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

3) Total Intensity or Polarization Map?

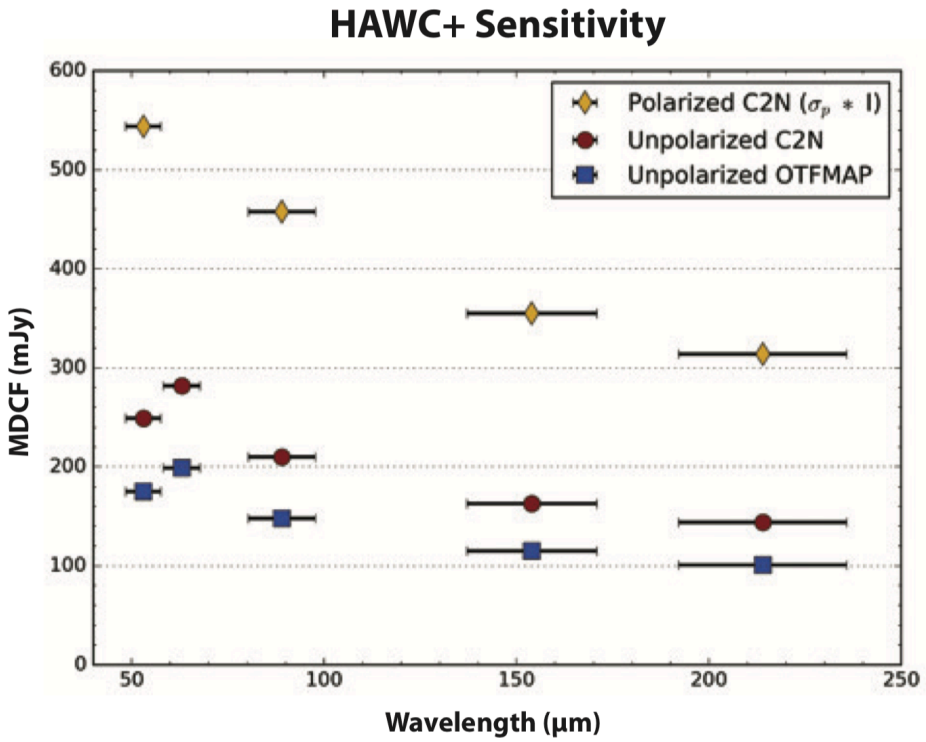
4) Nod Match Chop (NMC) or OTFMAP?
   - OTFMAP is recommended for Total Intensity to reduce overheads
   - Polarization OTFMAP is “shared risk”
   - Note: Scan mode (Lissajous or Box) is determined in Phase II
   - Choose “Off” position that is < 10% of the source flux
   - HAWC+ does not have a beam 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

Preparing HAWC+ AORs: Cycle 9

5) Estimate Source Intensities

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

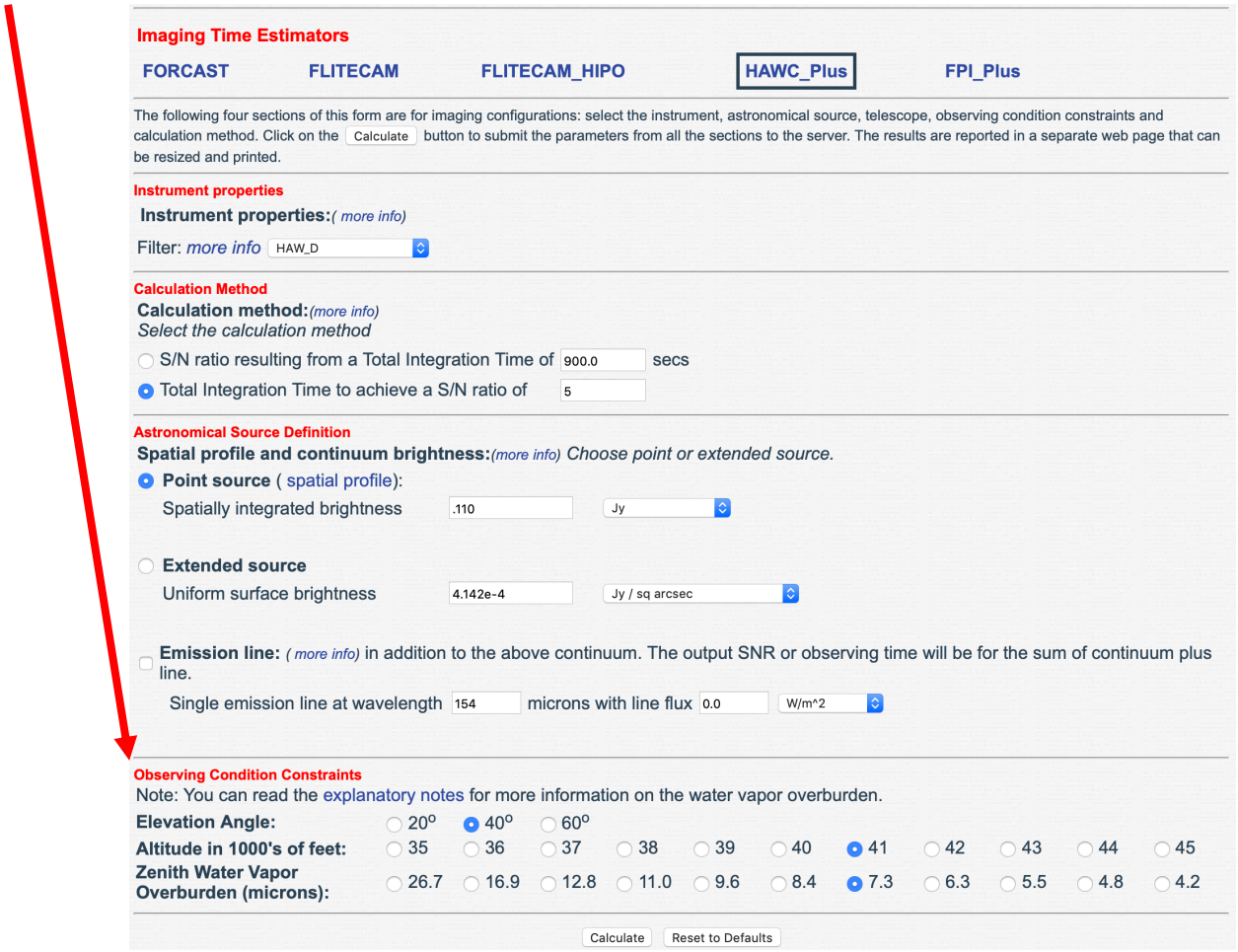
Herschel Archive: http://archives.esac.esa.int/hsa/whsa/ and/or
IRSA Herschel Archive: https://irsa.ipac.caltech.edu/Missions/herschel.html
are very useful for FIR observations



Preparing HAWC+ AORs: Cycle 9

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 Calculate 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 900.0 secs

Total Integration Time to achieve a S/N ratio of 5

Astronomical Source Definition

Spatial profile and continuum brightness: *(more info) Choose point or extended source.*

Point source (spatial profile):

Spatially integrated brightness .110 Jy

Extended source

Uniform surface brightness 4.142e-4 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 154 microns with line flux 0.0 W/m^2

Observing Condition Constraints

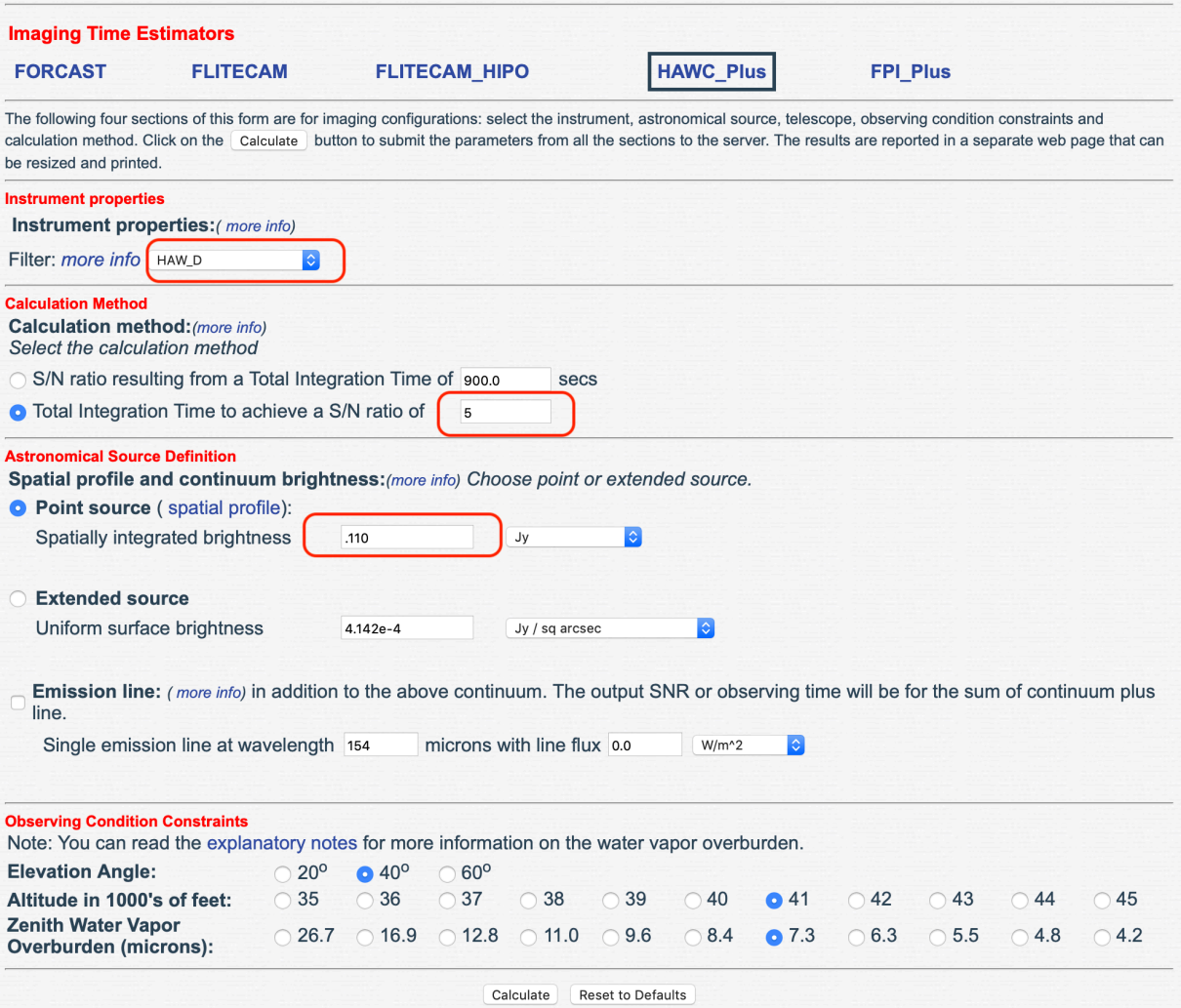
Note: You can read the explanatory notes for more information on the water vapor overburden.

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	

Calculate Reset to Defaults

Example: Point Source Photometry

We want to observe a point source in Band D (154μm).
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)*

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 900.0 secs

Total Integration Time to achieve a S/N ratio of 5

Astronomical Source Definition

Spatial profile and continuum brightness: *(more info) Choose point or extended source.*

Point source (spatial profile):

Spatially integrated brightness .110 Jy

Extended source

Uniform surface brightness 4.142e-4 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 154 microns with line flux 0.0 W/m^2

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

Calculate | Reset to Defaults

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

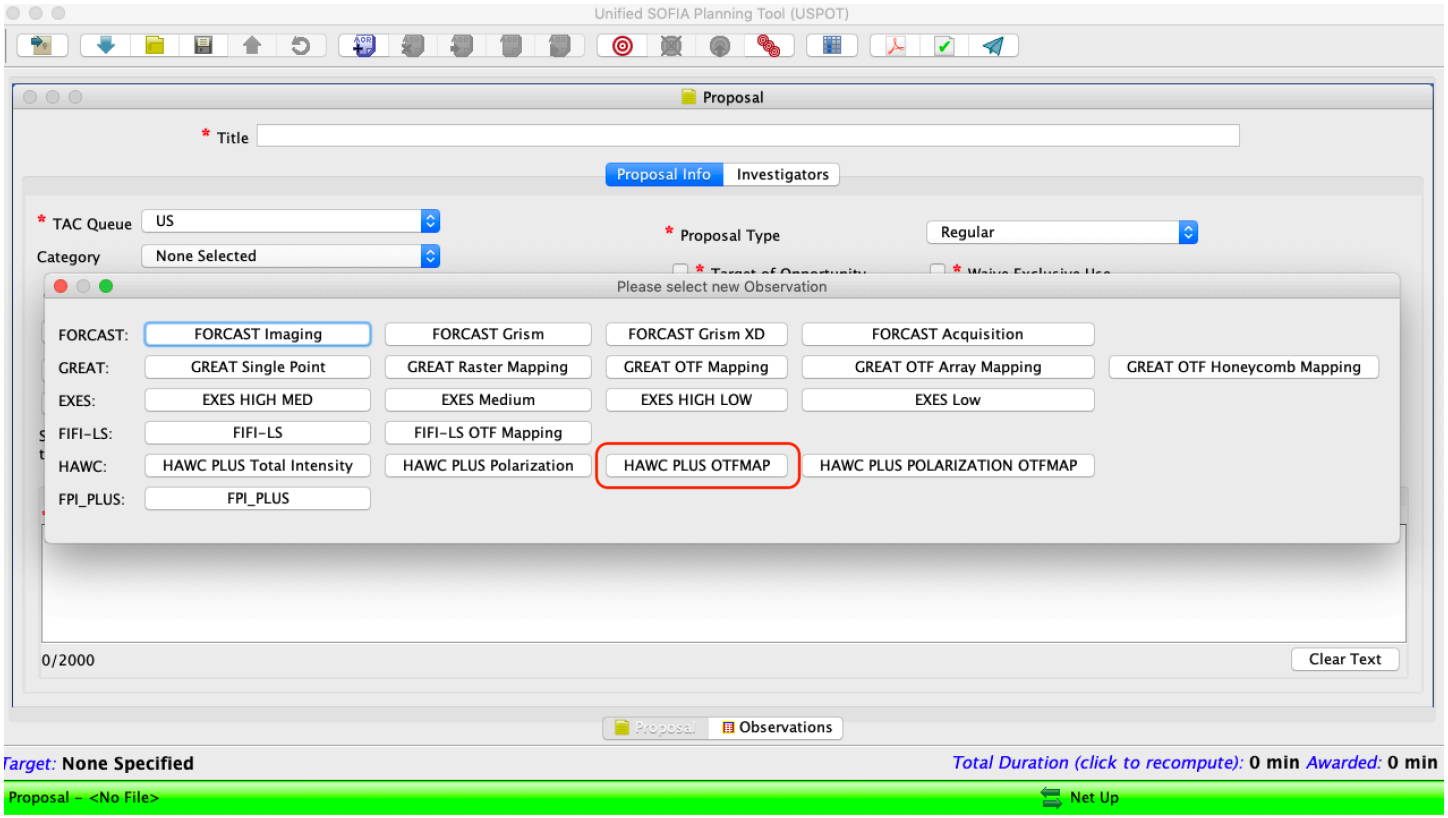
Apparent source size	13.600	arcseconds

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.



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.)

Example: Polarization Map

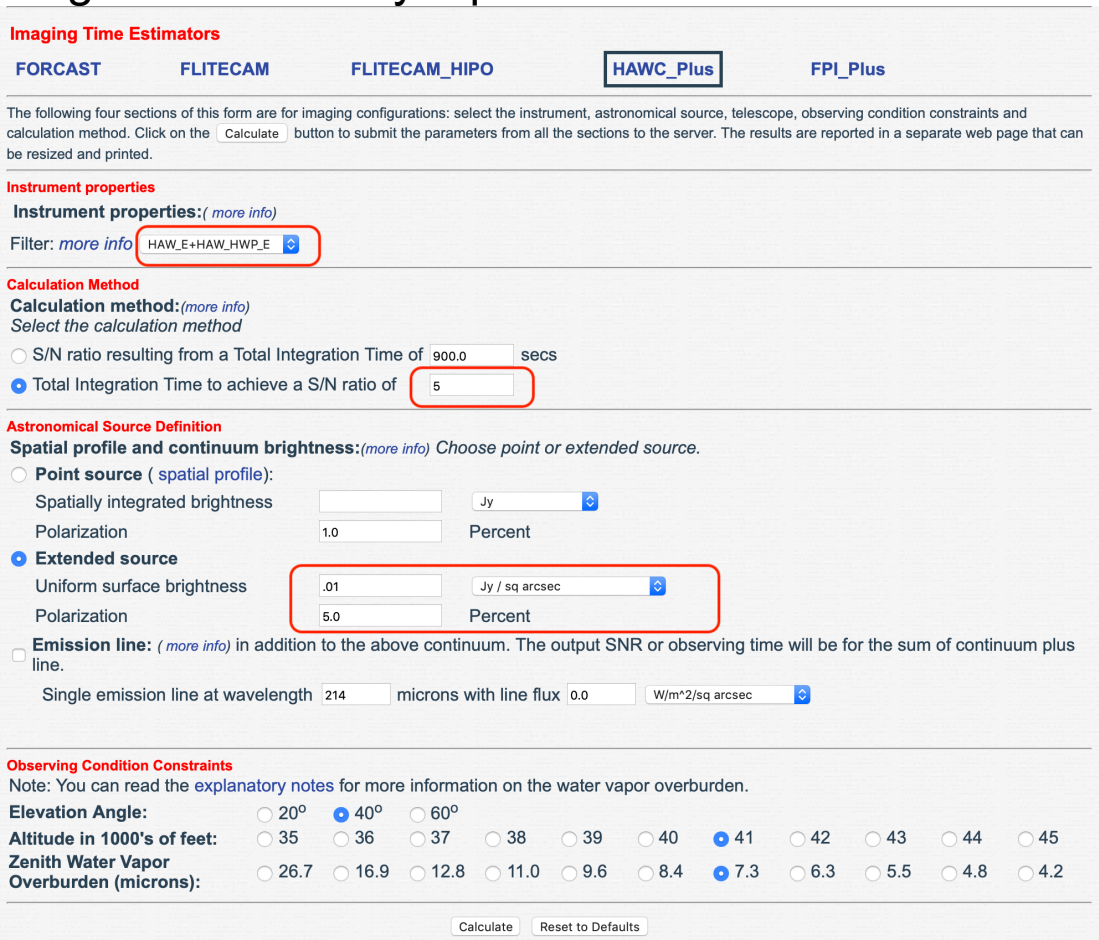
To estimate the source percent polarization:

- 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 250μm with the following minimum intensity:

Surface Brightness: 0.01 Jy/sq arcsec



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 Calculate 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_E+HAW_HWP_E

Calculation Method

Calculation method: *(more info)*

Select the calculation method

- S/N ratio resulting from a Total Integration Time of 900.0 secs
- Total Integration Time to achieve a S/N ratio of 5

Astronomical Source Definition

Spatial profile and continuum brightness: *(more info) Choose point or extended source.*

- **Point source** (spatial profile):
  - Spatially integrated brightness — Jy
  - Polarization 1.0 Percent
- **Extended source**
  - Uniform surface brightness .01 Jy / sq arcsec
  - Polarization 5.0 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 214 microns with line flux 0.0 W/m^2/sq arcsec

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	

Calculate | Reset to Defaults

Example: Polarization Map

HAWC+ Band E (214μm): 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

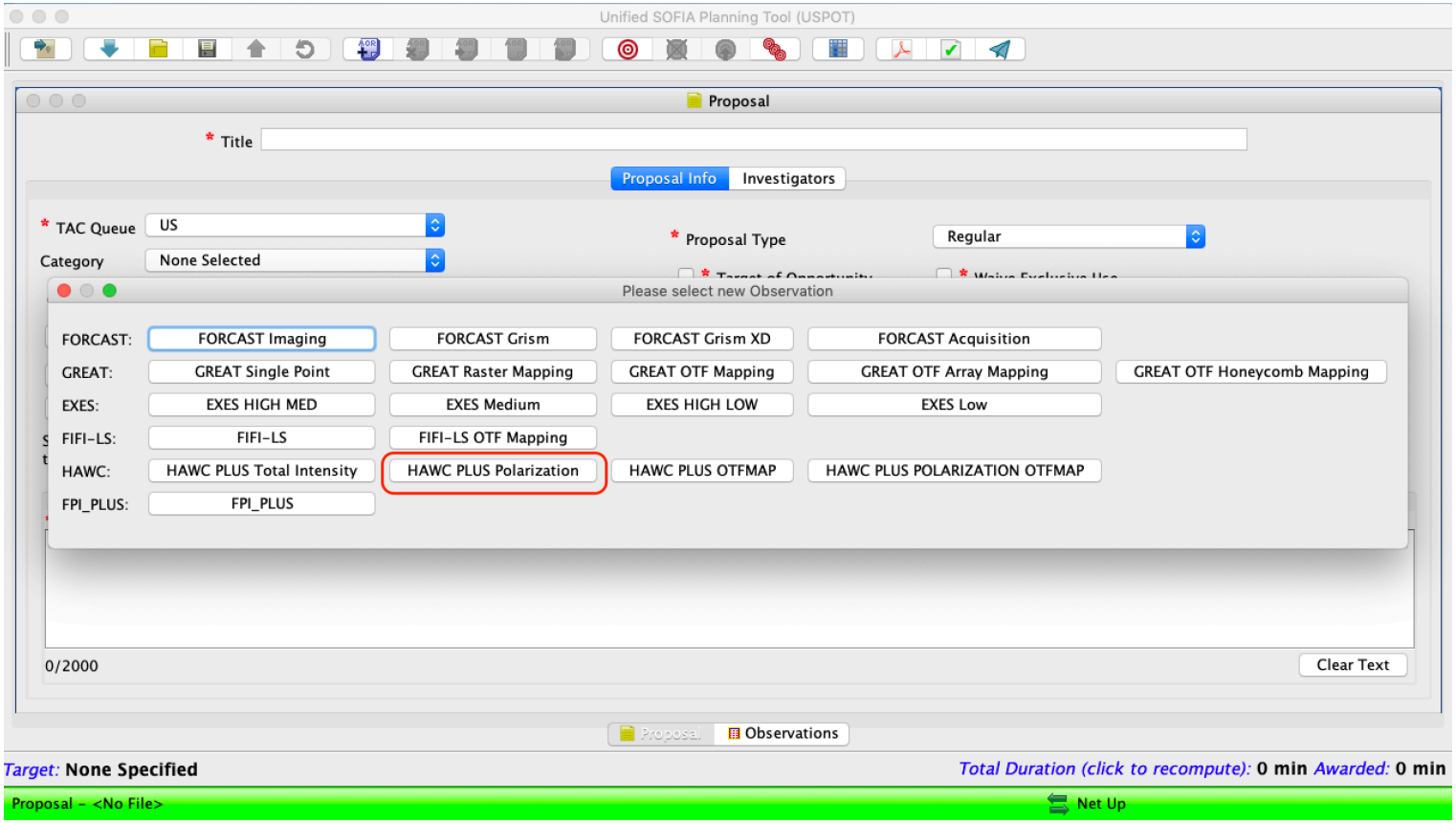
Close Print Help

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.



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.