Searching for high-z DSFGs with NIKA2 and NOEMA

Longji Bing,
on behalf of NIKA2 and N2CLS collaboration

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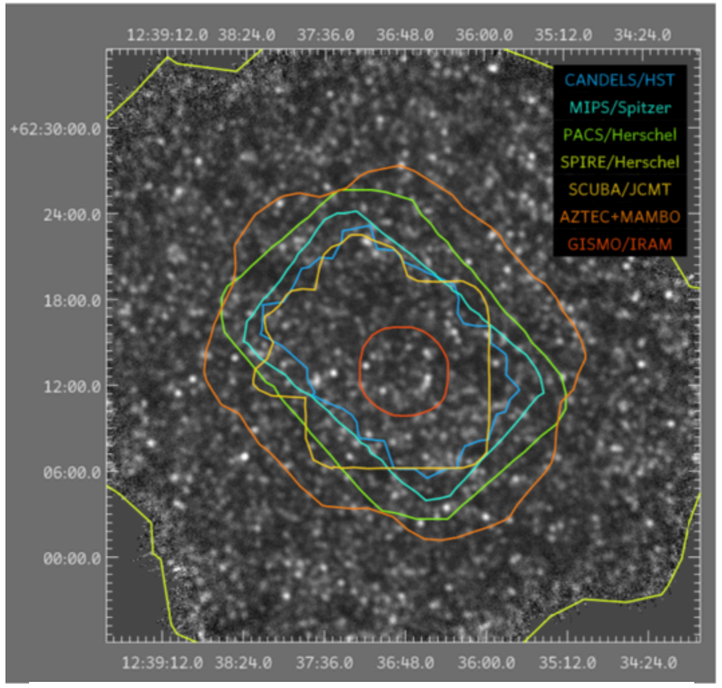
Collaborators: Matthieu Bethermin, Stefano Berta, Francois-Xavier Desert, Roberto Neri, and many other people from NIKA2 and N2CLS collaboration

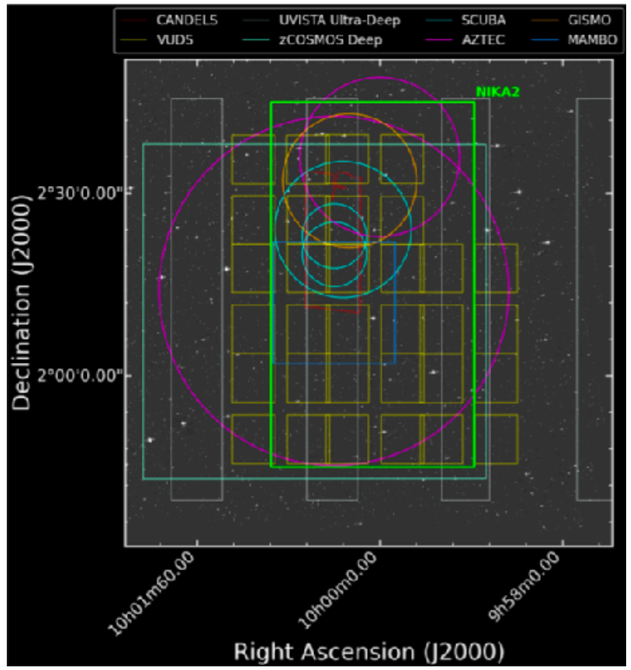
Observing the millimeter Universe with the NIKA2 camera
Jul. 1st, 2021

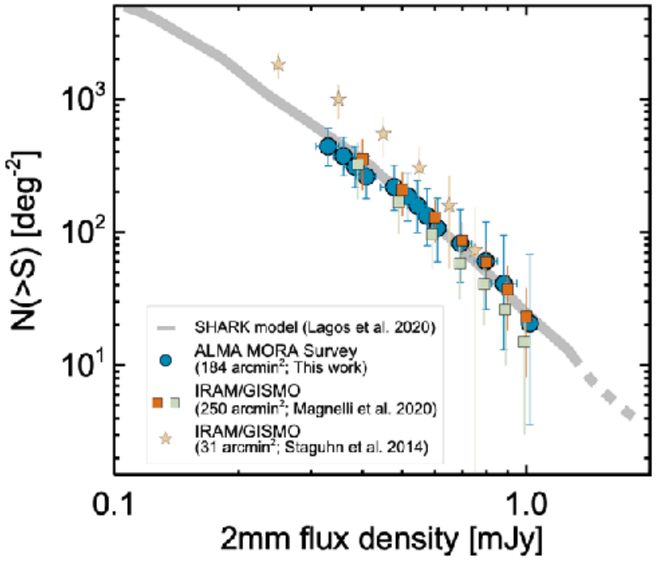
LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

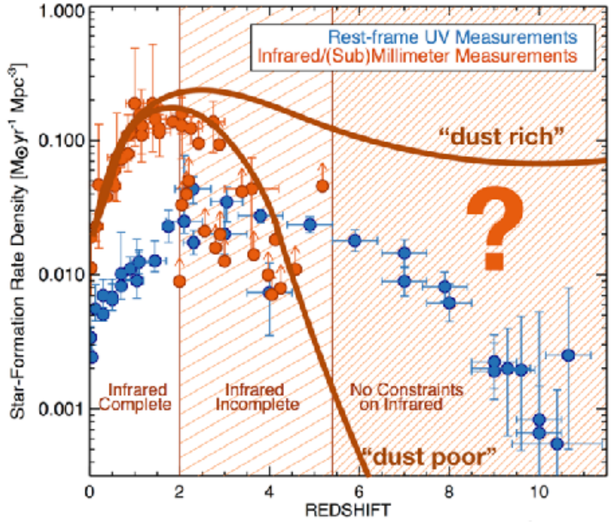
NIKA2Sky

NIKA2 Cosmological Legacy Survey (N2CLS): Introduction









NIKA2 GTO Large Program (300h)

2 deepfields: GOODS-N & COSMOS,
2 bands(1.2+2mm) simultaneously.

Narrow & Deep + Wide & Shallower
Good synergy between depth and width

Rich ancillary data covering 2 fields.
Full SED + source redshift

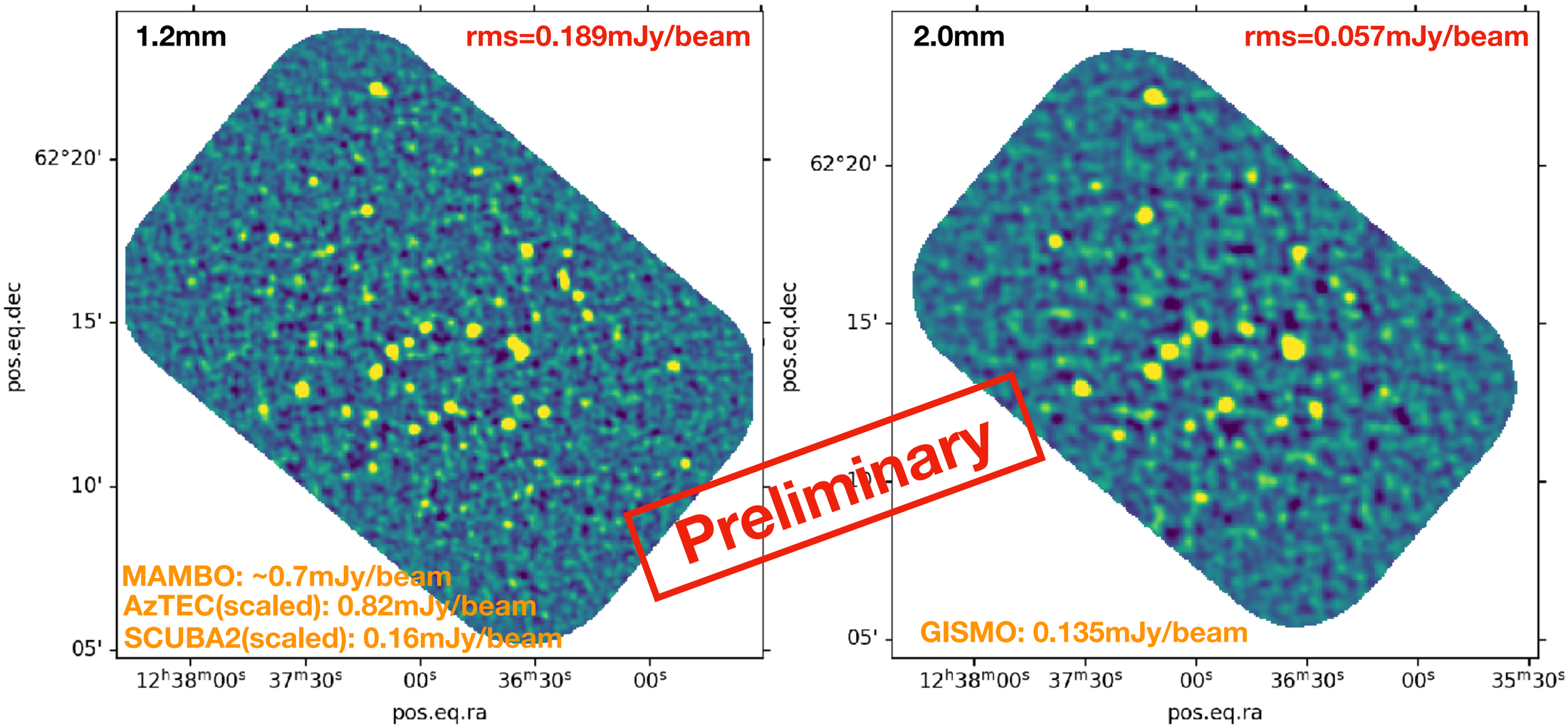
Longer wavelength favours higher-z

Scientific goals:

0. Census on high-z DSFGs
1. Number counts & confusion limit
2. High-z obscured SFRD
3. DSFG clustering at z>2

……

N2CLS Status: GOODS-N

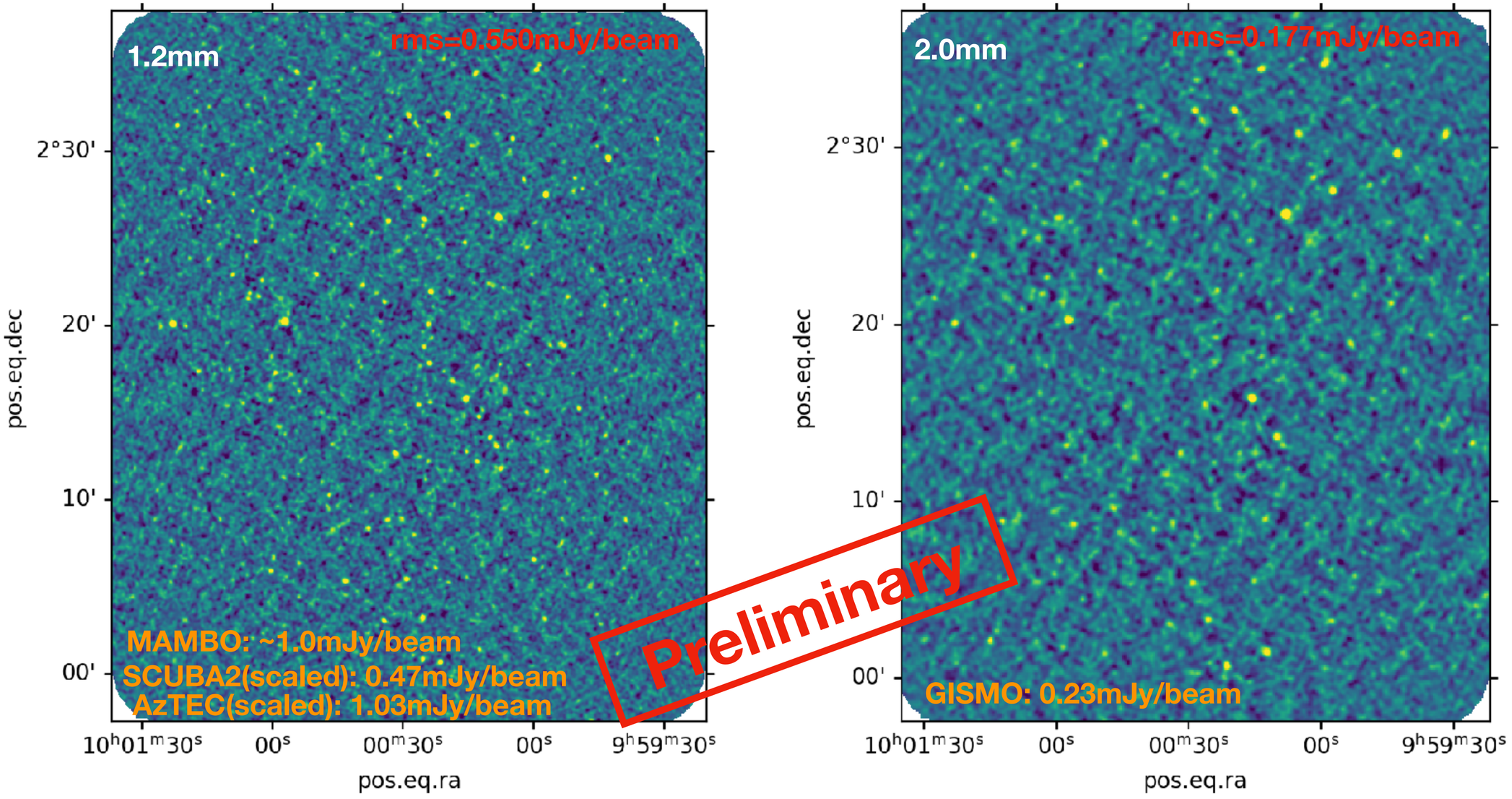


85.2h by Mar. 2021

62/25 sources @1.2mm/2mm with SNR>4

N2CLS Status: COSMOS

145/60 sources @1.2mm/2mm with SNR>4

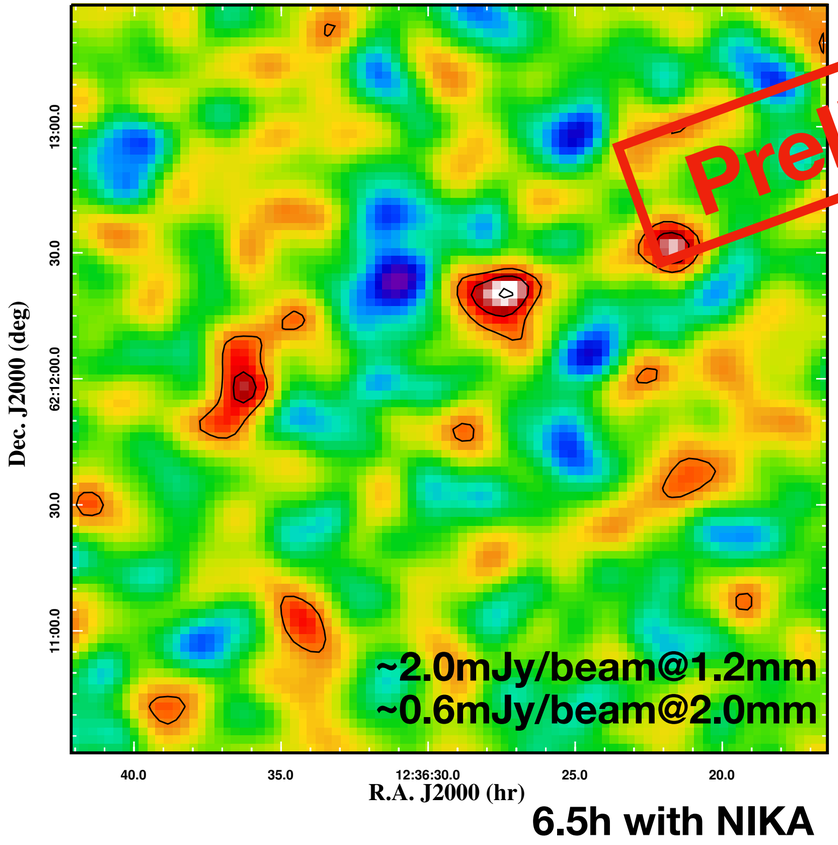


82.9h by Mar. 2021

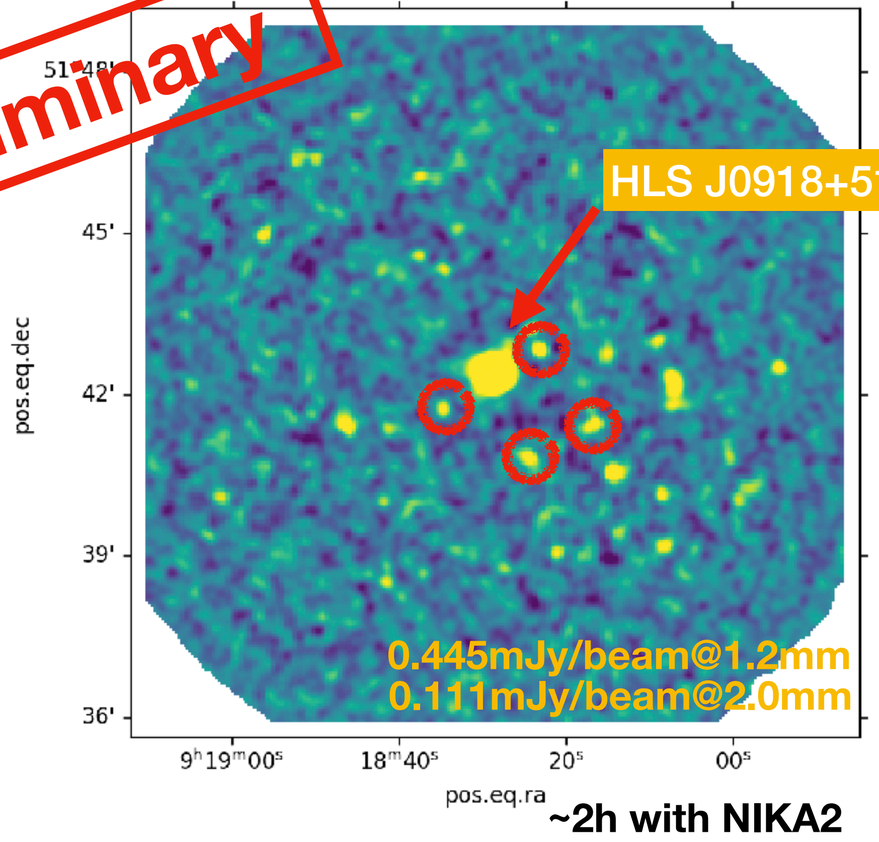
Source catalog + counterpart identification in progress

Science Verification Observations of Deep Blind Surveys

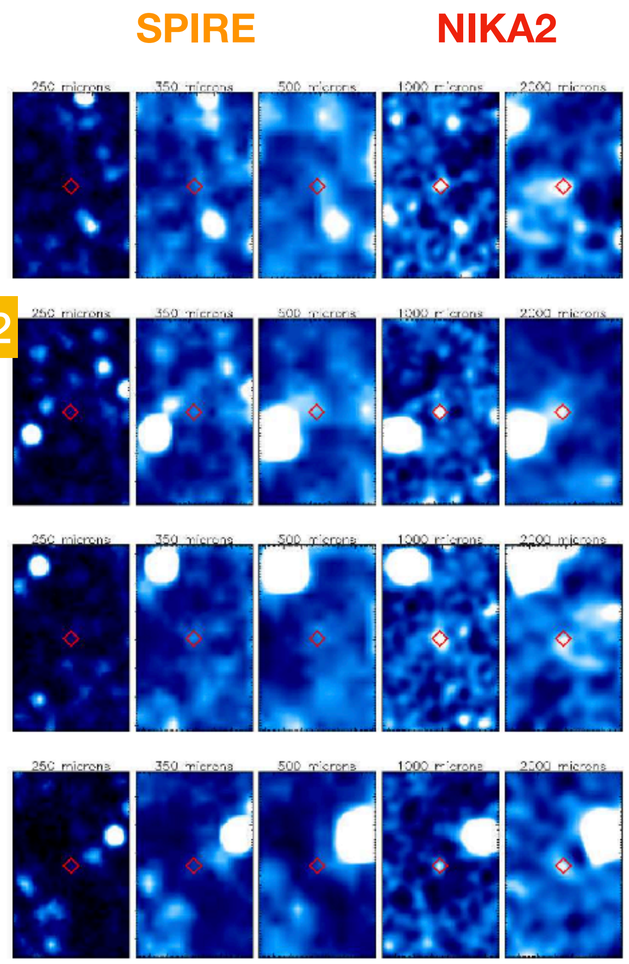
To understand the performance of NIKA2 (KIDs) in deep blind surveys



6.5h with NIKA

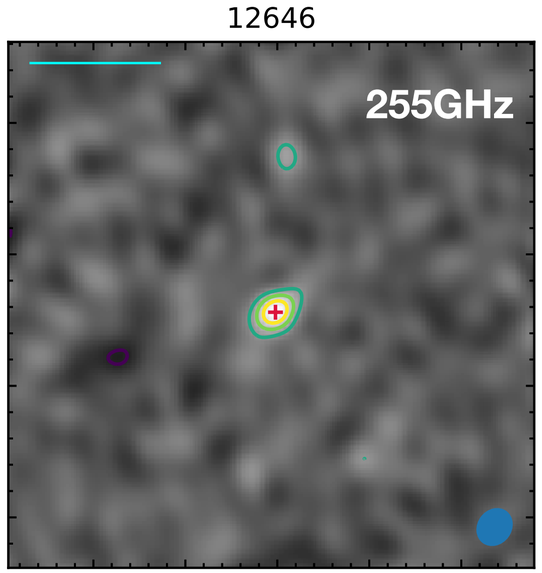


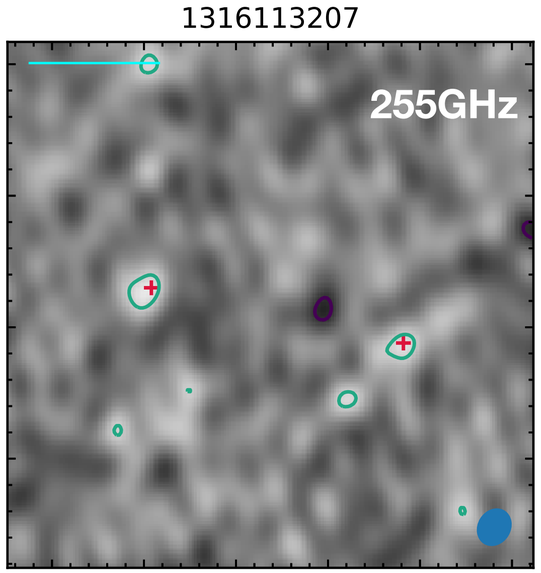
~2h with NIKA2

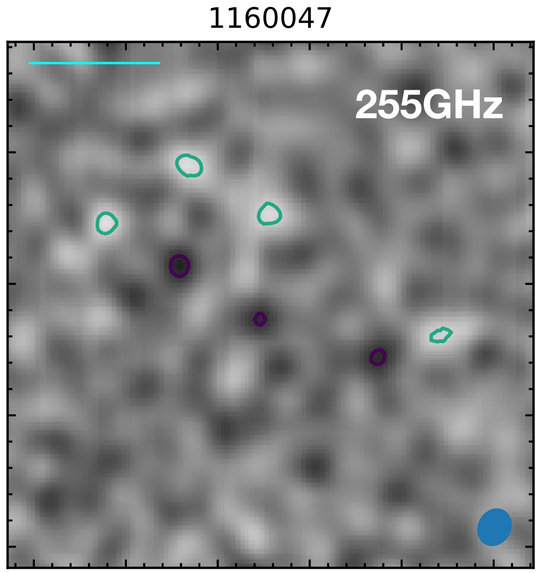


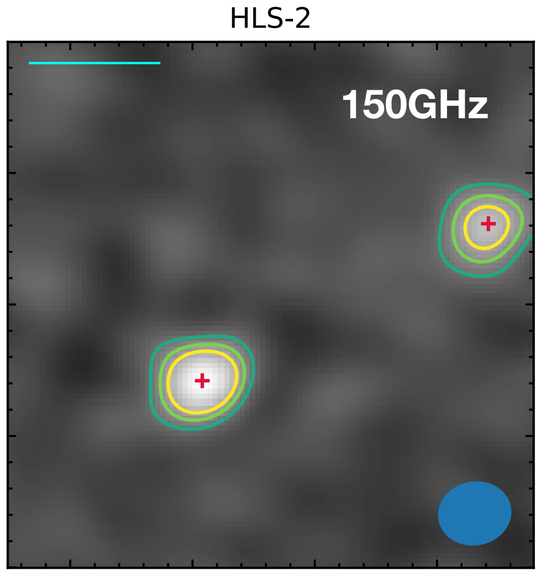
4 candidate high-z sources in HLS, bright at 1.2+2mm but faint/undetected in SPIRE, z_FIR ~ 3-7

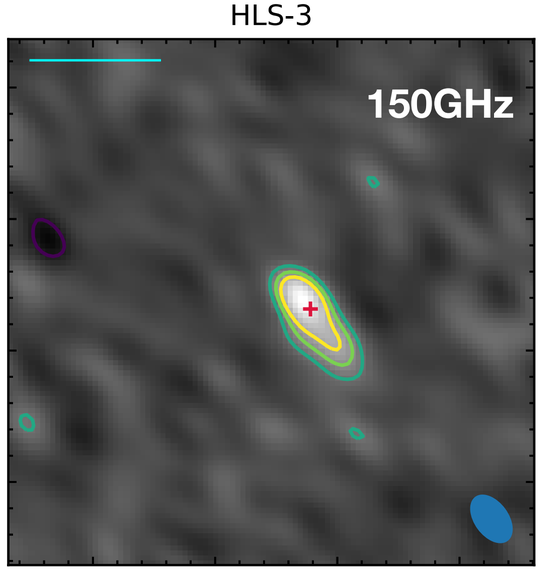
PdBI/NOEMA observations on 4 HLS+ 3 GN sources: z_spec, molecular gas and strategies of N2CLS follow-up

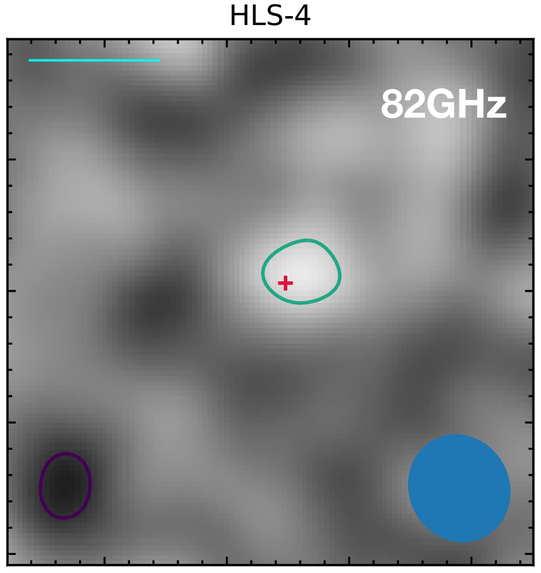


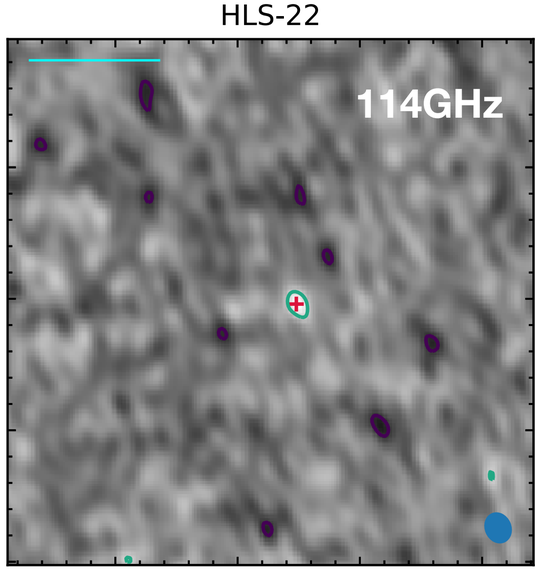










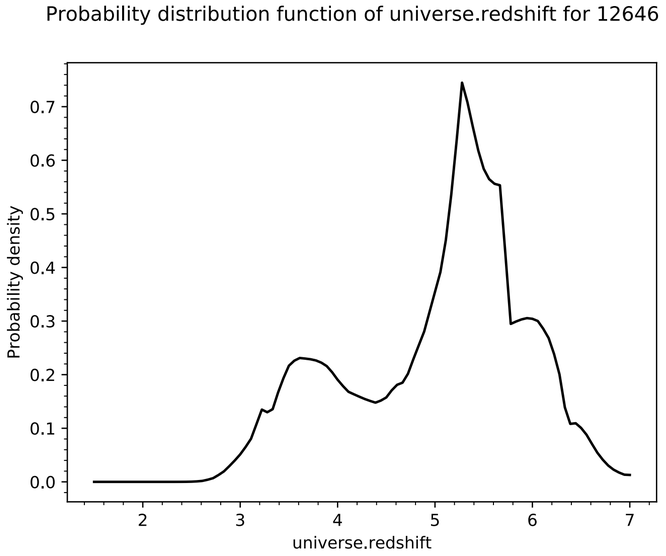


6 in 7 sources have continuum counterparts detected at SNR~4 or higher.

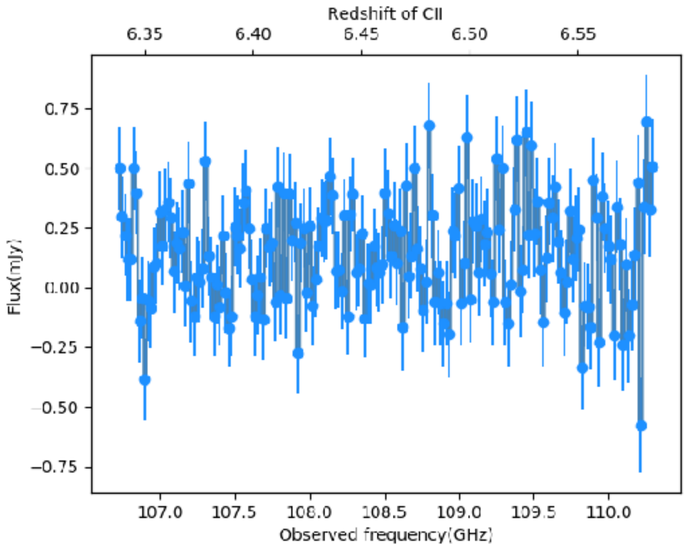
1160047: No OIR sources around NOEMA peaks, no detection N2CLS-GN

Start with 4.8h(B3)+38.9h(B1) on source, only 1 SNR~6 line detection + a few tentative ones…

Joint constraints on redshift with PDF of photo-z and NOEMA spectral scans

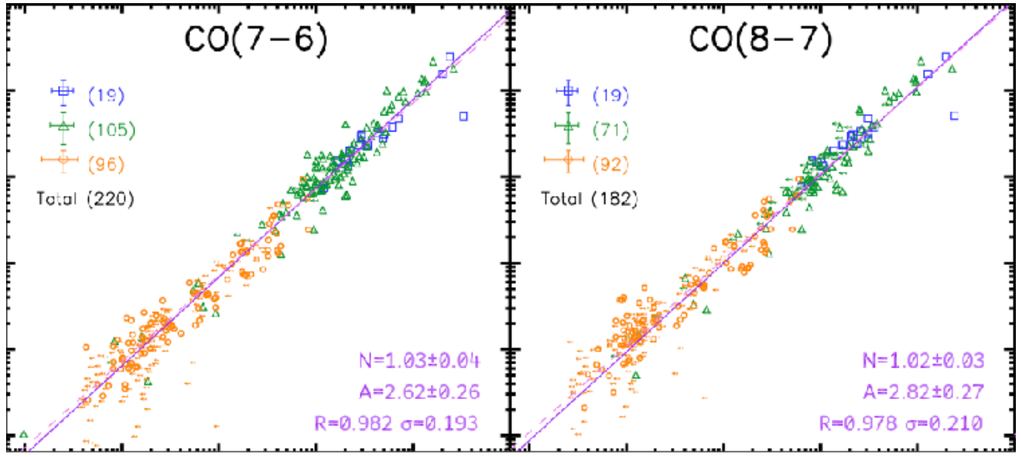


PDF of z and $L_{IR}(z)$ from SED fitting



NOEMA Spectra

First time to apply this method to obtain the redshift of DSFGs?



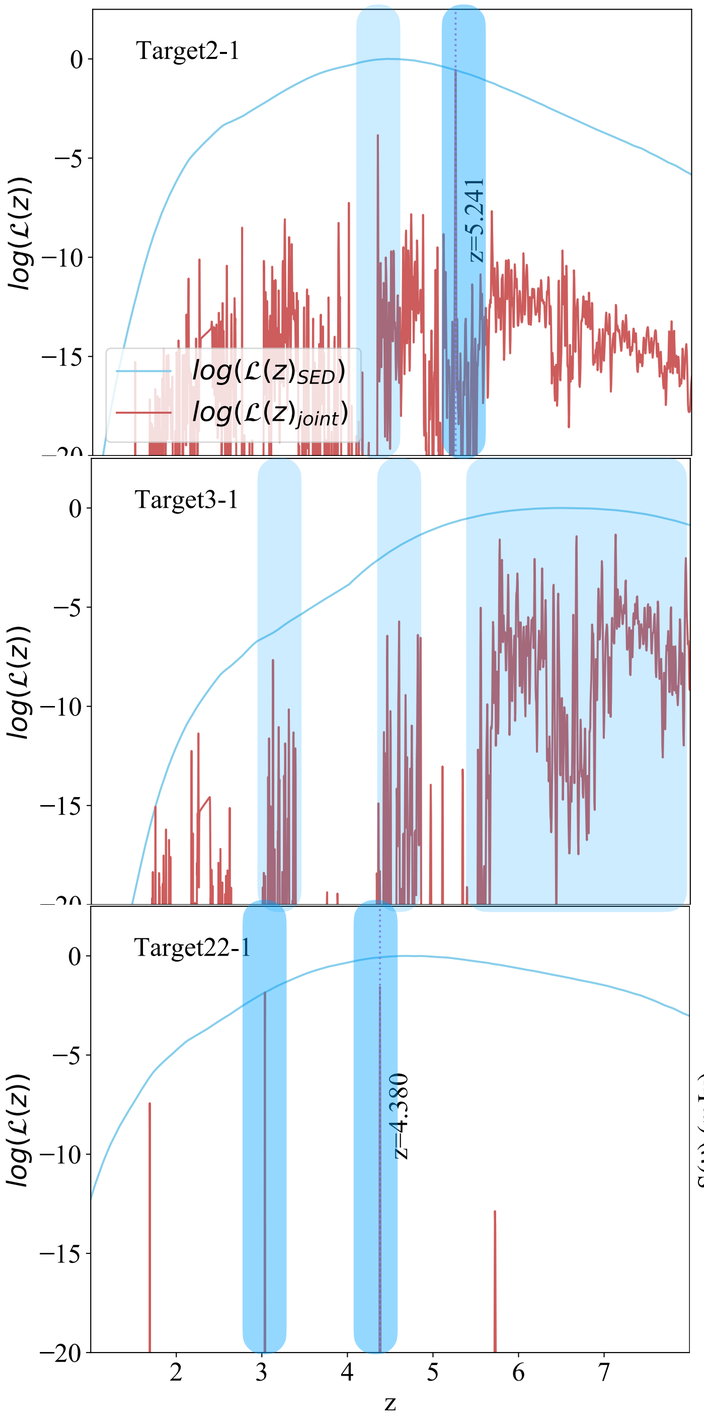
$L_{IR}(z)$ to $S_{line}(z)$ using scaling relations

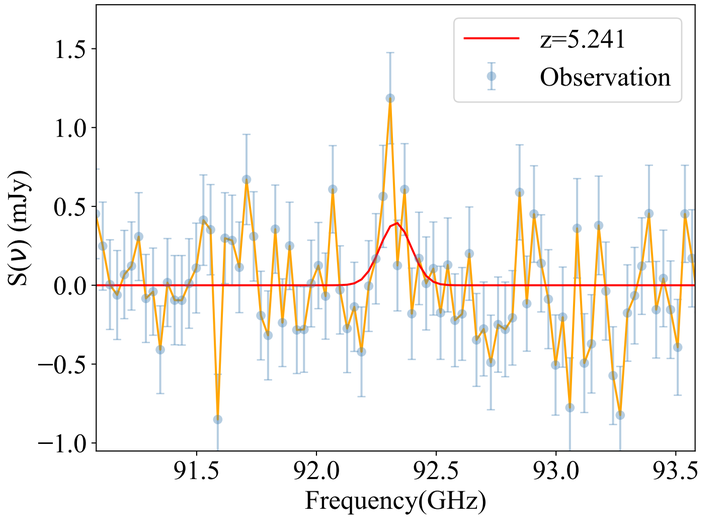
Generate the model spectra

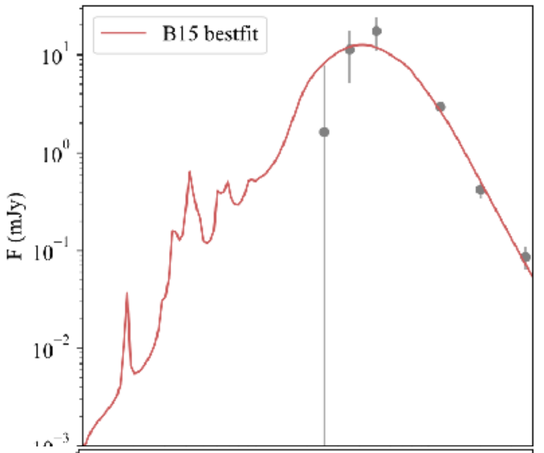
$$\mathcal{L}(z) \propto exp(-\chi^2(z)/2)$$

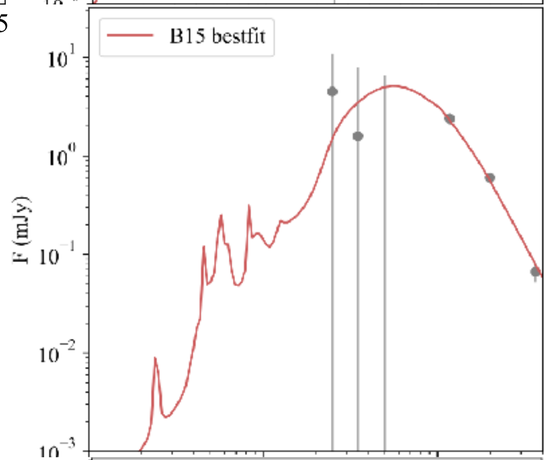
χ^2 between model and observation

Multiple sources are assumed to share the same PDF(z) if unresolved data are used in SED fitting

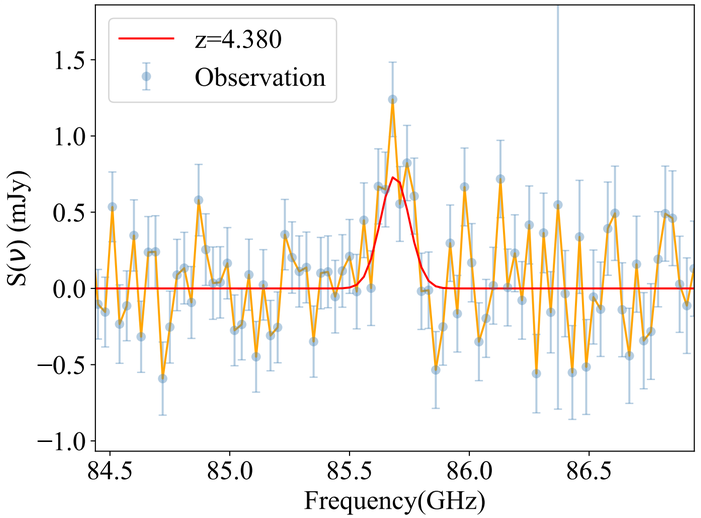


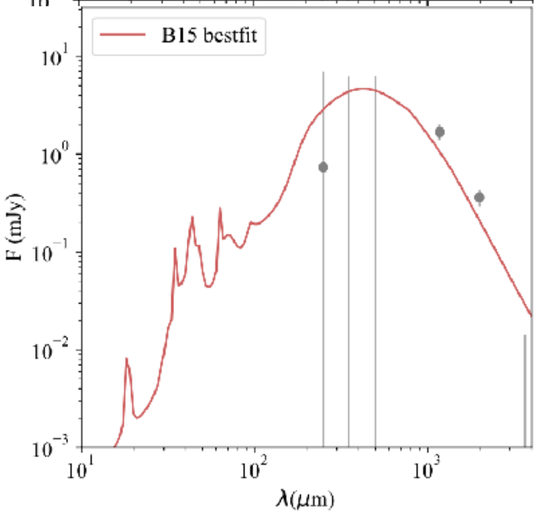






Intial estimation of the redshifts of HLS soures

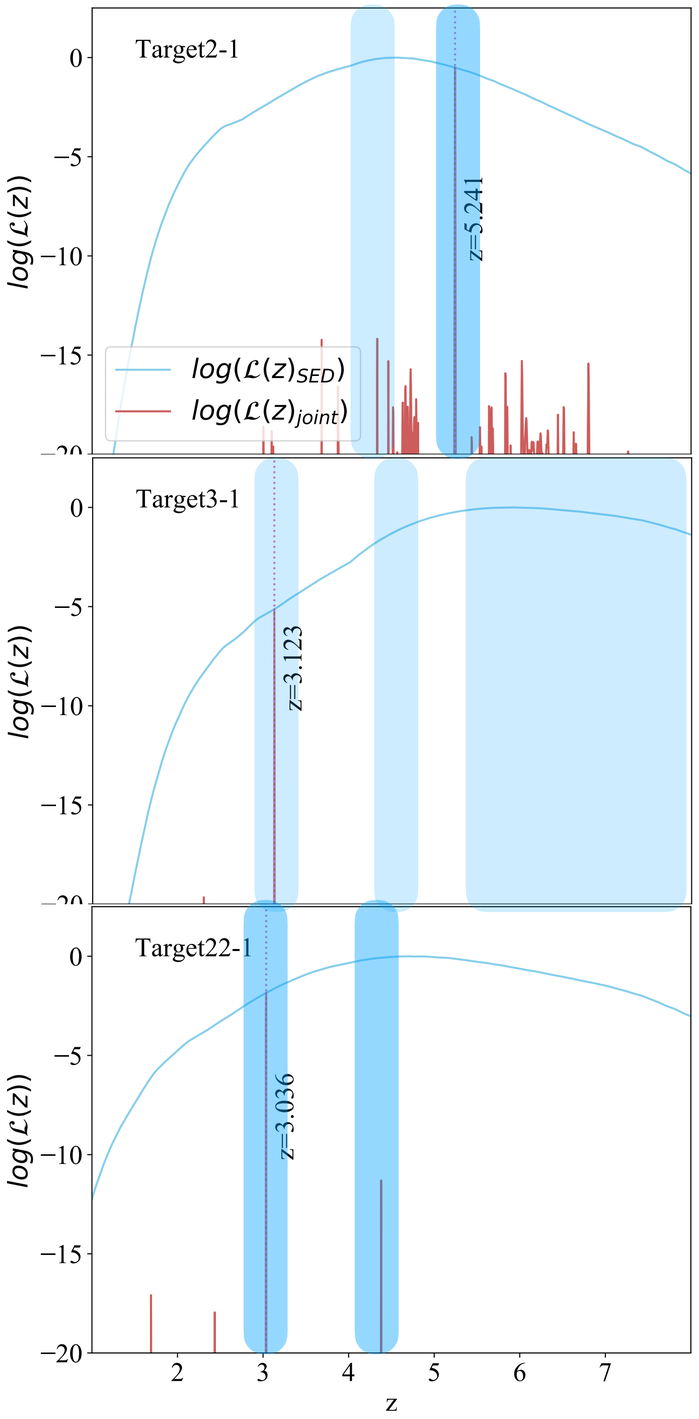


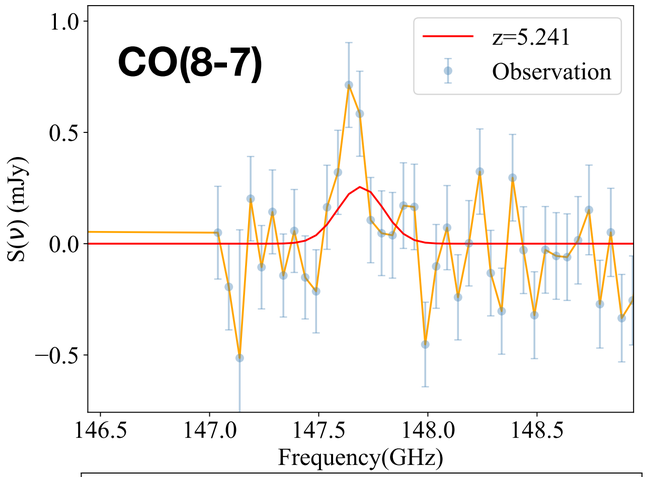


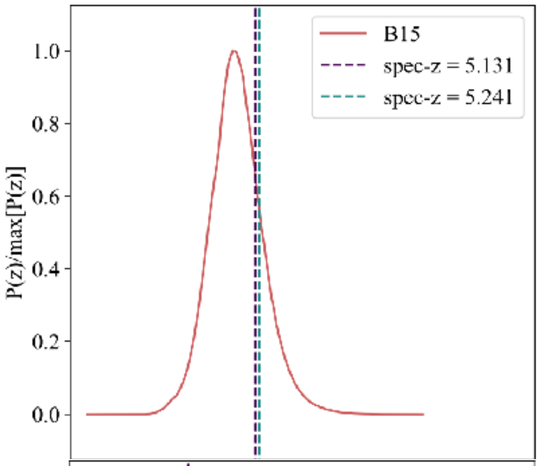
HLS-2-1: 1 tentative line detection+Far-IR Photometric redshift

HLS-3: no line detected, Far-IR SED only

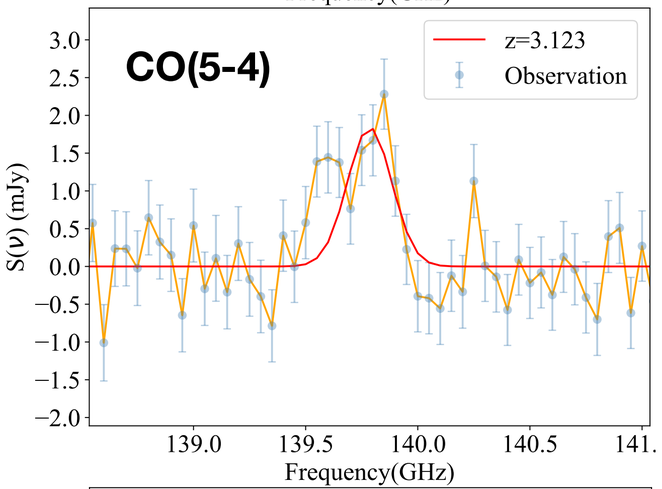
HLS-2-1: 1 significant line detection+Far-IR Photometric redshift

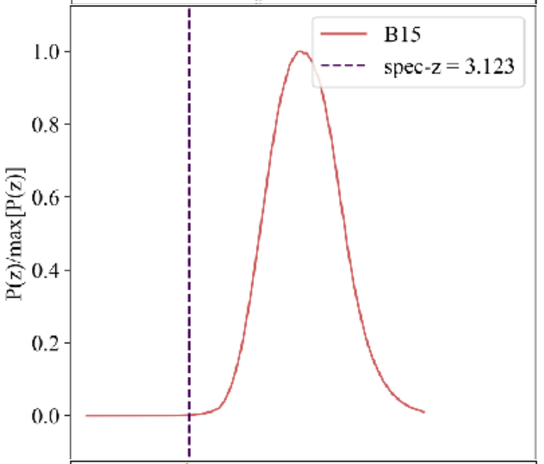




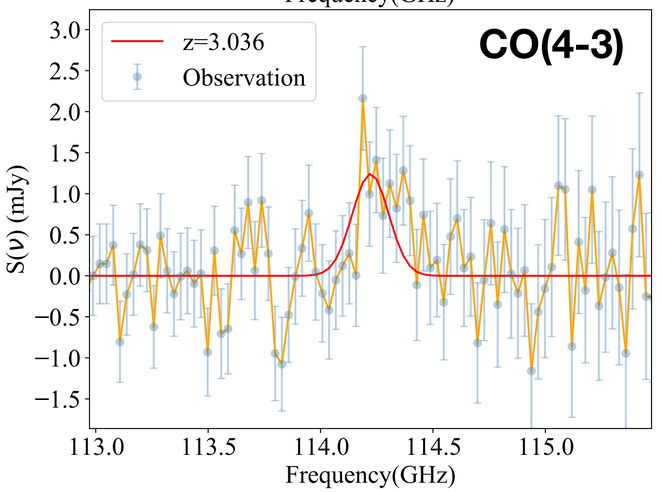


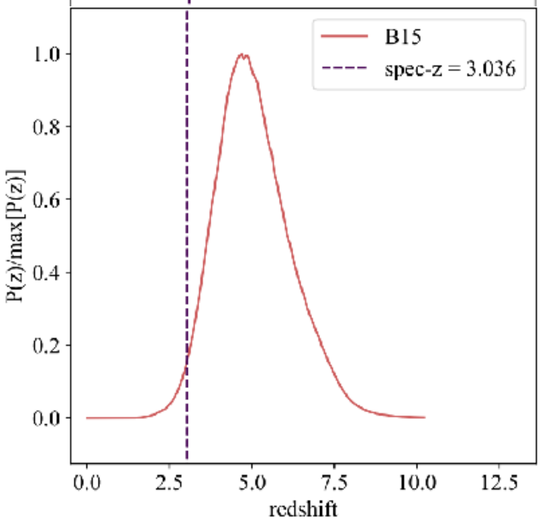
HLS-2-1: Most probable redshift solution confirmed, z_{spec} consistent with z_{farIR}



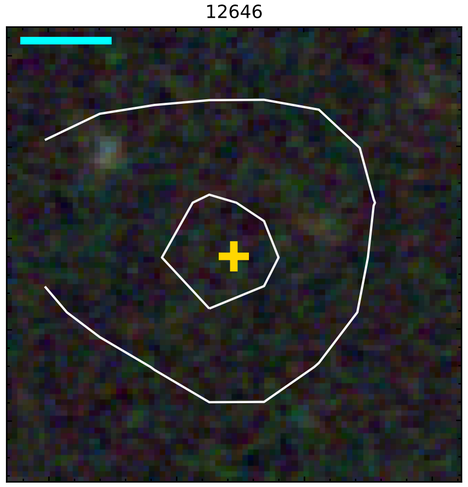


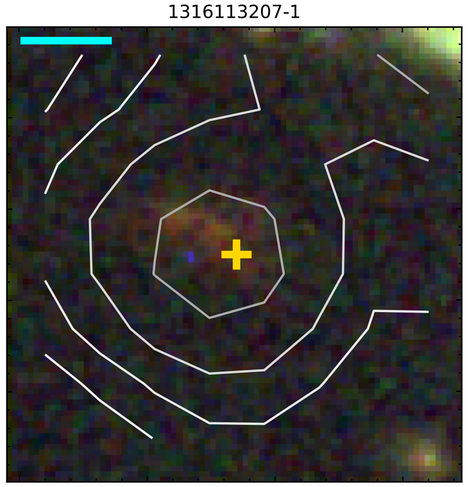
HLS-3: redshift solution from 1 detection + 1 line coverage, but z_{spec} inconsistent with z_{farIR}

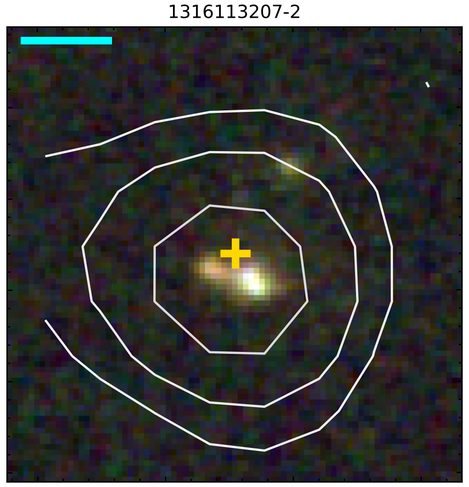




HLS-22: The 2nd most probable redshift solution confirmed, z_{spec} roughly consistent with z_{farIR}

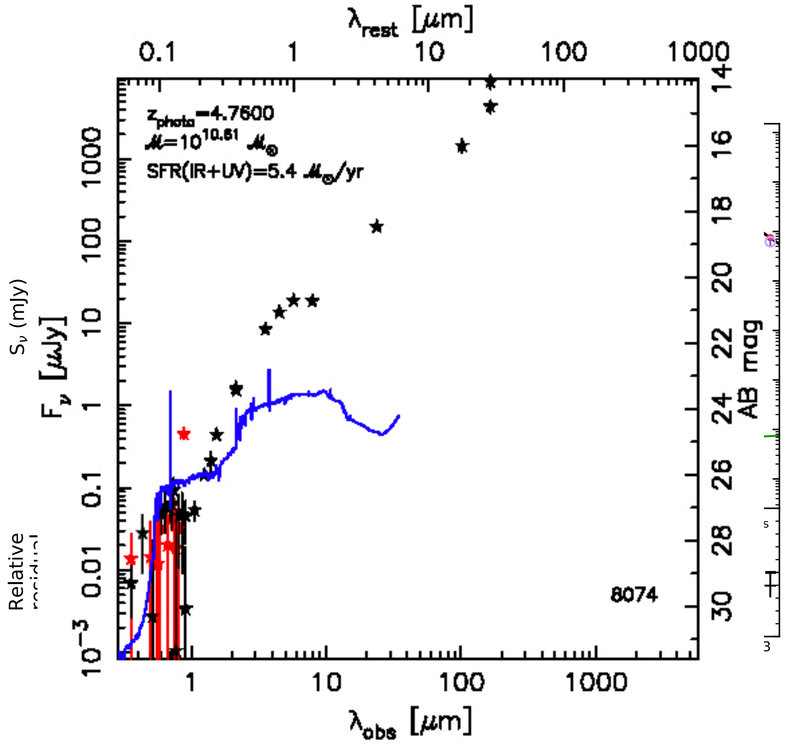


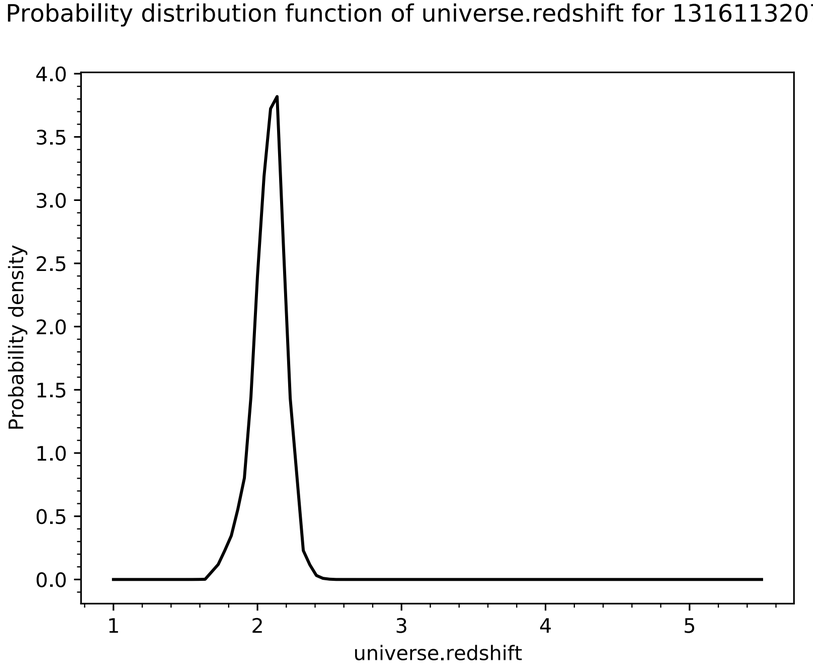




Redshift of GN sources:

- Old WideX data, narrow BW
- Continuum position to locate optical-IR counterparts



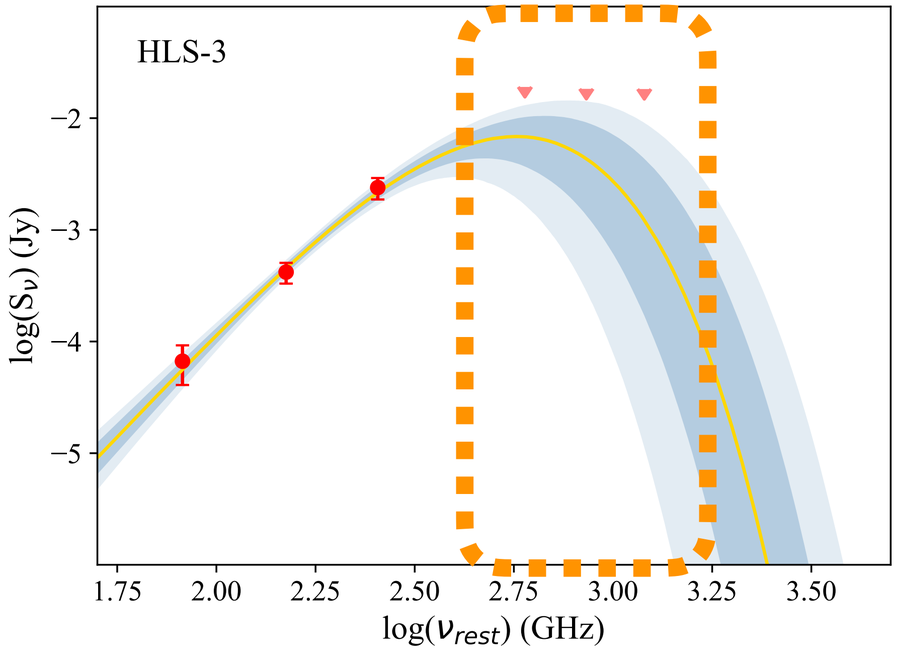


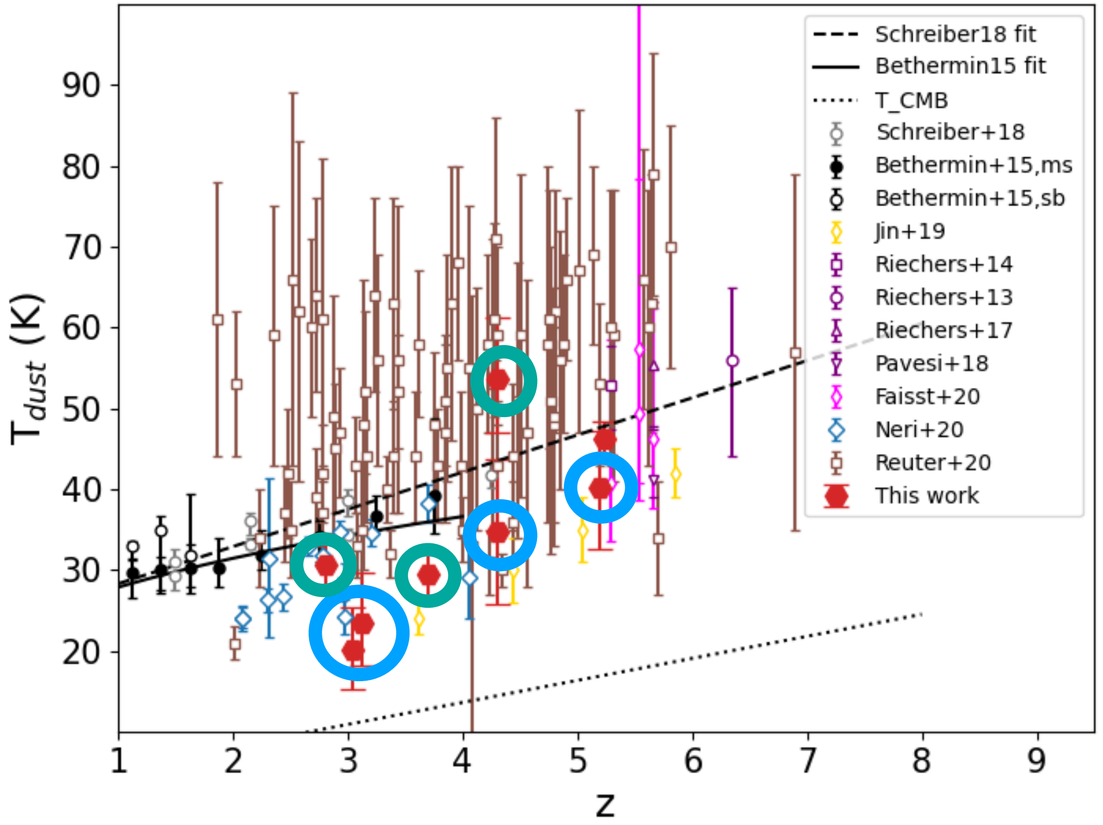
Full SED fit with CIGALE

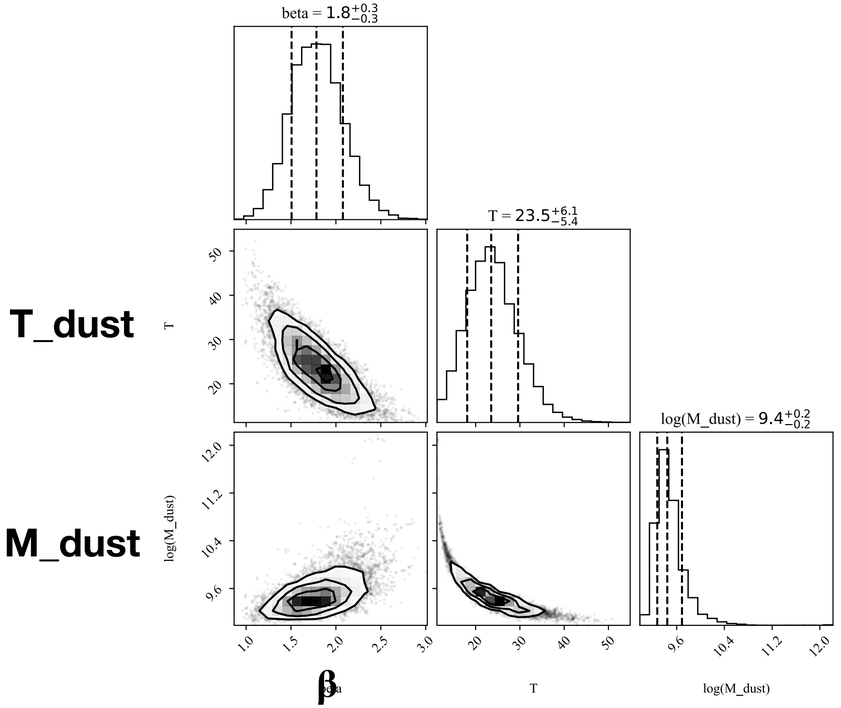
- z as a free parameter
- O-IR data provide better constraints on z.
- Inconsistent with CANDELS for some sources, failed fitting on highly obscured sources?

Source Name	RA	Dec	z_phot	z_spec
12646	12:36:27.5	62:12:17.8	$3.7^{+2.1}_{-0.3}$ 2nd peak at z~6.0	N/A
1316113207-1	12:36:37.5	62:11:56.5	$2.1^{+0.1}_{-0.1}$	N/A
1316113207-2	12:36:36.1	62:11:54.4	$4.3^{+0.2}_{-0.1}$	N/A
HLS-2-1	09:18:16.3	51:41:28.1	$4.6^{+0.8}_{-0.7}$	5.241
HLS-2-2	09:18:17.5	51:41:22.1		5.128
HLS-3	09:18:23.1	51:42:51.6	$6.1^{+1.1}_{-1.0}$	3.123
HLS-4	09:18:24.3	51:40:50.3	$4.3^{+1.1}_{-0.9}$	N/A
HLS-22	09:18:34.8	51:41:44.8	$4.9^{+1.2}_{-1.0}$	3.036

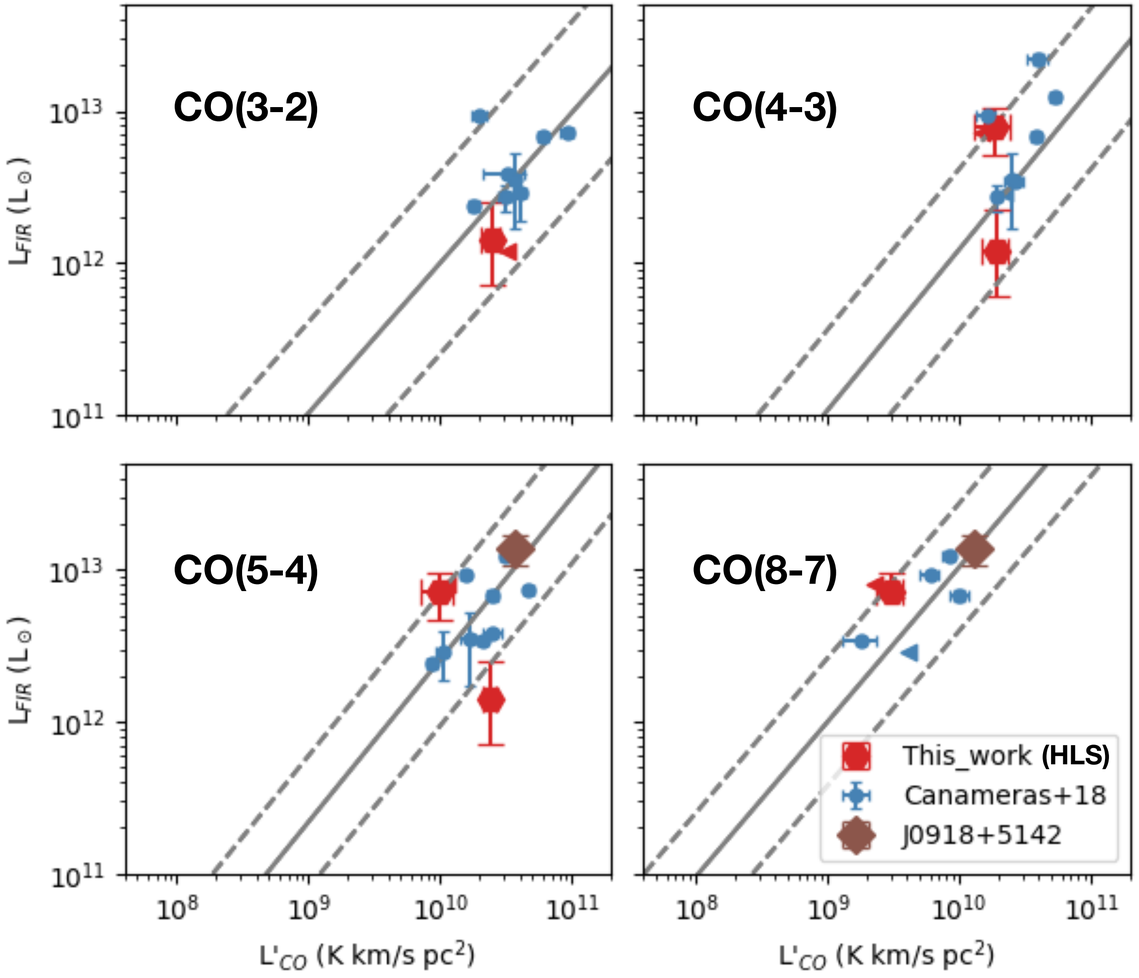
J0918+5142 at z=5.243, a possible overdensity of DSFG at z>5?

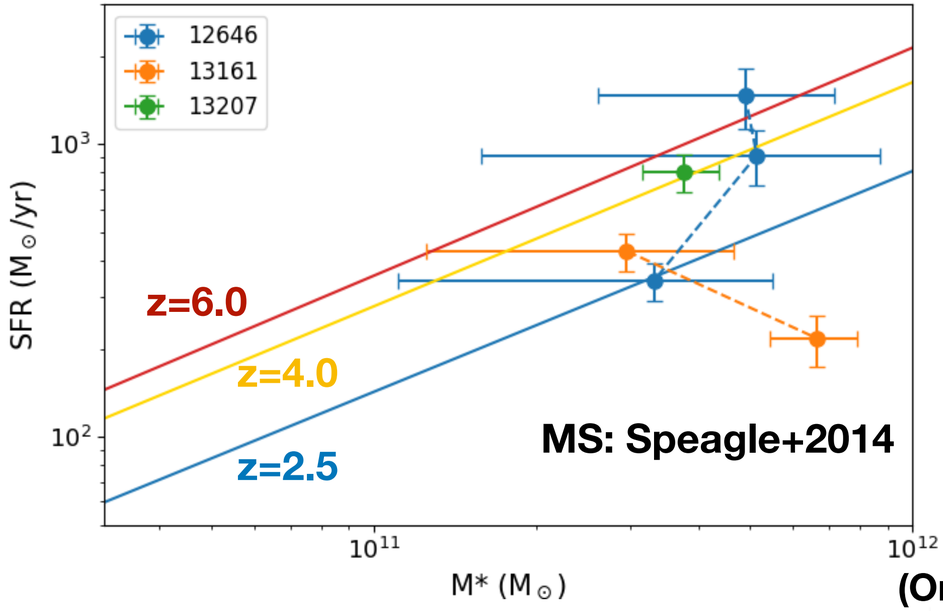




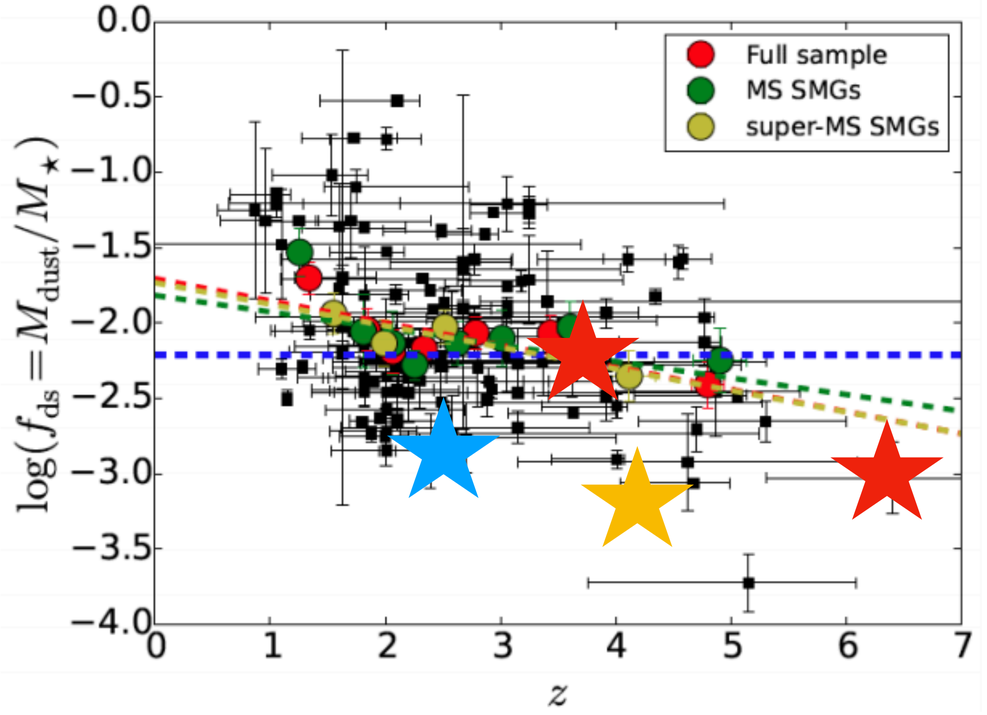


- **Dust properties: low T in HLS—> misleading high-z from Far-IR? Seems to be the case for HLS-3.**
- **Poor constraints < 1mm, T_dust might be affected(fluxes, optical-thin/optical-thick…)**





(Only GOODS-N)



Source properties: Massive high-z MS galaxies(?)

Similar gas and dust properties compared to other high-z SMGs/lensed DSFGs

Summary & Take-home Messages

N2CLS:

- **Designed for census on high-z DSFGs, other science cases using the data are welcomed!**
- **>50% of observations have been completed and the data are being reduced.**
- **Already the deepest survey at ~1.2mm/2mm in GOODS-N and the deepest wide-area (> a few hundred arcmin^2) survey at ~1.2mm/2mm in COSMOS**

NIKA(2) SV deepfields:

- **A new framework for joint analysis on redshifts of high-z DSFGs**
- **A population of "cold" (low T_dust under optical thin modified blackbody model) sources in SV deepfields selected from far-IR SED.**

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