HAWC+ Status
for SOFIA Users Group

C. Darren Dowell for HAWC+ team
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Note: This presentation contains preliminary commissioning and GTO science data. Please consult with HAWC+ P.I. before using or distributing this material.
Topics

• instrument status
• commissioning summary
• pipeline status
• GTO progress
Overall HAWC+ Instrument Status

• Work on instrument in July-August 2016 solved several thermal problems, but not all.
• October 2016: demonstration of science capability; continued commissioning
• December 2016: completion of commissioning; G.I. & G.T.O. science flights for Cycle 4
• May 2017: G.I. & G.T.O. science flights for Cycle 5
• June – July 2017: further work on cryogenic system, plus some other maintenance
• September 2017: next scheduled flights
• January 2018: target date for Acceptance Review
Commissioning Summary

- Preliminary summary of commissioning was reported to NASA in February & March.
- All intended observing modes and configurations work well, except for saturated Band B (62 μm).
- Polarization sensitivity to extended emission is at predicted value (Cycle 4-5) for Bands A (53 μm), C (89 μm), & D (154 μm). Preliminarily ~50% worse than prediction in Band E (214 μm).
- Unfortunately, there appears to have been a factor of ~2 error in the point source sensitivity prediction for Cycle 4-5; updated (worse) sensitivity is making its way into future versions of the Observer’s Handbook.
- Sensitivity for scan mode is less well determined, and it is likely to benefit from improvement to instrument thermal stability.
- Beam shape (diffraction-limited + small pointing jitter) is as predicted with only minor “ghost” images.
- Instrumental polarization has been measured with high precision, and we should be able to meet requirements for systematic error < 0.6% after subtraction.
- Cryogenic system does not have required hold time, and science flights have been typically planned for 8.5 hours total duration by necessity.
HAWC+ Commissioning:
Orion Molecular Cloud

Beam
8"

OMC1
(B-field)

HAWC+
89 μm
Preliminary Data

1.8 min. (elapsed time)

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53 μm

8.7 min. (elapsed time)

154 μm

15 arcmin.
Cooling System Performance

- Liquid helium system is working as designed: one fill/day, in the morning. No issues in flight.
- 1K cooler has held for all flights.
- 0.2K ADR cooler performance varies:
  - URD open run time in Oct. 2016: 5.3, >5.5 hr
  - run time in Dec. 2016: 5.3, 5.2, 4.7, 4.0, 5.6, 5.5, 6.0, >6.2 hr
  - run time in May 2017: >6.2, >6.1, >6.4, >>4.5, 6.0 hr
- Recovery plan:
  - Engineering analysis and redesign for past ~6 months.
  - Advised by NASA tiger team.
  - Implementing redesign now (June 2017).
    - Relatively simple, non-invasive approach.
Cycle 4&5 HAWC+ Flights (so far)

• October & December 2016:
  – 11 flights planned, 1 canceled (instrument servicing problem), 10 completed successfully
  – ~60% of time was commissioning.
  – Remainder was G.I. & G.T.O. science and calibration.

• May 2017:
  – 10 flights planned, 5 canceled (aircraft), 5 completed successfully
  – 4 hours G.T.O. science
  – Remainder was G.I. science and calibration.
Pipeline Status

• As of May 2017, in-flight pipeline is producing maps with good fidelity and providing useful feedback in near real time.

• SI team working with DPS team toward a first data release.
• All of the usable observations have been identified and processed.
• Many aspects of the data look good, including:
  – detector gain flatfielding
  – polarization reproducibility where S/N is high
• However, we are continuing to work on:
  – data cuts and measurement uncertainties
  – instrumental polarization (3 measurement methods)
  – flux calibration
HAWC+ G.T.O. Status and Plans

- G.T.O. targets to date (besides Orion) are in intensity images below. (~9 observing hours total)
- We have high S/N polarization maps for most of the targets; several publications are planned.

Rho Oph A
89 μm

Sgr A CND
53 μm

M82
53 μm

NGC 1068
53 μm
HAWC+ observing modes

- **NMC/C2N - Chop-Nod-Dither-Pol**
  - ABBA nod sequence with 4 HWP positions (left) at each dither position (right)
  - Only delivered mode for polarimetry - Stokes I measured, in addition to Q, U
HAWC+ observing modes

- **OTFMAP – Lissajous**
  - Recommended scan mode for imaging compact sources
  - Works very well!
  - Mars (left) from October; DR 21 (right) from April

360 arcsec pk-pk, 200 arcsec/sec, 60 sec duration
HAWC+ observing modes

- **OTFMAP – Box (a.k.a. raster, waffle)**
  - Recommended scan mode for imaging large sources
  - Works very well!
  - Mars (Band E) shown below
HAWC+ observing modes

- **OTFMAP – Box (a.k.a. raster, waffle)**
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  - Mars (Band E) shown below