Historical Review of Airborne Astronomy: The Evolution of SOFIA

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Dedication

Nans Kunz
1957 – 2016
NASA’s Chief SOFIA Engineer
1985 – 2007
Historical Review of Airborne Infrared Astronomy: The Evolution of SOFIA
1957: (Sir) John Houghton measured 1-6 μm solar flux from a Canberra jet

Martin B-57 Canberra Jet
Maximum Altitude 70,000 Feet
Mid 1960’s: Program of IR astronomy began at NASA Ames, using a Convair 990 and a Learjet.
1966 Gerard Kuiper and Fred Forbes measured 1-2.5 μm spectrum of Venus, from the CV990.
1968: Frank Low and Carl Gillespie made Far-IR observations from the Lear Jet. Their telescope used a chopping secondary, and bolometer detectors.
1969 KAO Development began.

Figure 7. Development timeline of the Kuiper Airborne Observatory
1970: Decadal Survey “Greenstein” Report recommended study of 3-m class stratospheric infrared telescope.

Infrared Panel Members included:
Eric Becklin
Jim Houck
Harold Larson
Frank Low
1970: NASA purchased the C-141 for the KAO from Lockheed for $1M
1971: Ames-built telescope for the Lear Jet became available for the IR community.

User group PIs:
Erickson/Ames, Harwit/Cornell, Houck/Cornell,
Pipher/Rochester, Townes/Berkeley, Witteborn/Ames
1972: KAO Telescope assembled and tested at Ames prior to installation at Lockheed Ontario.
1974: KAO became operational.
Three major activities:

1. KAO operations
   a. Observations / researcher training
   b. Instrument developments
   c. Teacher program

2. SOFIA promotions

3. SOFIA definition/design

1974 – 1995:
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Figure 17. The Main (Telescope) Console (1995). This view, looking forward toward the starboard side of the C-141, demonstrates the significant contribution to operating efficiency, as was the layout of the consoles which enabled effective non-verbal communication.
1974 – 1995: KAO operations

Teachers


1980: First IAU Symposium on IR Astronomy: LAT concept received positive reaction from the community.
1982: Peter Mezger toured KAO, expressed interest for Germany to participate in the airborne program.

1984: Airborne Astronomy Symposium celebrated 10 years of KAO operation. Much enthusiasm for a LAT.

1984: Martin Harwit produced first glitzy brochure promoting airborne astronomy.

1985: Carl Gillespie coined the acronym SOFIA. SOFIA Study Office & Science Working Group formed. NASA-BMFT (DLR) begin collaboration discussions.
1986: SOFIA Technology Workshop hosted U.S. and German contractors interested in building SOFIA. Collaboration with Germany firmly established.

1987: Detailed studies funded. KAO users began serious advocacy efforts.

1990: Decadal Survey “Bahcall” Report recommended development of SOFIA and SIRTF.

1994: Following 2nd Airborne Astronomy Symposium, NASA requested funding to develop SOFIA.

Engineering problem: B747SP is not 3x C141

General configuration of telescope installation

Studies addressed *critical* issues before development:

TELESCOPE: support, isolation

Major Telescope Components

- *Hydraulic spherical bearing isolation*
- *Rubber bladder supports*
1974–1995: SOFIA Definition, Design Studies addressed *critical* issues before development:

AIRCRAFT: cavity door and shear layer control.

Aft Ramp

Ames Wind Tunnel tests
1995: Congress was deliberating the budget.

A SOFIA Science Evening at German Embassy in D.C. was organized by Hans Peter Röser

Talks given by
David Hollenbach, NASA Ames
Reinhard Genzel, MPI Garching
France Cordova, Chief Scientist NASA HQ

Attended by:
NASA HQ Officials
SOFIA Science Working Group
> 100 Congressional Staffers

Congress approved SOFIA funding one month later.
1995: KAO operation ended to help fund SOFIA.

**KAO Focal Plane Instrument PIs in 1995***

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<tr>
<th>A. Betz, Colorado</th>
<th>J. Bregman, NASA Ames</th>
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<td>E. Dunham, NASA Ames</td>
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<td>D. Harper, Yerkes</td>
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<td>T. Herter, Cornell</td>
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<td>H. Moseley, NASA GSFC</td>
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<td>F. Witteborn, NASA Ames</td>
<td>J. Zmuidzinas, Caltech</td>
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These and other KAO users – in particular Dan Lester and Harley Thronson – advocated SOFA at NASA HQ, in the science community, and in congress.

*Not all 16 flew in 1995, but all instruments were highly advanced, had flown.*
Kuiper Airborne Observatory (KAO)  
1974 - 1995

A Lockheed C-141 Star Lifter with a three-foot diameter telescope. 

Based at NASA Ames Research Center in California

>300 investigators, ~50 Ph.D.s, ~40 instruments, 
1463 research flights, ~9200 observing hours
Many users came to pay their respects.

SOFIA was supposed to fly in five years.

The decade+ of prior study paid off: the technical features of SOFIA were developed with no surprises.

Organization of the project:
1997: Principal People at Start of SOFIA

Caroff
Wiltsee
Kunz
Erickson
Dunham

NASA

DLR

USRA

Himmes

MAN

K-T

Bonner
Becklin
Davidson
Kärcher
Bittner
1997 – 2007: Development

1997: *Clipper Lindbergh* B747SP acquired
1997 – 2007: Development

Optics
1997 – 2007: Development

2001: Telescope structure

Primary mirror cell - CFRP

Deformation analysis
1997 – 2007: Development

2001: Telescope assembly in Augsburg
1997 – 2007: Development

2002: Aircraft modification in Waco
1997 – 2007: Development
Aircraft modification
Prior engineering design
1997 – 2007: Development

2002: Telescope delivered to Waco.
1997 – 2007: Development
2003: Telescope installed.
1997 – 2007: Development
2004: Proof pressure test.
1997 – 2007: Development

2004: First light.
1997 – 2007: Development

2004: First light.
1997 – 2007: Development

2005: Ames team installs their door

Aft Ramp
1997 – 2007: Development

April 2007: First flight!
1997 – 2007: Development
June 2007: Celebration at AFRC.