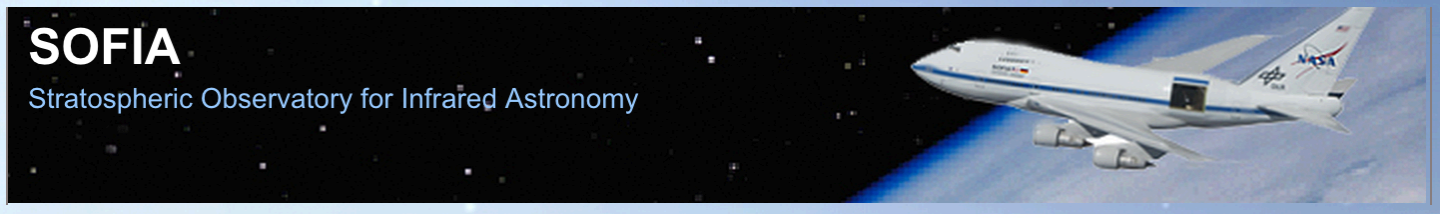
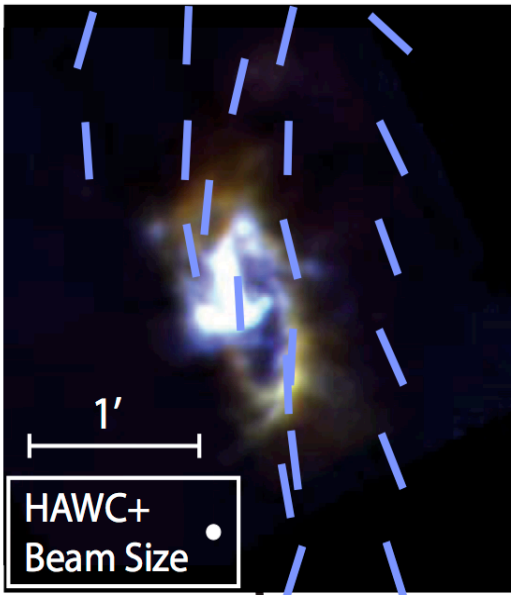
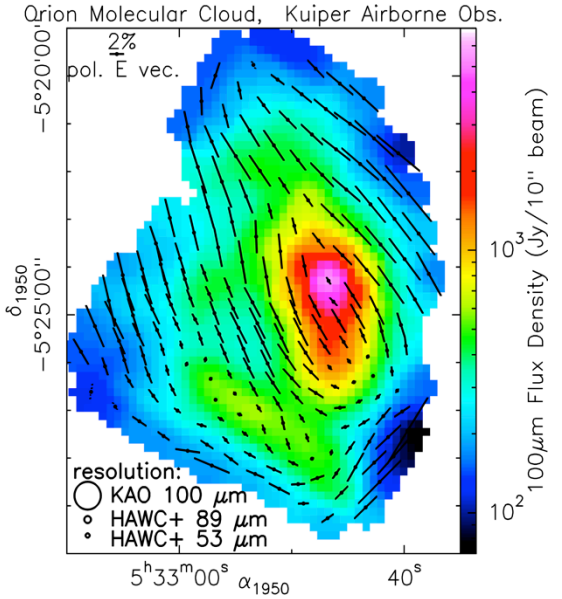


High-resolution Airborne Wideband Camera +

HAWC+ is a Facility-class, far-infrared camera and polarimeter for SOFIA. It is scheduled for commissioning in early 2016. HAWC+'s optics, state-of-the art detector arrays, and upgradability will permit a broad range of important astrophysical investigations. The ongoing HAWC+ upgrade adds capability to measure linear polarization, providing the unique and powerful ability to map magnetic fields in molecular clouds.



Magnetic field vectors (100 µm) overlaid on a SOFIA/FORCAST 3-color image (20, 32, 37 µm) of the circumnuclear disk in the Galactic center (Hildebrand+ 1993, ApJ 417:565, Lau+ 2013, ApJ 775:L37). The angular resolution of SOFIA/HAWC+ will allow for a more detailed mapping of this and many other regions.



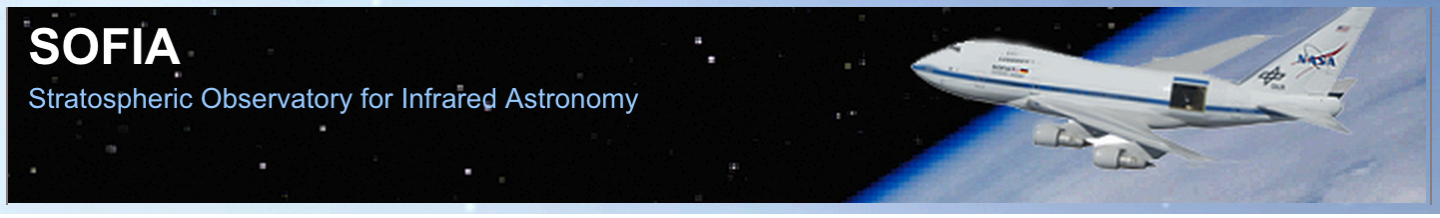
HAWC+ will produce maps of linear polarization, akin to the Kuiper Airborne Observatory map of Orion (*above*; D. A. Schleuning 1998, ApJ 493:811). SOFIA/HAWC+ has much better sensitivity, 10-50× better areal resolution, and multiple wavelength bands. The polarization is due to dust grains aligned with respect to the interstellar magnetic field. Polarization mapping reveals the structure of magnetic fields and estimates their strength.

HAWC+ will investigate many topics, including:

- Estimates of magnetic field strength and turbulent power spectrum in nearby molecular clouds
- Efficiency of dust grain alignment
- Magnetic field configuration of the Galactic Center
- Polarization and (potentially) the primary magnetic field orientation of T Tauri star disks and envelopes
- Magnetic structure in the dense interstellar medium of nearby bright galaxies

HAWC+ will obtain useful polarization maps and images with thousands of vectors in part of a single SOFIA flight.

SOFIA Stratospheric Observatory for Infrared Astronomy · NASA · DLR · USRA · DSI · SETI Institute · JPL Jet Propulsion Laboratory



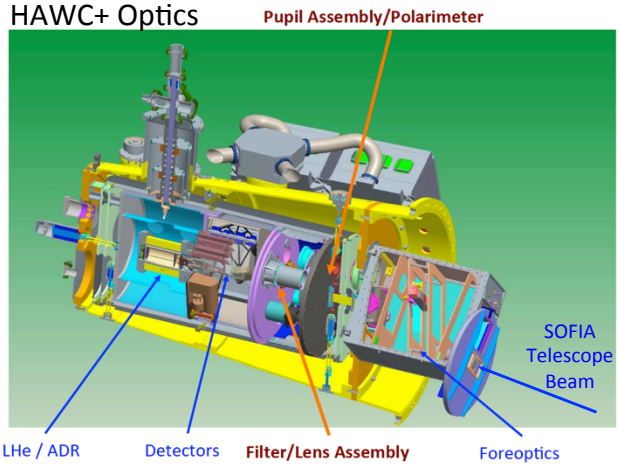
HAWC+ Specifications

Principal Investigator: Dr. Darren Dowell,
Jet Propulsion Laboratory

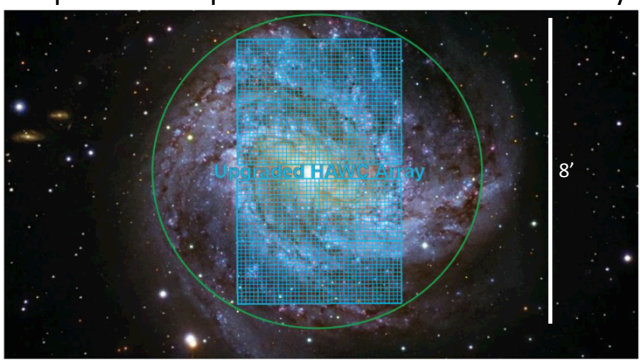
SOFIA Instrument pages - http://www.sofia.usra.edu/Science/instruments

HAWC+ is designed to offer imaging and polarimetry in each of five bands from λ = 53 to 216 μm. NASA/Goddard and NIST are producing the two bolometer detector arrays for HAWC+. For SOFIA far-IR continuum bands, the detectors will deliver background-limited performance with high quantum efficiency. The baseline format of each array is 32×40, and the system is designed to support up to 64×40. HAWC+ uses standard chopped-nodded SOFIA observing patterns for polarimetry and will optimally use cross-linked scans for imaging.

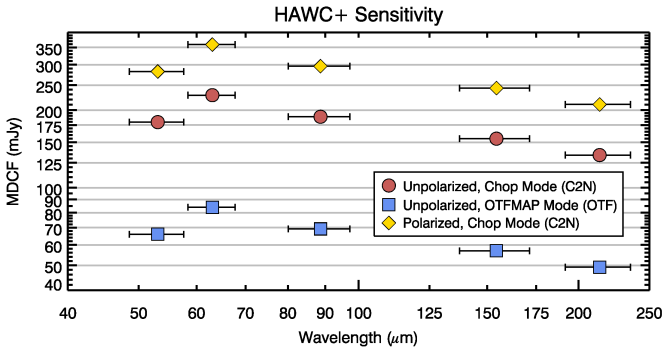
HAWC+ Optics



Expected Footprint of the 64x40 HAWC+ Array



HAWC+ Sensitivity



Sensitivity estimates in units of the Minimum Detectable Continuum Flux (MDCF) into a single beam. Values take into account all expected overheads. For polarization, the plotted data show the polarized intensity p x I, where p is the fractional polarization.

Instrument Parameter	Band A	Band B	Band C	Band D	Band E
NESB[a] (MJy sr^{-1} h$^{1/2}$)	12	10	4.6	1.2	0.57
MDCF[b] (mJy)	57	73	60	49	43
Mapping Speed[c]	0.031	0.11	0.52	21	150
MDCPF	9.0	11	9.4	7.7	6.7
MIfP	20,000	17,000	7600	2100	940

[a]Noise Equivalent Surface Brightness for S/N=1 into a single beam.

[b]Minimum Detectable Continuum Flux for a point source with S/N=4 in 900s.

[c]Real scan rate required to achieve a given NESB. Units: arcmin^2 h^{-1} (MJy sr^{-1})$^{-2}$

[d]Minimum Detectable Continuum Polarized Flux for a point source with S/N=4 in 900s.

[e]Minimum total Intensity required to measure Polarization to an uncertainty level $\sigma_p \leq$ 0.3%. All chop/nod and polarization overhead values have been applied to this value.

Predicted performance for continuum imaging and polarimetry

Band / Wavelength	Δλ/λ	Angular Resolution	Field of View (arcmin)
A / 53 μm	0.17	4.7” FWHM	2.7 x 1.7
B / 63 μm	0.15	5.8” FWHM	4.2 x 2.6
C / 89 μm	0.19	7.8” FWHM	4.2 x 2.6
D / 154 μm	0.22	14” FWHM	7.3 x 4.5
E / 214μm	0.20	19” FWHM	8.0 x 6.1