Extragalactic Surveys: Prospects from Herschel-PACS

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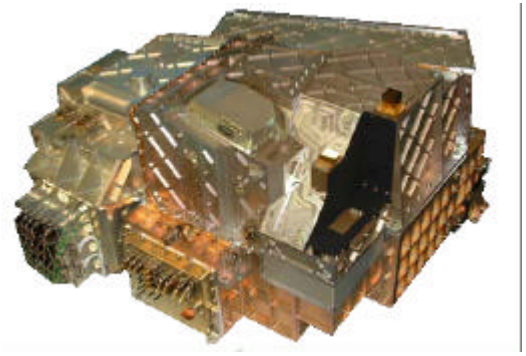
PACS Team, PACS GT extragalactic survey (PEP) Team

PI: Dieter Lutz

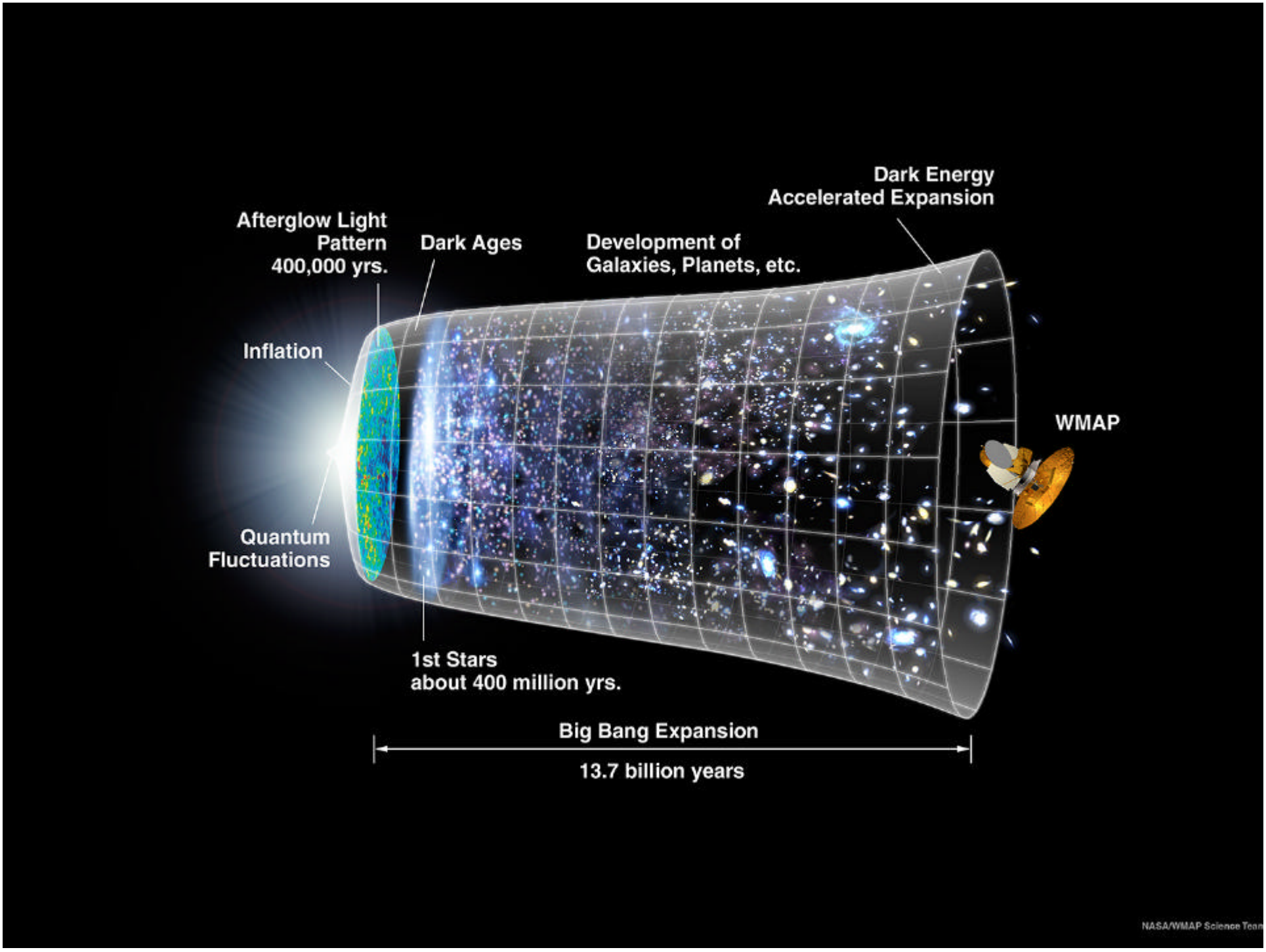


PEP in a nutshell

- Comprehensive far-infrared survey of the extragalactic sky
- 75μm, 110μm & 170μm
- “multi-cone” strategy coordinated with SPIRE
- Coverage :
  - 4 sq. deg. to confusion limit (CL) at 170mm (11 mJy)
  - 0.75 sq.deg to 7 mJy at 110mm
  - 150 sqarcmin in the GOODS-S to 1.5 mJy at 75 mm & 110 mm

- Survey set up as a ‘shared GT KP, with framework set up by a MOU

Institution	Time (h)
MPE (**PI: D. Lutz**)	360
CEA (**D. Elbaz**)	80
IAC (**J. Cepa**)	80
ESA	80
INAF (P.Andreani)	50
MS (M.Harwitt)	10
Total	**660**


Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
400,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years
NASA/WMAP Science Team

PACS in a nutshell

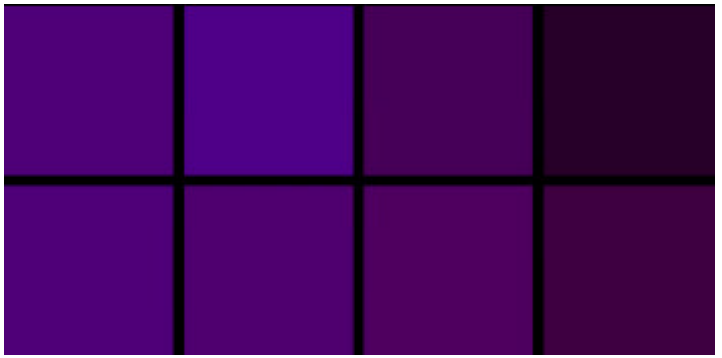
- Camera and spectrometer for 60-200μm

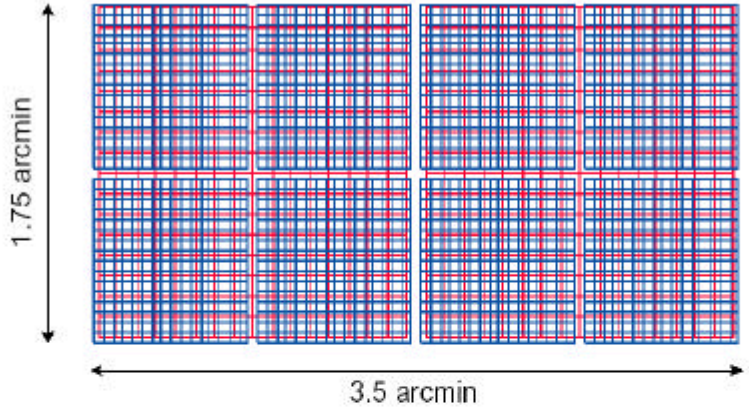
- Camera operating simultaneously at [75μm or 110μm] and 170μm

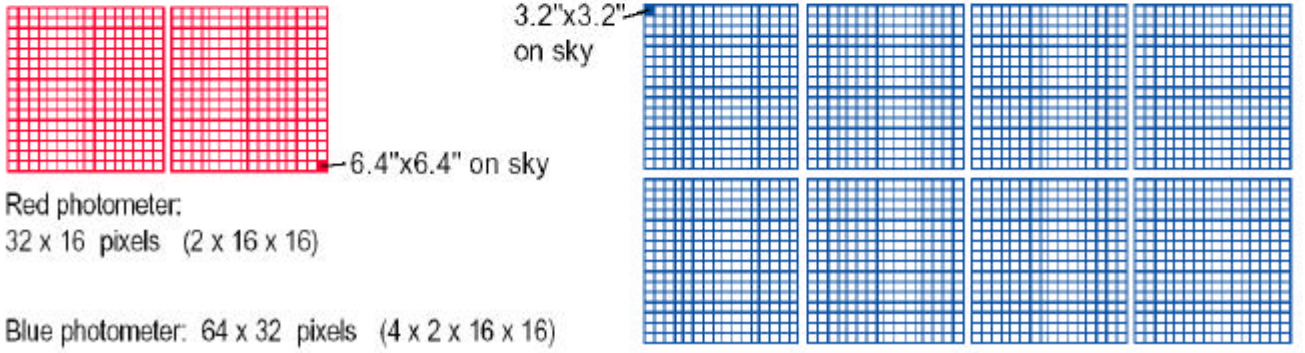
- Instantaneous FOV 1.7'x3.5'

- PSF FWHM: 6-13"

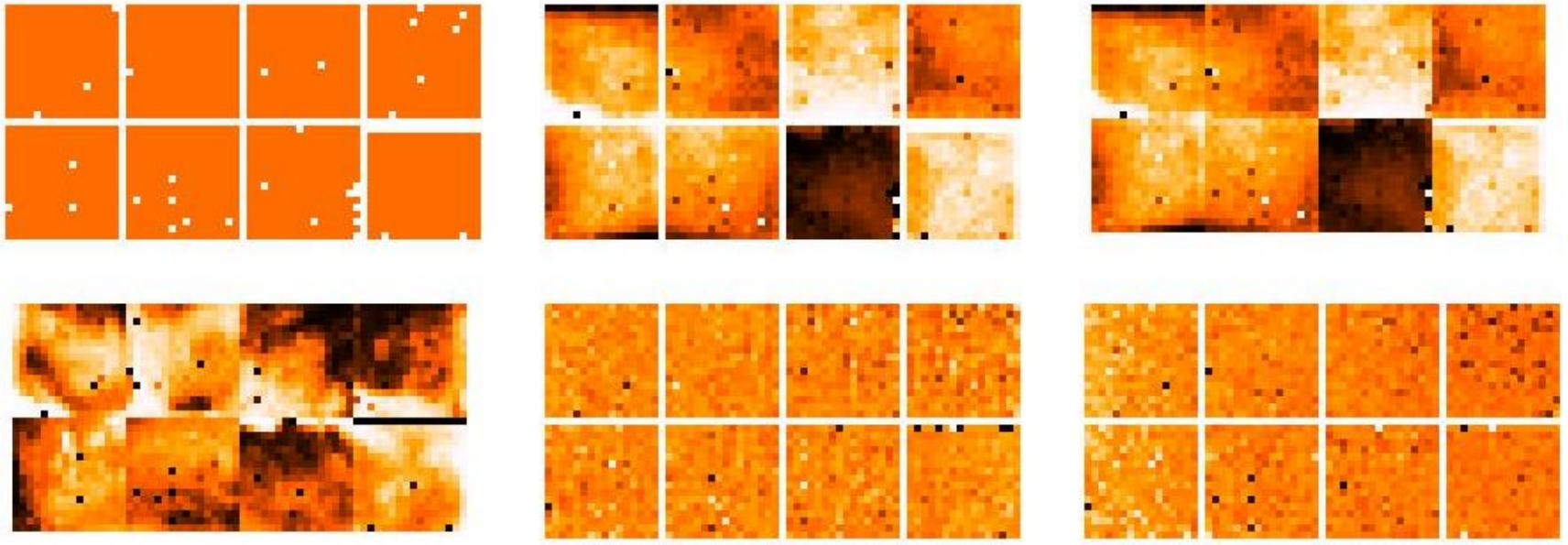
- Sensitivity:
point source ~4mJy 5σ 1 hour
1sq.deg. to ~10mJy 5σ: ~100 hour







First FM-ILT ‘reduced’ data



PACS Extragalactic Surveys: Science Goals

- **Resolve the Cosmic Infrared Background and determine the nature of its constituents**

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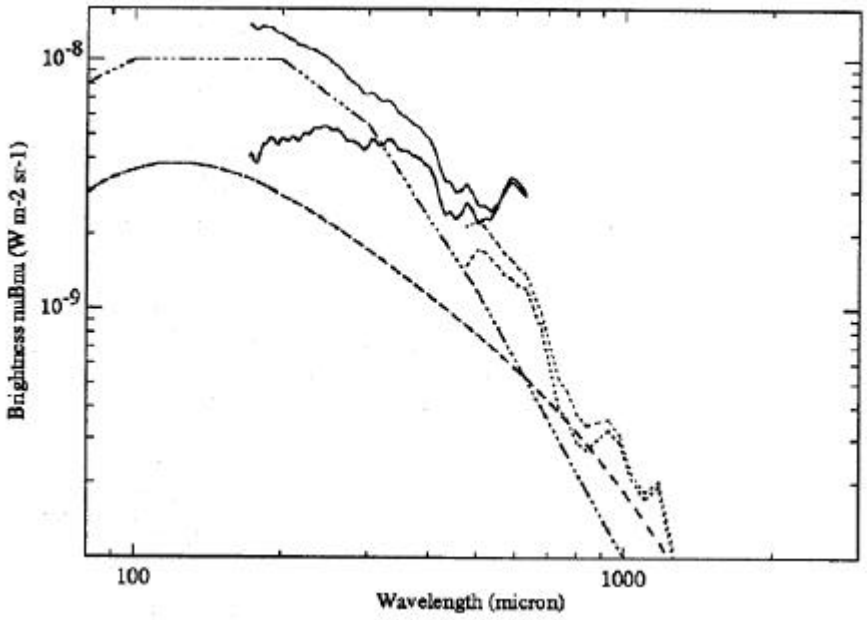
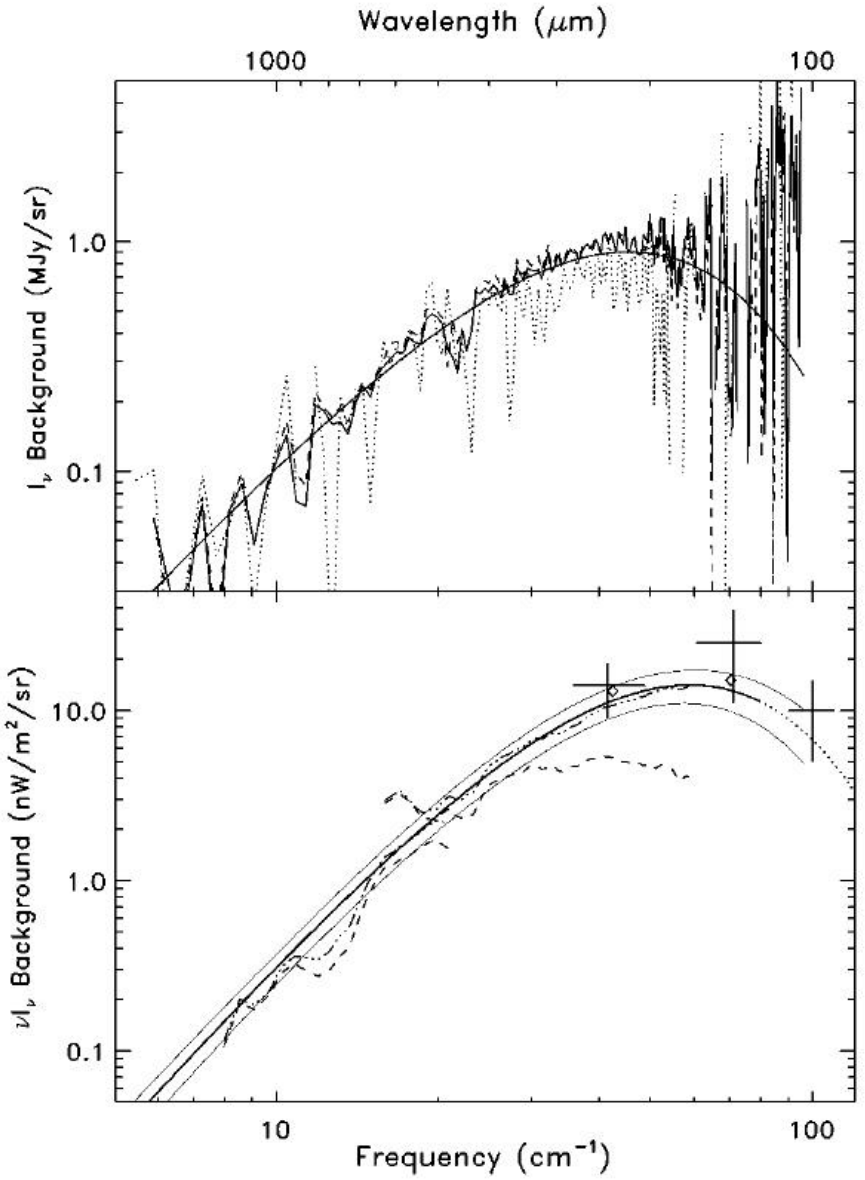
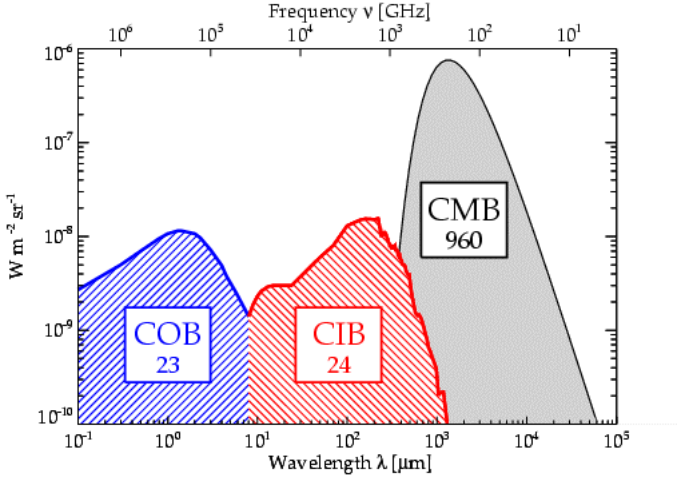
COBE 1996: Detection of CIB

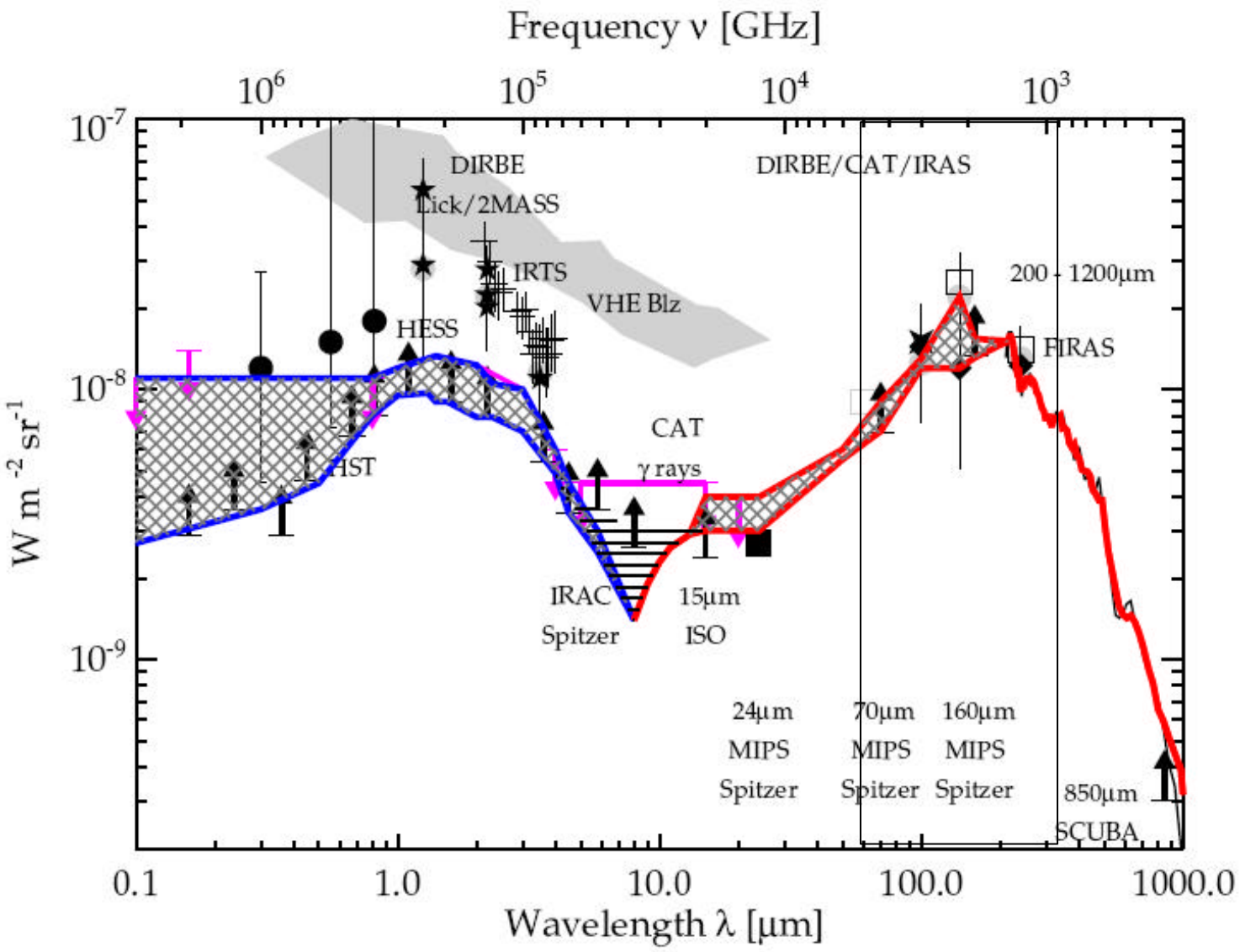




Puget et al. 1996, Fixsen et al. 1998, Hauser et al. 1998,…



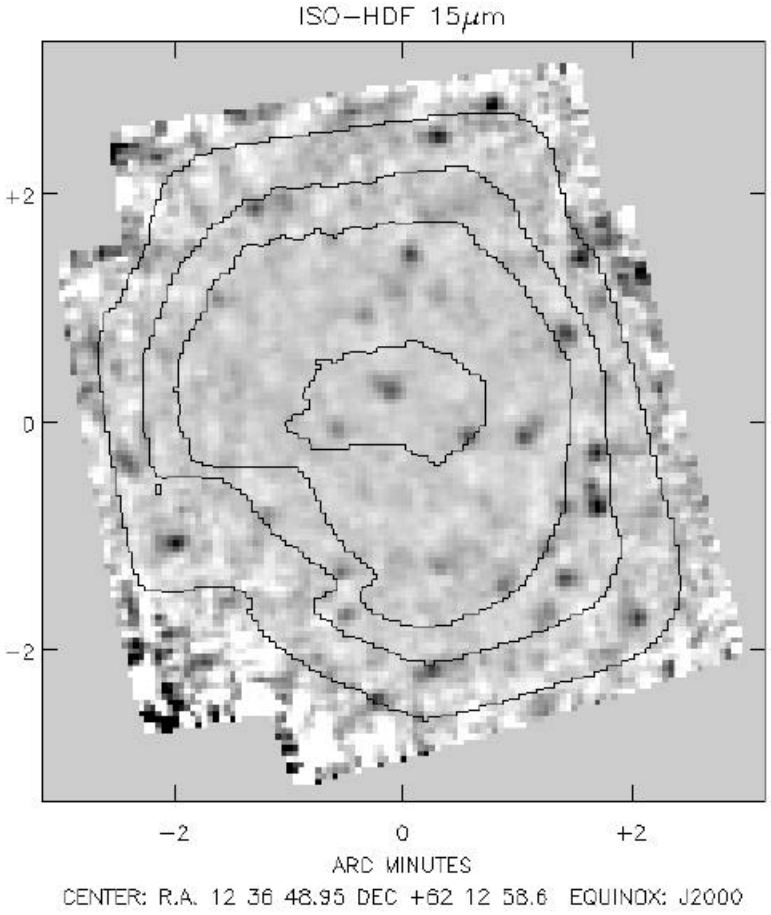
Cosmic background

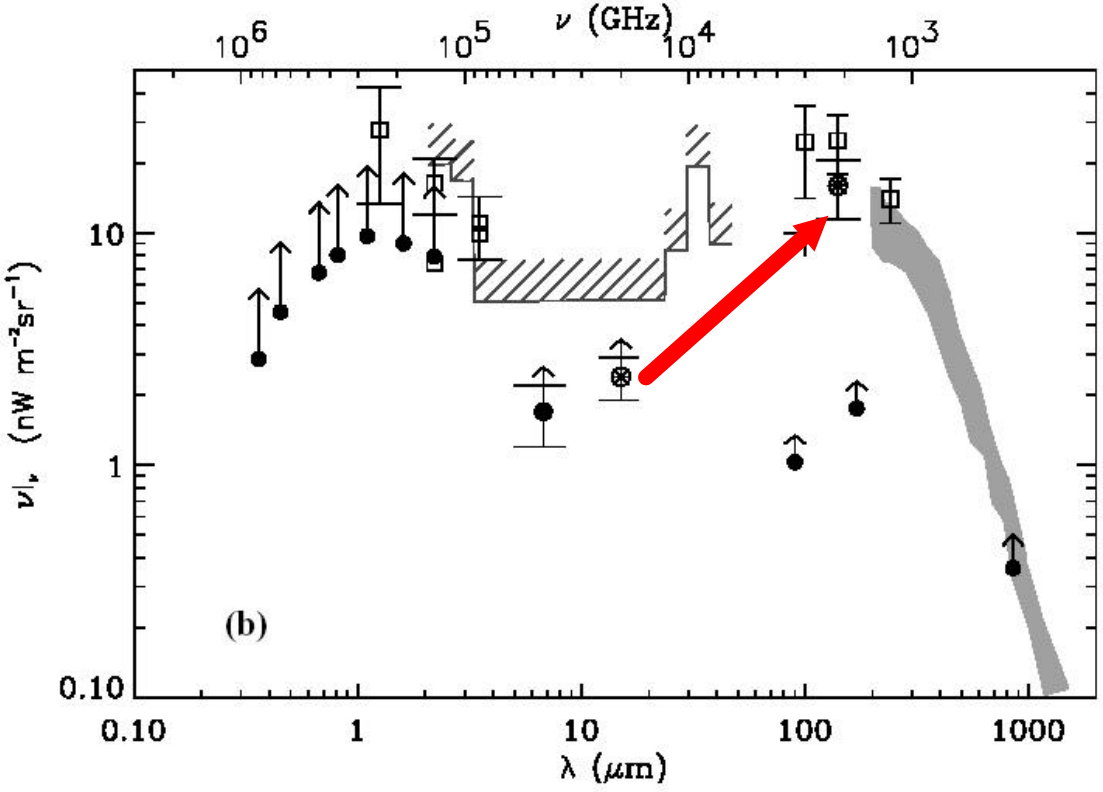


Dole et al. 2006

ISO 1995-1998: Relation CIB to mid-infrared sources

Detection of modest size samples of 15μm sources
SED- and redshift-based extrapolation
⇒ Most of CIB originates in sources detected in the mid-IR: (U)LIRGs at z~1





Aussel et al. 1999

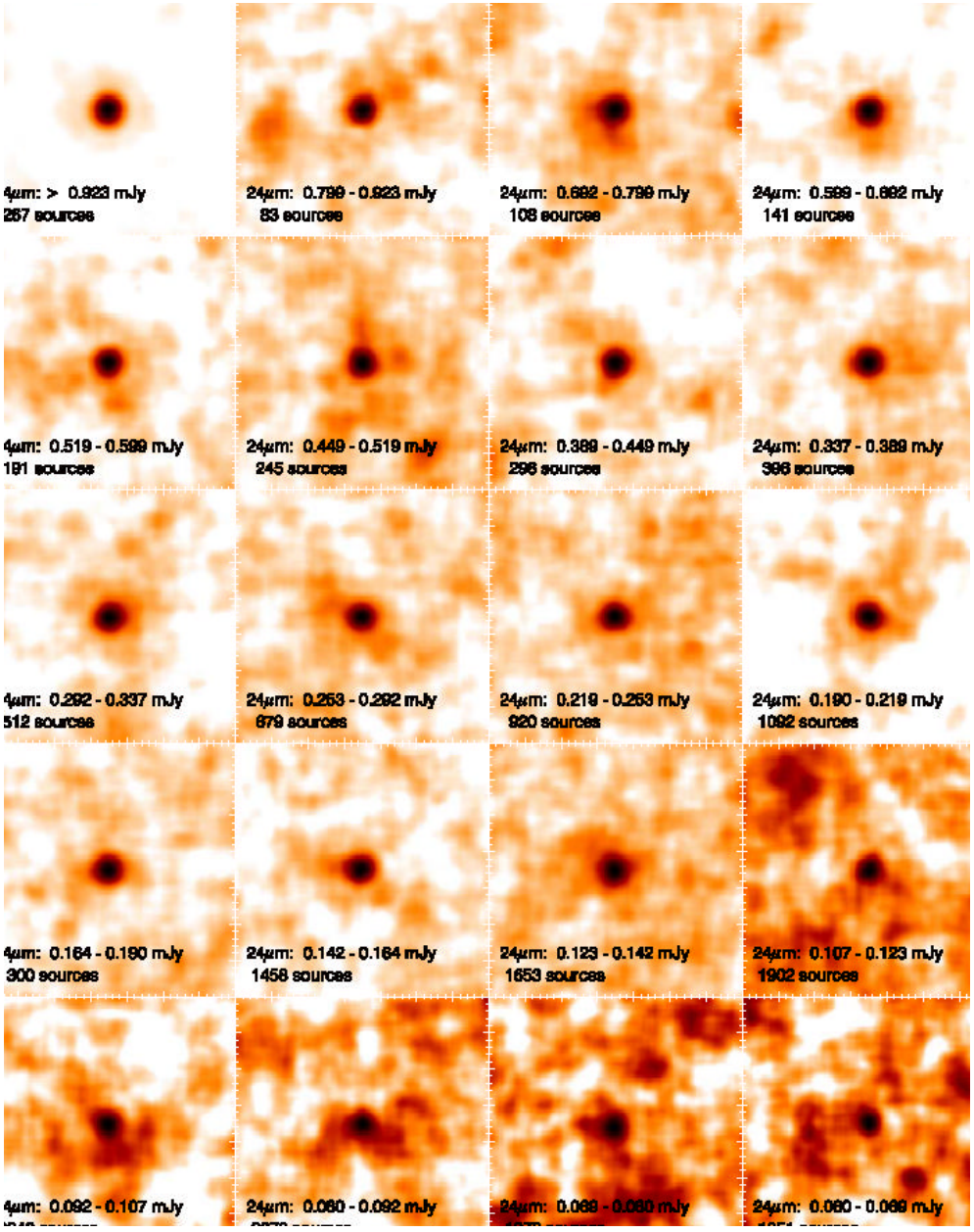
Elbaz et al. 2002

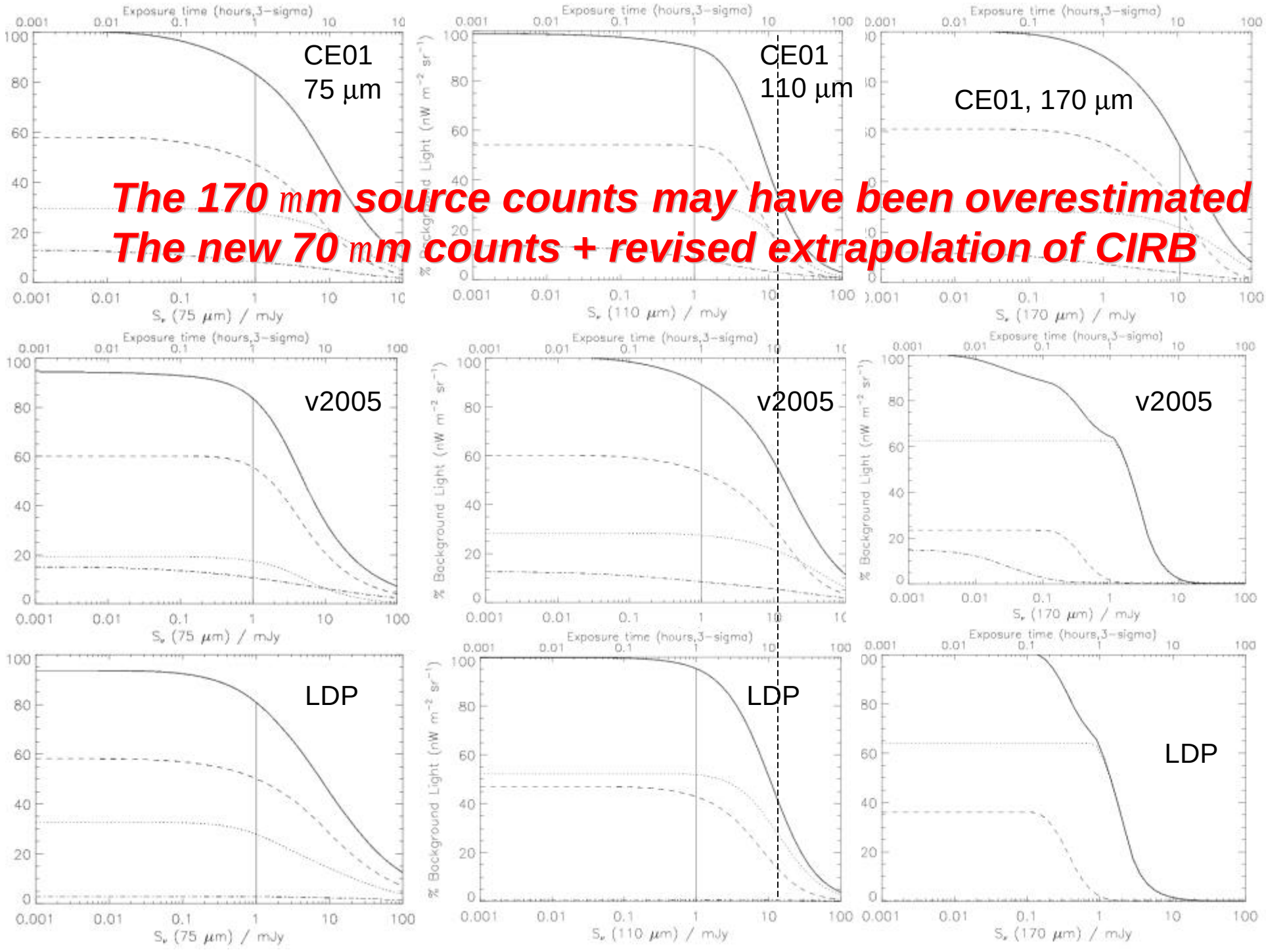
Spitzer 2006: CIB resolution on statistical basis

Dole et al. 2006:

Stacking of far-infrared signal at the positions of many mid-infrared sources.

- Statistical detection down to S(24μm)-60μJy
- **Representing 70% (90%) of CIB at 160㎜ (70㎜)**





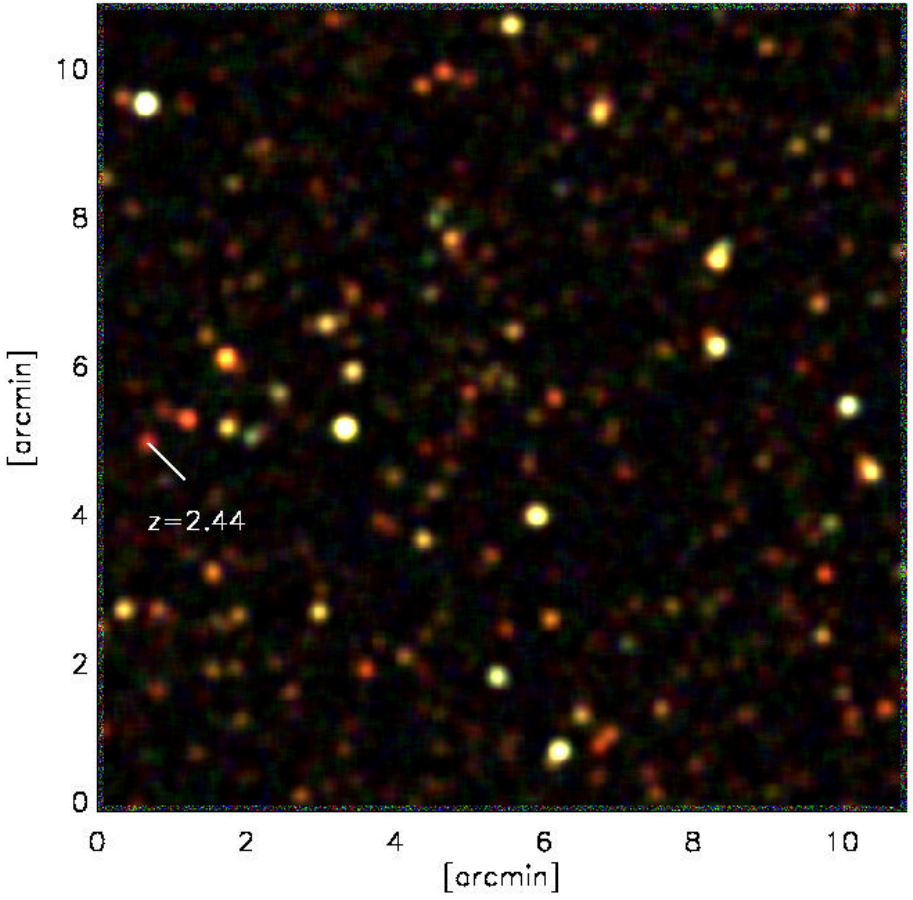
The 170 ㎜ source counts may have been overestimated

The new 70 ㎜ counts + revised extrapolation of CIRB

Herschel 2008+: CIB resolution into individual sources

CIB Resolution into **individually 5s detected** sources for current blank field PACS survey plans:
~80% @75µm
~85% @110µm
~55% @170µm

... and more from lensing clusters, stacking, fluctuation analysis,...

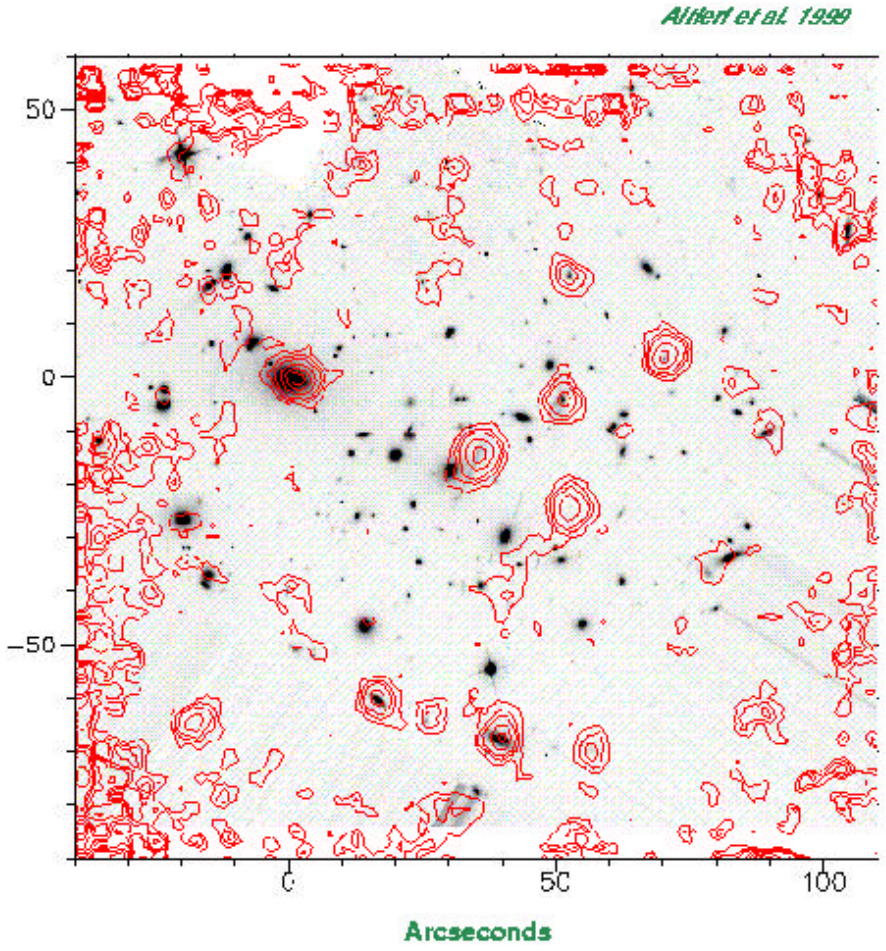


Simulated deep PACS survey

Deepest ISOCAM image

ISOCAM 15 microns (LW3 filter)

Abell 2390 contours over an HST (F814W) I-band image.

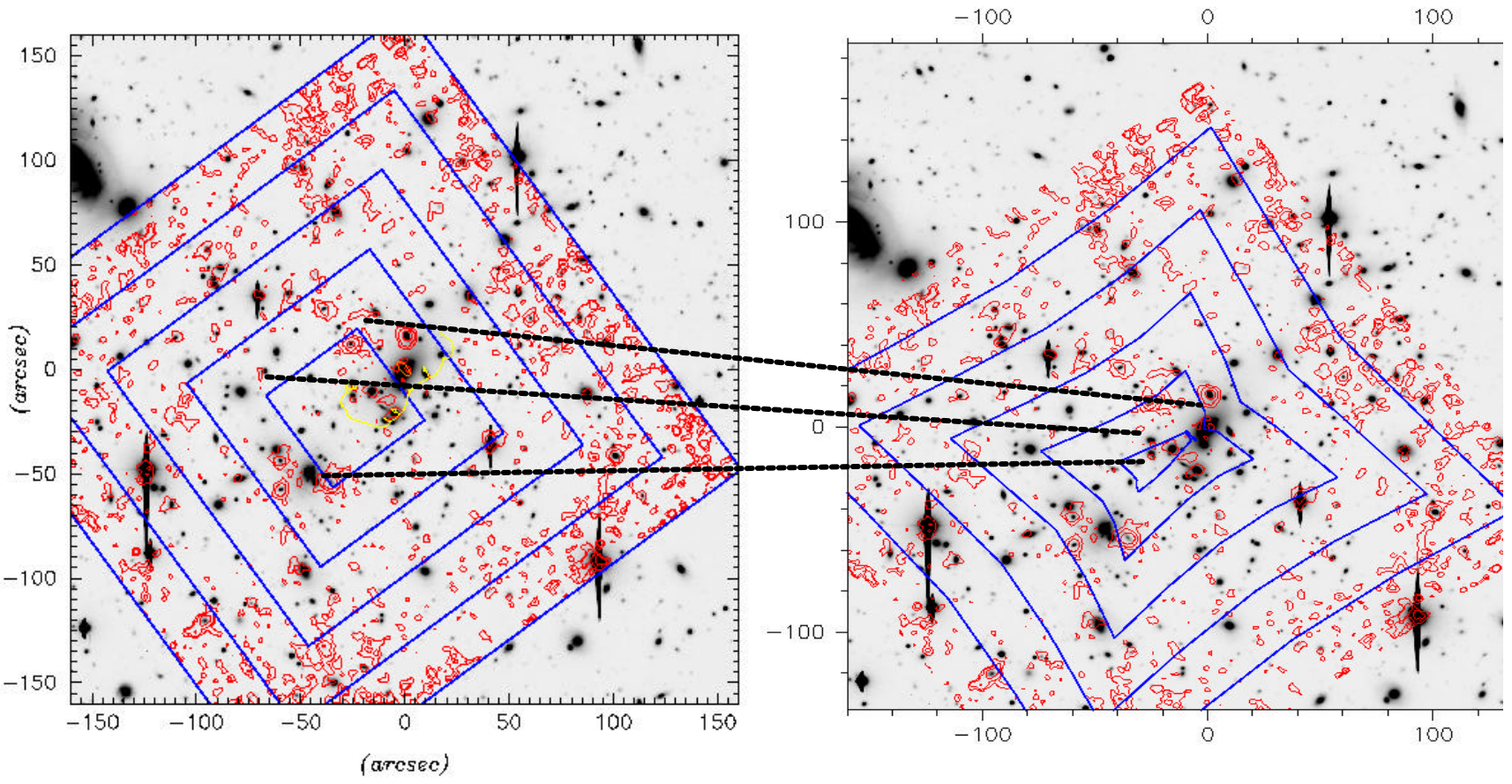


Using gravitational lensing

If we observe this on the sky

→

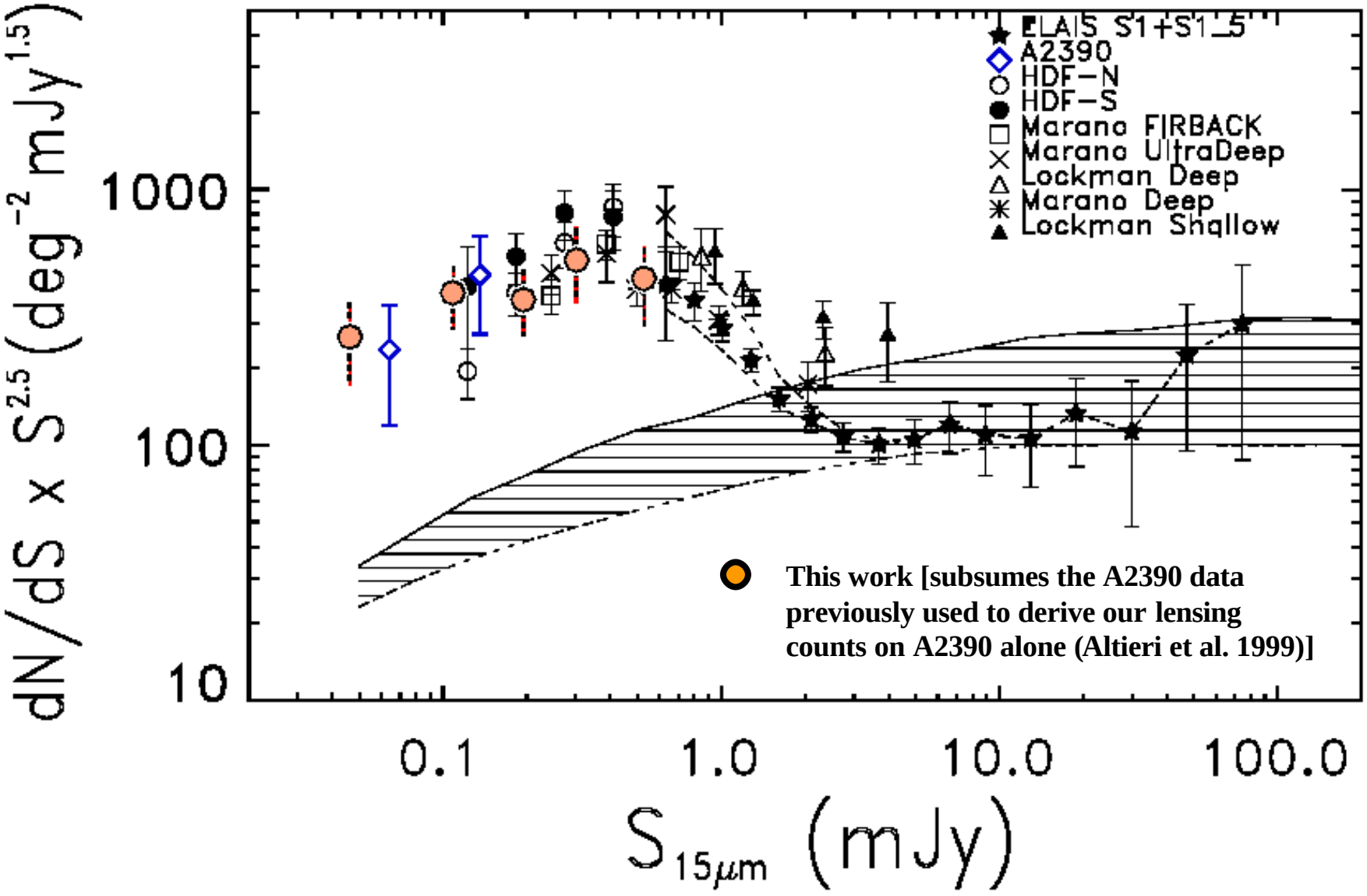
… this is an instance of how it might appear in the source-plane **(in this example for z=1)**



… note the substantial dilation of surface area - especially near the cluster centre

Case of Abell 2218 for z=1 background sources

Results of several ISO 15 mm surveys



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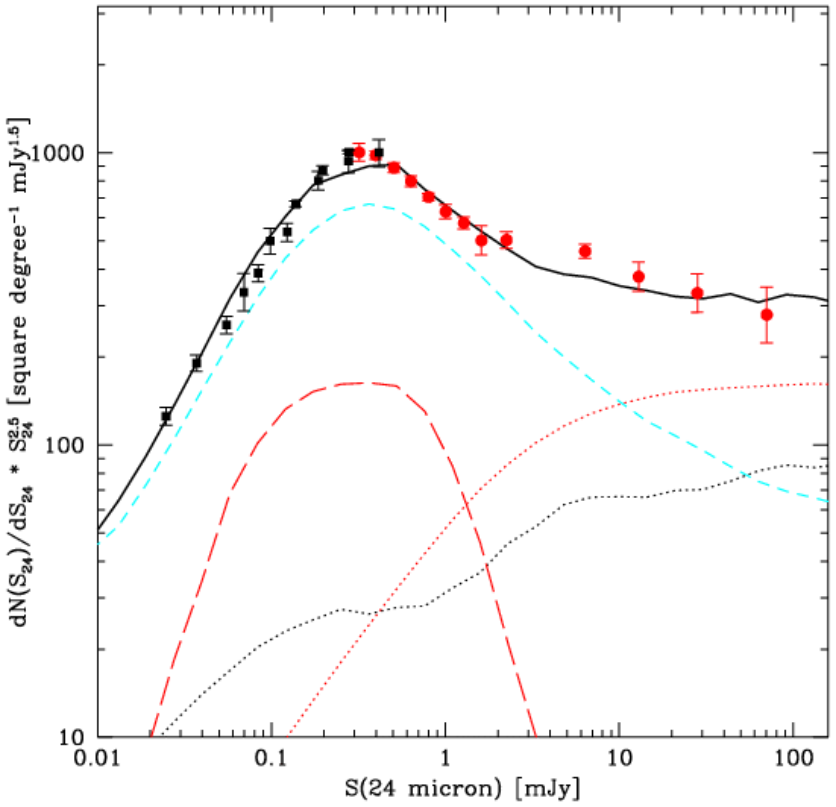
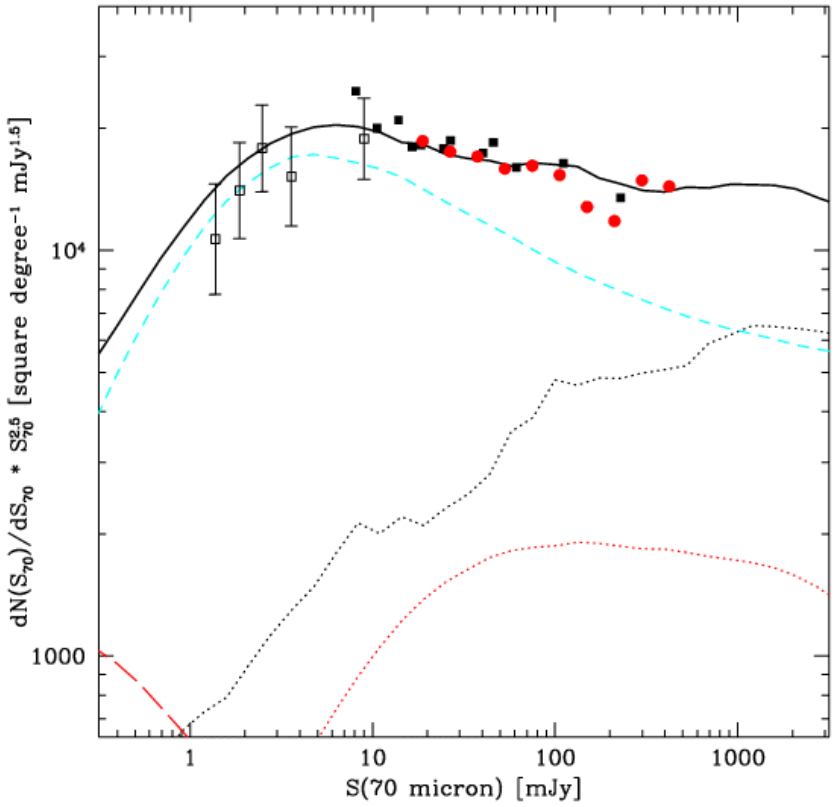
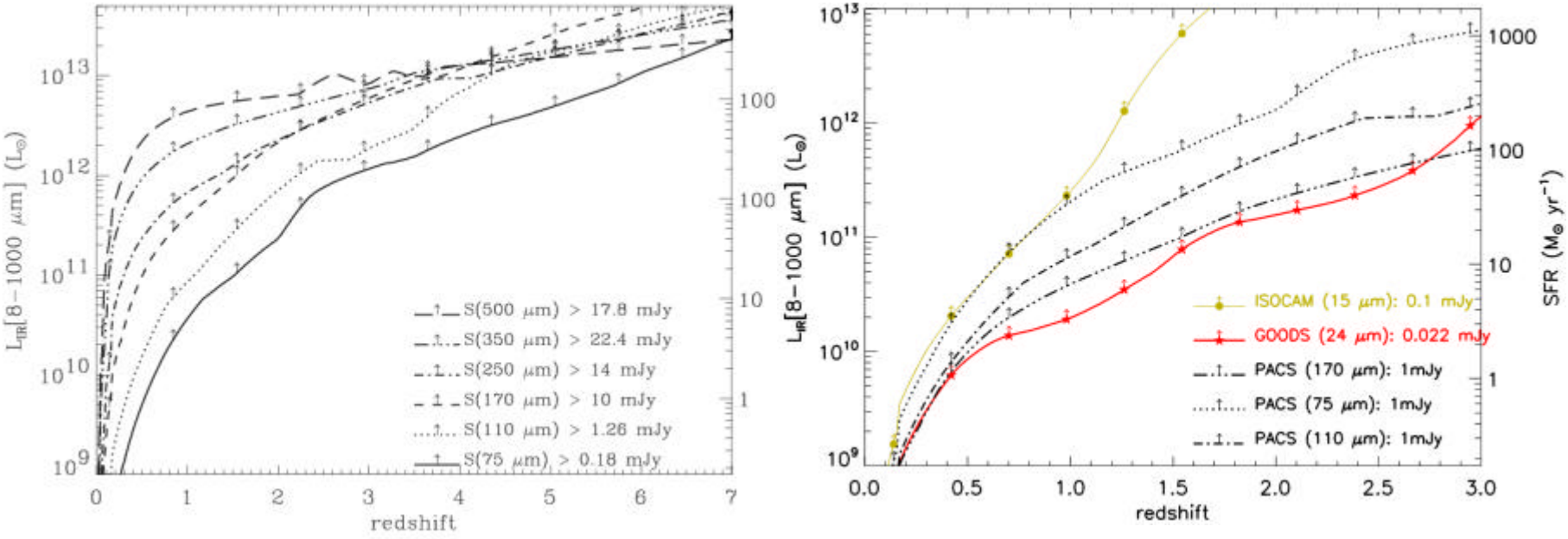
Constrain latest evolution models





Franceschini et al. 2006

Luminosities in reach for various IR wavelengths



Reachable L(z) for surveys of varying depth for a *single star-forming SED family* (D. Elbaz)

PACS needed to go deep at z~1-2 **and** probe rest frame far-infrared in a way that is robust to SED variations, AGN contribution...

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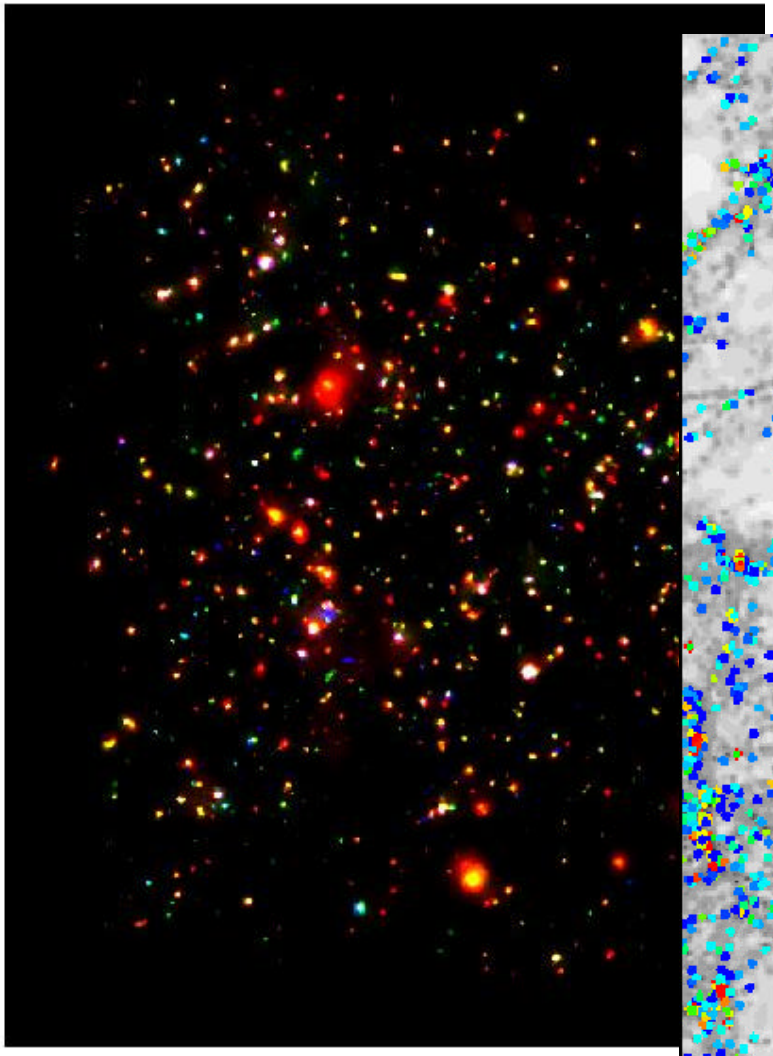
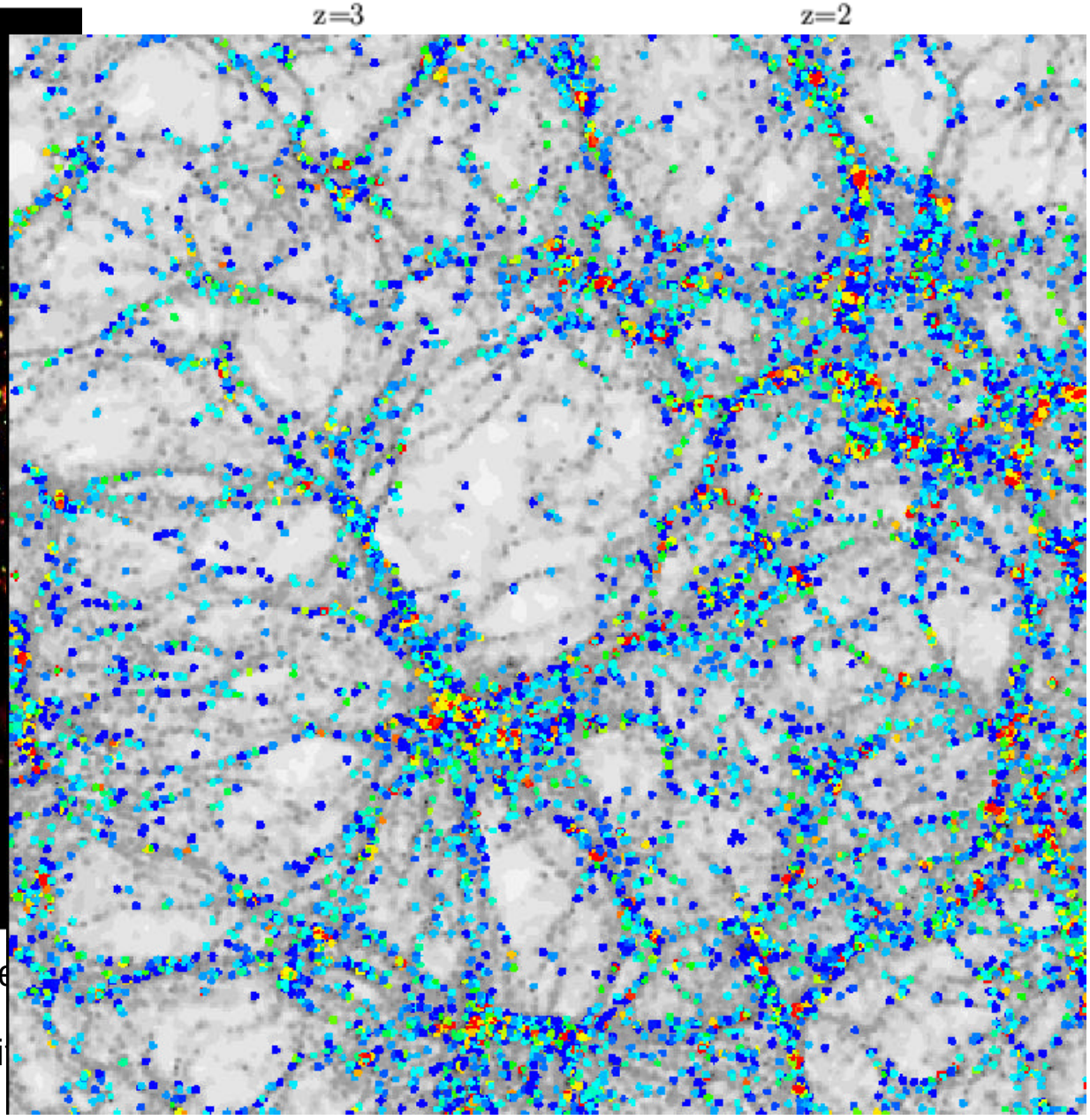
Probing a wide range of environments





1.4'*1.4' XMM COSMOS (Hasinger e

Kauffmann, Colberg, Diaferio & Whi

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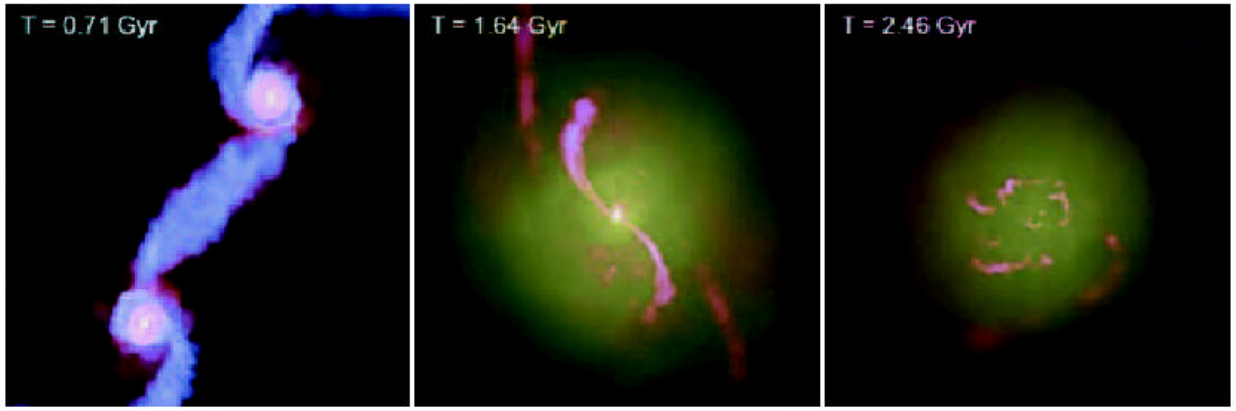
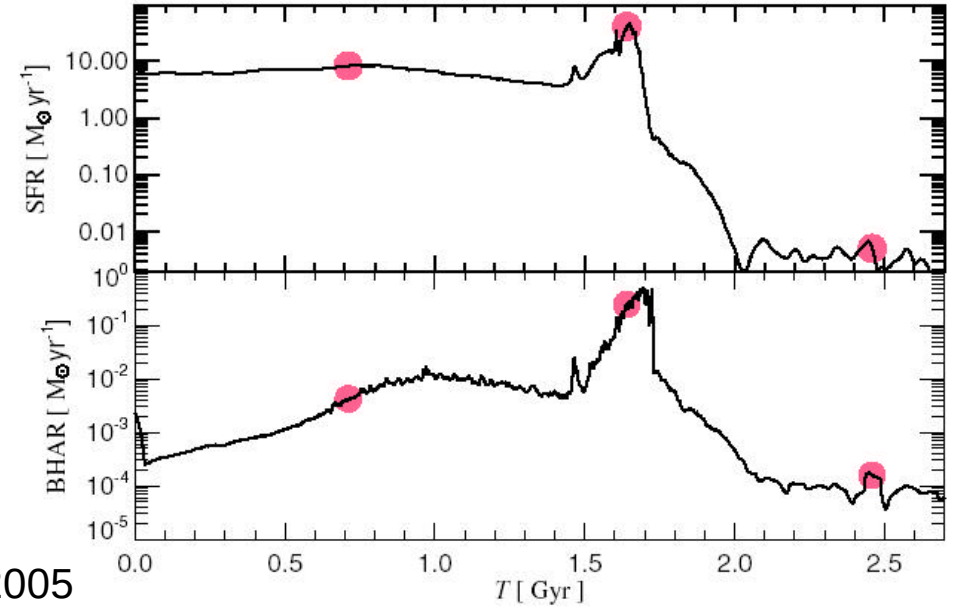
Relation of AGN, star formation, feedback…

Global evolution of cosmic star formation and of accretion are similar – how do AGN growth and star formation relate in detail?

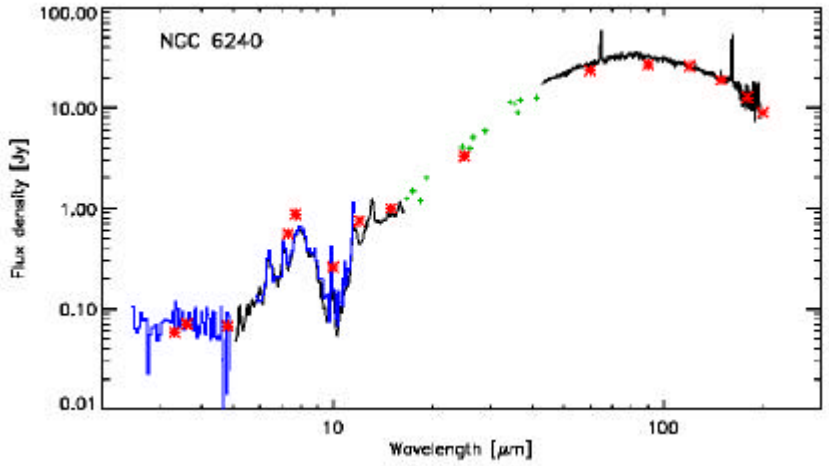


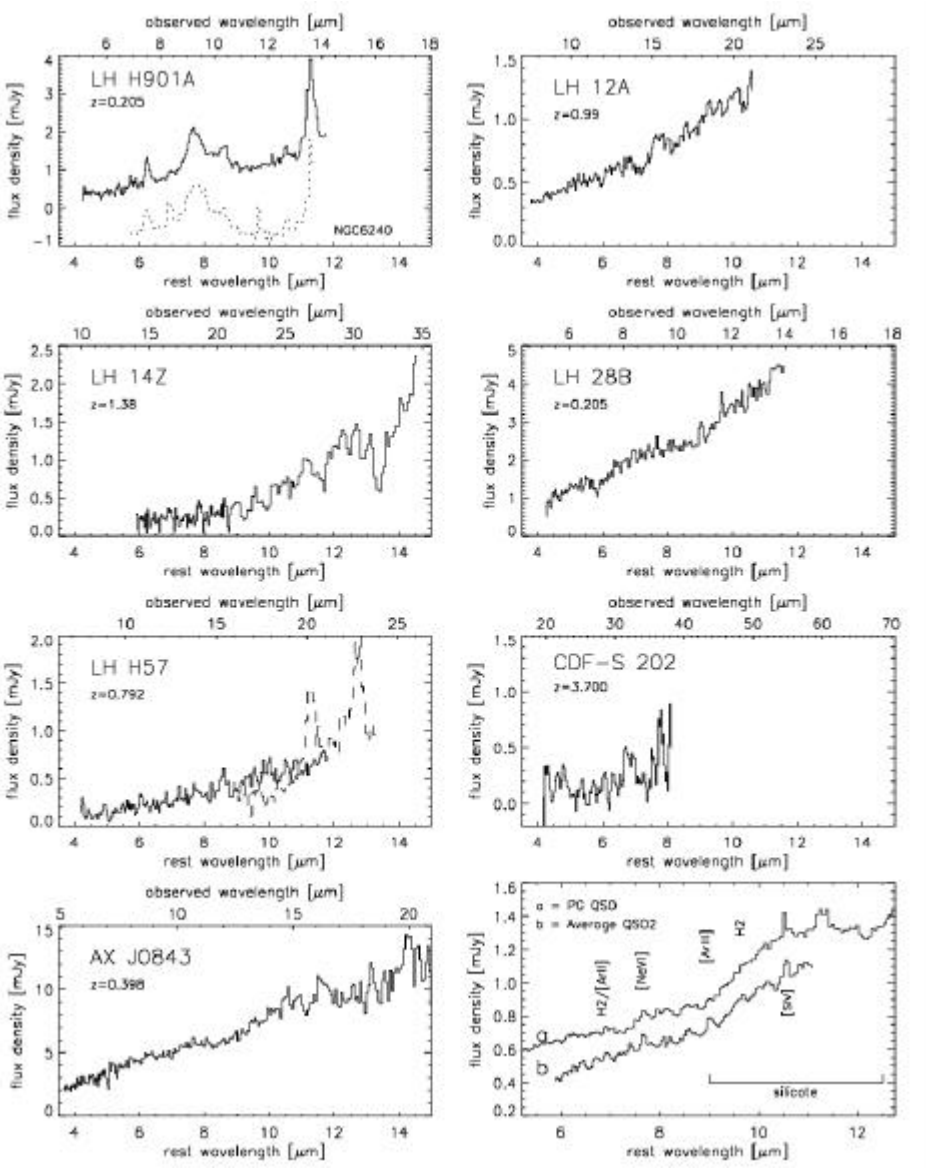


Springel et al. 2005

Relation of AGN and star formation

Tool: 110 & 170μm measurements of known X-ray sources (**difficult with photometry at shorter wavelengths**)





Sturm et al. 2006: $L_{Starburst}$ typically<~$10^{11}L_{Sun}$ for a sample of X-ray selected QSO2s

Need deep 170+110μm over the area of the major X-ray survey fields, stacking, statistics over z, X-ray L, N_H…

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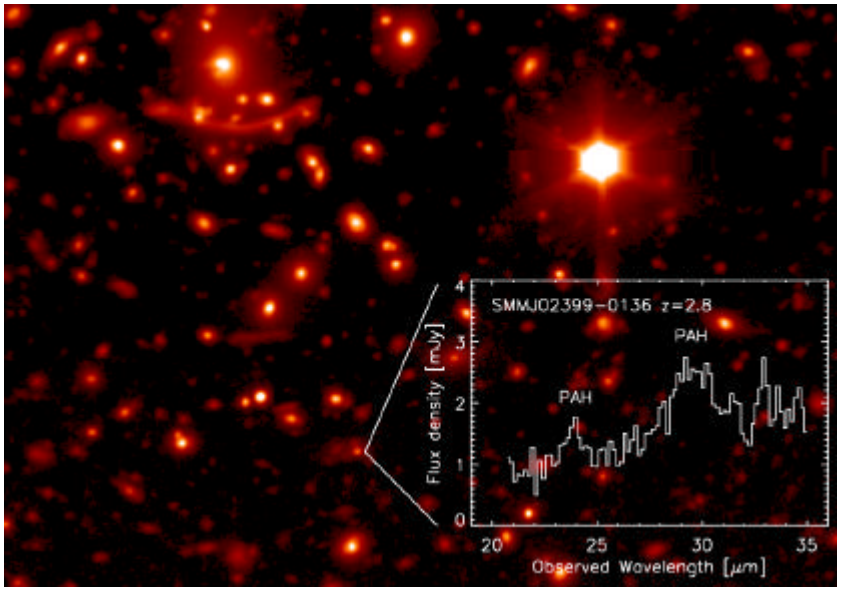
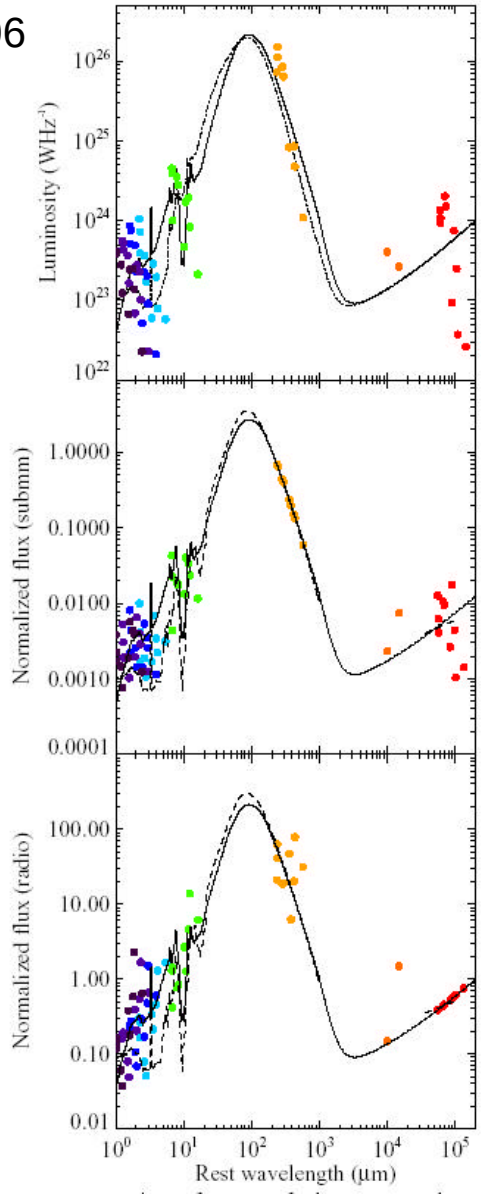
Example: Submm galaxies



Lutz et al. 2005

Pope et al. 2006



…Intensely studied and showing formation of massive galaxies at z~2-3

But even basic quantities like luminosity and dust temperature still uncertain! Sample rest frame SED peak.

Implementation Example: Preliminary PACS GTO plans

Fields(s)	Size	Wavelength, 5σ depth	Time
COSMOS, XMM-LSS	2*2 sq.deg	110+170, 11mJy	2*110h
Lockman, Groth, ECDFS	3*0.25 sq.deg	110+170, 7mJy	3*34h
Goods-N	150 sq.arcmin	110+170, 3mJy	27h
Goods-S	150 sq.arcmin	75,110,170,1.5mJy	2*115h
5 z~1 clusters	5' x 10'	110+170, 7mJy	5*2h
10 lensing clusters	4' x 4'	110+170, 1.5-3mJy	70h

2008