

credit: Elbaz et al. 2011

A Highly Deconfused Mid-far-IR to Submm Catalog

GOODS-N

I. Techniques and Performances

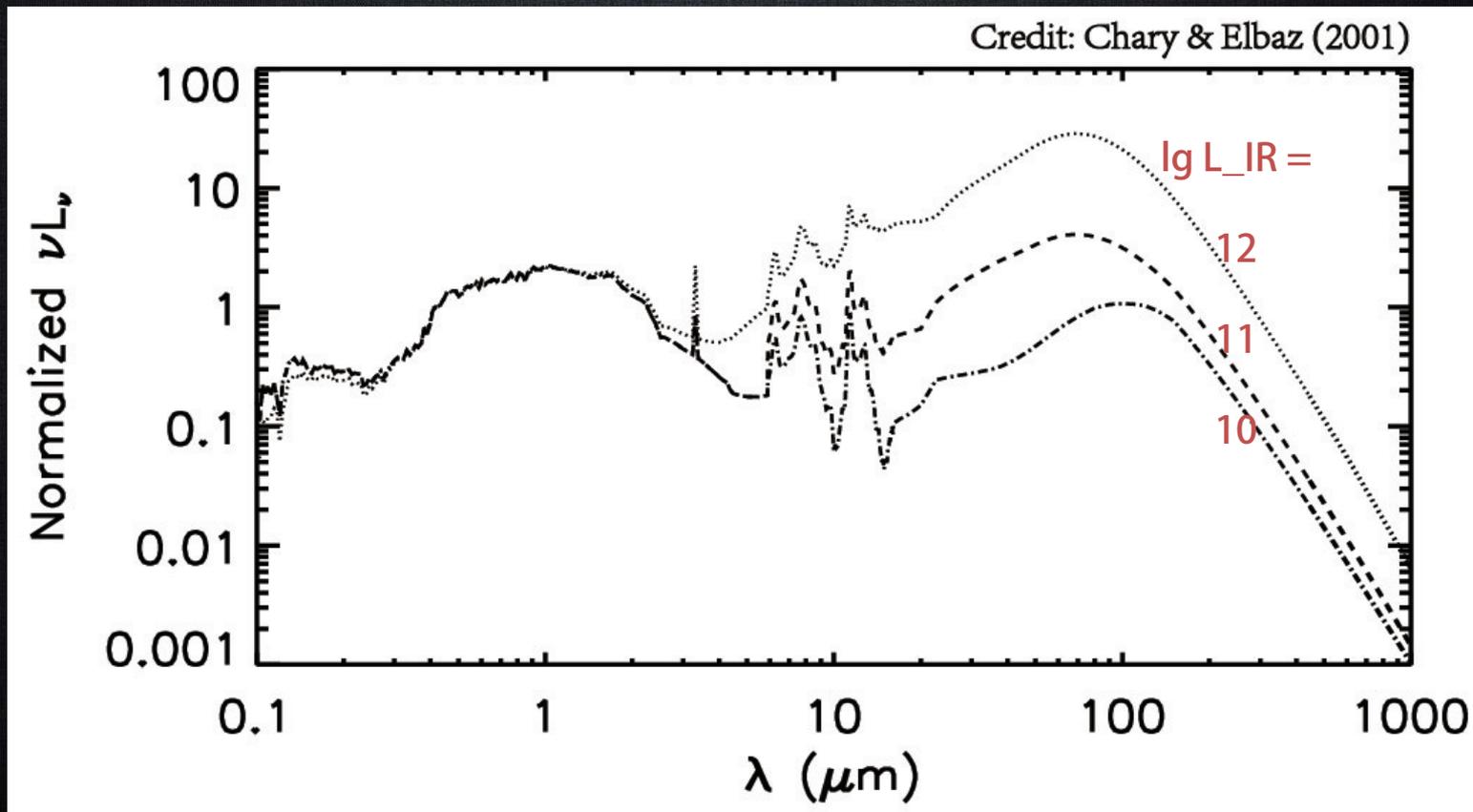
Daizhong Liu, Emanuele Daddi, M. Dickinson, F. Owen
& GOODS team etc
Jan 26th 2015

- Background & Dataset
- First-step Catalog & Photometry & Simulation
- Next-steps Catalog & Photometry & Simulation
- Final Catalog
- Preliminary Science

Herschel Far-IR :

Unique & Powerful:

Ideally -- directly measuring the FIR peak (dust-obscured SFR)



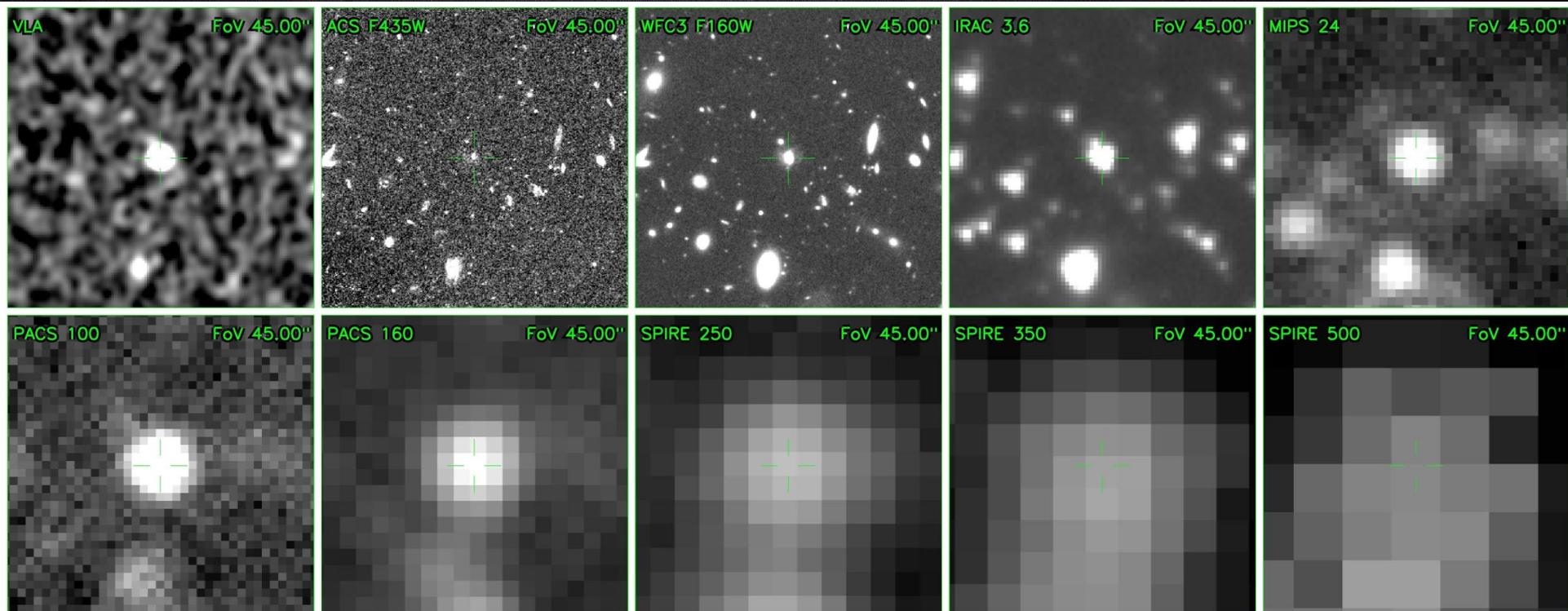
Herschel Far-IR :

Unique & Powerful:

Ideally -- directly measuring the FIR peak (dust-obscured SFR)

But practically -- the confusion problem (due to large PSF)

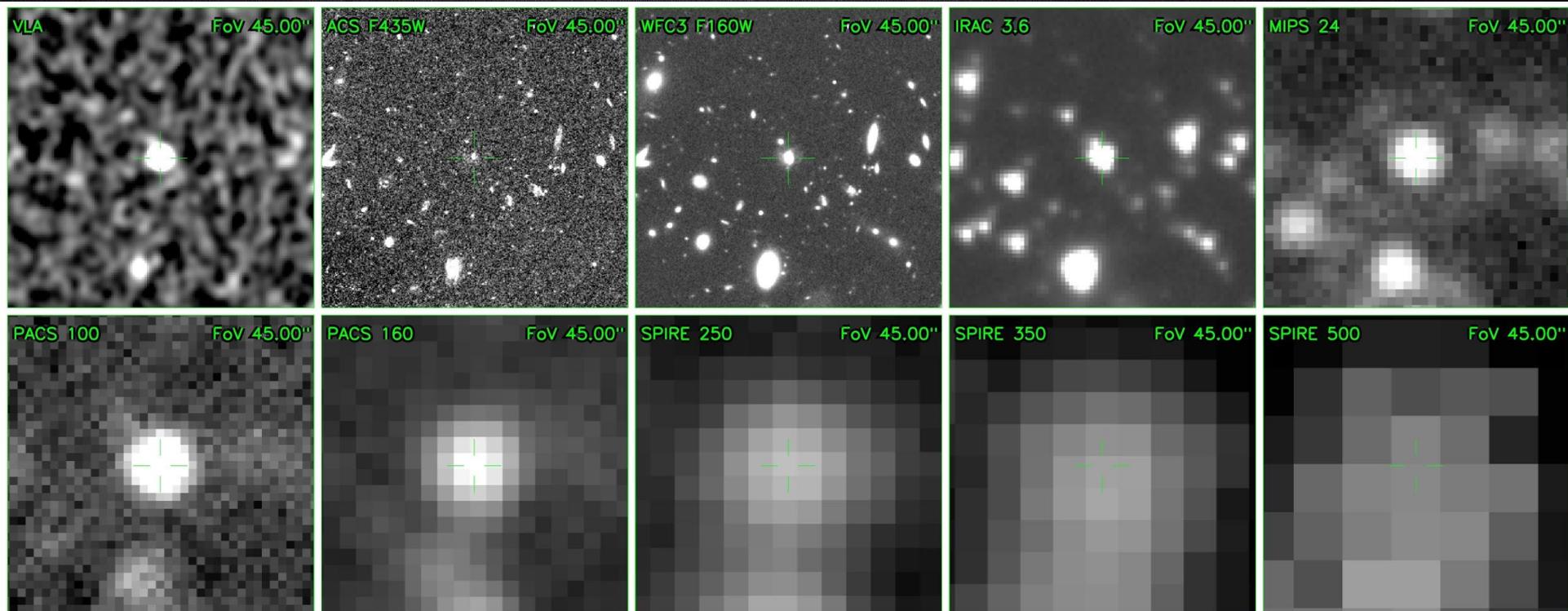
*We show this example
throughout all following slides:
ID12000 (GOODS850-19)*



Our goal -- make the most of Herschel:

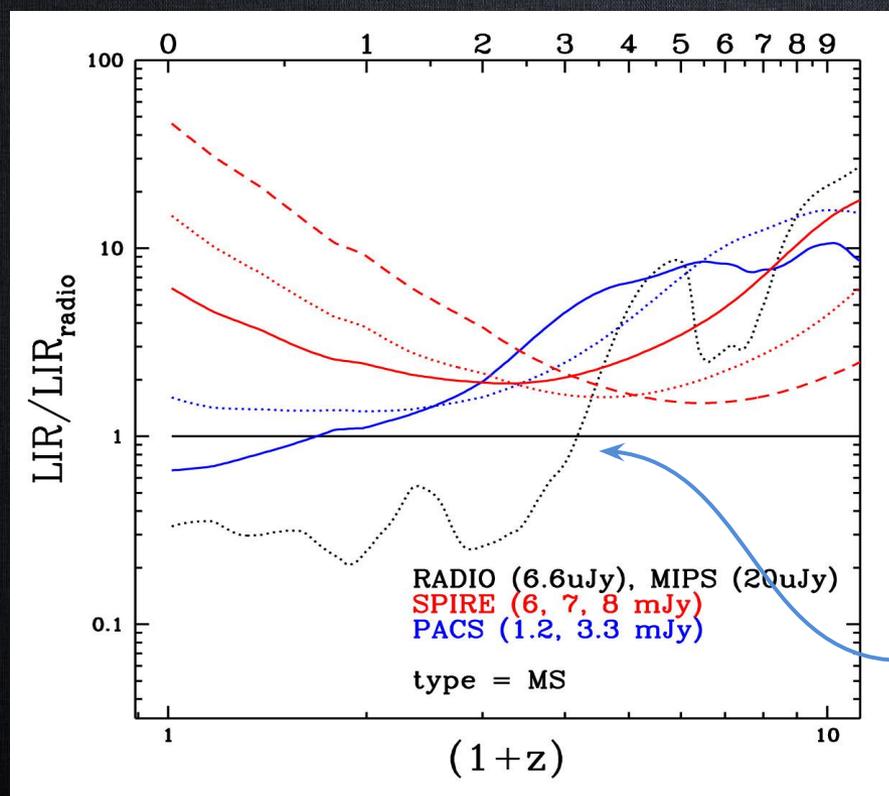
- deconfuse those objects
- robust measurements of flux and flux uncertainty
- build NIR & mid-far-IR-to-submm & Radio SEDs

*We show this example
throughout all following slides:
ID12000 (GOODS850-19)*



What's unique --

- VLA 20cm together with MIPS 24um for prior catalog (see image below)
- Original deconfusion approach
- Realistic flux uncertainty for each source



at $z < 3$
 radio is shallower
 but at $z > 3$
 radio is the deepest

Photometric Dataset:

K band

IRAC 3.6, 4.5, 5.8, 8.0 um	PSF ~ 2"	IRAC Catalog (from GOODS Legacy Program)
IRS Peak-up 16um	PSF ~ 3.6"	$3\sigma \sim 75 \mu\text{Jy}$
MIPS 24um	PSF ~ 5"	$5\sigma \sim 30 \mu\text{Jy}$
PACS 100um	PSF ~ 6.7"	$1\sigma \sim 0.36 \text{ mJy}$ (sim: 0.35 mJy)
PACS 160um	PSF ~ 11"	$1\sigma \sim 0.80 \text{ mJy}$ (sim: 0.84 mJy)
SPIRE 250um	PSF ~ 18.2"	$1\sigma \sim 1.98 \text{ mJy}$ (sim: 2.13 mJy)
SPIRE 350um	PSF ~ 24.9"	$1\sigma \sim 2.48 \text{ mJy}$ (sim: 2.56 mJy)
SPIRE 500um	PSF ~ 36.3"	$1\sigma \sim 3.54 \text{ mJy}$ (sim: 4.13 mJy)
AzTEC+MAMBO 1.16mm	PSF ~ 19.5"	$1\sigma \sim 0.5 \text{ mJy}$
VLA 20cm	PSF 1.7x1.6"	$1\sigma \sim 2.5 \mu\text{Jy}$

1st-step:

IRAC Catalog	---	MIPS 24um + VLA 20cm	---	output 1st-step catalog
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Next-steps:

1st-step catalog	--	PACS 100um	---	output 2nd-step catalog
2nd-step catalog	--	PACS 160um	---	output 3rd-step catalog
3rd-step catalog	--	SPIRE 250um	---	output 4th-step catalog
4th-step catalog	--	SPIRE 350um	---	output 5th-step catalog
5th-step catalog	--	SPIRE 500um	---	output 6th-step catalog
6th-step catalog	--	AzTEC+MAMBO 1.16mm	---	output final catalog

Final catalog

photo-z (Pannella et al 2015; 3DHST) and spec-z from many literatures.

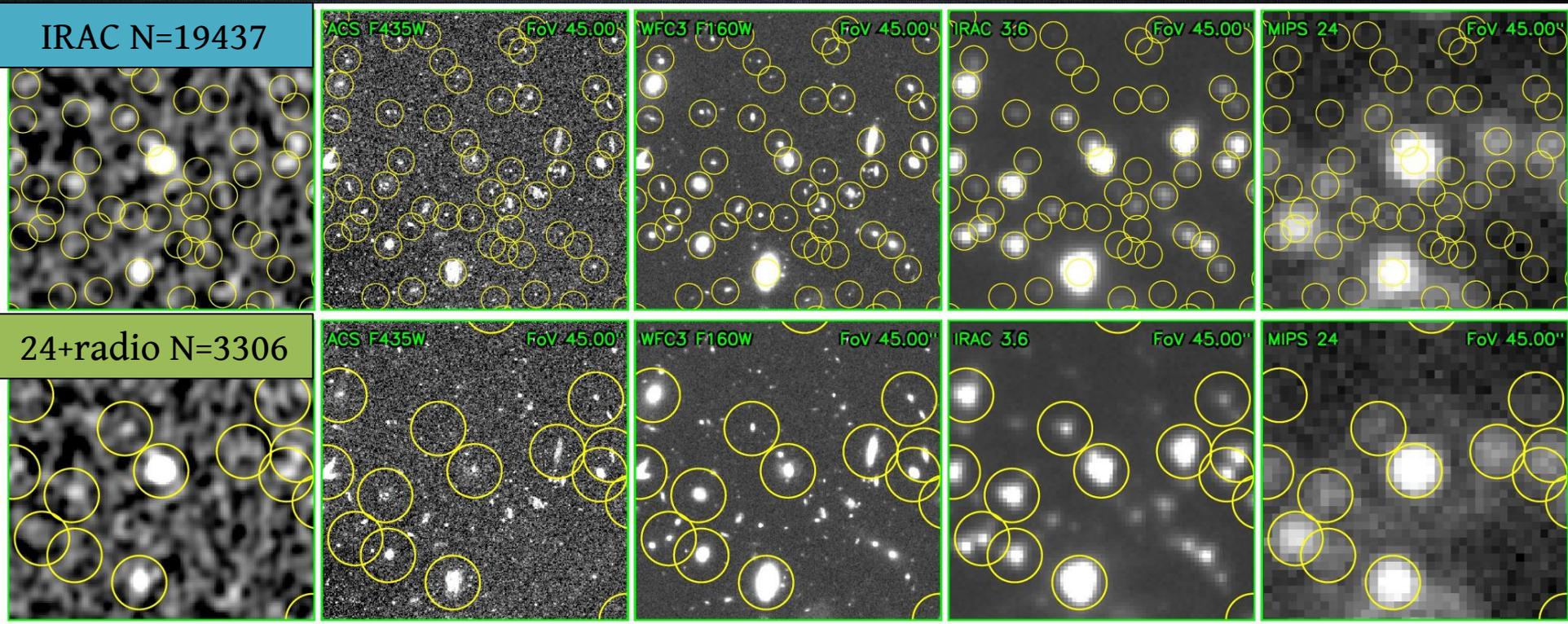
1st-step:

IRAC Catalog

MIPS 24um + VLA 20cm

$$f_{24}/df_{24} > 3 \quad \text{or} \quad f_{radio}/df_{radio} > 3$$

183 sources only detected in radio!



1st-step:

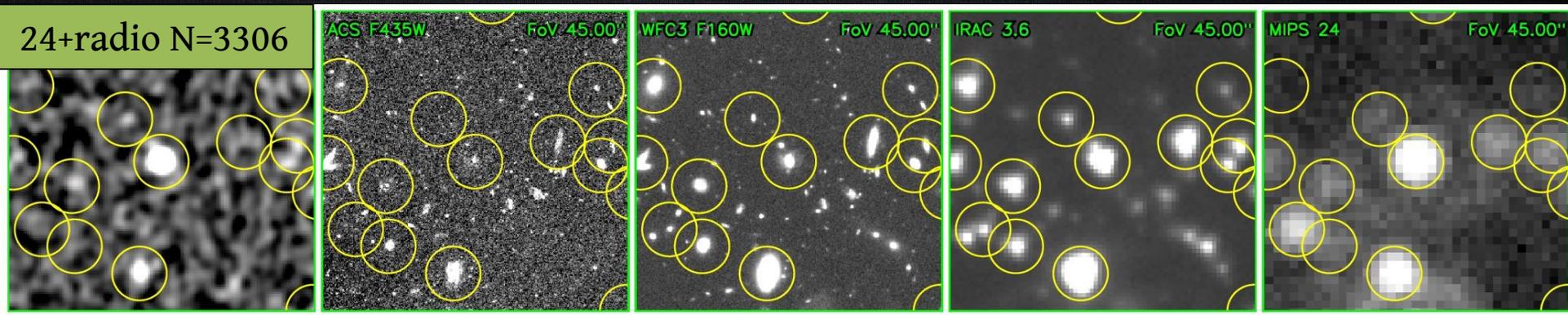
IRAC Catalog

MIPS 24um + VLA 20cm

$f_{24}/df_{24} > 3$ or $f_{radio}/df_{radio} > 3$

flux --- galfit measurement

flux uncertainty --- monte carlo simulation



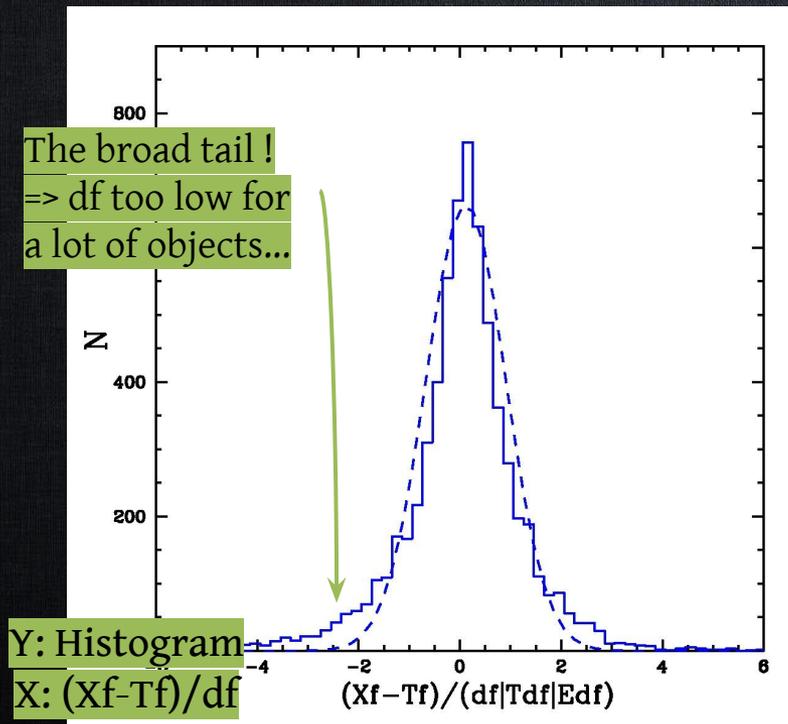
Flux Uncertainty -- Monte Carlo Simulation:

$N + 1$ each time each band $\times 8000$ times

input: X_f

output: $T_f \pm df$ (galfit)

statistically: $(X_f - T_f) / df$ (corrected) --- Gaussian $\sigma \sim 1.0$



Corrections:

Correcting df (galfit) by an overall factor?

--- No

Find out what objects contribute to the tail!

--- high df (galfit)

--- high residual

--- high crowding

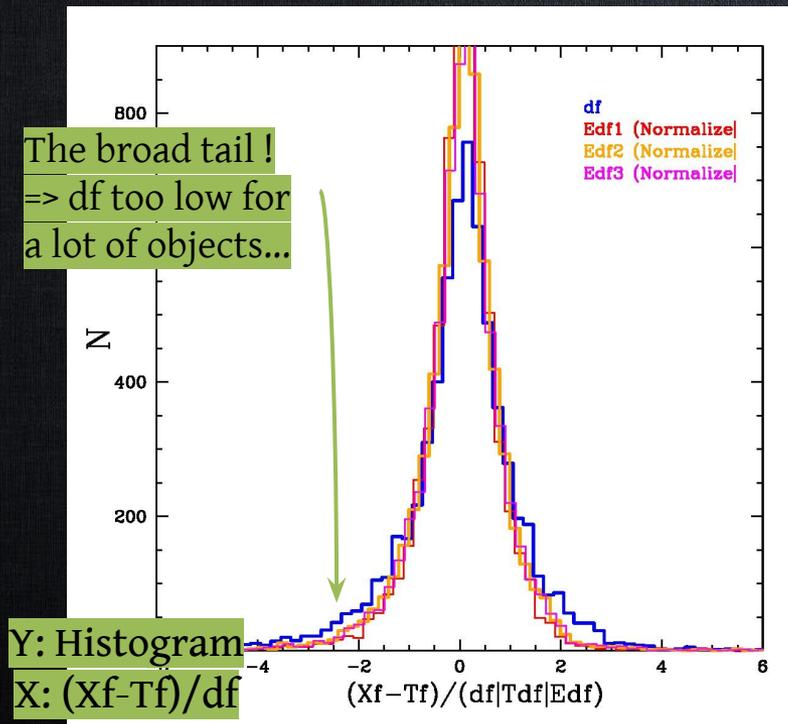
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1st-step:

IRAC Catalog

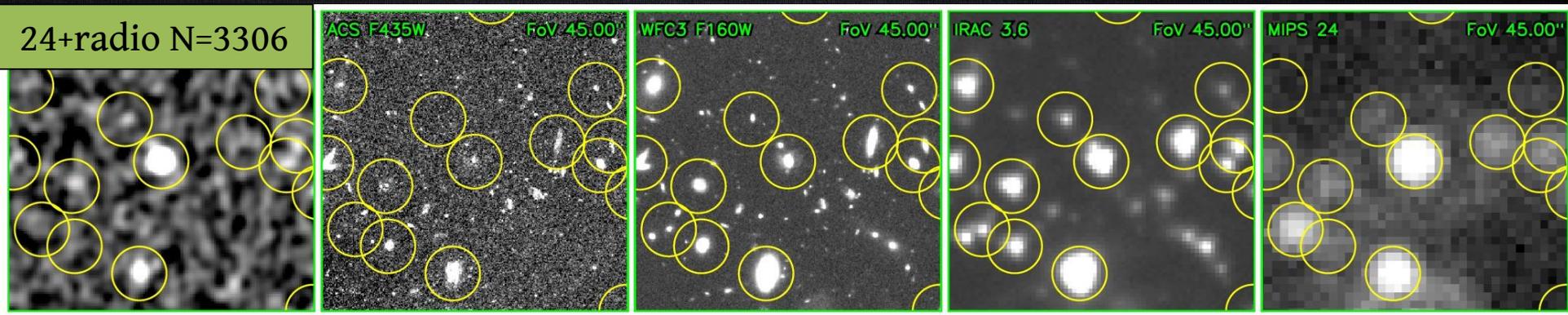
MIPS 24um + VLA 20cm

$f_{24}/df_{24} > 3$ or $f_{radio}/df_{radio} > 3$

flux --- galfit measurement

flux uncertainty --- monte carlo simulation

SED fitting --- K+IRAC+MIPS+VLA (Magdis SED Templates)



1st-step:

IRAC Catalog

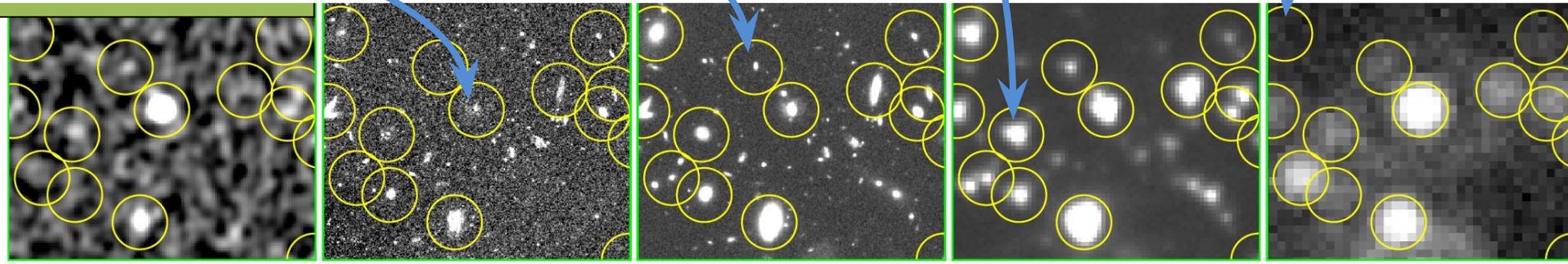
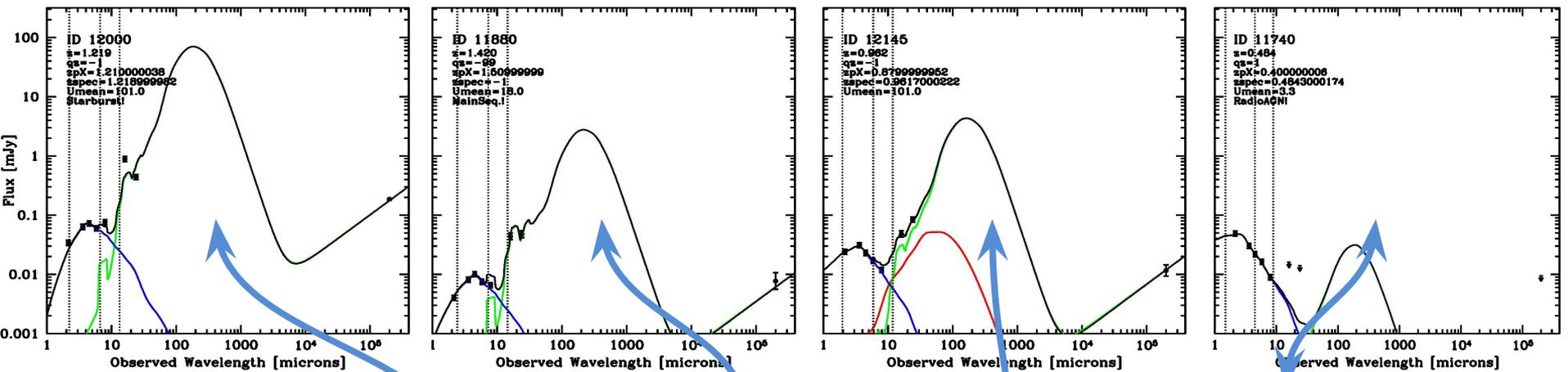
MIPS 24um + VLA 20cm

$f_{24}/df_{24} > 3$ or $f_{radio}/df_{radio} > 3$

flux --- galfit measurement

flux uncertainty --- monte carlo simulation

SED fitting --- K+IRAC+MIPS+VLA (Magdis SED Templates)



1st-step:

IRAC Catalog

MIPS 24um + VLA 20cm

$f_{24}/df_{24} > 3$ or $f_{radio}/df_{radio} > 3$

flux --- galfit measurement

flux uncertainty --- monte carlo simulation

SED fitting --- K+IRAC+MIPS+VLA (Magdis SED Templates)

find out sources too faint at 100um --- subtract them at 100um

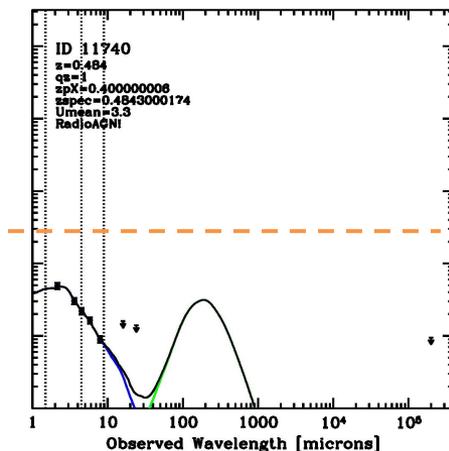
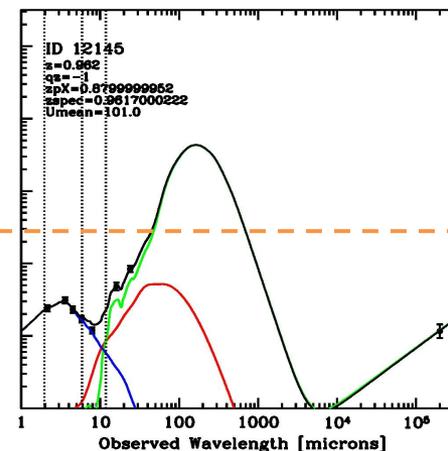
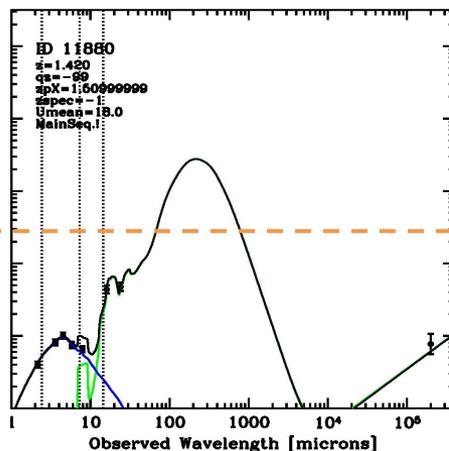
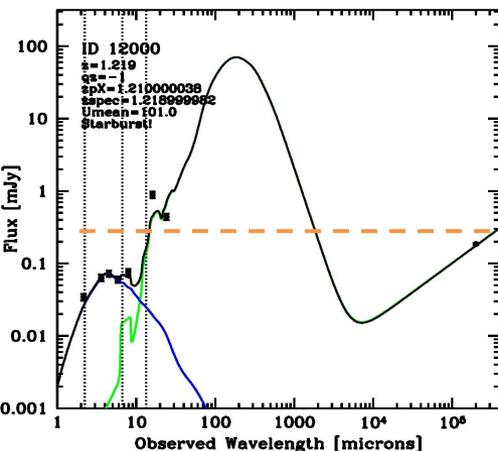
output 1st-step catalog

$f_{SED} + 2 df_{SED} > f_{Excl}$

$f_{SED} + 2 df_{SED} > f_{Excl}$

$f_{SED} + 2 df_{SED} > f_{Excl}$

$f_{SED} + 2 df_{SED} < f_{Excl}$



1st-step:

IRAC Catalog

MIPS 24um + VLA 20cm

 $f_{24}/df_{24} > 3$ or $f_{radio}/df_{radio} > 3$

flux --- galfit measurement

flux uncertainty --- monte carlo simulation

SED fitting --- K+IRAC+MIPS+VLA (Magdis SED Templates)

find out sources too faint at 100um --- subtract them at 100um

output 1st-step catalog

(93 objects subtracted at 100)

1st-step:

IRAC Catalog --- MIPS 24um + VLA 20cm --- output 1st-step catalog

Next-steps:

1st-step catalog --

PACS 100um

flux --- galfit for only objects not subtracted

flux uncertainty --- monte carlo simulation

SED fitting --- K+IRAC+MIPS+100um+VLA

find out sources too faint at 160um --- subtract them at 160um

--- output 2nd-step catalog

1st-step:

Next-steps:

nth-step catalog

--

nth-band *semi-automatically repeating:*

flux --- galfit for only objects not subtracted

*check residual
if new objects
appear*

flux uncertainty --- monte carlo simulation

SED fitting --- K + IRAC + MIPS + (n-1) bands + VLA

find out sources too faint --- subtract them at this band

--- *output (n+1) step catalog*

PACS 100um	$1\sigma \sim 0.36$ mJy (sim: 0.35 mJy)	$f_{\text{Excl.}} \sim 0.34$ mJy	$N_{\text{Excl.}} = 93$
PACS 160um	$1\sigma \sim 0.80$ mJy (sim: 0.84 mJy)	$f_{\text{Excl.}} \sim 1.34$ mJy	$N_{\text{Excl.}} = 360$
SPIRE 250um	$1\sigma \sim 1.98$ mJy (sim: 2.13 mJy)	$f_{\text{Excl.}} \sim 3.4$ mJy	$N_{\text{Excl.}} = 1631$
SPIRE 350um	$1\sigma \sim 2.48$ mJy (sim: 2.56 mJy)	$f_{\text{Excl.}} \sim 5.0$ mJy	$N_{\text{Excl.}} = 2477$
SPIRE 500um	$1\sigma \sim 3.54$ mJy (sim: 4.13 mJy)	$f_{\text{Excl.}} \sim 5.0$ mJy	$N_{\text{Excl.}} = 2882$
AzTEC+MAMBO 1.16mm	$1\sigma \sim 0.5$ mJy	$f_{\text{Excl.}} \sim 0.7$ mJy	$N_{\text{Excl.}} = 2925$

Final Catalog

Median df sim.

Numb. S/N \geq 5

K band

IRAC 3.6, 4.5, 5.8, 8.0 μ m

IRS Peak-up 16 μ m

MIPS 24 μ m

PACS 100 μ m

PACS 160 μ m

SPIRE 250 μ m

SPIRE 350 μ m

SPIRE 500 μ m

AzTEC+MAMBO 1.16mm

VLA 20cm

1 σ \sim 8.4 μ Jy

911

1 σ \sim 7.6 μ Jy

2232

1 σ \sim 0.31 mJy

576

1 σ \sim 0.68 mJy

568

1 σ \sim 1.83 mJy

480

1 σ \sim 2.34 mJy

144

1 σ \sim 2.71 mJy

57

1 σ \sim 0.64 mJy

7

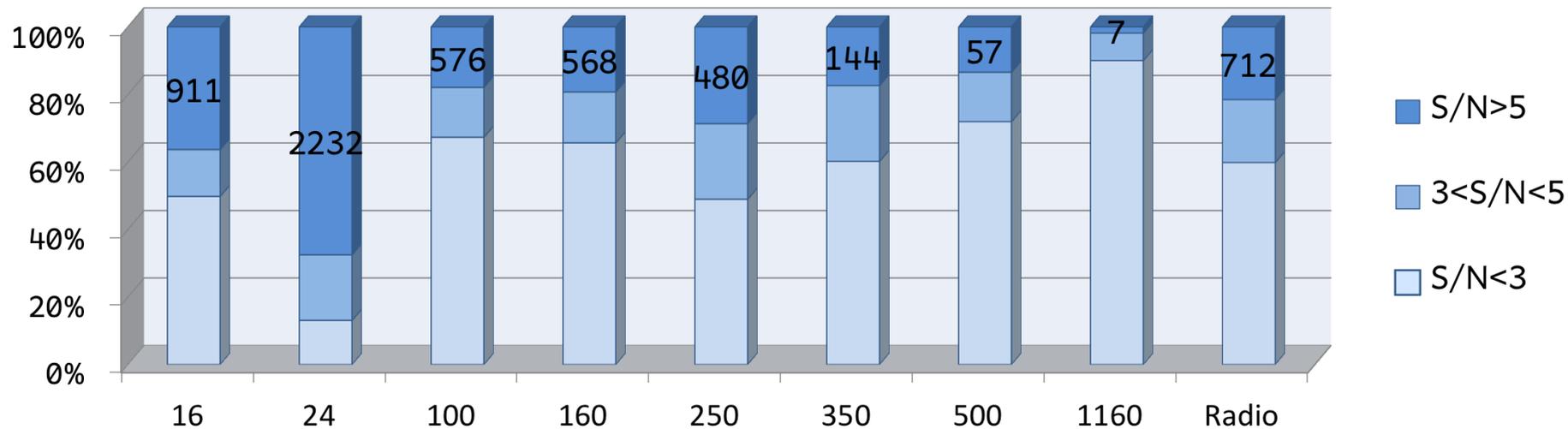
1 σ \sim 2.5 μ Jy

712

Numb. S/N FIR-SMM

(100,160,250,350,500,1160) \square 5

=> 1127 Objects !



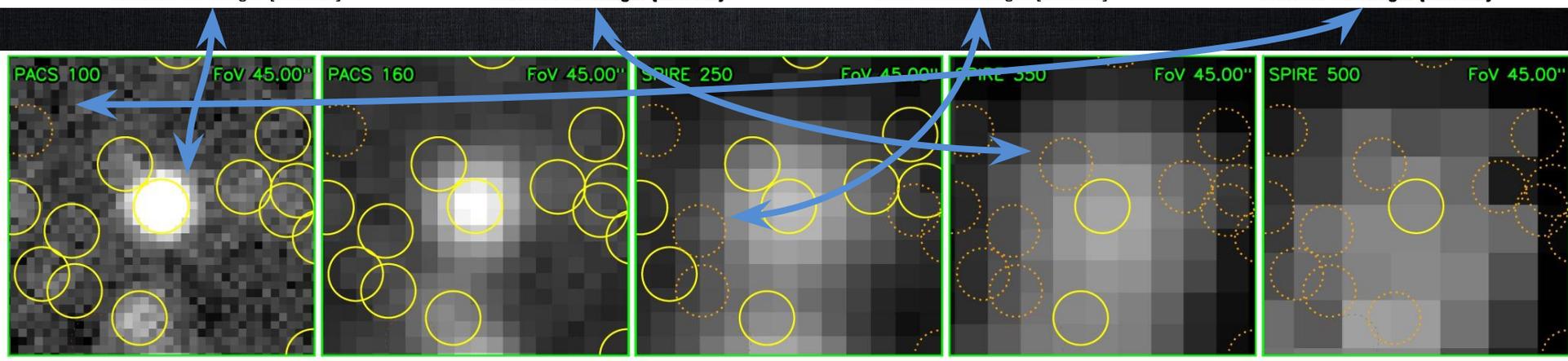
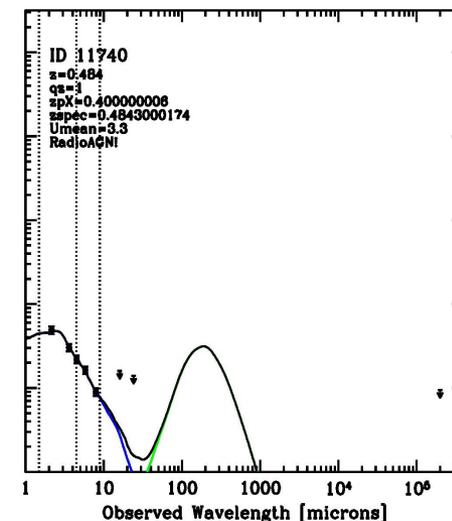
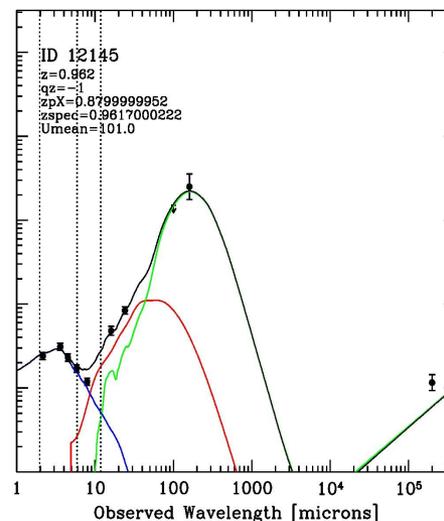
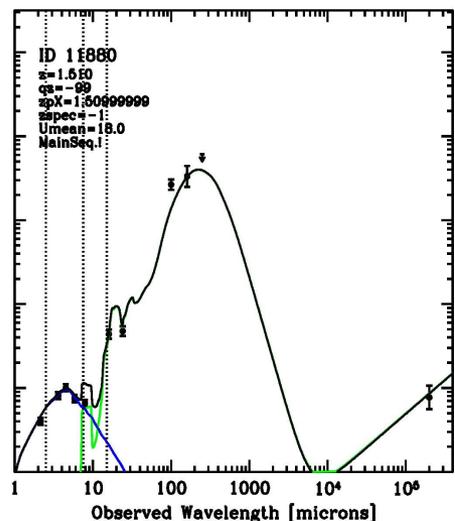
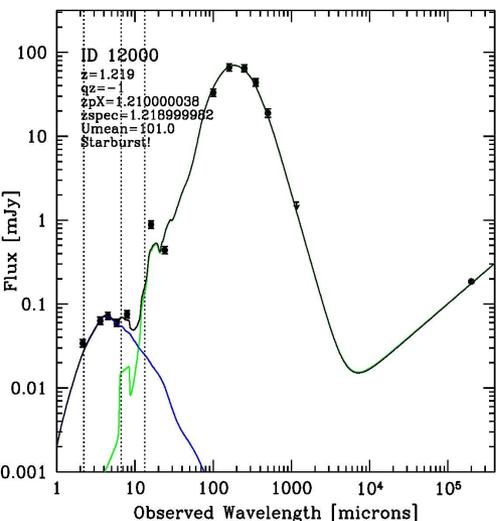
Final SEDs

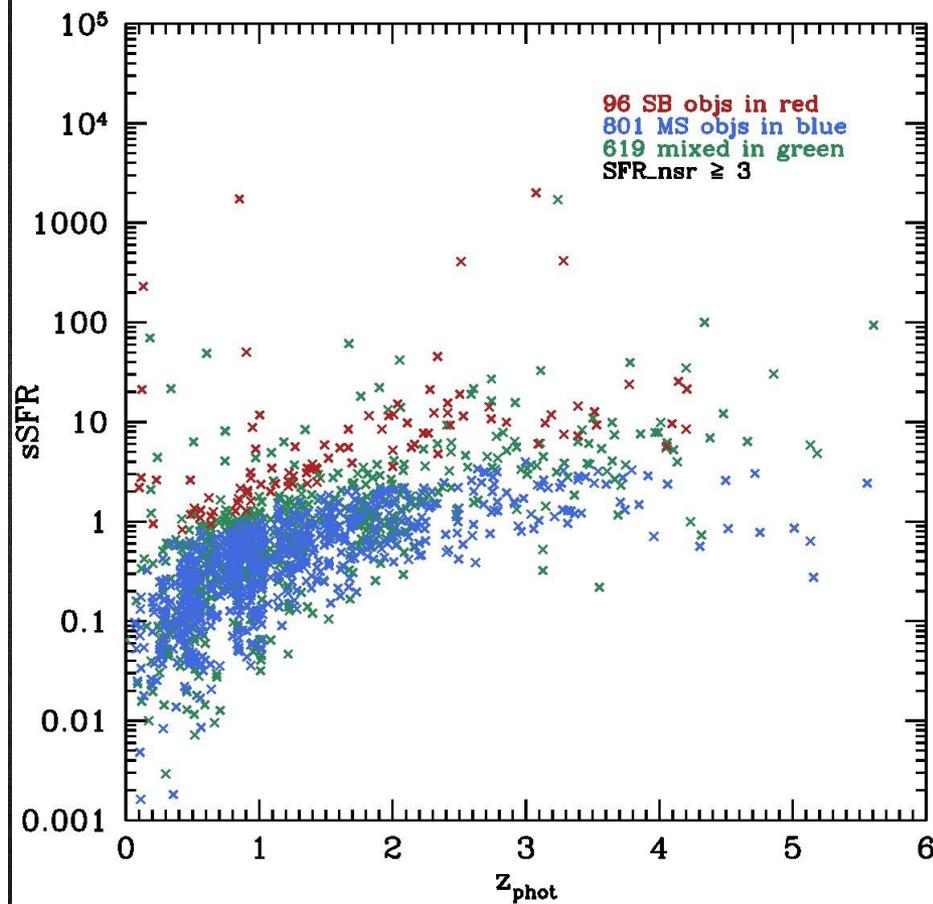
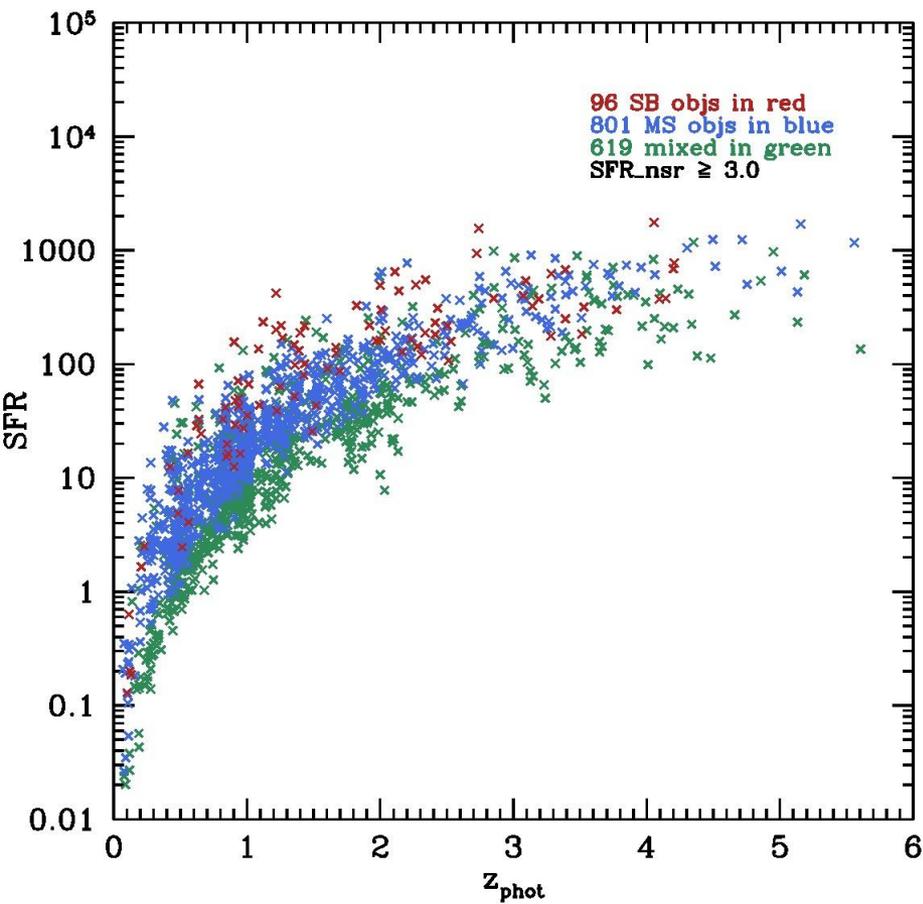
Incl. at all bands

Excl. since 350um

Excl. since 250um

Excl. since 100um





Welcome to
Emanuele's talk at Thursday

A highly deconfused IR multiwavelength catalog (GOODSN)

- Radio + 24um as 1st-step prior catalog
- Step-by-step IR-to-radio SED
- Step-by-step photometry & catalog
- Realistic flux uncertainty

*and a few new objects
appear in residuals*

A highly deconfused IR multiwavelength catalog (GOODSN)

- Radio + 24um as 1st-step prior catalog
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Thank you!