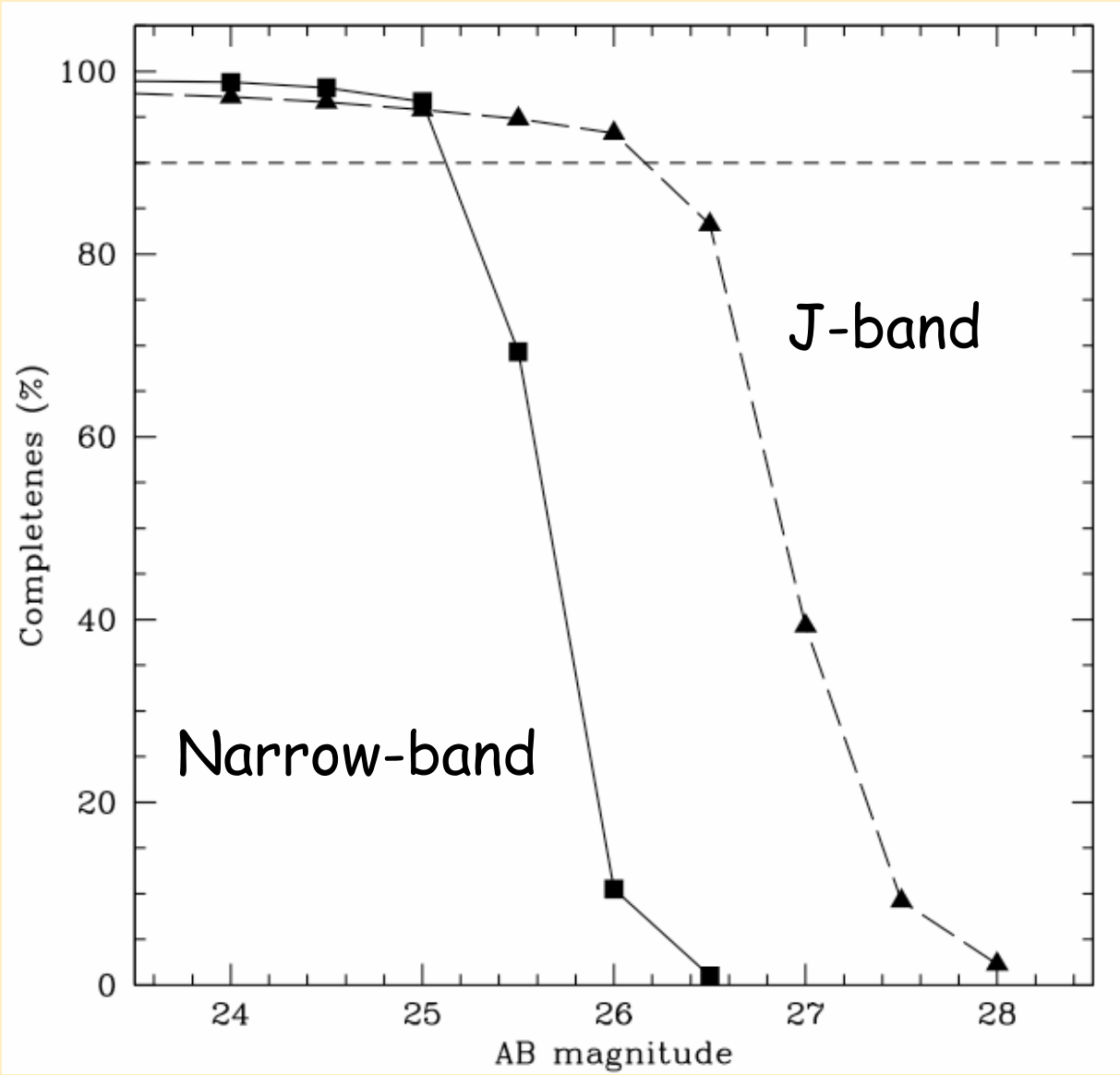
ZEN1
Willis & Courbin, 2005, MNRAS 357, 1348

- Hubble Deep Field South
- 32h requested, 40h on-target
- field of view 6 times smaller than expected
- final seeing 0.47" down to 3.3 x 10^{-18} erg s^{-1} cm^{-2}, AB=25.2 (90%)
- no NB-excess object that is not detected in the optical

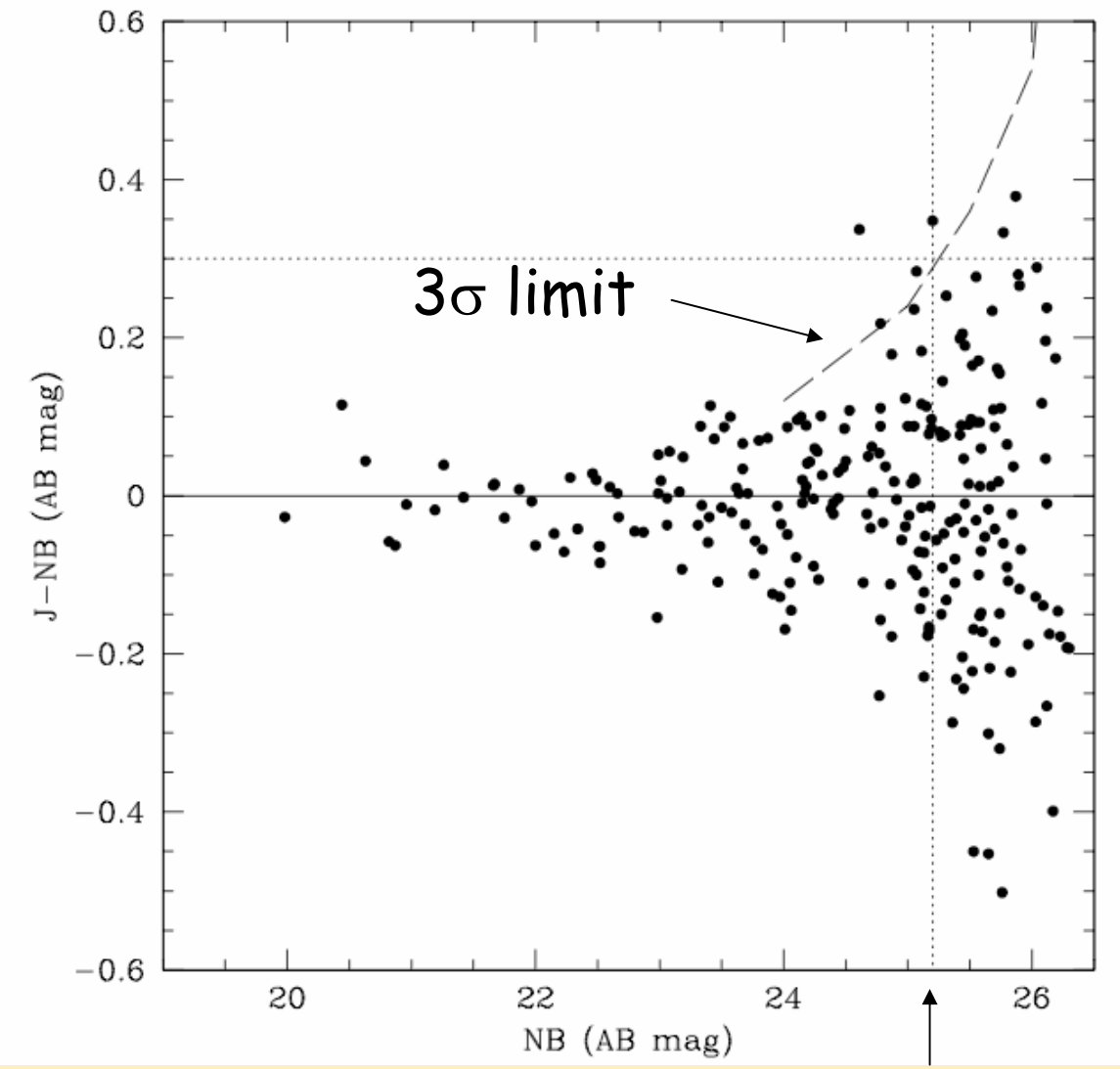
ZEN2
Willis, Courbin, Kneib, Minniti, 2008 MNRAS 384, 1039

- target lensed fields
- optimize the field-of-view vs. depth trade-off
- select galaxy clusters with public deep optical data
- still no ZEN detection but set useful flux limit

ZEN1 selection: completeness plot

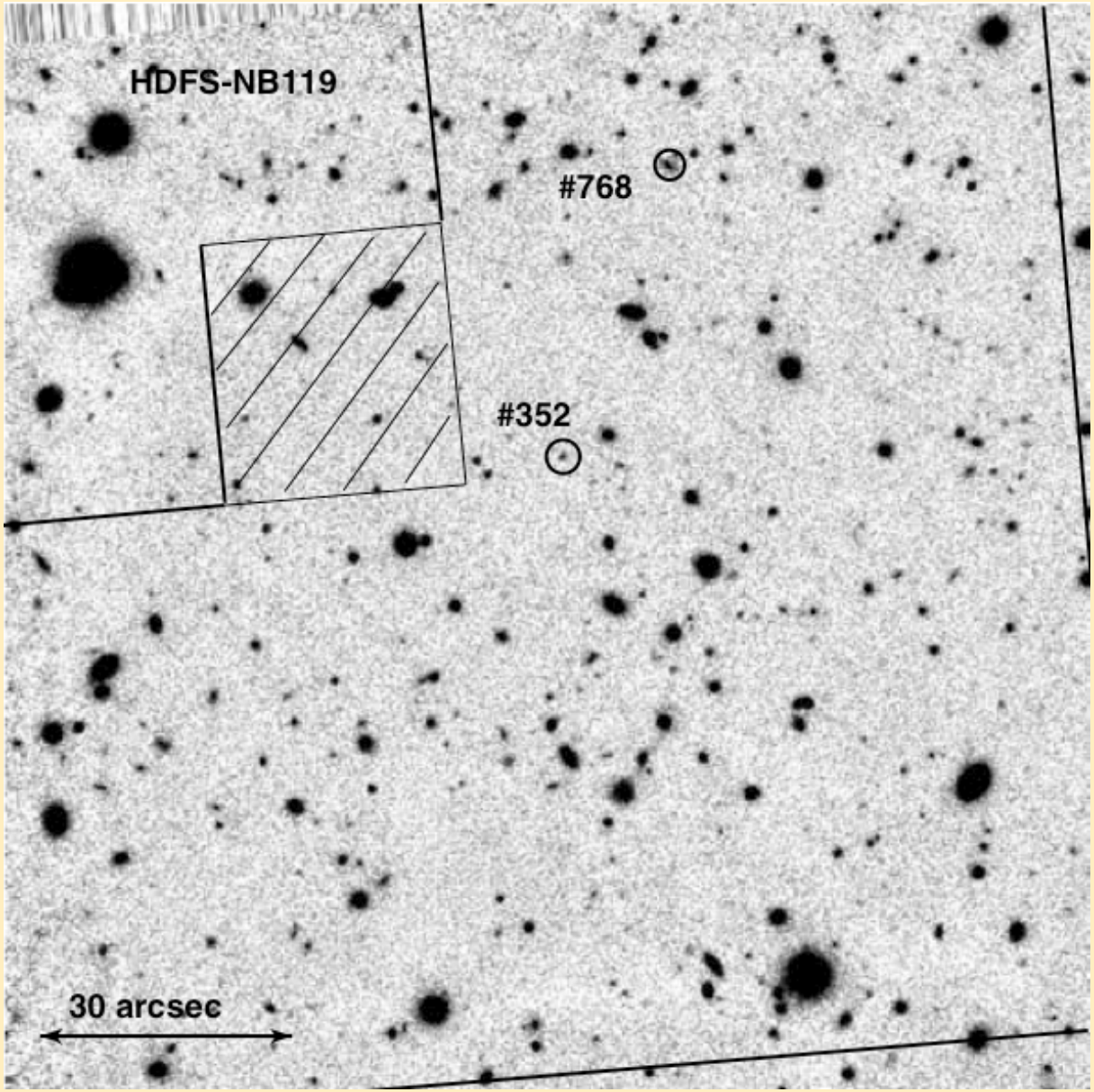


ZEN selection: colour criteria

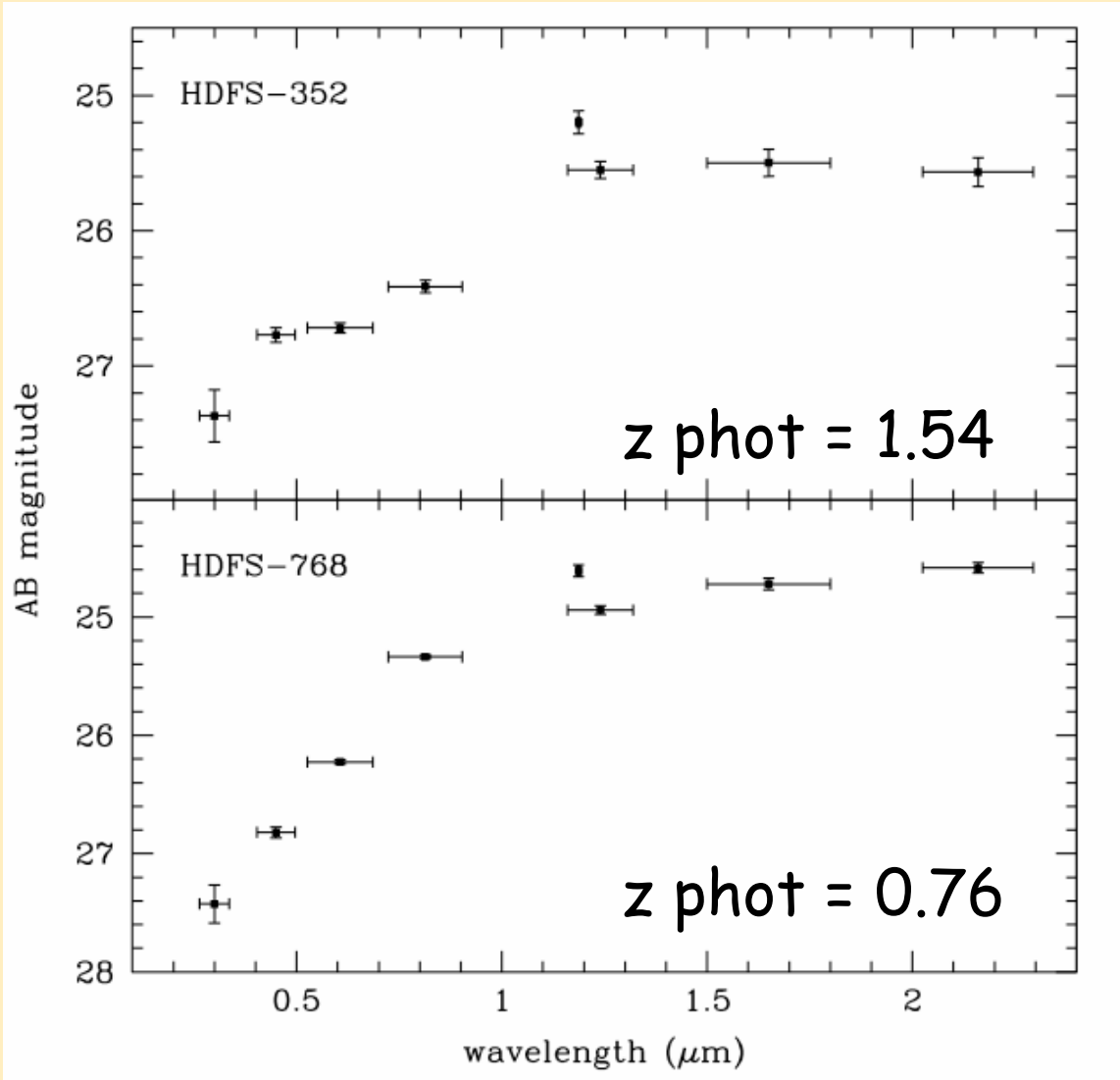


90% completeness NB mag (25.2)

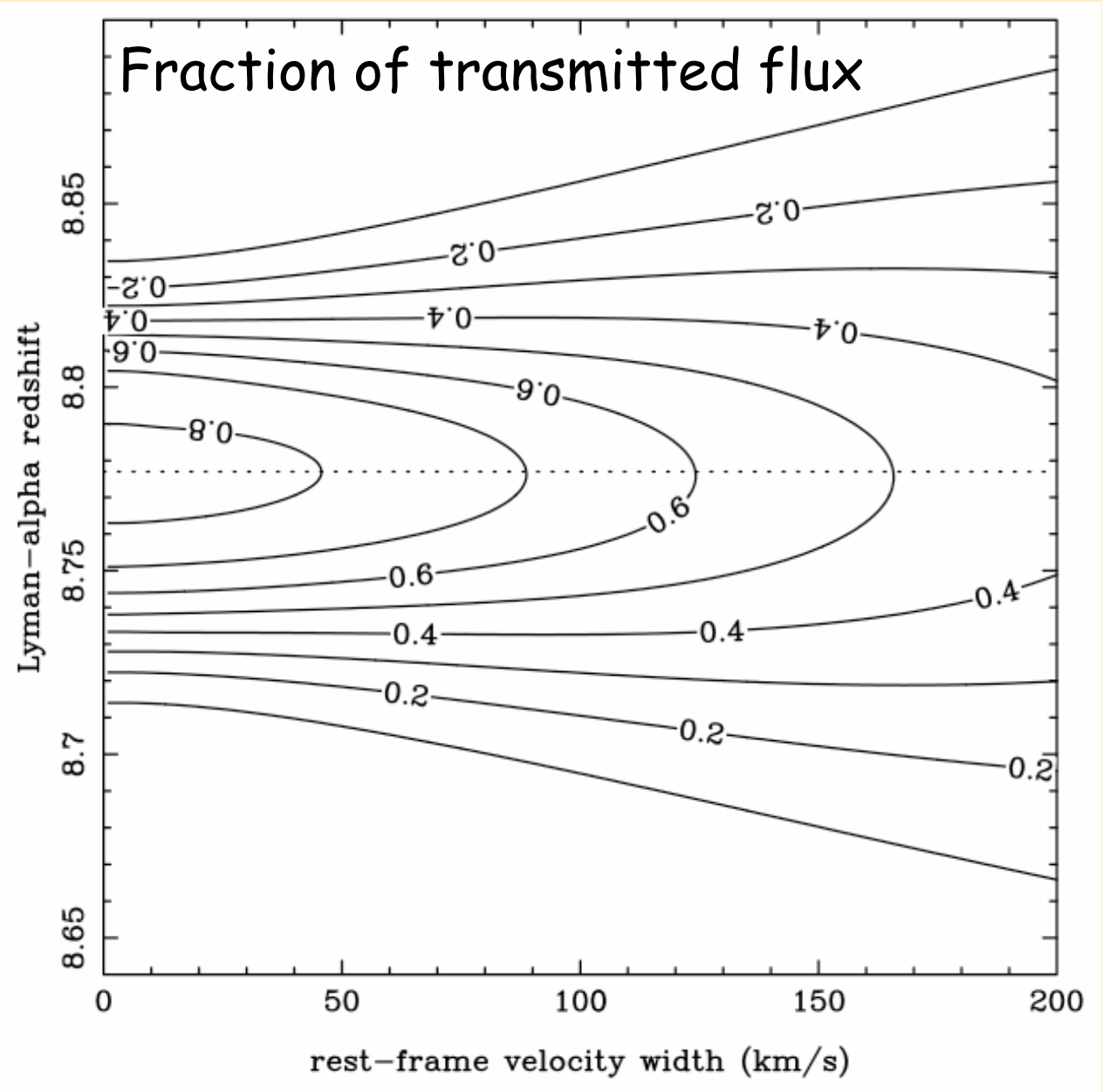
The ZEN1 field (HDFS)



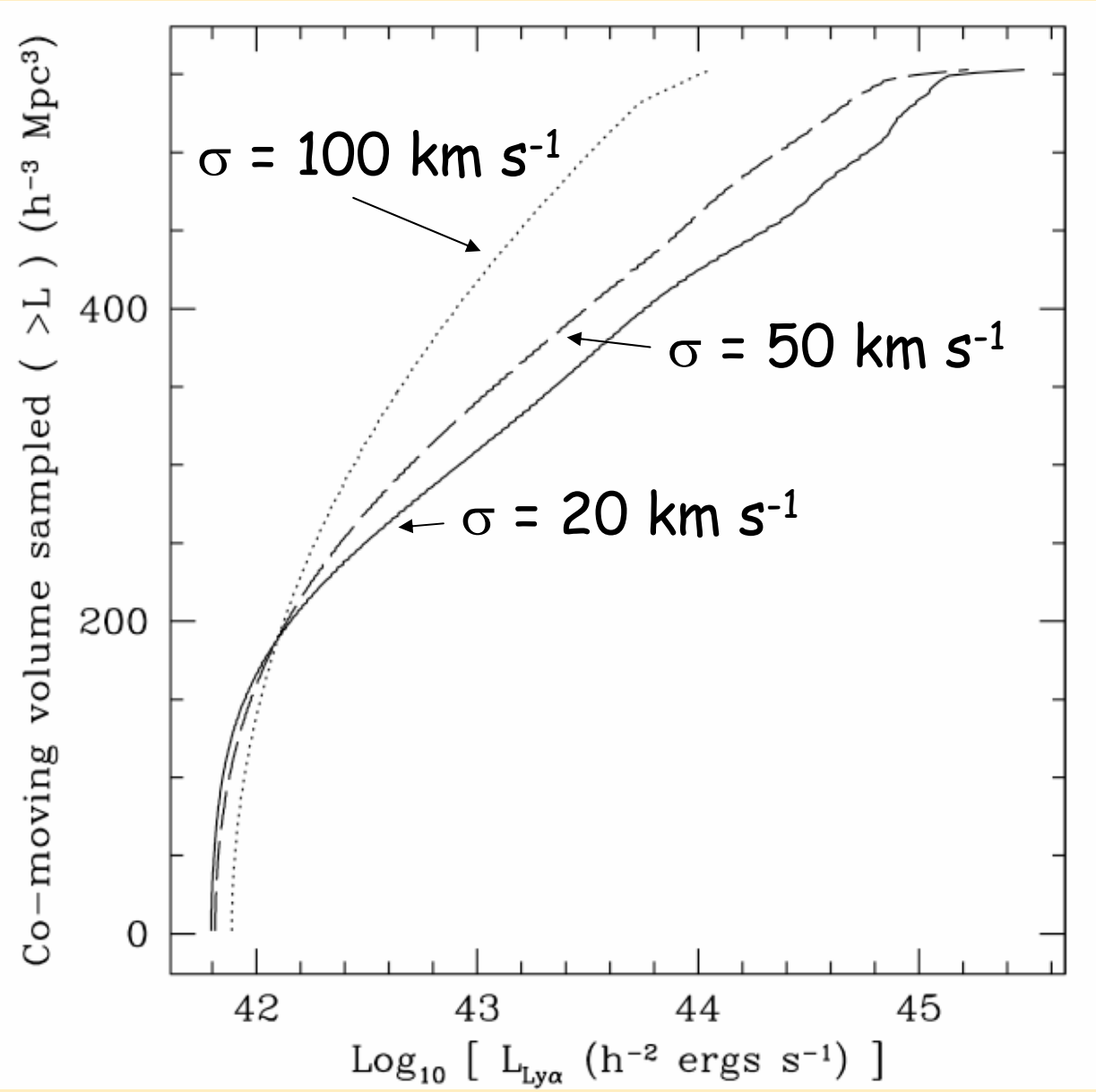
The ZEN1 field: two interlopers



The ZEN1 selection function



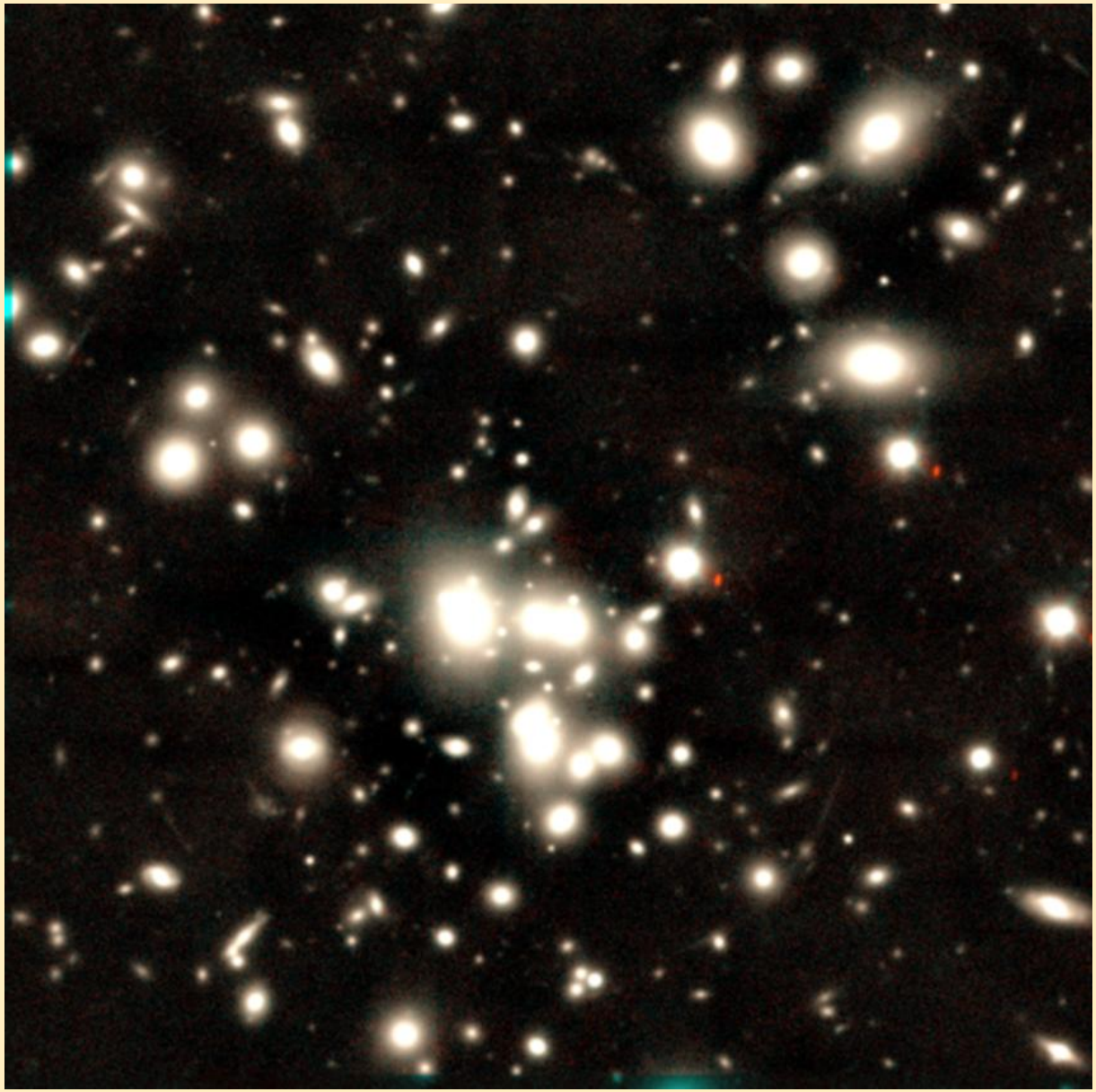
Resulting volume sampled by ZEN1



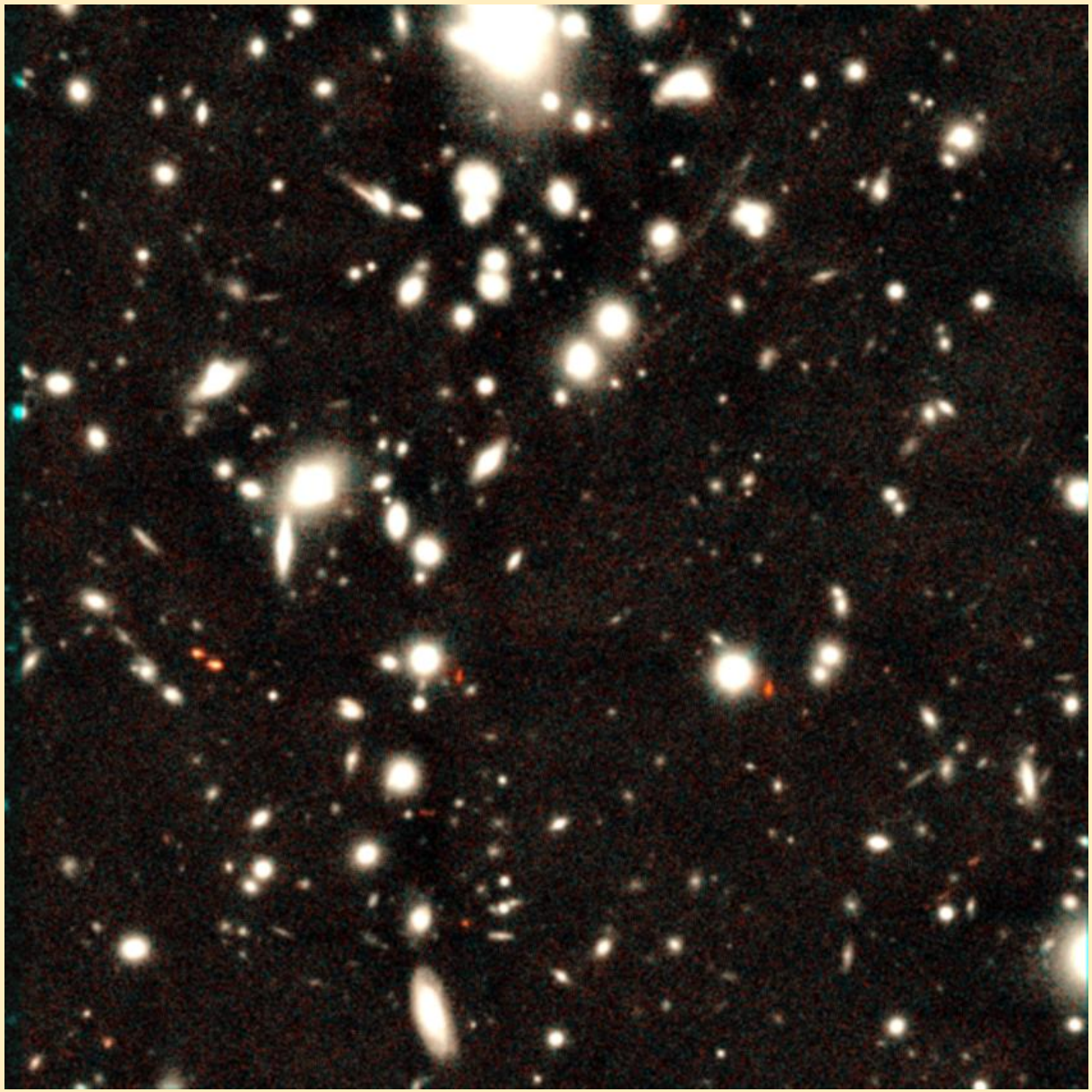
ZEN1 results

- Volume sampled is 340 Mpc^{-3}
- Scaling the surface density of z=5.7 objects (Hu et al. 2004), and assuming no evolution, then the probability to find a ZEN object is 0.12
- Volume is an issue rather than depth
- ZEN2 aims at observing larger volumes
- Three clusters: AC114, A1835, A1689

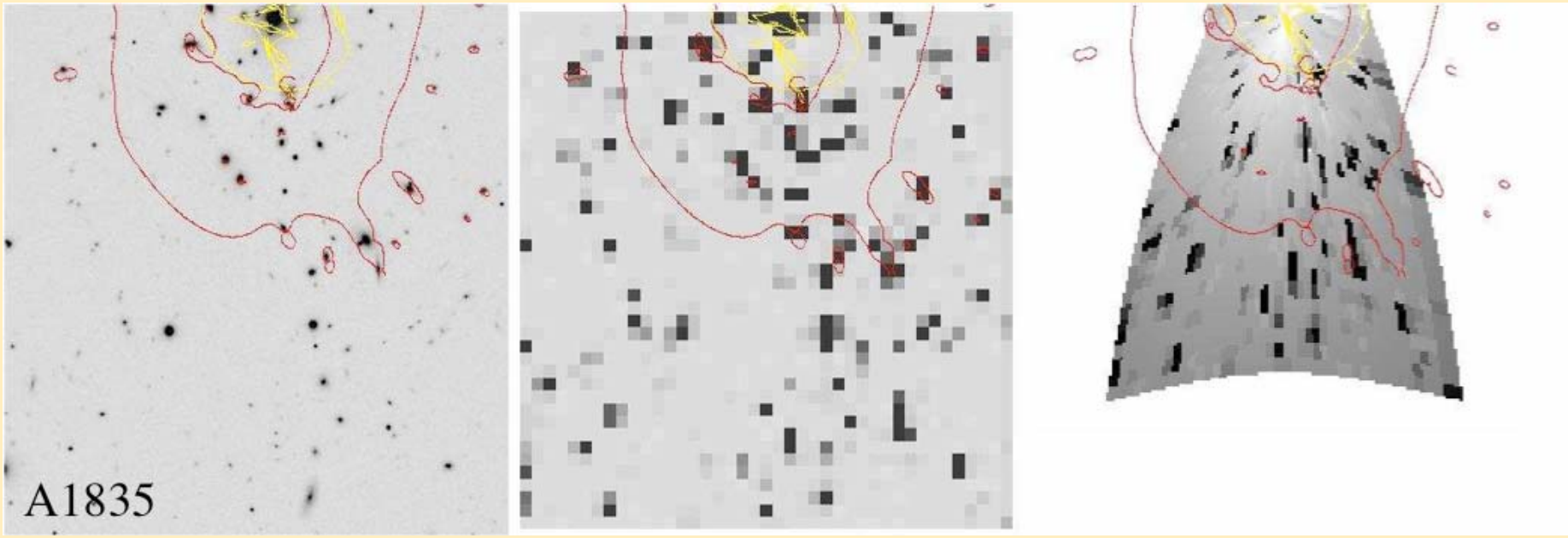
A1689 (z=0.18)



A1835 (z=0.25)



Volume sampled by ZEN2



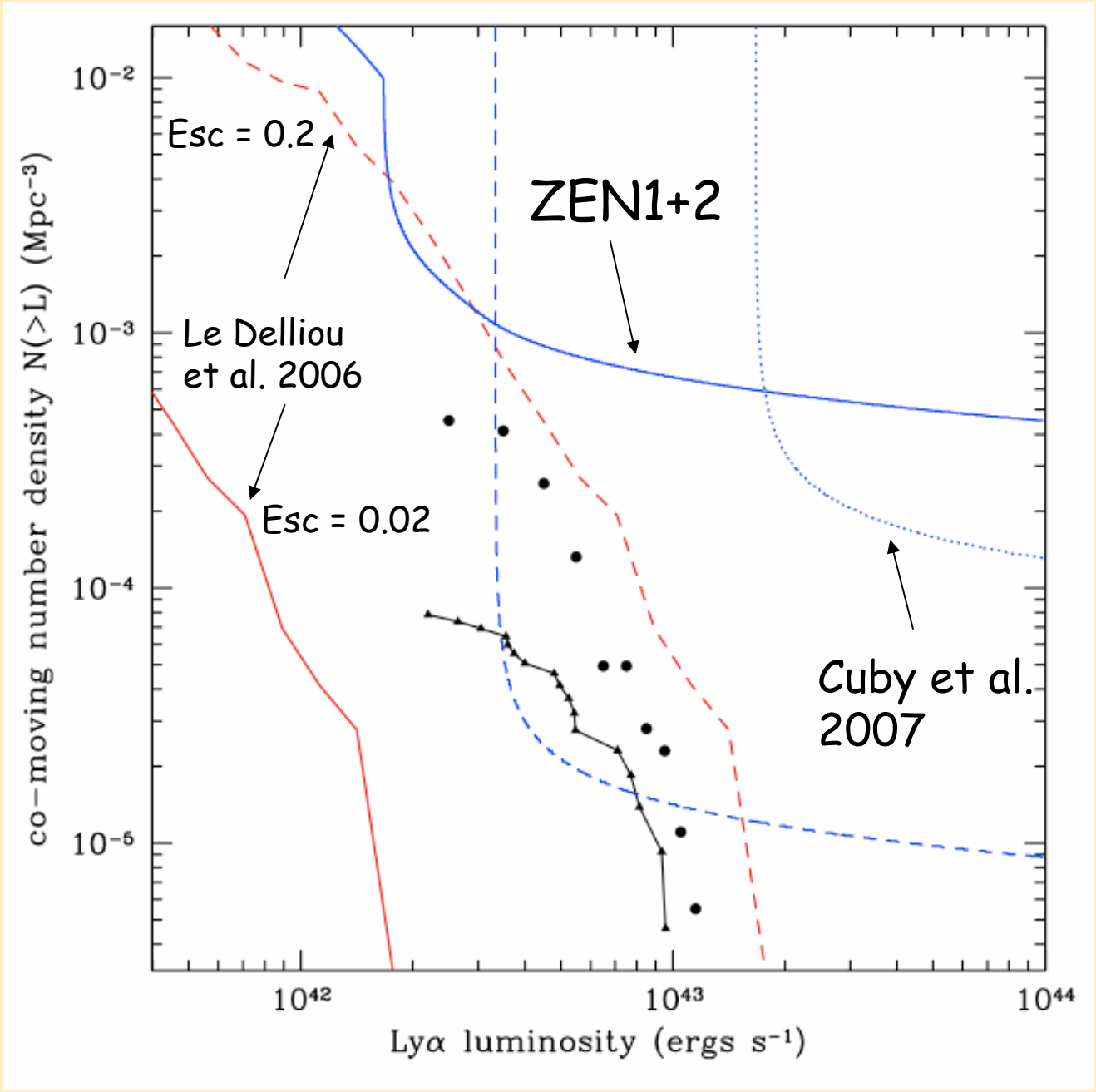
Original field

Completeness map

Completeness map + lensing

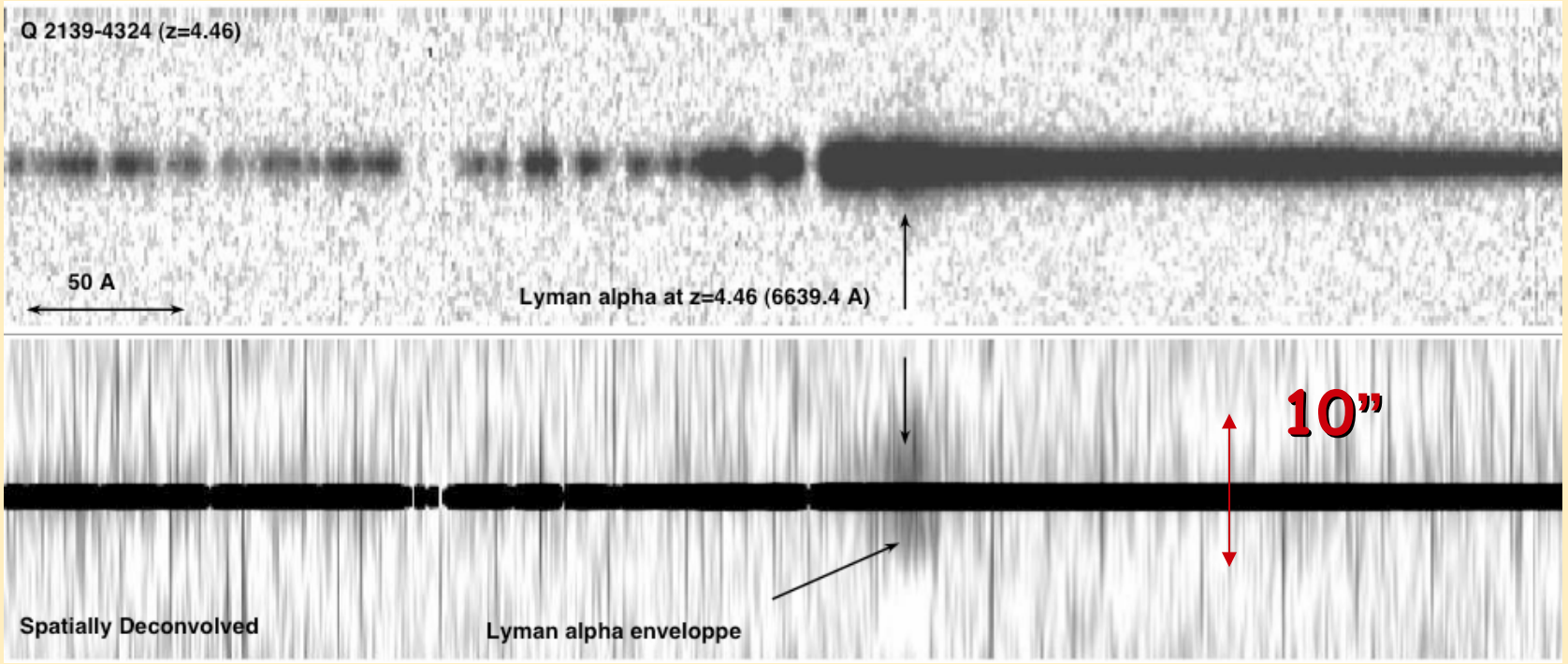
Final volume sampled 1360 Mpc^{-3}, down to 3.8×10^{-18} erg s^{-1} cm^{-2}

Combined ZEN1+2 volume



Black dots: z=6.6 objects (Kashikawa et al. 2006)

We miss all ZENs: is size an issue ?



ZENs might be more extended than expected, e.g., as quasar Lyα envelopes

Courbin et al. Astro-ph/0803.2519.
See also Poster by North et al.

Summary

- Deep VLT search for Lyα at z~9
- ZEN1 samples 340 Mpc^{-3} in a blank field
- ZEN2 samples 1360 Mpc^{-3} in 3 lensed fields
- No ZEN detection
- Importance of optical bands
- Volume sampled so far rules out large escape fractions
- But beware of surface brightness that might be lower than expected
- ZEN3 started at the VLT as an ESO large program (PI: Cuby)