HAWC+ Update

John Vaillancourt, USRA
HAWC+ Instrument Scientist

- Facility far-infrared camera for SOFIA: spectral range 40–300 μm
- 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
• Four user-selectable filters at 53, 88, 155, and 215 µm, Dl/l~0.2
  - Upgrade will add 5th filter at 63µm
• Four user-selectable filters at 53, 88, 155, and 215 μm, Dl/l~0.2
  - Upgrade will add 5th filter at 63μm
• Diffraction limited resolution = 5 – 19 arcsec in each passband
HAWC/HAWC+ Summary

- Four user-selectable filters at 53, 88, 155, and 215 μm, Dl/l~0.2
  - Upgrade will add 5\textsuperscript{th} filter at 63μm
- Diffraction limited resolution = 5 – 19 arcsec in each passband
- 12 × 32 detector array, cooled to 0.2 K
  - Upgrade to 40 × 64 detector array
  - cooled to ~0.1 K
  - 10× larger FOV at each passband:
    - ~4 – 46 arcmin\(^2\)
• Four user-selectable filters at 53, 88, 155, and 215 μm, Dl/l~0.2
  - Upgrade will add 5th filter at 63μm
• Diffraction limited resolution = 5 – 19 arcsec in each passband
• 12 × 32 detector array, cooled to 0.2 K
  - Upgrade to 40 × 64 detector array, cooled to ~0.1 K.
  - 10× larger FOV at each passband: ~ 4 – 50 arcmin²
• 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 μm
• 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 μm, Dl/l~0.2
  – Upgrade will add 5th filter at 63μm
• Diffraction limited resolution = 5 – 19 arcsec in each passband
• 12 × 32 detector array, cooled to 0.2 K
  – Upgrade to 40 × 64 detector array, cooled to ~0.1 K.
  – 10× larger FOV at each passband: ~ 4 – 50 arcmin²
• Upgrade with polarization capabilities
  – Two new detector arrays, one for each polarization component
  – insert rotating wave-plate and wire grid in optical path
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

HAWC+ detector

HAWC+ / HAWC OMS

half-wave plate at pupil

SOFIA telescope

polarizer

Lens & filter

chopping secondary
Confirmed that new polarimeter hardware fits in existing HAWC cryostat

**HAWC Pupil Wheel**

**HAWC+ Pupil Wheel**
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 \( P_{sys} < 0.6\% \) 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 \( P_{sys} < 0.3\% \) for HAWC+, also allow future polarization science at shorter wavelengths