

# GREAT example: Mapping the Horsehead Nebula

Randolf Klein, Simon Coudé, Kyle Kaplan

# How to choose the GREAT channels and frequencies:

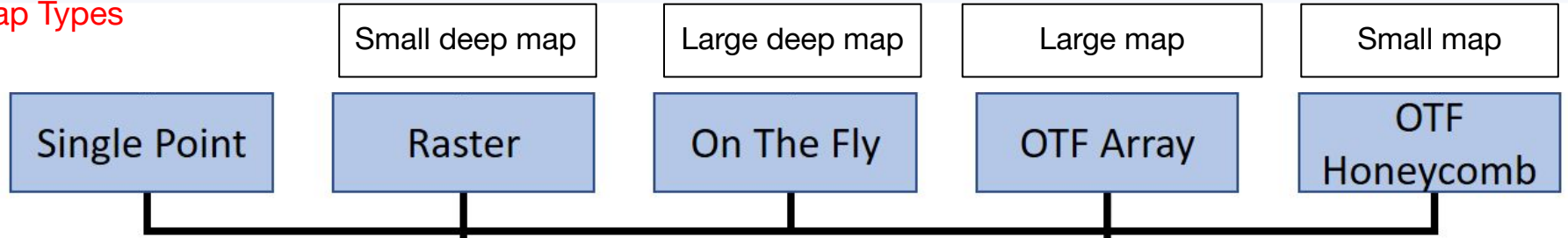
Channel Parameters

Channels	Frequency Range [THz]	$T_{rec}$ Double Sideband	FWHM	Astronomical Lines of Interest
upGREAT HFA	4.7447 +/- 100 km/s	1250 K	6"	[OI]
upGREAT LFA-H	1.835–2.007	1000 K	15"	[CII], CO, OH <sup>2</sup> $\pi_{1/2}$
upGREAT LFA-V	1.835–2.007 2.060–2.065	1000 K	15"	[OI], [CII], CO, OH <sup>2</sup> $\pi_{1/2}$
4GREAT	2.490–2.590	3300 K	12"	OH <sup>2</sup> $\pi_{3/2}$ , <sup>18</sup> OH <sup>2</sup> $\pi_{3/2}$
	1.240–1.395 1.427–1.525	1100 K	19"	[NII], CO, OD, HCN, SH, H <sub>2</sub> D <sup>+</sup>
	0.890–0.984 0.990–1.092	>600 K 300 K	25"	CO, CS
	0.491–0.555 0.560–0.635	<150 K	50"	NH <sub>3</sub> , [CI], CO, CH

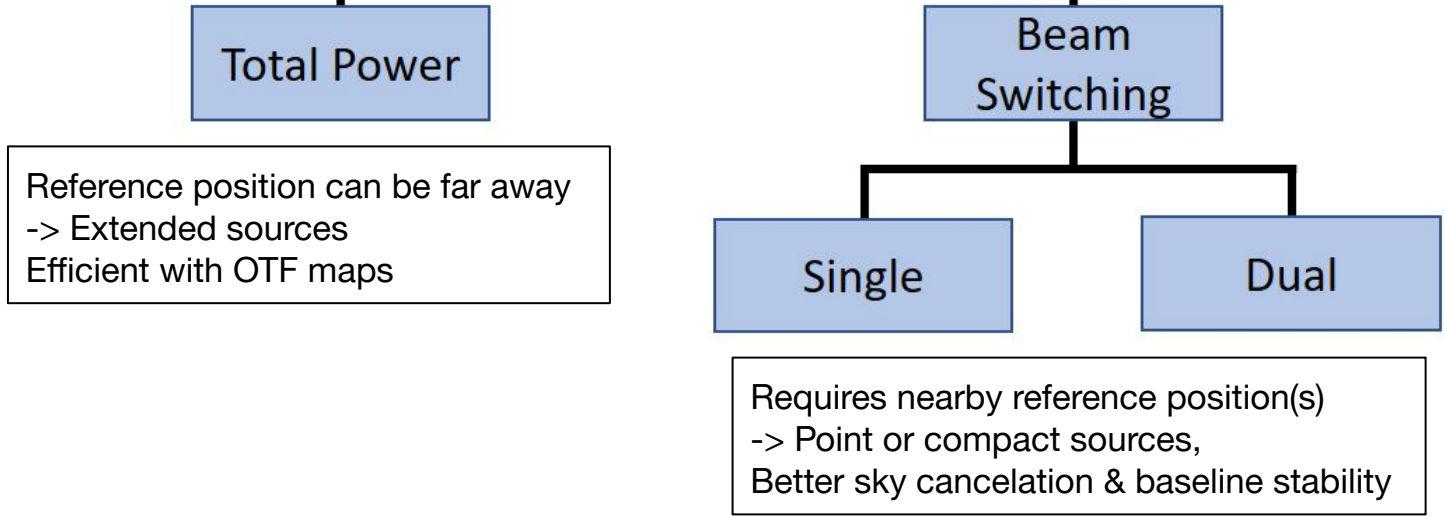
- Configurations:
- LFA/HFA
  - 4GREAT/HFA

# How to choose GREAT AORs and modes:

## Map Types

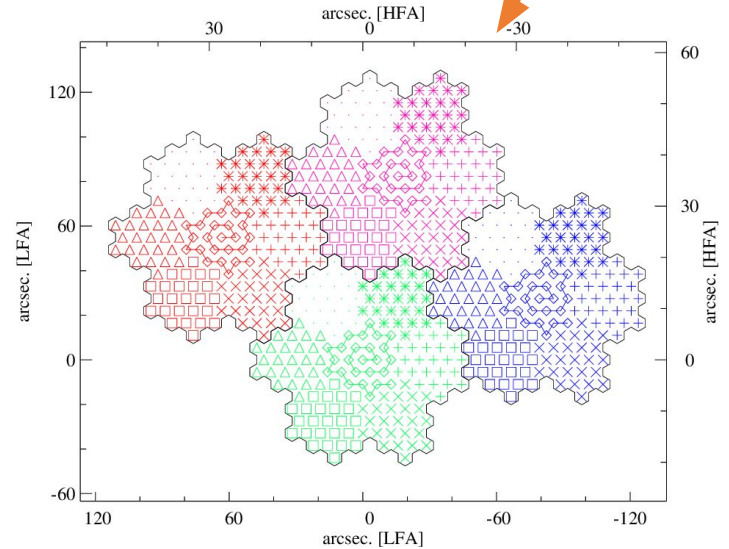
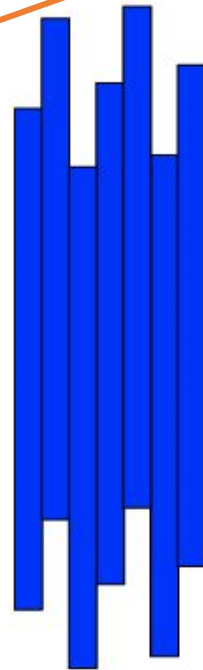
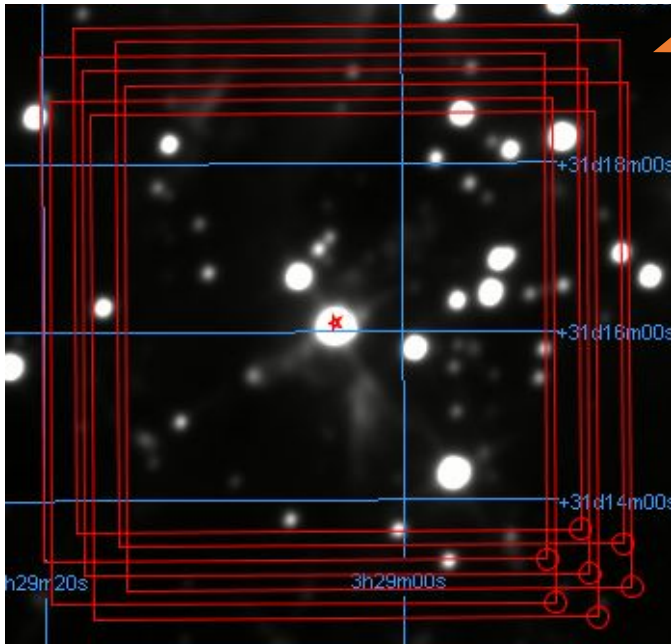
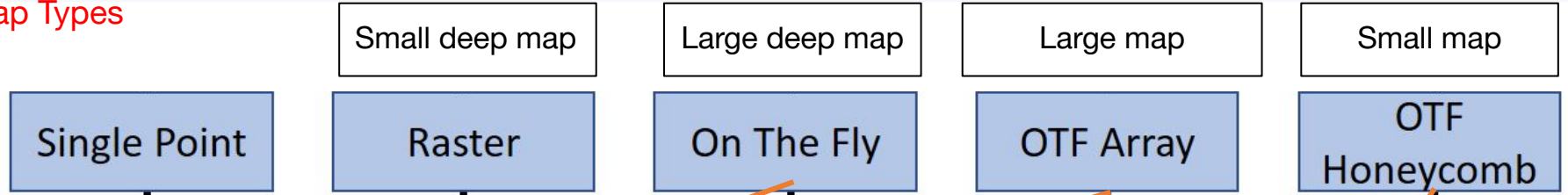


## Observing Modes



# How to choose GREAT AORs and modes:

## Map Types



More details:

## *Cycle 9 Observer's Handbook*

contains more examples and details  
on the mapping modes.

**Ask us early at:**

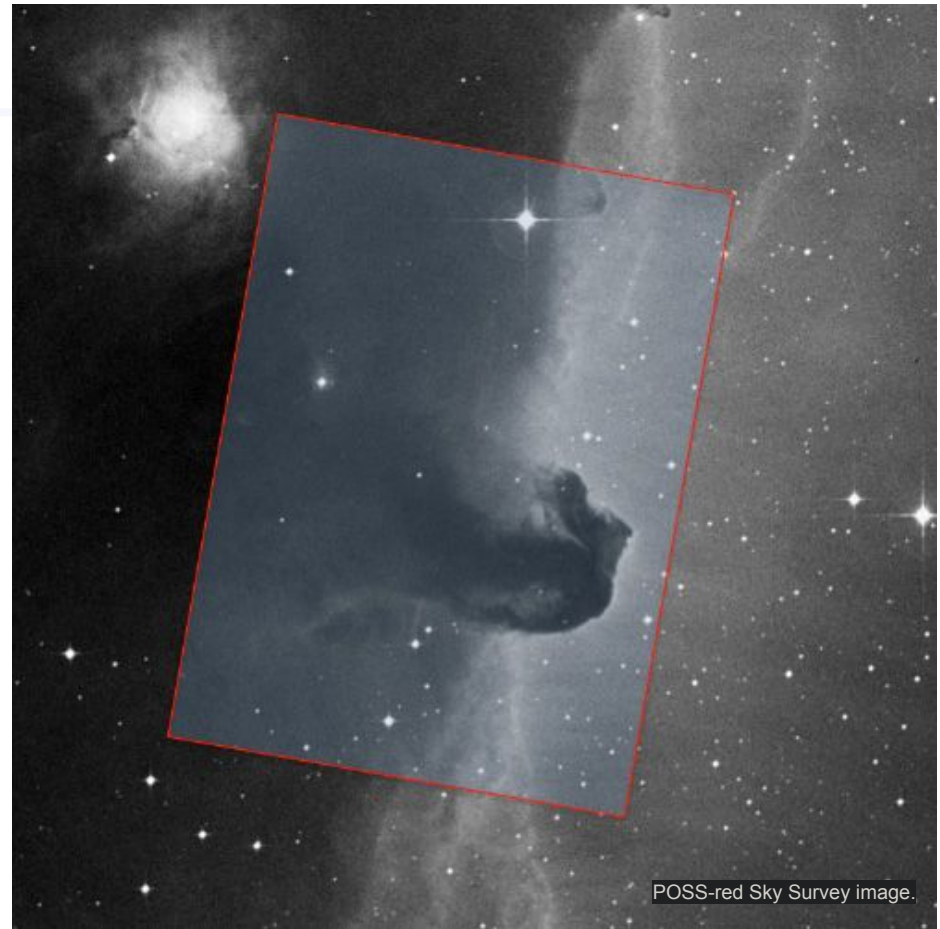
**sofia\_help@sofia.usra.edu**

# Example Science Case

Study the kinematics and physical conditions in the Horsehead Nebula:

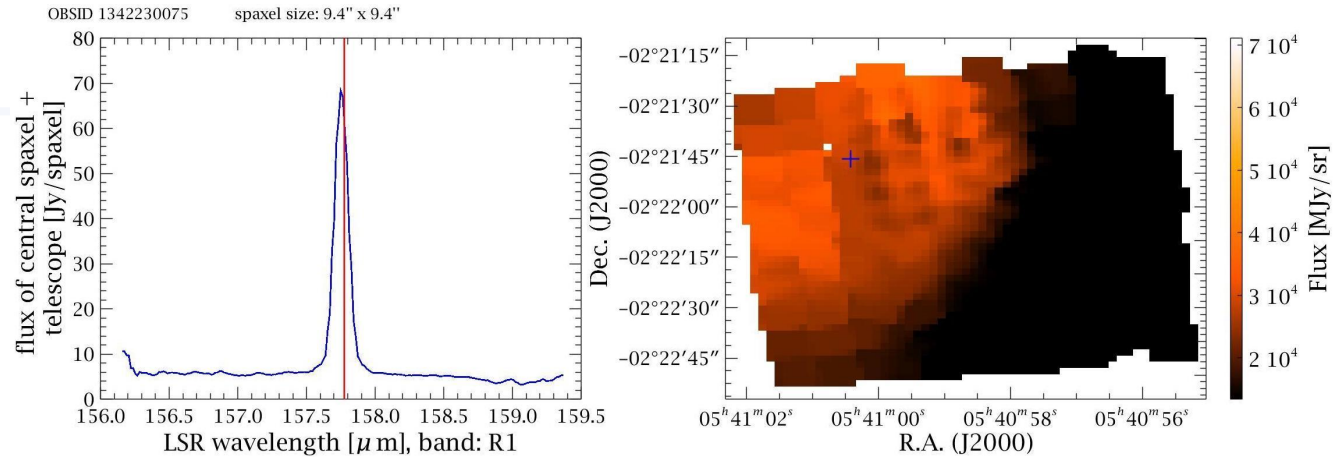
- [CII] (158 $\mu$ m or 1.9THz) mapping at high spectral resolution
- Spectral resolution: 1km/s or  $R = 300,000$
- Mapping area: 12'x17'

Wavelength and spectral resolution require GREAT!



# Flux Estimate

For example  
from PACS/  
Herschel  
observations:



- Unresolved line width:  $\sim 0.14 \mu\text{m}$  or  $\sim 1.7 \text{GHz}$
- Line height:  $\sim 65 \text{Jy/spaxel}$  or  $\sim 0.69 \text{Jy/arcsec}^2$
- Convert to [CII]-beam (14.1"):  $\sim 110 \text{Jy/beam}$
- Assume an intrinsic linewidth of  $10 \text{km/s}$  or  $63 \text{MHz}$
- Intrinsic peak flux density:  $\sim 2.9 \text{kJy/beam}$
- Convert to Antenna Temperature  $T_A^* = \sim 2.9 \text{K}$   
(Eq. 6-8 Observer's Handbook)



## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

Frequency/Velocity Resolution:

Line Width (for averaging sky transmission):

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

$N_{\text{on}}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

(THz, use 7 decimals)

MHz

km/s

MHz

km/s

TP OTF/Raster Map

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Desired S/N ratio of

Total Integration Time of  secs

Calculate

## Astronomical Source Definition

Brightness Temperature,  $T_R^*$ (K):

Source Velocity:

LSR, km/s

redshift

# Time Estimate - SITE



## Instrument properties

# Time Estimate - SITE

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz

km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

$N_{\text{on}}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

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km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

N<sub>on</sub>:

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Calculate

Desired S/N ratio of

Total Integration Time of  secs

## Astronomical Source Definition

Brightness Temperature, T<sub>R</sub>\* (K):

Source Velocity:

LSR, km/s

redshift

## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( *GREAT Band Frequencies*)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz

km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

$N_{\text{on}}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Desired S/N ratio of

Total Integration Time of  secs

Calculate

## Astronomical Source Definition

Brightness Temperature,  $T_R^*$ (K):

Source Velocity:

LSR, km/s

redshift



## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

 MHz km/s

Line Width (for averaging sky transmission):

 MHz km/s

Type of Observation:

 SinglePoint or BeamSwitch  
OTF/Raster Map TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

N<sub>on</sub>:

Map Type:

 Classical OTF Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

 Desired S/N ratio of Total Integration Time of  secs

Calculate

## Astronomical Source Definition

Brightness Temperature, T<sub>R</sub>\* (K):

Source Velocity:

 LSR, km/s redshift

## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( *GREAT Band Frequencies*)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz

km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X x Y in arcsec):

Leave empty,  
25 for TP Honeycombe OTF

$N_{on}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Desired S/N ratio of

Total Integration Time of  secs

Calculate

## Astronomical Source Definition

Brightness Temperature,  $T_R^*$ (K):

Source Velocity:

LSR, km/s

redshift

## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz

km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

N<sub>on</sub>:

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Desired S/N ratio of

Total Integration Time of

secs

Calculate

## Astronomical Source Definition

Brightness Temperature, T<sub>R</sub>\* (K):

Source Velocity:

LSR, km/s

redshift



## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( *GREAT Band Frequencies*)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz  km/s

Line Width (for averaging sky transmission):

MHz  km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

$N_{\text{on}}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

Select the calculation method

Desired S/N ratio of

Total Integration Time of  secs

Calculate

## Astronomical Source Definition

Brightness Temperature,  $T_R^*$ (K):

Source Velocity:

LSR, km/s  redshift



## Instrument properties

Instrument properties: *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

 MHz km/s

Line Width (for averaging sky transmission):

 MHz km/s

Type of Observation:

 SinglePoint or BeamSwitch  
OTF/Raster Map TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

N<sub>on</sub>:

Map Type:

 Classical OTF Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

Calculation method: *(more info)*

Select the calculation method

 Desired S/N ratio of Total Integration Time of

secs

Calculate

$$T_R^* = T_A^*/0.97 \text{ (Eq. 6-6)}$$

## Astronomical Source Definition

Brightness Temperature, T<sub>R</sub><sup>\*</sup>(K):

Source Velocity:

 LSR, km/s redshift

## Instrument properties

**Instrument properties:** *(more info, input parameter details)*

Rest Frequency: ( GREAT Band Frequencies)

(THz, use 7 decimals)

Frequency/Velocity Resolution:

MHz

km/s

Line Width (for averaging sky transmission):

MHz

km/s

Type of Observation:

SinglePoint or BeamSwitch  
OTF/Raster Map

TP OTF/Raster Map

TP OTF Map Size (X × Y in arcsec):

×

$N_{\text{on}}$ :

Map Type:

Classical OTF

Array OTF

Observer Velocity (VLSR, km/s):  OR  Compute Velocity

## Calculation Method

**Calculation method:** *(more info)*

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## Astronomical Source Definition

Brightness Temperature,  $T_R^*$ (K):

Source Velocity:

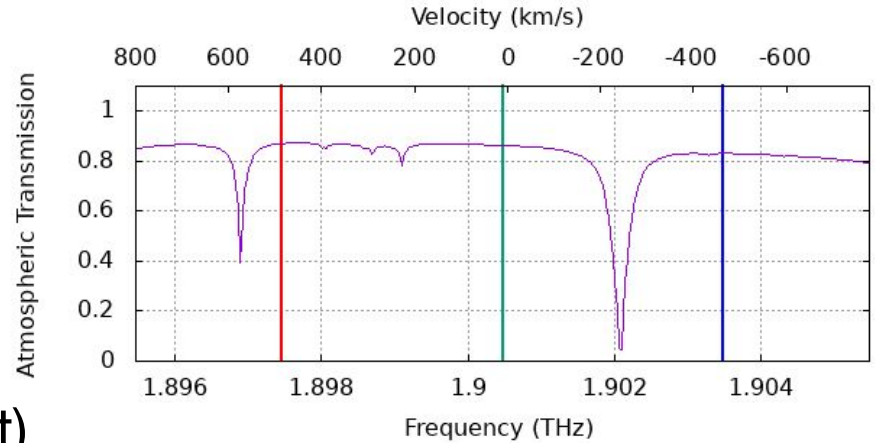
LSR, km/s

redshift

# Time Estimate - SITE

Output:

- $N_{\text{ON}}$ : 85
- Integration Time: 3.8s  
(U/LSB, ON source per map point)



Default map spacing for LFA: 6''

With  $N_{\text{ON}} = 85$ , the scan length is 510'', which is half the map.

An OTF-scan should be shorter than 30s including the off-position:

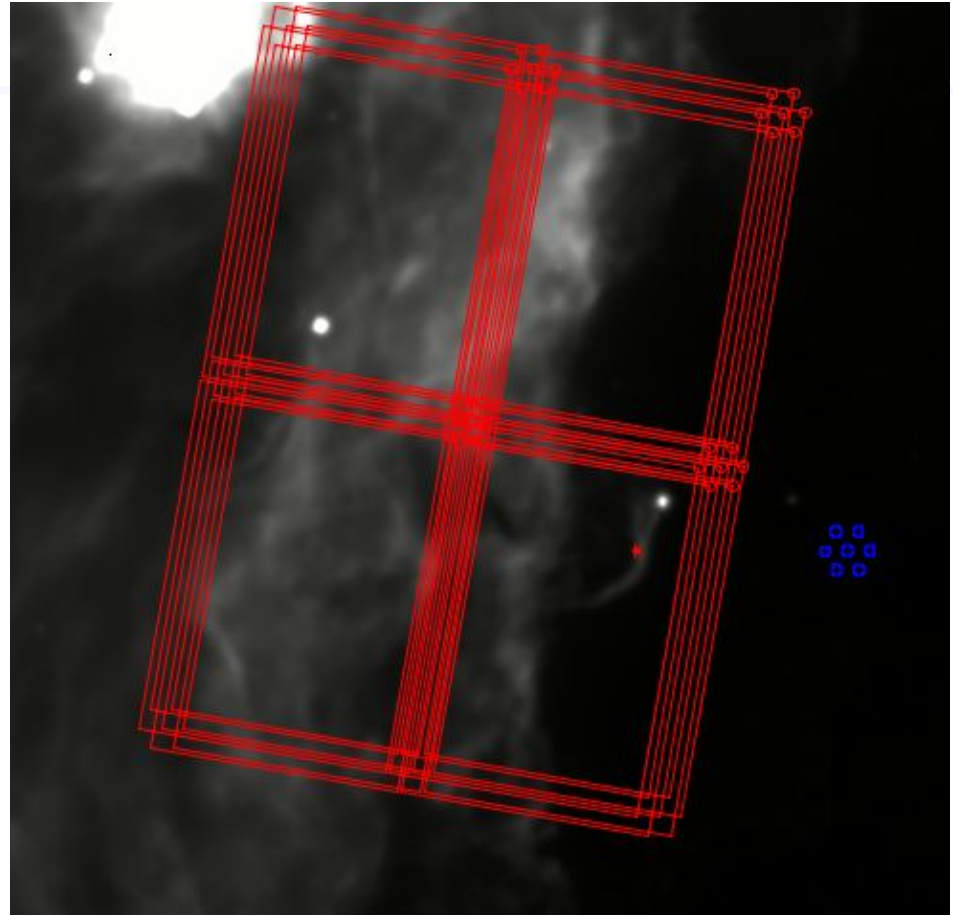
$$\text{On-source exposure time per point: } 30\text{s}/(N_{\text{ON}} + \sqrt{N_{\text{ON}}}) = 0.3\text{s}$$

With an Array OTF map the scan length needs to be one array larger than the map area. For Array OTF,  $N_{\text{ON}} = 91$ .

# Map layout

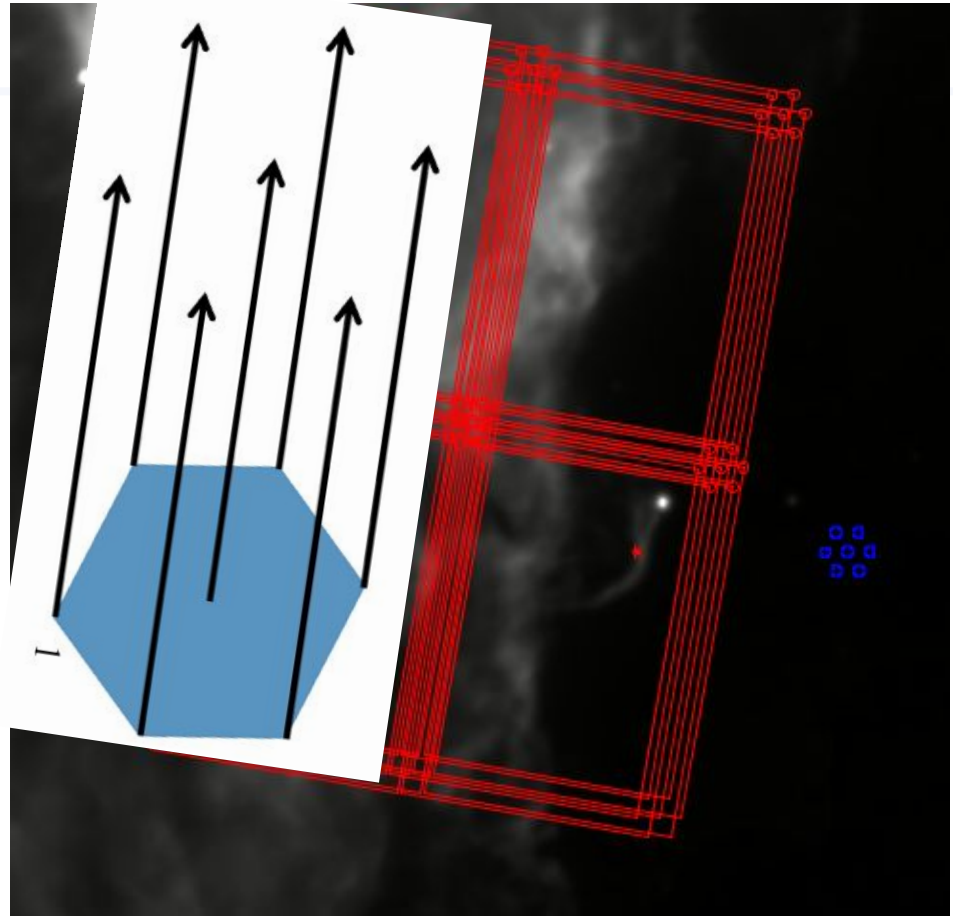
- As SITE indicates split map area in 2x2 sub-maps 510" x 360" in size.
- With an 6" step size, that is 85x60 steps.
- Some trigonometry to calculate the map offsets. For the rotated map.
- Map angle:  $80^\circ$
- "Magic" array angle:  $19.1^\circ$
- Final array angle:  $99.1^\circ$

Background: WISE Band 3



# Map layout

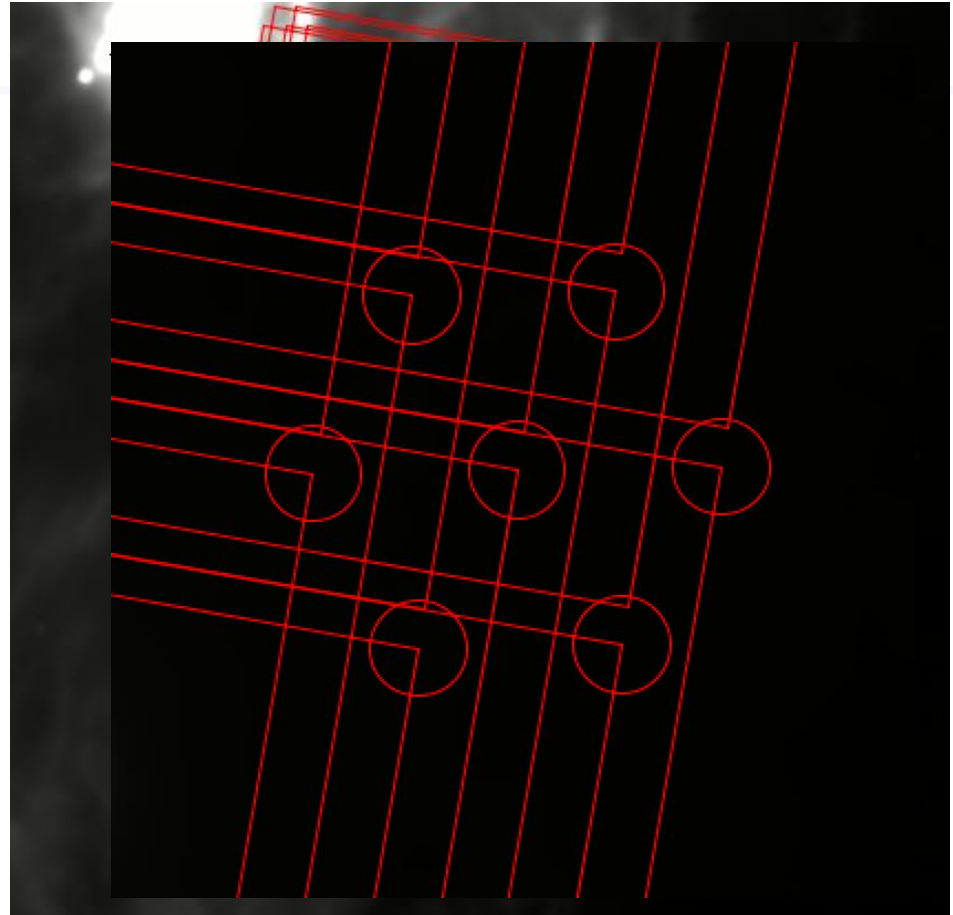
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- Final array angle:  $99.1^\circ$





# Map layout

- As SITE indicates split map area in 2x2 sub-maps 510"x360" in size.
- With an 6" step size, that is 85x60 steps.
- Some trigonometry to calculate the map offsets. For the rotated map.
- Map angle:  $80^\circ$
- "Magic" array angle:  $19.1^\circ$
- Final array angle:  $99.1^\circ$



# Time estimate

- With the Classical OTF map all 7 pixels with 2 polarizations cover the inner part of the map. (Array OTF: only 1 pixel!)
- With one coverage the time per point is:
  - $14 \times 0.3\text{s} = 4.2\text{s} \approx 3.8\text{s}$ .
- Total integration time per AOR:
  - $60 \times (85 + \sqrt{85}) \times 0.3 = 1695.952\text{s}$
- Plus overhead of 1816s: 3511.9s
- **4 AORs: Total time of 3.9h**



# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	10.500
* HFA Frequency (GHz)	4,744.777490
* 4G Frequency 4 (GHz)	2,514.316705
* 4G Frequency 3 (GHz)	1,267.014490
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.536900
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.536900
* Primary Frequency	LFAV
** Tracking required in off position	FFI
** ID String (SMO Only)	
Desired Resolution (km/s)	1.000
Expected Linewidth (km/s)	10.000
* Mixer 1	GRE_HFA
* Mixer 2	GRE_LFA

\* Instrument Mode Total Power

Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinate	Sky

## Reference Position

Ref Type

By Offset

By Position

Reference Name	
RA Offset (arcsec)	-300.000
Dec Offset (arcsec)	0.000
RA (deg)	85.142714
Dec (deg)	-2.466667

Position: 5h40m34.2514s, -2d28m00.001s

Choose Position

## Mapping Parameters

Array Rotation Angle (deg)	99.100
Exposure Time Per Cycle (sec)	1695.952
* On-source Exp. Time Per Point (sec)	0.3
* Cycles	1
Min Contiguous Exp Time (sec)	0.000
Map Offset RA (arcsec)	100.000
Map Offset Dec (arcsec)	-100.000
Step size in the x-direction (arcsec)	6.000
Step size in the y-direction (arcsec)	6.000
* Num Steps in the x-direction	85
* Num Steps in the y-direction	60
ScanDirection	x direction
** ScanDirectionVector	+1
** ScanOrder	-1
** Scan Lines Per Off	1
MapAngle (deg)	80.000
** Number of off measurements per load	5
** Number of OTF lines per load	5

# USPOT entries

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** ScanOrder	-1
** Scan Lines Per Off	1
MapAngle (deg)	80.000
** Number of off measurements per load	5
** Number of OTF lines per load	5

# USPOT entries

Observing Condition & Acquisition / Tracking

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* Velocity (km/s)	<input type="text" value="10.500"/>
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* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s, -2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>



# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)	<input type="text" value="0.000"/>
Chop Angle (deg)	<input type="text" value="0.000"/>
Chop Angle Coordinate	<input type="text" value="Sky"/>

## Reference Position

Ref Type

By Offset

By Position

Reference Name	<input type="text"/>
RA Offset (arcsec)	<input type="text" value="-300.000"/>
Dec Offset (arcsec)	<input type="text" value="0.000"/>
RA (deg)	<input type="text" value="85.142714"/>
Dec (deg)	<input type="text" value="-2.466667"/>

Position: 5h40m34.2514s,-2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)	<input type="text" value="0.000"/>
Chop Angle (deg)	<input type="text" value="0.000"/>
Chop Angle Coordinate	<input type="text" value="Sky"/>

## Reference Position

Ref Type

By Offset

By Position

Reference Name	<input type="text"/>
RA Offset (arcsec)	<input type="text" value="-300.000"/>
Dec Offset (arcsec)	<input type="text" value="0.000"/>
RA (deg)	<input type="text" value="85.142714"/>
Dec (deg)	<input type="text" value="-2.466667"/>

Position: 5h40m34.2514s, -2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>



# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s, -2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	10.500
* HFA Frequency (GHz)	4,744.777490
* 4G Frequency 4 (GHz)	2,514.316705
* 4G Frequency 3 (GHz)	1,267.014490
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.536900
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.536900
* Primary Frequency	LFAV
** Tracking required in off position	FFI
** ID String (SMO Only)	
Desired Resolution (km/s)	1.000
Expected Linewidth (km/s)	10.000
* Mixer 1	GRE_HFA
* Mixer 2	GRE_LFA

\* Instrument Mode Total Power

Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinate	Sky

## Reference Position

Ref Type

By Offset

By Position

Reference Name	
RA Offset (arcsec)	-300.000
Dec Offset (arcsec)	0.000
RA (deg)	85.142714
Dec (deg)	-2.466667

Position: 5h40m34.2514s, -2d28m00.001s

Choose Position

## Mapping Parameters

Array Rotation Angle (deg)	99.100
Exposure Time Per Cycle (sec)	1695.952
* On-source Exp. Time Per Point (sec)	0.3
* Cycles	1
Min Contiguous Exp Time (sec)	0.000
Map Offset RA (arcsec)	100.000
Map Offset Dec (arcsec)	-100.000
Step size in the x-direction (arcsec)	6.000
Step size in the y-direction (arcsec)	6.000
* Num Steps in the x-direction	85
* Num Steps in the y-direction	60
ScanDirection	x direction
** ScanDirectionVector	+1
** ScanOrder	-1
** Scan Lines Per Off	1
MapAngle (deg)	80.000
** Number of off measurements per load	5
** Number of OTF lines per load	5

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s, -2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s,-2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s, -2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>



# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	<input type="text" value="10.500"/>
* HFA Frequency (GHz)	<input type="text" value="4,744.777490"/>
* 4G Frequency 4 (GHz)	<input type="text" value="2,514.316705"/>
* 4G Frequency 3 (GHz)	<input type="text" value="1,267.014490"/>
* 4G Frequency 2 or LFAH Freq. (GHz)	<input type="text" value="1,900.536900"/>
* 4G Frequency 1 or LFAV Freq. (GHz)	<input type="text" value="1,900.536900"/>
* Primary Frequency	<input type="text" value="LFAV"/>
** Tracking required in off position	<input type="text" value="FFI"/>
** ID String (SMO Only)	<input type="text"/>
Desired Resolution (km/s)	<input type="text" value="1.000"/>
Expected Linewidth (km/s)	<input type="text" value="10.000"/>
* Mixer 1	<input type="text" value="GRE_HFA"/>
* Mixer 2	<input type="text" value="GRE_LFA"/>

\* Instrument Mode

Chop Throw (arcsec)

Chop Angle (deg)

Chop Angle Coordinate

## Reference Position

Ref Type

By Offset

By Position

Reference Name

RA Offset (arcsec)

Dec Offset (arcsec)

RA (deg)

Dec (deg)

Position: 5h40m34.2514s,-2d28m00.001s

## Mapping Parameters

Array Rotation Angle (deg)	<input type="text" value="99.100"/>
Exposure Time Per Cycle (sec)	<input type="text" value="1695.952"/>
* On-source Exp. Time Per Point (sec)	<input type="text" value="0.3"/>
* Cycles	<input type="text" value="1"/>
Min Contiguous Exp Time (sec)	<input type="text" value="0.000"/>
Map Offset RA (arcsec)	<input type="text" value="100.000"/>
Map Offset Dec (arcsec)	<input type="text" value="-100.000"/>
Step size in the x-direction (arcsec)	<input type="text" value="6.000"/>
Step size in the y-direction (arcsec)	<input type="text" value="6.000"/>
* Num Steps in the x-direction	<input type="text" value="85"/>
* Num Steps in the y-direction	<input type="text" value="60"/>
ScanDirection	<input type="text" value="x direction"/>
** ScanDirectionVector	<input type="text" value="+1"/>
** ScanOrder	<input type="text" value="-1"/>
** Scan Lines Per Off	<input type="text" value="1"/>
MapAngle (deg)	<input type="text" value="80.000"/>
** Number of off measurements per load	<input type="text" value="5"/>
** Number of OTF lines per load	<input type="text" value="5"/>

# USPOT entries

Observing Condition & Acquisition / Tracking

## Instrument Parameters

* Velocity (km/s)	10.500
* HFA Frequency (GHz)	4,744.777490
* 4G Frequency 4 (GHz)	2,514.316705
* 4G Frequency 3 (GHz)	1,267.014490
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.536900
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.536900
* Primary Frequency	LFAV
** Tracking required in off position	FFI
** ID String (SMO Only)	
Desired Resolution (km/s)	1.000
Expected Linewidth (km/s)	10.000
* Mixer 1	GRE_HFA
* Mixer 2	GRE_LFA

\* Instrument Mode Total Power

Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinate	Sky

## Reference Position

Ref Type

By Offset

By Position

Reference Name	
RA Offset (arcsec)	-300.000
Dec Offset (arcsec)	0.000
RA (deg)	85.142714
Dec (deg)	-2.466667

Position: 5h40m34.2514s, -2d28m00.001s

Choose Position

## Mapping Parameters

Array Rotation Angle (deg)	99.100
Exposure Time Per Cycle (sec)	1695.952
* On-source Exp. Time Per Point (sec)	0.3
* Cycles	1
Min Contiguous Exp Time (sec)	0.000
Map Offset RA (arcsec)	100.000
Map Offset Dec (arcsec)	-100.000
Step size in the x-direction (arcsec)	6.000
Step size in the y-direction (arcsec)	6.000
* Num Steps in the x-direction	85
* Num Steps in the y-direction	60
ScanDirection	x direction
** ScanDirectionVector	+1
** ScanOrder	-1
** Scan Lines Per Off	1
MapAngle (deg)	80.000
** Number of off measurements per load	5
** Number of OTF lines per load	5



Questions:

**Ask us at early:  
sofia\_help@sofia.usra.edu**