Toward a complete SOFIA Archive

Bill Reach

SOFIA Chief Science Advisor
Statement of Purpose

- As the mission matures, archival research becomes a critical element of scientific productivity
  1. SOFIA’s archival research “wedge” is just beginning
  2. Improvement in science archive interface: IRSA
  3. Proposed addition of Archival Research Program
  4. Encouraging publication
1. SOFIA’s Publication Rate

![Graph showing SOFIA’s publication rate over years, with a notable increase starting in 2017.](image_url)
1. What is the publication rate GOAL?

- Assume publication rate proportional to observing time
- Ground-based observatories
  - 220 good nights/year, 8 hr/night
  - Pub rates: 11-21 hr/paper
- Space-based observatories
  - 10-19 hr/paper
- Adopt SOFIA goal 15 hr/paper

<table>
<thead>
<tr>
<th>Telescope</th>
<th>#</th>
<th>Hours/yr</th>
<th>pub/yr</th>
<th>hours/paper</th>
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<tr>
<td><strong>Ground-based Observatories</strong></td>
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<td>Gemini</td>
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<td>235</td>
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<td><strong>Airborne Observatories</strong></td>
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<tr>
<td>SOFIA</td>
<td>1</td>
<td>800</td>
<td>53</td>
<td>15.0</td>
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<tr>
<td>Herschel</td>
<td>1</td>
<td>5400</td>
<td>560</td>
<td>9.6</td>
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<tr>
<td>Chandra</td>
<td>1</td>
<td>7900</td>
<td>430</td>
<td>18.5</td>
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</table>
1. SOFIA Publication rate model

- Publication rate = 1 per 15 Research Hours flown
- Data analysis and interpretation period of 2 years
- Using actual flight history:
2. Science Archive transition to IRSA

- NASA recognizes importance of a robust archive and has funded an effort to transition the archive from NASA Ames to IRSA/IPAC
- Infrared Science Archive (IRSA; led by H. Teplitz) at the Infrared Processing and Analysis Center (IPAC; led by G. Helou)
- IRSA provides access to more than 20 billion astronomical products, including all-sky coverage in 24 bands
  - July 2018: SOFIA/IRSA Design Walkthrough
  - October 2018: SOFIA/IRSA Data Review (all Cycle 4-5 data)
  - Feb 2019: SOFIA/IRSA First release (2 of FORCAST, FIFI-LS, GREAT)
SOFIA data are now available at IRSA!
SOFIA Search

Spatial Constraints
- Object/Position
- Multiple Positions
- NAIF ID
- Precovery
- All-Sky

No spatial constraints requested.

Proposal Constraints
- Abstract Text:
- Program / Plan ID:
- Primary Investigator:

Observation Constraints
- Mission ID:
- AOR ID:
- Observation Date:
Observation Constraints

- Mission ID:
- AOR ID:
- Observation Date:

Instrument Constraints

- Any
- FIFI-LS
- FORCAST
- GREAT

Data Product Constraints

- Processing Stage: □ Level 0 □ Level 1 □ Level 2 □ Level 3 □ Level 4
- Observation Type: Any
- Product Type: Any
### SOFIA Search Results

#### Observation Constraints
- **AOR ID:**
- **Plan ID:**
- **Mission ID:**

#### Details & Data & Coverage

<table>
<thead>
<tr>
<th>Name</th>
<th>ra</th>
<th>dec</th>
<th>Instrument</th>
<th>config</th>
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#### Prepare Download

- ![Prepare Download](image)

#### Catalogs

- ![Catalogs](image)
**SOFIA/IRSA example instrument selection: EXES**

### Instrument Constraints

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Configuration Options</th>
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<tr>
<td>Any</td>
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<td>EXES</td>
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<tr>
<td>FIFI-LS</td>
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<td>FLITECAM</td>
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<tr>
<td>FORCAST</td>
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<tr>
<td>FPI+</td>
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<tr>
<td>GREAT</td>
<td></td>
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<tr>
<td>HAWC+</td>
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### Spectral Element

- Any
- EXE_LOW (10 – 28 μm)
- EXE_MED (5 – 28 μm)
### Instrument Constraints

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Spectral Element</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>Any</td>
<td>Med Res. Spectroscopy (order 1,000)</td>
</tr>
<tr>
<td>EXES</td>
<td>BLUE (51 – 120 µm)</td>
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<tr>
<td>FIFI-LS</td>
<td>RED (115 – 200 µm)</td>
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<tr>
<td>FLITECAM</td>
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<tr>
<td>FORCAST</td>
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<tr>
<td>FPI+</td>
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<tr>
<td>HAWC+</td>
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</tbody>
</table>
SOFIA/IRSA example instrument selection: FORCAST

Instrument
- Any
- EXES
- FIFI-LS
- FLITECAM
- FORCAST
- FPI+
- GREAT
- HAWC+

Camera
- Any
- SWC (5 – 25 \( \mu m \))
- LWC (25 – 40 \( \mu m \))
- Both

Configuration
- Any
- Total Intensity
- Low Res. Spectroscopy (order 100)

Spectral Element
- Any
- G063 (4.9 – 8.0 \( \mu m \))
- XG063 (4.9 – 8.0 \( \mu m \))
- G111 (8.4 – 13.7 \( \mu m \))
- XG111 (8.4 – 13.7 \( \mu m \))
- G227 (17.6 – 27.7 \( \mu m \))
- G329 (28.7 – 37.1 \( \mu m \))
SOFIA/IRSA example instrument selection: HAWC+

- **Instrument**
  - Any
  - EXES
  - FIFI-LS
  - FLITECAM
  - FORCAST
  - FPI+
  - GREAT
  - HAWC+

- **Spectral element**
  - Any
  - Band_A (53 μm, 0.17 μm)
  - Band_B (63 μm, 0.15 μm)
  - Band_C (90 μm, 0.19 μm)
  - Band_D (154 μm, 0.22 μm)
  - Band_E (214 μm, 0.20 μm)

- **Configuration**
  - Any
  - Polarization
  - Total Intensity
3. Proposed addition of Archival Research Program

- SOFIA is considering adding a funded Archival Research Program
  - Hubble, Chandra have many Cycles of funded archival research
  - Specifically-SOFIA research would no longer be eligible for the NASA Astrophysics Data Analysis Program (*multi-mission still included*)

- Synchronize Archival Call with annual Guest Observer & Legacy Calls

- Total funds being considered $500k/yr
  - 10% compared to total funding for Observers of $5M/year

- Goal is to encourage studies encompassing multiple projects
  - Classes of target
  - Multi-instrument, comprehensive studies of regions
  - Encouraging publication of “orphaned” data
4. Encouraging Publications

• “Event” driven encouragement
  • Meeting-in-Meeting at June 2018 Denver AAS
  • Special Session at Jan 2019 Seattle AAS
  • Forthcoming Special Issue of Journal of Astronomical Instrumentation
  • Forthcoming Focus Issue of ApJL

• Routine monitoring and “nagging”
  • Publication status tracked and reported to SOFIA Users Group on a per-project basis
  • Guest Observers contacted by Instrument Scientist through project lifetime
  • Guest Observers contacted by senior science staff when publication overdue
  • Annual survey of Guest Observers includes publication status queries
4. ApJL Focus Issue

First results of HAWC+ and FIFI-LS instruments
13 articles for issue
7 submitted
2 accepted
Goal to open by end of 2018
4. Dec 2018 Special Issue of JAI - status

2. Colditz et al.: Spectral and Spatial Characterization and Calibration of FIFI-LS - the Field Imaging Spectrometer on SOFIA (Accepted)
3. Ennico et al.: An Overview of the Stratospheric Observatory for Infrared Astronomy since Full Operation Capacity (Under review)
4. Fischer et al.: FIFI-LS: The Field Imaging Far-Infrared Line Spectrometer on SOFIA (Accepted)
5. Graf et al.: Image Size and Control System Developments of the Airborne Telescope SOFIA (Accepted)
6. Herter et al. FORCAST: A Mid-Infrared Camera for SOFIA (Accepted)
7. Lammen et al.: Increasing the SOFIA Secondary Mirror Mechanism’s fast steering capability by identification of a structural resonance and its subsequent elimination through mass redistribution. (Accepted)
8. Leppik et al.: SOFIA Flight Planning and Execution (Accepted)
9. Pfueller et al.: The SOFIA Focal Plane Imager: A highly sensitive and fast Photometer for the wavelength range 0.4 to 1 micron (Accepted)
10. Reinacher et al.: The SOFIA Telescope in Full Operation (Accepted)
11. Richards et all. HIRMES: Looking forward to the HIgh-Resolution Mid-infrarEd Spectrometer (Under review)
12. Richter et al.: The Echelon-cross-Echelle Spectrograph for SOFIA (Under Review)
13. Risacher et al.: The 4GREAT spectrometer for the SOFIA Observatory (Under Review)
14. Runyan et al.: The HAWC+ Far Infrared Camera and Polarimeter for SOFIA. (Accepted)
4. Exploiting Data in the Archive

• Effort to date has focused on encouraging guest observers to publish their data

• New emphasis (comments welcome) will be on advertising large or orphaned datasets. Ideas:
  • Web page listing large datasets, links to any papers, guide to data
  • Same for “orphaned” programs
  • Newsletter table
  • more ideas?
Toward a Complete SOFIA Archive

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