Crowdsourced Lessons Learned from the 2017 Solar Eclipse LF Exercise

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NATIONAL EARTH SCIENCE TEACHERS ASSOCIATION

NAGT

What is the EclipseMob project?

Crowdsourced effort to conduct a large-scale LF radio wave propagation experiment during 2017 solar eclipse

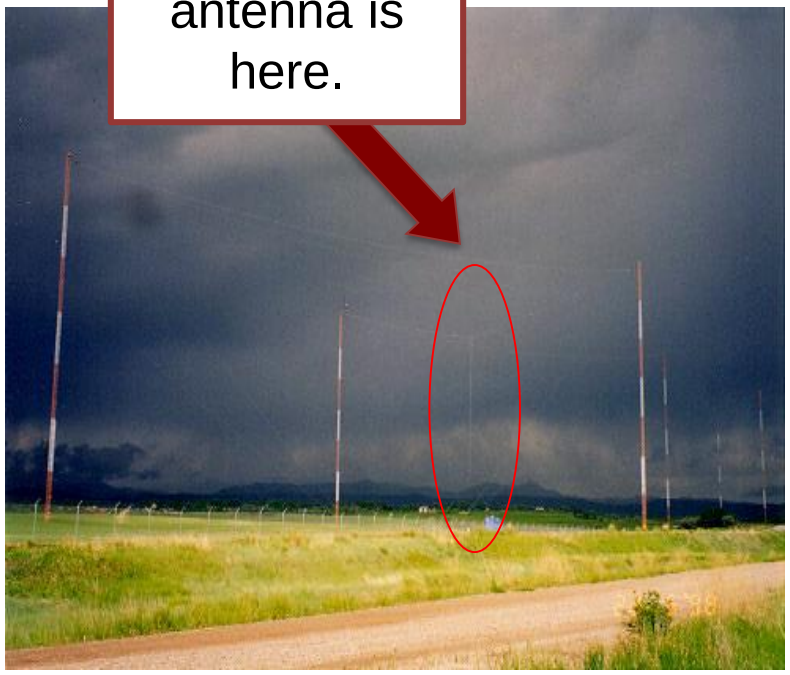
Why? **Crowdsourcing affords a large enough dataset for meaningful analysis.**

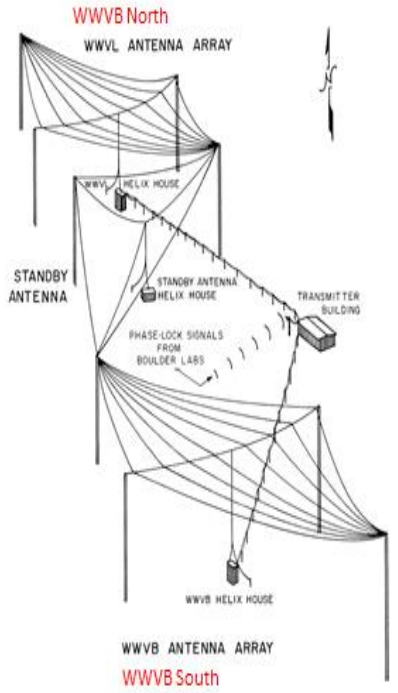
Colorado WWVB Transmitter

US Government Time and Frequency Transmitter

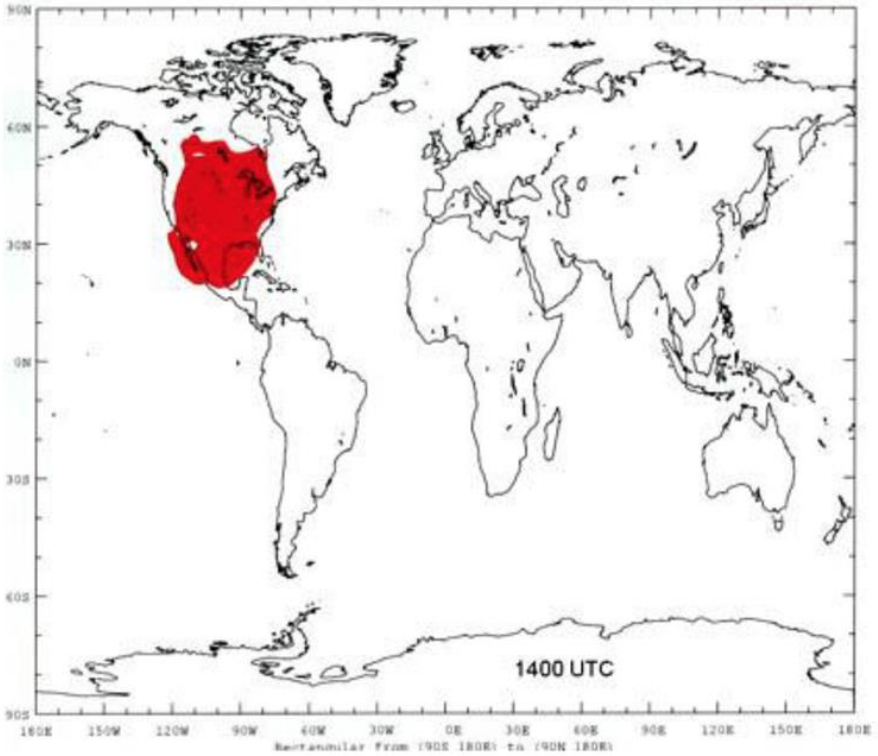
Operates at 60 kHz

Always Transmitting!

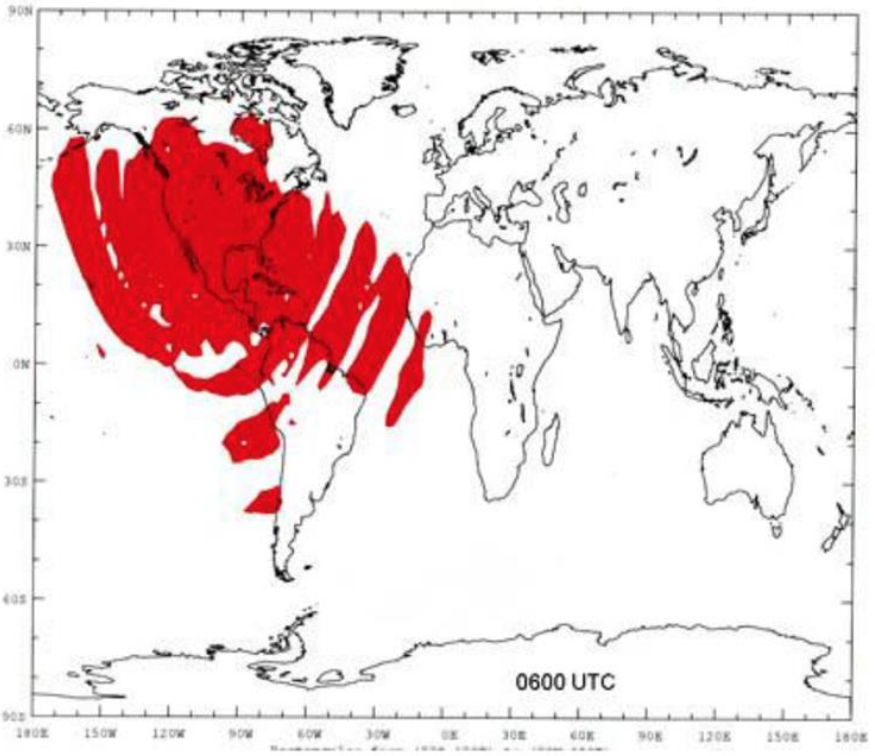




WWVB Coverage*

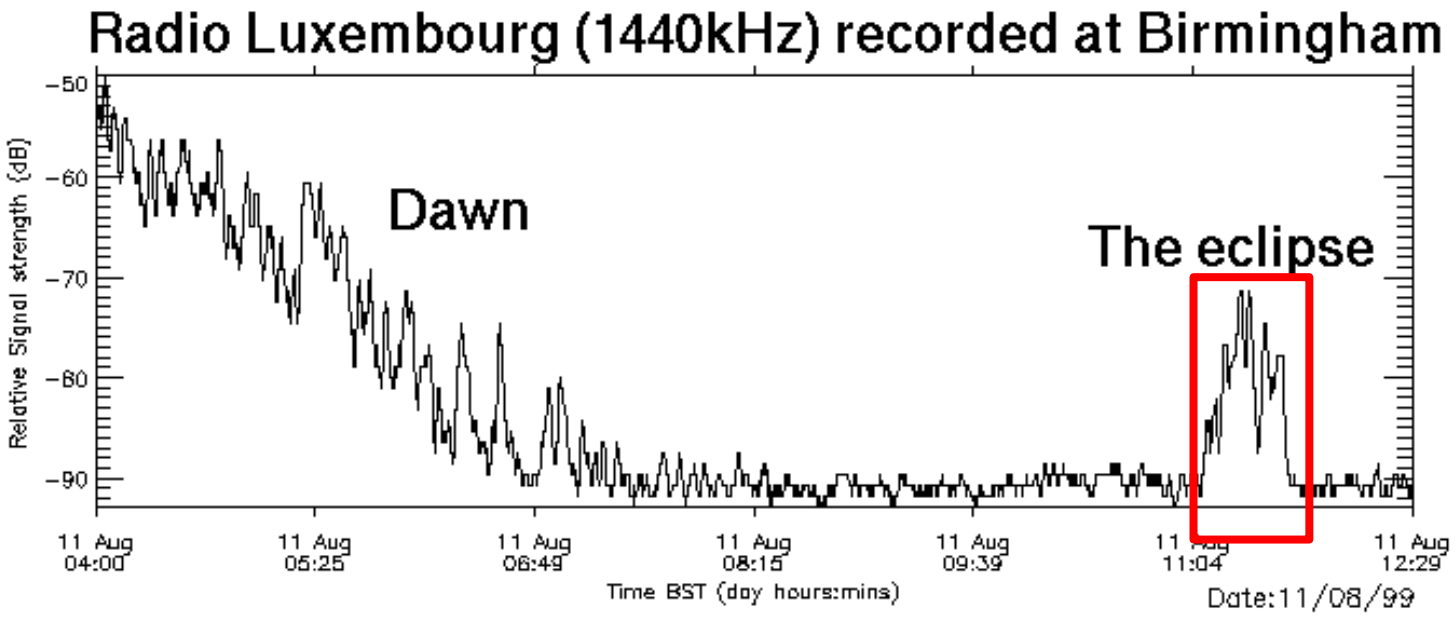


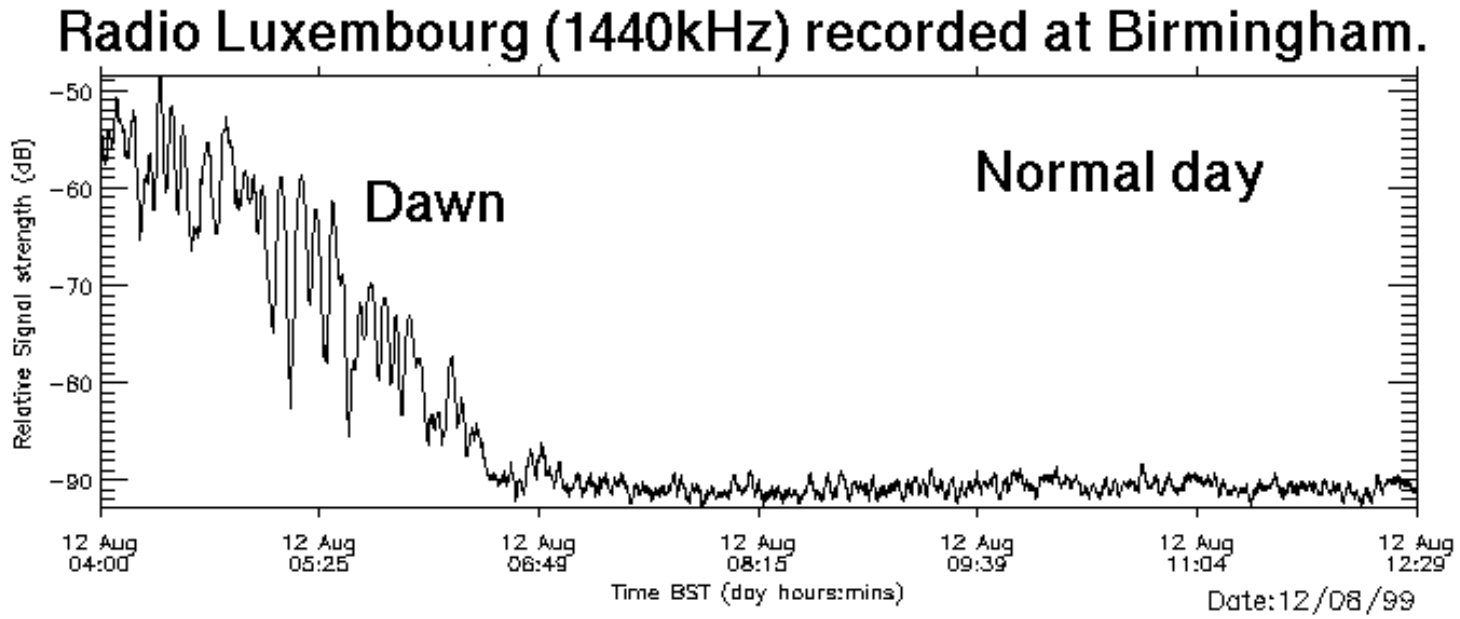
Daylight Coverage Area



Nighttime Coverage Area

* This depicts coverage as “heard” by a tiny clock antenna.


Radio Luxembourg (1440kHz) recorded at Birmingham
Relative Signal strength (dB)
-50
-60
-70
-80
-90
Dawn
The eclipse
11 Aug 04:00
11 Aug 05:25
11 Aug 06:49
11 Aug 08:15
11 Aug 09:39
11 Aug 11:04
11 Aug 12:29
Time BST (doy hours:mins)
Date:11/08/99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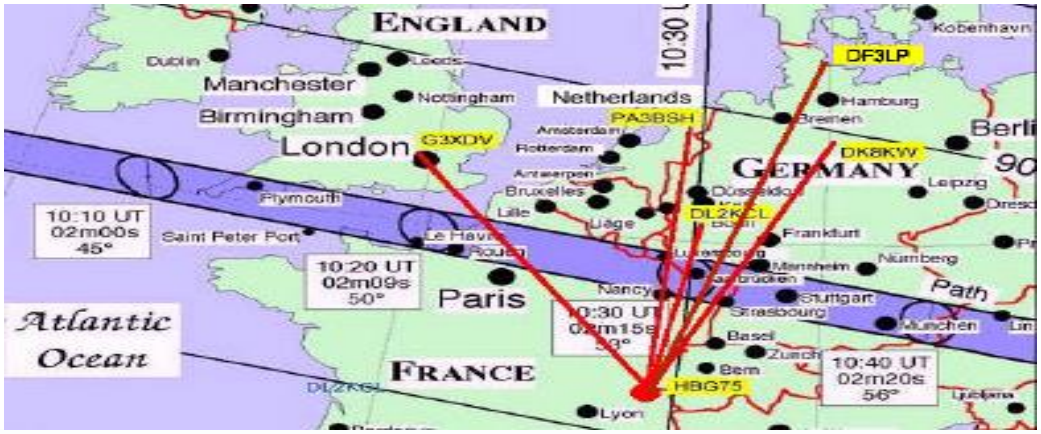
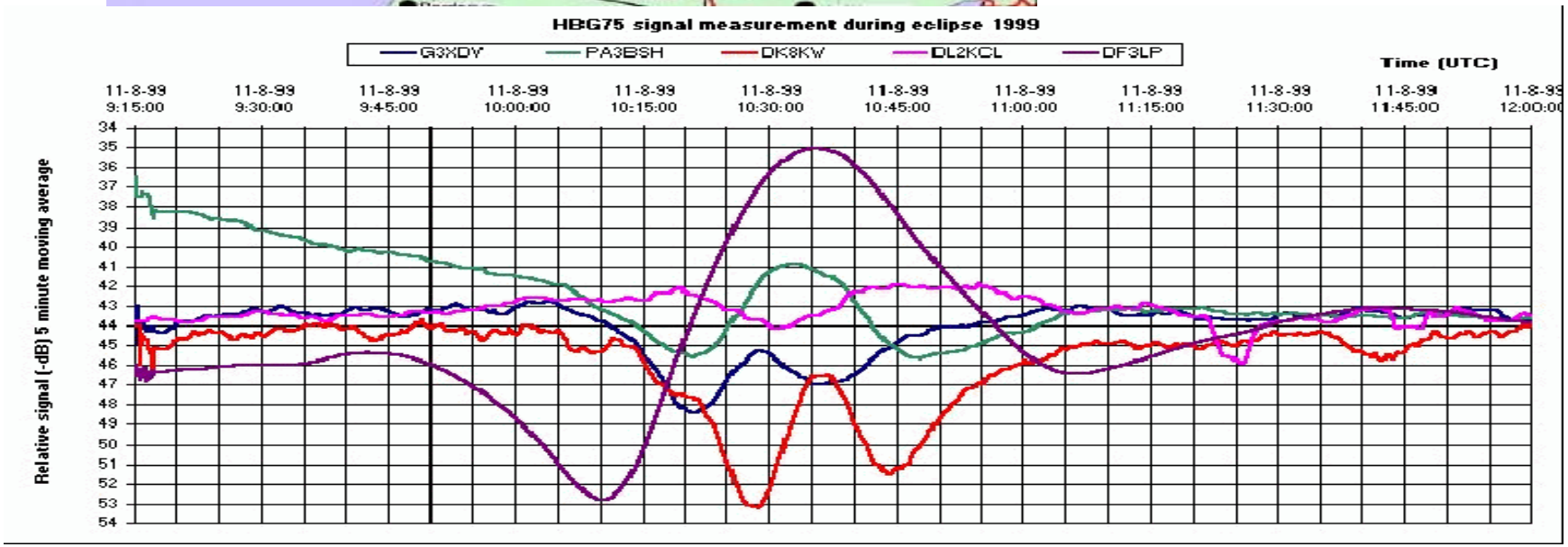
1999 Solar Eclipse effects on 75 kHz





M. Sanders, 1999. "Solar eclipse effect on the propagation of LF radio signals" from December 3rd 1999 that is available via Internet at URL: http://www.xs4all.nl/~misan/eclipse.htm.

Project activities

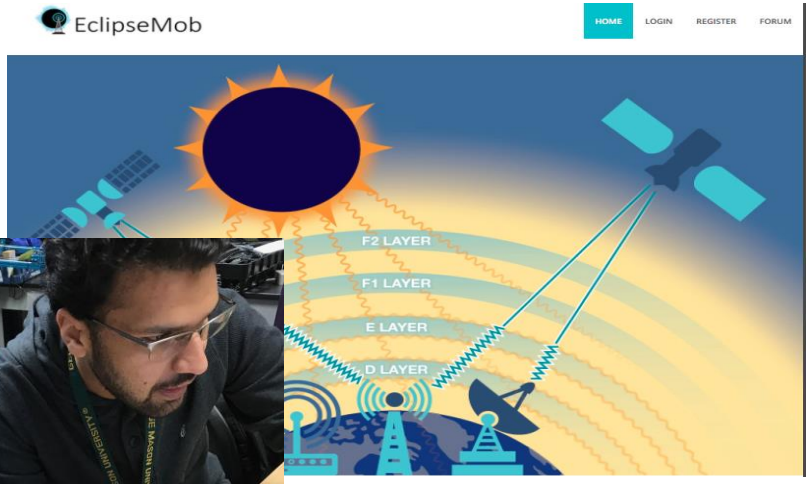
Designing receiver systems/software (require little previous knowledge or tools) and **providing** kits

Creating web portal (resources, forum, collect data): EclipseMob.org

Designing and sharing K-12 lesson plans

Educational Webinars (with the Geological Society of America)

Public engagement events (libraries, museums, etc.) to **recruit & support** others to build/test



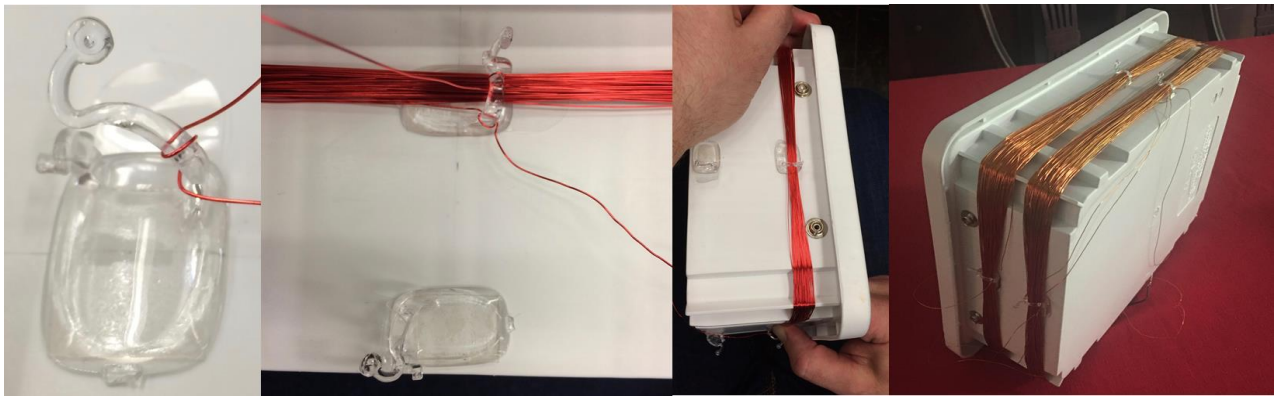

Air and Space Museum event (July 2017)

Project reach

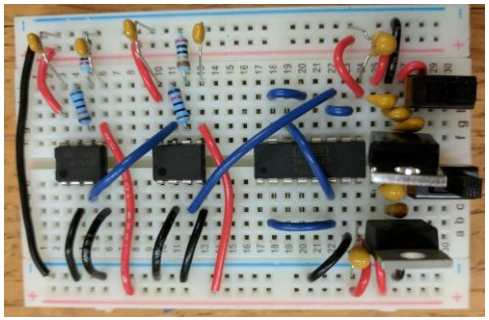
- **150** kits delivered
- Additional participants designed/built their own receiver systems
- **80+** people follow the EclipseMob Facebook page
- Over **100** views on EclipseMob forum posts
- Over **7000** hits on EclipseMob.org

DIY Eclipse Mob Kits & Instructions

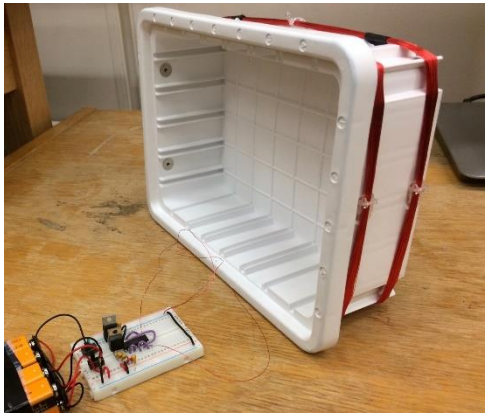
Antenna design with step-by-step instructions



Available receiver kits (Free!)



Integration



ANTENNA WITH/WITHOUT CAPACITOR

Movie courtesy of George Lemaster

Files Formats

JSON Files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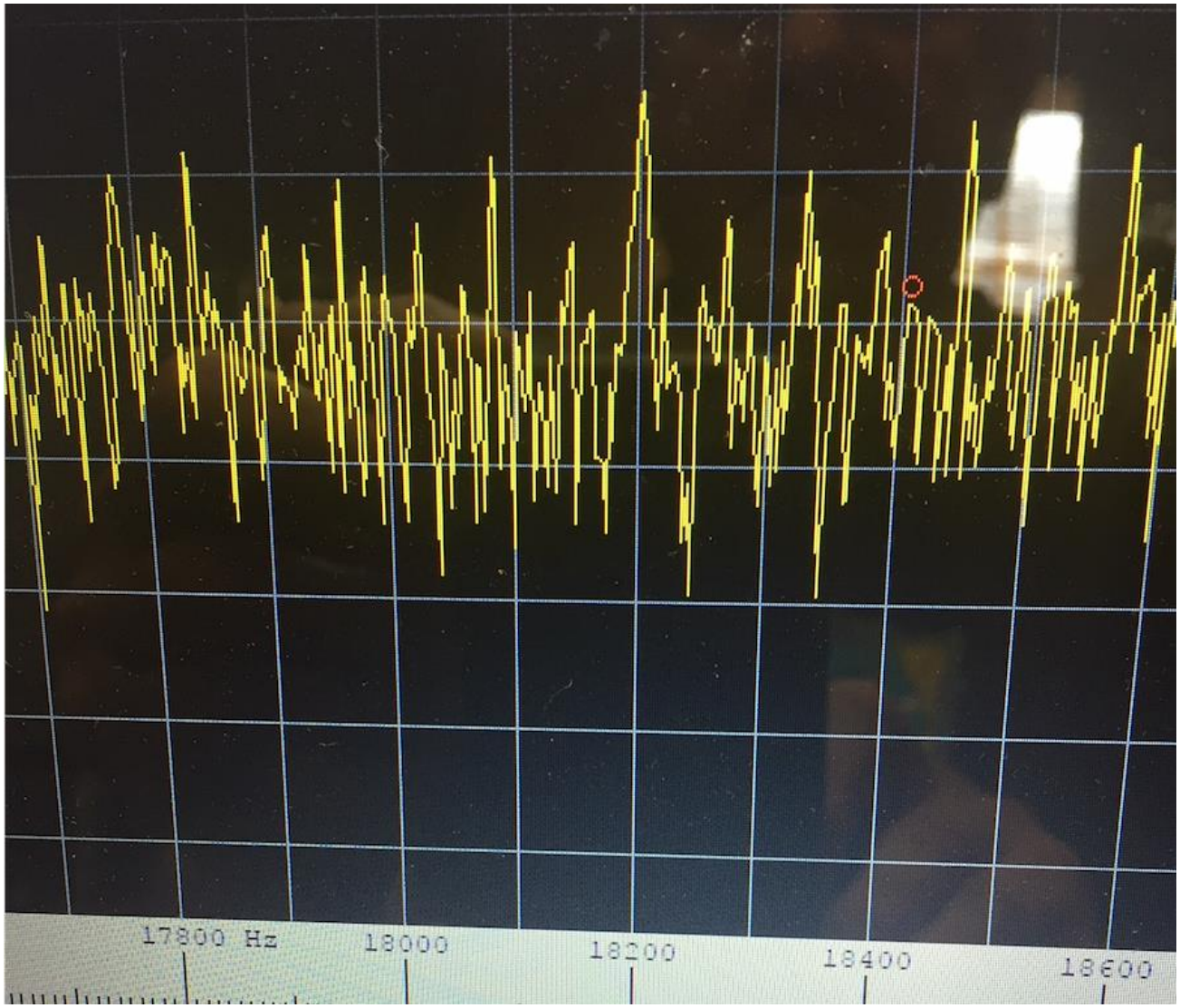
 {
  "createdAt": "Aug 21, 2017 2:35:39 PM",
  "duration": 572.859,
  "id": "e98110fe-d70e-4735-a70a-4e00471fd328",
  "latitude": 26.xxxxxxx,
  "longitude": -80.xxxxxxx,
  "size": 50520064
}
```


Date File

wav format mono with sampling rate

Spectrum Showing 18.2 kHz Signal

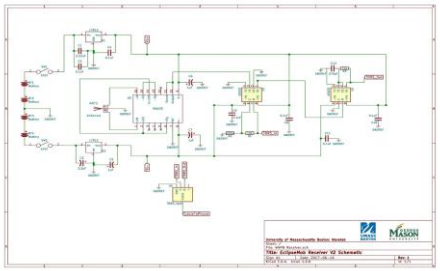


Design challenges:

- **Student design group participation unreliable; required additional expertise**
- **Receiver designs didn't meet usability needs or failed testing; including post release**
- **problem with the app-receiver interface**, extracting the signal has proven to be a challenging signal processing problem.

Key takeaways:

- **Be prepared to seek outside help if needed**
- **Test, retest, retest equipment before releasing**



Recruitment/ Participation Challenges:

- Recruitment timeline primarily dependent on **resource material availability**
- Eclipse date limited # of potential class participants
- **Participant data collection dependent on having kits/materials, help testing, and app to test before eclipse event**
- Participants **needed more on site support** than we had capacity to provide before/day of experiment

Key takeaways:

- **Have a working system and apps available BEFORE recruiting**
- **Don't estimate release dates**
- **Maintain frequent and ongoing communications via email, social media, and Q&A events**

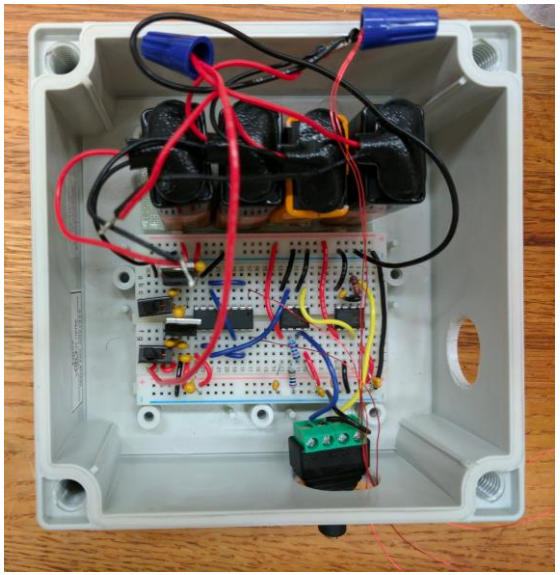
Remote & on site Q&A Event at GMU Mix Space (Aug. 2017)

Data challenges:

- Due to a **problem with the app-receiver interface**, the WWVB signal strength is lower than we anticipated, so detecting and extracting the signal has proven to be a challenging signal processing problem.
- If data issue is unresolvable, **how do you communicate experiment failure to citizen scientist participants in a way that minimizes negative attitudes towards STEM and the scientific community?**

Key takeaways:

- **Test, retest, retest before running experiment**
- **Be prepared to explain the value of work and contributions—designate a public relations person**



Questions?

EclipseMob.org

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Jill Nelson: Signal processing; project and grant management; outreach; graduate student mentor -- jnelson@gmu.edu

Bill Liles: Experiment design; technical support; outreach; graduate student mentor

George LeMaster: Receiver design, testing, and outreach →

Special thanks to George!

Jennifer Henry: Communication & outreach specialist

Janet Oputa: Communication & outreach specialist

Partners:

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