



Preparing HAWC+ AORs: Cycle 9



Steps:

1) Has target been observed before by SOFIA?

- Check Archive at IRSA: <https://irsa.ipac.caltech.edu/Missions/sofia.html>

2) Which Band(s)?

- Band A (53 μ m; FWHM = 4.85")
- Band B (62 μ m; FWHM = 10.5") *Band B is "shared risk" in Cycle 9
- Band C (89 μ m; FWHM = 7.8")
- Band D (154 μ m; FWHM = 13.6")
- Band E (214 μ m; FWHM = 18.2")

3) Total Intensity or Polarization Map?

4) Nod Match Chop (NMC) or OTFMAP?

- OTFMAP is recommended for Total Intensity to reduce overheads
- Polarization OTFMAP is "shared risk"
- Note: Scan mode (Lissajous or Box) is determined in Phase II
- Choose "Off" position that is < 10% of the source flux
- HAWC+ does not have a beam rotator, array orientation is determined by the rotation of the field on a given flight and airplane heading, HAWC+ team will work with the GO before the flight

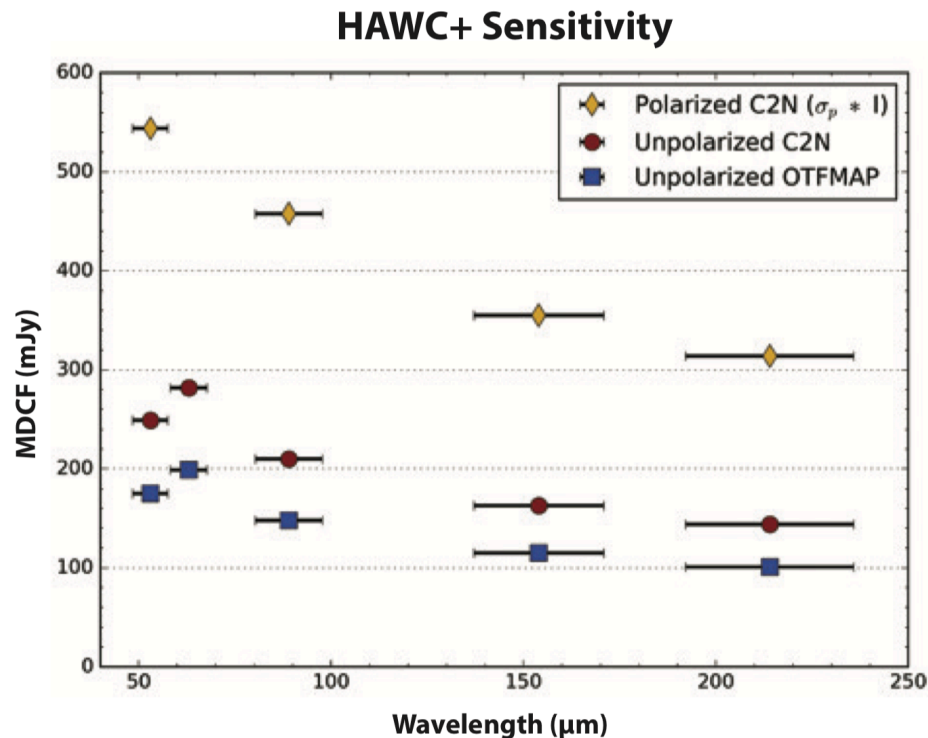


5) Estimate Source Intensities

- Get flux estimates from literature, a SED model, or archives:

Herschel Archive: <http://archives.esac.esa.int/hsa/wlsa/> and/or

IRSA Herschel Archive: <https://irsa.ipac.caltech.edu/Missions/herschel.html>
are very useful for FIR observations





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- 6) Use SITE to estimate on-source integration times.
Use default “Observing Condition Constraints”
(i.e. elevation angle, altitude, and water vapor)

Imaging Time Estimators

FORCAST FLITECAM FLITECAM_HIPO **HAWC_Plus** FPI_Plus

The following four sections of this form are for imaging configurations: select the instrument, astronomical source, telescope, observing condition constraints and calculation method. Click on the button to submit the parameters from all the sections to the server. The results are reported in a separate web page that can be resized and printed.

Instrument properties
Instrument properties: ([more info](#))
Filter: [more info](#) HAW_D

Calculation Method
Calculation method: ([more info](#))
Select the calculation method

S/N ratio resulting from a Total Integration Time of secs

Total Integration Time to achieve a S/N ratio of

Astronomical Source Definition
Spatial profile and continuum brightness: ([more info](#)) Choose point or extended source.

Point source (spatial profile):
Spatially integrated brightness Jy

Extended source
Uniform surface brightness Jy / sq arcsec

Emission line: ([more info](#)) in addition to the above continuum. The output SNR or observing time will be for the sum of continuum plus line.
Single emission line at wavelength microns with line flux W/m²

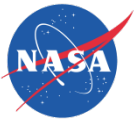
Observing Condition Constraints
Note: You can read the [explanatory notes](#) for more information on the water vapor overburden.

Elevation Angle: 20° 40° 60°

Altitude in 1000's of feet: 35 36 37 38 39 40 41 42 43 44 45

Zenith Water Vapor Overburden (microns): 26.7 16.9 12.8 11.0 9.6 8.4 7.3 6.3 5.5 4.8 4.2





Example: Point Source Photometry



We want to observe a point source in Band D (154 μ m).
The source has an intensity of 110 mJy and we desire a SNR = 5.

Imaging Time Estimators

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Instrument properties
Instrument properties: ([more info](#))
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Calculation Method
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S/N ratio resulting from a Total Integration Time of secs

Total Integration Time to achieve a S/N ratio of

Astronomical Source Definition
Spatial profile and continuum brightness: ([more info](#)) Choose point or extended source.

Point source (spatial profile):
Spatially integrated brightness Jy

Extended source
Uniform surface brightness Jy / sq arcsec

Emission line: ([more info](#)) in addition to the above continuum. The output SNR or observing time will be for the sum of continuum plus line.
Single emission line at wavelength microns with line flux W/m²

Observing Condition Constraints
Note: You can read the [explanatory notes](#) for more information on the water vapor overburden.

Elevation Angle: 20° 40° 60°

Altitude in 1000's of feet: 35 36 37 38 39 40 41 42 43 44 45

Zenith Water Vapor Overburden (microns): 26.7 16.9 12.8 11.0 9.6 8.4 7.3 6.3 5.5 4.8 4.2





Example: Point Source Photometry



SITE estimates a “Total Integration Time” of 3359 sec.

SOFIA Instrument Time Estimator (SITE)

HAWC_Plus

Outputs

Relative atmospheric transmission	0.99806	
Total Integration Time	3359	seconds

User Inputs

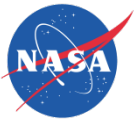
Filter name	HAW_D	
Band center	154.000	microns
Band width	34.000	microns
Source type	point	
Total continuum flux	0.11	Janskys
Elevation angle	40.0	degrees
Zenith water vapor	7.3	microns
Aircraft Altitude	41.0	Kfeet
Total signal to noise	5.0	

Instrument Parameters

Apparent source size	13.600	arcseconds
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Close Print Help





Example: Point Source Photometry



Set up the AOR:

Generate a single AOR per object per band, although the final requested time may be several hours, the HAWC+ team will schedule the object across multiple flights.

The screenshot displays the Unified SOFIA Planning Tool (USPOT) interface. The main window is titled 'Proposal' and contains several fields and buttons. The 'TAC Queue' is set to 'US', and the 'Proposal Type' is 'Regular'. A modal window titled 'Please select new Observation' is open, showing a grid of observation options. The 'HAWC PLUS OTFMAP' option is highlighted with a red box. The interface also shows a 'Clear Text' button and a status bar at the bottom indicating 'Target: None Specified' and 'Total Duration (click to recompute): 0 min Awarded: 0 min'.





Example: Point Source Photometry



For OTF scan mode, the recommended on-source time per iteration is 100-120 sec.

Using a “Lissajous Scan Duration” of 120 sec., 28 iterations will be needed to get the desired SNR for this source.
(120 sec. * 28 iterations = 3360 sec.)

HAWC PLUS OTFMAP [AOR ID: ...]

Unique AOR Label: HAWC_OTFMAP-0000

Target: Alpha Ori Type: SOFIA Fixed Single
88.792939, 7.407064 Equ J2000 or 5h55m10.3054s, +7d24m25.430s Equ J2000

New Target Modify Target ... Target List...

Observing Condition & Acquisition / Tracking

HAWC_PLUS

Observation Order: 1
Total Exposure Time (sec): 3360.0
Example Rotation Angle (deg): 0.000
Half Wave Plate: OPEN
* PassBand: HAW_D (154)

* Mode: OTFMAP
Scan Type: Lissajous
Number of iterations: 28
Range of Initial Scan Angles (Low) (deg): -30.000
Range of Initial Scan Angles (High) (deg): 30.000
Number of Subscans: 1
* Lissajous Scan Duration (sec): 120.000
Scan Rate (arcsec/sec): 100
Scan Coordinate System: Sky
Length of Linear Scan Element (arcsec): 870.000
Distance Between Linear Scan Elements (arcsec): 68.000
Number of Scan Steps: 1
Perform Cross Scan: True
^Scan Amplitude(Elevation) (arcsec): 70.000
^Scan Amplitude(Cross Elevation) (arcsec): 70.000
Scan Frequency Ratio: 1.414214
Scan Relative Phase: 0.000

Nod & Map

Chop / Nod

* Mode OTFMAP

Chopping: False
Chop Angle Coordinate Reference: Sky
Chop Type: 2_point
Chop Throw (arcsec): 300.000
Chop Angle (deg): 0.000
Chop Frequency: 10.2
Chop Sync Source: External (HAWC+)
Chop on or off chip: False

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

Cancel Apply OK



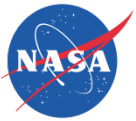


Example: Polarization Map



To estimate the source percent polarization:

- Check the typical polarization for the astrophysical object at a given surface brightness and use that as an estimate in SITE.
- Kuiper Airborne Observatory (KAO) observations are also a good source for estimating polarizations
- Use a physical model. GOs should provide references and/or explanations to the model used.



Example: Polarization Map



We want to obtain a polarization map of a star forming region using HAWC+ Band E. The region was observed with Herschel SPIRE at $250\mu\text{m}$ with the following minimum intensity:
Surface Brightness: $0.01 \text{ Jy/sq arcsec}$

Imaging Time Estimators

FORCAST FLITECAM FLITECAM_HIPO **HAWC_Plus** FPI_Plus

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Instrument properties
Instrument properties: ([more info](#))
Filter: [more info](#) **HAW_E+HAW_HWP_E**

Calculation Method
Calculation method: ([more info](#))
Select the calculation method

S/N ratio resulting from a Total Integration Time of secs

Total Integration Time to achieve a S/N ratio of

Astronomical Source Definition
Spatial profile and continuum brightness: ([more info](#)) Choose point or extended source.

Point source (spatial profile):
Spatially integrated brightness Jy

Polarization Percent

Extended source
Uniform surface brightness Jy / sq arcsec

Polarization Percent

Emission line: ([more info](#)) in addition to the above continuum. The output SNR or observing time will be for the sum of continuum plus line.
Single emission line at wavelength microns with line flux

Observing Condition Constraints
Note: You can read the [explanatory notes](#) for more information on the water vapor overburden.

Elevation Angle: 20° 40° 60°

Altitude in 1000's of feet: 35 36 37 38 39 40 41 42 43 44 45

Zenith Water Vapor Overburden (microns): 26.7 16.9 12.8 11.0 9.6 8.4 7.3 6.3 5.5 4.8 4.2





Example: Polarization Map



HAWC+ Band E (214 μ m): For an intensity of 0.01Jy/sq arcsec, 5% polarization, SNR = 5: SITE estimates a “Total Time” of 1144 sec.

SOFIA Instrument Time Estimator (SITE)

HAWC_Plus

Outputs

Relative atmospheric transmission	0.99907	
Total Integration Time	1144	seconds

User Inputs

Filter name	HAW_E+HAW_HWP_E	
Band center	214.000	microns
Band width	44.000	microns
Source type	extended	
Total continuum flux	0.01	Janskys/sq arcsec
Percent Polarization	5.0	
Elevation angle	40.0	degrees
Zenith water vapor	7.3	microns
Aircraft Altitude	41.0	Kfeet
Signal to noise per pixel	5.0	

Instrument Parameters

Instrument pixel size (X direction)	9.370	arcseconds
Instrument pixel size (Y direction)	9.370	arcseconds

Close Print Help

Note: The on-source time is per detector pixel. If GOs plan to bin the data then explicitly explain it in the feasibility section.





Example: Polarization Map



Set up the AOR:

Generate a single AOR per object per band, although the final requested time may be several hours, the HAWC+ team will schedule the object across multiple flights.

The screenshot shows the 'Unified SOFIA Planning Tool (USPOT)' interface. The main window is titled 'Proposal' and contains several fields for proposal configuration:

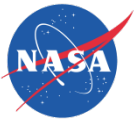
- * Title: [Empty text field]
- TAC Queue: US
- Category: None Selected
- Proposal Type: Regular
- * Target of Opportunity: [Empty text field]
- * Waiver Evaluation: [Empty text field]

A modal window titled 'Please select new Observation' is open, displaying a grid of observation options:

FORCAST:	FORCAST Imaging	FORCAST Grism	FORCAST Grism XD	FORCAST Acquisition	
GREAT:	GREAT Single Point	GREAT Raster Mapping	GREAT OTF Mapping	GREAT OTF Array Mapping	GREAT OTF Honeycomb Mapping
EXES:	EXES HIGH MED	EXES Medium	EXES HIGH LOW	EXES Low	
FIFI-LS:	FIFI-LS	FIFI-LS OTF Mapping			
HAWC:	HAWC PLUS Total Intensity	HAWC PLUS Polarization	HAWC PLUS OTFMAP	HAWC PLUS POLARIZATION OTFMAP	
FPI_PLUS:	FPI_PLUS				

The 'HAWC PLUS Polarization' option is highlighted with a red border. The bottom status bar shows 'Target: None Specified' and 'Total Duration (click to recompute): 0 min Awarded: 0 min'. The system tray at the bottom indicates 'Proposal - <No File>' and 'Net Up'.





Example: Polarization Map



- Keep "Time per full nod pattern (ABBA) (sec)" at 40 sec., which is total integration time (on and off) of 20 sec. on-source time.
- USPOT automatically includes the dither positions and the four polarizer angles. The minimum "Total Exposure Time (sec.)" on source is 80 sec. for total intensity and 320 sec. for polarimetry
- To reach desired total integration time, increase AOR repeats rather than dither positions.

HAWC PLUS Polarization [AOR ID: ...2]

Unique AOR Label: HAWC_POL_C2N--0000

Target: Alpha Ori Type: SOFIA Fixed Single
88.792939, 7.407064 Equ J2000 or 5h55m10.3054s, +7d24m25.430s Equ J2000

New Target Modify Target ... Target List...

Observing Condition & Acquisition / Tracking

HAWC_PLUS

Observation Order: 1

* Total Exposure Time (sec): 1280.0

AOR Repeats: 4

Time per full nod pattern (ABBA) (sec): 40.000

HWP Angle Sequence: 5.0, 50.0, 27.5, 72.5

Initial HWP angle (deg): 5

Example Rotation Angle (deg): 0.000

Half Wave Plate: HAW_E (215)

* PassBand: HAW_E (214)

Dither Patt...: 4 point

Dither Offset

Dither Coordinate System: Sky

Dither Offset X: 0.000

Dither Offset Y: 0.000

Dither Offset Unit: arcsec

Dither Scale: 27.000

Number	Offset East/Row/Perpen...	Offset North/Column/Pa...
1	27.0	27.0
2	27.0	-27.0
3	-27.0	-27.0
4	-27.0	27.0

Import Dither Offsets

Nod & Map

Chop / Nod

Nod/Chop Style: Nod Match Chop

Nod Throw (arcsec): 300.000

Nod Angle Coordinate: Sky

Nod Angle (deg): -180.000

Chop Type: 2-point

Chop Throw (arcsec): 300.000

Chop Angle (E of N) (deg): 0.000

Chop Angle Coordinate Reference: Sky

Chop Angle Coordinate Reference Type Unit: arcsec

Chop Frequency: 10.2 (Hz)

Chop Sync Source: External (HAWC+)

Chop on or off chip: False

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

Cancel Apply OK

