

K-band interference measurements with the Yebes 40m radiotelescope

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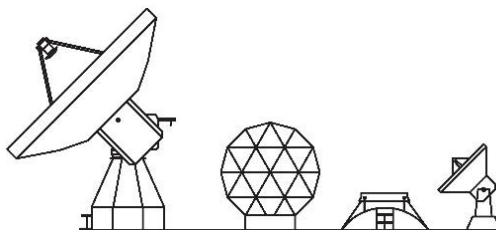
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IT- CDT 2017-14

Observatorio de Yebes

Apdo. 148, E-19080

Guadalajara SPAIN



1. Introduction

This report shows the results of the measurements performed during the second week of January 2017 with the Yebes 40 meter diameter radiotelescope, in order to check the changes of the interference levels found in technical report IT CDT 2016-14 and previous ones.

The maximum allowed level of RFI (radio frequency interference) in this band is regulated in *Orden CTE/ 1444/2003, de 22 de mayo, por la que se establecen limitaciones a la propiedad y servidumbres para la protección radioeléctrica del Centro Astronómico de Yebes, BOE 04/06/2003*, which sets a power flux intensity limit of $-148 \text{ dB} \left(\frac{\text{W}}{\text{m}^2} \right)$ for the 22,21-22.5 GHz band and $-147 \text{ dB} \left(\frac{\text{W}}{\text{m}^2} \right)$ for the 23.6-24GHz band.

Some RFI signals have been detected out of these protected bands, too. Their spectrum will be shown in this report.

2. Detected Interferences.

In this section we show the interferences detected from different azimuth angles. When a RFI signal is detected, ON-OFF measurements with an integration time of 30 seconds are made. The ON was done pointing towards the direction of the RFI source with an elevation of 5° and the OFF was done pointing to an elevation angle of 15° .

The plots are scaled in equivalent antenna temperature (Kelvin). Their power is translated to power flux in table 1.

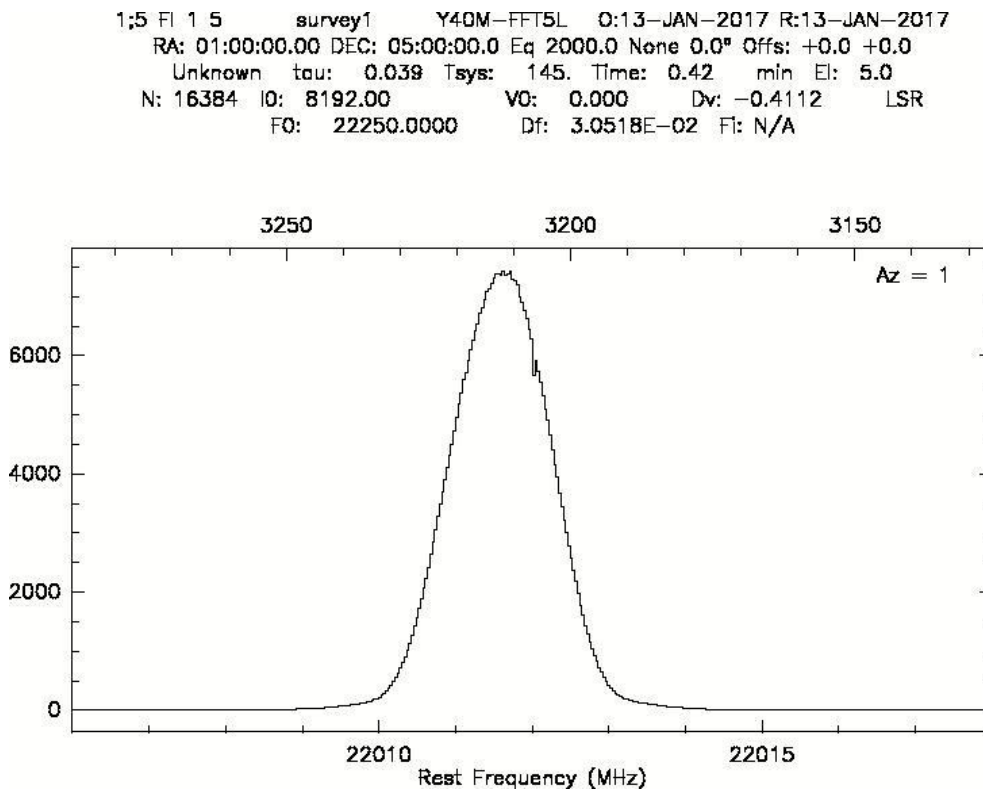


Figure 1 Interference detected at 22,017 GHz.

1;6 FI 243 5 survey1 Y40M-FFTSL O:12-JAN-2017 R:12-JAN-2017
 RA: 03:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 173. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 FI: N/A

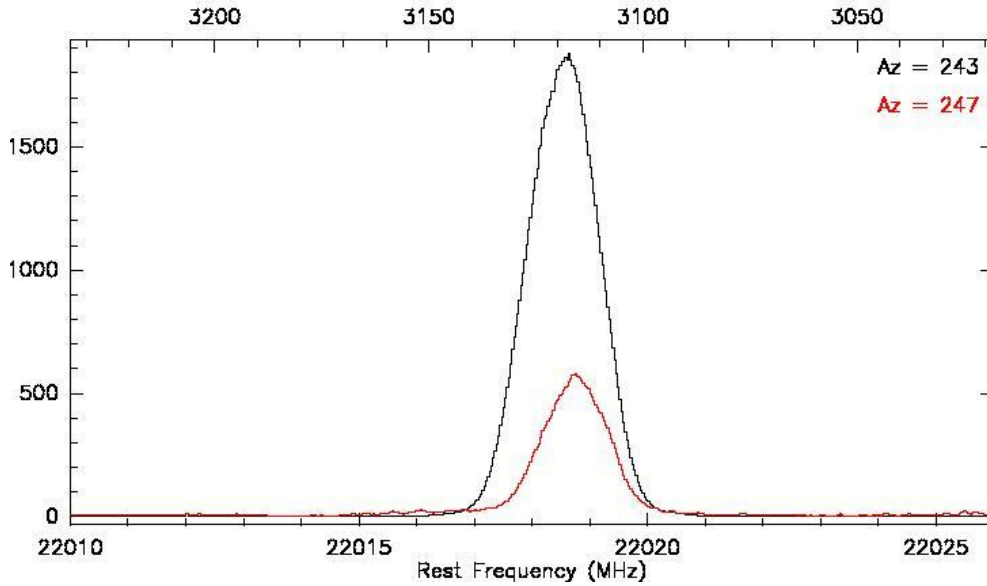


Figure 2 Interference detected at 22,018 GHz.

1;5 FI 298 5 survey1 Y40M-FFTSL O:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 197. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 FI: N/A

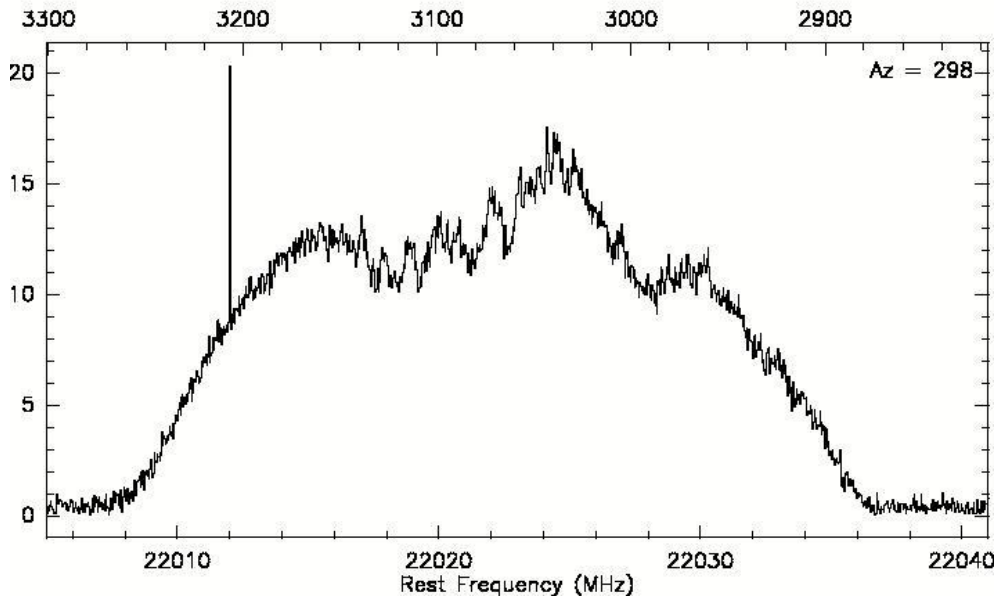


Figure 3 Interference detected at 22,021 GHz.

3;5 FI 309 5 survey1 Y40M-FFT5L 0:12-JAN-2017 R:12-JAN-2017
 RA: 21:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 189. Time: 0.40 min El: 5.0
 N: 16384 IQ: 8192.00 VO: 0.000 Dv: -0.4112 LSR
 FO: 22250.0000 Df: 3.0518E-02 Fi: N/A

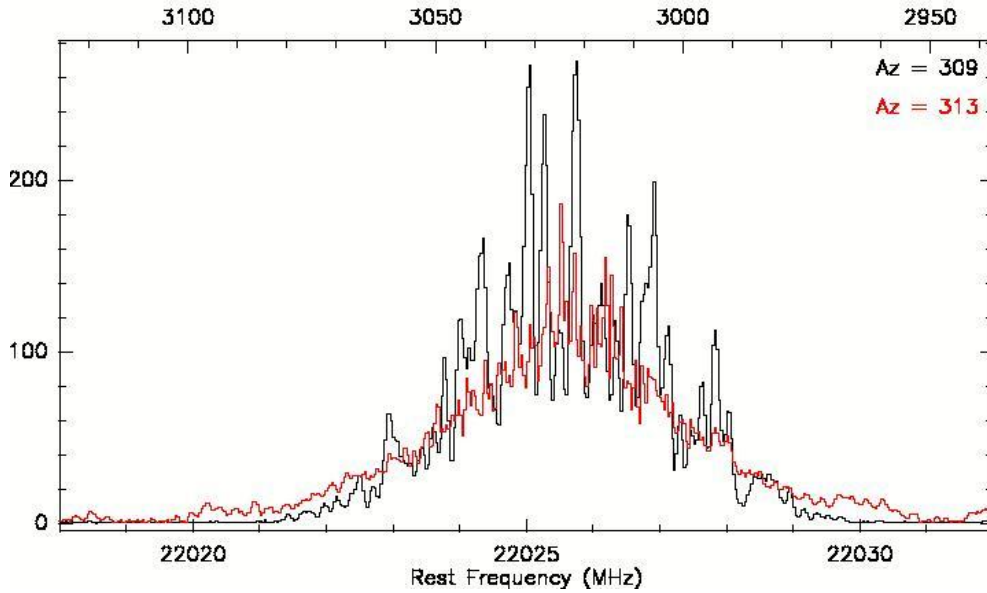


Figure 4 Interference detected at 22,025 GHz.

1;5 FI 136 5 survey1 Y40M-FFT5L 0:13-JAN-2017 R:13-JAN-2017
 RA: 16:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 173. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 VO: 0.000 Dv: -0.4112 LSR
 FO: 22250.0000 Df: 3.0518E-02 Fi: N/A

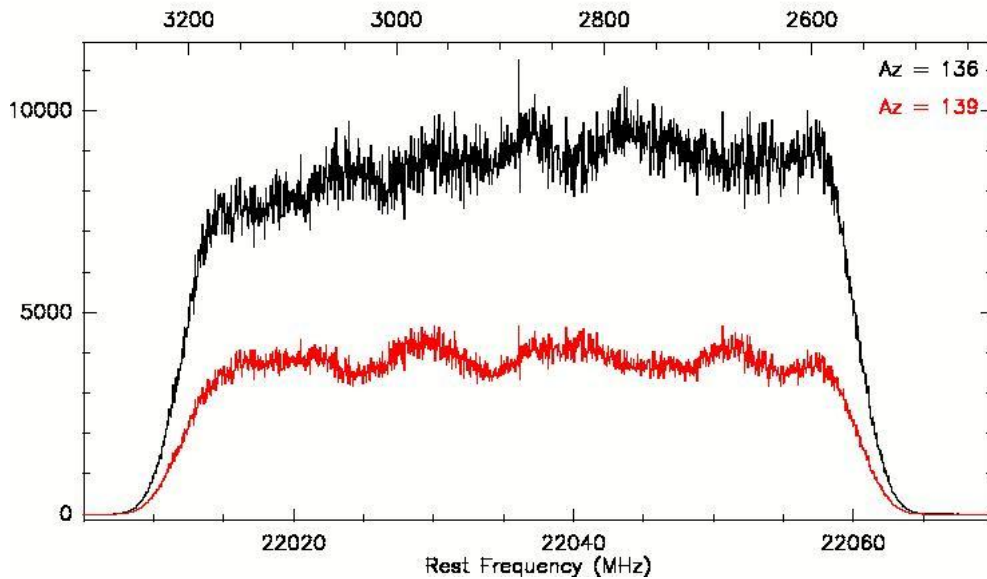


Figure 5 Interference detected at 22,035 GHz.

1;5 Fl 88 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 16:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 169. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

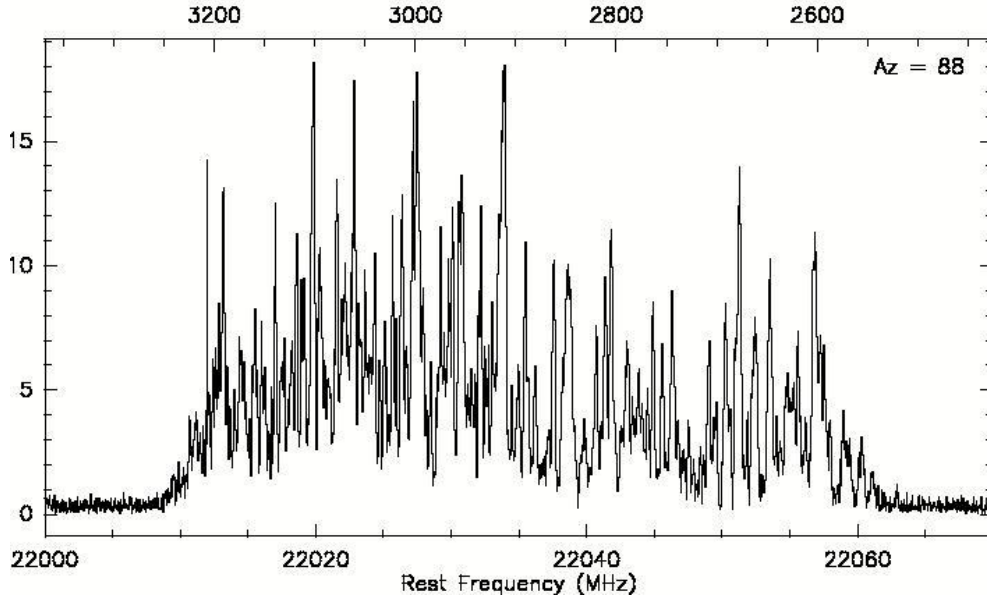


Figure 6 Interference detected at 22,035 GHz.

1;5 Fl 313 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 01:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 186. Time: 0.43 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

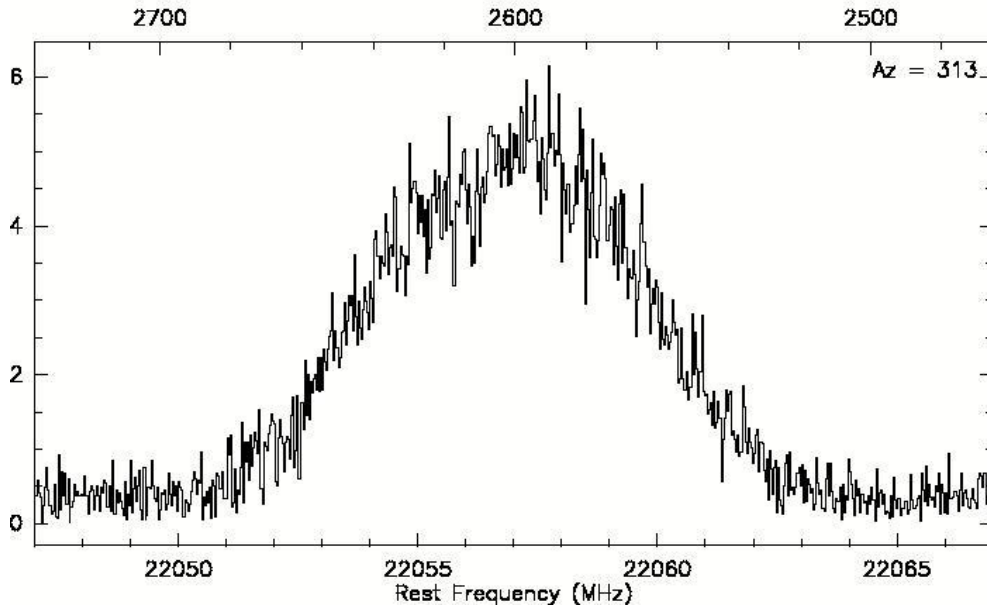


Figure 7 Interference detected at 22,057 GHz.

1;5 Fl 346 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.045 Tsys: 178. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Ff: N/A

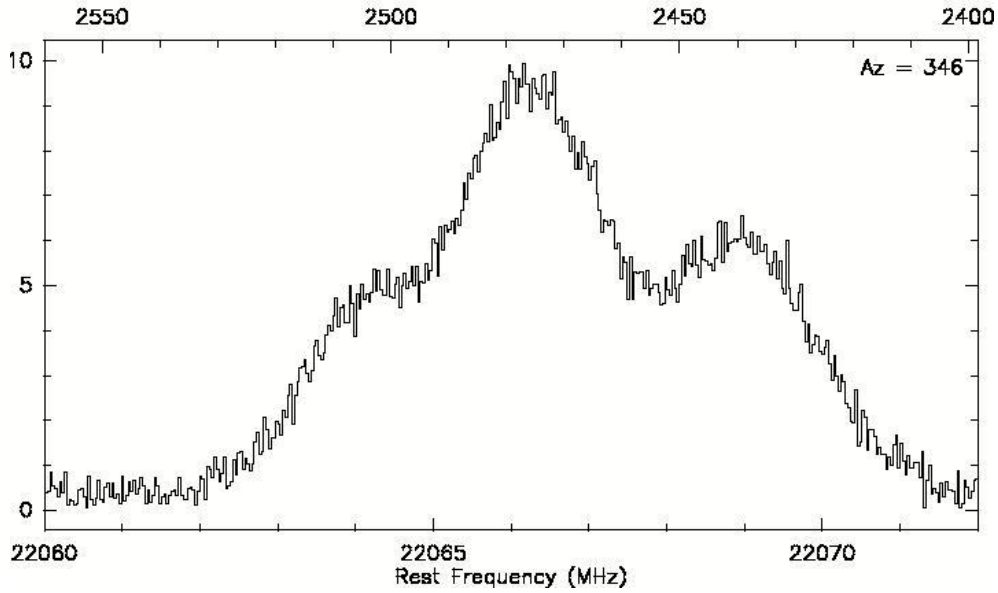


Figure 8 Interference detected at 22,066 GHz.

1;5 Fl 346 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.045 Tsys: 178. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Ff: N/A

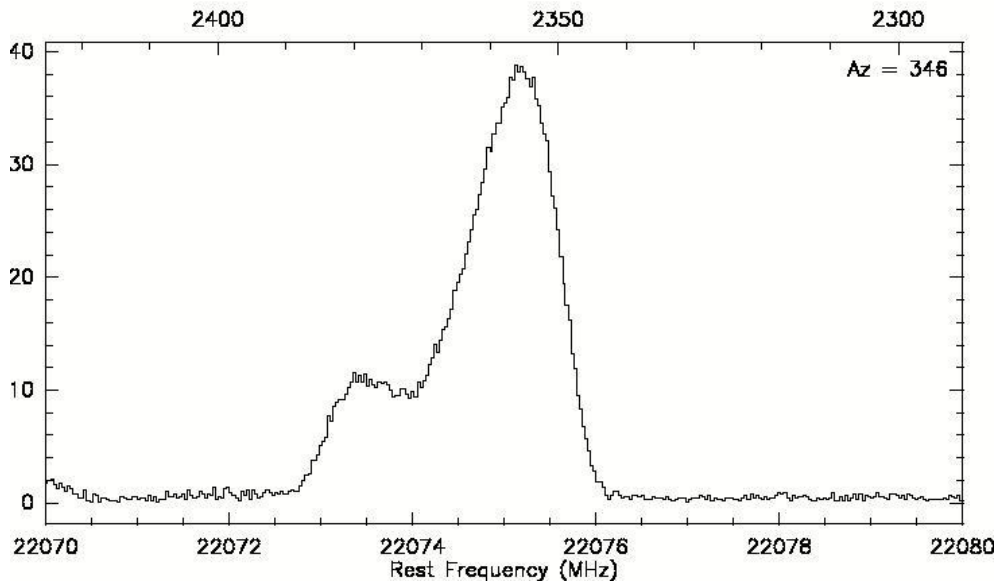


Figure 9 Interference detected at 22,075 GHz.

1;5 Fl 346 5 survey1 Y40M-FFTSL O:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.045 Tsys: 178. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 v0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fl: N/A

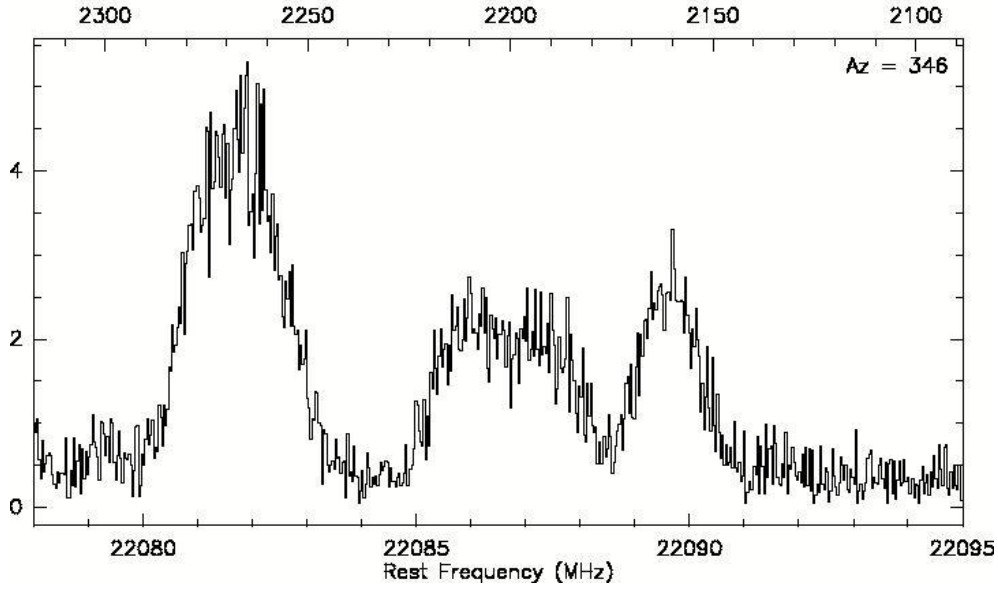


Figure 10 Interference detected at 22,0815 22,0865 and 22,0896 GHz.

1;5 Fl 346 5 survey1 Y40M-FFTSL O:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.045 Tsys: 178. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 v0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fl: N/A

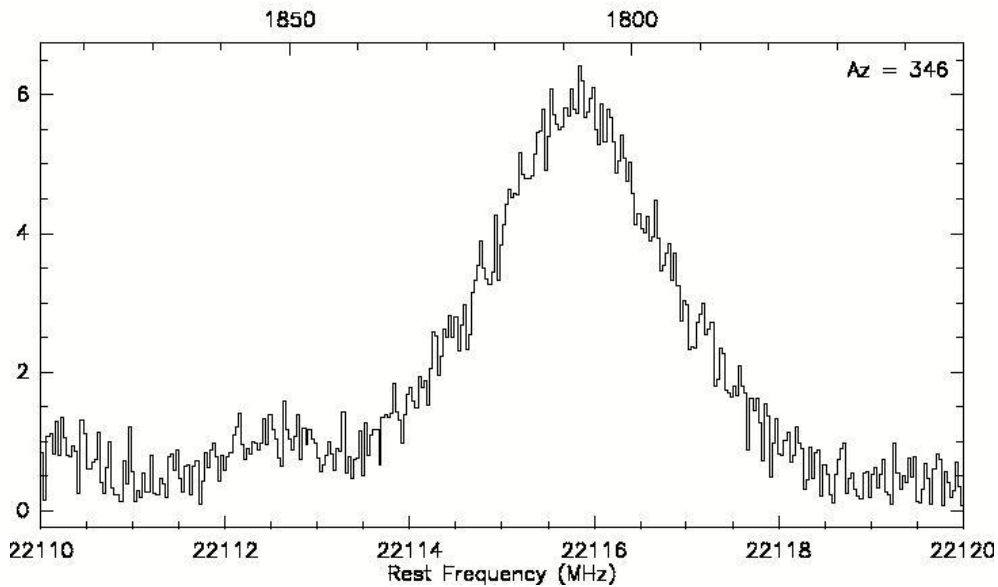


Figure 11 Interference detected at 22,1158 GHz.

1;5 Fl 43 5 survey1 Y40M-FFT5L 0:13-JAN-2017 R:13-JAN-2017
 RA: 19:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.047 Tsys: 171. Time: 0.43 min El: 5.0
 N: 16384 ID: 8192.00 VO: 0.000 Dv: -0.4112 LSR
 FO: 22250.0000 Df: 3.0518E-02 Fi: N/A

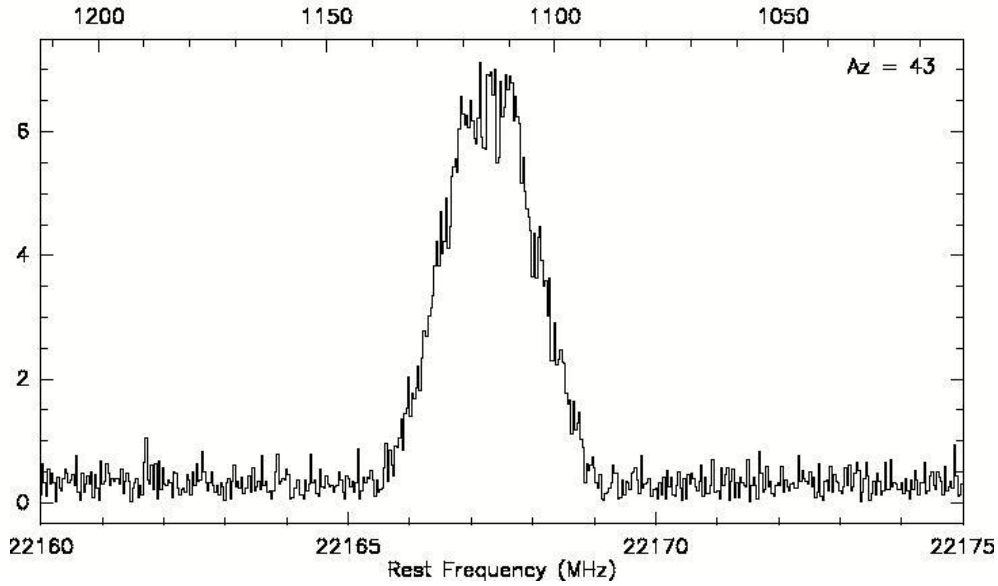


Figure 12 Interference detected at 22,167.5 GHz.

1;5 Fl 298 5 survey1 Y40M-FFT5L 0:13-JAN-2017 R:13-JAN-2017
 RA: 10:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 197. Time: 0.42 min El: 5.0
 N: 16384 ID: 8192.00 VO: 0.000 Dv: -0.4112 LSR
 FO: 22250.0000 Df: 3.0518E-02 Fi: N/A

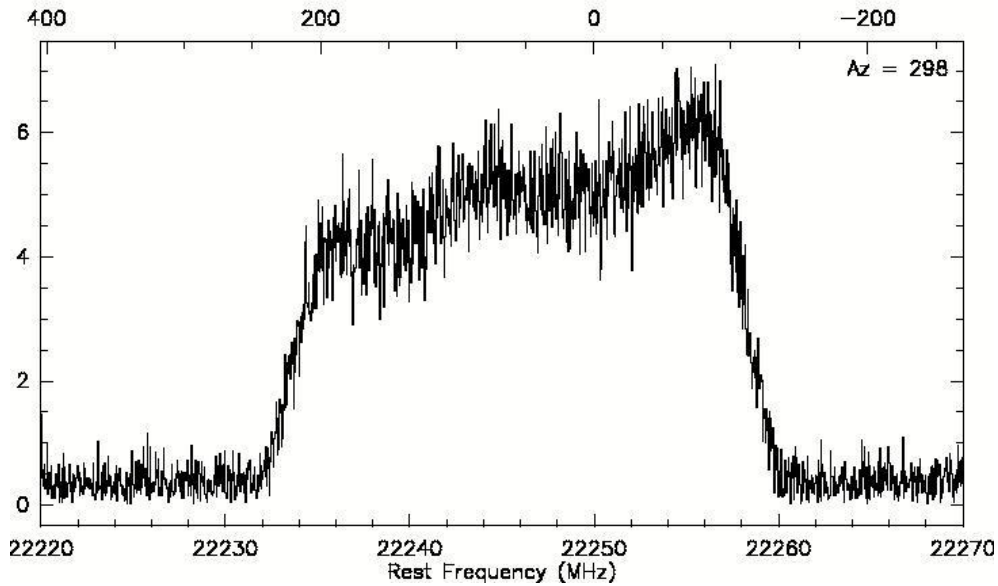


Figure 13 Interference detected at 22,246 GHz.

3;5 FI 67 5 survey1 Y40M-FFTSL 0:12-JAN-2017 R:12-JAN-2017
 RA: 19:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 172. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 FI: N/A

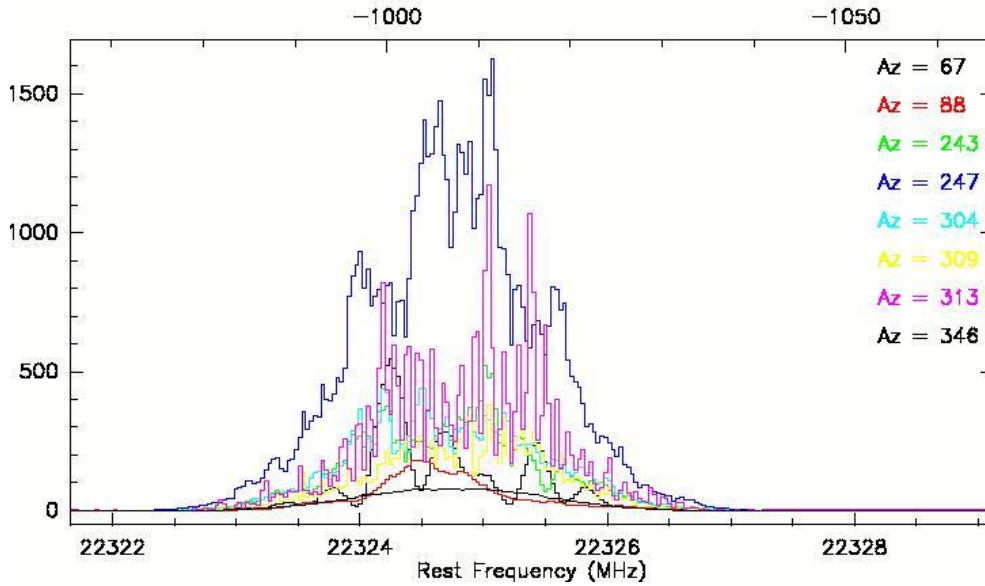


Figure 14 Interference detected at 22,325 GHz.

1;5 FI 1 5 survey1 Y40M-FFTSL 0:13-JAN-2017 R:13-JAN-2017
 RA: 01:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.039 Tsys: 145. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 FI: N/A

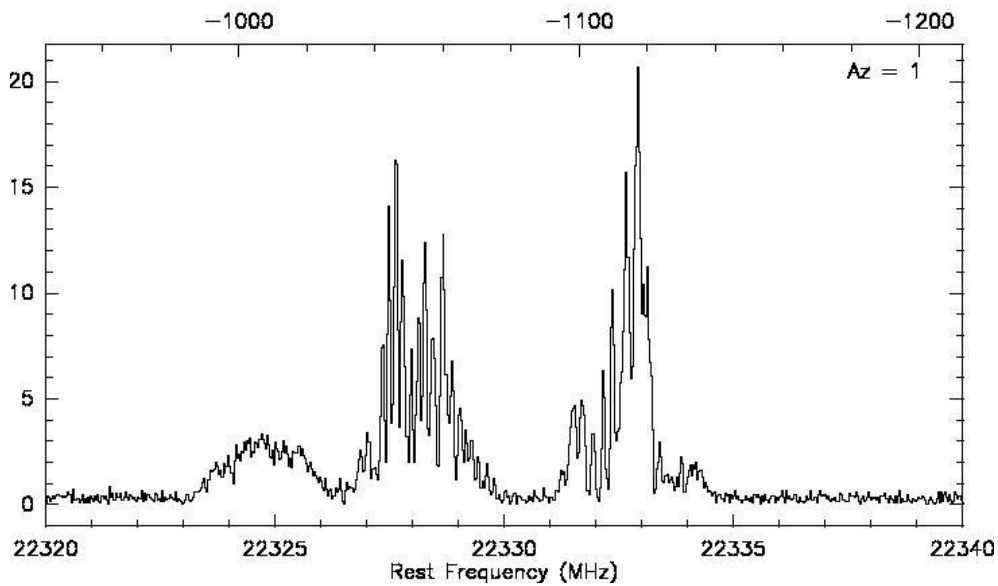


Figure 15 Interference detected at 22,325 22,328 and 22,333 GHz.

3;5 FI 41 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 17:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.038 Tsys: 148. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

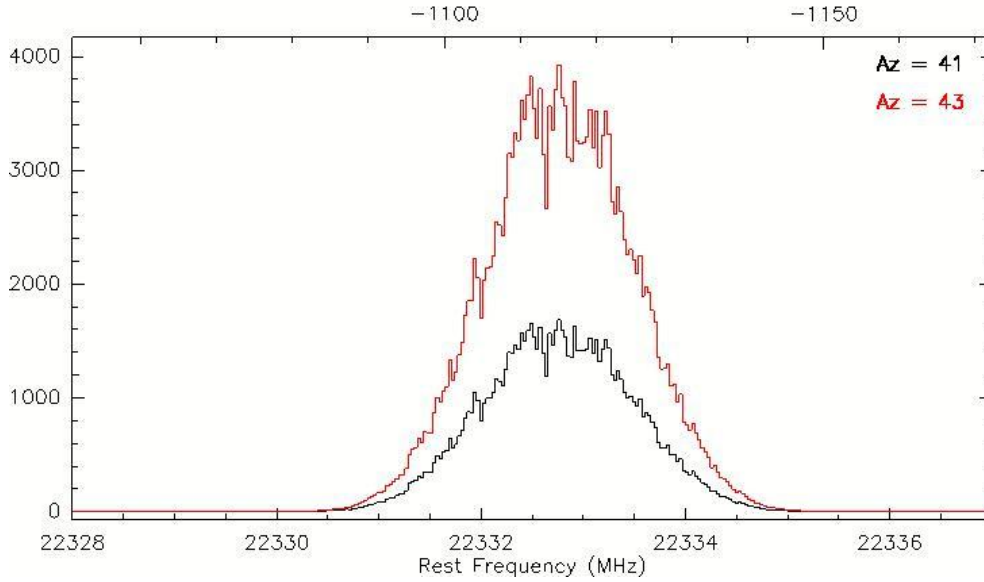


Figure 16 Interference detected at 22,333 GHz.

1;5 FI 1 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 01:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.039 Tsys: 145. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

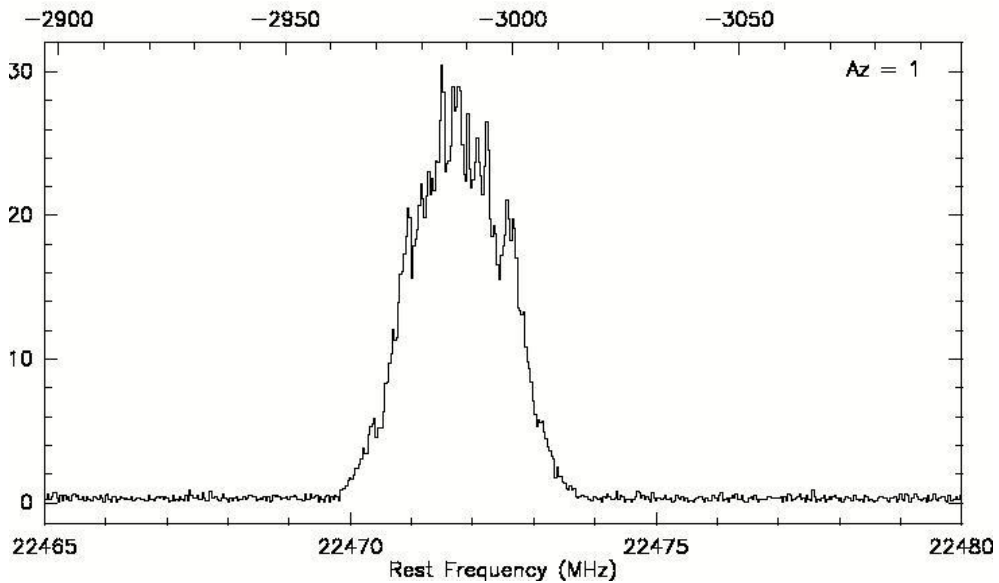


Figure 17 Interference detected at 22,472 GHz.

1;5 Fl 19 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 19:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.038 Tsys: 148. Time: 0.43 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

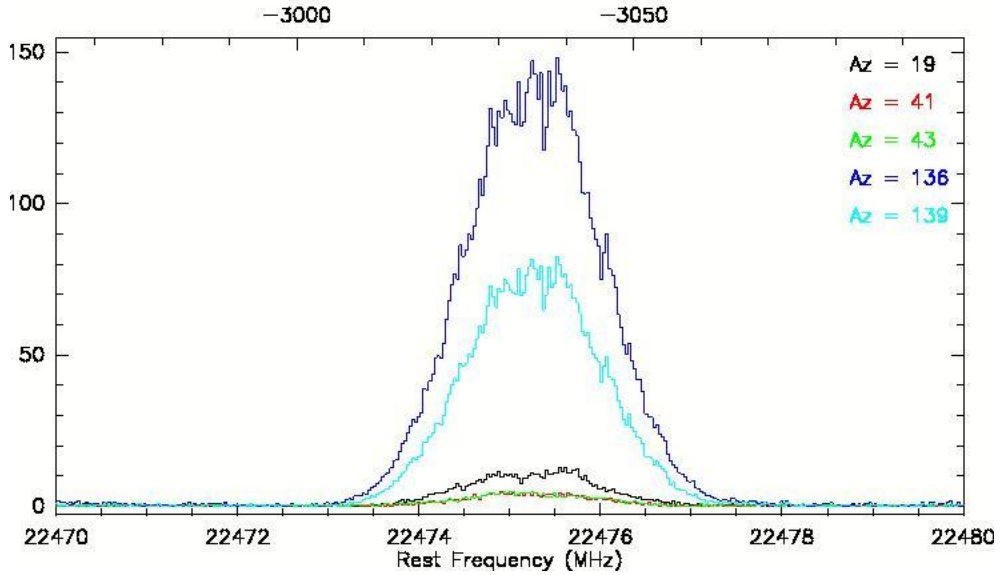


Figure 18 Interference detected at 22,475 GHz.

1;5 Fl 24.3 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 03:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.046 Tsys: 173. Time: 0.42 min El: 5.0
 N: 16384 l0: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fi: N/A

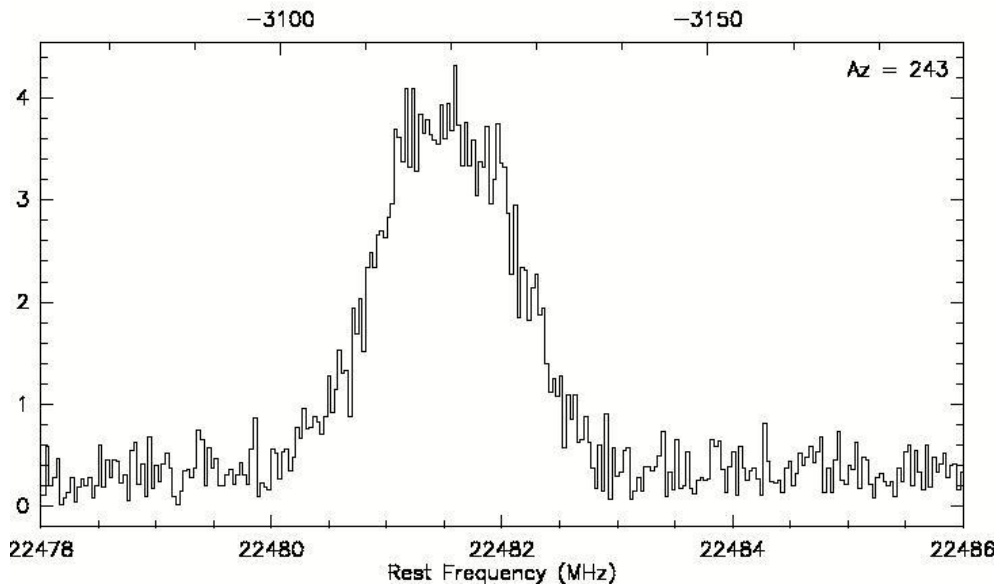


Figure 19 Interference detected at 22,481 GHz.

1;5 Fl 1 5 survey1 Y40M-FFT5L O:13-JAN-2017 R:13-JAN-2017
 RA: 01:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.039 Tsys: 14.5. Time: 0.42 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.4112 LSR
 F0: 22250.0000 Df: 3.0518E-02 Fl: N/A

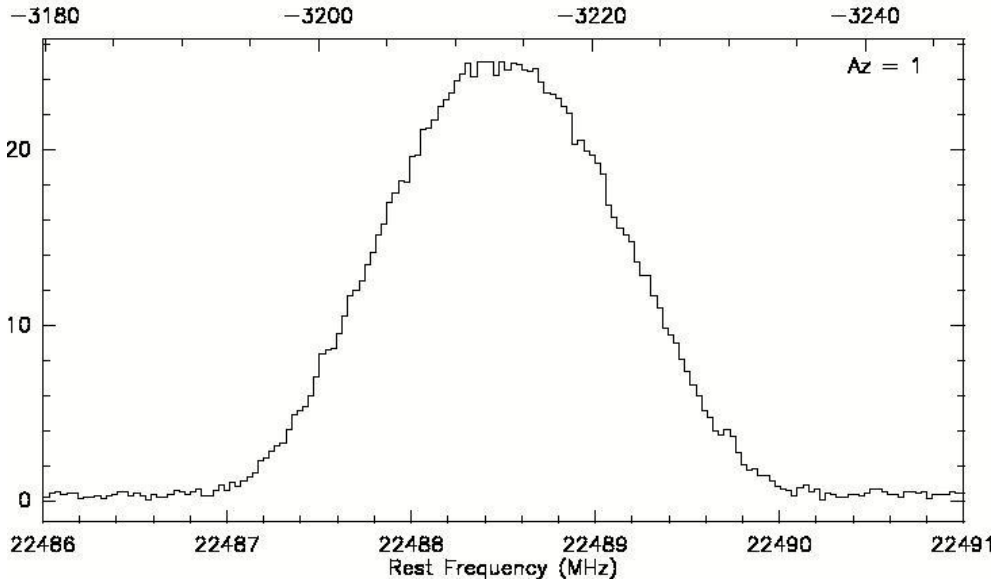


Figure 20 Interference detected at 22,4886 GHz.

1;5 Fl 0 5 TEST233 Y40M-FFT5L O:23-JAN-2017 R:23-JAN-2017
 RA: 00:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
 Unknown tau: 0.029 Tsys: 14.3. Time: 0.47 min El: 5.0
 N: 16384 IQ: 8192.00 V0: 0.000 Dv: -0.3852 LSR
 F0: 23750.0000 Df: 3.0518E-02 Fl: N/A

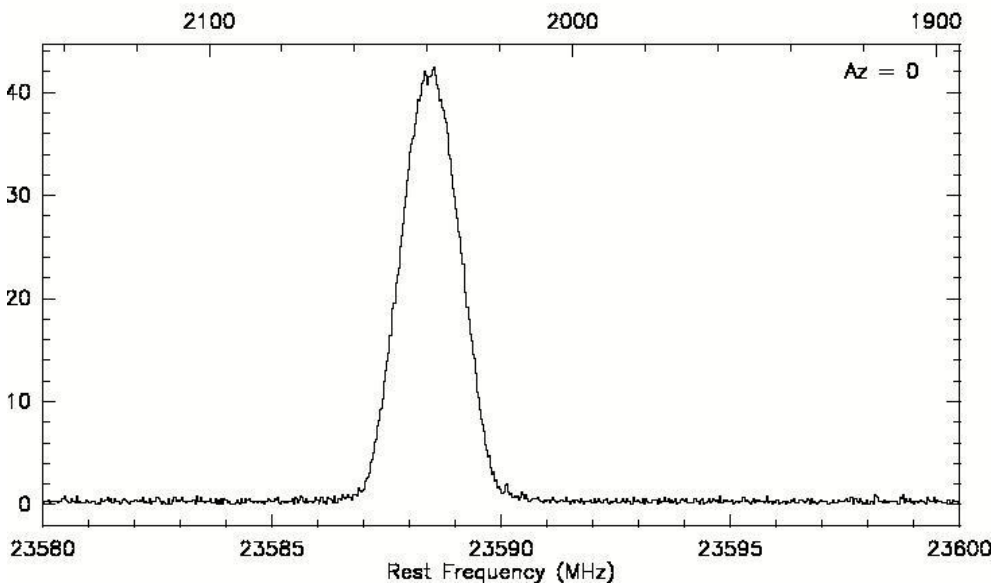


Figure 21 Interference detected at 23,5885 GHz.

1;4 FI 316 5 TEST238 Y40M-FFT5L 0:23-JAN-2017 R:23-JAN-2017
RA: 04:00:00.00 DEC: 05:00:00.0 Eq 2000.0 None 0.0° Offs: +0.0 +0.0
Unknown tau: 0.027 Tsys: 147. Time: 0.48 min El: 5.0
N: 16384 l0: 8192.00 v0: 0.000 Dv: -0.3812 LSR
F0: 24000.0000 Df: 3.0518E-02 Fi: N/A

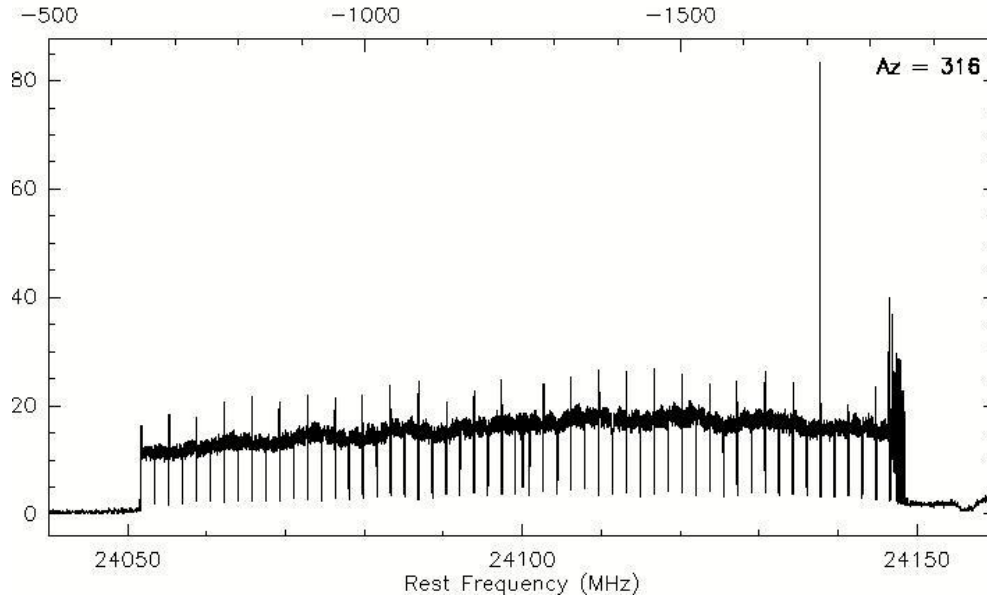


Figura 22 Interference detected at 24,100 GHz.

Frequency [MHz]	Azimuth [deg]	Bandwidth [MHz @ 3dB]	S_{ML} [dB ($\frac{W}{m^2}$)]	Orden CTE 1444/2003 [dB ($\frac{W}{m^2}$)]	Difference [dB]
22011,7	1	2	-90.1	-56.8	-33.3
22018	243	2	-97.1	-56.8	-40.3
22021	298	22	-106.3	-56.8	-49.5
22025	309	3	-104.3	-56.8	-47.2
22035	136	47.5	-75.1	-56.8	-18.3
22057,5	313	6	-116.5	-56.8	-59.7
22066	346	2.5	-117.5	-56.8	-60.7
22081,5	346	2	-122.3	-56.8	-65.5
22086,5	346	2.5	-124.1	-56.8	-67.3
22090	346	1	-126.6	-56.8	-69.8
22116	346	2	-121.1	-56.8	-64.3
22168	43	2	-120	-56.8	-63.2
22246	298	24	-110.8	-148	-54
22325	247	1.5	-96.6	-148	51.4
22328	1	2	-121	-148	27
22333	43	2	-93.9	-148	54.1
22472	1	2	-113.9	-148	34.1
22475	136	1.5	-106.9	-148	41.1
22481	243	1	-126.5	-148	21.5
22488,6	1	1.6	-115.4	-148	32.6
23588,5	0	1	-114.9	-56.8	-58.1
24100	316	95	-98.6	-56.8	-41.8

Table 1: Summary of detected RFI signals.

Table 1 summarizes the set of RFI signals detected during these measurements. It shows their frequency, azimuth direction of arrival, bandwidth, their measured power flux at Yebes, their limit according to regulations, and the difference between their power flux and the limit. The signals above the limit are highlighted in red.