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 ² π _{1/2}	
upGREAT LFA-V	1.835–2.007 2.060–2.065	1000 K	15"	[OI], [CII], CO, OH ² π _{1/2}	
	2.490-2.590	3300 K	12"	OH ² π _{3/2} , ¹⁸ OH ² π _{3/2}	
	1.240–1.395 1.427–1.525	1100 K	19"	[NII], CO, OD, HCN, SH, H_2D^+	
4GREAT	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 ₃ , [CI], CO, CH	

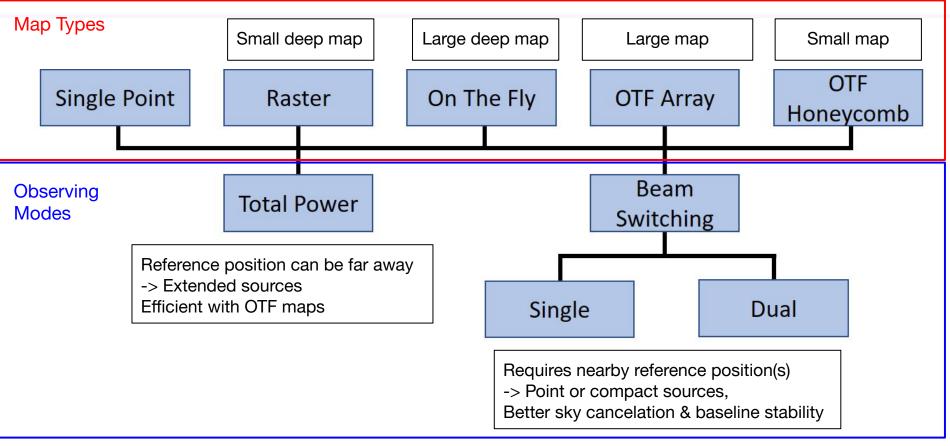
Configurations:

- LFA/HFA
- 4GREAT/HFA



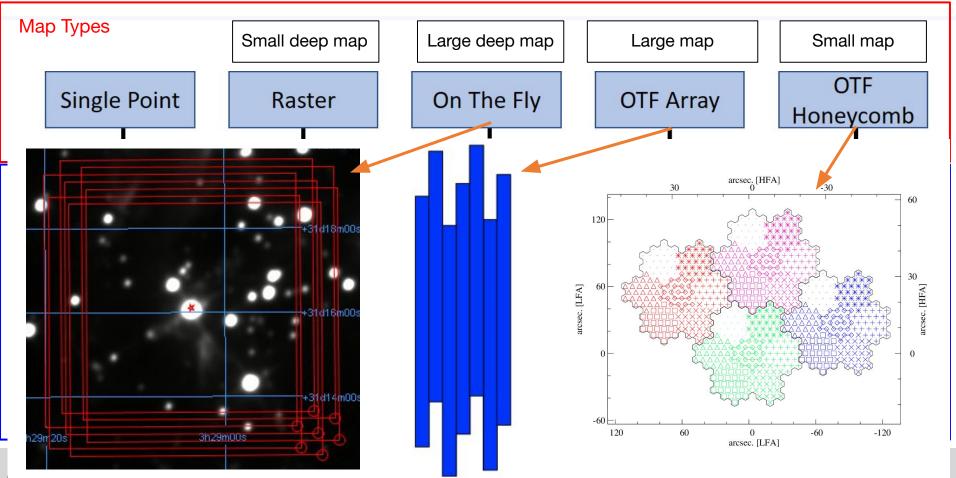


How to choose GREAT AORs and modes:





How to choose GREAT AORs and modes:



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:

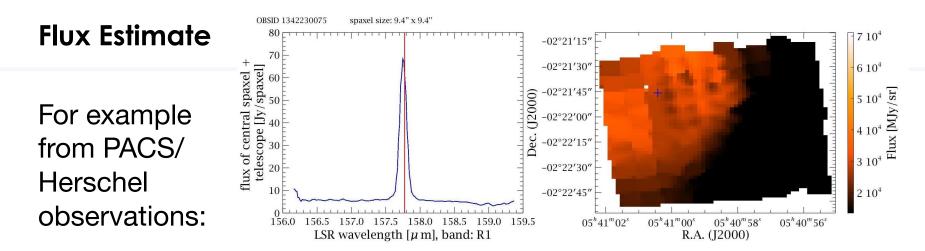
- [CII] (158µm or 1.9THz) mapping at high spectral resolution
- Spectral resolution: 1km/s or R = 300,000
- Mapping area: 12'x17'

Wavelength and spectral resolution require GREAT!









- Unresolved line width: ~0.14µm or ~1.7GHz
- Line height: ~65Jy/spaxel or ~0.69 Jy/arcsec²
- Convert to [CII]-beam (14.1"): ~110 Jy/beam
- Assume an intrinsic linewidth of 10km/s or 63MHz
- Intrinsic peak flux density: ~2.9 kJy/beam
- Convert to Antenna Temperature T_A^{*} = ~2.9K (Eq. 6-8 Observer's Handbook)





Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band 1.9005369 (THz, use 7 decimals) Frequencies) Frequency/Velocity Resolution: 1.0 ○ MHz km/s Line Width (for averaging sky 10 ○ MHz km/s transmission): SinglePoint or BeamSwitch Type of Observation: **TP OTF/Raster Map OTF/Raster Map** TP OTF Map Size (X × Y in arcsec): 1020 × 720 Non: Map Type: Classical OTF ○ Array OTF Observer Velocity (VLSR, km/s): 0.0 OR 🗌 **Compute Velocity Calculation Method** Calculation method: (more info) Calculate Select the calculation method Desired S/N ratio of 5.0 Total Integration Time of 10. secs Astronomical Source Definition Brightness Temperature, T_R*(K): 2.9 Source Velocity: 10.5 LSR, km/s ○ redshift

Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band	1.9005369	(THz, use 7 decimals)	
Frequency/Velocity Resolution:	1.0	O MHz ● km/s	
Line Width (for averaging sky transmission):	10	O MHz ● km/s	
Type of Observation:	 SinglePoint or BeamSwitch OTF/Raster Map 	TP OTF/Raster Map	
TP OTF Map Size (X × Y in arcsec):	1020	× 720	
N _{on} :			
Мар Туре:	Classical OTF	○ Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR Compute Velocit	У	
Calculation Method			
Calculation method:(more info) Select the calculation method		Calculate	
Desired S/N ratio of 5.0			
\bigcirc Total Integration Time of 10.	secs		
Astronomical Source Definition			
Brightness Temperature, T _R *(K): 2.9	Source Velocity:	10.5 • LSR, km/s · redshift	
			<d l<="" st="" td=""></d>

Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band Frequencies)	1.9005369	(THz, use 7 decimals)	
Frequency/Velocity Resolution:	1.0	○ MHz ● km/s	
Line Width (for averaging sky transmission):	10	○ MHz	
Type of Observation:	 SinglePoint or BeamSwitch OTF/Raster Map 	TP OTF/Raster Map	
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N _{on} :			
Мар Туре:	Classical OTF	\odot Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR Compute Velocity		
Calculation Method			
Calculation method:(more info) Select the calculation method		Calculate	
Desired S/N ratio of 5.0			
\bigcirc Total Integration Time of 10.	secs		
Astronomical Source Definition			
Brightness Temperature, T _R *(K): 2.9	Source Velocity: 10	0.5 OLSR, km/s Oredshift	
heric Observatory for Infrared Astronomy			∽ ∕×dsi′

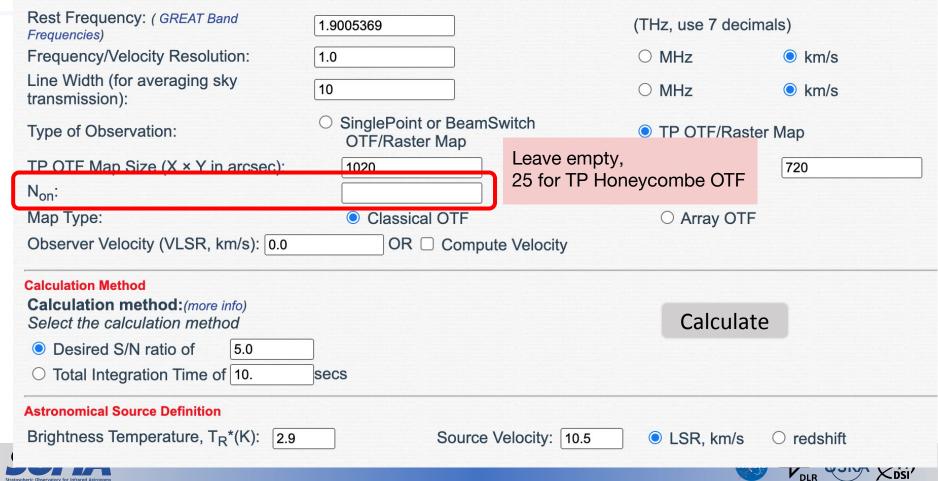
Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band Frequencies)	1.9005369	(THz, use 7 decima	lls)
Frequency/Velocity Resolution:	1.0	○ MHz	● km/s
Line Width (for averaging sky transmission):	10	○ MHz	● km/s
Type of Observation:	 SinglePoint or BeamSwitch OTF/Raster Map 	TP OTF/Raster	Мар
TP OTF Map Size (X × Y in arcsec):	1020	×	720
N _{on} :			
Мар Туре:	Classical OTF	○ Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR Compute Velocity		
Calculation Method			
Calculation method: (more info) Select the calculation method		Calculate	
Desired S/N ratio of 5.0			
\bigcirc Total Integration Time of 10.	secs		
Astronomical Source Definition			
Brightness Temperature, T _R *(K): 2.9	Source Velocity: 10	.5	⊖ redshift
heric Observatory for Infrared Astronomy			

Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band Frequencies)	1.9005369	(*	THz, use 7 decima	lls)
Frequency/Velocity Resolution:	1.0	(⊖ MHz	● km/s
Line Width (for averaging sky transmission):	10	() MHz	● km/s
Type of Observation:	 SinglePoint or BeamS OTE/Raster Map 	witch	TP OTF/Raster	Мар
TP OTF Map Size (X × Y in arcsec):	1020		×	720
N _{on} :				
Мар Туре:	Classical OTF		○ Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR 🗆 Compute	e Velocity		
Calculation Method				
Calculation method:(more info) Select the calculation method			Calculate	
Desired S/N ratio of 5.0				
\bigcirc Total Integration Time of 10.	secs			
Astronomical Source Definition				
Brightness Temperature, T _R *(K): 2.9	Source V	/elocity: 10.5	LSR, km/s	⊖ redshift
oheric Observatory for Infrared Attronomy				

Instrument properties: (more info, input parameter details)



Instrument properties: (more info, input parameter details)

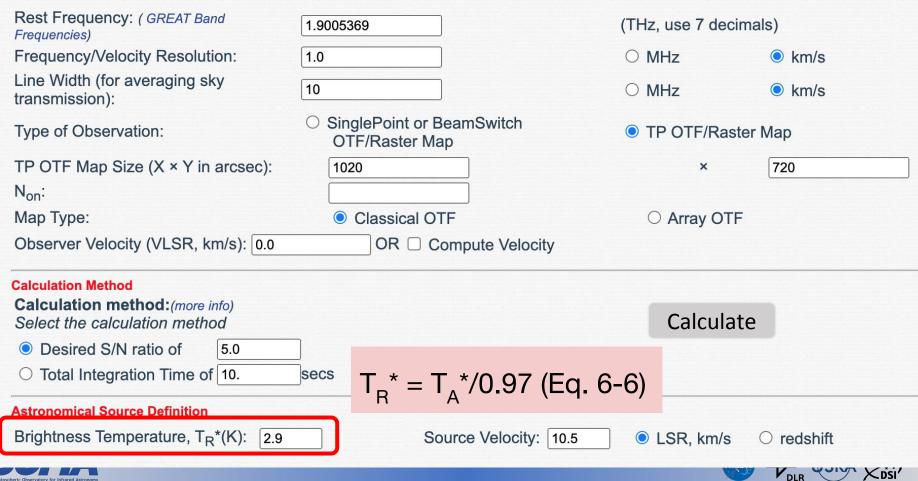
Rest Frequency: (GREAT Band 1.9005369 (THz, use 7 decimals) Frequencies) Frequency/Velocity Resolution: ○ MHz ○ km/s 1.0 Line Width (for averaging sky 10 ○ MHz ○ km/s transmission): SinglePoint or BeamSwitch Type of Observation: **TP OTF/Raster Map OTF/Raster Map** TP OTF Map Size (X × Y in arcsec): 1020 × 720 Non: Map Type: Classical OTF ○ Array OTF Observer Velocity (VLSR, km/s): 0.0 OR 🗌 Compute Velocity **Calculation Method** Calculation method: (more info) Calculate Select the calculation method Desired S/N ratio of 5.0 Total Integration Time of 10. secs Astronomical Source Definition Brightness Temperature, T_R*(K): 2.9 Source Velocity: 10.5 LSR, km/s ○ redshift

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Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band Frequencies)	1.9005369	(THz, use 7 decima	als)
Frequency/Velocity Resolution:	1.0	○ MHz	● km/s
Line Width (for averaging sky transmission):	10	○ MHz	● km/s
Type of Observation:	 SinglePoint or BeamSwitch OTF/Raster Map 	TP OTF/Raster	Мар
TP OTF Map Size (X × Y in arcsec):	1020	×	720
N _{on} :			
Мар Туре:	Classical OTF	○ Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR Compute Velocity		
Calculation Method			
Calculation method:(more info) Select the calculation method		Calculate	
Desired S/N ratio of 5.0			
O lotal Integration Time of 10.	secs		
Astronomical Source Definition			
Brightness Temperature, T _R *(K): 2.9	Source Velocity: 10.5	● LSR, km/s	⊖ redshift
spheric Observatory for Infrared Astronomy			

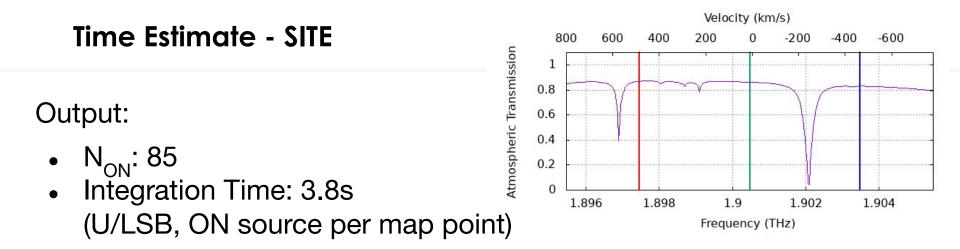
Instrument properties: (more info, input parameter details)



Stratospheric Observatory for Infrared Astronomy

Instrument properties: (more info, input parameter details)

Rest Frequency: (GREAT Band Frequencies)	1.9005369	(THz, use 7 decima	als)
Frequency/Velocity Resolution:	1.0	○ MHz	● km/s
Line Width (for averaging sky transmission):	10	○ MHz	● km/s
Type of Observation:	 SinglePoint or BeamSwitch OTF/Raster Map 	TP OTF/Raster	Мар
TP OTF Map Size (X × Y in arcsec):	1020	×	720
N _{on} :			
Мар Туре:	Classical OTF	○ Array OTF	
Observer Velocity (VLSR, km/s): 0.0	OR Compute Velo	ocity	
Calculation Method			
Calculation method:(more info) Select the calculation method		Calculate	
Desired S/N ratio of 5.0			
\bigcirc Total Integration Time of 10.	secs		
Astronomical Source Definition			
Brightness Temperature, T _R *(K): 2.9	Source Velocit	y: 10.5	⊖ redshift
Spheric Observatory for Infrared Astronomy			



Default map spacing for LFA: 6"

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

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

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

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

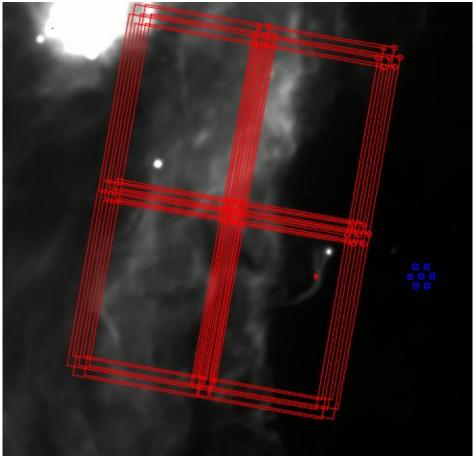




Map layout

- 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°
- "Magic" array angle: 19.1°
- Final array angle: 99.1°

Background: WISE Band 3

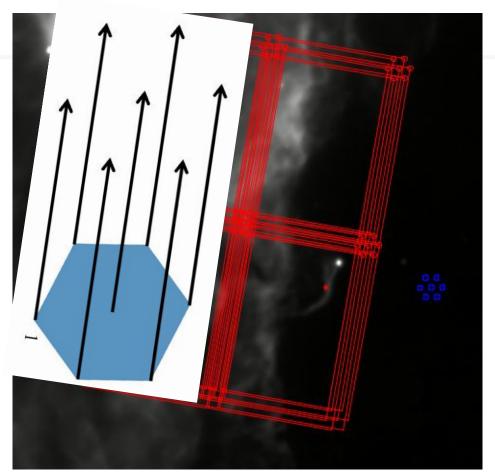






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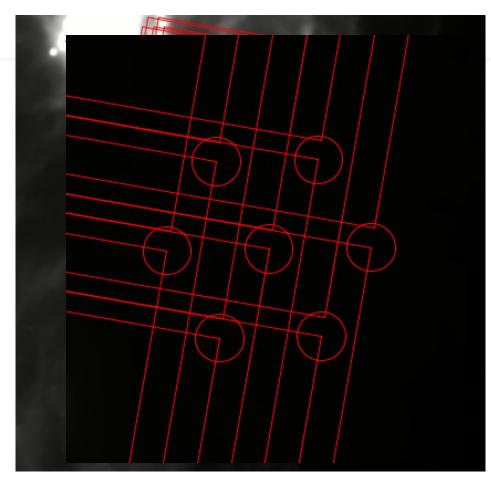






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- Final array angle: 99.1°







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 x 0.3s = 4.2s ≈ 3.8s.
- Total integration time per AOR:
 - $60 \times (85 + \sqrt{85}) \times 0.3 = 1695.952s$
- Plus overhead of 1816s: 3511.9s
- 4 AORs: Total time of 3.9h





* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	0
4G Frequency 4 (GHz)	2,514.31670	5
4G Frequency 3 (GHz)	1,267.01449	0
4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	0
4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	0
Primary Frequency	LFAV	0
* Tracking required in off position	FFI	0
* ID String (SMO Only)		
Desired Resolution (km/s)	1.000	
xpected Linewidth (km/s)	10.000	
Mixer 1	GRE_HFA	0
Mixer 2	GRE_LFA	0

Observing	Condition	& Acquisition	1	Tracking

* Instrument Mode Tota	al Power 🗘
Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinat	e Sky 🗘
Reference Position	
Ref Type By Off By Pos	
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



* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.7774	90
* 4G Frequency 4 (GHz)	2,514.3167	05
* 4G Frequency 3 (GHz)	1,267.0144	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.5369	00
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.5369	00
* 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	0

* Instrument Mode Total	Power 🗘
Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinate	sky 🗘
Reference Position	
By Offs By Posi Reference Name	
RA Offset (arcsec)	-300.000
Dec Offset (arcsec)	0.000
RA (deg)	85.142714
Dec (deg)	-2.466667

Choose Position

Observing Condition & Acquisition / Tracking

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	٥
** ScanDirectionVector	+1	٥
** ScanOrder	-1	٥
** Scan Lines Per Off	1	
MapAngle (deg)	80.000	
** Number of off measurements per load	5	
** Number of OTF lines per load	5	



* 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 0
** Tracking required in off position	FFI 0
** ID String (SMO Only)	
Desired Resolution (km/s)	1.000
	10.000
Expected Linewidth (km/s)	(
Expected Linewidth (km/s) * Mixer 1	GRE_HFA \$

* Instrument Mode Tota	l Power	\$
Chop Throw (arcsec)	0.000	
Chop Angle (deg)	0.000	
Chop Angle Coordinat	e Sky 🌣	
Reference Position		
Ref Type By Off By Pos Reference Name		
RA Offset (arcsec)	-300.000	
Dec Offset (arcsec)	0.000	
RA (deg)	85.142714	
Dec (deg)	-2.466667	

Observing Condition & Acquisition / Tracking

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 0
** Scan Lines Per Off	1
MapAngle (deg)	80.000
** Number of off measurements per load	5
** Number of OTF lines per load	5
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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 ≎

Total Power 0 * Instrument Mode Chop Throw (arcsec) 0.000 Chop Angle (deg) 0.000 $\hat{\mathbf{C}}$ 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 -2.466667 Dec (deg)

Observing Condition & Acquisition / Tracking

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 0
** 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



* 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 🗘

Observing Condition & Acquisition / Tracking Total Power \$ * Instrument Mode Chop Throw (arcsec) 0.000 Chop Angle (deg) 0.000 $\hat{\mathbf{x}}$ 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 -2.466667 Dec (deg) Position: 5h40m34.2514s,-2d28m00.001s

Choose Position

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	0
** 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	



* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	90
* 4G Frequency 4 (GHz)	2,514.31670)5
* 4G Frequency 3 (GHz)	1,267.01449	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	0
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	00
* Primary Frequency	LFAV	0
** 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	0

Observing Condition & Acquisition / Tracking			
* Instrument Mode Tota	al Power 🗘		
Chop Throw (arcsec) Chop Angle (deg) Chop Angle Coordinat	0.000		
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	
		-



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Instrument Parameters		_
* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.777490)
* 4G Frequency 4 (GHz)	2,514.316705	5
* 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	\$

Observing Condition & Acquisition / Tracking ries * 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 -2.466667 Dec (deg)

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0

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	



* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.7774	90
* 4G Frequency 4 (GHz)	2,514.316705	
* 4G Frequency 3 (GHz)	1,267.0144	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.5369	00
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.5369	00
* 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	0

	0.000	\$
Chop Angle (deg)		
	0.000	
Chop Angle Coordinate	0.000	
	Sky 🗘	
By Position Reference Name	on	
RA Offset (arcsec) -3	300.000	
Dec Offset (arcsec) 0.	000	
RA (deg) 85	5.142714	
Dec (deg) -2	2.466667	

Position: 5h40m34.251	4s,-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	0
** ScanDirectionVector	+1	0
** 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	



Instrument Parameters	3.	
* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	0
* 4G Frequency 4 (GHz)	2,514.31670	5
* 4G Frequency 3 (GHz)	1,267.01449	0
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	0
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	0
* Primary Frequency	LFAV	\$
** Tracking required in off position	FFI	0
** ID String (SMO Only)		
Desired Resolution (km/s)	1.000	
Expected Linewidth (km/s)	10.000	
* Mixer 1	GRE_HFA	¢
* Mixer 2	GRE_LFA	0

* Instrument Mode Tota	al Power 🗘
Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinat	te Sky 🗘
Reference Position	
Ref Type - By Off By Pos Reference Name	
RA Offset (arcsec)	-300.000
Dec Offset (arcsec)	0.000
RA (deg)	85.142714
Dec (deg)	-2.466667

Observing Condition & Acquisition / Tracking

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 x-direction* Num Steps in the y-direction	85 60	
* Num Steps in the y-direction	60	
* Num Steps in the y-direction ScanDirection	60 x direction ≎	
* Num Steps in the y-direction ScanDirection ** ScanDirectionVector	60 x direction ≎ +1 ≎	
* Num Steps in the y-direction ScanDirection ** ScanDirectionVector ** ScanOrder	60 x direction ≎ +1 ≎ -1 ≎	
 * Num Steps in the y-direction ScanDirection ** ScanDirectionVector ** ScanOrder ** Scan Lines Per Off 	60 x direction ≎ +1 ≎ -1 ≎ 1	
 * Num Steps in the y-direction ScanDirection ** ScanDirectionVector ** ScanOrder ** Scan Lines Per Off MapAngle (deg) 	60 x direction ≎ +1 ≎ -1 ≎ 1 80.000	



USPO	T entr	Ί€
Instrument Parameters		
* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	90
* 4G Frequency 4 (GHz)	2,514.31670)5
* 4G Frequency 3 (GHz)	1,267.01449	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	00
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	00
* Primary Frequency	LFAV	0
** Tracking required in off position	FEI	\$
** ID String (SMO Only)		
Desired Resolution (km/s)	1.000	
Expected Linewidth (km/s)	10.000	
* Mixer 1	GRE_HFA	\$
* Mixer 2	GRE_LFA	0

ies	Observing Condition & Acquisition			
		al Power		
0	Chop Throw (arcsec)	0.000		
5	Chop Angle (deg)	0.000		
0	Chop Angle Coordinat			
0	- Reference Position			
0	Ref Type			
٢	By Off By By			
٢	O By Pos	ltion		
	Reference Name			
	RA Offset (arcsec)	-300.000		
	Dec Offset (arcsec)	0.000		
٢	RA (deg)	85.142714		
٢	Dec (deg)	-2.466667		

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

Observing Condition & A	cquisition / Tracking	
Instrument Mode Total	Power 🗘	Mapping Param
		Array Rotation
Chop Throw (arcsec)	0.000	Exposure Time
Chop Angle (deg)	0.000	* On-source E
Chop Angle Coordinate	Sky ≎	* Cycles
chop Angle coordinate	Sky V	Min Contiguous
eference Position		Map Offset RA
Ref Type By Offse		Map Offset Dec
O By Posit	ion	Step size in the
Reference Name		Step size in the
		* Num Stand in

Mapping Parameters		
Array Rotation Angle (deg)	99.100	
Exposure Time Per Cycle (sec)	1695.952	T
* 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	



Instrument Parameters	T entr	
* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	90
* 4G Frequency 4 (GHz)	2,514.31670)5
* 4G Frequency 3 (GHz)	1,267.01449	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	0
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	0
* Primary Frequency	LFAV	\$
** Tracking required in off position	FFI	0
** ID String (SMO Only)		
Desired Resolution (km/s)	1.000	
Expected Linewidth (km/s)	10.000	
* Mixer 1	GRE_HFA	\$
* Mixer 2	GRE_LFA	0

Observing Condition &	Acquisition / Tr	acking
* Instrument Mode Tota	al Power	٥
Chop Throw (arcsec)	0.000	
Chop Angle (deg)	0.000	
Chop Angle Coordinat	te Sky 🌣	
Reference Position Ref Type By Off By Pos 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	٥
** ScanDirectionVector	+1	٥
** ScanOrder	-1	0
** Scan Lines Per Off	1	
MapAngle (deg)	80.000	
** Number of off measurements per load	5	
** Number of OTF lines per load	5	



Instrument Parameters	10 500	
* Velocity (km/s)	10.500	
* HFA Frequency (GHz)	4,744.77749	90
* 4G Frequency 4 (GHz)	2,514.31670)5
* 4G Frequency 3 (GHz)	1,267.01449	90
* 4G Frequency 2 or LFAH Freq. (GHz)	1,900.53690	00
* 4G Frequency 1 or LFAV Freq. (GHz)	1,900.53690	00
* Primary Frequency	LFAV	0
** 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	0

nstrument Mode Tota	ll Power 🗘
Chop Throw (arcsec)	0.000
Chop Angle (deg)	0.000
Chop Angle Coordinat	e Sky 🗘
erence Position Ref Type By Off	
Ref Type By Off By Pos Reference Name	ition
Ref Type By Off By Pos Reference Name RA Offset (arcsec)	ition -300.000
Ref Type By Off By Pos Reference Name	ition -300.000

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

Choose Position

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



USPO	T entries	Observing Condition &	Acquisition / Trackir	ng	
Instrument Parameters		-	al Power 🗘	Mapping Parameters	
* Velocity (km/s)	10.500			Array Rotation Angle (deg)	99.100
* HFA Frequency (GHz)	4,744.777490	Chop Throw (arcsec)	0.000	Exposure Time Per Cycle (sec)	1695.952
* 4G Frequency 4 (GHz)	2,514.316705	Chop Angle (deg)	0.000	* On-source Exp. Time Per Point (sec)	0.3
* 4G Frequency 3 (GHz)	1,267.014490	Chop Angle Coordinat	te Sky 🗘	* Cycles	1
	1,900.536900	Deferrer Desition		Min Contiguous Exp Time (sec)	0.000
	1,900.536900	Reference Position		Map Offset RA (arcsec)	100.000
* Primary Frequency	LFAV \$	By Off	fset	Map Offset Dec (arcsec)	-100.000
** Tracking required in off position	FFI 0	O By Pos	sition	Step size in the x-direction (arcsec)	6.000
		Reference Name		Step size in the y-direction (arcsec)	6.000
** ID String (SMO Only)			-300.000	* Num Steps in the x-direction	85
	1.000	RA Offset (arcsec)		* Num Steps in the y-direction	60
Expected Linewidth (km/s)	10.000	Dec Offset (arcsec)		ScanDirection	x direction 🗘
* Mixer 1	GRE_HFA 🗘	RA (deg)	85.142714		+1 0
* Mixer 2	GRE_LFA 🗘	Dec (deg)	-2.466667	** ScanDirectionVector	
				** ScanOrder	-1 🗘
				** Scan Lines Per Off	1
				MapAngle (deg)	80.000
		Position: 5h40m34.251	4s2d28m00.001s	** Number of off measurements per load	5
		Choose Po		** Number of OTF lines per load	5
atospheric Observatory for Infrared Astronomy					



Instrument Parameters	T entrie	
* 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 0	
** Tracking required in off position	FFI 0	
** ID String (SMO Only)		
Desired Resolution (km/s)	1.000	
Expected Linewidth (km/s)	10.000	
* Mixer 1	GRE_HFA 0	
* Mixer 2	GRE_LFA	

Observing Condition & Acquisition / Tracking Total Power \$ * Instrument Mode Chop Throw (arcsec) 0.000 Chop Angle (deg) 0.000 Chop Angle Coordinate Sky 0 Reference Position Ref Type By Offset By Position **Reference Name** RA Offset (arcsec) -300.000 Dec Offset (arcsec) 0.000 RA (deg) 85.142714 -2.466667 Dec (deg)

N

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

Choose Position

Mapping Parameters		
Array Rotation Angle (deg)	99.100	
xposure Time Per Cycle (sec)	1695.952	
On-source Exp. Time Per Point (sec)	0.3	
Cycles	1	
/in Contiguous Exp Time (sec)	0.000	
Map Offset RA (arcsec)	100.000	
Map Offset Dec (arcsec)	-100.000	
itep size in the x-direction (arcsec)	6.000	
itep size in the y-direction (arcsec)	6.000	
Num Steps in the x-direction	85	
Num Steps in the y-direction	60	
canDirection	x direction	٢
* ScanDirectionVector	+1	٥
* ScanOrder	-1	٢
* Scan Lines Per Off	1	
/lapAngle (deg)	80.000	
* Number of off measurements per load	5	
* Number of OTF lines per load	5	





Ask us at early: sofia_help@sofia.usra.edu



