Interoffice

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From: P. Crane

Subject: Diffraction losses between Mauna Loa and Mauna Kea

While calculating the propagation losses between sites near Hale Pohaku and the VLBA site on Mauna Kea and the summit, I also did an approximate calculation of the losses between the existing low-power microwave site on Mauna Loa and the new VLBA site on Mauna Kea.

The distance between the two locations is approximately 24.1 km. The elevations of the two sites are about 8200 ft and 12220 ft at the microwave site and the VLBA site, respectively. The only obstacle along the line of sight is a hill whose peak is about 313 m south of the VLBA site at an elevation of 12411 ft; the radius of curvature of the peak of the hill is approximately 750 ft. The calculations were done for diffraction by a single rounded obstacle.

The R**-2 losses reduce a 1 W signal to -98.6 dbW/square meter. The additional losses caused by diffraction over the hill are tabulated for many VLBA frequencies in the following table:

FREQUENCY (MHz)	DIFFRACTION LOSS (dB)	ANTENNA GAIN (dBi)
73.8	28.7	22.7
327.0	40.4	35.6
611.0	46.8	41.0
1413.5	57.2	49.6
1666.0	59.6	51.1
2250.0	64.2	53.9
4995.0	78.8	61.0
6035.0	82.8	62.5
8450.0	90.6	65.5
10690.0	96.4	67.5
15375.0	106.3	70.5
22230.0	117.8	73.4
23800.0	120.0	74.0
43000.0	122.5	79.1
89000.0	125.6	83.6

I have also included the peak antenna gains in the table. If the VLBA antenna is observing at low elevations to the south, the interference will be received through the main beam. The table shows that at least at

low frequencies, the gain of the antenna to first order cancels the loss caused by the hill.

Comparison with the limits given in VLBA Memorandum No. 488 shows that a high-power (e.g., 1 MW) transmitter broadcasting in a VLBA observing band thus would certainly saturate the receiver, at least over much of the southern sky. Low-power (1 W) transmitters would exceed the harmful interference level of one-percent of system temperature over most of the southern sky. Out-of-band emissions at the mW level, especially at low frequencies, would exceed the harmful interference limits over a smaller - but still important - area of the southern sky.

Based upon these results, I have reached the following conclusions:

1. The NRAO and the NSF should participate in the designation of any new, especially high-power, electronics site on Mauna Loa or in the vicinity.

2. Every effort should be made to avoid the assignment on the island of Hawaii of transmitter frequencies within VLBA observing bands.

3. Furthermore, high-power transmitters at frequencies adjacent to or with harmonics in VLBA observing bands should be avoided. The allocations of UHF-TV channels 14 and 38 should be changed.

4. Assignments of frequencies for low-power transmitters should be coordinated to avoid harmonics within radio-astronomical allocations.

5. Electronic sites located farther west and/or at higher elevations on Mauna Loa would be of great concern because transmitters there could look around or over the hill.