CO Observations of Spitzer Selected z~2 ULIRGs

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Outline

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- S03E project
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Introduction
ULIRGs at z~2

- $L_{(8\text{-}1000\mu m)} > 10^{12} L_{\odot}$
- Rare in local universe but common at z~2
  - Evolution (e.g Yan at al 04, Dole et al 04,…)
- Progenitor of massive elliptical galaxies or quasars
- Some of them showing strong PAH emission and silicate absorption
  - Starburst
  - Embedded systems

Introduction
Goals of study

- Caracterisation of CO properties
  - ULIRGs selected by mid-IR spectra and flux
  - z~2
  - Determination of molecular gas masses
  - Determination of dynamical properties
  - Evolution

S03E project
Observations 1/3

- CO(3-2) line
  - ν_{rest} =345.796GHz
- Sample of 4 sources
  - *Spectroscopic redshift: z~2*
  - *Large Mips to optical flux ratio*
    - $Log(\nu S_\nu[24\mu m]/\nu S_\nu[0.7\mu m])>1$
  - *Very red mid-IR colors*
    - $Log(\nu S_\nu[24\mu m]/\nu S_\nu[8\mu m])>0.5$

S03E project
Observations 2/3

- Done at PdBI during the summer period between June 08 and September 08

- ~2 tracks per source in 5 antenna D configuration (E03N11N07W08W05): angular resolution: ~3”

- 3mm observations

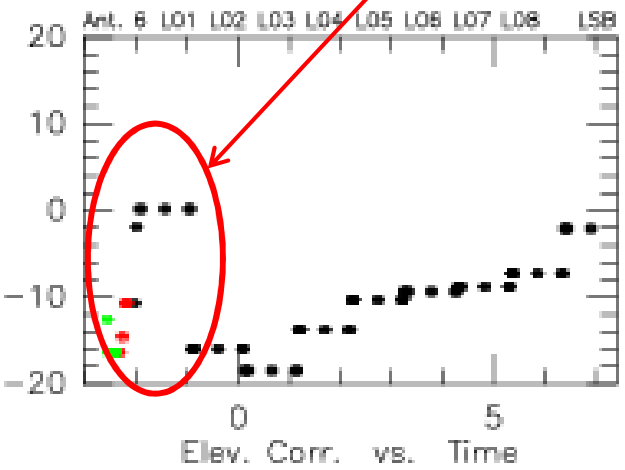
S03E project
Data reduction 1/9

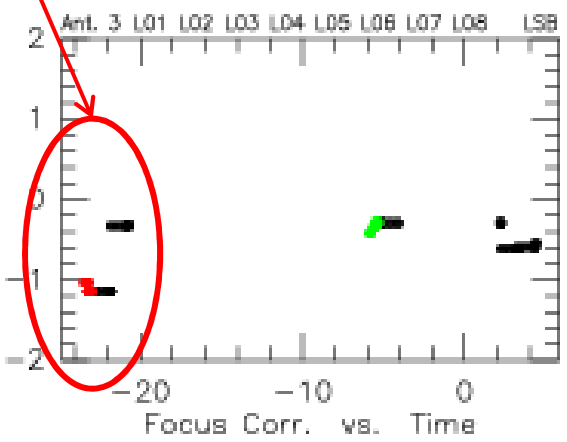
- Done with the applications CLIC and MAPPING
  - Contained in the GILDAS software
  - Developped at IRAM by J. Pety, F. Gueth and other collaborators

- Follow 3 major steps
  - Check the antenna responses
  - Calibration
  - Map and spectra

S03E project
Data reduction 2/9

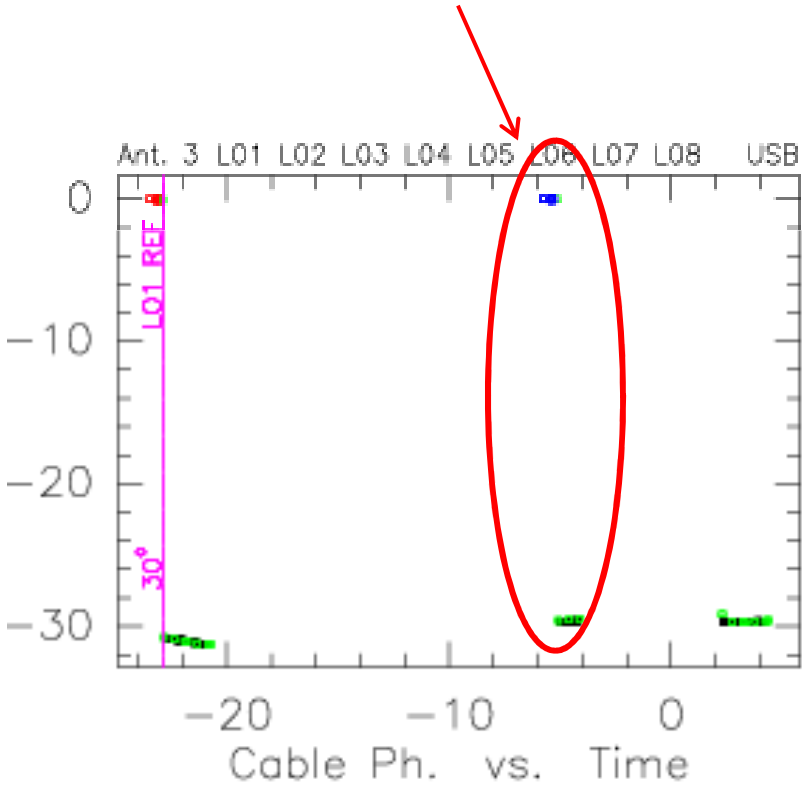
- Check the antenna responses
  - With the task in CLIC « FIRST look NGR »
  - Permit to show some problems with antenna
    - Bad pointing and/or bad focus





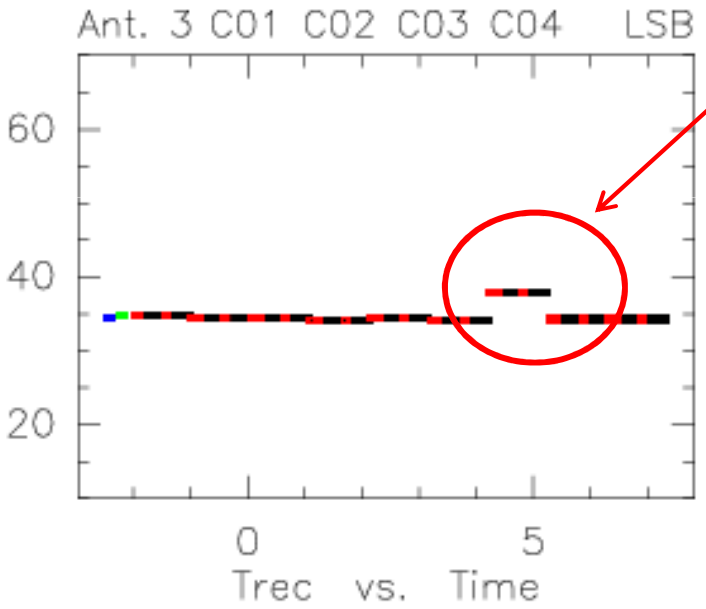
S03E project
Data reduction 3/9

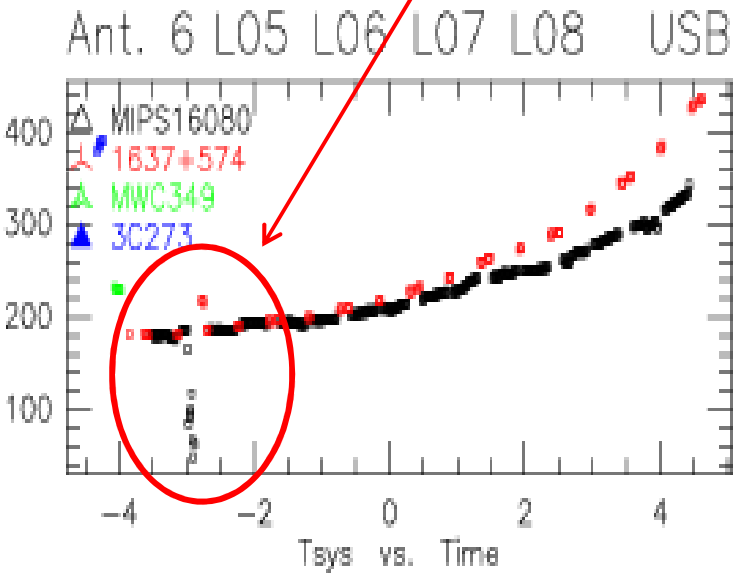
- Cable phase differences



S03E project
Data reduction 4/9

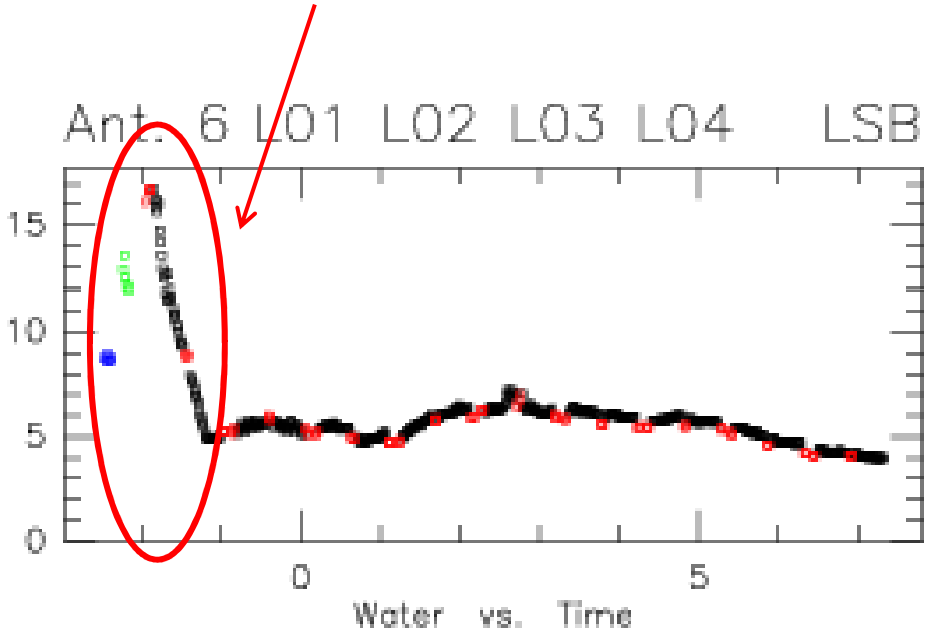
- Anormalous temperature of receiver or/and system





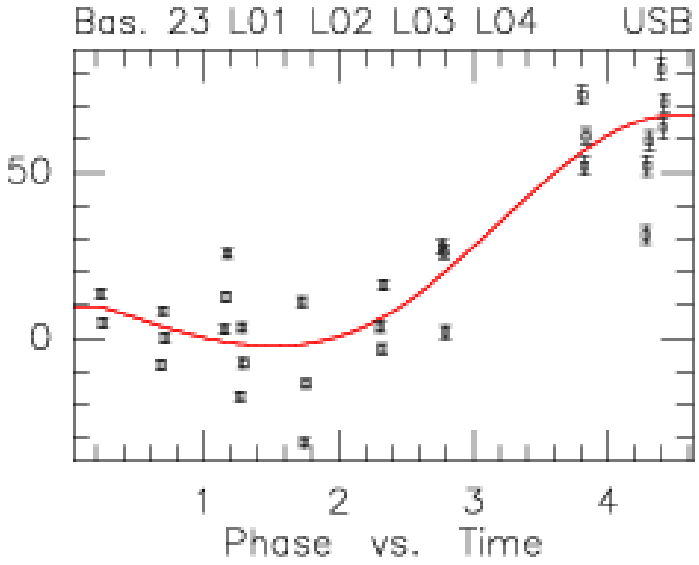
S03E project
Data reduction 5/9

- Unstable water vapor



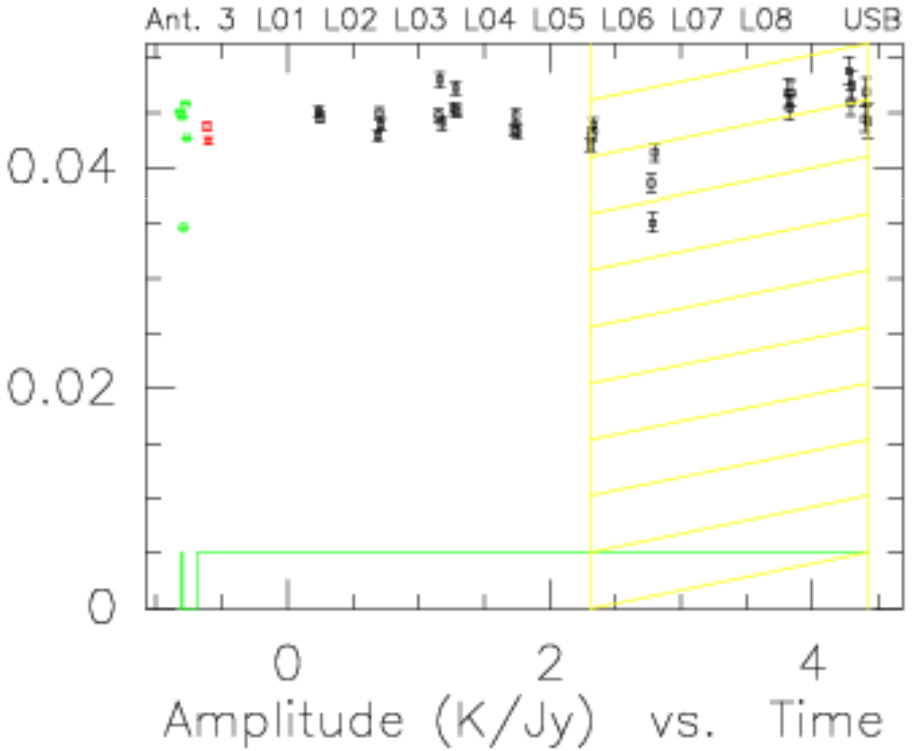
S03E project
Data reduction 6/9

- Calibration
  - With the task in CLIC « Standart calibration NGR »
  - Phase calibration



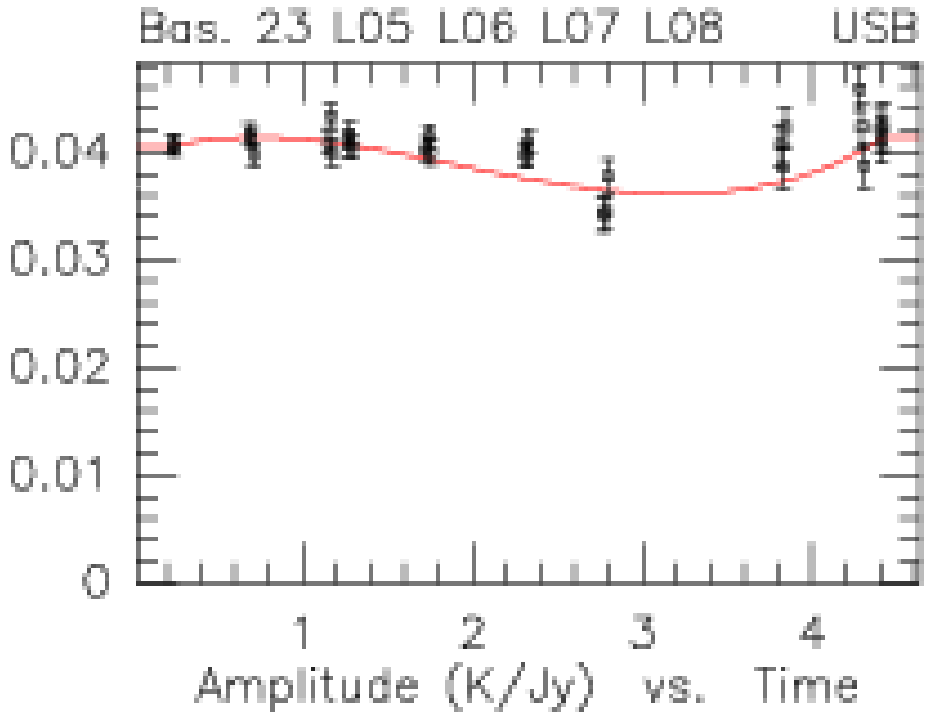
S03E project
Data reduction 7/9

- Flux calibration



S03E project
Data reduction 8/9

- Amplitude calibration

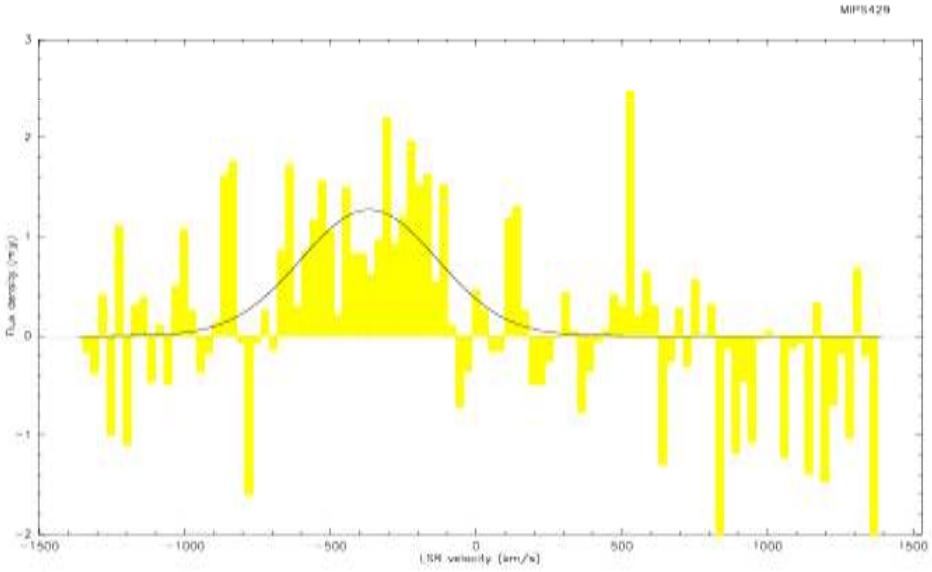


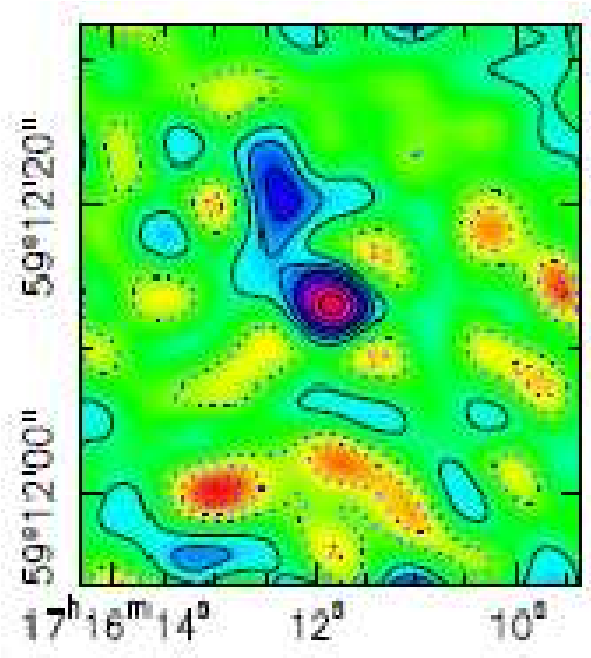
S03E project
Data reduction 9/9

- Map and spectra
  - Creation of uv table with CLIC
  - Plotting with MAPPING
    - Creation of spectra
    - Creation of map

S03E project
Preliminary results 1/5

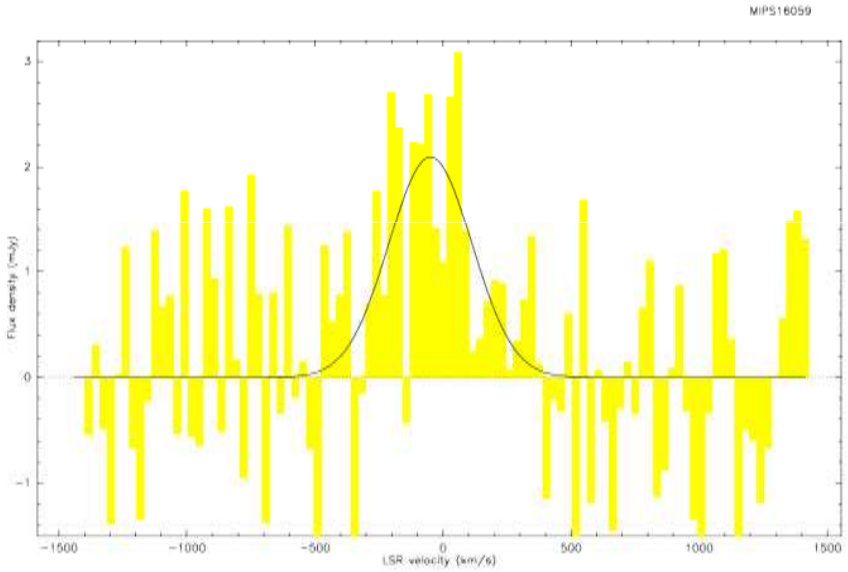
- 3 solid detections
  - MIPS 429: CO peak 1.27mJy

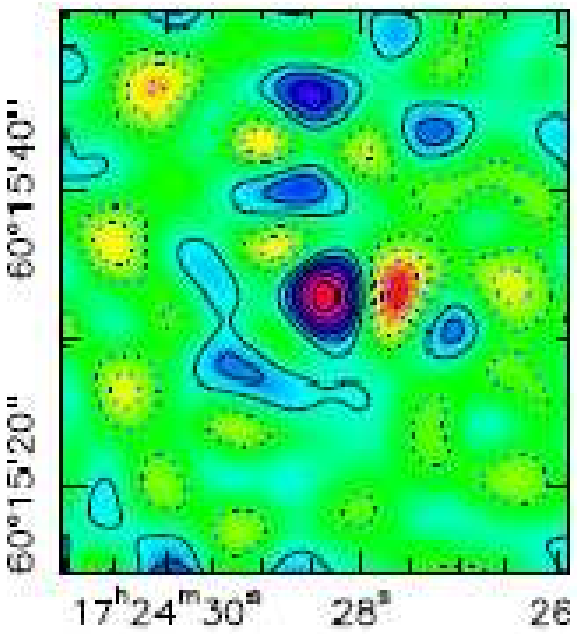




S03E project
Preliminary results 2/5

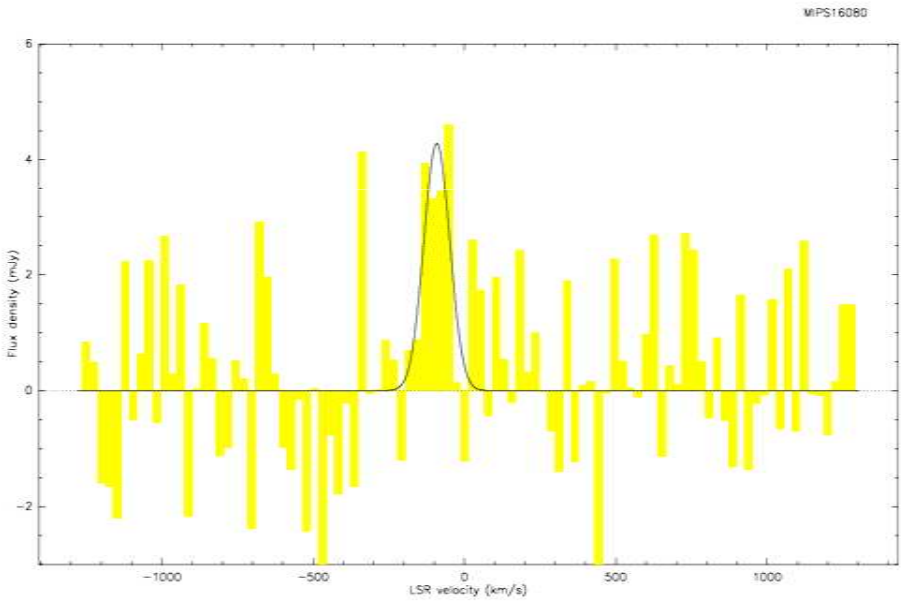
- MIPS 16059: CO peak: 2.09mJy

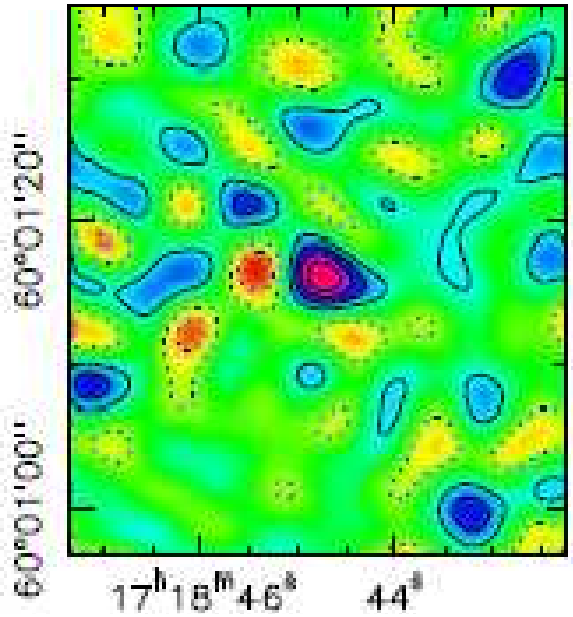




S03E project
Preliminary results 3/5

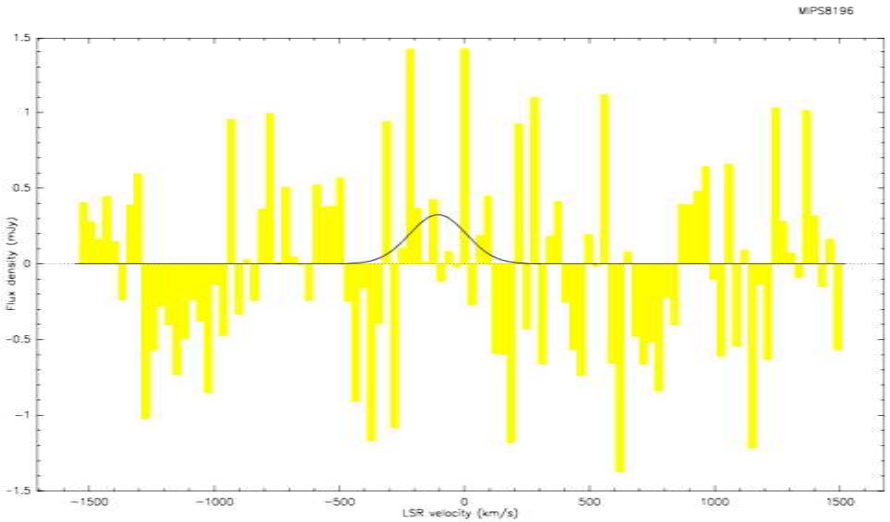
- MIPS 16080: CO peak 4.30mJy

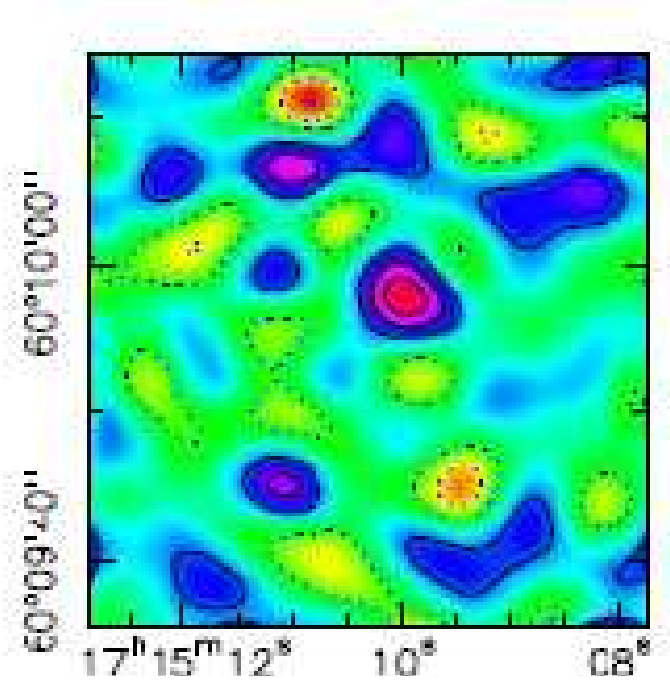




S03E project
Preliminary results 4/5

- 1 no detection
  - MIPS8196





S03E project
Preliminary results 5/5

- CO intensity and CO redshift

Table 1: CO emission of MIPS sources

MIPS ID	Project	z_{CO}TBC	$S_{1.2mm}$(mJy)	ICO(Jy km/s)	$\tau_{9.7}$	comments
429	S03E	2.213	1.03±0.57	~0.45-0.5	>7.3	
506	R047	2.470	1.37±0.53	~0.4-0.5	>6.7	borderline strong-PAH
8196	S03E	2.585	0.99±0.43	n.d	1.3	
8327	ROC4	2.441	1.03±0.59	0.22	2.4	radio-loud
8342	ROC4	1.562	0.98±0.52	0.58	0.2	
15949	ROC4	2.118	1.24±0.51	0.92	0.0	
16059	S03E	2.325	1.20±0.66	~0.45-0.5	2.7	radio-loud
16080	S03E	2.007	0.69±0.54	~0.5	2.1	
16144	ROC4	2.131	2.93±0.59	1.45	2.0	strong-PAH
22530	170-05	1.952	2.11±0.56	2.7 (4-3)	>5.2	strong-PAH

$<z_{co}>$=2.18 $<I_{CO}>$=~0.8 $<S_{1.2mm}>$=1.37mJy

Conclusions and prospect

- Conclusions
  - Efficiency of PdBI in this kind of research.
  - Succes in CO detection
  - CO detection in radio loud sources and strong PAH sources
  - Possible extension due to AGN outflow or starburst winds

Conclusions and prospect

- Prospect
  - Finish the analysis
    - Estimation of masses of the molecular gas reservoirs
    - Molecular gas exhaustion time scales
    - CO velocity dispersion
    - Place in context of massive galaxy evolution
  - Differences and similarities with the other SMGs and local ULIRGs
  - Follow-up studies whit another samples, other CO lines at 2mm or 1mm
  - High resolution mapping