Pilot Study on Aircraft Noise and Sleep

Project 17

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ASCENT
AVIATION SUSTAINABILITY CENTER

Introduction

- Field studies are needed to acquire current US data on sleep disturbance relative to varying degrees of aircraft noise exposure to inform any potential policy considerations
- An inexpensive methodology of using actigraphy and electrocardiography (ECG) has previously been found to provide a sensitive measure of awakenings
- We established the feasibility of having study participants complete unattended ECG and actigraphy measurements in a 3 night study near Philadelphia Airport
- Based on lessons learned from the Philadelphia study, the methodology was further refined and data collection for a second pilot study near ATL airport was finalized

Objectives

- Definition: A **pilot study** is a small scale preliminary study conducted in order to evaluate feasibility, time, cost, adverse events, and improve upon the study design prior to performance of a full-scale research project
- More specifically:
  - Establish feasibility of unattended acquisition of acoustic and physiologic field data (no field staff)
  - Determine field study recruitment methodology that maximizes response rate and minimizes cost
  - Begin sample size calculation for a National Sleep Study based on data gathered at US and German airports
  - Refine methodology for automatically detecting aircraft noise events in recorded sound files

Schedule and Status

Period	Tasks
10/2015-9/2016	**Study Preparation:**
	• Design recruitment questionnaire
	• Develop study protocol and obtain Institutional Review Board (IRB) approval
	• Determine airport and obtain flight operations, predict L_{night} levels and number of overflights, identify sampling regions based on predictions
9/2016-9/2018	**Data Acquisition and Data Analysis:**
	• Mail out recruitment questionnaires
	• Mail out equipment for in-home sleep study
	• Analyze survey data and acoustic and physiological data collected during in-home sleep study

Currently in no-cost extension

Approach-Recruitment Survey

- Brief surveys were mailed to randomly selected households in 10 sampling regions:
  - Five sampling regions East and West of the airport
  - Noise categories: < 40 dB (control region), 40-45 dB, 45-50 dB, 50-55 dB, and > 55 dB Lnight
- The survey contains sleep, health, and demographic questions
- Primary purpose of the survey is to determine eligibility for an in-home sleep study
- Participants indicate whether they would like to take part in the home sleep study on the survey
- The survey can be returned using a prepaid envelope or completed online

Recruitment Survey

17 mailing waves (each wave consisted of 240 addresses – 4,080 addresses total)

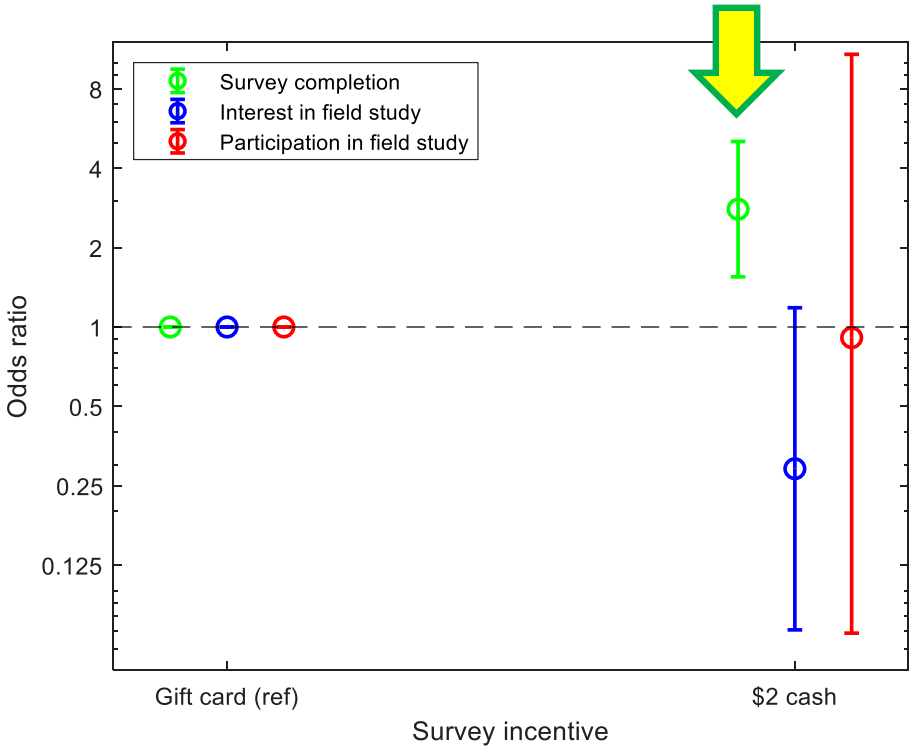
- **Incentive for returning the survey**
  - Promised $2, $5, or $10 Amazon gift card (waves 1-5)
  - Pre-paid $2 cash (waves 6-17)
- **Survey length**
  - Long (waves 1-7, 10-17)
  - Medium (contains all eligibility questions, wave 8)
  - Short (additional telephone screening necessary, wave 9)
- **Subject compensation for field study**
  - $100 (waves 1-5)
  - $150 (waves 6-9)
  - $200 (waves 10-17)
- **Survey follow-up**
  - No follow-up (waves 1-4, 11)
  - Pre-notification postcard (wave 5)
  - 3-wave follow-up (waves 6-10, 12-13)
  - 2-wave follow-up (waves 14-17)

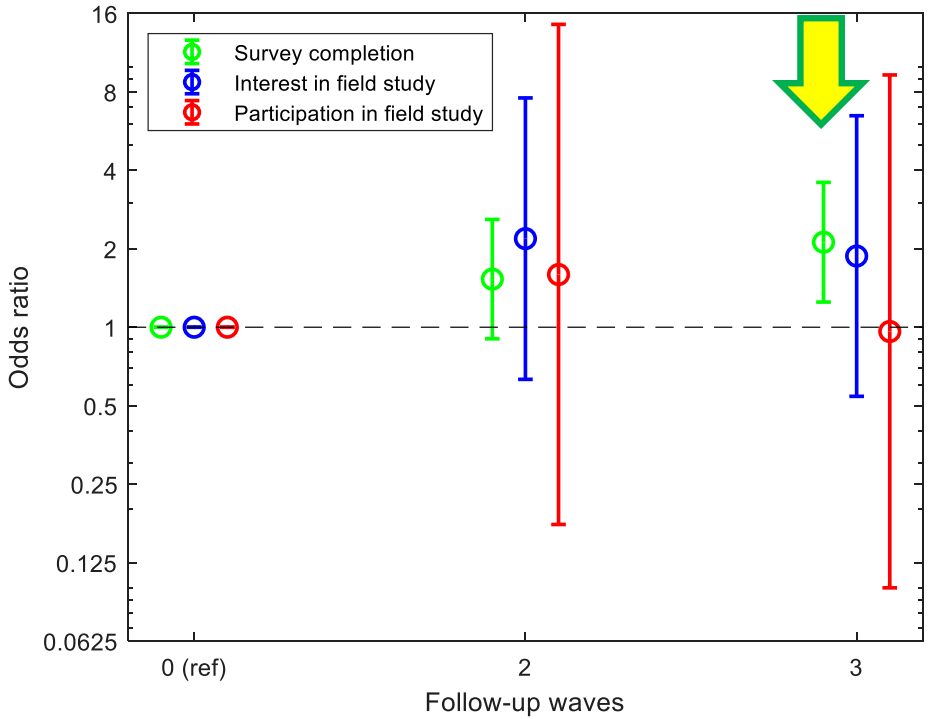
Survey approach effectiveness

- Binomial logistic regression
  - Model 1
    - Survey incentive ($2 cash/gift card)
    - Survey length (short/medium/long)
    - Number of follow-up waves (0/2/3)
    - Field study incentive ($150/$200)
  - Model 2. Same as Model 1 plus…
    - Noise exposure category (<40/40-45/45-50/50-55/>55 dB)
    - Direction from airport (West/East)
  - Model 3 (completed surveys only). Same as Model 2 plus…
    - Sex (male/female)
    - Age category (<30/30-39/40-49/50-59/60-69/≥70 years)
- Results consistent across models
  - Next slides report results from fully adjusted models
    - Model 2 for survey completion
    - Model 3 for interest in field study and participation in field study

Survey approach effectiveness

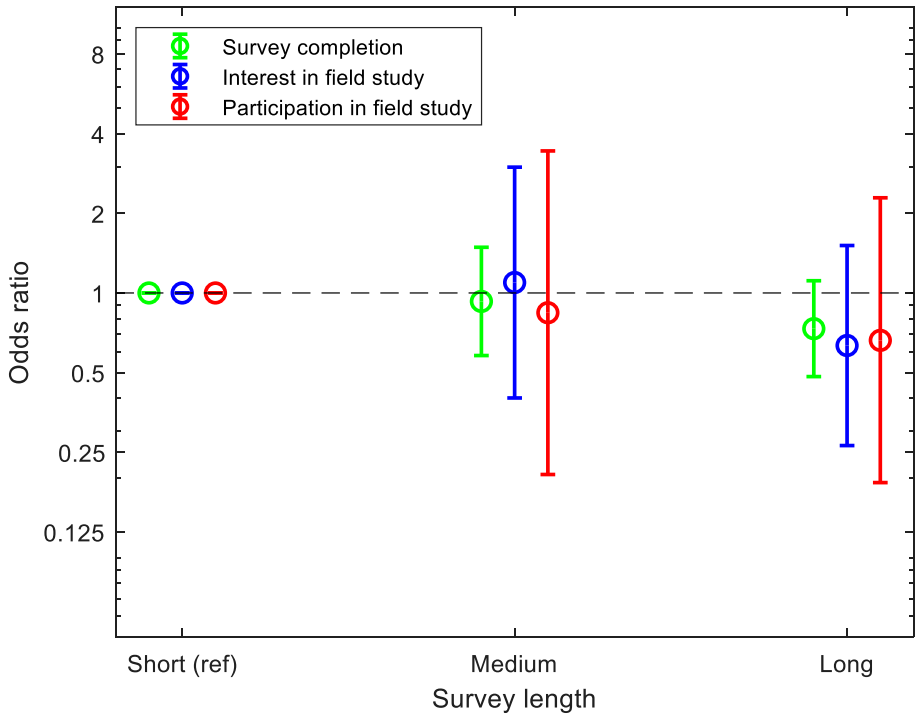
- Survey incentive (left)
  - Higher survey completion with $2 vs gift card ($p<0.001$)
  - No significant effect on interest or participation in field study
- Follow-up waves (right)
  - Higher survey completion with 3 follow-up waves ($p<0.01$)
  - No significant effect on interest or participation in field study

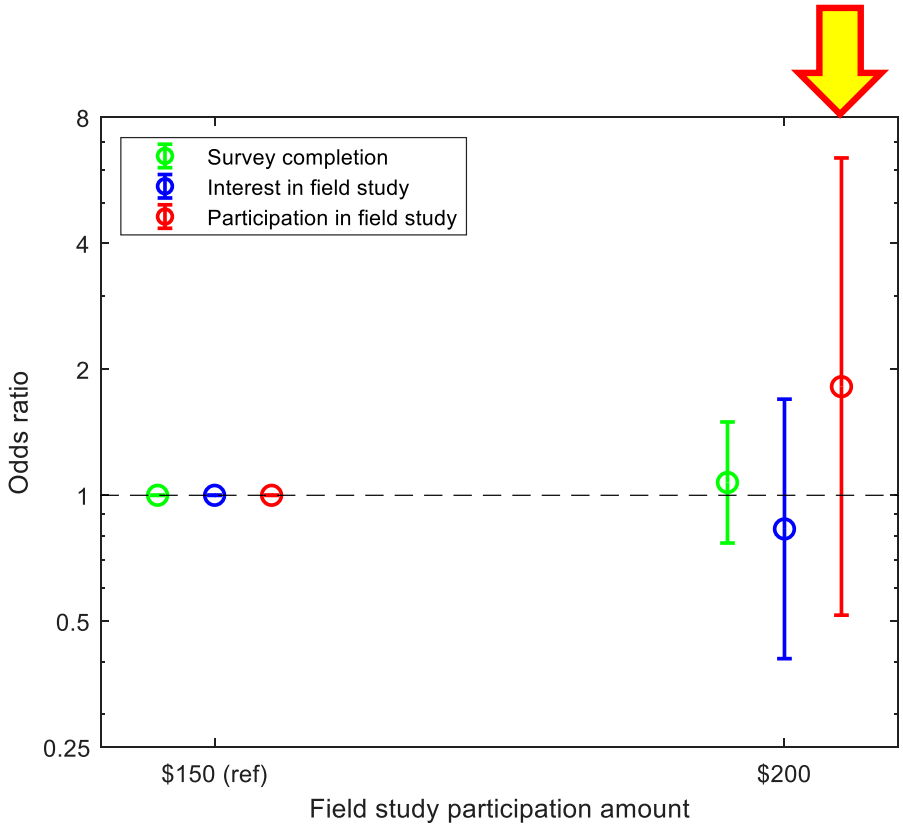




Survey approach effectiveness

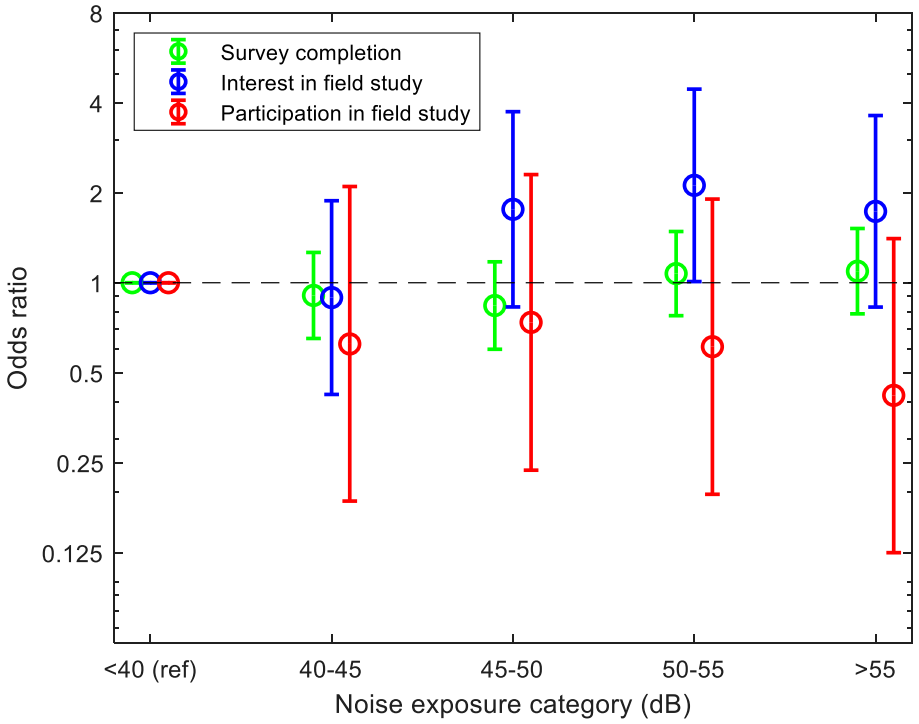
- Survey length (left)
  - No effect on survey completion, interest or participation in field study
- Field study participation amount (right)
  - No effect on survey completion, interest or participation in field study

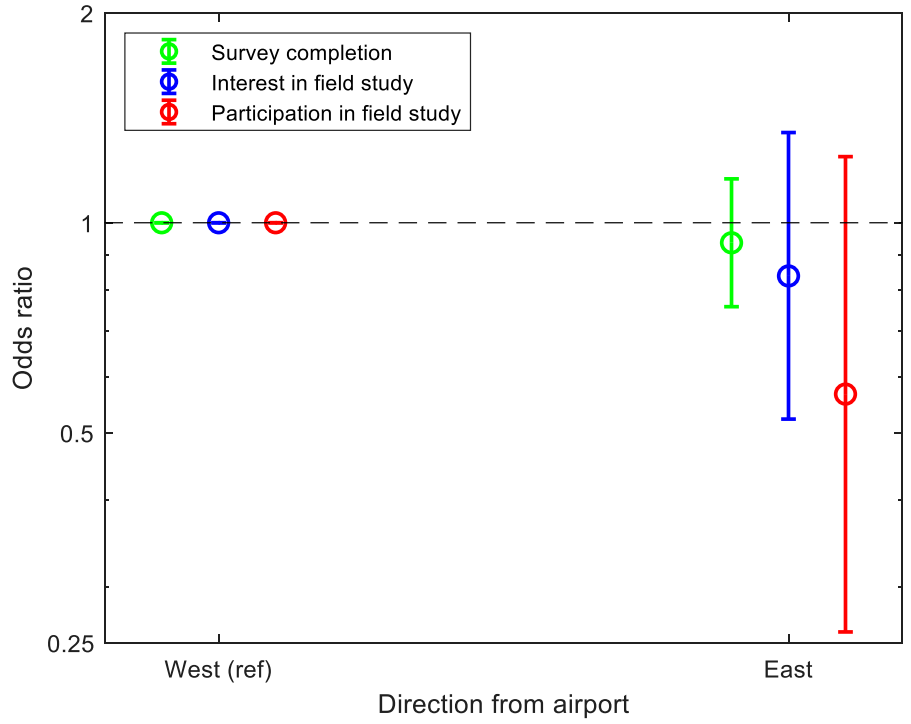




Survey approach effectiveness

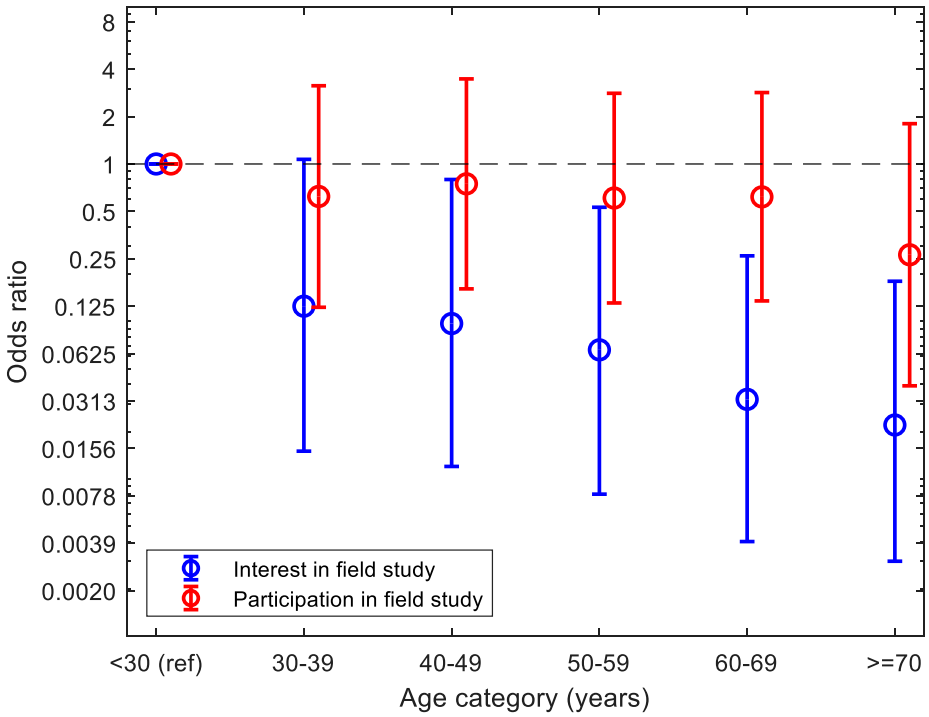
- Noise exposure (left)
  - Higher interest among 50-55dB than 40dB ($p<0.05$)
  - No significant effect on survey completion or participation in field study
- Direction from airport (right)
  - No effect on survey completion, interest or participation in field study

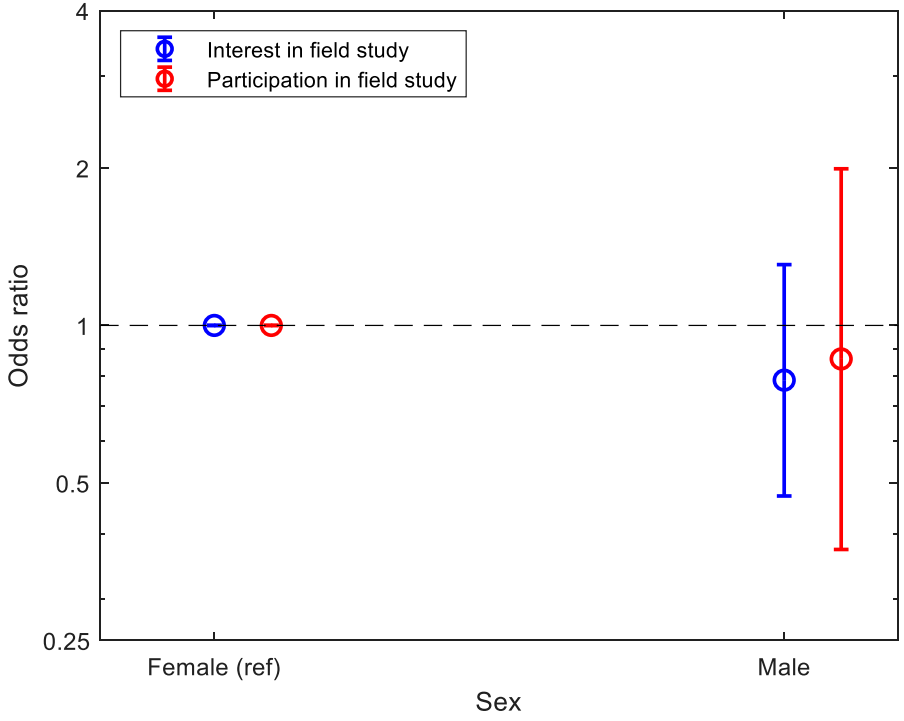




Survey approach effectiveness

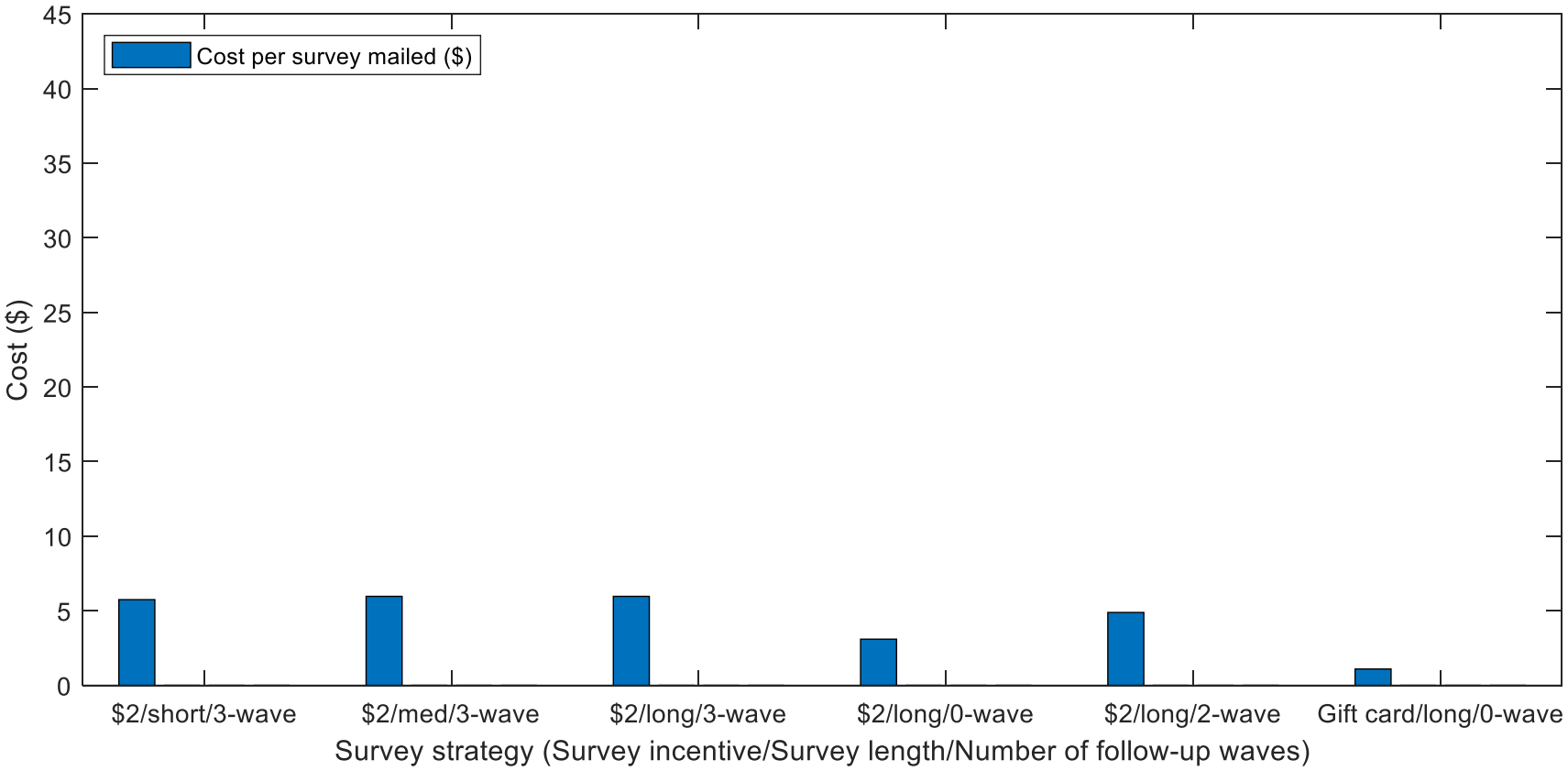
- Age (left)
  - Decreasing interest in the field study with increasing age ($p<0.001$)
  - No significant effect on participation in field study
- Sex (right)
  - No significant effect on interest or participation in field study





Survey approach effectiveness

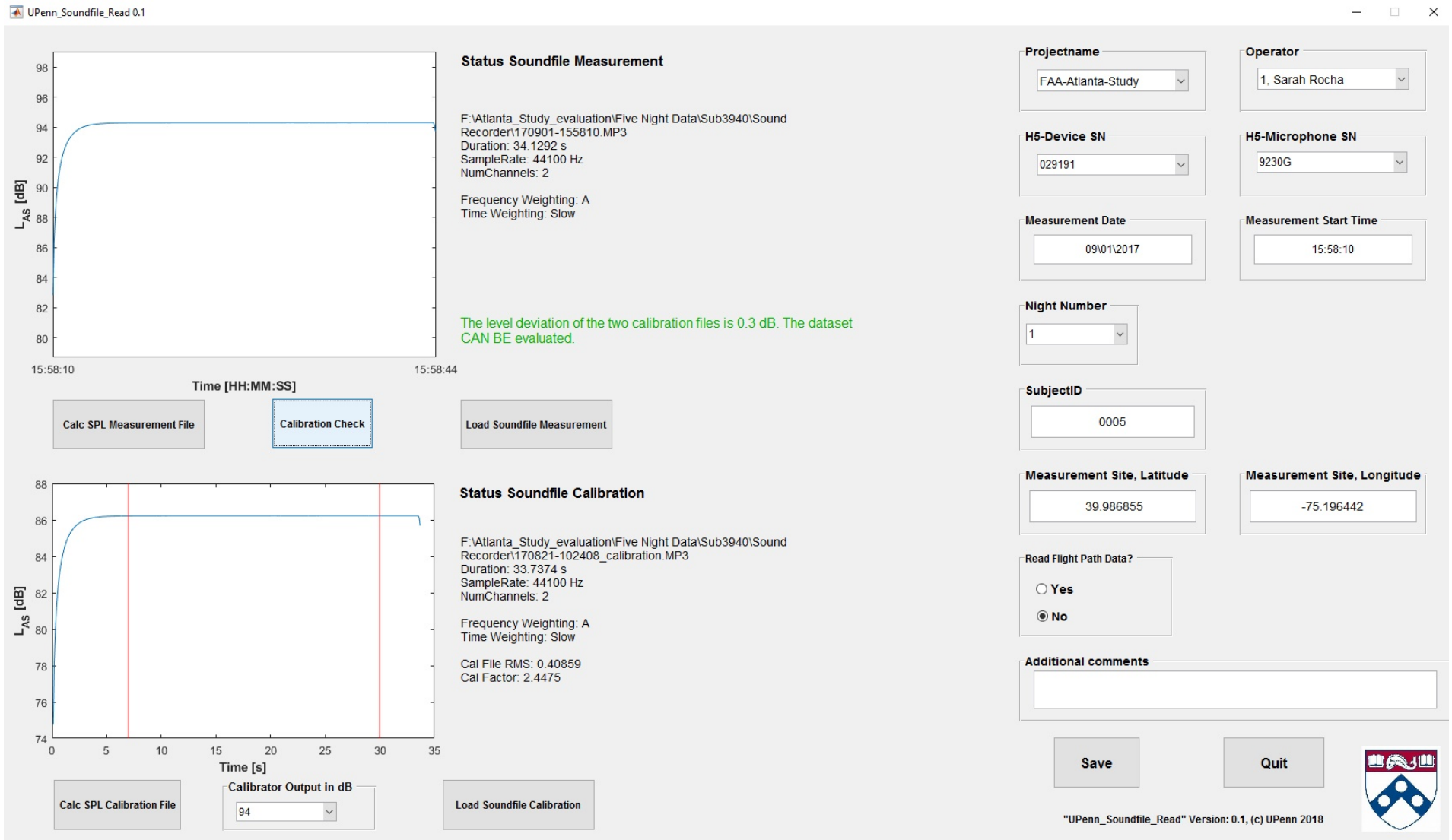
- Based on Model 1
- Only includes deliverable surveys (n=3576)
- Assumes 8.1% field study participation rate among respondents



Approach-In Home Study

- Equipment is mailed to participant's homes
- An instruction manual and videos are provided on how to use the equipment
- Physiological Monitoring: 2 cable (1 channel) ECG (1 kHz) and body movements (10 Hz)
- Sound recording equipment: Portable audio recorder with class 1 microphone
- Total equipment cost for 1 setup ~ $1,500
- Participants take part for 5 consecutive nights
- Staff are available by cell-phone to answer questions

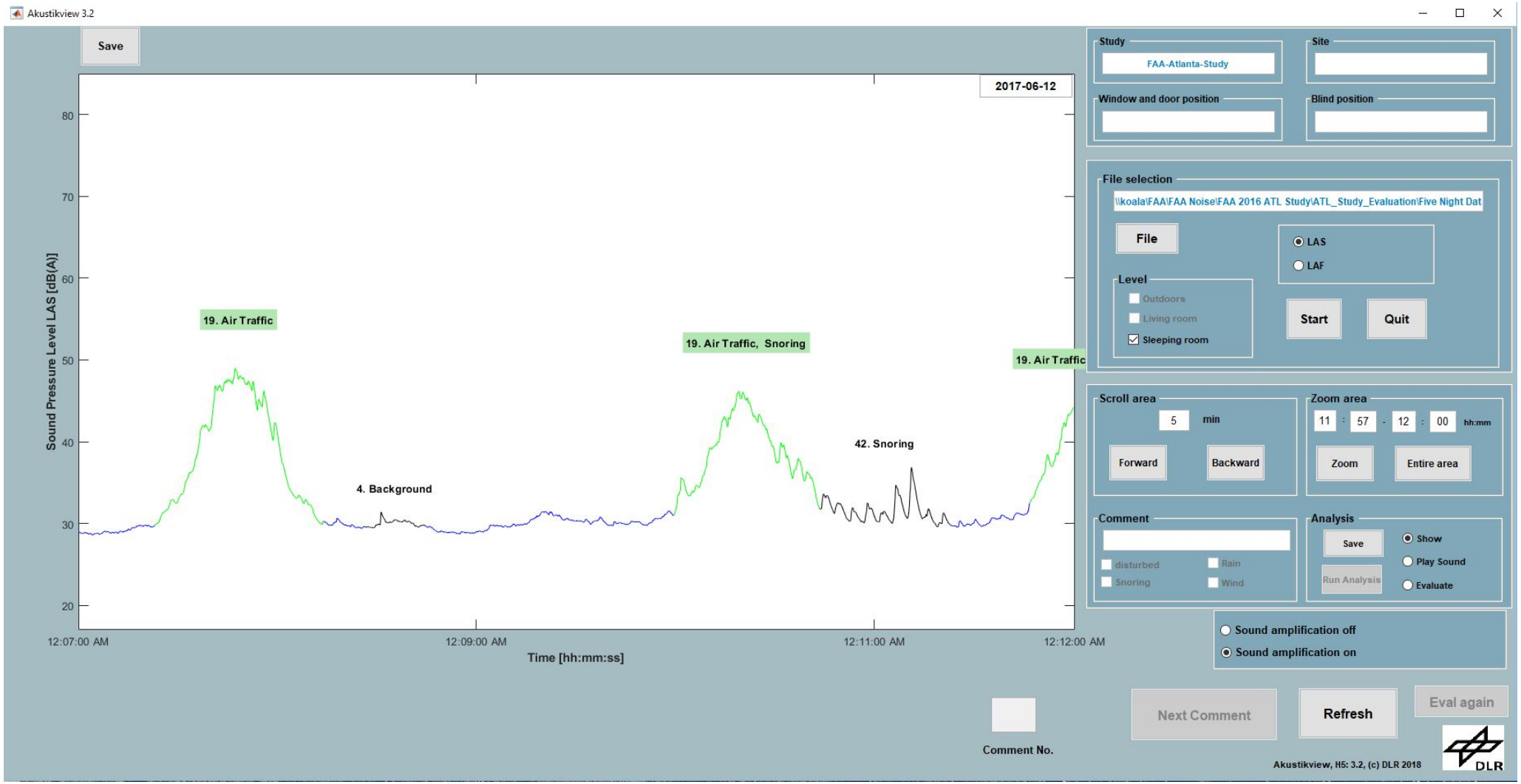
Field Data Analysis Software
Calibration and Conversion of MP3 Files



Field Data Analysis Software

Analysis of Acoustic Data

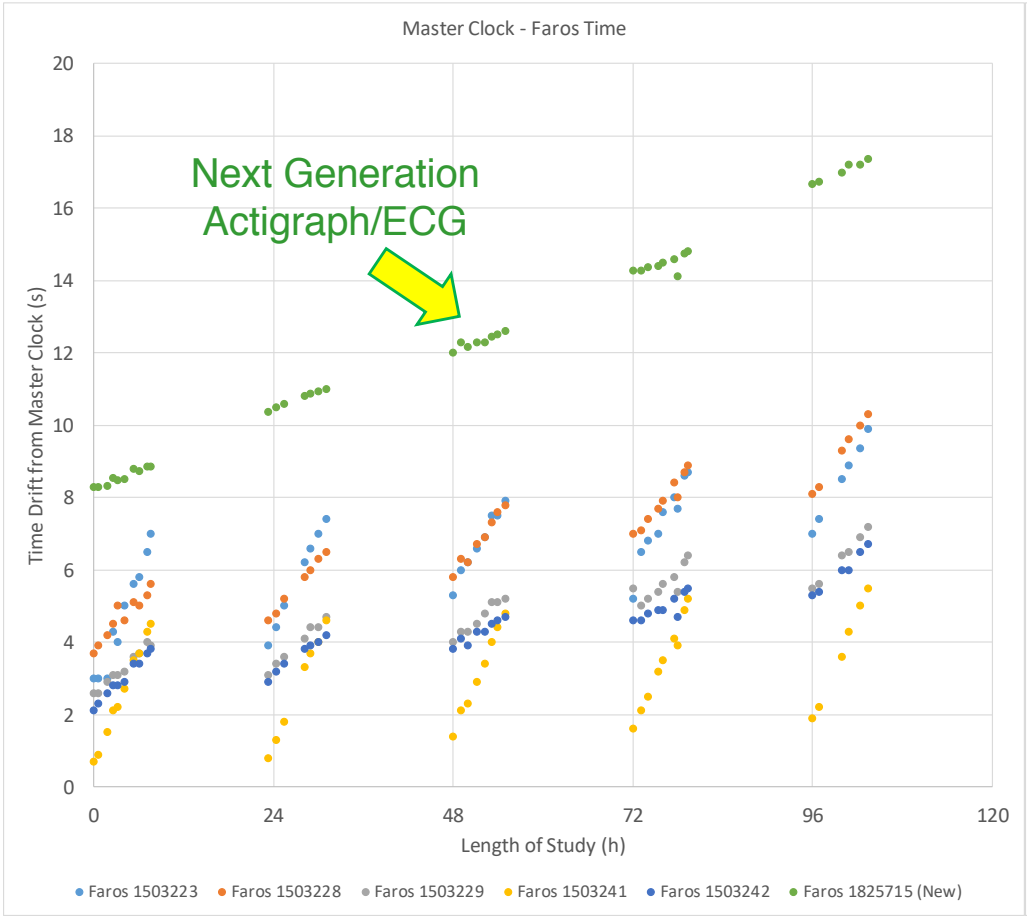
- Research Assistant listen to and classify noise events.
- We are in the process of using flight track data to pre-mark aircraft events.



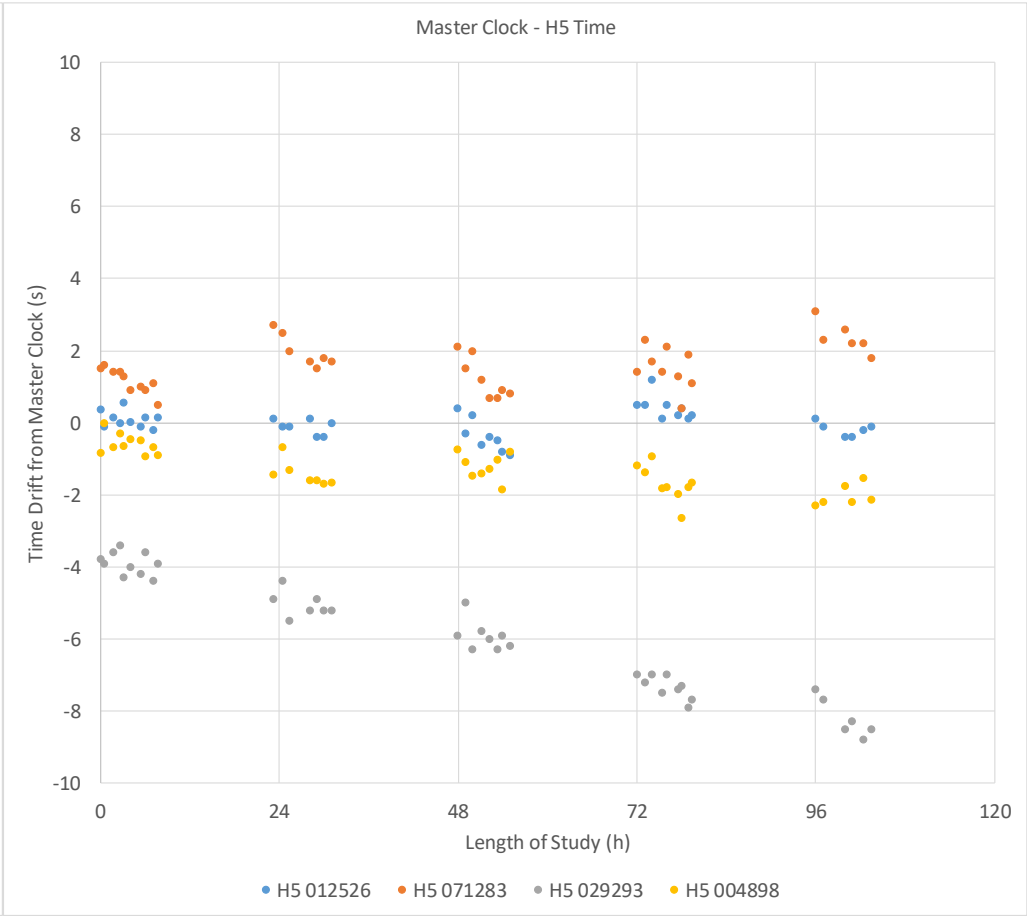
Field Data Analysis Software
Determination of Time Offset

- We simulated a 5-day study comparing time drift of physiologic and acoustic measurement devices with a master clock.

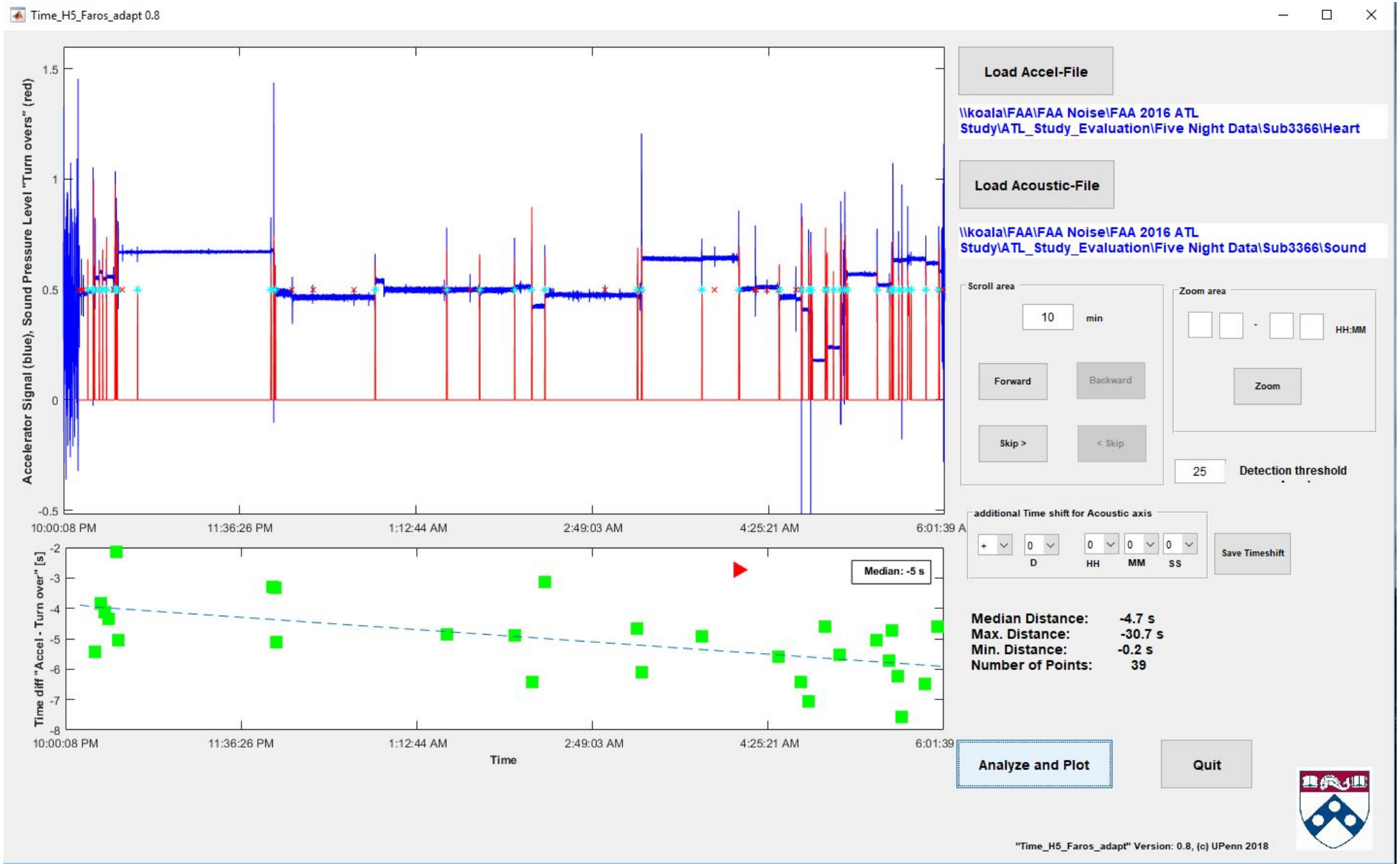
Actigraph/ECG



Sound Recorder



Field Data Analysis Software
Determination of Time Offset



Summary

- **Lessons learned**
  - The recruitment process was optimized to maximize response rate at minimal cost.
  - Overall, the approach was found to be feasible.
  - We identified ways to minimize data loss during the field study.
  - Specific software was generated for the analysis of acoustical and physiological signals (with the help of Dr. Uwe Müller, DLR).
- **Next steps**
  - Finalize analysis of acoustical and physiological data.
  - Continue preparation of National Sleep Study (funded through FAA William J. Hughes Technical Center).

Acknowledgements

- FAA has a cooperative agreement with DLR. The ECG and actigraphy methodology was jointly refined with colleagues from DLR.

Publications

- Basner, M., McGuire, S., Witte, M. Pilot sleep study near Philadelphia International Airport. ASCENT Project 17 Report
- Basner, M., Clark, C., Hansel, A., Hileman, J.I., Janssen, S.A., Shepherd, K., Sparrow, V.: Aviation noise impacts: state of the science. Noise & Health, 19(Mar-Apr), 41-50, 2017

Participants

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