Characterization of a first set of *Planck* High-z Candidates

Planck Collaboration

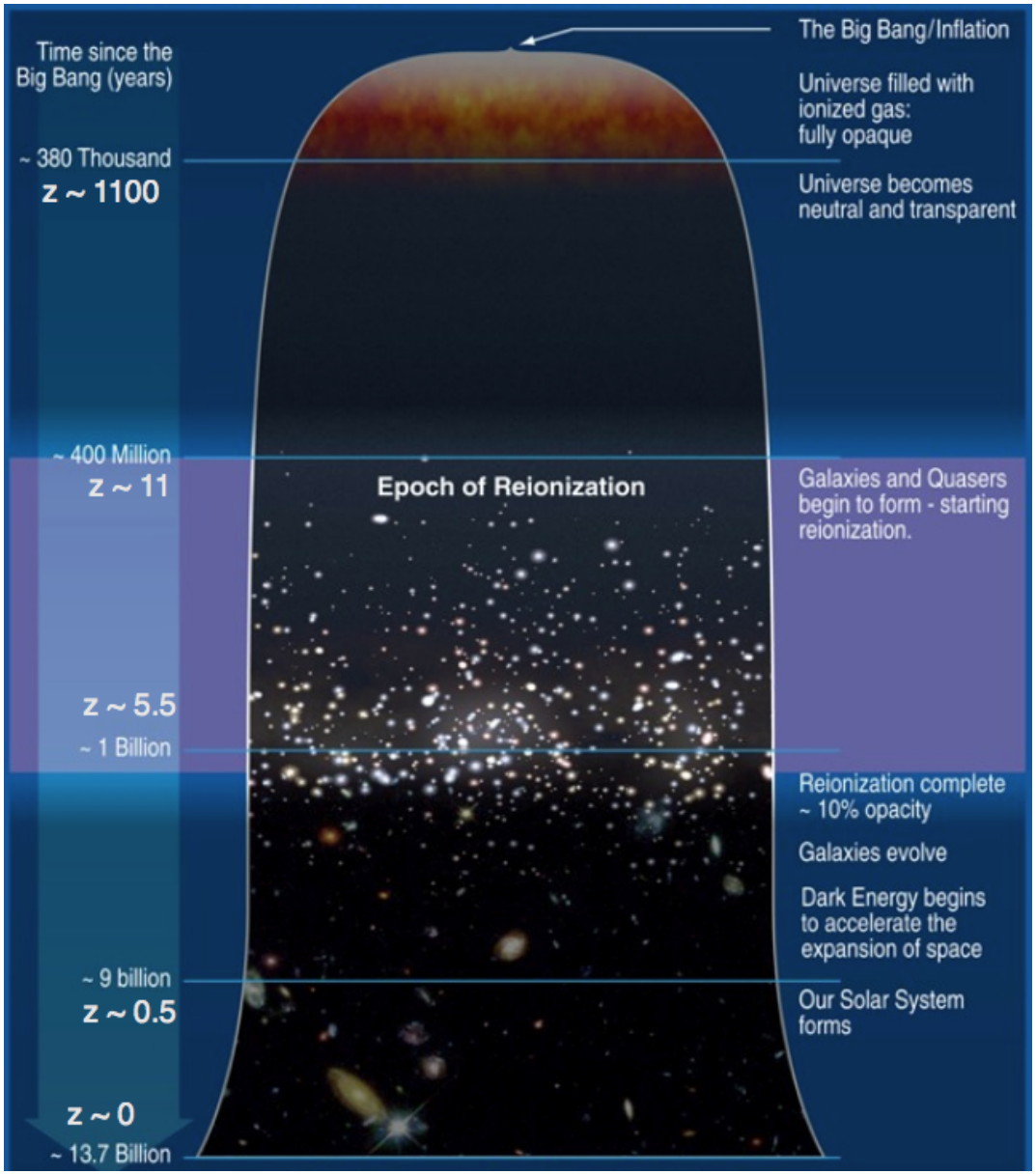
presented by
Ludovic Montier

Acknowledgements

The scientific results that we present today are the product of the Planck Collaboration, including individuals from more than 50 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA) and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.

‘Looking back at the dawn of time..’



redshift

1100

11

5.5

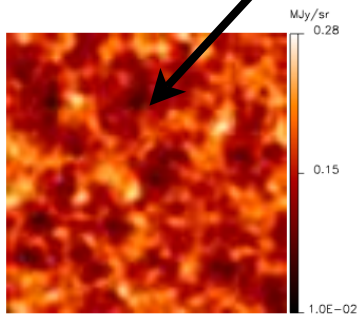
1

0.1

0

Do we detect
High-z Sources
in Planck Data ?

2 < z < 5



CIB Fluctuations

Galaxy Clusters

***Planck* ESZ**
SZ Catalog

Nearby Galaxies

Galactic Sources

***Planck* ERCSC**
Legacy Catalogs

Outline

How to detect High-z sources ?

- Component Separation Issue
- Looking through CIB fluctuations

→ Use the *Planck* ERCSC

Wardlow, Gonzales-Nuevo, & Clements' Talks

→ Original *Planck* Detection

What are the *Planck* High-z Sources ?

Lensed Galaxies ?

HyLIRG ?

Proto-Clusters / Proto-Groups ?

→ Look at SPT Dusty Galaxies in *Planck* Data

→ First Confirmations of *Planck* High-z Candidates

Use Follow-Up to characterize them:

→ Follow-Up on a newly discovered *Planck* High-z proto-group Candidate

- Better Resolution
- Other wavelength: from optical to submm
- Confirmation of photometric redshift estimates in optical

Planck High-z sources Extraction

The *Planck* Multi-Wavelength Detection

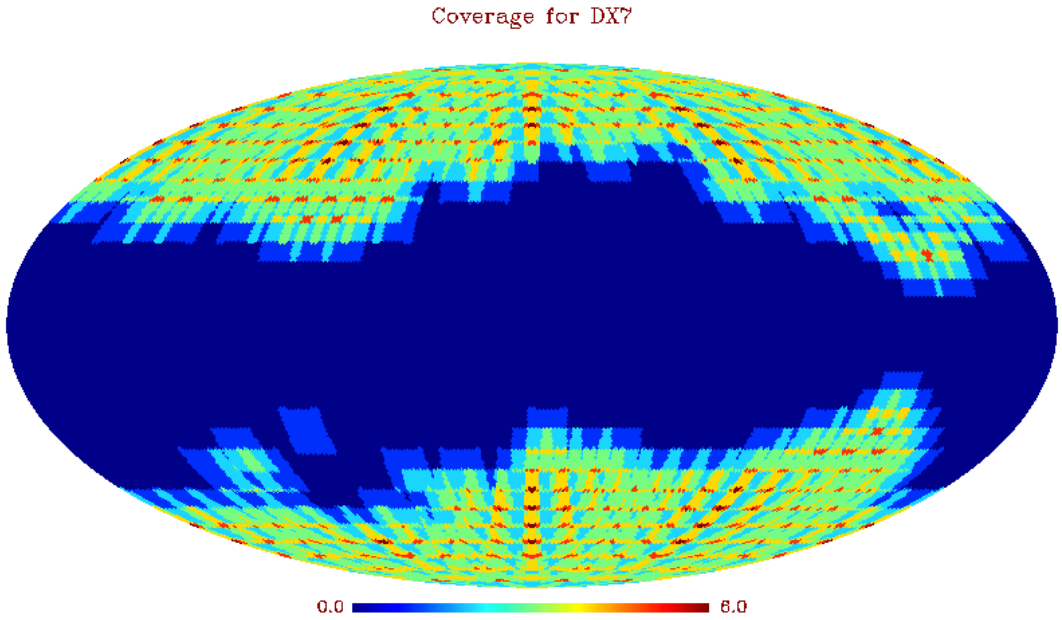
Data

30% of the sky

IRAS + *Planck*-HFI

3 THz

857 GHz 545 GHz 353 GHz
217 GHz 143 GHz 100 GHz



Component Separation:

- CMB Cleaning (143GHz removal)
- Galactic Cirrus Color Cleaning

(CoCoCoDeT Montier et al. 2010)

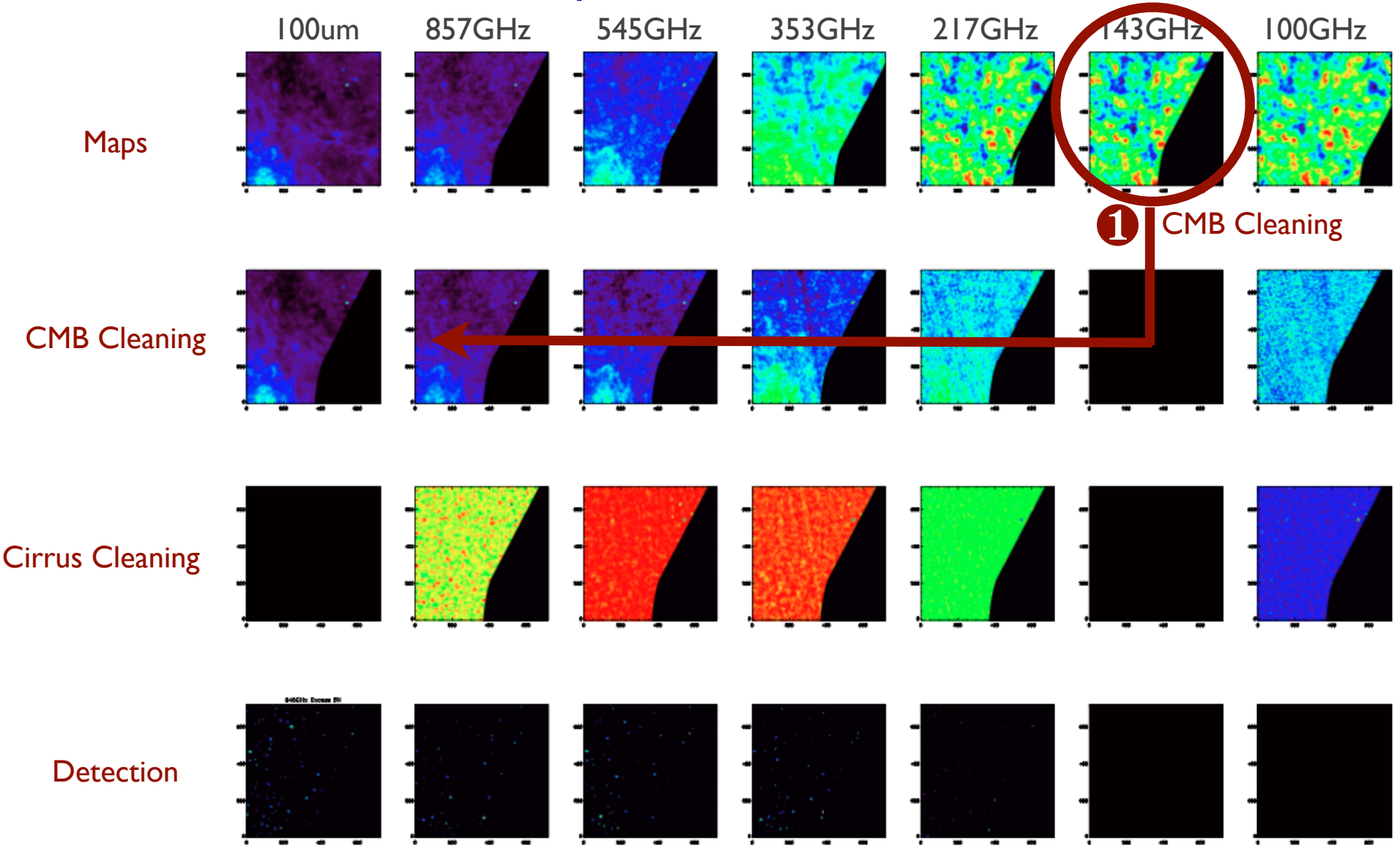
Source Detection:

- Looking through CIB residual + Noise
- Multi-Frequency Detection: Color Detection
- Multi-Scale Detection: Mexican Hat Wavelet

→ Original *Planck* List of High-z Candidates over 30% of the sky

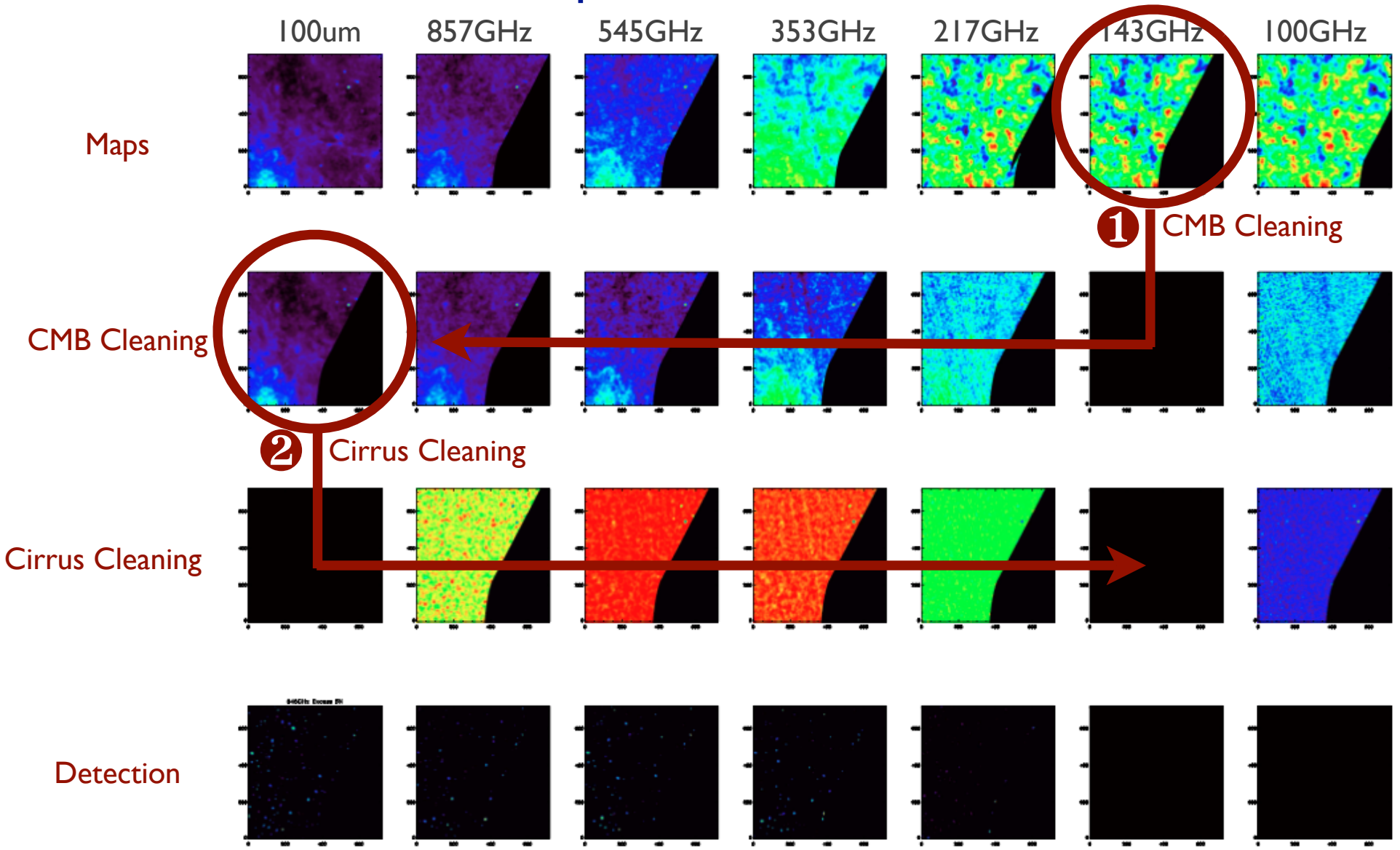
Planck High-z sources Extraction

Example of detection



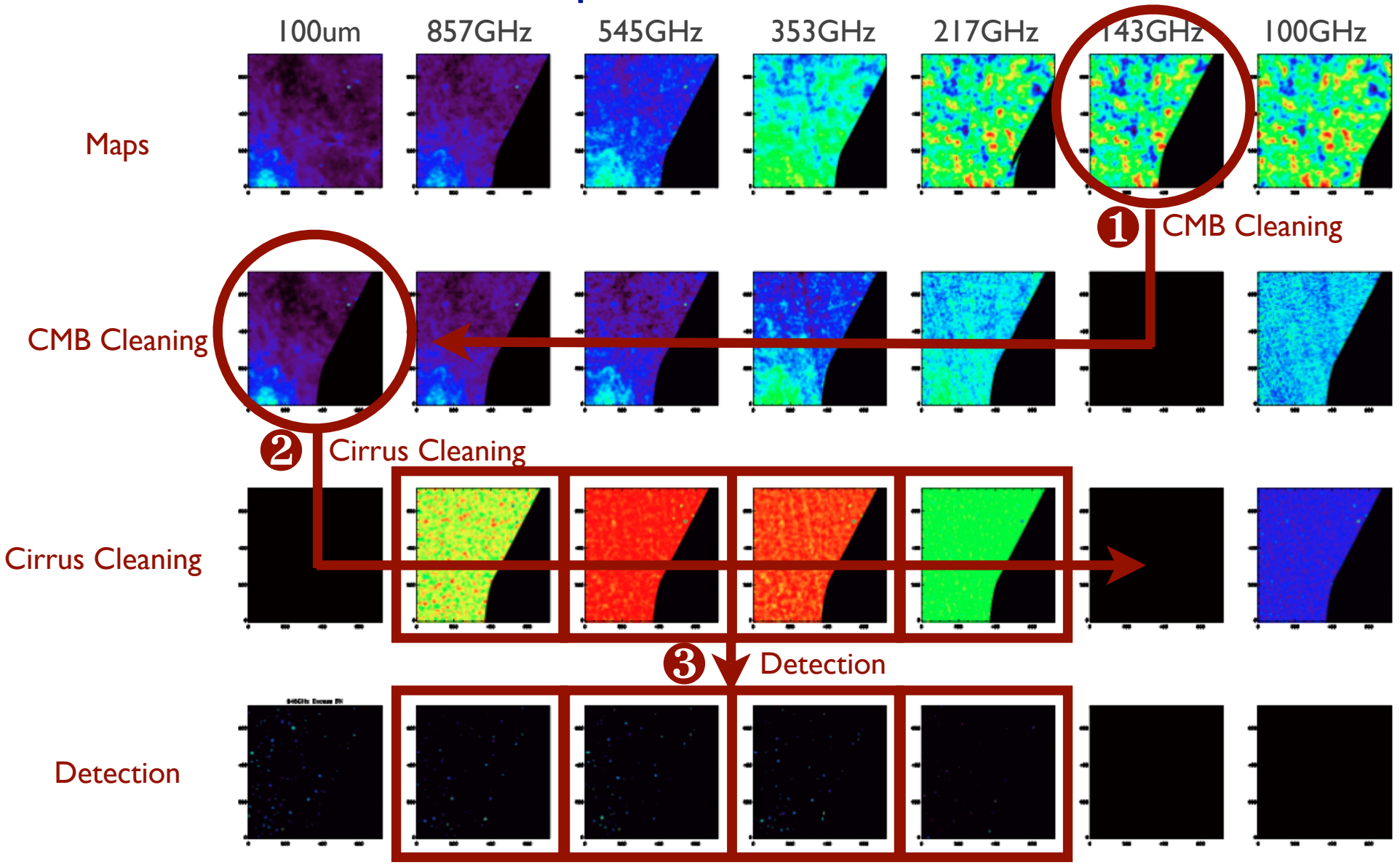
Planck High-z sources Extraction

Example of detection



Planck High-z sources Extraction

Example of detection



Planck Follow-Up of SPT Dusty Galaxies

Stacking on the SPT Dusty Galaxies

MoU with SPT team: J. Carlstrom, T. Crawford, D, Marrone, C. Reichardt, J.Vieira

SPT Dusty Galaxies:

(Vieira et al. 2011)

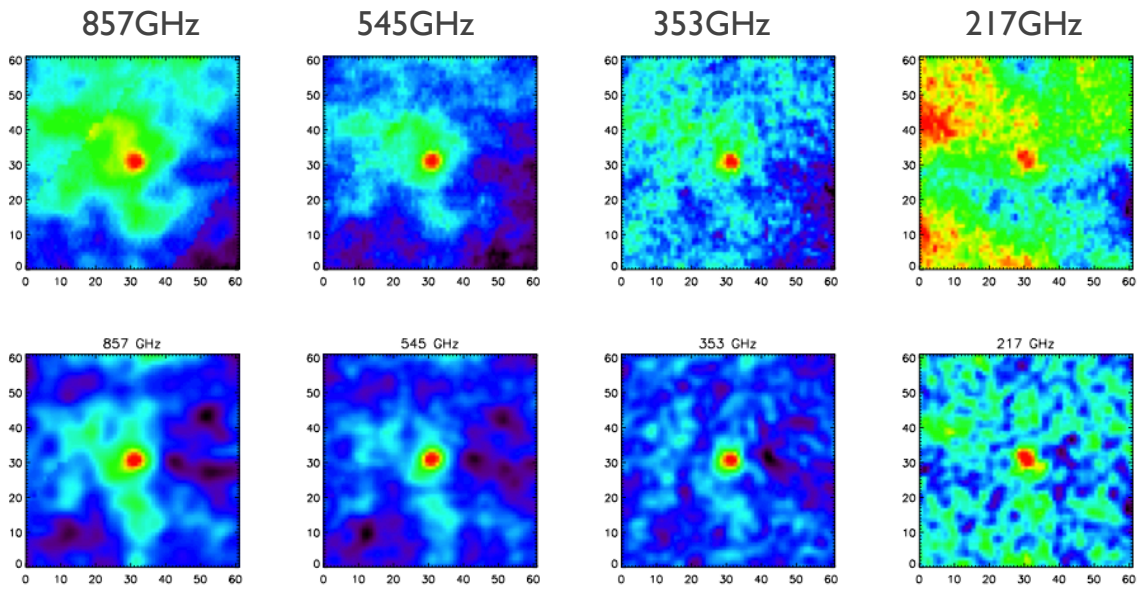
- 940 deg^2
- 107 Dusty Galaxy Candidates detected at 1.4mm / 2.1mm
- 54 observed with LABOCA
- 23 observed with SABOCA

=> photo-z estimates

- 2 observed with ZSpec

=> spectroscopic z estimates

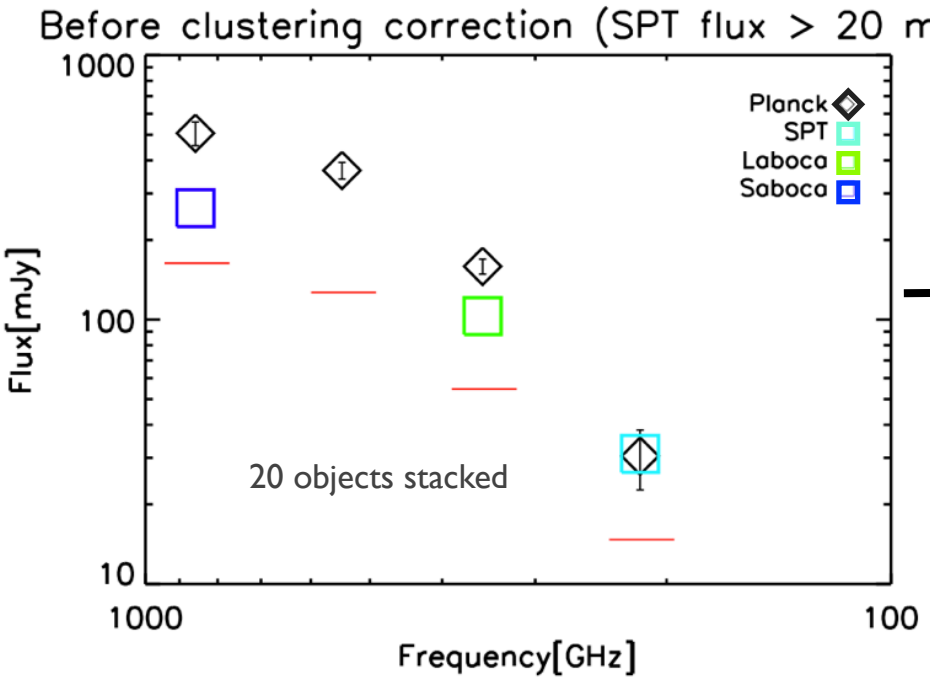
Stacking on Sources with Flux 1.4mm > 20mJy



	857GHz	545GHz	353GHz	217GHz
Sample Homogeneity	10%	7%	5%	11%
Photometry accuracy	13%	14%	9%	13%

Planck Follow-Up of SPT Dusty Galaxies

Clustering Estimate



'Clustering' Coefficients

857GHz	545GHz	353GHz	217GHz
1.9	1.7	1.5	1.

What do these coefficients count for ?

Clustering at low-z: Lensing Objects ?

Clustering at high-z: Lensed Halo ?

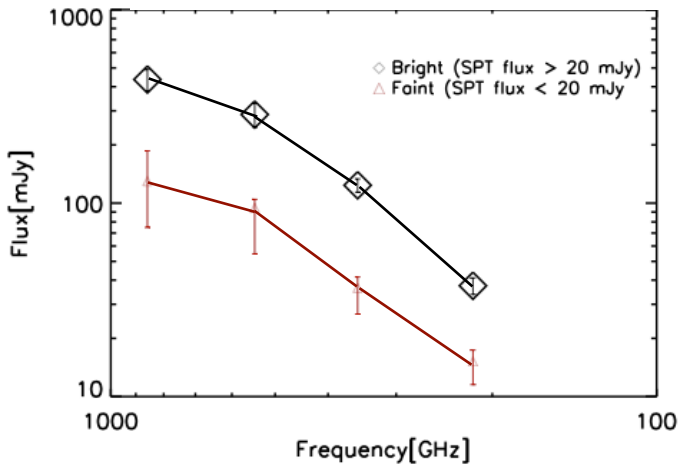
Color of the high-z halo ?

Can be used to extrapolate SPT number counts to *Planck* Bands

cf Dole's Talk

Planck Follow-Up of SPT Dusty Galaxies

Properties of Bright / Faint SPT Dusty Galaxies



Bright & Faint sample present compatible stacked SEDs
Suggesting the same population of sources

Redshift estimate

Based on grey-body fit using temperature distribution of a known lensed galaxy sample (Greve et al. 2012)

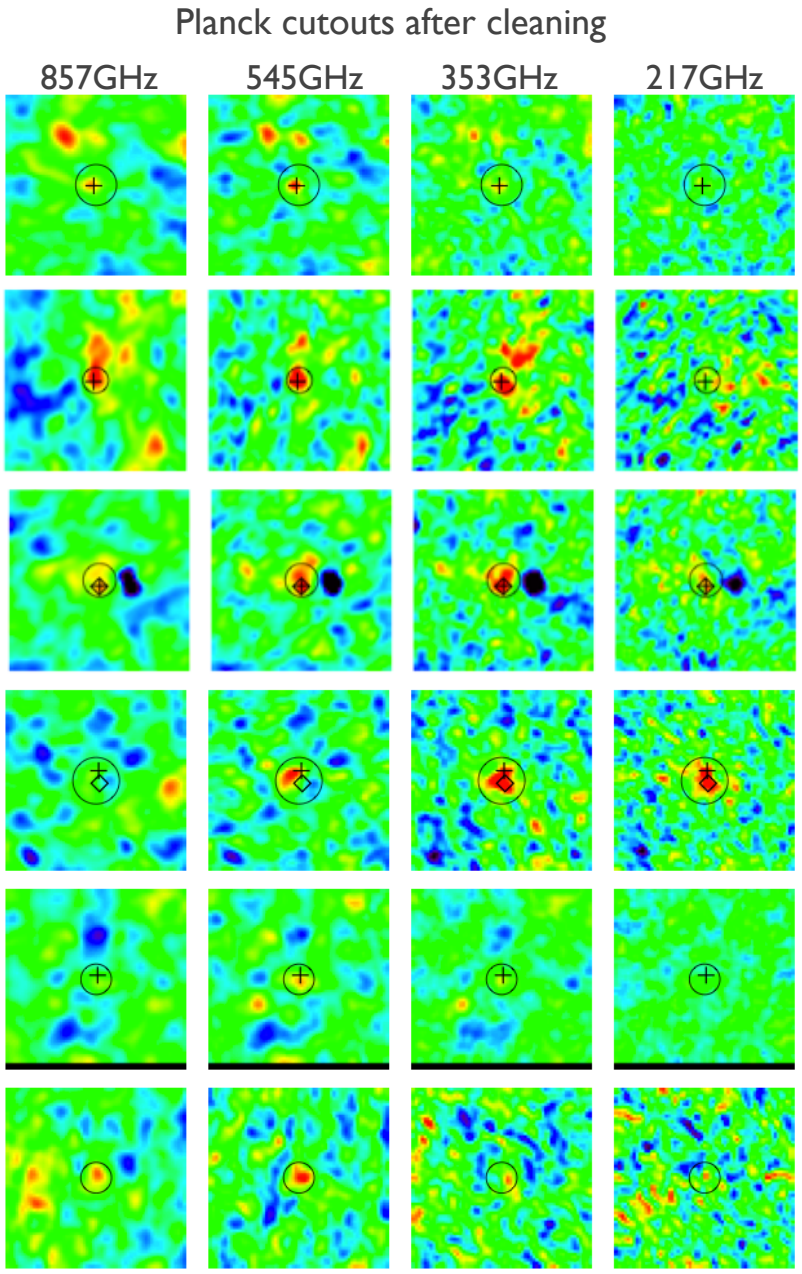
For 46 **Bright** SPT sources (> 20 mJy)
< z > = 3.0 +/- 0.6

For 61 **Faint** SPT sources (< 20 mJy)
< z > = 3.2 +/- 0.7

Planck Detections at 4 sigma

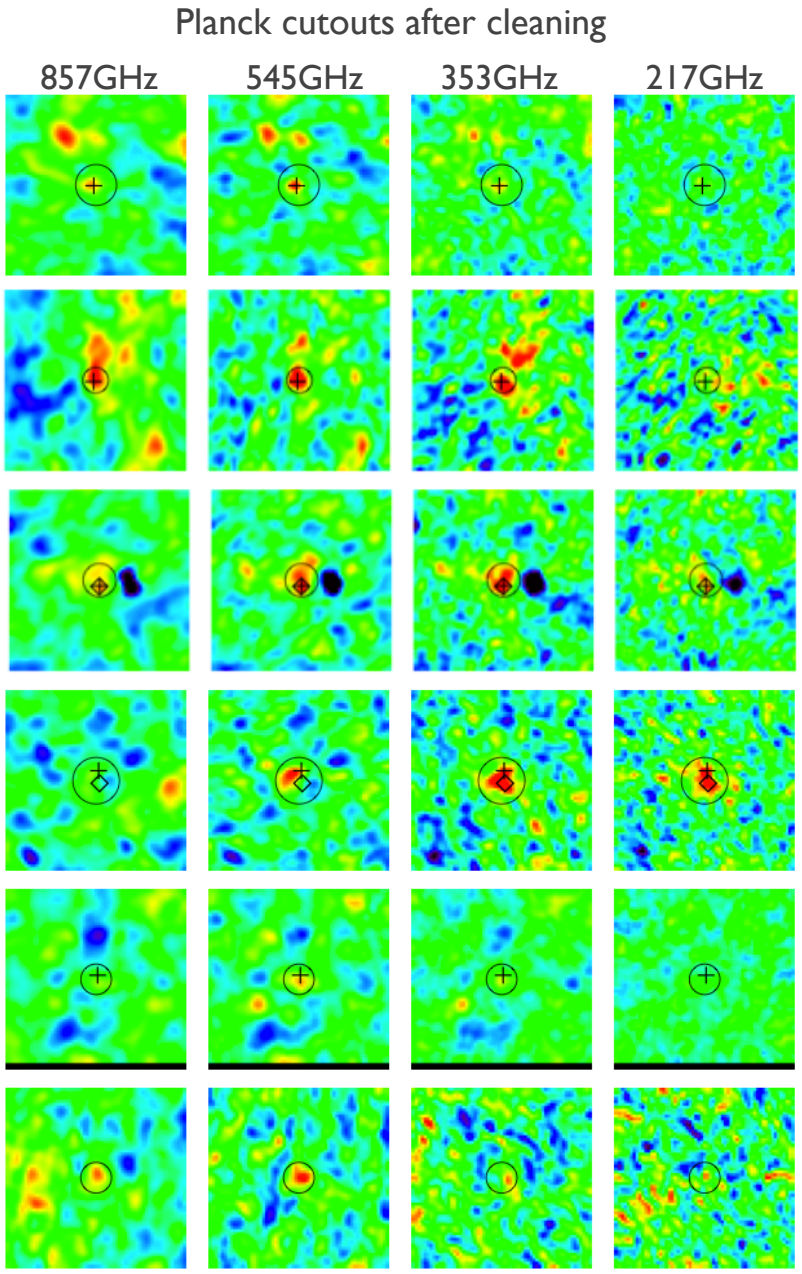
	SPT	Detected by Planck
All	107	7
flux 1.4mm > 20mJy	46	6
flux 1.4mm < 20mJy	61	1

First confirmations of *Planck* High-Z sources



Confirmation	Redshift	Nature
SPT (1)	2.783	Lensed Dusty Galaxy (Greve et al. 2012) (Marrone et al. in prep)
Herschel ATLAS	3.26	Lensed Dusty Galaxy (Herranz et al.2012) (Fu et al. 2012)
SPT (2)	2.738	Lensed Dusty Galaxy behind a Galaxy Cluster (Greve et al. 2012) (Vieira et al. in prep)
Herschel Lensing Survey	5.2	Lensed Dusty Galaxy behind a Galaxy Cluster (Combes et al. 2012)
Radio	1.48	Proto-Cluster Candidate (Galametz et al.2009)
Planck	1.67	Proto-Cluster Candidate (Planck Collaboration et al.2012)

First confirmations of *Planck* High-Z sources



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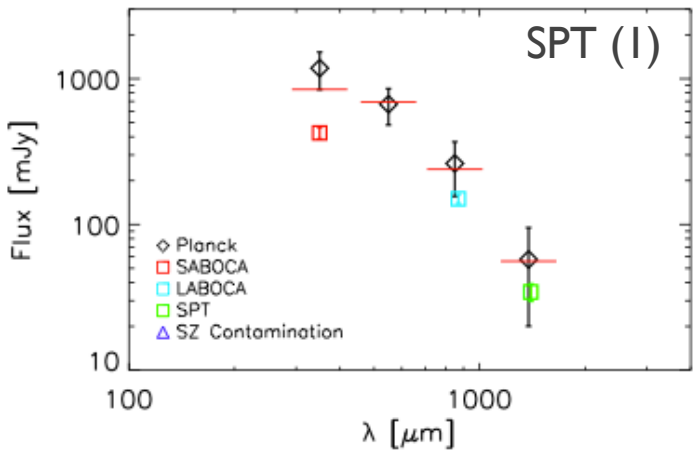
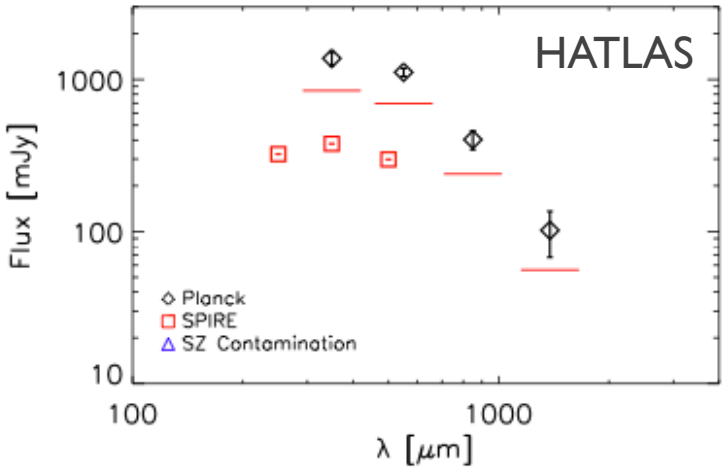
Lensed Dusty Galaxies

'Isolated'



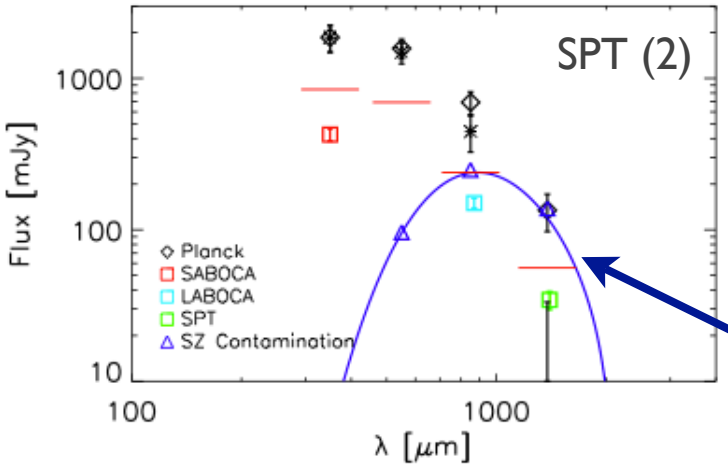


Planck SEDs > high resolution Ancillary SEDs

Confusion Limit + Flux boosting + Clustering

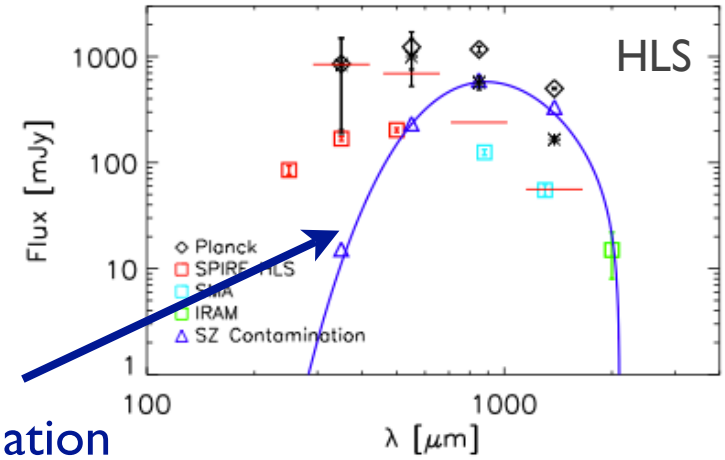
+ 10%-15% x 2 - 3

'Behind a Galaxy Cluster'



(SZY from Benson et al. 2011)

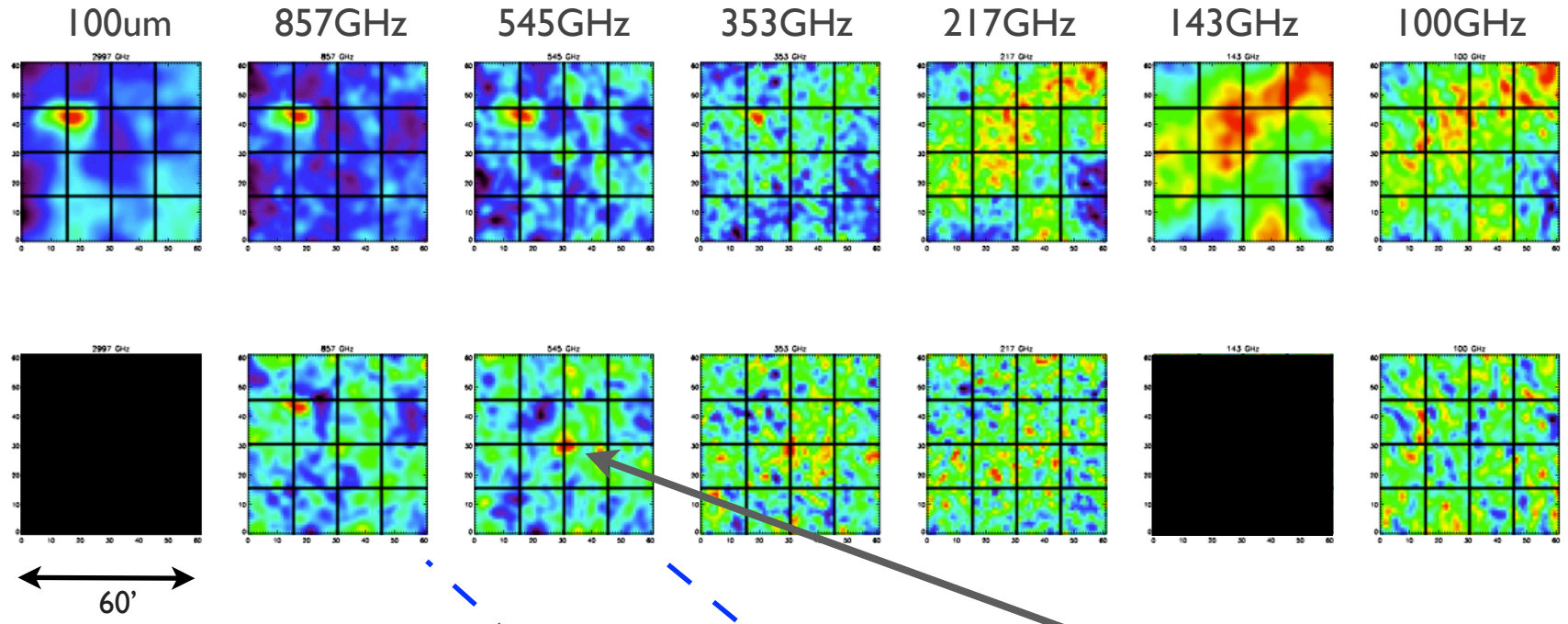
SZ Contamination



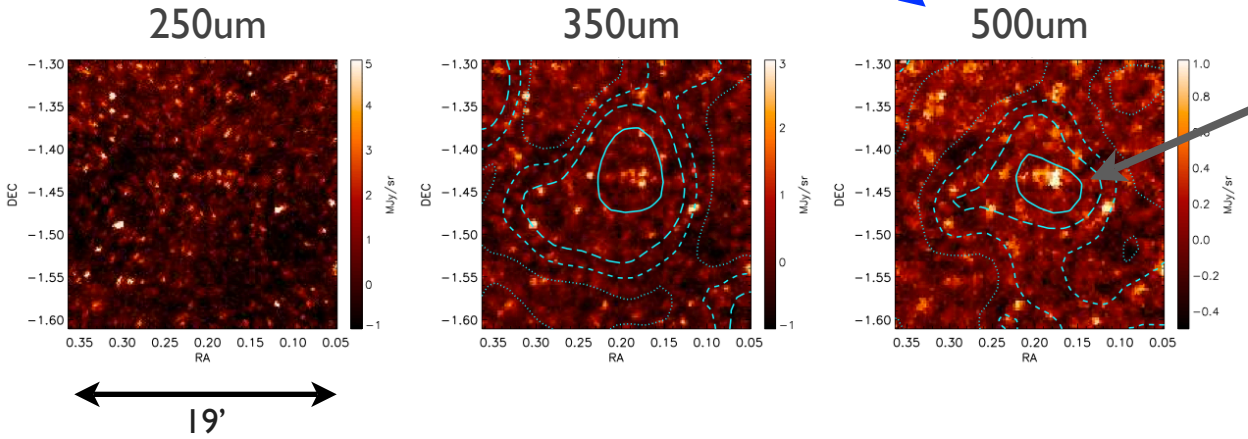
(SZY from ESZ, Planck Collaboration 2011)

Confirmation of a newly discovered *Planck* High-Z proto-group candidate:

Planck
Detection



SPIRE
Confirmation



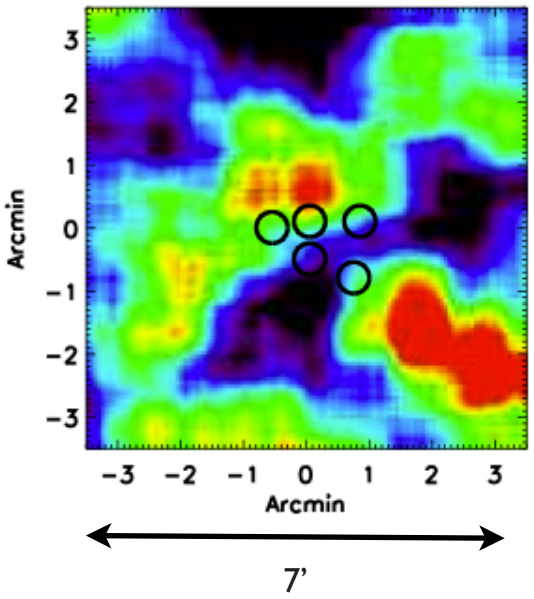
High-z
Candidate

CFHT Follow-Up

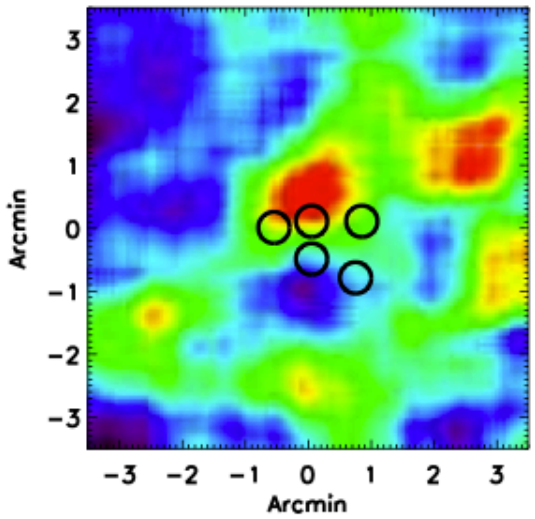
Evidence of an over-density at high-z

Observed during summer 2011 in i,g,J,H.,K bands

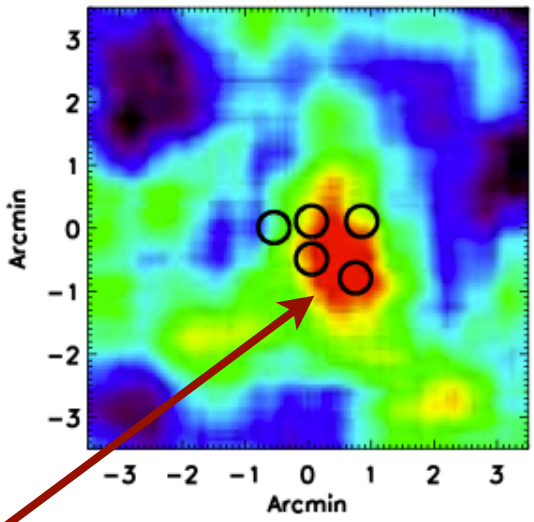
J-K<1



1 < J-K< 1.5



1.5 < J-K< 4



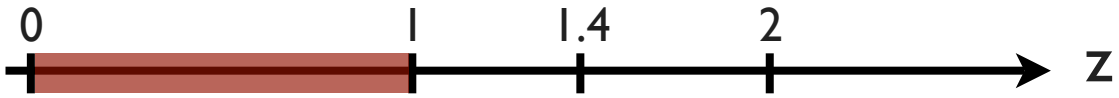
○ *Herschel* / SPIRE blobs coincident with *Planck* detection

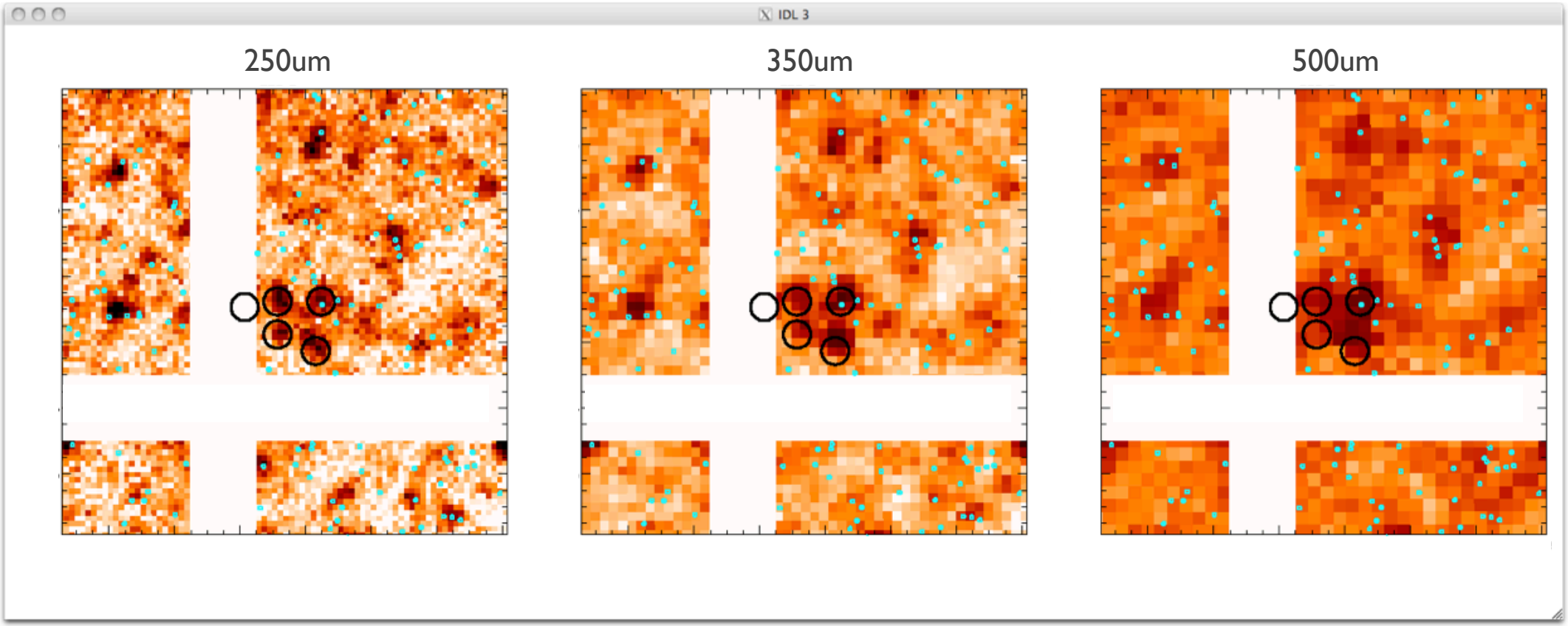
Over-density
of sources in J-K > 1.5

CFHT Follow-Up

Photometric Redshift Estimate

XCorrelation between SPIRE / CFHT sources



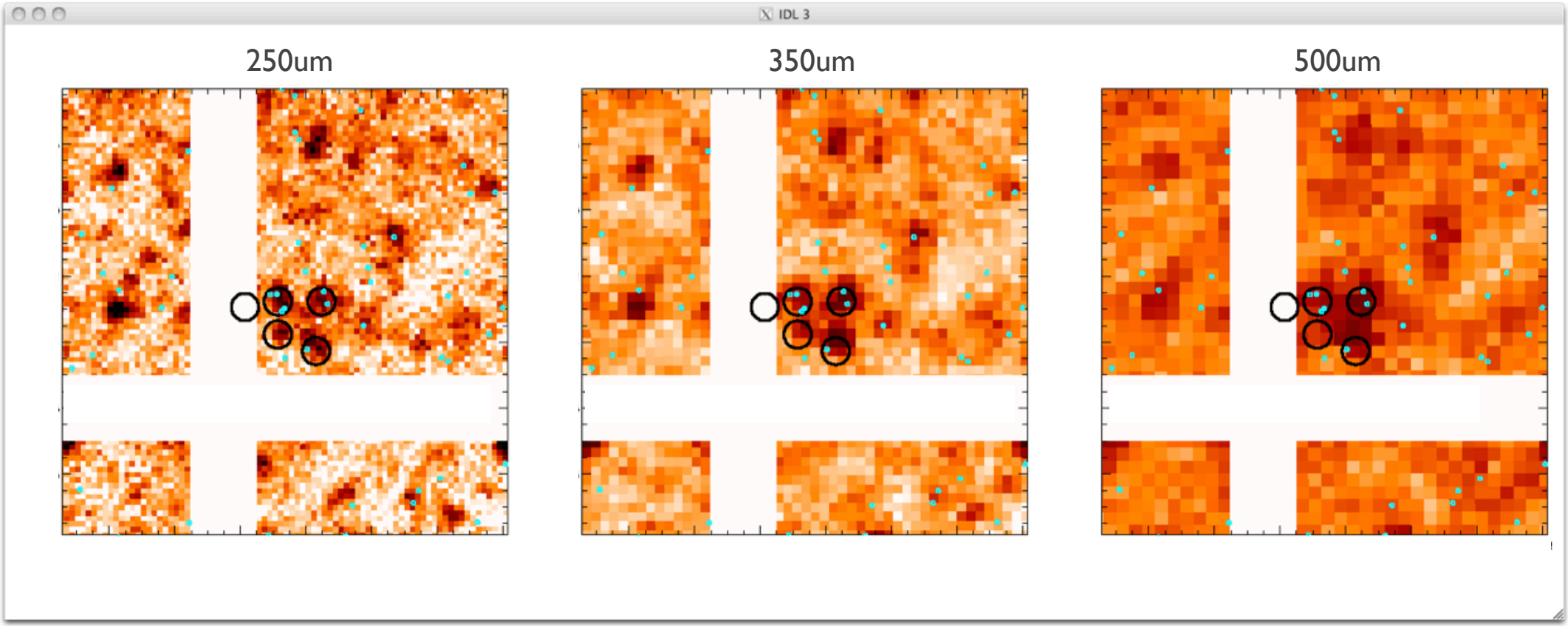


Individual Galaxies

CFHT Follow-Up

Photometric Redshift Estimate

XCorrelation between SPIRE / CFHT sources



Individual Galaxies

CFHT Follow-Up

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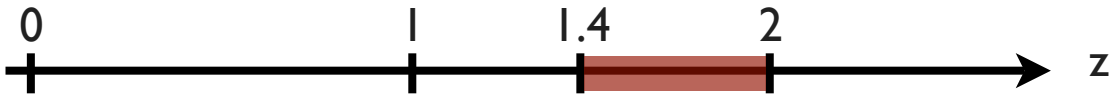
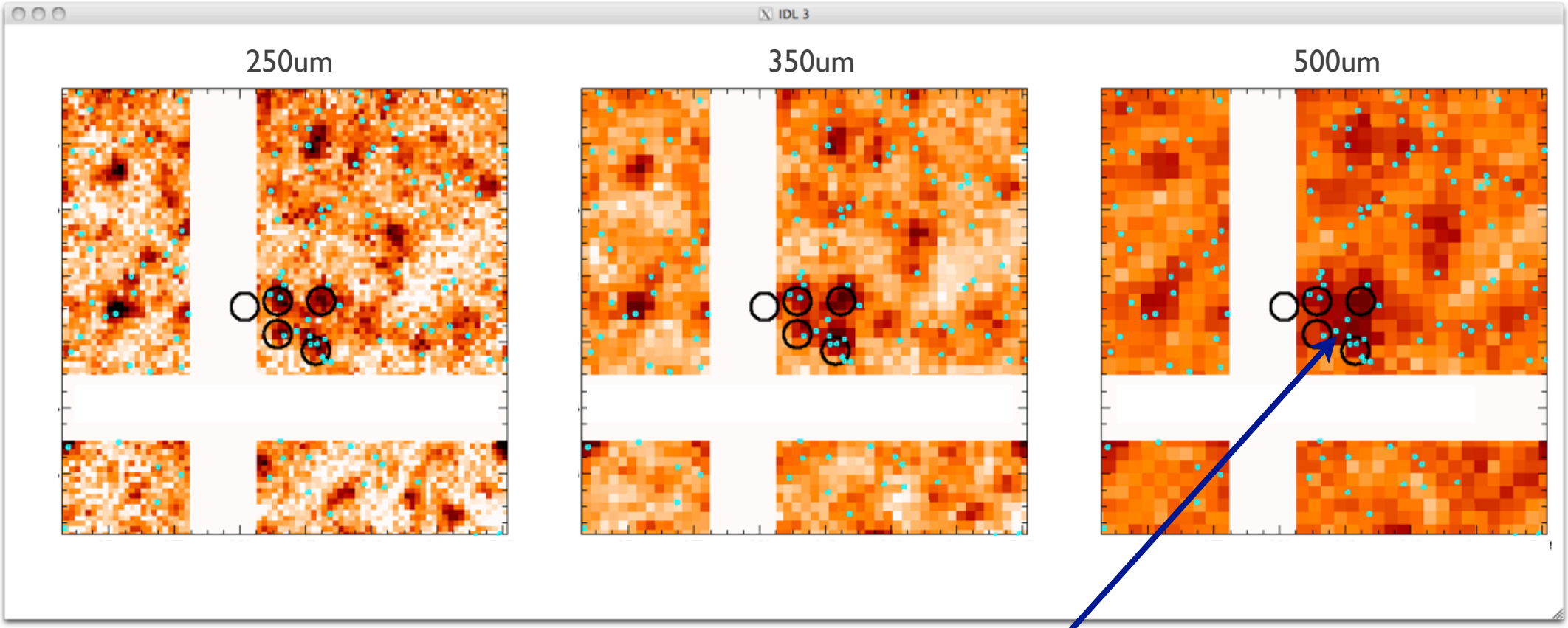




Individual Galaxies

'Proto-Group' ?

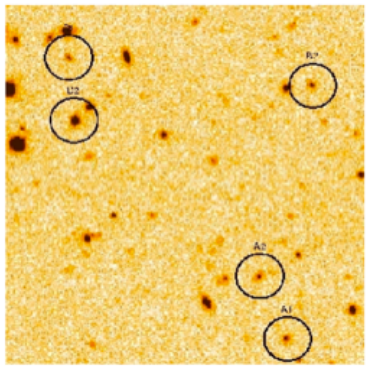
VLT XSHOOTER Follow-Up

Spectroscopic Redshift Estimate

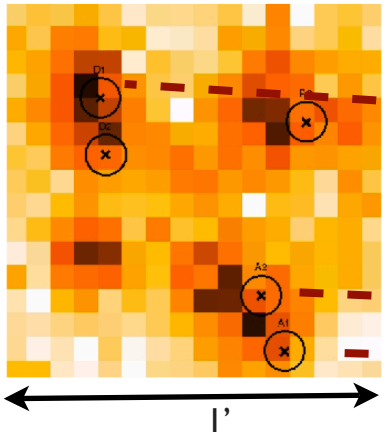
Observed during October between: 300-2500 nm

Follow-up of 5 targets

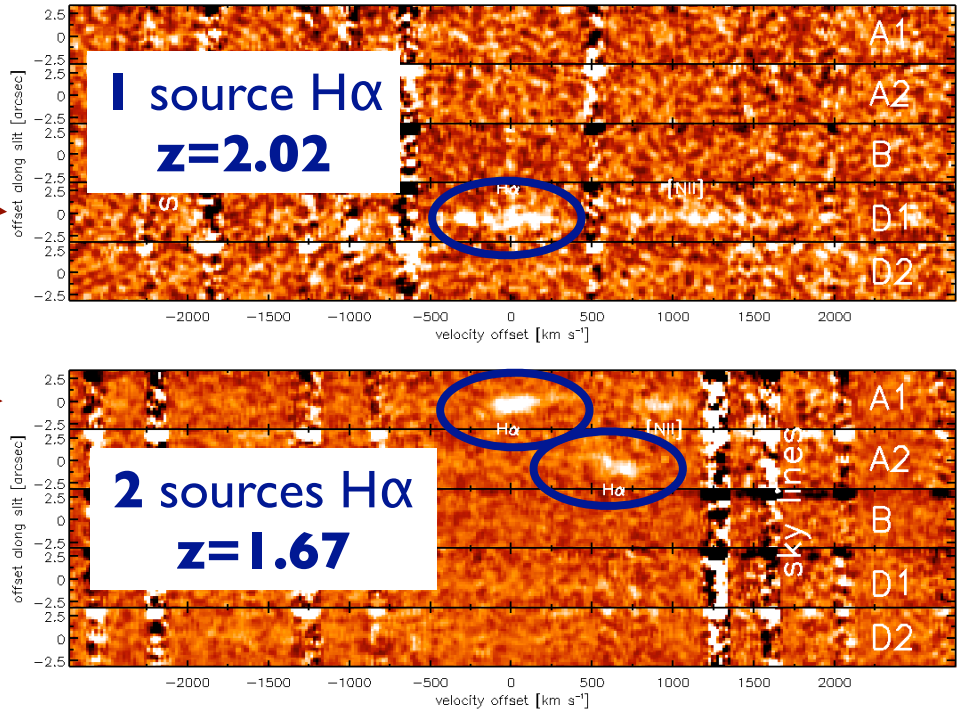
K band



SPIRE 250um



XSHOOTER
2D Spectra



3 detections in Hα and NII Robust !

No IR line detection of 2 others sources

Due to extinction ?

No UV/Optical line detection for all sources

Consistent with high extinction

Virialized DM halo Mass ~ $1.3 \times 10^{13}\ M_\odot$

SFR > 60 $M_\odot$/yr per galaxy

Summary

Planck is unique:

- We have an algorithm to clean HFI maps and detect high-z sources.

- *Planck* can provide a list of a few 100 high-z extreme objects over the cleanest 30% of the sky

- Less than 5% of those objects are already included in the ERCSC

- A few of them have already been confirmed on pilot programs:
  - Some are lensed dusty galaxies at z > ~3
  - 2 are proto-group/cluster candidates at z > ~1.5

..but *Planck* alone is not enough:

- Optical + Submm Follow-up are required to confirm/identify sources:
- Redshift estimates are the key issue for science analysis
- Large Follow-Up Programs are planned / on-going:
  (Herschel / SCUBA2 / CFHT / IRAM / XSHOOTER)

2 Planck Intermediate Papers:

- 'Unveiling the nature of SPT High Redshift Submillimeter Galaxies with *Planck*'
- 'Characterization of a first set of *Planck* high-z candidates'