LWA-MC MEMO #001
LOCO MEMO #063

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First Test of LWA Antenna and FEE on Site

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1. LWA Antenna First Tests

An LWA antenna and FEE were taken to the final LWA-MC site on Bar T Bar Ranch on June 13, 2025. The system was temporarily installed (3 hours total time on site) and connected to the "Big Metal Box" (BMB) enclosure with a 50-meter LMR-240 coaxial cable. The BMB contained two LFP 12V 100Ah batteries, a DC-to-AC inverter, a SP-320-24 switching DC power supply configured to 18V DC output, a Dell desktop computer with a Vitrek/Signatec PX14400 analog-to-digital converter (ADC) PCIe board sampling at 400 MS/s, and a Teltonika RUT142 2.4 GHz wireless router. The LWA FEE RF output was connected through a 190 MHz low-pass filter (from EDGES hardware) before entering the ADC. There was no ARX board used in the setup, but several combinations of amplifier and attenuators were tested as described below. The FEE was powered over the same cable used for the RF from the 18V DC supply through a bias-tee in the BMB. The BMB was in the back of an SUV that idled during the measurements for air conditioning. Phone calls and photographs were taken intermittently throughout the testing.

Figure 0. LWA antenna on site with rim of meteor crater in background to the south. The car and BMB were 50 meters north.

2. Case 1: Unmodified FEE + 190 MHz low-pass filter

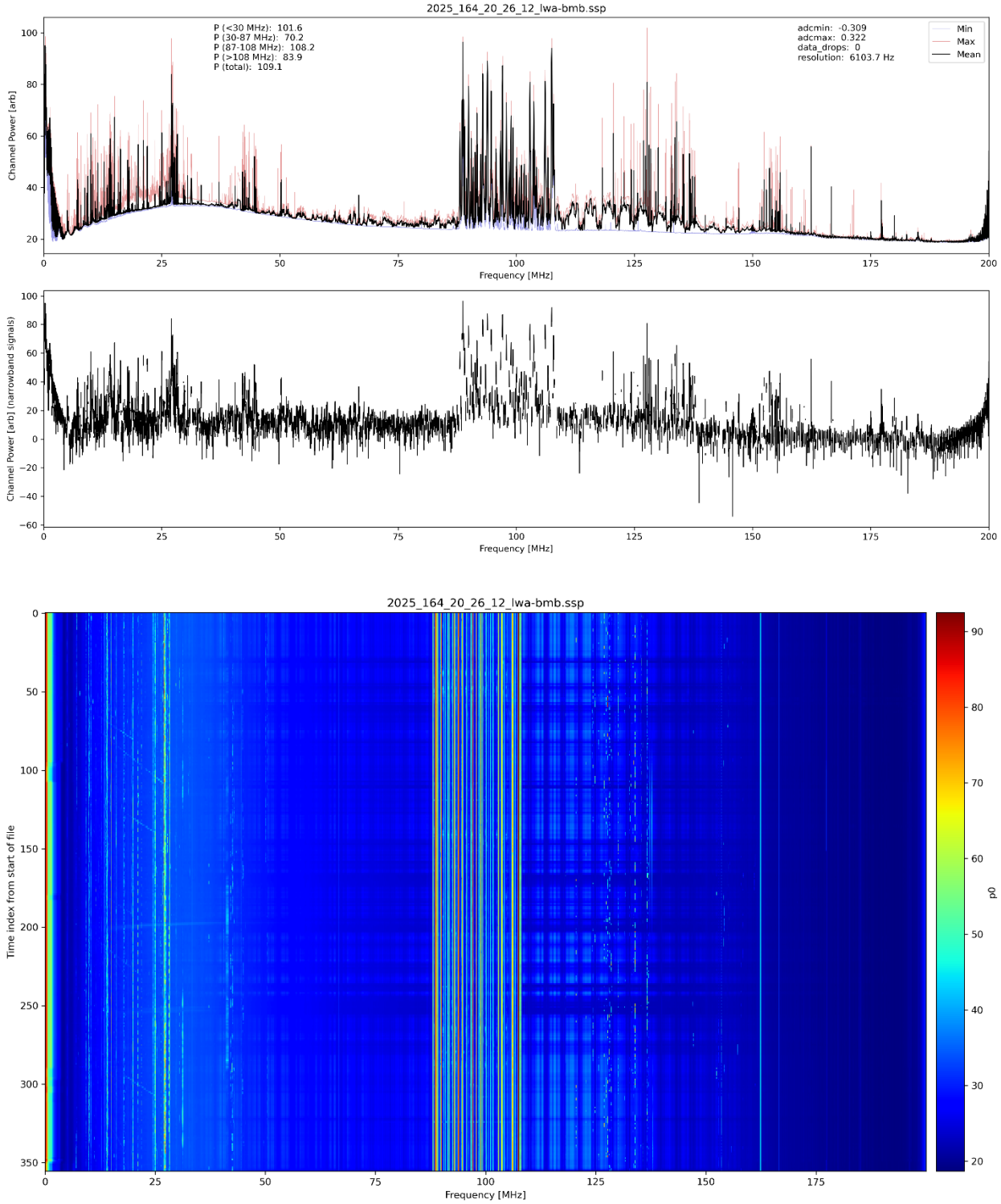

Figure 1. (top panels) Measurements for case 1 using an unmodified FEE with 190 MHz low-pass filter before the ADC. No other gain or filtering was included. The rolling lumps between 110 and 150 MHz are worrisome. One possibility is that they are caused by equipment in the BMB, including the 18V DC switching power supply that was connected through the bias-tee to power the FEE without filtering, or the wireless router, which had not been used in earlier RFI tests. A second possibility is

that there is saturation in the FEE LNAs. However, we previously estimated the power expected to be received and did not anticipate LNA saturation. Unfortunately, we did not have a power meter on site to test the output power of the FEE. (bottom panel) Waterfall of all individual spectra used for Figure 1a. The rolling lumps above the FM band vary in amplitude with time an appear to disappear at some times. Each row corresponds to about 6 seconds. The total time of observation was about 30 minutes.

3. Case 2: Modified FEE + 190 MHz low-pass + 2nd-stage amplifier (~20 dB)

Since the possibility of FEE saturation exists based on the observations above, we acquired a second measurement using a modified FEE. On one polarization of the FEE, the inputs were modified with the addition of 90 Ohm resistors at the input of each LNA in parallel with the dipole arms. This modification was made before the site trip and motivated by FEE saturation when testing the LNA antenna and FEE in Phoenix with its strong nearby FM and TV transmitters. The FEE we used in these site tests included one modified polarization (used here) and one unmodified polarization (used in Section 2 above). When switching to the modified polarization, we did not rotate the antenna to realign the active dipole with orientation of the original measurement in Section 2 above.

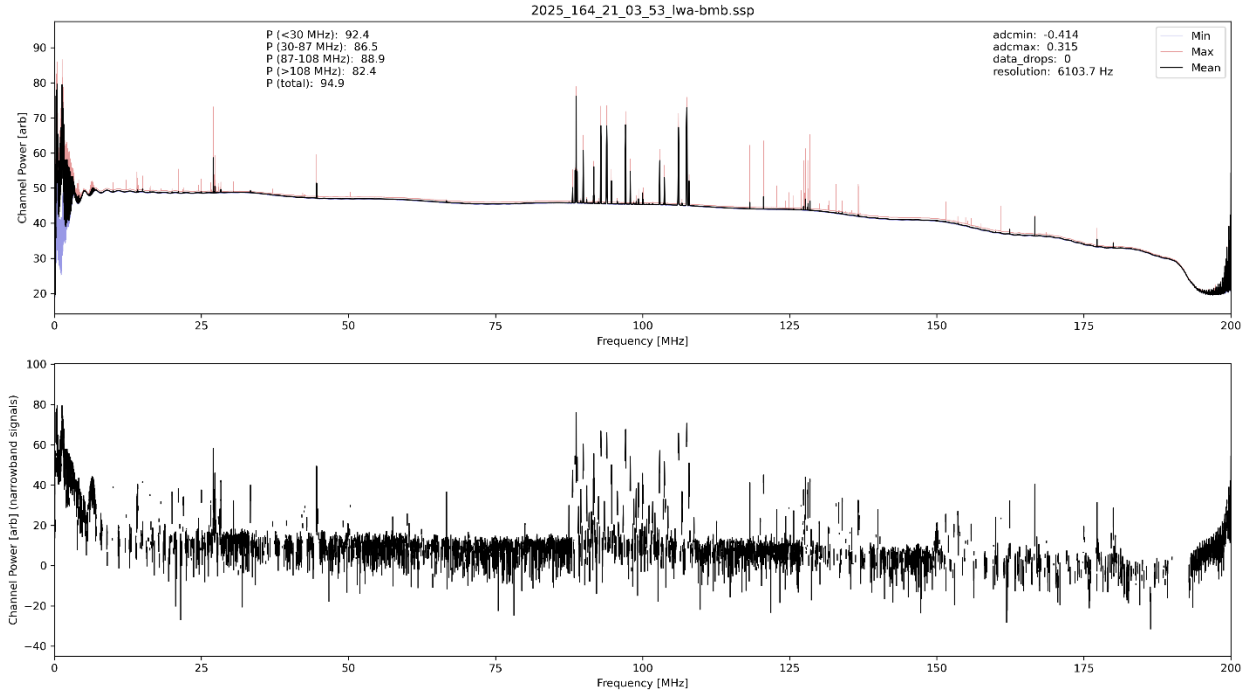

Figure 2. Observed spectrum using modified FEE with 90 Ohm resistors added in parallel to each LNA, 190 MHz low-pass filter, and 2nd-stage amplifier of about 20 dB. The amplifier is a Mini Circuits ZX60-3018G amplifier.

4. Comparison to other RFI measurements at the site

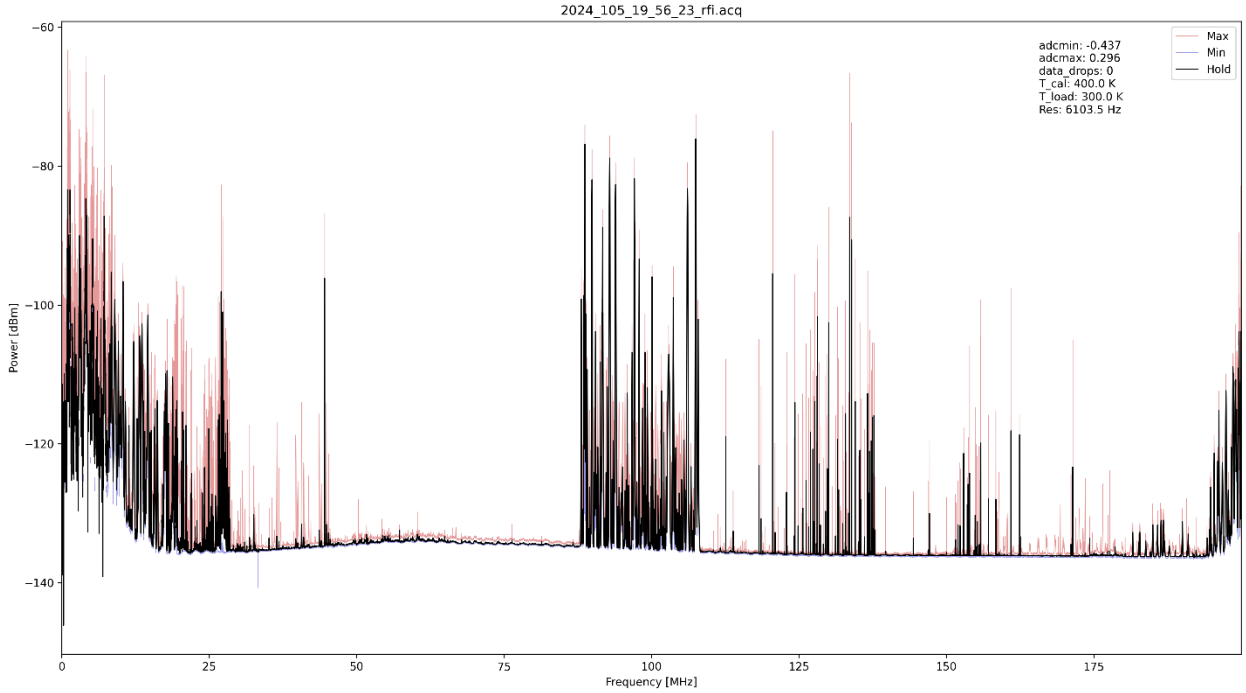

Figure 3: For comparison to the measurements reported above, the spectrum shown here was acquired near the gas station along Meteor Crater Road using the BMB and an EDGES signal chain connected to a standard test dipole in April 2024. See: G: / LWA-MC / Management / 0105 Slides and Overviews / SiteSurvey_20240414_MeteorCrater_Fastspec.pdf

5. Edited Field Notes

6/13/2025 1:05pm:

1. Started with 90 Ohm FEE pair and small amplifier in the BMB + 190 low-pass filter with 4 or 6 dB attenuator after. Looks good. Can see FM, nice bandpass.

2. Switched to standard FEE pair. No change to configuration in the BMB. See unusual spectral features. Initially ADC was saturating.

3. Tried adding 14 dB extra attenuation. ADC down to 0.2 or less (didn't record exact value, anything below 0.5 is acceptable) but still strong signs of something odd.

4. Removed amplifier and extra attenuators and still strong issues.

6/13/2025 1:25pm:

Started fresh data file for easy reference: 2025_164_20_26_12_lwa-bmb.ssp

RF configuration: Only the 190 low pass filter is in the path (no 2nd-stage amplifier or attenuators). Still see issues in spectrum. (This is the data for Section 2: Case #1 above)

adc min/max = 0.15

FM is about 60 dB above floor. Lumps above FM band look like saturation? Smaller hints of lumps below FM band

6/13/2025 2:05pm:

New file for easy reference: 2025_164_21_03_53_mwa-bmb.ssp

Configuration: Connected to 90 Ohm modified FEE output. In the BMB. using the small 2nd-stage amplifier and 190 MHz low-pass filter. No attenuators. (This is the data for Section 3: Case #2 above)

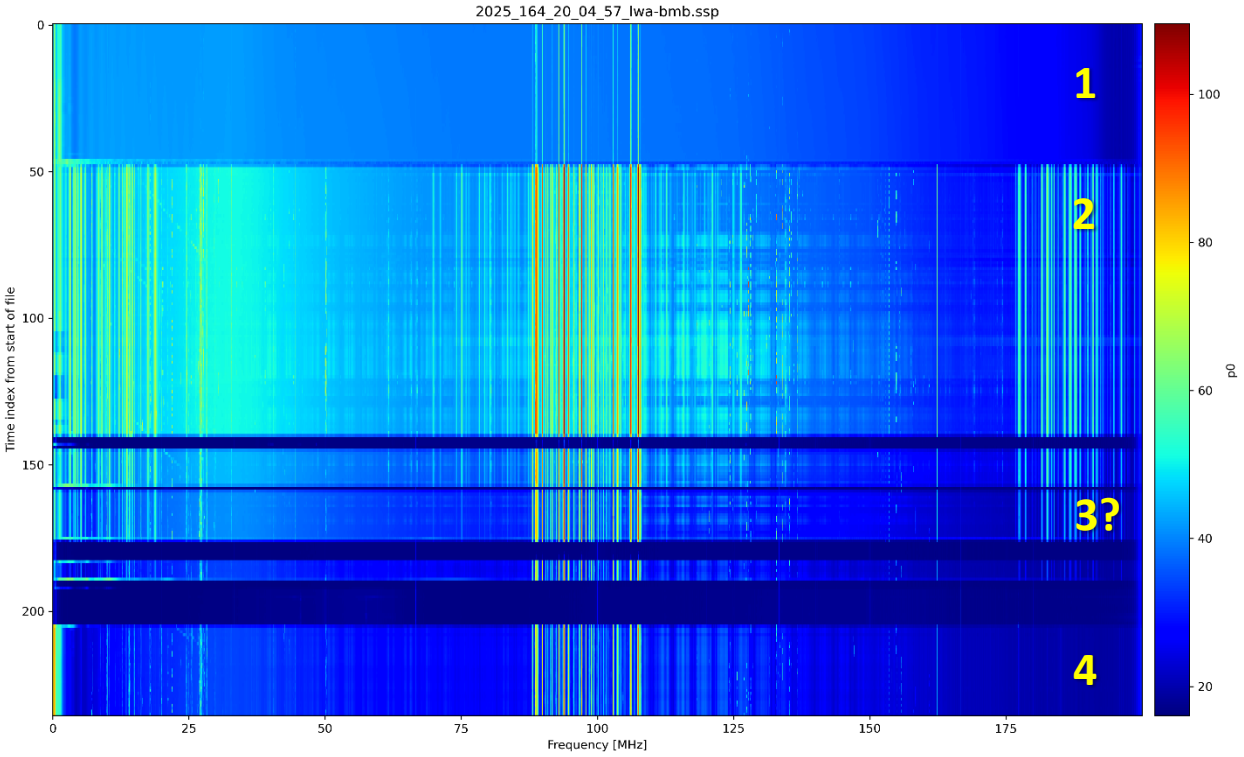

Figure 4. Waterfall of the data acquired during the initial tests described in the 6/13/2025 1:05pm activities. The four initial test configurations described in the 1:05pm notes are labeled here.