Infrared-luminous galaxies: their role in galaxy evolution and their environment

Emeric Le Floc'h
(University of Hawaii)

+ the COSMOS collaboration (Scoville et al.)

... and more specifically the S-COSMOS Legacy (PI: Sanders)

Credits: NASA / JPL / Caltech / DEEP

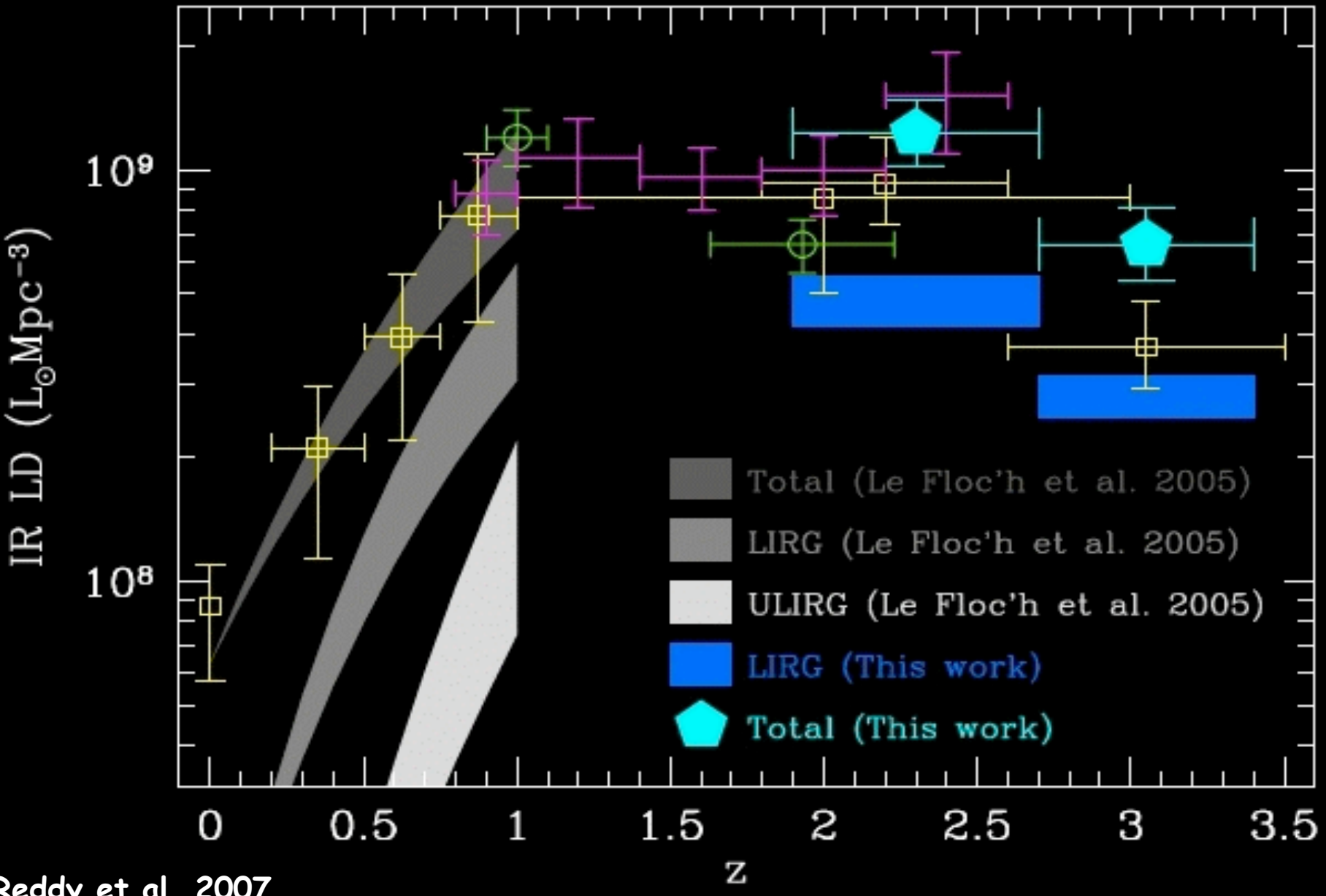
Infrared-luminous galaxies: their role in galaxy evolution and their environment

Emeric Le Floc'h
(University of Hawaii)

- O.Ilbert, S.Arnouts: connection with optical properties, masses, redshifts, …
- C.Feruglio, H.Aussel, N.Scoville, A.Finoguenov: environment (see poster)
- S.Heinis: clustering
- L.Riguccini: counts, redshift distributions, color selections
- D.Frayer, J.Kartaltepe: far-IR properties (70/160mic)
- XMM+Chandra-COSMOS: connection with AGNs

Credits: NASA / JPL / Caltech / DEEP

Obscured activity at high redshift



Reddy et al. 2007

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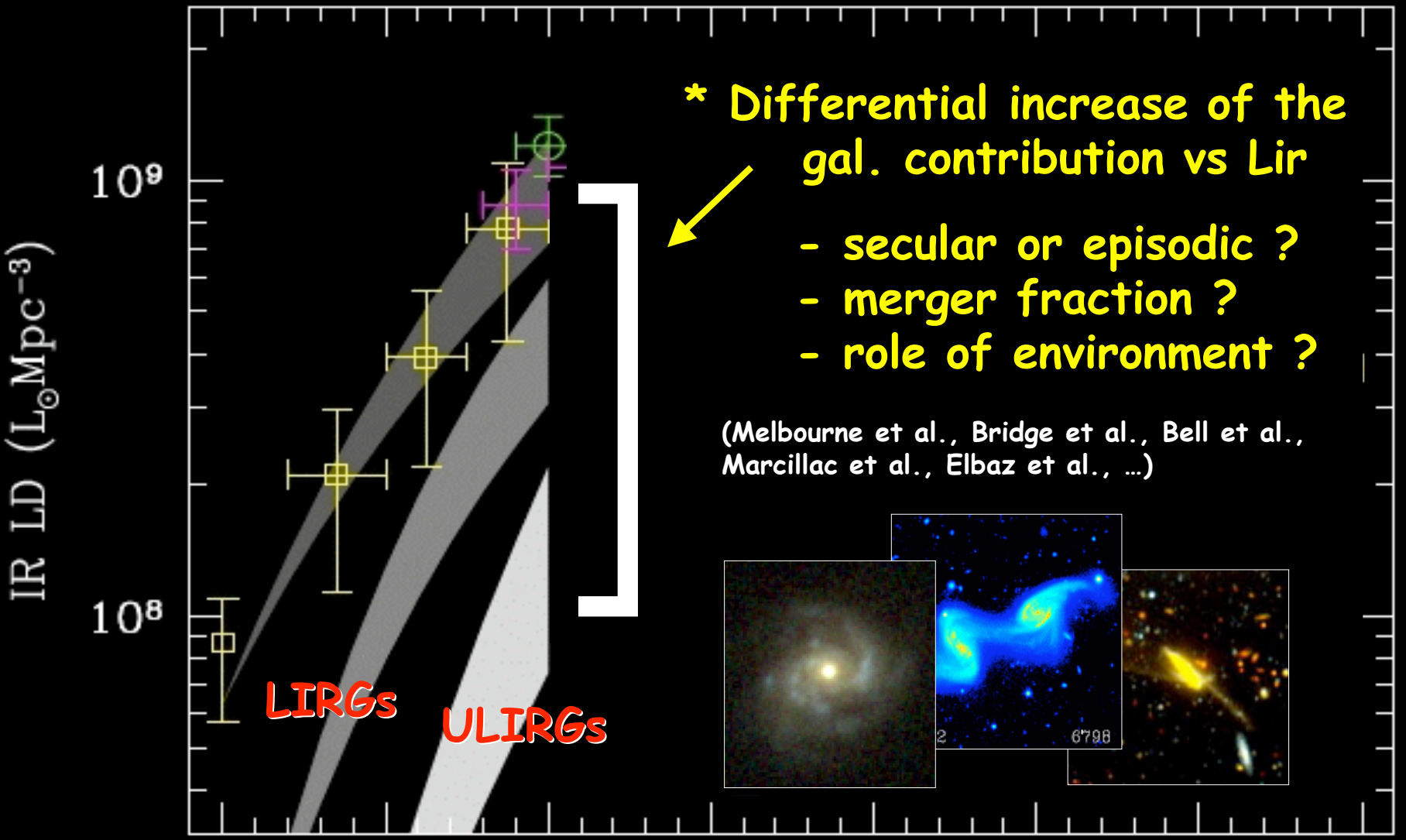

* Differential increase of the gal. contribution vs Lir

- secular or episodic ?
- merger fraction ?
- role of environment ?

(Melbourne et al., Bridge et al., Bell et al., Marcillac et al., Elbaz et al., …)

Reddy et al. 2007

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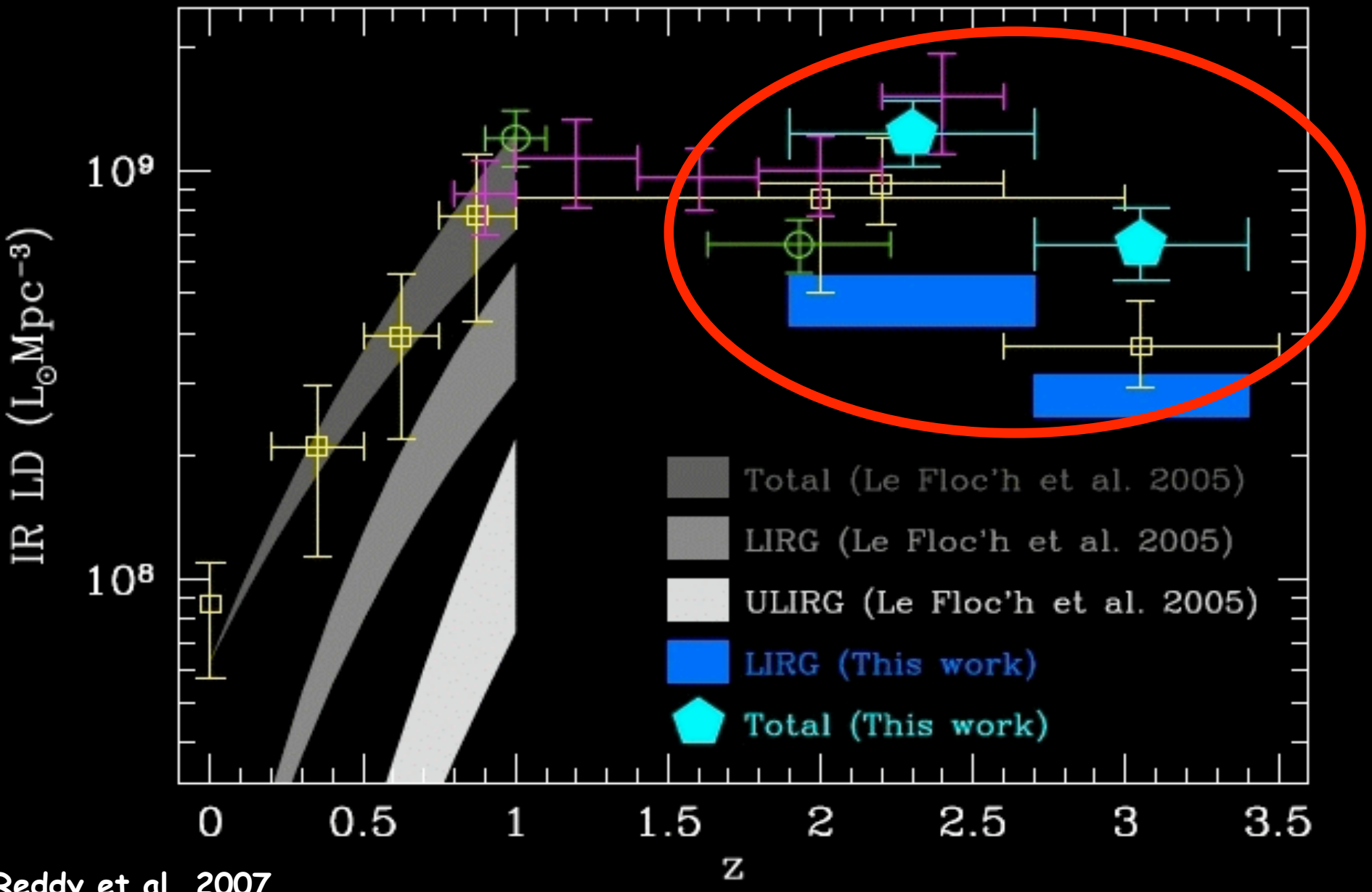

Reddy et al. 2007

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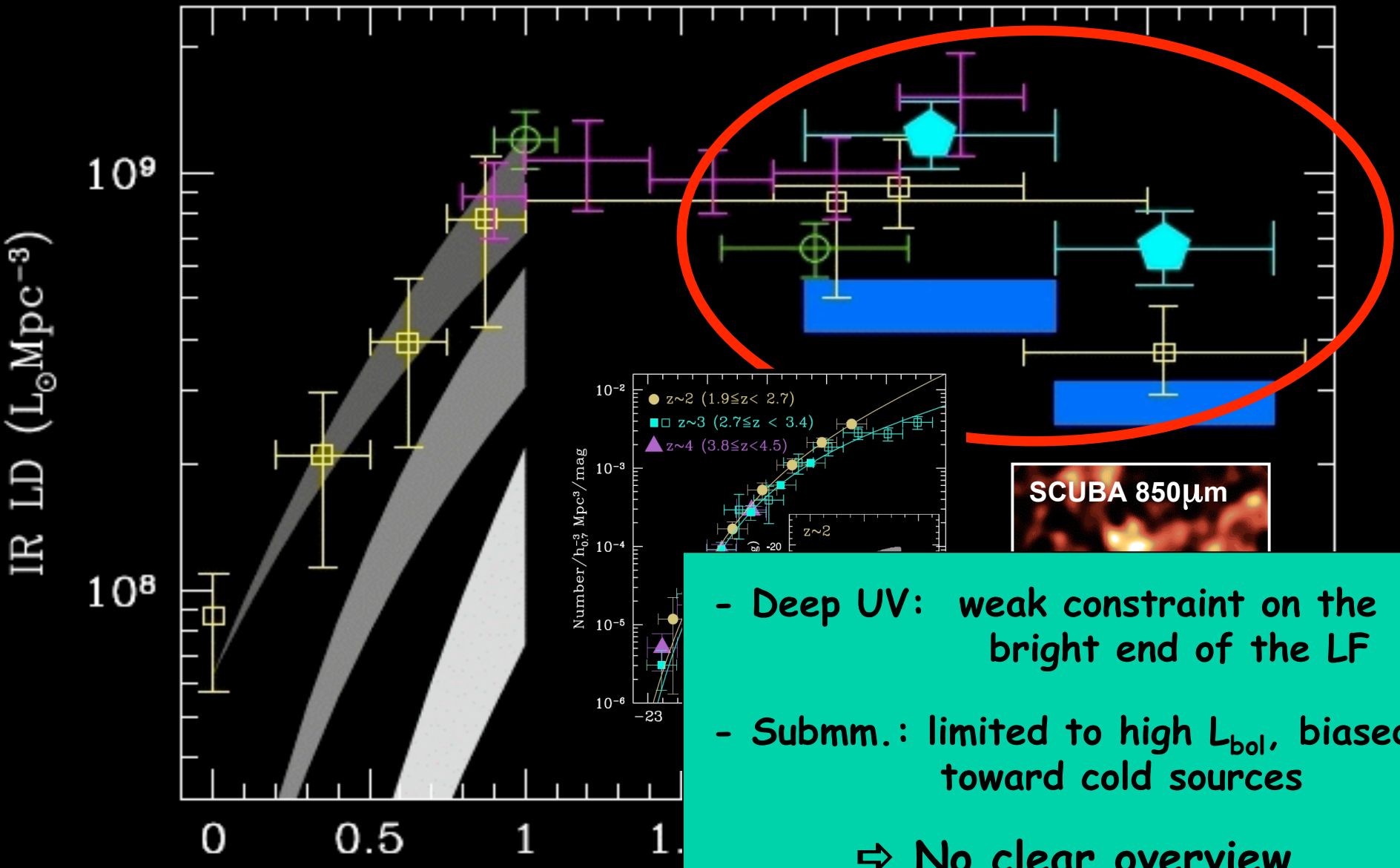


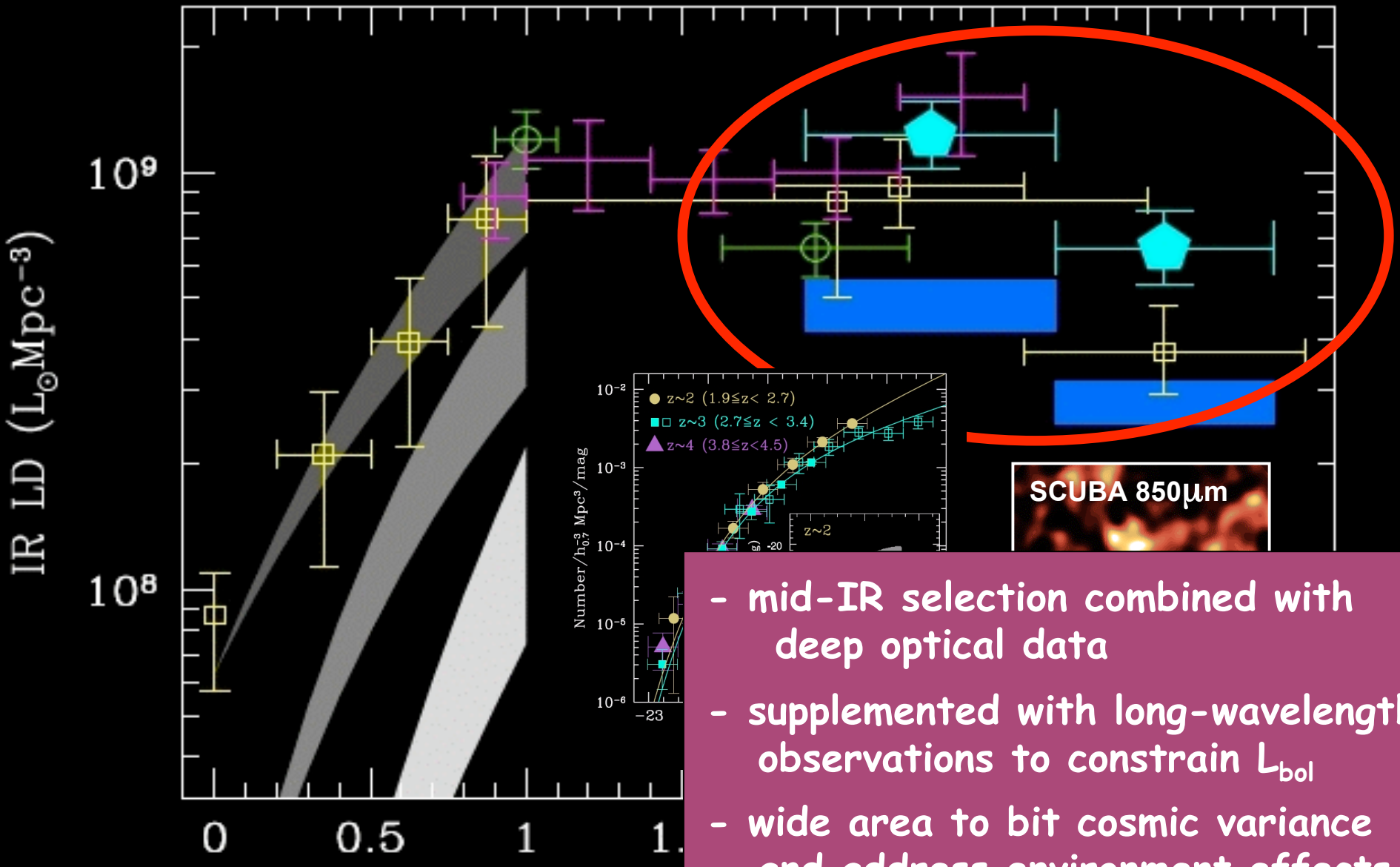
Reddy et al. 2007

- Deep UV: weak constraint on the bright end of the LF

- Submm.: limited to high L_{bol}, biased toward cold sources

⇨ No clear overview

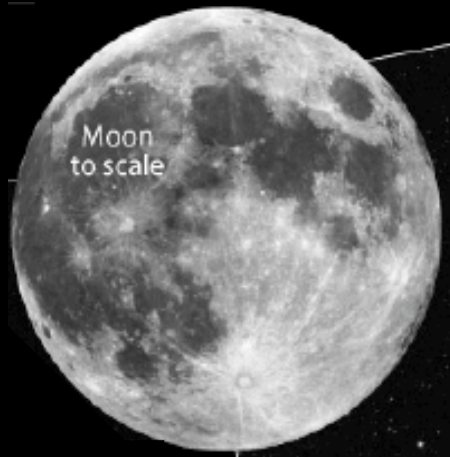
Obscured activity at high redshift

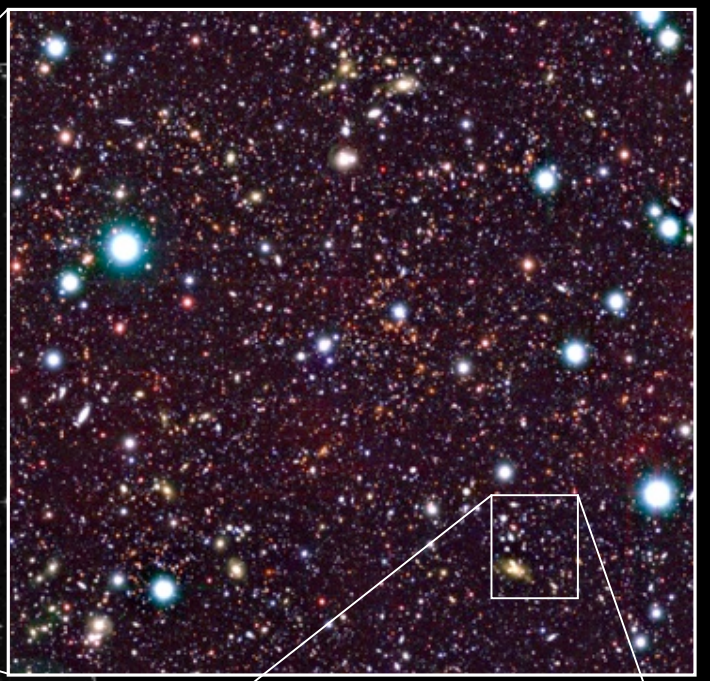


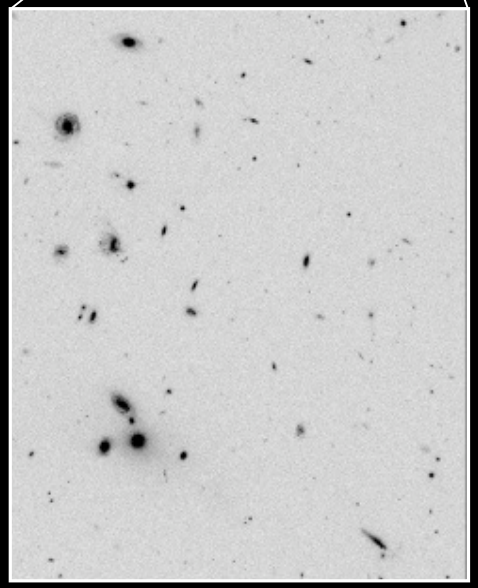
Reddy et al. 2007

- mid-IR selection combined with deep optical data
- supplemented with long-wavelength observations to constrain L_{bol}
- wide area to bit cosmic variance and address environment effects

The COSMOS field



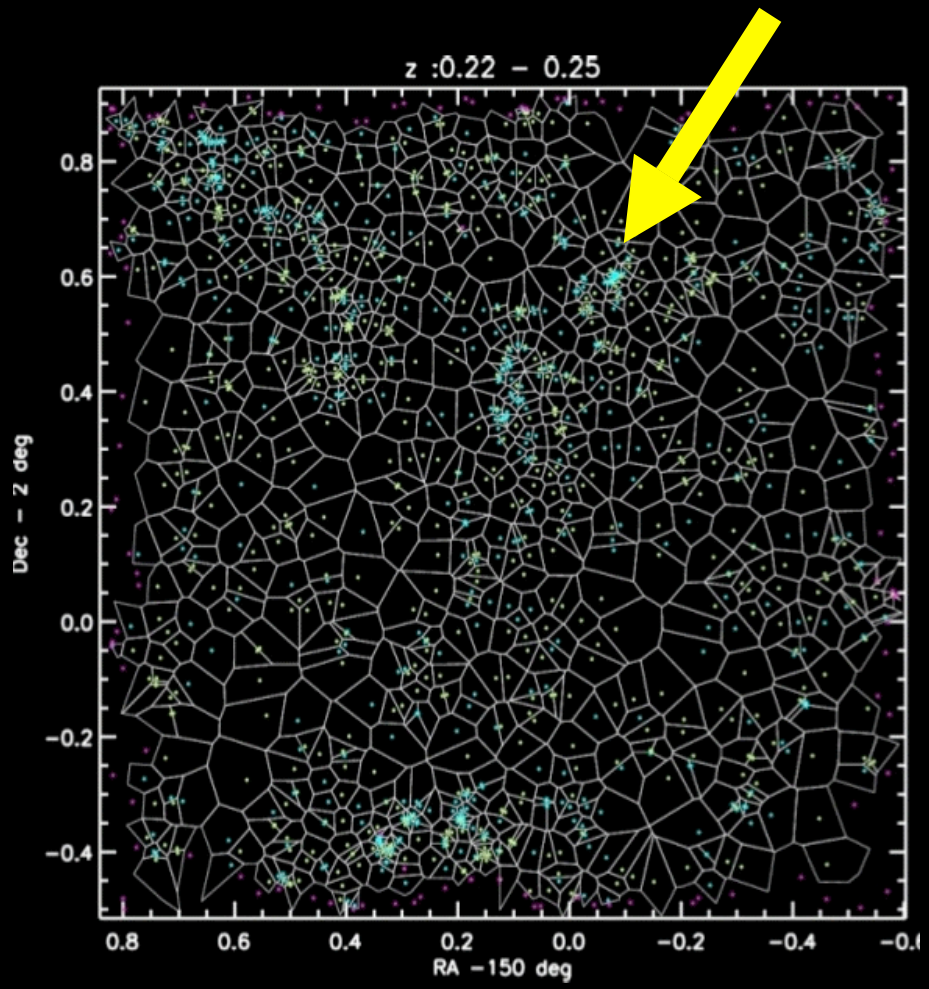


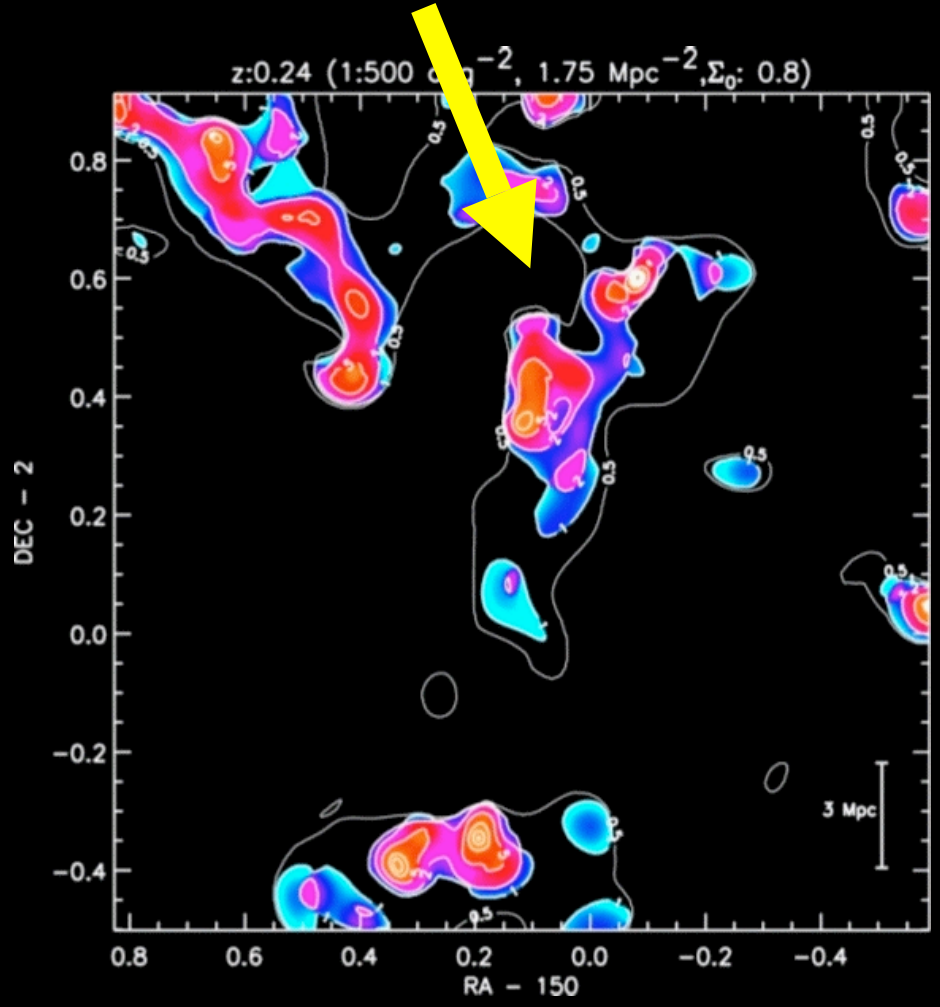


* Deep (I<26.5 AB) and wide (2 sq.deg.)
* Unique multi-lambda data set
  - clean SED characterization
  - accurate photo-z
    e.g., $\Delta z/(1+z)<1\%$ at I<22.5 !!!
    (Ilbert et al. 2009)

Large Scale Structures in COSMOS

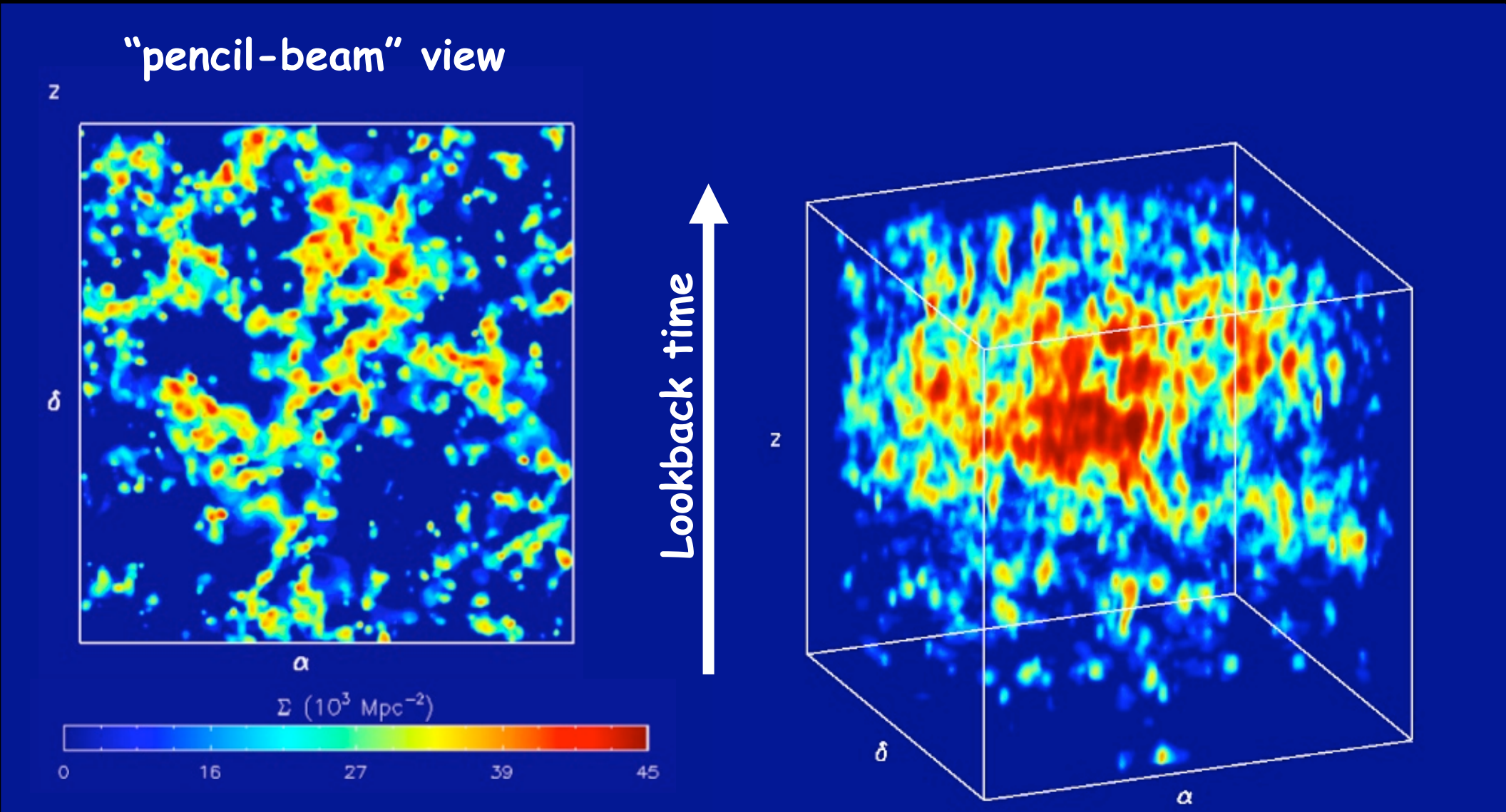
* Scoville et al. 2007, 2009: based on photo-z, 2 different approaches (Voronoi tesselation and adaptive smoothing)



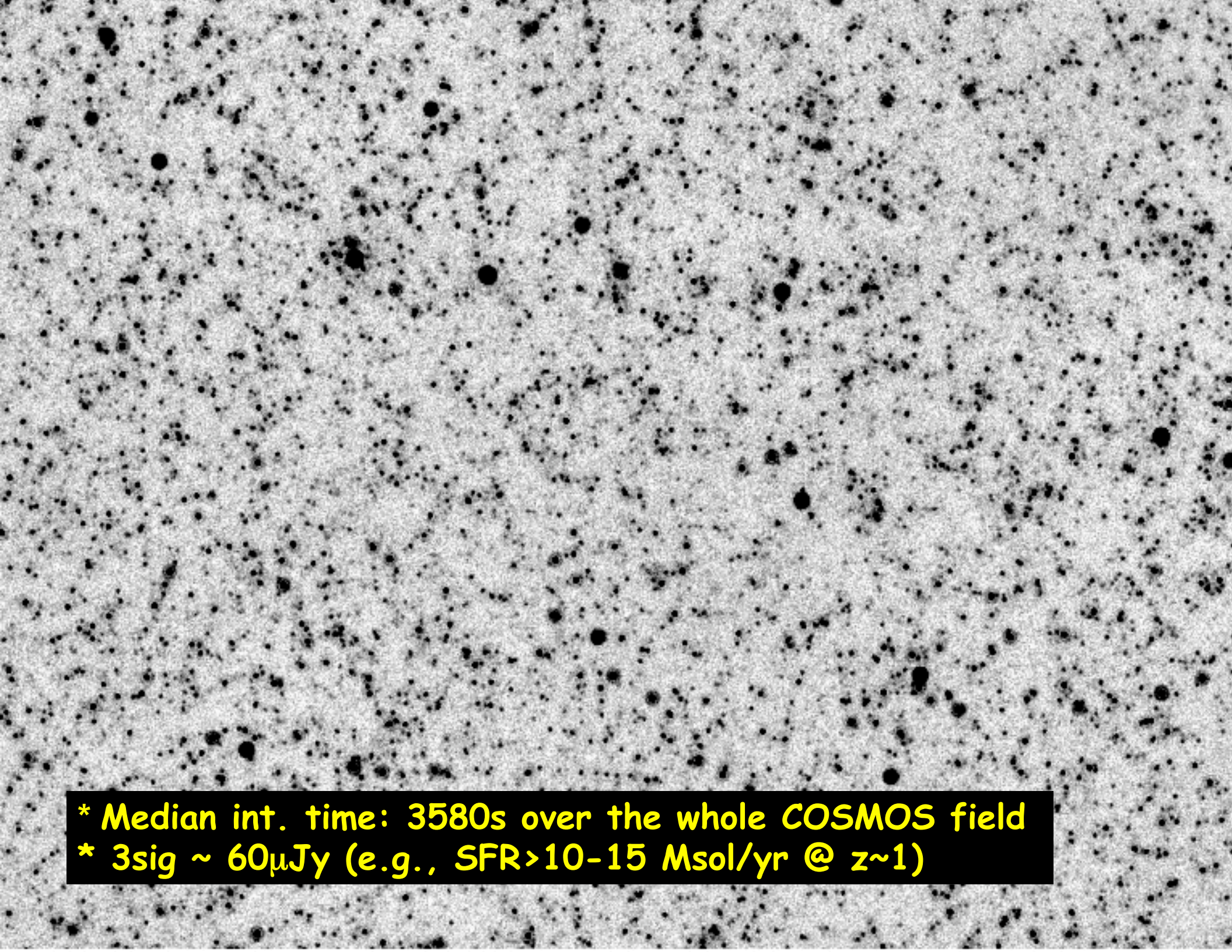


Good agreement between the 2, robustness checked with simulations

Large Scale Structures in COSMOS



Courtesy N.Scoville


* Median int. time: 3580s over the whole COSMOS field
* 3sig ~ 60μJy (e.g., SFR>10-15 Msol/yr @ z~1)

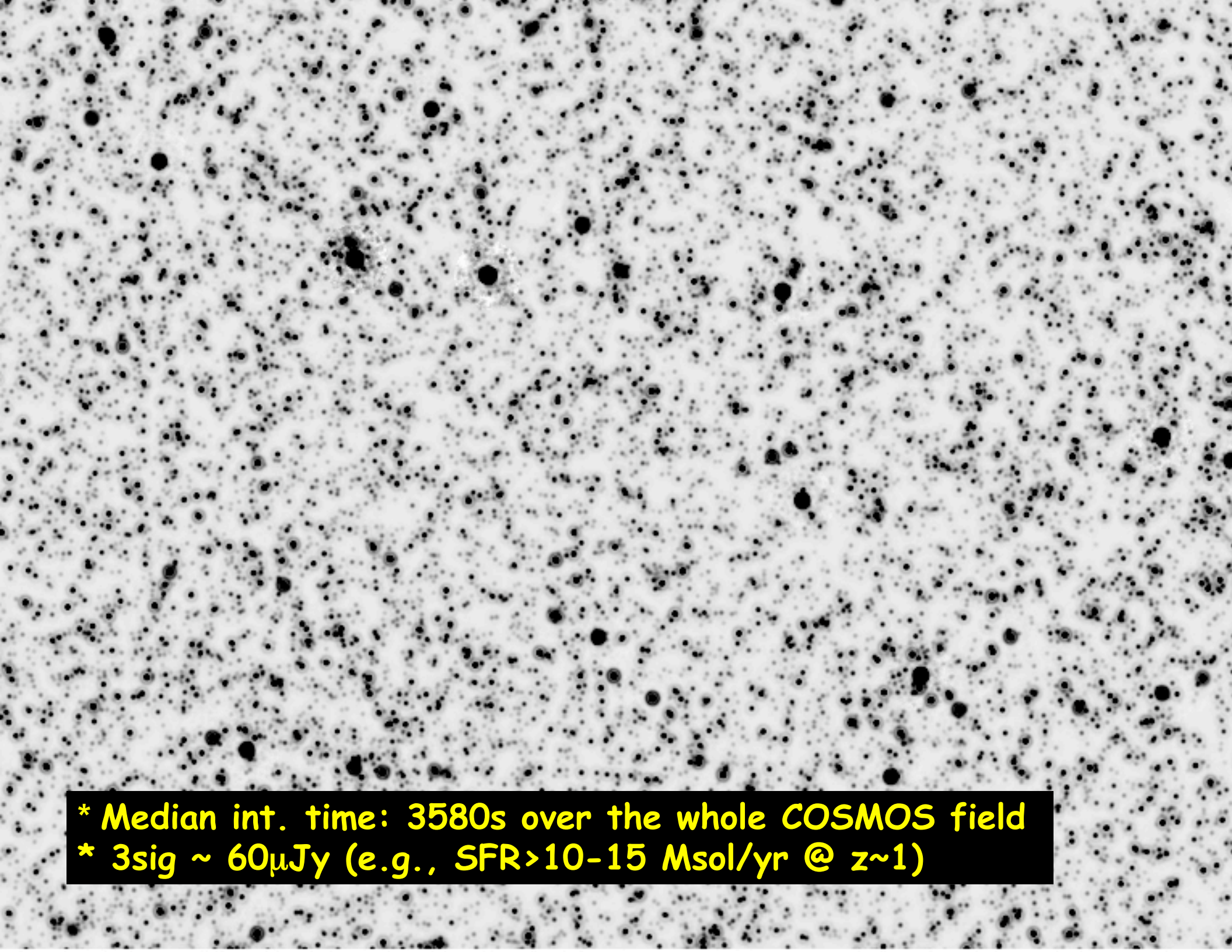

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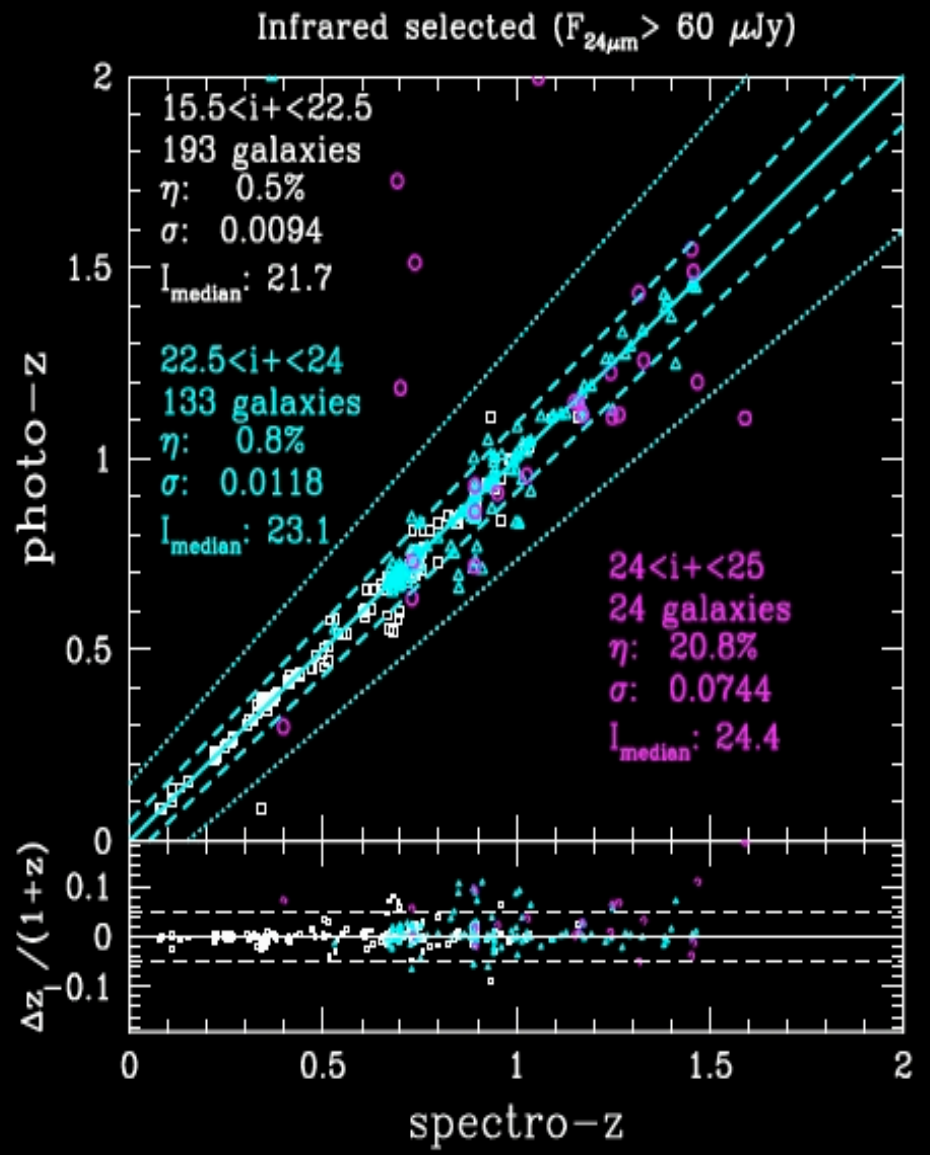
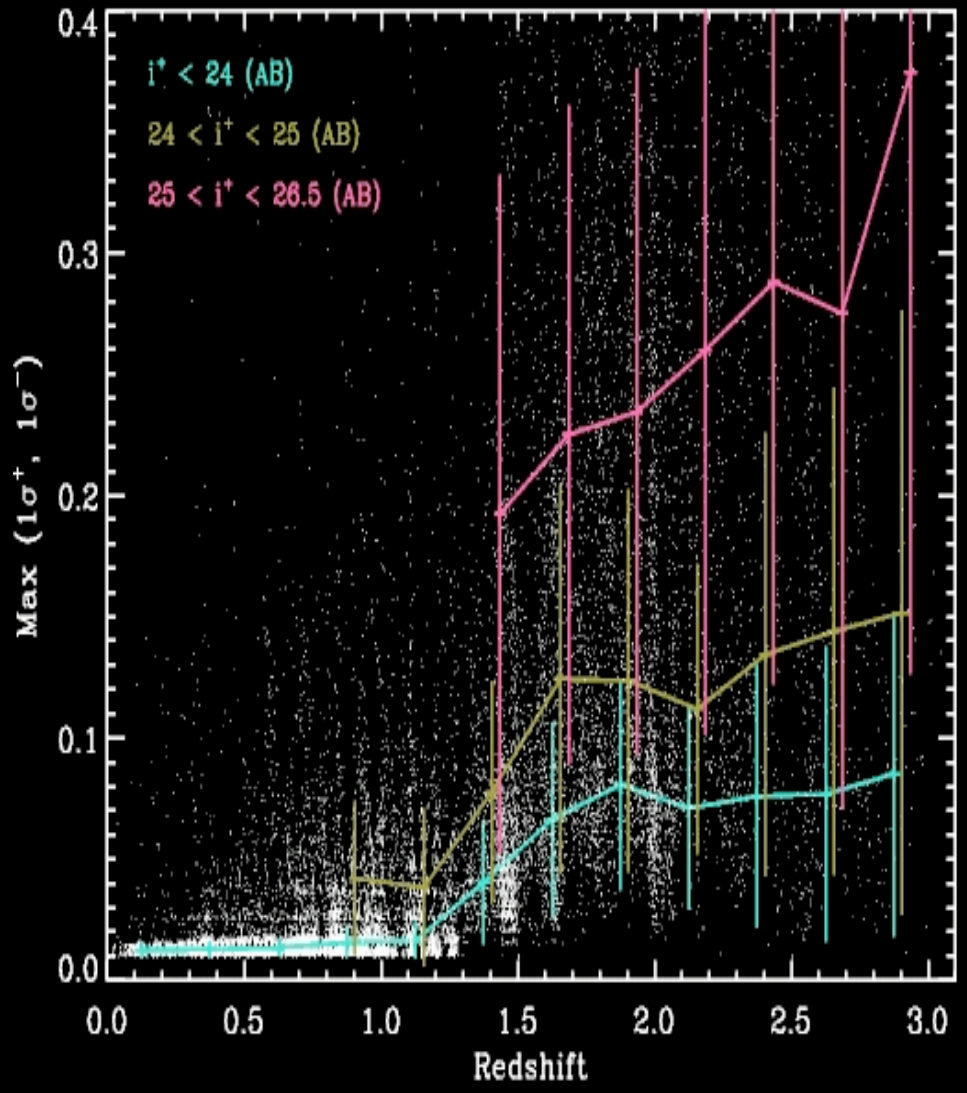
Photo-z accuracy for 24mic sources

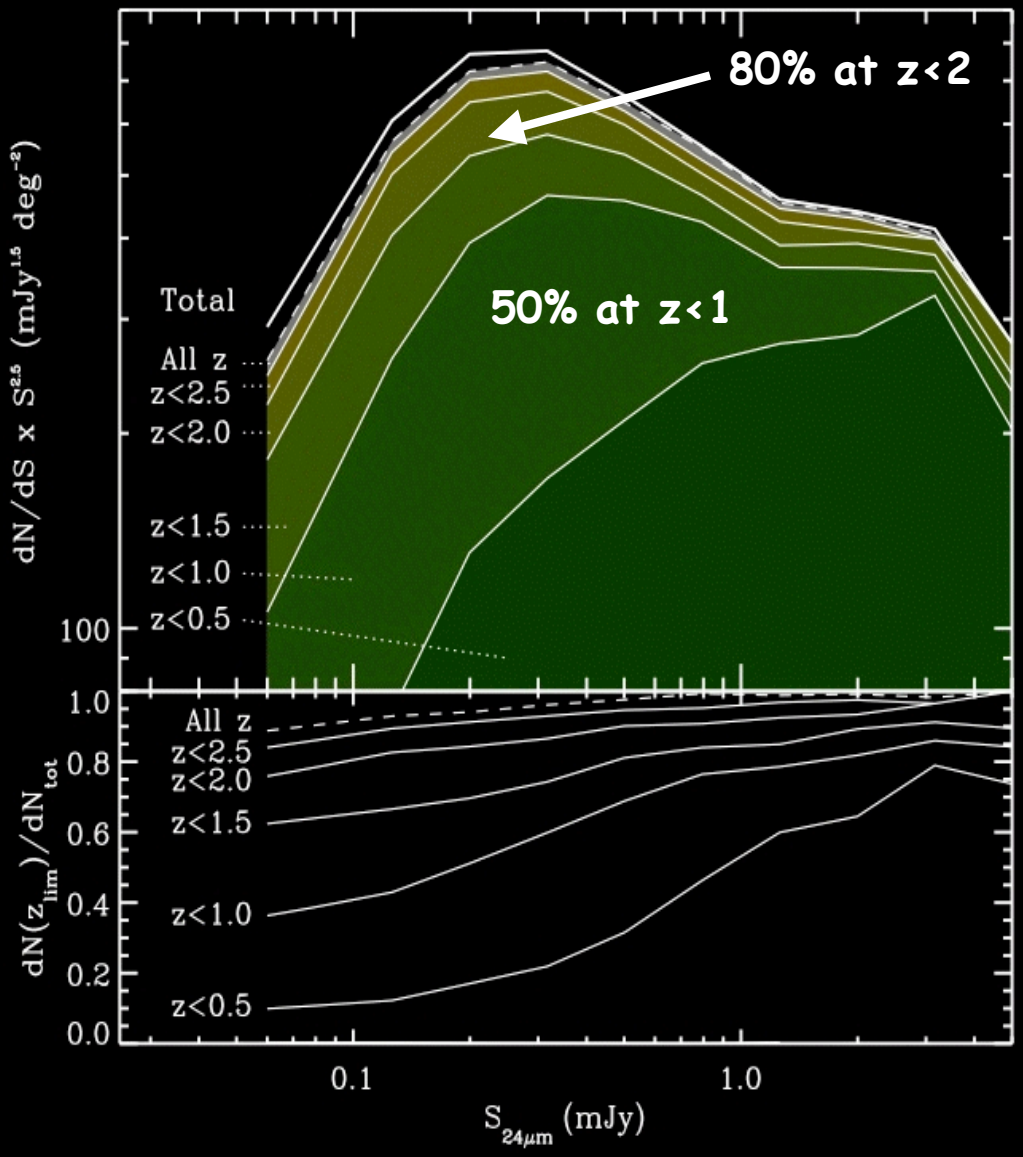


Ilbert et al. 2009



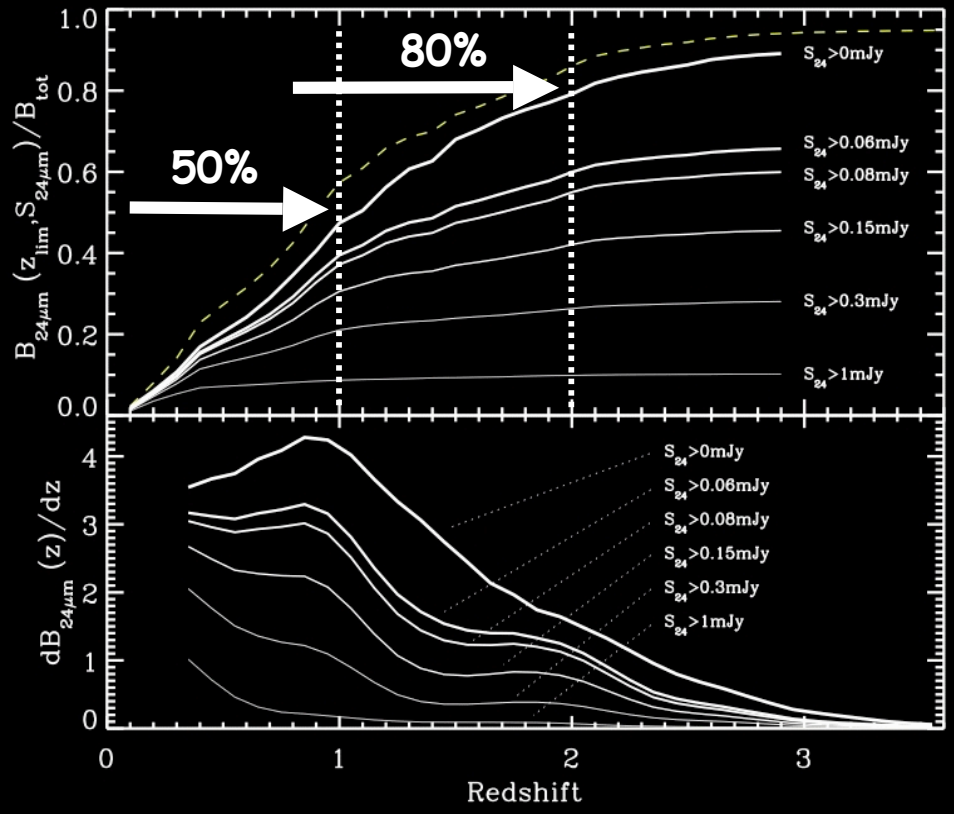
S24 > 80μJy

COSMOS at 24mic: results

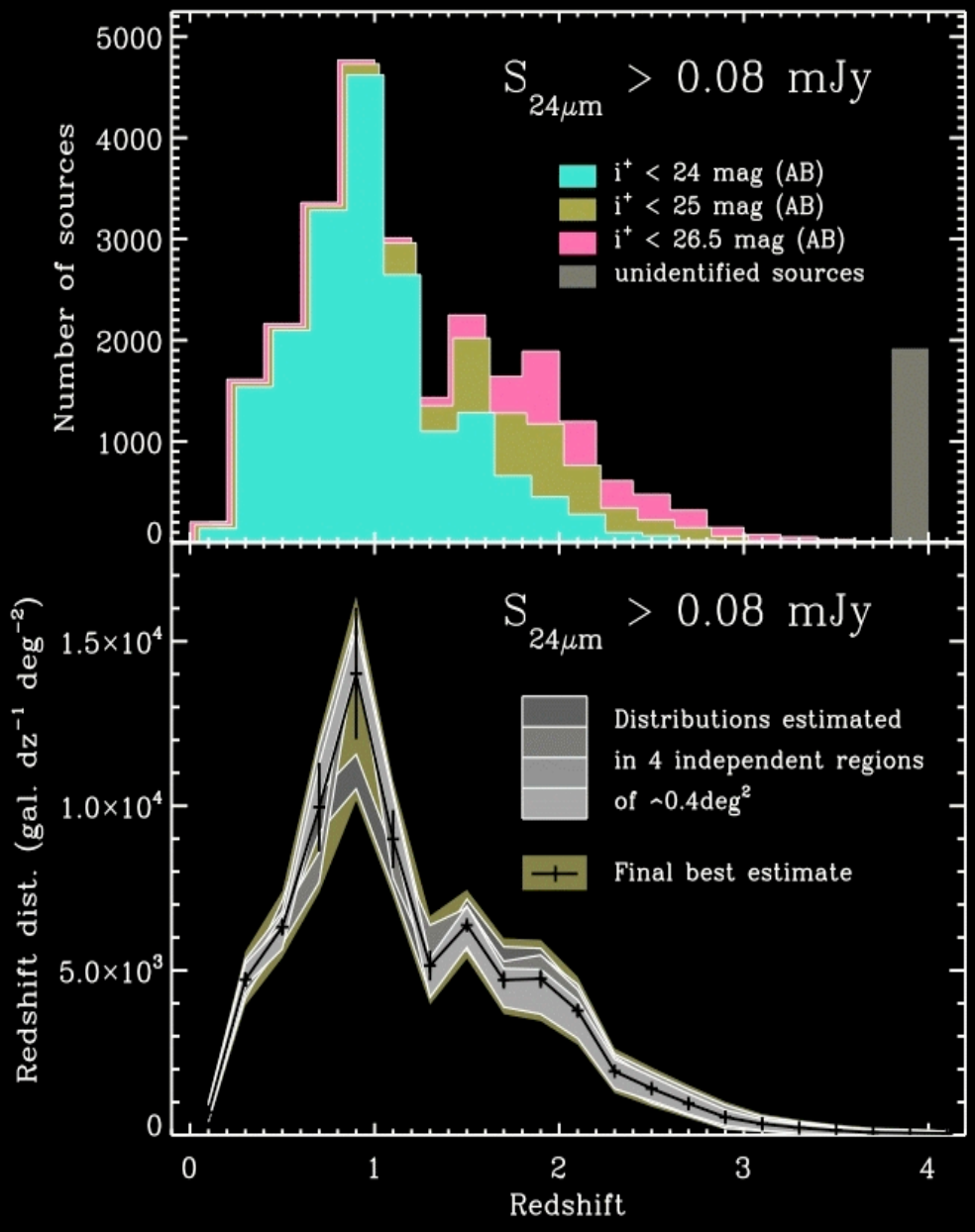


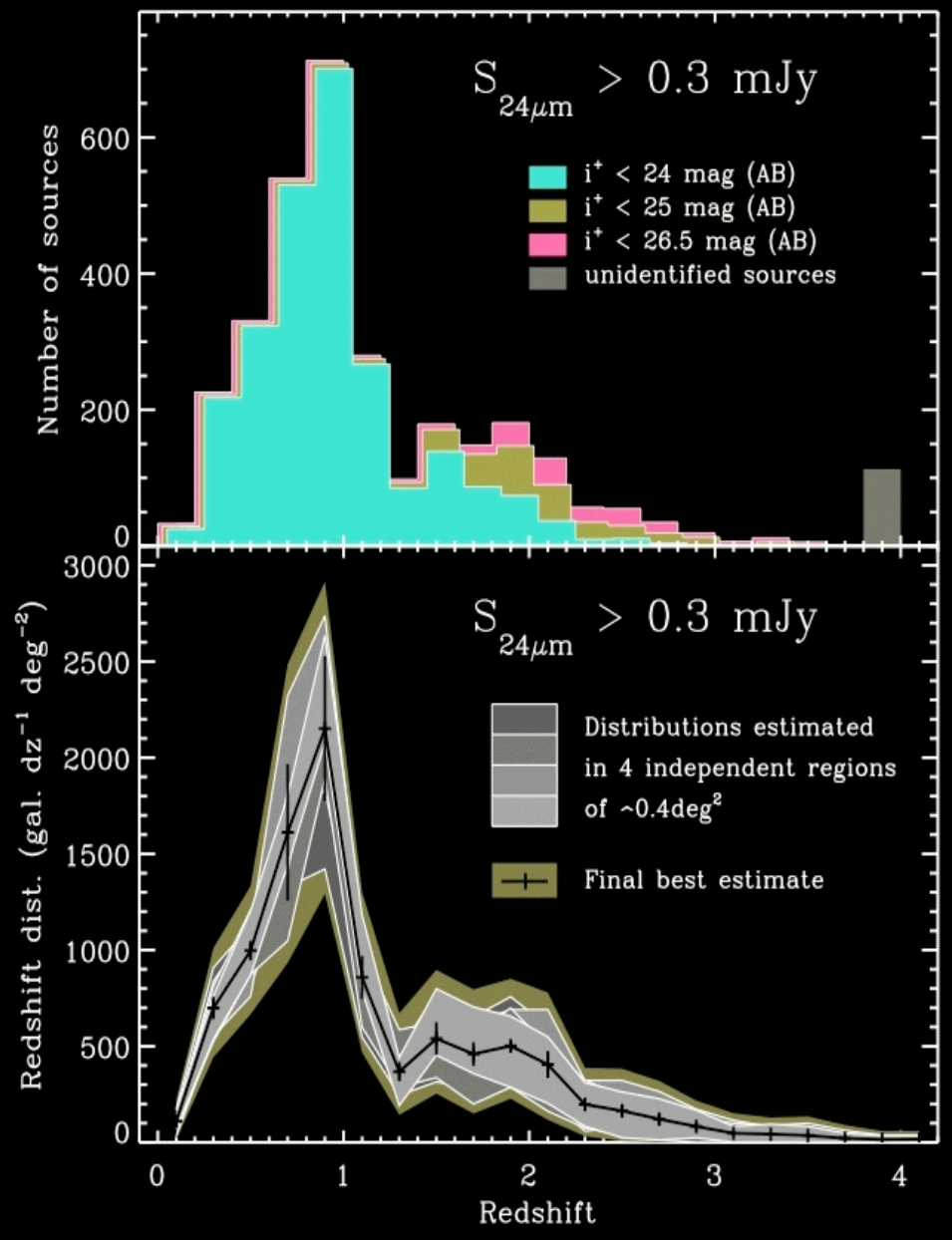
(Le Floc'h et al. submitted)

- Built-up history of the mid-IR background
- Redshift distributions
- Comparison with phenomenological and semi-analytical model predictions

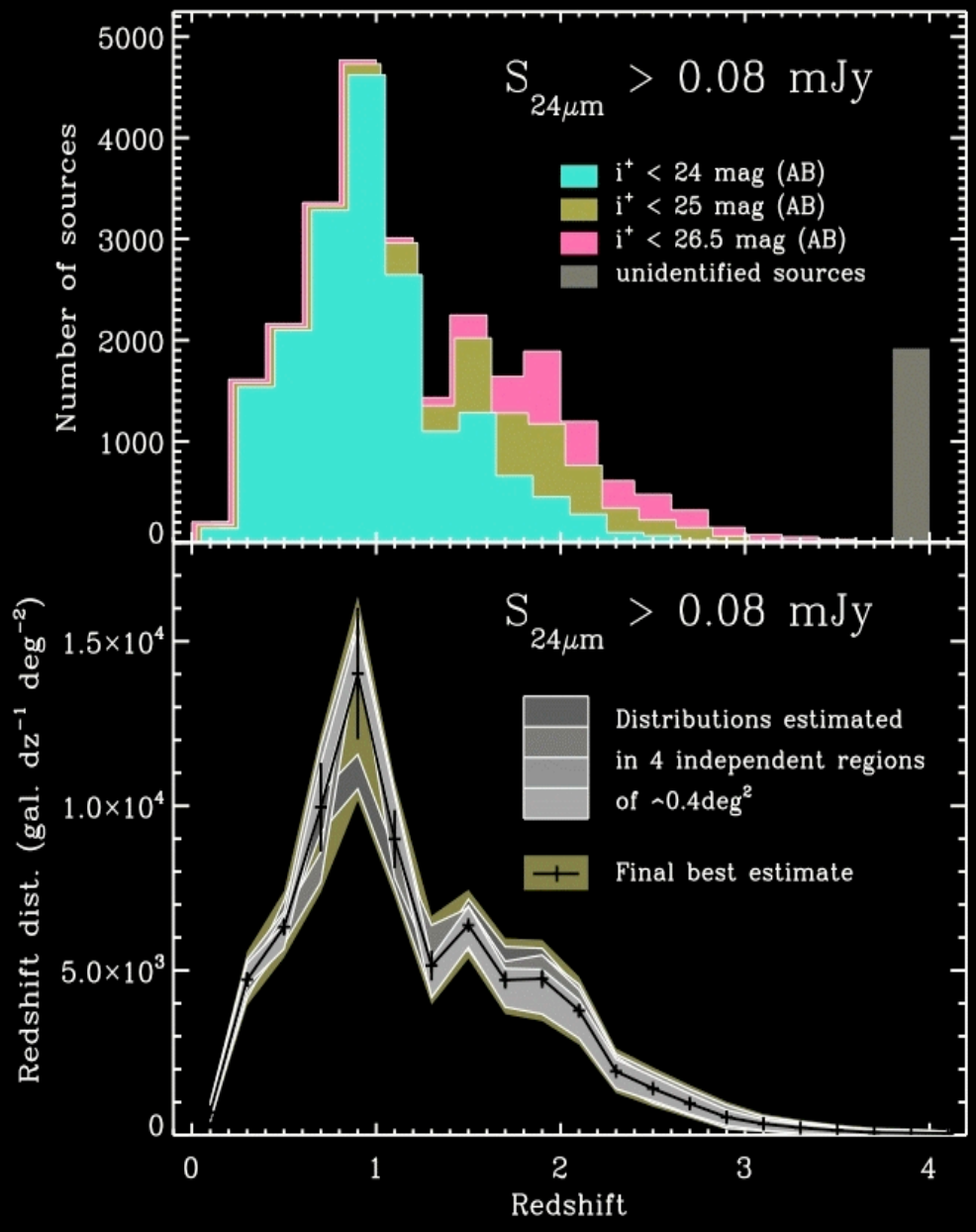


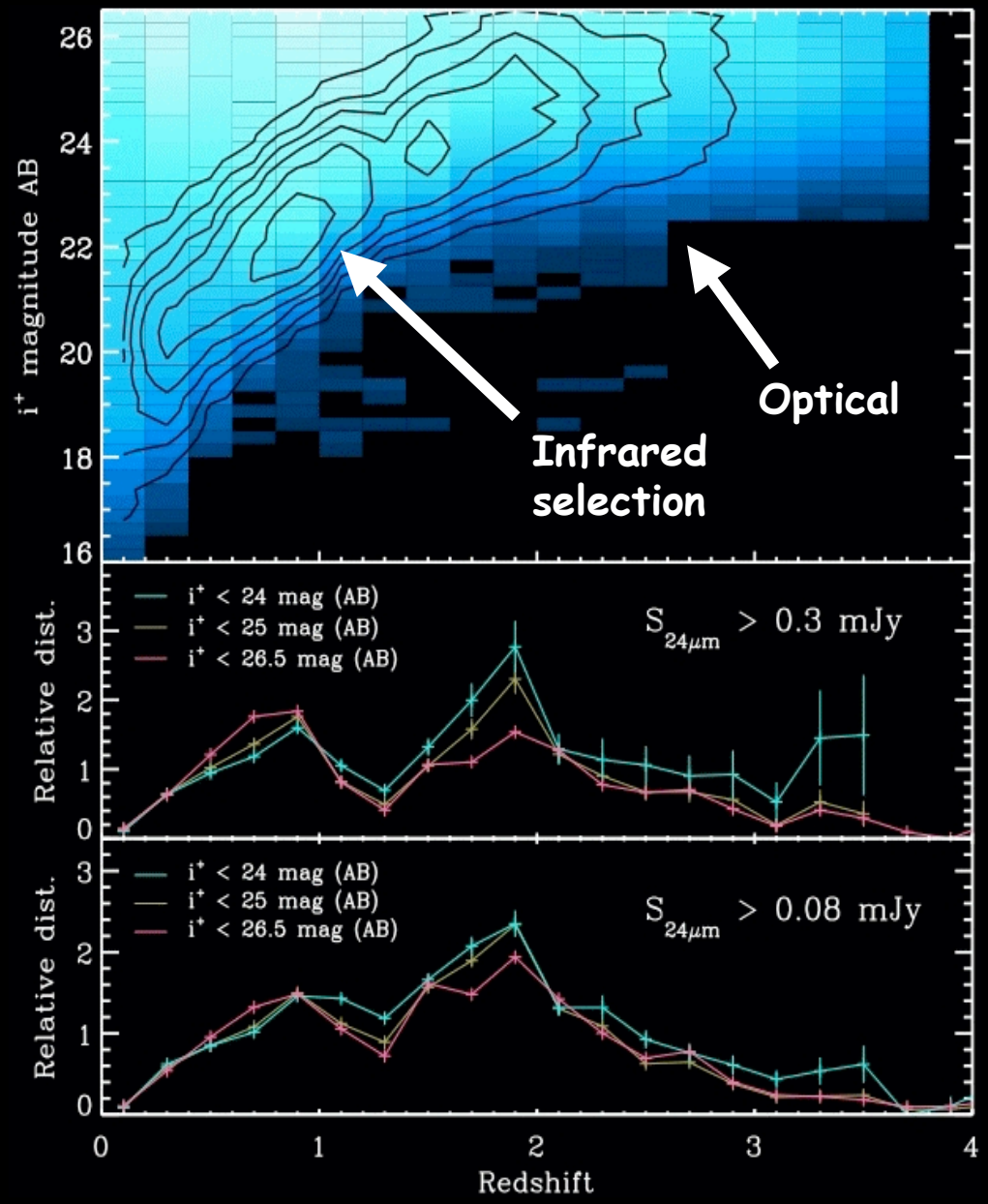
Redshift distributions





Redshift distributions





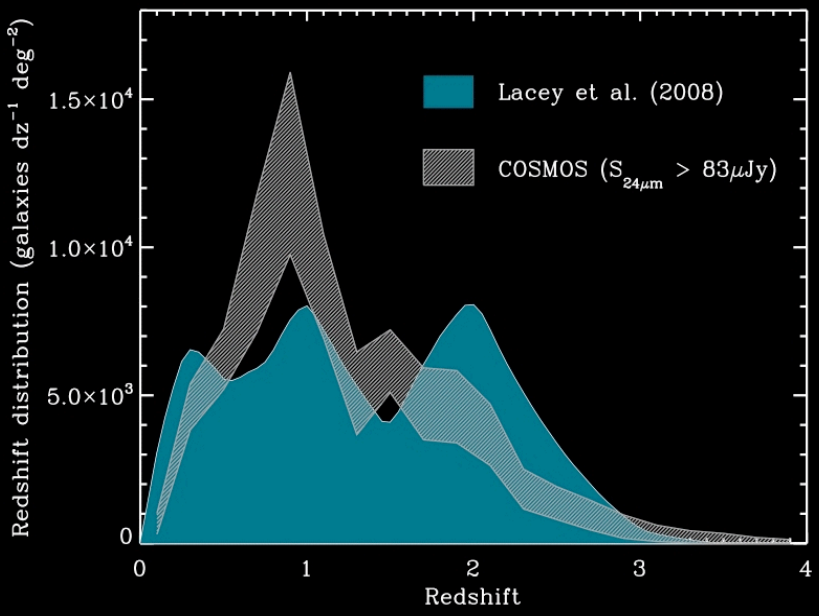
Semi-analytical predictions

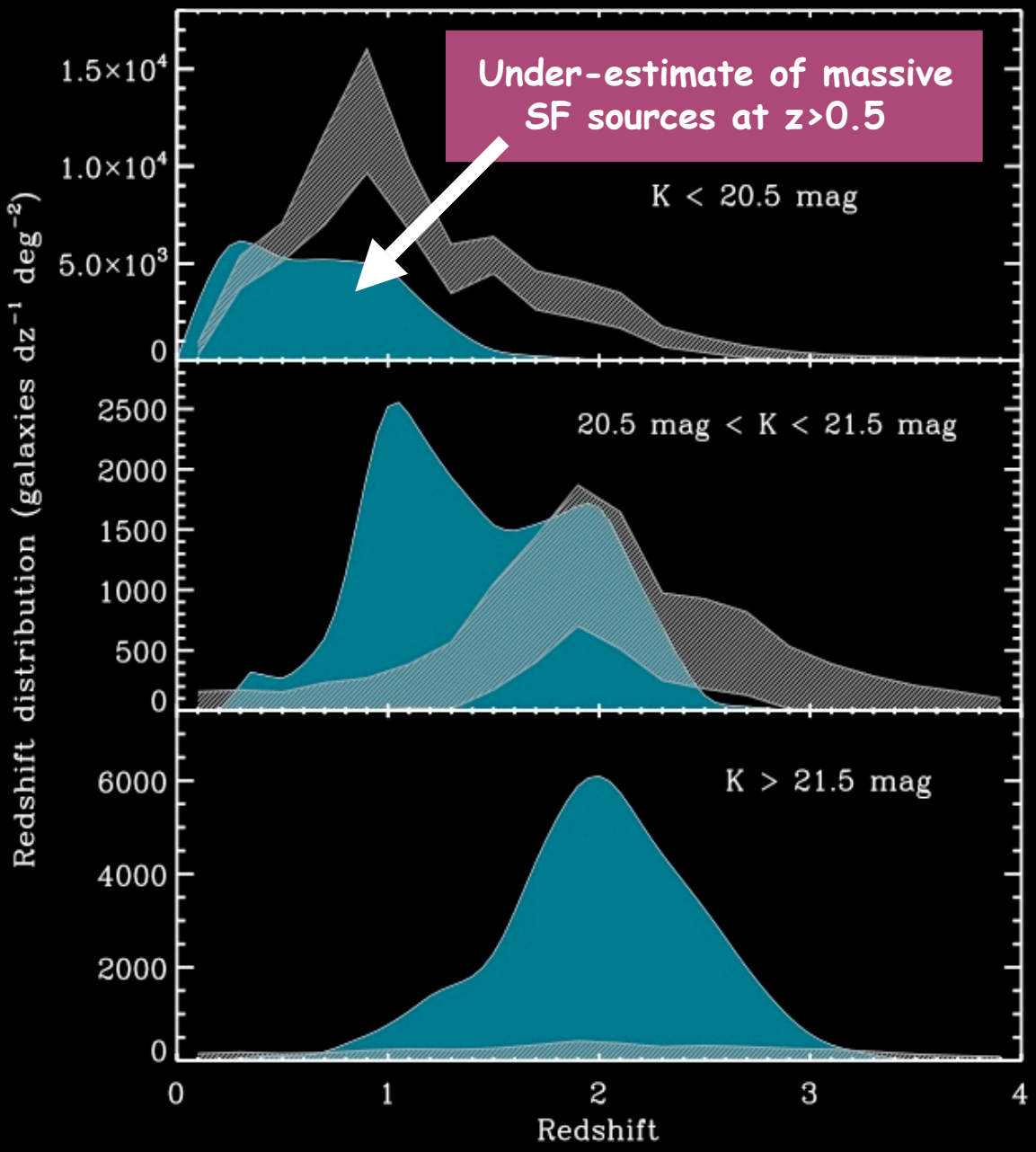
Lacey et al. 2008

* galaxy formation/evolution:
  GALFORM (ΛCDM)
* SEDs: GRASIL
* Top-heavy IMF
  (no AGN feedback, but AGNs dominate at the highest Lir)

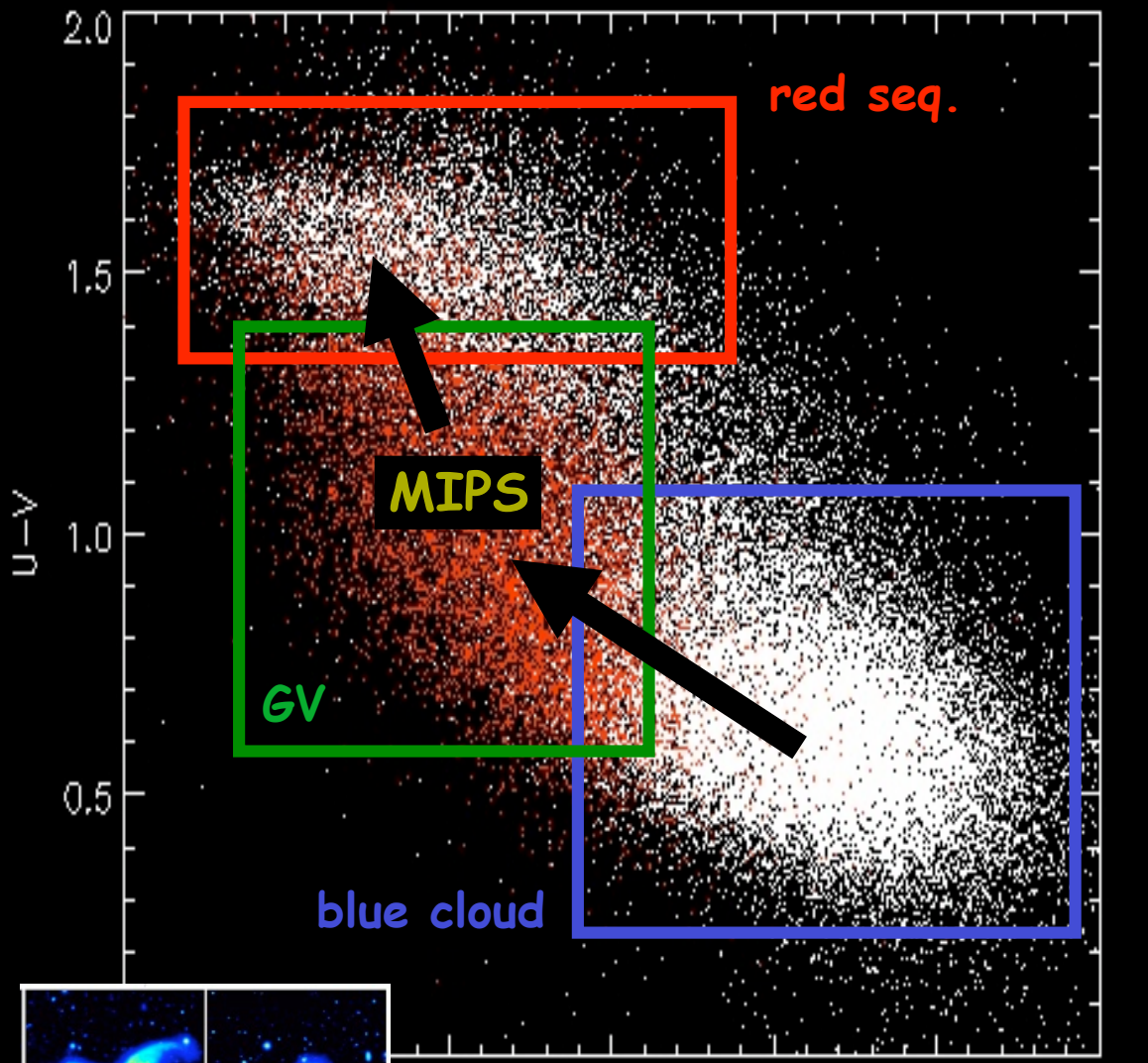
⇨ excess of sources at z~2
⇨ too blue predicted colors

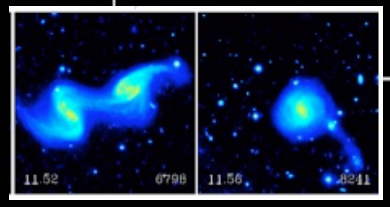
(LF+2009, submitted)





What makes LIRGs any special ????





LIRGs z=0 (Ishida)

IR-Luminous S-formers: a « transition » pop. ?

⇨ Probably not !! (at least at z<1)

- bright end of the GSMF did not evolve much since z~1 (Ilbert+2009, & many others)
- GV MIPS sources move back to the blue cloud after dust correction (e.g., Cowie & Barger 2008… also GALEX: Martin+05)
- Predominance of large spirals upon mergers, wrt what is seen at low z (Melbourne, Le Floc'h & Koo 2005, Lotz et al. 2008, …)

LIRGs z=1

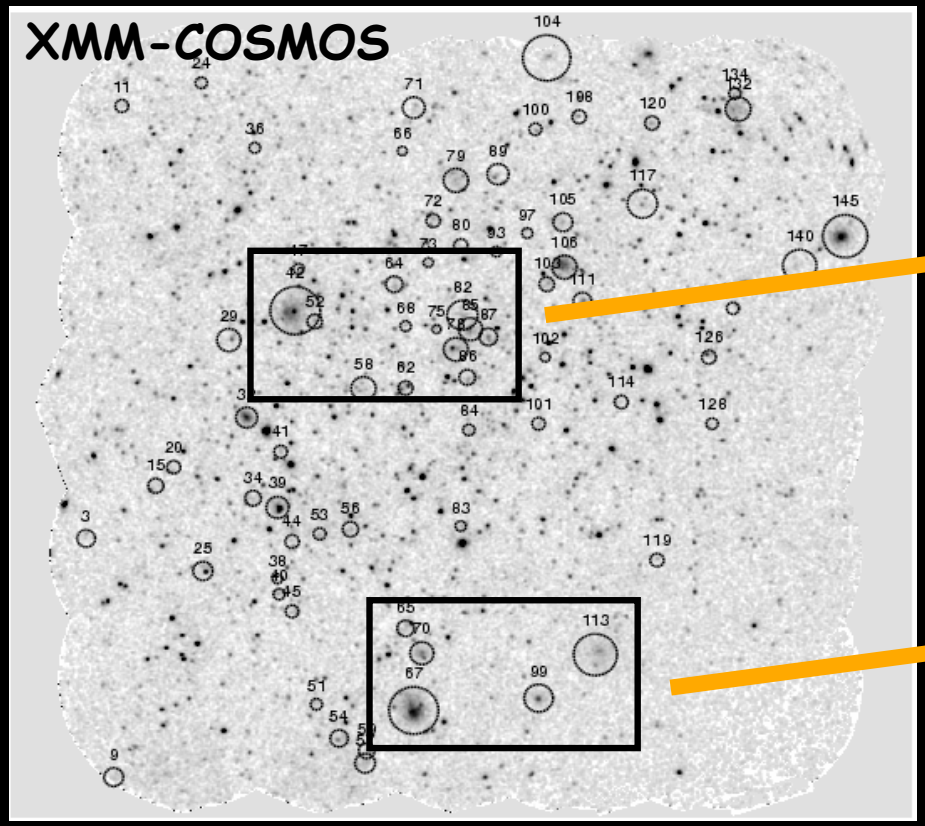
Environmental effects ?

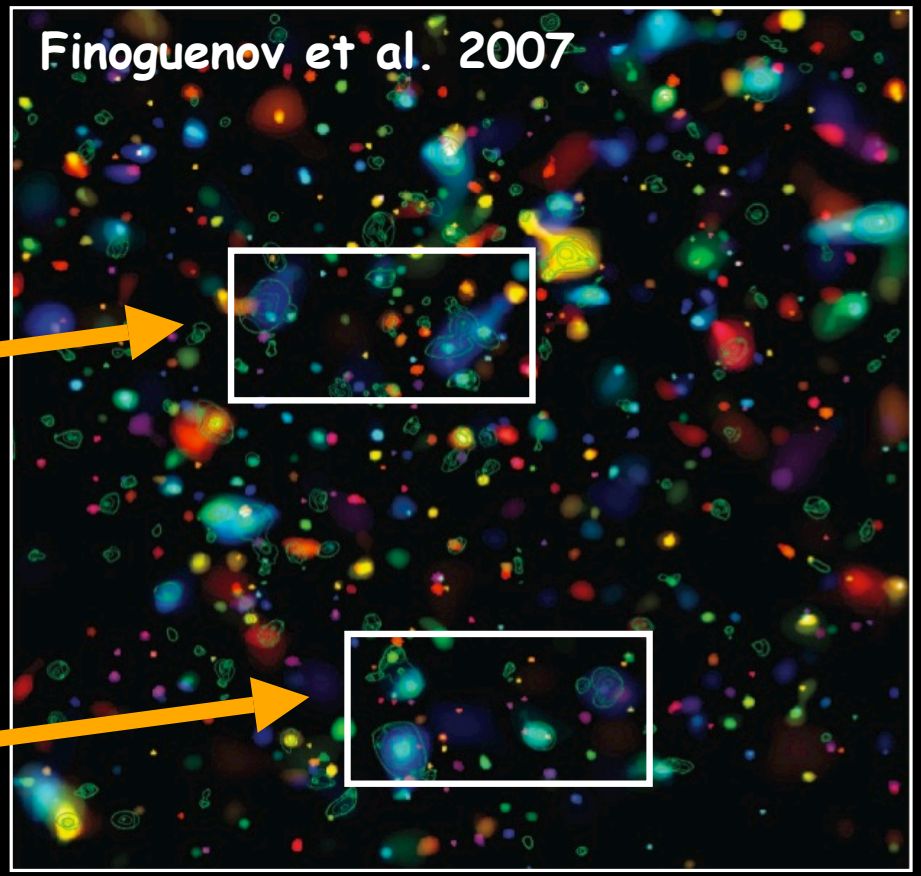
(i) 10th nearest neighbor (C.Feruglio et al. 2009, in prep., see poster)

(ii) clustering (correlation functions, HOD: S.Heinis et al., in progress)

(iii) Density estimates from Scoville et al.

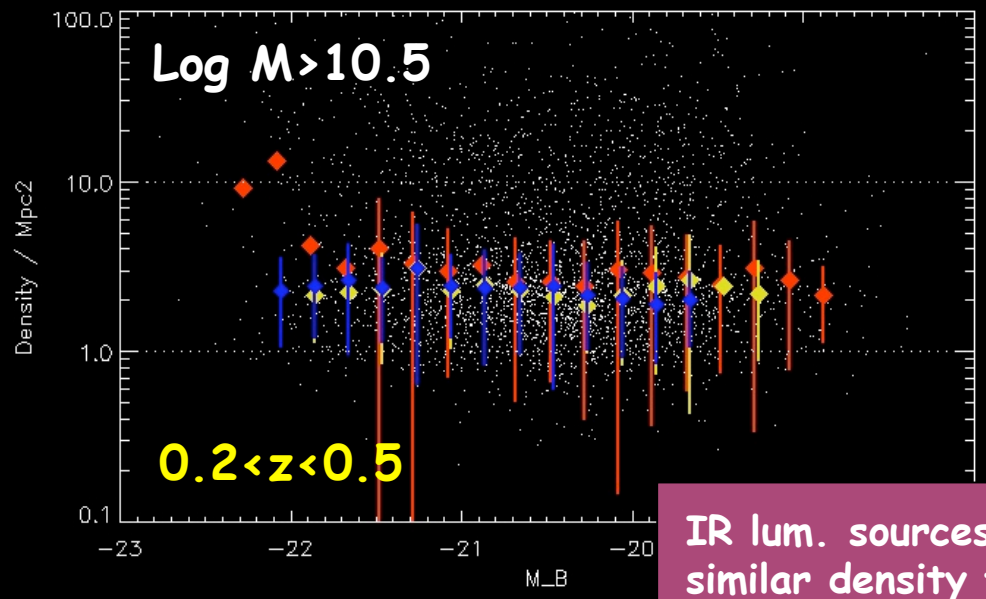
(iv) Association with clusters using X-ray identifications + wavelet reconstruction of early-type concentrations based on photo-z (from Alexis Finoguenov)

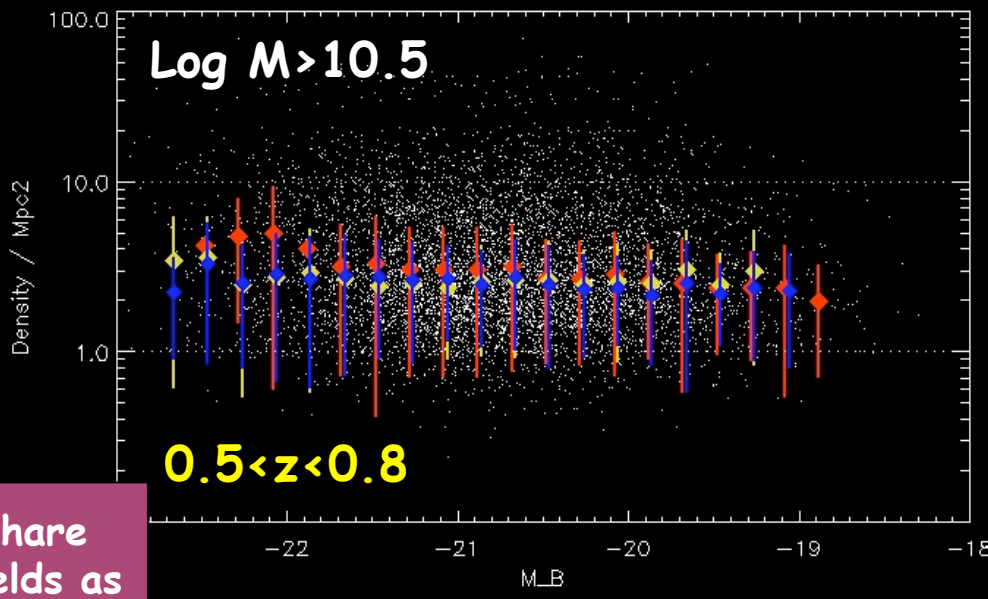




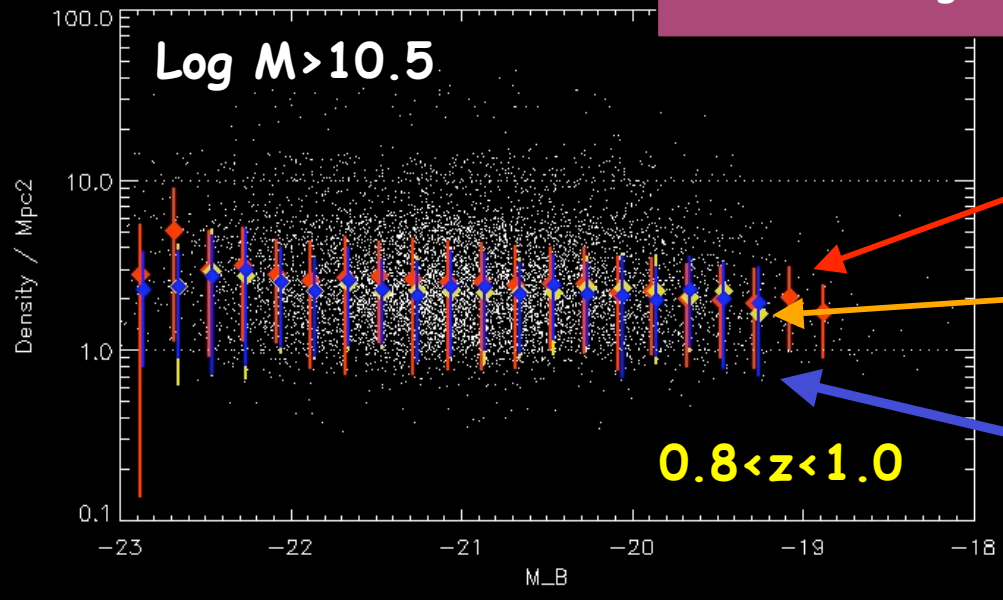
420 structures: z=0.1, z=0.3, z=0.5, z=0.7, z=1

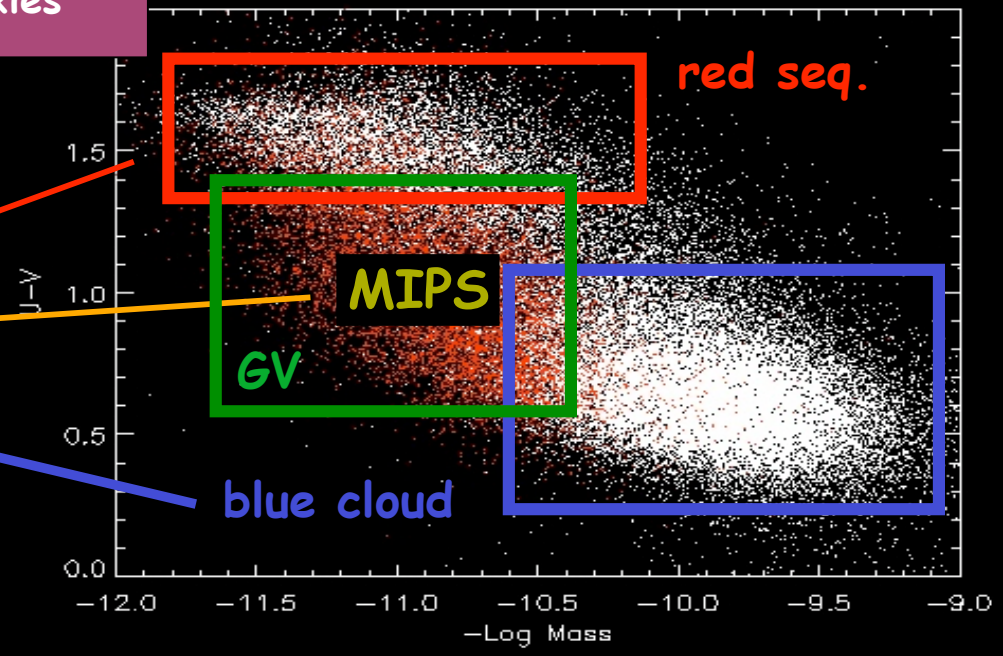
Environmental dependence on Lir





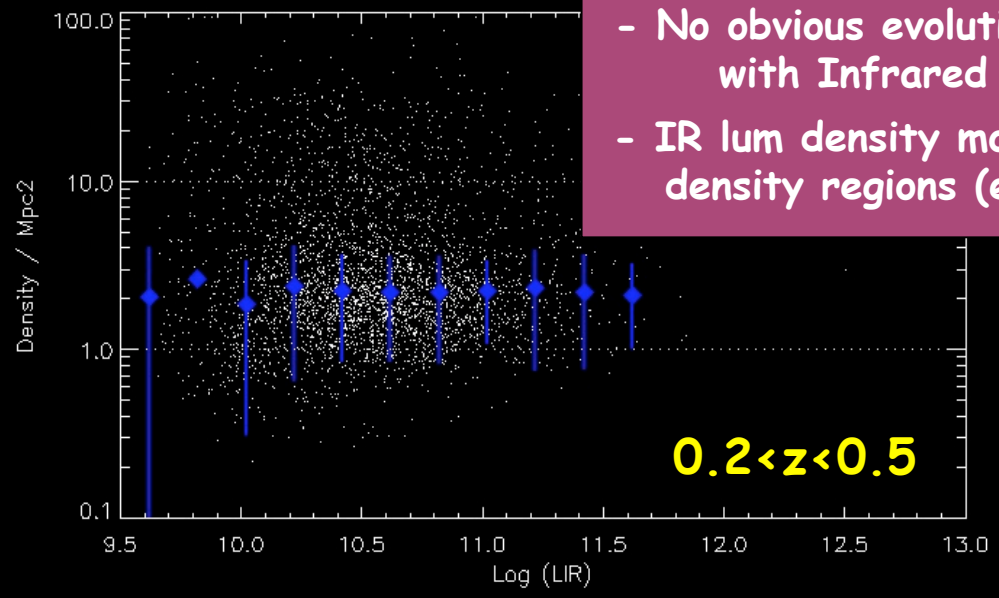
IR lum. sources share similar density fields as blue-cloud galaxies

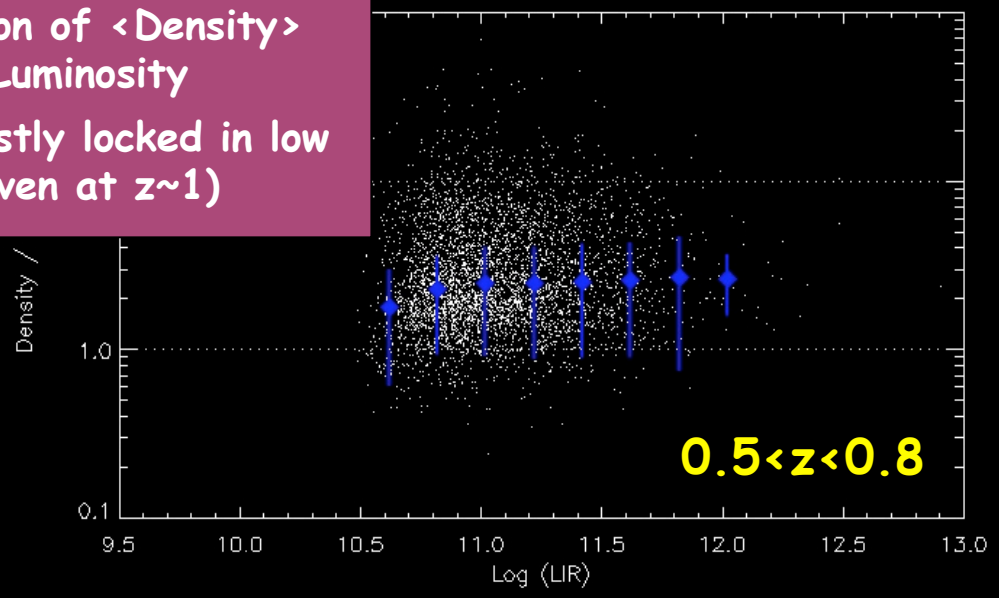


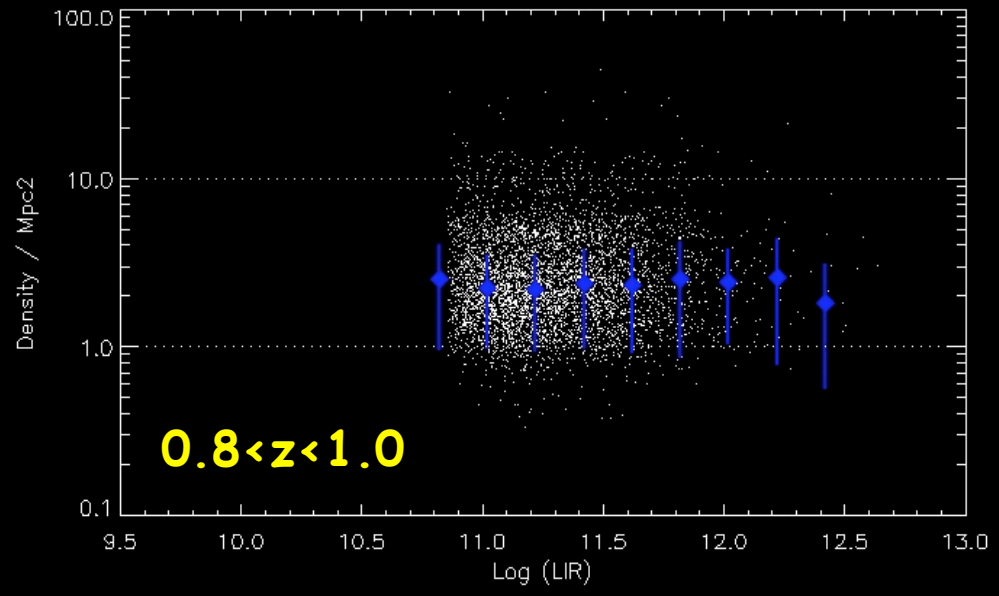


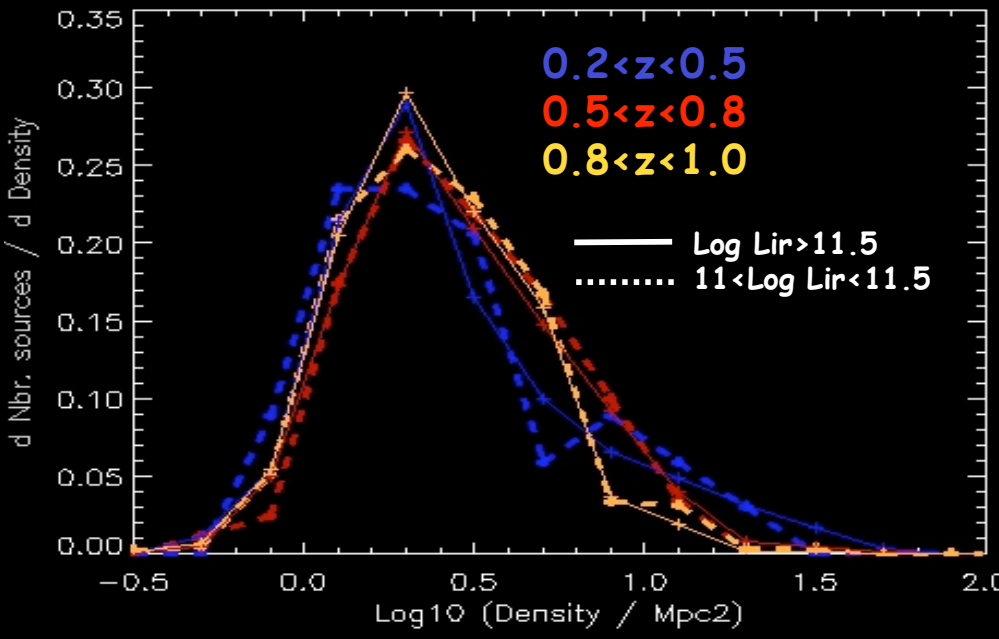
Environmental dependence on Lir

- No obvious evolution of <Density> with Infrared Luminosity
- IR lum density mostly locked in low density regions (even at z~1)









Environment / Clustering

Feruglio et al. 2009 (in prep., see also poster)

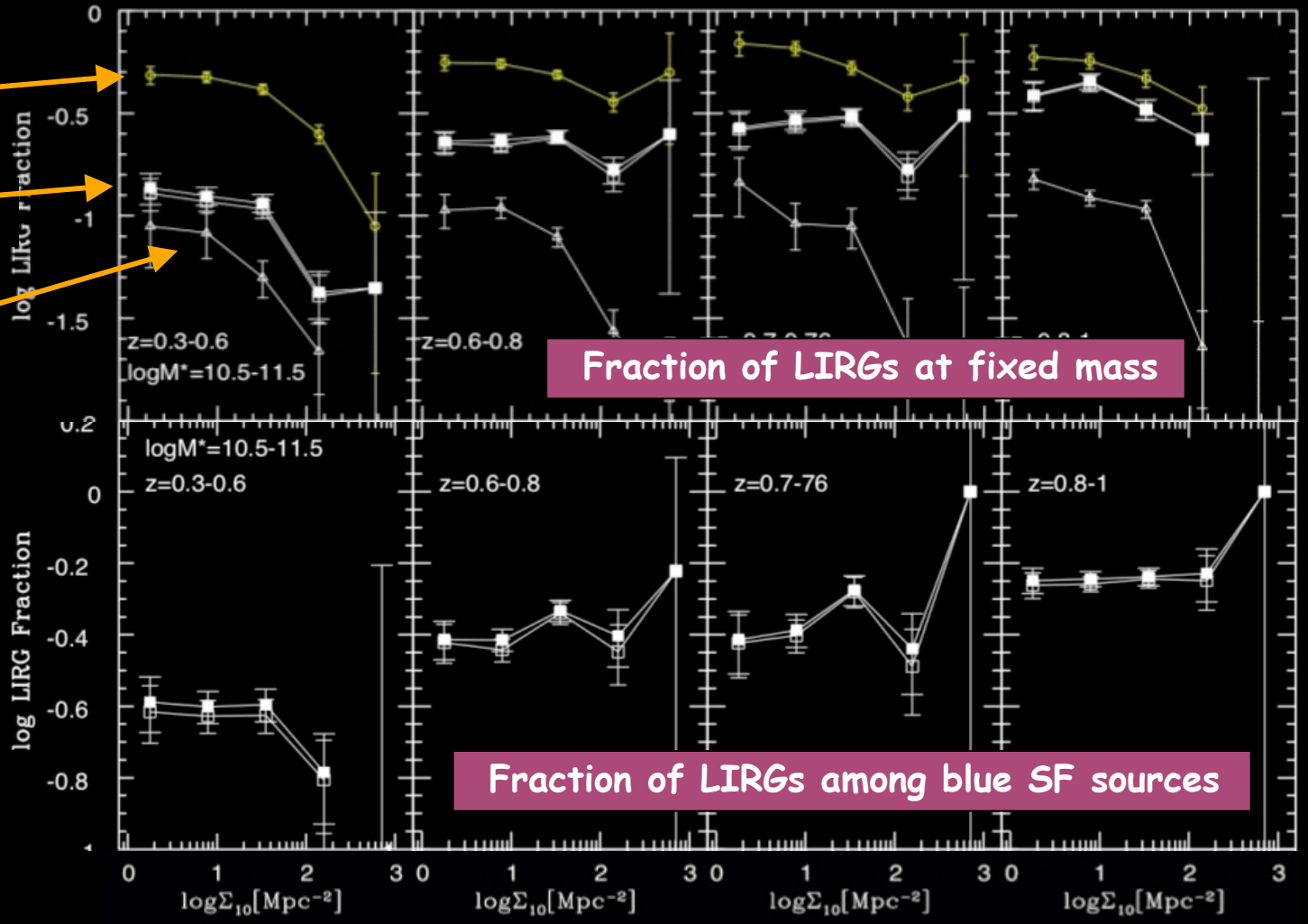
More rapid increase of the fraction of LIRGs with respect to parent populations (e.g., mass- or color-selected samples) in denser environments, versus z

Blue galaxies

LIRGs

Predicted LIRGs (Millenium)

⇨ Trend predicted by semi-analytical models, but LIRG fraction underestimated



Environment / Clustering

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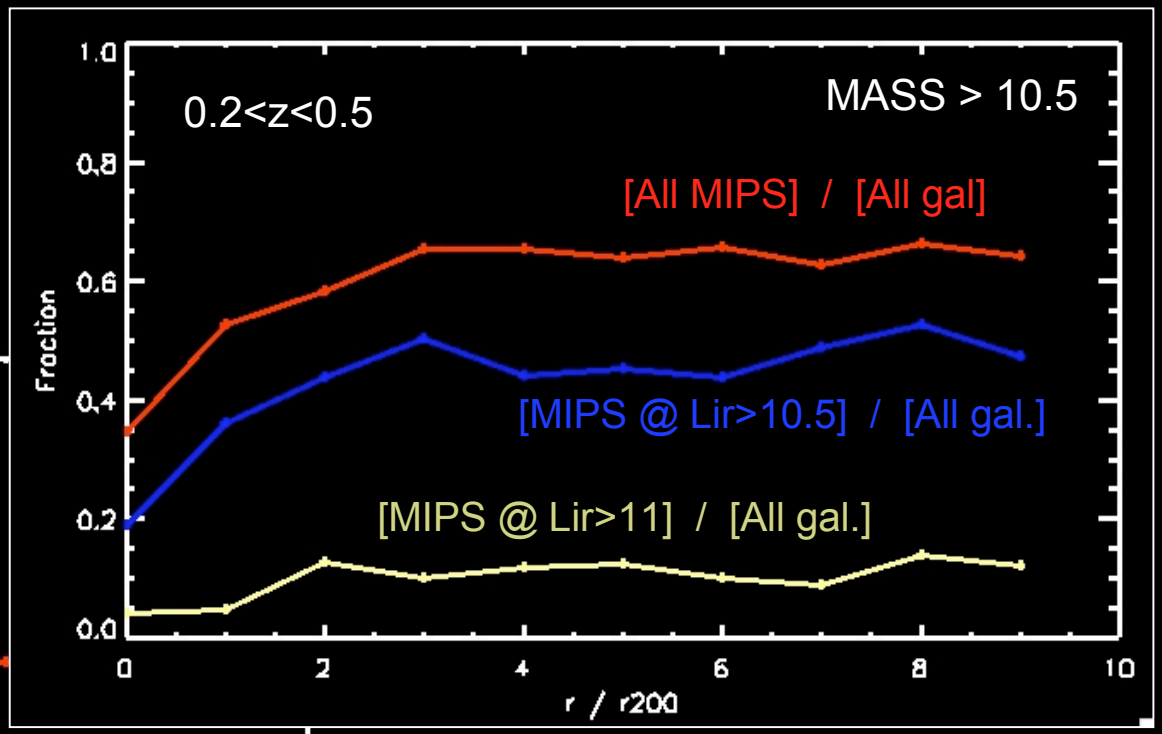
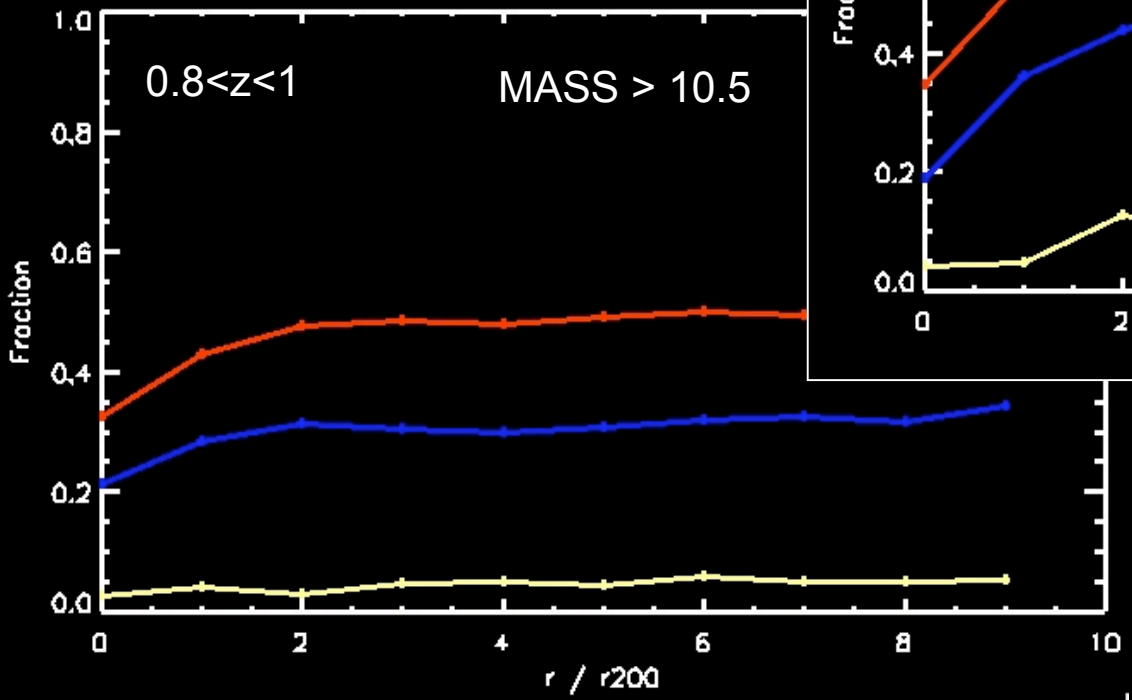
Same trends with cluster centric radii



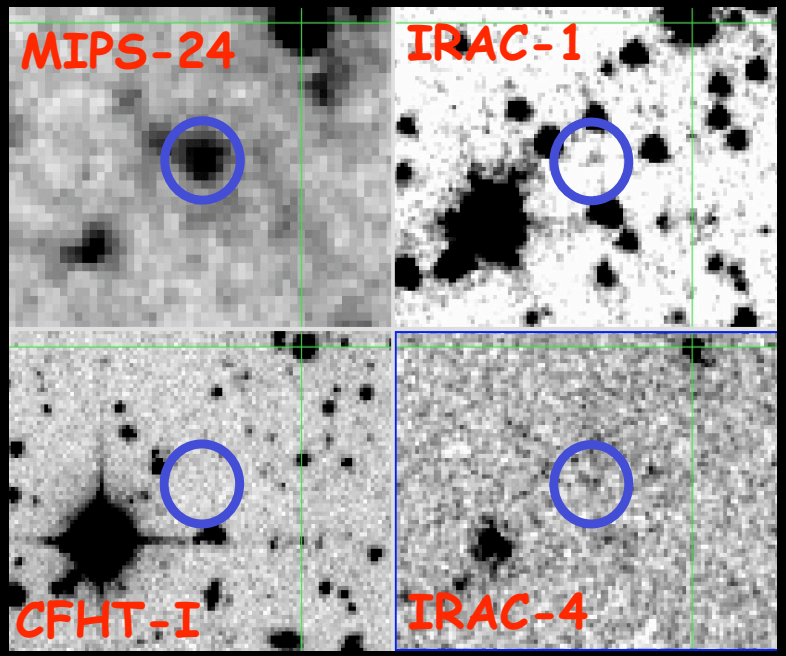


!!! (very preliminary) !!!

Summary/Perspectives

* COSMOS-24mic allows a detailed characterization of the contribution of luminous galaxies up to z~2 (but still a lot to do !!).

  - properties far from being understood in models
  - we do see trend with environment (i.e., a faster increase of the fraction of LIRGs at high density), but still very weak (might need to focuss on clusters themselves)



* Herschel will play a key role
* But need deeper NIR data (ULTRA-VISTA)
* Need to combine UV and IR light for total SF estimate vs environment