MILLIMETER ARRAY
MEMO NO. 76

RADIO-FREQUENCY INTERFERENCE AND THE mmA

Patrick C Crane

22 January 1992

The mmA should be designed carefully to minimize its sensitivity to radio-frequency interference.

One goal for the mmA is to provide continuous frequency coverage over very wide frequency bands, with individual receivers having bandwidths of 20-30 percent or more. But such bandwidths will include far more than the bands allocated to radio astronomy. I list below selected allocations for satellite-borne transmitters and powerful ground-based or airborne transmitters which fall in the frequency bands planned for the mmA:

<u>30-50 GHz Band:</u>

30.0- 31.3 GHz	Standard Frequency and Time Signal-Satellite (Space-to-Earth) (secondary)
33.4- 36.0 GHz	Radiolocation
38.6- 40.5 GHz	Fixed-Satellite (Space-to-Earth)
39.5- 40.5 GHz	Mobile-Satellite (Space-to-Earth)
40.5- 42.5 GHz	Broadcasting-Satellite
45.5- 47.0 GHz	Radionavigation-Satellite

<u>68-115 GHz Band:</u>

66.0- 71.0 GHz	Mobile-Satellite and Radionavigation-Satellite
76.0- 81.0 GHz	Radiolocation
81.0- 84.0 GHz	Fixed-Satellite (Space-to-Earth) and Mobile-Satellite (Space-to-Earth)
84.0- 86.0 GHz	Broadcasting-Satellite
92.0- 95.0 GHz	Radiolocation
95.0-100.0 GHz	Mobile-Satellite and Radionavigation-Satellite
102.0-105.0 GHz	Fixed-Satellite (Space-to-Earth)

<u>130-183 GHz Band:</u>

126.0-134.0 GHz	Radiolocation
134.0-142.0 GHz	Mobile-Satellite and Radionavigation-Satellite
144.0-149.0 GHz	Radiolocation
149.0-164.0 GHz	Fixed-Satellite (Space-to-Earth)

<u>195-314 GHz Band:</u>

190.0-200.0 GHz	Mobile-Satellite and Radionavigation-Satellite
231.0-241.0 GHz	Fixed-Satellite (Space-to-Earth)
241.0-248.0 GHz	Radiolocation
262.0-265.0 GHz	Mobile-Satellite and Radionavigation-Satellite

In many cases these allocations are adjacent to those for radio astronomy As well, many observations of interest will fall outside the allocations for radio astronomy.

While observations in these allocations may be interfered with directly, of equal concern is that signals from licensed users in these allocations will be strong enough to cause gain compression in the mmA receivers or even to damage them. Both HEMT cryoFETs and SIS receivers will be used on the mmA. Generic models of both types of receivers are needed to evaluate their sensitivities to radio-frequency interference. The model of Thompson and Schlecht (1985) for a FET receiver such as used on the VLA or VLBA may be appropriate for the HEMT receivers to be used on the mmA but no model is available for the SIS receivers. Tests indicate that received powers of 1-10 W will damage HEMT receivers. My impression is that HEMT receivers are much less sensitive to gain compression and more robust to damage than are SIS receivers.

Strong signals at adjacent frequencies may create additional problems by generating intermodulation signals during the mixing process from RF to IF frequencies.

The requirements for filtering radio-frequency interference will interact with other requirements such as image suppression (Kerr 1991). Techniques for low-pass, high-pass, bandpass, and notch filters at millimeter wavelengths should be investigated. Cryogenically cooled filters will be used in the Lband receiver at the Fort Davis VLBA antenna; perhaps similar filters can be used with the HEMT receivers on the mmA.

Interference from signals in the IF is a familiar problem at existing mm- and submm-wavelength observatories. The band is 1-2 GHz is commonly used but Kerr (1991) discusses 2-3 GHz and 3-4 GHz and even 20-40 GHz. Unfortunately, licensed transmitters in those bands may be quite strong and/or airborne or on satellites. Some examples are

1215- 1400 MHz	Radiolocation
1530- 1559 MHz	Mobile-Satellite (Space-to-Earth)
2310- 2360 MHz	Digital Audio Broadcast (Sound) (proposed)
2500- 2690 MHz	Broadcasting-Satellite
3100- 3700 MHz	Radiolocation
3700- 4200 MHz	Fixed-Satellite (Space-to-Earth)
4500- 4800 MHz	Fixed-Satellite (Space-to-Earth)
5250- 5925 MHz	Radiolocation
10700-12200 MHz	Fixed-Satellite (Space-to-Earth)
12200-12700 MHz	Broadcasting-Satellite
17700-20200 MHz	Fixed-Satellite (Space-to-Earth)

Great care will be needed to reduce the potential for such interference

The South Baldy and Mauna Kea sites for the mmA are both quite exposed - South Baldy to Albuquerque, White Sands, and Las Cruces; Mauna Kea to Hilo, the Mauna Loa electronics site, and perhaps to Kona. South Baldy is currently occupied by radio facilities of the Langmuir Laboratory as well as a node of the Forest Service's microwave communication system (transmitting at 1796, 1839, and 1849 MHz). The Springerville site probably has a cleaner radio environment but, nonetheless, it and the Alpine site are surrounded or traversed by other Lband links in the Forest Service's system and by microwave links for AT&T and MCI. All sites are exposed to satellite-borne transmissions.

Kerr, A.R. 1991, "Image Frequency Suppression on the mmA," mmA Memorandum No. 70

Thompson, A.R., and Schlecht, E. 1985, "Dynamic Range and Interference Thresholds in the Front-End and IF Units," VLBA Electronics Memorandum No. 39.