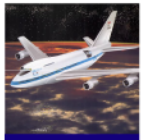


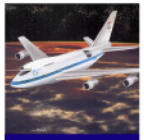
SOFIA Stratospheric Observatory for Infrared Astronomy

Revised SE01-003 SOFIA Image Size Requirement

Pasquale Temi

November 16, 2017

Preamble



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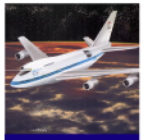
In September we internally discussed changes to the SOFIA performance requirements (SE01-003)

Before final approval we want to socialize the changes with the community and the SUG and accept comments and suggestions.

The original presentation has been distributed to SUG members. Here I will focus on the "*Image Size Requirement*" and summarize the motivations and rational behind the changes.

Motivations



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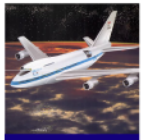
Why we are revising Level 3 Requirements:

- The SOFIA prime mission will end in April 2018
- A senior review is approaching in early 2019
- We need to close the V&V effort on all the high level SOFIA performance requirements (SE01-003).
- Since we are close to the end of the SOFIA Prime Mission, for such requirements we won't pursue waivers

Changing Technical Performance Requirements



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The current senior review effort is promoting a number of key changes including:

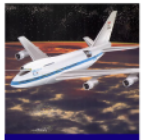
- A new Science vision with focused Science themes that will define and drive the requirements and reposition the Observatory in future years
- Focus on science delivered by the new generation of instruments with consequent shift in capabilities and performance requirements
- Decommissioning some of the first generation instruments in the next few years

We are now tasked with changing the technical performance requirements under this new paradigm.

The proposed approach is to:

- Use current performances as baseline for the requirements
- Leave room for improvements on specific key requirements
- Verify the science impact caused by the changes relative to original scope of the requirements

Proposed changes: Observatory Image Quality: Image Size



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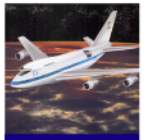
3.2.26: The SOFIA System shall produce point-source images in wavelengths of 5.0-10.0 microns with a diameter corresponding to 50% encircled energy of less than or equal to 3.8 arcseconds at an observing altitude of at least 41,000 feet and exposure times of at least one second, excluding the effects of the science instrument. A recommended goal is to produce images at wavelengths of 5.0-10.0 microns with a diameter corresponding to 50% encircled energy of less than or equal to 1.8 arcseconds

3.2.27: The SOFIA System shall produce point-source images in wavelengths of greater than or equal to 50 microns with a diameter (measured in arcseconds) corresponding to 50% encircled energy of less than or equal to the wavelength (in microns) divided by 9.4, at an observing altitude of at least 41,000 feet and exposure times of at least one second, excluding the effects of the science instrument. A recommended goal is to produce point-source images in wavelengths of greater than or equal to 25 microns with a diameter (measured in arcseconds) corresponding to 50% encircled energy of less than or equal to the wavelength (in microns) divided by 9.4.

Image Size



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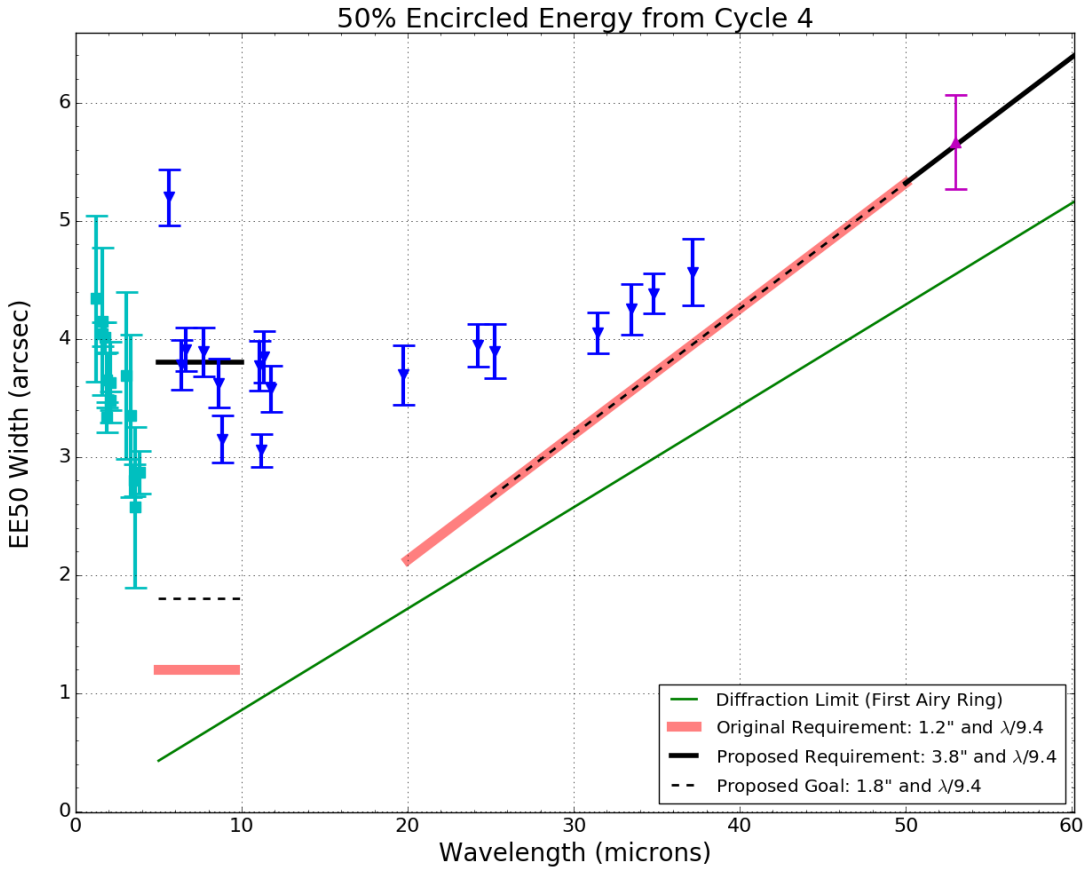
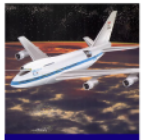


- Existing requirement valid for $\lambda > 50$ μm, as HAWC data shows compliance
- Data from HAWC and aberration analysis by DSI suggest we are diffraction limited at > 50 microns already

Observatory Image Quality: Image Size



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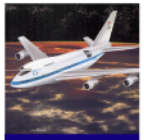
Although it has not been set as a hard requirement, the proposed goal in image size is highly desirable. Improvements in this regard, under the assumption of no interference with science operations, should proceed.

HIRMES, the new generation SI, is envisioned to produce high-impact and high-visibility science and is a central part of the SOFIA future.

EXES has unique capabilities that could be optimized

Observatory Image Quality: Image Size



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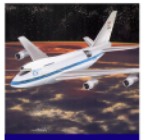
SCIENCE IMPACT:

- The requirement as written is optimized for FIR Observations (λ>50μm). Current performance are adequate if SOFIA position itself as a FAR-IR/Sub-mm platform.

Concerns about HIRMES:

- HIRMES team has evaluated the impact of a larger beam on science at λ<50 μm
    - Water Ice: (35< λ <45 μm) Low resolution grating mode using the Low-Res detector array. Undersample the diffraction beam; sensitivity will be unaffected by the larger beam.
    - Water Vapor: (λ~35 μm) High resolution detector array. The reduction in S/N will result in an increase of observing time of 20%.
    - Since it affects only this one aspect of the science program, it should have an overall effect of about 10% on the overall program.

Observatory Image Quality: Image Size



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SCIENCE IMPACT:

Concerns about EXES:

- EXES team has evaluated the impact of the beam size on science
    - Translate image quality improvements into EXES flight time on SOFIA.
    - Include time improvements from
        - being able to nod along the slit
        - reduced number of observing visits
        - Evaluated targets at various flux densities
        - ,
    - In general terms: improving the image size by ~25% (40%) will decrease on source integration time by ~40% (65%)