Plans for EclipseMob 2024

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EclipseMob 2017 was a collaborative effort to conduct a crowdsourced measurement of low-frequency radio wave propagation during the August 2017 solar eclipse.

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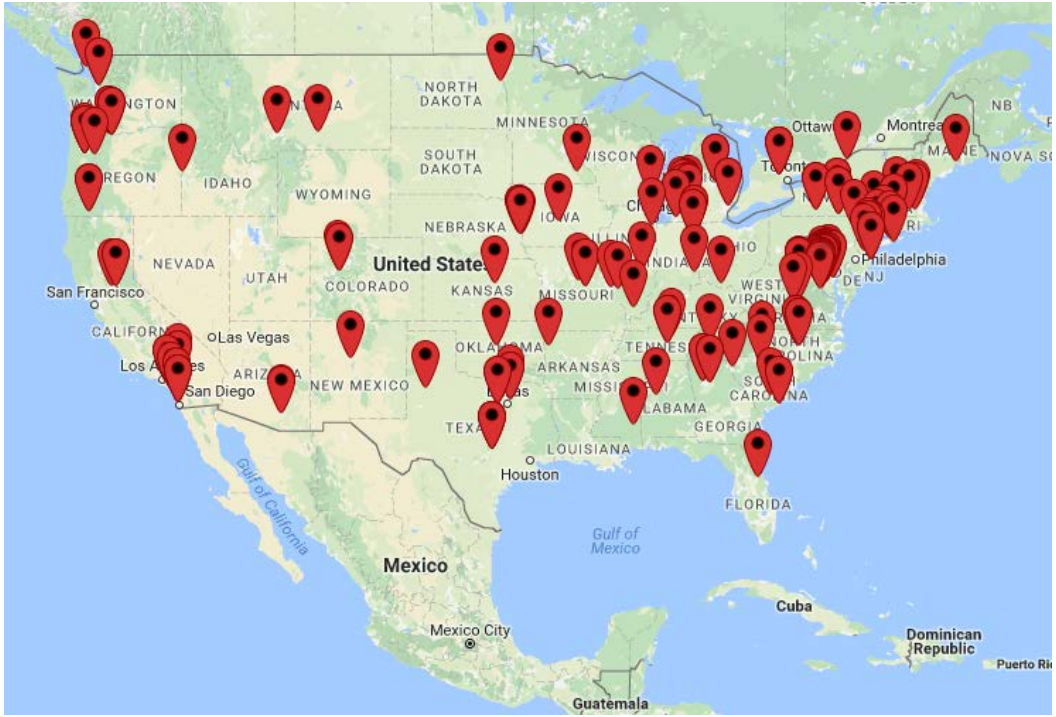
Crowdsourcing



Want to observe spatial variation of eclipse effect on LF wave propagation

Not enough engineers, plenty of citizen scientists

150 DIY kits, 31 states, 2 countries

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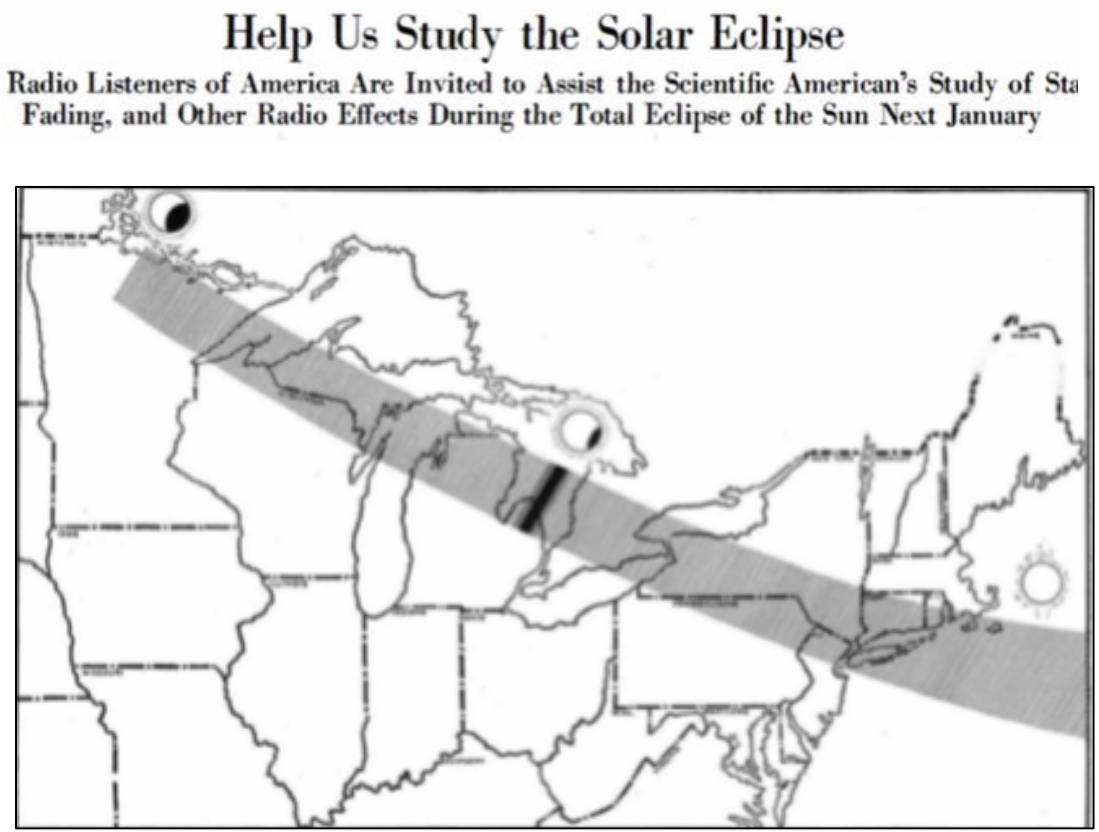

Help Us Study the Solar Eclipse

Radio Listeners of America Are Invited to Assist the Scientific American's Study of Sta
Fading, and Other Radio Effects During the Total Eclipse of the Sun Next January

Scientific American and ARRL coordinated measurements of January 25, 1925 Solar Eclipse

75 meter daytime signals arrived with intensity associated with nighttime signals

Close to 2,000 BCB & 150 Amateur Radio reports, but many with errors

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Opportunity

First total solar eclipse in contiguous US since development of GPS

Not just GPS, but smartphones, the internet, cloud services

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EclipseMob's Contribution

LF propagation below ~500 kHz is qualitatively different from higher frequencies - geographically distributed data is needed to explain this

Past crowdsourcing efforts suffered from inconsistency in transmitters, time/date/location/data recording

EclipseMob uses the widespread availability of WWVB, smartphones, and GPS to address consistency issue and deliver information on spatial variation

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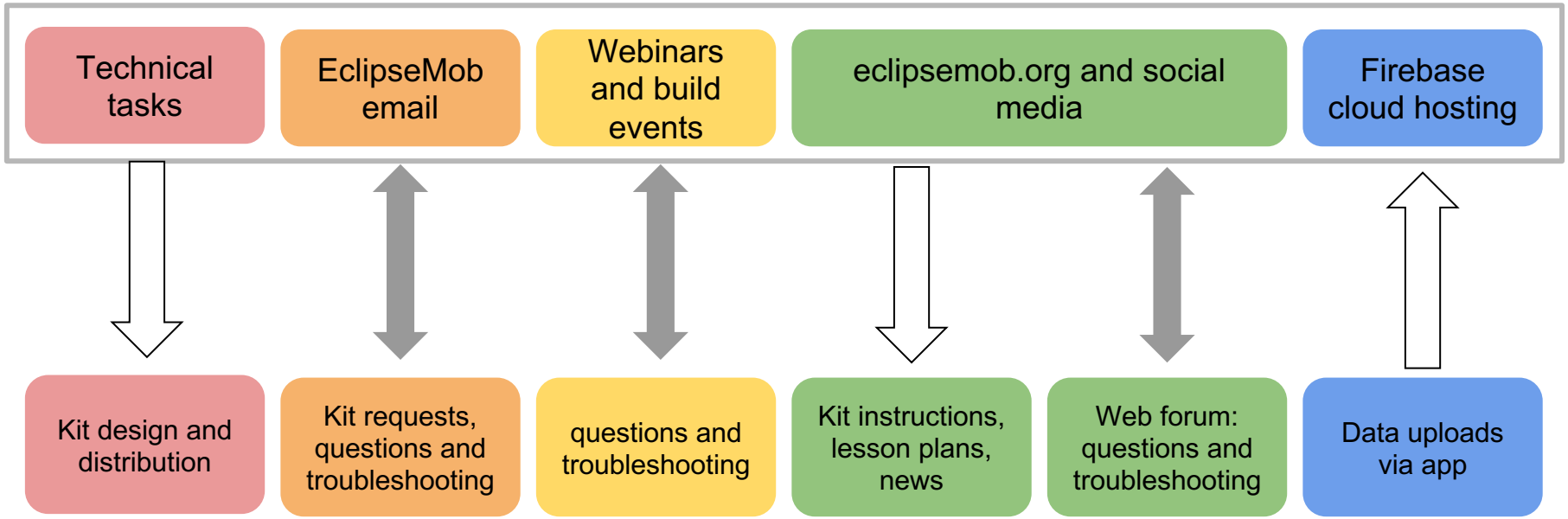
Project Coordination



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EclipseMob DIY kit

DIY antenna and receiver kit designed for minimal tool use, no soldering

Target audience: educators, K-12 students, hobbyists

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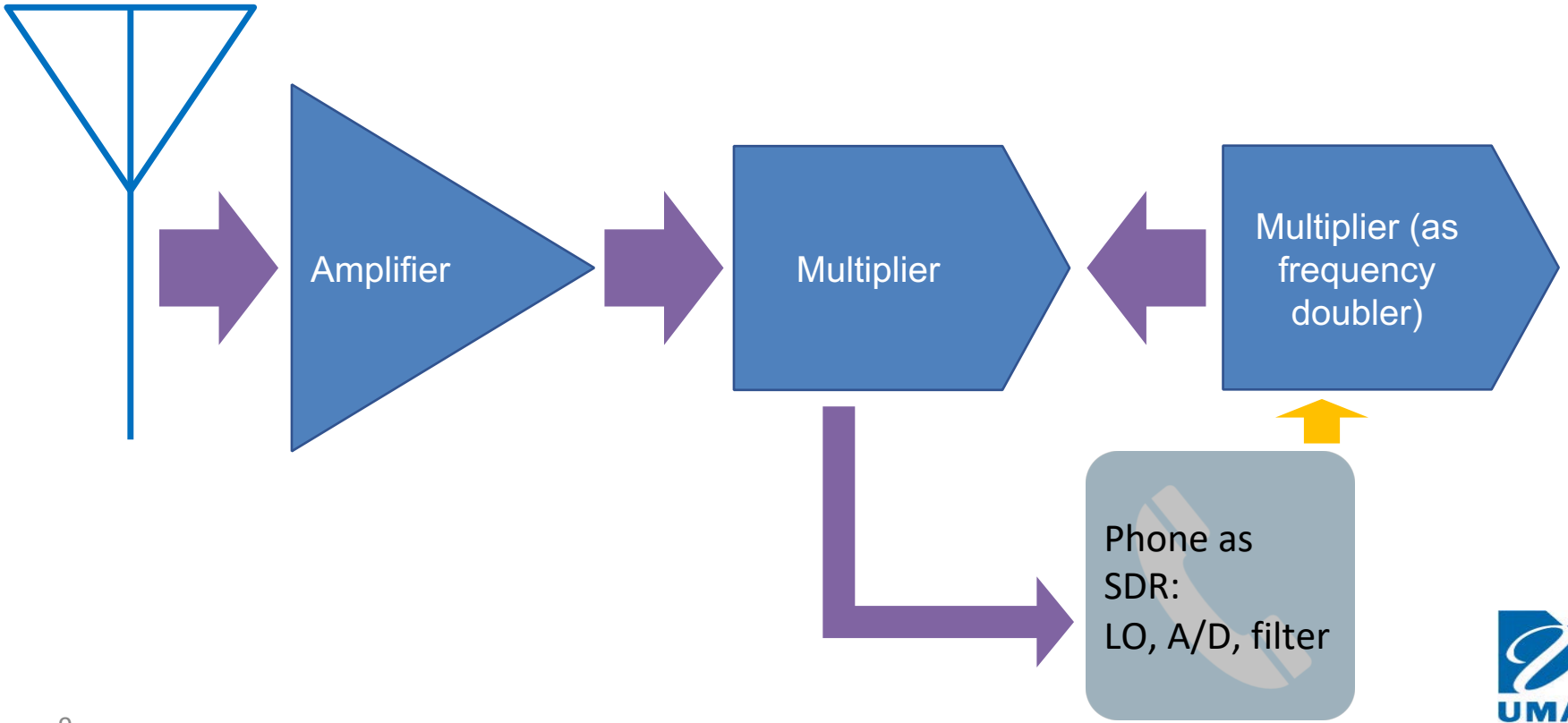
EclipseMob 2017 Receiver



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Participants

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Lessons Learned and Plans for 2024

What worked

Lots of interest from the public

- Received twice as many requests as initially available kits, had to make a second batch
- Received ~500 uploads

Crowdsourcing and DIY receiver concept

- Citizen scientist tasks are often very simple, not much science involved
- Participants were able to assemble the kit according to instructions despite complexity

What didn’t work

EclipseMob kit and app delivery were repeatedly delayed, frustrating participants

- Had to test receiver without app

Failed to detect kit-phone interface problem that made most data unusable (incorrect impedance to phone line in)

Web and social media communication was labor intensive

- No coherent communications strategy
- Responding to participant build questions fell to technical team despite communications team efforts

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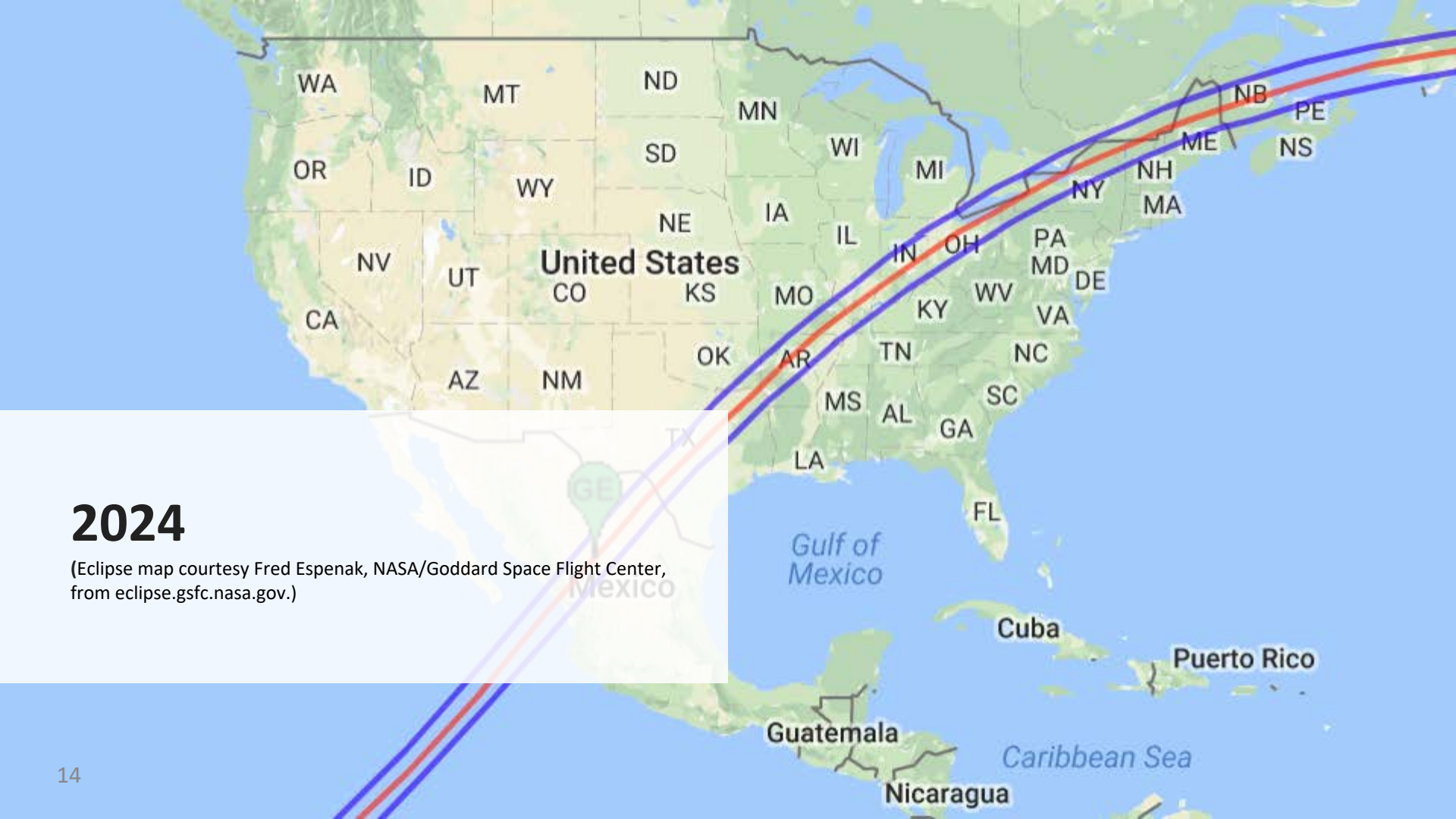

2024

(Eclipse map courtesy Fred Espenak, NASA/Goddard Space Flight Center, from eclipse.gsfc.nasa.gov.)

What will change for 2024

Project management

- Increased scale will require dedicated project manager

Outreach events

- In-person workshops with curriculum modules for educators

Web and social media communication

- Dedicated social media team, Use ticket system to track responses
- Pro web design

Curate geographical distribution - urban area clumps in 2017

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What will change for 2024

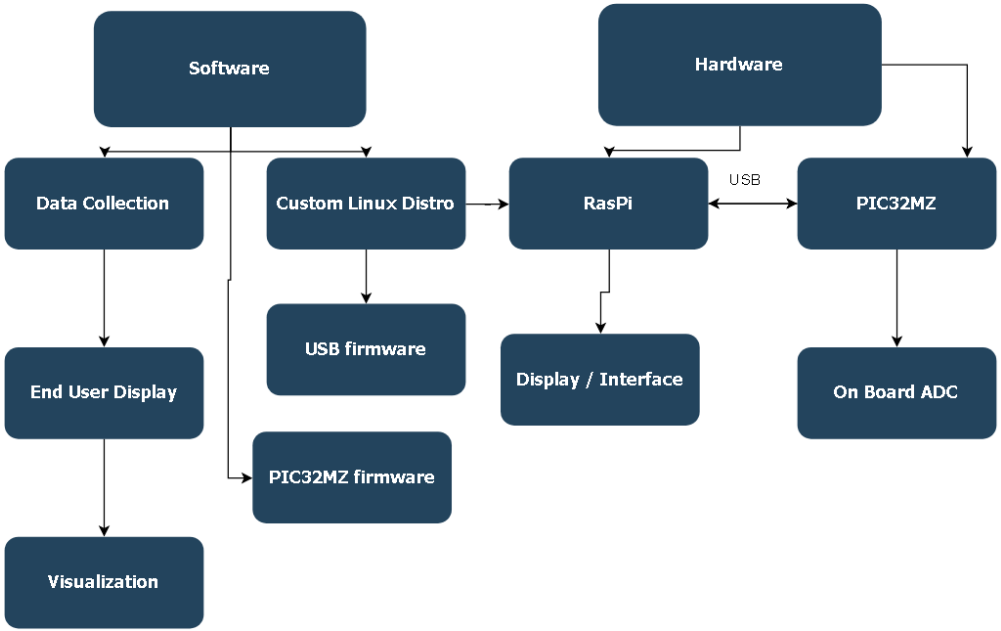
Kit development

- Develop kit earlier to allow more testing time
- Get expert guidance for critical tasks like app development

Smartphone makers are eliminating audio jacks

- New interface will be WiFi: hardware agnostic
- Direct digital receiver (no downconversion)

New Design



- Utilizes PIC32MZ 32 bit microcontroller and on board ADC to ensure optimal sampling speeds.
- Raspberry Pi used for data storage/manipulation
- A user friendly interface via Liquid Crystal Display will be used in place of transmitting data to phone wirelessly. Drastically simplifies design without sacrificing major functionality.

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Planned Functionality

1. Amplify received signal by factor of 100, signal goes through filter stages and DC Bias before ADC.
2. ADC of PIC32MZ Microcontroller will sample at least 200ks/sec, then transfer data samples to Raspberry Pi via USB.
3. Raspberry Pi will compile data and prepare visuals for LCD.
4. Several buttons providing control of user interface.

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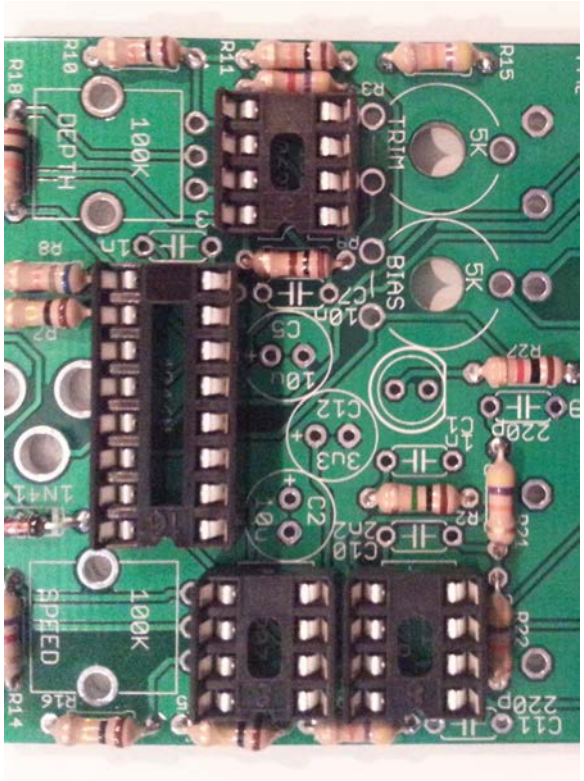
What will change for 2024



Simplify kit while preserving build experience at block diagram level

- Instead of breadboard, PCB with sockets for users to plug in components
- Reduce build errors and questions
- Participants still get to learn about and build their own receiver

Example photo of IC sockets from synthrotek.com

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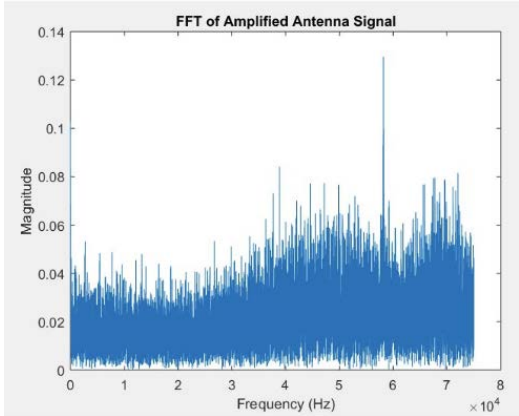
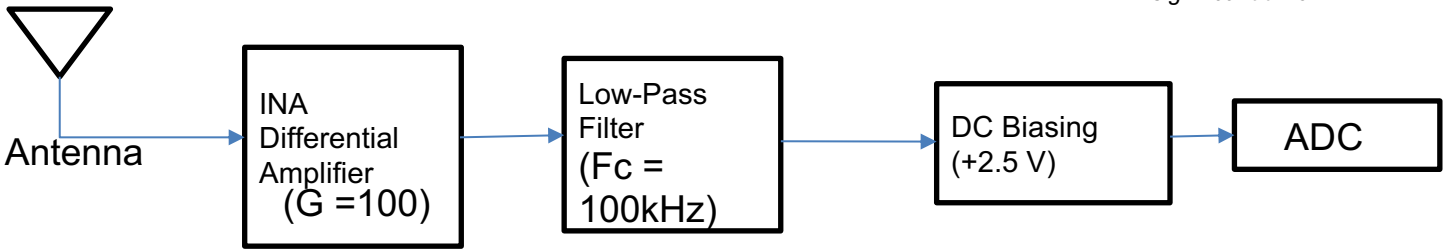
Current Status

- Circuit tested and confirmed to function. Tests will continue to ensure functionality with new design.
- Implementing software requirements into Raspberry Pi is currently in progress.



Most recent FFT results from receiver circuit (Arduino used) *Bandwidth too low to sample for significant time.*

Circuit Overview



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Next Steps

- Prepare development board for programming of PIC32MZ microcontroller.
- Sample rate test of external ADC as well as test bandwidth.

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Conclusion

EclipseMob 2024 will dwarf original EclipseMob with 1000+ target participants

New design improves on first EclipseMob kit:

- Compatible with any smartphone hardware
- PCB with sockets will reduce build complexity

Initial design completed, testing underway

Thank you

"We are deeply grateful to all of [our] collaborators. They have sent us data of great value. We hope that the knowledge of a good job well done will prove to them a satisfactory reward for their effort and time."

Scientific American Eclipse Party, "The Effects of the Eclipse on Radio," *Scientific American*, April 1925

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