



ngVLA Antenna Memorandum #19

Initial RFI testing of the ngVLA Prototype Antenna

K. Elder, P. Demorest (NRAO)

September 2025

Abstract

We provide a summary of initial RFI testing with the prototype antenna. We discuss the testing setups used and the purpose for each. Various calibration schemes are applied to the data to determine which is the most effective for data analysis. The results show that any RF emission from the prototype antenna as currently installed is below detectable thresholds with the VLA, after accounting for the uncertainty created by changing background radiation levels.

1 Introduction

The purpose of this test was to confirm that none of the systems currently installed on the ngVLA prototype antenna are radiating RFI at high enough levels to be observed by the surrounding VLA antennas. This was done by performing RFI scans pointing toward the North and South while turning on different systems in between individual scans. The scans can then be compared in order to identify if there is any RFI signals coming from the trailer or prototype antenna.

2 Testing details

The RFI scans were performed on August 14, 2025, between 17:56 and 20:27 UTC. The observations used the 8-bit samplers and the BD baseband only, with 8 x 128 MHz windows, dual-polarization and 896 channels each for a 143 kHz spectral

resolution. The tuning changed in steps of 1000 MHz, spending 30 seconds at each tuning. The correlator dump time was 1 sec and fringe rotation was off.

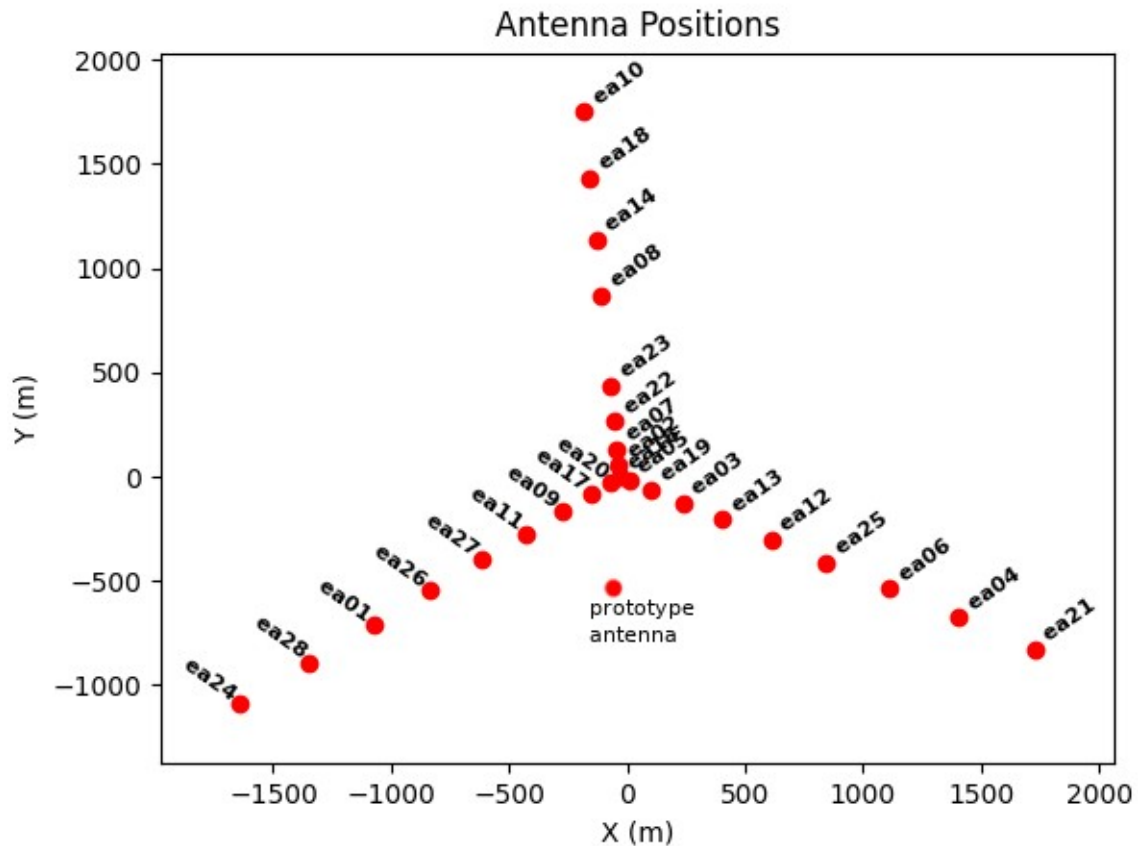


Figure 1. The antenna positions at the time of the test. The array was in C configuration. The location of the prototype antenna has been approximated in the plot.

The VLA was in C configuration at the time of the test. Figure 1 is a plot of the antenna locations. The prototype antenna was 409 m away from ea09 on pad W06.

We performed scans to measure RFI for four different set-ups with the prototype antenna: everything off; the trailer on, including a desktop computer, a laptop, and the printer; the trailer on and the antenna motors on with the antenna door closed; and the trailer on and the antenna motors on with the antenna door open. At the time of this report, the servo system and network switches are installed and operational, but signal chain electronics remain to be installed.

For each test set-ups, scans were preformed pointing both north and south. The north scan was pointed at the NCP, at approximately 0° az, 33.5° el. The south scan pointing was 180° az, 30° el.

This test was performed with frequency bands P through Ku. The highest frequency bands were not recorded because they are outside the frequency range of the expected RFI being studied.

3 Data processing

Even after calibrating the data, it was noted that in some cases, there was a large difference between the amplitudes of different scans. As there appeared to be no other significant difference between the features of the data, it was determined that this was an artificial deviation caused by potential errors in the calibration setups.

Therefore, multiple different calibration schemes were used in order to compare the results. The different calibration setups were: switched-power gains (swpow); requantizer gains (rq); swpow and gain curve and efficiency (gceff); rq and gceff. Each of these were applied using the gencal task in CASA. The goal of this comparison is to determine the most effective calibration setup for use in pipelines to analyze data in future RFI tests.

Below are examples of the different calibration schemes. Each plot is of the L-band from the South-facing scan and RR polarized. The data has been averaged across time and baseline and is plotted in log scale.

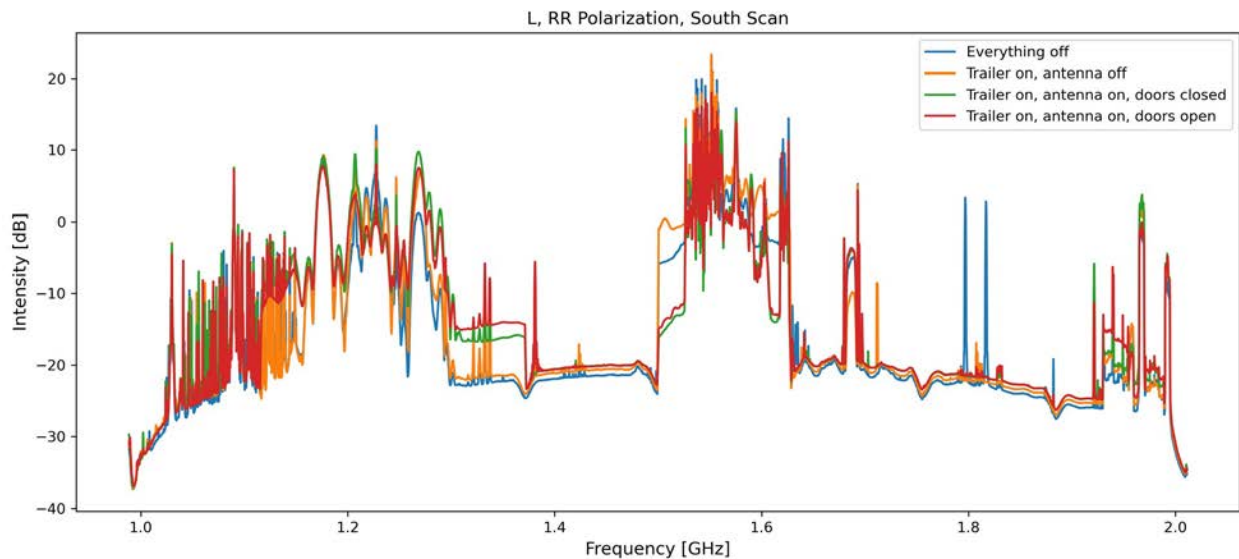


Figure 2. The uncalibrated data for each test plotted in dB for L-band.

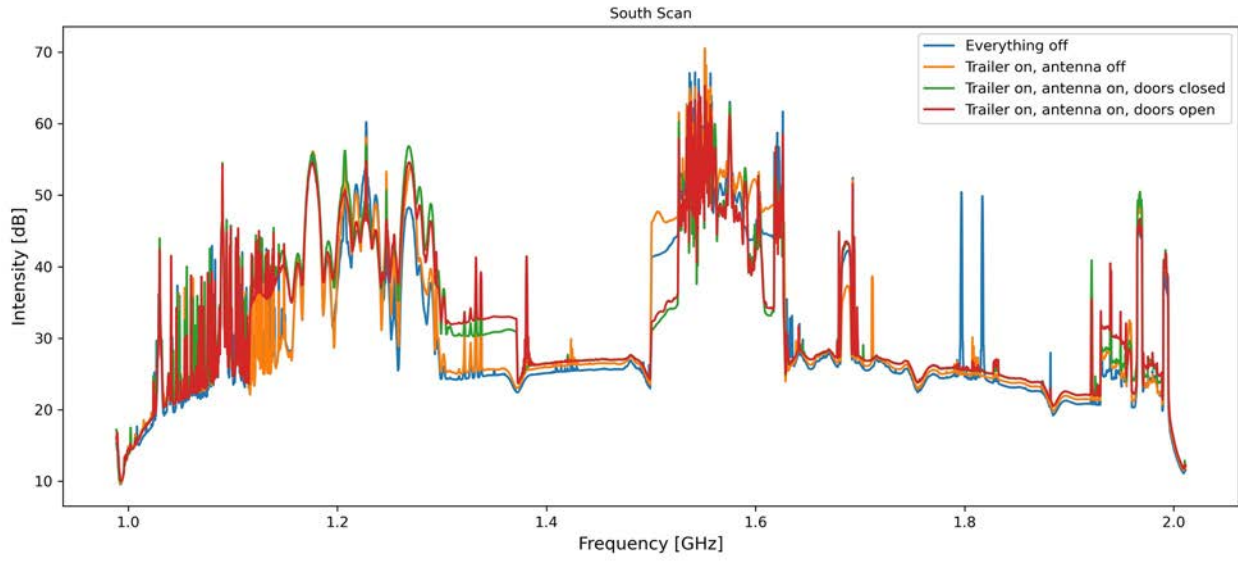


Figure 3. The same data with the requantizer gain calibration applied.

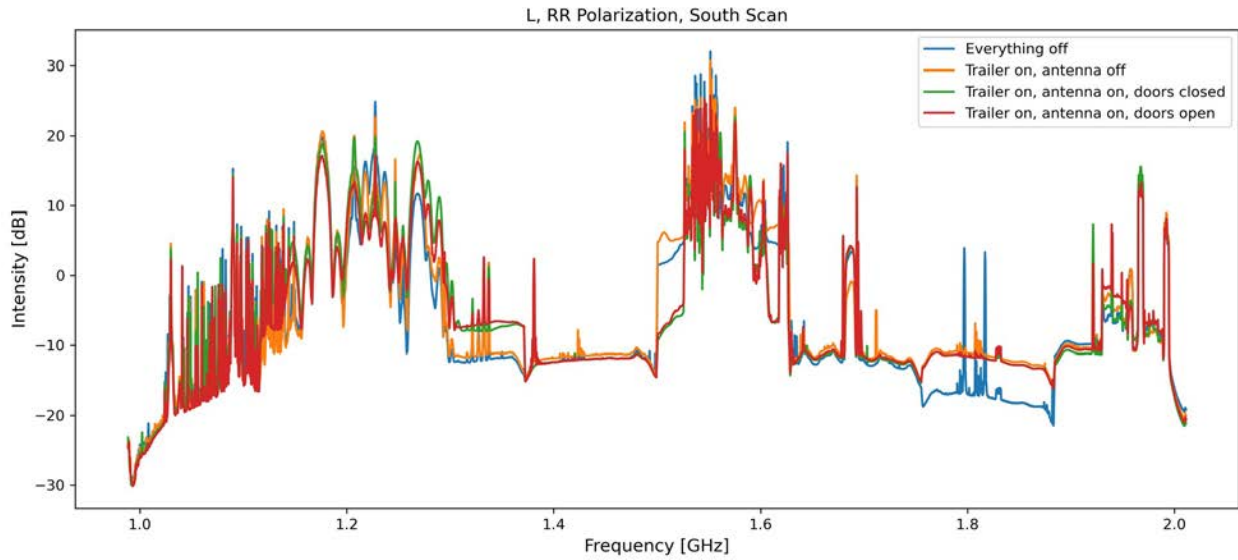


Figure 4. The same data with the switched power gains applied.

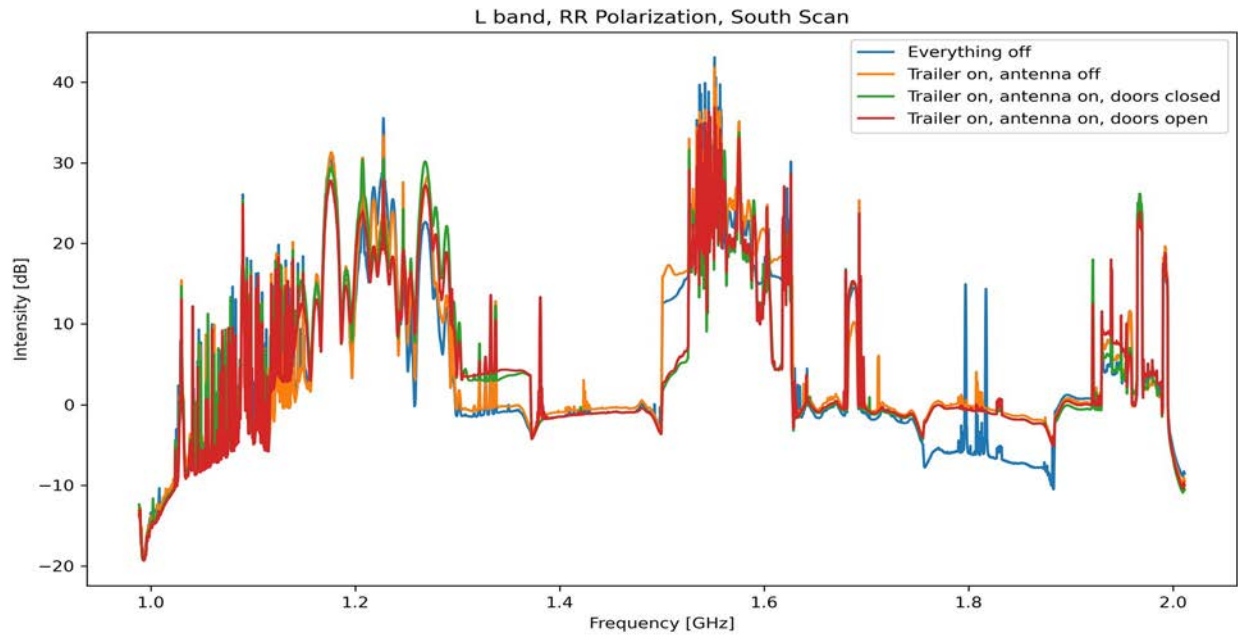


Figure 5. The same data with the switched power gains and gain curve efficiency calibration applied.

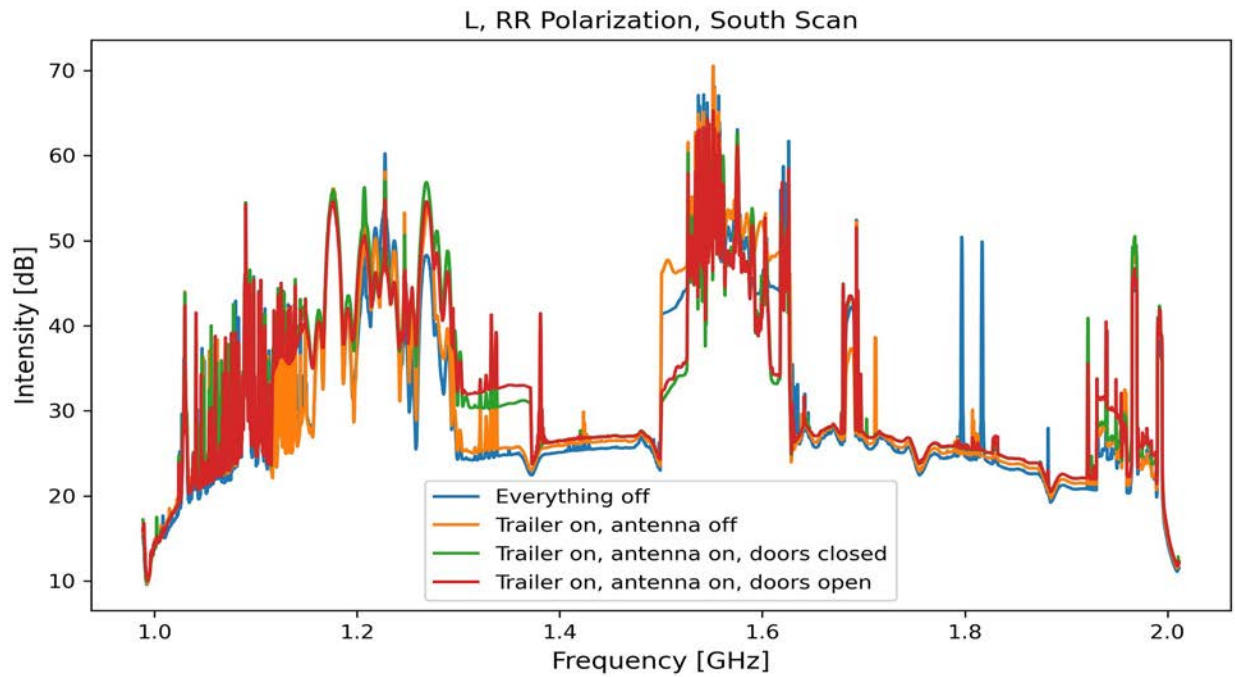


Figure 6. The same data with the requantized gains and gain curve efficiency calibration applied.

None of the calibration schemes fully removed the amplitude differences present between scans. For the time being, the data will be calibrated using the requantized gains only. However, if this is a continuing issue, more investigation maybe required.

4 Test results

The amplitudes of the antenna cross-correlation data (visibilities) have been averaged across time and baseline and are plotted in log scale. In order to compare the scans, the ratio of the test and the baseline, everything off scan are plotted. Any negative amplitude indicates a signal present in the baseline scan which was not present during the test. Only the South-facing scans in RR polarization are included in this memo. The North-facing scans and other polarizations do not show any significant difference and are quieter overall.

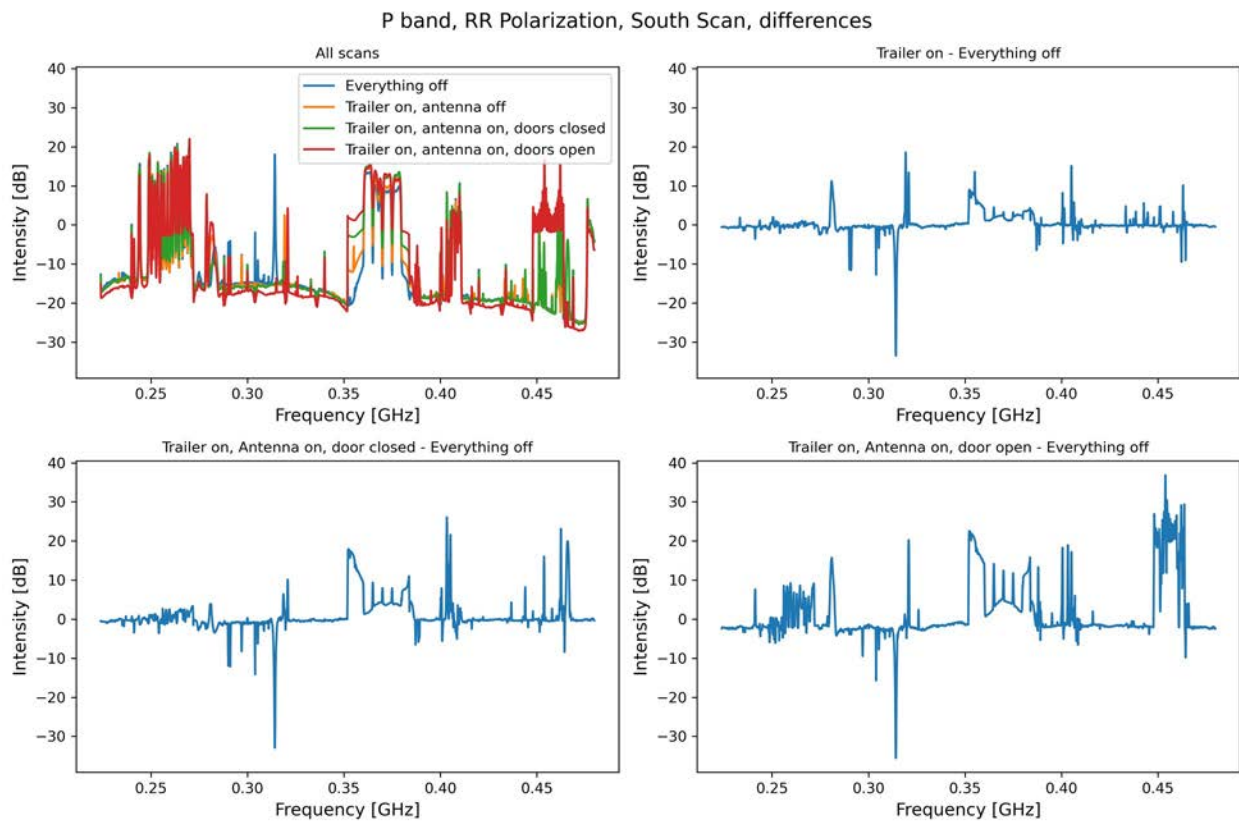


Figure 7. Plots of the scans and difference between test and baseline (everything off) scan for P-band.

L band, RR Polarization, South Scan, differences

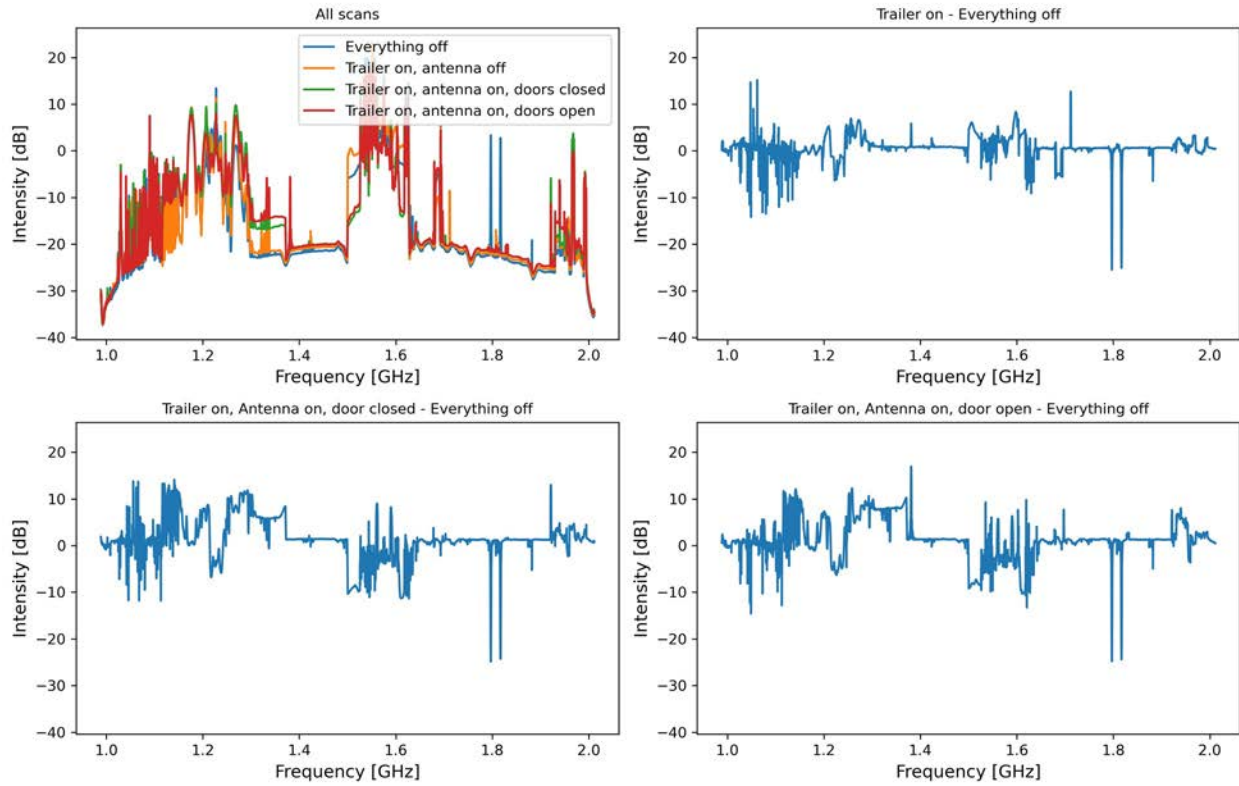


Figure 8. Plots of the scans and difference between test and baseline (everything off) scan for L-band.

S band, RR Polarization, South Scan, differences

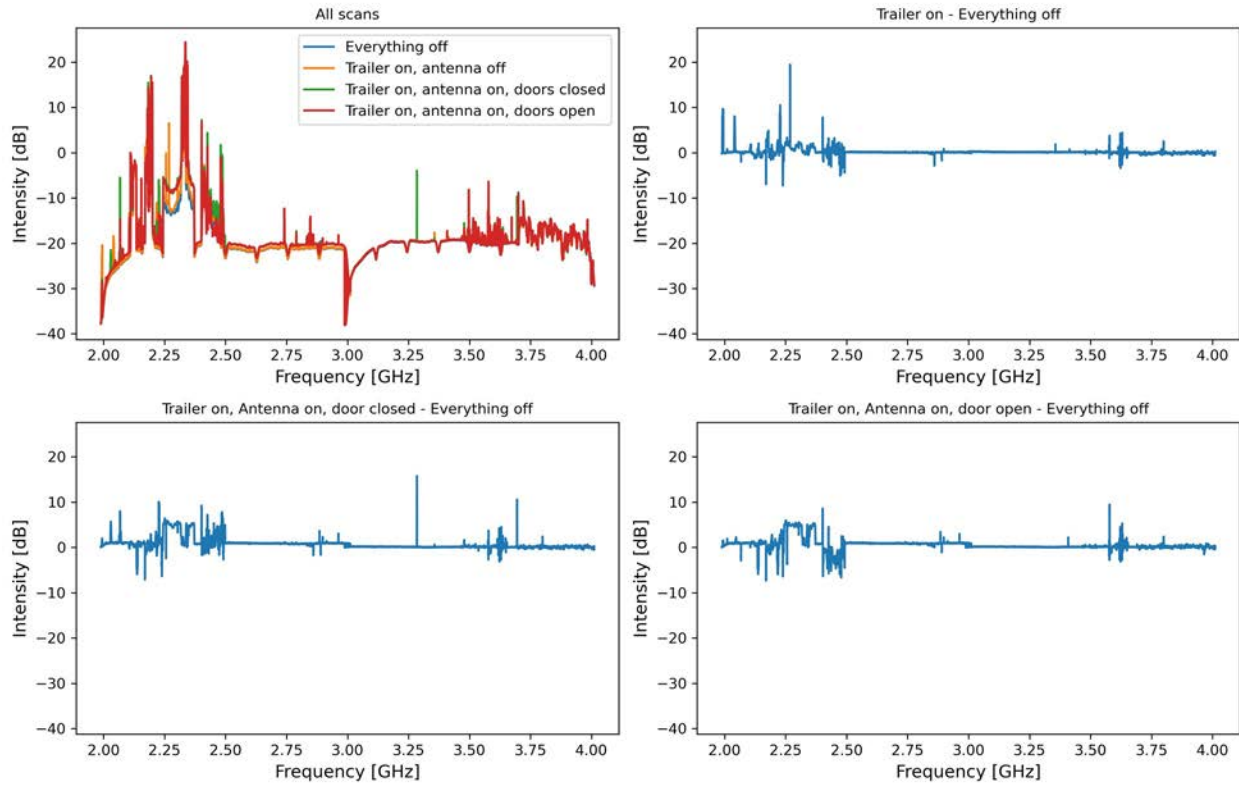


Figure 9. Plots of the scans and difference between test and baseline (everything off) scan for S-band.

C band, RR Polarization, South Scan, differences

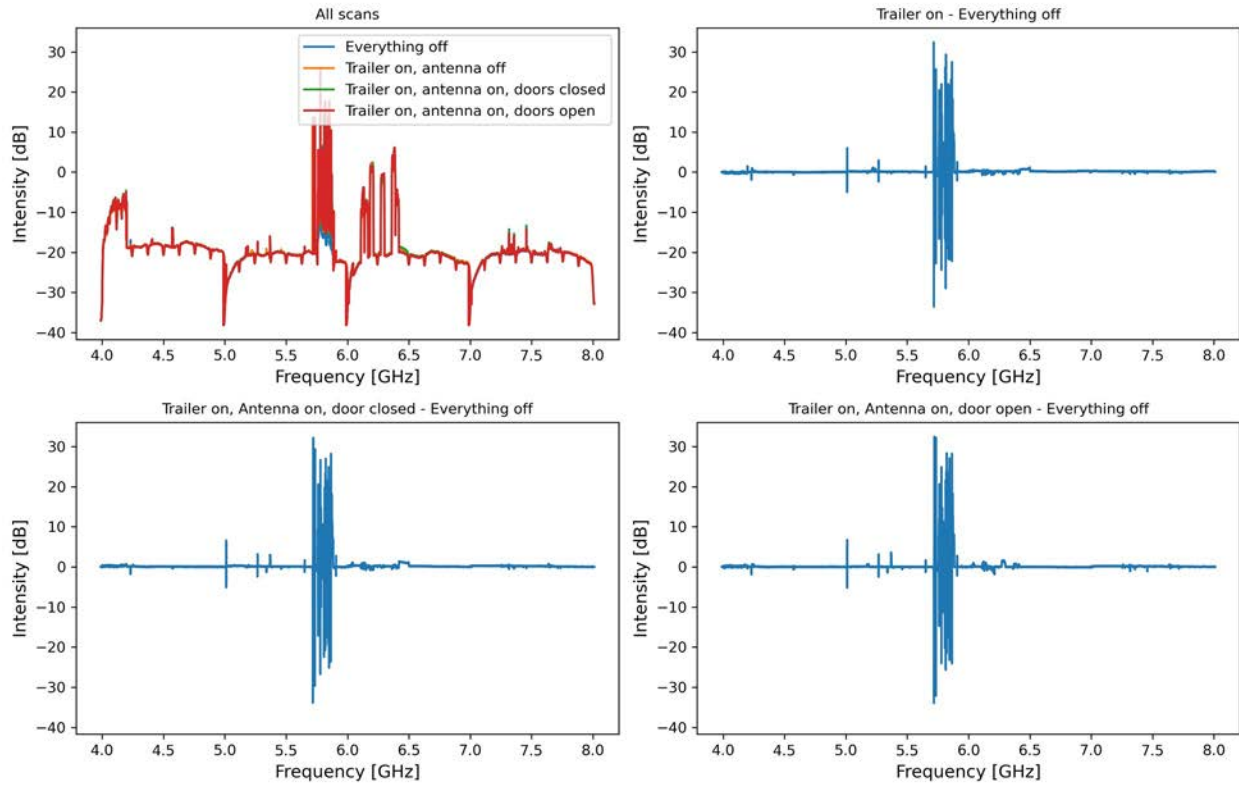


Figure 10. Plots of the scans and difference between test and baseline (everything off) scan for C-band.

X band, RR Polarization, South Scan, differences

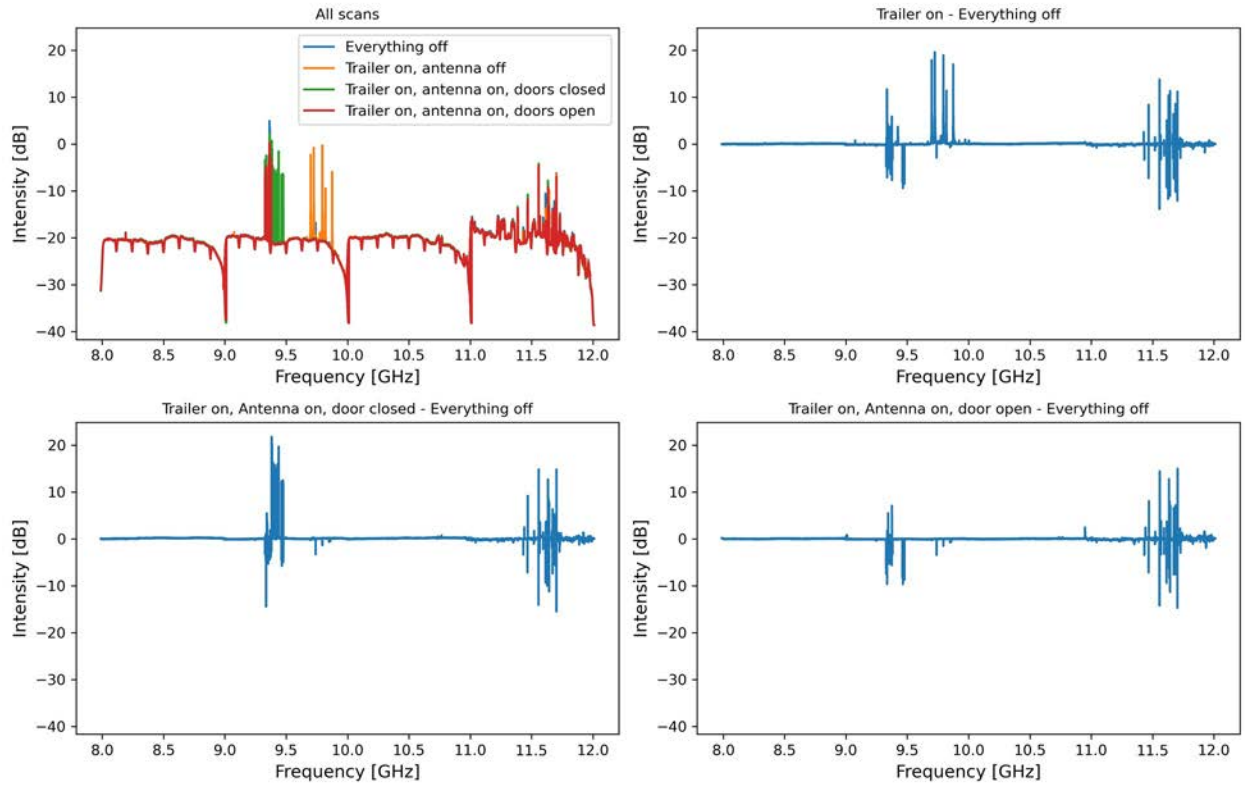


Figure 11. Plots of the scans and difference between test and baseline (everything off) scan for X-band.

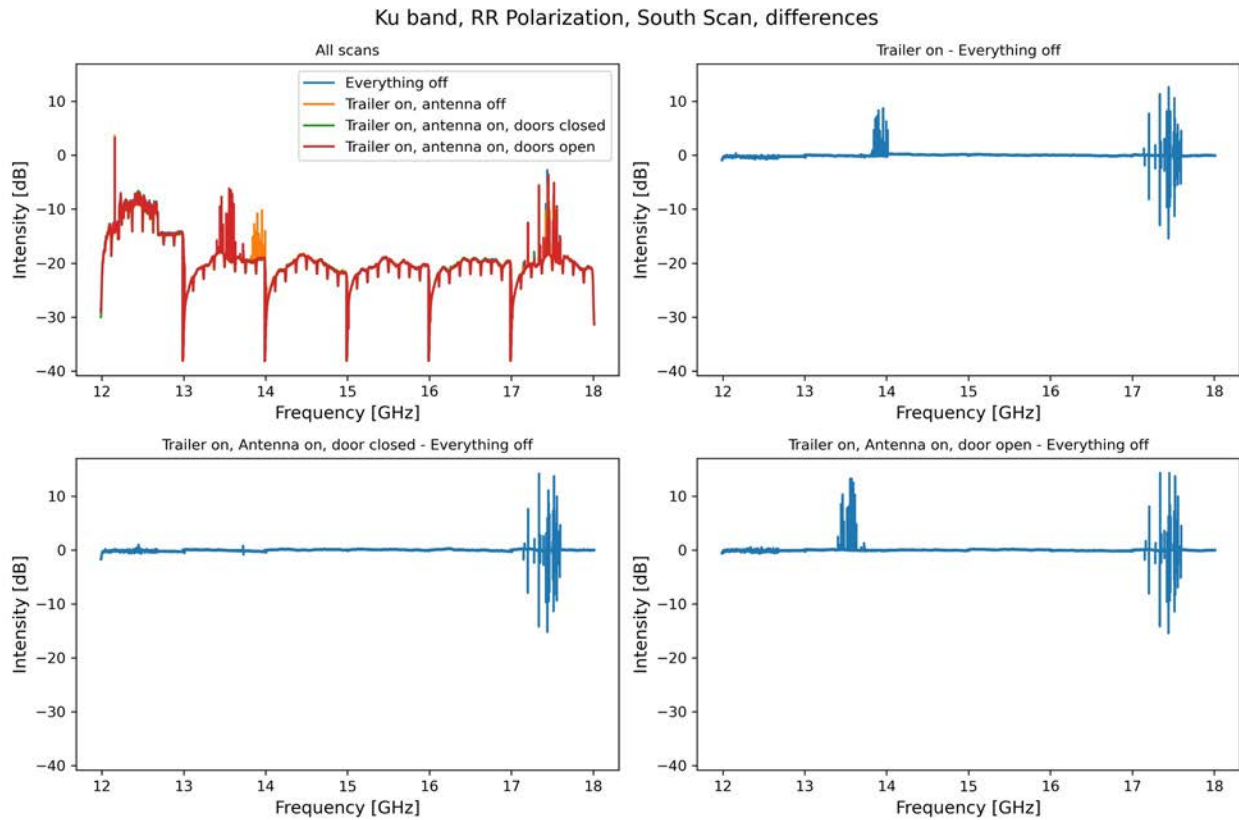


Figure 12. Plots of the scans and difference between test and baseline (everything off) scan for Ku-band.

5 EMS RFI monitor

At the same time as the test scans, from 10 am to 3 pm MDT, the Environmental Monitoring System (EMS) was recording data. The setup was configured to record for approximately 20 seconds every minute with a frequency range of 0 to 12 GHz. The data is shown in waterfall plots below. The magnitude is plotted in log scale.

Due to the observation setup, with the tuning steps and time, a corresponding waterfall plot using the VLA data is not available for comparison.

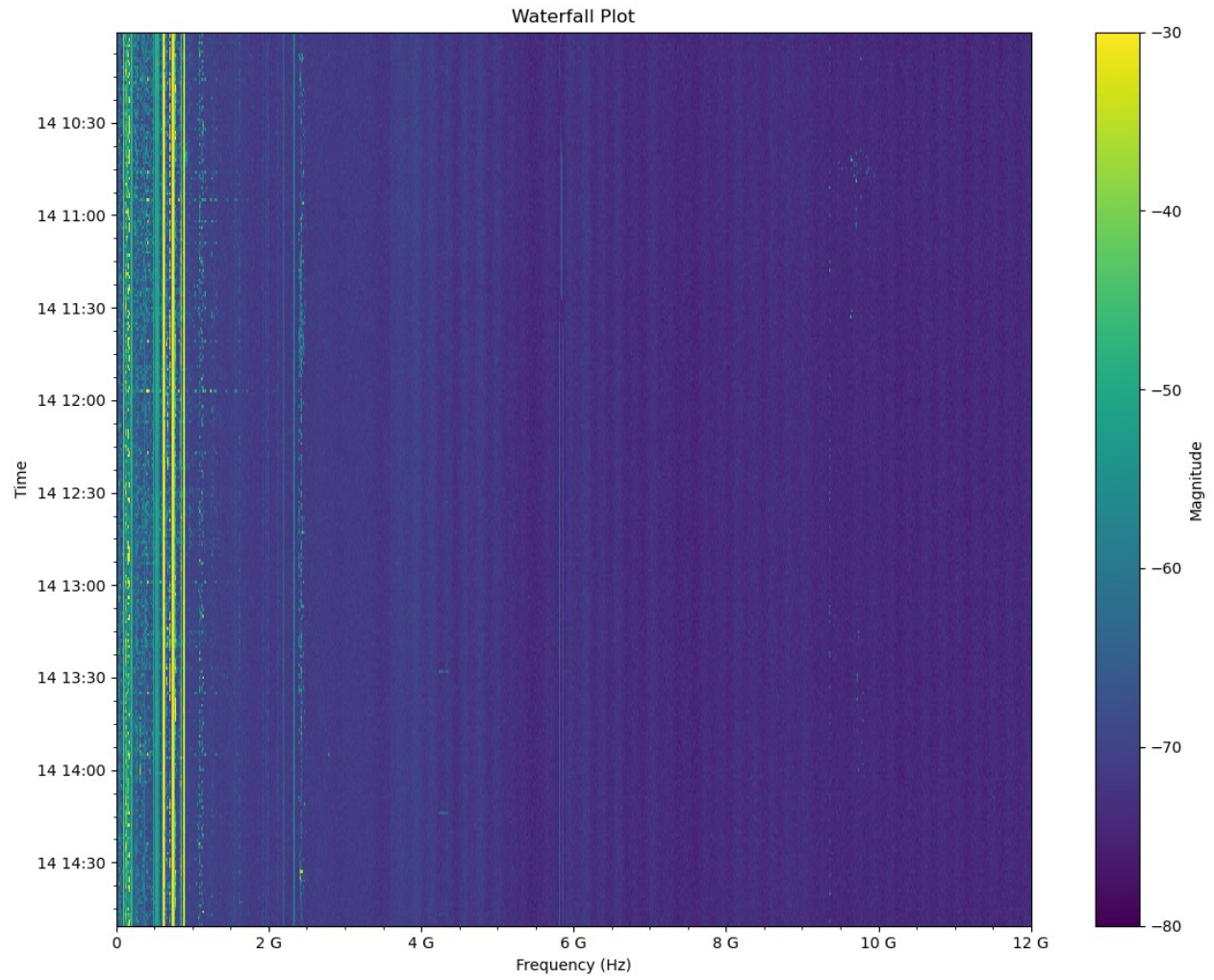


Figure 13. Waterfall plot of RFI monitor. The time is given in MDT.

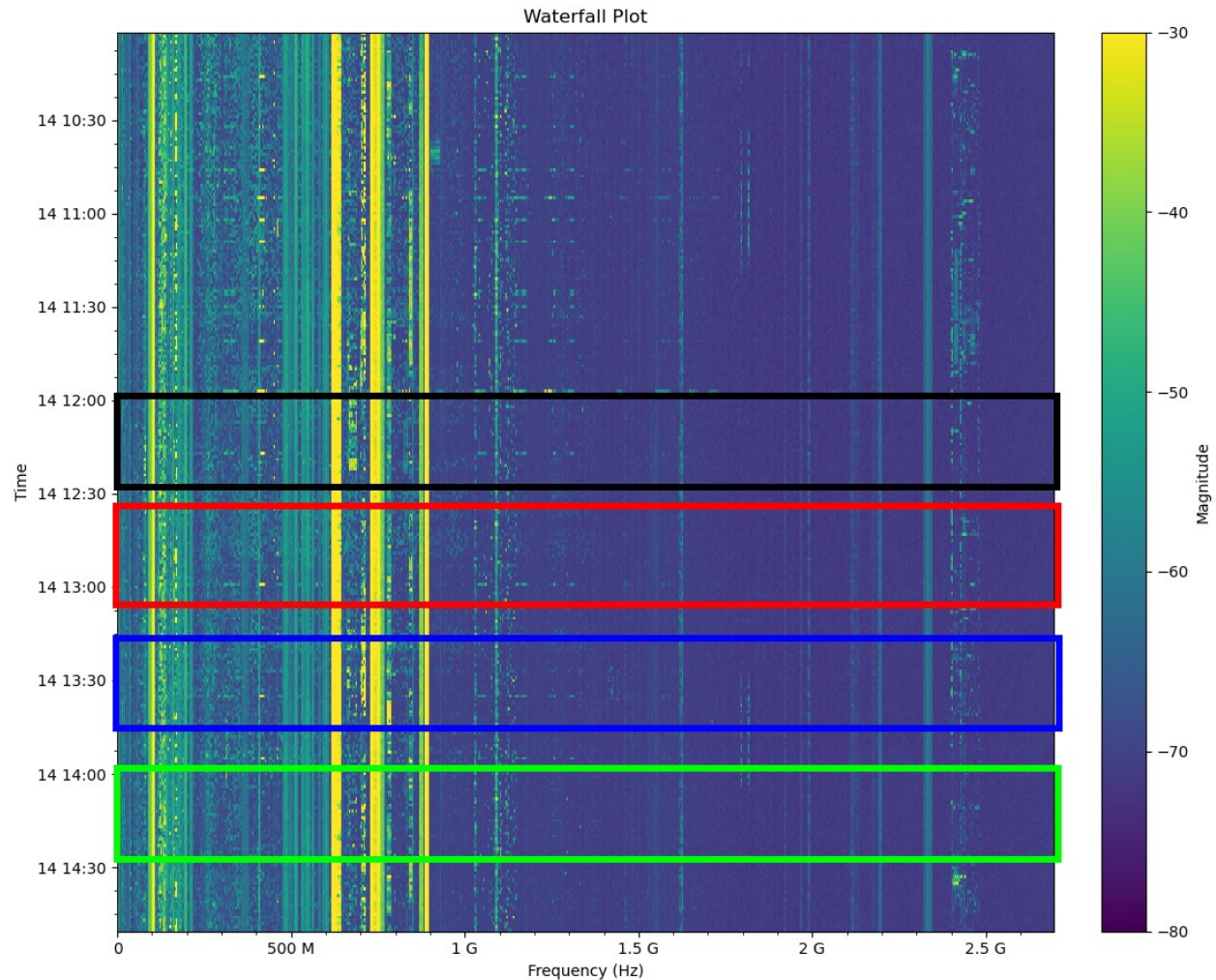


Figure 14. Zoom in for 0 to 2.7 GHz. The approximate times of the tests are marked with colored boxes. The black box is the trailer on, antenna on, and door open test; the red box is the trailer on, antenna on, and door closed test; the blue box is the trailer on and antenna off test; and the green box is the baseline, everything off test.

The approximate times of the test scans have been marked in Figure 13. The EMS monitor did not see any noticeable changes in RFI during the scans. It is important to note a bright RFI signal present at approximately 11:55 am, just before the first test scan shown. This is likely due to a cell phone call from site to the operators to confirm the test setup.

6 Conclusion

The results of this analysis do not indicate any sources of RFI present in the trailer or the antenna. Any spikes in RFI are not consistent across scans and, in several bands, the largest spikes in RFI are only present in the baseline scan without any of the equipment turned on. Additional investigations are required to improve the test scripts to ensure that system levels (attenuators, requantizers, etc) are constant between test runs to facilitate post facto analysis.

The National Radio Astronomy Observatory and Green Bank Observatory are facilities of the U.S. National Science Foundation operated under cooperative agreement by Associated Universities, Inc. This work was supported by awards AST-2034328 (MSIP Prototype Antenna) and AST-2334267 (ngVLA Design Activities); NRAO related activities are funded under award AST-1647378 (NRAO Operations/Development).

