



# HAWC+ Update



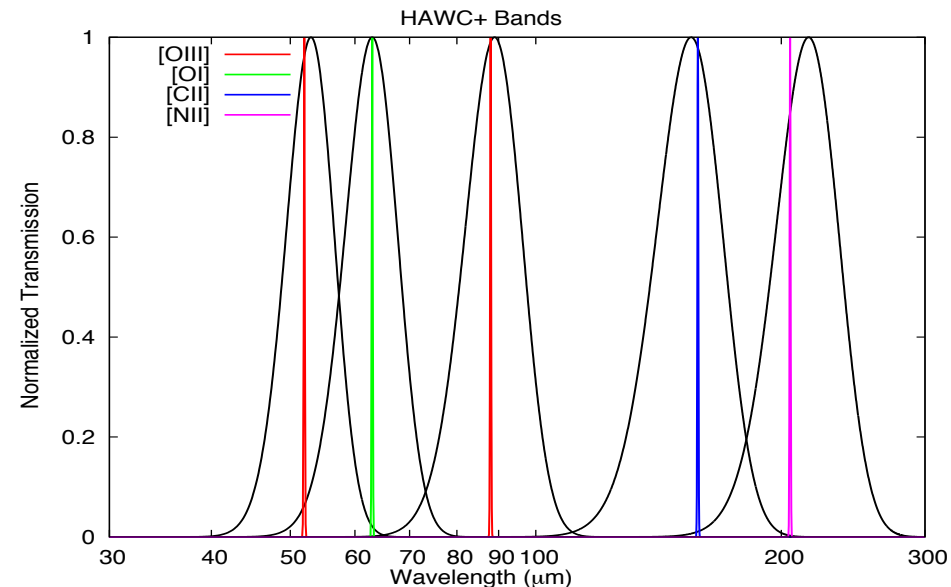
John Vaillancourt, USRA  
HAWC+ Instrument Scientist

- Facility far-infrared camera for SOFIA: spectral range 40–300  $\mu\text{m}$
- Built by University of Chicago (PI: Al Harper) in collaboration with Goddard Space Flight Center
- Upgrade by JPL (PI: Darren Dowell) in collaboration with GSFC, U. Chicago and others



# HAWC/HAWC+ Summary

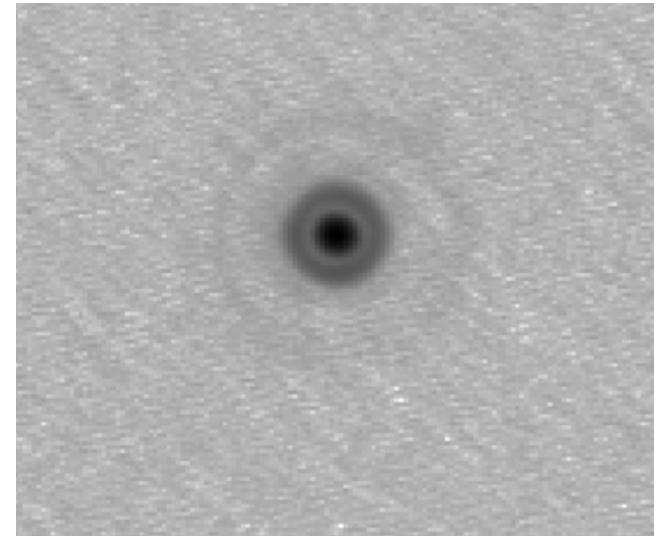
- Four user-selectable filters at 53, 88, 155, and 215  $\mu\text{m}$ ,  $\text{DI}/\text{I} \sim 0.2$ 
  - Upgrade will add 5<sup>th</sup> filter at 63  $\mu\text{m}$



# HAWC/HAWC+ Summary

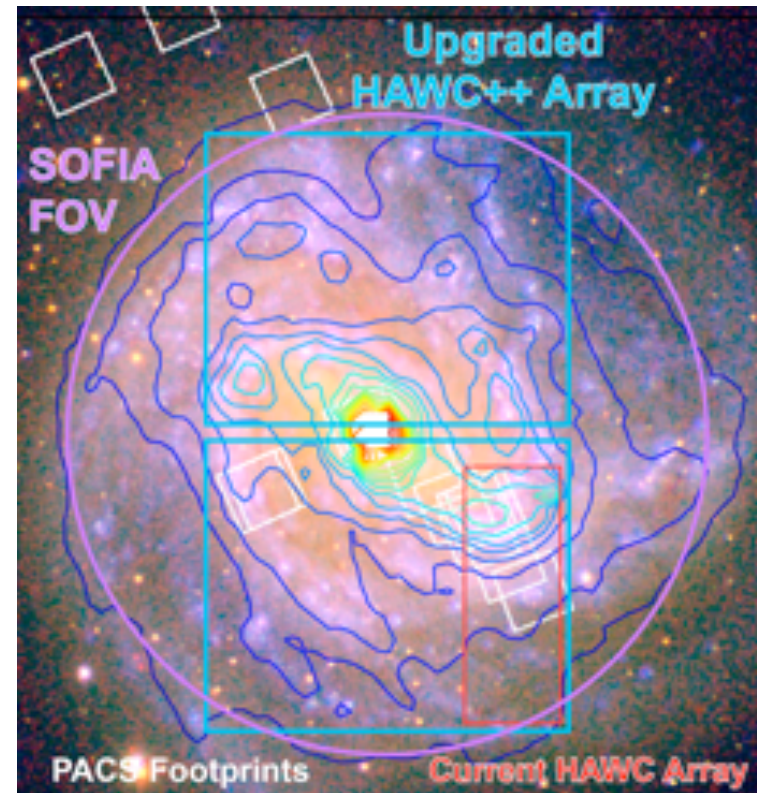
- Four user-selectable filters at 53, 88, 155, and 215  $\mu\text{m}$ ,  $\text{Dl/l} \sim 0.2$ 
  - Upgrade will add 5<sup>th</sup> filter at 63  $\mu\text{m}$
- **Diffraction limited resolution = 5 – 19 arcsec in each passband**

**HAWC PSF measured in lab**



# HAWC/HAWC+ Summary

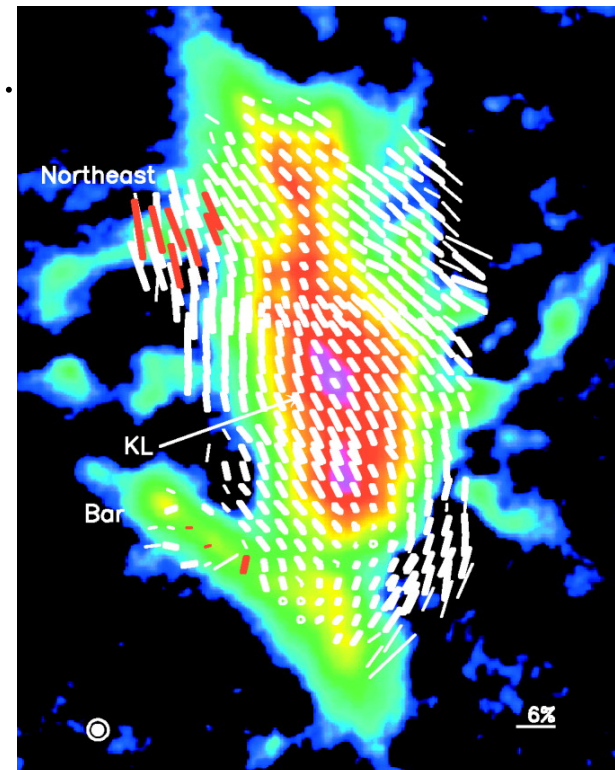
- Four user-selectable filters at 53, 88, 155, and 215  $\mu\text{m}$ ,  $\text{Df}/\text{f} \sim 0.2$ 
  - Upgrade will add 5<sup>th</sup> filter at 63  $\mu\text{m}$
- Diffraction limited resolution = 5 – 19 arcsec in each passband
- **12  $\times$  32 detector array, cooled to 0.2 K**
  - Upgrade to 40  $\times$  64 detector array
  - cooled to  $\sim 0.1$  K
  - 10 $\times$  larger FOV at each passband:  
 $\sim 4 - 46 \text{ arcmin}^2$





# HAWC/HAWC+ Summary


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  - Upgrade will add 5<sup>th</sup> filter at 63  $\mu\text{m}$
- Diffraction limited resolution = 5 – 19 arcsec in each passband
- 12  $\times$  32 detector array, cooled to 0.2 K
  - Upgrade to 40  $\times$  64 detector array, cooled to  $\sim 0.1$  K.
  - 10 $\times$  larger FOV at each passband:  $\sim 4 - 50$  arcmin<sup>2</sup>
- **Upgrade with polarization capabilities**
  - *Two* new detector arrays, one for each polarization component
  - insert rotating wave-plate and wire grid in optical path



# HAWC/HAWC+ Summary

- Facility far-infrared camera for SOFIA: spectral range 40–300  $\mu\text{m}$
- Built by University of Chicago (PI: Al Harper) in collaboration with Goddard Space Flight Center and Rochester Institute of Technology
  - Upgrade by JPL (PI: Darren Dowell) in collaboration with GSFC, U. Chicago, and others
- Four user-selectable filters at 53, 88, 155, and 215  $\mu\text{m}$ ,  $D\lambda/l \sim 0.2$ 
  - Upgrade will add 5<sup>th</sup> filter at 63  $\mu\text{m}$
- Diffraction limited resolution = 5 – 19 arcsec in each passband
- 12  $\times$  32 detector array, cooled to 0.2 K
  - Upgrade to 40  $\times$  64 detector array, cooled to  $\sim 0.1$  K.
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# HAWC+ Milestones

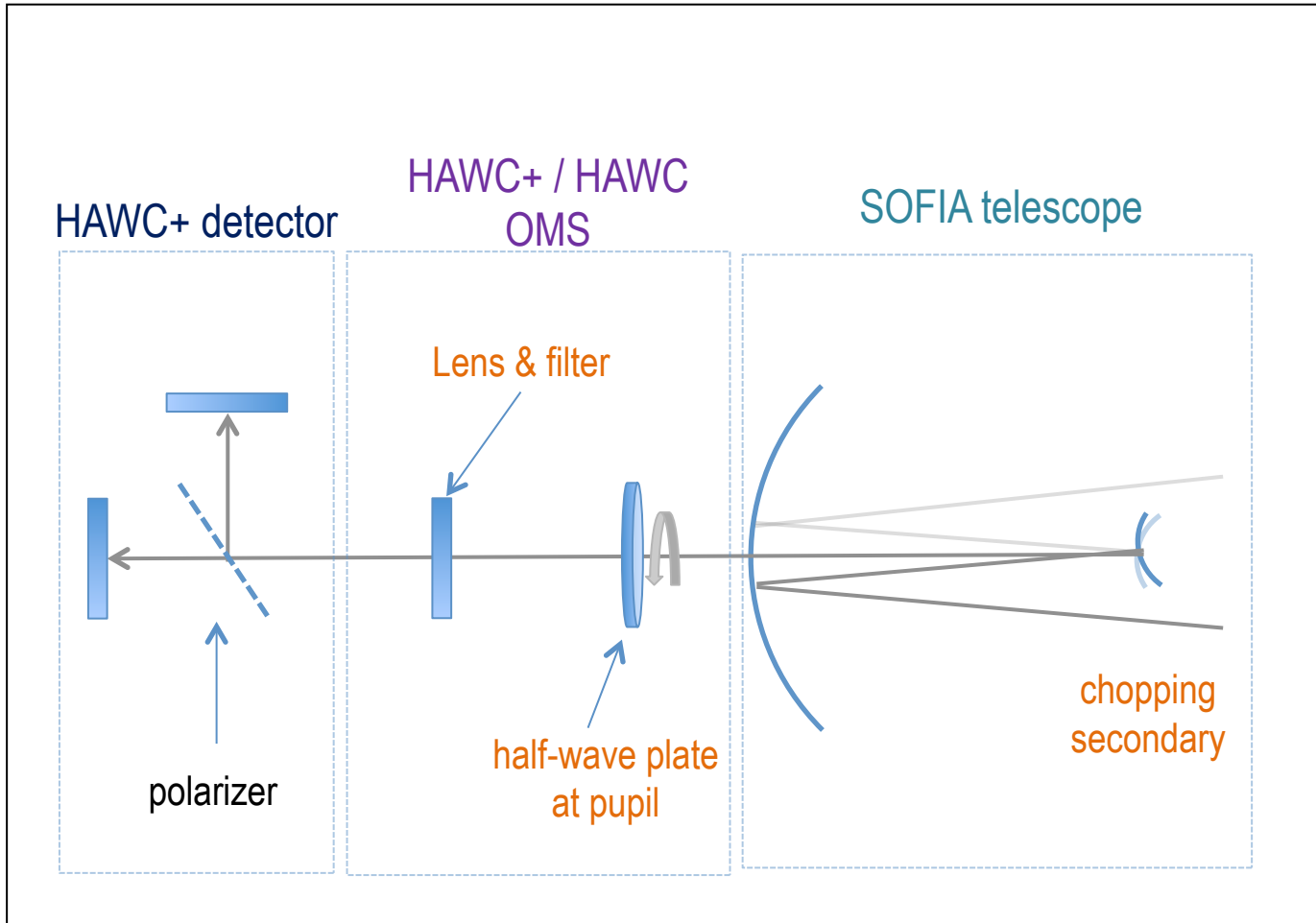
- HAWC successfully passed Pre-Ship review in July 2012
- HAWC+ design details for detectors and thermal spec.'s needed for 1-Kelvin stage are actively being worked (regular telecons)
  - Interface Control Document (ICD) for JPL-GSFC interface in draft form, discussions at SRR
- *Systems Requirement Review (SRR)*: scheduled for 2013-May-8
- Successful fit-check of JPL polarimeter hardware in HAWC cryostat [2013-April-2]
- Working HAWC ship date Yerkes  JPL is 2013-May-15

# HAWC+ Activities

- JPL team witnessed HAWC dewar partial disassembly during polarimeter fit-check
- Regular team telecons to discuss issues related to detector fabrication, installation, and testing
- HAWC wiki migrated to Northwestern, administered there by Nicholas Chapman (NU) and Marc Berthoud (Chicago)
- Goddard site-visit by Software team: discussions of required HAWC+ software (flight & lab) with respect to existing tools for HAWC, GISMO, TES/MCE.
- SOFIA Telescope polarization requirements. Pasquale Temi (NASA Lead) supported by Vaillancourt, Dotson, Dowell, Novak



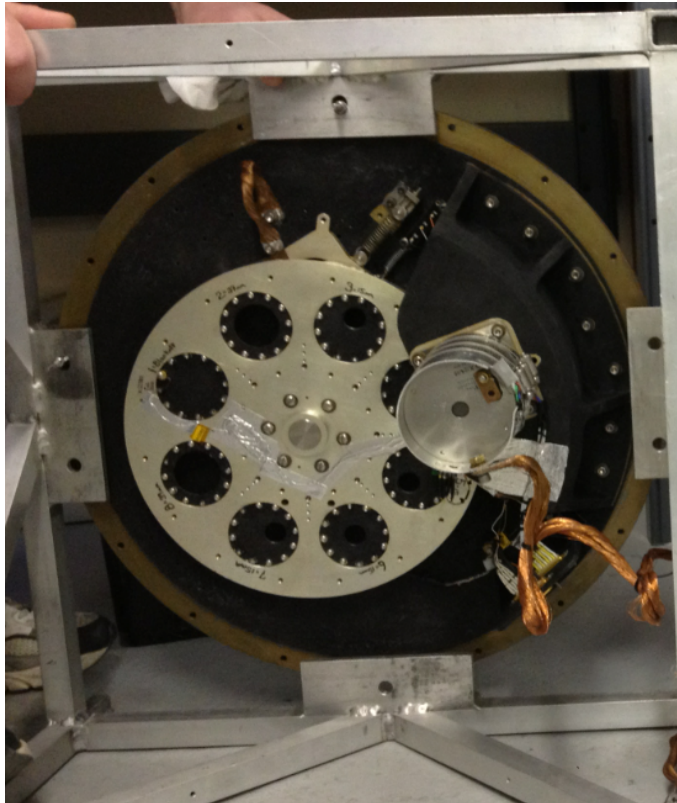
# HAWC+ Optical Path



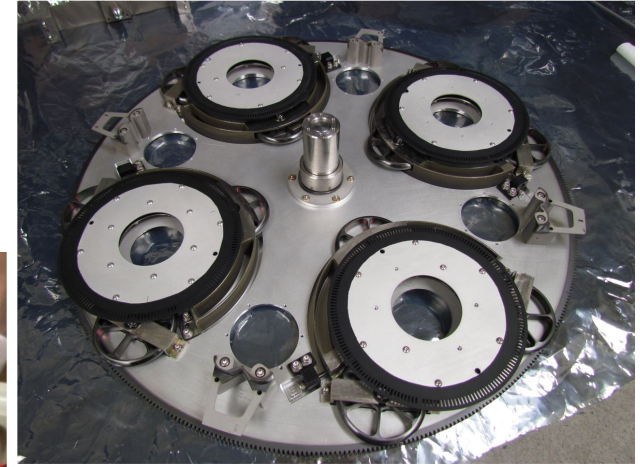
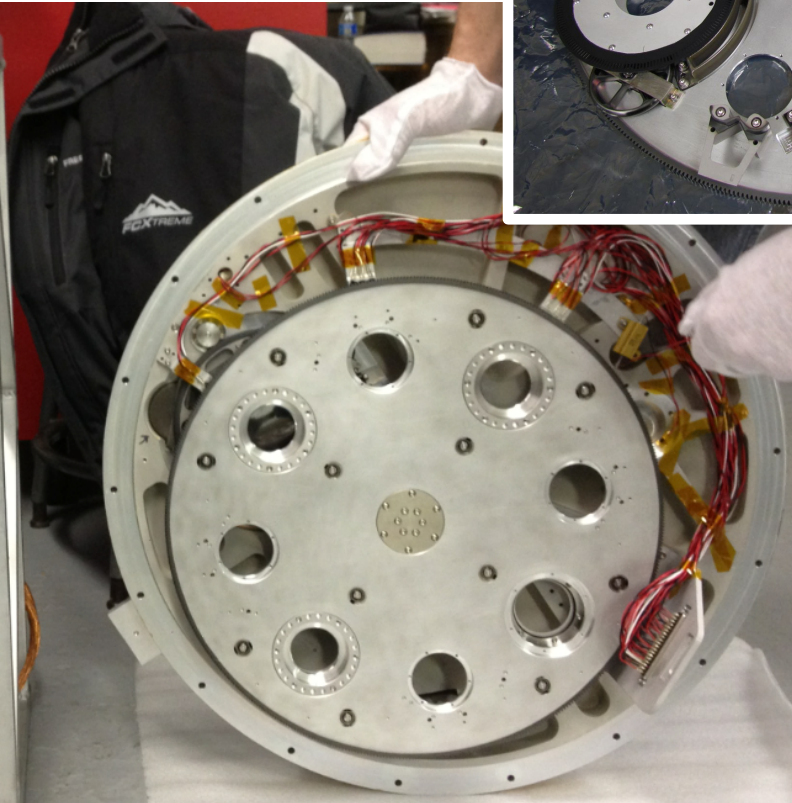
# Polarimeter Fit-Check

Confirmed that new polarimeter hardware fits in existing HAWC cryostat

**HAWC Pupil Wheel**



**HAWC+ Pupil Wheel**



SOFIA Users Group, 2013 April 26

John Vaillancourt

# Polarization Requirements

There currently exist no polarization requirements on the SOFIA telescope. Proposed requirements (not yet accepted by PMB):

- Require: telescope-induced pol'n  $P_{TA} \leq 4\%$  at  $\lambda = 40 - 300 \mu\text{m}$
  - Require: Systematic uncertainty in measurement of  $P_{TA}$ , **< 0.3% over most of 8 arcmin FOV**
  - Goal: telescope-induced pol'n  $P_{TA} \leq 1\%$  at  $\lambda > 3 \mu\text{m}$
- Ø Requirements should allow systematic uncertainty of  $P_{\text{sys}} < 0.6\%$  for astronomical measurements, as specified in HAWC+ instrument proposal. **Spec.'s above were achieved on the KAO at 60 & 100  $\mu\text{m}$**
- Ø Goal would yield  $P_{\text{sys}} < 0.3\%$  for HAWC+, also allow future polarization science at shorter wavelengths