**TDOA Science Experiment Operating Tips**

1. There are no regulatory waivers for this event and all normal rules and regulations for amateur radio must be followed. Transmitting stations must operate only on the band segments authorized by his or her license. No license is required for receive-only stations and SWL stations are invited to participate.
2. Operate in pairs or roundtable groups over prearranged paths. An ideal data set would be multiple waveform recordings over the same path(s) at 6-10 minute intervals during the time the eclipse passes over the continental US. The intent is to acquire TDOA data before, during, and after local eclipse passage to profile the impact of the eclipse on the ionosphere as a function of time. The annular eclipse approaches the coast of Oregon on October 14, 2023 at 1610 UTC (0910 PDT) and is past Texas in the Gulf of Mexico at 1710 UTC (1210 CDT). It traverses the US in about an hour. Taking data on 6 minute intervals would yield 10 data points. Additional data points from before and after this window are encouraged. The 2017 eclipse passed well north of WWV in Ft. Collins, CO yet had a significant impact on 5 MHz WWV and 60 kHz WWVB signal strengths into South Texas.
3. Perform dry run experiments before the eclipse to perfect your technique and to be sure you will have propagation at the time of day for the eclipse on the intended band and power level.
4. Check the HamSCI website for scheduled dry runs. WA5FRF and others will be in a roundtable QSO on scheduled dates around 12 noon CDT (1700 UTC). This is a time of day near the time of eclipse passage over Texas. Stations are invited to join the roundtable as a participant or to simply record and log the waveforms as they are sent.
5. Making an accurate log is critical. The minimum required documentation for each waveform transmission are: 1) the exact location of the transmitting and receiving stations in either latitude and longitude coordinates or six-digit grid squares, 2) the time of the transmission, and 3) operating frequency or band. It is recommended this data be encoded in the filename of the .wav file. Recordings from non-ham receiving stations (SWL) are most welcome as well. The waveform available on the HamSCI website precedes the actual science payload with station ID and grid square in Morse code, but not band. Include the call signs of both stations in the log. Also include the specifics of the waveform recording such as sample rate and bit depth. It is recommended that the computer and radio clocks be set in UTC time.
6. Suggested sampling parameters are 44100 SPS, fixed 16 bit resolution, and standard PCM encoding. Built-in audio recorders in Icom radios digitize at 8000 SPS (7300) and 16000 SPS (7610) have produced good results. Basically, if the audio player in a computer can playback the file it should be good to go.
7. Using the lowest frequency band that allows propagation over your path will give best conditions for getting both 1 and 2 hop propagation. Depending on distance, this could be 60 or 40 meters for the expected time of eclipse passage. 160 and 80 meters may have already closed due to daytime absorption over many paths at the expected time of eclipse passage. Except for sufficiently long paths, frequencies higher than the 14.2 MHz

band (20 meters) may not support a 2-hop mode. Working out these details is why a test run is important.

8. Set the transceiver operating mode to SSB. Choice of sideband is optional as long as both stations use the same. Suggest using the accepted conventions of LSB on 40, 80, and 160 meters and USB on 60 meters and 20 meters. By regulation, SSB selection on 60 meters is USB only.
9. The experiment can be run in either the phone or CW portions of the band. The waveform downloaded from the HamSCI website uses an audio tone to send the station ID and grid square in Morse Code. The scientific chirp payload is a swept audio tone that carries no communications information.
10. 60 meters gives excellent coverage over daytime regional paths but has only 5 fixed frequency channels that must be shared by all. Suggested channels on 60 meters are Ch1 or Ch2 to avoid interference with activities established on the other channels. Note that 60 meters has a power limitation of 100 watts and a bandwidth limitation of 2800 Hz. The transmitted bandwidth is set by the transmit bandwidth settings in the radio e.g., TBW 100-2900 Hz.
11. Antenna considerations: this experiment requires propagation of both a 1-hop and 2-hop mode. The 2-hop mode requires a higher angle of propagation than 1-hop. So the transmit antenna must be able to illuminate and the receive antenna must be able to respond to the ionosphere at both high and low angles. Horizontally polarized antennas mounted less than a quarter wavelength high are ideal. But any antenna including a vertical is worth a try.
12. Transceiver settings:
    a. Set transmit and receive audio filters bandwidths to widest possible bandwidth. E.g., 100-2900 Hz.
    b. Set receiver AGC to SLOW.
    c. Use just enough mic gain to drive the output to maximum power. Use sufficient legal transmit power to get the waveform plainly audible above the noise. The slowest chirps near the end of the waveform will give most reliable meter readings for output power measurements. Avoid use of heavy speech processing.
    d. For coupling the TDOA waveform in and out of the radio, a commercial or homebrew transformer isolated interface may be required to avoid ground loops and noise pickup. Any of the interfaces used for digital communications (FT-8, PSK31, etc.) are suitable.
    e. Some radios have transmit audio memories for calling CQ or contesting. It is convenient to load the waveform into a transmit memory for transmission.
    f. Similarly, many radios have a built-in RECORD function that will record incoming audio as a .wav file to a SD card in the radio. These functions are very useful for sending and receiving the TDOA waveform.

g. The transmit and receive stations should coordinate the timing of waveform transmission and recording start/stop times to capture the entire waveform without excessive dead air before and after the waveform payload. Preceding waveform transmission with a verbal “three, two, one, NOW” was very effective in dry runs.