EDGES MEMO #307

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

July 16, 2019

Telephone: 617-715-5571
Fax: 617-715-0590

To: EDGES Group

From: Alan E.E. Rogers

Subject: Tests of the effects of strong RFI

The test deployment of EDGES-3 to West Forks, Maine described in memo 306 raised concerns that the Spurious Free Dynamic Range (SFDR) for EDGES-3 was not as high as with EDGES-2. This concern was based on the comparison of the apparent broad width of the FM signal at 105.1 MHz when the same signal was observed to have close to the same strength in 2011 but without significant broadening. This broadening was also observed upon injection of the 100 MHz test signal from a RF Explorer.

Figure	RF level dBm	Power level	ADC max	rms 7-terms
1	-62	23%	0.4	26 K
2	-72	14%	0.3	3 K
3	-82	6%	0.25	1.7 K
4	Off	2.5%	0.25	1 K

Table 1 Signal injection strengths and results.

Table 1 gives the details of the cases used. A signal strength far below the ADC saturation level of 0.5 results in a significant contribution to the calibrated spectrum well outside the frequency range of the RFI. For example, in Figure 1 an injected sine wave at – 62 dBm increases the fraction of the power in the signal band from 2.5% of the total power to 23% of the total power which is now 77% out of band noise. While this signal is very strong it will be accepted unless the ADC threshold is set to 0.4 and then following RFI excision there will still be an rms of 26 K after 7-terms are removed. Even more modest signal levels which might occasionally be present even at the MRO might result in a significant effect on the calibrated spectrum. The Blackman-Harris window function should provide filter sidelobes below -90 dB compared with the sidelobe levels of about -65 dB present in Figures 1, 2 and 3. A test was made using a single "tap" in FASTSPEC with the results corresponding to Figures 1 and 2 are shown in Figures 6 and 7 respectively. FASTSPEC has the option to use multiple "phase windows".

For example, if 2 blocks of N samples are captured from the ADC card a Blackman-Harris weighted spectrum can be obtained from the first N samples, from the middle N samples and another from the last N samples. In this case the windowing function maintains the same SFDR but with improved SNR as a result of the lower noise. Apparently, there is a problem with the multiple "tap" mode which will be fixed. The sidelobes of the RF explorer used in tests were at about -75 dB so the results with 1 "tap" may still not be quite as good as expected and further tests will be made.

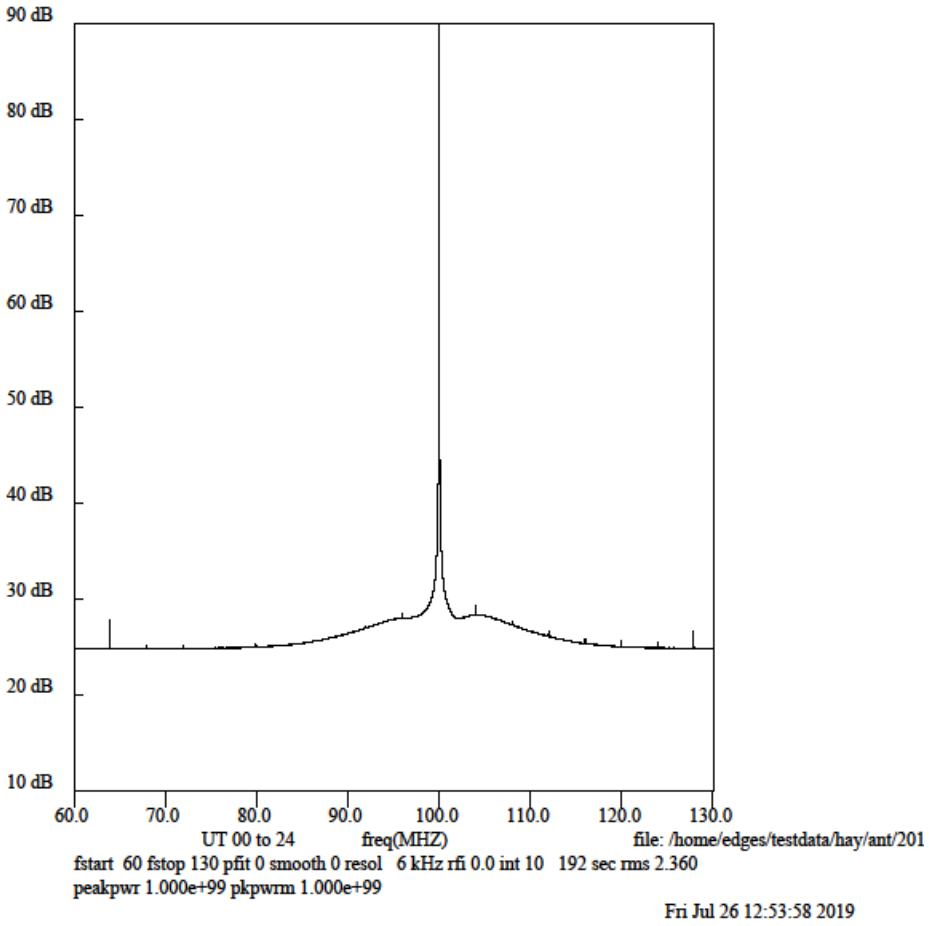

Figure 1. 100 MHz sine wave at -62 dBm from R.F. Explorer injected into EDGES-3.

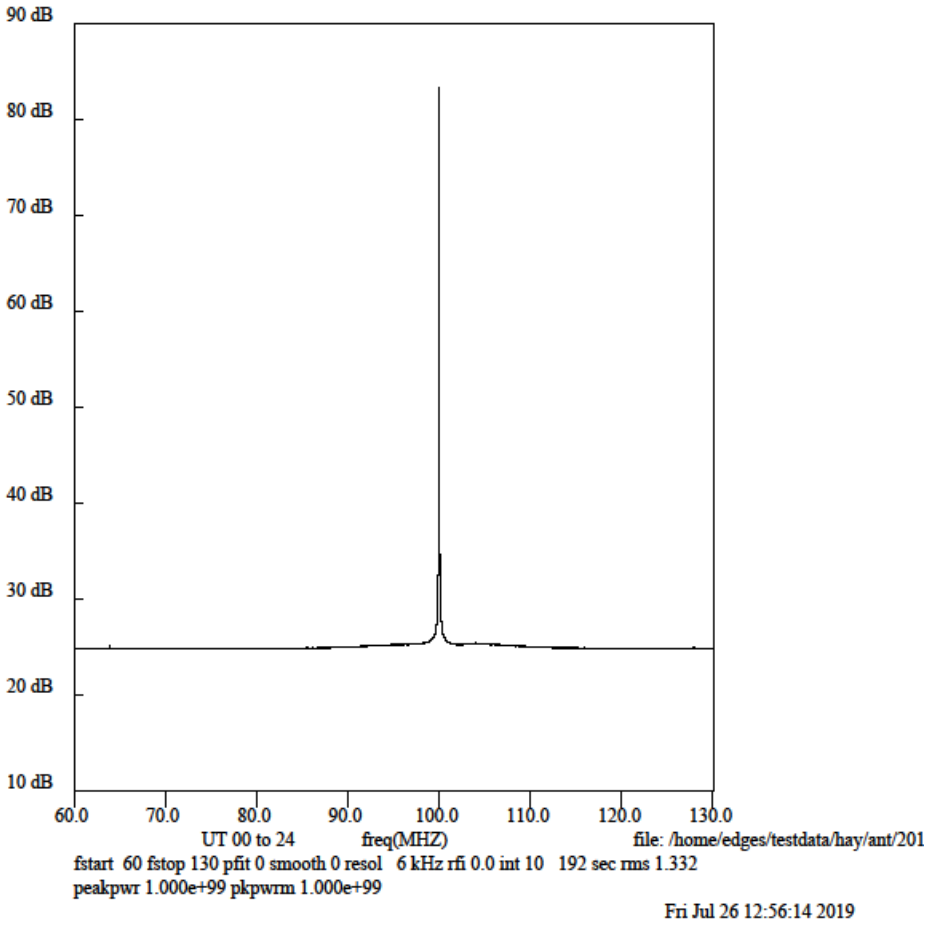

Figure 2. Signal at -72 dBm.

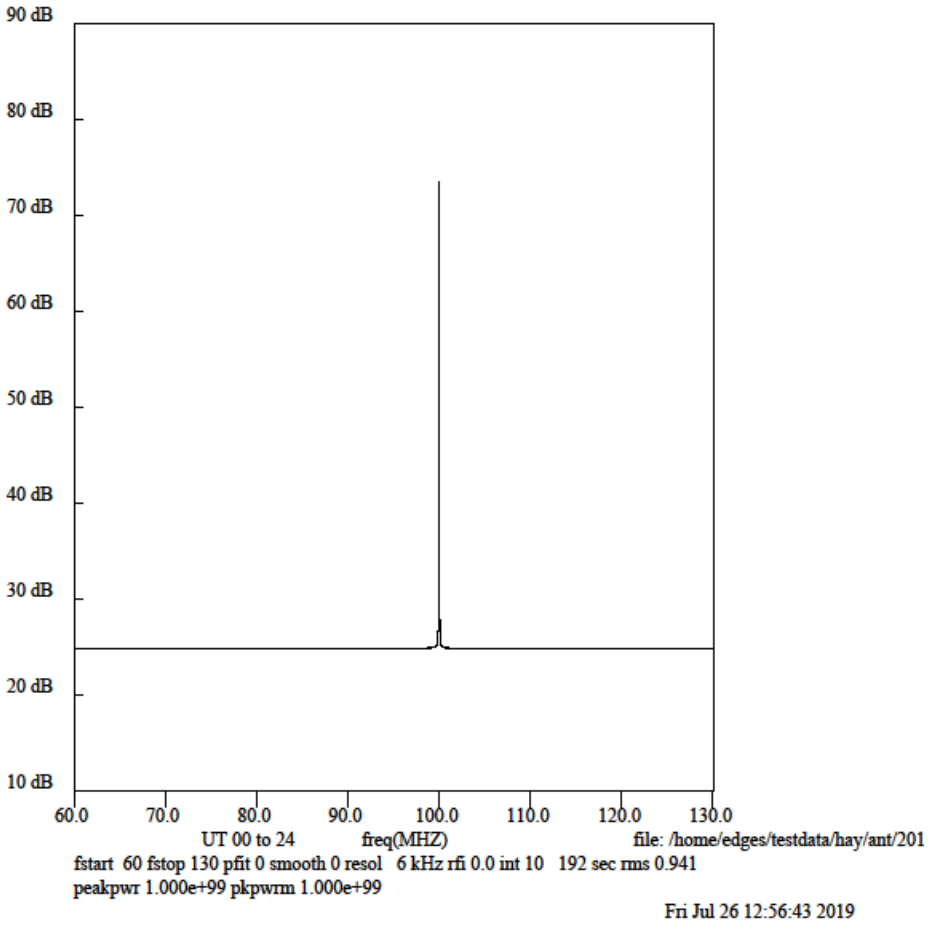

Figure 3. Signal at -82 dBm.

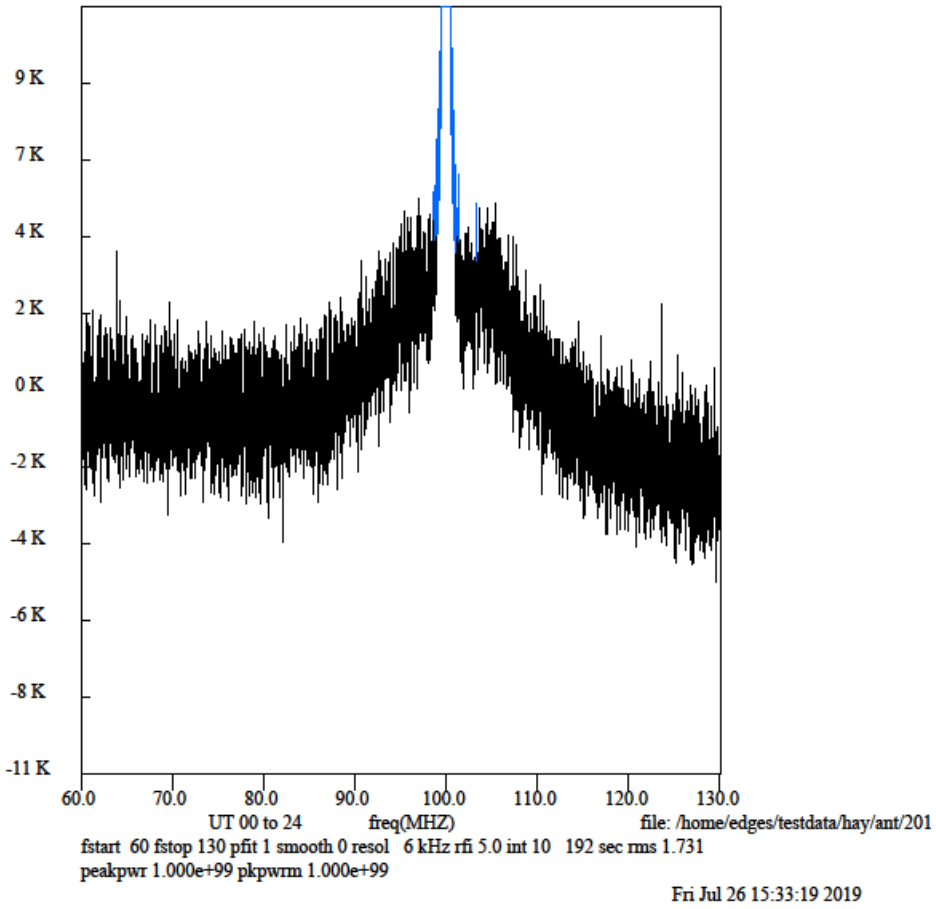

Figure 4. Signal at -82 dB after RFI excision and removal of 7-term.

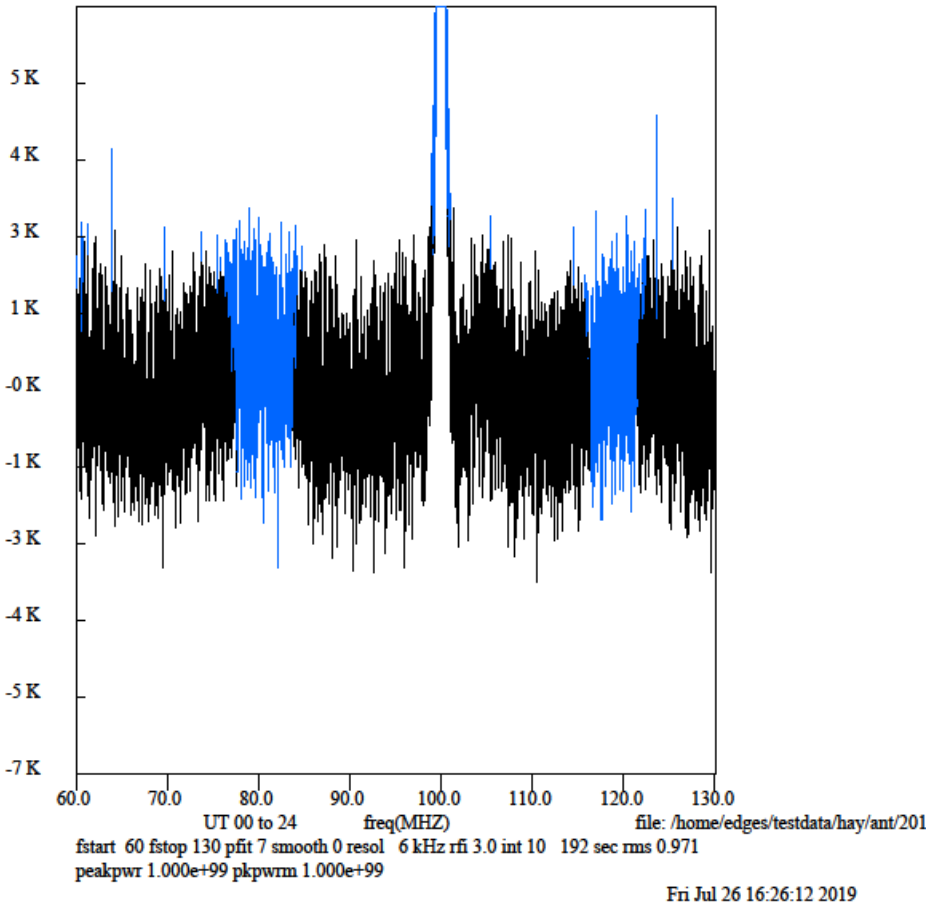

Figure 5. Signal at -82 dBm after RFI excision and 7-terms removed.

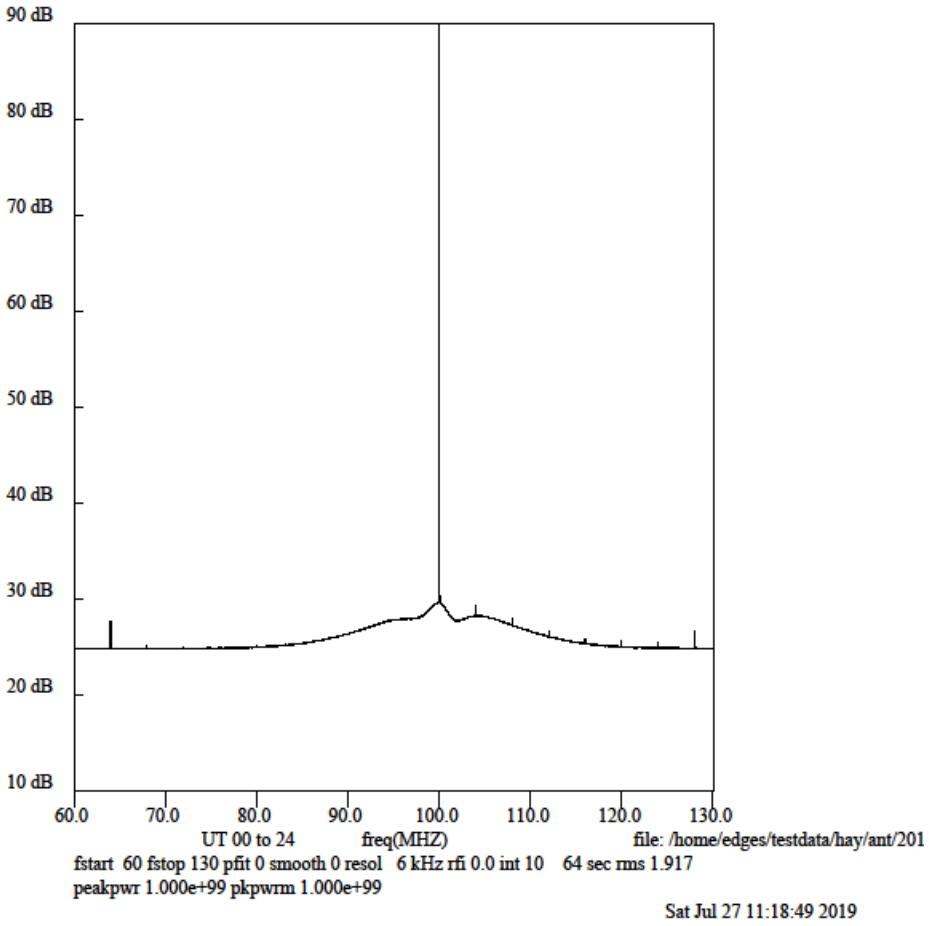

Figure 6. Test signal at -62 dBm using 1 “tap”.

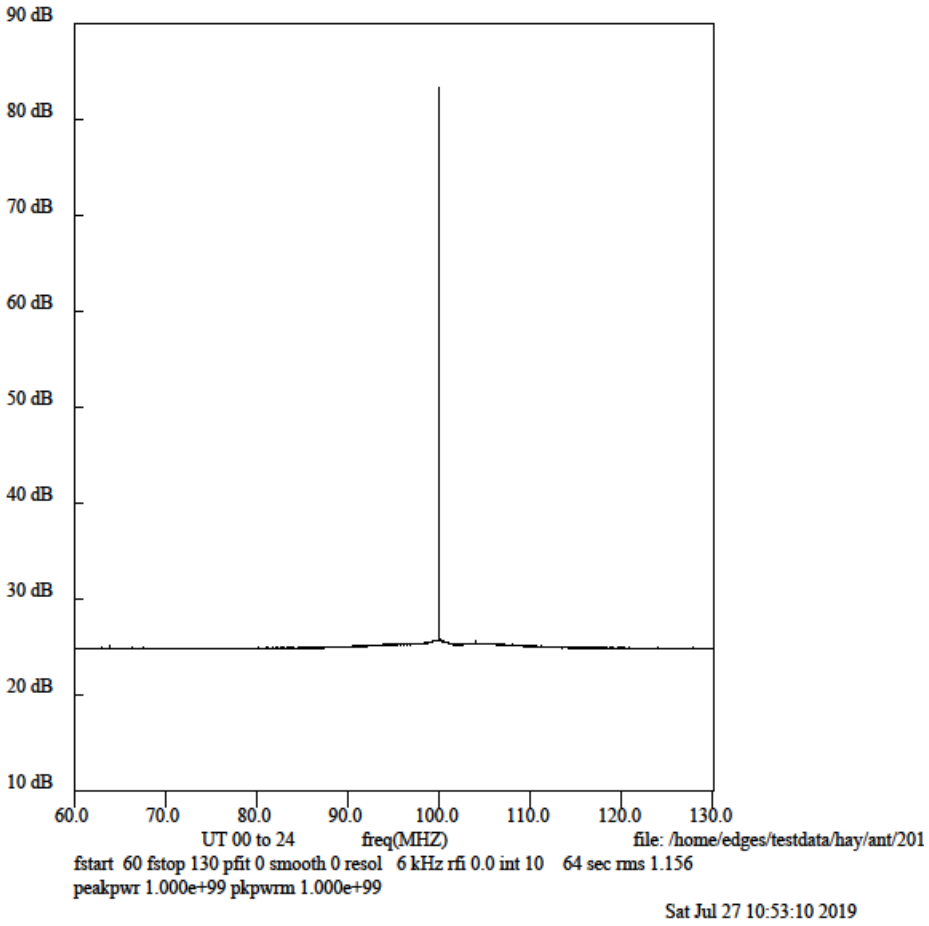

Figure 7. Test signal at -72 dBm using 1 “tap”.