

# News from the mm-horizon

A COSMOS view on massive structure/galaxy formation in the early Universe



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with P. Capak, V. Smolcic, S. Toft, E. Schinnerer, J. Staguhn,  
F. Bertoldi & many more from the COSMOS collaboration



Durham  
University

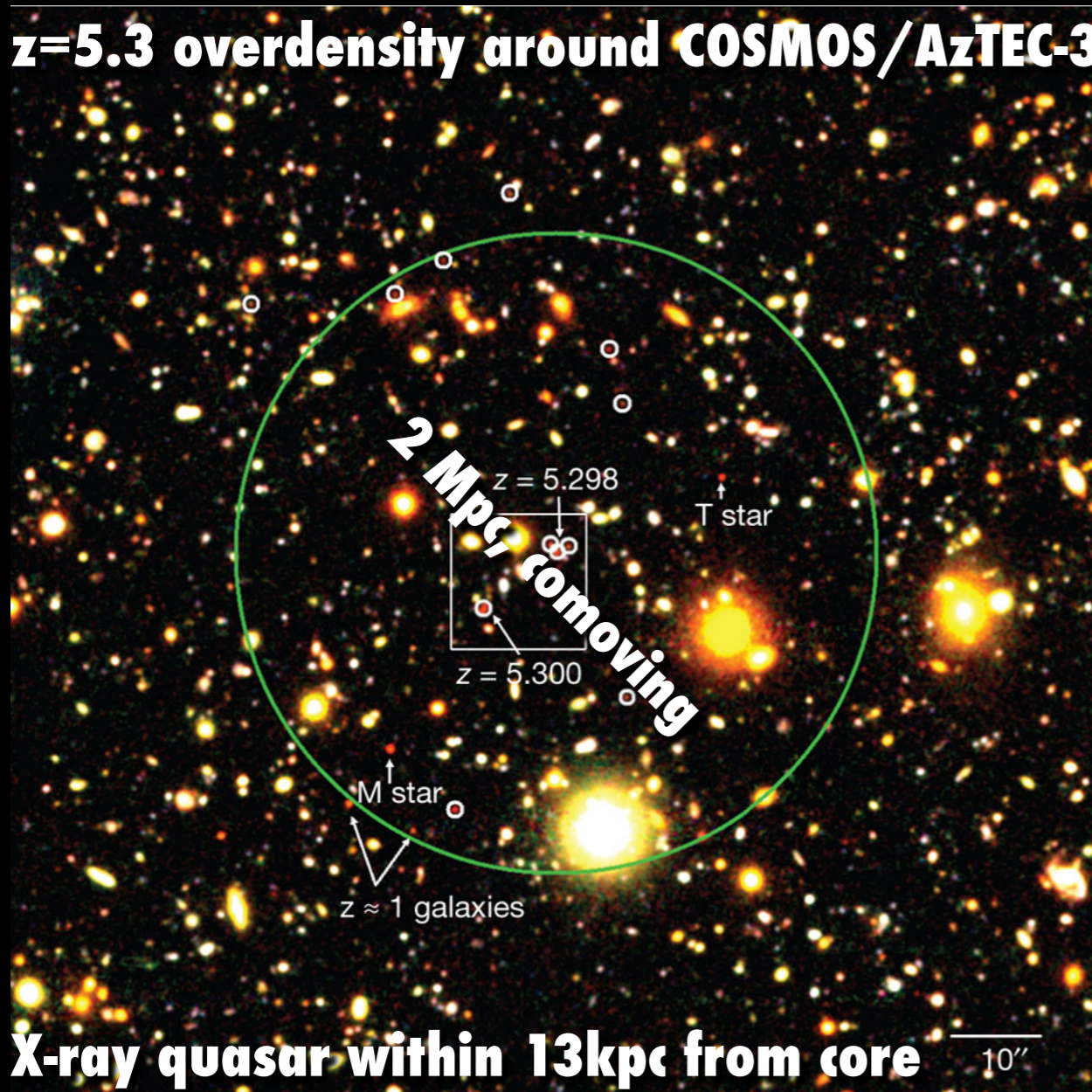
universität **bonn**



# Forming structures within the first 1.5Gyr

- ▶ Extreme starbursts as beacons of structure formation (high-z tail of sub-mm galaxies?)
- ▶ Large & deep (X-ray-radio) survey needed to catch up to 10Mpc (comoving) early overdensities

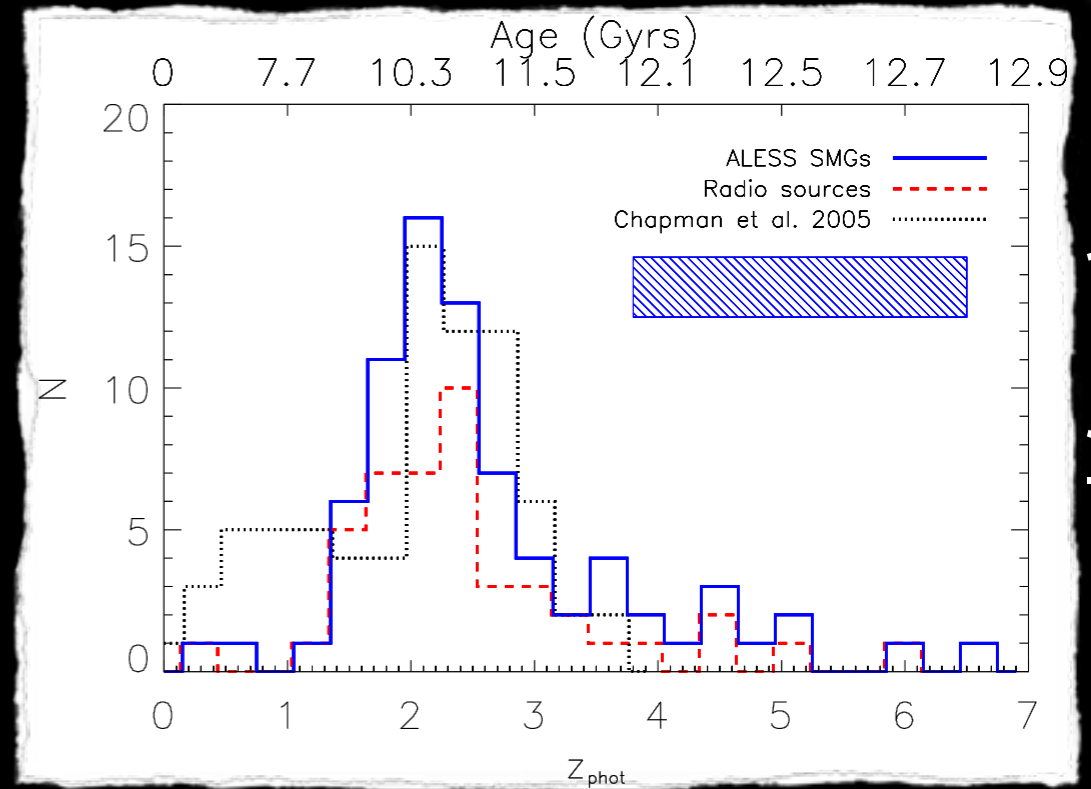
**$z=5.3$  overdensity around COSMOS/AzTEC-3**



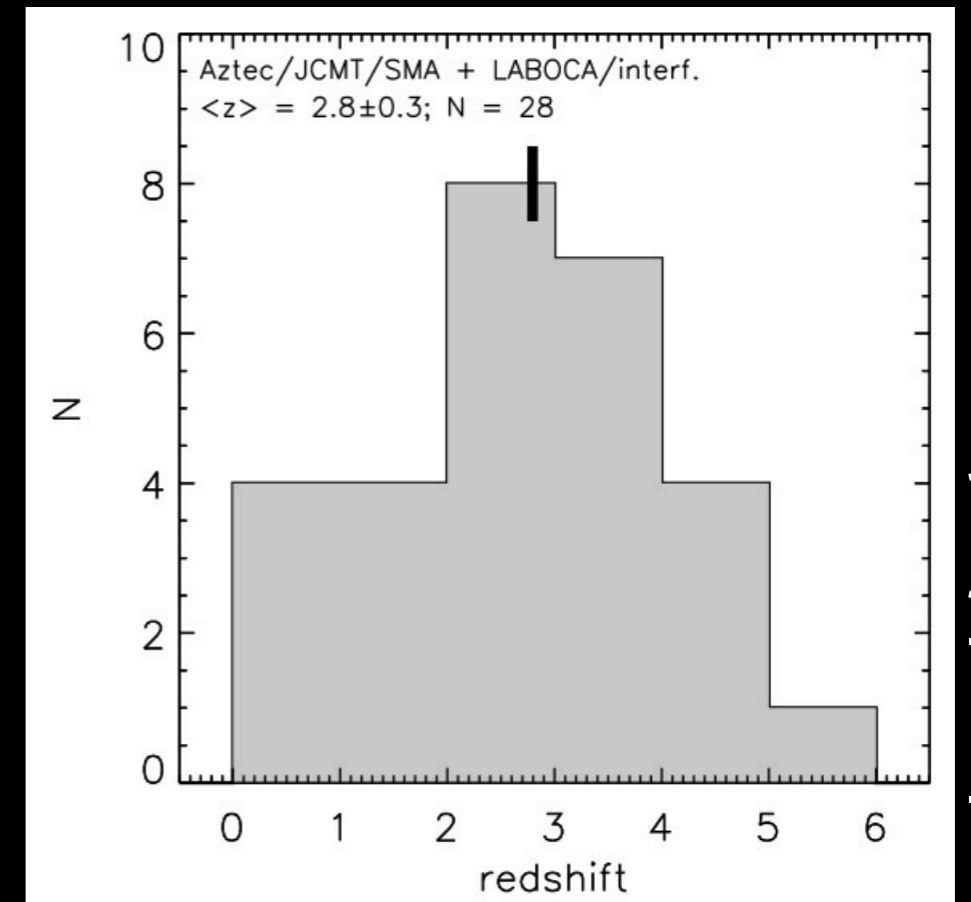
**X-ray quasar within 13kpc from core**

see also Walter et al. (2012)

Capak et al. (2011), Riechers et al. (2010/in prep.)



Simpson et al. (in prep.)

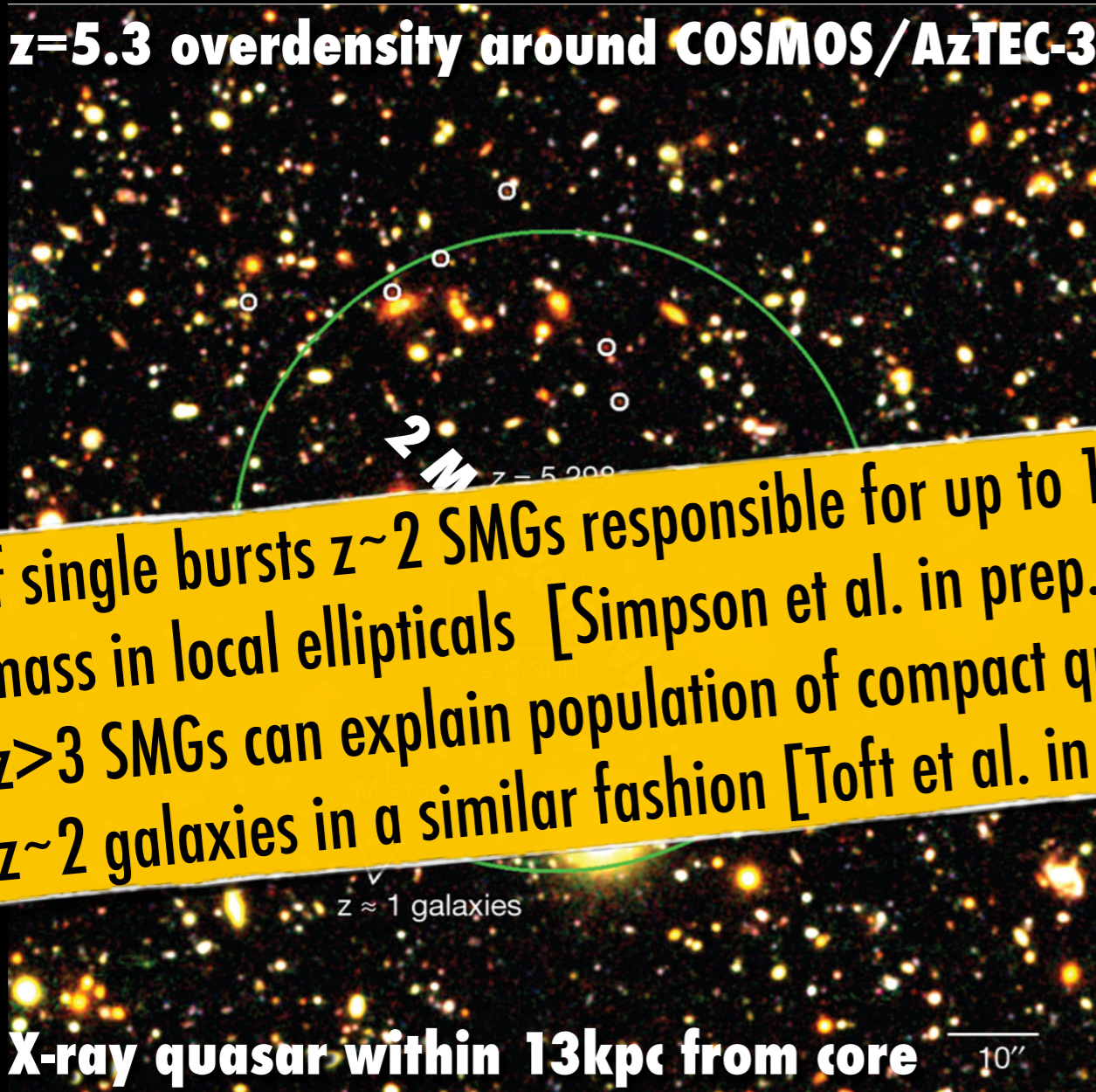


Smolcic et al. (2012)

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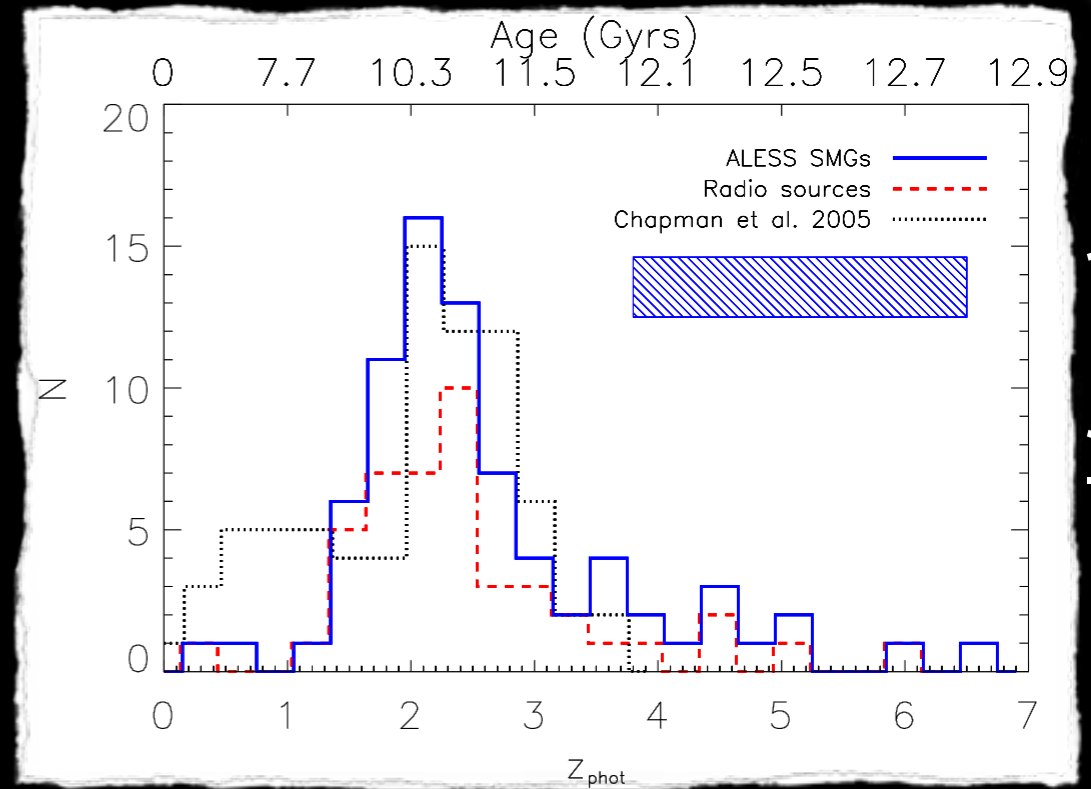
2010/in prep.

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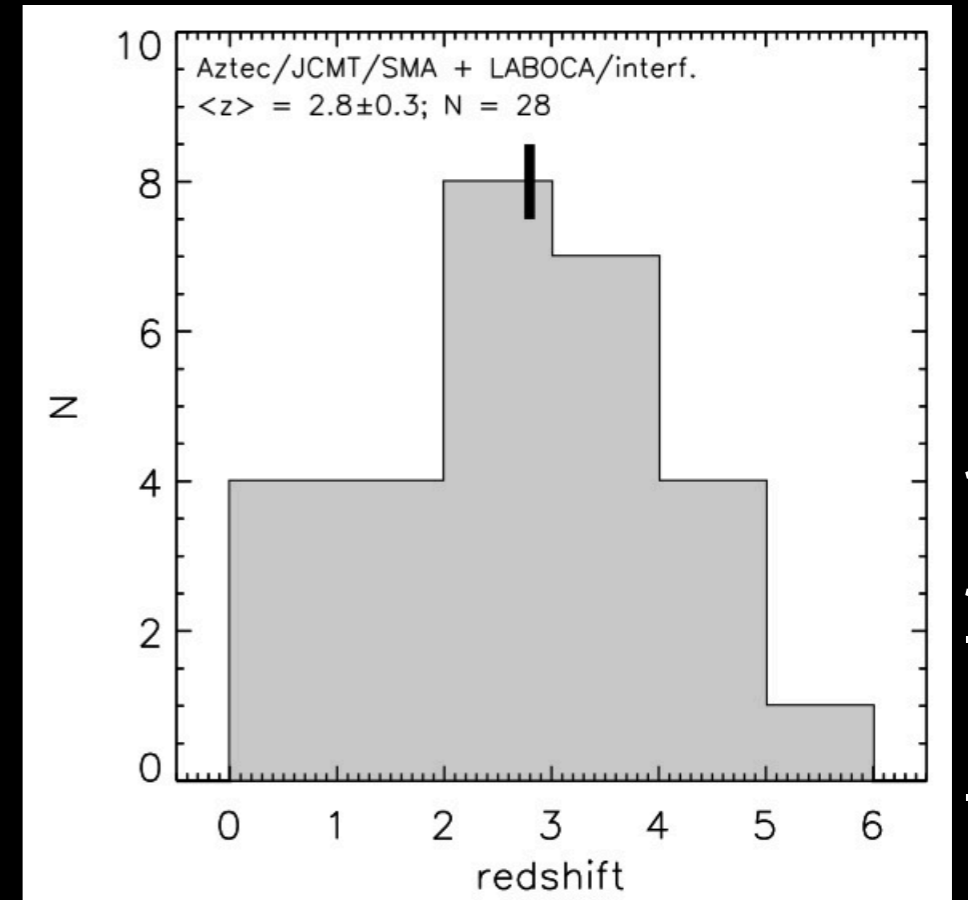
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10''

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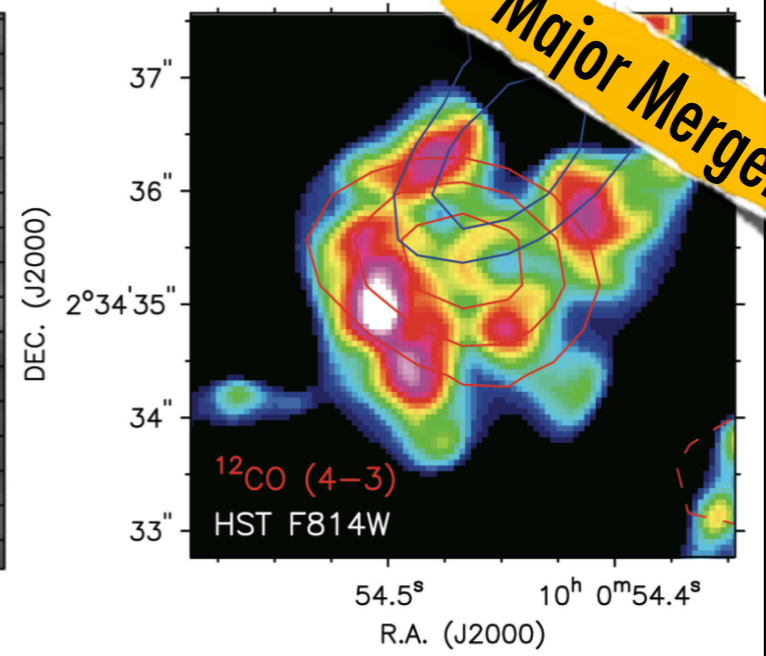
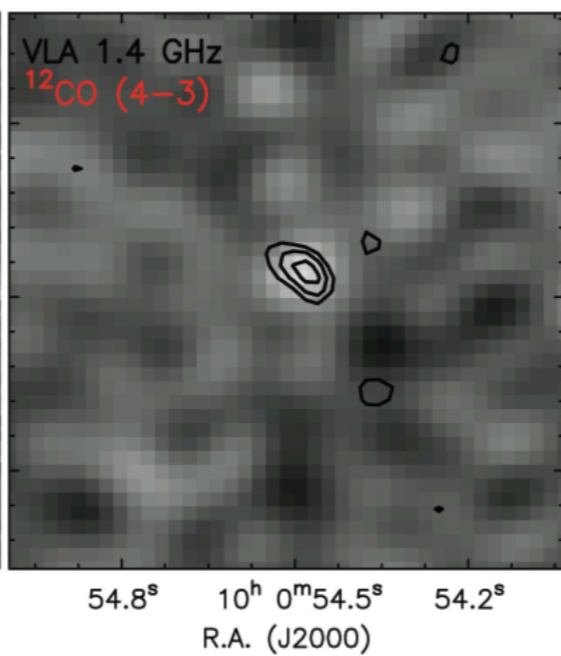
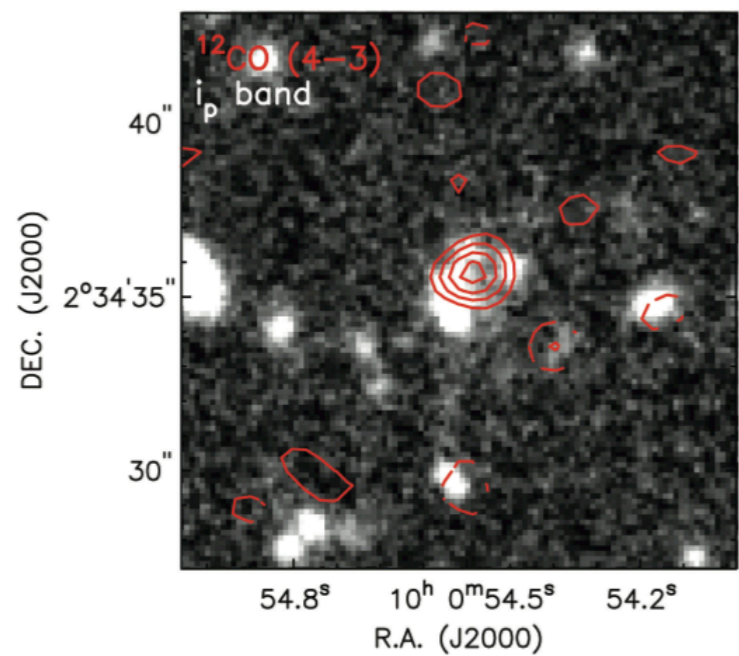


Smolcic et al. (2012)

- ▶ If single bursts  $z \sim 2$  SMGs responsible for up to 100% of mass in local ellipticals [Simpson et al. in prep.]
- ▶  $z > 3$  SMGs can explain population of compact quiescent  $z \sim 2$  galaxies in a similar fashion [Toft et al. in prep.]

# Goal: Finding extreme starbursts @ $z > 4$

J1000+0234 ( $z=4.542$ )

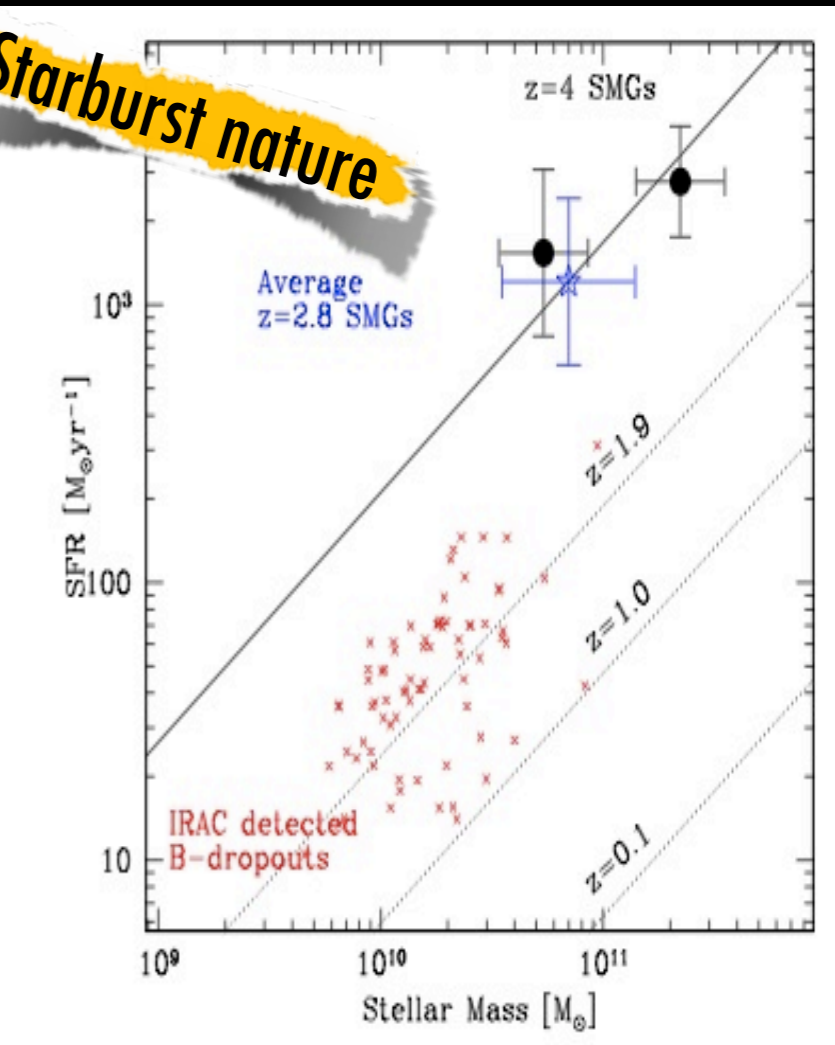
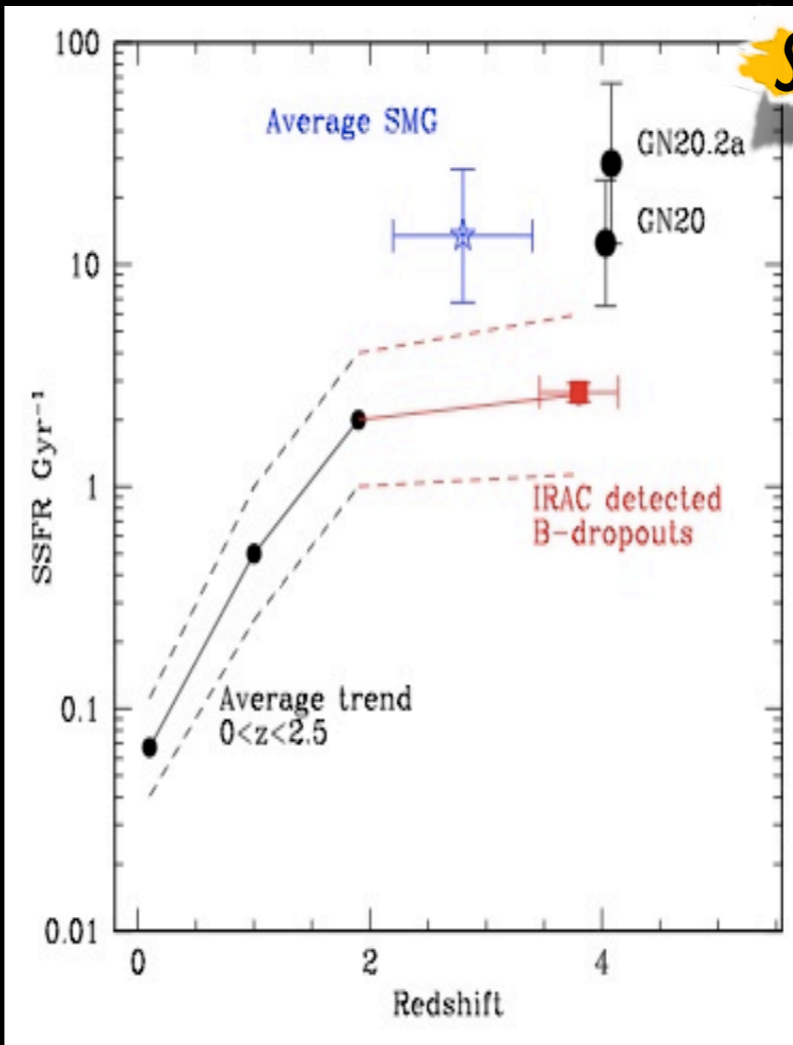


Major Mergers?

Schinnerer et al. (2008)

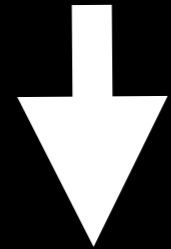
Daddi et al. (2009)

- ▶ To-date @  $z > 4$ : Only a few extreme starbursts studied in CO or CII (COSMOS, GOODS-N, E-CDF-S)
- ▶ Representative  $4 < z < 6$  sample still lacking



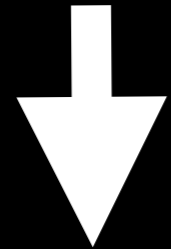
# Deep radio-selection: A road to success

Start from optical systems at  $z > 4$



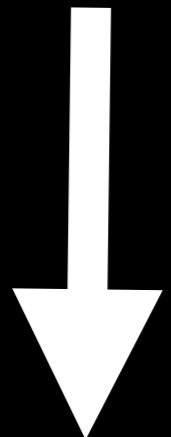
**~ 15,000 V-band drop-outs**

Find weak counterpart in  
deep VLA imaging



**typically ~40-80  $\mu\text{Jy}$  ( $4-8\sigma$ )**

spectroscopic & mm  
follow-up observations



**Ly- $\alpha$  (e.g. DEIMOS),  
rest-frame FIR  
constraint (e.g. GISMO,  
MAMBO-II)**

Interferometric follow-up

J1000+0234



**CONFIRMED**

Vd-17871



AK03



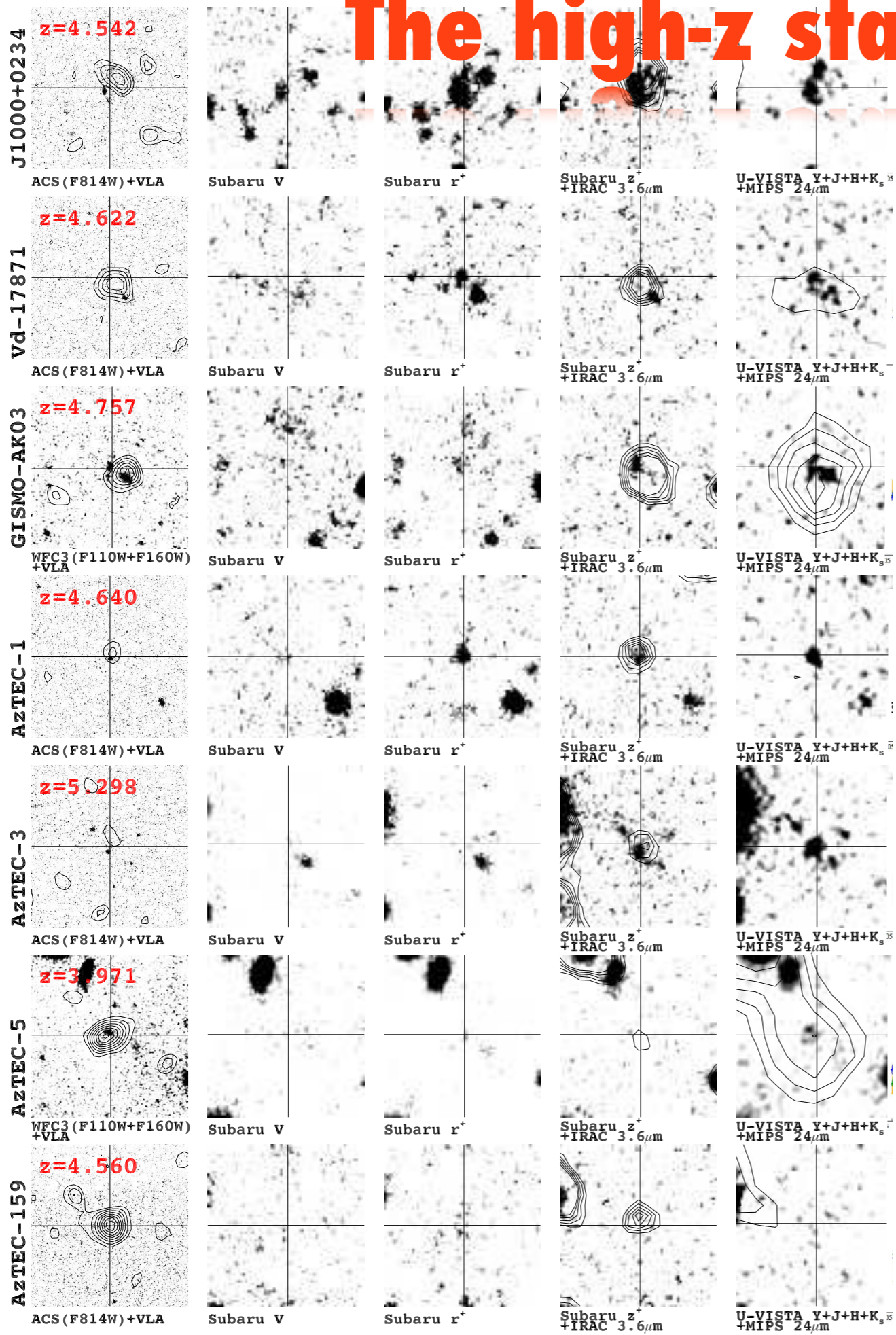
AK05



AK06



# The high-z starburst population

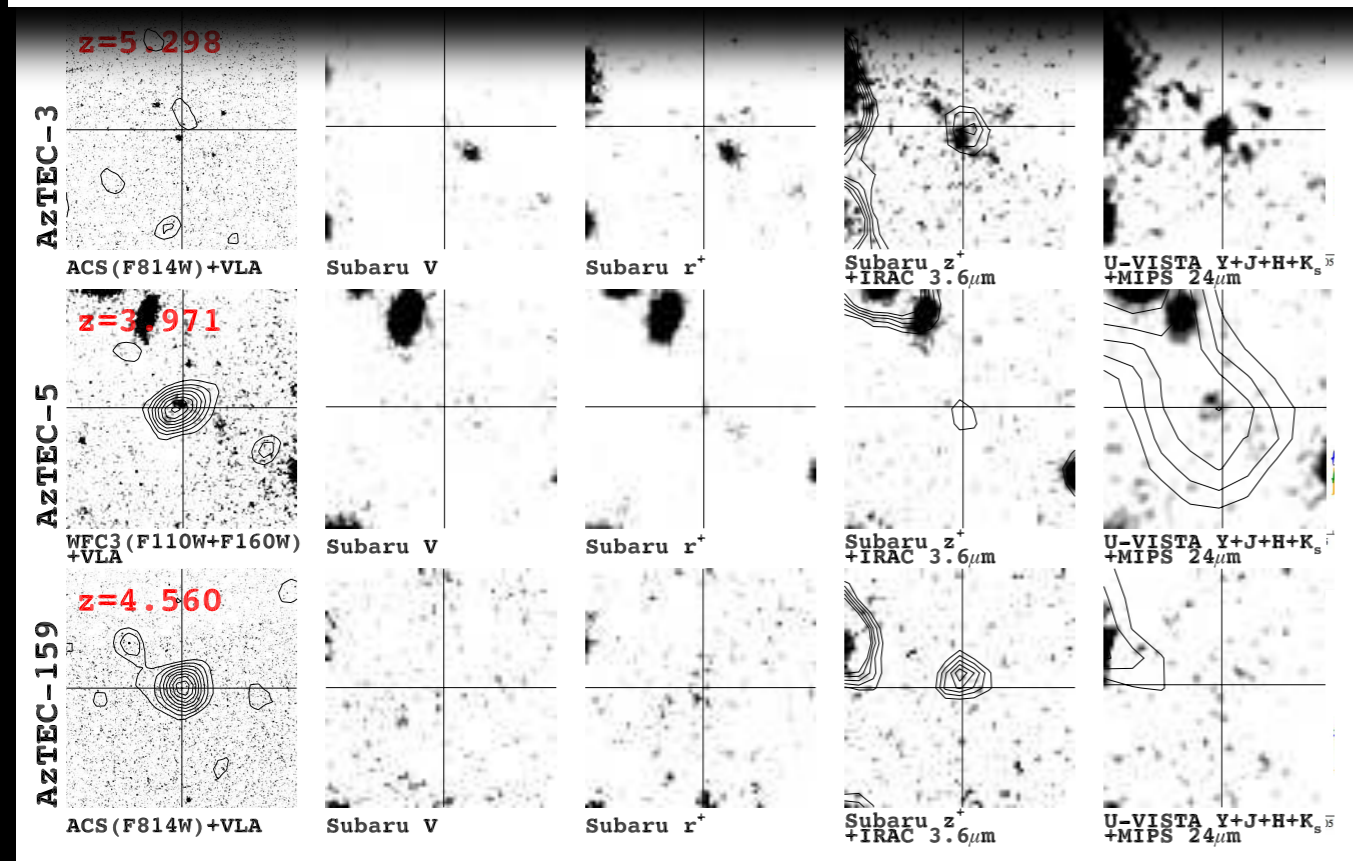
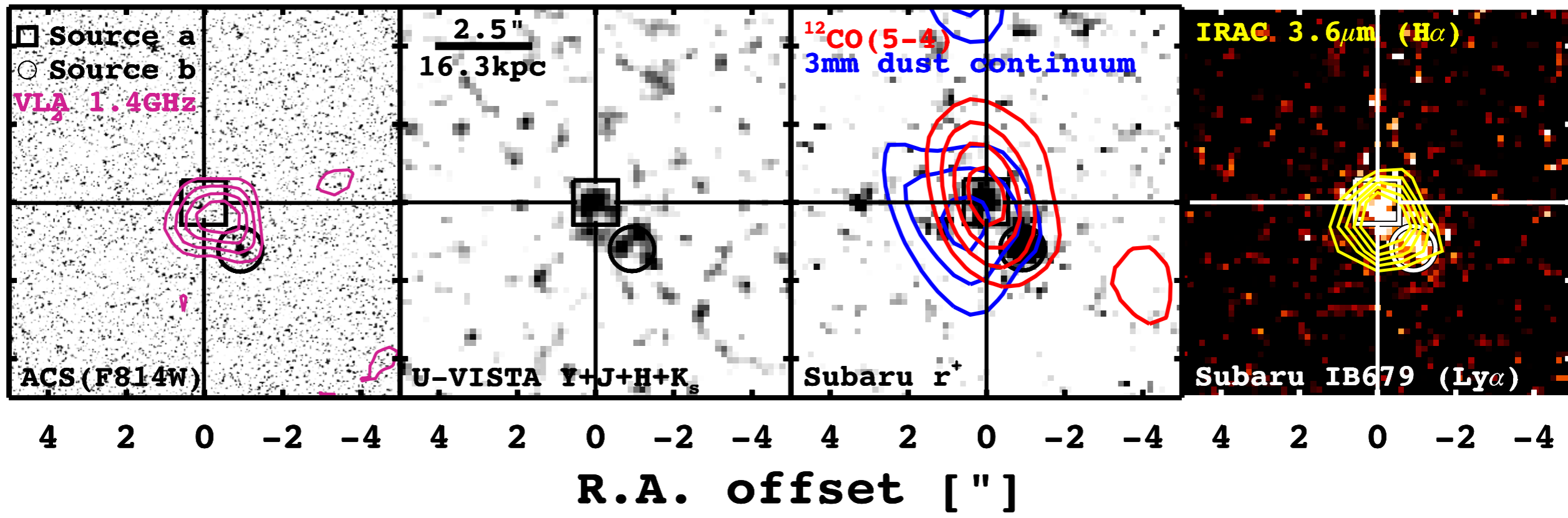


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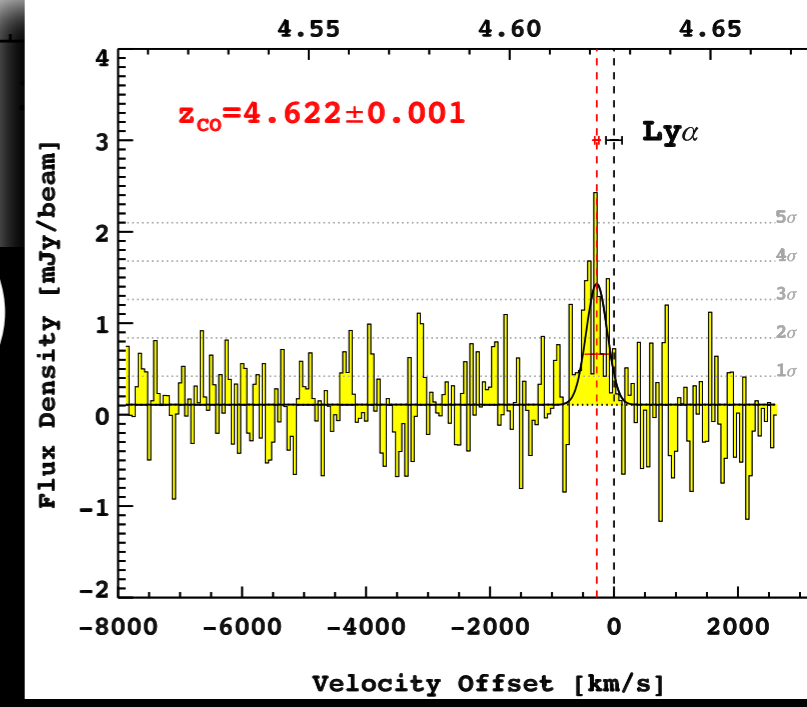
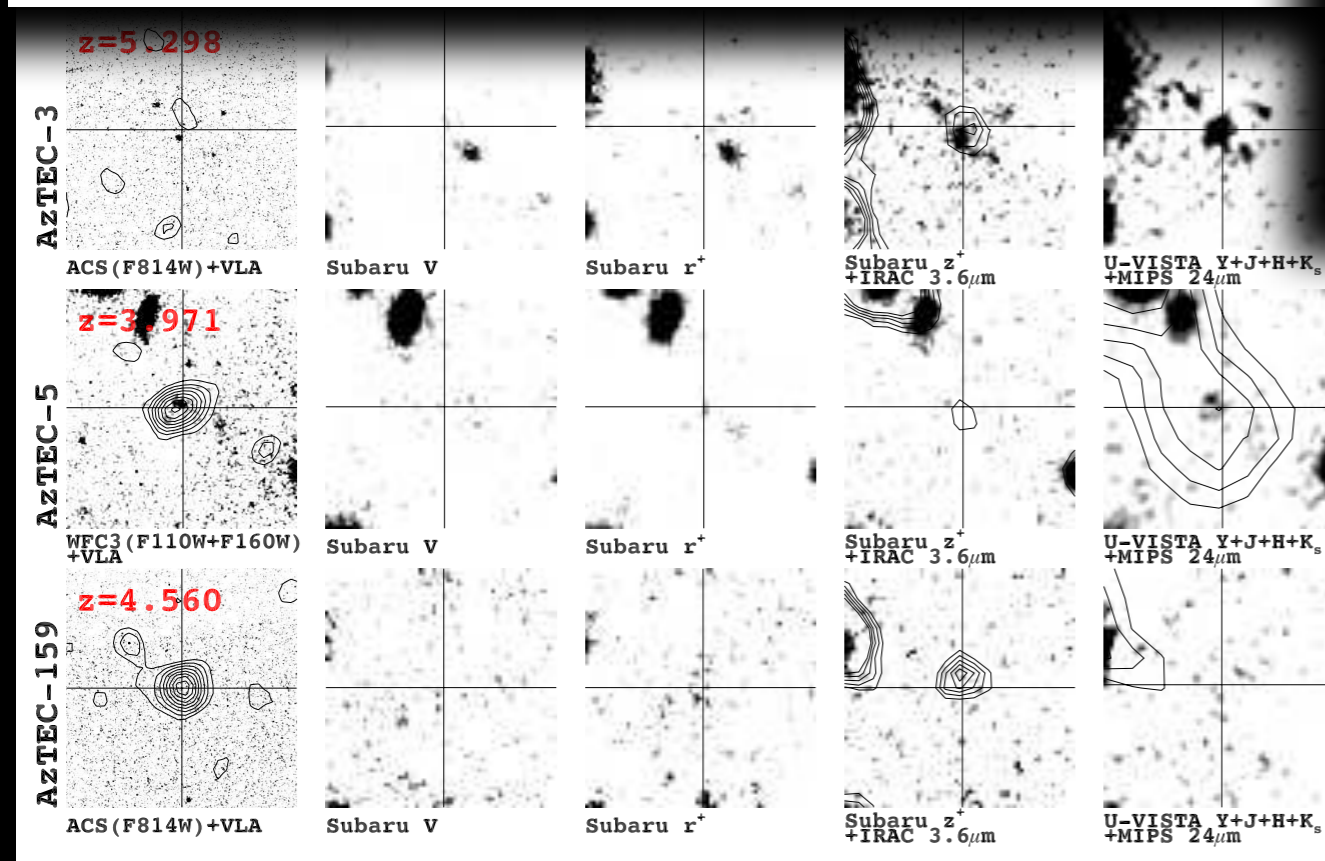
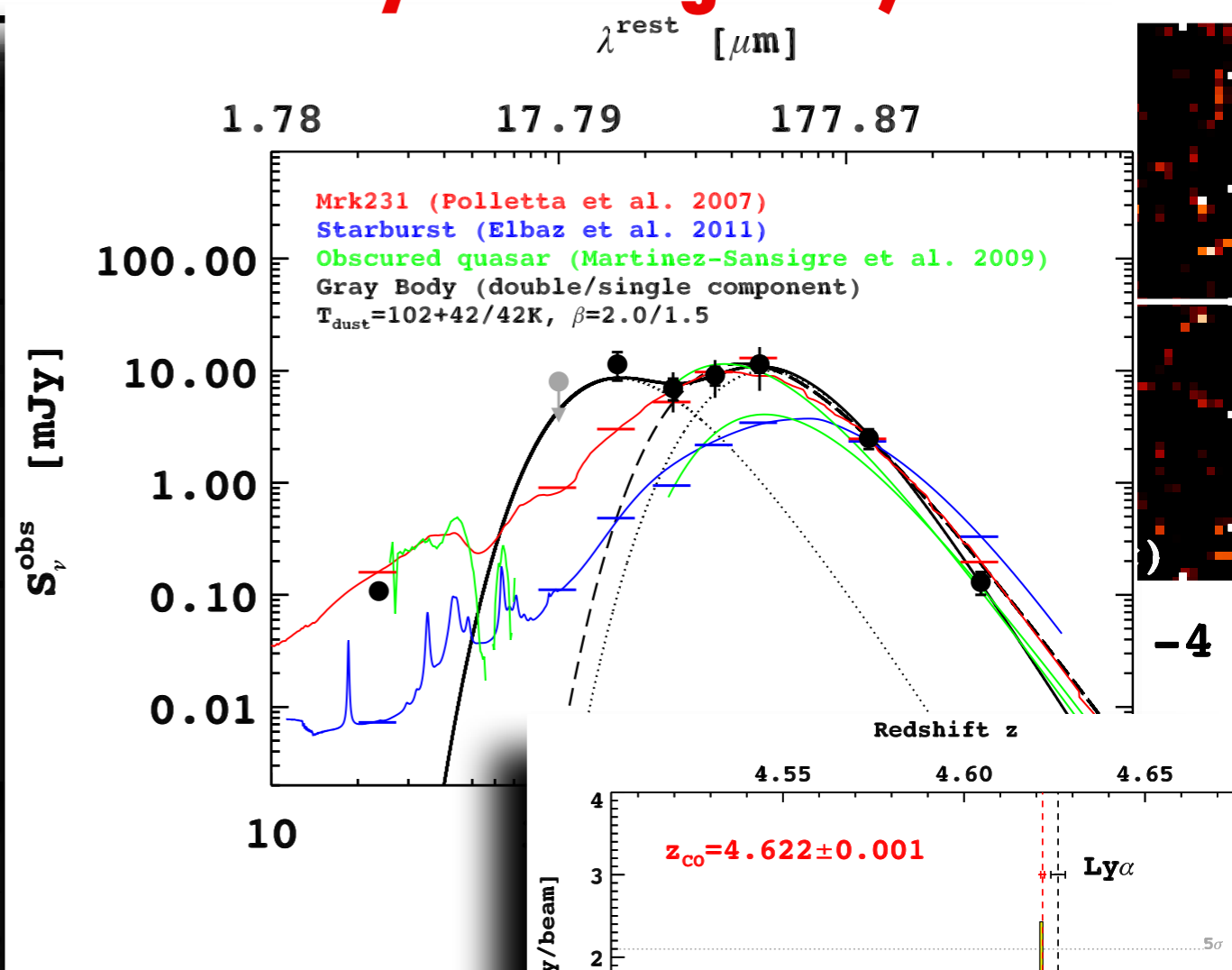
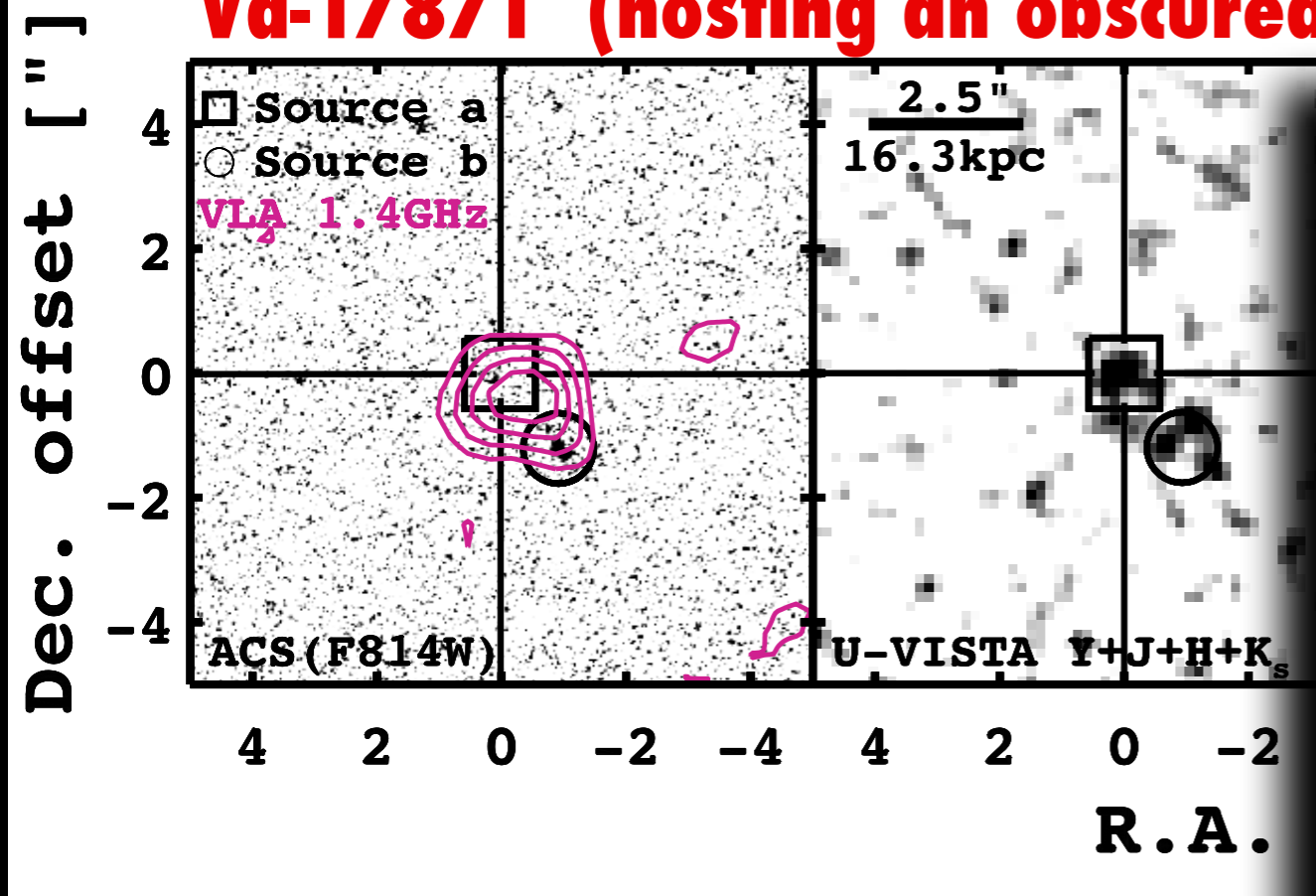
Dec. offset ["]

## Vd-17871



# The high-z starburst population

## Vd-17871 (hosting an obscured and heavily accreting AGN)



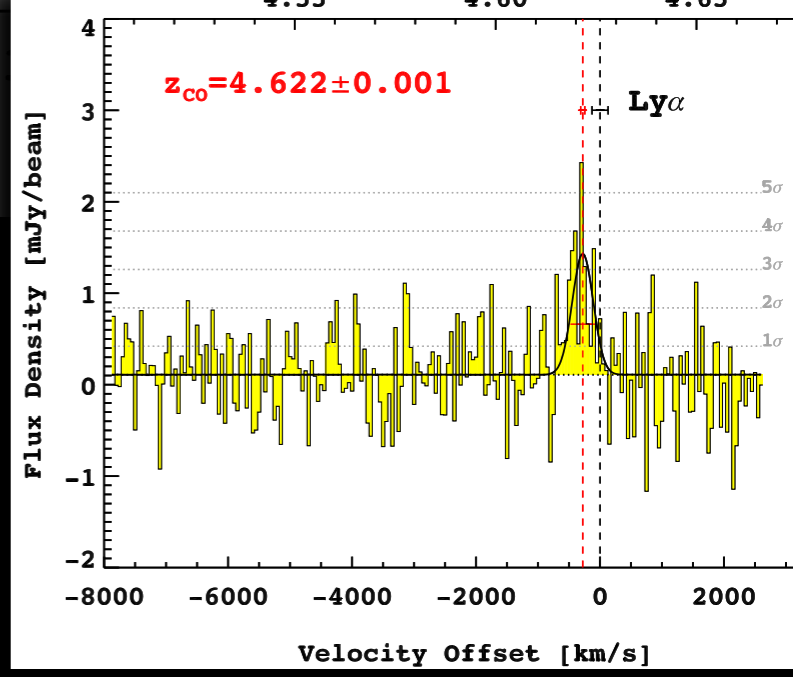
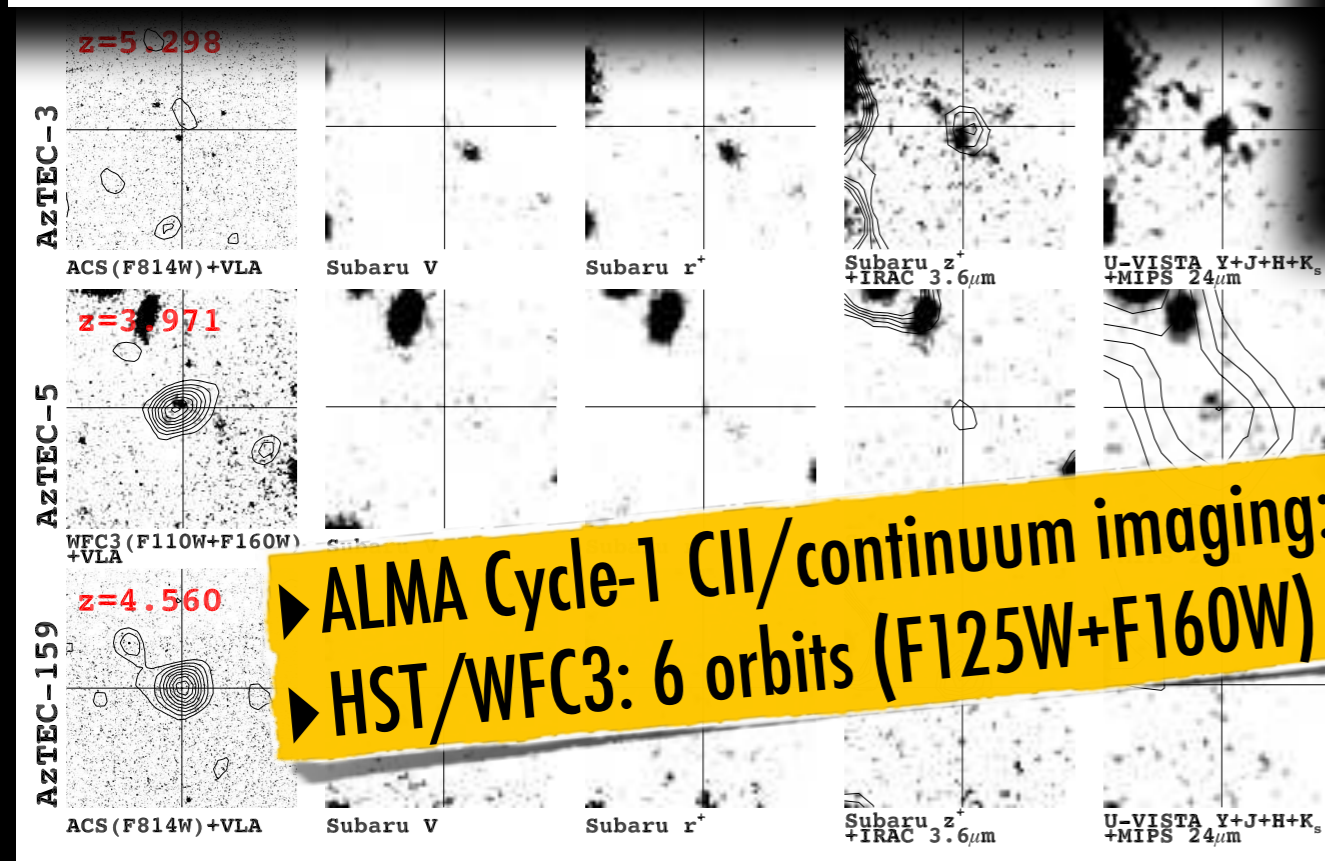
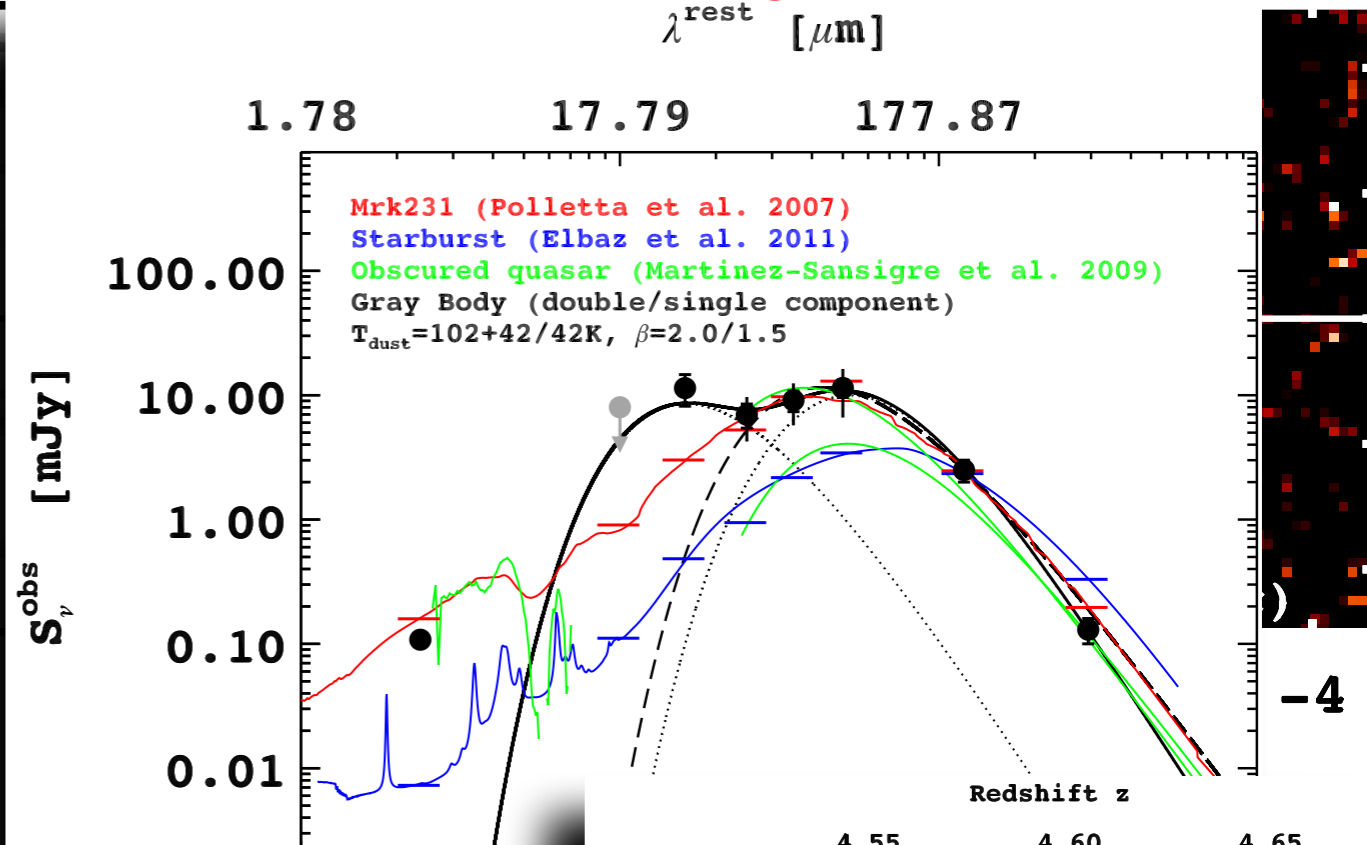
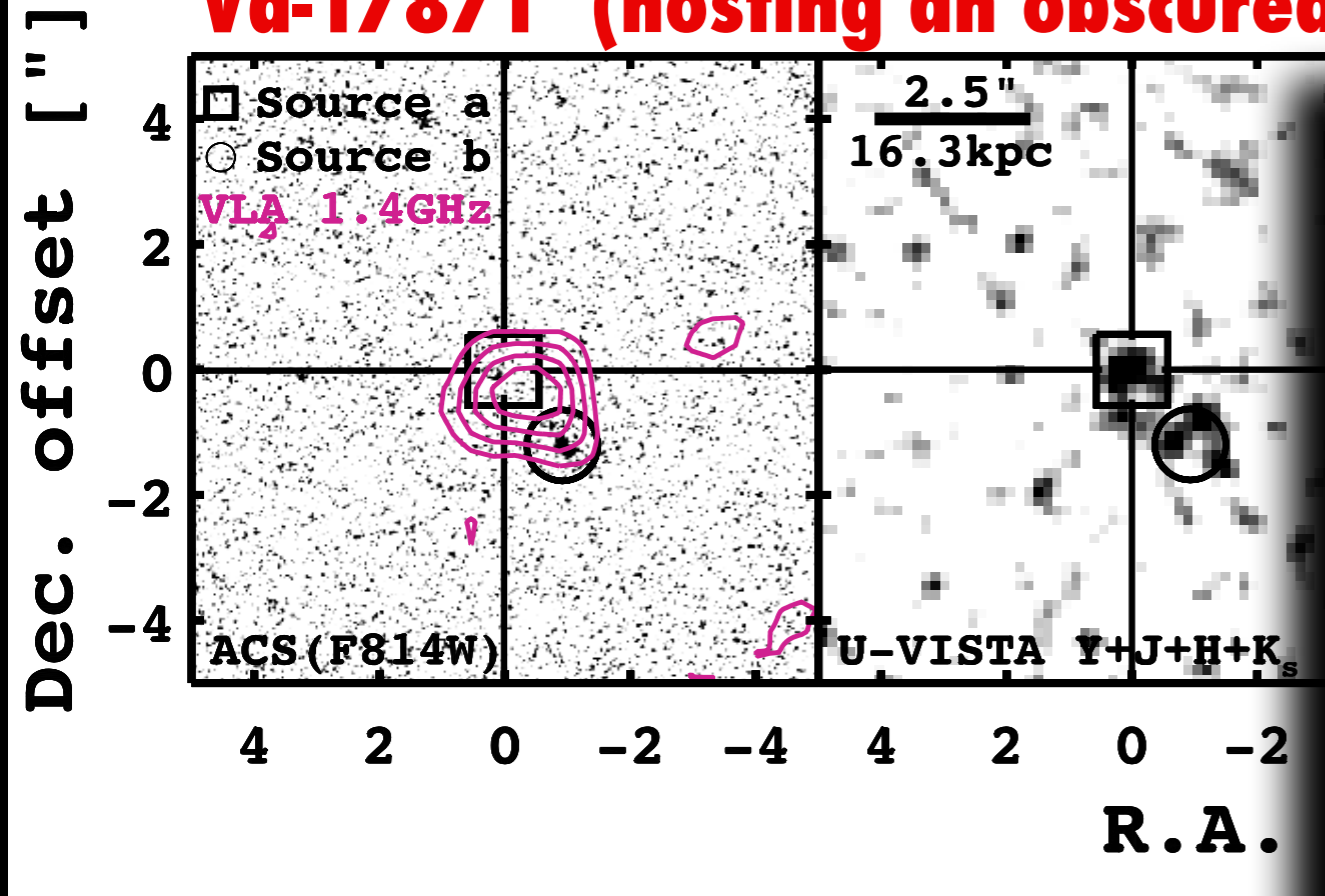
Karim et al. (in prep.)

Smolcic, AK et al. (in prep.), Toft et al. (in prep.); also Capak et al. (2008), Schinnerer et al. (2008)



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## Vd-17871 (hosting an obscured and heavily accreting AGN)



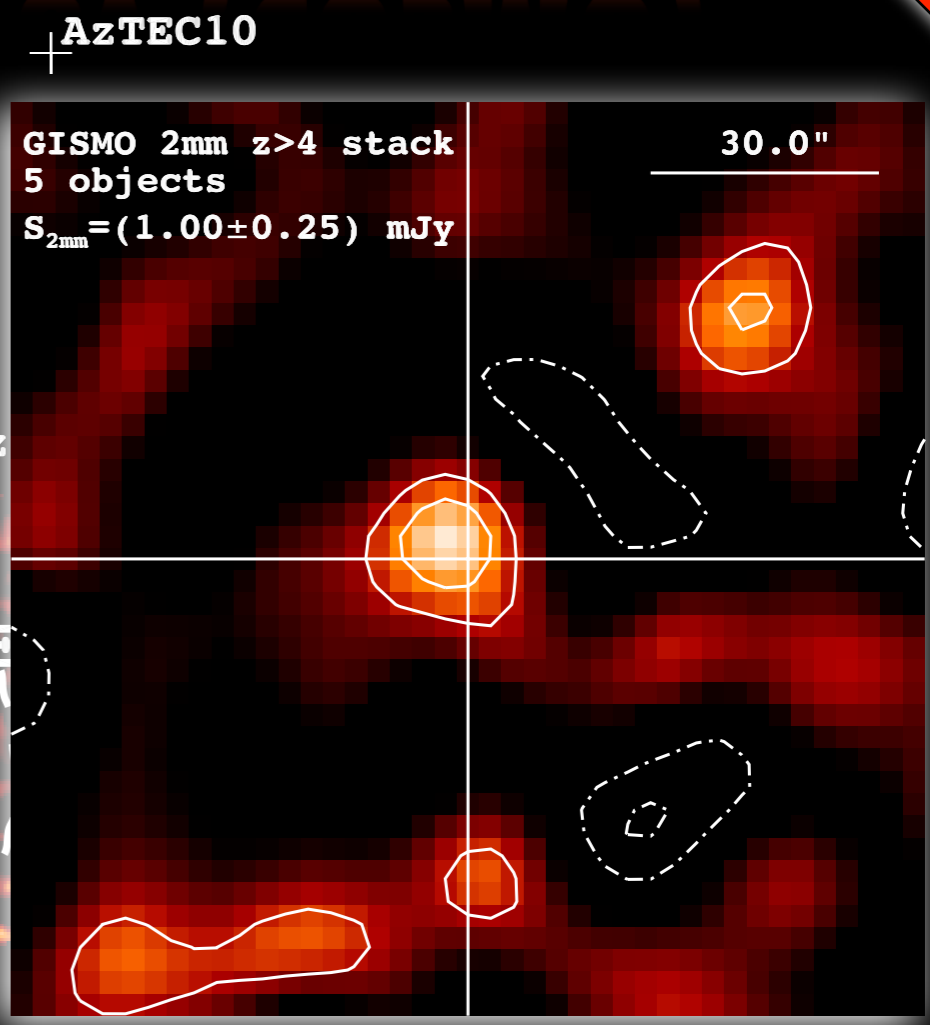
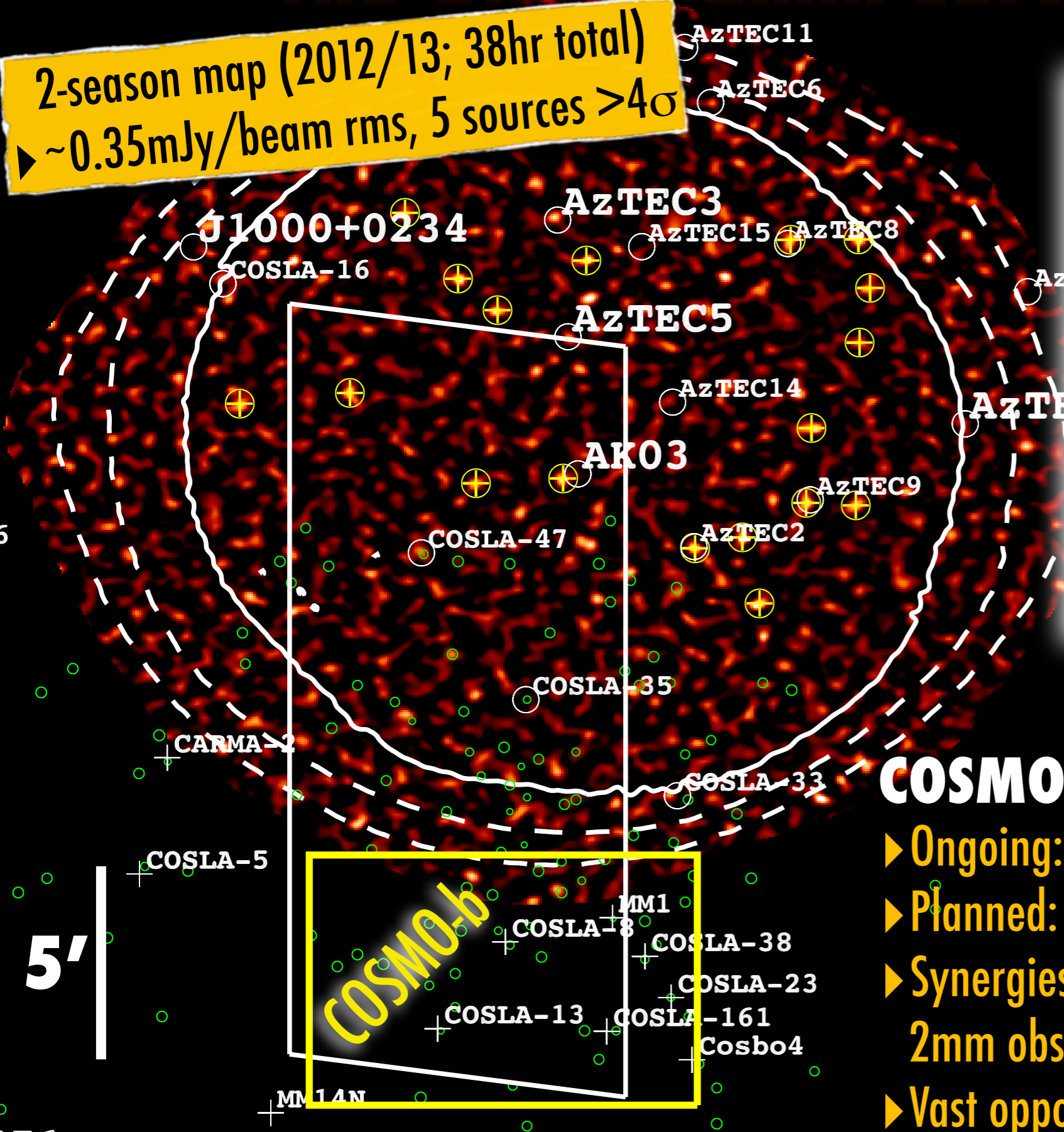
► ALMA Cycle-1 CII/continuum imaging: approved  
► HST/WFC3: 6 orbits (F125W+F160W) approved

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also Capak et al. (2008), Schinnerer et al. (2008)

# The GISMO 2mm survey (COSMO)

2-season map (2012/13; 38hr total)  
 ~0.35mJy/beam rms, 5 sources >4 $\sigma$



- COSMO: an ongoing effort**
- ▶ Ongoing: Full CANDELS 0.2mJy coverage
  - ▶ Planned: Shallow 2deg<sup>2</sup> coverage
  - ▶ Synergies with complementary GOODS-N/SPT 2mm observations, Herschel & Chandra-XVP
  - ▶ Vast opportunities for ALMA follow-up