GBT IF Tests

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22 January 2001

Abstract

The GBT IF system was tested for internal interference. Only a small section of the IF-space available was tested involving the local oscillators in the converter rack and the spectral processor. Interference was observed and in most cases can be confined to the spectral processor.

1 Setup

A broadband noise source in the IF rack was used to send power over the fiber from the optical fiber drivers to the optical fiber receivers. The signal was then routed to the converter rack where it was mixed twice. The IF signal was then sent to the spectral processor.

The are 5 LO oscillators: LO1 in the front end, LO2 and LO3 in the converter rack, and LO4 and LO5 in the spectral processor. In general LO1 was not used since the IF noise source is located behind the first mixer. Also, LO3 is fixed at 10500 MHz and LO5 at 160 MHz. Therefore, there are only two variables: LO2 and LO4. Another way to view this problem is in IF-space. The fiber will accommodate 1000-8000 MHz (IF1) and the spectral processor will accept 70-500 MHz (IF3). Hence we searched through IF1-IF3 space. The spectral processor was configured in the 2×1024 spectral line mode with a bandwidth of 40 MHz, yielding a frequency resolution of 39 kHz. A total integration time of 60 sections was used. Both IF1 and IF3 were incremented by 75% of the bandwidth or 30 MHz.

Table 1 summarizes the measurements. The data can be divided into two distinct periods during which the setup was significantly different. During the Summer of 2000 the IF rack was not completed and the components (IF noise source, optical fiber drivers, etc.) were located in the equipment room. During the Winter of 2001 the IF rack had been completed and installed on the GBT. IF3 was varied from 70–490 MHz and from 75–495 MHz by increments of 30 MHz. The phases are superfluous since the noise diode is at the Front End and thus the different phases are averaged together.

Table 1: Summary of IF Tests

Name	Date	MS	IF1 (MHz)	IF3 (MHZ)	Phases	Comments
DSB_SP1	28 May 2000	1	1000–2000	70–490	2	IF rack in Jansky Lab
DSB_SP2	27 May 2000	1	2000–3000	70–490	2	IF rack in Jansky Lab
DSB_SP3	15 June 2000	1	3000–4000	70–490	2	IF rack in Jansky Lab
DSB_SP4	19 June 2000	1	4000–5000	75–495	2	IF rack in Jansky Lab
DSB_SP5	9 Jan. 2001	2	5000–6000	75–495	4	IF rack on GBT
DSB_SP6	8 Jan. 2001	2	6000–7000	75–495	4	IF rack on GBT
DSB_SP7	10 Jan. 2001	2	7000–7575	75–495	4	IF rack on GBT

2 Results

A typical spectrum is shown in Figure 1. The intensity is in counts and the frequency axis is IF1 in units of MHz. The label indicates the scan number, the IF1 frequency of the center channel, the IF3 setting in the spectral processor, and the LO2 setting. (The value of LO2 is calculated using LO2 = LO3 + IF1 − IF3.) The vertical dotted lines indicate the location of channels 512, 256, and 128—locations of known internal interference within the spectral processor. This was verified by disconnecting the IF signals input into the spectral processor.

Between IF1 = 1000 − 4000 MHz the spectra appeared very clean, with the exception of the known internal spectral processor interference. It was noted by Rick Fisher that since IF3 was being incremented from 70–490 MHz by 30 MHz the setting of IF3=160 MHz would be located at the center channel. Since LO5 is fixed at 160 MHz IF3 was shifted by 5 MHz for the remaining tests and incremented from 75–495 MHz by 30 MHz. This revealed interference at ±5 MHz from the center of the band (channels 394 and 640), independent of IF1. This was most prominent at IF3 = 105 MHz for IF1 = 4000 − 5000 MHz (Figure 2).

The same interference was still present when the IF rack was placed at the GBT. (Because the power levels into the spectral processor were too weak Bill Shank added two amplifiers before the input into the spectral processor.) The interference at channels 394 and 640 was more prominent, especially at IF3 = 105 MHz (Figure 3), IF3 = 135 MHz (Figure 4), and IF3 = 195 MHz (Figure 5). Although occasionly interference was observed at other values of IF3.

Because the interference was always located at the same channel in the spectral processor and seemed to be independent of IF1 and LO2, it appears that these signals are arising from the spectral processor.

A further test was made on 15 June 2000 when Roger Norrod hooked up LO1 to a coupler which fed into the optical fiber receivers along with the normal IF noise source. The LO1 thus acted as a test tone which simulated RFI into the Front End. Table 2 lists the results. Additional interference was observed and is only present when LO1 is turned on. The

Table 2: IF Tests with a Test Tone

IF1 (MHz)	IF3 (MHz)	LO1 (MHz)	Interference (MHz)
3000	300	3005	3010, 3015
3000	300	2985	2990?, 2995
2995	300	2985	3005
2995	300	Off	None
2995	300	2987	2999, 2983
2995	300	2987.36	2999.73, 2982.65

interference moves when LO1 and LO2 are altered.

Further tests are required to pinpoint the interference source. Currently LO1 cannot be coupled into the IF noise source directly, however. An alternative method would be to use the sky as a noise source, although external RFI might complicate the experiment.

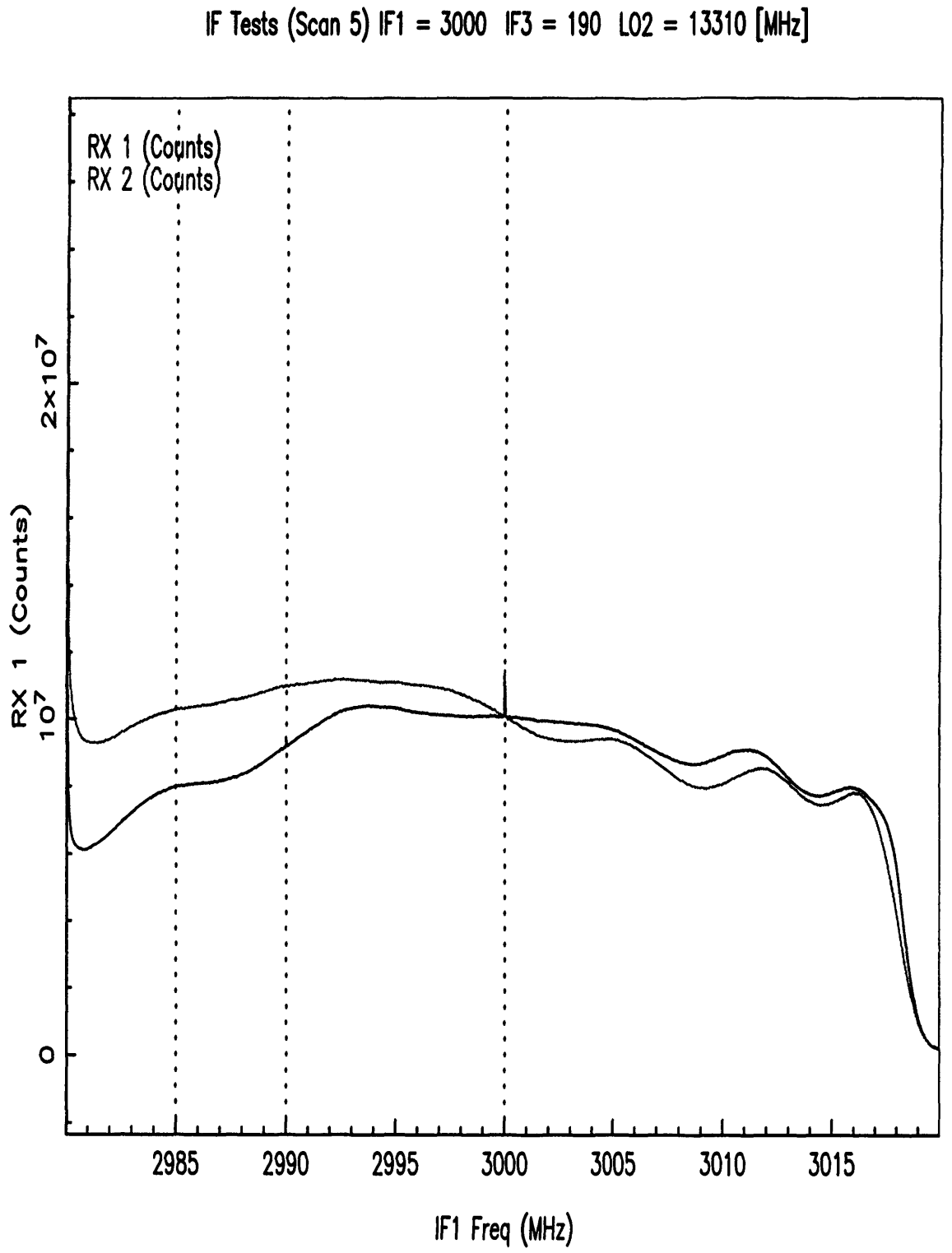

Figure 1: Typical spectrum which reveals the internal spectral processor interference located at channels 512, 256, and 128.

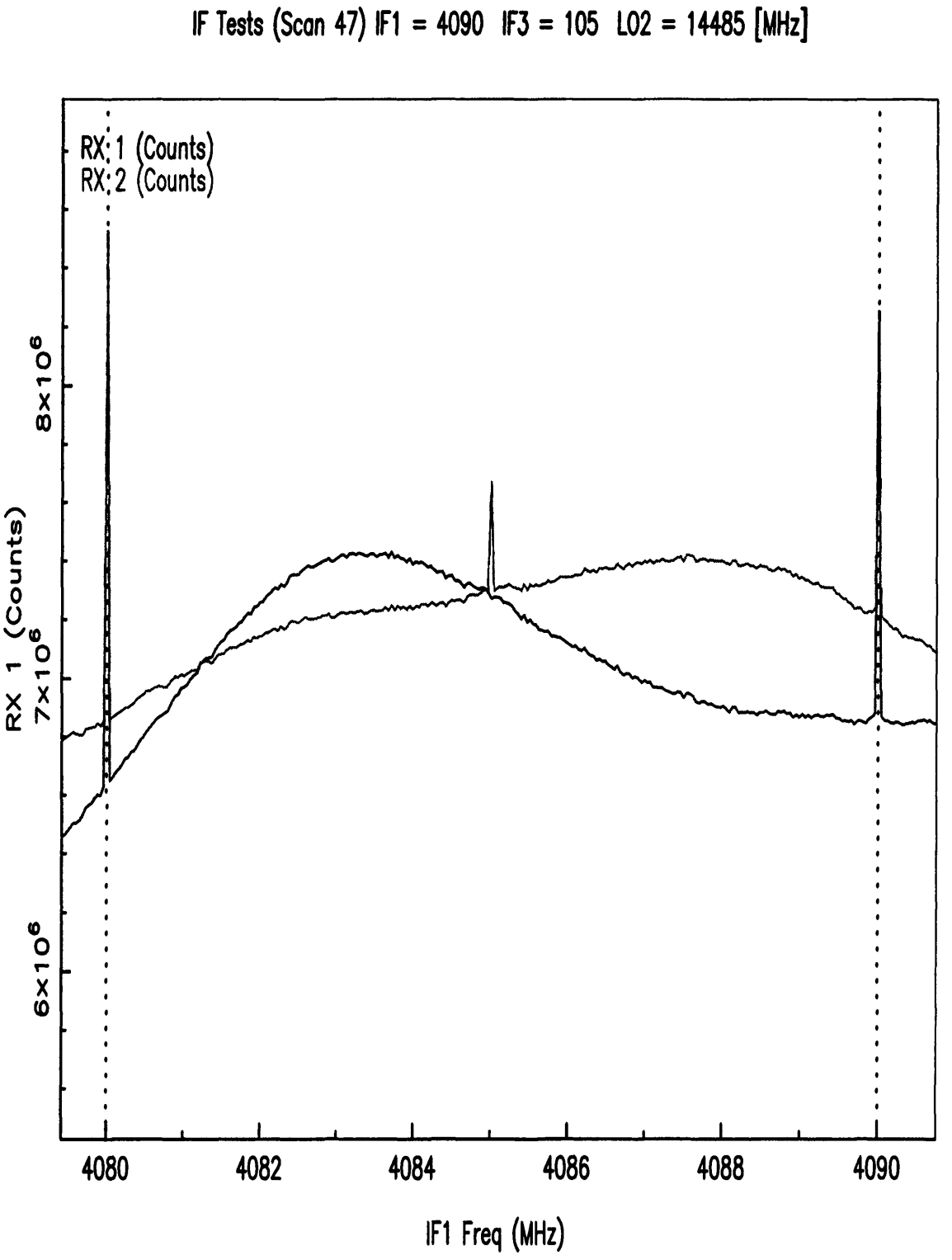

Figure 2: Additional interference located −5 MHz from the central channel (channel 384) when the IF3 increments were shifted to place 160 MHz away from the central channel. (Note: LO5 is fixed at 160 MHz.)

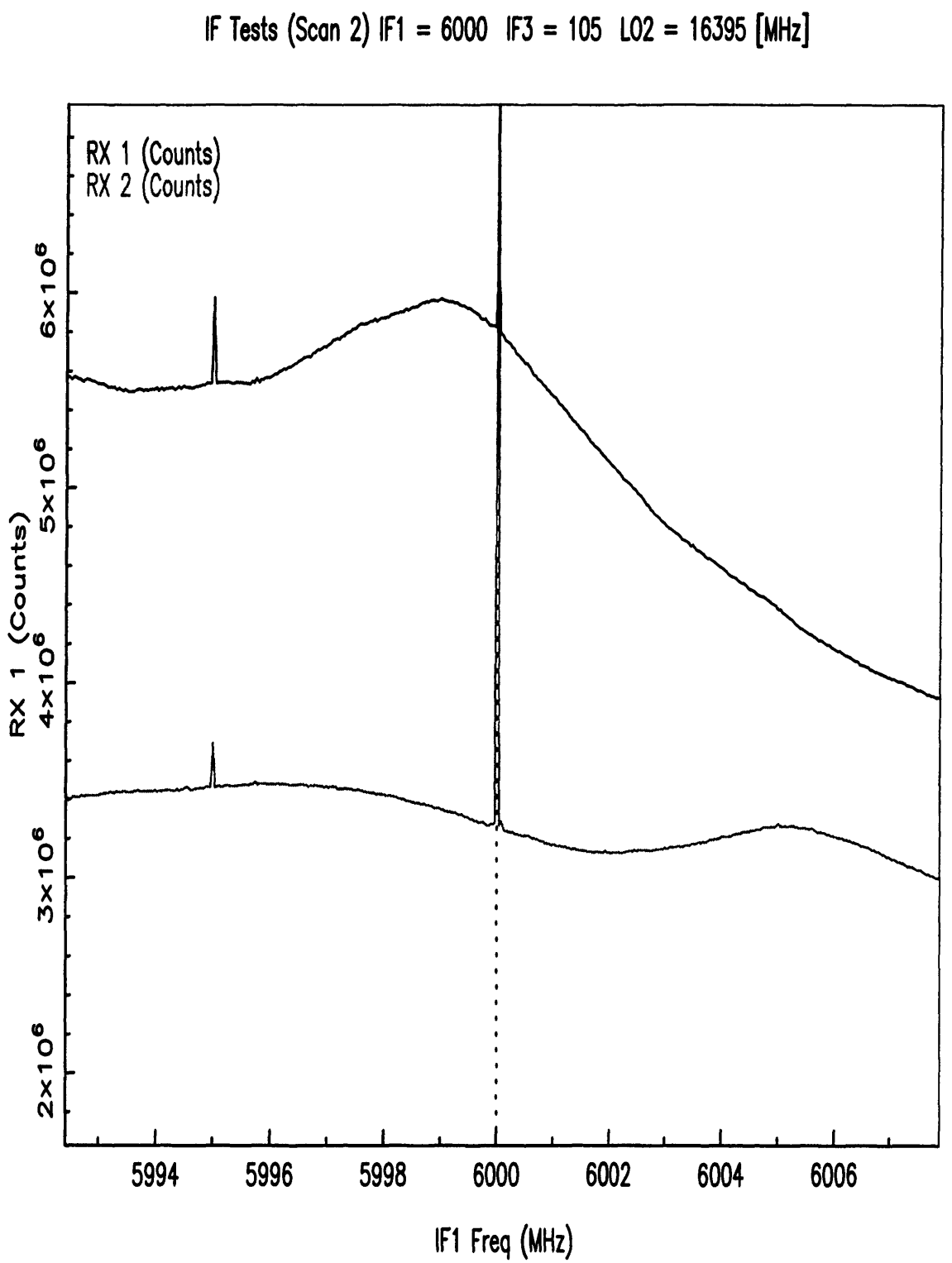

Figure 3: Same as Figure 2 except the IF rack is now located on the GBT.

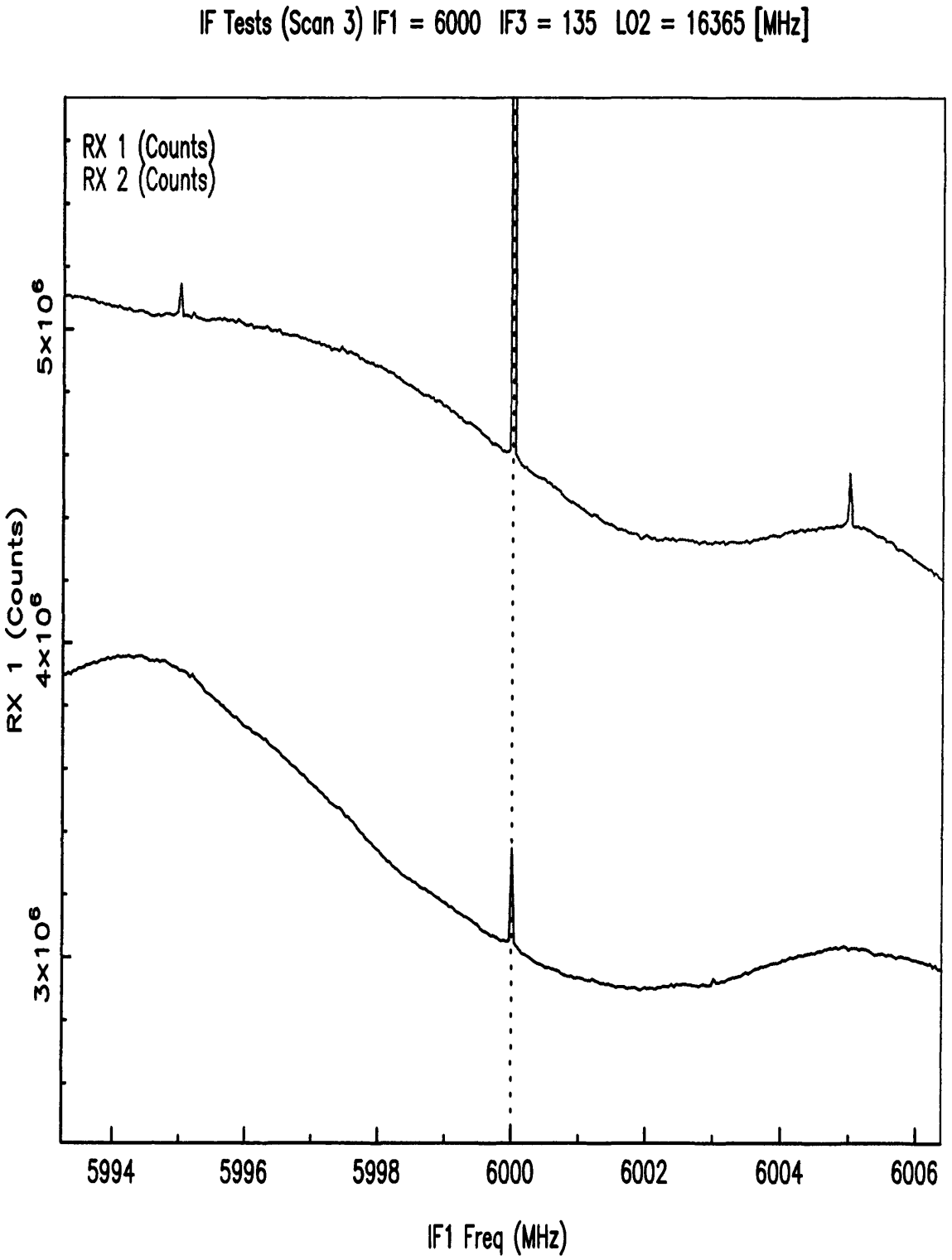

Figure 4: Interference located at channels 384 and 640 at IF3 = 135 MHz.

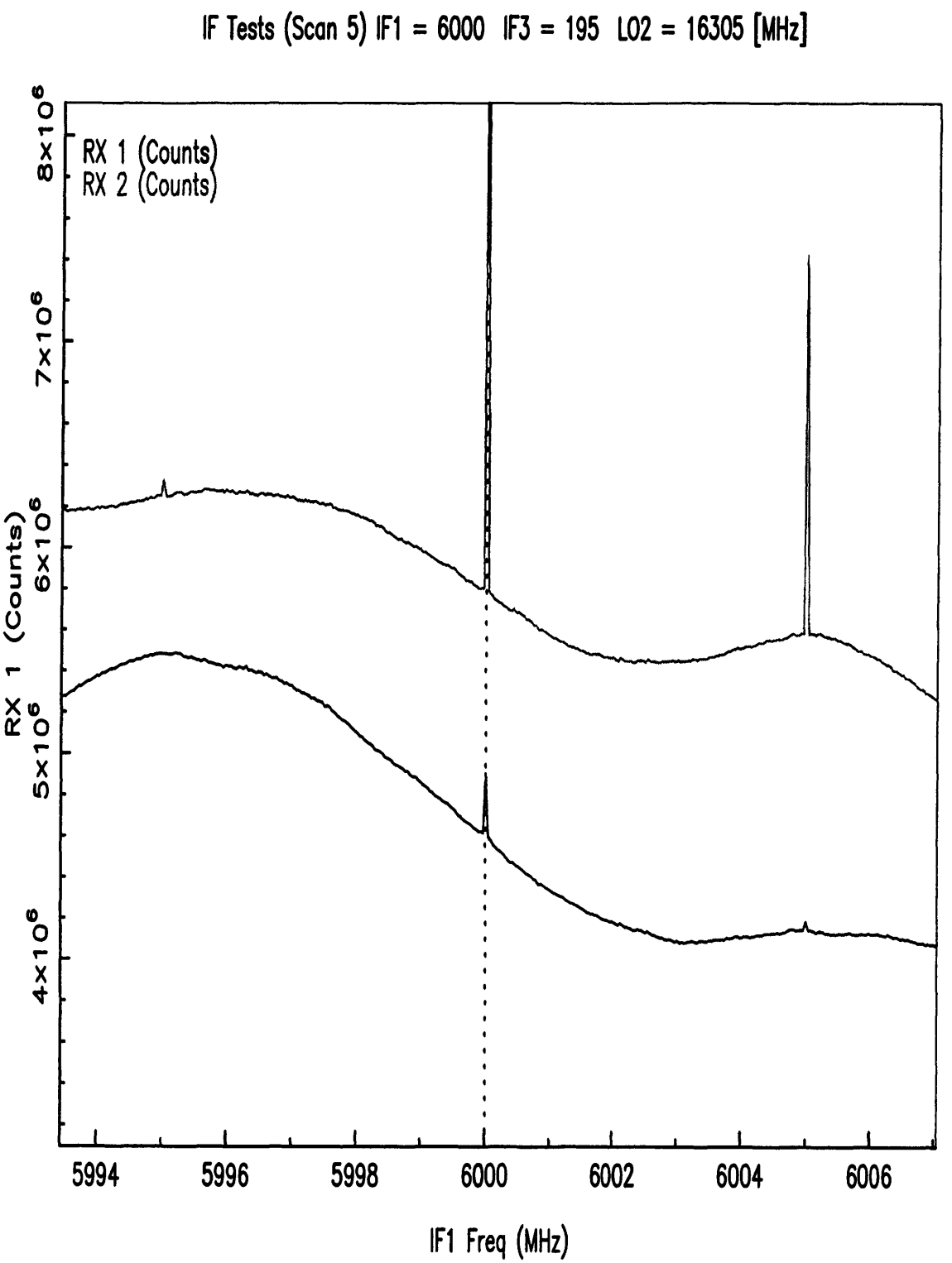

Figure 5: Strong interference located at channel 640 at IF3 = 195 MHz.