



SOFIA

Funding of First and Next Generation German Science Instruments



Heritage

- Two German instruments have been developed for SOFIA
 - FIFI-LS
 - GREAT

- Development of the instruments were fostered through participation in the Infrared Space Observatory (ISO) and the Kuiper Airborne Observatory (KAO)

- Both GREAT and FIFI-LS have predecessors which have been flown extensively on the KAO (on invitation by NASA!)

- In 1997 the development of GREAT and FIFI-LS as we know them today started in earnest



FIFI-LS

- Far Infrared Field Imaging Line Spectrometer
 - Developed by MPE Garching, MPIA Heidelberg, and - perhaps soon - IRS Stuttgart
 - Studies star formation and ISM on all scales, galactic & extragalactic
 - Examples are mapping the CII and OI lines
 - Equipped with two grating spectrographs
 - Channel 1 1,43 - 2,72 THz (210 - 110 μm)
 - Channel 2 2,72 - 7,15 THz (110 - 42 μm)
 - With two 25x16 Ge:Ga detectors



GREAT

➤ German Receiver for Astronomy at Terahertz Frequencies

➤ Developed by MPIfR Bonn, Universität zu Köln, MPS Katlenburg, DLR-PF Berlin

➤ Studies ISM, Molecular Clouds, Planetary Atmosphere, Comets

➤ Channel 1 1,25 - 1,50 THz (240 - 200 μm) H₂D, NII

➤ Channel 2 1,82 - 1,92 THz (165 - 156 μm) CII

➤ Channel 3 2,40 - 2,70 THz (125 - 111 μm) HD

➤ Channel 4 4,70 THz (63 μm) OI

➤ At any time two channels measure simultaneously with two mixers and two polarizations each

➤ Low resolution (1MHz) and High Resolution (0.06 MHz) Spectrometers



Funding Arrangement

- Airborne Observatories are generally not a part in the DLR Space Program
- So a “deal” was agreed on between the German Scientists and DLR:
 - The Science Institutes develop their instruments and participate in observation campaigns without DLR funding
 - The DLR takes the responsibility for the development of the Telescope and for a contribution to the operation of SOFIA
- On this basis the Memorandum of Understanding for the SOFIA Program was agreed between NASA and DLR



Funding of German Instruments (I)

- Funding for the German institutes for SOFIA instruments were thus provided by
 - Universities (internal resources, mainly personnel)
 - Deutsche Forschungsgemeinschaft (DFG) supporting Universities
 - Max-Planck-Gesellschaft resp. Institutes (MPG)
 - DLR Research and Development (R&D)

- This functioned quite well and by 2005 both German instruments were close to be ready for flight, at least with the majority of their channels (Funding had already been stretched to be in line with the program delay at that time)



Funding of German Instruments (II)

- But starting in 2005
 - when learning about the substantial schedule delays of SOFIA,
 - the attempts to cancel the program in 2006
 - and with no science to be presented at the reviews
- Funding was reduced (MPG) or even cancelled (DFG and DLR-R&D)
- The following years the institutes just kept the status of their instruments using limited internal resources
- To secure the German investments and to reduce the threat to loose the science support in Germany, the DLR jumped in to support the teams



Funding of German Instruments (III)

- After the re-organization of the program at NASA in 2007, DLR provided grants starting in 2008 to allow the institutes to finalize the instruments
- Those grants are terminating by the end of 2011
- So the Scientists and DLR agreed to jointly start talks with all involved funding entities to discuss the future funding of German instruments for SOFIA
- Not surprisingly these talks were planned to start after the Telescope Assembly Characterization and First Light Flight and after this Asilomar Conference
- German science community and DLR are confident that both events will definitely contribute positively to the outcome of those talks



Future Developments GREAT

➤ Near term

- Re-assemble GREAT and ship to the DAOF (asap!) with channels 1 and 2 (definitely) and channel 3 (probably) for Early Science flights in spring 2011 (channel 3 not included in AO for Early Science)
- Implement channel 4 to be ready for the following flights in 2012

➤ Medium term

- Develop and implement 4-pixel or 7-pixel array

➤ Long Term

- Modular design allows continuous upgrade to observe more lines and at even higher frequencies
- Large format heterodyne arrays



Future Developments FIFI-LS

➤ Issue

- Despite funding support by DLR the MPE in Jan 2010 decided to terminate the involvement in SOFIA for various reasons

➤ Potential Solution

- The Institute of Space Systems (IRS) of the University of Stuttgart is planning to take over FIFI from the MPE
- The MPE will support finishing the instrument and the know-how transfer to the IRS
- Once FIFI is fully assembled, tested and calibrated it will be shipped to the DAOF for first observations
- FIFI was since long planned to become a part time Facility Instrument and NASA/USRA were already funding the required adaptation (software I/F)
- Finally it will become a Facility Instrument



Outlook

- There is optimism that we will solve the instrument funding issues in Germany
- Reaching a reasonable flight rate in 2012 and a speedy ramp-up to the planned 1000 research hours per year would definitely help!
- There will be state of the art instruments from German institutes beyond FIFI and GREAT in the future



So I dare to FORCAST that SOFIA will provide GREAT contributions to the understanding of many astrophysical questions with state of the art instruments, both US and German

Thank You for Your patience!