



# HAWC Science Requirements

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Principal Investigator

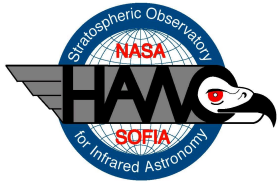


# HAWC

High-resolution Airborne Wide-band Camera



- SOFIA
  - Largest far-infrared telescope
  - Highest angular resolution
- HAWC
  - First generation facility far-infrared camera
  - Covers the 40-300  $\mu\text{m}$  range inaccessible from the ground
  - Principal access to high-angular-resolution, far-infrared imaging for the astronomical community



# HAWC Science



- Formation of stars in our galaxy
- Star formation in external galaxies
- Structure and evolution of proto-planetary and remnant disks
- Return of gas and dust from stars to the interstellar medium
- Composition and life-cycle of interstellar dust
- Interactions between young stars and their environments
- Conditions in regions surrounding active galactic nuclei



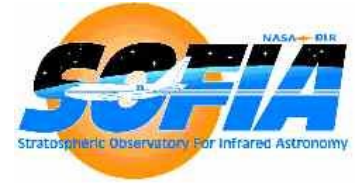
# Scientific Functional Requirements



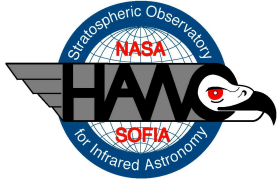
- Image with high sensitivity at spatial frequencies unique to SOFIA
- Map luminosity, color temperature, and optical depth of large-grain component of interstellar dust
- Search efficiently for low-luminosity sources in the presence of bright extended emission
- Resolve multiple sources with separations near the resolution limit of SOFIA
- Observe bright Solar-System objects (science and calibration)
- Easily and accurately combine HAWC data with data from other instruments and facilities
- Rapidly produce calibrated images



# Flowdown to System Level



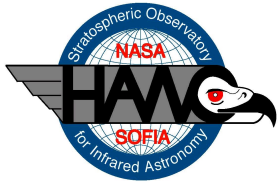
- Spectral passbands
- Pixel sizes
- Photometric sensitivity
- Photometric stability
- Dynamic range
- Cross-talk
- Pointing precision and accuracy
- Image quality
- Frequency response
- Observing efficiency
- Data processing efficiency
- Detector array format and technology
- Operational constraints
- Physical interface
- Electrical interface
- Data system interface
- Simulator interfaces
- Instrument installation
- Airworthiness



# Design Criteria



- Image quality and positional accuracy
- Sensitivity
- Operational efficiency
- Photometric accuracy and stability
- Minimal stray light and ghost images
- Reliability
- Ease of operation
- Ease of maintenance

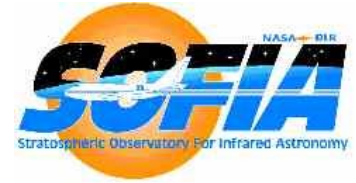


# HAWC System-level Design Requirements

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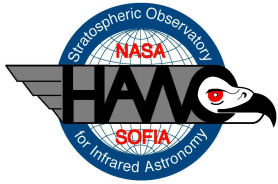


# Optical Requirements

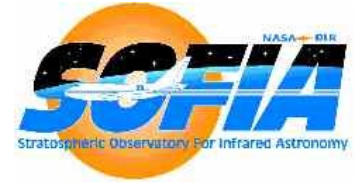


## HAWC Instrument Optical Requirements

		Units	Band 1	Band 2	Band 3	Band 4
Central Wavelength		$\mu\text{m}$	58	90	155	215
Bandwidth ( $\Delta\lambda/\lambda$ )			0.43	0.35	0.20	0.25
$\lambda_{swl}$ (4% of peak)		$\mu\text{m}$	45	73	133	175
$\lambda_{swhm}$ (50% of peak)		$\mu\text{m}$	46	74	140	188
$\lambda_{lwhm}$ (50% of peak)		$\mu\text{m}$	70	106	171	242
$\lambda_{lwl}$ (4% of peak)		$\mu\text{m}$	76	114	182	263
$T_{fore-optics}$			0.96	0.96	0.96	0.96
$T_{window}$			0.58	0.72	0.79	0.80
$T_{cold}$			0.14	0.18	0.22	0.22
$P_{ob}/P_{ib}$ (background power)		%	<1	<1	<1	<1
$N_{ob}/N_{ib}$ (photon noise)		%	<1	<1	<1	<1
$S_{ob}/S_{ib}$ (Rayleigh-Jeans signal)		%	<1	<1	<1	<1
Cross-talk		%	<1	<1	<1	<1
Magnification			2.14	1.42	0.71	0.53
Pixel size		arcsec	2	3	6	8
Image diameter (FWHM)	Standard Mode	arcsec	6.2	8.8	15.4	21.3
	High-res Mode	arcsec	TBD	TBD	TBD	TBD

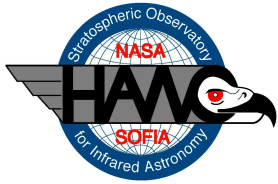


# Photometric Sensitivity



## HAWC Photometric Sensitivity

	Units	Band 1	Band 2	Band 3	Band 4
Central wavelength	$\mu\text{m}$	58	90	155	215
Mean transmission (cold optics)	%	0.14	0.18	0.22	0.22
Mean transmission (warm optics)	%	0.48	0.60	0.66	0.67
Mean transmission (atmosphere, 10 $\mu\text{m}$ precipitable water, elevation 40 $^\circ$ )	%	0.60	0.50	0.65	0.75
NEP (thermal background limit, one pixel)	fW/hz <sup>1/2</sup>	2.27	1.66	0.81	0.61
Frequency range (for background-limited performance)	Hz	5-100	5-100	5-100	5-100
Frequency range (operational for electronics)	Hz	1.25-2000	1.25-2000	1.25-2000	1.25-2000
NEFD (extended source, background limit, Airy disk FWHM, 10 $\mu\text{m}$ precipitable water, elevation 40 $^\circ$ )	Jy/Hz	1.1	1.2	1.0	0.8



# System requirements flow down to the following subsystems



## Major Subsystems

Subsystem	Abbreviation	Reponsible IPT
Detector	DET	Detector
Detector Electronics	DEL	Detector
Cryostat	CRY	Cryogenics
Adiabatic Demagnetization Refrigerator	ADR	Cryogenics
Housekeeping Subsystem	HKS	Cryogenics
Instrument Handling Cart	IHC	Cryogenics
Optics	OPT	Opto-mechanical
Opto-mechanical Subsystem	OMS	Opto-mechanical
External Calibration Subsystem	XCS	Opto-mechanical
Mounting Flange Subsystem	MFS	Opto-mechanical
Instrument Control Subsystem	ICS	Software
Data Processing Subsystem	DPS	Software
Power Conditioning Subsystem	PCS	Systems Engineering