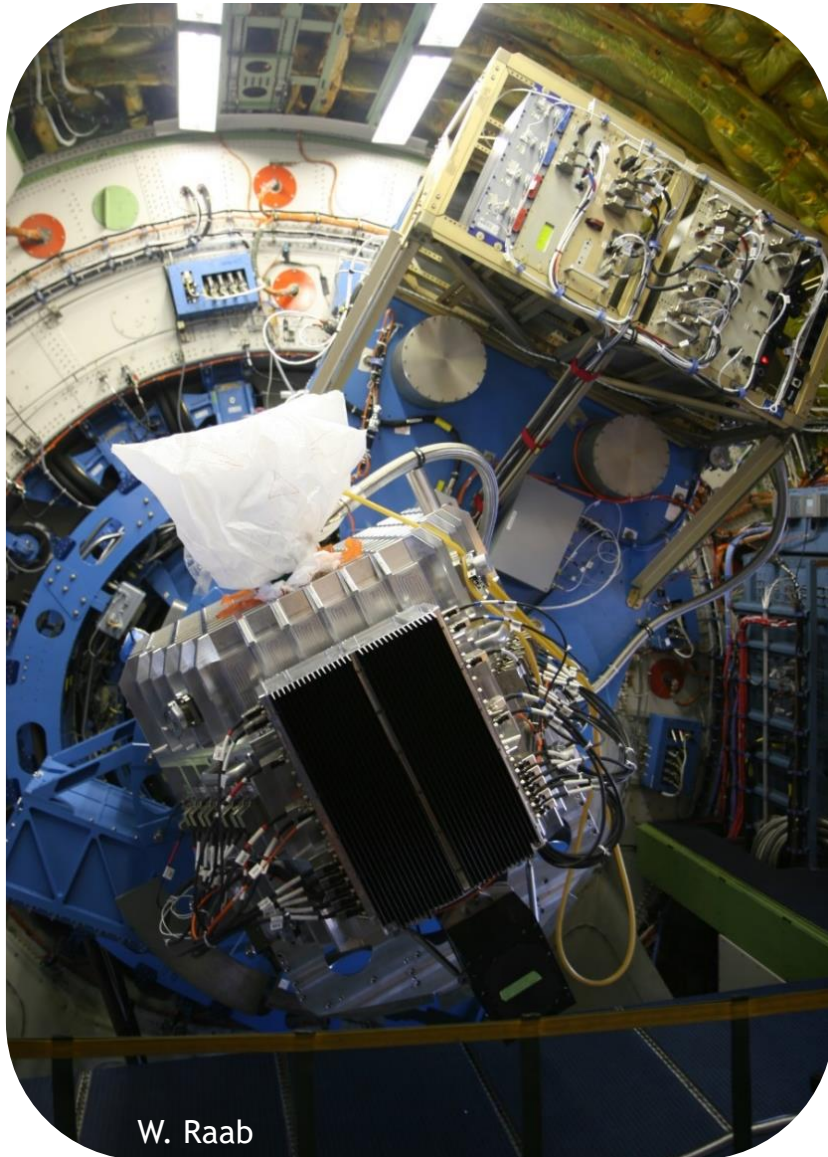




Universität Stuttgart

Institut für Raumfahrtsysteme (IRS)
Deutsches SOFIA Institut (DSI)



W. Raab

C. Fischer, W. Vacca

FIFI-LS Tutorial

C. Fischer
W. Vacca
&
FIFI-LS Team



USPOT



FIFI-LS [AOR ID: N/A]

Unique AOR Label: FIFI_LS-0000

Target: None Specified

New Target Modify Target Target List...

Observing Condition & Acquisition / Tracking

Observation Order	0	On-source exp. time (sec)	60	* Instrument Mode	Symmetric Chop
* Rest Wavelength Blue (micron)	63.184	* On	30.000	Chop Type	Sym
* Width of Spectrum Blue (km/s OR micron)	0.000	* Cycles	1	Total Chop Throw (arcsec)	120.000
Width of Spectral Feature Blue (km/s OR micron)	0.000	Min Contiguous Exp Time (sec)	0.000	Chop Angle Coordinate	J2000
* Rest Wavelength Red (micron)	157.741	* MapType	Grid	Chop Pos Angle (deg)	90.000
* Width of Spectrum Red (km/s OR micron)	0.000	* Number of Points Along Lat (Grid Only)	1	Set Chop Angle Ranges	
Width of Spectral Feature Red (km/s OR micron)	0.000	* Number of Points Along Lon (Grid Only)	1	Reference Position	
Width Unit	km/s	Step Size Along Lat (arcsec)	30.000	Ref Type	
* Source Velocity (km/s)	0.00000	Step Size Along Lon (arcsec)	30.000	<input checked="" type="radio"/> By Offset	
Dichroic	105_micron	Map Offset RA (arcsec)	0.000	<input type="radio"/> By Position	
Pointing Array	Blue	Map Offset Dec (arcsec)	0.000	Map Ref. Pos.	false
Spectral 1	FIF_BLUE	Map Priority	Map order	Reference Name	
Spectral 2	FIF_RED	FOV Angle (deg)	0.000	RA Offset (arcsec)	600.000

Number	Offset East/Row/Perpendicular (")	Offset North/Column/Parrell (")
1	0.0	0.0

*Import Map Offsets (Custom Only) Export Map Offsets Export Map Positions

Observation Est... Comments... Proposal Info...

OK Apply Cancel Help

(* = required for Phase I)



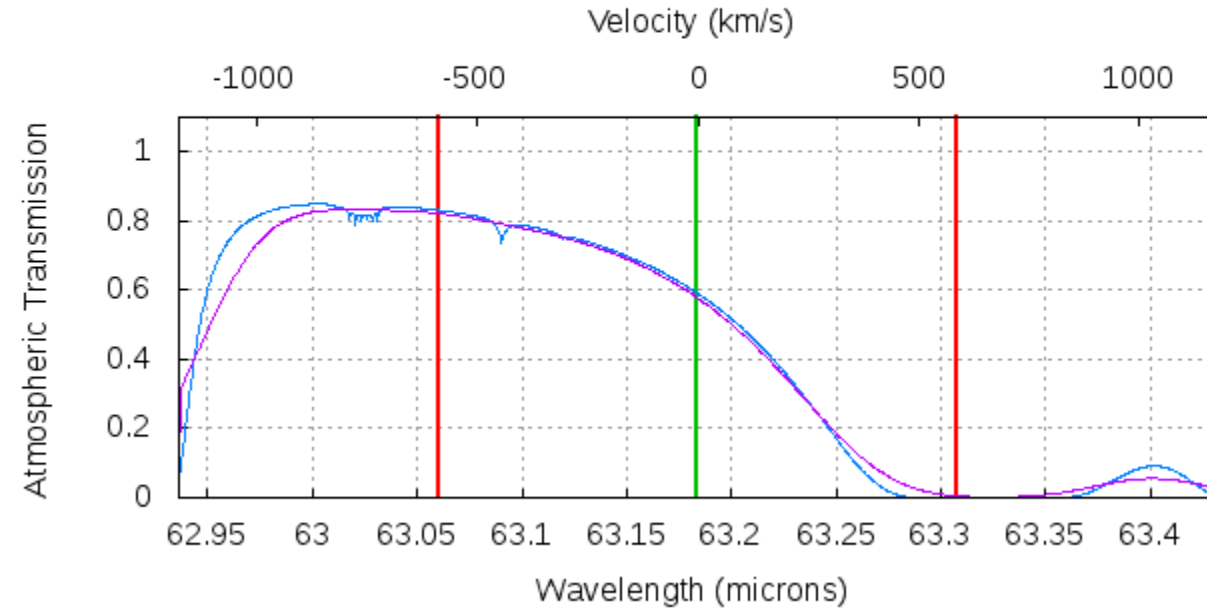
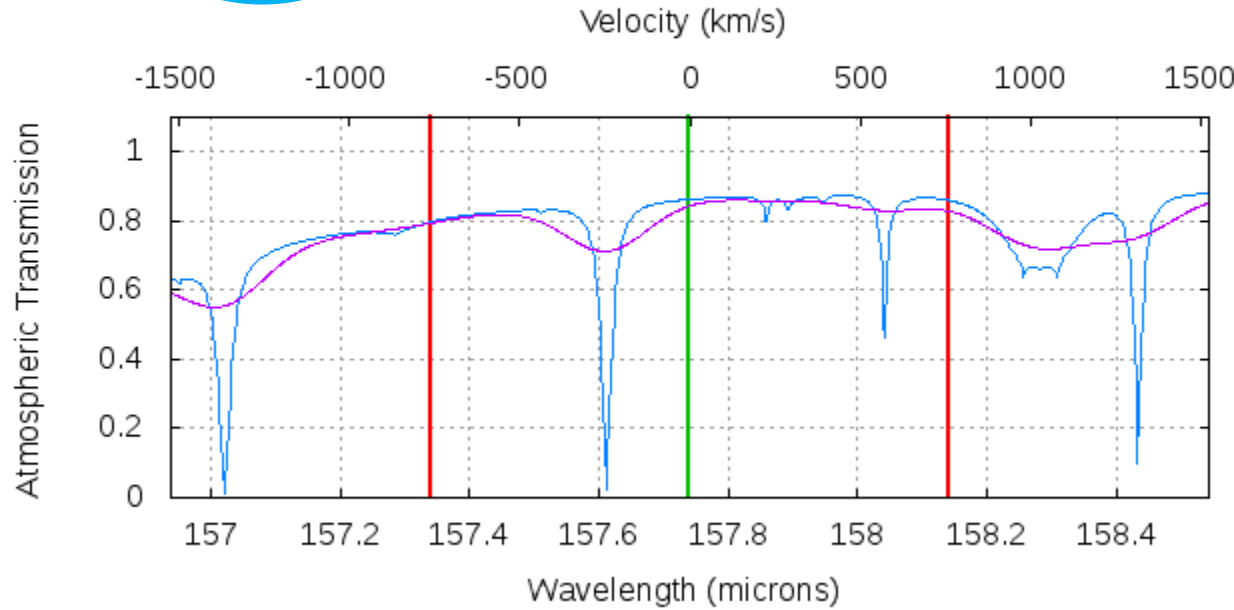


Checklist

1. **If you have any questions, ask us!**
2. Does the atmosphere allow my observation?
3. Flux estimates (on source)
4. How wide is my line
5. What observing mode do I need?
6. Define mapping area
7. Overall time estimate
- Much later: More details and Strategy



- Does the atmosphere allow my observation?
 - Both plots 41000 ft, 40° elevation, standard water vapor



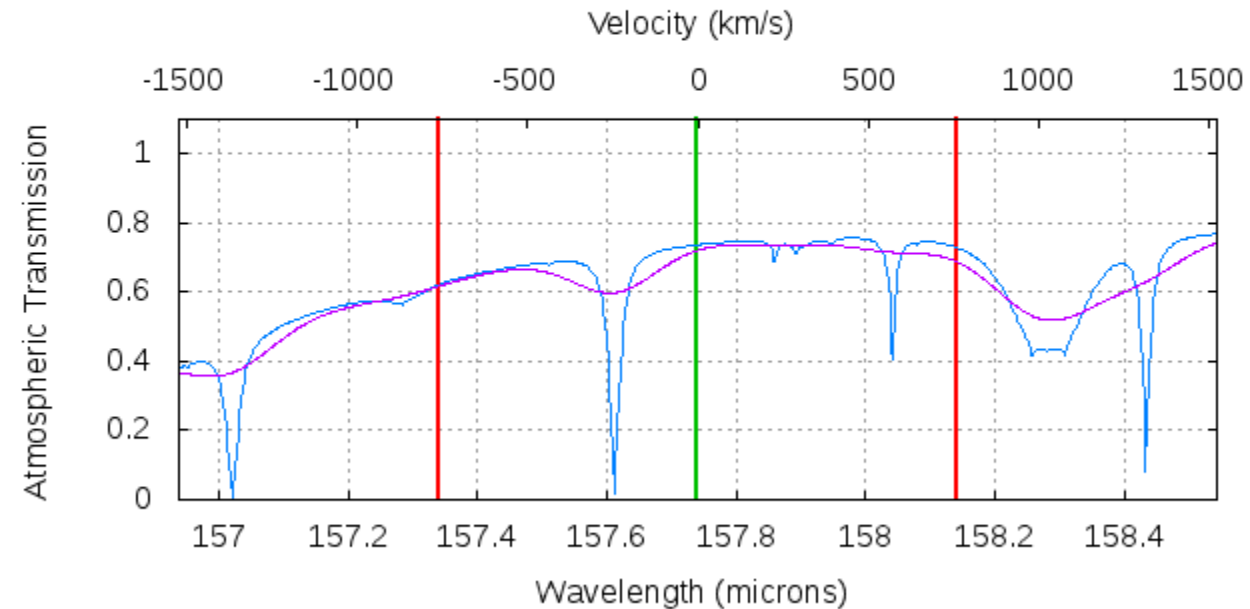
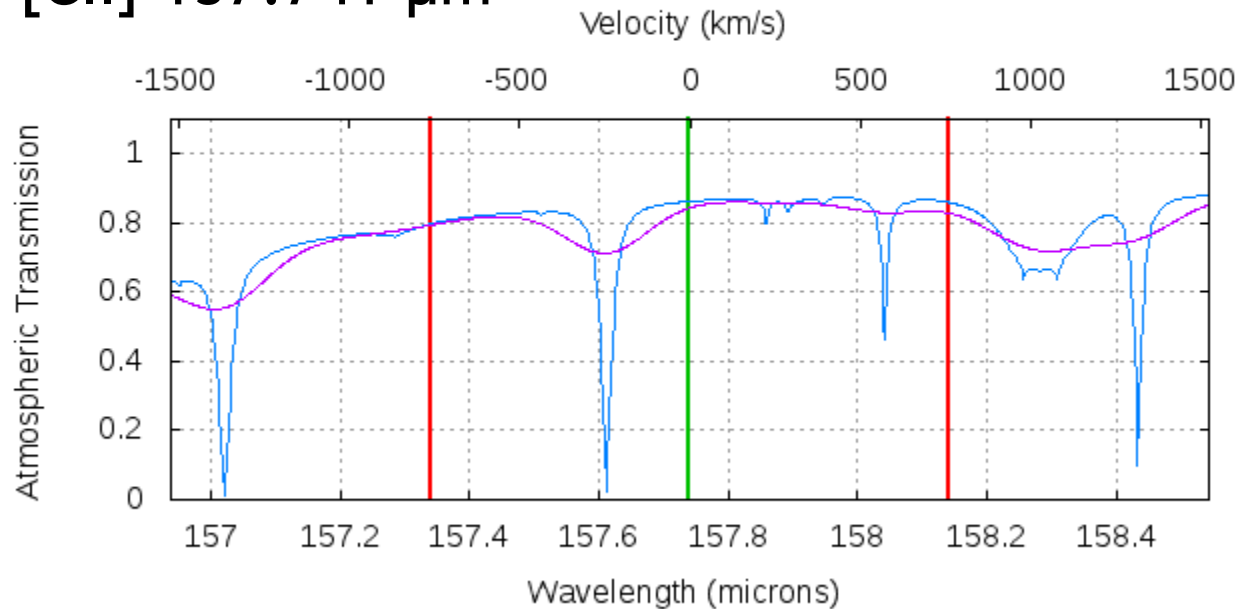
altitude [ft]	water vapor [μm]	altitude [ft]	water vapor [μm]
38000	11	42000	6.3
39000	9.5	43000	5.5
40000	8.4	44000	4.8
41000	7.3	45000	4.2

Water vapor overburden (zenith) assumed by a ATRAN



- Does the atmosphere allow my observation?
 - Now 41000 ft, 40° elevation, standard water vapor (7.3 μm) left and 15 μm on the right
 - Transmission robust against water vapor

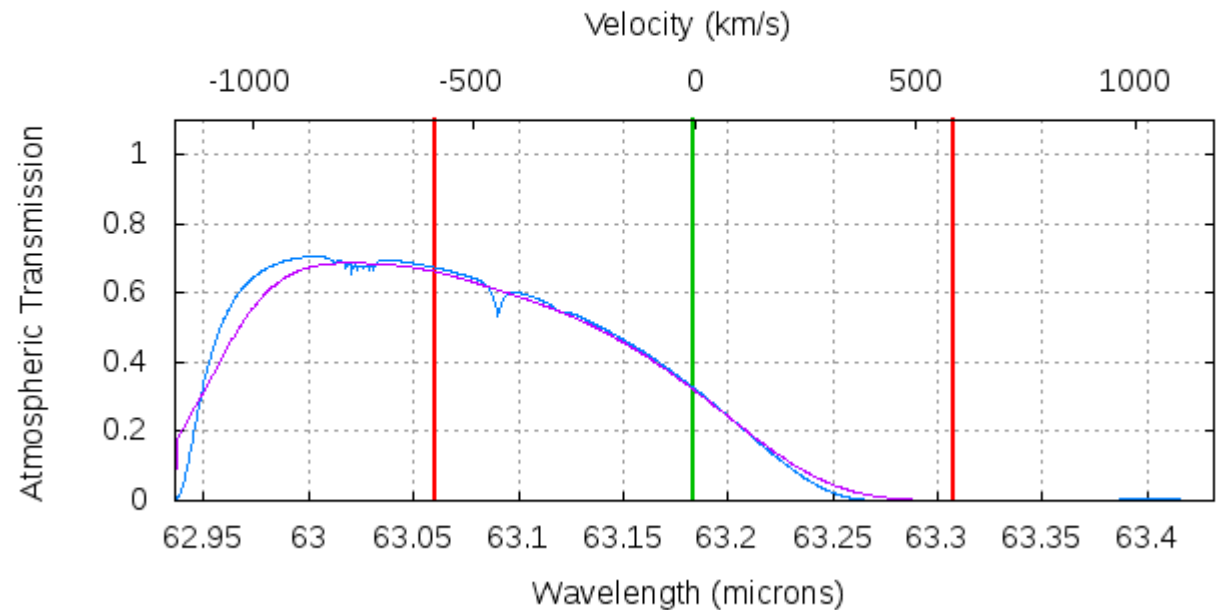
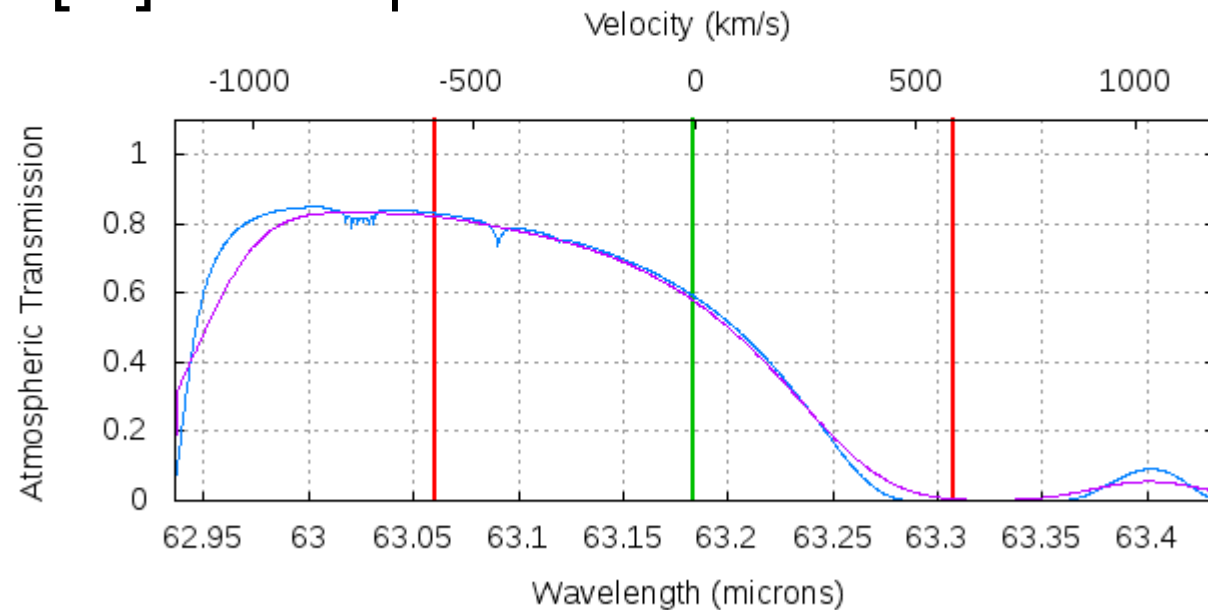
[CII] 157.741 μm





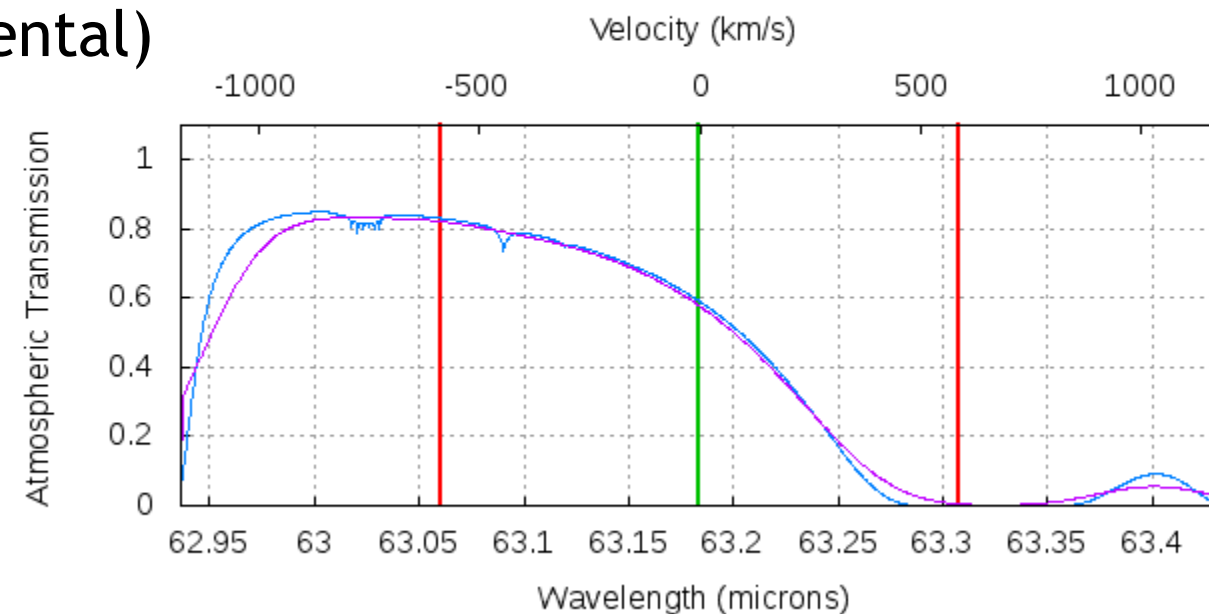
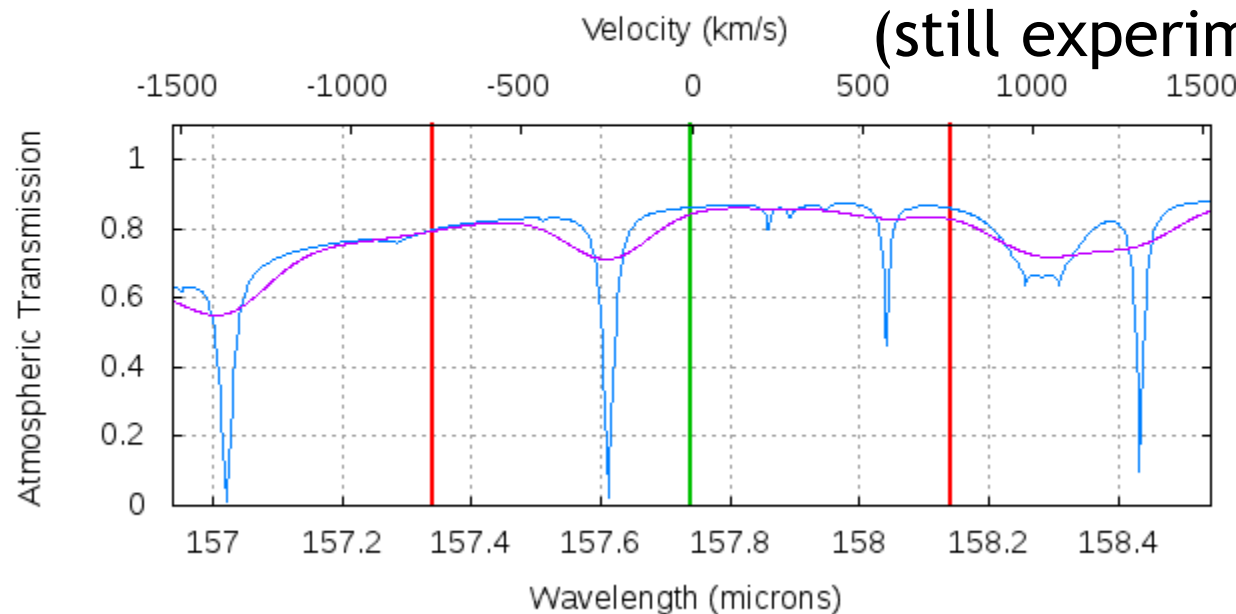
- Does the atmosphere allow my observation?
 - Now 41000 ft, 40° elevation, standard water vapor (7.3 μm) left and 15 μm on the right
 - Transmission strongly varies with water vapor

[OI] 63.184 μm





- Does the atmosphere allow my observation?
 - Check for your redshift!
 - we can measure the water vapor (with 8% additional overhead)





Checklist

1. If you have any questions, ask us!
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Checklist

- Flux estimates (on source)
 - We really can't help you with that, but some things to keep in mind:

Observatory Altitude (in feet; < 60000 ft):	<input type="text" value="38000"/>	<input checked="" type="radio"/> ft <input type="radio"/> m
Water Vapor Overburden (in microns; 0 if unknown):	<input type="text" value="0"/>	
Telescope elevation (between 20 and 60 deg):	<input type="text" value="40"/>	
Signal to Noise Ratio / Integration Time (minutes):	<input type="text" value="5"/>	<input checked="" type="radio"/> SNR <input type="radio"/> On-Source Int. Time
Wavelength (in microns, between 51 and 203):	<input type="text" value="157.741"/>	
Source :	<input type="text" value="2.087e-17"/>	<input checked="" type="radio"/> line (in W/m ²) <input type="radio"/> continuum (in Jy)
Velocity correction (source VLSR, in km/s):	<input type="text" value="0"/>	
Band width :	<input type="text" value="0"/>	<input checked="" type="radio"/> km/s <input type="radio"/> microns
Comment :	<input type="text"/>	

- per spatial pixel (“spaxel”)
 - 6’’x6’’ blue channel
 - 12’’x12’’ red channel

<https://fifi-ls.sofia.usra.edu/cgi-bin/fifi-ls/fifi.cgi>

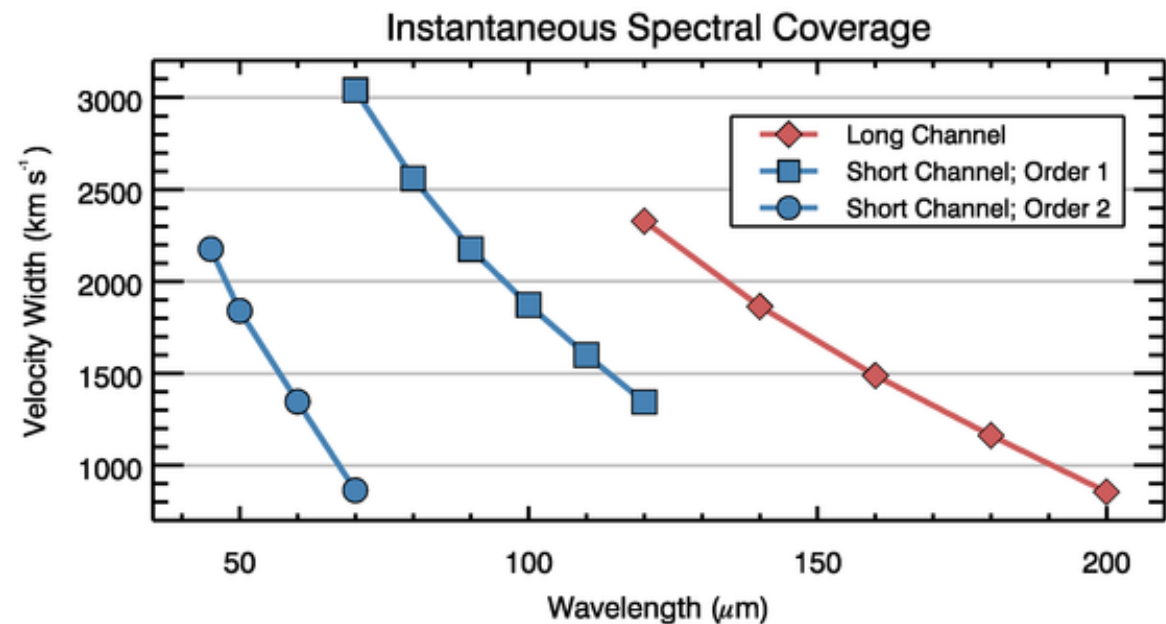
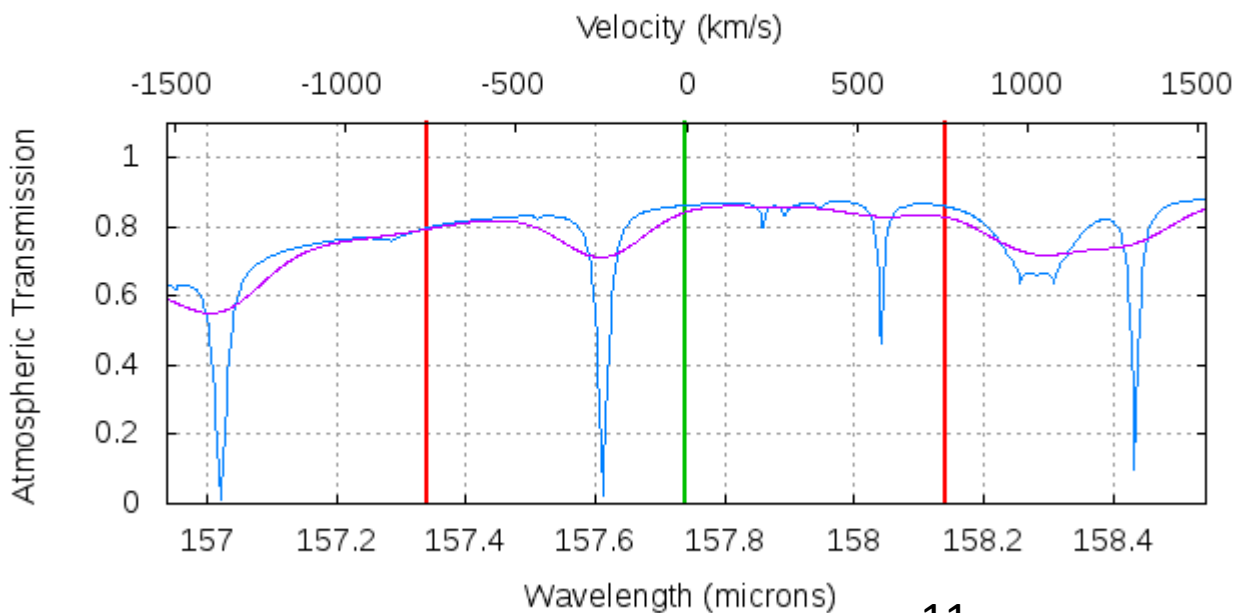
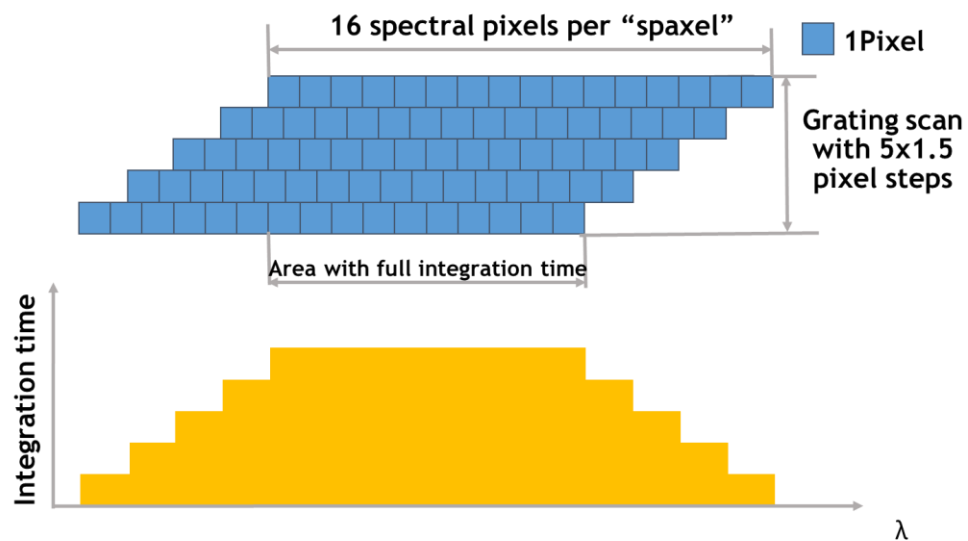


Checklist

1. If you have any questions, ask us!
2. Does the atmosphere allow my observation?
3. Flux estimates (on source)
4. How wide is my line
5. What observing mode do I need?
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 - Much later: More details and Strategy

Checklist

- How wide is my line





Checklist

1. If you have any questions, ask us!
 2. Does the atmosphere allow my observation?
 3. Flux estimates (on source)
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 5. What observing mode do I need?
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Checklist

- What observing mode do I need?

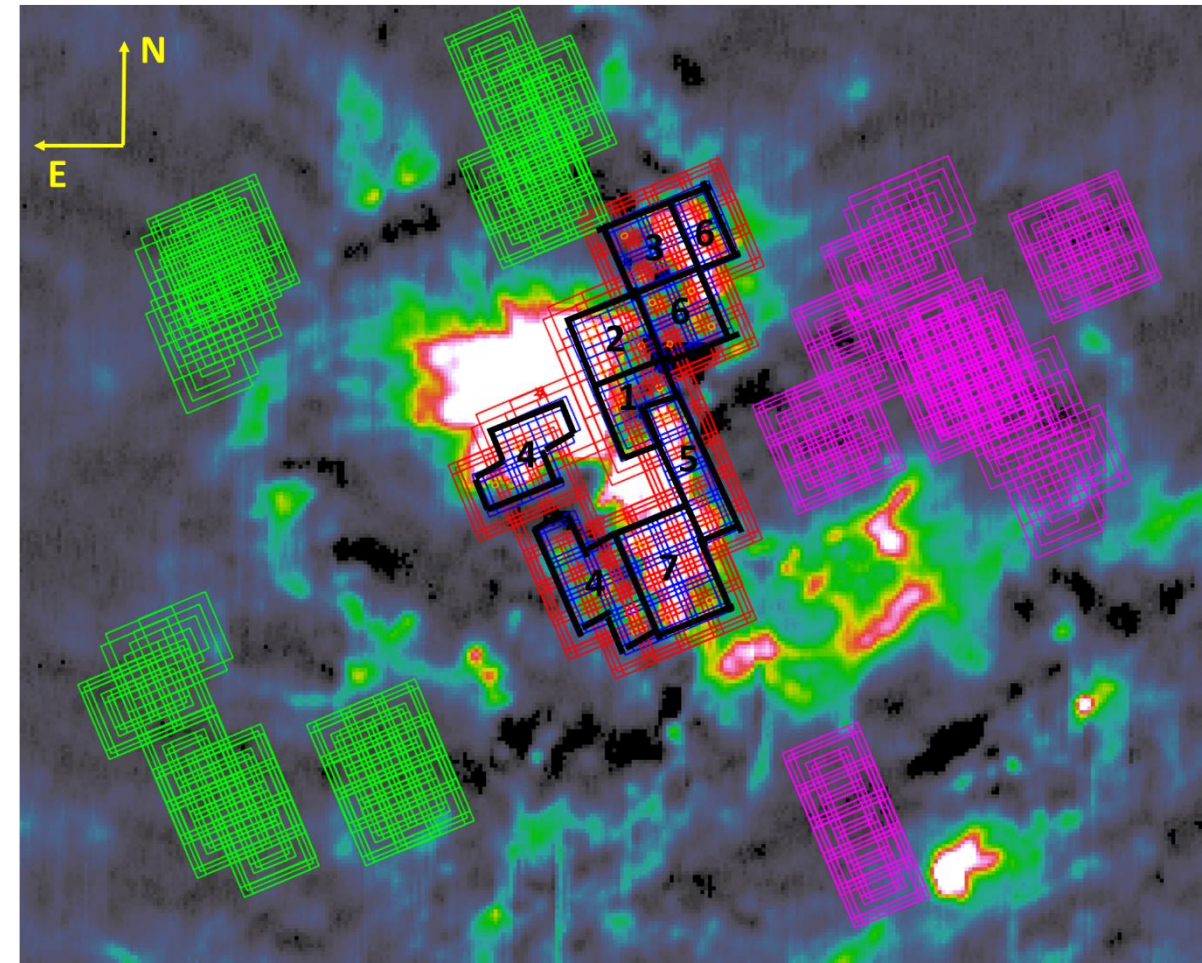
- Symmetric chopping is the most used mode
- Total power (TP) and On the fly (OTF) mapping are now available
 - Enable observations where chopping is not feasible
 - TP overhead comparable to symmetric chopping, OTF a bit better



Checklist

- What observing mode do I need?

- Symmetric Chopping is the most efficient mode
 - Max throw depends on wavelength
 - Recommended:
 - <math><5'</math> below - <math><6'</math> below - Max.
 - Emission free on “both sides”

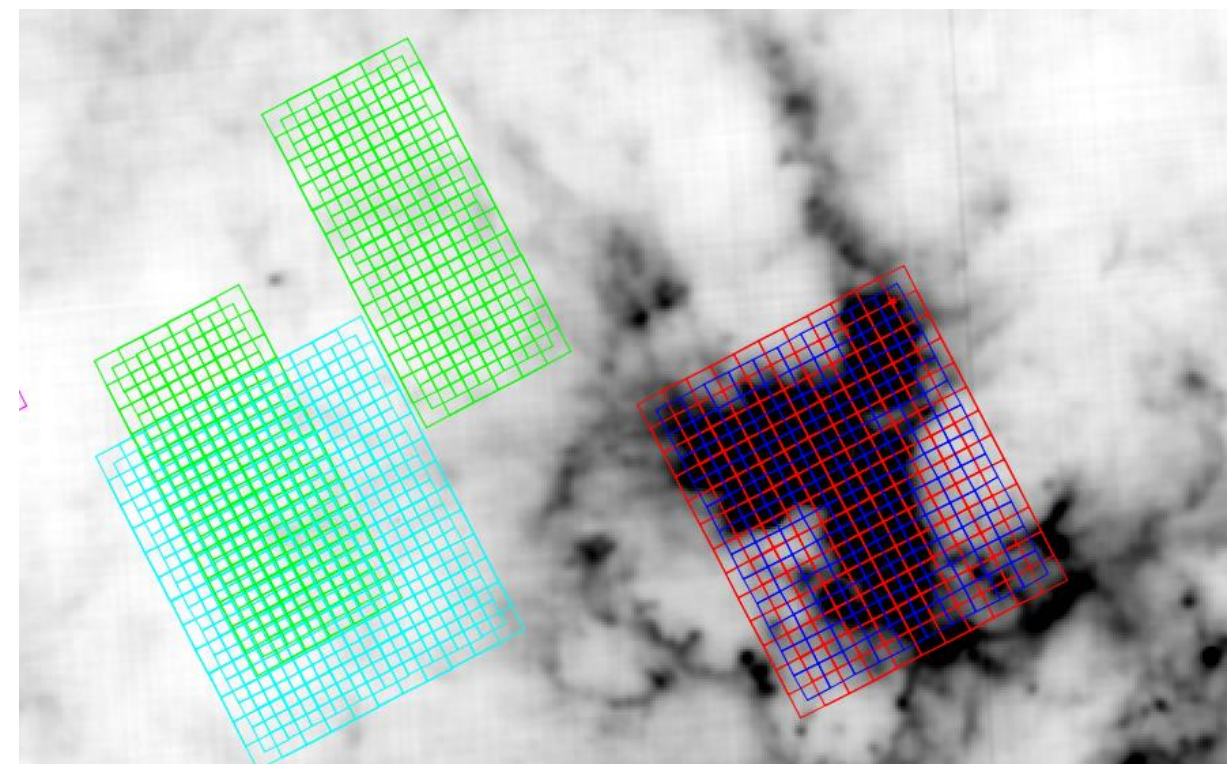




Checklist

- What observing mode do I need?

- “[CII] is everywhere”
 - Sometimes asymmetric is the safer way to go
 - For “narrow” lines Bright Object helps to ease the pain
 - Don’t worry about telescope chop angle limitations while proposing (we can do partial asymmetric chopping)
 - Contact us for unchopped observations





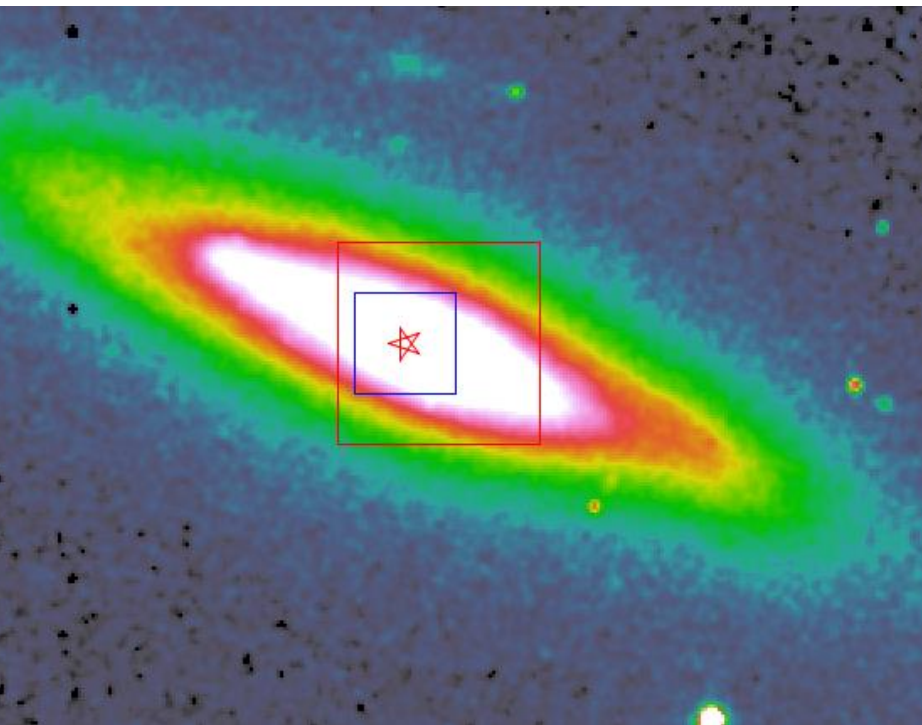
Checklist

1. If you have any questions, ask us!
2. Does the atmosphere allow my observation?
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Checklist

- Define mapping area
 - Different array sizes
 - ~10arcsec offset between red and blue channel
 - Can be rotated as needed with detector angle
- You probably want to dither
 - Keep in mind you will get edges
 - We will take care of the dither in Phase II
- For larger Maps 15 or 30 arcsec rasters are popular

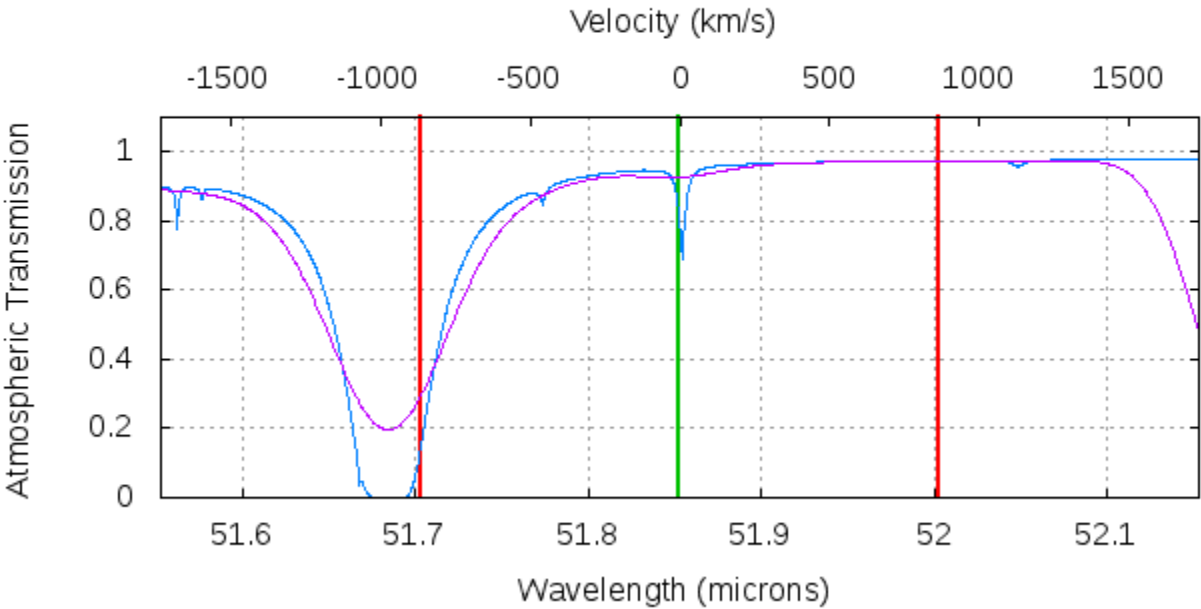


Example M82

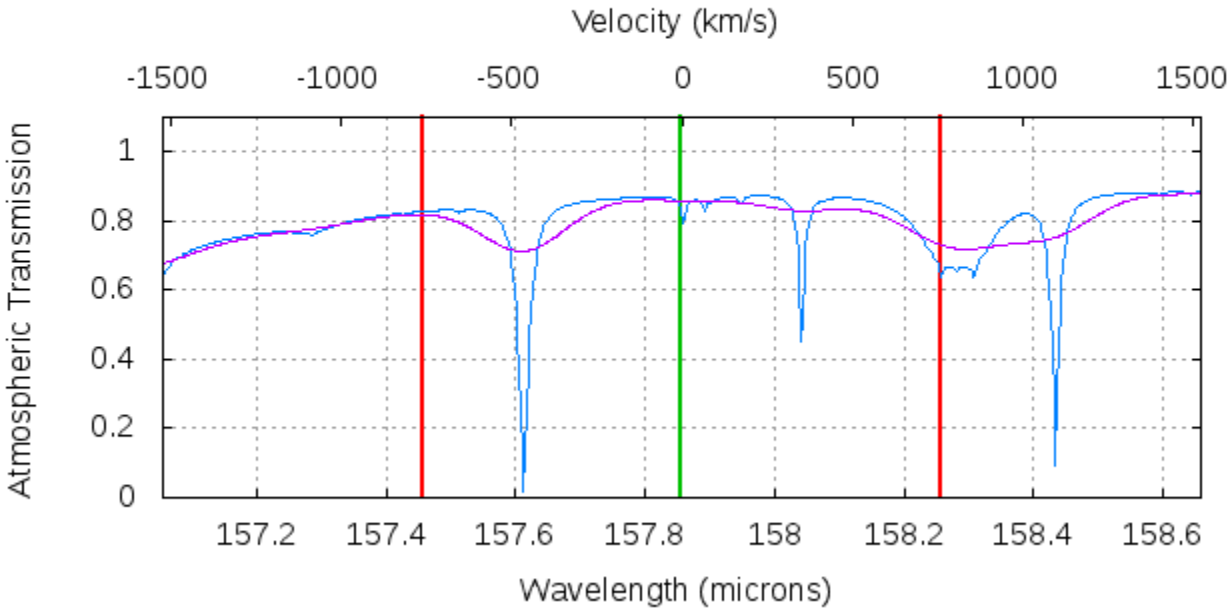
- Does the atmosphere allow my observation?
 - $Z = 0.00073$ (~220km/s)



[OIII] 51.815 μm



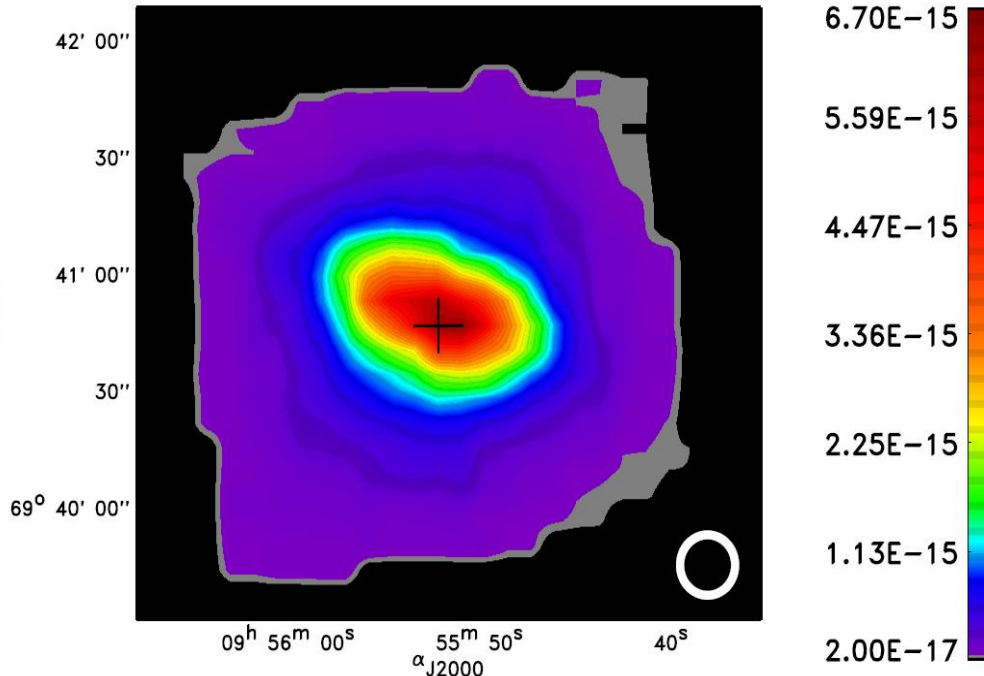
[CII] 157.741 μm





Example M82

• Flux estimates



- Fluxes per 9.4'' x 9.4'' PACS spaxel
 - From Contursi et al. 2013

[OIII] 52μm from ISO LWS:

- 10.4 W/m² e-14 per beam (80 arcsec)
- 7.4 W/m² e-16 per FIFI-LS blue channel “spaxel”
- Ask the time estimator
- SNR 10 in 30 sec on source
- **peak should be easy**
- **getting a map possible**

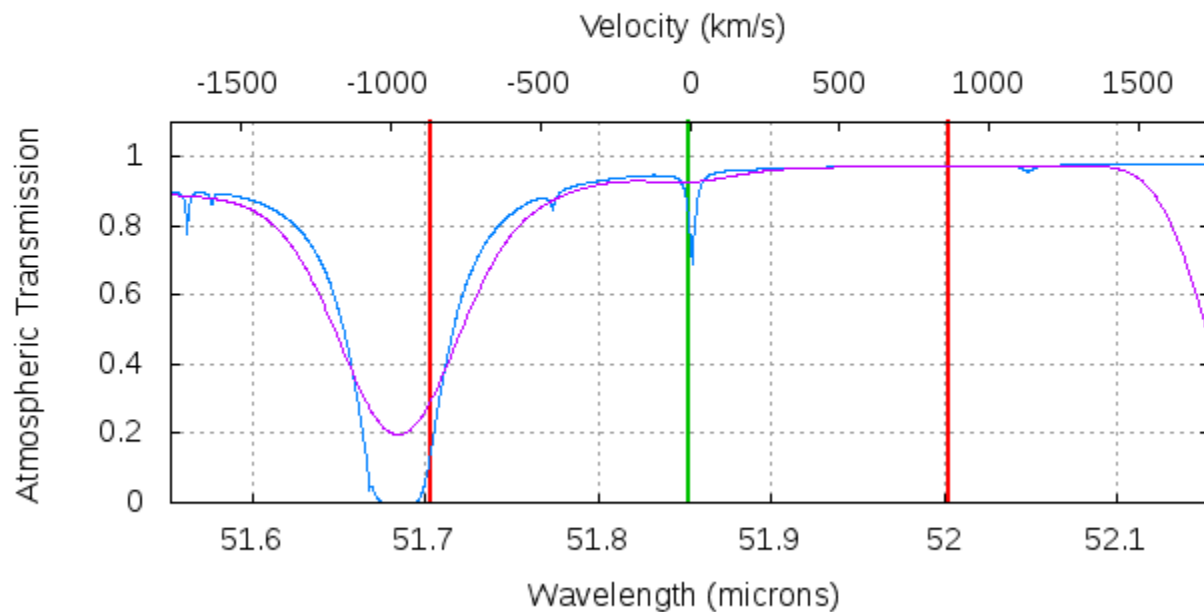
[CII] 158μm from PACS:

- Lets ignore different Spaxel sizes (FIFI-LS / PACS) here
- On the edges ~2 W/m² e-17 per “spaxel”
- Ask the time estimator
- SNR 4 in 15 min on source for the edges (~40min total)
- **Excellent SNR in central region**
- **Extending map in the outflows should be possible**

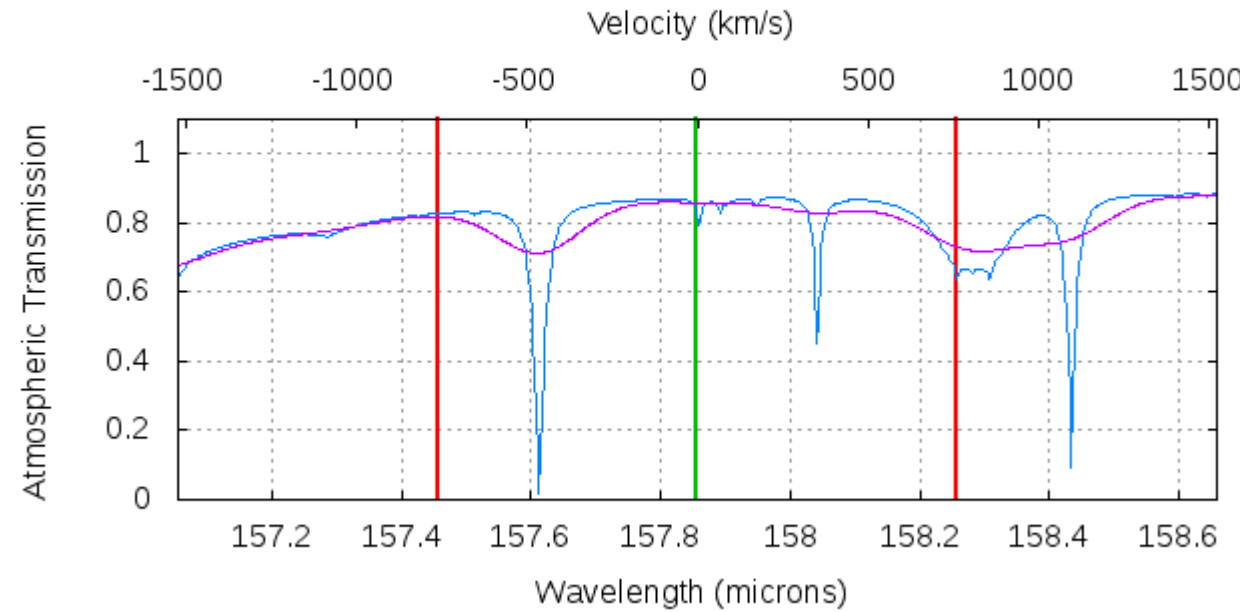
Example M82



- How wide is my line
 - We have about +/- 750 km/s on the detector
 - FWHW of the Instrument is about 300 km/s
 - From PACS: Rotation ~ +/-150km/s ; Dispersion < 400km/s



[OIII] 51.815 μm



[CII] 157.741 μm

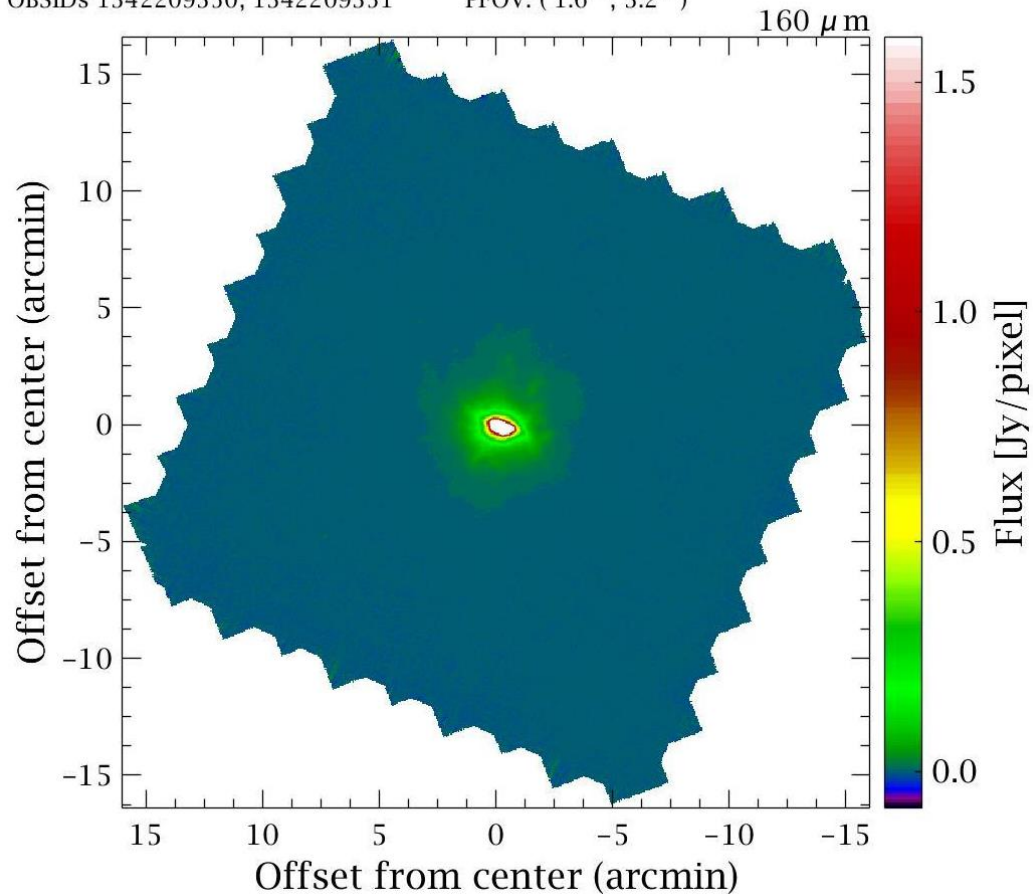


- What observing mode do I need?
- Can we chop symmetrically?



Scan map SPG v14.2.0 JScanam

OBSIDs 1342209350, 1342209351 PFOV: (1.6'', 3.2'')



- No big issue here
- E-W chop to get out of the outflow



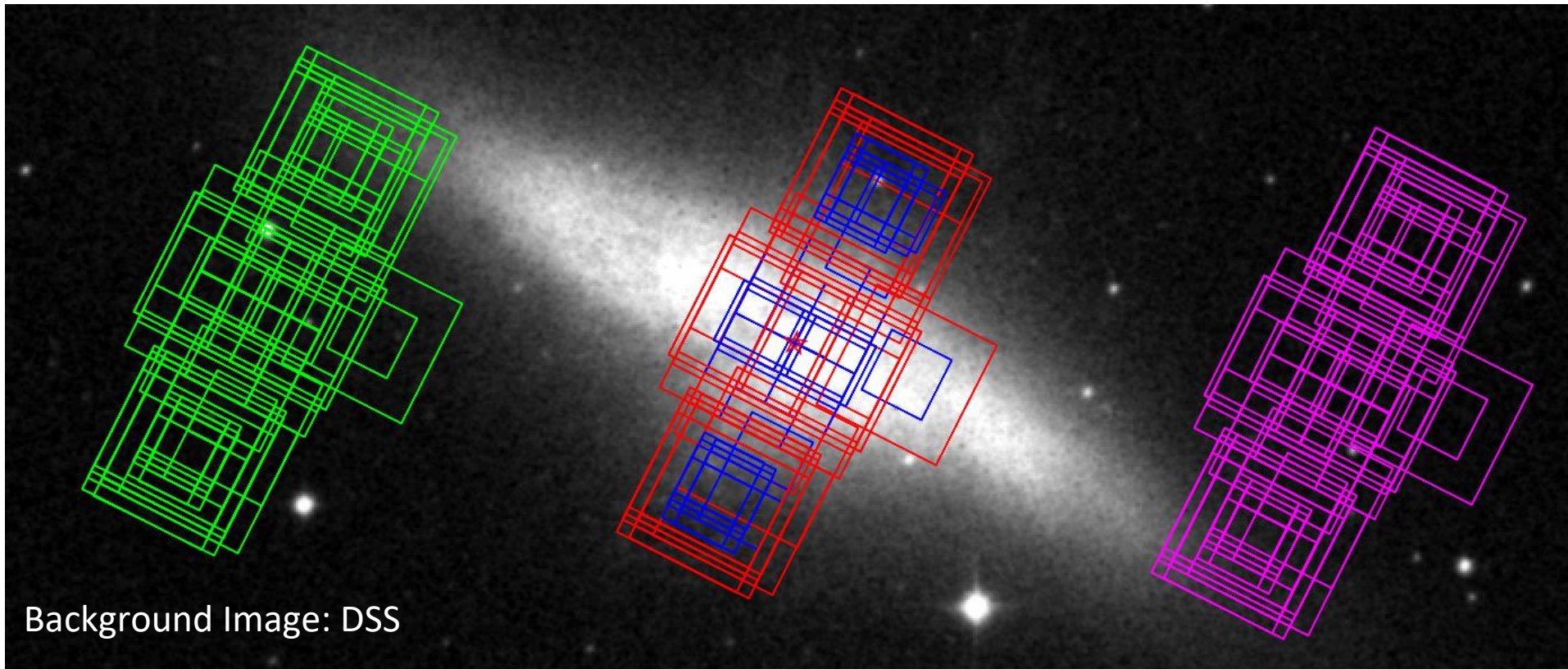
Example M82

- What observing mode do I need?
 - Can we chop symmetrically? -> Yes
 - And lets look at the mapping area



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- Basically 2 maps
- Center for [OIII] will need about 2 fields and give us cross calibration with PACS [CII] for free
- Outflows for [CII]; ~ 2 fields; plus “intermediate” fields

Background Image: DSS



Checklist

- Overall time estimate
 - Center with [OIII] is rather easy
 - Around 30min total for 2 fields
 - 15min per field; ~6min on source
 - Outflows in [CII] will dominate the integration time
 - Around 6h total for 2 fields + some overlap
 - 2.5h per fields; would result in SNR ~10 based on PACS edge fluxes (now considering the bigger FIFI-LS pixels)
- Total time about 6.5h