First results from PACS deep surveys

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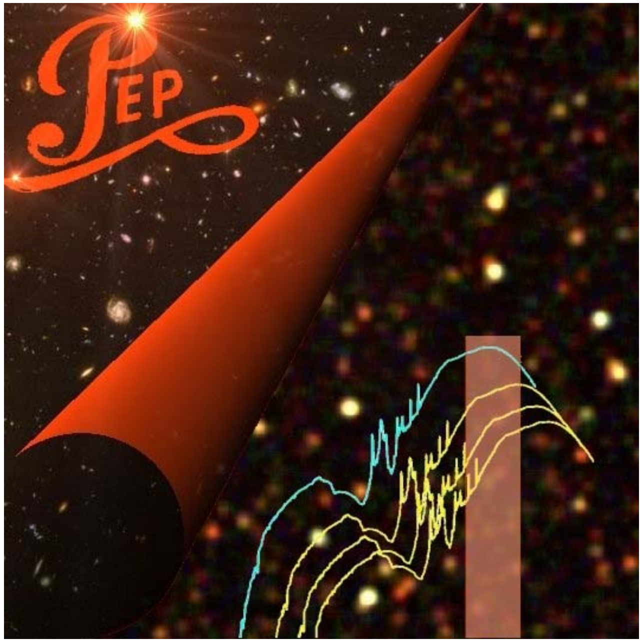
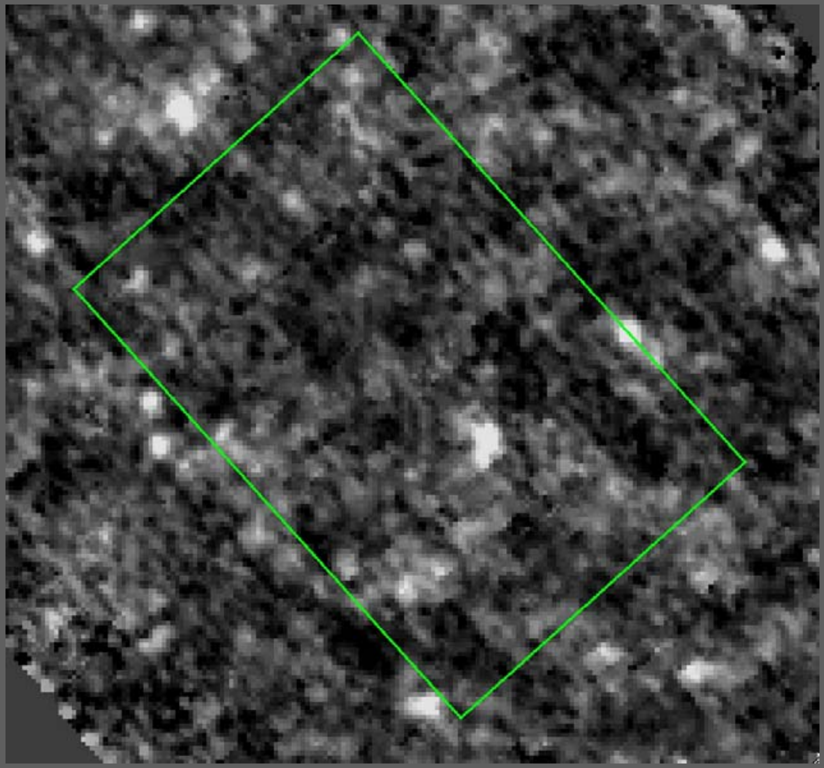
Herschel SDP Workshop

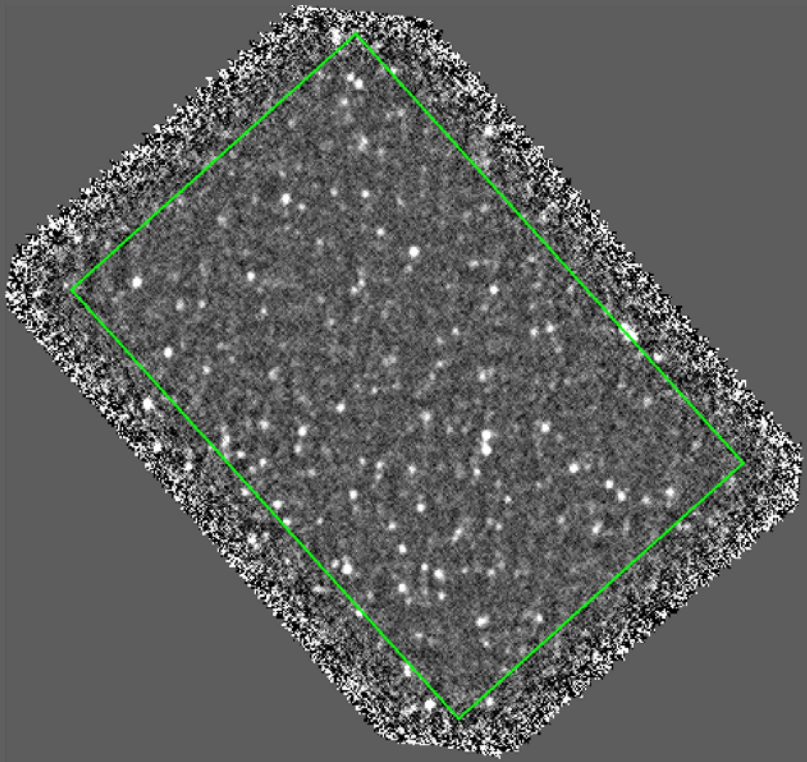
Dec 17/18, 2009



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

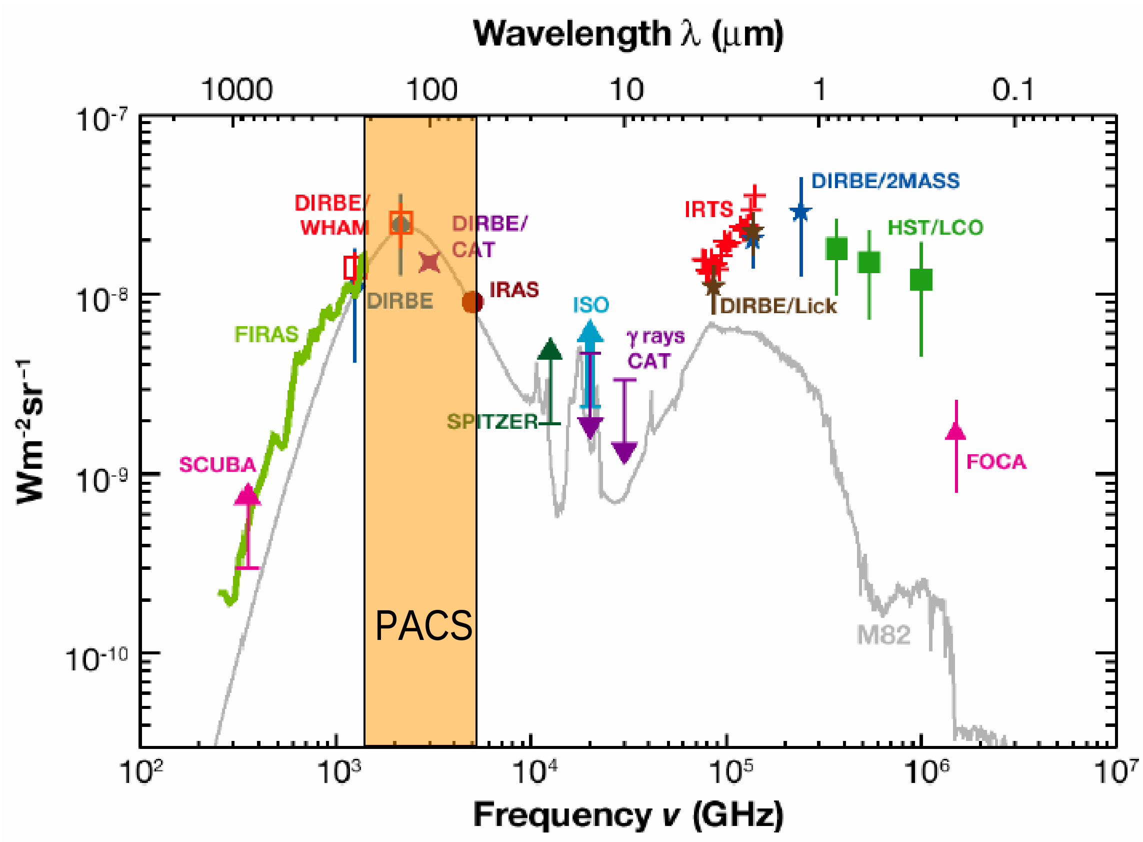
- PEP is the major Herschel 100/160um extragalactic survey of key multiwavelength fields

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

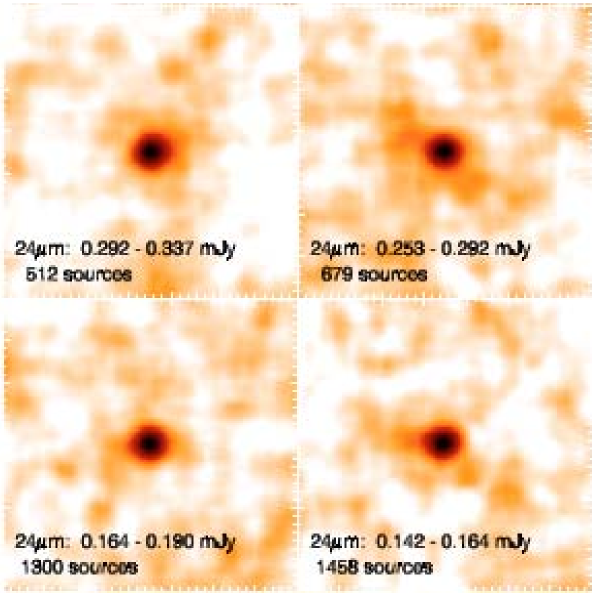
- +10 lensing clusters

- 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

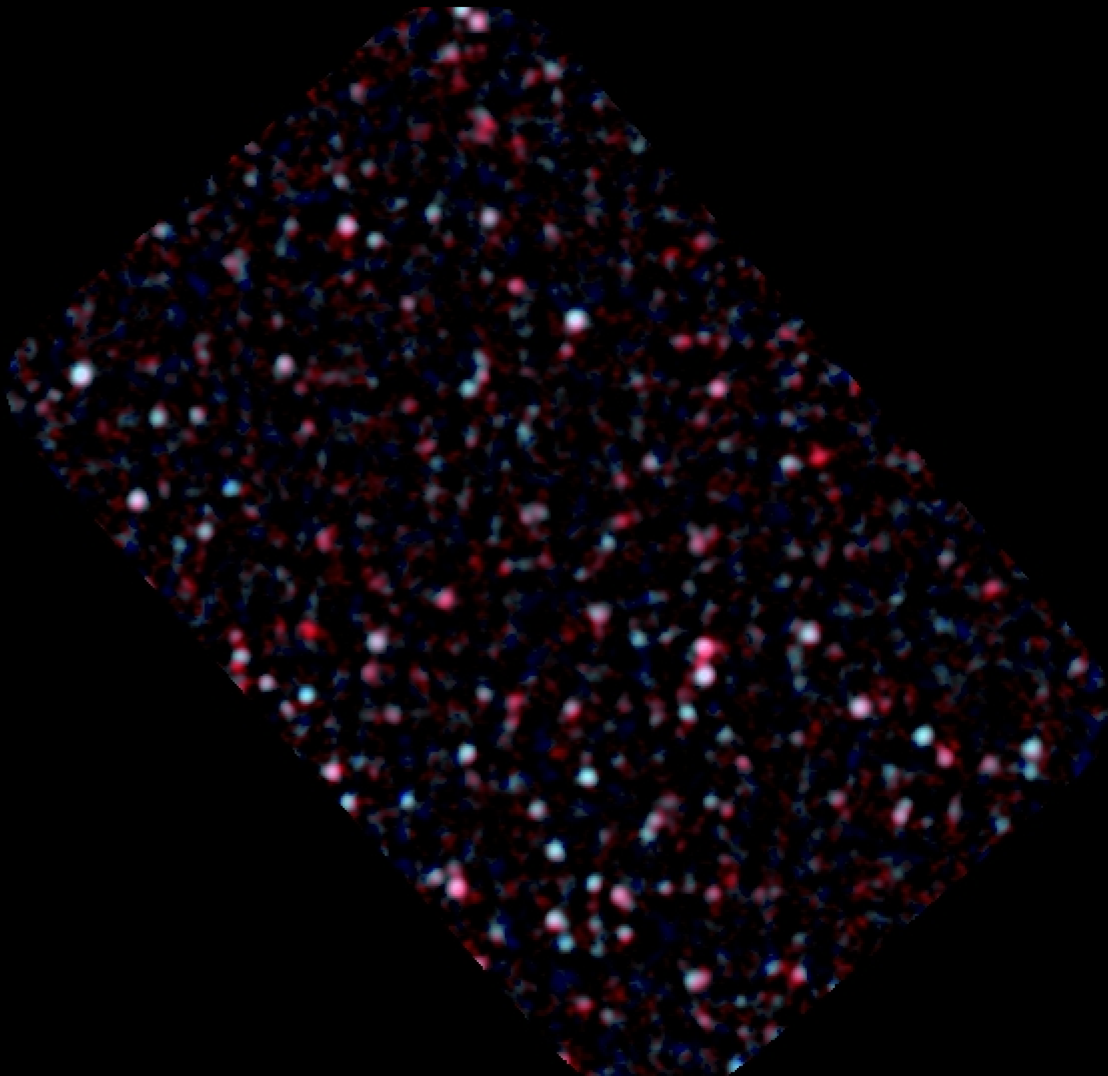


Lagache et al. 2005 ARAA



Dole et al. 2006

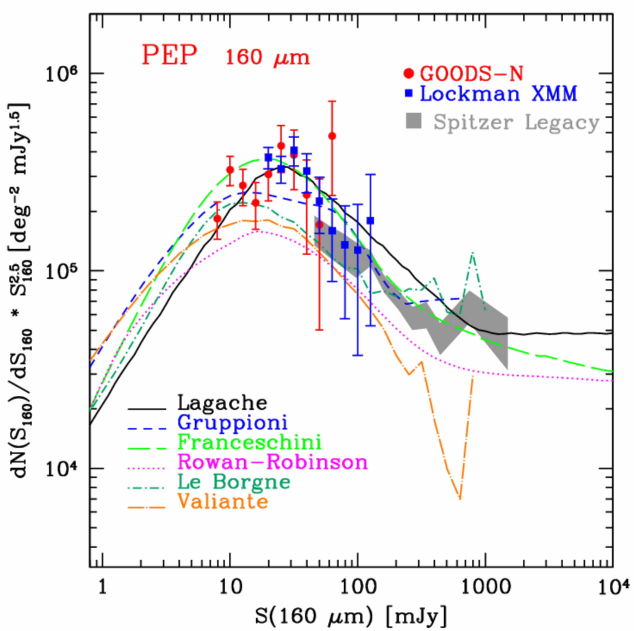
Resolving the CIB into individual galaxies

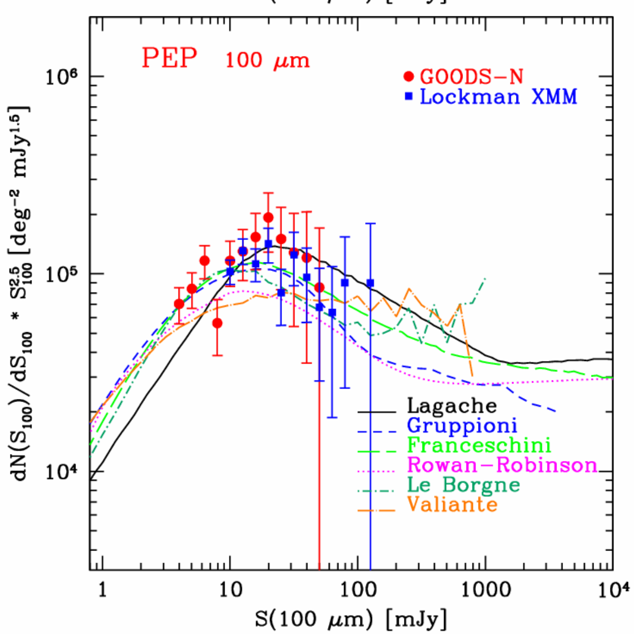


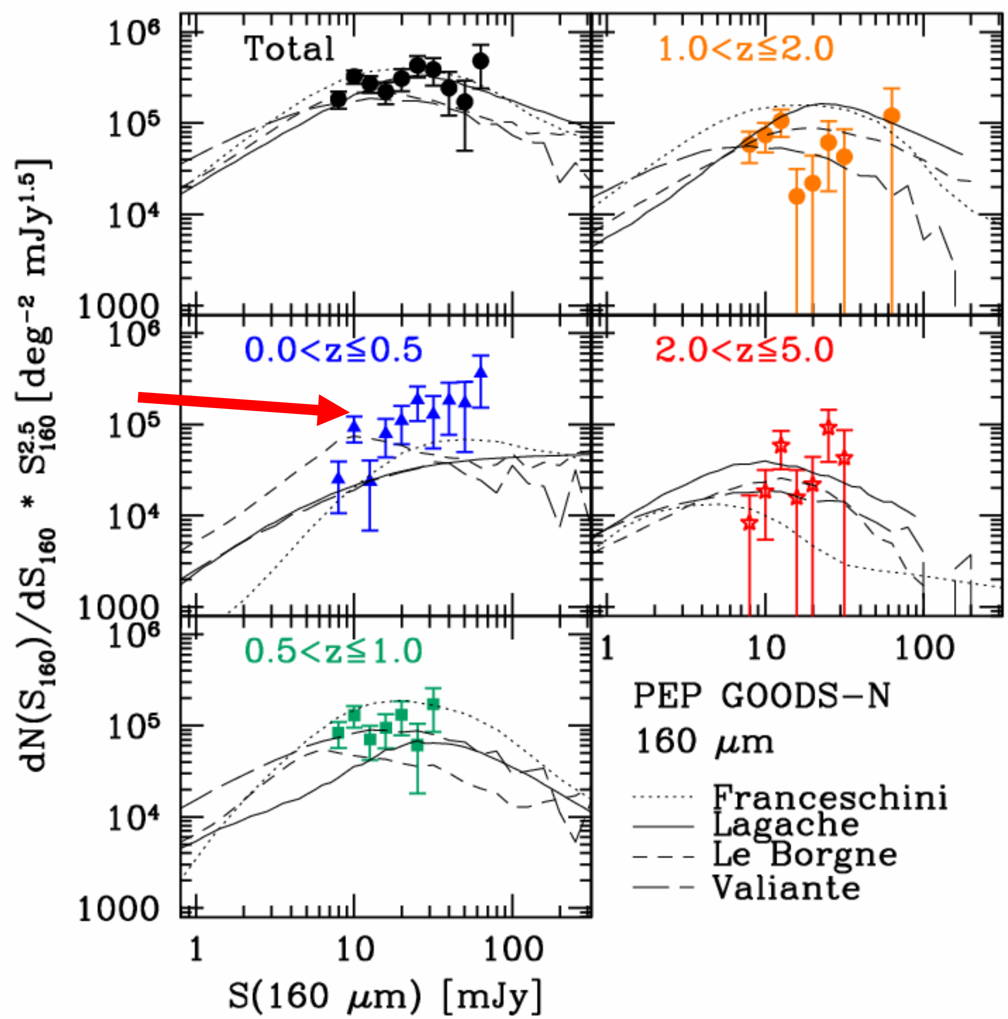
Already the SDP GOODS-N data **resolve ~60% of the CIB at 100 and 160μm into individually well detected (5σ)** sources

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

Analysing the CIB: Berta et al. in prep.

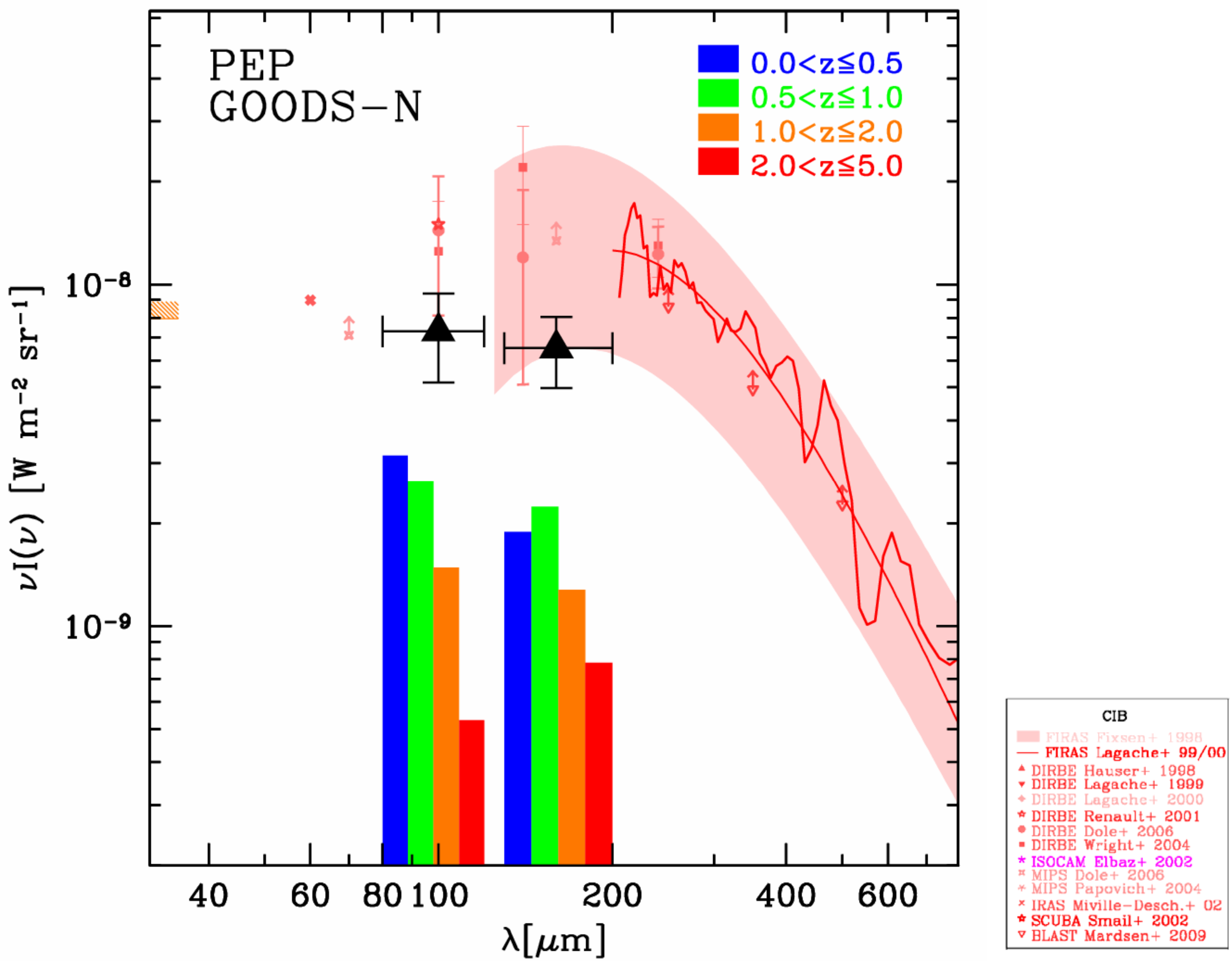




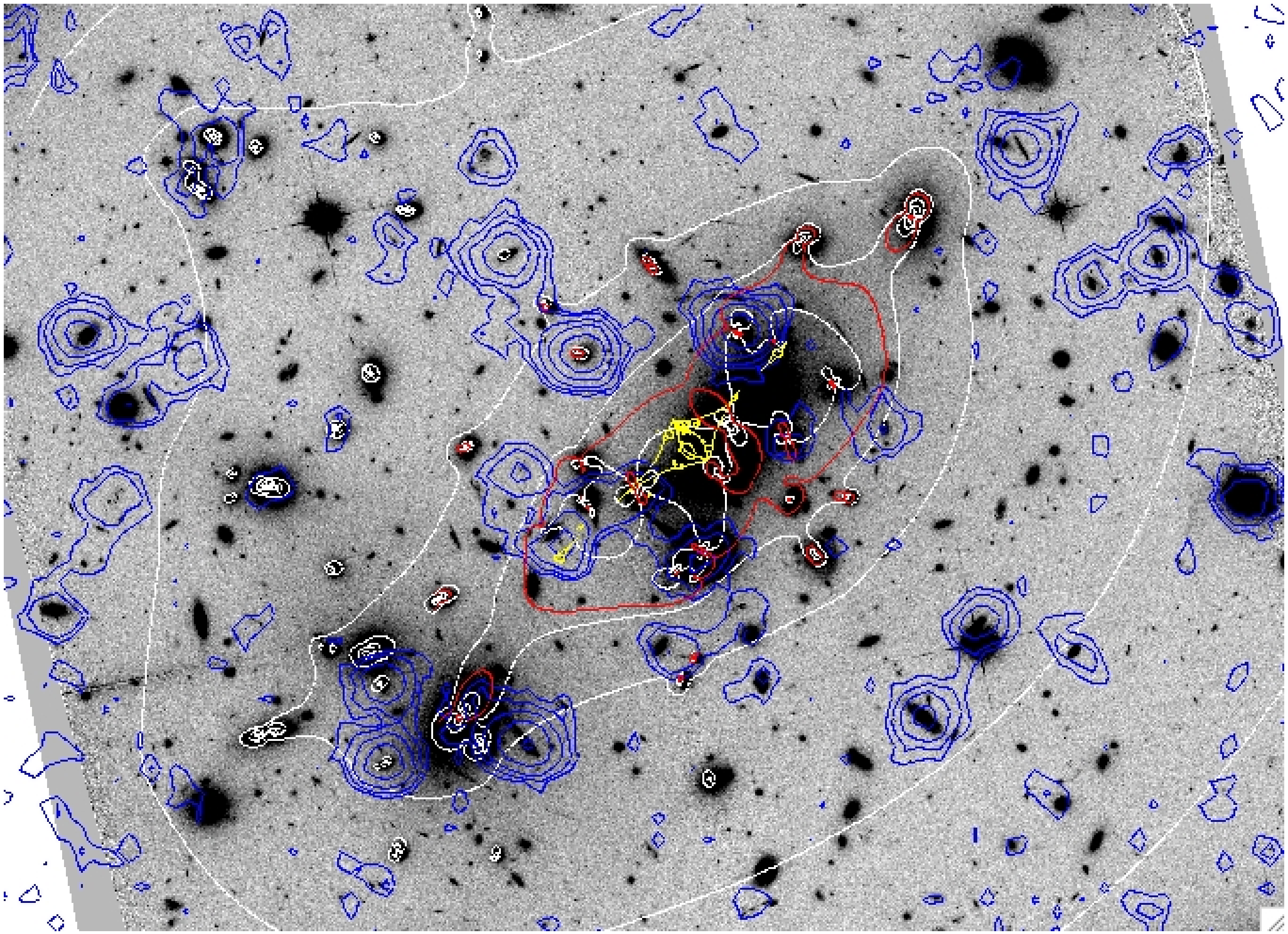


- Counts ~ at high end of previous models
- local (cool?) objects boosting the counts

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



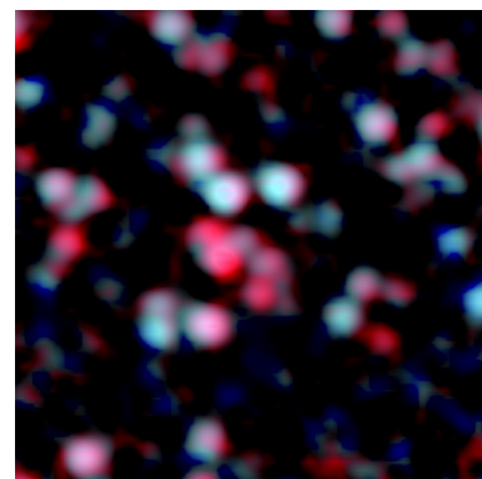
Pushing deeper via cluster lensing: Altieri et al. in prep.



Abell 2218

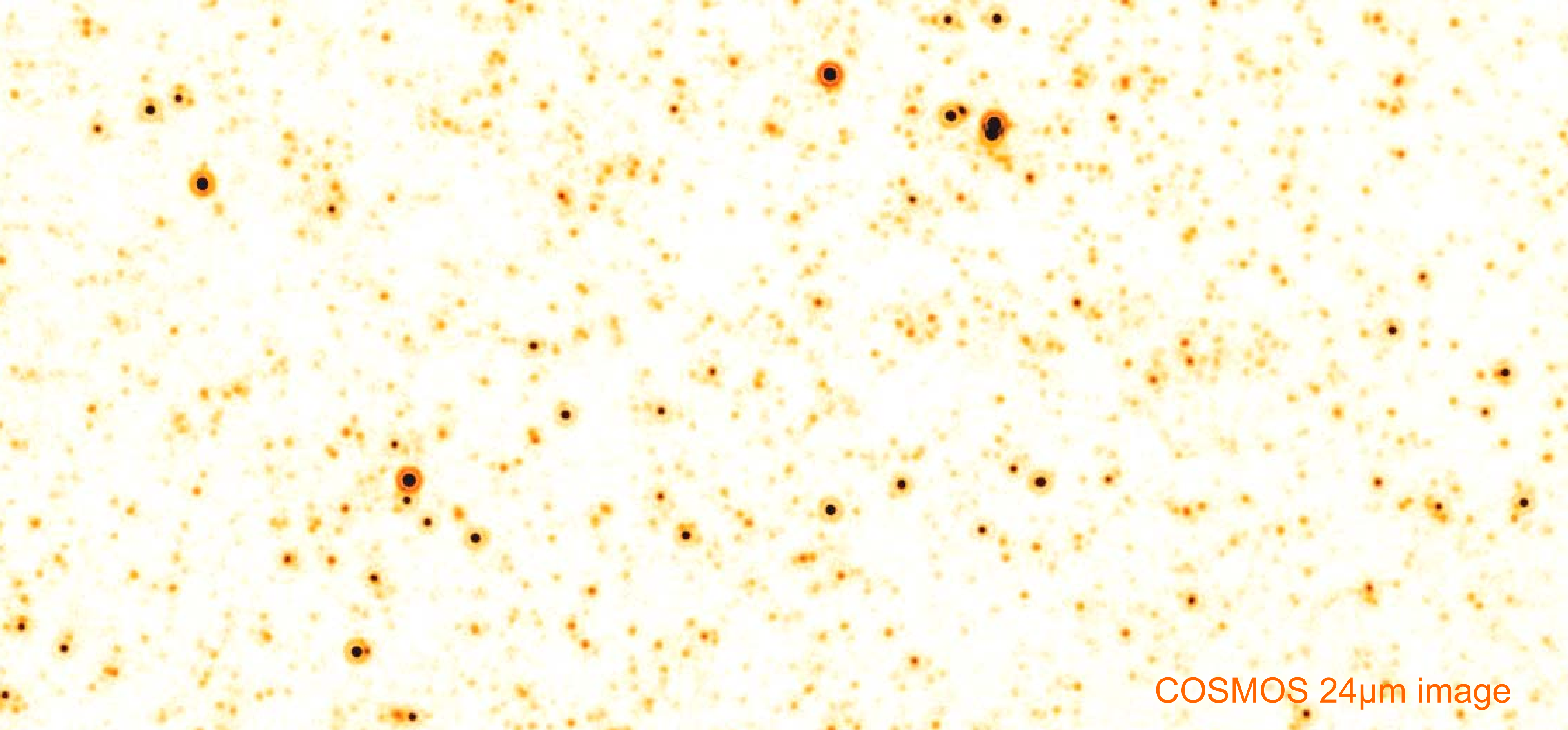
Blue: PACS100μm
White: z=1.5 amplification 0.5,2,5,20
Red: Critical lines

PACS 100+160μm

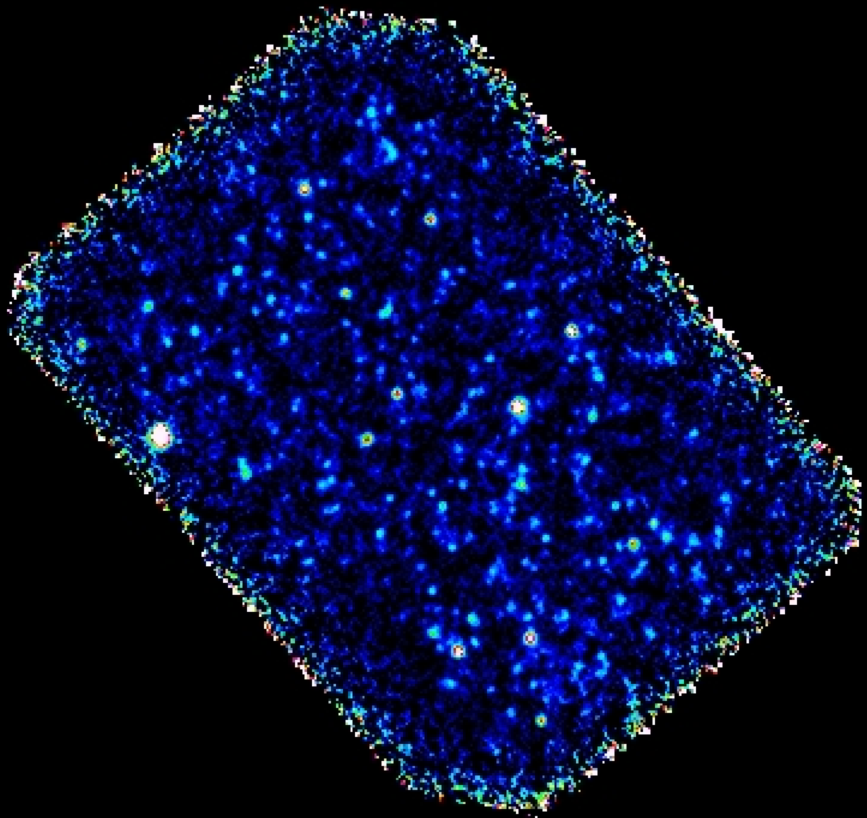


Theme 2: The need for far-IR calorimetric star formation rates

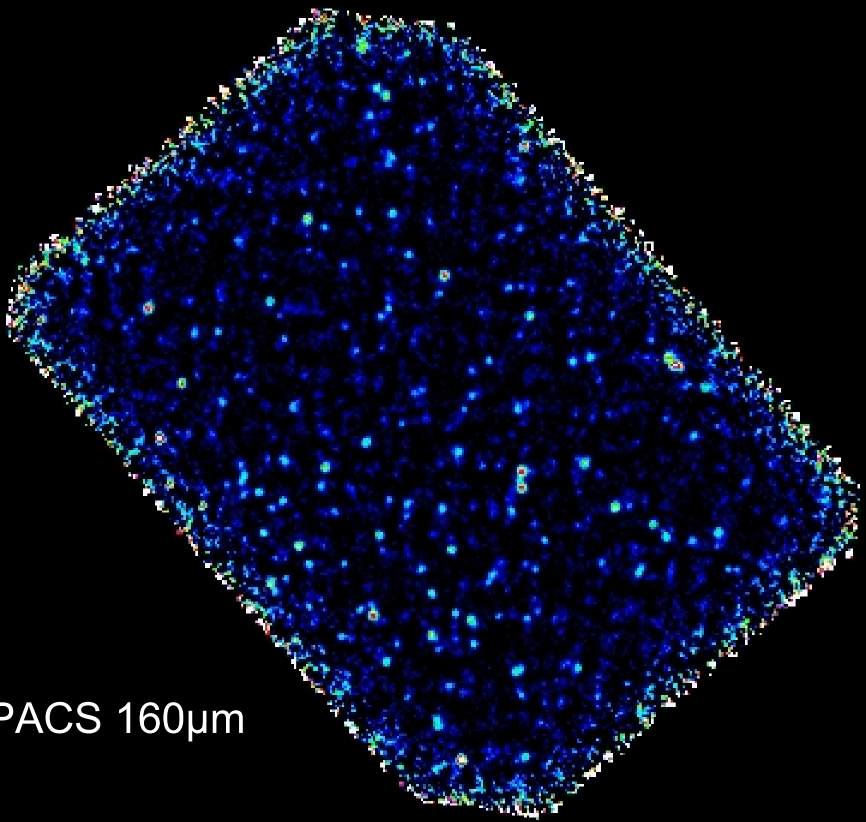
- Our community has been relying almost exclusively on extrapolation from the optical and mid-infrared as the avenue towards studying galaxy evolution.and star formation rates
- We know this extrapolation is pretty good
- **But how good?**



COSMOS 24μm image



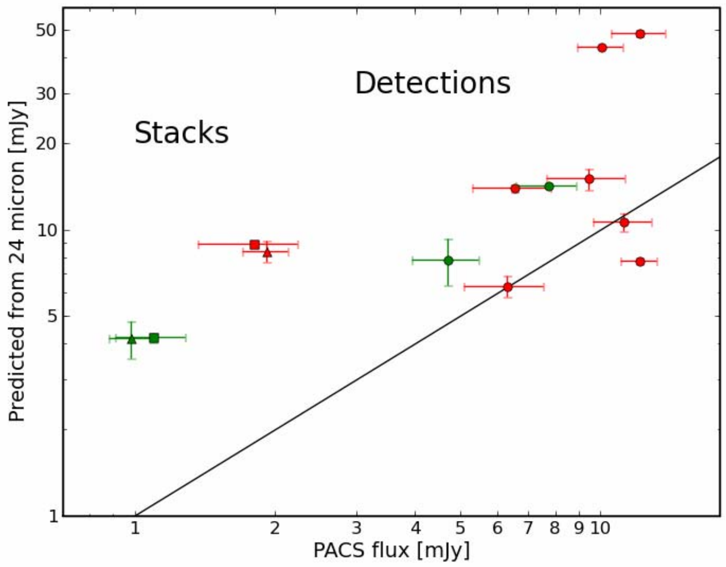
Extrapolation from 24µm to 160µm (B. Magnelli)



PACS 160µm

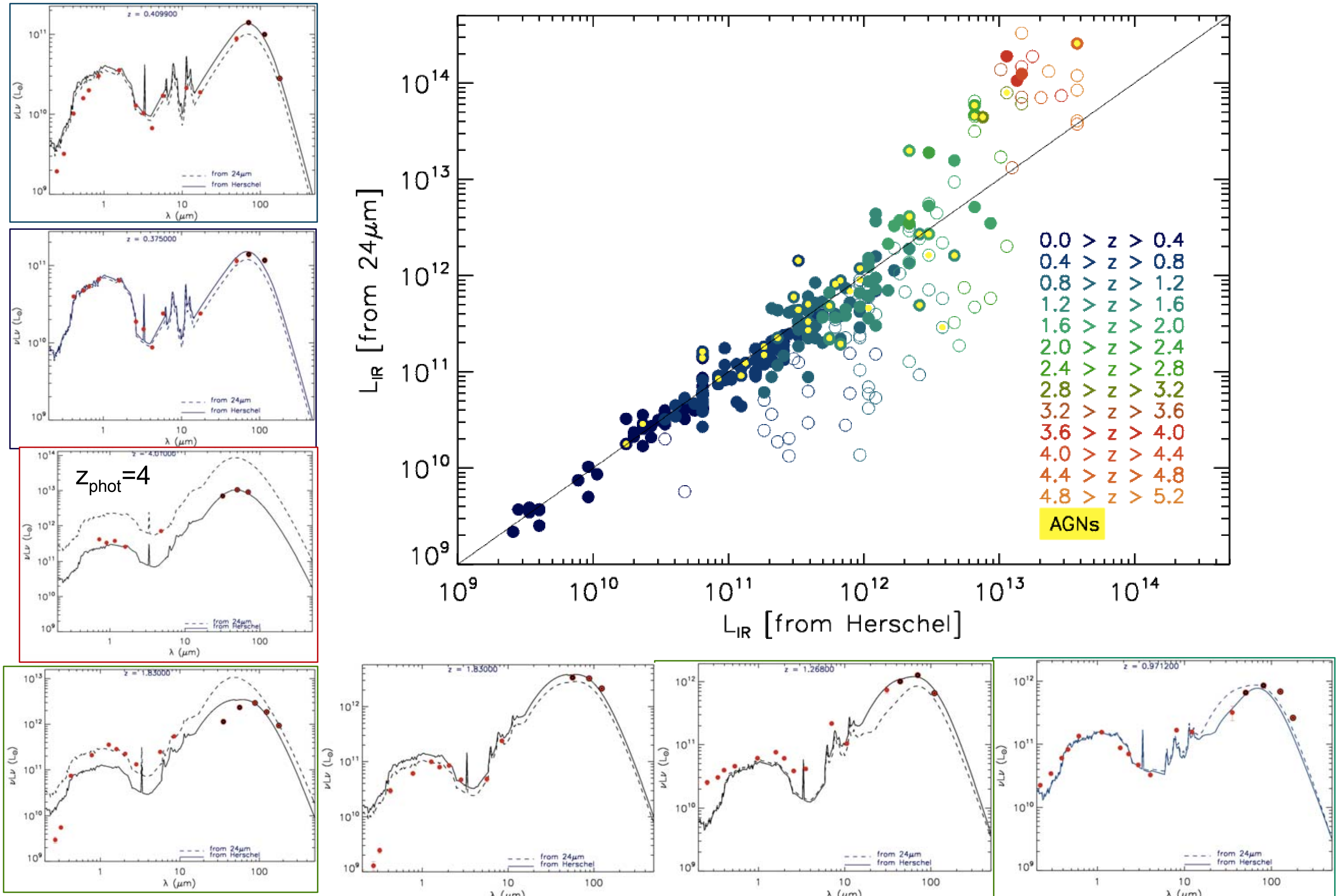
Star formation in z~2 massive galaxies: Nordon et al. in prep.

- 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**

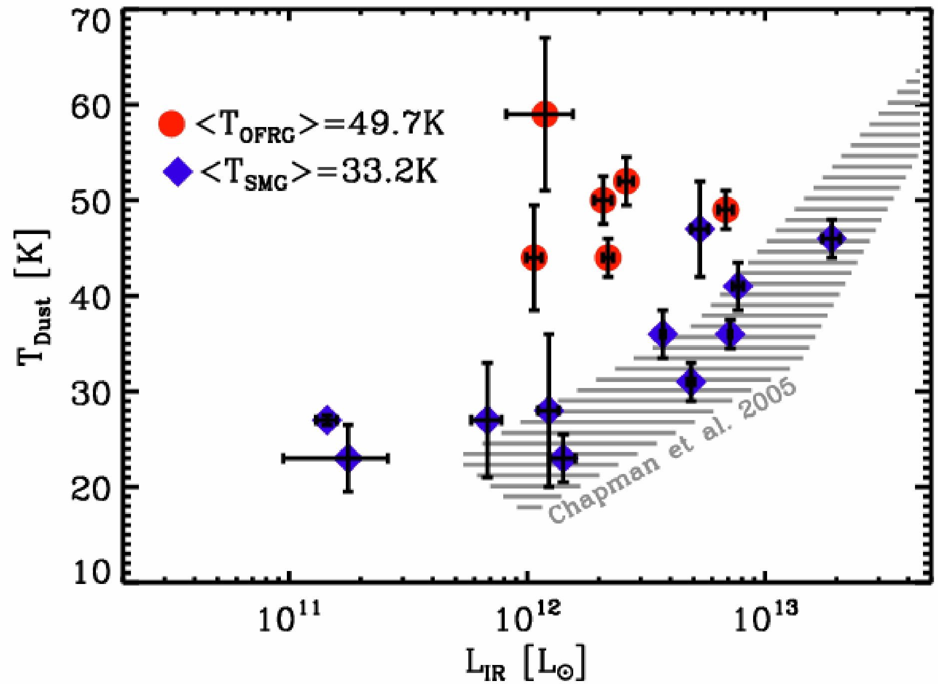
Mid-IR extrapolated IR luminosities vs. PACS+Spire PEP+Hermes (Elbaz et al. in prep.)

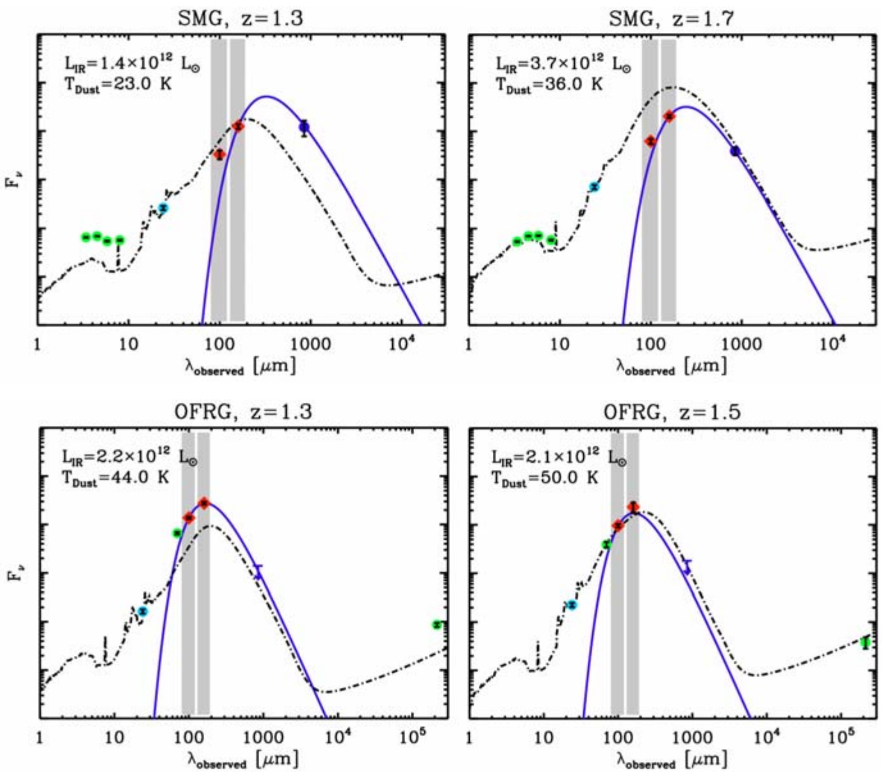


Huge star formation rates in SMGs and OFRGs: Magnelli et al. in prep

- 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)

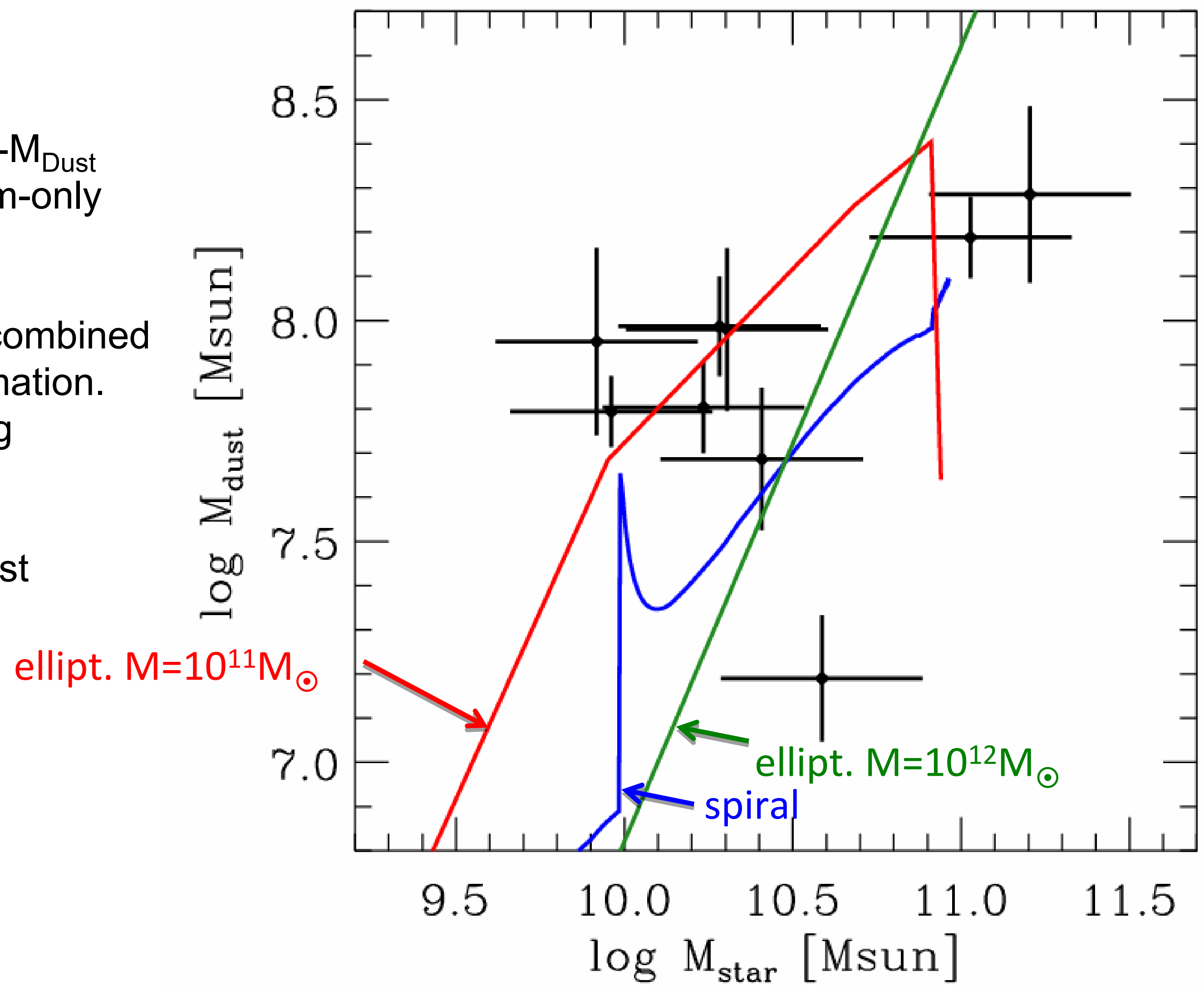
Dust masses at z~1.5: Maiolino et al. in prep.

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

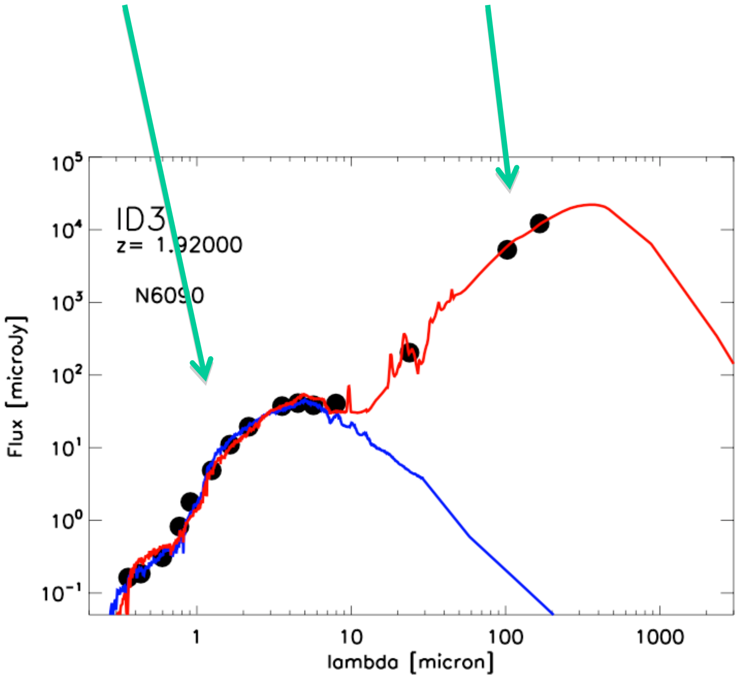
Improving statistics to test correlation



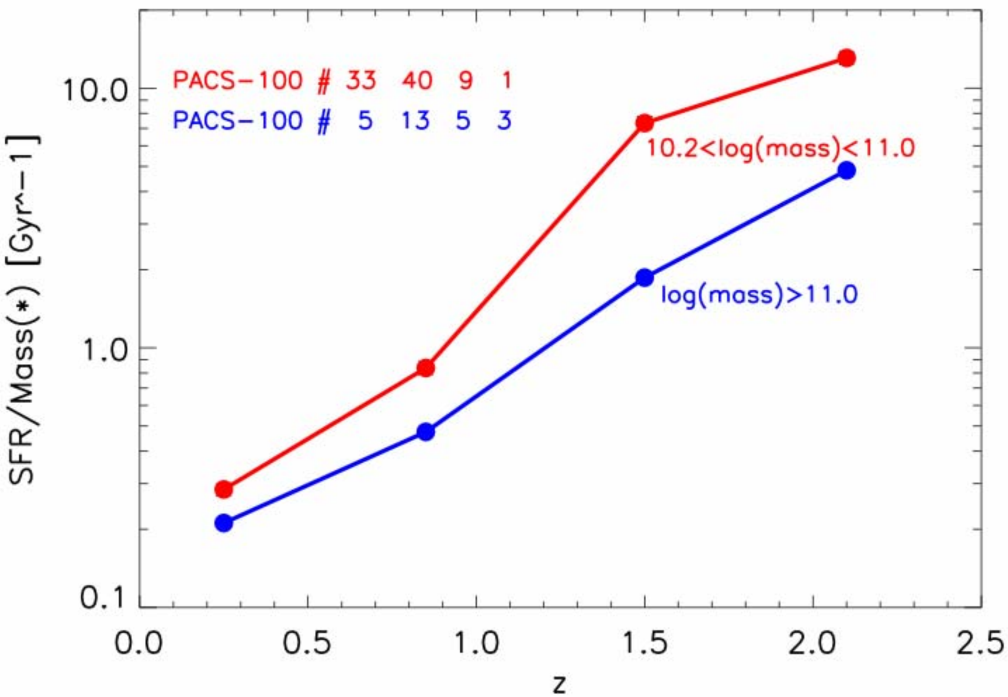
Models from Calura et al. 08

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

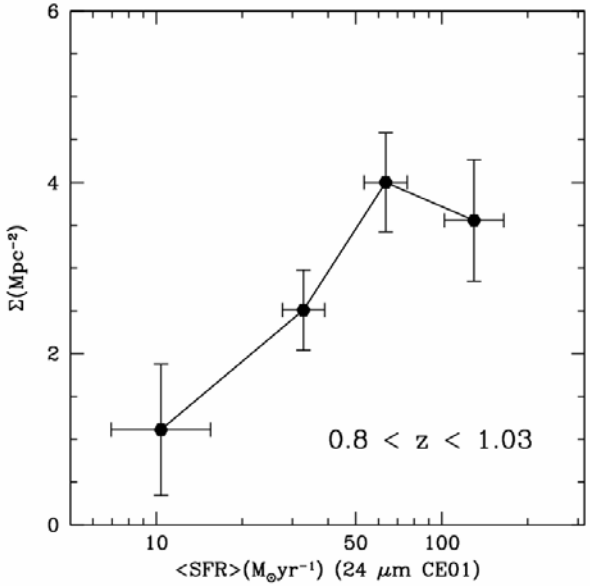
Using ~200 PACS-detected sources with S_{100}>5mJy in GOODS-North
Masses and total IR luminosities are derived from SED fitting (BC03 + Polletta templates)



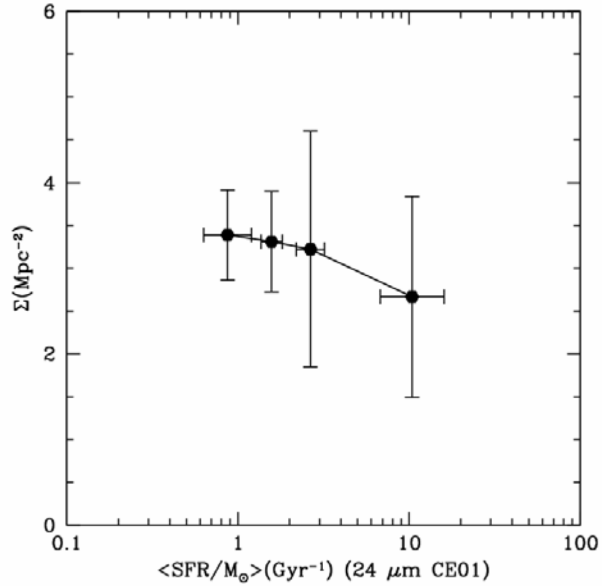
massive galaxies have smaller sSFR at all redshifts



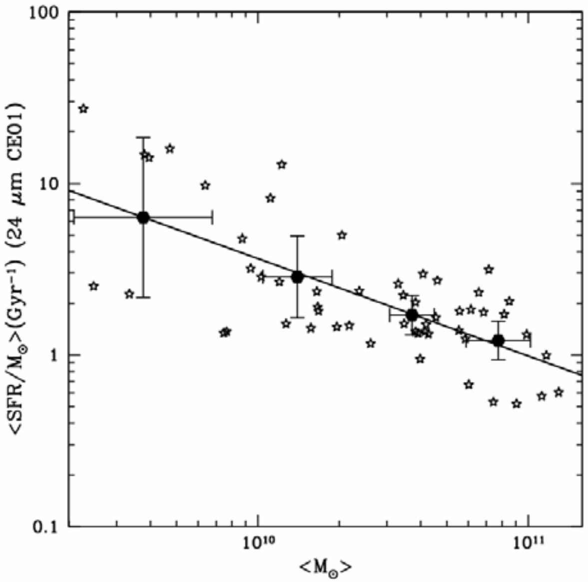
The role of environment at z~1: Popesso et al. in prep.



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



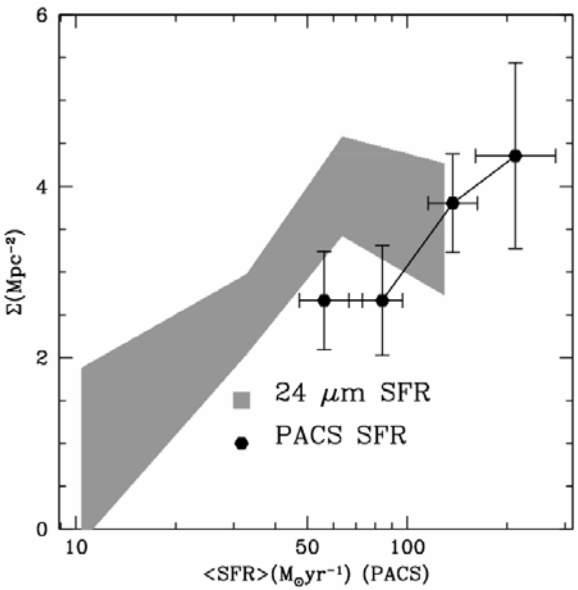
No specific star formation rate / density relation (Elbaz et al. 07)

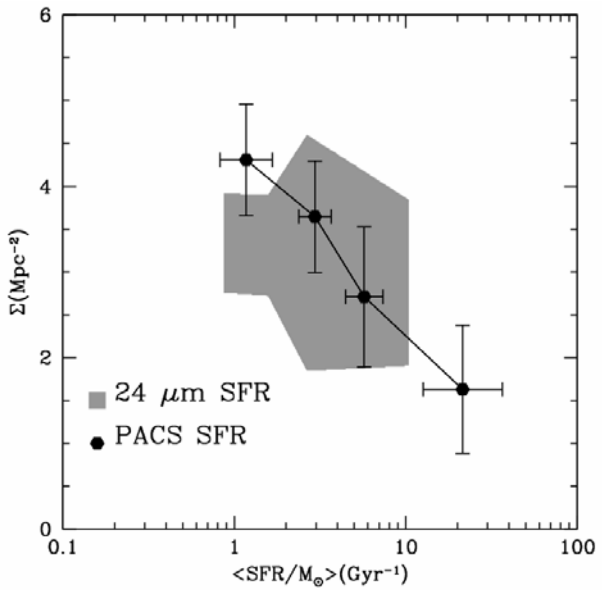


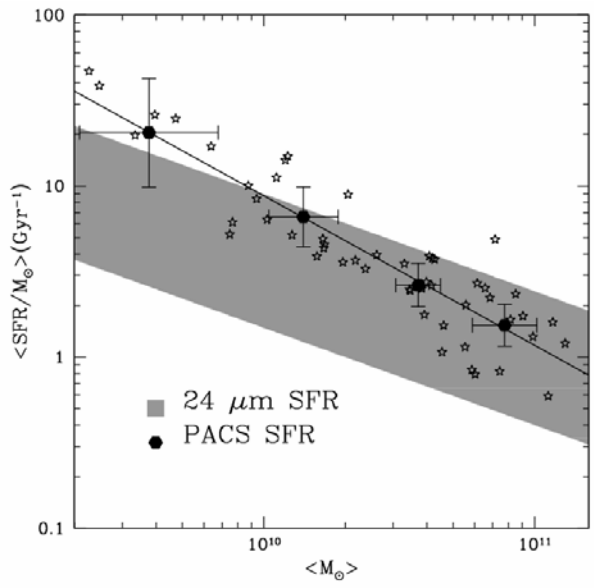
Mass / SSFR relation

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.)

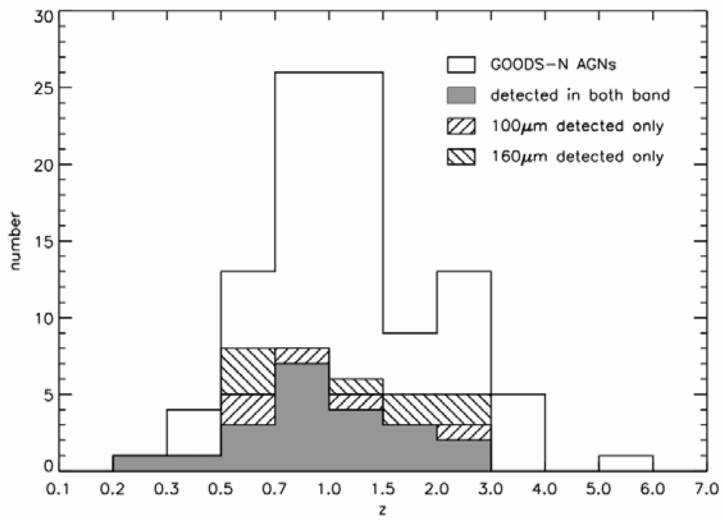
- For these z~1 objects, 24μm *under*estimated the SFR
- This underestimate is a function of mass!

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

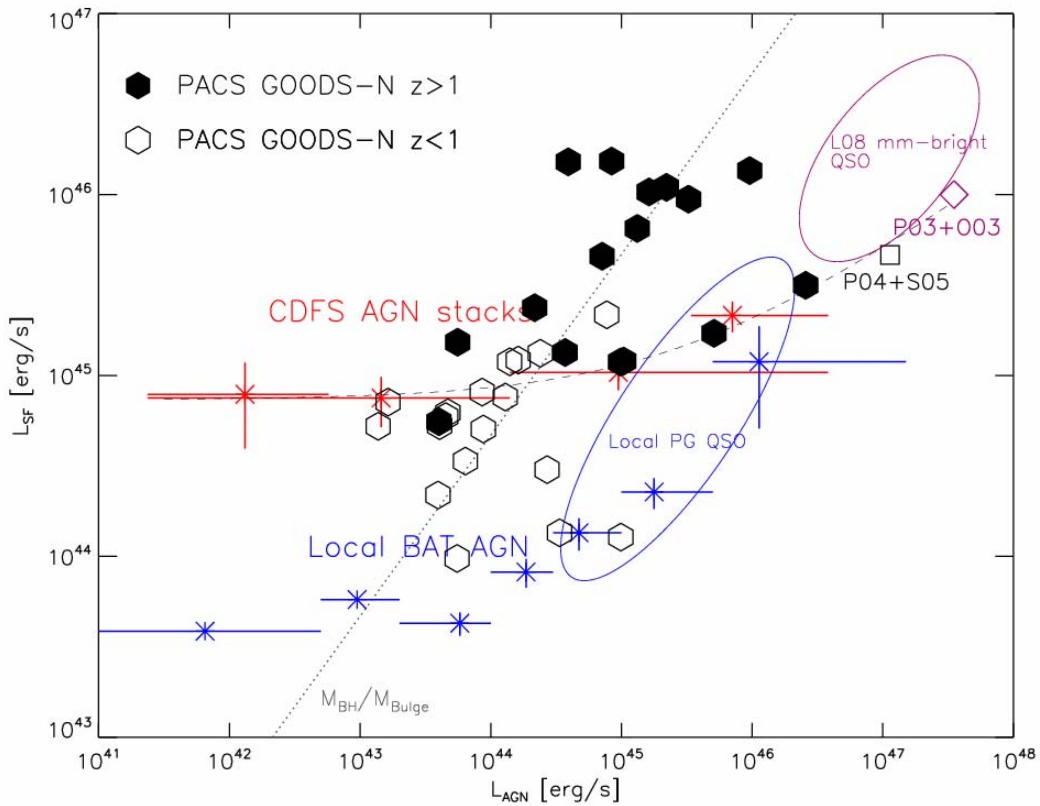
The co-evolution of AGN and star formation: Shao et al. in prep.

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!

Jose Acosta
Bruno Altieri
Paola Andreani
Herve Aussel
Stefano Berta
Angel Bongiovanni
Damien Le Borgne
Nicolas Bouche
Drew Brisbin
Hector Castaneda
Antonio Cava
Jordi Cepa
Andrea Cimatti
Emanuele Daddi
Helmut Dannerbauer
Helena Dominguez-Sanchez
David Elbaz
Emeric Le Floc'h
Natascha Förster Schreiber
Reinhard Genzel
Ignacio Gonzalez
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Andrea Grazian
Carlotta Gruppioni
Martin Harwit
Ho-Seong Hwang
Georgios Magdis
Benjamin Magnelli
Roberto Maiolino
Leo Metcalfe
Raanan Nordon
Koryo Okumura
Ana Perez
Ismael Perez Fournon
Albrecht Poglitsch
Paola Popesso
Francesca Pozzi
Laurie Riguccini
Giulia Rodighiero
Jose Miguel Rodriguez
Amelie Saintonge
Fadia Salmi
Miguel Sanchez
Paola Santini
Li Shao
Eckhard Sturm
Linda Tacconi
Ivan Valtchanov
Michael Wetzstein
Eckhard Wieprecht