RF Survey for the Magdalena Ridge Observatory Interferometer Site

Chethan Parameswariah, Colby Jurgenson

Magdalena Ridge Observatory, New Mexico Institute of Mining and Technology,
801 Leroy Place, Socorro, NM 87801.

ABSTRACT

Magdalena Ridge Observatory Interferometer (MROI) is a ten telescope optical interferometer array being built on the Magdalena Mountains 20 miles west of Socorro, New Mexico. A Radio Frequency (RF) survey in the 100 MHz to 3 GHz RF band has been conducted at the site of the interferometer array on the ridge. The RF site characterization plan is to conduct a pre-construction RF survey and document the existing RF background. A post-construction RF survey will also be conducted after installation and commissioning of the MROI to understand quantitatively any changes to the RF environment at the site. This paper describes the instrumentation and methods used for the RF survey and the results obtained to date. With Langmuir Laboratory for lightning research, MRO 2.4m Telescope co-located on the mountain and with the Very Large Array and the White Sands Missile Range facilities also near by; these data are presented as they may be useful for them and other facilities in future. The RF survey is also proposed as a useful tool to better design MROI facility with knowledge and understanding of the environment for RFI/EMC control and mitigation.

Keywords: site characterization, site survey, radio frequency, RF, MRO, MROI

1. INTRODUCTION

The Magdalena Ridge Observatory Interferometer - a 10-element optical and near-infrared model-independent imaging interferometer [1], due for first light in 2008, is being built on the Magdalena Mountains, about 45 minutes west of Socorro, NM at 10,500 feet. The interferometer is being designed by collaboration between New Mexico Institute of Mining and Technology and the University of Cambridge. The goal of this survey is to monitor and document the current RF levels in the 100 MHz to 3 GHz RF band at the center of the interferometer site before construction of the array facility. The results of this survey will also be useful to better design MROI facility with knowledge and understanding of the RF environment for RFI/EMC control and mitigation.

2. OBSERVATORY LOCATION

The Magdalena Ridge Observatory (MRO) is located in the Magdalena Mountains 20 miles west of Socorro, New Mexico. The facility will consist of two separate telescope systems: the MRO Single Telescope (MROST) will be a 2.4-meter fast-tracking telescope and the MRO Interferometer (MROI) will consist of 10 1.4-meter telescopes having baselines of up to 400 meters and working in the optical and near-infrared (NIR)(See Creech-Eakman et al. for details[1]). The MROST will be located at the northern end of Magdalena Ridge at an elevation of 10,600 feet (3,230 meters) and the MROI will be located approximately 3,000 feet south at an elevation of 10,450 feet (3,185 meters). Figure 1 is an aerial view of Magdalena Ridge looking northeast from an elevation of approximately 12,000 feet (3650 meters). The locations of the two telescopes are marked as MROST and MROI. The symbols “nw", “ne" and “sw" indicate the ends of the interferometer arms, while “MROI" is the location of the center of the array.

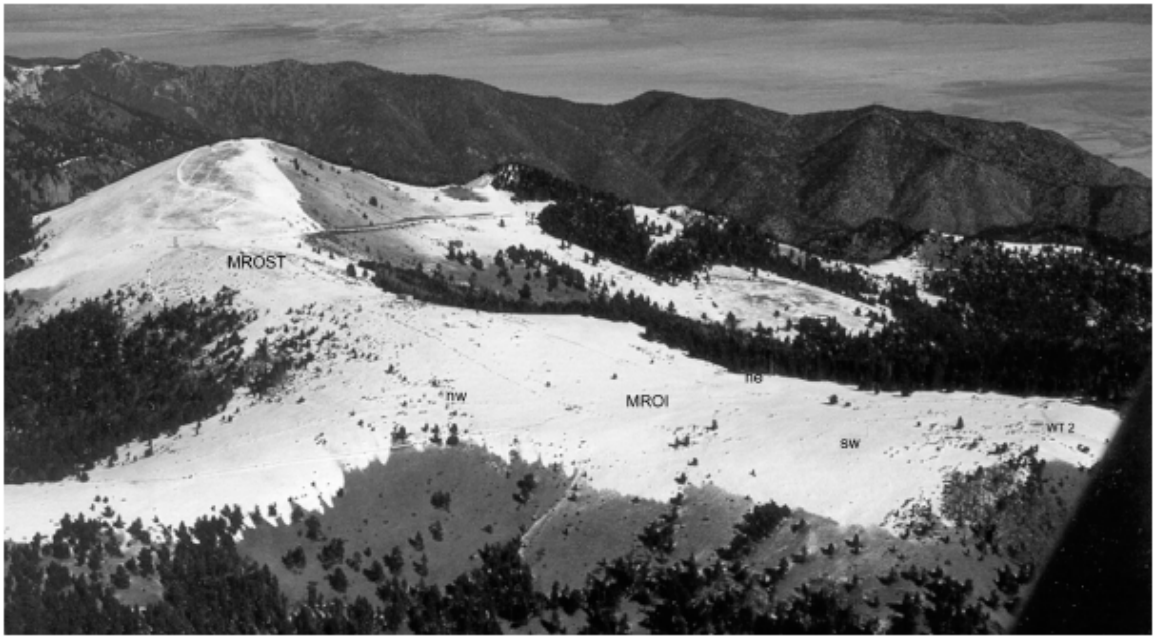

Figure 1: Aerial View of Magdalena Ridge Observatory site

3. INSTRUMENTATION

The RF survey setup consists of a directional rectangular horn antenna with a low noise pre-amplifier and filter connected to a battery-operated portable spectrum analyzer. Figure 2 shows the rectangular horn antenna with the low noise pre-amplifier. Figure 3 shows the Anritsu Site Master S332B spectrum analyzer which has a frequency range of 25MHz to 3300 MHz. We acknowledge and thank Dan Mertely of NRAO for providing us the RF survey setup.

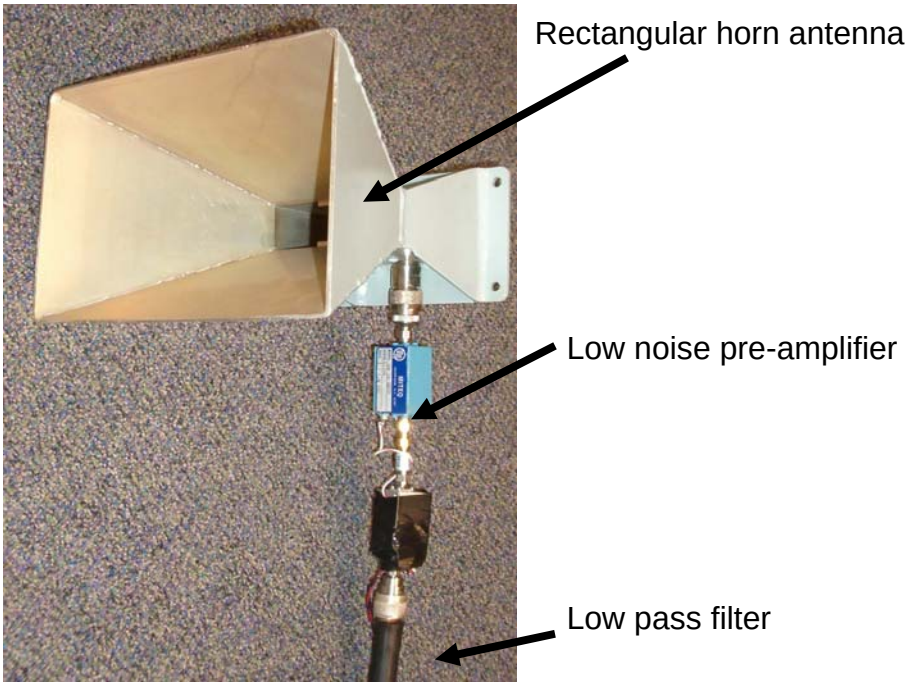

Figure 2: Horn antenna with a low noise pre-amplifier

Figure 3: Anritsu Site Master S332B

4. RF SURVEY PROCESS

The RF survey was conducted at the center of the interferometer site (GPS co-ordinates – 33.98^{o} N 107.19^{o} W) on top of Magdalena mountains. The RF survey was conducted at various times both during night and day during the months of September to November, 2005. The horn antenna was pointed at eight different directions – North (N), Northeast (NE), East (E), Southeast (SE), South (S), Southwest (SW), West (W) and Northwest (NW) during each survey. A spectrum analyzer was used to record the spectrum of RF radiation for each direction for a frequency range of 0.1 GHz to 3 GHz with a resolution bandwidth of 10 KHz. The setup was powered by a car battery. For each survey, the

spectrum analyzer was swept from 100 MHz to 3 GHz with the horn antenna pointing in each of the above eight directions for approximately half an hour.

The data stored in the spectrum analyzer is downloaded on to a computer using the Anritsu provided software. Data is collated and presented. Figures 5 through 12 show the spectrum analysis of the RF survey for each of the eight directions with a topological map of the interferometer site shown in the center. Each plot in the figure has 6 sets of data – the first three from the weeknight survey, the next two for the weekend nights and the last one for the weekday.

5. RF SURVEY ANALYSIS

Broadband noise -80 dB was found to be the noise limit of the spectrum analyzer used for the RF measurement setup. This was checked by shorting the input to the spectrum analyzer with an impedance matched load. Various spectral lines are seen in the plots some of which have been identified by a RF survey done by VLA at their site [2]. Sources for some of these spectral lines have been identified and listed in the VLA survey. The United States Radio Frequency allocation chart [3] can also be used to understand the source of the given spectral line and identify it. It is also interesting to note some of the spectral line frequencies are intermittent while others are continuous depending on the source.

Langmuir Lab for lightning research and 2.4m MRO Telescope are co-located on the ridge. Other facilities such as television and cell phone towers are located close-by on other mountain tops where as Very Large Array (VLA), White Sands Missile Range (WSMR), the Albuquerque airport are located in the plains. These are identified on the topographical map on figure 4.

Figure 4: Topo map of the MRO Interferometer location

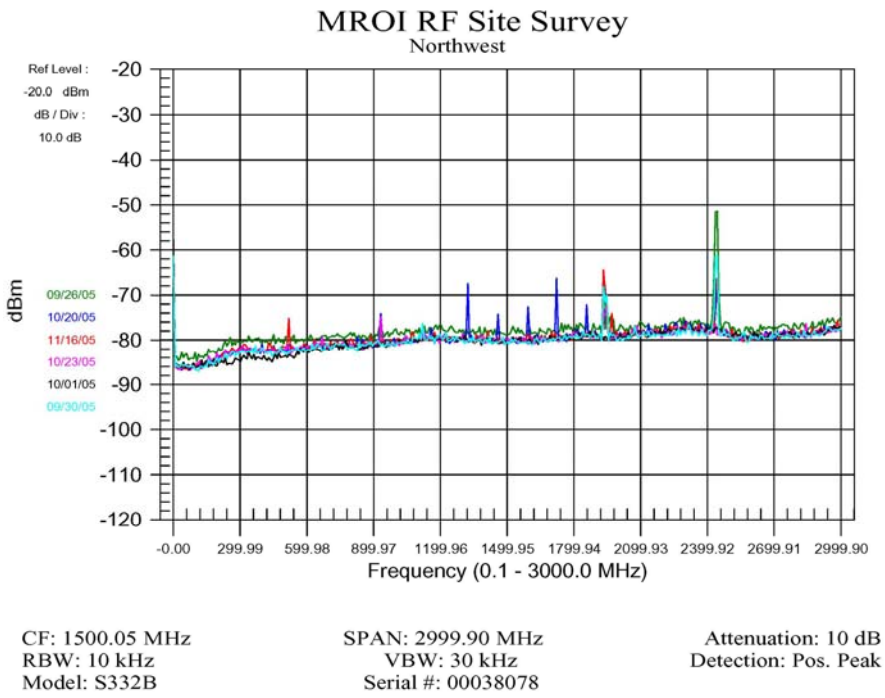

Figure 5: RF Survey with the horn antenna pointed in the Northwest direction with six sets of data.

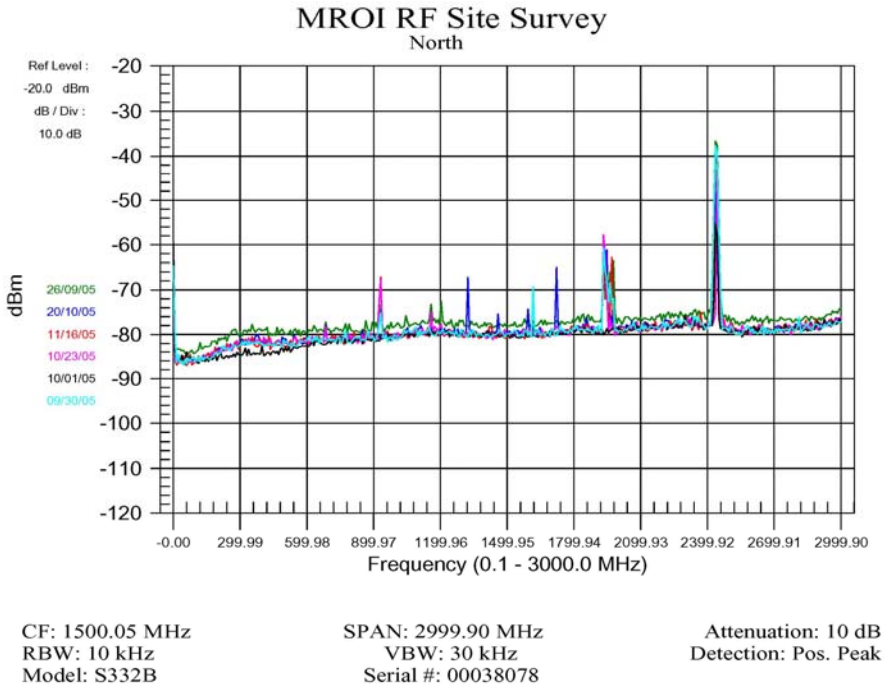

Figure 6: RF Survey with the horn antenna pointed in the North direction with six sets of data.

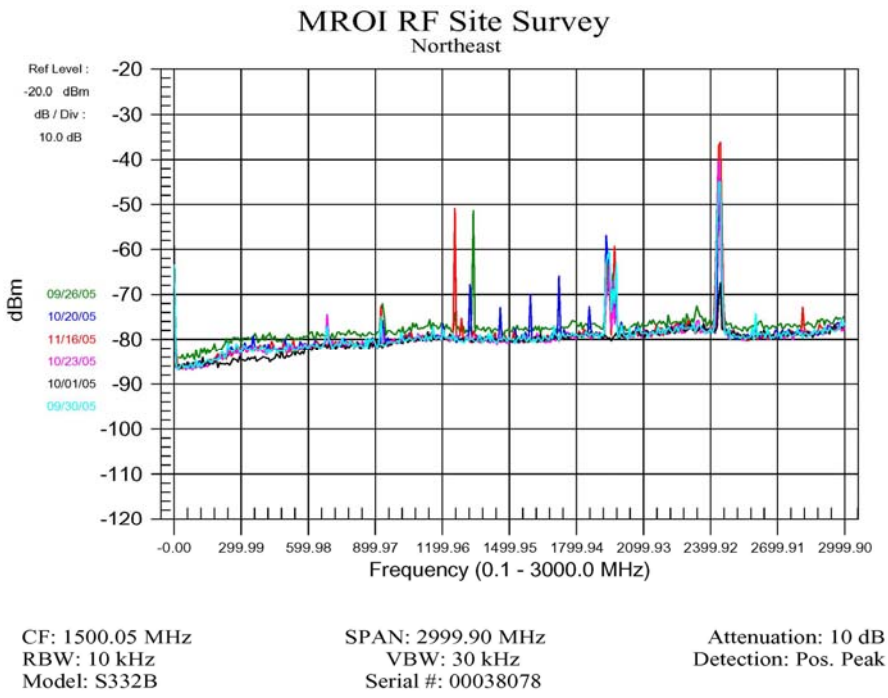

Figure 7: RF Survey with the horn antenna pointed in the Northeast direction with six sets of data.

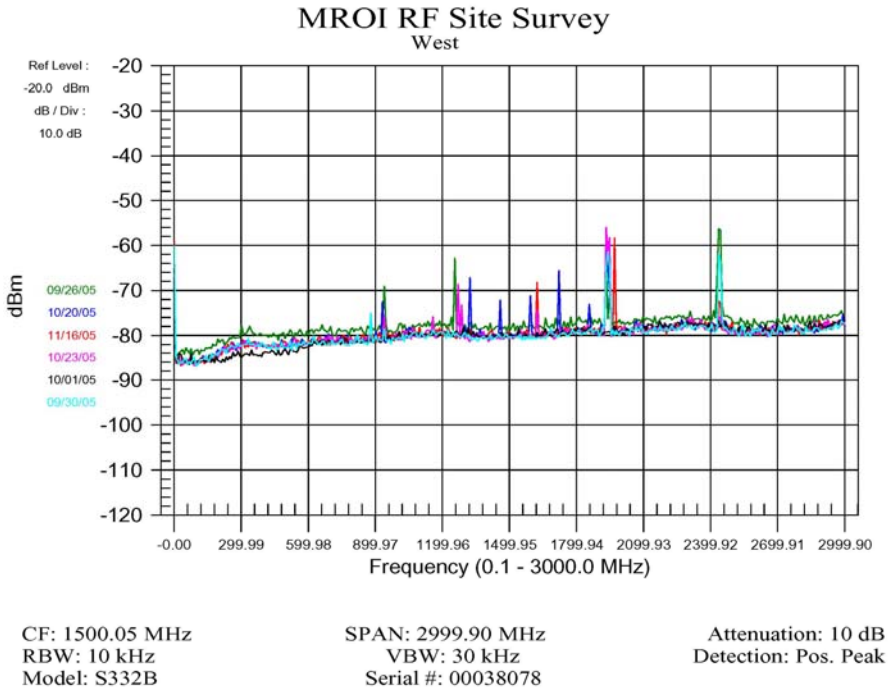

Figure 8: RF Survey with the horn antenna pointed in the West direction with six sets of data.

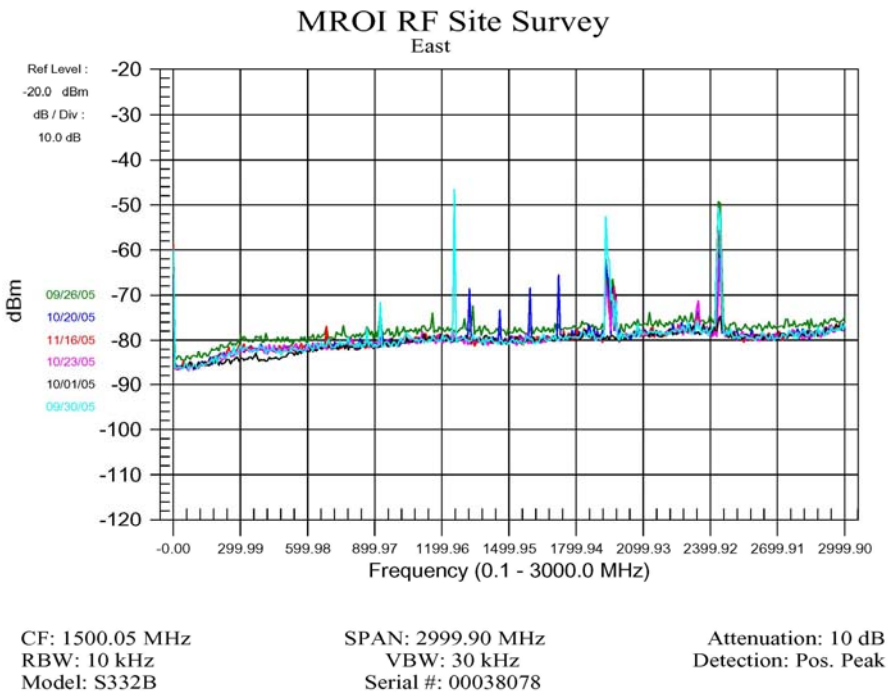

Figure 9: RF Survey with the horn antenna pointed in the East direction with six sets of data.

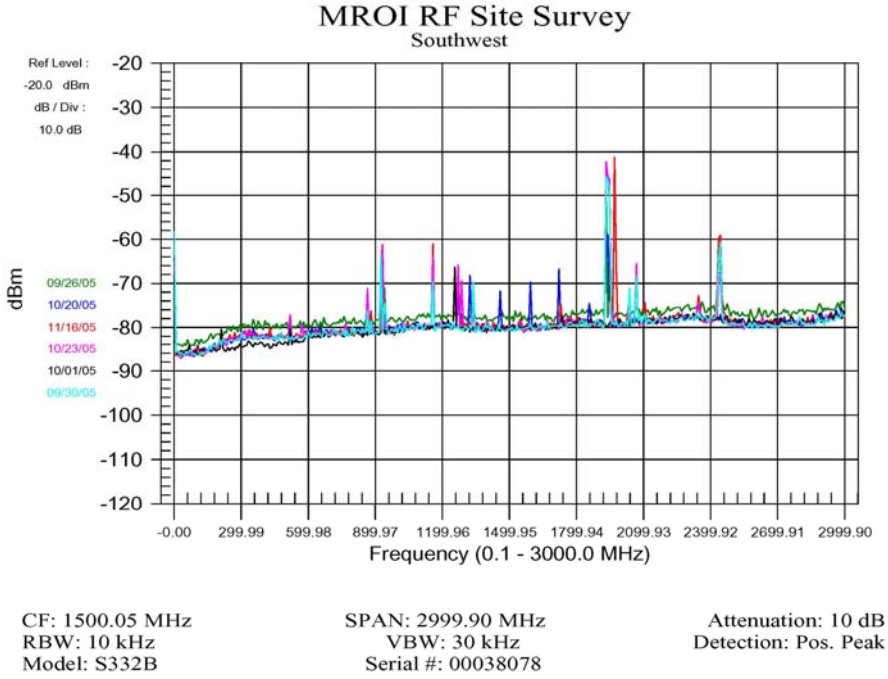

Figure 10: RF Survey with the horn antenna pointed in the Southwest direction with six sets of data.

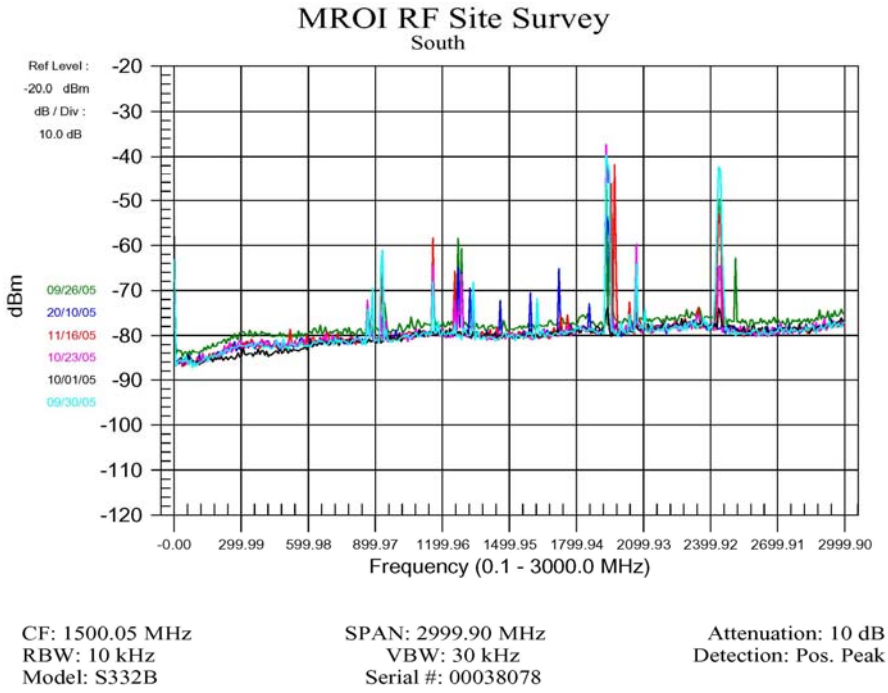

Figure 11: RF Survey with the horn antenna pointed in the South direction with six sets of data.

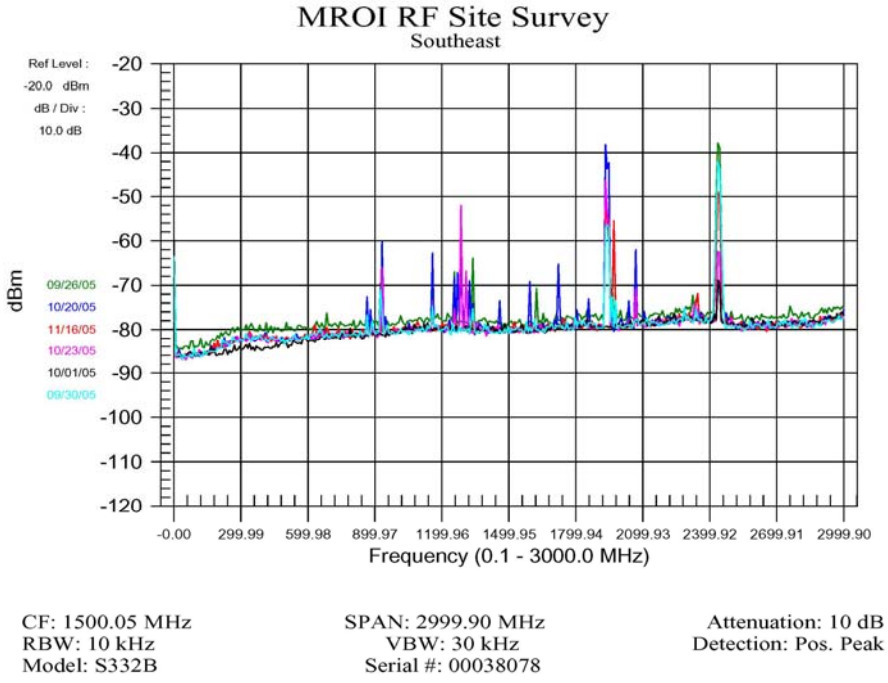

Figure 12: RF Survey with the horn antenna pointed in the Southeast direction with six sets of data.

The source of the 2.4 GHz line seen prominently on the plots is identified as local wireless link currently used for various inter-communications between different sites on

the ridge and between various instrumentation. Table 1 lists description and the location of source for some of the major continuous spectral lines seen on the plots. The last column indicates the continuous, intermittent or malfunctioning source.

Table 1: Description and location of source for some of the major continuous spectral lines seen on MRO Interferometer site

Description of RF Source	Place (State, Location)	Frequency (MHz)
Unknown (Mobile ?)	??	880 – 930
Unknown (Aeronautical Radio Navigation?)	??	1140
FAA ARSR4	??	1254.42
FAA ASR	NM, Albuquerque	1310
Unknown (Mobile ?)	??	1950
Wireless link	NM, Magdalena Ridge	2400

6. RF SURVEY OBSERVATIONS

The interferometer site is located in the valley on top of Magdalena mountains and is hidden from direct line of sight to various sources. Compared to the VLA site survey, the interferometer does not see as many spectral lines (for the current sensitivity of the RF setup).

The wireless link is a local source located on Magdalena mountain which contributes to the 2.4 GHz line. Current site infrastructure plans have fiber runs which will eventually remove the long wireless links on top of the mountain.

The RF environment at the interferometer site has only a small number of prominent continuous spectral lines which can be easily notched for RFI mitigation and hence the interferometer site provides a better RF environment.

7. ACKNOWLEDGEMENTS

Magdalena Ridge Observatory (MRO) is funded by Agreement No. N00173-01-2-C902 with the Naval Research Laboratory (NRL). MRO Interferometer is hosted by New Mexico Institute of Mining and Technology (NMT) at Socorro, NM, USA, in collaboration with the University of Cambridge (UK). We would also like to acknowledge the support of Dan Mertely at NRAO for the RF survey instrumentation setup.

8. REFERENCES

1) Magdalena Ridge Observatory Interferometer: status update, Michelle Creech-Eakman, et. al., *Paper No. 6268-70*, this conference.

2) List of identified RFI frequencies, *http://www.vla.nrao.edu/astro/rfi/rfifreqs.txt, 2004*

3) United States Frequency Allocations - The Radio Spectrum, *US Department of Commerce, National Telecommunications and Information Administration, Office of Spectrum Management, 2003*