

The Hat Creek Radio Observatory

GReX Electromagnetic Interference Measurements



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This document summarizes the testing of the GReX electronics' EM interferences at the Hat Creek Radio Observatory (HCRO) on April 3rd, 2024.

1 Measurement setup

The GReX unit is placed in the HCRO's screened room and its electromagnetic emissions are recorded by a spectrum analyzer connected to an omnidirectional antenna through a signal amplifier. A schematic of the setup is shown in figure 1, a list of the components used in table 1 and a picture of the setup inside the screened room is shown in figure 2. A list of settings for the spectrum analyzer is shown in table 2. One modification was done for all the tests, compared to the state in which the GReX module was received: steel wool was added in the opening for the fiber cable to further shield the GReX enclosure.

A first baseline measurement was done with all the GReX electronics turned off. Then, the GReX was powered on and the emission spectrum was recorded for the GReX enclosure closed and opened separately. The SNAP board was programmed with the "2023-08-16_1325" firmware after switching the unit on, but the 10 Gigabit Ethernet output was not enabled. As a final test, RF absorbers were placed in the GReX enclosure and the emission spectrum was once again measured with the enclosure closed. The hypothesis tested here is that the GReX enclosure acts as a resonant chamber for the EMI. Adding absorbers in the enclosure would reduce the interferences inside the enclosure, thus reducing the amount escaping the enclosure causing interferences on the outside.

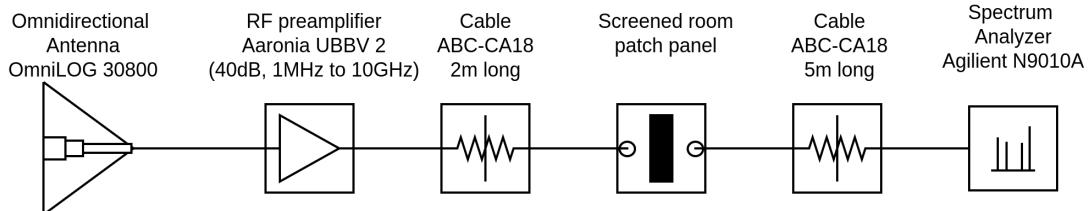


Figure 1: GReX EMI measurement setup schematics.

Description	Designation
Omnidirectional antenna	OmniLOG 30800
RF preamplifier	Aaronia UBBV 2
Female-Female SMA cable 2m	ABC-CA18-SMSM-2.OM
Female-Female SMA cable 5m	ABC-CA18-SMSM-5.OM
Spectrum analyzer	Agilent N9010A

Table 1: Components list for the GReX EMI measurements.

Description	Setting
Start Frequency	300 MHz
Stop Frequency	6 GHz
Number of points	1001
Sweep time	656.176 s
RBW	100 Hz
VBW	1000 Hz
Attenuation	0 dB
Trace type	Maxhold
Detector	Peak

Table 2: Agilent N9010A spectrum analyzer settings list for the GReX EMI measurements.



Figure 2: GReX EMI measurement setup in the HCRO screened room.

2 Results

The baseline spectrum is shown in figure 3. The emission peaks around 1 GHz are due to the EMI emitted by the spectrum analyzer itself, even though it is set outside the screened room for the measurements. However, this contribution is negligible compared to the GReX measurements shown below. Figure 4 shows the spectrum for the GReX enclosure open. The spectrum measurement result with the GReX enclosure closed is shown in figure 5. Finally, figure 6 shows the effect of adding absorbers inside the enclosure. These four spectra are respectively referred below as “baseline”, “open”, “closed” and “absorber”. A list of the highest interference peaks, defined as a value greater than 30 dB above its neighbors and a distance of at least 5 spectrum values between each peaks, is reported in table 3.

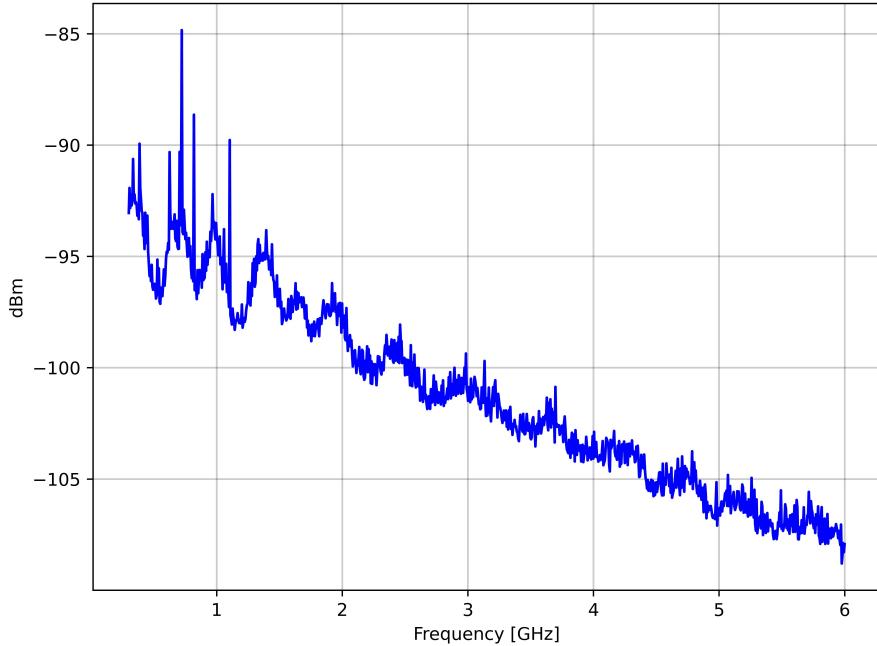


Figure 3: Baseline spectrum for the GReX EMI measurements.

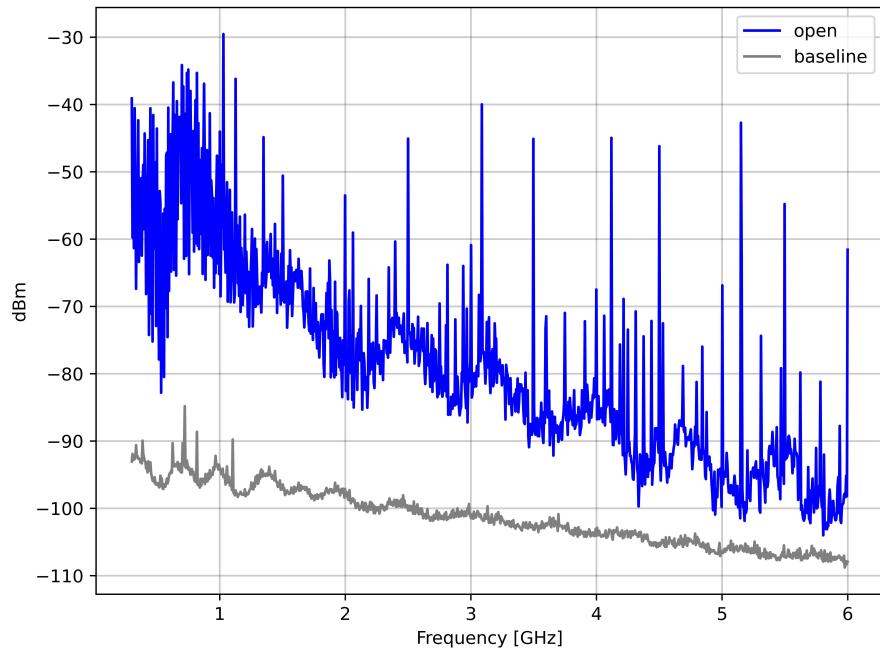


Figure 4: EMI emission spectrum of the GReX unit with its enclosure opened, compared with the baseline spectrum.

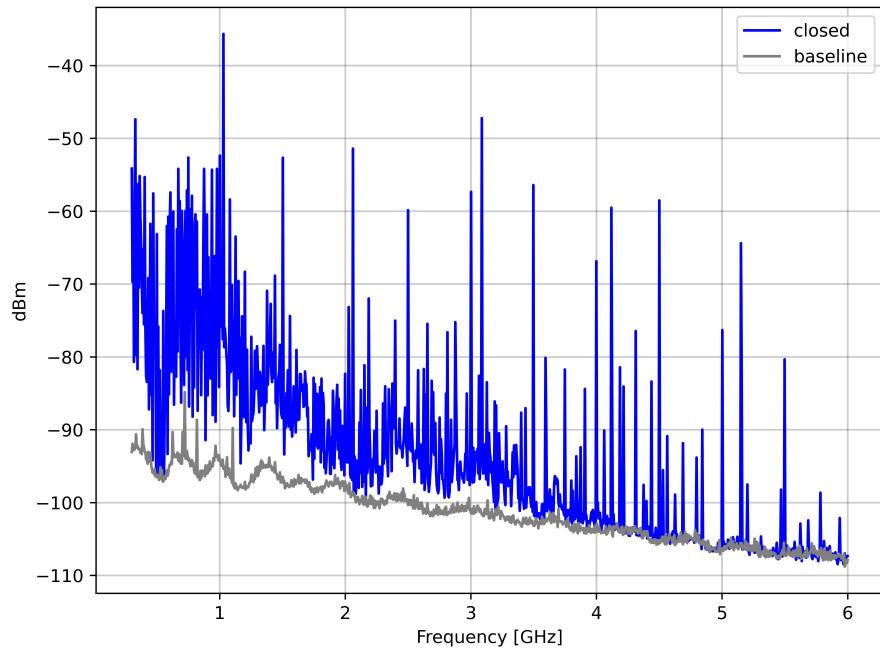


Figure 5: EMI emission spectrum of the GReX unit with its enclosure closed, compared with the baseline spectrum.

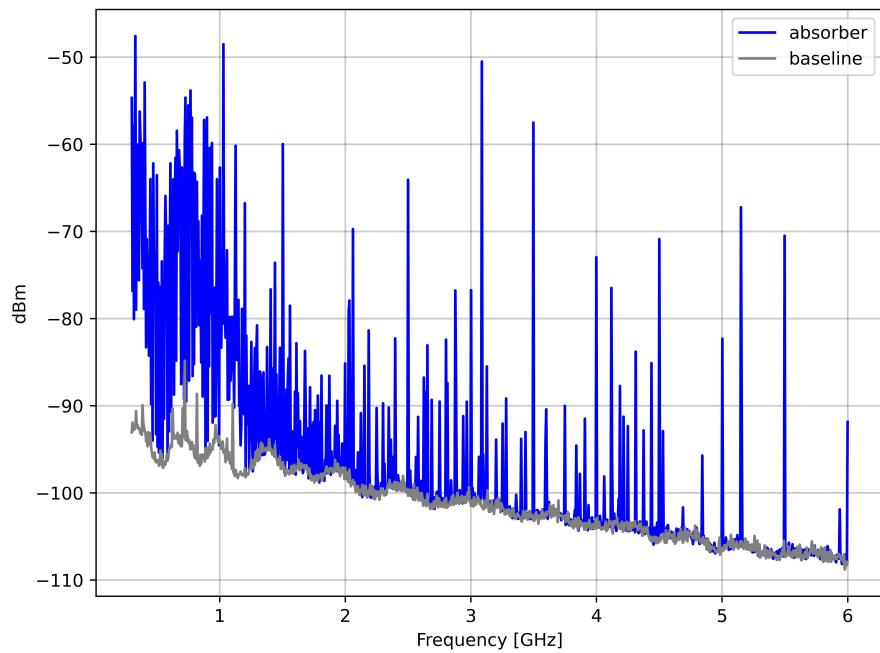


Figure 6: EMI emission spectrum of the GReX unit with its enclosure closed and absorbers added inside the enclosure, compared with the baseline spectrum.

Measurement	Frequency [GHz]	Amplitude [dBm]
open	3.0873	-39.978501
open	3.4977	-45.107806
open	4.1190	-44.959350
open	4.5009	-46.206643
open	5.4984	-54.792139
closed	0.4995	-63.143009
closed	1.0296	-35.672183
closed	1.5027	-52.661033
closed	2.0613	-51.418850
closed	2.5002	-59.862832
closed	3.0018	-57.345924
closed	3.0873	-47.234282
closed	3.4977	-56.419926
closed	3.9993	-66.870435
closed	4.5009	-58.519204
absorber	1.0296	-48.517166
absorber	2.5002	-64.079893
absorber	3.0873	-50.503989
absorber	3.4977	-57.511396
absorber	3.9993	-72.956611
absorber	4.5009	-70.879781
absorber	5.4984	-70.499525

Table 3: List of main emission peaks in the spectrum recorded for the GReX EMI measurements. Computed using `scipy.signal's find_peaks` function (threshold: 30, distance: 5).