First results from PACS deep surveys

Dieter Lutz, for the PACS Evolutionary Probe (PEP) team

Herschel SDP Workshop

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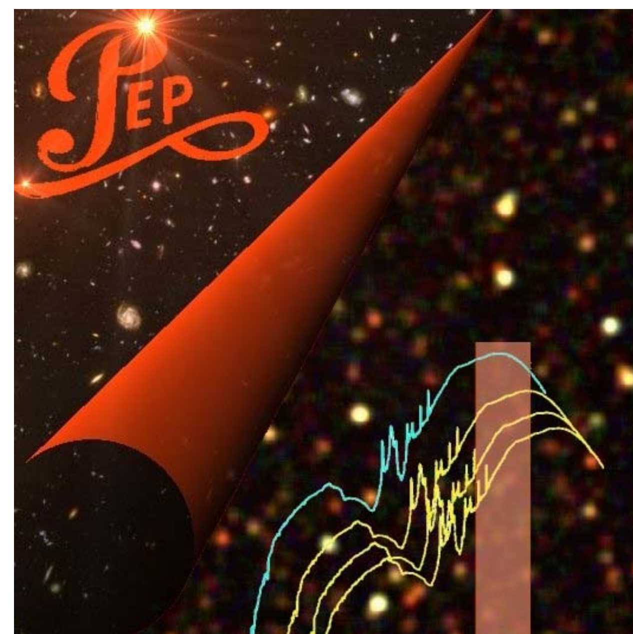
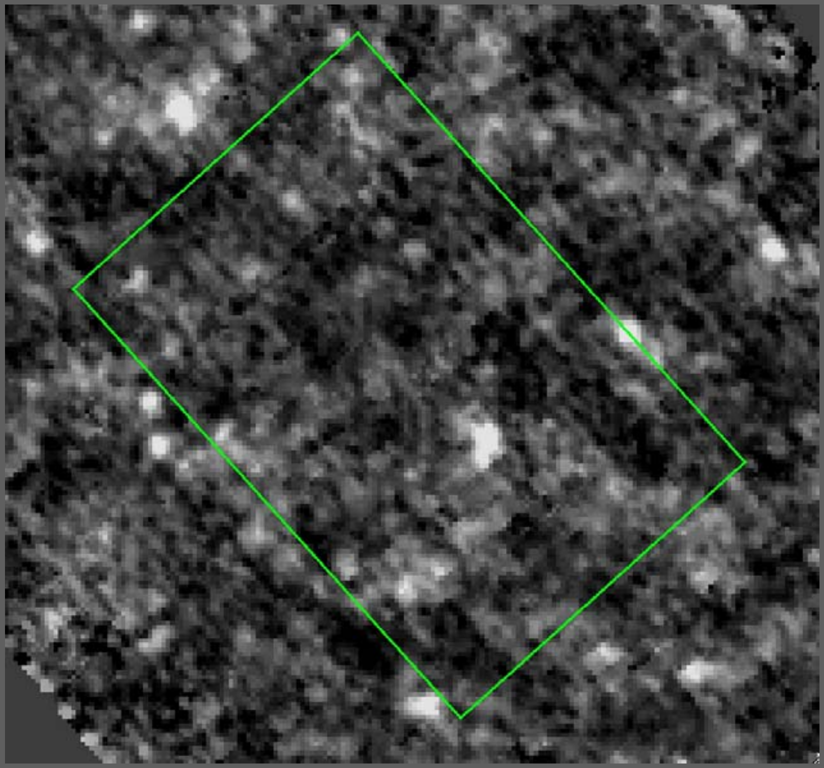
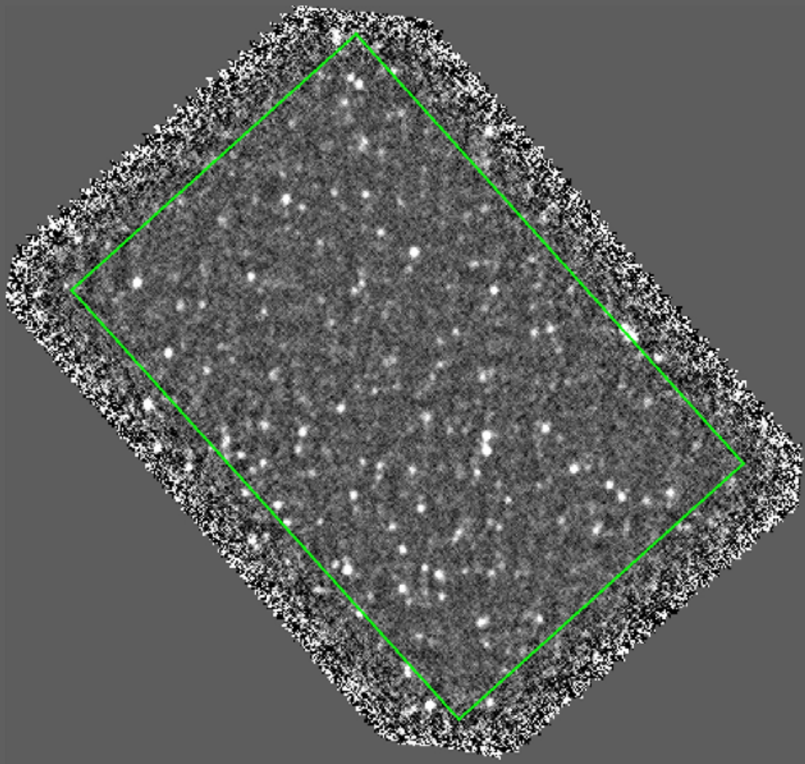


From MIPS to PACS



GOODS-N 160µm
MIPS team
+ FIDEL team



GOODS-N 160µm
Herschel-PACS
PEP team

PEP in the complement of Herschel extragalactic surveys

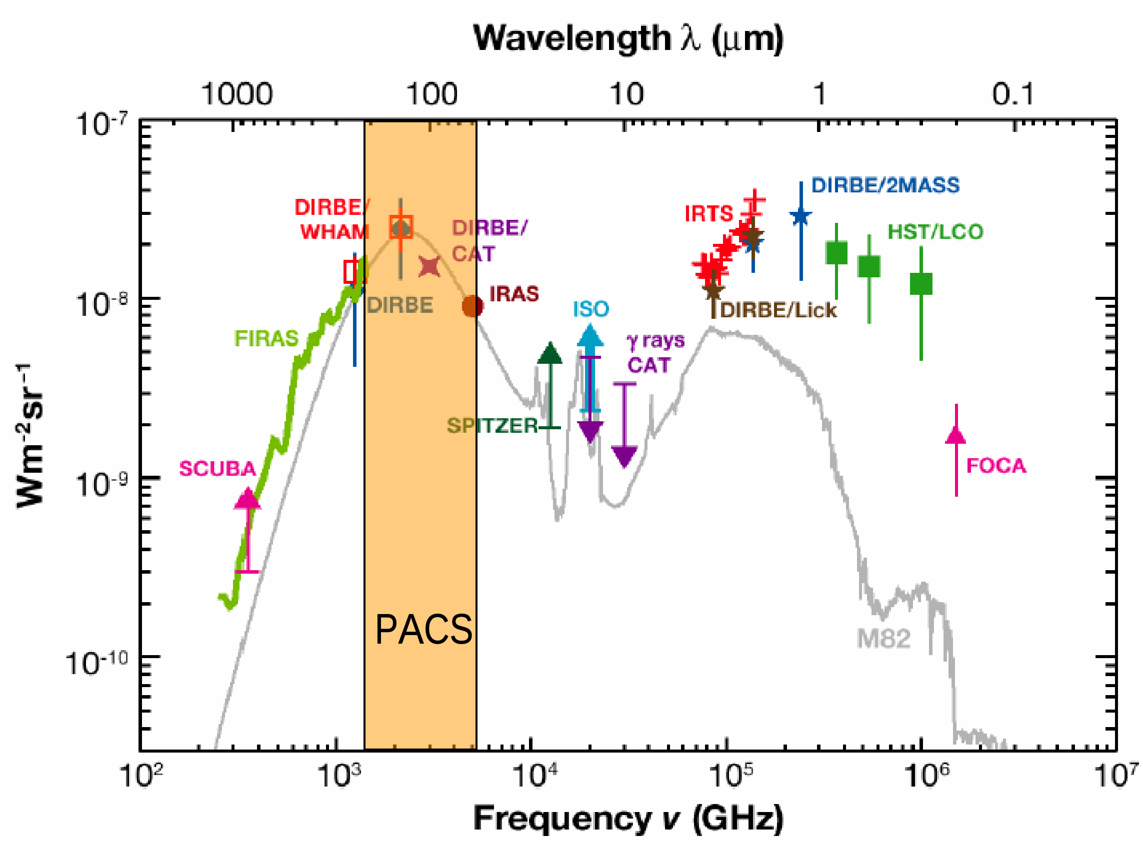
- PEP is the major Herschel 100/160um extragalactic survey of key multiwavelength fields

Field	Area	Total Exp. [hours]	5 sigma (70) [mJy]	5 sigma (100) [mJy]	5 sigma(160) [mJy]
COSMOS	85'x85'	213	--	6.13	8.63
Lockman Hole	24'x24'	35	--	4.90	6.84
E-CDFS	30'x30'	35	--	5.90	8.25
Groth Strip	67'x10'	35	--	5.44	7.75
GOODS-S	10'x15'	113 113	1.61 --	-- 1.72	2.43 2.43
GOODS-N	10'x15'	30	--	3.33	4.70

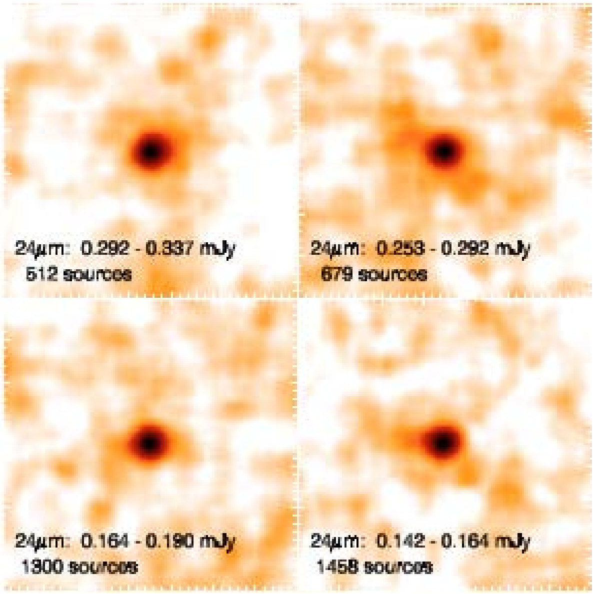
- +10 lensing clusters

- Coordinated with Hermes for SPIRE coverage
- Hermes and Atlas extend to wider+shallower PACS coverage
- GOODS-Herschel will go deeper on (parts of) GOODS fields
- Herschel lensing survey will substantially extend the number of lensing clusters

Theme 1: The Nature of the Cosmic Infrared Background

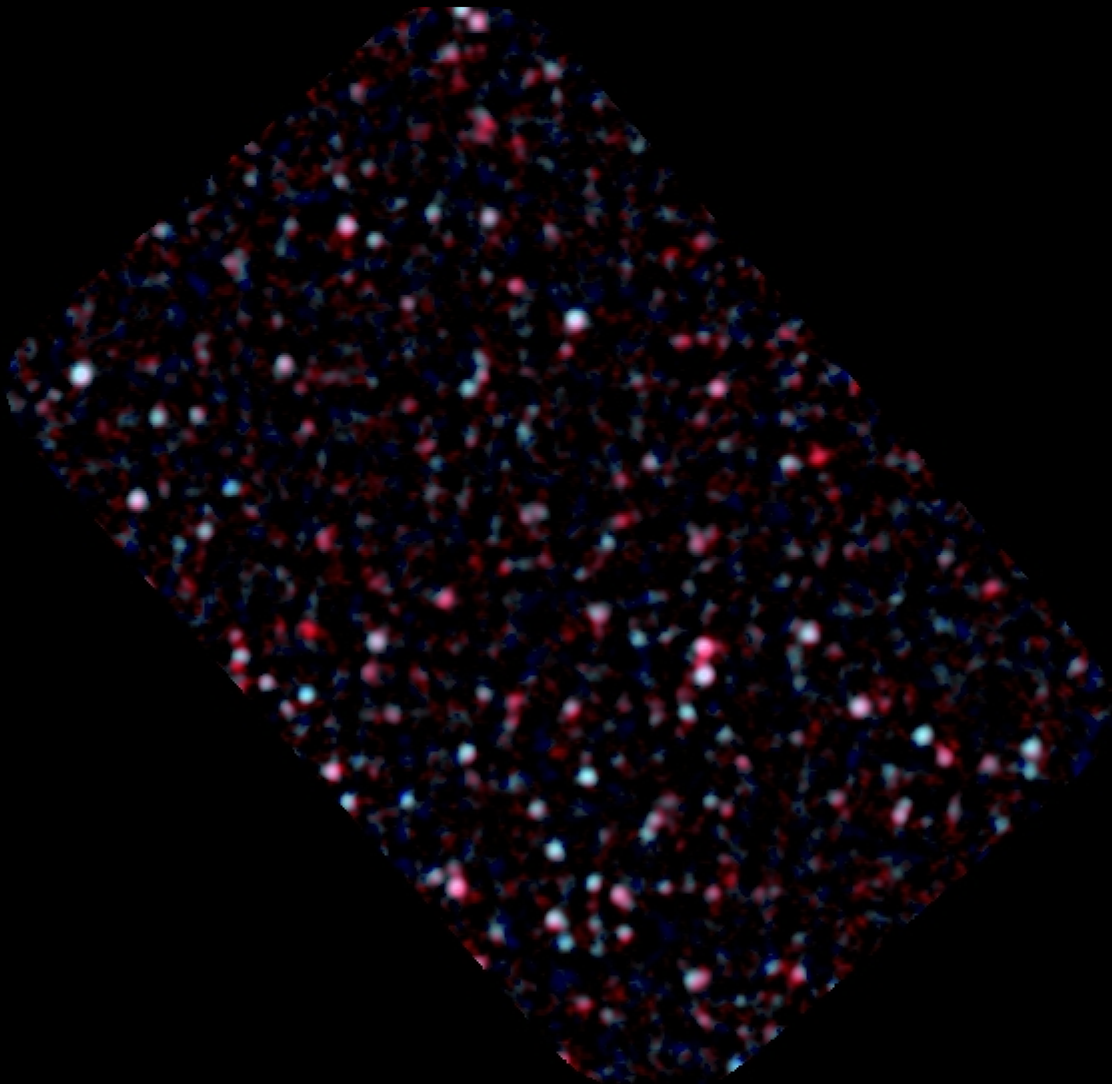


Lagache et al. 2005 ARAA



Dole et al. 2006

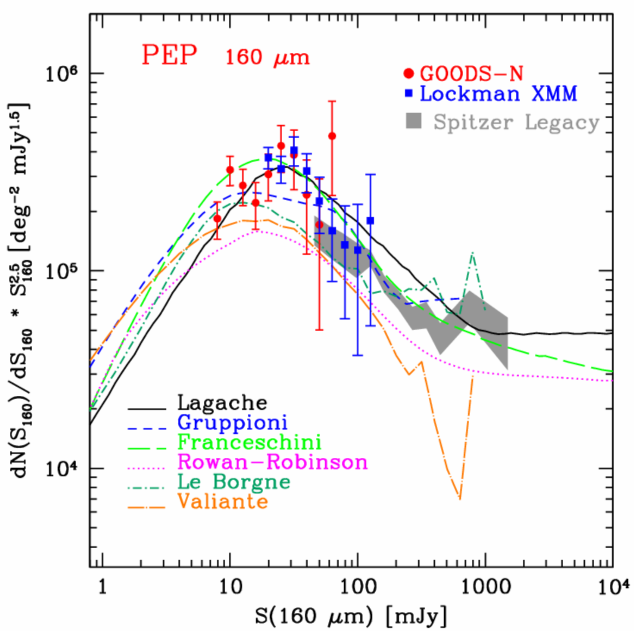
Resolving the CIB into individual galaxies

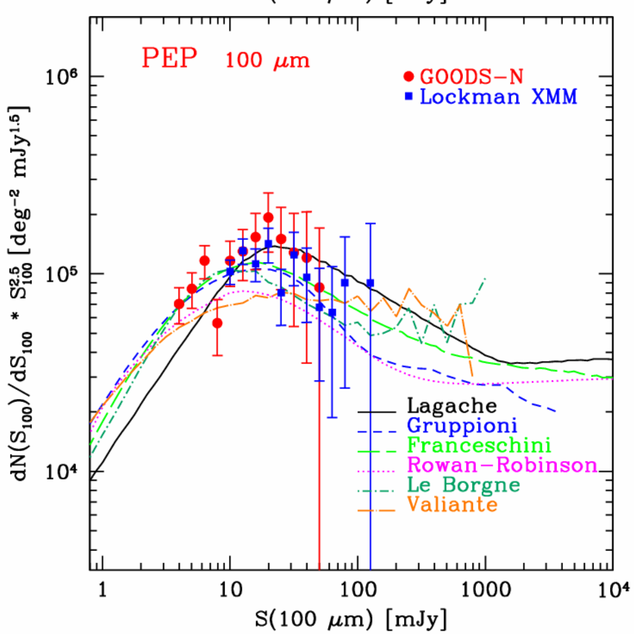


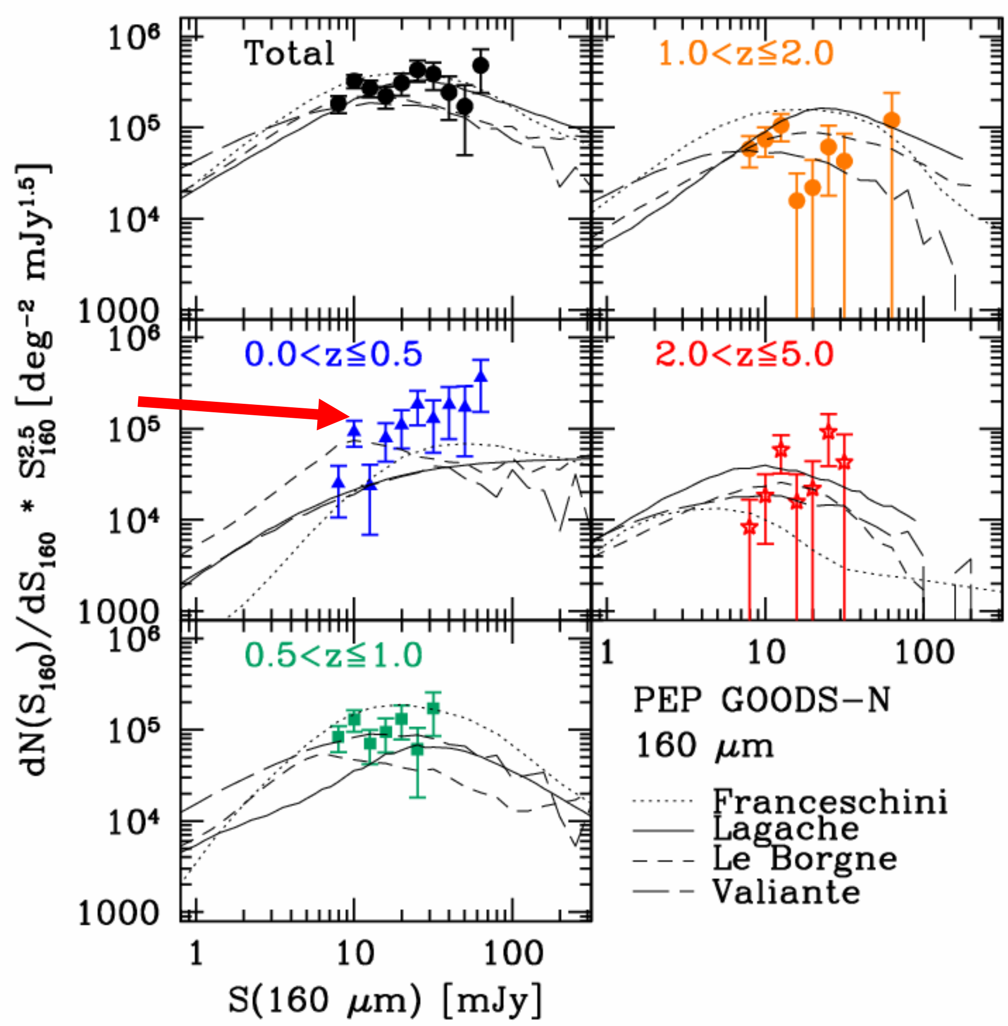
Already the SDP GOODS-N data **resolve ~60% of the CIB at 100 and 160μm into individually well detected (5σ)** sources

Great prospects for further characterisation and deeper observations with PEP and GOODS-Herschel!

Analysing the CIB: Berta et al. in prep.

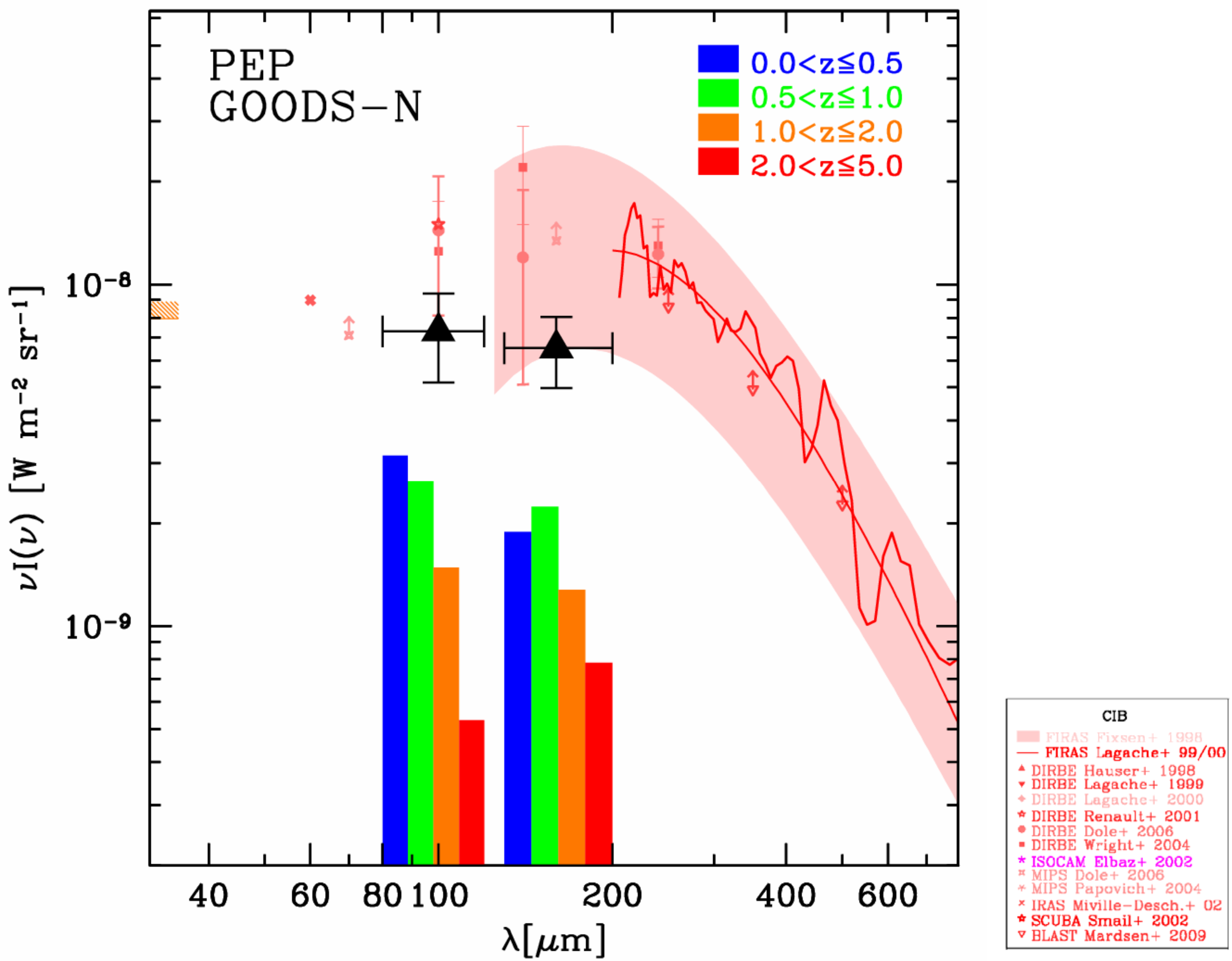




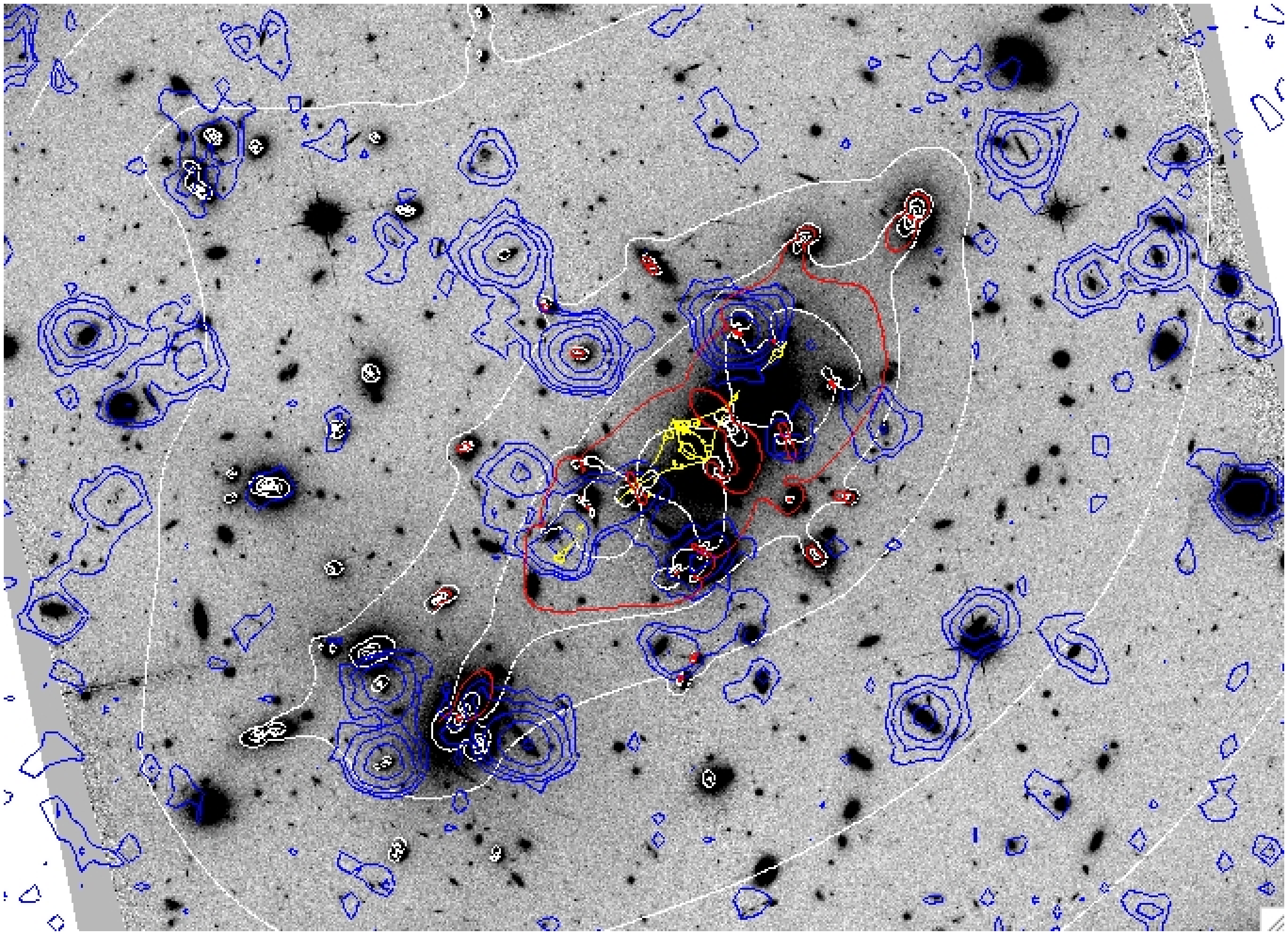


- Counts ~ at high end of previous models
- local (cool?) objects boosting the counts

Slicing the CIB by redshift: Berta et al. in prep.



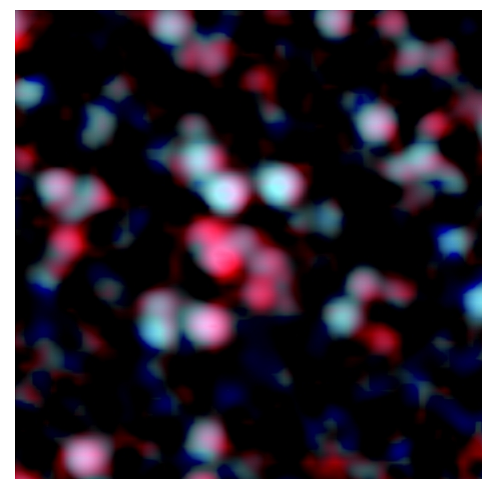
Pushing deeper via cluster lensing: Altieri et al. in prep.



Abell 2218

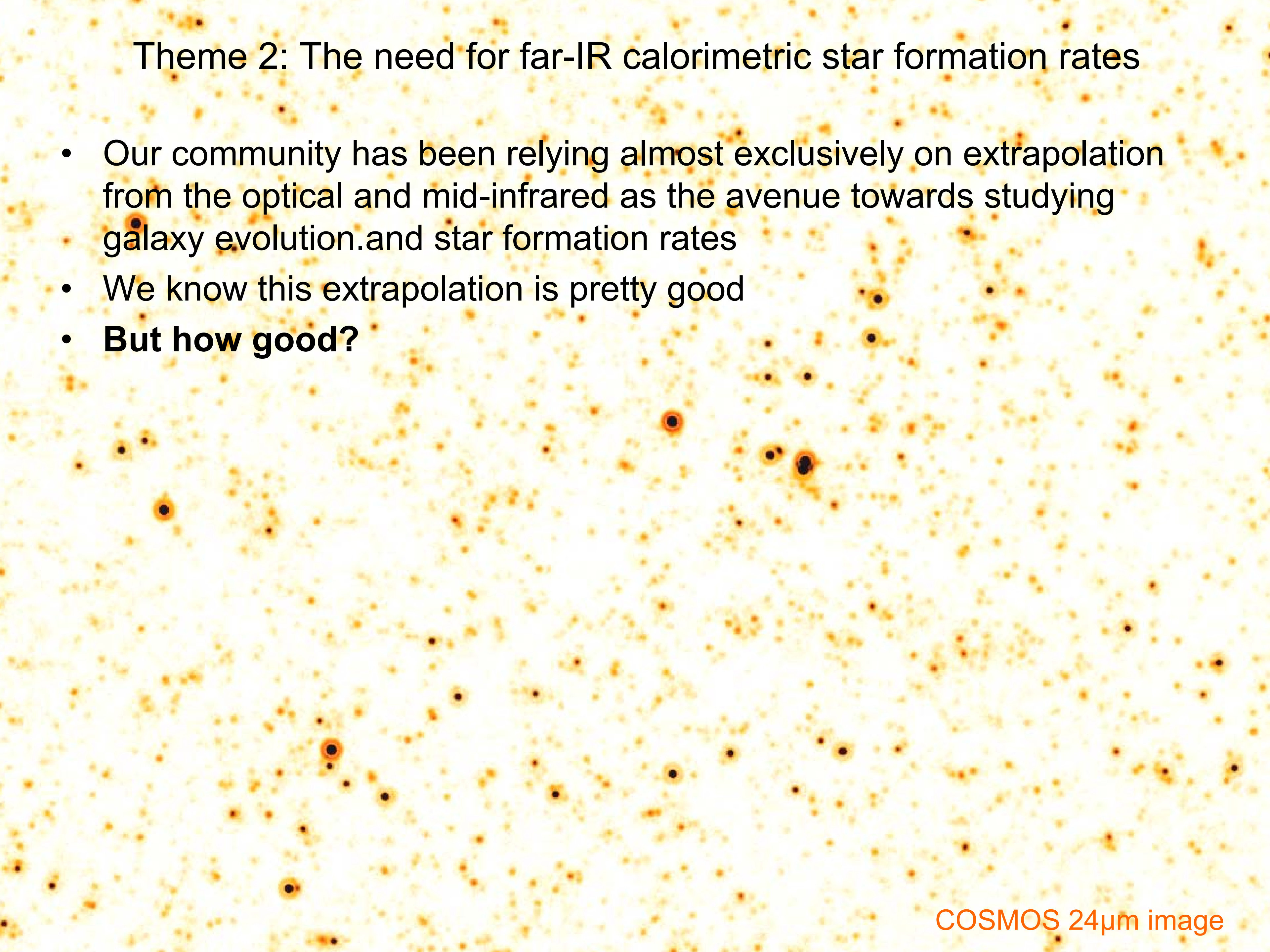
Blue: PACS100μm
White: z=1.5 amplification 0.5,2,5,20
Red: Critical lines

PACS 100+160μm

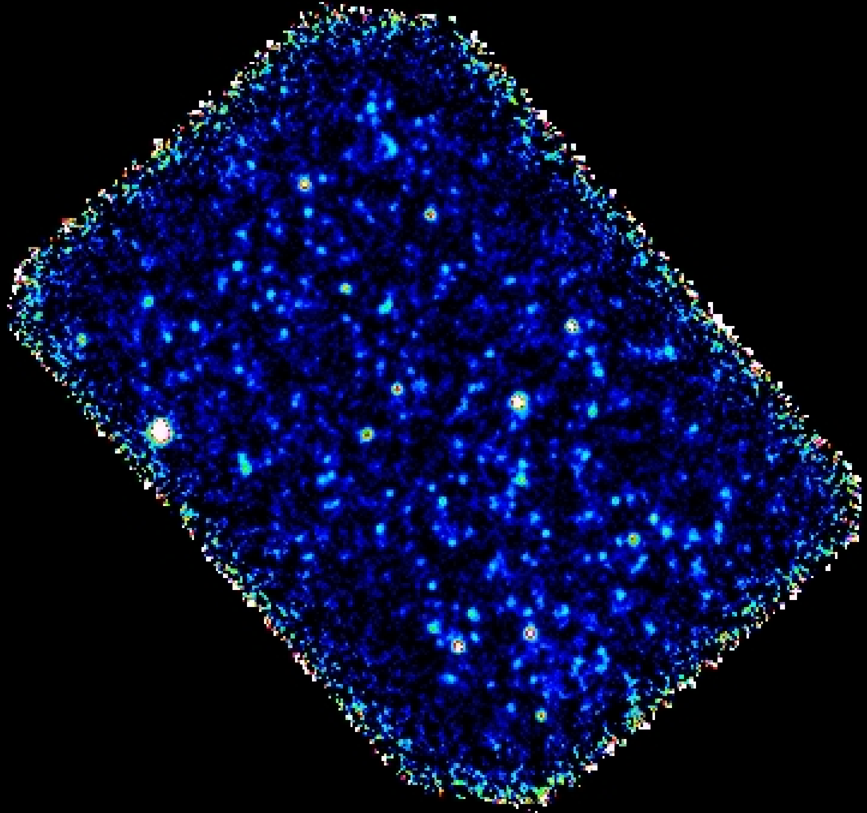


Theme 2: The need for far-IR calorimetric star formation rates

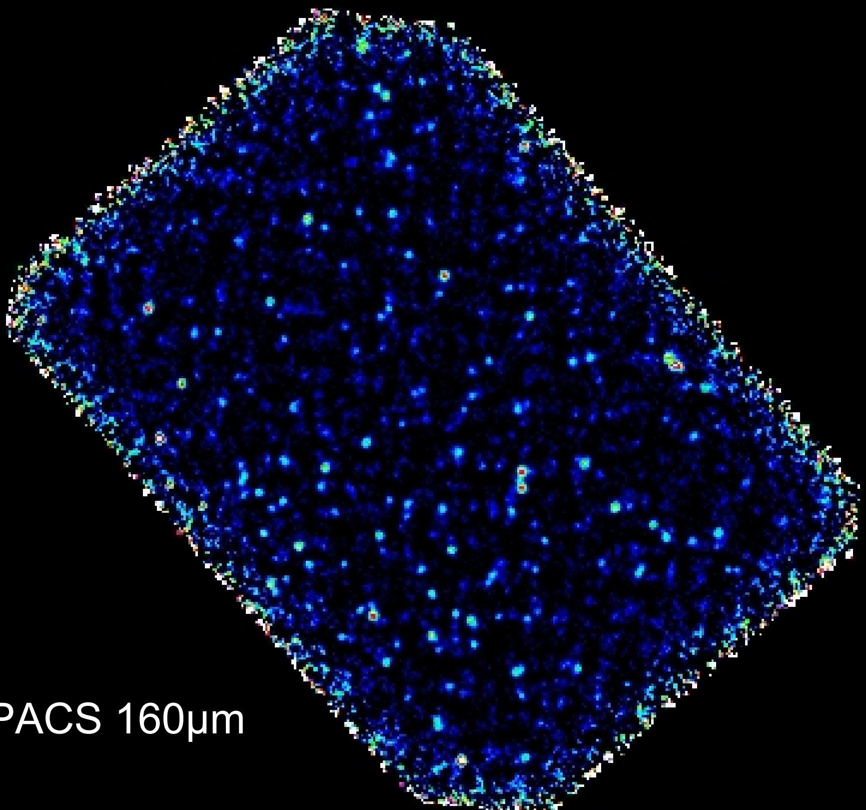
- Our community has been relying almost exclusively on extrapolation from the optical and mid-infrared as the avenue towards studying galaxy evolution.and star formation rates
- We know this extrapolation is pretty good
- **But how good?**



COSMOS 24μm image



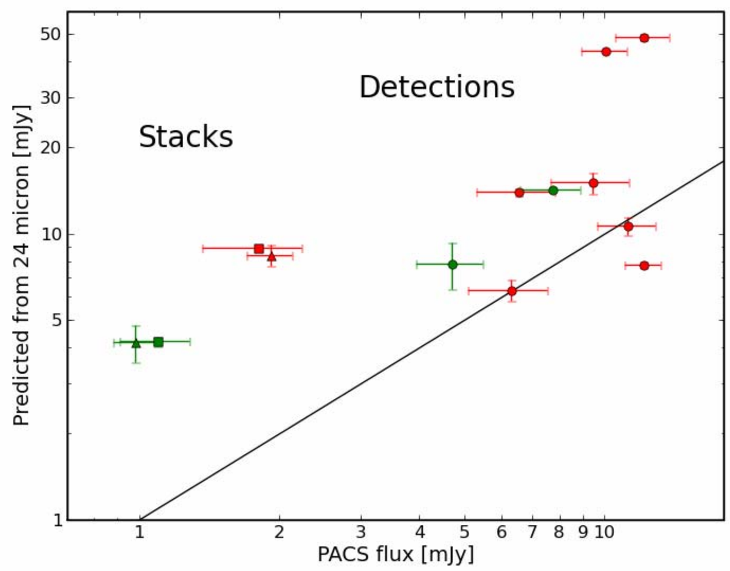
Extrapolation from 24μm to 160μm (B. Magnelli)



PACS 160μm

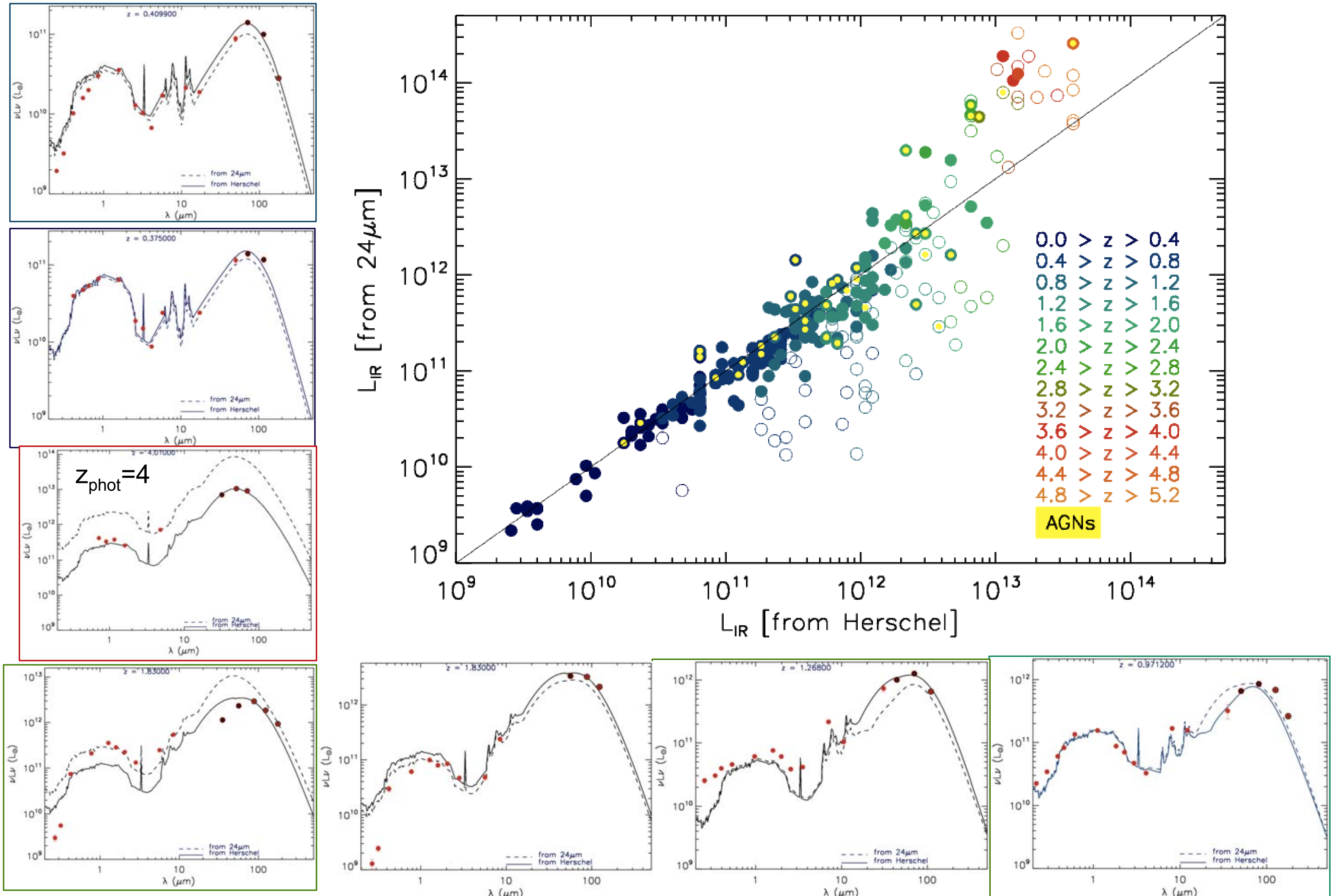
Star formation in z~2 massive galaxies: Nordon et al. in prep.

- Massive z~2 galaxies: BzK optical/NIR selected, $K_{AB}<22$, spec-z or phot-z
- Compare
  - FIR flux predicted from the mid-IR using the unique result from z, S_{24}, Chary&Elbaz 01 SED family
  - FIR flux measured by PACS (stack the nondetections!)



- ***For this population*, extraplation from mid-IR overestimates the far-IR luminosity**
- **AGN dilution of the mid-IR (Daddi et al. 07) and/or evolution of the star forming SED families themselves towards colder dust**

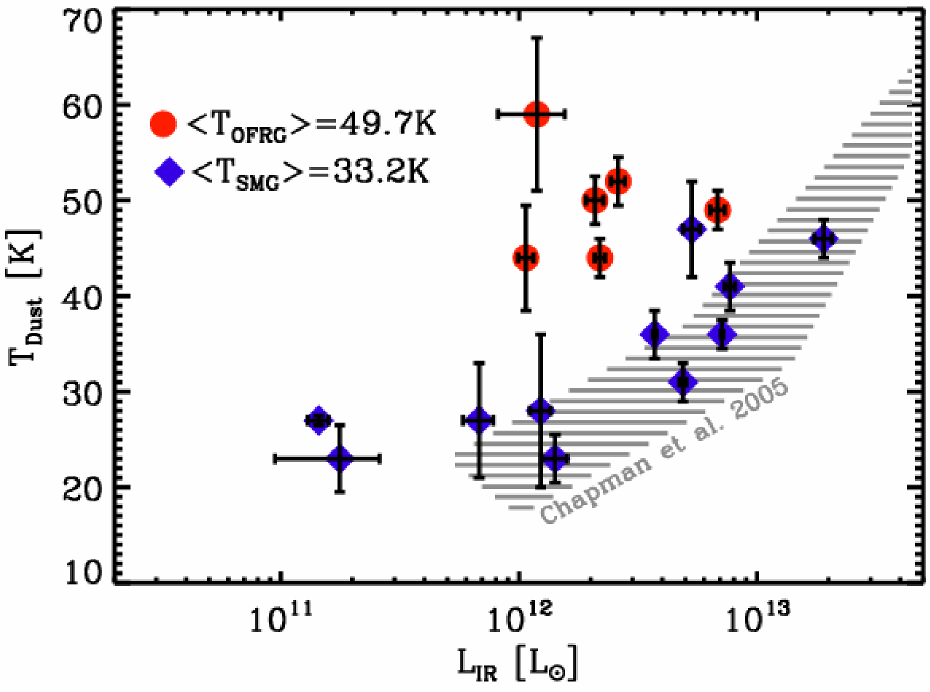
Mid-IR extrapolated IR luminosities vs. PACS+Spire PEP+Hermes (Elbaz et al. in prep.)

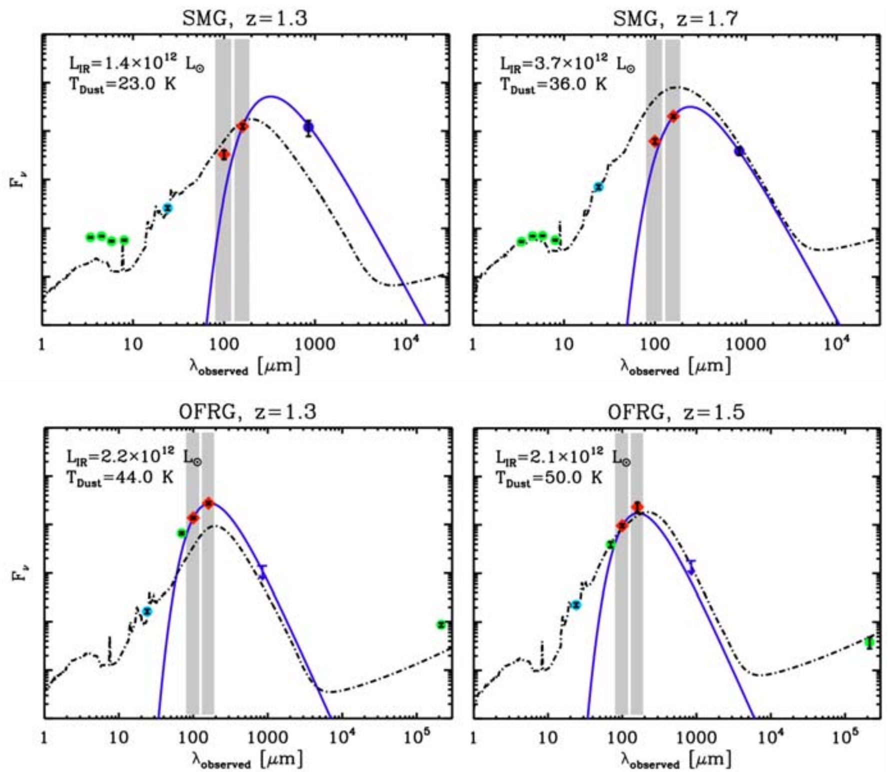


Huge star formation rates in SMGs and OFRGs: Magnelli et al. in prep

- Quantifying fundamental properties (luminosities/SFRs and dust temperatures)
- Selection effects in submm/radio

Sources: Pope et al. 2006, Casey et al. 2009





Very high IR luminosities of SMGs as estimated from submm/radio are substantiated by Herschel data, star formation rates ~1000/yr

→ Brief, merger driven events (e.g. Tacconi et al. 2008)

→ Difficult to reconcile with non-merger SFRs (e.g. Davé et al. 2009)

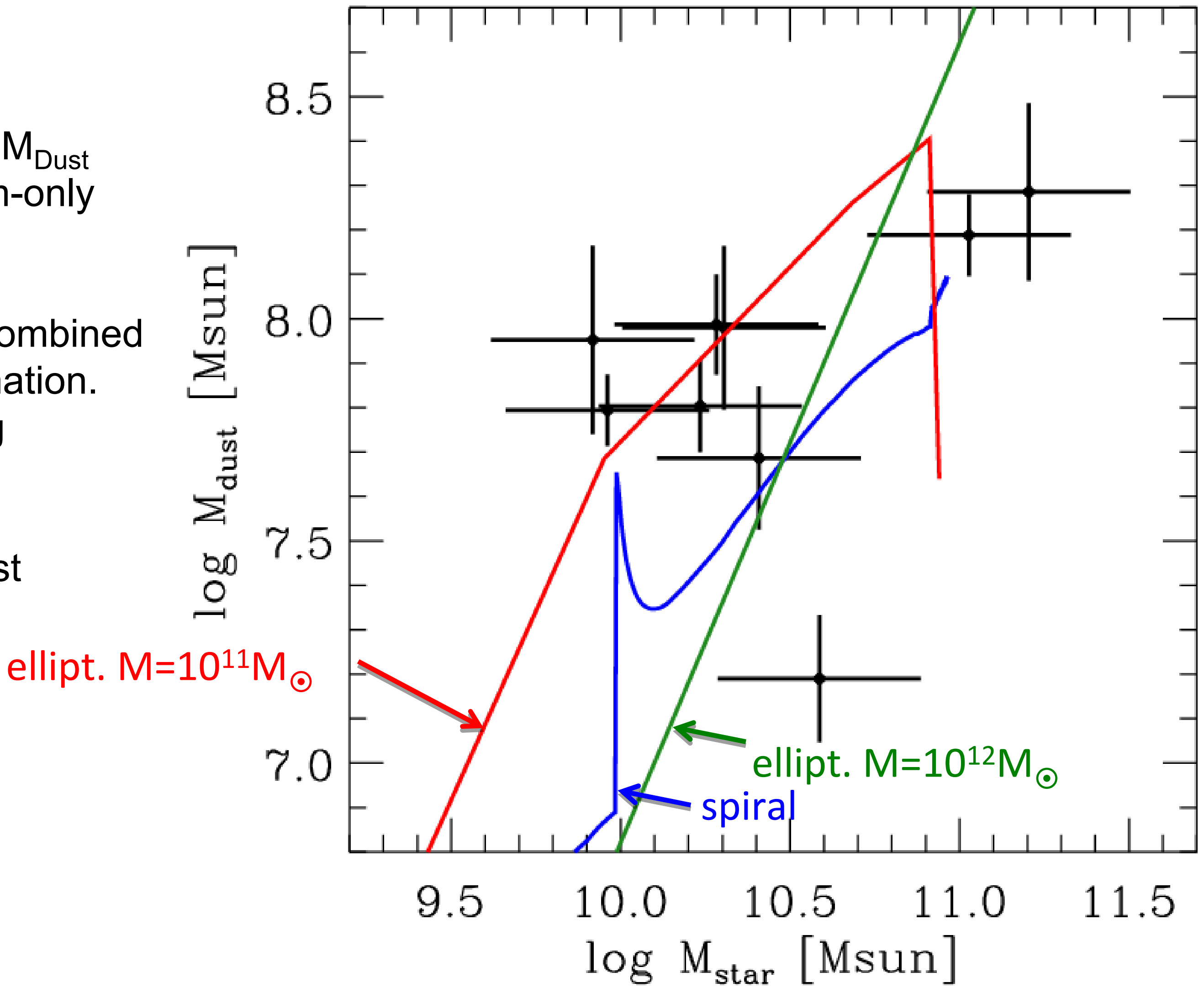
Dust masses at z~1.5: Maiolino et al. in prep.

Here: PACS+Scuba

Break the degeneracy T-M_{Dust} that is inherent to submm-only data

Objects reproduced by combined models of star+dust formation. Generally rapidly forming spheroids

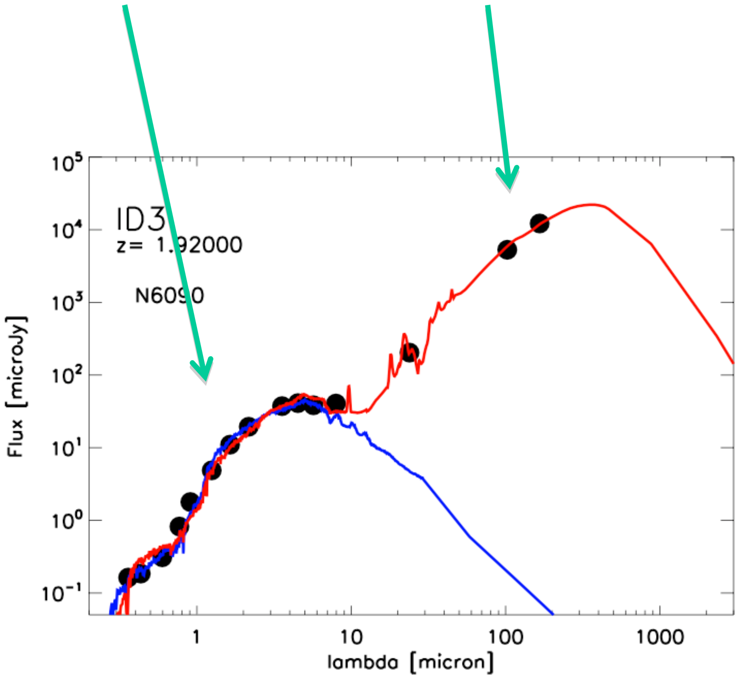
Improving statistics to test correlation



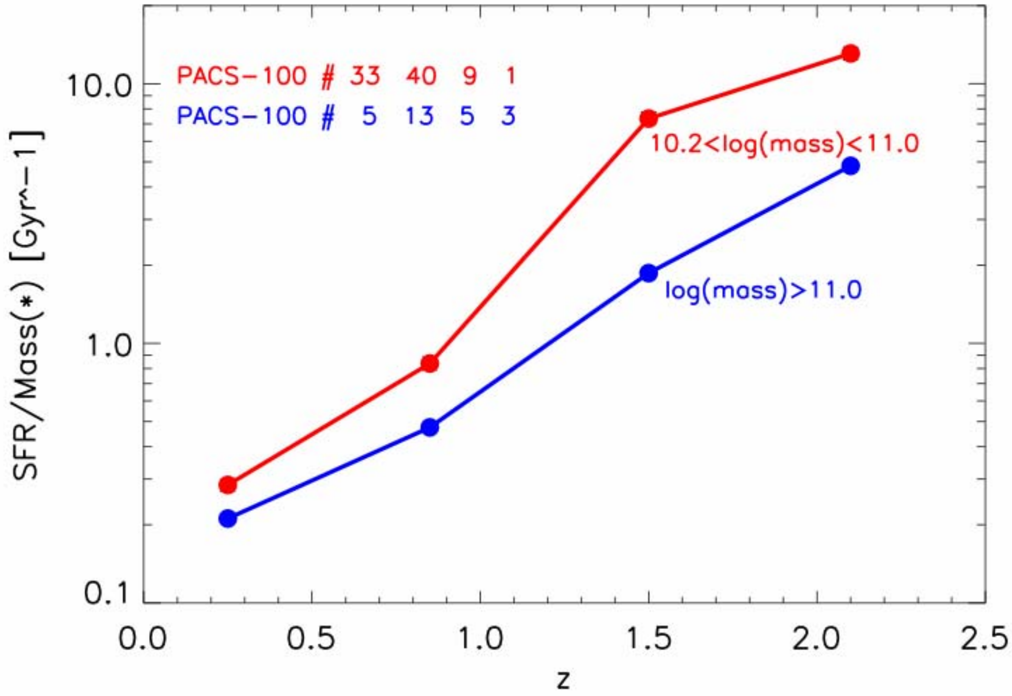
Models from Calura et al. 08

Evolution of specific star formation rates: Rodighiero et al. in prep.

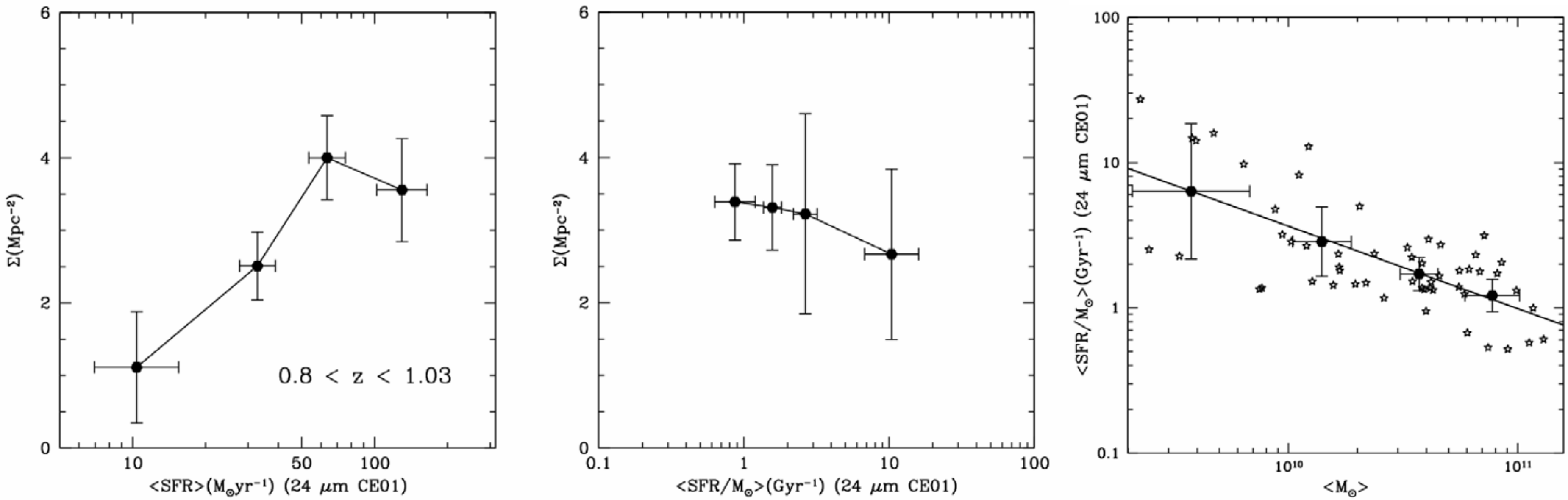
Using ~200 PACS-detected sources with S_{100}>5mJy in GOODS-North
Masses and total IR luminosities are derived from SED fitting (BC03 + Polletta templates)



massive galaxies have smaller sSFR at all redshifts



The role of environment at z~1: Popesso et al. in prep.



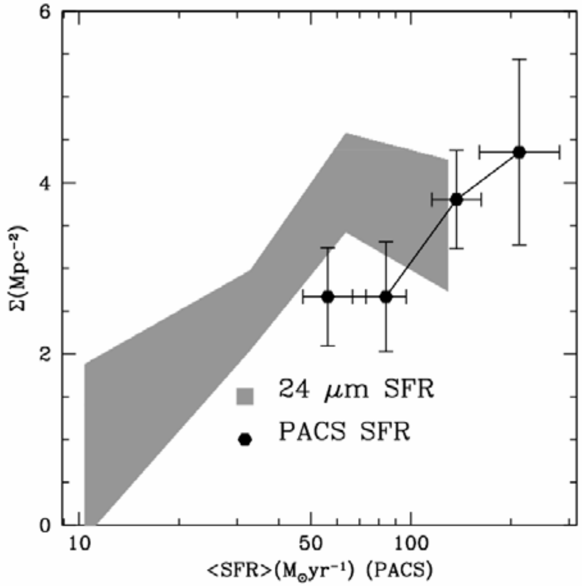
The 'Reversal of the SFR / density relation' (Elbaz et al. 07)

No specific star formation rate / density relation (Elbaz et al. 07)

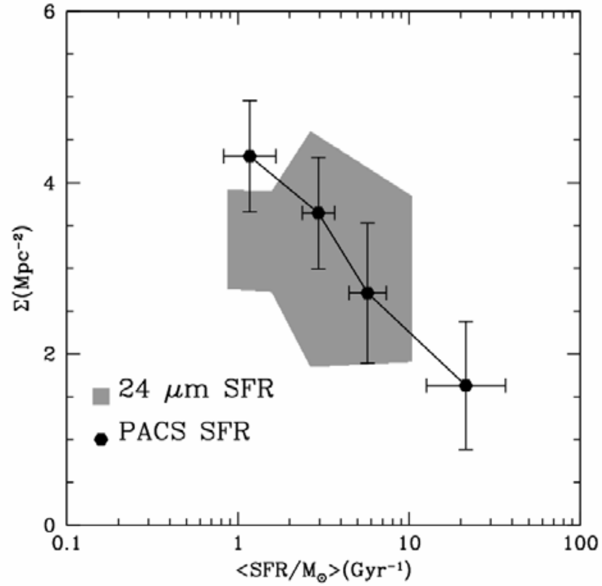
Mass / SSFR relation

***24µm-based star formation rate estimates**, same sample as next slide*

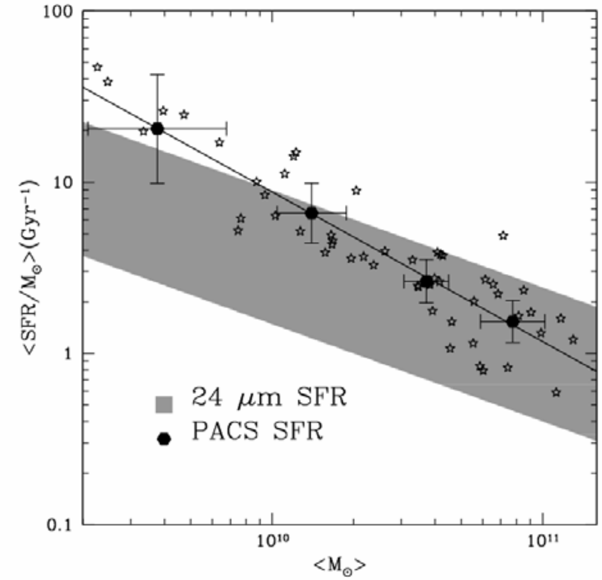
The role of environment at z~1: Popesso et al. in prep.



The 'Reversal of the SFR / density relation' confirmed



Lower specific star formation rate in dense environments!



Mass / SSFR relation
(see also Rodighiero et al. in prep.)

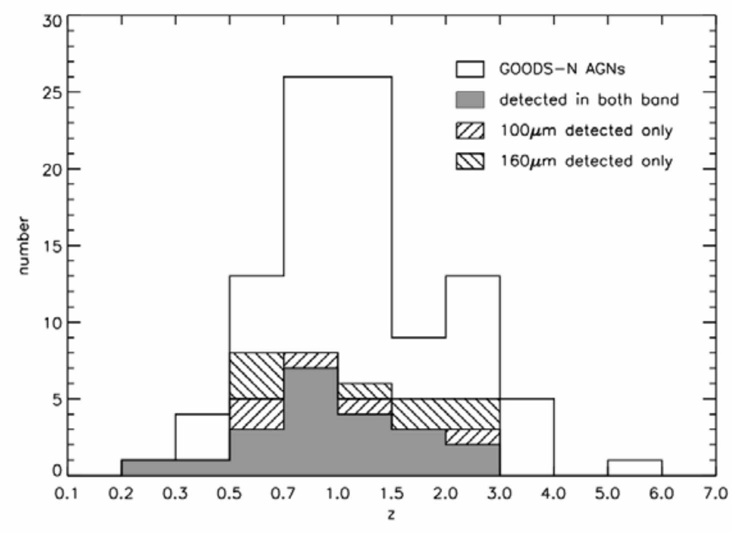
- For these z~1 objects, 24µm *under*estimated the SFR
- This underestimate is a function of mass!

***Herschel-based star formation rate estimates**, same sample as previous*

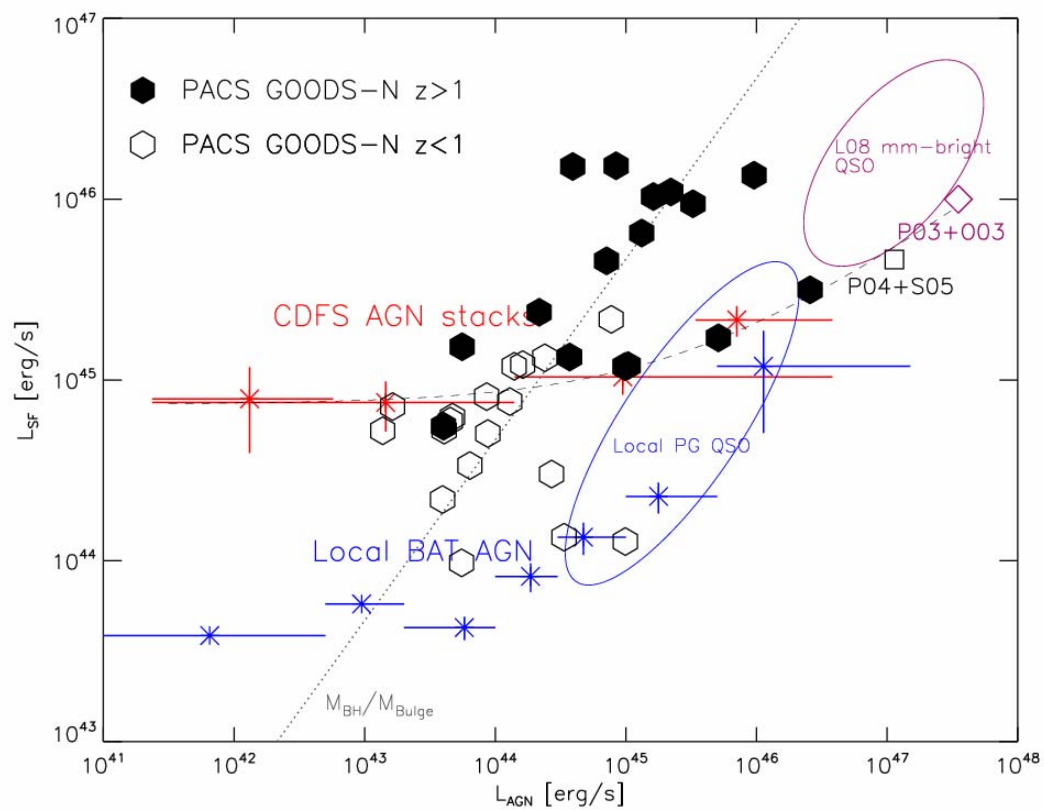
The co-evolution of AGN and star formation: Shao et al. in prep.

Rest frame far-infrared can be used to measure the star formation in AGN hosts

This is impossible in the mid-infrared which is more rapidly AGN dominated



FIR detection rate ~30% for X-ray AGN with spec-z



APEX/LABOCA submm stacking results for (E)CDFS: Lutz et al. ApJ submitted
- Merger (diagonal) & secular (horizontal) branch
- On secular branch, host SFR grows with redshift, as for inactive galaxies

Thank you!

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